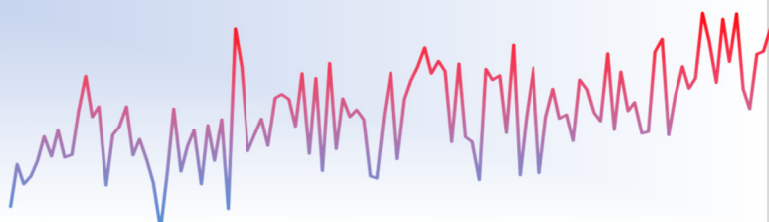
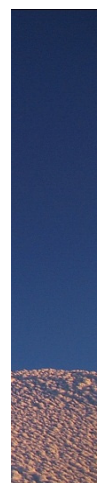


# ENVironmental Research and Monitoring SONNBLICK Programme 2011- 2015

## ENVISON



Sonnblick Beirat  
Central Institute of Meteorology and Geodynamics



Sonnblick - Research at the highest level

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## PREAMBLE:

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ENVISON is the research programme of the Sonnblick Observatory for the period 2011-2015. It is based on the strengths and scientific uniqueness of this research station and was formulated in the light of recent research topics by the members of the Sonnblick-Beirat (the advisory board for the development and the coordination of research of the Sonnblick Observatory).

ENVISON is neither a financed project nor does it exclude other research topics at Sonnblick. It, however, outlines the general research focus and structures in the frame of international research activities and monitoring programmes and is integrated in the strategy plan of ZAMG. ENVISON is not a funding programme by itself. It is based on a synergy of running and already funded monitoring programmes and research projects as well as, considering future activities, research foci of Austrian funding agencies, such as the very recently signed (at the level of ministers for science and research) agreement between Switzerland and Austria for common research on mountains regions.

### Members of the Sonnblick Beirat (in alphabetical order)

August Kaiser  
Anne Kasper-Giebl  
Bernd Niedermoser  
Dietmar Baumgartner  
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Reinhard Böhm  
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Stana Simic  
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## PAST DEVELOPMENT AND ACTUAL STATUS:

The Sonnblick Observatory was founded in 1886 by the Austrian climatologist Julius Hann (substantially supported by the owner of the nearby goldmine Ignaz Rojacher) motivated from the need for upper-air measurements in meteorology. Among a larger number of mountain observatories established that time, Sonnblick is the only station located in a high 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 and glaciology became an important field of investigations at Sonnblick as well, with contributions of Albrecht Penck or 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. Alpine wide studies on atmospheric chemistry and atmospheric physics initiated at Sonnblick resulted in the acceptance of the site in the Global Atmosphere Watch Programme (GAW) of the World Meteorological Organization. Today the funding of the GAW contribution of Sonnblick is based on a national contract. The environmental monitoring and related research projects grew significantly during the last 25 years and show the internationally outstanding position of Sonnblick in the fields of climatology, atmospheric research and glaciology.

