



WP 15

Agenda Item: 4.3.6

Person Responsible: T. Wilson

XXXIII SCAR Delegates Meeting

Auckland, New Zealand, 1-3rd September 2014

Solid Earth Response and influence on Cryospheric Evolution



Executive Summary

Title: *Solid Earth Response and influence on Cryospheric Evolution (SERCE)*

Authors: Terry J Wilson

Introduction/ Background:

The Solid Earth Response and influence on Cryospheric Evolution (SERCE) SRP targets new understanding of solid earth – cryosphere interactions at a crucial time in earth history when global change is driving variations in mass balance of the polar ice sheets. SERCE promotes integration of new earth science data sets into modeling of ice mass balance, ice dynamics, and solid earth responses to mass change.

Important Issues or Factors:

- Successful Activities have been completed, including AGU/EGU thematic sessions, 2 SCAR OSC thematic sessions, and an international science symposium.
- Postponement of ‘training school’ from 2014 to 2015, carry over of funds required
- Planned activities requiring support in 2015-16

Recommendations/Actions and Justification:

- Approval of budget requests, including carry over, to implement programme plans
- Seek recommendations for partnerships with other international/national organizations pursuing geodynamic and cryospheric research overlapping with SERCE objectives

Expected Benefits/Outcomes:

- Partnerships between SCAR-SERCE and other organizations effectively leverage the scope and impact of science and outreach activities
- Science infrastructure, capacity, data sharing and collaboration facilitated through SERCE activities

Partners:

SERCE has engaged, or seeks, international partners to leverage each activity. Partners that have been identified are:

- International Lithosphere Programme, Upper Mantle Dynamics and Quaternary Climate in Cratonic Areas (DynaQlim) and new group
- International Association of Geodesy
- EGU Training School funding scheme
- U.S. National Science Foundation (training schools)
- ISMASS
- CLIC
- APECS

Budget Implications:

Carry over of Funding of \$19,780 allocated in 2014; \$23,000 for 2015 and \$25,000 for 2016 are requested to support SERCE activities.

Solid Earth Response and influence on Cryospheric Evolution (SERCE)

1. Rationale for the Programme

The Solid Earth Response and influence on Cryospheric Evolution (SERCE) scientific research programme aims to *advance understanding of the interactions between the solid earth and the cryosphere to better constrain ice mass balance, ice dynamics and sea level change in a warming world*. This objective will be accomplished through integrated analysis and incorporation of geological, geodetic and geophysical measurements into models of glacial isostatic adjustment (GIA) and ice sheet dynamics. The programme is designed to synthesize and integrate the extensive new geological and geophysical data sets obtained during and subsequent to the International Polar Year with modeling studies, in a timeframe to contribute to IPCC AR6. SERCE will provide the international collaborative framework and scientific leadership to investigate systems-scale solid earth – ice sheet interactions across Antarctica and relate these results to global earth system and geodynamic processes. A series of expert workshops and thematic symposia are designed to improve data-modeling integration and will propel the science of solid earth – cryosphere interactions beyond the current state of knowledge. The SERCE programme will conduct major efforts in capacity building, training and public outreach using complementary strategies to achieve technical capacity via information exchange, analytical capacity via training schools, engagement of new polar researchers via thematic science sessions, and public outreach via the world-wide web.

2. Important Issues or Factors

i) Five Scientific Highlights

The selected highlights given below all represent science results that were presented orally at SERCE-sponsored thematic sessions or symposia:

A. Discovery of active subglacial magmatism in West Antarctica

Clustered seismic events beneath the ice are spatially coincident with the subglacial extension of the Executive Committee Range chain of volcanoes and the long periods and frequency contents of the events are characteristic of subsurface magma movement, in some cases signaling pending eruptive activity. High heat flux associated with active magmatism may impact the behaviour of the overlying ice sheet.

