UC Berkeley selected to build NASA's next space weather satellite

April 17 2013, by Robert Sanders

This picture of Earth and the ionosphere, taken with a handheld camera by an astronaut on the International Space Station, shows a bright red wall of plasma near the equator. The ICON satellite will image this glowing plasma in order to connect Earth storms to ionospheric storms and better predict space weather. Though the glowing plasma looks like the aurora, it's much higher in altitude.Credit: NASA.

(Phys.org) —NASA has awarded the University of California, Berkeley, up to $200 million to build a satellite to determine how Earth's weather affects weather at the edge of space, in hopes of improving forecasts of extreme "space weather" that can disrupt global positioning satellites (GPS) and radio communications.

The satellite mission, called the Ionospheric Connection Explorer (ICON), will be designed, built and operated by scientists at UC Berkeley's Space Sciences Laboratory. Scheduled for launch in 2017, ICON will orbit 550 kilometers (345 miles) above Earth in the ionosphere: the edge of space where the sun ionizes the air to create constantly shifting streams and sheets of charged particles. These charged particles can interfere with GPS signals and radio signals that travel through and bounce off the ionosphere.

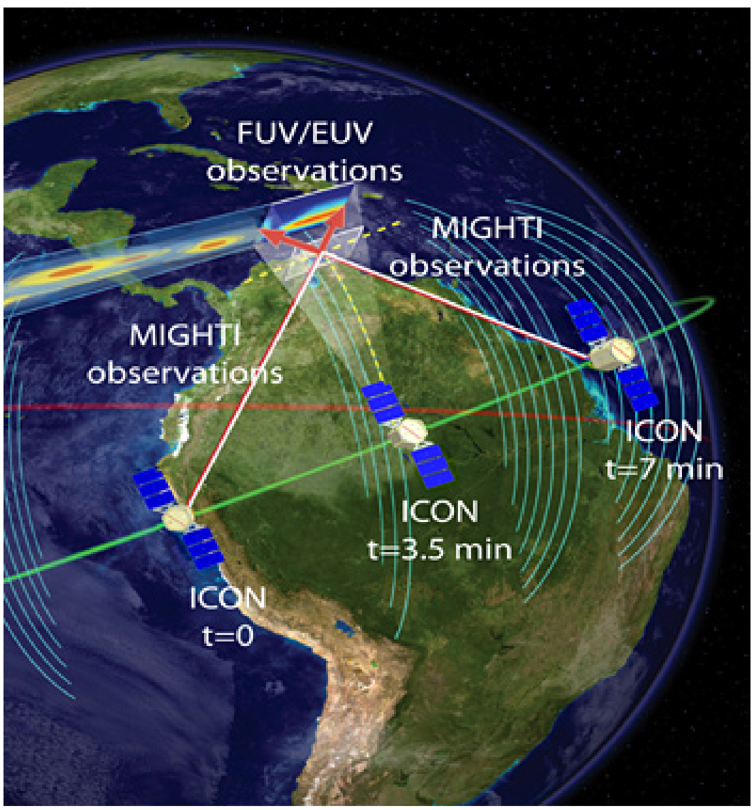
ICON will collect data needed to establish the connection between storms that occur near Earth's surface and space-weather storms, allowing scientists to better predict space weather. These results could help airliners, for example, which today cannot rely solely on GPS satellites to fly and land because signals from these satellites can be distorted by charged-particle storms in the ionosphere.

"Ten years ago, we had no idea that the ionosphere was affected and structured by storms in the lower atmosphere," said the project's principal investigator, Thomas Immel, a senior fellow at the Space Sciences Laboratory. "We proposed ICON in response to this new realization."

NASA announced the award last week, along with another mission called the Global-scale Observations of the Limb and Disk (GOLD), which will image Earth's thermosphere and ionosphere from a commercial geosynchronous satellite.

"One of the frontier areas of heliophysics is the study of the interface between outer space and the upper reaches of Earth's atmosphere," said John Grunsfeld, NASA associate administrator for science at NASA Headquarters in Washington, D.C. "These selected projects use innovative solutions to advance our knowledge of this relatively unexplored region. The two missions together will result in significantly more advances in our understanding of Earth's atmosphere and ionosphere than either would alone."

