Sensitivity of (sub)tropical convection and large-scale circulation to parameterized shallow convective momentum transport

Louise Nuijens (TU Delft)

Main idea:

In this breakout group I want to discuss and elicit interest in organizing a modelling activity that addresses the question:

What is the impact of shallow convective momentum transport on the structure of the ITCZ?

Some background info:

Despite playing a key role in the atmospheric circulation, the representation and impact of momentum transport by moist convection, in particular shallow convection, has been largely overlooked by the model community over the past decade, compared to diabatic and radiative effects of clouds. Recent observations and simulations suggest that in particular larger organized shallow precipitating systems accompanied by mesoscale flows influence the large-scale wind in ways that go beyond a simple cumulus friction effect that extends beyond the top of the turbulent mixed-layer.

To the extent that the large-scale circulation is driven by boundary layer wind convergence, convective momentum transport (CMT) can play an important role in setting the intertropical convergence zone and thus strength of the Hadley circulation. This makes parameterized (shallow) CMT an important candidate to take into account when addressing double ITCZ problems in climate models. It is a challenging coupled problem that involves feedbacks of surface fluxes, with so far little observational constraint on the boundaries of the effects.

There is evidence from global experiments that shallow CMT matters. For instance, the ECMWF IFS model, as well as ERA5, produces excessive near-surface easterlies and a weaker meridional overturning circulation. The bias near the surface goes away without shallow CMT, and reveals errors in winds and pressure gradients throughout the lower atmosphere that are coupled to equatorial convection. Highly idealized aquaplanet experiments using the CESM show that shallow CMT promotes a double ITCZ, while deep CMT promotes a single ITCZ.

Proposal to be discussed:

Global models in aquaplanet mode may be used to study the influence of shallow CMT through the use of different existing parameterizations or by turning off shallow CMT. This can be done using ways to maintain the same climatological distribution of surface wind used in surface flux parameterizations, and it may be done in atmosphere only or ocean-atmosphere coupled runs.

In the session I will present both observational and modelling evidence so far and will solicit feedback. Participation and ideas on the use of global CRMs or alternative experiments are very welcome.