Part of the WSL and
thus of the ETH Domain

Snow-cover observations:
from early stages until today

Charles Fierz, WSL Institute for Snow and Avalanche Research SLF, Davos, Switzerland

Content

- History of snow observations
- Snow stratigraphy
- Snow classifications
- Best practices
- Terminology
  - *Short break*
- Snow density and water equivalent of snow cover
- Automatic measurements
- Snow-cover modelling
- Snow monitoring
- Snow Monitoring Competence Centre

History of snow-cover observations

James Edward Church Leaving Big Meadows cabin while on a snow survey.

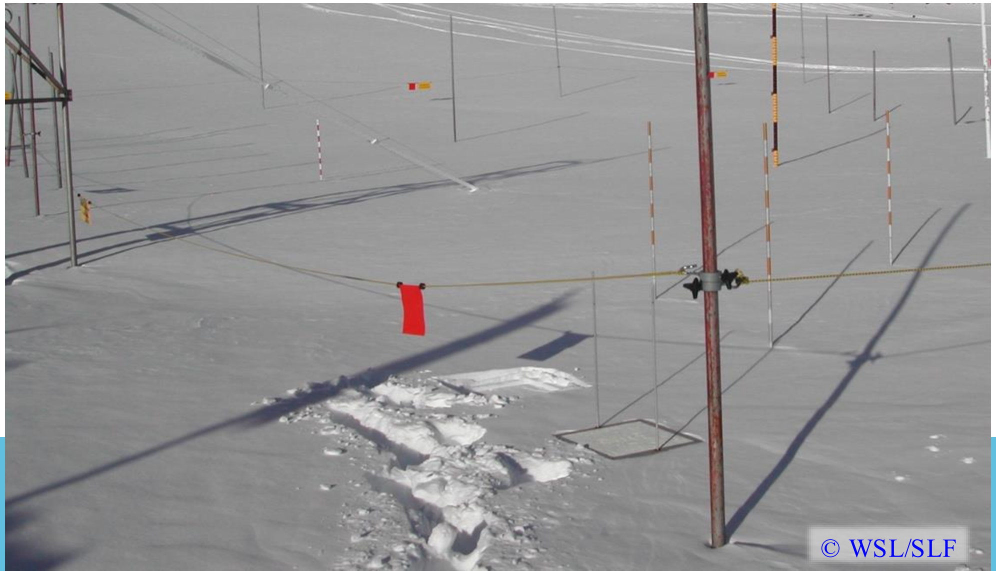
https://www.unr.edu/nevada-today/news/2021/libraries-edward-church-papers

Early observations of snowfall (driven by meteorology)

- Sédileau (France, 1692) found that the volume of [fresh] snow was about five to six times the volume of the melted snow (water volume)
- Grand Saint-Bernard (Switzerland, 2469 m asl, since ~1848)
  - density of new snow ~ 110 kg m^{-3} , 3000 observations.1862-1881

Lancaster, A.: La densité de la neige, Ciel et Terre, Revue Populaire d'Astronomie, de Météorologie et de Physique du Globe, 49–58, 1888.

- Snowboard: when did it start (Finland winter 1921)?



Observation of snow mass (driven by hydrology)

- Water equivalent of snow cover (from ~1900, James Edward Church)
  - snow surveys, snow tubes, …

Step 4
If there is no marker at sampling point No. 1, find the point by measuring the correct distance from the snow course end marker, following directions shown on the snow course map.

One surveyor should carry the sampling tube and headend of tape. The second surveyor should carry the scale and notebook and hold the rear end of the tape. The second surveyor sights the first surveyor on line of the course with the next marker.

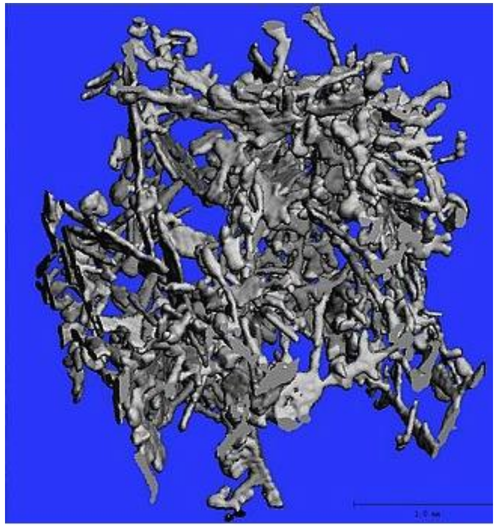
Step 5
Before taking a sample, look through the tube to check for cleanliness. Hold the sampling tube away from your eye, cutter end up.

USDA, W. S. F. U.: Snow survey sampling guide: handout, United States Department of Agriculture, Washington DC, USA, 32 pp., 1984.

Observation of snow properties (driven by snow physics)

- Avalanche formation (from ~1930)
  - Snow metamorphism
  - Stratification
    - (snow profiles, manual and visual observations)
  - Formation of weak layers

- Snow physics (from ~1990)
  - Snow metamorphism
  - Snow physical properties
    - density, specific surface area, liquid water content
  - Objective measurements
    - snow micro-penetrometer, micro-computer tomography, …



Snow stratigraphy

B. Schneeprofile, Schneefärbung und Wasserhorizonte.

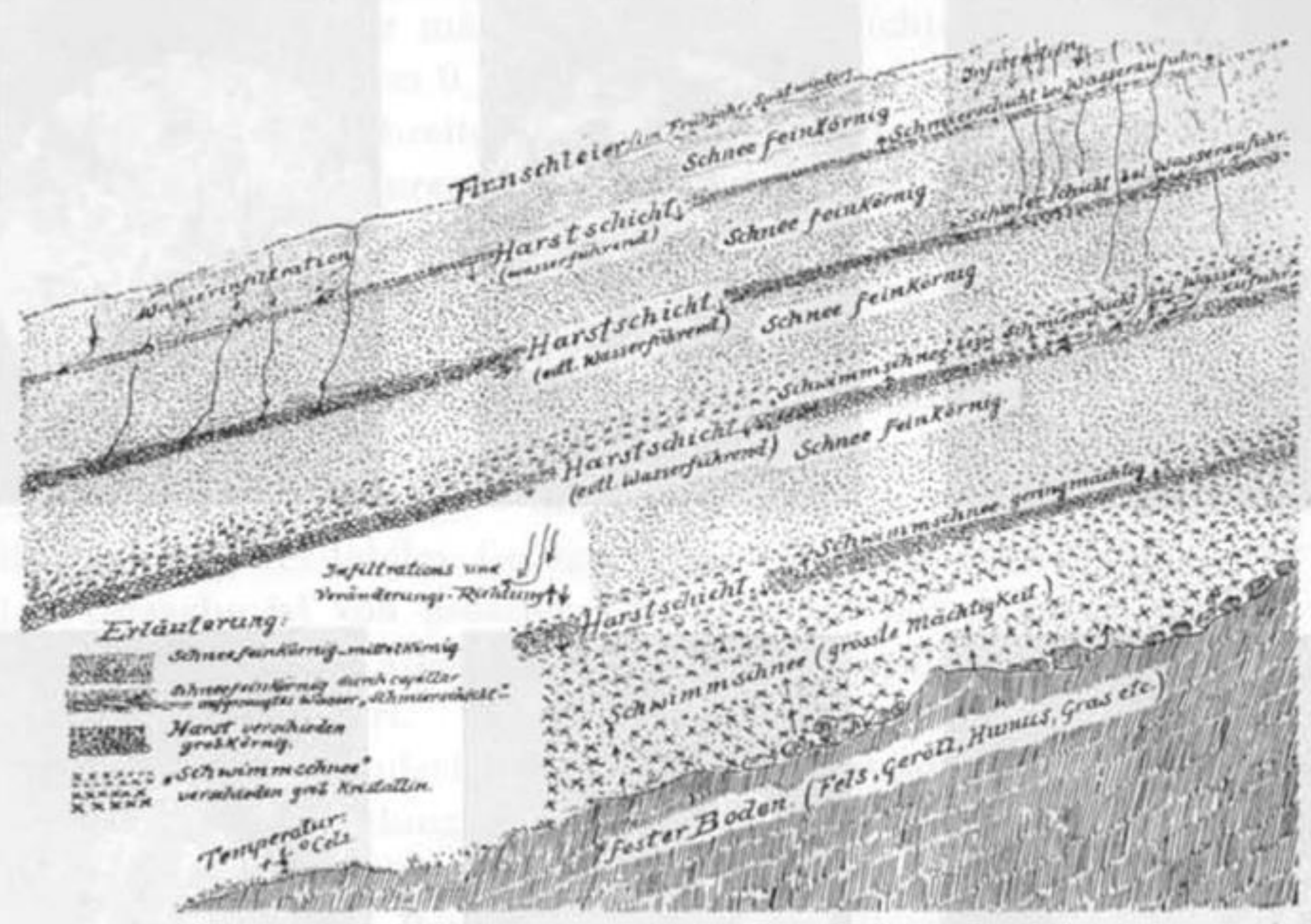
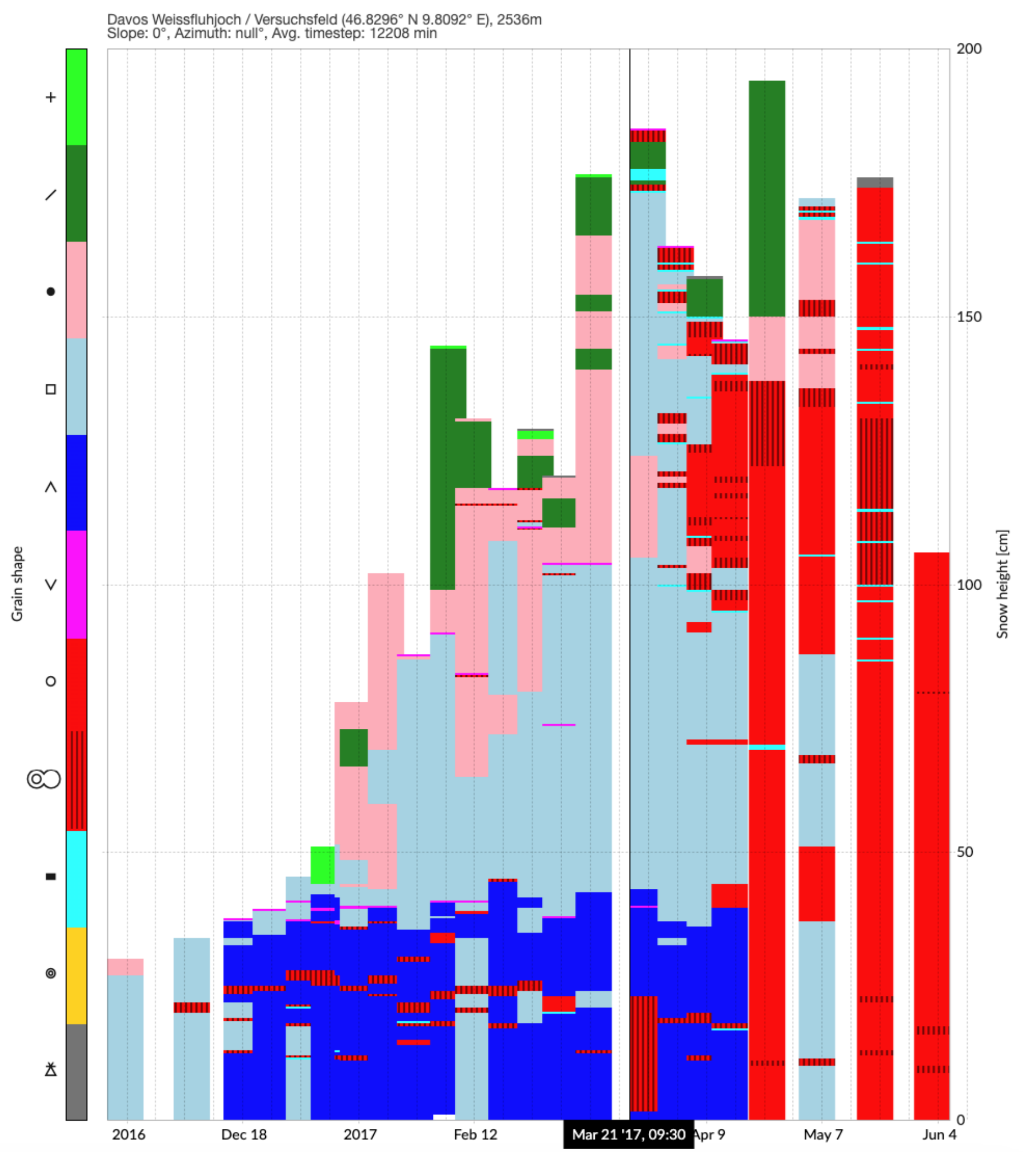
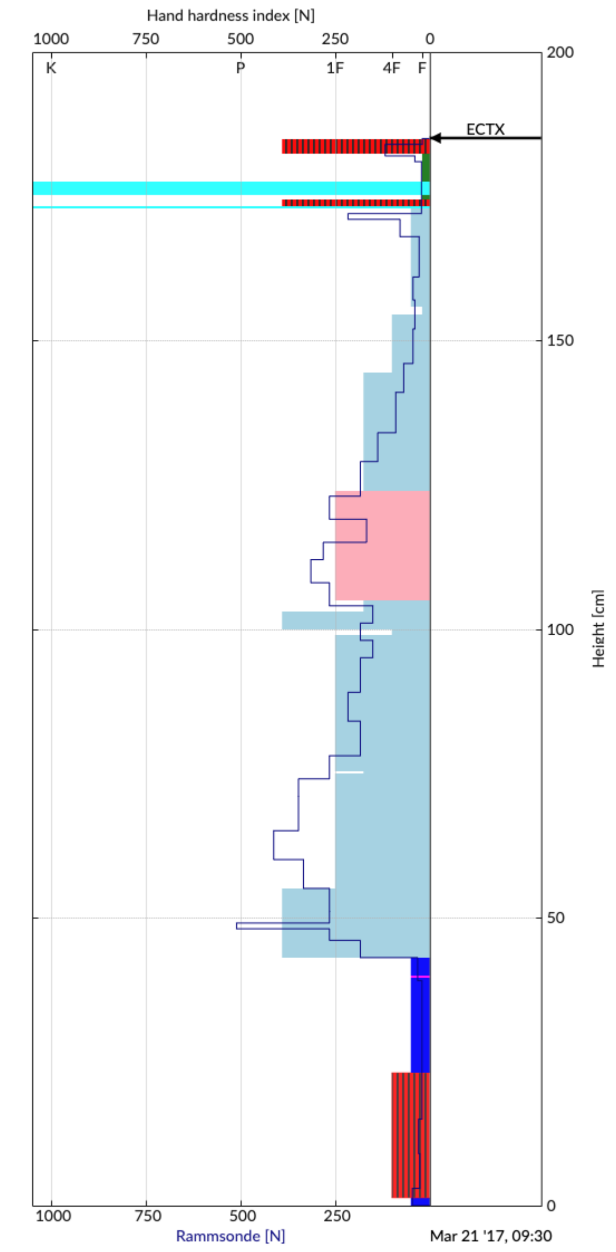


