Upcoming changes to the UK data assimilation system

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2024 Momentum®UK Partnership Convective Scale Workshop

11th September 2024

Contents

DA testing in Parallel Suite PS47

Intended to complement RAL3 operationalisation talk on Thursday pm

- Alignment of DA with new RAL3 model microphysics scheme (CASIM-DA)
- ‘DA Bias’ Package
- PS47 Radar Reflectivity Enhancements

3 DA Testing Phases

PS47 Trial Phase	DA Change	Rationale	Ticket	RAL3P1b	DABias_P2	REFL
1b	CASIM DA	Align with RAL3 CASIM microphysics	#1338	✓	✓	✓
2	Latent Heat Nudging (LHN) off	Strategic (NGDA / LFRic)	#1291		✓	✓
2	Adaptive Vertical Grid (AVG) off	Strategic (NGDA) /Performance	#1293		✓	✓
2	RTTOV Instrument to Model Levels	Strategic (NGDA)	#1339		✓	✓
2	SurfaceCloud Bug Fixes	Bug Fix	#1340		✓	✓
2	VisQC back on	Performance	#1290		✓	✓
	Reflectivity Tuning >					
3	Reflectivity enhancements	Performance	#1127			✓

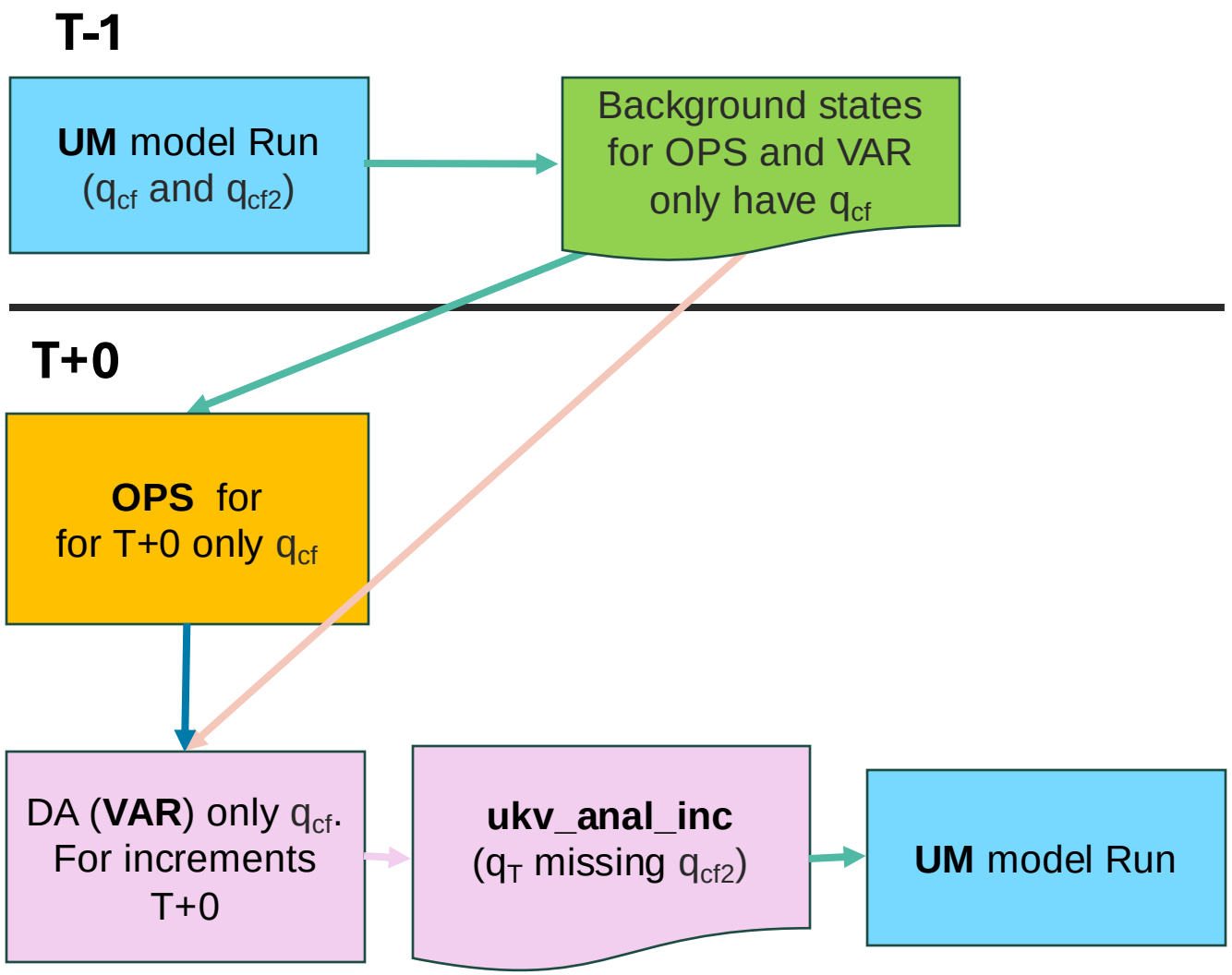
RAL3 (1a) > + CASIM DA (1b) > + 'Dabias' Package (2) > + Reflectivity Enhancements (3)

