Aerosol and cloud remote sensing from high resolution infrared sounders. Application to IASI observations.

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Framework

High resolution infrared sounders are widely used to retrieve abundances of atmospheric trace gases, but they are scarcely ever employed for aerosol and cloud studies. However, remote sensing of gas concentrations are very often affected by the presence of aerosols and/or clouds in the line-of-sight; in particular, during events such as dust storms, volcanic eruptions, or biomass burning. The very high spectral resolution over a wide spectral range allows observing and retrieving aerosol and cloud optical properties [1-3]. Consequently, the analyses of measurements obtained from instruments such as ACE-FTS or IASI represent an alternative and promising way for a better characterization of aerosols and clouds.

Here, we present the sensitivity of IASI spectra on aerosols and clouds. We describe the algorithm that we actually develop to retrieve aerosol information. We show that the high spatial and temporal sampling of IASI/METOP allows obtaining unprecedented information about aerosol distributions on local and global scales. The latter is illustrated by a qualitative analysis during a major dust event.

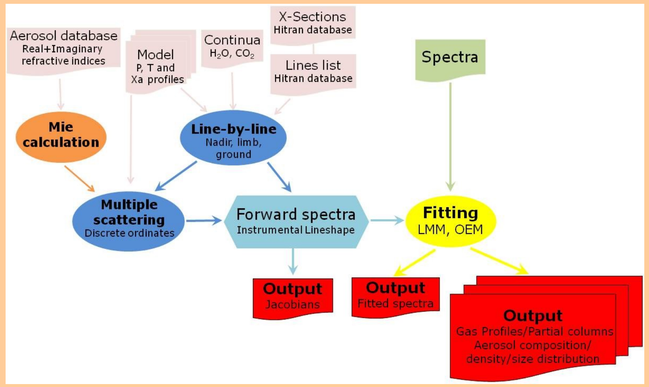
1. The Retrieval Method

-Forward Model: Based on a line-by-line radiative transfer model [4] + discrete ordinates theory

-Inversion: Use of Levenberg-Marquardt,
Optimal Estimation Method …

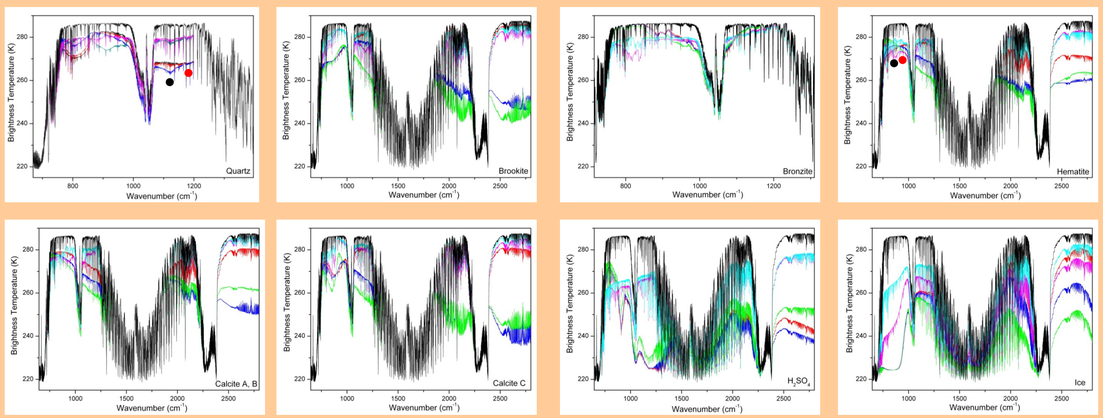
-Inputs: P(z), T(z), VMR(z)
Instrument and geometry definitions
Databases (Lines list, Cross sections and complex refractive indices)

-Outputs: Jacobians
Fitted spectra
Gas Profiles (or partial columns)
Aerosol composition, density and size distribution



• This code offers the possibility to retrieve vertical concentration of atmospheric constituents (gas, liquid, solid) simultaneously from spectra, which may have been recorded by different instruments (from IR to UV).

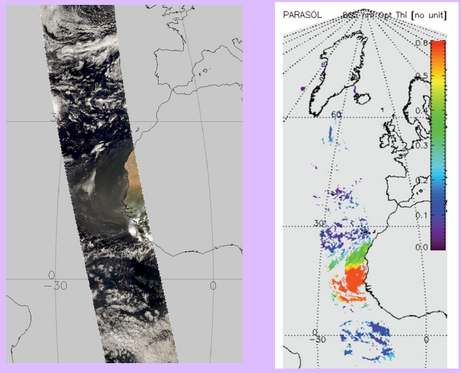
- Some examples of forward spectra which illustrate the aerosol signal impact on IASI spectra. The black line is for clear sky conditions (only gaseous absorption). The red, blue, green, magenta and cyan colors are for 0.1, 0.5, 1, 5 and 10 µm effective radii respectively, for each composition.



