LATE REQUEST FOR A SPECIAL PROJECT 2014–2016

MEMBER STATE: United Kingdom

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Project Title: Reducing drift and correcting biases in coupled seasonal hindcasts

Current project code spgbhain

Would you accept support for 1 year only, if necessary?	YES	NO

Computer resources required for 2014-2016: (The project duration is limited to a maximum of 3 years, agreed at the beginning of the project. For late requests the project will start in the current year.)	**2014**	**2015**	**2016**
High Performance Computing Facility (units)	500,000	500,000	500,000
Data storage capacity (total archive volume) (gigabytes)	1000	1000	1000

*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): ……11th March 2014……

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: Keith Haines (University of Reading)

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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.

It is intended that, if possible, this project be a continuation of the project from 2013 of the same title **(project code spgbhain).**

We are working at Reading University within a NERC project (ERGODICS, until end 2015) focused on improving the initialisation of coupled systems, and on the new ERA-CLIM2 (until end 2016) project where we will be developing coupled assimilation methods. Both projects have Met Office interests. Our present work has been analysing model drift and the development of biases in available seasonal hindcasts. Our focus is on ocean biases, forming both as part of the model's drift from observations towards its own climatology, and potentially as a result of insufficiently balanced initial conditions that can produce 'initialisation shocks'. Analysis to date has indicated that such shocks may be common along the tropical thermocline, and this is therefore an area in which we believe improvements to the initialisation procedure are possible.

We started work with ECMWF hindcast data (from model version 36r1, provided by Linus Magnusson (see Magnusson et al., 2012)), as well as Glosea4 data from the Met Office. In autumn 2013 we got late access to ECMWF special project resources (**spgbhain**) with the aim of performing several hindcast simulations using the latest model cycle 40r1, to ensure results were up to date and useful for developing the current system. We initiated the 40r1 experiments in December 2013, again with the help of Linus Magnusson at ECMWF because cy40r1 is not externally available until May 2014 under ECMWF rules. These data are now being analysed in Reading.

We are now seeking to extend this special project for a further 3 years for the following investigations

1) To continue the hindcast initialisation work under ERGODICS. The late application last year meant we did not request an extended project to cover further work.
2) The start of the new FP7 ERACLIM2 project in January 2014, which covers a closely related area and involves close working with the ECMWF coupled Reanalysis system. The work here is for WP2 of the project, led by the Met Office (Matt Martin). It was agreed at the ERA-CLIM2 kickoff meeting that we join the requirements for Reading into this special project application.

David Mulholland will initially continue to work on the coupled hindcast research and on improving the treatment of ocean biases in the coupled system which is within the remit of both ERGODICS and ERA-CLIM2. A second PDRA supported by ERACLIM2 will be added to this project and will focus on analysing coupled covariances and covariance errors using the data products from coupled reanalyses being performed at the centre.

Work proposed under ERGODICS

'Initialisation shocks' (in which model fields rapidly adjust at the beginning of a hindcast) occur where there is an imperfect balance between ocean and atmosphere fields in the initial conditions, which may lead to prediction errors on longer timescales (Zhang, 2011, Hudson et al., 2010). From current analyses of older hindcast shocks in the equatorial thermocline it is not clear which of two possible sources of the adjustment is most important: (i) the instantaneous removal of the equatorial pressure correction scheme (Bell et al.,

2004), which prevents the reversal of density increments due to erroneous wind forcing during the oceanic assimilation phase, or the occurrence of a rapid drift in the atmospheric model, as typically occurs in initialised model runs. Both are capable of introducing a shock-like signal into the tropical upper ocean.

We will investigate initialisation shocks and model drift using a number of short hindcast simulations starting from a number of different initial conditions, including: (i) 40r1 hindcasts using current seasonal forecasting initialisation methods (ii) hindcasts based on new CERA coupled DA methodology, (iii) modifications of the above for test cases to investigate the coupled evolution of model drift. Experiments will use the standard cy40r1 seasonal forecast resolution of T255 with 91 vertical levels in the atmosphere and ORCA1 ocean resolution with 42 vertical levels. The length of these short hindcasts will be 1 month or less, during which ocean model output will be saved at daily frequency or higher, in order to study the behaviour of the ocean-atmosphere interface in the first days of the hindcast. Hindcast sets will cover a subset of the thirty (1981-2010) start dates used by the 'control' 40r1 set mentioned above.

