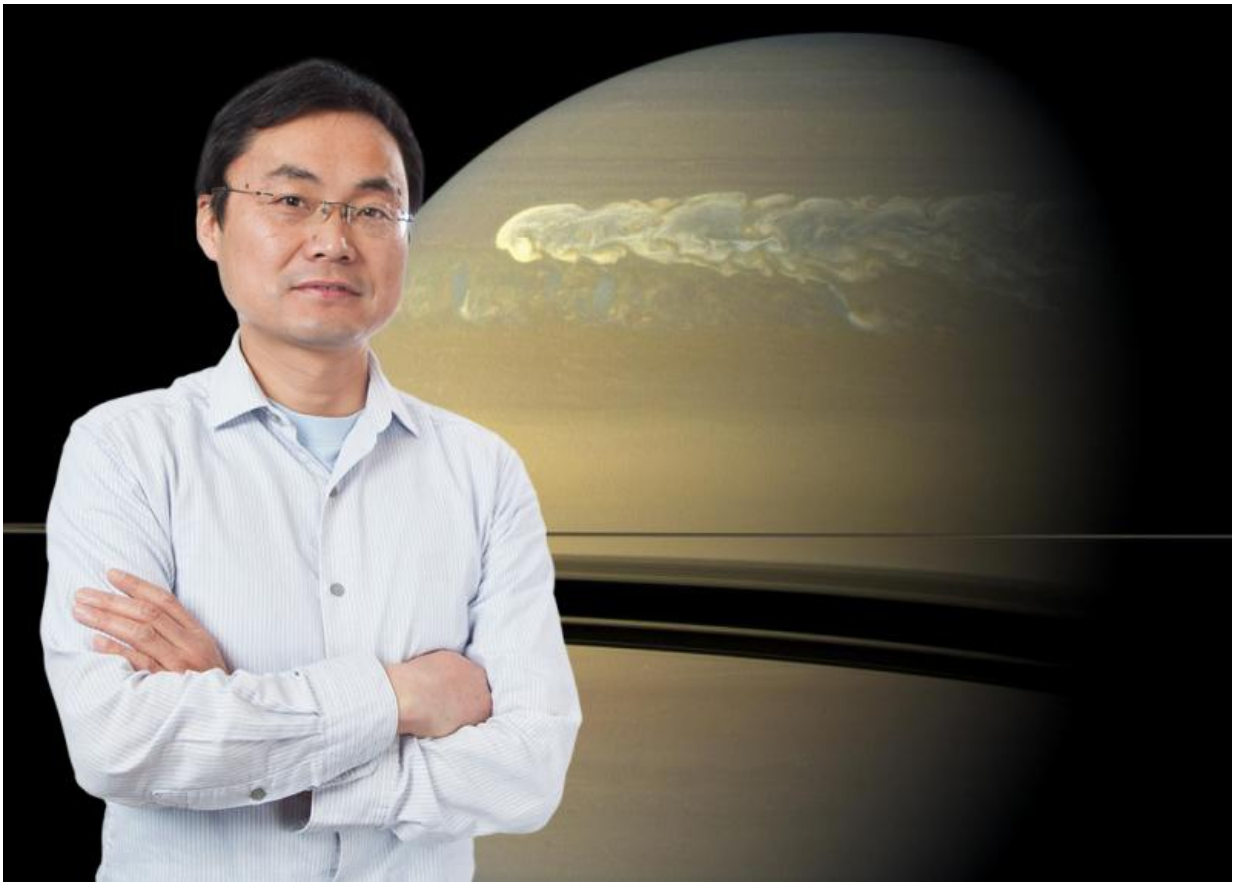
Climate of Jupiter and Saturn may yield clues to Earth's weather

February 24 2016



Turning his interest in meteorology toward planetary science, University of Houston physics professor Liming Li is analyzing data collected from Jupiter, Saturn and Saturn's largest moon, Titan, to find clues about Earth's past and future weather. Credit: Chris Watts

What can the climates of other planets tell us about the Earth's weather? According to a researcher at the University of Houston, data being collected from Jupiter, Saturn and Saturn's largest moon, Titan, can offer clues to the Earth's past and future atmospheric conditions.

