16/03/2016: RCE Investigation of Convective Cloud Spectrum

Goals

- To learn how to pose meaningful scientific questions and set about answering them.
- To get experience in running the Idealized UM and analysing its output.

Questions to be addressed:

1. How resolution affects cloud spectrum statistics.
2. How closely parameterized models match Cloud Resolving Models (CRMs).
3. What happens when convection parameterization is run at CRM resolution.

When addressing question 1, I will need to use diagnostic tools for determining cloud cells and tracking these over time. Of interest will be: cell lifetime, cell lifecycle, number of cells, statistics of cell spectrum and total cell mass flux (upwards and downwards). Another facet of the study could involve looking at how these statistics are affected by performing the same analyses at downscaled resolutions (e.g. $2\Delta x$).

Question 2 will build on question 1 by analysing how a parameterized model compares to a CRM when the CRM is downscaled to the same resolution as the parameterized model. In particular, whether the parameterized mass-flux matches the diagnosed mass-flux from the CRM, and how the flow in the parameterized model matches the downscaled CRM flow. The latter could be done by comparing the spectral decomposition of the respective flows.

In question 3 I will see how the overuse of parameterization impacts on a CRM resolution model. The aim will be to shed some light on the way the parameterization interacts with the model dynamics when both are effectively modelling the same phenomenon.

Hypotheses to be tested:

- **Energy balance:** Total surface heat flux should balance OLR.
- **Moisture balance:** Latent heat flux should balance precipitation.
- **Convergence:** Whether cell statistics converge when going to higher resolutions.

Model setup and runs

The model used will be the Idealized UM (IdUM), version 10.3(4?). The model will be run with interactive radiation, over a sea held at around 300 K, with bi-periodic boundary conditions, over a domain of 60 km x 60 km. Models will be run until a steady-state is reached, and then for an additional time period to allow gathering of statistics (how long? considerations?). High resolution runs without convective parameterization will be run at $\Delta x = 200\,\text{m}$, 300 m and 400 m to allow for a comparison of resolutions and to check for convergence. Parameterized runs will be done at $\Delta x = 200\,\text{m}$ and 12 km, representing the over-parameterized run and the sensibly parameterized run respectively.

The Smagorinksy turbulence parameterization will be used throughout. (? check this.)