Remotely operated aircraft successfully tested as tool for measuring changes in polar ice sheets

April 2 2014, by Peter West

The UAS lands in Antarctica. Credit: University of Kansas

(Phys.org) —Scientists studying the behavior of the world's ice sheets—and the future implications of ice sheet behavior for global sea-level rise—may soon have a new airborne tool that will allow radar measurements that previously would have been prohibitively expensive or difficult to carry out with manned aircraft.

In a paper published in the March/ April edition of *IEEE Geoscience and Remote Sensing Magazine*, researchers at the Center for Remote Sensing of Ice Sheets (CReSIS) at the University of Kansas noted that they have successfully tested the use of a compact radar system integrated on a small, lightweight Unmanned Aircraft System (UAS) to look through the ice and map the topography underlying rapidly moving glaciers.

"We're excited by the performance we saw from our radar and UAS during the field campaign. The results of this effort are significant, in that the miniaturized radar integrated into a UAS promises to make this technology more broadly accessible to the research community," said Rick Hale, associate professor of aerospace engineering and associate director of technology for CReSIS.

With support from the National Science Foundation's Division of Polar Programs and the State of Kansas, the CReSIS team recently successfully tested the UAS at a field camp in West Antarctica.

The measurements were the first-ever successful sounding of glacial ice with a UAS-based radar. If further tests in the Arctic prove as successful, the UAS could eventually be routinely deployed to measure rapidly changing areas of the Greenland and Antarctic ice sheets.

The use of unmanned aircraft in Antarctica, which is becoming a subject of wide international interest, is scheduled to be discussed in May at the upcoming Antarctic Treaty Consultative Meeting in Brazil.

The small but agile UAS has a takeoff weight of about 38.5 kilograms (85 pounds) and a range of approximately 100 kilometers (62 miles). The compact radar system weighs only two kilograms, and the antenna is structurally integrated into the wing of the aircraft.

The radar-equipped UAS appears to be an ideal tool for reaching areas that otherwise would be exceptionally difficult to map. The light weight and small size of the vehicle and sensor enable them to be readily transported to remote field locations, and the airborne maneuverability enables the tight flight patterns required for fine scale imaging. The UAS can be used to collect data over flight tracks about five meters apart to allow for more thorough coverage of a given area.

According to Shawn Keshmiri, an assistant professor of aerospace engineering, "a small UAS also uses several orders of magnitude less fuel per hour than the traditional manned aircraft used today for ice sounding."

This advantage is of great benefit, the researchers point out, "in remote locations, such as Antarctica, [where] the cost associated with transporting and caching fuel is very high."

The vast polar ice sheets hold an enormous amount of the Earth's freshwater—so much so that in the unlikely event of a sudden melt, global sea level would rise on the order of 66 meters (216 feet).

Even a fraction of the melt, and the associated sea-level, rise would cause severe problems to people living in more temperate areas of the globe, so scientists and engineers are seeking quicker, less expensive ways to measure and eventually predict exactly what it is that the ice sheets are doing and how their behavior may change in the future.

Until now, the lack of fine-resolution information about the topography underlying fast-flowing glaciers, which contain huge amounts of freshwater and which govern the flow of the interior ice, makes it difficult to model their behavior accurately.

"There is therefore an urgent need to measure the ice thickness of fast-flowing glaciers with fine resolution to determine bed topography and basal conditions," the researchers write. "This information will, in turn, be used to improve ice-sheet models and generate accurate estimates of sea level rise in a warming climate. Without proper representation of these fast-flowing glaciers, advancements in ice-sheet modeling will remain elusive."

With the successful test completed in the Antarctic, the researchers will begin analyzing the data collected during this field season, miniaturizing the radar further and reducing its weight to 1.5 kilograms (3.3 pounds) or less, and increasing the UAS radar transmitting power.

In the coming months, they will also perform additional test flights in Kansas to further evaluate the avionics and flight-control systems, as well as optimize the radar and transmitting systems.

In 2014 or 2015, they plan to deploy the UAS to Greenland to collect data over areas with extremely rough surfaces and fast-flowing glaciers, such as Jakobshavn, which is among the fastest flowing glaciers in the world.

Provided by National Science Foundation