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	2015
Project Title:	Small-scale severe weather events: Downscaling using Harmonie
Computer Project Account:	SPNLSTER
Principal Investigator(s):	Andreas Sterl
Affiliation:	KNMI (Royal Netherlands Meteorological Institute)
Name of ECMWF scientist(s) collaborating to the project (if applicable)	n/a
Start date of the project:	01 Jan 2015
Expected end date:	31 Dec. 2015, but extension will be requested through new application

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)			25 M	
Data storage capacity	(Gbytes)			15,000	

Summary of project objectives

(10 lines max)

The non-hydrostatic Harmonie model is used to downscale climate model results. It offers the possibility to investigate the effect of climate change on small-scale phenomena like convective rainfall and wind gusts. This is not only relevant from a scientific point of view, but has many applications. for example, wind turbines suffer from night-time low level jets that are not represented well in current climate models.

Summary of problems encountered (if any)

(20 lines max)

- The request for this proposal was based on using Harmonie on a horizontal domain of 500 x 500 grid points (7°W – 10°E, 48°N – 59°N). This domain turned be too small as often convective systems developing over France are advected into the Netherlands. A new domain, including the whole of France and comprising of 800 x 800 grid points, had to be used instead. This increases CPU usage and storage amount by roughly a factor of 2.5.
- A memory leak in the model currently prevents longer (more than about 10 days) runs. The problem is under investigation.

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

The work up to now concentrated on two aspects,

1. technically setting up the model at ECMWF and create an environment for running it over long periods of time
2. identifying the most suitable combination of model physics (parameter values and parametrizations)

Although Harmonie is used operationally at KNMI, action (2) is needed because we use a newer version of the Harmonie code (38h1.2) than is used in operations, with improved parametrizations, and because we want to run the model in climate mode rather than in forecast mode. In climate mode only values at the lateral boundaries of the model domain are regularly updated from the driving model (here ERA-Interim), while it is free to evolve in the interior. In forecast mode, also interior values are regularly updated. The suitability of the model to run in this mode had to be tested.

Setting up the model

The originally envisaged model domain of 500 x 500 grid points proved to be too small. Convective systems often develop over France and are advected into the Netherlands. As convection is not properly resolved in the driving model (the model from which the lateral boundary conditions are taken), this process is not well represented when the southern model boundary lies over northern France. The model domain had therefore to be extended to the 800 x 800 point domain shown in Fig. 1.

The technical infrastructure to perform long model runs was established. It is now possible to run the model in three modes, namely

1. forecast mode: series of short runs, each fully initialized from driving model (“cold start”)
2. hindcast mode: as 1., but soil parameters not initialized but taken from preceding run
3. climate mode: only lateral boundary values and SST from driving model

Hindcast mode is presently used to test the model. Climate model will be used for production.

