WP 19a

Agenda Item: 5.1

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SERCE-POLENET

(Solid Earth response and Cryosphere Evolution)-(POLar Earth observing NETwork)

Draft

Executive Summary – Draft

(to be discussed and modified during SCAR Business Meetings)

Title: SERCE-POLENET (Solid Earth response and Cryosphere Evolution) - (POLar Earth observing NETwork)

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Introduction/ Background: The goal of the SERCE programme is to improve the understanding of the interaction between solid earth, cryosphere and climate as a contribution to sea level change.

It will require the study of processes (geodynamics, tectonics, ice mass change,..) and of geophysical models. We have to identify and develop key disciplinary and interdisciplinary components of a science programme aimed at advancing understanding of the interactions between the solid earth and the cryosphere. This includes glacial isostatic adjustment (GIA) and ice mass change and the influence of solid earth parameters (heat flow, disposition of sediments) on ice sheet dynamics.

Observations will be the input for physical and geophysical modellers who will work on GIA, PGR models in order to furnish a good sea level change model between the integration of observations in Antarctica and global observation and /or models.

The considerable amount of data archived within the POLENET project is the base of the SERCE Programme. GPS and seismic data are fundamental but other geophysical observations will also be used.

Important Issues or Factors: SERCE-POLENET has the goal of improving understanding of the interaction between solid earth, cryosphere and climate as a contribution to sea level change.

Summarizing, GPS is used to measure rebound and with Seismology earth properties can be determined; those results improve “rebound” correction for spaceborne measurements of Ice Mass Change. This information is essential for sea level change predictions.

Recommendations/Actions and Justification: Maintaining, and potentially augmenting, the remote autonomous POLENET infrastructure, as the International Polar Year (IPY) ends, that provides an international essential technological framework for Antarctic and Arctic science.

The sea level change prediction is an essential contribution to Antarctic science and global climate.

Fundamental for sea level change prediction is the Rebound estimation that should be studied principally through the knowledge of ice load history and geo-mechanical structure of the region.

Following a bi-polar approach, it is essential to extend the programme to the Arctic region.

Expected Benefits/Outcomes:

- Extensive use of POLENET data infrastructure
- GIA model optimization
- Sea level change prediction

Partners:

- SCAR SSG-GS AG and EG; SCAR SSG-PS
- European Polar Board
- International scientific institutions involved in space research in Antarctica: NASA, ESA, Canadian Space Agency.

Budget Implications: US $10,000 for organising workshops and attending meetings; workshop with different WGs end of 2010 or 2011; joint meeting with Arctic researchers – IASC, SAON .

SERCE-POLENET
(Solid Earth response and Cryosphere Evolution)-
(POLar Earth observing NETwork)

A new **Scientific Programme Planning Group** has been proposed on "Solid Earth Response and influences on Cryospheric Evolution (**SERCE**)" which has the aim of continuing the **POLENET IPY** project by using the data infrastructure created within POLENET. Therefore we propose to change the name to **SERCE-POLENET PPG.**

Activity has been focused on defining the scientific research and in looking for researchers to be involved in the programme. Being typical interdisciplinary research, as the first step we had to involve several people and disciplines, a long and complicated process. Only now are we able to define the goals of the project and the working groups that will be necessary to produce the awaited results.

First, we have to answer one fundamental question: is SERCE-POLENET a real improvement for Antarctic science? The answer is 'yes', if we should respond to big scientific questions. We can identify the answer in actions that can be summarised in the following two lines:

Improving understanding of the interaction between solid earth, cryosphere and climate as a contribution to sea level change.

This means the study of processes (geodynamics, tectonics, ice mass change,..) and of geophysical models. We have to identify and develop key disciplinary and interdisciplinary components of a science programme aimed at advancing understanding of the interactions between the solid earth and the cryosphere, including glacial isostatic adjustment (GIA) and ice mass change and the influence of solid earth parameters (heat flow, disposition of sediments) on ice sheet dynamics.

To achieve this goal, one key action is to communicate and coordinate with other international groups that are investigating ice mass change, ice sheet contributions to global sea level rise, glacial isostatic adjustment models of Greenland and other ice caps, and other pertinent research efforts.

Another key is that we will arrive at evaluation of sea level change by using observations. Observations will be the input for physical and geophysical modellers who will work on GIA / PGR (Glacial Isostatic Adjustment / Post-Glacial Rebound) models in order to furnish a good sea level change model between the integration of observations in Antarctica and global physical and geophysical models.

