Met Office

AMV superobbing

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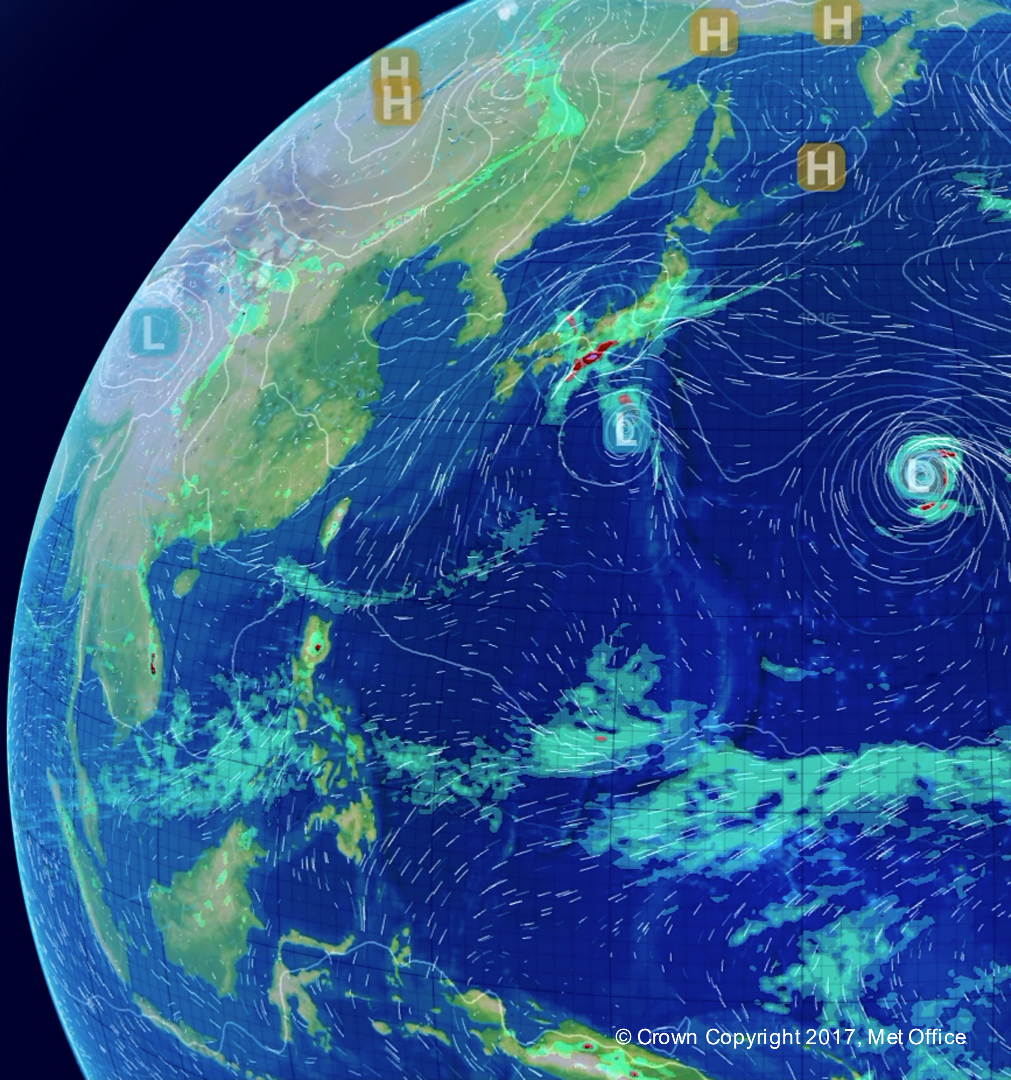
IWW15, April 2021



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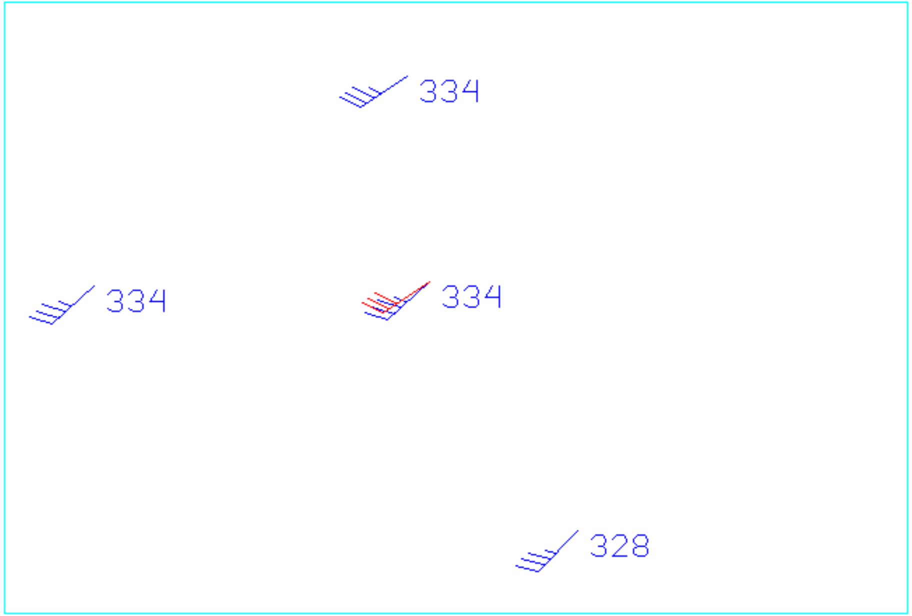
Stepping back in time

