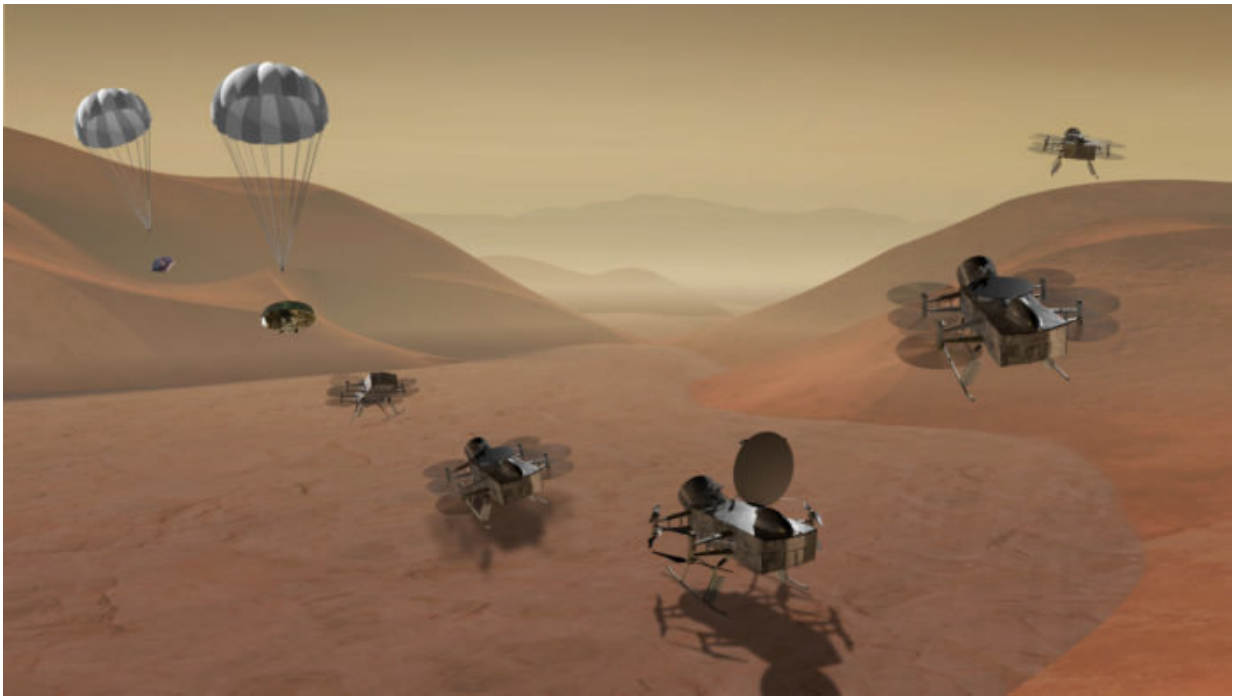
Researcher sets eyes on Saturn's largest moon

February 23 2018, by Debora Van Brenk



An artist's rendering shows the proposed Dragonfly quadcopter landing on the surface of Saturn's moon Titan, unfolding its rotors and lifting off again to survey the landscape and atmosphere. Credit: Steve Gribben/Johns Hopkins APL

Co-led by a Western space scientist, NASA is exploring a revolutionary plan that could see a drone-like quadcopter buzz above the surface of Saturn's largest moon.

The Dragonfly project would take advantage of Titan's dense, calm atmosphere to fly from site to site as it measures and analyzes the massive moon's chemistry, geology – and potential for life. The craft is modeled after drones on Earth, and would have four pairs of stacked rotors that would enable it to zip – as much as an object with a mass of a few hundred kilograms could be said to 'zip' – across Titan geography that has intrigued and mystified scientists for decades.

Unlike conventional, slow-moving rovers that suss out the surface of Mars, Dragonfly would be able to explore across hundreds of kilometres, all the while scouting for geologic points of interest and taking valuable measurements of surface, sub-surface and atmospheric conditions.

As co-investigator, Earth Sciences professor and planetary geologist Catherine Neish is helping define and achieve the mission's science goals. She is part of a team led by Elizabeth Turtle at Johns Hopkins Applied Physics Laboratory (APL) whose proposal for a revolutionary rotorcraft to investigate Titan was recently selected by NASA as one of two finalists for the agency's next New Frontiers mission.

Not quite as tiny, but at least as nimble, as its namesake in the low-gravity atmosphere, this Dragonfly would be about two metres long, with multiple rotors that enable good control of the vehicle and built-in mechanical redundancies.

For many years, people thought to explore Titan by balloon, rover or small airplane but each has limitations that include mobility, durability, range and effective control.

