Hints of Earth Splash a Saturnian Moon Landscape

By DENNIS OVERBYE

The lakes of southern Titan are shrinking.

The level of Ontario Lacus, the largest lake in the southern hemisphere of this Saturnian moon, has fallen by some 15 feet over the last four years, causing its shore to recede by as much as 6 miles in some places. Other lakes nearby have similarly receded, according to radar measurements made by the Cassini spacecraft.

However, if prolonged spells of 90-degree temperatures have you yearning for a refreshing icy dip, there are still plenty of bathing opportunities on Titan.

Of course the lakes there are made of liquid methane — and the 90 degrees of temperature are on the Kelvin scale, near enough to absolute zero to challenge even the most cosmically adept polar bear. The atmosphere is nitrogen and methane.

Titan is the only body in the solar system other than Earth that has been found to harbor liquid on its surface, leading many planetary scientists and aspiring astrobiologists to speculate that the same organic chemical processes that led to life on Earth are occurring in a frozen slush of hydrocarbons on Titan.

The discovery that Titan's lakes are evaporating, at least in the Southern Hemisphere, where summer just ended, suggests that there are active weather and geological cycles on Titan analogous to those on Earth. But on Titan the liquid driving those cycles is not water but methane, explained Oded Aharonson, a planetary scientist at the California Institute of Technology.

"This is a wonderful opportunity and rare in the solar system to observe a planet with working liquid on its surface, a volatile agent that is responsible for altering its geology and participating in its weather cycle by evaporating and precipitating," Dr. Aharonson said.

The research effort was led by Alexander G. Hayes, Dr. Aharonson's graduate student. Mr. Hayes was the lead author of a pair of papers, which will be published in Icarus and the Journal of Geophysical Research.

Planetary scientists have suspected that Titan might harbor exotic weather and chemistry ever since Voyager 1 flew by Saturn in 1980 and radio signals sent through Titan's atmosphere revealed a thick atmosphere of nitrogen.

In 2004 a camera known as the Imaging Science Subsystem on the Cassini spacecraft now orbiting Saturn recorded a blurry image of what looked like a lake basin about the size of Lake Ontario through Titan's hazy atmosphere. That is now named Ontario Lacus. Since then an imaging radar on Cassini has been periodically scanning Titan's terrain, a few strips at a time, during close flybys of the moon. These scans showed smooth dark areas that few scientists doubted were lakes. In January 2005, the Huygens probe landed in what looked like a fluvial plain with channels carved by methane.

NASA/JPL-CALTECH

DRYING UP The level of Ontario Lacus, a lake on Titan, has fallen 15 feet in the last four years, according to measurements by the Cassini spacecraft.

Discovering a familiar cycle of evaporation and precipitation.

Any lingering doubts were removed last year when Cassini's cameras recorded a glint of sunlight bouncing off Kraken Mare, a large lake-shaped basin near Titan's North Pole.

Lakes appear dark on the radar because if they are deeper than about 25 feet the radar waves are completely absorbed and do not come back to the spacecraft. Mr. Hayes and his colleagues were able to gauge the drop in lake levels by simply noting the shrinkage of dark nonreflecting areas and combining that with measurements of the slope of the lake bottom.

On the edges of the lake, they could see the lake bottom and thus measure its depth from altimetry, performing what Dr. Aharonson said was the first extraterrestrial bathymetry. The depth results matched the lake shrinkage. Where the slope into the methane was slow and gentle, the lakeshore receded the farthest; where there was a quick drop-off, against some mountains along the northern shore, the lake receded little.

Why should Titan be behaving like this? Dr. Aharonson said that a rough rule of thumb for hydrological systems like Earth or Titan was to expect that moisture would migrate seasonally from one hemisphere to the other, evaporating where it was summer and precipitating where it was winter. Indeed summer just ended in the southern hemisphere and the measurements show lakes were evaporating there, although there is no evidence that northern lakes are gaining yet.

But the actual dynamics of the Titanium atmosphere, he said, can be much more complicated, leading to cycles tens or hundreds of thousands of years long in which one hemisphere or the other could be wetter or colder than the other.

Because of the vagaries of its orbit around Saturn and Saturn's orbit around the sun, for example, Titan is closer to the sun during its southern summer than in its northern summer. As a result, southern summers are currently shorter and more intense than their northern counterparts. Dr. Aharonson and his colleagues argued in a recent paper that this could cause liquid to collect more in the northern hemisphere than the southern hemisphere, leading to a net migration of methane to the north over many Titan years.

That kind of migration could explain why the area covered by lakes in the north is about 100 times the area of all the lakes in the southern hemisphere. A similar cycle in the dynamics of the Earth's orbit around the Sun leads to what are known as Milankovitch climate cycles, thought to drive the ice ages.

As evidence for this theory, Dr. Aharonson pointed out that the observed evaporation rate in Ontario Lacus, about three feet a year, is not enough to fill all the lakes in the north in one season, suggesting some longer term effect is at work. "If we wait 15 years we won't see lakes migrate down to the south," he said. But if Titan has tens of thousands of years to move the methane from one hemisphere to the other, he explained, the rate can be much smaller.

The evaporation rate, he said, also sends a strong message about what the lakes are made of, namely pure methane, as opposed to heavier ethane or some other chemical, which is less volatile. "In order to evaporate that much stuff, it has to be stuff that evaporates," he said. If there is ethane present it is well mixed, the lake is not coated with a layer of gunk.

No tar balls on Titan. Yet.