Met Office

A study of the AMV correlation surface

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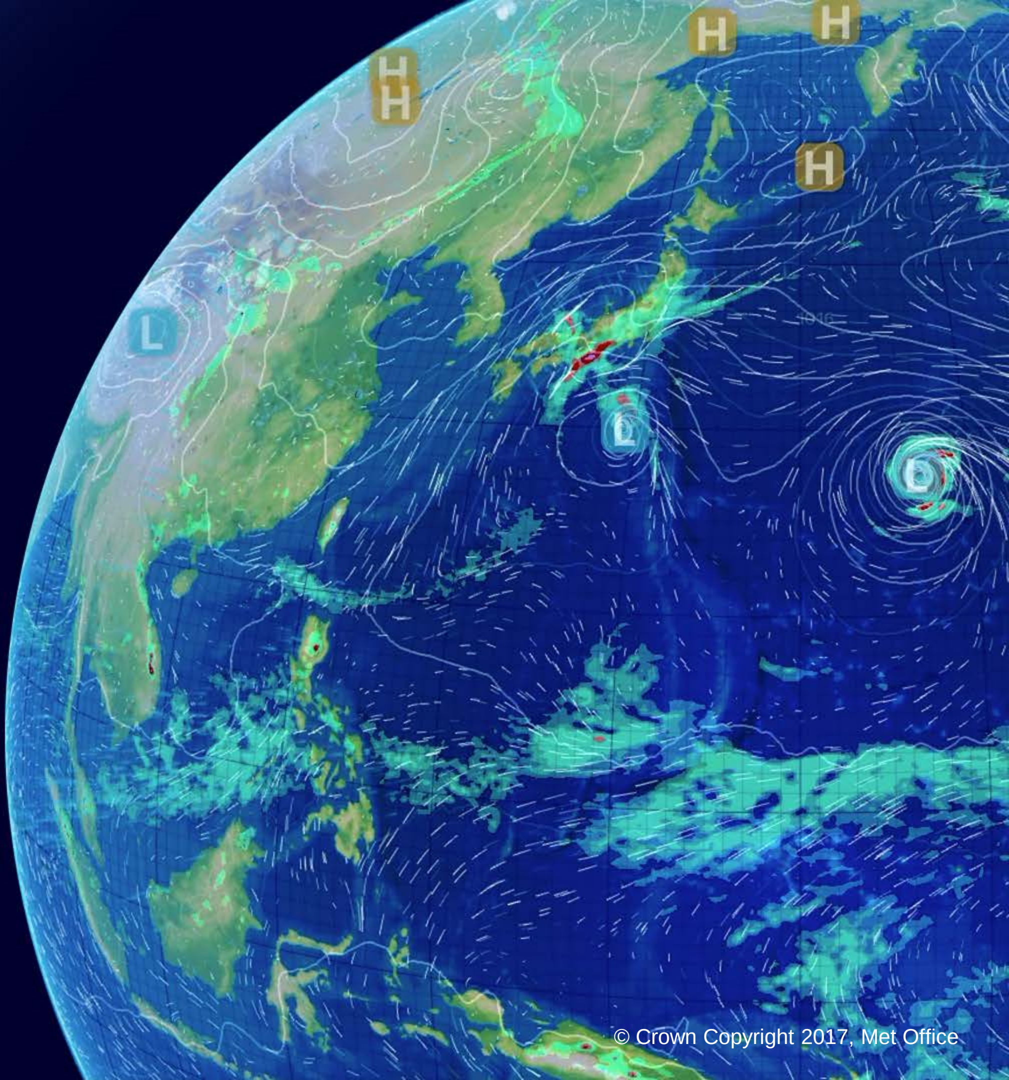
IWW14, 24/04/2018



Talk Outline

- Motivation
  - Polar data
  - High resolution data
  - Global data
- Early examples
- How can we use the information?

Motivation

How are AMVs produced?

