REQUEST FOR A SPECIAL PROJECT 2019–2021

MEMBER STATE: Ireland

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Project Title:

Configuration of the Stochastic Pattern Generator for SPPT perturbations in HarmonEPS at High Resolution

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.)	2019	
Would you accept support for 1 year only, if necessary?	YES ☒	NO ☐

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)	9M		
Accumulated data storage (total archive volume)[2]	(GB)	10TB		

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 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

Background

HarmonEPS is an ensemble prediction system for the short-range (36-48h) based on the non-hydrostatic HARMONIE-AROME model configuration in the ALADIN-HIRLAM NWP system (Bengtsson et al. 2017). HarmonEPS includes a number of schemes which can be activiated in order to account for model/physical parameterisation uncertainties. These include surface perturbations (Bouttier et al. 2015), multi-model physics options and the stochastically perturbed parameterisation tendencies (SPPT) scheme which was originally developed at the ECMWF (Buizza et al. 1999). HarmonEPS is running operationally at a number of HIRLAM institutes, e.g. the MEPS (Andrae et al. 2017) configuration in Sweden, Finland and Norway and the COMEPS (Yang et al. 2017) configuration in Denmark. Met Éireann will soon implement its own operational configuration of HarmonEPS, the Irish Regional Ensemble Prediction System (IREPS). IREPS will be an 11 member ensemble (10 perturbed + 1 control) with the perturbed members being generated using the Scaled Lagged Average Forecasting (SLAF) technique (Ebisuzaki and Kalnay 1991). Surface perturbations will also be activated following the method described in Bouttier et al. 2015.

Within the HIRLAM community, efforts continue to be placed on improving the representation of uncertainties related to initial conditions, later boundary conditions and model error. Uncertainties creep into the modelling process from a number of sources, e.g. through the parameterised description of complex atmospheric processes such as turbulence or cloud microphysics. This special project concerns itself with the configuration of a new pattern generator for the SPPT approach based on the work of Tsyrulnikov, M. and Gayfulin, D., 2016. This pattern generator was first tested within the ALADIN community (Szucs, 2016a, 2017). The motivation behind implementing this pattern generator was the unsatisfying behaviour of the default random pattern generator in its LAM setting. Szucs 2017 found that the main disadvantage of the default pattern generator was that the same time correlation belongs to all the spatial scales. Secondly, the default pattern generator gives too many perturbation values at the extremes (-1,1), while failing to generate satisfactory spread in HarmonEPS runs (see figure 1 for an example of this lack of spread from the pre-operational configuration of IREPS). Szucs 2017 demonstrated that a much smoother perturbation field can be produced using the SPG pattern generator and that SPG is more easily tunable and also has the proportionality of scales property. Following on from this work, this special project aims to uncover a suitable configuration of the SPG pattern for HarmonEPS. Physics perturbations can be highly sensitive to the horizontal resolution of the parent model (Fresnay et al. 2012). In order to further investigate this point, it is also envisaged that this special project perform experiments to test the impact of activating SPPT perturbations at finer horizontal resolutions.

