LATE REQUEST FOR A SPECIAL PROJECT 2019–2021

MEMBER STATE: United Kingdom

Principal Investigator[1]: David MacLeod

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Other researchers: Chris O'Reilly (Uni Oxford)
Martin Todd (Uni Sussex)

Project Title: Diagnosing subseasonal to seasonal predictability of the East African long rains

If this is a continuation of an existing project, please state the computer project account assigned previously.	**SPGBMACL**	
Starting year: (A project can have a duration of up to 3 years, agreed at the beginning of the project.)	2019	
Would you accept support for 1 year only, if necessary?	**YES** ☐	☐

Computer resources required for the years: (To make changes to an existing project please submit an amended version of the original form.)		**2019**	**2020**	**2021**
High Performance Computing Facility	(SBU)	**750,000**		
Accumulated data storage (total archive volume)[2]	(GB)			

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.
[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.

Principal Investigator: David MacLeod

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Extended abstract

Resources from the finished 2018 Special Project *"Diagnosing subseasonal to seasonal predictability of the East African long rains*" have been used to explore the predictability of the climate over East Africa. This work supports the NERC/DFID project "ForPAc" (www.forpac.org), which is evaluating the potential for humanitarian early action in Kenya based on climate forecasts.

The special project followed four separate lines of enquiry: two of these investigations have recently been published (MacLeod 2019, MacLeod & Caminade 2019 – see spgbmacl special project final report for further details).

The final investigation considered the impact of different ENSO 'flavours' on East African climate. It is well known that El Nino is a strong predictor of short rains (Oct-Nov-Dec) rainfall over East Africa, however the sensitivity of this link to the precise location of the ENSO SST anomalies is less well understood. Specifically, we ask the question: do the East African short rains respond differently depending on whether ENSO SST anomalies are in the central Pacific or the East Pacific (i.e. if ENSO is canonical or "modoki", Ashok et al 2007).

Atmosphere-only seasonal reforecasts have been run to explore this question. The lower boundary condition came from modified SST fields. In the control the field was a daily SST climatology, and in the experiment various warm or cold anomalies were added to specified regions in the Pacific. The test regions correspond to the longitudes of the Nino3, Nino3.4, and Nino4 boxes, with latitudes between 20N & 20S.

Initial analysis of these experiments has been completed, and the suggest that the tropical atmosphere is significantly more sensitive to perturbations in Nino4 (central Pacific), compared with Nino3 (East Pacific). See figure 1 for an example.

