ENVIronmental Research and Monitoring SONNBLICK Programme 2026-2030

ENVISON-2030

GeoSphere Austria

Sonnblick Advisory Board “Sonnblick Beirat”
GeoSphere Austria, Department Sonnblick Observatory

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CONTENT:

PREAMBLE

ENVISON-2030 describes the science focus of the Sonnblick Observatory for the period 2026-2030. ENVISON was formulated by the Sonnblick Advisory Board[1] in the light of key research questions and by exploiting the strengths and scientific uniqueness of the Sonnblick Observatory.

ENVISON-2030 is neither a financed program, nor does it exclude other research topics at the SBO. It outlines the general research priorities in the frame of international research activities and monitoring programs and is integrated in the strategic plan of the owner and operator GeoSphere Austria. It is based on the synergy of running and already funded monitoring programs and research projects as well as considering future research needs.

Members of the Sonnblick Advisory Board in 2026 (in alphabetical order)

NAME	INSTITUTION
AVIAN, MICHAEL	GeoSphere Austria
BAUER-BECK, SYLVIA	GeoSphere Austria
BAUMANN-STANZER, KATHRIN	GeoSphere Austria
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BUXBAUM, IRIS	Umweltbundesamt
GILGE, STEFAN	DWD (Deutscher Wetterdienst)
KASPER-GIEBL, ANNE	TU Wien
KRANABETTER, ALEXANDER	Amt der Salzburger Landesregierung
KRIECH, MARTIN	BMLUK
LUDEWIG, ELKE	GeoSphere Austria
NICKUS, ULRIKE	Universität Innsbruck
RIEGER, ANGELIKA	Nationalpark Hohe Tauern
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SATTLER, BIRGIT	Universität Innsbruck
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SCHAUER, GERHARD	GeoSphere Austria
SCHMID, HANNES	Amt der Kärntner Landesregierung
SCHÖNER, WOLFGANG	Universität Graz
SIMIC, STANA	Universität für Bodenkultur (BOKU)
SUPPER, ROBERT	GeoSphere Austria
WEINZIERL, BERNADETT	Universität Wien

FROM THE HOUSE ABOVE THE CLOUDS TO A UNIQUE RESEARCH PLATFORM

The **Sonnblick Observatory** was established in 1886 by the Austrian climatologist Julius Hann substantially supported by the owner of the nearby goldmine Ignaz Rojacher. Julius Hann was motivated by the need for upper-air measurements in meteorology. Among a larger number of mountain observatories established that time, the Sonnblick Observatory is the only station located in a high-altitude alpine environment which survived without any breaks until today. With meteorology being the starting point for the Sonnblick Observatory, other research disciplines identified the great experimental potential of the site very soon. The Nobel-prize winner V.F. Hess conducted experiments on cosmic rays. Glaciology became an important field of research at Mt. Hoher Sonnblick, with contributions by Albrecht Penck and by Eduard Richter being examples.

With its 100-years anniversary in 1986 the Sonnblick Observatory moved towards a new scientific era. The monitoring and investigation of the state of the environment including the climate and climate impacts became a new and highly relevant scientific topic. As a result, the research and monitoring program has been continuously developed and expanded.

With 2026 the Sonnblick Observatory performs and hosts excellent research in the fields of climatology, atmospheric sciences and glaciology. The many years of participation in monitoring programs of the WMO, like GCW (Global Cryosphere Watch Program, GAW (Global Atmosphere Watch Program), BSRN (Baseline Surface Radiation Network) have been complemented by involvement in European Research Infrastructures. Sonnblick Observatory supports the upcoming European Research Infrastructure LTER (Long-Term Ecosystem Research Network) and is founding member of ACTRIS (European Research Infrastructure for Aerosol, Cloud and Trace Gas). Contributions to ACTRIS comprise the topical center unit ECCINT (European Center for Cloud ambient Intercomparison and Standardization) and national facilities for aerosol and cloud in-situ measurements.

An up-to-date compilation of scientific activities is given annually within the brochure ‘Scientific Activities at the Sonnblick Observatory’ available via www.sonnblick.net.

INFRASTRUCTURE AND SERVICE FOR RESEARCH

The Sonnblick Observatory offers physical, remote and virtual access and personnel support.

Physical access is easy and safe via a 10-minute cable-car ride. The station is electrically operated and thus almost emission-free.

Technicians are available 24/7 at the station and can assist during operation. Accommodation for longer field experiments is available from the adjacent mountain hut “Zittelhaus”. Special advice on weather conditions for field experiments is provided from the GeoSphere Austria regional office at Salzburg.

