Understanding AMV errors through the NWP SAF monitoring and Analysis reports

James Cotton, 11th International Winds Workshop, Auckland, 20-24 February 2012

Acknowledgements: Mary Forsythe, Antonio Garcia Mendez (ECMWF)

Contents

This presentation covers the following areas

- Introduction and updates
- Examples from 5th Analysis Report
  - Somali Jet
  - Mid level improvements
  - MTSAT typhoon
- Summary

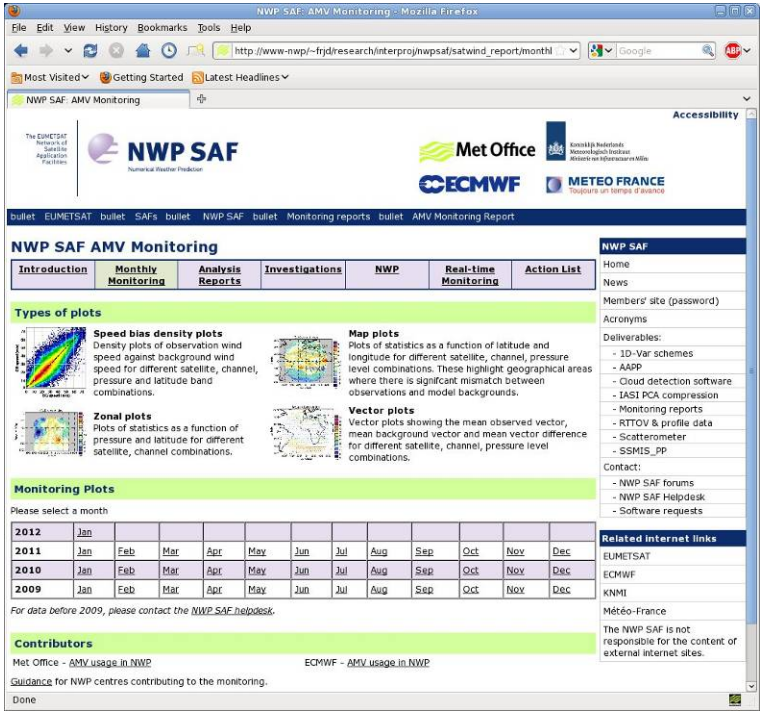
Introduction

Website

http://research.metoffice.gov.uk/research/interproj/nwpsaf/satwind_report/

Aims

- Provision of rolling 3 year archive of monthly O-B monitoring plots (UKMO and ECMWF)
- Producing analysis reports every 2 years to coincide with the IWWs – core is a record of features identified in the O-B monitoring
- Improve understanding of AMV error characteristics in order to enable improvements to the AMV derivation and their treatment in NWP models



Updates since IWW10

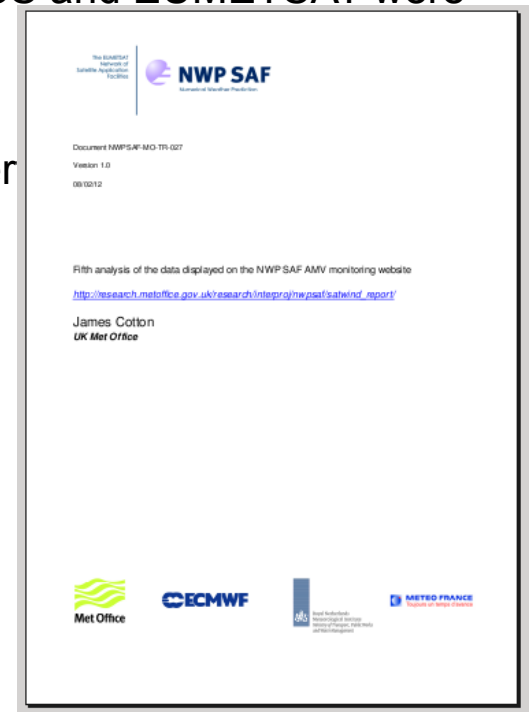
- Updates were supplied for the information on how AMVs are used in different global NWP systems – relocated to new 'NWP' page

http://research.metoffice.gov.uk/research/interproj/nwpsaf/satwind_report/nwp.html

- March 2011: a new joint investigation comparing mode best-fit pressure statistics – see talk by Kirsti Salonen, ECMWF

http://research.metoffice.gov.uk/research/interproj/nwpsaf/satwind_report/investigations.html

- November 2010: Metop-A AVHRR polar winds produced by CIMSS and EUMETSAT were added to the monthly monitoring
- November 2010: new look vector plots were added
- June 2010: following feedback from IWW10 the plots were conver higher resolution gif format (archived also updated)
- 5th Analysis report released Feb 2012



Examples

from 5th NWP SAF Analysis report

Somali Jet

Low level

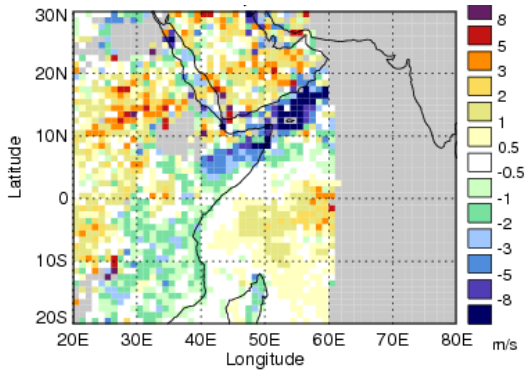
Feature: Meteosat-9 visible winds much slower than model forecast over Arabian Sea

Season: July-August, observed every year during peak of Somali Jet

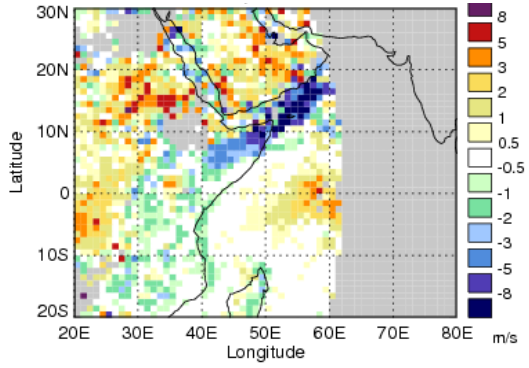
Channels: visible (0.8μ and hrvis), less noticeable in IR

Models: both UKMO and ECMWF, slightly worse in UKMO

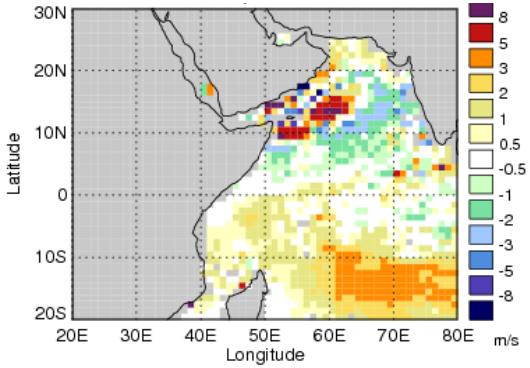
UKMO Met-9 vis0.8



ECMWF Met-9 vis0.8



UKMO Met-7 visible



O-B speed bias for August 2011, QI2 > 80 (without FG check)