Met Office

Alignment of DA with new RAL3 model microphysics scheme (CASIM-DA)

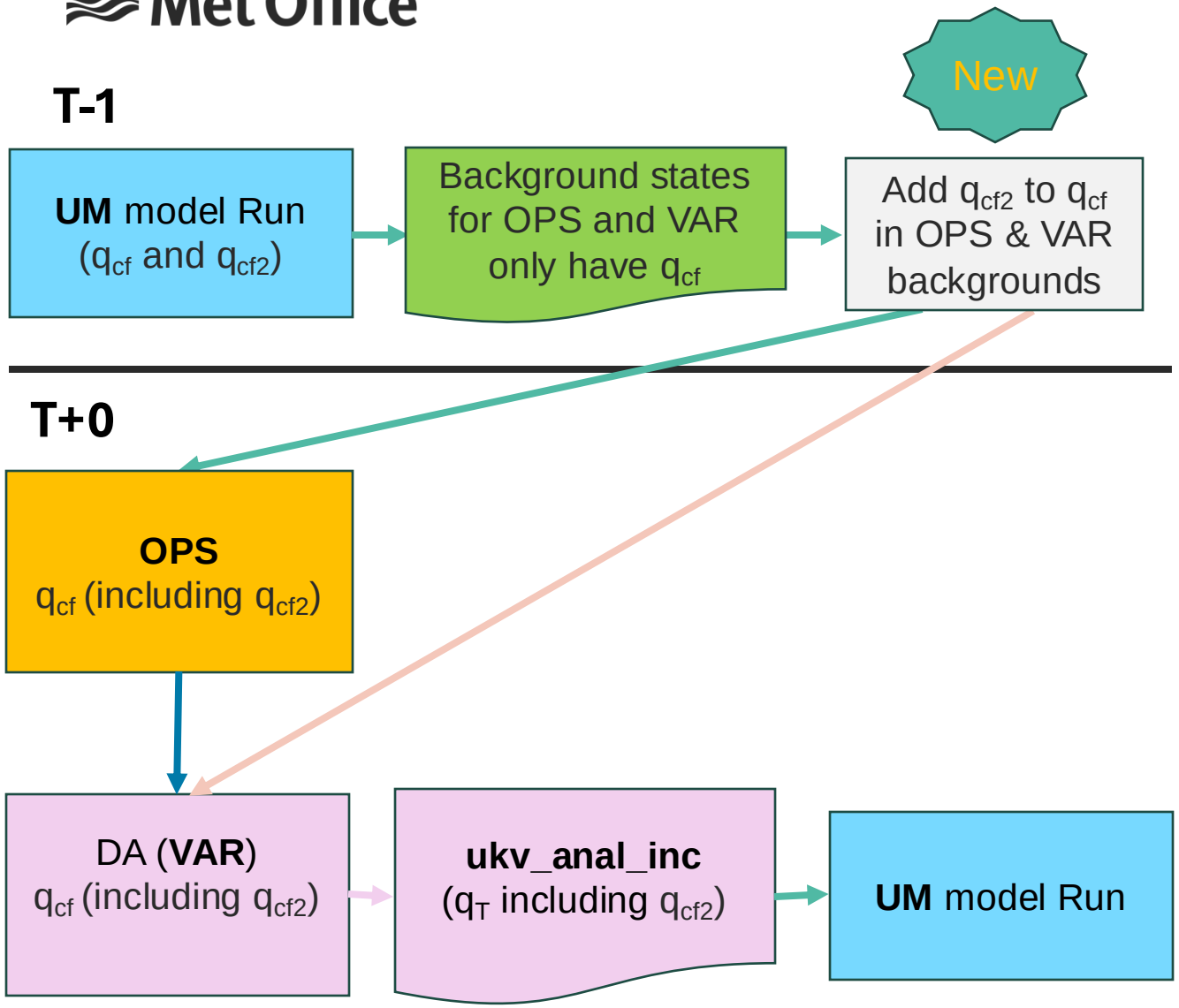
Marco Milan, Gordon Inverarity, Gareth Dow, Stephen Gallagher, Adrian Semple

NEW ICE PARTICLE IN RAL3 CASIM microphysics



- RAL3: the new microphysics CASIM splits frozen cloud particles into two, snow (q_{cf}) and ice (q_{cf2}).
- VAR and OPS don't have the cloud ice particle (q_{cf2}) coded in.
- To make VAR and OPS consistent with CASIM the two cloud ice particles should ideally be recognised in the code.
- But abandoned due to lack of time
- By simply adding q_{cf2} to q_{cf} in the suite environment we can avoid VAR and OPS code changes.

