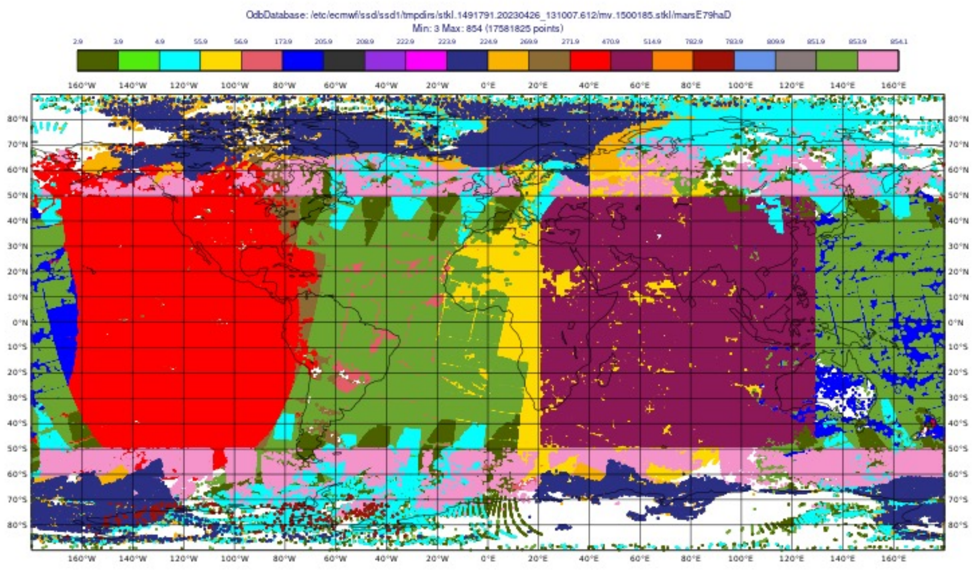
Status of AMV Assimilation in ECMWF's IFS Model

Francis Warrick, Katie Lean, Niels Bormann
Research Department, ECMWF, Reading, United Kingdom

Quality Control of AMVs in the IFS

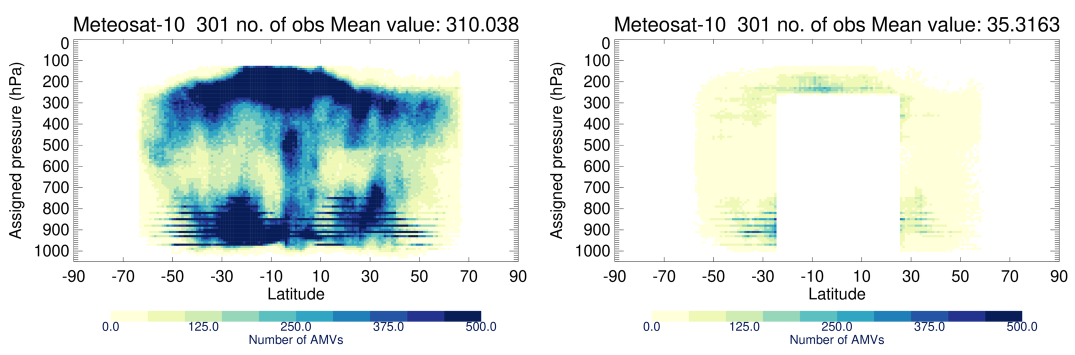
Start: Monitored AMVs



Monitoring in region of 17 million winds per cycle
Metop-B Metop-C Meteosat-9 Meteosat-10 Himawari-9 NOAA-15 NOAA-18 NOAA-19 NPP NOAA-20 GOES-16 GOES-18 Insat-3D Terra Dual-Metop LeoGeo

Spatial Rejections

AMVs are rejected at certain heights where high background departures have been identified. For example, geostationary AMVs are not used over land between the surface and 500 hPa.