Markedly different departures for Met-7 visible winds – generally much faster than models

Somali Jet

Models - analysis

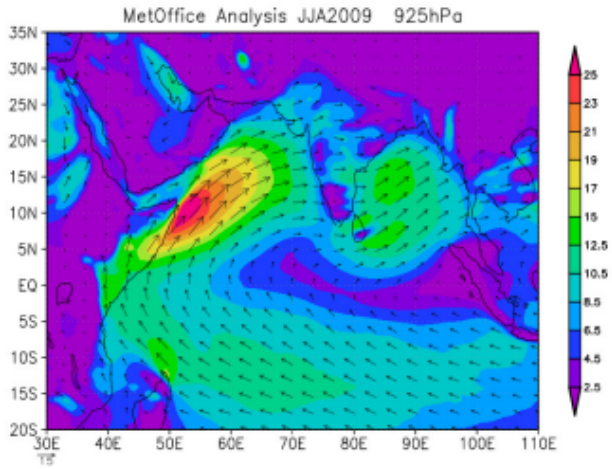
How well do the models perform in the Somali jet?

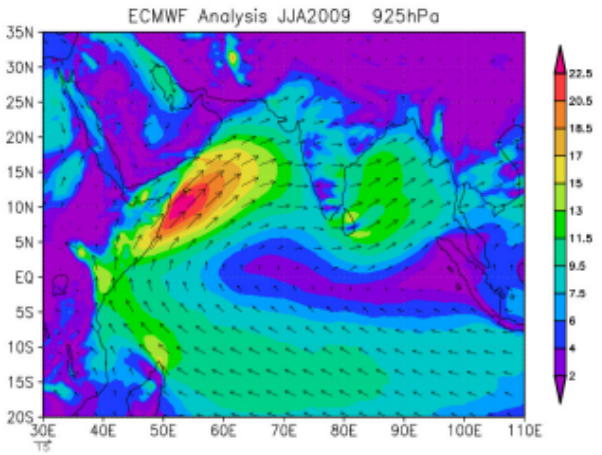
Both climate and NWP models show significant systematic errors in the representation of the Asian Monsoon:

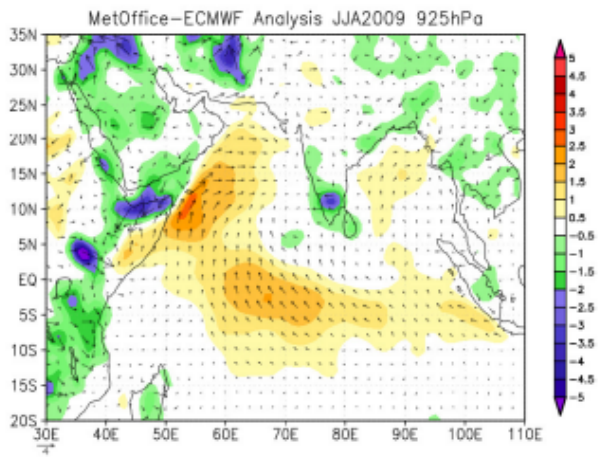
- Unified Model (UM) “dry” monsoon – not enough rain over India
- ECMWF “wet” monsoon – overactive precipitation

Low level wind analyses JJA 2009 qualitatively similar: intense low level jet (>20 m/s) off coast of Somalia.

UKMO has systematically stronger ocean winds: 2.5 m/s in Somali jet (10% of observed value)







(From Milton et al, 2011)

Somali Jet

Models – T+24 forecast

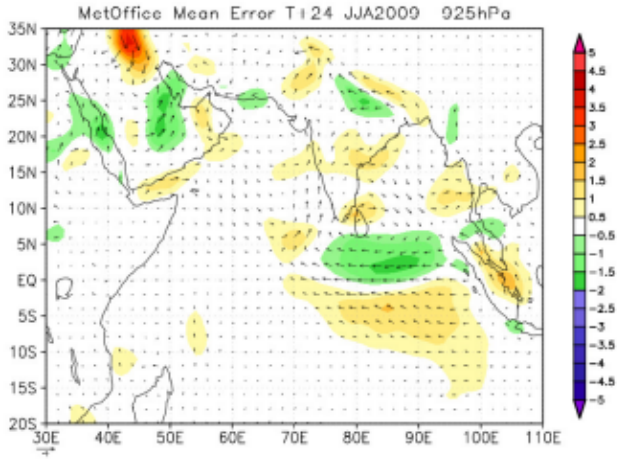
T+24 forecast differences (C) look similar to analysis differences i.e. UKMO stronger winds in jet

- Agrees with O-B plots which shows AMV departures slightly larger versus UKMO
- ECMWF analysis fitting closer to (slower) wind observations?

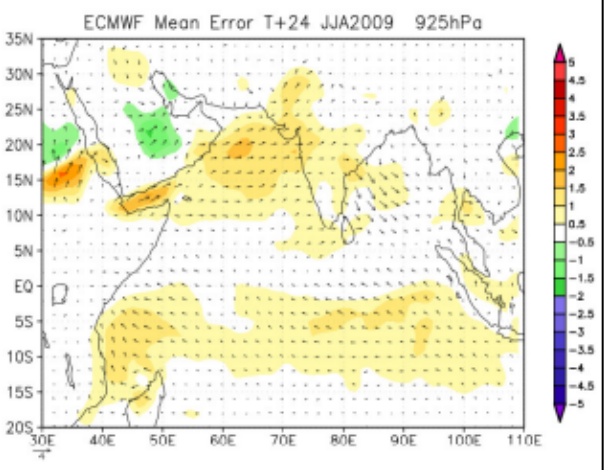
UKMO short range T+24 forecast error (A) shows neutral bias in jet region – well forecast

Systematic model differences are small (~2m/s) compared with AMV departures (>20 m/s) – AMV errors dominant signal

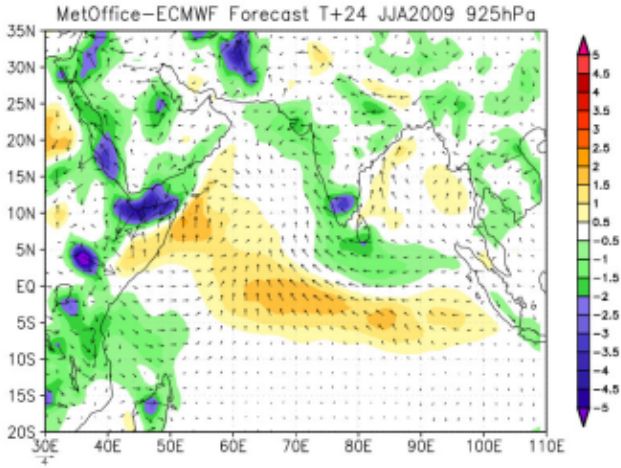
A



B



C



Against own analysis

(From Milton et al, 2011)

