FRANCE ENERGIES MARINES

TAIFU Wind/Waves

Paul Renaud – paul.renaud@france-energies-marines.org

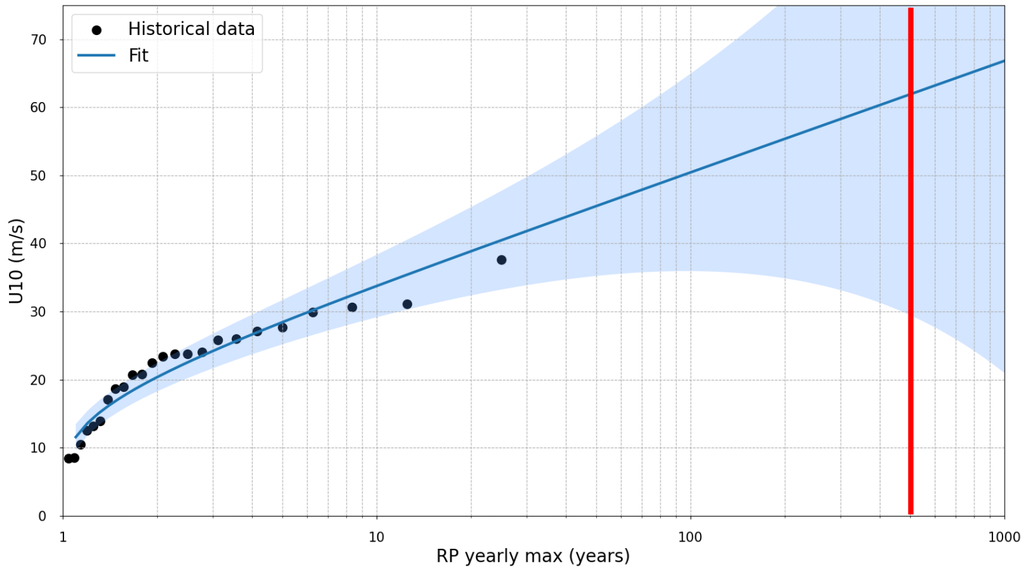
Objectives :

1) Reproduce historical events

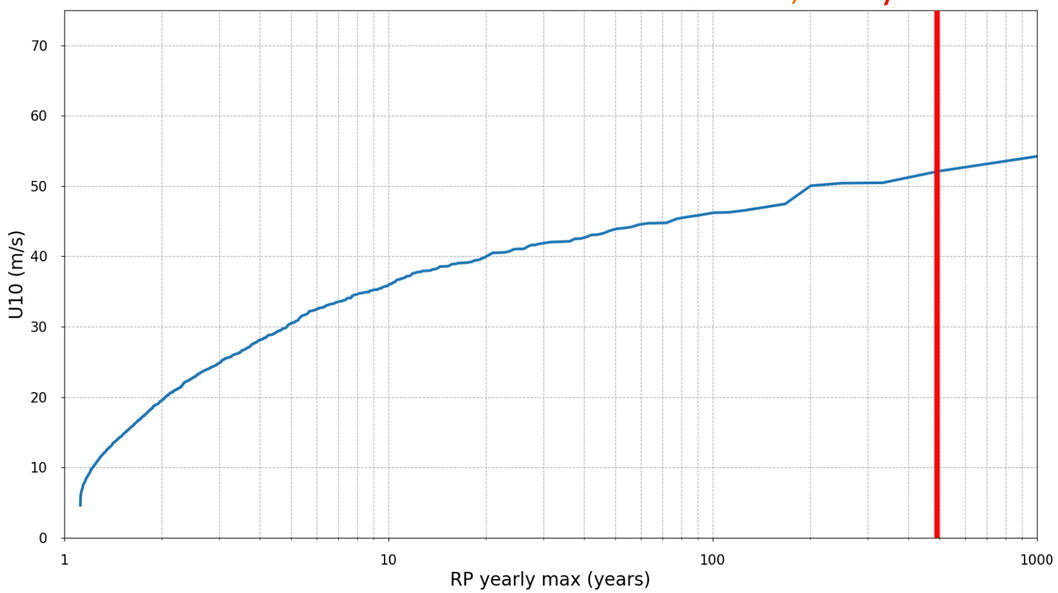
Failure analysis, life extension (fatigue analysis)

2) Derive extreme wind and waves statistics for the design of offshore structures

For OWT in cyclonic area, design standard IEC 61400-3-1 introduced DLC I.1: $U_{10\text{-min, }500\text{-y}}$ & $Hs_{500\text{-y}}$