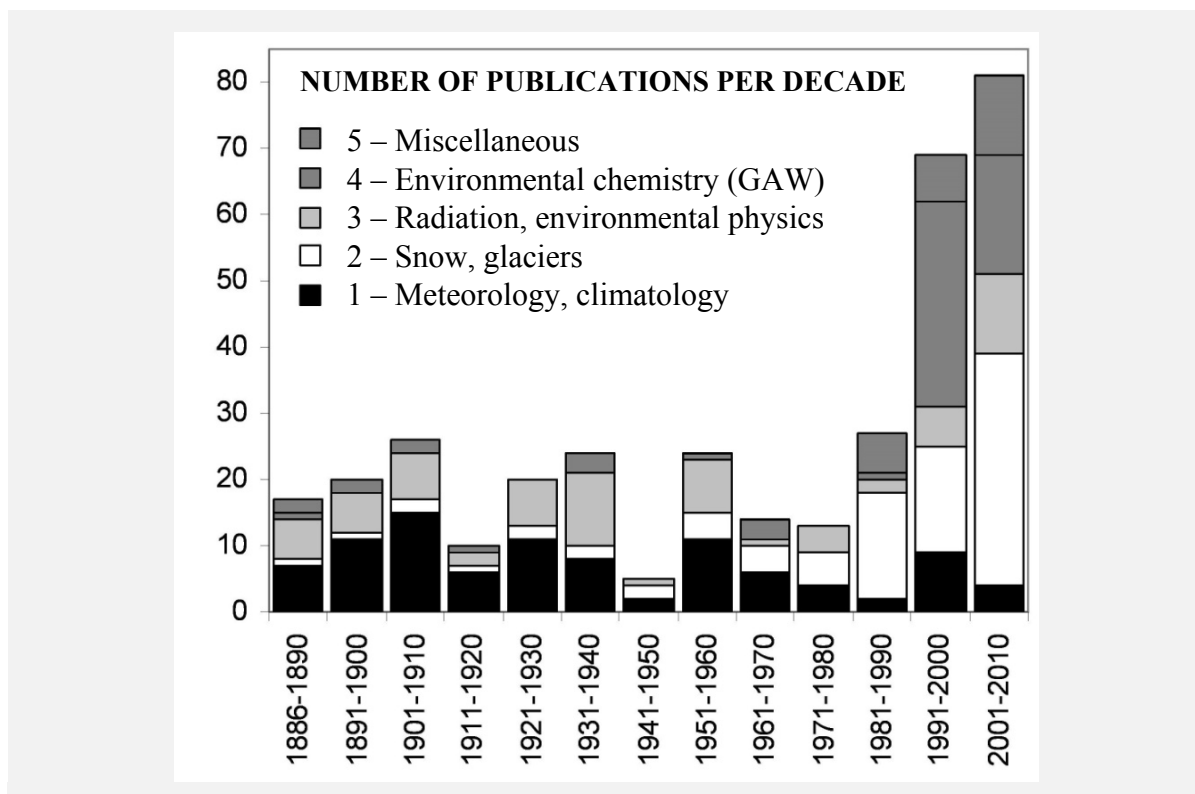


Figure 1: Development of Sonnblick research described by the number of publications and related research tasks

## UNIQUENESS:

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In the international context of high-mountain research the Sonnblick Observatory and its science stand out because of:

- the unique climate time-series from 1886 until now which allow to investigate and understand climate change in the Alpine region from the pre-industrial level to the period of significant influence of men
- the unique position of the atmospheric monitoring platform at 3100m at the summit of Sonnblick without local pollution sources around and thus optimum background conditions combined with
  - the direct access to the surrounding glaciers
- the highly interlinked monitoring and research programme covering the atmosphere, the hydrosphere, the lithosphere and partly the biosphere including the easy access to all environments – thus enabling to study not only temporal trends but also exchange and cycling processes in the environment.
- the high experimental potential offered by the onsite technical staff thus enabling permanently supervised measurements or sampling campaigns.



