Microphysical controls on condensate distributions and the tropical energy budget in global storm-resolving models

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EGU 2023

Universität Hamburg
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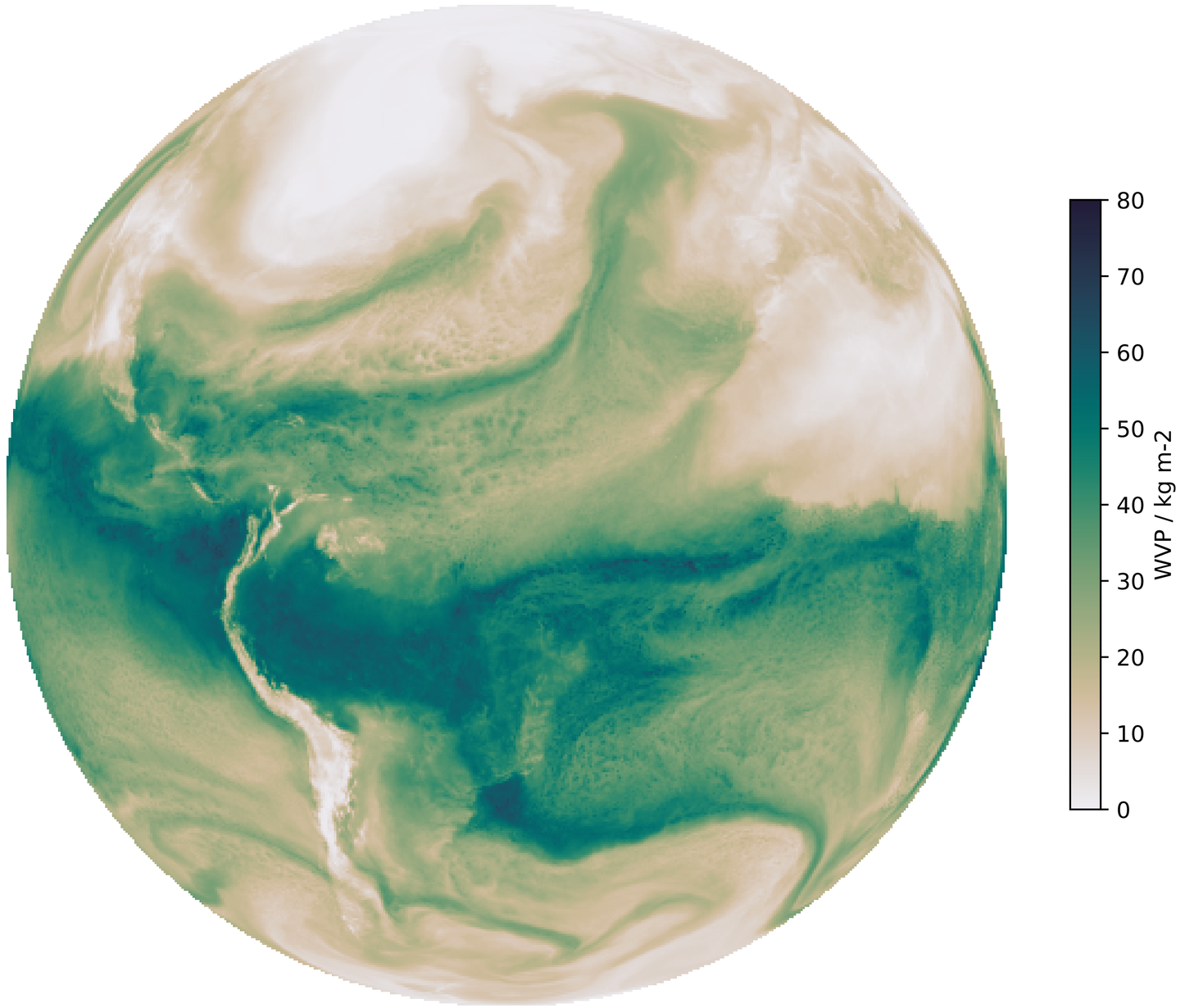
CLUSTER OF EXCELLENCE
CLIMATE, CLIMATIC CHANGE, AND SOCIETY (CLICCS)

MAX-PLANCK-INSTITUT FÜR METEOROLOGIE

Simulating the tropical heat budget at kilometre-scale resolution

In global-storm resolving models that resolve the vertical energy transport through deep convection, microphysical processes are directly linked to their controlling factors.

