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Projected changes in cloud properties in low/medium/high ECS models from CMIP5 and CMIP6

Lisa Bock[1], Axel Lauer[1], and Veronika Eyring[1,2]
[1]Deutsches Zentrum für Luft- und Raumfahrt (DLR), Institut für Physik der Atmosphäre, Oberpfaffenhofen, Germany
[2]University of Bremen, Institute of Environmental Physics (IUP), Bremen, Germany

Since the release of the first CMIP6 simulations one of the most discussed topics is the higher effective climate sensitivity (ECS) of some of the models resulting in an increased range of ECS values in CMIP6 compared to previous CMIP phases. An important contribution to ECS is the cloud climate feedback. Although climate models have continuously been developed and improved over the last decades, a realistic representation of clouds remains challenging. As projected changes in cloud properties and cloud feedbacks also depend on the simulated present-day fields, this contributes to the large uncertainties in modelled ECS.

In this study, we investigate the representation of both, cloud physical and radiative properties from CMIP5 and CMIP6 models grouped by ECS. Model results from historical simulations are compared to observations and projected changes of cloud properties in future scenario simulations are analysed by ECS group. For consistent processing of all datasets, the Earth System Model Evaluation Tool (ESMValTool) is applied to CMIP5 and CMIP6 simulations alongside with satellite observations.

Our results show that there are significant differences in simulated cloud properties and cloud radiative effects among the low/medium/high ECS groups with the high ECS models typically showing a better agreement with observations than the two other groups. Further analysis also shows differences in the projected changes in cloud properties among the different ECS groups related to cloud cover, cloud ice and cloud liquid water content. For example, a decrease in TOA net cloud radiative effect with increasing temperature is found in the tropics in the high ECS models whereas there is an increase in TOA net cloud radiative effect in medium and low ECS models.