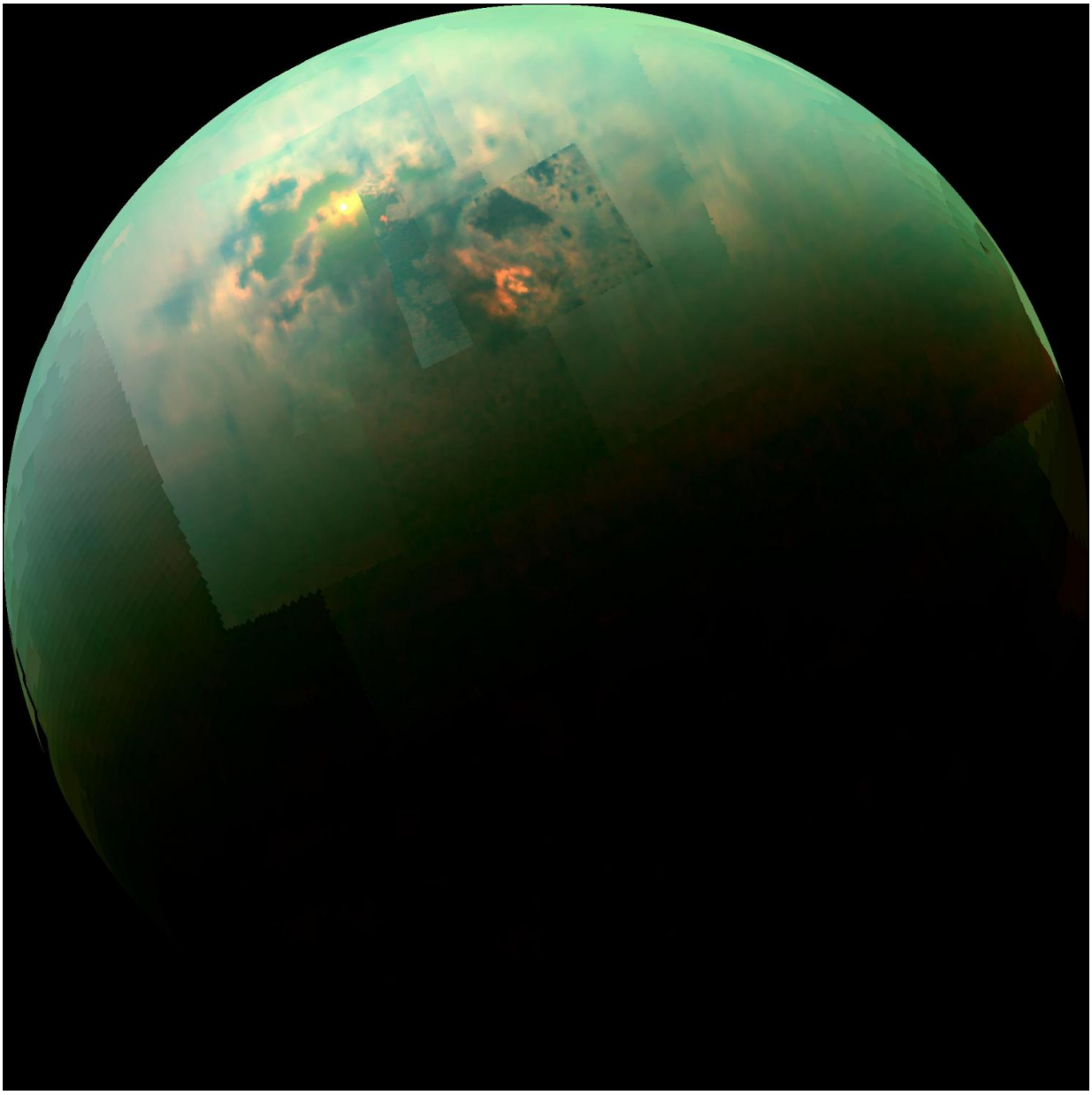
Cassini explores a methane sea on Titan

April 26 2016, by Preston Dyches



Sunlight glints off of Titan's northern seas this near-infrared, color mosaic from

NASA's Cassini spacecraft. Credit: NASA/JPL/Univ. Arizona/Univ. Idaho

Of the hundreds of moons in our solar system, Titan is the only one with a dense atmosphere and large liquid reservoirs on its surface, making it in some ways more like a terrestrial planet.

