Report from 1st SSF-JCI workshop: Pan-Svalbard Cooperation, 17-21.8.2009.

(Content provided by: Kristin Christoffersen, Kjellmar Oksavik, Tavi Murray, Doug Benn, and Marzena Kaczmarska).

The workshop took place on the research vessel Horyzont II offered by the Geophysical Institute of Polish Academy of Sciences and was attended by 30 participants. Participants represented 3 different groups: science management, upper atmosphere research and glaciology research. Each participant presented his/her institute/department/research group ongoing research or science management issues. The main aim of the workshop was to visit 4 main research stations in Svalbard (Longyearbyen, Hornsund, Barentsburg and Ny-Ålesund) to gain more thorough knowledge about the facilities available there, the research programmes being currently carried out or planned for the future and to learn what are the overlapping areas that could be undertaken jointly with other research stations.

This approach proved very satisfying as for many scientists it was the first time they had an opportunity to see other research bases. Each day of workshop included oral presentations, tour of research facilities, discussion and work in working groups.

The scientific working groups have prepared reports that show their joint goals and plans for future cooperative efforts (Appendix 2 and 3)

1. The management group (WG1):

WG1 has discussed potential for long-term Joint Cooperation Initiative mechanism that could work well for all research stations involved. This mechanism could be built in a similar manner as it is currently being done for Ny-Ålesund through the EU 6th Framework Programme: Trans-National Access Action (ARCFAC V). The main benefit is that the research projects are evaluated by both independent reviewers and the consortium members to ensure high scientific value, complementarity, feasibility etc. This initiative would be very beneficial for entire Svalbard research. However, it has a chance to be developed further only if some money is provided to initiate the work on building the consortium and preparing the proposal to funding agencies.

Another step toward better coordinated research could be done by extensive use of RiS database in connection with SIOS. RiS could be developed in order to store all information about research facilities in Svalbard, instruments and ongoing measuring campaigns. This would require strengthening SSF secretariat to maintain and update this information constantly.

It was also suggested that the next SSF-JCI workshop could involve researchers from the following disciplines:

- Oceanography
- Permafrost
- Marine environment
- Biology/climate change

2. Upper atmosphere research group (WG2):

WG2 has identified main scientific interests and knowledge gaps that the participants will be working on together in the future:

- Studying the solar energy input into upper atmosphere – this will require better synchronization of all measurement campaigns and use of instruments that might not have been exploited enough in the past; also calibration of all optical instruments will be done to ensure comparable data sets.
- Radio tomography and active experiments (heating) – planning the heating experiments in synchronization with other measurements;
- Further work on space weather impact on navigation and radio communication in the high Arctic – the exchange of all available data will be improved, some GPS instruments will be moved to more suitable locations instead of having them all gathered in 1 place (e.g. in Ny-Ålesund are several GPS located next to each other – some will be moved to Barentsburg, Svea, Isfjord and maybe Hopen).
- Joint large and long-term measurement campaign during the next solar maximum: 18-month-long continuous measurements (e.g. Oct 2012-March 2014) would be extremely valuable and might provide answers to many open questions; that would repeat the EISCAT IPY programme with added value of Doppler Sounder and optical measurements done at the same time.
- Student/researcher mobility scheme would be a great addition: especially important is to find sources to cover travel and living expenses in Svalbard as many researchers and students could benefit from UNIS short courses in upper atmosphere processes;
- WG2 has prepared the exhausting list of all instruments and research facilities from their respective institutes available in Svalbard;
- WG2 will have next workshop in 2010 in Barentsburg with focus on solar energy input to upper atmosphere;

3. Glaciology research group (WG3):

The current location of glaciological study sites is largely determined by the location of the established research bases. The concentration of effort in one region means that many other areas are seriously under-represented in the mass-balance record, and it is uncertain to what degree the existing records are representative of Svalbard as a whole. There is therefore a clear need to facilitate glaciological research in more remote parts of the archipelago, as well as continuing support for the established research bases.

Two main research aims were identified:

- to obtain a comprehensive view of current glacier mass changes for the whole of Svalbard:
  - need for more balanced regional coverage of glaciers
  - focus on in situ measurements to provide ground truth for satellite studies (e.g. converting glacier elevation changes into volume change)
  - High spatial and temporal resolution ice velocity and calving flux measurements for the whole archipelago are recognized as a high research priority – calving and surge are both great contributors to loss of mass from Svalbard glaciers, current data cannot serve as reference for the whole Svalbard as these processes are highly variable on several time scales and the velocity measurements taken occasionally may deliver results that vary greatly from long-term values;
  - Determining total ice volume and subglacial topography - a widespread program of airborne radar surveys is required in order to know the thickness and volume of ice; closely spaced survey lines are necessary;
- to develop a better understanding of fundamental glaciological processes – there is a clear need to improve the representation of dynamic processes in glacier models, and to collect data specifically for purposes of model testing and validation. Key areas are:
  - Calving processes and the dynamics of tidewater glaciers, and their climatic and oceanographic controls;
  - Controls on surging behaviour;
  - Glacial hydrology, and its links to glacier dynamics;
  - Glacier thermal regime and temperature evolution, including superimposed ice formation.