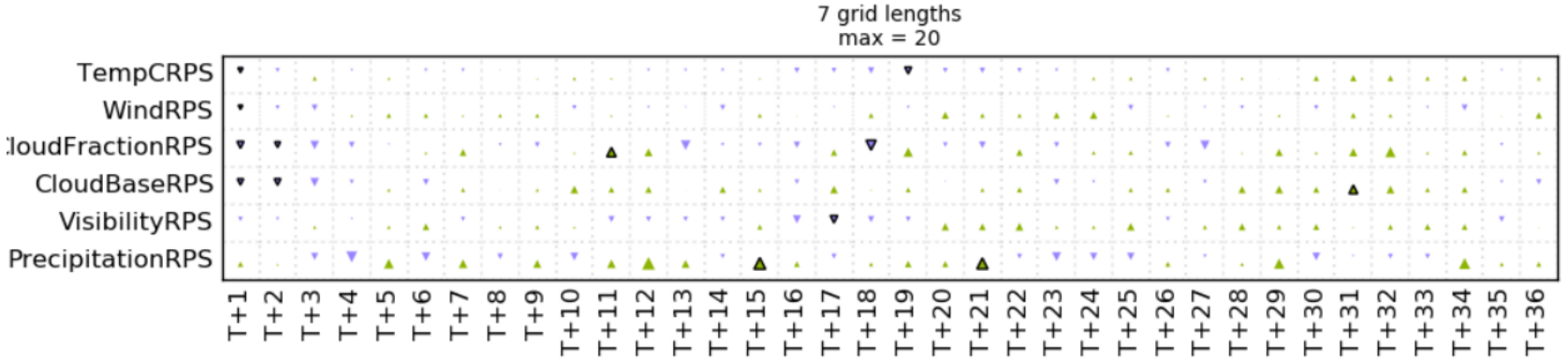
ACTUAL SOLUTION UNDER TRIALING IN PS47



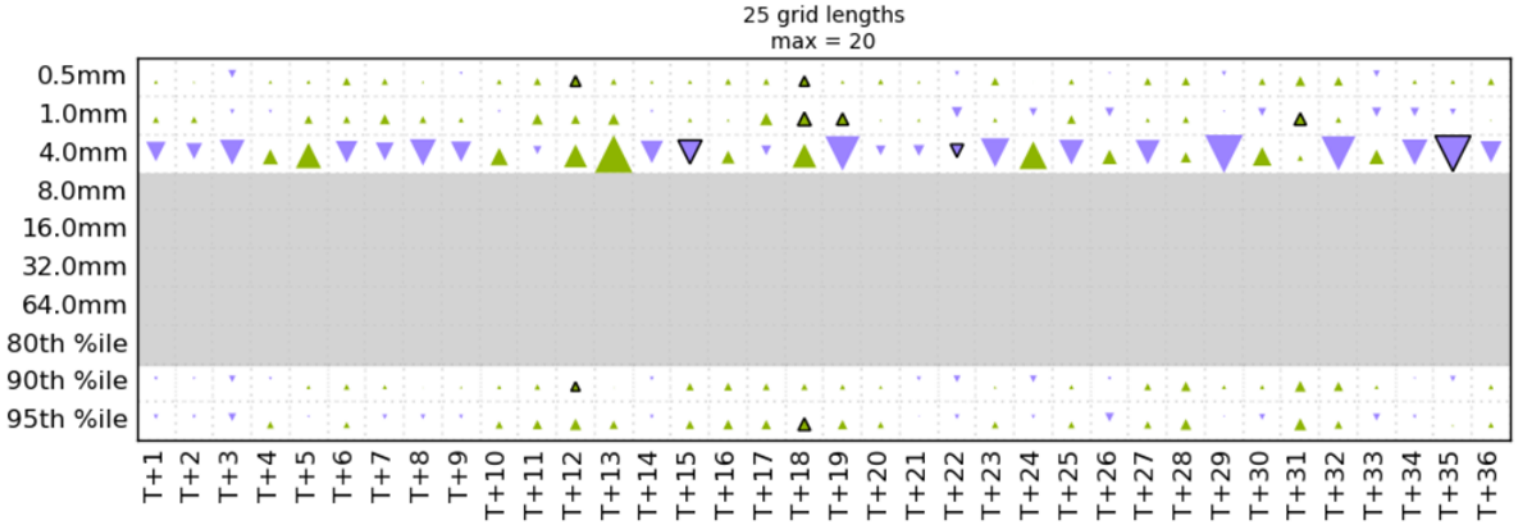
- Mule script adds cloud ice to cloud snow. Thus, the total cloud snow (q_{cf}) in VAR and OPS contains implicitly also the cloud ice (q_{cf2}).
- Apply the script to:
  - LS background states for VAR.
  - The background file for OPS.
- VAR and OPS unchanged, but the amount of q_{cf} in the input fields is changed.
- The changes are on suite/workflow level.
  - New tasks for calling the script (inserted immediately after the forecast task)
  - Graph changes
  - Archiving and housekeeping
- The new method ensures physical consistency with RAL3 CASIM, which is a requirement for PS47.

