**Benefits of 3G Correlation**

3G Correlation helps re/insurers avoid surprises that can arise from incomplete accounting for correlation. Incomplete modeling of correlation tends to underestimate extreme losses. In catastrophe risk models, correlation describes relationships among simulated events, losses, and their uncertainty. It is through correlation that a catastrophe model transforms statistical simulations into rational expectations for “real-life” losses. Correlation is essential to quantifying uncertainty, particularly for the rarest losses, where the methodology for correlation and uncertainty matter most.

With 3G Correlation, insurers minimize the risk that a loss exceeds reinsurance cover, and re-insurers minimize underestimation of portfolio risk at the tail of the curve. Correlation also affects decisions informed by low-probability, high-consequence losses:

- Risk of ruin
- Pricing
- Capital decisions
- Communicating risk to stakeholders
- Reinsurance purchasing decisions
- Setting expectations about risk

In addition, 3G Correlation with 3D Output allows re/insurers to allocate risk and uncertainty across operational units with a statistically stable and coherent methodology, both forward and in reverse. Catastrophe losses can be incorporated directly into enterprise risk management without further simulation, using simple arithmetic, and without assumptions on event loss distributions.

**Limitations of 1G/2G Correlation**

RQE raises correlation modeling to the third generation, integrating robustness with ease of use. A first generation (1G) approach to correlation uses simple rules, for example, estimating a constant proportion of sites for which damage is statistically independent. The advantage of 1G is ease of use; fixed rules are straightforward and transparent to replicate when using event losses to aggregate and allocate portfolio risk. With fixed rules for correlation, however, tail results are highly sensitive to the rule chosen. Models using 1G correlation suffer discrepancies between estimated results and observed event losses. 1G risk simulation effectively ignores tail risk because it does not allow users to carry the standard deviation into capital allocation modeling.

A second generation (2G) approach to correlation allows for different modeled correlation between different components of the loss distribution calculation: distance and exposure characteristics. Characterization of correlation is based on empirical analysis of loss data. The extent of correlation varies by peril and region. 2G applies different correlation relationships to each component of the loss calculation. It models observed phenomena and robustly represents complex distributions. However, 2G results are not easy to use, because the complexity and directionality of 2G calculations preclude aggregation/disaggregation of results outside of the model.

**Correlation Modeling in RQE**

Within a given event, 3G uses layers of multi-dimensional matrices to dynamically assess correlation with distance, time, and structure/occupancy type. Each region has a unique distance matrix with varying dimensions, as large as 30,000. Residing within each cell of the distance matrix is a 72x72 matrix of exposure characteristics. RQE dynamically calculates unique correlation relationships for each pair of sites in the portfolio. In addition, correlation varies with frequency and severity.

RQE uses a high-resolution simulation with a 300,000-year horizon, the necessary level of refinement to capture extremely rare losses with confidence, yet lean enough to remain computationally efficient.

**3D Output: RQE’s Year Loss Table**

3G Correlation is expressed through RQE’s Year Loss Table. Our YLT is unique in reporting the third dimension of output: explicit representation of uncertainty, as captured through multiple loss outcomes from each event. The remaining two dimensions are mean event losses and simulation year. Intra-event correlation is preserved through usage of ranked samples.
With 3G Correlation and 3D output, RQE achieves what has not yet been possible: integration of catastrophe risk model uncertainty into enterprise risk management. With 3G/3D, risk aggregation or allocation across regions, perils, and business units retains robust representation of correlation and uncertainty.

Conventional loss metrics can be derived from EQECAT’s 3D YLT with queries or sums:
- Expected Annual Loss (EAL) = Mean sum of losses for all years
- Per Occurrence Exceedance (OEP) = Sort vector of Max loss per year
- Annual Aggregate Exceedance (AEP) = Sort vector of Sum of losses in each year
- Event Loss Table (ELT) = Mean & Standard Deviation of losses for each event

**Dimensions of Correlation Captured in 3G**

Catastrophe losses can be correlated in time, spatially, or by exposure class.

**Temporal Correlation**
Events tend to cluster in time. Weather perils cluster due to variable-length cycles in atmospheric conditions, and temporal clustering of earthquakes is reflected in time dependency and stress transfer mechanisms.

Temporal clustering is modeled through event frequencies and the assignment of events to each year of simulation, as defined in the EQECAT Stochastic Risk Atlas (SRA).

**Spatial Correlation**
The geographic extent and variability of an event footprint affects the degree of correlation:
- Tropical cyclones affect multiple regions within a basin
- Earthquakes can trigger cascading ruptures along the same fault system
- Footprint contours from actual windstorms are “lumpy” and not smooth

These forms of spatial correlation are captured through event definition, such as the intensity of inland wind speeds relative to the coast.

Spatial correlation is also manifest in concentrated “pockets” of damage. Real-world damage does not occur smoothly, the way that models estimate. 3G correlation represents “damage pockets” through the use of a distance-based correlation matrix.

**Loss Response Correlation**
Post-event observations of damage patterns identify clusters of damage to structures with common construction attributes. For any given event, 3G correlates damage to varying degrees across different exposure characteristics. The level of correlation between each exposure class differs, leading to the use of a multi-dimensional correlation matrix. Correlation is expressed as the quantifiable likelihood of outcomes being similar; identical damage is not enforced. Correlation is derived through analysis of claims data.

Parameters affecting exposure class correlation are the characteristics related to structural response:
- Line of Business/Risk Type
- Occupancy
- Structural Layout
- Construction Material
- Building Height
- Era of Construction

**About EQECAT, Inc.:**
EQECAT connects re/insurance and financial services clients with the world’s leading scientific minds to quantify and manage exposure to catastrophic risk. Leveraging decades of experience, EQECAT’s comprehensive methodology is distinguished by a unique treatment of uncertainty that helps clients set rational expectations about risk. EQECAT, a subsidiary of ABSG Consulting Inc., was founded in 1994 and is headquartered in Oakland, California.

**About RQE™ (Risk Quantification & Engineering):**
RQE, EQECAT’s new catastrophe risk modeling platform, will provide enhanced functionality and user experience with a new financial model, import workflow and user interface. Increased analytical speed, expanded reporting and improved integration capabilities will provide clients with increased transparency and faster access to results for 180 natural hazard software models for 96 countries spanning six continents.

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