

CHARTER Snow Protocol

This protocol is part of the CHARTER project (<http://www.charter-arctic.org/>) lead by the Arctic Centre, Rovaniemi. CHARTER is an international project funded by EU Horizon and it is on-going until 2024. CHARTER combines expertise from Earth System sciences and biodiversity studies within a social-ecological system (SES) framework and with a strong participatory approach involving indigenous and local communities. Snow observations in Fenno-Scandia and Yamal peninsula are part of the project.

Of specific interest are ice layers and rain on snow events which affect animals (digging through snow) and plants. This also includes aspects relevant for herding.

Data from snow profiles is used for the development of snow monitoring using satellite data. The spatial resolution start from 10 m (pixel size) to 12.5 km (radar beam footprint). Results will be used also to evaluate climate models which are used for future scenarios of snow conditions and impacts.

For the measurements you need

- GPS or phone
- Camera or phone with camera
- pencil
- notebook/ CHARTER field log
- measure stick exceeding snow height or stick exceeding snow height and measure tape or ruler
- knife
- spade/shovel
- thermometer (optional)
- If you want to observe the snow density and snow water equivalent, have also a tube that can be used to sample the snow, and a plastic bag with you, and a scale if possible (dimensions of the tube can vary, but e.g. 10cm diameter and 1m height are fine; tube can be metal or plastic for example sewer pipe type; one end of the tube should be covered). It is good to have also thin sheet of metal to slide between the surface of the ground and the rim of the tube to cleanly gather the entire sample of snow.
 - tube
 - plastic bag
 - scale
 - sheet of metal

You can print the CHARTER field log for writing the values in the field or you can use any notebook or paper. After the field trip, measurements and photos should be uploaded to <https://link.webropolsurveys.com/S/40A073BB484C2434>. You may also send your scanned notebook/field log to leena.leppanen@ulapland.fi.

CHARTER field log is available in:

https://drive.google.com/file/d/1MK4hGzJ3QpSOICvp4LfVuaE8PE4G6IK_/view?usp=sharing

Measurements

Snow height measurements can be carried out at a single point, a transect of two points or square of five points (20 m square, each corner and centre). Make 3-4 measurements within a 1 m radius and average.

Ice layers are defined in 1-2 points where snow depth was measured.

For the same 1-2 points, there are also optional advanced measurements with more detailed characterization of snow layers and snow water equivalent.

Measurement area

Make sure that your site is comparably homogenous and at least 100 m away from roads, houses etc.

Measurement notes

General information

Name

Date and time of measurement

Internal ID (optional, defined by you)

Location (free description)

GPS coordinates (any projection)

Use a GPS device to get coordinates. Another option is to use a smartphone: open www.google.com/maps and press the measurement location, it will show coordinates above the map. Use preferably the WGS84 coordinate system (Google Maps uses it automatically) and indicate if you know that you use some other. For example, "67.366, 26.633".

Measured or estimated air temperature

Description of surroundings (you can choose multiple)

Low shrub (< 30 cm) to no shrub tundra

Shrub Tundra (> 30 cm height)

Deciduous transition zone (birch belt)

Mixed forest

Needleleaf forest

Bog/fen/peatland

Bare rock (boulders, outcrop)

Other (free text)

Type of reindeer pasture /Time of the year when the area is used by reindeer (you can choose multiple)

early winter

mid winter

late winter

calving area§ b

spring (other than calving area)

early summer
mid summer
late summer
early autumn
late autumn
other (free text)

Signs of foraging, visible impact on vegetation

Yes/no or you can use following Saami language categories:

Suovdnji: Feeding crater

Fieski: Area where grazing has occurred (slightly to moderately packed snow)

Čiegar: Area where a grazing herd has been for a longer period (moderately to completely packed snow)

Čiegargovvi: Large area where grazing has occurred several times over a long period (completely packed to ice-covered snow)

Estimated percentage of visible trampling or digging signs in 10 m radius from the survey point(s), excluding your own track.

Take overview photo

In addition, write down any comments you have during the measurements.

You can optionally take a photo of your written notes in the end. For example, if you have some additional information or drawn illustration.

Snow height

Snow height measurements can be carried out at a single point, a transect of two points or square of five points (20 m square, each corner and centre).

Measure snow height with a stick from the points. Make 3-4 measurements within a 1 m radius and average.

Point Snow depth (cm)

1
2
3
4
5

Layer structure

Measurements of snow layer structure are made in 1-2 points. Record number of the point where layer structure measurements are made according to previous snow height survey. Record layer information separately for the both points.

Dig a small pit to snowpack with spade/shovel to have a smooth wall with vertical structure of snow (figure 2). Estimate ground type after digging a pit. You can test with shovel is soil or sand frozen or not.

Ground (you can choose multiple)

Lichen, moss, grass

Low shrub (< 30 cm)

Frozen soil or sand

Non-frozen soil or sand

Gravel

Stony terrain

Rock

Water

Ice

Bodneskárta, Bodneviški, Skilži - Ice on the ground encapsulating plants and lichens

Other (free text)

Layers are separated by hardness, wetness and visual appearance (figure 2). Hardness is tested by pushing snow first with fist, then with 4 fingers, 1 finger, pencil and knife blade, until snow is too hard to be pierced. The layer is ice, if the knife blade doesn't penetrate the layer. The test should be made with constant force, which is approximately the same which you can use to push your nose. Videos of hand harness test: <https://youtu.be/D4qm9CiKM6w?t=1102> (IEEE GRSS together with WSL-SLF, Météo France and FMI) and <https://youtu.be/vLFUvYE9nVI?t=131> (American Avalanche Institute).

