REQUEST FOR A SPECIAL PROJECT 2013–2014

MEMBER STATE: Germany

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Project Title:

The role of the polar regions in weather and seasonal prediction

If this is a continuation of an existing project, please state the computer project account assigned previously.		
Starting year: 2013 (Each project will have a well defined duration, up to a maximum of 3 years, agreed at the beginning of the project.)		
Would you accept support for 1 year only, if necessary?	YES	

Computer resources required for 2013-2015: (The maximum project duration is 3 years, therefore a continuation project cannot request resources for 2015.)	**2013**	**2014**	**2015**
High Performance Computing Facility (units)	615.000	2.950.000	-
Data storage capacity (total archive volume) (gigabytes)	3.300	12.000	-

*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): 27.04.2012

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: Prof. Dr. Thomas Jung

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Extended abstract

It is expected that Special Projects requesting large amounts of computing resources (500,000 SBU or more) should provide a more detailed abstract/project description (3-5 pages) including a scientific plan, a justification of the computer resources requested and the technical characteristics of the code to be used. The Scientific Advisory Committee and the Technical Advisory Committee review the scientific and technical aspects of each Special Project application. The review process takes into account the resources available, the quality of the scientific and technical proposals, the use of ECMWF software and data infrastructure, and their relevance to ECMWF's objectives. - Descriptions of all accepted projects will be published on the ECMWF website.

Introduction

The International Polar Year (March 2007 to March 2009) brought a renewed and timely scientific focus to the polar regions. This included an IPY-THORPEX cluster of nine projects contributing to the core THORPEX aim of improving forecasting of high impact weather. Although THORPEX (The Observing System Research and Predictability Experiment) has its main focus on weather prediction to fourteen days, the emphasis on improved understanding of processes and enhancements to modelling systems brings benefits to climate modelling as well.

The polar regions are of particular interest because of concerns about amplification of anthropogenic climate change, combined with an increasing interest of many governments in polar regions. Furthermore, increased economic and transportation activities in polar regions (particularly in the Arctic) are leading to more demands for sustained and improved availability of integrated observational and predictive weather, climate and water information to support decision-making. However, many remaining gaps in data availability, the scientific understanding and modelling of processes and interactions in polar regions, including stable boundary layers, polar clouds and precipitation, sea ice/ocean dynamics and hydrology hamper reliable forecasting in the polar regions across a wide range of time scales.

The WMO Commission of Atmospheric Sciences (CAS) recommended in November 2009, as a legacy of the IPY, the establishment of a polar research project to improve understanding of the impact of polar processes on polar weather, the assimilation of data in polar regions, and the prediction of high impact weather over polar regions. This WWRP Polar Prediction Project (as it is now called) is expected to provide major improvements in the skill of polar prediction on time scales from hourly to seasonal time scales.

The aim of this project is to determine how medium-range and seasonal prediction in the mid-latitudes and especially over Europe will benefit from improved predictions in polar regions. To this end relaxation experiments will be carried out with the ECMWF model (atmosphere-only) in which the development of forecast error in the polar regions is suppressed during the course of the integration by relaxing the model toward reanalysis fields over the Arctic and Antarctic. Differences in forecast skill with and without relaxation will highlight those areas, which will benefit from improved prediction capabilities in the polar regions. The relaxation approach has been successfully applied in a number of diagnostic studies at ECMWF (Jung et al. 2010a, Jung et al 2010b, Vitart and Jung 2010, Jung 2011). An example for an experiment with relaxation in the North Pacific region for different seasons is shown in Figure 1.

An important aspect of this project will be to study how possible polar-lower latitude linkages vary as a function of flow (i.e. flow-dependence) and season. Therefore, It will be necessary to consider a large number of cases. Furthermore, an additional experiment will be carried out with relaxation

in the non-polar regions (50S-50N) in order to explore the role of lower-latitude processes on polar prediction skill.