Superobbing scheme developed at the Met Office by Howard Berger in 2002-03 (VS mission from UW-CIMSS to the Met Office)

- Alternative to thinning
- Enables greater use of high density observations that cannot easily be assimilated at full resolution because of spatially and temporally correlated errors.
- Should reduce random error
- Averaging the innovations is safer than averaging the observations. Less likely to average out features in regions of wind shear.

Introduction to AMV superobbing



1. Sort obs into boxes e.g. 200 km, 100 hPa, 2 hour
2. Sum the u and v innovations (O-Bs) for all obs in the box passing QC and calculate the mean
3. Find observation closest to average position. Add mean u/v innovation to the background value at that observation location.

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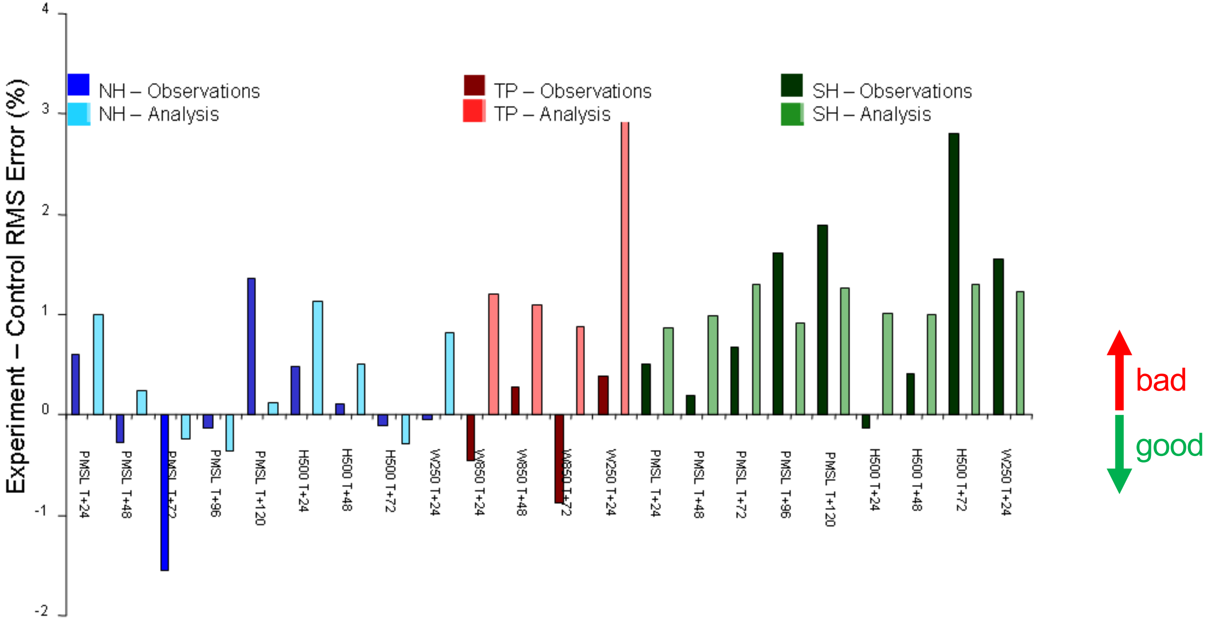
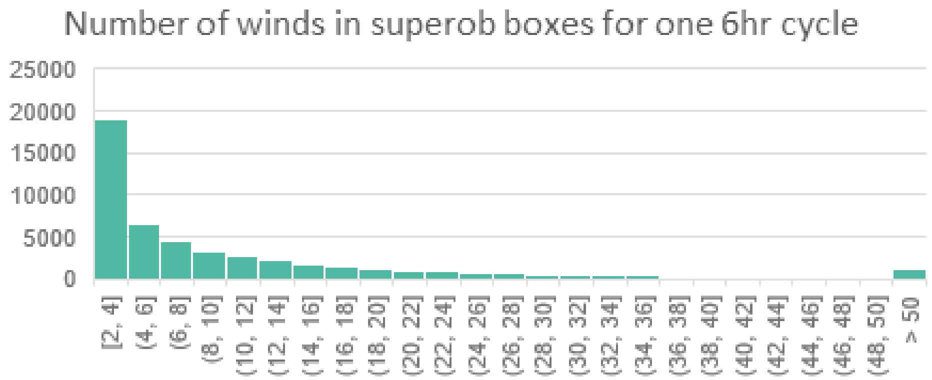
Superobbing trial results

