Experience with the initialisation of MOGREPS-UK

Warren Tennant, Christine Johnson, Nigel Roberts, Anne McCabe and Richard Swinbank

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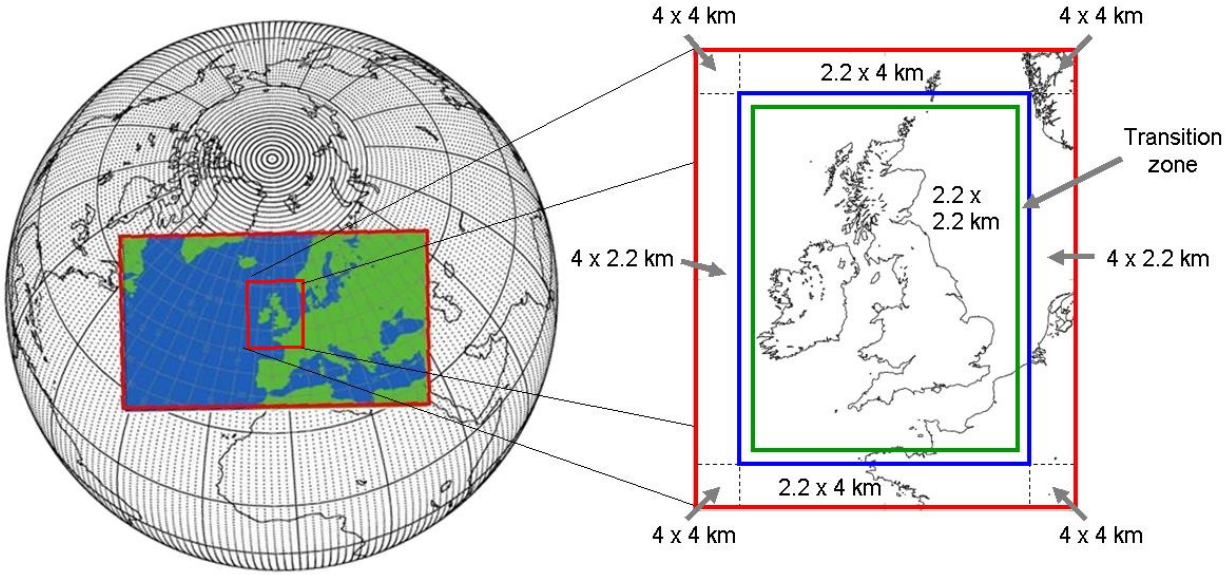
Contents

- MOGREPS-UK configuration
- Impact of driving model
  - Relative costs/benefits of single/two-tiered nesting
  - Issues with LBCs and nesting
- Initialisation of different scales
  - Methods to initialise LAM
  - Verification results and case studies
- New developments: Stoch Phys; ENDGame

MOGREPS-UK Configuration

- 2.2km variable resolution
- 12-member ensemble
- Run to T+36h 4xdaily at 03/ 09/ 15/ 21Z
- Nested in 33km MOGREPS-G
- Hourly LBCs
- Based on 1.5km UKV physics
- 75-sec time-step



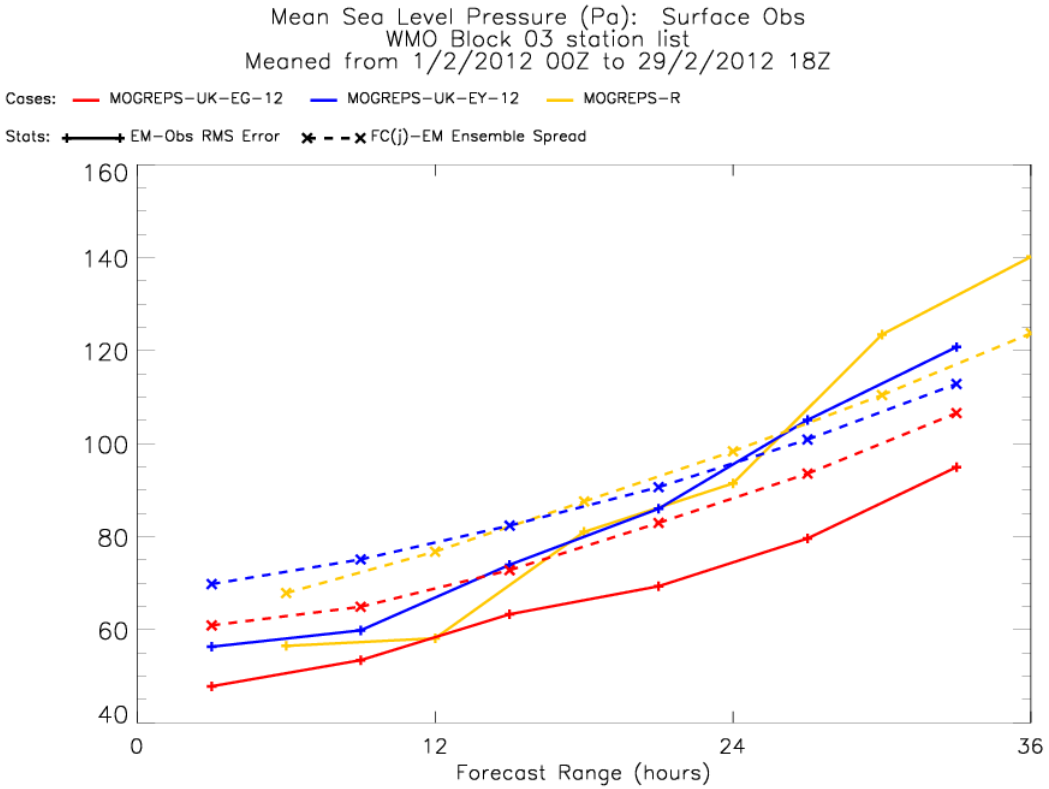
Resolution of driving model (background)

- MOGREPS-UK was driven by MOGREPS-R (18km) until Jan 2013
- Upgraded to run directly from MOGREPS-G (33km)
- Alternative was to run MOGREPS-G (40km) and MOGREPS-EU (12km), but maintenance concerns and verification scores pointed to a single nesting strategy

Driving model	**MOGREPS-G (60km) + MOGREPS-R (18km)**	**MOGREPS-G (33km)**	**MOGREPS-G (40km) + MOGREPS-EU (12km)**
CPU cost (IBM P7)	20min – 3 nodes 30min – 1 node	30min – 6 nodes	20min – 6 nodes + 10min – 6 nodes
Age of LBC	T+9h	T+3h	T+9h

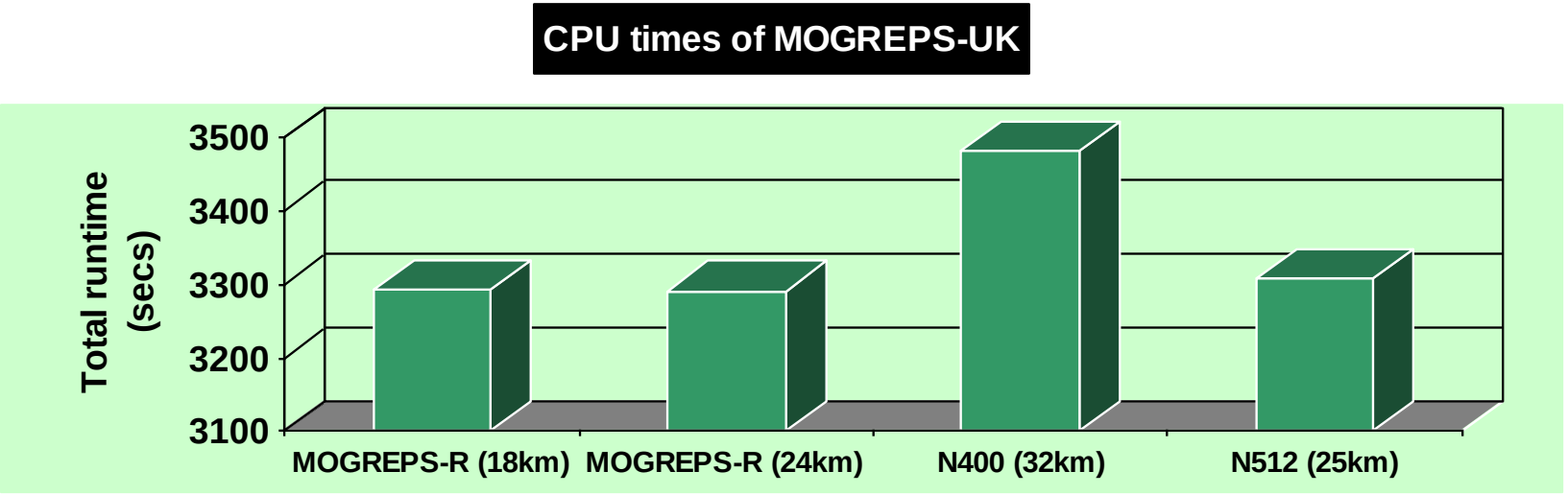
Resolution of driving model

- Lower RMSE in MSLP when driven from **33km global model** than **18km regional model**
- **MOGREPS-R** (18km) verification scores for MSLP poorer than global model (since model is tuned for surface weather parameters)



Resolution of driving model

- Runtime of MOGREPS-UK increased by several minutes when changed to being driven by MOGREPS-G
- After some investigation it appears to be related to the relatively larger jump in resolution and increased iterations of GCR solver
- Tests to increase rim-width, orography blending zone, LBC frequency and GCR solver tolerance had little benefit and increased cost



