# GIROJ's Typhoon Loss Model

General Insurance Rating Organization of Japan

# The Overview of GIROJ's Typhoon Loss Model

- GIROJ's Typhoon Loss Model estimates typhoon damage by the following two types of simulations.

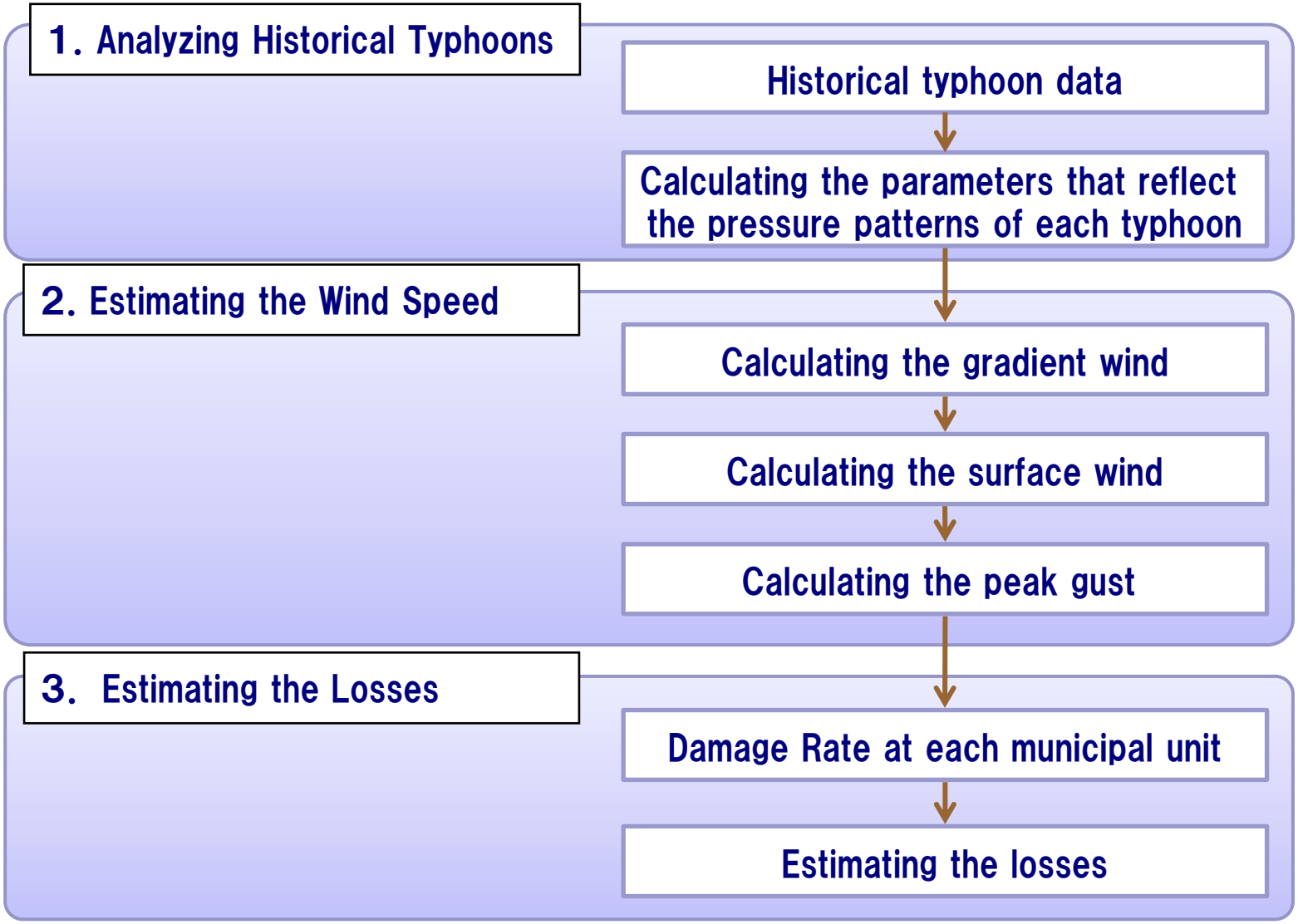
## Ⅰ. Historical Typhoon Simulation

A simulation that replicates the typhoons that hit and brought damage to Japan in the past, followed by assessing the risks if these typhoons recur.

