New test of snow's thickness may 'bear' results key to polar climate studies, wildlife habitat

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Aircraft flights are coordinated with ground measurements of the snow and ice properties to validate the aircraft instruments. Credit: J. Maslanik

A NASA-funded expedition to the Arctic to map the thickness of snow has a legion of unexpected furry fans hailing from one of the world's coldest regions: polar bears.

From mid-March to mid-April, researchers embark on an Arctic field experiment using a new airborne radar to determine the accuracy of satellite measurements of snow's thickness atop polar sea ice. Snow thickness is just one of several cutting-edge measurements taken by the Advanced Microwave Scanning Radiometer (AMSR-E) aboard NASA's Aqua satellite.

The ability to accurately measure snow depth will help researchers understand much more about how climate changes in Earth's polar regions. As a bonus, this research will tell wildlife biologists and ecologists about the amount of snow polar bears and other Arctic wildlife have to build their habitats.

Historically, it has been very difficult to measure the thickness of snow on top of the sea ice. "It's not as easy as going into your backyard and sticking a ruler in the snow to measure the snowfall," said Thorsten Markus, a cryospheric scientist at NASA's Goddard Space Flight Center, Greenbelt, Md., and co-principal investigator of the field campaign. "Measuring snow's thickness is something that people have done for many years from ships. Navigating those waters posed dangers to human beings, and did not always garner the most accurate results. In this new age, satellites have the potential to provide the most precise measurements of snow depth ever."

Prasad Gogineni, an engineer from the University of Kansas, Lawrence, developed the new ultra wide-band snow radar, a system that can now measure snow thickness from an airplane. These airborne measurements will confirm, or validate, data taken by the satellite. The new radar transmits a pulse that penetrates the snow on top of the sea ice. It then measures the return time for both the reflection from the top of the snow blanket and from the bottom where the snow touches the ice. The difference in reflection times is converted to a snow depth.

The blanket of snow that covers Arctic sea ice plays an important role in the region's climate by slowing the flow of heat from ocean waters to the air. Polar sea ice is an insulator between the warm ocean and the very cold atmosphere. Snow acts like a heavy blanket on top of the sea ice, providing a thicker, added layer of insulation between the water and the atmosphere.

A thick insulating blanket of snow can also be vital to polar bears and other Arctic wildlife. Polar bears living in Alaska, Canada, Greenland, Norway, and Russia dig out their dens on snowy slopes to give birth or to shelter their young during blizzards. The temperature under a layer of snow does not usually fall below freezing, so polar bears will also curl up and allow snow to drift around their bodies to form an insulating layer of warmth. The less snowfall on the sea ice the less snow polar bears have to build their dens.

"Officials who manage wildlife are very interested in our measurement capabilities," said Markus. "In addition to polar bears needing a lot of snow to create their dens, polar foxes and sled dogs use the snow for insulation. Field mice and lemmings can remain active throughout the coldest winters, searching for plant food in a network of tunnels under the snow."

AMSR-E measures several important aspects of the Earth critical to global change science and monitoring efforts in addition to snow depth, including precipitation, oceanic water vapor, cloud water, near-surface wind speed, sea surface temperature, soil moisture, and sea ice. This year's Arctic experiment will be the second Alaskan Arctic field campaign to confirm measurements made by AMSR-E.

"Over the last several decades, we've observed significant changes in the Arctic and in particular the decreasing Arctic sea ice cover," said Donald Cavalieri, a Goddard senior research scientist, satellite remote sensing specialist, and lead principal investigator for this year's Arctic field experiment. "We need to continue to monitor these changes and to understand why this is happening because it could have very profound effects on our climate and wildlife."

This project is a collaboration between NASA; the U.S. Army Cold Regions Research and Engineering Lab, Hanover, N.H.; the National Oceanic and Atmospheric Administration's Environmental Technology

Laboratory, Boulder, Colo.; the University of Kansas, Lawrence; The Johns Hopkins University Applied Physics Laboratory, Laurel, Md.; and the University of Colorado at Boulder.

Source: NASA Goddard Space Flight Center