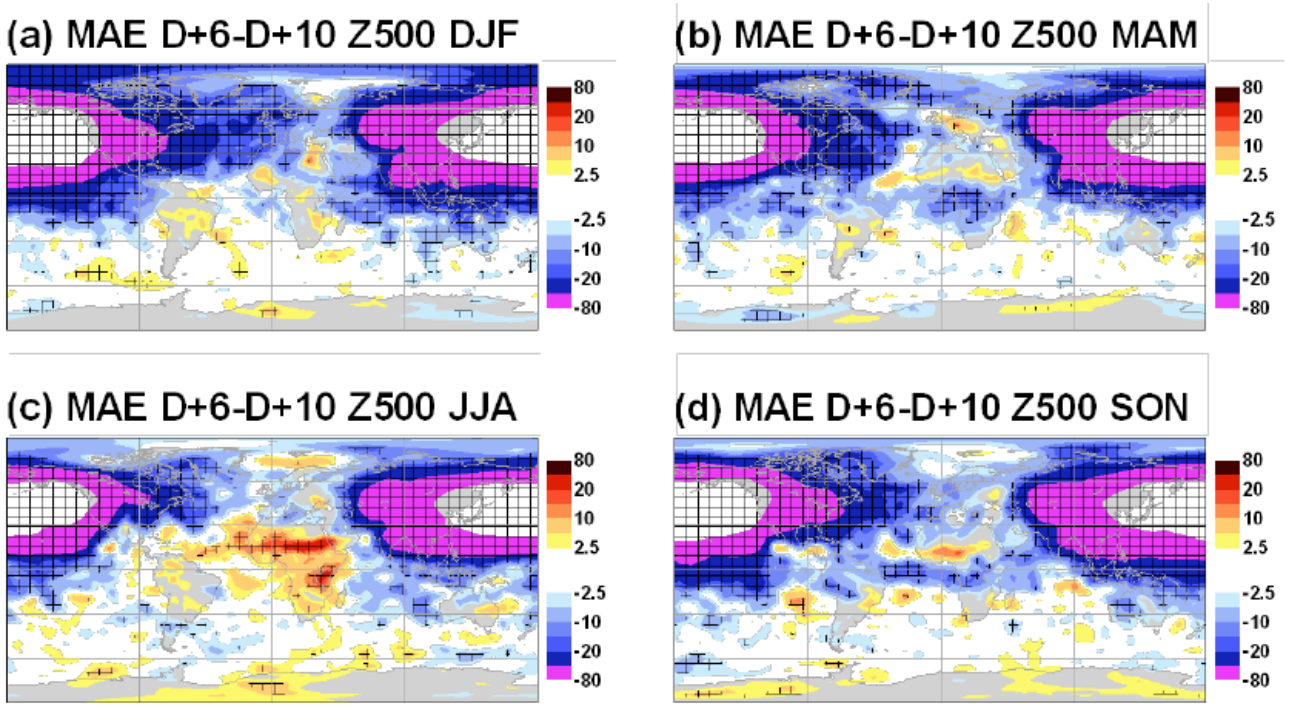

Figure 1: Difference in mean absolute Z500 forecast error (D+6-D+10) between an experiment with and without relaxation toward analysis data in the North Pacific (90E-140W, 10-60N).

Experimental design

Weather forecasting

In 2013 the emphasis of the project will be on weather forecasts using Cy38r1 of the IFS at a resolution of T255 with 60 levels in the vertical. The model will be relaxed toward ERA-Interim data, which is available at the same resolution. 14-day long integrations will be carried out twice a month, for each month of the year and the period 1979-2011. There will be one control integration, one experiment with simultaneous relaxation of the Arctic and Antarctic and one experiment in which the lower latitudes are relaxed towards ERA-Interim. A summary of all the weather forecasting experiments with the resources required is given in Table 1. Estimates are based on the assumption that 1 day of integration will require 18.5 SBUs and 100 Mb of data storage.

The PI and both of the other scientist are familar with the IFS and the ECMWF infrastructure. The PI has work for 9 years at ECMWF. During this time he implemented the relaxation formulation in the IFS.

Table 1: Summary of the weather forecast experiments planned for 2013 along with the required computational and mass storage requiments.

Experiment	Forecast days	SBU (kilo units)	Archive (Gb)
Control run	11088	205	1.1
Polar relaxation	11088	205	1.1
Lower-latitude relaxation	11088	205	1.1
Total	**33264**	**615**	**3.3**

Seasonal forecasting

In the second year of the project the focus will be on the role of the polar region for seasonal prediction. The experiments will be carried out using the same model cycle 38r1. However, a lower horizontal resolution of T159 will be used to match that of ERA-40, which will be used as reference fields for relaxation. The period considered is 1957-2001 with 9 member, 120 day seasonal forecasts started on 1 November and 1 May of each of the respective years. In total three different experiments will be carried out, one control experiment, one experiment with relaxation of the arctic and antarctic atmosphere and one experiment in which the lower latitudes are relaxed towards ERA-40.

A summary of all the seasonal forecasting experiments with the resources required is given in Table 2. Estimates are based on the assumption that 1 day of integration will require 10 SBUs and 41 Mb of data storage.

Table 2: Summary of the seasonal forecast experiments planned in 2014 along with the required computational and mass storage requiments.

Experiment	Forecast days	SBU (kilo units)	Archive (Gb)
Control run	97200	972	4.0
Polar relaxation	97200	972	4.0
Lower-latitude relaxation	97200	972	4.0
Total	**33264**	**2916**	**12.0**

References

Jung, T., M. J. Miller, T. N. Palmer, 2010a: Diagnosing the Origin of Extended-Range Forecast Errors. *Mon. Wea. Rev.*, **138**, 2434–2446.

Jung, T., T. N. Palmer, M. J. Rodwell, S. Serrar, 2010a: Understanding the Anomalously Cold European Winter of 2005/06 Using Relaxation Experiments. *Mon. Wea. Rev.*, **138**, 3157–3174.

Vitart, F., and T. Jung, 2010: Impact of the Northern Hemisphere extratropics on the skill in predicting the Madden Julian Oscillation, *Geophys. Res. Lett.*, 37, L23805, doi:10.1029/2010GL045465.

Jung, T., 2011: Diagnosing remote origins of forecast error: relaxation versus 4D-Var data-assimilation experiments. Q.J.R. Meteorol. Soc., 137: 598–606. doi: 10.1002/qj.781