Trials in 2003 showed slightly negative impact and the work was put on hold. At the time we were reducing the observation errors for the superobbed winds. It was thought we were probably reducing them too much; the plan was always to revisit……



15 years later!

We now have higher density data – more potential for superobbing approach?



200 km x 200 km x 100 hPa x 2 hr superob box
Applied 70N-70S

Majority of superob boxes have only a few observations, but some have more than 50!

- Run a trial without reducing observation errors for the superobs.
- Apply in region 70N-70S. Elsewhere use thinning

Work undertaken by Adam Martins who joined the group on secondment for a year.

<u>Trial details:</u>

- 3 months, 4 Jul – 30 Sep 2017
- PS41 baseline
- N320, 70 levels global, N216/N108 uncoupled hybrid 4D-Var

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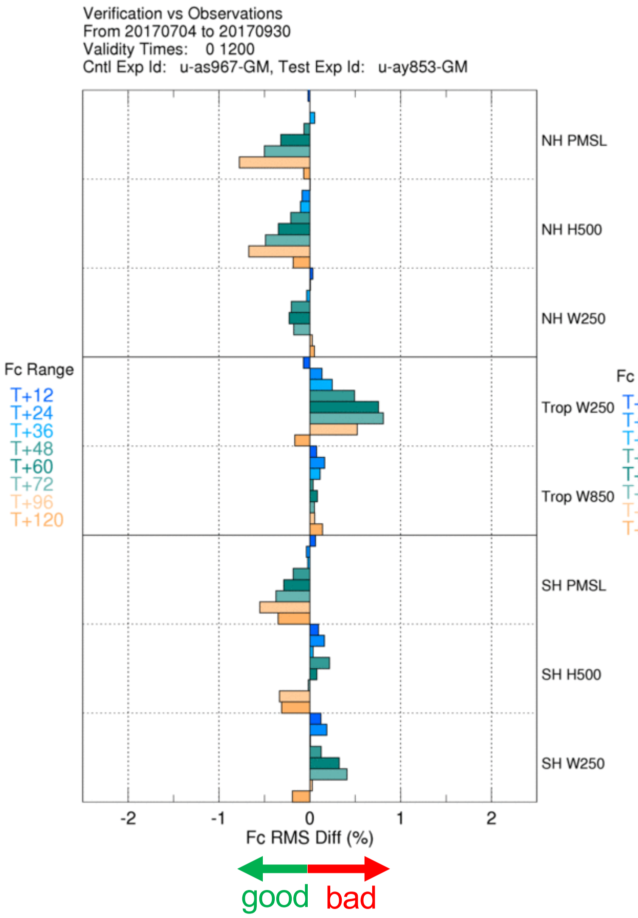
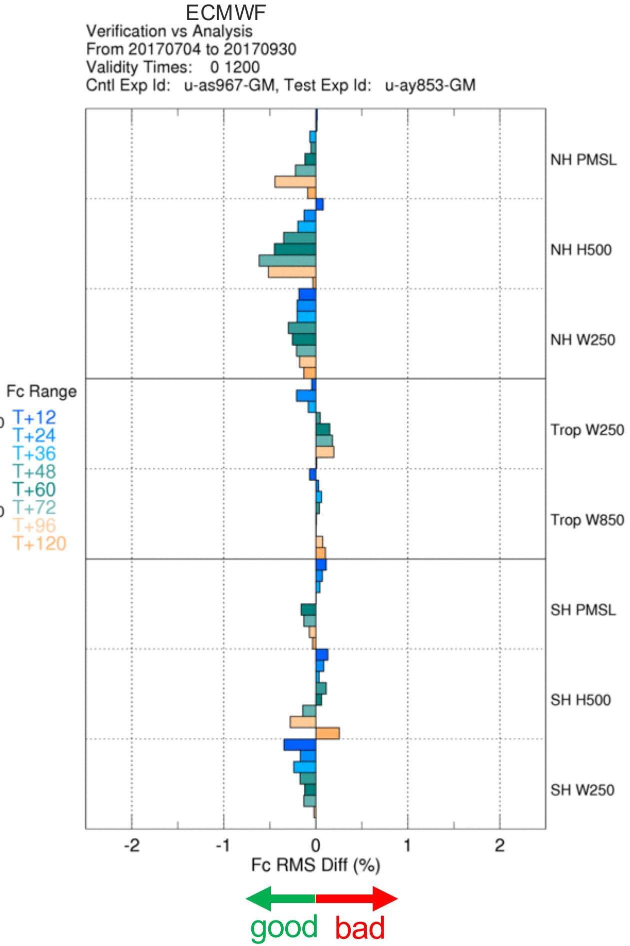
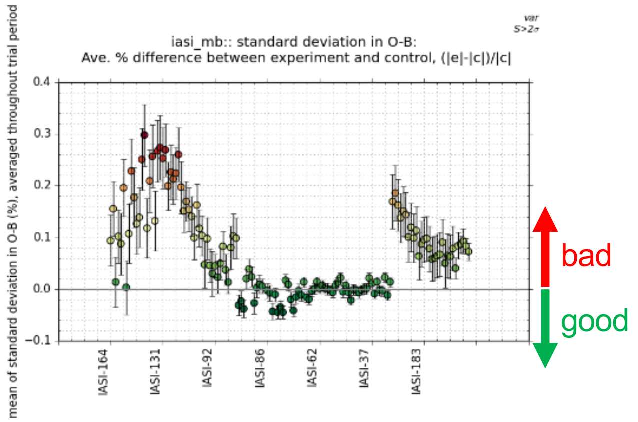
Evaluation





