REQUEST FOR A SPECIAL PROJECT 2017–2019

MEMBER STATE: …………….…………UK….………………….………………………….

Principal Investigator[1]:   ………Keith Haines………………………………….……….….

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Other researchers: ……Dr Xiangbo Feng; Dr David Mulholland………….………

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Project Title: Coupled Data Assimilation Experiments using CERA…
                (Previous project, spgbhain, "Reducing drift and correcting biases in coupled seasonal hindcasts")………….……

If this is a continuation of an existing project, please state the computer project account assigned previously.	**SP** __gbhain_____	
Starting year: (Each project will have a well-defined duration, up to a maximum of 3 years, agreed at the beginning of the project.)	2017	
Would you accept support for 1 year only, if necessary?	YES X ☐	NO ☐

Computer resources required for 2017-2019: (To make changes to an existing project please submit an amended version of the original form.)	**2017**	**2018**	**2019**
High Performance Computing Facility (SBU)	500,000	500,000	500,000
Accumulated data storage (total archive volume)[2] (GB)	1,000	1,000	1,000

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):

                …………1st July 2016…………………

                                    Continue overleaf

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[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.

[2] If e.g. you archive x GB in year one and y GB in year two and don't delete anything you need to request x + y GB for the second project year.

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Project Title: …… Coupled Data Assimilation Experiments using CERA …

Extended abstract

It is expected that Special Projects requesting large amounts of computing resources (1,000,000 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.

In our previous special project we have used project resources to explore the role that ocean bias corrections have on the initiation of coupled forecasts using the ECMWF seasonal forecasting system. Two papers have been produced;

D. P. Mulholland, K. Haines and M. A. Balmaseda. Improving seasonal forecasting through tropical ocean bias corrections. *Quarterly Journal of the Royal Meteorological Society*, Accepted.

D. P. Mulholland, P. Laloyaux, K. Haines and M. A. Balmaseda, 2015. Origin and impact of initialization shocks in coupled atmosphere-ocean forecasts. *Monthly Weather Review*, 143(11):4631-4644.

The paper now in press demonstrates that the skill of SST seasonal forecasts can be improved by maintaining ocean bias correction forces for a short period at the start of the coupled forecasts. A larger hindcast set is also being attempted this summer using the current operational ECMWF seasonal forecasting system, to verify these improvements with a view to possible use in the operational system.

