REQUEST FOR A SPECIAL PROJECT 2021–2023

MEMBER STATE: Ireland

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Project Title: Optimisation of Cycling Strategies for a Nowcasting configuration of HARMONIE-AROME for Ireland

If this is a continuation of an existing project, please state the computer project account assigned previously.	**SP** __________________	
Starting year: (A project can have a duration of up to 3 years, agreed at the beginning of the project.)	2021	
Would you accept support for 1 year only, if necessary?	YES ☒	NO ☐

Computer resources required for 2021-2023:
(To make changes to an existing project please submit an amended version of the original form.)

		2021	2022	2023
High Performance Computing Facility	(SBU)	9.5M		
Accumulated data storage (total archive volume)[2]	(GB)	5TB		

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.

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Extended abstract

1. Background

The shared ALADIN-HIRLAM numerical weather prediction system is used for operational weather forecasting by 26 national meteorological services in Europe and North Africa which form the HIRLAM (High Resolution LimitedArea Model) and ALADIN (Aire Limitee Adaptation Dynamique Developpement International) consortia. The Irish Meteorological Service, Met Éireann, is one of the 26 members and has been using the HARMONIE-AROME canonical configuration of this system since 2011. We currently use Cycle 40 of the system operationally (Bengtsson et al, 2017, Met Éireann 2018) and since 2018 use HARMONIE-AROME as the basis for the Irish Regional Ensemble Prediction System (IREPS), an 11 member ensemble (10 perturbed + 1 control).

While NWP modelling has traditionally been focused at the short and medium range, it's use in the area of Nowcasting (0-6/9 hours) has become a growing area of research across many NMHS (Ballard S. et al, 2015; Auger L. et al, 2015; Olsen B.T. et al, 2015). The primary objective is to provide improved short term prediction of high-impact weather events (Yong Wang 2017).

The focus of this special project will be on developing an optimal configuration of HARMONIE-AROME suitable for Nowcasting purposes. This work will investigate cycling strategies (Rapid Refresh and Rapid Update Cycling), data assimilation algorithms (3D-Var and 4D-Var), techniques that can reduce model spin-up (Incremental Analysis Updates (Bloom et al, 1996)) and the assimilation of observations with higher spatial and temporal resolutions (radar reflectivity, Doppler winds, Mode-S, GNSS). Testing of these different aspects will provide the basis for a NWP Nowcasting configuration for Ireland which will be run on a smaller domain and higher model resolution than the current operational IREPS.

2. Justification of the SBU resources requested:

The current IREPS operational domain for Ireland covers an area of 1000 x 900 points (Figure 1, orange domain) with a horizontal grid spacing of 2.5 km and 65 vertical levels. Running this domain for one 24-hour forecast cycle costs approximately 13000 SBUs. The proposed experiment domain (Figure 1, red domain) covers an area of 540 x 500 grid points. Running the proposed test domain for a Nowcasting type configuration consisting of twenty-four 12-hour forecast cycles per day would cost approximately 48000 SBUs.

