Titan ripe for drone invasion

May 5 2017, by Matt Williams

A proposed eight-bladed drone (aka. "dragonfly") could be ideally suited for exploring Saturn's moon Titan in the coming decades. Credit: APL/Michael Carroll

With its dense and hydrocarbon-rich atmosphere, Titan has been a subject of interest for many decades. And with the success of the Cassini-Huygens mission, which began exploring Saturn and its system of moons back in 2004, there are many proposals on the table for follow-up

missions that would explore the surface of Titan and its methane seas in greater depth.

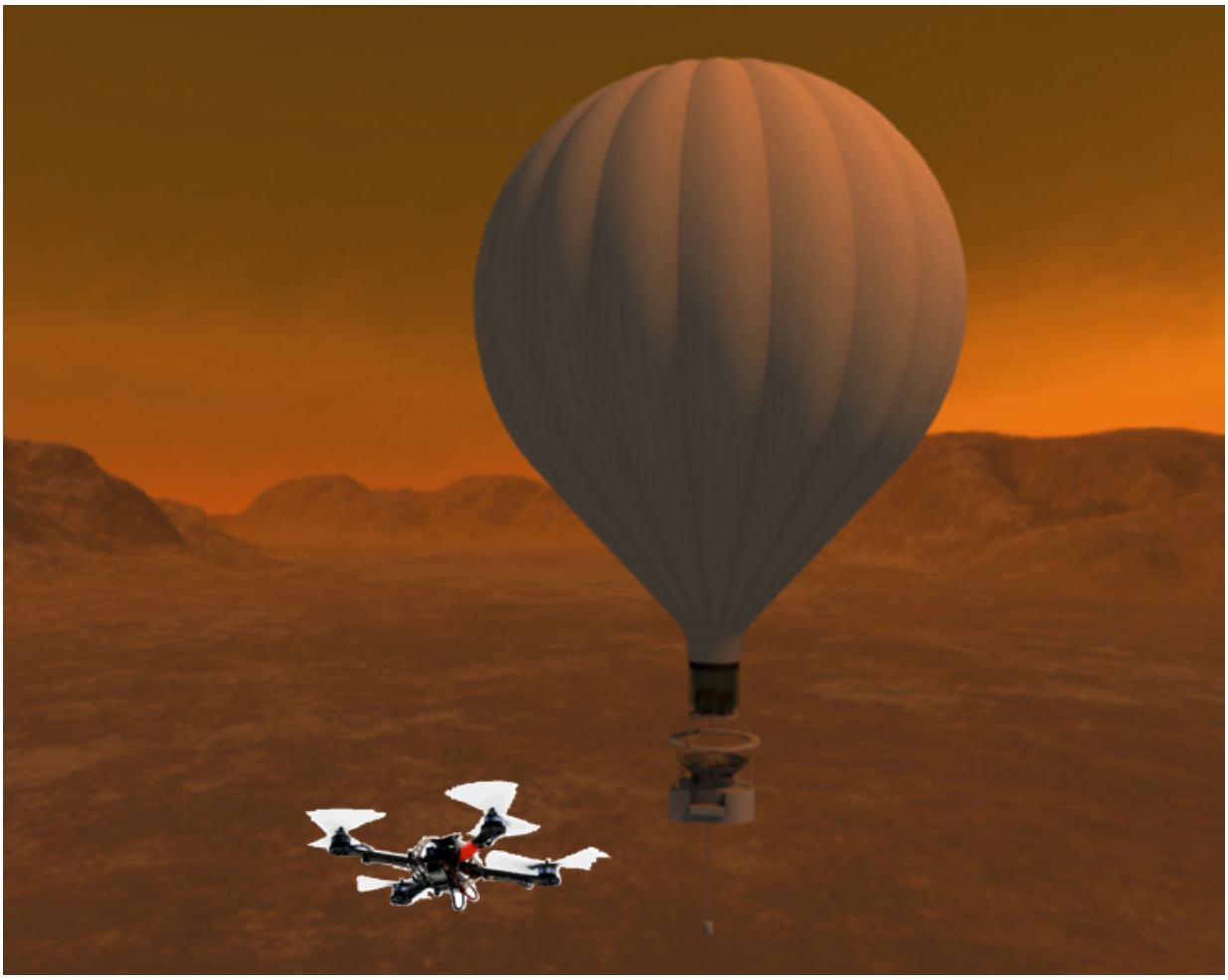
The challenges that this presents have led to some rather novel ideas, ranging from balloons and landers to floating drones and submarines. But it is the proposal for a "Dragonfly" drone by researchers at NASA's JHUAPL that seems particularly adventurous. This eight-bladed drone would be capable of vertical-takeoff and landing (VTOL), enabling it to explore both the atmosphere and the surface of Titan in the coming decades.

