SATURN'S ORBIT CONTROLS TITAN'S LAKES

This artist's conception shows a lake on the surface of Titan. Researchers recently identified the liquid in the lake as the hydrocarbon ethane, making Titan the only other body in our solar system known to contain liquid at the surface.

Just like Earth's orbital eccentricities affect its climate, Saturn's orbit may similarly affect the climate of its moon Titan. Researchers recently determined that Saturn's asymmetric orbit alters the moon's climate so that Titan's northern pole has many more lakes than its southern pole.

Despite a surface temperature of about 93 kelvins, Titan has a lot in common with Earth: a nitrogen-based atmosphere; geologic processes like volcanism, erosion and wind transport; and a system of evaporation, condensation and precipitation analogous to our hydrologic cycle — though the liquids on Titan are hydrocarbons such as methane and ethane, not water.

The similarity of the two worlds was captured by NASA's Cassini spacecraft in 2004. The first radar images of Titan's northern hemisphere revealed a landscape dotted with lakes and empty lakebeds. So researchers were surprised when later passes of Cassini over Titan's southern pole showed few lakes or lakebeds. Recently, a team led by Oded Aharonson, a planetary geologist at Caltech in Pasadena, Calif., studied the images and counted the number of lakes and lakebeds. They found 20 times more lakes north of 55 degrees North latitude than they found south of 55 degrees South latitude, and three times more empty lakebeds near the northern pole.

The team found no evidence of differences in crustal composition to explain why methane wasn't forming lakes near the southern pole. Instead, Aharonson and his colleagues reported in Nature Geoscience, Titan's climate cycles are to blame for the lake anomalies, and those climate cycles are a result of Saturn's asymmetric orbit. The current tilt of Titan's axis and Saturn's elliptical orbit make southern summers shorter and more intense than northern ones. This leads to a hydrologic imbalance between the two hemispheres where significant cycles of evaporation and precipitation are enhanced in the north. These cycles may last tens of thousands of years, but when Saturn's orbit changes and puts the northern hemisphere closer to the sun during its summer, that distribution will flip-flop.

Rosaly Lopes, a volcanologist at NASA's Jet Propulsion Laboratory in Pasadena, Calif., who works on the Cassini mission but is not affiliated with this study, calls the hypothesis "the best explanation we have at the moment" for Titan's lopsided distribution of lakes. She says none of the previous explanations for the distribution, such as topographic differences or seasonal variations due to methane evaporation and condensation, "seemed very good. This idea is really quite nice."

There are still a number of unanswered questions, however, such as why there are few empty lakebeds in the southern hemisphere, something researchers would expect to find if these cycles have been occurring, Lopes says. Such lakebeds may be hidden from Cassini's radar because of erosion and deposition, Aharonson says. Other unanswered questions are how quickly the imbalance in lake distribution reverses and whether methane and ethane respond differently to the seasonal changes.

Aharonson and his team are also hoping that further research will allow them to better understand the effects of Titan's seasons on its hydrologic cycle and specifically on methane transport between the hemispheres. Lake levels appear to drop in the summer — as much as one to one and a half meters — as methane evaporates and precipitates in the cooler hemisphere.

For now, Aharonson is just excited at the possibility that they have identified orbital climate forcing on another body. "External forcing is potentially not unique to Earth," he says, and in this, he sees "a bigger picture of our place in the solar system."

Sam Lemonick