Bias Correction of Ocean Wave Forecasts using Machine Learning Methods

For operators at sea, the prediction of sea state typically involves using physics-based ocean wave models that numerically solve the evolution of the sea surface due to momentum and energy transfer. Despite the continual improvement in physical parameterisations, biases persist in these models' outputs, arising from processes that cannot be resolved explicitly. To alleviate these issues, bias correction techniques often employ so-called post-processing methods such as manual intervention or Kalman filtering, however, it is increasingly recognised that deep learning approaches can potentially offer an effective and efficient alternative. Here, we describe the adaptation and application of the promising new Machine Learning for Low-Cost Offshore Modelling (MaLCOM) framework to bias correction, with the aim of better augmenting traditional physics-based forecasts. The approach consists of using an attention-based long short-term memory recurrent neural network to learn the temporal patterns from a network of available buoy observations, which is then combined with a random forest based spatial nowcasting model, trained on Met Office hindcast data, to provide a complete spatiotemporal prediction for the region of interest. To assess its benefit in a bias correction context, two different configurations of the framework are compared: one consisting of using a machine learning observations-based wave forecast (driven by the wave data from a network of coastal buoys) to adjust the raw physics-based wave model outputs in wave parameter space, and the other driven by the difference between the model and observations at the same coastal buoy locations to adjust the raw physics-based model outputs in bias space. Results from an example domain encompassing the South West of the UK show that real-time, rapidly-updating, gridded corrections are possible – with the potential for the approach to be considered as a candidate in future upgrades to the Met Office operational ocean wave post-processing system. In addition, the flexibility of the method, combined with its very low resource requirements, make this both quick and easy to apply to other regions of interest, both on the European North West Continental Shelf and beyond (e.g. South Africa), supporting the critical forecasts issued in service to marine and maritime users.

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