

AMVs in the operational ECMWF system

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AMV sample coverage: monitored

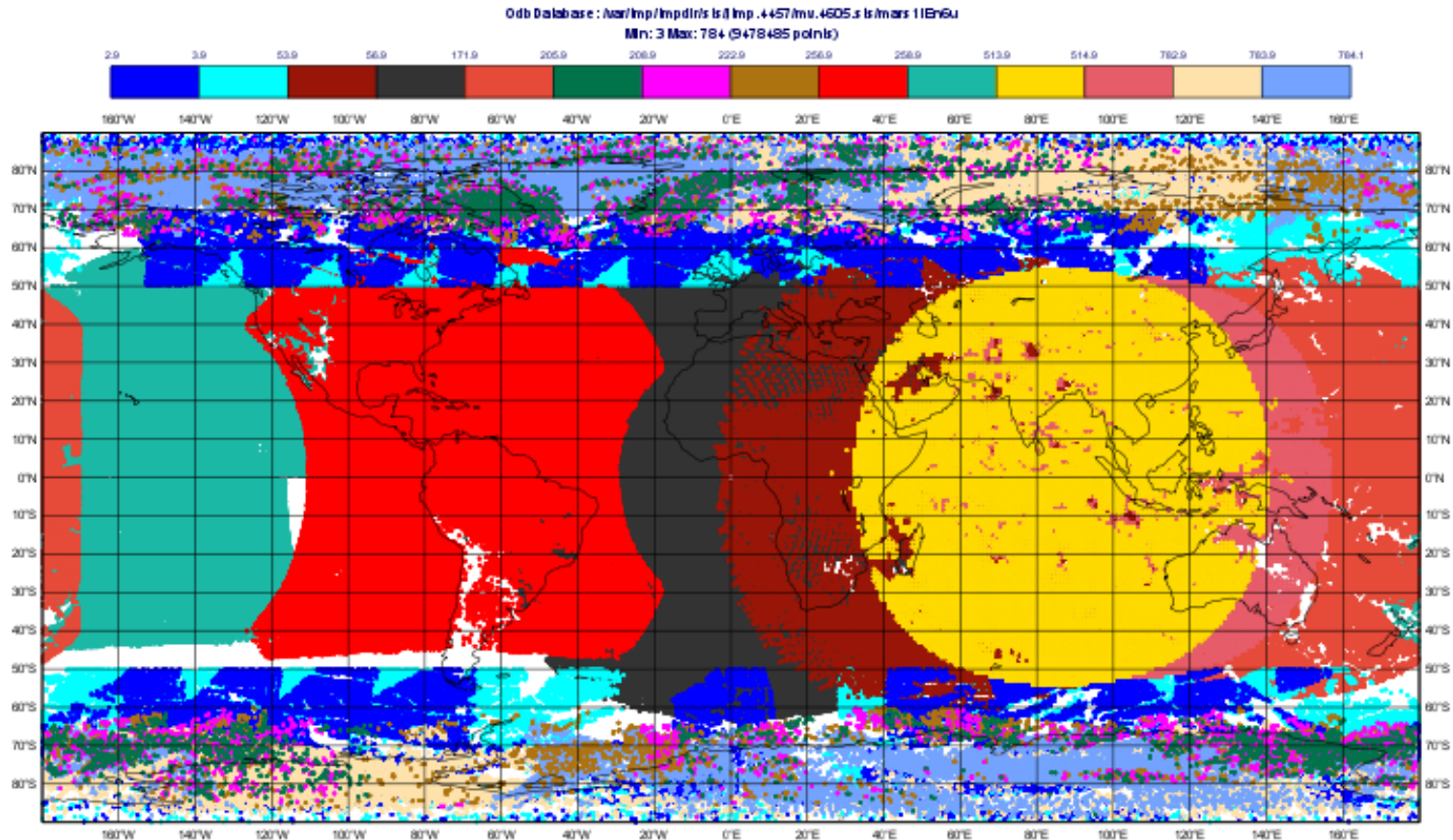
GOES-15
NOAA-15
AQUA

GOES-13
NOAA-18
TERRA

MET-10
NOAA-19
METOP-A

MET-7
FY-2D
METOP-B

MTSAT-2
FY-2E



AMV sample coverage: active

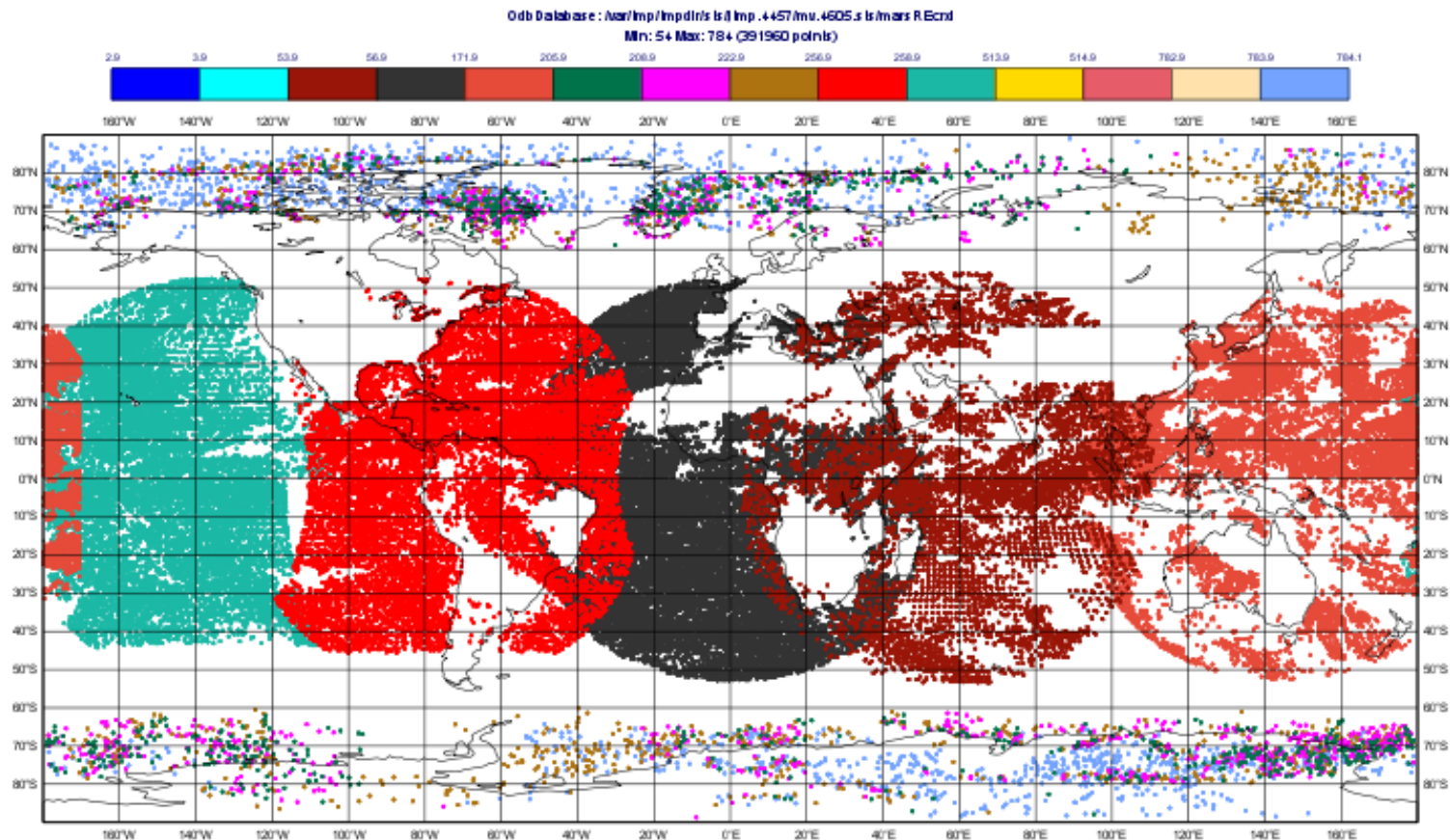
GOES-15
NOAA-15
AQUA

GOES-13
NOAA-18

MET-10
NOAA-19

MET-7

MTSAT-2



Significant changes after IWW11

Time	Event
2012 August	Changes in MET-9/-10 processing, introduction of the CCC method
November	Activation of NOAA-15, -16, -18 AVHRR AMVs
2013 January	Switch from MET-9 to MET-10
March	Operational monitoring of NOAA-19
April	Operational monitoring of METOP-B Fix for MET-10 low level winds introduced
June	MODIS AMVs from Terra passive
August	Activation of NOAA-19 AVHRR AMVs
November	Situation dependent observation errors and revised AMV usage, IFS cycle 40R1
