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Enhancing the AOTF-based NO2 camera with light polarization sensitivity for aerosol retrievals

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The AOTF-based NO_2 camera is a remote sensing instrument primarily aimed at imaging and quantifying the NO_2 field above cities or in industrial plumes. The measurement principle consists in acquiring a number of spectral images of the scene at selected wavelengths. Each pixel is therefore recording a discrete spectrum of the radiance collected in its acceptance cone, enabling the retrieval of the NO_2 column density in its optical path by application of the DOAS method on the measured spectrum.

The core element of the instrument principle is the acousto-optical tunable filter (AOTF). This device works under the principle of the acousto-optical interaction, the coupling of the light electric field with the modulation of the crystal lattice by a shear acoustic wave created by a transducer. The coupling takes place at a single wavelength, and diffracts that part of the spectrum into another direction. By blocking the undiffracted light beam, and imaging the diffracted order, one can capture a monochromatic image of the scene.

We propose to expand the capabilities of the NO_2 camera by exploiting another aspect of the acousto-optic interaction. The coupling between light and sound actually takes place in a birefringent crystal (TeO_2), and one usually works with a single linear polarization of the incoming light (e-light, or o-light). The two polarization components are diffracted in different directions. If the current design is modified such that the two components can be imaged, then an information on the degree of linear polarization of the light can be obtained.

In the atmosphere, the scattering of light by air (Rayleigh), and particles (Mie) is controlling the state of polarization of the scattered solar light. Hence, aerosols not only introduce a smooth spectral signatures, but also a change of the state of polarization. The proposed modification of the NO_2 camera design can provide some sensitivity on this, potentially enhancing the scientific return of the instrument with aerosol retrievals capabilities. The new instrumental design will be presented, and vector radiative transfer simulations will be produced to estimate the benefit of this change.