AMV research activities at ECMWF

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Geostationary changes

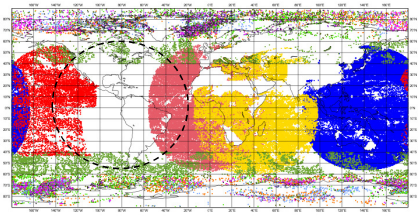
It has been an active 18 months for geostationary satellites with changes to 3 out of the 5 operationally used:

- Meteosat-8 replaced Meteosat-7 (2nd Mar 2017, Indian Ocean Data Coverage (IODC))
- Meteosat-11 replaced Meteosat-10 (20th Feb 2018, 0° service)
- GOES-13 removed (2nd Jan 2018) and GOES-16 monitored (18th Apr 2018, 75.2°W)

AMVs over the Indian Ocean have been a particular area of focus at ECMWF [1]. After the successful introduction of Meteosat-8, bringing improvements as a newer generation satellite, a subsequent investigation explored the benefit of assimilating other satellites with good coverage of the Indian Ocean region including FY-2E (86.5°E) and INSAT-3D (82°E). Despite variation in data quality, assimilation experiments revealed a lot of similarity in the forecast impacts.

While the experiments confirmed the continued benefit of an Indian Ocean satellite, a challenging area at low levels for both the AMVs and model was identified in a localised region over the ocean. Investigation is ongoing and this has now been noted for further study in the latest NWP SAF monitoring report [2].

All assimilated AMVs 12Z 25th Feb 2018



Current data use

Assimilated: Dual Metop A/B, Single Metop A/B, Himawari-8, GOES-15, Met-8*, Met-11*, AQUA, NOAA-15, NOAA-18, NOAA-19, SNPP*

Monitored: GOES-16*, FY-2E, FY-2G, INSAT-3D, COMS-1, TERRA

*New in operational system since July 2016

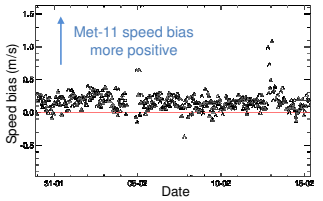
Meteosat-11 replaces Meteosat-10

Meteosat-11 is the same generation as Meteosat-10 so the data quality was very similar as expected.

A small shift in the raw radiances (~0.2K) used in height assignment leads to Met-11 AMVs having similar wind speed but, on average, assigned higher pressures (~5hPa) than Met-10.

➡ Results in small shift in speed bias with Met-11 less negative (more positive)

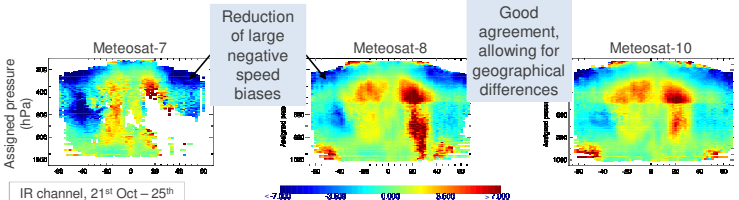
Diff speed bias (Met-11 – Met-10)



All 7.35μm water vapour winds (hourly data)

Meteosat-8 replaces Meteosat-7

Moving from a 1st to 2nd generation Meteosat satellite results in many more AMVs available and better data quality. First guess departure statistics (observed – model background) show Meteosat-8 has very similar characteristics to Meteosat-10 (as expected) and improvements over Meteosat-7.



IR channel, 21st Oct – 25th Nov 2016, QI (forecast indep.) > 80
Boxes with n > 20 only

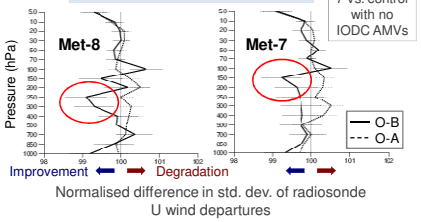
Assimilation Experiments

Due to close similarity, to test the longer term forecast impact the configuration for Met-8 is almost the same (added rejected for P < 150hPa) as Met-10.

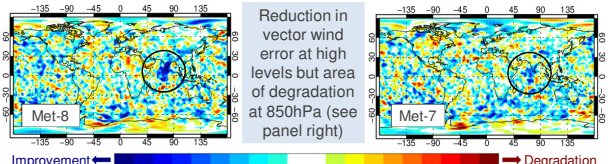
Results are mostly small positive/neutral but show continued benefit from IODC satellite.