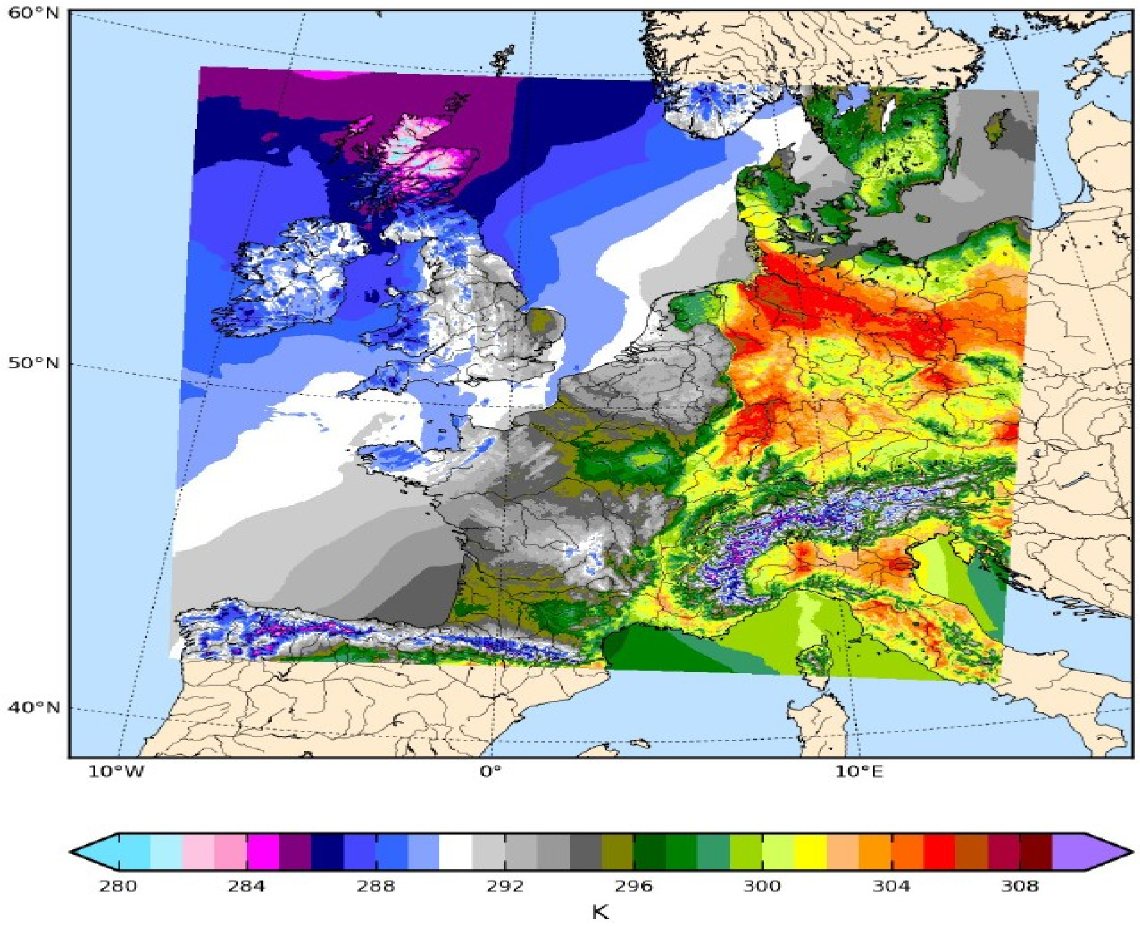

Figure 1: Model domain used. Depicted is surface temperature on 14.07.2010 (for illustration purposes only).

Model physics

A new model version of Harmonie is used (version 38h1.2). It comes with several new parametrization options, which had to be tested. Especially, we tested new parametrizations of

- ice clouds, and
- turbulence (called HaRaTu).

The latter is based on the RACMO turbulence scheme, where it greatly improved the representation of shallow convection. Furthermore, in Harmonie the cloud inhomogeneity factor (INHF) is traditionally set to 0.7. We also investigated the impact of the more natural choice of setting it to 1.

We made runs with different choices for the parametrizations for some months with special characteristics. As an illustration we here show results for August 2010, which was characterised by very high precipitation (155 mm) in the Netherlands. Figure 2 shows the precipitation over that month as simulated by Harmonie, by the coarser RACMO, and from observations. Precipitation intensities generated by Harmonie are in much better agreement with observations than are those from RACMO, but the maxima are shifted a little to the north-east as compared to observations.

