

TALISMAN: A Multi-Angle Polarimetric and SWIR Instrument for Enhanced Methane Detection from Microsatellite Platforms

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TALISMAN (*liquid crysTAL polarimetry-based earth observation mISsion for MethANe detection*) is an Earth observation mission developed under the European Space Agency (ESA) InCubed program through a collaboration between Satlantis Microsats S.A. and the Spanish National Institute for Aerospace Technology (INTA). The mission aims to enhance methane detection and quantification from microsatellite platforms by exploiting the synergistic use of visible multi-angle polarimetry and short-wave infrared (SWIR) measurements.

The mission is enabled by the iSIM-PMP instrument, which builds on Satlantis' heritage in high-resolution iSIM optical systems and methane-sensitive SWIR channels demonstrated in previous Satlantis missions. The instrument adopts a binocular iSIM architecture, consisting of two co-aligned channels: a visible channel with polarimetric capability and a SWIR channel dedicated to methane detection. Polarimetric functionality is implemented within the visible channel by combining Satlantis' iSIM opto-mechanical and detector architecture with INTA's Polarization Modulation Package (PMP), based on liquid-crystal technology. The system operates in three visible spectral bands (490, 670, and 875 nm), following the observational heritage of POLDER/3MI missions.

A key objective of TALISMAN is to reduce uncertainties in methane retrievals associated with aerosol scattering. To address this challenge, TALISMAN's polarimetric measurements, combined with the GRASP (*Generalized Retrieval of Aerosol and Surface Properties*) algorithm, enable the retrieval of aerosol properties, which are subsequently used to improve methane retrievals. Performance analyses using GRASP demonstrate the expected improvement in aerosol characterization, while ongoing work focuses on quantifying the resulting impact on methane retrieval accuracy through dedicated Multispectral Differential Photometry (MDP) models. The end-to-end processing chain integrates polarimetric demodulation, aerosol retrieval, and methane inversion, enabling the coherent exploitation of polarimetric and SWIR observations within a unified framework.

The instrument design relies on high-TRL heritage subsystems, integrating the proven iSIM optical architecture with the PMP polarimetric module, which requires system-level optimization of optical, thermal, and mechanical interfaces. Instrument performance is maximized by employing Signal-to-noise ratio (SNR) analyses and acquisition strategies, balancing multi-angle observations, PMP operation, and back-scanning techniques. Calibration and validation activities include comprehensive ground-based characterization campaigns and planned in-orbit strategies designed to ensure radiometric and polarimetric accuracy and long-term stability throughout the mission lifetime.

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