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Assessment and Trialling of New AMV Datasets in the Met Office Global Model since IWW13

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Abstract

Between the 13th and 14th International Winds Workshops, new AMV datasets were assessed at the Met Office including: AMVs derived using the new 'nested tracking' algorithm on GOES-13 and -15 imagery, Meteosat Second Generation (MSG) AMVs with alternative height assignment from the Optimal Cloud Analysis (OCA) product, and AMVs from GOES-16.

The GOES-16 infra-red AMVs were trialled and showed a positive impact compared to a baseline with no GOES-East AMVs; operational assimilation began in May 2018. Assessment of the nested tracking GOES13/15 AMVs showed they had larger O-B differences than the auto-edited heritage product, and smaller differences than the un-edited heritage product. The OCA heights for MSG gave a slight reduction in O-Bs, mostly for the water vapour channels, but this did not translate into improved model performance when they were trialled.

GOES-16 AMVs

O-Bs of GOES-16 AMVs from early 2018 were assessed, comparing to GOES-13 AMVs from early 2017. O-B biases were larger in some areas, smaller in others but the AMVs were generally of similar quality.

The GOES-16 AMVs were then trialled in the Met Office global model, alongside a control trial using no GOES-East AMVs. Quality control was mostly the same as GOES-13, including height error profiles and the blacklist of low level infra-red AMVs over northern hemisphere land.

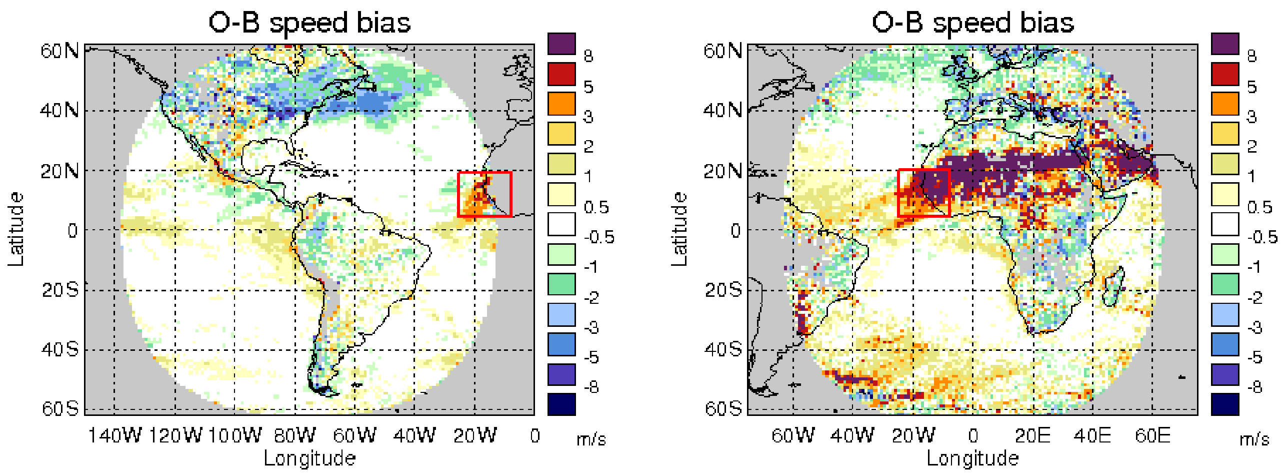

Figure 1: **Map of infra-red AMVs from GOES-16 (left) and Meteosat-10 (right), February 2018, below 700 hPa. Red box shows location of spatial blacklisting**

At first only the infra-red GOES-16 AMVs were trialled. The GOES-16 AMVs have greater coverage than GOES-13 and now reach as far as the West African coast. In the low-level (below 700hPa) infra-red AMVs a similar fast bias is seen in the GOES-16 and the Meteosat Second Generation (MSG) data. Consequently the same blacklisting used for MSG in this area was used for GOES-16 (Figure 1). An additional blacklist was added for all infra-red AMVs above 250 hPa due to a negative O-B speed bias of many AMVs at those heights (Figure 2).

