Comparison of MetOp IASI Cloud Products for cloudy radiances assimilation

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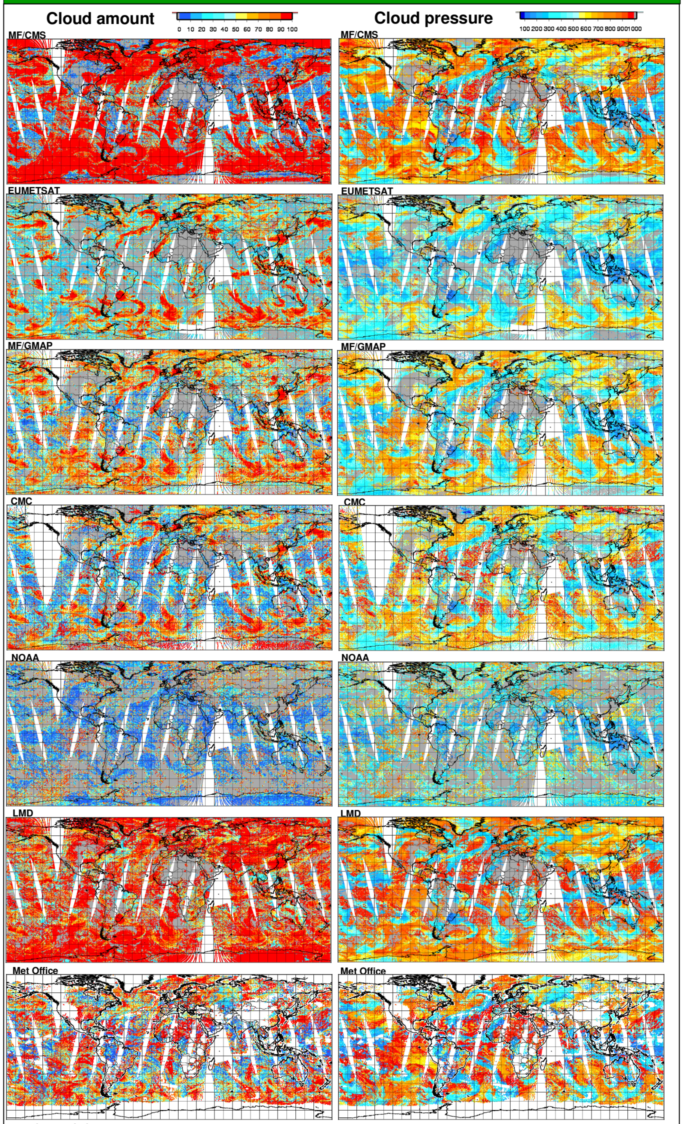
The cloud characterization systems

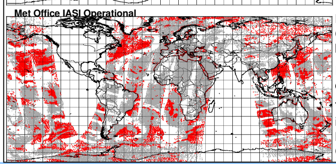
IASI data for temperature and humidity sounding are now assimilated in clear conditions at many operational meteorological centres, providing good impact on forecast skill. However more than 80% on the whole globe is covered by clouds and the centres began to handle cloud-affected data, the first step 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 the different processing schemes for the same observations. For this study, 9 different schemes are applied to a 12 hour global acquisition on 18 November 2009.

Researcher	Affiliation	Scheme status	Scheme description	IASI Channels	Radiative Transfer	A Priori
Gambacorta	NOAA	IASI operational Level2	Cloud clearing method using the 2x2 IASI spots in conjunction with AMSU and MHS. Up to 2 cloud layers.	69 channels from 666 -1200 and 2385 -2600 cm-1 bands	SARTA v10	climatology
Arriaga	EUMETSAT	IASI operational Level 2	Detection: AVHRR + IASI different tests - Characterization: CO_2-Slicing. 1 layer	41 CO2 pairs	RTIASI-4	ECMWF forecast
Ruston	NRL	IASI operational Level2	No cloud characterization. Clear channels assimilation.	39 in CO2	JSCDACRTM	NOGAPS 3,6,9 forecast
Stubenrauch	LMD	IASI Level2	Detection: 'a posteriori' test based on coherence of the retrieved cloud spectral emissivities. Characterization: Weighted χ^2 method. 1 layer.	8 channels in CO2	4A	Atmos. profiles from AIRS
Pavelin	Met Office	Operational AIRS, pre-operatinal assimilation	1D-Var retrieval of cloud parameters together with atmospheric profile. 1 layer.	92 channels	RTTOV7	MetOffice 6h forecast Minimum residual method
Hilton	Met Office	Operational IASI assimilation	Detection: using Bayesian and other cloud tests, residual surface anomalies identified with AMSU. Clear channels assimilation.		RTTOV7	MetOffice 6h forecast.
Lavanant	Météo-France/CMS	IASI operational Level2	Detection: AVHRR - Characterization: AVHRR for opaque clouds, CO_2-Slicing for homogeneoussemi-transparent. Up to 3 cloud layers	40 CO2 pairs in 366	RTTOV9.3	ECMWF 12h forecast
Fourrié	Météo-France/GMAP	Operational AIRS, pre-operatinal IASI assimilation	Detection: IASI tests, comparison with surface temperature- Characterization: CO_2-Slicing. 1 layer.	34 channels	RTTOV9	Meteo-France 6h forecast
Heilliette	CMC	Operational IASI assimilation	Detection: AVHRR, comparison with surface temperature - Characterization: CO_2-Slicing. 1 layer.	13 CO2 pairs	RTTOV8.7	CMC 6h forecast