Lough, Amanda C., Wiens, Douglas A., Barcheck, C. Grace, Anandakrishnan, Sridhar, Aster, Richard C., Blankenship, Donald D., Huerta, Audrey D., Nyblade, Andrew, Young, Duncan A., Wilson, Terry J. 2013. "Seismic detection of an active subglacial magmatic complex in Marie Byrd Land, Antarctica." *Nature Geoscience* 6, 1031–1035 doi:10.1038/ngeo1992.

Examples of science news coverage:

- **Scientists find Volcano Simmering beneath Western Antarctica:**
<http://www.natureworldnews.com/articles/4956/20131118/scientists-find-volcano-simmering-beneath-western-antarctica.htm>
- **Active Volcano Discovered Under Ice Sheet in West Antarctica**
<http://www.sci-news.com/othersciences/geophysics/science-active-volcano-west-antarctica-01555.html>

B. Improved models of Glacial Isostatic Adjustment (GIA) in Antarctica

Glacial isostatic adjustment, the response of the solid earth to the changing mass of overlying ice, produces displacements of the crust measureable by modern geodetic techniques. Much effort is focused on improving the ice history model and earth rheology model components of GIA models, as well as obtaining new geodetic measurements to test these models. Examples are:

- Thomas, I. D. et al. Widespread low rates of Antarctic glacial isostatic adjustment revealed by GPS observations. *Geophys. Res. Lett.* **38**, L22302 (2011).
- Whitehouse, P. L., Bentley, M. J., Milne, G. A., King, M. A. & Thomas, I. D. A new glacial isostatic adjustment model for Antarctica: calibrated and tested using observations of relative sea-level change and present-day uplift rates. *Geophys. J. Int.* **190**, 1464–1482 (2012).

C. Improved estimates of modern ice mass balance in Antarctica

Improving estimates of how Antarctic ice mass change has contributed to global sea level rise requires an accurate model for glacial isostatic adjustment (GIA), used to ‘correct’ mass estimates derived from time-varying gravity measurements. Increased recognition of the importance of the GIA factor has led to renewed efforts to improve both observational constraints and modeling methods. Two examples of many articles published on this topic are:

Ivins, Erik R., Thomas S. James, John Wahr, Ernst J. O. Schrama, Felix W. Landerer and Karen M. Simon, 2013. Antarctic contribution to sea level rise observed by GRACE with improved GIA correction. *Journal of Geophysical Research: Solid Earth*, Volume 118, Issue 6, pages 3126–3141.

King, **Matt A.**, Rory J. Bingham, Phil Moore, Pippa L. Whitehouse, Michael J. Bentley & Glenn A. Milne. 2012. Lower satellite-gravimetry estimates of Antarctic sea-level contribution. *Nature* **491**, 586–589 (22 November 2012) doi:10.1038/nature11621.

D. Demonstration of importance of deep earth structure in elastic and viscoelastic GIA response in Antarctica

Modern ice mass loss can produce an immediate elastic crustal motion response, superimposed on the steady viscoelastic GIA motions induced by ice loss since the Last Glacial Maximum. Although well-documented in Greenland, rapid uplift due to modern ice mass change is now reported for the Amundsen Embayment and Antarctic Peninsula regions. In addition, a viscoelastic response to young ice mass loss can occur where the mantle has low viscosity. Recent examples of these discoveries are:

Groh, A., H. Ewert, M. Scheinert, M. Fritsche, A. Rülke, A. Richter, R. Rosenau, R. Dietrich, 2012. An investigation of Glacial Isostatic Adjustment over the Amundsen Sea sector, West Antarctica. *Global and Planetary Change*, 98–99: 45–53.

Nield, Grace A., Valentina R. Barletta, Andrea Bordononi, Matt A. King, Pippa L. Whitehouse, Peter J. Clarke, Eugene Domack, Ted A. Scambos, Etienne Berthier, 2014. Rapid bedrock uplift in the Antarctic Peninsula explained by viscoelastic response to recent ice unloading. *Earth and Planetary Science Letters*, 397: 32–41.