Example of the reduction in observation count from data received (left) to assimilated (right) for Meteosat-10 IR10.8 micron channel due to quality control steps showing the rejection of this satellite-channel combination from the surface to 250 hPa in the tropics

Quality Indicator Thresholds (forecast-independent)

Satellite	Channel	Threshold
GOES-16/18	IR	90
	VIS	
	WV6.15	
Meteosat-9/-10	IR	85
	VIS0.8	
	WV7.3	
	WV6.2	
Himawari-9	IR	70
	VIS	
	WV6.95	
Metop/ S-NPP/NOAA-20	IR	60

AMV Observation Errors Scheme

AMV errors consider both the error in the wind speed from the tracking, and the error in wind speed from the error in assigning a height as follows:

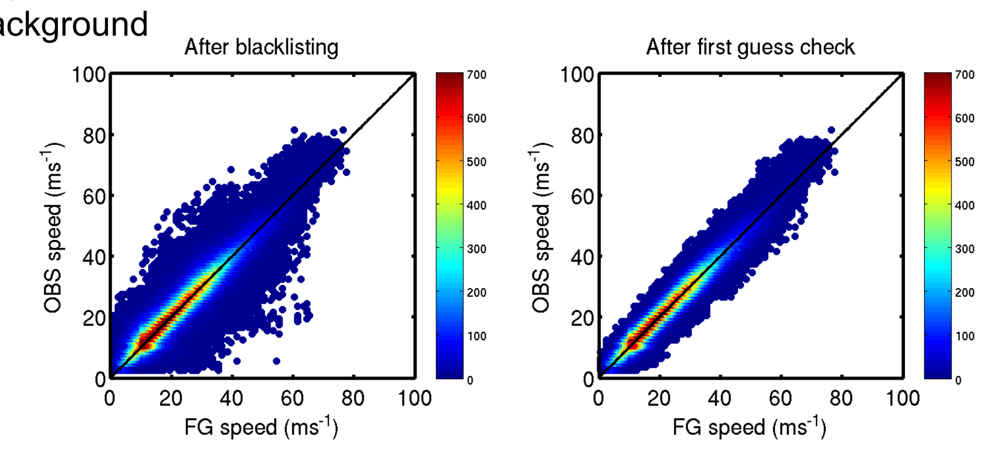
$$\sigma^2_{FINAL} = \sigma^2_{TRACKING} + \sigma^2_{PRESSURE}$$

The tracking error is derived from wind speed background departures from low wind shear situations.

The pressure error estimate is derived from differences between assigned and model best-fit pressure.

First-Guess Check

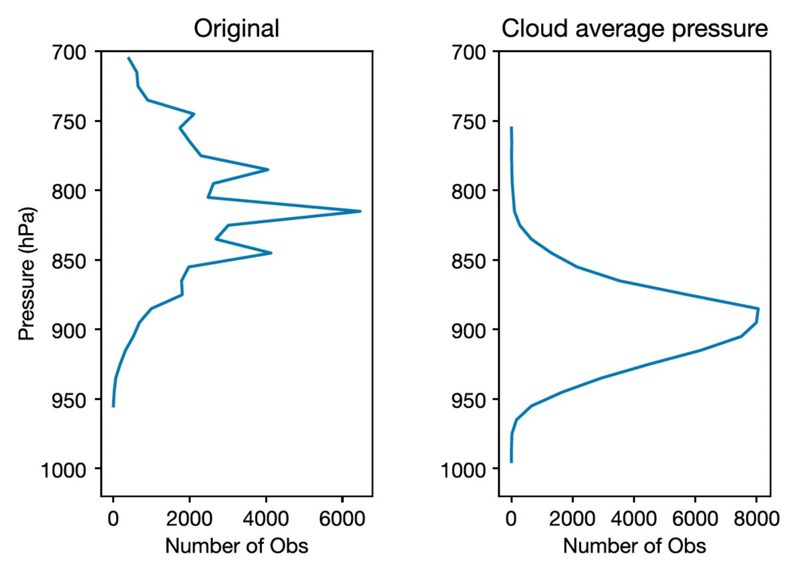
Reject AMVs with wind speeds too far from the model background



Varies between 8 to 13 m/s depending on AMV height [Salonen and Bormann 2012]

Low-Level Height Reassignment

Operational since October 2021, the low level height reassignment is applied to AMVs with a pressure greater than 700 hPa whose pressure is lower than the model cloud pressure at their location. Such AMVs have their pressure reassigned the average pressure of the model cloud.



