Dynamics Research at Met Éireann

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Noise in MSLP Fields

In numerous recent cases, noise patterns were observed in the MSLP plots of the operational Cycle 40 HARMONIE-AROME forecasts. The noisey feature appeared in all forecast cycles, appearing at the same location at the same time. Figure 1 below shows an example, along with vertical cross-sections through the noisey region. The wavelength of the w noise is $\sim$ 10km and the noise seems to occur when u is such that a parcel travels 2×2.5km gridboxes in a 75s timestep ($u \approx 67$m/s). In all instances, the noise appeared and disappeared after a few hours; i.e. the model did not crash. This suggested that the issue is not a 'simple' linear instability.

Various experiments carried out. Noise can be removed by reducing timestep from 75s to 60s. Note that with 90s the forecast is still stable. Other options include switching to quadratic or cubic grids, or increasing spectral diffusion or adding off-centring. In Figure 2 zonal winds at level 13 along a section through the noisey region are shown for various experiments. Grey lines show where Courant number is 2 for various timesteps.

The simplest solution found was to switch the {LGWADV,LRDBBC} pair of parameters. By default in HARMONIE-AROME these are {FALSE,TRUE}. Figure 3 shows effect of changing to {LGWADV,LRDBBC}={TRUE,FALSE}.

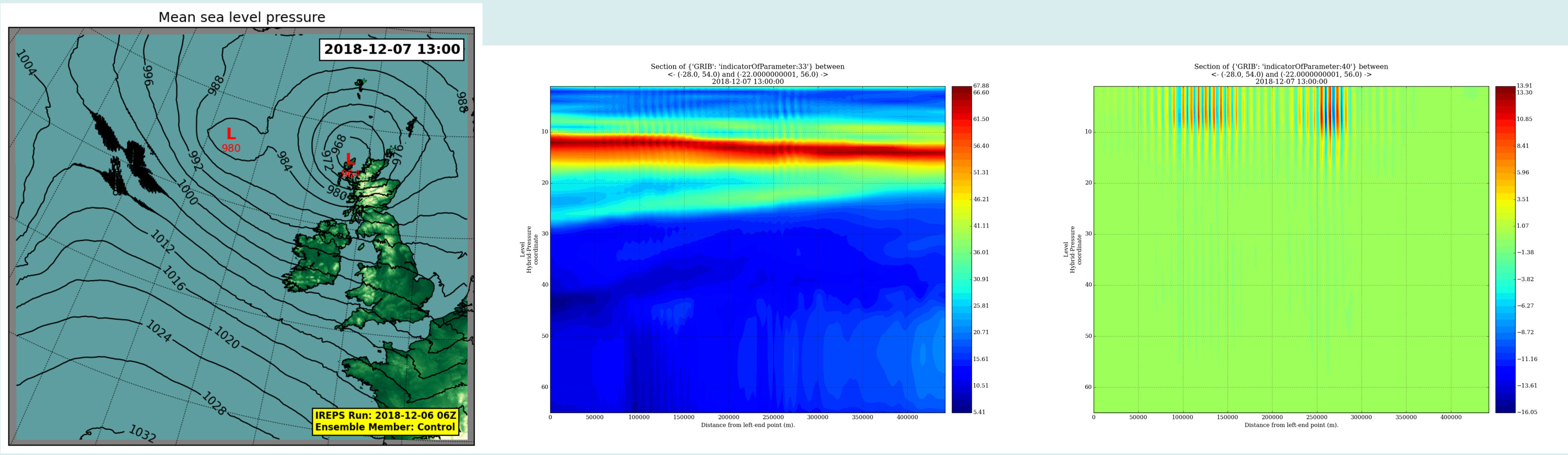

Figure 1: Noise in operational MSLP forecast (left). Vertical cross-sections through noisey region of zonal (middle) and vertical (right) velocities.