Both Earth and Titan have nitrogen-dominated atmospheres—over 95 percent nitrogen in Titan's case. However, unlike Earth, Titan has very little oxygen; the rest of the atmosphere is mostly methane and trace amounts of other gases, including ethane. And at the frigid temperatures found at Saturn's great distance from the sun, the methane and ethane can exist on the surface in liquid form.

For this reason, scientists had long speculated about the possible existence of hydrocarbon lakes and seas on Titan, and data from the NASA/ESA Cassini-Huygens mission does not disappoint. Since arriving in the Saturn system in 2004, the Cassini spacecraft has revealed that more than 620,000 square miles (1.6 million square kilometers) of Titan's surface—almost two percent of the total—are covered in liquid.

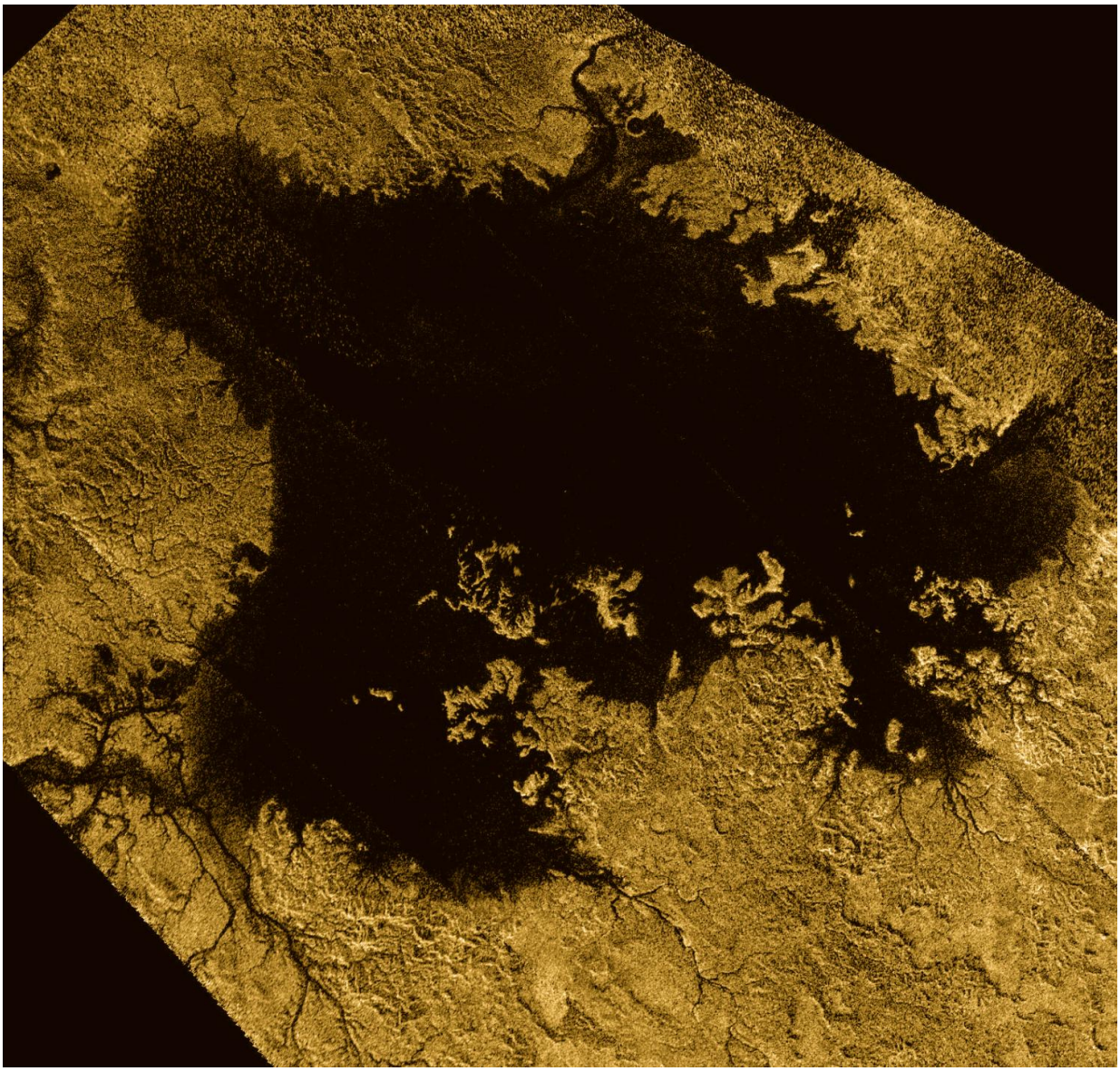
There are three large seas, all located close to the moon's north pole, surrounded by numerous of smaller lakes in the northern hemisphere. Just one large lake has been found in the southern hemisphere.

