The Addition of Great Britain Storm Surge to AIR's Extratropical Cyclone Model for Europe

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Agenda

- Introduction
- Updates to the Hazard Component
- Hazard Model Validation
- Updates to the Vulnerability Component
- Modeled Losses
- Upcoming Software Changes

Introduction

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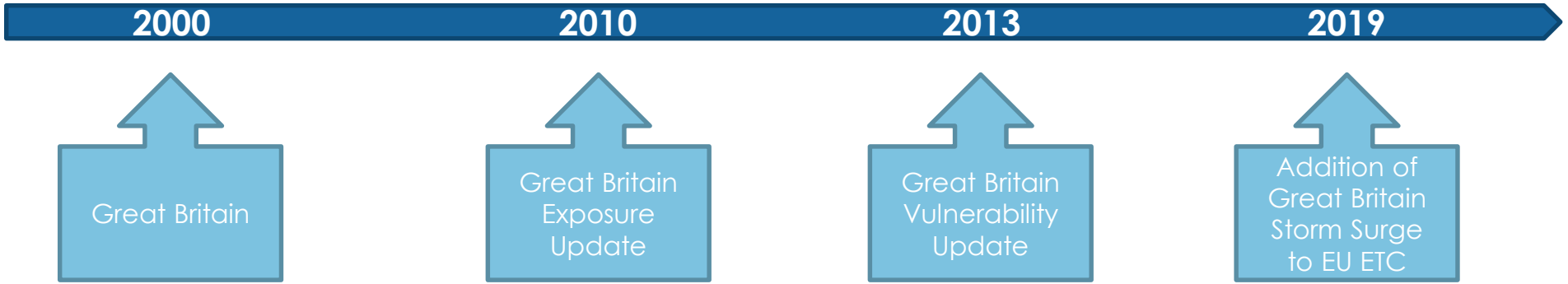
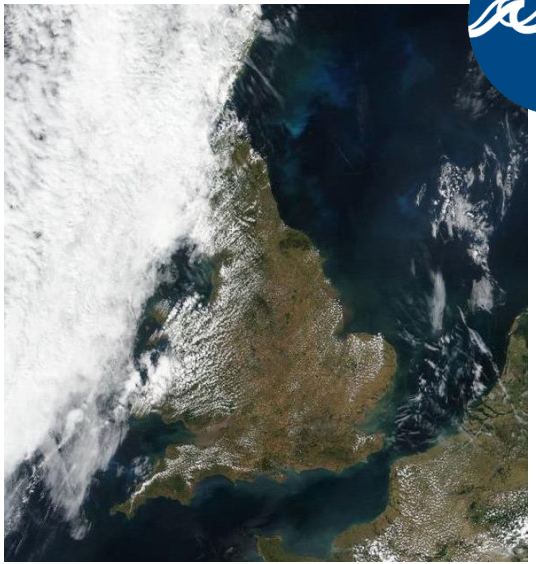
History of AIR's Coastal Flood Model for Great Britain



Changes in Model Configuration

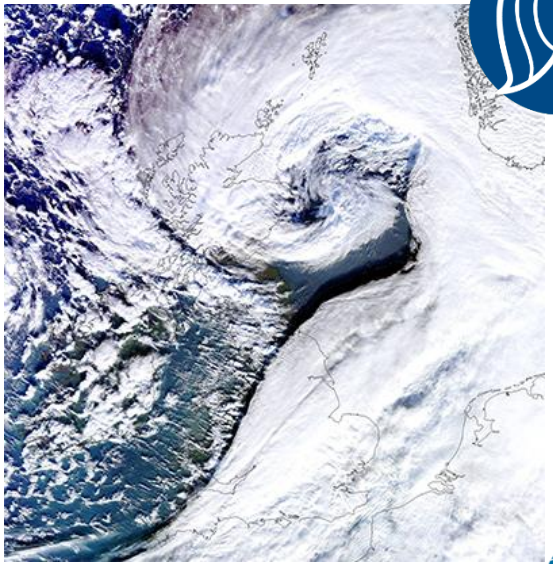
Previously:

AIR Coastal Flood Model for Great Britain

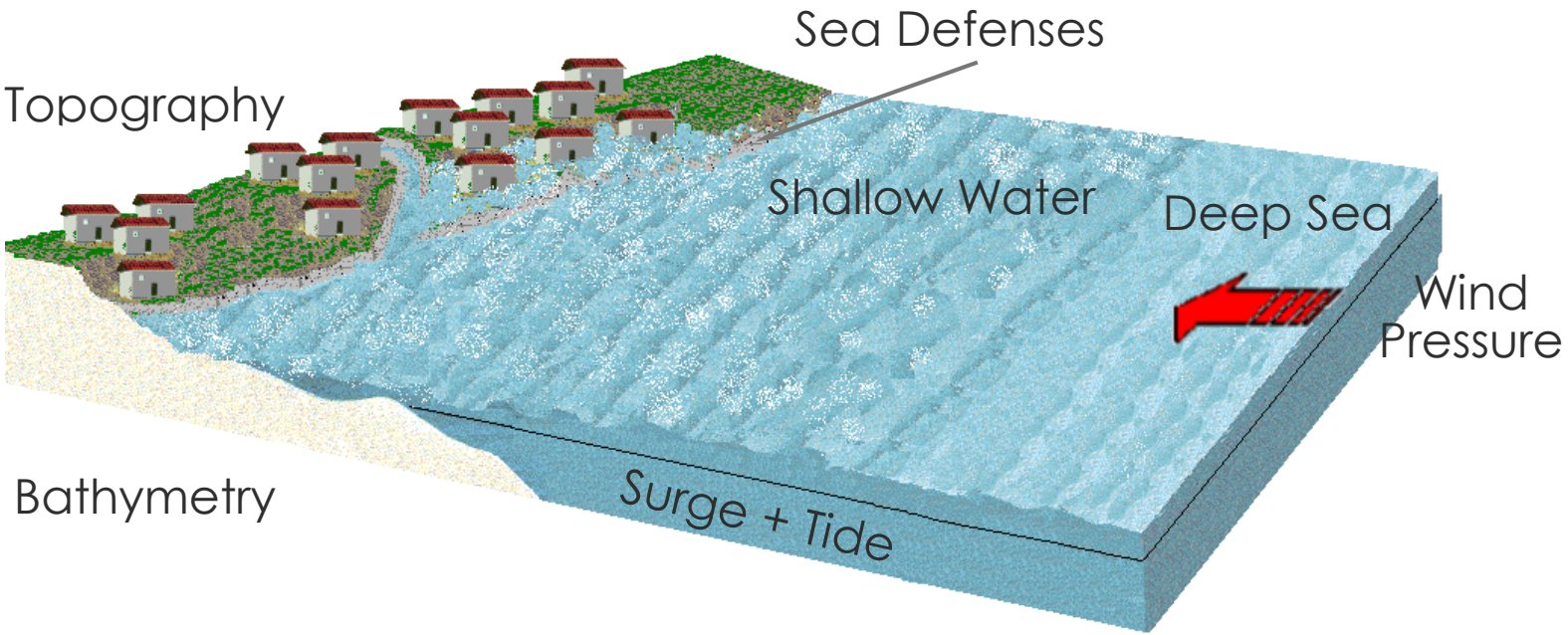


2019 Update:

Storm Surge sub-peril in the AIR Extratropical Cyclone Model for Europe

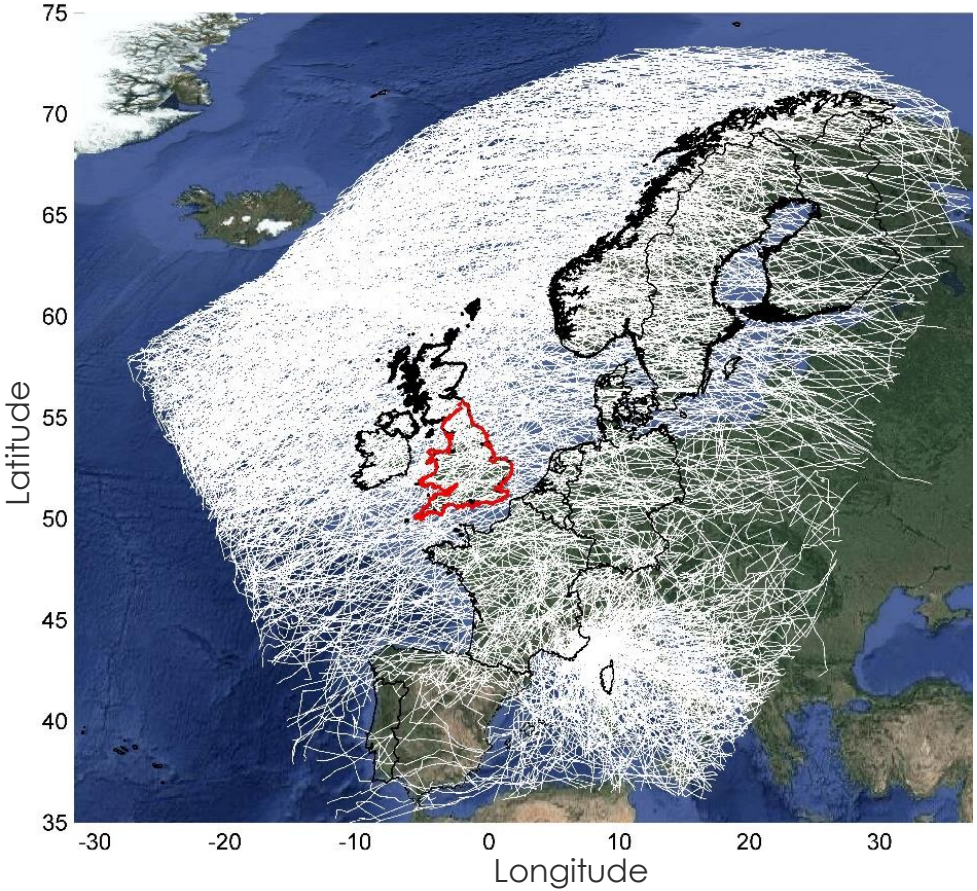


What Is Storm Surge?