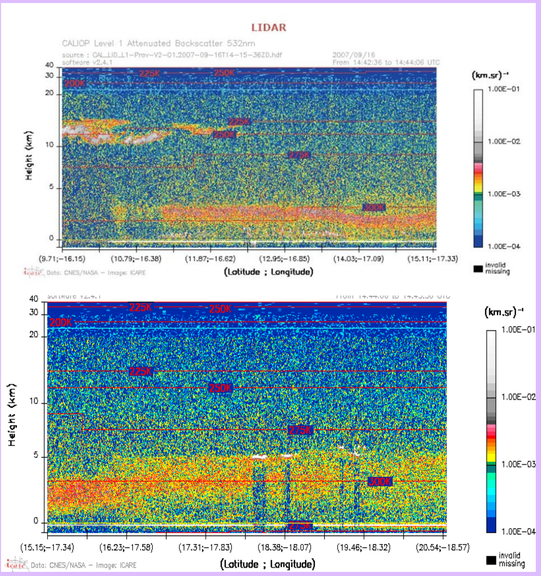
2. Case Study

-September 16, 2007: Dust Storm above west-Africa and Atlantic ocean.
The same location has been observed by different instruments of the A-TRAIN.

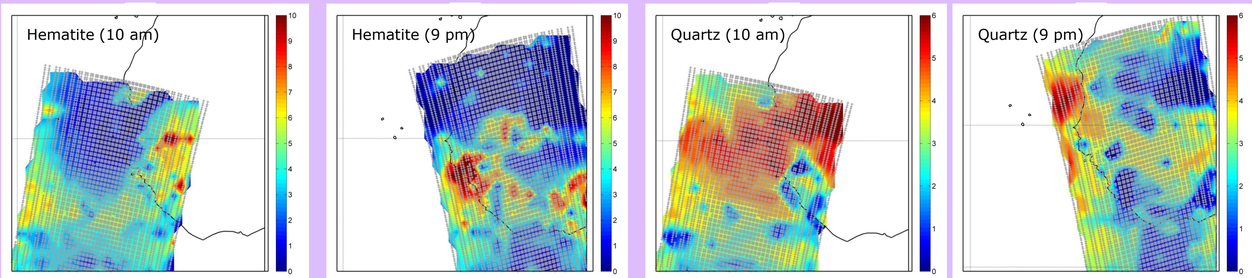
•**Parasol:**
865 nm optical thickness



•**Calipso:**
Lidar (Attenuated backscatter 532nm)



•**IASI:**
Brightness Temperature differences (ΔTB) between red and black circles (see forward spectra). These maps illustrate the sensitivity of IASI spectra to Hematite (Fe_2O_3) and Quartz (SiO_2) signal whatever the radius. We can see the spatial distribution variation for each mineral between 10 am and 9 pm.



3. Work in progress

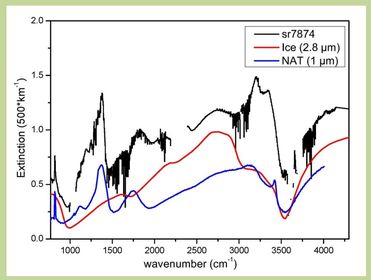
-Creation of an extending aerosol refractive indices database.

-Development of the inversion part of the algorithm. The first results obtain with ACE-FTS spectra are promising.

- Synergy with other instruments (Parasol, Calipso, etc).

- Application to aerosols and clouds on local scale during major meteorological events.

-Study of the impact of non spheroid particles:



Example of preliminary result : composition and size distribution retrieval for stratospheric cloud obtain with ACE-FTS.

References

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[3] M. Höpfner, B.P. Luo, F. Cairo, R. Spang, G. Di Donfrancesco, G. Stiller, T. von Clarmann, H. Fischer, and U. Biermann, Spectroscopic evidence for NAT, STS, and ice in MIPAS infrared limb emission measurements of polar stratospheric clouds, Atmospheric Chemistry and Physics, 6, 1201-1219, 2006.
[4] P. Dubuisson, V. Giraud, O. Chomette, H. Chepfer, and J. Pelon, Fast radiative transfer modeling for infrared imaging radiometry, Journal of Quantitative Spectroscopy and Radiative Transfer, 95, 201-220, 2005.