The Polar CLIMATE **SvalGlac** Project
Sensitivity of Svalbard Glaciers to Climate Change
Scientific Steering Committee Meeting
at the Uppsala University
Department of Earth Sciences
27 October 2012: 3.00-7.00 PM

Minutes

1. Welcome

The SC Meeting was chaired by **Jacek Jania (PI), Poland** – Coordinator and **Francisco Navarro, Spain** – Co-Coordinator, who welcomed everyone to the meeting:
Joanna Szafraniec – Coordination Office Scientific Secretary, Piotr Głowacki – Research Team Leader, Bartłomiej Luks – Project Researcher, **Poland**;
Daniela Mansutti **Italy** (PI);
Marco Möller, **Germany** (representant of PI) – Project Researcher;
John Moore (PI), Martina Schäfer – Project Researcher), **Finland**;
Veijo Pohjola, **Sweden** (PI), Rickard Pettersson (Project Researcher) – hosts;
Friedrich Obleitner, **Austria** (PI);
Rein Vaikmäe, **Estonia** (PI), Tõnu Martma – Project Researcher;
Jon Ove Hagen, **Norway** – Associated Partner;
Carleen Tijm-Reijmer, **the Netherlands** – Associated Partner.

2. Adoption of the agenda

Proposed agenda and the aim of the meeting were presented and accepted by Members of the Steering Committee. Point 4 was removed from the agenda.

3. National reports on project progress: field and laboratory work in 2012, budget execution

<u>Austria activity report 2012</u>

Members: F. Obleitner, F. Karner, G. Fiegl (IMGI) and J. Kohler (NP) and associated partners: B. Claremar, V. Pohjola (Uppsala), G. Jocher (AWI J. Reuder (Univ. Bergen) – cooperation with partners in Norway and Sweden.

Carried out field work (09 -23 April 2012): maintenance of 5 automatic weather stations at Kongsvegen (AWS), reduce Kongsvegen AWS network leaving 2 stations, set up remaining AWS at Kronebreen, M. Lovenbreen and A. Broggerbreen, clean up abandoned measurement sites to comply with SSF regulations, return equipment not used any more, assist NP snow and mass balance work on Kongsvegen. The stations mostly were withstanded and data were

successfully recovered (despite difficult conditions). Snow investigations – performed in limited extend. The current set up of Kongsfjorden AWSs – a common effort of IMGI and NP (RIS-ID 2203). The SvalGlac AWS metadata information: http://imgi.uibk.ac.at/node/618.

Data analysis included: reanalysis of pre-SvalGlac AWS data (Kongsvegen AWS6 and Ny-Alesund 2000 to 2010) and analyses of data gathered within SvalGlac focussed on:

- analysis of AWS data to investigate the meteorological conditions and the energy and the mass balance along the glacier Kongsvegen,
- analysis of turbulence characteristics in the Kongsfjorden environment (cooperation with AWI, Bremerhaven),
- investigation of snow characteristics (cooperation with SLF and LGGE),
- contribution to RCM validation studies (cooperation with University Uppsala),
- contribution to development of a new surface mass balance model (cooperation with IMAU, Utrecht).

Modelling:

- related to atmospheric modelling, in context of RCM validation: major efforts concern the application of energy and mass balance models to study the interaction of snow and ice with the atmosphere;
- main output based on modelling the mass and energy balance at a site close to the ELA of Kongsvegen glacier during the last decade;
- current work focuses on estimation of the inherent uncertainties, interpolation of the meteorological fields and evaluation of the spatial characteristics of snow structure.

Project developments and outlook: due to the delay in field work (and the discontinuation of the PhD work) it is indicated to **extend the duration of the national project at neutral costs until December 2014**. The planned next field work (April 2012) – devoted to further clean up at the measurements sites with the limited Austrian contribution (scientific cooperation with NP).

Details and publications in the report on the website: http://svalglac.eu/reports.htm (SVALGLAC-Austria - activity report 2012).

The Netherlands activity report, 2012

Members: Carleen Reijmer, Ward van Pelt (Utrecht University), Veijo Pohjola, Rickard Petterson (Uppsala University), Jack Kohler (Norwegian Polar Institute), Jon Ove Hagen, Thorben Dunse (University of Oslo).

Field activity: 9-22 April 2012 (IMAU, Uppsala University, the Geological Survey of Denmark and Greenland (Geus) – fieldwork on Nordenskiöldbreen, Svalbard; replacing the IMAU GPS instruments that measure stake locations year round (time series of glacier velocity); measurements of the stake locations with DGPS instruments for precision annual velocity determination and the stake height for the annual mass balance; the replacement of the two GPSs located closest to the front by one Argos transmitting GPS; collection of the AWS data;

necessary repairs; kinematic DGPS observations; high frequency snow radar profiling in order to determine surface height changes and accumulation patterns; deep radar measurements to improve the bedrock topography; snow pit observations of temperature, density and moisture content; ice core drilling in order to measure snow temperature and filming the layering in the core. Other activities on Svalbard: the replacement of Argos GPS on Kronebreen (NPI) and the replacement of Argos GPS on Austfonna (University of Oslo). Observations on the Austfona glacier Basin no3 – a glacier surge.

Analyses of all data: calculation of velocities from the GPS observations for Austfonna, Kronebreen and Nordenskiöldbreen, calculation of annual mass balances for Nordenskiöldbreen, applying an energy balance model to the AWS data on Nordenskiöldbreen; the validation studies for satellite products (MODIS) and regional Climate model output (WRF) with AWS data; related project using the bedrock data of Nordenskiöldbreen as validation – a dynamical ice flow model (PISM) used to determine bedrock topography based on surface elevation maps.

Details with illustrations and publications in the report on the website: http://svalglac.eu/reports.htm (Report of Dutch activities on Svalbard and related work, 2012)

Italy activity report 2012

Team: Daniela Mansutti, Edoardo Bucchignani, Alessandro Forieri, Giuseppe Pontrelli; Rossella Cossu and Andrea Di Mascio.