Impact of driving model: Summary

- Direct nesting of MOGREPS-UK in MOGREPS-G (33km) is chosen over a 2-tiered nesting strategy with MOGREPS-R:
  - Verification scores are improved for all parameters (except T2m)
  - LBCs used are from a more recent global run (6h)
  - Equivalent computer resource cost
    [40km global + 12km regional == 33km global]
  - Need to maintain only two model configurations/suites instead of three
  - Spin-up and model stability do not appear to be a problem but there are some issues at the boundary which are largely cosmetic

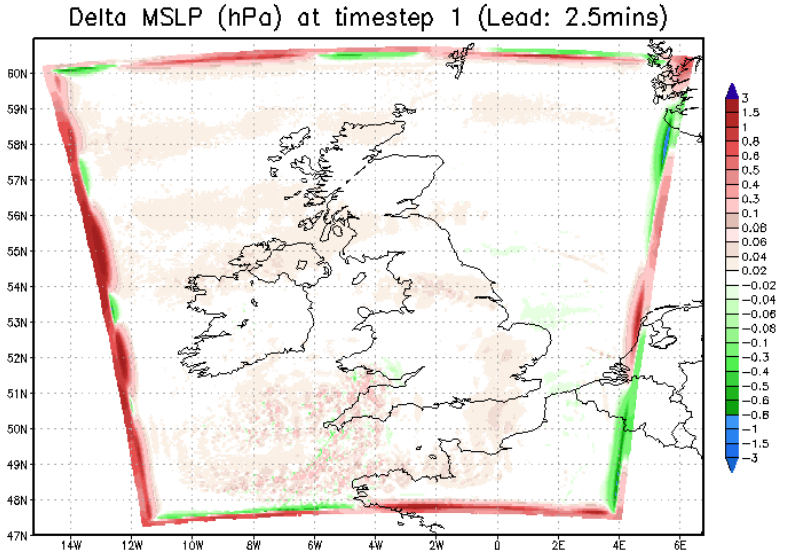
Initialising MOGREPS-UK

1. Direct downscaling
    - Interpolate each global ensemble member at T+3h
2. Cycle initial conditions
    - Only update LBCs at each forecast cycle
    - Merge in new LBCs over 1-hour (for a smoother transition)
3. Add large-scale perturbations to cycled IC
    - Update LBCs (as in 2 above)
    - Add interpolated T+3h global perturbations for selected fields
4. Add large-scale perturbations to UKV analysis
    - Interpolate 1.5km UKV analysis (valid at global T+3h)
    - Add interpolated global perturbations for selected fields

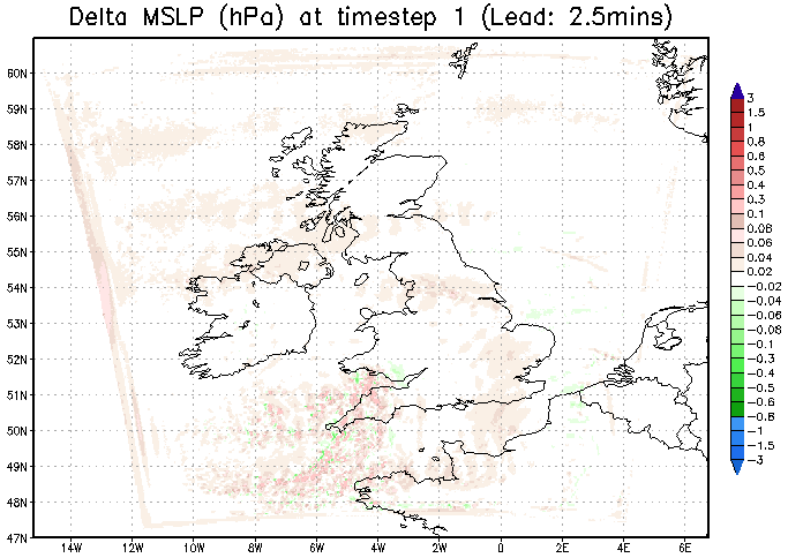
Initialisation: Delta-MSLP

- With cycled Initial Conditions (ICs) the change in LBCs from the new driving model cycle must be merged carefully
- Inconsistency between Initial Conditions and LBCs generates gravity waves that radiate in from the boundary

