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The role of resolution in characterising the water cycle under current climate and idealised climate change conditions.

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The water cycle is one of the most challenging aspects of climate modelling. Due to inherent model errors, attributed both to our incomplete understanding of the climate system and the lack of sufficiently detailed observations, discrepancies in precipitation and evaporation distributions persist in the models. As a consequence, general circulation models are not fit yet for simulating the evolution of the water cycle components with climate change. Several approaches are nowadays considered to quantify model uncertainties in simulating the water cycle components and to understand their origin. These approaches include analyses of the uncertainty due to choices of model parameters in perturbed physics ensembles, of the robustness of simulation results to modifications of the model structure and complexity, and process-based studies targeting specific regions or phenomena. In this study, we focus on the role of horizontal resolution in representing atmospheric dynamical processes important for simulating the water cycle. We make use of a global land-atmosphere model based on the UK Met Office-Hadley Centre HadGEM1a model of the IPCC AR4 at different horizontal resolutions, from N48 (270 km) to N216 (60 km). We performed some multi-decadal AMIP-style ensemble simulations of 3 to 4 members with varying initial conditions to explore the robustness of our findings. In a first part, we show how, under current climate conditions, the atmospheric transport of moisture over land is increased in high-resolution models due to an increase in both the mean and transient terms that reflect the better ability of high-resolution models in simulating storms. This has for result to decrease the contribution of local moisture recycling, which is believed to be highly overestimated in climate models compared to reality. The second part of this study focuses on the same processes in idealised climate change simulations performed with the same atmospheric models forced with 30-year sea surface temperature and sea ice fields obtained via the HiGEM (about 90 km for the atmosphere, 3rd degree for the ocean) coupled simulation under present, 2*CO2 and 4*CO2 conditions. We show preliminary results that evaluate the role of resolution in changes of the water cycle with climate change, and determine if and why high-resolution climate models show some features of changes in the water cycle that are different from other models with resolutions similar to the IPCC AR4 models. Our findings may contribute to assessments of the credibility of projected changes in the water cycle.