These aims are complementary, and are equally important for assessing the impact of past, present and future climate change on the Arctic cryosphere.

- **Interactions with other disciplines necessary for further progress and stimulation** (e.g. oceanography, glacial ecosystems, proglacial permafrost, river runoff and sediment fluxes) - It is proposed to organize inter-disciplinary workshops in Svalbard, to promote collaboration and cross-fertilization of ideas, methods and perspectives.
- **Data availability – suggested actions:**
  - the construction of an extended glacier inventory for Svalbard, including data such as DEMs, satellite imagery, and air photographs, as well as mass balance and other data;
  - increasing access to published papers and unpublished reports, by extending the Research in Svalbard (RIS) collection; and
  - contributing data layers and imagery to Google Earth.
- **Logistical and environmental issues:**
  - Efficient fieldwork requires comfortable and secure accommodation, and the capabilities of research scientists would be much improved if it were possible to erect camp facilities, such as temporary cabins, where needed. Helicopter availability and landing permissions were also identified as a key area of concern.
  - The needs of the scientific community and environmental concerns could be reconciled through coordinated liaison between scientists and the Governor's office. It is hoped that such a community communication channel could play a role in resolving conflicts of interest and informing policy development.

4. Summary

As Svalbard remains very popular place of fieldwork more and more research groups work here every year. The challenge is to have overview of all research projects being carried out, to create networks among scientists within the same disciplines and to streamline the research to avoid duplication and to improve use of resources.

RiS is growing as the information and networking tool and it has a potential to address some of the needs of programmes like SIOS.

The role of SSF as the main research coordinating body has been recognized and appreciated at the same time as the wish for greater impact has been formulated (e.g. closer links to independent scientific groups and Governor of Svalbard office).

It was agreed that the coordinating work has to continue, the workshop proved a success and there is a clear need and wish for similar workshops in the future.

Svalbard Science Forum, Marzena Kaczmarska, 19.10.2009

List of appendixes:

Appendix 1 – List of talks

Appendix 2 – WG2 summary report

Appendix 3 – WG3 summary report

Appendix 4 – list of participants

SSF-JCI 1ST WORKSHOP, 17-21.8.2009: PAN-SVALBARD COOPERATION

LIST OF TALKS

17 AUG 2009 (MONDAY)

1. Kirsten Broch Mathisen – *Polar research and funding opportunities through the Research Council of Norway*
2. Marzena Kaczmarska – *Svalbard Science Forum and Joint Cooperation Initiative (SSF-JCI)*
3. Georg Hansen – *Svalbard Integrated Arctic Earth Observing System (SIOS) – a new level of international research cooperation on Svalbard*
4. Esa Turunen – *On future plans of EISCAT*
5. Kjellmar Oksavik – *Overview of scientific activities and plans for near future: KHO & SOUSY*
6. Lisa Baddeley – *Space Plasma Exploration by Active Radar (SPEAR)*

18 AUG 2009 (TUESDAY)

7. Jacek Jania – *On dynamics of Hansbreen in Hornsund*
8. Doug Benn - *Glaciological research at UNIS*
9. Iwona Stanisławska – *Space weather at Hornsund station for RWC Warsaw service*
10. Nataly Blagoveshchenskaya - *Study of non-linear phenomena in the polar ionosphere induced by the SPEAR heating facility*
11. Piotr Głowacki – *Overview of current research activities/interests in Horsnund*
12. Sebastian Sikora – *Atmospheric Boundary Layer - thermal structure*
13. Tavi Murray – *Themes in Svalbard glaciology*
14. Marek Grześ – *Polar station Spitsbergen – Kaffiöyra*

19 AUG 2009 (WEDNESDAY)

15. Sergey Priamikov – *Russian research in Spitsbergen*
16. Vladimir Safargaleev – *Polar Geophysical Institute in Svalbard: Scientific tasks and links to SIOS*
17. Nikolai Osokin – *Glaciological research at the Institute of Geography, Russian Academy of Sciences in Svalbard*
18. Georgiana de Franceschi (presentation by Lisa Baddeley) – *Space weather effects on GPS signals in the Scandinavian sector*

19. Anna-Liisa Ylisirnio – *Arctic Centre and its research excellence. Arctic and cold climate research at Finnish research institutes and universities.*
20. Veijo Pohjola – *Ice dynamical work on Lomonosovfonna and Vestfonna: Overview of work done 1997-2009*
21. Thomas Schuler – *Ongoing research on Ausftfonna*

20 AUG 2009 (THURSDAY)

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22. Oddvar Midtkandal – *Presentation of Kings Bay AS*
23. Bendik Halgunset – *Research management in Ny-Ålesund*
24. Paal Berg – *Overview of current research activities/interests in Ny-Ålesund from NySMAC perspective. NILU research activities in Ny-Ålesund.*
25. Roland Neuber – *The joint French-German AWI-IPEV research base on Spitsbergen, a general introduction*
26. Roland Neuber – *Upper Atmosphere Research at the AWIPEV Base Ny-Ålesund*
27. Knut Stanley Jacobsen & Jøran Moen - *UiO Dayside Auroral Research Program*
28. Ruiyuan Liu - *Chinese UAP observations in Ny-Alesund*
29. Ming Yan (presentation by Ruiyuan Liu) - M*onitoring and studies of glaciers Austre Lovénbreen and Pedersenbreen, Ny-Ålesund, Svalbard*
30. Madeleine Griselin – *Hydro-glaciology research on the Austre Lovénbreen since the 60s to the last IPY*
31. Max König – *Norwegian Polar Institute glaciology activities on Svalbard*