Extratropical Cyclones Generate Storm Surge in Great Britain

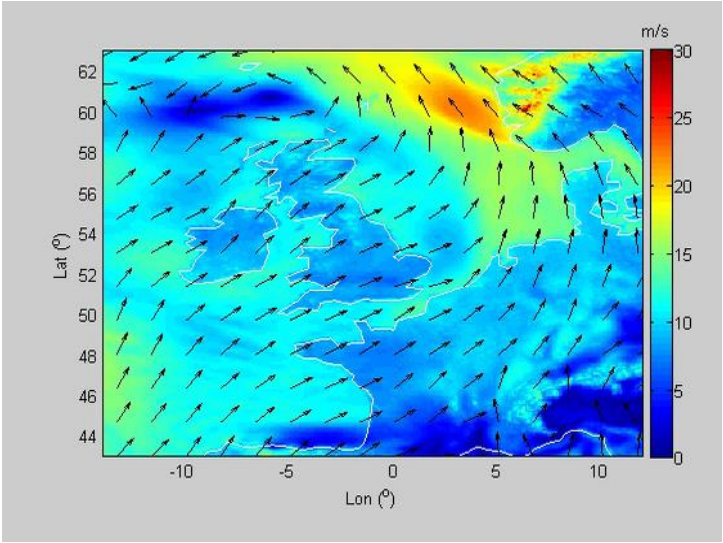
Historical Storm Tracks



Historical Events Affect Both the West and East Coasts

Storm Anne (2014): West Coast Example*

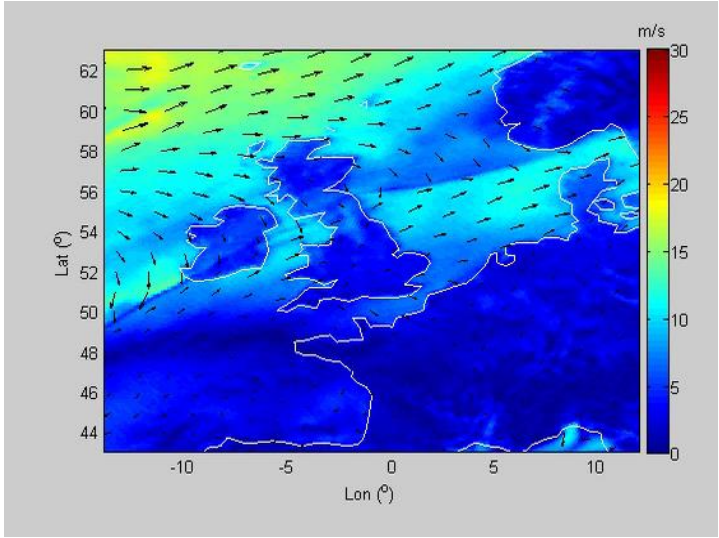
***another example is Storm Undine (1991)**



Southerly wind pushes water into Irish Sea

Storm Xaver (2013): East Coast Example**

****another famous example is North Sea Flood (1953)**



Northerly wind pushes water into the Channel

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Updates to the Hazard Component

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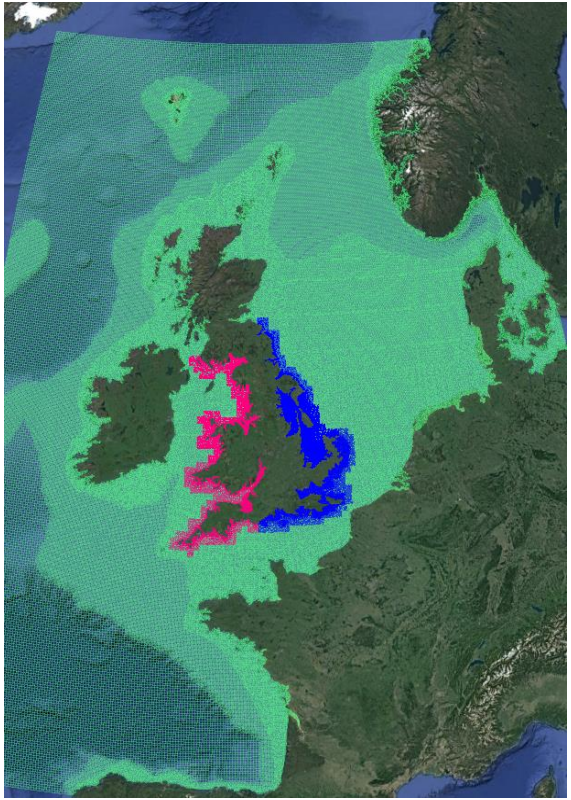
New Hydrodynamic Coastal Flood Model

- Expanded domain covers all of England and Wales
- Uses Delft3D Flexible Mesh
- Dynamic simulation of tides and surge
- Driven by wind and pressure from EU ETC model catalog
  (see Keshtpoor, Carnacina, and Yablonsky, 2019: New Statistical Approach to Select Coastal Flood-Producing Extratropical Cyclones from a 10,000-Year Stochastic Catalog. *J. Waterway, Port, Coastal, and Ocean Eng.*)
- Surge depth at 10-meter resolution via downscaling and topography subtraction



Hydrodynamic Domain Coarse Mesh

Fine Mesh:

Current Coverage

New Coverage

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CORINE Land Use/Land Cover Database

Corine land cover classes

1. Artificial surfaces

1.1 Urban fabric

- 1.1.1. Continuous urban fabric
- 1.1.2. Discontinuous urban fabric

1.2 Industrial, commercial and transport units

- 1.2.1. Industrial or commercial units
- 1.2.2. Road and rail networks and associated land
- 1.2.3. Port areas
- 1.2.4. Airports

1.3 Mine, dump and construction sites

- 1.3.1. Mineral extraction sites
- 1.3.2. Dump sites
- 1.3.3. Construction sites

1.4 Artificial, non-agricultural vegetated areas

- 1.4.1. Green urban areas
- 1.4.2. Sport and leisure facilities

2. Agricultural areas

2.1 Arable land

- 2.1.1. Non-irrigated arable land
- 2.1.2. Permanently irrigated land
- 2.1.3. Rice fields

2.2 Permanent crops

- 2.2.1. Vineyards
- 2.2.2. Fruit trees and berry plantations
- 2.2.3. Olive groves

2.3 Pastures

- 2.3.1. Pastures

2.4 Heterogeneous agricultural areas

- 2.4.1. Annual crops associated with permanent crops
- 2.4.2. Complex cultivation patterns
- 2.4.3. Land principally occupied by agriculture
- 2.4.4. Agro-forestry areas

3. Forest and seminatural areas

3.1 Forests

- 3.1.1. Broad-leaved forest
- 3.1.2. Coniferous forest
- 3.1.3. Mixed forest

3.2 Shrub and/or herbaceous vegetation associations

- 3.2.1. Natural grassland
- 3.2.2. Moors and heathland
- 3.2.3. Sclerophyllous vegetation
- 3.2.4. Transitional woodland shrub

3.3 Open spaces with little or no vegetation

- 3.3.1. Beaches, dunes, and sand plains
- 3.3.2. Bare rock
- 3.3.3. Sparsely vegetated areas
- 3.3.4. Burnt areas
- 3.3.5. Glaciers and perpetual snow

4. Wetlands

4.1 Inland wetlands

- 4.1.1. Inland marshes
- 4.1.2. Peat bogs

4.2 Coastal wetlands

- 4.2.1. Salt marshes
- 4.2.2. Salines
- 4.2.3. Intertidal flats

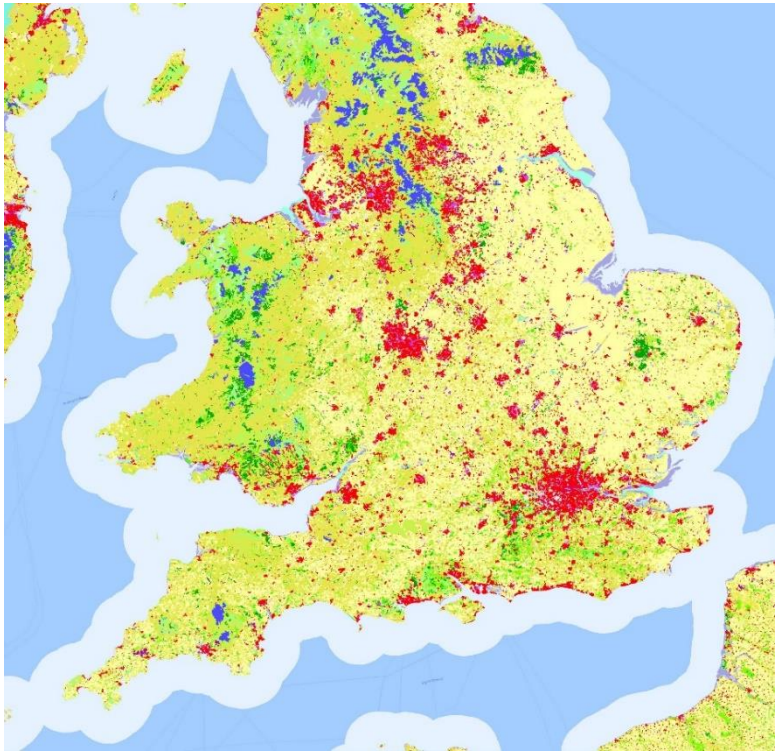
5. Water bodies

5.1 Inland waters

- 5.1.1. Water courses
- 5.1.2. Water bodies

5.2 Marine waters

- 5.2.1. Coastal lagoons
- 5.2.2. Estuaries
- 5.2.3. Sea and ocean



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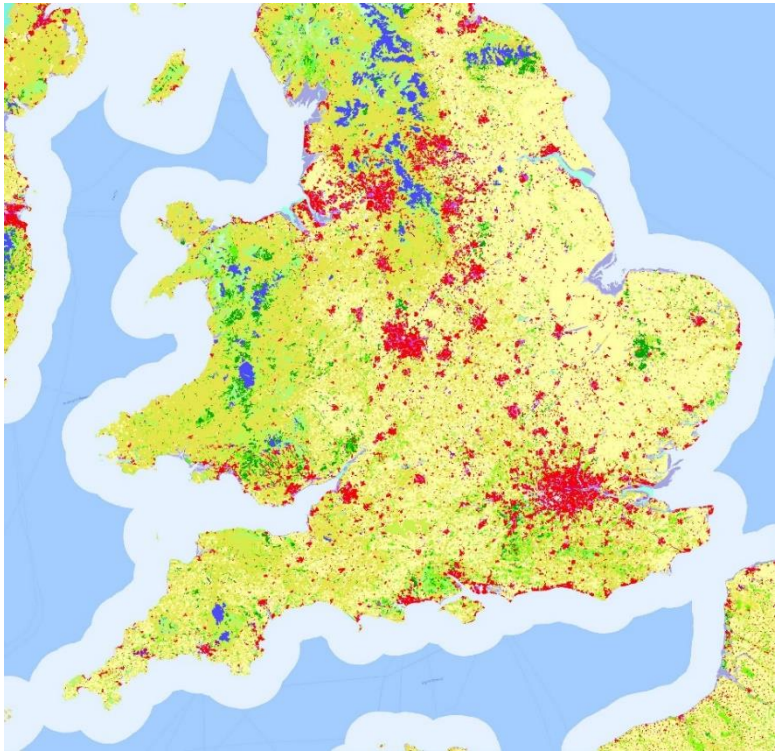
CORINE Land Use/Land Cover Database

- Data can be mapped to a Manning friction coefficient
- Helps to ensure proper flood extent over land
- Particularly challenging in urban areas



Incorporation of the Latest Levee Data Sources

UK Environment Agency Spatial Flood Defences Dataset

- 2016 vintage defense data set for the entire United Kingdom: defined crest heights, material, quality condition, and design type
- Undefined heights were extracted from 2- to10-meter topography (DTM) sources

Thames River Defenses

- The Thames Barrier was completed in 1984
- During construction, flood defenses were raised by ~2 meters for ~30 km downstream to match the Barrier
- Defenses for ~5 km upstream were also raised to increase protection and match protection of Central London