## Ⅱ. Monte Carlo Typhoon Simulation

A simulation that analyzes the typhoons that were replicated by the Historical Typhoon Simulation Model, followed by generating simulated typhoons in order to assess the risks.

# The Overview of Estimating Historical Typhoon Losses




※ "Historical typhoon losses" means the Loss generated by each Historical Typhoon using the current exposure data

# Estimating Historical Typhoon Losses 1. Analyzing Historical Typhoons

- Calculating the parameters that reflect the pressure patterns of each historical typhoon, from historical typhoon data and observation data.

**Historical typhoon data**

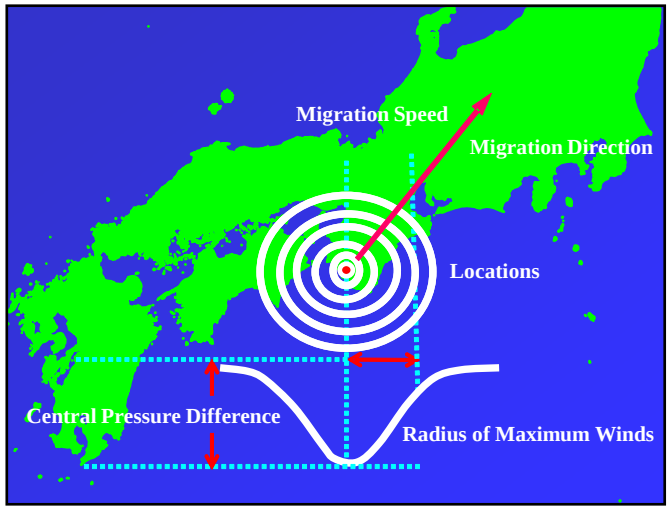
- Locations
- Central Pressure

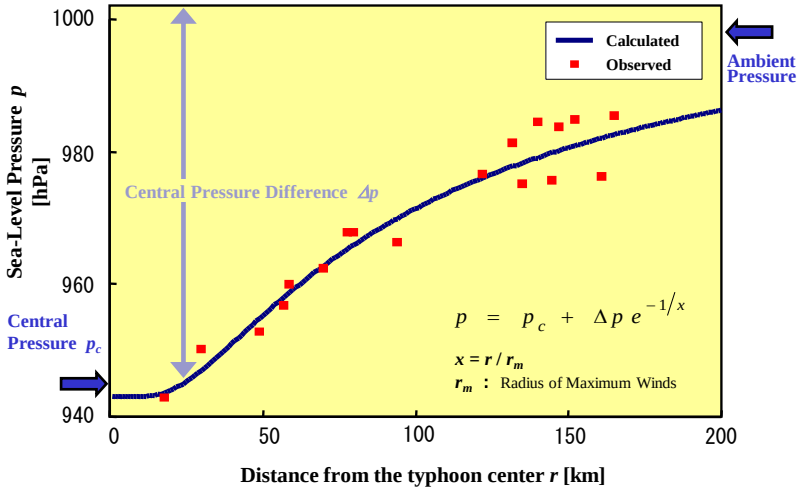
**Observation Data**

- Locations
- Sea-Level Pressure

**Calculating parameters that reflect the pressure patterns of each typhoon**

- Locations
- Migration Direction
- Migration Speed
- Central Pressure Difference
- Radius of Maximum Winds



# Estimating Historical Typhoon Losses 2. Estimating the Wind Speed

- Calculating the peak gust at each location using the analyzed typhoon parameters.