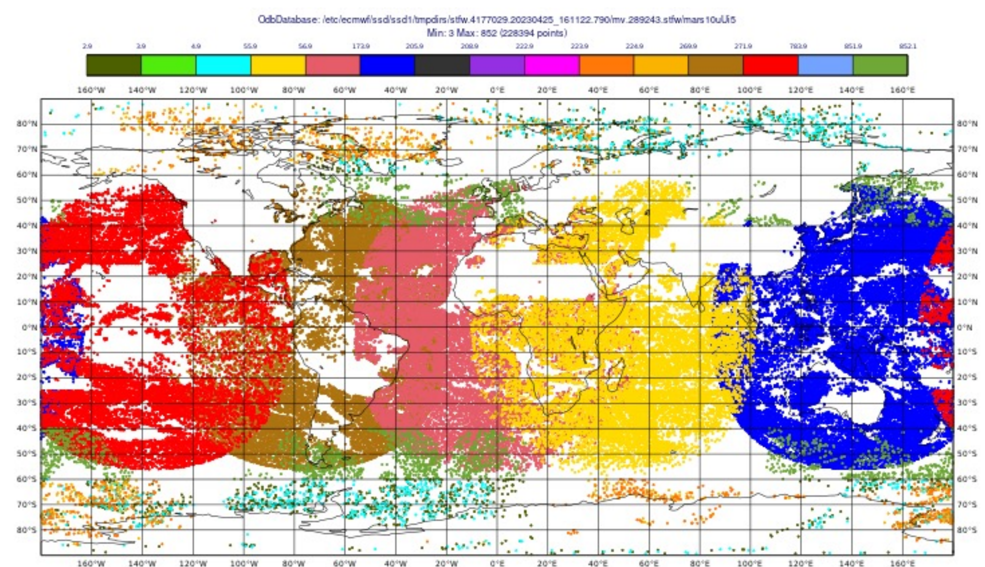
Effect of pressure reassignment for Meteosat-8 AMVs above model cloud level: before (left),after reassignment to cloud average pressure. (Figure from Lean and Bormann 2022)

Thinning

AMVs are thinned to mitigate the impact of correlated errors.

The current thinning scheme uses 200km x 200km x 50-175 hPa boxes (depends on nearest pressure level) every 30 minutes, the AMV with the highest quality indicator value in each box passes the thinning.

Finish: Assimilated AMVs



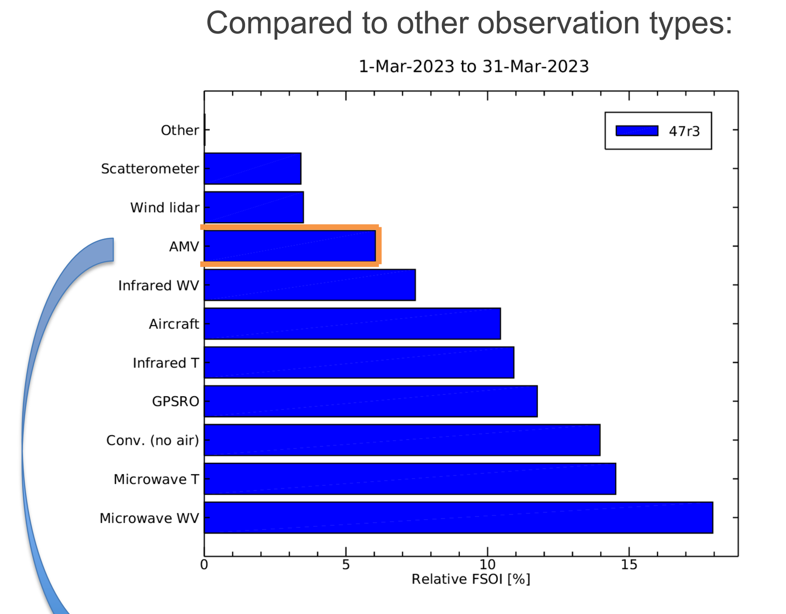
Assimilating in region of 230,000 winds per 12 hour cycle cycle
Metop-B Metop-C Meteosat-9 Meteosat-10 Himawari-9 NOAA-15 NOAA-18 NOAA-19 NPP NOAA-20 GOES-16 GOES-18 Terra Dual-Metop