Accounting for Breached Levees in Addition to Overtopping Levees

Hazard Model Validation

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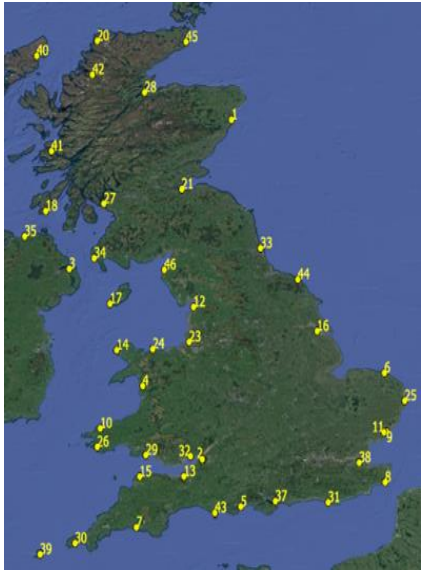
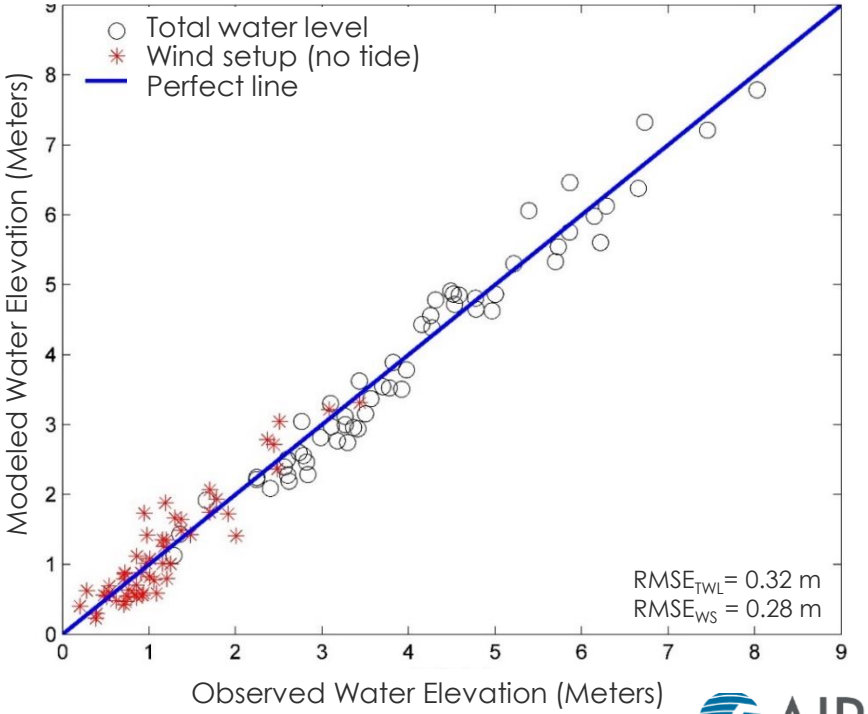
Storm Surge Model Validation at Great Britain Tide Gauges for Four Storms



Tide Gauge Locations

Four Storms Combined:
1953, Undine, Xaver, and Anne



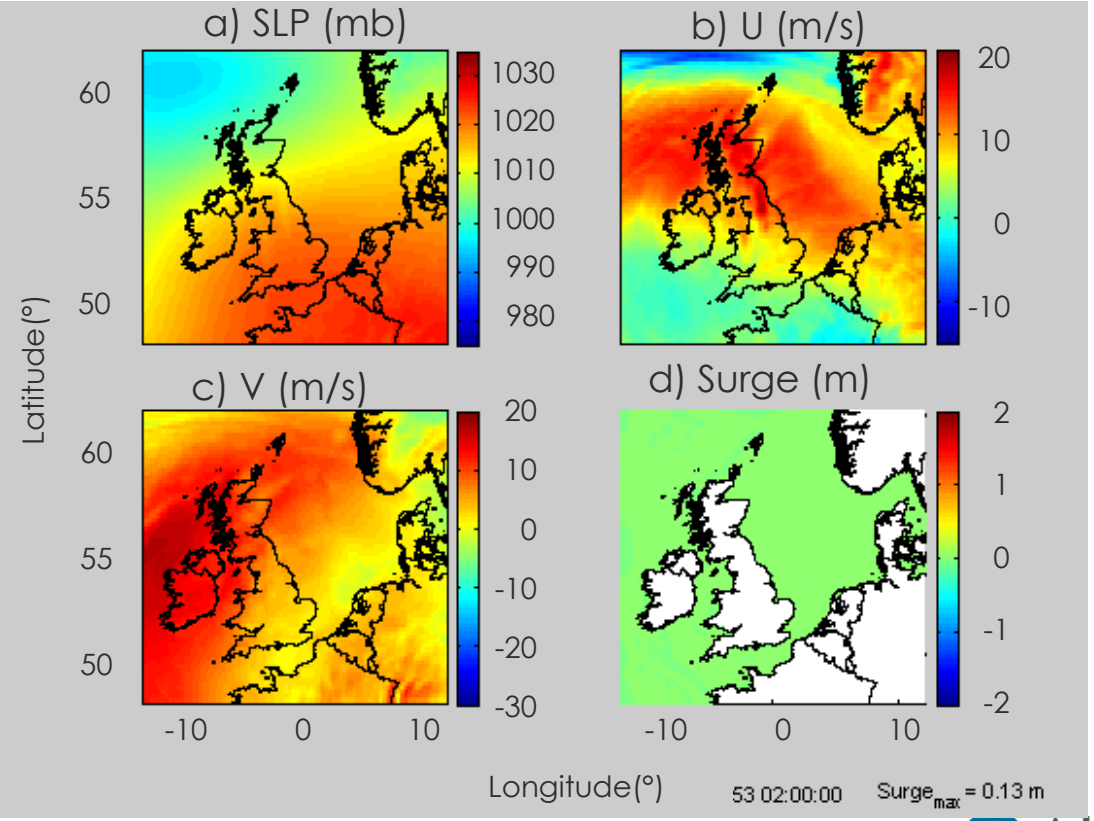
Modeled Pressure, Wind, and Surge During North Sea Flood of 1953

a) Sea level pressure

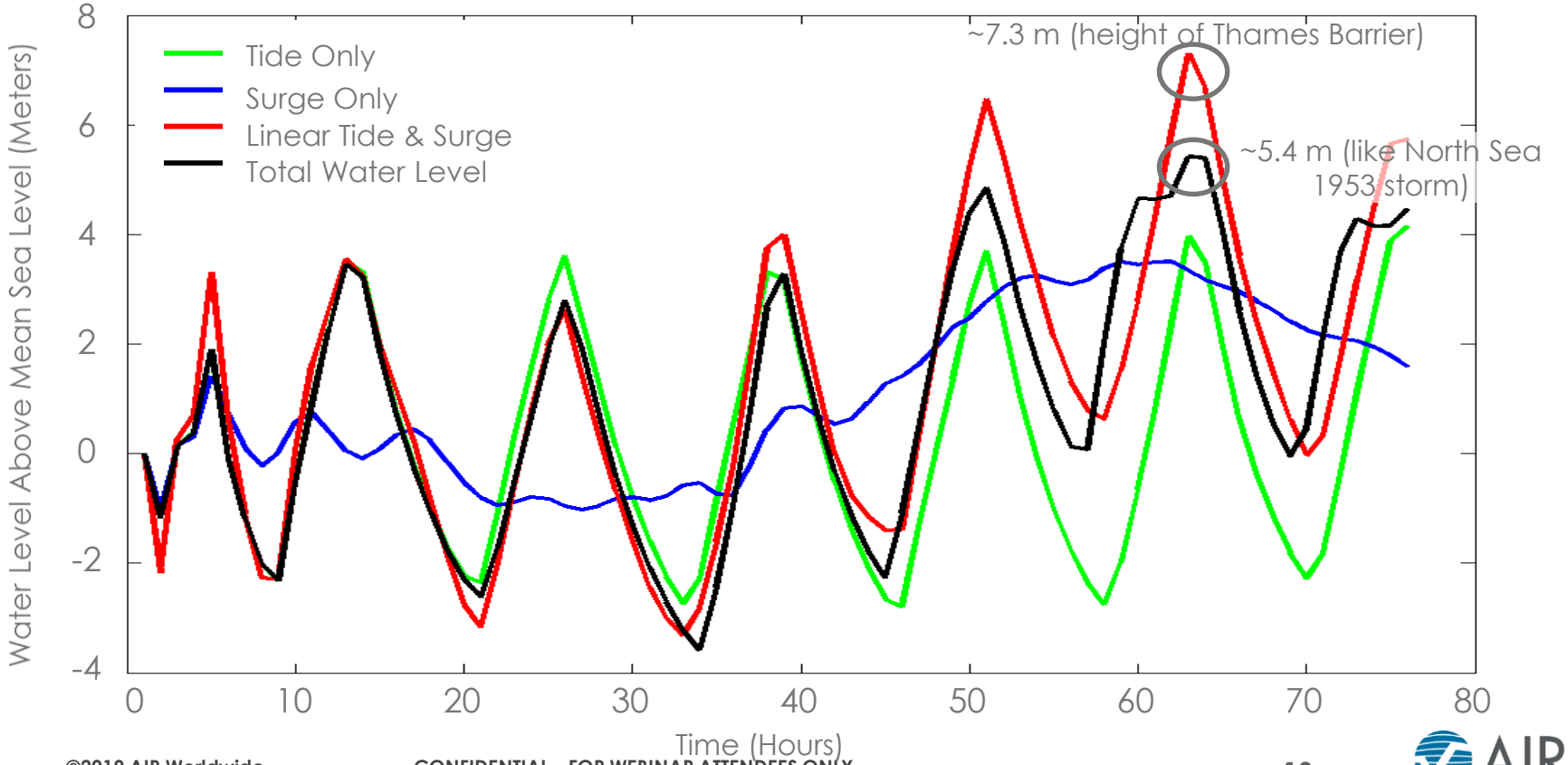
b) West-to-east wind speed (U) ~180 meters above ground

c) South-to-north wind speed (V) ~180 meters above ground

d) Water level due to wind setup (without tide)



Modeled Water Level Near Thames Barrier from a Storm Like the 1953 North Sea Flood



