Cat Modelling Update from AIR

Dr Milan Simic
Managing Director
AIR Worldwide Ltd
Agenda

• Update from AIR on 2010
  – US/Atlantic Hurricane
  – EU Windstorm
  – Japan/NW Pacific Typhoon

• Update from AIR on 2011
  – EU Earthquake
  – EU Flood
  – Big push on Solvency II

• Update on recent cat events
  – Chile 2010
  – New Zealand 2010 and 2011
  – Japan 2011
2010 – US/Atlantic Hurricane
2010 Featured an Updated Basinwide Catalog for All North Atlantic Tropical Cyclone Models

- 30% of storms impact multiple regions
- Consistent Event IDs across Atlantic TC models
  - U.S. Hurricane
  - U.S. Hurricane for Offshore Assets
  - Caribbean TC
  - Mexico TC

Key Takeaway: Basinwide catalog enables more accurate loss estimates for portfolios spanning multiple countries

Hurricane Wilma impacted the Caribbean, Mexico and Florida
Update to the Rmax Estimation and Addition of Rmax Evolution Based on High Resolution Radar Imagery

Spatial Variation in the Downward Transfer of Gradient Winds to the Surface Based on Dropsonde Observations

Dense Convection

Broken Convection

HIGH transfer efficiency

LOW transfer efficiency
Updated Methodology Using Dropsonde Data Results in Changes in Wind Speed at the Periphery of the Storm

- Recent research by Mark Powell and others documents similar reduction patterns using Stepped Frequency Microwave Radiometers (SFMR)
- The research by Powell provides methodology for quantifying these observations, which are related to the slant of the storm structure
Explicit Modeling of the Influence of Wave Action on Surface Roughness Based on New Data and Research

- Smoother Surface
- Moderate Waves
- Rougher Surface
- Intense Waves Generated by Higher Wind Stress
An Unprecedented Set of Observation Data Enables More Robust and Detailed Hazard Validation
AIR implemented a comprehensive approach to model spatial and temporal variations in vulnerability.

- AIR undertook an extensive, peer-reviewed study to understand the large number of building codes and standards that exist.
- For each location and year-built, *model buildings* were defined in terms of secondary risk features such as roof covering type.
A Coherent Approach to Modeling Vulnerability Better Captures the Impact of Interrelated Building Characteristics

Typical Approach

AIR Enhanced Approach

Overall Vulnerability

- General Vulnerability Functions
- Regional Modifiers
- Year-built Modifiers
- Feature Modifiers
- Other Modifiers

Individual Building Characteristics

Local Building Codes and Enforcement

Year-built

Local Construction Practices
2010 - European Windstorm
Extratropical Cyclones Have Complex Structures

Emma (2008)

Kyrill (2007)
Only Numerical Weather Prediction (NWP) Can Capture Vertical Elements within the Storm That Lead to Enhanced Surface Winds

Klaus – 23 January 2009, 18:00

Vertical Wind Speed

- Red: Upward
- Blue: Downward

Tropopause Fold

GFS 18Z 23 Jan 2009 (www.ukweatherworld.co.uk)
AIR’s ETC Model Uses the Most Advanced Application of NWP Built on 16 Years of Research and Development

NWP-BASED EUROPEAN WIND Model

1st GENERATION
FIRST EUROPEAN WIND MODEL
PARAMETRIC APPROACH
1994

2nd GENERATION
NWP-BASED EUROPEAN WIND MODEL
Full 3D Mesoscale Model
2000

3rd GENERATION
NWP-BASED EUROPEAN WIND MODEL
Increased Resolution
2003

4th GENERATION
NWP-BASED EUROPEAN WIND MODEL
Explicit Temporal and Spatial Clustering
Advanced Downscaling
2006

Update

MODEL DEVELOPMENT TIMELINE

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Stochastic Storm Generation Begins with Evolution of 1500 Historical Storms in Space and Time
...and Helps Create a Better Catalogue by Assigning Storm Order
...while Also Capturing a Realistic Distribution of Storms Occurring Each Month

