Met Éireann High Resolution HARMONIE-AROME Cycle 40 Experiments

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1. Introduction

- Met Éireann’s involvement in very fine resolution experiments using HARMONIE-AROME was initiated by Enda O’Brien, ICHEC, over 5 years ago.
- This work involved preparing and testing the ASTER 30 m database and running experiments in the 0.5-1 km grid spacing range.
- Our current aims include:
  - Running a sub-km version in “semi-operational” mode, i.e., on-demand over selected regional domains, on sporadic occasions when the risk of “extreme weather” appears to be high e.g. risks of flooding, convection, strong winds.
  - Creation of stable 750 m and 500 m set-ups for Ireland with optimised run-times and minimal use of diffusion.
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2. Domains

- We have tested two 500 m domains, one covering the greatest Dublin area in the east, the other covering the highest mountains in the southwest.
- We have also tested a 750 m domain covering Ireland – used for most of the results shown on this poster.
- Our experiments involved testing the effect of the following on the stability of the simulations:
  - Time-step (mostly 20-30 seconds)
  - Grid (linear, cubic, quadratic)
  - Time-stepping algorithm (SETTLS and Predictor Corrector (PC))
  - Diffusion (spectral via the RDAMP* coefficients, Semi-Lagrangian Horizontal Diffusion (LSLD)).

3. Case Study - Convective Rainfall

- This rainfall event was a “once in 100 years” intense thunderstorm event in the Northwest of Ireland with 63 mm recorded at Malin Head station on the coast in 2 hours.
- It overwhelmed drainage systems and destroyed old bridges.

4. Experiment Set-ups

- The table below shows the settings used for each experiment.
- The colour coding on the “Expt.” column denotes where an experiment ran successfully (green) or not (red). All 750 m were:
  - Defaults used otherwise.
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5. Results – Convective Case

- The following plots show 24-hour accumulations of rainfall for the period 02-07 August 2017.
- Observations on a 1 km grid and output from the Met Éireann operational run (2.5 km cycle 37h, surface DA and blending) are included for comparison.

6. Gravity Waves over Ireland

- March 27th 2018 was a cool, blustery, showy day in Ireland.
- Gravity/mountain waves were clearly visible on the MSG HRV satellite imagery (right).
- These waves could not be seen in our operational cycle 37 forecasts (2.5 km grid) – neither in total cloud cover nor the pseudo-satellite imagery.
- However, these waves are clearly visible in 750 m Exp. 1-5 (details in the table in Section 4) as shown below. Dynamics and physics options did not influence location of the waves.

7. Storm Darwin (February 2014)

- Storm Darwin caused gusts of up to 159 km/h, mean wind speeds of up to 117 km/h, waves of 25 m and huge destruction in parts of Ireland.
- This “weather bomb” caused the MSLP to drop by 39 hPa in 24-hours – strong jet (comma cloud) can be seen on the satellite image below.
- Our simulations for this test case were done using default cycle 40 (i.e. HARATU on etc.).
- The selection of 750 m and 500 m simulations is summarised in the table in Section 8, using the same traffic light colour system as before but with orange for simulations that ran for a time before failing. In addition to the time-step, time-stepping algorithm and diffusion, linear, cubic and quadratic grids were investigated.

8. Darwin Experiment Set-ups

- The plots below shows 24-h forecasts valid at 122 on February 12th 2014 at grid spacings of 2.5 km, 750 m and 500 m.
- Two of our southern stations recorded mean wind speeds of over 50 knots at 12 z - the model runs did not capture the full strength of these extremes. The diffusion applied in the 500 m runs appears to have been detrimental; boundaries may also be an issue in the 750/500 m runs which do not show the core of stronger winds seen in the 2.5 km simulation.

9. Results – Storm Darwin

- One of the issues in verifying forecasts for Storm Darwin is a lack of wind observations for Ireland.
- There are lots of privately owned wind farms in the country but these data are commercially sensitive and not publically available.
- Nevertheless, the comparisons to the right, done using the Monitor software, include available synoptic observations within the domain.

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