Overall some small but encouraging signs, fit to AMVs improved by about 10%, but fit to some obs slightly worse e.g. IASI.



Slight concern remains at how well the superobbing handles boxes with more wind shear.

Should we fall back on thinning in these cases?

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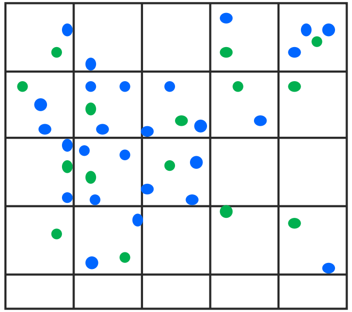
Where next?

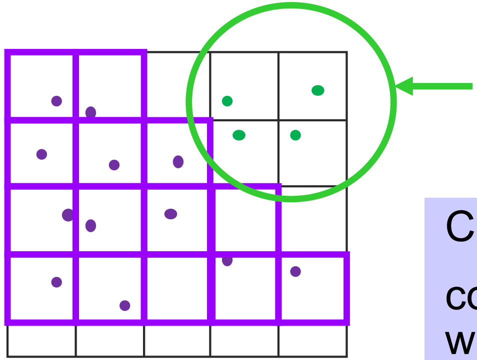
Dynamic thinning/superobbing



Step 1: Thin everywhere

200 km, 200 hPa, 2 hr

- Selected by thinning
- Rejected by thinning



Fall back on thinning in these boxes

Step 2: Superob round applied to some boxes (purple)

200 km, 100 hPa, 2 hr

- Selected by thinning
- Superob

Criteria for step 2:

could look at variability of wind speed/direction in box, ensemble output ++

Likely to be dynamically interesting areas e.g. jets, regions of circulation…

SuperobThin

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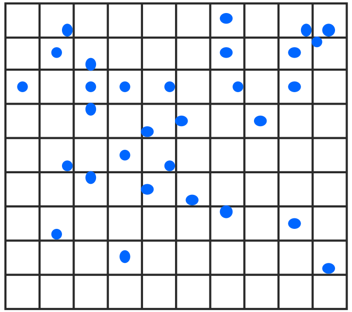
Where next?

Dynamic thinning/superobbing

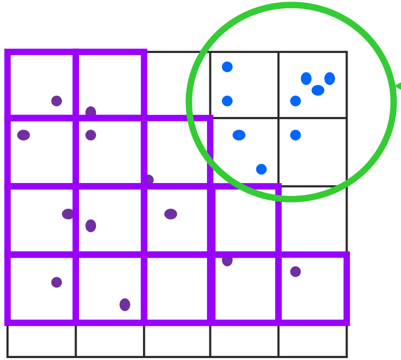
We could take this one step further to look at using the data at higher density in these regions of interest.



Step 1: thin everywhere

100 km, 100 hPa, 1 hr

Inflate errors?