E. Triggering of Antarctic ice sheet deformation by distant tectonic earthquakes

Triggering of earthquakes in active tectonic zones due to transient energy perturbations is well known, but a newly recognized phenomenon is the triggering of icequakes, due to induced basal slip or internal fracturing of ice, as reported in the following articles:

Walter, J. I., Peng, Z., Tulaczyk, S. M., O’Neel, S. & Amundson, J. M. 2013. Triggering of glacier seismicity (Icequakes) by distant earthquakes. *Seismol. Res. Lett.* **84**, 372.

Peng, Zhigang, Jacob I. Walter, Richard C. Aster, Andrew Nyblade, Douglas A. Wiens and Sridhar Anandkrishnan, 2014. Antarctic icequakes triggered by the 2010 Maule earthquake in Chile. *Nature Geoscience*, ONLINE: 10 AUGUST 2014 | DOI: 10.1038/NCEO2212

ii) Progress against prior work plan, including metrics of performance.

SCAR-SERCE has met the activity schedule originally proposed, with the exception of two activities (see summary table below). In order to secure participation of all key instructors for the ‘GIA Training School’, the activity was postponed from 2014 to 2015. However, plans for the Training School are mature, with the

venue booked and instructor list nearly complete. The web site is currently in progress, under contract with Ms. Megan Berg, and is anticipated to be up and accessible within the next 2 months.

Planning is underway for all activities planned for 2015. Initial partners have agreed to support all activities (detailed in Section 5, below), funds are secured from partners (and pending for the 15-16 SCAR budget request), venues have been booked or are under discussion. Planning groups have been initiated for both the 2015 and 2016 activities.

YEAR	WORKSHOP/SYMPOSIA	THEME SESSION	TRAINING	OUTREACH
2012	Earth Structure/Modeling ✓	Earth – Cryo. Interactions SCAR OSC ✓ AGU ✓		Logo ✓ Web site plan ✓
2013	<i>Reconciling Observations and Models of Elastic and Viscoelastic Deformation due to Ice Mass Change</i> ✓			Complete Web site ✗
2014		Earth – Cryo. Interactions EGU ✓ SCAR OSC ✓	GIA Training School ✗ <i>Postponed to 2015</i>	Complete Web site
2015	• Data archiving & exchange - ISAES • Workshop w/ IAG: GIA/GNSS Velocity Component Modeling	Earth – Cryo. Interactions ISAES EGU	• GIA Training School • Autonomous Systems-ISAES	Training Videos on web
2016	Crustal motion rates: GPS vs GIA on laterally-varying earth	Earth – Cryo. Interactions AGU SCAR OSC	Cryoseismology Training School	Training Video on web

✓ denotes completed. ✗ denotes delayed.

3. Outputs/Deliverables

3.1 Workshops and Thematic Sessions

- A. **SCAR Open Science Conference, Portland, USA, July, 2012:** SERCE Thematic Science Session.
- B. **SCAR meetings, Portland, USA, July, 2012:** Expert workshop on assimilation of earth structure in GIA modelling; general open meeting for SERCE scientists.
- C. **AGU, San Francisco, December, 2012:** *Interactions Between The Solid Earth And Cryosphere*, Thematic Session. Convenors: Terry Wilson, Rick Aster, Douglas Wiens. Selected as a ‘Hot Topic’ by AGU program committee. 11/25 presentations by student/early-career researchers (44%).
- D. **International Symposium - 30 May - 2 June 2013, Ilulissat, Greenland:** *Reconciling Observations and Models of Elastic and Viscoelastic Deformation due to Ice Mass Change* (<http://wwwx.dtu.dk/Subsites/iag.aspx>)
Co-Sponsors of this symposium were:
 - National Space Institute, Denmark (DTU Space)
 - Scientific Committee on Antarctic Research (SCAR) - Solid Earth Response and influences on Cryospheric Evolution Scientific Programme (SERCE) (provided the majority of travel funds for students, early-career scientists, SCAR nation scientists)
 - International Union of Geodesy and Geophysics (IUGG)
 - International Lithosphere Program (ILP)