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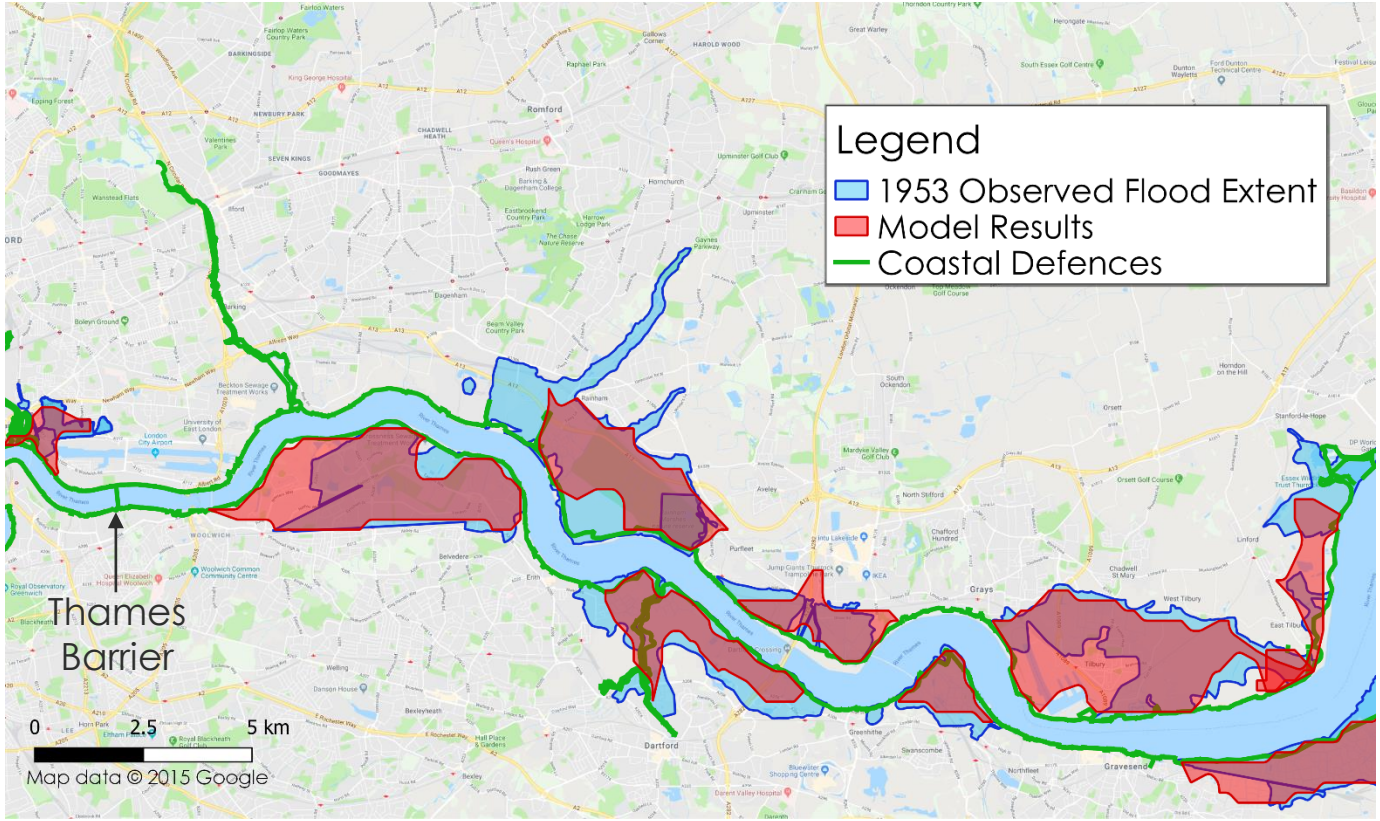
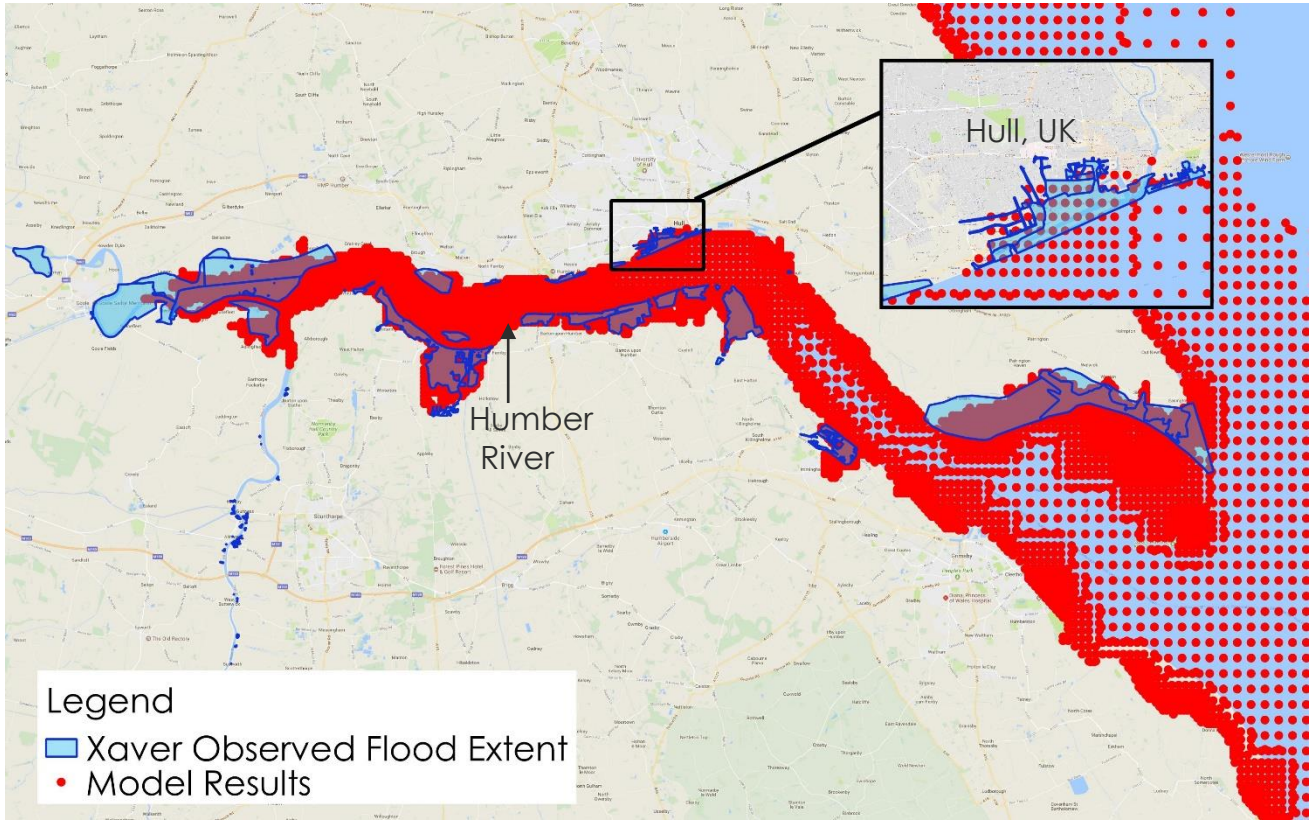
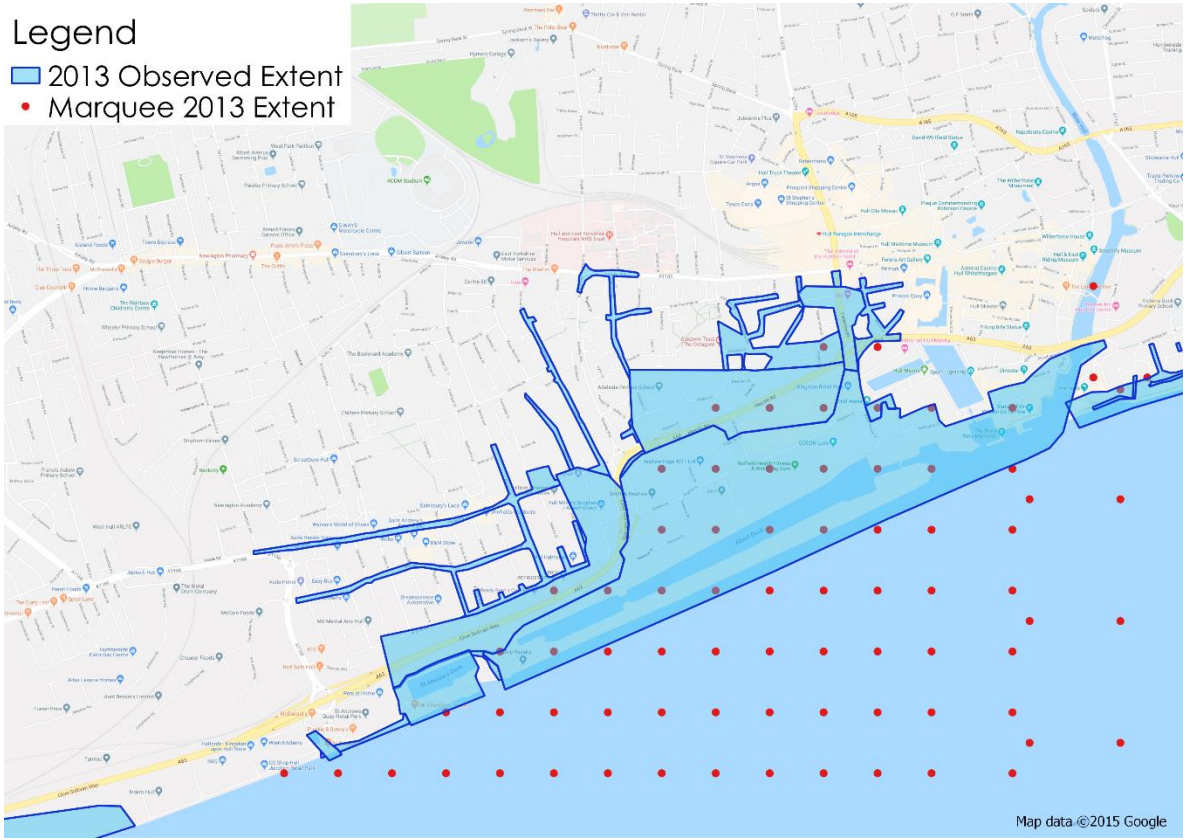
Flood Extent Validation for the 1953 North Sea Flood Event (Thames River)



