Japan Typhoon

Japan is one of the most complex areas of the world for modeling tropical cyclone risk. The RMS Japan Typhoon model addresses the challenges of Japan through a combination of innovative modeling methodologies, new historical information, and extensive high resolution geophysical data. Incorporating over five years of research in cooperation with local experts, the model defines a new standard for quantifying typhoon risk in Japan,

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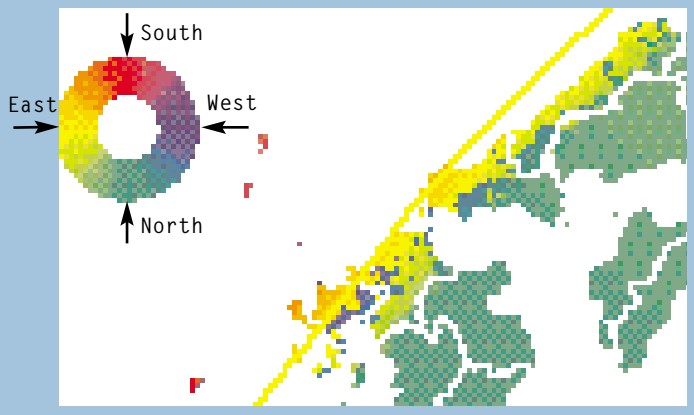


Wind direction at time of peak gust for Typhoon Mireille

Modeling Challenges in Japan

Unlike simple continental coastline environments, insured exposures in Japan are spread across a mountainous archipelago of four main islands and numerous smaller ones. The largest cities are all situated in bays or on the backside of islands relative to the direction of approaching typhoons. To accurately quantify risk in Japan, a model must:

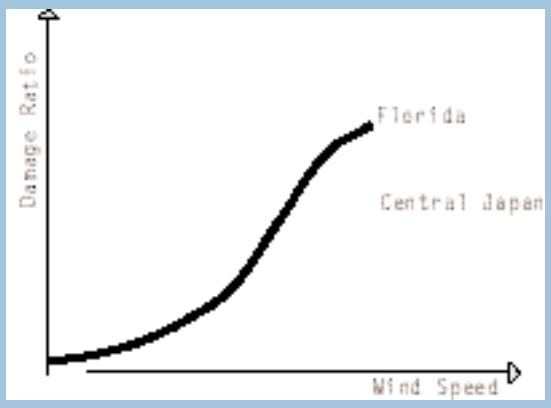
- Explicitly represent the evolution of a typhoon as it makes landfall, travels over an island, exits, and often repeats this process several times
- Simulate the directional behavior of winds as they move around the eye of a typhoon and travel alternately over water and land
- Account for the impact of significant variations in surface roughness across coastal regions, urban environments, and heavily forested and mountainous terrain
- Reflect the direction of typhoon motion relative to Japan's complex coastal geography

Advanced Windfield Modeling

RMS developed a new, state-of-the-art windfield modeling methodology to address the complex behavior of typhoons in Japan. This methodology, coupled with detailed surface roughness data derived from satellite imagery, enables high resolution modeling throughout the country.

This approach is critical for accurate modeling of risk at any resolution including prefecture and CRESTA Zone, the levels at which aggregate exposures are typically reported to reinsurers. A typhoon model that only estimates wind speeds at prefecture resolution can not capture the significant variability of losses in Japan for storms with different tracks and intensities.

The RMS model provides a robust capability for analyzing ward, prefecture, or CRESTA Zone exposures based on high-resolution windfield modeling and detailed data on the geographic distribution of insured exposures.



Comparison of composite residential vulnerability in Japan and the U.S., accounting for building stock mix

Japanese Building Vulnerability

The RMS Japan Typhoon model includes 25 specific building types to reflect the unique characteristics of Japanese buildings. Damage curves have been calibrated against more than ¥350 billion of detailed insurance loss data from Japanese insurers. The data encompass major historical events such as typhoons Mireille (#19) in 1991 and Yancy (#13) in 1993 as well as numerous smaller typhoons.