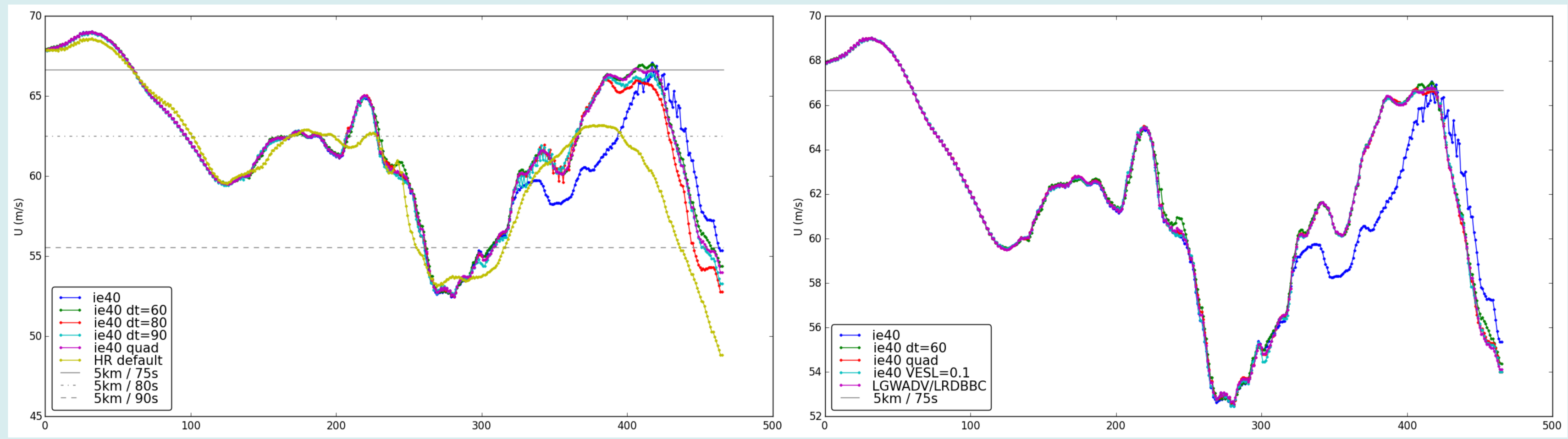

Figure 2: Zonal winds at model level 13, section through the noisey region, various experiments.