Term	Hand hardness test	Number
Very soft	Fist	1
Soft	4 fingers	2
Medium	1 finger	3
Hard	Pencil	4
Very hard	Knife blade	5
Ice	Ice	6

Measure at least for ice layers distances (cm) of the top and bottom interface from the ground.

Ice layer Distances of the layer top and bottom from the ground (cm)

1

2

3

....

Advanced: Define for each layer (including ice layers) grain type, hardness, and distances of the layer top and bottom from the ground.

If there are more than 8 layers, write information to any free space of the field log paper.

<u>Layer</u>	<u>Distance of the layer top and bottom from the ground (cm)</u>	<u>Grain type</u>	<u>Hardness</u>
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1

2

3

....

Hardness (1=fist, 2=4 fingers, 3=1 finger, 4=pencil, 5 =knife blade, 6=ice)

Grain type (new snow, rounded grains, depth hoar, ice, crust, polycrystals, wet, slush)

Depth hoar is snow in the bottom part of the snowpack, where grains are large and structure is fragile (figure 3). New snow is newly fallen precipitation at top of snowpack. Rounded grains are older snow. Multiple icy grains are frozen together in polycrystals. Crust layers are formed during melting and refreezing. Snow is wet when you can easily make a snowball. Snow is slush when there is visible water between snow grains. You can choose another grain type if needed, for example “new snow, wet”. More information in “The International classification for seasonal snow on the ground” <https://unesdoc.unesco.org/ark:/48223/pf0000186462> pages 13-20 description and 22-37 photos of snow classification.

Advanced: Take profile photo

Place a scale next to the profile and take a photo (figure 2). You may use a folding ruler or some other object of known size (write down also size of the object).

Advanced: Description of snow conditions in your own language

For example, you can use North Saami language reindeer herding snow categories:

- *Gaskageardni: Crust in the middle of the snowpack*
- *Gaska muohta: Looser snow between layers of Gaskageardni*
- *Gutna guohtun: Ash snow or powder snow*
- *Vacha: New loose snow*
- *Seaŋaš: Granular snow at the base of a layer of snow or most of the snowpack, or depth hoar*
- *Ceavvi: Hard-packed or hard-compacted snow developed during heavy snowfalls under relatively high temperatures and compressed by later snowfall*
- *Čearga: Hard snowdrift*
- *Geardni: Thin crust on top of snow pack*
- *Cuoŋu: Hard crust on snow*
- *Moarri: Sharp, non-bearing crust which may damage reindeer feet (occurring in April- May)*
- *Sievlla: Wet, non-bearing snow in spring (April-May)*
- *Jiekŋa: Ice*

Advanced: Snow water equivalent / density

Sample all snow on the ground with the tube. Invert the tube and push it vertically through the entire depth of snow on the ground that represents the average snow depth (Figure 4). Measure snow

height outside of the tube. Make sure that snow does not fall out of the tube when you remove the snow core. It is very helpful to have a firm, thin sheet of metal to slide between the surface of the ground and the rim of the tube to cleanly gather the entire sample of snow. The snow is then poured carefully in a plastic bag and weighed with a scale. If you use a heavier container than a plastic bag for weighing snow, weigh it and reduce it from the mass of the snow sample.

When snow depth is higher than the height of your tube, take multiple samples (write results separately for each sample). If you need to take multiple samples, it is easier to take first full tens of centimeters from top of the snowpack, such as 40 cm, and irregular height with the last sample from bottom of the snowpack. Then it is easier to find a starting point for the sample below.

Diameter of tube (cm) Snow height in tube (cm) Weight of snow sample (g)

Photos



Figure 1: Example for snow depth measurements (& overview picture). Use a stick with scale or one without scale and a measuring tape/folding rule.



Figure 2: Example for snow profile (definition of layer structure) and ice layer description with folding rule.

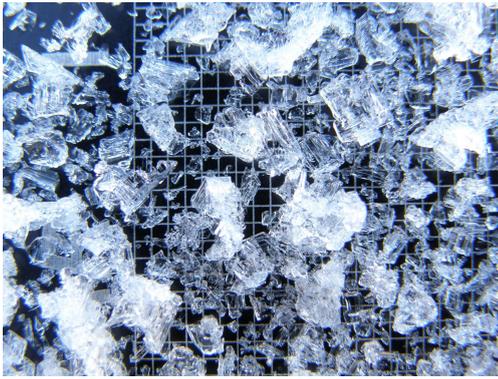


Figure 3: Example for depth hoar grains against 1-mm reference grid (as found at base of snow)



Figure 4: Snow water equivalent / density measurement with a tube. Snow is then poured carefully in a plastic bag and weighed with a scale. Take multiple samples, when snow depth is higher than the height of your tube.

Photos: Finnish Meteorological Institute