# Operational and Hectometric NWP at Met Éireann

Colm Clancy, Geoffrey Bessardon, Conor Daly, Rónán Darcy, Kevin Devine, James Fannon, Emily Gleeson, Alan Hally, Eoghan Harney, Ewa McAufield, Eoin Whelan

Operational NWP Suite

Met Éireann runs the HARMONIE-AROME model as part of an operational suite known as IREPS - the Irish Regional Ensemble Prediction System. Since March 2021, IREPS has been running with Cycle 43h2.1 of HARMONIE-AROME, with the configuration detailed below.

Component	Description
Data assimilation	3D-Var for upper-air and OI for surface
Observations	CONV, MODES (winds only), AMSU-A, MHS, IASI, ATMS, MWHS2, ASCAT and SYNOP RH_{2m}/T_{2m} for surface
Dynamics	Non-hydrostatic (ALADIN)
Physics	HARMONIE-AROME
Grid	2.5 km horizontal grid and 65 vertical levels (first at 12 m, model top at 10 hPa)
EPS perturbations	EDA, SLAF boundaries, multi-physics, scale_pert=yes, WG perturbations off
EPS configuration	Lagged 1+15 EPS: 1+10 at 0000/0600/1200/1800; 1+5 at 0300/0900/1500/2100 UTC
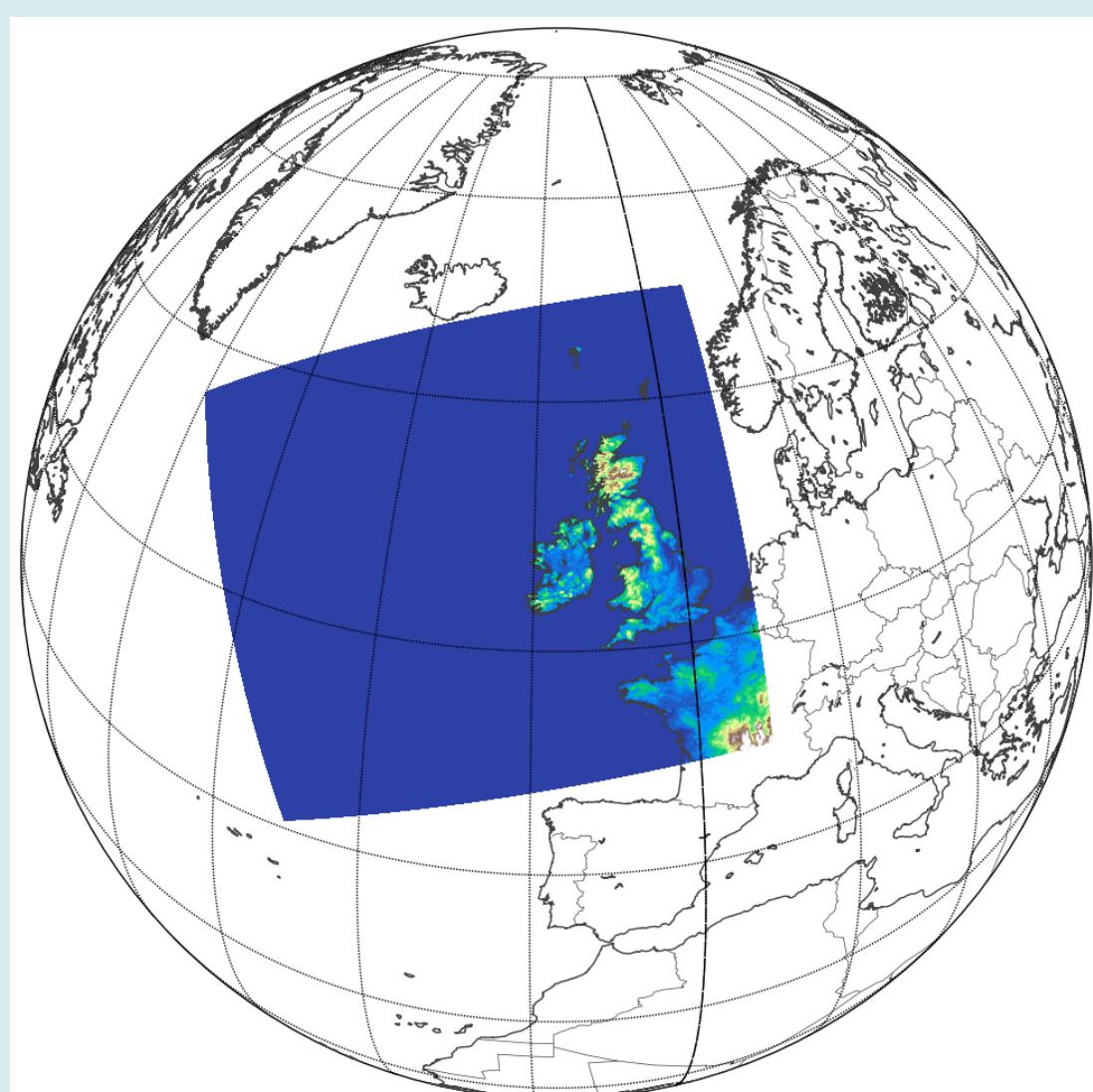
IREPS domain

