REQUEST FOR A SPECIAL PROJECT 2012–2014

MEMBER STATE: The Netherlands

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Project Title:

Decadal Predictions (DECPRED)

If this is a continuation of an existing project, please state the computer project account assigned previously.	**SP** NLDECP_____	
Starting year: (Each project will have a well defined duration, up to a maximum of 3 years, agreed at the beginning of the project.)	2011	
Would you accept support for 1 year only, if necessary?	YES ☒	NO ☐

Computer resources required for 2012-2014: (The maximum project duration is 3 years, therefore a continuation project cannot request resources for 2014.)	**2012**	**2013**	**2014**
High Performance Computing Facility (units)	2400000	2400000	
Data storage capacity (total archive volume) (gigabytes)	2000	2000	

*An electronic copy of this form **must be sent** via e-mail to:* *special_projects@ecmwf.int*

Electronic copy of the form sent on (please specify date): 26-04-2011

Continue overleaf

Principal Investigator: Dr. R.J. Haarsma

[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.

Project Title: Decadal Predictions (DECPRED)

Extended abstract

Due to its chaotic character the climate is on short timescales, in the order of less than one year, dominated by its internal variability. On long time scales, in the order of 100 year, the climate is dominated by the change in external forcings. For the coming century this is the anthropogenic change in greenhouse gas concentrations. On decadal time scales anthropogenic change in greenhouse gas concentrations and internal variability of the climate system both affect the climate signal. Due to its large heat capacity the ocean is strongly affecting the decadal variability. For reliable decadal forecasts therefore the initial state of the ocean and the ocean dynamics as well as its coupling with the atmosphere should be simulated adequately. Dominant modes of variability that affect the ocean variability on decadal times are the Merdional Overturning Ciculation (MOC) and the Pacific Decadal Oscillation (PDO). Decadal fluctuations in other external forcings such as aerosols, land coverage and internal variability in the cryosphere will also affect the decadal variability of the climate.

In recent years progress has been made in decadal predictions. This is due to substantial developments in coupled ocean-atmosphere models, and in ocean observing systems. New data assimilation systems haven been developed (Zhang et al. 2007) and seasonal forecasts are being made with state-of-the-art coupled models. These developments provide the scientific basis to perform decadal predictions. Recent studies have demonstrated the potential predictability at decadal time scales and decadal prediction experiments have recently been started at several climate centers around the world (Smith et al. 2007, Keenlyside ate al. 2007) .

An important issue of these decadal predictions is to untangle the impact of the change in radiative forcing during the integrations and the effect of the slow manifold of the climate attractor. This issue will be studied by performing ensemble integrations starting from different initial conditions of the atmosphere and ocean. Due to its large heat capacity the ocean plays a key role for the long time scales in the climate system. Other components that can potentially affect the slow manifold are soil moisture, sea-ice and snow.

The KNMI participates in the FPU 7 projects THOR and COMBINE that coordinate the European efforts in decadal prediction. Within the framework of these two FPU7 projects we will make decadal predictions using EC-EARTH (Hazeleger et al. 2010) and investigate the potential impact on decadal predictability of new components and initialization procedures developed in these FPU projects. It is expected that these new components will improve the quality of the decadal predictions. The decadal predictions are also required for the “Near-Term” (decadal) part of the CMIP5 project, which will form the basis of the next IPCC AR5 report. The FPU 7 projects fund for the KNMI only the personnel costs but not the required computer resources.

EC-EARTH is based on the seasonal forecast system of ECMWF that is used for decadal and multi-decadal integrations. Currently EC-EARTH, is now ready for use and version 2.2 has been distributed among EC-EARTH partners. This version will be used for the decadal predictions. EC-EARTH v2.2 consists of IFS Cy31r1 at T159 horizontal resolution and 62 vertical levels (identical resolution to System 3 of ECMWF) and the 1 degree horizontal resolution version of NEMO v2 ocean model.

We will work closely with the Seasonal Forecast Group at ECMWF and partners in the EC-EARTH consortium in this project. The initial ocean conditions (NEMOVAR) will be provided by the Seasonal Forecast Group that also participates in those two FPU7 projects. Because of this close collaboration the results of the DECPRED project will be highly beneficial for the Seasonal Forecast Group. ECMWF will perform decadal forecasts based on a slightly different model system (that is, EC-EARTH will be tuned differently than the operational ECMWF System 3 and System 4, although the physical basis will be the same).The output of the project will be shared within the EC-EARTH consortium (see ecearth.knmi.nl; 10 member states of ECMWF are represented) and within the FPU 7 projects THOR and COMBINE, which will perform a common analysis of all runs.

Summary of experiments of last year:

The decadal predictions runs for CMIP5 are finished and the preliminary results show that skilfull decadal predictions with EC-EARTH using the ECMWF NEMOVAR initial conditions are feasible. However, during the analysis it appeared that there was a bug in the aerosol forcing. It was therefore decided to redo the decadal predictions with the bug fix for the aerosols. Therefore the specific experiments as planned for last year still have to be performed. The sensitivity runs with respect to impact of the leaf area index have been performed. The next step is to focus on the role of the albedo. New sensitivity runs are planned.

The specific experiments of DECPRED planned for the coming year are:

1. Sensitivity runs to the test impact for of different observing systems and there relative impact. The runs that are planned consist of two 10-year twin experiments of 5 member ensembles for two start start dates. The two twin experiments correspond to the inclusion/exclusion of ARGO data in the initial ocean state and the interchange of start data and forcing fields. This set of experiments requires in total 400 years of model integration. One model year of coupled integration requires 3000 SBU. The requested computer resources are therefore 1200000 SBU.

2. Sensitivity runs to test the impact of land surface schemes and new land surface parametrizations on decadal predictions. The runs that are planned also consist of two 10-year twin experiments of 5 member ensembles for two start start dates. Here the planned twin experiments will be focused on the role of albedo. The requested computer resources for these experiments are also1200000 SBU.

The total requested computer resources for DECPRED for the coming year are therefore:

1200000+1200000=2400000 SBU

The specific details of the runs for the following years have to be decided yet but will include:

- Potential predictability runs with new developed components and initialization procedures.
- Decadal prediction runs with new developed components and initialization procedures.
- Investigation of the impact of the new release of EC-EARTH on the skill of the decadal predictability.

References

Hazeleger, W. et al., *EC-Earth: A Seamless Earth System Prediction Approach in Action*, Bull. Amer. Meteor. Soc., 91, 1357-1363, 2010.

Keenlyside, N.S, M. Latif, J.Jungclaus, L. Kornblueh, E. Roeckner, Advancing decadal-scale climate prediction in the North Atlantic sector, Nature, 453,84-88.

Smith, D.M., S. Cusack, A.W. Colman, C.K. Folland, G.R. Harris and J.M. Murphy,Improved surface temperature prediction for the coming decade from a global climate model, Science, 317, 796-799, doi:10.1126/science.1139540, 2007

Zhang, S., M.J. Harrison, A. Rosati and A. Wittenberg, System design and evaluation of coupled ensemble data assimilation for global oceanic climate studies, Mon. Wea. Rev., 135, 3541-3564, 2007.