REQUEST FOR A SPECIAL PROJECT 2022–2024

MEMBER STATE: Ireland

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

Computer resources required for 2022-2024: (To make changes to an existing project please submit an amended version of the original form.)		**2022**	**2023**	**2024**
High Performance Computing Facility	(SBU)	35M		
Accumulated data storage (total archive volume)[2]	(GB)	(use national allocation)		

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

The completed form should be submitted/uploaded at https://www.ecmwf.int/en/research/special-projects/special-project-application/special-project-request-submission.

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.

Following submission by the relevant Member State the Special Project requests will be published on the ECMWF website and evaluated by ECMWF as well as the Scientific Advisory Committee. The evaluation of the requests is based on the following criteria: Relevance to ECMWF's objectives, scientific and technical quality, and 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 asking for 3,000,000 SBUs or more should be more detailed (3-5 pages). Large requests asking for 10,000,000 SBUs or more might receive a detailed review by members of the Scientific Advisory Committee.

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 consortium ACCORD (A Consortium for COnvection-scale modelling Research and Development). 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 43 operationally 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 60s. ALADIN non-hydrostatic dynamics (Benard et al. 2010), non-hydrostatic mesoscale (MesoNH) physics (Lafore et al. 1998) and the SURFEX (Surface Externalisee) externalised surface scheme (Masson et al. 2013) are used.

This project focuses on testing all surface related physics modules in order to improve weather forecast over Ireland.

HARMONIE-AROME cycle 43, uses the latest version of ECOCLIMAP (Masson et al. 2003) land cover map, ECOCLIMAP-SG (CNRM (n.d.)). First evaluations of ECOCLIMAP-SG over Ireland showed an underestimation of sparse urban areas and an overestimation of grassland area as illustrated in figure 1, leading to the use of the FAKETREE option in cycle 43 which artificially adds 10% trees to grassland and crop areas in the land-cover map. This has also motivated work towards the creation of a land-cover map for Ireland (Walsh et al. 2021). ECOCLIMAP-SG, in contrast to previous versions, uses pure rather than mixed vegetation classes, external tree heights, albedos and leaf area index (LAI) data inputs (CNRM (n.d.)). The implementation of this new land cover map in HARMONIE-AROME consequently requires modifications of add-ons datasets and surface physics parametrizations that needs to be tested. This project will be of benefit to other countries as the method used in (Walsh et al. 2021) can be potentially used for the whole HARMONIE-AROME domain and also for the new operational consortium United Weather Centres West (UWC-West), of which Ireland is a member.

