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Effect of weather noise on the spring barrier of ENSO prediction

Xiaohui Tang[†];
[†] Institute of Oceanology, Chinese Academy of Sciences, China, People's Republic of
Leading author: txhtang@gmail.com

In prediction of the El Niño-Southern Oscillation (ENSO), many coupled models encounter decrease of forecast skill when passing through the boreal spring. This so called "spring predictability barrier" (SPB) is a noted feature that limits ENSO forecast skills, but its cause and mechanism is still insufficiently understood. In this study, two ensembles of prefect model prediction experiments were conducted to investigate the effect of weather noise on the formation of SPB. The coupled model we used consists an atmospheric general circulation model and a 1-1/2 layer reduced gravity ocean model, which has good simulation and forecast skills of ENSO. In both prefect model prediction experiments, we specified the thermocline depth anomaly as "observation" during forecasts, where rescaled upper 500m heat content of GFDL ODA data are used as observation. This allows us to test the upper limit of model skill in predicting SST given a perfectly "predicted" thermocline variability. In the second experiment alone, an atmospheric noise filter was introduced into the coupled model to suppress weather noise in wind stresses and surface heat fluxes that pass to the ocean, in order to enhance the signal-to-noise ratio (SNR) and test the impact of weather noise on ENSO prediction. Both experiments were initialized from Jan 1st of 1980-2000, and conducted SST prediction for 12 months. The results show that, the model with "perfect thermocline variability" still has SPB, and ensemble spreads are largest in boreal spring. However, the second experiment with noise filter has much better ENSO forecast skill in spring and smaller ensemble spread than the first experiment. This suggests that SPB may come from atmospheric variability. The strong weather noise and weak coupling signal in spring causes rapid error growth and low forecast skill. Although assimilation of thermocline depth anomaly has been proved effective in reducing SPB in ENSO prediction, the ocean memory alone may not be enough to eliminate it. Improving the model SNR is another possible way to further alleviate SPB in ENSO prediction.