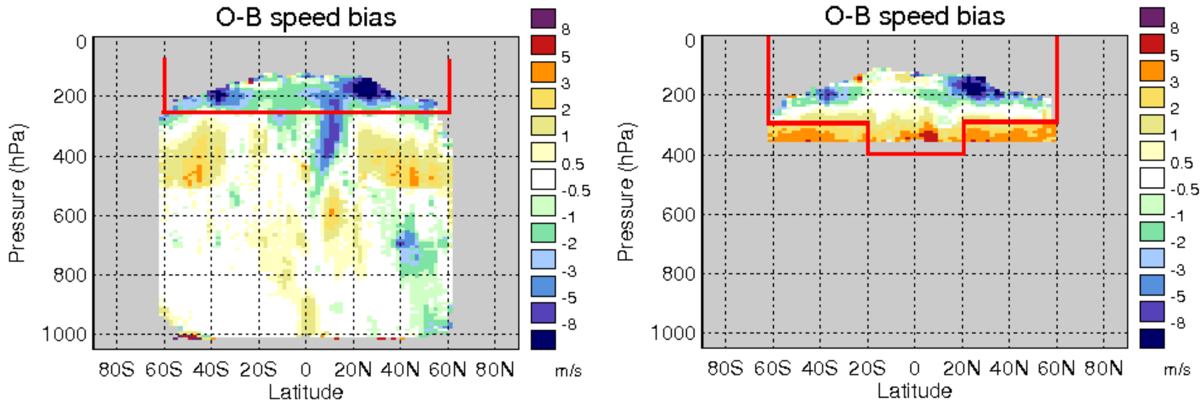

Figure 2: **GOES-16 infra-red (left) and water vapour 6.2 micron AMVs (right), February 2018. AMVs blacklisted above red line (infra-red) and below (water vapour).**

Results from the first trial are shown in Figure 3, given as percentage difference in forecast errors. While the impact is mostly neutral in the tropics and northern hemisphere, the southern hemisphere shows some improvement when verified against observations and model analyses (both Met Office and ECMWF). Forecast fit-to-observations was improved for AMVs and radiances.

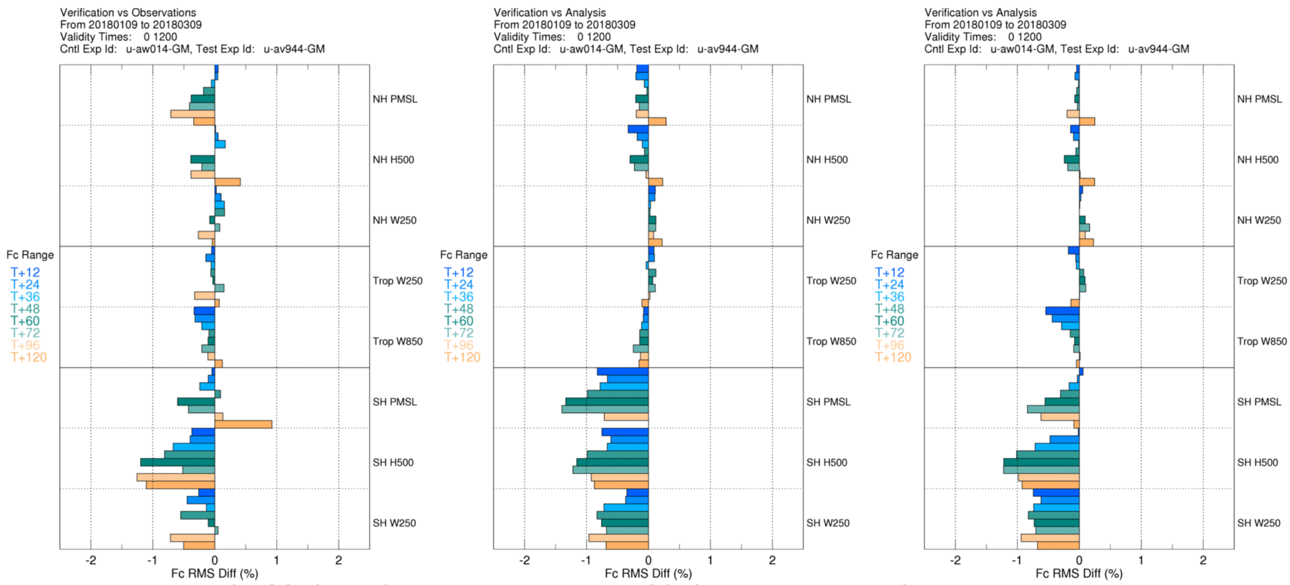

Figure 3: **Trial results for GOES-16 infra-red AMVs versus a no GOES-East baseline. Verification is against observations, Met Office analyses, ECMWF analyses (from left).**

A second trial added GOES-16 cloudy water vapour 6.2 micron AMVs on top of the first trial. Extra blacklisting was introduced for the water vapour to avoid assimilating fast biases in the extra-tropics (Figure 2).

