3rd International Conference on Earth System Modelling
Vol. , 3ICESM-212, 2012
3rd International Conference on Earth System Modelling

Analyzing the climate sensitivity of MIROC and CMIP3/5 ensembles

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To better understand the inter-model difference in climate sensitivity, we have created various ensembles from a climate model, MIROC, and analyzed them as well as the multi-model ensemble (MME) of CMIP3/5 and available observations. One important feature of MIROC is that there are two versions, MIROC3 and MIROC5, with different model schemes and different climate sensitivity. While the climate sensitivity of MIROC3 is about 3.6K, which has been grouped into 'high sensitivity models' in CMIP3, that of MIROC5 is 1K lower. We examine the mechanisms which determine the climate sensitivity in the two versions by analyzing the model response to CO_2 quadrupling in fully coupled OAGCM and AMIP-type configurations. Also, we attempt to quantify the uncertainty range of climate sensitivity by generating a physics parameter ensemble (PPE) using MIROC5, in which a novel method that avoids climate drift with a fully coupled system has been adopted. This PPE is compared with another pre-existing PPE using MIROC3. A feedback analysis reveals that opposite sign of the cloud shortwave feedback is responsible for the difference in climate sensitivity between MIROC3 and MIROC5. A large difference in tropospheric adjustment of cloud radiative effect is also found between the two versions, which is related to the instantaneous radiative forcings calculated with different radiation schemes. The result underlines the importance of evaluating the instantaneous radiative forcing with line-by-line calculations. The PPEs generated from MIROC3 and MIROC5 do not overlap in the forcing-feedback phase space, indicating that the structural change of the model has a greater impact on the climate sensitivity compared to the change in parameter values. We therefore generated another set called multi-physics ensemble (MPE) based on a hybrid version of the two models by replacing one or more schemes for several processes in the atmosphere model (cumulus convection, cloud physics, and turbulence). The MPE spans the gap in climate sensitivity between the two PPEs, indicating its validity for exploring the structural differences between the two versions. Preliminary results of analyzing these PPE, MPE, and CMIP3/5 MME will be presented at the conference.