Current Usage and Impact of AMVs

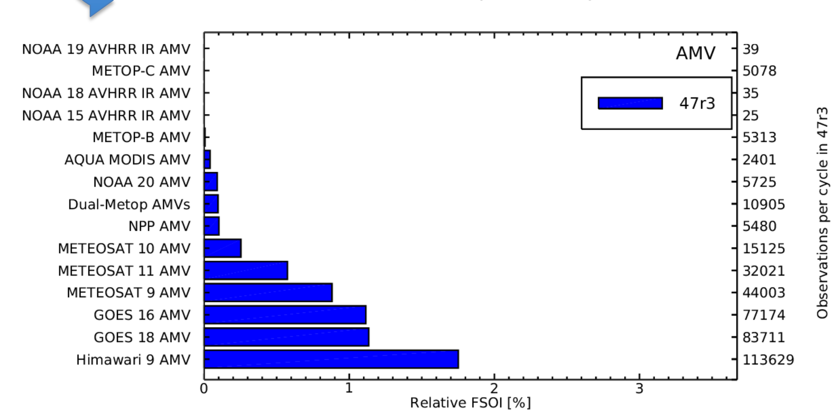
AMV usage with changes from IWW15 to IWW16
JMA: Himawari-8 -> Himawari-9 Began Himawari-9 assimilation 13/12/22
EUMETSAT 0°: Meteosat-11 -> Meteosat-10 Began Meteosat-10 assimilation 23/3/23
EUMETSAT Indian Ocean: Meteosat-8 -> Meteosat-9 Began Meteosat-9 assimilation 7/6/22
GOES-17 -> GOES-18 12/1/23 Time-of-day restrictions removed, GOES-18 used with same quality control as GOES-16
Metop-B Single Metop-C Single Metop-B/C and C/B Dual Metop-A EOL 1/11/21
Terra MODIS NOAA-15,18,19 AVHRR NPP and NOAA-20 VIIRS

Forecast Sensitivity to Observations Impact of AMVs

Compared to other observation types:

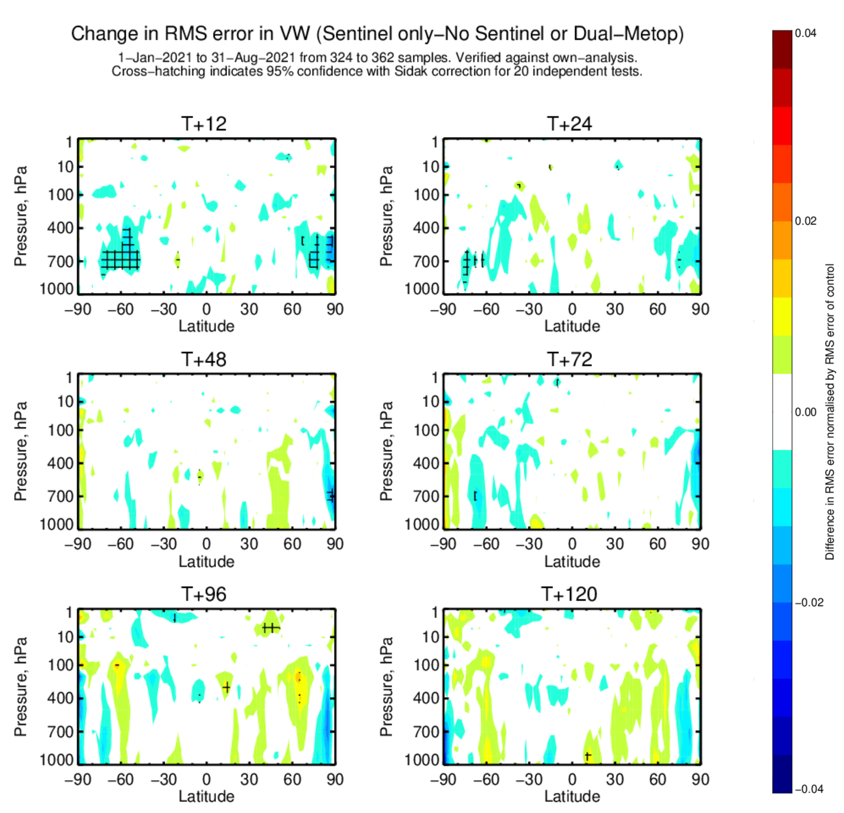


Impact split by AMV type:



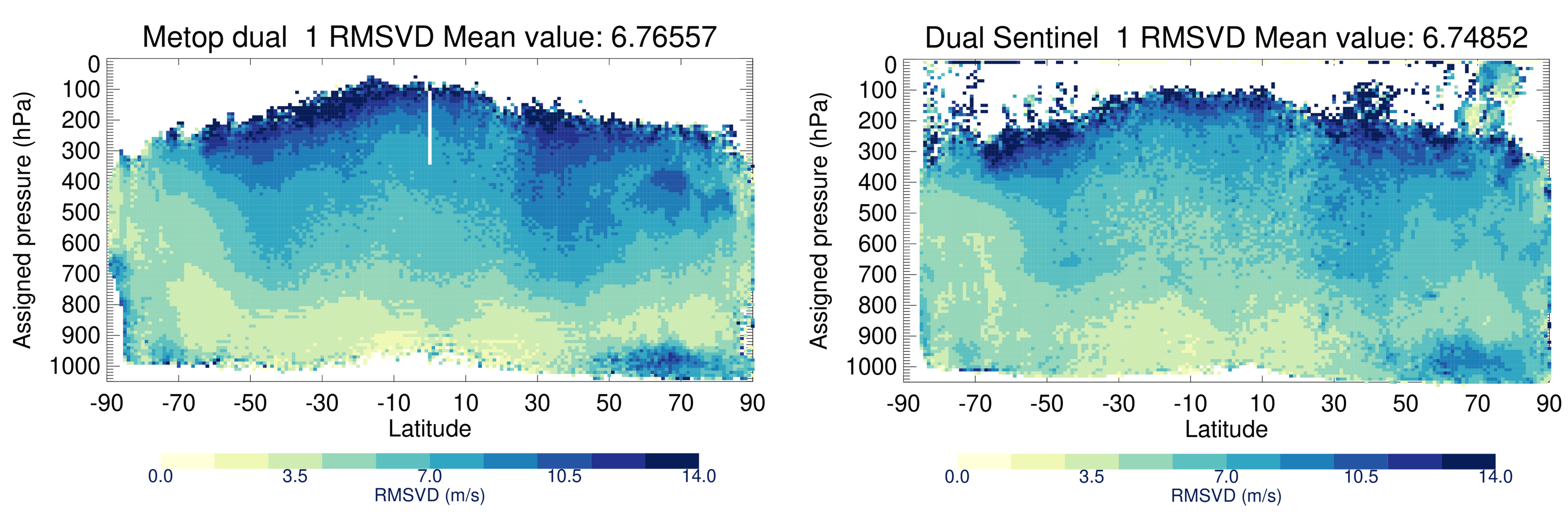
Assessment of new data: Sentinel AMVs

- Dual-Sentinel AMVs provided by EUMETSAT use are derived with one image each from the SLSTR instrument on Sentinel-3A and 3B.
- Their derivation is similar to the Dual-Metop AMVs already used operationally at ECMWF and which play a key role in filling the coverage gap between geostationary and polar AMV data.
- Background departures were roughly the same as the Dual-Metop AMVs (below) though the data volume is a little lower due to the narrower swath of SLSTR compared to Metop's AVHRR instrument. The height distribution is also different due to the cloud masks available for each instrument.
- Assimilation experiments with Dual-Sentinel showed some forecast improvement in the absence of Dual-Metop (right). This shows the Dual-Sentinel AMVs could be a useful replacement for the Dual-Metop AMVs during the transition from Metop to Metop-SG.



Impact on wind field forecast skill of assimilating the Dual-Sentinel AMVs in the absence of Dual-Metop. Cross-hatching indicates statistically significant impacts.

- The LeoGeo mixed AMV product from CIMSS was also studied for its potential to improve AMV coverage. It had very low background departures compared to other AMVs. However, assimilation experiments showed some negative results, particularly in the geopotential height field.
- The LeoGeo product could be re-tested if it moved to the newer nested tracking AMV derivation and if the contributing satellites could be identified for each AMV.
- See fellowship report referenced below for full details.



Zonal distribution of root-mean-square vector difference of Dual-Metop and Dual-Sentinel AMVs versus ECMWF model background, January 2021

References & Acknowledgements

Lean, K. and Bormann, N., 2022: *Using Model Cloud Information to Reassign Low-Level Atmospheric Motion Vectors in the ECMWF Assimilation System.* Journal of Applied Meteorology and Climatology, Volume **62**, pp361-376

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Salonen K., and Bormann N., 2012: *Atmospheric Motion Vector observations in the ECMWF system: Second year report,* EUMETSAT/ECMWF Fellowship Programme Research Report **24**

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