Winter scorecard

RAL3DA_P1b vs RAL3_P1a Winter



RAL3DA_P1b vs RAL3_P1a Winter

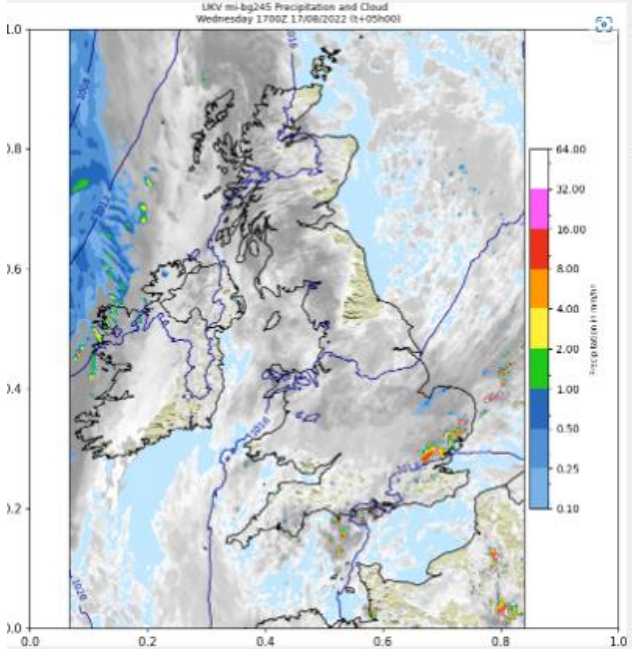


- **RAL3_P1a** version without CASIM-DA changes.
- **RAL3DA_P1b** physical consistency between VAR and CASIM.
- Generally neutral results for all variables (similarly for summer).

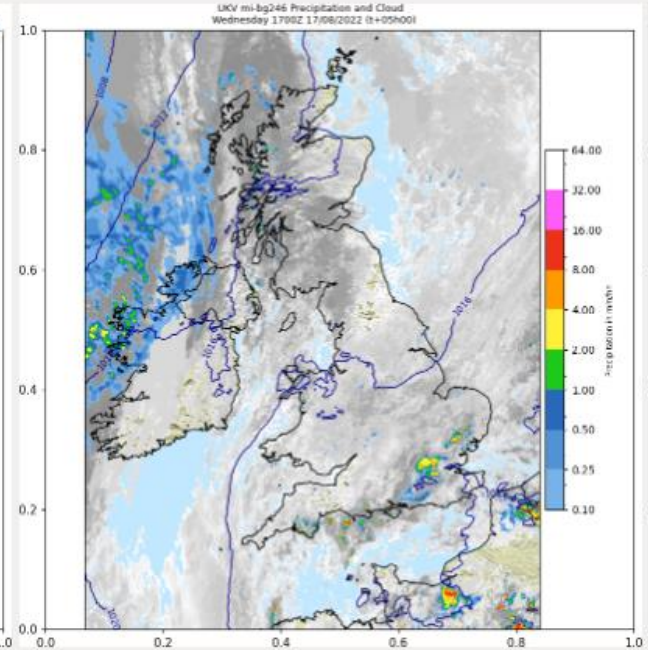
Subjective Evaluation

- Differences using this upgrade are small/negligible.
- Some slight improvements using CASIM DA.