Abb. 9. Erstmalige (halbschematische) Darstellung eines Profils durch eine Schneeablagerung. — (Zum Vortrag.)

Paulcke, W.: Über die wichtigsten Ergebnisse meiner Schnee- und Lawinen-Forschungen.
In: Snow and Ice, IAHS Publication No. 23,
International Association of Scientific Hydrology, Edinburgh, UK, 639–665, 1936.

Timeline of traditional snow profiles for the winter 2017
Weissfluhjoch, 2540 m asl, Davos, Switzerland





Rendering: niViz.org

Snow classifications

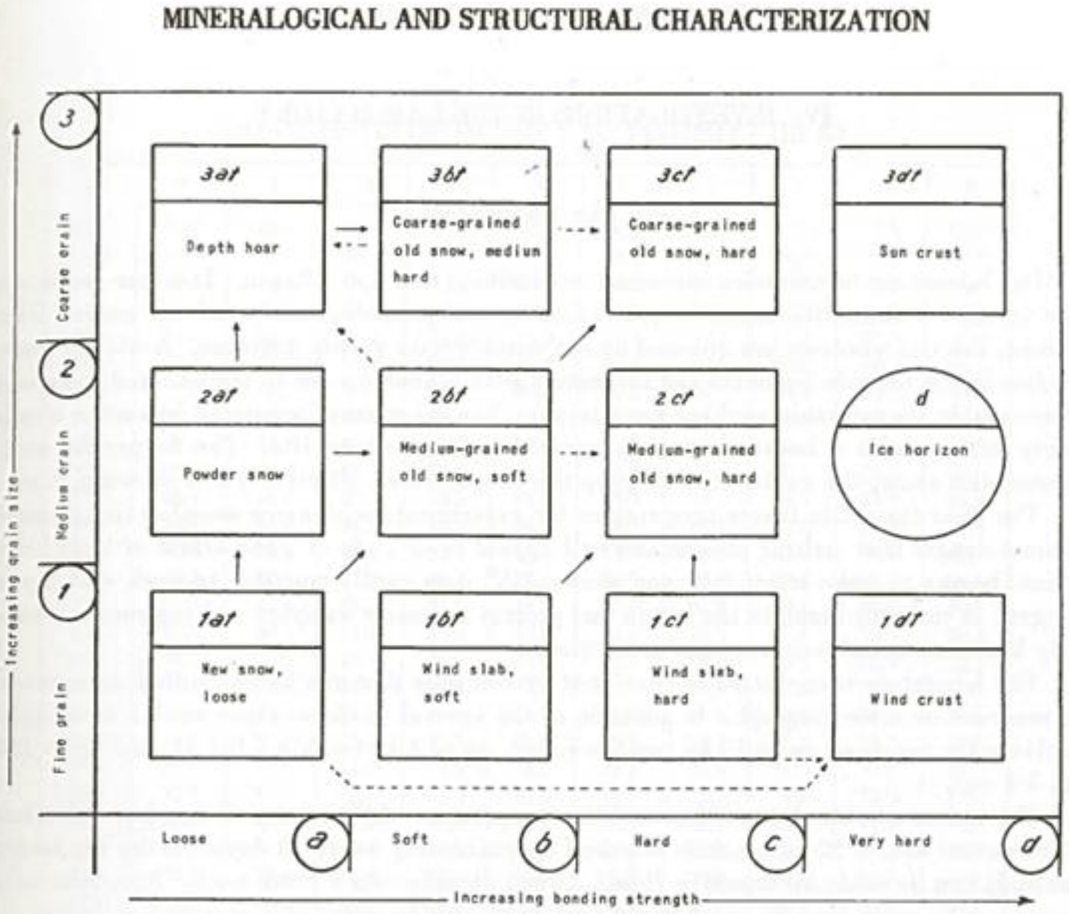


Figure 7. Snow classification for field work

1 = fine grain
2 = medium grain
3 = coarse grain

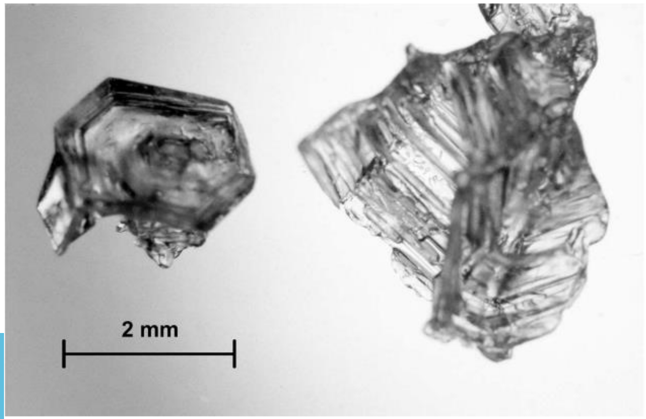
a = loose or soft
b = medium hard
c = hard
d = very hard

n = wet
t = dry

Bader, H. P., Haefeli, R., Bucher, E., Neher, O., Eckel, O., and Thams, C.: Snow and its metamorphism. Snow, Ice and Permafrost Research Establishment, Wilmette, Illinois, USA, 42 of 313 pp., 1954. Translation from “Der Schnee und seine Metamorphose”, 1939.

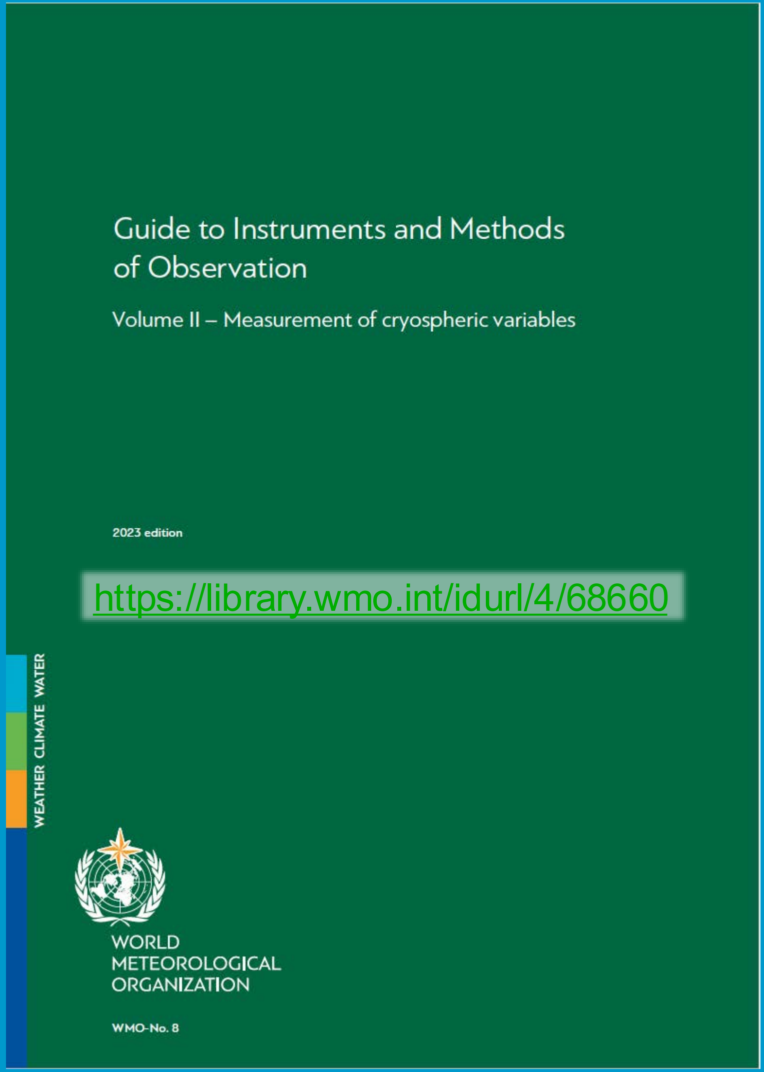
International Classifications

- 1954 : The international classification for snow (with special reference to snow on the ground)
  Schaefer et al., IASH(ICSI)
  - *To set up a classification as the basic framework which may be expanded or contracted to suit the needs of any particular group ranging from scientists to skiers.*
- 1970 : Seasonal snow cover: A guide for measurement, compilation and assemblage of data
  M. de Quervain [Ed.], UNESCO / IASH(ICSI) / WMO
  A contribution to the International Hydrological Decade
- International Classification for Seasonal Snow on the Ground
  - 1990 : Colbeck et al., IAHS(ICSI)
  - 2009 : Fierz et al., IACS



