Update to Touchstone Re Loss Estimates

Version 8.0 Technical Update

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Revision History

Date	Description
July 10, 2020	Original release
August 7, 2020	Component-level change figures for the AIR Earthquake Model for the Caribbean are revised to correct a labeling error.

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1 Executive Summary

AIR Inland Flood Model for the United States

The AIR Inland Flood Model for the United States has major enhancements in the 2020 release. The model includes greater continuity across flood sources, as both pluvial and fluvial flooding are physically modeled and use the same flood intensity metric. In addition, the model has a new, higher-resolution, digital terrain model (DTM), new precipitation catalog, four new secondary risk characteristics (SRCs), and new damage functions and secondary uncertainty distributions. The model includes an updated stochastic catalog and updated historical event set (9 new events). The model also supports new lines of business -- marine risks, builder's risk, and infrastructure assets.

AIR Hurricane Model for the United States

The AIR Hurricane Model for the United States includes a new module for precipitation-induced flood risk due to hurricanes in the 2020 release. All U.S. hurricane-related catalogs are updated to support this new sub-peril, and one new hurricane is added to the historical event set. The updated local intensity calculation includes precipitation-induced flood, and a precipitation-induced flood damage module is added to the model. Secondary risk characteristics (SRC) already in use in the storm surge module and in the AIR Inland Flood Model for the United States are enabled for the precipitation-induced flood module of the U.S. Hurricane Model. Three new SRCs are introduced for precipitation-induced flood and storm surge. The AIR Hurricane Model for the United States and the AIR Inland Flood Model for the United States support the same primary and secondary risk characteristics.

AIR U.S. Hurricane Model for Offshore Assets

The 2020 release of the AIR United States Hurricane Model for Offshore Assets includes updates to the market prices of oil and gas and updates to the Industry Exposure Database for Offshore Assets in the Gulf of Mexico (current as of October 2019), reflecting changes to the counts, locations, production, and replacement values of platforms and rigs in the Gulf of Mexico.

AIR Wildfire Model for the United States

The AIR Wildfire Model for the United States includes an expanded and enhanced stochastic catalog for the 2020 release. Events and fire intensities are no longer tied exclusively to the *AIR Industry Exposure Database for the United States*.

AIR Earthquake Model for the Caribbean

In the 2020 release, the AIR Earthquake Model for the Caribbean expands its model domain from 10 countries to 29 countries. The historical event set contains 39 newly supported events, and a new catalog of Extreme Disaster Scenarios (EDS) is introduced. The updated model supports two new sub-perils: tsunami and liquefaction. The local intensity calculation module uses an updated suite of GMPEs as well as new high-resolution soil maps. The damage estimation module adds explicit support for large industrial facilities, as well as support for infrastructure, builder's risk, and marine cargo, for a total of 23 new construction classes. Vulnerability zones have higher resolution, and vulnerability age bands are now developed by country. Damage functions for unknown characteristics are calculated at the CRESTA level, and secondary uncertainty distributions are updated.

AIR Tropical Cyclone Model for the Caribbean

The AIR Tropical Cyclone Model for the Caribbean incorporates lessons learned from significant events and damage in this region since the previous model release. Four tropical cyclones are added to the historical event set in the 2020 release and the stochastic catalog is updated. A new Extreme Disaster Scenario (EDS) catalog is introduced with three supported hurricane events. Local intensity calculations for wind are improved by calculating wind speeds at a 1-km resolution and then interpolating to individual exposure locations. The damage module updates vulnerability assumptions based on lessons learned from recent events, explicitly incorporating local building characteristics into the damage functions. Damage functions for unknown characteristics are calculated at the CRESTA level and are performed on-the-fly. Modeled losses are validated using loss data from recent events as well as losses from older events. Policy conditions are revised, and many additional construction classes are supported.

AIR Earthquake Model for Australia

The AIR Earthquake Model for Australia incorporates learnings from the 2018 National Seismic Hazard Assessment for Australia (NSHA18) from Geoscience Australia (GA) in the model's 2020 release. The historical catalog, stochastic catalog, and historical event set are all updated, and a new Extreme Disaster Scenarios (EDS) catalog is introduced. Local intensity calculation module enhancements include updates to soil maps, the site amplification model, the liquefaction model, as well as incorporation of the latest ground motion prediction equations (GMPE) for a stable continental region. Marine cargo and hull, builder's risk, and infrastructure are newly-supported lines of business. The updated model includes 83 new construction classes and four new occupancy classes.

AIR Multiple Peril Crop Insurance Model for China

The AIR Multiple Peril Crop Insurance Model for Mainland China is updated to include five new crop lines of business, new lines of business for livestock and poultry, a new heat sub-peril for crops, new weather and disease sub-perils for livestock and poultry, additional historical crop data, an updated stochastic catalog, updated policy conditions, and updated exposure data.

Industry Exposure Database Updates

The Industry Exposure Databases for the United States and the Caribbean are fully updated to reflect exposure counts and values, current as of the end of 2019. Policy conditions in the Industry Exposure Database for New Zealand are also updated in Touchstone Re 8.0.

AIR Typhoon Model for Mainland China

The AIR Typhoon Model for Mainland China now includes updated automobile damage functions for wind and flood.

2 The AIR Inland Flood Model for the United States

2.1 Overview of Model Updates and Changes

The AIR Inland Flood Model for the United States includes significant updates. These improvements are summarized below, and details are presented in the following sections.

- New, high-resolution (10-m) digital terrain model (DTM)
- Updated 10,000 year catalog – includes new events
- Historical event set – expanded from 11 to 20 events
- Revised precipitation catalog with better bias correction
- New, physically-based approach to pluvial (off-floodplain) modeling
- More extensive collection of flood hazard maps at a higher resolution
- Additional lines of business and construction/occupancy codes supported, consistent with the AIR Hurricane Model for the United States
- Expanded list of secondary risk characteristics (SRCs), consistent with the AIR Hurricane Model for the United States
- Updated damage functions and new damage distributions
- New/updated data sets

2.2 Catalogs and Event Sets

Stochastic Catalog

The model includes an updated 10,000-year stochastic catalog, which includes approximately 453,000 events.

All event IDs are new.

Historical Event Set

The updated historical event set includes 20 flood events. Nine events are **new**.

Table 1. Historical events available in the AIR Inland Flood Model for the United States

Year	Event Name
1993	Great Flood (Mississippi River)

Year	Event Name
1995	California Flood
1995	Gulf Coast Flood
1996-1997	Pacific Northwest Flood
1997	Red River Flood
1998	Texas Flood
2001	**Tropical Storm Alison**
2006	Northeast Flood
2008	Midwest Flood
2008	**Tropical Storm Fay**
2009	**East Florida Storm**
2010	Rhode Island Flood
2010	Tennessee Flood
2011	Mississippi River Flood
2011	**Tropical Storm Lee**
2013	**Florida Panhandle Storm**
2013	**Colorado Flood**
2015	**South Carolina Flood**
2016	**Louisiana Flood**
2017	**California Flood**

1. The Great Flood, 1993
2. California Flood, 1995
3. Gulf Coast Flooding, 1995
4. Pacific Northwest 1996-1997
5. Red River Flood, 1997
6. Texas Flood, 1998
7. Tropical Storm Allison, 2001
8. Northeast Flood, 2006
9. Midwest Flooding, 2008
10. Tropical Storm Fay, 2008
11. East Florida Storm, 2009
12. Rhode Island Flooding, 2010
13. Tennessee Flooding, 2010
14. Lower Mississippi River, 2011
15. Tropical Storm Lee, 2011
16. Florida Panhandle Storm, 2013
17. Colorado Flood, 2013
18. South Carolina Flood, 2015
19. Louisiana Flood, 2016
20. California Flood, 2017

Figure 1. Historical event set for the U.S. inland flood model

2.3 Hazard

The hazard module includes multiple updates to the precipitation, hydrological, and hydraulic models, including a new pluvial model. In addition, the model uses a new, higher-resolution digital terrain model (DTM) and several new or updated data sets, as listed below. With the updated DTM and new pluvial model, the on- and off-floodplain flooding hazard can be compared and the maximum hazard selected prior to damage estimation.

New or Updated Data Sets

- New DTM
  - Higher resolution - The DTM in the updated model has a resolution of 10 m. This is a significant improvement, as the DTM resolution in the previous version was 30 m.
  - Larger LiDAR coverage – The DTM in the updated model includes greater coverage of LiDAR-based elevation data. The updated DTM has 25% LiDAR coverage as compared to 15% in the previous model.
- The model incorporates new/updated data sets:
  - Precipitation data (observational data sets)
    - PRISM - historical precipitation data set
    - NOAA Atlas 14 – precipitation frequency
    - North American Land Data Assimilation System (NLDAS) – land surface model
  - The updated model incorporates six more years of hydrology and hydraulics data (up to 2017). The previous model used data up to 2011. Stream gauge rating data for the updated hydraulic model includes data from approximately 1,300 more gauges than the previous version, for a total of 5,800 gauges.
  - A newer vintage of land use / land cover (LULC) data is used in the updated model. The previous version was based on 2006 vintage and the updated model incorporates 2011 vintage LULC data.
  - Levees
    - The updated model includes approximately 40,000 km (25,000 mi) of levee information from the National Levee Database (NLD), and AIR derived an additional 6,400 km (4,000 mi) of levee data, from the high-resolution DTM. The previous model included about 23,000 km (14,500 mi) of levee information from NLD.
    -

Event Generation

The event generation component of the 2020 model includes a new precipitation catalog with improved statistical properties and precipitation climatology, updates to the hydrological model, and improvements to event definition.

Precipitation Catalog

The model includes an updated precipitation catalog, which incorporates new observational data sets, an updated spatial and temporal downscaling method, and a new process for bias correction and climatological adjustment.

Spatial and Temporal Downscaling of Coarse-resolution Precipitation

The updated model includes an improved process for spatial and temporal downscaling of coarse-resolution precipitation from the Weather Research and Forecasting (WRF) model. In addition to preserving the coherence in precipitation patterns, this method captures the anisotropy introduced by motions in the atmosphere (fronts, cyclones, waves) in the downscaling process. To do this, AIR developed a directional, multiresolution framework for the analysis and synthesis of anisotropic fields. The process consists of two steps. First, the coarse precipitation from the NWP output is analyzed in multiple directions to obtain the local anisotropy characteristics in terms of a unit ellipse at each grid cell (Figure 2). Then, a fine scale simulation is conducted by introducing spatially correlated noise that represents the average geo-statistical properties of precipitation fields and the local anisotropy.

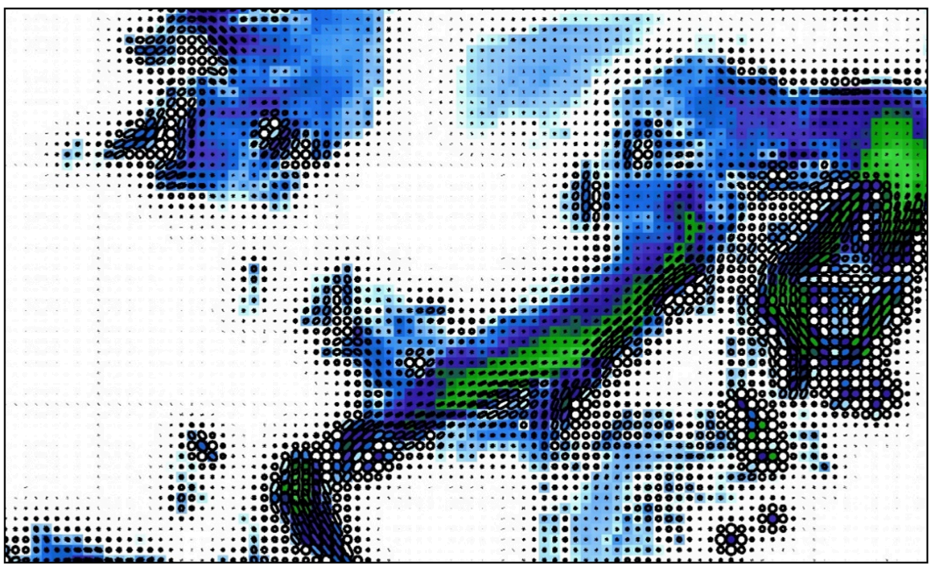


Figure 2. Example of data inferred local anisotropy and variance from coarse (64-km) weather research and forecasting (WRF) model precipitation
The ratio between ellipse axes measures the magnitude of local anisotropy. The axes are scaled by the standard deviation of local fluctuations.

Figure 3 illustrates a downscaled version of the coarse precipitation in Figure 2.

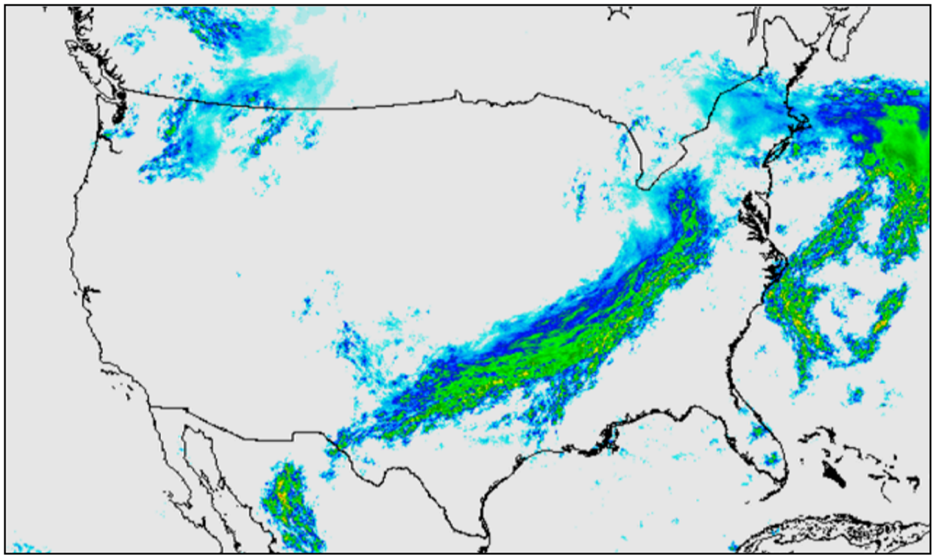


Figure 3. Example of downscaling 64-km WRF model precipitation output to 8-km resolution
Note the realistic radar-like, small-scale detail, elongated in a northeast direction along the cold front in the southern part of the country.

Precipitation Adjustment

The updated model includes a new method for bias correction, which involves adjusting the output for each grid cell to the local climatology. This adjustment addresses the entire precipitation distribution and its seasonal variation, including the proportion of wet spells, mean precipitation, and extreme accumulations at different recurrence intervals.

The AIR adjustment process consists of the following steps:

- Selection of a target dataset, which serves as a good representation of the near present climate
- Addressing the bias in the target dataset and building the climatology for each 8-km grid cell
- Quantile mapping to adjust the AIR precipitation catalog to the target dataset

AIR selected the PRISM precipitation dataset as a benchmark, or target dataset. To account for a bias in the dataset's extreme values, AIR researchers augmented the extreme values, modifying the tails of the PRISM daily precipitation distributions with those provided by NOAA on their Precipitation Frequency Data Server.[1] Figure 4 provides two examples of PRISM daily accumulation data blended with the NOAA Atlas partial duration series for return periods (years) $RP = \{1, 2, 5, 10, 25, 50, 100, 200, 500, 1000\}$ (Figure 4).

[1] https://hdsc.nws.noaa.gov/hdsc/pfds/.

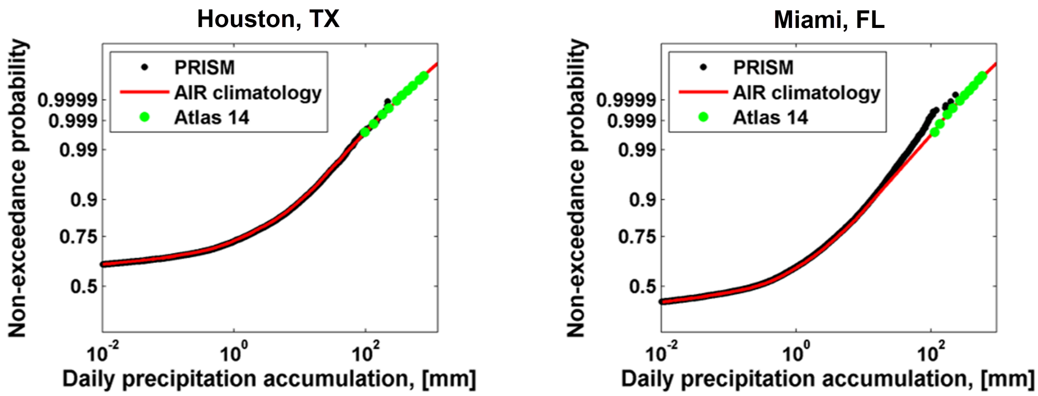


Figure 4. Examples of PRISM time series adjustment with the tails provided by NOAA Atlas 14
While the adjustment for Houston, TX is negligible, for Miami, FL, the adjustment of extreme values is substantial.

For the final step, AIR employed quantile mapping to adjust the precipitation catalog to the adjusted PRISM climatology. Quantile mapping is a frequently used approach in the natural sciences where a transformation – generally a non-linear one – is made from the distribution of a data source to a desired target distribution.

Figure 5 presents examples of quantile mapping (daily precipitation) for four locations in the United States. The figure shows the mapping between the initial values (i.e., the output from the downscaling) to the final climatology.

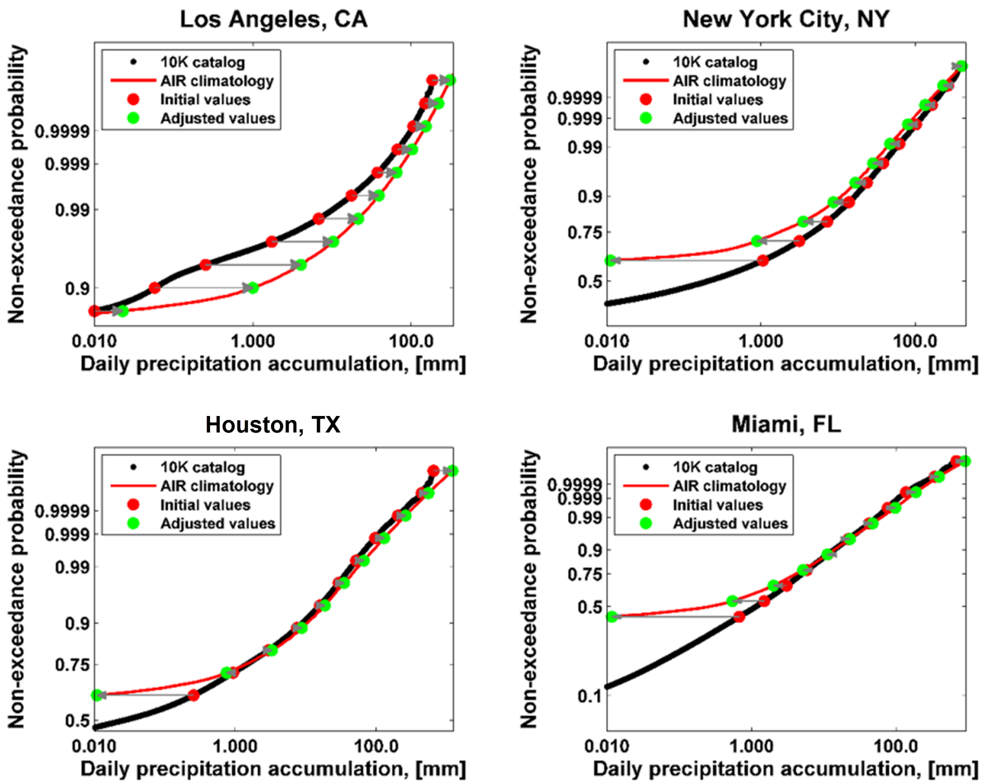


Figure 5. Examples of precipitation catalog quantile adjustment based on AIR climatology for four locations in the United States

Hydrological Model

The hydrological model includes a new method for reservoir modeling.

Reservoir Modeling

The updated model includes explicit modeling of over 21,000 lakes, dams, and reservoirs. For dams with sufficient historical storage state data, the updated model employs a machine learning-based reservoir model. The remaining dams are modeled by linear reservoir routing.

For the machine learning-based model, AIR selected 258 reservoirs, based on the availability of good storage state data for training the artificial neural network (ANN) model and model performance. A separate neural network model was trained for each reservoir. Figure 6 provides a schematic representation of the ANN model. Fully-connected feed forward networks were used to develop these models. The architecture of the network (i.e., the number of hidden layers and the neurons in each layer) was optimized for every reservoir separately but limited to a maximum of three hidden layers and nine neurons per layer due to computation limitations. Another measure AIR introduced was the inclusion of two months of precipitation beyond the current time step, which assumes reservoir operators will have information on precipitation forecasts and will be able to adjust the reservoir operations accordingly. This is suitable for stochastic simulation framework, as the future precipitation is readily available for any stochastic month.

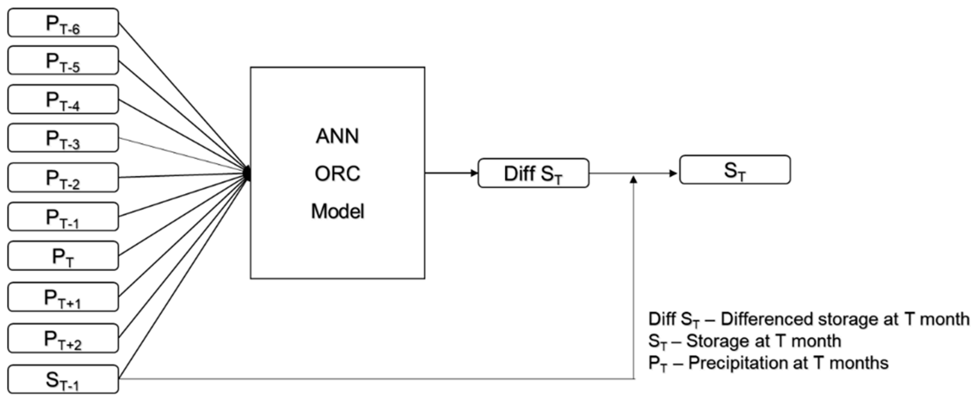


Figure 6. Artificial neural network model architecture
(Source: Gosh et al., 2019)

The previous version addressed all lakes and reservoirs with linear reservoir routing.

Event Definition

AIR has improved the event definition methodology to reflect the continuity of events and allow for events of slightly longer durations. As illustrated in Figure 7, the majority of the model's marquee events, or historical event set, exceeds 168 hours. This is due to prolonged rainfall or large river basins. In an effort to provide more realistic events, AIR has employed an iterative approach, which first groups precipitation events based on duration (168 hours) and distance (3,500 km) criteria. Then, events are merged according to their centroidal distance and temporal proximity.

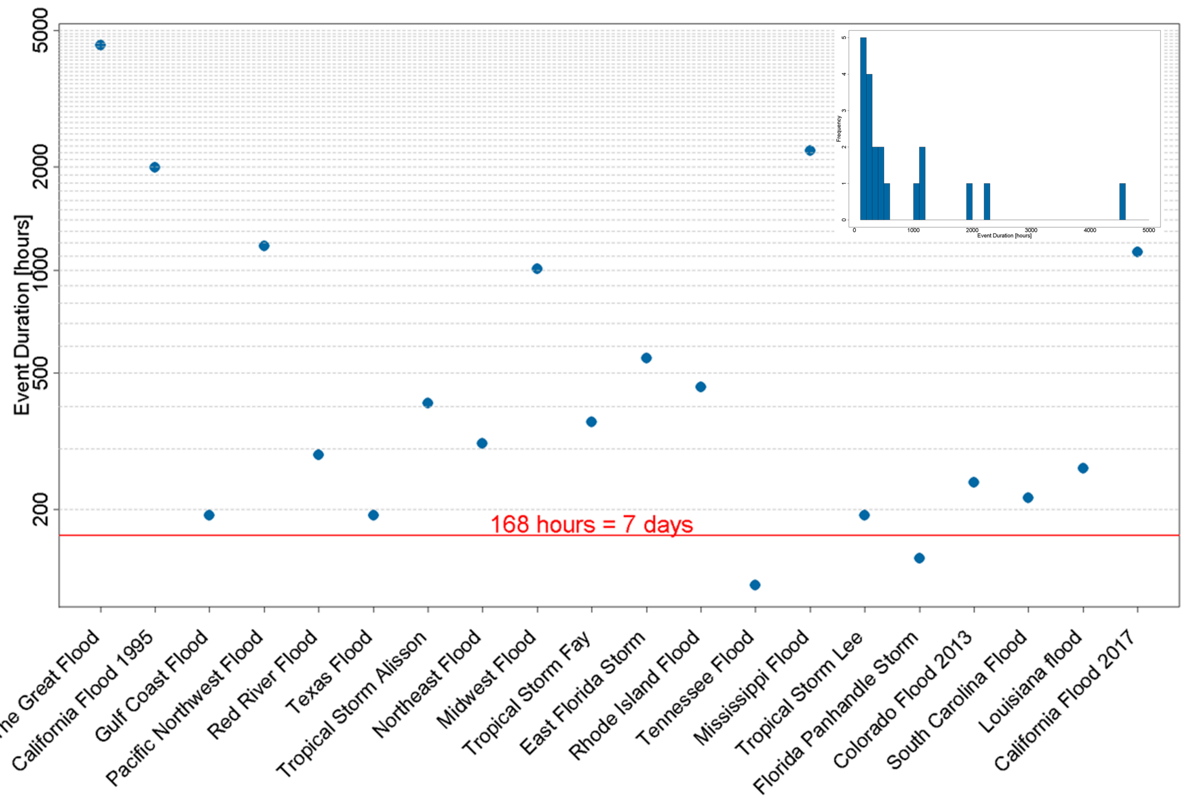


Figure 7. Event duration of 20 flood events available in the marquee catalog

In addition, the threshold for a flooding instance has increased from a 2-year return period to a 5-year return period. AIR raised the threshold to avoid attaching losses to very high frequency and low severity flood hazard instances.

Event definition in the previous version was also based on a period of 168 hours. However, the distance considered was shorter (3,300 km), and time and distance were measured simultaneously. The flood instance threshold was a 2-year return period.

Figure 8 provides a comparison of event characteristics in the updated and pervious models.

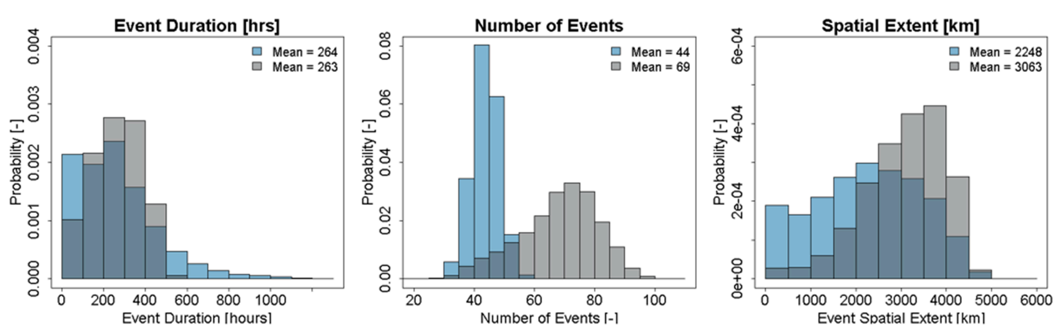


Figure 8. Comparison of events in current and previous version of the model
Gray = Previous version
Blue = Updated model

Local Intensity Calculation

The updated model includes several improvements to the local intensity calculation on- and off-floodplain. The new, higher resolution (10-m) DTM allows for more granular analysis, and AIR has applied comprehensive river channel corrections to the DTM for increased accuracy in hydraulic modeling. The model includes a new pluvial model, used to calculate inundation depths for off-floodplain locations and small catchments. The intensity parameter for both on- and off-floodplain locations is now consistent (inundation depth). In addition, the updated model includes more realistic flooding across catchment boundaries, an improved lower Mississippi River breach model, an enhanced flood defense failure module, and expanded flood hazard maps that now reflect a unified view of flood risk (on- and off-floodplain).

Pluvial Model

The new pluvial model is a physically-based, two-dimensional (2D) shallow-water wave model, which computes the temporal evolution of surface runoff depth over a fine grid in response to intense precipitation. Using precipitation intensity, the DTM, land use, and drainage capacity as input, this model dynamically simulates the flux (change in volume of water over time) and accumulation of water over each grid cell (Figure 9). The model calculates inundation depth directly for each affected grid cell, using the maximum 24-hour precipitation accumulation in a unit catchment. Like the new DTM, the pluvial model resolution is 10 m.

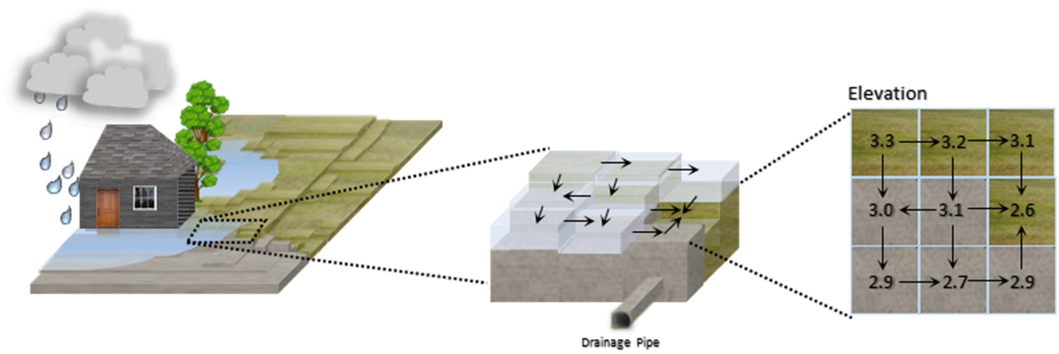


Figure 9. Schematic representation of the new 2D pluvial flood model
The different fill-types of grid cells signify different land use and roughness characteristics of the ground surface.

In addition to off-floodplain areas, the shallow-water wave model also models inundation depths along streams with cumulative catchment areas smaller than 500 km^2, to varying degrees.

The previous model employed a statistical model to evaluate off-floodplain locations, and extended the pluvial flood footprint to a much larger area, affecting a significantly greater number of exposures. The new, model, physically-based model confines the pluvial flood damage to a lesser extent along small rivers and creeks.

Flooding Across Catchment Boundaries

In the updated model, AIR has improved the modeled interaction between rivers and their tributaries to provide more realistic flooding across catchment boundaries. The previous version of the model included discontinuities and artifacts along catchment boundaries, due to differing standards of protection and flow return periods between large and small rivers. Improvements are illustrated in Figure 10.

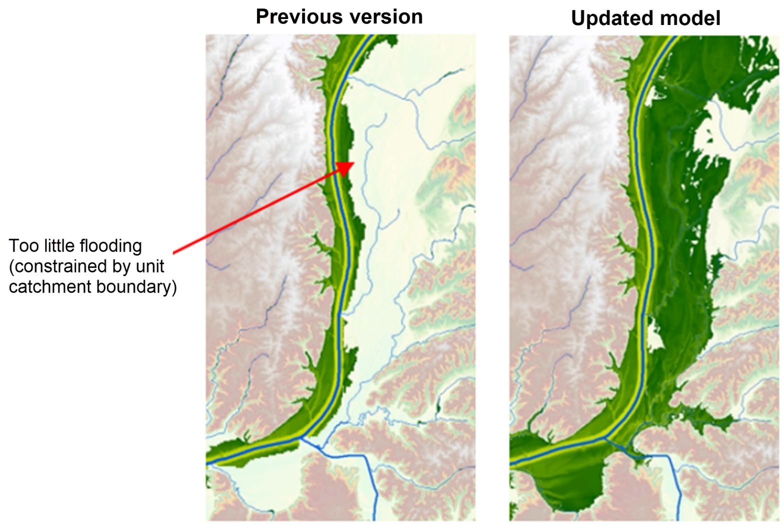


Figure 10. More realistic flood extents across catchment boundaries for a large river

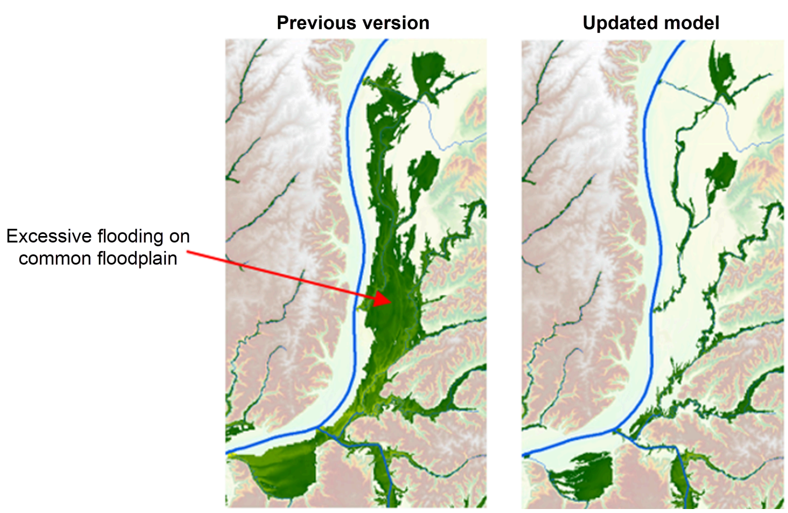


Figure 11. More realistic flood extents across catchment boundaries for a small river or tributary

Lower Mississippi River Breach Model

The updated AIR model includes an enhanced lower Mississippi River breach model, which simulates levee failure scenarios on selected breach points. For each point, the 2D, shallow-water wave model dynamically simulates the flood propagation resulting from a potential breach for several return period flows. The model estimates the flow hydrograph through the breach, based on the flow hydrograph in the river and the geometry of the levee breach. This robust approach is more effective in areas with complex conditions, particularly for wider, flatter floodplains, where water is more likely to flow out or spread in all horizontal directions.

In the previous version, the model simulated levee failure scenarios on incremental river stretches. For each stretch, the model determines the maximum hydrograph volume, derived from historical data, that would occur due to a levee breach.

Flood Defenses

In addition to a significant increase in levee data [from 23,000 km (14,500 mi) to 47,000 km (29,000 mi)], the updated model includes an enhanced flood defense failure module, which accounts for flood protection along river segments protected by means other than levees (e.g., deepening, channelization, paving/lining river channels, etc.). Flood defense fragility curves are not applied to river links with these features [approximately 127,000 km (79,000 mi) of rivers]. In these cases, the standard of protection is applied by increasing the channel capacity such that flooding does not occur below the flow with a return period corresponding to that standard of protection. The model uses exposure replacement values and exposure counts to estimate the standards of protection for stream links with potential flood protection through channelization measures. For areas protected from flooding using river channel modification, AIR uses modified rating curves to increase the main channel conveyance so that flows less than the estimated protection levels are contained in the main channel.

Figure 12 illustrates two example rating curves: a natural river section and the same river channelized to convey 25-year return period flow as simulated in the AIR model. The impact of the channelization on the river stage (or water level) decreases as the discharge increases.

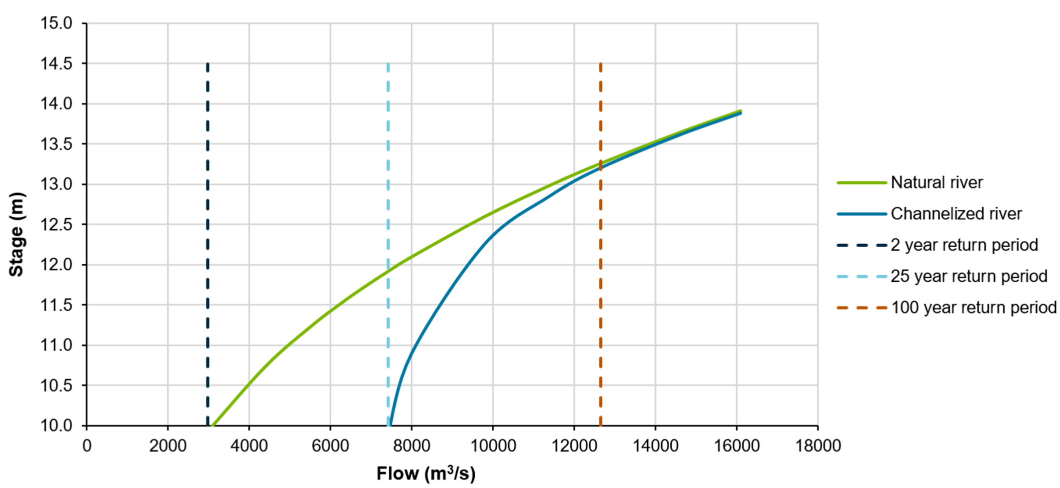


Figure 12. Rating curve for a natural river and a river channelized to carry 25-year return period flow

The significant increase in known levee information [from about 23,000 km (14,500 mi) to 40,000 km (25,000 mi)] led to an upward revision of the model's standard of protection (SOP) estimates for leveed river segments.

In the previous version of the model, all modeled river segments were treated using the same methodology as leveed links. This led to “jumps” in the rating curve when the flow corresponding to the SOP was exceeded. Realistically though, rating curves for non-leveed rivers should be continuous.

Flood Hazard Maps

The updated model includes an expanded set of flood hazard maps. Maps are now available for six return periods: 25, 50, 100, 200, 250, and 500 years. In addition, these maps are higher resolution (10-m) maps.

The previous version included lower resolution (30-m) maps for three return periods: 100, 250, and 500 years.

Impact of Hazard Updates on Modeled Losses

In general, updates to the model's hazard component reduce modeled losses.

The following actions/updates serve to avoid the overestimation of flood extents:

- AIR's extensive review of the new, high-resolution DTM along modeled rivers and subsequent hydro-corrections, to avoid undue floodwater back up.
- Hydraulic model calibration, which leveraged exposure locations

Additional updates contributing to a decrease in losses:

- By increasing the threshold for a flood instance (from 2- to 5-year return period), the model avoids attaching losses to the very high frequency and low severity events. This causes a significant reduction of low return period flooding instances at any given location, and a significant decrease in losses.
- The new physically-based off-floodplain model, confines pluvial flood damage to a smaller extent that adjoins small rivers and creeks. This results in a significant reduction in the overall off-floodplain footprint. The older statistical model extended the pluvial flood footprint to a much larger area, affecting a significantly greater number of exposures.
- The significant increase in known levee information led to an upward revision of the model's standard of protection (SOP) estimates. This revision, in part, reduced losses in some areas.

See Also
Hazard
Event Definition
Pluvial Model
Flood Defenses

2.4 Vulnerability

Improvements to the AIR Inland Flood Model for the United States include a substantial overhaul of the model's vulnerability component. These enhancements include the application of a component-based approach to building damage functions, a single set of damage functions that apply to both the on- and off-floodplain hazard, new damage distributions, updated vulnerability of large industrial facilities, improved methods for capturing spatial and temporal variation, and expanded coverage to new lines of business.

The new component-based approach enhances the vulnerability framework that AIR has implemented in the US Hurricane Storm Surge Model, where the vulnerability module incorporates high-resolution data from multiple organizations, including the US Census Bureau, the US Department of Energy, data from the National Flood Insurance Program (NFIP) of the Federal Emergency Management Agency (FEMA), RSMeans, and, significantly, information from AIR's parent company Verisk Analytics, including detailed building information from ProMetrix (formerly SPI), ISO, and replacement values from 360Value from Xactware.

Component-based Approach for Traditional Lines of Business

Like the previous version, the updated model's damage functions have been designed using a component-based approach. However, the updated model expands this approach and considers the building vulnerability function in terms of six key building components, plus clean-up and miscellaneous costs:

Foundation The foundation forms the part of the building that transmits the loads from the building to the ground below. The types of foundations used for residential buildings vary and may be in the form of a basement, crawlspace, slab, or others.

Structure This component includes all load-carrying structural parts of the building including the roof frame, structural envelope, and exterior walls.

Interior The interior component refers to interior walls (e.g., partition walls and drywall), flooring and floor coverings, and other interior finishes.

Mechanical Systems Mechanical systems typically constitute the heating, ventilation, and air conditioning (HVAC) systems, ducts, and elevators.

Electrical Systems The electrical systems component includes electrical switchboards, meters, distribution panels, switches, circuit

	breakers, and control and utilization systems such as lighting and wiring.
Plumbing Systems	Plumbing systems consist of water piping and sewage treatment and disposal systems, including septic tanks, bathroom drains, sinks, and interior pipes.
Clean-up and Miscellaneous	Clean-up and other activities associated with repair can add substantially to the replacement costs.

Figure 13 shows and example of the component-level damage functions and the overall building damage function for a one-story, single-family home of wood frame construction on a slab foundation. Water depth is measured from the floor level and not the ground level.

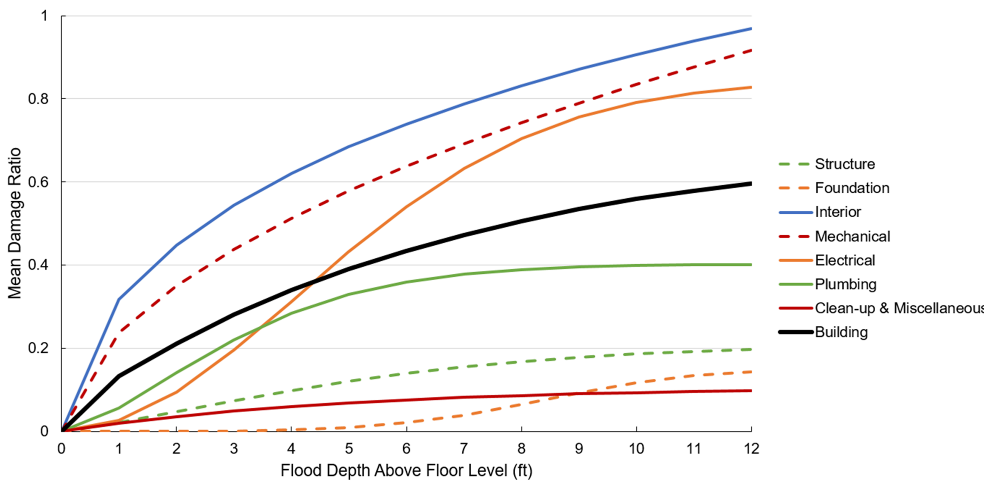


Figure 13. Overall building and component-level damage functions for a 1-story, single family home

The component level damage functions at each story level are aggregated to yield the corresponding building damage function. These are then aggregated across the stories of the building based on component cost breakdowns.

For a building with a basement, the damage functions accommodate basements with depths below 0 (ground level), with non-zero mean damage ratios (MDRs) at those depths.

The process of developing the component-level damage functions for buildings of different heights is presented in Figure 14. As illustrated, the functions are not a smooth curve; rather, they tend to be "lumpy" due to the variable rate at which damage increases over different flood depths. For example, even if only the lower portion of a wall has been affected by a flood, generally the entire wall will need to be re-plastered.

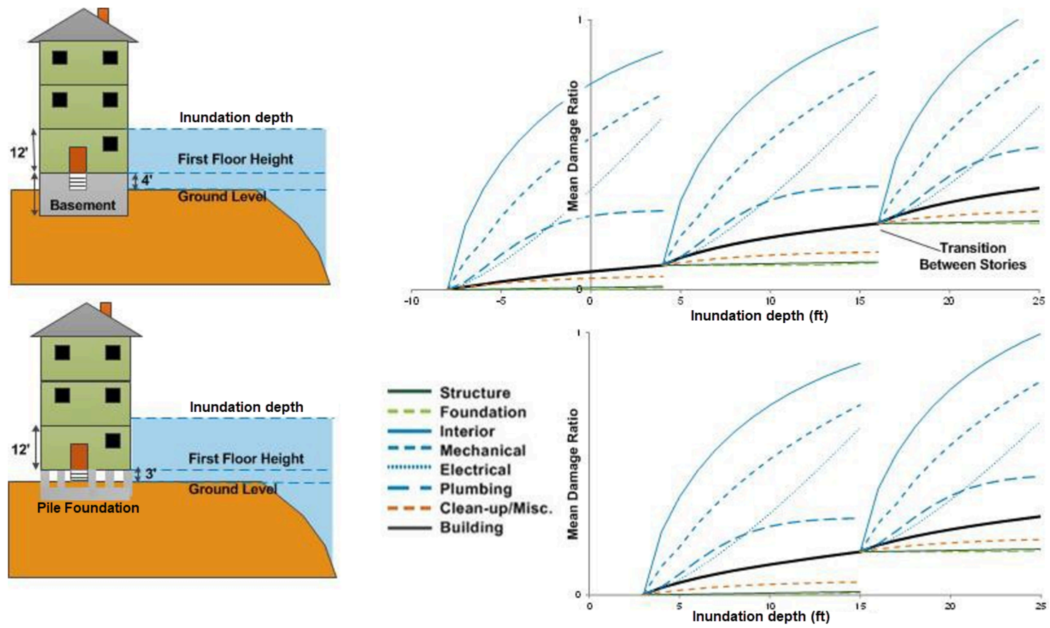


Figure 14. Component-level approach to developing flood damage functions for buildings, for a basement and pile foundation

When the representative building damage function is built with the component-level framework, AIR explicitly models secondary building features such as first floor height and impact of different foundation types, including the presence of a basement. In addition, other mitigation features are taken into consideration (e.g., engineered commercial and industrial buildings generally follow higher construction standards). The vulnerability framework is flexible and supports more than 13 secondary risk characteristics, allowing Touchstone users more than 50 options for different combinations to refine their risk assessment.

Although the benefits of having detailed building attributes cannot be overstated, when secondary risk characteristics are not available, the flood vulnerability calculations incorporate regional data to build damage functions. The secondary characteristics have been determined from an exhaustive study that accounts for variation in building code requirements, construction guidelines, and flood management practices by community and flood zone within each state.

Separate Damage Functions for Each Number of Stories

Building height is an important determinant of vulnerability as higher engineering attention is given to high-rise buildings, including better flood defenses. While precipitation flooding primarily affects the lower floors, significant portions of the electrical and mechanical fixtures for a high-rise building might be in the basement or ground floor, where they pose a greater loss potential.

The updated model features separate precipitation flood damage functions for each building story. However, the height categories for inland flood damage remain unchanged:

- Low-rise: 1 to 3 stories
- Mid-rise: 4 to 7 stories
- High-rise: 8+ stories

While there are separate damage functions for buildings of one, two, and three stories, these buildings are all considered low-rise buildings.

Contents Damage Functions

The updated model includes a new approach to contents damage. The contribution of building contents to the total damage to a building from flood can be considerable. Its severity depends on the flood depth, as different contents have different vulnerabilities depending on the inundation depth and the floor on which the contents are located. The vulnerability of contents varies by line of business, as this determines the engineering level of the building, often the location of contents, and the types of contents.

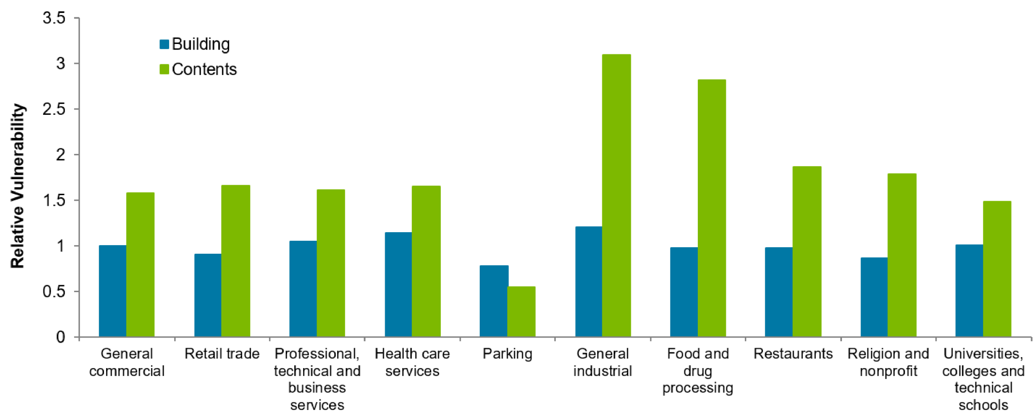


Figure 15. Relative vulnerability of building and contents for selected commercial occupancies

Like buildings, AIR contents damage functions are generated using a component-level approach, based on the cost distribution of contents within the floors of the building. Each component damage function is developed based on flood depth, measured from the floor level.

Regional and Temporal Variations in Precipitation Flooding Vulnerability

A distinguishing feature of the new vulnerability framework is the ability to explicitly capture the temporal and spatial variation by accounting for the year that typical flood management practices were enacted across the country. The year built serves as an effective proxy for the building characteristics, such as the distribution of foundation types and the associated first floor height.

Year Built Enhancements

In the United States, the adoption and enforcement of building codes and construction practices vary regionally. AIR has incorporated the years that flood mitigation regulations came into effect in different areas of the country in the new model, through a community-level Flood Insurance Rate Map (FIRM) adoption map (Figure 16).

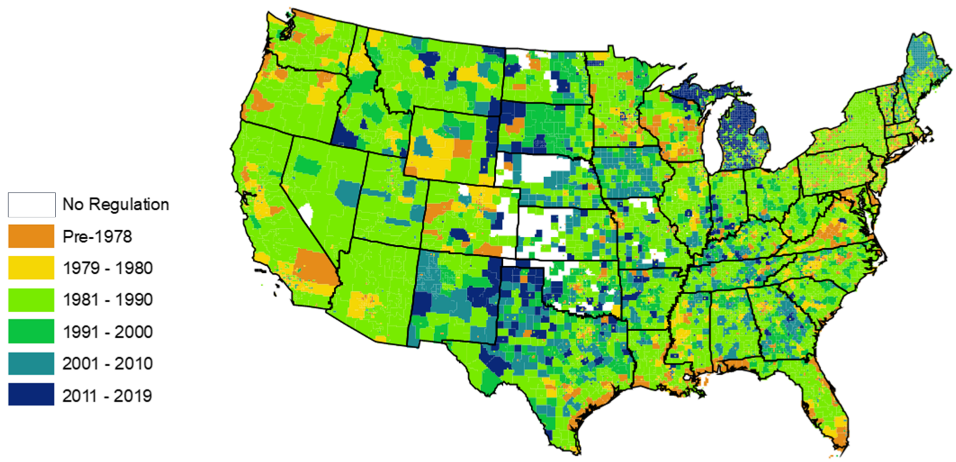


Figure 16. Community level FIRM enactment year, based on BCEGS® data and FEMA community data
BCEGS® is ISO's Building Code Effectiveness Schedule

Buildings constructed in communities after the enactment of these flood mitigation regulations are typically referred to as Post-FIRM structures. Current building codes, such as those published by the International Code Council (ICC), including the International Building Code (IBC) and the International Residential Code (IRC), and the flood standards they reference, such as the American Society of Civil Engineers (ASCE) Standard 24, all use the National Flood Insurance Program (NFIP) guidelines for construction in Special Flood Hazard Areas (SFHAs). These SFHAs are areas within the 100-year FEMA flood-zone, demarcated using FIRMs, and require minimum standards for the elevation of the lowest inhabitable floor, enclosures or openings in the foundation, and protection of mechanical or other service equipment. Indeed, flood mitigation enforcement varies even within a state (as seen in Figure 16) since enrollment in NFIP and following the flood protection guidelines is voluntary for communities living outside the SFHA.

Off-floodplain Vulnerability Model Enhancements

The off-floodplain, or pluvial, component of the model has been completely re-designed from a hazard and vulnerability perspective. Given that the new pluvial model is physically-based and provides flood depth hazard intensities, the model uses the same component-based framework to create all damage functions. Therefore, all the features mentioned above are valid for the pluvial loss calculation. In addition, all secondary risk characteristics are applicable for all losses attributed to precipitation flooding (on- and off-floodplain).

In the previous model, the off-floodplain damage functions were not related to flood depth. Instead, the model used a statistical model where the damage functions were related to excess runoff and relative elevation. Given the limitations of the statistical model, secondary modifiers (e.g., custom elevation, first floor height, base flood elevation, and custom flood protection) were not applicable to off-floodplain locations.

Automobile Damage Functions

The updated model considers two classifications of automobiles (personal and commercial), and accounts for the likelihood of flood warnings. Advanced flood warning can have a significant impact on vehicle losses; 100% of the loss can easily be avoided by moving the vehicle well away from the inundation area. The updated model takes this into consideration when determining the number of vehicles that are likely to be in a flooded area at the time of the event.

The updated model incorporates separate vulnerability functions for car dealerships (commercial). These damage functions recognize the amount of damage associated with large numbers of automobiles parked within a limited area. Following a flood warning, the evacuation of a personal vehicle is more feasible than commercial vehicles. This ease of movement is reflected in the damage functions (Figure 17).

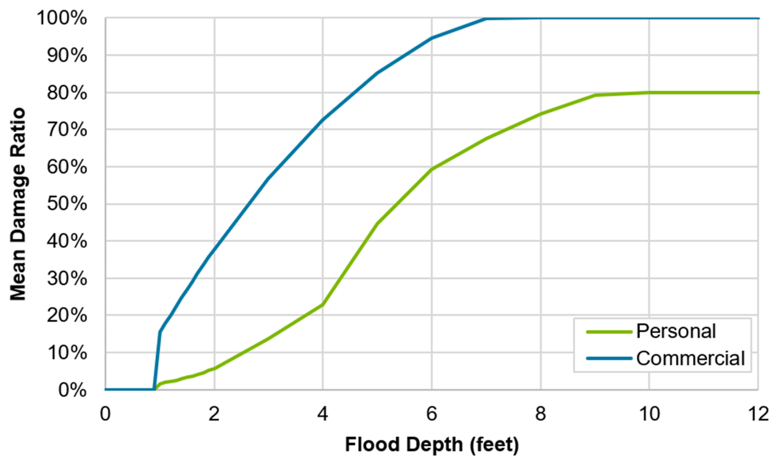


Figure 17. Damage functions for personal and commercial automobiles

The previous model addressed auto damage with a single damage function, and did not differentiate between the residential and commercial lines of business.

Supported Risk Types

The updated model supports an expanded list of risk types. In addition to residential, mobile home, commercial/industrial, auto, agriculture, and large industrial facilities, the model now supports:

- Builder's risk
- Infrastructure
- Marine risks

With this release, supported risks are now consistent with the AIR Hurricane Model for the United States.

Construction and Occupancy Codes

The updated model supports several new construction and occupancy codes.

Construction

- Infrastructure (200-series)
- Marine cargo (270-276)
- Marine inland transit warehouse (259)
- Marine hull (260)
- Pleasure boats and yachts (265-267)

Occupancy

- Builder's Risk (381-384)

In addition, the 100/300 construction/occupancy combination is explicitly modeled with a damage function. In the previous version, this combination was mapped to a commercial damage function.

Loss Calculation

The updated inland flood model uses the transformed beta family of distributions combined with empirically derived probabilities of 0% and 100% damage levels to model the uncertainty around the mean damage.

The previous version of the model employed an “inflated” beta distribution (a combination of beta and Bernoulli distributions).

Impact of Vulnerability Updates on Modeled Losses

Changes to the overall vulnerability assessment contribute to a general decrease in modeled losses in the updated model, relative to the existing model. The following updates contribute to a decrease in losses:

- New component-level damage functions for conventional lines of business, based on inundation depths, account for losses for both on- and off- floodplain hazard. The implementation of these new damage functions results in a significant reduction of low-depth intensities, which are modeled in the new physically-based pluvial model.
- New "unknown" damage functions provide details by state, FEMA flood zone, and year built. This granularity results in an overall better representation of flood secondary attributes and a more realistic view of flood vulnerability. The year built and flood zone enhancements led to a reduction of vulnerability for properties inside the FEMA A and V zones, where the new functions explicitly capture construction and mitigation practices described in flood regulations and building codes.

- Better protection for engineered buildings, resulting in less frequent flooding, due to:
    - Increased first floor height assumptions for commercial buildings
    - Implementation of minimum custom standard of protection levels for large industrial facilities

See Also
Component-based Approach for Traditional Lines of Business
Regional and Temporal Variations in Precipitation Flooding Vulnerability

2.5 Industry Exposure Database

The updated model uses the *AIR Industry Exposure Database for the United States*, available on the AIR Client Portal. Exposures in the databases are current as of the end of 2019.

AIR created a high-resolution industry exposure database (at 90-m resolution) to reflect the state of the private insurance market as it pertains to flood risk in the United States. While NFIP tends to be the insurer of choice when it comes to residential and small commercial risks, mid-market and large commercial/industrial risks continue to buy flood insurance through the well-established insurance marketplace, albeit with specialized policy terms. These attributes are captured in this newly developed industry exposure database, which is then used to create industry insured loss estimates across all available catalogs supported in Touchstone Re.

2.6 General Impact of Model Updates on Loss Estimates

To estimate the impact of model updates on loss estimates, AIR traditionally runs the model two ways to produce loss changes:

Overall change	New model + New industry exposure database v. Previous model + Previous industry exposure database
Change with constant exposure	New model + Previous industry exposure database v. Previous model + Previous industry exposure database

For this update, however, such loss analysis is not useful, due to the nature of the model updates and extreme differences in the two industry exposure databases. To gain a general understanding of how the model updates impact losses, AIR recommends reviewing the changes to modeled losses presented for the model in the *Update to Touchstone Loss Estimates Technical Update - 2020*, available on the AIR Client Portal, or contact your AIR representative.

See Also
Industry Exposure Database

3 The AIR Hurricane Model for the United States

3.1 Overview of Model Updates and Changes

The AIR Hurricane Model for the United States is updated in the 2020 release to include:

- New module for precipitation-induced flood risk due to hurricanes
- Support for precipitation-induced flood across all U.S. hurricane-related stochastic catalogs
- Addition of Hurricane Florence (2018) to the historical event set
- Explicit addition of precipitation-induced flood to the historical events listed in the **Catalogs and Event Sets** section below
- Event-level demand surge factor updates that reflect the values in the 2019 Industry Exposure Database for the United States
- Explicit modeling of flood vulnerability of large industrial facilities, including new secondary risk characteristics

3.2 Catalogs and Event Sets

Updates to the Historical Catalog

The historical catalog is updated to support the new precipitation-induced flood sub-peril. Precipitation-induced flood is explicitly added to the following historical events:

- Andrew (1992)
- Opal (1995)
- Fran (1996)
- Georges (1998)
- Floyd (1999)
- Frances (2004)
- Ivan (2004)
- Jeanne (2004)
- Katrina (2005)
- Wilma (2005)
- Ike (2008)

- Irene (2011)
- Sandy (2012)
- Harvey (2017)
- Florence (2018)

Hurricane Florence (2018) is added to the historical event set.

The following event ID's have changed:

Touchstone Re 7 ID	Touchstone Re 8 ID
112	113
113	114
114	115
115	116

Updates to the Stochastic Catalog

The summer 2020 release adds support for precipitation-induced flood to all events in the 10,000-year stochastic catalog by mapping unique and realistic spatio-temporal precipitation patterns onto the track of each hurricane. This new precipitation catalog more closely represents precipitation from hurricanes as well as from other weather systems.

The stochastic catalogs are unchanged from the previous version with respect to wind and storm surge hazard, the number of events, and event IDs.

3.3 Event Generation

The 2020 release of the model introduces a new precipitation-induced flood model that simulates the rainfall patterns of hurricanes. AIR created a new precipitation catalog that more closely resembles precipitation from hurricanes as well as from other weather systems. For a realistic view of the precipitation hazard as observed in nature, AIR blends its existing general circulation model (GCM) coupled to the numerical prediction model (NWP) with the new precipitation simulation and with the tracks from its existing U.S. Hurricane catalog. In each stochastic year, any ambient precipitation along a hurricane track is replaced by the simulated hurricane precipitation. The blending process is done smoothly so that there is no jump between the hurricane precipitation and the ambient precipitation.

Process Overview

The updated model employs the high-resolution Numerical Weather Prediction (NWP) simulations of the Weather Research and Forecasting model (WRF). The model simulates historical hurricanes that create precipitation when they make landfall in the model domain or brush the United States coastline. The stochastic model uses these simulations to analyze and produce realistic spatio-temporal patterns of precipitation for all stochastic tracks. The general process is as follows:

1. Employ a high-resolution ensemble to simulate each historical event that occurred between 1950 and 2017.
2. Simulate stochastic precipitation fields at different life-stages by learning from the historical ensemble.
3. Blend precipitation from all sources.