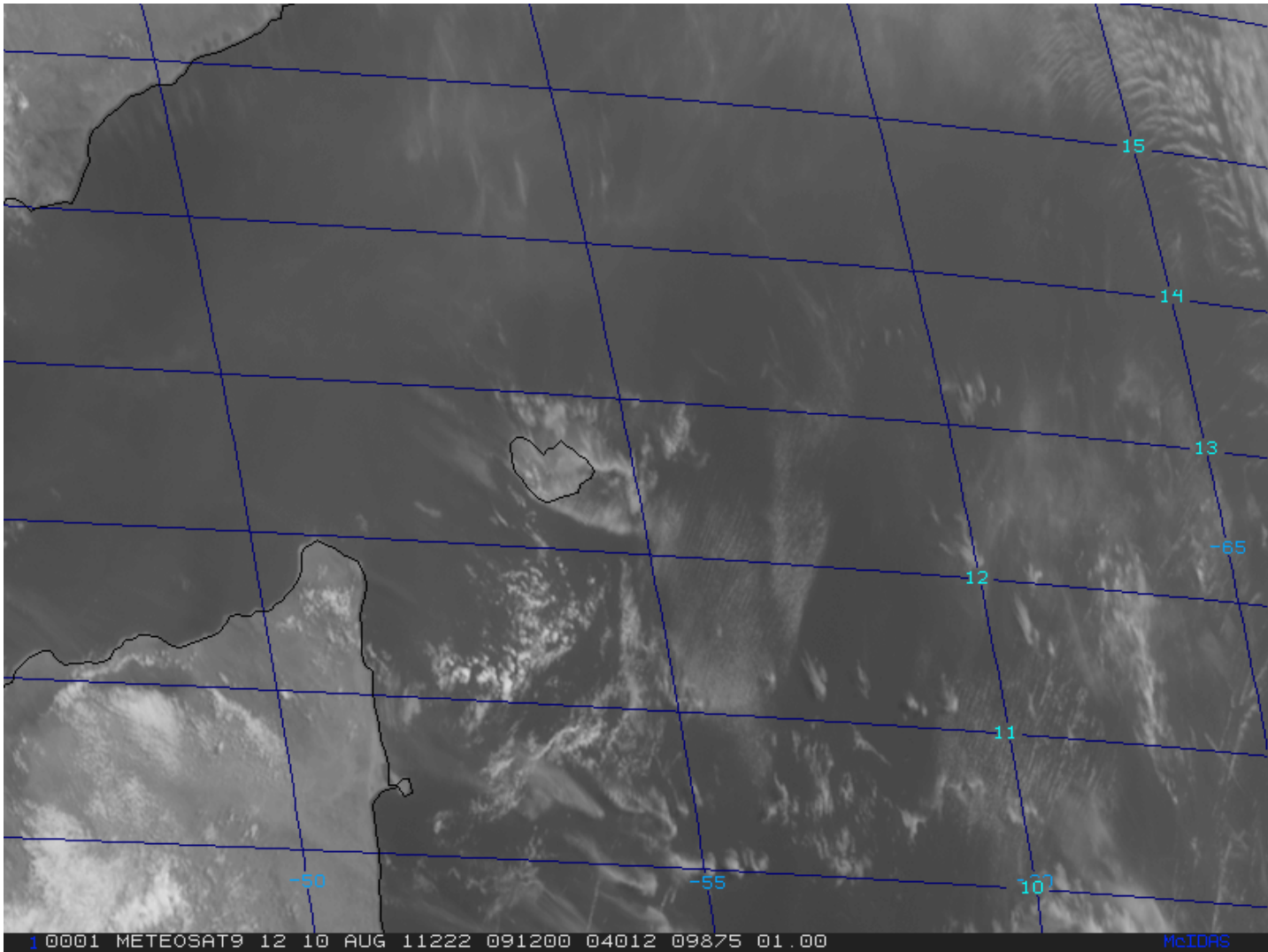
Somali Jet

Case study: Meteosat-9 high resolution visible

Temporal analysis shows strong signal in 12z run 10 August 2011

High resolution visible imagery loop:

09:00-13:30z



Somali Jet

Case study

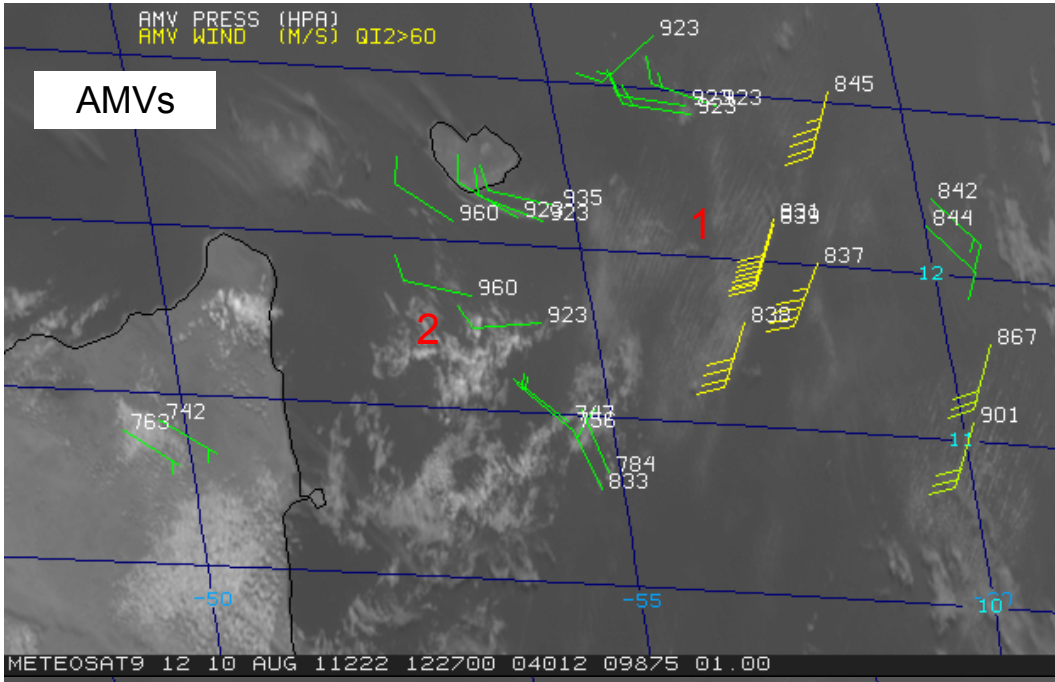
HRVIS winds derived at 1230z

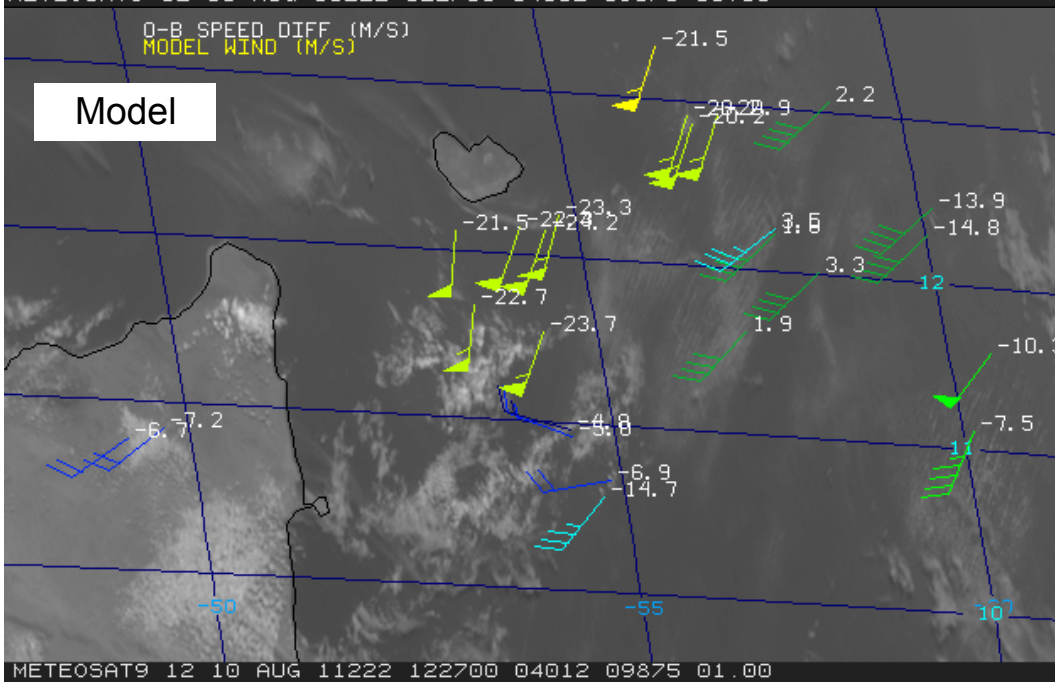
1) Moderately fast AMVs at ~840 hPa tracking narrow bands of clouds aligned parallel to African coast.

- Closely-spaced cloud lines indicative of strong low level winds
- AMVs show good agreement with model speed (some direction error)

2) Brighter, shallow convective clouds

- slow AMVs ~5m/s from west or NW assigned as low as 960 hPa
- collocated model winds > 25 m/s clearly part of Somali jet
- model best-fit pressure well constrained at 700 hPa suggest significant HA error in this case
- few winds assigned 750 hPa show better agreement