Step 2: coarser superobbing round applied to some boxes (purple)

200 km, 100 hPa, 2 hr

Assimilating at higher resolution in region of interest

SuperobFineThin

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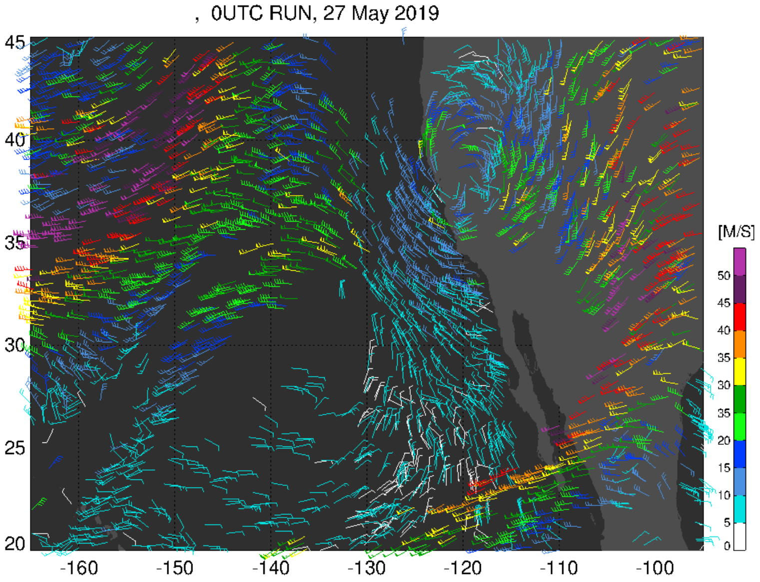
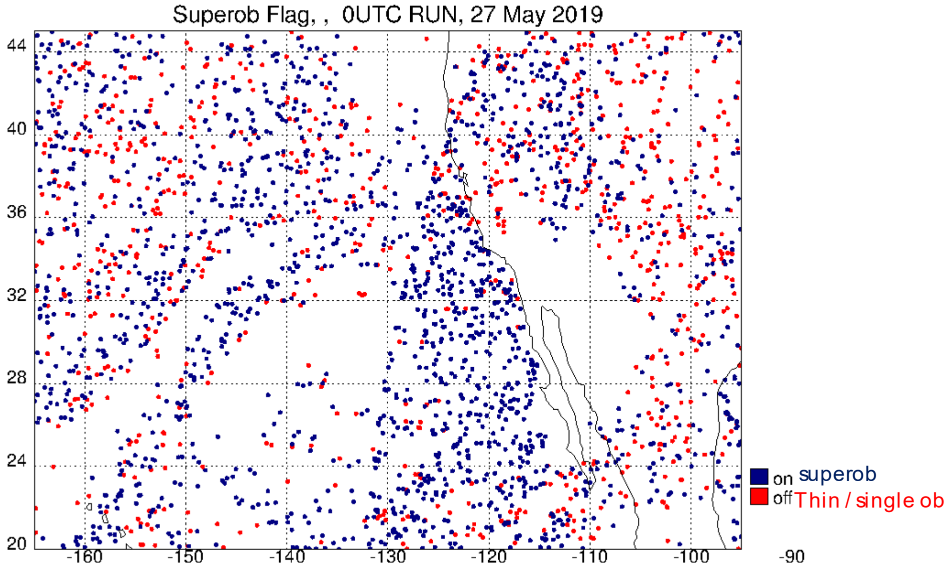
Motivation

- Scientific curiosity
- To make more use of the AMV data (we currently throw over 90% away).
- Can we improve forecasts by using AMVs and/or other observations at higher density in regions of interest (dynamically interesting or poorly constrained regions)?
- To inform strategy for NWP requirements for AMV derivation. Could we benefit from higher density datasets (everywhere / some places?) or are they likely to cost more (in production, storage, processing) and we end up throwing most away.

SuperobThin





Initial test applying thinning at 200 km, 100 hPa, 2 hr everywhere and replacing with 200 km, 100 hPa, 2 hr superobbing in regions with less wind variability (sd speed < 3.5 m/s, sd direction < 20 degrees)

