REQUEST FOR A SPECIAL PROJECT 2024

MEMBER STATE: Ireland

Principal Investigator[1]: Enda O'Dea

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Project Title: Coupled HCLIM-NEMO Regional Downscaling Simulations for Ireland Phase1: Historical Comparison with Atmosphere Only.

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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.		
Starting year: (A project can have a duration of up to 3 years, agreed at the beginning of the project.)	2024	
Would you accept support for 1 year only, if necessary?	YES X☐	NO ☐

Computer resources required for project year:		**2024**	**2025**	**2026**
High Performance Computing Facility	[SBU]	30 million		
Accumulated data storage (total archive volume)[2]	[GB]	60,000		

EWC resources required for project year:		**2024**	**2025**	**2026**
Number of vCPUs	[#]			
Total memory	[GB]			
Storage	[GB]			

[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.

Number of vGPUs[3]	[#]			

Continue overleaf.

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Enda O'Dea
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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 5,000,000 SBU should be more detailed (3-5 pages).

Aim:

This project is designed to develop, validate, and implement a high resolution regional coupled Atmosphere-Ocean (AO) climate projection system for Ireland. This project is concerned with an AO model but will be step one in a longer-term effort at building a fully coupled HCLIM-NEMO-WWIII based earth system model including waves. HCLIM is the climate version of the NWP non-hydrostatic meso-scale HARMONIE model (Bengtsson et al., 2017). The initial developmental stage involves contributing to the HCLIM-NEMO coupling development underway within the HCLIM consortium and building an AO coupled configuration for Ireland based on the existing atmosphere only projections. The purpose of such a system is to provide high-resolution coupled regional projections of the impacts of climate change on sea levels and storm surges around the Irish coast. The HCLIM coupling initiative involves contributions from several HCLIM member nations and this project would both contribute to and build upon that wider expertise in the HCLIM community. In this project the aim is to develop and validate the initial HCLIM-NEMO coupled system over an historical period and compare with existing atmosphere only HCLIM runs of the same period. If this project is successful, the HCLIM-NEMO coupled system will be used to simulate the future regional climate of Ireland at high spatial resolution O(4 *km*) by downscaling CMIP6 datasets under the full range of ScenarioMIP "tier 1" RCPs; SSP1-2.6, SSP2-4.5, SSP3-7.0 & SSP5-8.5. In addition to providing tidal forced projections, the coupled systems are expected to provide more accurate projections of storms and onshore climate fields and will enhance the existing ensemble of Regional Climate Model (RCM) projection datasets for Ireland.

If ~~NEMO-~~HCLIM-NEMO proves to require substantially more effort than anticipated, we envisage a contingency where we will implement the Coupled Ocean–Atmosphere–Wave–Sediment Transport (COAWST) (Warner et. al (2010)) modelling system (comprising WRF, ROMS & WAVEWATCH3) to provide the coupled system. COASWT would be used in place of HCLIM-NEMO for the proposed historical period. However, if HCLIM-NEMO is successful, and the project is progressing ahead of

schedule we could also envisage running COAWST in compliment to HCLIM-NEMO with a view to the use of future multi-model approaches to high resolution coupled Irish Climate projections.

Scientific Background:

The purpose of this project is to carry out the first coupled HCLIM-NEMO downscaling projections for~~of~~ Ireland. The shelf seas surrounding the British Isles are very tidally active and as such the SST is very dynamic with the evolution of tidal mixing fronts between stratified and tidally mixed areas changing hour to hour. The importance of inclusion of tidal processes and its important omission in global coupled models has been demonstrated in several papers including Arnold et al. (2021), Mahmood et al. (2021) and Timko et al. (2019). The inclusion of the NEMO Ocean component will allow for atmosphere ocean exchange in this dynamically active shelf seas region. Mahmood et al. (2021) for example have shown that mean errors are improved significantly in an NWP configuration be replacing a static SST boundary condition with a dynamic forecasted ocean boundary condition. Nuances such as reduced surface land temperatures during summertime shown in Arnold et al. (2021) could be important for summer heatwave projections and impacts on human activities. Predecessor HCLIM projects conducted at Met Éireann have archived atmosphere only simulations against which we can compare the coupled simulations over the historical period. If the coupled runs show sufficient skill and added value, then this project will form the foundation stone towards later coupled projections.

Timeline

Work on this project is expected to start in 2024, with development on foundational work of the coupled HCLIM-NEMO system already underway led by researchers at MetNo, FMI, DMI, AMET, and Met Éireann. A demonstrator coupled experiment that shows that the HCLIM-NEMO coupled system~~s~~ is stable is phase 1 of this project. Thereafter phase 2 is a validation stage simulating the historical period 1995-2015 with lateral boundaries for HCLIM and NEMO taken from ERA5 and the Copernicus Global Ocean Physics Reanalysis product. Met Éireann have already conducted HCLIM Atmosphere-only simulations forced by ERA5 and we would aim to validate and compare the effect of the coupling over the historical period in both the Atmosphere-~~-~~only and the new Atmosphere-Ocean coupled simulations. If the HCLIM-NEMO simulations are robust it will enhance confidence ahead of a follow-on project to use the coupled system for Irish Climate projections.

	Description	Simulation yrs.	Total SBUs	Total Archive
Phase1	Initial testing of coupled system	<5	<5 million	10 TB
Phase 2	Historical1995-2015 HCLIM-NEMO (COAWST as contingency model)	20	25 million	50 TB

Total			30 million	60 TB

References

Arnold, A. K., Lewis, H. W., Hyder, P., Siddorn, J., & O'Dea, E. (2021). The sensitivity of British weather to ocean tides. Geophysical Research Letters, 48, e2020GL090732. https://doi.org/10.1029/2020GL090732

Bengtsson, L., and Coauthors (2017). The HARMONIE-AROME model configuration in the ALADIN-HIRLAM NWP system, Mon. Weather Rev., 145(5), 1919-1935.

Mahmood, S, Lewis, H, Arnold, A, Castillo, J, Sanchez, C, Harris, C. The impact of time-varying sea surface temperature on UK regional atmosphere forecasts. Meteorol Appl. (2021); 28:e1983. https://doi.org/10.1002/met.1983

Timko P., Arbic B., Hyder P., Richman J., Zamudio L., O'Dea E., Wallcraft A., Shriver J. Assessment of shelf sea tides and tidal mixing fronts in a global ocean model. Ocean Modelling, Volume 136, (2019), https://doi.org/10.1016/j.ocemod.2019.02.008

Warner J., Armstrong B., He R., Zambon J., Development of a Coupled Ocean–Atmosphere–Wave–Sediment Transport (COAWST) Modeling System, Ocean Modelling, Volume 35, Issue 3, (2010) https://doi.org/10.1016/j.ocemod.2010.07.010