Verification from the second trial is shown in Figure 4. Adding in the cloudy water vapour 6.2 winds improves the some forecast scores but worsens others, particularly tropical winds at 250 hPa. For this reason it was decided to err on the side of caution, and only use the infra-red GOES-16 AMVs operationally initially, in May 2018.

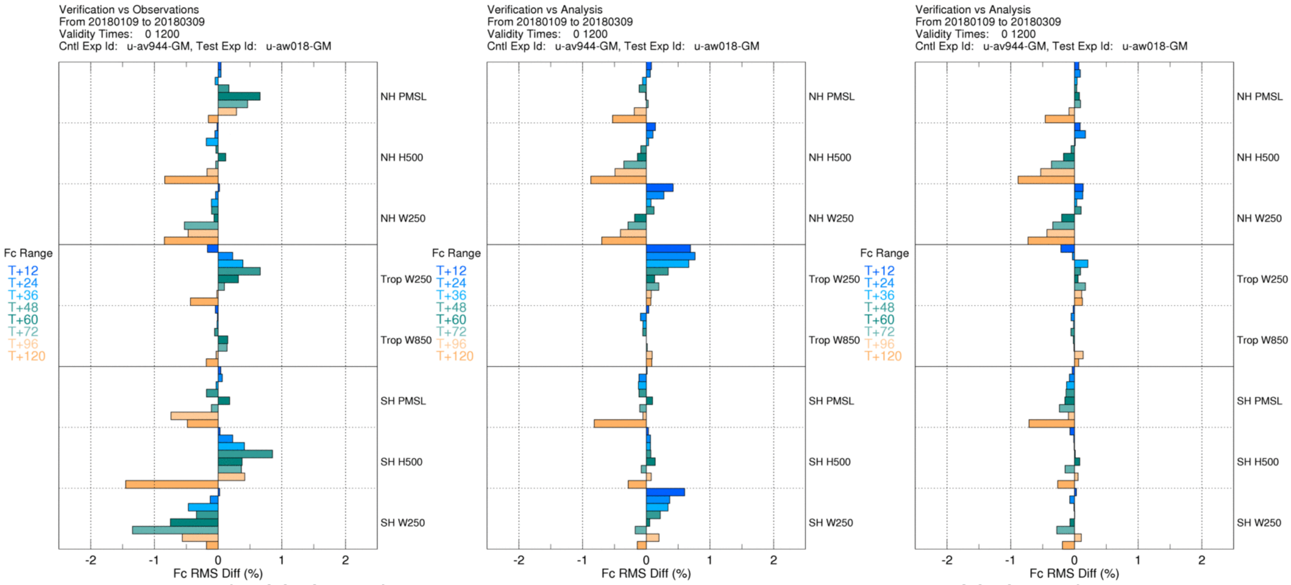

Figure 4: **Trial results for GOES-16 infra-red and water vapour 6.2 AMVs versus a control trial GOES-16 infra-red AMVs only. Verification is against observations, Met Office analyses, ECMWF analyses (from left).**

NESTED TRACKING VERSUS NESDIS HERITAGE DERIVATION

Test data was provided by NESDIS using the nested tracking algorithm [1], designed for GOES-16 onwards, on GOES-13 and GOES-15 imagery, allowing direct comparison of the nested tracking algorithm to the heritage GOES algorithm. An important difference between the two alogrithms is that the auto-editor [2] is no longer used to adjust AMV heights and speeds in the nested tracking algorithm.

O-Bs for the nested tracking AMVs are compared with those of the heritage algorithm with and without auto-editor in Figure 5. Generally the nested tracking AMV quality was in between that of the auto-edited and un-edited heritage algorithm.

