LOAC: a light aerosol counter/sizer for characterizing the size distribution and nature of the particles in the ice giants atmospheres

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Abstract

Liquid and solid aerosols are present in the atmosphere of many solar system objects. Measuring aerosol properties is of major importance for the understanding of the processes controlling both atmospheric composition and dynamics. While some aerosol properties, such as average grain size or main composition, can be estimated using remote-sensing measurements, their size distributions, which are related to their their origin, their formation process and their evolution, are often poorly known; thus sophisticated in situ measurement are required.

LOAC (Light Optical Aerosol Counter) is an ultra-light and compact optical counter and sizer designed to perform measurements of liquid and solid particles at ground and under all kinds of balloons in the Earth atmosphere. The aerosols are injected in an optical chamber by a pump; they cross a laser beam and their scattered light is recorded by photodiodes. In its current version, measurements are performed at two scattering angles. The first one is around 15○, and is almost insensitive to the refractive index of the particles; the second one is around 65○ and is strongly sensitive to the refractive index of the particles. By combining the signals at the two angles, it is possible to retrieve the concentrations for 19 sizes between 0.2 and 100 micrometers and to estimate the main typology of the particles based on their light absorbing properties (droplets, carbonaceous particles, minerals particles, salts, ices).

A new version of LOAC, called LOAC-S (S for "Spatial") in under development in the frame of a "Research and Development" project funded by the CNES French Space Agency. The aim is to first improve the existing version of LOAC in terms of performance for the detection of sub-micronic aerosols, and secondly for operating the instrument in the space environment (low temperatures, low and high pressures, electro-magnetic radiations, required low consumption).

LOAC-S can be used for the study of ice giants atmospheres. This version is planned to use about 15 scattering angles to retrieve the whole scattering phase function of the aerosols.

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It will be then possible to derive the aerosol concentrations per size classes but also to estimate their refractive index and to distinguish between liquid and iced particles. LOAC-S could be an excellent candidate for a descending probe in the Uranus or Neptune atmospheres. In this case, no pumping system is needed, the particles will be injected directly inside the optical chamber considering the relative speed between the probe and the atmospheric gas motion.

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