Topic 2
International Winds Working Group (IWWG)
11th Workshop -- AMV Impact Studies

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IWWG Workshop Topics

1. AMV impact intercomparison
2. Better AMV error characterization
3. New and future AMV products
4. Simulated AMV studies
5. Mesoscale AMVs
6. Other avenues in AMV assimilation

IWWG Background

Provides a forum to discuss and coordinate research and developments in data production, verification/validation procedures, and assimilation techniques.

- Established in 1991
- Became a formal working group of the Coordination Group for Meteorological Satellites (CGMS) in 1994
- Currently about 50-60 active members.

Focus on derivation and applications of atmospheric winds derived from:

- Geostationary and polar imagery (clouds and water vapor)
- Radar backscatter & conical microwave radiometers (ocean surface winds)
- Research instruments (e.g., MISR)
- Future instruments (space-borne LIDAR, Geo-Hyperspectral)

Biennial Workshops, with the most recent (IWW11) held February 2012 in Auckland, New Zealand

- NWP centers from the following organizations were represented at the workshop: NCEP, NASA, JCSDA, ECMWF, UK Met Office, DWD, Météo-France, FNMOC, NRL, JMA, and KMA.

http://cimss.ssec.wisc.edu/iwwg/iwwg.html

1. AMV impact intercomparison
Background

From Lars Peter Riishojgaard's presentation at the previous IWW10 in 2010:

- Diminished relative impact of AMVs in some global NWP systems as recorded in the last WMO sponsored impact workshop (Geneva, May 2008)
- However, some adjoint sensitivity studies show very significant impacts, especially on a per observation basis
- Inconsistencies among assessments of AMV impact

To address this:

IWW10.1: NWP centers to coordinate a joint AMV and scatterometer data denial study, also looking at adjoint sensitivity statistics where available. Aim to summarize in a report to the WMO GOS impact workshop and IWW11.

CGMS-A39.30: The co-chairs of IWWG and CGMS representative requested to discuss the results from NWP impact studies at IWW11 and to synthesize general observations on performance.

1. AMV impact intercomparison
Study details

Expand on the preliminary study from 2008/09 by selecting two longer trial seasons (6 weeks) and coordinating a more consistent approach to producing verification results.
Period 1: 15 Aug – 30 Sep 2010, NH summer, captures all major Atlantic hurricanes
Period 2: 1 Dec 2010 – 15 Jan 2011, NH winter

Test options:
- AMV denial (Periods 1 and 2)
- Scatterometer denial (Period 1)
- Polar AMV denial (Period 2)
- Sensitivity study (Period 1)

Results from 8 NWP centers

Focus on AMV results

	No AMV	No Scat	No Polar	Sensitivity
DWD	✓ ✓	✓	✓	
ECMWF	✓ ✓	✓	✓	✓
GMAO				✓
JMA	✓ ✓	✓	✓	✓
KMA	✓ ✓			
Météo-France	✓ ✓		✓	✓
NRL	✓ ✓	✓	✓	✓
UKMO	✓ ✓	✓		✓

1. AMV impact intercomparison
Analysis

Identified plots to be produced in an agreed form to enable easier comparison:

- Impact on 200/250 hPa analysis wind field
- Fit of first guess and analysis to radiosonde winds
- Impact on T+48 RMS forecast error for 500 hPa geopotential height
- Time series of T+24 mean and RMS wind error at 850 and 200/250 hPa
- Forecast Sensitivity
  - Bar charts of forecast sensitivity to all observation types
  - Break down of forecast sensitivity for AMVs by satellite-channel
  - Maps of mean impact/sensitivity by level

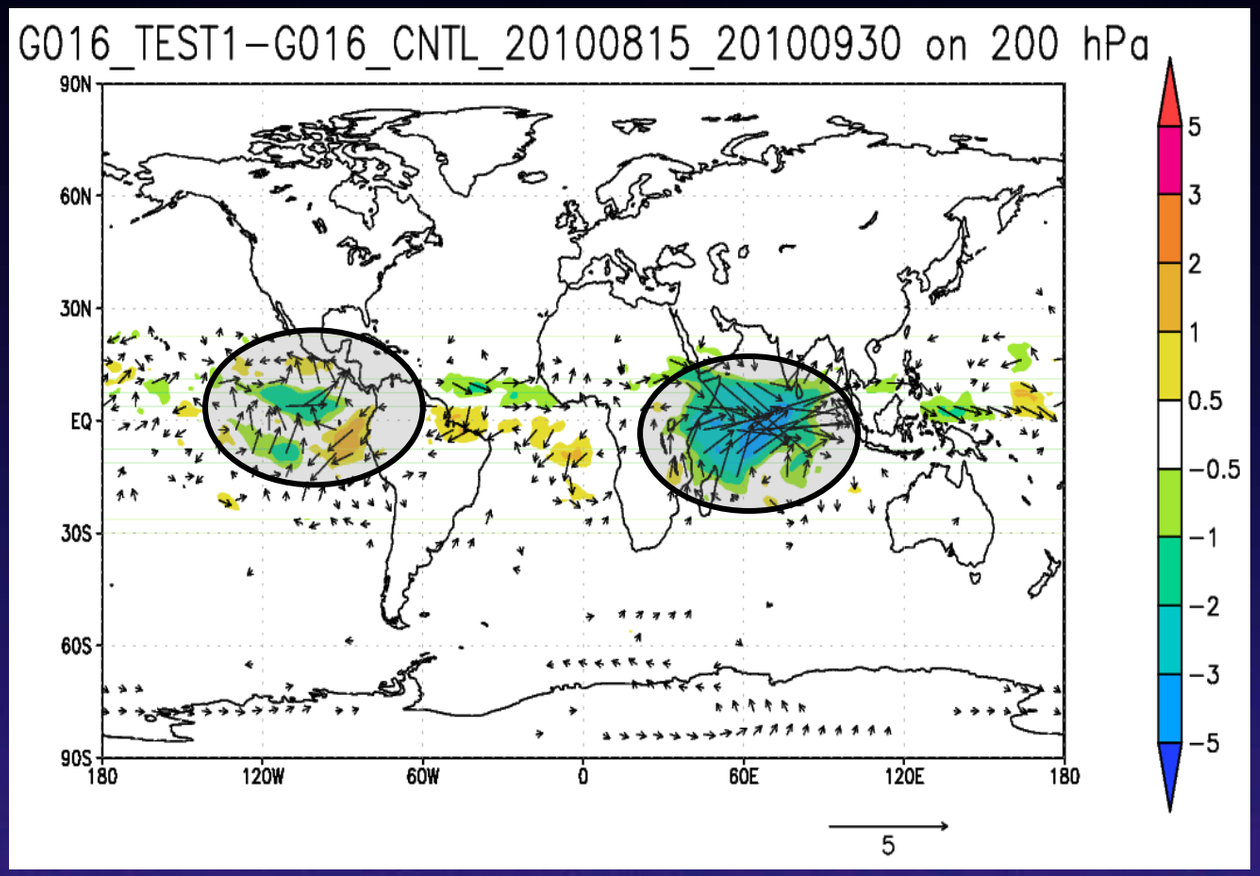
Analyzed differences in:

