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FRANCE 2030

R&D Webinar - OROWSHI Project Outcomes

Towards new standards for the design of the offshore wind turbines exposed to topical cyclones

FRANCE ENERGIES MARINES · Centrale Méditerranée · École nationale des Ponts et Chaussées · Institut Polytechnique de Paris · EDF · Ifremer · Ørsted · RWE · SHOM · skyborn · TotalEnergies

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WP3 – Improved Monte-Carlo Simulation Method

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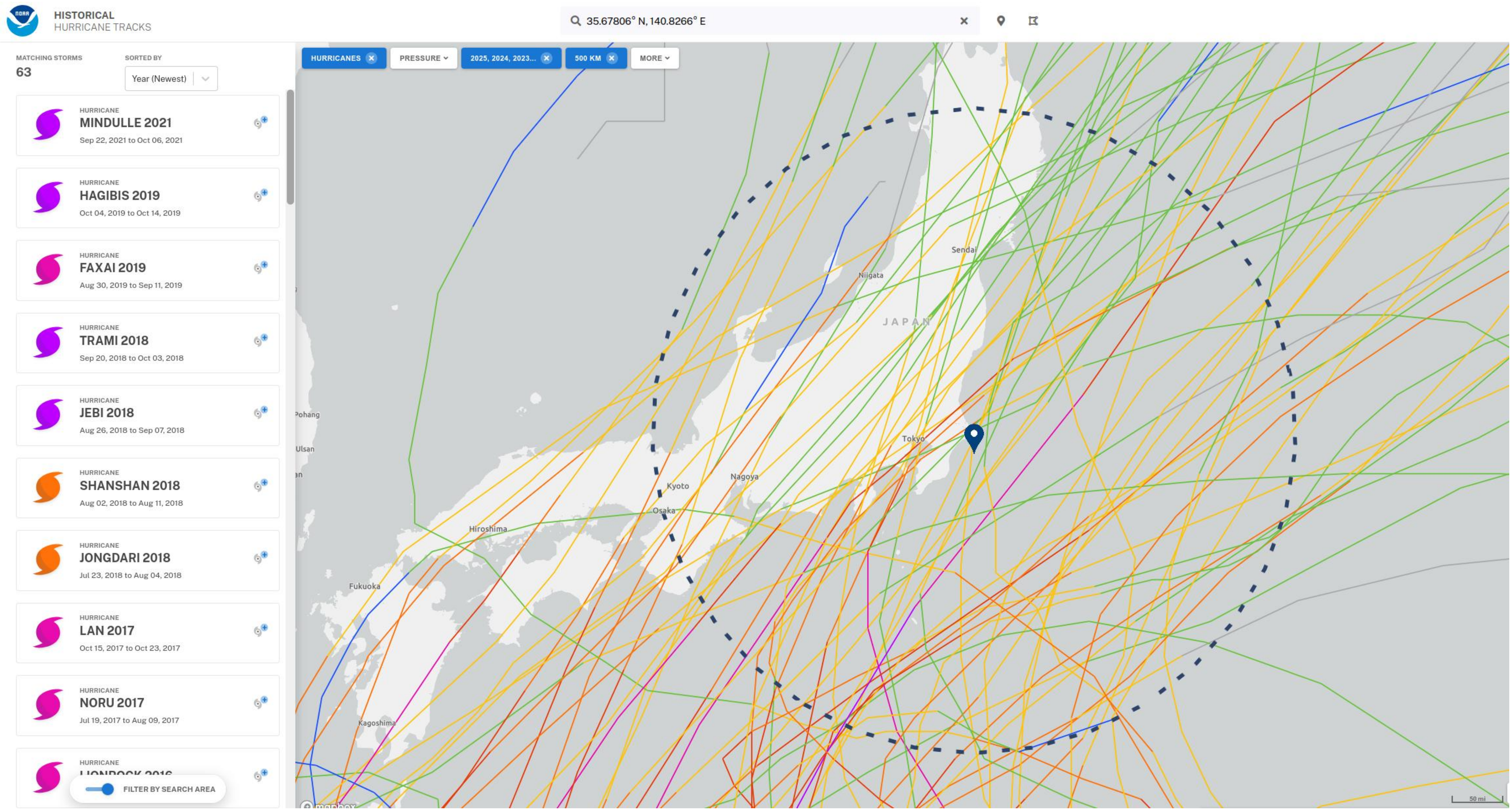


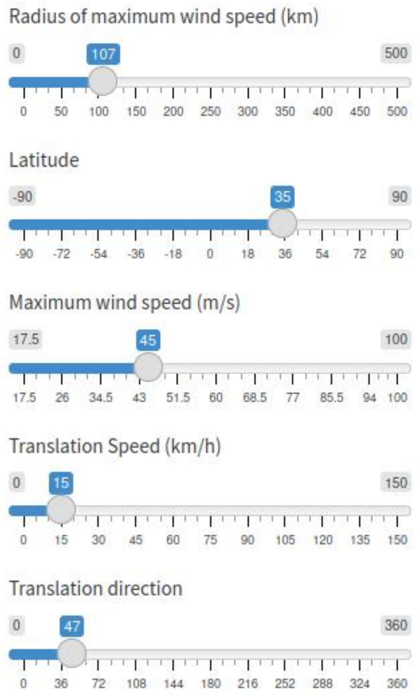
Typhoon are scarce by nature

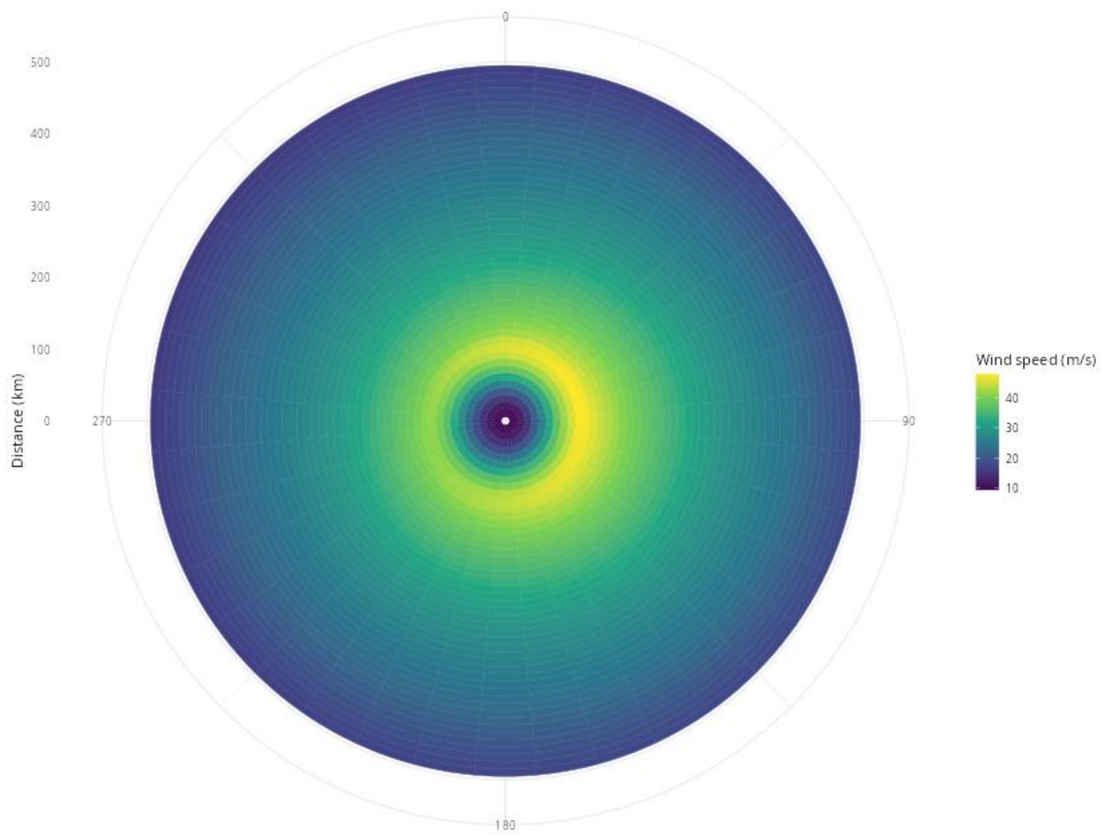
- Offshore location as in Ishihara & Yamaguchi, 2015
- From 2001 to 2025 : 63 events at a distance < 500km