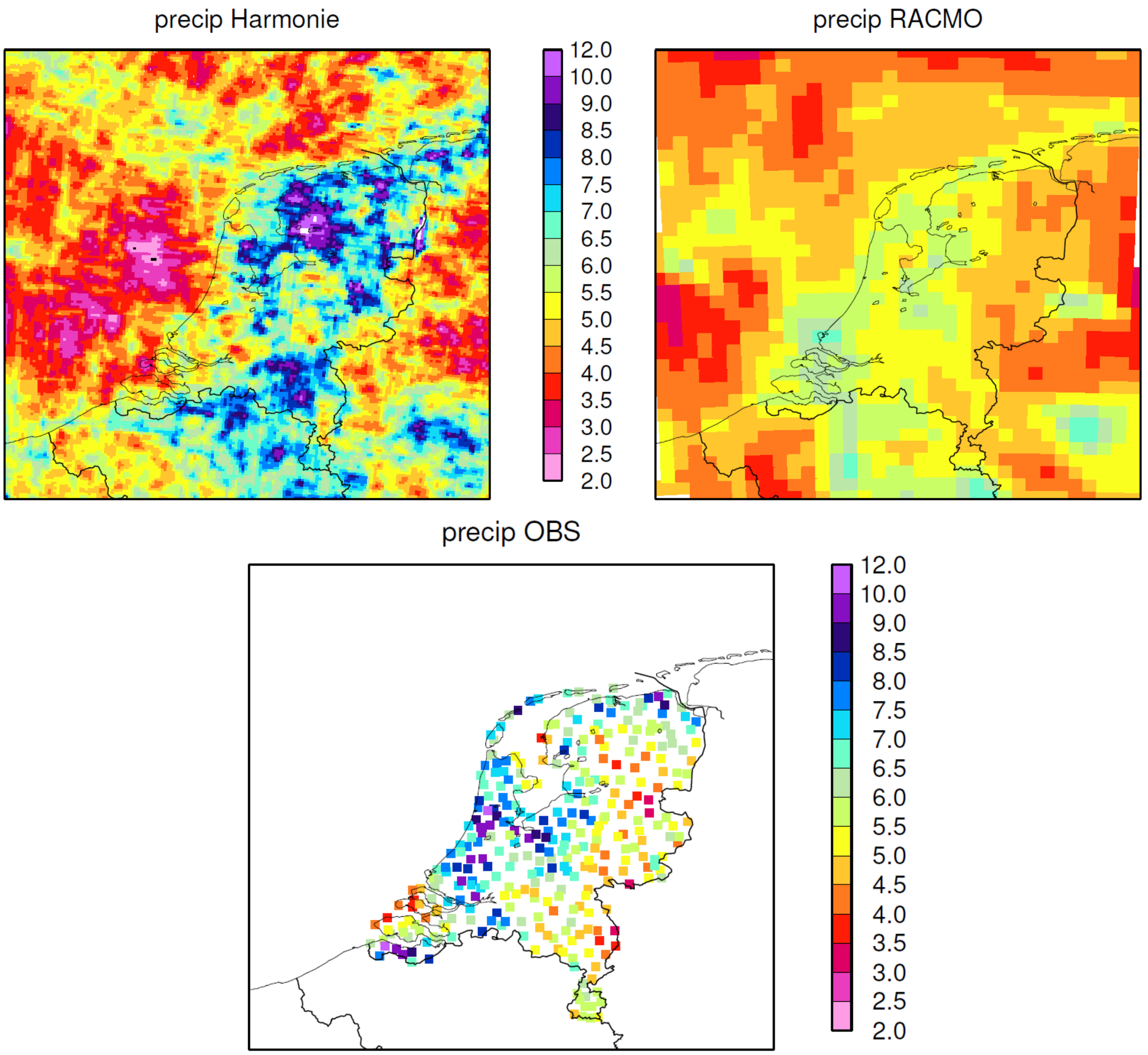

Figure 2: Precipitation (in mm/day) in the Netherlands in August 2010 as modelled by Harmonie, by RACMO, and as observed.

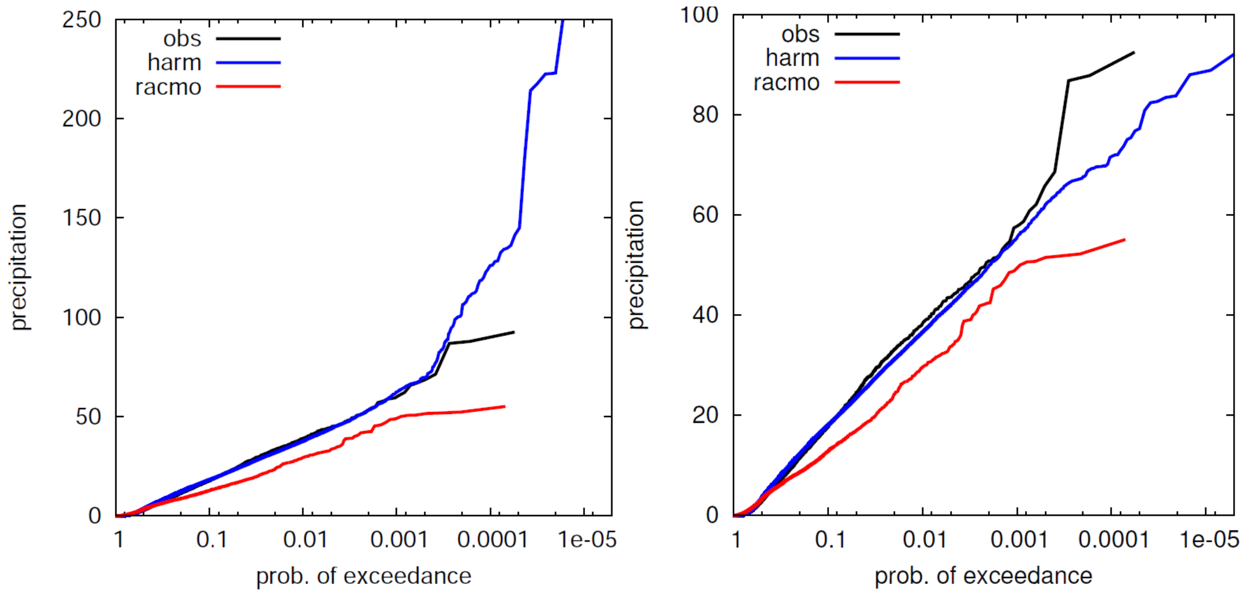

Figure 3: Pooled statistics (all Dutch land grid points) of daily precipitation amount vs. probability of exceedance. Comparison between Harmonie, RACMO, and observations. Left: all days, right: all days except July 4 (see text for explanation).