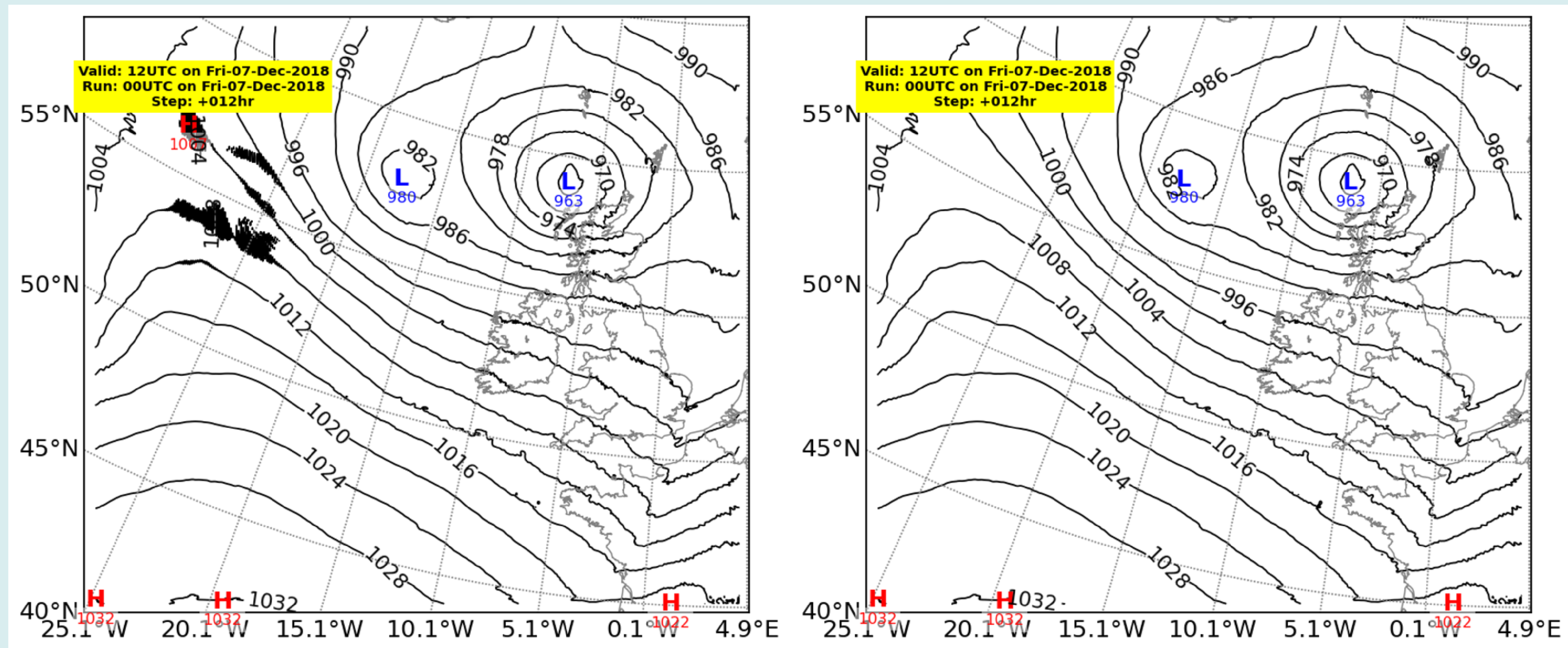

Figure 3: MSLP from experiments with {LGWADV,LRDBBC} options. Left: default {FALSE,TRUE}. Right: {TRUE,FALSE}.

High-Resolutions: Stability and Noise

Model performance at higher resolutions is being studied. For a test period from 1st to 16th of October 2017, experiments at 750 m resolution have been stable on a quadratic grid with 30 s timestep and spectral diffusion coefficients RDAMP*=10. However, some noise is visible in forecasted fields of MSLP; see Figure 4 to the right, showing Storm Ophelia on the 16th.

Other stable set-ups were tested for this particular case, looking to remove this noise without overdamping the solution. Details are given in the Table below, with results shown in Figure 5.

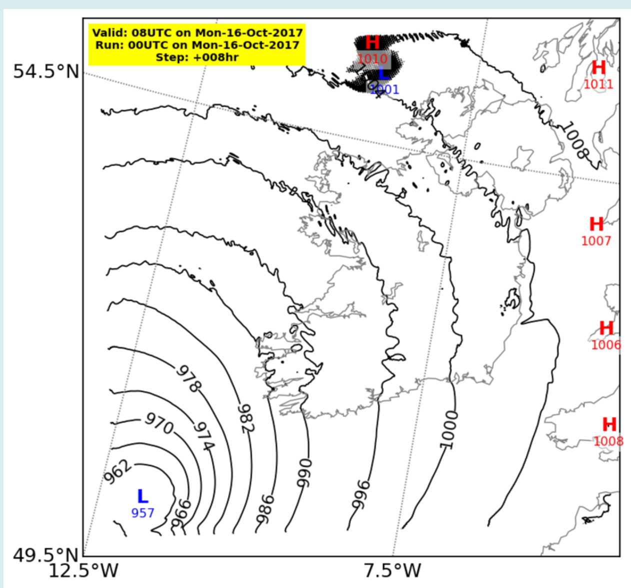

Figure 4: MSLP forecast at 750 m resolution, from 00Z on 16th Oct 2017.

Exp.	Grid	Timestep	RDAMP	VESL	Other details and comments
(a)	Quadratic	30	10	0.1	Off-centred
(b)	Quadratic	30	1	0	Higher spectral diffusion
(c)	Quadratic	30	10	0	LGWADV=T and LRDBBC=F
(d)	Cubic	30	10	0	
(e)	Quadratic	30	10	0	Predictor-corrector time scheme with SLHD
(f)	Quadratic	30	1	0	LGWADV=T and LRDBBC=F; SITRA=100; higer spectral diffusion