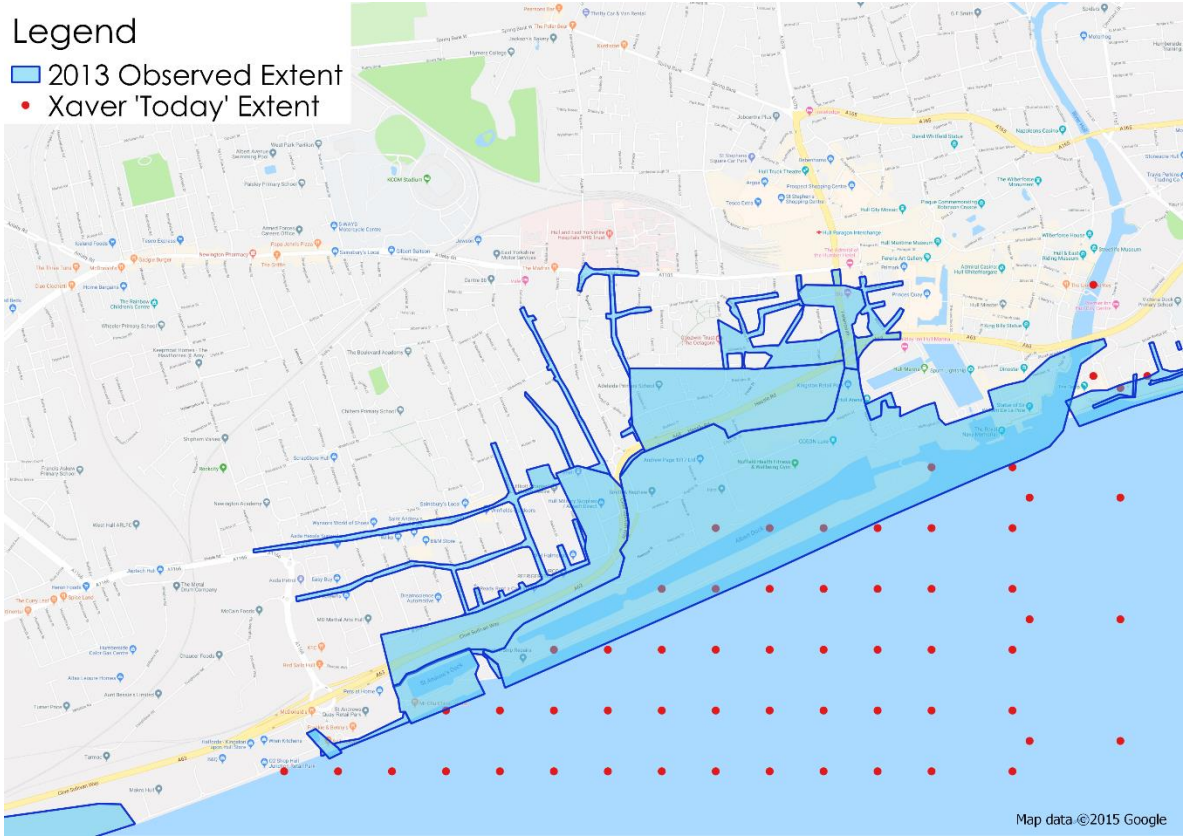
Flood Extent Validation Along the Humber River for 2013 Storm Xaver



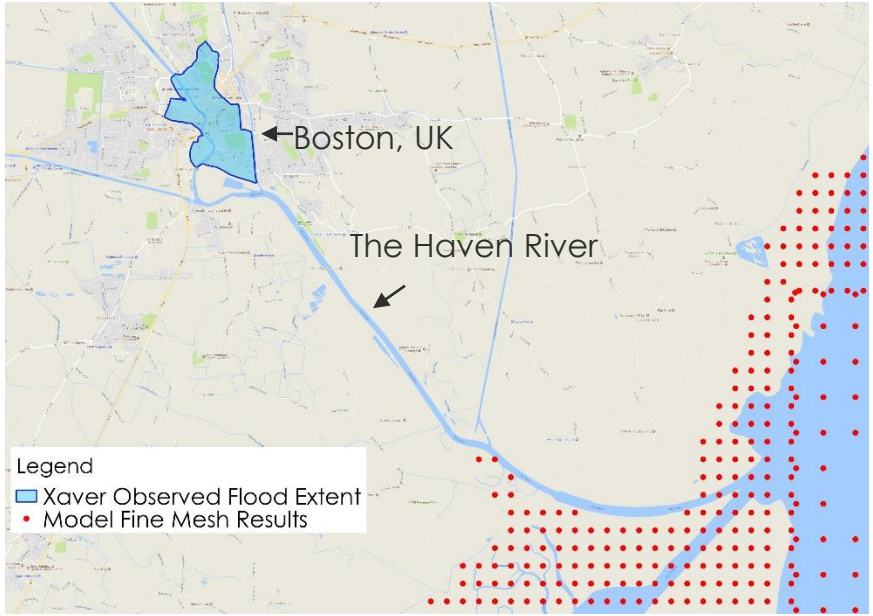
City of Hull Close Up: Storm Xaver in 2013



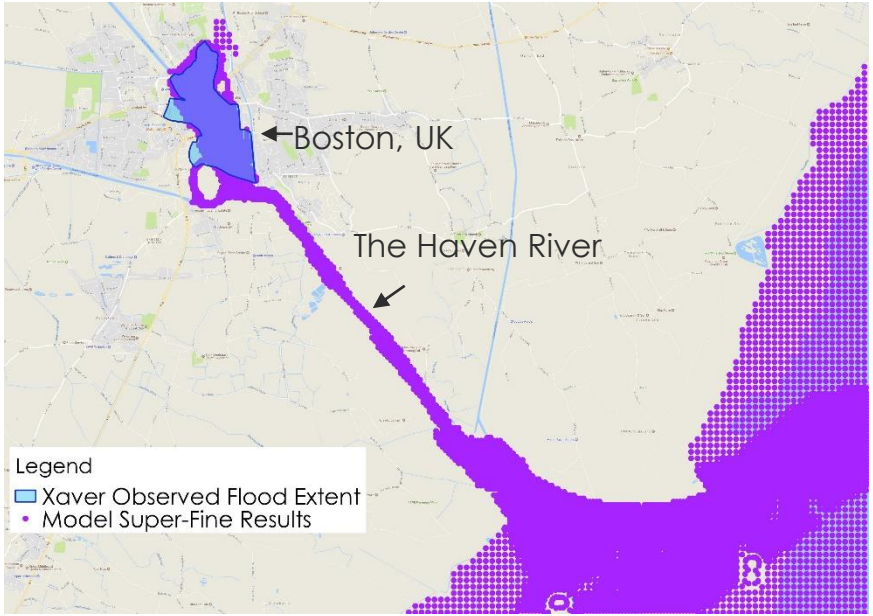
City of Hull Close Up: Storm Xaver "Today"



Flood Validation for Storm Xaver in Boston, UK: Fine Mesh Versus Super-Fine Mesh



Insufficient resolution (~220 m) for water to reach Boston, UK



Sufficient resolution (up to 35 m) for water to reach Boston, UK

Updates to the Vulnerability Component

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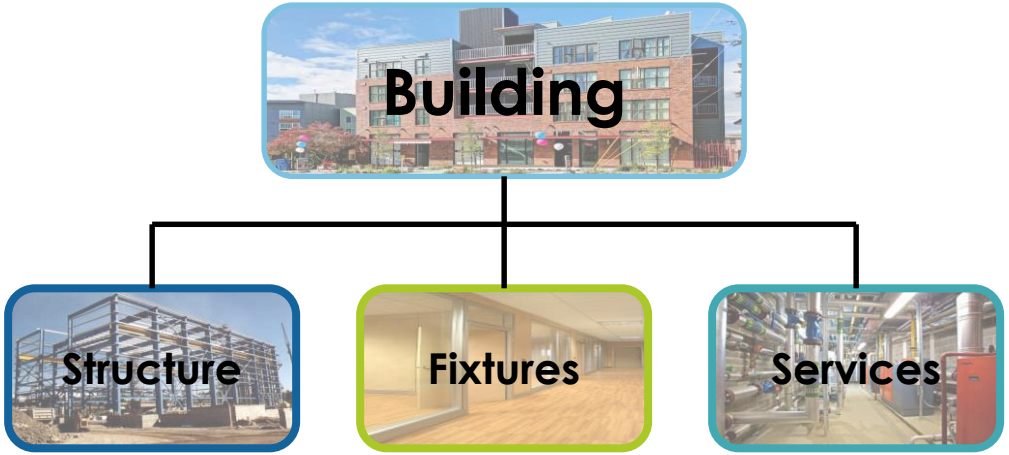
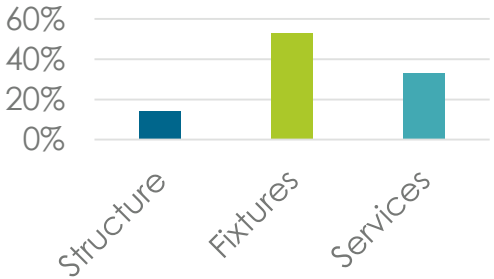
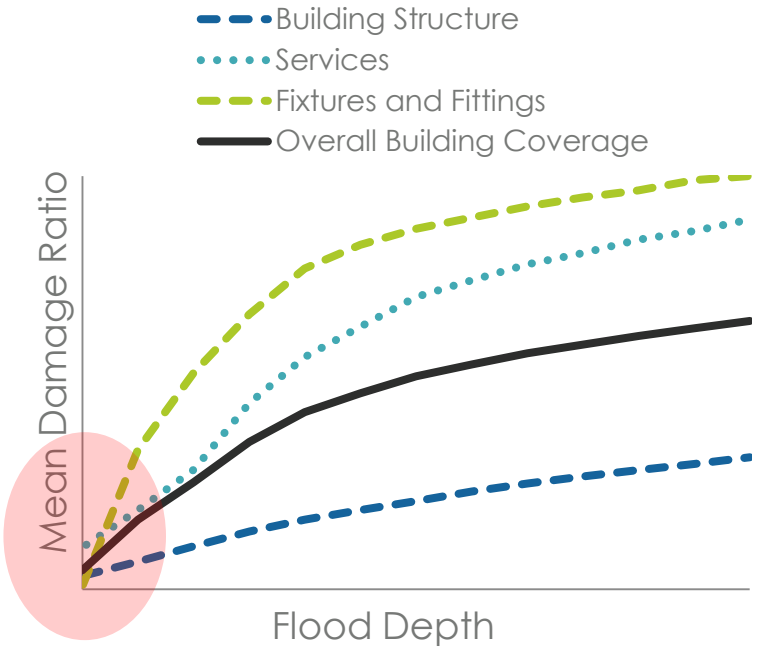
Component-Level Damage Functions