**1. Analyzing Historical Typhoons**

The typhoon parameters

Locations for calculation
(a 1km grid base)

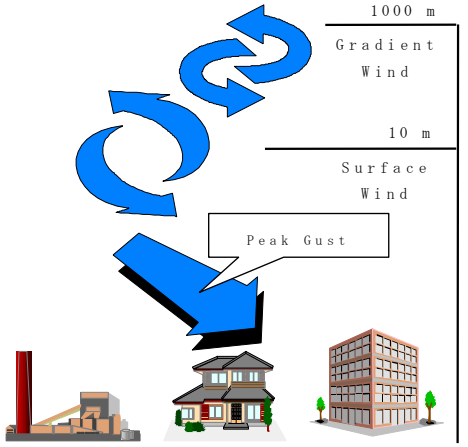
**2. Estimating the Wind Speed**

Calculating the gradient wind

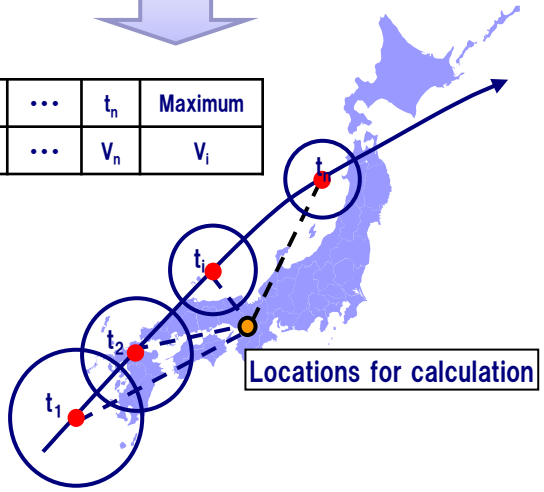
Calculating the surface wind

Calculating the peak gust

Extracting the maximum value of each time step




| Time | $t_1$ | $t_2$ | ··· | $t_n$ | Maximum |
|---|---|---|---|---|---|
| Wind | $V_1$ | $V_2$ | ··· | $V_n$ | $V_i$ |



# Estimating Historical Typhoon Losses 3. Estimating the Losses

- Estimate losses by peak gust at each location and relationships between the peak gust and fragility, damageability.

**2. Estimating the Wind Speed**

The peak gust at each municipal unit

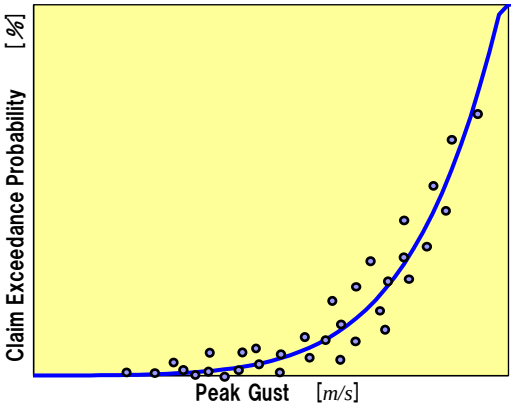
Relation between the peak gust and fragility, damageability