Hollow cups DHcp, ∧ (AINEVA UniMilano) #34

Guide to Instruments and Methods of Observation



https://library.wmo.int/idurl/4/68660

WMO-No. 8, Guide to meteorological instruments and methods of observation (published from 1950 to 2017)

- Chapter 6. Measurement of precipitation
  - **Section 6.7 Measurement of snowfall and snow cover**
    - 2014 edition, updated in 2017:
      The authoritative texts on this topic are the *Guide to Hydrological Practices* (WMO-No. 168), Volume I and *Snow Cover Measurements and Areal Assessment of Precipitation and Soil Moisture* (WMO-No. 749), which cover the hydrological aspects, including the procedures, for snow surveying on snow courses. The following is a brief account of some simple and well-known methods, and a brief review of the instrumentation.
- WMO Commission for Instruments and Methods of Observation (CIMO, today SC-MINT) proposed to split WMO-No.8 in volumes
- Global Cryosphere Watch (GCW) agreed to develop a volume on cryospheric measurements, involving the scientific community through the International Association of Cryospheric Sciences (IACS)

WMO-No. 8, Volume II – Measurement of cryospheric variables

- **Chapter 1. General**
- **Chapter 2. Measurement of Snow**
  - First published in 2018
  - Coordination with publication of Chapter 3 in 2023
  - Ad hoc GCW Snow Watch Team revised and augmented this chapter in 2024. *To be sent out for external review.*
- **Chapter 3. Measurement of Glaciers**
  - First published in 2023
- **Chapter 4. Permafrost :**
  - Approved by WMO in 2024
  - To be published in 2025, provisional edition available here
- **Sea ice :**
  - Sea Ice Watch is expected to designate a Task Team soon.

Terminology

WORLD METEOROLOGICAL ORGANIZATION
Weather • Climate • Water

Global Cryosphere Watch

Home | About | News | Cryosphere Now | Surface | Satellites | Activities | Reference | Data Portal | Outreach

Cryosphere Glossary

The official GCW Glossary is in preparation. It will be formally vetted and then translated over the coming years. In the meanwhile, GCW has compiled a database of cryosphere terms from a variety of sources (see the References). At present, there are 4174 entries from 27 sources; 2249 are unique. The GCW glossary will include and be consistent with the recommended and desired variables for CRYONET and also with GCW best practices for cryospheric measurements. The GCW glossary terms will ultimately be included in WMO's METEOTERM. *Use the lists or search box below to filter the results. Or select a letter for a list of all terms that begin with that letter. You can select multiple values in the lists by using shift-, control-, or command-click combinations.*

Cryosphere element: Snow, Sea Ice, Freshwater Ice, Glaciers
Source: AMS - glossary of meteorology, Australian Bureau of Meteorology 2016, ASPECT 2012, Bushuyev 2004
Keyword: Filter Reset

OR select the first letter of the term: A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z

Term	Definition	Source
Avalanche	Mass of snow which becomes detached and slides down a slope, often acquiring great bulk by fresh addition as it descends.	NSIDC accessed 2016
Avalanche	A mass of snow, rock, and/or ice falling down a mountain or incline. In practice, it usually refers to the snow avalanche. In the United States, the term snow slide is commonly used to mean a snow avalanche.	NOAA National Weather Service Glossary 2009
Avalanche	Mass of snow and ice falling suddenly down a mountain slope and often taking with it earth, rocks and rubble of every description.	WMO METEOTERM accessed 2016
Avalanche	A slide or flow of a mass of snow, firn or ice that becomes detached abruptly, often entraining additional material such as snow, debris and vegetation as it descends. The duration of an avalanche is typically seconds to minutes.	Cogley et al. IACS-UNESCO Glacier Mass Balance 2011
Avalanche	Mass of snow and ice suddenly sliding down a mountain-side and often taking with it earth, rocks and rubble.	UNESCO-WMO International Glossary of Hydrology 2012
Avalanche	A mass of snow (perhaps containing ice and rocks) moving rapidly down a steep mountain slope. Avalanches may be characterized as loose and turbulent, or slab; either type may be dry or wet according to the nature of the snow forming it, although dry snow usually forms loose avalanches and wet snow forms slabs. A large avalanche sweeps a current of air along with and in front of it as an avalanche wind, which supplements its already tremendous destructive force. (Also called snowslide.)	AMS - glossary of meteorology
Avalanche	Mass of snow which becomes detached and slides down a slope, often acquiring great bulk by fresh additions as it descends.	Illustrated Glossary of Snow and Ice
Avalanche	Snow avalanches; Ice avalanches	Illustrated GLIMS Glacier Classification Manual
Avalanche wind	Rush of air produced by an avalanche or landslide.	WMO METEOTERM accessed 2016
Avalanche wind	The rush of air produced in front of an avalanche of dry snow or in front of a landslide. The most destructive form, the avalanche blast, occurs when an avalanche is stopped abruptly, as in the case of an almost vertical fall into a valley floor. Such blasts may have very erratic behavior, leveling one house without damaging its neighbor.	AMS - glossary of meteorology
Avalanching	Mass transfer by avalanches which redistribute snow, firn and ice. Avalanching from a valley wall to the glacier surface constitutes accumulation. Avalanching from the glacier margin constitutes ablation	Cogley et al. IACS-UNESCO Glacier Mass Balance 2011

The glossary includes descriptions from 27 sources, among other things:

- The International Meteorological Vocabulary
- The International Glossary of Hydrology

There are:

- 8 descriptions for *avalanche*
- 7 descriptions for *snowfall*
- 13 descriptions for *snow*
- 6 descriptions for *snow cover*

https://globalcryospherewatch.org/reference/glossary.php

Snowfall, snow, snow cover, base surface, …

- Atmospheric snow is a hydrometeor defined as a solid precipitation (see WMO-No.8, Volume I, Chapter 6) → snowfall
- Snow is a fascinating material
- Snow is a component of the cryosphere, which is part of the Earth system
- Snow cover refers to the blanket of snow covering any surface of the Earth and includes the concepts of depth and areal extent (see Sturm et al., 1995).
  - A reference horizon, also called base surface, is taken as the interface at the bottom of the snow cover
- Snow variables are properties of either the snow cover or of a layer within the snow cover.

Sturm, M., Holmgren, J., and Liston, G. E.: A Seasonal Snow Cover Classification System for Local to Global Applications, J. Climate, 8, 1261–1283, https://doi.org/10.1175/1520-0442(1995)008<1261:ASSCCS>2.0.CO;2, 1995.

Depth of snowfall or height of new snow

- Vertical depth of freshly fallen snow that has accumulated during a specific period, usually of 24 hours, on any surface of the Earth.
- It is important to make a clear distinction between depth of snowfall and solid precipitation → location of measurement!
- Water equivalent of snowfall is the vertical depth of the water that would be obtained if the freshly fallen snow melted completely, which equates to the new snow mass per unit area.

Snow depth or snow height or height of snow

- Vertical distance from the snow surface to a stated reference level, most often the base surface or a reference horizon marked at some fixed time.

Snow density & bulk snow density of snow cover

- Snow density is the density of a snow layer of any thickness expressed in kg m^{-3}. If the layer thickness equals the snow depth, snow density is referred to as bulk snow density (that is, the density of the snow cover) and denoted $\rho_{s,bulk}$

Water equivalent of snow cover or snow water equivalent (SWE)

- Water equivalent of snow cover is the vertical depth of water that would be obtained if the snow cover melted completely, which equates to the snow-cover mass per unit area. It is expressed either in mm w.e. or in kg m^{-2}

Bulk snow density and water equivalent of snow cover

The bulk snow density of snow cover is defined as:

$$\rho_{s,\mathrm{bulk}} = \mathrm{SWE}/H_s \qquad (\mathrm{kg\ m^{-3}}),$$

where:

SWE is the water equivalent of snow cover,
its mass per unit area (kg m^{-2}), and H_s is the snow depth (m)

It is known for long that bulk density of snow cover varies less than snow depth and water equivalent of snow cover.

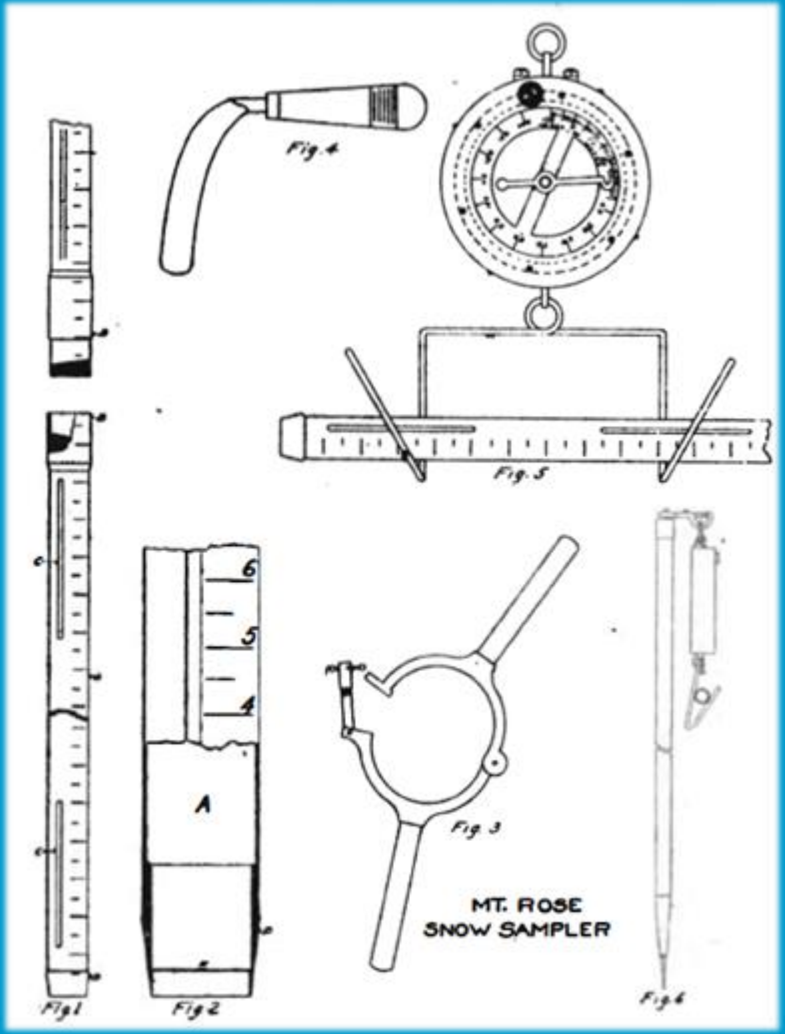
For example, see Korhonen, W. W.: Über die lokale Veränderlichkeit der Schneedecke, Kleinere Mitteilungen, Meteorologische Zeitschrift, 72–76, 1932. (Finland)

