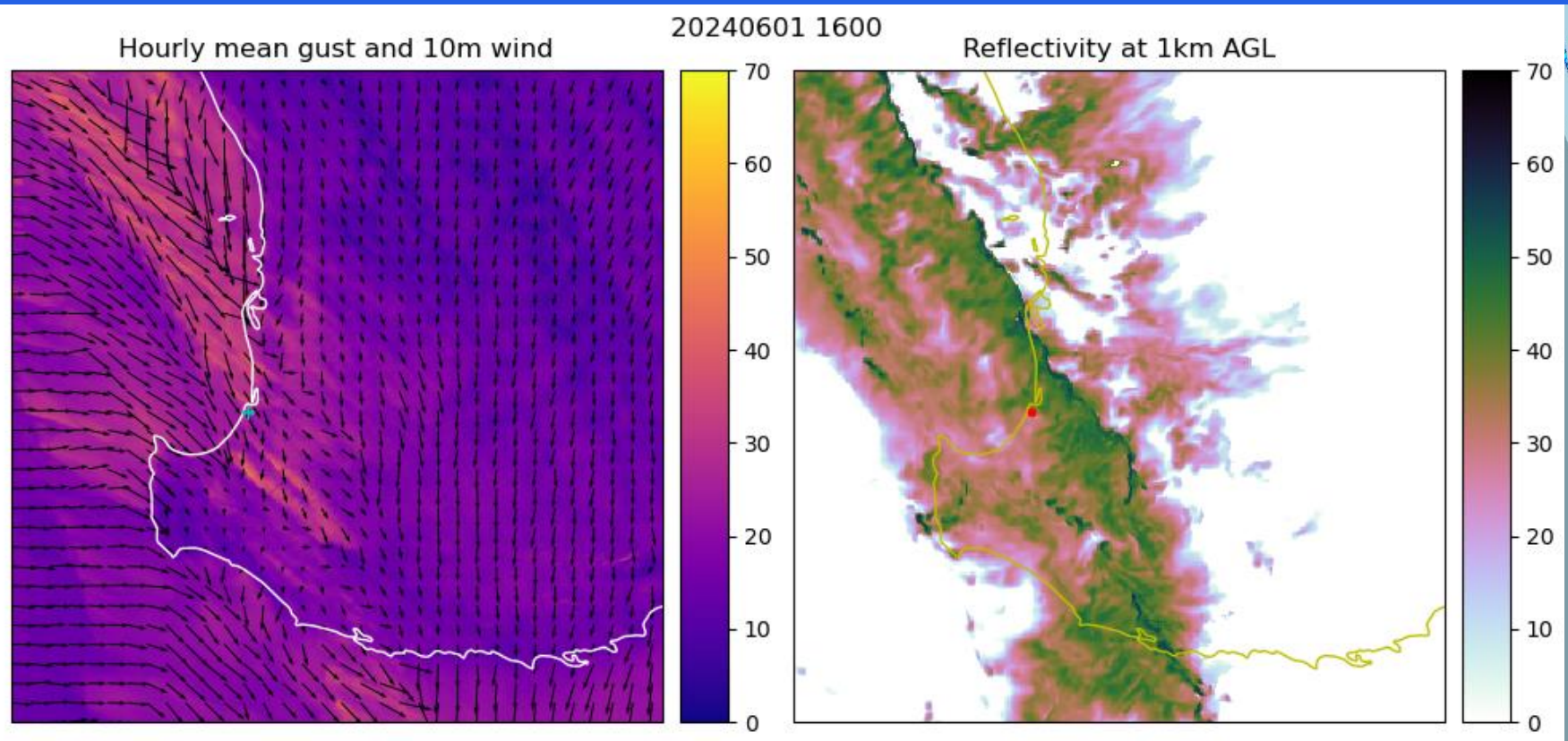
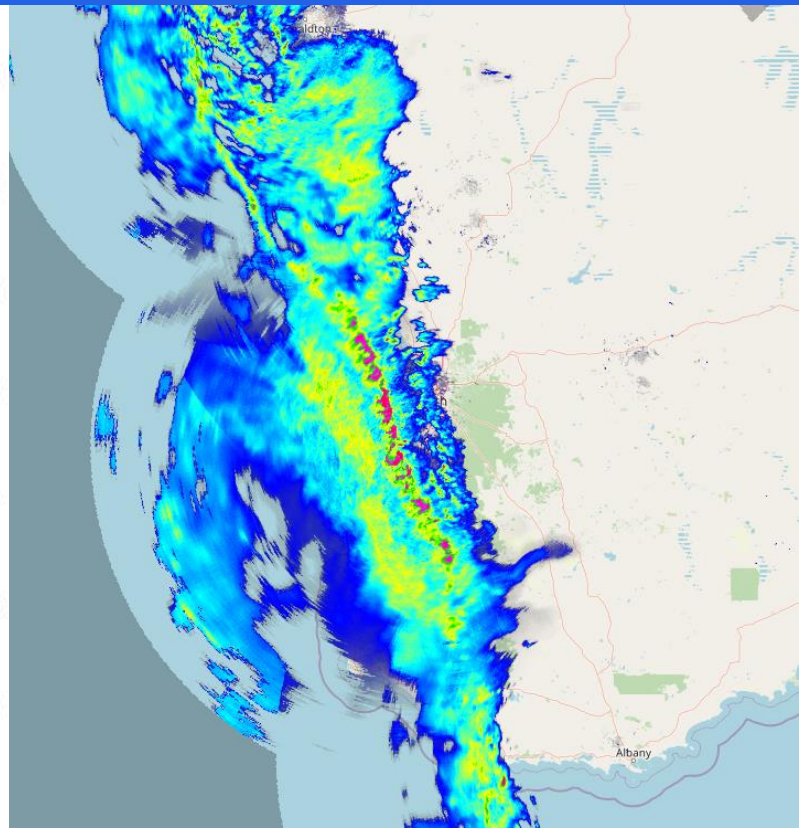
The Bureau of Meteorology