Activity: diagnostic study of a subglacial lake and mechanisms underlying the icefield/lake system via an in-house computational code. Testing on Amundsenisen icefield upon data provided by J.Otero and F. Navarro:

- physical aspects added in the code during the past one year: viscosity dependency on deformation tensor (Glen's law, n=3) and constant water content coefficient, thermal field of firn (according to field data by Zagorodnov, 1985), calibration of eddy viscosity/diffusion coefficients of lake Large Eddy Simulation (LES);
- work in progress: estimation of local ice water content according to conservation equation, acquisition of firn density from Zagorodnov data (1985), further tuning of sliding law constant (ice/rock), inclusion of water density dependency on pressure, inclusion of water filtration at rocky bottom.

Further aims: study of system sensitivity to geothermal heat flux (with melting at ice-rock interface) and external temperature (with unsteady top ice surface), focus on other physical parameters to be observed and measured on field for improvement of subglacial lake diagnostic simulation.

Details – publications, budget, effects of numerical simulations for Amundsenisen in the report on the website: http://svalglac.eu/reports.htm (Activities developed by the Italian group, 2012).

Finland activity report 2012

Details in the Glacier Dynamics Modelling Group activities 2012 report (see point 5) and in the report on the website: http://svalglac.eu/reports.htm (Glacier dynamics modelling group activities in 2012).

Estonia activity report 2012

δD and $\delta^{18}O$ analysis of ice core samples with Picarro laser instrument (Picarro L2120-i), also continuation of the Lomonosovfonna 2009 ice core δD and $\delta^{18}O$ analysis (coooperation with Paul Scherrer Institut Switzerland, NPI and Uppsala University) – 4000 samples for isotopes, chemistry and black carbon; isotope measurements is planned to finish in January 2013.

Holtedahlfonna 2012 shallow core δD and $\delta^{18}O$ measurements – completed (coooperation with NPI and Institute for the Dynamics of Environmental Science, Venice).

Lomonosovfonna and Austfonna shallow core $\delta^{18}O$ measurements (coooperation with Uppsala University; in progress). Results of $\delta^{18}O$ measurement – for dating and interpretating the paleoclimatolocical conditions.

Jan Mayen shallow core δD and $\delta^{18}O$ measurements (coooperation with Arctic Center; in progress).

Sea ice studies in Svalbard area (cooperation with NPI). Study of the spring sea ice evolution in Rijpfjorden.

Changes in the work plan: cancelation of the fieldwork in Amundsenisen in spring 2012 because of unfavourable ice conditions in Svalbard fiords. It was impossible to transport people and equipment to Hornsund station. Suggestion of the Estonian Research Council to **prolong the usage of SvalGlac budget up to the end of 2013**!

Details with publications in the report on the website: http://svalglac.eu/reports.htm (Estonia - Progress report and scientific highlights 2012).

Norway activity report 2012

GPS and flow velocity measurements data and mass balance data.

Snow accumulation distribution studies.

Cooperation with Austrian, Spanish & Russian, Finland, and Dutch partners.

Results in papers (see: table below).

Germany activity report 2012

Field campaign in May 2012 – Vestfonna, De Geerfonna: AWS, snow pits, removal of AWS and stakes.

Surface-albedo model for Vestfonna, extension of CMB time series for Vestfonna back to 1979, snowdrift model for NW Vestfonna and adjacent field areas, analysis of near-surface air

temperature.

WRF modeling:

- finished: standard V1 30 km, 2 km;
- future: evaluation and analysis output data, revision of dataset for SvalGlac project partners, analysis of potential relations CMB – atmospheric circulation, until 2100.

Spain (& Russia) activity report 2012

Team: Corcuera, María Isabel; Cuadrado, María Luisa; Lapazaran, Javier; Machío, Francisco; Martín-Espanol, Alba; Navarro, Francisco; Otero, Jaime; Rodríguez-Cielos, Ricardo and Vasilenko, Evgeny (Russia).

Fieldwork: planned Hornsund-based GPR campaign, spring 2012, could not be done because of inaccessibility of Hornsund station due to fiord ice conditions; switched to Barentsburg-based GPR campaign performed by Russian team (Vasilenko, Macheret, Lavrentiev).

Data processing: all GPR data from above campaign already processed.

Modelling: advances in modelling of Hansbreen dynamics; consulting on Amundsenisen modelling (Italian partners).

Inventory (& vol. comp.) Svalbard echo sounded glaciers: substantial advance in the work. Paper on western Nordenskiöld Land glaciers submitted (31 July) to Ann. Glaciol.

IMPORTANT POINT: requested to Spanish Ministry of Economy and Competitiveness the **extension of the project & budget expenditure to 31 Dec 2013**.

Details, budget, publications (also planned) in the report on the website: http://svalglac.eu/reports.htm (Report of activities of Spanish (& Russian) national team in 2012).

Poland activity report 2012

Fieldwork in the Hornsund region:

- spring 2012 – expedition failed due to unfavorable sea ice conditions in fiords;
- summer/fall 2012 – maintenance of AWSs on Hansbreen, mass balance and snow studies, measurements of incoming and reflected shortwave radiation, albedo, air temperature, snow cover thickness and density, snow grains size and their classification, moisture content, time-lapse terrestrial scanning of ice cliff during summer (M. Pętlicki), record of mini-tsunami by sea level divers (M. Ciepły), maintenance of time-lapse cameras (D. Ignatiuk);
- 26-31 August 2012 – "Field Workshop on Studies of Tidewater Glaciers", Svalbard, cruise on the r/v "Horyzont II";
- As a result of the Project – PhD thesis of D. Puczko (Institute of Geophysics, Polish Academy of Sciences): "Temporal and spatial variability of velocity of Spitsbergen tidewater glaciers on Hans Glacier as an example".

4. ESF Polar CLIMATE reporting and conference

Removed.

5. Reports from Working Groups – implementation of the Projects' objectives

Ground Penetrating Radar Working Group activities 2012

Teams involved: Technical University of Madrid, University of Oslo, Russian Academy of Sciences, University of Silesia

- RES fieldwork 2012 in western Nordenskiöld Land (using central frequency 20 MHz anntenas): on Fridtjovbreen, Erdmanbreen, Dahlfonna – thickness of ice (Technical University of Madrid and Russian Academy of Sciences);
- 800 MHz Ramac GPR system and kinematic GPS: snow accumulation distribution, glacier facies on Austfonna (University of Oslo);
- On Hansbreen - medium range soundings with 100 MHz central frequency in frontal part of the glacier – monitoring of the drainage system, processing of archival GPR data for snow accumulation, water content and hydrothermal structure; inventory of GPR/RES equipment (http://www.klima.tu-berlin.de/KB/) (University of Silesia).