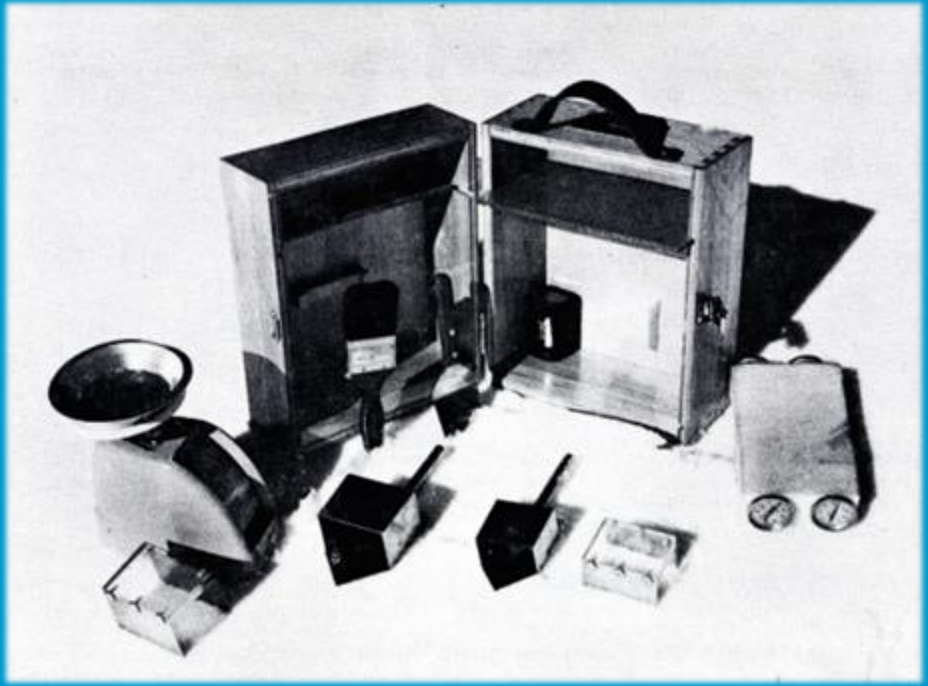
Further snow variables treated in WMO-No.8, Volume II, Chap. 2

- Presence of snow on the ground
- Snow albedo
- Snow surface temperature
- Snow temperature
- Snow cover extent (SCE)
- Snow surface state
- Liquid water content, specific surface area and drifting and blowing snow are left for future revisions


Short break !

Snow density and water equivalent of snow cover (SWE)





Carroll, T.: A Comparison of the CRREL 500 cm3 Tube and the ILTS 200 and 100 cm3 Box Cutters used for determining snow densities.
Journal of Glaciology, 18, 334–337, https://doi.org/10.3189/S0022143000021420, 1977.

Church, J. E.: Snow surveying: Its problems and their present phases with reference to mount rose, Nevada and vicinity.
In: Proceedings of the second Pan American scientific congress, Washington DC, USA, Dec 1915.
Washington, Govt. print. off., Washington DC, USA, 496–549, 1917.

A dataset of 600+ snow profiles

- At Weissfluhjoch, bulk snow density is measured bi-weekly since the winter 1937
- Care was taken to measure the water equivalent accumulated from profile to profile and thus the 500 cm^3 CRREL-cylinder was used
- Around 2000, the ETH-cylinder replaced the CRREL-cylinder for the bi-weekly ‘standard’ profiles
- Starting around 1990, many of these ‘standard’ measurements are accompanied by parallel measurements of *snow density* with smaller snow samplers or the electronic Denoth device

The instruments used

Large **cylinder samplers:**

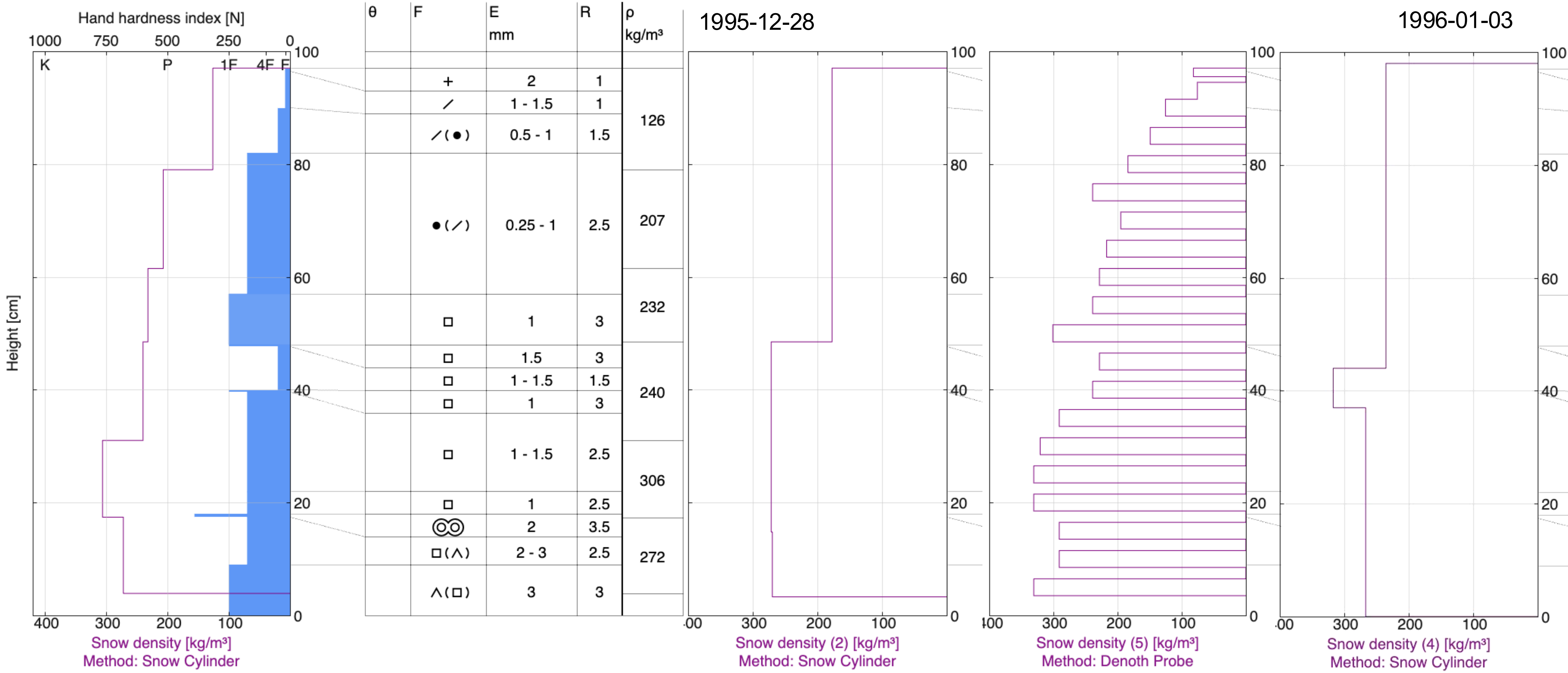
CRREL[1)]: 500 cm^3, ø 5.8 cm;
used vertically or/and horizontally

ETH : 3850 cm^3, ø 9.4 cm;
always used vertically

Denoth probe: 500 cm^3

1) CRREL: Cold Regions Research and Engineering Laboratory

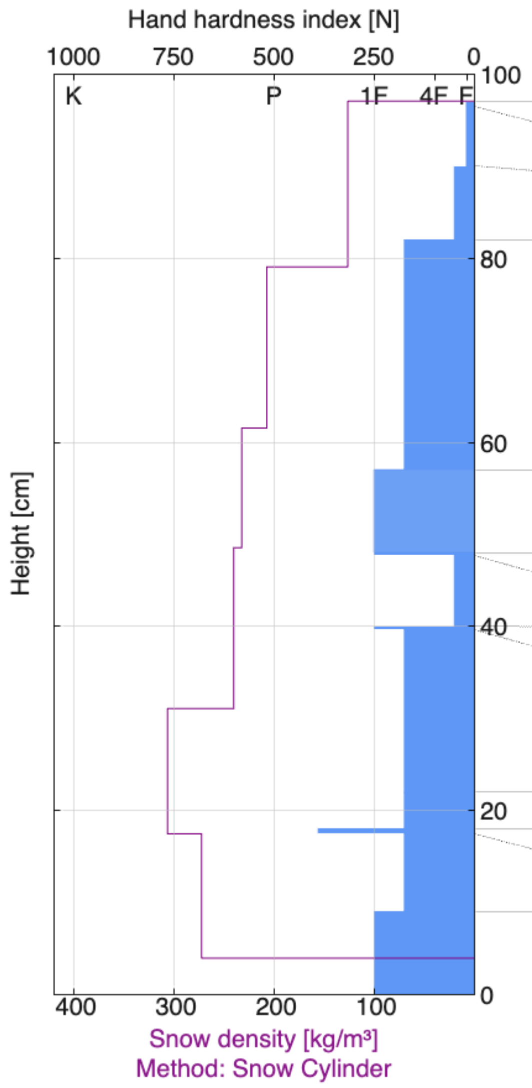
How well do we measure bulk density of snow cover ?



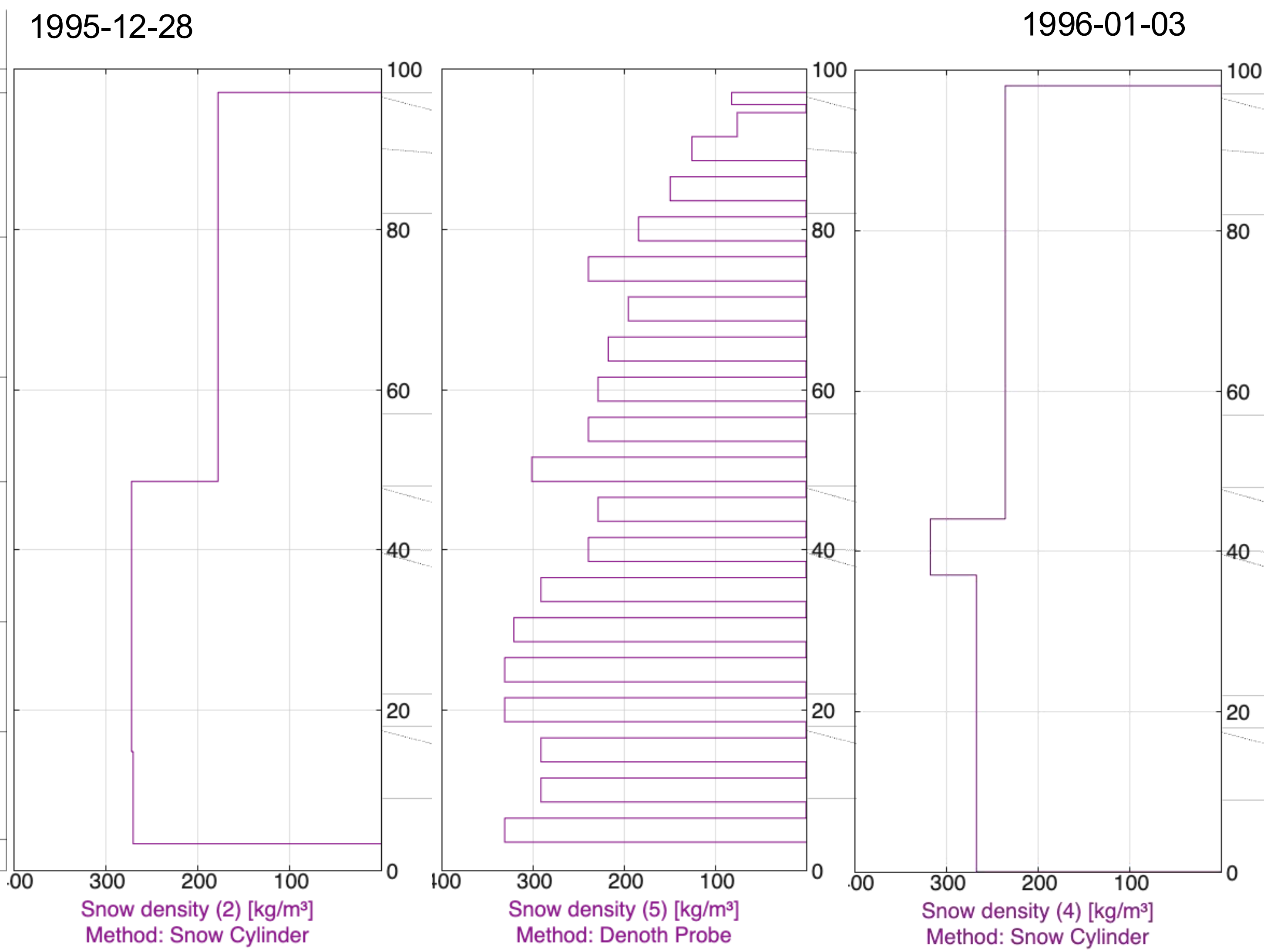
F	E (mm)	R
+	2	1
⁄	1 - 1.5	1
⁄ (●)	0.5 - 1	1.5
● (⁄)	0.25 - 1	2.5
□	1	3
□	1.5	3
□	1 - 1.5	1.5
□	1	3
□	1 - 1.5	2.5
□	1	2.5
◎◎	2	3.5
□ (∧)	2 - 3	2.5
∧ (□)	3	3

$\rho_{s,bulk}$ (kg m^{-3}) CRREL: 225 ETH: 223 Denoth: 237 CRREL: 253

How well do we measure bulk density of snow cover ?