Operational Clock and Technical Details
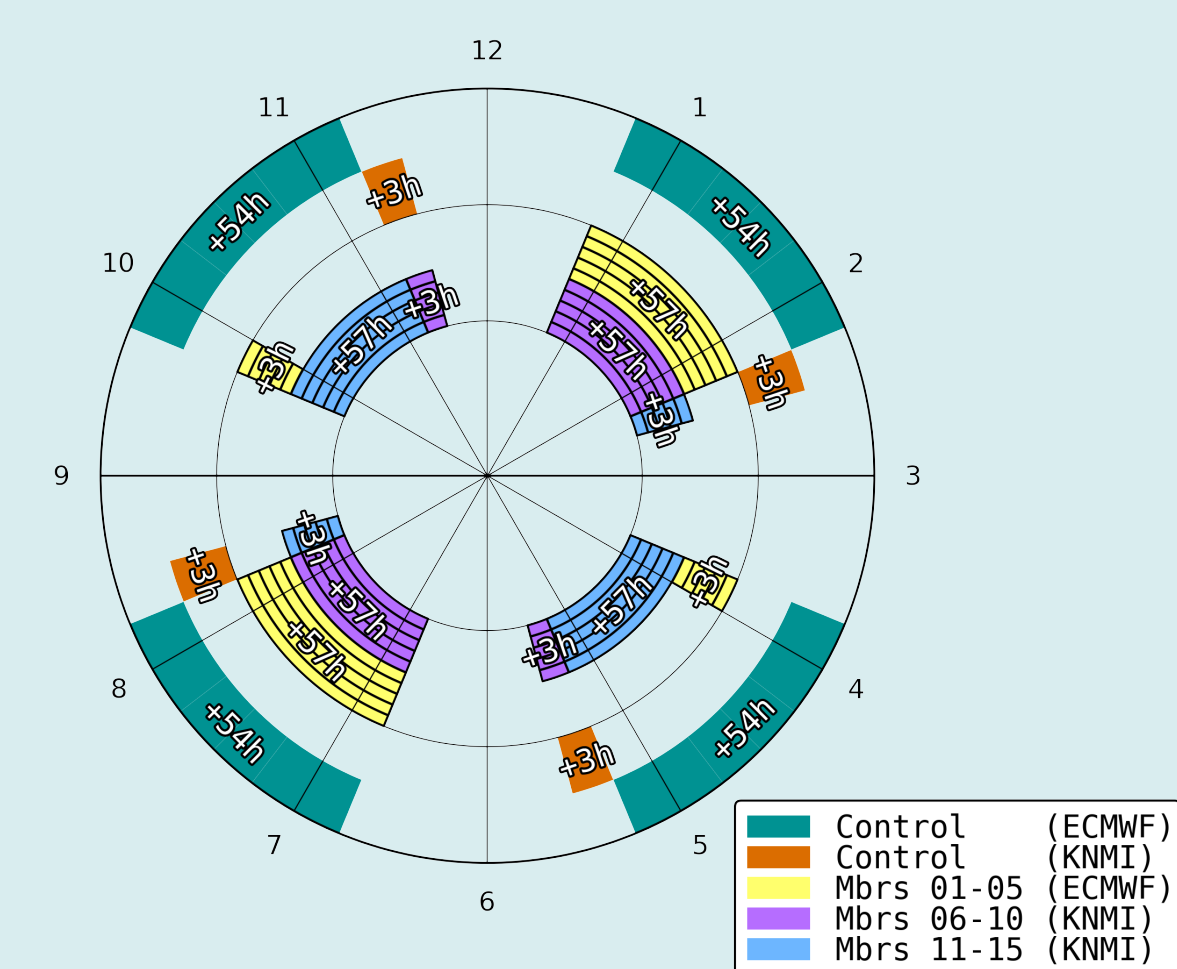
Operational clock showing forecast length, start time, duration, and HPC centre

- The control and all perturbed members use an observation cutoff of T+0:45
- To optimise node usage on the KNMI HPC, the +57 hour perturbed forecasts are given priority with the +3 hour assimilation cycles running afterwards
- All forecast data should be delivered by T+2:15
- All observations are processed by SAPP—Met Éireann's operational observations processing system provided under an ECMWF optional programme.
- The upgrade to cycle 43 in 2021 saw the full migration from GRIB1 to GRIB2 for all in-house products
- Products are disseminated to Met Éireann HQ from ECMWF using the ECMWF Product Dissemination Suite (ECPDS). From KNMI, a simple `rsync` is used.

