Environnement et Changement climatique Canada | Environment and Climate Change Canada

AMV Activities and Progress at the Meteorological Service of Canada

Stéphane Laroche[1], Judy St-James[2] and Iriola Mati[2]

[1] Meteorological Research Division, Environment and Climate Change Canada
[2] Meteorological Service of Canada, Environment and Climate Change Canada

Contact: stephane.laroche@canada.ca

14th International Wind Workshop, Jeju, South Korea 23-27 April 2018

Summary of changes made to AMV data processing and assimilation

- Hourly AMV data from all geostationary satellites are now used. Dual-Metop AMVs in the 40-60S and 40-60N latitude bands are assimilated.
- Several modifications to the blacklisting were brought: AMVs above 160 hPa over the Tropics and above 200 hPa elsewhere are rejected. AMVs from geostationary satellites are rejected beyond zenith angle of 68 degrees instead of 62 degrees. The recursive filter flag (RFF) has been replaced by the quality indicator (QI with first guess check) for GOES satellites.
- The background check is applied to the square vector difference instead of on individual wind components.
- The horizontal data thinning has been improved and does not rely on boxes anymore (see more details below).
- The situation dependent observation error algorithm has been implemented into the 4D-EnVar scheme (see more details below).

Data Selection

Old

The data selection is performed for 10 layers centered on the following pressures:1000, 925, 850, 700, 500, 400, 300, 250, 200, 150 and 100 hPa and for 25 time bins of 15 minutes (7.5 min both ends) within the 6-h assimilation window.

For each layer and time bin, one AMV is selected by tile of:
- 1.5° X 1.5° for geostationary satellites;
- 180 X180 km² for polar orbiting satellites.

The priority is given to the closest data to the analysis time having the maximum quality index.

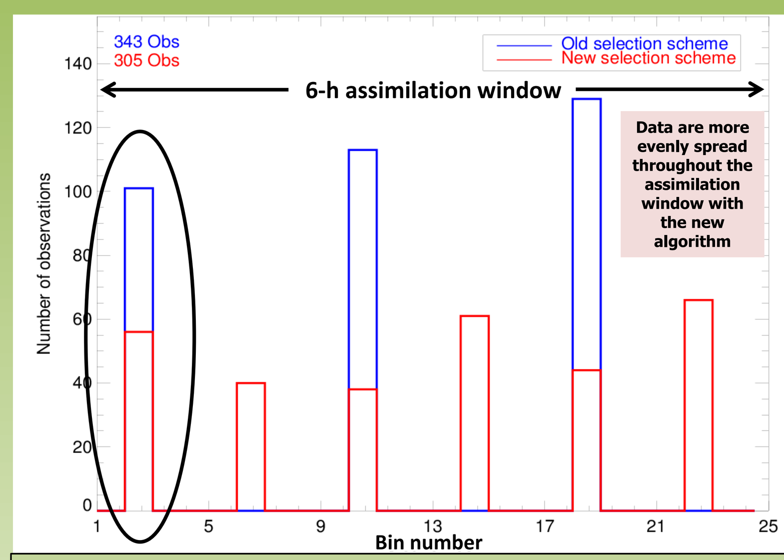

Fig.1: Number of IR AMVs selected over the 6-h assimilation window from **Meteosat-10** on 2016061500. In the old selection scheme (blue), data every 2 hours are chosen, whereas all the available data can be selected in the new scheme (red).