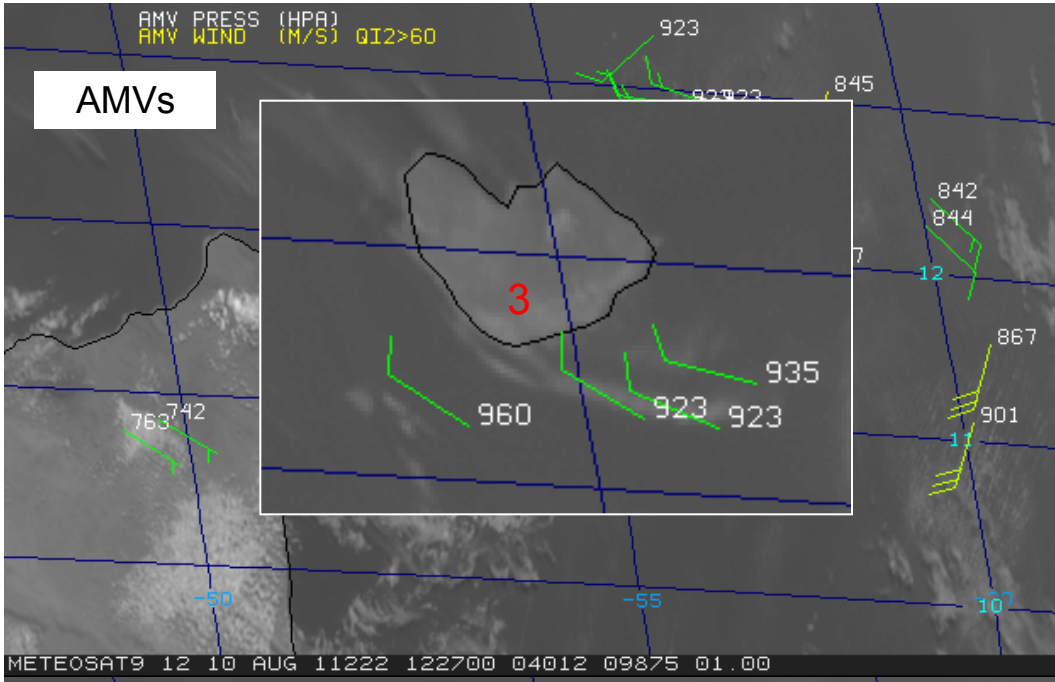
Somali Jet

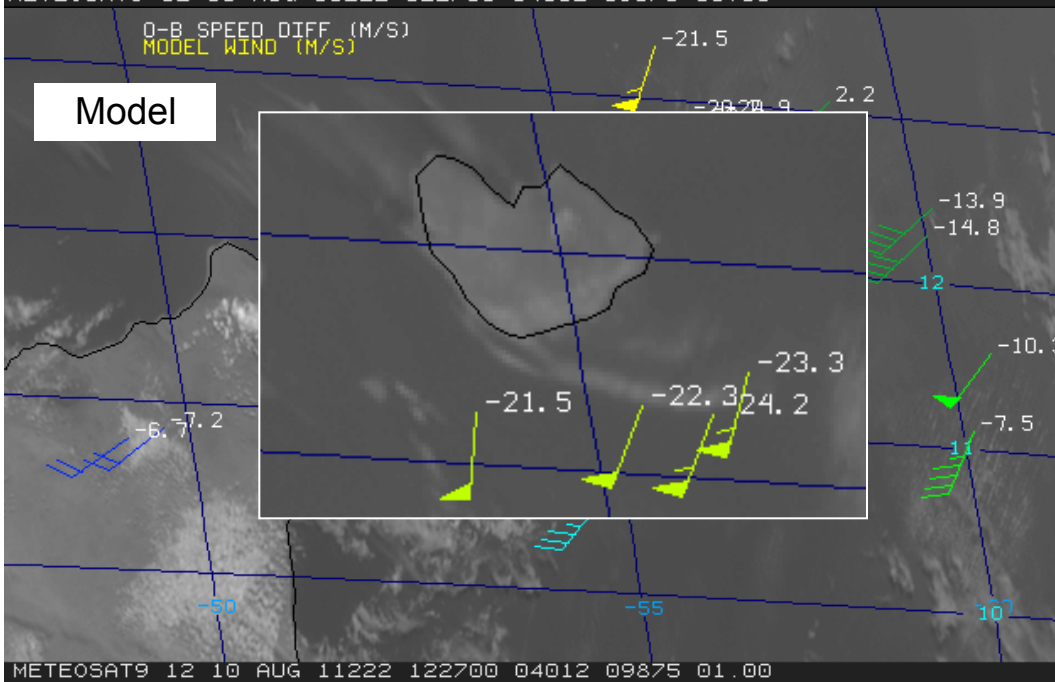
Case study

HRVIS winds derived at 1230z

3) Cloud formation along windward slopes of island

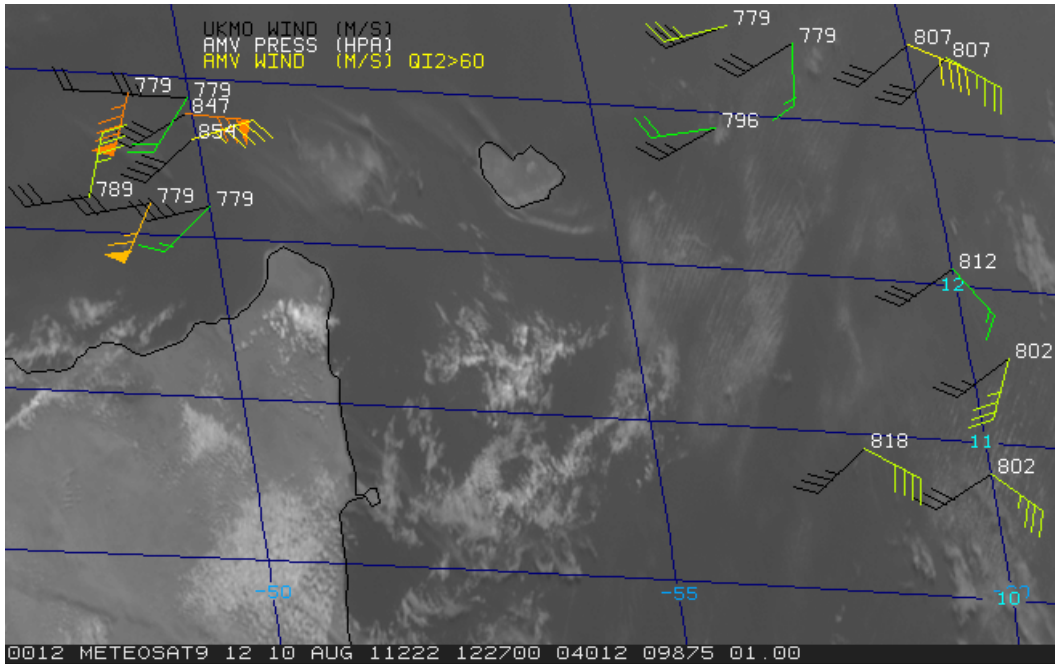
- Clouds suppressed from flowing over terrain in southerly flow indicating inversion
- Slow AMVs tracking a stationary wave-like cloud (gravity wave?) extending out from the island
- Very poor agreement in speed and direction: O-B departures up to 24 m/s
- Slow bias here appears linked to influence of an island, with high mountainous terrain (1500m), in a very strong low level flow





Somali Jet

Case study



Meteosat-7 visible winds

- Some spuriously fast winds
- No AMVs extracted below 900 hPa and none in problematic areas as seen for MSG
- Could be due to lower resolution imagery: Met-7 visible 5km compared to MSG visible 1km or 3km (SSP)

Model improvements

Mid level

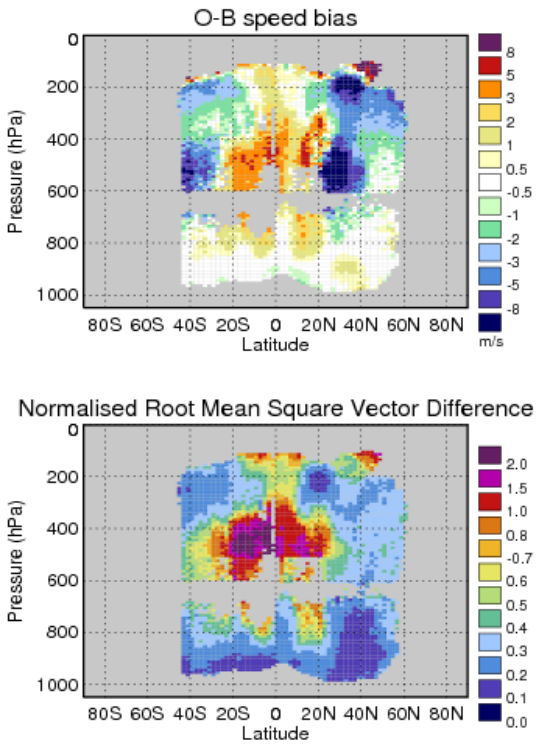
Feature: Generally see fast bias in tropics, slow bias in extratropics

Example: GOES-11 IR

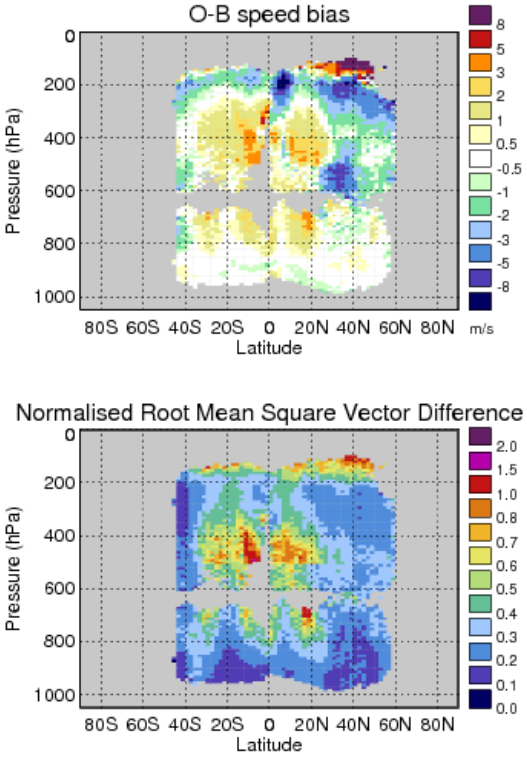
Apparent improvement in mid level biases versus UKMO model (less so ECMWF) in the Pacific

- reduction in O-B speed bias and vector differences
- No observed changes in GOES East

January 2010



January 2011



GOES-11

Mid level

Check trends using long-term time series of CGMS statistics calculated routinely versus UKMO model and Sondes