Cycled IC : LBC inconsistency

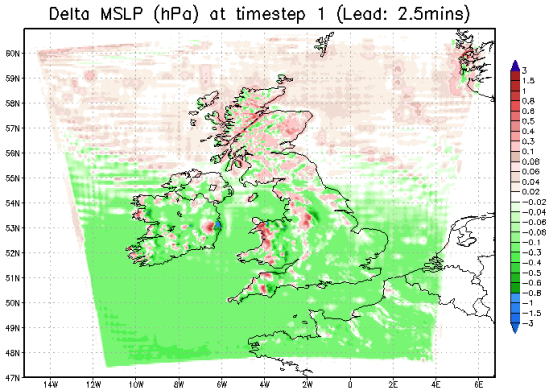


Cycled IC : Merged LBCs

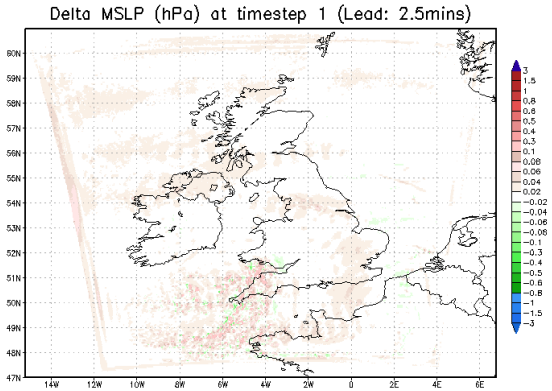


Initialisation :: Delta-MSLP Timestep 1

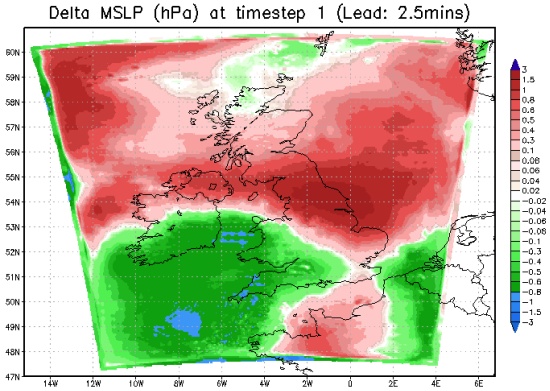
Downscaled



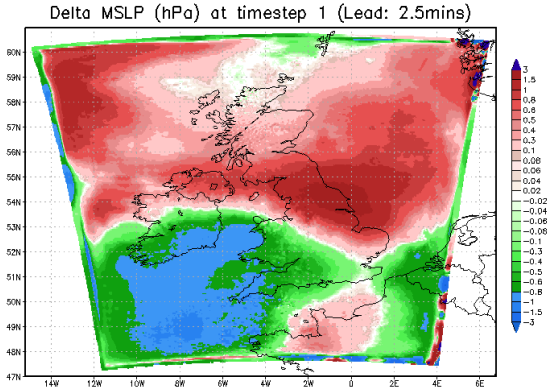
Cycled IC



L/S Perts + cycled IC

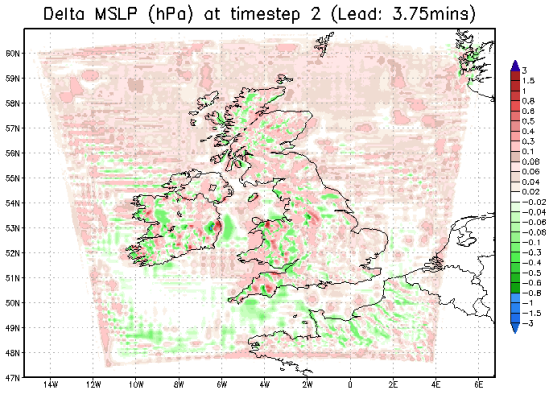


L/S Perts + UKV

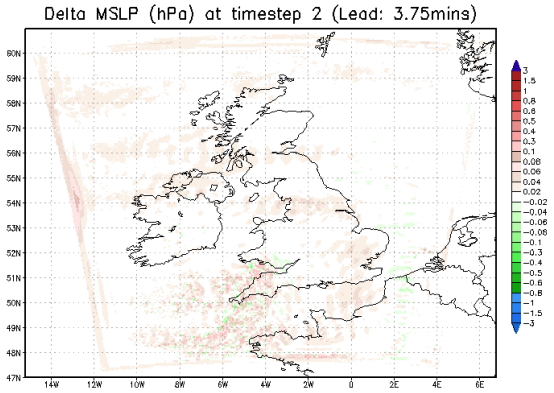


Initialisation :: Delta-MSLP Timestep 2

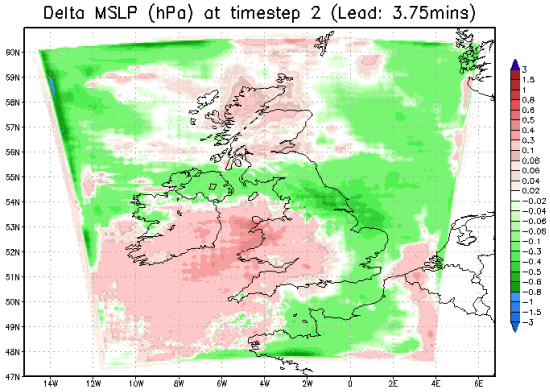
Downscaled



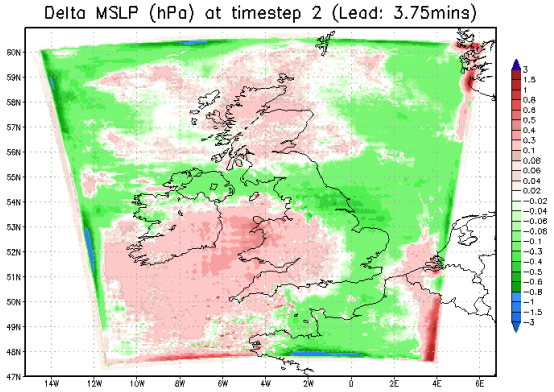
Cycled IC



L/S Perts + cycled IC

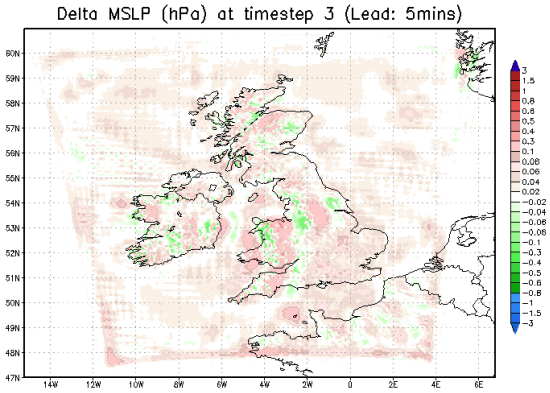


L/S Perts + UKV

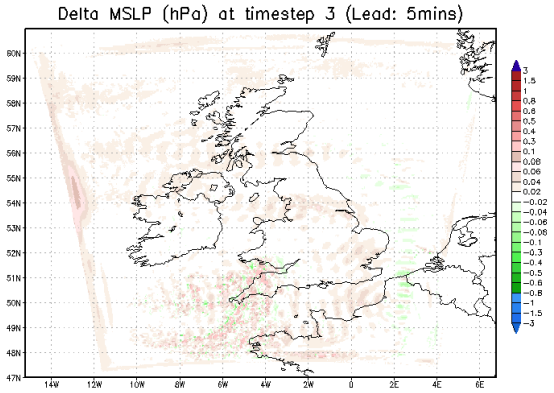


Initialisation :: Delta-MSLP Timestep 3

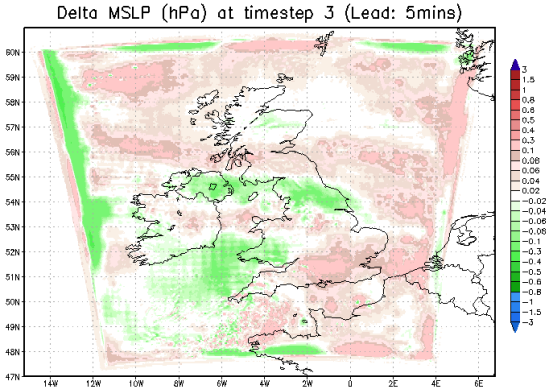
Downscaled



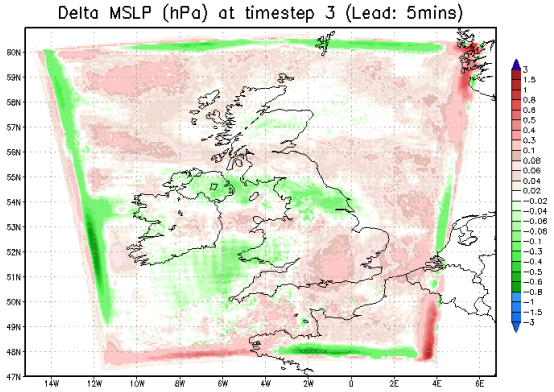
Cycled IC



L/S Perts + cycled IC

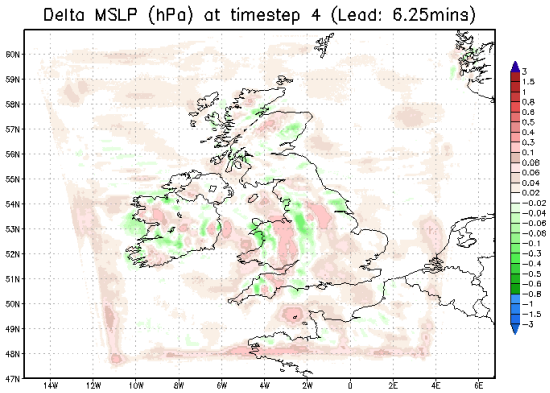


L/S Perts + UKV

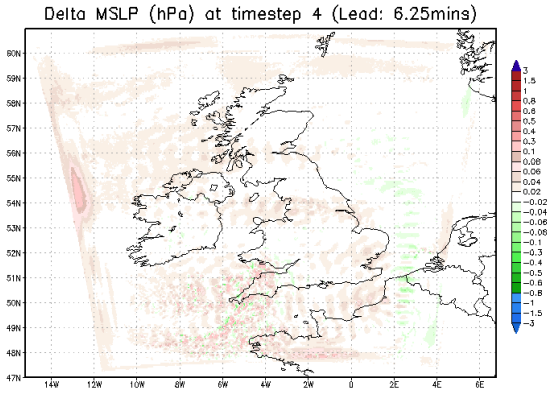


Initialisation :: Delta-MSLP Timestep 4

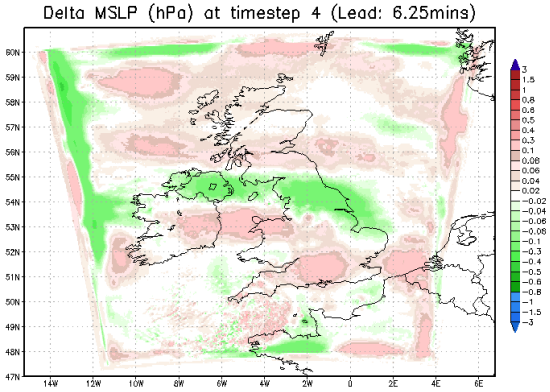
Downscaled



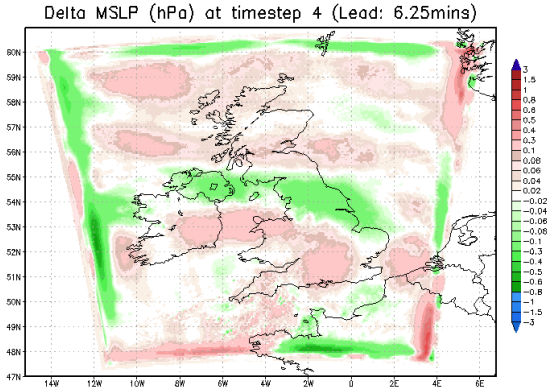
Cycled IC



L/S Perts + cycled IC

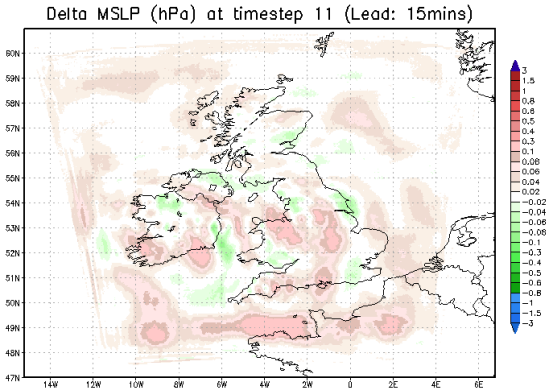


L/S Perts + UKV



Initialisation :: Delta-MSLP Timestep 11

Downscaled



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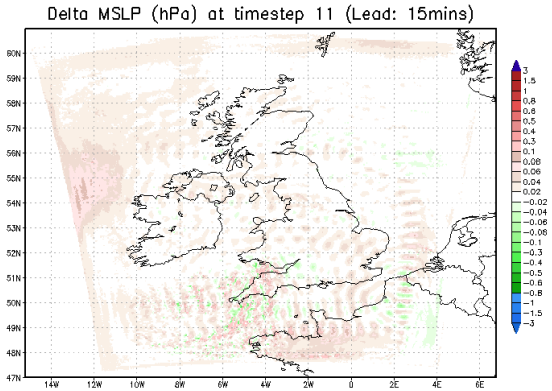
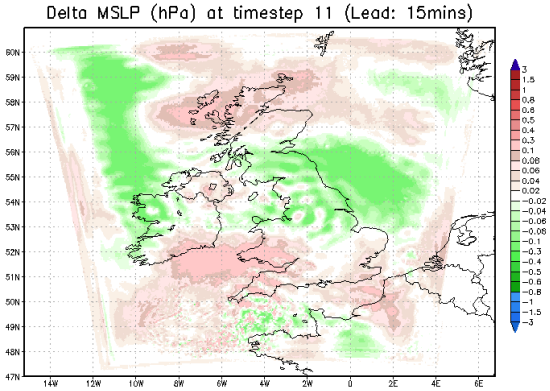
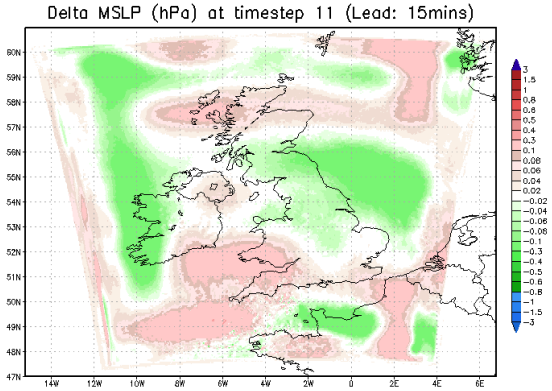


