



**SDM** **10**  
 Agenda Item: 4.1.3  
 Person Responsible: M King and P Whitehouse

**XXXV SCAR Delegates Meeting  
 Davos, Switzerland, 25-26 June 2018**

## Solid Earth Response and influence on Cryosphere Evolution (SERCE)

**Report Authors**

Matt King (Australia) and Pippa Whitehouse (UK)

**Summary of activities from 2016-18 and other important matters**

Activities have focused on small-group workshops and training schools. During 2017-18 SERCE has sponsored the following activities, primarily by providing travel funding for ECRs and researchers from countries with emerging Antarctic programs:

- A training school focused on exploring glacial seismology was held from 11-17 June 2017 on the campus of Colorado State University, Fort Collins, Colorado, USA. The program included lectures and practical exercises aimed at current and emergent seismological studies of glacial dynamics, structure, seismogenic processes, and seismic observables. 45 participants attended, from 16 different countries, including a number of countries with developing Antarctic programs (Switzerland, Canada, Romania, Chile, and Costa Rica). 41 out of 45 participants were ECRs.
- A workshop on ‘Glacial Isostatic Adjustment and Elastic Deformation’ was held on September 5-7, 2017, at Grand Hotel Reykjavik, Iceland with more than 80 participants from Europe, North America and Australia. The workshop delivered 10 challenges for the community to work toward in the future.
- A workshop on geothermal heatflux was initiated and hosted in Hobart on 21-23 March 2018. The workshop was attended by a diverse community of about 50 international researchers across the solid Earth-cryosphere sciences who met to discuss current efforts, collaborations and future directions in geothermal heat flux research. Several recommendations for SCAR were drafted.
- SERCE co-sponsored a recent summer school on Polar Geodesy, held 10-19 May 2018 in Russia. The school was primarily organised by GIANT. All attendees were ECRs.
- Following the 2016 review recommendations, an ECR member has been appointed to the SERCE Management Committee following a call for expressions of interest from APECS (Nadya Yanakieva, Bulgaria).
- SERCE-facing conference sessions have taken place at EGU17/18, AGU17, and IAG. Session proposals were accepted for POLAR2018 and IUGG2019.
- Plans are underway to host a workshop and training school in 2019.

**Recommendations** - None

**Summary Budget 2017 to 2020**

	2017	2018	2019	2020
	Spent	Allocated	Request	Request
<b>(US\$)</b>	\$36,263	\$21,000	\$21,000	\$21,000



SDM 10  
Agenda Item: 4.1.3  
Person Responsible: M King and P Whitehouse

## XXXV SCAR Delegates Meeting Davos, Switzerland, 25-26 June 2018

### Progress and Plans

#### Major Outcomes

**Infrastructure:** Over the last 12 months our capacity to make observations that relate to the scientific aims of SERCE has been significantly strengthened, thanks to continued support by national funding agencies. A network of bedrock GPS sites along the Antarctic Peninsula and around the Weddell Sea embayment, which were originally installed and supported by a combination of UK, US, and Australian funding, and which were due to be decommissioned over the next 1-2 years, now come under the remit of an over-arching grant funded by the UK funding agency NERC. These sites will continue to collect data through to 2022, and over this period they will gradually be upgraded so that data is transmitted off continent in near-real-time and made available to all through open source data repositories. In addition, funding for the NSF-funded POLENT network of GPS sites, which cover the remainder of West Antarctica and the Transantarctic Mountains, has been renewed. Both these proposals were motivated by SERCE-facing science and were supported by statements from SERCE. SERCE led a community submission to SCAR Executive to seek a revision to the Terrestrial Code of Conduct to clarify that geodetic monuments should not be removed from the field when there is long-term science value in their retention; consequently, an appropriate amendment was adopted in a draft revision to the Code. Our capacity to image Earth structure beneath the ice sheet has also strengthened due to the completion of a successful seismic campaign across the southern Antarctic Peninsula during 2015-18, and the fact that the POLENET project also supports a network of seismometers.

