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The wave model SWAN (Booij et al., 1999) solves the spectral action balance equation to produce nearshore wave forecasts and climatologies. It is widely used by the coastal modeling community and is part of a variety of coupled ocean-wave-atmosphere model systems. A variational data assimilation system (Orzech et al., 2013) has recently been developed for SWAN and is presently being transitioned to operational use by the U.S. Naval Oceanographic Office. This system is built around a numerical adjoint to the fully nonlinear, nonstationary SWAN code. When provided with measured or artificial "observed" spectral wave data at a location of interest on a given nearshore bathymetry, the adjoint can compute the degree to which spectral energy levels at other locations are correlated with – or "sensitive" to – variations in the observed spectrum. Adjoint output may be used to construct a sensitivity map for the entire domain, tracking correlations of spectral energy throughout the grid. When access is denied to the actual locations of interest, sensitivity maps can be used to determine optimal alternate locations for data collection by identifying regions of greatest sensitivity in the mapped domain.

The present study investigates the properties of adjoint-generated sensitivity maps for nearshore wave spectra. The adjoint and forward SWAN models are first used in an idealized test case at Duck, NC, USA, to demonstrate the system's effectiveness at optimizing forecasts of shallow water wave spectra for an inaccessible surf-zone location. Then a series of simulations is conducted for a variety of different initializing conditions, to examine the effects of seasonal changes in wave climate, errors in bathymetry, and variations in size and shape of the inaccessible region of interest. Model skill is quantified using two methods: (1) a more traditional correlation of observed and modeled spectral statistics such as significant wave height, and (2) a recently developed RMS spectral skill score summed over all frequency-directional bins. The relative advantages and disadvantages of these two methods are considered.

References:

Booij, N., R.C. Ris, and L.H. Holthuijsen, 1999: A third-generation wave model for coastal regions: 1. Model description and validation. J. Geophys. Res. 104 (C4), 7649-7666.

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