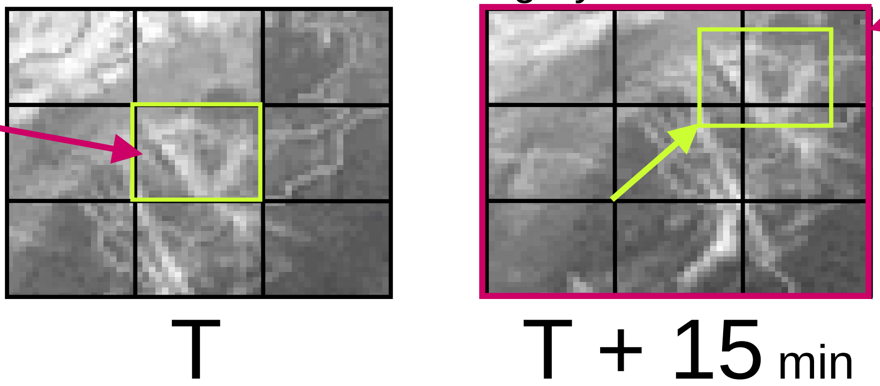
1. Initial corrections (image navigation etc.)
2. **Tracking**

Infrared Imagery

Target Box / Tracer

e.g. 24 x 24 pixels

pixel – 3 km



Search Area

80 x 80 pixels centred on target box

new location determined by best match of individual pixel counts of target with all possible locations of target in search area.

3. Assign a **height** to the derived vector – moving towards use of optimal estimation - not always easy!

Normally repeat from image 2-> 3 to give a second vector for quality control

In recent years……

For traditional AMV production from geostationary satellites - height assignment thought to be the dominant source of error – less focus given to tracking step.

But….