Employing a High-resolution Ensemble to Simulate Each Historical Event

Using the high-resolution capabilities of the WRF numerical weather prediction model, AIR simulated the precipitation of all historical hurricanes that impacted the United States between 1950 and 2017. For each historical hurricane that either bypassed or made landfall on the Atlantic coast or the Gulf of Mexico during those years, a set of high-resolution (9-km) WRF simulations was completed.

Ensemble modeling is a technique in which multiple versions of each historical hurricane are modeled, each version having slightly different initial and boundary conditions. AIR ran 25 versions of more than 120 historical hurricanes, using the 9-km simulations, to capture some of the uncertainty around the location and intensity (rainfall rates) of feeder bands and the intensity within each hurricane.

The ensemble modeling effort resulted in nearly 800,000 hours of numerically simulated hurricane precipitation. The results of the analysis served as the training set for machine learning algorithms that simulate precipitation along the stochastic tracks of the AIR Hurricane Model for the United States.

Staging and Simulating Stochastic Precipitation by Learning From the Historical Ensemble

The AIR model defines the following life-stages for all historical and stochastic tropical cyclone events:

- Genesis
- Maturity
- Dissipation--tropically or extratropical transition

The precipitation pattern of a storm can vary greatly from one life-stage to another. The model determines the transition between the stages by determining the time at which threshold values of various physical properties are reached.

The stochastic model learns from the historical events and then simulates patterns of hurricane precipitation along the stochastic tracks in AIR's U.S. hurricane stochastic catalogs. The model then makes precipitation pattern choices to match the defining features for different types of hurricanes, and for different stages within the same hurricane track at each moment in time. For the genesis stage, which is the first segment of each track, the nearest historical ensemble is chosen based on the physical distance between the track parameters.

Hourly precipitation is simulated along the entire track of each hurricane for each of the more than 200,000 hurricanes that make landfall on or closely bypass the East Coast of the United States or the Gulf of Mexico in the 100,000-year stochastic catalog.

The following figure shows an example event from the AIR U.S. hurricane stochastic catalog, its track according to intensity, and staging with the newly modeled precipitation field at landfall and after dissipation inland. In this figure, the left panel shows the event track from the stochastic catalog. The top right panel shows the modeled precipitation along this track right before landfall, at hour 50. The bottom right panel shows the modeled precipitation along this track when the storm has begun to dissipate and become weaker over land, at hour 68.

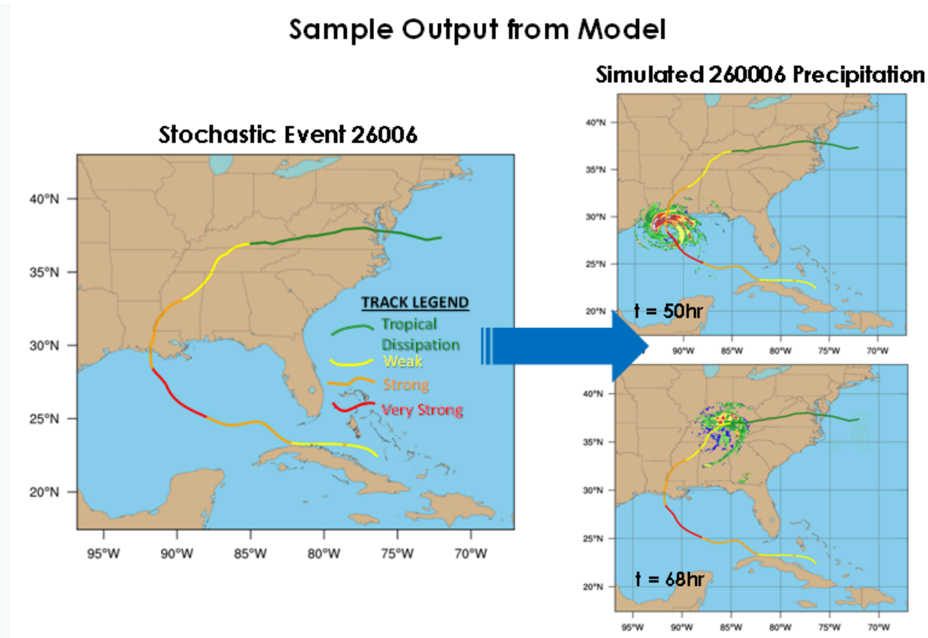


Figure 18. Example hurricane event track from the AIR U.S. hurricane stochastic catalog (left panel) and modeled precipitation along this track during the maturity and dissipation stages (right panels)

Blending Precipitation from All Sources

The final step in the process is blending the hurricane precipitation patterns into the non-hurricane precipitation catalog. In each stochastic year of the non-hurricane precipitation catalog, any precipitation along a hurricane track is replaced by the simulated hurricane precipitation. The blending process is done smoothly so that there is no jump between the hurricane precipitation and the ambient precipitation. The final product is a unified view of the precipitation hazard as observed in nature.

Impact of Event Generation Updates

The explicit addition of hurricane precipitation-induced flooding to the model increases the estimated losses due to the addition of a new sub-peril that was not included previously. Until recently, it was not possible to adequately simulate precipitation associated with tropical cyclones. The updated model more closely reflects the natural weather system and captures a more comprehensive view of the risk. The following figure shows the contribution of hurricane precipitation-induced flooding to the private market insured hurricane average annual loss (AAL) across all lines of business. Precipitation-induced flooding contributes only 3.6% to the loss, compared with 7.3% for storm surge and 89.1% for wind.

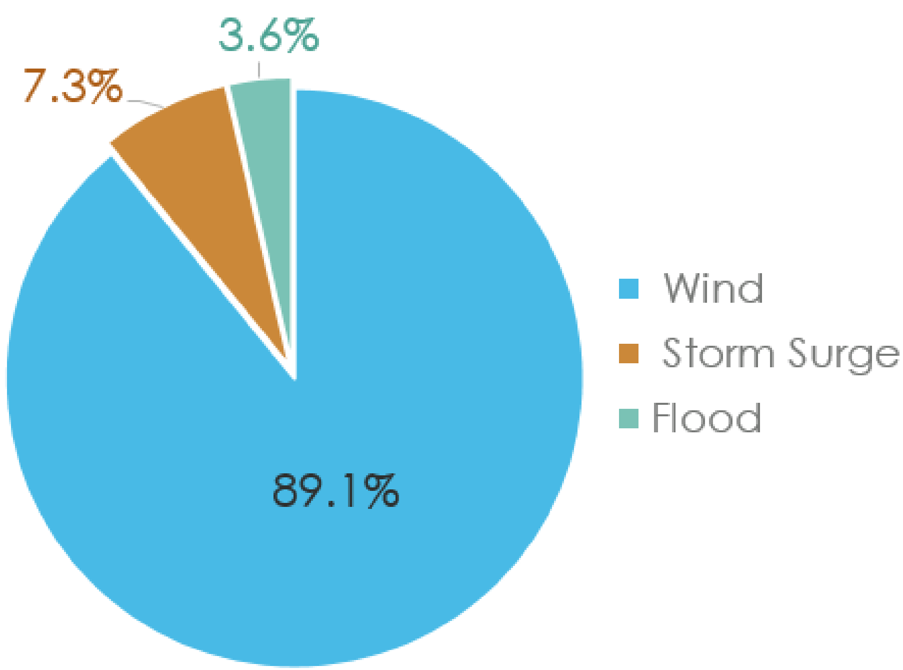


Figure 19. Impact of hurricane precipitation-induced flooding on the private market insured average annual loss

3.4 Local Intensity Calculation

Beginning in the summer 2020 release, the local intensity calculation includes precipitation-induced flood. Precipitation-induced flood intensity generation is identical to that of the AIR Inland Flood Model for the United States. The methodology for calculating wind and storm surge intensity remains unchanged.

3.5 Damage Estimation

The 2020 update to the AIR Hurricane Model for the United States adds a precipitation-induced flood damage module to the model. Damage functions that characterize precipitation-induced flood vulnerability are consistent with the storm surge module and with the precipitation-induced flood damage module of the AIR Inland Flood Model for the United States. Unknown damage functions for precipitation-induced flooding are state-specific. The resolution is consistent with the existing wind and storm surge unknown damage functions. All of the previously-supported risk types are now supported across all three modeled sub-perils:

- Wind
- Storm surge
- Precipitation-induced flood

Large industrial facilities (400-series AIR occupancy codes) now have enhanced storm surge vulnerability support in addition to the new support for precipitation-induced flood vulnerability. The model includes a new framework that accounts for the level of risk of individual facilities from a design standpoint, their locations, and their possible levels of protection.

Secondary risk characteristics (SRC) already in use in the AIR Hurricane Model for the United States storm surge module and in the AIR Inland Flood Model for the United States are enabled for the precipitation-induced flood module of the U.S. Hurricane Model. In addition, the updated model now features the following new SRCs for precipitation-induced flood and storm surge:

- **Wet Floodproofing**-- indicates the level of floodproofing at the location of interest: Unprotected, Low protection (to 1 ft elevation), Medium protection (to 3 ft elevation), or High protection (above 3 ft elevation).
- **FIRM compliance**--indicates whether or not the building's design and construction complies with FEMA flood zone requirements
- **Custom Flood Zone**--indicates the FEMA flood zone in which the building is located.

The model's view of wind vulnerability is unchanged. The model for storm surge vulnerability is also unchanged, except for large industrial facilities, as described above, and other minor enhancements.

Supported Lines of Business

The 2020 model supports the same construction and occupancy codes as the previous version of the model.

3.6 Industry Exposure Database

For wind and storm surge losses, the updated model uses the United States Industry Exposure Database that is fully updated and current as of end of year 2019. For precipitation-induced flood losses, the updated model uses only private market data, not National Flood Insurance Program (NFIP) data.

AIR created a new industry exposure database to estimate insured losses due to the newly-added sub-peril of precipitation-induced flooding. This industry exposure is at a 90-meter resolution. It uses inland flood-specific policy conditions and take-up rates that capture what is insured by the private insurance market (excluding the FEMA-instituted National Flood Insurance Program (NFIP).

The updates to the United States Industry Exposure Database include updates to the event-level demand surge factors for exposures in the United States.

3.7 Impact of Model Updates on Loss Estimates

The major enhancement to the AIR Hurricane Model for the United States in Touchstone Re 8.0 is the explicit addition of hurricane precipitation-induced flooding.

The supported stochastic catalogs in Touchstone Re 7.0 and Touchstone Re 8.0 are identical with respect to wind and surge hazard, the total number of events, and event IDs. Precipitation-induced flood hazard is evaluated for every event in the model's stochastic catalog.

There is no change to the wind vulnerability of supported risk types in the model. Large industrial facilities (400-series occupancy codes) have enhanced storm surge vulnerability support. The storm surge model also has other minor enhancements.

The impacts of adding precipitation-induced flood to the AIR Hurricane Model for the United States are different by region and by line of business. The impact on the residential side is minimal because the private insurance market has minimal penetration in residential lines of business; the FEMA-instituted National Flood Insurance Program (NFIP) is the predominant insurer in this space. AIR's industry view of insurable risk depicts the risk profile for the private insurance market and does not include NFIP. The same is true for the manufactured homes line of business, in which the impact of adding hurricane precipitation-induced flooding is negligible. However, for the commercial/industrial lines of business, the impact of adding precipitation induced flooding may be more pronounced. Although NFIP is the insurer of choice for small commercial lines, the private insurance market predominates for mid-market and large commercial/industrial buildings. Therefore, adding precipitation-induced flood might have a slightly greater impact. The impact of adding hurricane precipitation-induced flooding to the automobile line of business is also slightly greater than the impact on residential and manufactured homes.

The following figure shows the impact of adding precipitation-induced flood to the occurrence EP curve for all modeled states. It shows that the AAL for the private market changes from the previous model (wind and storm surge only) to the updated model (wind + storm surge + precipitation-induced flood) are less than 3%. For the other return periods, the losses change by less than 1%.

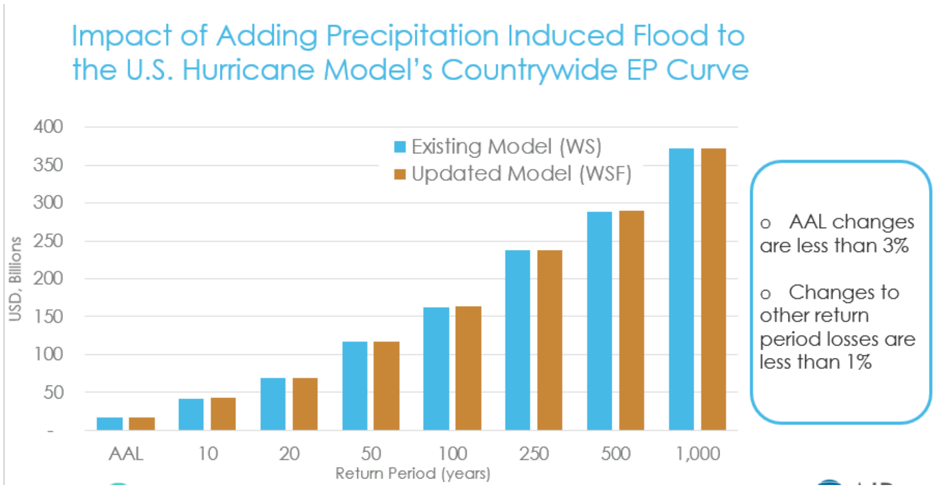
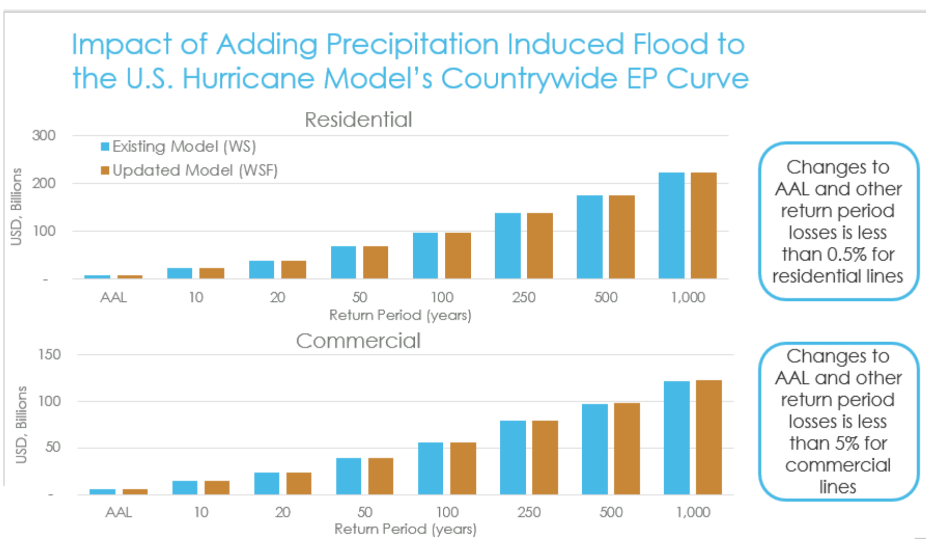


Figure 20. Impact of adding precipitation-Induced flood to the AIR Hurricane Model for the United States occurrence EP curve for the private market

The following figure shows the impact of adding precipitation-induced flood to the occurrence EP curve broken down by line of business. For residential properties, the addition of the precipitation-induced flood peril to the model results in less than 0.5% increase in the losses at each return period. For commercial properties, the losses increase by less than 5%.

Figure 21. Impact of adding precipitation-Induced flood to the AIR Hurricane Model for the United States EP curve for residential and commercial lines of business



General Impact of Model Updates on Loss Estimates

The following tables show the overall impact of the updates to the AIR Hurricane Model for the United States on gross insurable occurrence and aggregate losses. Loss changes represent the percentage change in loss estimates calculated byTouchstone Re 8.0 as compared with those calculated by version 7.0 for all modeled states combined, as well as by region. A second set of tables shows the impact of the updates with exposure held constant.

Note

The Touchstone Re 8.0 losses include losses due to the new precipitation-induced flood model in addition to the losses due to wind and storm surge. The precipitation-induced flood model is not present in Touchstone Re 7.0; the Touchstone Re 7.0 losses are due to wind and storm surge only. Therefore, the loss changes will appear higher than usual. The main driver of the loss changes is the addition of the precipitation-induced flood sub-peril to the model.

The regions are defined as follows:

Florida	
Texas	
Gulf States	Alabama, Louisiana, Mississippi
Southeast	Georgia, North Carolina, South Carolina
Mid-Atlantic	Delaware, Maryland, Pennsylvania, Virginia, Washington D.C.
Northeast	Connecticut, Massachusetts, Maine, New Hampshire, New Jersey, New York, Rhode Island, Vermont
Interior	Arkansas, Illinois, Indiana, Kentucky, Missouri, Ohio, Oklahoma, Tennessee, West Virginia

Touchstone Re settings used in the associated model runs are provided in the Analysis Settings section.

Note

Note that caution should be exercised before relating the industry changes shown here to a particular portfolio. The changes to individual books of business may deviate from the losses represented here to the extent that their spatial distribution and construction/ occupancy mix deviate from industry averages.

Percentage Overall Change in Insurable Occurrence Loss Estimates Using the 10K Standard Catalog

The following table shows the percentage overall change in gross insurable occurrence loss estimates using the 10,000-year Standard catalog. The losses due to wind, storm surge, and precipitation-induced flood are combined in Touchstone Re 8.0. The Touchstone Re 7.0 losses are due to a combination of wind and storm surge. The table compares (wind + 5% storm surge) using the 2019 Industry Exposure Database + private market (not National Flood Insurance Program) precipitation-induced flood data using Touchstone Re 8.0 against (wind + 5% storm surge) using the 2017 Industry Exposure Database and Touchstone Re 7.0. Demand surge is included.

Table 2. Percentage overall change in insurable occurrence loss estimates using the 10K Standard catalog

All Modeled States					
10K Standard Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Overall Change				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	11%	6%	13%	17%	11%
2% (50yr)	12%	7%	11%	11%	11%
1% (100yr)	14%	6%	10%	10%	11%
0.5% (200yr)	15%	6%	9%	9%	12%
0.4% (250yr)	13%	6%	9%	8%	9%
0.2% (500yr)	15%	7%	9%	6%	9%
0.1% (1000yr)	13%	7%	9%	7%	9%
Est AAL	12%	5%	17%	23%	13%

Gulf States					
10K Standard Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Overall Change				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	9%	1%	11%	10%	9%
2% (50yr)	10%	2%	9%	8%	8%
1% (100yr)	9%	2%	9%	4%	8%
0.5% (200yr)	8%	1%	9%	2%	7%
0.4% (250yr)	9%	0%	9%	3%	8%
0.2% (500yr)	8%	3%	9%	8%	7%
0.1% (1000yr)	8%	3%	8%	2%	8%
Est AAL	9%	1%	13%	13%	10%

Interior					
10K Standard Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Overall Change				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	12%	1%	389%	>500%	129%
2% (50yr)	13%	1%	170%	461%	49%
1% (100yr)	12%	2%	87%	355%	21%
0.5% (200yr)	12%	1%	86%	392%	22%
0.4% (250yr)	12%	0%	63%	346%	20%
0.2% (500yr)	13%	2%	31%	284%	13%
0.1% (1000yr)	11%	1%	31%	276%	11%
Est AAL	14%	1%	183%	>500%	68%

Mid-Atlantic					
10K Standard Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Overall Change				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	13%	-2%	138%	229%	54%
2% (50yr)	15%	-2%	72%	159%	22%
1% (100yr)	14%	0%	62%	151%	22%
0.5% (200yr)	13%	-2%	29%	127%	12%
0.4% (250yr)	16%	-3%	29%	118%	13%
0.2% (500yr)	13%	0%	14%	106%	13%
0.1% (1000yr)	14%	-1%	10%	105%	12%
Est AAL	14%	-1%	85%	197%	37%

Northeast					
10K Standard Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Overall Change				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	12%	2%	94%	162%	31%
2% (50yr)	10%	1%	26%	60%	13%
1% (100yr)	12%	2%	13%	45%	12%
0.5% (200yr)	11%	2%	10%	23%	10%
0.4% (250yr)	11%	2%	18%	23%	12%

Northeast					
10K Standard Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Overall Change				
	Residential	Manufactured Home	Commercial	Auto	Total
0.2% (500yr)	11%	2%	10%	16%	10%
0.1% (1000yr)	11%	1%	18%	7%	12%
Est AAL	12%	1%	35%	63%	20%

Southeast					
10K Standard Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Overall Change				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	18%	3%	11%	23%	14%
2% (50yr)	17%	3%	11%	15%	13%
1% (100yr)	18%	3%	11%	12%	13%
0.5% (200yr)	17%	2%	11%	10%	13%
0.4% (250yr)	19%	2%	10%	9%	12%
0.2% (500yr)	17%	2%	11%	7%	13%
0.1% (1000yr)	17%	3%	11%	13%	14%
Est AAL	17%	3%	16%	29%	15%

US - Florida					
10K Standard Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Overall Change				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	9%	9%	11%	11%	10%
2% (50yr)	11%	10%	10%	11%	13%
1% (100yr)	12%	8%	10%	8%	11%
0.5% (200yr)	10%	8%	8%	8%	12%
0.4% (250yr)	12%	9%	9%	8%	13%
0.2% (500yr)	10%	6%	9%	6%	8%
0.1% (1000yr)	15%	7%	7%	7%	12%
Est AAL	10%	8%	11%	11%	10%

US - Texas					
10K Standard Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Overall Change				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	20%	5%	46%	78%	28%
2% (50yr)	18%	5%	28%	83%	22%
1% (100yr)	18%	6%	18%	61%	19%
0.5% (200yr)	20%	6%	16%	54%	19%
0.4% (250yr)	18%	7%	14%	50%	18%
0.2% (500yr)	19%	6%	17%	26%	16%
0.1% (1000yr)	21%	6%	17%	16%	19%
Est AAL	19%	5%	30%	66%	24%

Percentage Change in Insurable Occurrence Loss Estimates Using the 10K Standard Catalog with Exposure Held Constant

The following table shows the percentage change in gross insurable occurrence loss estimates using the 10,000-year Standard catalog with exposure held constant. The losses due to wind, storm surge, and precipitation-induced flood are combined in Touchstone Re 8.0. The Touchstone Re 7.0 losses are due to a combination of wind and storm surge. The table compares (wind + 5% storm surge) using the 2017 Industry Exposure Database + private market (not National Flood Insurance Program) precipitation-induced flood data using Touchstone Re 8.0 against (wind + 5% storm surge) using the 2017 Industry Exposure Database and Touchstone Re 7.0. Demand surge is included.

Table 3. Percentage change in insurable occurrence loss estimates using the 10K Standard catalog with exposure held constant

All Modeled States					
10K Standard Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	-3%	3%	3%	11%	1%
2% (50yr)	-1%	4%	3%	4%	0%
1% (100yr)	-1%	3%	1%	4%	0%
0.5% (200yr)	-2%	3%	1%	2%	1%
0.4% (250yr)	-2%	2%	1%	3%	-2%
0.2% (500yr)	-2%	2%	1%	1%	-2%
0.1% (1000yr)	-1%	2%	0%	0%	-1%

All Modeled States					
10K Standard Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
Est AAL	-2%	2%	7%	17%	2%

Gulf States					
10K Standard Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	1%	0%	4%	9%	3%
2% (50yr)	0%	0%	2%	7%	1%
1% (100yr)	0%	1%	2%	4%	1%
0.5% (200yr)	0%	1%	2%	1%	1%
0.4% (250yr)	1%	0%	2%	1%	1%
0.2% (500yr)	0%	0%	2%	6%	1%
0.1% (1000yr)	0%	0%	1%	1%	1%
Est AAL	1%	0%	6%	12%	4%

Interior					
10K Standard Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	2%	0%	352%	>500%	114%
2% (50yr)	2%	0%	149%	457%	39%
1% (100yr)	1%	1%	74%	352%	11%
0.5% (200yr)	0%	0%	71%	388%	12%
0.4% (250yr)	2%	0%	51%	338%	9%
0.2% (500yr)	0%	0%	20%	269%	3%
0.1% (1000yr)	0%	0%	22%	276%	2%
Est AAL	3%	0%	161%	>500%	55%

Mid-Atlantic					
10K Standard Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	2%	0%	118%	222%	42%
2% (50yr)	3%	0%	58%	154%	12%
1% (100yr)	1%	2%	49%	146%	11%
0.5% (200yr)	0%	1%	18%	123%	2%
0.4% (250yr)	4%	-1%	19%	114%	2%
0.2% (500yr)	1%	0%	5%	103%	2%
0.1% (1000yr)	2%	0%	2%	103%	2%
Est AAL	3%	0%	70%	191%	25%

Northeast					
10K Standard Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	1%	0%	79%	156%	21%
2% (50yr)	0%	0%	16%	56%	4%
1% (100yr)	2%	1%	5%	41%	2%
0.5% (200yr)	0%	1%	2%	20%	1%
0.4% (250yr)	0%	1%	9%	21%	2%
0.2% (500yr)	1%	1%	2%	13%	1%
0.1% (1000yr)	0%	0%	10%	4%	1%
Est AAL	1%	0%	24%	58%	10%

Southeast					
10K Standard Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	2%	1%	2%	17%	2%
2% (50yr)	1%	1%	2%	10%	2%
1% (100yr)	1%	1%	1%	7%	2%
0.5% (200yr)	1%	1%	2%	4%	1%
0.4% (250yr)	0%	0%	1%	4%	0%

Southeast					
10K Standard Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
0.2% (500yr)	0%	1%	3%	3%	1%
0.1% (1000yr)	0%	1%	1%	4%	1%
Est AAL	1%	1%	7%	23%	3%

US - Florida					
10K Standard Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	-5%	4%	2%	4%	-1%
2% (50yr)	-3%	5%	1%	4%	0%
1% (100yr)	-4%	3%	1%	2%	0%
0.5% (200yr)	-4%	3%	0%	1%	-1%
0.4% (250yr)	-4%	5%	1%	1%	0%
0.2% (500yr)	-4%	2%	0%	0%	-2%
0.1% (1000yr)	-2%	2%	0%	0%	-1%
Est AAL	-4%	3%	2%	4%	-1%

US - Texas					
10K Standard Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	2%	2%	30%	68%	12%
2% (50yr)	2%	1%	14%	72%	7%
1% (100yr)	1%	2%	5%	50%	4%
0.5% (200yr)	1%	1%	3%	44%	3%
0.4% (250yr)	1%	2%	2%	43%	3%
0.2% (500yr)	1%	1%	4%	18%	1%
0.1% (1000yr)	1%	1%	4%	8%	2%
Est AAL	2%	1%	16%	56%	8%

Percentage Overall Change in Insurable Occurrence Loss Estimates Using the 10K WSST Catalog

The following table shows the percentage overall change in gross insurable occurrence loss estimates using the 10,000-year Warm Sea Surface Temperature (WSST) catalog. The Touchstone Re 8.0 losses are due to the combination of wind, storm surge, and precipitation-induced flood. The Touchstone Re 7.0 losses are due to a combination of wind and storm surge. The table compares (wind + 5% storm surge) using the 2019 Industry Exposure Database + private market precipitation-induced flood data using Touchstone Re 8.0 against (wind + 5% storm surge) using the 2017 Industry Exposure Database and Touchstone Re 7.0.Demand surge is included.

Table 4. Percentage overall change in insurable occurrence loss estimates using the 10K WSST catalog

All Modeled States					
10K WSST Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	**Overall Change**				
	Residential	**Manufactured Home**	**Commercial**	**Auto**	**Total**
5% (20yr)	10%	6%	13%	17%	11%
2% (50yr)	14%	6%	11%	10%	12%
1% (100yr)	12%	7%	10%	8%	12%
0.5% (200yr)	12%	5%	9%	8%	9%
0.4% (250yr)	10%	6%	10%	6%	10%
0.2% (500yr)	12%	7%	8%	6%	11%
0.1% (1000yr)	11%	7%	8%	7%	12%
Est AAL	12%	5%	17%	22%	13%

Gulf States					
10K WSST Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	**Overall Change**				
	Residential	**Manufactured Home**	**Commercial**	**Auto**	**Total**
5% (20yr)	8%	2%	10%	8%	10%
2% (50yr)	7%	1%	10%	6%	9%
1% (100yr)	9%	2%	10%	6%	8%
0.5% (200yr)	7%	0%	9%	5%	8%
0.4% (250yr)	7%	3%	10%	3%	8%
0.2% (500yr)	8%	0%	10%	5%	9%
0.1% (1000yr)	8%	0%	9%	3%	8%
Est AAL	9%	1%	13%	13%	10%

Interior					
10K WSST Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Overall Change				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	11%	2%	288%	>500%	95%
2% (50yr)	11%	1%	134%	369%	41%
1% (100yr)	13%	1%	75%	309%	24%
0.5% (200yr)	10%	2%	47%	268%	15%
0.4% (250yr)	10%	1%	39%	262%	18%
0.2% (500yr)	12%	1%	15%	214%	10%
0.1% (1000yr)	12%	2%	9%	205%	10%
Est AAL	13%	1%	151%	493%	57%

Mid-Atlantic					
10K WSST Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Overall Change				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	16%	-2%	132%	209%	42%
2% (50yr)	13%	-1%	60%	176%	23%
1% (100yr)	12%	-2%	60%	134%	20%
0.5% (200yr)	13%	0%	28%	112%	14%
0.4% (250yr)	13%	-3%	19%	104%	13%
0.2% (500yr)	14%	-2%	20%	100%	12%
0.1% (1000yr)	11%	0%	12%	73%	14%
Est AAL	14%	-1%	84%	196%	37%

Northeast					
10K WSST Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Overall Change				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	10%	2%	94%	186%	30%
2% (50yr)	10%	1%	24%	68%	13%
1% (100yr)	13%	2%	14%	47%	14%
0.5% (200yr)	11%	2%	10%	28%	10%
0.4% (250yr)	11%	2%	18%	32%	12%

Northeast					
10K WSST Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Overall Change				
	Residential	Manufactured Home	Commercial	Auto	Total
0.2% (500yr)	11%	2%	10%	20%	10%
0.1% (1000yr)	11%	1%	18%	9%	12%
Est AAL	12%	1%	39%	74%	22%

Southeast					
10K WSST Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Overall Change				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	18%	3%	13%	17%	14%
2% (50yr)	17%	4%	11%	11%	14%
1% (100yr)	17%	4%	11%	12%	11%
0.5% (200yr)	17%	3%	11%	10%	14%
0.4% (250yr)	17%	4%	11%	11%	15%
0.2% (500yr)	18%	2%	9%	10%	14%
0.1% (1000yr)	16%	5%	10%	9%	14%
Est AAL	17%	3%	15%	25%	14%

US - Florida					
10K WSST Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Overall Change				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	11%	9%	10%	10%	10%
2% (50yr)	10%	9%	9%	9%	11%
1% (100yr)	12%	8%	12%	10%	11%
0.5% (200yr)	12%	8%	9%	8%	11%
0.4% (250yr)	13%	8%	10%	7%	9%
0.2% (500yr)	13%	7%	8%	7%	10%
0.1% (1000yr)	12%	7%	8%	6%	11%
Est AAL	10%	8%	11%	11%	10%

US - Texas					
10K WSST Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Overall Change				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	19%	6%	42%	88%	27%
2% (50yr)	19%	6%	26%	79%	19%
1% (100yr)	21%	6%	19%	61%	20%
0.5% (200yr)	20%	7%	15%	53%	19%
0.4% (250yr)	21%	6%	21%	46%	16%
0.2% (500yr)	15%	5%	15%	27%	18%
0.1% (1000yr)	19%	5%	15%	16%	19%
Est AAL	19%	5%	30%	64%	24%

Percentage Change in Insurable Occurrence Loss Estimates Using the 10K WSST Catalog with Exposure Held Constant

The following table shows the percentage change in gross insurable occurrence loss estimates using the 10,000-year WSST catalog, with exposure held constant. The losses due to wind, storm surge, and precipitation-induced flood are combined in Touchstone Re 8.0. The Touchstone Re 7.0 losses are due to a combination of wind and storm surge. The table compares (wind + 5% storm surge) using the 2017 Industry Exposure Database + private market (not National Flood Insurance Program) precipitation-induced flood data using Touchstone Re 8.0 against (wind + 5% storm surge) using the 2017 Industry Exposure Database and Touchstone Re 7.0. Demand surge is included.

Table 5. Percentage change in insurable occurrence loss estimates using the 10K WSST catalog with exposure held constant

All Modeled States					
10K WSST Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	-2%	2%	3%	12%	0%
2% (50yr)	-1%	2%	2%	4%	0%
1% (100yr)	-2%	4%	2%	2%	1%
0.5% (200yr)	-2%	1%	1%	1%	-1%
0.4% (250yr)	-3%	2%	0%	2%	0%
0.2% (500yr)	-1%	2%	0%	1%	-2%
0.1% (1000yr)	-3%	3%	0%	1%	-1%

All Modeled States					
10K WSST Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
Est AAL	-2%	2%	7%	17%	2%

Gulf States					
10K WSST Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	0%	1%	4%	7%	4%
2% (50yr)	0%	1%	3%	5%	2%
1% (100yr)	0%	0%	3%	4%	2%
0.5% (200yr)	0%	0%	2%	3%	1%
0.4% (250yr)	0%	0%	3%	1%	2%
0.2% (500yr)	0%	0%	4%	3%	3%
0.1% (1000yr)	0%	0%	3%	2%	1%
Est AAL	0%	0%	6%	12%	3%

Interior					
10K WSST Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	1%	1%	258%	>500%	83%
2% (50yr)	1%	1%	116%	357%	30%
1% (100yr)	2%	0%	63%	296%	14%
0.5% (200yr)	0%	1%	36%	264%	6%
0.4% (250yr)	0%	0%	28%	258%	9%
0.2% (500yr)	0%	0%	7%	205%	1%
0.1% (1000yr)	0%	1%	2%	208%	0%
Est AAL	2%	0%	131%	482%	45%

Mid-Atlantic					
10K WSST Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	3%	0%	113%	203%	31%
2% (50yr)	2%	1%	47%	170%	14%
1% (100yr)	0%	0%	47%	130%	10%
0.5% (200yr)	2%	0%	18%	107%	4%
0.4% (250yr)	2%	0%	9%	101%	3%
0.2% (500yr)	2%	0%	10%	98%	2%
0.1% (1000yr)	1%	1%	3%	72%	4%
Est AAL	3%	0%	69%	190%	25%

Northeast					
10K WSST Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	0%	0%	80%	180%	19%
2% (50yr)	0%	0%	15%	63%	3%
1% (100yr)	3%	2%	5%	43%	3%
0.5% (200yr)	0%	1%	2%	24%	1%
0.4% (250yr)	0%	1%	9%	29%	2%
0.2% (500yr)	1%	1%	2%	16%	1%
0.1% (1000yr)	0%	0%	10%	6%	1%
Est AAL	1%	0%	28%	69%	11%

Southeast					
10K WSST Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	1%	1%	4%	12%	3%
2% (50yr)	0%	2%	2%	6%	2%
1% (100yr)	1%	1%	3%	7%	1%
0.5% (200yr)	1%	1%	2%	3%	1%
0.4% (250yr)	1%	1%	3%	6%	1%

Southeast					
10K WSST Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
0.2% (500yr)	2%	1%	1%	5%	1%
0.1% (1000yr)	0%	1%	2%	5%	2%
Est AAL	1%	1%	6%	19%	3%

US - Florida					
10K WSST Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	-4%	4%	2%	4%	-1%
2% (50yr)	-3%	4%	1%	3%	-1%
1% (100yr)	-4%	4%	1%	1%	-1%
0.5% (200yr)	-4%	4%	1%	1%	-2%
0.4% (250yr)	-2%	4%	1%	0%	-2%
0.2% (500yr)	-3%	2%	0%	0%	-2%
0.1% (1000yr)	-2%	2%	0%	0%	-2%
Est AAL	-4%	3%	2%	4%	-1%

US - Texas					
10K WSST Catalog - Insurable Occurrence					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	2%	2%	26%	76%	11%
2% (50yr)	1%	2%	12%	69%	4%
1% (100yr)	2%	1%	6%	51%	3%
0.5% (200yr)	1%	2%	3%	44%	2%
0.4% (250yr)	2%	1%	8%	39%	1%
0.2% (500yr)	-1%	1%	2%	19%	2%
0.1% (1000yr)	0%	0%	2%	8%	1%
Est AAL	2%	1%	16%	55%	8%

Percentage Overall Change in Insurable Aggregate Loss Estimates Using the 10K Standard Catalog

The following table shows the percentage change in gross insurable aggregate loss estimates using the 10,000-year Standard catalog. The losses due to wind, storm surge, and precipitation-induced flood are combined in Touchstone Re 8.0. The Touchstone Re 7.0 losses are due to a combination of wind and storm surge. The table compares (wind + 5% storm surge) using the 2019 Industry Exposure Database + private market precipitation-induced flood data using Touchstone Re 8.0 against (wind + 5% storm surge) using the 2017 Industry Exposure Database and Touchstone Re 7.0.Demand surge is included.

Table 6. Percentage change in insurable aggregate loss estimates using the 10K Standard catalog

All Modeled States					
10K Standard Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	**Overall Change**				
	Residential	**Manufactured Home**	**Commercial**	**Auto**	**Total**
5% (20yr)	12%	5%	16%	20%	13%
2% (50yr)	10%	6%	13%	14%	12%
1% (100yr)	11%	6%	13%	13%	11%
0.5% (200yr)	10%	6%	11%	10%	9%
0.4% (250yr)	13%	4%	9%	10%	13%
0.2% (500yr)	11%	6%	10%	11%	9%
0.1% (1000yr)	10%	6%	9%	7%	12%
Est AAL	12%	5%	19%	28%	15%

Gulf States					
10K Standard Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	**Overall Change**				
	Residential	**Manufactured Home**	**Commercial**	**Auto**	**Total**
5% (20yr)	8%	1%	12%	12%	10%
2% (50yr)	9%	1%	9%	7%	9%
1% (100yr)	9%	1%	10%	8%	8%
0.5% (200yr)	8%	1%	11%	3%	8%
0.4% (250yr)	7%	0%	9%	2%	8%
0.2% (500yr)	8%	0%	9%	4%	7%
0.1% (1000yr)	8%	2%	8%	5%	8%
Est AAL	9%	1%	14%	15%	11%

Interior					
10K Standard Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Overall Change				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	13%	1%	415%	>500%	141%
2% (50yr)	16%	1%	189%	495%	55%
1% (100yr)	13%	1%	89%	376%	24%
0.5% (200yr)	10%	2%	87%	387%	23%
0.4% (250yr)	12%	1%	79%	353%	25%
0.2% (500yr)	13%	2%	44%	292%	14%
0.1% (1000yr)	11%	1%	32%	303%	19%
Est AAL	14%	1%	199%	>500%	74%

Mid-Atlantic					
10K Standard Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Overall Change				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	13%	-2%	153%	243%	57%
2% (50yr)	13%	-1%	78%	167%	26%
1% (100yr)	13%	-2%	73%	157%	24%
0.5% (200yr)	13%	0%	32%	119%	23%
0.4% (250yr)	13%	-1%	33%	110%	13%
0.2% (500yr)	13%	1%	17%	95%	13%
0.1% (1000yr)	14%	-1%	16%	106%	14%
Est AAL	15%	-1%	93%	211%	40%

Northeast					
10K Standard Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Overall Change				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	12%	2%	96%	166%	33%
2% (50yr)	11%	1%	26%	62%	13%
1% (100yr)	12%	2%	16%	48%	12%
0.5% (200yr)	11%	2%	10%	22%	10%
0.4% (250yr)	11%	2%	15%	28%	11%

Northeast					
10K Standard Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Overall Change				
	Residential	Manufactured Home	Commercial	Auto	Total
0.2% (500yr)	11%	2%	10%	21%	10%
0.1% (1000yr)	11%	1%	15%	15%	15%
Est AAL	12%	1%	36%	66%	21%

Southeast					
10K Standard Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Overall Change				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	18%	3%	14%	35%	15%
2% (50yr)	18%	4%	11%	14%	13%
1% (100yr)	18%	4%	11%	13%	13%
0.5% (200yr)	17%	3%	9%	10%	12%
0.4% (250yr)	17%	4%	14%	13%	16%
0.2% (500yr)	16%	3%	12%	11%	14%
0.1% (1000yr)	18%	3%	11%	14%	14%
Est AAL	17%	3%	17%	33%	15%

US - Florida					
10K Standard Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Overall Change				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	11%	8%	11%	12%	9%
2% (50yr)	10%	7%	10%	9%	10%
1% (100yr)	12%	7%	10%	9%	12%
0.5% (200yr)	13%	9%	9%	7%	9%
0.4% (250yr)	13%	8%	10%	9%	11%
0.2% (500yr)	11%	6%	8%	6%	9%
0.1% (1000yr)	16%	7%	7%	7%	12%
Est AAL	10%	7%	11%	11%	10%

US - Texas					
10K Standard Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Overall Change				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	19%	5%	44%	85%	29%
2% (50yr)	20%	6%	27%	83%	21%
1% (100yr)	19%	6%	19%	66%	22%
0.5% (200yr)	19%	6%	21%	57%	20%
0.4% (250yr)	22%	5%	21%	56%	19%
0.2% (500yr)	21%	5%	18%	35%	20%
0.1% (1000yr)	21%	6%	17%	16%	19%
Est AAL	19%	5%	32%	68%	25%

Percentage Change in Insurable Aggregate Loss Estimates Using the 10K Standard Catalog with Exposure Held Constant

The following table shows the percentage change in gross insurable aggregate loss estimates using the 10,000-year Standard catalog, with exposure held constant. The losses due to wind, storm surge, and precipitation-induced flood are combined in Touchstone Re 8.0. The Touchstone Re 7.0 losses are due to a combination of wind and storm surge. The table compares (wind + 5% storm surge) using the 2017 Industry Exposure Database + private market (not National Flood Insurance Program) precipitation-induced flood data using Touchstone Re 8.0 against (wind + 5% storm surge) using the 2017 Industry Exposure Database and Touchstone Re 7.0. Demand surge is included.

Table 7. Percentage change in insurable aggregate loss estimates using the 10K Standard catalog with exposure held constant

All Modeled States					
10K Standard Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	-1%	2%	7%	14%	2%
2% (50yr)	-3%	2%	4%	8%	1%
1% (100yr)	-3%	2%	3%	7%	0%
0.5% (200yr)	-2%	2%	2%	3%	-2%
0.4% (250yr)	-2%	1%	1%	4%	0%
0.2% (500yr)	-3%	2%	1%	5%	0%
0.1% (1000yr)	-1%	2%	1%	0%	2%

All Modeled States					
10K Standard Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
Est AAL	-2%	2%	10%	22%	4%

Gulf States					
10K Standard Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	1%	0%	5%	11%	3%
2% (50yr)	1%	0%	3%	6%	3%
1% (100yr)	1%	1%	3%	6%	1%
0.5% (200yr)	1%	0%	5%	2%	1%
0.4% (250yr)	0%	0%	2%	1%	2%
0.2% (500yr)	-1%	0%	2%	4%	1%
0.1% (1000yr)	1%	0%	1%	4%	2%
Est AAL	1%	0%	7%	14%	4%

Interior					
10K Standard Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	2%	0%	376%	>500%	125%
2% (50yr)	4%	1%	167%	484%	44%
1% (100yr)	1%	0%	75%	368%	15%
0.5% (200yr)	1%	1%	73%	381%	14%
0.4% (250yr)	1%	0%	66%	347%	15%
0.2% (500yr)	0%	1%	31%	279%	5%
0.1% (1000yr)	1%	0%	21%	304%	9%
Est AAL	3%	0%	175%	>500%	61%

Mid-Atlantic					
10K Standard Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	3%	0%	132%	238%	45%
2% (50yr)	2%	1%	63%	161%	14%
1% (100yr)	2%	-1%	59%	151%	14%
0.5% (200yr)	1%	1%	22%	118%	11%
0.4% (250yr)	1%	0%	23%	106%	2%
0.2% (500yr)	1%	1%	7%	92%	2%
0.1% (1000yr)	2%	0%	5%	104%	4%
Est AAL	3%	0%	77%	205%	29%

Northeast					
10K Standard Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	1%	0%	80%	160%	22%
2% (50yr)	0%	0%	16%	58%	3%
1% (100yr)	2%	0%	7%	45%	2%
0.5% (200yr)	0%	1%	2%	18%	1%
0.4% (250yr)	1%	1%	6%	25%	1%
0.2% (500yr)	1%	1%	2%	18%	1%
0.1% (1000yr)	0%	0%	6%	13%	5%
Est AAL	1%	0%	26%	62%	10%

Southeast					
10K Standard Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	1%	1%	5%	29%	3%
2% (50yr)	1%	1%	3%	9%	2%
1% (100yr)	1%	2%	3%	8%	2%
0.5% (200yr)	0%	1%	1%	5%	1%
0.4% (250yr)	1%	1%	5%	7%	2%

Southeast					
10K Standard Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
0.2% (500yr)	-1%	1%	3%	4%	0%
0.1% (1000yr)	1%	1%	2%	6%	1%
Est AAL	1%	1%	8%	27%	4%

US - Florida					
10K Standard Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	-4%	4%	2%	6%	-1%
2% (50yr)	-4%	4%	1%	3%	0%
1% (100yr)	-3%	3%	1%	3%	0%
0.5% (200yr)	-3%	4%	1%	1%	-2%
0.4% (250yr)	-3%	4%	1%	1%	-1%
0.2% (500yr)	-3%	2%	0%	0%	-2%
0.1% (1000yr)	-1%	2%	0%	1%	-1%
Est AAL	-4%	3%	2%	4%	-1%

US - Texas					
10K Standard Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	1%	1%	28%	74%	13%
2% (50yr)	2%	2%	13%	72%	5%
1% (100yr)	2%	1%	6%	57%	6%
0.5% (200yr)	1%	2%	6%	48%	4%
0.4% (250yr)	1%	1%	8%	49%	4%
0.2% (500yr)	2%	0%	3%	25%	6%
0.1% (1000yr)	1%	1%	4%	9%	2%
Est AAL	2%	1%	17%	58%	9%

Percentage Overall Change in Insurable Aggregate Loss Estimates Using the 10K WSST Catalog

The following table shows the percentage change in gross insurable aggregate loss estimates using the 10,000-year Warm Sea Surface Temperature (WSST) catalog. The losses due to wind, storm surge, and precipitation-induced flood are combined in Touchstone Re 8.0. The Touchstone Re 7.0 losses are due to a combination of wind and storm surge. The table compares (wind + 5% storm surge) using the 2019 Industry Exposure Database + private market precipitation-induced flood data using Touchstone Re 8.0 against (wind + 5% storm surge) using the 2017 Industry Exposure Database and Touchstone Re 7.0.Demand surge is included.

Table 8. Percentage change in insurable aggregate loss estimates using the 10K WSST catalog

All Modeled States					
10K WSST Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Overall Change				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	12%	5%	14%	21%	13%
2% (50yr)	10%	6%	11%	13%	12%
1% (100yr)	15%	7%	11%	11%	13%
0.5% (200yr)	13%	5%	10%	11%	13%
0.4% (250yr)	13%	6%	10%	9%	12%
0.2% (500yr)	10%	4%	15%	9%	12%
0.1% (1000yr)	10%	6%	10%	8%	9%
Est AAL	12%	5%	19%	28%	15%

Gulf States					
10K WSST Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Overall Change				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	9%	1%	13%	13%	10%
2% (50yr)	9%	2%	11%	9%	8%
1% (100yr)	8%	2%	9%	6%	8%
0.5% (200yr)	8%	2%	9%	3%	9%
0.4% (250yr)	9%	1%	10%	9%	10%
0.2% (500yr)	8%	0%	8%	3%	7%
0.1% (1000yr)	8%	4%	8%	5%	7%
Est AAL	9%	1%	13%	15%	11%

Interior					
10K WSST Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Overall Change				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	12%	1%	325%	>500%	107%
2% (50yr)	13%	1%	138%	392%	47%
1% (100yr)	11%	1%	88%	317%	19%
0.5% (200yr)	12%	1%	53%	275%	17%
0.4% (250yr)	8%	1%	51%	268%	12%
0.2% (500yr)	12%	2%	23%	242%	10%
0.1% (1000yr)	11%	2%	26%	234%	11%
Est AAL	13%	1%	166%	>500%	63%

Mid-Atlantic					
10K WSST Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Overall Change				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	14%	-2%	146%	229%	51%
2% (50yr)	14%	-1%	70%	177%	29%
1% (100yr)	13%	-1%	64%	139%	20%
0.5% (200yr)	16%	-1%	31%	117%	15%
0.4% (250yr)	14%	-1%	25%	123%	16%
0.2% (500yr)	14%	-2%	19%	113%	13%
0.1% (1000yr)	11%	-1%	12%	94%	17%
Est AAL	15%	-1%	93%	212%	41%

Northeast					
10K WSST Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Overall Change				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	11%	1%	95%	186%	31%
2% (50yr)	11%	1%	25%	72%	15%
1% (100yr)	13%	2%	18%	52%	13%
0.5% (200yr)	11%	2%	10%	32%	10%
0.4% (250yr)	11%	2%	15%	43%	11%

Northeast					
10K WSST Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Overall Change				
	Residential	Manufactured Home	Commercial	Auto	Total
0.2% (500yr)	11%	2%	10%	24%	10%
0.1% (1000yr)	11%	1%	15%	19%	15%
Est AAL	12%	1%	41%	78%	23%

Southeast					
10K WSST Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Overall Change				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	18%	3%	14%	20%	12%
2% (50yr)	16%	3%	12%	14%	14%
1% (100yr)	18%	4%	13%	13%	14%
0.5% (200yr)	18%	2%	11%	13%	14%
0.4% (250yr)	17%	2%	11%	14%	16%
0.2% (500yr)	18%	3%	11%	11%	14%
0.1% (1000yr)	18%	3%	11%	13%	13%
Est AAL	17%	3%	16%	29%	15%

US - Florida					
10K WSST Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Overall Change				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	8%	8%	11%	11%	11%
2% (50yr)	11%	8%	9%	9%	10%
1% (100yr)	11%	8%	9%	8%	8%
0.5% (200yr)	12%	8%	10%	7%	11%
0.4% (250yr)	10%	7%	10%	6%	8%
0.2% (500yr)	13%	7%	9%	8%	10%
0.1% (1000yr)	12%	7%	8%	6%	11%
Est AAL	10%	7%	11%	11%	10%

US - Texas					
10K WSST Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Overall Change				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	21%	5%	44%	82%	29%
2% (50yr)	18%	6%	24%	74%	21%
1% (100yr)	19%	6%	25%	68%	21%
0.5% (200yr)	20%	7%	16%	51%	16%
0.4% (250yr)	20%	5%	19%	51%	19%
0.2% (500yr)	18%	7%	19%	31%	16%
0.1% (1000yr)	22%	6%	16%	14%	19%
Est AAL	19%	5%	31%	67%	24%

Percentage Change in Insurable Aggregate Loss Extimates Using the 10K WSST Catalog with Exposure Held Constant

The following table shows the percentage change in gross insurable aggregate loss estimates using the 10,000-year WSST catalog, with exposure held constant. The losses due to wind, storm surge, and precipitation-induced flood are combined in Touchstone Re 8.0. The Touchstone Re 7.0 losses are due to a combination of wind and storm surge. The table compares (wind + 5% storm surge) using the 2017 Industry Exposure Database + private market (not National Flood Insurance Program) precipitation-induced flood data using Touchstone Re 8.0 against (wind + 5% storm surge) using the 2017 Industry Exposure Database and Touchstone Re 7.0. Demand surge is included.

Table 9. Percentage change in insurable aggregate loss estimates using the 10K WSST catalog with exposure held constant

All Modeled States					
10K WSST Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	-2%	1%	5%	15%	1%
2% (50yr)	-3%	3%	2%	7%	1%
1% (100yr)	-1%	3%	3%	5%	0%
0.5% (200yr)	-2%	3%	1%	4%	0%
0.4% (250yr)	-1%	3%	1%	3%	0%
0.2% (500yr)	-1%	1%	6%	2%	-1%
0.1% (1000yr)	-1%	2%	0%	2%	-1%

All Modeled States					
10K WSST Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
Est AAL	-1%	2%	10%	22%	4%

Gulf States					
10K WSST Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	1%	0%	6%	11%	3%
2% (50yr)	0%	1%	4%	7%	1%
1% (100yr)	0%	0%	2%	5%	1%
0.5% (200yr)	-1%	0%	2%	2%	3%
0.4% (250yr)	-1%	0%	3%	7%	2%
0.2% (500yr)	0%	0%	1%	2%	1%
0.1% (1000yr)	1%	1%	2%	3%	0%
Est AAL	1%	0%	6%	13%	4%

Interior					
10K WSST Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	2%	0%	293%	>500%	92%
2% (50yr)	0%	1%	120%	377%	37%
1% (100yr)	0%	0%	75%	317%	11%
0.5% (200yr)	1%	0%	42%	268%	8%
0.4% (250yr)	0%	0%	40%	255%	7%
0.2% (500yr)	0%	1%	14%	232%	0%
0.1% (1000yr)	0%	1%	15%	235%	1%
Est AAL	3%	0%	145%	>500%	51%

Mid-Atlantic					
10K WSST Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	3%	0%	126%	221%	39%
2% (50yr)	2%	2%	56%	171%	19%
1% (100yr)	0%	0%	51%	135%	9%
0.5% (200yr)	4%	0%	20%	113%	5%
0.4% (250yr)	1%	0%	15%	121%	5%
0.2% (500yr)	2%	0%	10%	108%	2%
0.1% (1000yr)	1%	1%	3%	90%	7%
Est AAL	3%	0%	78%	206%	29%

Northeast					
10K WSST Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	0%	0%	80%	179%	20%
2% (50yr)	1%	0%	16%	68%	5%
1% (100yr)	3%	0%	10%	48%	4%
0.5% (200yr)	0%	1%	2%	29%	1%
0.4% (250yr)	1%	1%	6%	38%	1%
0.2% (500yr)	1%	1%	2%	21%	1%
0.1% (1000yr)	0%	0%	6%	15%	5%
Est AAL	1%	0%	30%	73%	12%

Southeast					
10K WSST Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	2%	1%	6%	15%	1%
2% (50yr)	0%	1%	2%	9%	2%
1% (100yr)	0%	1%	3%	6%	1%
0.5% (200yr)	1%	1%	2%	8%	1%
0.4% (250yr)	1%	1%	2%	8%	3%

Southeast					
10K WSST Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
0.2% (500yr)	2%	2%	2%	5%	1%
0.1% (1000yr)	1%	1%	2%	8%	1%
Est AAL	1%	1%	7%	23%	3%

US - Florida					
10K WSST Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	-5%	4%	2%	5%	0%
2% (50yr)	-3%	5%	1%	3%	-1%
1% (100yr)	-4%	4%	1%	2%	-2%
0.5% (200yr)	-4%	4%	1%	1%	-1%
0.4% (250yr)	-4%	3%	1%	0%	-2%
0.2% (500yr)	-3%	2%	0%	1%	-2%
0.1% (1000yr)	-2%	2%	-1%	0%	-2%
Est AAL	-4%	3%	2%	4%	-1%

US - Texas					
10K WSST Catalog - Insurable Aggregate					
Exceedance Probability (Return Period)	Constant Exposure				
	Residential	Manufactured Home	Commercial	Auto	Total
5% (20yr)	2%	1%	28%	72%	13%
2% (50yr)	2%	1%	11%	64%	6%
1% (100yr)	0%	2%	11%	56%	5%
0.5% (200yr)	1%	2%	4%	43%	2%
0.4% (250yr)	1%	1%	6%	43%	4%
0.2% (500yr)	1%	2%	5%	23%	1%
0.1% (1000yr)	2%	2%	2%	9%	1%
Est AAL	2%	1%	17%	57%	9%

3.8 Analysis Settings

Table 10. Touchstone Re analysis settings for model runs to determine the loss changes.

Setting	Selected Option(s)
Perils modeled	Wind, storm surge, and precipitation-induced flood combined
Catalog	10,000-year Standard 10,000-year Warm Sea Surface Temperature (WSST)
Industry exposure vintage	The Touchstone Re 8.0 losses are generated using the end of year 2019 Industry Exposure Database for wind and storm surge and private market data for precipitation-induced flood. The Touchstone Re 7.0 losses are generated using the end of year 2017 Industry Exposure Database. Another set of losses is generated holding the exposure constant, such that the 2017 Industry Exposure Database is used for both the Touchstone Re 8.0 and 7.0 runs.
Take-up rates	N/A Analyses were done for insurable loss estimates only. Take-up rates do not apply.
Demand surge*	On

* Development of region-specific demand-surge functions is currently underway at AIR. While AIR recommends incorporating demand surge into modeled loss estimates where appropriate, AIR makes no recommendation as to the form of the demand-surge function for hurricanes in the United States. Clients may apply a user-defined demand-surge function if they choose.

4 The AIR U.S. Hurricane Model for Offshore Assets

4.1 Overview of Model Updates and Changes

The AIR U.S. Hurricane Model for Offshore Assets is updated in the 2020 release to include:

- Current values of oil and gas market prices
- Industry Exposure Database updates that account for changes in the counts, locations, and production rates of platforms and rigs in the Gulf of Mexico (GOM).

4.2 Update to the Industry Exposure Database

The Industry Exposure Database is updated to reflect changes in the counts, locations, and production rates of platforms and rigs in the Gulf of Mexico. Market prices of oil and gas are updated to current prices.

Data regarding moveable exposures (mobile rigs and floating platforms) is obtained from RigLogix, a product of RigZone. Data regarding platforms in federal waters is obtained from the Bureau of Ocean Energy Management (BOEM). Both databases are current to November 2019. The market prices of oil and gas were updated using data from BOEM and the U.S. Energy Information Administration (EIA).

Compared to the previous release of the model in Touchstone Re 7.0, the total number of platforms has decreased by about 5%. The total replacement value of the AIR industry exposure in Touchstone Re 8.0 has decreased by about 7% as compared to Touchstone Re 7.0.

In Touchstone Re 8.0, the production rate of gas has increased by about 8% and the production rate of oil has increased by 12% in comparison to Touchstrone Re 7.0. The production rates for assets in federal waters were revised based on 2019 production reports from BOEMRE.

The following table summarizes the changes in exposure between Touchstone Re 8.0 and Touchstone Re 7.0. Note that the numbers in the table represent active platforms capable of producing losses today.

Table 11. Summary of exposure changes to active platforms and rigs, Touchstone Re 8.0 and Touchstone Re 7.0

Parameter	Touchstone Re 7.0	Touchstone Re 8.0	Percent Change
Number of Platforms and Rigs	3,749	3,551	-5.3%
Replacement Value (USD billions)	121.9	113.349	-7.0%
Oil Production (BLLS/day)	1,732,357	1,939,043	11.9%
Gas Production (MCF/day)	2,680,253	2,901,525	8.3%
Oil Unit Price (USD/BLLS)	68.64	59.83	-12.8%
Gas Unit Price (USD/MCF)	2.40	2.75	14.6%

4.3 General Impact of Model Updates on Loss Estimates

The following tables illustrate the overall impact of the updates to the AIR U.S. Hurricane Model for Offshore Assets on loss estimates. Loss changes represent the percentage change in loss estimates calculated by Touchstone Re 8.0 as compared with those calculated in Touchstone Re 7.0.

The tables present the percentage change in insurable **ground-up** occurrence and aggregate losses, respectively, for offshore assets in the Gulf of Mexico. Touchstone Re settings used in the associated model runs are provided in the next section.

Note that to prepare the comparisons below, the price of oil ($59.83/bbl) used with the current model is also used in the comparison runs in order to avoid unrealistically large changes in business interruption losses.

Note that caution should be exercised before relating the industry changes shown here to a particular portfolio. The changes to individual books of business may deviate from the losses represented here to the extent that their spatial distribution and construction/occupancy mix deviate from industry averages.

The following table shows the percentage change in insurable ground-up aggregate loss estimates, by line of business, using the 10,000-year Standard catalog.

Table 12. Percentage change in insurable aggregate losses by LOB— 10K Standard Catalog

Gulf of Mexico						
Insurable Aggregate Losses						
Overall Change						
Exceedance Probability (Return Period)	Physical Damage	Removal of Debris	Operator's Extra Expense	Total Excluding Business Interruption	Business Interruption	TOTAL
5% (20 yr)	-7%	-6%	-2%	-4%	11%	5%
2% (50 yr)	-7%	-3%	-2%	-4%	12%	4%
1% (100 yr)	-7%	-6%	-4%	-4%	14%	5%
0.5% (200 yr)	-5%	-9%	-3%	-4%	12%	5%
0.4% (250 yr)	-6%	-8%	-4%	-4%	13%	6%
0.2% (500 yr)	-5%	-6%	-3%	-5%	12%	4%
0.1% (1000 yr)	-5%	-8%	-4%	-4%	11%	4%
Est. AAL	**-7%**	**-6%**	**-2%**	**-4%**	**13%**	**7%**

The following table shows the percentage change in insurable ground-up aggregate loss estimates, by line of business, using the 10,000-year Warm Sea Surface Temperature (WSST) catalog. The analysis assumes a constant oil price of $59.83/BBL.