- Upper Mantle Dynamics and Quaternary Climate in Cratonic Areas (DynaQlim)
- EGU (student travel funds)
- NSF (travel funds for U.S. scientists)

This symposium attracted 60 scientists from across the globe, and gave the SERCE programme a significant profile beyond initial SCAR participants. It achieved two key parts of SERCE strategy: organizing meetings at the core of cross-disciplinary problems, and finding partners to co-fund activities in order to achieve the breadth and critical mass required to address the problems.

- E. **EGU, April 2014, Vienna, Thematic Session:** The Antarctic region - Lithosphere structure and geodynamic evolution. Convenors: F. Ferraccioli, D. Wiens, Joachim Jacobs
- F. **SCAR Open Science Conference, Auckland, New Zealand, August, 2014:** SERCE Thematic Science Session Convenor: Terry Wilson

3.2 Related Publications and Presentations

See 'scientific highlights' section above.

- **Special Issue of Solid Earth: 'Lithosphere – Cryosphere Interactions'** published in 2014. The editorial team for this issue includes C. Pascal (Ruhr Univ., Bochum), V. Klemann (GFZ, Potsdam), M. Poutanen (Finnish Geodetic Institute), and B. Vermeersen (TU Delft). These individuals are leaders of the DynaQlim ILP project and participants in SERCE. SERCE scientists contributed papers to the volume.
- **A published report on the Ilulissat workshop:** King, M., Milnes, G., and Wiens, D., Improving Models of Earth's Response to Ice and Ocean Loading Changes, Summary of the Symposium "Reconciling Observations and Models of Elastic and Viscoelastic Deformation Due to Ice Mass Change"; *Ilulissat, Greenland, 30 May to 2 June 2013*. *Eos*, Vol. 94, No. 40, 1 October 2013.
- **A Special Issue on "Recent Advance in Polar Seismology - Global Impact of the International Polar Year –"**, Eds. by Dapeng Zhao (Tohoku University), Douglas A. Wiens (Washington University in St. Louis), Eleonore Stutzmann (Institut de Physique du Globe de Paris) and Masaki Kanao (National Institute of Polar Research), *Polar Science*, <http://ees.elsevier.com/polar/>. As of August 2014, 17 articles have been submitted and are under review. The Special Issue will be published in early 2015.

Scope: The IPY2007-2008 has witnessed that a growing community of geoscientists, including many seismologists, have undertaken considerable efforts to acquire high-quality data for the polar conditions. The justification for developing seismic arrays addresses both the unique aspects of seismology in Antarctica and general issues that are important to global Earth sciences, for example, lithospheric dynamics in an ice-covered environment; how the processes drive and are driven by global environmental changes etc. Taking these issues into account, we invite contributions to a special issue on "Recent Advance in Polar Seismology" in an Elsevier journal, *Polar Science*, which will cover the recent achievements on polar seismology and cryoseismology. All seismological topics related to the polar regions are welcome, such as studies of crust and mantle structure, monitoring of tectonic and glacier-related seismicity, recent large earthquakes and seismotectonics, tsunamis, and infrasonic waves, etc. We particularly encourage contributions based on all kinds of seismic signals associated with the dynamics of ice sheets, sea-ice, icebergs and glaciers. The glacial earthquakes are the most prominent evidence found recently in the polar region. We hope that these contributions present the results of innovative seismological studies in the polar regions, as well as descriptions of observational experiments and long-term monitoring under the extreme conditions of the polar environment.

3.3 Education and Outreach Activities

- A. SERCE logo designed by consultant Megan Berg.
- B. SERCE website design contracted to consultant Megan Berg; initial web content developed.
- C. SERCE provided the majority of travel funds for students, early-career scientists, and more senior scientists from selected SCAR nations to participate in the Ilulissat international science symposium.