Lagged Ensemble Details

Scaled Lagged Average Forecasting (SLAF) is used to perturb the boundaries taken from IFS HRES. A lagged 1+15 ensemble is then produced every 3 hours, assembled in the following way:

- Control member runs every 3 hours and forecasts to +54 hours
- All perturbed members forecast to +57 hours
- At 00Z, 06Z, 12Z, 18Z: members 1-10 run
- At 03Z, 09Z, 15Z, 21Z: members 11-15 run

Thus, in any 6 hour window there will be 15 perturbed members and 2 control members, of which we use the most recent.
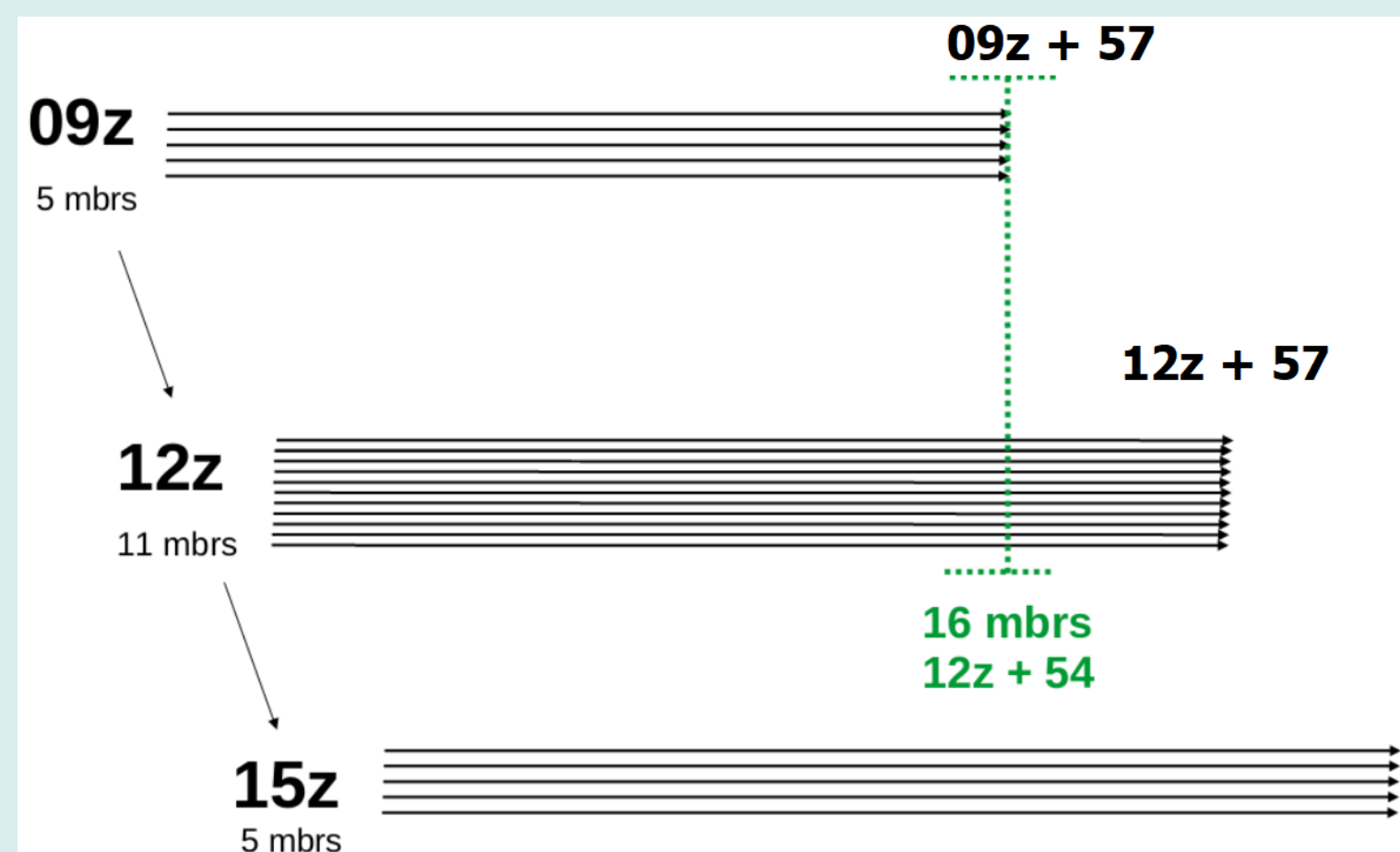