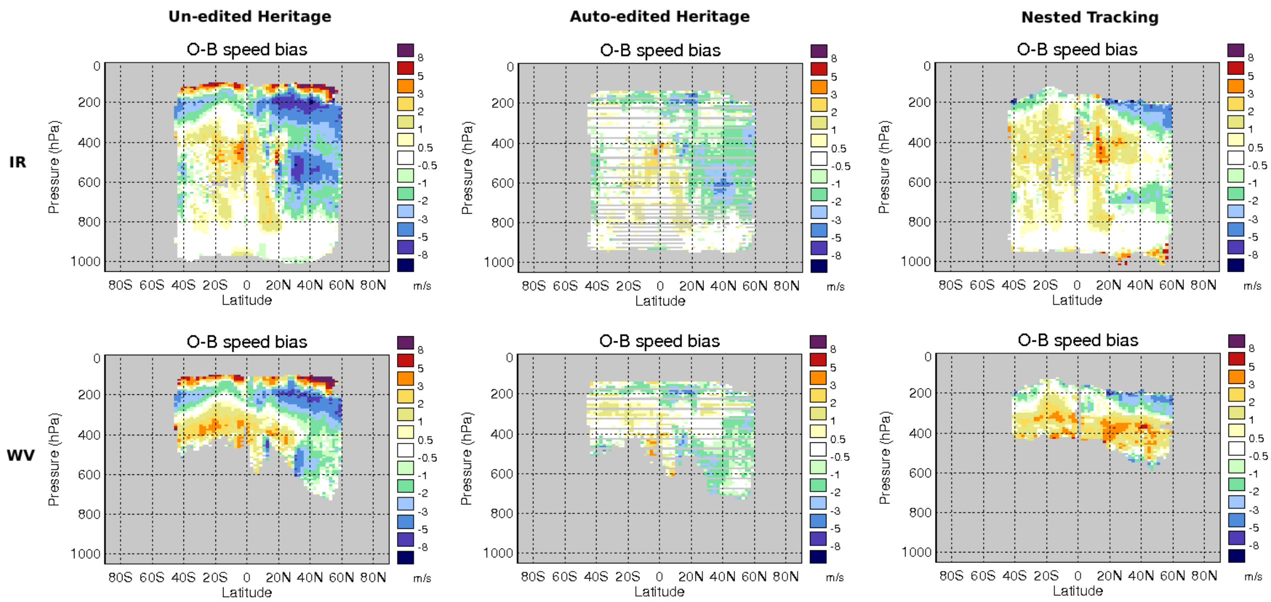

Figure 5: **O-B speed bias of GOES-15 infra-red (top row) and cloudy water vapour (bottom row) AMVs, February 2017.**

The nested tracking AMVs were trialled in the Met Office global model. The nested tracking AMVs have a better impact than the un-edited heritage AMVs (Figure 6) but a worse impact than the auto-edited heritage AMVs (Figure 7). Verifying the nested tracking AMVs against a no-GOES control gives slightly positive impact except against own analyses in the tropics.

