EUCLIPSE

EU Cloud Intercomparison, Process Study & Evaluation Project

B. Stevens, T. Crueger, B. Möbis

(Max-Planck-Institut für Meteorologie, Hamburg)

Project summary

The project is an international effort, funded under the Framework Program 7 of the European Union, designed to improve the evaluation, understanding and description of the role of clouds in the Earth's climate with a focus on the cloud feedback in a warming climate. Cloud feedbacks in Earth System Models (ESMs) remain the largest source of uncertainty in projections of future climate. Through interactions with the large-scale circulation, cloud processes also contribute to synoptic circulations and regional climate. They are therefore critical to the prediction of future changes in precipitation patterns, climate variability and extreme events. The aim is to reduce uncertainties in the representation of cloud processes and feedbacks in the new generation of ESMs. The MPI-M contribute to EUCLIPSE with experiments on a wide range of model setups. Besides atmospheric general circulation models also aqua planet models are utilitzed to address the project questions. All experiments are performed with ECHAM6, the atmospheric component of the Max Planck Institute Earth System Model.

Clouds – on – off – AMIP experiments

Within the EUCLIPSE project a new experiment package has been developed, which aims at the exploration of the influence of ***cloud radiation effects*** on climate and climate change. For that reason, clouds are made transparent to radiation.

Fig.1

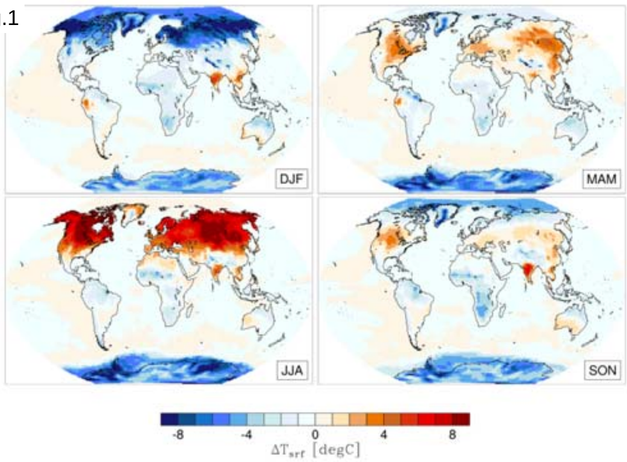


Fig. 1 shows the difference of the surface temperature between the clouds-off AMIP and the corresponding clouds-on experiment. The seasonal cycle is greatly amplified over the northern hemisphere extra tropical land areas, with much warmer summer temperatures and much colder winter temperatures. This can be expected to substantially alter the land-sea circulations, driving more precipitation over land in the summer season.

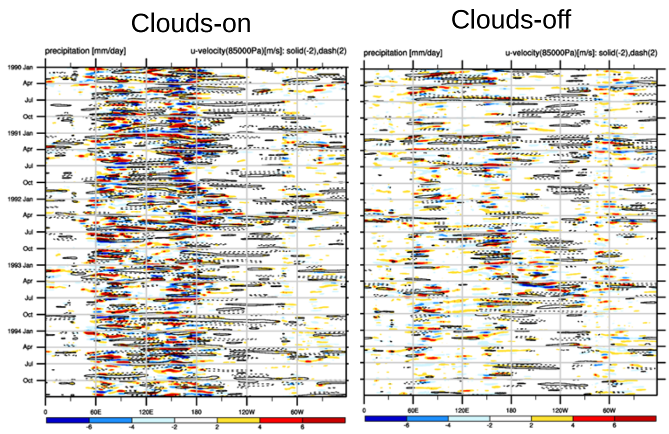


Fig. 2

Fig. 2: The cloud-radiative effects influence the Madden-Julian Oscillation (MJO), the dominant mode of equatorial intraseasonal variability. The MJO is weaker in the clouds-off experiment. This is obvious from the Hovmöller plots of the equatorial precipitation (color) and 850 hPa zonal wind (contours) anomalies. In the clouds-on experiment strong precipitation signals occur between 60E and 180E, which are related to alternating easterly and westerly wind anomalies (left). In the clouds-off experiment the signals are much weaker, especially those of precipitation (right).

The double ITCZ problem in the ECHAM6 aqua planet

Fig. 3

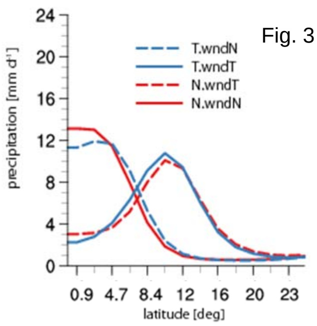


Fig. 4

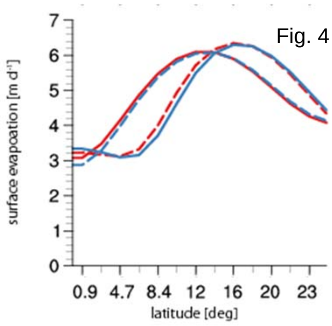


Fig. 5

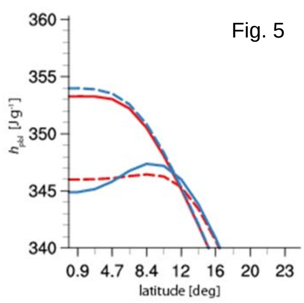
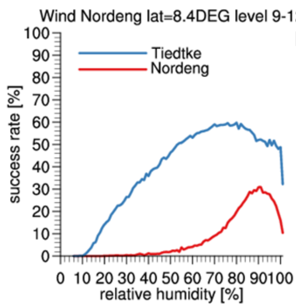


Fig. 6



Most state-of-the-art GCMs have some degree of the double ITCZ problem. Aqua-planet simulations with ECHAM6 and either the Nordeng (default) and Tiedtke convection scheme are performed where the Nordeng scheme shows a single, and the Tiedtke scheme a double ITCZ. The convective organization is dominated by a feedback loop process which includes a wind evaporation feedback in the PBL which controls the moist static energy profile there. This feedback loop can be broken by prescribing the wind speed input to the surface heat flux scheme. Under such forcing the ITCZ mainly depends on the wind forcing and nearly becomes independent from the choice of the convection scheme (Fig. 3, 4 & 5). The higher updraft mixing rates of the Nordeng scheme lead to a higher humidity sensitivity of deep convection relative to the Tiedtke scheme (Fig. 6), which cause the different ITCZ pattern produced by the two schemes.