Operational Performance: February 2022

- Storms Dudley, Eunice and Franklin impacted Ireland in a single week in February 2022
- Scatterplots of wind-speed (right) show that HARMONIE-AROME continues to perform best with extreme values, although over-prediction occurs at lower speeds
- Raw model output predicted heavy snow for Storm Eunice; however, little was actually observed. The post-processed precipitation types product provided better guidance.
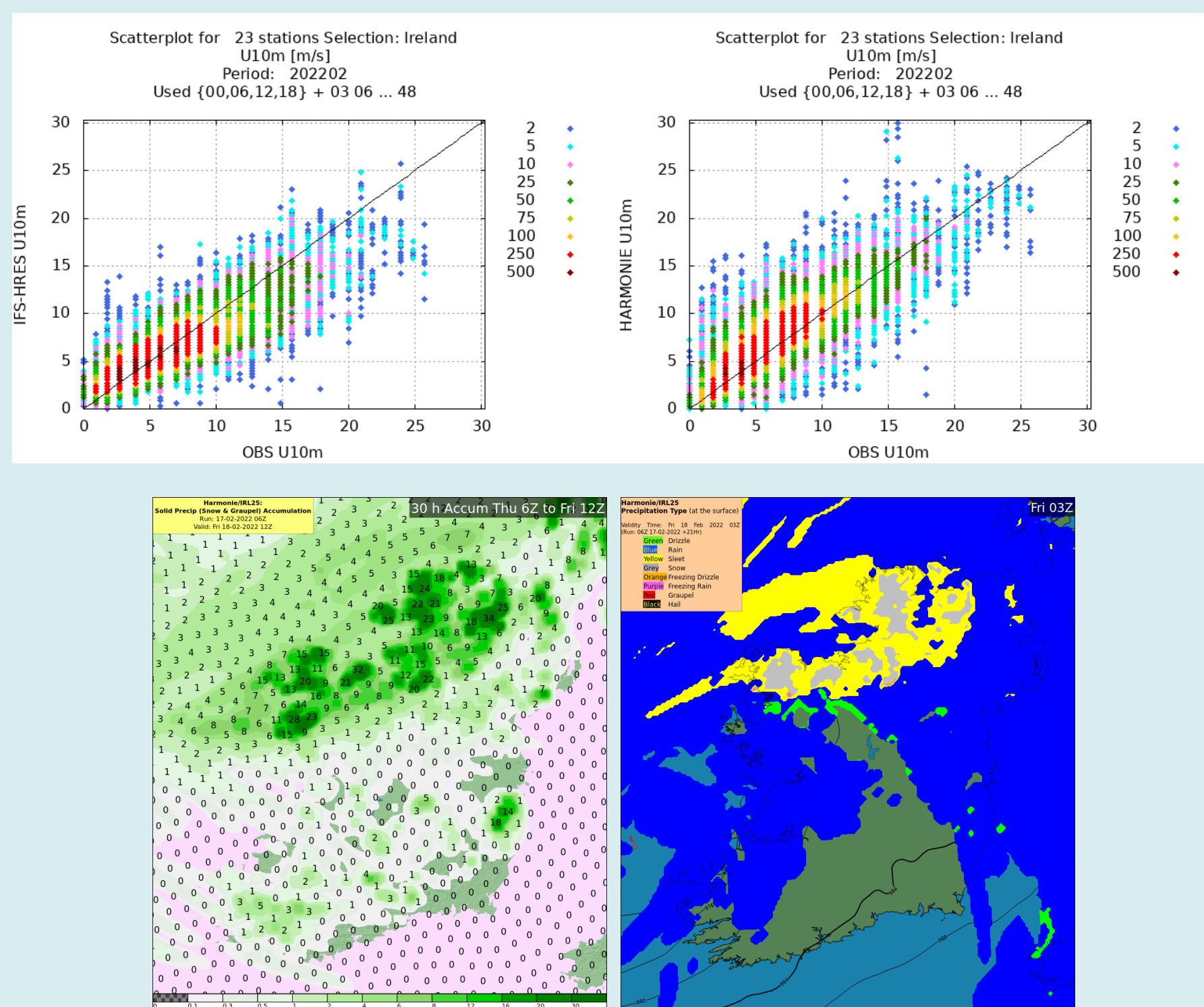