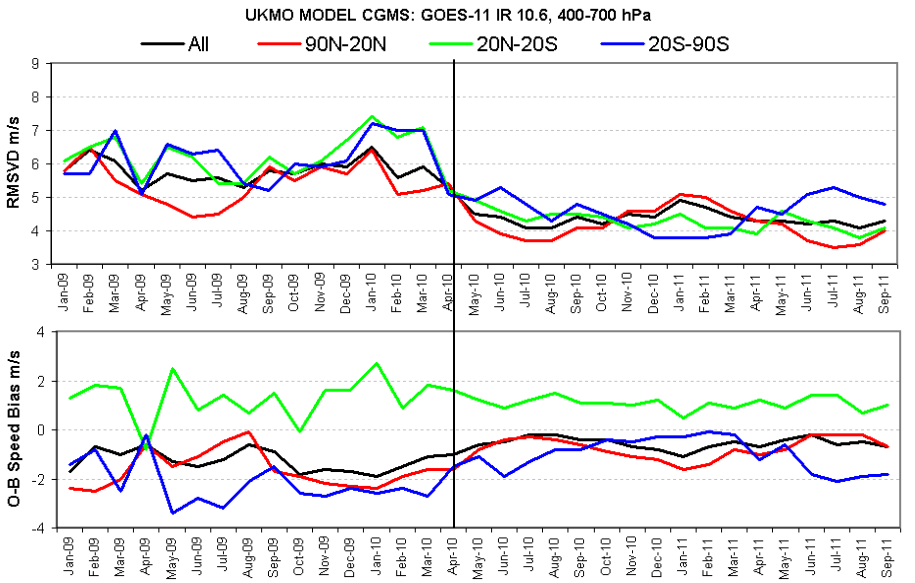
- Improved fit to model for all latitude bands from around April/May 2010
- Drop in RMS and less noise in bias

Statistics look unchanged versus sondes

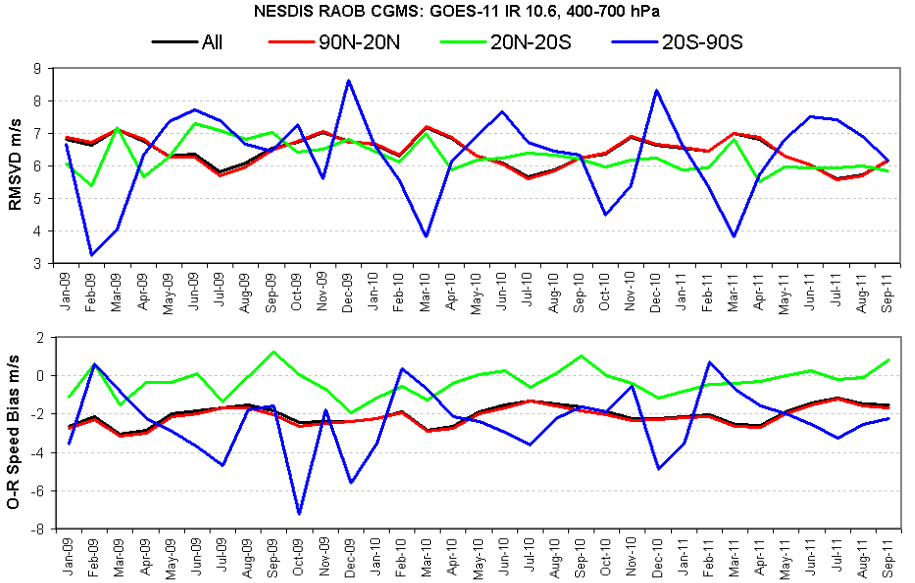
Improved fit due to changes in model winds over Pacific region?

- Nov 2009: vertical resolution increased from 50 to 70 levels – benefits in tropics
- **March 2010**: Large package of changes. Increased horiz resolution to 25km (n512) - improvement in extratropical winds
- July 2010: updated cloud scheme – better tropical temp profiles and therefore winds

UKMO model



Radiosondes (Hongming Qi, NOAA)



MTSAT
High level

Met Office

The EUMETSAT Network of Satellite Application Facilities

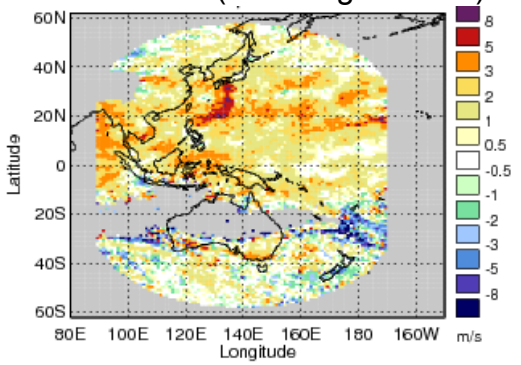
NWP SAF Numerical Weather Prediction

Feature: well-structured areas of fast bias in NW Pacific

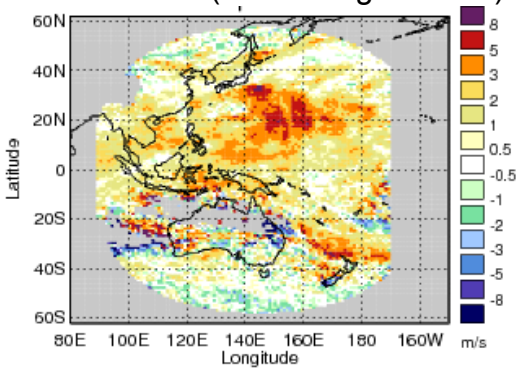
Season: July-Sept

Channels: cloudy WV

MTSAT-1R WV (3-15 August 2011)

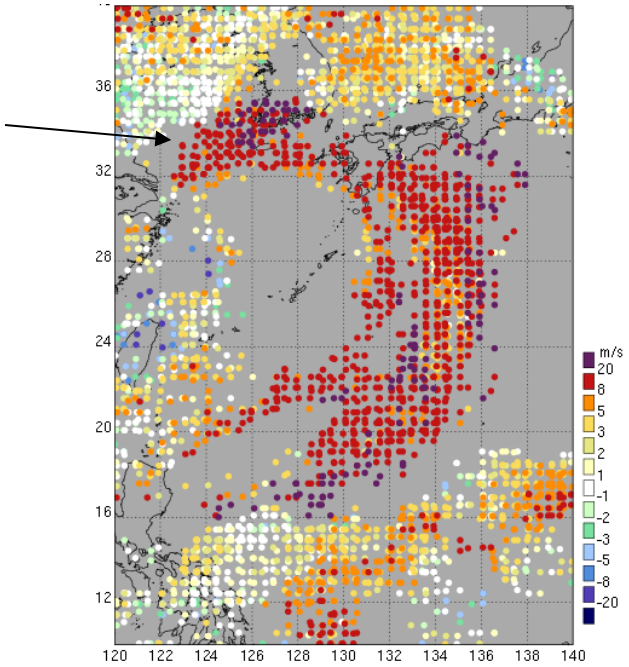


MTSAT-2 WV (rest of August 2011)



Hovmoeller plots indicates strong signal 5/6 August near 20-35N

- Large swathe of winds much faster than collocated model estimates
- O-B in excess of 20m/s in worst case



