REQUEST FOR A SPECIAL PROJECT 2019–2021

MEMBER STATE: Ireland

Principal Investigator[1]: Emily Gleeson

Affiliation: Met Éireann

Address: 65/67 Glasnevin Hill
Dublin 9
D09 Y921
Ireland

Other researchers: Colm Clancy
Ronan Darcy
Alan Hally
Jonathan McGovern
Eoin Whelan
Geoffrey Bessardon

Project Title: Evaluation, Tuning and Optimisation of Surface Physics Parametrizations in HARMONIE-AROME for NWP forecasting for Ireland

Computer resources required for 2019-2021: (To make changes to an existing project please submit an amended version of the original form.)		**2019**	**2020**	**2021**
High Performance Computing Facility	(SBU)	3M	3M	3M

[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] 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.

Accumulated data storage (total archive volume)[2]	(TB)	6	12	18

Continue overleaf

Principal Investigator: Emily Gleeson

Project Title: Evaluation, Tuning and Optimisation of Surface Physics Parametrizations in HARMONIE-AROME for NWP forecasting for Ireland

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 Limited Area 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) with a set-up using a 1000 x 900 horizontal grid on a Lambert Conformal projection with 2.5 km spacing at the centre and 65 vertical levels. The lowest level is at 12 m with a nominal model top at 10 hPa and an integration time step of 60 s. ALADIN non-hydrostatic dynamics (Benard et al. 2010), non-hydrostatic mesoscale (Meso-NH) physics (Lafore et al. 1998) and the SURFEX (Surface Externalisee) externalised surface scheme (Masson et al. 2013) are used. This version of the model uses version 7 of the SURFEX code. The next version of HARMONIE-AROME, cycle 43, uses version 8 of SURFEX (Le Moigne et al., 2018) which contains more advanced surface physics schemes. In particular, a 14-layer Diffusion Soil Scheme, a multi-layer Explicit Snow Scheme (Boone, 2000; Boone and Etchevers, 2001) and the ISBA Mutli-Energy-Budget Explicit Vegetation Scheme (Boone et al., 2017; Napoly et al., 2017).

The focus of this project will be primarily on testing surface related physics modules in the model in order to improve weather forecasts for Ireland but also to feed all improvements back into the shared ALADIN-HIRLAM system for the benefit of all collaborating members. This work has currently not been carried out for any HARMONIE domain and it crucial in order to make the best use of the system and to continue to improve the skill of the forecasts. Testing the sensitivity of the surface physics will also feed into the mesoscale ensemble systems of the members.

2. SBU justification for the various Experiments

The 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. Our previous operational domain (Figure 1, red domain) covered an area of 500 x 540 grid points. Running this domain for one 24-hour forecast cycle costs approximately 4000 SBUs.

