FER*MAP*

Franz Josef Land Environmental Research, Monitoring and Assessment Programme

An Austrian Initiative to the International Polar Year IPY 2007/2008

What's so crucial about polar research?

The polar regions are an integral and highly important component of the Earth's climate system. Huge masses of cold air and water are introduced from the Arctic into the global ocean and air circulation system. This effects the climate not only in the Arctic itself but across the northern hemisphere and the entire planet. Additionally, the polar ice caps which account for more than 80% of the world's fresh water, have protected us so far from rapid global warming by its buffering capacity. This climatic buffer, however, depends on the extent of the sea ice. Since the large white surfaces reflect solar radiation back into space, polar ice significantly contributes to the natural cooling which counteracts global warming.

The Arctic regions are also an important component of the worlds carbon cycle. Not only are vast amounts of carbon stored in the frozen soils of Arctic tundra, which maybe mobilized under a future climate environment. But also is the thermohaline circulation driven by the Polar oceans. Cold currents flow out of the Arctic ocean straight into the Atlantic, directly impacting the carbon cycle and making the Atlantic one of the Earth's principle oceanic carbon sinks.

The polar regions additionally encompass some of the Earth's last undisturbed terrestrial and marine ecosystems. Studying the indigenous fauna and flora and their response to environmental change, human exploitation and environmental pollution is an important contribution to the conservation of biodiversity and to a sustainable development of these regions.

The International Polar Year

All of the above presses for urgent research in polar regions. From there the international scientific community as well as policy makers and international organisations initiated the fourth International Polar Year (IPY). For this reason the International Council for Science (ICSU) defined six IPY research themes. Among them there are: to determine the present environmental status of polar regions, to quantify past and present environmental and social changes and improve projections of future change and to advance the understanding of the links and interactions between polar regions and the rest of the globe, and of the processes controlling these.

The IPY is an international effort across national boundaries, multidisciplinary, and should leave a legacy of observing sites, facilities and systems to support ongoing polar research and monitoring. It thus will strengthen the international cooperation and collaboration of research. Small countries such as Austria, without an advanced polar research programme have been explicitly invited to contribute to this international effort. Thus, small countries are able to contribute to the goals of this research effort, thereby taking responsibility for an environmental issue of global importance.

How FER*MAP* contributes to the IPY

The proposed multidisciplinary activity will substantially contribute to the assessment of the present environmental status of the Arctic by closing the knowledge gap that FJL currently constitutes. This assessment study will be used to establish a long-term observation system for changes of climate, cryosphere, hydrosphere and terrestrial ecosystems of the FJL archipelago. Recovery of historical data (aerial photographs, satellite imagery, climate instrumental data) will be the base to reconstruct regional changes over the last century. New scientific frontiers will be achieved by interdisciplinary approaches and the use of advanced techniques of remote sensing and geo-informatics.

The project will leave a legacy of meteorological stations, monitoring sites for vegetation changes, active layer dynamics and a glacier observation network on different islands of the FJL archipelago integrated in a SensorWeb system. A baseline reference geo-database integrating all georeferenced data and imagery will be made available to the scientific community.

European and International Integration

FER*MAP* is an Austrian-Russian research initiative which is part of the IPY COMAAR (Consortium for coordination of Observation and Monitoring of the Arctic for Assessment and Research) project cluster and which is interlinked to the IPY project clusters ARC.DIV.NET (Arctic climate and biological Diversity studies Network). COMAAR is an initiative under the auspices of the Arctic Council of Ministers and has been approved by the International Arctic Science Committee (IASC). FER*MAP* has already been evaluated by ICSU and has been invited to submit a full proposal.

The integration of European polar research has also been identified as a key target by the European Union. Recently the European Polar Board (EPB) has successfully initiated an ERA-NET European Polar Consortium (EPC), which shall establish European nations at the forefront of international polar research. Austria, represented by the Austrian Science Fund (FWF) and the Academy of Sciences is already part of this pan-European development.

The Austrian Vision

Austrian arctic science has strong geographical and historical relations to FJL. In 1873 the archipelago was discovered by the Austrian expedition of Julius Payer and Carl Weyprecht. They did some first geographical mapping and measurements of meteorology and oceanography. Weyprecht was, however, unsatisfied by the low level of scientific outcome of the polar expeditions at this time. He thus proposed and initiated the first International Polar Year (IPY) in 1882/83. Austria also participated in the following IPYs for example establishing a research station at Jan Mayen island at the second IPY.

This artic scientific tradition of Austria was reactivated in the 1990s by establishing a Russian-Austrian cooperation for environmental research in FJL. Based on a summer research camp at Ziegler island, research projects in glaciology, ecology and geology were realized. During the last 5 years these activities were ceased, due to difficulties with the Russian authorities. The closed polar station on Krenkel island (FJL), however, is currently rebuild by a joint Russian-U.S. initiative. FER*MAP* proposes to participate in the effort to re-establish this research station by adding an Austrian module to it.

A total of 15 research departments at 5 different Austrian universities and 3 non-university research organizations have agreed to actively develop a joint research programme with Russian and US scientists. This initiative involves more than 45 individual Austrian scientists from a variety of different disciplines.

Scientific Background

The Franz-Joseph Land (FJL) archipelago is located in the extreme north (between 80 und 82 °N) and constitutes one of the northernmost pieces of land at the border of the summer sea ice extent. While Ellesmere Island, Svalbard and N-Greenland at similar latitudes are integrated into many international research efforts (e.g., AMAP, CALM, ACIA, ITEX), research initiatives are sparse on FJL, although this archipelago would be an important link for many circumpolar research questions.

Based on the reactivated research station on Hayes Island (Krenkel station) we will use both remote-sensing and in-situ approaches to cover the entire archipelago with an area of approximately 16,100 km2. A series of high-density spatial and temporal measurement campaigns during the period of the IPY 2007/2008 are planned that should constitute a thorough characterization of the present (initial) state of the system, both for prospective and retrospective comparisons and analysis.

FER*MAP* constitutes a systems approach to the Arctic covering all aspects of the terrestrial and aquatic ecosystems, and the cryosphere as well as their abiotic environments (climate, hydrology and environmental pollution) in the present and future (Figure 1).