New challenges in Australia-wide convective-scale data assimilation

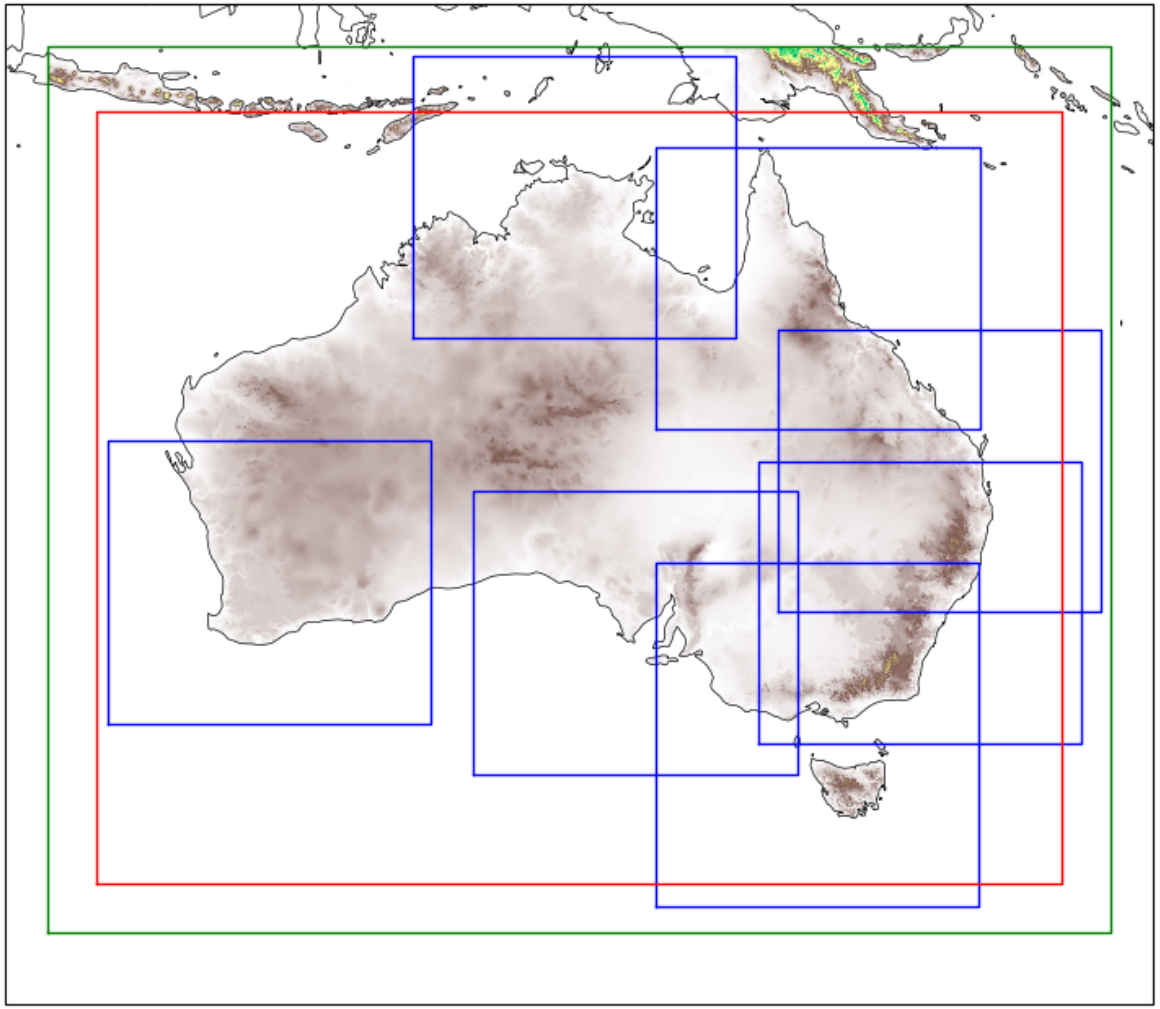
Susan Rennie, Peter Steinle, Monika Krysta, Andy Smith, Meelis Zidikheri, Fiona Smith, Nahidul Samrat, Jordan Brook, Charmaine Franklin, Shaun Cooper, Belinda Roux, Jill Finch, Christopher Griffin, Imtiaz Dharssi, Mathew Lipson, Chris Bridge





System description

- Covers Australia at ~1.5 km resolution (variable grid)
- Replaces 7 ACCESS-C domains
- Many upgrades compared with ACCESS-C
- 90 levels and RAL3.2 (UM13.0)
- Ancillary updates including land cover from CCIv2 and WorldCover for urban areas, and 2-tile urban scheme
- Hourly 4D-Var (4.5 km grid) and land DA
- Supports National Analysis System (hourly low-latency 3D-Var analysis with overfitting to observations)
- Workflow u-cx959, Cylc 8, site portable



