IASI, IASI-NG and TANSO-FTS capabilities to retrieve gas and aerosols.

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Introduction
IASI and TANSO-FTS instruments have a good signal to noise ratio and high spectral resolution. These features have provided relevant information for tropospheric chemistry and climate variables. In particular, their measurements have improved or just enabled the detection of many species in clear sky conditions. Moreover, in case of scattering atmosphere, recent works have demonstrated that the high resolution infrared instruments can be a complementary tool to sensors such as PARASOL or CALIPSO. Finally, the results of IASI increases confidence for a successful future mission IASI-NG. The instrumental characteristics of the latter are very promising (Noise IASI/2 and Spectral Resolution/2).

Here, we present the sensitivity of IASI, IASI-NG and TANSO-FTS spectra on aerosols and gas. We describe the algorithm that we actually develop to perform information aerosol (IC) analysis and to retrieve aerosol parameters and gas vertical profiles from IASI, IASI-NG and TANSO-FTS. The IC analysis is separated on 3 cases: (1) gaseous profiles in clear sky condition, (2) gaseous columns in presence of an aerosol layer, and (3) simultaneous gas and aerosol retrieval.

1. The Instrumental Specifications
As IASI, TANSO-FTS is a Fourier transform spectrometer; some specifications of the two sounders and most probable IASI-NG specifications are summarized in this Table:

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Spectral coverage (cm⁻¹)</th>
<th>Spectral resolution (cm⁻¹)</th>
<th>Signal to noise ratio</th>
<th>Spatial resolution at Nadir (km)</th>
<th>Spatial coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>IASI</td>
<td>645-2760</td>
<td>0.5</td>
<td>500</td>
<td>12</td>
<td>2 times/day</td>
</tr>
<tr>
<td>IASI-NG</td>
<td>645-2760</td>
<td>0.25</td>
<td>1000</td>
<td>12</td>
<td>2 times/day</td>
</tr>
<tr>
<td>TANSO-FTS</td>
<td>700-1800</td>
<td>0.2</td>
<td>300</td>
<td>10.5</td>
<td>1 time/3 days</td>
</tr>
<tr>
<td>TANSO-FTS</td>
<td>4800-5200</td>
<td>0.2</td>
<td>300</td>
<td>10.5</td>
<td>1 time/3 days</td>
</tr>
</tbody>
</table>

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 has further advantages over TANSO-FTS like spatial coverage and temporal sampling. The main advantage of TANSO-FTS is its ability to measure in the SWIR, especially in the case of scattering atmosphere.

2. Forward Model and Retrieval Method
Algorithm developed at LOA:
Absorption of gaseous constituents:
- Line-by-line RTC 600-50000 cm⁻¹ (Dubovik et al., 2002)
- Voigt line-shape + continua (H2O, CO2)
- Aerosol absorption and scattering:
  - Effective index database + Mie code with log-normal and bimodal distribution
- Atmospheric description:
  - Surface properties: P, T and Xn a priori profiles
  - RT is resolved by discrete ordinates method (DISORT)

Retrieval process
Iterative method: To retrieve the most probable state using measurement, measurement error, first guesses, expected variability and correlations. (Hedges, 2002)
Non-linear least squares calculation:
- Iterative-
- Levenberg-Marquardt
- Gaseous columns or vertical profiles
- Aerosol parameters (effective radius, standard deviation, concentration)

Illustration of TANSO-FTS spectrum in clear sky condition. Solar contribution and individual major molecular absorbers. Band 4 is almost similar to IASI and IASI-NG.

3. Information content Comparison
A. Water vapor profile
- DOFs of H2O, from IASI (black lines), IASI-NG (red lines) and TANSO-FTS (blue lines) vertical profiles.

B. Gas in scattering atmosphere
- Water vapor columns DOFs and errors (in %) vs. aerosol optical depth for Volcanic ash (left panel) and Dust (right panel); from IASI (black lines), IASI-NG (red lines), TANSO-FTS only Band 4 (blue lines), and TANSO-FTS all Bands (green lines).

C. Gas and aerosol simultaneously
- DOFs (upper panel) and total error (in %, bottom panel) for each parameter of the state vector. H2O, CO2, and CH4 are for total columns of each gas; C is number of particles, r is mean radius and σ is deviation of the radius.

4. Work in progress
- Improve the algorithm to reduce the computation time.
- Study the polarization contribution of the SWIR bands of TANSO-FTS for aerosol retrieval.
- Case studies with co-located measurements from TANSO-FTS and IASI.

Conclusions
- We have developed an algorithm which is able to simulate IASI, IASI-NG and TANSO-FTS radiances in clear sky and scattering atmospheres.
- We performed a sensitivity study and information content analysis for each instrument.
- We have compared the capabilities of the three instruments to retrieve gas and aerosol information in terms of spectral characteristics.