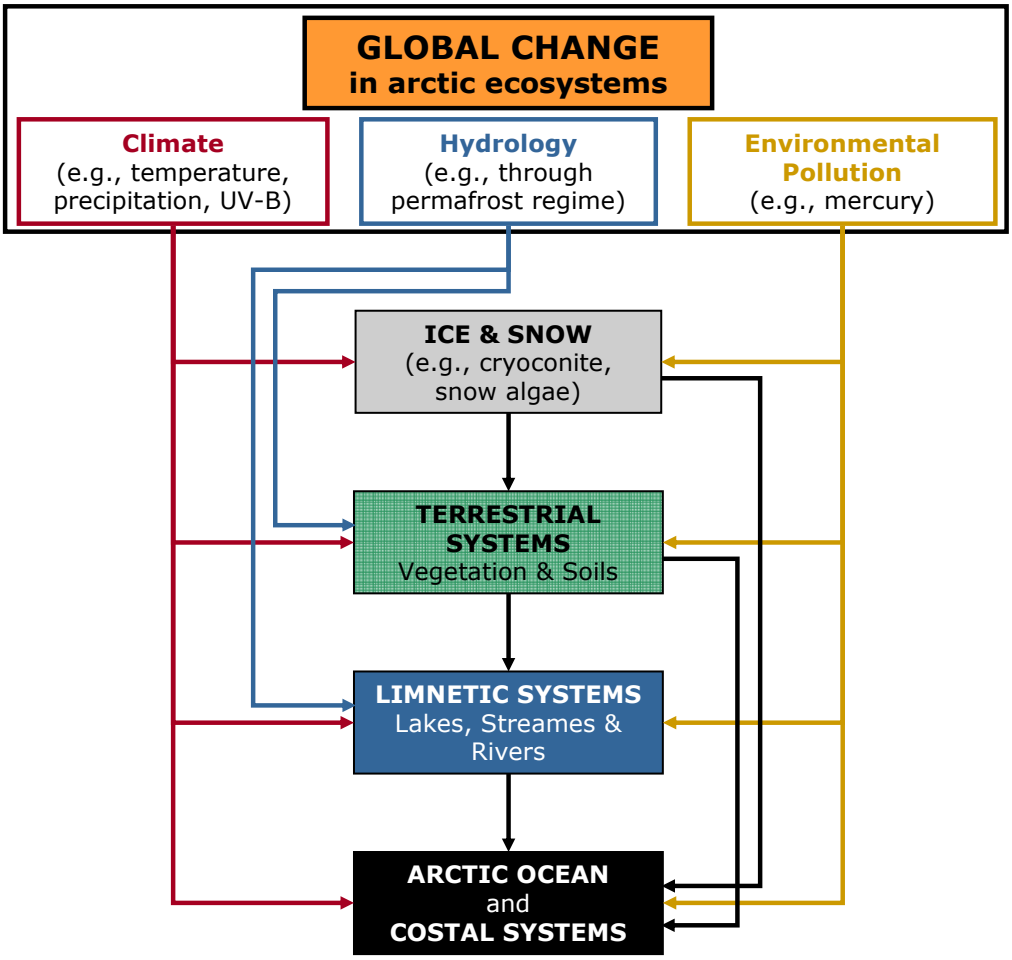

Figure 1: The system approach of FERMAP

FER*MAP* is a joint Russian-Austrian contribution to the IPY 2007-2008 and is designed to determine the present environmental status on the FJL archipelago and to track past and present change in its natural environment. The overall goal of the proposed research activity is to fill the existing regional gap in research thereby contributing to existing research efforts and networks. The initiative consists of 4 modules which are highly interlinked (Figure 2):

Clim-*MAP*

This module investigates the abiotic environment and its temporal changes encompassing geology, climatology and glaciology

Eco-*MAP*

This module is designed to assess the current state of the biotic environment and to conduct research into the impacts of climate change on biodiversity and Arctic ecosystem functioning

Sense-*MAP*

This module is an integrating activity enabling spatially explicit research through remote sensing and spatial data infrastructures

Edu-*MAP*

This module provides outreach, education and communication for FER*MAP*

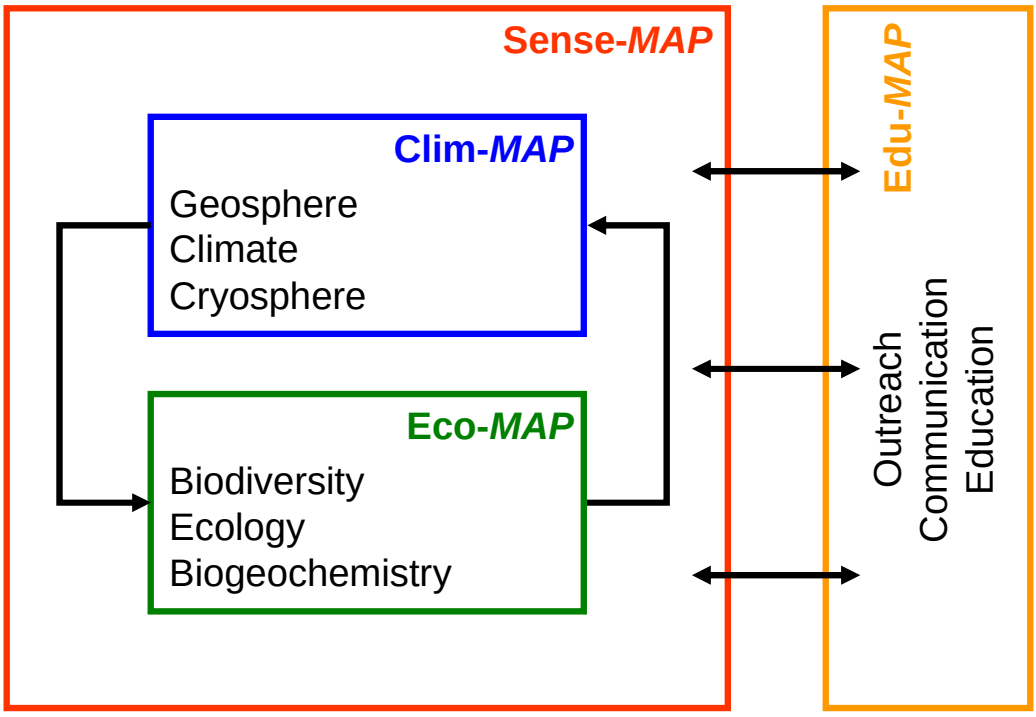

Figure 2: Linkage of FERMAP modules

Time Schedule

The duration of the project is planned to be 11 years in three phases.

Phase 1: Year 2006
Expansion of the Krenkel research station at FJL and call for full proposal (including evaluation and selection)

Phase 2: Years 2007-2011
Includes the IPY period with the most intense field work and mid-term evaluation and end-evaluation of individual projects and an evaluation of the programme in 2011

Phase 3: Year 2012-2016
Last project phase with new individual projects

***Table 1**: Overview over activities of the first 6 years of* FER*MAP*

ACTIVITY	2006	2007	2008	2009	2010	2011
Coordination of Cluster COMAAR						
Coordination with IPY-IPO						
Expansion of Krenkel station (Austria module)						
Preparation of field works and pre-expedition to FJL						
Selection of FJERMAP projects						
Individual projects of FJERMAP						
Field expeditions to FJL (summer only)						
Outreach, communication and education						
Evaluations of project						

Budget Estimate

Costs for the whole programme are calculated to be 5.175 Mio Euros in total for 6 years. This includes the funding of up to 20 individual projects with a total of 3.64 Mio Euros and expeditions costs of 0.89 Mio Euros.

We expect that this sum will include the employment of about 15-20 junior scientists (mostly at the PhD and PostDoc level). Special measures will be introduced to strengthen the role of female researchers in Artic science.

***Table 2**: Cost estimate for the first 6 years of* FER*MAP (in **k€**)*

ACTIVITY	2006	2007	2008	2009	2010	2011
Expansion of Krenkel station (Austria module)	300					
Coordination and Administration	30	30	30	30	30	30
Infrastructure (incl. costs for expeditions)	60	190	190	190	130	130
Individual projects		840	840	840	560	560
Outreach activities	20	35	35	45	15	15
Total	410	1095	1095	1105	735	735

Clim-*MAP*

Module 1: Climatology – Glaciology - Geology

(task lead: Wolfgang Schöner)

Background

Global climate change is expected to have its most pronounced regional effects on the Arctic. The Franz Josef Land archipelago is situated in the region of the Arctic with highest sensitivity to due its location close to the summer sea ice edge. A decreasing trend of the sea ice extent has been observed for the last 25 years. Many studies have proved that changes of Arctic ocean circulation and weather patterns (due to changes of the energy balance of the Arctic atmosphere and the Arctic ocean) will have significant consequences for European weather and climate. In spite of the importance of the Arctic weather and climate to the entire Northern hemisphere, long term and high quality climatological measurements are spatially sparse especially for the Russian Arctic as economical shortage in Russia led to a shutdown of many Arctic research stations and measurement programmes. This is the case for WMO standard climate elements but even more so for measurements of e.g. UV radiation, Ozone, surface energy balance or atmospheric chemical compounds. Moreover, several measurements show a decreasing trend in the duration of seasonal Arctic snow cover which will imply not only a feedback mechanism on surface energy balance but will also have strong consequences on Arctic ecology. Thus statements about current climate change and model results about possible future climate change are quite uncertain or even not at all available for many regions of the Arctic.
GCM derived climate scenarios show an especially pronounced climate change signal for the Arctic compared to other regions of the globe. Expected increase of temperature will result in remarkably changes of the cryosphere (decrease of snow cover, of glaciers, of ice caps, of sea ice and permafrost). Furthermore, the related increase in meltwater will result in an increase of sea levels. Changes in the extent of snow cover and ice masses are not only related to melt processes but also highly sensitive to feedback mechanisms from the energy balance of earth surface and thus to global atmospheric circulation.
Multidisciplinary reference sites have been recommended in international assessments (e.g. IPCC, ACIA, AMAP) and research programmes (WCRP CliC and GEWEX, IGOS-P Water and Cryosphere) to provide circumpolar data to develop new knowledge on cold climate water, energy and carbon cycles, for model parameterization, satellite validation and development of new integrated models of climate system.