Outer domain boundary
Fixed resolution boundary
ACCESS-C domains

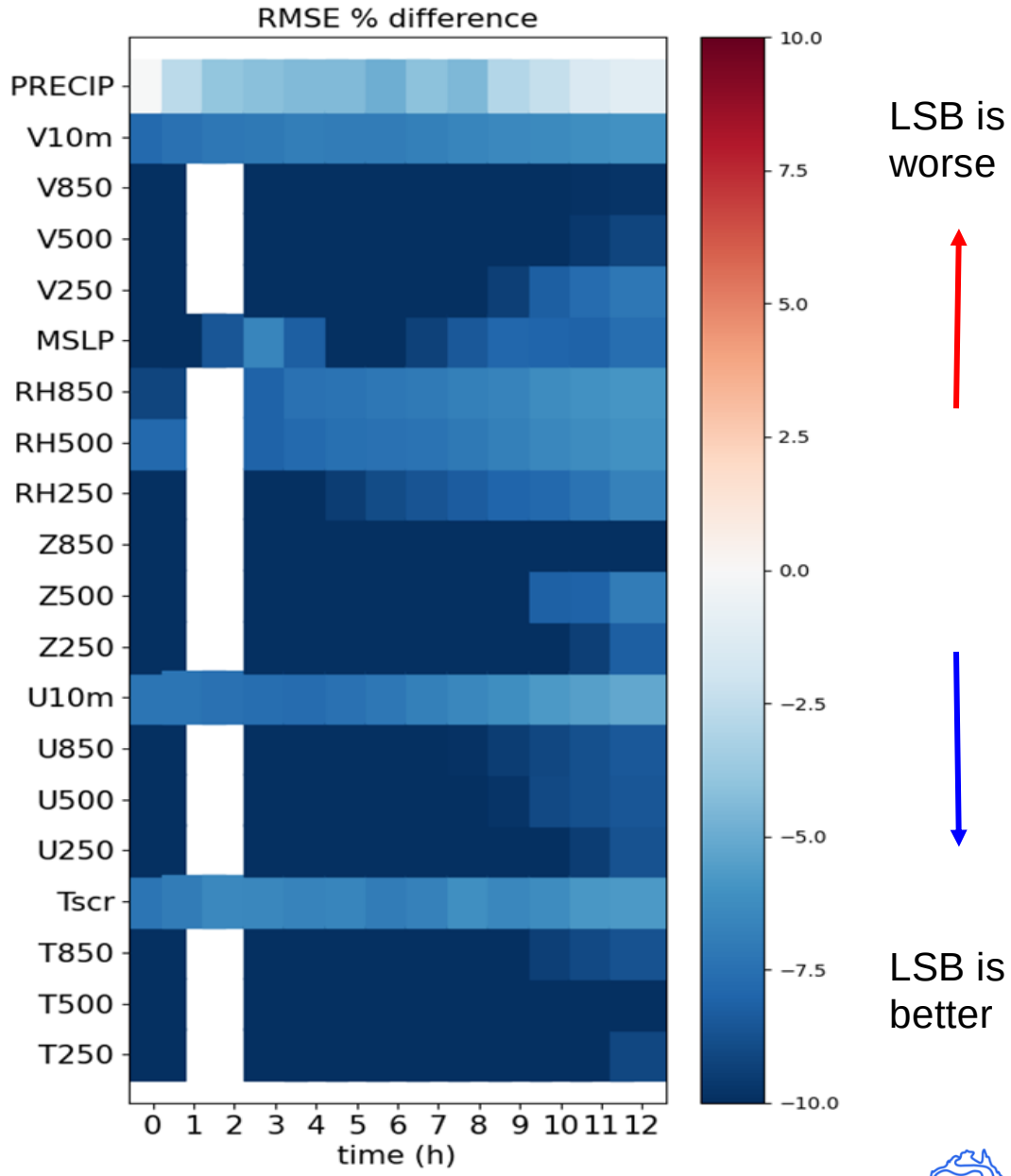
#1 Challenge

IT'S BIG

A lot of time spent on trying to make tasks computationally efficient, to fit a 1-hour cycle.

Large-Scale Blending

- A technique to blend large-scale information from the global model into the convective-scale model (BGIncs, Milan et al. 2023)
- Length scales > 700 km are nudged towards the global model
- LSB is implemented at the T+5 cycle after the global cycle, spinning up from a T+3 global dump
- Conducted 1-month trials in Austral winter and summer
- Verification included RES, and verifying forecast skill in the 0-12 h range using ERA5 reanalyses and observations. **Report forthcoming**
- LSB improves forecast skill compared to not using LSB across most model fields
- Adjusting relative humidity improved forecast skill compared to preserving relative humidity



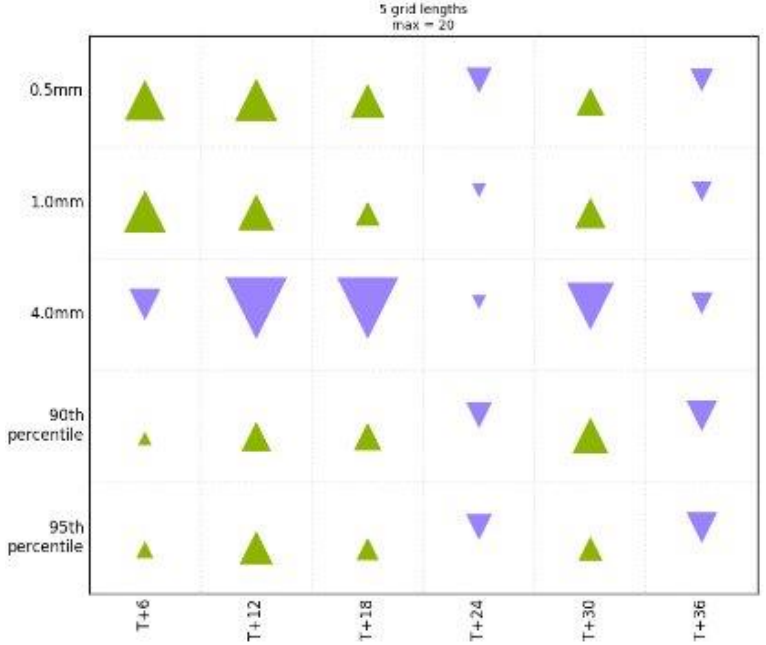
Milan, M., Clayton, A., Lorenc, A., Macpherson, B., Tubbs, R. & Dow, G.(2023) Large-scale blending in an hourly 4D-Var framework for a numerical weather prediction model. Quarterly Journal of the Royal Meteorological Society, 149 (755), 2067–2090. Available from: https://doi.org/10.1002/qj.4495

Satellite radiance observation processing

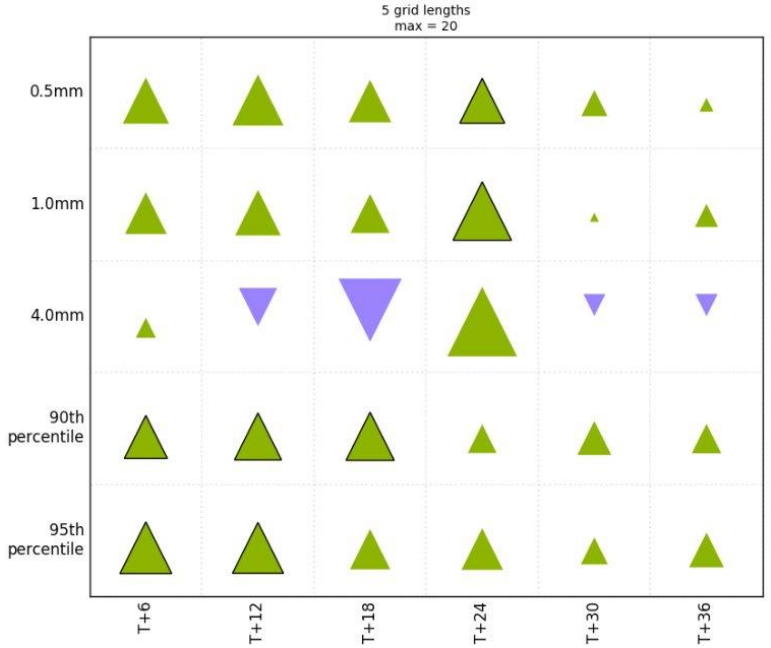
- Himawari BUFR file split by cloudy and clear observations (reduce cost in OPS)
- Thinning experiments using ACCESS-DN (RA1-T)
  - Spatially correlated errors
  - Tested original, 9, 30 and 70 km
  - 2% time reduction in VAR compared to original settings