![Seasonal Average Count Graph](image-url)

- Observed
- Version 12

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<tr>
<th>Month</th>
<th>Observed Proportion</th>
<th>Version 12 Proportion</th>
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</tr>
<tr>
<td>Mar</td>
<td>10%</td>
<td>10%</td>
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</table>
2010 - Japan/NW Pacific Typhoon
2010 Saw the Implementation of a Basinwide Northwest Pacific Typhoon Catalogue

- Basinwide stochastic catalogue for modelling risk in entire region
Motivation for the Creation of a Basinwide Catalogue

77 mph windspeed reported in Yamagata Prefecture

300+ mm of precipitation reported in Miyazaki Prefecture

up to 200 mm of precipitation in parts of Taiwan and China

Typhoon Ted 1992
Morakot (2009) is a recent example of a typhoon impacting Taiwan and China – flooding was significant in both countries.
Regional Variability in Wind Vulnerability for Non-Engineered Buildings Incorporates Multi-Hazard Characteristics

- Regions defined based on basic design code wind speeds
  - Low hazard
  - High hazard

- Regions defined based on design codes for spectral acceleration
  - Low hazard
  - High hazard

- Regions defined based on snow depth
  - Low hazard
  - High hazard

Non-Engineered Buildings: Based on multi-hazard characteristics of the regions
2011 – European Earthquake
AIR Is Significantly Expanding the Domain of the Earthquake Model for Europe
Seismicity of Europe is Shaped by Complex Interaction between Various Seismotectonic Features
A Regional Kinematic Model Using GPS, Plate Motion Velocity, and Fault Slip Rate Calculates Strain and Seismic Moment Rates
AIR’s Pan European Earthquake Model Realistically Captures Observed GPS Velocities
AIR’s Pan European Earthquake Catalogue is Optimised for Low Seismicity Regions

1,000,000-year catalogue

Extracted 100,000-year catalogue

Program generated 10,000-year catalogue

Catalogue optimization procedure can obtain a better spatial distribution of events and preserve magnitude-frequency and hazard distribution.
Temporal and Spatial Variation of Vulnerability across the Pan-European Region in the AIR Earthquake Model

1950: Most countries did not abide by any code. Codes existed in Turkey, Italy, and Romania only.
1955: Efforts to develop first version of codes in Austria, Bulgaria, France, Israel, and Portugal started.
1960: First version of code released for Germany, Greece, and Portugal.
1965: Seismic codes for Austria, Israel, France, and Slovenia released. Codes for Turkey, Bulgaria, and Romania revised.
1985: Code update for Greece, Portugal, France, Germany, and Slovenia.
1990: Code updated for Italy and Bulgaria. First versions of code released for Switzerland and Cyprus.
2000: Update to Austria, Czech Rep., Slovakia, and Israel. Turkey adopt provisions similar to Eurocode 8.
2005: Italy, Germany, and Greece adopt provision similar to Eurocode 8. Code update for Hungary and Switzerland.
2010: Romania and Slovenia adopt provisions similar to Eurocode 8.
2011 – European Flood
AIR’s Innovative Solution Overcomes the Inherent Challenges of Using a Global Climate Model (GCM)

• Couple GCM at global scale with a NWP model at regional scale to provide coherent large-scale patterns
• Employ sophisticated downscaling techniques to realistically simulate small scale features
• Utilise “quantile mapping” to preserve local rainfall statistics
AIR Developed a Novel Approach to Separate Storms within Continuous NWP-based Simulations

- Based on space-time analysis of sea level pressure and vorticity
- Provides a unique storm system ID for each spatial and temporal location
2011 – Big Push on Solvency II
AIR Interacts with Regulatory Bodies in Europe

• Creation of AIR website Solvency II host page
• Formation of client steering group
• AIR contributed to the QIS5 effort
• Interaction with FSA, BaFin and other European Regulatory Bodies
• AIR Solvency II Reference Guide is designed to allow clients to quickly navigate to pertinent data
Update on Recent Cat Events
ALERT™ (AIR Loss Estimates in Real Time)