How do microphysical choices affect the energy budget of the tropics?

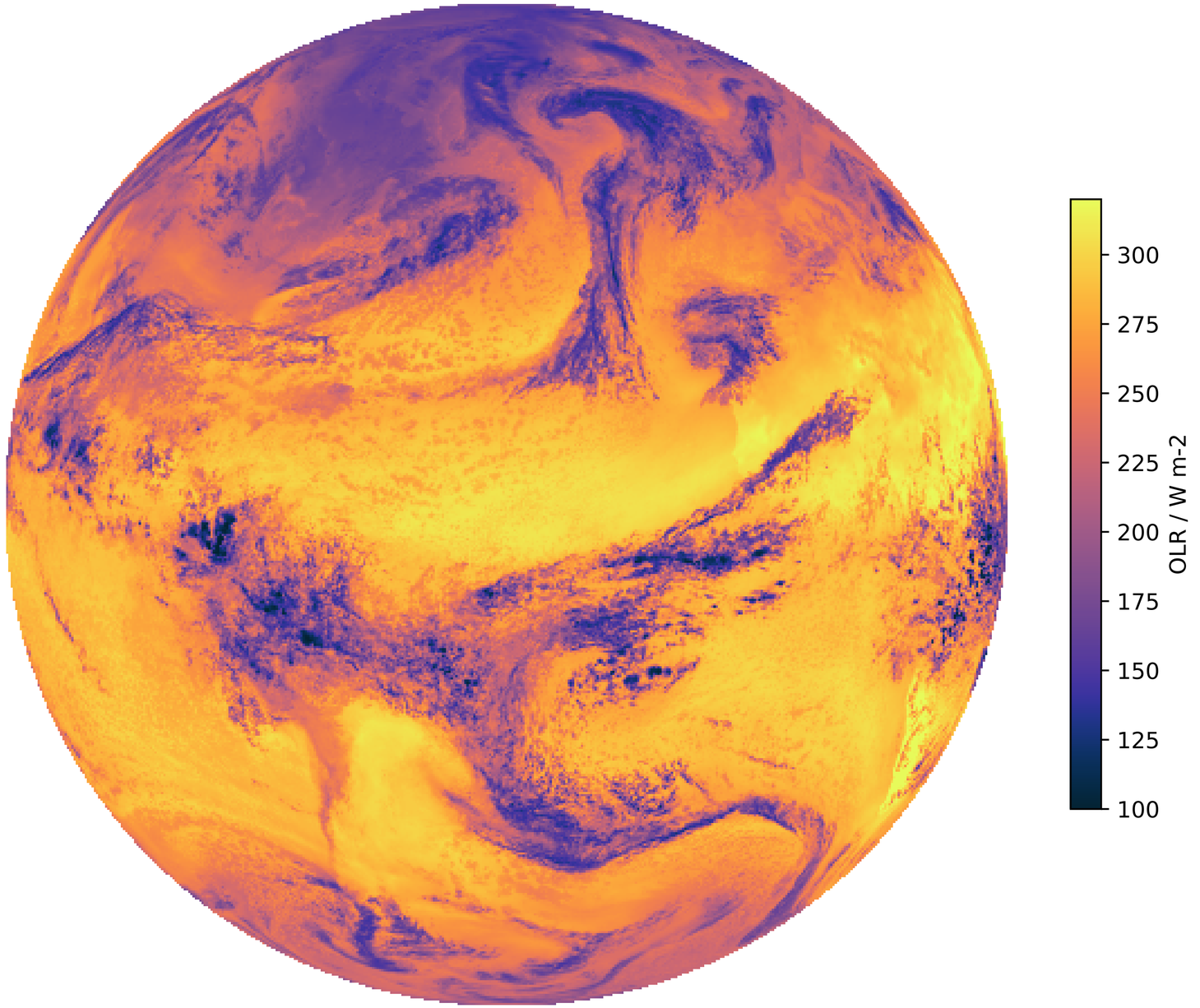


Simulating the tropical heat budget at kilometre-scale resolution

global simulations with ICON-Sapphire (Hohenegger et al., 2023) using a 5 km grid spacing

