SPECIAL PROJECT PROGRESS REPORT

Progress Reports should be 2 to 10 pages in length, depending on importance of the project. All the following mandatory information needs to be provided.

Reporting year	Until June 2017…………………………………..……
Project Title:	Spatial and temporal dependencies extreme precipitation in a warming climate using large eddy simulation …………………………………………………………..……
Computer Project Account:	SPNLLEND…………………………………………..……
Principal Investigator(s):	G. Lenderink…………………………………………..…… …………………………………………………………..……
Affiliation:	KNMI…………………………………………………..……
Name of ECMWF scientist(s) collaborating to the project (if applicable)	…………………………………………………………..…… …………………………………………………………..……
Start date of the project:	1-1-2017……………………………………………..……
Expected end date:	31-12-2018…………………………………………..……

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)			5,000,000	-

Data storage capacity	(Gbytes)			12,000	-

Summary of project objectives
(10 lines max)

In this project we will investigate with a Large Eddy Simulation (LES) changes in precipitation extremes in a warming climate. We specifically investigate the following questions: i) What are the controlling factors that govern cloud organization? What are the influences of wind shear, instability and moisture content? ii) How does precipitation intensity depend on warming? Does this response depend on the degree of organization of the convective clouds? and iii) How does the degree organization of convective clouds respond to a warming scenario, and how does this impact changes in storm rainfall volume? In order to study these questions a rain-cell tracking algorithm will be applied to LES simulations of convective conditions for present-day climate and future climate conditions, applying a surrogate climate change scenario.

Summary of problems encountered (if any)
(20 lines max)

Testing runs with the Dutch Atmospheric Large Eddy Simulation (DALES) model at ECMWF with the latest version of the model turned out to be more expensive than anticipated, partly due to the rather heavy IO handling. We also had to retune DALES and adjust the modelling code to avoid numerical instability. These runs were done at ECMWF in December 2016 (on the general allocation provided to KNMI) and were not accounted to this project (started after first of January this year). At the moment one runs at ECMWF at an approximately 200x200 km domain costs 130 kSBU. Depending on the exact number of simulation will run at this computational domain, or a 300x300 km domain

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Summary of results of the current year (from July of previous year to June of current year)
This section should comprise 1 to 8 pages and can be replaced by a short summary plus an existing scientific report on the project

A modelling experiment setup has been completed. These consist of the forcing conditions to drive the LES model. They are based on the average large-scale forcing for 297 events of extreme precipitation for the Netherlands. Large-scale forcing conditions have been obtained from a downscaling of ERA-interim with the regional climate model RACMO. The DALES setup consists of 240 vertical levels up to 22 km, and horizontal domain of 192x192 km, with grid spacing of 200m. Runs are one-day long.

We have completed a set of 6 simulations at ECMWF with DALES (in December 2016). 2 simulations for the reference set up, 2 for a 2-degrees warmer, and 2 for a 4-degrees warmer atmosphere. (At the time there were still computational instabilities in the code, which resulted in 3 crashed runs.) Early 2017 we have solved the instability problems, which turned out to relate to a recent update of the LES code. The runs to solve the instability problem have been done locally at KNMI. Also we spent quite some time define and optimize the output of the LES model.