Goals

Module 1 of FER*MAP* aims

- to establish a spatially distributed monitoring network of automatic weather stations across the Franz Josef Land archipelago
- to perform detailed glacier mass balance studies on selected Franz Josef Land glaciers using in-situ as well as remote sensing techniques for investigation of reaction of Franz Josef land glaciers to climate change, and further on for estimation of possible impacts of Franz Josef Land glaciers variations on sea level change
- to contribute to an extensive atmospheric monitoring program of Russian polar station Krenkel performing measurements of UV-radiation, stratospheric ozone, atmospheric aerosols and trace compounds, wet deposition and total deposition in the seasonal snow-cover. These measurements will also serve as a necessary data input for ecological, glaciological and hydrological studies of the project and will contribute to international monitoring and measurement programs (AMAP, CliC)
- to use paleo-archives (glacier firn and ice, basaltic melts) for investigation of reactive halogen hydrocarbons in the Arctic Region and volcanic contribution to volatile components in the atmosphere.

Table 3: Science questions and approaches of the **Clim-*MAP***

Field	**Arctic Atmospheric Changes**	**FJL Glacier – Climate Relation**	**Biogeochemistry of Arctic Glaciers**
Core Questions	+ Does long-range transport of contaminants play a major role for the Arctic region? + How can be a long-term Arctic environmental network established? + What and which amount of volatile components has been transported from the geospheres to the atmosphere during and after intensive volcanic activity?	+ How do Franz Josef Land glaciers react to climate change? + How large is the contribution of calving to mass balance of FJL glaciers? + Is it possible to establish a long term satellite monitoring concept for largest European glacial complexes	+ What are major processes and sources of atmospheric deposition on Arctic glaciers? + Can cryoconites from arctic glaciers act as reliable indicators and archives of environmental pollution
Specific Topics	+ Volcanic emissions of volatile components to the atmosphere + Reactive Halogen Hydrocarbons in the Arctic Region	+ Mass balance of FJL glaciers from ground truth and satellite interpretation + Measurement of surface energy balance of glaciated and periglacial sites + Multifactor analysis of glacio-marine interactions and related periglacial processes along the fronts of active tidewater glaciers.	+ Temporal changes in the ionic composition of seasonal snow-cover + Screening of biological relevant trace elements
Approach	Long-term observation and interpretation of archives (snow and ice cores, basaltic melts)	Experimental approaches – Remote Sensing (observations)	Process Studies – Modelling (synthesis)
Research Groups	[6] DGAM – University of Graz [8] DGS – University of Vienna [9] DES – University of Bristol [3] IAC – Technical University Vienna	[1] IMGI – University of Innsbruck [2] ZAMG – Central Institute of Meteorology and Geodynamics [5] IGR – University of Graz [4] JR – Joanneum Research	[2] ZAMG – Central Institute of Meteorology and Geodynamics [6] PHY – University of Salzburg [3] IAC – Technical University Vienna

Core Research Groups of Clim-*MAP*

[1] **IMGI** – University of Innsbruck
Prof. Dr. Michael Kuhn
Institute of Meteorology and Geophysics, University of Innsbruck
email: michael.kuhn@uibk.ac.at

[2] **ZAMG –**Central Institute of Meteorology and Geodynamics
Dr. Wolfgang SCHÖNER
Department of Climatolog, Central Institute of Meteorology and Geodynamics
email: Wolfgang.schoener@zamg.ac.at

[3] **IAC** – Technical University Vienna
Prof. Dr. Anne KASPER-GIEBL
Institute for Analytic Chemistry, Technical Unversity Vienna
email: anne.kasper@tuwien.ac.at

[4] **JR** – Joanneum Research Ges.m.b.H
Dr. Aleksey I. Sharov
Institute of Digital Image Processing, Joanneum Research
email: aleksey.sharov@joanneum.at

[5] **DGAM** – University of Graz
Dr. Erich PUTZ
Department for Geophysics, Astrophysics and Meteorology, University of Graz
email: erich-putz@uni-graz.at

[6] **PHY** – University of Salzburg
Dr. Peter Bossew
Ass.-Prof. Dr. Herbert Lettner
Division of Physics and Biophysics
e-mail: Herbert.lettner@sbg.ac.at

[7] **IGR** – University of Graz
Prof. Dr. Gerhard K. Lieb
Institute of Geography and Regional Science, University of Graz
email: gerhard.lieb@uni-graz.at

[8] **DGS** – University of Vienna
Ass.Prof. Dr. Theodor NTAFLOS
O. Prof. Dr. Wolfram RICHTER
Deapartment of Geological Sciences,
University of Vienna,
email: Theodoros.Ntaflos@univie.ac.at

[9] **DES** – University of Bristol
Dr. Martina HALMER
Department of Earth Sciences
University of Bristol
email: Martina.Halmer@bristol.ac.uk

Eco-*MAP*

Module 2: Arctic Ecology

(task lead: Andreas Richter)

Background

Arctic ecosystems are known to be especially vulnerable to *Climate Change*. As temperature-limited systems they are thought to react sensitive to *Global Warming*. Moreover, arctic ecosystems are prone to changes in hydrology, which may occur as a consequence of alteration of the permafrost regime and precipitation pattern and to elevated UV-B radiation, which is the result of stratospheric ozone depletion over the Arctic.

Since the Arctic is a significant component of the global climate system (e.g. tundra soils as carbon sinks or sources, ice cover of the Arctic ocean controlling the surface heat and mass budgets of the northern hemisphere), many of the proposed changes in the Arctic may have global implications. The science plan of Eco-*MAP* is therefore devoted to a better understanding of the complex coupling among atmospheric, terrestrial, limnetic, glacial and oceanic processes in the Arctic under the light of global change

Goals

The core aim of this project is to understand the complex pattern of interrelated changes in terrestrial and aquatic environments that currently occur in the Arctic. The specific research questions and approaches are illustrated in Table 1.
The proposed study constitutes a broad, interdisciplinary and multi-scale assessment of the current state of the ecology of the high-arctic Franz-Joseph-Land archipelago.

We will focus on three main areas:

1. Arctic biodiversity and population dynamics ("monitoring changes in the biosphere")
2. Ecophysiology of arctic organisms ("understanding adaptations to a changing environment")
3. Biogeochemistry of arctic ecosystems ("dissecting the effect of environmental change on ecosystem functions and understand potentially important feedbacks on climate change")

The research focus on the Franz-Joseph-Land archipelago offers us a unique opportunity to take a regional and interdisciplinary approach to global change and to provide information on polar processes across disciplines and environments for a little-known.

Table 4: Science questions and approaches of Eco-*MAP*

Field	**Arctic Biodiversity**	**Ecophysiology of Arctic Organisms**	**Biogeochemistry of Arctic Ecosystems**
Core Questions	+ What changes will occur in the Arctic in terms of biodiversity and population structure? + What will be the effects of such changes on ecosystem functioning?	+ Which ecophysiological adaptation of organisms in the Arctic can be observed/expected? + What are the physiological responses of arctic biota to climate change?	+ How will Climate Change affect the biogeochemistry of arctic ecosystems? + What are the important biogeochemical interactions among land, ice, ocean and atmosphere?
Specific Topics	+ Biotic indicators of a changing arctic + Effects of changing species composition on functioning of arctic ecosystem	+ Thermal adaptations and limitation of species + Effect of climate change on availability of pollutants and accumulation in the food web	+ Biotic control over carbon fluxes of terrestrial and aquatic ecosystems + Effect of changing hydrology on terrestrial biogeochemical cycling + Fluxes of organic matter from land to ocean
Approach	Long-term observation (experimental approaches)	Experimental approaches (observations, process studies)	Process Studies – Remote Sensing – Modelling (synthesis)
Organisation	Species - Populations	Molecular-Cellular-Organismic	Ecosystem - Landscape
Disciplines	Microorganisms – Lichens/Bryophytes – Higher Plants	Microbes - Animals – Lichens / Bryophytes – Higher Plants	Ice/Snow – Vegetation/Soils – Lakes, Streams, Rivers – Coastal Systems - Ocean – Atmosphere
Research Groups	[14] CVL – University of Vienna [16] LIM – University of Innsbruck [17] ORG – University of Salzburg	[10] OAW – Academy of Sciences [11] BOT - University of Innsbruck [13] AWI – Alfred-Wegener-Institute [17] ORG – University of Salzburg	[12] FEW – University of Vienna [15] ChECO - University of Vienna [16] LIM - University of Innsbruck [18] IPF – Technical University

