SPECIAL PROJECT PROGRESS REPORT

All the following mandatory information needs to be provided. The length should *reflect the complexity and duration* of the project.

Reporting year	2021 (first half year)
Project Title:	Mesoscale Organisation of Shallow Cumulus Convection ……………………………………………………………….……
Computer Project Account:	spnlsieb
Principal Investigator(s):	A.P. Siebesma
Affiliation:	Delft University of Technology
Name of ECMWF scientist(s) collaborating to the project (if applicable)	……………………………………………………………….…… ……………………………………………………………….……
Start date of the project:	01-01-2021
Expected end date:	31-12-2021

Computer resources allocated/used for the current year and the previous one

(if applicable)
Please answer for all project resources

		Previous year		Current year	
		Allocated	Used	Allocated	Used
High Performance Computing Facility	(units)	n/a	n/a	10000000	0
Data storage capacity	(Gbytes)	n/a	n/a	2000	0

Summary of project objectives (10 lines max)

The execution of a series of high resolution large eddy simulation runs over large domains in various configurations, based on the EUREC4A observations. These simulation will help answering a number of key questions on mesoscale organisation shallow cumulus convection over the subtropical oceans in present and future climate.

Summary of problems encountered (10 lines max)

Geiske de Groot, a Phd student who was planning to set up and execute the EUREC4A runs with our Large Eddy Simulation model (DALES) is suffering from long-Covid has not been able to work on this project since November 2021. For this reason Allesandro Savazzi (TU Delft) works now on this project and is preparing and testing the set up of the runs. At the moment we are testing the coupling of DALES with HARMONIE. The latter model provides the lateral boundary conditions. This testing has been done on our local machines on small domains and needed to be done before starting the large domain runs on ECMWF's HPC. Hence we have not used any SBU's so far.

Summary of plans for the continuation of the project (10 lines max)

Plans for simulations for 2021:

1. ***CTRL-run:*** Simulations of the period 05-02-2020 to 11-02-2020 on a 100 by 100 km domain. Horizontal resolution 100m. 80 levels in the vertical with a resolution of 20m near the surface increasing to a resolution of 50m around 5 km height. Periodic Boundary Conditions. Spatially Uniform SST. Control Simulation
2. ***SST-Pattern-run***: As the CTRL but with a SST-pattern superposed on the mean SST to explore the effect of SST variations of mesoscale cloud organisation.
3. ***OPEN-BC-run:*** As the CTRL but with open-BC instead of periodic boundary conditions. We have just developed an option to run DALES with open boundary condition, which is, certainly at larger domains of 100 km and beyond a more realistic way of downscaling.

If successful the plan is to extend the period of the runs to the full period of the EUREC4A experiment and after that repeat it with a Pseudo Global Warming (PGW) experiment which will provide an answer how these clouds and the simulated mesoscale organisation will change with global warming and how the radiative cloud feedback is affected. These runs are foreseen in 2022.

List of publications/reports from the project with complete references

None so far….

Summary of results

If submitted **during the first project year**, please summarise the results achieved during the period from the project start to June of the current year. A few paragraphs might be sufficient. If submitted **during the second project year**, this summary should be more detailed and cover the period from the project start. The length, at most 8 pages, should reflect the complexity of the project. Alternatively, it could be replaced by a short summary plus an existing scientific report on the project attached to this document. If submitted **during the third project year**, please summarise the results achieved during the period from July of the previous year to June of the current year. A few paragraphs might be sufficient.

During the first halve year we have experimented with the set up of the runs where we concentrated on 05-02-2020. In general the large scale forcings for temperature and specific humidity ϕ can be written as

$$\left.\frac{\partial \widetilde{\psi}}{\partial t}\right|_{\mathrm{LS}} = -\underbrace{\left\langle u_j^{\mathrm{LS}} \frac{\partial \psi^{\mathrm{LS}}}{\partial x_j}\right\rangle}_{\text{advection}} - \underbrace{\left\langle w^{\mathrm{LS}}\right\rangle \frac{\partial \widetilde{\psi}}{\partial z}}_{\text{subsidence}} + \underbrace{\frac{1}{\tau_{\mathrm{n}}}\left(\left\langle \psi^{\mathrm{LS}}\right\rangle - \left\langle\widetilde{\psi}\right\rangle\right)}_{\text{relaxation}} + \underbrace{\left\langle F_\psi^{\mathrm{LS}}\right\rangle}_{\text{sources}}$$

Where the large-scale vertical velocity and the horizontal advection terms are determined form the observations.