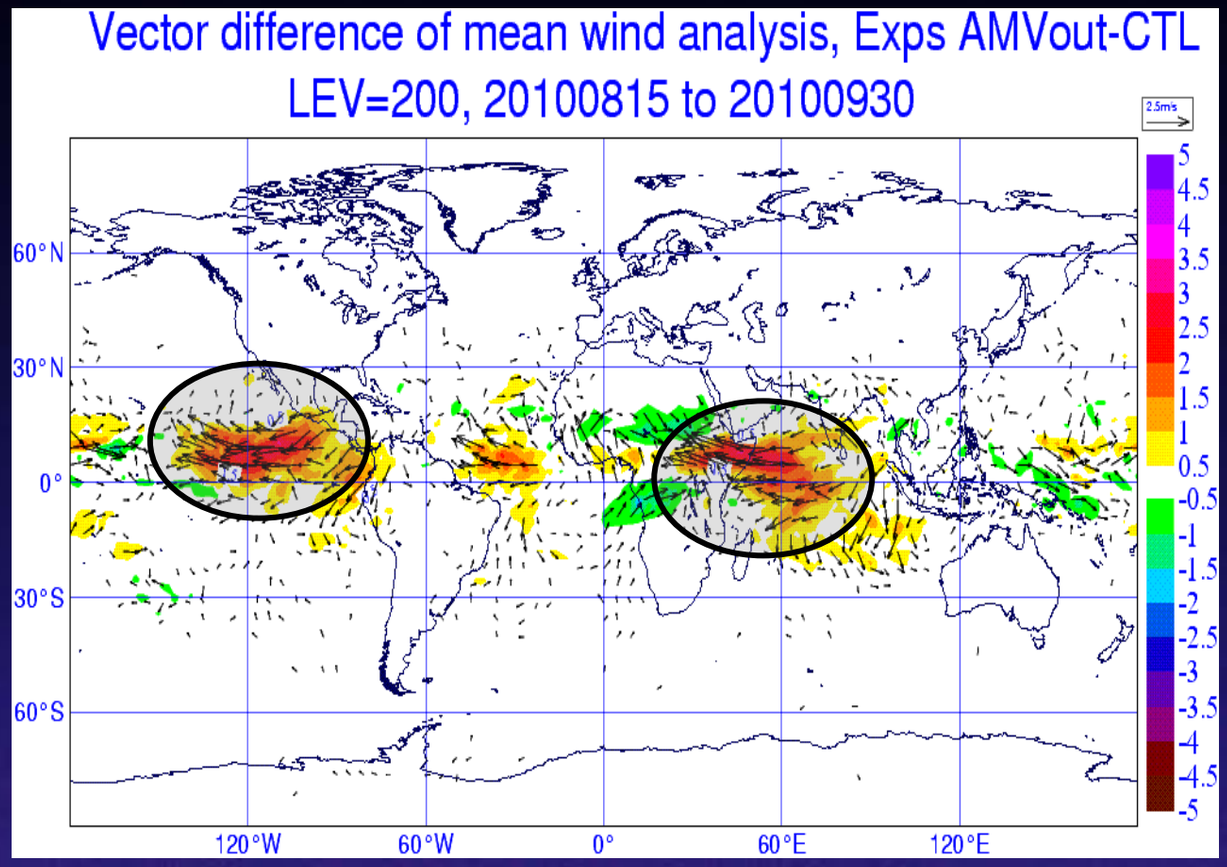
- NWP configurations (resolution, 3D-Var/4D-Var)
- AMV types assimilated and QC
- Other observation usage

1. AMV impact intercomparison Highlights

Impact on mean wind analysis at 200/250 hPa:

- Concentrated in tropics: Eastern Pacific and Indian Ocean
- Impact not consistent between centers:
  - During Period 1 there is a predominantly easterly mean flow in the tropics.
  - The inclusion of the AMVs tends to enhance the easterly flow at DWD, JMA, and NRL, but reduce it at ECMWF and Météo-France



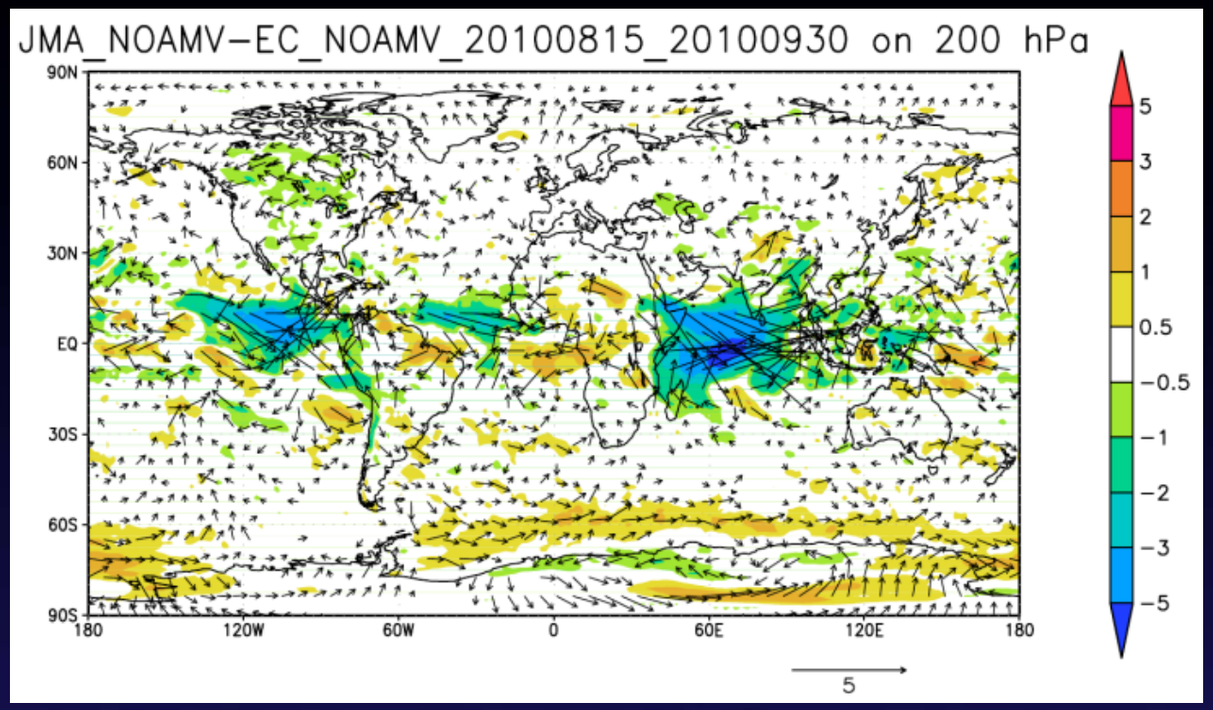


Denial – Control: green/blue represent where the analysis is faster as a result of assimilating AMVs

