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Use of AMV Cross Correlation Matrices and the NWP guess to explore accurcy of AMVs

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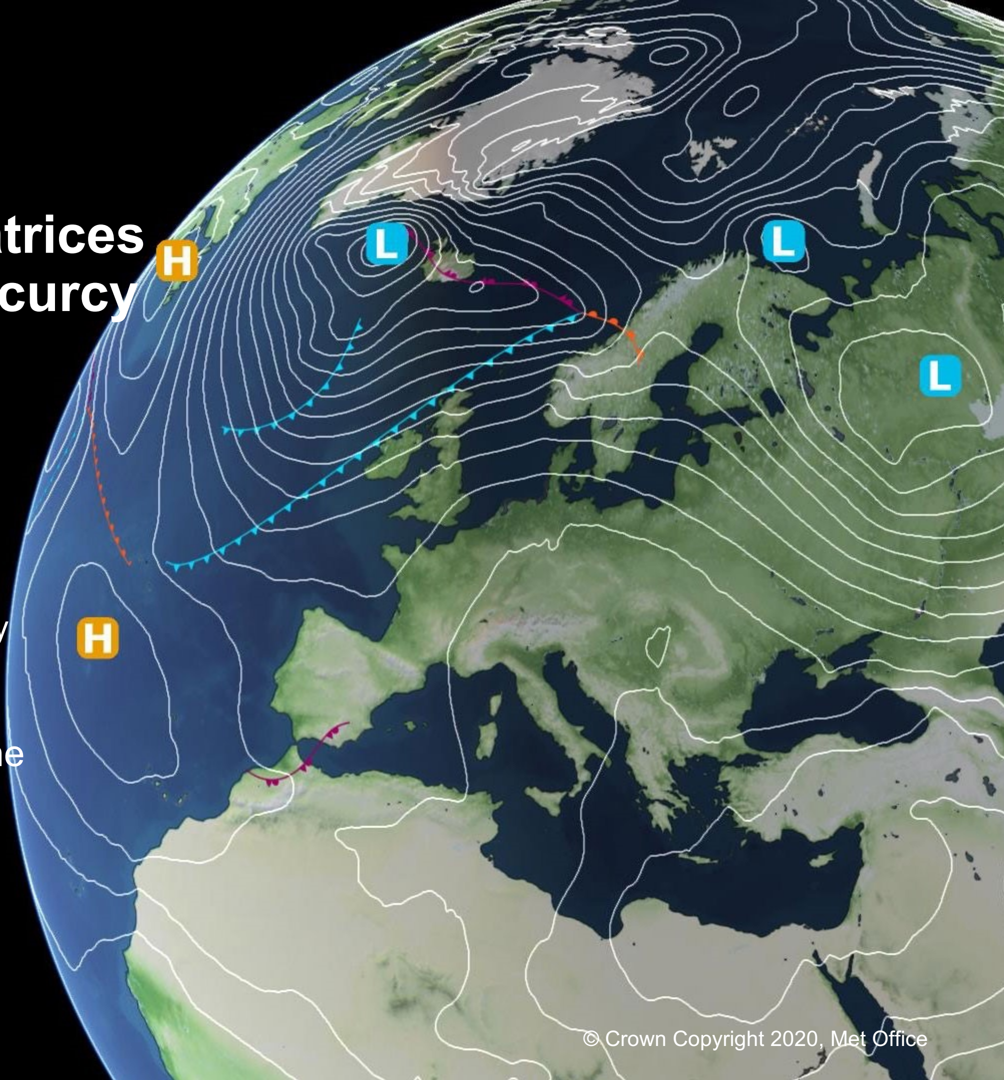
This talk is based on the NWP SAF AMV monitoring: the 10th Analysis Report (AR10)



NWP SAF AMV monitoring

Aim
Improve our understanding of AMV errors in order to enable improvements to the AMV derivation and their impact in NWP

Deliverables
- Monthly O-B monitoring (UKMO/ ECMWF)
- AMV-Lidar height collocations
- **Analysis reports**
- [Data use in NWP]