The mission concept was proposed by a science team led by Elizabeth Turtle, a planetary scientist from NASA's Johns Hopkins University Applied Physics Laboratory (JHUAPL). Back in February, the concept was presented at the "Planetary Science Vision 2050 Workshop" – which took place at NASA's headquarters in Washington, DC – and again in late March at the 48th Lunar and Planetary Science Conference in The Woodlands, Texas.

Such a mission, as Turtle explained to Universe Today via email, is both timely and necessary. Not only would it build on many recent developments in robotic explorers (such as the Curiosity rover and the Cassini orbiter); but on Titan, there is simply no shortage of opportunities for scientific research. As she put it:

"Titan's an ocean world with a unique twist, which is the rich and complex organic chemistry occurring in its atmosphere and on its surface. This combination makes Titan a particularly good target for studying planetary habitability. One of the big questions about the development of life is how chemical interactions led to biological processes. Titan's been doing experiments in prebiotic chemistry for millions of years – timescales that are impossible to reproduce in the lab – and the results of these experiments are there to be collected."

Their proposal is based in part on previous Decadal Surveys, such as the Campaign Strategy Working Group (CSWG) on Prebiotic Chemistry in the Outer Solar System. This survey emphasized that a mobile aerial vehicle (i.e an airship or a balloon) would well-suited to exploring Titan. Not only is Titan the only known body other than Earth that has a dense, nitrogen-rich atmosphere – four times as dense as Earth's – but it's gravity is also about 1/7th that of Earth's.



Artist's concept of a Titan Aerial Daughter quadcopter and its "Mothership" balloon. Credit: NASA/STMD

However, balloons and airships would be unable to study Titan's methane lakes, which are one of the most exciting draws as far as research into prebiotic chemistry goes. What's more, an aerial vehicle would not be able to conduct in-situ chemical analysis of the surface, much like what the Mars Exploration Rovers (Spirit, Opportunity and Curiosity) have been doing on Mars.

As such, Turtle and her colleagues began looking for a proposal that represented the best of both worlds – i.e. an aerial platform and a lander. This was the genesis of the Dragonfly concept.

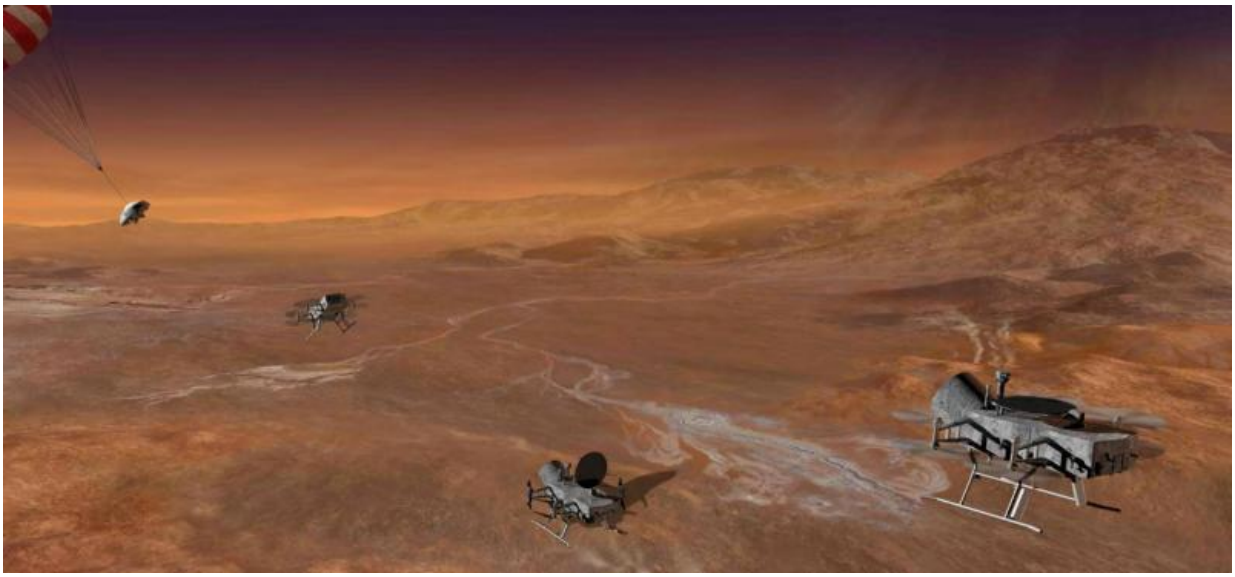
"Several different methods have been considered for in-situ aerial exploration of Titan (helicopters, different types of balloons, airplanes)," said Turtle. "Dragonfly takes advantage of the recent developments in multi-rotor aircraft to provide aerial mobility for a lander with a sophisticated payload. Because Dragonfly would be able to travel long distances – a few tens of kilometers at a time, and up to a few hundred kilometers over the course of the mission – it would be possible to make measurements at multiple sites with very different geologic histories."