2014 February	Dual Metop-A/B test data available
May	Updated GOES AMV product operational

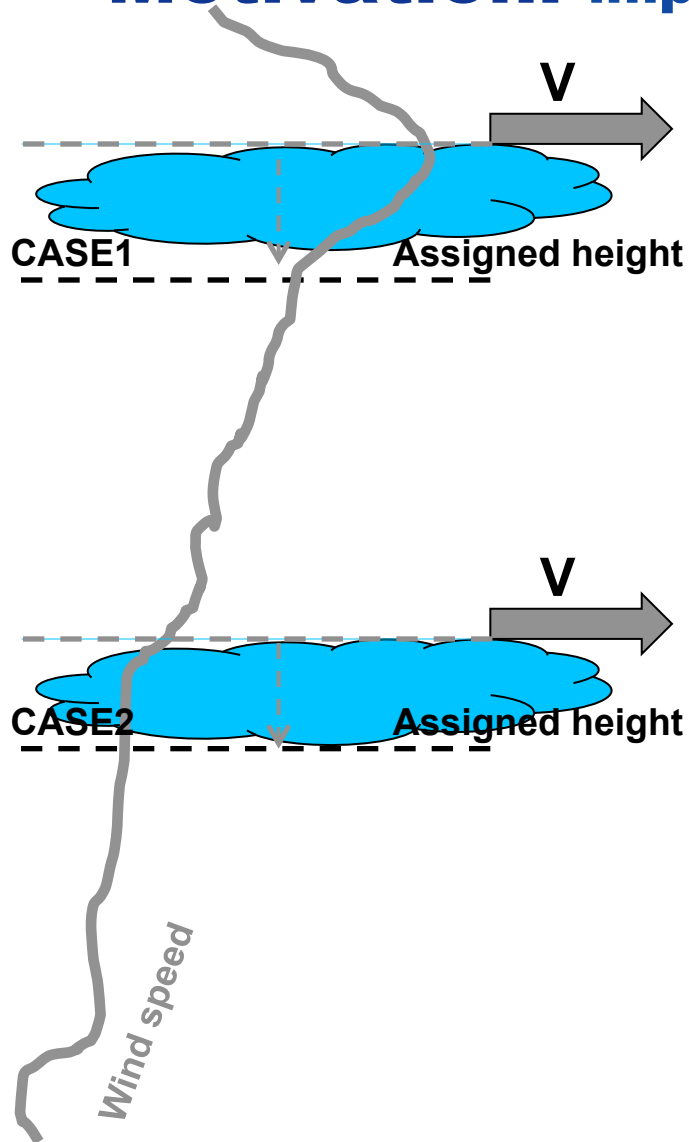
Outline

- **Revised AMV usage, situation dependent observation errors**
- **Updated GOES AMVs**
- **Latest activities with polar AMVs**

Salonen, K. and Bormann, N., 2013: Atmospheric motion vector observations in the ECMWF system: third year report. Available at <http://old.ecmwf.int/publications/library/do/references/show?id=91001>

Salonen, K. and Bormann, N., 2012: Atmospheric motion vector observations in the ECMWF system: second year report. Available at <http://old.ecmwf.int/publications/library/do/references/show?id=90665>

Motivation: impact of height assignment errors



- **Dominant source of error for AMVs:**

- Built-in assumptions in the methods
- Difficulties linking the height assignment to features dominating the tracking
- Errors in short-range NWP forecasts used in height assignment