θ	F	E mm	R	ρ kg/m³
	+	2	1	
	⁄	1 - 1.5	1	126
	⁄ (●)	0.5 - 1	1.5	
	● (⁄)	0.25 - 1	2.5	207
	□	1	3	232
	□	1.5	3	
	□	1 - 1.5	1.5	240
	□	1	3	
	□	1 - 1.5	2.5	306
	□	1	2.5	
	◎◎	2	3.5	
	□ (∧)	2 - 3	2.5	272
	∧ (□)	3	3	



$\rho_{s,\mathrm{bulk,mean}}$ = 235 kg m^{-3}; Δ_{max} = 15 kg m^{-3} , i.e. ~ ±6 %

Comparison of bulk measurements from 4 winters

Snow depth (cm)	CRREL	ETH	Denoth	$\rho_{s,bulk}$ (kg m^{-3})	Δ_{max} (kg m^{-3})	± (%)
97	225	223	237	**228**	**7**	**3**
100	291		268	**280**	**24**	**4**
109		274	272	**273**	**2**	**0**
119	301	289	284	**291**	**17**	**3**
137	484	483		**484**	**11**	**1**
138	245	231		**239**	**7**	**3**
150	326	311	306	**314**	**20**	**3**
151	278	255		**269**	**23**	**4**
164		269	264	**267**	**6**	**1**
175	399	366		**383**	**33**	**4**

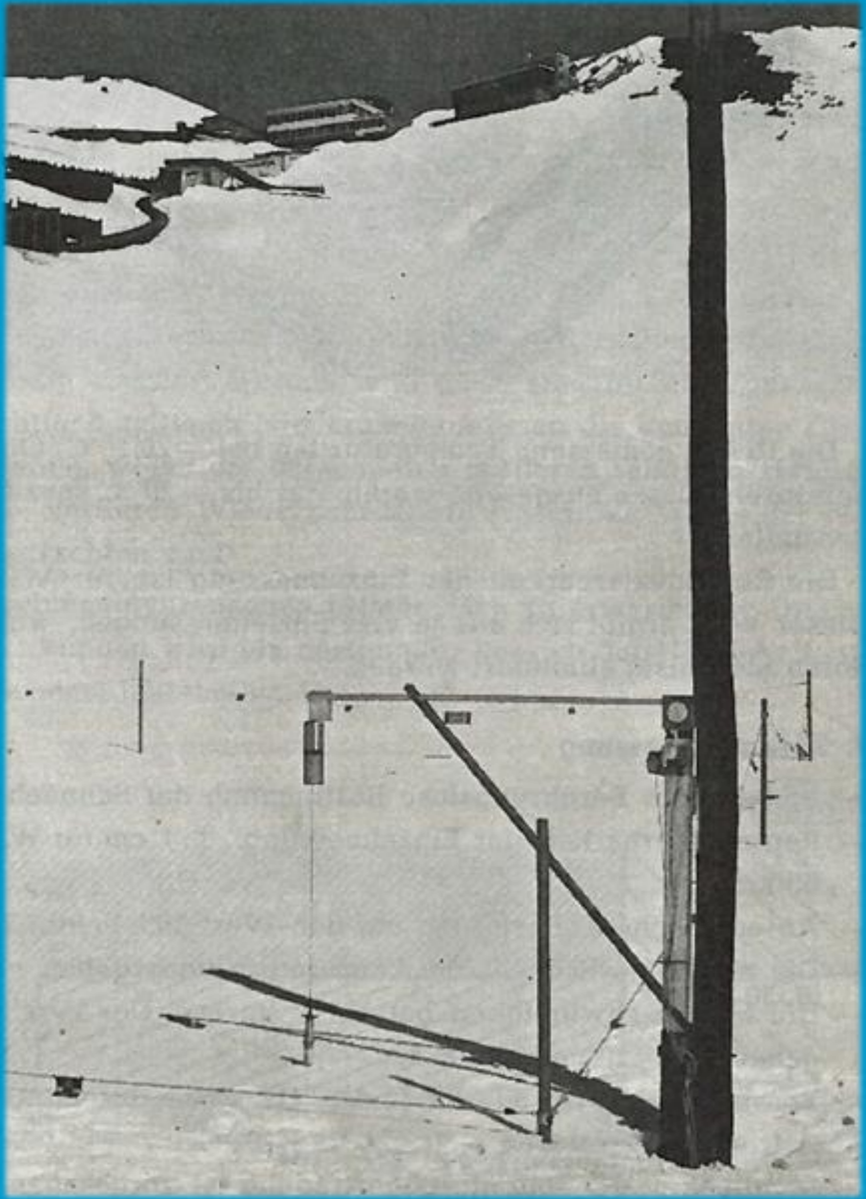
Comparison of bulk measurements from 4 winters

Snow depth (cm)	CRREL	ETH	Denoth	$\rho_{s,bulk}$ **(kg m^{-3})**	**Δ_{max} (kg m^{-3})**	**± (%)**
176	320	303	307	**310**	**17**	**3**
179	444	447		**446**	**3**	**1**
186		309	295	**303**	**14**	**2**
202		342	325	**334**	**17**	**3**
206		315	285	**299**	**30**	**5**
213		301	289	**294**	**12**	**2**
237		352	323	**332**	**29**	**5**
288		311	294	**305**	**17**	**3**
288		367	340	**353**	**27**	**4**

Bulk density of snow cover: so, what?

- The bulk density of snow cover eases comparisons as it does not depend on snow depth
- There is no ‘true’ or ‘reference’ value
- In general, different methods or observers will agree within **10 %**
- Each method has pros and cons!

