Assimilation of new satellite observations

in the Météo-France global 4D-Var data assimilation system

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During the last decade, the number of observations in data assimilation has increased significantly leading to improved analyses and forecasts. This increase comes from two factors : on one hand is the availability of new measuring systems (in particular from satellites) and on the other hand is the capacity of data assimilation systems to ingest more data from existing platforms.

In July 2013, the number of observations assimilated in the Météo-France operational global four-dimensional variational data assimilation system has increased dramatically from the combined availability of three new satellites. In October 2011, the satellite « Suomi-NPP[1] », having onboard a microwave sounder ATMS[2] and an hyperspectral infra-red sounder CrIS[3], was launched by the United States. The radiances from ATMS are assimilated in similar way to AMSU-A and AMSU-B/MHS instrument expect that additional quality flags have been defined thanks to the availability of all frequencies from 24 GHz to 191 GHz on the same instrument. Morever, the instrumental noise is reduced for temperature channels by a "3x3" spatial average of the satellite pixels. Regarding CrIS, a sub-set of 43 channels among the 1305 is assimilated in clear sky conditions. In September 2012, the satellite « MetOp-B » has been launched by EUMETSAT, as a follower of « MetOp-A » that remains available. The various instruments on board MetOp-B are assimilated (AMSU-A, MHS, GRAS, ASCAT) with the exception of the infra-red HIRS sounder. At last, surface wind data from the scatterometer OSCAT[4] onboard the Indian satellite OCEANSAT-2 launched in 2009 are available in real time for the scientific community since the end of 2012. The winds from OSCAT are assimilated with a spatial thinning of 50 km (compared to 100 km for ASCAT) but with increased observation errors. These three instruments have produced an increase of data by a factor of 2 in the global model ARPEGE, the largest contribution is coming from the infra-red hyperspectral sounders as shown in Figure 1. Forecast sensitivity to observations based on the adjoint method with the ARPEGE model and a 24-h forecast error defined by a dry energy norm with the new system (Figure 2) reveals that the AMSU-A instruments (7 sounders on different platforms) remain the most important observing system for improving the short-range model forecast skill followed by the two IASI instruments.

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[1] Suomi-NPP : US program for meteorological polar orbiting satellites
[2] ATMS : Advanced Technology Microwave Sounder
[3] CrIS : Cross-track Infra-Red Sounder
[4] OSCAT : OCEANSAT-2 Scatterometer