Figure 3 shows pooled statistics of daily rainfall amounts for all grid points in the Netherlands. The left panel is for all days in August 2010. Harmonie clearly follows the observations better than does RACMO, but at low probabilities of exceedance (= high return time, high amounts) the model significantly overestimates observations. The reason is that in the model a system of heavy precipitation occurred in the north-east of the country that hardly moved for a day, so that a lot of precipitation fell on the same grid points. In the observations the system moved, spreading a similar amount of total rainfall over a larger area. Leaving out the one day with the stationary convective system leads tot he statistics as displayed in the right panel of Fig. 3, which now shows a very good agreement with observations. It should be noted here that a quasi-stationary convective system is not impossible or prohibited by some basic physics. It just did not occur in August of 2010. Longer time series would be needed to decide whether chance is at play, or whether the model has a systematic tendency to hold convective systems in place. It should also be noted that, although the aggregated statistics of Figure 3 look very good, local correlations between observations and model results are often low. This shows that convective precipitation is a highly stochastic process, and that the model is able to reproduce the statistical characteristics of this process.

Figure 4 shows comparisons some model variables as obtained from different parametrization settings with measurements taken at the Cabauw tower. All four panels show that invoking the RACMO-based turbulence scheme has by far the largest impact. with the exception of near-surface temperature, this parametrization also leads to a better correspondence between model and observations.

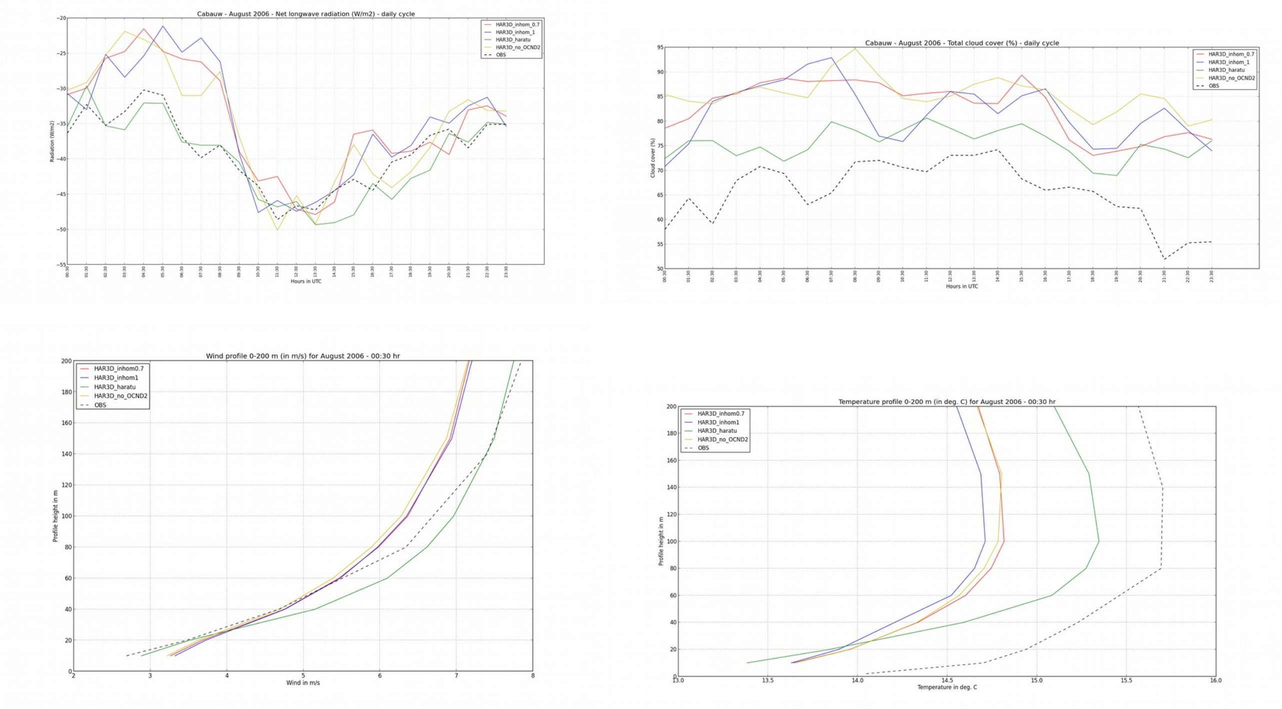

Figure 4: Comparison of model runs using different parametrization packages and observations from the Cabauw meteorological tower. red and blue: default Harmonie with two different values for INHF (0.7 and 1), green: with HaRaTu, yellow: with old parametrization of ice clouds. Upper row:mean daily cycle of long wave radiation (left) and total cloud cover (right). Lower row: night-time vertical profiles of wind (left) and temperature (right).

List of publications/reports from the project with complete references

n/a

Summary of plans for the continuation of the project

(10 lines max)

- Finishing the phase of setting-up and debugging the model and identifying the best configuration.
- Starting production by downscaling 10 years of ERA-Interim data later this year.
- Downscale EC-Earth data. Due to the need to extend the model domain (see *Summary of problems*) this cannot be done within the currently allocated resources. A request for a new Special Project (2016-2018) extending the present one will be submitted.