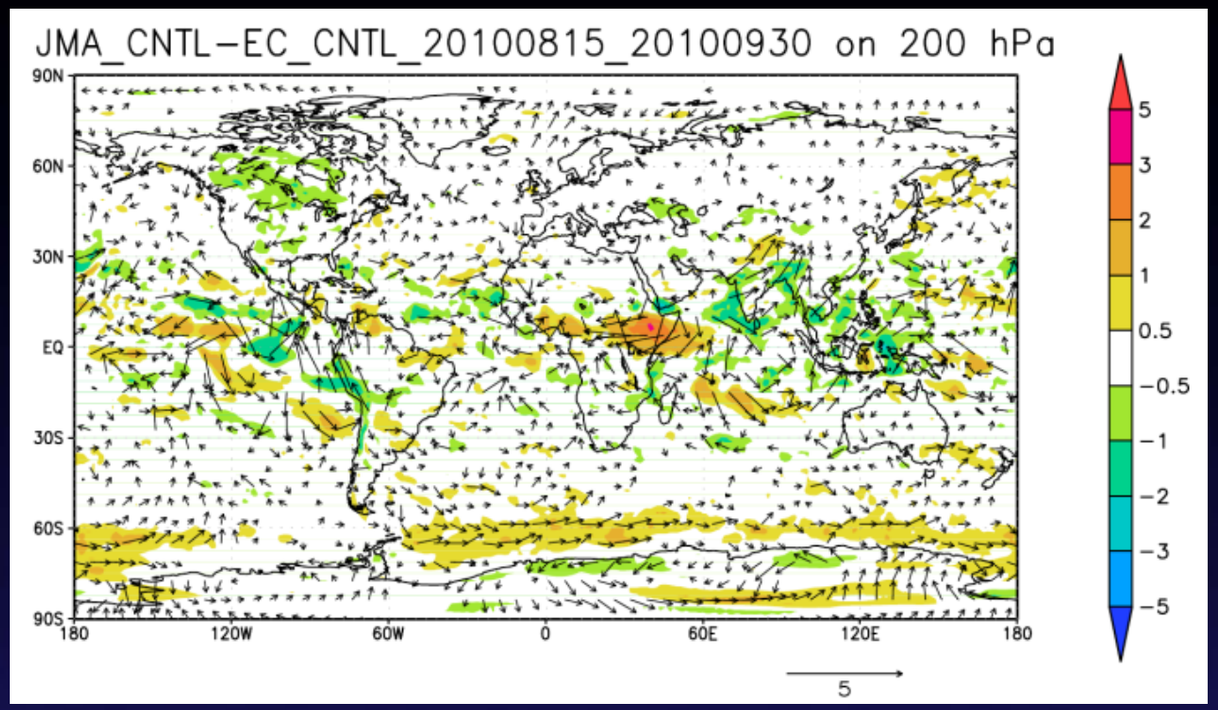
1. AMV impact intercomparison Highlights

Can we explain the different impacts in tropics?

Compare JMA and ECMWF wind analyses with and without AMVs



JMA - ECMWF (no AMVs)



JMA - ECMWF (with AMVs)

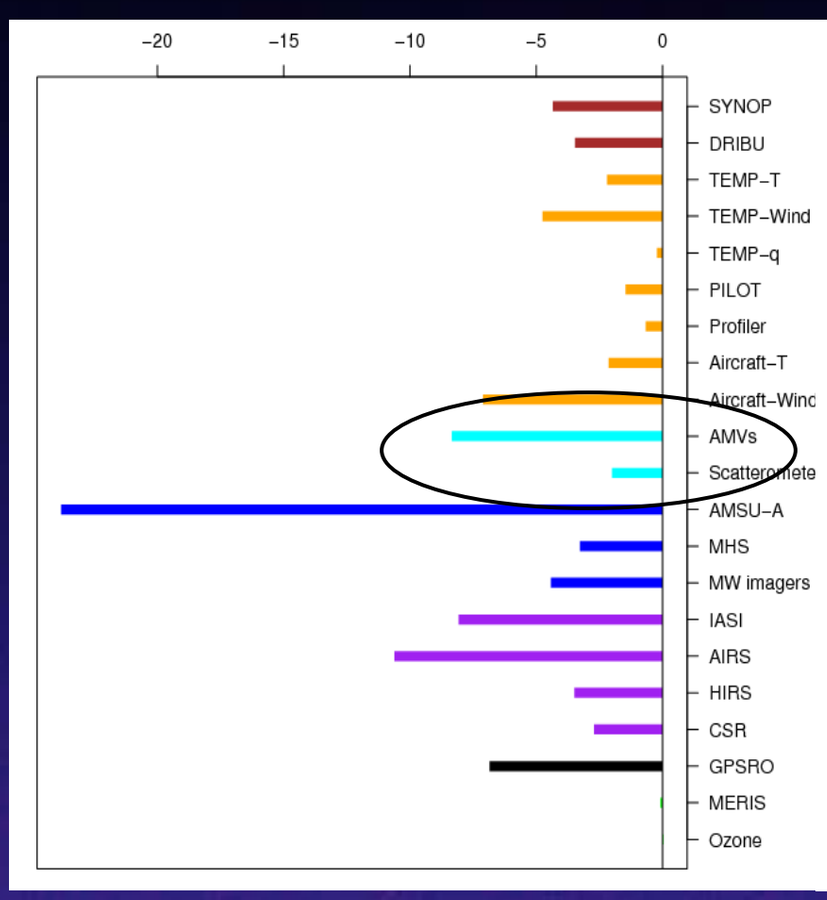
- Overall differences between ECMWF and JMA are significantly smaller in the experiments with AMVs than in the denial experiments
- The differences seen in the AMV denials are likely due to differences in the climatology of the forecast models of the centers
- AMVs act to bring the two systems in better agreement

1. AMV impact intercomparison Highlights

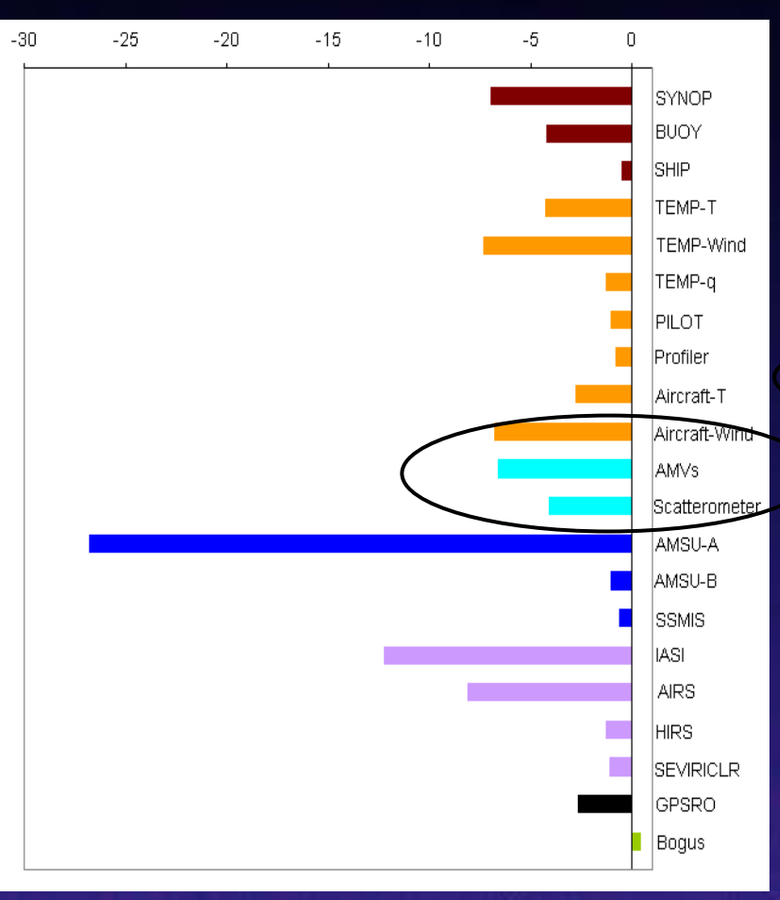
Forecast Sensitivity to Observations (FSO)

Adjoint-based FSO method gives estimate of the contribution of each observation towards reducing the 24-hour forecast error:

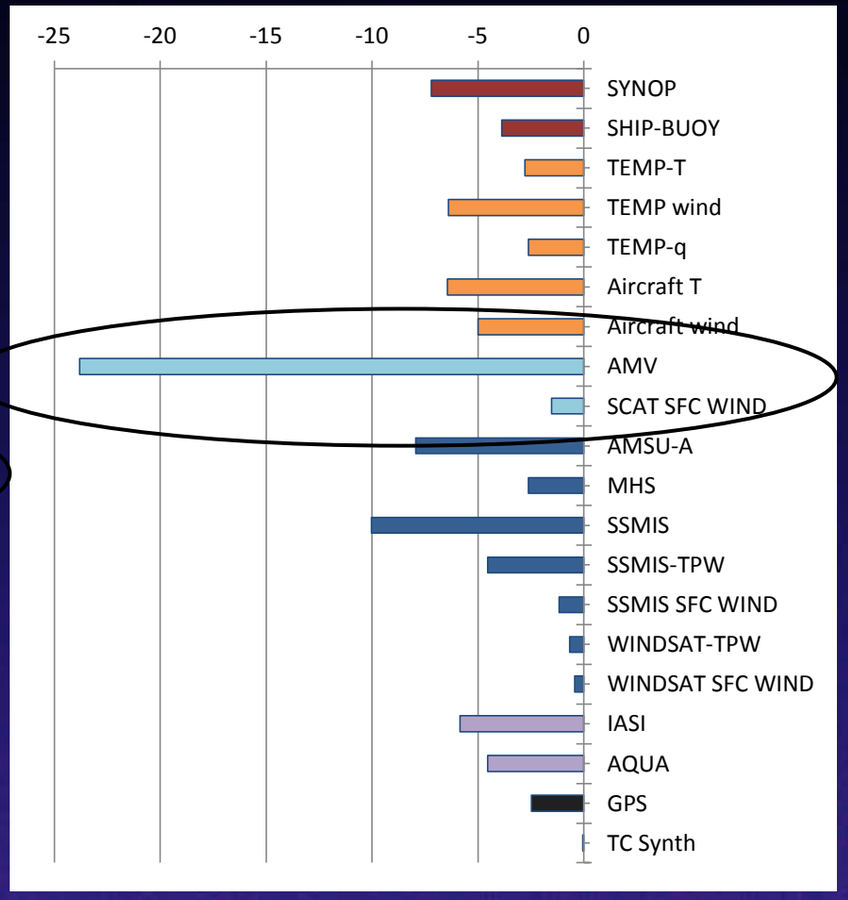
- ECMWF, Met Office: AMV FSO10%
- NRL: AMV FSO 23%



ECMWF



Met Office



NRL

1. AMV impact intercomparison Summary

- In general, the study demonstrates a consistent level of positive forecast impact from AMVs across all NWP centers
- Nearly all centers see a strong impact on the tropical mean wind analysis
- Larger AMV impact from NRL, whose FSO statistics suggest a different impact from the various components of the observing system
- Unlike previous findings, there are no apparent geographical regions where the AMVs are performing consistently poor, suggesting most regions of varying impact are mainly NWP system-dependent (QC, thinning, assimilation scheme, forecast model, etc.), rather than AMV-dependent (by processing center)
- In addition to the traditional data denial study, the FSO statistics further indicate significant relative importance of the AMVs in the global observing system context.

2. Better AMV error characterization

New methods are emerging for the AMV derivation, in terms of the:

- Tracking (e.g., nested tracking)
- Linking of tracked targets and height assignment (Cross-Correlation Contribution, CCC)
- Actual height assignment (optimal estimation-based methods with error estimates, cloud phase estimates, layer heights, etc.)
- Quality Control (Quality Indicator (QI), Expected Error (EE))

These provide new information on the winds derivation and situation-dependent AMV characteristics.

They offer an opportunity to address a long-standing request from NWP centers: Improve the error characterization of the AMVs and its height assignment.

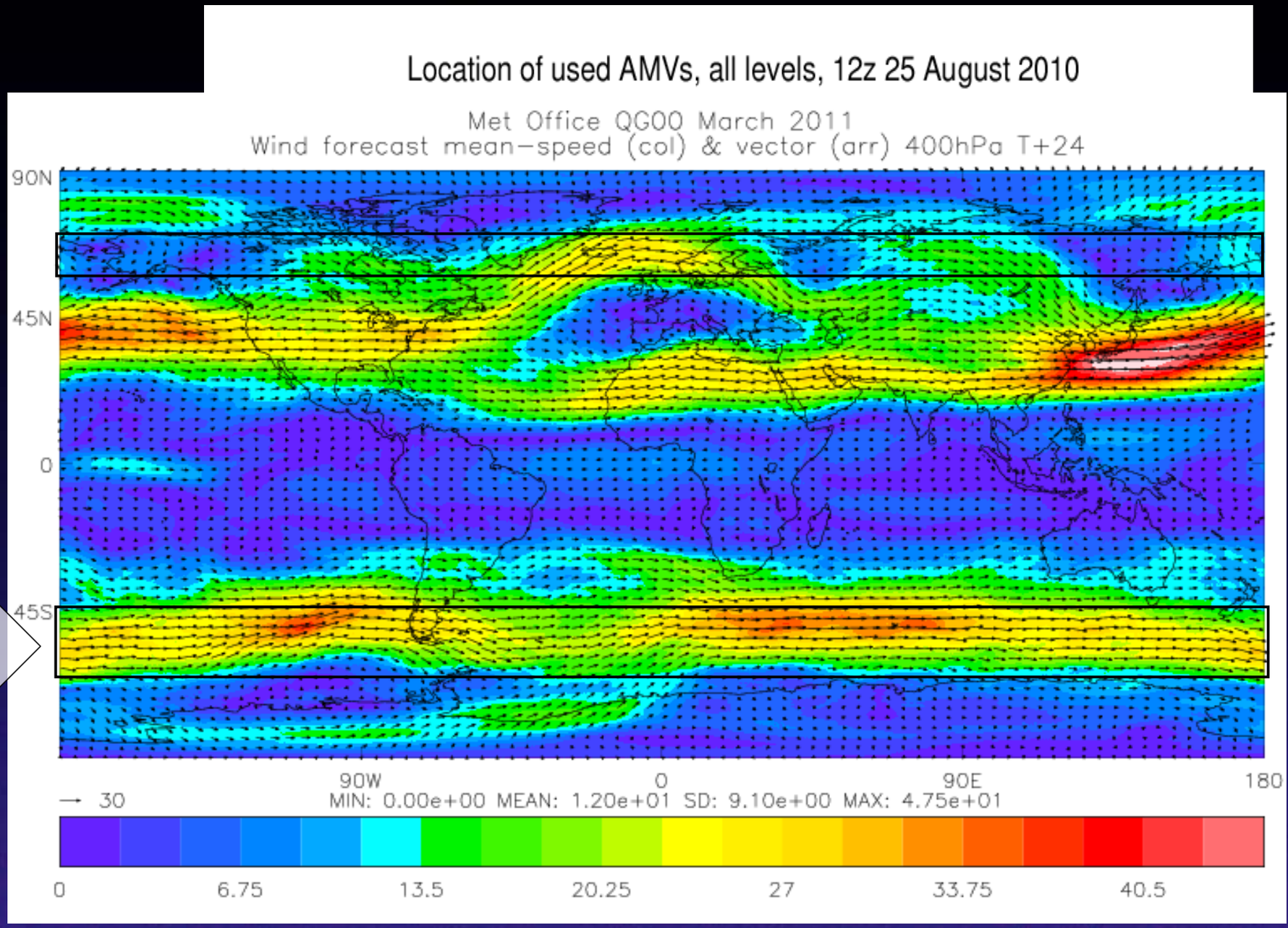
3. New and future AMVs/products

A number of new AMV products have been developed recently or will be developed:

- Leo/Geo AMVs derived from a blend of instruments over the high latitudes
- VIIRS polar AMVs which continue the AVHRR heritage
- Metop-A/B mixed AMVs which should provide global coverage using the two AVHRR instruments operated in tandem on the Metop-A and Metop-B spacecrafts flying in the same orbit approximately 50 min apart.
- Canadian Space Agency (CSA) to embark on providing imager data from a highly elliptical orbit (Polar Communications and Weather satellite, PCW). This will result in geostationary-like wind coverage in the polar regions, with expected lower tracking errors due to higher temporal resolution images.
- Sounder-derived AMVs
- AMVs produced from new operational satellites (China, Korea, India)
- MISR AMVs

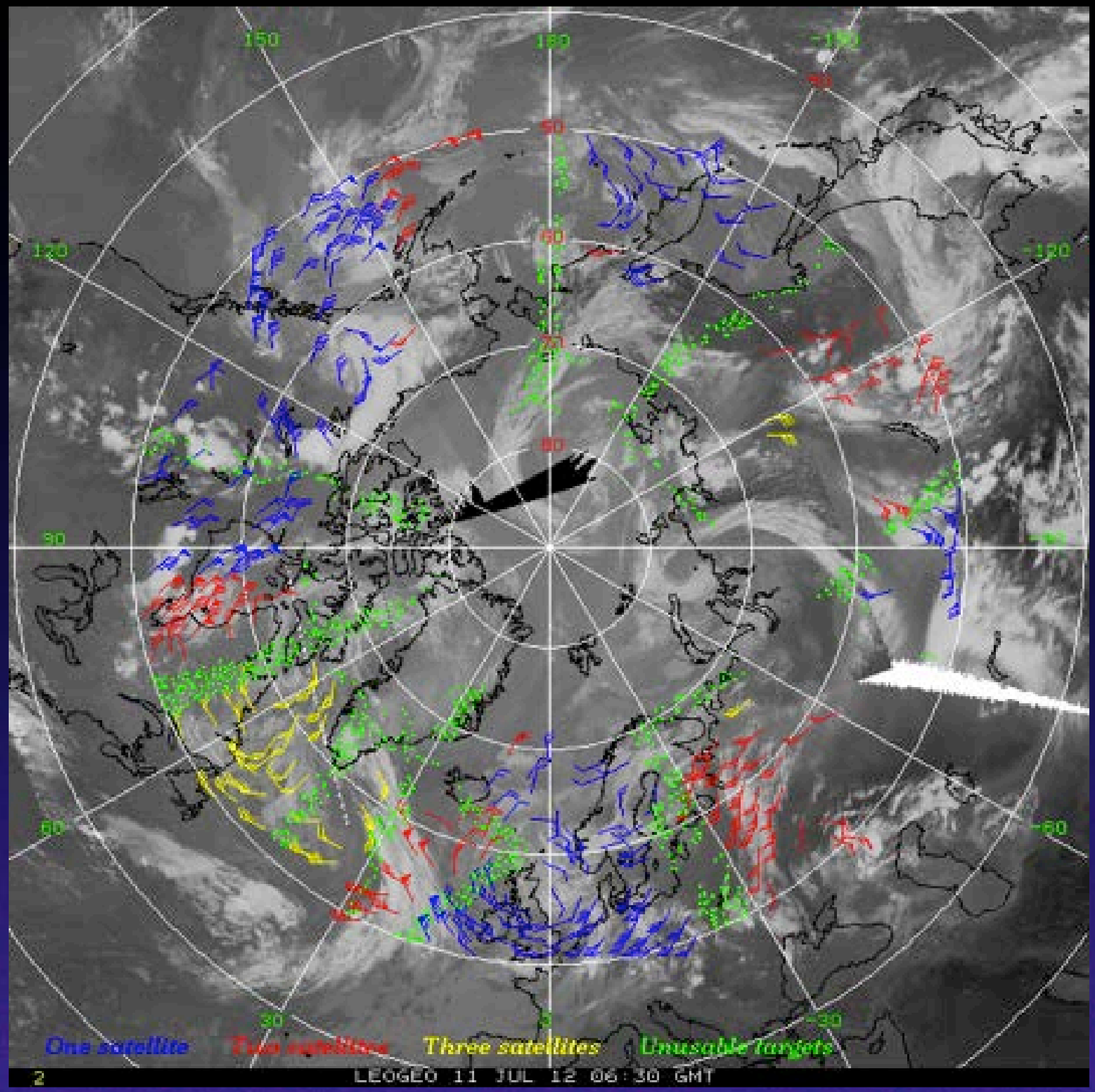
3. New and future AMVs/products: Identify AMV coverage gaps

- Key high-latitude baroclinic areas are currently void of AMV observations
- Lack of other wind data in AMV data voids
- Useful for constraining polar front jets



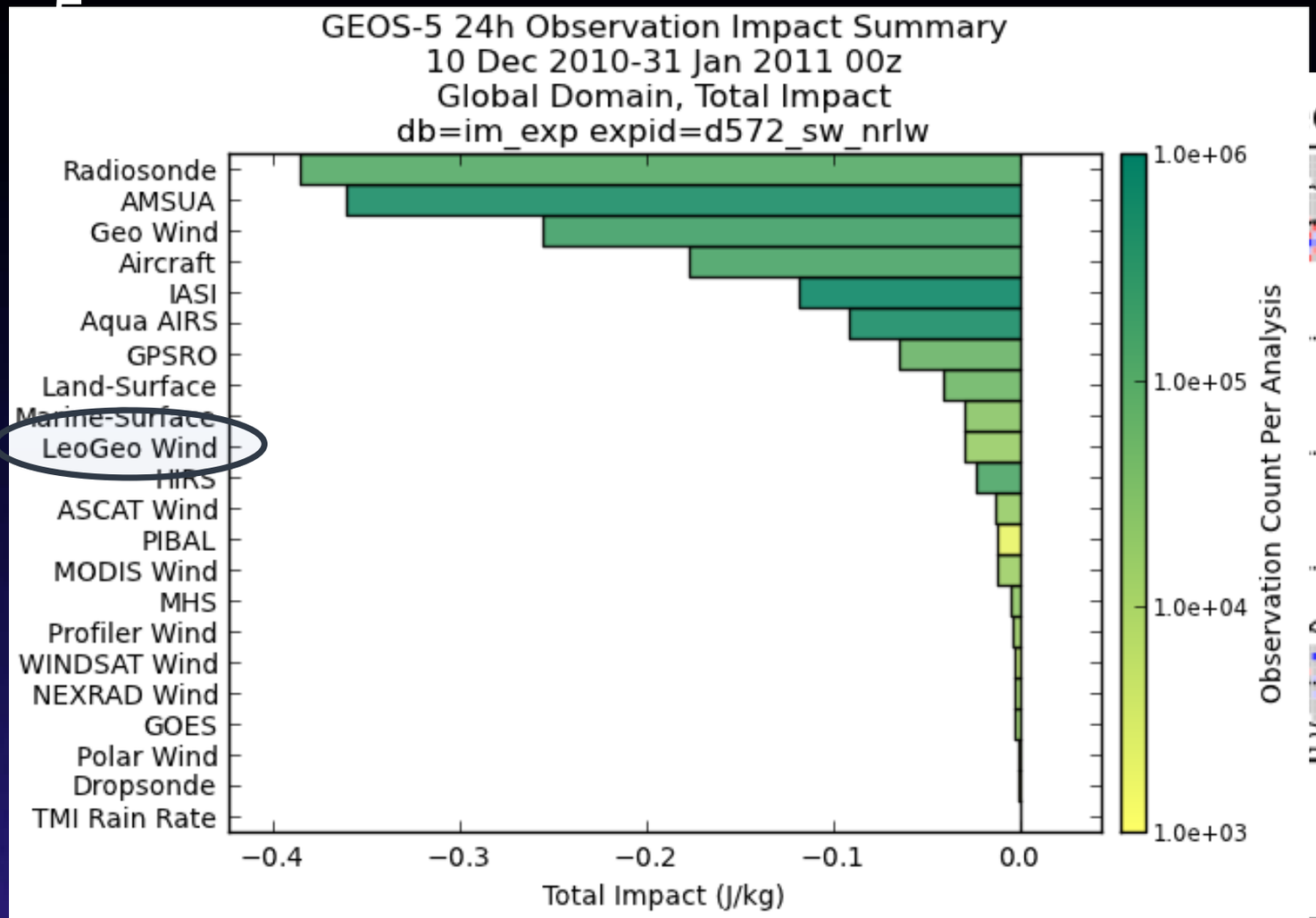
3. New and future AMVs/products: Closing the gap with Leo/Geo winds