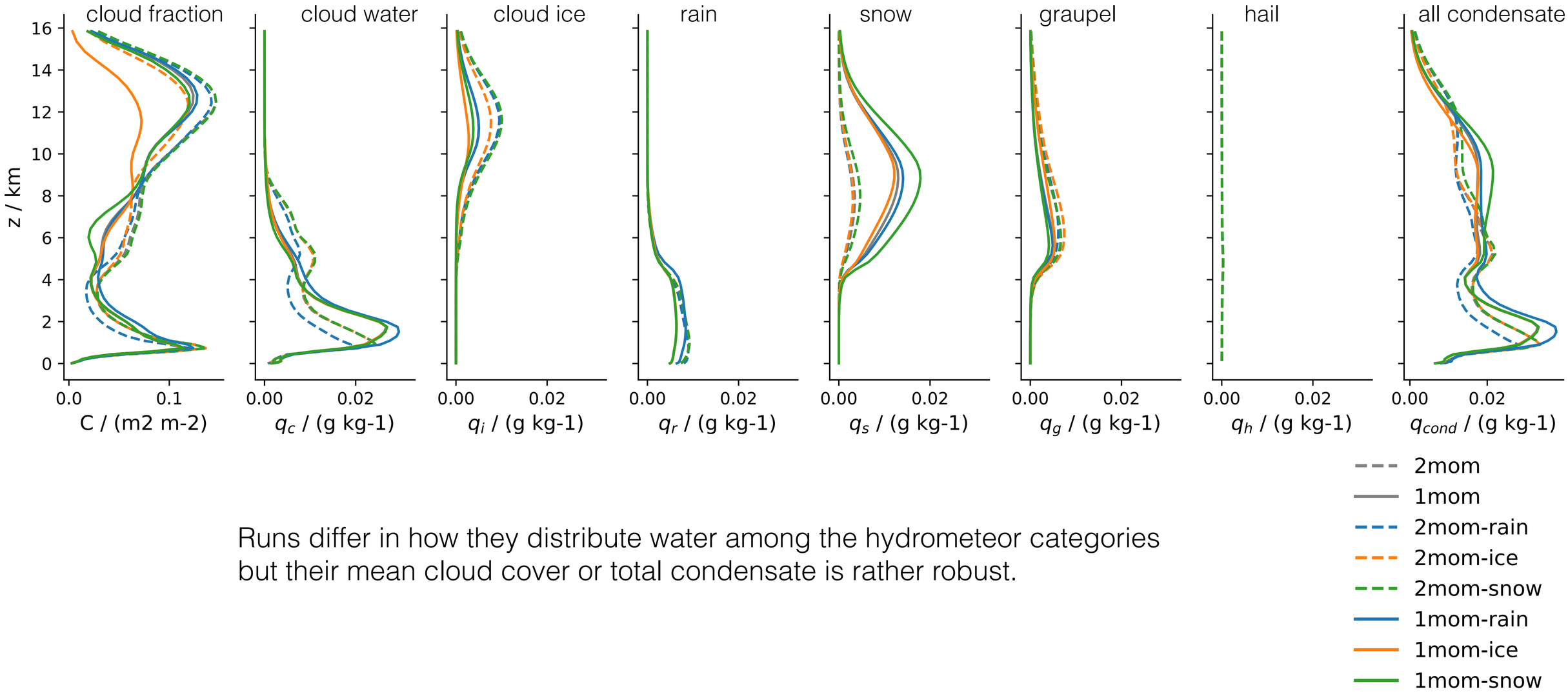
- with a one- and a two-moment microphysics scheme (Baldauf et al., 2011; based on Seifert and Beheng, 2006)
- perturbing one parameter of one hydrometeor category

8 simulations:
1mom
1mom-rain
1mom-ice
1mom-snow
2mom
2mom-rain
2mom-ice
2mom-snow



