Comparison of METOP IASI cloud products

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Introduction

IASI data for temperature and humidity sounding are now assimilated in clear conditions at many operational meteorological centres, providing good impact on forecast skill. However, a large amount of situations, more than 80% on the whole globe, are covered by clouds. All the centres began to handle these data, the first step being to detect and characterize the clouds in the footprint of the sounder. One way of investigating the limitations of a particular methodology is to perform a careful intercomparison of the results of different processing schemes for the same observations. The intercomparison was discussed and recommended during a meeting of the IASI Sounding Science Working Group (ISSWG) and then endorsed by the WMO Working Group on Numerical Experimentation.

For this study, height cloud schemes are applied to a 12 hour global acquisition on 18 November 2009. Various methods of detection and characterization are used by the different participants. A large number of schemes are based on the CO_2Slicing method (MF/GMAP, CMC, EUMETSAT, JMA, MF/CMS for single non-opaque layers) but the settings differ like different lists of channels, one reference channel for all channels or couples of channels. NOAA uses a cloud-clearing method in the IASI FOR in conjunction with AMSU and MHS, MetOffice a 1D-Var retrieval system and LMD runs a weighted $\chi 2$ method. The number of channels also differ dramatically from 8 channels (LMD) to 92 channels (MetOffice). The AVHRR information in the IASI fov is processed by MF/CMS and CMC. And many other differences exist like different rules for the thinning of the fovs or like the possibility to determine up to 3 layers for NOAA and MF/CMS while the other centres only retrieve one single layer. All schemes need an a priori temperature profile which could be a climatology (NOAA, LMD) or a NWP forecast. Finally the RT models are different (RTTOVv7 to RTTOVv9.3, RTIASI, SARTA, 4A) and NOAA is the only centre taken in account cloud optical properties.

We can see from figures1 that the main meteorological structures have been well retrieved by all the schemes but the cloud heights can be very different. Not seen here, similar methods leads to similar results (e.g. MF/GMAP and CMC). For MF/CMS and NOAA which retrieve multi layers, the upper cloud is selected for its importance in cloudy assimilation. NOAA scheme is able to detect and characterize very thin clouds above lower clouds which explains the “colder” map, compared to the other schemes. Thin clouds are detected by CMS but not characterized.

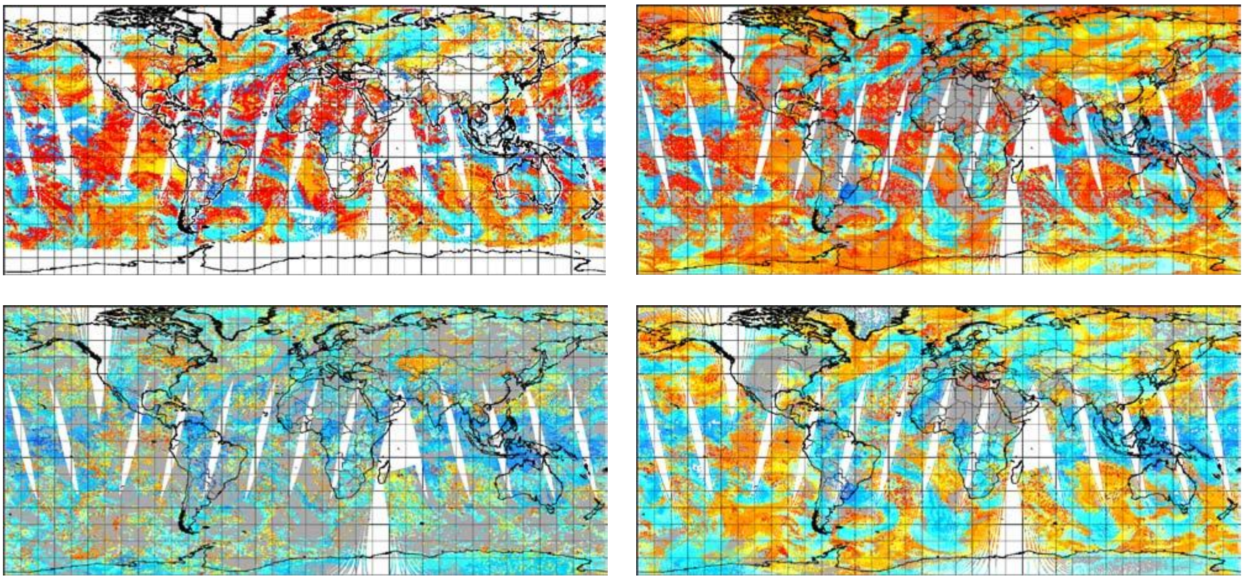

Figure 1: Cloud top pressure over the Globe for schemes based on different methods. Upper left) MetOffice uses 1dvar. Upper right) LMD uses a weighted $\chi 2$ method. Lower left) NOAA is based on a cloud-clearing method. Lower right) MF/GMAP on a CO_2Slicing method.

