Met Office

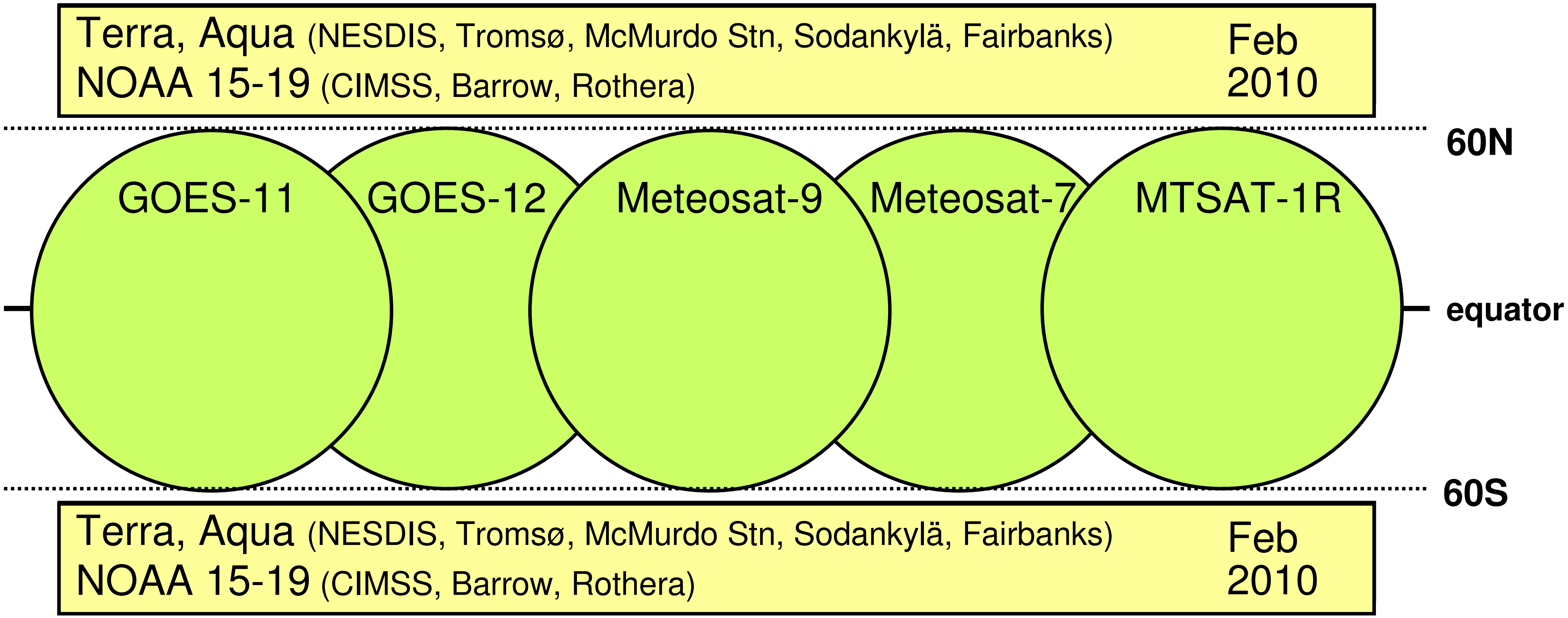
Improving AMV impact in NWP

Mary Forsythe, James Cotton and Roger Saunders

10th International Winds Workshop, 22-26 February 2010

Met Office AMV usage

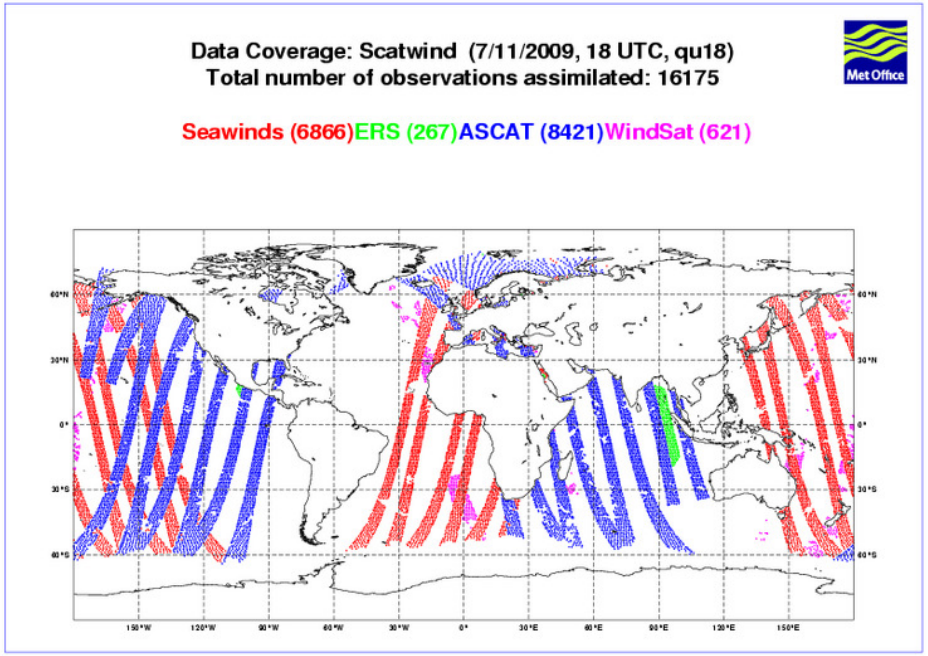
Changes since the 9th International Winds Workshop

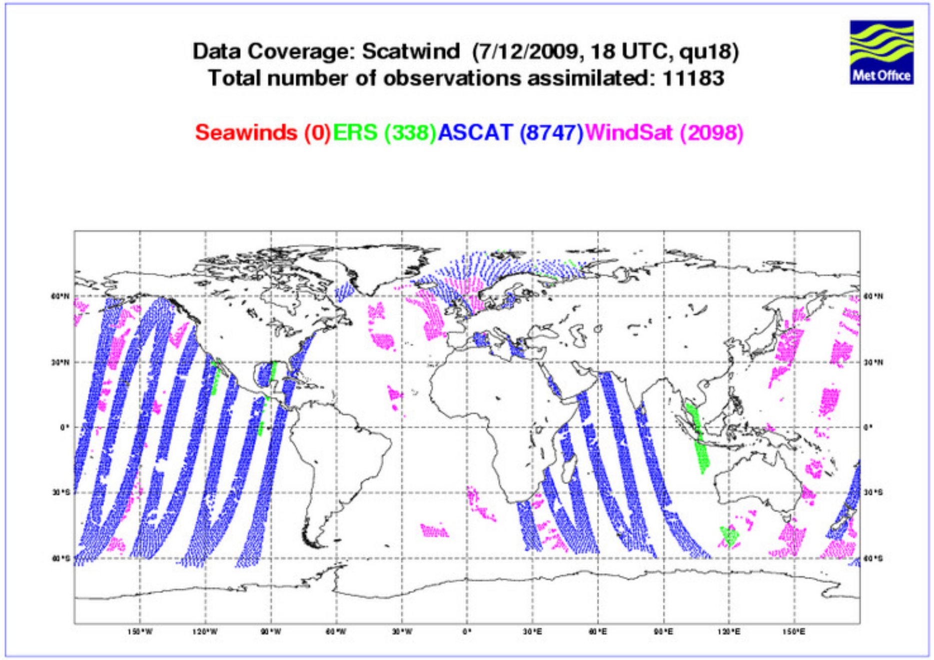


Assimilation Changes

- Jul 08: New observation error scheme
- Nov 09: Stricter, symmetric background check

Met Office surface wind usage





Nov 2008: Started assimilating WindSat winds

Nov 2009:

Demise of Seawinds

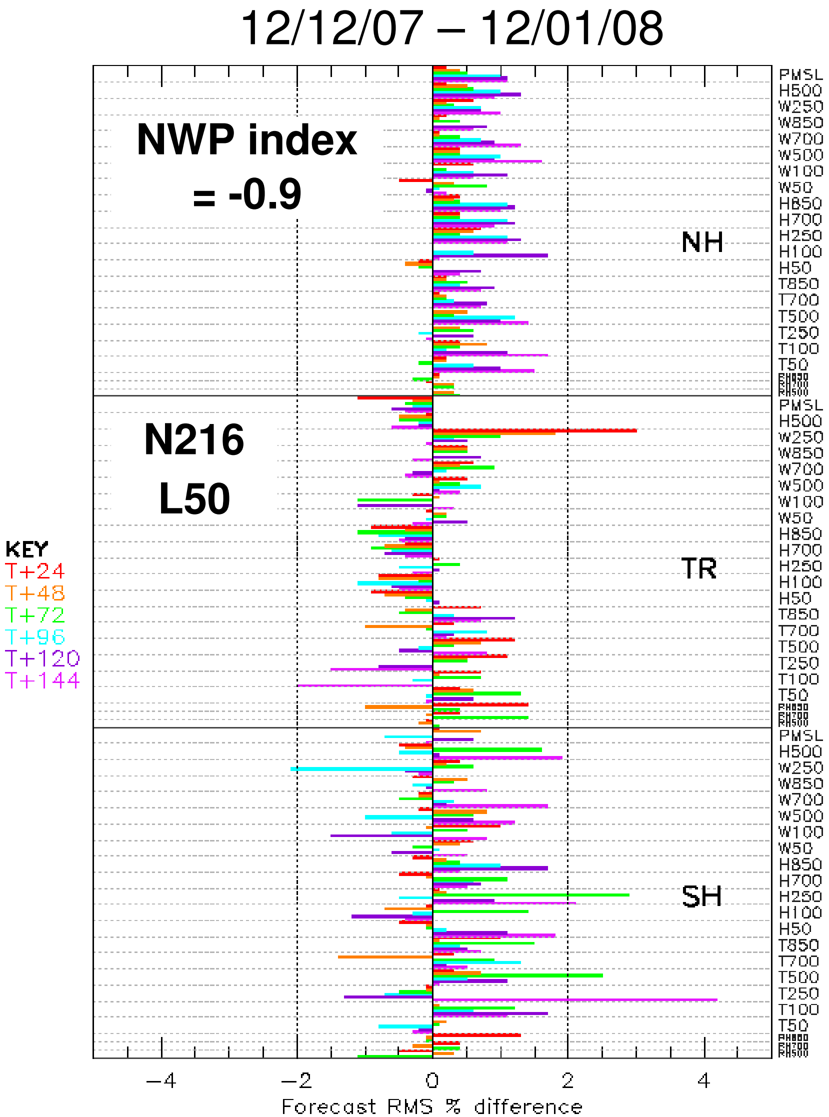
WindSat helps to fill holes in scatterometer coverage

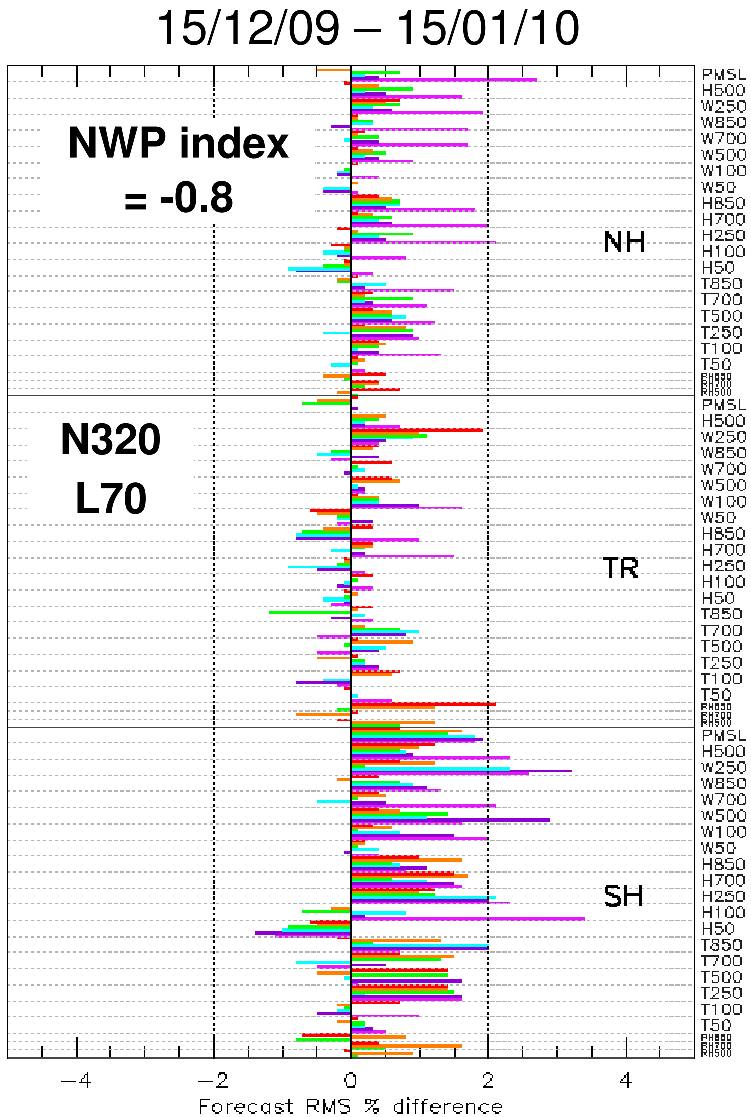
James Cotton looks after this work at Met Office

AMV data denial trials

Verification versus observations

good





Contents

This presentation covers the following areas

- New AMV datasets – improving the coverage
- New AMV datasets – for high resolution NWP
- Options for improving the AMV assimilation
- Summary

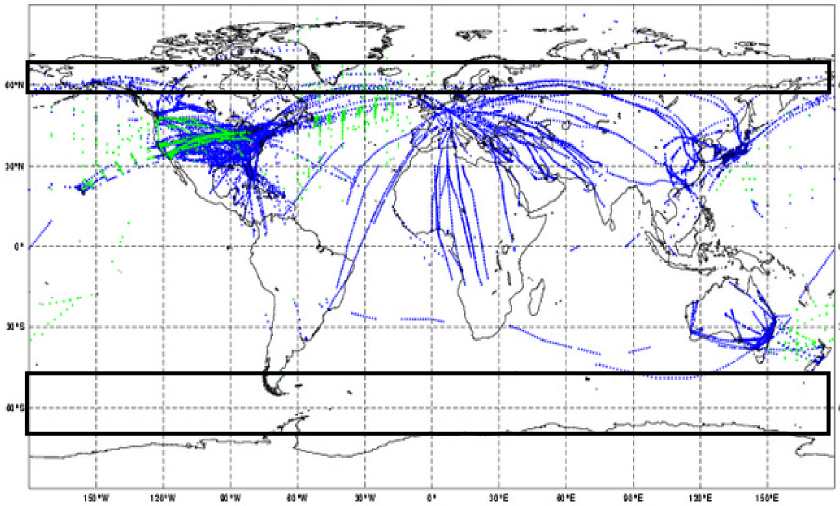
Met Office

New AMV datasets

Improving coverage

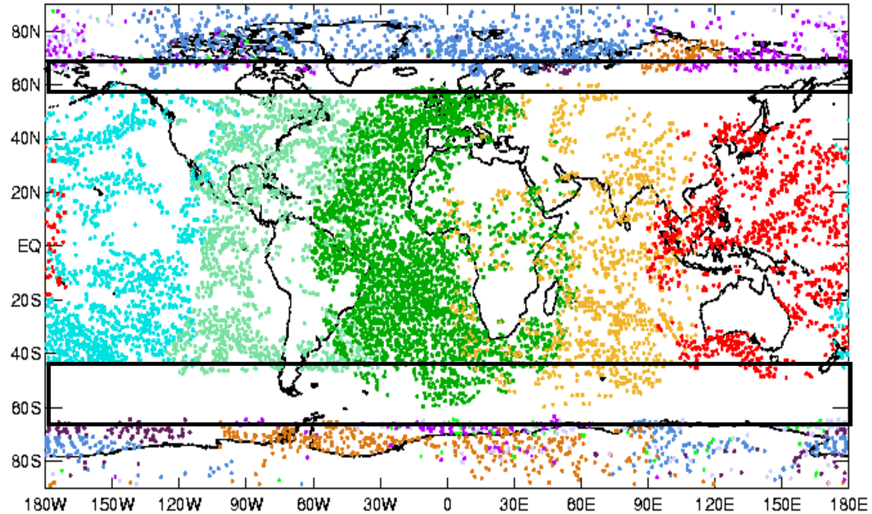
Closing the gap...