Core Research Groups of *Eco*-MAP

[10] **OeAW** – Austrian Academy of Siences
Dr. Günter KÖCK
Austrian Academy of Sciences and Institute of Zoology and Limnology,
University of Innsbruck
email: guenter.koeck@uibk.ac.at

[11] **BOT** – University of Innsbruck
O. Prof. Dr. Cornelius LÜTZ
Institute of Botany, University of Innsbruck
email: cornelius.luetz@uibk.ac.at

[12] **FEW –** University of Vienna
Mag. Michaela PANZENBÖCK
O. Prof. Dr. Fritz SCHIEMER
Department of Freshwater Ecology, University of Vienna
email: michaela.panzenboeck@univie.ac.at

[13] **AWI –** Alfred-Wegener-Institute
Prof. Dr. Hans Otto PÖRTNER
Alfred-Wegener-Institute, Bremerhaven, Germany
(negotiation for professorship at the University of Vienna)
email: hpoertner@awi-bremerhaven.de

[14] **CVL –** University of Vienna
Ass. Prof. Dr. Karl REITER
O. Prof. Georg GRABHERR
Department of Conservation Biology, Vegetation- and Landscape Ecology
University of Vienna
email: reiter@pflaphy.pph.univie.ac.at

[15] **ChECO –** University of Vienna
Ao. Prof. Dr. Andreas RICHTER
Department of Chemical Ecology and Ecosystem Research, University of Vienna
email: andreas.richter@univie.ac.at

[16] **LIM** – University of Innsbruck
Dr. Birgit SATTLER
O. Prof. Dr. Roland PSENNER
Institute of Zoology and Limnology, University of Innsbruck
email: birgit.sattler@uibk.ac.at

[17] **ORG** – University of Salzburg
Prof. Dr. Roman TÜRK
Institute of Organismic Biology, University of Salzburg
email: roman.tuerk@sbg.ac.at

[18] **IPF** – Technical University Vienna
Prof. Dr. Wolfgang WAGNER
Institute of Photogrammetry and Remote Sensing, Technical University of Vienna
email: ww@ipf.tuwien.ac.at

Sens-*MAP*

Module 3: Spatial Data Infrastructure – Remote Sensing

(task lead: Josef Strobl)

Background

Spatial Data Infrastructures (SDIs) recently have evolved from a generic concept into partly operational implementations in many countries across the world (see www.gsdi.org). This is particularly true for highly developed regions with established cadastral and / or topographic mapping systems. For peripheral territories like the Arctic measurable synergies and economic benefits of course are difficult to identify. Therefore we currently have only little experience in establishing SDI's outside of developed regions with substantial economic activities.

Looking at SDIs from a research organisation perspective, and even more so from a transdisciplinary research angle, we have to acknowledge that this concept actually is an indispensable part of empirical research whenever results from different disciplines and individual projects have to be integrated to yield the intended results. A well designed SDI not only avoids duplicate base-mapping and georeferencing efforts, but provides a spatial view across disciplines. Just like charting diagrams in empirical statistics, mapping is considered the main hypotheses-generating tool for all spatially oriented disciplines. With the ultimate aim of a unified geospatial platform which can be integrated with global mapping toolsets and data, the FJL regional SDI node will be established as a core asset for the entire research programme.

Beyond this broad-based spatial services infrastructure, geospatial data and appropriate spatial analysis capabilities will be leveraged to help answering numerous research questions of their own. Change analysis frequently is done by comparing sensor recordings or sensor locations over time, different types of sensors or mapping results only can be compared by co-registering by location. High latitude georeferencing and spatial analysis poses specific research challenges, touching on geoid models, map projections, positioning sensor characteristics, remote sensing illumination and reflectance angles and communication characteristics with in-situ and mobile sensors. All this adds up to the very substantial objective of researching the feasibility of establishing a standards-conformant spatiotemporal information infrastructure in a dynamic Arctic environment.

Goals

Research results from ecological, climatological and glaciological studies all have to be georeferenced to a common geographical datum in order to enable full integration and building links and relationships between data, insights and outcomes. Therefore this research area pursues multiple purposes:

1. Establishing the spatial component of a cross-cutting research infrastructure as a foundation for all other themes. Research results will be referenced to and accessible through this spatially indexed view. This includes providing a common mapping and spatial communication interface supporting all disciplines.
2. In and of itself, the design and implementation of the infrastructure for an area outside of traditional large scale national mapping efforts is a substantial research topic. In terms of database development and multimedia support, there is no precedent with similar ambitions.
3. Within this area, independent leading edge research towards remote sensing technologies and applications will be conducted. Microwave / radar applications with a focus on high latitude ice/snow/water issues are planned including a comparison between artic and antarctic environments.

Overall, geoinformation research within this programme will balance the service infrastructure and basic research components, providing a spatially oriented framework as well as original developments or methodologies and systems architectures.

Due to seasonal differences in illumination characteristics, weather patterns, snow-cover as well as (just) near-polar satellite tracks, sensor choices are limited in high latitudes, excluding reflected natural spectra in most cases. High emphasis is therefore put on micro-wave remote sensing platforms and sensors for all high latitude applications. Incidentally, this is an area where Austrian researchers have been able to make very significant contributions since the first steps of imaging radar applications in the late 1970ies and 80ies.

Table 5: Science questions and approaches of the Sens-*MAP*

Field	Spatial Data Infrastructure	Web Services – Gazetter	Satellite Remote Sensing
Core Questions	+ How can a common data catalogue / data store for georeferenced data be established? + How can dynamic multi-source data sets be homogenised? + How can the SDI support on-the-fly modelling and geostatistical interpolation of research data based on geoprocessing services?	+ Verification of OpenGIS frameworks and standards across ambiguous naming conventions + Implementation of multilingual gazetteers with non-parallel toponymic references + Identification of issues arising with handling of non-conventional placenames and moving / mobile features	+ Can we determine glacier regime and mass balance in FJL with satellite remote sensing? + Which relevant glacio-climatic parameters can be derived from spaceborne imagery? At which scale, periodicity and accuracy? + Is it possible to get reliable attestations to current climatic changes in the Arctic via satellite data?
Specific Topics	+ Alternatives for image handling + Feasibility / accuracy of vertical datum implementation + Linkage of sensorweb data streams into an SDI + Online visualisation interface (webmapping engine)	+ Set up of a multilingual toponymic database + Strategies for ambiguity resolution + Prototyping of a live online gazetteer service integrated with online visualisation services	+ Precise geocoding of glacier image models independently from the use of surveyed control points. + Verification and representation of results in the form of satellite image map series, value-added interferometric products and graphic animations.
Approach	Setup of a testbed environment as a precursor for an operational distributed online database, in order to evaluate strategies and verify operational capabilities of individual services (SDI). Within this framework the critical research questions stated above will be analyzed.	In a three-step process research will begin with (1) building of a toponymic database including linguistic and positional verification, (2) transfer into a prototypical gazetteer architecture and (3) integration as a service with the wider framework of an FJL SDI	Straightforward and rigorous procedure will be developed for the generation, absolute orientation and orthorectification of glacier image models making use of spaceborne photogrammetric, interferometric and altimetric data and sensor-specific imaging models.
Research Groups	[17] Z_GIS – Salzburg University	[17] Z_GIS – Salzburg University	[18] JR – Joanneum Research [19] IPF – Technical University [20] IMGI – University of Innsbruck

Core Research Groups of Sens-*MAP*

[19] **Z_GIS** – Salzburg University
Prof. Dr. Josef Strobl
Centre for Geoinformatics, Salzburg University
email: josef.strobl@sbg.ac.at

[4] **JR** – Joanneum Research Ges.m.b.H
Dr. Aleksey I. Sharov
Institute of Digital Image Processing, Joanneum Research
email: aleksey.sharov@joanneum.at

[18] **IPF** – Technical University Vienna
Prof. Dr. Wolfgang WAGNER
Institute of Photogrammetry and Remote Sensing, Technical University of Vienna
email: ww@ipf.tuwien.ac.at

[20] **IMGI** – University of Innsbruck
Prof. Dr. Helmut Rott
Institute for Meteorology and Geophysics, University of Innsbruck
email: helmut.rott@uibk.ac.at

Module 4: Education, Outreach and Communication

(task lead: Markus Langer)

Background

The polar regions provide a powerful context for teaching and learning, attracting a wide and diverse audience. From there education, outreach and communication with the media is an integral component of FEMAP.

