

## SCIENTIFIC PROGRAMME PLANNING GROUP proposal

A SPPG is fostered by SSG-G with the aim to develop and to propose a Scientific Research program (SRP) titled "POLENET".

SRP title: **POLENET – POLar Earth observing NETwork**

SSG submitting proposal: **Geosciences – SSG-G**

Expected duration : **6-8 years**

SCAR funding needed for 09-10 SPPG: **10.000 \$**

SPPG Chief Officer – **to be decided in St.Petersburg Polenet meeting**

SPPG core membership: **to be decided in St.Petersburg Polenet meeting**

### POLENET SRP description

#### *The objectives of the program*

The polar regions have unique geodynamic environments where the solid earth, the cryosphere, the oceans, the atmosphere and the global climate system are intimately linked. The aim of this programme is to investigate systems-scale interactions within the polar earth system and polar geodynamics by deploying autonomous remote observatories, on the continents and possibly offshore.

#### *Scientific background*

The principal geodetic and geophysical observatories consists of continuous GPS and seismometers, with the potential addition of meteorology packages, geomagnetic observatories, tide gauges (at coastal sites), and bottom pressure gauges (at offshore sites). Remoteness and environmental challenges have resulted in a dearth of observational systems in the polar regions of Earth, which this programme will overcome.

#### *Program rationale and methodologies*

The analysis and interpretation of data from geodetic and geophysical observations is an essential contribution for studying and modelling regional and global earth change like PGR(Post Glacial rebound), GIA (Glacial Isostatic Adjustment) that are strictly related even to Global Climate Change.

Geodetic studies, including GPS measurements of crustal motion, tide-gauge measurements of relative sea-level change, and gravity measurements of mass change, constitute essential elements in developing an understanding of the stability and mass balance of the cryosphere and of ongoing sea-level change. There is a critical need to understand the contribution to sea-level change due to changes in mass balance of the major ice sheets of the world, most importantly the Antarctic and Greenland ice sheets. Accurate measurement of millimeter-scale vertical and horizontal crustal motions is possible in only 2-5 years if continuous GPS trackers are deployed. Deployment of C-GPS stations in optimal positions with respect to historical and modern ice mass changes, and at sufficiently high spatial resolution, provides robust constraints on ice models, improving our ability to predict sea-level change. Deployment of C-GPS stations across tectonic blocks and boundaries allows crustal motions due to global plate motion and intraplate neotectonic deformation to be measured and velocity fields to be mapped and modeled.

Seismological data from the observatories will provide the first relatively high-resolution data on the Earth beneath the polar seas and ice sheets. Advanced techniques to image the Earth's deep interior, such as seismic tomography, will be used to place constraints on the planet's internal processes. Seismic imaging of the crust and mantle will assess causes for anomalously high elevations in East Antarctica, linked with ice sheet development, will provide information on heat flow and mantle viscosity that are key factors controlling ice sheet dynamics and the Earth's response to ice mass change, and will provide constraints on the magma sources for polar volcanism. The axial vantage points of the poles will allow unprecedented studies of Earth's inner core, contributing to our understanding of the initial differentiation of the Earth, the Earth's thermal history, and the physics and variability of the Earth's magnetic field. Enhanced seismic station coverage will vastly improve the detection level for earthquakes and permit evaluation of seismotectonic activity and associated seismic hazard across the remote high latitudes. POLENET is coordinated with the AntarcticArray seismological initiative to establish a permanent backbone sensor network, a lattice seismic array at South Pole (CRYSTAL), evolving regional array deployments, process-oriented experiments, and active-source seismology.

This effort is complementary to national/international programmes studying the dynamic earth e.g. Geonet (Japan, New Zealand), Earthscope (USA) GGOS (IAG). The results of an observatory program will bring polar regions into the global geodynamics framework and will allow cutting edge analysis methods developed in the context of these national programmes to be applied to the polar regions.

The GPS seismic and meteorological data envisioned will be used by a global community that extends beyond the traditional polar community POLENET, which will establish autonomous geographically distributed research platforms with power and telemetry, would also be a logical platform for hosting additional sensors in the future as new technologies develop.

#### *Program management*

An international steering committee will be established for POLENET, and international sub-committees to oversee Antarctic and Arctic arrays will be instituted. These SC will interact with IRIS, UNAVCO, SCAR, IASC, and national polar operators to promote participation of the widest possible array of nations and researchers, to ensure coordination of technologies and logistics, and to establish open data archiving and access. Annual workshops will be held to review, assess and exchange results, and to promote integrated interpretation and modelling efforts. Thematic symposia will be planned at international meetings, with resultant publications.

#### *Expected outcomes*

- ✓ Measurements of vertical and horizontal solid-earth deformation at mm/yr accuracy, providing first comprehensive view of bedrock motions across polar regions.
- ✓ Prediction of mass fluxes of polar ice sheets, improved models of glacial isostatic adjustment, and better modeling and prediction of sea-level change
- ✓ First tests of glacial isostatic adjustment models for the Antarctic interior achieved during IPY from repeat measurement on existing SCAR, WAGN, TAMDEF sites.
- ✓ Integration of geodetic observations with complementary seismic imaging studies
- ✓ Understanding crustal and mantle dynamics that cause earthquakes and volcanoes, including the nature of links with ice-mass change
- ✓ Improved understanding of the Earth's inner core
- ✓ Improved understanding of secular variation of Earth's magnetic field, and core structure and dynamics, including quantification of rapid field decrease that may signal a reversal of the Earth's field.
- ✓ Establish a legacy framework for ongoing international geophysical observation network.