- Ahead of the IWW, a thorough evaluation of the AMV monitoring is documented in a series of analysis reports (AR)
- Reports identify features from the monitoring statistics and document how these evolve over time. Where possible attempts are made to diagnose the cause of the difference between the AMVs and the model.
- Latest report, AR10, published in April 2023

https://nwp-saf.eumetsat.int/site/monitoring/winds-quality-evaluation/amv/

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EUMETSAT NWP SAF NUMERICAL WEATHER PREDICTION

AMV data monitored (2023)

Geostationary AMVs	Producer	Channels
Meteosat-8/9/10/11	EUMETSAT	IR 10.8, WV 6.2, WV 7.3, VIS 0.8, HRVIS
Himawari-9	JMA	IR, WV 6.2, WV 6.7, WV 7.3, VIS
GOES-16/18	NOAA/NESDIS	IR, SWIR, WV, VIS
INSAT-3D/3DR	ISRO	IR, SWIR, WV, VIS
GK-2A	KMA	IR, SWIR, WV, VIS
FY-2G	CMA	IR, WV
Leo AMVs		
Terra	NESDIS, DB	IR
Aqua	NESDIS, DB	IR, WV, CSWV
NOAA-15/18/19	CIMSS, DB	IR
Metop-B	EUMETSAT, CIMSS	IR
Metop-C	EUMETSAT	IR
Suomi NPP	NESDIS, DB	IR
NOAA-20	NESDIS	IR
Mixed AMVs		
LeoGeo	CIMSS	IR
Dual-Metop	EUMETSAT	IR

Transitions since AR9

- GOES-18
- Meteosat-9
- Meteosat-10
- Himawari-9

AR10 contents

1.Introduction

2. Index of features identified in the monitoring

3. Assessment of new data

4. General thoughts on plot comparisons

5. Use of the NWC SAF package in the Tropics

6. Validity of AMVs in the African Tropical region

6.1 Differences in a MCS over Western Africa.

6.2 AMVs in the Tropical boundary layer assigned incorrect pressures

** Items in blue will be discussed **

5. Use of cross-correlation matrices

A modified version of the NWC SAF package was run over the UKV region with the UKV model for two months.

The output O-B data set included cross-correlation matrices.

It was found that features of the cross-correlation matrix, such as the strength and uniqueness of central maxima were related to AMV O-Bs (Kelly, 2021).

Met-11image below shows underlying clouds (300 hPa) are moving in the opposite direction to the upper flow (196 hPa)

