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 July 2010 – June 2011

Project Title: Multi-annual integrations with the KNMI regional climate model RACMO2

Computer Project Account: SPNLKRCM

Principal Investigator(s): Dr. E. van Meijgaard

Affiliation: Royal Netherlands Meteorological Institute (KNMI)

Name of ECMWF scientist(s) collaborating to the project
(if applicable)

Start date of the project: July 2005

Expected end date: December 2011

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)	500 kSBU	556 kSBU	499 kSBU	513 kSBU
Data storage capacity	(Gbytes)	500	?	500	?

Summary of project objectives
(10 lines max)

Computational resources within this special project are used to perform multi-annual integrations with the KNMI regional climate model RACMO2 in contribution CORDEX. First, the RACMO2 ability to represent current European but also African climate conditions is assessed. For this purpose, medium-term RACMO2 integrations (1989-2009) forced by ERA-Interim meteorological fields will or have been performed at 10km (Europe) or 50km (Africa) horizontal resolution. Next, an identical model configuration of RACMO2 (same model formulation, same domain, same resolution) is used to carry out transient runs for a 150-year time span (1950-2100). Lateral forcings for this run are taken from a GCM participating in CMIP5. RACMO2 output will eventually be stored permanently on the KNMI local storage server, but temporary data storage on ECFS is anticipated necessary.

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

No problems were encountered.

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

See paragraph APPENDED at bottom of this document

List of publications/reports from the project with complete references
RACMO2 results, in part obtained from the special project, contributed to

Hurk, B van den, and Co-Authors, 2006: Climate Changes scenarios 2006 for the Netherlands, KNMI Scientific Report 2006-01, pp. 82

Lenderink, G., A. van Ulden, B. van den Hurk, and F. Keller, 2007: A study on combining global and regional climate model results for generating climate scenarios of temperature and precipitation for the Netherlands Clim Dyn, 29, 157-176, DOI: 10.1007/s00382-007-0227-z

Lenderink G., Meijgaard E. van., Selten F., 2008. Intense coastal rainfall in the Netherlands in response to high sea surface temperatures: analysis of the event of August 2006 from the perspective of a changing climate. Climate Dynamics. DOI 10.1007/s00382-008-0366-x

Lenderink, G. en E. van Meijgaard, Increase in hourly precipitation extremes beyond expectations from temperature changes Nature Geoscience, 2008, 1, 8, 511-514, doi:10.1038/ngeo262.

Meijgaard, E. van, L.H. van Ulft, W.J. van den Berg, F.C. Bosveld, B.J.J.M. van den Hurk, G. Lenderink, A.P.Siebesma, 2008: The KNMI regional atmospheric climate model RACMO, version 2.1. KNMI Technical Report 302, 43 pp. Available from KNMI, Postbus 201, 3730 AE, De Bilt, The Netherlands.

Lenderink, G. en E. van Meijgaard, Reply: Unexpected rise in extreme precipitation caused by a shift in rain type? Nature Geoscience, 2009, 2, 6, 373, doi:10.1038/ngeo524

Hurk, B.J.J.M. van den, and E. van Meijgaard, 2010: Diagnosing land-atmosphere interaction from a regional climate model simulation over West Africa J. Hydrometeor., 11, 467–481.

Summary of plans for the continuation of the project
(10 lines max)
The project will NOT be continued beyond 2011.

Summary of results of the current year

Introduction

In previous years, the KNMI regional atmospheric climate model RACMO2 (van Meijgaard et al., 2008) has been used to produce high-resolution climate scenario calculations on the European scale, including the entire Mediterranean basin. This activity was in contribution to the EU-project ENSEMBLES (www.ensemble-eu.org). An important finding from analyzing these integrations was a pronounced delayed feedback from warmer near-coastal water temperatures of the North Sea inherited from previous warm episodes in summer to enhanced in-land precipitation in the coastal zone in The Netherlands in subsequent cooler and more unstable episodes.

A case study on the influence of the North Sea on the Dutch climate

In August 2006 exceptionally high precipitation amounts were recorded in The Netherlands, in particular in areas close to the sea. August 2006 was preceded by a long period of very warm weather, and consequently the temperature of the North Sea was very high at the end of July. When the atmospheric circulation changed to a very strong North Westerly flow on the 1st of August, this resulted in strong shower activity and lots of precipitation. The question was "how much did the warm North Sea water contribute to the high precipitation amounts in August 2006?" This question is answered by performing simulations with the KNMI- RACMO2. Figure 1 shows the observed precipitation amounts in August of 300 stations in the Netherlands (left panel). The middle panel shows results of RACMO2, when forced with realistic atmospheric conditions at the lateral boundaries and observed sea surface temperatures. The right panel shows results of an identical simulation with RACMO2, with the exception of the sea surface temperature which is now prescribed to be approximately 2 degrees colder. Such colder sea surface temperatures are representative of the normal sea surface temperature during August. Comparing both RACMO2 simulations it is clear that the high sea surface temperature contributed considerably to the high precipitation amounts in the coastal area. A more in depth analysis showed that about 30 % of the rain in the coastal area was due to the high sea surface temperature.

