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	2017
Project Title:	Coupled seasonal forecasts of the 20th Century (CSF-20C)
Computer Project Account:	spgbweis
Principal Investigator(s):	Dr. Antje Weisheimer
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Name of ECMWF scientist(s) collaborating to the project (if applicable)	Dr. Patrick Laloyaux (ECMWF)
Start date of the project:	01/01/2017
Expected end date:	32/12/2018

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)			26200000	6987.62
Data storage capacity	(Gbytes)			24000	0

Summary of project objectives
(10 lines max)

While the sources of predictability on seasonal timescales are dominated by the influence of the tropical Pacific (ENSO), the question of whether the North Atlantic Oscillation (NAO) and associated climate anomalies over the North Atlantic-European area can be predicted with any confidence is still a matter of on-going scientific debate. Of particular interest is the question if the findings of relatively high levels of NAO forecast skill over recent decades provide a sound manifestation of improved predictions in the presence of decadal-scale climate variability. Following on a previous project using atmosphere-only simulations, this project aims at providing coupled seasonal hindcasts over the 20th Century period from 1900 to 2010.

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

No problems encountered that are worth reporting here.

Summary of results of the current year (from July of previous year to June of current year)
This section should comprise 1 to 8 pages and can be replaced by a short summary plus an existing scientific report on the project

This project is a based on a successful previous special project (Seasonal forecasts of the 20th Century: Reliability, attribution and the impact of stochastic perturbations) which ended in 2016. The aim of the previous project was to generate, for the first time, a seasonal hindcast data set that was substantially longer in the hindcast period covered than what is usually the case. We performed atmospheric seasonal hindcasts experiments with the ECMWF atmospheric seasonal forecast model (IFS cycle 41R1) over the period 1900 to 2010 for several start dates around the year. The forecasts were initialised with ECMWF's atmospheric reanalysis of the 20th Century ERA-20C.

These hindcast data sets provided us with the opportunity to study decadal variability in seasonal hindcast skill. Recent state-of-the-art seasonal hindcasts from forecasting centres around the world indicated rather high levels of forecast skill for the NAO but questions were raised about the robustness of these results. A particular concern is that these promising results were obtained over an often-used hindcast length of 20-30 years covering the most recent decades. However, some studies in the literature hinted on substantially less skill in predicting the NAO for hindcast periods before the 1980s or so. Indeed, our findings from the 20th-Century seasonal hindcasts confirmed a substantial level of decadal variability in NAO forecast skill over the period 1900 to 2010. In particular, we found that the skill during a prolonged period in the middle of the Century dropped to non-significant levels while it was higher again in earlier decades of the 20th Century (*Weisheimer et al., 2017*). Our analysis pointed towards a more global pattern of climate variability that showed a change in behaviour between the middle of the Century and more recent decades which included tropical sea surface temperatures, circulation indices like the PDO and most remarkably also the Pacific North American (PNA) pattern (*O'Reilly et al., 2017*).

In the new project, we would like to go one step further: to run a fully coupled ocean-atmosphere seasonal hindcast for the 20th Century. The recent completion of ECMWF's coupled reanalysis of the 20th Century (CERA-20C) makes such an endeavour feasible as it also provides ocean state estimates from 1900 onward. The coupled hindcasts will allow us, by comparison with the data from the previous project, so study the impact of air-sea interaction on seasonal predictability and will provide a more realistic framework for analysing the NAO prediction question.

In the first 6 months of the project we have started work towards the technical implementation of such coupled seasonal hindcasts. We are using IFS cycle 41R1 in T_L255L91 resolution coupled to the default version of NEMO3.4 in 1 degree configuration with 42 vertical levels.

The first step involved testing uncoupled simulations initialised with CERA-20C instead of ERA-20C. CERA-20C consists of an ensemble of reanalysis with 10 members, whereas ERA-20C only had one realisation. As outlined in the project application, we are first aiming to run hindcasts over the 1981-2010 period in order to be able to compare with existing coupled hindcasts using ERA-I and ORA-S4 as initialisation.

The second step involved running a coupled experiment where the atmosphere is initialised with CERA-20C but the ocean still uses ORAS4. Further steps include testing of initialising the ocean with the ocean-only reanalysis ORA-20C in combination with atmospheric initialisation from CERA-20C.

The current status of the work is that we are still testing configurations which involves modifications mostly at the script level of the model and running short test cases. This explains why we have used up only a relatively small proportion of the SBUs allocated for this year.

List of publications/reports from the project with complete references

No publications or reports are available yet.

Publication from the previous projects on which this project builds on:

Weisheimer, A., N. Schaller, C. O'Reilly, D. MacLeod and T.N. Palmer (2017). Atmospheric seasonal forecasts of the 20th Century: multi-decadal variability in predictive skill of the winter North Atlantic Oscillation and their potential value for extreme event attribution. *Q. J. R. Meteorol. Soc.*, **143**, 917-926, doi:10.1002/qj.2976.

O'Reilly, C.H., J. Heatley, D. MacLeod, A. Weisheimer, T.N. Palmer, N. Schaller, and T. Woollings (2017). Variability in seasonal forecast skill of Northern Hemisphere winters over the 20th Century. *Geophys. Res. Lett.*, doi:10.1002/2017GL073736.

Summary of plans for the continuation of the project

(10 lines max)

The plan for the second half of the year is to start running longer hindcasts periods once we have obtained an experimental set-up and configuration that works well and reliably. While some of the steps described above have been tested for individual start dates, a longer set of hindcasts in these configurations still needs to be done. Thus, it is envisaged to use the allocated computing units mostly in the second half of this year.