Session: B7 Oral presentation

The role of the atmosphere during ENSO: a CLIVAR/CMIP perspective

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The ability of coupled ocean-atmosphere general circulation models (CGCMs) to simulate the El Niño Southern Oscillation (ENSO) has largely improved over the last few years. Nevertheless, the diversity of model simulations of present-day El Niño characteristics indicate current limitations in our ability to model this climate phenomenon and anticipate changes in its properties on short and long time scales. A recent body of studies shows that the atmosphere GCM may lie at the heart of these limitations and that ENSO in CGCMs is extremely sensitive to the representation of atmospheric convection and of tropical clouds. Nevertheless the diversity and complexity of the processes involved has so far been a severe limiting factor for the understanding of this sensitivity. Starting from the standard conceptual view of atmospheric processes during ENSO, namely the response of the wind stress to SST anomalies (the positive Bjerknes feedback) and the response of surface heat fluxes to SST anomalies (usually a damping), the reasons behind that sensitivity are explored in current generation GCMs both coupled and atmosphere only (CMIP3 and CMIP5). It is shown that both responses are too weak in CGCMs, leading to an error compensation. A deficient shortwave heat flux response in the eastern tropical Pacific can explain a large fraction of the spurious diversity of ENSO amplitude in CGCMs. The response of clouds to the different dynamical regimes present in the tropical Pacific (subsidence and deep convection) and mean state errors developing in coupled mode both contribute to this key shortcoming. Beyond pointing to specific process-based model errors, these results further suggests that the response of surface heat fluxes to SST anomalies, usually taken as constant in ENSO theory, may require a more physical representation in simple ENSO models. Guilyardi E., A. Wittenberg, A. Fedorov, M. Collins, C. Wang, A. Capotondi, G.J. van Oldenborgh, T. Stockdale (2009). Understanding El Niño in Ocean-Atmosphere General Circulation Models : progress and challenges. Bull. Amer. Met. Soc., 90, 325-340 Guilyardi E., P. Braconnot, F.-F. Jin, S. T. Kim, M. Kolasinski, T. Li and I. Musat (2009). Atmosphere feedbacks during ENSO in a coupled GCM with a modified atmospheric convection scheme. J. Clim., 22, 5698-5718 Lloyd J., E. Guilyardi, H. Weller, J. Slingo (2009). The role of atmosphere feedbacks during ENSO in the CMIP3 models. Atmos. Sci. Let., 10, 170-176 Lloyd J., E. Guilyardi, H. Weller, (2010) The Role of Atmosphere Feedbacks During ENSO in the CMIP3 Models. Part II: Using AMIP Runs to Understand the Heat Flux Feedback Mechanisms. Clim. Dyn., published on-line Lloyd J., E. Guilyardi, H. Weller, (2011) The Role of Atmosphere Feedbacks During ENSO in the CMIP3 Models. Part III: The Shortwave Flux Feedback. J. Clim., submitted