IASI Channel Selection in Cloudy Conditions

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Introduction

The InfraRed Atmospheric Sounding Interferometer **IASI** onboard Metop satellite provides temperature and humidity profiles at a high spectral resolution. With **8461** channels, it covers a range from 645cm-1 to 2760cm-1.

As it is not feasible to assimilate all the 8461 channels in real time, the European Centre for Medium Range Weather Forecast (ECMWF) monitors a subset of 366 channels operationally. This selection called **CM2009** (Collard and McNally 2009 [1]) hereafter was carried out through **clear atmospheric profiles.**

All NWP centres intend to take advantage of cloud-affected radiances to improve the analysis in meteorologically sensitive areas. With the view to add the cloud variables (liquid water content, ice water content) in the state vector of the assimilation system, this poster describes a methodology to evaluate the quality of the CM2009 selection on **cloudy profiles** and the relevance of a new channel selection.

2) Method

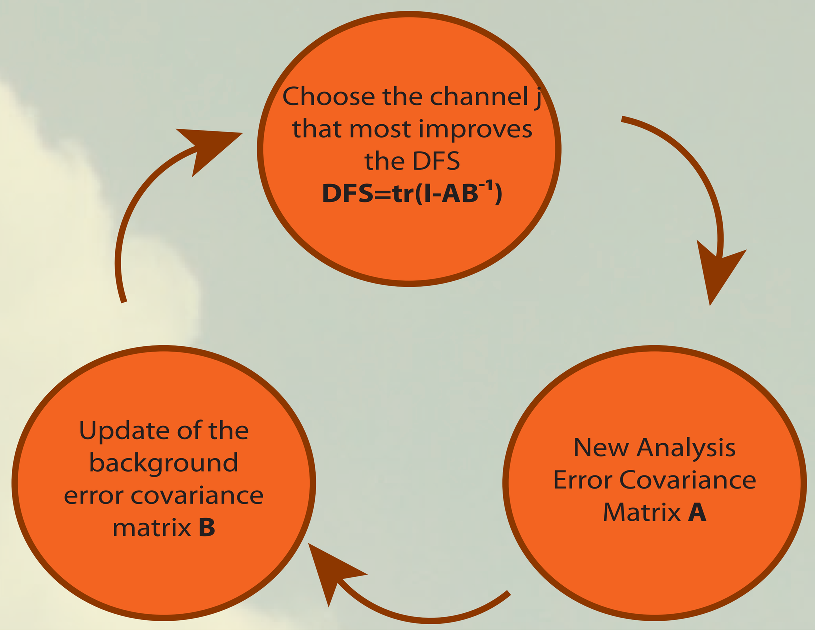
The atmospheric parameters for which information is expected are:

- Temperature (**T**)
- Humidity (**q**)
- Liquid Water Content (**ql**)
- Ice Water Content (**qi**)

The cloud profiles were extracted from the **convective scale** model **AROME W MED** over the Mediterranean Sea in the context of the HyMeX campaign.
The cloud profiles were selected within IASI footprints homogeneously covered by clouds by a screening procedure based on the AVHRR imager (Martinet et al 2011[3]). 20 profiles were chosen:

- 5 high opaque clouds
- 5 semi-transparent ice clouds
- 5 liquid clouds
- 5 mixed phase clouds

The methodology is based on the information-content theory of Rodgers (Rodgers 2000 [2]) using **Degrees of Freedom for Signal (DFS)** as the figure of merit of the selection.