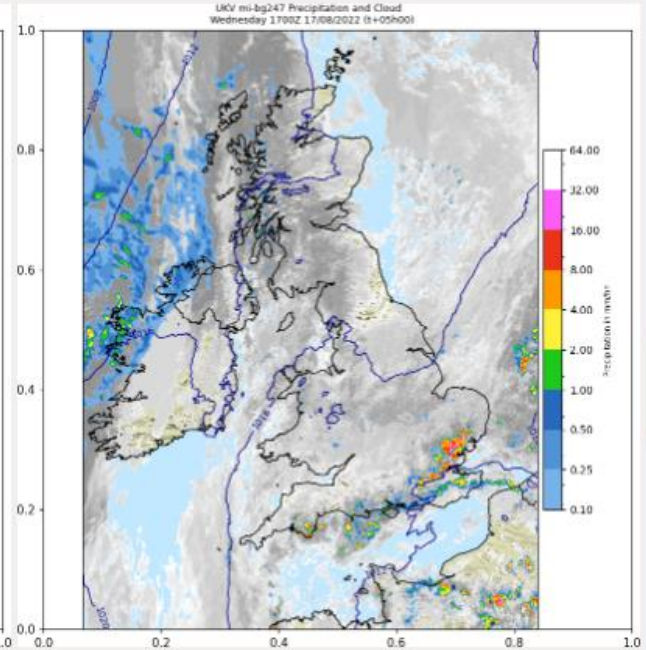
RA2M

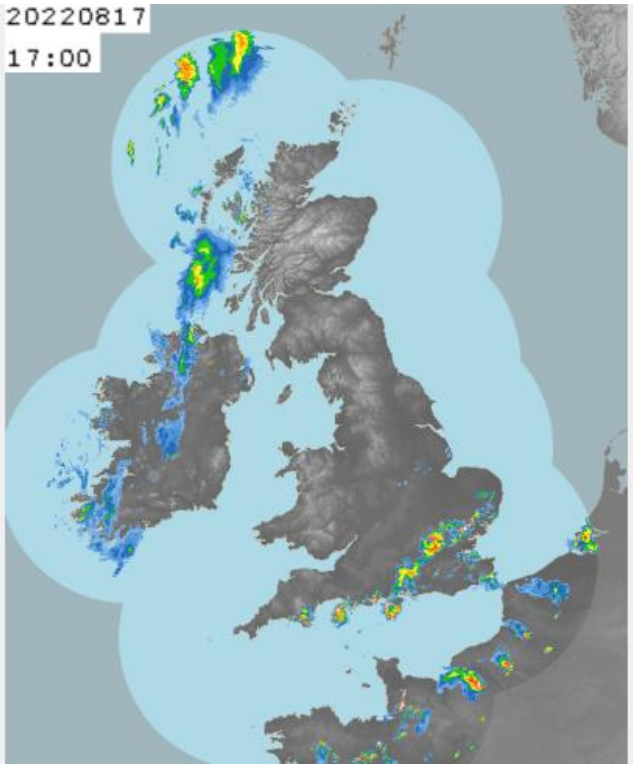


RAL3P1a



CASIM DA





‘DA Bias’ Package

David Simonin et al

Main ‘DA bias’ changes

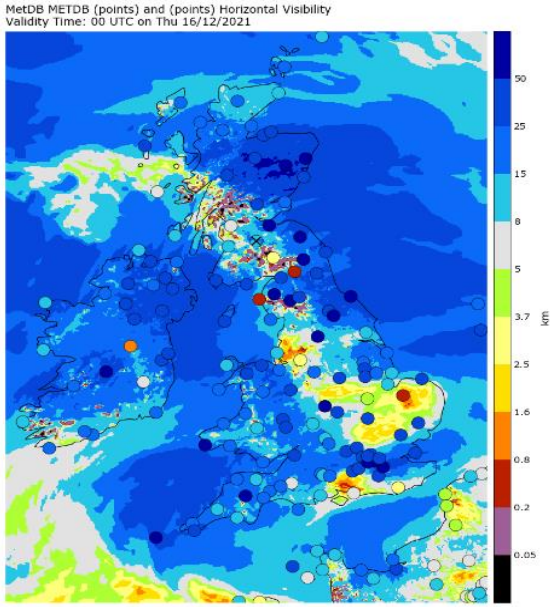
- Package applied on top of CASIM-DA
- Switch OFF of LHN. LHN is not supported by LFRic, and is inconsistent with the DA of all other OBS.
- Switch OFF of Adaptive Vertical Grid (AVG).
  - The climatological B matrix is homogeneous and isotropic.
  - These properties are lost with AVG. Giving some issues also in the treatment of humidity in VAR.
    - 4D-Var evolves background error covariances during the DA window. Do we need AVG?
    - The AVG can generate instabilities (particularly over orography).
    - Potentially detrimental in the summer, particularly with convection.
    - NG-DA entirely different system, no need of AVG.
- Switch back on VisQC (next slide)

VisQC switched back on

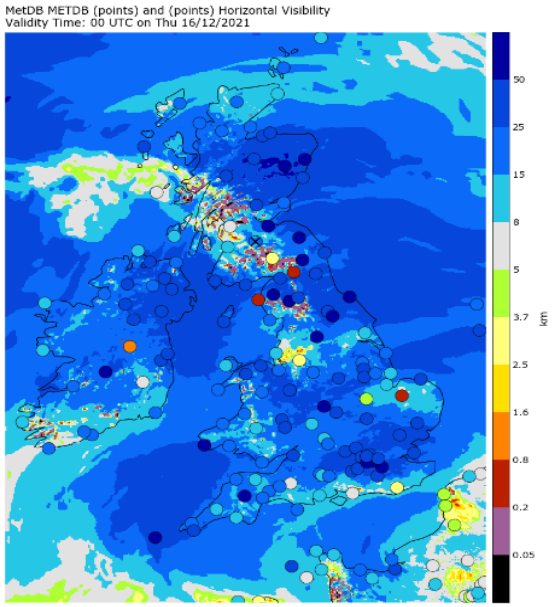
- Rejects ‘inconsistent’ RH and vis obs
- Switched off at PS43, resulting in:
  - Suppressed visibilities from 5-10 km to 1-5 km (range important for aviation customers)
  - coincides with what appears to be spuriously high levels of aerosols at short lead times, leading to complaints from OpMets
- Putting the quality control back on tested in PS47 trials and considered to be an improvement

