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Novel Atmospheric and Sea State Modeling in Ocean Energy Applications

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The rapidly increasing use of renewable energy sources poses new challenges for the research and technological community today. The integration of the, usually, highly variable wind and wave energy amounts into the general grid, the optimization of energy transition and the forecast of extreme values that could lead to instabilities and failures of the system can be listed among them.
In the present work, novel methodologies based on state of the art numerical wind/wave simulation systems and advanced statistical techniques addressing such type of problems are discussed. In particular, extremely high resolution modeling systems simulating the atmospheric and sea state conditions with spatial resolution of 100 meters or less and temporal discretization of a few seconds are utilized in order to simulate in the most detailed way the combined wind-wave energy potential at offshore sites. In addition, a statistical analysis based on a variety of mean and variation measures as well as univariate and bivariate probability distributions is used for the estimation of the variability of the power potential revealing the advantages of the use of combined forms of energy by offshore platforms able to produce wind and wave power simultaneously. The estimation and prediction of extreme wind/wave conditions - a critical issue both for site assessment and infrastructure maintenance – is also studied by means of the 50-year return period over areas with increased power potential.
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