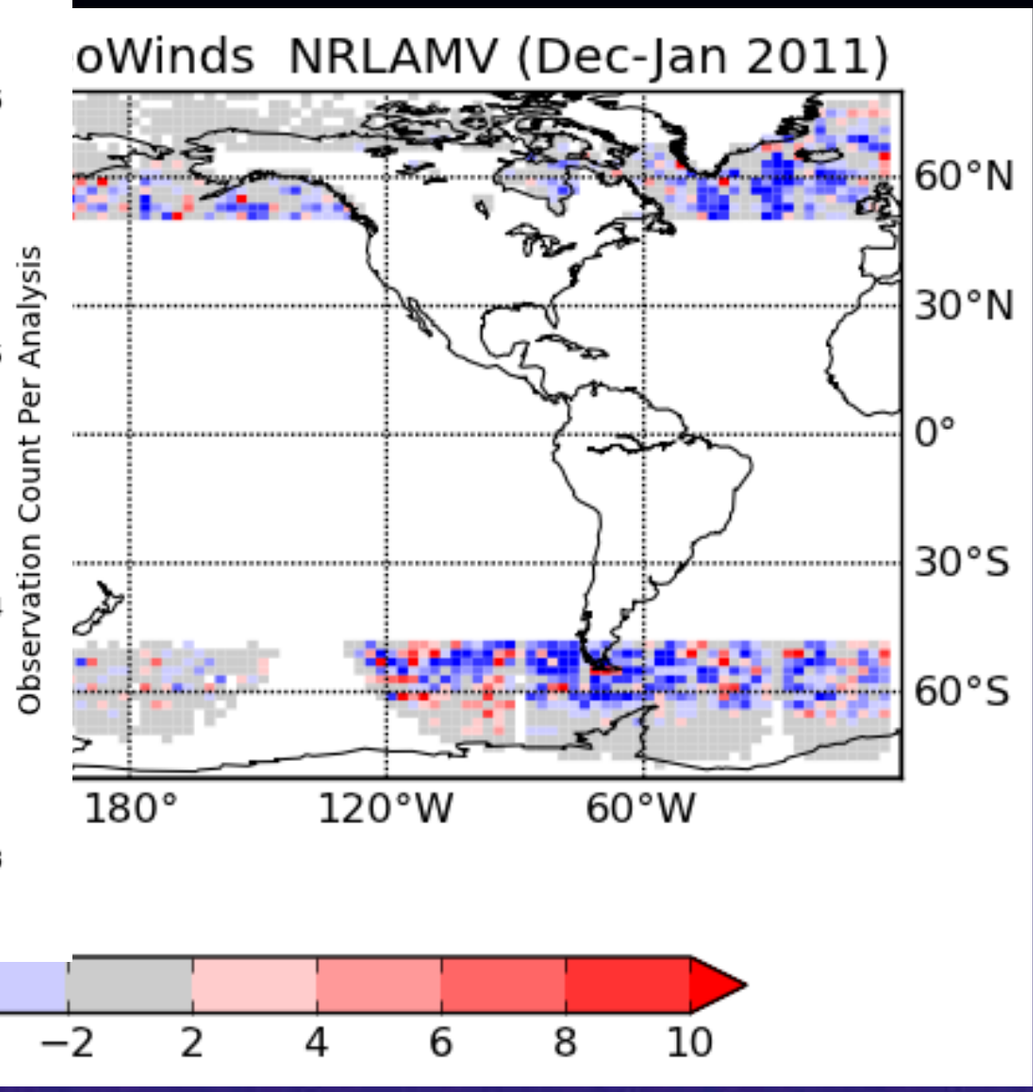
- Composites of GOES, Meteosat, FY-2, MTSAT, AVHRR, MODIS
  - AVHRR: Metop A, NOAA-15, 16, 18, 19
  - MODIS: Terra and Aqua
- Tracking clouds in infrared window channel, accounting for:
  - Variable pixel time
  - Parallax



3. New and future AMVs/products: Closing the gap with Leo/Geo winds

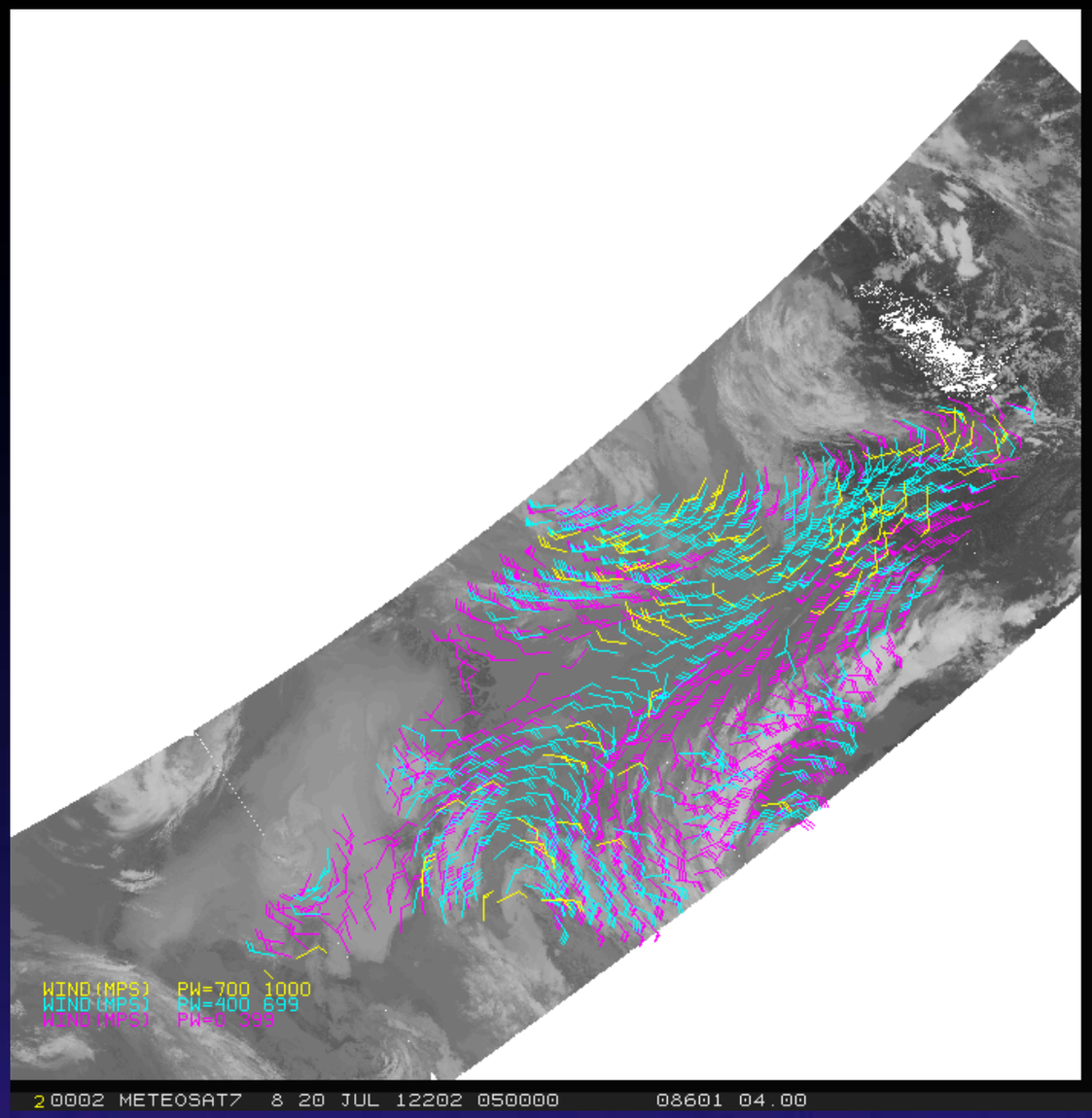
Impact of Leo/Geo winds: NRL superobbed winds in NASA GMAO GEOS-5



