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Early results from NASA's SnowEx campaign

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SnowEx is a multi-year airborne snow campaign with the primary goal of addressing the question: How much water is stored in Earth's terrestrial snow-covered regions? Year 1 (2016-17) focuses on the distribution of snow-water equivalent (SWE) and the snow energy balance in a forested environment. The year 1 primary site is Grand Mesa and the secondary site is the Senator Beck Basin, both in western, Colorado, USA. Ten core sensors on four core aircraft will make observations using a broad suite of airborne sensors including active and passive microwave, and active and passive optical/infrared sensing techniques to determine the sensitivity and accuracy of these potential satellite remote sensing techniques, along with models, to measure snow under a range of forest conditions. SnowEx also includes an extensive range of ground truth measurements—in-situ samples, snow pits, ground based remote sensing measurements, and sophisticated new techniques. A detailed description of the data collected will be given and some early results will be presented.

Seasonal snow cover is the largest single component of the cryosphere in areal extent (covering an average of 46M km2 of Earth's surface (31 % of land areas) each year). This seasonal snow has major societal impacts in the areas of water resources, natural hazards (floods and droughts), water security, and weather and climate. The only practical way to estimate the quantity of snow on a consistent global basis is through satellites. Yet, current space-based techniques underestimate storage of snow water equivalent (SWE) by as much as 50%, and model-based estimates can differ greatly vs. estimates based on remotely-sensed observations. At peak coverage, as much as half of snow-covered terrestrial areas involve forested areas, so quantifying the challenge represented by forests is important to plan any future snow mission.

Single-sensor approaches may work for certain snow types and certain conditions, but not for others. Snow simply varies too much.

Thus, the snow community consensus is that a multi-sensor approach is needed to adequately address global snow, combined with modeling and data assimilation. What remains at issue, then, is how best to combine and use the various sensors in an optimal way. That requires field measurements. NASA's SnowEx airborne campaign is designed to do exactly that.

A list of core sensors is as follows. All are from NASA unless otherwise noted.
• Radar (volume scattering): European Space Agency's SnowSAR, operated by MetaSensing
• Lidar & hyperspectral imager: Airborne Snow Observatory (ASO)
• Passive microwave: Airborne Earth Science Microwave Imaging Radiometer (AESMIR)
• Bi-directional Reflectance Function (BRDF): the Cloud Absorption Radiometer (CAR)
• Thermal Infrared imager
• Thermal infrared non-imager from U. Washington
• Video camera
The ASO suite flew on a King Air, and the other sensors flew on a Navy P-3.

In addition, two NASA radars flew on G-III aircraft to test more experimental retrieval techniques:
• InSAR altimetry: Glacier and Ice Surface Topography Interferometer (GLISTIN-A)
• Radar phase delay: Uninhabited Aerial Vehicle Synthetic Aperture Radar, (UAVSAR)