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ORACLE: A DUAL-SMALLSAT MISSION TO INVESTIGATE THE MARTIAN CLIMATE

Abstract

The planet Mars has always been one of the main targets of space exploration programs. A key science objective of future missions to Mars will be a thorough investigation of the interaction between its atmosphere and the formation and evolution of the polar caps. We present here the mission concept Mars Orbital Radio science and Altimetry for CLimate Experiment (ORACLE) devoted to enhancing our knowledge of the carbon dioxide seasonal cycle through accurate measurements of mass, volume and composition of the seasonal polar deposits. This mission concept consists of a pair of SmallSats in a low-altitude orbit (e.g., MRO-like 250x320 km orbit) about Mars with three scientific instruments. A radio science system is designed to enable inter-satellite tracking for highly accurate gravity observations, which measure the mass anomalies associated to CO2 accumulation. An infra-red wide-angle camera is hosted onboard one of the two SmallSats to monitor the seasonal extension of the polar caps' edges. A third instrument is a solid heritage laser altimeter that allows measuring the seasonal variations of the polar caps thickness. By combining altimetry and imaging data, we will retrieve accurate estimates of the volume of the seasonal carbon dioxide deposits. Simultaneous observations of these geophysical quantities will yield unprecedented measurements of the density of the seasonal polar deposits. The proposed mission architecture is obtained through a novel scheme for inter-satellite tracking. We demonstrate that this scheme provides very accurate orbit determination when inter-satellite data are combined with ground tracking data. This inter-satellite tracking system may be employed for deep-space autonomous navigation. The proposed system is based on sharing elements with the Telemetry, Tracking and Command (TTC) unit, enabling a compact design. This instrument scheme leads to significantly lower mass and power budgets with respect to the NASA missions GiRACE and GRAIL. We present here the mission subsystems that support the operations of the three science instruments for the multi-disciplinary investigations achievable with the proposed dual-SmallSat mission.