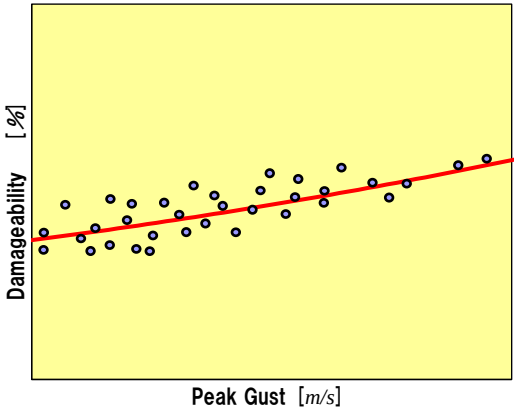
**3. Estimating the Losses**

Damage Rate at each municipal unit

Insurance Data

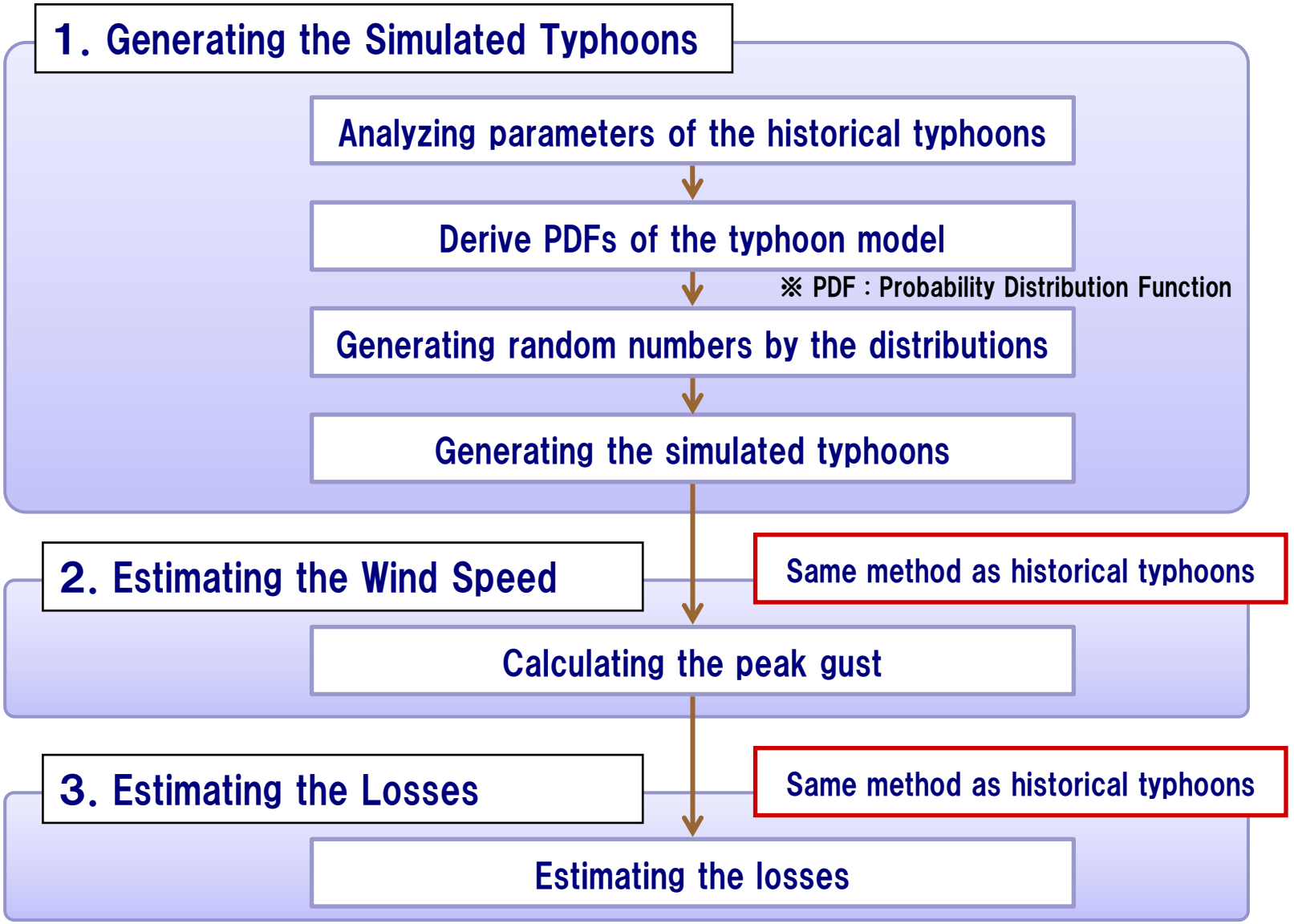
Estimating the losses




※ The figures are not from the actual data.

