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The Cloud and Aerosol Lidar for Global Scale Observations (CALIGOLA): Overview of the current status and future steps of a groundbreaking multidisciplinary Mission

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The Cloud and Aerosol Lidar for Global Scale Observations of the Ocean-Land-Atmosphere System (CALIGOLA) is an advanced multi-purpose space lidar mission with a focus on atmospheric and oceanic observation aimed at characterizing the Ocean-Earth-Atmosphere system and the mutual interactions within it. This mission has been conceived by the Italian Space Agency (ASI) with the aim to provide the international scientific community with an unprecedented dataset of geophysical parameters capable of increasing scientific knowledge in the areas of atmospheric, aquatic, terrestrial, cryospheric and hydrological sciences. The Italian Space Agency is partnering with NASA on this exciting new space lidar mission. The mission is planned to be launched in the time frame 2031-2032, with an expected lifetime of 3-5.

Exploiting the three Nd:YAG laser emissions at 354.7, 532 and 1064 nm and the elastic (Rayleigh-Mie), depolarized, Raman and fluorescent lidar echoes from atmospheric and ocean constituents, CALIGOLA will carry out multi-wavelength profile measurements of the backscatter, extinction and fluorescent coefficient and the depolarization ratio of atmospheric and ocean particles. These measurements will enable determinations of the microphysical and dimensional properties of atmospheric aerosols and clouds and their typing. Measurements of ocean optical properties will document phytoplankton seasonal and inter-annual dynamics and will improve understanding on marine biogeochemistry, the global carbon cycle, and responses of plankton ecosystems to climate variability. One specific measurement channel at 685 nm will be dedicated to fluorescence measurements from atmospheric aerosols and marine chlorophyll, for the purpose of aerosol typing and characterization of phytoplankton nutrient stress and primary production. CALIGOLA will provide accurate measurements of small-scale variability in earth surface elevation, primarily associated with variations in the ice and snow, terrain, and terrestrial vegetation height (e.g., forest canopies).

Phase A studies, commissioned by the Italian Space Agency to Leonardo S.p.A. and focusing of the technological feasibility of the laser source and the receiver, were conducted from October 2022, while Phase A/B1 activities for the payload, platform, and end-to-end system will start in January-February 2025. Scientific studies in support of the mission are ongoing, commissioned by the Italian Space Agency to University of Basilicata (KO: November 2021) and ISMAR-CNR (KO: September 2023). In September 2023, NASA-LARC initiated a pre-formulation study to assess the

feasibility of a possible contribution to the CALIGOLA mission focused on development of the detection system and sampling chain and the implementation of data down link capabilities. The pre-formulation study ended in September 2024, the Mission Concept Review was successfully completed, and a phase A/formulation study has been finalized in preparation for a System Requirements Review, which should start shortly. This presentation will provide details on current status and future steps of this groundbreaking multidisciplinary lidar mission.

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