Table 13. Percentage change in insurable aggregate losses by LOB— 10K WSST Catalog

Gulf of Mexico						
Insurable Aggregate Losses						
Overall Change						
Exceedance Probability (Return Period)	Physical Damage	Removal of Debris	Operator's Extra Expense	Total Excluding Business Interruption	Business Interruption	TOTAL
5% (20 yr)	-6%	-7%	-3%	-5%	13%	5%
2% (50 yr)	-7%	-5%	-2%	-4%	12%	4%
1% (100 yr)	-5%	-7%	-2%	-4%	11%	4%
0.5% (200 yr)	-7%	-9%	-2%	-4%	12%	5%
0.4% (250 yr)	-4%	-8%	-4%	-4%	13%	6%
0.2% (500 yr)	-5%	-9%	-3%	-4%	11%	3%
0.1% (1000 yr)	-5%	-6%	-2%	-5%	11%	4%
Est. AAL	**-7%**	**-6%**	**-2%**	**-4%**	**13%**	**7%**

The following table shows the percentage change in insurable ground-up occurrence loss estimates, by line of business, using the 10,000-year Standard catalog. The analysis assumes a constant oil price of $59.83/BBL.

Table 14. Percentage change in insurable occurrence losses by LOB— 10K Standard Catalog

Gulf of Mexico						
Insurable Occurrence Losses						
Overall Change						
Exceedance Probability (Return Period)	**Physical Damage**	**Removal of Debris**	**Operator's Extra Expense**	**Total Excluding Business Interruption**	**Business Interruption**	**TOTAL**
5% (20 yr)	-6%	-8%	-3%	-5%	11%	4%
2% (50 yr)	-6%	-7%	-2%	-3%	12%	2%
1% (100 yr)	-5%	-6%	-2%	-4%	12%	4%
0.5% (200 yr)	-4%	-8%	-2%	-4%	11%	3%
0.4% (250 yr)	-7%	-8%	-3%	-5%	13%	2%
0.2% (500 yr)	-7%	-5%	-4%	-3%	13%	4%
0.1% (1000 yr)	-5%	-7%	-3%	-4%	11%	2%
Est. AAL	**-7%**	**-6%**	**-2%**	**-4%**	**12%**	**5%**

The following table shows the percentage change in insurable ground-up occurrence loss estimates, by line of business, calculated using the 10,000-year WSST catalog. The analysis assumes a constant oil price of $59.83/BBL.

Table 15. Percentage change in insurable occurrence losses by LOB— 10K WSST Catalog

Gulf of Mexico						
Insurable Occurrence Losses						
Overall Change						
Exceedance Probability (Return Period)	**Physical Damage**	**Removal of Debris**	**Operator's Extra Expense**	**Total Excluding Business Interruption**	**Business Interruption**	**TOTAL**
5% (20 yr)	-6%	-7%	-2%	-4%	11%	5%
2% (50 yr)	-6%	-3%	-2%	-4%	11%	3%
1% (100 yr)	-6%	-7%	-2%	-5%	11%	5%
0.5% (200 yr)	-5%	-9%	-3%	-5%	11%	2%
0.4% (250 yr)	-4%	-8%	-2%	-4%	13%	2%
0.2% (500 yr)	-7%	-6%	-3%	-5%	13%	4%
0.1% (1000 yr)	-5%	-6%	-5%	-4%	11%	2%
Est. AAL	**-7%**	**-6%**	**-2%**	**-4%**	**12%**	**5%**

4.4 Analysis Settings

Table 16. Touchstone Re analysis settings for model runs to determine the loss changes.

Setting	Selected Option(s)
Perils modeled	Wind and waves combined
Catalog	10,000-year Standard 10,000-year Warm Sea Surface Temperature (WSST)
Industry exposure vintage	December 2019
Take-up rates	N/A Analyses were done for insurable loss estimates only. Take-up rates do not apply.
Demand surge	Off
Price of Oil	$59.83/BBL
Price of Gas	$2.75/MCF

5 The AIR Wildfire Model for the United States

5.1 Overview of Model Updates and Changes

Updates to the AIR Wildfire Model for the United States are limited to an expanded and enhanced stochastic catalog. Details of these improvements are presented below.

5.2 Catalogs and Event Sets

Stochastic Catalog

AIR has significantly improved the 10,000-year stochastic catalog by expanding its size and updating the application of fire intensities to event footprints.

The stochastic catalog now includes events that do not cause losses to the *AIR Industry Exposure Database for the United States*. In contrast, the previous version's catalog was limited to loss-causing events.[2] Catalog details are presented below.

Table 17. Stochastic catalog details for the AIR Wildfire Model for the United States

Model Version	Total Number of Events	Event Type
Updated	6,620,407	729,836 Loss-causing events[3] 5,890,571 Non loss-causing events[4]
Previous	729,836	All loss-causing[5]

All event IDs are new.

5.3 Industry Exposure Database

The updated model uses the *AIR Industry Exposure Database for the United States*, available on the AIR AIR Client Portal. Exposures in the databases are current as of the end of 2019.

[2] Events that cause losses to the *AIR Industry Exposure Database for the United States*.
[3] Events that cause losses to the *AIR Industry Exposure Database for the United States*.
[4] Events that do **not** cause losses to the *AIR Industry Exposure Database for the United States*.
[5] Events that cause losses to the *AIR Industry Exposure Database for the United States*.

5.4 General Impact of Model Updates on Loss Estimates

Model updates are limited to the expansion and enhancement of the stochastic catalog. In order to provide a general view of modeled losses and loss changes between model versions, AIR runs the current and previous versions of the model using the *AIR Industry Exposure Database for the United States*. The loss changes presented below are associated with the update to the exposure database. These changes reflect two years of industry exposure growth, as the AIR database was not updated for the previous release. Industry exposure updates reflect increases in exposure values for buildings, contents, and the time element.

The following tables illustrate the overall impact of model updates on loss estimates from the previous version of Touchstone Re to Touchstone Re 8.0. Table 18 and Table 19 present the percentage change in insurable Aggregate and aggregate losses, respectively, for the model domain and individual states. Settings used in the associated model runs are provided in the next section.

The left side of each table below ("Overall Change") shows the change in industry gross insurable occurrence losses. This column indicates the combined effects of all changes (e.g., updates to the catalog, policy conditions, take-up rates, post codes), including updated property values. Overall Changes are developed by comparing the total industry insurable losses in the prior industry loss file to the total industry insurable losses in the new industry loss file. In Touchstone Re, 100% sums insured based market shares are analyzed against each loss file and the percentage differences calculated in the resulting loss distributions.

The right side of each table below ("Constant Exposure") shows what the user will likely see if the same sums insured analyzed in the previous version of Touchstone Re are compared with the current version's results, using the same sums insured with the "use latest industry exposure database" option enabled.

Caution should be exercised before relating the industry changes shown here to a particular portfolio. Changes to individual books of business may deviate from the losses represented here to the extent that their spatial distribution and construction/ occupancy mix deviate from industry averages.

Table 18. Percentage change in GROSS INSURABLE OCCURRENCE losses, by LOB – 10,000 yr catalog

Western United States (13 States)										
Insurable (Occurrence) Losses										
EP (Return Period)	Overall Change					Constant Exposure				
	RES	COM/ IND	MH	AUTO	TOTAL	RES	COM/ IND	MH	AUTO	TOTAL
5% (20 yr)	18%	13%	3%	7%	18%	3%	2%	1%	2%	3%
2% (50 yr)	18%	14%	3%	7%	16%	4%	3%	1%	2%	2%

Western United States (13 States)										
Insurable (Occurrence) Losses										
EP (Return Period)	**Overall Change**					**Constant Exposure**				
	RES	**COM/ IND**	**MH**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**MH**	**AUTO**	**TOTAL**
1% (100 yr)	17%	12%	3%	7%	15%	3%	2%	2%	3%	2%
0.5% (200 yr)	13%	10%	2%	7%	15%	2%	2%	2%	2%	2%
0.4% (250 yr)	18%	12%	3%	8%	14%	5%	2%	2%	3%	2%
0.2% (500 yr)	14%	16%	6%	7%	16%	1%	1%	3%	3%	1%
0.1% (1000 yr)	14%	16%	2%	8%	13%	1%	2%	1%	3%	1%
Est. AAL	16%	11%	2%	6%	15%	1%	1%	1%	1%	1%

Arizona										
Insurable (Occurrence) Losses										
EP (Return Period)	**Overall Change**					**Constant Exposure**				
	RES	**COM/ IND**	**MH**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**MH**	**AUTO**	**TOTAL**
5% (20 yr)	15%	8%	2%	6%	14%	0%	0%	0%	0%	0%
2% (50 yr)	16%	7%	1%	7%	15%	0%	0%	1%	0%	0%
1% (100 yr)	16%	8%	1%	6%	15%	0%	0%	1%	2%	1%
0.5% (200 yr)	16%	9%	-2%	6%	13%	0%	0%	0%	0%	0%
0.4% (250 yr)	17%	9%	4%	7%	15%	0%	2%	1%	0%	0%
0.2% (500 yr)	19%	10%	3%	9%	17%	3%	4%	2%	2%	3%
0.1% (1000 yr)	17%	11%	1%	8%	21%	1%	2%	0%	2%	5%
Est. AAL	15%	8%	1%	7%	14%	0%	0%	0%	0%	0%

California										
Insurable (Occurrence) Losses										
EP (Return Period)	**Overall Change**					**Constant Exposure**				
	RES	**COM/ IND**	**MH**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**MH**	**AUTO**	**TOTAL**
5% (20 yr)	17%	12%	3%	7%	17%	3%	3%	2%	2%	3%
2% (50 yr)	15%	13%	5%	8%	17%	2%	3%	3%	4%	4%
1% (100 yr)	15%	10%	2%	8%	18%	3%	2%	2%	2%	4%
0.5% (200 yr)	15%	13%	3%	5%	16%	2%	2%	2%	2%	4%
0.4% (250 yr)	17%	11%	5%	8%	15%	2%	1%	3%	4%	2%
0.2% (500 yr)	14%	12%	8%	6%	14%	1%	1%	7%	2%	1%

California										
Insurable (Occurrence) Losses										
EP (Return Period)	**Overall Change**					**Constant Exposure**				
	RES	**COM/ IND**	**MH**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**MH**	**AUTO**	**TOTAL**
0.1% (1000 yr)	14%	12%	3%	6%	13%	1%	2%	2%	1%	1%
Est. AAL	15%	11%	2%	6%	15%	1%	1%	1%	1%	1%

Northern California[6]										
Insurable (Occurrence) Losses										
EP (Return Period)	**Overall Change**					**Constant Exposure**				
	RES	**COM/ IND**	**MH**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**MH**	**AUTO**	**TOTAL**
5% (20 yr)	14%	12%	2%	6%	14%	1%	1%	1%	1%	1%
2% (50 yr)	17%	12%	1%	7%	18%	4%	1%	1%	2%	3%
1% (100 yr)	15%	12%	1%	8%	14%	3%	1%	2%	2%	2%
0.5% (200 yr)	16%	15%	4%	7%	18%	3%	4%	4%	2%	3%
0.4% (250 yr)	14%	13%	3%	6%	14%	3%	2%	2%	2%	2%
0.2% (500 yr)	12%	13%	4%	5%	13%	1%	3%	3%	1%	2%
0.1% (1000 yr)	14%	9%	3%	7%	20%	2%	2%	2%	3%	9%
Est. AAL	15%	12%	2%	5%	14%	1%	1%	1%	1%	1%

Southern California[7]										
Insurable (Occurrence) Losses										
EP (Return Period)	**Overall Change**					**Constant Exposure**				
	RES	**COM/ IND**	**MH**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**MH**	**AUTO**	**TOTAL**
5% (20 yr)	15%	12%	3%	7%	15%	1%	2%	1%	2%	2%
2% (50 yr)	17%	13%	2%	8%	16%	4%	2%	1%	3%	2%
1% (100 yr)	16%	13%	4%	7%	18%	2%	3%	2%	2%	4%
0.5% (200 yr)	17%	13%	5%	10%	16%	2%	2%	5%	5%	3%
0.4% (250 yr)	17%	15%	5%	7%	17%	2%	4%	2%	4%	2%
0.2% (500 yr)	19%	14%	5%	8%	19%	3%	3%	2%	2%	3%

[6] Northern California includes the following counties: Alameda, Alpine, Amador, Butte, Calaveras, Colusa, Contra Costa, Del Norte, El Dorado, Fresno, Glenn, Inyo, Kings, Lake, Lassen, Madera, Marin, Mariposa, Mendocino, Merced, Modoc, Mono, Napa, Nevada, Placer, Plumas, Sacramento, San Benito, San Francisco, San Joaquin, San Mateo, Santa Clara, Santa Cruz, Sierra, Siskiyou, Solano, Sonoma, Stanislaus, Sutter, Tehama, Trinity, Tulare, Tuolumne, and Yolo.

[7] Southern California includes the following counties: Imperial, Kern, Los Angeles, Orange, Riverside, San Bernardino, San Diego, San Luis Obispo, Santa Barbara, and Ventura.

Southern California[7]										
Insurable (Occurrence) Losses										
EP (Return Period)	**Overall Change**					**Constant Exposure**				
	RES	**COM/ IND**	**MH**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**MH**	**AUTO**	**TOTAL**
0.1% (1000 yr)	15%	15%	5%	5%	14%	3%	3%	3%	1%	1%
Est. AAL	15%	11%	2%	6%	15%	1%	1%	1%	1%	1%

Colorado										
Insurable (Occurrence) Losses										
EP (Return Period)	**Overall Change**					**Constant Exposure**				
	RES	**COM/ IND**	**MH**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**MH**	**AUTO**	**TOTAL**
5% (20 yr)	16%	11%	5%	6%	16%	0%	0%	0%	1%	0%
2% (50 yr)	15%	12%	4%	4%	14%	0%	0%	0%	0%	0%
1% (100 yr)	15%	11%	8%	6%	14%	0%	0%	1%	0%	0%
0.5% (200 yr)	17%	11%	6%	8%	17%	0%	0%	0%	3%	1%
0.4% (250 yr)	18%	11%	3%	6%	18%	0%	0%	0%	0%	1%
0.2% (500 yr)	18%	10%	5%	5%	19%	0%	0%	0%	0%	1%
0.1% (1000 yr)	14%	16%	6%	8%	16%	1%	3%	0%	1%	2%
Est. AAL	15%	12%	5%	6%	15%	0%	0%	0%	0%	0%

Idaho										
Insurable (Occurrence) Losses										
EP (Return Period)	**Overall Change**					**Constant Exposure**				
	RES	**COM/ IND**	**MH**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**MH**	**AUTO**	**TOTAL**
5% (20 yr)	20%	8%	1%	2%	14%	0%	0%	0%	0%	0%
2% (50 yr)	20%	7%	2%	6%	17%	0%	0%	0%	0%	0%
1% (100 yr)	20%	11%	5%	7%	18%	0%	0%	0%	0%	0%
0.5% (200 yr)	20%	7%	2%	4%	21%	1%	0%	0%	0%	0%
0.4% (250 yr)	21%	10%	3%	9%	22%	0%	0%	0%	0%	0%
0.2% (500 yr)	23%	12%	6%	6%	22%	0%	2%	0%	1%	0%
0.1% (1000 yr)	24%	10%	6%	4%	27%	0%	0%	1%	0%	4%
Est. AAL	20%	9%	2%	5%	17%	0%	0%	0%	0%	0%

[7] Southern California includes the following counties: Imperial, Kern, Los Angeles, Orange, Riverside, San Bernardino, San Diego, San Luis Obispo, Santa Barbara, and Ventura.

Montana										
Insurable (Occurrence) Losses										
EP (Return Period)	**Overall Change**					**Constant Exposure**				
	RES	**COM/ IND**	**MH**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**MH**	**AUTO**	**TOTAL**
5% (20 yr)	19%	8%	4%	5%	17%	0%	0%	0%	0%	0%
2% (50 yr)	18%	8%	2%	5%	18%	0%	0%	0%	0%	0%
1% (100 yr)	21%	14%	2%	9%	17%	0%	0%	0%	0%	0%
0.5% (200 yr)	24%	11%	4%	6%	17%	0%	0%	0%	0%	0%
0.4% (250 yr)	21%	9%	3%	7%	19%	0%	0%	0%	0%	0%
0.2% (500 yr)	23%	12%	4%	6%	19%	0%	0%	0%	0%	0%
0.1% (1000 yr)	26%	11%	2%	9%	19%	0%	0%	0%	0%	0%
Est. AAL	19%	10%	2%	5%	17%	0%	0%	0%	0%	0%

Nevada										
Insurable (Occurrence) Losses										
EP (Return Period)	**Overall Change**					**Constant Exposure**				
	RES	**COM/ IND**	**MH**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**MH**	**AUTO**	**TOTAL**
5% (20 yr)	16%	15%	3%	5%	17%	0%	0%	0%	0%	0%
2% (50 yr)	19%	17%	1%	7%	18%	0%	1%	0%	0%	0%
1% (100 yr)	21%	19%	4%	5%	17%	0%	0%	0%	0%	0%
0.5% (200 yr)	19%	16%	3%	6%	21%	0%	0%	0%	0%	0%
0.4% (250 yr)	21%	15%	2%	5%	16%	0%	0%	0%	0%	0%
0.2% (500 yr)	25%	6%	6%	8%	21%	3%	0%	2%	0%	0%
0.1% (1000 yr)	21%	15%	4%	5%	23%	0%	0%	0%	0%	2%
Est. AAL	19%	15%	3%	6%	18%	0%	0%	0%	0%	0%

New Mexico										
Insurable (Occurrence) Losses										
EP (Return Period)	**Overall Change**					**Constant Exposure**				
	RES	**COM/ IND**	**MH**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**MH**	**AUTO**	**TOTAL**
5% (20 yr)	9%	6%	3%	2%	8%	0%	0%	0%	0%	0%
2% (50 yr)	9%	6%	-2%	1%	7%	0%	0%	0%	0%	0%
1% (100 yr)	14%	7%	2%	-1%	12%	0%	0%	1%	0%	0%
0.5% (200 yr)	17%	6%	0%	-4%	10%	0%	0%	0%	0%	0%

New Mexico										
Insurable (Occurrence) Losses										
EP (Return Period)	Overall Change					Constant Exposure				
	RES	COM/ IND	MH	AUTO	TOTAL	RES	COM/ IND	MH	AUTO	TOTAL
0.4% (250 yr)	12%	8%	1%	3%	10%	0%	0%	0%	0%	0%
0.2% (500 yr)	12%	7%	1%	1%	7%	0%	0%	0%	0%	0%
0.1% (1000 yr)	12%	9%	5%	-2%	7%	0%	1%	0%	0%	0%
Est. AAL	9%	7%	2%	2%	8%	0%	0%	0%	0%	0%

Oklahoma										
Insurable (Occurrence) Losses										
EP (Return Period)	Overall Change					Constant Exposure				
	RES	COM/ IND	MH	AUTO	TOTAL	RES	COM/ IND	MH	AUTO	TOTAL
5% (20 yr)	6%	8%	3%	1%	7%	0%	0%	0%	0%	0%
2% (50 yr)	6%	9%	3%	1%	6%	0%	0%	0%	0%	0%
1% (100 yr)	8%	8%	4%	1%	6%	0%	0%	0%	0%	0%
0.5% (200 yr)	7%	7%	3%	1%	7%	0%	0%	0%	0%	0%
0.4% (250 yr)	5%	5%	2%	2%	6%	0%	0%	0%	0%	0%
0.2% (500 yr)	7%	8%	7%	2%	5%	0%	0%	0%	0%	0%
0.1% (1000 yr)	3%	7%	5%	2%	6%	0%	0%	0%	0%	0%
Est. AAL	6%	8%	3%	1%	7%	0%	0%	0%	0%	0%

Oregon										
Insurable (Occurrence) Losses										
EP (Return Period)	Overall Change					Constant Exposure				
	RES	COM/ IND	MH	AUTO	TOTAL	RES	COM/ IND	MH	AUTO	TOTAL
5% (20 yr)	16%	7%	3%	6%	14%	0%	0%	0%	0%	0%
2% (50 yr)	16%	10%	4%	9%	15%	0%	0%	0%	0%	0%
1% (100 yr)	18%	10%	6%	7%	15%	0%	0%	0%	0%	0%
0.5% (200 yr)	18%	10%	4%	7%	14%	0%	0%	0%	0%	0%
0.4% (250 yr)	18%	12%	3%	8%	12%	0%	0%	0%	0%	0%
0.2% (500 yr)	16%	11%	0%	5%	17%	0%	0%	0%	0%	0%
0.1% (1000 yr)	21%	11%	4%	11%	17%	0%	0%	0%	0%	0%
Est. AAL	17%	10%	3%	7%	15%	0%	0%	0%	0%	0%

Texas										
Insurable (Occurrence) Losses										
EP (Return Period)	Overall Change					Constant Exposure				
	RES	COM/ IND	MH	AUTO	TOTAL	RES	COM/ IND	MH	AUTO	TOTAL
5% (20 yr)	17%	11%	5%	7%	14%	0%	0%	0%	0%	0%
2% (50 yr)	17%	12%	4%	6%	17%	0%	0%	0%	0%	0%
1% (100 yr)	20%	16%	4%	7%	17%	0%	0%	0%	0%	0%
0.5% (200 yr)	22%	13%	4%	8%	17%	0%	0%	0%	0%	0%
0.4% (250 yr)	19%	9%	4%	8%	21%	0%	0%	0%	0%	4%
0.2% (500 yr)	20%	14%	6%	8%	20%	0%	0%	0%	0%	1%
0.1% (1000 yr)	22%	14%	6%	10%	15%	1%	1%	0%	0%	1%
Est. AAL	17%	12%	4%	6%	16%	0%	0%	0%	0%	0%

Utah										
Insurable (Occurrence) Losses										
EP (Return Period)	Overall Change					Constant Exposure				
	RES	COM/ IND	MH	AUTO	TOTAL	RES	COM/ IND	MH	AUTO	TOTAL
5% (20 yr)	20%	9%	2%	9%	17%	0%	0%	0%	0%	0%
2% (50 yr)	19%	9%	6%	9%	16%	0%	0%	0%	0%	0%
1% (100 yr)	19%	9%	4%	9%	19%	0%	0%	0%	0%	0%
0.5% (200 yr)	18%	8%	2%	8%	18%	0%	0%	0%	0%	0%
0.4% (250 yr)	19%	8%	0%	10%	21%	0%	0%	1%	0%	0%
0.2% (500 yr)	17%	11%	-1%	8%	19%	0%	0%	0%	0%	0%
0.1% (1000 yr)	21%	10%	16%	8%	20%	3%	0%	0%	0%	1%
Est. AAL	19%	10%	4%	9%	17%	0%	0%	0%	0%	0%

Washington										
Insurable (Occurrence) Losses										
EP (Return Period)	Overall Change					Constant Exposure				
	RES	COM/ IND	MH	AUTO	TOTAL	RES	COM/ IND	MH	AUTO	TOTAL
5% (20 yr)	19%	10%	0%	6%	16%	0%	0%	0%	0%	0%
2% (50 yr)	19%	9%	3%	3%	18%	0%	0%	0%	0%	0%
1% (100 yr)	18%	9%	1%	4%	15%	0%	0%	0%	0%	0%
0.5% (200 yr)	20%	12%	0%	6%	17%	0%	0%	0%	0%	0%

Washington										
Insurable (Occurrence) Losses										
EP (Return Period)	**Overall Change**					**Constant Exposure**				
	RES	**COM/ IND**	**MH**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**MH**	**AUTO**	**TOTAL**
0.4% (250 yr)	20%	12%	0%	4%	16%	0%	0%	0%	0%	0%
0.2% (500 yr)	21%	12%	0%	5%	15%	0%	0%	0%	0%	0%
0.1% (1000 yr)	18%	11%	2%	6%	15%	0%	0%	0%	1%	0%
Est. AAL	18%	11%	1%	5%	16%	0%	0%	0%	0%	0%

Wyoming										
Insurable (Occurrence) Losses										
EP (Return Period)	**Overall Change**					**Constant Exposure**				
	RES	**COM/ IND**	**MH**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**MH**	**AUTO**	**TOTAL**
5% (20 yr)	9%	6%	1%	0%	7%	0%	0%	0%	0%	0%
2% (50 yr)	11%	7%	1%	-3%	9%	0%	0%	0%	0%	0%
1% (100 yr)	7%	8%	2%	-1%	9%	0%	0%	0%	0%	0%
0.5% (200 yr)	9%	6%	0%	-3%	8%	0%	0%	0%	0%	0%
0.4% (250 yr)	12%	7%	4%	-4%	6%	0%	0%	0%	0%	0%
0.2% (500 yr)	6%	9%	4%	-1%	10%	0%	0%	0%	0%	0%
0.1% (1000 yr)	12%	8%	2%	-4%	6%	0%	1%	0%	0%	0%
Est. AAL	9%	8%	2%	-1%	8%	0%	0%	0%	0%	0%

Table 19. Percentage change in GROSS INSURABLE AGGREGATE losses, by LOB – 10,000 yr catalog

Western United States (13 States)										
Insurable (Aggregate) Losses										
EP (Return Period)	**Overall Change**					**Constant Exposure**				
	RES	**COM/ IND**	**MH**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**MH**	**AUTO**	**TOTAL**
5% (20 yr)	16%	12%	3%	7%	16%	2%	2%	1%	2%	3%
2% (50 yr)	17%	12%	4%	8%	17%	4%	2%	2%	3%	3%
1% (100 yr)	19%	14%	4%	9%	18%	5%	4%	2%	4%	5%
0.5% (200 yr)	20%	14%	4%	9%	17%	5%	3%	2%	4%	3%
0.4% (250 yr)	19%	15%	3%	11%	19%	5%	3%	2%	6%	6%
0.2% (500 yr)	15%	15%	6%	11%	17%	3%	6%	4%	7%	3%
0.1% (1000 yr)	14%	16%	4%	13%	13%	1%	5%	3%	9%	1%

Western United States (13 States)										
Insurable (Aggregate) Losses										
EP (Return Period)	**Overall Change**					**Constant Exposure**				
	RES	**COM/ IND**	**MH**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**MH**	**AUTO**	**TOTAL**
Est. AAL	15%	11%	3%	5%	14%	1%	1%	1%	1%	1%

Arizona										
Insurable (Aggregate) Losses										
EP (Return Period)	**Overall Change**					**Constant Exposure**				
	RES	**COM/ IND**	**MH**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**MH**	**AUTO**	**TOTAL**
5% (20 yr)	16%	8%	1%	6%	14%	0%	1%	0%	0%	0%
2% (50 yr)	15%	9%	0%	7%	14%	0%	0%	0%	0%	0%
1% (100 yr)	15%	8%	1%	7%	15%	0%	0%	0%	0%	0%
0.5% (200 yr)	19%	8%	2%	6%	14%	4%	1%	0%	0%	0%
0.4% (250 yr)	14%	7%	3%	6%	13%	0%	0%	2%	0%	1%
0.2% (500 yr)	17%	12%	0%	9%	16%	1%	2%	0%	2%	1%
0.1% (1000 yr)	21%	10%	1%	10%	20%	4%	1%	3%	2%	4%
Est. AAL	15%	8%	1%	7%	14%	0%	0%	0%	0%	0%

California										
Insurable (Aggregate) Losses										
EP (Return Period)	**Overall Change**					**Constant Exposure**				
	RES	**COM/ IND**	**MH**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**MH**	**AUTO**	**TOTAL**
5% (20 yr)	16%	13%	3%	6%	16%	3%	2%	1%	1%	3%
2% (50 yr)	18%	15%	4%	9%	18%	4%	4%	2%	3%	5%
1% (100 yr)	20%	15%	7%	11%	20%	6%	5%	4%	7%	6%
0.5% (200 yr)	18%	15%	7%	10%	19%	5%	5%	4%	6%	6%
0.4% (250 yr)	20%	16%	5%	11%	20%	6%	7%	4%	6%	7%
0.2% (500 yr)	16%	20%	7%	12%	14%	4%	9%	5%	8%	2%
0.1% (1000 yr)	13%	22%	7%	15%	13%	1%	11%	6%	11%	1%
Est. AAL	15%	12%	3%	6%	15%	2%	2%	1%	1%	2%

Northern California[8]										
Insurable (Aggregate) Losses										
EP (Return Period)	**Overall Change**					**Constant Exposure**				
	RES	**COM/ IND**	**MH**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**MH**	**AUTO**	**TOTAL**
5% (20 yr)	15%	11%	3%	5%	14%	1%	1%	1%	1%	0%
2% (50 yr)	15%	14%	2%	6%	15%	1%	2%	1%	2%	2%
1% (100 yr)	18%	14%	3%	8%	16%	3%	4%	2%	4%	2%
0.5% (200 yr)	16%	15%	3%	8%	18%	3%	4%	2%	3%	4%
0.4% (250 yr)	15%	14%	2%	6%	16%	2%	3%	2%	1%	4%
0.2% (500 yr)	15%	12%	3%	9%	14%	4%	2%	2%	6%	3%
0.1% (1000 yr)	18%	11%	4%	10%	18%	5%	4%	2%	6%	6%
Est. AAL	15%	12%	3%	5%	14%	1%	1%	1%	1%	1%

Southern California[9]										
Insurable (Aggregate) Losses										
EP (Return Period)	**Overall Change**					**Constant Exposure**				
	RES	**COM/ IND**	**MH**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**MH**	**AUTO**	**TOTAL**
5% (20 yr)	16%	11%	3%	6%	15%	1%	1%	2%	1%	1%
2% (50 yr)	18%	13%	4%	8%	18%	3%	3%	3%	3%	3%
1% (100 yr)	20%	14%	7%	11%	19%	6%	3%	4%	6%	5%
0.5% (200 yr)	20%	14%	8%	11%	17%	4%	5%	6%	4%	3%
0.4% (250 yr)	22%	15%	8%	6%	19%	7%	4%	7%	2%	5%
0.2% (500 yr)	19%	21%	8%	15%	16%	6%	11%	6%	9%	3%
0.1% (1000 yr)	20%	22%	7%	10%	20%	6%	11%	4%	6%	7%
Est. AAL	16%	12%	3%	7%	15%	2%	2%	1%	2%	2%

[8] Northern California includes the following counties: Alameda, Alpine, Amador, Butte, Calaveras, Colusa, Contra Costa, Del Norte, El Dorado, Fresno, Glenn, Inyo, Kings, Lake, Lassen, Madera, Marin, Mariposa, Mendocino, Merced, Modoc, Mono, Napa, Nevada, Placer, Plumas, Sacramento, San Benito, San Francisco, San Joaquin, San Mateo, Santa Clara, Santa Cruz, Sierra, Siskiyou, Solano, Sonoma, Stanislaus, Sutter, Tehama, Trinity, Tulare, Tuolumne, and Yolo.

[9] Southern California includes the following counties: Imperial, Kern, Los Angeles, Orange, Riverside, San Bernardino, San Diego, San Luis Obispo, Santa Barbara, and Ventura.

Colorado										
Insurable (Aggregate) Losses										
EP (Return Period)	**Overall Change**					**Constant Exposure**				
	RES	**COM/ IND**	**MH**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**MH**	**AUTO**	**TOTAL**
5% (20 yr)	14%	11%	5%	5%	13%	0%	0%	0%	0%	0%
2% (50 yr)	16%	12%	4%	6%	15%	0%	1%	0%	0%	0%
1% (100 yr)	17%	12%	3%	5%	16%	0%	0%	0%	0%	0%
0.5% (200 yr)	14%	12%	5%	6%	17%	0%	0%	0%	0%	0%
0.4% (250 yr)	15%	13%	4%	7%	15%	0%	0%	0%	2%	0%
0.2% (500 yr)	16%	11%	1%	5%	18%	0%	0%	0%	0%	0%
0.1% (1000 yr)	14%	16%	6%	6%	16%	1%	0%	0%	0%	1%
Est. AAL	15%	12%	5%	6%	14%	0%	0%	0%	0%	0%

Idaho										
Insurable (Aggregate) Losses										
EP (Return Period)	**Overall Change**					**Constant Exposure**				
	RES	**COM/ IND**	**MH**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**MH**	**AUTO**	**TOTAL**
5% (20 yr)	18%	9%	2%	5%	14%	0%	0%	0%	0%	0%
2% (50 yr)	18%	9%	1%	4%	16%	0%	0%	0%	0%	0%
1% (100 yr)	15%	9%	3%	4%	17%	0%	0%	0%	0%	0%
0.5% (200 yr)	18%	9%	1%	4%	19%	0%	0%	0%	0%	1%
0.4% (250 yr)	23%	8%	7%	8%	18%	0%	0%	6%	0%	0%
0.2% (500 yr)	23%	10%	4%	4%	22%	0%	4%	0%	0%	0%
0.1% (1000 yr)	24%	10%	9%	6%	24%	0%	0%	3%	2%	1%
Est. AAL	19%	9%	2%	5%	17%	0%	0%	0%	0%	0%

Montana										
Insurable (Aggregate) Losses										
EP (Return Period)	**Overall Change**					**Constant Exposure**				
	RES	**COM/ IND**	**MH**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**MH**	**AUTO**	**TOTAL**
5% (20 yr)	19%	8%	2%	6%	17%	0%	0%	0%	0%	0%
2% (50 yr)	19%	9%	4%	5%	17%	0%	0%	0%	0%	0%
1% (100 yr)	17%	12%	3%	5%	15%	0%	0%	0%	0%	0%
0.5% (200 yr)	24%	9%	5%	6%	19%	0%	0%	0%	0%	0%

Montana										
Insurable (Aggregate) Losses										
EP (Return Period)	Overall Change					Constant Exposure				
	RES	COM/ IND	MH	AUTO	TOTAL	RES	COM/ IND	MH	AUTO	TOTAL
0.4% (250 yr)	23%	8%	7%	5%	19%	0%	0%	0%	0%	0%
0.2% (500 yr)	22%	12%	3%	6%	19%	0%	0%	0%	0%	0%
0.1% (1000 yr)	24%	12%	10%	5%	18%	0%	0%	0%	0%	0%
Est. AAL	19%	9%	2%	5%	16%	0%	0%	0%	0%	0%

Nevada										
Insurable (Aggregate) Losses										
EP (Return Period)	Overall Change					Constant Exposure				
	RES	COM/ IND	MH	AUTO	TOTAL	RES	COM/ IND	MH	AUTO	TOTAL
5% (20 yr)	17%	16%	3%	5%	17%	0%	1%	0%	0%	0%
2% (50 yr)	19%	15%	1%	5%	18%	1%	0%	0%	0%	0%
1% (100 yr)	19%	15%	4%	5%	16%	0%	0%	0%	0%	0%
0.5% (200 yr)	18%	12%	4%	5%	15%	0%	0%	0%	0%	0%
0.4% (250 yr)	21%	15%	3%	5%	20%	0%	0%	0%	0%	0%
0.2% (500 yr)	22%	19%	2%	6%	21%	2%	2%	0%	0%	0%
0.1% (1000 yr)	21%	15%	4%	11%	21%	0%	0%	0%	3%	0%
Est. AAL	19%	15%	3%	5%	17%	0%	0%	0%	0%	0%

New Mexico										
Insurable (Aggregate) Losses										
EP (Return Period)	Overall Change					Constant Exposure				
	RES	COM/ IND	MH	AUTO	TOTAL	RES	COM/ IND	MH	AUTO	TOTAL
5% (20 yr)	8%	6%	2%	2%	8%	0%	0%	0%	0%	1%
2% (50 yr)	8%	6%	1%	1%	7%	0%	0%	0%	0%	0%
1% (100 yr)	12%	6%	3%	0%	9%	0%	0%	0%	0%	0%
0.5% (200 yr)	13%	8%	1%	-3%	10%	0%	0%	0%	0%	0%
0.4% (250 yr)	9%	8%	-2%	2%	11%	0%	0%	0%	0%	0%
0.2% (500 yr)	8%	7%	0%	2%	9%	0%	0%	0%	0%	0%
0.1% (1000 yr)	12%	9%	5%	-2%	7%	0%	1%	0%	0%	0%
Est. AAL	9%	7%	2%	2%	8%	0%	0%	0%	0%	0%

Oklahoma										
Insurable (Aggregate) Losses										
EP (Return Period)	Overall Change					Constant Exposure				
	RES	COM/ IND	MH	AUTO	TOTAL	RES	COM/ IND	MH	AUTO	TOTAL
5% (20 yr)	7%	9%	4%	1%	6%	0%	0%	0%	0%	0%
2% (50 yr)	7%	8%	3%	2%	7%	0%	0%	0%	0%	0%
1% (100 yr)	7%	9%	2%	1%	6%	0%	0%	0%	0%	0%
0.5% (200 yr)	7%	6%	1%	2%	7%	0%	0%	0%	0%	0%
0.4% (250 yr)	6%	10%	4%	3%	6%	0%	0%	0%	0%	0%
0.2% (500 yr)	7%	7%	1%	3%	7%	0%	0%	0%	0%	0%
0.1% (1000 yr)	12%	7%	1%	6%	9%	0%	0%	0%	0%	0%
Est. AAL	6%	8%	3%	1%	6%	0%	0%	0%	0%	0%

Oregon										
Insurable (Aggregate) Losses										
EP (Return Period)	Overall Change					Constant Exposure				
	RES	COM/ IND	MH	AUTO	TOTAL	RES	COM/ IND	MH	AUTO	TOTAL
5% (20 yr)	17%	10%	1%	7%	15%	0%	0%	0%	0%	0%
2% (50 yr)	15%	10%	1%	6%	18%	0%	0%	0%	0%	0%
1% (100 yr)	18%	11%	4%	8%	16%	0%	0%	0%	0%	0%
0.5% (200 yr)	18%	9%	3%	8%	16%	0%	0%	0%	0%	0%
0.4% (250 yr)	18%	9%	2%	7%	15%	0%	0%	0%	0%	0%
0.2% (500 yr)	20%	11%	1%	9%	16%	0%	0%	0%	0%	0%
0.1% (1000 yr)	21%	11%	1%	8%	15%	0%	0%	0%	0%	0%
Est. AAL	17%	10%	3%	7%	14%	0%	0%	0%	0%	0%

Texas										
Insurable (Aggregate) Losses										
EP (Return Period)	Overall Change					Constant Exposure				
	RES	COM/ IND	MH	AUTO	TOTAL	RES	COM/ IND	MH	AUTO	TOTAL
5% (20 yr)	16%	13%	3%	5%	12%	0%	0%	0%	0%	0%
2% (50 yr)	16%	11%	4%	5%	15%	0%	0%	0%	0%	0%
1% (100 yr)	17%	13%	7%	7%	15%	0%	0%	0%	0%	0%
0.5% (200 yr)	18%	11%	6%	7%	18%	0%	0%	0%	0%	0%

Texas										
Insurable (Aggregate) Losses										
EP (Return Period)	**Overall Change**					**Constant Exposure**				
	RES	**COM/ IND**	**MH**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**MH**	**AUTO**	**TOTAL**
0.4% (250 yr)	17%	13%	4%	7%	16%	0%	0%	0%	0%	0%
0.2% (500 yr)	14%	14%	3%	7%	18%	0%	0%	0%	0%	0%
0.1% (1000 yr)	25%	13%	5%	5%	24%	4%	0%	0%	1%	4%
Est. AAL	17%	12%	4%	5%	15%	0%	0%	0%	0%	0%

Utah										
Insurable (Aggregate) Losses										
EP (Return Period)	**Overall Change**					**Constant Exposure**				
	RES	**COM/ IND**	**MH**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**MH**	**AUTO**	**TOTAL**
5% (20 yr)	20%	8%	5%	9%	17%	0%	0%	0%	0%	0%
2% (50 yr)	20%	9%	3%	8%	19%	0%	0%	0%	0%	0%
1% (100 yr)	19%	9%	4%	8%	17%	0%	0%	0%	0%	0%
0.5% (200 yr)	18%	9%	4%	8%	18%	0%	0%	0%	0%	0%
0.4% (250 yr)	21%	12%	-1%	8%	16%	0%	3%	0%	0%	0%
0.2% (500 yr)	18%	12%	4%	8%	18%	0%	2%	0%	0%	0%
0.1% (1000 yr)	18%	8%	6%	8%	19%	0%	0%	0%	0%	2%
Est. AAL	19%	10%	4%	9%	17%	0%	0%	0%	0%	0%

Washington										
Insurable (Aggregate) Losses										
EP (Return Period)	**Overall Change**					**Constant Exposure**				
	RES	**COM/ IND**	**MH**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**MH**	**AUTO**	**TOTAL**
5% (20 yr)	18%	11%	1%	5%	16%	0%	0%	0%	0%	0%
2% (50 yr)	17%	11%	2%	5%	16%	0%	0%	0%	0%	0%
1% (100 yr)	19%	12%	1%	4%	17%	0%	0%	0%	0%	0%
0.5% (200 yr)	20%	10%	0%	5%	15%	0%	0%	0%	0%	0%
0.4% (250 yr)	20%	12%	0%	3%	18%	0%	0%	0%	0%	0%
0.2% (500 yr)	21%	11%	0%	5%	15%	0%	0%	1%	0%	0%
0.1% (1000 yr)	17%	9%	1%	3%	17%	0%	0%	0%	0%	0%
Est. AAL	18%	10%	1%	5%	16%	0%	0%	0%	0%	0%

Wyoming										
Insurable (Aggregate) Losses										
EP (Return Period)	Overall Change					Constant Exposure				
	RES	COM/ IND	MH	AUTO	TOTAL	RES	COM/ IND	MH	AUTO	TOTAL
5% (20 yr)	8%	6%	1%	-1%	7%	0%	0%	0%	0%	0%
2% (50 yr)	11%	8%	0%	-1%	8%	1%	0%	0%	0%	0%
1% (100 yr)	9%	6%	4%	-3%	8%	0%	0%	0%	0%	0%
0.5% (200 yr)	7%	9%	3%	0%	8%	0%	0%	0%	0%	0%
0.4% (250 yr)	11%	6%	3%	-4%	7%	0%	0%	0%	0%	0%
0.2% (500 yr)	10%	7%	-1%	-3%	8%	0%	0%	0%	0%	0%
0.1% (1000 yr)	6%	6%	8%	-3%	6%	0%	0%	0%	0%	0%
Est. AAL	9%	8%	2%	-1%	8%	0%	0%	0%	0%	0%

See Also

Stochastic Catalog
Industry Exposure Database
Analysis Settings

5.5 Analysis Settings

AIR used the following analysis settings in model runs to produce loss changes.

Table 20. Touchstone Re analysis settings for model runs

Setting	Selected Option(s)
Perils modeled	Wildfire
Catalog	10,000-year
Industry exposure vintage(s)	2019 Wildfire insurable
Take-up rates	N/A
Demand surge	On

6 The AIR Earthquake Model for the Caribbean

6.1 Model Updates and Changes

The summer 2020 release of the AIR Earthquake Model for the Caribbean includes new and updated features, including the following:

- Expanded model domain from 10 to 29 countries
- Updated hazard information, including new historical catalog sources, ground motion prediction equation suite, and soils data
- Enhancement of the vulnerability assessment framework
- Explicit modeling of liquefaction and tsunami
- Fully updated Industry Exposure Database

Model Domain

The updates to the AIR Earthquake Model for the Caribbean included in the 2020 release of Touchstone Re include the expansion of the model domain from 10 to 29 Caribbean nations, bringing the model in sync with the domain of the AIR Tropical Cyclone Model for the Caribbean. Modeled countries include (newly modeled countries are **highlighted**):

- **Anguilla**
- **Antigua and Barbuda**
- **Aruba**
- Bahamas
- Barbados
- **Bermuda**
- **British Virgin Islands (BVI)**
- Cayman Islands
- **Cuba**
- **Curacao**
- **Dominica**
- Dominican Republic
- **Grenada**
- **Guadeloupe**
- **Haiti**
- Jamaica

- **Martinique**
- **Montserrat**
- **Netherlands BES (Bonaire, St Eustatius, Saba)**
- Puerto Rico
- **Saint Barthelemy**
- **Saint Kitts and Nevis**
- **Saint Lucia**
- Sint Maarten
- Saint Martin
- **Saint Vincent and the Grenadines**
- Trinidad and Tobago
- **Turks and Caicos Islands**
- U.S. Virgin Islands (USVI)

Catalogs and Event Sets

Historical Catalog

The historical earthquake catalog used in the development of the stochastic catalog for the AIR Earthquake Model for the Caribbean is compiled from a variety of local and global sources. These sources include historical and instrumental earthquake event catalogs from:

- United States Geological Survey (USGS)
- Global Earthquake Model (GEM)
    - GEM Historical Catalog
    - GEM Instrument Catalog
- International Seismological Centre (ISC)
    - Puerto Rico Seismic Network (PRSN)
    - Jamaica Seismograph Network (JSN)
    - Eastern Caribbean Seismograph Network (TRN)
- Centro Nacional de Investigaciones Sismológicas (CENAIS, Cuba)
- Instituto Panamericano de Geografia e Historia (IPGH)
- Global Centroid Moment Tensor (GCMT)

Data on earthquake magnitude from these sources is captured on a variety of magnitude types, including body-wave, surface-wave, or duration magnitude. In order to homogenize the master historical earthquake catalog, AIR researchers developed scaling relationships to convert from these scales to moment magnitude. The homogenized historical catalog is declustered to remove foreshocks and aftershocks.

Stochastic Catalog

The model supports a 10,000-year time-dependent stochastic catalog.

Historical Event Set

Thirty-nine historical events are available for analysis in Touchstone Re. All events in the historical event set are newly supported, and are listed in Table 21.

Table 21. Historical Events available in the AIR Earthquake Model for the Caribbean

Earthquake	Magnitude (M_W)	Year	Earthquake	Magnitude (M_W)	Year
Dominican Republic	7.7	1562	Cuba	6.7	1932
Northern Lesser Antilles	7.0	1690	Puerto Rico Trench	7.7	1943
Jamaica	7.5	1692	Dominican Republic	7.8	1946
Haiti	6.6	1701	Dominican Republic	6.58	1953
October Dominican Republic	7.5	1751	Trinidad and Tobago	6.1	1954
November Haiti	6.5	1751	Northern Lesser Antilles	7.46	1974
Offshore Cuba	7.6	1766	Muertos Trough Dominican Republic	6.65	1979
Trinidad and Tobago	7.5	1766	Offshore Dominican Republic	6.7	1984
Haiti	7.5	1770	Northern Lesser Antilles	6.3	1985
Haiti	6.75	1784	Trinidad and Tobago	6.63	1988
Puerto Rico	8.0	1787	Cuba	6.81	1992
Martinique	7.8	1839	Trinidad and Tobago	6.7	1997
Haiti	7.8	1842	Dominican Republic	6.4	2003
Guadeloupe	8.0	1843	Guadeloupe	6.3	2004
Offshore Cuba	7.51	1852	Cayman Islands	6.77	2004
Santiago de Cuba	7.31	1852	Martinique	7.4	2007
Offshore U.S. Virgin Islands	7.51	1867	Haiti	7.04	2010
Jamaica	6.8	1907	Venezuela	7.3	2018
Offshore Dominican Republic	6.8	1916	Haiti	5.9	2018
Offshore Puerto Rico	7.2	1918			

World Scenarios Event Set

A catalog of Extreme Disaster Scenarios is released with the updated model version. All events in this catalog are new.

Event Generation

The 10,000-year time-dependent stochastic catalog used by the AIR Earthquake Model for the Caribbean is generated based on historic earthquake data, active fault geometries, and seismic moment rates from geodetic data.

AIR researchers compiled data on historical earthquakes in the Caribbean from various sources, homogenized magnitude scales, and declustered foreshocks and aftershocks.

The model utilizes Global Positioning System (GPS) data to enhance and supplement AIR's view of risk from historical seismicity. GPS strain rate calculations allow researchers to understand and quantify the amount of strain accumulation in a given region. The calculations also determine the potential for fault "locking", resulting in an increased probability of seismic activity in the time-dependent model.

A comprehensive fault database was compiled from a variety of sources and further refines AIR's view of seismicity in the Caribbean. Data from paleoseismic studies, marine surveys, and GPS campaigns were integrated and the resulting updated fault database is used to further constrain the distribution of simulated earthquake events. The more detailed fault model considers the effects of fault orientation and incorporates multiple fault segment rupture scenarios.

Impact of Event Generation Updates

In general, there is a decrease in losses across all lines of business (i.e., residential, commercial and auto) for the countries supported in the current model. This is driven by updates to both hazard and vulnerability. However, driven by the updates in hazard, losses increase for the 20-year return period in Jamaica and Puerto Rico and across all return periods in Bahamas.

The new stochastic catalog incorporates improved magnitude-rate curves, spatial event distribution and well-constrained seismic source geometries such as depth, strike, and dip. While the impact of the catalog update on loss varies across the Caribbean, it is notable in the Bahamas, leading to a consistent increase in loss. In contrast, the existing catalog was primarily dependent on historical data, thus susceptible to clustering where historical earthquakes were observed. This led to fewer events impacting regions with low seismicity such as the Bahamas. The new catalog has a continuous distribution of events which is a better representation of background seismicity.

The scientific understanding of the fault structures in the region has greatly improved in the past decade and simulated fault rupture geometries in the new model better reflect potential rupture scenarios. The improved event geometries drive loss reduction in some countries, such as the U.S. Virgin Islands and Puerto Rico, where the events along the Puerto Rico Trench have more realistic strike and dip angles than previously modeled.

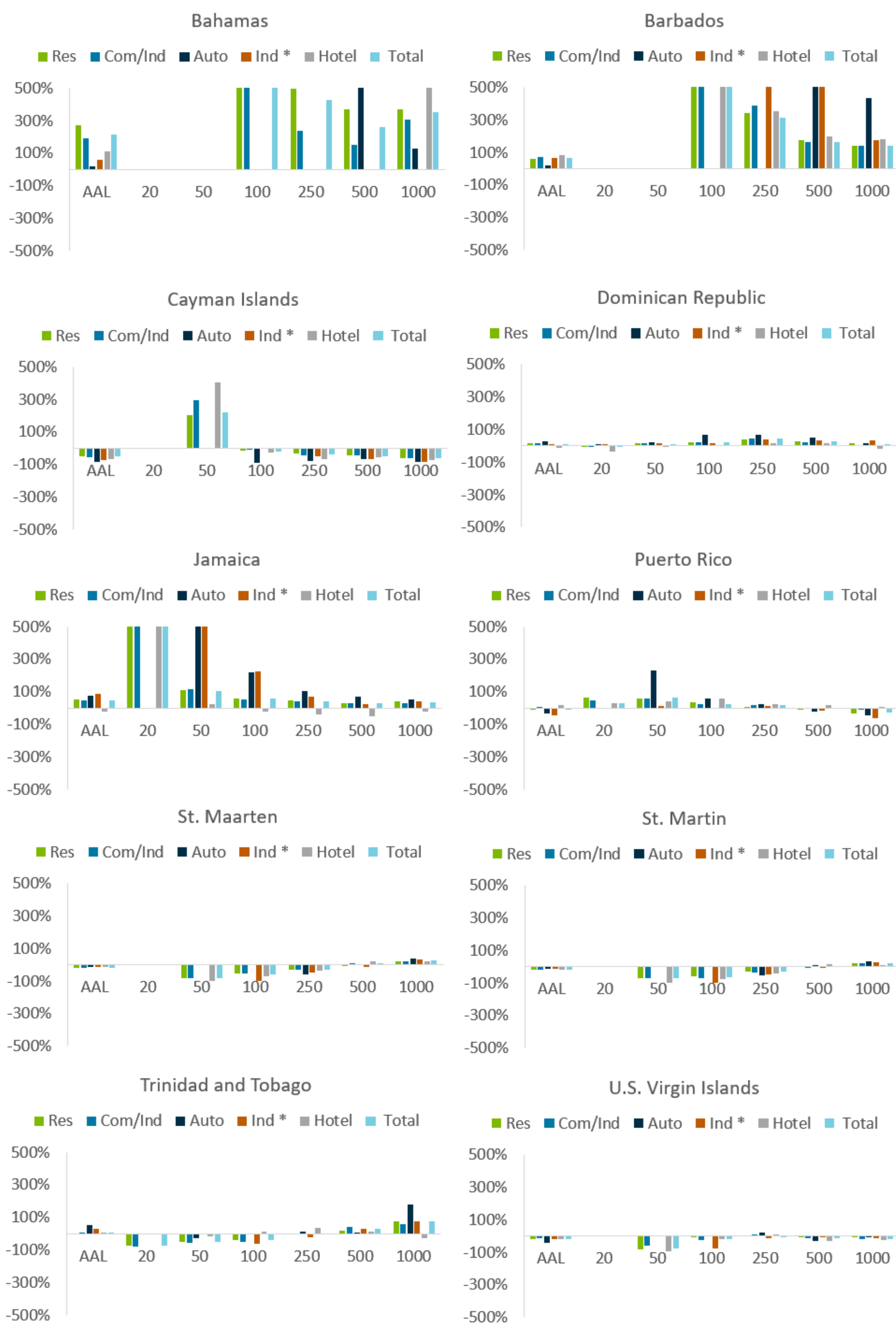


Figure 22. Impact of catalog updates on modeled ground-up losses

Local Intensity Calculation

The updated suite of ground motion prediction equations (GMPEs) implemented in the AIR Earthquake Model for the Caribbean represent ground motion attenuation in a wide variety of tectonic settings found throughout the region. Using a logic tree approach, GMPEs corresponding to six different tectonic regimes are combined and applied. Local amplification and dampening effects due to site soil conditions are considered in calculation of ground motion at a given location. High resolution soil maps obtained from a variety of sources are included in the 2020 model update.

Ground Motion Prediction Equation Updates

Since the last update to the AIR Earthquake Model for the Caribbean, significant improvements have been made in understanding the manner in which seismic energy propagates through the ground. More earthquakes, including large events such as the Tohoku, Japan 2011 and Maule, Chile 2010 events, have occurred since the last model update and provided a wealth of data that has been used to develop more robust GMPEs. GMPEs developed for various global tectonic environments are applied in the update to the AIR Earthquake Model for the Caribbean using a logic tree approach that better captures ground motion uncertainty. While the Touchstone Re 7.0 model version included three types of tectonic environments, the Touchstone Re 8.0 model version includes six tectonic domains.

Soil Map Updates

The addition of high resolution soil data is another major update introduced in the Touchstone 8.0 model version; more than 25 maps were digitized and classified using NEHRP soil classification (Figure 23). The Touchstone 7.0 model version did not include soil when calculating ground motion at a given location.

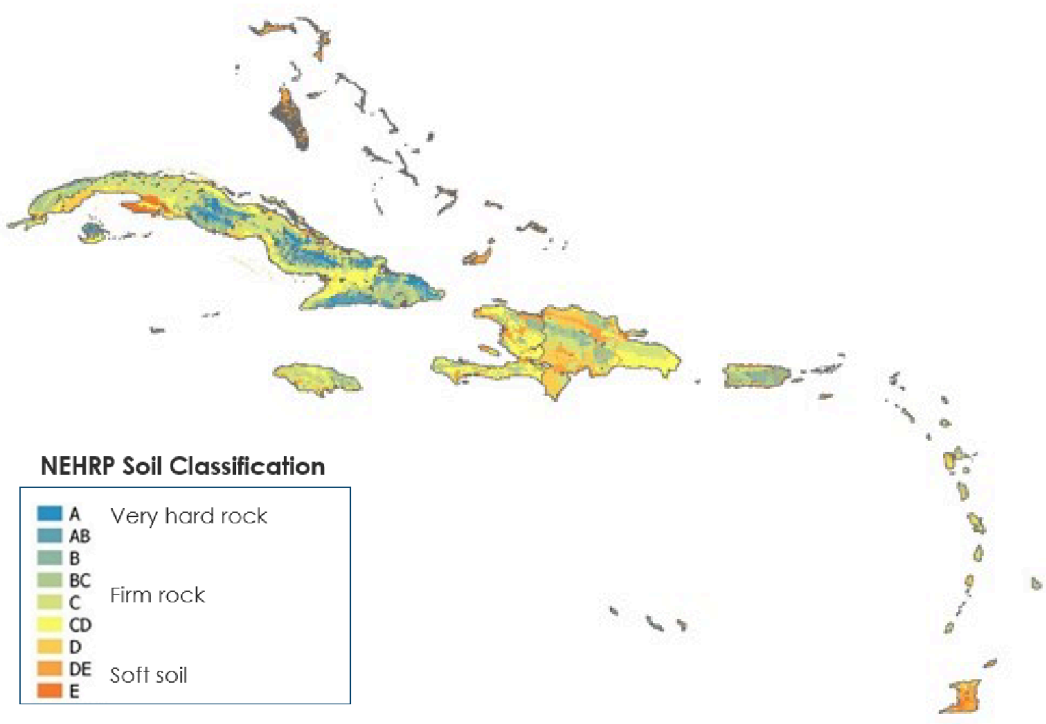


Figure 23. Soil data used in the calculation of ground motions in the updated model

Aerial imagery was also used to identify regions of reclaimed land or anthropogenic landfill that may not be reflected in some of these geological maps. These regions are important to capture because they represent some of the most susceptible land to risk.

Impact of Local Intensity Calculation Updates on Modeled Losses

The improved GMPE logic tree contributes to a systematic decrease in losses across the model domain. The Touchstone Re 7.0 model version does not account for soil. In the Touchstone Re 8.0 model version, the inclusion of soil alongside GMPE updates, increases losses for cities located on soft soil such as San Juan (Puerto Rico) where large exposure populations are concentrated. The soft soil along similar coastlines in the Dominican Republic makes for relatively higher risk than would not be captured without the incorporation of soil data and seismic site response, thereby increasing losses. Figure 24 shows the combined effects of updates to GMPEs and soil maps have on ground-up loss estimates.

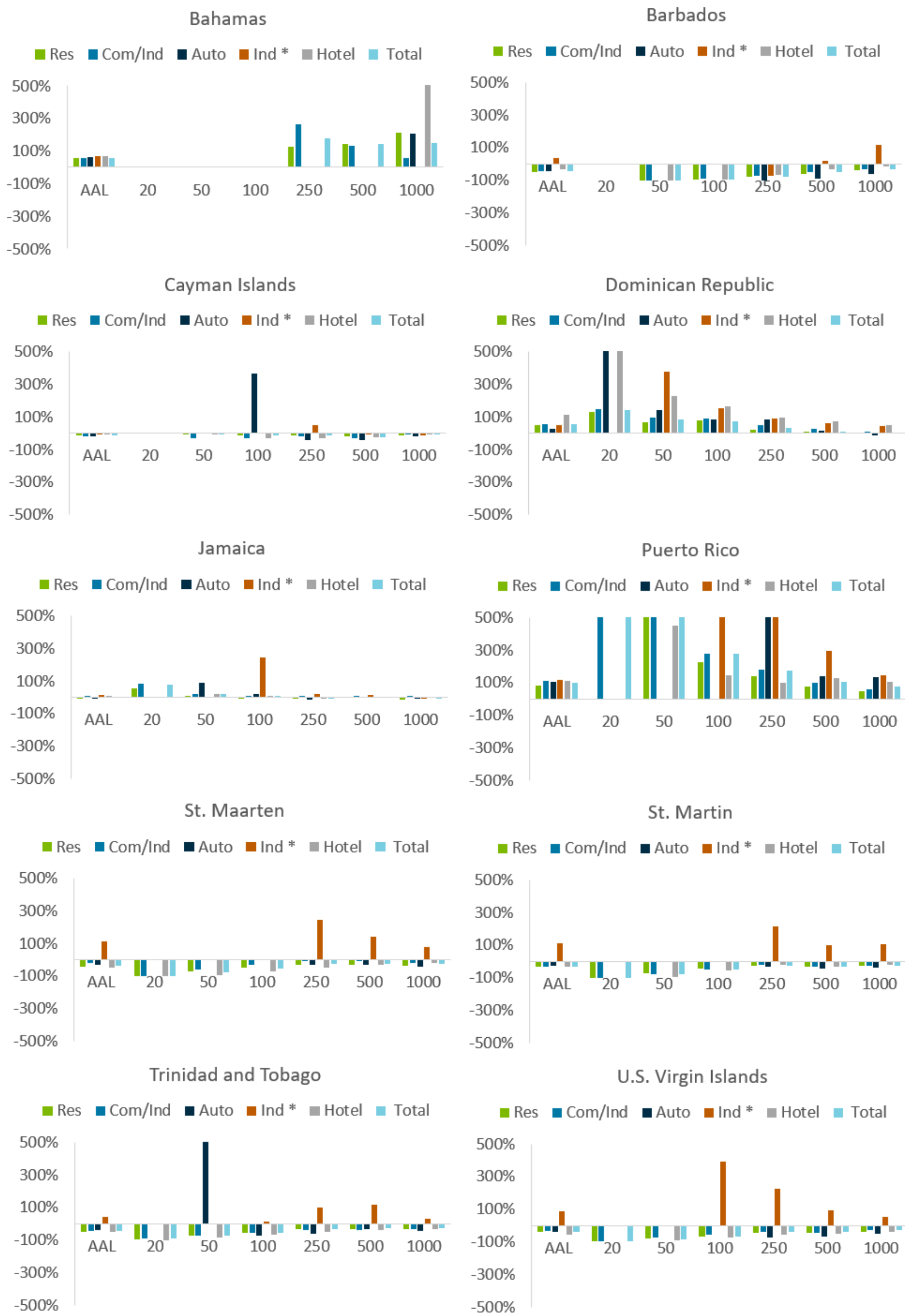


Figure 24. Impact of GMPE and soil updates on modeled ground-up losses

Damage Estimation

In addition to the added support of nineteen new countries and two new sub-perils (tsunami and liquefaction), damage estimation updates to the AIR Earthquake Model for the Caribbean in 2020 include:

- Higher resolution vulnerability zonation
- Vulnerability age bands developed by country
- Support for one additional height band
- Spectral acceleration-based intensity-damage calculations
- Updated secondary uncertainty distributions

The model update also benefits from the application of AIR's vulnerability classification framework. In this system, structural response is quantified based on the evolution of design code requirements. The model also makes use of AIR's work in updating the wind vulnerability assessment framework as part of coincident updates to the AIR Tropical Cyclone Model for the Caribbean.

