I. Introduction

Recent empirical studies across a broad range of observational scales have attempted to characterize aspects of convective phenomena with a view to rerouting convective parametrizations. In this contribution, we aim to characterize aspects of convective phenomena with a view to rerouting convective parametrization. We will further characterize precipitation and column moisture content, as well as, study precipitation clusters properties, in order to improve understanding about atmospheric convection self-organization processes.

II. Data - Unified Model Output

We simulate a multi-year, 3-D, Cloud-Resolving Simulations of Different Aggregation Scenarios. The model is run at 16 km and the model domain size 72x72x36 km and periodic horizontal boundary conditions. It is run for 40 days.

We also analyze real case of organized convection that resemble the idealized setup. They are centered on the equator where rotation effects are at a minimum; have an aggregated (highly clustered) state within at least the middle 5 days of the 15-day simulation but still significant mean rainfall during that time; as well as, sufficiently warm sea surface temperatures (SSTs).

The lateral boundary conditions come from ECMWF operation analyzes (updated every 6 h) simulation but still significant mean rainfall during that time; as well as, sufficiently warm sea surface temperatures (SSTs). Rotation effects are at a minimum; have an aggregated (highly clustered) state within at least the middle 5 days of the 15-day simulation. The model physics includes Smagorinsky-type sub-grid mixing in the horizontal and vertical dimensions and a mixed-phase microphysics scheme with three-component: ice/snow, cloud liquid water, and rain. Almost all rainfall is generated explicitly.

Perturbed studies have tried to connect convective organization with theories of critical phenomena and statistical physics (Peters and Soden, 2006; Peters et al., 2008). We have obtained the classic cluster labeling algorithm, but here our focus is on the coarsening of the clusters to be also reconsidered as neighbors. This algorithm is an application of the well-known to computer science Union-Find algorithm.

Figure 2: This figure shows the evolution of the cluster identifications algorithm used, applied to a matrix of bits which sites can be filled (blue) or empty (white).

We also look at how cluster statistical properties change with coarse graining. In this case, we consider energy released, which is the area multiplied by the total amount of rain. A clear data collapse is obtained for the different spatial aggregations.

Figure 5: Cluster size (horizontal area of the clusters) distributions for the different runs. The figures indicate which clusters are not indicative and which values are not missed.

The distribution of cluster sizes are present differences for the idealized and the realistic run. The distributions can be approximated by a power law for several orders of magnitude, as seen for real data by Peters et al. (2009), Wood and Field (2011).

Figure 3: Distribution of the rain rate (a) and the integrated column water vapor (b) for the different runs. In (a) we show the distribution of the rain rate for run A for different coarse grained (averaging to one single value, values corresponding to 2x2 grid points and grid point), (b) shows the same as (a) but resolved.

V. Results - Precipitation-Moisture Relationship

We analyze the functional relationship between column water vapor and the average precipitation. In this case, the idealized run curve peaks much earlier than the realistic run. For the idealized run and for the spatially coarse grained corresponding output, the curves are comparable an asymptotic approach to a maximum over rate. For the realistic run, it is unclear if it saturates or not around a precipitation average value.

Figure 4: Relationship between column water vapor and the average precipitation for all runs (a) and for different coarse spatial aggregations for run A. We also analyze the upscale evolution of the precipitation and CWV fields in time and space. We distinguish if the precipitation comes from a convective or an stratiform cloud.

VI. Results - Clusters Properties

• The rain rate distributions can be approximated with a power law with an exponential tail for the three-case-study.
• The column water vapor distributions peaks around the so-called ‘critical value’ in Peters and Soden (2006), however we do not observe long tail.
• The functional relationship between column water vapor and the average precipitation has a clear up pick.
• The point of pick up depends on the run. For high water vapor values the shape is unclear.
• In addition, the effect of spatial averaging does not explain the differences, as suggested by Yaroslav et al. (2012). As recently pointed out by Gillese (2015) and Almen and Shinbiorn (2015), this relationship study is dissipated due to the low sensitivity to noise.
• The distribution of cluster sizes are present differences for the idealized and the realistic run. We analyze the energy released per cluster distribution has scaling properties.

Conclusions

• We are working on expanding the analysis to a 1 minute temporal resolution (current analysis uses hourly data).
• Determining if the precipitation comes from a convective or stratiform cloud.
• Analyze correlated of the precipitation and CWV fields in time and space.

Outlook


References