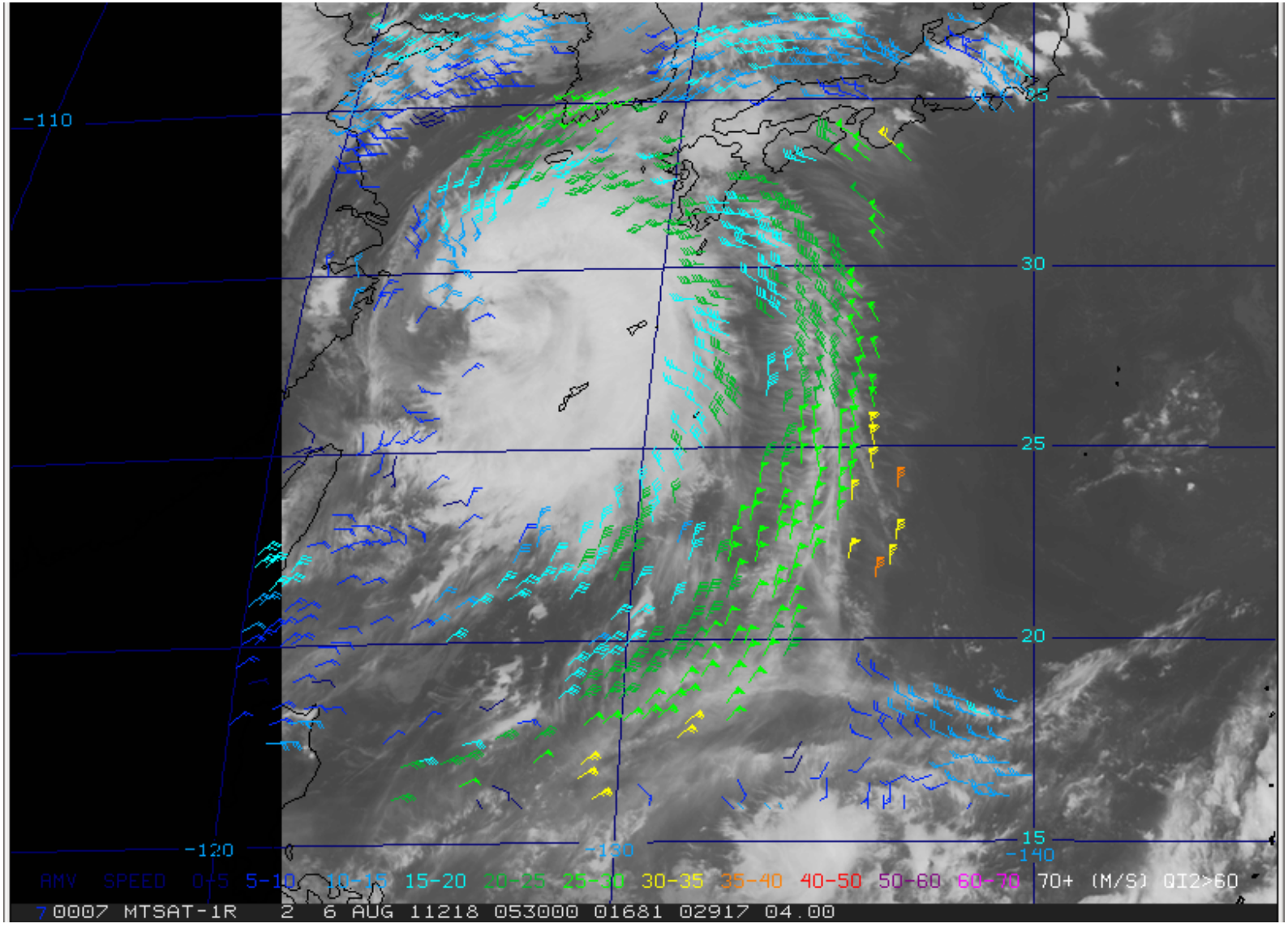
MTSAT-1R WV 06z 6 August 2011

MTSAT

High level

MTSAT-1R
WV winds

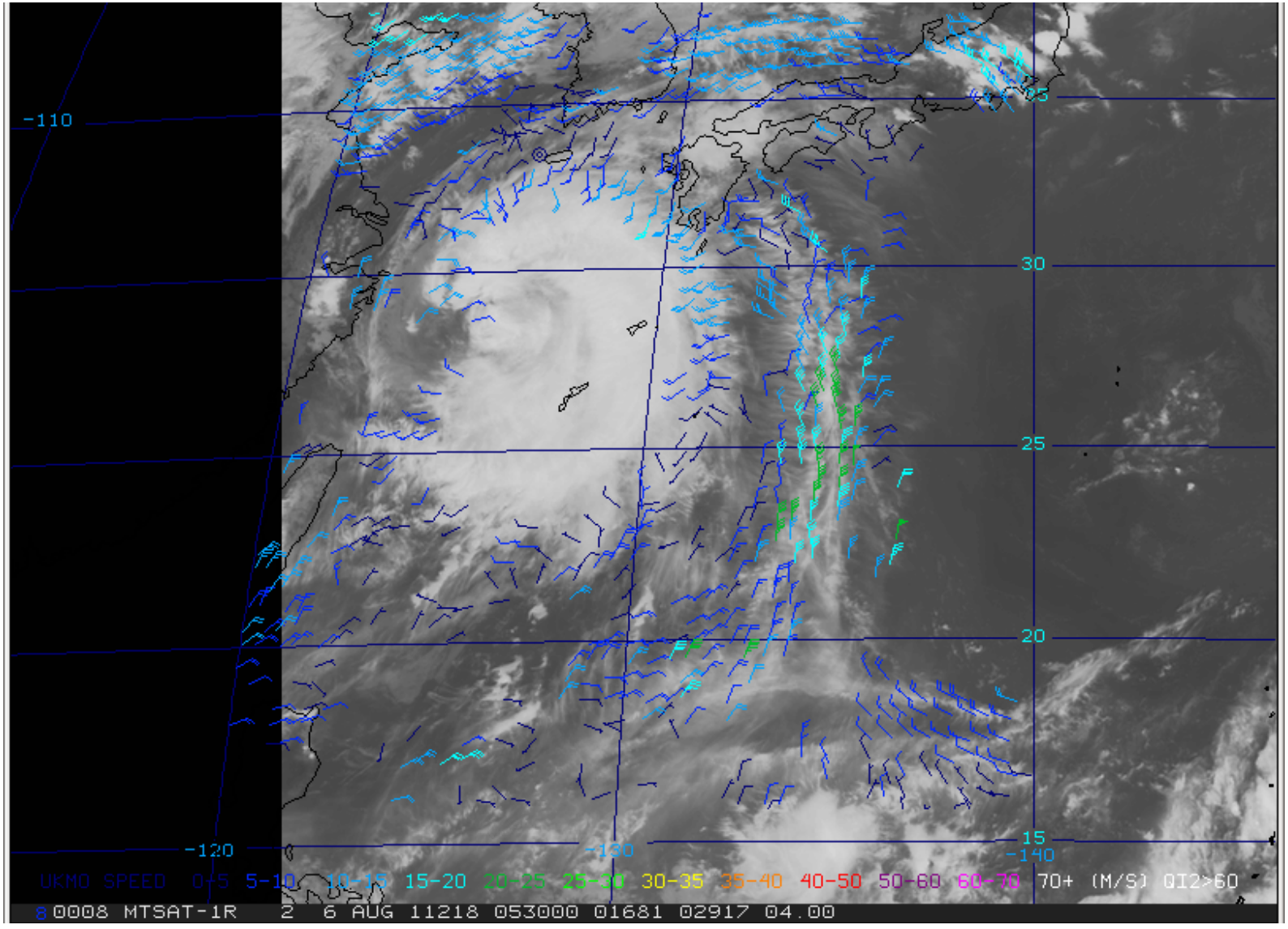
(IR imagery)