1. Maps of Cloud cover / effective amount and Cloud Pressure



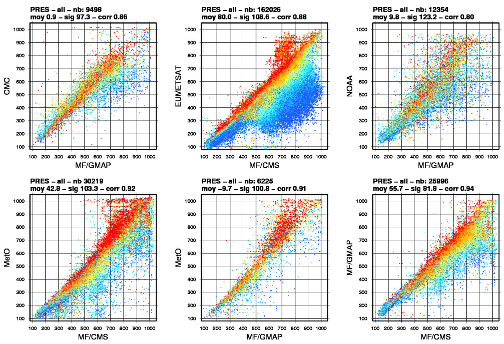


Left figures shows the cloud effective amount (cloud cover for CMS from AVHRR). The MetOffice_IASI operational map is based on a cost function using microwave channels.

Right figures correspond to cloud top pressure. The grey color corresponds to clear situations or undetermined cloud heights.

The upper cloud is selected for CMS and NOAA, for its importance in cloudy assimilation. For complex situations the height of the semi-transparent layer is often not determined by CMS and the the bottom layer is showned.

2. Cloud Pressure scatter plots



Cloud amount

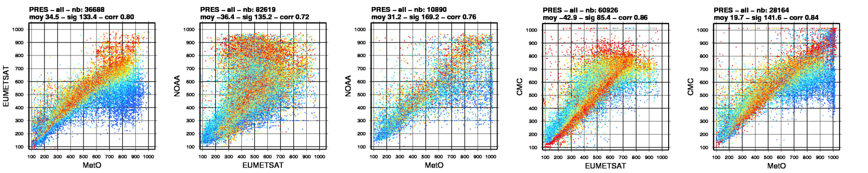
Each figure shows a cloud pressure intercomparison from 2 schemes, for all situations during the 12 h period.

The upper cloud layers are selected for CMS and NOAA schemes. CMS cases with a upper layer undetermined in height are discarded.

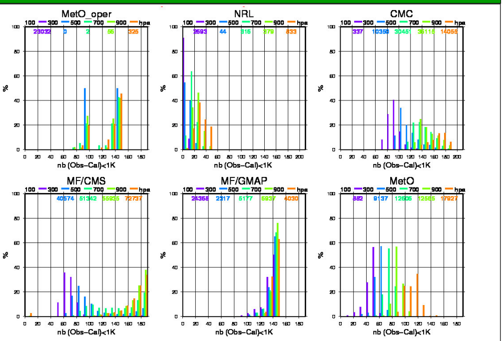
Colors correspond to the retrieved cloud effective amount of the scheme in abscissa. Situations with effective cloud amount less than 10% are discarded. For most of the schemes the agreement is better for high clouds and for opaque/full covered situations.

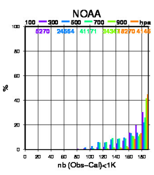
Correlations are up to 0.94 and the standard deviations of differences about 80-150hpa. The different schemes sampling explain the various numbers.

The EUMETSAT scheme seems to under-estimate the cloud pressure for small cloud effective amount. It accounts for temperature inversions in the low troposphere, what may explain the differences in the CTP of low level with high ECA values (red/orange CTP EUMETSAT dots higher than CMS's).



3. Number of channels with (Btcal – Btobs) <1K





The figures show the number of channels in the CO2 band among the 366 / 661 selected subset (at most 189 / 209 channels) for which the difference between the observed and the calculated brightness temperatures is smaller than 1K. The 1K value is coherent with the confidence grant to a channel in the assimilation.

NOAA and CMS multi-cloud layers schemes simulate a large amount of situations with a good accuracy for all channels. NOAA differences are very small probably because the RTM takes into account the cloud microphysical properties. Note the good performance of the GMAP scheme.

Despite a good correlation of CMS and MetO cloud pressures, MetO results are surprising slightly worse. Maybe because the MetO system does not see the bottom layer.

Conclusions and next steps

From the maps in section 1, we see that the main meteorological structures have been retrieved by all the schemes but the cloud heights can be very different.

In spite of different retrieval methods, the Met Office, GMAP and CMS outputs are close. GMAP and CMC exhibit similar behaviors, linked to similar retrieval methods.

The CO2 slicing algorithm accounts for temperature inversion in the lower troposphere, in case it is detected in the NWP forecast. Low level clouds over very cold surfaces are hard to detect, and the CO2 slicing method may have large CTP error if the cloud amount is low. The CO2 slicing algorithm retrieves the CTP of the highest cloud always.

The occurrence of complex situations with multi-cloud layers is about 30% in this study (not shown on the poster). The difference between the 2 layers in the IASI footprint is often large (>300hpa). The agreement between the different schemes clearly depends on the complexity of the situation.

The NOAA scheme is able to detect and characterize very high thin clouds above lower clouds. This explains the "colder" map in section 1, compared to some other schemes. These cases are detected by CMS but not characterized in height.

Taking into account several cloud layers allows to better simulate the observation, as seen in section 3.

The RTTOV radiative transfer model does not calculate cloud microphysical properties and consequently the poor simulation of the observation for high level cloud layers have a large impact in the capacity of assimilating these situations

In this comparison, we did not have access to the truth. In a second step, one could make use of the A-Train data to get a further understanding (North data).

We intend a further intercomparison exercise with in-situ observations from future campaigns (i.e: the Concordlasi campaign) or/and using a collocated dataset of radiosonde and IASI data.

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