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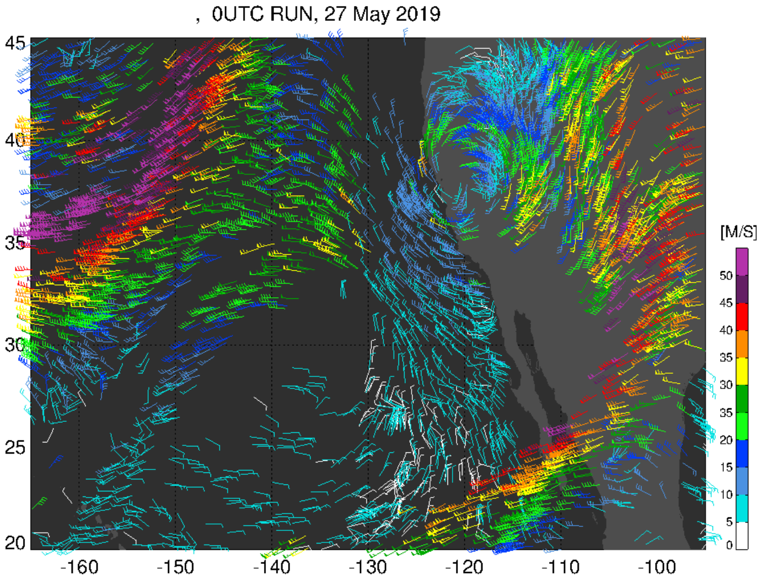
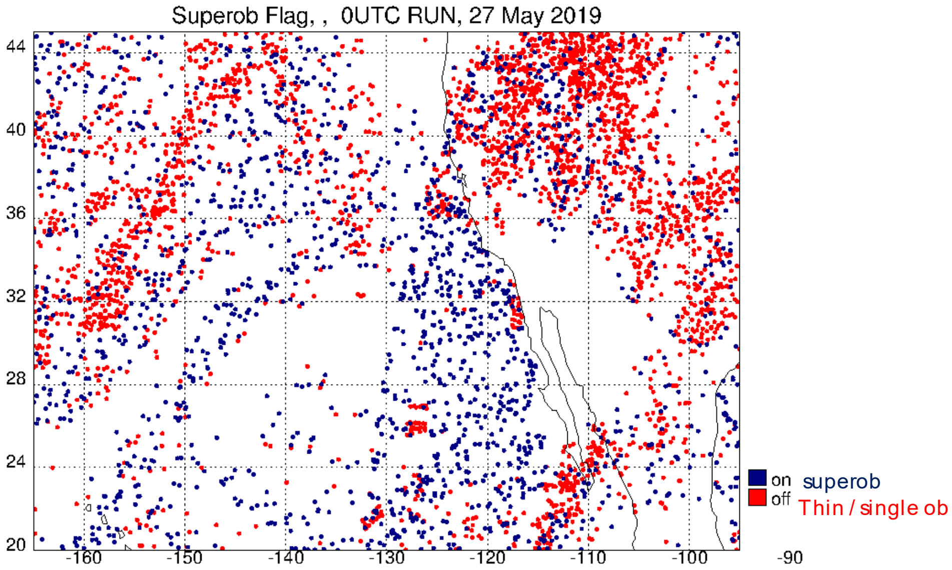
SuperobFineThin





Initial test applying thinning at 50 km, 50 hPa, 1 hr everywhere and replacing with 200 km, 100 hPa, 2 hr superobbing in regions with less wind variability (sd speed < 3.5 m/s, sd direction < 20 degrees)

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Assimilation trials

Started running assimilation trials for

1) Superob – normal superobbing
2) SuperobThin - fall back on thinning when criteria met
3) SuperobFineThin – fall back on thinning when criteria met, thinning round at higher resolution

Criteria to fall back on thinning, any one of following:

- Standard deviation of wind speed in box > 3.5 m/s
- Standard deviation of wind direction in box > 15º
- Vector difference between superob and original ob > 7 m/s

Thinning box size - Control

- 200 km, 100 hPa, 2 hr

Thinning box size - SuperobThin

- 200 km, 100 hPa, 2 hr

Thinning box size - SuperobFineThin

- 100 km, 50 hPa, 1 hr

Superob box size (in all experiments)

- 200 km, 100 hPa, 1 hr

- Based on PS43 baseline
- 3 month trial: 23 Aug 2019 – 11 Nov 2019
- N320, 70 levels global, N216/N108 uncoupled hybrid 4D-Var

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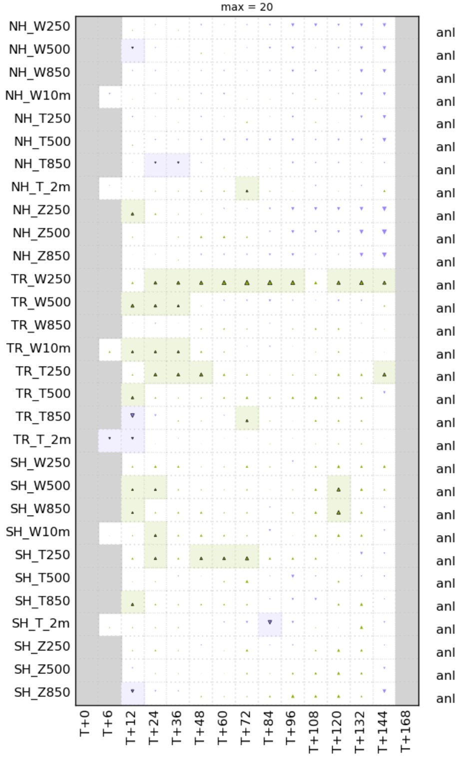
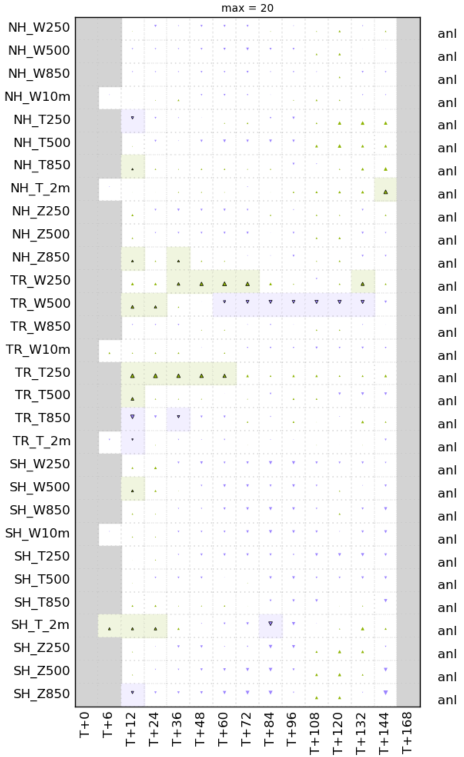
CAUTION: Very preliminary evaluation (< 1mon) vs ECMWF