Instrument	Original thinning distance
ATOVS	24 km
CrIS	60 km
IASI	60 km
AHIClr	12 km
ATMS	5 km

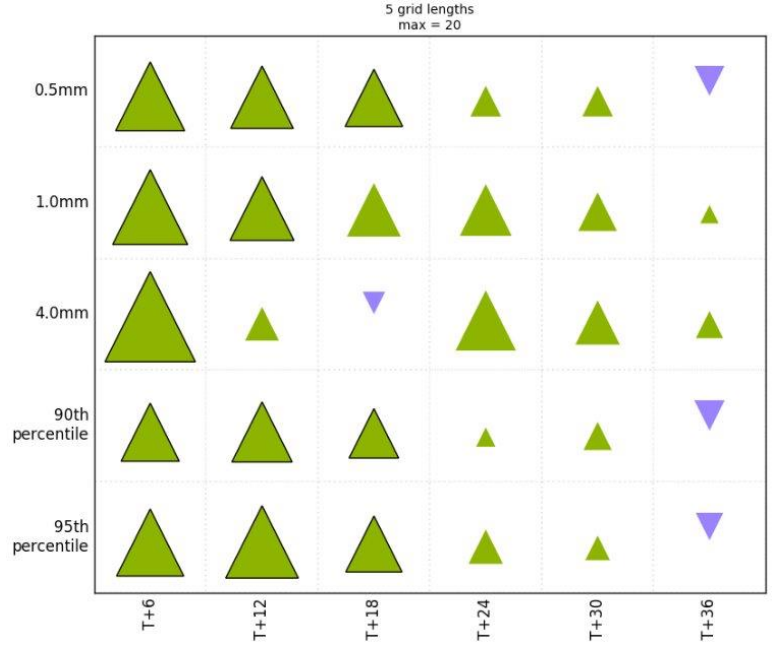
9 km



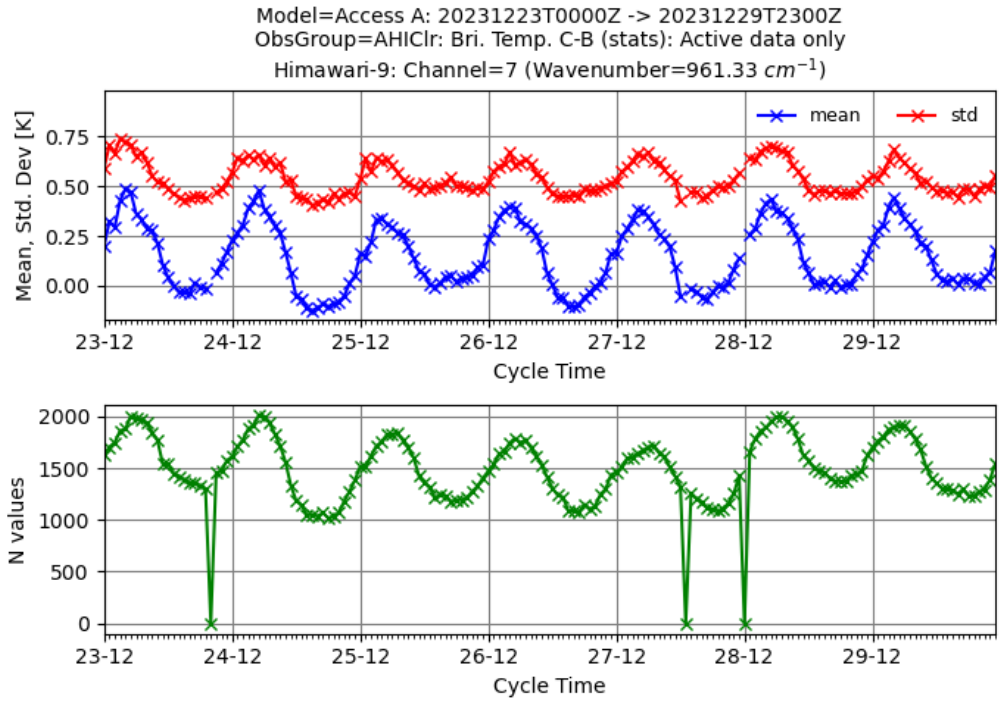
30 km



70 km

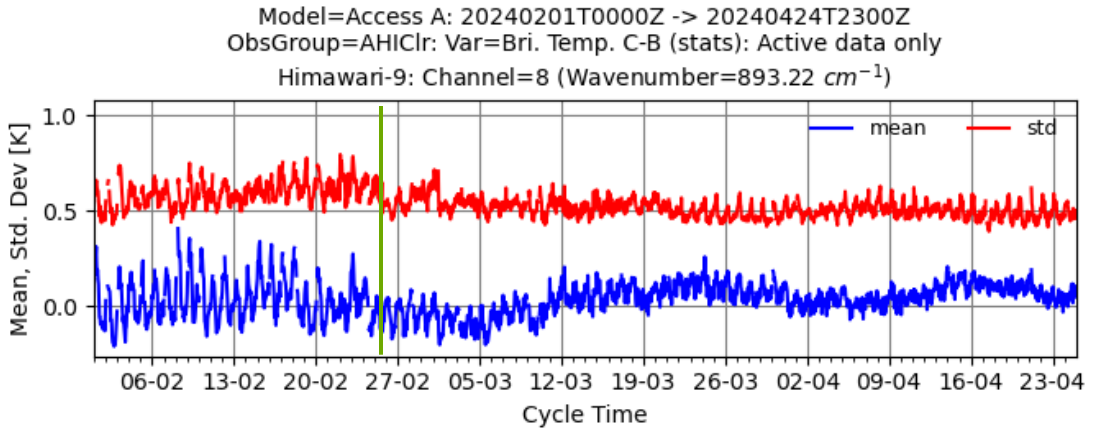


Geostationary Satellite DA with VarBC

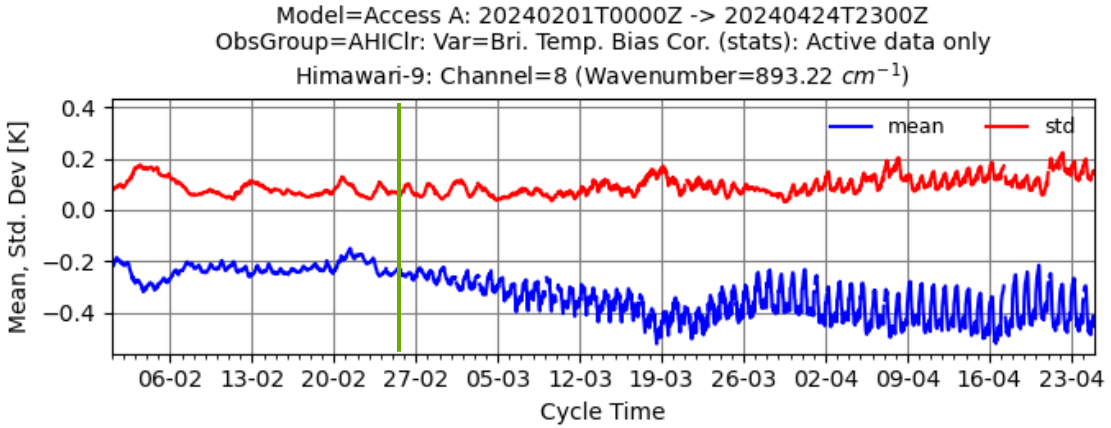


- Bias has a strong diurnal cycle
- VarBC doesn't currently have predictors to compensate, e.g. solar zenith angle
- Workaround is to use a separate VarBC file each hour of the day

Bias



Bias correction