Figure 2: The Sonnblick seen from the North



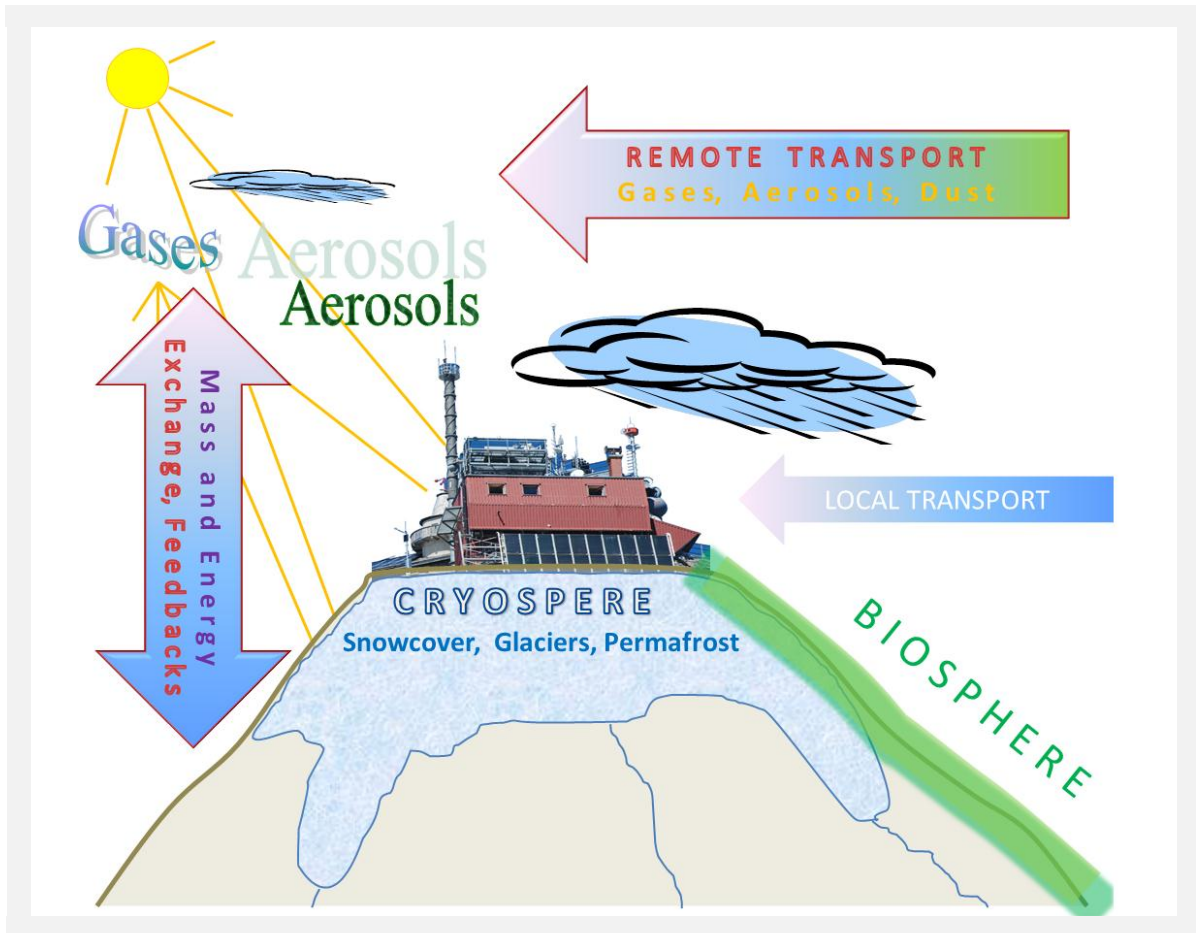


Figure 3: The Sonnblick Observatory at the virtual interface between the Atmosphere, the Cryosphere and the Biosphere

## ENVISON RELEVANT RESEARCH TOPICS:

1) Observation and understanding of climate change including its natural and anthropogenic driving forces in Austria and the Alpine Region (Baseline Climate Monitoring Station of Austria) and of climate impact on various spheres of the nature in the Alps as the region with most significant changes observed.

2) Observation and understanding of the anthropogenic influence on concentration

levels of trace species (gases, aerosols) as well as on processes and biogeochemical cycles in the background environment (with special focus on the atmosphere, the cryosphere and the biosphere).

3) Observation of extreme events (e.g. dust falls, volcanic activity, long range transport) and understanding of their impact on the environment

## CONCEPT:

Since **monitoring** and **research** are highly interlinked and depend on each other, e.g. monitoring programmes are often initiated from research projects, significant statements on changes are dependent on sufficiently long monitoring series. Thus ENVISON does not split according to this criterion but by the three major sub-spheres of the geosphere which surround the Observatory. The general structure of ENVISON is described by Figure 4.

The ENVISON monitoring is structured into three sub-programmes: ATMON (the monitoring of the atmosphere), CRYMON (the monitoring of the cryosphere) and BIMON (the monitoring of the Biosphere). Each monitoring sub-programme will be guided by an internationally accepted expert. The complexity and extensiveness of the three monitoring sub-programmes varies, depending on the general research topics of ENVISON and on the needs of shorter-term research projects.

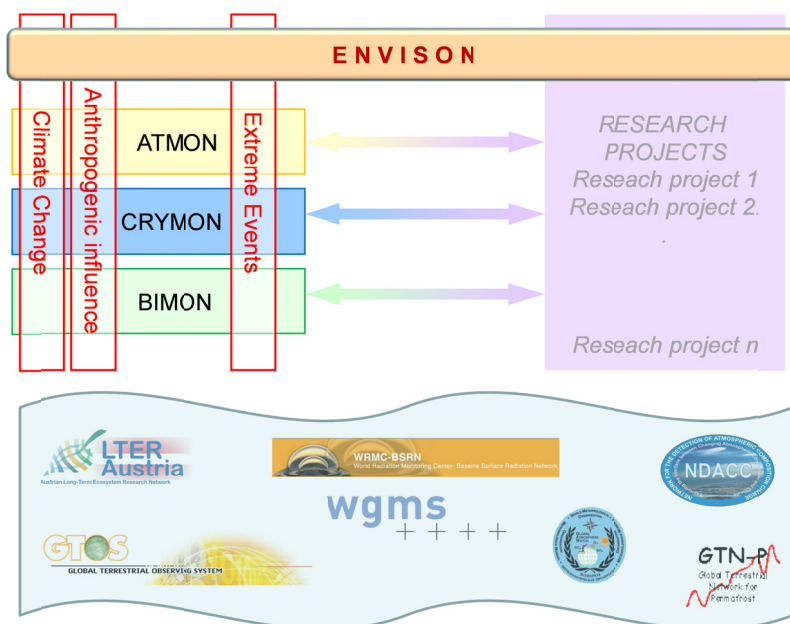


Figure 4: The ENVISON concept

**ATMON:**

The monitoring of the Atmosphere covers the acquisition of meteorological parameters as well as the determination of atmospheric trace gases, particulate matter and radiation. Regarding air constituents the Sonnblick Observatory allows a determination of the composition of the mid-troposphere, frequently reaching into the free troposphere, through all seasons. While a limited set of parameters, e.g. defined by the demands of GAW, has to be determined on a routine basis research projects introduce novel techniques and additional short term programs.



