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ENSO amplitude change in doubled CO2 experiments evaluated by the temperature variance equation

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In this study, the impact of CO2 on ENSO amplitude is discussed by applying the equation of interannual SST (sea surface temperature) variance which can evaluate a growth rate of ENSO (Imada et al., to be submitted) to a series of climate simulations. Our updated coupled GCM (general circulation model) MIROC5 (the Model for Interdisciplinary Research on Climate, version five) can control the ENSO amplitude by means of the parameter which affects the efficiency of the entrainment rate in cumuli, and can cover the all type of ENSO simulated by CMIP3 (Phase 3 of Coupled Model Intercomparison Project) models. Four doubled CO2 experiments with different parameter settings indicate that the amplitudes of all type of ENSO increase under the global warming.
A comparison of the four pre-industrial control runs and the four doubled-CO2 experiments through the budget analysis of SST variance reveals the mechanisms for the ENSO amplitude change. The budget analysis indicates a significant contribution of the enhanced zonal advection feedback (Jin et al 2009) to the ENSO amplitude increase. On the other hand, change in the thermocline feedback plays a secondary role.
The zonal advection feedback is represented by the multiplication of the mean zonal SST gradient and the covariance between zonal current and SST anomalies in the SST variance equation. The mean zonal SST gradient rather decreases under the doubled-CO2 condition because all simulations with four type of ENSO show the El Nino-like SST trend in the tropical Pacific Ocean. On the other hand, the covariance of SST and zonal current anomalies is greatly increases under the doubled-CO2 condition. This can be understood from the theory that atmospheric feedback to ENSO is enhanced through intensified air-sea interaction because active convective regions expand eastward in the equatorial Pacific under the warmer SST. Interestingly, the model which has the largest ENSO amplitude (about 1.6 K) in the pre-industrial control runs shows the weakest increase of ENSO amplitude under the doubled-CO2 condition. This result suggests that the simulated ENSO is almost saturated to the limitation of growth. Therefore, the series of simulations in this study has possibility to provide a clue to find the threshold of ENSO growth.

Imada, Y., F.-F. Jin, M. Kimoto, and M. Watanabe: ENSO amplitude change during twentieth century evaluated by the temperature variance equation. (to be submitted).
Jin, F.-F, S.-T. Kim, and L. Bejarano, 2006: A coupled-stability index for ENSO. Geophys. Res. Lett., 33, L23708.