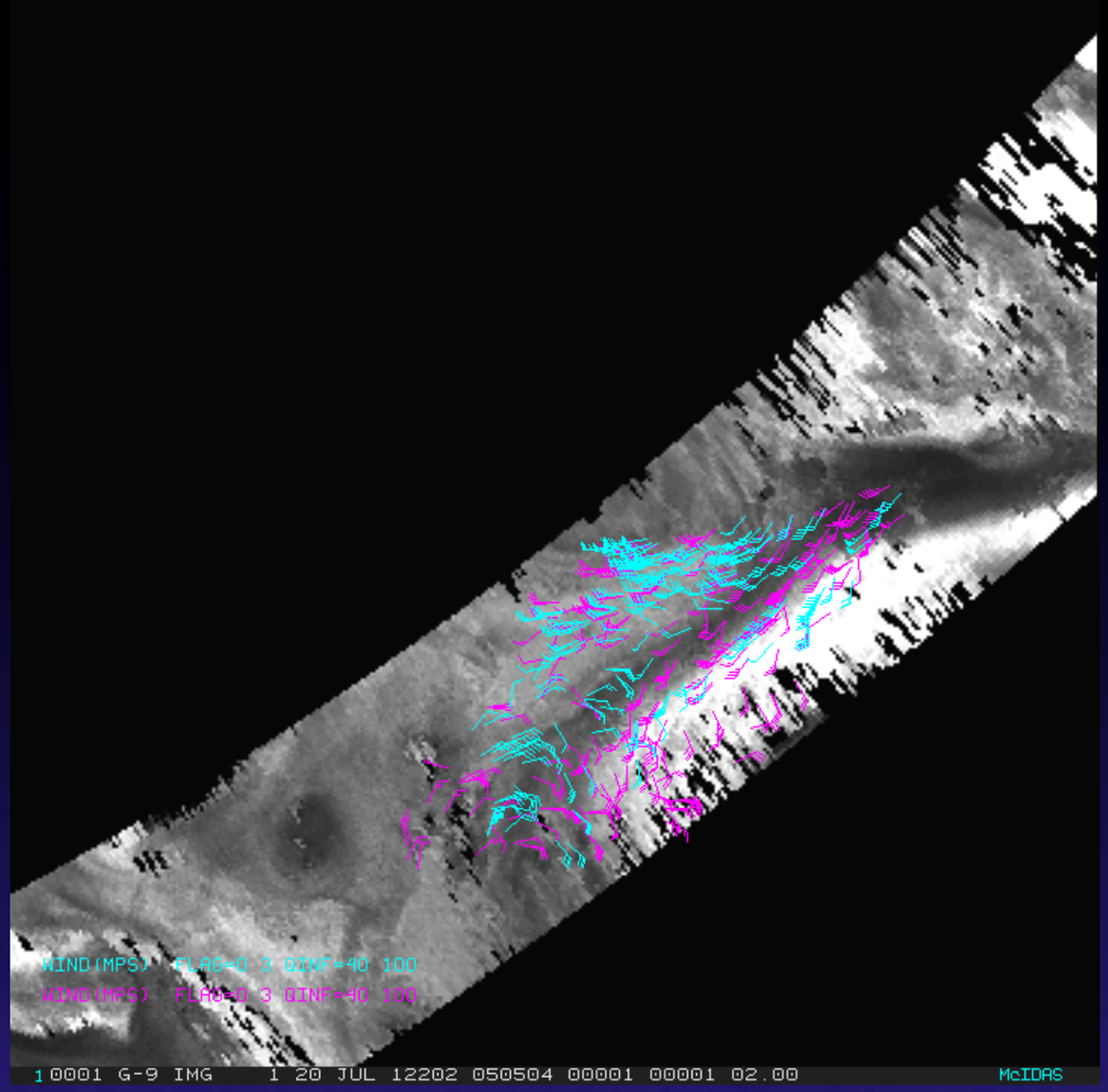


Courtesy of Dagmar Merkova and Ron Gelaro

3. New and future AMVs/products: Sounder-derived AMVs

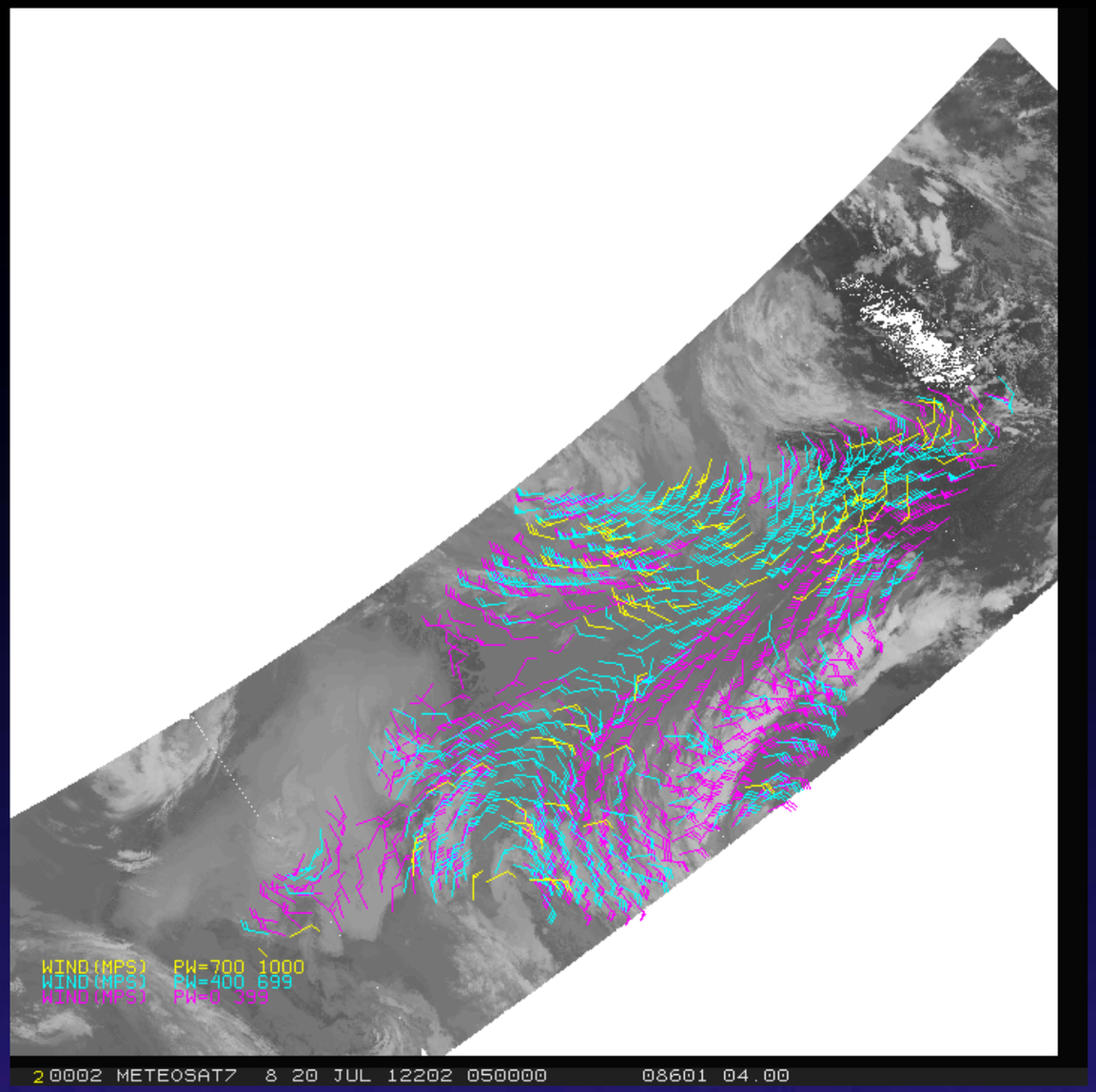


MODIS 20 July 2012 0551 UTC
Infrared and Water Vapor
(including clear sky)



AIRS 20 July 2012 0505 UTC
Ozone: 103 to 201 hPa
Moisture: 359 to 616 hPa

3. New and future AMVs/products: Sounder-derived AMVs



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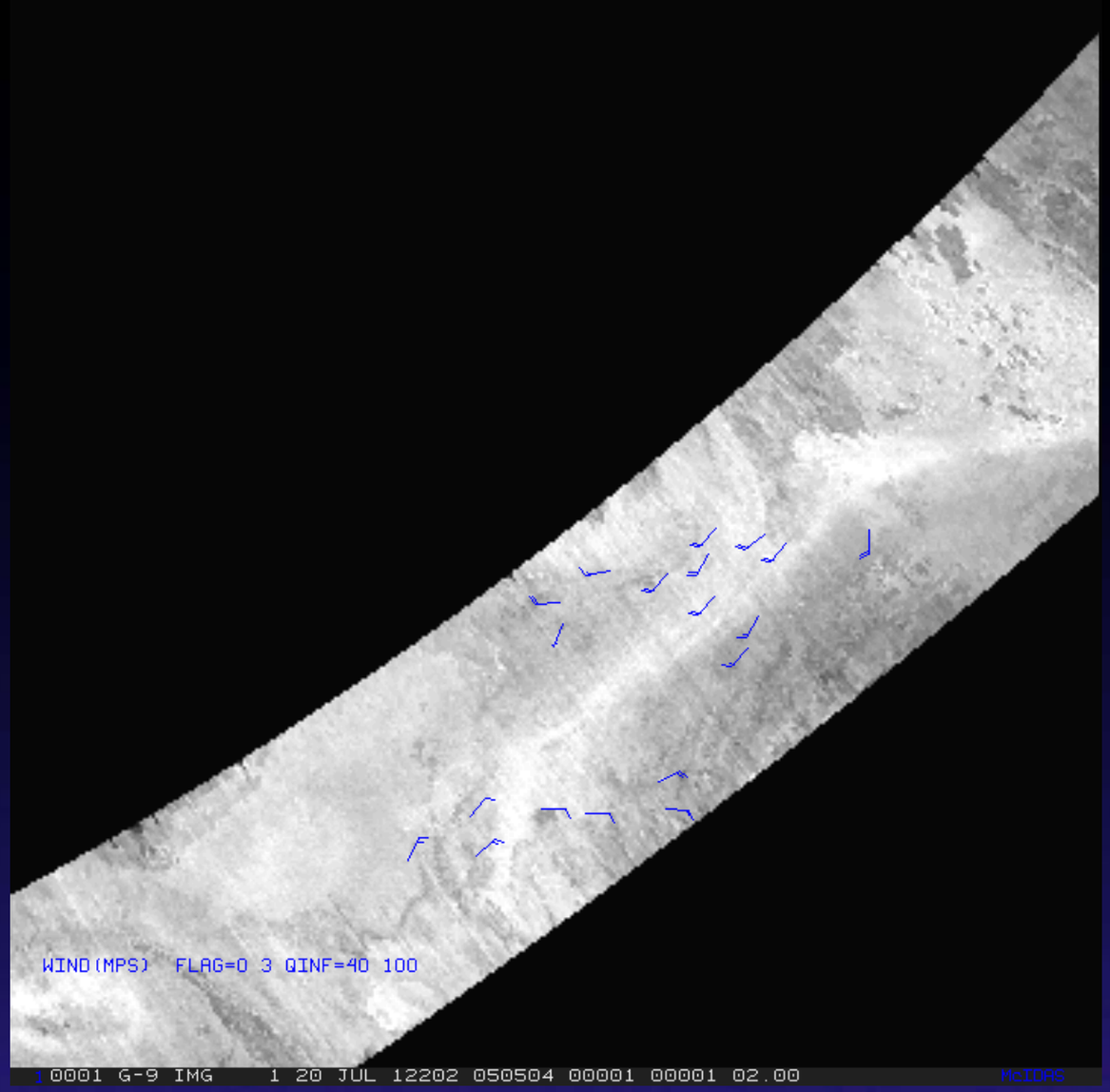

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4. Simulated AMV studies

Simulation studies are seen as a useful tool to:

- Further characterize current AMVs
- Study whether AMVs should be treated as layer or level estimates of winds
- Prepare for future instruments
- Investigate sources of error correlation:
  - Height assignment
  - QC methods
  - Use of forecast grids in AMV algorithms

Activities in this area are on-going at CIMSS, ECMWF, and University of Reading/Met Office.

5. Mesoscale AMVs

The use of AMVs in mesoscale NWP systems may raise new issues, including:

- Are AMV datasets with higher spatial resolution/sampling required?
- The QI aims to favor synoptically consistent AMVs – should the QI thresholds be adjusted to avoid penalizing mesoscale features?
- Is different (less) thinning/superobbing required for mesoscale assimilation systems and if so are there implications from spatial error correlations in the AMVs?

Studies addressing some of these aspects are underway in some NWP systems in cooperation with CIMSS.

Addressed further by Majumdar/Velden in presentation tomorrow

6. Other avenues in AMV assimilation

The Met Office and ECMWF will continue to investigate the role of layer averaging in the observation operator for AMVs, in conjunction with the simulated winds studies undertaken at these centers.

ECMWF also has plans to re-visit the benefits of hourly winds compared to less frequent sampling once GOES hourly winds are available.

There is also a continued need to investigate which metrics of forecast impact to use in addition to the standard metrics, for instance in order to highlight particular aspects of forecast performance (e.g., impact on cyclones, severe weather).

The superobbing procedure developed at NRL is the subject of further investigations, in terms of how it performs compared to thinning procedures used at other centers, and in terms of how the superobbed data performs in other centers (NASA GMAO). Ron Gelaro will present more details in the following talk.