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# On the use of partial interferograms for GHG measurement using a solar occultation geometry

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ImSPOC which acronym means Imaging Spectrometer On Chip is a concept of compact Fourier imaging-spectrometer developed at ONERA and IPAG since a few years [French patent registered the 30th, June 2016 under n°16 56162]. It is based on a static micro-interferometer array that provides one-shot retrieval of both spatial and spectral information without scanning component. The first onboard prototypes operate in visible and in near infrared with a mid-spectral resolution (R from 10 to 100) and a few square dozens of imaging pixels, for geophysics or drone-based gas detection purposes.
We studied the capabilities of the concept for high spectral resolution monitoring of GreenHouse Gases (1,000<R<10,000) on the atmospheric column. The goal is to measure the main GHG ($CO_2$, CO, CH4 and N2O) with a statistical error less than 1% of the averaged column density. For these resolutions, the small number of available interferometric samples requires to use partial interferogram and to retrieve geophysical and atmospheric parameters directly in the Fourier domain. Such an approach has been already considered for the IASI space instrument and demonstrated a gain in terms of bias impact reduction [Grieco et al. 2011, Serio et al. 2012]. We must now assess the ImSPOC concept performances with its own instrumental specificities (radiometry, spectral channel, sampling), and demonstrate the breakthrough regarding weigh and volume for this kind of instrument.
The work we present is a numerical simulation of main GHG column amount retrieval ($CO_2$, CO, CH4 and N2O) from an ImSPOC-based imaging spectrometer in clear sky condition using a solar occultation geometry.
We have developed an inverse model based on the line-by-line radiative transfer code LBLRTM and a Levenberg-Marquardt algorithm. This tool allows deducing atmospheric variables from partial interferograms using the ImSPOC instrumental function. Firstly, we used LBLRTM downwelling radiances (calculated with the US standard description of the atmosphere) as input of our instrumental model to generate synthetic measured partial interferograms. After chosen the optimal interferometric samples, we studied the accuracy on the various gases retrieval by varying atmospheric composition, molecular column amount and temperature profile.
For an example, some promising preliminary results have been obtained on the 1.6 $\mu$m $CO_2$ band. We chose 100 joints interferometric samples (four sample per fringe) at the maximum of instrumental sensitivity for the $CO_2$ on this band. We introduced a bias over the atmospheric composition in our model of 10% for all the molecular amounts (by profile scaling), and we kept only three free parameters for the inversion ($H_2O$, $CO_2$ and $O_2$ molecular total amount). As a result, we retrieved the introduced $CO_2$ concentration over the column density with an estimation error less than 10-3%. We generalize and discuss this preliminary result to the other species and bands by considering more error sources (concentration and temperature profile). Then, real observed spectral radiances will be used to validate the model.
In this paper, after a brief presentation of the ImSPOC concept and a description of the method, the first results of this study will be presented and discussed.