

Motivation

- Addressing uncertainties is a fundamental step toward the improvement of an ocean forecasting system
- In ocean forecasting, the uncertainty associated with atmospheric forcing is a primary source of forecast uncertainty (Pinardi et al., 2011)
- Ensemble perturbations could be quantified by the study of the statistical distributions of the atmospheric fields and their moments

Dataset

The atmospheric dataset is derived from ECWMF analyses (European Center for Medium-range Weather Forecasts) -

- It covers a 10-year period for January 2011 to December 2020 for wind at 10m (U,V) components
- Temporal resolution – 6 hours
- Spatial resolution of 1/8 degree

The Weibull PDF functions

The Weibull PDF is widely used to analyze the statistics of offshore wind energy potential, but PDF analysis of model wind data using Weibull in the Mediterranean Sea is not a common approach

$$f(V; k, \lambda) = \frac{k}{\lambda} \left(\frac{V}{\lambda}\right)^{k-1} \exp\left(-\left(\frac{V}{\lambda}\right)^k\right) \quad (1)$$

$$f(V; k, \alpha, \lambda) = \alpha \frac{k}{\lambda} \left(\frac{V}{\lambda}\right)^{k-1} \exp\left(-\left(\frac{V}{\lambda}\right)^k\right) \left(1 - \exp\left(-\left(\frac{V}{\lambda}\right)^k\right)\right)^{\alpha-1} \quad (2)$$

Where, V = random variable, α , k = shape and λ = scale parameter (Ali et al., 2018). Eq. 1 defines 2 parameter Weibull function and Eq. 2 is for 3 parameter Exponential Weibull

The probability distribution of wind amplitude

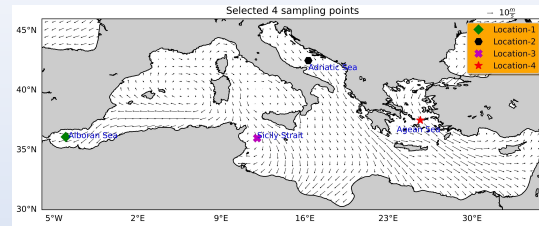


Fig.1: Four selected sampling grid points for histogram

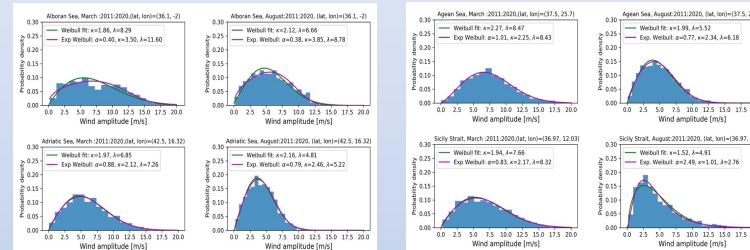


Fig.2: Histograms of selected points for March & August:2011-2020

Weibull fitting parameters for wind amplitude

$$W = \sqrt{U^2 + V^2} \quad (3)$$

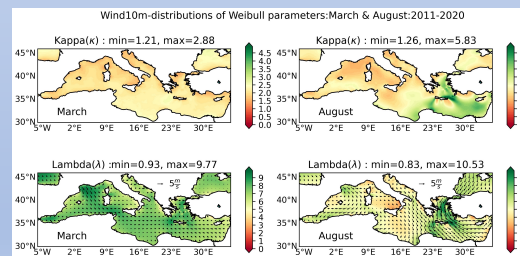


Fig.3: Weibull parameter horizontal field, March(left), August(right) for period 2011-2020

Validation of the distribution parameters

The moments of Wind amplitude are validated comparing the moments statistics computed directly from the data with the one computed from the Weibull distribution parameters

$$Mean(V) = \lambda \Gamma\left(1 + \frac{1}{k}\right) \quad (4)$$

$$Std(V) = \lambda \left[\Gamma\left(1 + \frac{2}{k}\right) - \Gamma^2\left(1 + \frac{1}{k}\right) \right]^{\frac{1}{2}} \quad (5)$$

$$Skewness(V) = \frac{\Gamma\left(1 + \frac{3}{k}\right) - 3\Gamma\left(1 + \frac{1}{k}\right)\Gamma\left(1 + \frac{2}{k}\right) + 2\Gamma^3\left(1 + \frac{1}{k}\right)}{\left[\Gamma\left(1 + \frac{2}{k}\right) - \Gamma^2\left(1 + \frac{1}{k}\right) \right]^{\frac{3}{2}}} \quad (6)$$

$$Kurt(V) = \frac{\Gamma\left(1 + \frac{4}{k}\right) - 4\Gamma\left(1 + \frac{1}{k}\right)\Gamma\left(1 + \frac{3}{k}\right) + 6\Gamma^2\left(1 + \frac{1}{k}\right)\Gamma\left(1 + \frac{2}{k}\right) - 3\Gamma^4\left(1 + \frac{1}{k}\right)}{\left[\Gamma\left(1 + \frac{2}{k}\right) - \Gamma^2\left(1 + \frac{1}{k}\right) \right]^2} \quad (7)$$

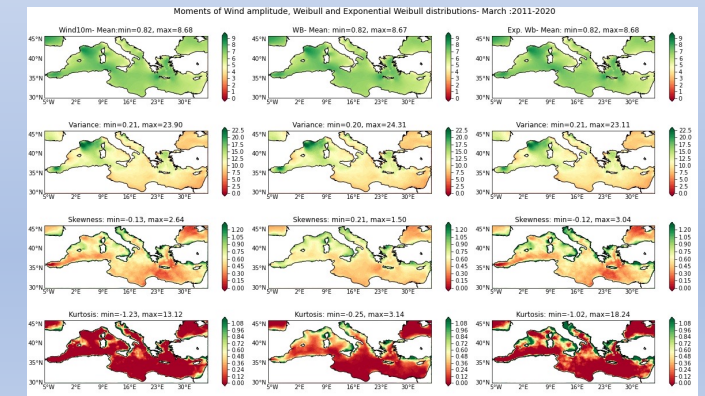


Fig.4: Moment statistics computed from the data (left column), Weibull (central column) and Exp. Weibull (right column) computed from distribution parameters

Conclusions

Both Weibull(2 parameters) and Exponential Weibull(3 parameters) are a good fit for model wind data and almost identical in their parameter distributions in the Mediterranean Sea.