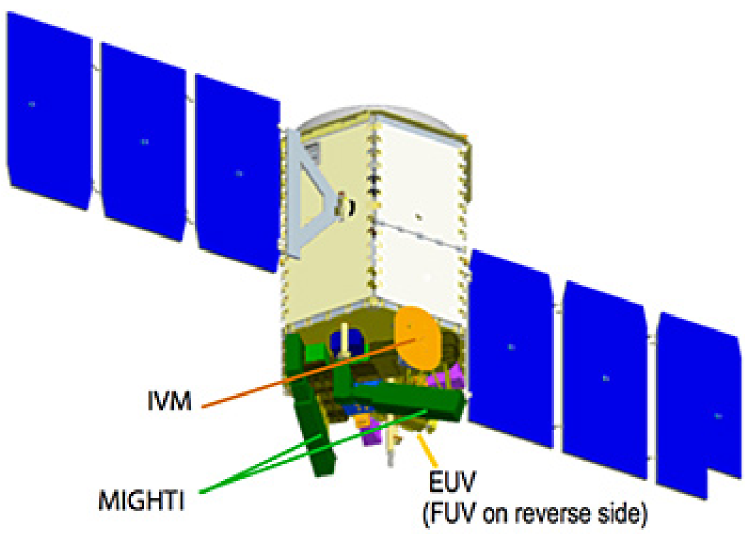
Until recently, Immel said, the ionosphere was thought to be affected primarily by the solar wind, which consists of charged particles emitted from the sun. When the sun is active and firing bursts of charged particles toward Earth, the ionosphere erupts in chaotic storms. But a slew of satellites orbiting Earth to study the sun, solar wind and Earth's magnetic field have now shown that Earth's space environment, specifically activity in the ionosphere, can't be explained solely by particles streaming from the sun.



The ICON satellite will orbit Earth at a 27 degree angle to the equator, pointing its MIGHTI imager and far and extreme ultraviolet sensors at ionospheric storms as on-board instruments measure the flow of charged-particles (guided by the arched magnetic field shown with blue lines) at the position of the satellite.

"We know that the solar wind plays a big role in the ionosphere, but most of the time the sun is relatively quiet, and our space environment still varies quite a bit," he said. "We think that variability is coming from weather on our own planet, which can be very powerful."

This can happen, Immel said, when surface storms compress and heat the atmosphere, driving huge waves upward into space and causing charged particles to move across magnetic fields in unpredictable ways. This can also lead to extreme fluctuations of temperature in the ionosphere.



The ICON spacecraft, with blue solar panels and limb-pointing instruments to measure winds in the thermosphere (MIGHTI), far and extreme ultraviolet emissions (FUV and EUV) from the ionosphere and the in situ ion velocity meter (IVM).

"There are huge waves at an altitude above 100 kilometers (63 miles), with amplitudes as large as 50 degrees Kelvin, where the average temperature is about 300 degrees Kelvin (77 degrees Fahrenheit) – a 20-30 percent variation," he said. "That may sound small, but imagine a wave rolling through your neighborhood with a temperature swing of 100 degrees Kelvin, or 180 degrees Fahrenheit – from freezing to boiling! These waves can change the composition of the upper atmosphere and how the ionosphere grows during the day."

ICON will explore these and other processes that control the dynamics and chemistry of the upper atmosphere and ionosphere. One question, for example, is why "North America is, in a way, like tornado alley for space storms," Immel said, where huge masses of ionized plasma roll over the country and disrupt GPS and other communications.

"We want to understand where this plasma comes from – Is it generated in situ? Does it grow in outer space? Or are we pulling plasma up from lower latitudes like the Caribbean?" he said.

The satellite will operate in a circular orbit tilted 27 degrees from the equator and simultaneously map winds in the upper atmosphere and charged particle currents, called plasmas, in the ionosphere, a region that stretches from an altitude of about 85 to 600 kilometers (50 to 370 miles).

The instrument called MIGHTI (Michelson Interferometer for Global High-resolution Thermospheric Imaging), which will be built by scientists at the Naval Research Laboratory, will detect the aurora-like glow of air molecules and measure their temperature and speed via Doppler imaging. These winds routinely blow at 200 miles per hour in a part of the upper atmosphere called the thermosphere.

Two other instruments built at UC Berkeley's Space Sciences Laboratory will simultaneously image the upper atmosphere in the far and extreme ultraviolet, while a fourth instrument from the University of Texas, Dallas, will measure the charged particles and flowing plasma at the location of the satellite.

"ICON's imaging capability, combined with its in situ measurements on the same spacecraft, gives a perspective of the coupled system that would otherwise require two or more orbiting observatories," he said.

UC Berkeley will control the spacecraft from its Mission Operations Center at the Space Sciences Laboratory, which currently operates the satellite missions THEMIS, ARTEMIS, RHESSI and NuSTAR, all NASA Explorer missions, and recently operated the FAST Explorer.

NASA is funding ICON through the Explorer program, the agency's oldest continuous program, designed to provide frequent, low-cost access to space for principal investigator-led space science investigations relevant to the heliophysics and astrophysics programs in NASA's Science Mission Directorate in Washington.

More information: icon.ssl.berkeley.edu/

Provided by University of California - Berkeley