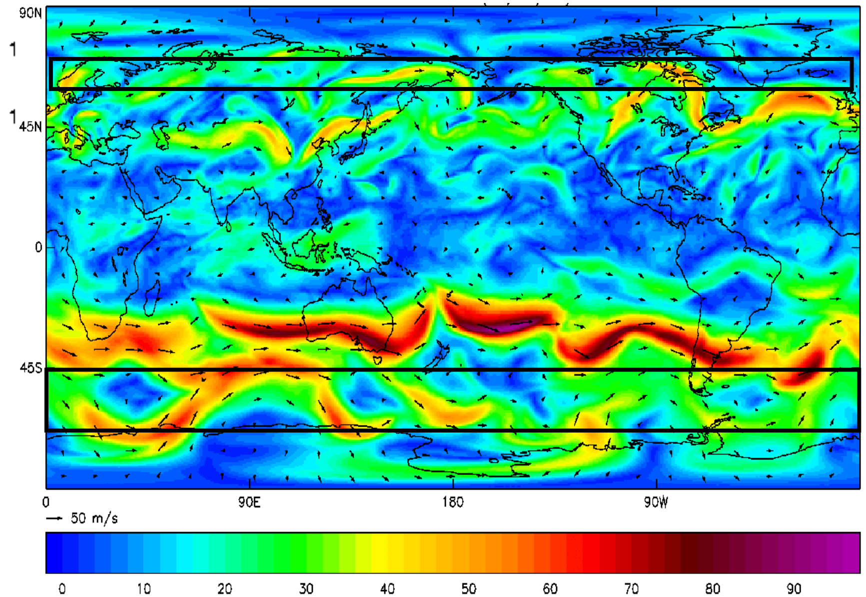
Incentive: not much other wind data in AMV data voids.



Useful for constraining polar front jets.

Location of used AMVs, all levels, 18z 08 July 2008

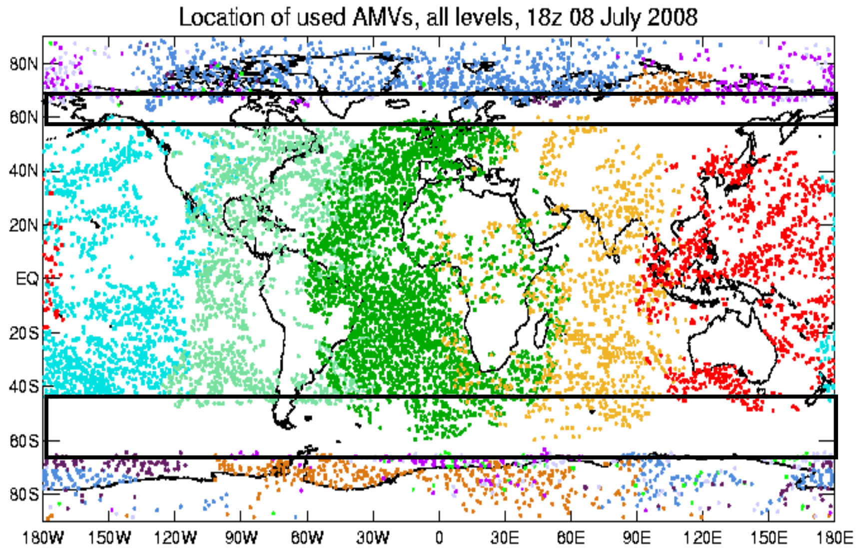




Closing the gap...

Possibilities:

- Increased geostationary coverage
  GOES in SH

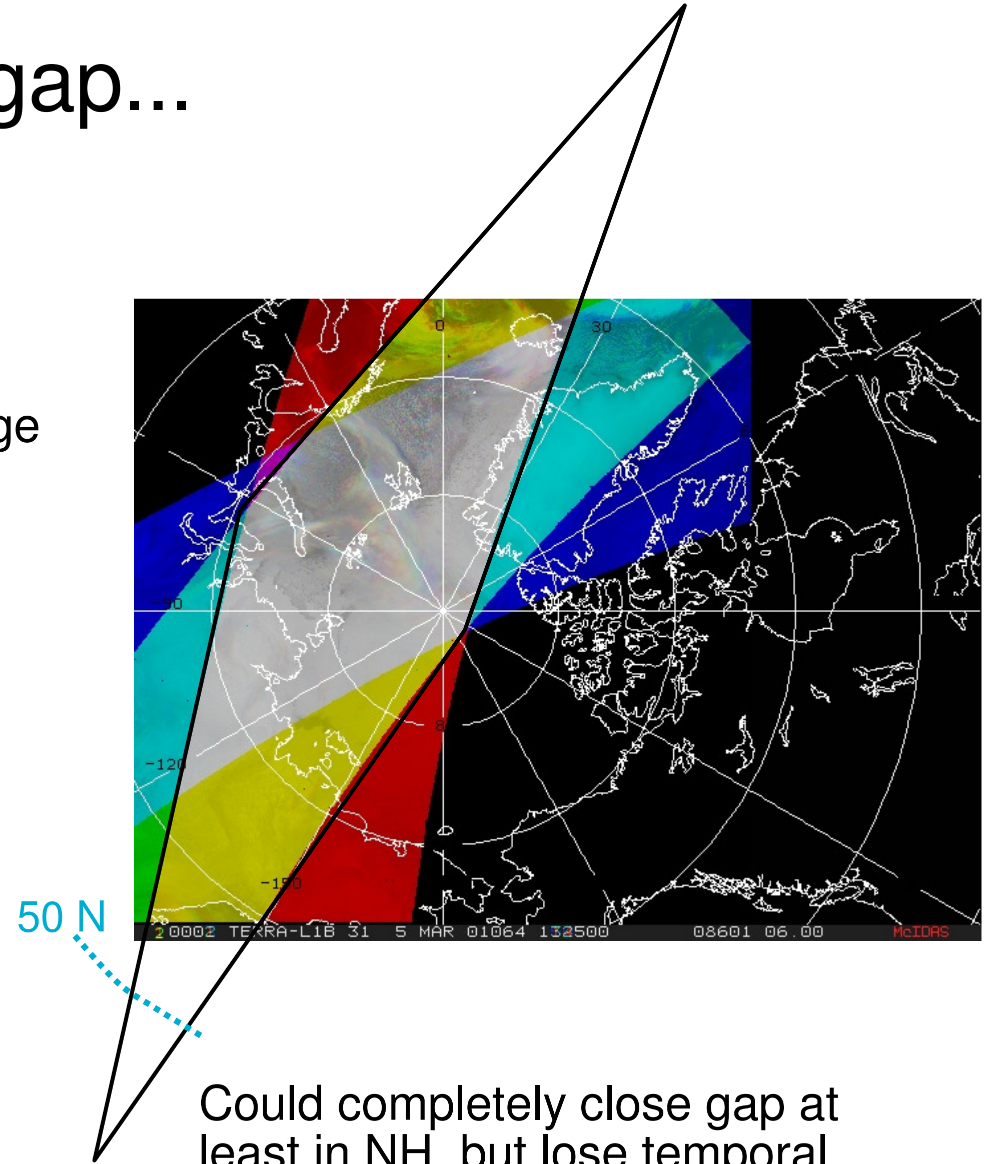


Closing the gap...

Possibilities:

- Increased geostationary coverage
  GOES in SH

- Polar winds using only 2 images
  Metop AVHRR

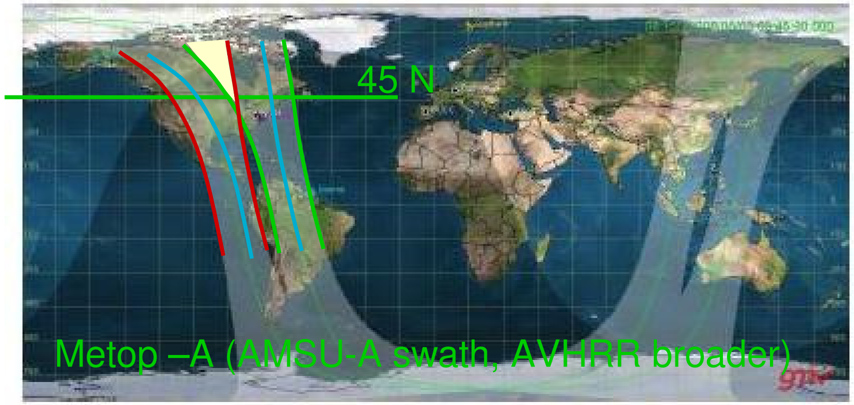


Could completely close gap at least in NH, but lose temporal quality checks between derived vectors

Closing the gap...

