

REQUEST FOR A SPECIAL PROJECT 2014–2016

MEMBER STATE: Germany

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Other researchers: Prof. Dr. Thomas Jung (AWI), Dr. Soumia Serrar (AWI) and
Dip. Met. Gereon Gollan (GEOMAR).

Dr. Serrar will carry out the experiments.

Project Title: The role of the tropics and the stratosphere for seasonal and decadal prediction

If this is a continuation of an existing project, please state the computer project account assigned previously.	No	
Starting year: (Each project will have a well defined duration, up to a maximum of 3 years, agreed at the beginning of the project.)	2014	
Would you accept support for 1 year only, if necessary?	YES	

Computer resources required for 2014-2016: (The maximum project duration is 3 years, therefore a continuation project cannot request resources for 2016.)	2014	2015	2016
High Performance Computing Facility (units)	3.450.000		
Data storage capacity (total archive volume) (gigabytes)	18.576		

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):
10.06.2013

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.

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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

A meeting of the Royal Meteorological Society was held in London in March 2013 on the topic of long-range weather forecasting. The meeting was prompted by the 50th anniversary of the unusually severe European winter of 1962/63. As a result of the severe weather, the UK Met Office introduced the "Monthly Weather Survey and Prospects" that started in November 1963. Since that time there has been enormous progress in the area of monthly and seasonal forecasting as well as a growth of interest in decadal prediction, for example as part of the activities of the Climate Model Intercomparison Project (CMIP5) of the World Climate Research Programme. An example in Germany is the BMBF MiKlip project that aims to provide a decadal prediction system with a focus on needs and requirements in Germany and in which Professors Greatbatch and Jung participate.

An important source of predictability on seasonal and decadal time scales is the tropics (for an example on decadal time scales see Ding et al., 2013) and it is important to quantify that influence over middle latitudes, especially over Europe where the direct influence of the El Niño Southern Oscillation (ENSO) phenomenon is known to be weak in comparison with the Pacific sector. It is also known that the stratosphere has an influence on the mid-latitude troposphere on seasonal and decadal time scales during winter. One way to access the importance of both these influences is to use a relaxation technique in which parts of the model domain of a forecast model are constrained to be close to reanalysis (e.g. as in Jung et al., 2010), a technique implemented by Thomas Jung during his time at ECMWF. Greatbatch et al. (2012b) describe an analysis of such experiments using a recent version of the ECMWF operational model and covering all winters from 1960/61 to 2001/02. In these experiments, the model is drawn towards the ERA-40 reanalysis in either the tropics or the stratosphere. The results show that there is some influence from the tropics over Europe, although somewhat weaker than over the North Pacific sector, as well as influence from the stratosphere and some additional impact (be it relatively weak) from extratropical sea surface temperature (SST) and sea-ice anomalies. In individual winters it is, nevertheless, possible for there to be a strong influence from the tropics over Europe, a notable example being that of 1962/63 (see Greatbatch et al., 2013 and Figure 1 and note that the best model performance compared to panel (b) is by CLIM-TROPICS, the case that includes only relaxation in the tropics). We have also looked at the trends in these experiments on time scales of 11, 21 and 31 years and compared them to the observed trends (Greatbatch et al., 2012a). It appears that the influence of the tropics on trends in the North Atlantic Oscillation (NAO), important for Europe, increases with increasing time scale. In a third paper (Gollan et al. 2012), we show that there is an important influence from the tropics on the interannual variability of the East Asian Winter Monsoon (EAWM) even though the direct influence of ENSO on the EAWM is weak.

The objective of this project is to determine how seasonal and decadal predictions in the mid-latitudes and especially over Europe will benefit from improved predictions in the tropics and the stratosphere. To accomplish this, we shall carry out experiments similar to those analysed in Greatbatch et al. (2012b) but this time using relaxation towards the ERA-Interim reanalysis and

covering the period from 1980 to the present day. We shall also carry out relaxation experiments for the boreal summer (May/June/July/August; MJJA) in order to investigate the impact of the tropics, as well as extratropical SST and sea-ice, during that season. With these experiments, we can update the analysis in Greatbatch et al. (2012a,b) and Gollan et al. (2012) to the present day and also carry out a similar analysis for the boreal summer season. The UK Met Office have a new coupled model prediction system that shows remarkable skill at predicting the NAO for winters from 1996/97 to 2009/10 (Scaife, personal communication) and we are hoping that our experiments throw some light on the reasons for this success. Carrying out an analysis for the summer season will also help to establish if, for example, Arctic sea-ice depletion has played a role in the recent series of poor summers in Europe, as suggested by Balmeseda et al. (2010). We also plan to focus on particular winters and summers as in Greatbatch et al. (2013) for the 1962/63 winter and Jung et al. (2011) for the strongly negative NAO winter of 2009/10.

