CSAS Snowpack Profiles Metadata

1) Snow Profile Locations
   a) CSAS performs routine snowpack profiles within undisturbed, physically demarcated snow profile plots located adjacent to the Swamp Angel Study Plot (SASP) and Senator Beck Study Plot (SBSP) instrument arrays.
   b) Both the SASP and SBSP snow profile plots slope approximately 3-4 degrees to the northeast. The ground surface at the sub-alpine SASP consists of gravelly soils with substantial grass and vascular plant cover; no large rocks, logs, bushes, or other significant protrusions above the planar surface are present. The ground surface at SBSP consists of low tundra vegetation; some exposed rock outcrops exist, producing variation in an otherwise generally planar surface.
   c) The very well sheltered SASP plot in general, and the planar snow profile plot in particular, are thought to experience negligible snow redistribution by wind after deposition at the surface, making SASP suitable for conducting a time series of snowpack profiles where spatial variation in snowcover properties is minimized within the snow profile plot at a given point in time.
   d) The SBSP plot is subject to significant wind effects and wind redistribution of snow during and after deposition at the surface, creating significant spatial variation in snowcover properties throughout the snow profile plot at a given moment in time. Terrain surrounding the SBSP snow profile plot is somewhat elevated above the profile plot and generally causes increased wind deposition into the profile plot.
   e) Occasional snow profiles are performed in Senator Beck Basin at other locations. Contact CSAS for specific additional details regarding those locations.

2) Snow Profile Time Series Method (directions are in reference to looking at the snowpit front wall).
   a) In order to maximize efficient utilization of the snow profile plots, and to maximize comparability between sequential snowpack profiles, each seasonal time series of snowpack profiles is begun in the northwestern of both the SASP and SBSP plots. Every snowpit is fully backfilled to minimize lateral snowpack temperature contamination forward, and to the side, (by air temperatures) in the adjoining snowcover.
   b) Following Pit #1, the far right end of next profile is performed moving to the left a distance of at least 1x the current snowpack depth away from the (marked) closest front corner of the prior snowpit. Snowpits are typically 1.5-2.0 m wide at the front face.
   c) When the first row of pits reaches the left edge of the snow profile plot, the rear wall of the next pit is performed at least 2x the current snowpack depth forward of the (marked) front face of the prior snowpit row. That row then moves to the right until reaching the other edge of the plot, then forward to begin another row, moving back left.

3) CSAS Snow Profile Protocols
   a) Routine snow profiles are dug at SASP and SBSP at/near the first of each month in early and mid-winter, then more frequently as desert dust deposition begins in late winter.
   b) Routine snow profiles document the entire snowpack, to the ground.
   c) Snowpack profile observers are noted, by initials, in the upper left corner of each profile.
   d) Measurements are made in metric units.
   e) Height of snow and layer boundaries are measured in the left front corner of the snowpit.
   f) CSAS snowpack profiles are hand drawn in the field, then re-drawn by hand in the office, to ensure capture of detail not easily represented in current snow profile software; CSAS snowpack profile data are not available in digital form.
   g) Snowpack properties documented include:
      (1) Snowpack depth, stratigraphy, grain type and size, layer density(s), layer hand hardness(s), a snow temperature profile at 10 cm intervals beginning at the ground, and snow wetness;
      (2) Dust-in-snow layers (when present) are also sketched and described;
      (3) Snow water equivalence of the full snowpack is measured in the left end wall of the snowpit in a series of slope-normal continuous samples from the snowpack surface to the ground. A slope normal measurement of HS is also made at the point of the SWE profile and mean snowcover density is calculated.
   h) A temperature profile is performed adjacent to the ruler in the left front corner of the snowpit with full surface shading of all measurements from the snow surface down to a depth of at least 30 cm

4) Measurement Tools
   a) Snow density is measured with a Winter Engineering™ Strongstich density cutter and direct-reading scale; resolution is ±10 kg/m^3
   b) Snow water equivalence (SWE) is measured using a Snowmetrics™ brand 30 cm storm board tube in a series of continuous samples from the snow surface to the ground; resolution is ±1-2 mm per sample
   c) Snow temperatures are measured using a digital, "ama-digit, ad 12^{th}" model sensor with and calibrated to 0° C; resolution is ±0.1° C.
   d) Grain types and size are observed with a 16x hand lens.

5) Snow Profile Notations, Symbols
   a) In general, snow grain type and snow properties notations and descriptions follow the conventions established in Snow, Weather, and Avalanches: Observational Guidelines for Avalanche Programs in the United States, published the American Avalanche Association, 2004, and/or the International Classification for Seasonal Snow on the Ground, IHP-VII Technical Documents in Hydrology No. 83, published by UNESCO, 2009.

b) Exceptions or enhancements to those conventions include the following:
   (1) Mixed grains, where faceting and rounding are present on the same grain, regardless of trend, are shown as an open square with an attached, solid black "half-moon" on one side of the square.
   (2) Mixed grains that are beginning to develop bonds between grains are shown using two of the symbols described in (1) above, attached to each other at the solid black "half moon" end of each grain.
   (3) Clustered mixed grains are shown using three of the forms described in (1) above and attached to each other, in the center of the cluster, at the solid black "half moon" end of each grain.
   (4) Intra-layer variations in hand hardness are often graphically represented across a range of hardness values, rather than as a single value representing an entire layer; CSAS utilizes a "two finger" test to discriminate between "one finger" and "four finger" snow.
   (5) Layers containing diffuse dust impurities have a light 'cross-hatching' shown in the hand hardness depiction of the layer, and in the notes for that layer
   (6) The "DOD" column in the CSAS profile form is for noting known "date of deposition" of a layer; in the case of dust layers, this notation often refers to a sequential seasonal dust event number.
   (7) Snow water equivalent (SWE) sample data are shown, at the far right, in mm units.
   (8) Snowpack temperature data are shown at the far left of the profile form.

6) CSAS Snow Profile Limitations and Appropriate Use
   a) CSAS snowpack profiles are performed for research and snowpack monitoring purposes at their respective study plots; a snowpack stability evaluation is not performed.
   b) Snowpack conditions represented in CSAS snowpack profiles are subject to spatial and temporal variability; most profiles are performed on near-level ground surfaces and, therefore, do not capture the effects of increased slope angle or variations in slope aspect that would be observed on adjacent terrain.