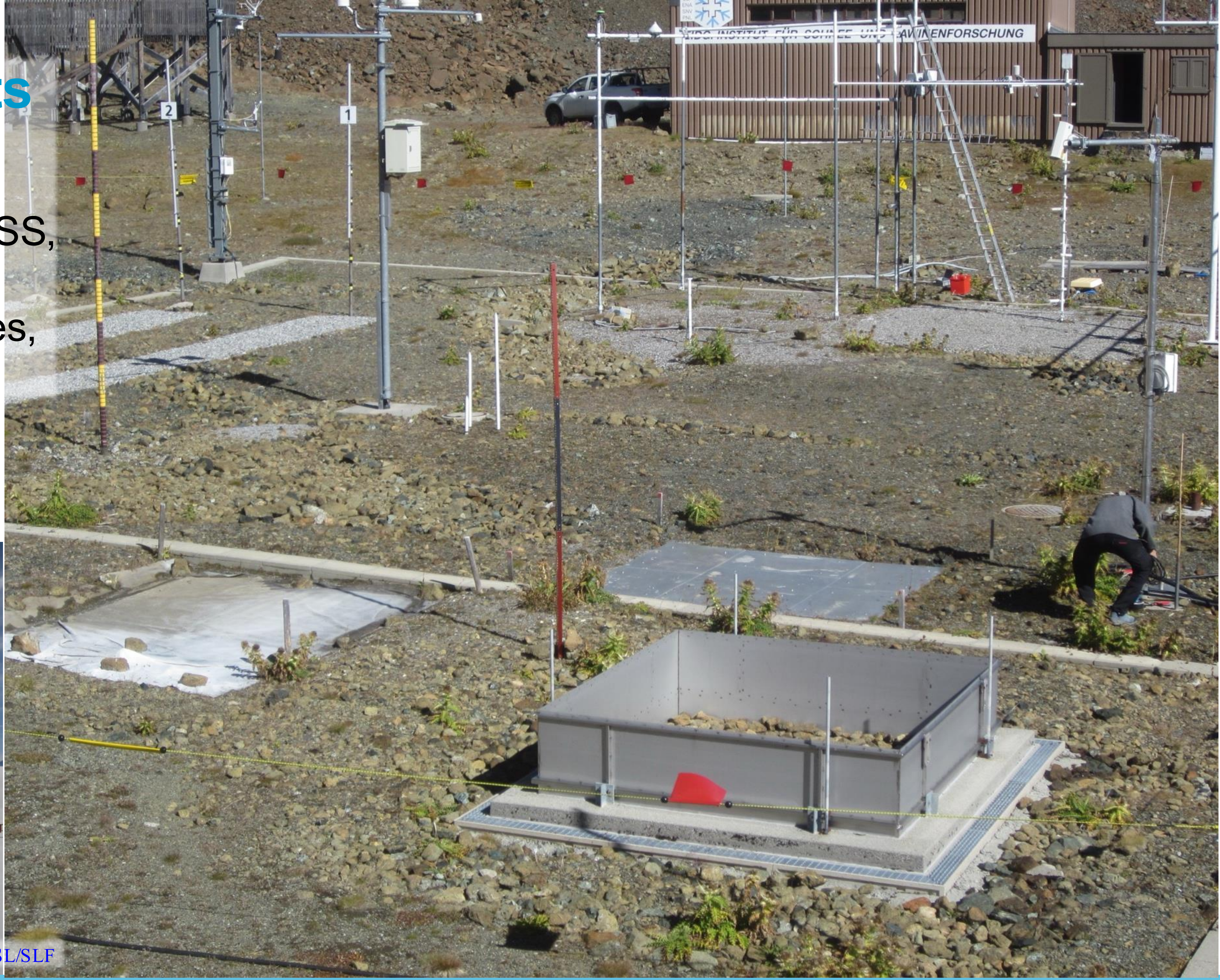
Automatic measurements



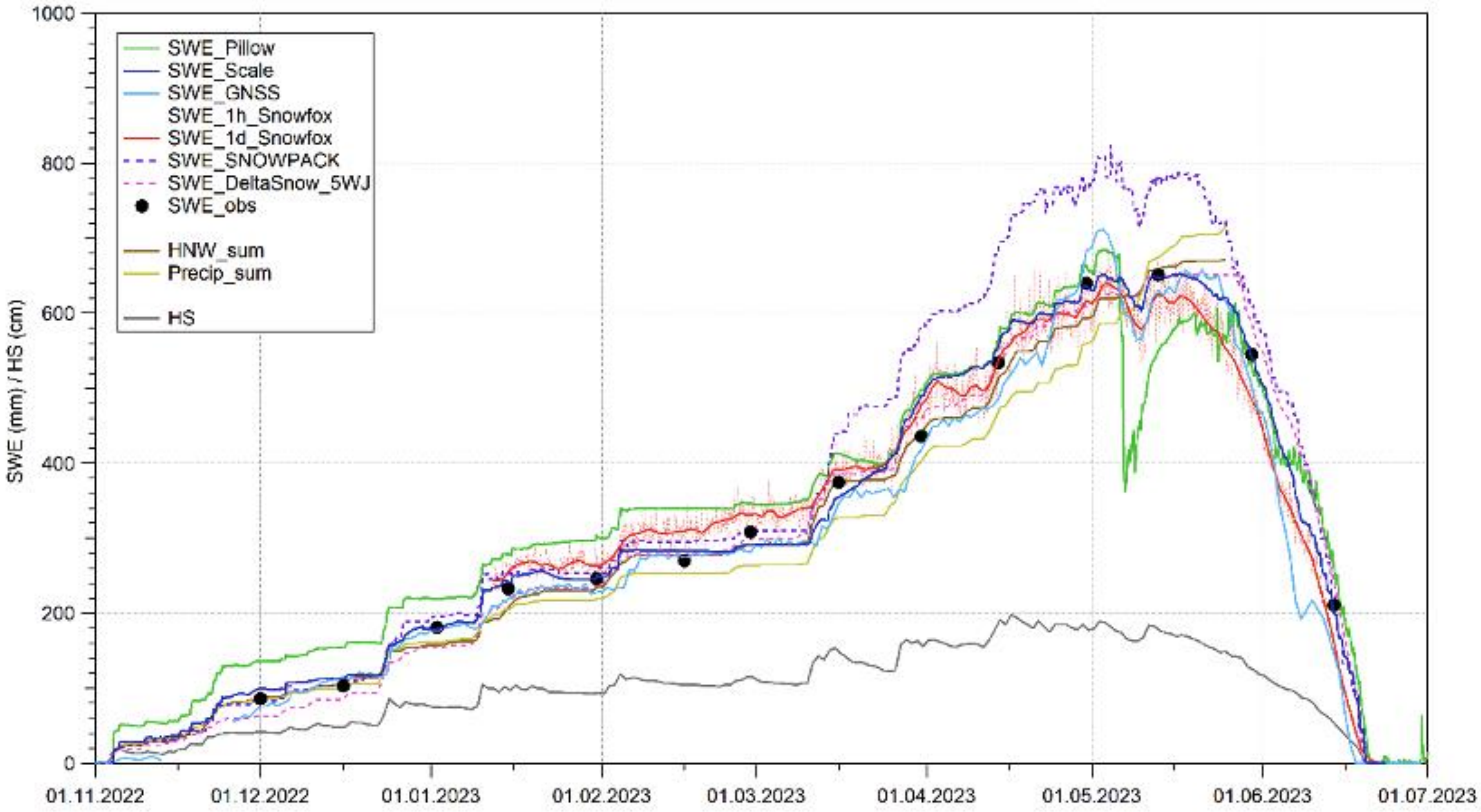
Good, W. and Krüsi, G.: Besondere Beiträge: Ein optoelektronischer Schneehöhenmesser.
In: Schnee und Lawinen in den Schweizeralpen. Winter 1972/73, Eidg. Institut für Schnee- und Lawinenforschung SLF, Weissfluhjoch/Davos, Switzerland, 150–156, 1974.

Automatic measurements at Weissfluhjoch

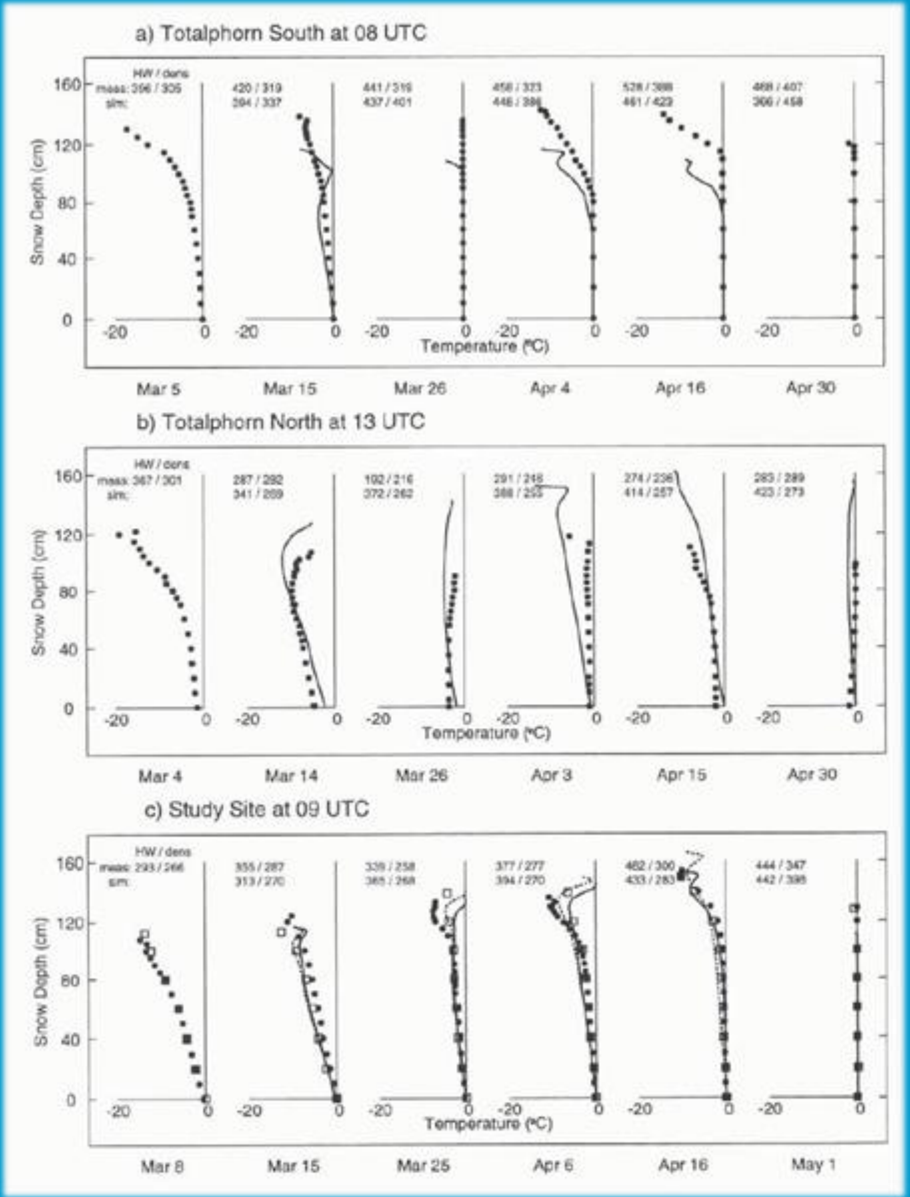
Snow depth, SWE (pillow, scale, GNSS, CRS-Snowfox), snow temperatures, snow albedo, meteorological variables, …



SWE measurements at Weissfluhjoch over the winter 2023



Snow-cover modelling



Fierz, C., Plüss, C., and Martin, E.: Modelling the snow cover in a complex Alpine topography. Annals of Glaciology, 25, 312–316, https://doi.org/10.3189/S0260305500014208, 1997.

Snow density, winter 2016, Weissfluhjoch, Davos, 2540 m

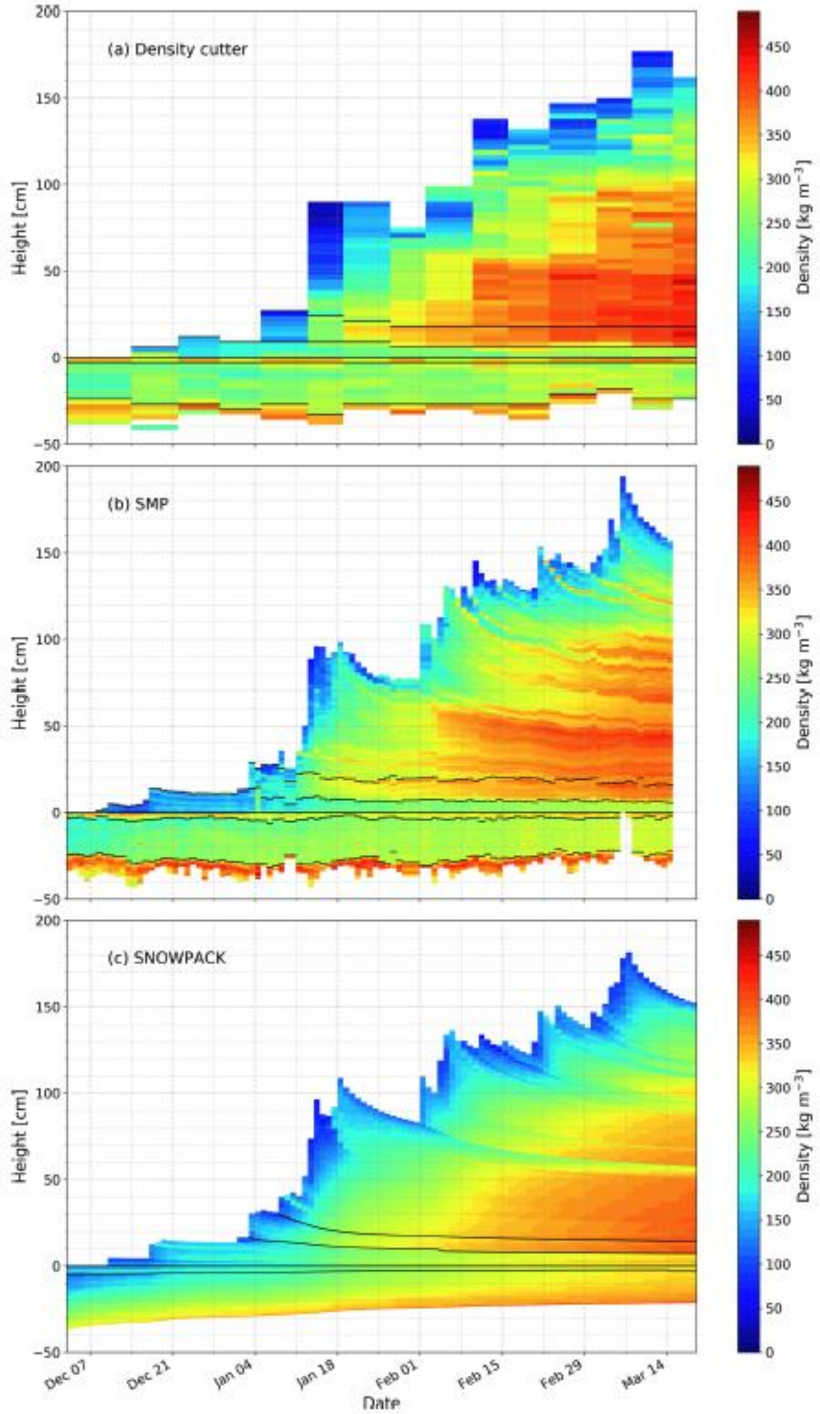
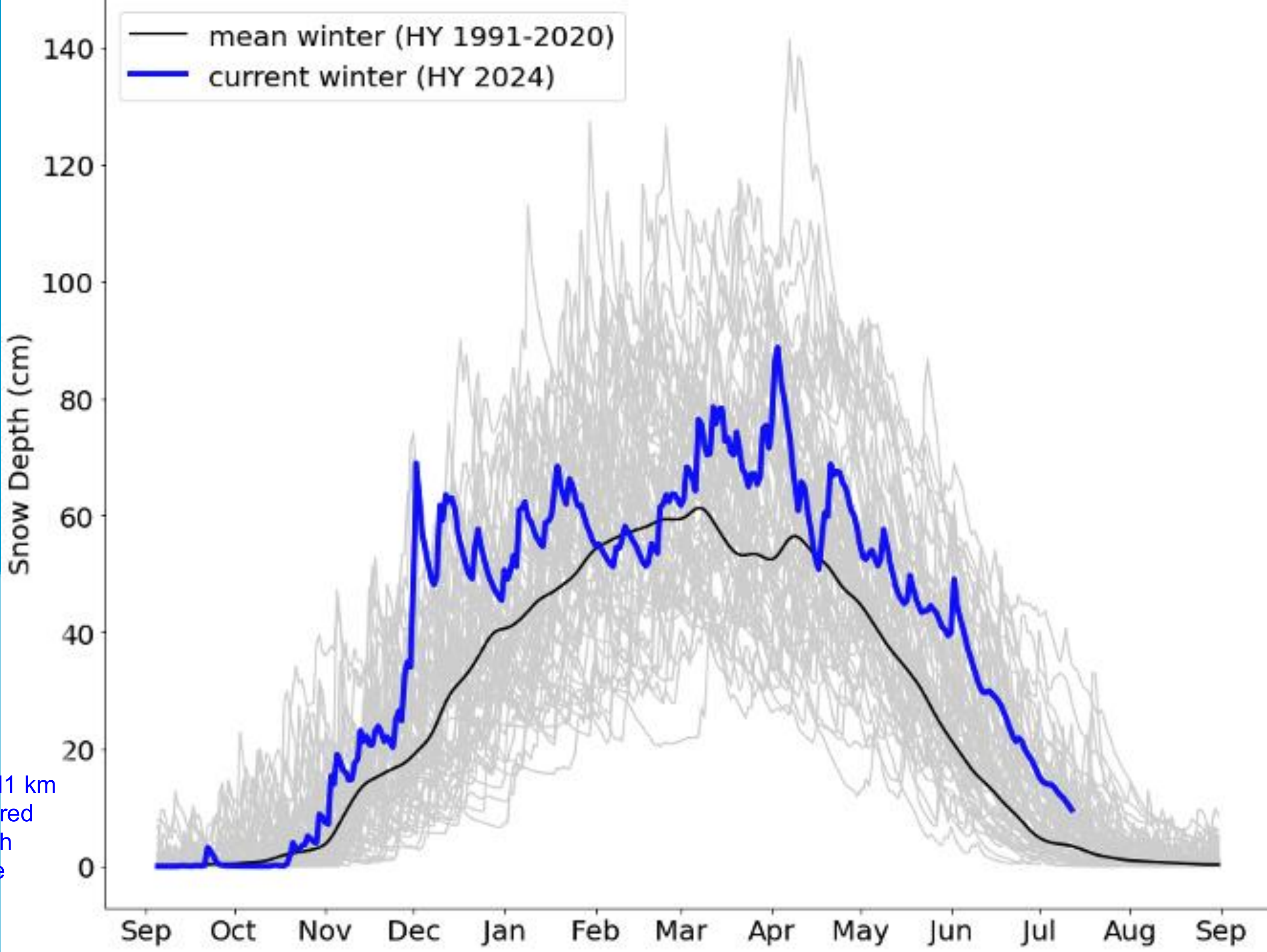