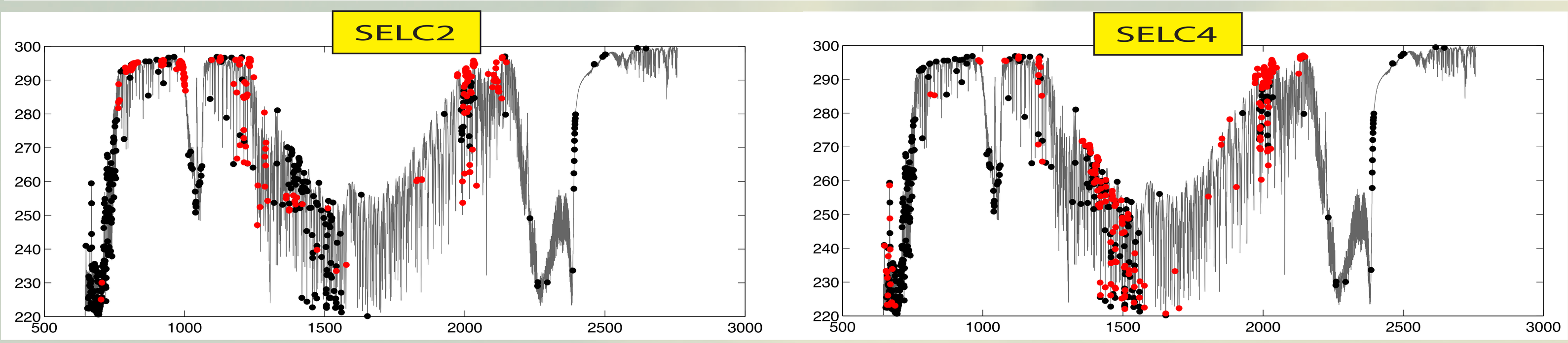


3) Results

200 channels added to the CM2009 selection
- SELC**2**: **ql, qi** in the state vector
- SELC**4**: **T, q, ql, qi** in the state vector
- **60** channels shared by the two selections

SELC4 is chosen:
- **Higher** DFS values
- Information on T,q for **clear** profiles
- **Computation time**

Figure 1: Location of the selected channels averaged over all the 20 profiles. The CM2009 selection of ECMWF is represented with black points, the 200 new channels in red points.



EXP	Temperature	Humidity	Liquid Water Content	Ice Water Content	Total
CM2009	4.11 (68%)	2.79 (69%)	0.17 (59%)	1.45 (76%)	8.52 (70%)
SELC2	4.24 (71%)	2.93 (73%)	**0.20 (66%)**	**1.59 (84%)**	8.95 (73%)
SELC4	**4.41 (73%)**	**3.08 (76%)**	0.19 (63%)	1.54 (81%)	**9.22 (75%)**
All channels	6.00	4.04	0.30	1.90	12.24

Table 1: DFS values for each variable and each channel selection.

4) Dependence to the cloud type

~**66%** of channels shared between a constant selection and each cloud dedicated channel selection

Loss of information **negligible** when applying a cloud-type dedicated channel to a different one.

Robustness of the selection with respect to the cloud type

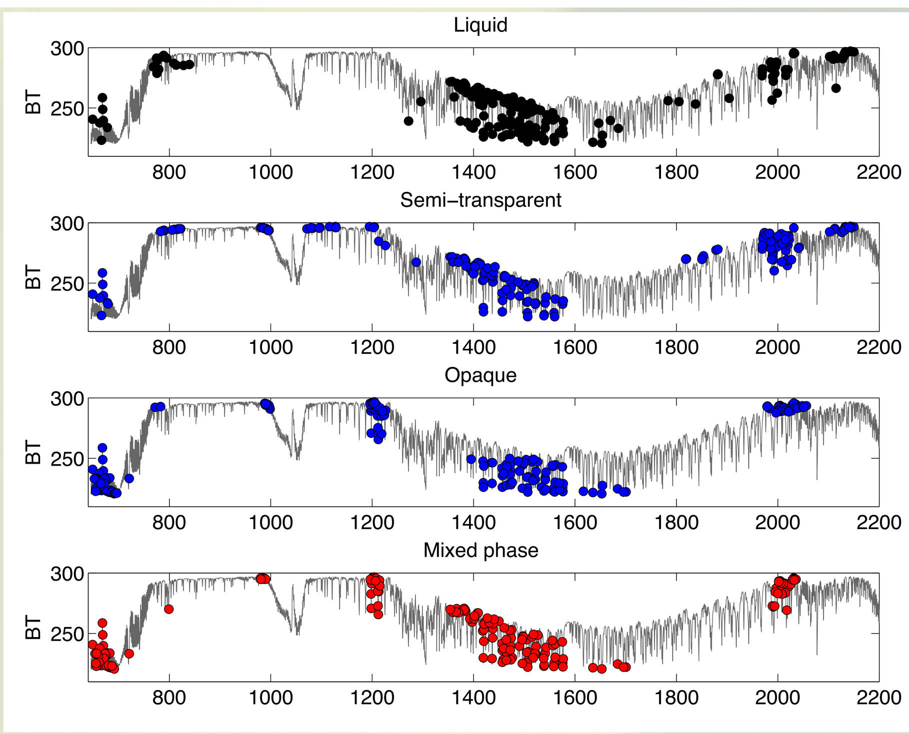


Figure 3: Location of the selected channels for each cloud-type dedicated channel selection (SELC4 method is used).