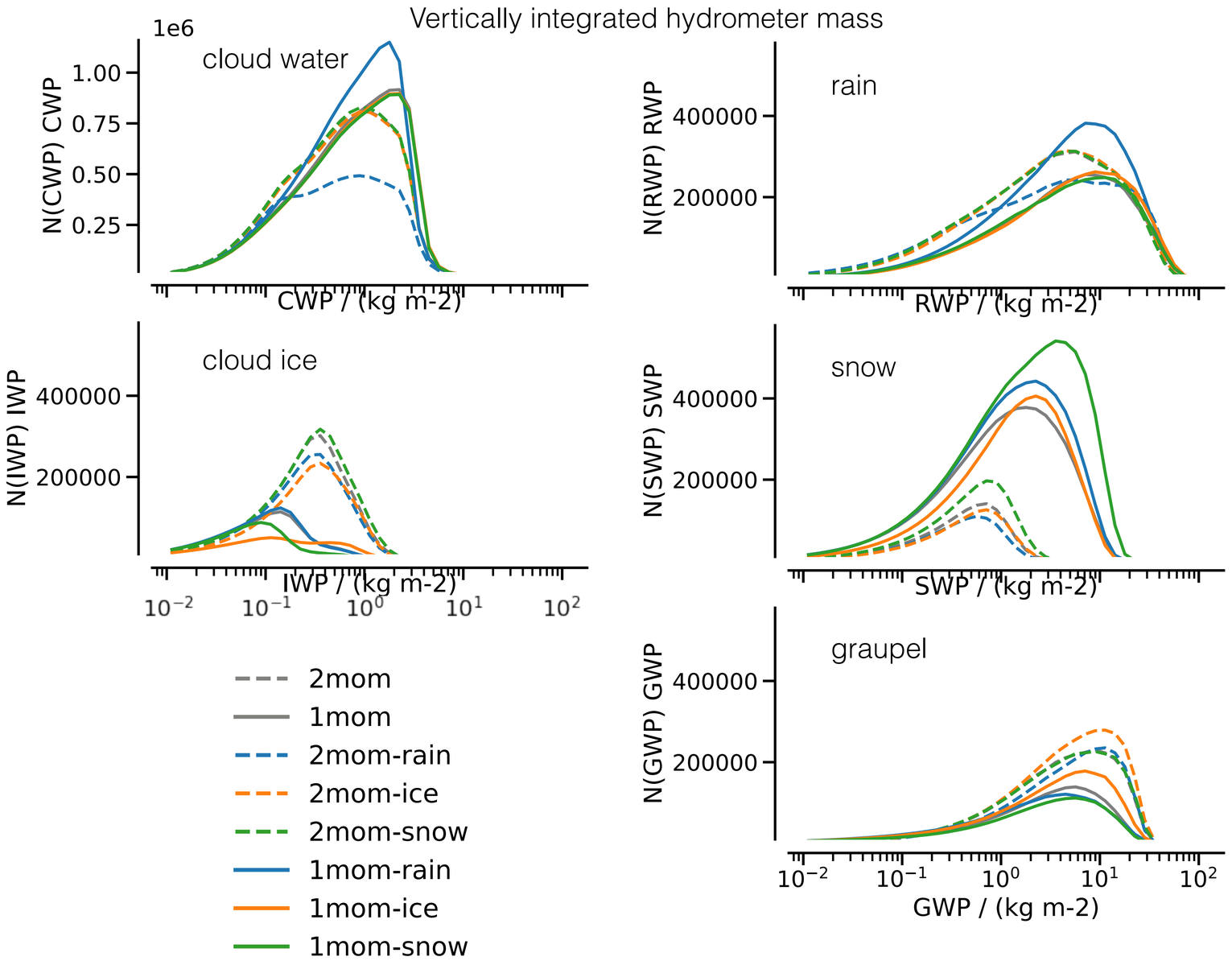
The two-moment scheme less easily converts ice to snow

mean profiles over tropical oceans



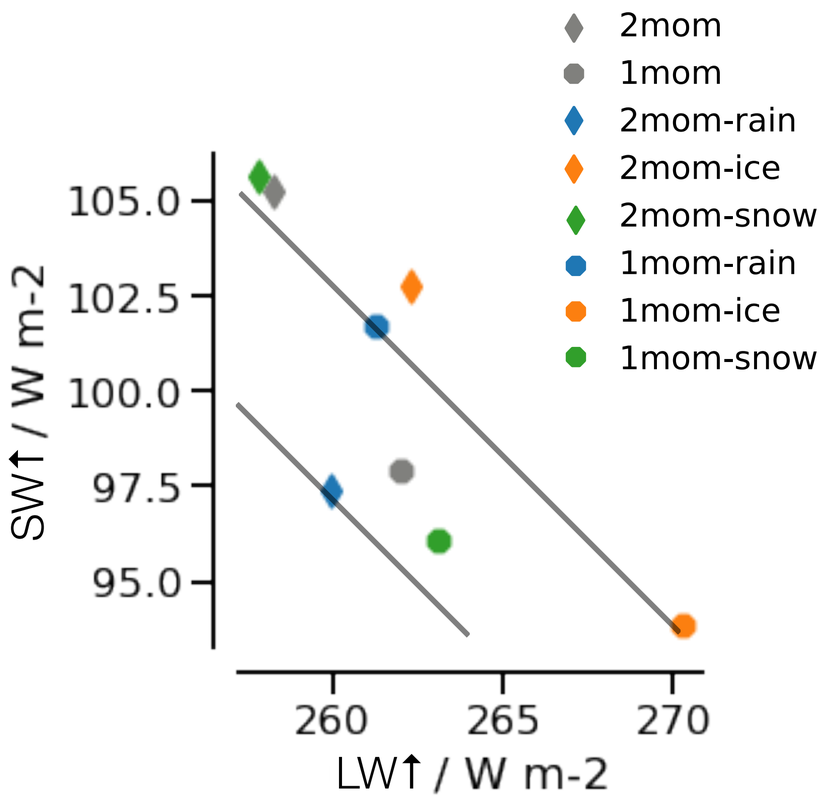
Runs differ in how they distribute water among the hydrometeor categories but their mean cloud cover or total condensate is rather robust.

