Geophysical Research Abstracts
Vol. 13, EGU2011-4726, 2011
EGU General Assembly 2011

How well do coupled models replicate ocean energetics relevant to ENSO?

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Accurate replication of the processes associated with the energetics of the tropical ocean is necessary if coupled GCMs are to simulate the physics of ENSO correctly, including the transfer of energy from the winds to the ocean thermocline and energy dissipation during the ENSO cycle. Here, we analyze ocean energetics in coupled GCMs in terms of two integral parameters describing net energy loss in the system using the approach recently proposed by Brown and Fedorov (2010) and Fedorov 2007. These parameters are (1) the efficiency γ of the conversion of wind power into the buoyancy power that controls the rate of change of the Available Potential Energy (APE) in the ocean and (2) the e-folding rate α that characterizes the damping of APE by turbulent diffusion and other processes. Estimating these two parameters for coupled models reveals potential deficiencies (and large differences) in how state-of-the-art coupled GCMs reproduce the ocean energetics as compared to ocean-only models and data assimilating models. The majority of the coupled models we analyzed show a lower efficiency (values of γ in the range of 10-50% versus 50-60% for ocean-only simulations or reanalysis) and a relatively strong energy damping (values of α^{-1} in the range 0.4-1 years versus 0.9-1.2 years). These differences in the model energetics appear to reflect differences in the simulated thermal structure of the tropical ocean, the structure of ocean equatorial currents, and deficiencies in the way coupled models simulate ENSO.