Single Precision Testing

- Scorecard (below) summarising the impact of single precision (SP) forecasts for a 1+3 member ensemble over two-week summer period. Comparison with operational IREPS; red indicates a degradation in SP
- Relatively neutral impact on ensemble performance for surface parameters, apart from a positive MSLP bias.
- ~ 30 % runtime saving observed.
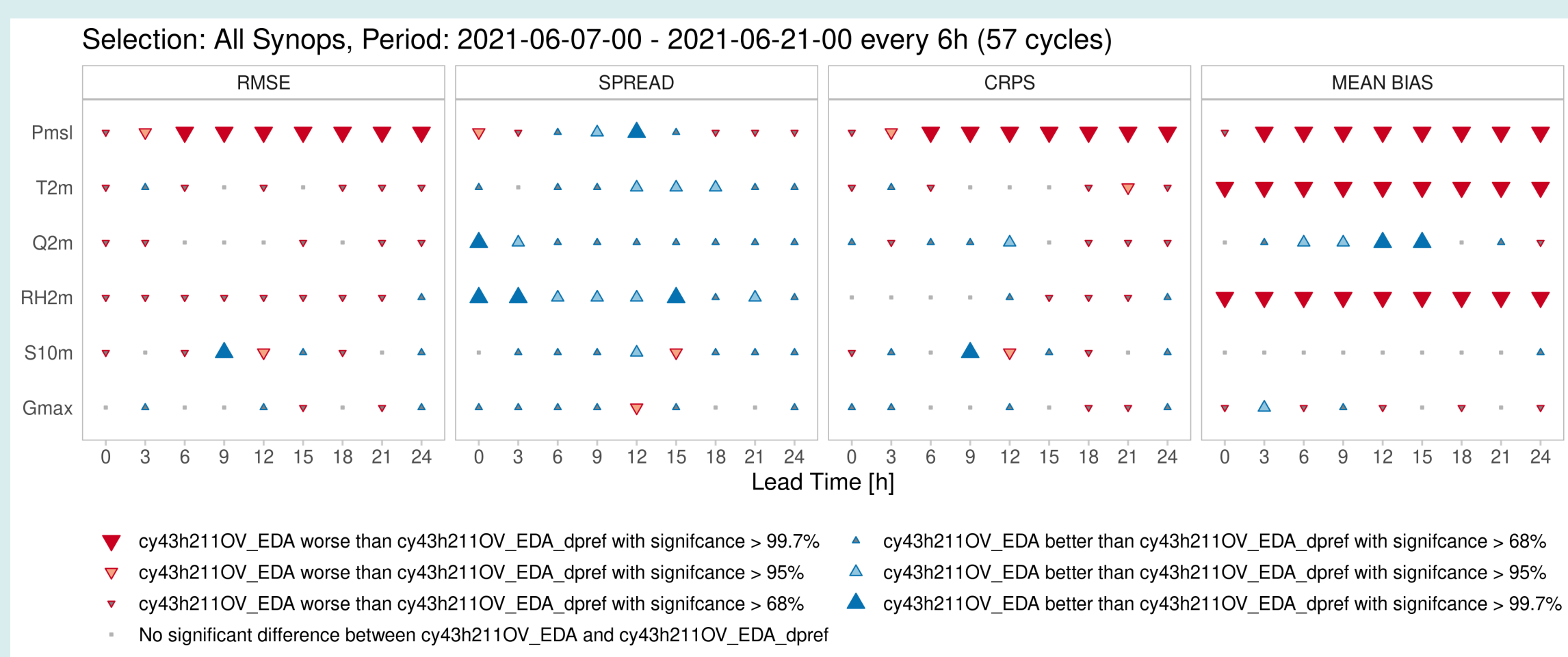
Hectometric Configuration