Impact of Vulnerability Updates on Modeled Losses

There is a general reduction in losses due to vulnerability updates in the Caribbean, for all lines of business. The updates are driven by a detailed study on the spatiotemporal variation in vulnerability as described earlier alongside review of the latest data from the historical events in the region and global vulnerability models (in context of the limited data available for the Caribbean). Over the past two decades, many countries in the region enacted or updated their building codes (e.g., national codes in Jamaica and Puerto Rico based on international building code post-2002). The seismic vulnerability of such structures built to the new or updated standards is relatively low compared to those that haven't considered seismic design guidelines. The updated model captures the lower vulnerability of the buildings built to these codes, leading to a reduction in losses. Furthermore, at the same time, significant progress has been made in accurately representing the structural vulnerability using hazard metrics such as spectral acceleration. This is in contrast with the MMI-based damage functions that were historically used in the existing model and can potentially overestimate losses. The new spectral acceleration-based damage functions better represent the vulnerability of buildings and thus contribute to a reduction in losses.

Figure 25. Impact of vulnerability updates on modeled ground-up losses

Sub-Peril Updates and Additions

The 2020 update of the AIR Earthquake Model for the Caribbean in the 2020 release of Touchstone Re includes the explicit modeling of the tsunami and liquefaction sub-perils.

Tsunami

Probabilistic tsunami modeling is added to the AIR Earthquake Model for the Caribbean for all countries supported in the updated model domain. The entire Caribbean region is characterized by large populations and concentrations of exposure along the coast. Tsunamigenic sources exist regionally in the Caribbean and the physical parameters of stochastic events in these source zones are used to simulate tsunami formation.

The tsunami module utilizes high-resolution, fully numerical models to determine the height and velocity of the tsunami waves, which propagate outward from the source. As the simulated waves approach the shore, high-resolution bathymetric/topographic elevation data along with surface roughness/friction maps are used to compute the inundation footprint, depth, and inland wave velocity. The fluctuation of astronomical tides is also considered in these calculations. By identifying nearby ports and coastal industrial centers, the potential likelihood for the presence of large, damaging debris is also estimated. These variables (inundation depth, flow velocity, and debris factor) are accounted for in calculating local tsunami intensity, which are then used to carry out damage estimation.

Liquefaction

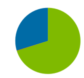
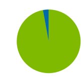
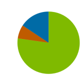
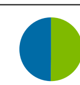
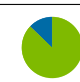
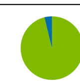
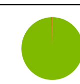
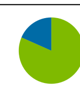
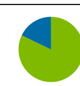
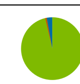
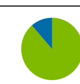
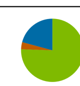
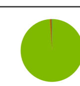
The liquefaction component of the AIR Earthquake Model for the Caribbean incorporates detailed geological and ground water data to inform an assessment of liquefaction susceptibility. Using a given earthquake's physical parameters and considering the behavior of characteristic soil profiles, liquefaction likelihood functions model where significant ground displacement is expected.

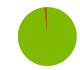
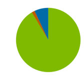
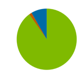
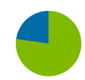
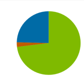
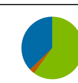
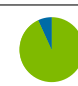
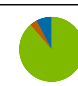
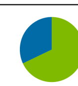
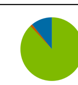
Artificially filled land is identified via study of historical maps and comparison to present day land features, and local liquefaction susceptibility studies are used to supplement and hone the relative liquefaction susceptibility scale. The performance of the model's liquefaction module is validated against observed liquefaction features and damage from historical earthquakes in the Caribbean.

Impact of Sub-Peril Additions on Modeled Loss Estimates

Table 22 shows the percentage of modeled average annual ground-up loss contributed by ground shaking, liquefaction, and tsunami, respectively.

Table 22. Sub-peril contribution to ground-up AAL, by country/territory

Country/ Territory	Shake %	Liquefaction %	Tsunami %	Ground Shaking Liquefaction Tsunami
Anguilla	55	0	45	
Antigua and Barbuda	70	0	30	
Aruba	97	0	3	
Bahamas	92	0	8	
Barbados	77	7	16	
Bermuda	8	0	92	
Bonaire, St. Eustatius, Saba	50	0	50	
British Virgin Islands	87	0	13	
Cayman Islands	96	0	4	
Cuba	100	0	0	
Curacao	82	0	18	
Dominica	82	0	18	
Dominican Republic	96	1	3	
Grenada	89	0	11	
Guadeloupe	75	4	21	
Haiti	99	1	0	

Country/ Territory	Shake %	Liquefaction %	Tsunami %	Ground Shaking Liquefaction Tsunami
Jamaica	98	2	0	
Martinique	91	2	7	
Montserrat	89	0	11	
Puerto Rico	90	1	9	
St. Barthelemy	89	0	11	
St. Kitts and Nevis	87	0	13	
St. Lucia	77	0	23	
St. Maarten	73	2	25	
St. Martin	60	3	37	
St. Vincent and the Grenadines	93	0	7	
Trinidad and Tobago	89	3	8	
Turks and Caicos	68	0	32	
U.S. Virgin Islands	88	1	11	

6.2 Industry Exposure Database

The update of the AIR Earthquake Model for the Caribbean coincides with the release of an updated AIR Industry Exposure Database for the Caribbean, current as of the end of 2019.

6.3 General Impact of Model Updates on Loss Estimates

The following tables show the overall impact of the updates to the AIR Earthquake Model for the Caribbean on gross insurable occurrence and aggregate losses. These losses do not include demand surge. Loss changes represent the percentage change in loss estimates calculated by the previous version of Touchstone Re 7.0 as compared with those calculated by the current version of Touchstone Re 8.0 for all modeled islands/territories combined, as well as by selected islands/territories, using the 10,000-year standard catalog. Changes below represent overall change, including the effects of model updates and updated industry exposures.

Note that caution should be exercised before relating the industry changes shown here to a particular portfolio. The changes to individual books of business may deviate from the losses represented here to the extent that their spatial distribution and construction/occupancy mix deviate from industry averages.

Table 23. Percentage change in gross insurable occurrence and aggregate loss estimates, overall change - Caribbean

Caribbean - 10 Version 7.0 Countries								
All Perils (7.0) vs All Perils (8.0)								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20)	-22%	-28%	-56%	-25%	-30%	-36%	-60%	-33%
2% (50)	43%	22%	3%	26%	30%	12%	-4%	18%
1% (100)	72%	53%	38%	62%	61%	50%	28%	55%
0.5% (200)	69%	61%	52%	56%	65%	47%	50%	52%
0.4% (250)	69%	56%	73%	57%	65%	50%	62%	55%
0.2% (500)	34%	32%	65%	37%	32%	40%	48%	32%
0.1% (1000)	-8%	0%	28%	-5%	-7%	3%	31%	-6%
Est. AAL	**-11%**	**-19%**	**-28%**	**-15%**	**-18%**	**-26%**	**-34%**	**-22%**

Table 24. Percentage change in gross insurable occurrence and aggregate loss estimates, overall change - Bahamas

Bahamas								
All Perils (7.0) vs All Perils (8.0)								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2% (50)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1% (100)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
0.5% (200)	>500%	>500%	451%	>500%	>500%	>500%	451%	>500%
0.4% (250)	>500%	>500%	>500%	>500%	>500%	>500%	>500%	>500%
0.2% (500)	>500%	>500%	>500%	>500%	>500%	>500%	>500%	>500%
0.1% (1000)	>500%	>500%	>500%	>500%	>500%	>500%	>500%	>500%
Est. AAL	**>500%**	**424%**	**>500%**	**>500%**	**>500%**	**424%**	**>500%**	**>500%**

Table 25. Percentage change in gross insurable occurrence and aggregate loss estimates, overall change - Barbados

Barbados								
All Perils (7.0) vs All Perils (8.0)								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2% (50)	-98%	-93%	N/A	-95%	-98%	-93%	N/A	-95%
1% (100)	-79%	-49%	-29%	-64%	-80%	-50%	-31%	-65%
0.5% (200)	-42%	42%	-11%	0%	-42%	42%	-11%	0%
0.4% (250)	-17%	75%	37%	31%	-17%	75%	37%	31%
0.2% (500)	43%	259%	190%	117%	43%	259%	190%	117%
0.1% (1000)	179%	342%	333%	256%	178%	338%	331%	256%
Est. AAL	**2%**	**81%**	**61%**	**40%**	**1%**	**80%**	**60%**	**39%**

Table 26. Percentage change in gross insurable occurrence and aggregate loss estimates, overall change - Cayman Islands

Cayman Islands								
All Perils (7.0) vs All Perils (8.0)								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2% (50)	-44%	-83%	N/A	-68%	-44%	-83%	N/A	-68%
1% (100)	-48%	-80%	-99%	-66%	-48%	-80%	-99%	-66%
0.5% (200)	-45%	-80%	-91%	-66%	-46%	-80%	-91%	-66%
0.4% (250)	-38%	-76%	-75%	-60%	-42%	-78%	-77%	-63%
0.2% (500)	-14%	-67%	-53%	-46%	-13%	-64%	-53%	-44%
0.1% (1000)	-26%	-69%	-55%	-52%	-26%	-69%	-55%	-52%
Est. AAL	**-32%**	**-74%**	**-70%**	**-58%**	**-32%**	**-74%**	**-70%**	**-57%**

Table 27. Percentage change in gross insurable occurrence and aggregate loss estimates, overall change - Dominican Republic

Dominican Republic								
All Perils (7.0) vs All Perils (8.0)								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20)	-11%	-39%	-74%	-27%	-9%	-41%	-75%	-29%
2% (50)	41%	-6%	-14%	14%	39%	-5%	-15%	14%
1% (100)	93%	53%	76%	75%	86%	48%	68%	71%
0.5% (200)	156%	78%	144%	114%	156%	75%	140%	113%
0.4% (250)	184%	93%	146%	133%	192%	95%	155%	139%
0.2% (500)	138%	88%	176%	111%	145%	79%	169%	106%
0.1% (1000)	155%	62%	194%	90%	158%	67%	193%	97%
Est. AAL	**74%**	**22%**	**36%**	**46%**	**73%**	**21%**	**34%**	**45%**

Table 28. Percentage change in gross insurable occurrence and aggregate loss estimates, overall change - Jamaica

Jamaica								
All Perils (7.0) vs All Perils (8.0)								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20)	>500%	>500%	-48%	>500%	>500%	>500%	-48%	>500%
2% (50)	171%	162%	-52%	150%	170%	160%	-52%	153%
1% (100)	232%	224%	16%	249%	226%	221%	18%	243%
0.5% (200)	281%	242%	102%	278%	278%	234%	98%	278%
0.4% (250)	334%	267%	104%	278%	334%	295%	99%	295%
0.2% (500)	368%	324%	289%	369%	368%	324%	289%	369%
0.1% (1000)	448%	269%	402%	342%	442%	252%	389%	316%
Est. AAL	**310%**	**250%**	**145%**	**277%**	**305%**	**245%**	**141%**	**272%**

Table 29. Percentage change in gross insurable occurrence and aggregate loss estimates, overall change - Puerto Rico

Puerto Rico								
All Perils (7.0) vs All Perils (8.0)								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20)	-96%	-92%	N/A	-95%	-97%	-92%	N/A	-95%
2% (50)	-86%	-76%	-99%	-82%	-86%	-76%	-99%	-82%
1% (100)	-78%	-67%	-97%	-73%	-77%	-66%	-97%	-72%
0.5% (200)	-65%	-44%	-92%	-52%	-68%	-46%	-93%	-55%
0.4% (250)	-62%	-41%	-89%	-52%	-62%	-41%	-89%	-54%
0.2% (500)	-56%	-36%	-78%	-46%	-58%	-36%	-80%	-47%
0.1% (1000)	-60%	-37%	-76%	-49%	-60%	-37%	-76%	-49%
Est. AAL	**-71%**	**-51%**	**-89%**	**-62%**	**-71%**	**-52%**	**-89%**	**-62%**

Table 30. Percentage change in gross insurable occurrence and aggregate loss estimates, overall change - St. Maarten

St. Maarten								
All Perils (7.0) vs All Perils (8.0)								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2% (50)	-94%	-95%	-95%	-95%	-94%	-95%	-95%	-95%
1% (100)	-77%	-81%	-50%	-79%	-79%	-83%	-53%	-80%
0.5% (200)	-37%	-41%	16%	-38%	-39%	-43%	11%	-40%
0.4% (250)	-33%	-34%	13%	-36%	-31%	-36%	9%	-38%
0.2% (500)	57%	77%	82%	72%	57%	77%	82%	72%
0.1% (1000)	108%	108%	162%	111%	103%	106%	146%	107%
Est. AAL	**-52%**	**-49%**	**-30%**	**-50%**	**-53%**	**-50%**	**-32%**	**-51%**

Table 31. Percentage change in gross insurable occurrence and aggregate loss estimates, overall change - St. Martin

St. Martin								
All Perils (7.0) vs All Perils (8.0)								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2% (50)	-82%	-93%	-86%	-89%	-83%	-93%	-87%	-90%
1% (100)	-44%	-75%	118%	-62%	-48%	-76%	103%	-64%
0.5% (200)	33%	-34%	164%	-12%	30%	-35%	159%	-14%
0.4% (250)	36%	-30%	180%	-10%	33%	-31%	175%	-12%
0.2% (500)	193%	115%	331%	149%	193%	115%	384%	149%
0.1% (1000)	297%	196%	>500%	230%	280%	184%	>500%	216%
Est. AAL	**-1%**	**-33%**	**114%**	**-22%**	**-3%**	**-34%**	**108%**	**-24%**

Table 32. Percentage change in gross insurable occurrence and aggregate loss estimates, overall change - Trinidad and Tobago

Trinidad and Tobago								
All Perils (7.0) vs All Perils (8.0)								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20)	-100%	-100%	N/A	-100%	-100%	-100%	N/A	-100%
2% (50)	-95%	-96%	-99%	-95%	-95%	-96%	-99%	-95%
1% (100)	-88%	-86%	-71%	-87%	-89%	-87%	-73%	-88%
0.5% (200)	-75%	-80%	-34%	-77%	-77%	-82%	-40%	-79%
0.4% (250)	-64%	-68%	-33%	-67%	-67%	-71%	-39%	-70%
0.2% (500)	-30%	-41%	-16%	-36%	-35%	-42%	-21%	-39%
0.1% (1000)	37%	26%	6%	23%	23%	13%	-4%	8%
Est. AAL	**-85%**	**-85%**	**-82%**	**-85%**	**-85%**	**-86%**	**-83%**	**-86%**

Table 33. Percentage change in gross insurable occurrence and aggregate loss estimates, overall change - U.S. Virgin Islands

U.S. Virgin Islands								
All Perils (7.0) vs All Perils (8.0)								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2% (50)	-100%	-97%	N/A	-98%	-100%	-97%	N/A	-98%
1% (100)	-90%	-87%	N/A	-90%	-91%	-88%	N/A	-90%
0.5% (200)	-57%	-52%	-98%	-54%	-59%	-53%	-98%	-56%
0.4% (250)	-53%	-43%	-98%	-47%	-54%	-44%	-98%	-49%
0.2% (500)	-35%	-10%	-90%	-19%	-35%	-12%	-90%	-19%
0.1% (1000)	-2%	19%	-67%	11%	-2%	19%	-68%	11%
Est. AAL	**-70%**	**-59%**	**-93%**	**-64%**	**-70%**	**-59%**	**-94%**	**-64%**

The following tables show the overall impact of the updates to the AIR Earthquake Model for the Caribbean on gross insurable occurrence and aggregate losses. These losses do not include demand surge. Loss changes represent the percentage change in loss estimates calculated by the previous version of Touchstone Re 7.0 as compared with those calculated by the current version of Touchstone Re 8.0 for all modeled islands/territories combined, as well as by selected islands/territories, using the 10,000-year standard catalog. Changes below represent changes due to model updates only. That is, changes are calculated by comparing losses from the Touchstone Re 7.0 and Touchstone Re 8.0 model versions, using the same industry exposure database in each model version.

Note that caution should be exercised before relating the industry changes shown here to a particular portfolio. The changes to individual books of business may deviate from the losses represented here to the extent that their spatial distribution and construction/occupancy mix deviate from industry averages.

Table 34. Percentage change in gross insurable occurrence and aggregate loss estimates, change with constant exposure - Caribbean

Caribbean - 10 Version 7.0 Countries								
All Perils (7.0) vs All Perils (8.0)								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Change with Constant Exposure							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20)	-63%	-55%	-67%	-58%	-68%	-60%	-71%	-62%
2% (50)	-36%	-23%	-21%	-31%	-42%	-26%	-27%	-34%
1% (100)	-26%	-4%	-6%	-9%	-31%	-7%	-12%	-15%
0.5% (200)	-27%	5%	2%	-15%	-26%	-5%	3%	-15%
0.4% (250)	-27%	-1%	7%	-15%	-29%	-3%	2%	-15%
0.2% (500)	-43%	-18%	7%	-22%	-46%	-14%	-4%	-29%
0.1% (1000)	-58%	-20%	-14%	-44%	-56%	-17%	-12%	-37%
Est. AAL	**-60%**	**-47%**	**-50%**	**-53%**	**-63%**	**-52%**	**-55%**	**-57%**

Table 35. Percentage change in gross insurable occurrence and aggregate loss estimates, change with constant exposure - Bahamas

Bahamas								
All Perils (7.0) vs All Perils (8.0)								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Change with Constant Exposure							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2% (50)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1% (100)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
0.5% (200)	>500%	>500%	144%	>500%	>500%	>500%	144%	>500%
0.4% (250)	>500%	>500%	199%	>500%	>500%	>500%	199%	>500%

Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Change with Constant Exposure							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
Bahamas								
All Perils (7.0) vs All Perils (8.0)								
0.2% (500)	>500%	>500%	>500%	>500%	>500%	>500%	>500%	>500%
0.1% (1000)	>500%	>500%	257%	>500%	>500%	>500%	257%	>500%
Est. AAL	**275%**	**160%**	**422%**	**208%**	**275%**	**160%**	**422%**	**208%**

Table 36. Percentage change in gross insurable occurrence and aggregate loss estimates, change with constant exposure - Barbados

Barbados								
All Perils (7.0) vs All Perils (8.0)								
Exceedance Probability % (Return Period, years)	**Insurable Occurrence**				**Insurable Aggregate**			
	Change with Constant Exposure							
	RES	**COM/ IND**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**AUTO**	**TOTAL**
5% (20)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2% (50)	-99%	-96%	N/A	-97%	-99%	-96%	N/A	-97%
1% (100)	-88%	-67%	-43%	-78%	-88%	-68%	-44%	-78%
0.5% (200)	-68%	-10%	-24%	-41%	-68%	-10%	-24%	-41%
0.4% (250)	-57%	11%	18%	-22%	-57%	11%	18%	-22%
0.2% (500)	-25%	127%	146%	34%	-25%	127%	146%	34%
0.1% (1000)	45%	180%	240%	110%	44%	178%	239%	110%
Est. AAL	**-46%**	**15%**	**33%**	**-17%**	**-47%**	**14%**	**32%**	**-17%**

Table 37. Percentage change in gross insurable occurrence and aggregate loss estimates, change with constant exposure - Cayman Islands

Cayman Islands								
All Perils (7.0) vs All Perils (8.0)								
Exceedance Probability % (Return Period, years)	**Insurable Occurrence**				**Insurable Aggregate**			
	Change with Constant Exposure							
	RES	**COM/ IND**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**AUTO**	**TOTAL**
5% (20)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2% (50)	-79%	-82%	N/A	-80%	-78%	-81%	N/A	-80%
1% (100)	-80%	-80%	-99%	-81%	-80%	-80%	-99%	-81%

Cayman Islands								
All Perils (7.0) vs All Perils (8.0)								
Exceedance Probability % (Return Period, years)	**Insurable Occurrence**				**Insurable Aggregate**			
	Change with Constant Exposure							
	RES	**COM/ IND**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**AUTO**	**TOTAL**
0.5% (200)	-79%	-81%	-92%	-80%	-79%	-81%	-92%	-80%
0.4% (250)	-76%	-78%	-76%	-77%	-77%	-79%	-78%	-79%
0.2% (500)	-67%	-72%	-54%	-70%	-66%	-70%	-54%	-67%
0.1% (1000)	-70%	-74%	-56%	-73%	-70%	-74%	-56%	-73%
Est. AAL	**-74%**	**-77%**	**-71%**	**-75%**	**-74%**	**-77%**	**-71%**	**-75%**

Table 38. Percentage change in gross insurable occurrence and aggregate loss estimates, change with constant exposure - Dominican Republic

Dominican Republic								
All Perils (7.0) vs All Perils (8.0)								
Exceedance Probability % (Return Period, years)	**Insurable Occurrence**				**Insurable Aggregate**			
	Change with Constant Exposure							
	RES	**COM/ IND**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**AUTO**	**TOTAL**
5% (20)	-64%	-65%	-82%	-65%	-64%	-66%	-83%	-66%
2% (50)	-45%	-45%	-47%	-45%	-44%	-45%	-49%	-44%
1% (100)	-24%	-11%	-3%	-17%	-27%	-14%	-8%	-20%
0.5% (200)	1%	2%	28%	3%	1%	1%	26%	3%
0.4% (250)	9%	13%	31%	12%	11%	13%	31%	13%
0.2% (500)	-3%	3%	46%	0%	-4%	2%	47%	-2%
0.1% (1000)	-1%	-10%	55%	-7%	1%	-8%	55%	-4%
Est. AAL	**-32%**	**-30%**	**-24%**	**-31%**	**-32%**	**-31%**	**-26%**	**-31%**

Table 39. Percentage change in gross insurable occurrence and aggregate loss estimates, change with constant exposure - Jamaica

Jamaica								
All Perils (7.0) vs All Perils (8.0)								
Exceedance Probability % (Return Period, years)	**Insurable Occurrence**				**Insurable Aggregate**			
	Change with Constant Exposure							
	RES	**COM/ IND**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**AUTO**	**TOTAL**
5% (20)	291%	>500%	-77%	407%	292%	>500%	-77%	389%

Jamaica								
All Perils (7.0) vs All Perils (8.0)								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Change with Constant Exposure							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
2% (50)	-15%	-23%	-77%	-18%	-16%	-22%	-78%	-18%
1% (100)	9%	-1%	-47%	17%	7%	-1%	-47%	15%
0.5% (200)	13%	38%	-9%	22%	12%	35%	-11%	21%
0.4% (250)	29%	56%	-9%	35%	29%	58%	-11%	35%
0.2% (500)	34%	117%	80%	93%	34%	117%	80%	93%
0.1% (1000)	53%	103%	125%	84%	51%	94%	119%	74%
Est. AAL	**23%**	**50%**	**11%**	**37%**	**21%**	**47%**	**9%**	**35%**

Table 40. Percentage change in gross insurable occurrence and aggregate loss estimates, change with constant exposure - Puerto Rico

Puerto Rico								
All Perils (7.0) vs All Perils (8.0)								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Change with Constant Exposure							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20)	-97%	-89%	N/A	-93%	-97%	-89%	N/A	-93%
2% (50)	-87%	-71%	-99%	-80%	-87%	-71%	-99%	-80%
1% (100)	-78%	-59%	-94%	-69%	-78%	-58%	-94%	-69%
0.5% (200)	-65%	-33%	-83%	-50%	-67%	-35%	-83%	-53%
0.4% (250)	-63%	-25%	-77%	-45%	-63%	-25%	-77%	-47%
0.2% (500)	-56%	-14%	-59%	-37%	-59%	-15%	-62%	-39%
0.1% (1000)	-66%	-24%	-51%	-45%	-66%	-24%	-51%	-45%
Est. AAL	**-73%**	**-43%**	**-78%**	**-59%**	**-73%**	**-44%**	**-78%**	**-59%**

Table 41. Percentage change in gross insurable occurrence and aggregate loss estimates, change with constant exposure - St. Maarten

St. Maarten								
All Perils (7.0) vs All Perils (8.0)								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Change with Constant Exposure							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2% (50)	-96%	-96%	-95%	-96%	-97%	-96%	-95%	-96%
1% (100)	-87%	-85%	-45%	-85%	-88%	-86%	-49%	-86%
0.5% (200)	-65%	-53%	27%	-57%	-66%	-55%	22%	-58%
0.4% (250)	-63%	-47%	24%	-53%	-62%	-49%	20%	-55%
0.2% (500)	-13%	40%	100%	24%	-13%	40%	100%	24%
0.1% (1000)	16%	65%	188%	52%	13%	63%	170%	50%
Est. AAL	**-73%**	**-60%**	**-23%**	**-64%**	**-74%**	**-61%**	**-25%**	**-64%**

Table 42. Percentage change in gross insurable occurrence and aggregate loss estimates, change with constant exposure - St. Martin

St. Martin								
All Perils (7.0) vs All Perils (8.0)								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Change with Constant Exposure							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2% (50)	-94%	-96%	-90%	-95%	-94%	-96%	-91%	-95%
1% (100)	-81%	-87%	49%	-84%	-82%	-88%	39%	-85%
0.5% (200)	-54%	-65%	81%	-61%	-55%	-66%	77%	-62%
0.4% (250)	-53%	-63%	91%	-60%	-54%	-64%	88%	-61%
0.2% (500)	1%	13%	194%	14%	1%	13%	231%	14%
0.1% (1000)	36%	56%	>500%	52%	31%	49%	496%	46%
Est. AAL	**-66%**	**-65%**	**46%**	**-64%**	**-67%**	**-66%**	**42%**	**-65%**

Table 43. Percentage change in gross insurable occurrence and aggregate loss estimates, change with constant exposure - Trinidad and Tobago

Trinidad and Tobago								
All Perils (7.0) vs All Perils (8.0)								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Change with Constant Exposure							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20)	-100%	-100%	N/A	-100%	-100%	-100%	N/A	-100%
2% (50)	-97%	-96%	-99%	-96%	-97%	-96%	-100%	-96%
1% (100)	-93%	-83%	-77%	-87%	-94%	-84%	-79%	-87%
0.5% (200)	-84%	-78%	-47%	-82%	-85%	-79%	-52%	-83%
0.4% (250)	-76%	-76%	-46%	-78%	-79%	-77%	-52%	-80%
0.2% (500)	-55%	-59%	-33%	-59%	-58%	-60%	-37%	-61%
0.1% (1000)	-26%	-28%	-16%	-29%	-34%	-36%	-23%	-37%
Est. AAL	**-91%**	**-89%**	**-85%**	**-90%**	**-91%**	**-90%**	**-86%**	**-91%**

Table 44. Percentage change in gross insurable occurrence and aggregate loss estimates, change with constant exposure - U.S. Virgin Islands

U.S. Virgin Islands								
All Perils (7.0) vs All Perils (8.0)								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Change with Constant Exposure							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2% (50)	-100%	-99%	N/A	-99%	-100%	-99%	N/A	-99%
1% (100)	-96%	-94%	N/A	-95%	-96%	-94%	N/A	-95%
0.5% (200)	-82%	-76%	-99%	-78%	-83%	-76%	-99%	-79%
0.4% (250)	-76%	-71%	-98%	-74%	-76%	-71%	-98%	-76%
0.2% (500)	-72%	-57%	-92%	-61%	-72%	-58%	-92%	-61%
0.1% (1000)	-56%	-45%	-66%	-47%	-56%	-45%	-67%	-47%
Est. AAL	**-85%**	**-80%**	**-94%**	**-83%**	**-86%**	**-80%**	**-94%**	**-83%**

6.4 Analysis Settings

Table 45. Touchstone Re analysis settings for model runs to determine the loss changes.

Setting	Selected Option(s)
Perils modeled	All Perils
Catalog	10,000-year Standard
Industry exposure vintage	December 2019
Take-up rates	N/A Analyses were done for insurable loss estimates only. Take-up rates do not apply.
Demand surge*	Off

* Development of region-specific demand-surge functions is currently underway at AIR. While AIR recommends incorporating demand surge into modeled loss estimates where appropriate, AIR makes no recommendation as to the form of the demand-surge function for tropical cyclones in the Caribbean. Clients may apply a user-defined demand-surge function if they choose.

7 The AIR Tropical Cyclone Model for the Caribbean

7.1 Overview of Model Updates and Changes

The AIR Tropical Cyclone Model for the Caribbean is updated in the 2020 release to include:

- The expansion of individually-supported islands/territories from 28 to 29
- The addition of four tropical cyclones to the historical event set
- An update to the Great Okeechobee Hurricane (1928) event in the historical event catalog
- An update to the stochastic event intensities in the 10K and 50K Standard and Warm Sea Surface Temperature (WSST) Catalogs
- The addition of an Extreme Disaster Scenario (EDS) Catalog with three supported hurricane events
- Support for many additional construction and occupancy classes, including infrastructure and marine (inland transit, marine cargo and hull, pleasure boats, and builder's risk)
- An implementation of a novel framework to accurately account for temporal and spatial variation in vulnerability
- Updated industry-level modeled losses to reflect the latest 90-m geographic resolution Industry Exposure Database for all modeled islands/territories in the Caribbean domain
- Revised policy terms and take-up rates

7.2 Catalogs and Event Sets

Historical Catalog

The historical catalog associated with the 2020 release of the AIR Tropical Cyclone Model for the Caribbean is updated with North Atlantic Hurricane Database, HURricane DATa 2nd generation (HURDAT2) data from the National Oceanic and Atmospheric Administration (NOAA) through 2017. The previous release included HURDAT2 data through 2007.

Stochastic Catalog

HURDAT2 data from 1950-2017 is the foundation of the AIR Tropical Cyclone Model for the Caribbean's stochastic catalogs. The frequency of tropical cyclone events in the Caribbean basin remained remarkably stable over the additional years (2008-2017) since the last model update. As a result, no major updates were required for stochastic event frequencies.

However, a subset of event intensities was updated to better represent the distribution of historically-observed intensities in the additional data.

The 2020 version of the AIR Tropical Cyclone Model for the Caribbean supports two 10,000-year (10K) and two 50,000-year (50K) stochastic catalogs, as did the previous version of this model:

- 10K Standard
- 10K Warm Sea Surface Temperature (WSST)
- 50K Standard
- 50K WSST

Historical Event Set

Based on HURDAT2 data through 2017, the historical catalog is updated to contain:

- Four additional hurricanes, expanding the number of historical events available in the AIR Tropical Cyclone Model for the Caribbean from 33 to 37 events. These four hurricanes include:
    - Gonzalo (2014)
    - Matthew (2016)
    - Irma (2017)
    - Maria (2017)
- One re-analyzed hurricane: The Great Okeechobee Hurricane (1928)

The Great Okeechobee Hurricane re-analysis resulted in:

- Minor track changes
- A weaker intensity over Puerto Rico
- A slightly faster forward speed as the storm moved across the Bahamas

Extreme Disaster Scenarios

New to the AIR Tropical Cyclone Model for the Caribbean is the support of an Extreme Disaster Scenarios (EDS) catalog with three events. These three events include:

Table 46. EDS descriptions

Event ID	Description	Islands/Territories Impacted
16	EDS South Caribbean Hurricane	Barbados, Trinidad and Tobago, Grenada, and Curaçao
17	EDS Greater Antilles Hurricane	Puerto Rico, Dominican Republic, Haiti, Cuba, British Virgin Islands, U.S. Virgin Islands, Saint Martin, and Sint Maarten

Event ID	Description	Islands/Territories Impacted
18	EDS Jamaica, Bahamas, Bermuda Hurricane	Jamaica, Cayman Islands, Bahamas, and Bermuda

7.3 Event Generation

There are no major changes to the AIR's stochastic catalog event generation module in the 2020 version of the AIR Tropical Cyclone Model for the Caribbean. Minor updates are made to the stochastic catalog event intensities based on the updated historical record.

Model Domain

Although the supported model domain has not changed, the number of supported individual islands/territories has been expanded from 28 to 29 in the 2020 version of the AIR Tropical Cyclone Model for the Caribbean. This expansion is a result of subsetting the Netherlands Antilles into Curaçao and the Netherlands BES (Bonaire, Sint Eustatius, and Saba).

Generating the Stochastic Catalog

Stochastic events in the 2020 version of the AIR Tropical Cyclone Model for the Caribbean were generated using successive sampling of event parameters fitted to the data on their historical counterparts. The modeled parameter distributions are developed hierarchically, such that the simulation of multiple cyclone parameters preserves statistical relationships between features of real tropical cyclones (e.g., the inverse relationship between storm intensity and size). Further details on the event simulation are described in the model documentation for the AIR Tropical Cyclone Model for the Caribbean, available on the AIR Client Portal.

No changes were made to the previous version of the AIR Tropical Cyclone Model for the Caribbean's stochastic catalog's storm frequencies and tracks because they are representative of current conditions. Minor intensity adjustments were made to some storms in the stochastic catalog, however, to address an underdispersion in the previous version of the AIR Tropical Cyclone Model for the Caribbean stochastic catalog's intensity distribution. Prior to the adjustment, the stochastic catalog's intensity distribution was under-dispersed with too many intermediate Category 1 and 2 strength hurricane events, and too few very low (tropical storms) and major Category 4 and 5 strength hurricane events on the Saffir-Simpson wind scale as compared to the historical tropical cyclone dataset. By making minor intensity adjustments, significant improvements resulted, especially in the five key regions of Puerto Rico, the U.S. and British Virgin Islands, the western Bahamas, western Cuba, and Trinidad and Tobago.

Impact of the Event Generation Update

Figure 26 shows the significant improvements to the tropical cyclone intensity distribution that resulted from making slight intensity adjustments to AIR's stochastic catalog. The updated stochastic catalog more closely represents the spread of probability mass in the historical tropical cyclone intensity distribution toward both the low and high ends of the wind speed spectrum, which is a substantial improvement to the underdispersed distribution present in the previous stochastic catalog.

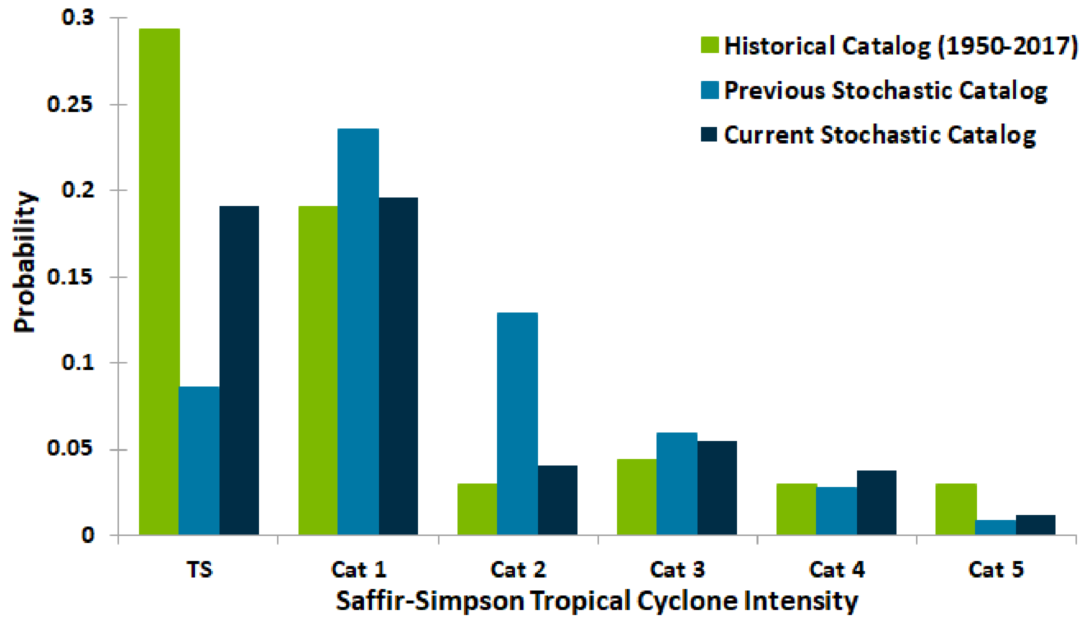


Figure 26. Comparison of probability density distributions of tropical cyclone event intensities for the previous stochastic catalog (blue), current stochastic catalog (dark blue), and historical event catalog (1950-2017; green) near Puerto Rico

Model loss changes resulting from intensity changes made to AIR's stochastic catalog in the 2020 version of the AIR Tropical Cyclone Model for the Caribbean are shown in the following figures. These figures show the event generation component gross insurable occurrence loss changes for all lines of business between the existing and the new 2020 version of the AIR Tropical Cyclone Model for the Caribbean over various return periods as well as the average annual loss (AAL) using the 2019 version of AIR's Caribbean Industry Exposure Database for a selected subset of modeled islands/territories. These loss changes represent tropical cyclone wind and precipitation-induced flood loss changes combined and do not include demand surge.

Minor intensity adjustments made to the stochastic event generation component of the AIR Tropical Cyclone Model for the Caribbean caused varying loss changes depending on island location. For Caribbean islands whose average annual tropical cyclone frequency is low, such as Trinidad and Tobago and Barbados, a decrease in losses across the exceedance probability curve is evident. This reduction is due to increasing the intensity probability dispersion and, hence, a greater likelihood of very weak storms. In contrast, islands whose average annual tropical cyclone frequency is relatively high, such as Saint Martin, Sint Maarten, Jamaica, and the Cayman Islands, experience an increase in losses across the exceedance probability curve. This increase is a result of a greater likelihood of storms not only at the lower end but also at the higher end on the hurricane intensity scale.

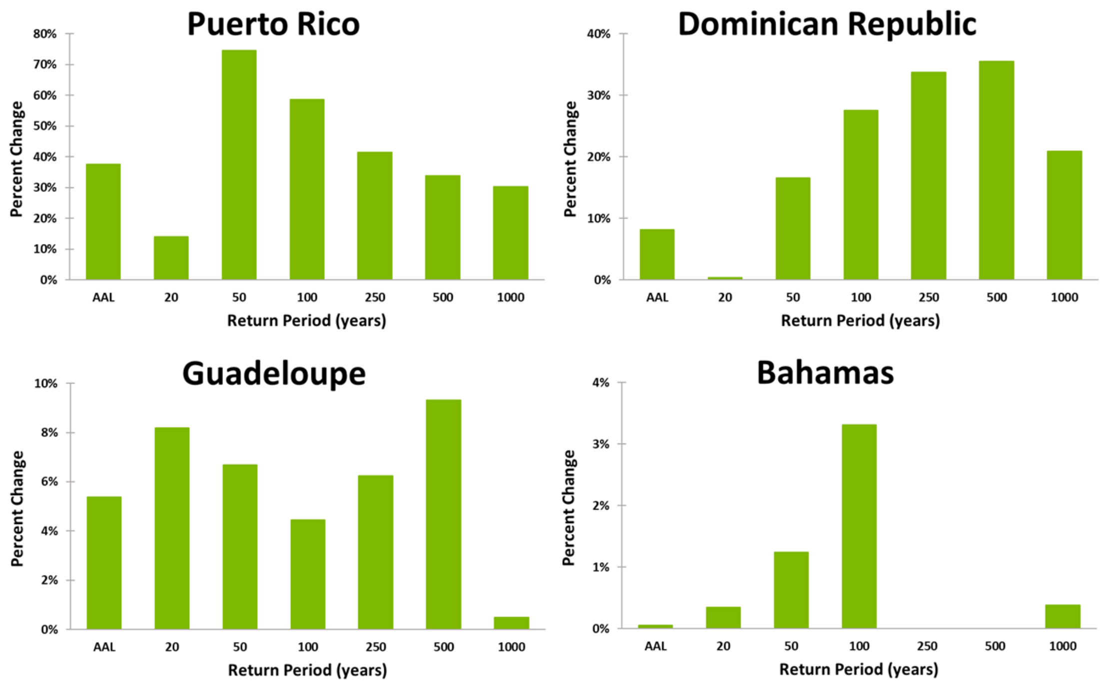


Figure 27. 10K Stochastic Catalog component gross insurable occurrence loss changes between the existing and the new 2020 version of the AIR Tropical Cyclone Model for the Caribbean for various return periods (and for the aggregate average annual loss (AAL)) for Puerto Rico (top left), the Dominican Republic (top right), Guadeloupe (bottom left), and the Bahamas (bottom right).

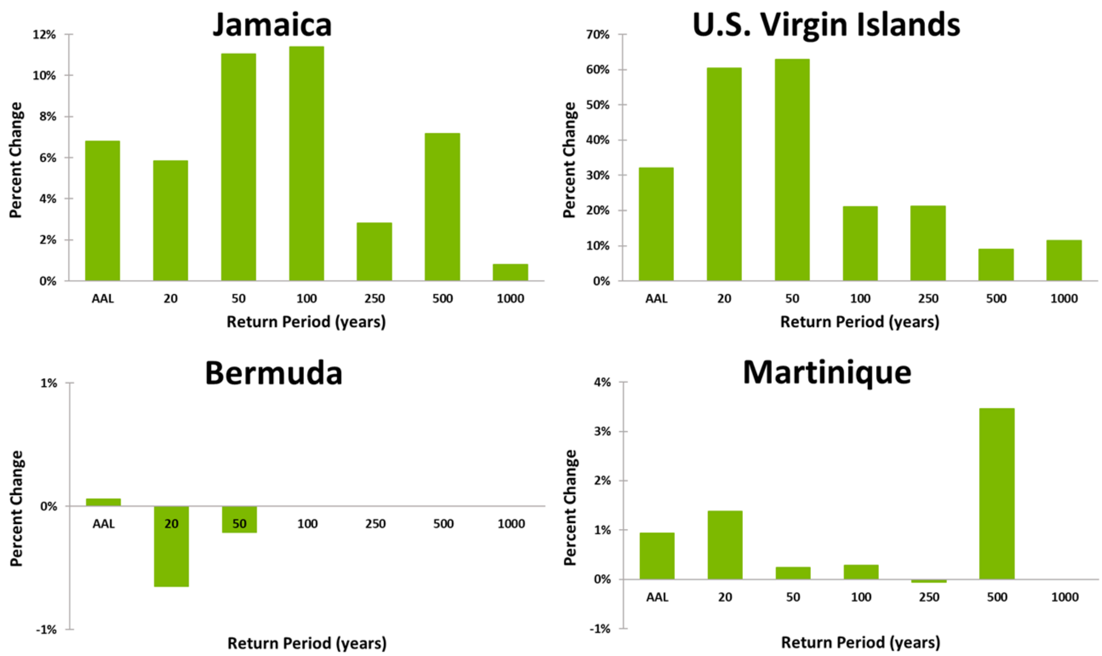


Figure 28. 10K Stochastic Catalog component gross insurable occurrence loss changes between the existing and the new 2020 version of the AIR Tropical Cyclone Model for the Caribbean for various return periods (and for the aggregate average annual loss (AAL)) for Jamaica (top left), the U.S. Virgin Islands (top right), Bermuda (bottom left), and Martinique (bottom right).

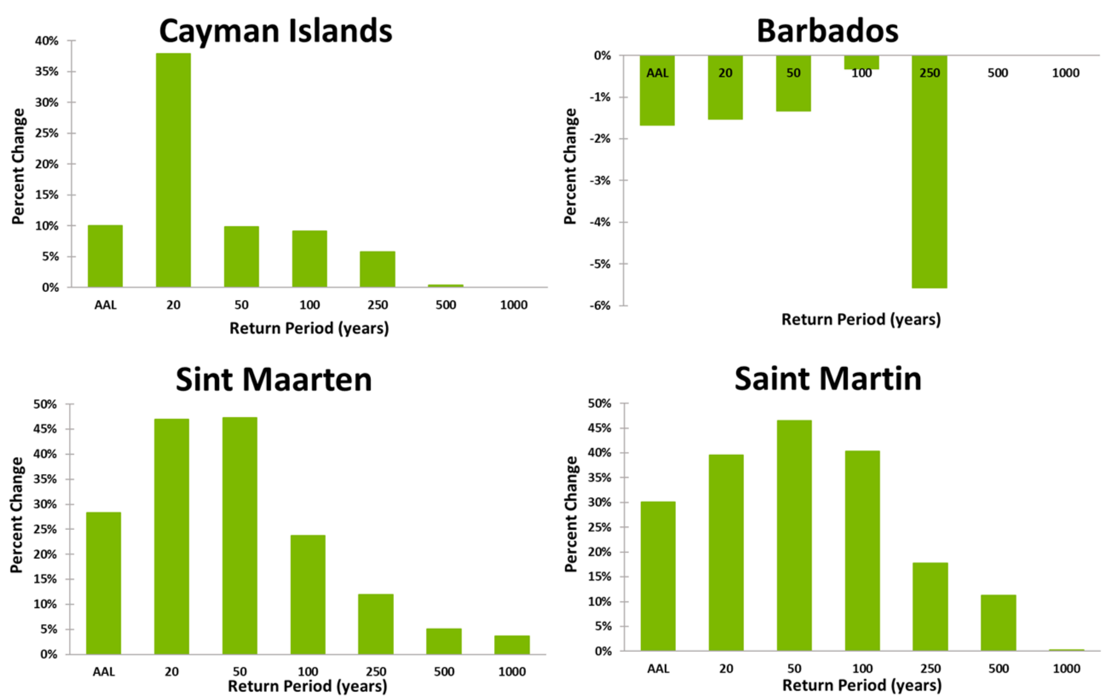


Figure 29. 10K Stochastic Catalog component gross insurable occurrence loss changes between the existing and the new 2020 version of the AIR Tropical Cyclone Model for the Caribbean for various return periods (and for

the aggregate average annual loss (AAL)) for the Cayman Islands (top left), Barbados (top right), Sint Maarten (bottom left), and Saint Martin (bottom right).

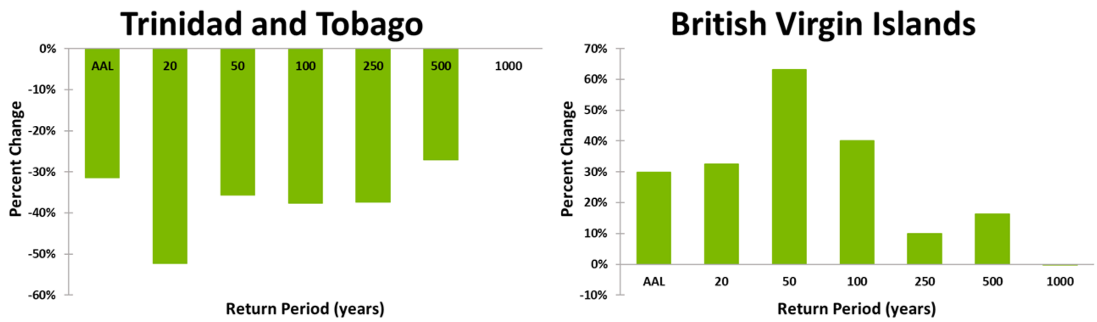


Figure 30. 10K Stochastic Catalog component gross insurable occurrence loss changes between the existing and the new 2020 version of the AIR Tropical Cyclone Model for the Caribbean for various return periods (and for the aggregate average annual loss (AAL)) for Trinidad and Tobago (left) and the British Virgin Islands (right).

7.4 Local Intensity Calculation

The previous (i.e. existing) version of the AIR Tropical Cyclone Model for the Caribbean calculates wind speeds on a 5 km x 5 km grid cell and then interpolates these wind speeds to 1-km resolution to create the wind speed intensity file. The physical properties (terrain roughness and elevation data) are applied to the intensity file wind speed values in the downstream loss code prior to being used by the damage functions. The 2020 version of this model, however, calculates wind speed directly on a 1 km x 1 km grid cell, applies physical properties *a priori* during this hazard calculation process, and outputs this final wind speed into the intensity file. Then, in the loss code, the final wind speeds are interpolated to the exposure locations to be used by the damage functions.

Impact of the Local Intensity Calculation Update

The direct calculation of maximum wind speed at a 1-km resolution in the 2020 version of the AIR Tropical Cyclone Model for the Caribbean made a relatively minor impact overall on the resulting losses. The following figures show the local intensity component gross insurable occurrence loss changes for all lines of business between the existing and the new 2020 version of the AIR Tropical Cyclone Model for the Caribbean over various return periods as well as the aggregate average annual loss (AAL) using the 2019 version of AIR's Caribbean Industry Exposure Database for a selected subset of modeled islands/territories. These loss changes represent tropical cyclone wind and precipitation-induced flood loss changes combined and do not include demand surge.

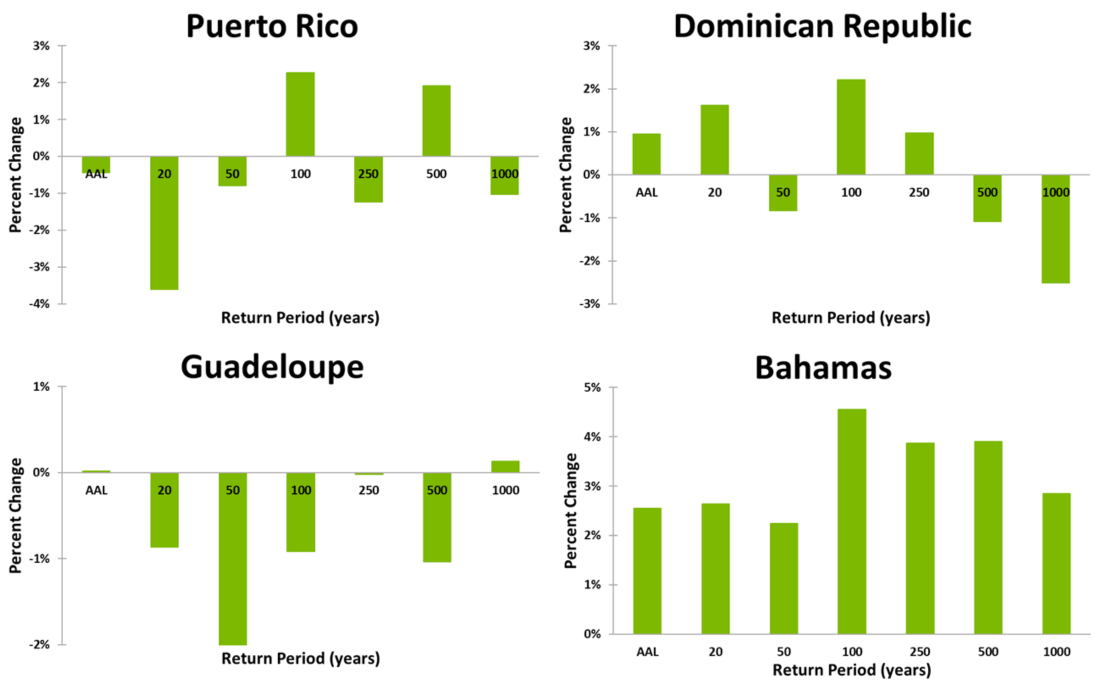


Figure 31. Local intensity component gross insurable occurrence loss changes between the existing and the new 2020 version of the AIR Tropical Cyclone Model for the Caribbean for various return periods (and for the aggregate average annual loss (AAL)) for Puerto Rico (top left), the Dominican Republic (top right), Guadeloupe (bottom left), and the Bahamas (bottom right).

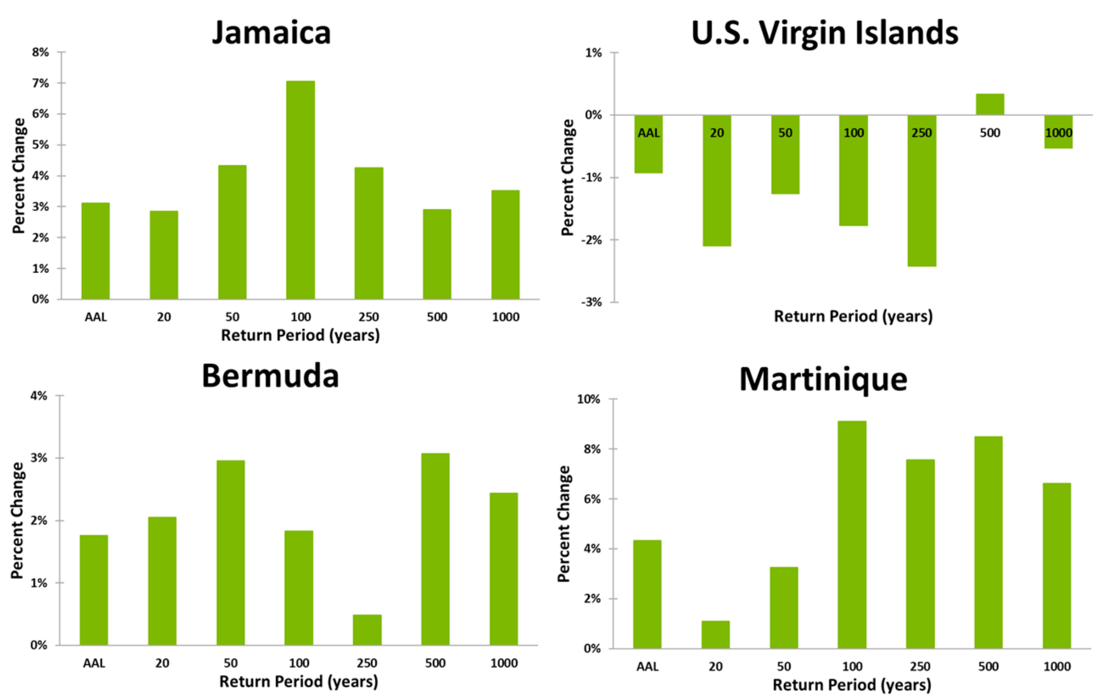


Figure 32. Local intensity gross insurable occurrence loss changes between the existing and the new 2020 version of the AIR Tropical Cyclone Model for the Caribbean for various return periods (and for the aggregate

average annual loss (AAL)) for Jamaica (top left), the U.S. Virgin Islands (top right), Bermuda (bottom left), and Martinique (bottom right).

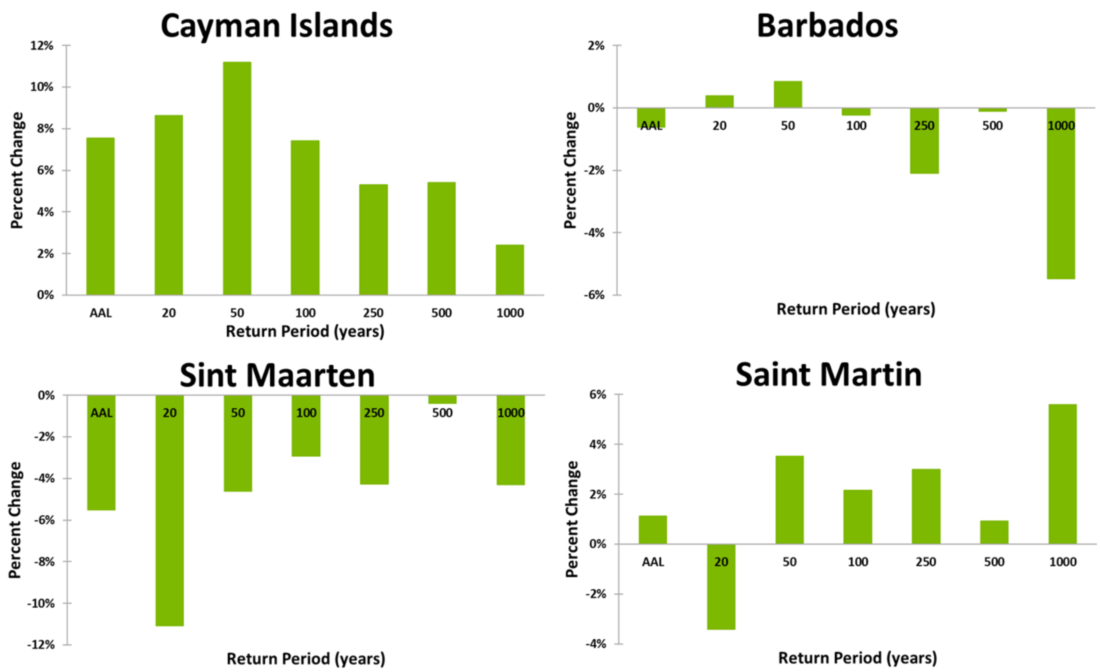


Figure 33. Local intensity gross insurable occurrence loss changes between the existing and the new 2020 version of the AIR Tropical Cyclone Model for the Caribbean for various return periods (and for the aggregate average annual loss (AAL)) for the Cayman Islands (top left), Barbados (top right), Sint Maarten (bottom left), and Saint Martin (bottom right).

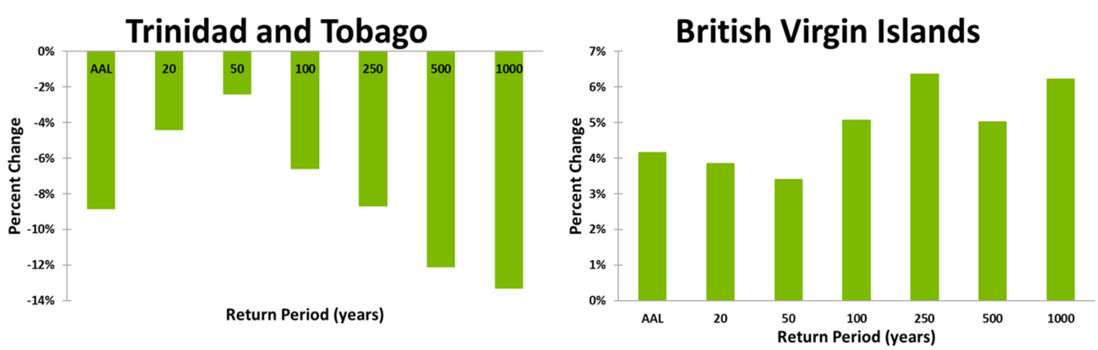


Figure 34. Local intensity gross insurable occurrence loss changes between the existing and the new 2020 version of the AIR Tropical Cyclone Model for the Caribbean for various return periods (and for the aggregate average annual loss (AAL)) for Trinidad and Tobago (left) and the British Virgin Islands (right).

7.5 Damage Estimation

The 2020 version of the AIR Tropical Cyclone Model for the Caribbean includes:

- Support for several new construction and occupancy codes, including infrastructure and marine risks
- Updates to the vulnerability framework to better account for spatial and temporal variation in vulnerability
- Updates to the damage distributions

For the 2020 update to the AIR Tropical Cyclone Model for the Caribbean, AIR performed a comprehensive assessment of the latest building codes, as well as construction and enforcement practices, for the Caribbean islands included in this model. In addition, AIR researchers performed damage surveys after recent major tropical cyclone events, and the data from these surveys, as well as the industry loss reports and claims data from these events, are incorporated into the updated model.

The data utilized, and the assumptions made for modeling the vulnerability of various risks, have been verified by experts and scientists familiar with the Caribbean Islands and their building stock characteristics. The modeled losses for the existing and new events in the select historical catalog have been carefully validated against the newly collected suite of industry loss reports, which accounts for the underlying uncertainties in reported losses and in the trending procedure. In addition, stochastic loss return periods have been validated by comparing them to the losses generated using the full historical catalog, which contains all historical events that have impacted the region since 1900.