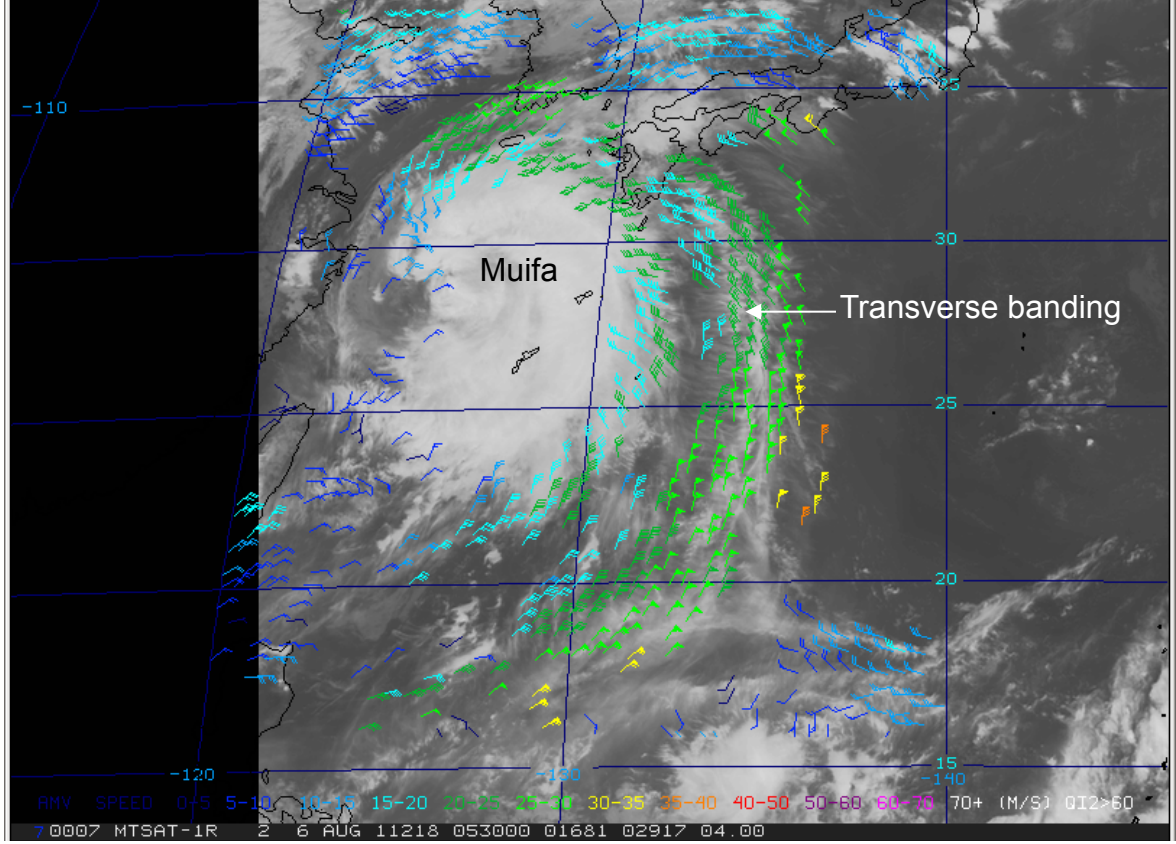
MTSAT

High level

Collocated UKMO model winds



MTSAT
High level



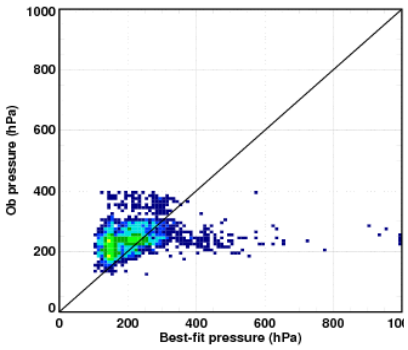
Problem AMVs tracking high level outflow from Typhoon Muifa centred to SW of Japan

Winds look consistent with a smooth clockwise flow following upper level cirrus – high QI values (without FG)

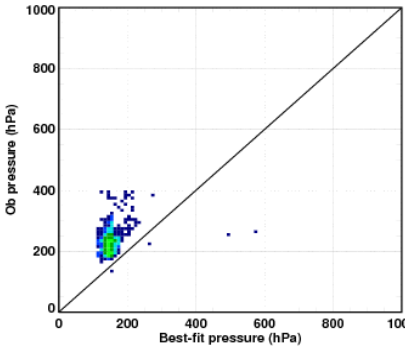
Comparison with model best-fit pressure

- WV winds assigned ~40 hPa too low (A)
- Cluster of WV winds causing the fast bias assigned 180-280 hPa, model 110-180 hPa (**B**)
- IR winds mean press difference of just 3 hPa (C)

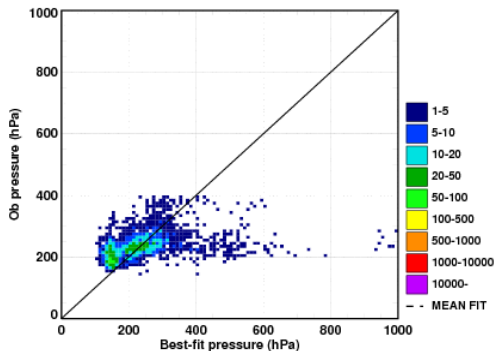
(**A**) MTSAT-1R WV



(**B**) MTSAT-1R WV O-B > 8m/s



(**C**) MTSAT-1R IR



WV intercept heights vs model best-fit pressure

Summary

Summary

NWP SAF AMV monitoring hosts collection resources aimed at better understanding AMV error characteristics

- Monthly O-B plots showing departures against UKMO and ECMWF global models. Rolling 3-year archive. Can help separate model/AMV error.
- Analysis reports produced every 2 years to tie in with IWW. Examine new data sets and maintain a record of features identified in the monitoring.
- One-off investigations
- Information on how AMVs are used in NWP

Looking for any user requirements, suggestions..

Questions