Education refers to efforts designed to promote the development of programmes, infrastructure and resources needed to improve knowledge of polar-focused science, technology and humanities. These formal educational efforts mainly occur within classrooms. Formal education is not necessarily limited to curricula, but ranges from teacher training to classroom science experiments.

Outreach, sometimes called informal education, is used here to refer to experiences for learning experiences outside of formal classroom environments through stimulating media, exhibits, and community-based programmes. Examples of outreach activities include field trips, museums exhibits, zoo exhibits, lecture series, computer software, school competitions, quizzes and essay writing.

Communication is used here to identify interactions with the print, television, radio, internet and film media.

Goals

Education and Outreach:

The project will focus on secondary education level by a "virtual classroom" concept, allowing school children remote participation in research experiments. Opportunities for teachers to participate in field work will be also provided. Additionally the project will act as a partner of Herodot.net.
The proposed activity will include a program for research and field experiences for graduate students and a joint Russian and Austrian PhD program for polar research to attract young people to polar research themes.

Communication:

The general public will be targeted via the Austrian Broadcasting Company (ORF), major print media and an interactive internet platform ("ask a scientist").

Core Groups of Edu-*MAP*

[21] **FUB** – Forum Umweltbildung
Name Dr. Markus Langer
email: markus.langer@umweltbildung.at

[22] **UDV** – Umweltdachverband
Mag. Franz Mayer
email: franz.maier@umweltdachverband.at

[23] **ORF –** Austrian Broadcast Company
Dr. Martin Bernhofer
email: martin.bernhofer@orf.at

[24] **ORF –** Austrian Broadcast Company
Dr. Gisela Hopfmüller
email: gisela.hopfmueller@orf.at

Appendix A

Abstracts of Proposed Research Projects for FER*MAP*

[1] Stratigraphy and mass balance of an ice cap on Franz Josef Land
UIMG - M. Kuhn (University of Innsbruck)

The mass balance of a typical ice cap will be investigated along a profile from the top to the lower end by the glaciological method. The deposition of organic and inorganic ions on the snow surface and its redistribution in the metamorphosis of the snow pack and during re-freezing will be analyzed and compared to measurements performed in 1994 and 95.

Under the climatic conditions of Franz Josef Land the accumulation of ice is to a large degree established by refreezing of melt water that has percolated from the surface to the base of the snow pack. This superimposed ice is enriched in ionic species that were washed out preferentially in the melting snow.

Accumulation of snow and its redistribution by wind, melt conditions and the formation of superimposed ice are determined by meteorological conditions. These will be continuously monitored with three automatic weather stations at the base, top and intermediate altitude of the ice cap.

[2] Effects of climate change on variations of Franz Josef Land glaciers
ZAMG – W. Schöner (Department of Climatology, Central institute of Meteorology and Geodynamics)

The sensitivity of various ice masses to climate change has to be investigated by reliable measurements of the mass balance of Arctic ice masses, energy balance measurements over ice surfaces and modelling attempts. Whereas reliable data of mass balance and earth surface energy balance are available for Greenland, Svalbard and N-American Arctic data from Russian Arctic are very sparse. FJL between 80 and 82° north lies in a very sensitive zone of the Arctic as it is situated close to the border of summer sea ice extent and is therefore from especially high interest in the circumpolar region.

The project aims to estimate the mass balance of two FJL glaciers including one land based and one calving glacier. To investigate the climate sensitivity and to establish relation to climate of FJL glaciers mass balance data have to be assisted by climate data from automatic weather stations. Available longer-term climate data series as well as established climate-glacier relation will be used to describe glacier behaviour back in time for some decades.

Investigation of the mass balance of two FJL glaciers (one land based and one calving type) will be performed by in-situ measurements (measurement of accumulation, ablation, shallow firn cores). To estimate the rate of calving detailed measurements of surface velocity (GPS measurements) will be performed and will be assisted by satellite interferometry To enstablish a glacier model of flux components measurements of surface velocity as well as glacier bed topography (by GPR measurements)will be done. Derived glacier flux model will be cross checked with models derived by satellite methods.

[3] Monitoring of long range transport and scavenging processes of atmospheric compounds at an Arctic sampling site

IAC – A. Kasper-Giebl (Institute Analytical Chemistry, Technical University Vienna)

Background measurements at the Arctic sampling site Krenkel station (Franz Josef Land), a sampling site under extreme climate conditions, are used for investigation of long range transport phenomena and scavenging processes of atmospheric compounds in the Arctic region. Stack filter measurements are applied for the determination of selected atmospheric trace gases (sulphur dioxide, nitric acid and ammonia) as well as selected water-soluble aerosol compounds (sulphate, nitrate, oxalate, ammonium, chloride, sodium, potassium, magnesium, calcium). Samples are collected on a daily bases in accordance with a parallel wet precipitation sampling and (at least) seasonal snow cover sampling.

Together with other measurements conducted at Krenkel station the results are interpreted to characterize the air status of a remote Arctic site , to identify local as well as long-range transport phenomena and to characterize scavenging phenomena, i.e. to investigate the transport of air pollutants into cloud water droplets and further on into the wet deposition.

Moreover the project will cooperate with other FERMAP partners for investigation of cryoconite at an Artic sampling site. The optical characteristics of cryoconite are mainly affected by organic matter, which is dark in colour, and less influenced by mineral particles. Spatial distribution of the composition of cryoconite (organic matter content) will be determined and compared with changes in surface albedo.

[4] Reactive Halogen Hydrocarbons in Arctic Regions

DGAM - E. Putz (Institute of Physics, Dept. for Geophysics, Astrophysics and Meteorology, University of Graz)

The recent discovery of chloro-acetats in firn, snow and glacier ice (von Sydow et al.,2000) dating back to the pre-industrial age added new evidence for novel natural sources of currently known precursors of these phytotoxic substances. This year Weissflog et al. (2005) could show for the first time, that volatile highly chlorinated C2- and C1-hydrocarbons, precursors of halogenated acetic acids, can also be formed naturally in the sediments of salt lakes. Chlorinated acetic acids are a potential thread to the ecosystem by the destabilisation of vegetation due to their phytotoxicity. The most injurious one is trichloro-acetic acid (TCA).

In the framework of this proposed project, samples of ice, snow, firn at Franz-Josefs-Land will be collected to investigate the occurrence of halogen acetates in precipitation at such a remote site over a long period of time. The role of natural sources as compared to hitherto supposed anthropogenic sources of halogenated hydrocarbons will be analysed.

[5] Cryoconite as indicator and archive for environmental pollution
PHY – P. Bossew, H. Lettner (Division of Physics and Biophysics, Univ. Salzburg)

As cryoconite holes act as a sink for airborne environmental pollutants, these substances accumulate over time. Cryoconites can thus serve as a particular source of information on the pollution history of the respective environment, in this case the FJL region about which little is known so far.
A wide knowledge gap exists on cryoconite formation processes and its dynamics; As a first step the project aims are to obtain basic information on the physico-chemical characteristics of the cryoconites, and their spatial distributions and inventories on glaciers.
The role of microbiota (algae) in the formation process of the cryoconites shall also be investigated in cooperation with the university of Innsbruck (LIM). The role of cryoconites as ecological indicators will be compared with the well-established one of lichens, in cooperation with ORG. The investigation will be carried out in the depletion region of low lying glaciers where an enhanced surface accumulation rate of cryoconites can be expected. As easy to measure indicators for airborne pollution natural and anthropogenic radiotracers like ^{210}Pb and ^{137}Cs will be used, but the investigation shall extend to chemico-toxic, biologically more relevant trace elements like Hg, Pb, Cd. Screening for minor tracers may give additional information on the origin and ecological role of cryoconites.
Melting of glaciers leads to an increase of cryoconite inventory on their surfaces. The thus reduced albedo leads to a positive feedback effect on glacier melting, for which no quantitative model exists as yet. On the other hand, transport with melt water (surface and bottom run off) leads to a translocation of a, so far unknown, fraction of the cryoconite inventory into surface water bodies (streams, lakes and finally the coastal shelf) and its accumulation in sediments. Screening sediment profiles for pollutants which point to their origin as cryoconite may therefore give information about the dynamics of transport processes.