Details in the report on the website: http://svalglac.eu/reports.htm (Ground Penetrating Radar Working Group Report 2012).

Glacier Dynamics Modelling Group activities 2012

Group members: Bucchignani, Edoardo (Italy); Corcuera, María Isabel (Spain); Cuadrado, María Luisa (Spain); Dunse, Thorben (Norway); Forieri, Alessandro (Italy); Mansutti, Daniela (Italy); Navarro, Francisco (Spain); Otero, Jaime (Spain); Pettersson, Rickard (Sweden); Pontrelli, G. (Italy); Schäfer, Martina (Finland); new members: R. Cossu (Italy); A. Di Mascio (Italy); Timo Riikilä (Finland); Rupert Gladstone (Finland).

2-D modelling of Hansbreen by Spanish team: improvements in 2D full-Stokes (Elmer) modelling of the transient dynamics of Hansbreen, including a Benn-type calving low:

- improved basal boundary conditions: introduced initialization scheme according to Arthern & Gudmundsson (2010);
- improved treatment of lateral drag; still facing problems with inconsistent field data!

Modelling of Amundsenisen: after 3D-modelling and supply to Italian partners 2D flowlines, consulting activities to Italian partners on physics of model and interpretation of results.

Italian Partner:

- AIM: diagnostic study of a subglacial lake and of mechanisms underlying the icefield/lake

system via an in-house computational code. Testing on Amundsenisen icefield with data provided by J. Otero & F. Navarro;

- Physical aspects added in the code during the past one year: viscosity dependency on deformation tensor (Glen's law, n=3) and constant water content in temperate ice; firn thermal field (according to field data by Zagorodnov, 1985); tuning of eddy viscosity/diffusion coefficients of lake Large Eddy Simulation;
- Difficulties have been faced at computational level: mesh refinement at ice/lake interface (lake side) is mandatory for correct description of phase change mechanism; strong dependence of Large Eddy Simulation of lake flow on basin geometry (Antarctic lakes are quite different!); guess of an initial lake flow and thermal field (combined with lengthy time evolution);
- Improved understanding of the physics of icefield/lake system: the presence of a firn layer cannot be neglected, in particular when dealing with temperate icefields.
- Work in progress: estimation of ice local water content according to conservation equation; experimentation of deeper lake basin geometry; acquisition of firn density from Zagorodnov data (1985) within computational code; further tuning of sliding law constant (ice/rock); inclusion of water filtration at bedrock;
- In addition: study of system sensitivity to geothermal heat flux and external temperature; focus on physical parameters to be observed and measured on field for improvement of subglacial lake diagnostic simulation.

Finland Partner:

- Timo Riikilä – construction of a discrete element model for viscoelastic materials with fracture: application calving, model consists of variable sized mass spheres connected with massless springs, springs are allowed to break when a certain threshold is exceeded (fracture), viscotic behaviour is modeled with breaking and forming of springs under breakdown, limit with small propability (example in the report);
- Rupert Gladstone – modeling Austfonna ice-cap, satellite based observations of velocity fields on the surface of the Nordaustlandet ice-caps: "Basin 3" region enlarged on the right (Basin 3 is a surging glacier on Austfonna), from top to bottom velocities from 1995, 2008 and 2011, used to construct a refined mesh for use with the Elmer/Ice model; inverse techniques used to infer the spatial distribution of basal stress of Austfonna: involves optimising the basal data model stress coefficient to minimise the discrepancy between modelled and observed velocities, modelled velocities are shown for Basin 3 for 1995. Plans: use the results of the inverse modelling to investigate the possible relationship between temperature and basal drag, implementation of basal drag law that will allow for surging behavior, simulations of future behaviour of Austfonna;
- Martina Schäfer – Vestfonna: similar to ASF project, TC paper (http://www.the-cryosphere.net/6/771/2012/tc-6-771-2012.html), study of temperature distribution inside the icecap (friction heat is the most important heatsource in the fastflowing outlets) and link to basal drag obtained from inverse method, log(basal drag) shown left with approximated temperature, right with full temperature evolution (1995), intercomparison of basal drag in 1995, 2008, 2011 inferred with inverse method from surface velocities

(basal drag observed at 3 different periods is shown, acceleration at Franklinbreen visible); Paierlbreen: first modeling steps, but mainly still data gathering phase (bedrock data OK, velocity data search still undergo, TerrraSAR-X images ordered for December 2012, no modeling results will be achieved before end of Finnish SVALGLAC).

Details in the report on the website: http://svalglac.eu/reports.htm (Glacier dynamics modelling group activities in 2012).

AWS and Mass Balance Working Group report 2012

Scope of working group activities:

- Mass balance work – based on standard methods (stakes and snow pits) and is increasingly supported by additional measurements (GPS, DGPS and Argos transmitting, high frequency snow radar profiling, deep radar measurements and ice core drilling);
- Energy balance and temperature index models are used; distributed models and multilayered models are considered. The proposed modeling work includes both surface mass balance modeling and sensitivity analysis.
- Modelling – both energy balance models and degree day (temperature index) approaches are used in local and distributed modes. The model strategy will be tailored to the scale and data availability and also includes sensitivity analysis.

Regions:

- Team: work was mainly carried through by IMGI, NP, UiO, with contributions from associated partners (University of Bergen, AWI, IMAU) – **NW Spitsbergen** (Kongsvegen and Kronebreen): routine MB measurements (NP with support by Austria and UiO); operate Argos GPS on Kronebreen (NP with support by IMAU); update ground based GPS and satellite data for ice surface topography (NP and UiO); continue Kongsvegen bed topography radar and surface profiling in the upper area; long-term AWS and snow measurements at stake 6 (2000-2012,IMGI and NPI); intermittent intensification of Kongsvegen AWS network (2010-2011, IMGI and NPI); intermittent intensification of Kongsvegen snow investigations (2011, IMGI and NPI); special measurements (May 2011, turbulence, UAV; IMGI, University of Bergen); perform data analyses and simulations;
- Team: Work was mainly conducted by IMAU/Utrecht, Uppsala University and GEUS/Denmark – **NE Spitsbergen** (Lomonosovfonna / Nordenskiöldbreen): operate an AWS located on the central flow line of the glacier since 2009; operate GPS instruments measuring stake locations year round; stake locations were also measured with DGPS instruments for precision annual velocity determination and the stake height for the annual mass balance; operate Argos transmitting GPS at two sites close to the front; high frequency snow radar profiling to determine surface height changes and accumulation patterns; deep radar measurements to improve the bedrock topography; snow pit observations of temperature, density and moisture content; ice core drilling in order to measure snow temperature and filming the layering; perform data analyses and simulations;
- Team: work was mainly conducted by the German partners (Technische Universität Berlin,

