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Using zenith observations for evaluation of an improved interferometric imaging spectrometer

Aneline Dolet[1,2], Daniele Picone[1], Silvère Gousset[3], Mauro Dalla Mura[1,4], Etienne Le Coarer[3], and Didier Voisin[2]

[1]GIPSA-lab, Univ. Grenoble Alpes, CNRS, Grenoble INP, GIPSA-lab, Grenoble, France (aneline.dolet@grenoble-inp.fr)
[2]Institut des Géosciences de l'Environnement (IGE), Grenoble, France
[3]Institut de Planétologie et d'Astrophysique de Grenoble (IPAG), Grenoble, France
[4]Tokyo Tech World Research Hub Initiative (WRHI), School of Computing, Tokyo Institute of Technology, Tokyo, Japan

In the context of climate change, atmospheric gas monitoring is of major interest. Accurate measurements of the concentration of CO_2, CH_4, NO_2, O_3, etc. are necessary to control their emissions. Indeed, these gases have impacts on climate change as well as on people's health.

Good control of such emissions requires gas concentration measurements with high spatial, spectral and temporal resolutions. These acquisitions are mostly done with conventional dispersive hyperspectral imaging systems. However, these instruments result from a compromise between price, resolutions and size which not always allows concentration evaluation that are accurate enough. The Imaging Spectrometer On Chip (ImSPOC) device is based on a ground-breaking concept to overcome the compromise size versus performances allowing snapshot acquisition. Indeed, it is an interferometric imaging spectrometer, sized like a matches' box, allowing acquisition of an interferogram by pixel instead of a spectrum. In this way, a snapshot acquisition with high spectral resolutions can be acquired from Nano-satellites, drones or ground. The device is composed of a matrix of Fabry-Perot interferometers of different thickness combined with a matrix of photodetectors. ImSPOC is then a competitive device for real-time acquisitions of the atmosphere. However, despite these advantages, the acquisition of interferograms requires *ad hoc* signal processing techniques to reconstruct the corresponding spectra used for the estimation of the gas concentration. As the interferogram acquisitions are only on a range of thicknesses, some information are missing and need to be compensated with the signal processing methods that are specially developed to provide accurate spectra allowing to evaluate the concentration of gases. The development of these algorithms is then quite challenging.

To validate the most recent ImSPOC prototype in the UV-visible range and the corresponding developed methods, zenith observations were acquired with the ImSPOC device and a classical dispersive hyperspectral spectrometer. These acquisitions allow the validation of ImSPOC at two different levels: 1) the reconstructed spectra are qualitatively compared to the spectra acquired by the classical device and 2) using the Differential Optical Absorption Spectroscopy (DOAS) method

on both devices spectra, the evaluated concentrations of the gases are quantitatively compared. These comparisons allow us to validate the usefulness of the ImSPOC device for the evaluation of the gas concentration using zenith observations.