[6] Monitoring air/surface/ground interface energy flux parameters
IGRG – J. Deutscher, M. Avian (Insitute of Geography, University of Graz)

The energy balance on the air/surface/ground interface is determined by radiative and mass fluxes, which influence the ground thermal regime, active layer as well as the ground surface or the type of freeze/thaw cycle. Such processes may govern e.g. rock fall activity, maximum size of detachable rock (→ rock glacier nourishment), solifluction, debris flow release and other mass-wasting processes. Miniature temperature data-loggers provide information about snow-cover duration, length of zero-curtain periods, onset of meltwater percolation, mean annual ground-surface temperatures, duration of ground freezing, and thawing. Detailed energy balance measurements provide a better understanding of the energy exchange processes at the atmosphere/lithosphere boundary in periglacial environments.

Methods: Monitoring energy fluxes in subaereal, surface and subsurface environments with the aid of (a) automatic energy- balance monitoring stations and (b) miniature data-logger. One automatic energy-balance monitoring station consists of different sensors measuring: air, surface and subsurface temperature, air humidity, wind speed, short- and longwave radiation, soil moisture and snow height (indirectly by subaerial temperature sensors vertically aligned on a pole). Two different approaches: *vertical temperature and humidity near-surface profiles* in order to monitor vertical energy fluxes (ground temperature profiles in areas underlain by permafrost will help to characterise the thickness of active layer and freeze/thaw cycles) and *horizontal temperature profiles*, solifluction lobes, in a coarse, blocky debris environment (measuring the non-conductive heat transfer in open voids) or on rock faces - in order to analyse the superficial thermal regime which gives conclusions for permafrost and periglacial issues.

[7] The High Arctic Large Igneous Province

DGS – Th. Ntaflos & W. Richter (Department of geological Sciences, University of Vienna)

Franz Josef Land is a Continental Flood Basalt (CFB) Province. CFB provinces cover large areas with large quantities of basaltic lava flows, erupted through Precambrian to Quaternary times. Most of the flood basalts erupted rapidly. The viscosities of lavas were low enough to allow them to spread out as almost horizontal sheets.
This proposal is focused on the geochemical and isotopic characteristics of the Franz Josef Land CFBs, dykes and sills.

The main goals are:

1. to study the Continental Flood Basalts from Franz Josef Land, in order to provide additional geochemical and radiogenic isotopic data that could contribute towards complete understanding the origin of the High Arctic Igneous Province.
2. to contribute towards understanding the evolution of the Arctic Ocean
3. to establish the origin of the Franz Josef Land dykes and sills and their relationship to the lava flows.
4. as Franz Josef Land Continental Flood Basalts have a plume signature, the geochemical and petrologic characterization of the dykes and sills is very important. It could reveal, in case that dykes and sills are related to major continental rifts, the real dimensions of a plume in a region like the Arctic Ocean, which is largely inaccessible, and the genetic relationships to the ongoing ocean spreading of the Nansen ridge.
5. the understanding of the flood basalt genesis in the Arctic will provide additional arguments to test the hypotheses about the origin of the continental flood basalts and their relationships to the plumes and to the tectonic environment where they have been emplaced worldwide.

[8] Transport of volatile components from the Geosphere to the Atmosphere

DES – Martina Halmer & Theodor Ntaflos (Department of Earth Sciences, University of Bristol, Department of Geological Sciences, University of Vienna)

The principal endogeneous factors, that may significantly affect climate are volcanic emissions of volatile components to the atmosphere.The project is focused on the fundamental problem of the effect of magmatic mass transfer of volatile components from inner geospheres to the Earth's surface on the global climate changes
Main objectives: The determination of the volatile components content (H_2O, CO_2, S, F, Cl) in basaltic melts and other magmas of Franz Josef Land Continental Flood Basalts and the estimates of their global fluxes during the activity of the given magmatic system.

General plan of investigations for the whole period of project:

1. Petrographic and geochemical investigation of the phaenocrysts in rock collections, the search for melt inclusions, experiments with heating and cooling stages.
2. The analysis of melt microinclusions and bulk rock specimens by EMPA and LA-ICP-MS.
3. Thermodynamic modeling of mineral equilibria with volatile components.
4. The estimation of the fluxes of volatile components during the formation of magmatic system and their effect on the global climate changes.
5. Comparative investigation of the flux of volatile components in the Kola province of alkaline rocks and carbonatites.

[9] Linkage of climate warming and increasing mercury in landlocked fish in the high arctic

OeAW – G. Köck (Austrian Academy of Sciences)

The general objective of this proposed research is to examine the vulnerability of landlocked Arctic char to increased Hg exposure due to climate warming within the Canadian high Arctic Archipelago. Of particular interest for this project is whether Hg, which is highly bioaccumulative in its methylated form (MeHg), might be more available if warming increased rates of methylation. The findings will be used to evaluate climate warming effects on mercury availability in freshwater systems in the Austrian Alps.

The specific objectives are to:

1. Examine temporal trends of Hg in muscle of archived and newly collected landlocked Arctic char in a variety of Canadian Arctic lakes over a latitudinal gradient and combine this information with data from other previous and ongoing monitoring studies of mercury to infer a link between climate warming and increased mercury, and other toxic metal contaminants The findings will be used to evaluate climate warming effects on mercury availability in freshwater systems in the Austrian Alps.
2. Investigate the entry of MeHg in Arctic lakes by studying Hg concentrations in the watershed area, the surrounding wetlands, the water body and lake sediments. Furthermore, sediments cores for paleolimnological studies will be collected. Lake Hazen on Ellesmere Island will be used as a "model lake" for these studies. This lake receives most of its water inflow from glaciers, and therefore is likely to be a sink for persistent contaminants entering the lake via glacial runoff and direct atmospheric deposition.
3. Consider possible adaptation processes and strategies to minimize negative impacts to the fish and to human consumers assuming mercury levels are increasing.

[10] Comparison of UV and temperature resistance between alpine and polar higher plants and snow algae

BOT – C. Lütz (Institute of Botany, University of Innsbruck)

Anthropogenic influences have triggered stratospheric ozone depletion, which enhances UV-B radiation. It has been observed first in the Antarctic, and is now of public concern also in Europe because of the increase in UV-B in the northern hemisphere. This means, that the general stress loads may now and in the future overrun the defence capacities of many plants resulting in changed species composition in the ecosystems. Further, a comparison of the adaptation mechanisms of arctic and high alpine plants on a cellular level is of scientific interest *per se*.

The objective of our current and planned work with polar higher plants is to study the range of climate adaptation expressed in ultrastructure of cells and tissues, in photosynthetic metabolism, in antioxidative and sun screen compounds in a cold and reduced UV-B environment in comparison of a large data pool already raised mainly from European high alpine plants, which live partially under stronger cold and different light regimes, especially higher UV-B. We want to find out, whether adaptations found in some alpine plants occur similarly in polar forms.

Our previous studies with snow algae from the Alps, Svalbard and the maritime Antarctic have demonstrated, that the species studied showed specific adaptation to their local environments. These differences reflect not only climate or habitat differences but indicate a different embedding of the snow algae in their specific ecological niche containing other nutrient supply, bacterial and fungal communities etc. The aime of this research activity is to compare selected snow algae from polar and alpine habitats via their primary production, cellular structures and different red and green pigmentations, as these parameters depend on local light climate, ice/snow conditions and microbiota, which may strongly influence the life of snow algae. The work contributes to a better understanding of the observed biodiversity of world-wide distributed snow algae.

[11] Effects of Global Change on the Carbon fluxes between arctic terrestrial and aquatic ecosystems

FEW – M. Panzenböck, F. Schiemer (Freshwater Ecology, University of Vienna)

Tundra soils also have a high potential for horizontal carbon export, as indicated by high contents of dissolved organic carbon (DOC) of terrestrial origin in Arctic rivers and the Arctic ocean. A large amount of the exported DOC, however, is not mineralizable by microorganisms. This highly refractory DOC was recently suggested to act as a contemporary sink in the global carbon cycle.

