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NASA's IceCube no longer on ice

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Typically found at heights greater than 20,000 feet, cirrus clouds are composed of ice crystals, which IceCube will measure as the Science Mission Directorate's first Earth-1 CubeSat mission. Credit: NOAA Photo Library

NASA's Science Mission Directorate (SMD) has chosen a team at

NASA's Goddard Space Flight Center in Greenbelt, Maryland, to build its first Earth science-related CubeSat mission.

The tiny payload, known as IceCube or Earth-1, will demonstrate and validate a new 874-gigahertz submillimeter-wave receiver that could help advance scientists' understanding of ice clouds and their role in climate change.

MD also selected five heliophysics-related missions, two involving Goddard scientists who will serve as co-investigators responsible primarily for data analysis and instrument design. All will fly on a three-unit or 3U CubeSat, which is comprised of individual units each about four inches on a side. Each satellite will weigh about three pounds.

For the IceCube team, led by Principal Investigator Dong Wu, the news was sweet.

"Needless to say, we were thrilled when we got the news that the directorate had chosen it as its first Earth-1 CubeSat," said Jeff Piepmeier, associate head of Goddard's Microwave Instruments and Technology Branch. "I really think it's an important opportunity."

Qualifying COTS Receiver

As the sole Earth science CubeSat mission selected by SMD, IceCube will demonstrate and space-qualify a commercially available 874-gigahertz submillimeter-wave receiver developed by Virginia Diodes Inc. (VDI), of Charlottesville, Virginia, under a NASA Small Business Innovative Research contract. Ultimately, the team wants to infuse this receiver into an ice-cloud imaging radiometer for NASA's proposed Aerosol-Cloud-Ecosystems (ACE) mission.

IceCube will lead to the development of an instrument capable of providing an accurate daily assessment of the global distribution of atmospheric ice. Knowing this distribution will help scientists describe the linkage between the hydrologic and energy cycles in the climate system. Ice clouds ultimately are a product of precipitating cloud systems and dramatically affect Earth's emission of infrared energy into space and its reflection and absorption of the sun's energy. To this day, the amount of atmospheric ice on a global scale remains highly uncertain.

The key is obtaining measurements over a broader frequency band, from the infrared to submillimeter wavelengths, IceCube team members said. Submillimeter wavelength coverage fills the data gap in the middle and upper troposphere where ice clouds are often too opaque for infrared and visible sensors to penetrate. Microwave wavelengths are not sensitive to ice.

Although NASA has flown submillimeter receivers in airborne missions—a capability that was non-existent just a decade ago before VDI began advancing its 874-gigahertz receiver—it has not flown them in space.

"What we want to do is modify this receiver to fly in space and raise its technology-readiness level for deployment on a satellite," said Goddard scientist Paul Racette, a member of Goddard's IceCube team. Although the technology itself has proven its mettle in aircraft, challenges remain.

"The receiver technology is very challenging," Racette added. "The team must make sure the receiver is sensitive enough to detect and measure ice clouds using little power from a very small platform. This project will help us develop the processes required to space-qualify commercial-off-the-shelf components," he said.

IceCube will be managed and co-funded by NASA's Earth Science

Technology Office (ESTO), which has an existing stable of CubeSat projects under development and already in-orbit. IceCube will be the eighth Earth science technology validation effort to use the CubeSat platform.

Goddard Heliophysicists Play Role

IceCube, however, wasn't the only winning proposal involving Goddard scientists and engineers.

Co-Investigator Eric Christian is serving as the Goddard lead on the CubeSat Mission to Study Solar Particles over the Earth's Poles (CuSPP), led by the Southwest Research Institute in San Antonio, Texas. With an innovative miniaturized sensor, the mission will study the sources and mechanisms that accelerate solar and interplanetary particles in near-Earth orbit. It also will examine ion precipitation emanating from the magnetosphere into the high-latitude ionosphere.

Under the other heliophysics-related CubeSat mission, Goddard scientist Phil Chamberlin will analyze data collected by the Miniature X-ray Solar Spectrometer (MinXSS), a mission led by the University of Colorado in Boulder. The objective is to better understand the energy distribution of soft X-rays emitted by solar flares and discovering how they affect Earth's ionosphere, thermosphere and mesosphere.

"Right now, we don't know their distribution," Chamberlin said, adding that solar-flare events adversely affect satellites and other assets in low-Earth orbit. "This will be the first time we've accurately measured the distribution of soft X-rays."

Provided by NASA's Goddard Space Flight Center