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# Progress in Multi-Center Probabilistic Wave Forecasting and Ensemble-Based Data Assimilation using LETKF at the US National Weather Service

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The combination of ensemble predictions of Hs made by the US National Weather Service (NEW) and the US Navy Fleet Numerical Meteorological and Oceanography Center (FNMOC) has established the NFCENS, a probabilistic wave forecast system in operations at NCEP since 2011. Computed from 41 combined wave ensemble members, the new product outperforms deterministic and probabilistic forecasts and nowcasts of Hs issued separately at each forecast center, at all forecast ranges. The successful implementation of the NFCENS has brought new opportunities for collaboration with Environment Canada (EC). EC is in the process of adding new global wave model ensemble products to its existing suite of operational regional products. The planned upgrade to the current NFCENS wave multi-center ensemble includes the addition of 20 members from the Canadian WES. With this upgrade, the NFCENS will be renamed North American Wave Ensemble System (NAWES). As part of the new system implementation, new higher-resolution grids and upgrades to model physics using recent advances in source-term parameterizations are being tested. We provide results of a first validation of NAWES relative to global altimeter data, and buoy measurements of waves, as well as its ability to forecast waves during the 2012 North Atlantic hurricane Sandy.

A second line of research involving wave ensembles at the NWS is the implementation of a LETKF-based data assimilation system developed in collaboration with the Argentinian Navy Meteorological Service. The project involves an implementation of the 4D-LETKF in the NWS global wave ensemble forecast system GWES. The 4-D scheme initializes a full 81-member ensemble in a 6-hour cycle. The LETKF determines the analysis ensemble locally in the space spanned by the ensemble, as a linear combination of the background perturbations. Observations from three altimeters and one scatterometer were used. Preliminary results for a prototype system running at the NWS, including significant wave observations from altimeters show stable errors after the spin-up in the significant wave height, when the background fields are compared to the observations. The same can be said when compared to independent observations from off-shore moored buoys. The observational departures from the full 6-hour assimilation window show a much smoother behavior than the errors at the analysis time, at the ending time of the window.