The continuous monitoring of trace gases and aerosols allows the evaluation of satellite data, model data and comparison with short time data of e.g. vertical profiles obtained by airplane measurements. The long-term GAW data as well as meteorological data enable interpretation of the outcome of a short term program (e.g. measuring campaign) in the light / scope of long term observations.

**CRYMON:**

The general aim of CRYMON is to monitor the status and the changes of the Cryosphere in the spatiotemporal domain at high elevation sites of the Alps as well as its linkages to the atmosphere and the biosphere. This includes the measurements of glaciers, perennial snow and permafrost. In order to capture all these aspects of the monitoring spatially distributed observations at glaciers, test fields of permafrost distribution and the snow cover are established. The spatial variability of atmospheric conditions in the region demands for meteorological observations not only at the summit of Sonnblick but also at various sites covering local variability. CRYMON contributes to various international monitoring programmes as e.g. WGMS (World Glacier Monitoring Service), Permanet and to the newly established WMO GCW (Global Cryosphere Watch).

**BIMON:**

Whereas ATMON and CRYMON are fully developed programmes linked to international monitoring programmes, BIMON is at the initial state. It is foreseen to establish a regular monitoring of vegetation changes and of changes of stream-flow ecology. Thus it will be possible to explore high 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. It is foreseen to transfer the project based research to a regular monitoring (in cooperation with Nationalpark Hohe Tauern).

## SERVICE:

Sonnblick offers a state-of-the-art research platform at the 3100m level with full power supply and high-speed access to the internet via WLAN. Very recently Sonnblick Observatory have started cooperation with external partners in order to provide a robust WLAN in the broader area of the observatory capturing the distributed network of sensors and stations in the field and to include them into the Sonnblick data base and offering online access via the internet.

Accommodation for longer field experiments is available from the adjacent mountain hut "Zittelhaus". Several mountain huts around Sonnblick offer

accommodation for field trips covering the area between the base station Kolm Saigurn and the top of Sonnblick. The Observatory can be accessed by cable-car by 20 minutes ride from base-station Kolm Saigurn. Special advice on weather conditions for field experiments are provided from the ZAMG regional office at Salzburg.

Data measured at Sonnblick Observatory and in the field are stored in the data base Sonnblick.net, accessible via the web. Thus not only the own data can be visualised but also access to other data is possible.

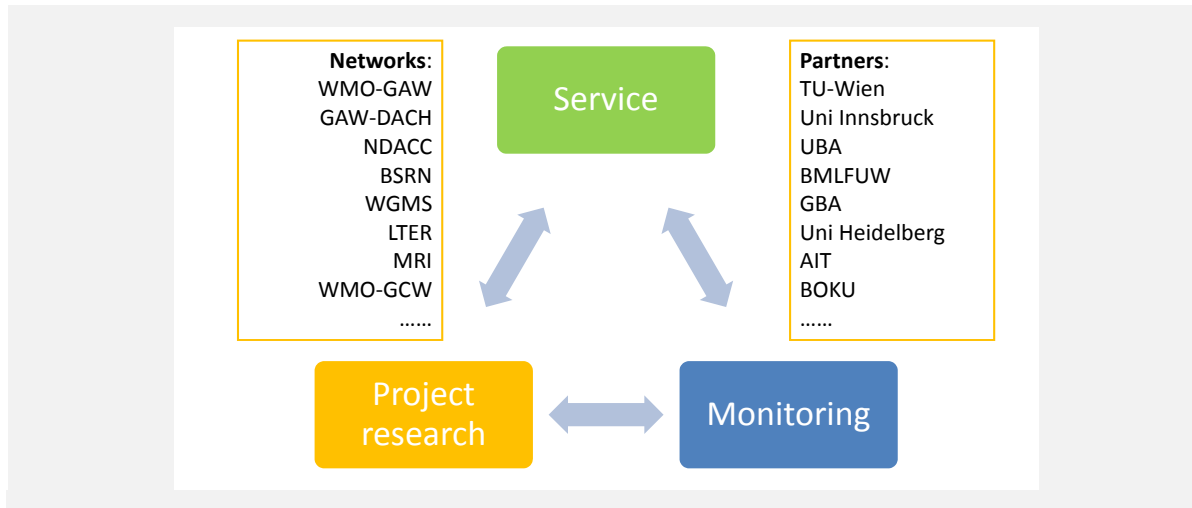


Figure 5: ENVISON in the frame of international networks and partners

## ENVISON FOCUS FOR 2011-2015:

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For the period 2011-2015 ENVISON will focus on 2 major research tasks:

### **FOCUS 1: Aerosols and radiation monitoring**

Atmospheric aerosols are a complex mixture of particles of different size, shape and chemical composition. Their strong influence on the radiation budget of our atmosphere is composed of direct and indirect effects. The complexity of these effects introduces uncertainties in assessing the net anthropogenic forcing. Backscattering of solar radiation leads to a cooling effect, while absorption processes warm the atmosphere. By inducing cloud formation aerosol particles alter cloud reflectivity and cloud lifetime and thus further influence the radiation balance.

Investigations of these processes rely on extensive campaign like measurement collecting programs and a routinely operated monitoring program, including instruments for the continuous determination of aerosol mass, size distribution, light scattering and absorption coefficients. This effort has been initiated with a number of pilot cooperative projects. Aerosol light absorption measurements at different wavelengths with an aethalometer have already been started and will be continued in cooperation with Aerosol d.o.o. (Ljubljana, Slovenia). The University of Vienna (Aerosol Physics and Environmental Physics) shows interest in supporting the measurements with a multi-wavelength nephelometer and a SMPS (Scanning Mobility Particle Sizer). The ZAMG is about to install a monitor for the continuous determination of aerosol mass and a new aerosol inlet ('internal project' QRS Sonnblick). The aerosol

measurements have to be closely linked to available trace gas measurements, which act as tracers and precursors for particulate matter. Measurements of aerosol properties do not serve only climate studies but a well-equipped aerosol monitoring program allows to detect and respond to extreme events like dust falls (Saharan dust) or volcanic activity and to characterize long range transport of forest fire and anthropogenic pollution events. The combination of aerosol and trace gas monitoring and atmospheric modeling supports forecasts of key parameters linked to air quality, climate and radiation.

### **FOCUS 2: Linkages of cryosphere to atmosphere, water cycle and downstream ecology**

During the last decades Alpine glaciers have been strongly retreated and Alpine permafrost has been decreased due to atmospheric warming. Alpine cryosphere is among the most prominent climate impacts. Beside their impressive appearance glaciers are important for mountain hydrology and ecology. The surface energy balance and the surface radiation balance in particular are of high interest in order to understand the changes and feedbacks of Alpine cryosphere in relation to the larger scale climate. In this regard aerosols play a major role not only as important factors of radiative forcing in the atmosphere, but also for dry and wet deposition and consequently for the surface conditions of glaciers and snow fields (albedo effect). The surface conditions of glaciers are known to significantly influence the surface radiation balance and, consequently, the glacier melt. From the

group of aerosols black carbon is of highest interest for both the atmosphere and the cryosphere because of its significant influence on radiation scattering and absorption as well as surface reflection (albedo). Moreover, through the physical process of snow- and glacier melt deposited aerosols are dissolved in melt water influencing glaciers ecosystems (e.g. cryoconite) and the downstream river flow ecology.

Several of these processes described above are either already captured from running measurements of the monitoring programmes or planned as part of focus 1. Additionally, in 2010 measurements of black carbon were initiated at Sonnblick, too. Thus applying a cross-cutting approach merging several monitoring projects the transfer of black carbon from the atmosphere to the cryosphere and finally to the biosphere can be studied.

## NATIONAL AND INTERNATIONAL INVOLVEMENT OF ENVISON:

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### ***National partnership:***

National partnerships already cover a number of institutions listed in the Table at page 8. ENVISON is open to new cooperations in the future.