We are partners in the ECMWF-lead EU project ERACLIM2 which will now run to the end of 2017. As part of this project we have a remit to examine the potential role of assimilation bias corrections within the coupled data assimilation system CERA. We now have access to all the data assimilation increments from CERA and are starting to analyse how a bias correction system might be implemented. An example of these increments shown in Figure 1. The mean increments of opposite sign in the western and eastern Pacific show that the equatorial thermocline E-W slopes are being incorrectly modelled. The signature from the TAO moorings are also very clear which raises questions about whether the zonal covariances being used to develop increments are sufficient.
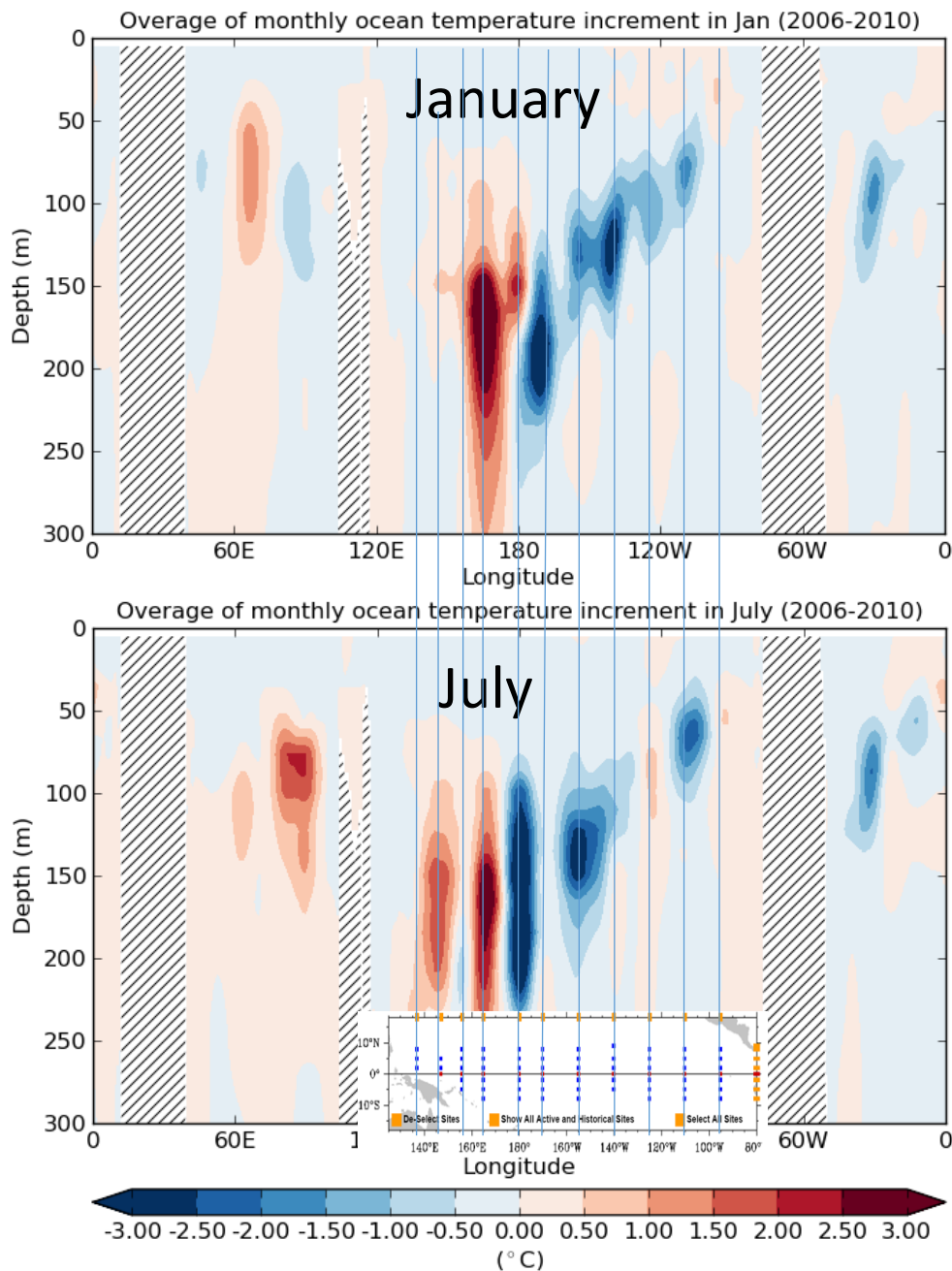
Figure 1: Five year mean (2006-2010) temperature increments in the CERA-20C coupled reanalysis. The cooling (E Pacific) and warming (W Pacific) thermocline biases suggest that a pressure correction approach to bias correction, similar to that used in the ocean reanalysis ORAS4, could be beneficial to CERA-20C.

We envisage using these new (extended) special project resources to test how bias corrections might influence both the coupled reanalysis and the performance of hindcasts launched from the CERA reanalysis.

In addition to the bias correction work, we are using the ensemble CERA products (10 members are produced) to study the covariance structures within the ensemble. These covariances are being used to condition the background error covariances which are part of the data assimilation process. We aim to understand the consistency of the ensemble products in terms of their spread and evolution in