Draft report, 31 August 2009

Report from WG2: Upper polar atmosphere

The Upper Polar Atmosphere working group met during the cruise onboard MS Horyzont II on 17-21 August 2009, where the following items were discussed:

1) Studying the energy input into the upper polar atmosphere: A key overall science goal for several group members is to study the energy input from the solar wind into the upper polar atmosphere. Two important subtopics of cooperation were identified as important:

- *Synchronization of measuring campaigns:* Each year multiple observation campaigns are carried out using expensive infrastructure like EISCAT, sounding rockets, and SPEAR. But to get optimal coverage, it would be useful to have observational support from all instrumentation in Svalbard. The group has the following recommendations:
  - Inform everyone about upcoming campaigns and offer mutual data support during EISCAT, sounding rocket, and SPEAR heating campaigns. EISCAT has many long-duration common programs, which are coordinated with other radars around the world and are known up to one year in advance (i.e. it should be easy to inform everyone about these runs to ensure optimal data coverage)
  - Aim for one mutual Pan-Svalbard campaign each year where the potential capabilities of all instruments are maximized. Run instruments at all sites as optimal as possible, e.g. in winter for two weeks around new moon (one week before and after). Everyone can suggest an observation campaign.
- *Calibration of optical instruments:* Very few optical instruments in Svalbard have been inter-calibrated. With funding from the Research Council of Norway, PGI and UNIS have used the optical laboratory at UNIS to calibrate all optical instruments in Longyearbyen and Barentsburg. Other institutions in Svalbard are strongly encouraged to also calibrate their optical instruments at UNIS, so that all optical instruments in Svalbard are inter-calibrated and measurements can easily be compared.

2) Radio tomography and active experiments (heating): Another topic shared by several group members is radio tomography and active experiments using the SPEAR facility. UNIS has obtained funding until June 2012 to operate SPEAR and invites collaboration with all institutions in Svalbard. Lisa Baddeley is working fulltime on the project and serves as a point of contact. She plans SPEAR experiments (several per year) based on geomagnetic activity, solar wind parameters, season, and overflying satellite tracks. She will also inform Zhongshan station of possible conjugate studies. She then makes a schedule of possible experiment times. Currently, there is only limited EISCAT time is available for these experiments (primarily Norwegian, Russian and Chinese time). Other countries are invited to contribute with EISCAT time and/or observational support from ground-based instruments around Svalbard.

- <u>Action:</u> Everyone is happy to join the heating campaigns and contribute with data. It is suggested that Poland may try to obtain additional EISCAT time as third-party or over the transnational access programme. Lisa Baddeley will explore the possibility of installing a Doppler Sounder in Hornsund, Ny Ålesund and at the SPEAR site (currently the only such equipment is in Barentsburg). Lisa Baddeley and Nataly Blagovechenskaya will discuss details later.

3) Space weather impact on navigation and radio communication in the high-Arctic: Scintillation effects on GPS navigation signals is a potential hazard for airplane transportation, and Svalbard is in a critical region where such effects are more dramatic than elsewhere. Iwona Stanislawska would like to use historic scintillation data from all stations in Svalbard to develop an algorithm that will predict scintillation effects on GPS signals. TEC maps will be a by-product. It will be very timely for the European navigation system Galileo. Currently there is wide coverage of GPS scintillation equipment in Svalbard; 3 Chinese and 2 Italian receivers in Ny-Ålesund, 3 Polish receivers in Hornsund, 1 Chinese and 1 Italian receiver in Longyearbyen (EISCAT and SOUSY). At the moment Barentsburg does not have GPS scintillation receivers, and currently there is very little collaboration between institutions having GPS instruments in Svalbard.

- Action #1: Iwona Stanislawska will need GPS scintillation data from all stations to develop her algorithm, make a model, and show the potential of a future prediction service for the Svalbard area. Everyone agreed to provide her with data from specific time periods in the past.
- Action #2: There appears to be too many GPS receivers in Ny-Ålesund. Possibly some could be moved to Barentsburg, Svea, Isfjord, or even Hopen. Also the groups can become better to share their GPS scintillation data.
- Action #3: Can EU's Galileo GPS project be a source of funding?

4) Joint measurement campaigns during the upcoming solar maximum: The one-year IPY run of EISCAT provided unprecedented data during solar minimum conditions. In a few years there will be a new maximum in solar activity. We now have a unique opportunity to repeat the IPY heritage by running EISCAT continuously during the solar maximum expected to take place in 2012-2014. The price tag for EISCAT is known from the IPY. All other instruments should run as much as possible; e.g. Doppler Sounder (all the time), optical cameras running (continuously during polar night, except when moon is up), etc. An idea would be to let the solar max year last for two winters and one summer (e.g. from October 2012 to March 2014).

