Not Afraid to Ride the Wind: Titan by Balloon

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Saturn's moon Titan has a dense atmosphere with hazes of organic molecules that obscure the surface and make mapping from Earth and space difficult. The ongoing NASA/ESA/ASI Cassini mission has revealed Titan to be a complex, perhaps recently active, world, and the most Earthlike of solar system bodies in terms of the balance of geologic and atmospheric processes. Though profoundly cold and hence likely devoid of Earth-like life, Titan is rich in methane, nitrogen, and organic products of these simple compounds. It has winds and rain that have shaped the surface, producing vast areas of dunes and a diversity of fluvial features from drainages extending over tens or hundreds of kilometers to locally cut streambeds that have carried ice pebbles down to the plains where Huygens landed. Features that look like volcanic domes, chains of mountains, mysterious pits, and circular features hint at a complex geologic past, while kidney-shaped lakes and bays—perhaps dry today—stand as mute testament to a past that might have included seas of liquid hydrocarbons.

Titan can be explored in a variety of ways, but future missions that both extend our knowledge of this planet-sized world and capture the imagination of the public could use the dense atmosphere to enable unique means of exploration. The extended nature of the atmosphere allows spacecraft to aerobrake into desired orbits, and provides relatively benign entry conditions compared to the giant planets, and even Earth. Particle radiation is low around Titan and absent in the environment near surface. The air density at lower altitudes is higher than on Earth, the air is cold and mostly stable nitrogen, and the winds relatively light and predictable below 10-20 kilometers. The most economical, elegant, and reliable way to navigate this environment is with a hot air balloon that uses the varying winds at different altitudes to cruise across the landscape and sample interesting regions. Here we describe the Titan Planetary Explorer mission, a hot-air balloon that could cruise with the wind at jetliner altitudes, circumnavigating the globe, while occasionally descending to the surface to sample sites of particular interest from the point of view of organic chemistry and the exotic geology of a giant water-ice world. Slow north-south winds would allow drift from one latitude region to another. Vistas that the mission would relay to Earth, based on the evocative scene imaged by Huygens, could well prove to be among the most hauntingly familiar yet exotically different landscapes viewed by humankind since the first images of our neighboring planets were returned some four decades ago from the Moon and Mars.