University of Bonn, Aachen University) with logistic support from UiO and Uppsala University – **Nordaustlandet** (DeGeerfonna and Vestfonna): operate two AWSs on DeGeerfonna (AWS1) and Vestfonna (ECS2) which were left over from KINNVIKA; continue ice temperature measurements at five KINNVIKA sites on DeGeerfonna and Vestfonna; continue ablation and ice velocities measurements at five KINNVIKA sites; perform data analyses and simulations;

- Team: work was mainly conducted by the Norwegian and Swedish partners (UiO, NP, Uppsala University) and with support by IMAU – **Austfonna**: operate two automatic weather stations at 370 and 540 m a.s.l. along Etonbreen (W-slope of Austfonna); repeat DGPS measurements of (~20) mass balance stakes on the Austfonna ice cap and continuous GPS records on two fast flowing outlets. The continuous measurements are made in cooperation with IMAU; install temperature loggers in several elevations to obtain air temperature gradients; measure snow and ice temperatures in shallow boreholes at 4 locations (two close to the top of the ice cap, one is at low elevation in SE and one is at 370 m at the W-slope). A new DEM of the Austfonna ice cap by combining SAR interferometry with ICESat laser altimetry; measure surface mass balance along profiles established in 2004 and snow accumulation using GPR along existing and additional profiles; perform studies of internal accumulation and superimposed ice formation using shallow cores; observe internal ice temperature conditions using HF GPR (200-400 MHz); determine ice surface topography by ground based GPS, airborne laser scanning (by airplane and Unmanned Air Vehicles, UAV) and from satellite data. Use laser scanner measurements and high resolution imagery focused on exit zones to determine calving flux; measure bed topography by airborne and ground-based low frequency radars to refine the existing data obtained by SPRI airborne survey in 1985. Russian scientists have specialized in developing suitable LF-radar for this purpose and will participate in the field; measure surface velocity vectors by static GPS and permanent GPS receivers/loggers will be deployed at some localities to obtain continuous velocity records.

6. SvalGlac web site and TU-Berlin Knowledge Base – remarks and suggestions

Without any remarks and suggestions.

7. List of publications and submitted papers consistent with the project proposal and suggested common overview papers related to major tasks of the project

OBJECTIVES OF THE PROJECT	PAPERS / CONFERENCE ABSTRACTS
1. OBTAIN A RELIABLE ESTIMATE OF THE TOTAL ICE VOLUME STORED IN SVALBARD	
A. Martín-Español, F.J. Navarro, J. Otero, J.J. Lapazaran and M. Błaszczyk: Volume-area (-length?) relationships for Svalbard glaciers and estimate of the total ice volume stored in Svalbard glaciers. To be submitted to *The Cryosphere/J. Glaciol.*; STATUS: Planned June 2013; RELATED TASKS: Task 1, in general, with emphasis on 1c and 1d	

1a. Make an updated catalogue of the radio-echo sounded glaciers and ice caps of Svalbard and define a new set of glaciers to be echo-sounded using the available platforms for logistic support	See 1b
1b. Undertake the planned echo-sounding campaigns and produce the corresponding ice thickness maps and ice volume estimates	E.V. Vasilenko, F. Machío, J.J. Lapazaran, F.J. Navarro and K. Frolovskiy (2011): A compact lightweight multipurpose ground-penetrating radar for glaciological applications. *J. Glaciol.*, **57** (206), 1113-1118; STATUS: Published. A. Martín-Español, E.V. Vasilenko, F.J. Navarro, J. Otero, J.J. Lapazaran, I. Lavrentiev, Y.Y. Macheret and F. Machío (submitted): Radio-echo sounding and ice volume estimates of western Nordenskiöld Land glaciers, Svalbard. Submitted to *Ann. Glaciol.*; (31-07-2012). Under review. and 1a F.J. Navarro, A. Martín-Español, J.J. Lapazaran, M. Grabiec, J. Otero, E.V. Vasilenko and D. Puczko (in preparation): Radio-echo sounding and ice volume estimates of Wedel Jarlberg Land glaciers, Svalbard. To be submitted to *Arct. Antarct. Alp. Res.*?; STATUS: Planned January 2013. and 1a Pettersson, R., P. Christoffersen, J.A. Dowdeswell, V.A. Pohjola, A. Hubbard and T. Strozzi. 2011. A new subglacial bed topography dataset for Vestfonna ice cap, Svalbard, including constraints on thermal regime and basal conditions. Geogr.Ann., 93(A), 311–322, DOI: 10.1111/j.1468-0459.2011.00438.x. Van Pelt, W.J.J., J. Oerlemans, C.H. Reijmer, V.A. Pohjola, R. Pettersson and J.H. van Angelen. 2012. Simulating melt, runoff and refreezing on Nordenskiöldbreen, Svalbard, using a coupled snow and energy balance model. The Cryosphere, 6(3), 641-659, doi:10.5194/tc-6-641-2012 See 1c
1c. Derive from all available ice volume estimates new volume/area relationship appropriate for Svalbard glaciers of different typology	J.J. Lapazaran, A. Martín-Español, J. Otero and F.J. Navarro (in preparation): On the errors involved in the estimate of glacier ice volume from ice thickness data. To be submitted to *J. Glaciol.*; STATUS: Planned March 2013 and 1b See 1 (general)
1d. Use such relationships, together with updated remote sensing images or maps, to produce an updated estimate of the ice volume and mass stored in Svalbard glaciers	See 1 (general) Pettersson, R., P. Christoffersen, J.A. Dowdeswell, V.A. Pohjola, A. Hubbard and T. Strozzi. 2011. A new subglacial bed topography dataset for Vestfonna ice cap, Svalbard, including constraints on thermal regime and basal conditions. Geogr.Ann., 93(A), 311–322, DOI: 10.1111/j.1468-0459.2011.00438.x. Braun, M., V.A. Pohjola, R. Pettersson, M. Möller, R. Finkelnburg, U. Falk, D.