5) Reduction of Background Errors

- Small loss of information compared to the 8461 channels
- Useful improvement of the analysis over the background for liquid clouds
- Little information extracted from mixed phase clouds (not shown)

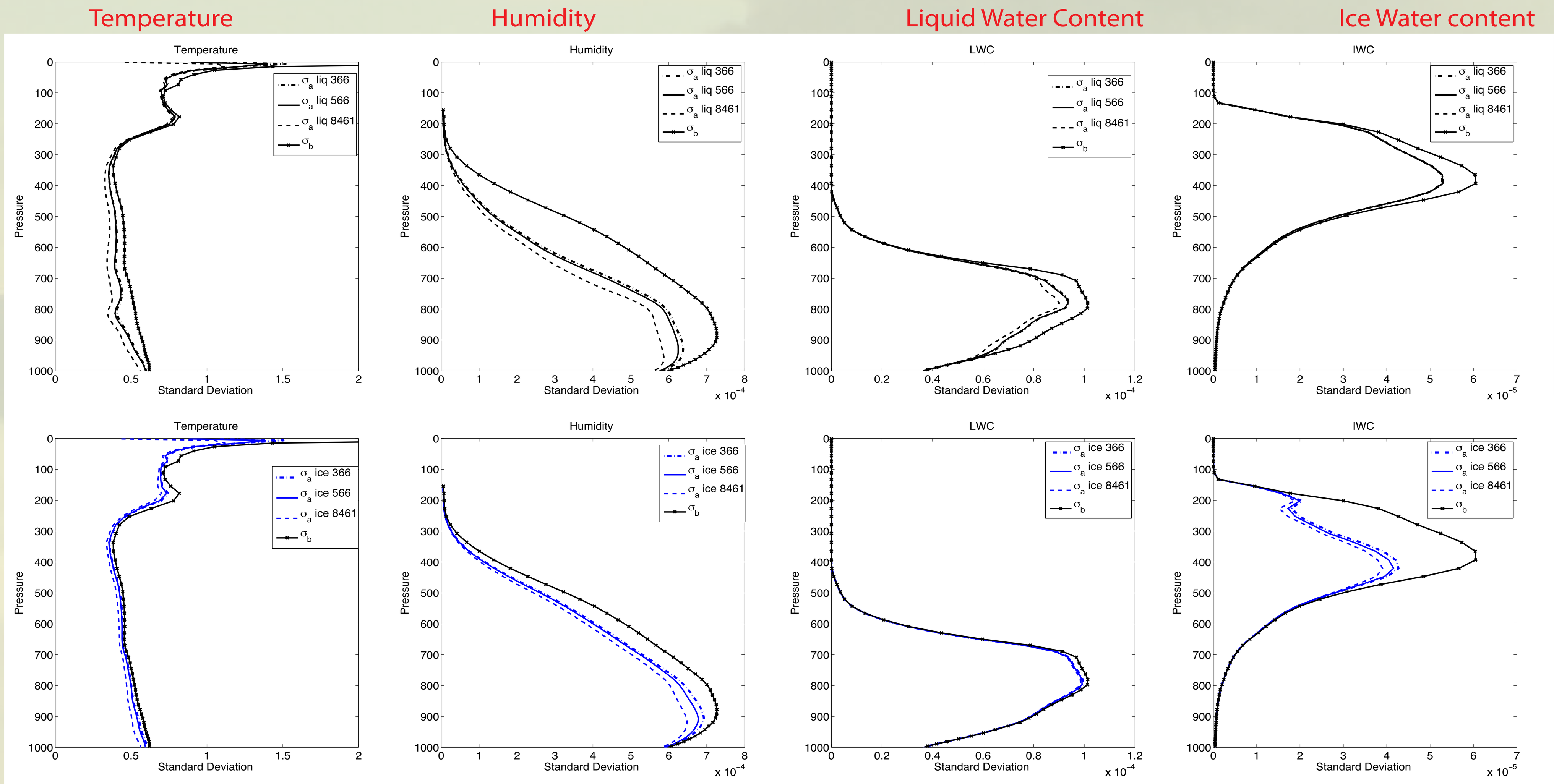


Figure 2: Analysis-Error Standard Deviations for each cloud type: liquid clouds in black, ice clouds in blue, mixed phase clouds in red. Solide lines represent the performance on the new selection of 566 channels, dotted lines the best performance using all the channels and dash-dot lines the performance of the CM2009 selection of 366 channels.

6) Dependence to the ice cloud parameterization

In RTTOV, possibility to choose the scheme to use to parameterize the effective diameter and the ice shape (hexagonal ice crystals or ice aggregates).
Figure 4 compares the new channel selection for two parameterizations and two ice shapes.

Robustness of the selection with respect to the cloud optical **parameterization**.

Selection more **sensitive** to the **ice crystal shape**.