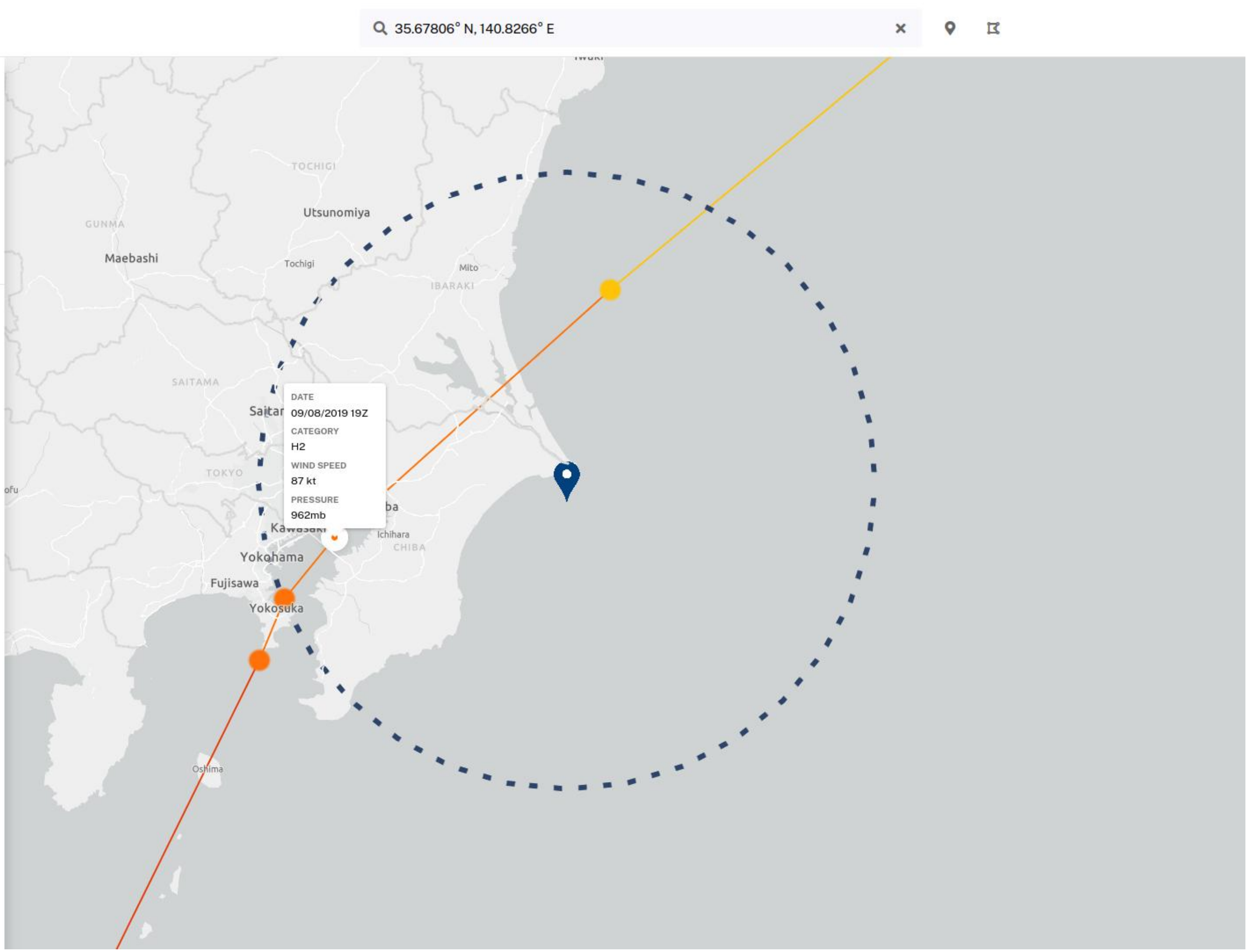
WP3 - Improved Monte-Carlo Simulation Method

Historical wind without direct measurements :

- **Parametric wind model to estimate wind speed from TC parameters**
- **Model of Vinour et al, 2025**
- **6 parameters needed**