L/S Perts + cycled IC

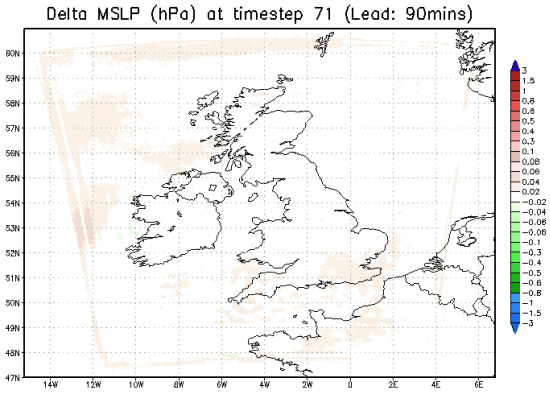


L/S Perts + UKV



Initialisation :: Delta-MSLP Timestep 71

Downscaled



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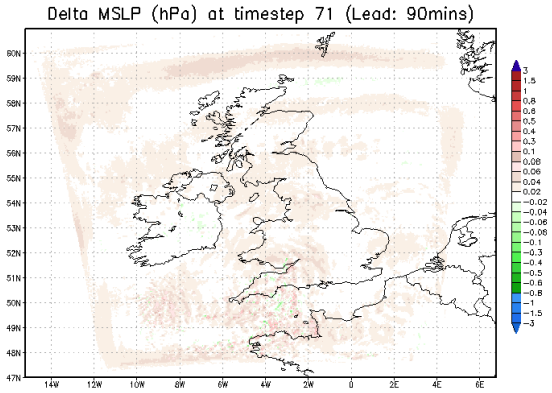
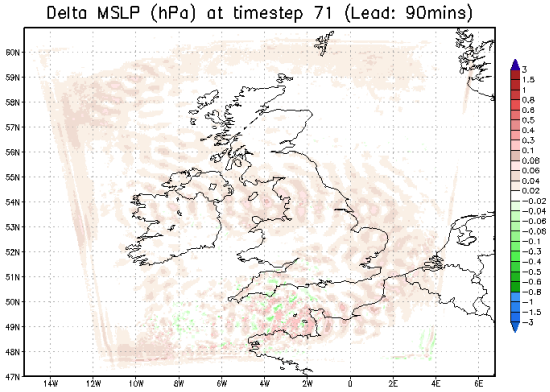
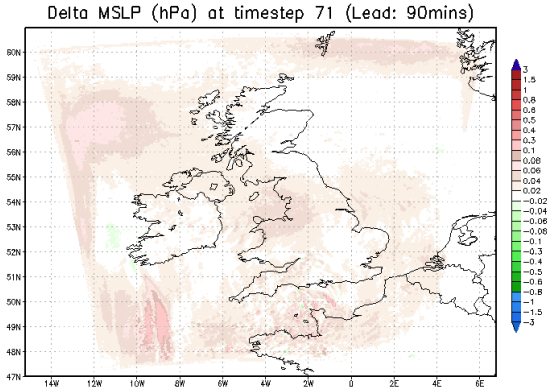


L/S Perts + cycled IC



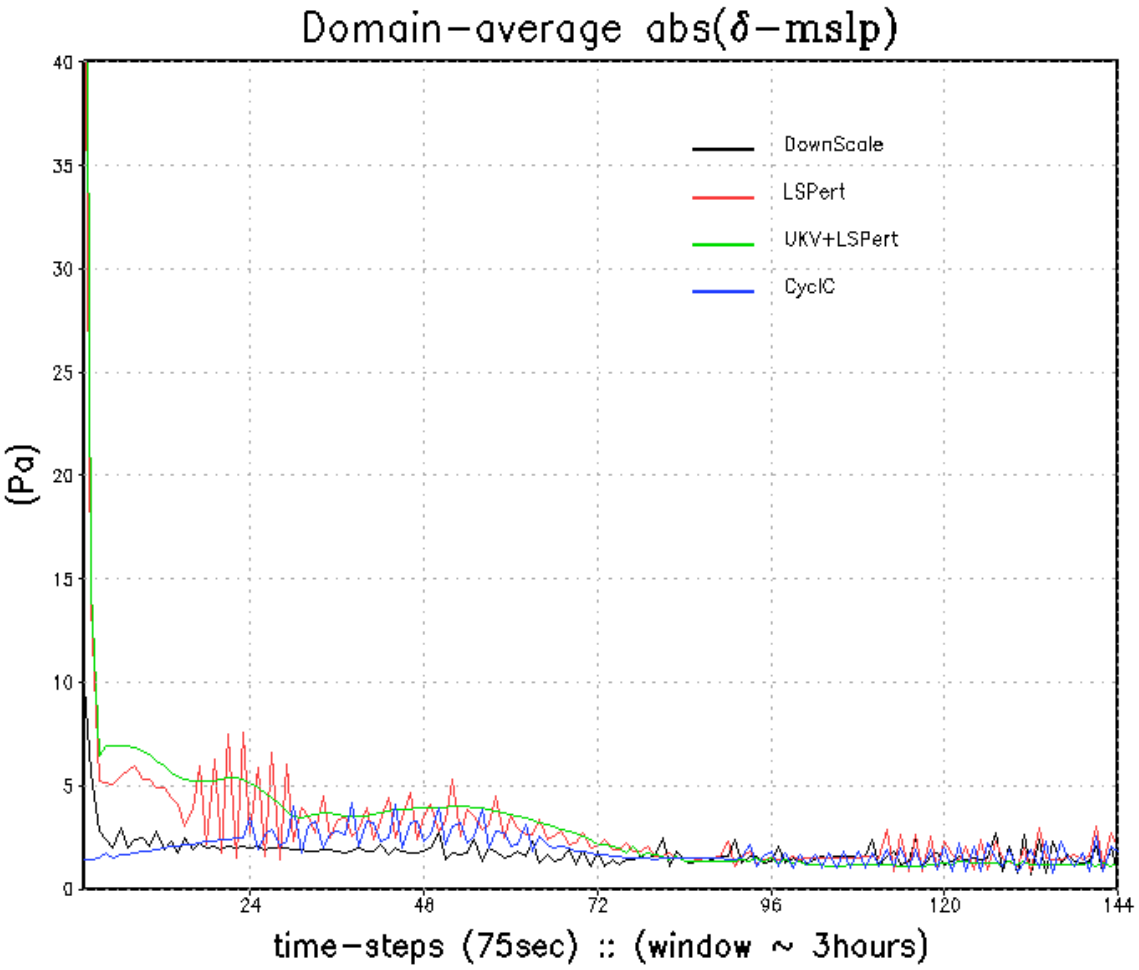
L/S Perts + UKV



Initialisation :: Delta-MSLP

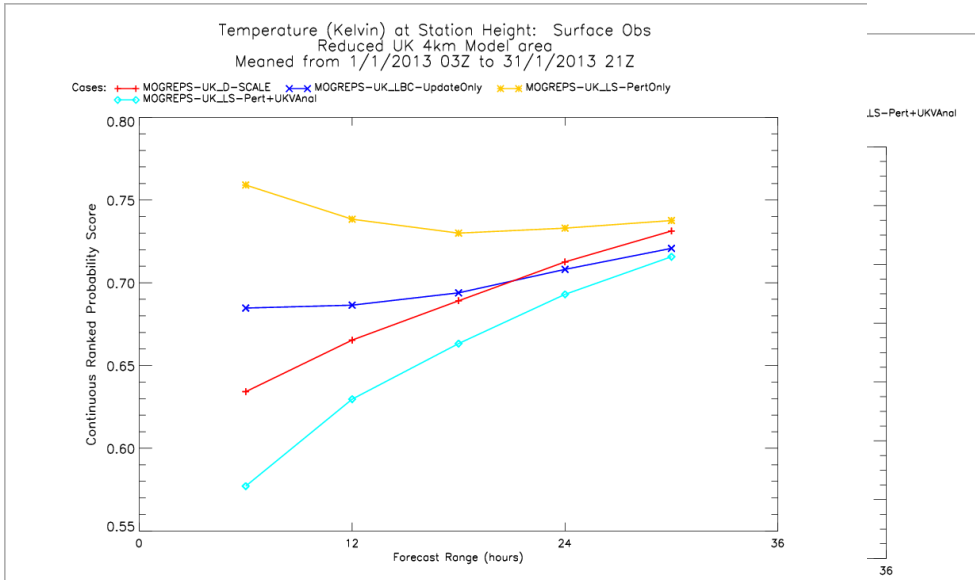
Domain ave time-series

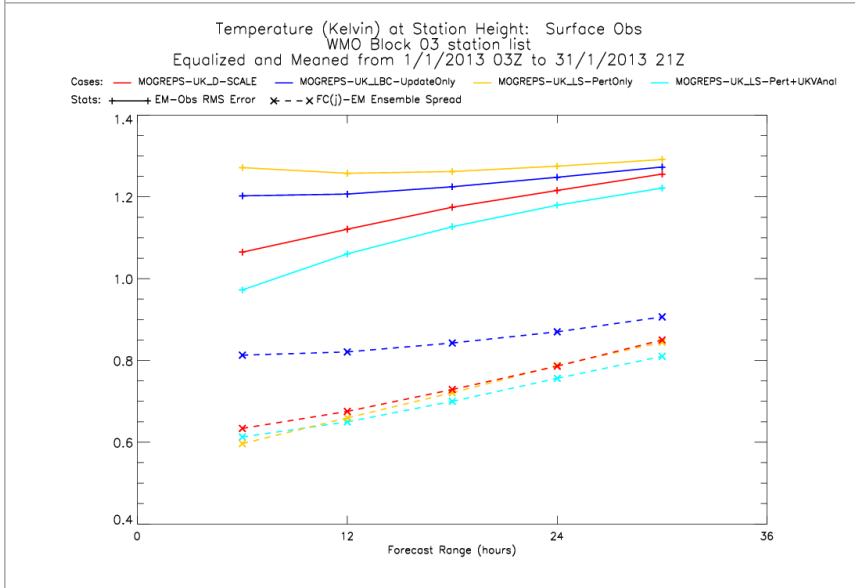
- Cycling initial conditions has smallest initial shock
- Adding large-scale perturbations to IC derived from high-res analysis (UKV) results in smoother forecast evolution
- Most initialisation schemes induce time-step oscillations which decay with time



