LOAC-S: a small aerosol optical counter/sizer for planetary measurements of the size distribution and nature of atmospheric particles.

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On Earth, the study of aerosols in the troposphere and in the stratosphere is of major importance both for climate and air quality studies. In the solar system, the atmospheric aerosols size and distribution are key parameters for radiative fluxes assessment not only for solid planets like Mars but also for the gaseous planets like Saturn.

Among the numerous instruments available, aerosol particles counters provide the size distribution in diameter range from few hundreds of nm to few tens of um. Most of them are very sensitive to the nature of aerosols, and this can result in significant biases in the retrieved size distribution. It is not the case for the versatile optical particle/sizer counter (OPC) named LOAC (Light Optical Aerosols Counter), which has been used for years to perform measurements not only at the surface but under all kinds of balloons in the Earth atmosphere (more than 100 flights in the stratosphere since 1993). As a consequence, the instrument reliability is now demonstrated and it is light and compact enough to address planetary missions.

LOAC is an original OPC performing observations at two scattering angles. The first one is around 12°, and is almost insensitive to the nature of the particles; the second one is around 60° and is strongly sensitive to the refractive index of the particles. By combining measurements at the two angles of the light scattered by the particles that cross a laser beam, it is possible to retrieve accurately the size distribution and to estimate the nature of the dominant particles (droplets, carbonaceous, salts and mineral particles) in 19 size classes in the 0.2-19 μm range. This typology is based on calibration charts obtained in the laboratory. Several campaigns of cross-comparison of LOAC with other particle counting instruments and remote sensing photometers have been run to validate both the size distribution derived by LOAC and the retrieved particle number density. The speciation of the aerosols has been validated in well-defined conditions including urban pollution, desert dust episodes, fog, and cloud. Comparison with reference aerosol mass monitoring instruments also shows that the LOAC measurements can be successfully converted to mass concentrations [1].

The weight of LOAC is of about 200g and the consumption is below 3W. Figure 1 presents the LOAC instrument used for measurements under all kinds of balloons, including meteorological balloons.

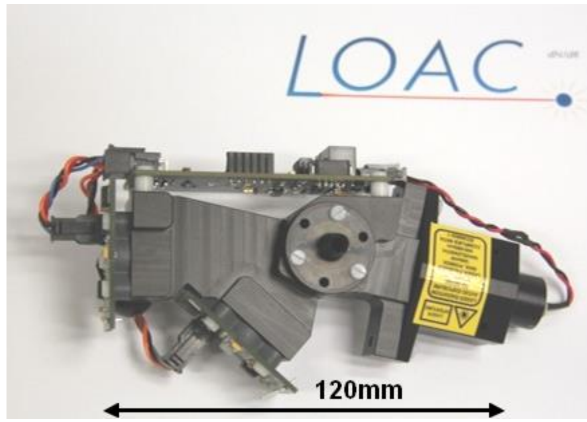

Figure 1: the LOAC instrument

Some hardware and software improvements are in progress for performance enhancements (size detection down to 0.1 μm and concentration above 1000 particles per cm^3), to satisfy the space conditions, and to be able to easily address opportunities for the future planetary missions.

Two main objectives are identified:
- The study of the atmosphere of Saturn, in the frame of the HERA project that will be submitted to the M5 call for proposals of the European Space Agency. This project consist of an entry probe into the cloud forming region of the troposphere, below the region accessible from remote sensing, to better understand the formation and the composition of the Saturn atmosphere. LOAC will provide the size distributions of the aerosols, which are unknown at present.

- The study of the Martian atmosphere, from a lander, a rover or even a balloon, although no mission have been yet identified. LOAC could determine the aerosols size distribution, and could provide a better estimate of the nature of the liquid and solid particles in the atmosphere and at ground, including for the "dust devils".
- Three others objectives can be also considered in the future: the clouds of the Venus atmosphere, the Titian atmosphere, and the comet comae.

References: [1] Renard J.-B. et al. (2016), *Atmos. Meas. Tech., 9*, 1721-1742.