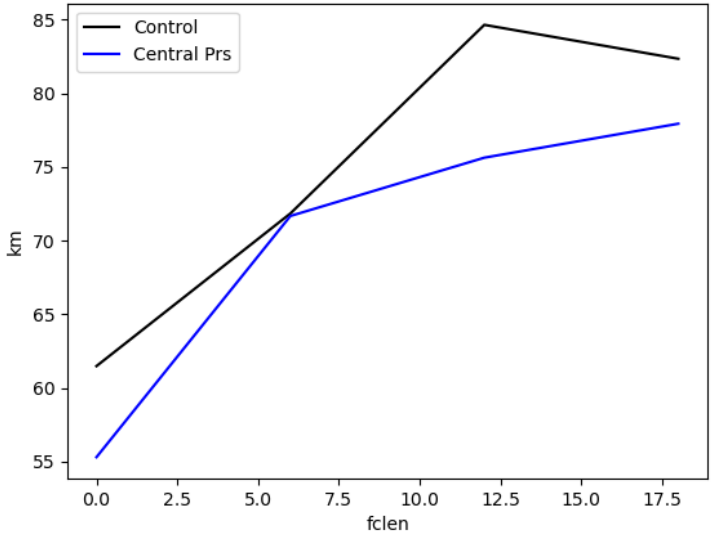


Andy Smith, Fiona Smith

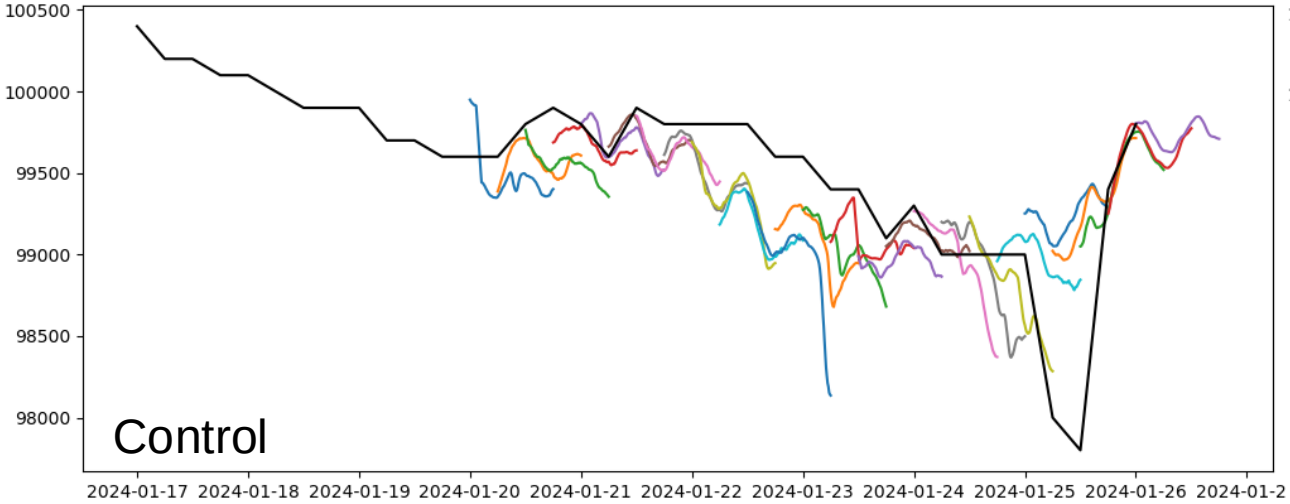
TC Bogus

- ACCESS-A does not deepen tropical cyclones enough
- Trialling of TC bogussing with a single central pressure over 3 cyclones (Jasper, Kirrily, Megan)
- Also tried a small vortex of pressures, but this did not work out well. The vortex is the wrong shape
- Recommended to use central pressure bogus for small positive or neutral impact
- Will require using TC forecast data as analysis data will be too late

