Analyzing Atmospheric Forcing Distributions and Potential Extreme Events for Ocean Forecasting

Addressing uncertainties is a fundamental approach in improving ocean forecasting systems. Despite using high-performance computing facilities for numerical model runs, uncertainties can still arise from different sources, particularly from atmospheric forcing. The analysis of the Probability Density Distributions (PDFs) of atmospheric variables is then a significant step in understanding ocean forecasts and minimizing associated uncertainties. Therefore, the study of atmospheric forcing variables is an important step before evaluating uncertainties in forecasts. Initially, we have extensively investigated the statistical distributions of atmospheric surface variables for the Mediterranean Sea using an atmospheric analysis dataset. The probability distribution functions (PDFs) are fitted to the seasonally detrended surface atmospheric variables for wind components (U, V), wind amplitude, air temperature (T2M), dew point temperature (D2M), and mean sea-level pressure (MSL-P). For wind amplitude, the Weibull two-parameter distribution fits well and aligns with previous studies on atmospheric surface wind analysis. However, our research reveals that for T2M, D2M, MSL-P, and wind anomaly components, a three-parameter skew-normal PDF is necessary. This distribution adequately captures the variance and asymmetric tails (skewness) of the data, with skewness being slight to moderate for most variables. The PDF parameters vary across different regions, particularly the shape (related to the asymmetric tails) and the scale (related to the distribution's spread) parameters. This experimental approach applied to the Mediterranean Sea has yielded significant results for major atmospheric variables, indicating the need for further investigation on a global scale. The developed statistical methodologies now aim to analyze the probability distributions of atmospheric and oceanic variables globally, as well as to examine potential extreme events using historical datasets and climate scenarios to detect changes.

*Mahmud Hasan Ghani*a, Francesco Trotta*b, Yann Drillet*c and Nadia Pinardi a Dept. of Physics and Astronomy, University of Bologna, Bologna, Italy b Euro-Mediterranean Center on Climate Change, Bologna, Italy ,c Mercator Ocean Int, Toulouse, France*