Geophysical Research Abstracts
Vol. 17, EGU2015-12260, 2015
EGU General Assembly 2015

Development of the Scientific Instruments for the PICASSO Mission

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The Pico-Satellite for Atmospheric and Space Science Observations (PICASSO) is an ESA mission initiated to join the QB50 project as scientific in-orbit demonstrator. The orbit is expected to be 380x700 km altitude with 98° inclination. PICASSO is a triple unit CubeSat of dimensions 300x100x100 mm with four two-unit long deployable solar panels and a mass of less than 4 kg. The payload consists in two scientific instruments: a sweeping Langmuir probe (SLP) and a miniaturised hyper-spectral imager (VISION). The total average power consumption is about 6.5 W. The communication will be ensured by VHF/UHF links for housekeeping data and an S-band link for the scientific data. By using magneto-torquers and dynamical wheels PICASSO is 3-axis stabilised with a pointing accuracy of about 1° (knowledge: 0.2°).
The SLP instrument includes four thin cylindrical probes whose electrical potential is swept to measure both plasma density and electron temperature together with the spacecraft potential. The plasma density is expected to fluctuate over a wide range, from about $1e8/m^3$ at high latitude and high altitude up to $1e12/m^3$ at low/mid latitude and low altitude. The electron temperature is expected to lie between approximately 1000 K and 3000 K. Given the high inclination of the orbit, the SLP instrument will allow a global monitoring of the ionosphere with a maximum spatial resolution of the order of 150 m. The main goals are to study 1) the ionosphere-plasmasphere coupling, 2) the subauroral ionosphere and corresponding magnetospheric features, 3) auroral structures, and 4) polar caps. The main issue implied by the use of a pico-satellite platform for a Langmuir probe instrument is the limited conducting area of the spacecraft which can lead to spacecraft charging and drift of the instrument's potential during the sweep (unusable data). In order to avoid this problem, the probes are swept in a particular way and a mitigation technic has been developed.
VISION is a Fabry-Pérot based hyper-spectral 2D camera with a spectral range of 430-800 nm and a resolution from 5 to 10 nm. The optical elements and the command electronics hold in a volume of $95x95x50\ mm^3$, for a total mass of 700 g. A dedicated payload computer will process the experimental data (about 8 GB per observation) to derive meaningful quantities. VISION main target is to retrieve stratospheric ozone vertical profiles. During an occultation of the Sun by the Earth atmosphere, the sunlight gets scattered and absorbed. This reduces its intensity at wavelengths specific to the constituents present along the light path. Simulations show that the ozone layer should be retrieved with a vertical resolution better than 1 km and a 5% relative uncertainty. A second goal is to demonstrate in real flight conditions the applicability of the Atmospheric Refractivity from Inversion of Dilution method to determine vertical temperature profile based on the deformation of the Sun image by the atmospheric refraction.