First challenge - polar winds

Greg Dew's talk IWW10 Feb 2010

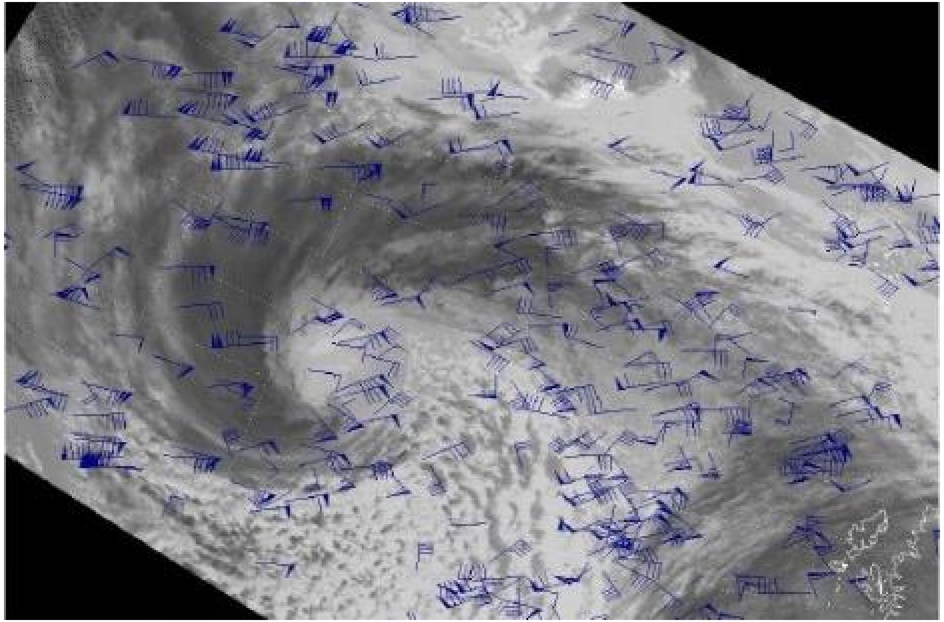


Image interval longer at ~100 min

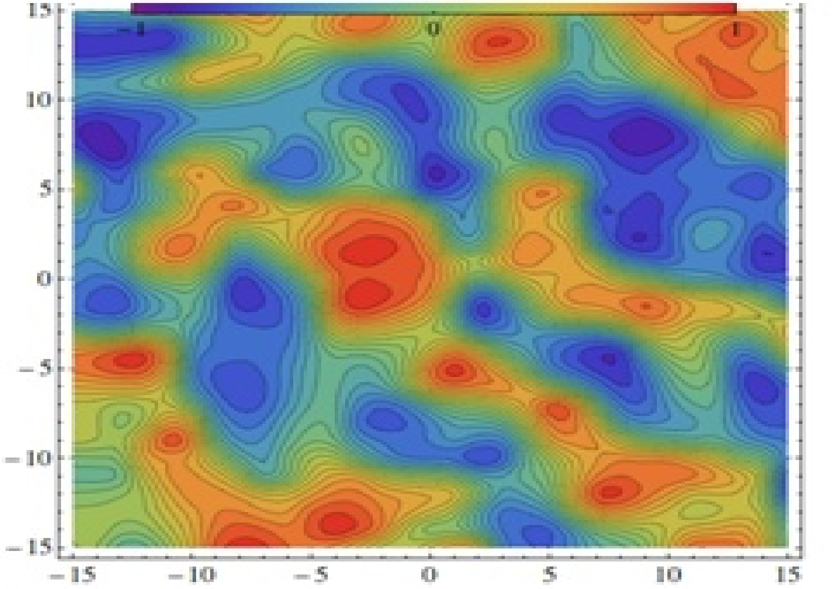
Target size 28x28

Lots of noise in vector field due to longer image interval

Conclude: need first guess to guide tracking for polar winds

Second challenge – high resolution winds

Kazuki Shimoji's talk IWW12 Jun 2014



Aim to generate winds more representative of local flow - move to smaller target box sizes

Target size 5x5

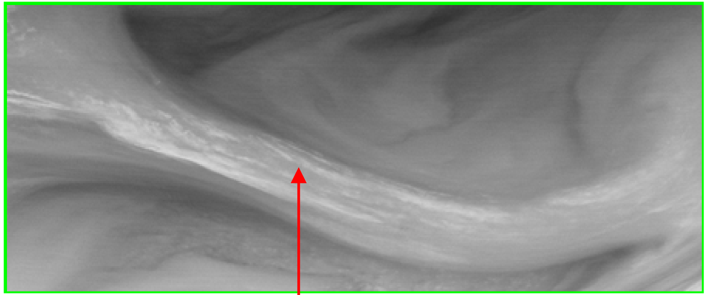
More noise, multiple peaks in correlation surface