Possibilities:

- Increased geostationary coverage
  GOES in SH
- Polar winds using only 2 images
  Metop AVHRR
- Multi-satellite polar winds e.g. Metop-A and Metop-B



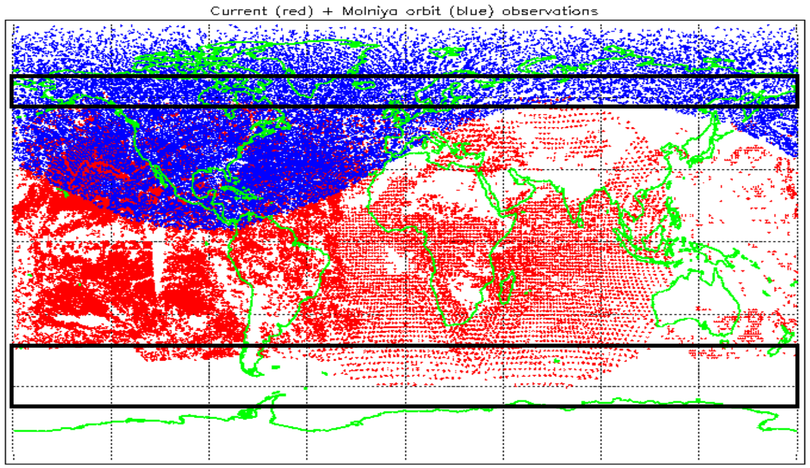
?2012 -> for Metop-A/B, possibly earlier for other less optimal configurations

Could completely close gap. Also benefit from shorter image interval of 50 min rather than 100 min.

Closing the gap...

Possibilities:

- Increased geostationary coverage
  GOES in SH
- Polar winds using only 2 images
  Metop AVHRR
- Multi-satellite polar winds e.g. Metop-A and Metop-B
- Highly elliptical orbit
- Other winds datasets
  - ADM-Aeolus DWL
  - MISR follow-on



From Riishojgaard, IWW8 talk

?2016

Possible POLARSAT Canadian mission for 2 satellites.

See Louis Garand's talk

New AMV datasets

For high resolution NWP

High resolution AMVs

Why are we interested?

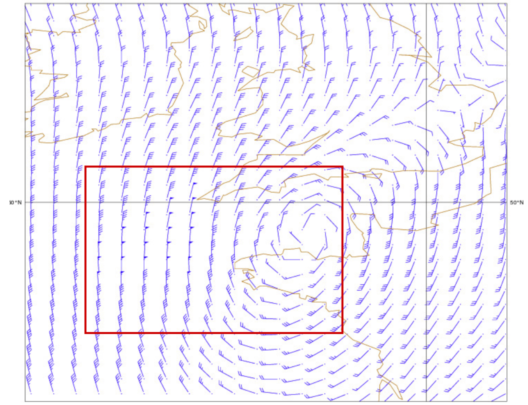
- Current AMV products capture broad-scale flow.
- NWP moving to higher spatial resolution

  e.g. Met Office global 25 km
  regional 12 km
  UK 1.5 km

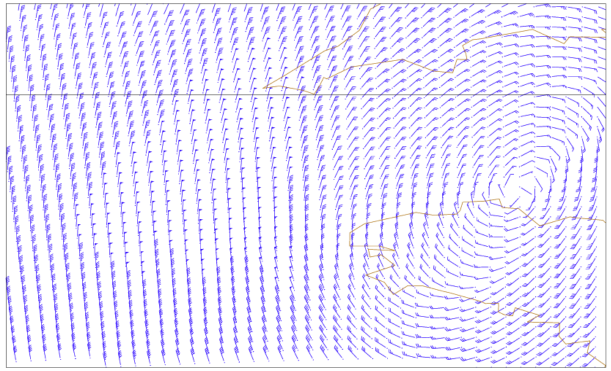
- Can we derive more useful AMV information for nowcasting or assimilation in high resolution models? Particularly to help with forecasting high impact weather events.
- Information available on smaller scales in the imagery (e.g. Purdom IWW8)
- Higher temporal resolution

  e.g. Meteosat-8 5 min interval imagery over Europe, GOES rapid scanning for severe weather

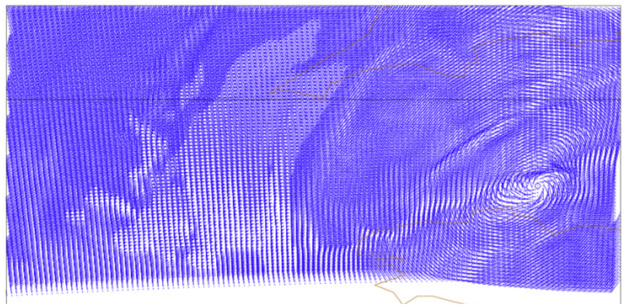
Global model 40 km



NAE 12 km



UK 4km



Examples of wind field resolution from Met Office operational models

High resolution AMVs

Considerations for NWP

1. Poorer low speed winds (limited by pixel resolution and image interval e.g. 4 km, 5 min - > 13.3 m/s to move one pixel).
2. May want to reduce dependence on existing quality control measures (spatial/temporal consistency, NWP forecast comparisons) – but risk of increased amount of poor quality data.
3. Spatial and temporal error correlations – currently handled by thinning, but would lose a lot of local flow information – how best to handle in NWP?

High resolution AMVs

Case study – 13 November 2009

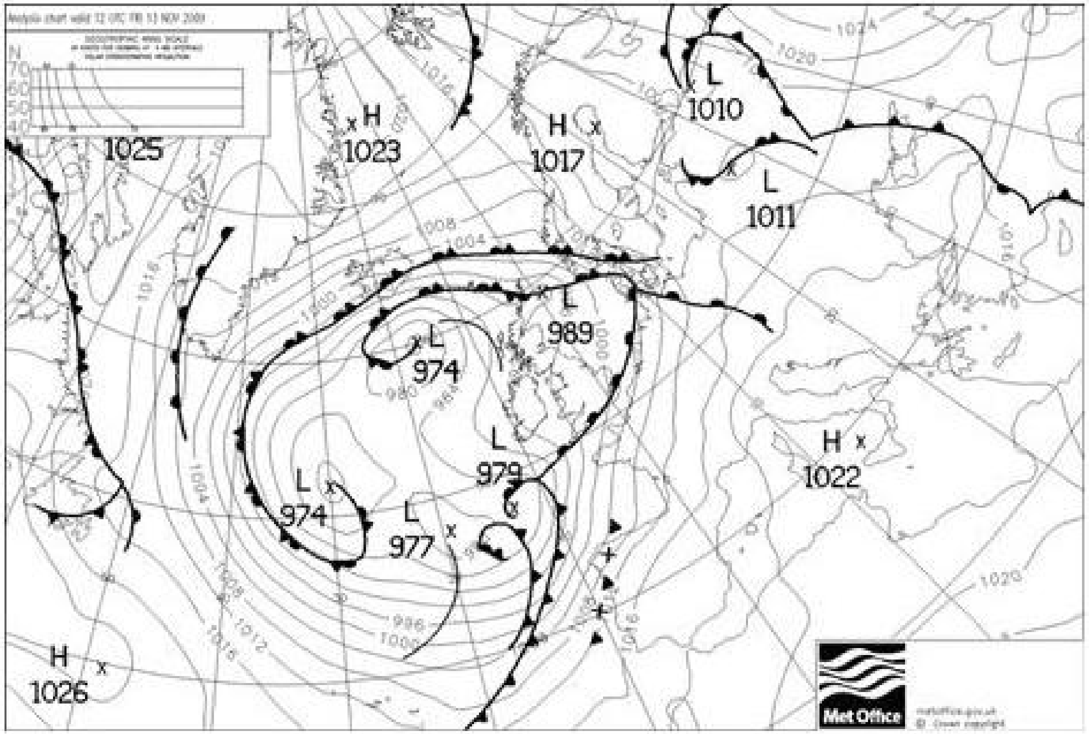
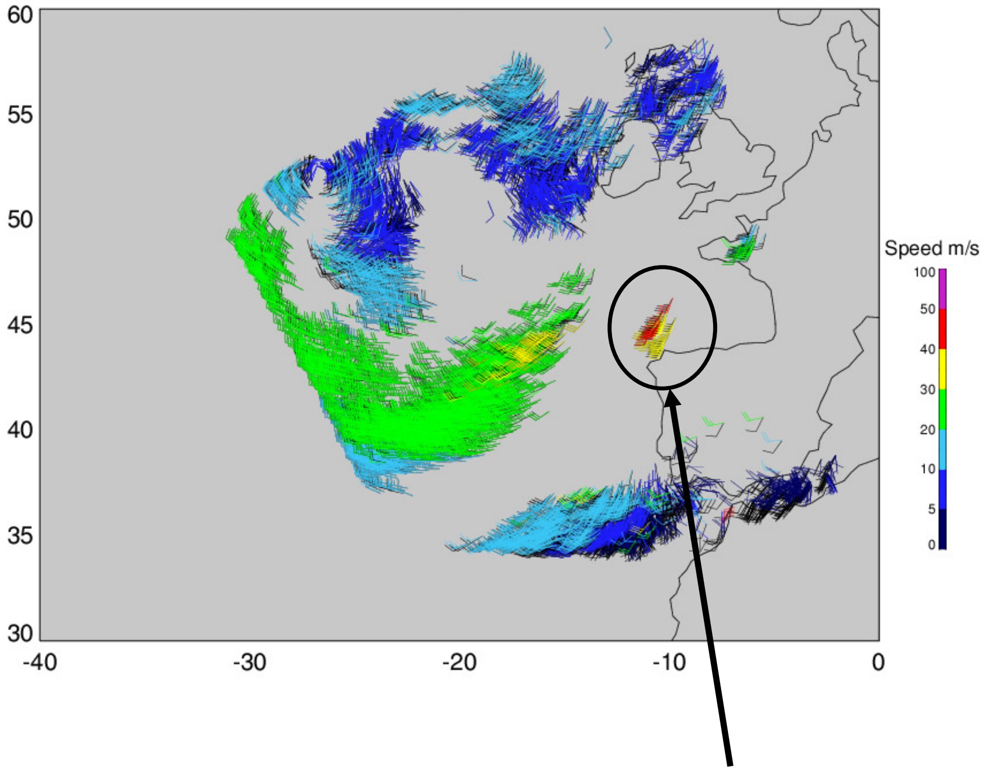


Figure 1: Met Office analysis chart for 1200 UTC 13 November 2009. A rapidly deepening low pressure system is moving north eastwards towards the UK.