Standard Diags v obs

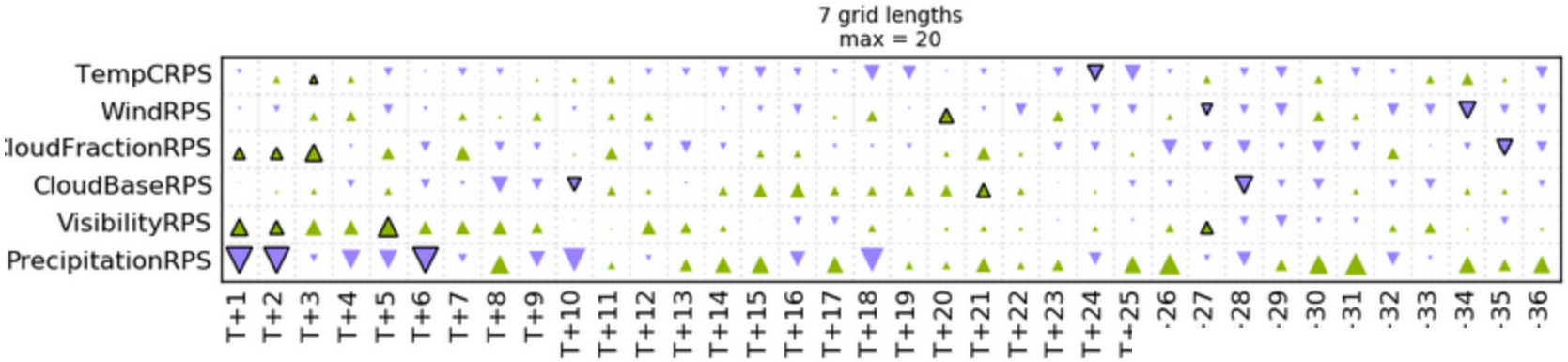
VisQC OFF

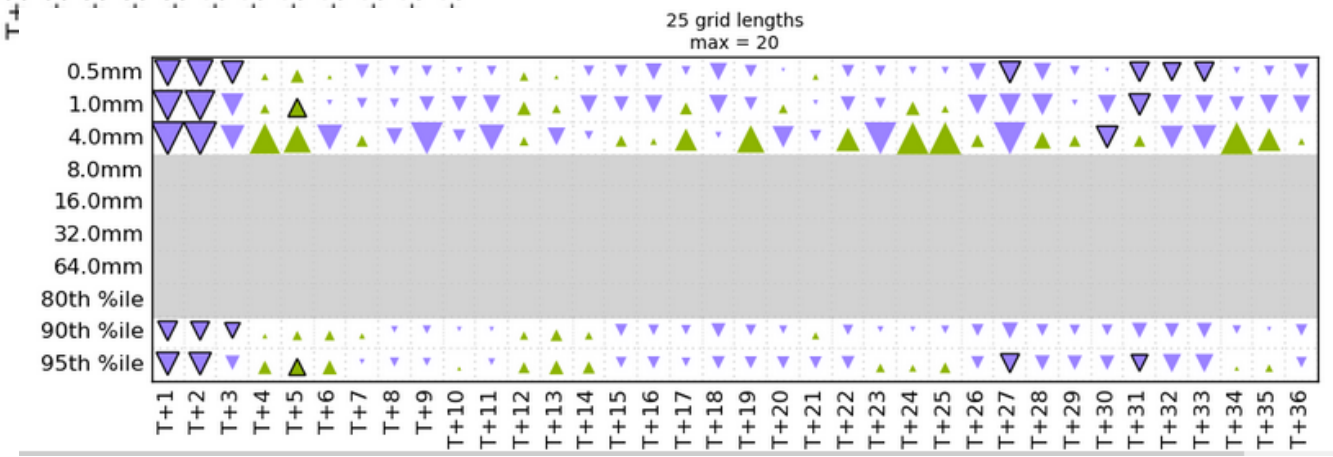


VisQC ON



DABias vs RAL3P1b Scorecards





- Mainly neutral for most variables.
- Precipitation FSS detrimental for the first 2-3 hours of forecast.
- Probably due to LHN switched OFF.
- Work underway to understand rainfall metrics particularly in assessment of LHN which assimilates (very similar) composite to that which is also used in FSS verification

PS47 Radar Reflectivity Enhancements

Lee Hawkness-Smith et al

Reflectivity experiments:

REFL: as DA package 2-step Var with

- Improved coverage over UK/Ireland (including removal of 3°C min temp)
- Inclusion of French and German radar scans
- Retuned observation operator

REFL4: as REFL with

- Larger reflectivity observation error

- Based on subjective and objective evaluations have chosen to go with **REFL4** over REFL – but differences were generally small
- Other experiments were also run (including smaller errors) but were clearly detrimental with respect to REFL and REFL4