Initialisation :: Verification (1)

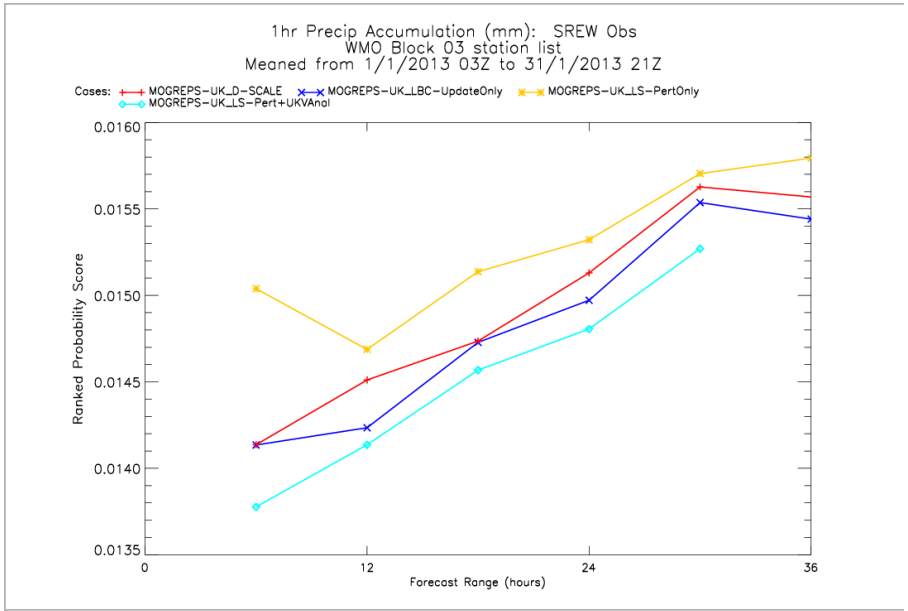
- MSLP is over-spread for all initialisation methods (probably caused by global ensemble)
- **LSPert + UKV** has best results for both T2m and MSLP. Decrease in RMSE ~15-20% (as MOGREPS-R)
- **Adding large-scale perturbations to cycled IC** has poorest scores all round
- **Cycling ICs** does have best spread for T2m **but** higher ensemble mean RMSE and lower CRPS

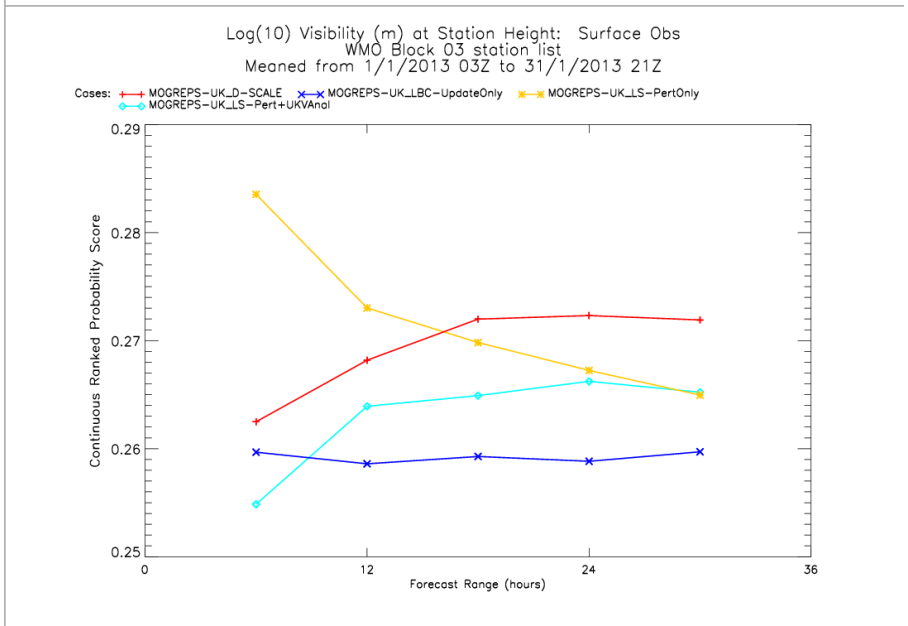




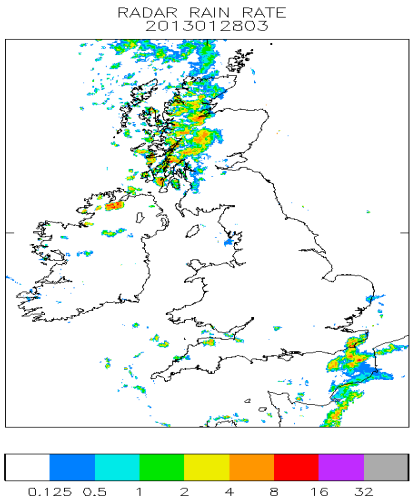
Initialisation :: Verification (2)

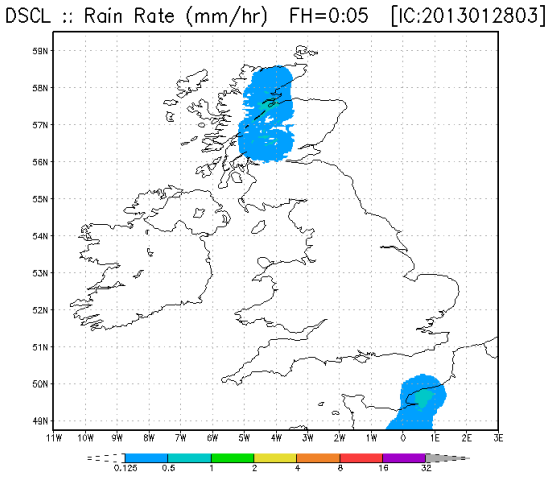
- Precipitation RPS verification has similar results – **LSPert + UKV** is best but **updating LBCs** is slightly better than **downscaling**
- But, for log-visibility (weighted on low thresholds) **updating LBCs** is better than **LSPert+UKV** (except T+6)
- These support the idea of cycling certain fields from one run to the next to merge with analysis data