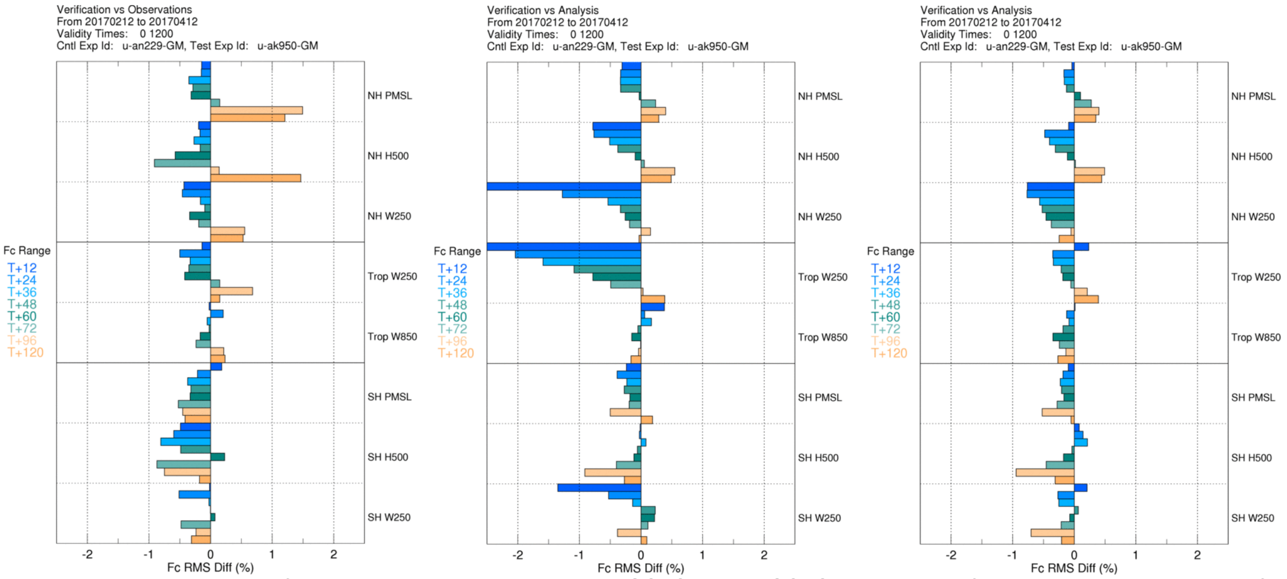

***Figure 6*: Forecast impact of assimilating the nested tracking GOES-13 and GOES-15 AMVs verified against observations (left), Met Office analyses (middle) and ECMWF analyses (right). The control trial used un-edited heritage GOES AMVs in this case.**

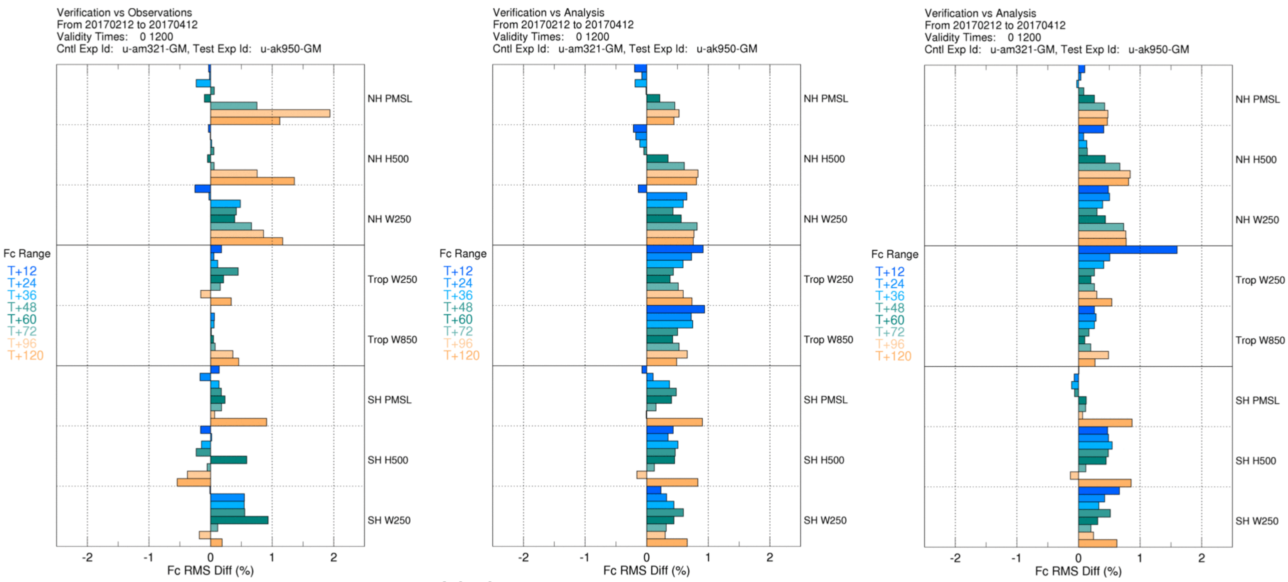

***Figure 7*: As Figure 5, but with auto-edited GOES AMVs used in the control.**

IMPACT OF OCA HEIGHTS ON MSG AMVs

Alternative AMV height assignments using the OCA cloud product [3] were made available by EUMETSAT for Meteosat-10 and Meteosat-8. The OCA scheme has the capability to handle two-layer cloud situations and in these cases AMV heights are assigned to the upper layer.

Figure 8 shows differences between AMV pressures and their best-fit pressures (BFPs - height at which O-B speed difference is minimised), both for the operational heights (CLA) and the OCA heights. A positive number means the AMV altitude is lower than its BFP. OCA heights generally show smaller BFP differences than CLA heights at high level, larger at low level.