**Outreach:** Online material (lecture slides and recordings) continues to be available from both the 2015 (GIA) and 2017 (Glacial Seismology) training schools that were supported by SERCE, in collaboration with POLENT. It is not possible to track how many times the material has been accessed (such a feature will to be implemented for the proposed 2019 GIA training school), but anecdotal evidence suggests that this resource is a valuable online learning and teaching tool.

**Science direction:** During both the Iceland workshop on 'Glacial Isostatic Adjustment and Elastic Deformation', and the Hobart workshop on Geothermal Heat Flux ('Taking the Temperature of the Antarctic Continent), attendees at these SERCE-sponsored activities drew up a series of community priorities for future research directions. The output from these activities were shared on the SERCE news page and circulated via relevant email distribution lists, and it is hoped that these exercises provide motivation, and encourage support, for future research in the field of Cryosphere-solid Earth interactions. The research priorities from the Iceland workshop are discussed in a recent review article on Glacial Isostatic Adjustment (Whitehouse, P.L. 2018. Glacial Isostatic Adjustment modelling: historical perspectives, recent advances, and future directions. *Earth Surface Dynamics*, 6, 401-429), while issues directly relating to feedbacks between solid Earth processes and the evolution of the Antarctic Ice Sheet are discussed in an invited review paper that has recently been submitted. Awareness of the importance of such feedbacks in relation to ice sheet dynamics has significantly increased over the lifetime of the SERCE program.



SDM 10  
Agenda Item: 4.1.3  
Person Responsible: M King and P Whitehouse

### XXXV SCAR Delegates Meeting Davos, Switzerland, 25-26 June 2018

#### Notable Papers

1. Aster, R.C. & Winberry, J.P. 2017. Glacial Seismology. *Reports on Progress in Physics*, **80**, 126801. *This article provides a thorough review of the emerging field of glacial seismology and discusses future directions for this rapidly evolving area of research.*
2. Begeman, C. B., Tulaczyk, S. M. & Fisher, A. T. 2017. Spatially variable geothermal heat flux in West Antarctica: Evidence and implications. *Geophysical Research Letters*, **44**. [https://doi.org/ 10.1002/2017GL075579](https://doi.org/10.1002/2017GL075579). *This study presents a new geothermal heat flux (GHF) measurement from beneath the West Antarctic Ice Sheet, and compares this to other directly and geophysically-determined estimates across the region. The authors identify significant variability in GHF across West Antarctica, and suggest that it will be difficult to predict ice sheet evolution without more accurate quantification of GHF variability.*
3. Brenn, G.R., Hansen, S.E. & Park, Y. 2017. Variable thermal loading and uplift along the Transantarctic Mountains, Antarctica. *Geology* **45**, doi:10.1130/G38784.1. *This article seeks to quantify the thermal contribution to uplift along the Transantarctic Mountains (TAM). Using seismic tomography the authors identify regions of low velocity, indicative of partial melt and warm upper mantle, and suggest that thermal buoyancy plays a major role in controlling the uplift of the TAM.*
4. Gomez, N., Latychev, K. & Pollard, D. 2018. A coupled ice sheet-sea level model incorporating 3D Earth structure: Variations in Antarctica during the last deglacial retreat. *J. Climate*, **31**(10), 4041-4054. doi:10.1175/JCLI-D-17-0352.1. *This article presents results generated using a gravitationally self-consistent, global sea level model with 3D viscoelastic Earth structure that is interactively coupled to a 3D dynamic ice sheet model. This unique coupled model is applied to simulate the evolution of Antarctic ice-sheet change, global sea-level change, and solid Earth deformation over the last deglaciation, from 40 ka to the modern.*
5. Kingslake, J., Scherer, R., Albrecht, T., Coenen, J., Powell, R., Reese, R., Stansell, N., Tulaczyk, S., Wearing, M.G. & Whitehouse, P.L. 2018. Extensive retreat and re-advance of the West Antarctic ice sheet during the Holocene. *Nature* [to be published June 2018]. *This article documents evidence for grounding line retreat and readvance across the Ross and Weddell Sea embayments during the late Holocene. Numerical modelling suggests that solid Earth rebound in response to ice unloading was a key process in triggering grounding line readvance.*
6. Martos, Y. M., Catalan, M., Jordan, T. A., Golynsky, A., Golynsky, D., Eagles, G. & Vaughan, D. G. 2017. Heat flux distribution of Antarctica unveiled. *Geophysical Research Letters*, **44**. <https://doi.org/10.1002/2017GL075609>. *This article presents a high-resolution heat flux map for Antarctica, thus providing an important new boundary condition that can be used in studies on future subglacial hydrology, ice sheet dynamics, and sea-level change.*
7. Nield, G.A., Whitehouse, P.L., van der Wal, W., Blank, B., O'Donnell, J.P. & Stuart, G.W. 2018. The impact of lateral variations in lithospheric thickness on glacial isostatic adjustment in West Antarctica. *Geophysical Journal International*. <https://doi.org/10.1093/gji/ggy158>. *This article investigates the impact of lateral*