- Action: The group agrees to call this campaign the "Svalbard Solar Max Campaign Year". It should be a joint effort of everyone in Svalbard, possibly in network with other radars. Esa Turunen (with help of everyone) agrees to write a proposal. He will:
    - contact international radar community
    - investigate funding possibilities and deadline
    - everyone writes a short proposal with wishes/possibilities and send to Esa Turunen before 6 September 2009 for discussion at next EISCAT meeting. After that meeting Esa Turunen will send out information about the outcome and the further time schedule
    - AGU Fall meeting in December 2009 may be an opportunity to enquire the interest of the broader international scientific community

5) Joint workshops in Svalbard: The group agrees that there is a great need for joint workshops in Svalbard. It is suggested to have the next workshop in summertime (for 3 days) in the new observatory in Barentsburg. The topic could be "Energy input into the upper polar atmosphere", and it may be coordinated with the already existing workshop. We should think of inviting more people. Funding may be possible via Polar Geophysical Institute, Russian Foundation for Basic Research, Research Council of Norway.

- Action: Vladimir Safargaleev will investigate and report back to the group.

6) Researcher mobility and student exchange: For over a decade UNIS has been offering field-based education taught in English to a mix of national and international students; see http://www.unis.no/studies/Arctic_Geophysics/. Every spring (January to May) there are two UNIS courses that are useful for Master and PhD level students in our field:

- AGF-301 The Upper Polar Atmosphere (15 ECTS)

- AGF-304 Radar Diagnostics of Space Plasma (15 ECTS)

The first course gives students a background into the physics of the upper polar atmosphere, with field-work at the Kjell Henriksen Observatory on how to use optical techniques to study the aurora. The second course gives students a firm background in incoherent scatter theory and radar techniques, with field-work at the EISCAT Svalbard Radar. Together these two courses correspond to the work load of a full spring term on the Master/PhD level. Currently these courses have room for more students, provided that they have funding to cover travel to/from Svalbard and accommodation/food costs while in Longyearbyen. Except for a tiny exam fee, education at UNIS is completely free. UNIS also has facilities to welcome visiting scientists, provided that they also have funding to cover travel to/from Svalbard and accommodation/food costs while in Longyearbyen.

- Action: The group agreed that funding of mobility of researchers is a good thing, and several group members expressed that this represents a great opportunity of bringing closer together all the various research groups in Svalbard (Norwegian, Russian, Polish, and Chinese). The main obstacle appears to be funding for visiting students and scientists to cover travel to/from Svalbard and accommodation/food costs while in Longyearbyen. Can the Research Council of Norway (or other funding agencies) help?

7) List of upper atmosphere instrumentation in Svalbard: As part of the visit to all facilities, several members asked where information can be found about these stations on the internet. Here is a list of internet links:

- EISCAT Svalbard Radar (Longyearbyen) – http://www.eiscat.se/
- Kjell Henriksen Observatory (Longyearbyen) – http://kho.unis.no/
- Sousy Svalbard Radar (Longyearbyen) – http://radars.uit.no/sousy/
- University Centre in Svalbard (Longyearbyen) – http://www.unis.no/
- Polish Polar Station (Hornsund) – http://hornsund.igf.edu.pl/index_en.php
- PGI Research Station (Barentsburg) – http://pgi.webhop.net/
- AARI Station (Barentsburg) – ?
- Links to all research stations in Ny-Ålesund: http://www.kingsbay.no/index.php?option=com_content&id=127&Itemid=118

It also came up that there currently is no complete list of all upper atmosphere instruments in Svalbard. Kjellmar Oksavik is currently compiling a list as part of the ESFRI project SIOS; see http://ww.rcn.no/SIOS/. The latest version of his list is included here:

Existing upper atmosphere instrumentation in and around Svalbard

Instrument	Parameters observed	Location	Operated since	Responsible institution	Country	Science Question
Incoherent Scatter Radar with 32 and 42 m antennas (500 MHz)	Ionospheric plasma parameters (like Ne, Te, Ti, Vi)	Longyearbyen, EISCAT	1996 & 1999	EISCAT	International	1, 2, 3, 4, 5, 6, 7
3 small interferometry antennas (500 MHz)	Radar imaging of fine-scale plasma structures	Longyearbyen, EISCAT	2005	Univ. Tromsø, RAL	Norway, UK	5, 6, 7
Ionospheric Scintillation Receiver	TEC and ionospheric scintillation	Longyearbyen, EISCAT	2008	CRIRP	China	2, 5, 7
Space Debris Receiver	Detection of Space Debris	Longyearbyen, EISCAT	2000	EISCAT	International	3

