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Cloud Aerosol Lidar for Global Scale Observations of the Ocean-Land-Atmosphere System – CALIGOLA

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The Italian space industry, and specifically Leonardo S.p.A., has gained unique skills at an international level in the development of space-qualified power laser sources with for lidar Earth observation applications (Aeolus, EarthCARE). Moreover, Leonardo S.p.A. and the Italian optical industry, has a consolidated technical-scientific knowledge and consolidated experience in the design and development of lidar receiver sub-systems (telescopes, optical devices and sensors) with space applications. The Italian Space Agency (ASI) intends to benefit from long-term expertise to design and develop a lidar system for Earth observation applications. Two separate feasibility studies, one focusing on technical aspects and one focusing on scientific aspects, are presently underway to define mission goals and a possible instrument layout.

CALIGOLA has a primary focus on the atmosphere, but also a strong focus on the study of the Ocean-Earth-Atmosphere system and the mutual interactions within it. Exploiting the three Nd:YAG laser emissions at 354.7, 532 and 1064 nm and the elastic (Rayleigh-Mie) and Raman lidar echoes from atmospheric constituents, CALIGOLA is conceived to carry out three-wavelength particle backscatter and depolarization ratio and two-wavelength particle extinction profile measurements from aerosols and clouds to be used to retrieve their microphysical and dimensional properties. Furthermore, measurement of the elastic backscattered echoes from the sea surface and the underlying layers, and their degree of depolarization, CALIGOLA will be exploited to characterize sea optical properties (ocean color) and the suspended particulate matter, which are needed to study the seasonal and inter-annual phytoplankton dynamics and to improve the understanding of the role of phytoplankton in marine biogeochemistry, in the global carbon cycle and in the response of marine ecosystems to climate variability. A specific measurement channel will be dedicated to fluorescence measurements from atmospheric aerosols and marine chlorophyll, for the purpose of aerosol typing and for characterizing ocean primary production. Aerosol fluorescence measurements at 680 nm/460 nm are also planned for the purpose of aerosol typing. CALIGOLA will also allow accurate measurements of the small-scale variability of the earth's surface elevation primarily associated with variations in the terrain, vegetation and forest canopy height.

The CALIGOLA project is explicitly included in the on-going Three-Year Activity Plan (2021-2023) of the Italian Space Agency, with a scheduled tentative launch window of 2026-2028. The considered strategy to develop the above described space lidar mission in such a short time relies on the maximum exploitation of subsystems already developed at national level for space applications, with a high TRL (TRL>7), ultimately leading to a space mission with high impact and scientific timeliness. The Phase A study of the technological feasibility of the laser source is on-going, commissioned by ASI to Leonardo S.p.A., and scientific studies in support of the mission also on-going, with the University of Basilicata being the leading scientific institution. The Italian Space Agency is willing to pursue this mission in a coordinated way with one or more other European or extra-European Space Agencies, with a bilateral or multi-lateral contributed mission approach, and, in this regard, any interest from other Agencies is welcome and desired.