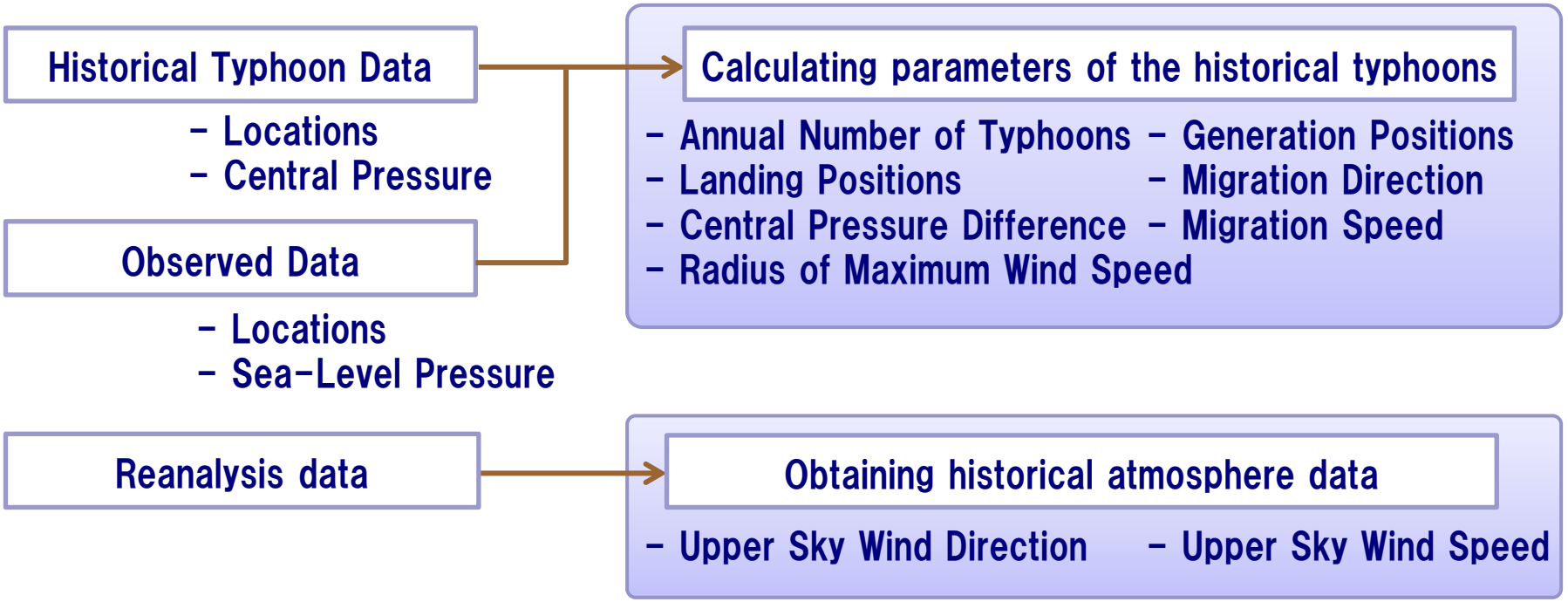
# The Overview of the Monte Carlo Simulation Model



# Monte Carlo Simulation Model 1. Generating the Simulated Typhoons

- Calculating the typhoon parameters from historical typhoon data and weather observation data.

  In addition, obtaining historical atmosphere data from Reanalysis data.



# Monte Carlo Simulation Model 1. Generating the Simulated Typhoons

■ Deriving PDFs using the calculated typhoon parameters and obtained atmosphere data.

**Obtaining and calculating the typhoon parameters**

↓

**Deriving the PDFs of the typhoon parameters**

- Annual Number of Typhoons
- Generation Position
- Upper Sky Wind Direction
- Upper Sky Wind Speed
- Central Pressure Difference
- Radius of Maximum Wind Speed

**Parameters for generating the typhoon and creating the tracks**

| Parameters | | | Probability Distribution | Remarks |
|---|---|---|---|---|
| Annual Number of Typhoons | $n$ | $(pcs)$ | Poisson Distribution | per month, per area |
| Generation Position | | | Empirical Distribution | per month, per area |
| Upper Sky Wind Direction | $\theta$ | $(rad)$ | Wrapped-Laplace Distribution | pre month, per latitude (correlation between the latitudes considered) |
| Upper Sky Wind Speed | $v$ | $(m/s)$ | an Asymmetric Conversion of a Normal Distribution (converted by a Box-Cox Transformation) | per month, per latitude, per wind direction (correlation between the latitudes considered) |