Auroral Structure and Kinetics Imagers (ASK)	Images of 427.8, 562.0, 673.0, 732.0 and 777.4 nm emissions in 42m radar beam (20-32 fps, 3x3 deg FOV)	Longyearbyen, EISCAT	2005	Univ. Southampton, KTH	UK, Sweden	4, 5, 6, 7
Dynasonde	Electron density profiles in ionosphere	Longyearbyen, SPEAR	2009	EISCAT	International	2, 5, 7
High-Power Heating Facility (4.45 MHz)	Active experiments in ionosphere	Longyearbyen, SPEAR	2004	UNIS, Univ. Leicester	Norway, UK	4, 5, 7
Low-Power All-Sky HF radar	Passive experiments in ionosphere	Longyearbyen, SPEAR	2004	UNIS, Univ. Leicester	Norway, UK	3, 4, 5, 7
Cadi Ionosonde	Electron density profiles in ionosphere	Longyearbyen, SPEAR	1997	Univ. Leicester	UK	2, 5, 7
All-Sky Imager	Images of 557.7 and 630.0 nm emissions (4-6 fpm, wide FOV)	Longyearbyen, KHO	1996	Univ. Oslo, UNIS	Norway	4, 5, 7
All-Sky Camera	High-speed monochrome movie of the sky (30 fps, wide FOV)	Longyearbyen, KHO	1997	Univ. Alaska Fairbanks	USA	4, 5, 7
All-Sky Imager	Images of 427.8, 557.7 and 630.0 nm emissions (3-4 fpm, wide FOV)	Longyearbyen, KHO	1996	Finnish Met. Inst.	Finland	4, 5, 7
All-Sky Colour Imager	RGB color images of the sky (every 5 min, wide FOV)	Longyearbyen, KHO	2008	Univ. Coll. London	UK	4, 5, 7
All-Sky Camera	High-speed monochrome movie of the sky (25 fps, wide FOV)	Longyearbyen, KHO	2008	UNIS	Norway	4, 5, 7
All-Sky dSLR Camera	RGB color images of the sky (2-12 fpm, wide FOV)	Longyearbyen, KHO	2006	UNIS	Norway	4, 5, 7
Auroral Spectrograph	Spectrum of 420-740 nm emissions (every 5 s, along meridian)	Longyearbyen, KHO	2000	NIPR	Japan	4, 5, 6, 7
CCD Spectrograph	NIR spectrum (every 2 min, near zenith)	Longyearbyen, KHO	1993	Embry Riddle Aeron. Univ.	USA	1, 2
NIR All-Sky Imager	NIR image (>2 min exposure, wide FOV)	Longyearbyen, KHO	2008	UNIS	Norway	1, 2, 5
Meridian Scanning Photometer	Intensity of 5 auroral lines along the meridian (every 16 s)	Longyearbyen, KHO	1978	Univ. Alaska Fairbanks	USA	4, 7
1 m “Silver” Ebert-Fastie Spectrometer	Spectrum of 7250-8650 nm emissions, i.e. OH airglow (every 5 min, near zenith)	Longyearbyen, KHO	1980	Univ. Alaska Fairbanks	USA	1, 2
1 m 'Green' Ebert-Fastie Spectrometer	Spectrum of proton aurora, variable range in UV-NIR (every 8-300 s, near zenith)	Longyearbyen, KHO	1978	Univ. Alaska Fairbanks	USA	4, 6, 7
1/2 m 'Black' Ebert-Fastie Spectrometer	Spectrum of proton aurora, variable range in UV-NIR (every 8-300 s, near zenith)	Longyearbyen, KHO	1978	Univ. Alaska Fairbanks	USA	4, 6, 7