Streams and rivers link land and ocean; thus, changes in carbon export and biogeochemical transformation processes along running waters caused by *Global Change* can alter the amount and the quality of terrestrial organic matter delivered to the Arctic ocean. However, little is known about the pre-ageing and degradation of DOC over the residence times of lakes and rivers. The proposed project therefore aims at investigating the effects of *Climate Change* on DOC export (quantity and quality) from terrestrial ecosystems and the role of limnetic systems in the transformation of this DOC on its way to the Arctic Ocean.

The main focus will be on:

+ Horizontal carbon fluxes between terrestrial and freshwater systems including experiments simulating altered conditions due to *Global Change*
+ The impact of changed DOC input on the metabolism of freshwater systems.
+ The role of limnetic systems in the transformation of terrigenous DOC and the effect of *Climate Change* on quality, quantity and transformation of DOC with possible consequences on the carbon balance of the Arctic ocean.

[12] Effects of Climate Change on Arctic marine fauna

AWI – H.O. Pörtner (Alfred Wegener Institute, Germany)

Understanding cause and effect relationships between climate-induced temperature changes and the responses of biota is key for an evaluation of climate effects on ecosystems. Recent progress in this field, achieved at the AWI, was largely possible due to successful integration of physiological and ecological studies at the species level, and has led to the development of a unifying hypothesis of thermal adaptation and limitation, and of their ecological consequences in aquatic animals. These results were built on comparisons of fish and invertebrates from various climates in a latitudinal cline between temperate zones and the Arctic as well as the Antarctic.

Further physiological studies at molecular, cellular and organism levels, in fish, invertebrates and their ontogenetic life stages, will help to clarify the mechanistic basis of biogeographical patterns. Research activities in the Arctic are an important asset in these activities. These studies should include work on marine fish from the high Arctic (e.g. Arctic cod). Extended efforts are not only needed to closely integrate ecological and physiological findings, but also to define the genetic potential of adaptability and its role and limits under the impact of environmental factors. Studies will focus on the genetic basis of energy turnover and the related adaptive flexibility of thermal tolerance. The combined study of genetic and environmental influences will help to define the functional ranges covered by each phenotype as it develops throughout all life stages. In this context, an integrated view of gene functions at various levels of complexity up to the whole organism is required to identify mechanistic links between environment, the organism's success and survival, and any evolutionary consequences.

As a perspective, the intended research on high Arctic fauna will support development of a mechanistic understanding of climate effects on other fauna, including aquatic fish and invertebrates from temperate zones.

[13] Polar deserts under climate change

CVL – K. Reiter, G. Grabherr (Department of Conservation Biology, Vegetation and Landscape Ecology, University of Vienna)

The installation of a research station on Ziegler island in Franz Josef Land by the Austrian Ministry of Science in 1996 added new possibilities to the field of vegetation ecology; it enabled intensive studies in an area similar to the High Alps. The main objective of this study therefore is to create a basis in order to record latitudinal vegetation distribution limits with reference to global warming.

Studies of high alpine and nivale vegetation during the last 10 years – especially the worldwide GLORIA program - act as a reference point for this new research project in polar deserts. A new method was developed, according to which, transects were laid out, providing information about altitude-related biodiversity gradients and small-scale, site-specific niche formation of species and populations. Combined with elevation models this data enables us to develop prognostic models about future vegetation patterns.

In summer 1996 the "alpine" method was applied to the arctic desert of Franz Josef Land and the analyses promised interesting possibilities for a comparative approach. For the first time, the two most extreme low temperature environments, marking limits of plant distribution, could be directly compared in a small-scale approach. Work of summer 1996 was characterized by studying arctic flora and vegetation and by the installation of permanent plots within an area of 3 km of the camp on the Ziegler Island. Geo co-ordinates of these plots were precisely measured and vegetation data collected as well as photographically documented.

The research work in summer 1996 and all the methodological developments during the last 10 years created a perfect basis for further surveys – especially for the re-visitation approach to determine the change of vegetation patterns as an effect of Global Change.

[14] Effect of climate change on carbon balance of high-arctic ecosystems

ChECO – A. Richter (Chemical Ecology & Ecosystem Research, University of Vienna)

Arctic ecosystems are of great importance for the global carbon cycle, since they store vast amounts of carbon (approximately 12% of the global carbon pool) in their soil organic matter. Historically, tundra ecosystems have been net sinks for atmospheric carbon, presumably due to limitations of decomposition. However, in the 1980s arctic ecosystems have undergone an change from a net carbon sink to a strong net source, during both summer and winter. Only recently it has been reported, that arctic ecosystems show a remarkable acclimation of ecosystem CO_2-exchange to these long-term changes in climate. The mechanisms involved in this adjustment remain unclear, but most likely include changes in biogeochemical cycles, especially in the cycling of nitrogen in soils. This urges investigations in the potential long-term effects of global warming on the availability and dynamics of nutrients. The proposed project therefore aims at investigating the impact of global warming on the physiology of arctic ecosystems, with special emphasis on biogeochemical feedbacks. Towards this goal the effects of increased temperatures and of altered plant composition on the constraints that the nitrogen cycle places on ecosystem productivity will be investigated. We will approach this goal by warming experiments (fertilized and non-fertilized), and removal experiments in arctic tundra ecosystems at FJL.

The main focus of the project will be on:

(a) the regulation of below-ground C and N transformation processes
(b) the competition of plants and microbes for nitrogen
(c) the dynamics and functional changes in microbial decomposer communities,

Overall, we hope to determine the controls on N fluxes in arctic ecosystems, but also the role of the soil compartment in the ecosystem response to anticipated climatic warming.

[15] Cryoconite holes as sensitive functional ecosystems

LIM – B. Sattler, R. Psenner (Institute of Zoology & Limnology, University Innsbruck)

Life in ice is no longer a paradox – on the contrary, vast snow and ice fields of the Earth´s cryosphere are increasingly recognized as habitats for a number of adapted organisms. Cryoconite holes have recently been documented as micro-habitats with high ecological relevance for glaciers worldwide. Cryoconites are depressions on glacial surfaces filled with organic and inorganic matter where highly active microbial communities thrive, providing biomass for grazers and contributing to the carbon budget of glaciers and their runoff. These funnel-shaped and cylindrical features, which can cover up to 30% of the glacial surface, are characterized by a lower albedo and, consequently, more heat capacity which enhances glacial melt processes. Cryoconites, thus, are not only small-scale ecosystems, but influence water chemistry and contribute to the rapid retreat of glaciers in polar regions. Nutrient budgets from glacial drainage systems must include a component that recognises the biogeochemical transformations mediated by the microbial communities of glaciers. Nutrient concentrations in runoff, snow and ice cannot be solely explained by chemical processes, since microbially influenced processes may both deplete and enhance the nutrient status, depending on the season and antecedent conditions. An investigation of the biodiversity of both structural and functional sense of GLIMCOs (glacier ice microbial communities) and metazoa is therefore crucial for the understanding of nutrient flows and alterations of functional biodiversity in the cryosphere, giving glaciers an ecological relevance as active ecosystems with carbon links coupled to other environments. Consequently, this proposal has a glaciological aspect including meteorology, hydrology, and modelling, but it also encompasses bio-geochemistry. Biodiversity is seen as an integral part of the cycling of water, nutrients and organic matter. The presence or absence of glaciers has a major influence on availability and quality of headwaters, thus the rapid glacial retreat in many parts of the world urges us to tackle questions of glacial biodiversity and its influence on geochemical processes.

[16] Biodiversity and performance of lichens in Franz Josef Land

ORG – R. Türk (Department of Organismic Biology, University of Salzburg)

This research programme aims to provide the science that will underpin the conservation, protection and management of the terrestrial ecosystems in Franz Josef Land. The aim is to identify, interpret and understand the status of the present terrestrial biodiversity which is primarily composed of mosses and lichens with the latter living on and within rocks, on the soil and on the residues of higher plants. Also the knowledge of the associations of lichens and mosses and their dependence on the structure of the diverse substrata, the water and nutrient supply and the microclimatic conditions and their relationship to the associations to higher plant is the key for the assessment of short term and long term changes of factors influencing the life in the extreme arctic environment. Although there are some reports about the lichen flora of Franz Josef Land, the knowledge of the saxicolous lichens with lecideoid apothecia is surprisingly poor. Thus the registration of the epilithic, endolithic and chasmolithic lichen flora and the distribution of microlichens delivers fundamental data about the biodiversity and their dependence on the site conditions. Using GPS and GIS techniques will enable future investigators to find out changes in the species composition of the lichen and moss associations due to the climatic change.
Lichens will also be used for investigations on the dating of ice free zones in Franz Josef Land.
Of cosmopolitan lichens species which occur from the Arctic and alpine zones to the Antarctica (*Xanthoria elegans, Lecidella stigmatea, Pseudephebe minuscula, P. pubescens and Rhizoplaca melanophthalma*) the possible differences in the total genomes will be investigated by means of AFLP. Also the CO2 gas exchange of cosmopolitan lichens is investigated by means of CO2-H2O-porometer and chlorophyll fluorescence to find out the specific patterns of adaptation to Alpine, Arctic and Antarctic environments. Additional investigations on protein-composition, plastid pigments, enzyme activity and ion contents will be carried out in the laboratory.