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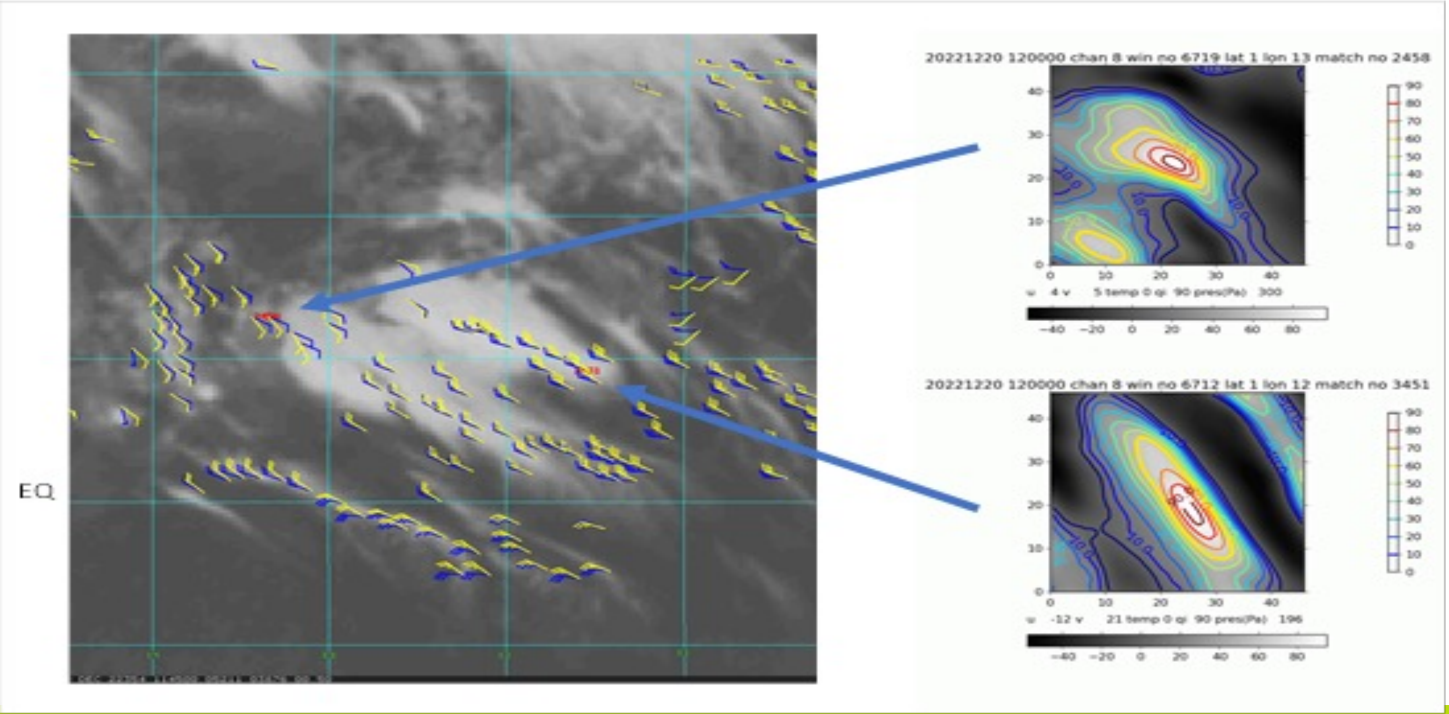

6. Validity of AMVs in the African Tropical region.

The African Tropical region in August is usually a very stormy time in comparison to March.

The upper-level mean O-B plots from Meteosat-11. Next slide shows March and August O-B density plots which are very different.

The O-B Standard Deviation (Stdv) in March is 3.8 m/s compared with the much larger value of 5.4 m/s for August.

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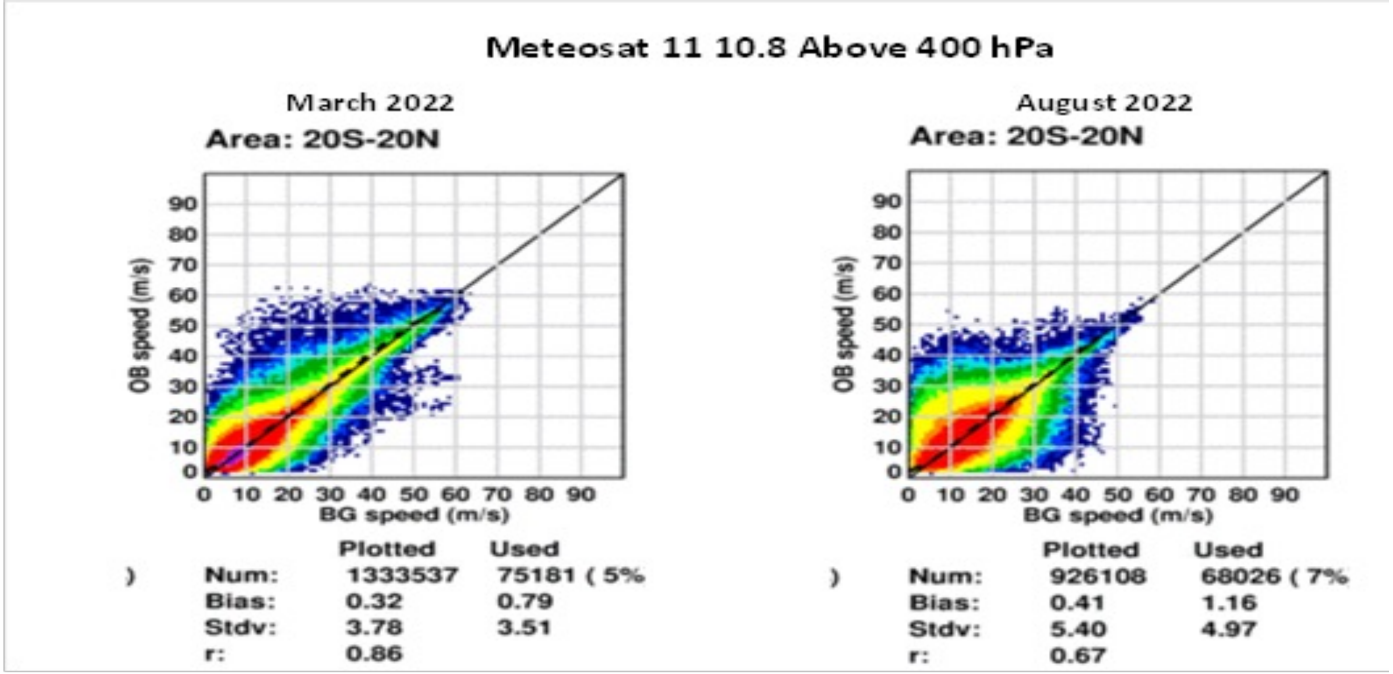
Density monthly monitoring plots for Meteosat-11 IR high level for March 2022 and August 2022.