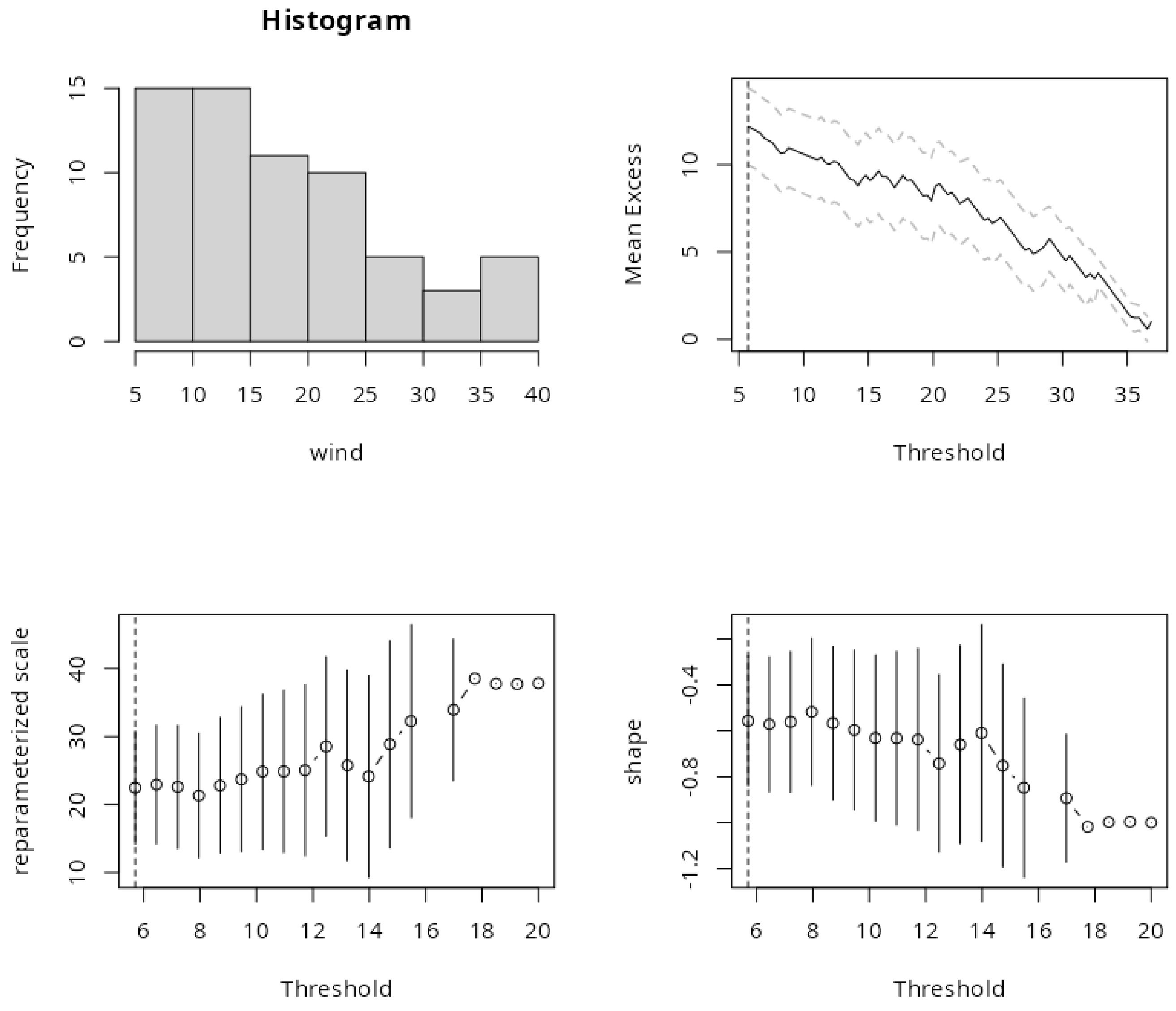


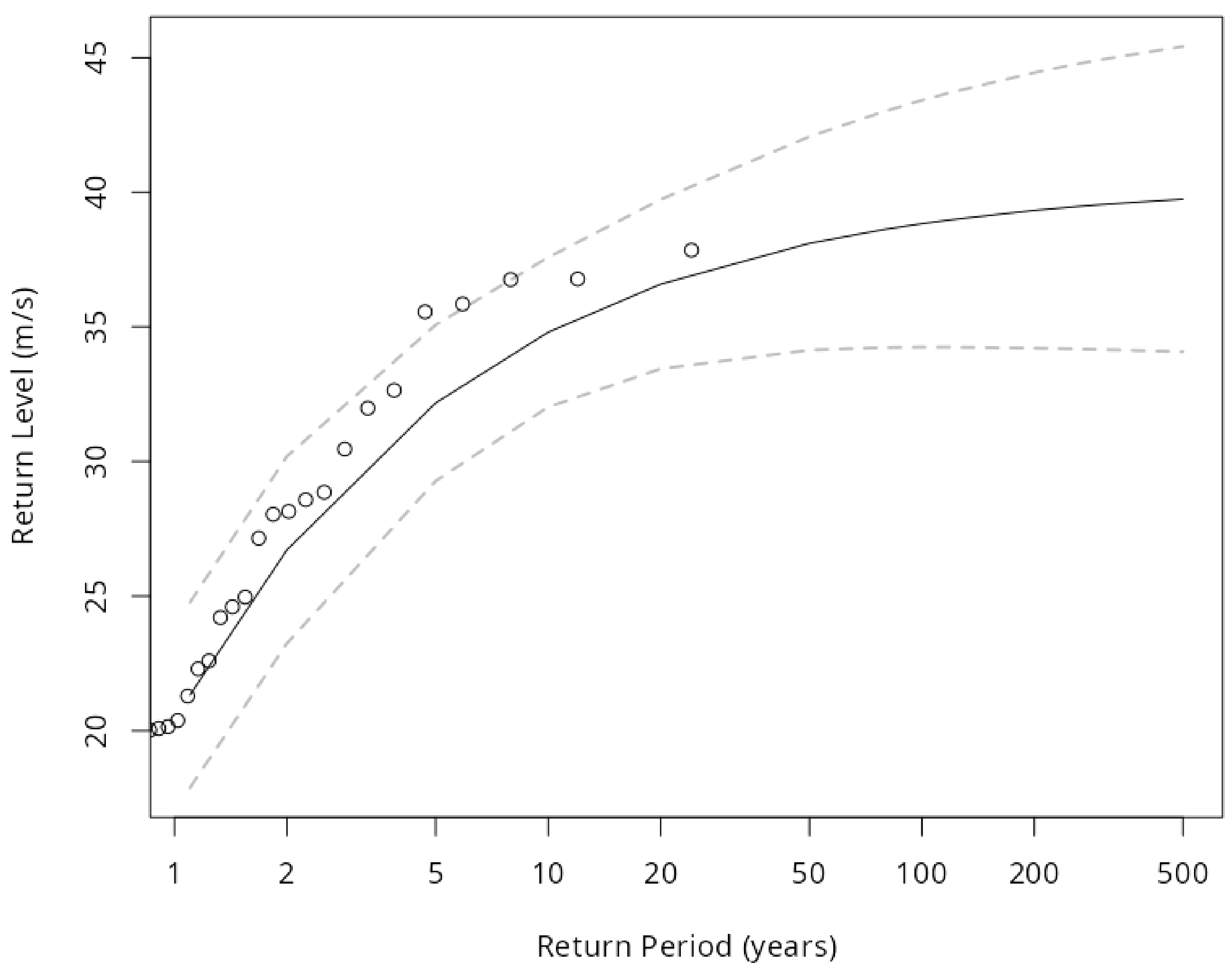




Classical GPD Approach

- Fit a GPD/POT to the data (threshold selection, parameters estimation...)
- Estimated the Return levels from TC using the fitted model
- **Large uncertainties** linked to the paucity of data