Extensive testing of HARMONIE-AROME at hectometric resolutions has been carried out over various Irish domains. Initials experiment showed a strong boundary effect when small domains were used, particularly for cloud and precipitation; the cloud forecasts below are all valid at the same time, and use 500m resolution with increasing domain sizes from left to right:
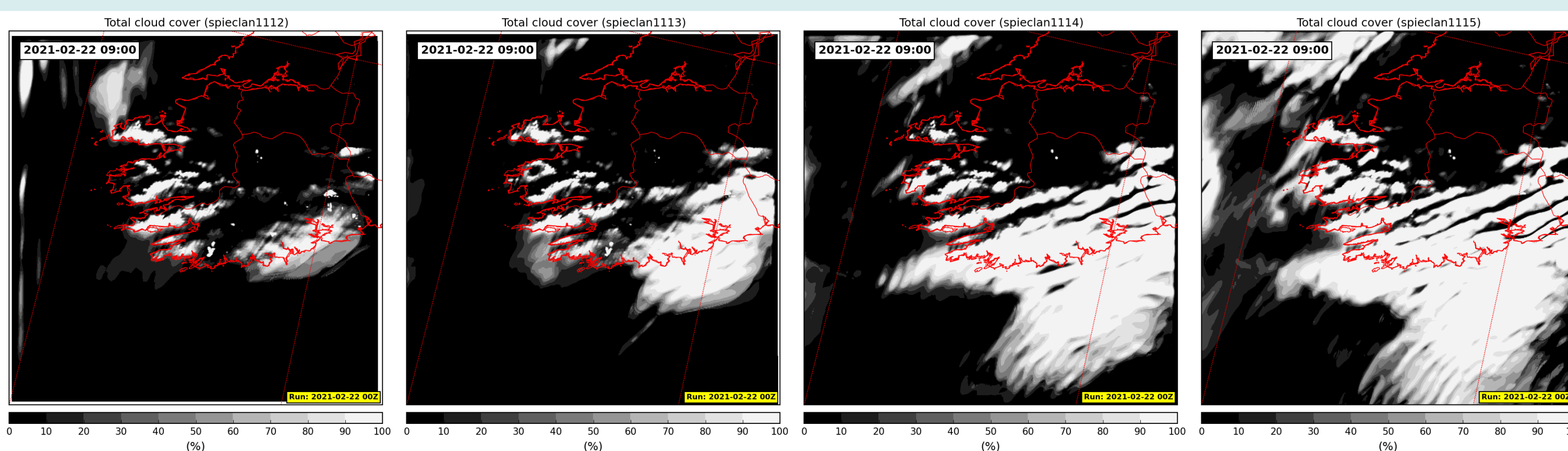