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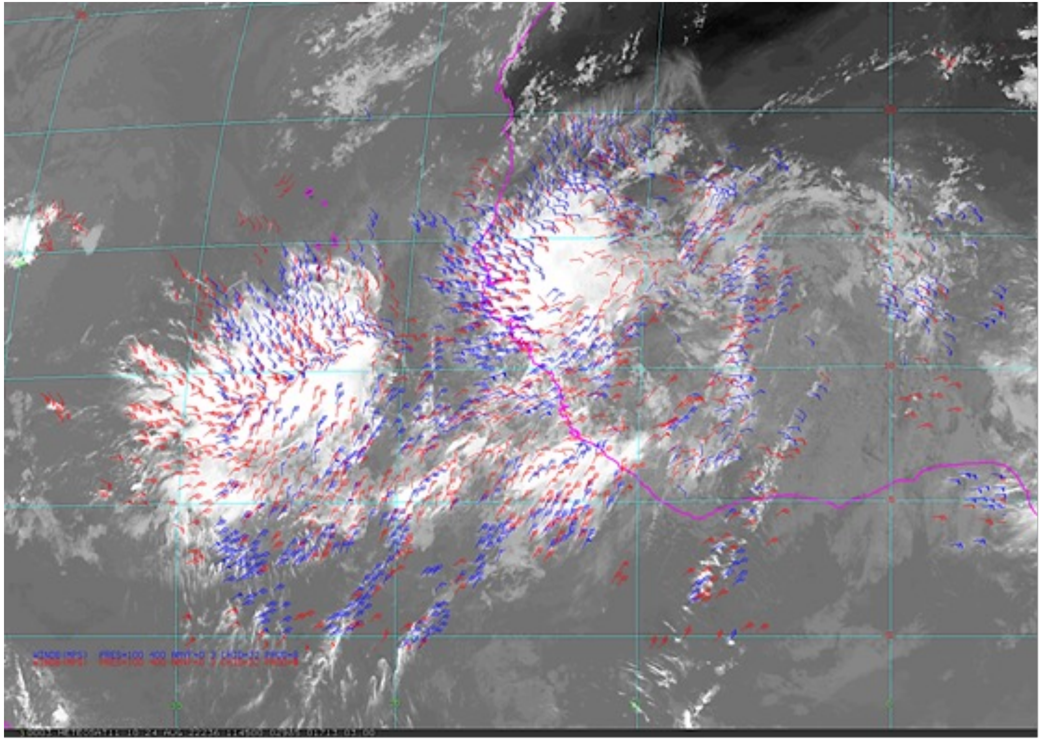
Two large MCS for11:45 UTC on 24/08/2022. AMVs with QI values greater than 0.7 between 100-400 hPa: EUMETSAT AMVs (red), NWC SAF AMVs (blue).