1/2 m 'White' Ebert-Fastie Spectrometer	Spectrum of proton aurora, variable range UV-NIR (every 12-300 s, along meridional)	Longyearbyen, KHO	1996	UNIS, Univ. Tromsø	Norway	4, 6, 7
Michelson Interferometer	Spectrum of OH airglow (every 20 s)	Longyearbyen, KHO	1993	Embry Riddle Aeron. Univ.	USA	1, 2
Imaging Fabry-Perot Interferometer	Termospheric winds and temperatures (every 30 s, several directions)	Longyearbyen, KHO	1986	Univ. Coll. London	UK	4, 6, 7
Scanning Doppler Imager	Termospheric winds and temperatures (every 1-2 min, wide FOV)	Longyearbyen, KHO	2006	Univ. Coll. London	UK	4, 6, 7
Spectrographic Imaging Facilities	Measurements of fine-scale aurora in narrow FOV along B; movie (25 fps), spectrum, and 4 photometers	Longyearbyen, KHO	1992	Univ. Southampton, Univ. Coll. London	UK	5, 6
HF acquisition system	Disturbance of signals from HF radio stations	Longyearbyen, KHO	2008	Inst. Radio Astronomy	Ukraine	2, 5
64-beam Imaging Riometer	Cosmic noise absorption maps (1 s)	Longyearbyen, KHO	1995	Danish Met. Inst., Univ. Tromsø	Denmark, Norway	2, 5, 7
Ionospheric Tomography Receiver	TEC and meridional electron density maps	Longyearbyen, KHO	1996	Univ. Wales Aberystwyth	UK	2, 5, 7
Auroral Radio Spectrograph	0.3-6 MHz auroral radio emissions (1 s)	Longyearbyen, KHO	2008	Tohoku Univ.	Japan	2, 5, 7
Search-coil Magnetometer	ULF magnetic wave activity (2 axes, 0.1 s)	Longyearbyen, KHO	2007	Augsburg College, Univ. New Hampshire	USA	4, 7
Fluxgate Magnetometer	Magnetic field (3 axes, every 10 s)	Longyearbyen, KHO	1993	Univ. Tromsø	Norway	2, 4, 7
Telescope	General purpose of viewing stars	Longyearbyen, KHO	1995	UNIS	Norway	1, 2
MST radar	tropospheric structure, PMSE	Longyearbyen, SOUSY	2003	Univ. Tromsø	Norway	1, 2, 3
Meteor Wind Radar	wind, temperature, 80-100km	Longyearbyen, SOUSY	2001	Univ. Tromsø, NIPR	Norway, Japan	3
Ionospheric Scintillation Receiver	TEC and ionospheric scintillation	Longyearbyen, SOUSY	2004	INGV	Italy	5, 7
All-Sky Imager	Images of 557.7 and 630.0 nm emissions (4-6 fpm, wide FOV)	Ny-Ålesund, Sverdrup Station	1997	Univ. Oslo	Norway	4, 5, 7
Meridian Scanning Photometer	Intensity of 2 auroral lines along the meridian (every 20 s)	Ny-Ålesund, Sverdrup Station	1988	Univ. Oslo	Norway	4, 7
Ionospheric Tomography Receiver	TEC and meridional electron density maps	Ny-Ålesund, Sverdrup Station	1996	Univ. Wales Aberystwyth	UK	2, 5, 7
SAOZ Spectrometer	Total ozone, NO2, PSC (spectral range 300-600 nm)	Ny-Ålesund, Sverdrup Station	1991	NILU, CNRS	Norway, France	1, 2
GUV	UV irradiance, total ozone	Ny-Ålesund, Sverdrup Station	1996	NILU	Norway	1, 2
UV-RAD ISAC Radiometer	UV fluxes (300-380 nm), Ozone Content	Ny-Ålesund, Sverdrup Station	2008 update	ISAC-CNR	Italy	1, 2

Brewer No. 50	Ozone Content - UV spectra	Ny-Ålesund, Rabot Station	2008 update	ISAC-CNR	Italy	1, 2
Ozonesondes	Vertical profiles of ozone	Ny-Ålesund, Koldewey Station	1988	AWI	Germany	1, 2
Stratospheric Ozone Lidar	Vertical profiles of ozone, PSC, strat. T, density, mesospheric OH-layer	Ny-Ålesund, Koldewey Station	1988	AWI	Germany	1, 2
FTIR spectrometer	Columns of stratospheric trace gasses	Ny-Ålesund, Koldewey Station	1992	AWI	Germany	1, 2
Microwave radiometer	Trace gasses in stratosphere and lower mesosphere	Ny-Ålesund, Koldewey Station	1994	AWI, Univ. Bremen	Germany	1, 2
All-Sky Imagers	Images of 557.7, 630.0, and 427.8 nm emissions (10 fpm, wide FOV)	Ny-Ålesund, Chinese Station	2003	PRIC	China	4, 5, 7
Imaging Riometer	Cosmic noise absorption (38.2 MHz)	Ny-Ålesund, Chinese Station	2008	PRIC	China	2, 5, 7
Ionospheric Scintillation Receiver	TEC and ionospheric scintillation	Ny-Ålesund, Chinese Station	2007	CRIRP	China	5, 7
All-Sky Camera	Images of 427.8, 557.7 and 630.0 nm emissions (6 fpm, wide FOV)	Ny-Ålesund, Italian Station	1999	IFSI-INAF	Italy	4, 5, 7
Ionospheric Scintillation Receiver	TEC and ionospheric scintillation	Ny-Ålesund, Italian Station	2003	INGV	Italy	5, 7
Ionospheric Scintillation Receiver	TEC and ionospheric scintillation	Ny-Ålesund, Statkart	2003	INGV	Italy	5, 7
FTIR spectrometer	Mesospheric Temperature	Ny-Ålesund, Dasan Station	2002	KOPRI	Korea	1, 2
Rocket Launcher	Sounding Rocket Facility	Ny-Ålesund, SvalRak	1997	Andøya Rocket Range	Norway	1, 5, 6
Fluxgate Magnetometer	Magnetic field (3 axes, every 10 s)	Ny-Ålesund	1967	Univ. Tromsø	Norway	2, 4, 7
Search-coil Magnetometer	ULF magnetic wave activity (2 axes, 0.1 s)	Ny-Ålesund	2007	Augsburg College, Univ. New Hampshire	USA	4, 7
Induction Magnetometer	Magnetic field wave activity (3 axes, 0.1-20 Hz, every 25 ms)	Barentsburg	2000	PGI	Russia	4, 7
Induction Magnetometer	Magnetic field wave activity (3 axes, 0.1-20 Hz)	Barentsburg	2005	Univ. Oulu	Finland	4, 7
Fluxgate Magnetometer	Magnetic field (3 axes, every 0.1 s)	Barentsburg	2000	PGI	Russia	2, 4, 7
Neutron Monitor	Cosmic rays (every 10 s)	Barentsburg	2007	PGI	Russia	2
All-Sky Television Camera	Monochrome movie of the sky (wide FOV, VHS format, ~6 fps)	Barentsburg	2000 (digital 2008)	PGI	Russia	4, 5, 7
4-channel Photometer	Emissions at 557.7 and 630.0 nm (every 25 ms)	Barentsburg	2008	PGI	Russia	4, 5, 7