### ***Already established participation in networks:***

**WMO-GAW** (Global Atmosphere Watch [www.wmo.int/pages/prog/arep/gaw/gaw\\_home\\_en.html](http://www.wmo.int/pages/prog/arep/gaw/gaw_home_en.html))

**GAW-DACH** (GAW-cooperation Germany, Austria, Switzerland)

**NDACC** (Network for the Detection of Atmospheric Climate Change [www.ndsc.ncep.noaa.gov](http://www.ndsc.ncep.noaa.gov))

**WGMS** (World Glacier Monitoring Service [www.wgms.ch](http://www.wgms.ch))

**GTN-P** (Global Terrestrial Network for Permafrost [www.gtnp.org](http://www.gtnp.org))

**MACC** (Monitoring atmospheric composition and climate [www.gmes-atmosphere.eu](http://www.gmes-atmosphere.eu))

### ***To be established participation in networks in the period 2011-2015:***

**BSRN** (Baseline Surface Radiation Network [www.gewex.org/bsrn.html](http://www.gewex.org/bsrn.html))

**WMO GCW** (Global Cryospheric Watch

[www.wmo.int/pages/mediacentre/infonotes/GlobalCryosphere.html](http://www.wmo.int/pages/mediacentre/infonotes/GlobalCryosphere.html))

**LTER** (European Long-Term Ecosystem Research Network [www.lter-europe.net](http://www.lter-europe.net))

**ACTRIS** associated partner (Aerosols, Clouds, and Trace gases Research Infra Structure Network [www.actris.net](http://www.actris.net))

Moreover ENVISON will cooperate with strategic partners such as e.g. MRI (Mountain Research Initiative) and Nationalpark Hohe Tauern.

## MANAGEMENT:

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### **a) ENVISON scientific steering group:**

station manager, deputy station manager, Monitoring program chairs, national experts, international experts

### **b) Sonnblickbeirat**

Scientific Advisory Board of the Director of the Central Institute for Meteorology and Geodynamics for the development and the coordination of research of the Sonnblick Observatory

## FINANCIAL MEANS FOR ESTABLISHING ENVISON:

### a) MoU GAW-DACH

The majority of measurements of the ENVISON monitoring are funded by the national GAW-DACH MoU. The MoU is supported by the BMLFUW, the BMWF, the province of Salzburg, the province of Carinthia and the Austrian Umweltbundesamt.

### b) Monitoring programmes at BMLFUW (Austrian Lebensministerium)

The cryospheric monitoring is performed with funding from BMLFUW including the projects HIGHmon and PERSON.

### c) BMWF via ZAMG:

The operation of Sonnblick Observatory is a sovereign function of ZAMG. In 2011 several ZAMG internal projects will significantly contribute to ENVISON. The following projects are foreseen: ARAD which is a follow-up for the monitoring of the radiation balance will establish Sonnblick as a BSRN standards station. QRS Sonnblick allows the installation of a new aerosol inlet and a monitor to

determine aerosol mass. Depending on the financial situation this kind of funding should contribute to ENVISON until 2015.

### d) FWF research focus (NFN or DACH)

A group of ENVISON researchers will initiate a research project for the ENVISON focus 1 or 2. Dependent on the number of participants and structuring either a NFN or a FWF-DACH cooperation is foreseen.

### e) ÖAW research programmes

The Austrian Academy of Sciences (ÖAW) is already supporting ENVISON from a bulk of projects related to changes of permafrost and glaciers. This kind of funding should be extended (according to the competitive rules of ÖAW for research projects).

### f) International programmes for science and research

Groups interested in conducting research at SBO will try to gain funds from international funding programmes.

Table 1: Annual expenditure for running the ENVISON monitoring

Monitoring sub-programme	Task	Manpower / year	Technician (PM)	Current status	Institution	Current funding
		Academic (PM) actual/total needed				
ATMON	Gases	8/8	3/3	running	UBA/ZAMG	UBA, BMWF, LS, LK
ATMON	Aerosols	0/12	0/2	open	TUVienna	
ATMON	Radiation	1/5	1/1	running	ZAMG	BMWF
ATMON	UV, O3	6/6	3/3	running	BOKU	BMLFUW
ATMON	Meteorology	6/6	48/48	running	ZAMG	BMWF
CRYMON	Glaciers	7/12	0/1	running	ZAMG	BMLFUW
CRYMON	Permafrost	6/12	0/1	running	ZAMG	BMLFUW
CRYMON	Snowcover	1/4	0/1	running	ZAMG	BMLFUW, BMWF
CRYMON	Hydrology	1/1	0/1	running	ZAMG	BMLFUW
BIOMON	Stream ecology	3/3	0/1	running	UIBK	ÖAW
<b>TOTAL</b>		<b>39/69 (56%)</b>	<b>55/62 (89%)</b>			
PM	Person months					

## MEASURE OF SUCCESS - EVALUATION:

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Increased national and international recognition of ENVISON research is the key task of this programme. Significant measures of the success of this programme are:

- Significant number of relevant peer-reviewed journal papers
- Increased number of academic works (Master thesis, Doctor thesis)
- Increased number of research projects
- Increase of internationality and participation in high quality international networks
- Establishing of ecological monitoring task
- General increase of the funding means for ENVISON monitoring

The success of ENVISON will be evaluated by an international group of experts in 2015.



