



DESIGNATION OF THE WMO MEASUREMENT LEAD CENTRE ON SNOW MONITORING — SNOW MONITORING COMPETENCE CENTRE, DAVOS (SWITZERLAND)

Overview

This INF document provides technical support for [Draft Resolution 6.2\(7\)/1 \(INFCOM-2\)](#) on the designation of the WMO Measurement Lead Centre on Snow Monitoring — Snow Monitoring Competence Centre, Davos (Switzerland)

Introduction

The proposal of a Snow Monitoring Competence Centre (SMCC) was developed by the Global Cryosphere Watch ([GCW](#)) community. With the recent integration of the GCW activities under the remit of the WMO Infrastructure Commission ([INFCOM](#)), sustaining both the availability of quality snow data and expert knowledge in snow measurement issues benefits from the sustainable framework as a Measurement Lead Centre.

Motivation

The global monitoring of snow variables is of increasing importance and requires the exchange of knowledge with regard to measuring snow variables, with common best practices developed and applied broadly to allow comparability.

Snow is an integral component of the Earth System in regard to climate (e.g. albedo feedback) and has a role as water storage resource for irrigation, drinking water, and hydropower. Snow as frozen precipitation is globally of increasing importance in a world which is faced on the one hand by more frequent droughts, where snow and ice (which can be seen as old snow from previous years) play an important role as water storage and on the other hand by more extreme precipitation events, where snow can dampen immediate run-off but on the other hand also cause avalanches or floods. Decreasing snow cover due to climate warming and due to increasing dust and soot loads lowers the planetary albedo, which changes the energy balance of our planet.

The COST Action "HarmoSnow", in which 29 European countries participated, that resulted in the compilation of the "European Snow Booklet" (Haberkorn, 2019) contains info on snow measurements from 38 European countries. The GCW Expert Team on Snow Watch prepared the new chapter "Measurement of Snow" in Volume II "Measurement of Cryospheric Variables" of the WMO [Guide to Instruments and Methods of Observation](#) (WMO-No. 8/Vol II). Such tasks clearly demonstrated the need for a SMCC, as a competence centre.

SMCC Terms of Reference

This proposal builds on the existing mature framework of WMO-INFCOM Measurement Lead Centres ([MLCs](#)), and is proposed as a specialized MLC, with terms of reference consistent with those defined by [Resolution 10 \(INFCOM-1\)](#). It will aim at establishing a knowledge-based

competence centre that would assume functions in support of sustaining the quality of both snow observations and snow data, and would include capacity development activities. This centre would link to the GCW data portal to facilitate the access to data sets and data providers.

The proposed SMCC shall provide high-level expertise in surface-based remote sensing and in situ instruments for the measurement of key snow variables, with the following functions:

- Be a competence centre where latest snow related instrument technology, systems and techniques are applied and explored, towards, among others, providing advice and expertise on their potential for operational and cost-effective use by WMO Members and the scientific community
- Provide, publish and promote its achievements and findings, in particular on integration of snow related surface-based remote sensing and in situ measurements, as well as on the development of standard procedures related to instrument use, operation and maintenance
- Collaborate with other MLCs and WMO regional centres in areas of common interest
- Collaborate with other scientific and development institutions and agencies, and instrument manufacturers
- Develop a special relationship with a companion facility from a developing country, where appropriate
- Actively contribute to the work of INFCOM, and in particular with SC-MINT, by contributing and developing relevant material to ensure that latest knowledge, procedures, and best practices are properly reflected in WMO regulatory and guidance publications

A Scientific Steering Committee under the auspices of the International Association of Cryospheric Sciences ([IACS/IUGG](#)) will support and advise the SMCC.

The proposed SMCC Davos will be part of the WMO-INFCOM Measurement Lead Centres network under the leadership of the Standing Committee for Measurements, Instrumentation and Traceability (SC-MINT) and the Expert Team on Snow Watch of the Global Cryosphere Watch Advisory Group (GCW-AG).

The proposal for the establishment of a SMCC is timely, coincides with the newly established Joint Body on the Status of the Mountain Snow Cover ([JB-SMSC](#)), a joint venture between IACS, the Mountain Research Initiative ([MRI](#)), and GCW, and it will support it.

Structure of the SMCC Davos

The SMCC will be located in Davos, Switzerland, under the remit of the WSL Institute for Snow and Avalanche Research ([WSL/SLF](#)), which includes the Climate Change, Extremes and Natural Hazards in Alpine Regions Research Centre ([CERC](#)). MeteoSwiss will serve as the link to WMO. Supporting partners are the Swiss Federal Office for the Environment ([FOEN](#)), the canton Graubünden through the newly established [CERC](#) under the remit of WSL/SLF, and potentially the Swiss Development Cooperation ([SDC](#)).