The simulations of DALES showed a reasonable steady state in the subcloud and cloud layer but a strong warming and drying the free troposphere (Figure 1). The simulated cloud fraction (10-15%) was substantially lower than the observed cloud fraction and contrary to the observation no organised cold pools were simulated (Figure 2). This is most likely due to the fact that the simulated runs were too dry and hence did not produces sufficient precipitation that would trigger cold pool organisation.

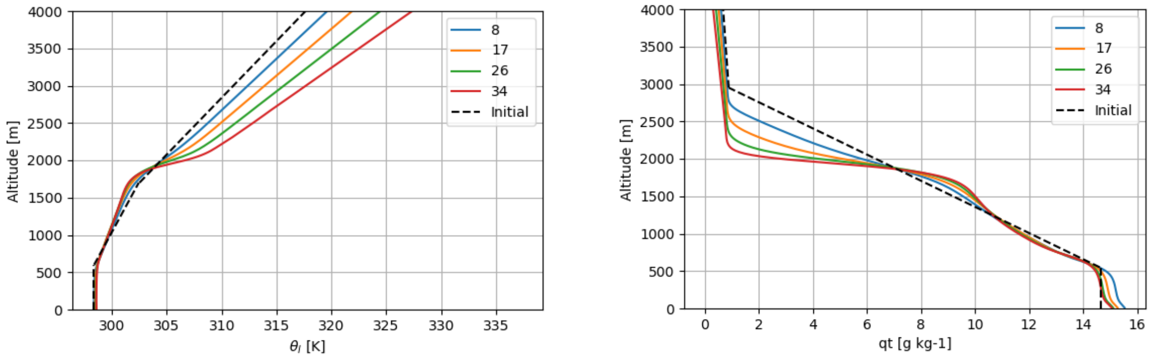

Figure 1: Hourly Profiles of liquid water potential temperature and total water specific humidity of DALES simulation of 05-02-2020 over the EUREC4A domain.

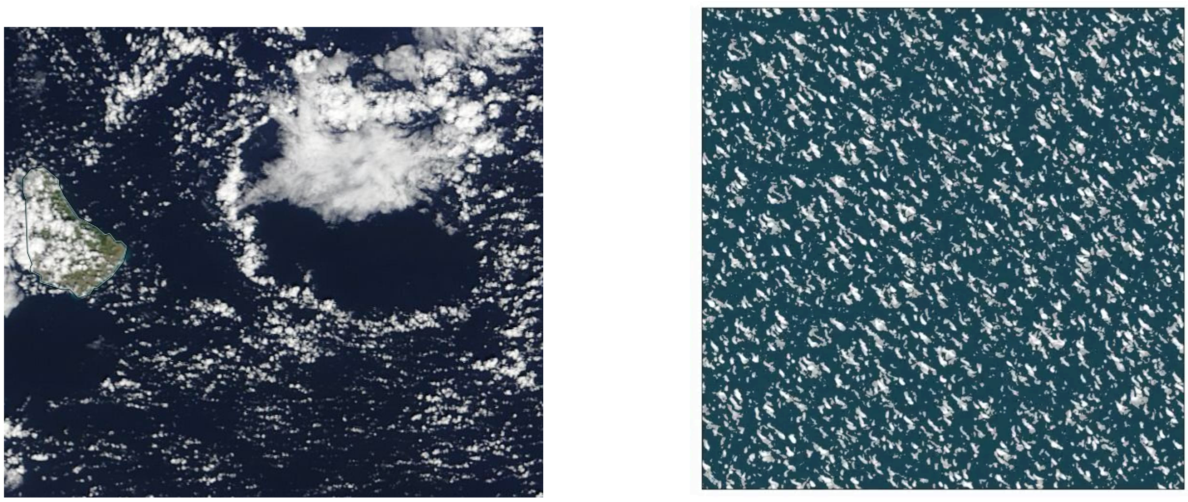

Figure 2 : Top view from the cloud field: left MODIS, right: DALES

Reasons for this absence of organisation are: the used periodic boundary conditions, the observation based forcings do not have sufficient spatiotemporal variability. So as a next step we have prepared large scale dynamical forings deduced from the operational mesoscale model HARMONIE that will force DALES. Alternatively we also formulated the option that DALES can run now with open boundary conditions. Also these will be obtained from HARMONIE.