Geophysical Research Abstracts
Vol. 14, EGU2012-1718, 2012
EGU General Assembly 2012

Impact of Assimilating Salinity on ENSO Variability and Seasonal Forecast Skill in a Coupled Model

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We assess the sensitivity of the simulated mean state and ENSO variability to assimilation of salinity and impact of improved ocean initial conditions for predicting ENSO using the Bureau of Meteorology's POAMA coupled model for the period 1982-2006. The new ocean initial conditions are provided by an ensemble-based analysis system that assimilates subsurface temperatures and salinity and which is a clear improvement over the previous optimal interpolation system which used static error covariances and was univariate (temperature only).

Large mean errors in the salinity field around the thermocline region of the western and central Pacific produced by the old assimilation scheme have strong impacts on the predicted mean state and variability in the Pacific for the entire 9 months of the forecast. Forecasts initialized from the old scheme undergo a rapid and systematic adjustment of density that causes large persistent changes in temperature both locally in the western and central Pacific thermocline but also remotely in the eastern Pacific via excitation of equatorial waves. The initial subsurface salinity errors in the western and central Pacific ultimately result in an altered surface climate because of induced temperatures changes in the thermocline that trigger a coupled feedback in the eastern Pacific.

Hindcasts using ocean initial conditions from the multi-variate ensemble analysis system have better skill at predicting sea surface temperature (SST) variations associated with ENSO, and this increased skill is derived from better dynamical balance between temperature and salinity and larger interannual variability of the surface salinity throughout the tropical Pacific in the initial condition, i.e. a more realistic mean state and interannual variability of salinity.

These results highlight the importance of accurately representing salinity in initial conditions for climate prediction and suggest subsurface salinity variability may be a source of long-lead climate predictability.