Third challenge – smoother cloud features

NWP SAF – 4th analysis report –
James Cotton, 2010

Example in jet region

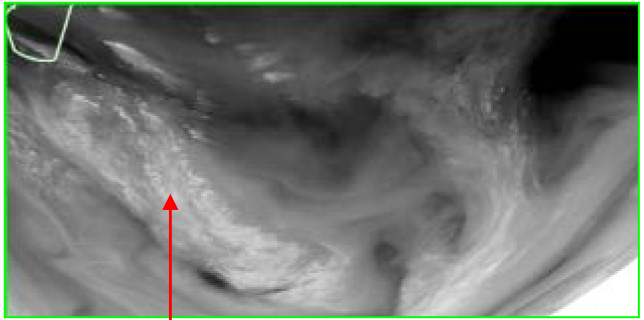
1) 22 June



Feature exhibiting large slow bias

- Narrow jet core
- Smooth linear features aligned parallel to direction of wind

2) 29 June



Feature with fairly neutral bias

- Much wider
- Less regular - more contrast details perpendicular to flow

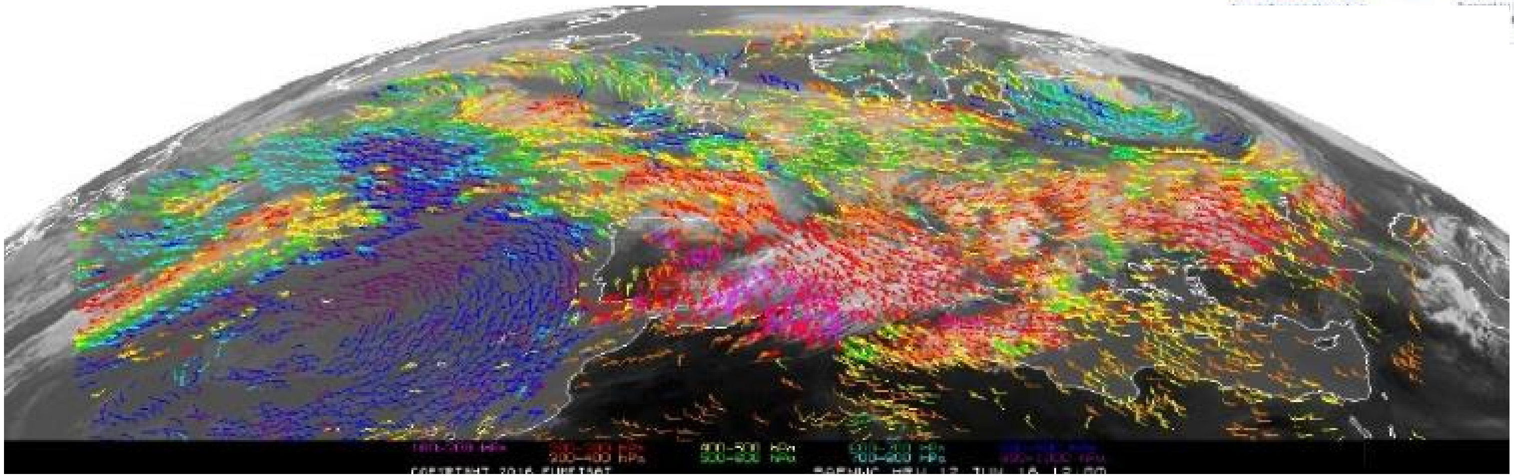
Differences in texture of the two features may be affecting success of tracking step.

Mean MetO background

O-B speed bias

Early examples

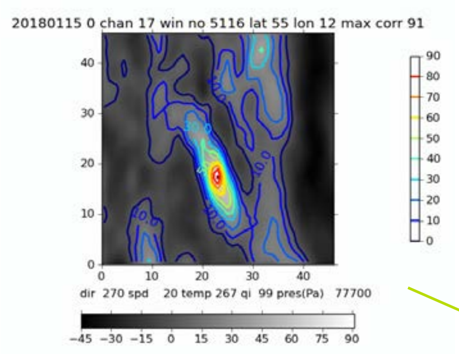
Plotting the correlation surfaces

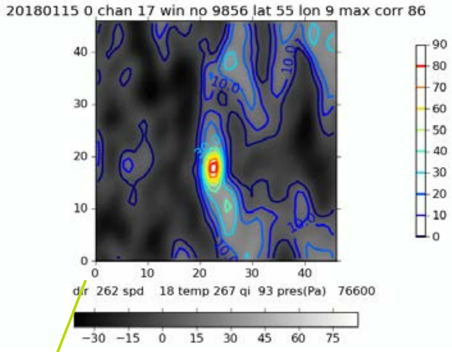


Javier Garcia Pereda provided a modified version of HRW v2016 (applicable with NWCSAF v2016 only) which includes the correlation matrices for each AMV.

This is running in test mode at the Met Office and Graeme Kelly has put together some code to plot the correlation matrices for winds within the UKV domain.