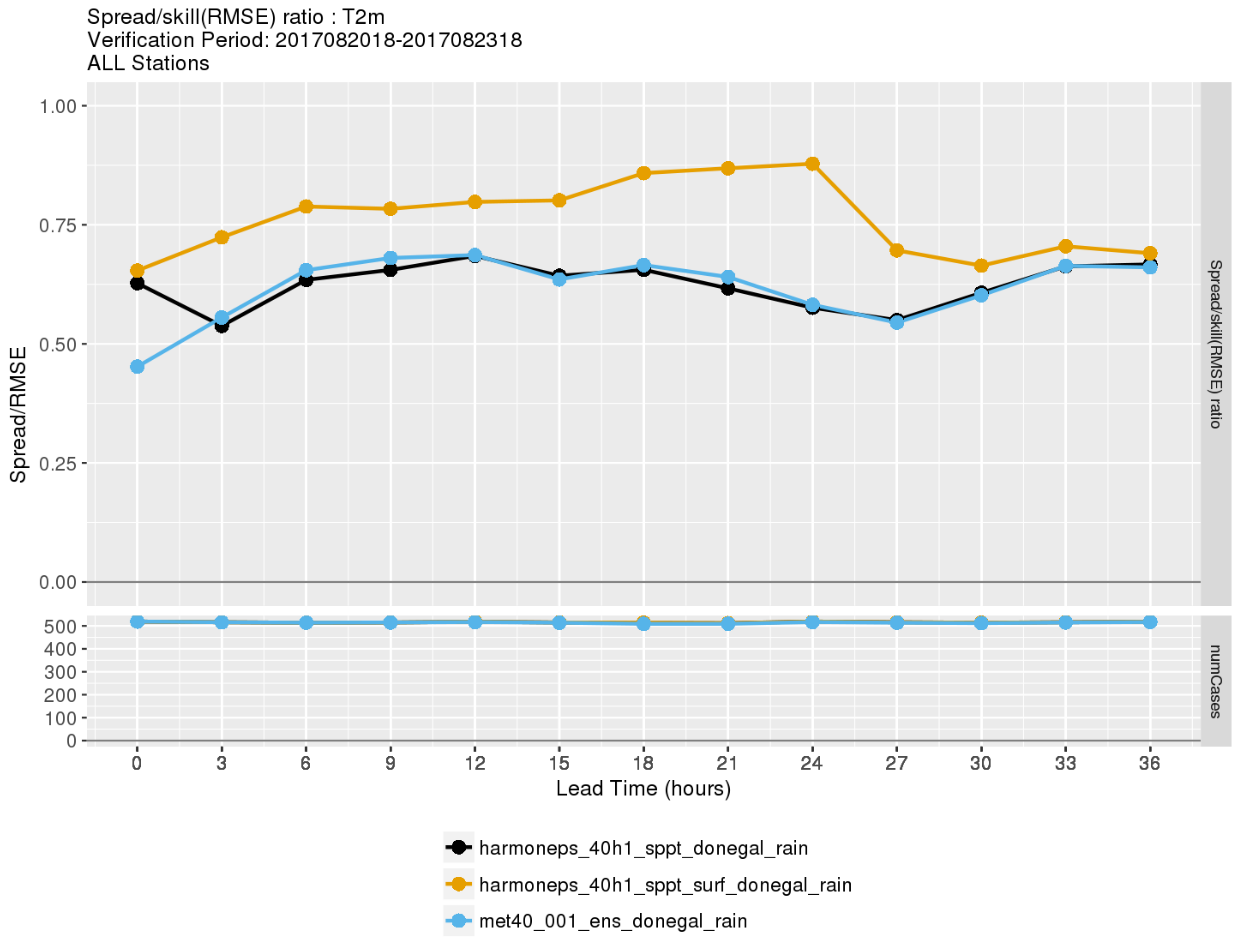

Fig 1. The spread/skill ratio for three experiments run using the pre-operational version of IREPS. The black line represents the spread/skill ratio for an IREPS run with SPPT perturbations (default pattern generator), the orange line a run with SPPT and surface perturbations and the blue line an experiment with neither SPPT or surface perturbations.