The previous version of the model supported 37 construction classes and 111 occupancy classes. The 2020 version supports 123 construction classes and 114 occupancy classes. The additional construction classes (with categories in parentheses) are:

- 138-141 (Concrete)
- 157, 159 (Steel)
- 204-206 (Pavement)
- 211-212 (Dams)
- 231-233 (Chimneys)
- 234-238 (Towers)
- 241-246 (Equipment)
- 251-260 (Miscellaneous)
- 265-267 (Marine Craft)
- 270-276 (Marine Cargo)
- 2010-2016, 2021-2022, 2031 (Bridges)
- 2131-2132, 2141-2142, 2150-2152 (Tunnels)
- 2210 - 2211, 2221, 2231 - 2233, 2241 - 2243, 2251 - 2253, 2261 - 2263 (Storage Tanks)
- 2270 - 2276, 2281 - 2286 (Pipelines)

The additional occupancy classes (with categories in parentheses) are:

- 381 (Construction/Erection Risks - Miscellaneous)

- 382 (Construction/Erection Risks - Residential)
- 383 (Construction/Erection Risks - Commercial)
- 384 (Construction/Erection Risks - Industrial)

While the secondary risk features are not directly supported in the 2020 version of the AIR Tropical Cyclone Model for the Caribbean, their impact is implicitly taken into account in this model's damage functions and vulnerability framework. In particular, the common construction practices in each of the Caribbean islands have been carefully studied through a detailed building inventory analysis, an in-depth building code study, and first-hand observations of buildings and their characteristics during damage surveys. Moreover, the data collected and the assumptions made were verified with several experts in the field to assure they reflect the characteristics of a built environment in the Caribbean.

The 2020 version of the AIR Tropical Cyclone Model for the Caribbean uses updated secondary distributions that are informed by a large amount of location-level claims data and engineering considerations.

Impact of the Damage Estimation Update

Modeled losses resulting from damage estimation changes made to the 2020 version of the AIR Tropical Cyclone Model for the Caribbean are shown in the figures at the end of this section. These figures show the vulnerability component gross insurable occurrence loss changes for all lines of business between the existing and the new 2020 version of the AIR Tropical Cyclone Model for the Caribbean over various return periods as well as the aggregate average annual loss (AAL) using the 2019 version of AIR's Caribbean Industry Exposure Database for a selected subset of modeled islands/territories. These changes include both updates to the vulnerability functions as well as updates to the secondary distributions. Since they are shown from a gross loss perspective, the impact of secondary distributions on gross losses are represented in the figures.

In addition, Figure 39 (located at the end of this section) shows the vulnerability component gross insurable aggregate AAL changes using the 2019 Caribbean Industry Exposure Database between the existing and the new 2020 version of the model for selected lines of businesses and selected islands. These loss changes represent tropical cyclone wind and precipitation-induced flood loss changes combined and do not include demand surge. These changes include both updates to the vulnerability functions as well as updates to the secondary distributions. Since they are shown from a gross loss perspective, the impact of secondary distributions on gross losses are represented in the figure.

Vulnerability changes have resulted in increased losses in Puerto Rico, with increases being more significant for the commercial lines of business. These changes have been verified using damage surveys in the aftermath of Hurricane Maria (2017), loss reports from recent events, and location level claims data for commercial and industrial constructions in Puerto Rico.

Vulnerability changes have resulted in increased losses of varying degrees for several additional modeled Caribbean islands, including the Dominican Republic, Jamaica, Bermuda, Barbados, Saint Martin, and the British Virgin Islands, due to an increase in the vulnerability of both residential and commercial risks. This increase is partly the result of conversations with several experts familiar with building codes, permitting processes, and construction quality in these islands, which led to a better understanding of the level of wind vulnerability of structures on these islands. An update made to the secondary distributions intensifies the increase in gross losses across all return periods.

In contrast, vulnerability losses in the Cayman Islands, Sint Maarten, and the U.S. Virgin Islands have decreased by varying degrees as a result of updates made to various components of the AIR Tropical Cyclone Model for the Caribbean. In the Cayman Islands, for example, loss reduction in the commercial/industrial line of business is due to the relatively good building code enforcement on the island and is justified based on loss reports resulting from some of the major hurricanes that have affected the island, including hurricanes Michelle (2001) and Ivan (2004). In the case of the U.S. Virgin Islands, residential vulnerability has decreased. These changes are verified by the observations made following hurricanes Irma and Maria and the losses are validated for the islands of St. Croix, St. John, and St. Thomas using damage reports and losses from recent events.

Regarding the automobile line of business, a new damage function has been developed and is being used for all supported islands in the region. This new damage function is adjusted based on automobile loss reports from past significant events in many Caribbean islands. In general, the use of the new damage function results in a decrease in the low to medium return period losses and an increase in higher return period losses.

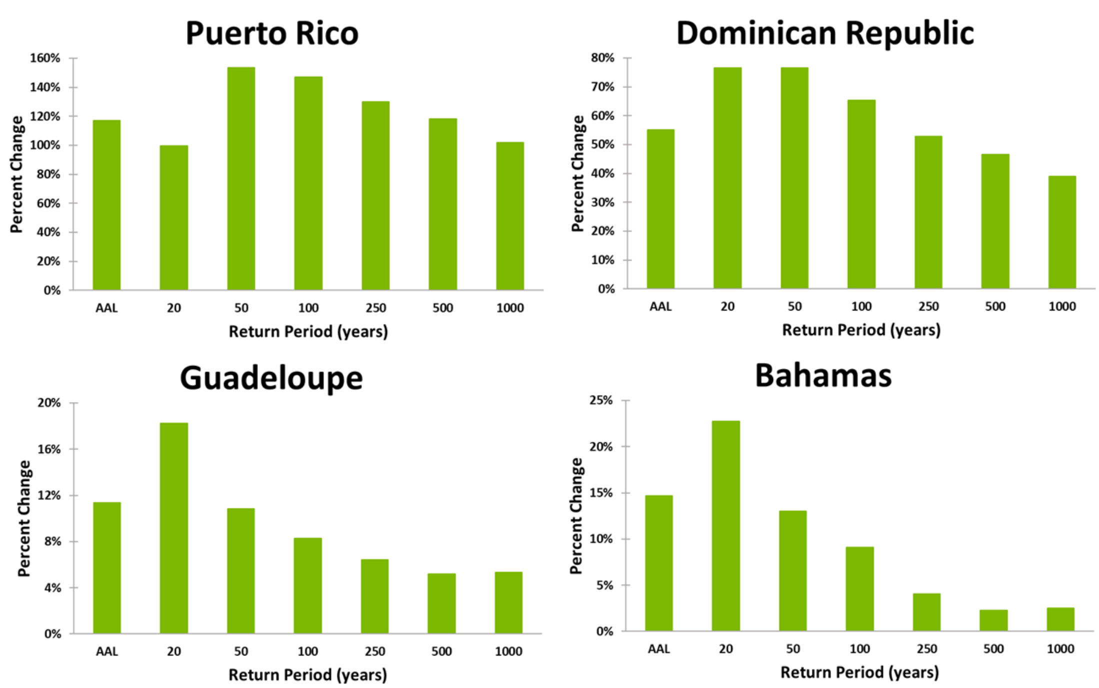


Figure 35. Vulnerability component gross insurable occurrence loss changes between the existing and the new 2020 version of the AIR Tropical Cyclone Model for the Caribbean for various return periods (and for the aggregate average annual loss (AAL)) for Puerto Rico (top left), the Dominican Republic (top right), Guadeloupe (bottom left), and the Bahamas (bottom right).

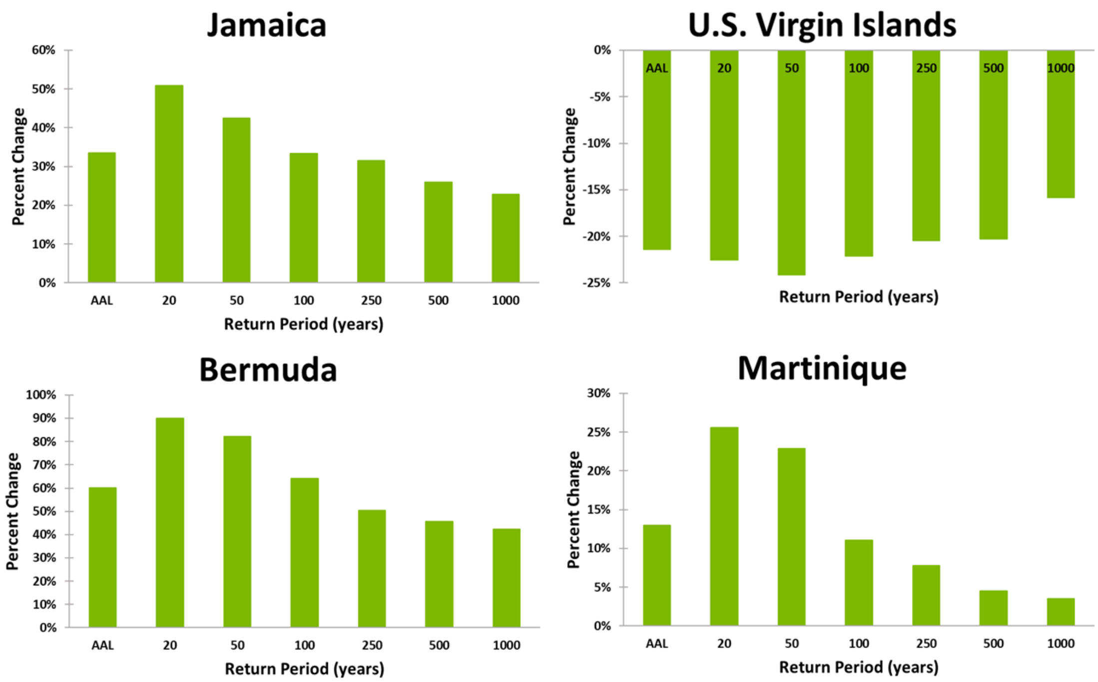


Figure 36. Vulnerability component gross insurable occurrence loss changes between the existing and the new 2020 version of the AIR Tropical Cyclone Model for the Caribbean for various return periods (and for the aggregate average annual loss (AAL)) for Jamaica (top left), the U.S. Virgin Islands (top right), Bermuda (bottom left), and Martinique (bottom right).

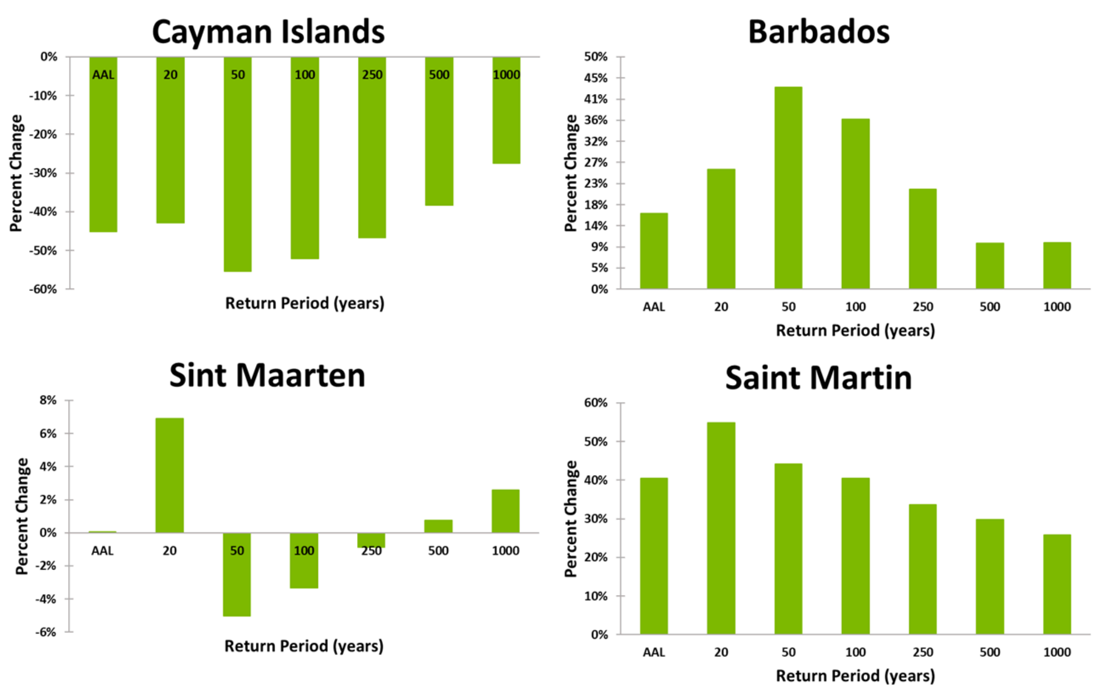


Figure 37. Vulnerability component gross insurable occurrence loss changes between the existing and the new 2020 version of the AIR Tropical Cyclone Model for the Caribbean for various return periods (and for the

aggregate average annual loss (AAL)) for the Cayman Islands (top left), Barbados (top right), Sint Maarten (bottom left), and Saint Martin (bottom right).

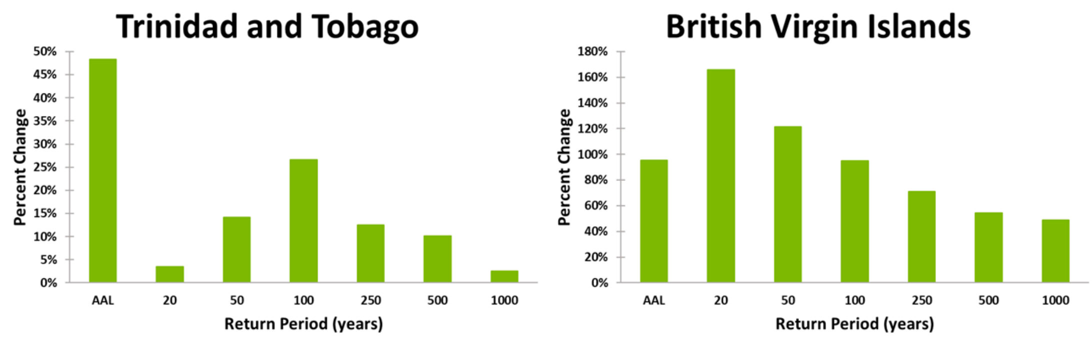


Figure 38. Vulnerability component gross insurable occurrence loss changes between the existing and the new 2020 version of the AIR Tropical Cyclone Model for the Caribbean for various return periods (and for the aggregate average annual loss (AAL)) for Trinidad and Tobago (left) and the British Virgin Islands (right).

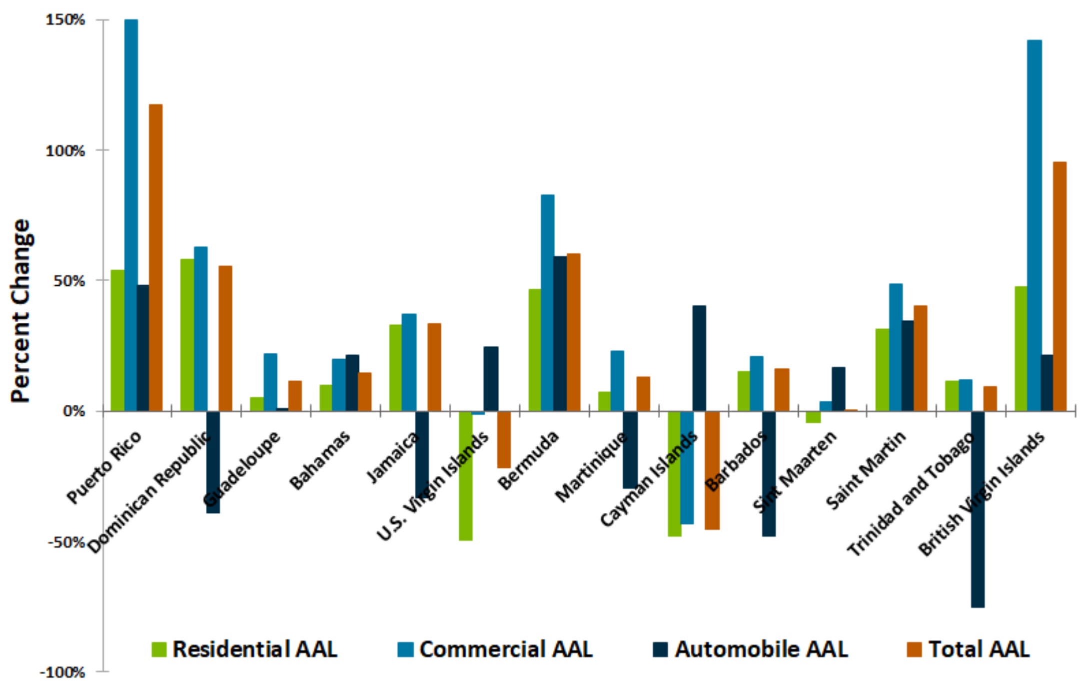


Figure 39. Vulnerability component gross insurable aggregate average annual loss (AAL) changes between the existing and the new 2020 version of the AIR Tropical Cyclone Model for the Caribbean for selected lines of businesses and selected islands.

7.6 Loss Calculation

The 2020 update to the AIR Tropical Cyclone Model for the Caribbean includes revised policy terms and take-up rates, updated industry loss values based on the 2019 AIR Industry Exposure Database for the Caribbean, and support for the loss estimation of several specialty risk types, including infrastructure and marine (inland transit, marine cargo and hull, pleasure boats, and builder's risk). For more details about the Industry Exposure Database, see the AIR Industry Exposure Databases for the Caribbean document, available on the AIR Client Portal.

The model loss calculations have been validated by using detailed claims data and industry loss estimates from client companies. The insured and economic industry losses were collected from various sources including Munich Re NatCat Service, Swiss Re, AON, AXCO, EM-Dat, PCS, and the French Insurance Federation. These loss estimates were collected not only for the newly added events, but also for historical events that were included in the previous version of the AIR Tropical Cyclone Model for the Caribbean to ensure modeled loss accuracy.

7.7 Industry Exposure Database

The 2020 AIR Tropical Cyclone Model for the Caribbean coincides with an updated 2019 version of the AIR Industry Exposure Database for the Caribbean. This latest Industry Exposure Database includes full insurable and insured updates, as well as updates to policy terms, take-up rates (to account for underinsurance in the market), construction mix, with special attention given to bunkers and mixed construction, and business interruption exposure modeling. The Caribbean Industry Exposure Database supports the 29 modeled islands/territories at 90-m resolution and provides a very accurate building construction, occupancy, and height mix database for the Caribbean. It also supports a wide array of risks including residential, commercial, industrial, hotels, large industrial facilities, and automobiles. Policy conditions are geared to specific lines in individual islands/territories together with insurance take-up rates that also reflect the case of undervaluation of risks which is rampant in the Caribbean. For more details, see the *AIR Industry Exposure Databases for the Caribbean* document, available on the AIR Client Portal.

7.8 General Impact of Model Updates on Loss Estimates

The following tables show the overall impact of the updates to the AIR Tropical Cyclone Model for the Caribbean on gross insurable occurrence and aggregate losses. These losses are due to tropical cyclone wind and precipitation-induced flood losses combined and do not include demand surge. Loss changes represent the percentage change in loss estimates calculated by the previous version of Touchstone Re 7.0 as compared with those calculated by the current version of Touchstone Re 8.0 for all modeled islands/territories combined, as well as by selected islands/territories, using the 10,000-year Standard catalog. Changes below represent overall change, including the effects of model updates and updated industry exposures.

As seen in the following tables, one of the more notable loss changes is Puerto Rico. Losses have increased in this island, with increases being more significant for commercial/

industrial and auto lines of business. This pattern is in line with adjustments made to the storm intensities in the new stochastic catalog as discussed previously. Also, these increases are partially due to the overall increase in the vulnerability of residential and commercial buildings. Changes (increases) in the modeled losses for Puerto Rico have been examined with respect to the return period of losses from Hurricane Maria, as well as the 1928 Hurricane that affected the island. The recurrence interval for these loss levels are in line with expected results given their intensities and the historical record.

Another location experiencing significant overall loss changes is the British Virgin Islands. Losses in the British Virgin Islands have significantly increased, particularly for commercial and industrial lines of business, but also for residential risks. Similar to Puerto Rico, these increases are a result of the storm intensity changes made to the stochastic catalog and vulnerability updates. These losses and their return periods have been carefully examined and validated against an extensive historical catalog dating back to 1900 as well as a newly-collected suite of industry loss reports. Results show the modeled losses are similar to the observed values.

Touchstone Re settings used in the associated model runs are provided in the next section.

For tables displaying "Overall Change" below, the left side of each table shows the change in industry gross insurable occurrence losses. These columns indicate the combined effects of all changes (e.g., updates to the catalog, policy conditions, take-up rates, post codes), including updated property values. Overall Changes are developed by comparing the total industry insurable losses in the prior industry loss file to the total insurable losses in the new industry loss file. In Touchstone Re, 100% sums insured based market shares are analyzed against each loss file and the percentage differences calculated in the resulting loss distributions.

Note that caution should be exercised before relating the industry changes shown here to a particular portfolio. The changes to individual books of business may deviate from the losses represented here to the extent that their spatial distribution and construction/occupancy mix deviate from industry averages.

Table 47. Percentage change in gross insurable occurrence and aggregate loss estimates due to tropical cyclone wind and precipitation-induced flood combined using the 10K Standard catalog in Touchstone Re for all modeled Caribbean islands/territories combined.

All Modeled Islands/Territories								
10K Standard Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	159%	114%	27%	128%	151%	106%	9%	124%
2% (50-yr)	126%	105%	52%	110%	135%	110%	43%	113%
1% (100-yr)	136%	100%	65%	103%	132%	104%	56%	112%

All Modeled Islands/Territories								
10K Standard Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
0.5% (200-yr)	115%	111%	97%	101%	126%	101%	94%	99%
0.4% (250-yr)	111%	101%	118%	103%	114%	83%	109%	98%
0.2% (500-yr)	113%	91%	135%	92%	120%	78%	122%	103%
0.1% (1000-yr)	117%	65%	108%	77%	118%	67%	108%	81%
Est. AAL	**152%**	**95%**	**6%**	**114%**	**152%**	**88%**	**-7%**	**109%**

Table 48. Percentage change in gross insurable occurrence and aggregate loss estimates due to tropical cyclone wind and precipitation-induced flood combined using the 10K Standard catalog in Touchstone Re for the Bahamas.

Bahamas								
10K Standard Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	278%	112%	143%	168%	284%	108%	120%	173%
2% (50-yr)	248%	122%	176%	171%	244%	123%	164%	165%
1% (100-yr)	230%	118%	126%	163%	216%	113%	123%	162%
0.5% (200-yr)	195%	104%	126%	143%	208%	107%	121%	146%
0.4% (250-yr)	197%	103%	93%	142%	194%	103%	100%	141%
0.2% (500-yr)	170%	103%	58%	128%	176%	108%	58%	133%
0.1% (1000-yr)	164%	108%	41%	126%	159%	101%	40%	121%
Est. AAL	**226%**	**103%**	**81%**	**149%**	**227%**	**101%**	**76%**	**147%**

Table 49. Percentage change in gross insurable occurrence and aggregate loss estimates due to tropical cyclone wind and precipitation-induced flood combined using the 10K Standard catalog in Touchstone Re for Barbados.

Barbados								
10K Standard Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	140%	51%	-92%	80%	143%	50%	-92%	81%

Barbados								
10K Standard Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
2% (50-yr)	199%	66%	-69%	111%	185%	58%	-71%	101%
1% (100-yr)	196%	60%	-24%	111%	194%	58%	-34%	109%
0.5% (200-yr)	147%	55%	84%	96%	147%	57%	64%	88%
0.4% (250-yr)	142%	54%	126%	95%	146%	56%	101%	100%
0.2% (500-yr)	107%	62%	118%	89%	111%	69%	83%	92%
0.1% (1000-yr)	96%	65%	83%	83%	96%	65%	83%	83%
Est. AAL	**118%**	**55%**	**-30%**	**80%**	**117%**	**54%**	**-34%**	**79%**

Table 50. Percentage change in gross insurable occurrence and aggregate loss estimates due to tropical cyclone wind and precipitation-induced flood combined using the 10K Standard catalog in Touchstone Re for Bermuda.

Bermuda								
10K Standard Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	104%	-9%	-4%	32%	101%	-7%	-6%	33%
2% (50-yr)	87%	-7%	-2%	27%	91%	-6%	-5%	29%
1% (100-yr)	83%	-8%	-13%	24%	84%	-8%	-14%	28%
0.5% (200-yr)	73%	-10%	-36%	19%	73%	-10%	-34%	19%
0.4% (250-yr)	84%	-12%	-39%	23%	84%	-11%	-38%	24%
0.2% (500-yr)	81%	-12%	-46%	23%	84%	-12%	-46%	24%
0.1% (1000-yr)	84%	-13%	-49%	23%	84%	-12%	-51%	23%
Est. AAL	**88%**	**-10%**	**-32%**	**26%**	**88%**	**-10%**	**-32%**	**26%**

Table 51. Percentage change in gross insurable occurrence and aggregate loss estimates due to tropical cyclone wind and precipitation-induced flood combined using the 10K Standard catalog in Touchstone Re for the British Virgin Islands.

British Virgin Islands								
10K Standard Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	494%	292%	135%	341%	480%	282%	109%	319%
2% (50-yr)	436%	346%	309%	372%	432%	327%	298%	362%
1% (100-yr)	275%	231%	170%	248%	276%	231%	168%	245%
0.5% (200-yr)	183%	167%	73%	170%	192%	177%	80%	172%
0.4% (250-yr)	173%	146%	61%	154%	181%	141%	64%	150%
0.2% (500-yr)	155%	129%	37%	133%	142%	128%	41%	126%
0.1% (1000-yr)	111%	98%	19%	100%	119%	104%	23%	105%
Est. AAL	**272%**	**206%**	**88%**	**222%**	**272%**	**204%**	**86%**	**221%**

Table 52. Percentage change in gross insurable occurrence and aggregate loss estimates due to tropical cyclone wind and precipitation-induced flood combined using the 10K Standard catalog in Touchstone Re for the Cayman Islands.

Cayman Islands								
10K Standard Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	184%	-14%	121%	52%	171%	-17%	118%	46%
2% (50-yr)	98%	-24%	201%	23%	105%	-23%	206%	26%
1% (100-yr)	83%	-22%	177%	24%	85%	-21%	168%	23%
0.5% (200-yr)	84%	-22%	121%	22%	84%	-23%	111%	22%
0.4% (250-yr)	77%	-22%	105%	27%	82%	-22%	110%	21%
0.2% (500-yr)	94%	-18%	55%	29%	94%	-18%	55%	29%
0.1% (1000-yr)	115%	-5%	33%	43%	115%	-6%	33%	42%
Est. AAL	**108%**	**-18%**	**94%**	**32%**	**109%**	**-18%**	**93%**	**32%**

Table 53. Percentage change in gross insurable occurrence and aggregate loss estimates due to tropical cyclone wind and precipitation-induced flood combined using the 10K Standard catalog in Touchstone Re for the Dominican Republic.

Dominican Republic								
10K Standard Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	405%	179%	6%	251%	373%	161%	-7%	233%
2% (50-yr)	458%	289%	163%	325%	419%	275%	119%	303%
1% (100-yr)	454%	316%	266%	374%	450%	296%	213%	359%
0.5% (200-yr)	405%	303%	245%	326%	414%	313%	244%	327%
0.4% (250-yr)	394%	315%	269%	335%	383%	310%	264%	336%
0.2% (500-yr)	375%	275%	328%	315%	335%	276%	292%	287%
0.1% (1000-yr)	294%	200%	187%	243%	288%	196%	187%	238%
Est. AAL	**344%**	**195%**	**57%**	**248%**	**337%**	**185%**	**42%**	**239%**

Table 54. Percentage change in gross insurable occurrence and aggregate loss estimates due to tropical cyclone wind and precipitation-induced flood combined using the 10K Standard catalog in Touchstone Re for Guadeloupe.

Guadeloupe								
10K Standard Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	354%	69%	50%	164%	341%	68%	27%	164%
2% (50-yr)	245%	57%	127%	120%	254%	64%	128%	132%
1% (100-yr)	187%	54%	102%	109%	188%	53%	98%	113%
0.5% (200-yr)	162%	55%	63%	99%	166%	56%	59%	100%
0.4% (250-yr)	162%	54%	72%	98%	160%	52%	74%	98%
0.2% (500-yr)	135%	53%	47%	88%	154%	56%	50%	95%
0.1% (1000-yr)	136%	49%	42%	88%	129%	50%	41%	81%
Est. AAL	**206%**	**55%**	**47%**	**114%**	**208%**	**54%**	**43%**	**114%**

Table 55. Percentage change in gross insurable occurrence and aggregate loss estimates due to tropical cyclone wind and precipitation-induced flood combined using the 10K Standard catalog in Touchstone Re for Jamaica.

Jamaica								
10K Standard Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	460%	280%	-5%	346%	444%	263%	-12%	331%
2% (50-yr)	434%	303%	127%	356%	422%	309%	97%	351%
1% (100-yr)	364%	295%	206%	332%	382%	304%	180%	353%
0.5% (200-yr)	321%	259%	202%	285%	329%	249%	181%	289%
0.4% (250-yr)	296%	246%	171%	258%	296%	245%	161%	257%
0.2% (500-yr)	277%	259%	158%	285%	277%	251%	158%	282%
0.1% (1000-yr)	246%	213%	114%	232%	246%	213%	108%	232%
Est. AAL	**348%**	**254%**	**47%**	**292%**	**349%**	**252%**	**40%**	**291%**

Table 56. Percentage change in gross insurable occurrence and aggregate loss estimates due to tropical cyclone wind and precipitation-induced flood combined using the 10K Standard catalog in Touchstone Re for Martinique.

Martinique								
10K Standard Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	239%	79%	-75%	125%	229%	70%	-77%	119%
2% (50-yr)	299%	88%	-23%	156%	282%	83%	-36%	143%
1% (100-yr)	296%	116%	45%	174%	281%	131%	23%	183%
0.5% (200-yr)	226%	151%	143%	173%	215%	151%	127%	167%
0.4% (250-yr)	215%	149%	168%	185%	213%	142%	166%	182%
0.2% (500-yr)	172%	108%	108%	135%	166%	109%	109%	136%
0.1% (1000-yr)	131%	97%	71%	114%	131%	97%	71%	114%
Est. AAL	**182%**	**85%**	**-6%**	**120%**	**180%**	**81%**	**-13%**	**117%**

Table 57. Percentage change in gross insurable occurrence and aggregate loss estimates due to tropical cyclone wind and precipitation-induced flood combined using the 10K Standard catalog in Touchstone Re for Puerto Rico.

Puerto Rico								
10K Standard Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	21%	40%	-65%	24%	20%	41%	-68%	19%
2% (50-yr)	67%	143%	42%	123%	65%	140%	19%	117%
1% (100-yr)	33%	109%	108%	89%	34%	111%	84%	91%
0.5% (200-yr)	12%	74%	141%	61%	16%	78%	123%	65%
0.4% (250-yr)	11%	71%	164%	58%	11%	66%	139%	49%
0.2% (500-yr)	19%	59%	151%	51%	19%	60%	140%	52%
0.1% (1000-yr)	13%	49%	185%	32%	13%	49%	168%	32%
Est. AAL	**27%**	**73%**	**-21%**	**55%**	**27%**	**71%**	**-29%**	**53%**

Table 58. Percentage change in gross insurable occurrence and aggregate loss estimates due to tropical cyclone wind and precipitation-induced flood combined using the 10K Standard catalog in Touchstone Re for Saint Martin.

Saint Martin								
10K Standard Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	>500%	345%	143%	453%	>500%	338%	130%	447%
2% (50-yr)	>500%	367%	451%	470%	>500%	365%	417%	464%
1% (100-yr)	>500%	304%	316%	384%	>500%	305%	302%	378%
0.5% (200-yr)	412%	230%	176%	284%	441%	238%	183%	295%
0.4% (250-yr)	425%	240%	173%	298%	423%	241%	177%	288%
0.2% (500-yr)	334%	181%	110%	226%	352%	190%	120%	236%
0.1% (1000-yr)	284%	161%	77%	194%	303%	170%	75%	207%
Est. AAL	**>500%**	**271%**	**163%**	**343%**	**>500%**	**271%**	**159%**	**343%**

Table 59. Percentage change in gross insurable occurrence and aggregate loss estimates due to tropical cyclone wind and precipitation-induced flood combined using the 10K Standard catalog in Touchstone Re for Sint Maarten.

Sint Maarten								
10K Standard Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	155%	11%	59%	51%	157%	12%	40%	50%
2% (50-yr)	148%	11%	137%	51%	147%	11%	127%	51%
1% (100-yr)	103%	-3%	84%	29%	102%	-2%	87%	30%
0.5% (200-yr)	79%	-5%	46%	20%	85%	-2%	48%	24%
0.4% (250-yr)	78%	-4%	24%	21%	79%	-4%	24%	21%
0.2% (500-yr)	80%	2%	10%	24%	80%	3%	10%	27%
0.1% (1000-yr)	76%	6%	3%	27%	79%	3%	5%	27%
Est. AAL	**116%**	**5%**	**29%**	**37%**	**117%**	**5%**	**27%**	**37%**

Table 60. Percentage change in gross insurable occurrence and aggregate loss estimates due to tropical cyclone wind and precipitation-induced flood combined using the 10K Standard catalog in Touchstone Re for Trinidad and Tobago.

Trinidad and Tobago								
10K Standard Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	-27%	-66%	-99%	-53%	-29%	-66%	-99%	-55%
2% (50-yr)	16%	-41%	-97%	-22%	14%	-42%	-97%	-23%
1% (100-yr)	16%	-37%	-91%	-18%	18%	-37%	-92%	-18%
0.5% (200-yr)	10%	-44%	-84%	-25%	7%	-47%	-85%	-29%
0.4% (250-yr)	3%	-49%	-82%	-30%	1%	-47%	-83%	-29%
0.2% (500-yr)	-3%	-49%	-68%	-33%	-3%	-48%	-71%	-33%
0.1% (1000-yr)	12%	-29%	-10%	-15%	12%	-30%	-9%	-15%
Est. AAL	**-1%**	**-43%**	**-82%**	**-28%**	**-1%**	**-43%**	**-82%**	**-29%**

Table 61. Percentage change in gross insurable occurrence and aggregate loss estimates due to tropical cyclone wind and precipitation-induced flood combined using the 10K Standard catalog in Touchstone Re for the U.S. Virgin Islands.

U.S. Virgin Islands								
10K Standard Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	25%	114%	71%	81%	22%	111%	57%	79%
2% (50-yr)	11%	114%	153%	65%	10%	109%	148%	68%
1% (100-yr)	-14%	78%	53%	26%	-15%	74%	48%	27%
0.5% (200-yr)	-16%	66%	41%	34%	-14%	73%	44%	35%
0.4% (250-yr)	-15%	74%	31%	31%	-14%	71%	30%	33%
0.2% (500-yr)	-19%	56%	5%	21%	-18%	62%	8%	27%
0.1% (1000-yr)	-12%	67%	20%	32%	-9%	74%	20%	38%
Est. AAL	**-4%**	**81%**	**38%**	**44%**	**-4%**	**81%**	**36%**	**44%**

The following tables show the overall impact of the updates to the AIR Tropical Cyclone Model for the Caribbean on gross insurable occurrence and aggregate losses. These losses are due to tropical cyclone wind and precipitation-induced flood losses combined and do not include demand surge. Loss changes represent the percentage change in loss estimates calculated by the previous version of Touchstone Re 7.0 as compared with those calculated by the current version of Touchstone Re 8.0 for all modeled islands/territories combined, as well as by selected islands/territories, using the 10,000-year Standard catalog. Changes below represent changes due to model updates only. That is, changes are calculated by comparing losses from the Touchstone Re 7.0 and Touchstone Re 8.0 model versions, using the same Industry Exposure Database in each model version.

Note that caution should be exercised before relating the industry changes shown here to a particular portfolio. The changes to individual books of business may deviate from the losses represented here to the extent that their spatial distribution and construction/occupancy mix deviate from industry averages.

Table 62. Percentage change in gross insurable occurrence and aggregate loss estimates due to tropical cyclone wind and precipitation-induced flood combined using the 10K Standard catalog in Touchstone Re with constant exposure for all modeled Caribbean islands/territories combined.

All Modeled Islands/Territories								
10K Standard Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Change with Constant Exposure							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	44%	52%	38%	50%	42%	51%	18%	49%
2% (50-yr)	26%	60%	87%	47%	28%	59%	68%	47%
1% (100-yr)	29%	51%	112%	41%	34%	57%	92%	42%
0.5% (200-yr)	17%	62%	137%	38%	24%	61%	120%	35%
0.4% (250-yr)	18%	63%	162%	41%	19%	47%	141%	39%
0.2% (500-yr)	15%	64%	222%	43%	21%	51%	201%	43%
0.1% (1000-yr)	21%	46%	243%	43%	18%	47%	239%	43%
Est. AAL	**38%**	**42%**	**30%**	**40%**	**38%**	**36%**	**13%**	**36%**

Table 63. Percentage change in gross insurable occurrence and aggregate loss estimates due to tropical cyclone wind and precipitation-induced flood combined using the 10K Standard catalog in Touchstone Re with constant exposure for the Bahamas.

Bahamas								
10K Standard Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Change with Constant Exposure							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	56%	5%	51%	23%	56%	5%	39%	24%
2% (50-yr)	41%	11%	83%	22%	42%	11%	74%	22%
1% (100-yr)	36%	6%	51%	21%	34%	5%	52%	20%
0.5% (200-yr)	24%	-1%	56%	12%	31%	2%	55%	15%
0.4% (250-yr)	26%	-1%	43%	12%	25%	-1%	36%	11%
0.2% (500-yr)	15%	0%	14%	6%	15%	1%	14%	6%
0.1% (1000-yr)	12%	2%	3%	5%	10%	0%	2%	2%
Est. AAL	**36%**	**1%**	**20%**	**14%**	**36%**	**0%**	**16%**	**14%**

Table 64. Percentage change in gross insurable occurrence and aggregate loss estimates due to tropical cyclone wind and precipitation-induced flood combined using the 10K Standard catalog in Touchstone Re with constant exposure for Barbados.

Barbados								
10K Standard Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Change with Constant Exposure							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	37%	-3%	-94%	9%	36%	-3%	-94%	10%
2% (50-yr)	65%	6%	-75%	26%	57%	2%	-77%	21%
1% (100-yr)	62%	3%	-39%	26%	59%	2%	-47%	23%
0.5% (200-yr)	22%	-2%	40%	9%	22%	-4%	25%	12%
0.4% (250-yr)	14%	-5%	76%	7%	13%	-3%	56%	6%
0.2% (500-yr)	5%	1%	74%	6%	10%	6%	46%	7%
0.1% (1000-yr)	-2%	2%	36%	1%	-2%	2%	36%	1%
Est. AAL	**15%**	**-2%**	**-46%**	**5%**	**15%**	**-3%**	**-49%**	**4%**

Table 65. Percentage change in gross insurable occurrence and aggregate loss estimates due to tropical cyclone wind and precipitation-induced flood combined using the 10K Standard catalog in Touchstone Re with constant exposure for Bermuda.

Bermuda								
10K Standard Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Change with Constant Exposure							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	29%	22%	114%	26%	28%	24%	109%	28%
2% (50-yr)	19%	21%	118%	23%	21%	24%	114%	26%
1% (100-yr)	16%	20%	92%	20%	16%	22%	93%	24%
0.5% (200-yr)	11%	17%	45%	14%	11%	17%	47%	14%
0.4% (250-yr)	16%	16%	35%	17%	17%	19%	37%	19%
0.2% (500-yr)	15%	17%	18%	17%	16%	17%	18%	19%
0.1% (1000-yr)	16%	15%	13%	15%	16%	15%	10%	15%
Est. AAL	**20%**	**19%**	**53%**	**20%**	**20%**	**19%**	**53%**	**20%**

Table 66. Percentage change in gross insurable occurrence and aggregate loss estimates due to tropical cyclone wind and precipitation-induced flood combined using the 10K Standard catalog in Touchstone Re with constant exposure for the British Virgin Islands.

British Virgin Islands								
10K Standard Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Change with Constant Exposure							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	133%	199%	99%	182%	136%	192%	79%	167%
2% (50-yr)	112%	242%	251%	204%	114%	225%	243%	196%
1% (100-yr)	46%	154%	132%	123%	49%	153%	131%	120%
0.5% (200-yr)	13%	104%	48%	73%	13%	111%	55%	74%
0.4% (250-yr)	8%	87%	37%	63%	8%	82%	42%	60%
0.2% (500-yr)	0%	76%	18%	49%	-5%	74%	21%	45%
0.1% (1000-yr)	-18%	51%	2%	29%	-15%	56%	6%	31%
Est. AAL	**48%**	**134%**	**61%**	**106%**	**48%**	**132%**	**59%**	**105%**

Table 67. Percentage change in gross insurable occurrence and aggregate loss estimates due to tropical cyclone wind and precipitation-induced flood combined using the 10K Standard catalog in Touchstone Re with constant exposure for the Cayman Islands.

Cayman Islands								
10K Standard Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Change with Constant Exposure							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	3%	-5%	109%	-5%	-3%	-8%	104%	-6%
2% (50-yr)	-25%	-30%	177%	-25%	-24%	-28%	181%	-24%
1% (100-yr)	-31%	-33%	154%	-29%	-30%	-32%	146%	-29%
0.5% (200-yr)	-31%	-33%	102%	-31%	-31%	-34%	93%	-31%
0.4% (250-yr)	-31%	-31%	87%	-28%	-31%	-34%	92%	-31%
0.2% (500-yr)	-26%	-28%	46%	-25%	-26%	-28%	46%	-25%
0.1% (1000-yr)	-17%	-21%	21%	-18%	-17%	-21%	21%	-18%
Est. AAL	**-23%**	**-25%**	**80%**	**-22%**	**-23%**	**-25%**	**79%**	**-22%**

Table 68. Percentage change in gross insurable occurrence and aggregate loss estimates due to tropical cyclone wind and precipitation-induced flood combined using the 10K Standard catalog in Touchstone Re with constant exposure for the Dominican Republic.

Dominican Republic								
10K Standard Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Change with Constant Exposure							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	91%	42%	-40%	58%	83%	35%	-47%	45%
2% (50-yr)	110%	85%	43%	94%	98%	76%	22%	80%
1% (100-yr)	112%	105%	103%	115%	110%	97%	74%	104%
0.5% (200-yr)	87%	100%	92%	86%	89%	97%	98%	95%
0.4% (250-yr)	83%	99%	103%	96%	82%	104%	101%	94%
0.2% (500-yr)	82%	80%	106%	85%	61%	77%	88%	74%
0.1% (1000-yr)	48%	63%	48%	56%	46%	60%	47%	53%
Est. AAL	**69%**	**52%**	**-15%**	**56%**	**66%**	**47%**	**-23%**	**52%**

Table 69. Percentage change in gross insurable occurrence and aggregate loss estimates due to tropical cyclone wind and precipitation-induced flood combined using the 10K Standard catalog in Touchstone Re with constant exposure for Guadeloupe.

Guadeloupe								
10K Standard Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Change with Constant Exposure							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	105%	30%	13%	54%	99%	29%	-4%	53%
2% (50-yr)	56%	21%	70%	30%	60%	26%	71%	37%
1% (100-yr)	29%	18%	52%	24%	30%	18%	49%	25%
0.5% (200-yr)	18%	19%	22%	18%	20%	20%	20%	18%
0.4% (250-yr)	18%	18%	29%	18%	17%	16%	30%	17%
0.2% (500-yr)	6%	18%	11%	13%	15%	19%	12%	16%
0.1% (1000-yr)	7%	14%	7%	13%	3%	15%	6%	8%
Est. AAL	**38%**	**19%**	**10%**	**26%**	**39%**	**19%**	**7%**	**26%**

Table 70. Percentage change in gross insurable occurrence and aggregate loss estimates due to tropical cyclone wind and precipitation-induced flood combined using the 10K Standard catalog in Touchstone Re with constant exposure for Jamaica.

Jamaica								
10K Standard Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Change with Constant Exposure							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	72%	21%	-58%	39%	67%	18%	-61%	37%
2% (50-yr)	62%	17%	1%	38%	58%	19%	-11%	35%
1% (100-yr)	44%	11%	36%	30%	46%	17%	24%	38%
0.5% (200-yr)	29%	4%	35%	18%	27%	6%	25%	19%
0.4% (250-yr)	18%	5%	16%	8%	18%	5%	12%	9%
0.2% (500-yr)	12%	7%	16%	20%	12%	5%	16%	18%
0.1% (1000-yr)	3%	1%	-5%	5%	3%	1%	-8%	5%
Est. AAL	**37%**	**11%**	**-35%**	**22%**	**37%**	**11%**	**-38%**	**22%**

Table 71. Percentage change in gross insurable occurrence and aggregate loss estimates due to tropical cyclone wind and precipitation-induced flood combined using the 10K Standard catalog in Touchstone Re with constant exposure for Martinique.

Martinique								
10K Standard Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Change with Constant Exposure							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	70%	12%	-79%	26%	65%	7%	-81%	22%
2% (50-yr)	100%	18%	-36%	42%	91%	15%	-46%	36%
1% (100-yr)	98%	35%	21%	54%	91%	45%	3%	60%
0.5% (200-yr)	63%	57%	104%	55%	58%	57%	91%	52%
0.4% (250-yr)	58%	56%	125%	61%	57%	51%	123%	60%
0.2% (500-yr)	36%	30%	74%	33%	33%	31%	75%	34%
0.1% (1000-yr)	15%	24%	43%	22%	15%	24%	43%	22%
Est. AAL	**41%**	**16%**	**-22%**	**25%**	**40%**	**14%**	**-27%**	**22%**

Table 72. Percentage change in gross insurable occurrence and aggregate loss estimates due to tropical cyclone wind and precipitation-induced flood combined using the 10K Standard catalog in Touchstone Re with constant exposure for Puerto Rico.

Puerto Rico								
10K Standard Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	**Insurable Occurrence**				**Insurable Aggregate**			
	Change with Constant Exposure							
	RES	**COM/ IND**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**AUTO**	**TOTAL**
5% (20-yr)	9%	66%	-27%	43%	8%	64%	-35%	33%
2% (50-yr)	52%	164%	192%	142%	49%	161%	145%	137%
1% (100-yr)	19%	121%	339%	105%	26%	125%	288%	104%
0.5% (200-yr)	3%	88%	399%	69%	1%	87%	363%	70%
0.4% (250-yr)	5%	79%	454%	64%	3%	73%	401%	57%
0.2% (500-yr)	7%	68%	421%	58%	7%	69%	406%	62%
0.1% (1000-yr)	4%	60%	511%	44%	4%	60%	474%	44%
Est. AAL	**15%**	**90%**	**64%**	**69%**	**15%**	**88%**	**48%**	**66%**

Table 73. Percentage change in gross insurable occurrence and aggregate loss estimates due to tropical cyclone wind and precipitation-induced flood combined using the 10K Standard catalog in Touchstone Re with constant exposure for Saint Martin.

Saint Martin								
10K Standard Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	**Insurable Occurrence**				**Insurable Aggregate**			
	Change with Constant Exposure							
	RES	**COM/ IND**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**AUTO**	**TOTAL**
5% (20-yr)	195%	134%	66%	147%	188%	130%	57%	145%
2% (50-yr)	184%	146%	276%	156%	181%	145%	253%	155%
1% (100-yr)	131%	112%	184%	121%	127%	113%	174%	116%
0.5% (200-yr)	76%	74%	89%	75%	86%	78%	94%	80%
0.4% (250-yr)	80%	79%	86%	81%	79%	80%	89%	77%
0.2% (500-yr)	49%	48%	44%	48%	55%	53%	50%	52%
0.1% (1000-yr)	32%	37%	21%	34%	38%	42%	20%	40%
Est. AAL	**114%**	**95%**	**79%**	**100%**	**114%**	**95%**	**77%**	**100%**

Table 74. Percentage change in gross insurable occurrence and aggregate loss estimates due to tropical cyclone wind and precipitation-induced flood combined using the 10K Standard catalog in Touchstone Re with constant exposure for Sint Maarten.

Sint Maarten								
10K Standard Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Change with Constant Exposure							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	42%	-12%	74%	4%	43%	-12%	54%	4%
2% (50-yr)	38%	-12%	161%	4%	37%	-12%	149%	4%
1% (100-yr)	13%	-23%	103%	-11%	12%	-23%	106%	-10%
0.5% (200-yr)	0%	-25%	60%	-16%	3%	-23%	63%	-14%
0.4% (250-yr)	-1%	-24%	37%	-16%	0%	-24%	36%	-16%
0.2% (500-yr)	0%	-19%	21%	-13%	0%	-18%	21%	-12%
0.1% (1000-yr)	-2%	-16%	13%	-11%	0%	-18%	16%	-11%
Est. AAL	**20%**	**-17%**	**42%**	**-6%**	**20%**	**-17%**	**39%**	**-5%**

Table 75. Percentage change in gross insurable occurrence and aggregate loss estimates due to tropical cyclone wind and precipitation-induced flood combined using the 10K Standard catalog in Touchstone Re with constant exposure for Trinidad and Tobago.

Trinidad and Tobago								
10K Standard Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Change with Constant Exposure							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	-55%	-71%	-99%	-66%	-56%	-71%	-99%	-67%
2% (50-yr)	-28%	-53%	-97%	-45%	-30%	-54%	-97%	-46%
1% (100-yr)	-28%	-52%	-93%	-44%	-26%	-51%	-93%	-44%
0.5% (200-yr)	-31%	-57%	-86%	-50%	-34%	-59%	-87%	-51%
0.4% (250-yr)	-36%	-61%	-85%	-52%	-37%	-60%	-86%	-51%
0.2% (500-yr)	-41%	-62%	-72%	-53%	-39%	-59%	-75%	-50%
0.1% (1000-yr)	-29%	-48%	-22%	-45%	-29%	-49%	-22%	-44%
Est. AAL	**-38%**	**-56%**	**-85%**	**-50%**	**-39%**	**-56%**	**-85%**	**-50%**

Table 76. Percentage change in gross insurable occurrence and aggregate loss estimates due to tropical cyclone wind and precipitation-induced flood combined using the 10K Standard catalog in Touchstone Re with constant exposure for the U.S. Virgin Islands.

U.S. Virgin Islands								
10K Standard Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Change with Constant Exposure							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	-32%	10%	64%	-5%	-33%	9%	50%	-7%
2% (50-yr)	-40%	7%	147%	-13%	-41%	6%	141%	-12%
1% (100-yr)	-53%	-7%	44%	-32%	-54%	-9%	43%	-33%
0.5% (200-yr)	-54%	-13%	33%	-30%	-54%	-11%	42%	-28%
0.4% (250-yr)	-54%	-12%	27%	-30%	-53%	-12%	26%	-29%
0.2% (500-yr)	-54%	-19%	10%	-35%	-55%	-19%	12%	-32%
0.1% (1000-yr)	-53%	-13%	18%	-31%	-51%	-14%	18%	-26%
Est. AAL	**-48%**	**-7%**	**36%**	**-23%**	**-48%**	**-8%**	**34%**	**-24%**

The following tables show the overall impact of the updates to the AIR Tropical Cyclone Model for the Caribbean on gross insurable occurrence and aggregate losses. These losses are due to tropical cyclone wind and precipitation-induced flood losses combined and do not include demand surge. Loss changes represent the percentage change in loss estimates calculated by the previous version of Touchstone Re 7.0 as compared with those calculated by the current version of Touchstone Re 8.0 for all modeled islands/territories combined, as well as by selected islands/territories, using the 10,000-year Warm Sea Surface Temperature (WSST) catalog. Changes below represent overall change, including the effects of model updates and updated industry exposures.

Note that caution should be exercised before relating the industry changes shown here to a particular portfolio. The changes to individual books of business may deviate from the losses represented here to the extent that their spatial distribution and construction/occupancy mix deviate from industry averages.

Table 77. Percentage change in gross insurable occurrence and aggregate loss estimates due to wind and precipitation-induced flood combined using the 10K WSST catalog in Touchstone Re for all modeled Caribbean islands/territories combined.

All Modeled Islands/Territories								
10K WSST Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	143%	112%	31%	123%	145%	101%	13%	116%
2% (50-yr)	131%	101%	53%	105%	131%	104%	37%	105%
1% (100-yr)	118%	99%	70%	101%	120%	96%	58%	102%
0.5% (200-yr)	115%	91%	102%	96%	126%	83%	96%	91%
0.4% (250-yr)	116%	75%	108%	93%	120%	74%	94%	94%
0.2% (500-yr)	112%	83%	124%	89%	120%	83%	114%	102%
0.1% (1000-yr)	115%	65%	108%	77%	112%	63%	99%	77%
Est. AAL	**148%**	**92%**	**5%**	**111%**	**150%**	**85%**	**-8%**	**107%**

Table 78. Percentage change in gross insurable occurrence and aggregate loss estimates due to wind and precipitation-induced flood combined using the 10K WSST catalog in Touchstone Re for the Bahamas.

Bahamas								
10K WSST Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	273%	109%	143%	171%	273%	109%	128%	164%
2% (50-yr)	244%	126%	150%	167%	245%	116%	150%	168%
1% (100-yr)	227%	115%	123%	157%	227%	109%	123%	156%
0.5% (200-yr)	205%	112%	83%	151%	200%	106%	94%	146%
0.4% (250-yr)	194%	101%	90%	140%	201%	113%	94%	150%
0.2% (500-yr)	166%	108%	63%	130%	170%	108%	66%	130%
0.1% (1000-yr)	159%	106%	38%	126%	161%	104%	40%	125%
Est. AAL	**226%**	**103%**	**81%**	**149%**	**227%**	**101%**	**76%**	**147%**

Table 79. Percentage change in gross insurable occurrence and aggregate loss estimates due to wind and precipitation-induced flood combined using the 10K WSST catalog in Touchstone Re for Barbados

Barbados								
10K WSST Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	146%	52%	-91%	84%	145%	51%	-92%	81%
2% (50-yr)	197%	66%	-66%	116%	178%	61%	-70%	102%
1% (100-yr)	191%	54%	-15%	110%	179%	57%	-26%	102%
0.5% (200-yr)	145%	58%	90%	98%	145%	51%	63%	93%
0.4% (250-yr)	146%	56%	121%	98%	142%	54%	98%	90%
0.2% (500-yr)	101%	59%	104%	86%	109%	59%	79%	86%
0.1% (1000-yr)	96%	65%	83%	83%	96%	65%	83%	83%
Est. AAL	**118%**	**55%**	**-32%**	**80%**	**118%**	**53%**	**-36%**	**79%**

Table 80. Percentage change in gross insurable occurrence and aggregate loss estimates due to wind and precipitation-induced flood combined using the 10K WSST catalog in Touchstone Re for Bermuda.

Bermuda								
10K WSST Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	103%	-6%	-1%	33%	101%	-7%	-7%	31%
2% (50-yr)	90%	-6%	-4%	28%	88%	-7%	-5%	29%
1% (100-yr)	84%	-11%	-17%	25%	81%	-11%	-18%	22%
0.5% (200-yr)	80%	-11%	-39%	23%	83%	-11%	-40%	24%
0.4% (250-yr)	80%	-12%	-38%	26%	80%	-12%	-40%	26%
0.2% (500-yr)	84%	-13%	-47%	25%	84%	-12%	-47%	24%
0.1% (1000-yr)	81%	-9%	-46%	26%	83%	-13%	-46%	24%
Est. AAL	**88%**	**-10%**	**-32%**	**26%**	**88%**	**-10%**	**-32%**	**26%**

Table 81. Percentage change in gross insurable occurrence and aggregate loss estimates due to wind and precipitation-induced flood combined using the 10K WSST catalog in Touchstone Re for the British Virgin Islands.

British Virgin Islands								
10K WSST Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	**Insurable Occurrence**				**Insurable Aggregate**			
	Overall Change							
	RES	**COM/ IND**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**AUTO**	**TOTAL**
5% (20-yr)	456%	316%	167%	353%	432%	303%	147%	332%
2% (50-yr)	396%	304%	273%	334%	392%	307%	268%	332%
1% (100-yr)	256%	217%	133%	227%	255%	211%	137%	227%
0.5% (200-yr)	172%	155%	63%	158%	183%	157%	65%	162%
0.4% (250-yr)	165%	128%	59%	139%	159%	144%	61%	148%
0.2% (500-yr)	135%	115%	30%	117%	136%	106%	33%	120%
0.1% (1000-yr)	111%	98%	19%	100%	121%	105%	23%	107%
Est. AAL	**262%**	**197%**	**83%**	**214%**	**263%**	**195%**	**80%**	**212%**

Table 82. Percentage change in gross insurable occurrence and aggregate loss estimates due to wind and precipitation-induced flood combined using the 10K WSST catalog in Touchstone Re for the Cayman Islands.

Cayman Islands								
10K WSST Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	**Insurable Occurrence**				**Insurable Aggregate**			
	Overall Change							
	RES	**COM/ IND**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**AUTO**	**TOTAL**
5% (20-yr)	164%	-14%	125%	49%	161%	-17%	121%	45%
2% (50-yr)	97%	-21%	211%	23%	90%	-25%	214%	19%
1% (100-yr)	88%	-25%	174%	20%	88%	-24%	171%	21%
0.5% (200-yr)	86%	-20%	113%	22%	87%	-22%	113%	22%
0.4% (250-yr)	81%	-21%	93%	22%	84%	-22%	98%	23%
0.2% (500-yr)	98%	-16%	53%	32%	98%	-16%	53%	32%
0.1% (1000-yr)	115%	-5%	33%	43%	115%	-6%	33%	42%
Est. AAL	**106%**	**-18%**	**93%**	**31%**	**107%**	**-19%**	**91%**	**31%**

Table 83. Percentage change in gross insurable occurrence and aggregate loss estimates due to wind and precipitation-induced flood combined using the 10K WSST catalog in Touchstone Re for the Dominican Republic.

Dominican Republic								
10K WSST Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	418%	186%	14%	260%	380%	175%	3%	240%
2% (50-yr)	448%	285%	163%	335%	413%	266%	116%	326%
1% (100-yr)	414%	297%	258%	359%	412%	270%	214%	319%
0.5% (200-yr)	408%	319%	241%	355%	425%	306%	243%	356%
0.4% (250-yr)	385%	306%	272%	336%	409%	304%	245%	367%
0.2% (500-yr)	326%	264%	277%	283%	328%	265%	233%	287%
0.1% (1000-yr)	260%	179%	187%	218%	260%	180%	180%	218%
Est. AAL	**343%**	**192%**	**54%**	**245%**	**335%**	**182%**	**39%**	**235%**

Table 84. Percentage change in gross insurable occurrence and aggregate loss estimates due to wind and precipitation-induced flood combined using the 10K WSST catalog in Touchstone Re for Guadeloupe.

Guadeloupe								
10K WSST Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	324%	66%	61%	156%	322%	60%	37%	154%
2% (50-yr)	224%	68%	135%	130%	247%	64%	127%	132%
1% (100-yr)	183%	58%	100%	109%	183%	57%	97%	109%
0.5% (200-yr)	163%	52%	64%	100%	168%	48%	60%	97%
0.4% (250-yr)	149%	49%	66%	94%	150%	51%	62%	97%
0.2% (500-yr)	153%	56%	50%	98%	150%	51%	48%	97%
0.1% (1000-yr)	136%	49%	42%	88%	129%	50%	41%	81%
Est. AAL	**205%**	**54%**	**46%**	**113%**	**208%**	**53%**	**41%**	**113%**

Table 85. Percentage change in gross insurable occurrence and aggregate loss estimates due to wind and precipitation-induced flood combined using the 10K WSST catalog in Touchstone Re for Jamaica.

Jamaica								
10K WSST Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	444%	267%	1%	332%	449%	257%	-4%	324%
2% (50-yr)	419%	328%	154%	361%	416%	295%	114%	351%
1% (100-yr)	362%	287%	202%	341%	374%	289%	177%	330%
0.5% (200-yr)	318%	257%	189%	274%	315%	241%	161%	268%
0.4% (250-yr)	282%	240%	165%	254%	278%	243%	150%	242%
0.2% (500-yr)	263%	258%	147%	270%	249%	261%	160%	270%
0.1% (1000-yr)	246%	213%	114%	232%	246%	215%	108%	234%
Est. AAL	**347%**	**254%**	**46%**	**292%**	**348%**	**252%**	**39%**	**290%**

Table 86. Percentage change in gross insurable occurrence and aggregate loss estimates due to wind and precipitation-induced flood combined using the 10K WSST catalog in Touchstone Re for Martinique.