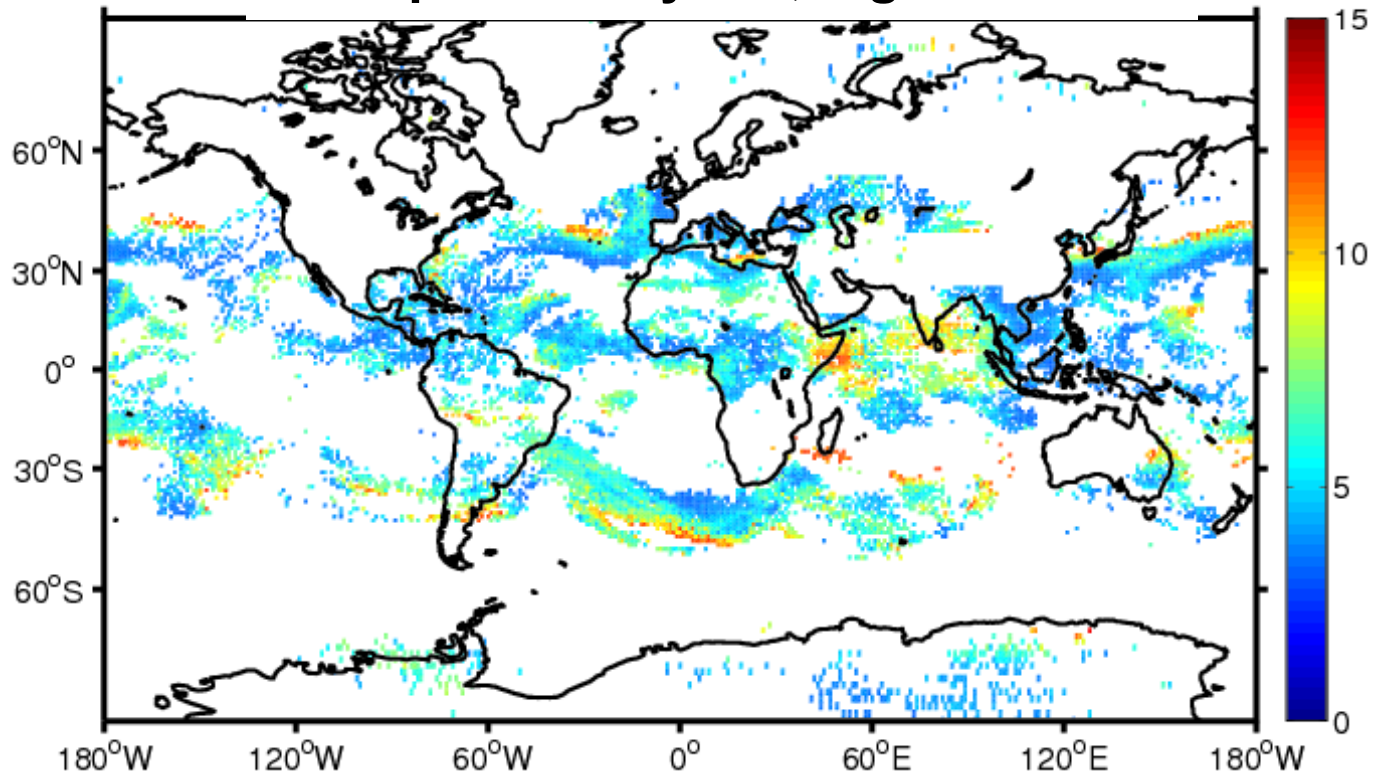
CASE 1: Wind shear in vertical, large error in wind speed.

CASE 2: Wind speed does not vary much with height, small error in wind speed.

Situation dependent observation errors

$$[\text{Total u/v error}]^2 = [\text{Tracking error}]^2 + [\text{Error in u/v due to error in height}]^2$$

Example: cloudy WV, high levels



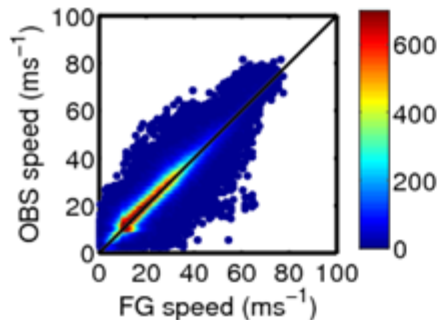
Forsythe M, Saunders R, 2008: AMV errors: A new approach in NWP. Proceedings of the 9th international winds workshop.

Salonen K, Bormann N, 2013: Winds of change in the use of Atmospheric Motion Vectors in the ECMWF system. ECMWF

Revised quality control

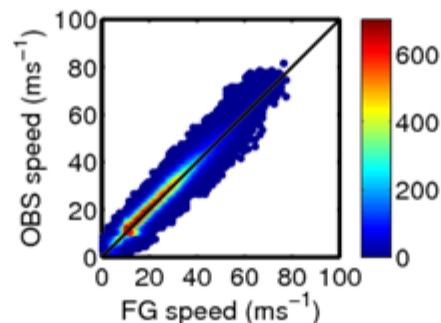
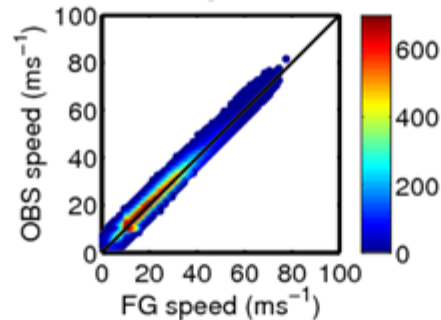
Blacklisting

- Rejects observations based on long-term monitoring.



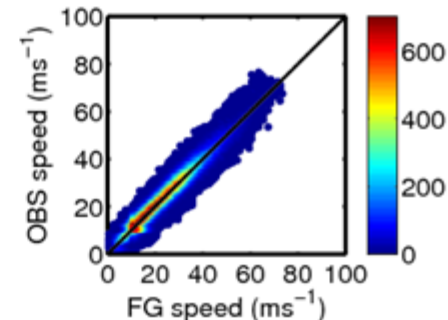
First guess check

- Compares observation to the model counterpart.
- Observation rejected if it deviates too much.



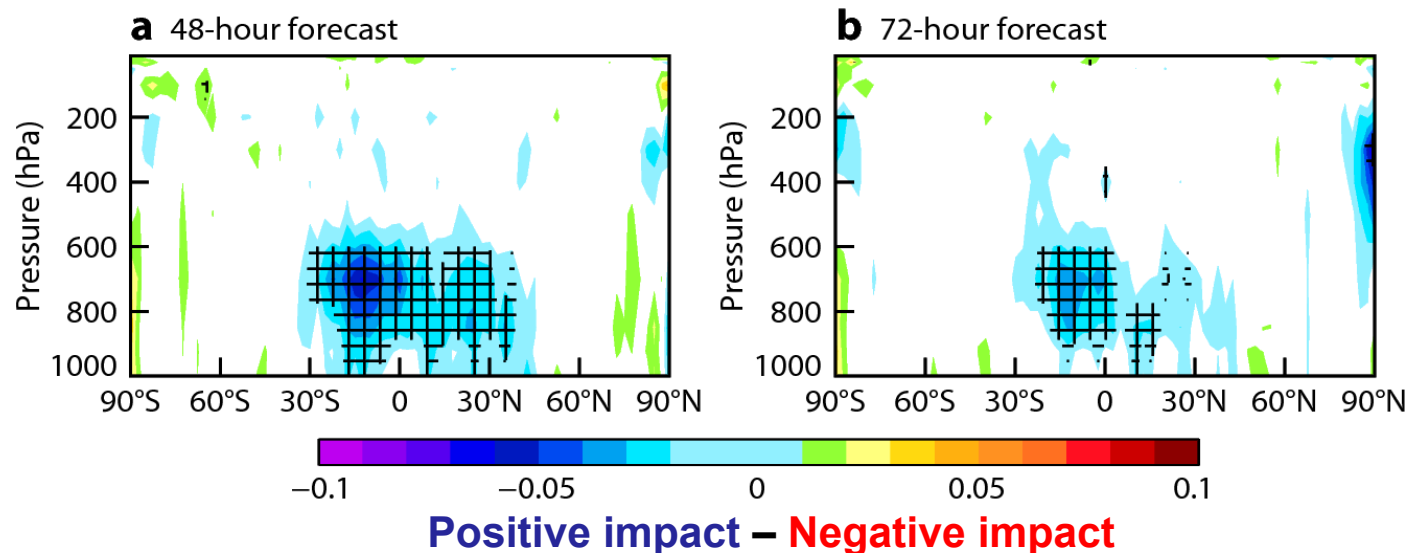
New QC criterion

- $\sigma_{\text{due to error in height}} < 4 \sigma_{\text{tracking}}$
- Motivated by the fact that height assignment errors are likely to be more correlated spatially.



