<u>LATE</u> REQUEST FOR A SPECIAL PROJECT 2026–2028

MEMBER STATE: ………United Kingdon…………..…

Principal Investigator[1]: …… Hannah Christensen……………..……

Affiliation: University of Oxford

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Other researchers:

Robert (Bobby) Antonio
Kristian Strommen

Project Title: *Speeding up ocean spin-up using stochastic parametrisations*

To make changes to an existing project please submit an amended version of the original form.)

If this is a continuation of an existing project, please state the computer project account assigned previously.	**SP** GBCHRI	
Starting year: (A project can have a duration of up to 3 years, agreed at the beginning of the project.)	2026	
Would you accept support for 1 year only, if necessary?	**YES** ☒	NO ☐

Computer resources required for project year:		**2026**	**2027**	**2028**
High Performance Computing Facility	[SBU]	4000000	0	0
Accumulated data storage (total archive volume)[2]	[GB]	2500	2500	2500

EWC resources required for project year:		**2026**	**2027**	**2028**
Number of vCPUs	[#]			
Total memory	[GB]			
Storage	[GB]			
Number of vGPUs[3]	[#]			

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 annual progress reports of the project's activities, etc.
[2] These figures refer to data archived in ECFS and MARS. 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 etc.
[3]The number of vGPU is referred to the equivalent number of virtualized vGPUs with 8GB memory.

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Extended abstract

All Special Project requests should provide an abstract/project description including a scientific plan, a justification of the computer resources requested and the technical characteristics of the code to be used. The completed form should be submitted/uploaded at https://www.ecmwf.int/en/research/special-projects/special-project-application/special-project-request-submission.

Following submission by the relevant Member State the Special Project requests will be published on the ECMWF website and evaluated by ECMWF and its Scientific Advisory Committee. The requests are evaluated based on their scientific and technical quality, and the justification of the resources requested. Previous Special Project reports and the use of ECMWF software and data infrastructure will also be considered in the evaluation process.

Requests exceeding 10,000,000 SBU should be more detailed (3-5 pages).

Project Overview:
The primary aim of this project is to use recent advances in machine learning (ML) to speed up the ocean spin-up in a coupled earth system model, to improve the quality of climate simulations as part of the EERIE (European Eddie-Rich ESMs) project. Our approach to do this is by coupling a machine learning emulator of the atmosphere (ACE2) to a standard ocean model (NEMO), which will significantly reduce the compute time required per year of spin up. We also hope to use this novel setup to explore scientific questions about how the atmospheric dynamics affect the ocean, and the behaviour of machine-learnt emulators. Coupling a machine-learnt emulator to a physical ocean model is challenging and novel work, which to the best of our knowledge has not been achieved elsewhere.

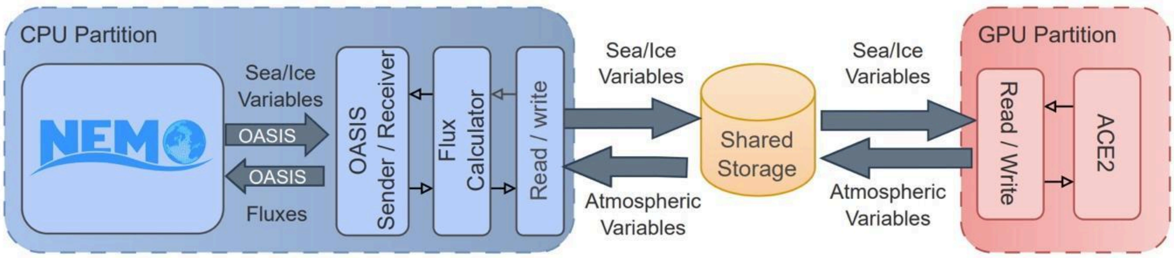

Fig. 1: Schematic diagram of the infrastructure used to couple ACE2 to NEMO.

Simulations performed so far:
We have successfully created a scheme to couple these models (see fig. 1), with the result that the coupled model is stable for 100s of years and produces realistic evolution (see fig. 2, upper panel) and realistic coupled variability (see regression of precipitation onto Niño 3.4 index in fig. 2, lower panel). We have successfully run 70-year historical and control runs using ECMWF's HPC system last year. Unfortunately, we recently found a bug in the code that was used to run the ocean spin-up runs, which means that this data is not suitable for evaluating the spin-up experiment, and so this experiment needs to be rerun. Investigating the feasibility of faster ocean spin-up is one of the central deliverables of our project, and therefore it is crucial that we are able to rerun this final simulation.