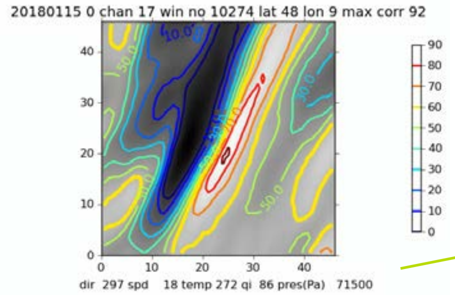
Low level examples

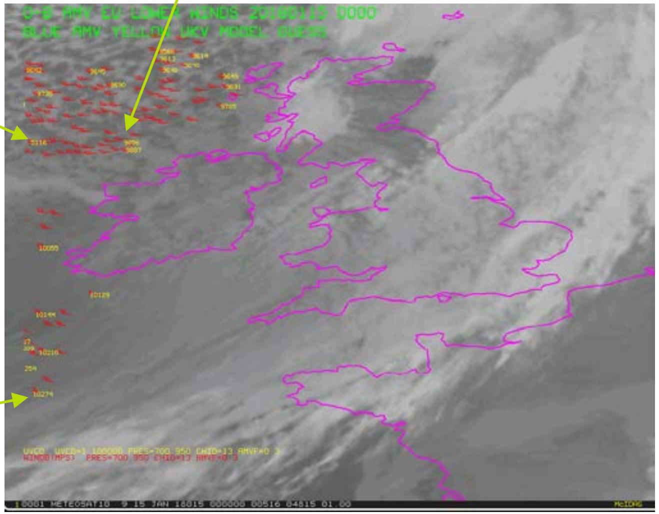




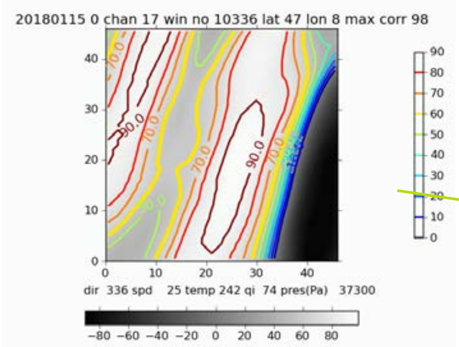
At low level generally see cleaner correlation surfaces.

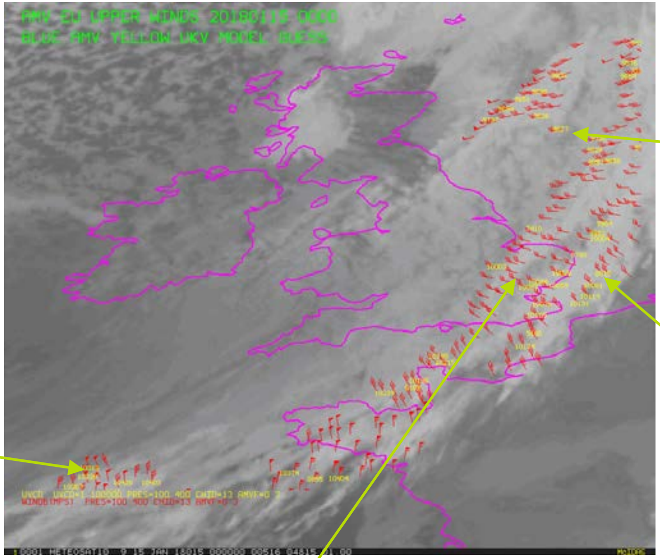
Correlation surface better constrained in area with more cloud texture