A collective fiber network at the site, access to and from the internet via VPN over broad band fiber connection and a central SQL database as a cloud service facilitate the technical aspects of undisturbed data exchange from the observatory to users in all parts of the world.

Sensors operated in the field around the Observatory can be included via LoRaWAN network.

Data is visualized via www.sonnblick.net while the SBO Data Portal provides an overview and access to data collected at the Observatory and its surroundings. It is accessible via the Sonnblick website or directly using data.sonnblick.net. The provision of near-real-time data is further pursued within ACTRIS and ENVISON-2030.

The Sonnblick Observatory is partner in several access projects funded by the European Union. Such access projects support scientists’ travel to the station and the stay at the Sonnblick Observatory.

UNIQUENESS

In the international context of high-mountain research, the Sonnblick Observatory and its science are outstanding because of:

- the unique climate time-series from 1886 to the present day, which allows us to investigate and understand climate change in the Alpine region from the pre-industrial period to the time of significant human influence
- the unique location of the atmospheric monitoring platform at 3100 m at the summit of Mt. Hoher Sonnblick without any local pollution sources in the surrounding area and thus optimal background conditions, at the same time with easy access to the surrounding high alpine landscape (including glaciers and permafrost sites)
- the highly interlinked monitoring and research programs covering the atmosphere, the hydrosphere, the lithosphere and the biosphere including the easy access to all environments – which allows not only to study temporal trends but also exchange and cycling processes in the environment
- the high experimental potential (physical, remote and virtual access is possible) offered by the Sonnblick team, enabling permanently supervised measurements or sampling campaigns
- the status as key climate monitoring station in Austria, monitoring essential climate variables

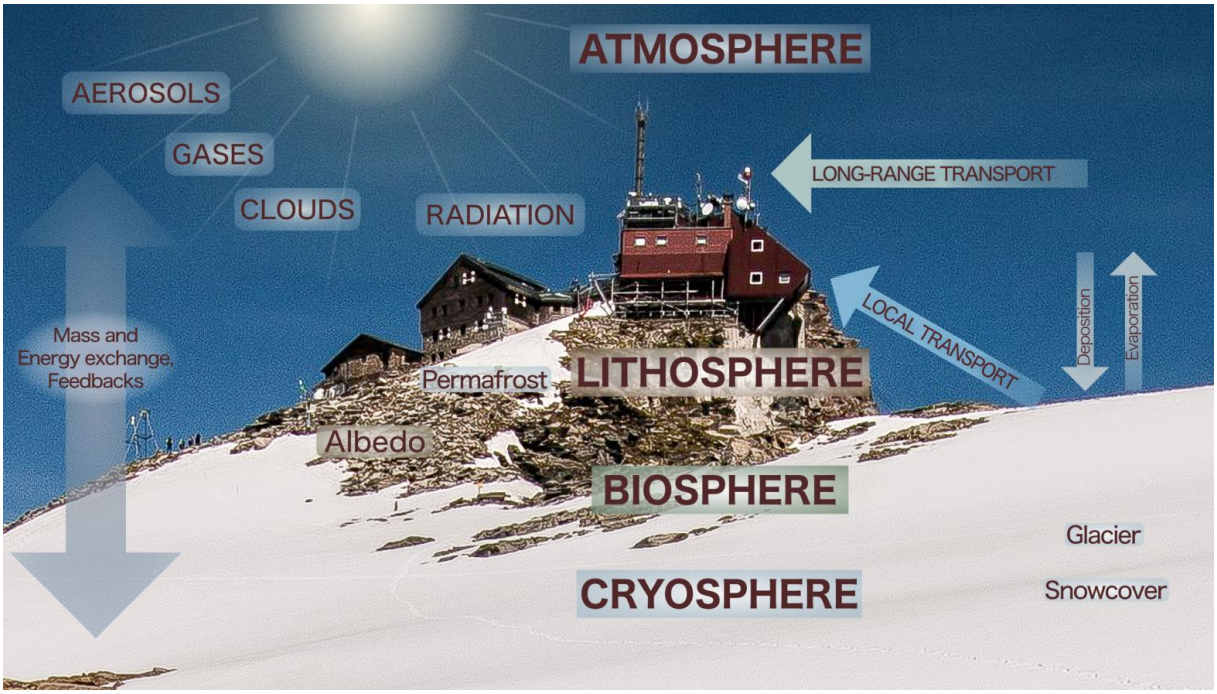

Figure 1: The Sonnblick Observatory at the virtual interface between the atmosphere, the cryosphere, the lithosphere and the biosphere.