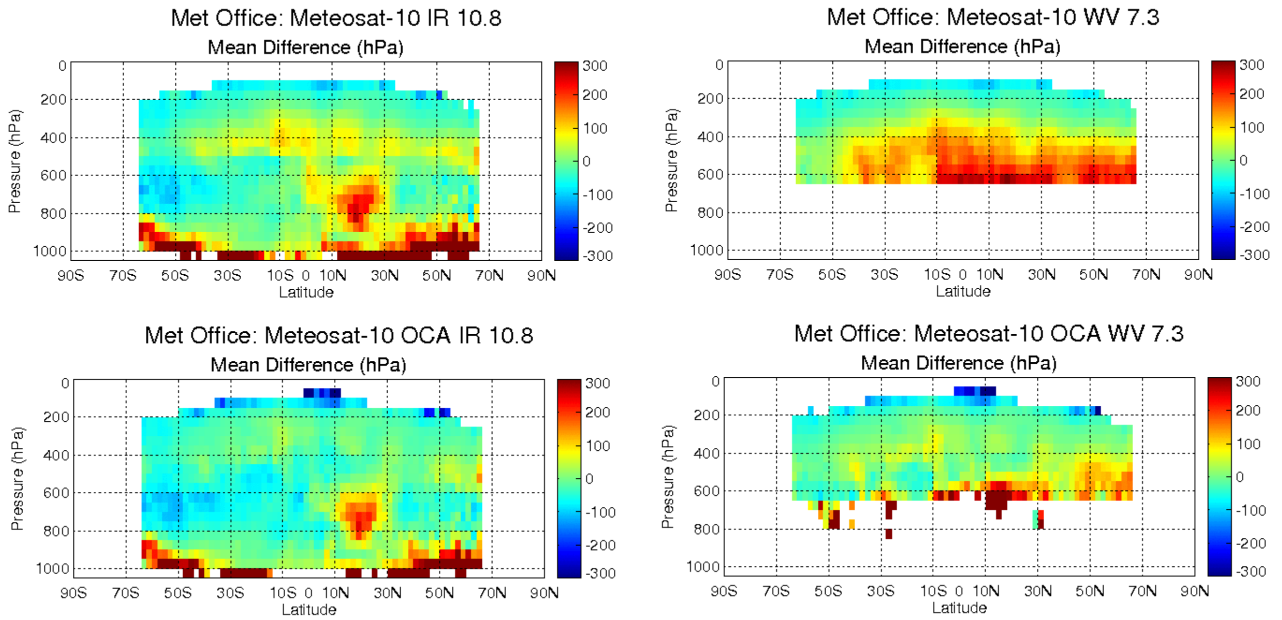

***Figure 8*: Difference between AMV pressures and their model best-fit pressures, May 2017. Top row uses CLA operational pressures, bottom row uses the OCA pressures.**

The effect on O-Bs of using OCA heights is shown in Figure 9. The high-level (above 400 hPa) infra-red AMVs show only small differences in the tropics, reducing some fast biases and increasing some slow biases. The low-level (below 700 hPa) infra-red AMVs show a more severe slow bias in the Gulf of Guinea. The water vapour AMVs show the most improvement from the OCA heights, reducing the fast bias seen in the tropics, especially for the 6.2 micron channel.

