Using Northeastern Pacific Buoy Surface Pressure Observations to Learn About Model Error

We use data assimilation statistics and Forecast Sensitivity Observation Impact (FSOI) of drifting buoy (drifter) surface pressure observations in the Northeastern Pacific to provide information on biases in the US Navy's Global Environmental Model (NAVGEM) and hybrid 4D-VAR data assimilation (DA) system, and how these biases may prevent the effective use of these observations. To account for the fact that model biases may be different for e.g., high pressure systems vs. cyclones, we separate the observations into quartiles, with the lowest (first) quartile populated by the lowest surface pressure values and the highest (fourth) quartile populated by the highest surface pressure values. Innovation (observation minus background) statistics indicate that the model has a conditional bias such that it systematically underestimates high pressures. FSOI indicates that almost all the beneficial impact on forecast error reduction comes from observations in the lowest quartile, with near neutral impacts from observations in the other quartiles. Case studies indicate that these beneficial observations occur in dynamically active regions such as cyclones, fronts and atmospheric rivers. When considering observation impact as a function of the hour within the six-hour DA cycle, the net impact of observations in the lowest quartile is always beneficial, with the largest beneficial impacts coming from observations taken late in the update cycle (similar to what was found for satellite observations in McNally 2019). For observations in the highest quartile, the observations taken at the beginning of the DA window are beneficial, but the observations taken in the second half of the DA window are non-beneficial. Taken together, the innovation statistics and FSOI results suggest that conditional model bias for high surface pressures is preventing the DA system (currently in "strong-constraint" mode) from using these observations effectively when taken at the end of the DA window (when model bias are most pronounced).

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