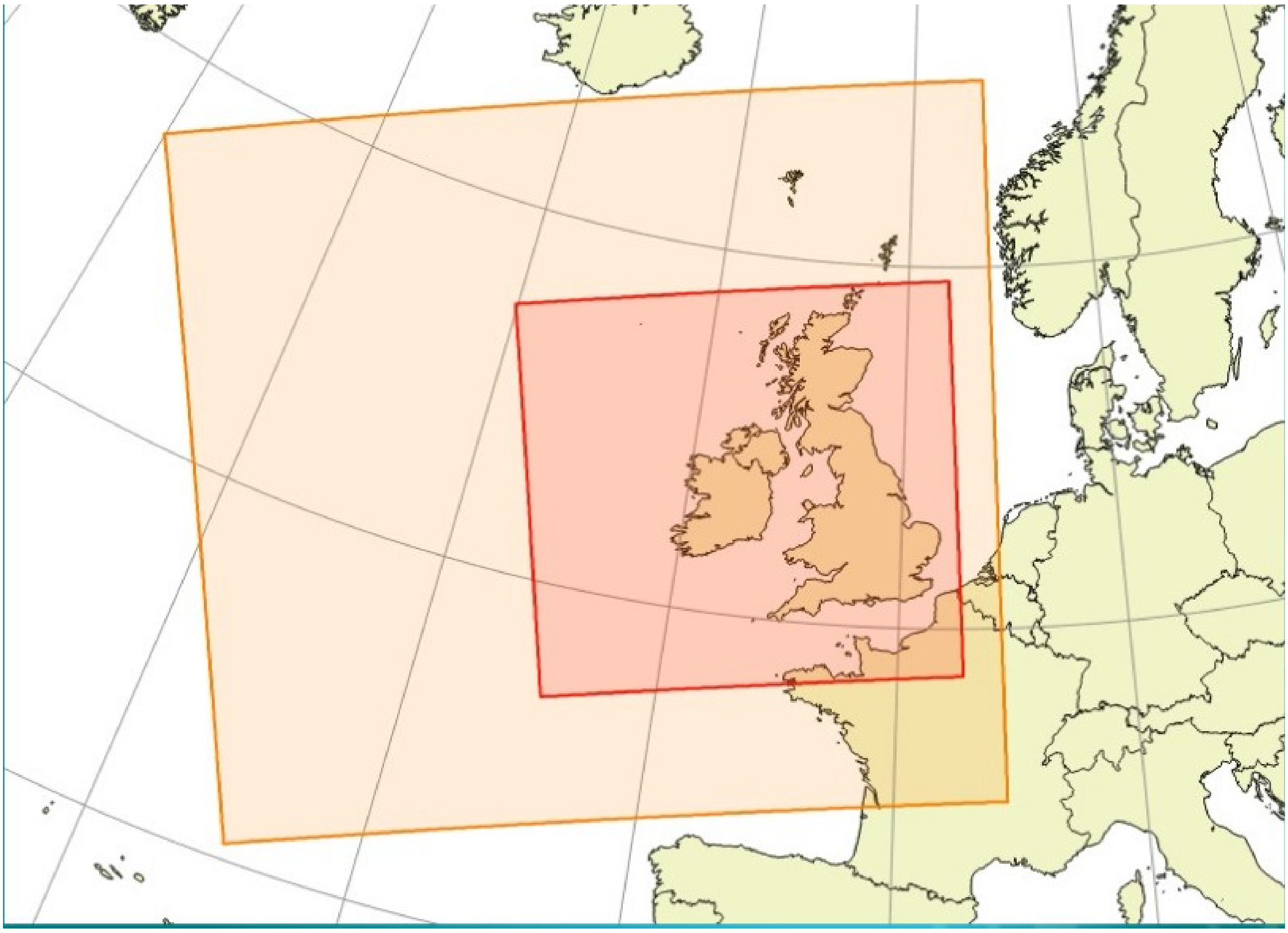

Fig 2. IREPS domains. Proposed operational domain in orange, test domain in red.

