REQUEST FOR A SPECIAL PROJECT 2013–2015

MEMBER STATE: Netherlands

Please provide the information requested for each special project you wish to propose for **2013-2015**.

Principal Investigator[1]: Gerrit Burgers

Affiliation: Royal Netherlands Meteorological Institute (KNMI)

Address:
KNMI
P.O. Box 201
NL-3730 AE DE BILT
The Netherlands

E-mail: Gerrit.Burgers@knmi.nl

Other researchers:
Jan Barkmeijer (KNMI)
Peter Baas (KNMI)
Sofia Caires (KNMI)

Project title: An extreme wind climatology for Dutch Water Defences

Project description: *An electronic copy of the project description/extended abstract must be sent via e-mail to:*

special_projects@ecmwf.int.

Electronic copy of the extended abstract sent on: April 23, 2012 (specify date)

A copy of the project description/ extended abstract must be attached.

Estimate of computer resources for 2013-2015:	**2013**	**2014**	**2015**
High Performance Computing Facility (units)	2 000 000	3 000 000	1 000 000
Data storage capacity (total) (Gbytes)	3000	4000	2000

Is this a continuation of an existing project:	YES ☒	NO ☐
If YES, please state the computer project account assigned for 2013:	**SP** _____	

Continue overleaf

[1] The Principal Investigator will act as contact person for this Special Project and, in particular, will be asked to register the project, provide an annual progress report of the project's activities, etc.

Principal Investigator: Gerrit Burgers ……

Project Title: An extreme wind climatology for Dutch Water Defences ……

Extended abstract

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Abstract

KNMI and Deltares are the partners in a programme for developing a new extreme wind climatology of the Netherlands in support of the safety assessment of Water Defences by the national Netherlands government. The new wind climatology will answer the need for a description of not only the strength but also the space and time characteristics of extreme storms. It will be based on combining surface wind measurements with simulations of a high-resolution (2.5 km) meteorological model. The simulations will be done with the Harmonie_Arome model, at a resolution of 2.5km, driven by ERA-Interim re-analyses. The aim of the proposed project is to carry out a substantial part of the simulations that are required for establishing the extreme wind climatology. The special project will show the value of ERA-Interim for driving high-resolution simulations of extreme storms. The knowledge of how well Harmonie_Arome can represent land-sea transitions in extreme storms and what the optimal model settings are for such situations will benefit the Harmonie_Arome model community.

Science Plan

The work is carried as part of a joint project of Deltares and KNM, Deltares is the Dutch research organization in the field of water, subsurface and infrastructure.

Millions of people in the Netherlands live and work in areas protected from flooding by dikes. Since wind is a main driver of flooding events, winds and extreme winds in the Netherlands have been the object of intensive study, e.g. in the KNMI publication of Wieringa and Rijkoort (1983, in Dutch). So far, these studies have used station observations and interpolation methods that account for differences in surface roughness from one location to another.

However, these methods face limitations when extrapolating from land observations to locations above water, in particular because of the difference in structure of the atmospheric boundary layer over land and over water. Also, the requirements on the wind climate have changed. In future assessments of Dutch Water Defences much more attention is paid to compound failure mechanisms. This means that not only the strength of a storm is needed, but also its extension and characteristics in space and time.

In 2011, KNMI and Deltares have started a joint project to address these questions. The project is funded by the Dutch national government. The objectives of the SBW Wind modelling project (Groeneweg et al. 2011) are:

1 Assessment of how well high-resolution atmospheric models can represent storm wind fields, and how can high-resolution models be used to represent the space-time structure of extreme storms.
2 Production of a long-term (of the order of 30 years) storm dataset that can be used for deriving the extreme wind statistics needed for the determination of hydraulic boundary conditions of Dutch water defenses.
3 Extreme value analysis of the surface wind / stress fields, including a proper time and space dependence.

The aim of the proposed special project is to carry out a substantial part of the simulations that are required for establishing the long-term storm dataset.