Building and Component Damage Functions for a Retail Shop



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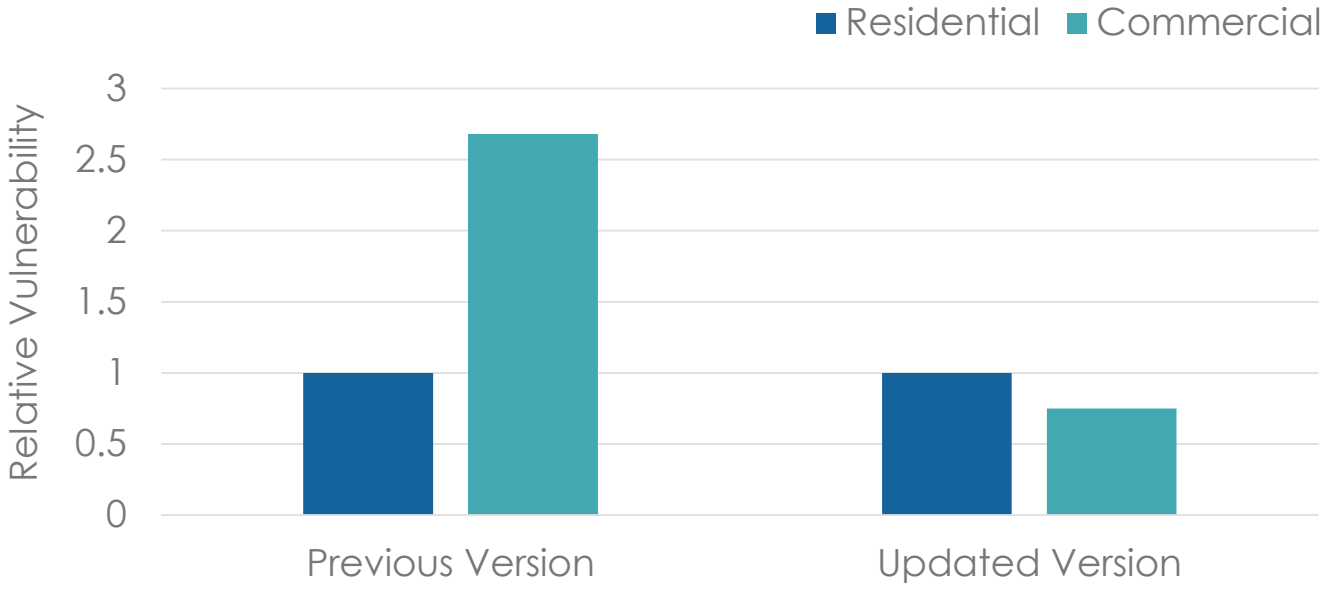
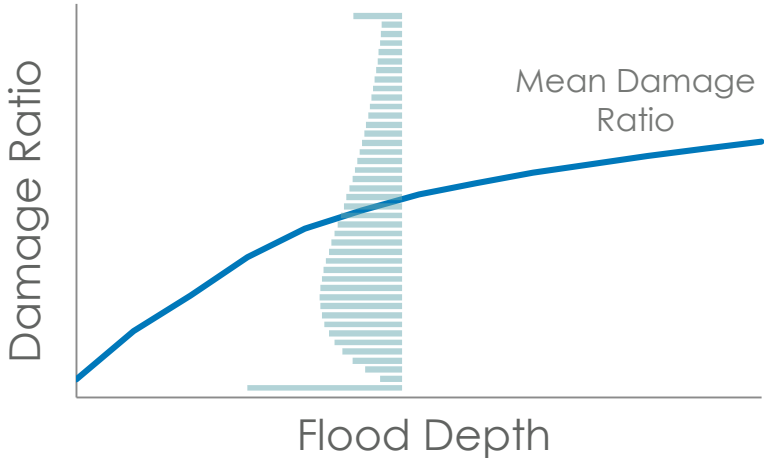
Reduction in Commercial Building Vulnerability Relative to Residential

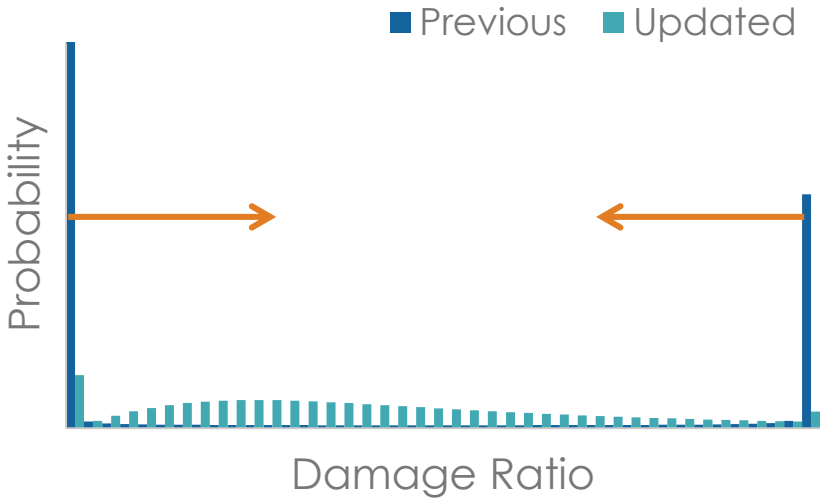


Vulnerability Updates Leverage a Unified Framework Across Models in Europe

- Addition of marine cargo, marine hull, industrial facilities, wind turbine, and builder's risk
- Incorporation of unknown damage functions at CRESTA level
- Updated secondary damage distributions

67K Claims from Four Historical Floods Inform the Latest Secondary Uncertainty Distributions





- Distinct secondary uncertainty distributions for Residential and Commercial risks
- In the new model, there is lower probability of zero or full damage

Support for New Secondary Risk Characteristics

Custom Flood Protection

Foundation Type

Floor of Interest

First-Floor Height

Custom Elevation

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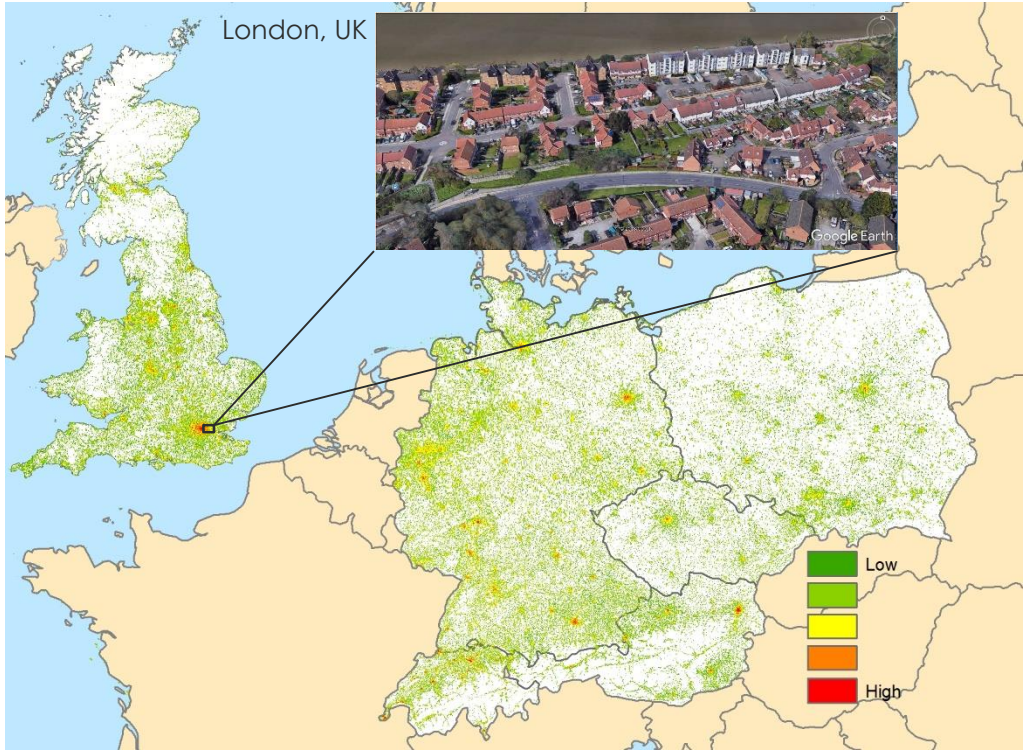
New Industry Exposures Modeled at 90-Meter Resolution



- Utilized best available building footprint data sets to accurately locate risks
- Updated construction splits, replacement costs, coverage splits, and policy conditions
- Improved automobile valuation methodology
- Identified high-value industrial facilities

New Industry Exposures Modeled at 90-Meter Resolution

New Industry Exposures Modeled at 90-Meter Resolution

Modeled Losses

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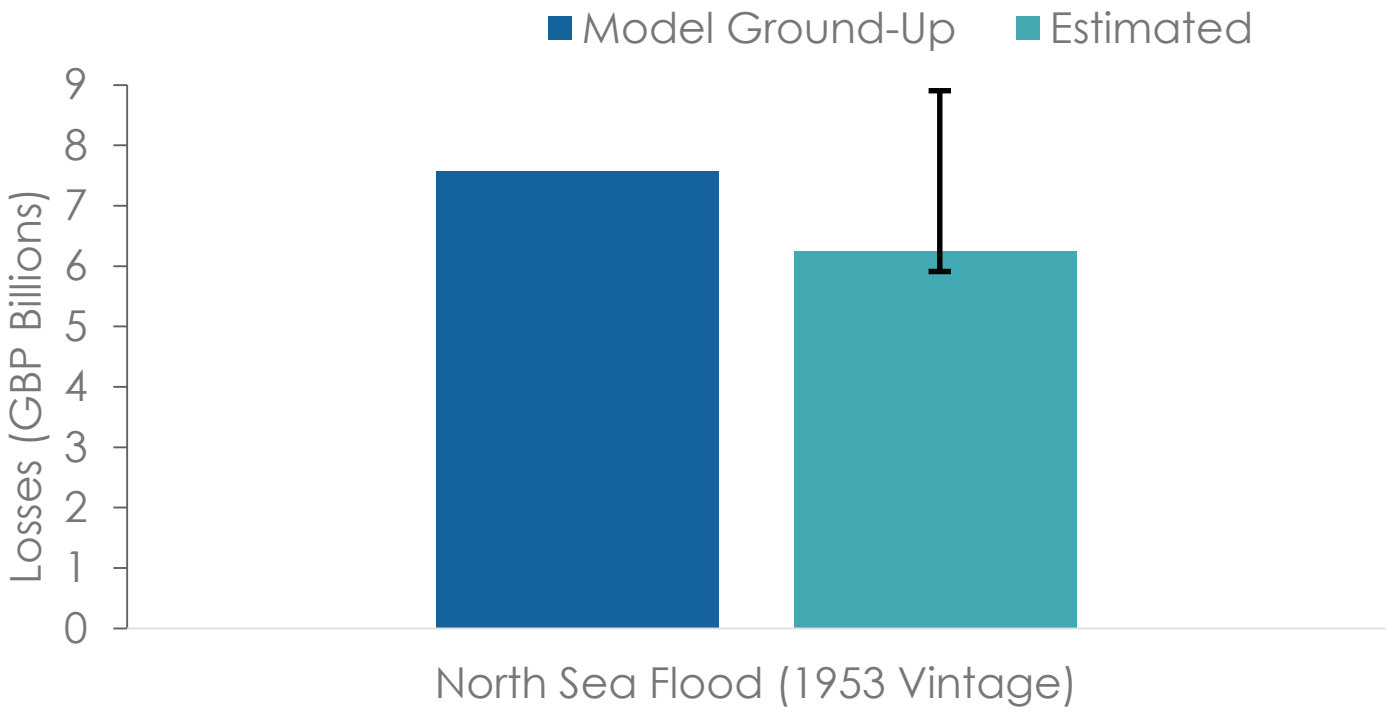
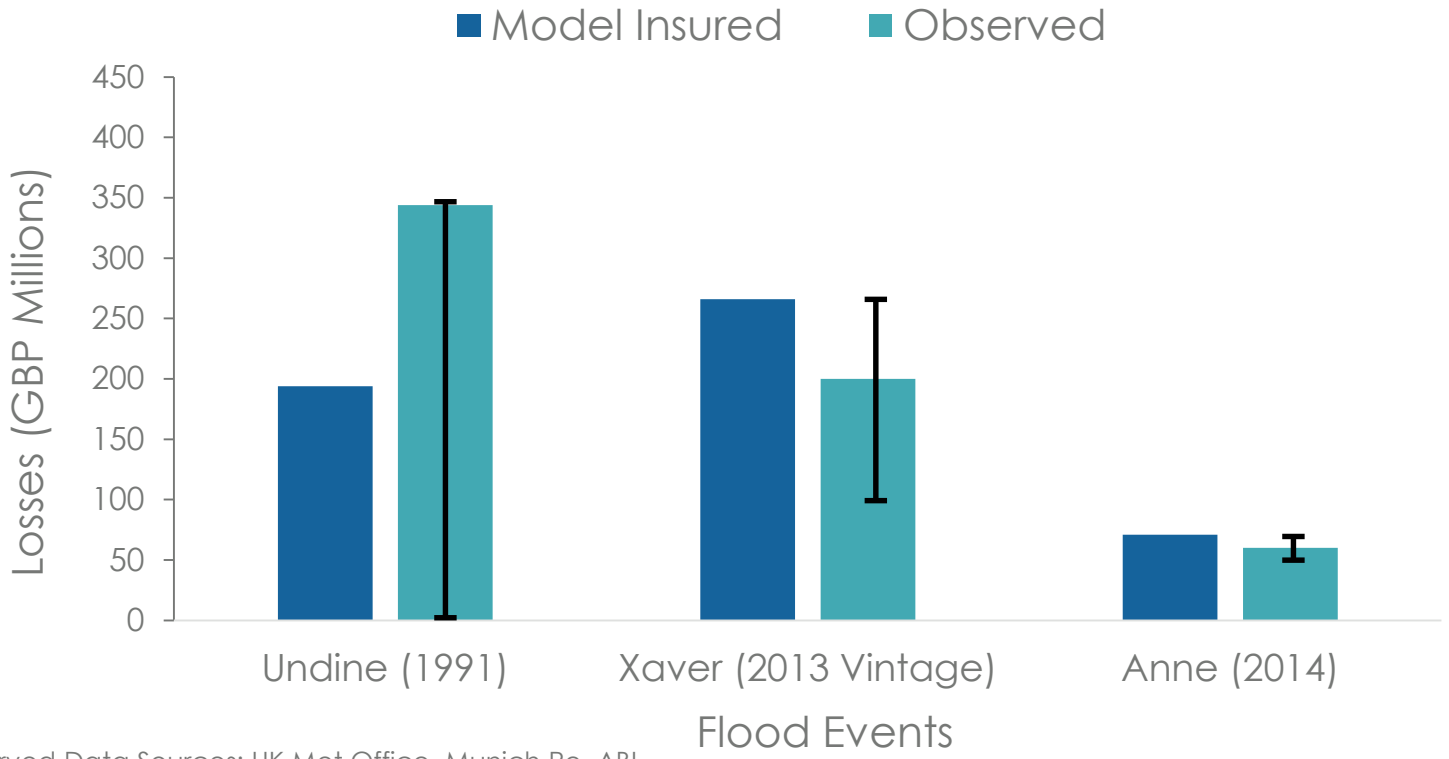
Historical Event Loss Validation