"There's something very 'simple' about having a little drone flying around Titan," Neish said. "It's clever in a way that people weren't expecting and, I think, it's audacious and exciting – and realistic."

The atmospheric conditions of Titan – with its orange-brown haze of methane and nitrogen – obscure high-resolution views and have made the moon largely inscrutable. The veil lifted only in part in 2005 when the Huygens probe (part of the Cassini mission) produced some images of the surface. Those were enough to tantalize researchers but not enough to show more than a glimpse of the whole.

"It's like landing on a London street and saying you've seen the whole Earth," Neish said.

Earth Sciences professor Catherine Neish, shown here at Mt. Whitney in California's Sierra Nevada Range, is co-leading a project that could see a quadcopter exploring Titan, Saturn's biggest moon. Credit: Special to Western

With solar power unavailable because of both Titan's distance from the sun and its dense atmosphere, Dragonfly would be plutonium-powered, using a Multi-Mission Radioisotope Thermoelectric Generator. That is the same power source as the Mars Curiosity rover and the Cassini space probe. It could fly several kilometres on a single 'Titan overnight' charge and potentially cover hundreds of kilometres during a Titan day (equivalent to 16 Earth days).

Dragonfly would spend less time flying than taking science measurements during its two-year mission. Its main tasks would be sampling for organic chemistry and habitability; monitoring atmospheric and surface conditions; shooting and transmitting images of landforms; and conducting studies of the moon's seismology.

The potential for significant discovery is exciting, Neish said.

"The chemistry is going to be amazing but I'm really interested in what Titan looks like. I'm guessing it's just this weirdly wonderful world that looks like Earth – a strange, frozen sedimentary place – but with all the wrong ingredients."

There's tantalizing evidence there are rivers of methane and ethane, flowing at 95 Kelvin (or minus-200 Celsius) and burnishing ice into marble-sized pebbles when they flood low-lying terrain. A smoggy, windless atmosphere floating above frozen hydrocarbon lakes. A peculiar, ice-water chemical soup sits near or below the surface and maybe, just maybe, could be a nursery for some form of life.

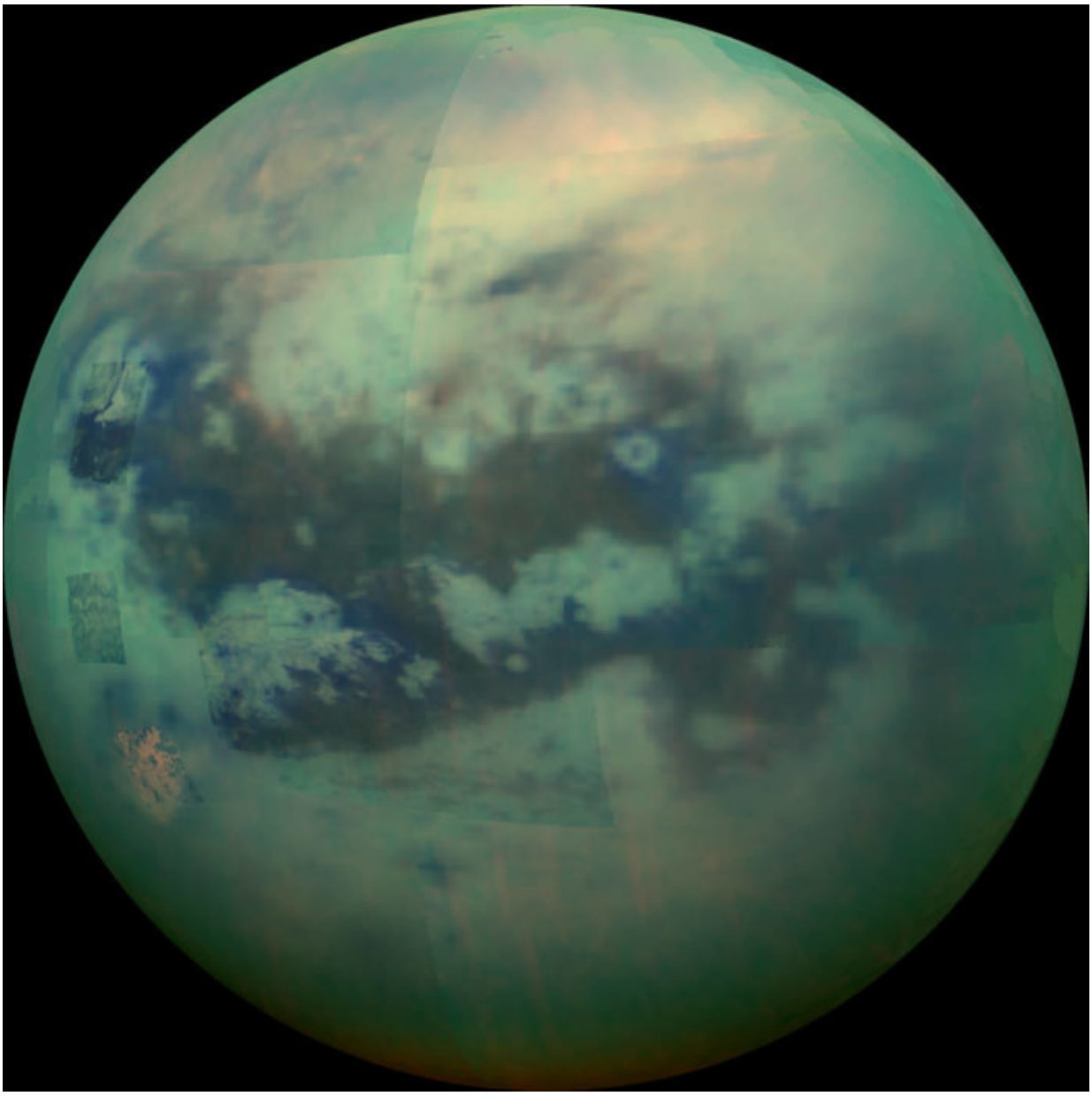
We know so little about Titan, Neish said, and what little we do know is