STRATEGIC CONCEPT OF ENVISON

ENVISON acknowledges that monitoring and research are closely linked, interdependent and need to be combined. Monitoring programs are often initiated by research projects, and research conducted during intensive field campaigns needs to be embedded in longer data series of baseline variables. Statements on significant changes during dedicated research studies depend on sufficiently long and homogeneous monitoring time series.

ENVISON focuses on the major sub-spheres of the Earth (atmosphere, cryosphere and biosphere) which surround the Observatory.

Three sub-programmes are realized as part of ENVISON:

- ATMON (monitoring of the atmosphere)
- BIMON (monitoring of the biosphere)
- CRYMON (monitoring of the cryosphere)

Each sub-program is guided by an internationally recognised expert.

Presently (ENVISON-2030, for 2026-2030) these tasks will be fulfilled by:

- ATMON
  Stana Simic, Universität für Bodenkultur, Wien
- BIMON
  Birgit Sattler, University of Innsbruck
- CRYMON
  Wolfgang Schöner, University of Graz

The general structure of ENVISON is outlined in Figure 4.

The complexity and extensiveness of the three sub-programs vary over time, depending on the general research topics of ENVISON and the needs of shorter-term research projects.

Figure 2: The ENVISON concept

ATMON:

The monitoring includes meteorological variables as well as trace gases, particulate matter and radiation using in-situ and remote sensing techniques. The detatched location of the site at 3.106 m a.s.l., clear of any obstacles, provides a unique platform for the observation of the remote background troposphere for both, long-term monitoring and short-term field experiments. Continuous measurements of a wide range of parameters, e.g. defined by the requirements of Global Atmosphere Watch (GAW) create an excellent environment for novel research projects including the development of new methods, short- and long-term observational programs, e.g. related to the investigation of emerging atmospheric pollutants, bioaerosols, microplastic, increased impact of fires, and aerosol-cloud-climate interactions. The continuous monitoring allows to interpret changes over time, to understand the results of short-term ground- and airborne campaigns in the context of long-term observations, to evaluate established and new satellite data products, and provides important boundary conditions for the improvement of modelling capabilities.

Networks involved: NDACC, BSRN, GAW, ACTRIS

CRYMON:

The main objective of CRYMON is to contribute to the monitoring of the state of the cryosphere and related spatial and temporal changes in the Alps. The complexity of climate related changes of the cryosphere requires to establish strong linkages to ATMON and BIMON. CRYMON includes the monitoring of glaciers, perennial snow and permafrost. To cover all these aspects of the monitoring, spatially distributed observations at glaciers, permafrost sites and the snow cover were established. The spatial extent of the cryosphere and the related variability of atmospheric conditions require meteorological observations not only at the summit of Sonnblick but also in the surrounding area. CRYMON contributes to various international monitoring programmes as e.g. WGMS (World Glacier Monitoring Service), GTN-P (Global Terrestrial Network for Permafrost) and WMO GCW (Global Cryosphere Watch).

Networks involved: WGMS, GCW, GTN-P

***BIMON*:**

BIMON establishes a regular monitoring of changes in vegetation, stream-flow ecology and the cryobiota in high altitude ecosystems. Glacial ecosystems are tightly linked to atmospheric properties and are highly sensitive sentinels for climate change. By observing biological activity and diversity, it will be possible to gain added value from linking atmospheric changes to changes in the cryosphere and finally to the consequences for the biosphere, not observed elsewhere in the Alps. Several ecological observations are currently performed as part of research projects. The co-operation with NP Hohe Tauern is part of BIMON. BIMON offers most valuable data sets for the network LTER in terms of biodiversity and biogeochemistry of aquatic and terrestrial ecosystems.

Networks involved: LTER, Biodiversity

RESEARCH TOPICS AT THE SONNBLICK OBSERVATORY

The status of monitoring and research activities are yearly summarized within the Sonnblick brochure "Sonnblick Observatory - Scientific Activities" which can be downloaded via the Sonnblick webpage (www.sonnblick.net/en/data/download-portal/reports/).

Research activities at Sonnblick Observatory comprise meteorology, radiation, deposition, air chemistry, aerosols and bio-aerosols, clouds, glaciology, permafrost, seismology, biology, natural hazards, technical and instrumental development, the upper atmosphere, and also projects outside the ENVISON frame.

In addition to this wide portfolio of projects the Scientific Advisory Board has identified three focus areas that should receive special attention in the coming years. These focus areas are outlined below.