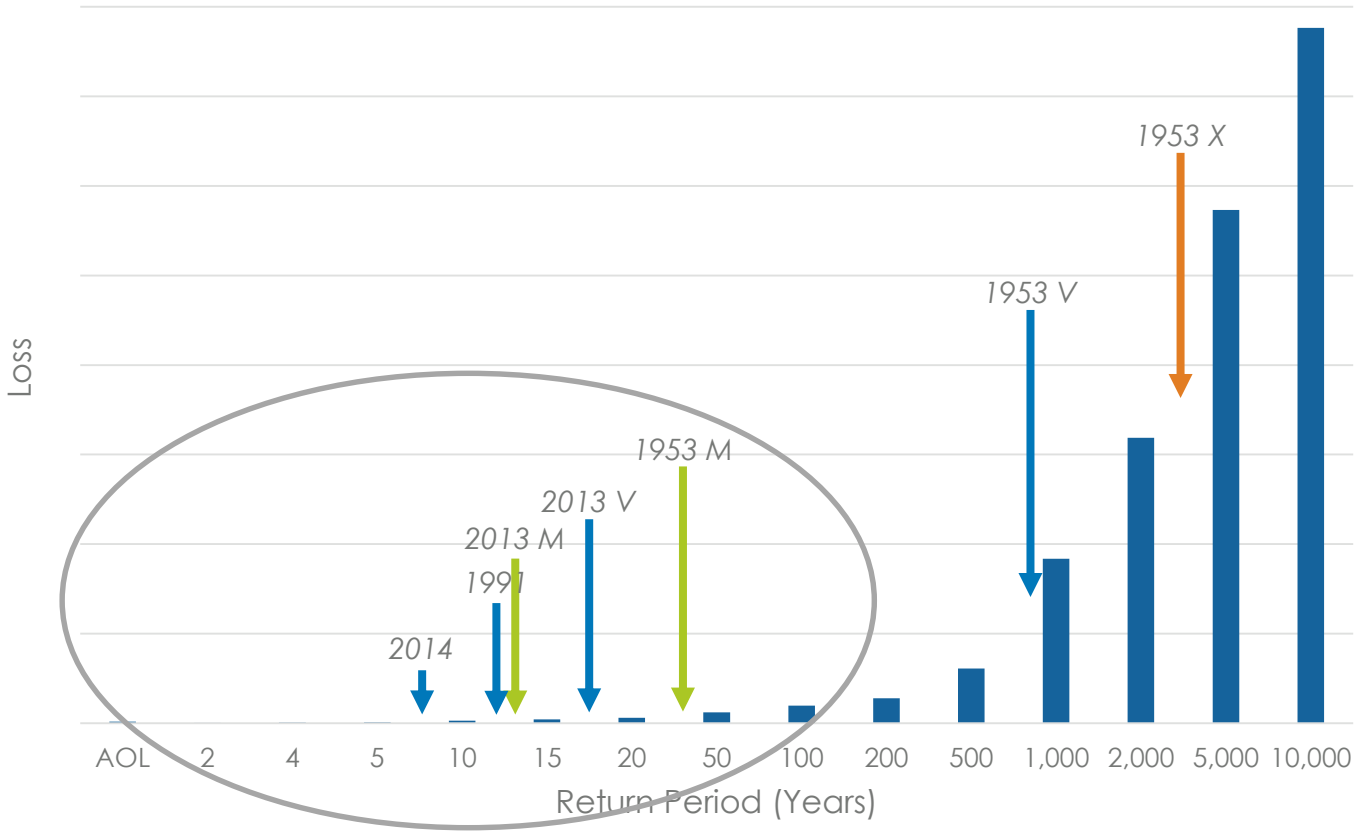
Observed Data Sources: UK Met Office, Munich Re, ABI

Historical Event Loss Validation



Observed Data Sources: UK Met Office, Munich Re, ABI

Exceedance Probability of Insurable Gross Loss



X = No SoP

V = Vintage SoP

M = Modern SoP

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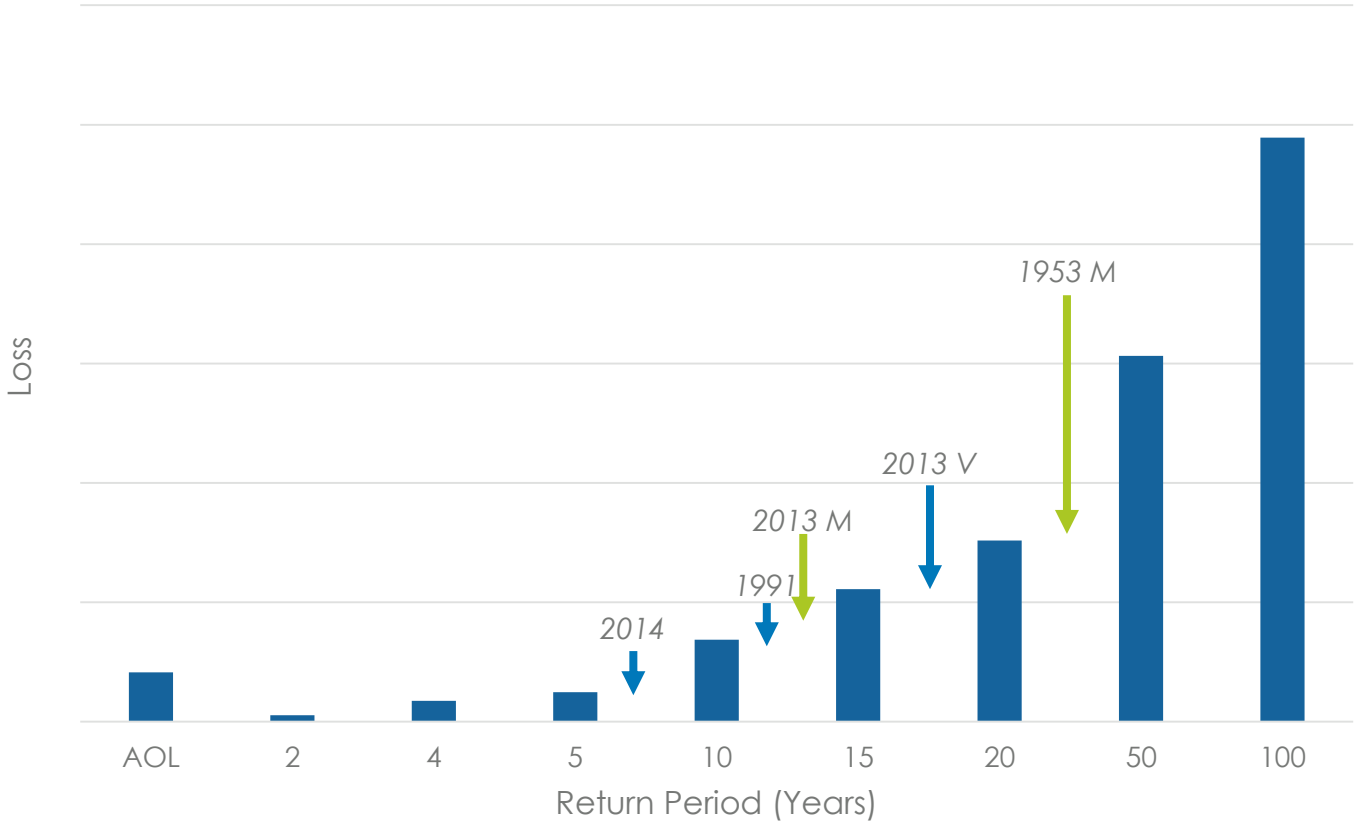
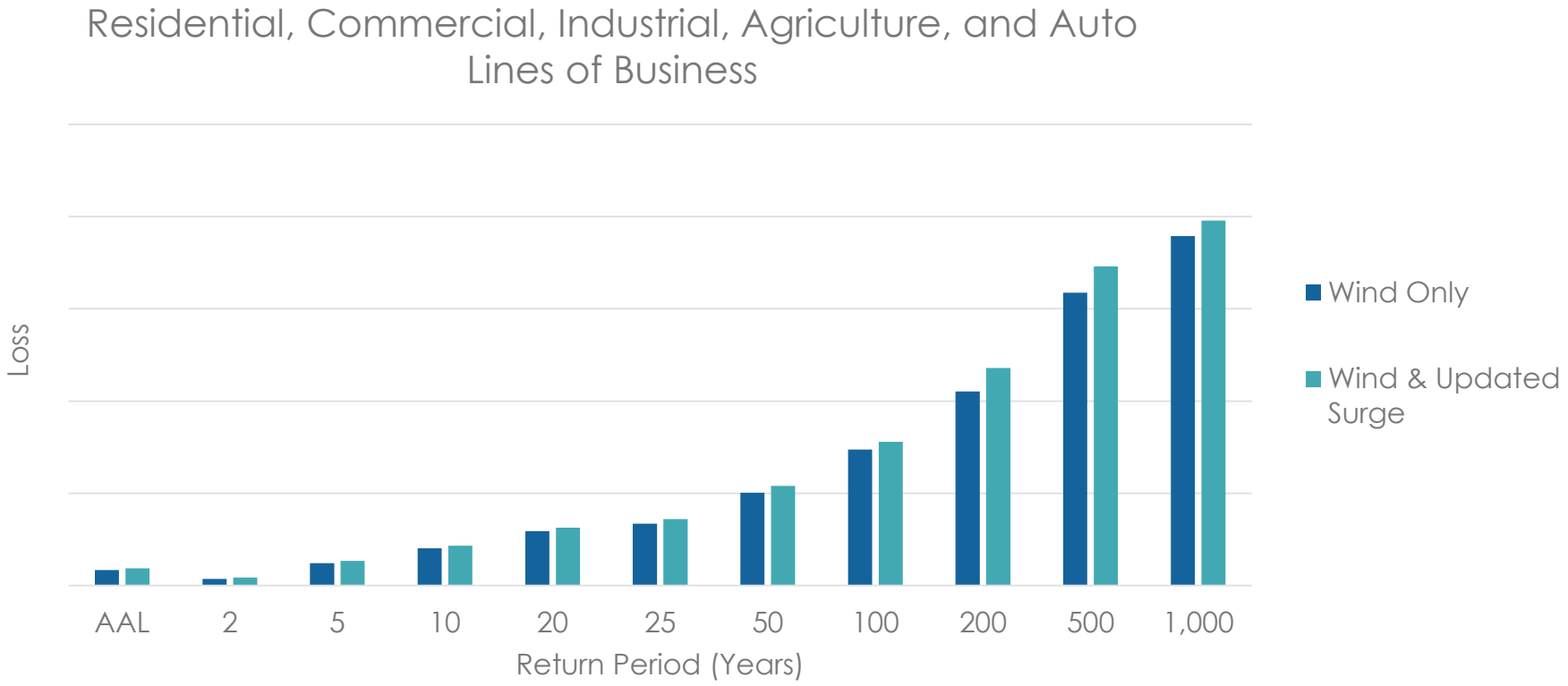
Exceedance Probability of Insurable Gross Loss