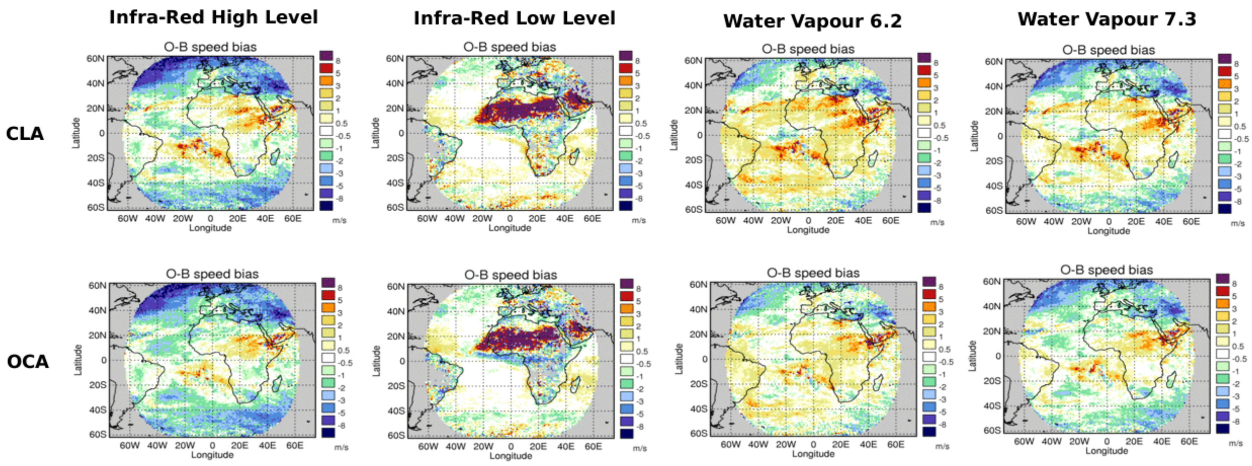

***Figure 9*: O-B speed biases of Meteosat-10 AMVs using CLA (operational) and OCA pressures, December 2016.**

A trial was run to assess the impact of using OCA heights instead of CLA heights. Figure 10 shows the results were generally poor for the OCA trial. The map of forecast impact shown in Figure 11 suggests height assignments of low-level AMVs may have caused the negative forecast impact. One caveat with the results is that the quality indicator (QI) values are set based on CLA heights, not OCA heights. This means it is not quite a fair comparison as the consistency and buddy checks used to calculate the Qis were based on the information from the CLA heights, not the OCA heights.

SUMMARY

AMV datasets assessed at the Met Office between IWW13 and IWW14 include the GOES-16 AMVs, of which the infra-red channel AMVs went operational in May 2018 following positive trial impact. GOES-16 water vapour 6.2µm AMVs were also trialled, but due to their mixed trial impact it was decided not to use them operationally yet. AMVs derived using the nested tracking algorithm on GOES 13 and 15 imagery were assessed and their O-Bs and forecast impact were better than those of un-edited heritage-algorithm AMVs, but worse than those of heritage-algorithm AMV with the auto-editor applied. Finally, the OCA alternative heights for MSG AMVs were assessed and trialled but did not give an improvement in forecast performance, though it is possible that better results could be achieved if the AMV QIs were set based on the OCA heights.

REFERENCES

[1] Bresky et al, 'New Methods toward Minimizing the Slow Speed Bias Associated with Atmospheric Motion Vectors', 2012, Journal Of Applied Meteorology And Climatology, Volume **51**, pp 2137-2151

[2] Forsythe M. and Saunders R., 'Third Analysis of the data displayed on the NWP SAF AMV monitoring website', 2008, NWP SAF Technical Report 22, Section 4.2

[3] 'Optimal Cloud Analysis: Product Guide', 2016, EUMETSAT Document number: EUM/TSS/MAN/14/770106, Issue v2A e-signed

