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Global Wave Hindcasts Using the Observation-Based Source Terms: Description and Validation

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Abstract

Global wave hindcasts are developed using the third generation spectral wave model WAVEWATCH III with the observation-based source terms (ST6) and a hybrid rectilinear-curvilinear, irregular-regular-irregular grid system (approximately at $0.25^{o} \times 0.25^{o}$). Three distinct global hindcasts are produced: (a) a long-term hindcast (1979–2019) forced by the ERA5 conventional winds U_{10} and (b) two short-term hindcasts (2011–2019) driven by the NCEP climate forecast system (CFS)v2 U_{10} and the ERA5 neutral winds $U_{10,new}$, respectively. The input field for ice is sourced from

the Ocean and Sea Ice Satellite Application Facility (OSI SAF) sea-ice concentration climate data records. These wave simulations, together with the driving wind forcing, are validated against extensive in-situ observations and satellite altimeter records. The performance of the ST6 wave hindcasts shows promising results across multiple wave parameters, including the conventional wave characteristics (e.g., wave height H_s and wave period) and high-order spectral moments (e.g., the surface Stokes drift and mean square slope). The ERA5-based simulations generally present lower random errors, but the CFS-based run represents extreme sea states (e.g., $H_s > 10$ m) considerably better. Novel wave parameters available in our hindcasts, namely the dominant wave breaking probability, wave-induced mixed layer depth, freak wave indexes and wave-spreading factor, are further described and briefly discussed. Inter-comparisons of H_s from the long-term (41 years) wave hindcast, buoy measurements and two different calibrated altimeter data sets highlight the inconsistency in these altimeter records arising from different calibration methodology. Significant errors in the low-frequency bins (period $T > 15$s) for both wave energy and directionality call for further model development.

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