Forecast impact

Normalised difference in the RMS error for 48-h and 72-h wind forecasts



- Tested over summer and winter periods, 1.1-31.3.2012, 1.6-31.8.2012, CY38r2, T511, 137 levels, 12-hour 4D-Var.
- Operational since 19th November 2013, CY40R1.

Updated GOES AMVs

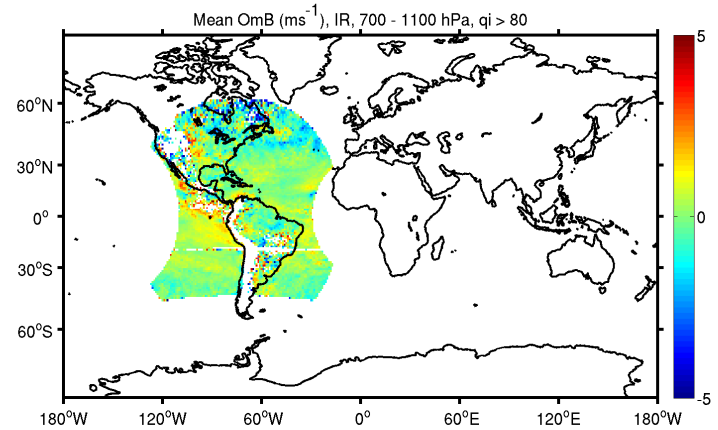
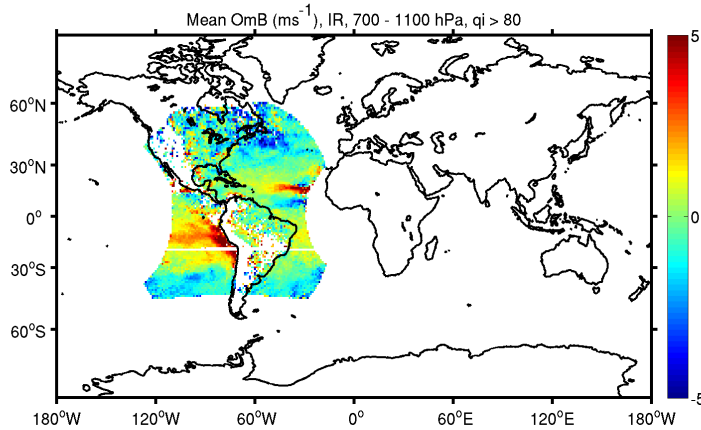
- **Operational since 6th May 2014**
 - **Additional quality indicator Expected Error (EE)**
 - **Actual scan line time to each AMV**
 - **Improvements to low level heights in areas over ocean where a low level temperature inversion exists**
 - **Test data has been available since May 2012**

Mean OmB, IR low level winds

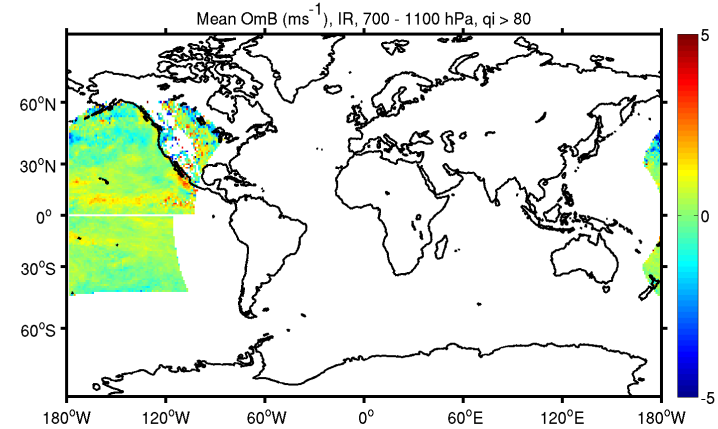
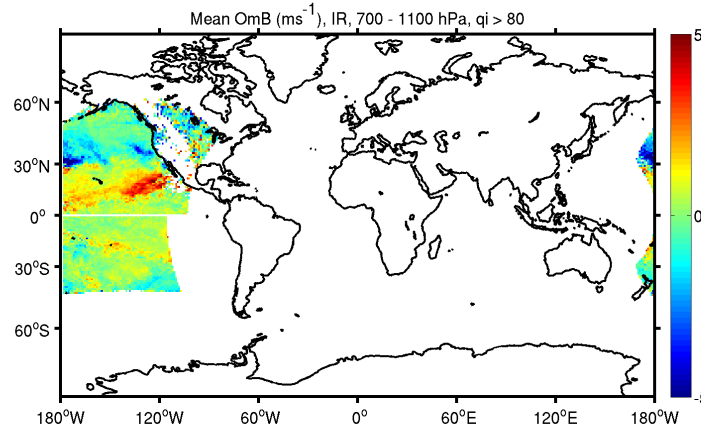
6.4-5.5.2014

7.5-6.6.2014

GOES-13



GOES-15



Forecast impact

- Using the updated wind product has some positive impacts over using the old operational AMVs.
- In the current system it is more beneficial to use the updated wind product 3-hourly than 1-hourly.

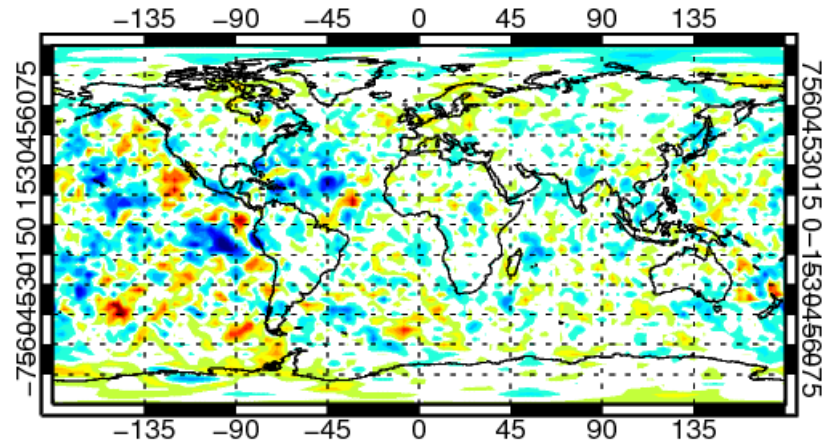
Experiments for 23.5-22.7.2012.