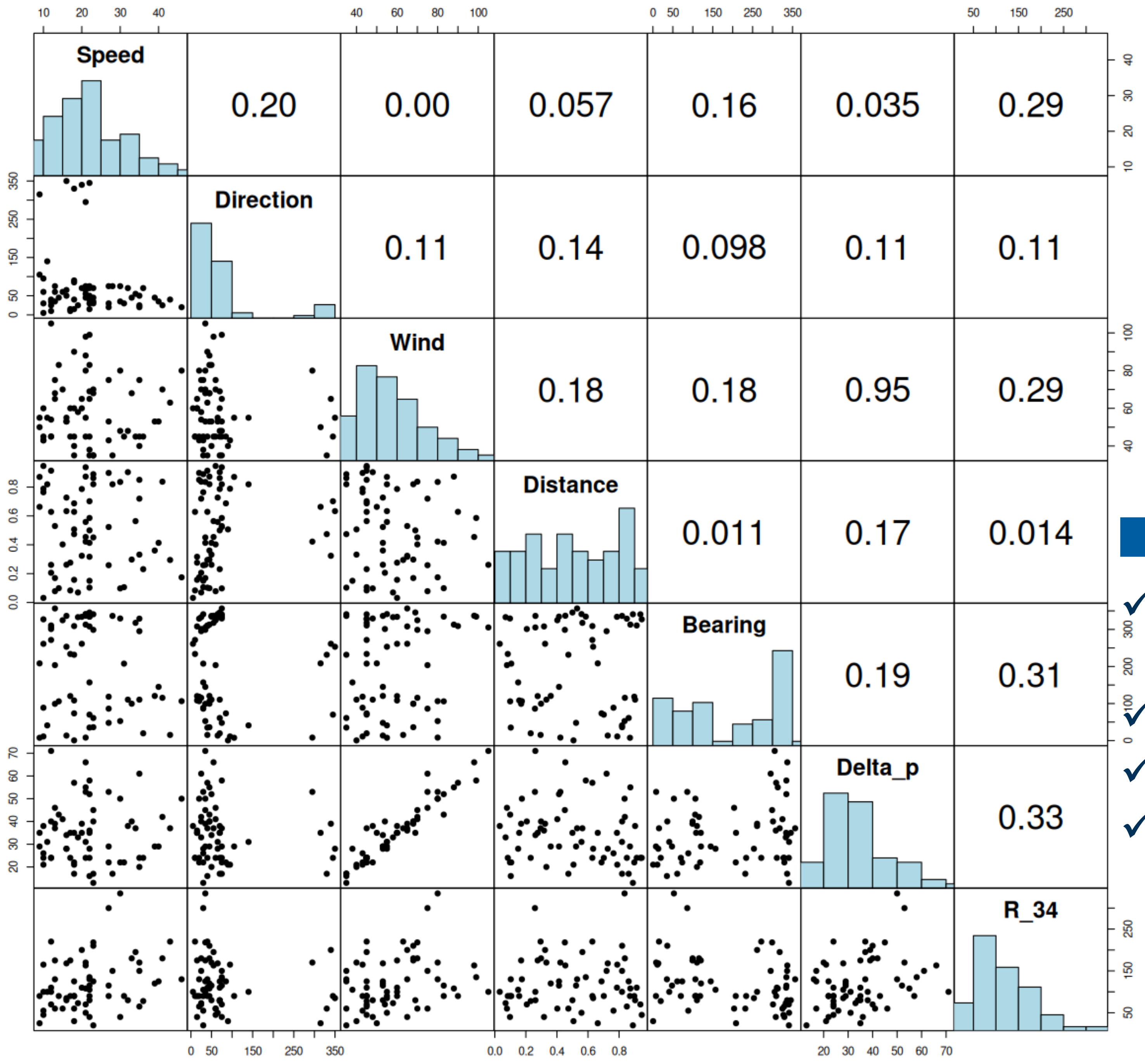
WP3 - Improved Monte-Carlo Simulation Method

Alternative : **augment** the database using **Stochastic Weather Generators**

- Accurate description of the past events ;
- **Cheap to simulate** a large number ;
- So-called Monte Carlo Approach ;
- Two elements : **marginal distributions** of parameters and **joint distribution.**

WP3 - Improved Monte-Carlo Simulation Method

Distribution of TCs parameters from IBTrACS data



For **each** variable

- ✓ Several models and mixtures thereof;
- ✓ Estimation : ML/EM ;
- ✓ Selection : **AIC**
- ✓ Specific models for directions

Table 2: Distributions used to model positive variables.

Name	Parameters
Exponential	1
Pareto	1
Inverse Gaussian	2
Log-Normal	2
Gamma	2
Inverse Gamma	2
Weibull	2
Generalized Pareto	2
Extended GPD[1]	3
Generalized Beta of second kind[2]	4
Two Log-Normal	5
Log-Normal and Gamma	5
Log-Normal and Generalized Pareto	5
Log-Normal and Weibull	5
Two Inverse Gaussian	5
Log-Normal and Inverse Gaussian	5

Table 3: Distributions used to model positive variables.

Name	Parameters
Normal[1]	2
Generalized Beta of 1^{st} kind	4
Beta	2
Logit Normal	2
Beta Inflated at 0	3
Beta Inflated at 1	3
Beta Inflated at 0 and 1	4
Two Log-Normal[1]	5
Two Beta	5
Two Logit-Normal	5