Martinique								
10K WSST Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	253%	77%	-73%	133%	238%	72%	-75%	122%
2% (50-yr)	303%	93%	-13%	158%	281%	85%	-29%	147%
1% (100-yr)	271%	124%	73%	187%	266%	121%	50%	167%
0.5% (200-yr)	220%	147%	129%	167%	224%	134%	115%	173%
0.4% (250-yr)	195%	112%	121%	148%	201%	115%	120%	152%
0.2% (500-yr)	158%	112%	109%	134%	157%	111%	109%	133%
0.1% (1000-yr)	138%	111%	51%	121%	134%	105%	47%	115%
Est. AAL	**182%**	**85%**	**-6%**	**121%**	**180%**	**81%**	**-13%**	**117%**

Table 87. Percentage change in gross insurable occurrence and aggregate loss estimates due to wind and precipitation-induced flood combined using the 10K WSST catalog in Touchstone Re for Puerto Rico.

Puerto Rico								
10K WSST Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	25%	57%	-56%	44%	25%	54%	-63%	41%
2% (50-yr)	55%	115%	53%	92%	52%	111%	24%	96%
1% (100-yr)	18%	89%	104%	69%	17%	90%	77%	69%
0.5% (200-yr)	9%	77%	139%	58%	5%	68%	114%	60%
0.4% (250-yr)	8%	53%	150%	46%	9%	52%	116%	41%
0.2% (500-yr)	17%	58%	132%	48%	17%	58%	120%	50%
0.1% (1000-yr)	13%	49%	155%	32%	13%	49%	155%	32%
Est. AAL	**23%**	**68%**	**-23%**	**50%**	**23%**	**65%**	**-31%**	**48%**

Table 88. Percentage change in gross insurable occurrence and aggregate loss estimates due to wind and precipitation-induced flood combined using the 10K WSST catalog in Touchstone Re for Saint Martin.

Saint Martin								
10K WSST Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	>500%	420%	214%	>500%	>500%	389%	184%	499%
2% (50-yr)	>500%	325%	390%	421%	>500%	318%	358%	418%
1% (100-yr)	485%	267%	256%	333%	497%	264%	254%	338%
0.5% (200-yr)	419%	228%	171%	283%	438%	239%	179%	296%
0.4% (250-yr)	403%	231%	163%	282%	407%	224%	167%	279%
0.2% (500-yr)	329%	183%	110%	226%	347%	195%	122%	238%
0.1% (1000-yr)	261%	144%	63%	177%	283%	166%	78%	200%
Est. AAL	**>500%**	**259%**	**154%**	**329%**	**>500%**	**258%**	**150%**	**329%**

Table 89. Percentage change in gross insurable occurrence and aggregate loss estimates due to wind and precipitation-induced flood combined using the 10K WSST catalog in Touchstone Re for Sint Maarten.

Sint Maarten								
10K WSST Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	153%	11%	81%	47%	153%	15%	52%	52%
2% (50-yr)	127%	3%	103%	37%	122%	4%	96%	37%
1% (100-yr)	90%	-7%	57%	23%	96%	-3%	60%	29%
0.5% (200-yr)	77%	-7%	24%	20%	79%	-4%	26%	23%
0.4% (250-yr)	73%	-5%	20%	18%	77%	-5%	19%	18%
0.2% (500-yr)	75%	-1%	4%	24%	78%	2%	7%	25%
0.1% (1000-yr)	74%	2%	-8%	22%	79%	3%	-7%	27%
Est. AAL	**110%**	**2%**	**25%**	**33%**	**111%**	**2%**	**22%**	**33%**

Table 90. Percentage change in gross insurable occurrence and aggregate loss estimates due to wind and precipitation-induced flood combined using the 10K WSST catalog in Touchstone Re for Trinidad and Tobago.

Trinidad and Tobago								
10K WSST Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	-17%	-59%	-98%	-45%	-18%	-59%	-98%	-46%
2% (50-yr)	15%	-39%	-95%	-20%	16%	-39%	-95%	-20%
1% (100-yr)	20%	-36%	-90%	-17%	20%	-36%	-90%	-17%
0.5% (200-yr)	8%	-47%	-81%	-28%	5%	-45%	-81%	-28%
0.4% (250-yr)	-3%	-46%	-76%	-26%	-5%	-48%	-77%	-28%
0.2% (500-yr)	43%	-33%	-56%	-6%	52%	-29%	-57%	1%
0.1% (1000-yr)	12%	-29%	-10%	-15%	12%	-30%	-12%	-15%
Est. AAL	**5%**	**-41%**	**-81%**	**-25%**	**4%**	**-41%**	**-82%**	**-25%**

Table 91. Percentage change in gross insurable occurrence and aggregate loss estimates due to wind and precipitation-induced flood combined using the 10K WSST catalog in Touchstone Re for the U.S. Virgin Islands.

U.S. Virgin Islands								
10K WSST Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Overall Change							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	16%	114%	89%	72%	14%	109%	73%	69%
2% (50-yr)	5%	82%	124%	54%	5%	83%	116%	53%
1% (100-yr)	-22%	64%	44%	25%	-19%	63%	41%	29%
0.5% (200-yr)	-18%	69%	37%	29%	-14%	71%	34%	30%
0.4% (250-yr)	-18%	62%	26%	27%	-17%	60%	23%	27%
0.2% (500-yr)	-19%	56%	1%	23%	-20%	54%	3%	23%
0.1% (1000-yr)	-10%	68%	16%	31%	-12%	68%	16%	30%
Est. AAL	**-8%**	**76%**	**34%**	**40%**	**-7%**	**75%**	**32%**	**39%**

The following tables show the overall impact of the updates to the AIR Tropical Cyclone Model for the Caribbean on gross insurable occurrence and aggregate losses. These losses are due to tropical cyclone wind and precipitation-induced flood losses combined and do not include demand surge. Loss changes represent the percentage change in loss estimates calculated by the previous version of Touchstone Re 7.0 as compared with those calculated by the current version of Touchstone Re 8.0 for all modeled islands/territories combined, as well as by selected islands/territories, using the 10,000-year Warm Sea Surface Temperature (WSST) catalog. Changes below represent changes due to model updates only. That is, changes are calculated by comparing losses from the Touchstone Re 7.0 and Touchstone Re 8.0 model versions, using the same Industry Exposure Database in each model version.

Note that caution should be exercised before relating the industry changes shown here to a particular portfolio. The changes to individual books of business may deviate from the losses represented here to the extent that their spatial distribution and construction/occupancy mix deviate from industry averages.

Table 92. Percentage change in gross insurable occurrence and aggregate loss estimates due to wind and precipitation-induced flood combined using the 10K WSST catalog in Touchstone Re with constant exposure for all modeled Caribbean islands/territories combined.

All Modeled Islands/Territories								
10K WSST Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Change with Constant Exposure							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	35%	53%	43%	49%	37%	45%	23%	42%
2% (50-yr)	27%	58%	87%	43%	28%	54%	65%	38%
1% (100-yr)	25%	56%	110%	39%	25%	55%	97%	39%
0.5% (200-yr)	17%	52%	140%	34%	24%	46%	127%	35%
0.4% (250-yr)	18%	42%	161%	36%	20%	41%	134%	37%
0.2% (500-yr)	14%	57%	207%	41%	26%	57%	196%	46%
0.1% (1000-yr)	21%	46%	243%	43%	16%	43%	224%	40%
Est. AAL	**36%**	**41%**	**29%**	**39%**	**37%**	**34%**	**11%**	**34%**

Table 93. Percentage change in gross insurable occurrence and aggregate loss estimates due to wind and precipitation-induced flood combined using the 10K WSST catalog in Touchstone Re with constant exposure for the Bahamas.

Bahamas								
10K WSST Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Change with Constant Exposure							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	52%	6%	56%	25%	52%	5%	44%	21%
2% (50-yr)	42%	12%	61%	22%	44%	11%	54%	22%
1% (100-yr)	38%	5%	55%	20%	35%	3%	57%	18%
0.5% (200-yr)	29%	4%	32%	16%	28%	2%	35%	14%
0.4% (250-yr)	26%	-3%	31%	11%	25%	4%	37%	15%
0.2% (500-yr)	15%	0%	16%	6%	17%	0%	18%	8%
0.1% (1000-yr)	10%	0%	0%	4%	11%	-1%	1%	4%
Est. AAL	**35%**	**1%**	**21%**	**14%**	**36%**	**-1%**	**17%**	**14%**

Table 94. Percentage change in gross insurable occurrence and aggregate loss estimates due to wind and precipitation-induced flood combined using the 10K WSST catalog in Touchstone Re with constant exposure for Barbados.

Barbados								
10K WSST Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Change with Constant Exposure							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	38%	-1%	-93%	11%	40%	-3%	-93%	10%
2% (50-yr)	67%	7%	-73%	26%	56%	3%	-76%	20%
1% (100-yr)	53%	-2%	-34%	21%	47%	-1%	-42%	18%
0.5% (200-yr)	16%	-3%	50%	6%	20%	-4%	29%	6%
0.4% (250-yr)	13%	-2%	71%	7%	14%	-4%	47%	2%
0.2% (500-yr)	7%	0%	59%	3%	7%	0%	39%	4%
0.1% (1000-yr)	-2%	2%	36%	1%	-2%	2%	36%	1%
Est. AAL	**16%**	**-2%**	**-47%**	**5%**	**16%**	**-3%**	**-50%**	**4%**

Table 95. Percentage change in gross insurable occurrence and aggregate loss estimates due to wind and precipitation-induced flood combined using the 10K WSST catalog in Touchstone Re with constant exposure for Bermuda.

Bermuda								
10K WSST Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Change with Constant Exposure							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	29%	24%	122%	26%	27%	23%	107%	26%
2% (50-yr)	19%	23%	115%	24%	21%	23%	115%	26%
1% (100-yr)	15%	18%	86%	20%	15%	19%	84%	16%
0.5% (200-yr)	12%	18%	37%	15%	18%	19%	35%	18%
0.4% (250-yr)	16%	16%	40%	19%	16%	17%	33%	20%
0.2% (500-yr)	17%	15%	20%	18%	18%	17%	20%	17%
0.1% (1000-yr)	14%	21%	21%	19%	16%	16%	20%	17%
Est. AAL	**20%**	**19%**	**53%**	**20%**	**20%**	**19%**	**53%**	**20%**

Table 96. Percentage change in gross insurable occurrence and aggregate loss estimates due to wind and precipitation-induced flood combined using the 10K WSST catalog in Touchstone Re with constant exposure for the British Virgin Islands.

British Virgin Islands								
10K WSST Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Change with Constant Exposure							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	130%	215%	127%	191%	119%	208%	111%	181%
2% (50-yr)	101%	207%	218%	180%	100%	209%	216%	177%
1% (100-yr)	42%	141%	101%	109%	44%	137%	104%	109%
0.5% (200-yr)	7%	93%	40%	65%	12%	97%	41%	68%
0.4% (250-yr)	2%	77%	37%	54%	2%	86%	39%	59%
0.2% (500-yr)	-7%	64%	11%	39%	-7%	57%	15%	41%
0.1% (1000-yr)	-18%	51%	2%	29%	-13%	57%	6%	33%
Est. AAL	**44%**	**127%**	**57%**	**101%**	**44%**	**126%**	**55%**	**100%**

Table 97. Percentage change in gross insurable occurrence and aggregate loss estimates due to wind and precipitation-induced flood combined using the 10K WSST catalog in Touchstone Re with constant exposure for the Cayman Islands.

Cayman Islands								
10K WSST Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Change with Constant Exposure							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	-2%	-12%	109%	-9%	-4%	-15%	111%	-10%
2% (50-yr)	-26%	-31%	186%	-27%	-29%	-33%	190%	-31%
1% (100-yr)	-31%	-34%	155%	-31%	-31%	-33%	152%	-30%
0.5% (200-yr)	-32%	-31%	97%	-29%	-32%	-32%	97%	-31%
0.4% (250-yr)	-32%	-33%	77%	-30%	-30%	-33%	80%	-29%
0.2% (500-yr)	-26%	-29%	39%	-26%	-26%	-29%	39%	-26%
0.1% (1000-yr)	-17%	-21%	21%	-18%	-17%	-21%	21%	-18%
Est. AAL	**-23%**	**-26%**	**79%**	**-23%**	**-23%**	**-26%**	**78%**	**-23%**

Table 98. Percentage change in gross insurable occurrence and aggregate loss estimates due to wind and precipitation-induced flood combined using the 10K WSST catalog in Touchstone Re with constant exposure for the Dominican Republic.

Dominican Republic								
10K WSST Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Change with Constant Exposure							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	97%	47%	-33%	60%	83%	42%	-41%	55%
2% (50-yr)	108%	89%	45%	94%	97%	84%	23%	84%
1% (100-yr)	100%	97%	90%	103%	96%	86%	68%	87%
0.5% (200-yr)	95%	100%	100%	95%	98%	97%	98%	103%
0.4% (250-yr)	81%	103%	97%	93%	89%	104%	83%	95%
0.2% (500-yr)	60%	77%	94%	69%	62%	95%	80%	68%
0.1% (1000-yr)	35%	53%	47%	44%	35%	53%	44%	44%
Est. AAL	**68%**	**51%**	**-17%**	**55%**	**66%**	**46%**	**-25%**	**50%**

Table 99. Percentage change in gross insurable occurrence and aggregate loss estimates due to wind and precipitation-induced flood combined using the 10K WSST catalog in Touchstone Re with constant exposure for Guadeloupe.

Guadeloupe								
10K WSST Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Change with Constant Exposure							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	92%	27%	21%	50%	90%	23%	3%	47%
2% (50-yr)	46%	29%	77%	35%	57%	26%	70%	37%
1% (100-yr)	28%	21%	50%	25%	28%	20%	48%	24%
0.5% (200-yr)	19%	17%	23%	20%	21%	13%	20%	17%
0.4% (250-yr)	12%	15%	25%	15%	13%	16%	22%	17%
0.2% (500-yr)	14%	20%	13%	18%	13%	16%	11%	17%
0.1% (1000-yr)	7%	14%	7%	13%	3%	15%	6%	8%
Est. AAL	**38%**	**18%**	**9%**	**25%**	**39%**	**18%**	**6%**	**26%**

Table 100. Percentage change in gross insurable occurrence and aggregate loss estimates due to wind and precipitation-induced flood combined using the 10K WSST catalog in Touchstone Re with constant exposure for Jamaica.

Jamaica								
10K WSST Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	**Insurable Occurrence**				**Insurable Aggregate**			
	Change with Constant Exposure							
	RES	**COM/ IND**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**AUTO**	**TOTAL**
5% (20-yr)	68%	21%	-55%	37%	68%	18%	-57%	34%
2% (50-yr)	58%	20%	10%	36%	59%	16%	-7%	35%
1% (100-yr)	41%	12%	31%	31%	43%	18%	19%	30%
0.5% (200-yr)	27%	6%	28%	9%	26%	4%	17%	12%
0.4% (250-yr)	12%	3%	14%	12%	11%	3%	10%	7%
0.2% (500-yr)	9%	14%	11%	15%	5%	14%	17%	16%
0.1% (1000-yr)	3%	1%	-5%	5%	3%	1%	-8%	5%
Est. AAL	**37%**	**11%**	**-35%**	**22%**	**37%**	**11%**	**-39%**	**21%**

Table 101. Percentage change in gross insurable occurrence and aggregate loss estimates due to wind and precipitation-induced flood combined using the 10K WSST catalog in Touchstone Re with constant exposure for Martinique.

Martinique								
10K WSST Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	**Insurable Occurrence**				**Insurable Aggregate**			
	Change with Constant Exposure							
	RES	**COM/ IND**	**AUTO**	**TOTAL**	**RES**	**COM/ IND**	**AUTO**	**TOTAL**
5% (20-yr)	77%	11%	-77%	30%	69%	8%	-79%	25%
2% (50-yr)	102%	21%	-27%	45%	90%	16%	-40%	38%
1% (100-yr)	86%	40%	45%	62%	83%	38%	26%	50%
0.5% (200-yr)	60%	55%	92%	52%	62%	47%	81%	55%
0.4% (250-yr)	48%	33%	85%	40%	51%	35%	85%	43%
0.2% (500-yr)	29%	33%	75%	33%	29%	33%	75%	32%
0.1% (1000-yr)	19%	32%	27%	26%	17%	29%	23%	23%
Est. AAL	**41%**	**16%**	**-21%**	**25%**	**40%**	**14%**	**-27%**	**22%**

Table 102. Percentage change in gross insurable occurrence and aggregate loss estimates due to wind and precipitation-induced flood combined using the 10K WSST catalog in Touchstone Re with constant exposure for Puerto Rico.

Puerto Rico								
10K WSST Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Change with Constant Exposure							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	13%	84%	-10%	61%	15%	84%	-22%	57%
2% (50-yr)	42%	148%	214%	122%	39%	142%	155%	121%
1% (100-yr)	12%	101%	333%	85%	9%	102%	282%	82%
0.5% (200-yr)	1%	80%	385%	63%	-4%	74%	334%	64%
0.4% (250-yr)	1%	59%	426%	56%	3%	59%	355%	49%
0.2% (500-yr)	5%	66%	381%	55%	5%	67%	365%	59%
0.1% (1000-yr)	4%	60%	447%	44%	4%	60%	446%	44%
Est. AAL	**11%**	**83%**	**60%**	**63%**	**11%**	**81%**	**43%**	**60%**

Table 103. Percentage change in gross insurable occurrence and aggregate loss estimates due to wind and precipitation-induced flood combined using the 10K WSST catalog in Touchstone Re with constant exposure for Saint Martin.

Saint Martin								
10K WSST Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Change with Constant Exposure							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	218%	173%	114%	184%	210%	157%	94%	169%
2% (50-yr)	161%	123%	235%	136%	162%	120%	213%	133%
1% (100-yr)	101%	93%	143%	97%	105%	91%	142%	99%
0.5% (200-yr)	78%	72%	85%	74%	85%	79%	90%	79%
0.4% (250-yr)	73%	74%	80%	74%	74%	70%	82%	72%
0.2% (500-yr)	47%	49%	43%	48%	53%	55%	52%	54%
0.1% (1000-yr)	24%	28%	11%	26%	32%	40%	22%	37%
Est. AAL	**107%**	**89%**	**74%**	**94%**	**107%**	**89%**	**71%**	**94%**

Table 104. Percentage change in gross insurable occurrence and aggregate loss estimates due to wind and precipitation-induced flood combined using the 10K WSST catalog in Touchstone Re with constant exposure for Sint Maarten.

Sint Maarten								
10K WSST Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Change with Constant Exposure							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	40%	-12%	99%	2%	41%	-9%	68%	5%
2% (50-yr)	26%	-18%	123%	-5%	23%	-18%	115%	-6%
1% (100-yr)	6%	-26%	72%	-16%	9%	-23%	76%	-11%
0.5% (200-yr)	-1%	-26%	37%	-17%	0%	-24%	39%	-14%
0.4% (250-yr)	-4%	-25%	32%	-18%	-2%	-24%	31%	-17%
0.2% (500-yr)	-3%	-22%	14%	-14%	-1%	-19%	17%	-12%
0.1% (1000-yr)	-4%	-20%	1%	-14%	-1%	-18%	2%	-11%
Est. AAL	**17%**	**-19%**	**37%**	**-8%**	**17%**	**-19%**	**35%**	**-8%**

Table 105. Percentage change in gross insurable occurrence and aggregate loss estimates due to wind and precipitation-induced flood combined using the 10K WSST catalog in Touchstone Re with constant exposure for Trinidad and Tobago.

Trinidad and Tobago								
10K WSST Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Change with Constant Exposure							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	-48%	-67%	-98%	-61%	-48%	-66%	-98%	-61%
2% (50-yr)	-27%	-52%	-96%	-44%	-26%	-51%	-96%	-43%
1% (100-yr)	-25%	-50%	-91%	-41%	-24%	-49%	-91%	-41%
0.5% (200-yr)	-33%	-60%	-84%	-51%	-35%	-59%	-85%	-50%
0.4% (250-yr)	-40%	-58%	-80%	-50%	-41%	-59%	-81%	-51%
0.2% (500-yr)	-12%	-46%	-62%	-36%	-7%	-46%	-63%	-34%
0.1% (1000-yr)	-29%	-48%	-22%	-45%	-29%	-49%	-24%	-44%
Est. AAL	**-35%**	**-54%**	**-84%**	**-48%**	**-35%**	**-54%**	**-84%**	**-48%**

Table 106. Percentage change in gross insurable occurrence and aggregate loss estimates due to wind and precipitation-induced flood combined using the 10K WSST catalog in Touchstone Re with constant exposure for the U.S. Virgin Islands.

U.S. Virgin Islands								
10K WSST Catalog - Wind and Precipitation-Induced Flood Combined								
Exceedance Probability % (Return Period, years)	Insurable Occurrence				Insurable Aggregate			
	Change with Constant Exposure							
	RES	COM/ IND	AUTO	TOTAL	RES	COM/ IND	AUTO	TOTAL
5% (20-yr)	-39%	6%	82%	-10%	-40%	2%	67%	-11%
2% (50-yr)	-43%	-7%	122%	-20%	-44%	-6%	113%	-19%
1% (100-yr)	-57%	-15%	43%	-33%	-56%	-15%	41%	-32%
0.5% (200-yr)	-56%	-13%	34%	-31%	-55%	-13%	30%	-30%
0.4% (250-yr)	-55%	-17%	23%	-32%	-55%	-17%	20%	-32%
0.2% (500-yr)	-55%	-21%	4%	-33%	-56%	-18%	6%	-35%
0.1% (1000-yr)	-52%	-13%	15%	-30%	-53%	-14%	15%	-31%
Est. AAL	**-50%**	**-10%**	**32%**	**-26%**	**-50%**	**-11%**	**30%**	**-26%**

7.9 Analysis Settings

Table 107. Touchstone Re analysis settings for model runs to determine the loss changes.

Setting	Selected Option(s)
Perils modeled	Wind and precipitation-induced flood combined
Catalog	10,000-year Standard 10,000-year Warm Sea Surface Temperature (WSST)
Industry exposure vintage	December 2019
Take-up rates	N/A Analyses were done for insurable loss estimates only. Take-up rates do not apply.
Demand surge*	Off

* Development of region-specific demand-surge functions is currently underway at AIR. While AIR recommends incorporating demand surge into modeled loss estimates where appropriate, AIR makes no recommendation as to the form of the demand-surge function for tropical cyclones in the Caribbean. Clients may apply a user-defined demand-surge function if they choose.

8 The AIR Earthquake Model for Australia

8.1 Overview of Model Updates and Changes

The AIR Earthquake Model for Australia captures the effects of ground shaking and liquefaction on properties in Australia. This is a stochastic, event-based model. The summer 2020 update of the model is the result of several years of research and development by many professionals at AIR and represents a major advancement in the scientific understanding of earthquakes and how assets respond to them.

The 2020 release of the model includes a significant update to the hazard component as it incorporates the learnings from the 2018 National Seismic Hazard Assessment for Australia (NSHA18), developed by Geoscience Australia (GA). Using a comprehensive methodology and the latest available data, AIR scientists and engineers have greatly enhanced the historical catalog of past Australian seismic activity, revised the approach to stochastic event generation, improved the local intensity calculation, and updated damage estimation methodology. New understandings leading to an updated seismic source characterization for Australia, along with the latest publications on site amplification and ground motion prediction equations for a variety of crustal settings, have been incorporated into this model update. The updated earthquake model also features improved modeling of liquefaction in major metropolitan areas.

This update includes revisions to the vulnerability framework, which now uses intensity-based damage functions, as opposed to the Capacity Spectrum Method (CSM) used in the previous version of the model. The updated damage functions reflect the re-analysis of claims data from historical Australian events and relevant information from recent global events. The damage estimation component of the AIR Earthquake Model for Australia has been extensively validated against published research and observed damage data from historical earthquakes. The vulnerability module has also undergone external peer review. Overall model performance has been validated against historical loss data from various events as well as location-specific claims when available. The model domain includes all regions of Continental Australia, the Island of Tasmania, and extends 150 km from the coast.

Note that even modeled independently, shake and liquefaction losses are not separable in Touchstone Re 8.0 for the AIR Earthquake Model for Australia. The updated model features a Historical Event Set consisting of 28 (as compared to 27 in the previous model version) historical events for analysis, along with nine Extreme Disaster Scenarios (as compared to none in the previous model version).

The following sections describe the updated model components and how the updated components affect losses.

8.2 Catalogs and Event Sets

The 2020 model includes updates to the comprehensive catalog of historically recorded earthquakes in Australia, which is used to derive the stochastic event set, as well as the historical and world scenario event sets, as described below.

Historical Catalog

AIR's updated historical catalog for Australia includes 724 earthquakes of moment magnitude (M_W) 4.160 and greater that have been compiled from multiple sources. The historical catalog includes data collected by Geoscience Australia, used for the NSHA18 model, and data collected from other sources, used to expand upon the NSHA18 catalog's time period ending in July 2017. This is done in an effort to include more recent events that have taken place as recently as December 2018. The following list contains the primary sources of data collected to compile AIR's catalog of historical seismicity for Australia:

- Australian Government Geoscience Australia[10]
- United States Geological Survey (USGS)[11]
- Global Earthquake Model (GEM) Foundation[12]
- International Seismological Centre (ISC)[13]
- Global Centroid-Moment-Tensor Project (GCMT)[14]

Notable features of AIR's historical catalog for Australia include:

- A comprehensive historical catalog including events as recent as December 2018

  The GA database includes earthquakes occurring between 1840 and July 2017, with epicenters located on the continent and at near-shore locations. The formats and minimum reported magnitudes of pre-1990 events in the GA database vary, while post-1990 earthquakes include uniform moment magnitudes as small as 1.0. AIR scientists supplemented the NSHA18 historical with records of moment magnitude for more recent events from other global databases. This effectively extends the relevancy of AIR's complied catalog from July 2017 to December 2018.

- Earthquake magnitudes have been homogenized to a consistent moment magnitude (M_W) scale

  To compile the historical earthquake catalog, conversions were made between local magnitude (M_L) and moment (M_W) scales for most earthquake events in the Geoscience 2018 database. However, AIR scientists have developed their own conversion methodology based on an analysis of the original local magnitude values from the GA

10 https://www.ga.gov.au
11 https://earthquake.usgs.gov
12 https://www.globalquakemodel.org/
13 http://www.isc.ac.uk
14 https://www.globalcmt.org/

database to create a proprietary moment-to-local magnitude relationship. Based on this nonlinear proprietary regression, it can be observed that AIR's comprehensive historical catalog contains more events with M_W greater than or equal to 5 than other comparable catalogs. This, in turn, results in a stochastic event set that exhibits a smoother cumulative magnitude rate curve than that of NSHA18.

- Declustered catalog to remove the impact of foreshocks and aftershocks

  The AIR Earthquake Model for Australia historical catalog was declustered using the algorithm of Reasenberg (1985) to remove foreshocks and aftershocks, resulting in more events with M_W 5 and higher in the catalog as compared to that of the NSHA18 assessment.

- Realistic modeling of earthquake depths

  While modeling regional seismicity, AIR seismologists re-sampled source zone depths to better reflect a range of expected depths in the western and eastern regions of Australia.

Stochastic Catalog

The processes used to generate the stochastic event catalog have been significantly updated and enhanced. The offering of catalogs in the 2020 model release has been updated to better represent AIR's view of seismicity for Australia. The model provides the time-independent (TID) view of seismicity in the catalog of 10,000 simulated years of events.

Notable features of stochastic event generation are:

- To model the potential seismicity that can occur in Australia, the source model developed by AIR relies on the NSHA18's seismotectonic model which is complimented with a background seismicity model. The seismotectonic model captures the seismicity in "known" sources (i.e., faults and zones of distinguished seismicity displayed in the last 100 to 150 years), while the background seismicity model captures the occurrence of significant earthquakes in locations away from known sources.
- Two data sources are considered for the active fault model in Australia. The primary source is the Fault Source Model (FSM) database, released as part of Australia's NSHA18 assessment, with 379 faults. The secondary data source is the Australian Neotectonic Features Database (ANFD). AIR scientists compiled both fault data sources and recent fault scarp studies to obtain a fault model with 391 faults.

Historical Event Set

The AIR Earthquake Model for Australia features two additions to the Historical Event Set, which contains scenarios representing the recurrence of 28 historical events. One historical event scenario for Adelaide has been removed, and two events (listed in Table 108 in **bold** typeface) have been included with this update. The ground shaking footprints for events, for which ground motions have been either extensively recorded or studied, are provided as calibrated stochastic ground motions. These calibrated ground motion footprints aim to represent the shaking that occurred during these events to the truest extent possible.

Table 108 lists 28 historical seismic events available in the model.

Table 108. Historical Events available in Touchstone Re

Earthquake	Magnitude (M_W)	Year	Earthquake[15]	Magnitude (M_W)	Year
Newcastle	5.1 (5.180)	1868	Gabalong	5.7 (5.700)	1955
Gayndah	5.8 (5.800)	1883	Robertson-Bowral	5.5 (5.490)	1961
Offshore Tasmania Sea	6.7 (6.740)	1885	Meckering	6.6 (6.580)	1968
Offshore Tasmania Sea	6.9 (6.850)	1892	Calingiri	5.7 (5.700)	1970
Beachport	6.4 (6.43)	1897	Picton	5.1 (5.100)	1973
Warooka	5.9 (5.910)	1902	Cadoux	6.1 (6.100)	1979
Warrnambool	5.5 (5.490)	1903	Tennant Creek	6.6 (6.580)	1988
Gunning	5.4 (5.380)	1934	Uluru	5.5 (5.490)	1989
Gayndah	5.5 (5.480)	1935	Newcastle	5.6 (5.600)	1989
Meeberrie	6.8 (6.820)	1941	Cessnok	5.1 (5.100)	1994
Dalton-Gunning	5.4 (5.380)	1949	Kalgoorlie-Boulder	4.2 (4.160)	2010
Adelaide 1	5.3 (5.280)	1954	Queensland	5.1 (5.140)	2011
Adelaide 2	5.3 (5.280)	1954	**Gippsland**	**5.0 (4.980)**	**2012**
Adelaide 3	5.3 (5.280)	1954	**Lake Muir**	**5.3 (5.250)**	**2018**

World Scenarios Event Set

The 2020 update to the AIR Earthquake Model for Australia also features a brand new World Scenarios event set that includes nine Extreme Disaster Scenario (EDS) events. The events represent scenarios that have been studied and discussed in various sources relevant to extreme disaster modeling for Australia. The event set includes a magnitude 5.1 earthquake near the Sydney airport, which is a standard stress test scenario developed by the Australian government. Other events are low-probability, high-impact events for the cities of Melbourne, Adelaide, and Perth.

8.3 Event Generation

The updated AIR Earthquake Model for Australia offers the time-independent versions of 10,000- and 100,000-year stochastic catalogs. These catalogs contain events whose frequency, epicenter, moment magnitude, rupture length, azimuth, depth, and rupture mechanism are simulated for individual source zones.

[15] Events in **bold** typeface are new to the model.

In the following sections, changes in hazard due to the updated stochastic catalog are discussed. Note that the change in losses reflects only the update to the stochastic catalog, with ground motion, vulnerability, and the AIR view of industry exposure held constant.

Model Domain

The size and shape of the stochastic catalog domain for the AIR Earthquake Model for Australia (shown in Figure 40) have changed, relative to the previous version of the model. Stochastic events in the Australia earthquake catalog are generated both on land and off the shores of Australia, as indicated by the boundary in Figure 40.

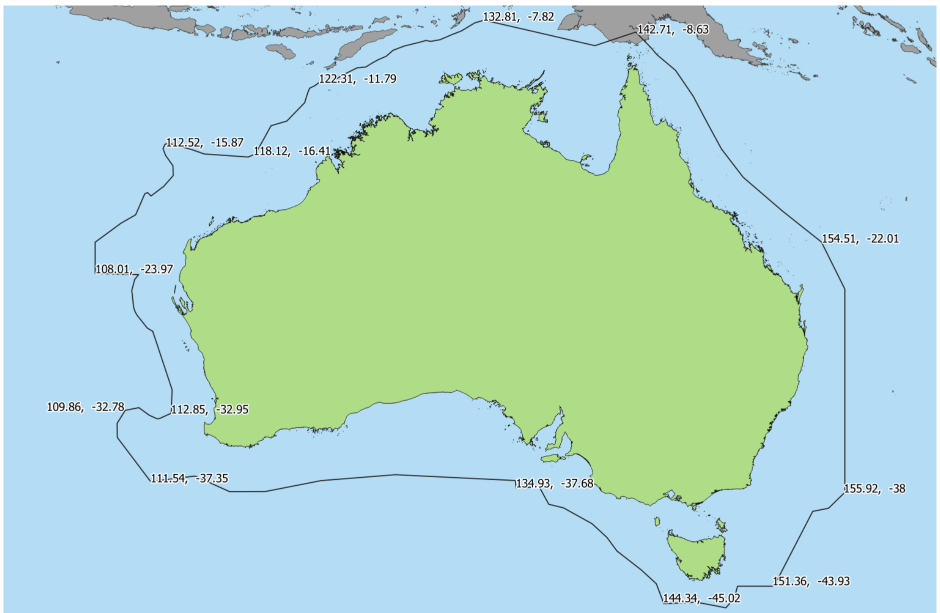


Figure 40. Domain of the AIR Earthquake Model for Australia

Generating the Stochastic Catalog

The AIR Earthquake Model for Australia provides a time-independent view of seismicity in Australia. AIR's model captures the complex seismicity of Australia by generating events along known active crustal faults, within 23 seismotectonic source zones, and seven background source zones. Through the use of smoothed background seismicity, the model captures the potential for earthquakes to occur where there has been little or no recorded historical seismic activity. The stochastic event generation process includes determination of the magnitude, location, rupture length along with the width, depth, and fault orientation/ mechanism.

The processes used to generate the stochastic event catalog have been significantly updated and enhanced. The offering of catalogs in the current model release has been updated to better represent AIR's view of seismicity for Australia.

Notable features of the stochastic event generation are:

- To model the potential seismicity that can occur in Australia, the source model developed by AIR relies on the NSHA18[16] seismotectonic model which is complimented with a background seismicity model. The seismotectonic model captures the seismicity in “known” sources (i.e., faults and zones of distinguished seismicity displayed in the last 100 to 150 years), while the background seismicity model captures the occurrence of significant earthquakes in locations away from known sources.
- Two data sources are considered for the active fault model in Australia. The primary source is the Fault Source Model (FSM) database, released as part of Australia’s NSHA18 assessment, with 379 faults. The secondary data source is the Australian Neotectonic Features Database (ANFD). AIR scientists compiled both fault data sources and recent fault scarp studies to obtain a fault model with 391 faults.

Impact of the Event Generation Update

As part of the latest updates to the National Seismic Hazard model for Australia, Geoscience Australia revised the magnitude of historic earthquakes in Australia. The revision led to a significant drop in the number of historic earthquakes of moderate to large magnitude and, hence, overall seismicity rate. For example, in southeastern Australia (including eastern Queensland, New South Wales, Victoria, and Tasmania), the cumulative number of earthquakes occurring since 1900 reduced by 30% for $M_L > 4.5$ and more than 50% for $M_L \geq 5.0$ after magnitude revision. The impact of catalog update on loss is significant across all regions and all return periods. The impact is more significant in areas of lower seismicity and at shorter return periods.

For more information about the hazard component of the model, refer to the AIR Earthquake Model for Australia model description.

See Also
Generating the Stochastic Catalog

8.4 Local Intensity Calculation

The calculation of local shake intensity requires the following distinct components: ground motion prediction equations (GMPEs), site amplification equations, and soil maps. The calculation of liquefaction intensity requires the utilization of the latest advancements in liquefaction modeling.

Modeling Ground Shaking

The model update includes the following changes to the local intensity calculation module.

[16] http://www.ga.gov.au/about/projects/safety/nsha

Incorporation of the latest GMPEs for a stable continental region

The updated suite of GMPEs implemented in the 2020 version of the AIR Earthquake Model for Australia is intended to represent the ground motion attenuation for a wide variety of tectonic settings found in Australia. AIR scientists have incorporated globally developed GMPEs for stable continental regions (NGA-East) and a corresponding logic tree weighting for calculating spectral accelerations at each site. This approach to modeling the local intensity has been reviewed and affirmed by external reviewers with intimate knowledge of the shaking hazard in Australia.

Updates to the site amplification model

The updated AIR model for Australia uses two unique site amplification models. One model is based on the NGA-West2 for locations of younger and more fissured rock, while a different model is based on the NGA-East for areas of more coherent geological formations. The final site amplification model is the combination of the two, based on the GMPE logic tree for different seismic regions of Australia.

The AIR model addresses attenuation relationships for three seismic regions of Australia in accordance with Geoscience Australia's (GA) superdomains – cratonic, non-cratonic, and extended crust (Clark et al., 2011), as outlined in Figure 41.

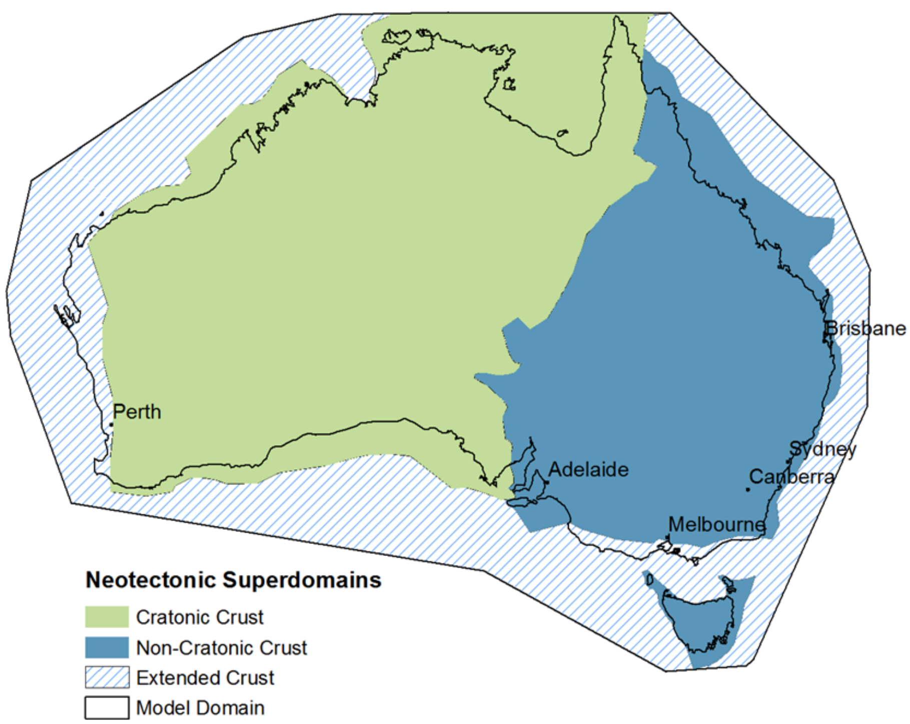


Figure 41. Neotectonic superdomains of Australia, after Clark et al., 2011

Table 110 summarizes the attenuation equations and weighting factors used for Western Australia Cratons. For the cratonic regions, the updated AIR model takes the GA NSHA18 model's GMPE selection with a 50% weighting for determining ground shaking in the region. The NSHA18 model uses seven GMPEs developed specifically for Australia. Because Australia is located in an area of relatively low seismicity, it lacks strong motion data. Furthermore, many of the GMPEs developed for Australia, or regions similar to Australia, are not well constrained by observational data, resulting in large uncertainties. Therefore, AIR considers two GMPEs, recommended by the USGS 2018 model for stable continental regions, as the second viable opinion for Australia. The updated model assigns a weight of 50% to the USGS 2018 GMPEs.

Table 109. Attenuation equations and weighting factors for cratonic crust (Western Australia Cratons)

Cratonic GMPE Model	GMPEs	Weighting Factor Within the Cratonic GMPE Model	Contribution by Group
GA NSHA18	Allen (2012)	0.192	50%
	Somerville et al. (2009)	0.228	
	Atkinson and Boore (2006)	0.124	
	Atkinson and Boore (2011)	0.119	
	Boore et al. (2014)	0.106	
	Chiou and Youngs (2014)	0.085	
	Zhao (2006)	0.146	
USGS CEUS 2018	NGA-East 2018 GMMs (Peterson et al., 2018)	2/3	50%
	Seed GMPEs	1/3	

Additional changes have been made to the ground motion model for non-cratonic crust: the updated model uses an equally-weighted mixture of GMPEs applicable to cratonic and non-cratonic regions (see Table 110).

To summarize, the cratonic GMPEs include the local Australian GMPEs developed by GA for cratonic crust and those developed by the USGS for typical stable continental regions (eastern North America). These cratonic GMPEs are collectively given a 50% weighting for non-cratonic ground motion calculations. The remaining 50% weighting is divided among six non-cratonic GMPEs: two developed for Australia and four Next Generation Attenuations (NGA) relationships (NGA-West2) developed for active crustal regions, such as western United States. Using the NGA-West2 GMPEs is appropriate for non-cratonic eastern Australia due to the similarity of the decay of ground motion over distance, calculated using GMPEs developed for eastern Australia and the limited ground motion records from earthquakes in southeastern Australia.

Table 110. Attenuation equations and weighting factors for non-cratonic Australia crust

GMPE Group	GMPE Model Description and Weighting Factor	GMPEs	Weighting Factor Within the GMPE Model	Contribution by Group
Cratonic GMPEs	See the **Attenuation equations and weighting factors for cratonic crust (Western Australia Cratons)** table.			50%
Non-cratonic GMPEs	Shallow Active Crustal (NGA-West2) 0.25	Boore et al. (2014)	0.25	50%
		Chiou and Youngs (2014)	0.25	
		Campbell and Bozorgnia (2014)	0.25	
		Abrahamson et al. (2014)	0.25	
	Local 0.25	Somerville et al. (2009) (non-cratonic)	0.5	
		Allen (2012)	0.5	

In the transition zone, the model uses a combination of non-cratonic and cratonic GMPEs, with weighting factors applied to smooth the transition from cratonic to non-cratonic regions. Note that the relative contribution of non-cratonic and cratonic GMPEs to ground motion calculations varies depending on the position of a simulated earthquake's epicenter within the zone. For example, near the western border of the transition zone, Western Australia Cratons GMPEs are dominant, while non-cratonic Australia GMPEs play a much smaller role. Near the eastern border of the transition zone, Western Australia Cratons GMPEs and non-cratonic Australia GMPEs each account for about 50% of the ground motion calculation.

Updates to soil maps

Underlying the local intensity calculations are the highest-quality geological soil maps. For the 2020 release, AIR scientists have updated the soil maps and improved their resolution and coverage, especially for Australia's coastal areas.

Modeling Liquefaction

The updated liquefaction model for Australia utilizes the latest advancements and improvements in liquefaction modeling that were developed for the recently released AIR Earthquake Model for New Zealand (2019), including:

- Improved liquefaction triggering methodology
- Updated characteristic soil profiles
- Introduction of liquefaction likelihood functions
- Expanded liquefaction coverage in New South Wales

Impact of the Local Intensity Calculation Update

The updated ground motion model incorporates the state-of-practice GMPEs developed for stable continental regions, such as Australia and eastern North America. The updated ground motion model leads to a reduction in the hazard and losses across the entire model domain. For southeastern Australia (a non-cratonic region), AIR took a more conservative approach by including the GMPEs developed for cratonic regions in addition to those non-cratonic and active crustal GMPEs to consider the limitation in the availability of observed ground motion records. In the cratonic regions and coastal areas of Western Australia, the mix of GA NSHA18 GMPE logic tree and the inclusion of the NGA-East 2018 model also lead to a decrease in the level of ground motion and, thus, a loss reduction.

The updated soil maps used in the 2020 model incorporate the soil map developed by McPherson (2017) and improve the spatial resolution of soil data along coastal regions where exposures data are most densely concentrated. The impact of soil map resolution on loss is mixed and relatively minor.

See Also
Generating the Stochastic Catalog

8.5 Damage Estimation

The improvements to the AIR Earthquake Model for Australia include an update to the model's vulnerability component.

At its core, the vulnerability framework has been changed from a Capacity Spectrum Method based approach to an Intensity-Based Damage Function (IBDF) approach. While the CSM is a suitable framework for assessing the seismic performance of a specific building at a single location, the performance of the CSM and IBDF approaches has been observed to be similar for the purposes of catastrophe risk modeling. This is due to the fact that the accuracy of the CSM approach applied to a single building, where many of the characteristics are known, can be overshadowed by the variability and uncertainty associated with a portfolio of spatially distributed buildings.

In addition to the shift in methodology, a further improvement is the creation of a new age band for risks built after 2018, based on the application of AIR's uniform vulnerability assessment framework. The framework is used to derive vulnerability classes from the chronology of historical building codes and to facilitate an identification of age bands and seismic zones that define the spatial and temporal changes in vulnerability. The result of this approach can be seen in Figure 42. The figure presents the results of the building code evaluation for lateral strength design that have been incorporated into the AIR Earthquake Model for Australia. In the maps, the cooler colors denote areas of higher hazard and, therefore, more stringent design standards resulting in buildings with lower vulnerability. Conversely, the locations in yellow and orange represent areas of moderate to low hazard, where the design requirements are less strict, resulting in buildings with higher vulnerability.

Note that the increased seismic resistance along the northern coast of Australia between 1980 and 2008 is an example of how increased wind loading in the wind design codes has been taken into consideration when evaluating the effect of increased lateral strength to resist earthquake shaking.

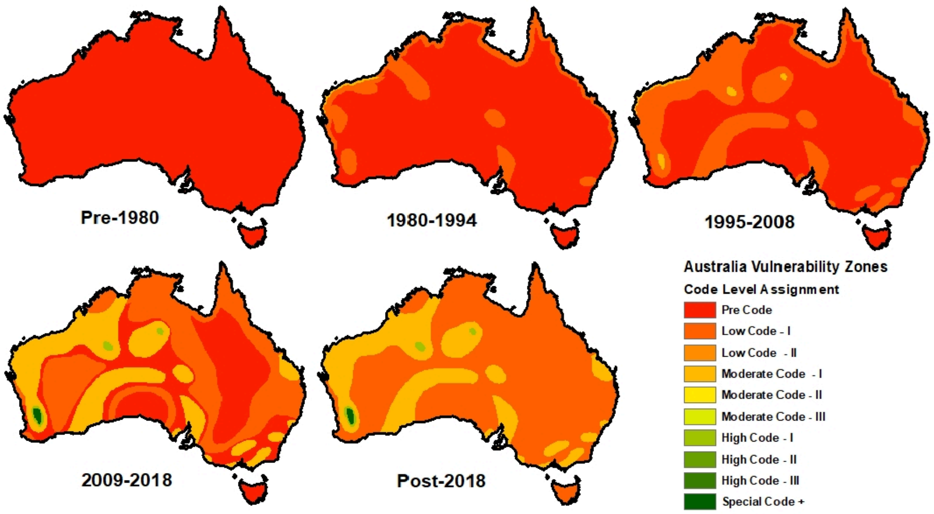


Figure 42. Spatial and temporal variation of vulnerability represented by code levels in Australia

The 2020 update also includes revisions to damage functions for specific construction types. Details are provided in the following sections, along with details for the newly added risk types.

Supported Risk Types

The updated model includes explicit support for a variety of new risk types. The risk types added as of this release are:

- Infrastructure
- Specialized (builder's risk, marine hall, and marine cargo)

Infrastructure

The AIR Earthquake Model for Australia can estimate earthquake damage to various types of infrastructure and lifelines.

The design and construction practices for each sub-class of infrastructure vary considerably in addition to variability in applicable regulations and standards. Moreover, the design of many types of infrastructure is determined by operational loads, wind loads, or hydrodynamic loads. For example, the design requirements of towers (e.g., broadcast towers or electrical transmission lines) are usually governed by high wind loads.

Each of these infrastructure types has a different response to earthquake ground shaking. For example, bridges are susceptible to damage and failure due to the bridge deck sliding from abutments or piers, whereas the large amount of mass within storage tanks filled with solids or liquid substances (e.g., grains, cement, water or fuel) can lead to the development of significant inertial forces during ground shaking.

Specialized Risks

The AIR Earthquake Model for Australia also supports a variety of specialized risks: builder's risk (buildings under construction), marine hull, and marine cargo.

Builder's risk is calculated by varying replacement value and vulnerability of the building under construction over the lifespan of the construction project. Most construction projects can be divided into four phases. The builder's risk ("construction all risks/erection all risks"; CAR/EAR) line of business determines potential losses resulting from earthquake damage to buildings while they are still under construction. Builder's risk can be applied to all supported 100-series construction classes, for all height bands. It supports all conventional residential, commercial, and industrial occupancy classes but does not apply to large complex industrial facilities (400-series occupancy classes) or to infrastructure. Note that contractor equipment is not modeled under builder's risk; it is modeled using existing construction and occupancy classes.

In the AIR model, the marine hull risk type includes the hull and machinery of a vessel. This risk can be modeled at a specific port location and for a particular status of port risk, builder's risk, or repair risk. The status that is used depends on whether the vessel is at port (loading, unloading cargo, or undergoing regular maintenance) or if it is under construction. In the AIR model, damage to marine hulls can be caused by ground shaking, liquefaction, and tsunami. In estimating earthquake-related damage, three different conditions are considered for marine hulls; namely, "at port", "at repair", and "under construction" (i.e., builder's risk). These three conditions for marine hull are represented by occupancy types 354, 314 and 381, respectively. Marine hull damage functions are developed using worldwide resources (mainly from Japan), but are applicable to other regions, including Australia.

Marine cargo covered in the AIR model includes general containers, heavy cargo, refrigerated containers, dry bulk cargo, liquid bulk cargo, and carpool. In the AIR model, damage to these risks is estimated for the ground shaking and liquefaction perils. Note that marine cargo is modeled as an independent risk type, and the total value is entered under Coverage A. It is assumed that the collapse of container cranes is the primary cause of shake damage to a ship's hull when it is located at a port, as the cranes are located next to the ship for loading and unloading. Records of crane damage and the corresponding PGA values at which this damage occurred were collected from field surveys and experimental studies.

Supported Construction and Occupancy Codes

The updated model includes new construction and occupancy codes:

- 83 construction classes are new (204-206, 211, 212, 231-238, 241-246, 251-260, 265-276, and 2010-2286). The total number of supported construction classes: 127

- 4 builder's risk classes are new (381-384) occupancy classes. The total number of supported occupancy classes: 114, including 62 classes for large industrial facilities (400-series)

Updated Damage Functions for Double Brick Cavity

In addition to the updated vulnerability framework, there have been some updates to the vulnerability of specific construction types. Specifically, Geoscience Australia recently revised their view of double brick cavity construction, resulting in lowering their view of vulnerability (see Figure 43). This type of unreinforced masonry construction is particularly common in western Australia. After a review of the double brick cavity vulnerability in the existing AIR Earthquake Model for Australia, it was determined that AIR's existing view of vulnerability was consistent with both observational data and GA's revised view of vulnerability. Therefore, very small changes in vulnerability are expected for this type of construction. Principally, any changes in double brick cavity losses are due to the transition from the CSM to the IBDF framework in the AIR Earthquake Model for Australia.

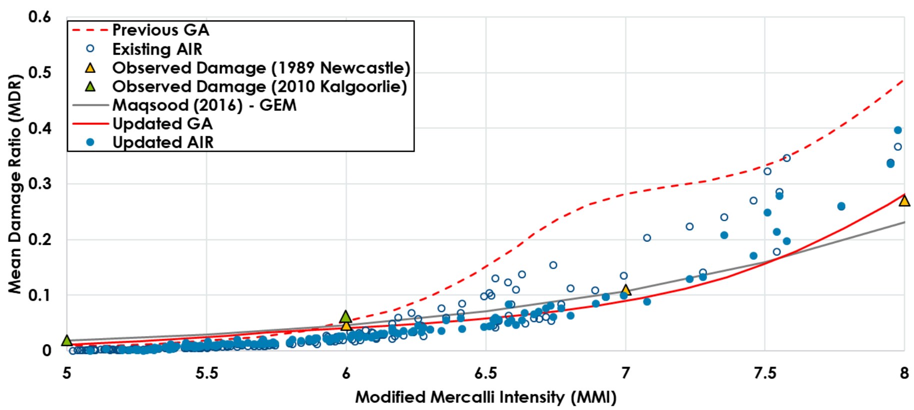


Figure 43. Double Brick Cavity Vulnerability

Updated Damage Functions for Masonry Veneer

In addition to double brick cavity, GA has revised their view of masonry veneer construction (see Figure 44). Masonry veneer is a type of wood (timber) frame construction that has an ornamental and non-structural masonry wall surrounding the wood structure. This type of construction is particularly common for residential buildings in eastern Australia. GA's revised view of masonry veneer vulnerability resulted in a lowering of losses for masonry veneer. Based on a reanalysis of claims data from the Newcastle and Kalgoorlie earthquakes, it was determined that AIR's view of masonry veneer vulnerability should be reduced. Therefore, the residential line of business in Eastern Australia is likely to see a reduction in losses on the order of 5% to 15%, depending on the exact location and return period of interest.

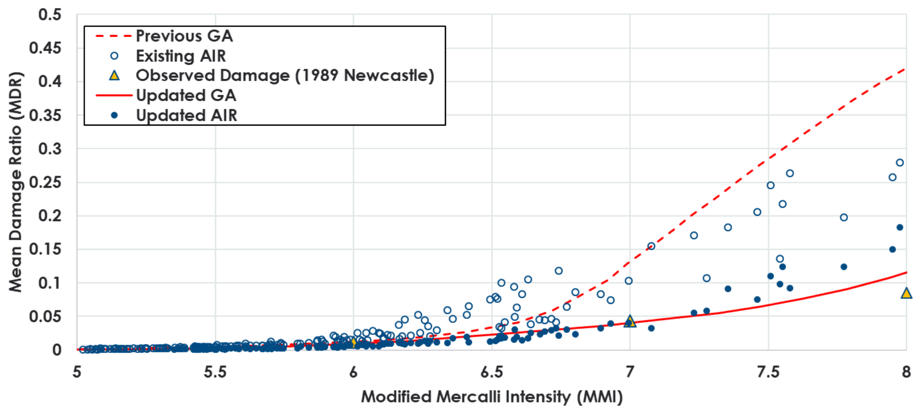


Figure 44. Masonry Veneer Vulnerability

Impact of the Damage Estimation Update

The most significant update to the vulnerability component of the AIR Earthquake Model for Australia is a shift in the damage assessment framework from the Capacity Spectrum Method to Intensity-Based Damage Functions (IBDF). In the CSM framework, roof drifts are estimated from a capacity curve, and then drift-based damage functions are used to calculate a mean damage ratio. In this update framework, damage ratios are calculated as a function of ground shaking intensity. The IBDF framework brings the vulnerability component of the AIR Earthquake Model for Australia into consistency with other recently released AIR earthquake models, for the United States and New Zealand. The impact of changing frameworks is relatively small and typically results in slight increases (less than 10%) in the shorter return periods and smaller decreases (less than 5%) in the longer return periods. The overall impact on the AAL on a country-wide industry basis is approximately a 5% increase due to this shift in vulnerability framework.

See Also

Generating the Stochastic Catalog

8.6 Treatment of Uncertainty in the Model

Accounting for uncertainties in earthquake loss analysis plays a critical role in catastrophe risk modeling in general and in AIR models in particular. Large parametric and model uncertainties exist in earthquake ground motions and the response of buildings to ground motions. Two sources of ground motion uncertainty, including inter-event (i.e., earthquake–to–earthquake) and intra-event (i.e., site-to-site), are specifically revised to improve damage and loss estimates within the context of stochastic modeling and provide a more accurate view of risk. Uncertainty in building damage, which considers variations in the response of buildings of similar characteristics, is also updated for ground-shaking.

For more information, refer to the Accounting for Uncertainty chapter of the model description, available on the AIR Client Portal.

8.7 Liquefaction Updates and Additions

The comprehensive updates to the AIR Earthquake Model for Australia include the newly improved methodology for calculating liquefaction settlement.

Liquefaction occurs when loose, saturated soils lose strength and act as a fluid due to intense shaking during an earthquake. Liquefaction can cause ground and foundation settlement that can damage buildings, port facilities, bridges, roads, automobiles and pipelines. The liquefaction hazard is modeled explicitly at a high resolution of 100 m in major urban areas, namely:

- Greater Melbourne
- East New South Wales, including Sydney and Newcastle
- The southern part of South Australia, including Adelaide
- Southwest Western Australia, including Perth
- Brisbane, Queensland

Considering the limited amount of historical earthquake data for Australia, the AIR liquefaction module for Australia have been developed and validated based on data and studies primarily conducted for New Zealand. Correlations were drawn between analogous locations in Australia and New Zealand and, as a result, the appropriate representative soil profiles have been utilized for the areas of Australia that exhibit similar levels of liquefaction susceptibility.

Note that the support for liquefaction is limited geospatially by the availability of accurate groundwater data. Therefore, the extent of liquefaction coverage is illustrated by the areas for which groundwater data is shown in Figure 45.

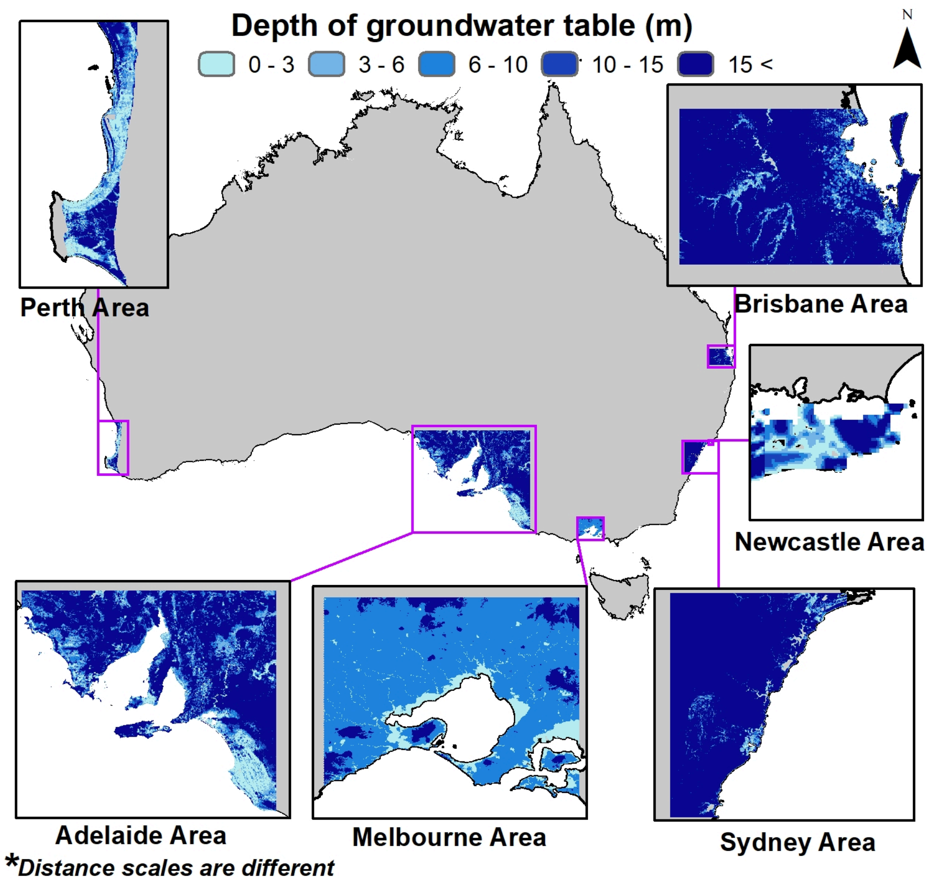


Figure 45. Liquefaction modeling coverage for Australia

Overall, the impact of including liquefaction results in a relatively minor increase in losses at the portfolio level, and the update to the liquefaction module itself results in a small reduction in the liquefaction losses themselves.

8.8 Industry Exposure Database

The Australia Industry Exposure Database is updated through the end of 2015. The database is constructed at a high-resolution (1-km by 1-km) and contains risk counts and their respective replacement values, along with information about the occupancy and physical characteristics of structures, such as construction type and height classification. Large industrial facilities are identified and valued separately from the rest of the industrial line.

In 2019, AIR released industry exposure scaling factors to bring values for Australia to 2018 levels. More information on these scaling factors can be found in the AIR document *U.S. Industry Exposure Index Factors 2019.*

For more information, see the AIR Industry Exposure Database for Australia, available on the AIR Client Portal at www.air-worldwide.com following the summer 2020 software release.