The considerable amount of data archived and available within the POLENET project is the base of the SERCE Programme. Overall GPS and seismic data are fundamental, but we should also use other geophysical observations. The essential action that we must follow is a bi-polar approach. We think that is essential to extend the programme to the Arctic region. The bi-polar approach has already been followed within POLENET and, starting from those interactions, we now have to extend this action to the scientific goals of SERCE.

The starting point of the programme is maintaining, and potentially augmenting, the remote autonomous POLENET infrastructure as the International Polar Year (IPY) ends, which provides an essential, international, technological framework for Antarctic and Arctic science.

We worked on clarifying the scientific goals of SERCE-POLENET, which are summarised in the following way. We should begin with a question: How should SERCE-POLENET approach the study of the contribution of polar ice sheets to global sea level change in a warming world?

The analysis of data from the GPS and seismology network, data archived within POLENET, will provide a proxy for ice mass change and evaluation of boundary conditions (ice dynamics). They should furnish answers on:

- Solid Earth - bedrock motions; heat flux
- Cryosphere- ice mass change; ice dynamics
- Climate.

Precision GPS surveys allow determination of uplift due to Glacial Isostatic Adjustment (GIA models). Through GPS observations, it should be possible to predict crustal motion when ice is removed. Post-Glacial Rebound (PGR) in North America and Fennoscandia are determined and they will be optimized by using longer data series in the future.

PGR models in Antarctica were computed (ICE5G, Peltier, 2004, IJ05, IVins & James, 2005**)** but data do not matched perfect and it should be possible to increase the quality of the models with longer series of GPS data in the coming years.

The Rebound should be studied principally through two factors:

1) **Ice load history -** should be improved with the knowledge of spatial distribution of ice mass; thickness of ice sheets and when/where ice is lost (relict glacier surfaces). An essential contribution will be ice core analysis, therefore scientists with this expertise (EPICA, Vostok,..) should be involved in SERCE-POLENET.
2) **Geo-mechanical structure of the region -** should be improved with seismological researches. Through knowledge of seismology images properties of earth's interior and the mechanical layers: the effective thickness of elastic lithosphere and the viscosity of upper mantle and lower mantle.

Seismic tomography techniques are applied for "seeing" below the ice sheets with higher resolution in order to evaluate: substrate below ice sheet; geological terraines; mantle plume(s).

Through the earth properties will control the rate (and pattern) of rebound: variable, but thin elastic lithosphere and warm and relatively low viscosity upper mantle.

The lithosphere thermal structure, effecting ice dynamics, should be determined, inferring temperature and heat flow from seismic structure. Ice sheet-climate models should be coupled based on pressure melting point and ice sheet thickness.

GPS and seismology will create a scale to " weight" the ice sheet through time: the rate of uplift due to "rebound" from removal of ancient ice load; the uplift due to recent changes in volume of the ice sheet.

The mass change of the ice sheet should be evaluated with satellite altimetry in terms of the difference between surface elevation and bedrock motion. In another way, the ice mass change is computed by the difference of gravity change and earth mass change.

Ice mass trend was derived using GRACE data after applying PGR correction. SERCE will increase this study, integrating GPS research (PGR determination) with GRACE data processing.

To summarise, with **GPS** we measure rebound and with **Seismology** earth properties will be determined; the results improve **"**rebound" correction for spaceborne measurements of ice mass change; this information is essential for sea level change predictions.

In processing the data, we do not forget Environmental Loading as atmospheric loading, sea level tide, earth tide and seasonal snow with ice loading. The surface loading signals will give an elastic response that should be discriminated in a dominant periodicity (annual) and mainly vertical signal. For this goal is very important to involve the community of oceanographers in SERCE-POLENET.

One more interesting scientific application should be included in GPS data processing (from the POLENET archive) at continental scale in order to estimate atmospheric parameters: it will contribute to troposphere model and space weather and climate study. This activity should be managed in collaboration with the GPS for Weather and Space Weather Forecasting (GWSWF) AG.

SERCE-POLENET is a typical interdisciplinary research programme, but on the basis of complex scientific proposals, we took the opportunity to organize the activity with the following working groups:

1) Earth structure - geodynamics
   - Geomorphology
   - GPS-Seismology

- seismology
- GPS-geodesy
- Magnetism
- GPS weather - models troposphere

2) Ice mass determination
   - glaciology
   - GPS-Grace - Cryosat2
   - oceanographers

The next actions will be:

- workshop with different working groups at the end of 2010 or 2011
- joint meeting with Arctic researchers – IASC, SAON (ask Volker)
- meeting during ISAES 12011
- programme development into SRP - SCAR meeting 2012

The report should be updated after the SSG-GS meeting planned on 2nd August.