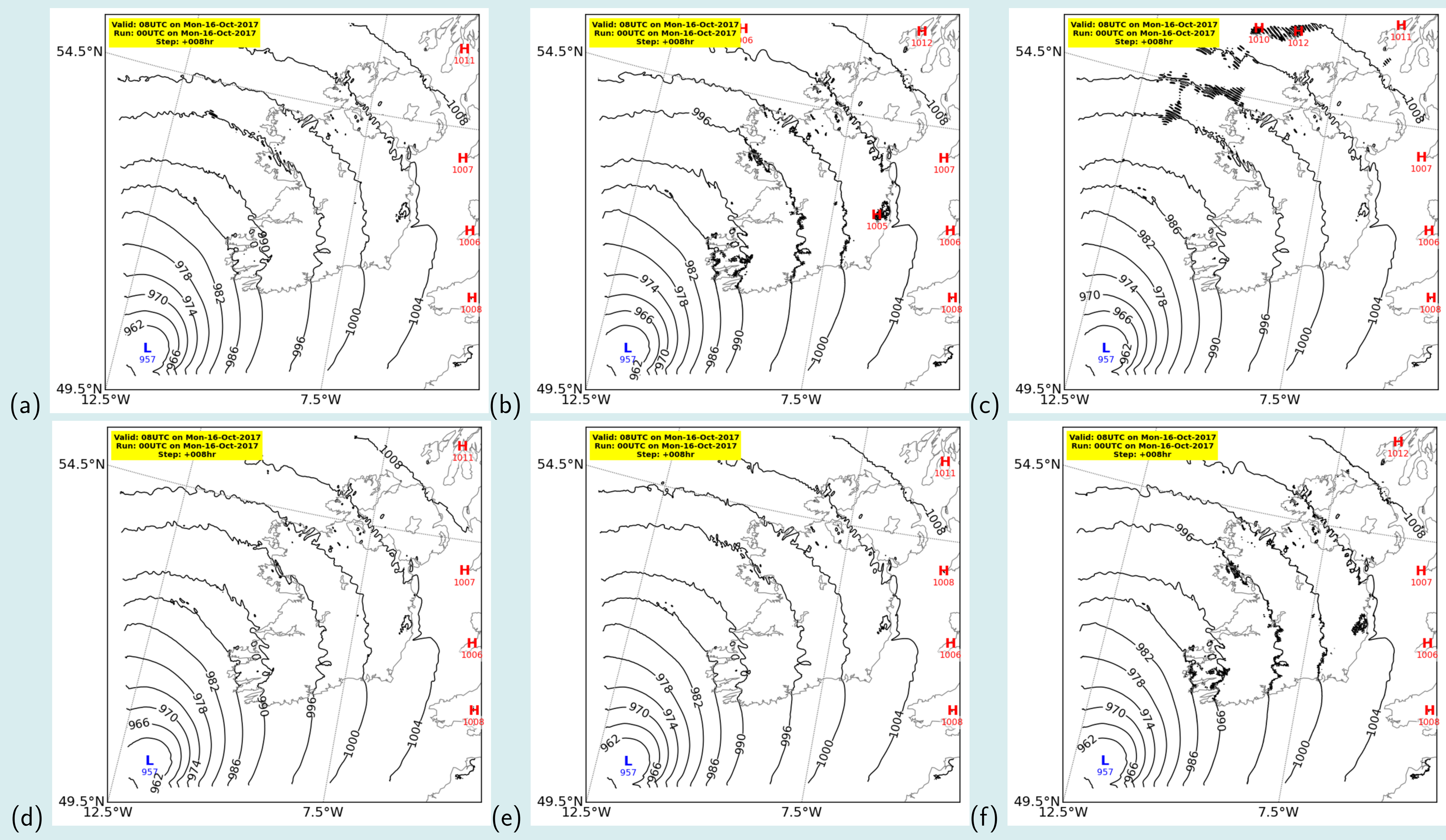

Figure 5: MSLP forecasts at 750 m resolution, from 00Z on 16th Oct 2017, to compare with Figure 4. Experiment details are given in the Table to the left.

