Statistical spatial wave downscaling in a regional sea from the global ERA5 dataset

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Abstract

Neural networks have been applied for fast downscaling of environmental fields. However, their inherent randomness can lead to prediction instability. This study introduces an ensemble neural network to assess the effectiveness of the ensemble method in mitigating instability in statistical spatial wave downscaling. Its performance is compared with a deterministic linear regression model. Significant wave height (SWH) in the western Black Sea is considered, with low-resolution SWH and wind data from ERA5 and high-resolution SWH data from a regional numerical model. Both self-variable downscaling (from low-resolution SWH) and cross-variable downscaling (from low-resolution wind fields) are considered. Results show that the ensemble method significantly reduces the base neural network's prediction instability. In self-variable SWH downscaling, two models perform similarly well, whereas in cross-variable downscaling, the ensemble model outperforms the linear model. These findings provide valuable insights into downscaling methodologies, contributing to improved spatial wave predictions.