Robust Validation of ENSO in IPCC-Class Coupled Models

Samantha Stevenson (1), Baylor Fox-Kemper (1), and Markus Jochum (2)

(1) University of Colorado, Atmospheric & Oceanic Sciences, Boulder, United States (samantha.stevenson@colorado.edu),
(2) National Center for Atmospheric Research, Boulder, CO, United States

Wavelet probability analysis, a new method of model validation, is used to assess the performance of ENSO in a variety of coupled climate models. Wavelet probability analysis relies on wavelet spectra for a given time series, for which the amount of spectral overlap between subsets is measured using a quantity known as the wavelet probability index (WPI). This approach provides quantitative estimates of model agreement relative to either observations or other models, accompanied by well-defined confidence levels. ENSO, as represented by the NINO3.4 index, has been examined in 2,000 year long coupled integrations of both the new NCAR CCSM3.5 and GFDL's CM2.1; interestingly, it is not possible to distinguish either model from observations of NINO3.4 during 1949-2003, for runs shorter than 200 years. At longer model run lengths, some inaccuracies are seen in both CCSM3.5 and CM2.1 relative to observations. CCSM3.5 and CM2.1 are compared to one another using hypothesis testing procedures, and changes in model physics discussed in terms of their impact on ENSO. Finally, the method is applied to non-equilibrium simulations, using both high-CO_2 'ramp-up' runs and selected IPCC AR4 integrations. This allows the effect of changing CO_2 levels on ENSO activity to be examined, and the statistical significance of such effects to be determined.