ENVISON FOCUS FOR 2026-2030:

FOCUS 1: Synergies between pilot-studies and long-term monitoring

The Sonnblick Observatory hosts unique time series of environmental data at the interface of atmosphere, cryosphere and biosphere. These long-term data sets provide a unique opportunity to frame dedicated process-oriented or technical studies and to foster intra- and interdisciplinary research in the field of Earth System Sciences.
The complementary support of long-term monitoring programs and dedicated research initiatives shall be further intensified. Based on the current involvement in ACTRIS and NDACC, aerosol-cloud-climate interactions and their influence on atmospheric radiation, can be one, but need not be the only topic.
Examples include an extension of the portfolio of parameters already assessed within monitoring programs to compounds of emerging concern (e.g. microplastics, PFAS or microbial communities) and the testing, development and application of innovative measurement techniques (e.g. related to ground-based remote sensing or to miniaturized measurements systems to be applied on mobile platforms). The complementary evaluation of monitoring activities and research projects should always be established.

Additionally, the integration of existing long-term time series, e.g. of UV radiation and ozone measurements and aerosol observations, shall be pursued to capture and model complex atmospheric processes. With its extensive long-term measurement series and active involvement in international calibration initiatives, the resulting evaluations will be essential for the validation of satellite-based observations and also for the support of science-based policy frameworks, such as the Montreal Protocol.

FOCUS 2: From point to space – linking in-situ observations with remote sensing data

Today, the Sonnblick Observatory is the center of an extensive environmental monitoring program around the observatory, unique for the Alps and located in the middle of the 'Hohe Tauern National Park'. While in the past ground-based measurements played a dominant role in many areas of environmental monitoring, the development of satellite-based observations has played an increasing role in the last decade. This role will increase in the future but remains dependent on high quality ground measurements, that allow calibration and validation of satellite methods. For this

purpose, ground measurements that are tailored to the satellite measurements (both spatially and temporally as well as by measuring specific spectra, etc.) are of great importance and are needed. Sonnblick with its already existing interfaces to satellite monitoring (e.g. for radiation via BSRN) will expand and strengthen these connections in the future. The aim is to integrate the Sonnblick Observatory even more closely into international satellite monitoring programs and to define standards for ground truth that are relevant for the creation of existing and new remote sensing products and data sources. A close interface with the ESA and other space organisations should therefore be sought.

FOCUS 3: Consequences of the rapid declining cryosphere

The Cryosphere —including the snow, glaciers, and permafrost—is currently in an exceptional phase of retreat, represented by e.g. decaying glaciers, glacial lake formation, unprecedented lack of snow or strong permafrost degradation. Natural hazards triggered by changes of single cryosphere components (e.g. glacier retreat) or compound effects (glacier and permafrost retreat) are causing many recent natural hazard events in the Alps, such as the large mudflow in 2023 at the foot of Sonnblick. A better understanding of the causes and effects of such events is essential for research and practice.

The strongly retreating cryosphere also represents unique and often extreme habitats that support a wide range of highly adapted microbial and other life forms. These organisms have evolved remarkable strategies to survive under conditions of persistent cold, low nutrient availability, and high radiation, making them not only fascinating from an ecological and evolutionary perspective but also highly valuable for biotechnological exploration. Their enzymes, proteins, and metabolic pathways frequently exhibit properties that are of interest for industrial, medical, and environmental applications, such as cold-active enzymes used in detergents or bioremediation processes. However, the rapid decline of these frozen ecosystems due to global climate change threatens the loss of not just ice and snow, but also the untapped biological and genetic resources they contain.

As such, there is a growing urgency to investigate the full extent of biodiversity within these vanishing habitats, with a focus not only on cataloguing species but also on understanding their functional roles and potential applications.

On the one hand, the research from focus 3 will provide a better process understanding of natural hazards caused by the strong changes of the cryosphere. This will include also an extensive monitoring of the cryosphere, as the basis of modelling approaches. On the other hand, the study of ecology of cryospheric environments will reinforce the importance of preserving these critical and fragile environments. Additionally, this initiative would fit into the planned “Glacier Stewardship Program” (period of 10 years) where a biobank for cryospheric microbes is planned.

