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	June 2017 to June 2018… ………………………………………………………
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)	5000 KSBU	4588 KSBU	5000 KSBU	-
Data storage capacity	(Gbytes)			15 Tb	17 Tb

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)

During the reporting period no problems have been encountered

Summary of results of the current year (from July of previous year to June of current year)

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A large ensemble of LES simulations has been performed at ECWMF. As reported earlier our main working domain is 200 by 200 km, but we also performed simulations at 100x100km2 and 300x300km2. An overview of the simulations can be found in Table 1. From these simulations high resolution output has been stored at ECMWF.

A first analysis of the results is now underway. Here, we focused mainly on the standard modeling setup (no nudging), the yellow part of the middle panel of Table 1. Simple statistics have been computed from these simulations, like rainfall area, rainfall intensity and rainfall sums. Figure 1 shows the average intensity as a function of time, where time is normalized with respect to the onset of precipitation. The warmer runs clear have higher intensities during the first several hours after the onset of precipitation, which can be primarily be attributed to the higher moisture content of the warmer simulation. After 10 hours, results become more diverse and the distinction between the warmer and colder simulation is less clear.

A more elaborate analysis focusses on the spatial characteristics of the rainfall fields. Figure 2 shows that there are pronounced differences in spatial extend of the convective rain cells between the colder and warmer simulations. In the warmest simulations large line structures have developed with lengths of more than 50 km. In the coldest simulation there are more rain cells, but their size is considerably smaller. A further analysis of these properties, and a linkage to the underlying dynamical processes in these simulation is now underway. A first draft of a journal paper is currently being written.

Based on the outcome of these analyses we will refine our modeling setup and perform additional experiments in the second half of 2018.

Table of experiments: domain 1, 96 km x 96 km

Run	# ens. members
Reference *†	4
-4 K †	4
+4 K *†	4
Reference with nudging	4

Table of experiments: domain 2, 192 km x 192 km

Run	# ens. members
Reference	1
-2 K uniform temperature perturbation with const. RH	1
-4 K uniform temperature perturbation with const. RH	1
+2 K uniform temperature perturbation with const. RH	1
+4 K uniform temperature perturbation with const. RH	1
Reference with nudging	1
-2 K uniform temperature perturbation with const. RH with nudging	1
-4 K uniform temperature perturbation with const. RH with nudging	1
+2 K uniform temperature perturbation with const. RH with nudging	1
+4 K uniform temperature perturbation with const. RH with nudging	1

Table of experiments: domain 3, 288 km x 288 km

Run	# ens. members
Reference	1

Table 1. Overview of the experiment performed with DALES at ECMWF in 2017

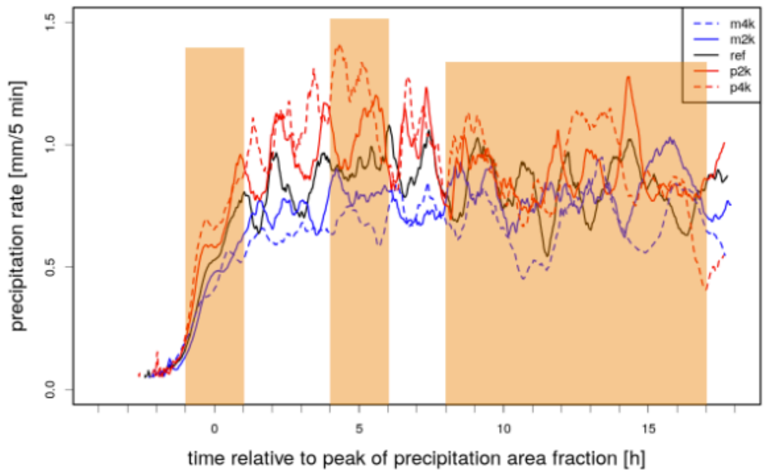

Figure 1. Time evolution of rainfall intensity in the 5 experiments, from coldest (blue dashed) to warmest runs (red dashed lines)

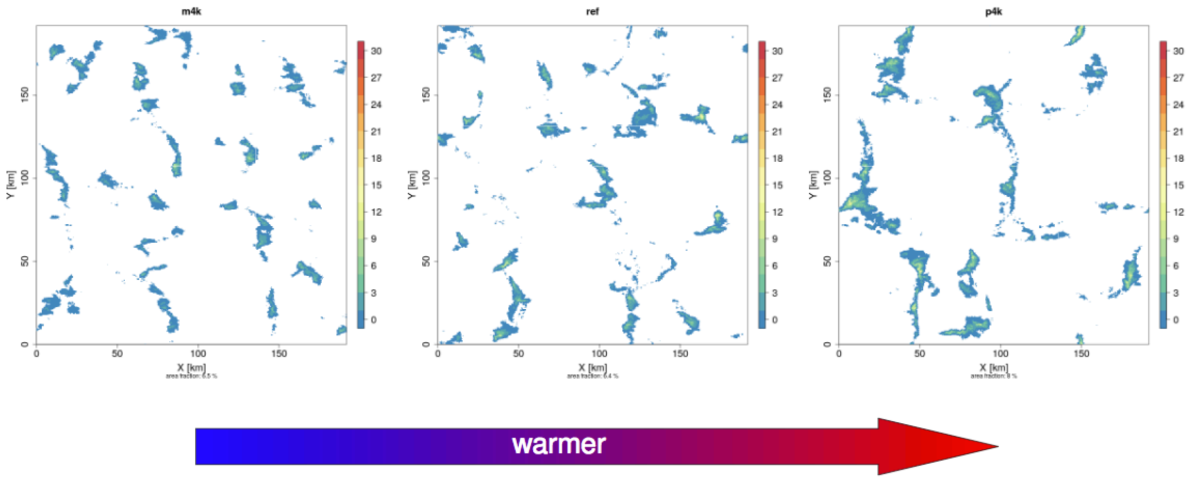

Figure 2. Snapshots of simulated precipitation intensity for the reference simulation (middle) and 4 degrees cooler and warmer conditions, left and right panel respectively. The snapshot is taken around hour 5 after the onset of precipitation (see Figure 1).

List of publications/reports from the project with complete references

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No papers yet……………………………………………………………………

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Summary of plans for the continuation of the project

(10 lines max)

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Based on the analysis of the model runs, and the scientific outcome, we will define a further set of experiments. These may include a different way of large-scale forcing the model. Also, we may do simulations with less wind shear to investigate the influence on the organization of convective clouds. Targeted runs with more detailed output to investigate the mesoscale dynamics is also an option. These runs will be done after summer, and probably start in October.