Mitigation of Model Bias Influences on Wave Data Assimilation with Multiple Assimilation Systems

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High-quality wave prediction with a numerical wave model is of societal value. To initialize the wave model, wave data assimilation (WDA) is necessary to combine the model and observations. Due to inaccurate wind forcing, imperfect numerical schemes, and approximated physical processes, a wave model is always biased in relation to the real world. In this study, two assimilation systems are first developed using two nearly independent wave models; then, “perfect” and “biased” assimilation frameworks based on the two assimilation systems are designed to reveal the uncertainties of WDA. A series of “biased” assimilation experiments is conducted to systematically examine the adverse impact of initial condition, boundary forcing, and model bias on WDA, then model bias play a strongest role among them. A statistical approach based on the results from multiple assimilation systems is explored to carry out bias correction, by which the final wave analysis is significantly improved with the merits of individual assimilation systems. The framework with multiple assimilation systems provides an effective platform to improve wave analyses and predictions and help identify model deficits, thereby improving the model.