Spin-up of small-scale detail T+0:05

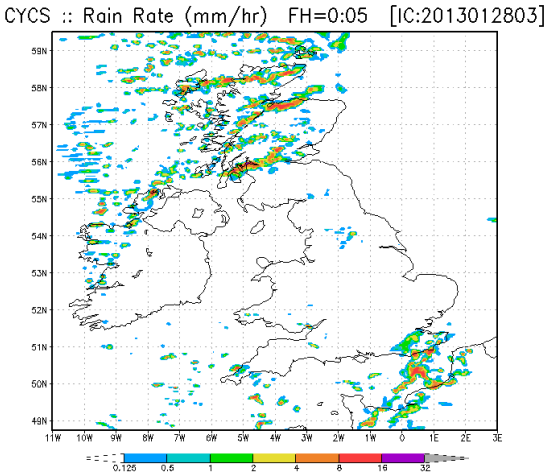


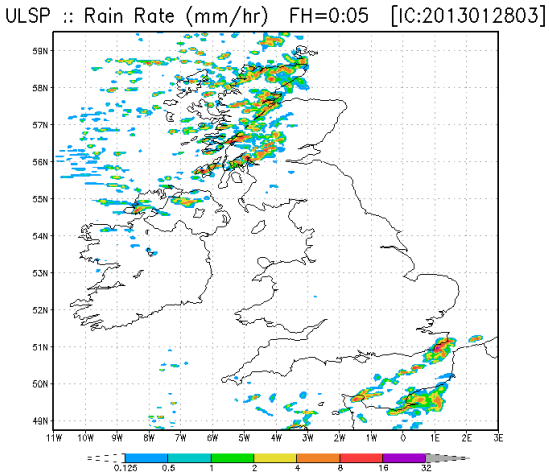


DSCL – downscale

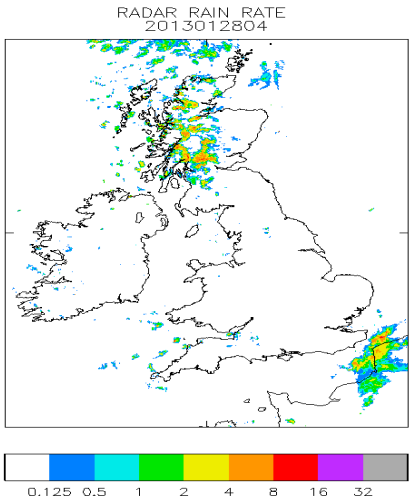
CYCS – cycling IC

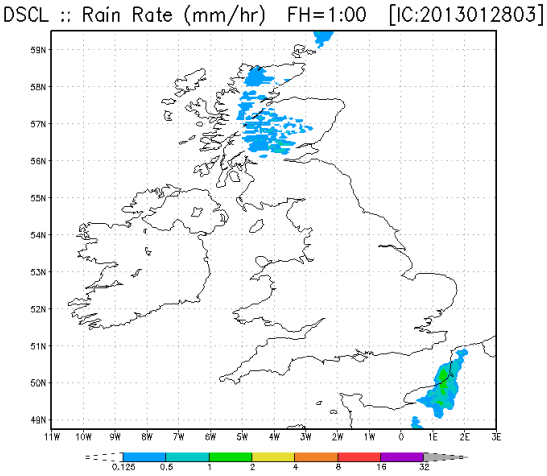
ULSP – UKV+LSPerts





Spin-up of small-scale detail T+1:00





DSCL – downscale

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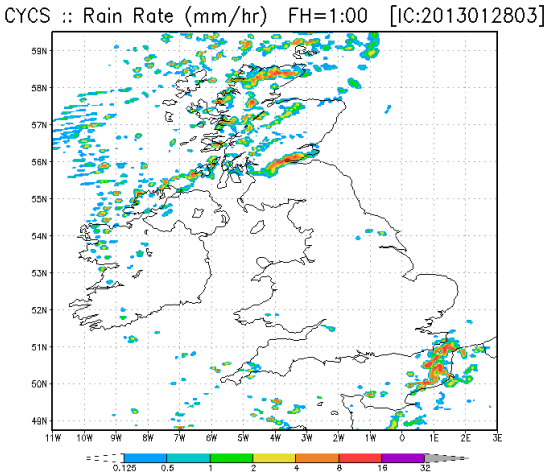
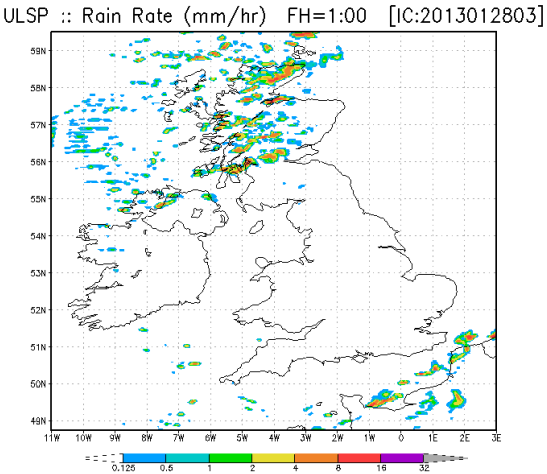
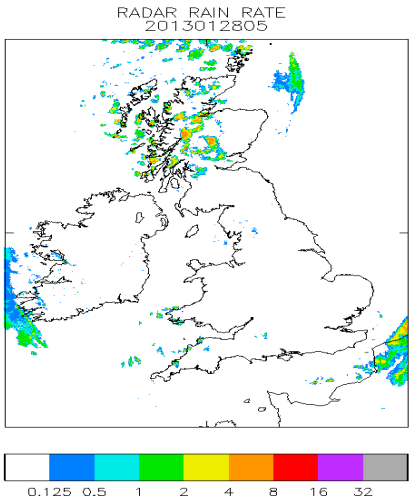
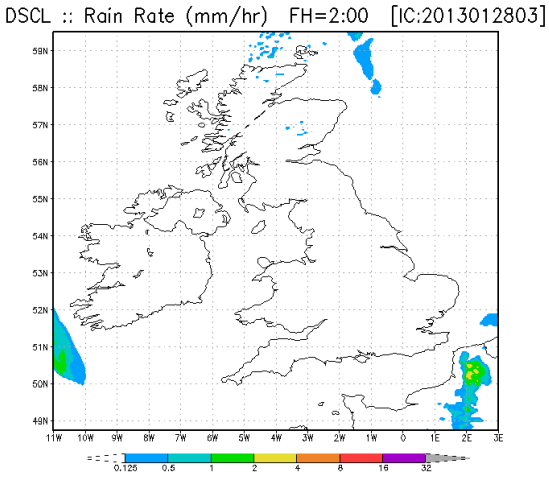




Spin-up of small-scale detail T+2:00

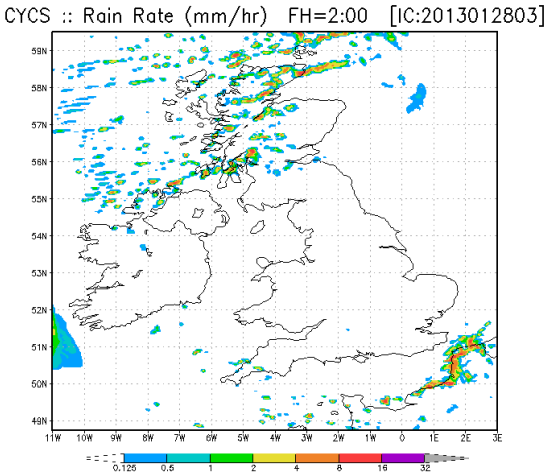


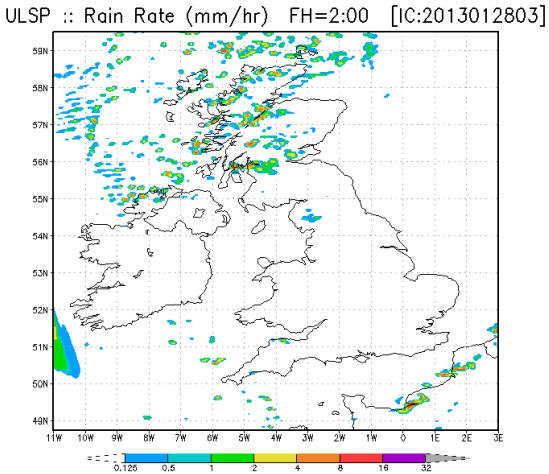


DSCL – downscale

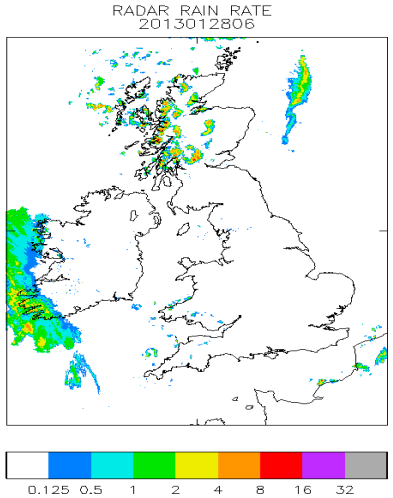
CYCS – cycling IC

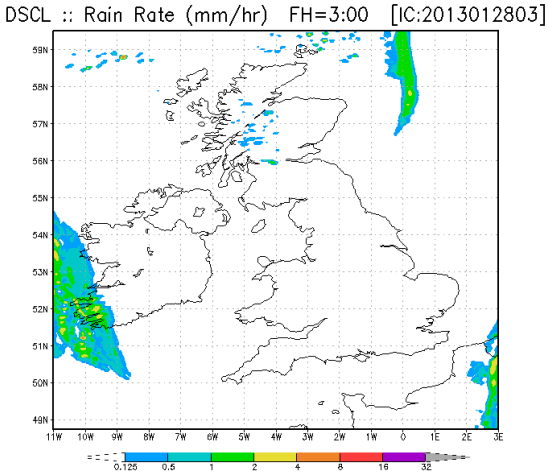
ULSP – UKV+LSPerts





Spin-up of small-scale detail T+3:00





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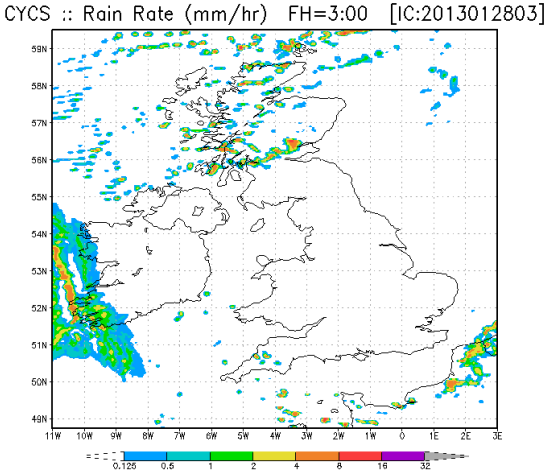
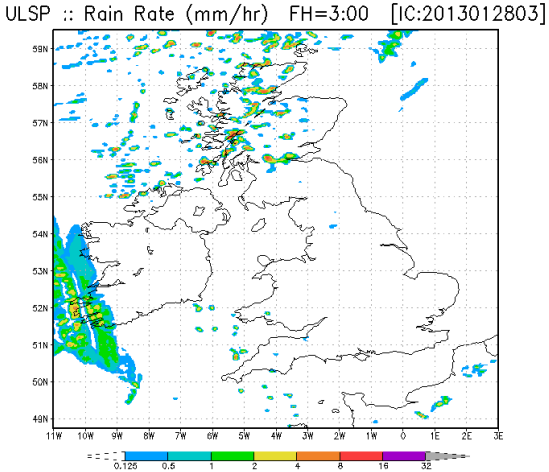
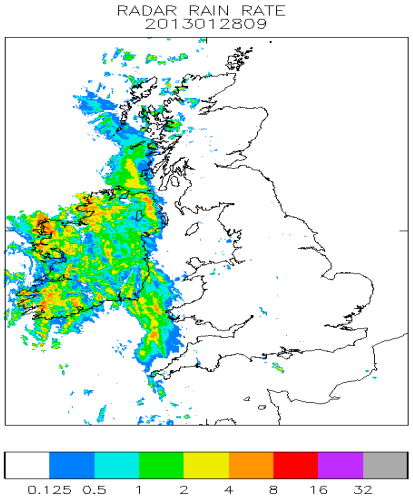
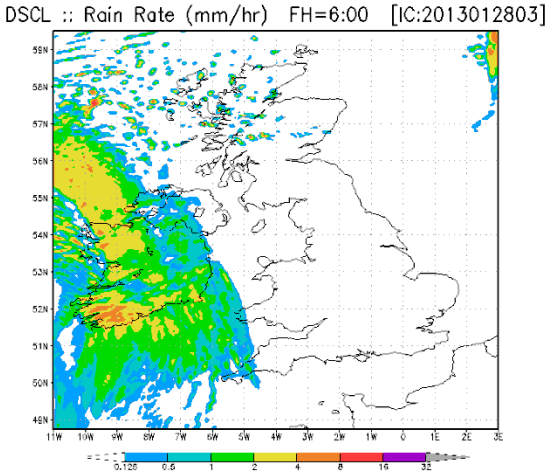
ULSP – UKV+LSPerts