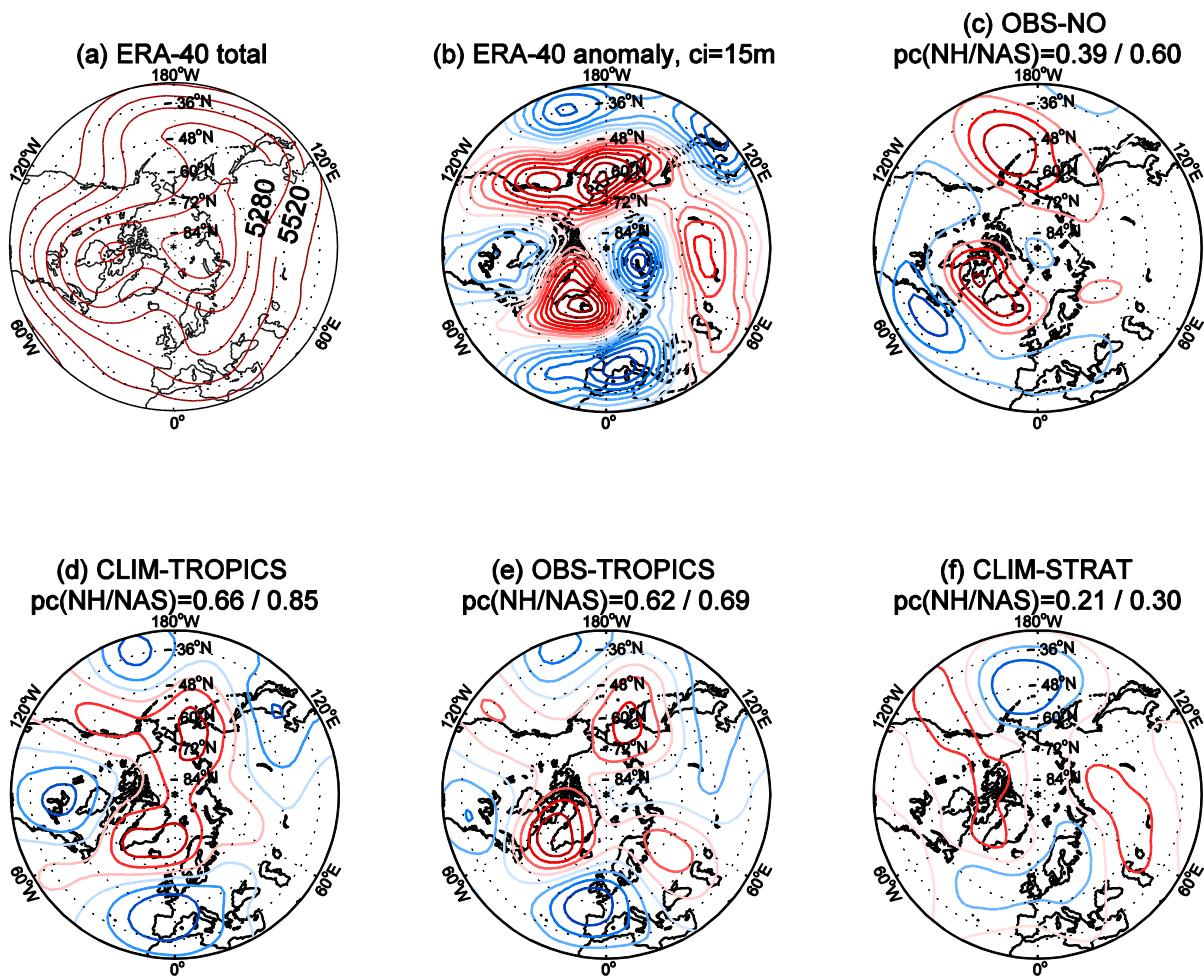


Figure 1: 1962/63 DJF mean 500 hPa geopotential height plotted over the region north of 30 N. (a) shows the full field from ERA-40 (contours are labelled, in meters, in the plot). (b) shows the ERA-40 anomaly field with respect to the average over the winters 1960/61 to 2001/02. The contour interval is 15 m. (c) as in (b) but for the ensemble mean of the experiment OBS-NO. The pattern correlations between the ERA-40 anomaly and the anomaly of the ensemble mean are given for the northern hemisphere north of 30 N (NH) and the North Atlantic sector (NAS; 90 W-40 E, 30 N - 80 N). (d) as (c) but for CLIM-TROPICS; (e) as (c) but for OBS-TROPICS; (f) as (c) but for CLIM-STRAT. OBS-NO uses the observed time series at SST and sea-ice at the lower boundary and the other experiments are described in the experimental design below.

Experimental design

The experiments will be carried out using the model cycle 38r1 of the IFS at a horizontal resolution of T255 and 60 levels in the vertical to match that of ERA-Interim, which will be used as reference fields for the relaxation. The period considered is 1979/80-2012/13 with 9 member, 120 day seasonal forecasts started on 1 November and 1 May of each of the respective years. For the winter season, three different experiments will be carried out. These are CLIM-TROPICS: using climatological SST and sea-ice but with relaxation of the tropical atmosphere; OBS-TROPICS: the same as CLIM-TROPICS but including the observed time series of extratropical SST and sea-ice; and CLIM-STRAT: the same as CLIM-TROPICS but with relaxation only in the extratropical, northern hemisphere stratosphere. We also plan to repeat CLIM-TROPICS and OBS-TROPICS for the summer season (but not CLIM-STRAT since stratosphere/troposphere coupling is weak during the summer season).

A summary of all the 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.

Table 1: Summary of the experiments planned in 2014 along with the required computational and mass storage requirements.

Experiment	Forecast days	SBU (kilo units)	Archive (Gb)
CLIM-TROPICS (NDJF and MJJA)	74520	1379	7.452
OBS-TROPICS (NDJF and MJJA)	74520	1379	7.452
CLIM-STRAT (NDJF)	36720	679	3.672
Total	185760	3437	18.576

Finally, we note that the experiments outlined in this proposal will augment those proposed in special project *spdejun2*, which employs the relaxation technique to improve our understanding of the impact of the polar regions on lower latitudes (including Europe) weather and climate. Both projects will share the same control ensemble experiment.(carried out in *spdejun2*), corresponding to OBS-NO in Figure 1 and using the observed time series of SST and sea-ice but no relaxation..

References

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