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Projected changes in tropical climate by ECHAM5/MPI-OM

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Large uncertainty exist in future projections of tropical climate variability. This is particularly true for the El Nino Southern Oscillation (ENSO), with the AR4 IPCC class models simulating a wide spectrum of changes. Detailed model intercomparison is one approach to reduce these uncertainties. However, the mechanisms for change in all models needs to be well understood. The aim of this study is to contribute to this goal by understanding the mechanism for the projected changes in the Max Planck Institute climate model ECHAM5/MPI-OM.

We focus on analysing the mutual changes of the mean state, annual cycle and ENSO variability projected by an ensemble of A1B scenarios. The mean state of the tropical Pacific experiences an El Nino like warming, weakening of surface trade winds, and eastward shift in convection. The annual cycle along the equator intensifies by almost 40%. ENSO variability becomes stronger, more regular, and more tightly locked to the annual cycle. There is also a shift from the weak westward propagating to weak eastward propagating El Nino events indicative for the changes of the coupled feedbacks.

The cause of changes in ENSO variability are explained by analysing the impact of the mean state on coupled feedbacks using the Bjerknes index proposed by Jin et al. 2006. Consistent with the increase in ENSO variability under global warming, the Bjerkness stability index strengthens. The increase in ENSO intensity is mainly due to enhanced atmospheric sensitivity and the thermocline feedback, but changes in the ocean basic state contribute. We tested the robustness of the method in other state-of-art models.

The limitation of this method are also be discussed.