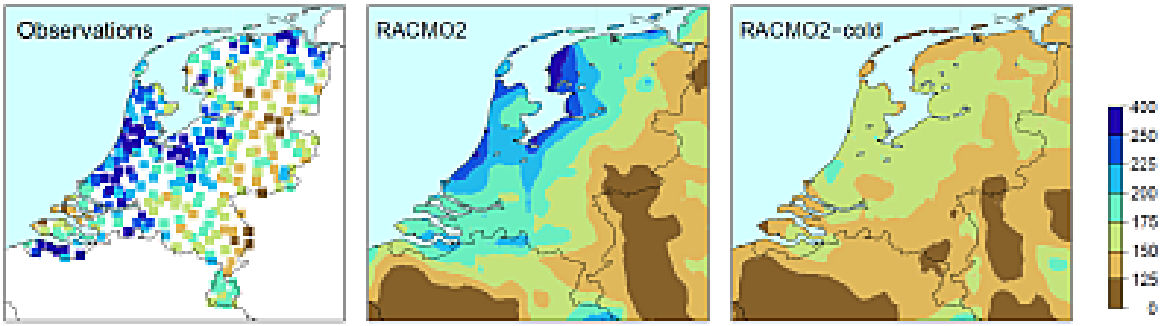

Figure 1. Observed (left) and simulated (middle and right) precipitation in August 2006. RACMO simulations are using observed (middle) and cold(er) sea surface temperatures.

Predicting future changes in coastal precipitation

The above case study clearly shows the potential influence of the North Sea on the Dutch climate. The influence of the North Sea is also visible in the climatological mean. In Spring with relatively cold sea water the coastal area is relatively dry compared to the interior of the Netherlands, whereas in Autumn the situation in reversed. The difference between coastal precipitation (less than ~40 km from the coastline) and precipitation in the interior is now called "the coastal effect".

It is not clear how this coastal effect responds to climate change. The main factor causing the coastal effect is the temperature difference between land and sea, and changes herein could be small. The coastal effect also depends strongly on the atmospheric flow with, for instance, north-westerly flows resulting in much precipitation in the coastal area in Autumn. Therefore, changes in the general circulation could have a large impact. On the other hand, rising seawater temperatures and therefore higher moisture content near the coast could increase the effect. Also projected drying over the continent in Summer could enhance the effect. Potentially important is also the influence of urbanization and land-use changes, which could also impact on the precipitation distribution within

The Netherlands. Besides mean precipitation, extremes are of major importance. Rain radar data from recent years show a remarkable peak of daily precipitation extremes near the coast in the province “Zuid-Holland”.

Scenarios issued by KNMI in 2006 did not discriminate within The Netherlands. Projected changes are the same over the Netherlands, and spatial differences in the climate of 2050 are therefore similar to the differences already existing in the present climate. Two reasons (amongst others) for this are: the relatively coarse resolution of the RCMs at that time (50 km), and the absence of a good description of the sea water temperatures of the North Sea.

Presently, we are running KNMI-RACMO2 at a resolution of 12 km RCMs usually take sea water temperatures from coarse resolution general circulation models (GCM) , which have a typical resolution of 200 km and therefore lack small scale features close to the coast. We have therefore implemented a simple ocean slab model in RACMO2 to restore these small scale features to the SST from the GCM, and are investigating their effect on the precipitation distribution over the Netherlands.