PhotonMax Camera	Imaging of aurora and airglow in daylight (25 deg FOV, every 10 s)	Barentsburg	2008	PGI	Russia	4, 5, 7
Near-infra-red Spectrometer	Sky luminosity (730-890 nm, 4 fpm)	Barentsburg	2008	PGI	Russia	2, 4, 7
Ionospheric Tomography Receiver	TEC and ionospheric scintillation	Barentsburg	2004	PGI	Russia	5, 7
Radio Interferometer	Stimulated EM emissions (1.5-32 MHz), remote monitoring of SPEAR	Barentsburg	2008	PGI	Russia	4, 5, 7
HF Doppler receiver sounder	ULF magnetic wave activity, remote monitoring of SPEAR	Barentsburg	2005	Univ. Leicester	UK	4, 5, 7
30 MHz riometer	Amplitude of cosmic noise absorption (every 0.1 s)	Barentsburg	2005	AARI	Russia	2, 5, 7
Oblique ionospheric sounding receiver	Amplitude of signals from St. Petersburg (time delay-frequency, every hour)	Barentsburg	2002	AARI	Russia	2, 5
Fluxgate magnetometer	Magnetic field (3 axes, every 0.1 s)	Barentsburg	2002	AARI	Russia	2, 4, 7
3 Spaced GPS Receivers	TEC and ionospheric scintillation	Hornsund	2007	Space Res.Center PAS	Poland	5, 7
30 MHz riometer	Cosmic noise absorption	Hornsund	1980's	Sodankyla Geoph. Obs.	Finland	2, 5, 7
Digital Ionosondes (vertical and oblique)	Electron density profiles in ionosphere	Hornsund	2009 Sep.	Space Res.Center PAS	Poland	2, 5, 7
30 MHz Riometer	Cosmic noise absorption	Hornsund	2009 Sep.	Natural Resources	Canada	2, 5, 7
Radioactive collector and field mill	Ground atmospheric electric field	Hornsund	1980's	Inst. Geophysics PAS	Poland	4, 5, 7
Torsion Digital Magnetometers	Magnetic field (3 axes and total field)	Hornsund	1970's	Inst. Geophysics PAS	Poland	2, 4, 7
Search-coil Magnetometer	ULF magnetic wave activity (2 axes, 0.1 s)	Hornsund	2007	Augsburg College, Univ. New Hampshire	USA	4, 7
Search-coil Magnetometer	ULF magnetic wave activity (2 axes, 0.1 s)	Isfjord	2007	Augsburg College, Univ. New Hampshire	USA	4, 7
SuperDARN HF ionospheric radar	Horizontal plasma velocity in ionosphere over Svalbard	Pykkvibaer (Iceland)	1995	Univ. Leicester	UK	3, 4, 5, 6, 7
SuperDARN HF ionospheric radar	Horizontal plasma velocity in ionosphere over Svalbard	Hankasalmi (Finland)	1995	Univ. Leicester	UK	3, 4, 5, 6, 7
Meteor radar	Winds in 80-100km altitude	Bjørnøya	2007	Univ. Tromsø, Univ. Nagoya	Norway, Japan	3
Ionospheric Tomography Receiver	TEC and meridional electron density maps	Bjørnøya	1996	Univ. Wales Aberystwyth	UK	2, 5, 7
Fluxgate Magnetometer	Magnetic field (3 axes, every 10 s)	Bjørnøya	1997	Univ. Tromsø	Norway	2, 4, 7
Fluxgate Magnetometer	Magnetic field (3 axes, every 10 s)	Hopen	1988	Univ. Tromsø	Norway	2, 4, 7

Fluxgate Magnetometer	Magnetic field (3 axes, every 10 s)	Jan Mayen	1978	Univ. Tromsø	Norway	2, 4, 7

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WG3 - Glaciology

Introduction

A wide variety of glaciological research is being conducted in Svalbard, much of which makes use of the logistical facilities available at Ny-Ålesund, the Polish Polar Station in Hornsund, the Russian Research Station in Barentsburg, UNIS and NPI in Longyearbyen. Despite the great diversity of this research, several common themes can be identified. There is already a good deal of collaboration between groups; however there is also great potential for future collaborative work towards common goals.

The current location of study sites is largely determined by the location of the established research bases. This has had both positive and negative effects. On the positive side, it is very easy to conduct long-term observational programs on accessible glacier systems, such as annual mass-balance monitoring of several of the glaciers close to Ny Ålesund. While this presents opportunities to study small- to mid-scale influences on glacier melting and accumulation, the concentration of effort in one region means that many other areas are seriously under-represented in the mass-balance record, and it is uncertain to what degree the existing records are representative of Svalbard as a whole. There is therefore a clear need to facilitate glaciological research in more remote parts of the archipelago, as well as continuing support for the established research bases.