- Provides real-time loss estimates
- Industry losses estimated for the most likely scenarios
- Posted on ALERT website as detailed hazard and loss maps
- Files containing all scenarios can be downloaded and input directly into AIR software for further analysis of company-specific losses
Mw 8.8 Maule Earthquake Affected a Very Large Area
Summary of ALERT Loss Estimates for the Maule Earthquake

M 8.8 MAULE Region of Chile (February 27, 2010)

- AIR Loss Estimate from Chile EQ (Feb. 28, 2010): $2B – $8B (USD)
- AIR Updated Loss Estimate from Chile EQ (March 25, 2010):
  - AIR Participates in EERI Field Damage Survey (March 12 – 21)
  - Swiss Re Estimate (March 26, 2010): $4B – $7B (USD)
- Munich Re Estimate: June 8, 2010 ~8B USD

*AIR industry insured loss estimate for property lines excluding infrastructure

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Summary of the Mw 7.1 (4 September 2010) and Mw 6.3 (22 February 2011) Christchurch Earthquakes
How Easy It Is to Estimate New Zealand AAL from Historical Events?

Historical AALs:

- 1900 – August 2010: 409m NZD
- 1900 – October 2010: 454m NZD
- 1900 – March 2011: 545m NZD
The Pacific Ring of Fire Represents The Most Seismically Active Area in the World

#1 Chile, 1960 M9.5

#2 Alaska, 1964 M9.2

#3 Sumatra, 2004 M9.1

#4 Tohoku, 2011 M9.0

#5 Kamchatka, 1952 M9.0

#6 Chile, 2010 M8.8

#7 Ecuador, 1906 M8.8

#8 Rat Islands, AK, 1965 M8.7

#9 Sumatra, 2005 M8.6

#10 Andreanof Islands, AK, 1957 M8.6
Japan Seismicity Is Dominated by the Subduction of the Pacific and Philippine Sea Plates
HERP Hazard Work Did Not Include This Level of Seismicity in the Region

- HERP (Headquarters for Research Promotion) was established after the 1995 Kobe earthquake
- The 2005 regional seismicity model has gone through incremental updates in 2006 and 2007
- HERP report includes information on
  - 98 well studied faults
  - 178 other faults
  - about 26 subduction zone segments
USGS-Estimated Fault Plane for 11 March 2011 Tohoku Earthquake
Considerable Uncertainty Remains Surrounding the Intensity of this Earthquake
AIR’s Modelled Inland Tsunami Penetration in Natori and Sendai
Knowing the Distribution of Exposure is Critical for Estimating Tsunami Loss Estimates

<table>
<thead>
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<th>Prefecture</th>
<th>0-1 km</th>
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<td>3.4</td>
<td>3.3</td>
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<tr>
<td>Iwate (3)</td>
<td>0.9</td>
<td>1.3</td>
<td>1.4</td>
</tr>
<tr>
<td>Miyagi (4)</td>
<td>1.3</td>
<td>3.4</td>
<td>4.0</td>
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<tr>
<td>TOTAL</td>
<td>5.1</td>
<td>9.4</td>
<td>10.3</td>
</tr>
</tbody>
</table>

Values in US$ Billion
ALERT Coverage and Loss Estimates for Tohoku Earthquake

MAIN SHOCK – M9.0 Tohoku Region (Mar. 11, 2011)

EARLY OBSERVATIONS (March 11th and 12th)

K-NET Ground Motion Data Becomes Available (Mar 12-24)

15B to 35B USD INSURED LOSS* (March 12)

* The loss estimates do not reflect:
  - Losses to uninsured properties
  - Losses to infrastructure
  - Indirect business interruption losses
  - Loss adjustment expenses
  - Losses from non-modeled perils, including tsunami and fire-following

20B to 30B USD INSURED LOSS* (March 24)

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Questions