and its total potential contribution to sea-level rise	Scherer, C. Schneider. Changes of glacial front positions of Vestfonna (Nordaustlandet, Svalbard). 2011. Geogr.Ann., 93(A),. 301–310, DOI: 10.1111/j.1468-0459.2011.00437.x
2. ESTIMATE THE RECENT PAST CLIMATE CHANGES AND MASS BALANCE RATES OF SVALBARD Beaudon, E., Arppe, L., Jonsell, U., Martma, T., Möller, M., Moore, J.C., Pohjola, V. (2011): Spatial and temporal variability of precipitation volume from shallow cores from Vestfonna ice cap. Geografiska Annaler: Series A, Physical Geography., 93(4); STATUS: Published. 2a, 2b and 3d	
2a. Make a catalogue of available estimates from shallow ice cores or locations where repeated measurements have been done for a sufficiently long period, and define locations, within the radar profiles in the glaciers selected in 1a, where further shallow ice cores should be drilled	Divine, D., Sjolte, J., Isaksson, E., Meijer, H., van de Wal, R., Martma, T., Pohjala, V. (2011): Modeling the regional climate and isotopic composition of Svalbard precipitation using REMOiso model: a comparison with available GNIP and ice core data. Hydrological Processes. 25, 3748-3759; STATUS: Published. and 3d Divine, D., Isaksson, E., Martma, T., Pohjola, V., Meijer, H., van de Wal, R. S.W., Moore, J., Godtliebsen, F. (2010): Reconstructing the past climate variability in Svalbard from the Lomonosovfonna and Holtedahlfonna $\delta^{18}O$ ice core records. Geophysical Research Abstracts, EGU General Assembly 2010, Vienna, Austria, 02-07 May 2010. 12, EGU2010-2624-1. Poster: STATUS: Published. and 3c Rein Vaikmäe, Tõnu Martma, Elisabeth Isaksson, Dmitry Divine, Veijo Pohjola, Harro A.J. Meijer (2011): The ice-core stable isotope records from small Arctic ice caps as proxis of climatic and environmental changes. Geophysical Research Abstracts 13, EGU2011-8934-1. Poster: STATUS: Published. See 1 (general)
2b. Undertake the planned shallow ice coring	Gabrieli Jacopo, Andrea Spolaor, Tõnu Martma, Jack Kohler, Mats Björkman, Elisabeth Isaksson, Paul Vallelonga, Carlo Barbante (2012): Sensitivity of trace and rare earth elements as dust source proxies in Svalbard and Greenland glaciers. IPICS (International Partnerships in Ice Core Sciences) OSC, 1.-5. October 2012, Presqu'île de Giens, France. Poster: STATUS: Published. and 3d Beaudon, E., L. Arppe, U. Jonsell, T. Martma, M. Möller, V.A. Pohjola, D. Scherer, J.C. Moore. 2011. Spatial and temporal variability of net accumulation from shallow cores from Vestfonna ice cap (Nordaustlandet, Svalbard). Geogr. Ann., 93(A), 287-299, doi: 10.1111/j.1468-0459.2011.00439.x Błaszczyk M., Jania J.A., Kolondra L. Seasonal and multi-year fluctuations of tidewater glaciers cliffs on Southern Spitsbergen. Workshop on the Dynamics and Mass Budget of Arctic Glaciers & the IASC Network on Arctic Glaciology Annual Meeting. 10 - 13 January 2012, Zieleniec, Poland. Poster. Błaszczyk M., Jania J.A., Kolondra L., (in preparation): Fluctuations of tidewater glaciers in Hornsund Fiord (Southern Svalbard) since the beginning of the 20th century. To be submitted to Polish Polar Research. STATUS: Planned January 2013.
2c. Analyse the ice cores for layer dating	Divine, D., Isaksson, E., Martma, T., Meijer, H.A.J., Moore, J., Pohjola, V., van de Wal, R.S.W., Godtliebsen, F. 2011. Thousand years of winter surface air

purposes (e.g. Tchernobyl layer) and estimate the mean mass balance for the period	temperature variations in Svalbard and northern Norway reconstructed from ice core data. *Polar Research* 30 (7379), 1-12. Van der Wel, L. G., Streurman, H. J., Isaksson, E., Helsen, M. M., Van de Wal, R. S. W., Martma, T., Pohjola, V. A., Moore, J. C., Meijer, H.A.J. 2011. Using high resolution tritium profiles to quantify the effects of melt on two Spitsbergen ice cores. International Glaciological Society. *Journal of Glaciology* 57 (206), 1087-1097. and 3c Divine, D., J. Sjolte, H.A.J. Meijer, R.S.W. van de Wal, T. Martma, V. Pohjola and F. Godtliebsen. 2011. Modeling the regional climate and isotopic composition of Svalbard precipitation using REMOiso model: a comparison with available GNIP and ice core data. *Hydrological Processes*. 25(24), 3748-3759, DOI: 10.1002/hyp.8100 Samyn, D., Vega, C. , H. Motoyama and VA. Pohjola. Nitrate and Sulfate Anthropogenic Trends in the 20th Century from Five Svalbard Ice Cores. 2012. Arc. Alp. Ant. Res., 44(4), 490-499.
2d. Drill one deep ice core on the summit of Austfonna and/or Vestfonna to extend the present and recent past climate history further back in time	Wendl, I., Eichler, A., Tobler, L., Eikenberg, J., Martma, T., Isaksson, I., Vogel, E., Schwikowski, M. (2012): First dating attempt for the 2009 ice core from Lomonosovfonna, Svalbard. Annual Report 2011. Eds: A. Türler, M. Schwikowski, A. Blattmann. Paul Scherrer Institut, Bern, 41; STATUS: Published. and 2c Divine, D., Isaksson, E., Martma, T., Pohjola, V., Meijer, H., van de Wal, R. S.W., Moore, J., Godtliebsen, F. (2010):. Reconstructing the past climate variability in Svalbard from the Lomonosovfonna and Holtedahlfonna $\delta^{18}O$ ice core records. Geophysical Research Abstracts, EGU General Assembly 2010, Vienna, Austria, 02-07 May 2010. 12, EGU2010-2624-1. Poster: STATUS: Published. and 2a One 150 m deep ice core drilled on Lomonosovfonna 2009, not yet published.
2e. Combine the above information with the layering from the high frequency radar data in order to estimate the spatial variability of average past mass balance	Work in progress
2f. Estimate long term geodetic mass balance changes during the recent past from comparison of maps/air photos and recent remote sensing images or topographic measurements (airborne laser and ground-based GPS)	Pohjola, V.A., P. Christoffersen, L. Kolondra, J.C. Moore, R. Pettersson, M. Schäfer, T. Strozzi and C.H. Reijmer. 2011. Spatial distribution and change in the surface ice-velocity field of Vestfonna ice cap, Nordaustlandet, Svalbard, 1995-2010 using geodetic and satellite interferometry data. Geogr. Ann., 93(A), 323-335, doi: 10.1111/j.1468-0459.2011.00441.x