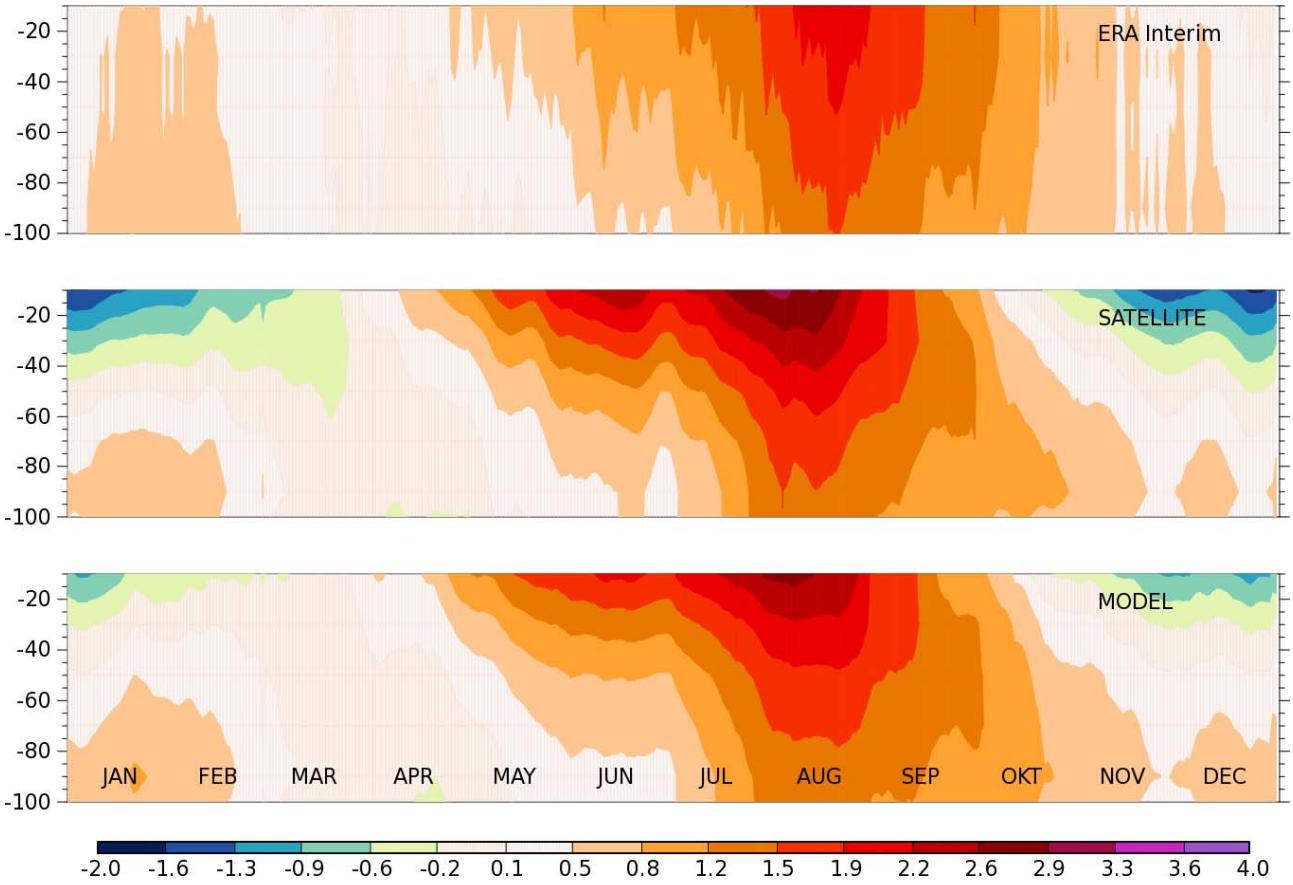

Figure 2.. Hovmöller (x-axis time; y-axis distance from the coast in km) plots of North-Sea temperatures averaged along the Dutch coast for a 15-year period (1996-2010) for a relatively coarse(~75 km) grained ERA-Interim reanalysis (upper panel), high resolution satellite observations (middle panel) and RACMO2 using a newly developed ocean slab model (lower panel). An harmonic annual cycle with an amplitude of 5.5 K and phase of 0.7184 radian(41 days) is subtracted. The off set is 284.13 K.. We note that the resolution of ERA-Interim is still high compared to the typical resolution of a GCM.

References

Attema, J.J., and G. Lenderink, 2011. The effect of a warming North Sea on coastal precipitation. International Conference on the Coordinated Regional Climate Downscaling Experiment - CORDEX, 21 - 26 March 2011, Trieste, Italy

Lenderink, G., E. van Meijgaard and F. Selten, Intense coastal rainfall in the Netherlands in response to high sea surface temperatures: analysis of the event of August 2006 from the perspective of a changing climate. Clim. Dyn., 2009, 32, 19-33, doi:10.1007/s00382-008-0366-x

Meijgaard, E. van, L.H. van Ulft, W.J. van den Berg, F.C. Bosveld, B.J.J.M. van den Hurk, G. Lenderink, A.P.Siebesma, 2008: The KNMI regional atmospheric climate model RACMO, version 2.1. KNMI Technical Report 302, 43 pp. Available from KNMI, Postbus 201, 3730 AE, De Bilt, The Netherlands.