Project: **1246**
Project title: **ROMIC II - Joint project: The Quasi-Biennial Oscillation in a Changing Climate (QUBICC)**
Principal investigator: **Marco Giorgetta**
Report period: **2021-11-01 to 2022-10-31**

The project aims to understand how the quasi-biennial oscillation modulates tropical deep organised convection. This may happen through different mechanisms: (i) horizontal wind and its vertical shear; (ii) adiabatic temperature changes in the upper troposphere / lower stratosphere; (iii) diabatic temperature changes; or possibly (iv) a combination of (i) to (iii). While the mechanisms (i) to (iii) cannot be separated in realistic experiments, this is possible in idealized experiments. Specifically we use an aqua-planet setup in ICON-A with further modifications as necessary for testing each of the mechanisms.

First results

The focus is on tropical conditions. The lower boundary conditions of the aqua-planet were modified to these conditions by scaling the sea surface temperature (SST). This allows an aqua planet simulation with SST and meridional SST gradients adapted to the tropics. In the next step, the u-wind QBO nudging is implemented. The experiment series (i) is calculated with three different stratospheric u-wind profiles (Figure 1) and a control simulation without any nudging.

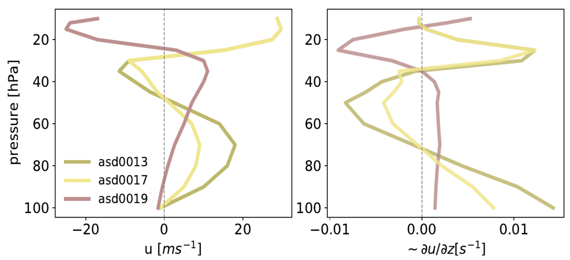

Figure 1 Idealised stratospheric u-wind profiles (left) and the corresponding vertical wind shear (right).

These first experiments are performed each for 30 days on mistral. After 30 days, the aggregation of the convection has progressed so far that two convection bands have formed in the individual experiments (Figure 2).

A composite of the vertical profiles of cloud properties inside the convection cells, here defined as exceeding the cloud water and cloud ice content of 0.1 g/kg, illustrates that no differences within the convection cells can be identified in this first analysis. This suggests that the role of the QBO associated wind and wind shear has a minor influence on the organised tropical deep convection.

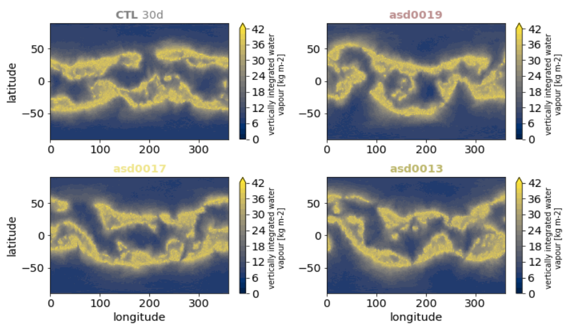

Figure 2 Snapshot of vertically integrated water vapour 30 days after inclusion of the qbo nudging. Profiles for asd0019 (upper right), asd0017 (lower left), and asd0013 (lower right) are shown in Figure 1. CTL is without QBO nudging.

The first analysis of these experiments shows during the aggregation process no significant differences in cloud properties (Figure 3) and temperature (not shown) between the experiments, indicating a minor influence of the QBO associated zonal wind structure on tropical deep convection.

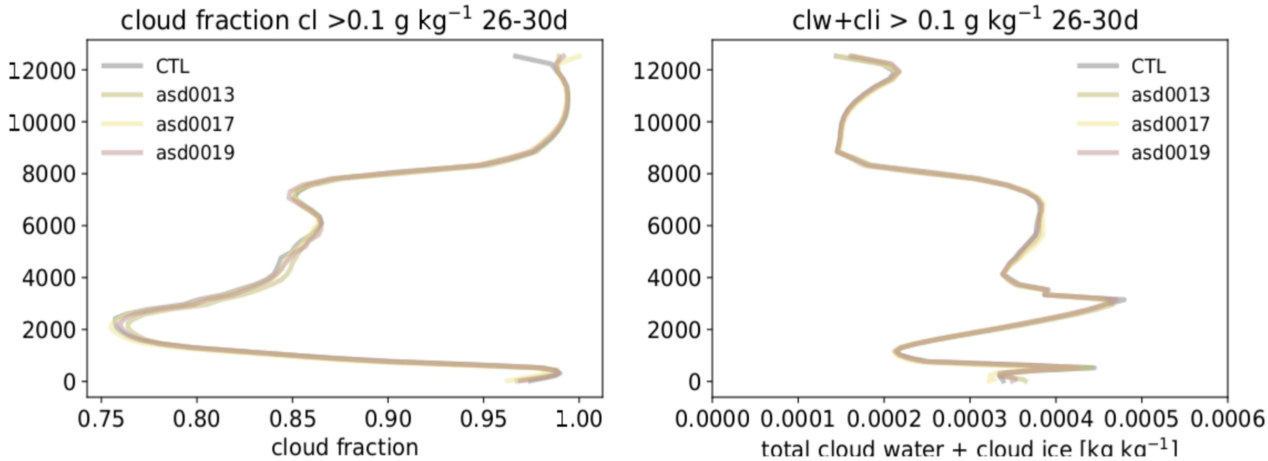

Figure 3 Mean vertical profiles of cloud properties for grid cells with cloud water and cloud ice content greater than 0.1 g/kg.

Transition from Mistral to Levante

In early summer 2022 the project migrated from Mistral to Levante and faced some technical problems concerning the model configuration for the new environment. Practically this required to change the code version and to reimplement the code changes developed for the experiments of this project. Additionally it showed that the new code on Levante was slower than expected from the nominal power increase of Levante nodes vs. Mistral nodes. The experiments for the mechanisms (ii) and (iii)and for the combination of all of them (iv) are therefore delayed and must be included in a new HLRE-request. The next step consists in the implementation of the meridional wind QBO nudging for the mechanism (ii), i.e. for testing the effect of the adiabatic temperature change on the deep convection.