Superob



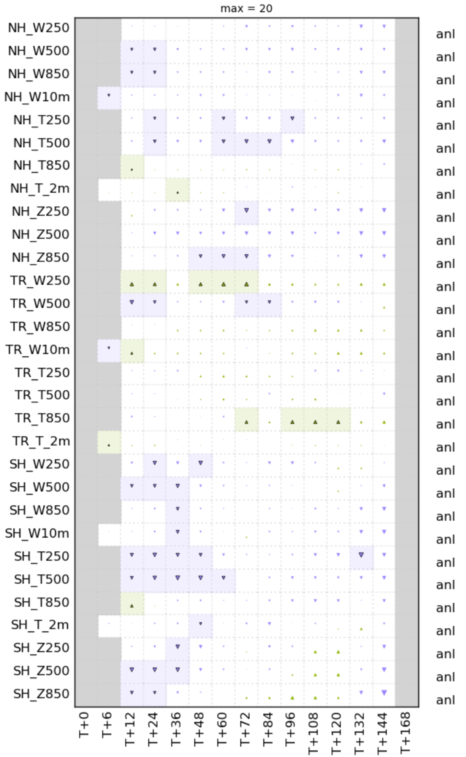
Fit to AMVs better by 9%
Fit to other obs slightly worse

SuperobThin



Fit to AMVs better by 7%
Fit to other obs fairly neutral

SuperobFineThin



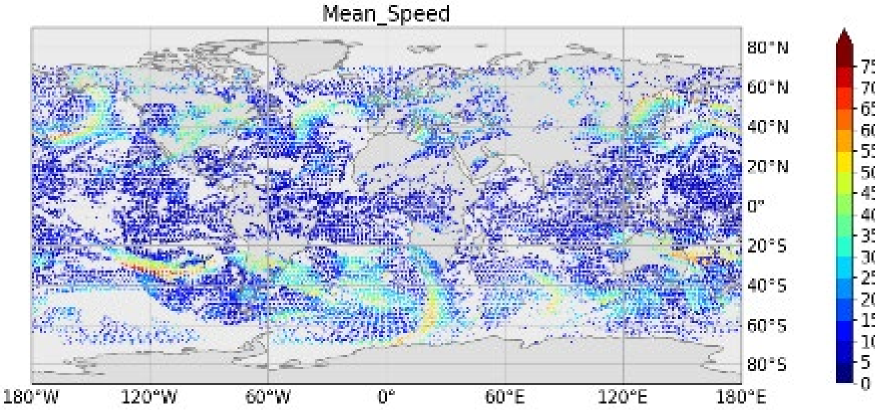
Fit to AMVs worse by 9% (27% more AMVs assimilated)
Fit to other obs slightly worse