IFS cycle 38r1, T511, 91 levels 12-hour 4D-Var, all operationally assimilated conventional and satellite observation used

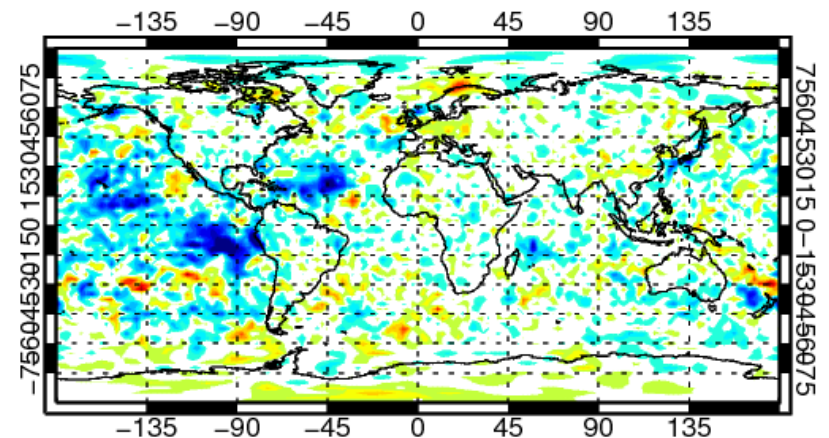
Normalised difference in VW RMS error

T+72; 850hPa

GOES 1-hourly – GOES old



GOES 3-hourly – GOES old

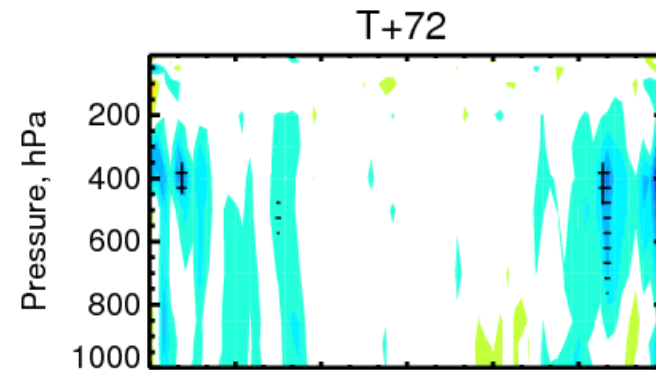
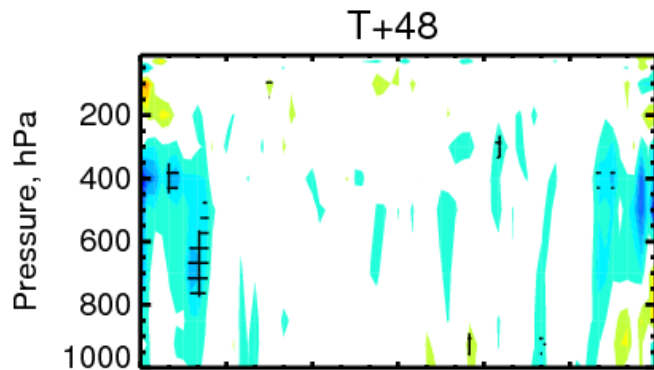


NOAA AVHRR AMVs

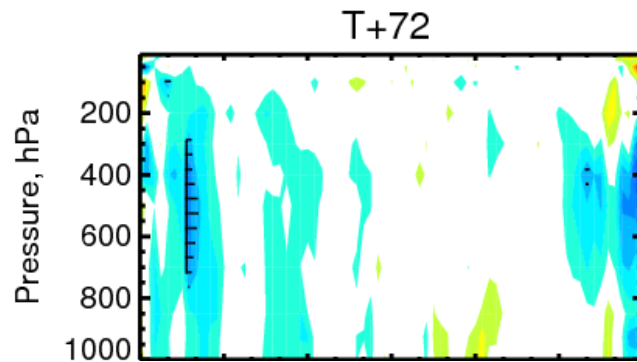
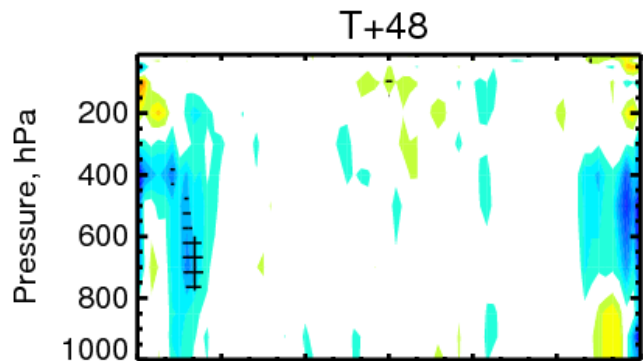
- **Used operationally in the ECMWF system**
 - NOAA-15,-16,-18 since November 2012
 - NOAA-19 since August 2013
- **Increased the number of used polar winds by ~75%.**

Normalised difference in VW RMS error

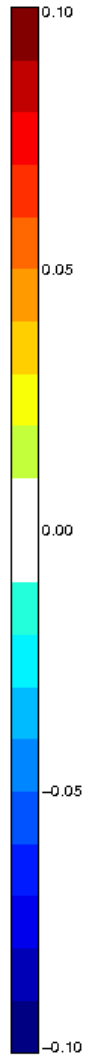
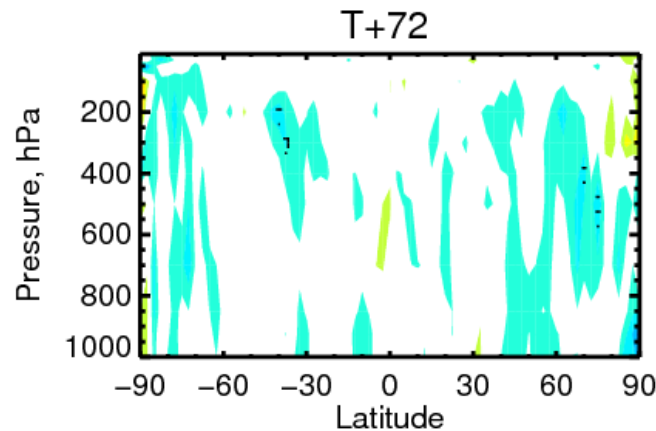
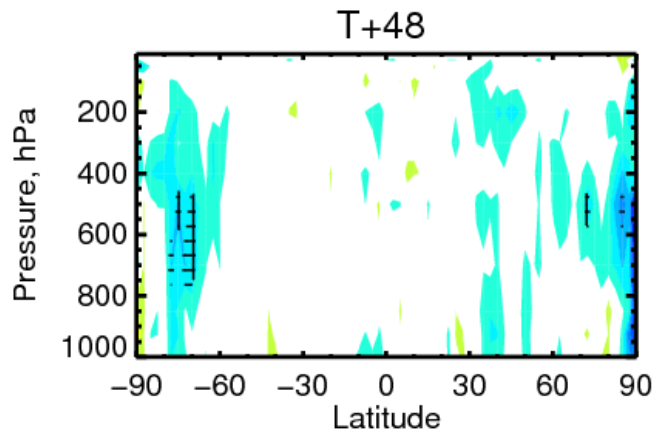
MODIS



