The future of CubeSats

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Todd Bonalsky holds the solar panel that will power the Dellingr satellite. Credit: NASA/Kristen Basham

(Phys.org) —To investigate climate change, scientists and engineers at NASA's Goddard Space Flight Center are developing the IceCube satellite, which will be no larger than a loaf of bread. In 2016, this satellite will mature technology that scientists will use to analyze cloud ice in the atmosphere.

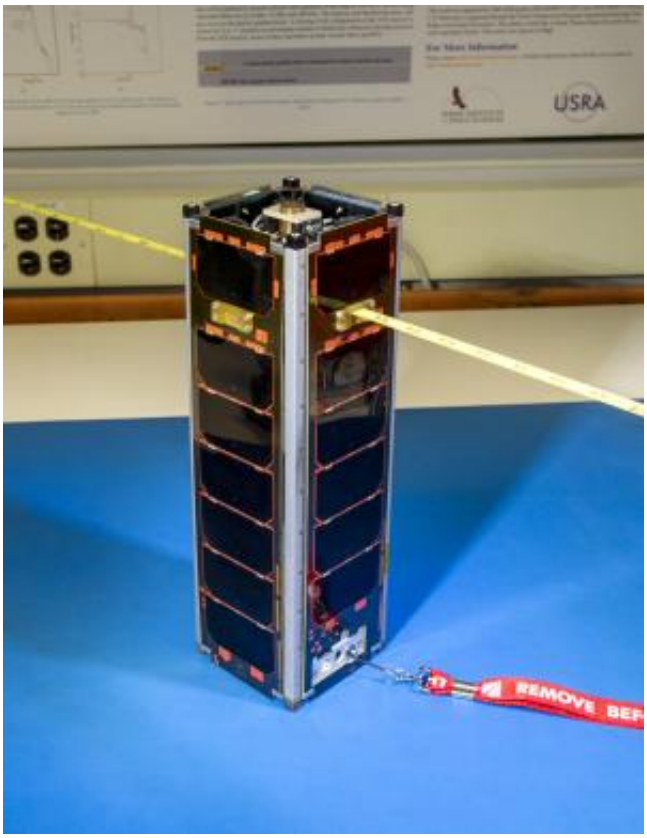
"We're using IceCube to test a radiometer that we want to fly on a big

space mission," said Jeffrey Piepmeier, associate head of Goddard's Microwave Instruments and Technology Branch. "Climate scientists have never used this frequency to measure cloud ice from space before."

The project highlights a growing trend toward testing instruments and running scientific experiments aboard CubeSats. "Every pound that you send into space costs a phenomenal amount of money," said Todd Bonalsky, an electrical engineer at Goddard. "Hence in the investment in CubeSats, which are tiny, complete satellites that are cheaper and easier to build than their larger counterparts."

Bonalsky's Dellingr CubeSat is slated to launch in March 2015. Employing a magnetometer system Bonalsky miniaturized for CubeSat use, Dellingr will measure magnetic fluctuations to help scientists better understand how space weather affects Earth. Dellingr will be the first CubeSat to fly this type of science grade magnetometer system.

Scientists however face a number of challenges when working on CubeSats. Due to their size, CubeSats cannot power many of NASA's formidable scientific instruments, and there are limits to what can be miniaturized. The Hubble Space Telescope for example uses a mirror nearly eight feet wide to capture light and translate it into images that a smaller mirror could not produce.