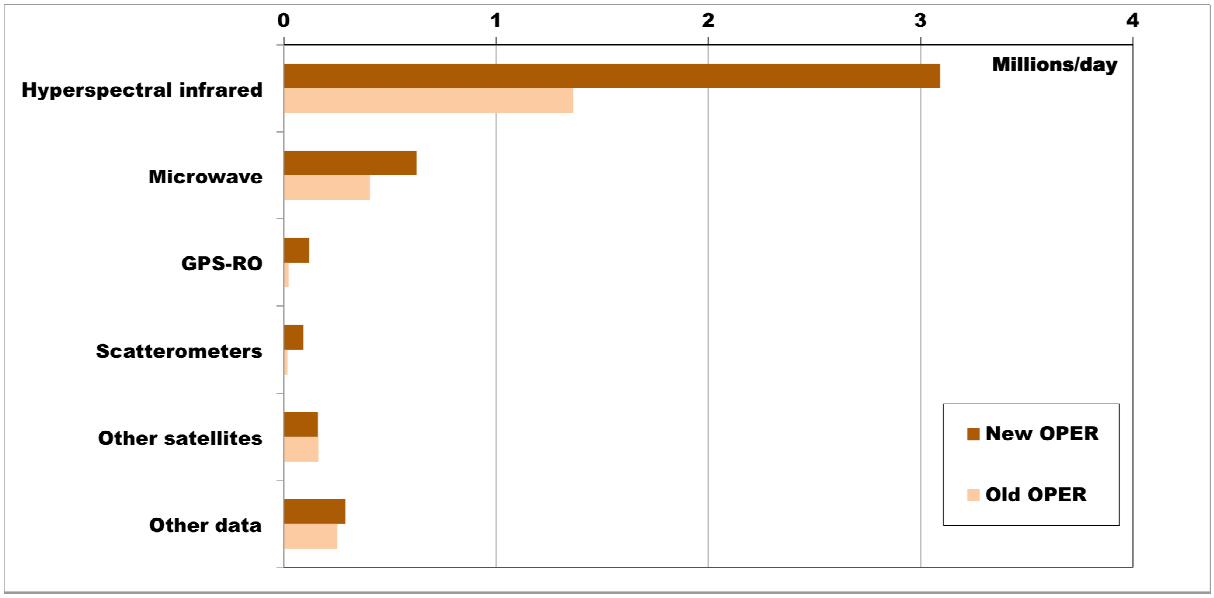

Figure 1 *: Comparison of daily observations assimilated in the global model ARPEGE for the main observing systems (instruments onboard satellites: hyperspectral infrared sounders, microwave sounders and imagers, temperature measurements from GPS radio-occultation, surface wind measurements from scatterometers; other satellite observations; other data from radiosoundings, surface networks, aircrafts, and buoys) since the 02 July 2013 (**New OPER**) and before this date (**Old OPER**).*

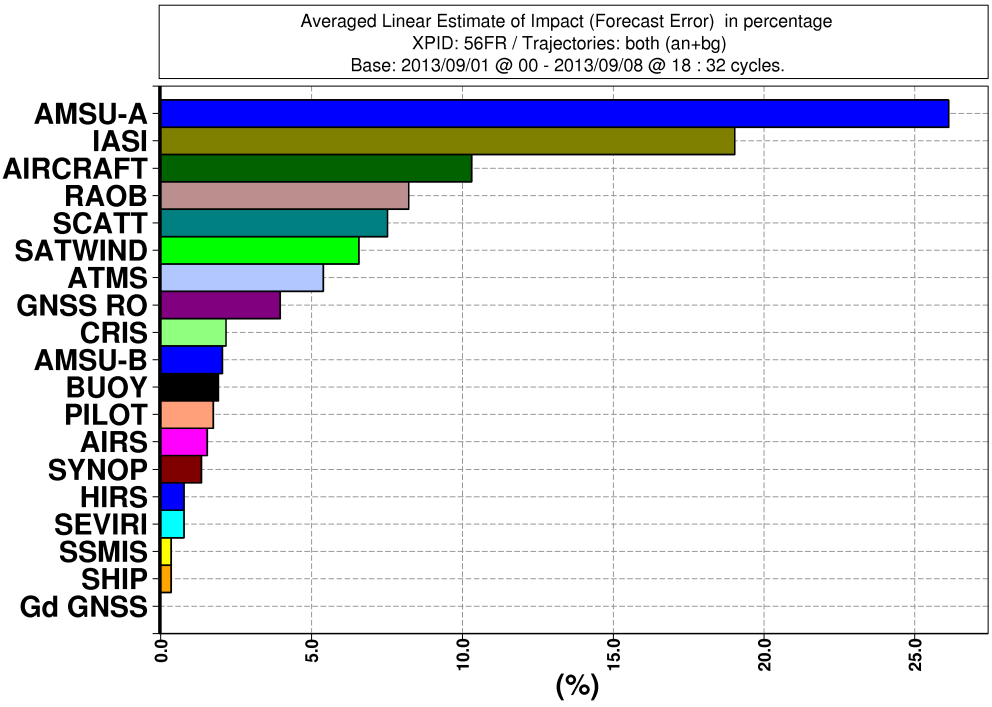

Figure 2 *: Percentage of reduction in 24-h forecast errors (dry energy norm) in the Météo-France global model ARPEGE with the **new OPER** system (since 02 July 2013) resulting from the use of various observation types as diagnosed by the adjoint method.*