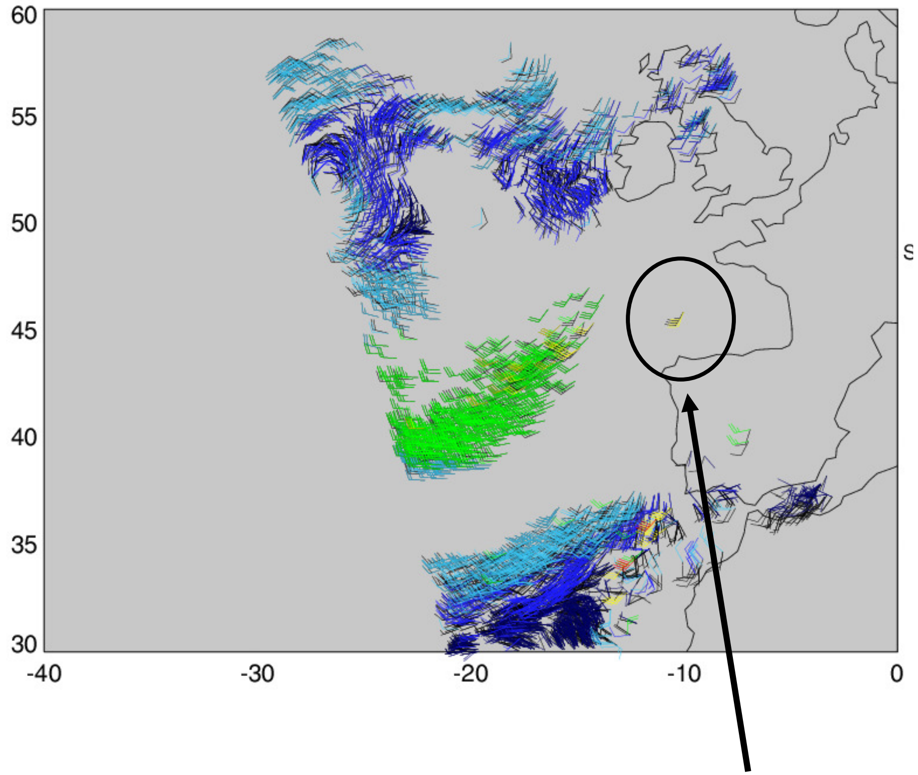
High resolution AMVs

Case study – 13 November 2009

Meteosat-8 HRVIS



Meteosat-9 HRVIS



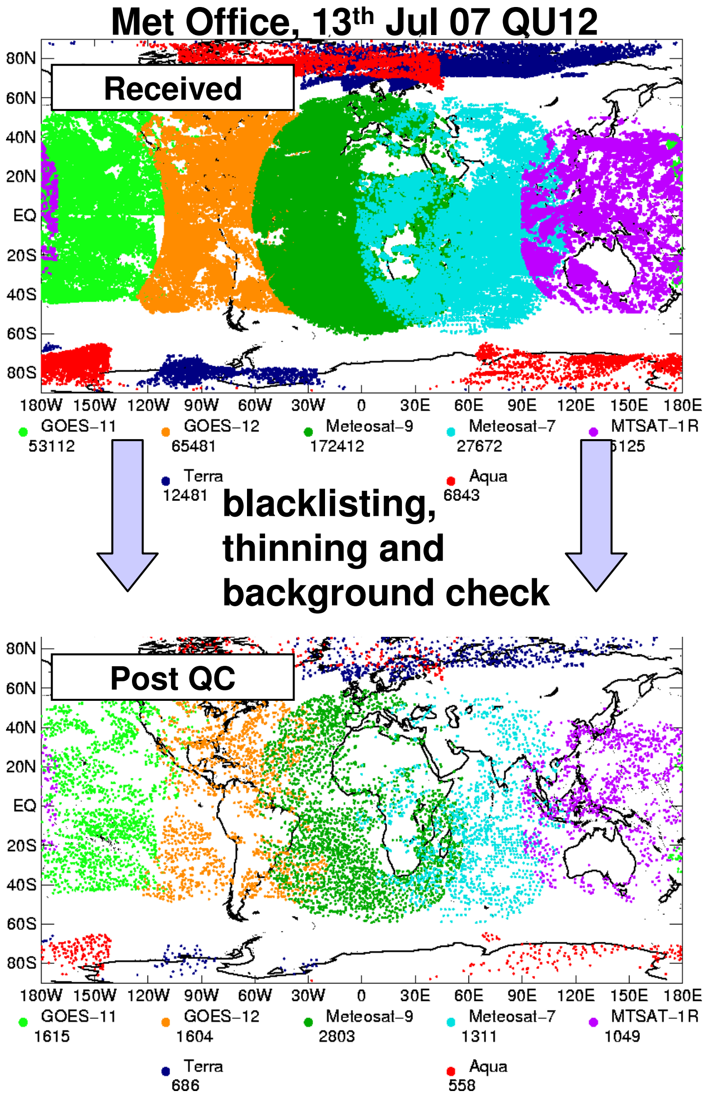
Enhanced wind speeds (35-45 m/s),
Agree well with Met Office model
background. Most have good QIs.

One wind (40 m/s),
QI<45

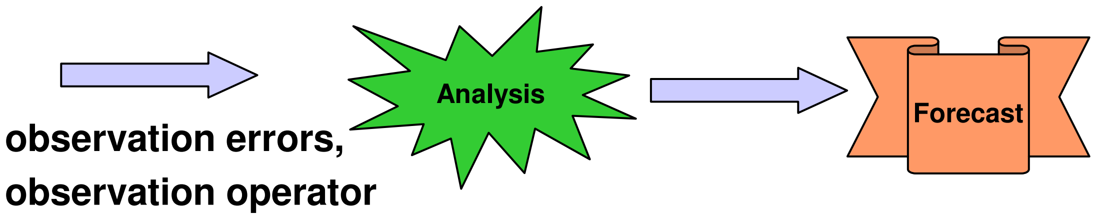
AMV assimilation

Current status and future options

Key areas of AMV assimilation



- Blacklisting
- Thinning
- Background check
- Observation errors
- Observation operator



Blacklisting

Balance between removing and down-weighting. Remove where consistently of poorer quality.

Spatial

e.g. all winds above 100 hPa, all VIS winds above 700 hPa etc.

