Sea-state clustering using k-means

The total wave variance of a number of individual wave systems developed by different weather events, can be described in frequency and direction space via the ocean wave (2D) spectra. However, saving the spectra at each grid point is sufficiently memory intensive (equivalent of order a thousand state variables at each grid point) to not be practical. For this reason, partitioning, i.e., the process to detect the different wave systems using morphological features of the spectra, is used to reduce the data, and avoid losing information. Currently at the Met Office wave partitions are identified from topographically determined energy peaks and then defined as wind-sea or swell based on a single dependency on wave age, using a threshold value for the ratio of wave speed to wind speed. This approach, however, can cause adverse impacts due to (a) the wave energy identified as wind-sea varying rapidly with fluctuations in the wind, resulting in the conceptual model identifying wind-sea and swell that may not match the reality of the sea-state and (b) compromises made to partitioning methods which may make the output characteristics poor for subsequent reconstruction of the full wave spectra (e.g. use a wind-sea energy cut-off that effectively splits a single topographically identified wave partition in two). This work explores an alternative, machine-learning based wind-sea and swell identification scheme using additional characteristics of the sea-state beyond wave age, which implicitly acknowledge the three categories of sea state behaviour: 1) wind-sea 2) swell and 3) a transitional state between wind-sea and swell. The method uses a k-means clustering, where the training is based on long period Met Office hindcast data. Feasibility of the approach for the prediction of the sea states is tested using idealised (bathtub) runs, where swell and wind sea can easily be identified. Preliminary results have shown promising success of the scheme.

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