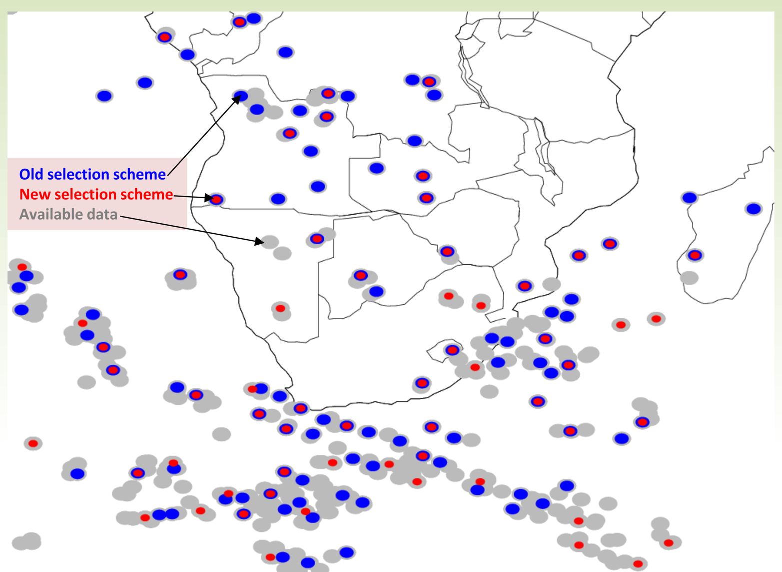

Fig.2: IR AMVs from **Meteosat-10** selected by the old scheme (blue dots) and new scheme (red dots) for the third time bin on 2016061500. Grey dots indicate available observations before selection.

New

The AMVs are first sorted according to their quality index on the same 10 layers.

For each AMV product, the selection process starts from the AMV with the highest QI.

The next AMV is selected if all previous selected data in the same layer and within 6 time bins (1h30).are beyond 200 km.

This selection process is repeated for all subsequent AMVs.

In the old scheme, one AMV is selected in every tile of 1.5° x 1.5°. No minimal distance is imposed between AMVs from adjacent tiles. This results in selected AMVs as close as less than 100km as shown in Fig. 3. In the new scheme, the minimal distance of 200 km is strictly respected.

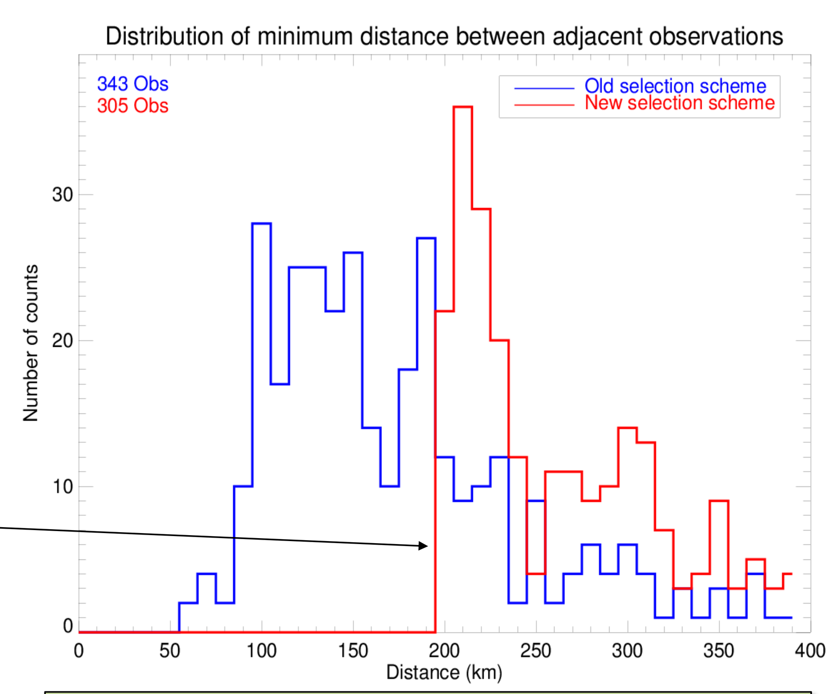

Fig.3: Minimal distance between adjacent IR AMVs from **Meteosat-10** at the same level and time bin on 2016061500.

Situation dependent observation errors

Method proposed by Forsythe and Saunders 2008.