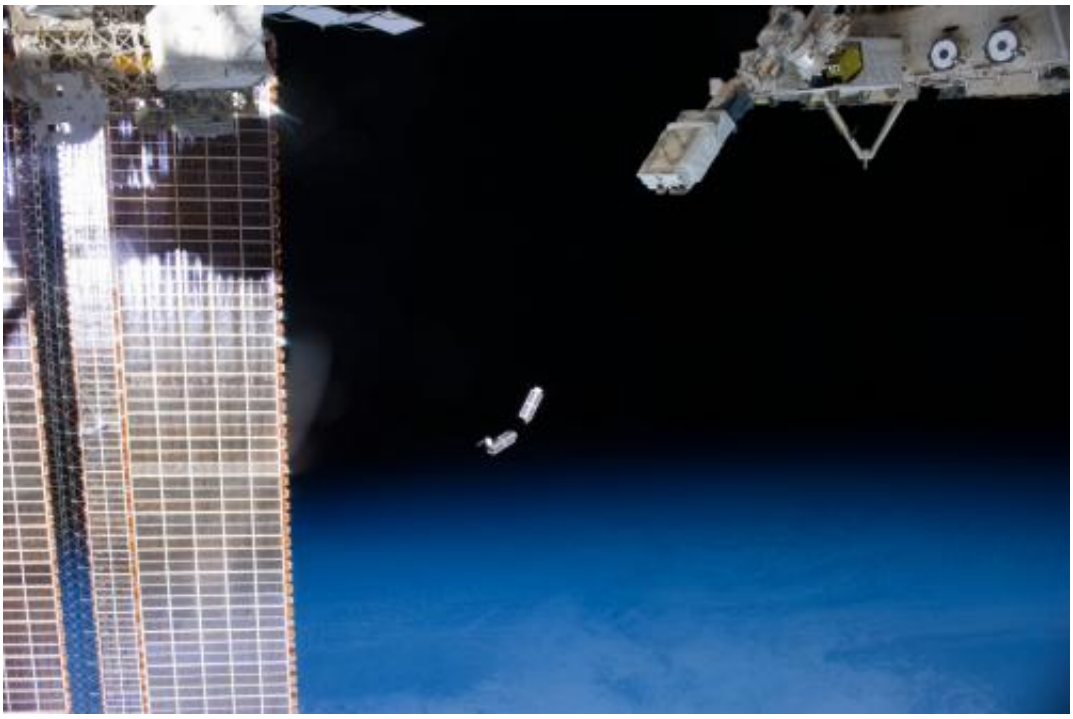


Three cans of soda would fill the Firefly CubeSat to the brim. But don't let its size fool you—NASA has big plans for these tiny satellites. Credit: NASA/Bill Hrybyk

Doug Rowland, a solar scientist at NASA, faced this dilemma when gathering data from his Firefly CubeSat. He built it to investigate the correlation between lightning and gamma radiation, but his CubeSat can only download 20 milliseconds slots of data to Earth each day. "The Firefly just doesn't have enough electrical power to simultaneously run its GPS receiver, its communications antenna and our experiment at the same time," Rowland said. "On a big spacecraft, you'd have a thousand times as much data, at least, and you'd have other ways to transmit the data down to Earth."

Despite such drawbacks, the size and cost of CubeSats open up new strategies for scientific investigations. In conventional missions, every component must function exactly as designed, but, depending on the mission, a single CubeSat is expendable.

"Instead of pouring money into one big satellite, we try to make a swarm," said Robert Clayton, a Goddard intern from Dartmouth College. "It's okay if we lose two or three from our swarm of 20. We instead focus on making each CubeSat as cheap and reproducible as possible."



At about a foot in length and four inches wide, these three-unit (3U) CubeSats are similar in design to IceCube. Credit: NASA

CubeSats can thus slash a scientific mission's budget and allow scientists to measure multiple data points that would be unobtainable otherwise.

Using multiple spacecraft for a single mission is by no means a novel concept. The Solar Terrestrial Relations Observatory for example is a pair of nearly identical observatories that trace solar matter as it flows from the sun. However losing one of these expensive observatories would spell catastrophe for the mission, as opposed to losing one CubeSat in a swarm.

Advances in the mobile phone industry opened the door for smaller solar panels and more efficient batteries. NASA develops such technology both to advance methods of cost-effective data collection and to test technology that will lead to larger missions down the road. Pioneering CubeSat missions may open new doors in the future of space exploration.

Provided by NASA