Data assimilation into a coupled atmosphere-ocean model with the ensemble Kalman filter

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We report an application of the ensemble Kalman filter (EnKF) and smoother (EnKS) to
an intermediate coupled atmosphere-ocean model of Zebiak and Cane, into which the sea surface height (SSH) anomaly observations by TOPEX/POSEIDON (T/P) altimetry are assimilated. Smoothed estimates of the 54,403 dimensional state are obtained from
1,981 observational points with 2,048 ensemble members. While assimilated data are SSH anomalies alone, the estimated sea surface temperature (SST) anomalies reproduce primary temporal characteristics of the actual SST. The smoothed estimate of the zonal wind anomalies is also consistent with the observation except for the westerly anomalies in the western Pacific.

To clarify the poor estimates of the westerly anomalies, we carried out additional experiments to examine consistency of the ZC model and the altimetry observations. The experiments and their results are: (1) If we cut a model coupling process from the ocean to the atmosphere, into which wind observation are inserted, the ocean component reproduces El Nino. (2) If we cut another coupling process, that from the atmosphere to the ocean, and insert the ocean variables obtained in experiment 1, the westerly winds are not generated in the western Pacific. (3) If we cut the ocean-to-atmosphere process again and substitute the wind output in experiment 2, where no westerly winds, El Nino events are still reproduced. These results indicate that the westerly winds in the western Pacific is a phenomenon outside of the ZC model, which is consistent with the fact that the westerly winds cannot be estimated by the SSH observations.