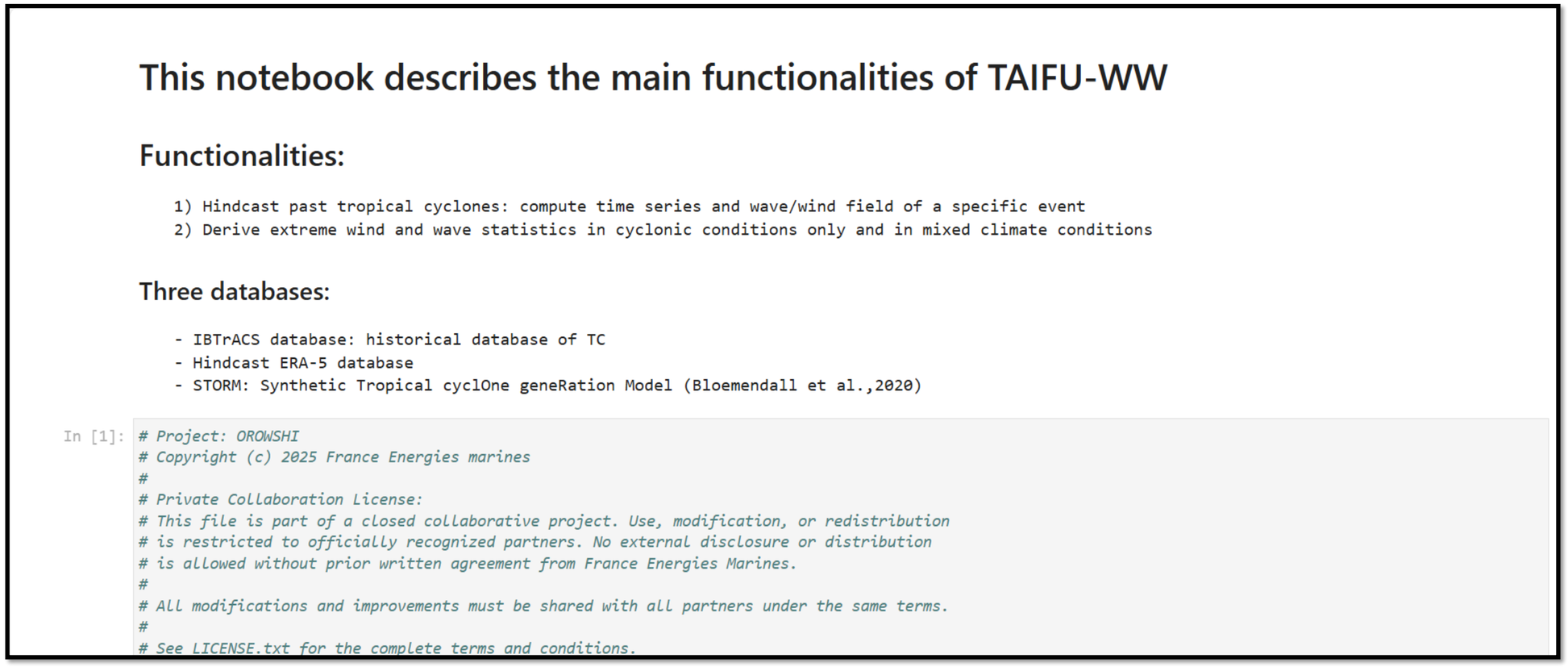
Extrapolation based on hindcast provides too much uncertainty



The Monte Carlo approach provides a less conservative return value and enables joint statistics analysis

Demo: Jupyter notebook illustrating the main functionalities of TAIFU-WW

https://taifu-ww.france-energies-marines.org/



This notebook describes the main functionalities of TAIFU-WW

Functionalities:

1) Hindcast past tropical cyclones: compute time series and wave/wind field of a specific event
2) Derive extreme wind and wave statistics in cyclonic conditions only and in mixed climate conditions

Three databases:

- IBTrACS database: historical database of TC
- Hindcast ERA-5 database
- STORM: Synthetic Tropical cyclOne geneRation Model (Bloemendall et al.,2020)