Spin-up of small-scale detail T+6:00

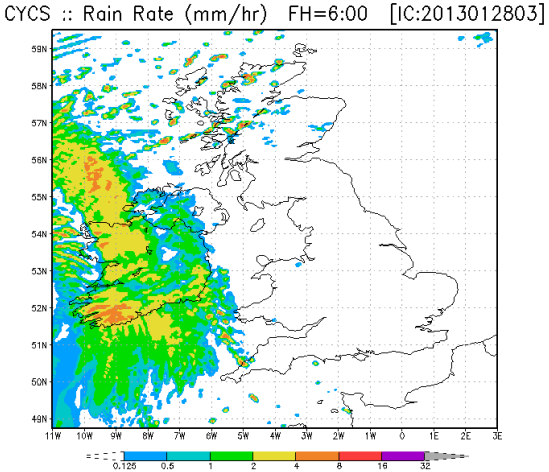


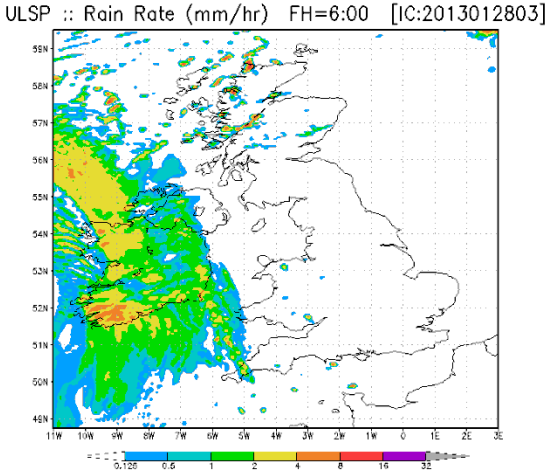


DSCL – downscale

CYCS – cycling IC

ULSP – UKV+LSPerts

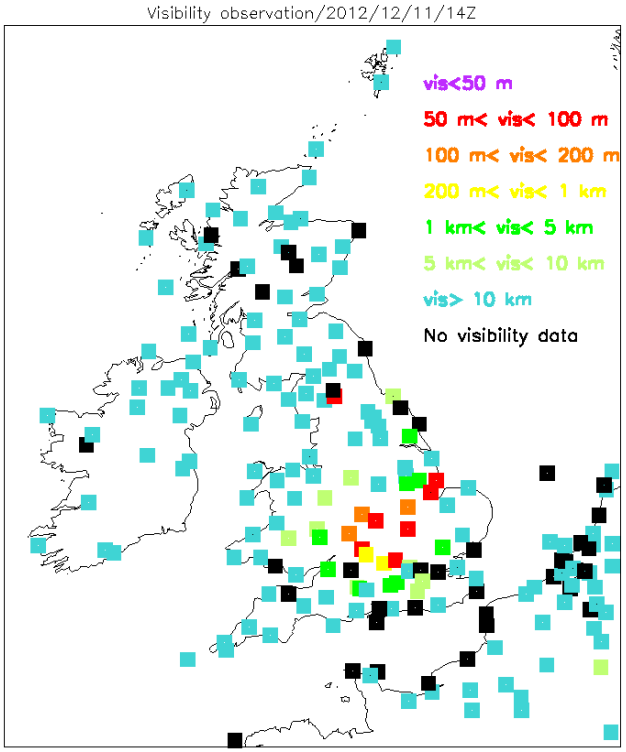




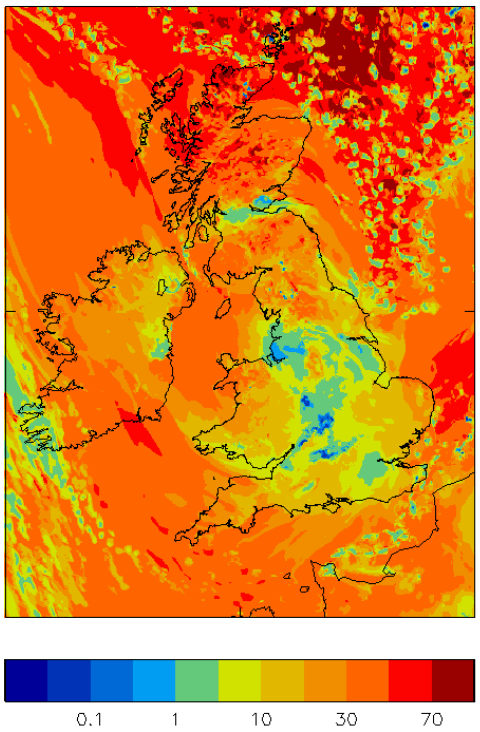
Initialisation :: Visibility Forecasts

- Stochastic physics (Random Parameters) is being tested to improve ensemble spread for visibility
  - Mixing length – affects wind turning and BL depth
  - Stability function – similar effect to mixing length above
  - Entrainment rate – mixing in dry air from above

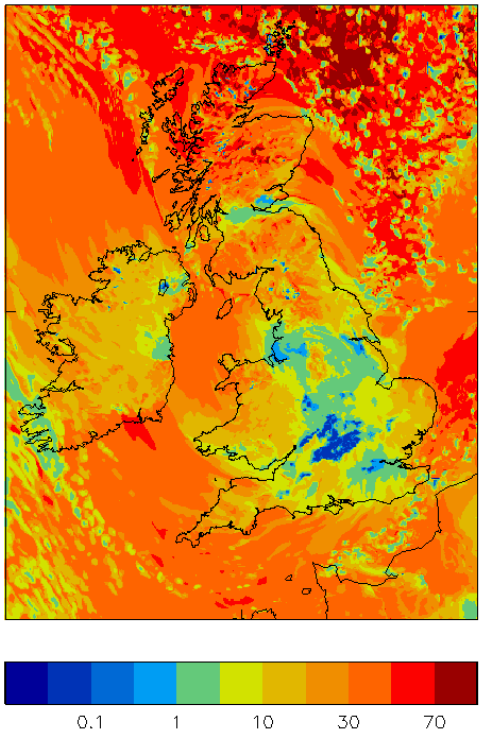
Observations



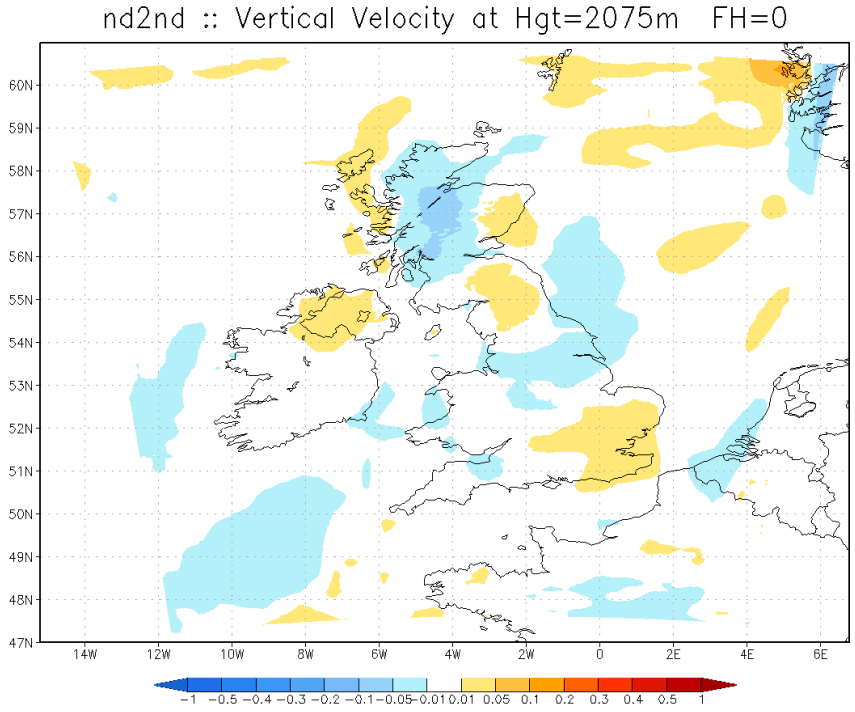
Control

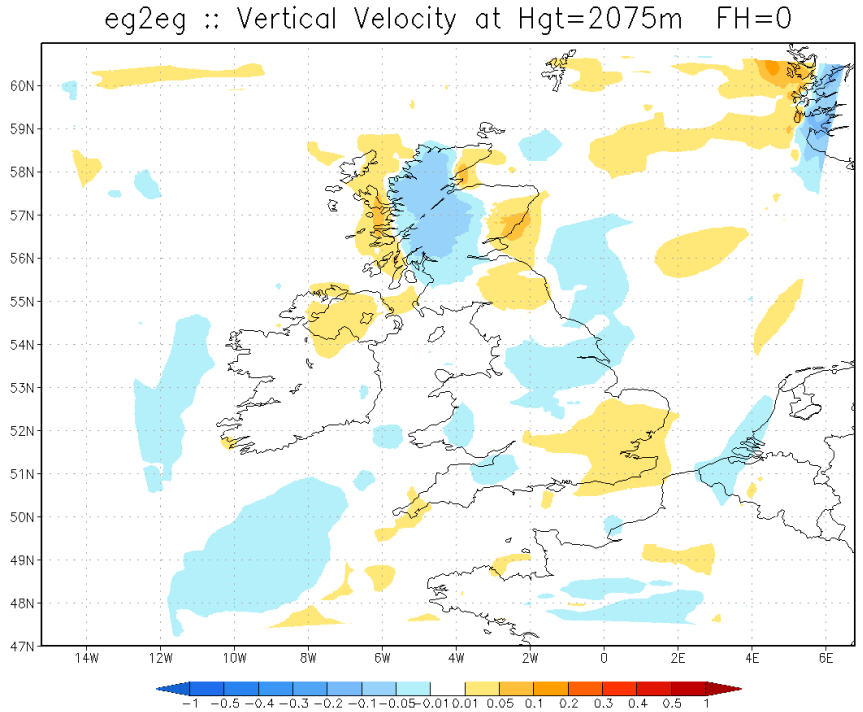


New Params



ENDGame vs New Dynamics comparison of vertical velocity near top of boundary layer :: Case - 03Z 16 July 2013