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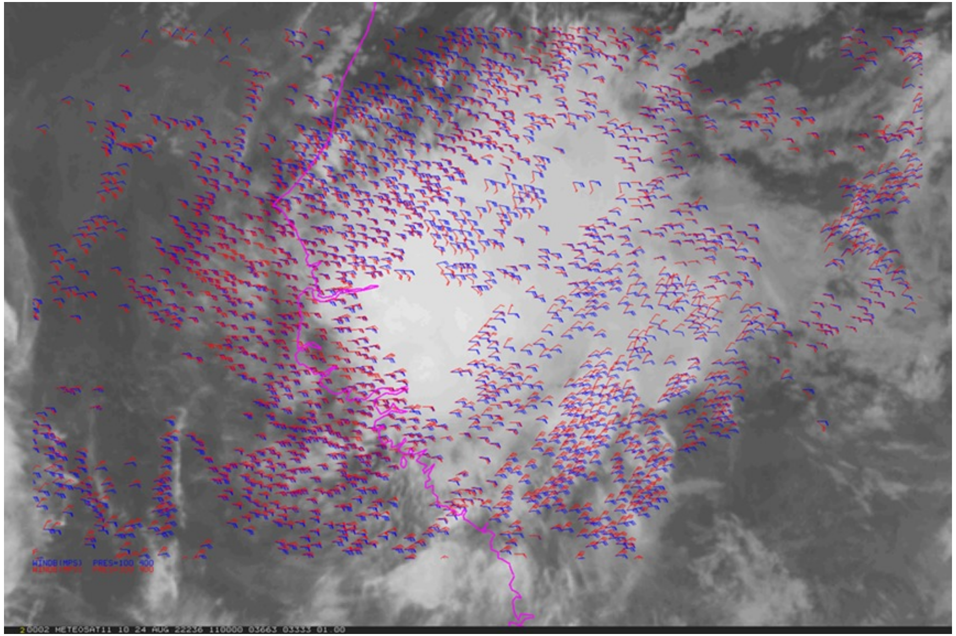
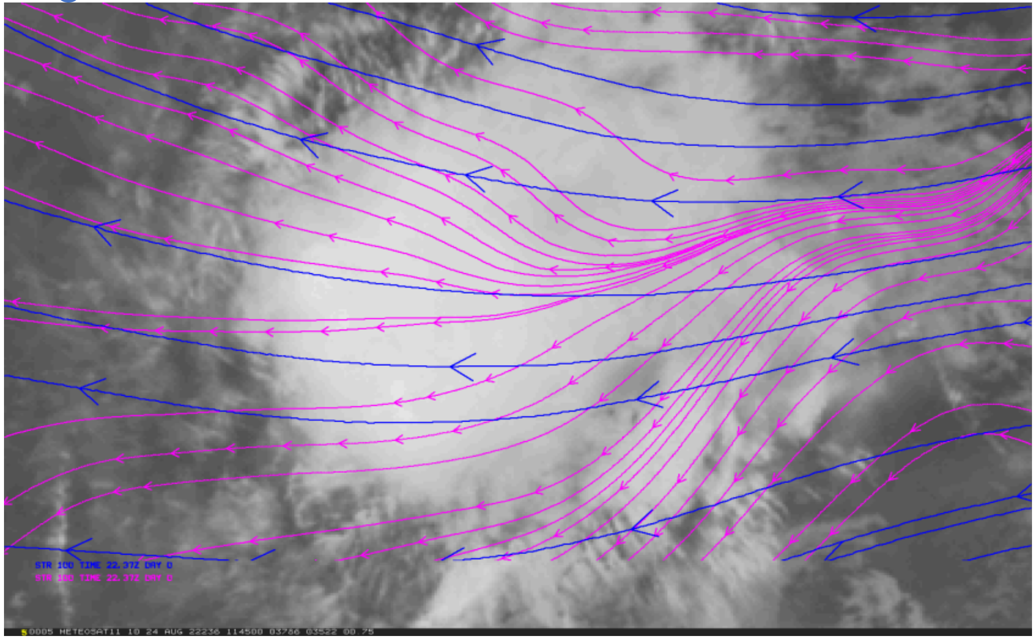
A large MCS 11:45 UTC on 24/08/2022 from the previous slide. All AMVs (no QC) Red vectors are NWC SAF and blue vectors model guess.



