Session: B12 Oral presentation

Modeling activity of the MIROC group for climate feedback and sensitivity studies

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We have used our climate model, Model for Interdisciplinary Research on Climate (MIROC) versions 3.2, for experiments proposed in CMIP3. Afterwards a newer version of MIROC5 has been developed by replacing many physical parameterization schemes for the atmosphere, increasing its resolution, updating of the ocean and sea-ice models, and so on. So far, we carried out most of experiments designed for the ongoing CMIP5 using this new model. Important differences in the climate change simulations with MIROC3.2 and MIROC5 are found in the climate feedback and effective climate sensitivity (CS). The latter is about 3.6K in MIROC3.2, which has been grouped into 'high sensitivity' in CMIP3, and is 1K lower in MIROC5. Since MIROC5 is not the Earth system model, these differences are attributed to different representation of the physical part probably in the atmospheric component model. Indeed, a feedback analysis reveals that opposite sign of the cloud shortwave radiative feedback (positive in MIROC3.2 and negative in MIROC5) is responsible for the change in CS. However, despite improvements in climate mean states as well as natural variability represented in MIROC5, we cannot say that the lower CS in MIROC5 gives more reliable result because of uncertainty in cloud and cloud-radiative interaction. To obtain physical insights into the mechanisms that determine the cloud feedbacks in the two models, we analyzed the cloud response in ensemble 4◊CO2 experiments together with outputs obtained from CFMIP1. Also, we attempt to quantify the uncertainty range of CS 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 can then be compared with the pre-existing PPE using MIROC3.2. The analysis is still underway at this moment, but preliminary we identified a smaller spread in the MIROC5 PPE than in the MIROC3.2 PPE due to a significant anti-correlation between the radiative forcing and feedback. The two ensembles do not overlap on a phase space, indicating that the structural change of the model has greater impact as argued in literature. We are therefore generating 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). MPE is anticipated to fill the gap of the two PPEs and provides a clue to the process-based understanding of the cloud feedback. We would overview the above modeling and analysis results in our group, and discuss a possible contribution to the forthcoming fifth assessment report.