**Parameters used for the landfall**

| Parameters | | | Probability Distribution | Remarks |
|---|---|---|---|---|
| Central Pressure Difference | $\Delta P$ | $(hPa)$ | Poisson Distribution | per area |
| Radius of Maximum Wind Speed | $rm$ | $(km)$ | Log- Normal Distribution | per area |

**Transition of the parameters after the landfall**

| Parameters | | | Function | Remarks |
|---|---|---|---|---|
| Central Pressure Difference | $\Delta P$ | $(1/h)$ | exponential | per area |
| Radius of Maximum Wind Speed | $rm$ | $(\%/h)$ | exponential | per area |

# Monte Carlo Simulation Model 1. Generating the Simulated Typhoons

■ Generating simulated typhoons based on the PDFs of several typhoon parameters.

START (Year 1)
Set the number of annual typhoons

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① Generating the Upper Sky Wind Speed

↓

② Generating the typhoon

↓

③ Creating the typhoon track

↓

Landfall

④ Assign landfall parameters

↓

⑤ Temporal change

↓

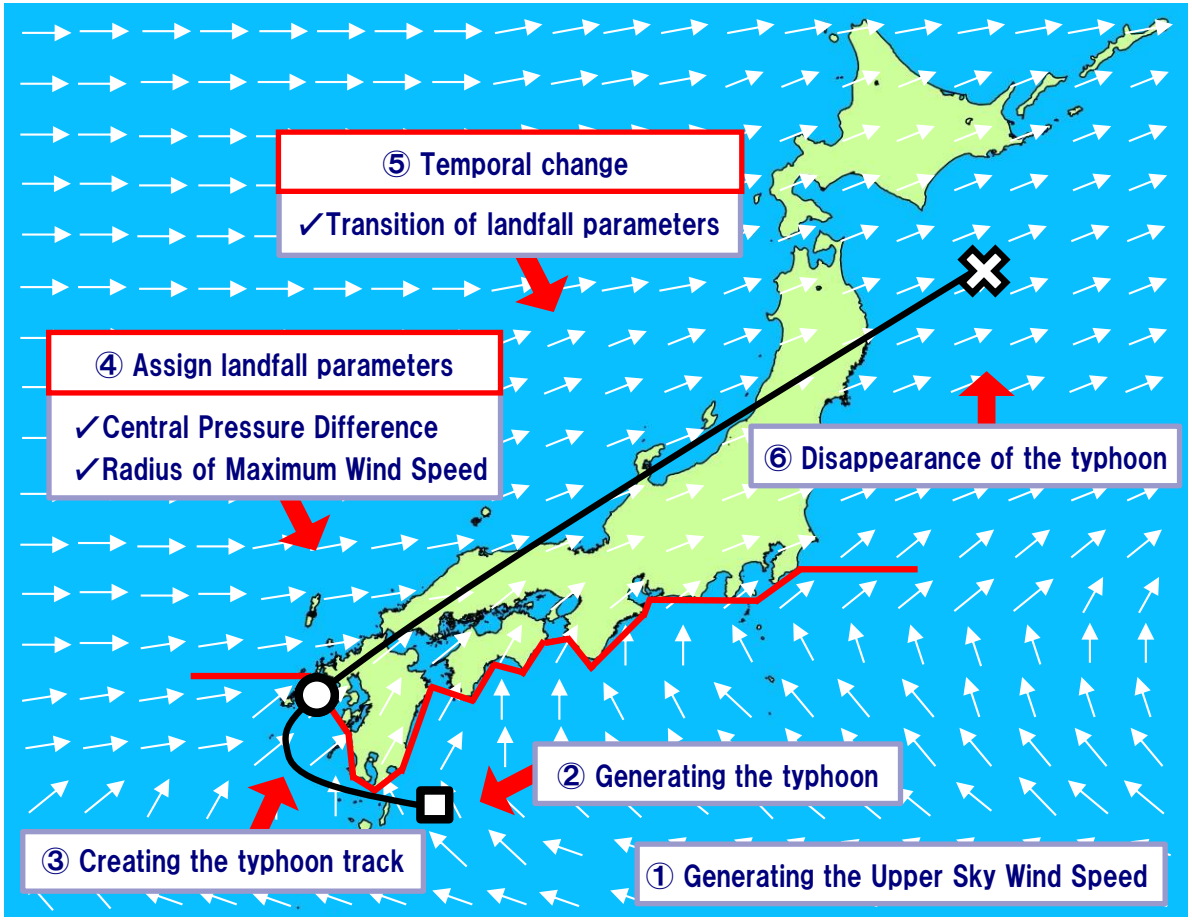
⑥ Disappearance of the typhoon

↓

Processing other typhoons

↓

END
(Repeat process in the following year)

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# Monte Carlo Simulation Model 2. Estimating the Wind Speed

- Calculating the peak gust at each location using the analyzed typhoon parameters.

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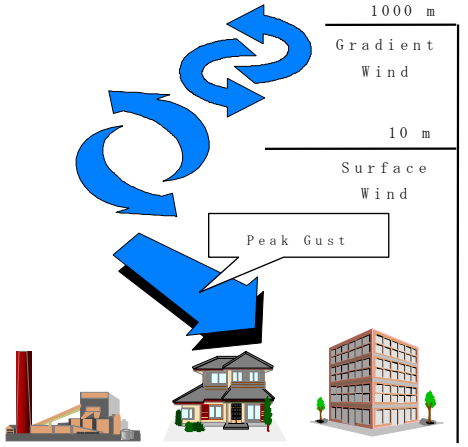


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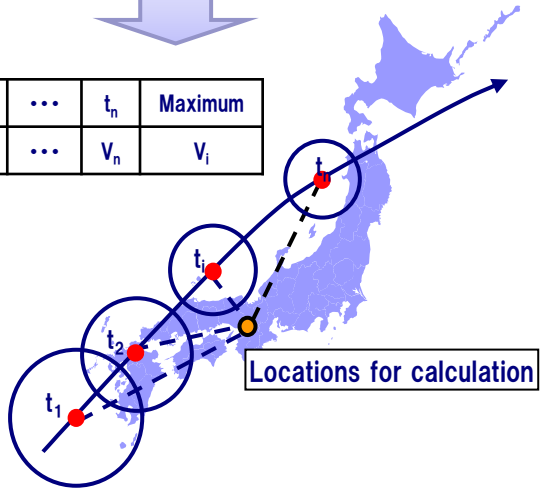

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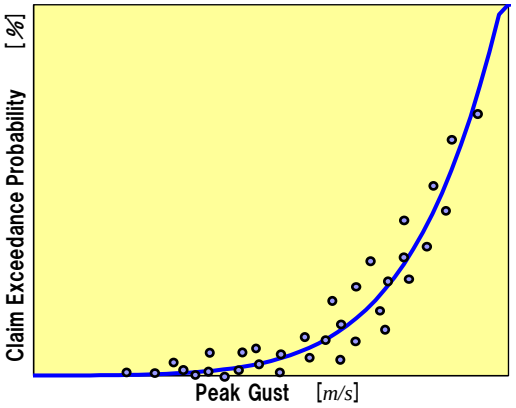


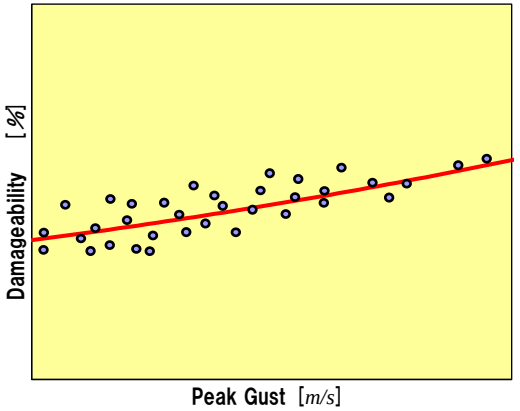


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