High-Resolutions: Gravity Wave Case

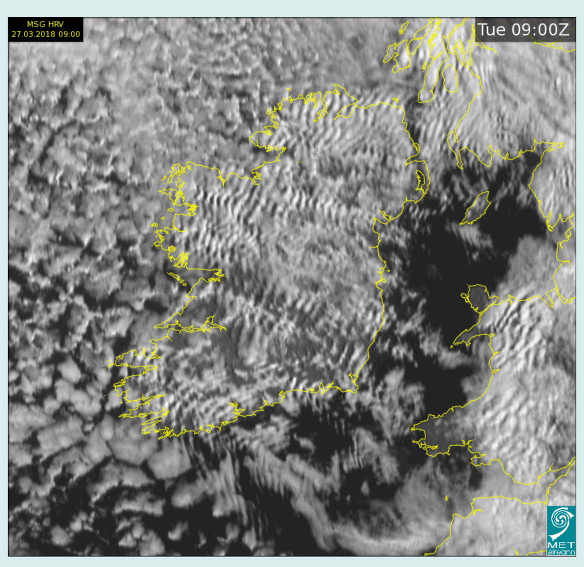

Figure 6: Satellite at 0900Z on 27th of March 2018. Experiments at varying resolutions aimed to simulate these gravity wave features.

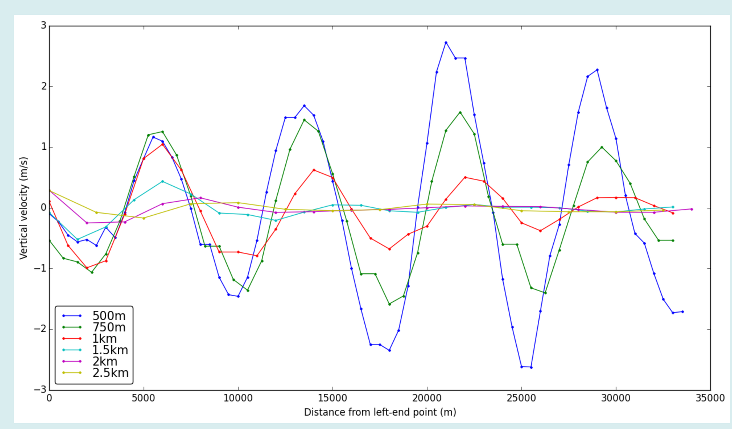

Figure 7: Vertical velocity at 2000 m along cross-section in Figure 9 to the right.

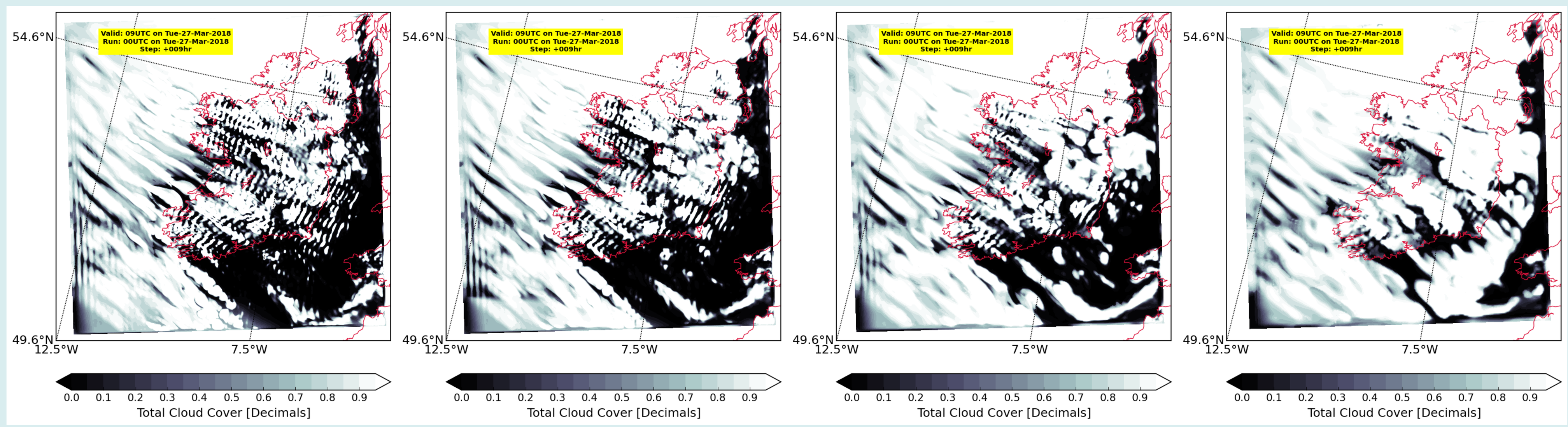

Figure 8: Forecasted total cloud cover. Resolution, from left to right: 750 m, 1 km, 1.5 km, 2.5 km. Gravity wave detail needs resolution of around 1 km or below.