P3 - Improved Monte-Carlo Simulation Method

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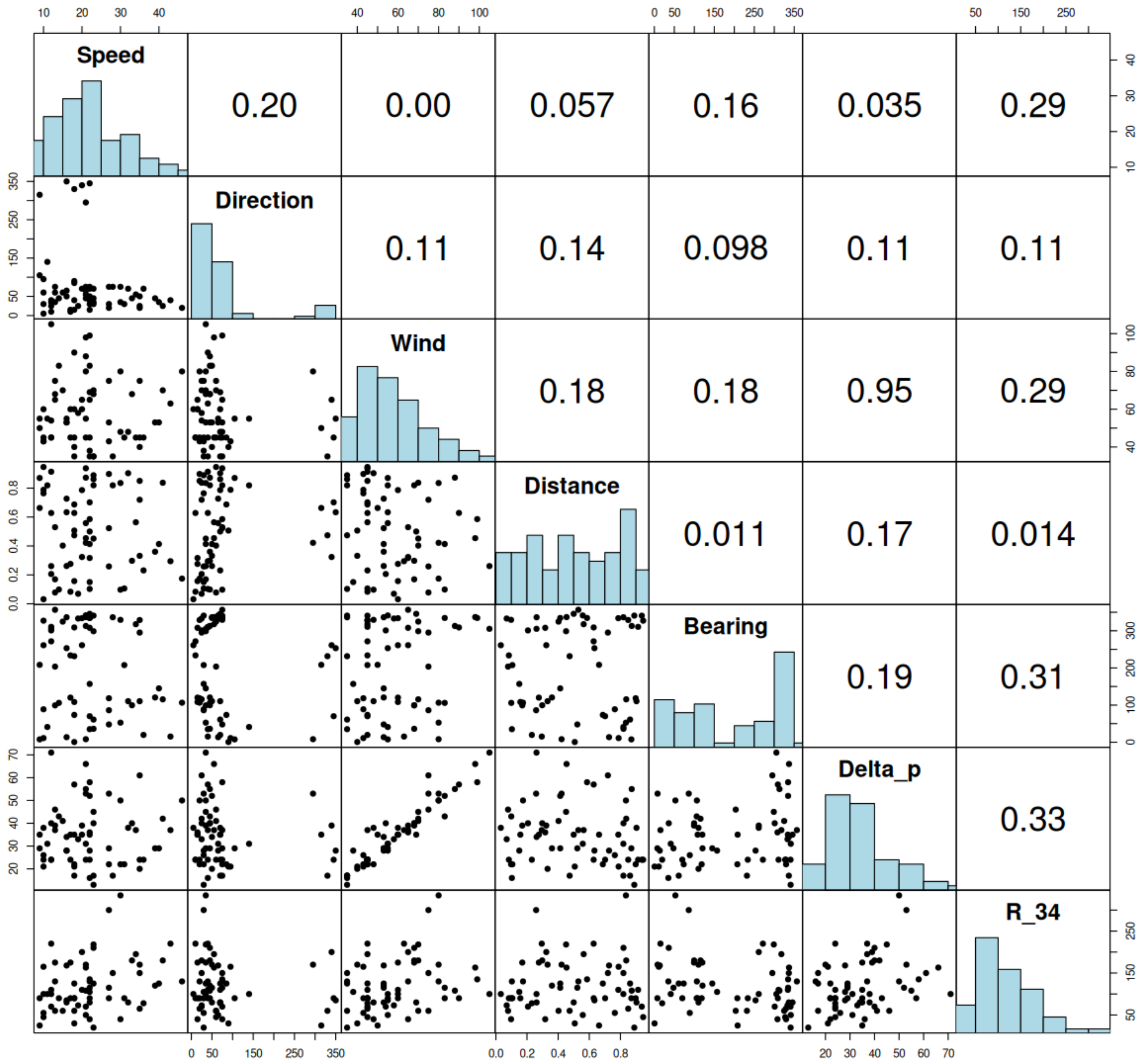
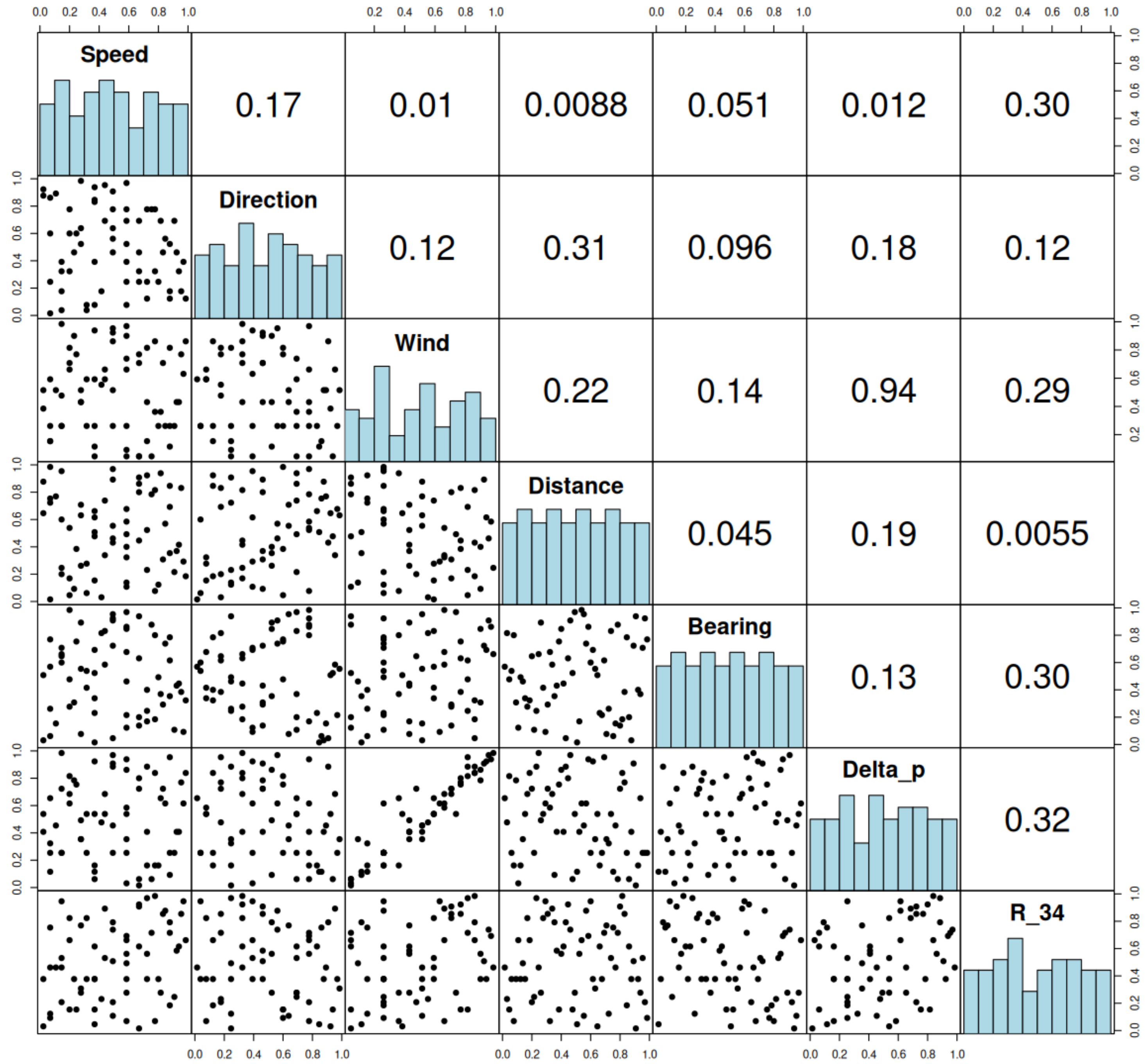
Distribution of TCs parameters from IBTrACS data



Transform to uniform margins



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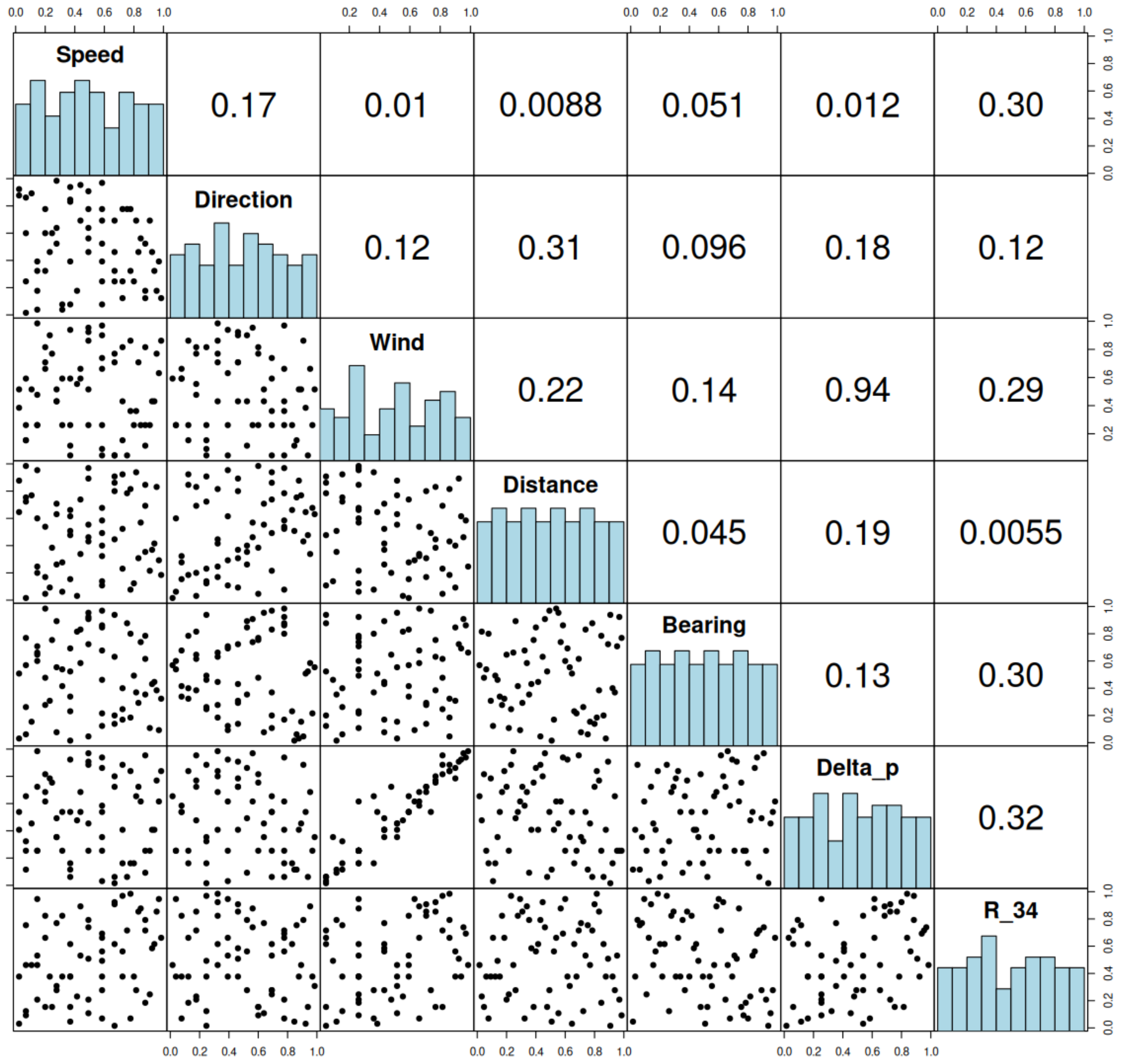
Distribution of TCs parameters from IBTrACS data