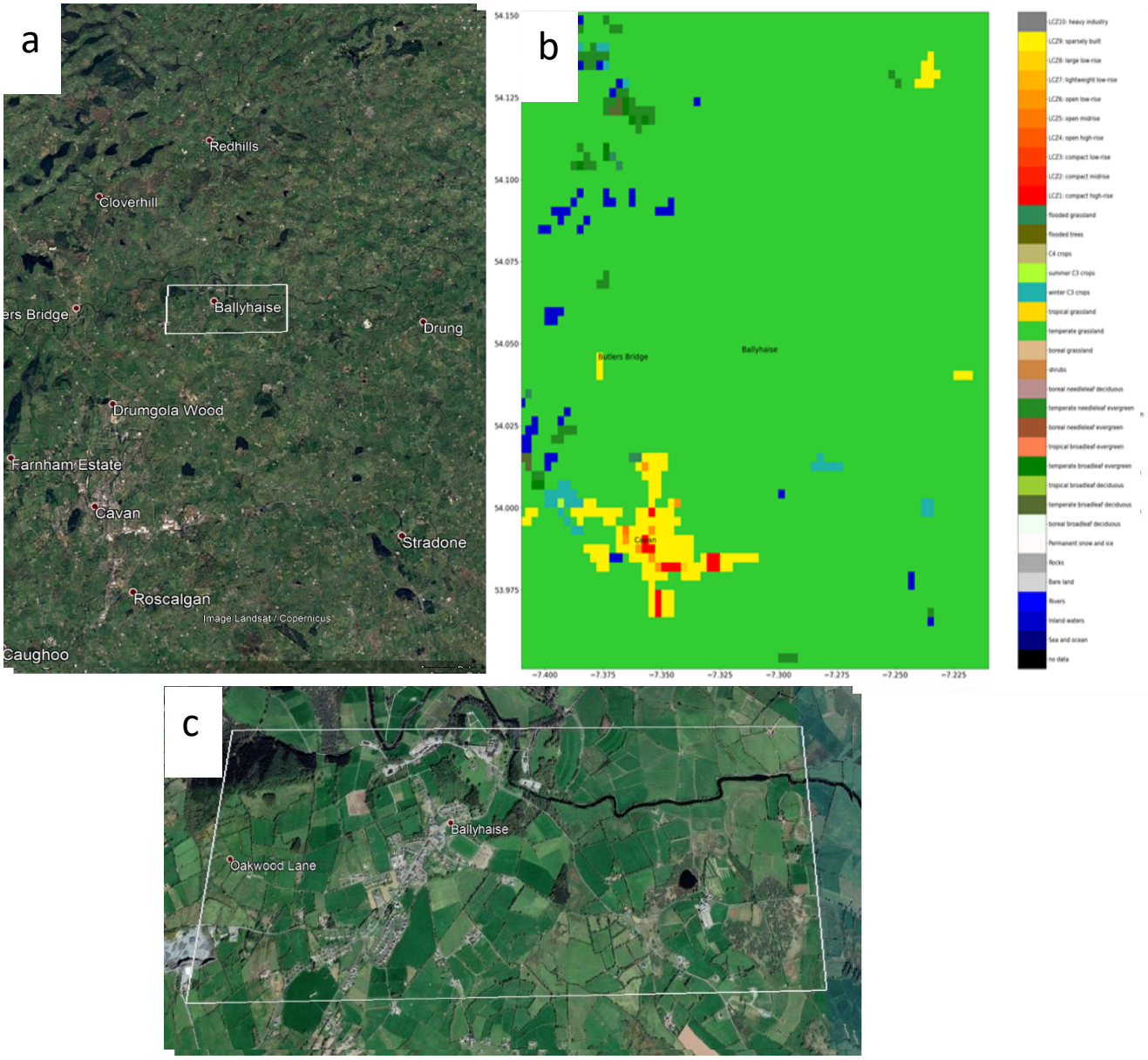

Figure 1 Example of ECOCLIMAP-SG limitation around the village of Ballyhaise (County Cavan) with the Google Earth overview of the area (a), the ECOCLIMAP-SG representation of the area (b), a zoom over the Ballyhaise village (c)

2. SBU justification for the various Experiments

The operational domain for Ireland covers an area of 1000 x 900 points (figure 2, orange domain) with a horizontal grid spacing of 2.5 km and 65 vertical levels. Our previous operational domain (figure 2, red domain) covered an area of 500 x 540 grid points.

The requested resource of 35 M SBUs will be spent as follows:

- The new land cover map produced in (Walsh et al. 2021) is of superior resolution (10-m) compared to ECOCLIMAP-SG (300-m). Tests using SURFEX in offline mode will be carried to evaluate the benefit of processing the (Walsh et al. 2021) map downsampled at different resolutions and the associated full set of surface options. This map, along with changes to the corresponding physiography datasets for LAI, albedo etc, will be tested across all seasons over Ireland.

- There is a positive bias in dew point temperatures in HARMONIE-AROME over Ireland in Spring and Summer as a result of excessive evaporation, which leads to negative temperature biases and positive biases in humidity. This will be thoroughly investigated using various tunings such as minimal stomatal resistance. Comparisons to flux dataset (sensible and latent heat) will enable us to evaluate the impact of any tunings more thoroughly.
- This evaporation issue also exasperates issues with fog in HARMONIE-AROME – the special project will be used to test new surface options in relation to fog case studies. There are also some issues with wind speed overestimation and urban minimum temperatures which are thought to be related to issues with the surface model and resolution of the underlying physiography. 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.
- Both cycle 43 and 46 will be used for the above testing.