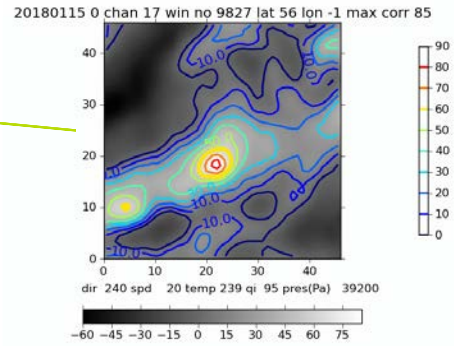


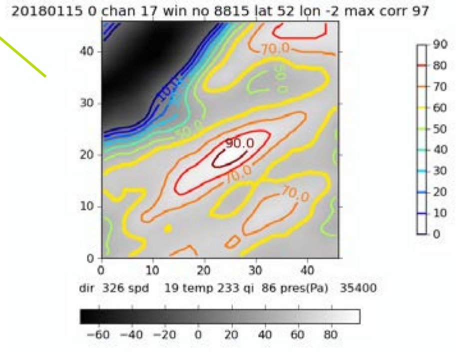


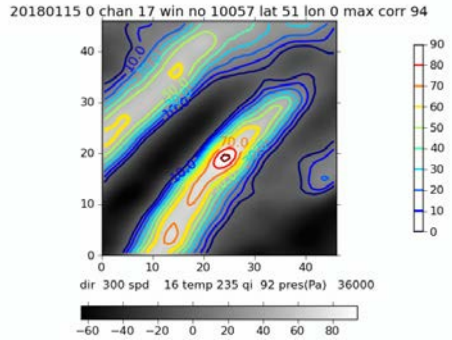
High level examples









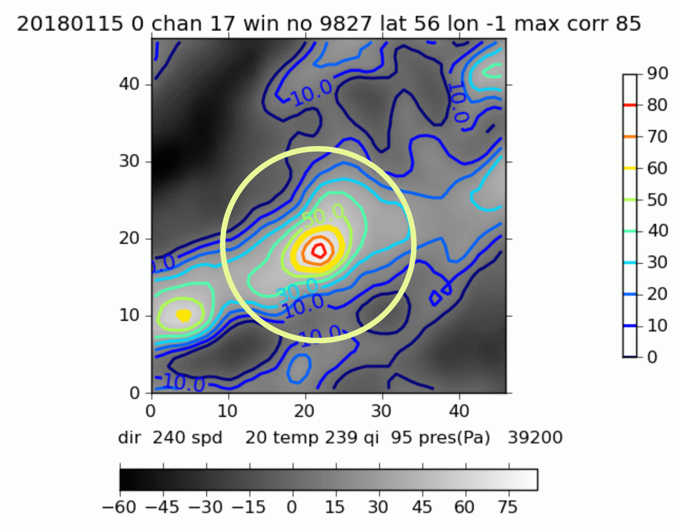


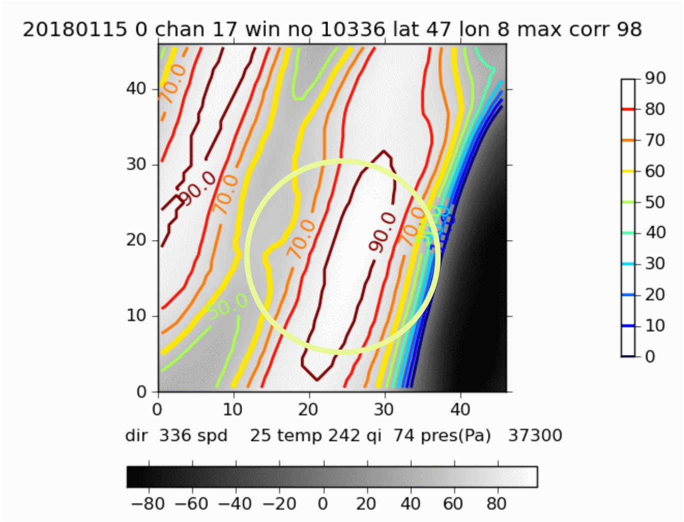
At higher level – correlation surfaces can look quite messy!

How can we use the information?

Filtering to remove the poorly constrained cases

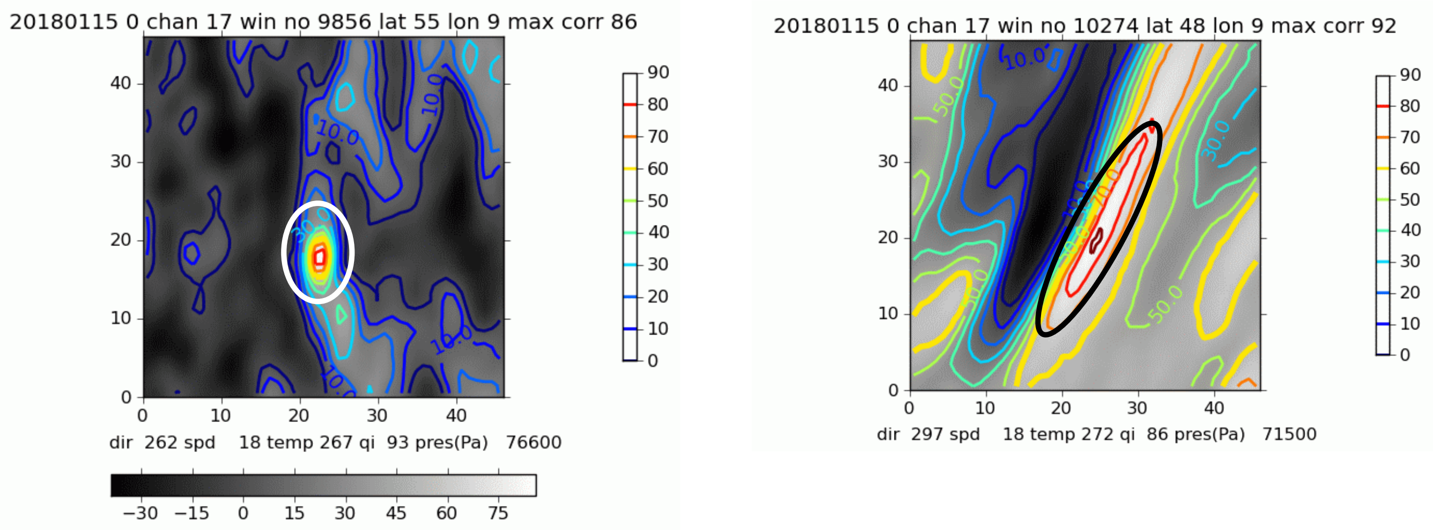
If correlation outside of a set region around the maximum correlation value exceeds a fraction of the maximum correlation – this test should remove cases with multiple maxima or broad maxima