Figure 6 from:
Calonne, N., Richter, B., Löwe, H., Cetti, C., Schure, J. ter, van Herwijnen, A., Fierz, C., Jaggi, M., and Schneebeli, M.: The RHOSSA campaign: multi-resolution monitoring of the seasonal evolution of the structure and mechanical stability of an alpine snowpack, Cryosphere, 14, 1829–1848, https://doi.org/10.5194/tc-14-1829-2020, 2020.

WSL SLF

IUGG IACS GCW WMO OMM

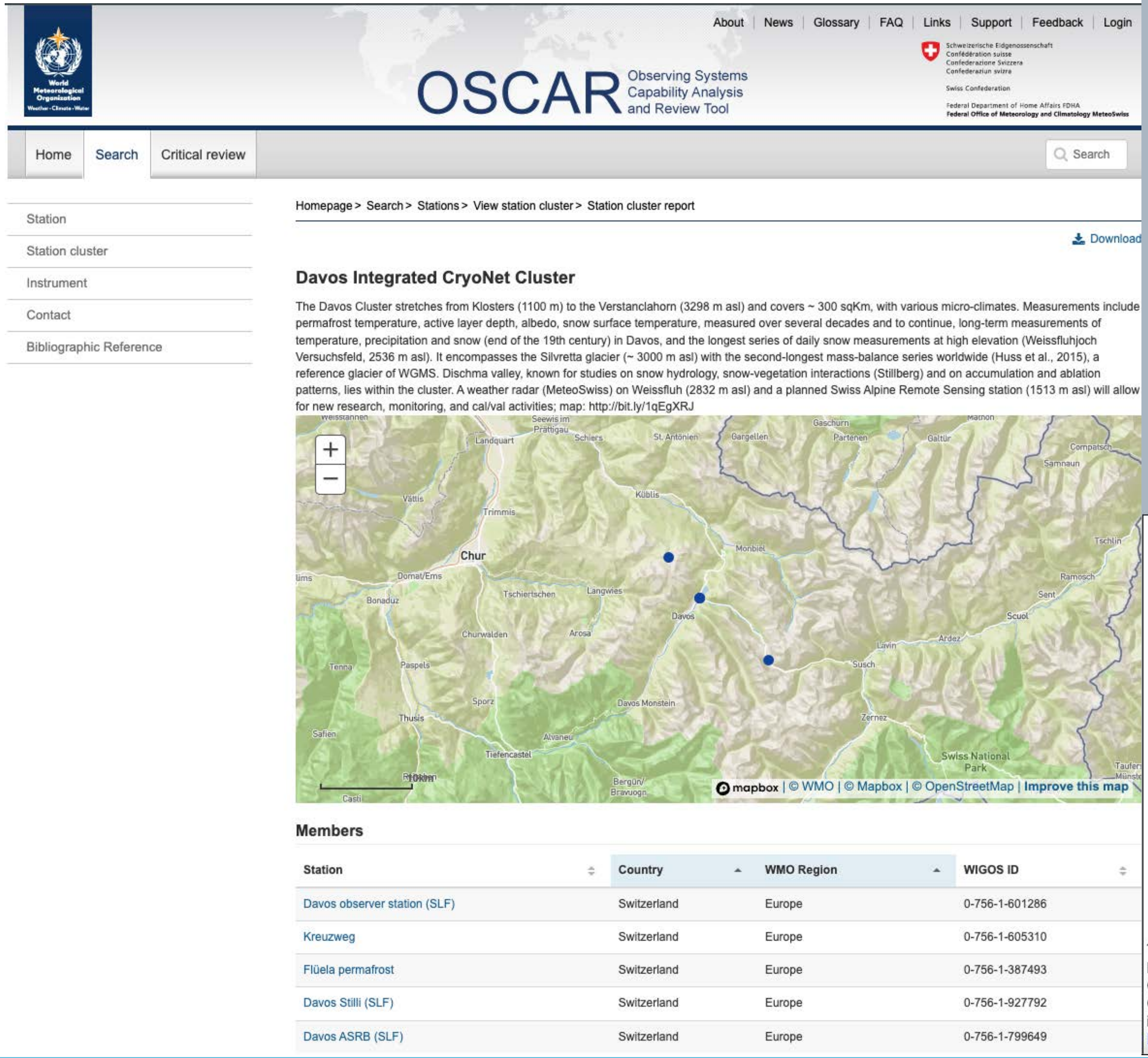
Snow monitoring



WMO GCW Snow Assessment for Winter 2023-2024, Northern Hemisphere and Regional Aspects
(Compiled by K. Luojus and the WMO GCW Snow Watch Team)

The snow season in the Swiss Alps 2023-2024
Author: C. Marty
Snow depth evolution during 2023/2024 based on modeled1 km gridded data for the Swiss Alps (elevation > 500 m) compared to the long-term mean. Except for February, the snow depth was generally well above average. The gray lines show the development for each hydrological year since 1962.

WMO GCW Snow



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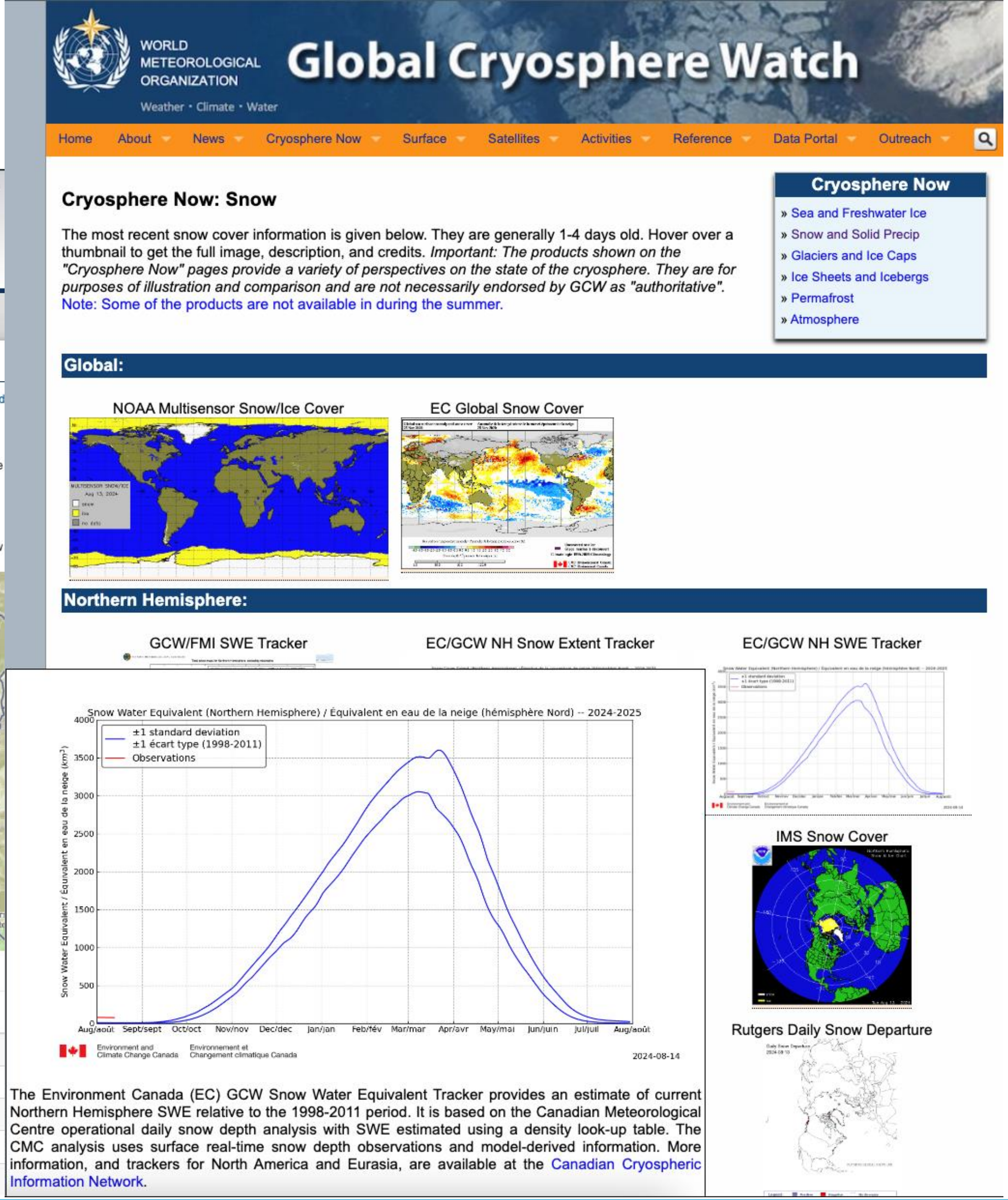
Davos Integrated CryoNet Cluster