For each AMV wind component, the observation error standard deviation is calculated as follows:

$$\sigma_o = \sqrt{\sigma_t^2 + \sigma_h^2}$$

$$\sigma_t = 7.5 - 0.05\mathrm{QI} \ \ (\mathrm{m/s})$$

$$\sigma_h = \sqrt{\frac{\sum_i W_i (v_i - v_n)^2 \Delta p_i}{\sum_i W_i \Delta p_i}}$$

$$W_i = exp\left(-\left[\frac{(p_i - p_n)^2}{2\sigma_p^2}\right]\right)$$

- i : model level
- v_i : model wind component
- v_n : model wind component at observation location
- p_i : model pressure
- p_n : pressure observation location

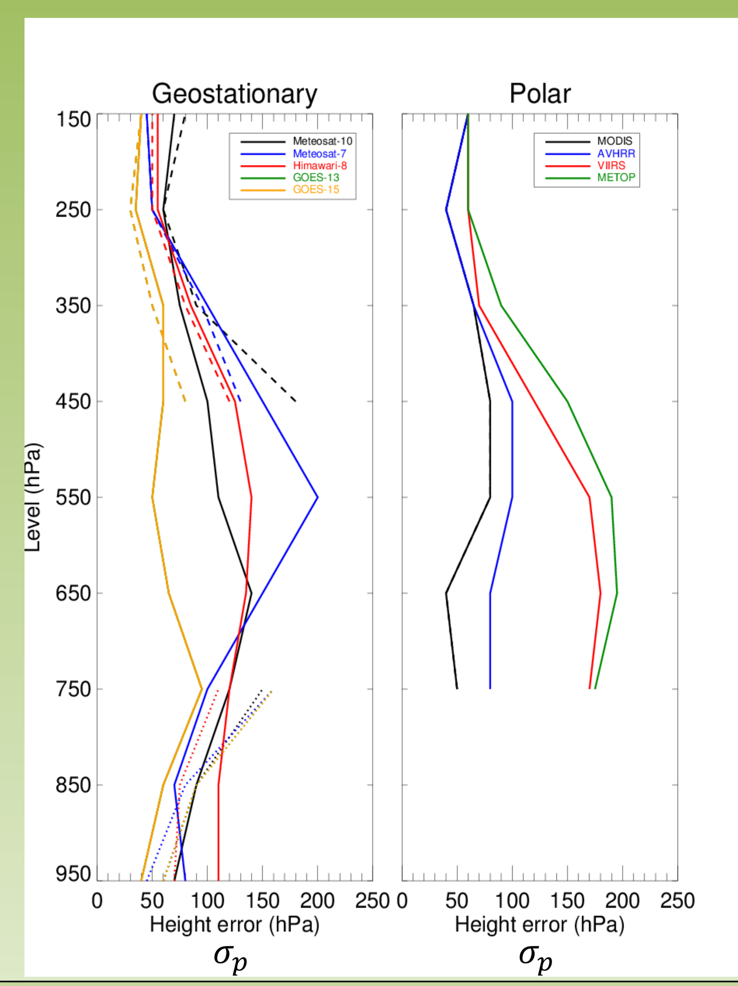

Fig.5: Height assignment error profiles for IR AMVs over water for geostationary (left) and polar (right) satellites. This set of error profiles were kindly provided by Francis Warrick (UK Met-Office).