The exact composition of these liquid reservoirs remained elusive until 2014, when the Cassini radar instrument was first used to show that Ligeia Mare, the second largest sea on Titan and similar in size to Lake Huron and Lake Michigan combined, is methane-rich. A new study published in the *Journal of Geophysical Research*: Planets, which used the radar instrument in a different mode, independently confirms this result.

"Before Cassini, we expected to find that Ligeia Mare would be mostly made up of ethane, which is produced in abundance in the atmosphere when sunlight breaks methane molecules apart. Instead, this sea is predominantly made of pure methane," said Alice Le Gall, a Cassini radar team associate at the French research laboratory LATMOS, Paris, and lead author of the new study.

The new study is based on data collected with Cassini's radar instrument during flybys of Titan between 2007 and 2015.

A number of possible explanations could account for the sea's methane composition, according to Le Gall. "Either Ligeia Mare is replenished by fresh methane rainfall, or something is removing ethane from it. It is possible that the ethane ends up in the undersea crust, or that it somehow flows into the adjacent sea, Kraken Mare, but that will require further investigation."



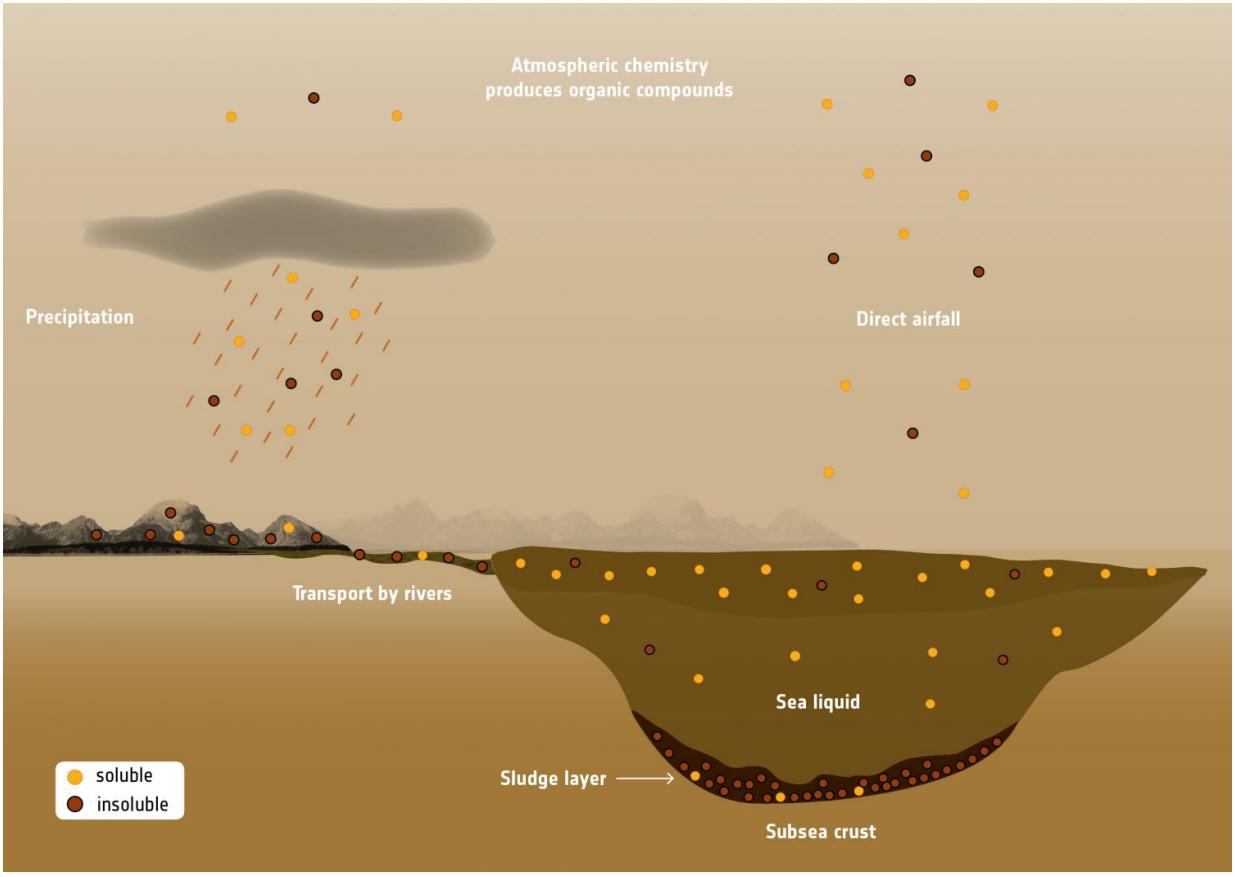
Ligiea Mare is the second largest body of liquid on Saturn's moon Titan. Credit: NASA/JPL-Caltech/ASI/Cornell