V = Vintage SoP

M = Modern SoP

Insured Aggregate Loss Comparison: Adding Surge



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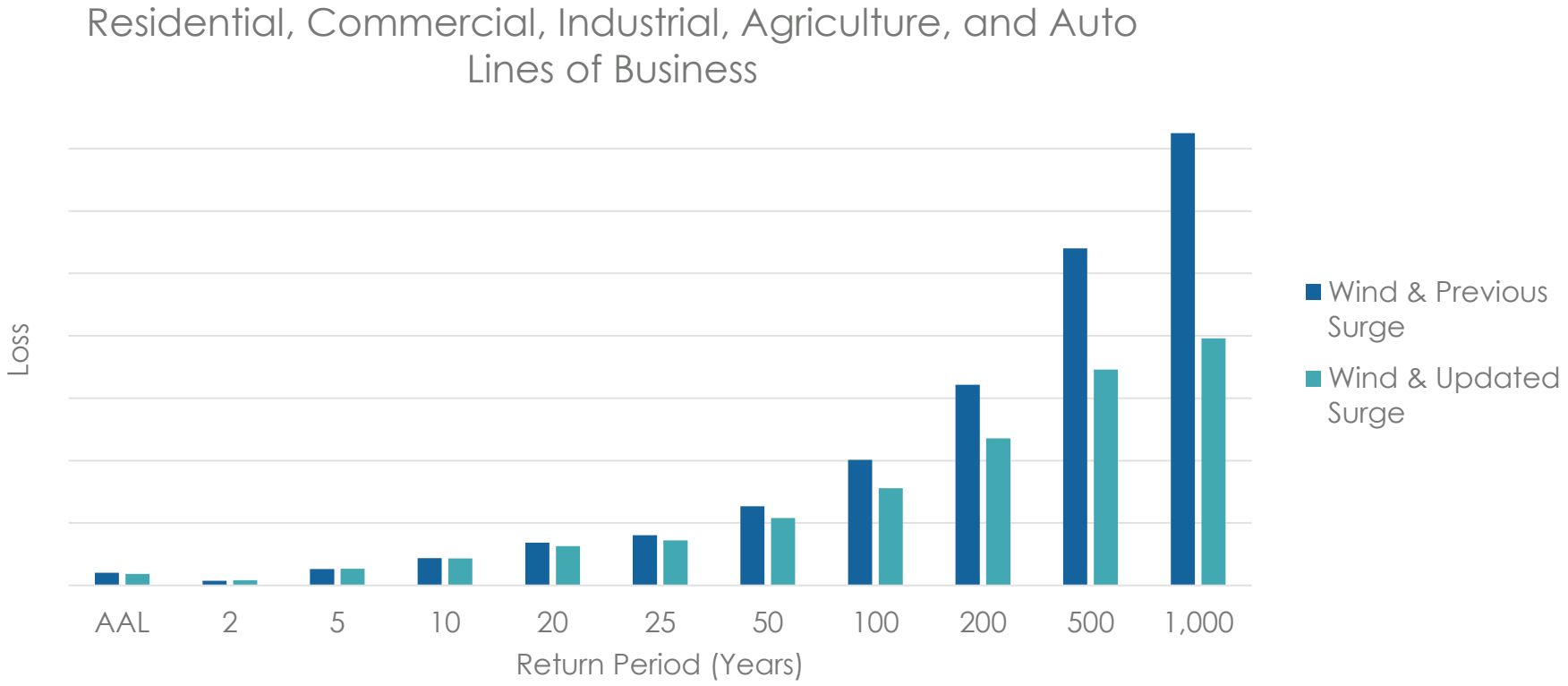
Insured Aggregate Loss Comparison: Wind & Surge



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Upcoming Software Changes

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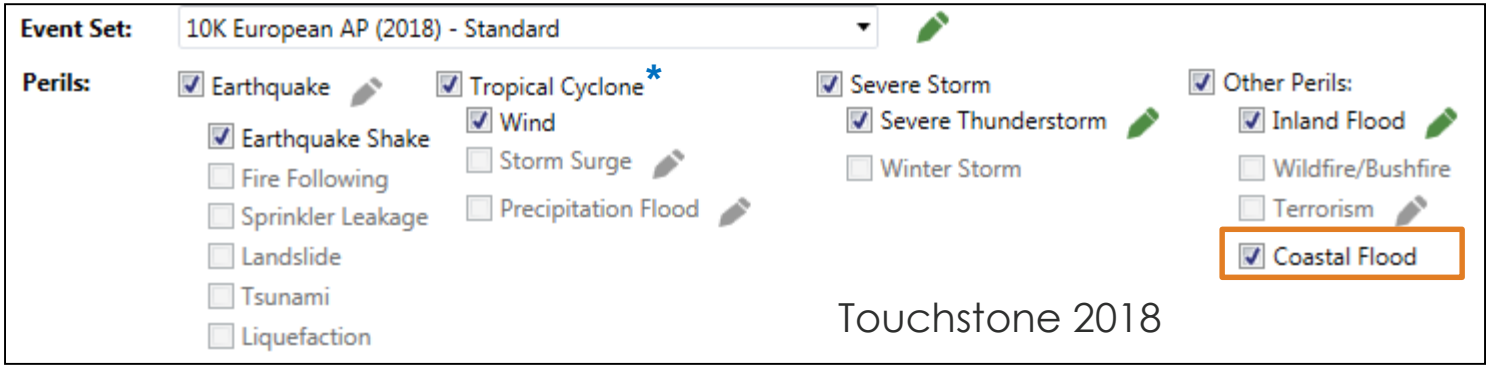
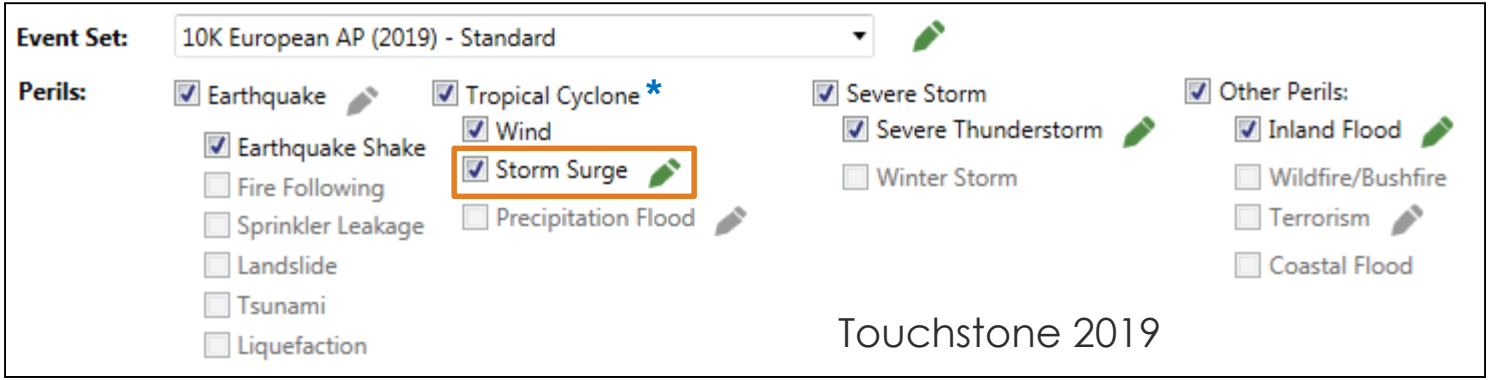
Functional Changes in Touchstone



* Europe Extratropical Cyclone is still categorized as a "Tropical Cyclone" peril in Touchstone



Bonus Features in Touchstone and CATRADER/Touchstone Re

1) Events in the Database are tagged as either Extratropical Cyclone (E), Surge (S) or Combined (C).
2) In Touchstone® 2019, you can run the previous and new versions of the GB storm surge model
3) Users can apply financial terms on combined wind and surge losses in Touchstone and CATRADER®/Touchstone Re™
4) CATRADER/Touchstone Re users can also get losses for the GB surge-only catalog
5) Exported CLFs will be for European ETC (even storm surge-only runs)

Summary

- Added the storm surge sub-peril as part of AIR's Extratropical Cyclone Model for Europe
- Expanded model coverage to include all of England and Wales
- Updated with modern-day levee information to improve surge footprints
- Enhanced damage functions using claims and peer-reviewed literature
- Greater selection of primary and secondary characteristics to represent your risk

Questions?

AIR