TITAN AERIAL EXPLORER (TAE): EXPLORING TITAN BY BALLOON

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Titan Aerial Explorer (TAE) is a mission concept for the exploration of Titan through use of a helium superpressure balloon. The 4.6 m diameter spherical balloon would cruise at a nominal altitude of 8 km just south of the equator and travel around the planet carried by the prevailing wind. The mission science floor is accomplished with a 3 month navigation, with a goal of complete circumnavigation that, at an estimated speed of 1 m/s, would require 6 months. The total floating mass is estimated to be 200 kg (including design margin and helium gas) of which 20 kg is science instruments carried in the gondola suspended below the balloon. The TAE mission would acquire in situ measurements of Titan's troposphere and conduct imaging and sounding of the surface and subsurface at high resolution. The instrument suite would consist of three remote sensors—a camera (VISTA-B), near-infrared spectrometer (BSS) and radar sounder (TRS)—and three in situ experiments—an aerosol collector and analyzer (TCAA), meteorology package (ASI/MET), and a device for measuring electric and magnetic fields and conductivity (TEEP-B). In addition, tracking of the balloon's radio signals would allow for determination of atmospheric circulation patterns at the cruising altitude. Collectively, these measurements would address the two scientific goals of the mission: (1) to explore how Titan functions as a system in the context of the complex interplay of the geology, hydrology, meteorology and aeronomy present there; and (2) to understand the nature of Titan's organic chemistry in the atmosphere and on the surface. The linkage between the scientific goals and the measurements to be performed flows through a detailed science traceability matrix. Delivery of the balloon and gondola into the atmosphere would be via a Huygens-like entry system with a 3 m diameter aeroshell, that is itself released from a carrier spacecraft after a several year interplanetary trip. The balloon would be aerially deployed and inflated while under parachute descent. The helium inflation gas would be carried in a set of high pressure storage tanks mounted inside the aeroshell. 240 W of electrical power would be provided by 2 Advanced Stirling Radioisotope Generators (ASRG) mounted on the gondola. Waste heat from the ASRGs would be used to keep the gondola interior temperature near 20 °C. Direct-to-Earth telecommunications would be provided by a 20 W X-band transmitter and a 0.75 m diameter steerable high gain antenna mounted on the gondola. It is estimated that an average of 170 Mbits of data would be transmitted to Earth during each Titan sol using ESA and/or NASA 35/34 m ground antennas. The balloon would be fabricated from a polyester film and fabric laminate. A vent valve and a few kilograms of ballast would be carried to enable a limited number of altitude excursions during the mission. Otherwise, the superpressure design will result in constant altitude flight with very small deviations of tens of meters from the nominal 8 km float altitude.