• How to set? based on limitations of derivation and O-B stats

QI thresholds

• Which QI or combination of QIs? preference model-independent QI

• How to select appropriate thresholds? QI versus stats plots, but ensure maintain reasonable coverage

Temporal thresholds

• Should we apply? remove timeslots affected by solar stray light

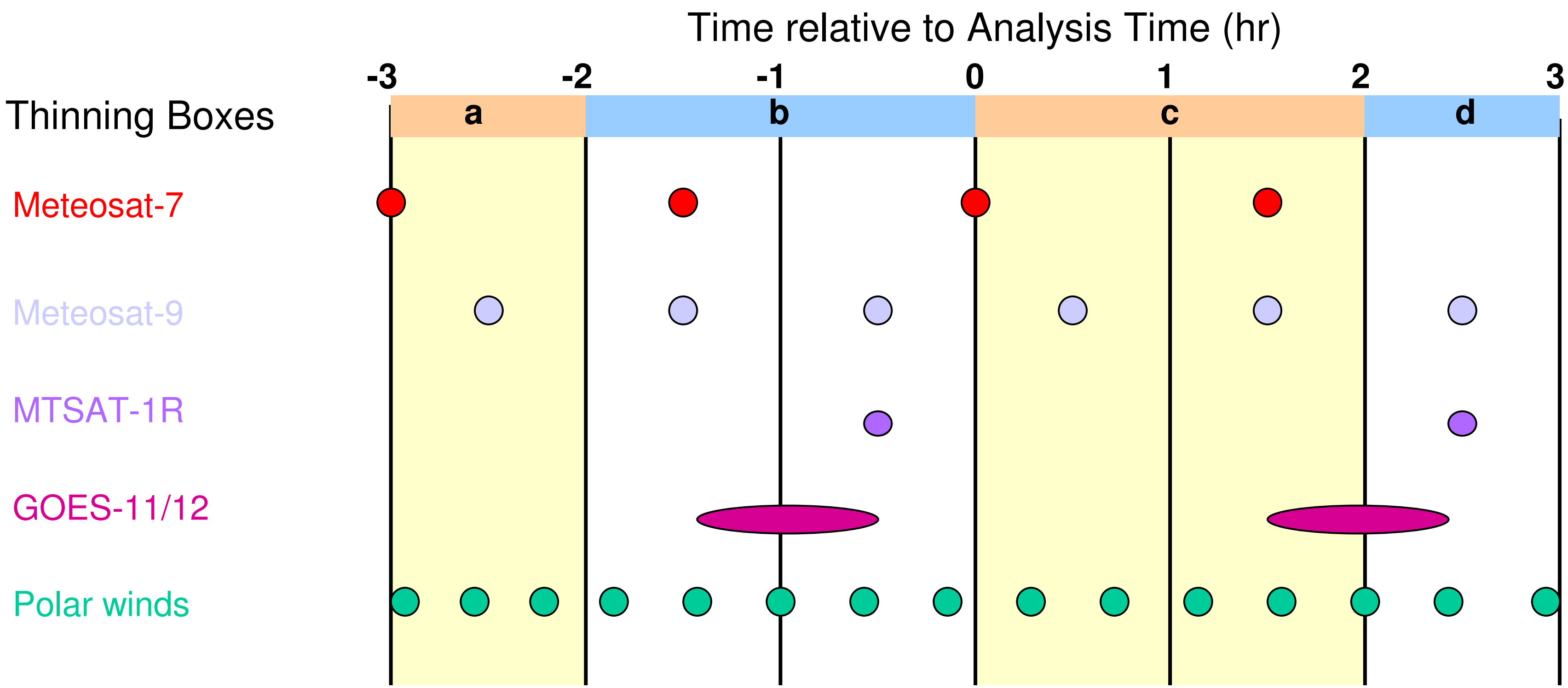
Speed thresholds

• Should we apply? remove slow winds (not well resolved)

Thinning

Main approach to alleviate problems with spatially and temporally correlated error. Another option is superobbing.

- Choice of horizontal, vertical and temporal box dimensions - 200 km about right? Less experience setting optimal temporal dimension for use in 4D-Var.
- How to select observation to use? closest to centre of box, highest QI, lowest observation error

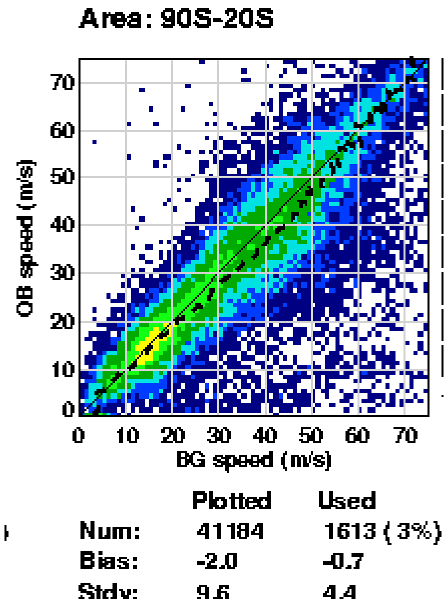


Background check

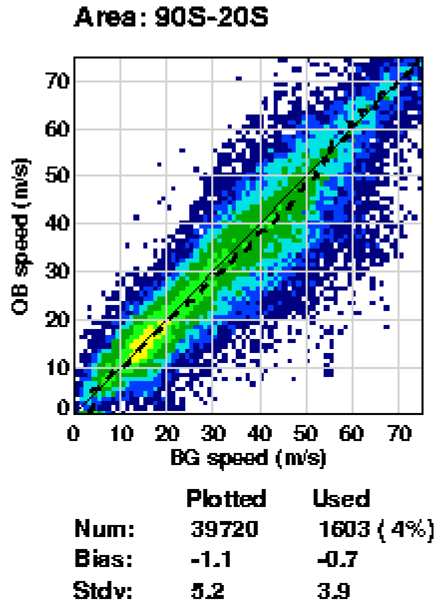
Met Office

Safeguard to avoid assimilating data that is very different to the background.

All data



After background check applied



- How to design test?
- Should it be symmetric / asymmetric?
- How strict should it be?
- Should we incorporate the check as part of initial QC or as part of VAR or both?

Observation errors

A good specification of the observation error is essential to assimilate in a near-optimal way

Two independent sources

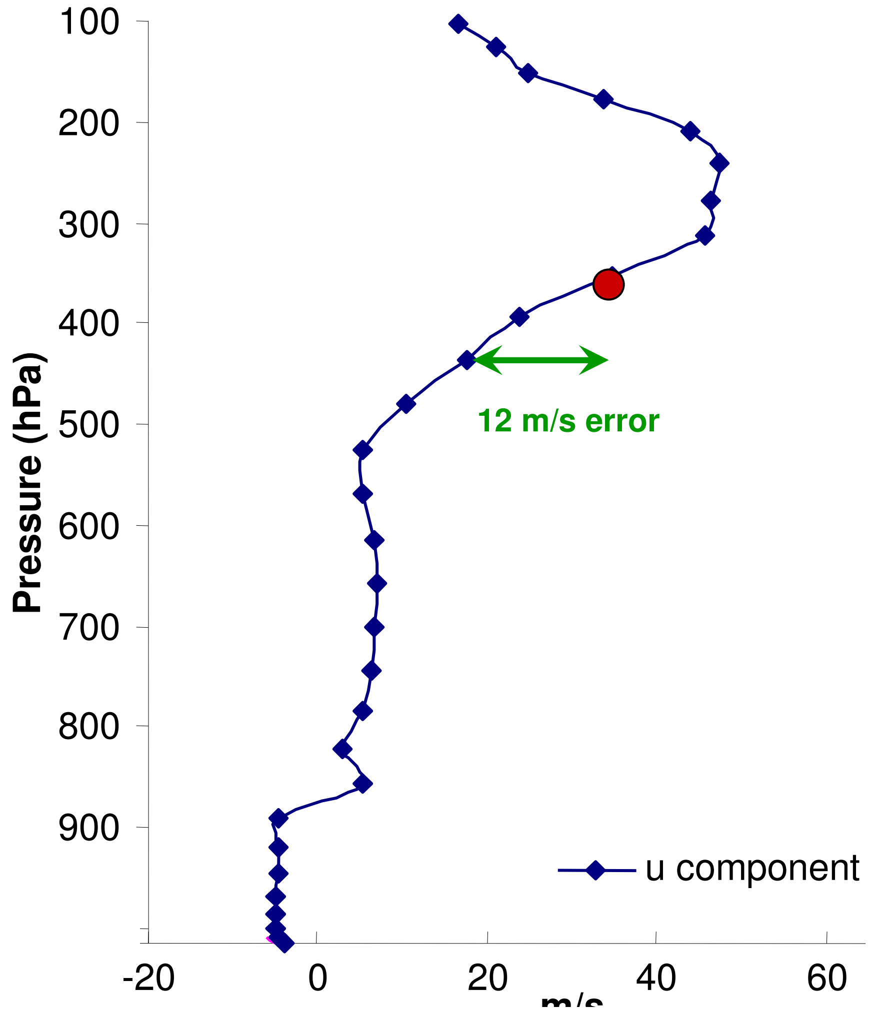
Error in vector

- Linked to accuracy of tracking step

Error in height

- Linked to accuracy of height assignment
- More problematic if large vertical wind shear

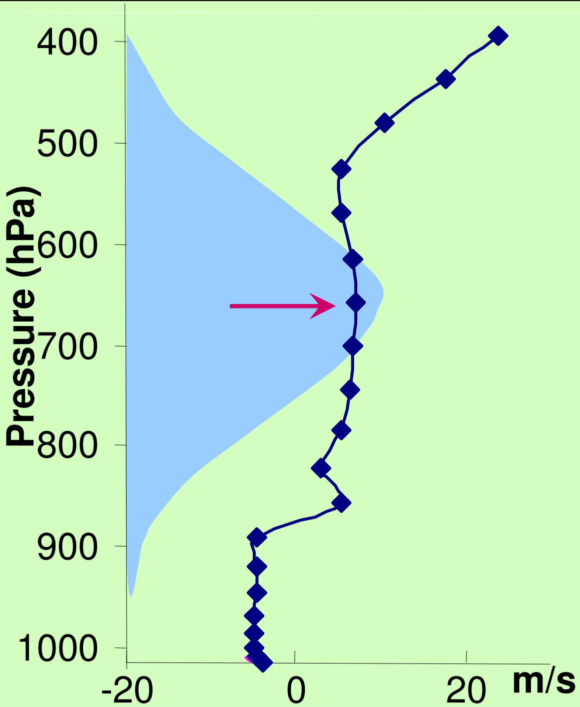
Currently assume uncorrelated errors – see Lars Isaksen's talk later.