An analysis of all AMVs and their NWP guesses for 11:45 UTC on 24/08/2022. The MCS in image from previous slide. Red vectors are NWC SAF AMVs and blue vectors model guess.



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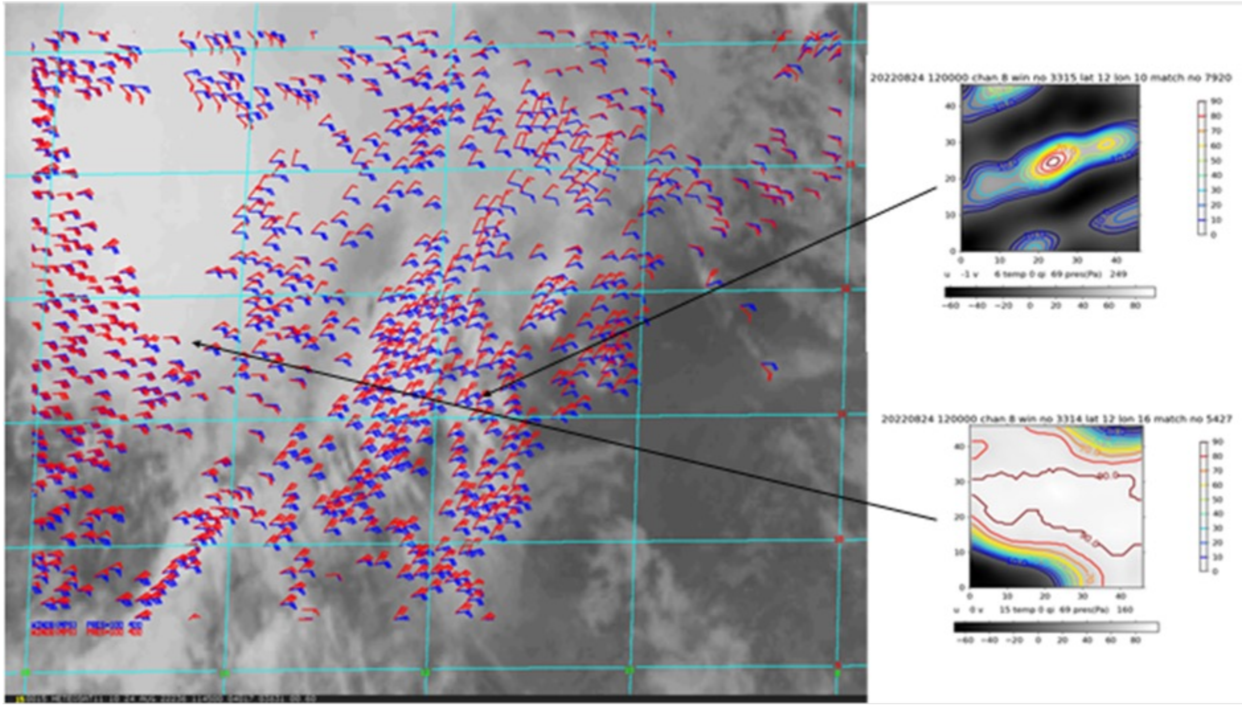
Expanded view of previous slide including two cross-correlation matrices. Red vectors are AMVs and blue vectors are the model guess.