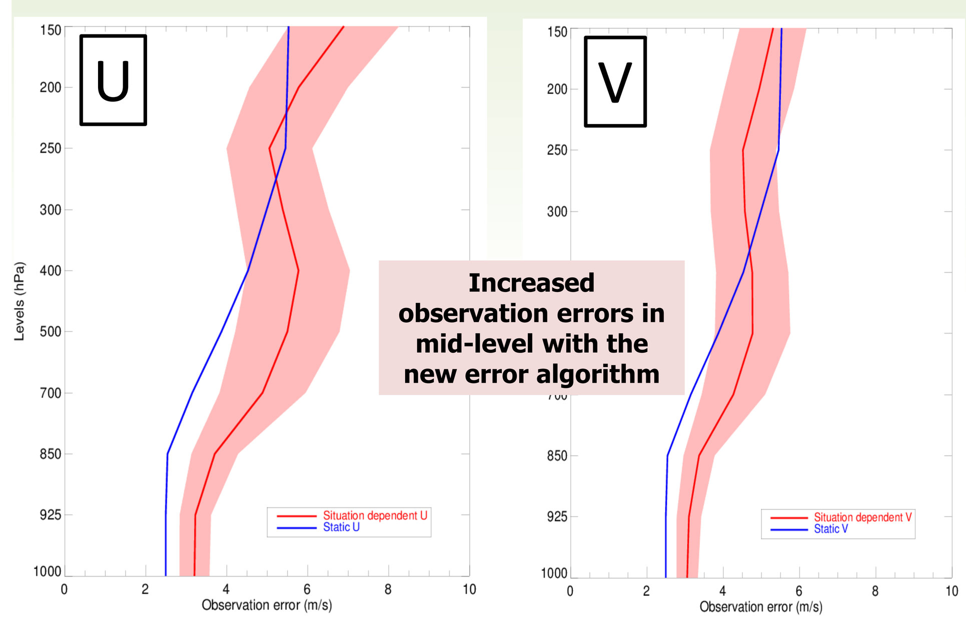

Fig. 4: Observation error standard deviations for all bands and all satellites as a function of pressure level for the zonal component (left) and meridional component (right). The blue curves are the static errors previously used. These errors only depend on pressure level and are the same for both components. The situation dependent errors statistics recently implemented are shown in red. The errors are varying from 2.5 m/s in the lowest levels to 5.5 m/s near the tropopause. The solid curve is the mean error standard deviation and the pink area indicates the error variability (one sigma).

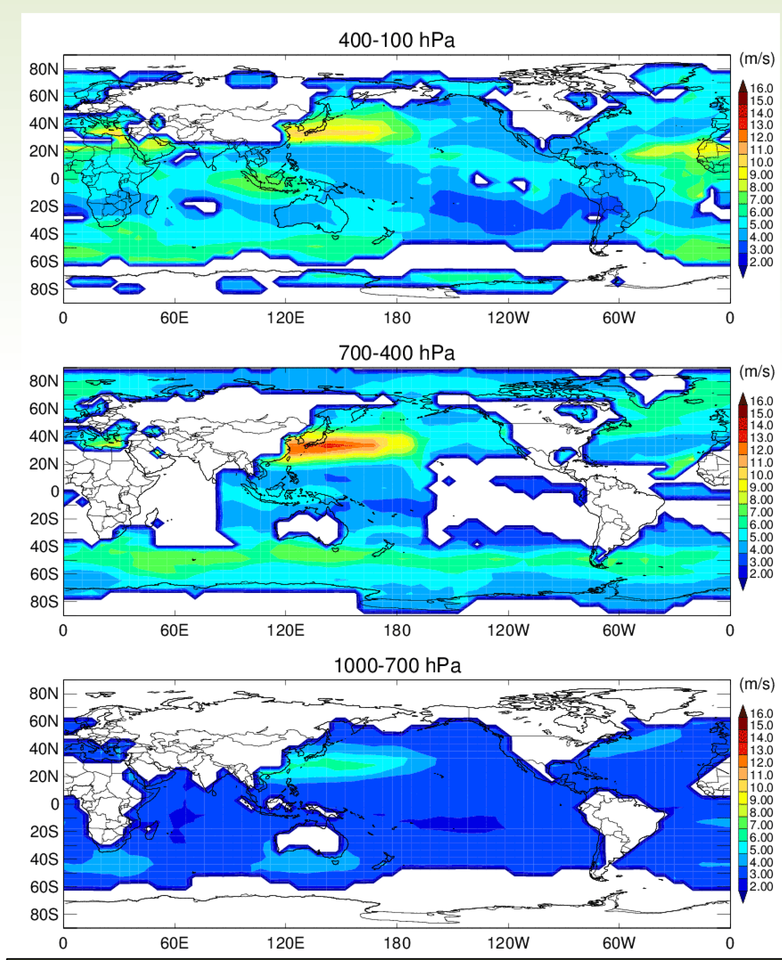

Fig.6: Mean zonal wind (u) observation error for January 2017 for IR AMVs above 400 hPa, between 700 and 400 hPa and below 700 hPa.