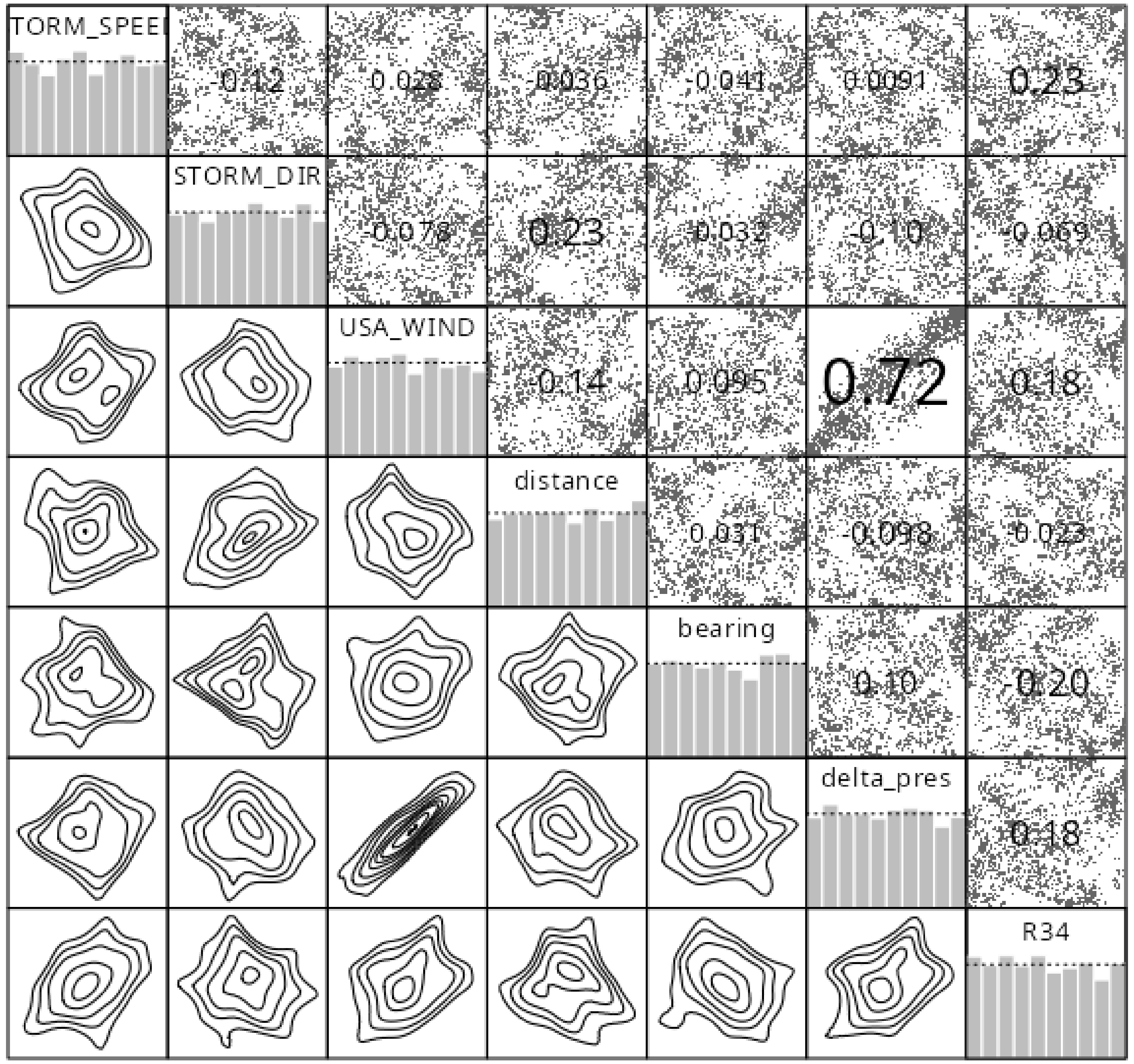


Fit a **Copula** model

3 models studied :