MODIS+
AVHRR



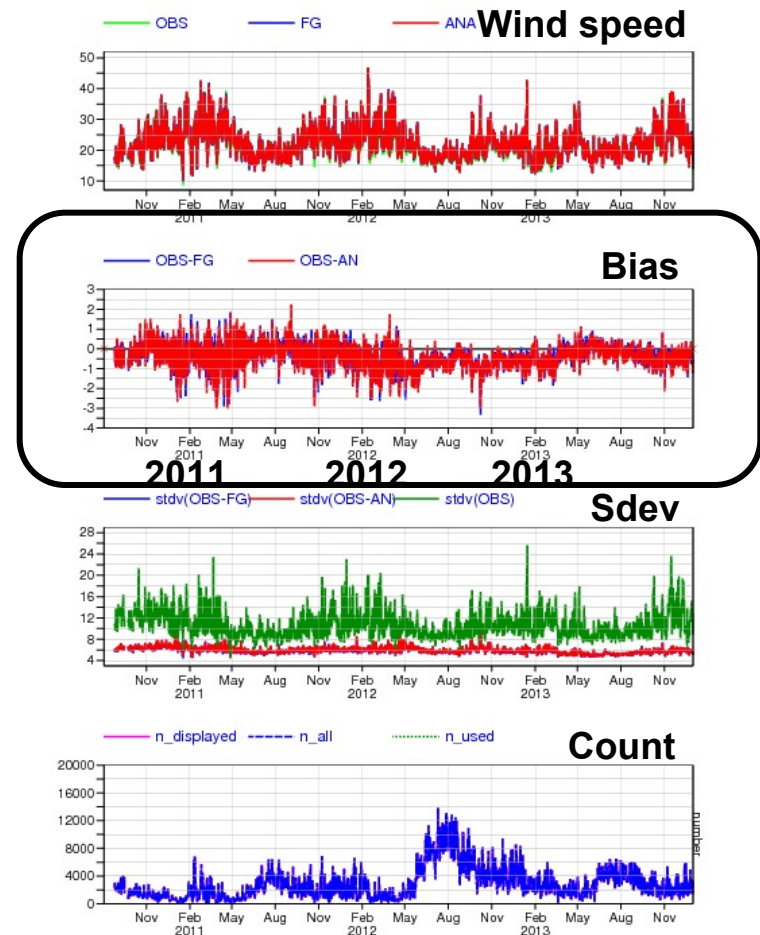
AVHRR



EUMETSAT Metop-A and Metop-B AMVs

- Long-term monitoring of Metop-A indicates improvements in data quality at high levels.
- Metop-B added to operational monitoring 14th May 2013.
- Metop-A and Metop-B share similar characteristics
 - Small or zero bias at high levels
 - Increased positive bias at mid and low levels

STATISTICS FOR WINDSPEED FROM METOP-A/AMV_IR
 LEVEL =0.00 - 400.00 HPA, ALL DATA [TIME STEP = 12 HOURS]
 Area: lon_w= 0.0, lon_e= 360.0, lat_s= 60.0, lat_n= 90.0 (over All_surfaces)
 EXP = 0001 (LAST TIME WINDOW: 2013123115)



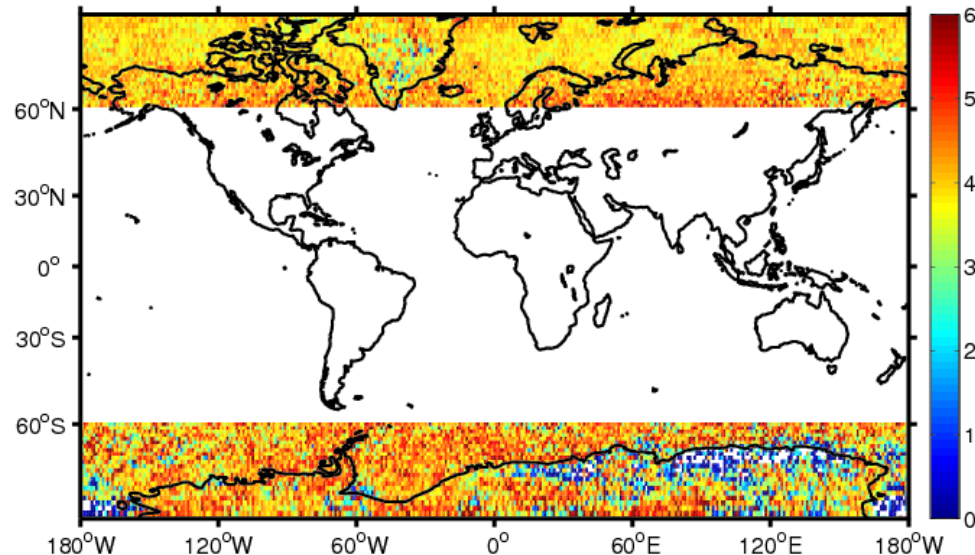
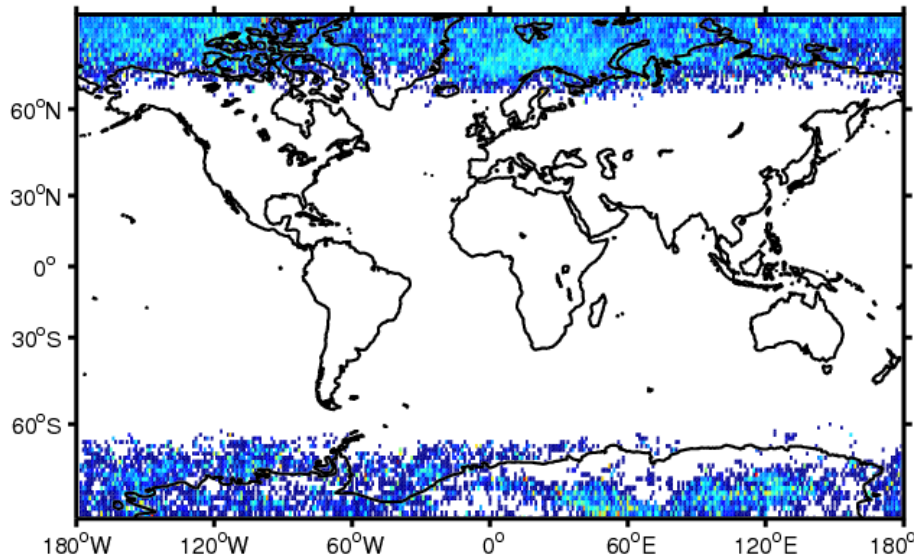
Observation errors for Metop AMVs

- Height errors around 170 hPa based on best-fit pressure statistics.
- Tracking error 4.2 m/s, 3.2 m/s for other polar AMVs above 400 hPa.
- Observation errors on average 4.9 m/s, for other polar AMVs 3.8 m/s.