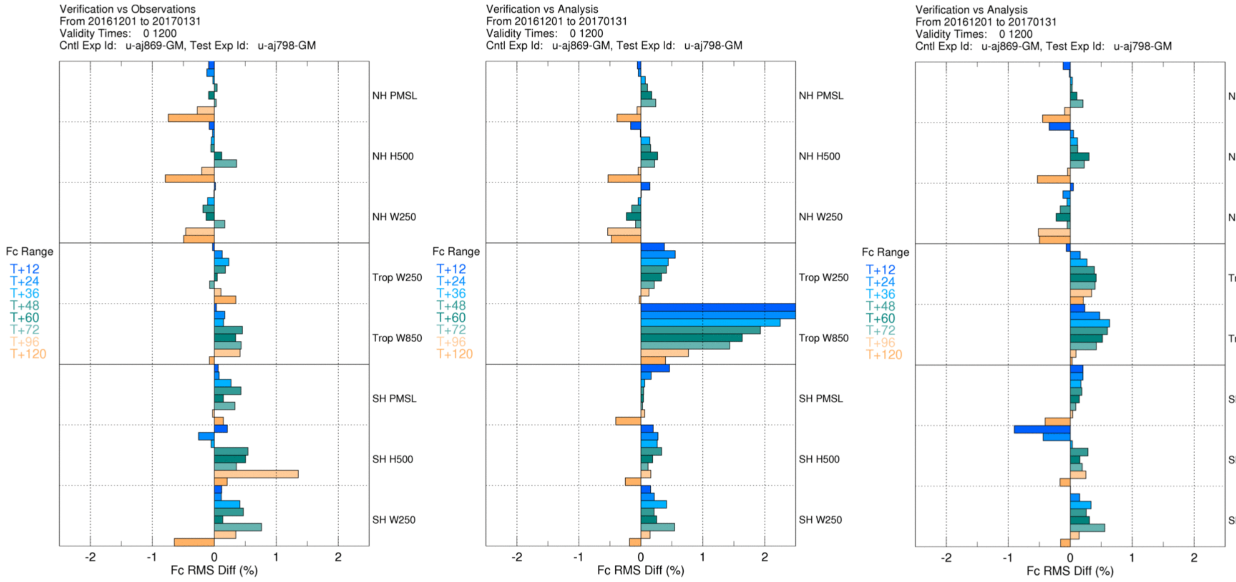

Figure 10: **Forecast impact of using OCA pressures instead of CLA pressures for MSG AMVs, versus observations (left), Met Office analyses (centre) and ECMWF analyses (right).**

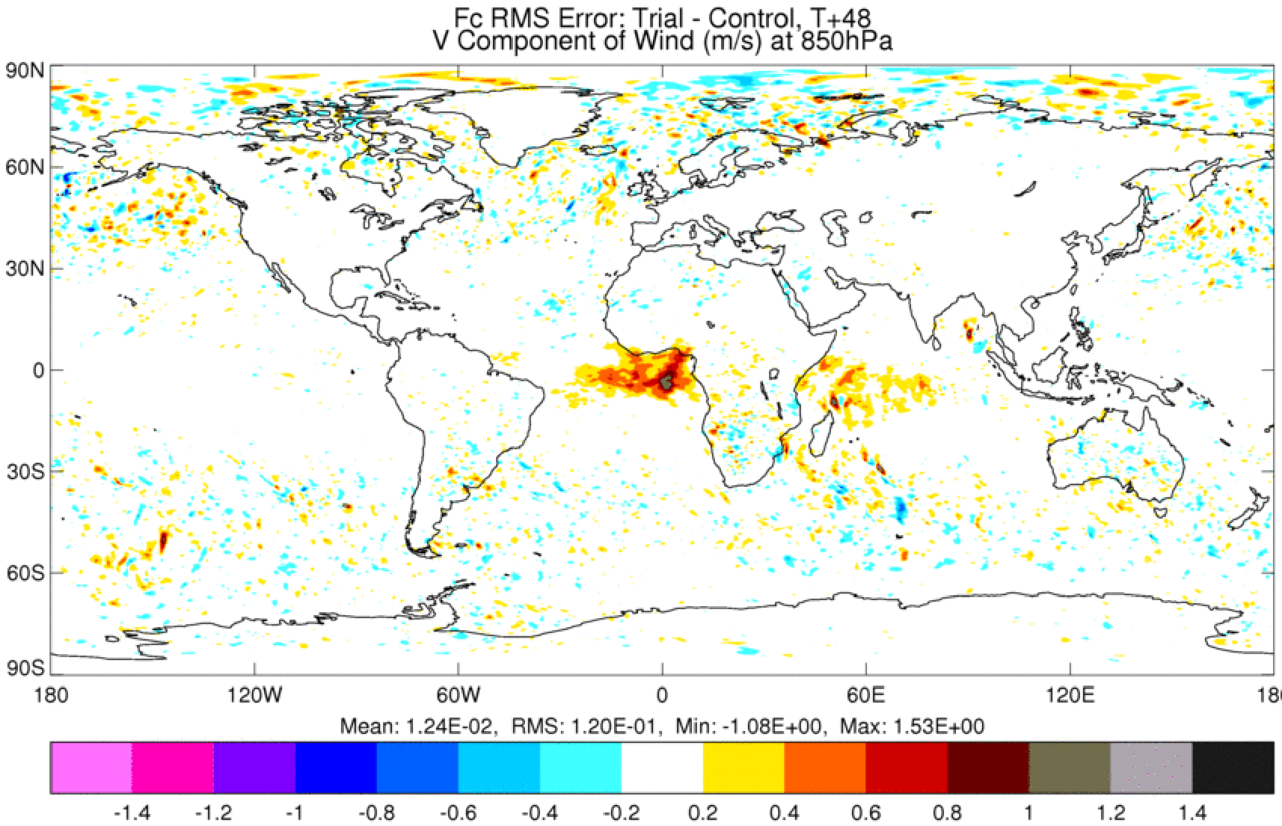

Figure 11: **Difference in root-mean-square error of wind v-components at 850 hPa, versus Met Office analyses, for forecasts using OCA heights (trial) versus CLA heights (control).**