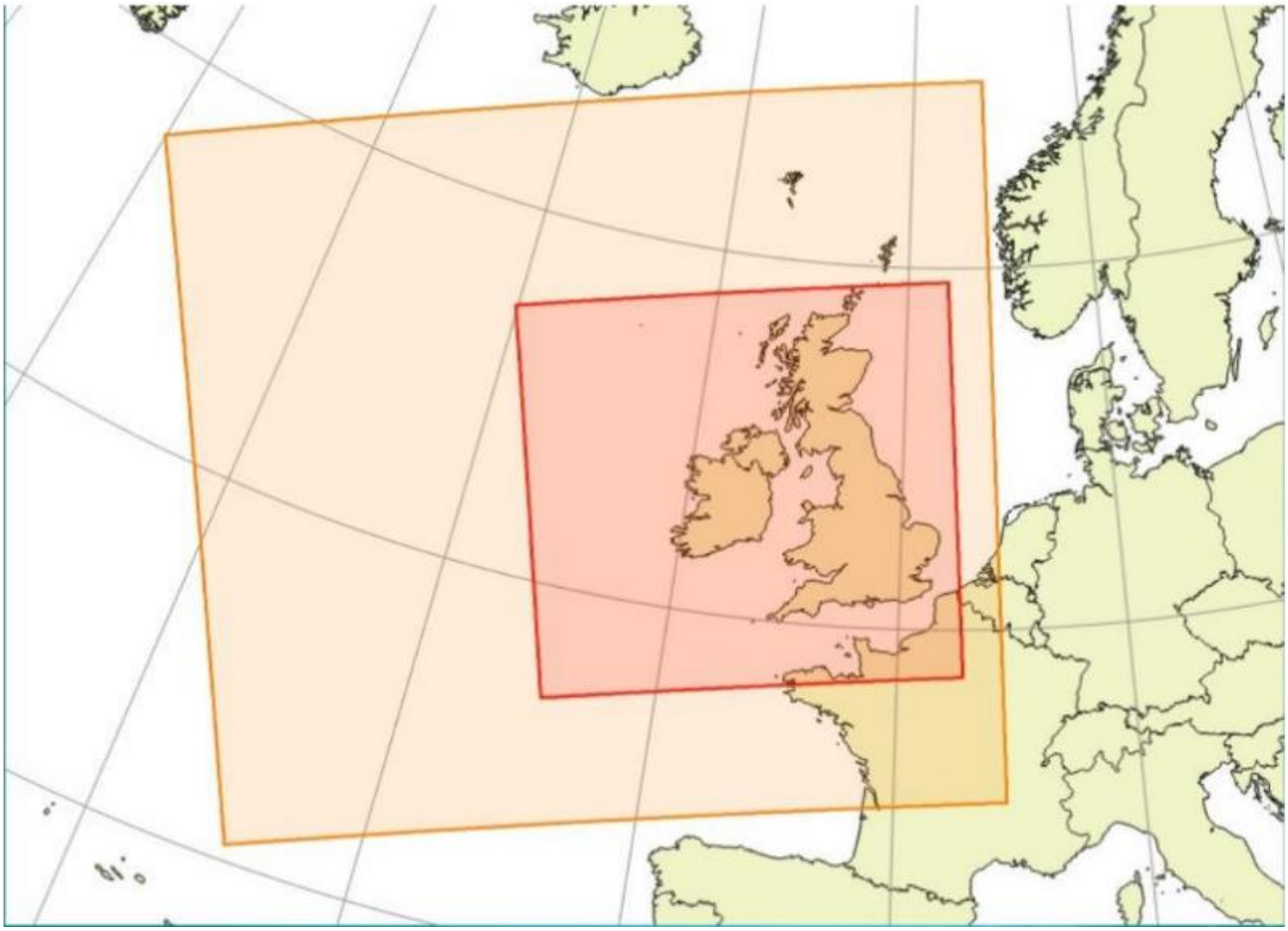

Figure 2 Irish operational domain in orange, old operational domain in red

3. Benefits of the project

Surface modelling is seen as a high priority in the HIRLAM community, and this work will evaluate the benefits of an improved physiography for operational forecasting. This will benefit the whole HIRLAM community as the method to produce the map for Ireland can be extended to other countries. The second part of the project will focus on correcting errors identified operationally in cycle 43. This work will also be of benefit to the development of the HARMONIE climate model, HCLIM and will feed into general improvements in cycle 46.

4. References

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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.

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