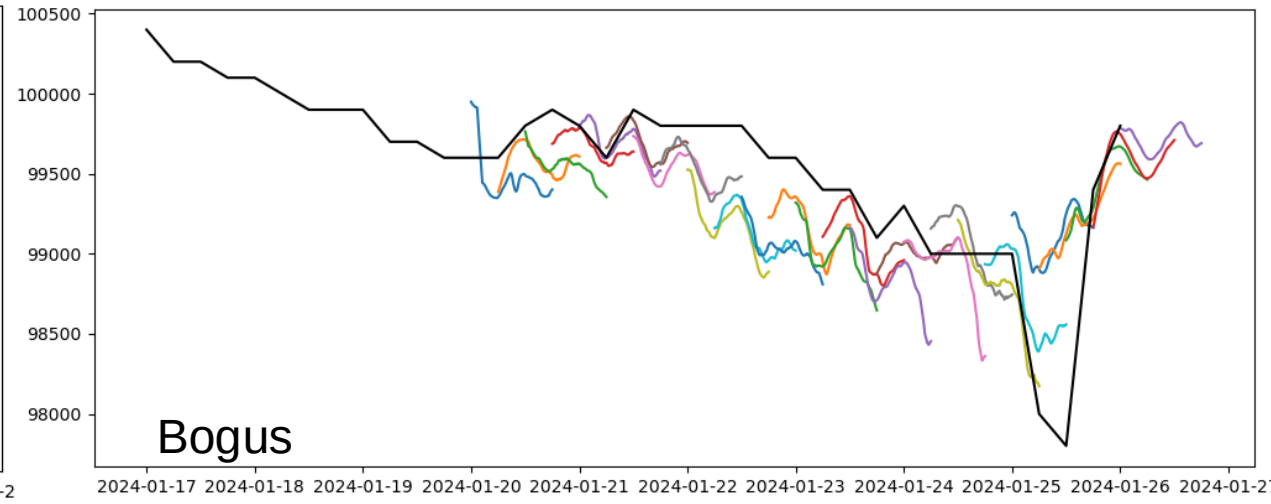
Kirrily mean track error



Kirrily central pressure

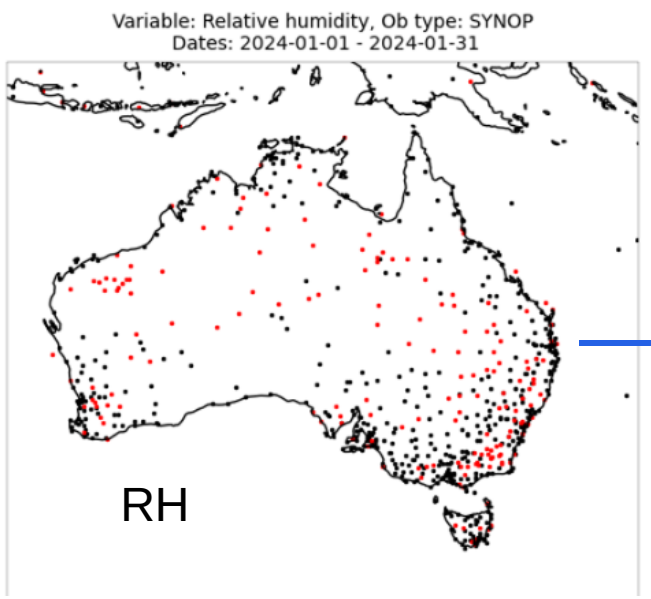


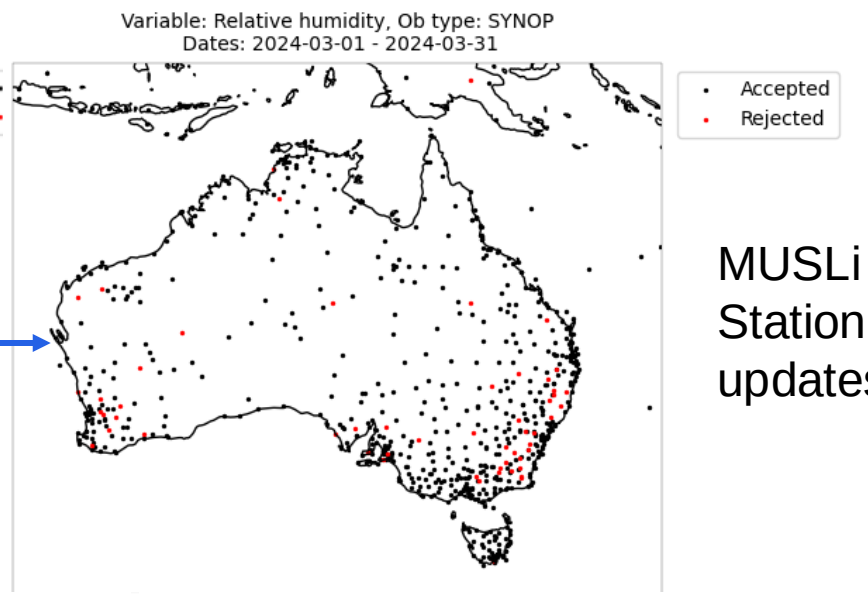
Kirrily central pressure



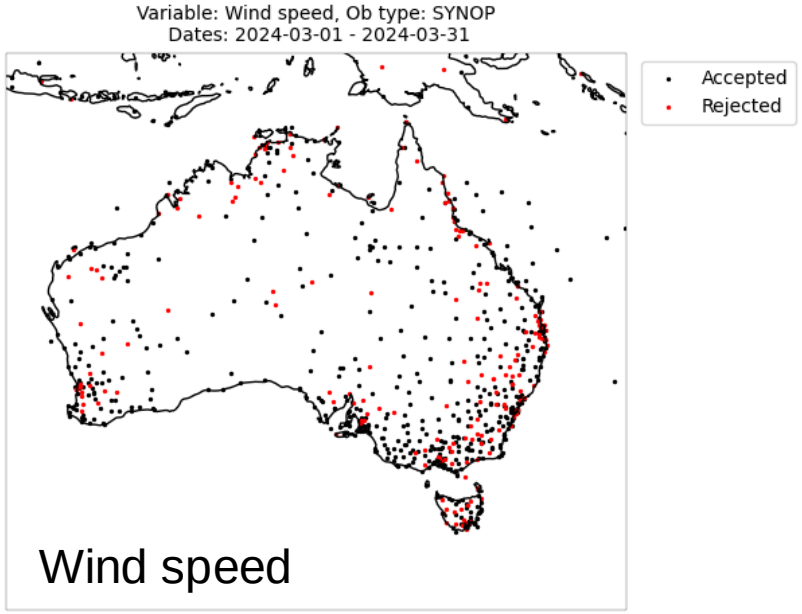
Susan Rennie, Tom Coleman

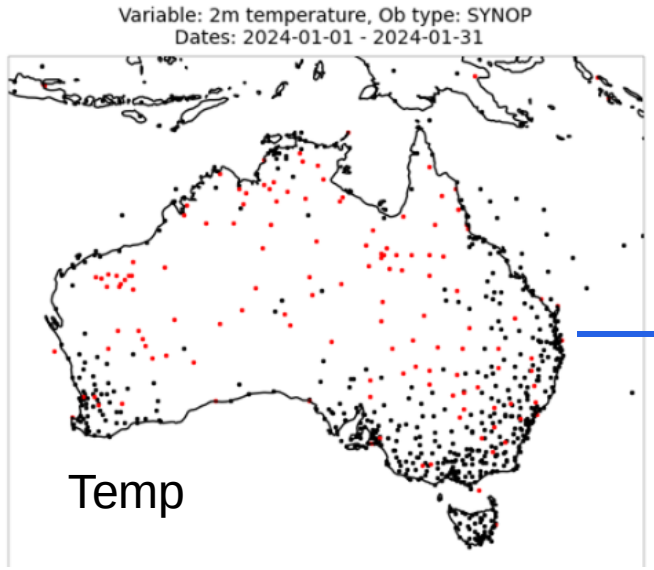
Surface observation handling

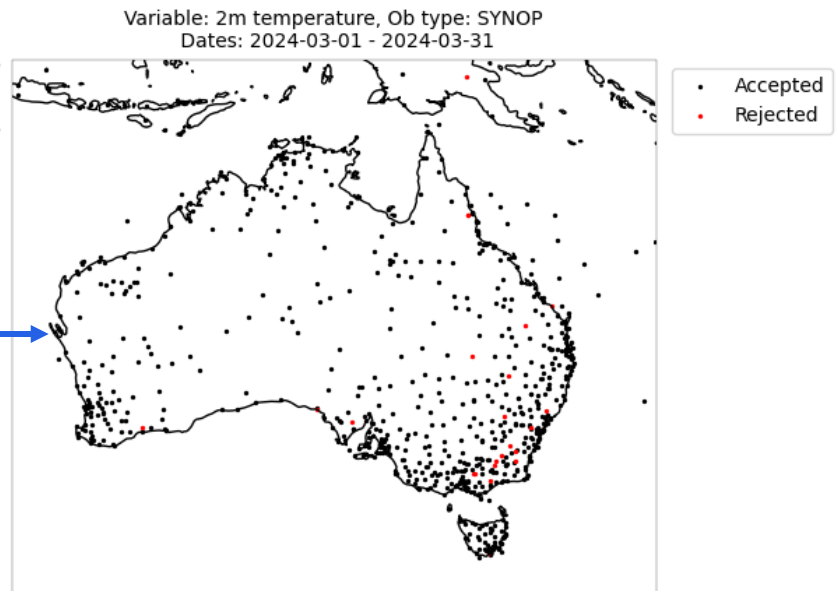


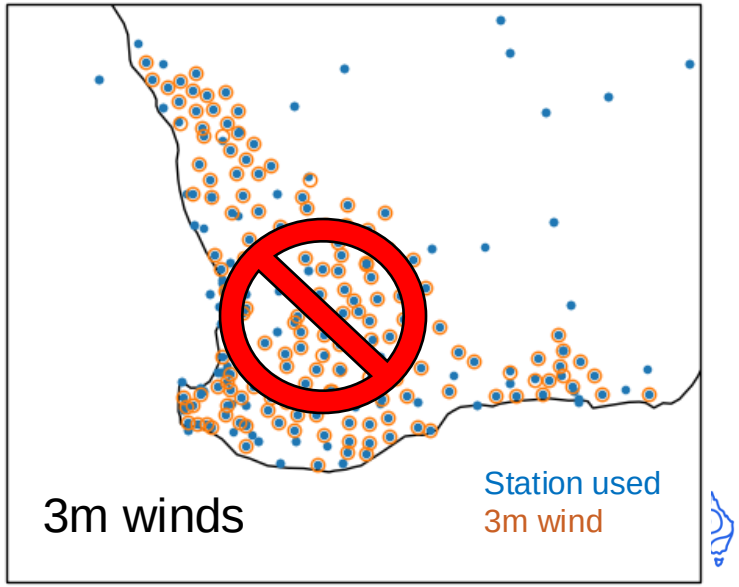


MUSLi StationList updates