Summary of work presented at the meeting

(talk abstracts)

Knowledge gaps and research priorities identified by the participants

Broadly, two main research aims were identified:

(1) to obtain a comprehensive view of current glacier mass changes for the whole of Svalbard; and

(2) to develop a better understanding of fundamental glaciological processes that act on Svalbard ice masses.

These aims are complementary, and are equally important for assessing the impact of past, present and future climate change on the Arctic cryosphere.

(1) Glacier mass changes for the whole of Svalbard

To obtain a comprehensive view of current ice losses from the whole of Svalbard, there is an urgent need for a more balanced regional coverage of glaciers than is currently available. Although regional coverage can be obtained from satellite measurements, there are problems with converting satellite-derived data (such as glacier elevation changes) into glacier volume changes. Therefore, field campaigns to measure glacier mass balance in remote parts of Svalbard (e.g. the Northern and Eastern parts, which also are the most glaciated areas) are necessary to provide ground truth for satellite studies.

Iceberg calving accounts for a large proportion of the glacier ice lost from Svalbard. Current calving losses are very poorly known, because both the positions of the calving fronts and glacier velocities (i.e. the rate at which ice is delivered to the front) are highly variable on several timescales. In Svalbard, glacier velocities can undergo large seasonal cycles, on which are superimposed short-term speedups and slowdowns. In addition, many Svalbard glaciers are of surge-type, and velocities can range across three orders of magnitude over surge cycles. 'Snapshot' measurements of ice velocity, therefore, may be very far from long-term average values, and can yield very inaccurate estimates of ice losses. High spatial and temporal resolution ice velocity and calving flux measurements for the whole archipelago are recognized as a high research priority.

For such velocity measurements to be translated into volume (and mass) changes, it is necessary to know how thick the glaciers are. Determining the subglacial topography beneath Svalbard's tidewater glaciers requires a widespread program of airborne radar surveys. Pilot studies on Kronebreen have demonstrated that accurate data can be obtained, even for highly crevassed glaciers, although closely spaced survey lines are necessary. A need for bathymetry data in front of calving glaciers was also emphasized.

(2) *Fundamental glaciological processes*

Our ability to predict the future response of Svalbard glaciers to climate change is limited by imperfect understanding of many of the processes governing glacier dynamics. Such processes are commonly non-linear, so that glacier response may undergo a sudden change at some threshold. For example, some Svalbard tidewater glaciers, such as those in inner Hornsund, have undergone very rapid retreat in recent years, and others, such as Kronebreen and Hansbreen, may be close to the threshold for similarly rapid retreat.

There is a clear need to improve the representation of dynamic processes in glacier models, and to collect data specifically for purposes of model testing and validation. Key areas identified by many workshop participants include the following.

• Calving processes and the dynamics of tidewater glaciers, and their climatic and oceanographic controls;

• Controls on surging behaviour;

• Glacial hydrology, and its links to glacier dynamics (in particular tidewater, polythermal and surging glaciers);

• Glacier thermal regime and temperature evolution, including superimposed ice formation.

Interactions with other disciplines

Glaciers interact with many other elements of the Earth system. Traditionally, glaciologists have focused on interactions between glaciers and the atmosphere, but it is increasingly recognized that other interactions are also of fundamental importance. First, calving glaciers may be very sensitive to energy exchanges with the oceans, and oceanographic changes may trigger large dynamic changes in glacier systems. Second, glacial ecosystems (including microbes and higher organisms) can play a major role in nutrient cycling and carbon fluxes. Third, changes in glacier extent can be strongly coupled with changes in other terrestrial systems, including proglacial permafrost, river runoff, and sediment fluxes.

Consequently, dialogue with other workers in other disciplines, such as oceanographers, hydrologists, and biologists could stimulate new research in these areas. It is proposed to organize inter-disciplinary workshops in Svalbard, to promote collaboration and cross-fertilization of ideas, methods and perspectives.

Data availability

There is a long history of glaciological research in Svalbard, and researchers may not be aware of relevant pre-existing work, particularly if published in languages other than their own. Important means of improving the flow of information include:

• the construction of an extended glacier inventory for Svalbard, including data such as DEMs, satellite imagery, and air photographs, as well as mass balance and other data (e.g. ice thickness data);

• increasing access to published papers and unpublished reports, by extending the Research in Svalbard (RIS) collection; and

• contributing data layers and imagery to Google Earth.

Logistical and environmental issues

The scientific community recognizes the need to preserve the environment of the Svalbard archipelago. It is hoped, however, that this consideration will not prevent scientists from conducting research in all parts of the archipelago, including the East coast. Efficient fieldwork requires comfortable and secure accomodation, and the capabilities of research scientists would be much improved if it were possible to erect camp facilities, such as temporary cabins, where needed. Helicopter availability and landing permissions were also identified as a key area of concern.

The needs of the scientific community and environmental concerns could be reconciled through co-ordinated liaison between scientists and the Governor's office. It is hoped that such a community communication channel could play a role in resolving conflicts of interest and informing policy development.

SSF-JCI 1ST WORKSHOP, 17-21.8.2009: PAN-SVALBARD COOPERATION
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