3. IMPROVE THE PROCESS UNDERSTANDING	
3a. Study the surface energy balance (by AWS) as a prerequisite for 3b and 3c	F. Karner, F. Obleitner, Th. Krismer, J. Kohler, W. Greuell, 2012: A decade of energy and mass balance investigations on the glacier Kongsvegen, Svalbard, in review at JGR-Atmospheres. G. Jocher, F. Karner, Ch. Ritter, F. Obleitner et al., The Near-Surface Small-Scale Spatial and Temporal Variability of Sensible and Latent Heat Exchange in the Svalbard Region: A Case Study, ISRN Meteorology, vol. 2012, Article ID 357925, 14 pages, 2012. doi:10.5402/2012/357925 http://www.isrn.com/journals/meteorology/2012/357925/ Möller, M., R. Finkelnburg, M. Braun, R. Hock, U. Jonsell V.A. Pohjola, D. Scherer, C. Schneider. 2011. Climatic mass balance of the ice cap Vestfonna, Svalbard - a spatially distributed assessment using ERA-Interim and MODIS data. *J. Geogr. Res*., 116 (F03009), doi:10.1029/2010JF001905, 14pp. R. Finkelnburg, M. Möller, E. Huintjes, T. Sauter, M. Braun, D. Scherer and C. Schneider (2010): Comparison of surface energy and mass balance of two sites (Vestfonna and De Geerfonna) at Nordaustlandet (Svalbard) during the ablation period 2009. *IPY Oslo Science Conference, Oslo*; STATUS: Published. C. Schneider, D. Scherer, M. Braun, M. Möller, O. Käsmacher and R. Finkelnburg (2010): Climate variability and glacier response at Vestfonna – a case study of Arctic Climate and Glacier dynamics at Nordaustlandet, Svalbard in recent years. *Nova Acta Leopoldina*, 112 (384), 145-151; STATUS: Published. and 3c R. Finkelnburg (2011): Weather and Climate observations on Nordauslandet, Svalbard. *TiP Young Scientists Workshop: Atmo-Cryo-Hydro: spheres and interactions, Berlin*. and 3c
3b. Study the coupling between surface melt water, subglacial water flow, melting at the glacier bed and sliding	See 5e Bucchignani, E., Mansutti, D., Navarro, J. F., Otero, J. and Glowacki, P., Numerical modelling of Amundsenisen Icefield for compatibility check of a subglacial lake. Preliminary tests, Geophysical Research Abstracts Vol. 14, EGU2012-8148, 2012 (poster); and 5e Bucchignani, E., Mansutti, D., Navarro, J. F., Otero, J. and Glowacki, P., Arguments from modelling about the existence of a subglacial lake at Amundsenisen Icefield (Svalbard), IGS Nordic Branch Meeting, Stockholm, 25-27 October 2012 (abstract and poster); and 5e Bucchignani, E., Mansutti, D., Navarro, J. F., Otero, J. and Glowacki, P., Arguments from modelling about the existence of a subglacial lake at Amundsenisen Icefield (Svalbard): effect of variable water content; STATUS: Planned September 2013, to be submitted to glaciology specialistic journal; and 5e Bucchignani, E., Mansutti, D., Navarro, J. F., Otero, J. and Glowacki, P., Arguments from modelling about the existence of a subglacial lake at Amundsenisen Icefield (Svalbard): effect of climate change; STATUS: Planned December 2013, to be submitted to glaciology specialistic journal;

	and 5e Schaefer, M., T. Zwinger, P. Christoffersen, F. Gillet-Chaulet, K. Laakso, R. Pettersson, V.A. Pohjola, T. Strozzi, and J.C. Moore 2012, Sensitivity of basal conditions in an inverse model: Vestfonna Ice-Cap, Nordaustlandet, Svalbard, The Cryosphere , 6, 771-783 and 5e Schäfer, M. and others (to be defined – probably Rupert Gladstone, Thomas Zwinger, Fabien Gillet-Chaulet, Tazio Strozzi, Veijo Pohjola, Rickard Pettersson, John Moore), Relative influence of heat production sources on the dynamics of VSF, to be submitted in 2012 and 5e Gladstone, R. and others (to be defined – probably Martina Schäfer, Thomas Zwinger, Fabien Gillet-Chaulet, Tazio Strozzi, Thorben Dunse, John Moore), Importance of basal processes in simulations of a surging Svalbard outlet glacier, to be submitted by March 2012 and 5e NIGS 2010, Basal drag pattern inferred from surface velocities for Vestfonna ice-cap (Svalbard) with a Full-Stokes model, Martina Schäfer, Thomas Zwinger, Kati Laakso, Veijo Pohjola, Rickard Pettersson, Fabien Gillet-Chaulet, Poul Christoffersen, John Moore and 5e NIGS 2011, Basal drag pattern inferred from surface velocities for Vestfonna ice-cap (Svalbard) with a Full-Stokes model in 1995 and 2008,Martina Schäfer, Thomas Zwinger, Veijo Pohjola, Rickard Pettersson, Fabien Gillet-Chaulet, Tazio Strozzi, Marco Möller, John Moore, and 5e IASC 2012, Basal drag pattern inferred from surface velocities for Vestfonna ice-cap (Svalbard) with a Full-Stokes model in 1995 and 2008, Martina Schäfer, Thomas Zwinger, Veijo Pohjola, Rickard Pettersson, Fabien Gillet-Chaulet, Tazio Strozzi, Marco Möller, John Moore and 5e Tidewater glacier workshop Svalbard 2012, Remote sensing data used on Svalbard glaciers to infer basal drag pattern from surface velocities with a Full-Stokes ice-sheet model (Vestfonna ice-cap 1995, 2008 and 2011), Martina Schäfer, Thomas Zwinger, Veijo Pohjola, Rickard Pettersson, Fabien Gillet-Chaulet, Tazio Strozzi, Marco Möller, John Moore and 5e NIGS 2012, Towards simulating Nordaustlandet surging glaciers: Inverse modelling through stages of surge events (part 1), The temperature distribution in the ice and its interaction with basal sliding (part 2), Martina Schäfer, Rupert Gladstone, Thorben Dunse, Fabien Gillet-Chaulet, John Moore, Rickard Petterson, Veijo Pohjola, Tazio Strozzi and 5e
3c. Study the surface melt-water production and the coupling to internal refreezing and superimposed ice formation	Van Pelt, W.J.J., J. Oerlemans, C.H. Reijmer, V.A. Pohjola, R. Pettersson and J.H. van Angelen. 2012. Simulating melt, runoff and refreezing on Nordenskiöldbreen, Svalbard, using a coupled snow and energy balance model. The Cryosphere, 6(3), 641-659, doi:10.5194/tc-6-641-2012 See 3a, 4d
3d. Evaluate the relationships between the resulting climate proxy records and the relevant climate	Caixin Wang, Liqiong Shi, Sebastian Gerland, Mats A. Granskog, Angelika H. H. Renner, Zhijun Li, Edmond Hansen, and Tõnu Martma. Spring sea ice evolution in Rijpfjorden (80°N), Svalbard, from in-situ measurements and Ice Mass Balance Buoy (IMB) data Submitted to Ann.Glaciol. Sept 2012; STATUS: Under review.