# STATUS LIST OF MONITORING AND RESEARCH PROJECTS AT SONNBLICK IN 2011:

## a) MONITORING

Name of project	Major objective	Monitoring type	Institution	Current funding
Meteorology	WMO standard meteorological elements	A	ZAMG	BMWF
Trace gases	NO, NO <sub>2</sub> , CO <sub>2</sub> , CO, surface O <sub>3</sub>	A	EAA	BMLFUW
StratoUV	UV, total Ozone	A	BOKU-MET	BMLFUW
Aerosols	Size distribution >0.2 >0.5 and 5 $\mu$ m	A	ZAMG	ZAMG
Aerosols	Number concentration	A	TUWAC/ÖAW/L-SBG	TUVAC
GNSS-Met	Water vapour in air column	A	TUVHG	FFG
ARAD	Shortwave and longwave radiation	A	ZAMG	BMWF
Radon	<sup>222</sup> Rn, Air masses characterisation from radon measurements	A	UHEID	UHEID
d18O, d2H	Stable isotopes of O and H in precipitation	A	UHEID	UHEID
Radioactivity	Radiativity aerosole monitoring, beryllium	A	AGES	BMLFUW
Radiation protection	Local dose rate, radiativity for aerosols and gases	A	BMLFUW	BMLFUW
MONARPOP	Persistent organic pollutants	A	UBA	BMLFUW
HIGHmon	discharge, glacier mass balance, snow chemistry, water temperature	C	ZAMG	BMLFUW
PERSON	Ground temperatures (GST, BTS, snowcover)	C	ZAMG	BMLFUW
Permafrost SBO	Temperature profiles and geophysics in bore holes	C	ZAMG	BMWF

BOKU-MET	University of Natural Resources and Life Sciences, Vienna, Institute of Meteorology			
ZAMG	Central Institute for Meteorology and Geodynamics			
EAA	Environment Agency Austria			
TUWAC	Technical University Vienna, Environmental and Process Analytics Research Division			
ÖAW	Austrian Academy of Sciences			
L-SBG	Federal state of Salzburg			
TUVHG	Technical University Vienna, Institute of Geodesy			
UHEID	University of Heidelberg, Institute of Environmental Physics			
AGES	Austrian Federal Office for Safety in Health Care			
BMLFUW	Federal Ministry of Agriculture, Forestry, Environment and Water Management			
BMWF	Federal Ministry of Science and Research			
FFG	Austrian Research Promotion Agency			
A	ATMON			
B	BIMON			
C	CRYMON			

## b) RESEARCH PROJECTS

Name of project	Major objective	Monitoring link	Institution	Funding	Involvement
Uglacier	Uncertainty of stream flow scenarios from glacierized catchments	A, C, B	ZAMG	ÖAW	+++
PROSECCO	Proglacial stream ecology	A, C, B	UIBK/ZAMG	ÖAW	++
Permanet	Permafrost map of the Alps, monitoring strategy, scenarios	C, A	ZAMG	EU	+++
MONARPOP	Persistent organic pollutants	A, B	EAA	EU	+++
Permafrost II	Permafrost in rock mass and its effect on ground stability and rock fall	C, A	ZAMG	ÖAW	+++
WAVES	Pollutant transport in the Alps	A	ZAMG	BMWF	++
Permafrost	Permafrost and alpine safety	C, A	ZAMG	ÖAW	+++
CLIMPAC	Climate and glacier change and related geo-hazards	C, A	UVIE/ZAMG	EU	++
QRS-Sonnblick	Aerosol mass	A	ZAMG	BMWF	++
SBK125	4D-Animation of glacier retreat	C, A	ZAMG	BMWF	+++
ASAG	Sonnblick as test site for satellite products of snowcover and glaciers	C, A	ENVEO/ZAMG	FFG	+
Cryoland	Sonnblick as test site for satellite products of snowcover and glaciers	C, A	ENVEO/ZAMG	EU	+
Tripolar	Microbial life in the atmosphere	A	UIBK	Sparkling Science	+
UVSkinRisk	UV radiation and its risk for skin cancer in a changing climate	A	BOKU-MET	ACRP	++
StratoUV	Driving factors for changes, modelling, impacts on man and ecosystems	A	BOKU-MET	BMLFUW	+++
Snowpat	Snowseries in the Alps	A, C	ZAMG	ACRP	+