- D. Planning for the SERCE sponsored ‘GIA Training School’, including extensive discussions with and site visit to venue, planning with instructors of prior training schools, and development of course syllabus completed.

4. Budgetary Implications

Main Expenditures

2013: Original budget of \$20,000, Additional funding of \$5,000.

1. \$25,000 spent on travel support for the Ilulissat symposium (payment to DTU, Denmark)
2. \$220 spent for logo design for SERCE web site

Overspend: \$220

2014: Original budget of \$20,000.

1. Cleared \$220 overspend from 2013.

Remaining Funds: \$19,780

Explanation: \$20,000 allocated for the SERCE ‘GIA Training School’ has been approved to carry over to 2015, to support the postponed training school.

Budget Request

2015: New funds requested: \$23,000

1. GIA Training School. [\$20,000] funding to support students/early career scientist participation.

NOTES: these funds are covered from 2014 allocation, carried over. The Training School is financially supported by the U.S.-NSF; additional support is sought from the International Lithosphere Program and the EGU Training School program.

2. Expert Workshop: \$10,000 funding for travel support for SCAR participants.

Modeling Elastic and Viscoelastic Components of the GIA Crustal Velocity Field, Alaska, USA, Spring 2015

NOTE: This workshop is also funded by the International Association of Geodesy.

3. ISAES - Autonomous Systems Workshop: \$10,000 funding for a) venue costs and b) travel support for costs associated with participation in the workshop.

NOTE: Funding for this workshop is being sought from IRIS-PASSCAL seismic facility, UNAVCO GPS facility, and the U.S. NSF, to cover the costs of shipment of equipment to the Goa venue, and for facility personnel to discuss/demonstrate equipment operation. Because the venue is the SCAR ISAES, we anticipate that participants will have the majority of their travel costs covered from other sources and the workshop will be a small additional cost for them.

4. Funds for completion of design and production of the SERCE web site: \$3000

NOTE: These funds are required to pay for the remaining design work on the SERCE website – originally allocated in 2013, these funds were redirected for the Ilulissat workshop when the web work was delayed.

2015 – Budget Explanation:

A key event for SERCE is the International Symposium on Antarctic Earth Sciences, planned for Goa, India. A thematic SERCE science session and a steering committee meeting will be held at the ISAES meeting. An open business meeting will focus on data management, archiving, and sharing, with the aim of identifying location and contact person, and negotiating access where necessary, for data from all Antarctic national

sources. SERCE will also plan a capacity-building activity for ISAES, which will provide a venue where typically all SCAR nations send earth scientists. The principal capacity-building activity will be a workshop demonstrating current technologies for autonomous geophysical instrument systems, and best practices for assembling and operating these systems at sites remote from research stations. SERCE has sought partnership (and, hopefully, additional funding) from the UNAVCO and IRIS/PASSCAL facilities, serving the GPS and seismic communities, respectively, to implement this workshop. To complement this technical workshop, we will organize an additional session on data management, archiving, and sharing, with the aim of identifying location and contact person, and negotiating access where necessary, for data from all Antarctic national sources.

An expert workshop on establishing a ‘*Modeling Elastic and Viscoelastic Components of the GIA Crustal Velocity Field*’ will be organized during 2015. Support for this activity will be sought from partner science programmes, using the successful strategy for the 2013 Greenland symposium.

2016: New funds requested: \$25,000

1. Cryoseismology Training School, Colorado, USA, August 2016. \$20,000 funding to support students/early career scientist participation.
2. Expert Workshop: \$5,000 for travel support for SCAR participants.
Common Reference Frame for Comparison of GIA Models and GNSS Crustal Velocity Fields
3. Thematic Session – SCAR Open Science Conference

2016 – Budget Explanation:

A ‘training school’ designed to build capacity in applying geodesy and seismology to study the cryosphere is planned. The 5-day short course will be jointly organized and funded by the NSF-sponsored POLENET-ANET project and other partners will be sought for funding. We expect that 20 U.S. (funded by NSF) and 20 additional students (funded by SCAR and, perhaps, additional partners) from a large number of nations will attend the course.