Work proposed under ERACLIM2

The work will focus on performance of the CERA Coupled DA system and in particular looking at two aspects: (i) the coupled covariance errors from this system which might subsequently be used to more tightly couple the assimilation of atmospheric and ocean data within a more "strongly coupled" approach. (ii) the development of improved methods of coupled bias corrections, which includes work on bias corrections in the ocean based on pressure corrections as in Bell et al. (2004).

The work required to investigate this involves: (i) full access to the ECMWF CERA data assimilation products to perform diagnostics on the output. This will mainly be done at ECMWF to avoid transferring large datasets. (ii) Short period assimilation experiments will be performed to test changing the covariance relationships and the bias correction algorithms employed during the assimilation. These will be done in close collaboration with Patrick Laloyaux who is developing CERA at the Centre. (iii) Short period (1 month or less) hindcast experiments with the coupled system to investigate the performance of retaining bias correction algorithms during coupled hindcasts, at least for a limited period of time, to reduce impact of initialisation shocks.

Resources required:

Year 1:

ERGODICS: Analysis of 40r1 hindcasts including investigation of initialisation shock impacts in tropics and elsewhere.

ERA-CLIM2: Preliminary analysis of CERA coupled reanalyses period 2009-2010, comparisons with standard reanalysis products for the same period and development of coupled covariance diagnostics. Initial analysis will use TAO and other OceanSITES buoys for local analysis.

ERGODICS and ERA-CLIM2: Assimilation and short hindcast experiments to isolate contributions to shocks of pressure correction removal and rapid atmospheric drift (3-5 sets of hindcasts, covering multiple start dates, run for up to 1 month, saving ocean fields at daily frequency or higher).

Total cost for year 1: 500,000 SBU, 1000 GB storage

Year 2:

ERACLIM2: Analysis of long periods of coupled hindcasts from CERA and from Met Office coupled system, and development of coupled covariance relationships focussing on space and time scales of model errors combining full Obs-Background error information.

ERGODICS and ERACLIM2: Testing of modified bias correction schemes for the coupled data assimilation system. Modifying reanalysis approach for short test periods to test the impact on transient wave generation. First tests on coupled hindcast experiments to prolong bias correction algorithms into the forecast stage to reduce initialisation shocks. Work will now focus on the CERA coupled assimilation approach in order to develop methodologies for future use.

Total cost for year 2: 500,000 SBU, 1000 GB storage

Year 3:

ERACLIM2: Continue testing of bias correction algorithms using reanalysis and short period hindcast experiments, supplemented by one set of longer hindcasts focused on an agreed test period (possibly still 2009-2010, the current CERA test period) to test whether seasonal forecast skill is enhanced. Test reanalyses

and short hindcasts using coupled covariance relationships to test methodologies for introducing coupled covariances within the CERA system (CERA currently consists of interleaved 4DVar atmosphere and 3DVar ocean assimilation but this may have evolved by year 3).

Total cost for year 3: 500,000 SBU, 1000 GB storage

References

Bell, M. J., Martin, M. J. and Nichols, N. K. (2004), Assimilation of data into an ocean model with systematic errors near the equator. Q. J. R. Meteorol. Soc. 130, 873-893.

Hudson, D., Alves, O., Hendon, H. H. and Wang, G. (2011), The impact of atmospheric initialisation on seasonal prediction of tropical Pacific SST. Clim. Dyn. 36:1155-1171.

Magnusson, L., M. Balmaseda, S. Corti, F. Molteni and T. Stockdale (2012), Evaluation of forecast strategies for seasonal and decadal forecasts in presence of systematic model errors. Clim. Dyn. 1-17 10.1007/s00382-012-1599-2.

Zhang, S (2011), A study of impacts of coupled model initial shocks and state-parameter optimization on climate prediction using a simple pycnoline prediction model. J. Climate 24, 6210-6266.