Initially, Turtle and her colleagues – which includes Ralph Lorenz (also from JHUAPL), Melissa Trainer of the Goddard Space Flight Center, and Jason Barnes of University of Idaho – had proposed a mission that would combine a Montgolfière-style balloon with a Pathfinder-like lander. Whereas the balloon would explore Titan from a low altitude, the lander would explore the surface up close.

However, by the 48th Lunar and Planetary Science Conference, they had made some adjustments to their idea. Instead of a balloon and multiple landers, they presented a concept for a "Dragonfly" qaudcopter to conduct both aerial and surface studies. This four-rotor vehicle, it was argued, would be able to take advantage of Titan's thick atmosphere and low gravity to obtain samples and determine surface compositions in

multiple geological settings.

In its latest iteration, the Dragonfly incorporates eight rotors (two positioned at each of its four corners) to achieve and maintain flight. Much like the Curiosity and upcoming Mars 2020 rovers, the Dragonfly would be powered by a Multimission Radioisotope Thermoelectric Generator (MMRTG). This system uses the heat generated by decaying plutonium-238 to generate electricity, and can keep a robotic mission going for years.



Artist's concept of the dragonfly being deployed to Titan and commencing its exploration mission. Credit: APL/Michael Carroll

This design, says Turtle, would offer scientists the ideal in-situ platform for studying Titan's environment:

"Dragonfly would be able to measure compositional details of different

surface materials, which would show how far organic chemistry has progressed in different environments. These measurements could also reveal chemical signatures of water-based life (like that on Earth) or even hydrocarbon-based life, if either were present on Titan. Dragonfly would also study Titan's atmosphere, surface, and sub-surface to understand current geologic activity, how materials are transported, and the possibility of exchange of organic material between the surface and the interior water ocean."

This concept incorporates a lot of recent advances in technology, which include modern control electronics and advances in commercial unmanned aerial vehicle (UAV) designs. On top of that, the Dragonfly would do away with chemically-powered retrorockets and could power-up between flights, giving it a potentially much longer lifespan.

"And now is the perfect time," says Turtle, "because we can build on what we've learned from the Cassini-Huygens mission to take the next steps in Titan exploration."

Currently, NASA's Jet Propulsion Laboratory is developing a similar concept. Known as the Mars Helicopter "Scout", for use on Mars, this aerial drone is expected to be launched aboard the Mars 2020 mission. In this case, the design calls for two coaxial counter-rotating rotors, which would provide the best thrust-to-weight ratio in Mars' thin atmosphere.

This sort of VTOL platform could become the mainstay in the coming decades, wherever long-term missions that involve bodies that have atmospheres are called for. Between Mars and Titan, such aerial drones could hop from one area to the next, obtaining samples for in-situ analysis and combining surface studies with atmospheric readings at various altitudes to get a more complete picture of the planet.

Source: Universe Today