[17] Spatial data infrastructure
Z_GIS – J. Strobl (Salzburg University)

Several clearly defined objectives are pursued towards the goal of an operational infrastructure providing a common georeferencing framework and interactive spatial communication infrastructure:

+ Georeferenced framework according to open access requirements
+ Establishing a baseline database of maps, imagery and observations
+ Setting up an architecture for a SensorWeb real time network
+ Dynamic / online visualisation of study region and related geo-information

These goals require the definition, specification and implementation of a distributed geospatial data management framework according to OGC standards. Due to the complexity, variety and sheer volume of data management issues involved, it is important to notice that support and collaboration from a leading DBMS vendor have already been secured.

Specific research questions:

- Establishment of a full georeference framework including vertical datum (as benchmark for sea level change assessment and gravity-controlled flows in relatively flat environments)
- Homogeneisation of multi-source digital elevation models (DEM)
- Database storage of remote sensing imagery (issue of multiple reference systems, pixels in high latitudes cannot be resampled to latlong)
- Common data catalog for georeferenced / multimedia data collections
- Multitemporal data models for seamless integration of sensor web data streams
- On-the fly modelling and geostatistical interpolation of research data based on geoprocessing services.

[18] Gazetter
Z_GIS – J. Strobl (University of Salzburg)

Spatial data infrastructures are based on many well coordinated interoperable web services, a gazetteer service is a practical example for one of these services. One key asset of spatial information infrastructures is providing a human language interface via toponymes. Historical as well as current documents are frequently georeferenced by place names. Gazetteer services provice an essential bi-directional cross reference between place names and geographical coordinates. A specific issue in international environments is the establishment of multilingual gazetteers supporting international cooperation and a common denominator for georeferencing based on toponymes. Gazetteer services today can well be established within standardized and open OGC – conformant frameworks and are an essential component in SDI's. During detailed planning, this service will be a clearly defined work package with an operational service as planned outcome.

Research questions:

+ Verification of OpenGIS frameworks and standards regarding suitability for supporting large area / small scale topographies with ambiguous naming conventions
+ Analysis of practical implementation issues for multilingual gazetteers across alphabets with non-parallel toponymic references
+ Identification of issues arising with handling of non-traditional placenames (numbering schemes, formal names for research and sensor stations) and moving / mobile features

[19] Satellite monitoring of glaciomarine interactions and ice-loss processes in Franz Josef Land

JR – A. Sharov (FH Joanneum Ges.m.b.H, Graz)

Detailed surveying, mapping and analysis of glacier changes in the Franz Josef Land archipelago (FJL) using remote sensing and terrestrial techniques will be performed. Special emphasis is placed on satellite monitoring of glaciomarine interactions along maritime margins of large tidewater glaciers with the final aim to improve the representation of glacier-related processes in regional climate models. The following research objectives are forseen:

+ Measurement and variational analysis of morphological, rheological and balance characteristics of the largest tidewater glaciers in the Franz Josef Land archipelago using satellite interferometry, altimetry and stereophotogrammetry.
+ Detection and thematic interpretation of diurnal, seasonal and annual glacier fluctuations, both in volumetric and fluxometric terms. Integral evaluation and inventorying of glacier changes at regional scale. Determination of the total ice discharge through maritime glacier fronts and estimation of glacier mass imbalance at both regional (FJL) and continental (Barents Sea Region) level.
+ Appraising interrelations between glacier rheology, marginal morphology, calving, marine abrasion and fast ice phenology. 3-D coupled modelling of glacier motion, glacier extent and mass balance at regional, sub-regional (Tyndall Ice Cap) and local (Renown, Impetuous, Milky, Karo outlet glaciers) scales.
+ Provision of the reliable basic control, visualization and full-value mapping of glacier dynamics, regime characteristics, glaciomarine interactions and other periglacial processes in the form of satellite image maps, value-added interferometric products and composites, scalable animated graphics, and basic layers for dynamic GIS.

[20] Microwave remote sensing for hydrologic, ecosystem and oceanographic research at FJL / high latitudes

IPF – W. Wagner (Institute of Photogrammetry & Remote Sensing, TU Vienna)

The dielectric properties of soil and snow change drastically with the amount of liquid water within that two media. Since active microwave satellites are capable of monitoring these changes they suited to collect data of relevance to hydrologic, ecosystem and oceanographic studies. These microwave data complement information available from optical/near infrared sensors.

Due to high arctic conditions the time period with unfrozen conditions of the upper soil (active layer) over non-glaciated terrain which is relevant for ecosystem analyses, e.g. the estimation of CO2 exchange, is fairly short. Therefore a high temporal resolution is needed to determine inter- and intra-seasonal patterns. Further on, monitoring of the high inter-annual variability of ice break up around FJL demands continuous time series over several years. The ASAR instrument on ENVISAT (1km spatial resolution in global mode, daily coverage) and scatterometers (e.g. Seawinds on QuikScat, 25km footprint, up to 8 visits per day, continuous acquisition since 1999) are microwave sensors which comply with these requirements. Microwave systems are also independent from cloud cover and signals are sensitive to soil moisture, surface roughness, and vegetation structure. Freeze/thaw changes can be detected and hydrological conditions which are interlinked with glacial dynamics monitored. In case of FJL, scatterometers are most suitable for applications over sea, whereas ASAR data are better suitable over land surface area due to its better spatial resolution. Specific products over land cover dynamics such as freeze/thaw on diurnal resolution and also seasonal patterns. The latter comprises inundation dynamics (wetlands) and soil moisture changes due to snow melt and permafrost features. All possible products over land are highly relevant for the determination of GHG fluxes at northern latitudes.

[21] APICS - Antarctic Peninsula Ice and Climate System Initiative
IMGI – H. Rott (University of Innsbruck)

Larsen Ice Shelf on the east coast of the Antarctic Peninsula has undergone accelerated retreat during the last decades due to a strong signal of regional climate warming, culminating in two spectacular disintegration events in 1995 on Larsen A and in 2002 on Larsen B. H. Rott and collaborators investigated the Larsen retreat and collapse in detail and were the first to prove that outlet glaciers accelerated rapidly after break-up of ice shelves. The ongoing ice retreat in this region represents a unique opportunity to study the response of ice shelves to changing climatic conditions and the impact of ice shelf collapse on the retreat of grounded ice. This is of great value for estimating the response of larger Antarctic ice shelves to the south to changing boundary conditions if climate warming proceeds, and also of Artic ice sheets. The overall program will include a ground-based component, satellite-borne remote sensing, and modelling of ice dynamics and ice-climate feedback. For in-situ measurements automatic weather stations, surface mass balance measurements, oceanographic measurements, ice penetrating radar, and an ice shelf drilling and thermal profiling program are proposed.
The IMGI contribution will focus on documenting and analysing in detail the ongoing changes of grounded and floating ice, and studying the processes leading to break-up events by means of satellite observations, using Envisat ASAR (and follow-on SARs) to map the ice boundaries, velocity fields and their temporal changes in detail, and satellite-borne altimetry of Envisat, ICESat, and the upcoming CryoSat for precise mapping the surface topography and ice shelf thickness. In addition, it is planned to carry out modelling studies in order to advance understanding of the processes that govern the dynamical characteristics of Larsen Ice Shelf and its high sensitivity to changing boundary conditions. This will include modelling of glacier – ice shelf interaction mechanisms in order to achieve new insights into the role of ice shelves for the stability of the grounded ice masses aup-stream.