NATIONAL AND INTERNATIONAL INVOLVEMENT OF ENVISON

Table 1: ***Already established participation in networks – a selection:***

Abbreviation	Name	Link
ACTRIS	Aerosols, Clouds, and Trace gases Research Infra Structure	https://www.actris.eu/ https://actris.i-med.ac.at/
ARAD	Strahlungsmonitoring & Strahlungsmessnetz Österreich	
BSRN	Baseline Surface Radiation Network	https://bsrn.awi.de/products/quality-code/comparisons/sonnblick-son/
Copernicus	Monitoring atmospheric composition and climate	https://www.copernicus.eu/en/monitoring-atmospheric-composition-and-climate
GTN-P	Global Terrestrial Network for Permafrost	www.gtn-p.org http://gtnpdatabase.org/boreholes
LAWI SBO	Lawinenmessstation Sonnblick Observatorium	http://www.lawine.salzburg.at
eLTER	European Long-Term Ecosystem Research Network	www.lter-europe.net https://deims.org/b2015216-ac0a-433f-8044-8ba8c46cc6c9
MONET MonAirNet	Monitoring Network of persistent organic compounds	www.umweltbundesamt.at/umweltthemen/stoffradar/projekte/monarpop
NDACC	Network for the Detection of Atmospheric Climate	https://ndacc.larc.nasa.gov/ https://ndacc.larc.nasa.gov/stations/hoher-sonnblick-austria
NDMC	Network for the Detection of Mesospheric Change	https://ndmc.dlr.de/
GTS, TAWES	Global telecommunication system, Teilautomatische Wetterstation	https://public.wmo.int/en/programmes/global-telecommunication-system https://www.geosphere.at/de/karten/aktuelles-wetter/messwerte-wetterstationen
WGMS	World Glacier Monitoring Service	www.wgms.ch https://wgms.ch/products_ref_glaciers/
WMO-GAW	Global Atmosphere Watch	https://community.wmo.int/site/knowledge-hub/programmes-and-initiatives/global-atmosphere-watch-programme-gaw
WMO-GCW	Global Cryosphere Watch	https://globalcryospherewatch.org

- Access projects, like the transnational access projects (TNA) of the European Union

Moreover, ENVISON-2030 co-operates with strategic partners such as e.g. MRI (Mountain Research Initiative), VAO (Virtuelles Alpenobservatorium) and Nationalpark Hohe Tauern.
Initiatives which promote the location for validation and development of satellite products are supported. ENVISON-2030 emphasizes the relevance of data submission to the respective networks.

FINANCIAL MEANS FOR ESTABLISHING ENVISON

a) Agreement GAW-DACH

The majority of measurements of the ENVISON monitoring are funded by the national GAW-DACH agreement. The agreement is supported by the BMLUK[1], the BMFWF[2], the province of Salzburg, the province of Carinthia and the Austrian Environmental Agency (Umweltbundesamt).

b) Memorandum of Understanding ACTRIS

The ACTRIS (Aerosols, Clouds, Trace gases Research Infrastructure) activities at the Sonnblick Observatory, the National Facilities for aerosol and cloud in situ and the operation of the European Centre for Cloud Intercomparison (ECCINT) are financed by GeoSphere Austria (former ZAMG) following an MoU which was delivered to the BMFWF in 2019.

The membership fee for the European research infrastructure ACTRIS is supported by the BMFWF.

c) Monitoring and research programmes at BMLUK

The cryosphere monitoring, including the projects GCW-Glacier and GCW-Permafrost, and the radioactivity monitoring are performed with funding from BMLUK[2].

The long-term investigations of spectral UV radiation and total ozone are currently supported by the project "Long-Term Measurements of Total Ozone and High-Resolution Spectral UV Radiation at Hoher Sonnblick and Groß-Enzersdorf 2019-2029", which builds on a longer series of research projects.

d) BMFWF via GeoSphere Austria

The operation of the Sonnblick Observatory is a mandatory function of GeoSphere Austria. Since 2012 a series of, at that time, ZAMG internal projects significantly contributed to ENVISON. The project ASBO (Active Sonnblick Observatory) supported activities and the implementationof national and international monitoring programmes and networks. ASBO contributed to BSRN, ARAD, GAW, GCW, ACTRIS (see Table 1). In addition to ASBO, the services within ACTRIS, AeroCloud AT, and LTER contribute to supporting ENVISION.

e) national and international research funds

Researchers are encouraged to initiate research projects within national and international research funds for specific questions apart from monitoring activities (e.g. FFG, FWF, ÖAW, EU, or international cooperation)

f) national and international access funds

Researchers being interested in conduction research at the Sonnblick Observatory are encouraged to apply for funds via the access projects in which the observatory is involved in. Such funding is mainly provided by the European Union and supports transnational, remote and virtual access to the Sonnblick Observatory.

[1] Federal Ministry Agriculture and Forestry, Climate and Environmental Protection, Regions and Water Management, Republic Austria

[2] Federal Ministry Women, Science and Research, Republic Austria

CONTACT for Research Collaboration and further information

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