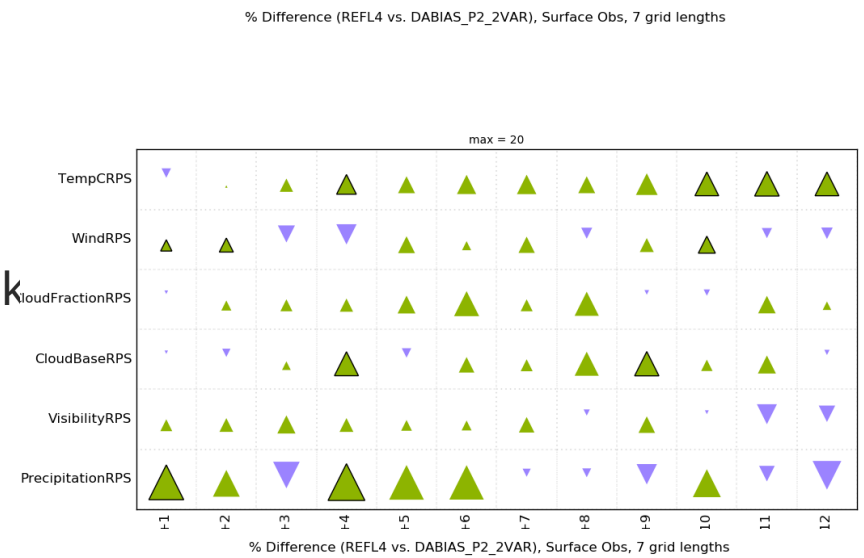
REFL4 vs DABIAS_P2

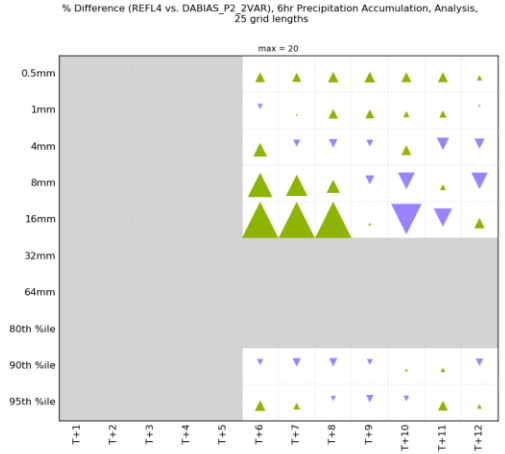
HiRA scorecard

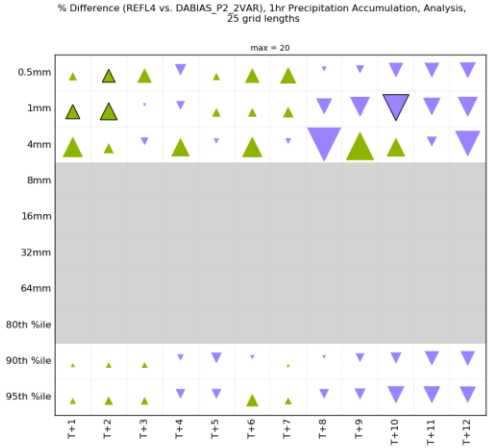
FSS 6-hour accum

FSS hour accum

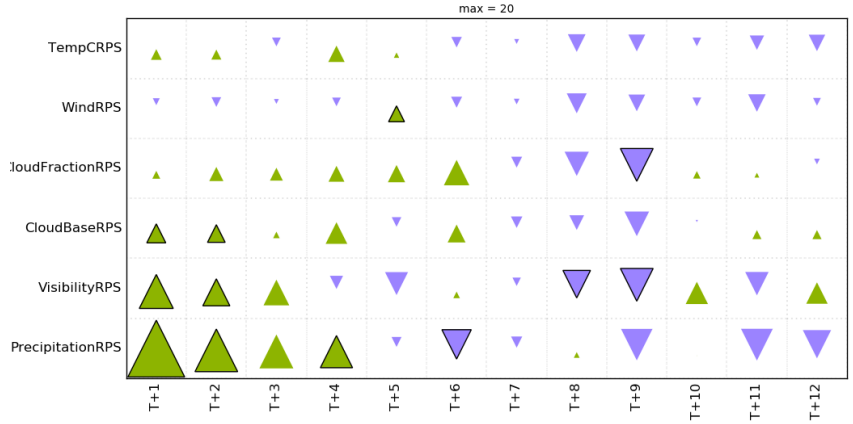
Aug 22 wet week

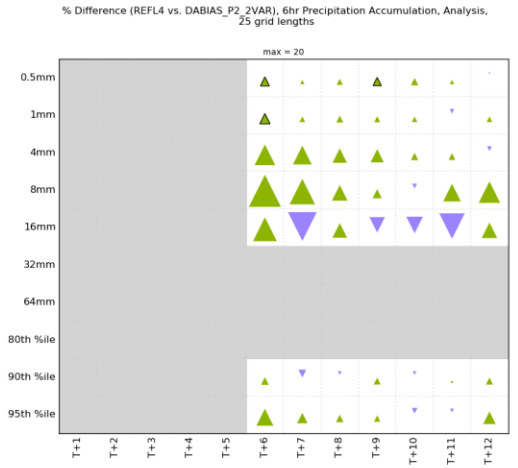


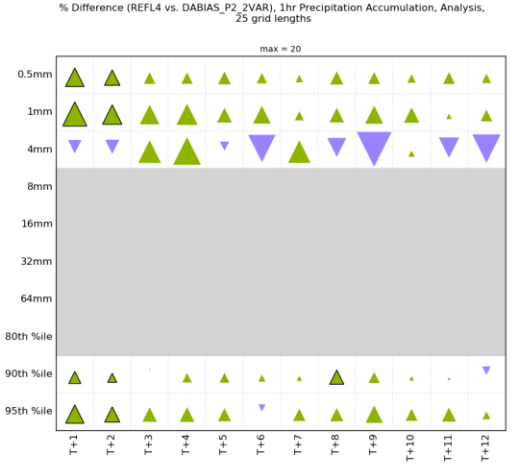


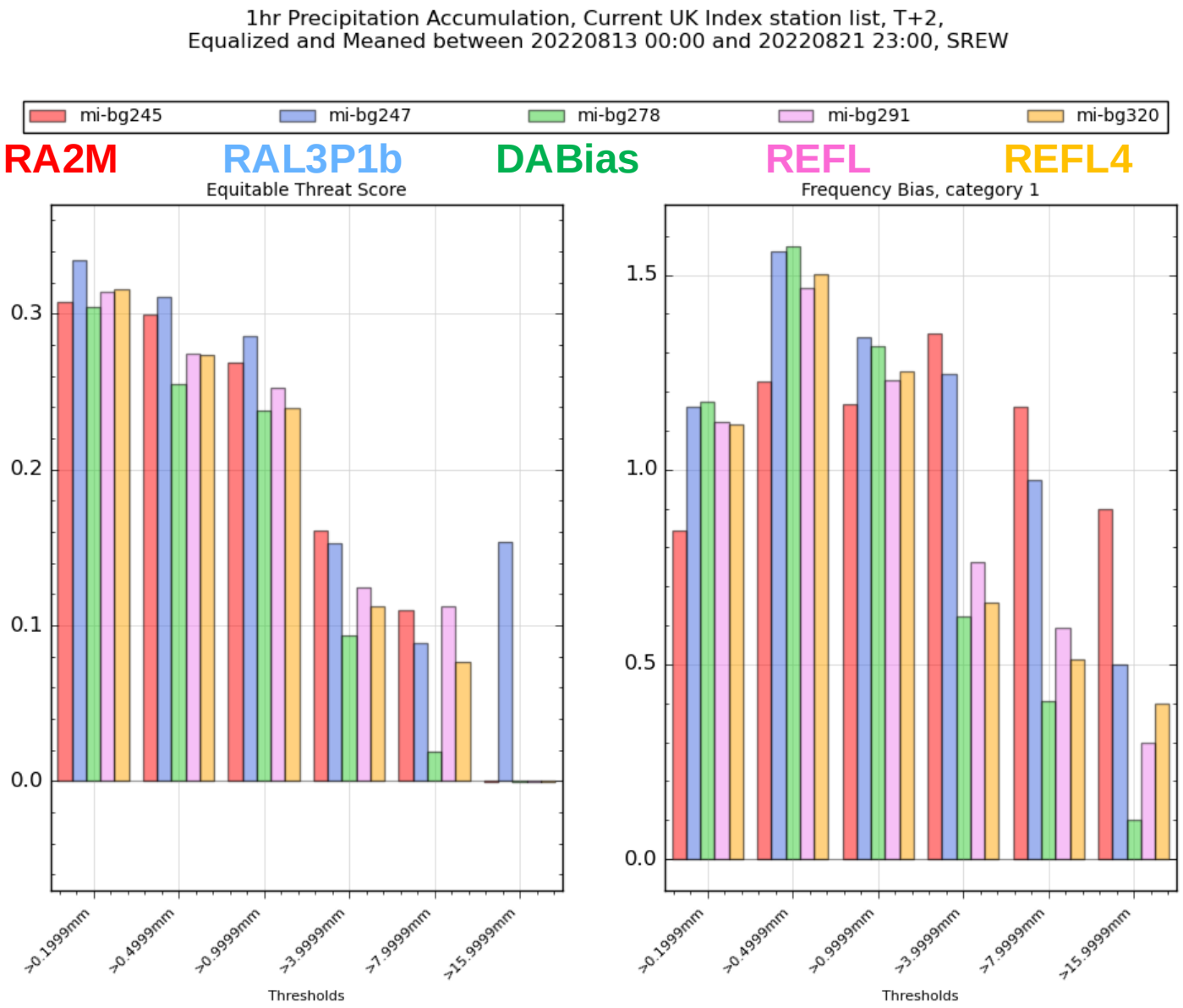


First week
Dec 21









RAL3P1b ➔ **DABias** ETS skill drop at T+2 largely due to loss of LHN.

Perhaps most keenly felt at higher thresholds.

Partially reversed by reflectivity upgrade.

Conclusions

- Physical consistency of DA with RAL3 CASIM microphysics (2 frozen particles)….needed for future DA development

  (Have not attempted to adjust CVT accordingly)

- Some big changes for the DA system. Switch OFF LHN and AVG.

- We see a degradation of precipitation skill in the first 3 hours of forecast time most likely due to LHN switch off

- Including reflectivity enhancements claws back some but by no means all of the early deficit in ppn skill. (However RAL3 also helps a bit in this regard).

- Some DA changes due to NGDA for LAM development requirements – which will likely be a very different (and ensemble-based) system.


THANK YOU