Estimating tracking errors

Could attempt to fit an ellipse to the peak correlation structure – could provide estimates of error across both axes of the ellipse



NWP AMV observation error schemes

Several NWP centres use an observation error scheme based on the following assumption

Two independent sources of error

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

Total u/v error = √ (u/v Error^2 + Error in u/v due to error in height^2)

For this we need an estimate of:

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

Potentially use information from the correlation surface for Eu and Ev

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

See Forsythe & Saunders, IWW9, 2008 for more information

Summary

- For many global AMVs – height assignment remains the main source of error
- For polar AMVs and high resolution AMVs, the tracking step has proved more problematic due to longer image intervals (polar) or smaller target sizes (high resolution).
- There may also be cases where traditional AMVs struggle due to smoother cloud features – in these cases motion often better constrained in one dimension.
- There is information in the correlation surfaces that could be used to filter out poorly constrained cases or provide estimates of errors in the tracking step for use in NWP.

Next steps

- So far the results have not shown much correlation between poorly constrained correlation surfaces and O-B fit, but we also haven't seen cases where the AMVs look noisy.
- We plan to look at reducing the quality control which might be filtering out the cases of poor tracking. We also plan to look at using smaller target box sizes which we know is more challenging.
- We can then look again at whether there is a relationship with O-B fit.
- Beyond that can we develop the ideas to provide flags or error estimates?

Spare slides

Example 3

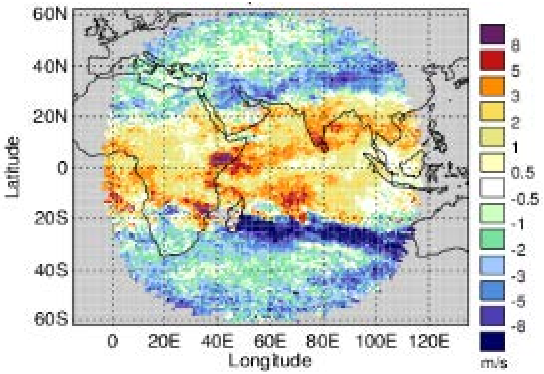
High level Jet region slow bias

Meteosat-7 WV Indian Ocean – large slow bias feature

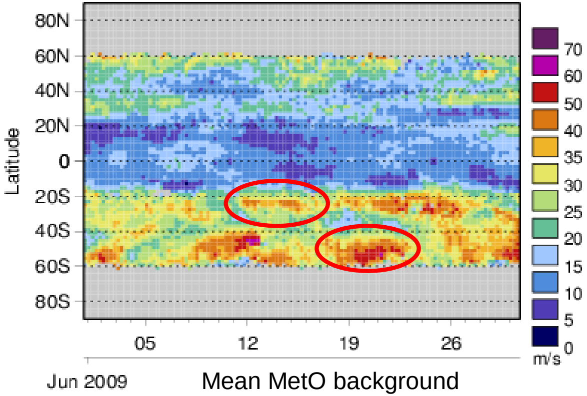
- Persist May-Sept (SH Winter)

Example for June 2009

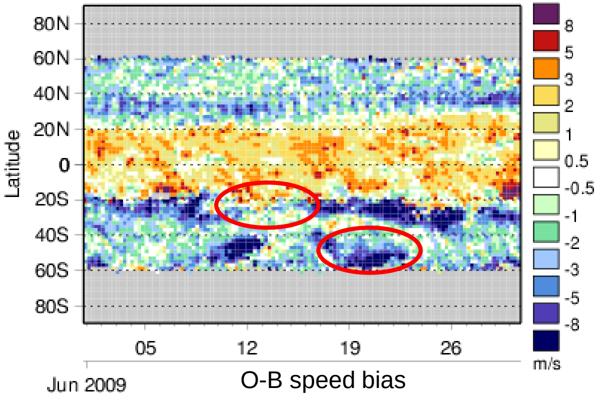
- Closely matches location of sub-tropical Jet around 20-30S
- Feature varies throughout June but not always coinciding with fastest wind speeds e.g.