Observation errors

New approach – operational since July 2008

Total u/v error = $\sqrt{}$ (u/v Error² + Error in u/v due to error in height²)



Error in vector due to error in height = $\dfrac{\sqrt{\Sigma W_i (v_i - v_n)^2}}{\Sigma W_i}$

where $W_i = e^{-((p_i - p_n)^2 / 2\mathbf{Ep}^2)} * dP_i$

Summation over levels with a significant W_i

- i = model level
- v_i = wind component on model level
- v_n = wind component at observation location
- p_i = pressure on model level
- p_n = pressure at observation location
- dP_i = layer thickness

For this we need an estimate of:

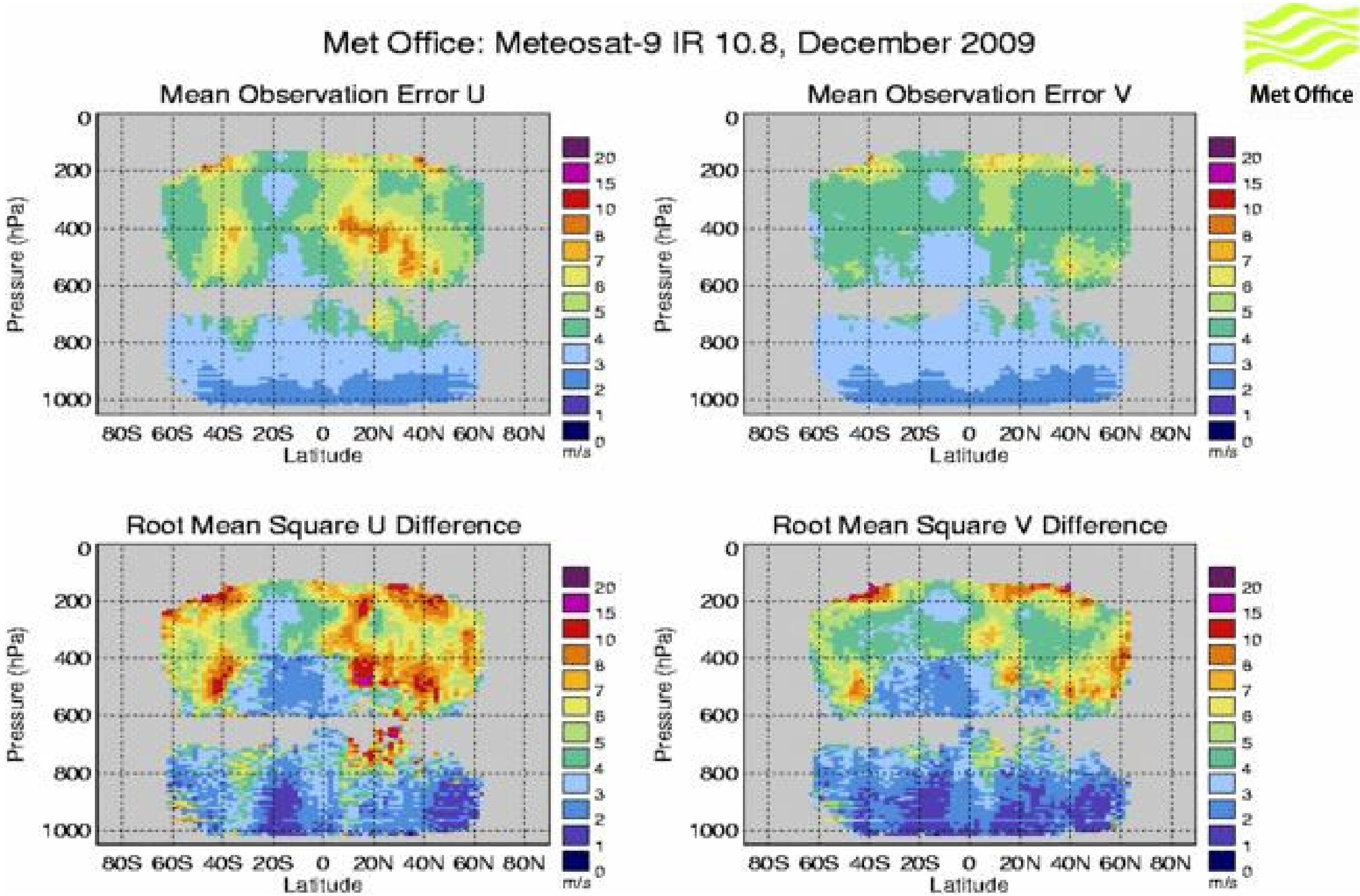
1. **u and v error (Eu and Ev)**
2. **height error (Ep)**

Ideally from data producers

Until then estimate Ep using best-fit pressure stats as a guide. Eu/v based on QI.