Figure 46 illustrates a spatial distribution of exposures in Australia:

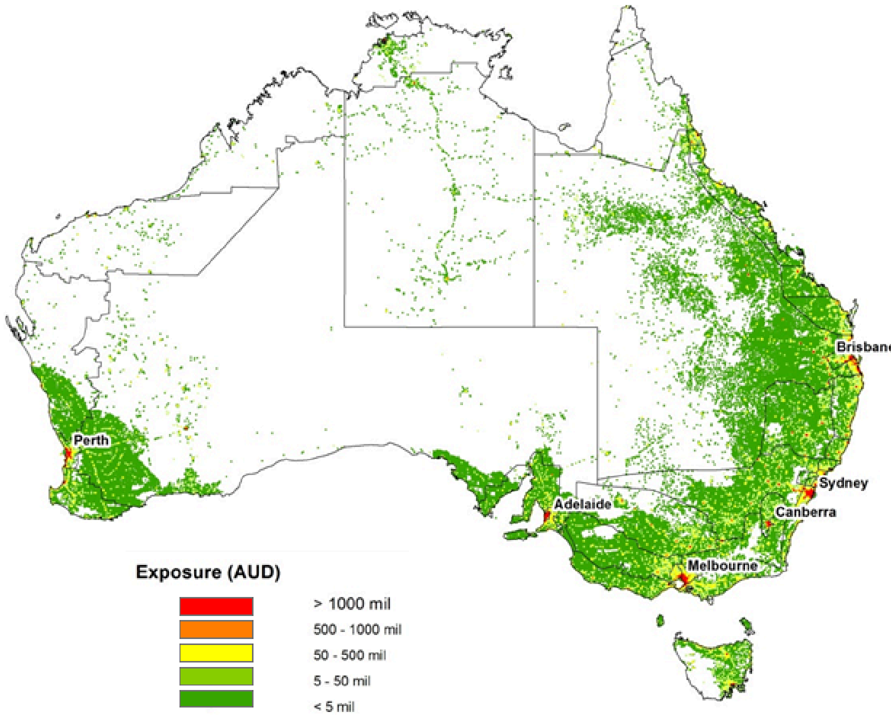


Figure 46. Exposures in Australia

8.9 General Impact of Model Updates on Loss Estimates

Both hazard and vulnerability components have been modified in the summer 2020 release of the AIR Earthquake Model for Australia. The hazard component—including the seismicity and ground motion models—is updated in response to the significant change to the underlying data for the seismicity model and updated view of the ground motion model in the National Seismic Hazard Assessment (NSHA) published by GA in 2018. For additional information regarding seismic hazard, consult the *AIR FAQ The Geoscience Australia National Seismic Hazard Model Update* and the AIR white paper *Understanding Earthquake Risks in Australia*. The overall losses show reductions across all return periods at both country and regional level. Such decreases are mainly driven by a significant reduction in seismicity rates due to the revision of historic earthquake magnitudes. Changes to the ground motion model, including the incorporation of the latest ground motion models for stable continental regions (NGA-East, 2018) also lead to some level of reduction in losses. The impacts of vulnerability updates are relatively minor.

The following tables illustrate the overall impact of model updates on loss estimates from the previous version of Touchstone Re (7.0) to the 2020 version of Touchstone Re (8.0). Table 111 through Table 125 present the percentage change in loss estimates for **ground-shaking** only, by line of business, for Australia and 14 aggregated CRESTA regions, using the time-independent 10,000-year catalog. Touchstone Re settings used in the associated model runs are provided in the next section. The loss changes do not reflect the impacts of demand surge.

The **Overall Change** columns show the change in industry gross insurable occurrence losses. This column indicates the combined effects of all changes (e.g., updates to the catalog, policy conditions, take-up rates, post codes), including updated property values. Overall Changes are developed by comparing the total industry insurable losses in the prior industry loss file to the total industry insurable losses in the new industry loss file. In Touchstone Re, 100% sums insured based market shares are analyzed against each loss file and the percentage differences calculated in the resulting loss distributions.

Note that losses include only ground shaking while implicitly accounting for the impact of liquefaction.

Table 111. Gross insurable loss changes – ground-shaking – countrywide

Australia: All Modeled Regions												
Exceedance Probability, % (Return Period, Years)	Insurable Occurrence						Insurable Aggregate					
	Overall Change											
	AGR	AUTO	COM/ IND	RES BLD	RES CNT	Total	AGR	AUTO	COM/ IND	RES BLD	RES COM	Total
5% (20)	-63%	-87%	-83%	-79%	-79%	-80%	-65%	-87%	-84%	-79%	-80%	-80%
2% (50)	-53%	-71%	-72%	-70%	-71%	-70%	-56%	-72%	-73%	-71%	-71%	-71%
1% (100)	-46%	-52%	-64%	-63%	-63%	-61%	-48%	-52%	-65%	-64%	-64%	-63%
0.5% (200)	-45%	-46%	-61%	-53%	-49%	-60%	-46%	-47%	-61%	-54%	-50%	-60%
0.4% (250)	-44%	-39%	-59%	-56%	-48%	-58%	-48%	-40%	-59%	-57%	-49%	-58%
0.2% (500)	-41%	-41%	-49%	-53%	-48%	-51%	-42%	-41%	-49%	-53%	-48%	-51%
0.1% (1000)	-46%	-44%	-52%	-51%	-36%	-48%	-45%	-44%	-52%	-51%	-36%	-48%
Est. AAL	-61%	-49%	-58%	-59%	-58%	-58%	-63%	-50%	-59%	-60%	-59%	-59%

Table 112. Gross insurable loss changes – ground-shaking – Canberra

Australia: Canberra - Capital Region - Aggregated Region 12, Zones 35-36, 39												
Exceedance Probability, % (Return Period, Years)	Insurable Occurrence						Insurable Aggregate					
	Overall Change											
	AGR	AUTO	COM/ IND	RES BLD	RES CNT	Total	AGR	AUTO	COM/ IND	RES BLD	RES COM	Total
5% (20)	-	-	-	-	-	-	-	-	-	-	-	-
2% (50)	-90%	-	-96%	-96%	-95%	-94%	-90%	-	-96%	-96%	-95%	-94%
1% (100)	-62%	-97%	-87%	-88%	-84%	-83%	-63%	-97%	-87%	-86%	-84%	-82%
0.5% (200)	-46%	-90%	-65%	-79%	-71%	-62%	-46%	-90%	-65%	-79%	-71%	-62%
0.4% (250)	-48%	-89%	-35%	-67%	-63%	-55%	-48%	-89%	-35%	-67%	-63%	-55%
0.2% (500)	-16%	-53%	-24%	-59%	-49%	-41%	-16%	-53%	-24%	-59%	-49%	-41%
0.1% (1000)	-40%	-14%	-30%	-60%	-44%	-36%	-40%	-14%	-30%	-60%	-44%	-36%
Est. AAL	-39%	-33%	-45%	-57%	-53%	-51%	-39%	-33%	-45%	-57%	-53%	-51%

Table 113. Gross insurable loss changes – ground-shaking – New South Wales-East

Australia: New South Wales-East - Aggregated Region 14, Zones 40-49												
Exceedance Probability, % (Return Period, Years)	Insurable Occurrence						Insurable Aggregate					
	Overall Change											
	AGR	AUTO	COM/ IND	RES BLD	RES CNT	Total	AGR	AUTO	COM/ IND	RES BLD	RES COM	Total
5% (20)	-	-	-	-	-	-	-	-	-	-	-	-
2% (50)	-88%	-100%	-98%	-97%	-95%	-96%	-88%	-100%	-98%	-97%	-95%	-96%
1% (100)	-69%	-95%	-84%	-81%	-81%	-83%	-69%	-95%	-84%	-82%	-81%	-83%
0.5% (200)	-61%	-81%	-64%	-67%	-61%	-58%	-61%	-81%	-64%	-67%	-61%	-58%
0.4% (250)	-58%	-78%	-54%	-57%	-54%	-53%	-60%	-78%	-57%	-57%	-54%	-53%
0.2% (500)	-48%	-54%	-58%	-49%	-49%	-54%	-48%	-54%	-58%	-49%	-49%	-54%
0.1% (1000)	-24%	-25%	-38%	-19%	-7%	-38%	-24%	-25%	-38%	-19%	-7%	-38%
Est. AAL	-50%	-17%	-50%	-33%	-41%	-41%	-51%	-17%	-50%	-33%	-41%	-41%

Table 114. Gross insurable loss changes – ground-shaking – New South Wales-West

Australia: New South Wales-West - Aggregated Region 13, Zones 37-38												
Exceedance Probability, % (Return Period, Years)	Insurable Occurrence						Insurable Aggregate					
	Overall Change											
	AGR	AUTO	COM/ IND	RES BLD	RES CNT	Total	AGR	AUTO	COM/ IND	RES BLD	RES COM	Total
5% (20)	-	-	-	-	-	-	-	-	-	-	-	-
2% (50)	-84%	-100%	-97%	-94%	-93%	-92%	-84%	-100%	-97%	-93%	-93%	-92%
1% (100)	-71%	-96%	-80%	-79%	-75%	-77%	-70%	-96%	-80%	-79%	-75%	-77%
0.5% (200)	-66%	-86%	-70%	-74%	-63%	-69%	-66%	-86%	-70%	-74%	-63%	-69%
0.4% (250)	-66%	-85%	-73%	-68%	-62%	-66%	-67%	-85%	-73%	-68%	-62%	-66%
0.2% (500)	-65%	-68%	-68%	-69%	-61%	-62%	-65%	-68%	-68%	-69%	-61%	-62%
0.1% (1000)	-69%	-7%	-66%	-54%	-58%	-62%	-69%	-20%	-66%	-57%	-60%	-63%
Est. AAL	-74%	-47%	-67%	-70%	-70%	-70%	-74%	-48%	-67%	-71%	-70%	-70%

Table 115. Gross insurable loss changes – ground-shaking – Northern Territory-North

Australia: Northern Territory-North - Aggregated Region 4, Zones 16-17												
Exceedance Probability, % (Return Period, Years)	Insurable Occurrence						Insurable Aggregate					
	Overall Change											
	AGR	AUTO	COM/ IND	RES BLD	RES CNT	Total	AGR	AUTO	COM/ IND	RES BLD	RES COM	Total
5% (20)	-	-	-	-	-	-	-	-	-	-	-	-
2% (50)	-	-	-	-	-	-	-	-	-	-	-	-
1% (100)	-	-	-	-	-	-	-	-	-	-	-	-
0.5% (200)	-	-	-	-	-	-	-	-	-	-	-	-
0.4% (250)	-	-	-	-	-	-	-	-	-	-	-	-
0.2% (500)	-91%	-	-100%	-95%	-93%	-95%	-91%	-	-100%	-95%	-93%	-95%
0.1% (1000)	-90%	-100%	-98%	-92%	-91%	-94%	-90%	-100%	-98%	-92%	-91%	-94%
Est. AAL	-75%	-95%	-93%	-75%	-71%	-81%	-75%	-95%	-93%	-75%	-71%	-81%

Table 116. Gross insurable loss changes – ground-shaking – Northern Territory-Remainder

Australia: Northern Territory-Remainder- Aggregated Region 5, Zone 18												
Exceedance Probability, % (Return Period, Years)	Insurable Occurrence						Insurable Aggregate					
	Overall Change											
	AGR	AUTO	COM/ IND	RES BLD	RES CNT	Total	AGR	AUTO	COM/ IND	RES BLD	RES COM	Total
5% (20)	-	-	-	-	-	-	-	-	-	-	-	-
2% (50)	-	-	-	-97%	-96%	-96%	-	-	-	-97%	-96%	-96%
1% (100)	-86%	-100%	-	-96%	-98%	-97%	-86%	-100%	-	-96%	-98%	-97%
0.5% (200)	-77%	-99%	-	-96%	-95%	-96%	-77%	-99%	-	-96%	-95%	-96%
0.4% (250)	-78%	-98%	-99%	-93%	-94%	-93%	-78%	-98%	-99%	-93%	-94%	-93%
0.2% (500)	-76%	-97%	-91%	-84%	-88%	-85%	-76%	-97%	-91%	-84%	-88%	-85%
0.1% (1000)	-83%	-91%	-78%	-82%	-78%	-80%	-83%	-91%	-78%	-82%	-78%	-80%
Est. AAL	-78%	-41%	-82%	-75%	-74%	-77%	-78%	-41%	-82%	-75%	-74%	-77%

Table 117. Gross insurable loss changes – ground-shaking – Queensland-East

Australia: Queensland-East- Aggregated Region 1, Zones 1-11												
Exceedance Probability, % (Return Period, Years)	Insurable Occurrence						Insurable Aggregate					
	Overall Change											
	AGR	AUTO	COM/ IND	RES BLD	RES CNT	Total	AGR	AUTO	COM/ IND	RES BLD	RES COM	Total
5% (20)	-	-	-	-	-	-	-	-	-	-	-	-
2% (50)	-	-	-	-	-	-	-	-	-	-	-	-
1% (100)	-82%	-	-94%	-95%	-94%	-93%	-82%	-	-94%	-95%	-94%	-93%
0.5% (200)	-59%	-98%	-86%	-78%	-75%	-78%	-59%	-98%	-86%	-78%	-75%	-79%
0.4% (250)	-51%	-97%	-84%	-78%	-73%	-78%	-51%	-97%	-84%	-78%	-73%	-78%
0.2% (500)	-46%	-82%	-78%	-72%	-73%	-74%	-46%	-82%	-78%	-72%	-73%	-74%
0.1% (1000)	-34%	-81%	-71%	-66%	-62%	-71%	-34%	-81%	-71%	-66%	-62%	-71%
Est. AAL	-31%	-75%	-75%	-71%	-68%	-72%	-32%	-75%	-75%	-72%	-69%	-73%

Table 118. Gross insurable loss changes – ground-shaking – Queensland-North

Australia: Queensland-North - Aggregated Region 2, Zones 12-14												
Exceedance Probability, % (Return Period, Years)	Insurable Occurrence						Insurable Aggregate					
	Overall Change											
	AGR	AUTO	COM/ IND	RES BLD	RES CNT	Total	AGR	AUTO	COM/ IND	RES BLD	RES COM	Total
5% (20)	-	-	-	-	-	-	-	-	-	-	-	-
2% (50)	-	-	-	-	-	-	-	-	-	-	-	-
1% (100)	-	-	-	-	-	-99%	-	-	-	-	-	-99%
0.5% (200)	-93%	-	-98%	-94%	-93%	-87%	-93%	-	-98%	-94%	-93%	-87%
0.4% (250)	-92%	-	-77%	-88%	-84%	-80%	-92%	-	-77%	-88%	-84%	-80%
0.2% (500)	-84%	-96%	-40%	-80%	-71%	-72%	-84%	-96%	-40%	-82%	-72%	-72%
0.1% (1000)	-80%	-75%	-32%	-48%	-31%	-47%	-80%	-75%	-32%	-48%	-31%	-47%
Est. AAL	-78%	-54%	-56%	-42%	-40%	-49%	-78%	-54%	-56%	-42%	-41%	-49%

Table 119. Gross insurable loss changes – ground-shaking – Queensland-West

Australia: Queensland-West - Aggregated Region 3, Zone 15												
Exceedance Probability, % (Return Period, Years)	Insurable Occurrence						Insurable Aggregate					
	Overall Change											
	AGR	AUTO	COM/ IND	RES BLD	RES CNT	Total	AGR	AUTO	COM/ IND	RES BLD	RES COM	Total
5% (20)	-	-	-	-	-	-	-	-	-	-	-	-
2% (50)	-82%	-100%	-98%	-96%	-95%	-91%	-82%	-100%	-98%	-96%	-95%	-92%
1% (100)	-69%	-97%	-89%	-83%	-80%	-82%	-70%	-97%	-89%	-83%	-79%	-82%
0.5% (200)	-58%	-86%	-85%	-72%	-68%	-75%	-58%	-86%	-85%	-72%	-68%	-75%
0.4% (250)	-59%	-80%	-81%	-66%	-64%	-69%	-59%	-80%	-81%	-66%	-64%	-69%
0.2% (500)	-50%	-46%	-55%	-58%	-58%	-61%	-50%	-46%	-55%	-58%	-58%	-61%
0.1% (1000)	-58%	-24%	-69%	-48%	-59%	-60%	-58%	-24%	-69%	-49%	-59%	-60%
Est. AAL	-62%	-46%	-63%	-66%	-67%	-64%	-62%	-46%	-63%	-66%	-67%	-65%

Table 120. Gross insurable loss changes – ground-shaking – South Australia/Adelaide

Australia: South Australia/Adelaide - Aggregated Region 8, Zones 25-28												
Exceedance Probability, % (Return Period, Years)	Insurable Occurrence						Insurable Aggregate					
	Overall Change											
	AGR	AUTO	COM/ IND	RES BLD	RES CNT	Total	AGR	AUTO	COM/ IND	RES BLD	RES COM	Total
5% (20)	-	-	-	-	-	-	-	-	-	-	-	-
2% (50)	-65%	-98%	-79%	-83%	-80%	-77%	-65%	-98%	-79%	-83%	-80%	-77%
1% (100)	-37%	-80%	-70%	-62%	-66%	-66%	-38%	-80%	-71%	-62%	-66%	-64%
0.5% (200)	-27%	-77%	-80%	-68%	-75%	-67%	-27%	-77%	-80%	-68%	-75%	-67%
0.4% (250)	-29%	-74%	-81%	-73%	-75%	-74%	-29%	-74%	-81%	-73%	-75%	-74%
0.2% (500)	-27%	-60%	-49%	-43%	-40%	-37%	-27%	-60%	-49%	-43%	-40%	-37%
0.1% (1000)	-37%	-65%	-56%	-60%	-40%	-55%	-37%	-65%	-56%	-60%	-40%	-55%
Est. AAL	-33%	-41%	-53%	-42%	-40%	-45%	-33%	-42%	-53%	-42%	-41%	-45%

Table 121. Gross insurable loss changes – ground-shaking – Tasmania

Australia: Tasmania - Aggregated Region 10, Zone 29												
Exceedance Probability, % (Return Period, Years)	Insurable Occurrence						Insurable Aggregate					
	Overall Change											
	AGR	AUTO	COM/ IND	RES BLD	RES CNT	Total	AGR	AUTO	COM/ IND	RES BLD	RES COM	Total
5% (20)	-	-	-	-	-	-	-	-	-	-	-	-
2% (50)	-	-	-	-	-	-	-	-	-	-	-	-
1% (100)	-	-	-100%	-100%	-100%	-100%	-	-	-100%	-100%	-100%	-100%
0.5% (200)	-89%	-100%	-93%	-96%	-96%	-92%	-89%	-100%	-93%	-96%	-96%	-92%
0.4% (250)	-84%	-98%	-83%	-94%	-95%	-87%	-84%	-98%	-83%	-94%	-95%	-88%
0.2% (500)	-83%	-86%	-82%	-84%	-89%	-79%	-82%	-86%	-82%	-84%	-89%	-79%
0.1% (1000)	-68%	-89%	-53%	-75%	-72%	-60%	-68%	-89%	-53%	-75%	-72%	-60%
Est. AAL	-67%	-56%	-59%	-70%	-71%	-67%	-67%	-56%	-59%	-70%	-71%	-67%

Table 122. Gross insurable loss changes – ground-shaking – Victoria/Melbourne

Australia: Victoria/Melbourne - Aggregated Region 11, Zones 30-34												
Exceedance Probability, % (Return Period, Years)	Insurable Occurrence						Insurable Aggregate					
	Overall Change											
	AGR	AUTO	COM/ IND	RES BLD	RES CNT	Total	AGR	AUTO	COM/ IND	RES BLD	RES COM	Total
5% (20)	-	-	-	-	-	-	-	-	-	-	-	-
2% (50)	-81%	-99%	-86%	-86%	-84%	-83%	-81%	-99%	-87%	-86%	-84%	-83%
1% (100)	-52%	-90%	-73%	-74%	-75%	-70%	-53%	-90%	-73%	-74%	-75%	-70%
0.5% (200)	-44%	-56%	-60%	-58%	-58%	-63%	-45%	-56%	-60%	-58%	-58%	-63%
0.4% (250)	-45%	-35%	-54%	-55%	-58%	-57%	-45%	-35%	-55%	-55%	-58%	-57%
0.2% (500)	-48%	-30%	-48%	-43%	-57%	-54%	-48%	-30%	-48%	-43%	-57%	-54%
0.1% (1000)	-58%	-34%	-50%	-41%	-38%	-46%	-54%	-34%	-50%	-41%	-38%	-46%
Est. AAL	-57%	-54%	-50%	-64%	-60%	-58%	-58%	-54%	-50%	-65%	-60%	-58%

Table 123. Gross insurable loss changes – ground-shaking – Western Australia-Broome/Dampier

Australia: Western Australia-Broome/Dampier - Aggregated Region 6, Zones 19-20												
Exceedance Probability, % (Return Period, Years)	Insurable Occurrence						Insurable Aggregate					
	Overall Change											
	AGR	AUTO	COM/ IND	RES BLD	RES CNT	Total	AGR	AUTO	COM/ IND	RES BLD	RES COM	Total
5% (20)	-	-	-	-	-	-99%	-	-	-	-	-	-99%
2% (50)	-86%	-100%	-100%	-99%	-99%	-98%	-85%	-100%	-100%	-99%	-99%	-98%
1% (100)	-78%	-100%	-90%	-85%	-80%	-83%	-78%	-100%	-90%	-85%	-80%	-83%
0.5% (200)	-84%	-100%	-83%	-79%	-66%	-80%	-84%	-100%	-83%	-79%	-67%	-80%
0.4% (250)	-86%	-100%	-84%	-77%	-66%	-78%	-86%	-100%	-84%	-77%	-66%	-78%
0.2% (500)	-67%	-84%	-80%	-68%	-62%	-73%	-67%	-84%	-80%	-68%	-62%	-74%
0.1% (1000)	-67%	-61%	-74%	-63%	-48%	-63%	-67%	-61%	-74%	-63%	-48%	-63%
Est. AAL	-69%	-68%	-78%	-70%	-63%	-72%	-69%	-68%	-78%	-70%	-63%	-72%

Table 124. Gross insurable loss changes – ground-shaking – Western Australia-Perth/Surroundings

Australia: Western Australia-Perth/Surroundings - Aggregated Region 7, Zones 21-23												
Exceedance Probability, % (Return Period, Years)	Insurable Occurrence						Insurable Aggregate					
	Overall Change											
	AGR	AUTO	COM/ IND	RES BLD	RES CNT	Total	AGR	AUTO	COM/ IND	RES BLD	RES COM	Total
5% (20)	-	-	-	-	-	-	-	-	-	-	-	-
2% (50)	-98%	-100%	-100%	-99%	-99%	-99%	-98%	-100%	-100%	-99%	-99%	-99%
1% (100)	-92%	-100%	-100%	-98%	-98%	-98%	-92%	-100%	-100%	-98%	-98%	-98%
0.5% (200)	-84%	-98%	-99%	-97%	-98%	-96%	-85%	-98%	-99%	-97%	-98%	-96%
0.4% (250)	-80%	-98%	-98%	-95%	-96%	-95%	-80%	-98%	-98%	-95%	-96%	-95%
0.2% (500)	-77%	-96%	-88%	-84%	-84%	-88%	-77%	-96%	-88%	-84%	-84%	-88%
0.1% (1000)	-73%	-92%	-81%	-79%	-67%	-79%	-73%	-92%	-81%	-79%	-67%	-79%
Est. AAL	-86%	-80%	-79%	-78%	-76%	-78%	-87%	-80%	-79%	-78%	-76%	-78%

Table 125. Gross insurable loss changes – ground-shaking – Western Australia-Remainder/South Australia-Reminder

Australia: Western Australia-Remainder/South Australia-Reminder - Aggregated Region 9, Zone 24												
Exceedance Probability, % (Return Period, years)	Insurable Occurrence						Insurable Aggregate					
	Overall Change											
	AGR	AUTO	COM/ IND	RES BLD	RES CNT	Total	AGR	AUTO	COM/ IND	RES BLD	RES COM	Total
5% (20)	-88%	-99%	-99%	-97%	-96%	-94%	-89%	-99%	-99%	-97%	-96%	-95%
2% (50)	-73%	-93%	-90%	-88%	-87%	-86%	-74%	-94%	-90%	-89%	-87%	-87%
1% (100)	-65%	-84%	-87%	-82%	-76%	-80%	-65%	-86%	-87%	-82%	-78%	-81%
0.5% (200)	-55%	-68%	-81%	-78%	-74%	-77%	-56%	-67%	-81%	-78%	-75%	-77%
0.4% (250)	-50%	-65%	-76%	-78%	-73%	-76%	-52%	-64%	-76%	-77%	-73%	-76%
0.2% (500)	-41%	-48%	-70%	-70%	-66%	-69%	-41%	-49%	-70%	-70%	-66%	-70%
0.1% (1000)	-49%	-20%	-64%	-56%	-48%	-55%	-49%	-20%	-64%	-56%	-49%	-55%

Australia: Western Australia-Remainder/South Australia-Reminder - Aggregated Region 9, Zone 24												
Exceedance Probability, % (Return Period, years)	Insurable Occurrence						Insurable Aggregate					
	Overall Change											
	AGR	AUTO	COM/ IND	RES BLD	RES CNT	Total	AGR	AUTO	COM/ IND	RES BLD	RES COM	Total
Est. AAL	-69%	-71%	-72%	-82%	-83%	-80%	-69%	-71%	-72%	-83%	-83%	-80%

8.10 Analysis Settings

Table 126. Touchstone Re analysis settings for the AIR Earthquake Model for Australia runs to determine occurrence and aggregate loss changes

Setting	Selected Option(s)
Perils modeled	Earthquake – Earthquake Shake
Catalogs	**10K Australia AP (2020) – Standard** against **10K Australia AP (2017) - Standard**
Industry exposure vintage	Australia 2015
Demand surge**	Off

* For more information on take-up rate assumptions, see the document *AIR Industry Exposure Database for Australia*, available on the AIR Client Portal.

** Development of region-specific demand-surge functions is currently underway at AIR. While AIR recommends incorporating demand surge into modeled loss estimates where appropriate, AIR makes no recommendation as to the form of the demand-surge functions for shake in Australia. Clients may apply a user-defined demand-surge function if they choose.

9 The AIR Multiple Peril Crop Insurance Model for Mainland China

9.1 Overview of Model Updates and Changes

The AIR Multiple Peril Crop Insurance Model for China is updated in the 2020 release of Touchstone Re to include:

- Five new crop lines of business
    - Barley
    - Peanut
    - Potato
    - Rubber
    - Sugar
- New heat sub-peril for crops
- New lines of business for livestock and poultry
    - Dairy cattle
    - Other cattle
    - Breeding sow
    - Other pig
    - Poultry
    - Sheep/goat
- New sub-perils for livestock and poultry
    - Weather
    - Disease
- Additional historical data
- Updated stochastic catalog
- Updated policy conditions
- Updated exposure to 2018 values

9.2 Catalogs and Event Sets

Historical Catalog

The historical catalog contains three additional years of crop data: 2016, 2017, and 2018. Aggregate losses for the years 1981 - 2018 are now available for each crop line of business. The forestry historical catalog remains the same, containing data from 1981 - 2015. The livestock and poultry catalog contains data from 1981-2018 for weather-related losses only.

Stochastic Catalog

The AIR Multiple Peril Crop Insurance Model for China supports a 10,000-year stochastic catalog. For this update, a new catalog was generated to support all crop and livestock and poultry lines of business and sub-perils, and to incorporate the effects of the additional historical data. **Note that the stochastic catalog event years have changed and do not correspond to the same weather scenarios as in the previous release of the model.**

The scenarios in the stochastic catalog for forestry remain unchanged. However, the event IDs were changed to match the event years in the crop and the livestock and poultry catalogs.

9.3 Event Generation

Generating the Stochastic Catalog

The 10,000-year stochastic catalog was regenerated to incorporate additional historical weather years, an additional crop sub-peril, and two new livestock and poultry sub-perils.

A new version of the 10,000-year stochastic catalog for crop, livestock, and poultry was generated from a longer historical weather record. The weather data included in the catalog are the weekly:

- Crop Moisture Index (CMI)
- AIR Flood Index
- Snow water equivalent
- Maximum wind speed
- Minimum air temperature
- Maximum air temperature (new in this update)

Impact of the Event Generation Update

The changes to the stochastic catalog have a minor impact on the loss estimates. The additional historical data includes only notable regional, rather than national events. The new maximum air temperature data, which supports the new heat sub-peril, has only a minor effect due to the strong correlation of air temperature with the CMI already in the catalog.

9.4 Local Intensity Calculation

There are no changes to the calculation of hazard intensity for sub-perils that are supported in the current model version. New hazard intensity relationships are added in the 2020 release of Touchstone Re to support the new crop sub-peril (heat) and two additional livestock and poultry sub-perils (weather and disease).

Impact of the Local Intensity Calculation Update

The new heat sub-peril accounts for 8% of the losses to the crop lines of business that were in the previous version of the model. This substantially reduces the percentage of losses attributable to flood and wind/hail.

9.5 Damage Estimation

Damage functions for crops are updated in the 2020 release. New damage functions are introduced for the new crop, livestock, and poultry lines of business and their associated sub-perils.

New damage functions for heat vulnerability are introduced for crop lines of business.

In Touchstone Re 8.0, location-specific vulnerabilities by crop sub-peril and developmental stage are updated using data from the China Agricultural Yearbook, updated to 2016.

Crop Vulnerability to Heat

The updated model estimates crop damage due to heat for the first time. The vulnerability of crops to heat changes over the course of the growing season, peaking in the middle of the season around the time of anthesis for flowering crops. The model estimates the weekly damage due to unusually high temperatures and aggregates it over the growing season.

Livestock and Poultry Vulnerability to Disease

The frequency and severity of disease outbreaks in livestock and poultry in mainland China are modeled at a national level, using data from the World Organization for Animal Health as well as from recent historical events. The model disaggregates the calculated frequency and severity data to a county level.

Livestock and Poultry Vulnerability to Weather

Livestock and poultry death rates due to extreme weather are estimated using a linear regression model that considers death rates due to heat, flood, drought, snow, wind, and frost. Cattle, sheep/goats, pigs, and poultry death rates are estimated separately at the grid cell level, and then aggregated to the county level.

Impact of the Damage Estimation Update

This update improves the county-level resolution of the crop damage vulnerabilities, improves the robustness of the county- and city-level losses, and enhances the completeness of the model for the covered perils.

9.6 Loss Calculation

The 2020 version of the AIR Multiple Peril Crop Insurance Model for China has province-specific crop loss calculations for the crop, forest, livestock, and poultry lines of business.

Crop losses are estimated for partial and total losses to the crop. Generically, partial losses for losses above the franchise deductible are estimated by the damaged portion of the liability minus a straight deductible and total losses are estimated by the liability multiplied by a crop developmental-stage indemnity ratio that reflects the point in the growing season when the crop was damaged minus a straight deductible. In this update, three provinces have province-specific modifications to the default calculation:

- Anjui--a developmental-stage indemnity ratio is applied to partial loss
- Fujian--the deductible for rice changes depending upon the damage ratio
- Jilin--a damage ratio-dependent indemnity index is applied to calculate partial loss

The updated model calculates losses from livestock and poultry deaths due to disease and weather sub-perils. Losses for animals that were culled is primarily covered by government compensation; the insurance company may pay only about 10% of the liability.

Impact of the Loss Calculation Update

Changes to the loss calculations and policy conditions contribute the largest share of loss changes to the updated AIR Multiple Peril Crop Insurance Model for China For the lines of business that were supported in the previous version of the model, these changes result in a modest increase in average losses, but cause reduced losses for return periods between 10 and 20 years for the nationwide insurable liability. On a loss ratio basis, the updated model shows lower losses between the 5- and 20-year return periods. Livestock and poultry losses are significantly larger than crop losses, both for the insurable livestock and poultry liability and on a loss ratio basis. Nationwide, however, the insured premium for livestock plus poultry is significantly smaller than the insured-crop premium.

9.7 Updates to the Industry Exposure Database

In Touchstone Re 8.0, the Industry Exposure Database is updated to reflect the new lines of business as well as the most up to date information on policy terms and conditions. Premium rate assumptions, deductible assumptions, franchise assumptions, and sums insured assumptions are updated to reflect 2018 values (which vary by line of business and by province).

Crop exposure area is updated using the China Statistical Yearbook (vintage 2018). In Touchstone Re 8.0, all counties and lines of business, with the exception of rubber, have at least a minimal amount of liability. Rubber is supported only in the provinces of Guangdong, Guangxi, Yunnan, and Hainan. This minimal exposure ensures that the province-level and county-level insurable liabilities and premiums are accurate and that users have the flexibility to assess loss across mainland China.

Forestry sums insured are updated to 2018 values.

Livestock and poultry exposure combines data from the 2010 Gridded Livestock of the World database (GLW 3) with recent government yearbook data. Province-level yearbook data is from 2017, and city-level data is from 2015. Data from the national China Statistical Yearbook is from 2018.

9.8 General Impact of Model Updates on Loss Estimates

The following tables show the overall impact of the updates to the AIR Multiple Peril Crop Insurance Model for China on gross insurable aggregate losses. Loss changes represent the percentage change in loss estimates calculated by the previous version of the model released in Touchstone Re version 7.0 compared with the losses calculated by the current version of the model released in Touchstone Re version 8.0 for Mainland China as a whole and for each province individually.

Touchstone Re settings used in the associated model runs are provided in the next section.

Mainland China									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-9%	-20%	-14%	13%	-30%	-19%	15%	-1%	9%
2% (50 yr)	-5%	-20%	-8%	15%	-31%	1%	18%	3%	1%
1% (100 yr)	-4%	23%	-3%	19%	-18%	17%	19%	7%	-2%

Mainland China									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
0.5% (200 yr)	0%	55%	7%	24%	-4%	22%	20%	8%	-3%
0.4% (250 yr)	2%	65%	8%	27%	3%	24%	19%	9%	-3%
0.2% (500 yr)	6%	78%	23%	31%	0%	24%	16%	6%	-3%
0.1% (1000 yr)	16%	75%	28%	39%	-2%	23%	17%	7%	-4%
Est. AAL	2%	16%	1%	26%	-14%	7%	28%	9%	10%
EP (Return Period)	Constant Exposure								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-17%	-32%	-13%	-12%	-30%	-24%	-11%	-11%	0%
2% (50 yr)	-11%	-28%	-4%	-10%	-31%	-8%	-5%	-5%	0%
1% (100 yr)	-11%	-2%	-3%	-8%	-11%	6%	-1%	-1%	0%
0.5% (200 yr)	-11%	24%	4%	-5%	4%	12%	1%	1%	0%
0.4% (250 yr)	-10%	34%	6%	-4%	10%	15%	2%	2%	0%
0.2% (500 yr)	-9%	41%	10%	1%	10%	15%	0%	0%	0%
0.1% (1000 yr)	-4%	42%	16%	5%	7%	14%	1%	1%	0%
Est. AAL	-8%	-5%	6%	1%	-10%	6%	-3%	-3%	0%

Anhui									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-18%	-66%	-45%	74%	-63%	2%	19%	11%	-4%
2% (50 yr)	-17%	-64%	-42%	43%	-67%	29%	24%	12%	-4%
1% (100 yr)	15%	-40%	-33%	43%	-37%	39%	32%	12%	-4%

Anhui									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
0.5% (200 yr)	49%	-23%	-12%	52%	-17%	51%	32%	16%	-4%
0.4% (250 yr)	56%	-9%	-9%	58%	-4%	55%	30%	17%	-4%
0.2% (500 yr)	75%	-9%	-2%	61%	-9%	63%	30%	21%	-4%
0.1% (1000 yr)	74%	-11%	5%	61%	-11%	70%	36%	30%	-4%
Est. AAL	17%	-68%	-17%	43%	-38%	8%	24%	12%	-4%
EP (Return Period)	Constant Exposure								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-41%	18%	-38%	36%	-50%	-14%	-6%	-6%	0%
2% (50 yr)	-42%	21%	-19%	12%	-55%	6%	-2%	-2%	0%
1% (100 yr)	-9%	45%	-6%	15%	-19%	15%	1%	1%	0%
0.5% (200 yr)	18%	82%	35%	22%	6%	29%	6%	6%	0%
0.4% (250 yr)	24%	93%	42%	32%	23%	32%	6%	6%	0%
0.2% (500 yr)	38%	108%	56%	36%	16%	37%	10%	10%	0%
0.1% (1000 yr)	38%	109%	61%	38%	14%	44%	18%	18%	0%
Est. AAL	-16%	2%	11%	25%	-18%	-8%	3%	3%	0%

Beijing									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-56%	-94%	>500%	-77%	-63%	-42%	-53%	-55%	0%
2% (50 yr)	-59%	-93%	>500%	-73%	-61%	-49%	-56%	-58%	0%
1% (100 yr)	-39%	-89%	>500%	-59%	-24%	-42%	-40%	-44%	0%

Beijing									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
0.5% (200 yr)	-30%	-87%	>500%	-43%	4%	-36%	-31%	-34%	0%
0.4% (250 yr)	-23%	-84%	>500%	-35%	30%	-26%	-25%	-28%	0%
0.2% (500 yr)	-25%	-85%	>500%	-28%	28%	-33%	-22%	-26%	0%
0.1% (1000 yr)	-26%	-86%	>500%	-27%	19%	-36%	-22%	-27%	0%
Est. AAL	7%	-89%	>500%	-35%	-25%	19%	14%	7%	0%
EP (Return Period)	Constant Exposure								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-24%	-44%	-51%	-76%	-42%	19%	-18%	-18%	0%
2% (50 yr)	-30%	-26%	-70%	-72%	-38%	7%	-27%	-27%	0%
1% (100 yr)	9%	11%	-69%	-54%	23%	23%	2%	2%	0%
0.5% (200 yr)	25%	41%	-69%	-28%	68%	35%	18%	18%	0%
0.4% (250 yr)	38%	54%	-67%	-24%	109%	55%	31%	31%	0%
0.2% (500 yr)	39%	68%	-63%	-11%	107%	41%	37%	37%	0%
0.1% (1000 yr)	38%	55%	-62%	-9%	92%	35%	36%	36%	0%
Est. AAL	91%	15%	-33%	-26%	19%	149%	98%	98%	0%

Chongqing									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	13%	>500%	154%	110%	-40%	-73%	85%	64%	2%
2% (50 yr)	15%	>500%	167%	68%	-46%	-74%	110%	64%	2%
1% (100 yr)	169%	>500%	159%	166%	-12%	-55%	165%	143%	2%

Chongqing									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
0.5% (200 yr)	237%	>500%	183%	210%	12%	-45%	193%	160%	2%
0.4% (250 yr)	306%	>500%	193%	254%	34%	-40%	201%	161%	2%
0.2% (500 yr)	304%	>500%	203%	241%	31%	-37%	215%	192%	2%
0.1% (1000 yr)	298%	>500%	198%	235%	29%	-37%	253%	189%	2%
Est. AAL	82%	>500%	108%	159%	-12%	-62%	136%	104%	2%
EP (Return Period)	Constant Exposure								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-41%	109%	26%	9%	-30%	-23%	-9%	-9%	0%
2% (50 yr)	-39%	147%	35%	-12%	-38%	-23%	-10%	-10%	0%
1% (100 yr)	38%	160%	31%	36%	2%	26%	29%	29%	0%
0.5% (200 yr)	75%	157%	43%	60%	30%	54%	42%	42%	0%
0.4% (250 yr)	108%	163%	44%	82%	55%	67%	44%	44%	0%
0.2% (500 yr)	109%	168%	47%	75%	53%	75%	60%	60%	0%
0.1% (1000 yr)	106%	165%	46%	72%	50%	75%	60%	60%	0%
Est. AAL	-2%	0%	10%	40%	5%	6%	16%	16%	0%

Fujian									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-58%	-42%	-75%	-22%	-67%	-92%	73%	-27%	70%
2% (50 yr)	-57%	-46%	-76%	-37%	-69%	-92%	71%	-37%	70%
1% (100 yr)	-52%	-36%	-66%	-24%	-57%	-92%	87%	-28%	70%

Fujian									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
0.5% (200 yr)	-49%	-22%	-61%	-10%	-50%	-90%	119%	-12%	70%
0.4% (250 yr)	-48%	-6%	-61%	-6%	-43%	-90%	119%	-11%	70%
0.2% (500 yr)	-47%	-12%	-60%	-6%	-46%	-90%	132%	-11%	70%
0.1% (1000 yr)	-45%	-15%	-62%	-8%	-50%	-91%	121%	-14%	70%
Est. AAL	-46%	-36%	-63%	19%	-62%	-92%	149%	3%	70%
EP (Return Period)	Constant Exposure								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-19%	-34%	-40%	-4%	-38%	-13%	-5%	-5%	0%
2% (50 yr)	-17%	-40%	-41%	-21%	-45%	-37%	-19%	-19%	0%
1% (100 yr)	-7%	-29%	-20%	-16%	-7%	-21%	-14%	-14%	0%
0.5% (200 yr)	7%	-13%	-10%	0%	8%	-4%	0%	0%	0%
0.4% (250 yr)	8%	5%	-11%	3%	24%	3%	3%	3%	0%
0.2% (500 yr)	12%	-2%	-9%	4%	18%	-3%	2%	2%	0%
0.1% (1000 yr)	15%	-5%	-13%	2%	9%	-12%	0%	0%	0%
Est. AAL	8%	-29%	-11%	44%	-20%	-9%	33%	33%	0%

Gansu									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-54%	-55%	-35%	-26%	-55%	-19%	-22%	-42%	8%
2% (50 yr)	-55%	-48%	-28%	-37%	-69%	-22%	-23%	-49%	8%
1% (100 yr)	-24%	15%	39%	-49%	-64%	135%	-2%	-32%	8%

Gansu									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
0.5% (200 yr)	4%	63%	95%	-45%	-58%	215%	19%	-8%	8%
0.4% (250 yr)	25%	105%	148%	-43%	-57%	289%	21%	9%	8%
0.2% (500 yr)	29%	108%	141%	-39%	-54%	284%	36%	12%	8%
0.1% (1000 yr)	32%	107%	134%	-39%	-53%	272%	63%	13%	8%
Est. AAL	-20%	-41%	5%	-28%	-27%	5%	12%	-15%	8%
EP (Return Period)	Constant Exposure								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-62%	-68%	-32%	-10%	-40%	-50%	-54%	-54%	0%
2% (50 yr)	-60%	-58%	-28%	-21%	-58%	-51%	-57%	-57%	0%
1% (100 yr)	-22%	0%	24%	-40%	-51%	48%	-32%	-32%	0%
0.5% (200 yr)	5%	42%	76%	-41%	-46%	100%	-9%	-9%	0%
0.4% (250 yr)	7%	75%	120%	-42%	-44%	146%	-7%	-7%	0%
0.2% (500 yr)	32%	81%	117%	-41%	-42%	142%	13%	13%	0%
0.1% (1000 yr)	34%	82%	111%	-40%	-40%	135%	14%	14%	0%
Est. AAL	-24%	-47%	5%	-16%	-2%	-34%	-24%	-24%	0%

Guangdong									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	9%	>500%	-42%	22%	-69%	-77%	77%	22%	0%
2% (50 yr)	11%	>500%	-33%	25%	-63%	-78%	118%	25%	0%
1% (100 yr)	9%	>500%	-16%	75%	14%	-30%	158%	78%	0%

Guangdong									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
0.5% (200 yr)	21%	>500%	8%	128%	59%	-2%	188%	132%	0%
0.4% (250 yr)	35%	>500%	28%	155%	105%	23%	189%	154%	0%
0.2% (500 yr)	35%	>500%	31%	169%	100%	22%	202%	175%	0%
0.1% (1000 yr)	17%	>500%	28%	161%	97%	21%	191%	172%	0%
Est. AAL	12%	>500%	-37%	43%	-59%	-69%	114%	39%	0%
EP (Return Period)	Constant Exposure								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	60%	-76%	-17%	-41%	-47%	-45%	-29%	-29%	0%
2% (50 yr)	76%	-77%	-2%	-41%	-43%	-47%	-25%	-25%	0%
1% (100 yr)	65%	-47%	0%	-19%	127%	87%	-8%	-8%	0%
0.5% (200 yr)	61%	-28%	24%	6%	216%	163%	19%	19%	0%
0.4% (250 yr)	65%	-16%	44%	12%	290%	230%	26%	26%	0%
0.2% (500 yr)	67%	-19%	50%	24%	287%	227%	45%	45%	0%
0.1% (1000 yr)	46%	-22%	47%	20%	286%	223%	44%	44%	0%
Est. AAL	45%	-100%	-4%	-34%	-28%	-23%	-27%	-27%	0%

Guangxi									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-27%	-71%	26%	-20%	-51%	-61%	62%	9%	37%
2% (50 yr)	-24%	-69%	-15%	-20%	-54%	-63%	77%	7%	37%
1% (100 yr)	26%	-67%	99%	135%	-27%	-48%	143%	55%	37%

Guangxi									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
0.5% (200 yr)	60%	-58%	159%	210%	-12%	-35%	170%	119%	37%
0.4% (250 yr)	83%	-50%	190%	264%	-8%	-28%	174%	119%	37%
0.2% (500 yr)	89%	-49%	210%	268%	-2%	-25%	212%	149%	37%
0.1% (1000 yr)	84%	-48%	207%	250%	0%	-31%	220%	159%	37%
Est. AAL	30%	-55%	144%	41%	-11%	-21%	107%	36%	37%
EP (Return Period)	Constant Exposure								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-63%	-51%	-58%	-40%	-49%	-54%	-27%	-27%	0%
2% (50 yr)	-58%	-25%	-62%	-39%	-62%	-51%	-33%	-33%	0%
1% (100 yr)	-35%	-21%	-41%	66%	-38%	-16%	8%	8%	0%
0.5% (200 yr)	-17%	-15%	-24%	119%	-25%	10%	45%	45%	0%
0.4% (250 yr)	-6%	-9%	-14%	158%	-21%	16%	50%	50%	0%
0.2% (500 yr)	-2%	-4%	-9%	160%	-16%	29%	62%	62%	0%
0.1% (1000 yr)	-4%	-3%	-9%	147%	-15%	17%	67%	67%	0%
Est. AAL	-31%	-13%	-19%	6%	-16%	-8%	-8%	-8%	0%

Guizhou									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-53%	-74%	-52%	-7%	-1%	-33%	-34%	-39%	67%
2% (50 yr)	-26%	-74%	-25%	-11%	16%	9%	-10%	-15%	67%
1% (100 yr)	19%	-54%	37%	55%	25%	74%	19%	15%	67%

Guizhou									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
0.5% (200 yr)	45%	-39%	66%	89%	49%	146%	52%	47%	67%
0.4% (250 yr)	51%	-27%	86%	113%	76%	165%	59%	54%	67%
0.2% (500 yr)	60%	-29%	88%	112%	69%	177%	63%	58%	67%
0.1% (1000 yr)	57%	-33%	87%	104%	57%	177%	77%	72%	67%
Est. AAL	6%	-64%	-1%	24%	-13%	-22%	20%	7%	67%
EP (Return Period)	Constant Exposure								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-54%	-56%	-51%	-51%	-51%	-14%	-50%	-50%	0%
2% (50 yr)	-9%	-54%	-10%	-59%	59%	39%	-7%	-7%	0%
1% (100 yr)	37%	21%	53%	-8%	78%	143%	27%	27%	0%
0.5% (200 yr)	64%	64%	82%	25%	84%	220%	60%	60%	0%
0.4% (250 yr)	71%	97%	103%	29%	84%	243%	64%	64%	0%
0.2% (500 yr)	79%	89%	105%	42%	80%	263%	66%	66%	0%
0.1% (1000 yr)	76%	79%	103%	38%	71%	270%	75%	75%	0%
Est. AAL	5%	-37%	0%	-23%	-27%	-3%	-7%	-7%	0%

Hainan									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	>500%	>500%	-6%	-11%	-33%	>500%	413%	-8%	3%
2% (50 yr)	>500%	>500%	14%	-5%	-12%	>500%	>500%	-4%	3%
1% (100 yr)	>500%	>500%	293%	23%	90%	>500%	>500%	28%	3%

Hainan									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
0.5% (200 yr)	>500%	>500%	408%	52%	164%	>500%	>500%	54%	3%
0.4% (250 yr)	>500%	>500%	493%	67%	220%	>500%	>500%	70%	3%
0.2% (500 yr)	>500%	>500%	>500%	72%	230%	>500%	>500%	75%	3%
0.1% (1000 yr)	>500%	>500%	>500%	72%	231%	>500%	>500%	77%	3%
Est. AAL	>500%	N/A	100%	32%	-31%	>500%	>500%	40%	3%
EP (Return Period)	Constant Exposure								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-24%	-58%	-98%	-37%	-29%	-73%	-37%	-37%	0%
2% (50 yr)	-38%	-59%	-97%	-29%	-5%	-68%	-29%	-29%	0%
1% (100 yr)	-33%	-8%	-90%	-13%	109%	-50%	-12%	-12%	0%
0.5% (200 yr)	-32%	27%	-87%	10%	199%	-34%	12%	12%	0%
0.4% (250 yr)	-34%	41%	-84%	17%	234%	-34%	17%	17%	0%
0.2% (500 yr)	-44%	52%	-83%	24%	274%	-29%	24%	24%	0%
0.1% (1000 yr)	-45%	47%	-83%	28%	274%	-24%	30%	30%	0%
Est. AAL	18%	N/A	-100%	-4%	-26%	0%	-5%	-5%	0%

Hebei									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-58%	-69%	-25%	-68%	-37%	-39%	-45%	-51%	2%
2% (50 yr)	-62%	-69%	-3%	-69%	12%	-50%	-44%	-49%	2%
1% (100 yr)	-36%	-51%	60%	-58%	63%	-13%	-33%	-38%	2%

Hebei									
Insurable Aggregate									
Exceedance Probability (Return Period)	**Overall Change**								
	Corn	**Cotton**	**Rapeseed**	**Rice**	**Soybean**	**Wheat**	**Combined New Crop**	**Combined Old Crop**	**Forestry**
0.5% (200 yr)	-19%	-37%	124%	-48%	99%	21%	-29%	-37%	2%
0.4% (250 yr)	-9%	-31%	175%	-41%	141%	48%	-28%	-36%	2%
0.2% (500 yr)	-7%	-31%	186%	-41%	133%	50%	-25%	-33%	2%
0.1% (1000 yr)	-10%	-33%	187%	-42%	121%	48%	-23%	-35%	2%
Est. AAL	-42%	-51%	11%	-62%	-5%	-20%	-28%	-36%	2%
EP (Return Period)	**Constant Exposure**								
	Corn	**Cotton**	**Rapeseed**	**Rice**	**Soybean**	**Wheat**	**Combined New Crop**	**Combined Old Crop**	**Forestry**
5% (20yr)	-39%	-43%	-29%	-40%	-50%	5%	-23%	-23%	0%
2% (50 yr)	-46%	-39%	-21%	-39%	-46%	-18%	-22%	-22%	0%
1% (100 yr)	-6%	-16%	53%	-21%	40%	44%	-8%	-8%	0%
0.5% (200 yr)	18%	7%	113%	3%	82%	98%	0%	0%	0%
0.4% (250 yr)	33%	17%	154%	12%	115%	142%	-1%	-1%	0%
0.2% (500 yr)	36%	16%	169%	16%	113%	145%	-1%	-1%	0%
0.1% (1000 yr)	32%	14%	170%	15%	100%	142%	-3%	-3%	0%
Est. AAL	-16%	-10%	1%	-31%	-22%	35%	0%	0%	0%

Heilongjiang									
Insurable Aggregate									
Exceedance Probability (Return Period)	**Overall Change**								
	Corn	**Cotton**	**Rapeseed**	**Rice**	**Soybean**	**Wheat**	**Combined New Crop**	**Combined Old Crop**	**Forestry**
5% (20yr)	-57%	>500%	>500%	-9%	-54%	-40%	-38%	-40%	0%
2% (50 yr)	-49%	>500%	>500%	-50%	-54%	-41%	-37%	-38%	0%
1% (100 yr)	-32%	>500%	>500%	-43%	-28%	-14%	-30%	-31%	0%

Heilongjiang									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
0.5% (200 yr)	-18%	>500%	>500%	-30%	-8%	7%	-7%	-9%	0%
0.4% (250 yr)	-9%	>500%	>500%	-27%	3%	22%	-7%	-8%	0%
0.2% (500 yr)	-8%	>500%	>500%	-20%	4%	25%	0%	-2%	0%
0.1% (1000 yr)	-9%	>500%	>500%	-21%	-1%	25%	1%	-2%	0%
Est. AAL	-33%	>500%	>500%	-14%	-27%	-41%	-22%	-25%	0%
EP (Return Period)	Constant Exposure								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-46%	-73%	6%	8%	-46%	-33%	-32%	-32%	0%
2% (50 yr)	-35%	-70%	3%	-47%	-47%	-29%	-29%	-29%	0%
1% (100 yr)	-14%	-67%	18%	-42%	-17%	-25%	-22%	-22%	0%
0.5% (200 yr)	4%	-58%	32%	-30%	5%	-2%	3%	3%	0%
0.4% (250 yr)	16%	-55%	46%	-26%	17%	0%	5%	5%	0%
0.2% (500 yr)	17%	-50%	51%	-19%	19%	10%	9%	9%	0%
0.1% (1000 yr)	15%	-51%	53%	-18%	14%	19%	12%	12%	0%
Est. AAL	-16%	0%	50%	-4%	-16%	-27%	-13%	-13%	0%

Henan									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	21%	-80%	-67%	-42%	31%	-42%	-13%	-30%	6%
2% (50 yr)	69%	-76%	-40%	-20%	23%	-32%	5%	-9%	6%
1% (100 yr)	74%	-70%	-46%	-17%	61%	5%	26%	16%	6%

Henan									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
0.5% (200 yr)	110%	-65%	-48%	-10%	89%	22%	36%	28%	6%
0.4% (250 yr)	124%	-63%	-49%	-9%	118%	33%	38%	31%	6%
0.2% (500 yr)	130%	-65%	-51%	-2%	103%	31%	39%	31%	6%
0.1% (1000 yr)	115%	-67%	-52%	2%	91%	25%	36%	28%	6%
Est. AAL	30%	-75%	-36%	-33%	45%	19%	38%	15%	6%
EP (Return Period)	Constant Exposure								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-4%	-37%	20%	-10%	14%	-49%	-37%	-37%	0%
2% (50 yr)	30%	-31%	80%	-9%	19%	-37%	-15%	-15%	0%
1% (100 yr)	41%	-14%	60%	-3%	54%	-2%	9%	9%	0%
0.5% (200 yr)	75%	11%	50%	12%	81%	13%	19%	19%	0%
0.4% (250 yr)	85%	18%	48%	13%	108%	21%	21%	21%	0%
0.2% (500 yr)	93%	11%	38%	18%	93%	22%	23%	23%	0%
0.1% (1000 yr)	79%	6%	36%	24%	81%	16%	21%	21%	0%
Est. AAL	6%	-19%	78%	6%	29%	10%	9%	9%	0%

Hubei									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	44%	-63%	-61%	30%	8%	-21%	17%	10%	0%
2% (50 yr)	22%	-61%	-68%	27%	0%	-10%	5%	1%	0%
1% (100 yr)	75%	-39%	-43%	104%	71%	22%	25%	20%	0%

Hubei									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
0.5% (200 yr)	102%	-25%	-27%	166%	111%	33%	43%	37%	0%
0.4% (250 yr)	109%	-12%	-16%	214%	134%	37%	45%	40%	0%
0.2% (500 yr)	116%	-11%	-13%	221%	145%	36%	55%	51%	0%
0.1% (1000 yr)	108%	-15%	-13%	221%	148%	33%	71%	68%	0%
Est. AAL	38%	-48%	-23%	82%	88%	4%	49%	34%	0%
EP (Return Period)	Constant Exposure								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	20%	-28%	-49%	-42%	-33%	-20%	-22%	-22%	0%
2% (50 yr)	-3%	-28%	-59%	-41%	-40%	-12%	-24%	-24%	0%
1% (100 yr)	38%	10%	-26%	-3%	6%	17%	-13%	-13%	0%
0.5% (200 yr)	61%	36%	-6%	26%	30%	28%	-6%	-6%	0%
0.4% (250 yr)	70%	60%	9%	46%	42%	32%	-5%	-5%	0%
0.2% (500 yr)	74%	61%	13%	51%	51%	31%	3%	3%	0%
0.1% (1000 yr)	66%	55%	13%	53%	52%	29%	15%	15%	0%
Est. AAL	26%	-1%	3%	-19%	20%	9%	-2%	-2%	0%

Hunan									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-12%	-46%	-32%	-29%	-9%	46%	-24%	-30%	0%
2% (50 yr)	-21%	-54%	-51%	-28%	-33%	100%	-25%	-28%	0%
1% (100 yr)	-11%	-42%	-44%	26%	-2%	59%	-1%	-4%	0%

Hunan									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
0.5% (200 yr)	8%	-23%	-33%	54%	19%	64%	20%	16%	0%
0.4% (250 yr)	20%	-15%	-28%	69%	30%	58%	32%	27%	0%
0.2% (500 yr)	22%	-17%	-23%	71%	38%	66%	34%	30%	0%
0.1% (1000 yr)	24%	-25%	-24%	63%	35%	63%	32%	28%	0%
Est. AAL	-5%	-45%	-6%	17%	-18%	12%	17%	10%	0%
EP (Return Period)	Constant Exposure								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-21%	5%	-28%	-26%	3%	80%	-27%	-27%	0%
2% (50 yr)	-33%	-14%	-49%	-27%	-26%	150%	-24%	-24%	0%
1% (100 yr)	-20%	7%	-42%	27%	8%	95%	-1%	-1%	0%
0.5% (200 yr)	0%	31%	-31%	55%	30%	108%	20%	20%	0%
0.4% (250 yr)	12%	52%	-27%	70%	42%	99%	29%	29%	0%
0.2% (500 yr)	16%	50%	-21%	73%	51%	110%	32%	32%	0%
0.1% (1000 yr)	16%	34%	-22%	65%	46%	106%	33%	33%	0%
Est. AAL	-7%	8%	4%	24%	2%	67%	18%	18%	0%

Inner Mongolia									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-51%	-38%	-39%	36%	70%	-57%	-31%	-38%	-11%
2% (50 yr)	-53%	-32%	-28%	8%	44%	-57%	-26%	-31%	-11%
1% (100 yr)	-13%	35%	15%	43%	73%	55%	-8%	-12%	-11%

Inner Mongolia									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
0.5% (200 yr)	6%	91%	66%	89%	113%	117%	8%	4%	-11%
0.4% (250 yr)	15%	131%	99%	115%	138%	165%	17%	14%	-11%
0.2% (500 yr)	17%	128%	107%	130%	148%	176%	17%	14%	-11%
0.1% (1000 yr)	20%	112%	109%	129%	153%	175%	21%	18%	-11%
Est. AAL	-23%	-25%	13%	131%	141%	-49%	-6%	-13%	-11%
EP (Return Period)	Constant Exposure								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-35%	-7%	-47%	-38%	-13%	-22%	-31%	-31%	0%
2% (50 yr)	-37%	24%	-34%	-44%	-30%	-28%	-8%	-8%	0%
1% (100 yr)	12%	92%	6%	-25%	-14%	230%	7%	7%	0%
0.5% (200 yr)	35%	169%	56%	-2%	8%	379%	27%	27%	0%
0.4% (250 yr)	48%	234%	85%	6%	20%	>500%	38%	38%	0%
0.2% (500 yr)	50%	221%	90%	16%	24%	>500%	39%	39%	0%
0.1% (1000 yr)	52%	196%	93%	15%	30%	>500%	42%	42%	0%
Est. AAL	-3%	0%	-3%	19%	28%	-4%	-1%	-1%	0%

Jiangsu									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	27%	-88%	-60%	15%	-37%	-11%	3%	-3%	-46%
2% (50 yr)	47%	-84%	-65%	14%	52%	-4%	3%	-3%	-46%
1% (100 yr)	120%	-75%	-43%	45%	81%	16%	32%	29%	-46%

