High spectral resolution infrared sounders (IASI, TANSO-fts, IASI-NG, IRS) capabilities to measure aerosols and trace gases emitted by volcanic eruptions.

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Introduction

Volcanic activity is an important source of aerosols (Ash , H_2SO_4) and trace gases (SO_2, H_2S) which have a significant impact on climate, and affect the regional air quality or air traffic.
In this context, spatial remote sensing represents an efficient tool for the spatio-temporal monitoring of volcanic emission. In particular, some recent works have demonstrated the potential of high spectral resolution infrared sounders to study the volcanic ash plumes distributions and to measure the SO_2 concentrations from local to continental scale. However, this kind of studies remains quite challenging. The applications are particularly sparse and concern often only the very large eruptions.

Here, we present a study conducted as part of the Stratoclim European project, which aims to determine the capabilities of present and futur infrared hyperspectral sounders (IASI, TANSO-fts, IASI-NG, MTG-IRS) to measure concentration and altitude of SO_2, H_2S and OCS, but also the volcanic ash and sulphate aerosols parameters (Height, thickness, size distribution).

Instrumental specifications

Each instrument is a Fourier transform spectrometer; some specifications of the 4 sounders are summarized in this Table :

	IASI	IASI-NG	Tanso-FTS	IRS
Spectral coverage (cm^{-1})	645-2760	645-2760	700-1800 ; 4800-5200 ; 5800-6400 ; 1290-13200	700-2175
Spectral resolution (cm^{-1})	0.5	0.25	0.20	0.625
Signal to noise ratio	500	1000	300	500
Spatial resolution at Nadir (km)	12.5	12.5	12.5	4
Spatial coverage	Global : 2 times/day	Global : 2 times/day	Global : 1 time/3 days	Lat. 30-65° N and long. 30° W to 45° E : 1 time/hour

- IASI and IASI-NG have a coarser spectral resolution as compared to TANSO-FTS, but they have a very high signal to noise ratio. IASI and IASI-NG have further advantages over TANSO-FTS like spatial coverage and temporal sampling.
- The main advantage of TANSO-FTS is its ability to measure the SWIR polarized bands, especially in the case of scattering atmosphere.
- IRS despite its weaker spectral resolution, has all the advantages of a geostationary instrument.

Forward Model & Information content

- The **ARAHMIS** (Atmospheric Radiation Algorithm for High-spectral resolution Measurements from Infrared Spectrometers) line-by-line radiative transfer model developed at LOA is used to perform SO_2 information content analysis:

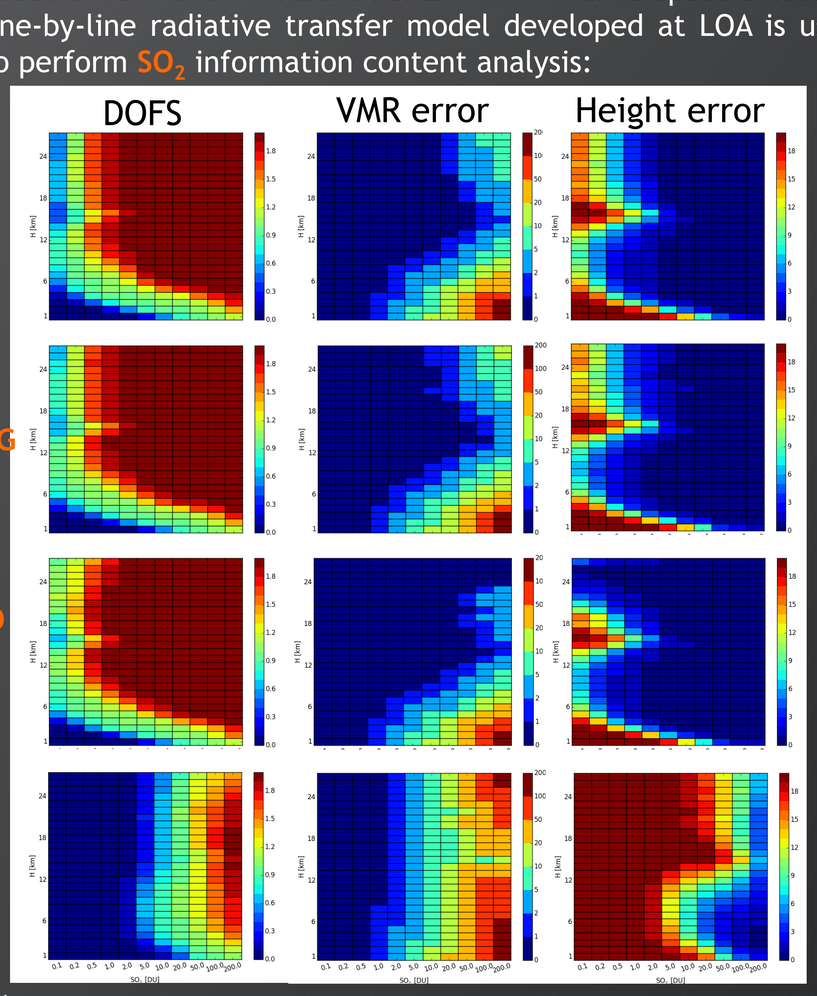
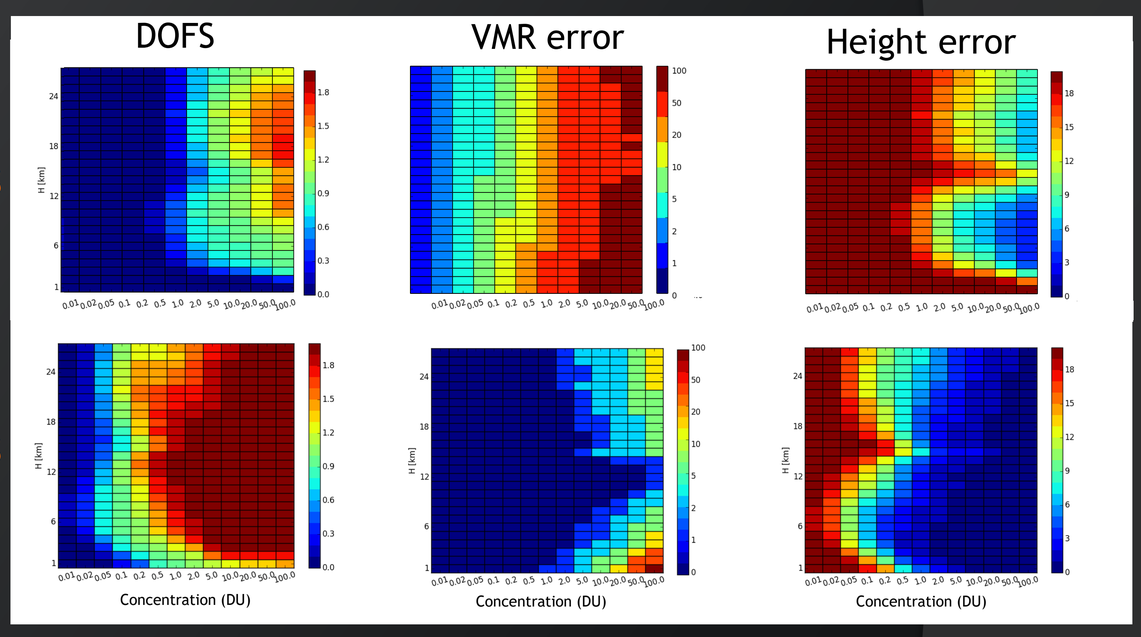


