TITAN AERIAL EXPLORER

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We propose the Titan Aerial Explorer (TAE) mission that would deploy and operate a super-pressure helium balloon in the lower atmosphere of Saturn's giant moon, Titan. The Cassini-Huygens mission revealed Titan to be a body with an active hydrological cycle involving methane, ethane and a variety of other organic molecules. It found methane oozing from the surface at the Huygens landing site, and liquid organics residing in vast near-polar deposits whose extent rivals or exceeds the great lakes and seas on Earth. Cassini observed methane clouds forming as convective storms in the summertime south, as ghostly echoes superimposed on methane seas sheathed in late winter darkness, and as unexpectedly vast outbursts in the mid-latitudes as the Sun crossed the equator of Titan at equinox. The geologic history of the surface remains a mystery after six years of Cassini data and will continue to be a mystery through the end of the Cassini mission. The variety of surface features and atmospheric phenomena seen only at moderate and low resolution by the orbiter tease us, because we know from nature of the one site visited *in situ* by the Huygens probe that hidden among the dunes and channels, the mountains and lake shores, is a complex history of climate change and chemical evolution tied to methane and its prodigious variety of organic products. We seek to understand this history by deploying at Titan the one type of vehicle that combines the mobility and coverage of the orbiter with the capability for high resolution and *in situ* observations demonstrated by the Huygens lander, and does so in an aerodynamically stable and low-risk fashion—an aerostat (balloon plus gondola).

TAE would utilize a helium-filled super-pressure (or "pressurized") balloon, rather than a hot air (montgolfière) design, as in many previous studies. The great advantage of the pressurized balloon is the maturity of its inflation and deployment scheme. Its disadvantage is relative sensitivity to the presence of small holes that can reduce dramatically the mission lifetime. The threshold science mission is achieved after a 3-month long navigation halfway around Titan, while the goal is a complete circumnavigation (6 months).

TAE science is organized around two themes, which emphasize the special nature of Titan and at the same time its important connections to studies of other planets and the Earth. These are (1) The presence of an atmosphere and liquid volatile "hydrologic" cycle, which implies climate evolution through time and (2) organic chemistry, which is pervasive through its atmosphere, surface, and probably interior. Therefore the first science goal is to explore how Titan functions as a system in the context of the complex interplay of the geology, hydrology, meteorology, and aeronomy present there. Goal 2 is to understand the nature of Titan's organic chemistry in the atmosphere and on its surface. These in turn lead to a set of primary science objectives for a balloon-borne system, which can then, through the science investigations that devolve from them, be addressed through a set of measurement objectives.