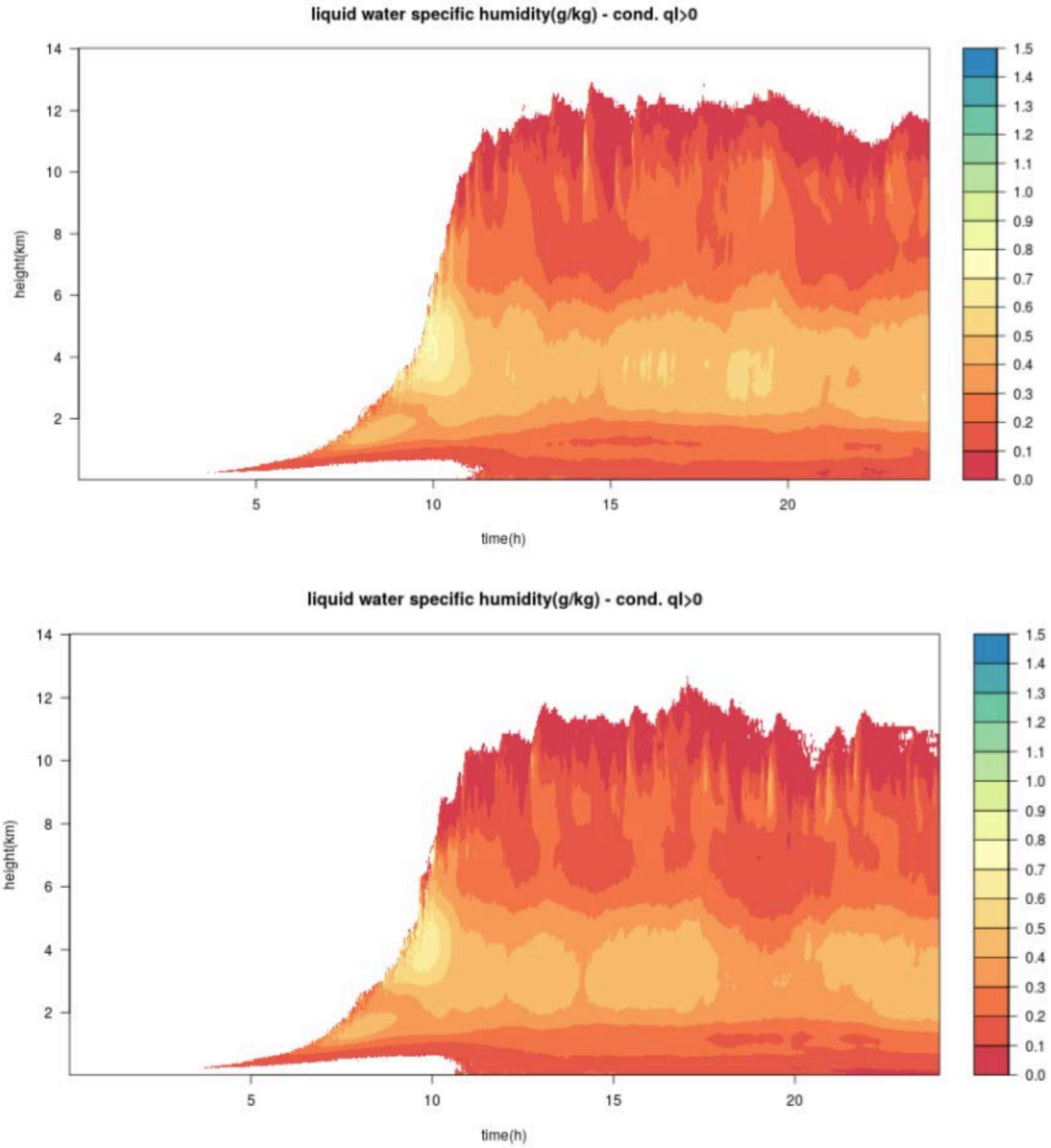

Figure 1. Time series of liquid water conditioned on the cloud and domain averaged as a function of height for the reference simulation (lower panel) and the 2-degrees warmer simulation (upper panel). Clouds develop after 6 hours and reach altitudes up to 12 km. The reference and the 2-degrees warmer simulation are similar, yet the warmer simulation produces higher value of liquid water, and clouds reach slightly higher altitudes.

At the same time the tracking algorithm that will be used to analyse the model results has been further developed, and has been first applied to rain radar data. This also provided further insight to improve our modelling setup. The outcome of the rain radar data is that the so-called super Clausius-Clapeyron (CC) scaling is only obtained for larger scale/organized convective events. As this is the behaviour we would like to track with the LES model, this provides input on our modelling setup. Therefore, we are considering to expand our modelling setup to conditions that favour big convective systems.

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List of publications/reports from the project with complete references

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None so far ……………………………………………………………………………………………

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Summary of plans for the continuation of the project

(10 lines max)

We will perform a first set of sensitivity experiments with our present model setup. These will at least contain 2 different levels of global warming (reference plus two surrogate climate change scenarios). To have a large enough statistical sample, we will also produce a small model ensemble. The runs will be analysed using the rain-cell tracking software which has been developed. In addition, the modelling setup will be adjusted to allow for bigger organized convective systems.
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