SDM 10  
Agenda Item: 4.1.3  
Person Responsible: M King and P Whitehouse

### XXXV SCAR Delegates Meeting Davos, Switzerland, 25-26 June 2018

variations in lithospheric thickness on Glacial Isostatic Adjustment (GIA) in Antarctica. The authors find that including lateral variations in lithospheric thickness, at least to the level of considering West and East Antarctica separately, is important for capturing short wavelength deformation and it has the potential to provide a better fit to GPS observations as well as an improved GIA correction for GRACE data.

8. Pollard, D., Gomez, N. & DeConto, R. 2017. Variations of the Antarctic Ice Sheet in a coupled ice- sheet – Earth - sea level model: sensitivity to viscoelastic Earth structure. *J. Geophys. Res. Earth Surface*, 122. doi:10.1002/2017JF004371. This study makes use of a coupled ice sheet-Earth-sea level model to investigate the sensitivity of ice dynamics to viscoelastic Earth properties under a number of different climate-forcing scenarios. A key finding is that the weak rheology inferred to exist beneath West Antarctica can have a strong negative feedback effect on ice retreat, and that 3D Earth structure should be incorporated into future coupled modelling efforts.
9. Sasgen, I., Martin-Espanol, A., Horvath, A., Klemann, V., Petrie, E.J., Wouters, B., Horvath, M., Pail, R., Bamber, J.L., Clarke, P.J., Konrad, H., Drinkwater, M.R. 2017. Joint inversion estimate of regional glacial isostatic adjustment in Antarctica considering a lateral varying Earth structure (ESA STSE Project REGINA). *J. Geophysical Journal International*, 211, 1534-1553. This study produces an estimate of the contemporary glacial isostatic adjustment (GIA) signal across Antarctica that is constrained by a suite of geodetic data, including GRACE, Envisat/ICESat and GPS data. The inversion accounts for spatial variability in Earth structure across Antarctica.
10. Seroussi, H., Ivins, E.R., Wiens, D.A. & Bondzio, J. 2017. Influence of a West Antarctic mantle plume on ice sheet basal conditions, *J. Geophys. Res. Solid Earth*, 122, doi:10.1002/2017JB014423. This study examines the impact of a realistic distribution of heat flux beneath West Antarctica, associated with a possible late Cenozoic mantle, on thermal and melt conditions at the base of the ice sheet. Through numerical modelling, the authors are able to place bounds on the geothermal heat flux that is necessary to be consistent with basal hydrology across the region.