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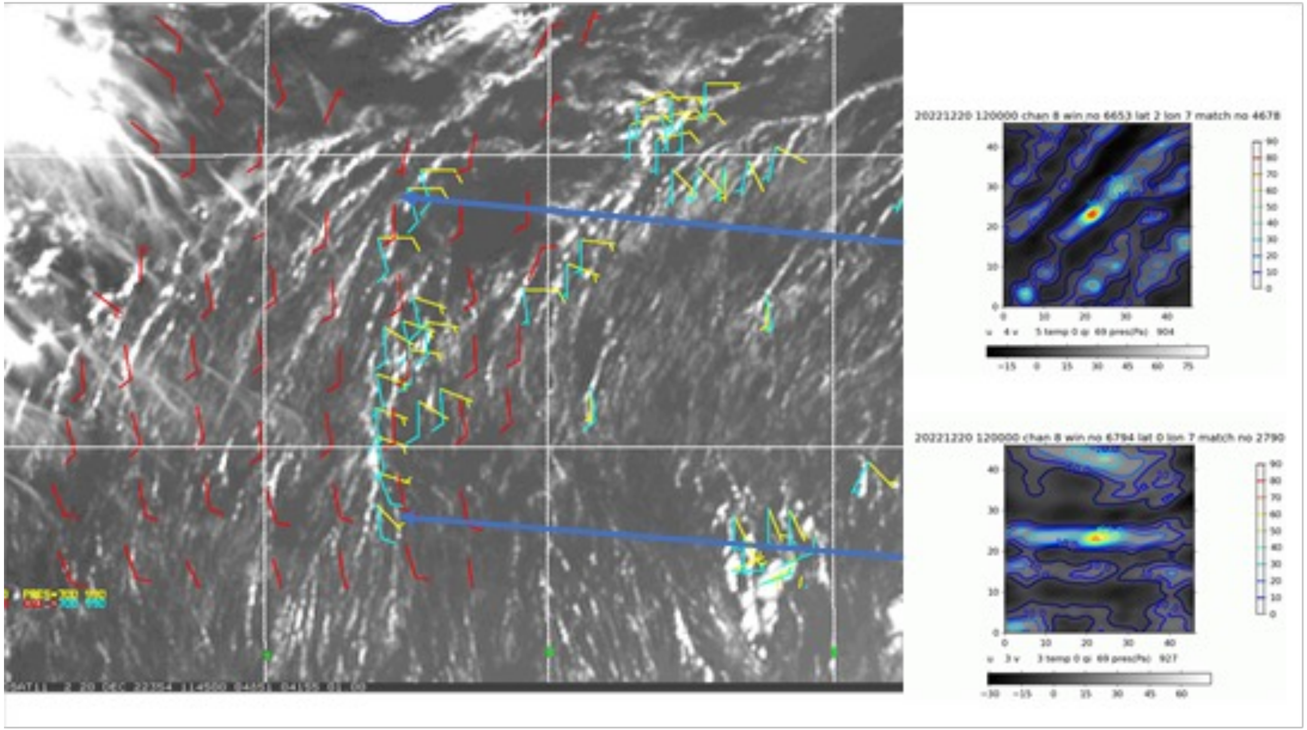
6.2. AMVs in the Tropical boundary layer assigned incorrect pressures.

The next slide shows a systematic difference in wind direction between the NWC SAF AMVs and the model guesses. It is interesting that the scatterometer surface wind vectors are closer to the NWC SAF AMVs, suggesting the AMVs are derived from clouds moving in the same general direction as the surface flow.

Also, in the next slide two cross-correlation matrices from AMVs in this region are shown. These are typical of the low level AMVs in this region and have small and well-defined maxima suggesting that the cloud tracking is well constrained.

Met-11 image 11:45 UTC on 20/12/2022 Low level AMVs (blue), their model guess field (yellow) and scatterometer winds (red). Examples of two cross correlation matrices.