In [1]:
```
# Project: OROWSHI
# Copyright (c) 2025 France Energies marines
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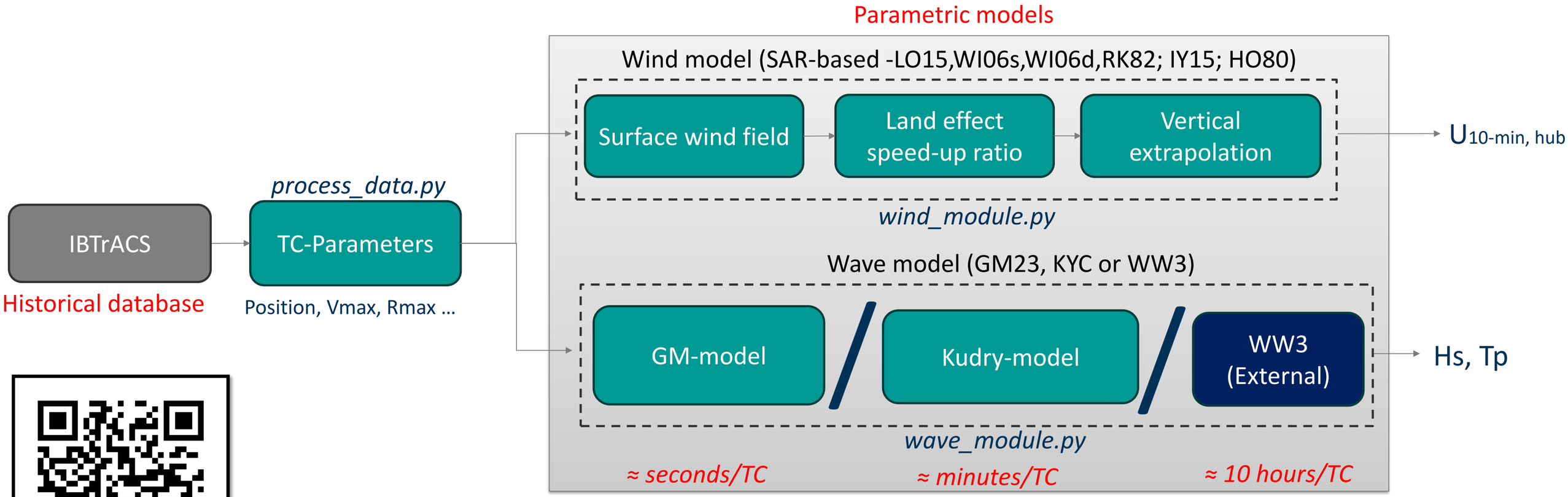
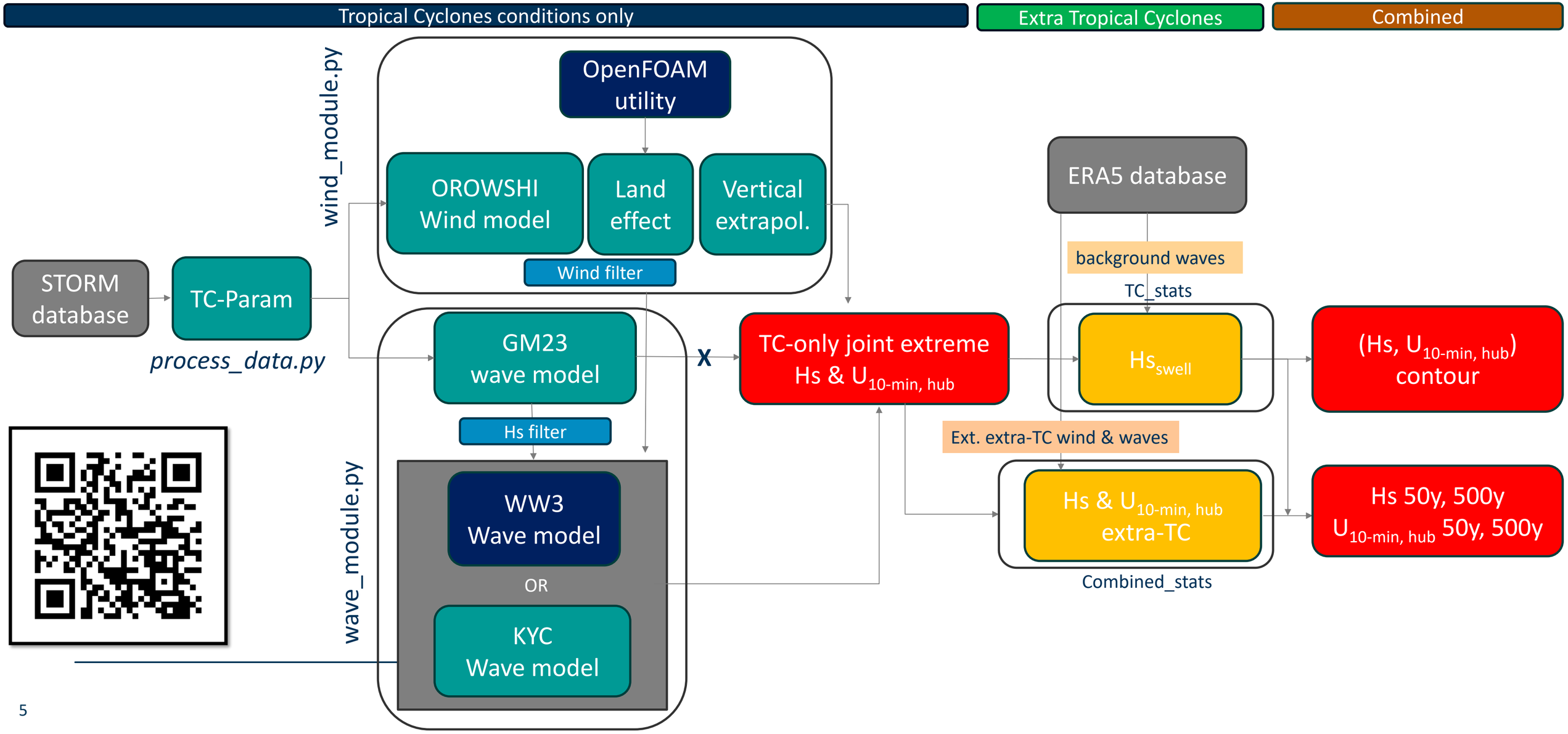
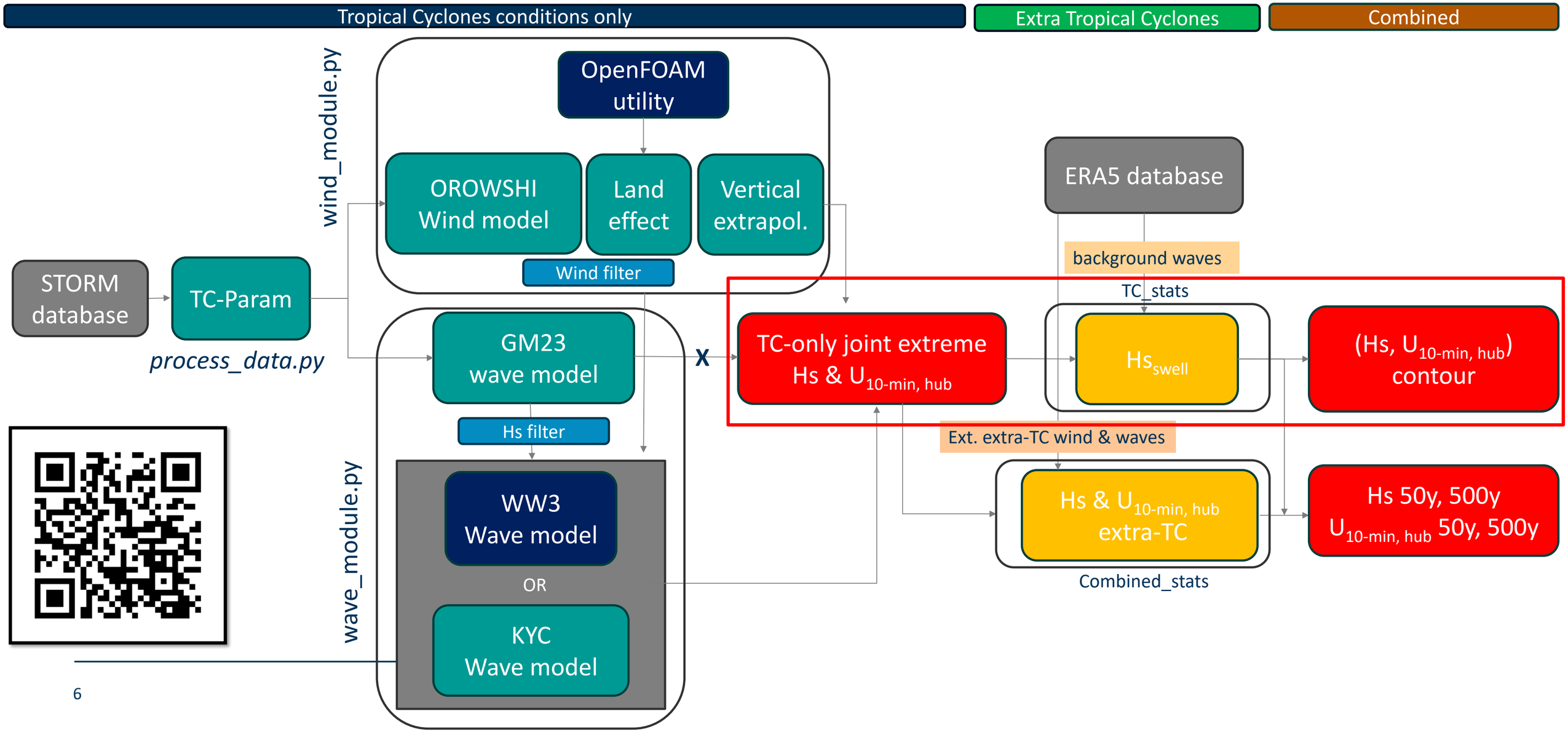
Hindcasting of Tropical Cyclones



TAIFU Wind/Waves: Joint statistics of wind and waves



TAIFU Wind/Waves: Joint statistics of wind and waves



TAIFU Wind/Waves: Mixed climate statistics

Tropical Cyclones conditions only | Extra Tropical Cyclones | Combined