In their research, the scientists combined several radar observations of heat given off by Ligeia Mare. They also used data from a 2013 experiment that bounced radio signals off Ligeia. The results of that experiment were presented in a 2014 paper led by radar team associate

Marco Mastrogiuseppe at Cornell University, Ithaca, New York, who also contributed to the current study.

During the 2013 experiment, the radar instrument detected echoes from the seafloor and inferred the depth of Ligeia Mare along Cassini's track over Ligeia Mare—the first-ever detection of the bottom of an extraterrestrial sea. The scientists were surprised to find depths in the sea as great as 525 feet (160 meters) at the deepest point along the radar track.

Le Gall and her colleagues used the depth-sounding information to separate the contributions made to the sea's observed temperature by the liquid sea and the seabed, which provided insights into their respective compositions.



This labeled graphic illustrates how different organic compounds make their way to the seas and lakes on Titan, the largest moon of Saturn. Credit: ESA

"We found that the seabed of Ligeia Mare is likely covered by a sludge layer of organic-rich compounds," adds Le Gall.

In the atmosphere of Titan, nitrogen and methane react to produce a wide variety of organic materials. Scientists believe the heaviest materials fall to the surface. Le Gall and colleagues think that when these compounds reach the sea, either by directly falling from the air, via rain or through Titan's rivers, some are dissolved in the liquid methane. The insoluble compounds, such as nitriles and benzene, sink to the sea floor.

The study also found that the shoreline around Ligeia Mare may be porous and flooded with liquid hydrocarbons. The data span a period running from local winter to spring, and the scientists expected that—like the seaside on Earth—the surrounding solid terrains would warm more rapidly than the sea.

However, Cassini's measurements did not show any significant difference between the sea's temperature and that of the shore over this period. This suggests that the terrains surrounding the lakes and seas are wet with liquid hydrocarbons, which would make them warm up and cool down much like the sea itself.

"It's a marvelous feat of exploration that we're doing extraterrestrial oceanography on an alien moon," said Steve Wall, deputy lead of the Cassini radar team at NASA's Jet Propulsion Laboratory in Pasadena,

California. "Titan just won't stop surprising us."

The Cassini-Huygens mission is a cooperative project of NASA, ESA (European Space Agency) and the Italian Space Agency. JPL, a division of the California Institute of Technology in Pasadena, manages the mission for NASA's Science Mission Directorate in Washington. The radar instrument was built by JPL and the Italian Space Agency, working with team members from the US and several European countries.

More information: A. Le Gall et al. Composition, seasonal change, and bathymetry of Ligeia Mare, Titan, derived from its microwave thermal emission, *Journal of Geophysical Research: Planets* (2016). DOI: 10.1002/2015JE004920 , dx.doi.org/10.1002/2015JE004920

Marco Mastrogiuseppe et al. The bathymetry of a Titan sea, *Geophysical Research Letters* (2014). DOI: 10.1002/2013GL058618 , dx.doi.org/10.1002/2013GL058618

Provided by NASA