- Balancing computational cost and the need for a large domain, the 750m-resolution domain shown on the right, covering all of Ireland, was chosen as a suitable target candidate.
- As well as horizontal resolution, the effect of increased vertical levels from 65 to 90 was investigated.
- Point verification plots below show improvement in wind and temperature scores.
- The biggest effect seems to come from the increase in vertical resolution, in particular the bias in 10m wind. The lowest of the 65 levels is at around 12m, for 90 levels it is closer to 5m.
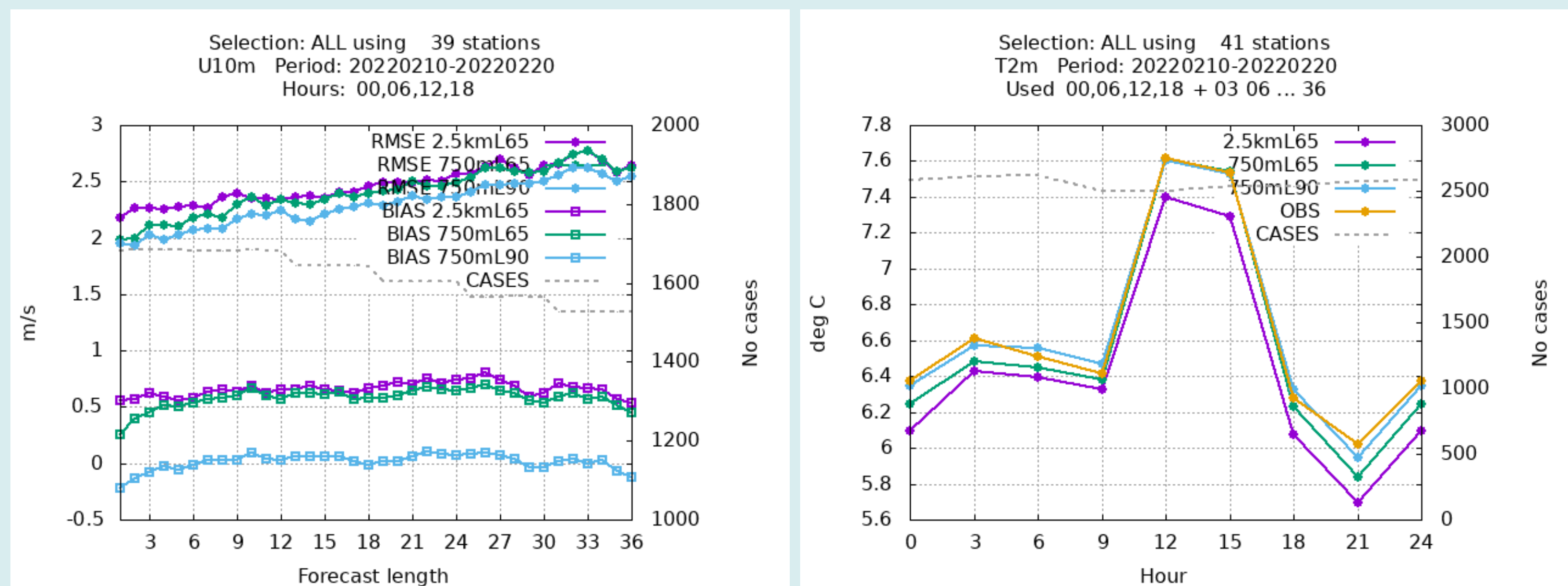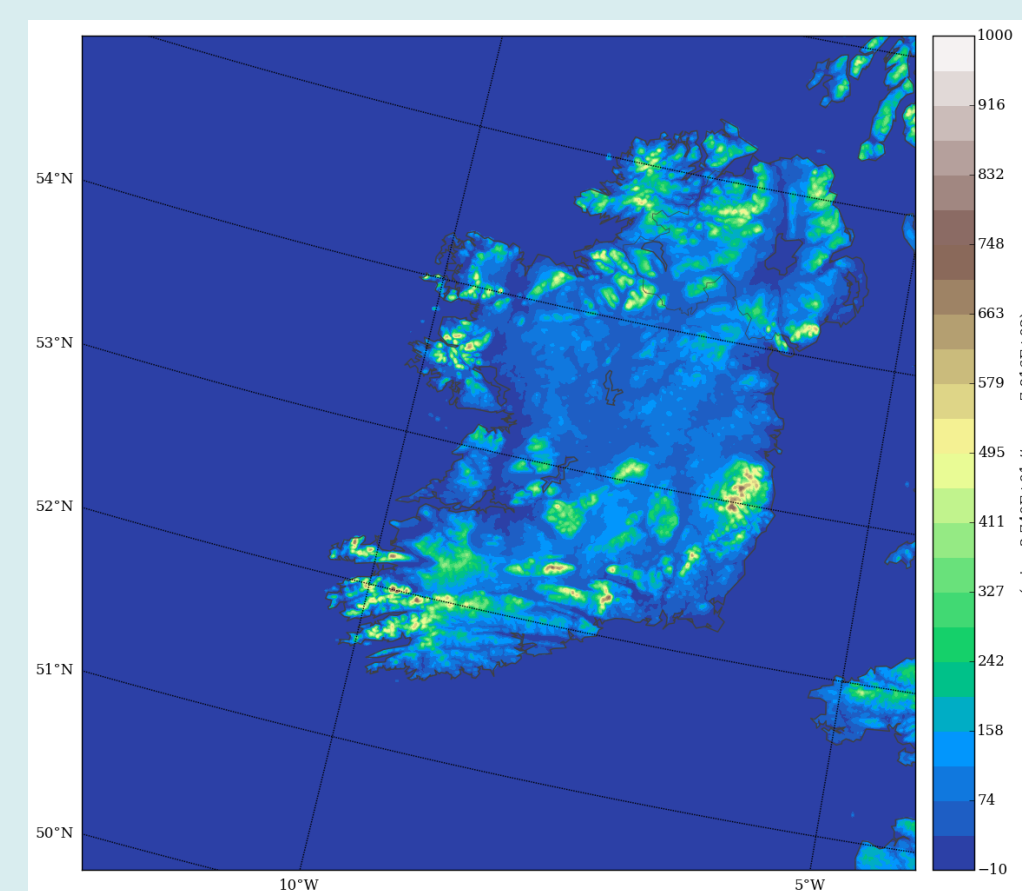
Point verification of wind and temperature forecasts during a February 2022 test period. Experiments with different resolutions, both horizontal (2.5km vs 750m) and vertical (65 vs 90 levels).