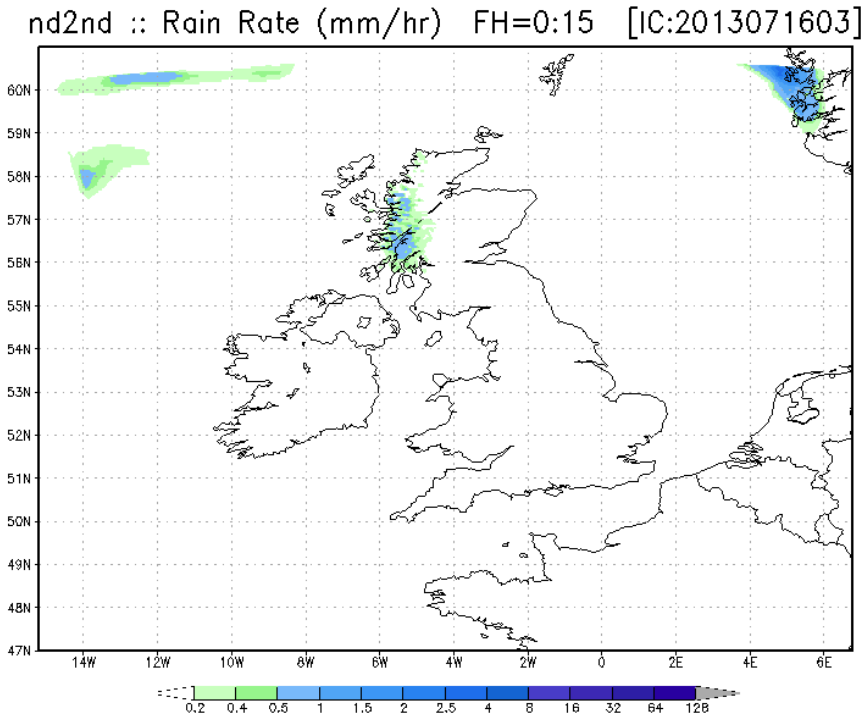
Summary and Discussion

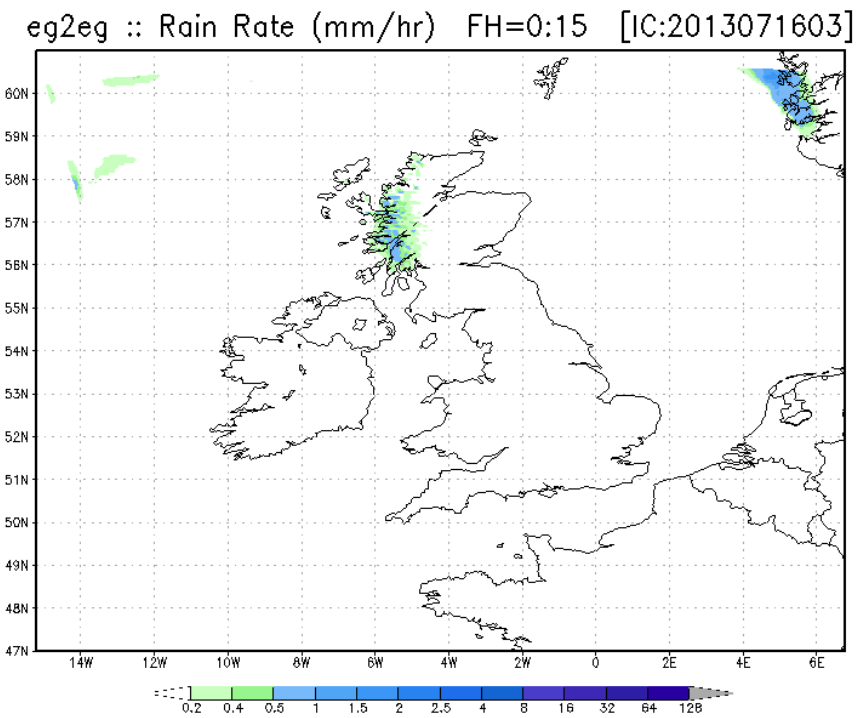
- Variable resolution LAM grid allows successful nesting of 2.2km directly into 33km global
- Verification results support direct nesting of convective-permitting LAM in global (rather than two-step nesting via regional model)
- Performance of LAM is highly sensitive to initial conditions and their balance with LBCs – which has implications for DA
- Various initialisation methods were tested and results favour centring large-scale perturbations around high-resolution analysis

Thank-you

any questions…

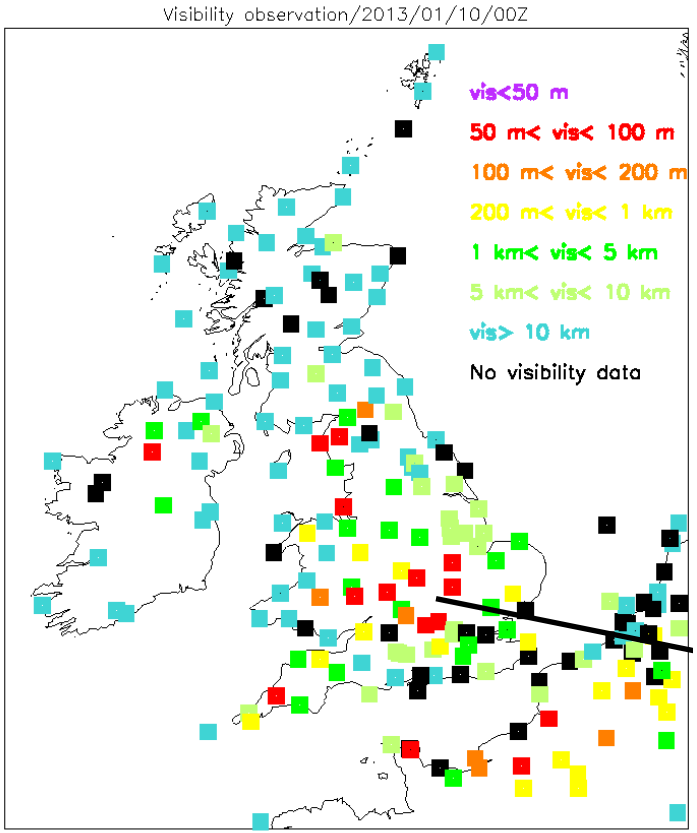
Formation of rain showers in ENDGame is increased

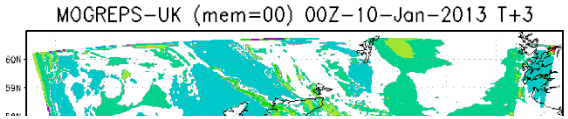


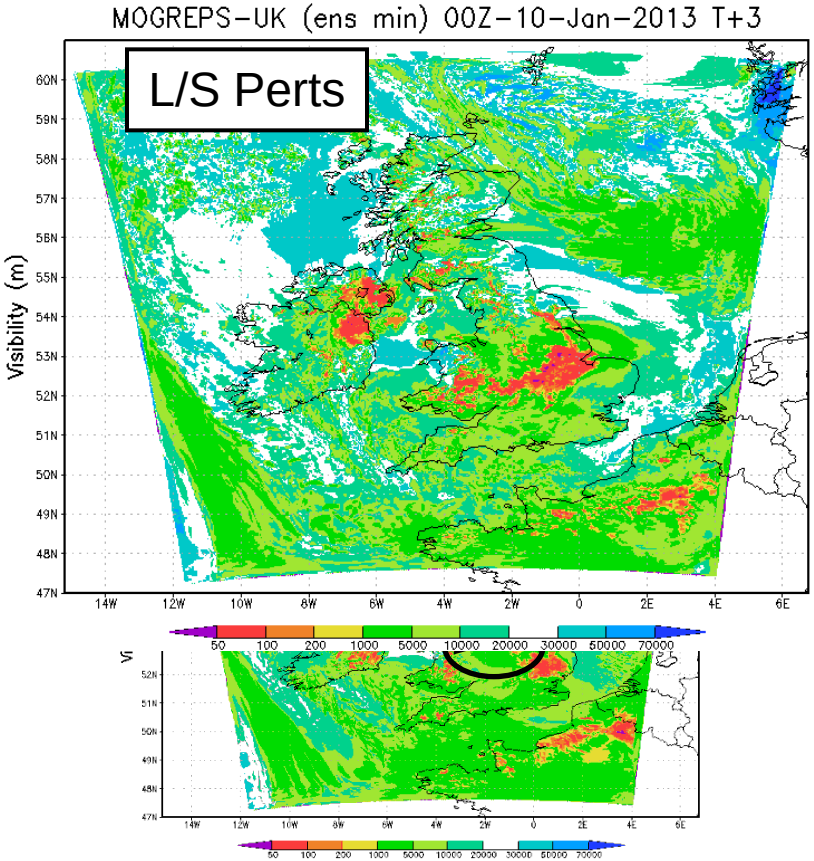


Initialisation :: Visibility Forecasts

- Insufficient spread in visibility :: for this case the foggiest member is still not foggy enough
- Cycling initial conditions is better in this case







Initialising MOGREPS-UK ::
Motivation from MOGREPS-R experience

- Earlier results for MOGREPS-R (18km) showed that adding large-scale perturbations to an interpolated NAE (12km) analysis was significantly more skilful than pure downscaling:
  - 10-15% difference in RMSE
- This could be partly attributed to different model physics between MOGREPS-G and MOGREPS-R