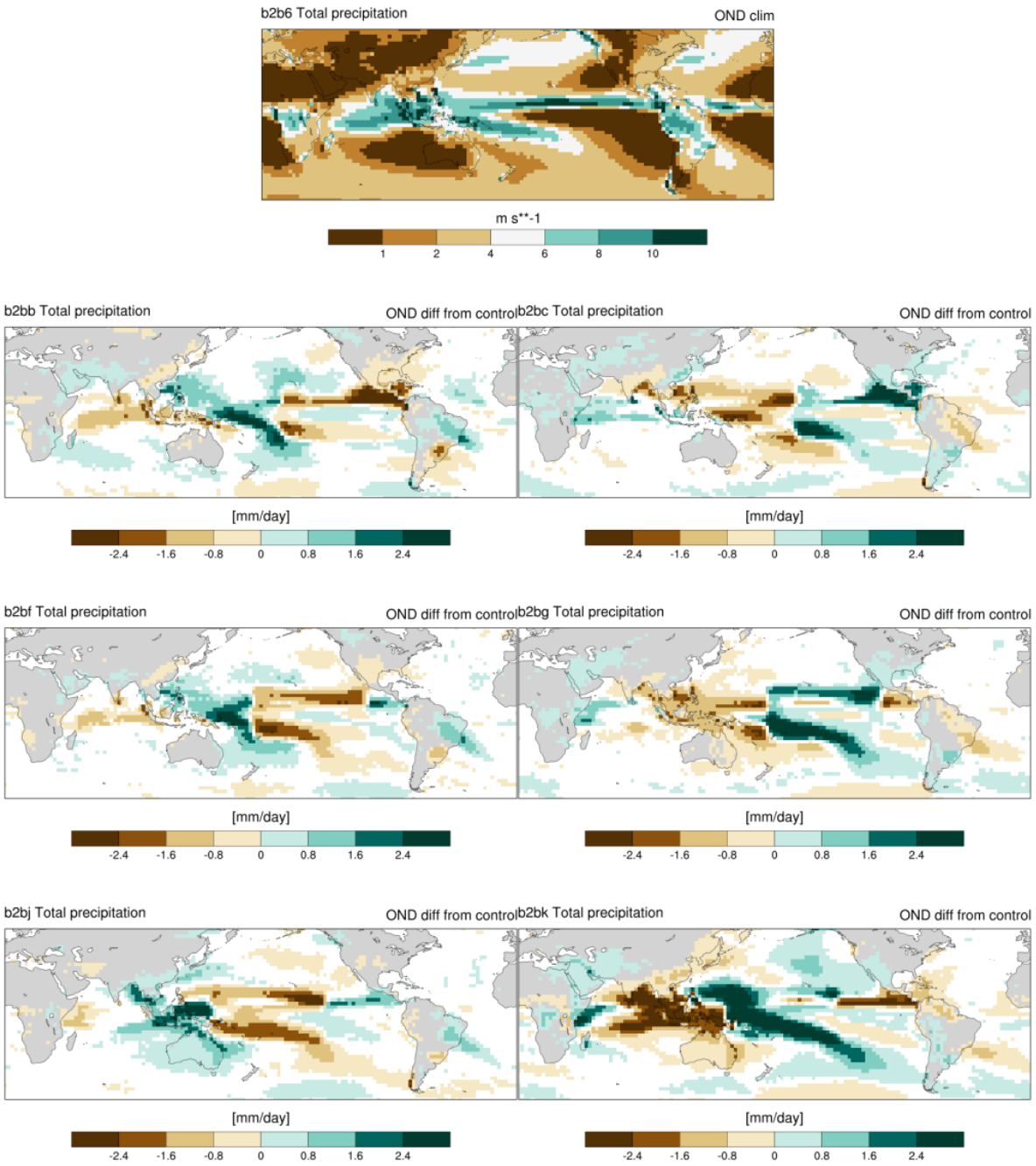

Figure 1: Atmospheric response to tropical Pacific SST perturbations. Top row: mean OND precipitation in control experiment. Below: difference from control when negative (left) and positive (right) 1K perturbation is added to Nino3 (2nd row), Nino3.4 (3rd row) and Nino 4 (4th row).

These experiments used perturbations over a relatively large latitude band (20N-20S) and relatively large perturbations (up to 2K). This was done in order to ensure a clear signal in the experiments. However, these experimental perturbations are rather high compared to observed SST variability in these regions, and the spatial pattern is not representative of the relatively narrow pattern of ENSO warming. As such, although these results inform understanding of model sensitivity and are suggestive of atmospheric sensitivity, they do not quite show the atmospheric response to a realistic forcing.

It would therefore be highly valuable to extend this investigation to include experiments with more realistic forcing of different ENSO flavours.

Instead of using a uniform anomaly perturbation within a large box, experiments are proposed which use an SST forcing based on observed SST composites. That is, for all years defined as 'canonical' or 'modoki' El Nino/La Nina a composite SST will be generated. A new SST forcing will then be created based on the climatological forcing, by replacing SST values the tropical Pacific with the composite values. By using a composite approach, the SST forcing applied to the atmosphere in these new experiments will be significantly more physically consistent than that used previously, and the new results will be more relevant to real-world impacts.

In addition the new experiments will be run for six months, instead of the initial four (SONDJF rather than SOND). Collaborators (Martin Todd & Chris O'Reilly, named as other researchers on this proposal) are looking to answer the same research question on ENSO impacts, but for different regions during the season DJF (looking South Africa, and Europe). By incurring a slight increase in computing cost with little extra effort, this extension to the DJF season will make the data directly releveant for them.

Resource request

Four experiments are planned:

- Modoki El Nino
- Modoki La Nina
- Canonical El Nino
- Canonical La Nina

Each experiment comprises an initial condition ensemble made up of one initialized ensemble every year for 37 years (1981-2017). Each member is run for six months.

Previous experiments indicate one month of simulation of CY41R1 in atmosphere-only mode costs 620SBU.

6 months X 37 years X 5 (four experiments plus one new 6-month control) = 688,200 SBU

Adding ~10% to accommodate variability in SBU estimates and small tests, this comes to **750,000SBU**.

References

Ashok, K., Behera, S.K., Rao, S.A., Weng, H. and Yamagata, T., 2007. El Niño Modoki and its possible teleconnection. *Journal of Geophysical Research: Oceans*, *112*(C11).

MacLeod, D. Seasonal forecasts of the East African long rains: insight from atmospheric relaxation experiments, Clim Dyn (2019). https://doi.org/10.1007/s00382-019-04800-6

MacLeod, D.. Caminade, C The moderate impact of the 2015 El Nino over East AFrica and its representation in seasonal forecasts, Under final revissions at J. Clim.