and climate forcing variables	Divine, D., Isaksson, E. D., Martma, T., Pohjola, V. A., Meijer, H. A., Van de Wal, R., Moore, J. C., Godtliebsen, F. (2010): Thousand years of winter surface air temperature variations in Longyerbyen, Svalbard Arhcipelago and Vardo, northern Norway, reconstructed from Svalbard ice core oxygen isotope data. 2010 AGU Fall Meeting, 13–17 December 2010, San Francisco, California, USA. AGU. Abstract C13B-0549., Poster; STATUS: Published see 1 (general) M. Möller (2012): A minimal, statistical model for the surface albedo of Vestfonna ice cap, Svalbard. *Cryosphere*, 6 (5), 1049-1061; STATUS: Published. C. Schneider, R. Finkelnburg, M. Möller, M. Braun, T. Sauter, O. Käsmacher, F. Meier and D. Scherer (2010): Climate forcing of glacier mass balance at Vestfonna, Nordaustlandet, Svalbard. *IPY Oslo Science Conference, Oslo*; STATUS: Published.
3e. Study the processes responsible for calving intensity	See 5e J.A. Aström, T. Riikilä, T. Tallinen, T. Zwinger, D. Benn, J. Moore, J. Timonen, A particle based simulation model for glacier dynamics to be submitted to The Cryosphere
4. OBTAIN AN UPDATED ESTIMATE OF THE PRESENT MASS BALANCE OF SVALBARD GLACIERS	
4a. Make a catalogue of glaciers for which estimates of present mass balance are available	http://imgi.uibk.ac.at/node/617 (to be updated upon input from partners) M. Braun, V.A. Pohjola, R. Pettersson, M. Möller, R. Finkelnburg, U. Falk, D. Scherer and C. Schneider (2011): Changes of glacier frontal positions of Vestfonna (Nordaustlandet, Svalbard). *Geogr. Ann. A,* Physical Geography, doi:10.1111/j.1468-0459.2011.00437.x; STATUS: Published
4b. Define areas of interest where new mass balance in situ measurement programs could be started, at low logistic cost, using the available platforms	
4c. Continue already running programs of in situ mass balance measurements, including calving flux as an important factor of mass loss on selected tidewater glaciers	See 4d Błaszczyk M., Jania J.A., Estimation of calving from Svalbard tidewater glaciers based upon satellite remote sensing. Tidewater Glaciers Workshop 2012, High Arctic Issues – 26-31 August Svalbard, Norway. Extended Abstrakt.
4d. Combine all of the	M. Möller, R. Finkelnburg, M. Braun, D. Scherer and C. Schneider

above information to get an improved estimate of the present mass balance of Svalbard and its current contribution to sea-level rise	(submitted): Variability of the climatic mass balance of Vestfonna ice cap (northeastern Svalbard) in the period 1979-2011. Submitted to *Ann. Glaciol.*; STATUS: Revised (31-10-2011). and 3c M. Möller, R. Finkelnburg, M. Braun, R. Hock, U. Jonsell, V.A. Pohjola, D. Scherer and C. Schneider (2011): Climatic mass balance of the ice cap Vestfonna – a spatially distributed assessment using ERA-Interim and MODIS data. *J. Geophys. Res.*, 116, F03009, doi:10.1029/2010JF001905; STATUS: Published. and 3c, 4c M. Möller, R. Möller, E. Beaudon, O.-P. Mattila, R. Finkelnburg, M. Braun, M. Grabiec, U. Jonsell, B. Luks, D. Puczko, D. Scherer and C. Schneider (2011): Snowpack characteristics of Vestfonna and DeGeerfonna (Nordaustlandet, Svalbard) – a spatiotemporal analysis based on multiyear snow-pit data. *Geogr. Ann. A*, 93 (4), 273-285; STATUS: Published. and 3d, 4d
5. MODEL THE EXPECTED RESPONSE IN SURFACE MASS BALANCE AND CALVING FLUX RATE UNDER DIFFERENT SCENARIOS OF CLIMATE CHANGE	
5a. Compile all available information from AWS and ice velocity as well as surface parameters from remote sensing data for model validation	For AWSs: http://imgi.uibk.ac.at/node/618 (to be updated upon input from partners) Möller, M., R. Finkelnburg, M. Braun, R. Hock, U. Jonsell V.A. Pohjola, D. Scherer, C. Schneider. 2011. Climatic mass balance of the ice cap Vestfonna, Svalbard - a spatially distributed assessment using ERA-Interim and MODIS data. *J.Geogr.Res*., 116(F03009), doi:10.1029/2010JF001905, 14pp. Claremar, B., F. Obleitner, C. Reijmer, V. Pohjola, A. Waxegård, F. Karner and A. Rutgersson, 2012. Applying a meso-scale atmospheric model to Svalbard glaciers. Advances in Meteorology, vol. 2012, Article ID 321649, 22 pages, 2012. doi:10.1155/2012/321649
5b. Develop a Regional Climate Model including a sub-surface snow model tuned using the mass balance data and forced with ERA-40 reanalysis data	B. Claremar, F. Obleitner, C. Reijmer, et al., Applying a Mesoscale Atmospheric Model to Svalbard Glaciers, Advances in Meteorology, vol. 2012, Article ID 321649, 22 pages, 2012. doi:10.1155/2012/321649 http://www.hindawi.com/journals/amet/2012/321649/ R. Finkelnburg, F. Maussion, M. Möller, M. Braun, D. Scherer and C. Schneider (2010): A regional atmospheric reanalysis approach for Nordaustlandet (Svalbard). *SvalGlac SC Meeting, Gdynia, Poland*; STATUS: Published.
5c. Develop mass balance models tuned using the mass balance data, AWS data, data available from manned stations, from ERA-40 reanalysis and from the Regional Climate Model described in 5b, as well as changes in geometry derived from dynamic	F. Karner, F. Obleitner, Th. Krismer, J. Kohler, W. Greuell 2012: A decade of energy and mass balance investigations on the glacier Kongsvegen, Svalbard, in review at JGR-Atmospheres.