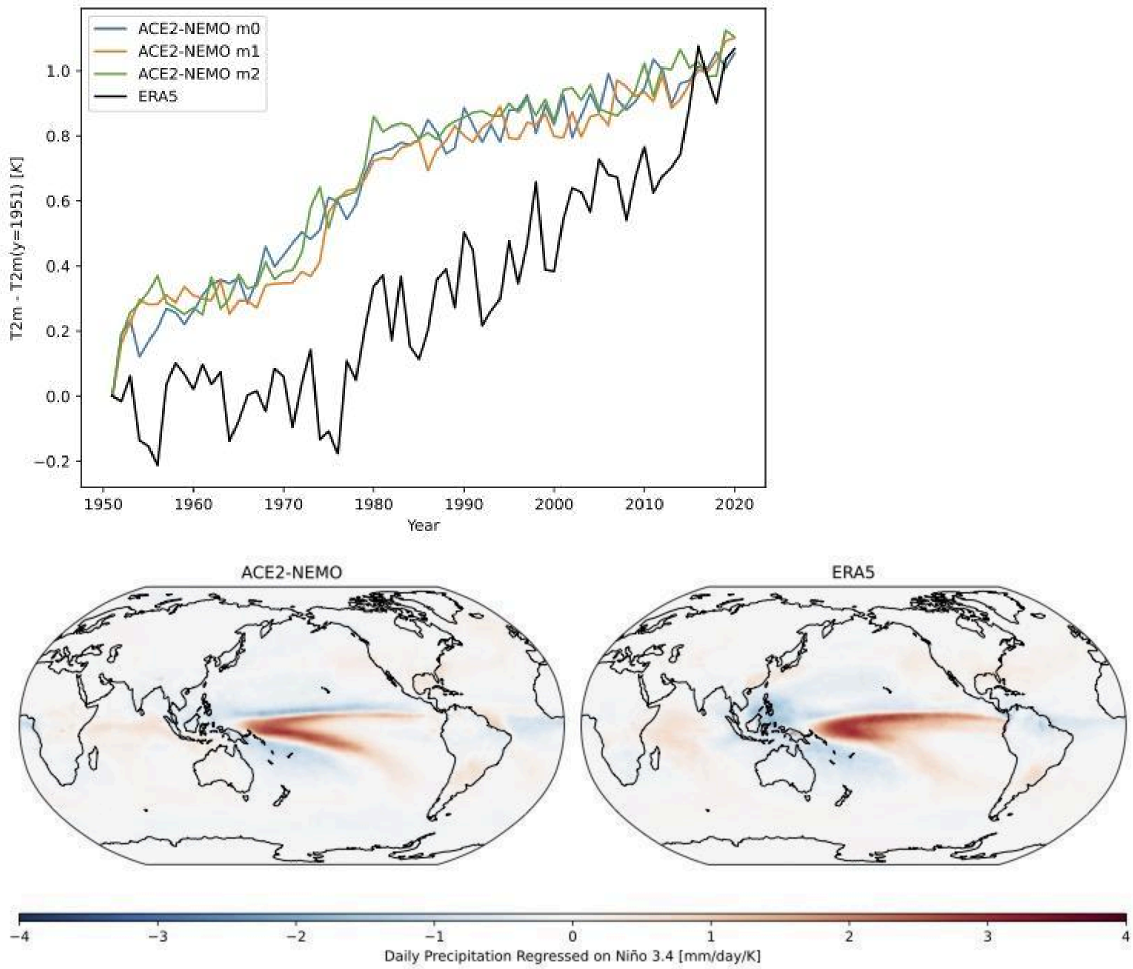

Fig. 2: Upper panel; Global 2-metre temperature evolution for ACE2-NEMO using historical CO2 forcings. Lower panel; daily precipitation regressed onto the Niño 3.4 index, for ACE2-NEMO compared with ERA5.

Resource requirements:
To run this 70-year simulation would require the use of 3 CPU nodes for running NEMO, and 1 GPU node for running ACE2, with a total predicted wall-clock time of 7 days (1 day of run time per decade of simulation); therefore we estimate this would require 2.5m SBU, and 1m GBU. To allow for some room for experimentation and testing, we have rounded this up to 4m SBU and 2m GBU. The compressed and monthly aggregated output from our simulations will be less than 100GB. Since our code was successfully run on ECMWF's HPC last year, and the bug in question (a config setting) is straightforward to fix, we do not anticipate any significant technical challenges that would prevent the simulations succeeding.

Technical Characteristics
We use the NEMO ocean model, which is written in Fortran and is written to be run in parallel over several nodes. For the atmosphere, we use ACE2, a recently developed machine-learnt emulator, which is written in Python and requires a GPU to run. We communicate with NEMO using the OASIS and pyOASIS libraries, and utilise shared scratch storage and a polling mechanism to pass information between the CPU nodes and the GPU nodes (see fig. 1).