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Towards coupled data assimilation in an intraseasonal-seasonal ensemble forecast system

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The Predictive Ocean Atmosphere Model for Australia (POAMA) is the dynamical seasonal forecast system at the Australian Bureau of Meteorology. POAMA consists of a global coupled ocean-atmosphere model, data assimilation schemes for ocean, land and atmosphere, and an ensemble forecast system. Like many current systems, data is assimilated separately into the ocean and atmosphere components of the coupled model. This approach leads to initialisation shock as the initial coupled model state is not in dynamical balance. Initialisation shock can manifest as spurious features or impede ocean-atmosphere feedbacks, such as associated with El Niño-Southern Oscillation (ENSO) and Madden-Julian Oscillation (MJO), and thus degrade forecasts.

We aim to develop a coupled data assimilation approach to improve the initialisation of the coupled model in an intraseasonal-seasonal forecast system. POAMA currently employs a highly successful ocean data assimilation scheme, based on a multivariate pseudo-ensemble Kalman filter. We propose to expand this scheme to include atmospheric variables. A keystone of the assimilation scheme is the set of background covariances developed from a non-stationary ensemble of ocean states. The new approach would use coupled ocean-atmosphere background covariances derived from an ensemble of the coupled states.

Our first step has been to examine the coupled covariances obtained from different ensemble sets produced by the POAMA coupled model. One large ensemble set captured MJO and ENSO activity during the build up to the 1997 El Niño event. Coupled covariances for a range of variables, such as surface winds, sea surface temperature (SST), out-going long-wave radiation and ocean currents, have been analysed. The results give guidance as to what methods should be used in obtaining and applying the coupled covariances, and their potential for improving coupled model initialisation.

One major finding was the coupled covariance structures for the atmospheric and oceanic equatorial Pacific, based on unfiltered SST and zonal surface wind errors, contained large-scale surface wind circulation patterns, shifts in the ocean thermocline, and regional enhancement or suppression of deep convection and precipitation, which were associated with the MJO and ENSO. The results showed the coupled covariance structures contained realistic information that could enhance the initialisation of these important coupled processes. The results indicate a coupled data assimilation approach using such covariances has potential to improve intraseasonal-seasonal forecasts.