models	
5d. Run these models for different scenarios of climate, in order to estimate the expected changes in surface mass balance	F. Karner, F. Obleitner, Th. Krismer, J. Kohler, W. Greuell 2012: A decade of energy and mass balance investigations on the glacier Kongsvegen, Svalbard, in review at JGR-Atmospheres. R. Finkelnburg, F. Maussion and D. Scherer (2011): Eine regionale Reanalyse der atmosphärischen Bedingungen in der europäischen Arktis (Svalbard) der Dekade 2001-2010. *30. Annual Meeting of the German Working Group on Climate (AK Klima), Graz, Austria*. D. Scherer, R. Finkelnburg and F. Maussion (2011): A regional atmospheric reanalysis for studying weather and climate in Svalbard. *11th Annual Meeting of the European Meteorological Society (EMS) / 10th European Conference on Applications of Meteorology (ECAM), Berlin, Germany*; STATUS: Published. M. Möller, R. Finkelnburg, M. Braun, D. Scherer and C. Schneider (2011): Climate sensitivity of the surface mass balance of Vestfonna, northern Svalbard. *EGU General Assembly 2011, Vienna, Austria*; STATUS: Published. M. Möller, R. Finkelnburg, M. Braun, D. Scherer and C. Schneider (in preparation): A 21st-century projection of the climatic mass balance of Vestfonna ice cap (Svalbard) from multi-model CMIP5 scenarios. To be submitted to *Clim. Dyn.*?; STATUS: Planned March 2013. See 5f
5e. Develop ice dynamics models for the main glaciers and basins, with a focus on calving ones	J. Otero, F.J. Navarro, J.J. Lapazaran, M. Grabiec, D. Puczko, C. Molina and A. Vieli (in preparation): Modelling the variations of the calving front position of Hansbreen, Svalbard. To be submitted to *J. Glaciol.*; STATUS: Planned March 2013 and 3b, 3e E. Bucchignani, D. Mansutti, F.J. Navarro, J. Otero and P. Glowacki (in preparation): Thermo-mechanical finite volume description of an icefield with firn cover and subglacial lake. An Arctic test case. To be submitted to *Int. Sci. Comp. J.*; STATUS: Planned June 2013 and 3b Schäfer, M., T. Zwinger, P. Christoffersen, F. Gillet-Chaulet, K. Laakso, R. Pettersson, V. A. Pohjola, T. Strozzi, and J. C. Moore. 2012. Sensitivity of basal conditions in an inverse model: Vestfonna ice cap, Nordaustlandet/Svalbard. TC, 6(4), 771-783 E. Bucchignani, D. Mansutti, F.J. Navarro, J. Otero and P. Glowacki: Finite volume modelling of an icefield with a subglacial lake, Congress on Numerical Methods in Engineering 2013, Bilbao, 25-28 June 2013, SEMNI, Spain,2013; STATUS: Under review for oral contribution; and 3b Poster EGU 2010: Present-day simulations of Vestfonna ice-cap (Svalbard) with Shallow-Ice and Full-Stokes models, Martina Schäfer, Thomas Zwinger, Kati Laakso, John Moore, IGS 2010 Ohio, *Present-day simulations of Vestfonna ice-cap (Svalbard) with Shallow-Ice and Full-Stokes models,* Martina Schäfer, Thomas Zwinger, Kati Laakso, John Moore and 3b See 5f
5f. Run these models for different scenarios	Gladstone, R. and others (to be defined – probably Martina Schäfer, Thomas Zwinger, Fabien Gillet-Chaulet, Tazio Strozzi, Thorben Dunse, John Moore)

of climate, in order to estimate the expected changes in surface geometry and calving flux rate and their corresponding contribution to mass balance	Century scale projections of the Austfonna icecap, to be submitted by May 2013 Martina & Marco and others, Impact of two-way coupling between mass-balance and ice-dynamics models for Vestfonna ice cap on century-scale glacier-evolution prognostics, submitted by March 2013 and 5d, 5e
5g. Combine all of the above information in order to obtain an estimate of the expected contribution of Svalbard glaciers to sea-level rise during the 21st century	

To discuss in Obergurgl – common papers for each task.

Proposal – to prepare special issue for common papers of SvalGlac.

8. Place and date of the next SSC meeting in 2013 and info on other relevant scientific meetings

Obergurgl (IASC-NAG), 25 February 2013 in the evening - after dinner

Kraków (ASSW), April 2013 – an invitation, especially to the "Cryospheric Changes: Drivers and Consequences" session (F. Navarro – one of the Conveners).

9. Other issues

Due to the failure of the spring Polish expedition 2012 to Hornsund and postponement of completion of the Project by the Partners, it is recommended to request the prolongation of the Project by the Polish team (as a coordinator).

10. Adjourn