

Performance simulation of a space-borne Raman Lidar for ATLAS

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The Atmospheric Thermodynamic LidAr in Space (ATLAS) is a mission concept proposed to the European Space Agency in the frame of “Earth Explorer-11 Mission Ideas” Call by a team of European and American researchers, with the aim to develop the first Raman Lidar in space capable to measure simultaneously atmospheric temperature and water vapour mixing ratio profiles with high temporal and spatial resolutions. Accurate measurements of these thermodynamic profiles in the lower troposphere are essential for the understanding of water and energy cycles, as well as the prediction of extreme events, that nowadays still show huge deficiencies on all temporal and spatial scales.

In the recent past an assessment of the specifications of the different lidar sub-systems has been performed with an analytical simulation model for space-borne Raman lidar systems. To estimate the performances in different atmospheric and light background conditions, a numerical end-to-end simulator has been developed. The simulator considers the behavior of all the devices in the experimental system (telescope, optical reflecting and transmitting components, spectral selection devices, detectors) which ultimately allows to simulate the signals measured by a space-borne Raman Lidar. The simulated signals also include the background contribution due to solar radiation. The background is calculated as the sum of three distinct contributions from atmospheric gases, the Earth surface and clouds. The clouds are considered also in the estimation of the atmospheric transmissivity so that the simulations are performed both in clear and cloudy sky conditions.

The simulated signals are then analysed to obtain vertical profiles of atmospheric temperature and water vapour mixing ratio. The simulator provides also statistical (RMS) and systematic (bias) uncertainties. Uncertainties affecting water vapour mixing ratio measurements are expressed as percentage (%) and absolute (g/kg) uncertainty and in terms of absolute uncertainty (K) for temperature measurements.

As input data for the simulations, thermodynamic and optical parameters from the 7km non-hydrostatic mesoscale model GEOS-5 Nature Run Ganymed Release were used. Data were extracted to simulate the performances along several dawn-dusk orbits around the Earth for different days of the year, with the aim to consider different background conditions in dependence of the solar zenith angle.

Simulations show very promising results, with different background contributions, both in clear and cloudy conditions. A comprehensive analysis of the assessed performances will be presented at the conference and in a forthcoming paper.