- Normal copula
- Beta empirical
- Regular Vine copula

Very cheap to simulate



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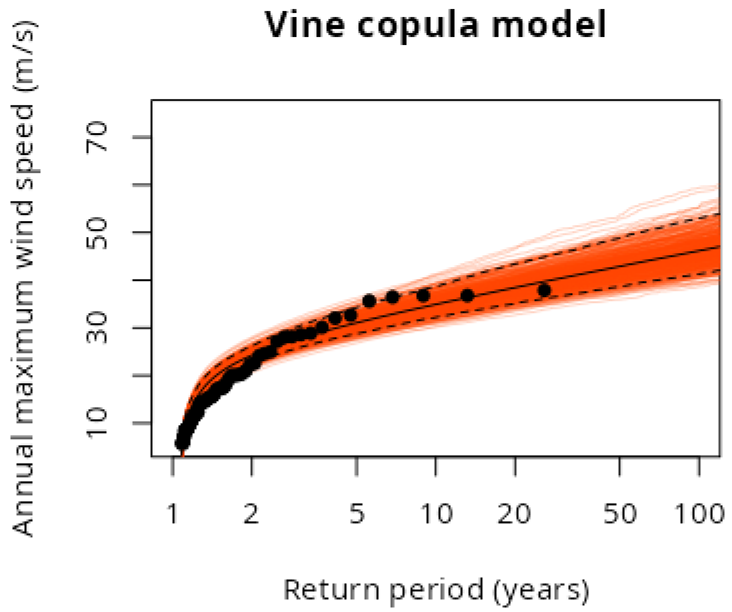
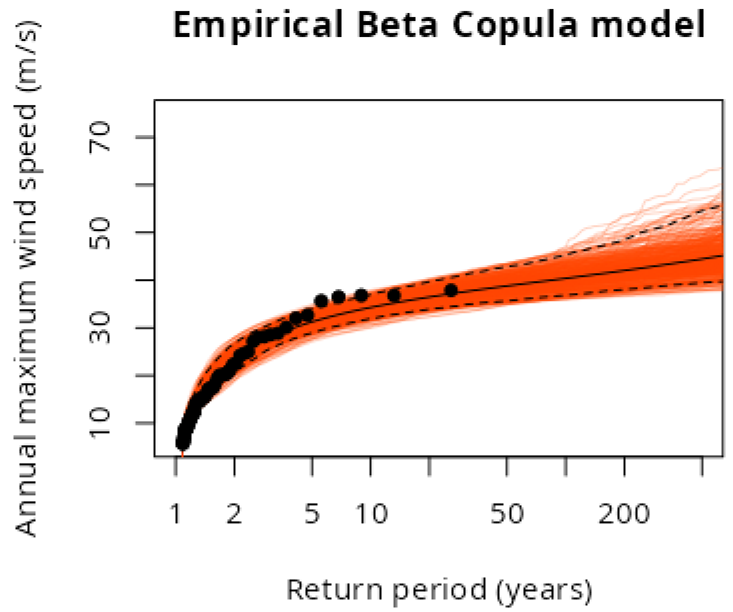
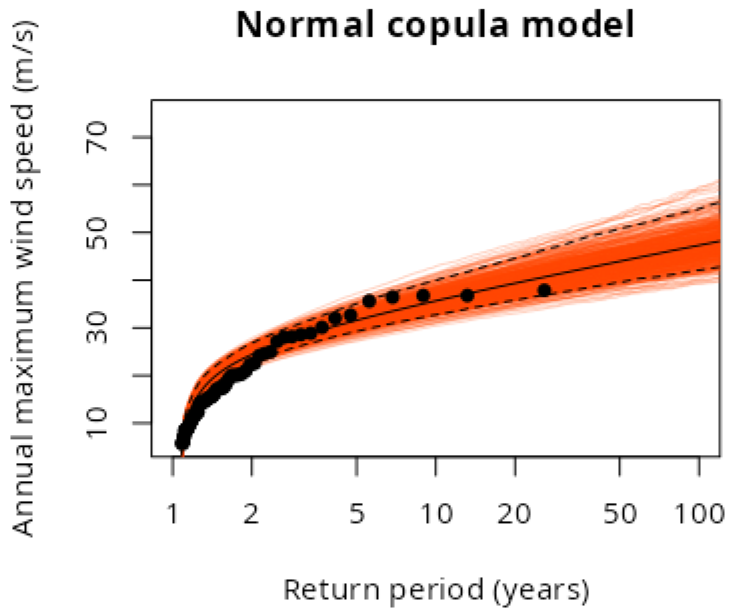
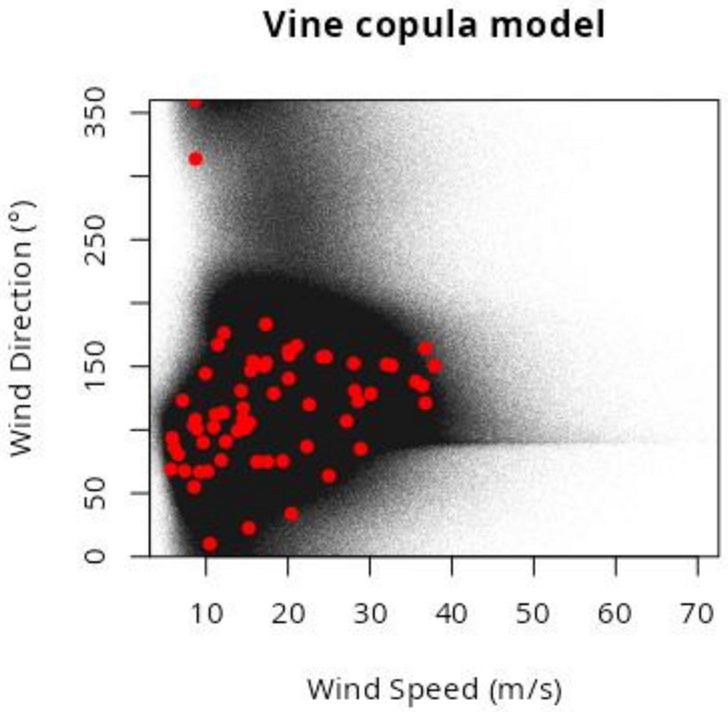
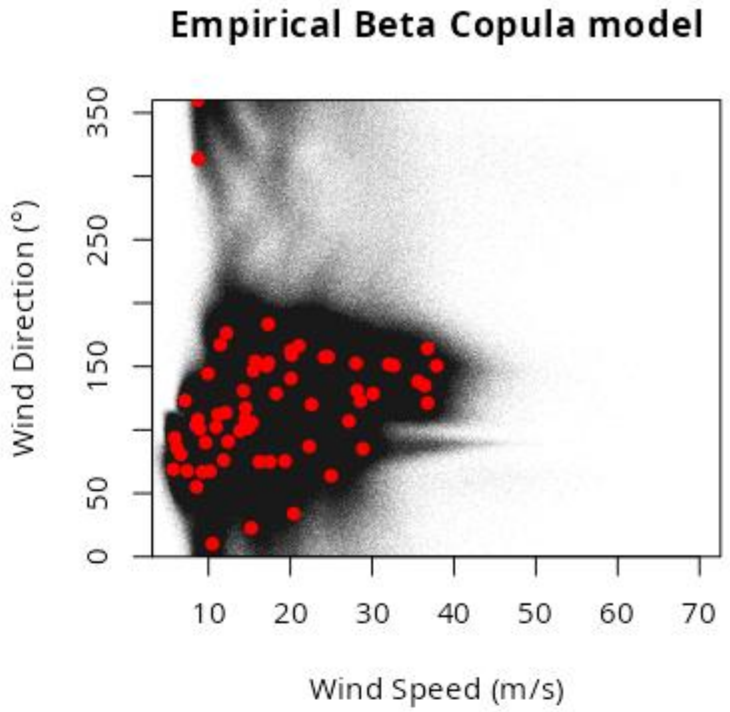
Monte Carlo approach : results