wind_module.py

OpenFOAM utility

OROWSHI Wind model

Land effect

Vertical extrapol.

Wind filter

STORM database

TC-Param

process_data.py

GM23 wave model

X

TC-only Hs &

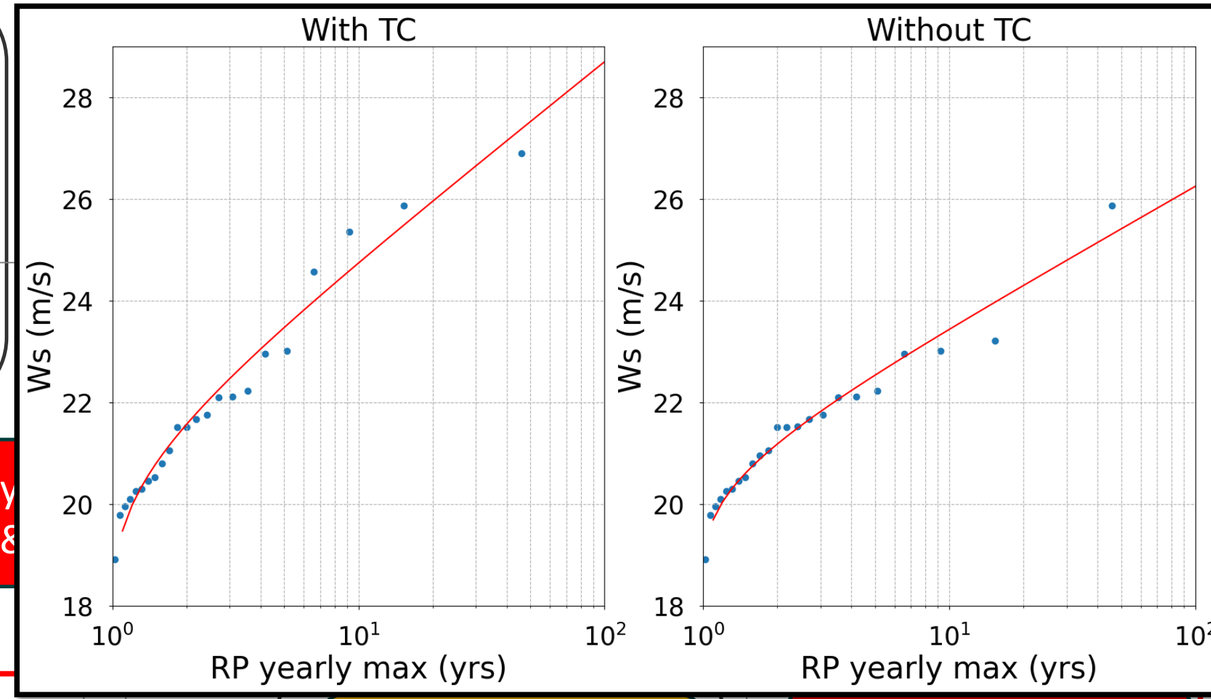
Hs filter

wave_module.py

WW3 Wave model

OR

KYC Wave model



Hs & $U_{10\text{-min, hub}}$ extra-TC

Hs 50y, 500y
$U_{10\text{-min, hub}}$ 50y, 500y

Combined_stats

Python package to derive extreme wind and wave statistics at sites exposed to tropical cyclones

- Method applicable to any oceanic basin

- Hindcast analysis of historical events

- Joint wind-wave statistics induced by tropical cyclones
  - Parametric models applied to the STORM synthetic database
  - Significant wave height accounts for the swell emitted by distant weather systems

- Univariate statistics in mixed climates
  - Extratropical cyclones contribution derived from ERA5 reanalysis

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Thank you for attention