Observation errors

Assessing how well we are doing

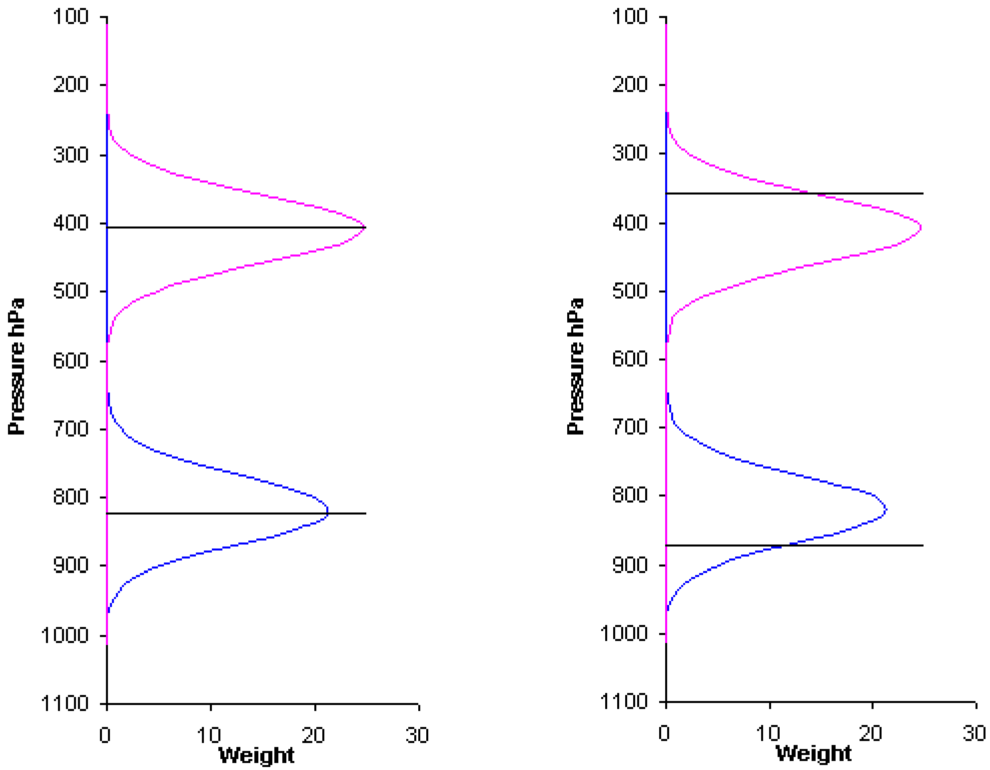


Plan to retrial with revised Ep look-up table

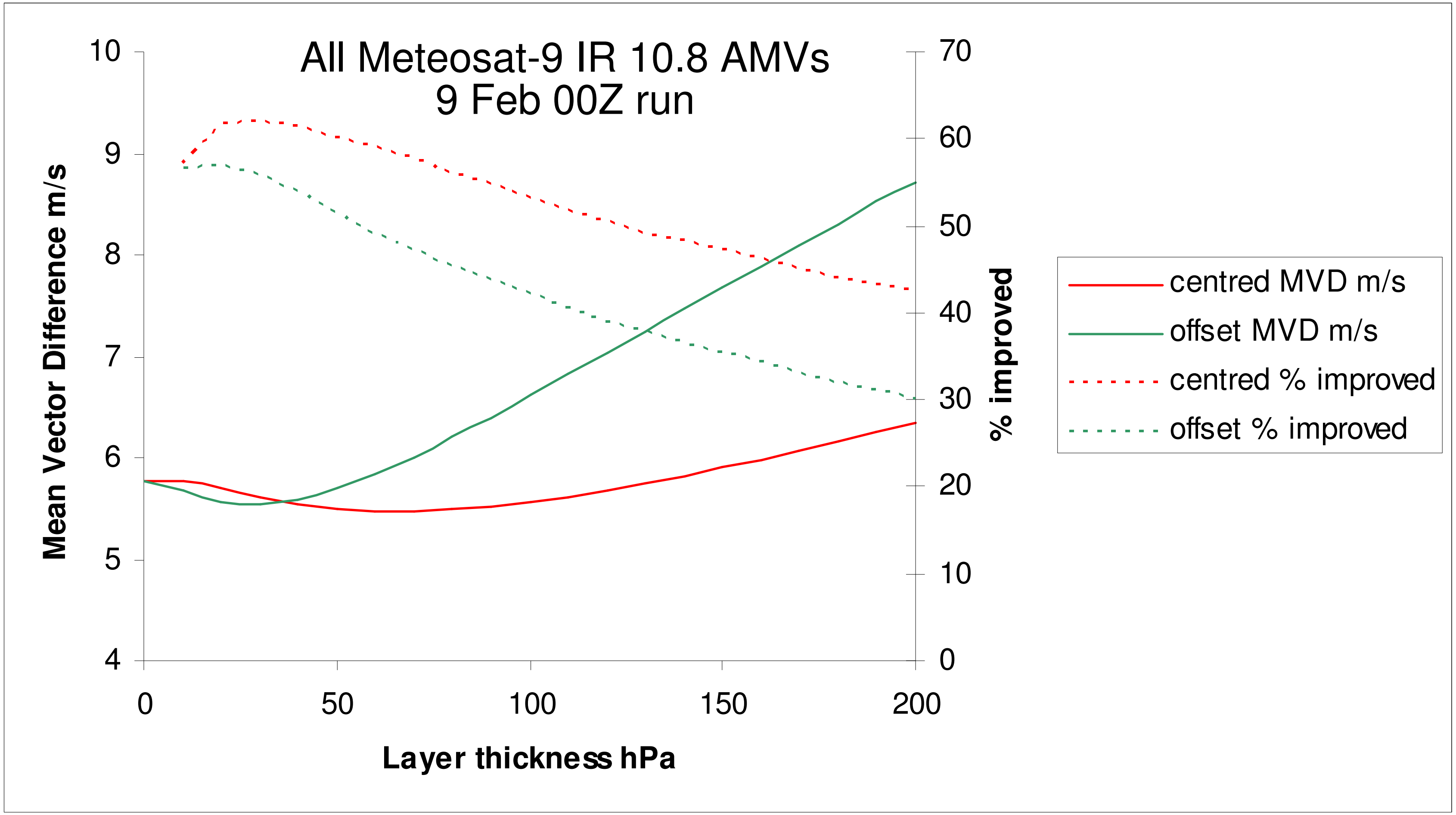
Observation operator

Currently treat as point winds in space and time – may want to treat as a layer....

- Layer shape – Gaussian preferred
- Layer location relative to assigned height – centred / offset
- Layer width – how to set?



Observation operator



Biggest improvement seen for layer widths of 20-60 hPa

Observation operator

It is unlikely that the same layer width will be suitable for all Meteosat-9 IR 10.8 winds.

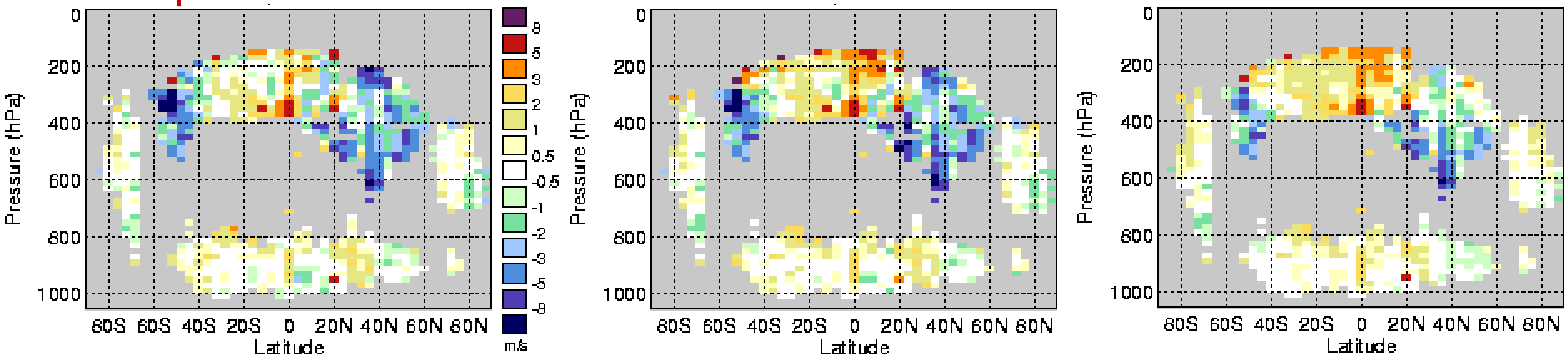
To get an upper limit of what might be possible, we also calculated O-B statistics where we allowed each observation to have its own best-fit layer width (defined as the layer in range 10-200 hPa giving minimum O-B vector difference).

	Mean Vector Difference m/s
Single level	5.78
Minimum fixed layer - centred	5.47 (5%)
Minimum fixed layer - offset	5.53 (4%)
Best-fit layer - centred	4.07 (30%)
Best-fit layer - offset	3.62 (37%)
Best-fit single level	1.75 (70%)

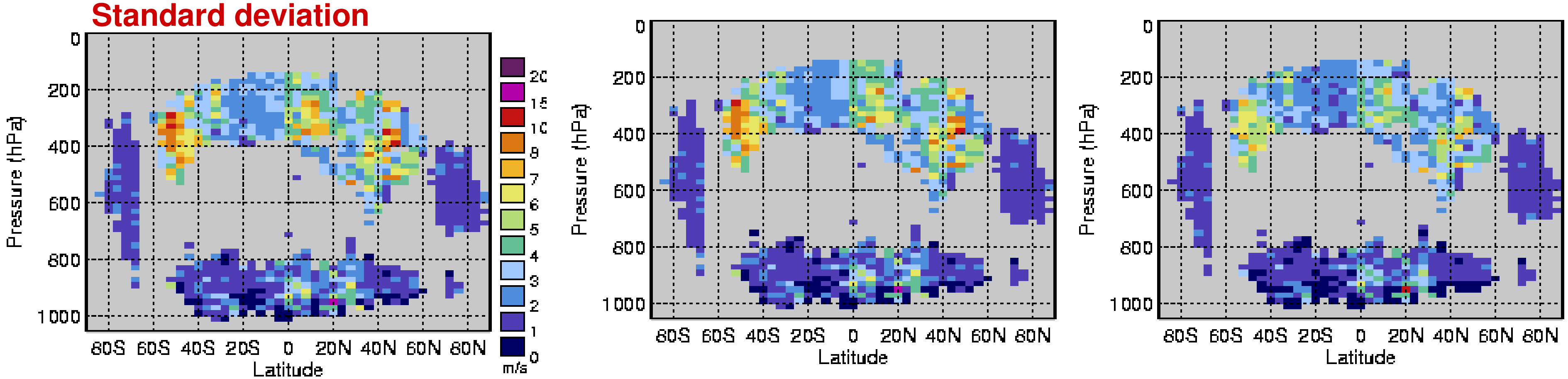
Observation operator

Single level | 50 hPa fixed layer | Best-fit layer

O-B speed bias



Standard deviation



All IR AMVs 16 Feb 00Z run

Summary

Summary

Met Office

1. Improving AMV coverage
    - Reducing the gap between geo and polar
    - Improving timeliness of polar data
2. Increasing interest in high resolution AMV products as model resolution improves.
    - Not straight-forward
    - Need to review and optimise derivation and assimilation approach
3. Improving the AMV assimilation
    - Areas to consider include:
        - Blacklisting (space, time, QI, speed)
        - Thinning / Superobbing
        - Background check
        - Observation errors
        - Observation operator
4. Many of these tasks will benefit from producers and users working together.

Questions and answers