IODC AMVs improved U component fit of independent radiosonde observations to model background over Indian Ocean region

1st Nov 2016 – 28th Feb 2017 Met-8/-7 vs. control with no IODC AMVs



Normalised difference in std. dev. of radiosonde U wind departures



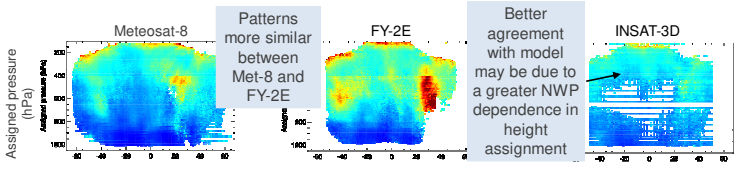
Reduction in vector wind error at high levels but area of degradation at 850hPa (see panel right)

21st Oct 2016 – 7th Mar 2017 Met-8/-7 vs. control with no IODC AMVs verified against own analysis.

T+48 Normalised Difference in RMS vector wind error at 200hPa

IODC options

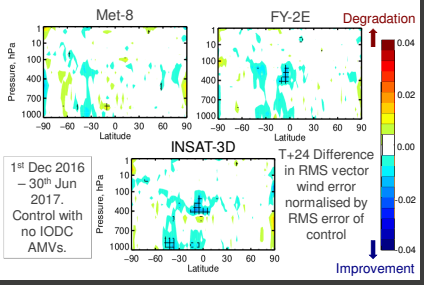
Alternative IODC options were explored by inter-comparison of Meteosat-8, INSAT-3D and FY-2E. The differing imaging instruments and derivation techniques led to significant differences in AMV numbers and data quality.



IR channel, 1st Dec 2016 – 15th Jan 2017. QI (fc indep.) and first guess check screening, boxes with n > 20 only

Despite their differences, forecast impacts of each satellite are similar with short range forecast benefits generally in the tropics/S. Hem.

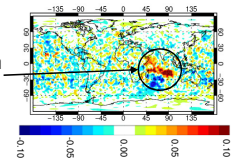
But to realise the full NWP benefit from IODC, the radiance product (Met-8 only) should also be included which has significant positive impacts on humidity fields.



1st Dec 2016 – 30th Jun 2017. Control with no IODC AMVs.

Low level challenges

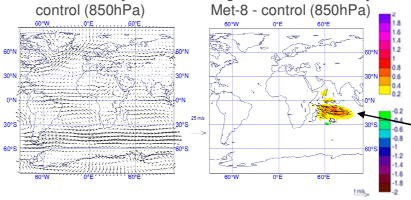
Meteosat-8 shows an area of apparent degradation at 850hPa localised over the Indian Ocean.



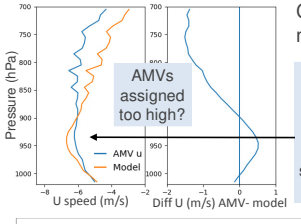
T+24 Normalised difference in RMS vector wind error at 850hPa

Mean wind analysis of control (850hPa)

Change to mean wind analysis Met-8 - control (850hPa)



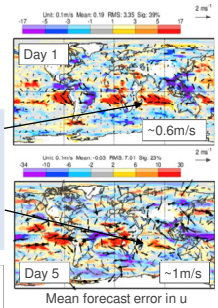
IODC AMVs act to increase the westward flow in the analysis with Met-8 showing the largest change.



Challenging area for both model and observations.

Less wind shear in AMV profile. Nearby radiosondes support more variation.

Increasing forecast error with lead time suggests model bias in early part of experiment



Mean forecast error in u component at 850hPa: Met-8 expt

Further investigation using MISR, CALIPSO and, later, Aeolus could help to verify the AMV heights

References

[1] Lean, K. and N. Bormann, 2018: "Indian Ocean AMVs: Moving to Meteosat-8 and assessing alternative options", *EUMETSAT/ECMWF Fellowship Programme Research Report No. 46*

[2] Warrick, F. and Cotton, J., 2018: "NWP SAF AMV monitoring: the 8th Analysis Report (AR8)", *Available online at https://www.nwpsaf.eu/site/monitoring/winds-quality-evaluation/amv/amv-analysis-reports/*

Katie Lean is funded by the EUMETSAT Fellowship Programme