Liming Li, an assistant professor of physics in the UH College of Natural Sciences and Mathematics, is leading a team of scientists from NASA's Jet Propulsion Laboratory and the University of Wisconsin-Madison to analyze data collected by instruments on board the Cassini spacecraft, which is on a mission to explore Saturn's systems. Through two new projects awarded by NASA's Planetary Science Division and funded for $709,000, Li and his team have the opportunity to study data collected aboard Cassini as it relates to climate. An international mission, Cassini is supported by NASA, the European Space Agency and the Italian Space Agency.

The Cassini-Huygens unmanned spacecraft launched aboard a rocket in 1997. Once deployed on its mission, it passed Jupiter and gathered data from it in 2000 and 2001. The craft, which included the Cassini orbiter and Huygens lander, reached Saturn in 2004. The Huygens landed on Titan in January 2005.

With 12 data-gathering instruments aboard Cassini, scientists have access to an unprecedented amount of data. The primary mission, scheduled to end in 2008, was so successful that NASA extended it several times. It is now slated to end in late 2017.

"The Saturn year is roughly 30 Earth years, so you need long-term observations to learn about the seasons. Fortunately, Cassini is a long-term mission, gathering data for more than 10 years," Li said. "Every year, every day, we are getting beautiful data from the spacecraft. For the first time, we will be able to learn about the seasonal changes of Saturn."

Li, who began his career in meteorology in China, concerned himself with weather conditions on Earth. When he came to the U.S. for his Ph.D., he turned his interests to planetary science, studying meteorology on other planets. In recent years, he has been actively involved in ongoing space missions exploring the giant planets in our solar system.

"The weather is so different among the various planets," Li said. "By studying the weather systems on planets, we can get a wide perspective for how the climate changes on Earth."

According to Li, since Earth and Saturn have roughly the same rotational angle, it would follow that they have similar seasonal changes. Before this mission, however, they didn't have the data. For an atmospheric scientist, seasonal change is an important topic. It offers the opportunity to look at climate change in a short-term scale. With data from 2004 to 2017, the Cassini observations will cover half a Saturn year providing data from two to three seasons.

"Saturn's atmospheric systems differ with the seasons," Li said. "For example, in spring and summer there are giant storms. Through Cassini, we observed probably the biggest storm in our solar system. It was 100,000 kilometers wide, which is more than 62,000 miles. That is much bigger than a storm on Earth and, actually, bigger than Earth."

Li and his team also are calculating the energy budget for Jupiter, Saturn and Titan, as it impacts understanding of planetary climate and evolution. The energy budget accounts for how much energy comes into a planet's climate system from the Sun and how much is emitted.

"On Earth, the incoming energy is about the same as the outgoing energy. That means the temperature doesn't change dramatically, even with greenhouse effects," he said. "Saturn and Jupiter are emitting more energy than absorbed, so they are generating some type of internal heat.

Earth and Titan are similar, with no significant internal heat."

Knowing whether the energy budget is balanced or imbalanced and how the energy budget changes with time, Li says, is important for understanding climate change and the evolution of a planet.

"Scientists think Titan's atmosphere is like the ancient atmosphere on Earth," he said. "By studying Titan's atmosphere, we can learn what has happened in the past to Earth's atmosphere."

Of the 12 instruments aboard Cassini, Li's group is analyzing data from three of them.

The Composite Infrared Spectrometer provides information about the chemical component of the planet's spectrum. From this data, they can determine the temperature.

With Cassini's Imaging Science Subsystem, the researchers have access to images of the planet at different visible wavelengths. The system's two cameras provide a narrow-angle, high-resolution view of a fixed area and a wide-angle, low-resolution image of larger areas. The wide-angle images help them identify interesting areas that can be studied using the higher-resolution images.

The third instrument, the Visible and Infrared Mapping Spectrometer, includes a camera and a spectrometer, providing real-time temperature and a visual at the same time. While the spectral resolution of the spectrometer isn't good, Li says if they see something interesting, then they can access images of that area taken by the camera.

"Through this data analysis, we hope to learn more about the processes operating in the atmospheres of giant planets and their natural satellites," Li said. "By studying other planets in different stages of their life, we

can learn about the past and future of our Earth."

In addition to the project team, a postdoctoral fellow and several students are involved with this research project. Participating from the Department of Physics are Li's postdoctoral fellow Daniel Liang, graduate students Yefeng Pan and Aaron Studwell, and undergraduate Joseph Hernandez. Contributing from the Department of Earth and Atmospheric Sciences is graduate student Justin Trammel.

Provided by University of Houston