An expert workshop on establishing a ‘*Common Reference Frame for Comparison of GIA Models and GNSS Crustal Velocity Fields*’ will be organized during 2016. Support for this activity will be sought from partner science programmes, using the successful strategy for the 2013 Greenland symposium.

5. Future Plans

1. SERCE website content produced, website goes live: end 2014 (*delayed from 2013*).
2. Plan and implement Training School: *Glacial Isostatic Adjustment Training School*, Ohio State University Stone Laboratory, Gibraltar Island (Lake Erie), Ohio. September, 2015 (*postponed from 2014*).
3. EGU Session, Vienna, April, 2015; *The Antarctic Lithosphere - geodynamic evolution and interactions with the cryosphere*; ad hoc steering committee meeting.
4. Expert Workshop: *Modeling Elastic and Viscoelastic Components of the GIA Crustal Velocity Field*, Alaska, USA, Spring 2015

Glacial isostatic adjustment (GIA) in regions where ice sheets have not fully disappeared since the Last Glacial Maximum (LGM) includes a long-term, steady crustal velocity field due to post-LGM ice loss and a variable velocity field recording the elastic response of the solid earth to modern ice mass change. In addition, there may be a component of motion arising from a viscoelastic response to recent ice mass change in regions where earth rheology is weak. In order to understand the contributions of the world’s ice sheets and ice caps to sea level rise, these components must be discriminated and modeled so that geodetic observations of the integrated crustal velocity field can be used reliably as constraints on GIA model results. This hands-on workshop will explore best practices in modeling elastic rebound from

modern IMB measurements, and then removing that component from total measured displacements to constrain viscoelastic response.

Tentative Plan: Planning in partnership with International Association of Geodesy SubCommission 3.4, and to be held in conjunction with a science symposium, Alaska, Spring 2015.

Initial planning committee: Matt King (U. Tasmania, Australia), Shfaqat Abbas Khan (DTU, Denmark), and Jeff Freymueller (U. Alaska, USA).

5. *SERCE Thematic Session/Steering Committee & Business meeting:* SCAR International Antarctic Earth Science Symposium, Goa, India, 2015.

6. *Autonomous GPS & Seismic Station Workshop,* Goa, India, July 2015

In the time period encompassing the International Polar Year, significant advances in autonomous GPS & seismic systems designed to operate year-round at remote locations in extreme polar environments were made. Lessons have been learned during IPY and subsequent deployments and system design has been iteratively improved. Robust systems can be built at relatively low cost. This workshop aims to distribute information broadly to the Antarctic earth science community on system types, design and installation parameters, and the range of applications these systems enable.

Goals:

- Capacity-building – distribute knowledge of recent advances in technologies facilitating deployments of autonomous remote systems and how they can be used in earth science applications.
- Facilitate improved seismic and geodetic infrastructure at remote sites distributed across the Antarctic interior.
- Expand the range of research on polar earth systems, and on solid earth – cryosphere interactions in particular.

Partners:

- SCAR-SERCE
- SCAR-GIANT?
- SCAR-GRAPE?
- U.S. NSF Projects
 - UNAVCO
 - IRIS-PASSCAL
 - POLENET-ANET
 - GeoIce
 - geoPebbles

Initial Plan: One-day workshop/training school to be held at the International Antarctic Earth Science Symposium in Goa, India, July, 2015. 1) Invited speakers will give overview of earth science research that can be done using autonomous remote systems, followed by 2) demonstration of design, installation, and operation of autonomous remote GPS and seismic systems, including the range of systems in use/under development.

Initial Steering Committee: Sridhar Anandakrishnan (Penn State U., USA), Paul Carpenter (IRIS-PASSCAL, USA), Joe Pettit (UNAVCO, USA), Paul Winberry (Central Washington U., USA).