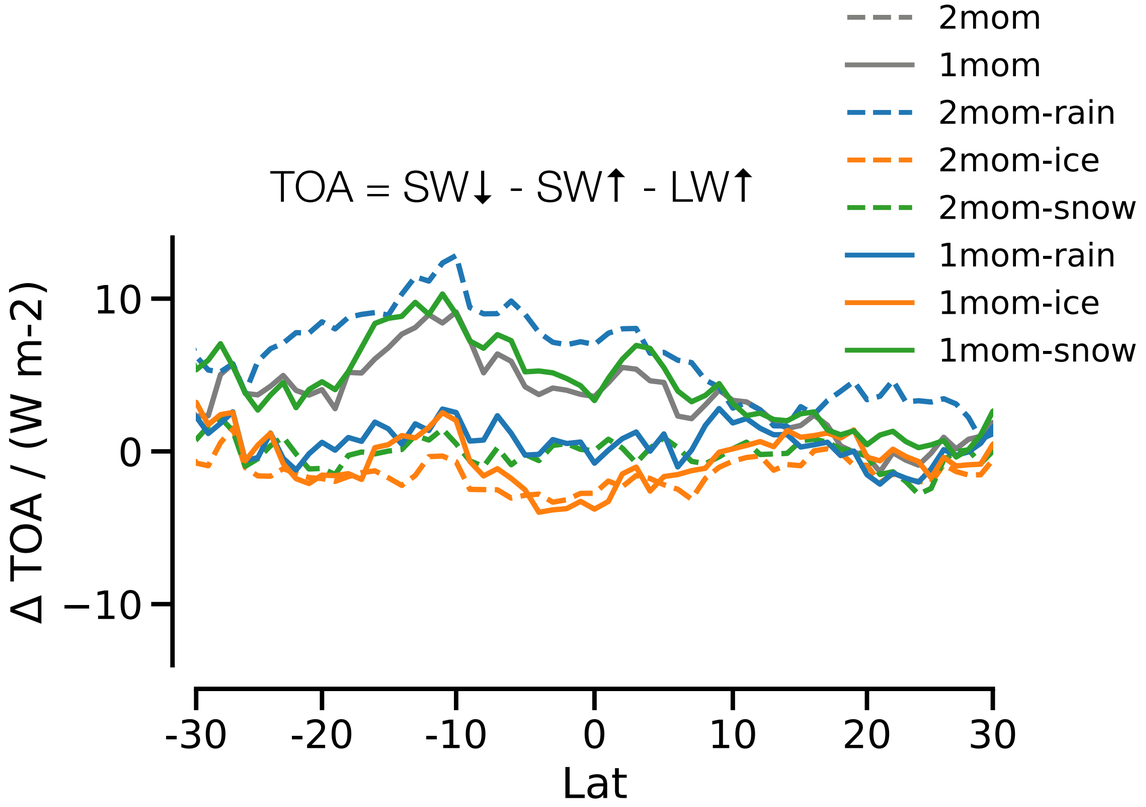
Cloud ice occurs in higher concentrations in the two-moment scheme



We expect an effect on the heat budget because in ICON ice is radiatively active while snow is not.