Aqua and Terra

Metop-A and Metop-B

OmB standard deviation in cases where error due to error in height is small

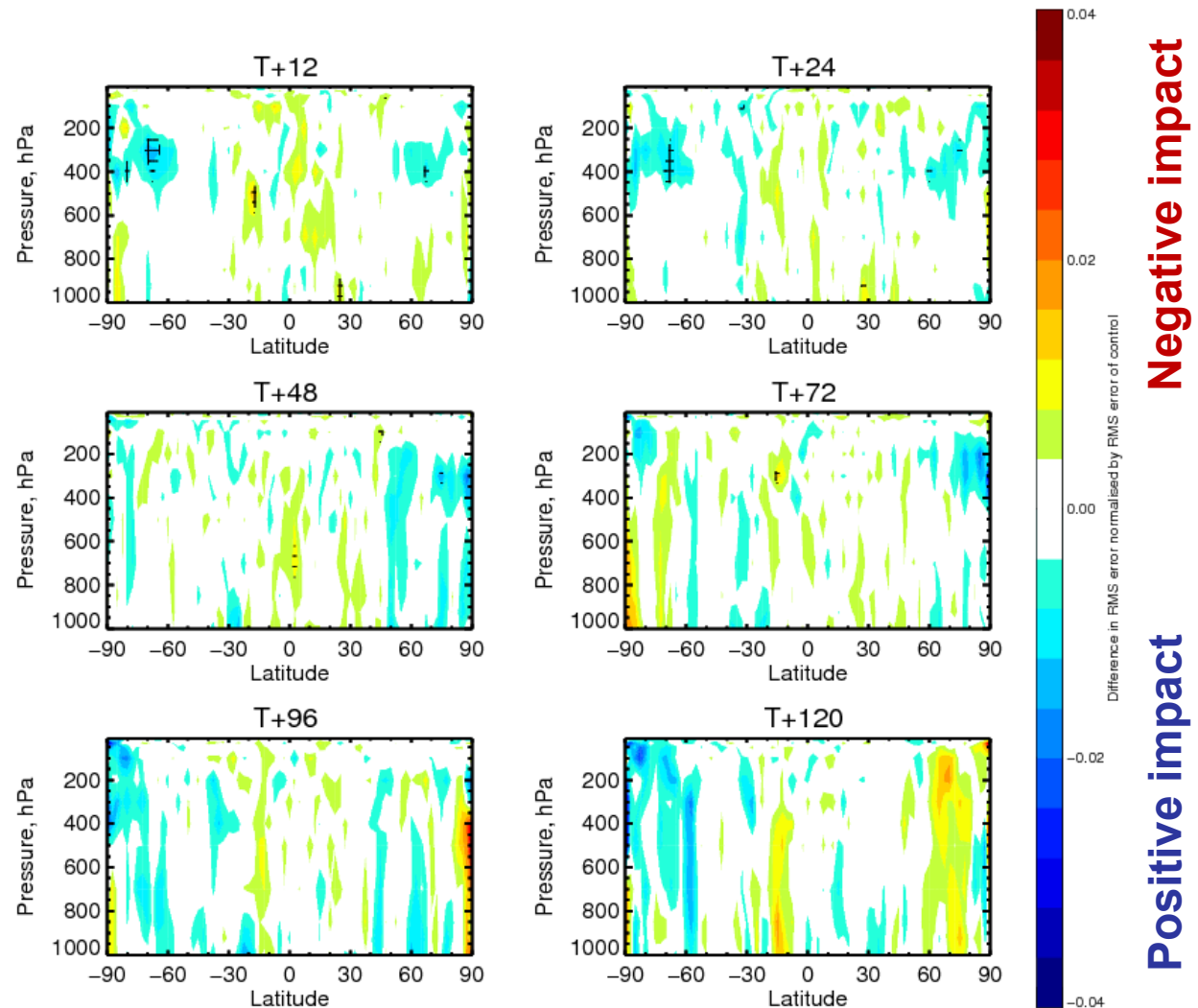


Normalised difference in VW RMS error

Control: all operationally assimilated conventional and satellite observation used

Experiment: Metop-A and Metop-B AMVs used in addition

- Above 400 hPa
- Forecast independent QI > 60
- Tracking error 4.2 m/s

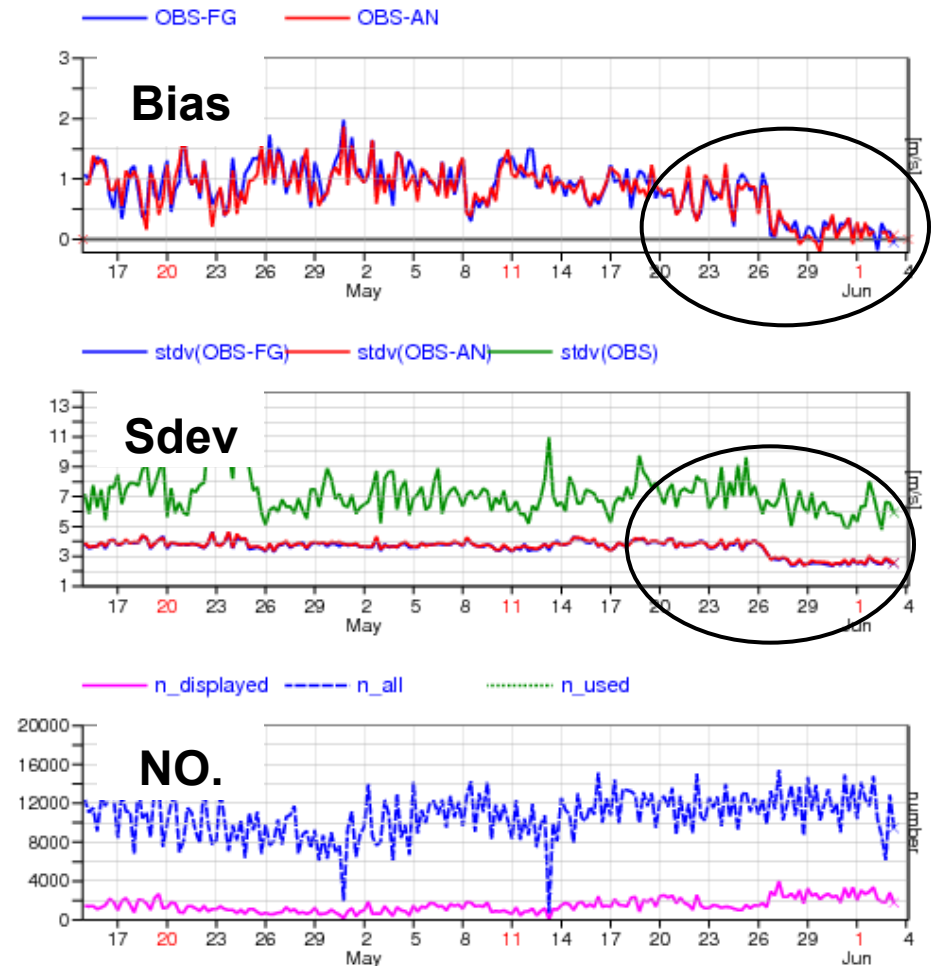


Experiments for 1.7-30.9.2013, 1.2.2013-28.2.2014. IFS cycle 40r1, T511, 137 levels 12-hour 4D-Var.

