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Tropical Pacific Climate and ENSO: Understanding Model Biases Through Flux Adjustment

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Abstract:

Coupled feedbacks and climate drifts greatly complicate the attribution of biases in simulations of tropical Pacific climate and the El Niño/Southern Oscillation (ENSO). Here we describe a systematic approach toward understanding and mitigating those biases, using flux-adjusted (FA) experiments in which a model's climatological SST, surface wind stress, and surface salinity are corrected toward observations. We demonstrate this approach using FLOR, a high-resolution coupled GCM recently developed by the NOAA Geophysical Fluid Dynamics Laboratory (GFDL). FLOR has shown remarkable skill in simulating and predicting ENSO and its impacts, and contributes monthly predictions of global seasonal-to-interannual climate as part of the North American Multi-Model Ensemble (NMME). The flux-adjusted version (FLOR-FA) shows major improvements in its atmospheric and oceanic climatologies and in several aspects of ENSO --- including the strength of its equatorial SST variations and their seasonal synchronization to the end of the calendar year. Other aspects, such as its short ENSO period, overly-westward SST anomaly propagation, and westward-displaced extratropical teleconnections, are either not improved or are even degraded by the FA. The reasons for this are illuminated through detailed analysis of the dominant coupled feedbacks. This analysis also helps to isolate climatological biases attributable to FLOR's atmospheric and oceanic components -- including an overly deep equatorial Pacific thermocline, which in the unadjusted coupled model is obscured by a compensating bias toward excessive wind-driven Sverdrup divergence near the equator. Implications of these results for improving models and forecasts, and assessing the future of tropical Pacific climate and ENSO under climate change, are discussed.

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