O-B speed bias June 2009



Mean MetO background



O-B speed bias

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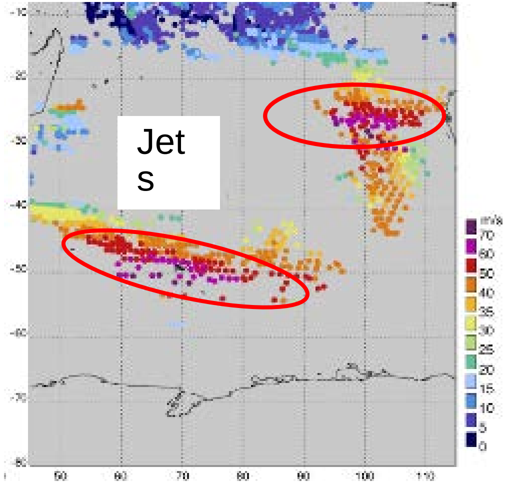
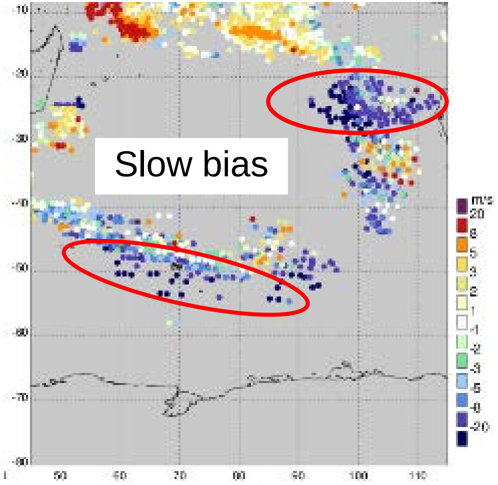
Example 3

High level Jet region slow bias

Case Study 1) 22 June 2009, 00UTC



MetO model background wind speed



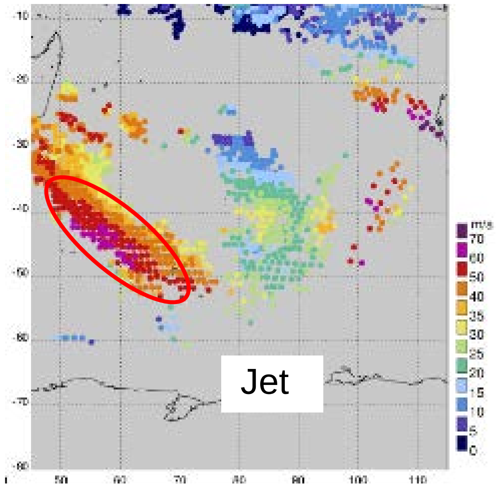
O-B speed bias

Both sub-tropical Jet and Polar Jet show fast model wind speeds (>70 m/s) for AMVs (WV) associated with large slow biases

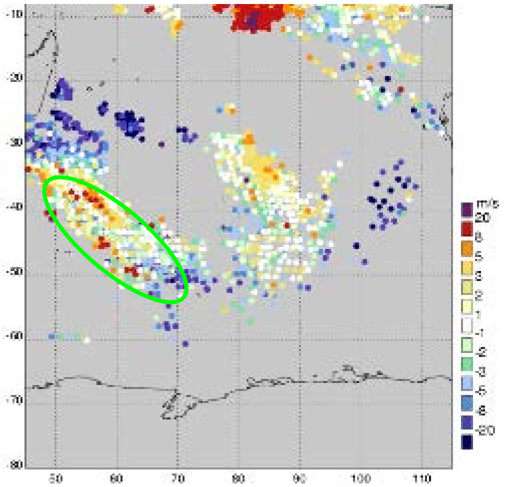
Example 3

High level Jet region slow bias

Case Study 2) 29 June 2009, 00UTC



MetO model background wind speed



O-B speed bias

Jet to SE Madagascar shows fast wind speeds, but AMVs in this case with neutral (or even slightly fast) bias.

Why large slow biases associated with very fast winds in some cases and not others?