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time. We have been specifically focussing on near surface atmosphere-ocean covariances because these could be used as part of the evolving coupled data assimilation system going forward. For example, recent focus has been on the atmosphere-ocean covariances around the Pacific warm pool compared with the rest of the tropics. Figure 2 shows time series of ensemble mean, spread and correlations for SST and T2m (2m air temperatures) over the Nino3.4 region for the CERA-20C 10-member ensemble reanalysis.
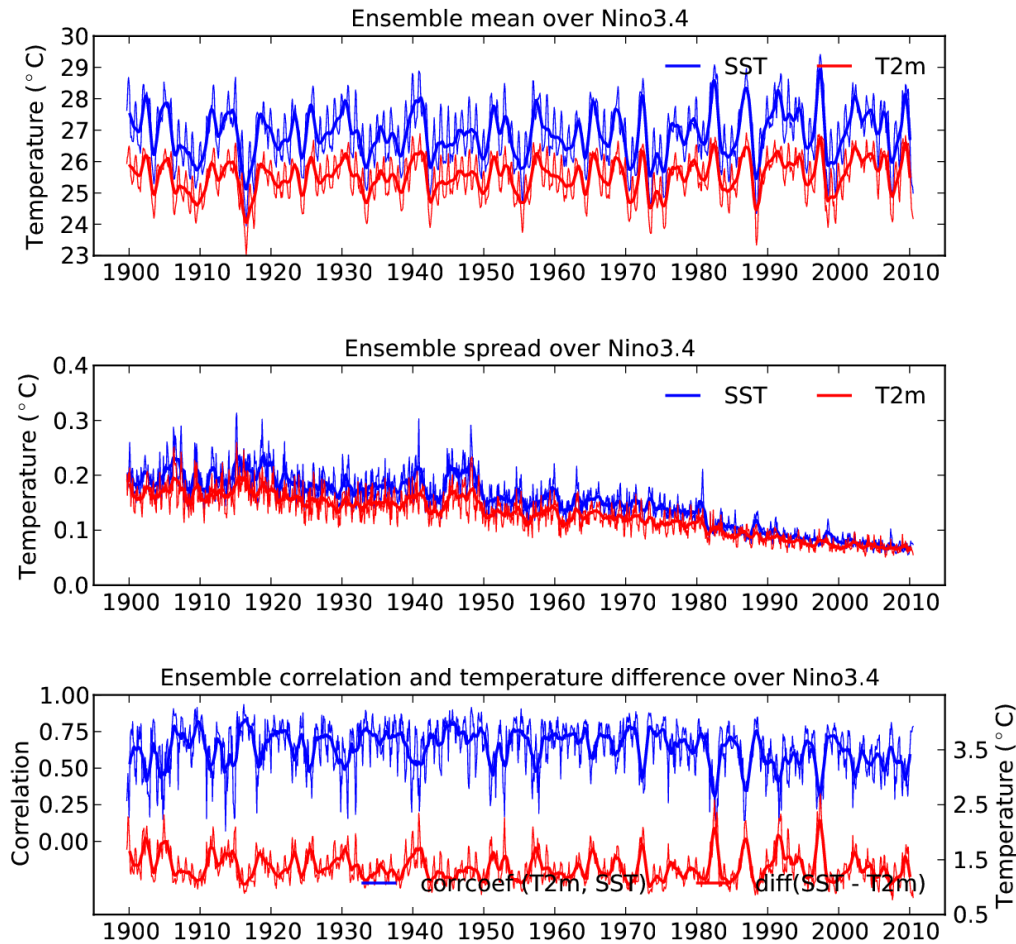

Figure 2. Time series of ensemble temperature products from CERA-20C over the Nino3.4 region. The bottom plot shows the increased air-sea temperature difference and the decreased correlation during El Nino events associated with the movement of the warm pool waters into the Nino3.4 region.

We envisage using these special project resources to do further analysis of the CERA-20C products and to test proposals of how modified data assimilation approaches might perform.

The resources we are requesting are based on what we have used in previous years, which have been sufficient for limited hindcast sets with the coupled model based on modified initial conditions or bias correction schemes. If any of these tests show strong promise of improvement we will seek to request larger resources to make experiments more robust.

Although the ERACLIM2 project extends only to the end of 2017 we would hope and expect to continue to maintain resources at Reading to investigate these processes as part of rolling support provided by the NCEO where Haines is Capability leader for marine data assimilation. Therefore we seek to propose this project focus for the next 3 years.