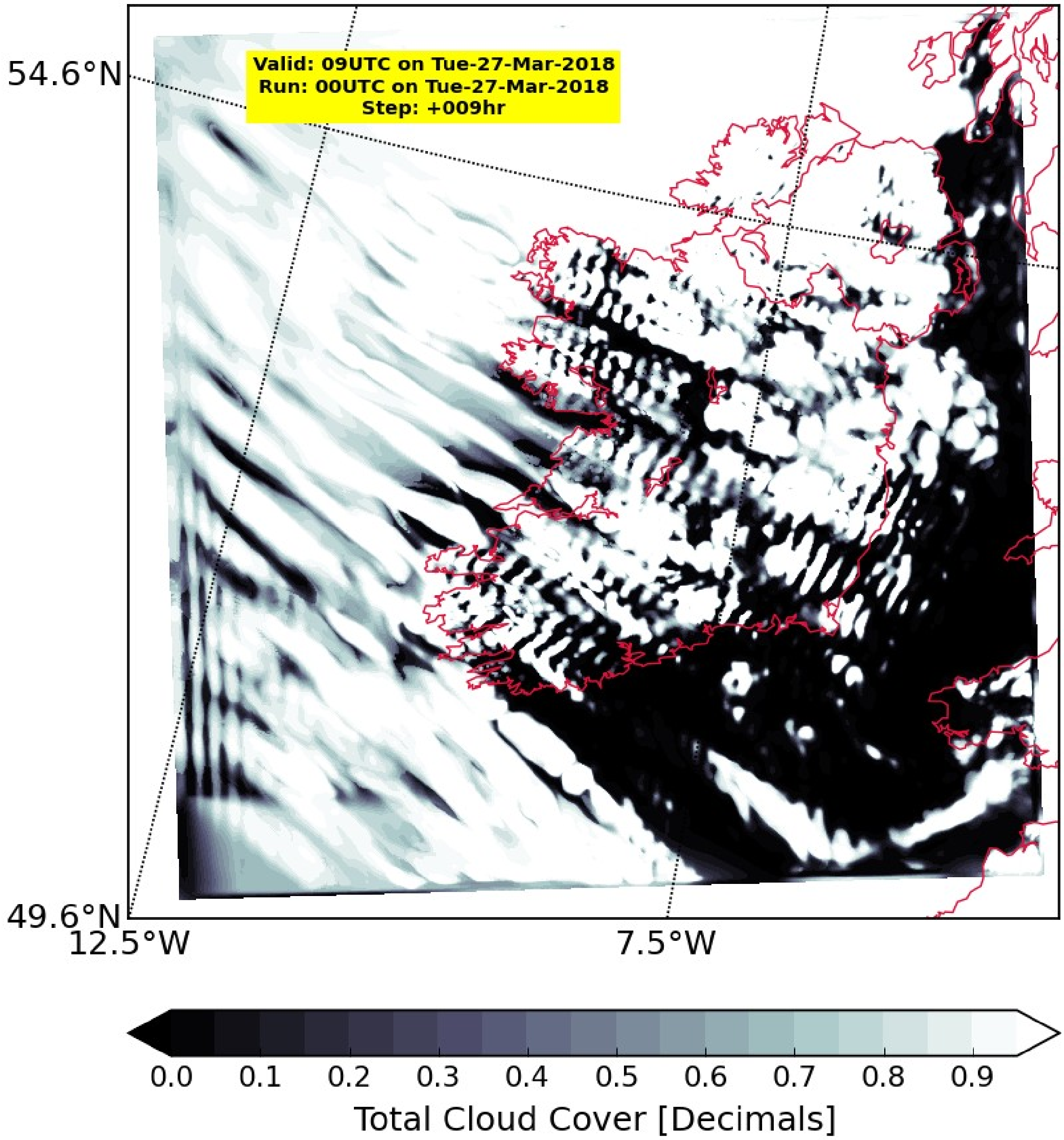

Fig 3. Proposed HighRes domain. This example shows Total Cloud Cover from a Harmonie experiment at 1km.

Method/Scientific Plan

We propose running numerous sensitivity tests based on the control parameters of the SPG pattern generator, in particular the time and spatial correlation parameters. This follows on from the work done by Szucs (2016a and 2017).

The most satisfactory SPG configuration will be the setup which gives the most improved spread/skill ratio when compared to a default setup without any SPPT perturbations.

Justification of computer resources requested

The operational domain of IREPS will cover an area of 1000x900 points (figure 2, orange domain), be constructed of 11 members, have a horizontal grid spacing of 2.5km and 65 vertical levels. However, it is planned to use a smaller domain (figure 2, red domain) for initial investigations into the configurations of the SPG pattern. This domain has 540x500 points with the same horizontal grid spacing as the operational domain. Running one 36 hour IREPS cycle (the proposed forecast length of IREPS) with the test setup would cost approximately 65,000 SBUs. The requested resource of 9MSBUs would be spent as follows:

1) Initial investigation of SPG configuration over 2 suitable periods (1 each from JJA and DJF), 5 days in length and with 1 cycle per day. Depending on initial results, the number of experiments will vary, but at least 8 per period are envisaged. This totals to 4 (SPG configurations) * 2 (periods) * 5 (days) * 1 (cycle) = 80 cycles, equaling ~ 5.2MSBUs

2) Following on from the results of 1), the most satisfactory SPG configuration (in terms of ensemble spread/skill) would be tested on the operational large domain over both test periods. One cycle over this domain equates to approximately 218,000 SBUs. 1 cycle per day over 5 days therefore equates to ~ 5 (days) * 1 (cycle) * 2 (periods) = 10 cycles, or ~2MSBUs

3) The remainder of the computational resources are expected to be used on investigating the impact of SPPT perturbations at higher resolutions (in the range 500m – 1km). This would be done over a domain covering just the island of Ireland (see Fig. 3). Running one cycle of IREPS over this domain at 1km resolution costs ~163,000 SBUs. 1 cycle per day over 5 days over 2 periods would equate to ~1.8MSBUs

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