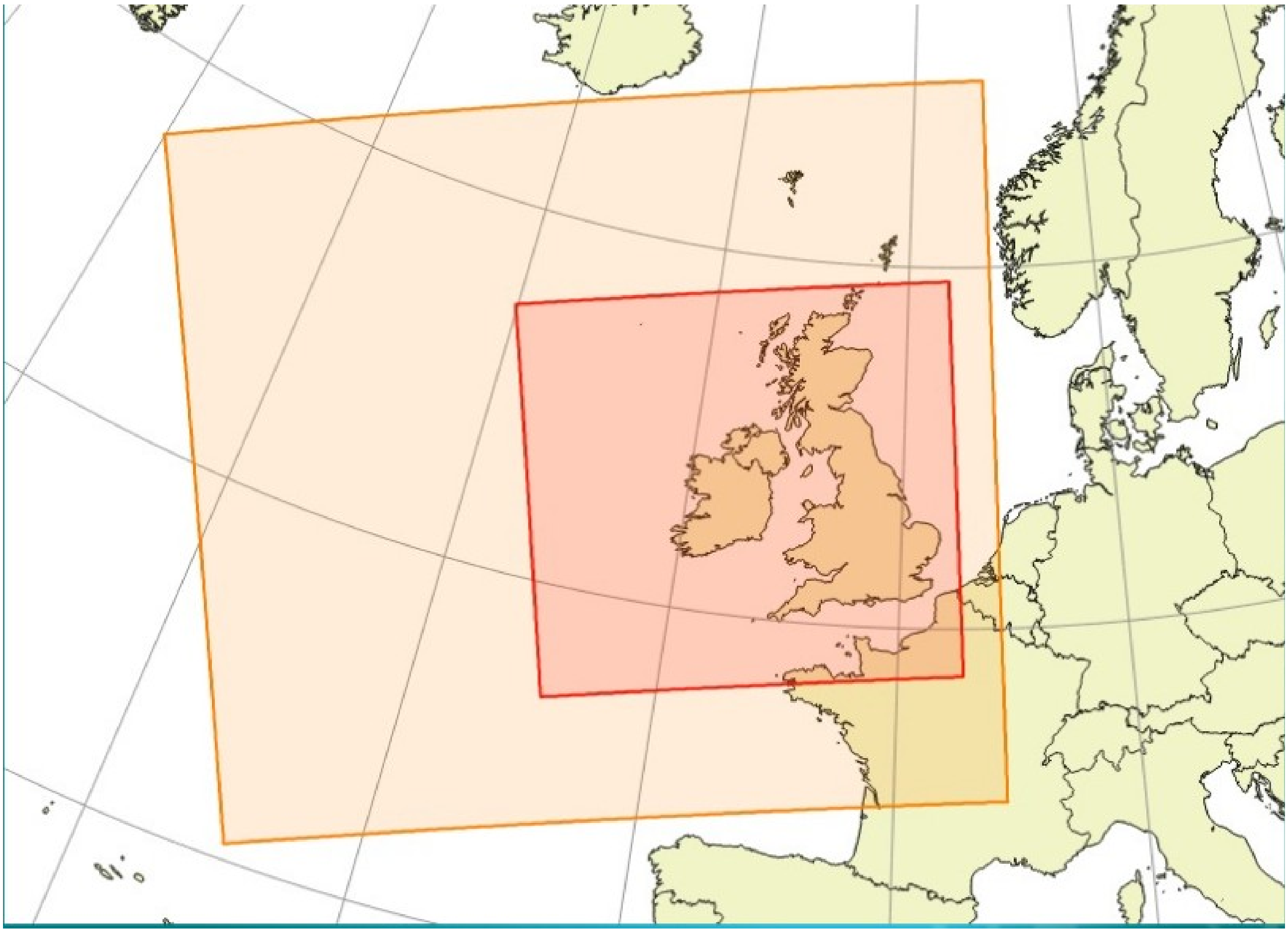

Figure 1: Current operational domain in orange, proposed test domain for experiments in red.

The requested resource of 5 MSBUs will be spent as follows:

1) Initial technical testing will be done with the cycling strategies and spin-up reducing techniques, this will consist of a number of one-day tests to ensure that the configurations work from a technical standpoint. It is proposed that there would be 2 tests with each option, giving a total of: 2 (tests per option) * 3 (3D-Var/4D-Var data assimilation, with 4D-Var costing approximately twice as much) * 3 (RR or RUC cycling strategy or IAU) * 48000 SBUs = 18 * 48000 SBUs ~ 1M SBUs.

2) Based on the results of the above two 5 day long tests will be performed on two periods (one in DJF and one in JJA). These will consist of one of the data assimilation algorithms (3D-Var/4D-Var) with one of the cycling strategies (RR/RUC) in combination IAU giving a total of: 2 (periods) * 5 days * 3 (3D-Var/4D-Var data assimilation, with 4D-Var costing approximately twice as much) * 2 (RR or RUC cycling strategy) * 2 (IAU) * 48000 SBUs = 120 * 48000 SBUs ~ 5.5M SBUs.

3) Based on the results of 2) the best performing configuration will be tested in an operational setting for 2 ten day long periods (one in DJF and one in JJA) to compare

against our operational forecasts. This will use a total of: 2 * 10 days * 48000 SBUs = 20 * 48000 SBUs ~ 1M SBUs.

4) The tests run in 3) will also be performed on a 1.25km resolution grid. This will use a total of: 2 * 10 days * 96000 SBUs = 20 * 96000 SBUs ~ 2M SBUs.

The above tests will initially be run using a forecast length of 12 hours, but this can be reduced to 9 or 6 hours if it is seen that longer lead times are not providing increased skill compared to the latest available operational forecasts.

3. Benefits of the Project

It is hoped that a successful configuration from the proposed testing will provide improved short term guidance to forecasters in high-impact weather events, and that the improved hourly analysis would give quicker verification of these events. Furthermore, the envisaged work could be combined with extrapolation of observation type Nowcasting systems to provide the basis of a Blended Nowcasting system as recommended by the WMO (Yong Wang 2017).

4. References:

Auger L. et al. (2015). AROME–NWC: a new Nowcasting tool based on an operational mesoscale forecasting system. Quarterly Journal of the Royal Meteorological Society, 141: 1603-1611.

Ballard S., Li Z., Simonin D, Caron J-F. (2015). Performance of 4D-Var NWP-based Nowcasting of precipitation at the Met Office for summer 2012, Quarterly Journal of the Royal Meteorological Society, 142: 472-487.

Bengtsson, L., U. Andrae, T. Aspelien, Y. Batrak, J. Calvo, W. de Rooy, E. Gleeson, B.Hansen-Sass, M. Homleid, M. Hortal, K. Ivarsson, G. Lenderink, S. Niemelä, K.P. Nielsen, J.Onvlee, L. Rontu, P. Samuelsson, D.S. Muñoz, A. Subias, S. Tijm, V. Toll, X. Yang, and M.Ø. Køltzow, 2017: The HARMONIE–AROME Model Configuration in the ALADIN–HIRLAM NWP System. Mon. Wea. Rev., 145, 1919–1935, https://doi.org/10.1175/MWR-D-16-0417.1

Bloom, S. C., L. L. Takacs, A. M. D. Silva, and D. Ledvina, 1996: Data assimilation using incremental analysis updates. Mon. Wea. Rev., 124, 1256-1271.

Met Éireann, 2018: HARMONIE-AROME 40h1.1 Upgrade, Technical Note, http://hdl.handle.net/2262/86034

Olsen B.T., et al. (2015). On the performance of the new NWP Nowcasting system at the Danish Meteorological Institute during a heavy rain period. Meteorology and Atmospheric Physics, 127: 519-535.

Yong Wang et al. (2017). Guidelines for Nowcasting Techniques, World Meteorological Organisation 2017.