Switzerland is an Alpine country with a well-known tradition in snow and avalanche research as well as maintainer of a dense network of long-term snow monitoring stations as well as for glaciers ([GLAMOS](#)) and permafrost ([PERMOS](#)). This makes Switzerland an excellent partner for the proposed SMCC Davos that will serve the community by:

- Providing expertise concerning in situ and remote measurement practices of key variables like snow depth, bulk snow density, water equivalent of snow cover, depth of snowfall, and of measurements of snow microstructure and macroscopic properties of the snowpack
- Elaborating measurement guidelines for the different snow variables depending on snow climate and application
- Defining standards and best practices for snow data quality checks depending on the application the snow data are used for
- Developing standards and procedures to fill gaps in snow data series
- Sharing expertise in homogenization of snow measurements
- Demonstrating the chances and limits of surface-based remote sensing measurements of snow, for example with drones
- Supplying infrastructure in long-term investigation fields to test new measurement sensors against reference measurements
- Organizing workshops in snow measurement techniques and snow data interpretation for scientists, modelling-experts, and practitioners

The WSL Institute for Snow and Avalanche Research SLF (WSL/SLF) has over 80 years of experience in monitoring the snow cover and measuring snow properties, not only in the Alpine environment. In recent years, research and applied projects have resulted in new approaches to homogenize long-term time series of snow observations and to develop gridded climatic products of both snow depth and water equivalent of snow cover.

With a long tradition in capacity building, WSL/SLF is ready to support installing efficient and sustainable snow monitoring networks in developing countries, for example in Central Asia. Considerations are given to the organization of courses and workshops. Finally, the WSL/SLF infrastructure is well suited for the development of instruments to measure snow properties as well as verification and validation of new methods of snow observation including terrestrial, airborne, and spaceborne remote sensing. Knowledge and resources available at WSL/SLF makes it an outstanding institution to establish a WMO-INFCOM Measurement Lead Centre on Snow Monitoring.

Current activities of WSL/SLF and MeteoSwiss in Davos

WSL/SLF and MeteoSwiss are in charge of a large [network](#) of manual and automatic in situ snow observations, which are among others used for avalanche warning, climatology, hydrology, and Numeric Weather Prediction. They build on a long tradition of in situ snow and meteorological measurements both at Weissfluhjoch (since [1937](#) and [1947](#), respectively) and Davos (since [1945](#) and [1866](#), respectively). The close collaboration of both institutions also reflects itself in the measurement of solid precipitation within the premises of the CryoNet station "[Weissfluhjoch Versuchsfeld](#)". There a Double Fence Automatic Reference (DFAR) and various other precipitation recording instruments were deployed during the active phase of the second WMO Solid Precipitation Intercomparison Experiment ([SPICE](#)). Today MeteoSwiss continues to monitor part of these instruments, including the DFAR, and uses the site for reference measurements.

WSL/SLF investigates all aspects of [snow](#) using measuring methods that have proved themselves over decades as well as state-of-the-art measurement instruments, many of which being developed in-house or adapted to the special requirements of snow research. Different automatic snow depth and SWE sensors are also being tested by SLF, analysing the potential

of drones to get information about the spatial variability of snow depth. Furthermore, a current project investigates the potential of semi-automatic methods to detect non-climatological breaks (inhomogeneities) in snow depth series.

Planned activities of the SMCC Davos

The starting activity of the SMCC Davos is closely linked to a proposal submitted to a joint call by GCOS-CH and GAW-CH and will be followed up independently of the outcome of this submission. The project "Boosting the quantification of spatio-temporal observations of solid precipitation and water equivalent of snow cover (SWE) in high mountain areas (BOSTOPS-mountain)" aims at fostering progress in snow monitoring techniques along an altitude transect between 800 and 3000 m asl. If approved, the project will deal with monitoring SWE at high altitude in the region of the Integrated CryoNet Cluster Davos. Thereby Quantitative Precipitation Estimates of the weather radar "Weissfluhgipfel" will be compared to in situ measurements from lake pressure sensors, cosmic ray sensors, Global navigation satellite system sensors, snow scales, and snow pillows. WSL/SLF will lead a consortium including the Laboratory of Hydraulics, Hydrology and Glaciology (VAW-ETHZ), the Glacier Monitoring Switzerland (GLAMOS), the Institute of Hydrology and Water Management (HyWa, BOKU Vienna), the Department of Geosciences of the University of Fribourg (UNIFR), MeteoSwiss, and two instrument manufacturers (Hydroinnova LLC, ANavS GmbH).

A second activity, the international project "Snowtinel" funded by the Swiss National Science Foundation, already started and will continue until 2025. The project aims at improving Sentinel-1 SAR assisted catchment hydrology for Alpine regions. This requires a better understanding of the physical interactions of the radar signal with a wet snowpack. The project includes in situ measurements of SWE, the liquid water content of the snow cover, and snow surface roughness at the CryoNet stations "Davos Laret" and "Weissfluhjoch Versuchsfeld".

Further reading

WSL/SLF: Schnee und Lawinen in den Schweizer Alpen.

<https://www.dora.lib4ri.ch/wsl/islandora/search/winterberichte?type=dismax>

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