

SnowEx Year 1 Site Recommendation to NASA HQ/THP

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SnowEx Organizing Team + N.Molotch

Background

The organizing team examined site-specific requirements to fulfill the primary Year 1 SnowEx objective. The primary objective for SnowEx Year 1 is to ascertain and challenge the capability of multiple snow remote sensing techniques to measure snow properties in forested environments. *In-situ* snow measurements will be used to validate results from the airborne instruments. Ground-based remote sensing at a fixed location will provide more temporally-dense measurements and a chance to test newer techniques.

The basic site requirements are: sufficient forest stands with a range of density and height (and other forest conditions); a range of snow depth/SWE conditions; sufficient flat snow-covered terrain of a size comparable to airborne instrument footprints/swath widths in order to simplify analyses; and other requirements related to logistical considerations. It would also be nice to have a site with existing/ongoing snow observations. To ensure that we can get *multi*-sensor measurements, we will also need snow that is intermediate in depth/SWE, and has a low risk of being wet during the winter (wet snow interferes with the microwave-retrieval techniques).

Site information coordinators Noah Molotch and Chris Crawford received and processed information on a wide variety of potential sites and organized the information into a snow site database to support SnowEx Year 1 site selection by the NASA THP program manager, Jared Entin. This database is available at <http://snow.nasa.gov>.

At the most recent NASA iSWGR community workshop which was held in Seattle on March 29-31, 2016, a short list of ‘top 3’ potential sites for SnowEx Year 1 evolved. Three geographic domains that fulfilled SnowEx Year 1 requirements are: western Colorado (multiple specific sites), eastern Sierra Nevada in California (multiple specific sites), and the eastern Canadian Rockies (Canadian Rockies Hydrological Observatory, CRHO). **Western Colorado is our recommendation for Year 1, and the Grand Mesa site in particular best fulfills the basic requirements directly related to the multisensor evaluation with the lowest risk.** Adding some targeted observations at the Senator Beck site (resources permitting) will provide desirable hydrological measurements and allow the community to begin considering complex terrain + forest questions.

NASA HQ also asked the SnowEx organizing team to select an additional, alternate site that fulfilled all of the SnowEx Year 1 requirements in case our primary site fell through. Fairbanks, Alaska, is our recommendation for the alternate site.

Note that the sites shown below, and other sites that have been considered for SnowEx Year 1 may be selected for SnowEx in the out years. All sites have many desirable characteristics for snow research. The ‘risks’ noted are specific to the objectives of Year 1, and will not necessarily carry over to the out years.

Sites that fulfill SnowEx Year 1 requirements:

Western Colorado

The western Colorado domain contains two potential Year 1 sites: Grand Mesa and Senator Beck. **The Grand Mesa site by itself meets all Year 1 site requirements related to multi-sensor evaluations and is our primary recommendation for the Year 1 campaigns.**

However, one characteristic missing is a closed gauged basin for more hydrology-focused studies. Fortunately, the Senator Beck site is relatively close to Grand Mesa, and would provide that, as well as allow the community to begin considering complex terrain + forest questions which might otherwise be postponed to the out years. Therefore, resources permitting, we recommend adding some targeted observations at the Senator Beck site. It is avalanche territory and ground truthers will need to be expert backcountry skiers, but these logistics are manageable. Preliminary estimates suggest the cost/benefit trade is reasonable.

Fairbanks, Alaska area

Given that the 'top 3' SnowEx Year 1 sites are located in high-elevation regions, it was necessary to identify a secondary/alternate site in the event that we are forced to fly at lower altitudes if an unpressurized aircraft is used. **Our recommendation for the alternate site is Fairbanks, Alaska.** The Fairbanks domain contains a suite of at least 4 sites: Bonanza Creek, Caribou Poker Creeks, Nome Creek, and Tanana Flats. The Fairbanks Suite meets all of the Year 1 requirements. Our analysis indicates that the additional cost to carry out the fall and winter campaigns in Alaska is not significant compared to the overall cost of SnowEx. The need to install some of the ground-based instrumentation prior to the onset of snow cover creates an early cutoff date beyond which the alternate site is no longer practical. That date is estimated to be during late September 2016.

Selection of other sites that were considered for SnowEx Year 1:

Eastern Sierra Nevada in California

The eastern Sierra Nevada domain contains one potential Year 1 site which is Mammoth Mountain (with the possibility of Lakes Basin nearby). The Mammoth site meets Year 1 requirements except that the snow is very deep across a large area, beyond the saturation limits of the active and passive microwave techniques. Although weather station observations indicate that wet snow occurrence has been low in February in recent years, the Mammoth site has the highest wet snow likelihood of the iSWGR Seattle workshop's 'top 3' sites. Below 2940 m a rain/snow mix occurs a few times a year.

Eastern Canadian Rockies

The eastern Canadian Rockies domain contains one potential Year 1 site which is the Canadian Research Hydrological Observatory (CRHO). The CRHO site meets Year 1 requirements except

for the availability of sufficient flat terrain. While there is very little wet snow in January – March, there is a small risk of a Chinook warming event leading to wet snow.

Other (re) considered sites:

Fort Montmorency, Quebec

Fort Montmorency has nearly all the desirable Year 1 site characteristics, but the risk of wet snow is significant and certainly higher than for other “complete” sites. Combining this site with the New England region sites in the U.S. would offer a broad range of tree types and characteristics, but wet snow is a risk for those sites as well.

The BERMS Network (formerly BOREAS sites), Saskatchewan

BERMS has nearly all the desirable Year 1 site characteristics, but the suitability of existing/ongoing snow observations are concerns.

University of Michigan Biological Station (UMBS)

UMBS has nearly all the desirable Year 1 site characteristics, but the suitability of existing/ongoing snow observations is a concern. In addition, the site is subject to unexpected melt during some winters, possible lack of adequate snow cover and wet snow.