D2.2 Data from interface and cloud direct numerical simulations

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D2.2: Data from interface and cloud direct numerical simulations

Work Package 2 is responsible for studying the dynamics of turbulent entrainment of dry environmental air into the cloud and the consequent microphysical and dynamics effects of turbulent mixing. To generate the corresponding datasets from simulations, studies are to be carried out by increasing the complexity in a step-by-step manner by adding different physical processes. The first simulation would include an Eulerian framework with a bulk approach to simulate wet thermodynamics. The second step would include a Lagrangian study on non-inertial tracer particles. The final step would include simulations of inertial droplets with the effects of collision and coalescence added. In this report, a brief description of the numerical setup and the data generated from the first step is included.

The main aim of this study was to develop a setup to study the interaction at cloud edges. Evaporative cooling of water droplets at cloud edges due to entrainment of dry environmental air results in the formation of a negatively buoyant subsiding shell. The dynamics of this subsiding shell was studied in detail. The shell is important since it acts as a buffer layer and pre-conditions the air entering and leaving the cloud. A detailed self-similarity analysis is conducted and empirical relations have been generated to predict the strength and thickness of the shell as a function of time. The results have been formally accepted to be published in the Journal of Atmospheric Sciences.

The setup was to be designed as close to actual actively growing cloud conditions; with a distinct cloud core with updrafts, surrounded by a thin subsiding shell layer with downdrafts. This was achieved by opting for temporal flow experiments in which the development of a small region at the edge of a shallow cumulus cloud is studied. The numerical domain is divided into a two-layer cloud-environment setup with a bulk thermodynamics approach adopted to simulate the moist cloud layer as shown in fig 1. The simulations are run using the in-house code SPARKLE.

The data provided includes the results from ten different simulations performed in this study. The simulations vary in the initial states of liquid water potential temperature (θ_l), specific humidity of total water vapor (q_t), and the strength of the updraft (w_c) in the cloud layer. The initial values are shown in table 1. The last column in the table indicates whether a subsiding shell forms in the simulation or not.

The data involves plane averaged statistics, budgets for the total kinetic energy and 2d slices to generate movies. Detailed description of the files have been provided in the README.txt file attached with the data.

Reference:

Nair, V., T. Heus, and M. van Reeuwijk, 2019: Dynamics of Subsiding Shells In Actively Growing Clouds With Vertical Updrafts. *Journal of the Atmospheric Sciences*, https://doi.org/10.1175/JAS-D-19-0018.1

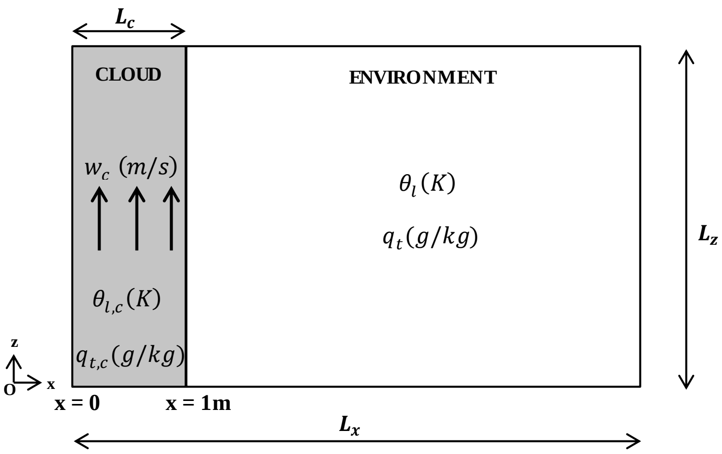

Figure 1: Numerical setup.

Table 1: Simulation parameters.

Sim No	Grid size	$\Delta\theta_l(K)$	$\Delta q_t(g/kg)$	$\theta_{lc}(K)$	$q_{lc}(g/kg)$	$w_c(m/s)$	$t_{\mathrm{sim}}(s)$	Shell
A01	3072 x 1536 x 1536	-6.2	5.4	288.5	3.0	0.81	148	Yes
A02	1536 x 768 x 768	-8.1	6.3	286.1	4.3	0.96	120	Yes
A03	1536 x 768 x 768	-5.9	5.5	288.7	3.0	0.81	120	Yes
A04	3072 x 1536 x 1536	-2.1	4.0	292.6	1.3	0.67	148	Yes
A05	1536 x 768 x 768	-5.2	6.0	292.8	3.0	0.52	148	Yes
A06	1536 x 768 x 768	-1.9	1.8	294.1	0.8	0.31	180	Yes
A07	1536 x 768 x 768	-2.6	2.0	296.4	1.3	0.31	240	No
A08	1536 x 768 x 768	-0.8	2.9	299.2	0.9	2.03	100	No
A09	3072 x 1536 x 1536	-2.6	2.0	300.4	1.2	0.43	220	No
A10	1536 x 768 x 768	-0.8	1.3	301.2	0.3	2.00	120	Yes