Benefit of increased horizontal resolution: model orography and temperature

- Valentia Observatory is indicated on the top right map. Forecasting here is complicated due to the location close to the sea, and between a number of hills.
- The middle and lower panels to the right show the model orography around Valentia and a sample 2m temperature forecast, respectively, for simulations at horizontal resolutions of 2.5km (left) and 750m (right). On this occasion, the operational 2.5km model was too cold at Valentia.
- The 750m simulation does a better job in capturing in more detail the local variations. Although still not perfect, the valleys and areas close to sea level, in particular, are better represented.
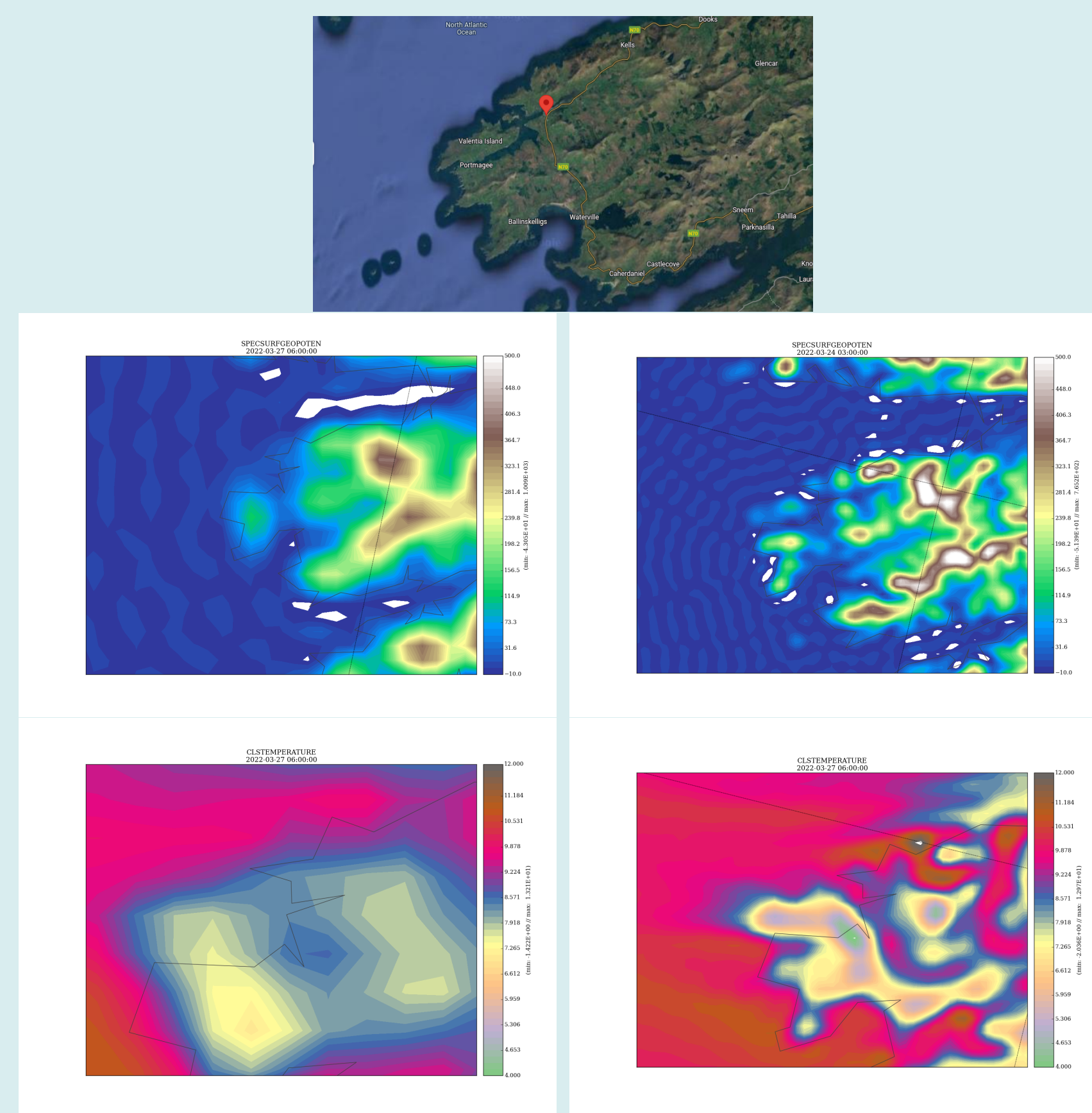
Benefit of increased vertical resolution: fog

- Mixed results were found when investigating the effect of hectometric horizontal resolutions on fog forecasts (500m and 750m tested).
- However, increasing the vertical resolution gave the clearest improvement in terms of fog and low cloud. Analysis of several cases suggests a significant reduction in erroneous fog extent when vertical resolution is increased to 90 levels.
- Right: Case study of the 14th April 2021, showing cloud base height and cloud cross section valid at 0600 UTC, from the 1200 UTC forecast on the 13th. Cross sections are taken over the Irish sea, indicated in the map. Vertical resolutions are 65 (top) and 90 (bottom) levels.