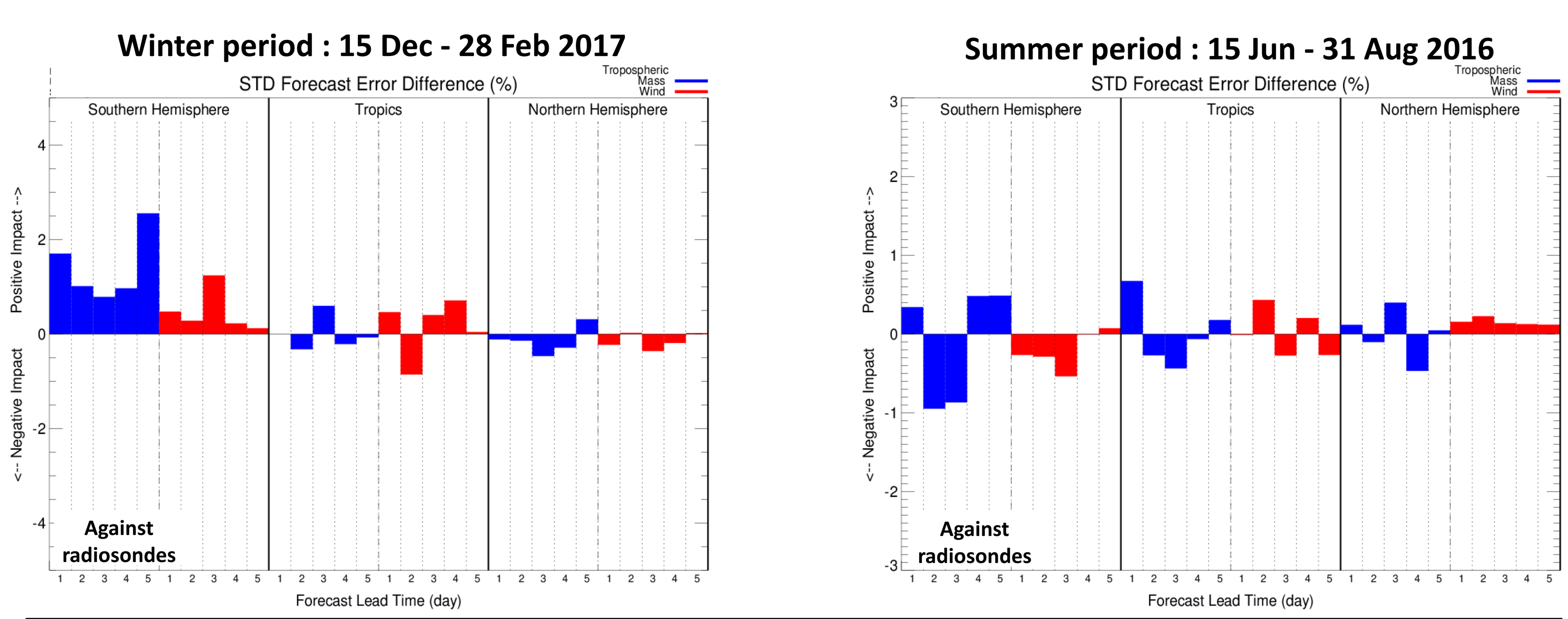

Fig.7: STD forecast error reduction in verification scores against radiosondes (in %) due to all the changes recently made for the AMV processing and assimilation except the situation dependent observation algorithm. Scores for the winter (left) and summer (right) periods for the mass (blue) and wind (right) fields in the troposphere for day-1 to day-5 forecast lead times.

