1. Introduction

Recent research has proved that hyperspectral satellite observations can be successfully used to map atmospheric trace gases throughout the planet. Differential Optical Absorption Spectroscopy is the most widely used approach. In this work we propose a new method to separate contributions from different atmospheric trace gases: the case of sulphur dioxide (SO$_2$) is considered. The main idea is to use a portion of the absorption waveform and the Blind Source Separation method.

The negative logarithm of the reflectance spectra can be expressed as a linear combination of absorption cross sections in their concentrations (Beer-Lambert law)

\[-\log(R(\lambda)) = -\log\left(\frac{\pi I(\lambda)}{\mu_0 E(\lambda)}\right) = \sum_n n_i \sigma_i(\lambda)\]

where

- $R(\lambda)$ is the reflectance,
- $I(\lambda)$ is the Earth radiance,
- $E(\lambda)$ the solar irradiance,
- $\mu_0$ the cosine of the solar zenith angle,
- $n_i$ the gas concentrations along the path [mol/cm$^3$],
- $\sigma_i(\lambda)$ their absorption cross-sections [cm$^2$/mol].

Direct application of a source separation algorithm to the model (1) is not appropriate for TWO MAIN REASONS...

2. Least Dependence

Scattering from air molecules, aerosols and clouds as well as absorption from the ground usually varies smoothly with wavelength and represents a source of dependence.

HIGH PASS FILTERING PRE-PROCESSING

3. Problem Formulation

The presence of all sources in any reflectance spectrum cannot be always assumed; thus we may have an ill-posed problem. To overcome this difficulty, a known contamination is introduced in each observation. Supposing for simplicity $m = n$

\[x_1(\lambda) = -\log(R(\lambda)), \quad x_2(\lambda) = -\log(R(\lambda)) + c_1 \sigma_1(\lambda) \]
\[\ldots \]
\[x_n(\lambda) = -\log(R(\lambda)) + c_{n-1} \sigma_{n-1}(\lambda)\]

where $c_i$ is the contamination factor.

4. Convergence

The procedure has been applied to the retrieval of sulphur dioxide SO$_2$ volcano emission using data from the NASA Ozone Monitoring Instrument (OMI) and the SCIAMACHY preflight model SO$_2$ absorption cross section as reference spectrum.

5. Results and conclusions

By comparing the two images, we observe that the LDA algorithm correctly detects the SO$_2$ plume. The procedure can be applied to other hyperspectral sensors like the ESA SCIAMACHY. In view of retrievals of different atmospheric components, results seem to be promising, but refinements are necessary in some contexts to get the most accurate results.