Science, Instrumentation, and Operations Concepts for a Titan Airplane

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Based on the ideas and engineering of Lemke (2008 IPPW), we have continued developing a mission concept for a stand-alone Titan airplane. The result is AVIATR – Aerial Vehicle for In-situ and Airborne Titan Reconnaissance – a small (120kg), nuclear-powered Titan airplane in the Discovery / New Frontiers class. The airplane platform allows for unique flexibility in terms of altitude, geography, and directed flight. The scientific goals of the mission are designed around that flexibility: to explore Titan's diversity both in terms of surface landforms, processes, and compositions, and in terms of atmospheric circulation, aerosols, and humidity. AVIATR would achieve all of the goals defined for the hot-air balloon concept in the Titan flagship studies, and its directed mobility allows for additional science investigations.

The instrument payload that we have defined is narrowly focused on those scientific objectives. The optical remote sensing suite consists of three instruments – an off-nadir high-resolution 2-micron camera, a horizon-looking 5-micron imager, a 1-6 micron pushbroom near-infrared spectrometer, and a sun-seeking upward-looking haze spectrometer. The in-situ instruments include atmospheric structure instruments, a methane humidity sensor, and a raindrop detector.

An airplane would have some operational advantages over a balloon. First and foremost, the airplane's piloted nature allows a go-to capability to image locations of known interest on Titan at will. This allows directed exploration of Titan's sand dunes, mountains, craters, channels, and lakes, features of primary geologic interest as evidenced by the number of journal articles on the topics over the past several years. Subsequent imaging can search for changes. The airplane can fly predesigned routes in order to build up large context mosaics of areas of interest, and then swoop down to low altitude to acquire high-resolution images at 30-cm spatial sampling similar to that of HiRISE at Mars. The elevation flexibility of the airplane allows us to acquire atmospheric profiles as a function of altitude at any desired location. Total scientific return from the mission is limited by the direct-to-Earth downlink bandwidth. In order to maximize the science per bit, we will employ novel data storage and downlink techniques, including lossy compression, downloading thumbnails, and on-board image evaluation.