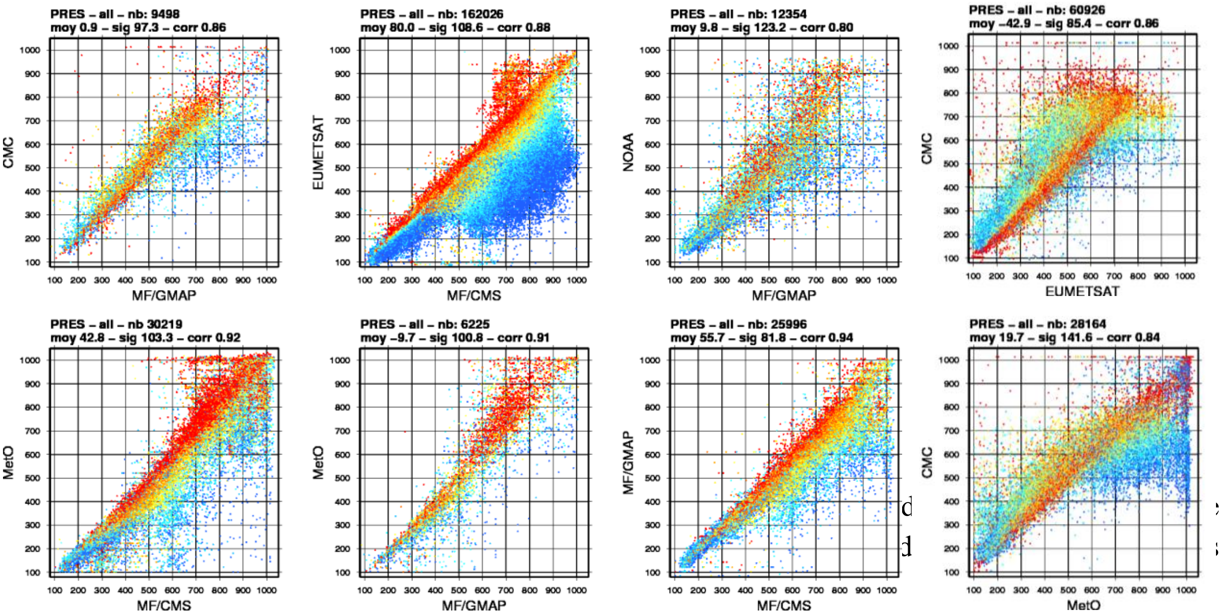

Figure 2 shows that for most of the schemes the agreement is better for high clouds and for opaque/full covered situations. In spite of different retrieval methods, the Met Office and MF/CMS outputs are close with a correlation of 0.92 and schemes using the CO2-slicing method often show a high correlation (e.g. MF/GMAP vs CMC). Standard deviations of differences are about 100-150hpa for all comparisons. Not seen, the weighted $\chi 2$ method of LMD scheme provides a larger spread in cloud pressure but also in cloud cover. The EUMETSAT scheme seems to under-estimate the cloud pressure for small cloud effective amount. This scheme accounts for temperature inversions in the low troposphere, what may explain the differences in the cloud pressure for low level layers having high cloud effective amount values (red/orange dots on MF/CMS vs EUMETSAT).

In figure 3, results are better for the NOAA and MF/CMS schemes which consider multi-cloud layers. The occurrence of complex situations with multi-cloud layers is about 30% in this study. The difference between the layers in the IASI footprint is often large. NOAA residuals are very small probably because their SARTA radiative transfer model takes into account the cloud microphysical properties. In this study, this is not the case of the RTTOV radiative transfer model and consequently, the poor simulation of the observation for high level cloud layers have a large impact in the capacity of assimilating these situations. Despite a good correlation of CMS and Met Office cloud pressures, the Met Office residuals are surprising quite large. Not seen, MF/GMAP and CMC have similar cloud distribution in the atmosphere and consequently similar histograms of Bts differences.

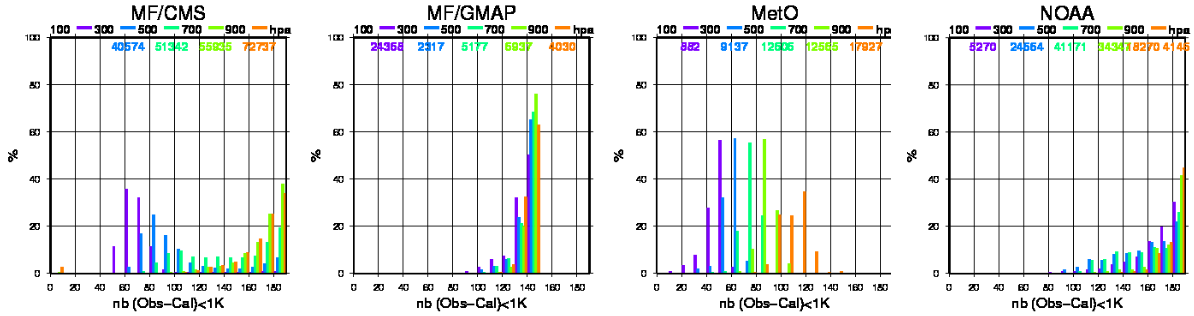

Figure 3: Number of channels in the CO2 band among the 366 ECMWF subset of IASI channels (at most 189 channels) for which the difference between the observed and the calculated brightness temperature is smaller than 1K. The 1K value is coherent with the confidence grant to a channel in the assimilation.

In this comparison, we did not have access to the truth and it is difficult to say more. A further intercomparison exercise is desirable with in-situ observations from existing datasets (e.g. Lindenberg lidar and radar) and from future campaigns (e.g. ConcordIasi campaign). Also we could make use of the A-Train data to get a further understanding (North data).

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