#### Main Activities

Our activities focus quite substantially on topics identified within the SCAR Horizon Scan. All of our activities focus on development of ECRs, with SCAR funding required to be directed toward supporting the attendance and/or training of ECRs. Our main activities over the past two years are:

1. **Workshop: Understanding geothermal heatflux through inter-disciplinary collaboration.** The geothermal heatflux workshop focused on SCAR Horizon Scan Question 27: “How do the characteristics of the ice sheet bed, such as geothermal heat flux and sediment distribution, affect ice flow and ice sheet stability?” And Question 36: “Do variations in geothermal heat flux in Antarctica provide a diagnostic signature of sub-ice geology?” Recent years have seen a rapid increase in efforts to characterise the geothermal heatflux under the ice sheet given the importance for ice sheet modelling, and to address the origins of



**SDM** **10**  
Agenda Item: 4.1.3  
Person Responsible: M King and P Whitehouse

### **XXXV SCAR Delegates Meeting Davos, Switzerland, 25-26 June 2018**

substantial inter-product differences. This workshop brought together specialists using geological, seismological, geophysical modelling and satellite datasets. The complexity of the problem demands an inter-disciplinary approach.

- 2. Workshop: Separating geophysical signals of bedrock motion associated with short or long-period solid Earth processes-** The workshop in Iceland focused on SCAR Horizon Scan Question 37: “What is the crust and mantle structure of Antarctica and the Southern Ocean, and how do they affect surface motions due to glacial isostatic adjustment?” This was timely due to the rapid expansion of GPS and seismic networks in Antarctica since IPY and the maturation of these time series. Collaboration on the topics of the workshop are required to robustly interpret these data. It was notable that the community in this workshop has grown by a factor of about 2 during the lifetime of SERCE.
- 3. Training School in seismic techniques applied in cryospheric environments** - Our cryo-seismology training school focused on training a generation of early career researchers within this emerging field of research. This field of research has produced new approaches for understanding the ice-bed interface and internal properties of the ice sheet. The field in general contributes to answering question 27 above. Given the recent emergence of this field, and the concentration of expertise in the US and Europe, the school opened the way for a diverse group of students to be trained and pass this knowledge onto others.

#### **Finalization Activities**

A major review paper has been submitted following an invitation from Nature Communications. The paper reviews interactions between the solid Earth and the Antarctic Ice Sheet.

#### **Expected Final Outcomes**

The final activity of SERCE will be to focus on the future, through a workshop focusing on ‘Grand Challenges’ in solid-Earth and ice interactions, within the context of future SRPs – notably one likely to emerge within the area of ‘Climate and Life’. This meeting will strongly celebrate the successes of SERCE but will primarily seek to establish key areas of activity in the coming decade. Emerging areas of interest will be particularly targeted, such as ice and volcanism interactions. We will again strongly support the attendance of ECRs and those from nations with emerging Antarctic programs and broaden the participation to include leadership from relevant emerging SRPs and the past ice sheet (PAIS) community.

We will plan toward a summary paper that will reflect the content of the workshop.

We anticipate in the period leading up to 2020 to be significantly involved in the planning for future SRPs. SERCE interests are represented in a draft white paper developed in response to plenary discussions at the 2017 SCAR PAIS conference held in Trieste, and we will use this document to frame discussions around future SRP activities.



**SDM** **10**  
 Agenda Item: 4.1.3  
 Person M King and  
 Responsible: P Whitehouse

**XXXV SCAR Delegates Meeting  
 Davos, Switzerland, 25-26 June 2018**

**Significant Deviations from the Implementation Plan**

We rolled over a number of activities but all activities have thus far occurred within 1 year of the original plan.

**Budget**

**Planned use of funds for 2018 to 2020**

Year (YYYY)	Purpose/Activity	Amount (in USD)	Contact Name	Contact Email
2020	Final workshop	21,000	Matt King	Matt.King@utas.edu.au
2019	GIA-ice sheet feedback workshop	10,000	Thomas James	thomas.james@canada.ca
2019	GIA training School	20,000	Pippa Whitehouse	pippa.whitehouse@durham.ac.uk
2018	Geothermal Heat Flux workshop	10,000	Jacqui Halpin	jacqueline.halpin@utas.edu.au
2018	ECR rep to POLAR18	500	Pippa Whitehouse	pippa.whitehouse@durham.ac.uk
2018	Polar Geodesy School	3,500	Mirko Scheinert	Mirko.Scheinert@tu-dresden.de

**Briefly describe funds usage and the desired results**

The vast majority of our funds are used to support ECRs and/or scientists from developing countries. Due to the clustering of activities in 2018 (including the Davos meeting) we plan to hold two keystone activities in 2019, and hence will carry over funds from 2018. Our budget total (\$65,000 over three years, 2018-2020) makes use of a small surplus from 2017, where we only spent \$36,263 of our projected \$40,000 spend.