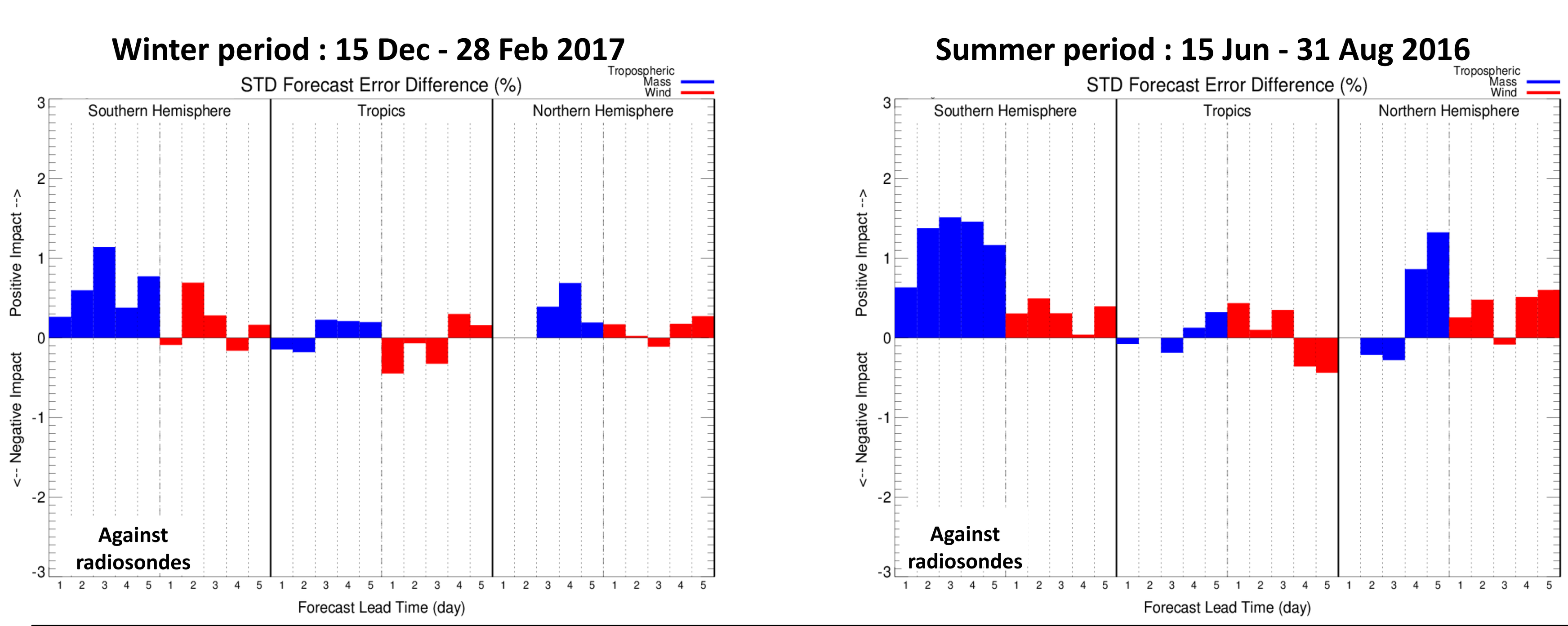

Fig.8: Same as Fig. 7 but for the contribution of the situation dependent observation algorithm only.

Conclusions

AMV data processing and assimilation in the ECCC forecast systems have substantially been upgraded. The new selection algorithm enables the use of hourly AMV data from all geostationary satellites. A minimal distance of 200 km and a minimal time difference of 1h30 between adjacent AMVs are strictly imposed at each level. As a result, the selected observations are better distributed in space and time while reducing the detrimental impact of observation error correlation between nearby AMVs. To fill the AMV gaps in high latitudes, Dual-Metop AMVs in the 40-60S and 40-60N latitude bands are now used and the zenith angle beyond which AMVs from geostationary satellites are rejected is extended to 68 degrees. Several minor modifications to the blacklisting and background check were also made. The impact of all these changes on forecasts is overall neutral except in winter over the southern hemisphere where the impact is positive, especially for the mass field. The impact of the situation dependent observation error algorithm on forecasts is overall positive in the extra-tropics and rather neutral in the tropics. This positive impact on forecasts is consistent with results reported by the UK Met Office and ECMWF in recent years. This is another confirmation that estimating height assignment and tracking errors separately and making the error component due to uncertainties in height flow dependent are important.