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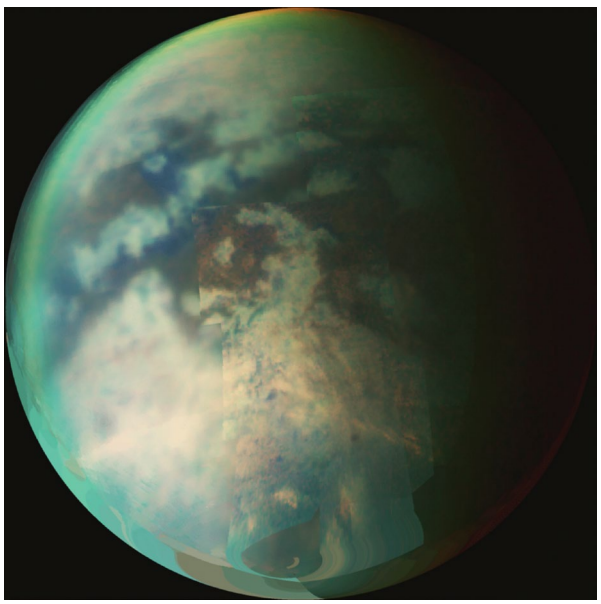
PLANETARY SCIENCE

Wind, rain and methane on Titan

Saturn's moon Titan (pictured) has a dynamic atmosphere and a diverse surface. Three studies in *Nature Astronomy* reveal new, unexpected features, such as an atmospheric jet stream breaking the speed of sound, disappearing hydrocarbon ponds and methane lakes that reach over 100 m deep.



Credit: NASA/JPL/University of Arizona

Emmanuel Lellouch and colleagues retrieved the Doppler shifts of six types of molecular spectra observed by the Earth-based Atacama Large Millimeter/submillimeter Array (ALMA) telescope, which allowed them to directly measure Titan's poorly known upper atmospheric winds. Contrary to expectations, they found a high-speed winds regime extending throughout the atmosphere. A supersonic jet, possibly fed by energy deposited by waves propagating from the lower atmosphere, was detected at the equator at an altitude of approximately 1,000 km.

The other two studies looked below the atmosphere at lakes in Titan's northern polar region. Shannon MacKenzie and colleagues used combined Cassini instruments data (radar, infrared mapping spectroscopy and camera images) data to monitor the changes in shallow hydrocarbon lakes over 13 Earth years, corresponding to half a Titanian year. These 'phantom lakes' disappeared over the time period, which the researchers attributed to evaporation and infiltration into the regolith below.

By contrast, Marco Mastroguiseppe and co-workers focused on deep lakes. An analysis of the Cassini RADAR data showed that these lakes are largely composed of methane and could be over 100 m deep. Furthermore, these lakes are located hundreds of metres above sea level, so they are likely rain fed and drain to the subsurface flow.

These three studies give insight into the complex atmospheric and geological phenomena taking place on the moon, suggesting that Titan should be further explored by future missions such as the proposed Dragonfly spacecraft.

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ORIGINAL ARTICLES Lellouch, E. et al. An intense thermospheric jet on Titan. *Nat. Astron.* https://doi.org/10.1038/s41550-019-0749-4 (2019) | Mastrogiuseppe, M. et al. Deep and methane-rich lakes on Titan *Nat. Astron.* https://doi.org/10.1038/s41550-019-0714-2 (2019) | MacKenzie, S. M. et al. The case for seasonal surface changes at Titan's lake district *Nat. Astron.* https://doi.org/10.1038/s41550-018-0687-6 (2019)