The Davos Cluster stretches from Klosters (1100 m) to the Verstanclahorn (3298 m asl) and covers ~ 300 sqKm, with various micro-climates. Measurements include permafrost temperature, active layer depth, albedo, snow surface temperature, measured over several decades and to continue, long-term measurements of temperature, precipitation and snow (end of the 19th century) in Davos, and the longest series of daily snow measurements at high elevation (Weissfluhjoch Versuchsfeld, 2536 m asl). It encompasses the Silvretta glacier (~ 3000 m asl) with the second-longest mass-balance series worldwide (Huss et al., 2015), a reference glacier of WGMS. Dischma valley, known for studies on snow hydrology, snow-vegetation interactions (Stillberg) and on accumulation and ablation patterns, lies within the cluster. A weather radar (MeteoSwiss) on Weissfluh (2832 m asl) and a planned Swiss Alpine Remote Sensing station (1513 m asl) will allow for new research, monitoring, and cal/val activities; map: http://bit.ly/1qEgXRJ

mapbox | © WMO | © Mapbox | © OpenStreetMap | Improve this map

Members

Station	Country	WMO Region	WIGOS ID
Davos observer station (SLF)	Switzerland	Europe	0-756-1-601286
Kreuzweg	Switzerland	Europe	0-756-1-605310
Flüela permafrost	Switzerland	Europe	0-756-1-387493
Davos Stilli (SLF)	Switzerland	Europe	0-756-1-927792
Davos ASRB (SLF)	Switzerland	Europe	0-756-1-799649



WORLD METEOROLOGICAL ORGANIZATION Weather • Climate • Water

Global Cryosphere Watch

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Cryosphere Now: Snow

The most recent snow cover information is given below. They are generally 1-4 days old. Hover over a thumbnail to get the full image, description, and credits. *Important: The products shown on the "Cryosphere Now" pages provide a variety of perspectives on the state of the cryosphere. They are for purposes of illustration and comparison and are not necessarily endorsed by GCW as "authoritative".* Note: Some of the products are not available in during the summer.

Cryosphere Now
- » Sea and Freshwater Ice
- » Snow and Solid Precip
- » Glaciers and Ice Caps
- » Ice Sheets and Icebergs
- » Permafrost
- » Atmosphere

Global:

NOAA Multisensor Snow/Ice Cover | EC Global Snow Cover

Northern Hemisphere:

GCW/FMI SWE Tracker | EC/GCW NH Snow Extent Tracker | EC/GCW NH SWE Tracker

The Environment Canada (EC) GCW Snow Water Equivalent Tracker provides an estimate of current Northern Hemisphere SWE relative to the 1998-2011 period. It is based on the Canadian Meteorological Centre operational daily snow depth analysis with SWE estimated using a density look-up table. The CMC analysis uses surface real-time snow depth observations and model-derived information. More information, and trackers for North America and Eurasia, are available at the Canadian Cryospheric Information Network.

IMS Snow Cover

Rutgers Daily Snow Departure

https://oscar.wmo.int/surface/#/search/stationClusterReport/8

https://globalcryospherewatch.org/state_of_cryo/snow

Homogenising manual snow depth series

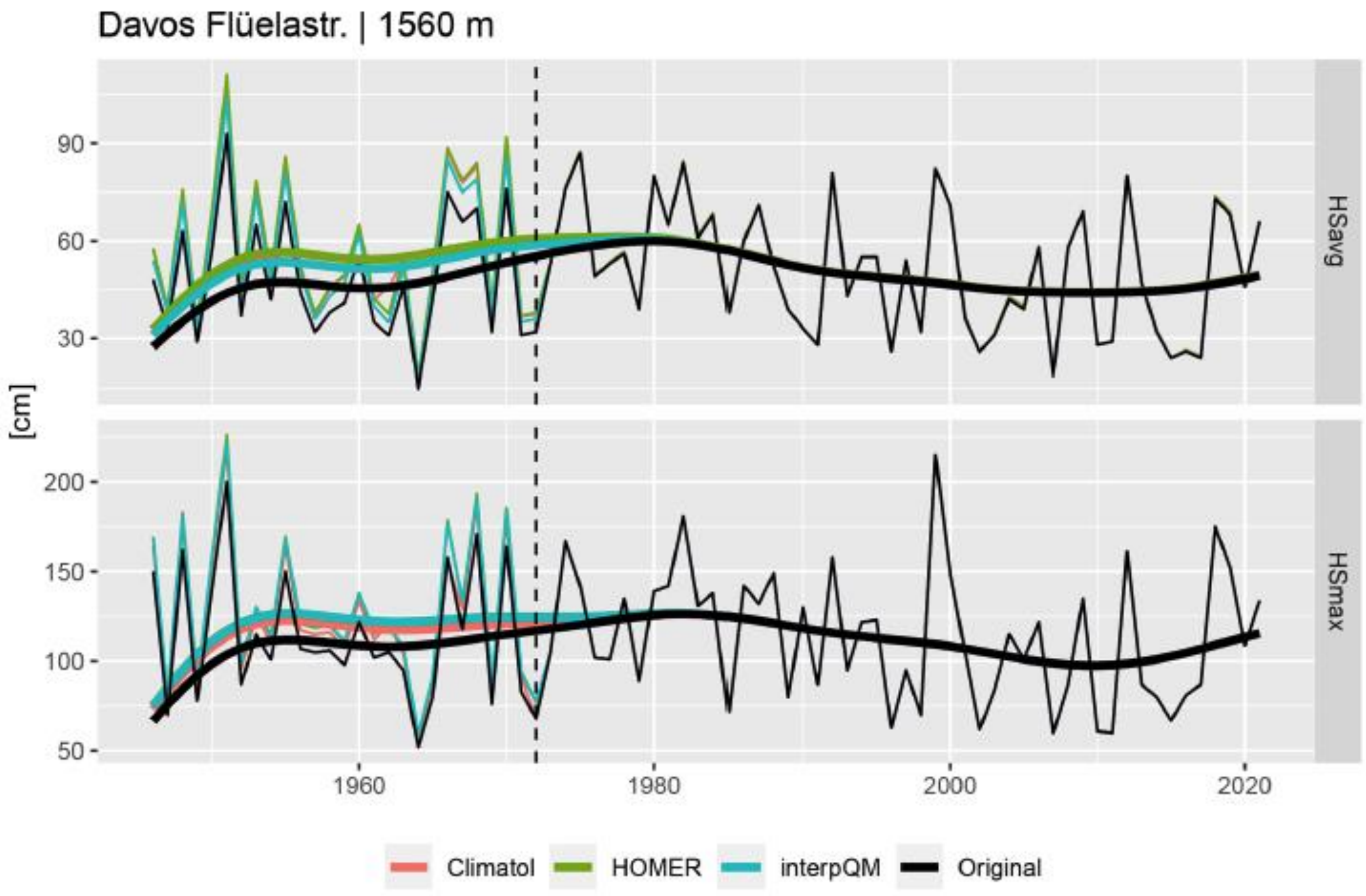


Figure 3. Comparison of original and homogenised seasonal mean (HSavg) and maximum (HSmax) snow depths for the SLF station in Davos. The thick lines show a Gaussian-filtered time series with a 30-year window and the vertical dashed line the identified break in 1972.

Buchmann, M., Resch, G., Begert, M., Brönnimann, S., Chimani, B., Schöner, W., and Marty, C.: The benefits of homogenising snow depth series – Impacts on decadal trends and extremes for Switzerland, The Cryosphere, 17, 653–671, https://doi.org/10.5194/tc-17-653-2023, 2023.

HarmoSnow (COST action ES1404)

The “European Snow Booklet” (ESB)

It is a book of reference for snow measurements, a unique collection of information about current operational snow observations in 38 European countries and what methods are used to perform basic measurements of snow on the ground. Numerous institutions of 38 European countries provided detailed information on their operational snow measurement networks. The ESB aims at a better knowledge transfer between the scientific community, operational services dealing with snow measurements, and the general public with regards to different basic snow measurement methods applied in each European country.

Anna Haberkorn (Ed.): European Snow Booklet – an Inventory of Snow Measurements in Europe, EnviDat, https://doi.org/10.16904/envidat.59, 2019.

Sodankylä (FI), 2018

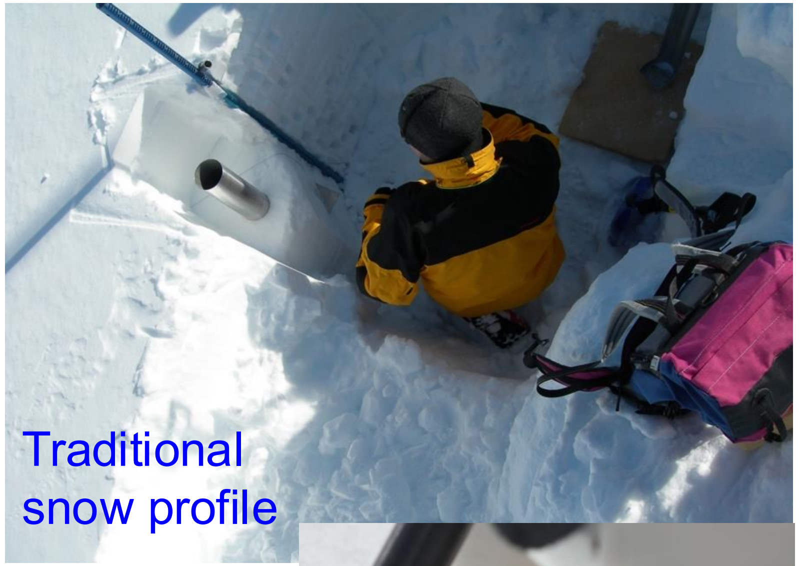
Intercomparison campaigns

López-Moreno, J. I., Leppänen, L., Luks, B., Holko, L., Picard, G., Sanmiguel-Vallelado, A., Alonso-González, E., Finger, D. C., Arslan, A. N., Gillemot, K., Sensoy, A., Sorman, A., Ertaş, M. C., Fassnacht, S. R., Fierz, C., and Marty, C.: Intercomparison of measurements of bulk snow density and water equivalent of snow cover with snow core samplers: Instrumental bias and variability induced by observers, Hydrological Processes, 34, 3120–3133, https://doi.org/10.1002/hyp.13785, 2020.

WMO Measurement Lead Centre:
Snow Monitoring Competence Centre (SMCC)
Davos, Switzerland

Scope of the Snow Monitoring Competence Centre

- The proposal of a Snow Monitoring Competence Centre (SMCC) was developed by the Global Cryosphere Watch (GCW) community.
- Establish a Competence Centre building on the existing mature framework of WMO-INFCOM Measurement Lead Centres
- Provide expertise on in situ snow measurements and standards for snow data quality checks
- Connect both measurement and modelling experts to raise awareness of each other needs



Concluding remarks

- Common terminology and practices are required to exchange data reliably across disciplines
- There is no ‘true’ or ‘reference’ value for SWE
- New methods need to be validated and their limits to be known
- Homogenisation of snow data series is an asset
- Snow in the atmosphere, as a material or as a cover is fascinating!


Thanks for your attention!
GCW CryoNet cluster Davos
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