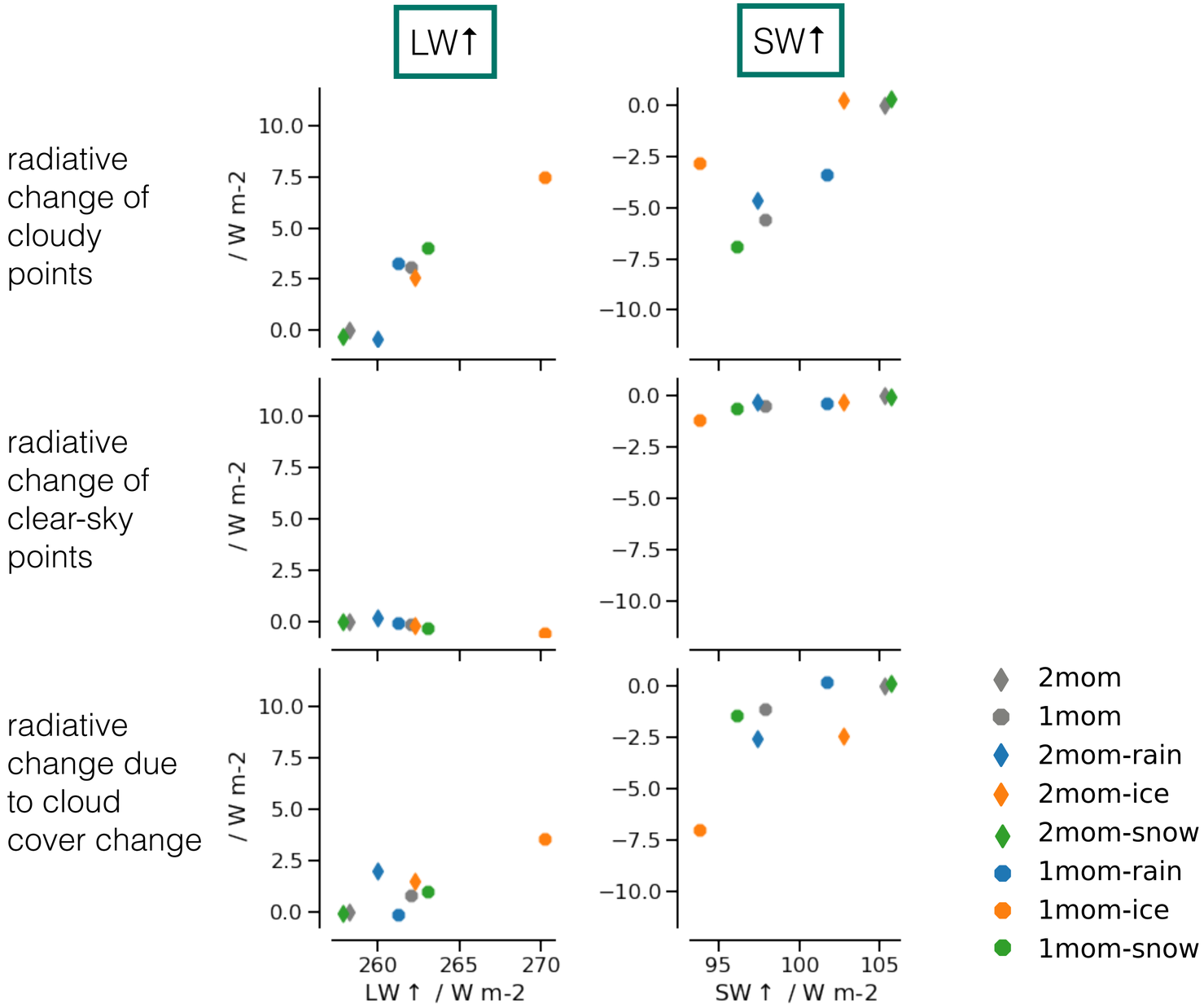
Radiation balance at the top of the atmosphere (TOA)





While microphysical effects largely balance for the net TOA flux, differences of a few W m-2 remain.

Decomposition of radiative changes at TOA



Changes in radiative properties of cloudy points dominate changes in the radiative balance at TOA.

Microphysical controls on condensate distributions and the tropical energy budget in global storm-resolving models

- Tropical cloud cover and total condensate are robust to changes in microphysical schemes and parameters.
- Differences between the simulations with a one- and two-moment scheme are much larger than among the perturbed runs of one scheme.
- Runs differ in how they distribute water among the hydrometeor categories.
- Higher concentrations of cloud ice in the two-moment scheme affects the radiative properties of cloudy grid points.