ECMWF re-analyses have been successfully used to study wind and wave climate over the world ocean (Caires and Sterl 2005), but for studying the impact of land-sea transitions and roughness variations over land a higher resolution is required. For this reason, ERA-Interim re-analyses (Dee et al. 2001), which cover the period 1979 – present, will be used to drive high-resolution regional model simulations of the Harmonie_Arome model (Seity et al. 2011) developed by Météo France and the Aladin and Hirlam model consortia. The version that will be used is essentially the Harmonie_Arome model that is being implemented as the new operational regional model of KNMI, but on a smaller grid because only a re-analysis is made.

The SBW Wind modeling project has been divided into three work packages.

WP1 – The use of high-resolution models in the determination of extreme wind fields.
A set of 17 storms has been selected (Groen and Caires 2011) for initial tests of the system. The system will be validated against in-situ observations, including measurements of the Cabauw measurement tower located in the centre of the Netherlands and satellite scatterometer measurements of surface winds over sea. A suitable set-up for driving an analysis cycle by ERA-Interim fields will be defined, as well as suitable model settings for the purpose of simulating storm wind fields, and establishing limitations in the ability of the model to represent these fields. The added value of high-resolution modeling for the purpose of establishing hydraulic loads will be assessed. The results of the modeling approach will be compared with results of traditional methods (see e.g. Caires et al. 2009).
First results in storm simulations by Harmonie_Arome have been quite encouraging (Baas and de Waal 2012), see Figure.

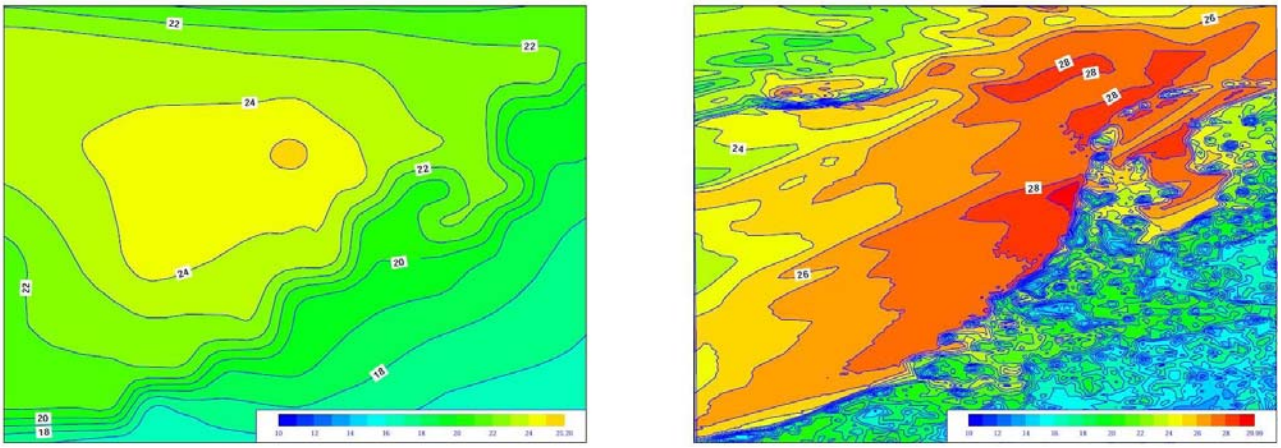

Figure. *10m wind field (m/s) for 25 January 1990, 18 UTC, along the Dutch coast and around the Netherlands. Left: ECMWF ERA-Interim re-analysis, resolution of about 80km; right: Harmonie_Arome dynamical downscaling, grid spacing 2.5km). Land-water are clearly visible in 2.5km resolution, as well as the contrast between urban/forest and open areas. The colour scale in the left and right panel is the same.*

WP2 – Database of high-resolution model results for the determination of the HBC.
Once a proper model set-up and validation has been completed, the model will be used to simulate all storms over Netherlands over the period 1979-2012, and this data set will be the basis of the extreme wind climatology. First a strategy will be defined to generate the data needed. Simply simulating the full ERA-Interim period probably will be too time consuming, so for a start the simulations will cover only periods with storms. It might be advantageous to include some very strong storms from the longer ERA-40 period as well. The generation strategy also needs to address which data will be archived. Once the generation strategy has been firmly established, the production stage of the project can start. It is envisaged that this stage will begin in the second half of 2013 and will end in the first half of 2015.