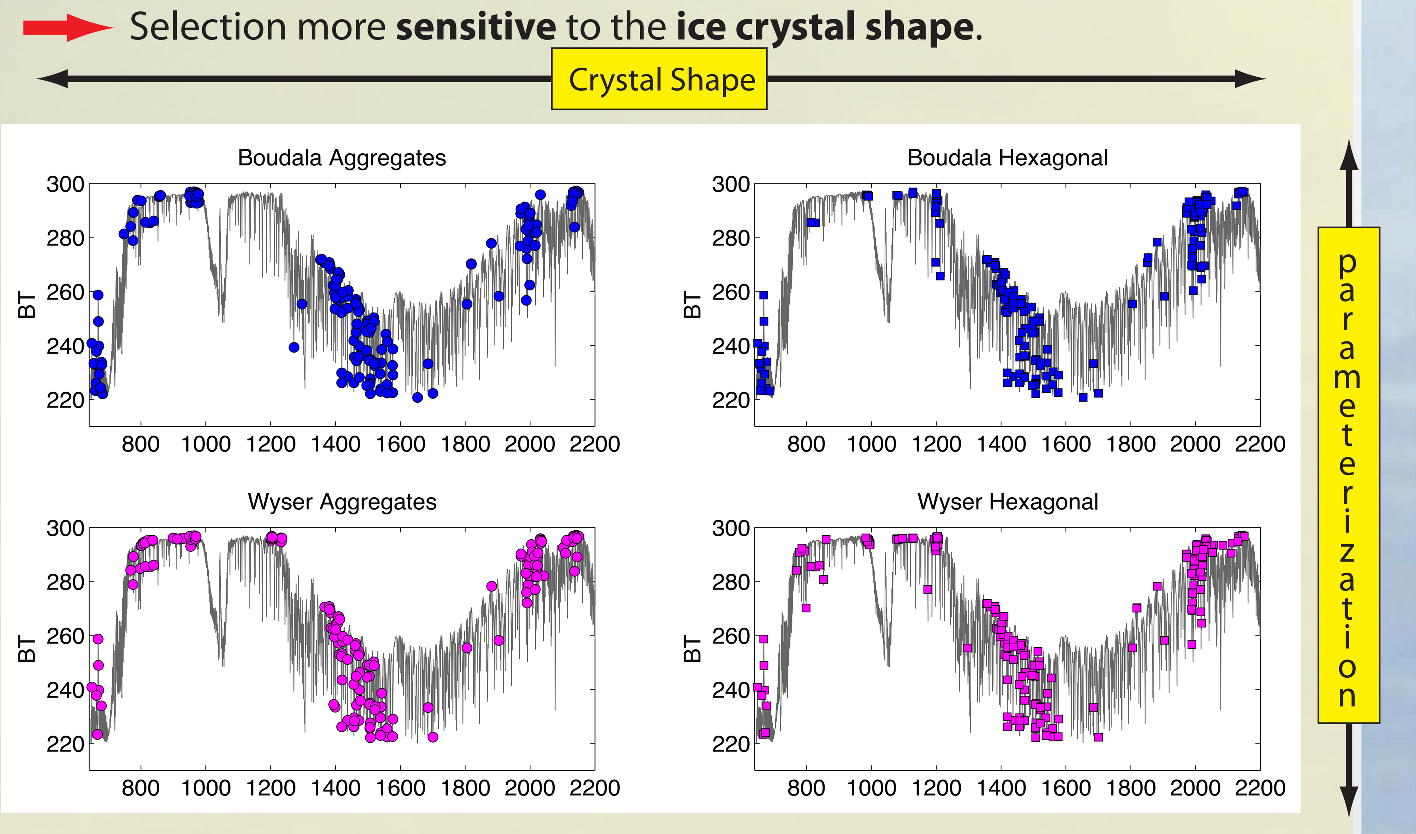


Figure 4: Location of the 200 selected channels when considering different ice cloud parameterizations and different ice crystal shapes.

Future prospects

- Use of the new channel selection in 1D-Var experiments with simulated observations.
- Comparison with a new channel selection on different air mass types (midlatitude, tropical, polar).
- Sensitivity of the retrieval to different cloudy **B** matrices.
- Evolution of the increments in a one-dimensional version of AROME.

References:
1. Collard A.D and McNally A.P, 2009: The assimilation of Infrared Atmospheric Sounding Interferometer radiances at ECMWF. Quart.J.Roy.Meteor.Soc, 135,1044-1058.
2. Rodgers CD 2000: Inverse methods for atmospheric soundings: theory and practice. World Scientific: Singapore.
3. Martinet P, Fourrié N, Guidard V, Rabier F, Montmerle T, Brunel P: Towards the use of microphysical variables for the assimilation of cloud-affected infrared radiances. Quart.J.Roy.Meteo.Soc, submitted.