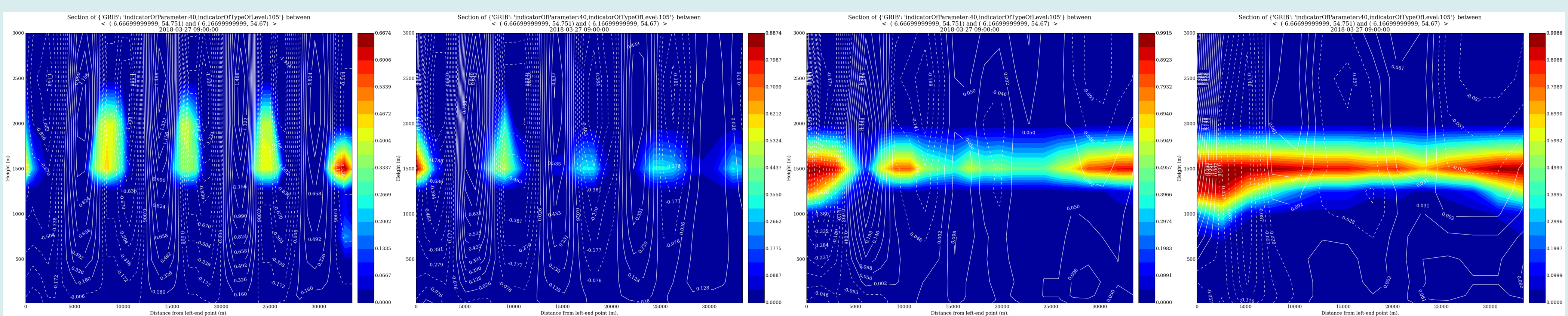

Figure 9: Cross-sections of cloud and vertical velocity (white contours). Resolution, from left to right: 750 m, 1 km, 1.5 km, 2.5 km.

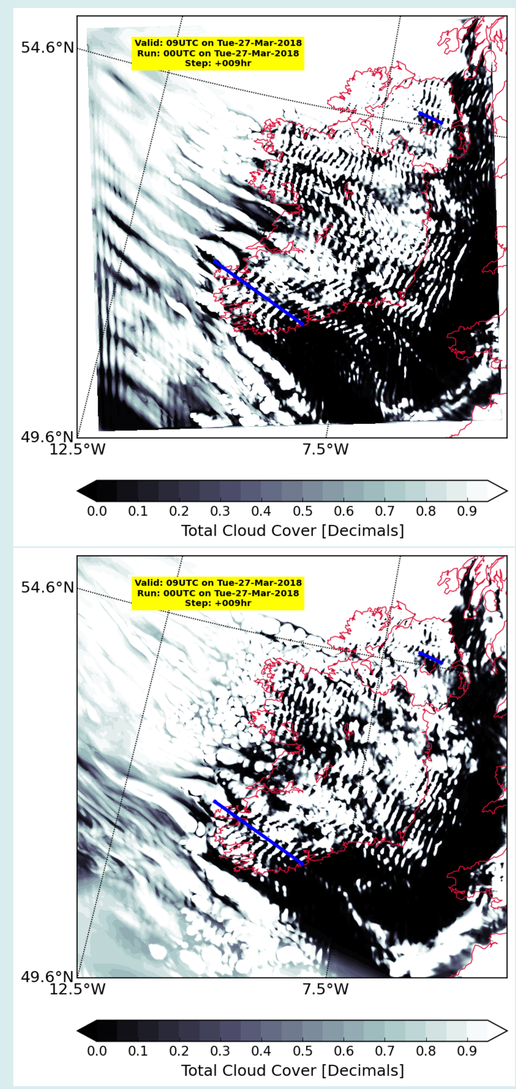

Figure 10: Comparing resolution versus domain size. Above: 500 m resolution. Below: 750 m with larger domain. Removing boundary effects appears preferential to increasing resolution here.