7. *GIA Training School,* Ohio, USA, September 2015

A ‘training school’ (short course) for graduate students and early-career researchers is planned, with the overarching goal of developing a new cadre of polar scientists trained in emerging/critical research areas that are currently underpopulated, specifically GIA modeling. Modeled after the very successful European Union COST Actions ‘Training Schools’, this 5-day short course will a) provide intensive training, including lectures and hands-on exercises b) provide students access to scientific leaders in multiple disciplines, and c) through the opportunity to network with other students, form the basis for future multidisciplinary, international collaboration. The GIA Training School will be co-funded by the U.S. NSF as part of the outreach program of the POLENET-ANET project. We expect that 20 U.S. (fund by NSF) and 20 additional students (funded by SCAR and, perhaps, additional partners) from a large number of nations will attend the course, and we will provide broader access via ‘live’

participation of off-site students using videocom and by recording and posting the school content on the POLENET and SERCE web sites.

Initial Plan: A venue for the course has been secured at the Ohio State University's Stone Laboratory, located on Gibraltar Island in Lake Erie. Lodging & meal rates are very reasonable. Instructors committed at this point include Dr. Bert Vermeersen, Delft; Dr. Wouter van der Wal, Delft, Dr. Pippa Whitehouse, Durham; Dr. Giorgio Spada, Italy; Dr. Matt King, Australia. Others to be invited.

8. Convene 'expert workshop' on 'Common Reference Frame for Comparison of GIA Models and GNSS Crustal Velocity Fields' in 2016.
9. Cryo-Seismology Training School, Colorado, USA, September 2016

A 'training school' (short courses) for graduate students and early-career researchers is planned, with the overarching goal of developing a new cadre of polar scientists trained in emerging/critical research areas that are currently underpopulated, specifically integrated geodetic and 'cryoseismology' techniques to study ice dynamics. This 5-day short course will a) provide intensive training, including lectures and hands-on exercises b) provide students access to scientific leaders in multiple disciplines, and c) through the opportunity to network with other students, form the basis for future multidisciplinary, international collaboration. The Cryoseismology Training School will be co-funded by the U.S. NSF as part of the outreach program of the POLENET-ANET project. We expect that 20 U.S. (funded by NSF) and 20 additional students (funded by SCAR and, perhaps, additional partners) from a large number of nations will attend the course, and we will provide broader access via 'live' participation of off-site students using videocom and by recording and posting the school content on the POLENET and SERCE web sites.

Initial Plan: A venue for the course is being explored at the Pingree Park Mountain Campus of Colorado State University, USA (<http://www.pingree.colostate.edu/conferences>).

10. *SERCE Thematic Session/Steering Committee & Business meeting:* SCAR Open Science Conference, Malaysia, 2016

Appendix

Steering Committee

NOTE: final membership still to be confirmed.

- Terry Wilson, Ohio State University, Columbus, Ohio, USA Convenor, Geodesy, Crustal Deformation
- *Pippa Whitehouse, University of Durham, Durham, U.K. Glacial isostatic adjustment modelling.
 - Liaison: SCAR-IASC ISMASS group
- Matt King, University of Tasmania, Hobart, Australia Polar geodesy
 - Liaison: International Association of Geodesy
 - Leader: EU COST Action on GIA (ended)
- *Stefania Danesi, INGV, Bologna, Italy Cryoseismology
- Masaki Kanao, National Institute of Polar Research, Japan. Seismology, geodynamics.
- Markku Poutanen, Finnish Geodetic Institute, Finland. Geodesy, geodynamics
 - Liaison: International Lithosphere Programme, DynaQlim Project
- Yves Rogister, University of Strasbourg, France. Gravity, geodesy, GIA.
- *Samantha Hansen, University of Alabama, USA Deep earth seismology

* *Early-Career researchers*

Ex-Officio Members – Liaisons to other groups

Francisco Navarro	IASC Cryosphere Working Group
Michael Bentley	PAIS (Holocene)
?	AntClim ²¹
?	APECS / Outreach