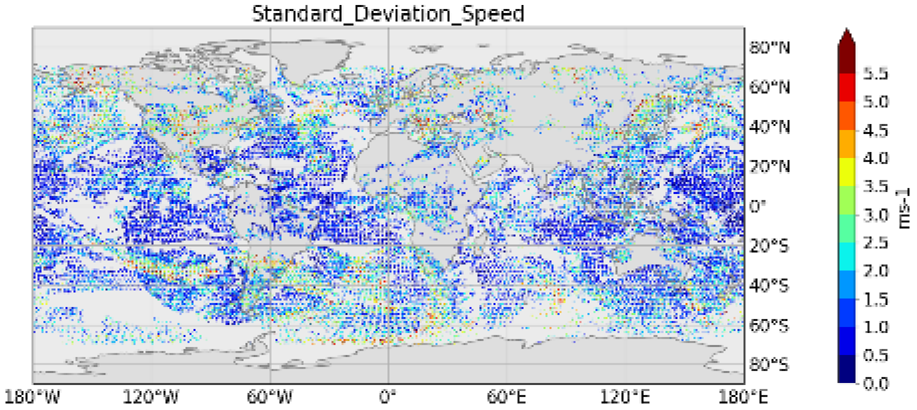
Talk Summary

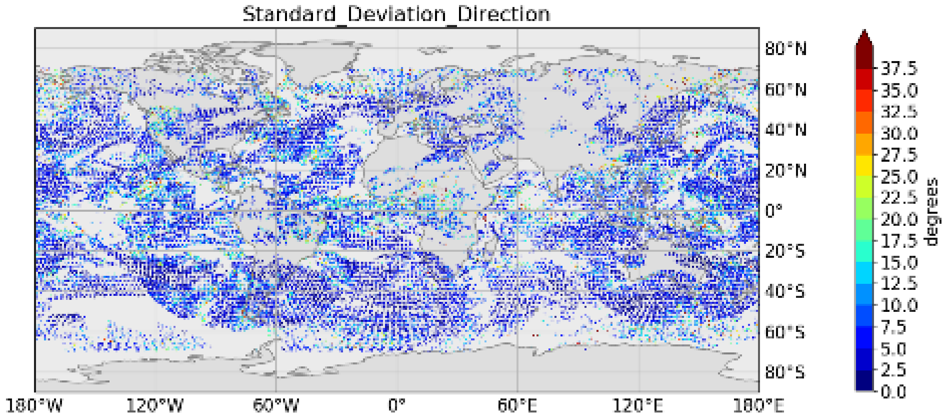
1. Superobbing scheme developed at the Met Office in 2002-03, but gave slightly negative impact.
2. More recent trials without reduced observation errors were more encouraging, but not quite there.
3. We have developed a basic scheme to use combined thinning and superobbing, including option to use data at higher density in regions of interest.
4. Preliminary trials underway. Suspect we might find a configuration that gives a small benefit to superobbing (particularly in combination with thinning).
5. Using AMVs at higher density in regions of interest likely to need some refinement!

Spare slides

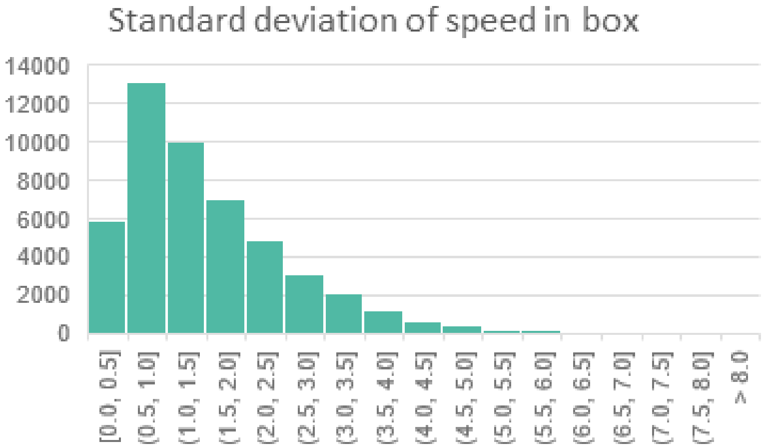
Wind statistics in superob boxes

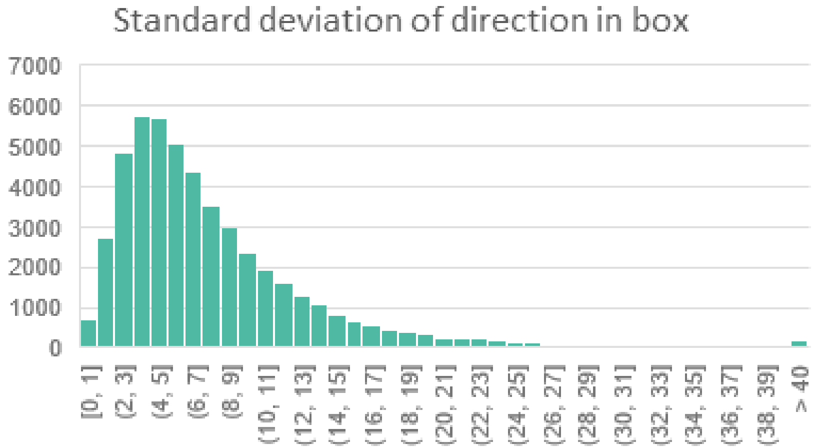






Wind variability in superob box





Observations in superob box have already passed blacklisting and background checks. Most show relatively low variability of speed and direction within the superob box.

We could define thresholds above which thinning is used instead

Data denial study