Contribution to tropospheric studies using IASI data
 Belgian Institute for Space Aeronomy (BIRA-IASB)
 M. Kruglanski, A.-C. Vandaele, C. Vigouroux, B. Dils, N. Kumps, M. De Mazière

The Belgian Institute for Space Aeronomy (BIRA-IASB) is involved in two EPS/Metop Research Announcements of Opportunity (ID2094 and ID2913) for the exploitation of IASI observations. It has committed itself to validate IASI level-2 products for tropospheric species and to evaluate the load of tropospheric aerosols from IASI level-1C spectra. The validation part makes use of ground-based remote Fourier transform infrared measurements from 13 stations in the Network for the Detection of Atmospheric Composition Change (NDACC, formerly ROCUS). The validation relates to total column as well as vertical profiles of CO, O₃, NO₂, H₂O, and HNO₃.

In order to achieve these goals, we have been developing the ASIMUT line-by-line spectral simulation and inversion code. The code includes an analytical calculation of the Jacobians for use in the inversion part of the algorithm, based on the Optimisation Estimation Method. A second inversion is used to evaluate the load of tropospheric aerosols, mainly sea-salt aerosols and transported Saharan dust above the Atlantic Ocean.

- Validation of IASI atmospheric chemistry products with FTIR ground-based network data
  The validation project includes 11 mobile and fixed stations worldwide with NDCC-qualified Fourier transform infrared (FTIR) spectrometers for remote sensing of the atmospheric composition. All stations are operated on a quasi-continuous basis and have long time series of data; most time series span at least a decade. At all stations the site is operated on a campaign basis. The ship cruises travel over the Atlantic Ocean from Bremen to Cape Town. They mostly happen every year, since more than 10 years ago.

The stations are operated by six partners having a long-lasting expertise in FTIR remote sensing: observations, algorithm development, data analysis, and exploitation of the data for the satellite validation. They also collaborate at the validation of Envisat atmospheric data products and participate in the European project uFTIR to improve the quality of tropospheric data products from ground-based FTIR observations.

- Preliminary retrieval of CH₄ columns above Saint-Denis using ASIMUT
  The ASIMUT program performs simulation and retrieval of atmospheric transmittances and retrievals in cases where scattering can be neglected and under conditions when local thermodynamic equilibrium is verified. The model assumes that all parameters are varying only with altitude. ASIMUT can be used to simulate/retrieve measurements recorded under various geometries ( nadir, off-axis nadir, down and up looking) with an instrument located at ground level, inside the atmosphere, or in space.

ASIMUT has been used to retrieve methane from both IASI level-1C and ground-based FTIR spectra. The illustrated data are related to August 15, 2007. Both retrievals are done in two passes, the first pass of which is mainly used to fit the water content. Temperature and pressure profiles are extracted from ECMWF analysis.

- IASI Level-1C orbit 4255 5:20 UT
  IASI pixels above Reunion Island located at less than 60km from St-Denis. Only seven pixels located above the area are used: green pixels are above land; red pixels have been rejected; orange pixels are from orbit 4262 (17:48:40UT) but have also been rejected. The cyan pixels satisfy the conditions:
  
  Pass 1: \( g \leq 5 \times 10^{-5} \) W/m²/cm²
  
  Pass 2: \( 2 \leq \text{RMS} \leq 3 \times 10^{-3} \) W/cm²/cm²

  To retrieve CH₄ from IASI spectra, we use 3 large windows (135S-135S, 358.3-378.9 and 529.9-539.9 cm⁻¹). It results to a RMS about 0.1-10⁻⁴ W/cm²/cm² and about 2° of degrees of freedom for CH₄.

  In order to facilitate the comparison, both cases use the same discretization and a priori data. The a priori vertical profiles are obtained from the IGAS climatologies (Remedios et al., 2007). The retrieved vertical profiles of CH₄ correlate reasonably well with the IGAS climatologies. The retrieved CH₄ is compared to the IGAS climatologies.

- Ground-based FTIR & St-Denis 7:00 UT
  The current campaign operated by BIRA-IASB extends from May to December 2007 using a BRUKER 120M coupled to a sun tracker.

  The illustrated data are based on a spectrum recorded at a zenith angle of 40° with a resolution of 0.12 nm; using an IRG diameter of 650 μm, a HDSC filter number 3 and a 3h1v detection.

- Atmospheric Aerosol Retrieval from Thermal Infrared Nadir Sounding
  We have developed an algorithm to retrieve tropospheric aerosol optical depth (AOD) over the ocean from nadir high-resolution radiance spectra in the thermal infrared that includes the effect of scattering within the aerosol layer. It consists of an optimal estimation method where the forward part implements the radiative interaction between the surface and the atmospheric layers, assuming a thin horizontal layer of a mixture of two aerosol types located at an arbitrary height. A simple doubling method is applied to evaluate the effects of scattering within the aerosol layer. The Jacobians associated with the surface temperature and the second aerosol are derived analytically.

  We plan to apply our algorithm on IASI spectra. ASIMUT will be used to generate the molecular vertical optical depths from the IASI level-2 products. The retrievals will be focussed on both sea-salt aerosols and transported Sahara dust above the Atlantic Ocean.

- Distribution of sea-salt aerosol in the boundary layer over the ocean obtained from IASI radiances with a simplified version of our algorithm where the effects of scattering is not taken into account. It assumes a mixture of both a coarse mode (SSCAH) and an accumulated mode (SSCMH) located just above the sea surface. The molecular vertical optical depths are generated from the ERA-40 daily fields.

  The results show:
  
  - sea-salt AOD at 1 km level between 0.71 and 0.65 for 50% of the pixels,
  
  - contribution of SSCM to aerosols to the AOD only between 0 and 25%, in 50% of the cases,
  
  - difference between surface and aerosol temperatures from 4.7 to 5.9 K

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