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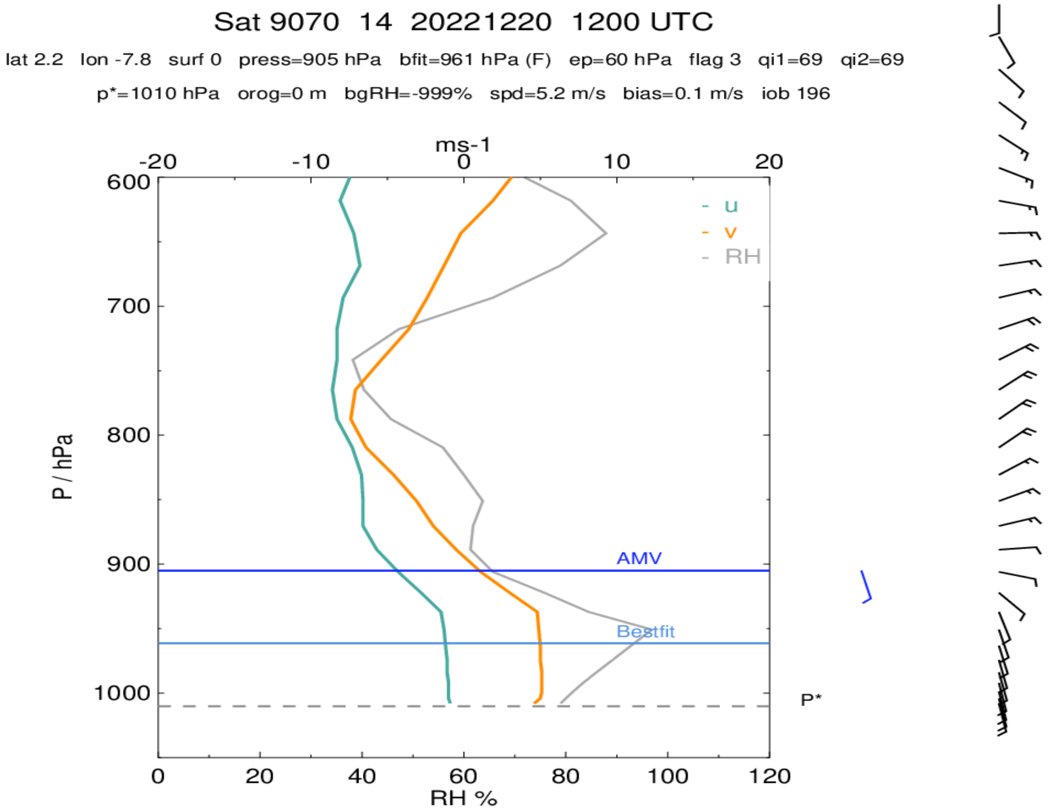

11:45 UTC on 20/12/2022. Model guess vertical profile at the location of the AMV in the top left u-wind component (green), v-wind (orange), and relative humidity (grey).

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7. Summary

Since the last NWP SAF report EUMETSAT, NOAA and JMA have rearranged their prime satellites. GOES-18 has replaced GOES-17, Himawari-9 replaced Himawari-8, Meteosat-9 replaced Meteosat-8 (IODC), and Meteosat-10 replaced Meteosat-11 at 0 degrees East.

Examples of the cross-correlation matrices were shown with various cases studies, and it is suggested that the AMV providers, based on a study (Kelly 2021), make more use of these cross-correlation surfaces during their AMV processing.

Summary (2)

In the second case it was found during August that the O-B standard deviation from the monthly upper-level monitoring in the tropical African region is much greater than in March.

August is the season of organized convection and there are strong outflow regions at the tops of the convection.

The upper-level flow, as captured by the AMVs, shows a strongly divergent wind pattern ahead of the MCS. In the case studied in this report, the NWP model completely failed to capture this feature.

In these regions the large O-B values suggest the model guesses may often be less reliable.

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Summary (3)

The third case study shows an example where AMVs derived from clouds in the boundary layer are assigned heights above the boundary layer. This is consistent with Feature 8.1 of AR8 and other studies (Santek 2023 and Lean 2021).

It is hoped the findings of this report will be useful to AMV producers seeking to improve aspects of the AMV derivation schemes, as well as for NWP centres in improving their methods of AMV data assimilation.