Update

- EUMETSAT updated the polar wind processing 27th May 2014:
 - Reference points used to compute the wind vector changed to centres of target box from CCC barycentres
 - The window search size depends on the expected displacement.
- Operational monitoring statistics show improvements at mid and low levels.

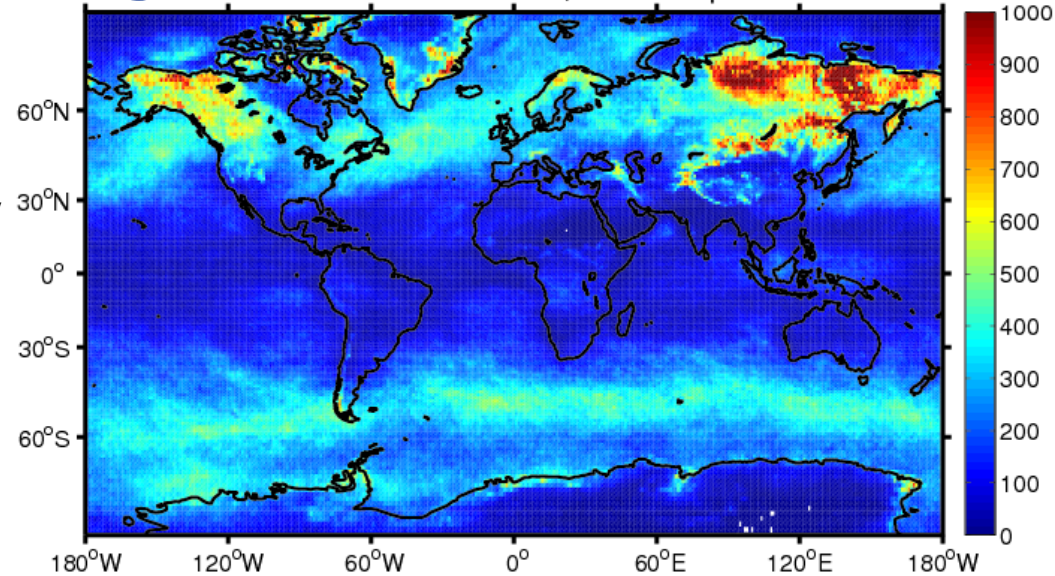
Metop-A: 400 – 700 hPa



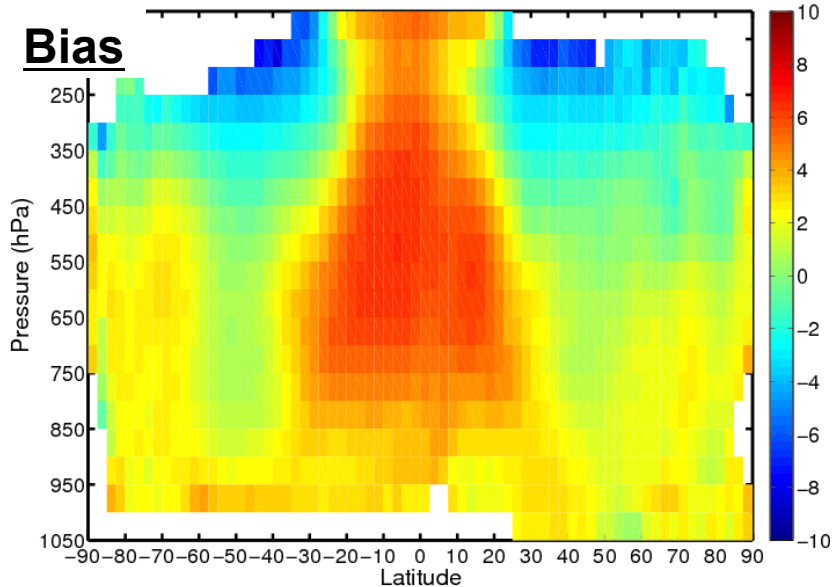
Dual Metop-A/B AMVs

- Global coverage.
- Data available for preliminary testing 20.10.2013-31.1.2014.
 - Passive monitoring, QI > 60.

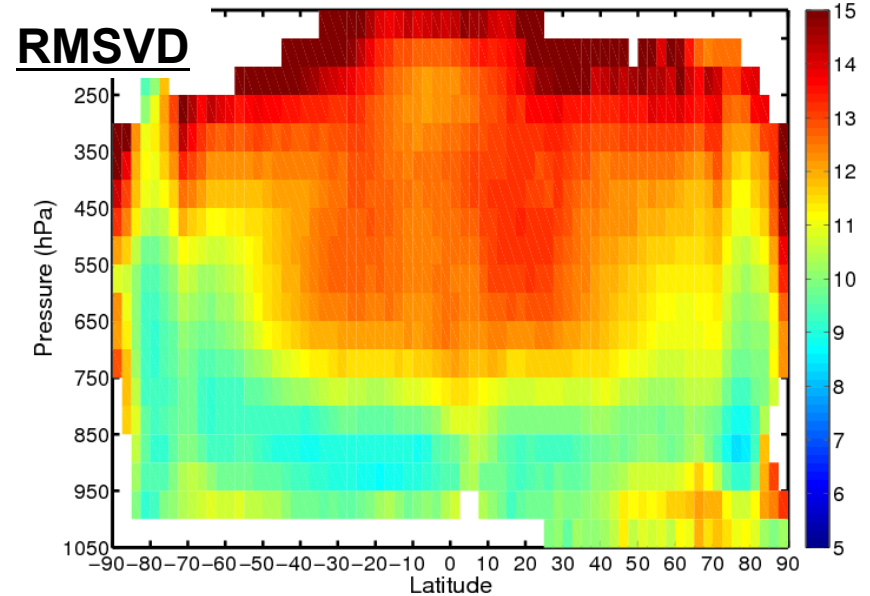
No. of observations, dual Metop



Mean OmB (ms^{-1}), dual Metop-A/B



RMSVD (ms^{-1}), dual Metop-A/B



Summary

- **Main improvements in the use of AMVs at ECMWF since IWW11**
 - Introduction of the situation dependent observation errors and revised quality control: positive impact on forecasts.
 - Increased use of polar AMVs: use of AVHRR AMVs has similar positive impact than use of MODIS AMVs.
 - Improvements in the quality of operationally disseminated AMVs: recent positive forecast impact from the updated GOES AMVs at low levels
- **New interesting data sets expected**
 - Global coverage dual-Metop AMVs
 - VIIRS polar AMVs