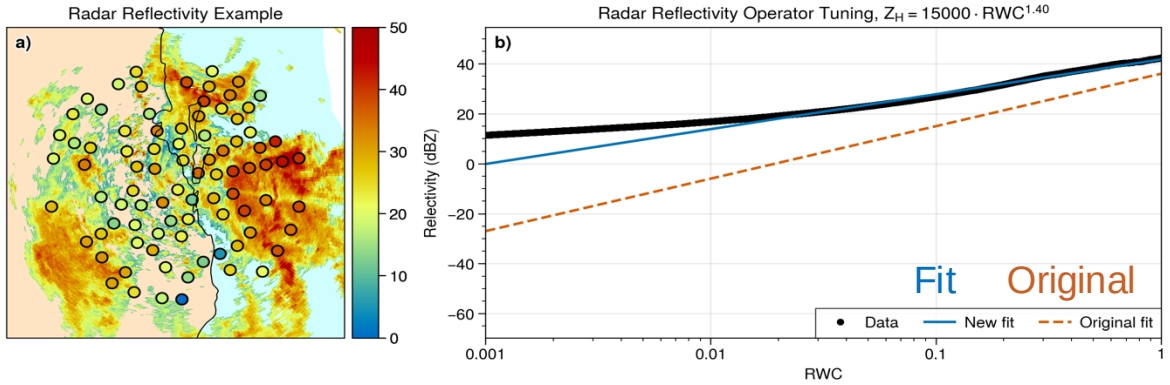




Susan Rennie, Chris Bridge

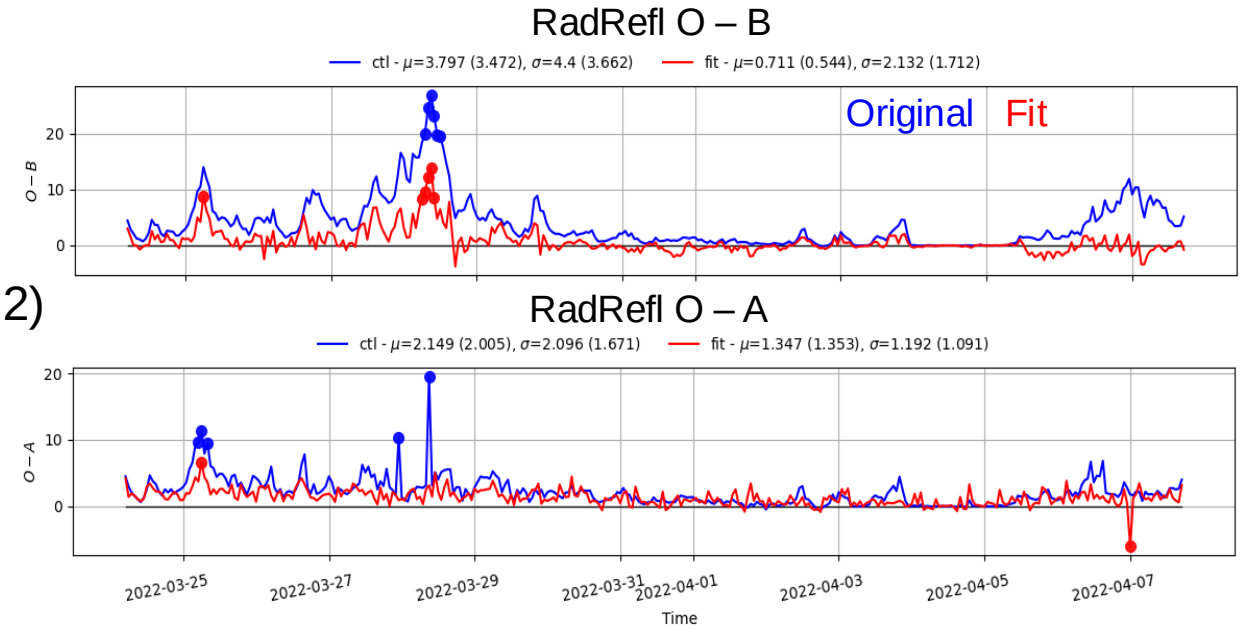
Radar Reflectivity Assimilation

1)

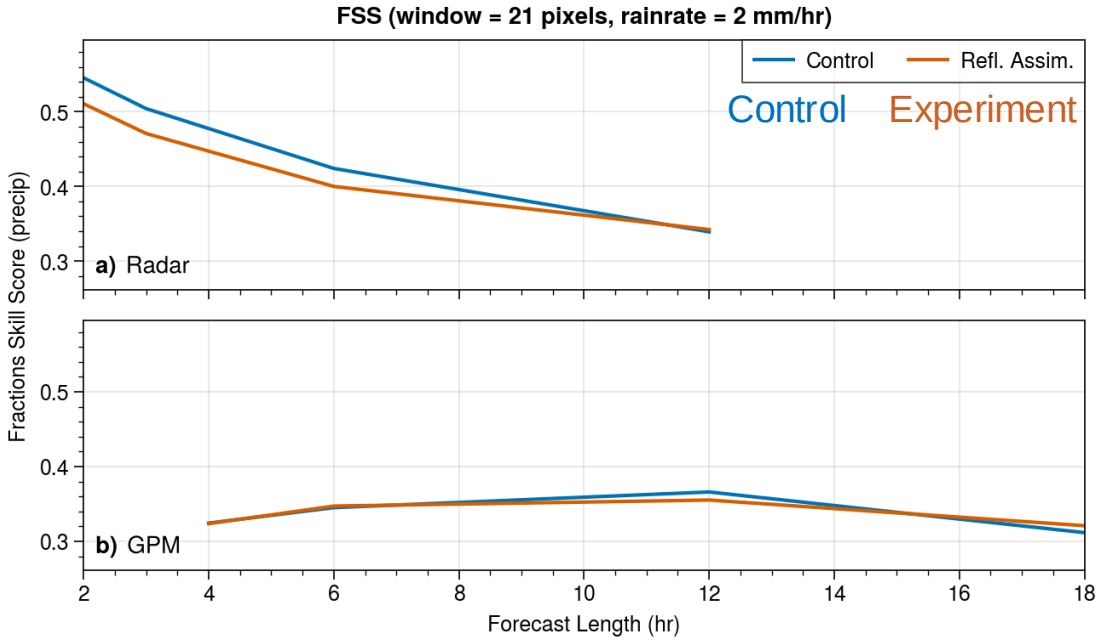


1) Tuning of observation operator equation (RAL3): $Z_H = C \times (RWC)^E$
2) More consistency between observed and model reflectivity → more effective assimilation
3) Replacing limited areas of LHN: Mostly neutral but positive (negative) impact for short range forecasts at larger (smaller) rain rates

2)



3)



Jordan Brook, Susan Rennie

What's next

- Summer and winter trials now started, to validate the system
- New observation tests planned next year
  - Locally generated AMVs
  - MODE-S aircraft observations
  - 3rd party AWS
- LSB review in the context of operational runtimes
- ACCESS-A1 handover mid-2025
- Future upgrades to ACCESS-A
  - JOPA
  - LFRic (no LHN)
  - Various possible satellite DA upgrades
  - …