Jiangsu									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
0.5% (200 yr)	182%	-65%	-28%	94%	80%	62%	43%	40%	-46%
0.4% (250 yr)	217%	-57%	-28%	117%	81%	89%	47%	43%	-46%
0.2% (500 yr)	228%	-56%	-27%	128%	95%	108%	60%	56%	-46%
0.1% (1000 yr)	236%	-58%	-15%	129%	110%	109%	65%	60%	-46%
Est. AAL	71%	-77%	-54%	11%	-12%	11%	16%	8%	-46%
EP (Return Period)	Constant Exposure								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	1%	-38%	-21%	-2%	-29%	-23%	-11%	-11%	0%
2% (50 yr)	15%	-21%	-35%	-2%	80%	-22%	-10%	-10%	0%
1% (100 yr)	69%	25%	10%	31%	111%	-3%	16%	16%	0%
0.5% (200 yr)	120%	76%	41%	79%	114%	39%	27%	27%	0%
0.4% (250 yr)	143%	112%	43%	97%	116%	56%	35%	35%	0%
0.2% (500 yr)	152%	118%	49%	111%	133%	77%	48%	48%	0%
0.1% (1000 yr)	159%	114%	66%	114%	154%	78%	53%	53%	0%
Est. AAL	31%	11%	-3%	-2%	0%	4%	3%	3%	0%

Jiangxi									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-34%	-67%	-64%	-10%	-56%	-33%	-8%	-14%	-3%
2% (50 yr)	-36%	-68%	-67%	-7%	-55%	2%	-1%	-5%	-3%
1% (100 yr)	-11%	-37%	-32%	53%	-19%	79%	45%	39%	-3%

Jiangxi									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
0.5% (200 yr)	3%	-16%	-17%	92%	6%	140%	85%	74%	-3%
0.4% (250 yr)	4%	6%	-1%	110%	30%	195%	93%	86%	-3%
0.2% (500 yr)	3%	0%	-4%	118%	31%	196%	110%	100%	-3%
0.1% (1000 yr)	-1%	-5%	-5%	119%	30%	192%	115%	101%	-3%
Est. AAL	36%	-55%	-11%	63%	-26%	12%	60%	50%	-3%
EP (Return Period)	Constant Exposure								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-42%	-42%	-61%	-51%	-44%	-66%	-49%	-49%	0%
2% (50 yr)	-44%	-45%	-64%	-52%	-45%	-66%	-41%	-41%	0%
1% (100 yr)	-20%	9%	-24%	-15%	3%	46%	-18%	-18%	0%
0.5% (200 yr)	-8%	46%	-7%	8%	36%	99%	3%	3%	0%
0.4% (250 yr)	-6%	85%	8%	15%	66%	147%	6%	6%	0%
0.2% (500 yr)	-9%	74%	8%	21%	69%	148%	16%	16%	0%
0.1% (1000 yr)	-13%	64%	7%	24%	67%	144%	19%	19%	0%
Est. AAL	4%	-24%	-2%	-8%	1%	-22%	-8%	-8%	0%

Jilin									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-7%	>500%	>500%	11%	-4%	221%	10%	6%	0%
2% (50 yr)	41%	>500%	>500%	29%	62%	310%	66%	61%	0%
1% (100 yr)	52%	>500%	>500%	35%	66%	377%	77%	72%	0%

Jilin									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
0.5% (200 yr)	55%	>500%	>500%	39%	67%	397%	78%	73%	0%
0.4% (250 yr)	56%	>500%	>500%	38%	69%	398%	76%	72%	0%
0.2% (500 yr)	55%	>500%	>500%	34%	65%	393%	73%	69%	0%
0.1% (1000 yr)	51%	>500%	>500%	30%	58%	386%	72%	67%	0%
Est. AAL	76%	>500%	>500%	100%	82%	421%	92%	84%	0%
EP (Return Period)	Constant Exposure								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-41%	-73%	-73%	-19%	-11%	-41%	-31%	-31%	0%
2% (50 yr)	-20%	-74%	-69%	9%	-14%	-22%	-3%	-3%	0%
1% (100 yr)	-13%	-68%	-68%	11%	-10%	-9%	4%	4%	0%
0.5% (200 yr)	-11%	-59%	-67%	11%	-9%	-5%	5%	5%	0%
0.4% (250 yr)	-10%	-52%	-67%	10%	-7%	-5%	4%	4%	0%
0.2% (500 yr)	-12%	-52%	-65%	7%	-9%	-7%	2%	2%	0%
0.1% (1000 yr)	-14%	-54%	-61%	2%	-14%	-7%	1%	1%	0%
Est. AAL	11%	0%	0%	47%	70%	-30%	19%	19%	0%

Liaoning									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-9%	-36%	-33%	-12%	-54%	-41%	5%	-8%	140%
2% (50 yr)	-1%	-38%	-56%	-30%	-45%	-42%	9%	-11%	140%
1% (100 yr)	32%	5%	-53%	-30%	1%	-41%	21%	12%	140%

Liaoning									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
0.5% (200 yr)	56%	51%	-39%	-25%	26%	-34%	43%	29%	140%
0.4% (250 yr)	72%	87%	-36%	-24%	48%	-35%	46%	35%	140%
0.2% (500 yr)	78%	90%	-37%	-19%	46%	-38%	52%	39%	140%
0.1% (1000 yr)	76%	87%	-34%	-19%	40%	-39%	61%	42%	140%
Est. AAL	21%	-26%	-33%	-5%	-40%	-42%	33%	14%	140%
EP (Return Period)	Constant Exposure								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-16%	-29%	10%	44%	-32%	48%	-3%	-3%	0%
2% (50 yr)	-5%	-33%	-33%	6%	-5%	41%	-8%	-8%	0%
1% (100 yr)	22%	16%	-28%	1%	42%	46%	11%	11%	0%
0.5% (200 yr)	37%	65%	-2%	-2%	80%	47%	24%	24%	0%
0.4% (250 yr)	51%	101%	2%	-3%	107%	44%	30%	30%	0%
0.2% (500 yr)	55%	109%	-1%	5%	108%	43%	32%	32%	0%
0.1% (1000 yr)	53%	106%	5%	5%	100%	42%	37%	37%	0%
Est. AAL	8%	-11%	4%	68%	-15%	64%	20%	20%	0%

Ningxia									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-62%	>500%	161%	-55%	-18%	-7%	-7%	-47%	-19%
2% (50 yr)	-57%	>500%	234%	-50%	0%	-9%	-3%	-47%	-19%
1% (100 yr)	-30%	>500%	307%	-19%	22%	21%	6%	-27%	-19%

Ningxia									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
0.5% (200 yr)	-7%	>500%	457%	4%	45%	46%	22%	-9%	-19%
0.4% (250 yr)	4%	>500%	>500%	15%	50%	66%	26%	-5%	-19%
0.2% (500 yr)	12%	>500%	>500%	24%	61%	46%	33%	1%	-19%
0.1% (1000 yr)	12%	>500%	>500%	27%	90%	34%	43%	3%	-19%
Est. AAL	-42%	>500%	126%	-16%	-21%	-5%	5%	-27%	-19%
EP (Return Period)	Constant Exposure								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-43%	-32%	-34%	-46%	-1%	-38%	-38%	-38%	0%
2% (50 yr)	-39%	-6%	3%	-38%	26%	-34%	-38%	-38%	0%
1% (100 yr)	15%	22%	38%	-5%	40%	17%	2%	2%	0%
0.5% (200 yr)	49%	73%	65%	19%	58%	45%	32%	32%	0%
0.4% (250 yr)	65%	100%	109%	27%	60%	57%	40%	40%	0%
0.2% (500 yr)	82%	109%	109%	40%	57%	48%	54%	54%	0%
0.1% (1000 yr)	103%	112%	104%	45%	67%	35%	65%	65%	0%
Est. AAL	-16%	0%	-31%	-4%	-2%	-27%	-17%	-17%	0%

Qinghai									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-49%	>500%	55%	>500%	-34%	9%	96%	51%	61%
2% (50 yr)	-42%	>500%	234%	>500%	-19%	-14%	101%	82%	61%
1% (100 yr)	-39%	>500%	262%	>500%	-4%	-2%	130%	115%	61%

Qinghai									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
0.5% (200 yr)	-48%	>500%	289%	>500%	15%	12%	149%	133%	61%
0.4% (250 yr)	-48%	>500%	291%	>500%	21%	15%	152%	135%	61%
0.2% (500 yr)	-45%	>500%	284%	>500%	43%	18%	160%	143%	61%
0.1% (1000 yr)	-44%	>500%	274%	>500%	66%	23%	161%	144%	61%
Est. AAL	-58%	>500%	63%	>500%	-40%	-18%	58%	18%	61%
EP (Return Period)	Constant Exposure								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-51%	-44%	30%	-66%	-24%	-20%	10%	10%	0%
2% (50 yr)	-37%	-57%	170%	-62%	-6%	-31%	43%	43%	0%
1% (100 yr)	-31%	-42%	201%	-53%	6%	-25%	71%	71%	0%
0.5% (200 yr)	-38%	-26%	226%	-46%	34%	-15%	88%	88%	0%
0.4% (250 yr)	-38%	-20%	232%	-47%	54%	-14%	92%	92%	0%
0.2% (500 yr)	-35%	-15%	225%	-49%	82%	-9%	96%	96%	0%
0.1% (1000 yr)	-33%	-13%	216%	-43%	125%	-7%	100%	100%	0%
Est. AAL	-47%	0%	40%	-67%	-20%	-42%	-17%	-17%	0%

Shaanxi									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-64%	-86%	29%	-25%	-65%	3%	-30%	-36%	10%
2% (50 yr)	-62%	-87%	43%	-16%	-65%	0%	-16%	-19%	10%
1% (100 yr)	21%	-72%	48%	14%	-47%	27%	22%	15%	10%

Shaanxi									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
0.5% (200 yr)	66%	-62%	55%	34%	-35%	66%	46%	37%	10%
0.4% (250 yr)	103%	-56%	59%	43%	-33%	89%	57%	53%	10%
0.2% (500 yr)	108%	-54%	57%	50%	-26%	78%	66%	56%	10%
0.1% (1000 yr)	110%	-58%	57%	51%	-27%	63%	57%	49%	10%
Est. AAL	-9%	-81%	-25%	-12%	-41%	4%	-2%	-9%	10%
EP (Return Period)	Constant Exposure								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-64%	-49%	-40%	-35%	-59%	14%	-32%	-32%	0%
2% (50 yr)	-62%	-42%	-34%	-27%	-57%	11%	-14%	-14%	0%
1% (100 yr)	21%	-17%	-20%	-5%	-44%	36%	16%	16%	0%
0.5% (200 yr)	65%	40%	-2%	11%	-32%	81%	39%	39%	0%
0.4% (250 yr)	102%	41%	5%	18%	-30%	99%	54%	54%	0%
0.2% (500 yr)	108%	47%	11%	22%	-25%	91%	58%	58%	0%
0.1% (1000 yr)	109%	56%	10%	24%	-26%	79%	50%	50%	0%
Est. AAL	-14%	-27%	-36%	-24%	-39%	14%	-9%	-9%	0%

Shandong									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	8%	-77%	-1%	-7%	-23%	38%	31%	13%	-4%
2% (50 yr)	29%	-76%	82%	-5%	1%	74%	64%	38%	-4%
1% (100 yr)	110%	-76%	86%	35%	3%	146%	120%	95%	-4%

Shandong									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
0.5% (200 yr)	157%	-72%	88%	65%	41%	235%	168%	144%	-4%
0.4% (250 yr)	185%	-67%	89%	72%	69%	283%	188%	165%	-4%
0.2% (500 yr)	183%	-67%	92%	78%	76%	310%	218%	192%	-4%
0.1% (1000 yr)	173%	-68%	95%	71%	76%	303%	234%	209%	-4%
Est. AAL	32%	-61%	-12%	-31%	-18%	48%	44%	23%	-4%
EP (Return Period)	Constant Exposure								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-26%	-43%	1%	51%	-23%	0%	-10%	-10%	0%
2% (50 yr)	-6%	-60%	92%	44%	1%	21%	6%	6%	0%
1% (100 yr)	44%	-42%	101%	61%	0%	92%	48%	48%	0%
0.5% (200 yr)	77%	-26%	111%	85%	37%	161%	84%	84%	0%
0.4% (250 yr)	95%	-10%	115%	87%	37%	191%	100%	100%	0%
0.2% (500 yr)	94%	-13%	128%	99%	70%	217%	119%	119%	0%
0.1% (1000 yr)	87%	-14%	133%	91%	73%	214%	132%	132%	0%
Est. AAL	-9%	3%	-13%	-1%	-20%	11%	0%	0%	0%

Shanghai									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-46%	-81%	-47%	7%	-85%	-30%	14%	-1%	-46%
2% (50 yr)	31%	-59%	27%	129%	-79%	-38%	98%	94%	-46%
1% (100 yr)	49%	-49%	99%	259%	-78%	-38%	182%	177%	-46%

Shanghai									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
0.5% (200 yr)	106%	-42%	129%	388%	-72%	-18%	285%	282%	-46%
0.4% (250 yr)	130%	-41%	151%	475%	-69%	-4%	342%	340%	-46%
0.2% (500 yr)	152%	-35%	143%	487%	-67%	3%	351%	349%	-46%
0.1% (1000 yr)	150%	-26%	137%	407%	-67%	4%	340%	336%	-46%
Est. AAL	-50%	-82%	-57%	61%	-87%	-56%	25%	18%	-46%
EP (Return Period)	Constant Exposure								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	31%	-11%	-7%	8%	55%	-21%	15%	15%	0%
2% (50 yr)	122%	77%	157%	94%	83%	-28%	79%	79%	0%
1% (100 yr)	154%	122%	301%	211%	96%	7%	165%	165%	0%
0.5% (200 yr)	270%	162%	358%	346%	98%	62%	261%	261%	0%
0.4% (250 yr)	310%	163%	407%	391%	98%	77%	278%	278%	0%
0.2% (500 yr)	357%	182%	385%	418%	92%	109%	309%	309%	0%
0.1% (1000 yr)	354%	229%	371%	358%	91%	117%	305%	305%	0%
Est. AAL	-9%	-15%	-16%	47%	1%	-25%	23%	23%	0%

Shanxi									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-16%	-83%	>500%	-24%	-35%	-5%	-2%	-11%	0%
2% (50 yr)	-18%	-86%	>500%	-22%	-31%	12%	-4%	-16%	0%
1% (100 yr)	26%	-71%	>500%	-4%	15%	52%	38%	28%	0%

Shanxi									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
0.5% (200 yr)	55%	-59%	>500%	24%	45%	98%	68%	59%	0%
0.4% (250 yr)	79%	-50%	>500%	31%	62%	125%	78%	69%	0%
0.2% (500 yr)	83%	-49%	>500%	36%	70%	116%	95%	84%	0%
0.1% (1000 yr)	74%	-49%	>500%	38%	72%	98%	90%	77%	0%
Est. AAL	17%	-82%	>500%	-6%	-23%	52%	24%	13%	0%
EP (Return Period)	Constant Exposure								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-45%	-16%	22%	-33%	-22%	12%	-22%	-22%	0%
2% (50 yr)	-45%	-31%	41%	-30%	-15%	44%	-31%	-31%	0%
1% (100 yr)	-12%	19%	80%	-14%	52%	44%	6%	6%	0%
0.5% (200 yr)	9%	68%	157%	15%	91%	79%	31%	31%	0%
0.4% (250 yr)	22%	105%	212%	18%	113%	101%	36%	36%	0%
0.2% (500 yr)	29%	112%	204%	25%	122%	94%	51%	51%	0%
0.1% (1000 yr)	23%	112%	188%	25%	126%	79%	46%	46%	0%
Est. AAL	-22%	-16%	13%	-20%	-4%	64%	-6%	-6%	0%

Sichuan									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-3%	-72%	91%	-4%	-11%	-54%	17%	-8%	14%
2% (50 yr)	-10%	-64%	57%	-41%	-8%	-56%	5%	-20%	14%
1% (100 yr)	138%	-56%	56%	10%	40%	-19%	106%	50%	14%

Sichuan									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
0.5% (200 yr)	209%	-39%	80%	39%	62%	1%	164%	88%	14%
0.4% (250 yr)	269%	-24%	87%	58%	79%	14%	184%	105%	14%
0.2% (500 yr)	269%	-22%	88%	62%	82%	15%	208%	117%	14%
0.1% (1000 yr)	265%	-22%	80%	58%	81%	19%	205%	114%	14%
Est. AAL	46%	-67%	98%	19%	13%	-37%	60%	25%	14%
EP (Return Period)	Constant Exposure								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-46%	11%	52%	-26%	-12%	-46%	-31%	-31%	0%
2% (50 yr)	-50%	22%	50%	-55%	-2%	-48%	-36%	-36%	0%
1% (100 yr)	31%	41%	48%	-16%	39%	-3%	2%	2%	0%
0.5% (200 yr)	71%	70%	55%	6%	60%	22%	28%	28%	0%
0.4% (250 yr)	106%	102%	59%	21%	76%	29%	36%	36%	0%
0.2% (500 yr)	105%	117%	61%	23%	80%	37%	46%	46%	0%
0.1% (1000 yr)	103%	115%	67%	20%	79%	40%	44%	44%	0%
Est. AAL	-22%	6%	64%	-10%	6%	-29%	-11%	-11%	0%

Tianjin									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-56%	-39%	-16%	492%	-51%	21%	-3%	-6%	0%
2% (50 yr)	-30%	2%	35%	370%	6%	58%	-6%	-8%	0%
1% (100 yr)	-26%	27%	45%	391%	20%	68%	-6%	-9%	0%

Tianjin									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
0.5% (200 yr)	-26%	45%	60%	331%	27%	81%	-7%	-9%	0%
0.4% (250 yr)	-16%	62%	73%	320%	50%	96%	-9%	-12%	0%
0.2% (500 yr)	-17%	65%	79%	226%	51%	96%	-12%	-15%	0%
0.1% (1000 yr)	-25%	69%	79%	195%	52%	97%	-20%	-22%	0%
Est. AAL	-9%	-26%	55%	424%	-23%	90%	27%	23%	0%
EP (Return Period)	Constant Exposure								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-32%	-32%	-27%	88%	-50%	20%	2%	2%	0%
2% (50 yr)	2%	9%	22%	52%	-10%	49%	5%	5%	0%
1% (100 yr)	8%	35%	30%	46%	0%	61%	5%	5%	0%
0.5% (200 yr)	9%	58%	43%	31%	26%	70%	9%	9%	0%
0.4% (250 yr)	24%	72%	52%	23%	49%	92%	7%	7%	0%
0.2% (500 yr)	20%	81%	57%	-4%	49%	93%	5%	5%	0%
0.1% (1000 yr)	11%	86%	58%	-13%	49%	93%	0%	0%	0%
Est. AAL	30%	-19%	36%	63%	-28%	86%	36%	36%	0%

Xinjiang									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-8%	-4%	122%	42%	-33%	-13%	8%	5%	0%
2% (50 yr)	4%	-19%	141%	31%	-29%	-8%	5%	2%	0%
1% (100 yr)	13%	45%	322%	115%	-26%	118%	23%	21%	0%

Xinjiang									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
0.5% (200 yr)	58%	90%	475%	177%	-5%	192%	37%	36%	0%
0.4% (250 yr)	65%	112%	>500%	227%	9%	231%	55%	51%	0%
0.2% (500 yr)	85%	125%	490%	229%	11%	246%	60%	59%	0%
0.1% (1000 yr)	83%	130%	>500%	222%	10%	234%	65%	63%	0%
Est. AAL	30%	40%	210%	30%	-35%	-7%	32%	29%	0%
EP (Return Period)	Constant Exposure								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-33%	-34%	30%	-29%	-22%	-26%	-23%	-23%	0%
2% (50 yr)	-30%	-45%	29%	-32%	-15%	-5%	-18%	-18%	0%
1% (100 yr)	-22%	6%	123%	-29%	-13%	122%	1%	1%	0%
0.5% (200 yr)	5%	40%	199%	6%	5%	198%	7%	7%	0%
0.4% (250 yr)	10%	49%	219%	11%	21%	234%	12%	12%	0%
0.2% (500 yr)	58%	66%	226%	28%	25%	253%	19%	19%	0%
0.1% (1000 yr)	56%	71%	221%	26%	25%	240%	23%	23%	0%
Est. AAL	-15%	-6%	53%	-39%	-24%	-9%	-9%	-9%	0%

Xizang									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-66%	>500%	-62%	-64%	-46%	-75%	-65%	-69%	0%
2% (50 yr)	-67%	>500%	-53%	-60%	-35%	-80%	-64%	-67%	0%
1% (100 yr)	-42%	>500%	-7%	-26%	-24%	-42%	-25%	-28%	0%

Xizang									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
0.5% (200 yr)	-25%	>500%	14%	-4%	-17%	-24%	-12%	-15%	0%
0.4% (250 yr)	-16%	>500%	20%	17%	-15%	-7%	-7%	-10%	0%
0.2% (500 yr)	-11%	>500%	31%	16%	-13%	-8%	5%	3%	0%
0.1% (1000 yr)	-8%	>500%	31%	11%	-13%	-11%	9%	6%	0%
Est. AAL	-60%	>500%	-66%	-65%	-45%	-59%	-54%	-59%	0%
EP (Return Period)	Constant Exposure								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-69%	-44%	-63%	-78%	-35%	-75%	-71%	-71%	0%
2% (50 yr)	-76%	-27%	-60%	-68%	-38%	-80%	-71%	-71%	0%
1% (100 yr)	-57%	-21%	-26%	-34%	-33%	-37%	-29%	-29%	0%
0.5% (200 yr)	-45%	-19%	-7%	-11%	-30%	-17%	-14%	-14%	0%
0.4% (250 yr)	-41%	-20%	2%	3%	-30%	1%	-10%	-10%	0%
0.2% (500 yr)	-34%	-15%	7%	4%	-29%	0%	3%	3%	0%
0.1% (1000 yr)	-32%	-10%	9%	2%	-30%	-3%	6%	6%	0%
Est. AAL	-64%	0%	-65%	-74%	-36%	-61%	-62%	-62%	0%

Yunnan									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	46%	-82%	27%	43%	-29%	-46%	173%	16%	0%
2% (50 yr)	91%	-80%	93%	134%	-25%	-37%	177%	83%	0%
1% (100 yr)	118%	-66%	92%	146%	-13%	-30%	204%	84%	0%

Yunnan									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
0.5% (200 yr)	170%	-55%	113%	200%	3%	-20%	225%	117%	0%
0.4% (250 yr)	204%	-53%	114%	244%	6%	-16%	231%	129%	0%
0.2% (500 yr)	223%	-50%	124%	244%	14%	-11%	249%	149%	0%
0.1% (1000 yr)	223%	-51%	129%	239%	13%	-10%	257%	155%	0%
Est. AAL	71%	-80%	18%	57%	-28%	-24%	151%	36%	0%
EP (Return Period)	Constant Exposure								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-44%	-37%	-31%	-23%	-32%	-45%	-38%	-38%	0%
2% (50 yr)	-28%	-36%	1%	10%	-11%	-40%	-13%	-13%	0%
1% (100 yr)	-6%	54%	8%	21%	0%	-28%	-9%	-9%	0%
0.5% (200 yr)	20%	106%	24%	59%	11%	-13%	9%	9%	0%
0.4% (250 yr)	36%	121%	25%	80%	15%	-10%	12%	12%	0%
0.2% (500 yr)	43%	137%	33%	86%	24%	-4%	22%	22%	0%
0.1% (1000 yr)	45%	131%	37%	83%	25%	2%	24%	24%	0%
Est. AAL	-25%	-23%	-30%	-19%	-27%	-18%	-22%	-22%	0%

Zhejiang									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-54%	-66%	-12%	4%	-31%	-30%	7%	3%	15%
2% (50 yr)	-48%	-47%	2%	19%	-61%	-19%	4%	2%	15%
1% (100 yr)	-42%	-40%	64%	43%	-18%	43%	32%	26%	15%

Zhejiang									
Insurable Aggregate									
Exceedance Probability (Return Period)	Overall Change								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
0.5% (200 yr)	-34%	-29%	120%	95%	2%	97%	80%	72%	15%
0.4% (250 yr)	-27%	-29%	159%	131%	16%	110%	98%	97%	15%
0.2% (500 yr)	-25%	-23%	158%	142%	19%	133%	115%	110%	15%
0.1% (1000 yr)	-28%	-17%	152%	145%	17%	131%	120%	114%	15%
Est. AAL	-43%	-63%	-10%	-1%	-39%	-30%	-2%	-7%	15%
EP (Return Period)	Constant Exposure								
	Corn	Cotton	Rapeseed	Rice	Soybean	Wheat	Combined New Crop	Combined Old Crop	Forestry
5% (20yr)	-40%	-2%	-8%	-25%	-18%	-37%	-19%	-19%	0%
2% (50 yr)	-39%	26%	32%	-19%	-52%	-24%	-27%	-27%	0%
1% (100 yr)	-24%	38%	38%	10%	2%	15%	0%	0%	0%
0.5% (200 yr)	-8%	62%	58%	50%	25%	56%	35%	35%	0%
0.4% (250 yr)	0%	63%	75%	71%	43%	60%	46%	46%	0%
0.2% (500 yr)	4%	59%	85%	85%	44%	83%	63%	63%	0%
0.1% (1000 yr)	0%	59%	78%	89%	41%	82%	66%	66%	0%
Est. AAL	-18%	-4%	-25%	-23%	-22%	-40%	-24%	-24%	0%

9.9 Analysis Settings

Table 127. Touchstone Re analysis settings for model runs to determine the loss changes.

Setting	Selected Option(s)
Perils modeled	China Agriculture
Catalog	10,000-year Standard
Industry exposure vintage	December 2018

Setting	Selected Option(s)
Take-up rates	N/A Analyses were done for insurable loss estimates only. Take-up rates do not apply.
Demand surge	N/A

10 The AIR Earthquake Model for New Zealand

10.1 AIR Earthquake Model for New Zealand

This update does not include changes to the hazard or vulnerability components the model. Therefore, the percentage changes in total industry insurable losses reported in the following tables reflect the impact of the update to policy conditions in the industry exposure database for New Zealand. These policy condition updates are implemented to reflect changes to the New Zealand Earthquake Commission (EQC) Act enacted in July 2019. These changes include an increase in building coverage deductible from NZD 100,000 to NZD 150,000 and the removal of contents coverage from the EQC program. In the Touchstone Re 7.0 release, AIR has also adjusted the application of the Coverage Percent of Loss (CPL) deductible, resulting in loss changes to the Residential Land line of business for the total insurable perspective (Table 132 and Table 133).

Table 128 through Table 131 provide the overall change in industry gross insurable aggregate and occurrence losses for the EQC and Net of EQC perspectives that will be observed when comparing industry results based on 100% user specified market shares between Touchstone Re 7.0 and 8.0.

Table 128. Percentage change in GROSS INSURABLE OCCURRENCE losses, EQC

New Zealand						
Insurable Occurrence						
EP (Return Period)	**Overall Change**					
	RES BLDG	**RES CONT**	**RES LAND**	**COM**	**AUTO**	**TOTAL**
5% (20)	9%	-100%	94%	N/A	N/A	-8%
2% (50)	10%	-100%	124%	N/A	N/A	-5%
1% (100)	10%	-100%	132%	N/A	N/A	-1%
0.5% (200)	13%	-100%	101%	N/A	N/A	1%
0.4% (250)	13%	-100%	88%	N/A	N/A	1%
0.2% (500)	14%	-100%	90%	N/A	N/A	2%
0.1% (1000)	13%	-100%	65%	N/A	N/A	1%
Est. AAL	**11%**	**-100%**	**76%**	**N/A**	**N/A**	**-5%**

Table 129. Percentage change in GROSS INSURABLE AGGREGATE losses, EQC

New Zealand						
Insurable Aggregate						
EP (Return Period)	**Overall Change**					
	RES BLDG	**RES CONT**	**RES LAND**	**COM**	**AUTO**	**TOTAL**
5% (20)	8%	-100%	91%	N/A	N/A	-8%
2% (50)	10%	-100%	121%	N/A	N/A	-6%
1% (100)	11%	-100%	127%	N/A	N/A	-4%
0.5% (200)	14%	-100%	101%	N/A	N/A	0%
0.4% (250)	13%	-100%	88%	N/A	N/A	1%
0.2% (500)	13%	-100%	90%	N/A	N/A	2%
0.1% (1000)	13%	-100%	65%	N/A	N/A	1%
Est. AAL	**10%**	**-100%**	**76%**	**N/A**	**N/A**	**-6%**

Table 130. Percentage change in GROSS INSURABLE OCCURRENCE losses, Net of EQC

New Zealand						
Insurable Occurrence						
EP (Return Period)	**Overall Change**					
	RES BLDG	**RES CONT**	**RES LAND**	**COM**	**AUTO**	**TOTAL**
5% (20)	-35%	>500%	N/A	0%	0%	14%
2% (50)	-34%	>500%	N/A	0%	0%	7%
1% (100)	-34%	412%	N/A	0%	0%	0%
0.5% (200)	-34%	366%	N/A	0%	0%	0%
0.4% (250)	-33%	359%	N/A	0%	0%	1%
0.2% (500)	-33%	333%	N/A	0%	0%	0%
0.1% (1000)	-33%	389%	N/A	0%	0%	1%
Est. AAL	**-34%**	**>500%**	**N/A**	**0%**	**0%**	**9%**

Table 131. Percentage change in GROSS INSURABLE AGGREGATE losses, Net of EQC

New Zealand						
Insurable Aggregate						
EP (Return Period)	**Overall Change**					
	RES BLDG	**RES CONT**	**RES LAND**	**COM**	**AUTO**	**TOTAL**
5% (20)	-35%	>500%	N/A	0%	0%	13%
2% (50)	-34%	>500%	N/A	0%	0%	6%

New Zealand						
Insurable Aggregate						
EP (Return Period)	**Overall Change**					
	RES BLDG	**RES CONT**	**RES LAND**	**COM**	**AUTO**	**TOTAL**
1% (100)	-33%	431%	N/A	0%	0%	2%
0.5% (200)	-34%	379%	N/A	0%	0%	3%
0.4% (250)	-34%	373%	N/A	0%	0%	1%
0.2% (500)	-32%	348%	N/A	0%	0%	0%
0.1% (1000)	-33%	376%	N/A	0%	0%	2%
Est. AAL	**-34%**	**>500%**	**N/A**	**0%**	**0%**	**10%**

Table 132 and Table 133 provide the overall change in industry gross insurable aggregate and occurrence losses for the insurable total perspective that will be observed when comparing industry results based on 100% user specified market shares between Touchstone Re 7.0 and 8.0. The loss changes shown in the Residential Land line of business are the result in an error in the application of the Coverage Percent of Loss (CPL) deductible in the Touchstone Re 7.0 model version. Due to the comparatively small losses to the Residential Land line, the impact of the application of the CPL deductible manifests in larger changes in the Residential Land line of business as compared to the Residential Building line.

Table 132. Percentage change in GROSS INSURABLE OCCURRENCE losses, Total

New Zealand						
Insurable Occurrence						
EP (Return Period)	**Overall Change**					
	RES BLDG	**RES CONT**	**RES LAND**	**COM**	**AUTO**	**TOTAL**
5% (20)	3%	0%	94%	0%	0%	2%
2% (50)	2%	0%	124%	0%	0%	1%
1% (100)	1%	0%	132%	0%	0%	1%
0.5% (200)	1%	0%	101%	0%	0%	1%
0.4% (250)	1%	0%	88%	0%	0%	2%
0.2% (500)	1%	0%	90%	0%	0%	1%
0.1% (1000)	1%	0%	65%	0%	0%	1%
Est. AAL	**2%**	**0%**	**76%**	**0%**	**0%**	**2%**

Table 133. Percentage change in GROSS INSURABLE AGGREGATE losses, Total

New Zealand						
Insurable Aggregate						
EP (Return Period)	**Overall Change**					
	RES BLDG	**RES CONT**	**RES LAND**	**COM**	**AUTO**	**TOTAL**
5% (20)	2%	0%	91%	0%	0%	1%
2% (50)	2%	0%	121%	0%	0%	1%
1% (100)	1%	0%	127%	0%	0%	1%
0.5% (200)	1%	0%	101%	0%	0%	1%
0.4% (250)	1%	0%	88%	0%	0%	2%
0.2% (500)	1%	0%	90%	0%	0%	2%
0.1% (1000)	1%	0%	65%	0%	0%	1%
Est. AAL	**2%**	**0%**	**76%**	**0%**	**0%**	**2%**

10.2 Analysis Settings

AIR used the following analysis settings in model runs to produce loss changes.

Table 134. Touchstone Re analysis settings for model runs

Setting	Selected Option(s)
Perils modeled	Ground shaking
Catalog	10,000-year Time-Dependent 100% Limits (default)
Industry exposure vintage(s)	2018
Demand surge	Off

11 The AIR Terrorism Model

11.1 The AIR Terrorism Model

This update does not include changes to the hazard or vulnerability components the model. Therefore, the percentage changes in total industry insurable losses reported in the following tables reflect the impact of the update to the industry exposure database for the United States.

When running a program using a company loss file (CLF) or sums insured exposures entered in Touchstone Re, the only changes observed for this model are due to the impact on demand surge of the industry exposure database update on overall industry losses. Demand surge—the increase in insurance losses that can result from increases in materials and labor costs in the aftermath of a catastrophe—is a function of industry losses. Because increases in replacement values and risk counts will increase industry losses, demand surge may also increase, or be triggered in cases where it was not previously triggered. (The opposite is true in those regions where total insurable values have decreased.) However, there should be no impact if analyses are run with demand surge disabled. Note that AIR's demand surge function has not changed with this release.

The tables below provide the overall change in industry gross insurable aggregate and insurable losses that will be observed when comparing industry results based on 100% user-specified market shares between Touchstone Re 7.0 and 8.0. Note that although not shown, loss changes calculated by excluding property values for this model are between 0% and 1%.

These changes include the effects of demand surge and were generated by scaling industry loss files (ILFs) using county-level exposure change factors.

Caution should be exercised before relating the industry changes shown here to a particular portfolio. The changes to individual books of business may deviate from the losses represented here to the extent that their spatial distribution and construction/ occupancy mix deviate from industry averages.

Table 135. Percentage change in GROSS INSURABLE AGGREGATE losses, by LOB

United States					
Insurable Aggregate					
EP (Return Period)	Overall Change				
	RES	MH	COM/IND	AUTO	TOTAL
5% (20 yr)	12%	3%	9%	9%	9%
2% (50 yr)	13%	1%	9%	9%	10%
1% (100 yr)	14%	3%	9%	9%	11%

United States					
Insurable Aggregate					
EP (Return Period)	**Overall Change**				
	RES	**MH**	**COM/IND**	**AUTO**	**TOTAL**
0.5% (200 yr)	13%	3%	9%	9%	10%
0.4% (250 yr)	13%	2%	9%	9%	10%
0.2% (500 yr)	13%	1%	10%	10%	12%
0.1% (1,000 yr)	15%	4%	10%	10%	11%
AAL	**13%**	**3%**	**9%**	**9%**	**10%**

Table 136. Percentage change in GROSS INSURABLE OCCURRENCE losses, by LOB

United States					
Insurable Occurrence					
EP (Return Period)	**Overall Change**				
	RES	**MH**	**COM/IND**	**AUTO**	**TOTAL**
5% (20 yr)	12%	3%	9%	4%	9%
2% (50 yr)	13%	1%	9%	4%	10%
1% (100 yr)	14%	4%	9%	5%	11%
0.5% (200 yr)	13%	3%	9%	4%	10%
0.4% (250 yr)	12%	1%	9%	5%	10%
0.2% (500 yr)	13%	2%	8%	5%	11%
0.1% (1,000 yr)	13%	4%	8%	5%	13%
AAL	**13%**	**3%**	**9%**	**4%**	**10%**

Table 137. Percentage change in workers' compensation GROSS INSURABLE AGGREGATE and OCCURRENCE loss estimates

United States		
EP (Return Period)	**Overall Change**	
	Insurable Aggregate	**Insurable Occurrence**
5% (20 yr)	8%	9%
2% (50 yr)	8%	8%
1% (100 yr)	8%	8%
0.5% (200 yr)	8%	8%
0.4% (250 yr)	8%	7%
0.2% (500 yr)	7%	7%
0.1% (1,000 yr)	6%	7%
AAL	**8%**	**8%**

11.2 Analysis Settings

AIR used the following analysis settings in model runs to produce loss changes.

Table 138. Touchstone Re analysis settings for model runs

Setting	Selected Option(s)
Perils modeled	Terrorism (default exlcusions)
Catalog	500K
Industry exposure vintage(s)	2019
Take-up rates	N/A
Demand surge	ON (does not impact Workers' Compensation losses)

12 The AIR Earthquake Model for the United States

12.1 The AIR Earthquake Model for the United States

This update does not include changes to the hazard or vulnerability components the model. Therefore, the percentage changes in total industry insurable losses reported in the following tables reflect the impact of the update to the industry exposure database for the United States.

When running a program using a company loss file (CLF) or sums insured exposures entered in Touchstone Re, the only changes observed for this model are due to the impact on demand surge of the industry exposure database update on overall industry losses. Demand surge—the increase in insurance losses that can result from increases in materials and labor costs in the aftermath of a catastrophe—is a function of industry losses. Because increases in replacement values and risk counts will increase industry losses, demand surge may also increase, or be triggered in cases where it was not previously triggered. (The opposite is true in those regions where total insurable values have decreased.) However, there should be no impact if analyses are run with demand surge disabled. Note that AIR's demand surge function has not changed with this release.

The tables below provide the overall change in industry gross insurable aggregate and insurable losses that will be observed when comparing industry results based on 100% user-specified market shares between Touchstone Re 7.0 and 8.0. Note that although not shown, loss changes calculated by excluding property values for this model are between 0% and 1%.

These changes include the effects of demand surge and were generated by scaling industry loss files (ILFs) using county-level exposure change factors.

Caution should be exercised before relating the industry changes shown here to a particular portfolio. The changes to individual books of business may deviate from the losses represented here to the extent that their spatial distribution and construction/occupancy mix deviate from industry averages.

Table 139. Percentage change in GROSS INSURABLE AGGREGATE losses, by LOB

United States					
Insurable Aggregate					
EP (Return Period)	**Overall Change**				
	RES	**MH**	**COM/IND**	**AUTO**	**TOTAL**
5% (20 yr)	15%	2%	12%	5%	13%

United States					
Insurable Aggregate					
EP (Return Period)	Overall Change				
	RES	MH	COM/IND	AUTO	TOTAL
2% (50 yr)	15%	2%	11%	6%	11%
1% (100 yr)	15%	2%	12%	6%	12%
0.5% (200 yr)	14%	2%	11%	6%	10%
0.4% (250 yr)	14%	3%	10%	4%	11%
0.2% (500 yr)	12%	1%	10%	4%	11%
0.1% (1,000 yr)	12%	0%	10%	4%	10%
AAL	**14%**	**2%**	**11%**	**5%**	**12%**

Table 140. Percentage change in GROSS INSURABLE OCCURRENCE losses, by LOB

United States					
Insurable Occurrence					
EP (Return Period)	Overall Change				
	RES	MH	COM/IND	AUTO	TOTAL
5% (20 yr)	15%	2%	2%	6%	12%
2% (50 yr)	16%	3%	3%	5%	12%
1% (100 yr)	13%	3%	3%	5%	13%
0.5% (200 yr)	14%	1%	1%	6%	16%
0.4% (250 yr)	13%	1%	1%	3%	10%
0.2% (500 yr)	11%	0%	0%	4%	10%
0.1% (1,000 yr)	12%	4%	4%	4%	10%
AAL	**14%**	**2%**	**2%**	**5%**	**12%**

Table 141. Percentage change in workers' compensation GROSS INSURABLE AGGREGATE and OCCURRENCE loss estimates

United States		
EP (Return Period)	Overall Change	
	Insurable Aggregate	Insurable Occurrence
5% (20 yr)	7%	10%
2% (50 yr)	8%	8%
1% (100 yr)	11%	9%
0.5% (200 yr)	10%	11%
0.4% (250 yr)	10%	13%
0.2% (500 yr)	8%	8%

United States		
EP (Return Period)	Overall Change	
	Insurable Aggregate	Insurable Occurrence
0.1% (1,000 yr)	2%	5%
AAL	**9%**	**9%**

12.2 Analysis Settings

AIR used the following analysis settings in model runs to produce loss changes.

Table 142. Touchstone Re analysis settings for model runs

Setting	Selected Option(s)
Perils modeled	All Perils (Shake + FF)
Catalog	10K TD
Industry exposure vintage(s)	2019
Take-up rates	N/A
Demand surge	ON (does not impact Workers' Compensation losses)

13 The AIR Earthquake Model for Hawaii

13.1 The AIR Earthquake Model for Hawaii

This update does not include changes to the hazard or vulnerability components the model. Therefore, the percentage changes in total industry insurable losses reported in the following tables reflect the impact of the update to the industry exposure database for the United States.

When running a program using a company loss file (CLF) or sums insured exposures entered in Touchstone Re, the only changes observed for this model are due to the impact on demand surge of the industry exposure database update on overall industry losses. Demand surge—the increase in insurance losses that can result from increases in materials and labor costs in the aftermath of a catastrophe—is a function of industry losses. Because increases in replacement values and risk counts will increase industry losses, demand surge may also increase, or be triggered in cases where it was not previously triggered. (The opposite is true in those regions where total insurable values have decreased.) However, there should be no impact if analyses are run with demand surge disabled. Note that AIR's demand surge function has not changed with this release.

The tables below provide the overall change in industry gross insurable aggregate and insurable losses that will be observed when comparing industry results based on 100% user-specified market shares between Touchstone Re 7.0 and 8.0. Note that although not shown, loss changes calculated by excluding property values for this model are between 0% and 1%.

These changes include the effects of demand surge and were generated by scaling industry loss files (ILFs) using county-level exposure change factors.

Caution should be exercised before relating the industry changes shown here to a particular portfolio. The changes to individual books of business may deviate from the losses represented here to the extent that their spatial distribution and construction/ occupancy mix deviate from industry averages.

Table 143. Percentage change in GROSS INSURABLE AGGREGATE losses, by LOB

Hawaii					
Insurable Aggregate					
EP (Return Period)	**Overall Change**				
	RES	**MH**	**COM/IND**	**AUTO**	**TOTAL**
5% (20 yr)	5%	14%	9%	5%	7%

Hawaii					
Insurable Aggregate					
EP (Return Period)	**Overall Change**				
	RES	**MH**	**COM/IND**	**AUTO**	**TOTAL**
2% (50 yr)	5%	13%	10%	4%	7%
1% (100 yr)	5%	11%	10%	5%	7%
0.5% (200 yr)	5%	12%	11%	6%	7%
0.4% (250 yr)	5%	12%	11%	4%	7%
0.2% (500 yr)	5%	12%	10%	6%	6%
0.1% (1,000 yr)	5%	12%	8%	4%	8%
AAL	**5%**	**13%**	**10%**	**5%**	**7%**

Table 144. Percentage change in GROSS INSURABLE OCCURRENCE losses, by LOB

Hawaii					
Insurable Occurrence					
EP (Return Period)	**Overall Change**				
	RES	**MH**	**COM/IND**	**AUTO**	**TOTAL**
5% (20 yr)	5%	16%	11%	5%	7%
2% (50 yr)	5%	14%	9%	4%	7%
1% (100 yr)	5%	12%	10%	5%	6%
0.5% (200 yr)	5%	12%	11%	5%	7%
0.4% (250 yr)	5%	11%	11%	5%	7%
0.2% (500 yr)	5%	12%	10%	6%	7%
0.1% (1,000 yr)	5%	13%	8%	4%	8%
AAL	**5%**	**13%**	**10%**	**5%**	**7%**

Table 145. Percentage change in workers' compensation GROSS INSURABLE AGGREGATE and OCCURRENCE loss estimates

Hawaii		
EP (Return Period)	**Overall Change**	
	Insurable Aggregate	**Insurable Occurrence**
5% (20 yr)	7%	7%
2% (50 yr)	5%	5%
1% (100 yr)	4%	4%
0.5% (200 yr)	6%	6%
0.4% (250 yr)	4%	4%
0.2% (500 yr)	4%	4%

Hawaii		
EP (Return Period)	**Overall Change**	
	Insurable Aggregate	**Insurable Occurrence**
0.1% (1,000 yr)	11%	11%
AAL	**6%**	**6%**

13.2 Analysis Settings

AIR used the following analysis settings in model runs to produce loss changes.

Table 146. Touchstone Re analysis settings for model runs

Setting	Selected Option(s)
Perils modeled	All Perils (Shake + FF)
Catalog	10K TD
Industry exposure vintage(s)	2019
Take-up rates	N/A
Demand surge	ON (does not impact Workers' Compensation losses)

14 The AIR Earthquake Model for Alaska

14.1 The AIR Earthquake Model for Alaska

This update does not include changes to the hazard or vulnerability components the model. Therefore, the percentage changes in total industry insurable losses reported in the following tables reflect the impact of the update to the industry exposure database for the United States.

When running a program using a company loss file (CLF) or sums insured exposures entered in Touchstone Re, the only changes observed for this model are due to the impact on demand surge of the industry exposure database update on overall industry losses. Demand surge—the increase in insurance losses that can result from increases in materials and labor costs in the aftermath of a catastrophe—is a function of industry losses. Because increases in replacement values and risk counts will increase industry losses, demand surge may also increase, or be triggered in cases where it was not previously triggered. (The opposite is true in those regions where total insurable values have decreased.) However, there should be no impact if analyses are run with demand surge disabled. Note that AIR's demand surge function has not changed with this release.

The tables below provide the overall change in industry gross insurable aggregate and insurable losses that will be observed when comparing industry results based on 100% user-specified market shares between Touchstone Re 7.0 and 8.0. Note that although not shown, loss changes calculated by excluding property values for this model are between 0% and 1%.

These changes include the effects of demand surge and were generated by scaling industry loss files (ILFs) using county-level exposure change factors.

Caution should be exercised before relating the industry changes shown here to a particular portfolio. The changes to individual books of business may deviate from the losses represented here to the extent that their spatial distribution and construction/ occupancy mix deviate from industry averages.

Table 147. Percentage change in GROSS INSURABLE AGGREGATE losses, by LOB

Alaska					
Insurable Aggregate					
EP (Return Period)	Overall Change				
	RES	MH	COM/IND	AUTO	TOTAL
5% (20 yr)	11%	-1%	11%	5%	11%

Alaska					
Insurable Aggregate					
EP (Return Period)	**Overall Change**				
	RES	**MH**	**COM/IND**	**AUTO**	**TOTAL**
2% (50 yr)	9%	0%	9%	6%	8%
1% (100 yr)	13%	0%	11%	6%	12%
0.5% (200 yr)	13%	0%	11%	6%	11%
0.4% (250 yr)	14%	0%	11%	4%	11%
0.2% (500 yr)	14%	0%	12%	4%	13%
0.1% (1,000 yr)	13%	-1%	11%	4%	12%
AAL	**13%**	**-1%**	**11%**	**5%**	**12%**

Table 148. Percentage change in GROSS INSURABLE OCCURRENCE losses, by LOB

Alaska					
Insurable Occurrence					
EP (Return Period)	**Overall Change**				
	RES	**MH**	**COM/IND**	**AUTO**	**TOTAL**
5% (20 yr)	11%	-2%	9%	6%	11%
2% (50 yr)	13%	0%	10%	5%	11%
1% (100 yr)	13%	0%	11%	5%	11%
0.5% (200 yr)	13%	0%	11%	6%	12%
0.4% (250 yr)	14%	1%	11%	3%	12%
0.2% (500 yr)	14%	0%	12%	4%	13%
0.1% (1,000 yr)	14%	-1%	11%	4%	12%
AAL	**13%**	**-1%**	**11%**	**5%**	**12%**

Table 149. Percentage change in workers' compensation GROSS INSURABLE AGGREGATE and OCCURRENCE loss estimates

Alaska		
EP (Return Period)	**Overall Change**	
	Insurable Aggregate	**Insurable Occurrence**
5% (20 yr)	8%	8%
2% (50 yr)	10%	10%
1% (100 yr)	10%	10%
0.5% (200 yr)	10%	10%
0.4% (250 yr)	10%	10%
0.2% (500 yr)	10%	10%

Alaska		
EP (Return Period)	**Overall Change**	
	Insurable Aggregate	**Insurable Occurrence**
0.1% (1,000 yr)	9%	9%
AAL	**9%**	**9%**

14.2 Analysis Settings

AIR used the following analysis settings in model runs to produce loss changes.

Table 150. Touchstone Re analysis settings for model runs

Setting	Selected Option(s)
Perils modeled	Shake
Catalog	10K TD
Industry exposure vintage(s)	2019
Take-up rates	N/A
Demand surge	ON (does not impact Workers' Compensation losses)

15 The AIR Severe Thunderstorm Model for the United States

15.1 The AIR Severe Thunderstorm Model for the United States

This update does not include changes to the hazard or vulnerability components the model. Therefore, the percentage changes in total industry insurable losses reported in the following tables reflect the impact of the update to the industry exposure database for the United States.

When running a program using a company loss file (CLF) or sums insured exposures entered in Touchstone Re, the only changes observed for this model are due to the impact on demand surge of the industry exposure database update on overall industry losses. Demand surge—the increase in insurance losses that can result from increases in materials and labor costs in the aftermath of a catastrophe—is a function of industry losses. Because increases in replacement values and risk counts will increase industry losses, demand surge may also increase, or be triggered in cases where it was not previously triggered. (The opposite is true in those regions where total insurable values have decreased.) However, there should be no impact if analyses are run with demand surge disabled. Note that AIR's demand surge function has not changed with this release.

The tables below provide the overall change in industry gross insurable aggregate and insurable losses that will be observed when comparing industry results based on 100% user-specified market shares between Touchstone Re 7.0 and 8.0. Note that although not shown, loss changes calculated by excluding property values for this model are between 0% and 1%.

These changes include the effects of demand surge and were generated by scaling industry loss files (ILFs) using county-level exposure change factors.

Caution should be exercised before relating the industry changes shown here to a particular portfolio. The changes to individual books of business may deviate from the losses represented here to the extent that their spatial distribution and construction/ occupancy mix deviate from industry averages.

Table 151. Percentage change in GROSS INSURABLE AGGREGATE losses, by LOB

United States					
Insurable Aggregate					
EP (Return Period)	**Overall Change**				
	RES	**MH**	**COM/IND**	**AUTO**	**TOTAL**
5% (20 yr)	14%	2%	10%	5%	11%
2% (50 yr)	14%	2%	10%	5%	12%
1% (100 yr)	15%	2%	10%	5%	12%
0.5% (200 yr)	14%	2%	10%	5%	12%
0.4% (250 yr)	16%	2%	10%	7%	12%
0.2% (500 yr)	13%	2%	8%	6%	13%
0.1% (1,000 yr)	15%	2%	11%	7%	10%
AAL	**13%**	**2%**	**10%**	**4%**	**11%**

Table 152. Percentage change in GROSS INSURABLE OCCURRENCE losses, by LOB

United States					
Insurable Occurrence					
EP (Return Period)	**Overall Change**				
	RES	**MH**	**COM/IND**	**AUTO**	**TOTAL**
5% (20 yr)	16%	16%	10%	6%	14%
2% (50 yr)	17%	17%	10%	7%	13%
1% (100 yr)	16%	16%	9%	7%	13%
0.5% (200 yr)	17%	17%	10%	9%	14%
0.4% (250 yr)	13%	13%	9%	5%	13%
0.2% (500 yr)	20%	20%	10%	6%	9%
0.1% (1,000 yr)	12%	12%	12%	9%	14%
AAL	**15%**	**15%**	**10%**	**5%**	**12%**

15.2 Analysis Settings

AIR used the following analysis settings in model runs to produce loss changes.

Table 153. Touchstone Re analysis settings for model runs

Setting	Selected Option(s)
Perils modeled	All Perils
Catalog	10K

Setting	Selected Option(s)
Industry exposure vintage(s)	2019
Take-up rates	N/A
Demand surge	ON

16 The AIR Tropical Cyclone Model for Hawaii

16.1 The AIR Tropical Cyclone Model for Hawaii

This update does not include changes to the hazard or vulnerability components the model. Therefore, the percentage changes in total industry insurable losses reported in the following tables reflect the impact of the update to the industry exposure database for the United States.

When running a program using a company loss file (CLF) or sums insured exposures entered in Touchstone Re, the only changes observed for this model are due to the impact on demand surge of the industry exposure database update on overall industry losses. Demand surge—the increase in insurance losses that can result from increases in materials and labor costs in the aftermath of a catastrophe—is a function of industry losses. Because increases in replacement values and risk counts will increase industry losses, demand surge may also increase, or be triggered in cases where it was not previously triggered. (The opposite is true in those regions where total insurable values have decreased.) However, there should be no impact if analyses are run with demand surge disabled. Note that AIR's demand surge function has not changed with this release.

The tables below provide the overall change in industry gross insurable aggregate and insurable losses that will be observed when comparing industry results based on 100% user-specified market shares between Touchstone Re 7.0 and 8.0. Note that although not shown, loss changes calculated by excluding property values for this model are between 0% and 1%.

These changes include the effects of demand surge and were generated by scaling industry loss files (ILFs) using county-level exposure change factors.

Caution should be exercised before relating the industry changes shown here to a particular portfolio. The changes to individual books of business may deviate from the losses represented here to the extent that their spatial distribution and construction/ occupancy mix deviate from industry averages.

Table 154. Percentage change in GROSS INSURABLE AGGREGATE losses, by LOB

Hawaii					
Insurable Aggregate					
EP (Return Period)	**Overall Change**				
	RES	**MH**	**COM/IND**	**AUTO**	**TOTAL**
5% (20 yr)	4%	13%	8%	4%	6%

Hawaii					
Insurable Aggregate					
EP (Return Period)	**Overall Change**				
	RES	**MH**	**COM/IND**	**AUTO**	**TOTAL**
2% (50 yr)	4%	12%	8%	4%	8%
1% (100 yr)	5%	17%	8%	4%	7%
0.5% (200 yr)	5%	14%	8%	2%	8%
0.4% (250 yr)	4%	22%	9%	5%	7%
0.2% (500 yr)	4%	16%	8%	2%	6%
0.1% (1,000 yr)	4%	19%	8%	1%	6%
AAL	**4%**	**16%**	**9%**	**2%**	**6%**

Table 155. Percentage change in GROSS INSURABLE OCCURRENCE losses, by LOB

Hawaii					
Insurable Occurrence					
EP (Return Period)	**Overall Change**				
	RES	**MH**	**COM/IND**	**AUTO**	**TOTAL**
5% (20 yr)	5%	13%	9%	4%	5%
2% (50 yr)	4%	12%	8%	4%	8%
1% (100 yr)	4%	14%	11%	4%	6%
0.5% (200 yr)	5%	14%	8%	2%	8%
0.4% (250 yr)	4%	22%	9%	5%	7%
0.2% (500 yr)	4%	14%	8%	2%	6%
0.1% (1,000 yr)	4%	19%	8%	1%	6%
AAL	**4%**	**16%**	**9%**	**2%**	**6%**

16.2 Analysis Settings

AIR used the following analysis settings in model runs to produce loss changes.

Table 156. Touchstone Re analysis settings for model runs

Setting	Selected Option(s)
Perils modeled	Wind
Catalog	10K
Industry exposure vintage(s)	2019
Take-up rates	N/A

Setting	Selected Option(s)
Demand surge	ON

17 The AIR Winter Storm Model for the United States

17.1 The AIR Winter Storm Model for the United States

This update does not include changes to the hazard or vulnerability components the model. Therefore, the percentage changes in total industry insurable losses reported in the following tables reflect the impact of the update to the industry exposure database for the United States.

When running a program using a company loss file (CLF) or sums insured exposures entered in Touchstone Re, the only changes observed for this model are due to the impact on demand surge of the industry exposure database update on overall industry losses. Demand surge—the increase in insurance losses that can result from increases in materials and labor costs in the aftermath of a catastrophe—is a function of industry losses. Because increases in replacement values and risk counts will increase industry losses, demand surge may also increase, or be triggered in cases where it was not previously triggered. (The opposite is true in those regions where total insurable values have decreased.) However, there should be no impact if analyses are run with demand surge disabled. Note that AIR's demand surge function has not changed with this release.

The tables below provide the overall change in industry gross insurable aggregate and insurable losses that will be observed when comparing industry results based on 100% user-specified market shares between Touchstone Re 7.0 and 8.0. Note that although not shown, loss changes calculated by excluding property values for this model are between 0% and 1%.

These changes include the effects of demand surge and were generated by scaling industry loss files (ILFs) using county-level exposure change factors.

Caution should be exercised before relating the industry changes shown here to a particular portfolio. The changes to individual books of business may deviate from the losses represented here to the extent that their spatial distribution and construction/ occupancy mix deviate from industry averages.

Table 157. Percentage change in GROSS INSURABLE AGGREGATE losses, by LOB

United States					
Insurable Aggregate					
EP (Return Period)	**Overall Change**				
	RES	**MH**	**COM/IND**	**AUTO**	**TOTAL**
5% (20 yr)	13%	2%	9%	4%	9%

United States					
Insurable Aggregate					
EP (Return Period)	**Overall Change**				
	RES	**MH**	**COM/IND**	**AUTO**	**TOTAL**
2% (50 yr)	12%	3%	10%	4%	11%
1% (100 yr)	13%	2%	10%	4%	10%
0.5% (200 yr)	12%	2%	9%	4%	10%
0.4% (250 yr)	15%	3%	10%	3%	10%
0.2% (500 yr)	11%	2%	10%	4%	10%
0.1% (1,000 yr)	11%	3%	9%	4%	10%
AAL	**13%**	**2%**	**9%**	**4%**	**10%**

Table 158. Percentage change in GROSS INSURABLE OCCURRENCE losses, by LOB

United States					
Insurable Occurrence					
EP (Return Period)	**Overall Change**				
	RES	**MH**	**COM/IND**	**AUTO**	**TOTAL**
5% (20 yr)	13%	2%	9%	4%	10%
2% (50 yr)	14%	3%	9%	4%	11%
1% (100 yr)	13%	2%	10%	3%	10%
0.5% (200 yr)	11%	3%	10%	3%	11%
0.4% (250 yr)	15%	3%	9%	3%	9%
0.2% (500 yr)	12%	4%	8%	3%	11%
0.1% (1,000 yr)	12%	4%	9%	3%	10%
AAL	**13%**	**2%**	**9%**	**4%**	**10%**

17.2 Analysis Settings

AIR used the following analysis settings in model runs to produce loss changes.

Table 159. Touchstone Re analysis settings for model runs

Setting	Selected Option(s)
Perils modeled	Wind
Catalog	10K
Industry exposure vintage(s)	2019
Take-up rates	N/A

Setting	Selected Option(s)
Demand surge	ON

18 Event ID Updates

The following table indicates changed event IDs in the updated models for Touchstone Re in 2020.

Table 160. Stochastic Event ID Updates

AIR Model	Stochastic Event IDs
AIR Inland Flood Model for the United States	All event IDs are new
AIR Hurricane Model for the United States	No change
AIR U.S. Hurricane Model for Offshore Assets	No change
AIR Wildfire Model for the United States	All event IDs are new
AIR Earthquake Model for the Caribbean	All event IDs are new
AIR Tropical Cyclone Model for the Caribbean	Some event IDs are new
AIR Earthquake Model for Australia	All events IDs are new
AIR Multiple Peril Crop Insurance Model for Mainland China	All event IDs are new

19 Industry Exposure Database Updates

With the release of updated version of Touchstone Re, AIR is providing a full exposure update of the high-resolution AIR Industry Exposure Databases for the United States and the Caribbean, which are current as of the end of 2019. The Industry Exposure Database is constructed at a high resolution 1-km grid. Large industrial facilities are identified and valued individually and are separated from the rest of the industrial line.

The Industry Exposure Database for Offshore Assets in the Gulf of Mexico is updated for the 2020 release of Touchstone Re to account for updates to the replacement values, counts, locations, and production of platforms and rigs in the Gulf of Mexico. The data in the Industry Exposure Database for Offshore Assets in the Gulf of Mexico is current as of November 2019.

About AIR Worldwide

AIR Worldwide (AIR) provides risk modeling solutions that make individuals, businesses, and society more resilient to extreme events. In 1987, AIR Worldwide founded the catastrophe modeling industry and today models the risk from natural catastrophes, terrorism, pandemics, casualty catastrophes, and cyber incidents. Insurance, reinsurance, financial, corporate, and government clients rely on AIR's advanced science, software, and consulting services for catastrophe risk management, insurance-linked securities, longevity modeling, site-specific engineering analyses, and agricultural risk management. AIR Worldwide, a Verisk (Nasdaq:VRSK) business, is headquartered in Boston with additional offices in North America, Europe, and Asia. For more information, please visit www.air-worldwide.com.

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