Geophysical Research Abstracts
Vol. 20, EGU2018-10702, 2018
EGU General Assembly 2018

Convective aggregation driven by large-scale instabilities

Chiel van Heerwaarden (1), Lars van Galen (1), and Linda Schlemmer (2)

(1) Wageningen University, Meteorology and Air Quality Group, Wageningen, Netherlands, (2) Institute for Atmospheric and Climate Science, ETH Zürich, Switzerland

Convective aggregation and its explanation has played an important role in studies of radiative-convective equilibrium in recent years. The understanding of this phenomenon remains incomplete and multiple hypotheses exists for the mechanisms driving the onset of aggregation as well as the following development into a single large structure. One particularly striking property of aggregation that came out of simulation studies is that for many studies it only happens in a sufficiently large domain, although even this observation is not consistent among studies (Wing et al., 2017, Surv Geophys).

In our study, we have on focused on the question whether aggregation is driven from the small scales up, or from the large scales down. The former would suggest a gradual increase in the dominant horizontal length scale in the turbulent moisture field, whereas in the latter case the formation of large wet and dry patches is independent of the range of scales present in the turbulent fields.

We have performed large-eddy simulations of a non-rotating RCE with the MicroHH (www.microhh.org) model. Rather than running a full radiation model, we have chosen for a simpler configuration with a described cooling profile with additional cooling in those regions where the integrated liquid water path is less than 80 per cent of the maximum in the domain, following the paper of Muller and Bony (GRL, 2015).

Based on extensive spectral analysis of various fields in the domain, we found out that in our simulations the clustering starts at the lowest wave numbers in the domain, which represent scales larger than 120 km. These wave numbers are unstable, and variance at these spatial scales is increasing, while the scales in between those unstable modes and those that belong to turbulence contain almost no variance.

Our study has also shown that the speed of clustering is sensitive to the imposed surface roughness and that the surface-layer formulation might be an underappreciated factor in convection over surfaces with a constant temperature.