The model accounts for the distribution of building types within the 6 main lines of business in Japan. For example, the residential building stock includes a high proportion of wind-resistant high-rise apartment buildings, resulting in lower overall residential vulnerability relative to most other parts of the world. The model also distinguishes the unique construction mix and geographic distribution of exposure for agricultural cooperatives such as Zenkyoren.

Historical Typhoon Activity

A major challenge in developing a viable typhoon model for Japan is accessing complete and accurate meteorological data on historical typhoon activity, since no relevant history of insurance losses is available prior to 1984 when windstorm coverage was introduced for fire policies. Incorrect assumptions resulting from limitations in the readily available historical databases have been one of the major factors behind very conservative results from previous modeling attempts for Japan.

RMS performed extensive research to construct a new historical catalog extending back to 1900 for the most severe typhoons. The new catalog:

- Was developed by working with Japanese scientists to individually reconstruct all significant typhoons of the past century
- Served as the basis for modeling assumptions regarding typhoon activity rates, overall and by region within Japan

Typhoon	Typhoon Number	Year	Saffir-Simpson Category at Landfall	Estimated Industry Loss ¥(Billions)
Vera	#15	1959	4	1,050
Nancy	#18	1961	4	960
Mireille	#19	1991	4	560
Muroto	#7	1934	5	480
Shirley	#23	1965	4	300
Makurazaki	#16	1945	5	300

RMS estimated industry loss for largest historical events, based on current insurance industry exposures

• Reveals two typhoons this century–Vera (#15) in 1959 and Nancy (#18) in 1961–that would cause greater losses if they occurred today than Typhoon Mireille, the largest actual historical loss

• Supports RMS' conclusion that the return period for a loss the size of Typhoon Mireille is approximately 30 years

Regional Risk

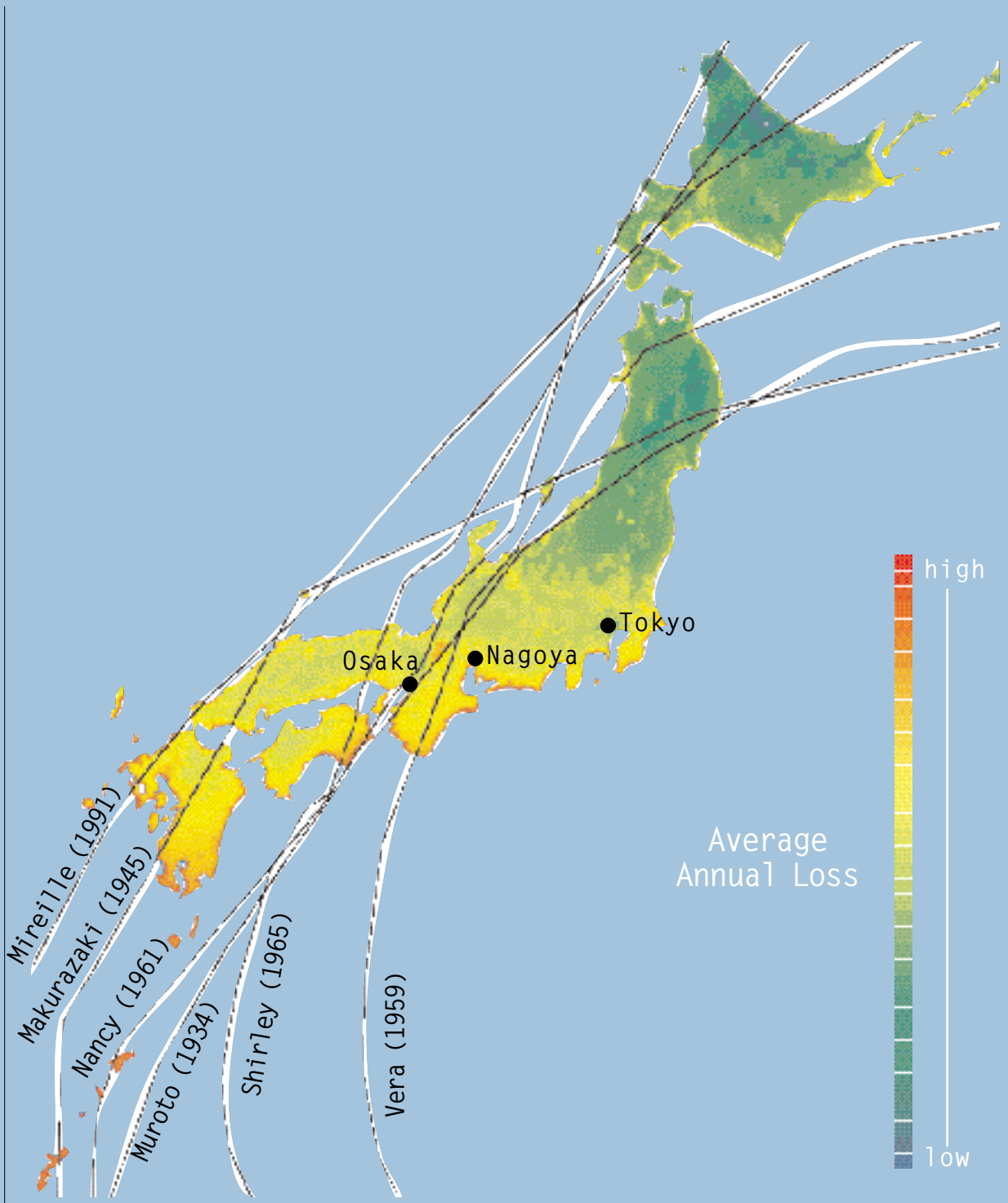
Although typhoons can affect the tremendous concentration of insured exposure in the Tokyo Bay region, such scenarios are not the main driver of risk in Japan for several reasons:

• Sea surface temperatures off the coast south of Tokyo are not warm enough to sustain typhoons as powerful as those that affect areas to the south and west–the highest possible intensity of typhoons reaching Tokyo is Category 4 on the Saffir-Simpson scale

• The predominant northeasterly track orientation and the coastal geography near Tokyo make it highly unlikely that a typhoon would make direct landfall on Tokyo

• Strong typhoons that skirt Japan to the east are typically at least 100 km from downtown Tokyo, with the strongest winds on the right side of the track passing harmlessly offshore

The main driver of risk is strong typhoons making landfall in central Japan between Osaka and Nagoya, the second and third largest metropolitan regions in the country. Significant losses can also be caused by events affecting the southern island of Kyushu, although the lower density of insured exposure there requires either a very severe typhoon or one with an unusually damaging track such as Mireille in order to register as a major loss.



Geographic pattern of risk in Japan and tracks of largest historical events

Japan Typhoon Model History

- Originally released: 1994
- Most recent upgrade: 1998

Geographic Scope

- All of Japan

Exposure Data Resolution

- Ward, Prefecture, or CRESTA Zone

Probabilistic Event Set

- Approximately 12,500 stochastic events
- Stochastic events generated using Stratified Sampling / Latin Hypercube simulation
- Typhoon activity rates based on historical data back to 1900
- Maximum storm landfall intensities based on sea surface temperatures
- Complete tracks are modeled for each stochastic event, including multiple landfalls

Hazard Modeling

- Japan-specific directional windfield modeling to represent the unique characteristics of wind behavior in Japan's complex island environment
- Ward-level surface roughness factors derived from high resolution satellite imagery

Vulnerability Modeling

- Building, contents, and business interruption
- 25 distinct building classes and 3 height ranges
- Separate damage curves for three regions account for variations in building vulnerability
- Building inventory databases reflect building stock mix by prefecture, line of business, height, and year of construction

Special Features

- Financial model explicitly incorporates "franchise" deductibles commonly used in Japan
- Model calibrated to reflect complete "retained" exposures including multi-year policies

ALM[tm] Profiles

- Resolution: Prefecture, CRESTA Zone
- Lines of Business: Dwelling, Apartment, Commercial, Industrial, Government Housing, Long Term Comprehensive, Zenkyoren
- Exposure Data Reporting Basis: Accounting, Retained

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