BOKU-MET	University of Natural Resources and Life Sciences, Vienna, Institute of Meteorology				
ZAMG	Central Institute for Meteorology and Geodynamics				
EAA	Environment Agency Austria				
UVIE	University of Vienna, Institute of Geology				
ÖAW	Austrian Academy of Sciences				
UIBK	University of Innsbruck, Institute of Ecology				
ENVEO	Environmental Earth Observation IT GmbH				
BMLFUW	Federal Ministry of Agriculture, Forestry, Environment and Water Management				
BMWF	Federal Ministry of Science and Research				
FFG	Austrian Research Promotion Agency				
EU	European Union Framework programme				
ACRP	Austrian Climate Research Programme				
A	ATMON				
B	BIMON				
C	CRYMON				

# ANNEX: MAP OF SONNBLICK AND SURROUNDING NETWORK OF OBSERVATIONS

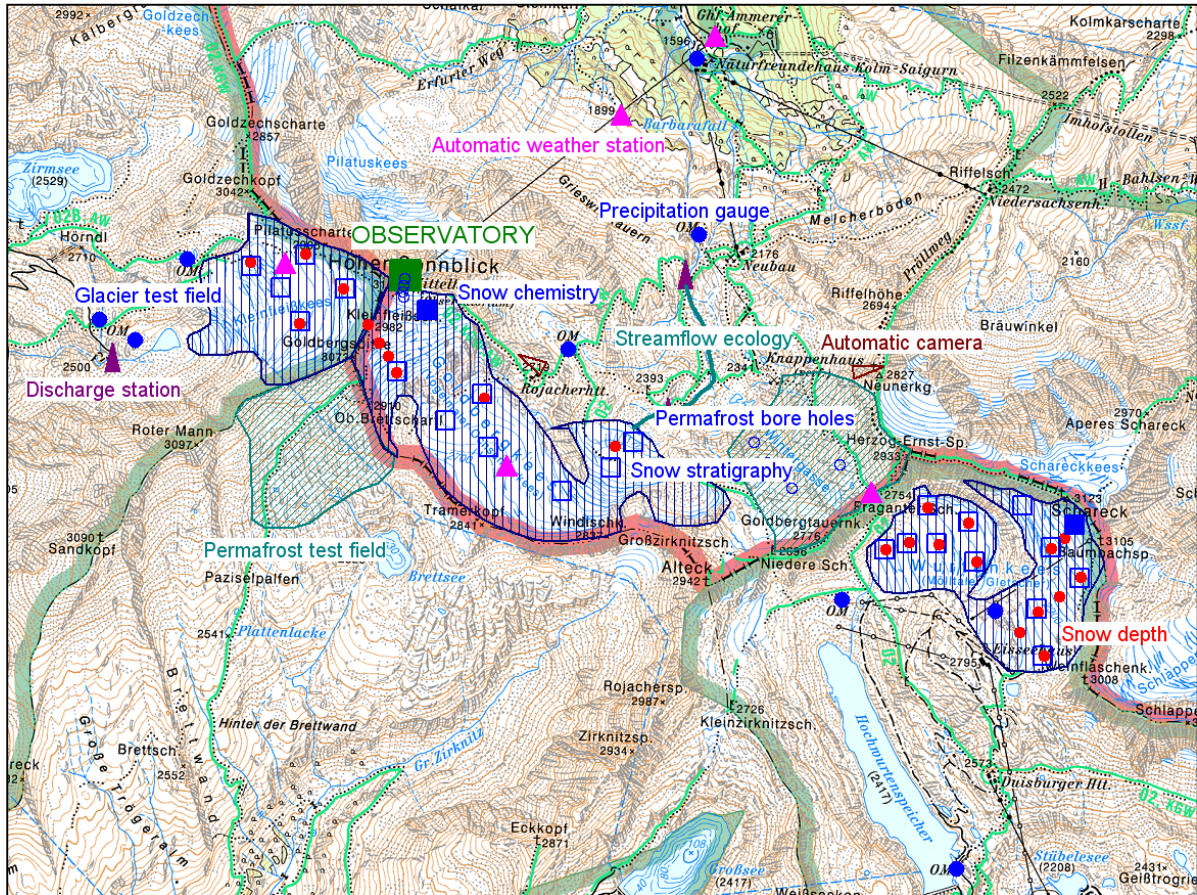


Figure 6: Map showing the Sonnblick Observatory and the observational network around the Observatory. All symbols are explained in the map