so recently discovered. "Before Huygens in 2005, we had no idea what the surface of Titan would be like."

Neish's specialty is the geology of planetary surfaces, specifically understanding the processes of impact cratering through radar imaging. She is involved in several spacecraft missions with international, multi-disciplinary teams. She is believed to be the only Canadian researcher on the Dragonfly project.

"Planetary science is such a collaborative endeavour. It's a team effort," she said.

Dragonfly is one of two NASA recently short-listed– from an original proposal group of a dozen – as part of the agency's New Frontiers planetary science program.



This composite image shows an infrared view of Saturn's moon Titan from NASA's Cassini spacecraft, acquired during the mission's T-114 flyby on Nov. 13, 2015. Credit: NASA // Special to Western News

The other project is called CAESAR (Comet Astrobiology Exploration Sample Return), which would seek to return to Earth a sample from a

comet called 67P/Churyumov-Gerasimenko and determine its origin and history. Led by Steven Squyres of Cornell University in New York, CAESAR would be managed by NASA's Goddard Space Flight Center.

Both teams will receive NASA funding of $4 million this year to further develop their ideas and re-submit proposals. NASA is expected to decide by mid-2019 which one project to support with as much as almost $1 billion in development costs.

If Dragonfly were chosen, it could launch as early as 2025 and then potentially take five years or more to reach Titan, Neish said. In space time, that's not long, she said, noting Dragonfly has gone from hypothesis to concept to scale modelling in just two years.

The name Titan comes from a generic term for the children of Ouranos (Uranus) and Gaia in ancient Greek mythology. In the stories, the Titans were the ancestors of the human race. The Titans were known to have devoured the limbs of Dionysus, the son of Zeus. Enraged, Zeus struck the Titans with lightning. (Zeus had intended this child to have dominion over the world.) The lightning burned the Titans to ashes, and from the ashes, mankind was formed.

Saturn's largest moon Titan is the second largest moon in our solar system, second only to Jupiter's Ganymede, which is only 2 per cent larger. With a mean radius of 2,575 km (1,600 miles), Titan is bigger than Earth's moon and even larger than the planet Mercury.

Titan is the only moon in our solar system that has clouds and a dense atmosphere, mostly nitrogen and methane. It is also the only other place in the solar system known to have an Earthlike cycle of liquids flowing across its surface.

Titan orbits Saturn at a distance of about 1.2 million km (759,000

miles), taking 15 days and 22 hours to complete a full orbit. Titan is tidally locked in synchronous rotation with Saturn, and permanently presents one face to the planet as it completes its orbit.

In 1994, NASA's Hubble Space Telescope recorded pictures of Titan, which suggested that a huge bright continent exists on the hemisphere that faces forward in orbit. These Hubble results didn't prove that liquid seas existed, however; only that Titan has large bright and dark regions on its surface.

Titan's surface remained shrouded in secrecy below the clouds until July 2004. That's when NASA's Cassini spacecraft arrived. Cassini was specially designed to peer through Titan's haze with radar and in certain colors of light, called spectral windows that allow a glimpse of what lies below. During dozens of flybys, the Cassini orbiter has mapped a large fraction of Titan's surface and made detailed studies of its atmosphere. Cassini also carried the European-built Huygens probe, which parachuted through Titan's atmosphere in 2005 to make the first landing on a body in the outer solar system.

Provided by University of Western Ontario