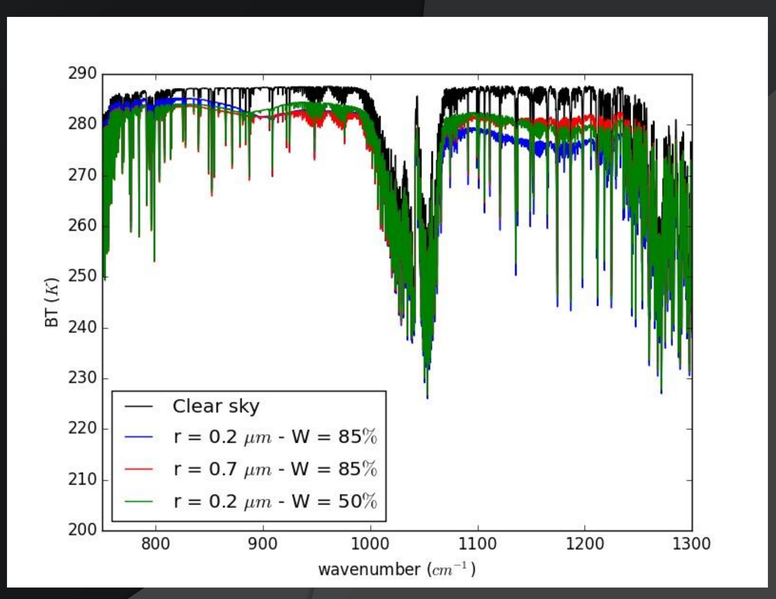
Fig.1 *IASI, IASI-NG, TANSO-FTS, and IRS Degrees Of Freedom for Signal (height and concentration); Volume Mixing Ratio (VMR) and Height errors for SO_2.*

Fig.2 *DOFS (height and concentration); Volume Mixing Ratio (VMR) and Height errors for* H_2S and OCS from IASI.



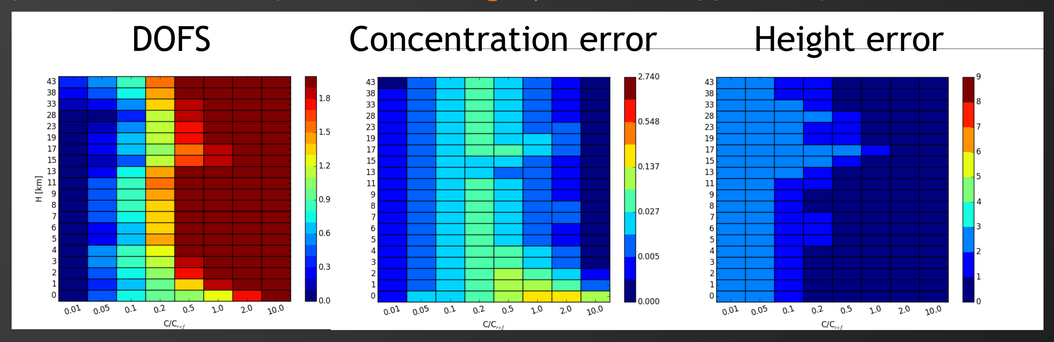
✓ Retrieval of quantitative informations for H_2S and OCS is restrained to important and elevated eruptions.

Fig.3 *H_2SO_4 spectral extinction is influenced both by size distribution and the dropplet composition (%).*



✓ We have established a parametrization for radius and acid weight based on thermodynamical equilibrium.

Fig.4 *Example of DOFS (height and concentration); particles concentration (part/cm³), and Height errors for H_2SO_4 (radius dropplet =1 µm) from IASI.*



Conclusion

- ✓ We have developed an algorithm which is able to simulate IRS, IASI, IASI-NG and TANSO-FTS radiances in clear sky and scattering atmospheres.
- ✓ We performed a sensitivity study and information content analysis of volcanic species (gas/aerosols) for each instrument.
- ✓ We have compared the capabilities of the four instruments to retrieve gas and aerosol parameters.

Work in progress

- ✓ An algorithm based on channels selection is currently being developed. It allows detecting these volcanic species in near real time conditions.

Fig.5 *shows spatio-temporal distribution of SO2 concentrations during the eruption of Kasatochi volcano (07/08/2008), using IASI spectra.*