WP3 – Extreme value analysis of the high-resolution model 10-m wind fields.
In this work package, an extreme value analysis of the model results will be carried out. A method will be developed that gives a proper representation of the time and space evolution of wind fields with very long (up to 10000 yr) return periods. It might very well be that it will be needed to calibrate model results against observations. The methods will be first tested on coarse resolution data sets, and in a next stage applied to the high-resolution data sets that are produced in WP2.

The results of WP1 and WP2 will give insight in how ERA-Interim re-analyses can be used to drive high-resolution simulations of extreme storms, and in how well Harmonie_Arome can represent high-resolution features of extreme storms.

Especially the second work package is computationally demanding. This is the reason we apply for this special project.

Justification of computer resources

In the test runs we have performed, HPCF usage was around 100 units per simulated hour, and storage of relevant fields around 150MB per simulated hour. If we would make a complete simulation comprising 30 years from ERA Interim, more than 25 Munits would be needed. To reduce the computational load, we will only simulate the 10-20% periods that contain strong wind episodes. This leads to a total requirement in the order of 6 Munits if one allows for test runs, and an associated amount of data storage capacity. Test runs will continue well into 2013. The start of the production runs is envisaged for the second half of 2013, and production should be completed by mid 2015.

Technical characteristics of the code.

An implementation of the Harmonie-Arome model (Seity et al. 2011) will be used that is similar to the version that is being implemented for operational use at KNMI.

So far, a recent version of the Harmonie_Arome system has been employed (Cy36h1.3). The horizontal integration domain was defined in such a way that it encompasses the ZUNO (ZUidelijk NOordzee model) domain, which is frequently used in studies with hydrodynamic models. To satisfy this constraint, a 500 x 500 grid point domain at 2.5 x 2.5 km2 grid resolution was constructed. In the vertical, 60 model levels are employed with the lowest model levels situated at around 10, 30, and 60 m. The model time step is 1 minute.

For the time being, the ECUME module, which takes into account effect of atmospheric convection, precipitation and gustiness on surface fluxes over sea, was switched off. Further experiments must point out if ECUME can be included and gives better results than a simple parameterization of ocean surface roughness. In the present study, a wind speed dependent Charnock relation was used with the Charnock constant taken as 0.015.

References

Baas, P. and H. de Waal. Interim report on the validation of Harmonie. SBW – HB Wind modelling. KNMI and Deltares report 1204199-004-HYE-0004, January 2012.

Caires, S. and A. Sterl, 2005: 100-year return value estimates for ocean wind speed and significant wave height from the ERA-40 data J. Climate, 18, 7, 1032-1048.

Caires, S., De Waal, H., Groen, G., Wever, N., Geerse, C., 2009. Assessing the uncertainties of using land-based wind observations for determining extreme open-water winds. SBW-Belastingen: Phase 1b of subproject "Wind modelling". Deltares report 1200264-005, October 2009.

Dee, D.P., and coauthors, 2011. The ERA-Interim reanalysis: configuration and performance of the data assimilation system. Quart. J. Roy. Met. Soc., 137, 553-597.

Groen, G., Caires, S., 2011. Selection of historical storms for atmospheric model validation. SBW-HB Wind modelling. KNMI and Deltares report 1204199-004-HYE-0002, November 2011.

Groeneweg, J., Burgers, G., Caires, S., Feijt, A., 2011. Plan of approach SBW wind modelling. SBW - Belastingen. Deltares report 1202120-003-HYE-0001, May 2011.

Seity, Y., Brousseau, P., Malardel, S., Hello, G., Bénard, P., Bouttier, F., Lac, C., Masson, V., 2011. The AROME France convective-scale operational model. *Mon. Wea. Rev.*, **139**, 976-9991.

Wieringa, J., and P. Rijkoort, P., 1983. *Windklimaat van Nederland [in Dutch]*. Staatsuitgeverij, Den Haag, 263pp.