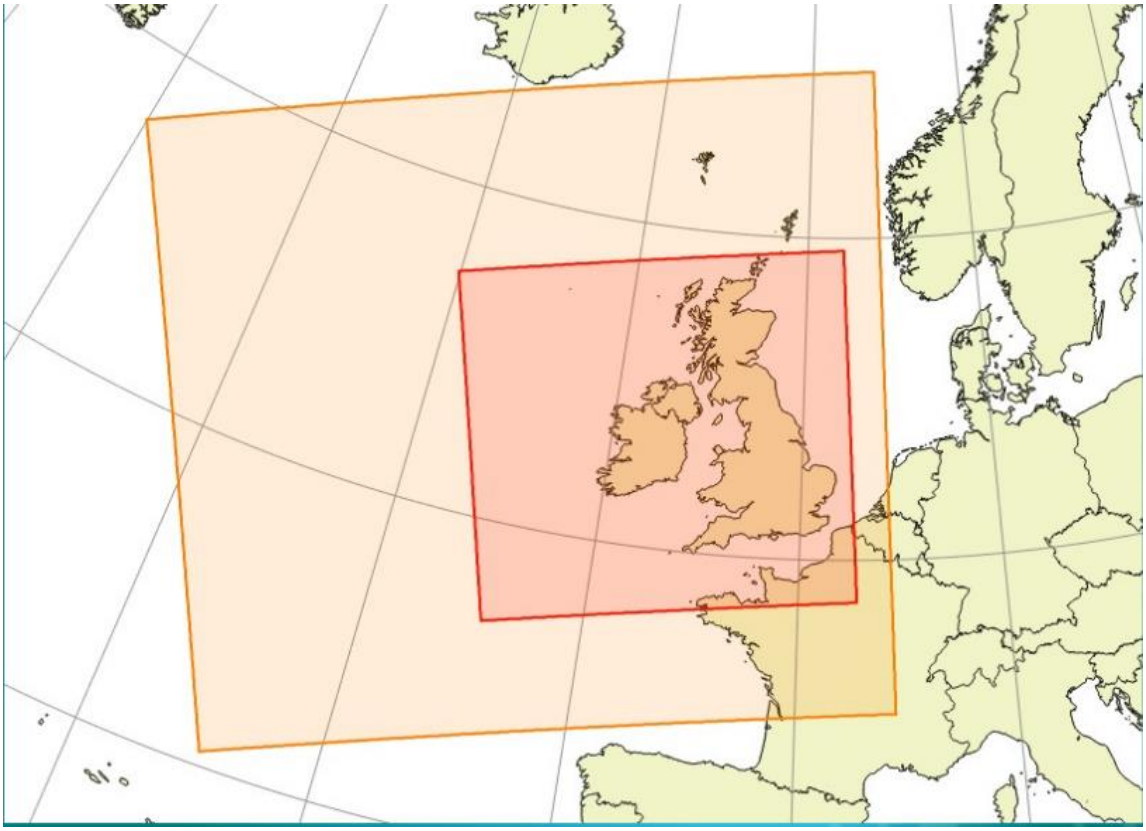

Fig 1. Irish operational domain in orange, old operational domain in red.

The requested resource of 9 MSBUs will be spent as follows:

- A 3-year long HARMONIE-AROME cycle 43 simulation in climate rather than NWP mode. This will be used to test the new surface physics options in the model (soil, snow, vegetation) over the Irish operational domain in order to identify systematic biases – it is important to run it in climate mode as using the system with data assimilation masks/reduces much of the biases and from experience we have found that a climate style simulation is a lot more revealing. SBU cost (using the smaller domain) ~ 4M SBUs.
- SURFEX uses physiography databases relating to land-cover, topography, soil/clay/sand and lakes. These databases have not been thoroughly checked for Ireland – several issues have been uncovered for other domains and a thorough check and comparison with local databases for Ireland (e.g. GSI, agriculture databases) will firstly be carried out. Summer and Winter month-long simulations using HARMONIE-AROME cycle 43 simulation in climate rather than NWP mode will be carried out to test the sensitivity of the physiography datasets. Tests using SURFEX in offline mode will also be carried out to evaluate a

complete set of surface options. SBU cost (smaller domain) based on 5 sensitivity tests, each 2 months long: 1.2M SBUs.

- When upgrading to cycle 40 of HARMONIE-AROME we found issues relating to maximum temperatures and over-prediction of fog which are thought to be related to issues with the surface model. The remainder of the SBUs will therefore be used for a suite of sensitivity experiments that will help and lead to the tuning of various surface parametrizations. Many of the tunings are currently only valid for specific climates. SBU estimate: 4.8M SBUs.

3. Benefits of the Project

This work has not been carried out for Ireland to date. Surface modelling is seen as a high priority in the HIRLAM community. A thorough check of the surface descriptions, and in particular land-cover types, is firstly required. Improvements to the surface physiography may lead to improvements in the operational weather forecasts – this is important for impact based forecasting and for improving the authoritative voice of National Meteorological/Hydrological Services. The second part of the project will involve making improvements and tunings to the surface physics in the model – this will also lead to improvements in forecasts through improving known biases and uncovering other issues with the model. We are aware of issues with visibility due to over-prediction of mist and fog and also issues with maximum daily temperatures thought to be related to the soil scheme and leaf area index climatologies. This work will also be of benefit to the development of the HARMONIE climate model, HCLIM.

4. References

Benard, P., J. Vivoda, J. Masek, P. Smolıkova, K. Yessad, C. Smith, R. Brozkova, and J.-F. Geleyn, 2010: Dynamical kernel of the Aladin-NH spectral limited-area model: Revised formulation and sensitivity experiments. Quart. J. Roy. Meteor. Soc., 136 (646), 155–169, doi:10.1002/qj.

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

Boone, A., Modelisation des processus hydrologiques dans le schema de surface ISBA: Inclusion d'un reservoir hydrologique, du gel et modelisation de la neige. PhD thesis, University Paul Sabatier, Toulouse, France, 2000.

Boone, A. and P. Etchevers. An intercomparison of three snow schemes of varying complexity coupled to the same land surface model: Local-scale evaluation at an alpine site. J. Hydrometeorol., 2(4):374–394, 2001.

Boone, A., P. Samuelsson, S. Gollvik, A. Napoly, L. Jarlan, E. Brun, and B. Decharme. The interactions between soil-biosphere-atmosphere (isba) land surface model multi-energy balance (meb) option in surfex - part 1: Model description. Geosci. Model Dev., 30:1–30, 2017.

Lafore, J. P., and Coauthors, 1998: The Meso-NH Atmospheric Simulation System. Part I: adiabatic formulation and control simulations. Ann. Geophys., 16 (1), 90–109, doi:10.1007/s00585-997-0090-6.

Le Moigne, P., and Coauthors, 2013: SURFEX (8.1) Scientific Documentation, 2018.

Masson, V., and Coauthors, 2013: The SURFEXv7.2 land and ocean surface platform for coupled or offline simulation of earth surface variables and fluxes. Geosci. Model Dev., 6 (4), 929–960, doi:10.5194/gmd-6-929-2013.

Napoly, A., A. Boone, P. Samuelsson, S. Gollvik, E. Martin, R. Seferian, D. Carrer, B. Decharme, and L. Jarlan. The interactions between soil-biosphere-atmosphere (isba) land surface model multi-energy balance (meb) option in surfex - part 2: Model evaluation for local scale forest sites, 2017.