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Validation of a Wave Data Assimilation System Based on SWAN

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SWAN is one of the most broadly used models for wave predictions in the nearshore, with known and extensively studied limitations due to the physics and/or to the numerical implementation. In order to improve the performance of the model, a 4DVAR data assimilation system based on a tangent linear code and the corresponding adjoint from the numerical SWAN model has been developed at NRL(Orzech et. al., 2013), by implementing the methodology of Bennett 2002. The assimilation system takes into account the nonlinear triad and quadruplet interactions, depth-limited breaking, wind forcing, bottom friction and white-capping. Using conjugate gradient method, the assimilation system minimizes a quadratic penalty functional (which represents the overall error of the simulation) and generates the correction of the forward simulation in spatial, temporal and spectral domain. The weights are given to the output of the adjoint by calculating the covariance to an ensemble of forward simulations according to Evensen 2009. This presentation will focus on the extension of the system to a weak-constrainted data assimilation system and on the extensive validation of the system by using wave spectra for forcing, assimilation and validation, from FRF Duck, North Carolina, during August 2011. During this period, at the 17 m waverider buoy location, the wind speed was up to 35 m/s (due to Hurricane Irene) and the significant wave height varied from 0.5 m to 6 m and the peak period between 5 s and 18 s. In general, this study shows significant improvement of the integrated spectral properties, but the main benefit of assimilating the wave spectra (and not only their integrated properties) is that the accurate simulation of separated, in frequency and in direction, wave systems is possible even nearshore, where non-linear phenomena are dominant. The system is ready to be used for more precise reanalysis of the wave climate and climate variability, and determination of coastal hazards in regional or local scales, in case of available wave data.

References:
Orzech, M.D., J. Veeramony, and H.E. Ngodock, 2013: A variational assimilation system for nearshore wave modeling. J. Atm. & Oc. Tech., in press.