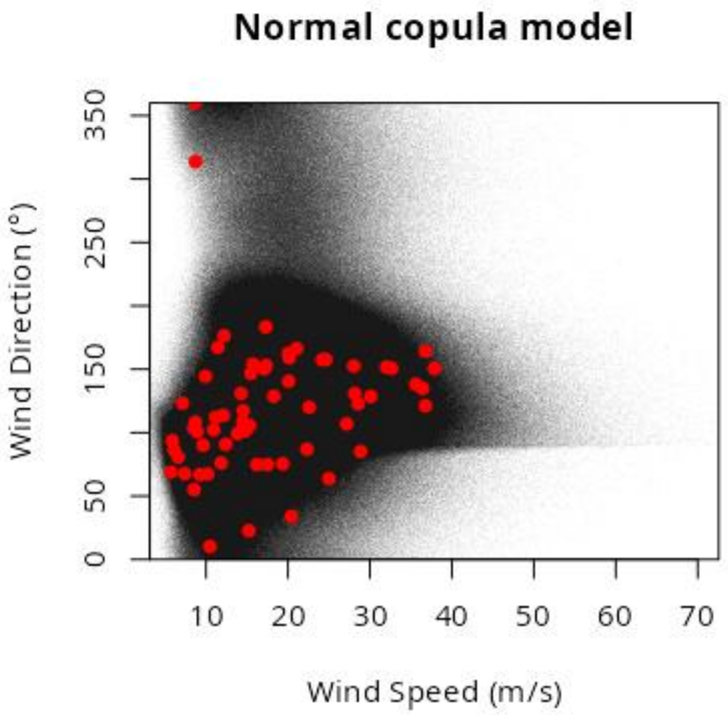






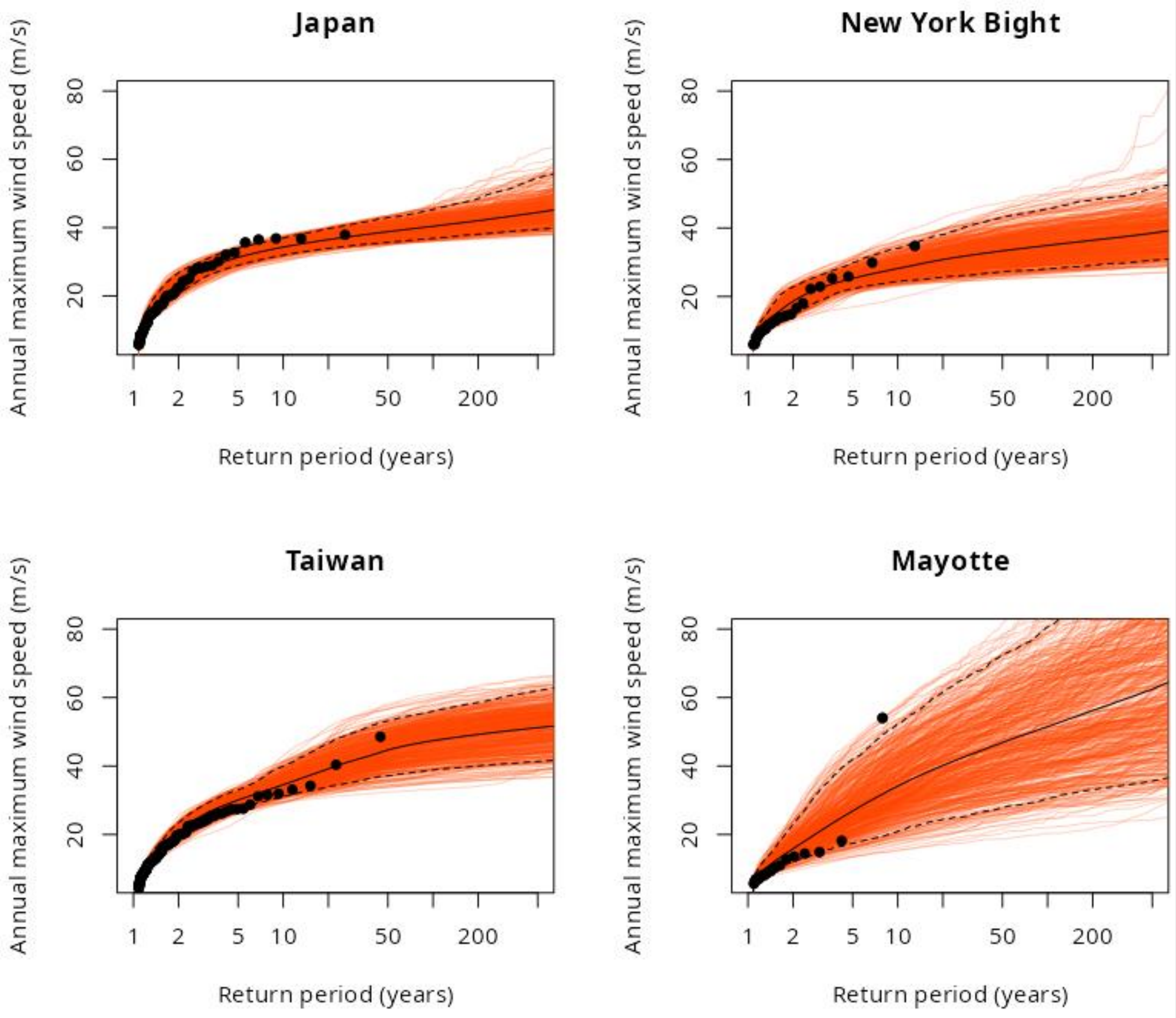
Figures from Raillard et al, 2026. *In prep.*

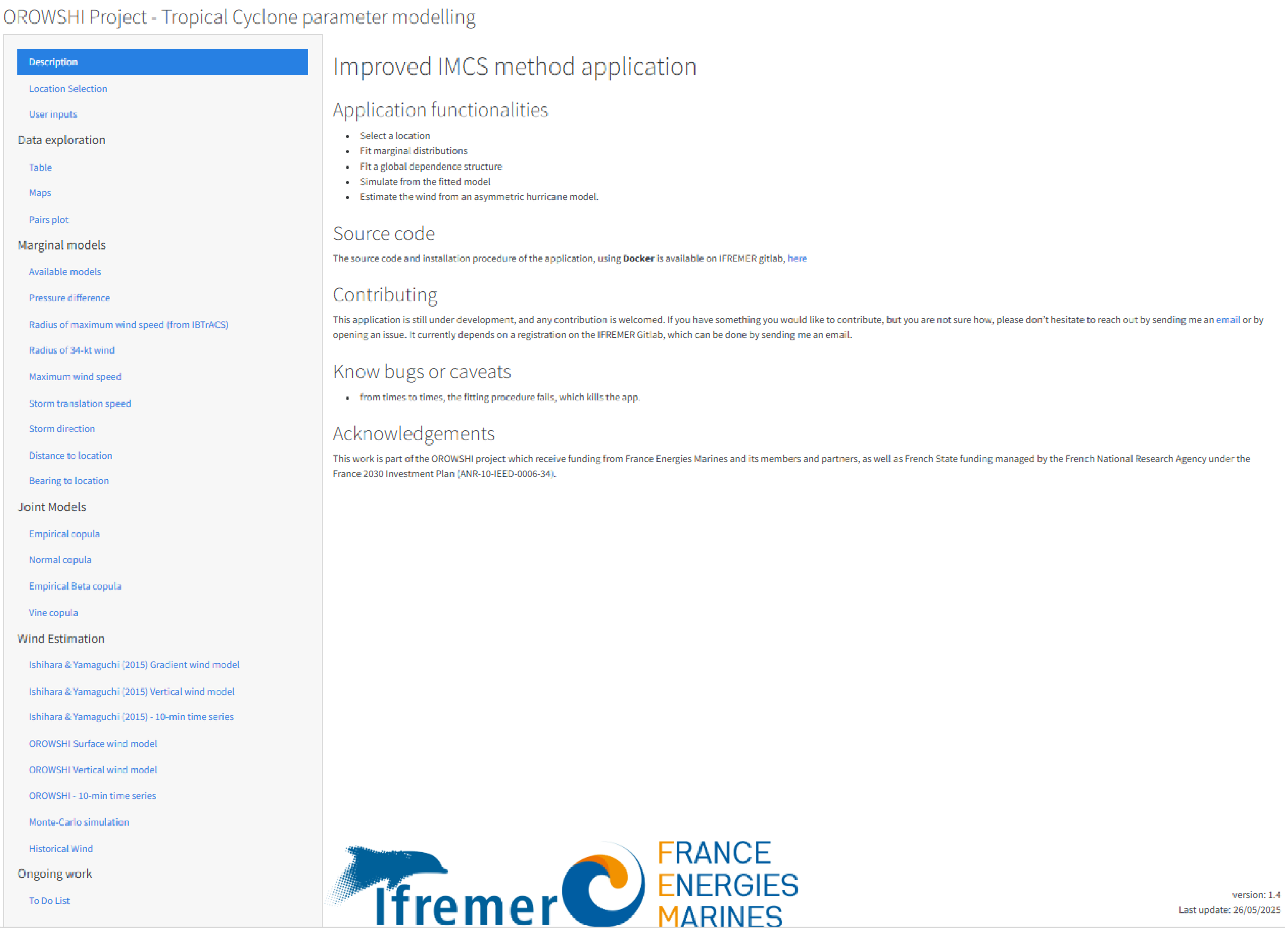
- Replicates the **historical winds** ;
- Provides estimates for **any return period** ;
- Uncertainties estimated using parametric bootstrap ;
- Provides the **joint distribution** of wind speed and direction



Conclusion

- Implemented into a Web Application using R {shiny}
- Versatile and robust method ;





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Thank you for your attention!