**2020: Final Workshop**

- Grand challenges in solid-Earth and ice interactions. We will again strongly support travel of ECRs and those from nations with emerging Antarctic programs. We will broaden the focus by inviting leaders of emerging SRPs and representative communities.

**2019: GIA-ice sheet feedback workshop (Canada)**

- Allocated SERCE funds will exclusively be used to provide travel support to ECRs and/or scientists from developing countries

**2019: GIA training school (Scandinavia)**

- Allocated SERCE funds will primarily be used to provide travel support to ECRs and/or scientists from developing countries



**SDM** **10**  
Agenda Item: 4.1.3  
Person Responsible: M King and P Whitehouse

### **XXXV SCAR Delegates Meeting Davos, Switzerland, 25-26 June 2018**

- With support from other partners (POLENET, and hopefully IACS and EGU) we also hope to be able to provide full support (board and lodging) to all participants and lecturers
- The detailed allocation of funds will become clearer as we finalize the details of the support we hope to receive from other groups

#### **2018: Attendance of ECR rep at POLAR18 (Davos, Switzerland)**

- SERCE funds have been allocated to provide travel support for our ECR rep to attend the POLAR18 meeting in Davos
- ECR rep comes from a country with an 'Initial-Stage' Antarctic program

#### **2018: Polar Geodesy School (Russia)**

- Allocated SERCE funds have exclusively been used to provide travel support to ECRs and/or scientists from developing countries

#### **2018: Geothermal Heat Flux Workshop (Hobart, Australia)**

- Allocated SERCE funds have exclusively been used to provide travel support to ECRs and/or scientists from developing countries

#### **Percentage of the budget to be used for support of early career researchers**

2018: 90%  
2019: 90%  
2020: 90%

#### **Percentage of the budget to be used for support of scientists from countries with developing Antarctic programmes**

2018: 10%  
2019: 10%  
2020: 10%

## **Linkages**

### **Direct support from outside organisations**

1. The Antarctic Gateway Partnership (University of Tasmania) supported the 2018 geothermal heatflux workshop with \$10,000 cash.
2. The Danish Technical University supported the 2017 Iceland workshop with 2,000 Euros in cash.
3. The European Space Agency (ESA) supported the 2017 Iceland workshop with 5,000 Euros in cash
4. The International Association of Cryospheric Sciences (IACS) supported the 2017 Cryo-Seismology Training School with 1,500 Euros in cash.
5. The 2017 Cryo-Seismology Training School received additional funding from the International Glaciological Society and NSF, with the latter providing support through the Antarctic Network (ANET) component of the Polar Earth Observing Network (POLENET)
6. Additional funding for the Workshop on GIA-Ice Sheet modelling (Canada, 2019) will be provided by Polar Knowledge Canada



**SDM** **10**  
 Agenda Item: 4.1.3  
 Person M King and  
 Responsible: P Whitehouse

**XXXV SCAR Delegates Meeting  
 Davos, Switzerland, 25-26 June 2018**

7. Additional funding for the GIA Summer School (Europe, 2019) will be provided by the NSF-funded POLENET project, and we also plan to apply for support from IACS and EGU.

**Major collaborations**

**Within SCAR**

1. PAIS/AntClim – co-organizers of mini-symposium at SCAR 2016; ongoing discussion regarding SRP activity beyond 2020
2. ISMASS – co-organizers of SERCE-facing session at POLAR2018
3. GIANT - ongoing joint project to consolidate Antarctica GPS data

**Outside SCAR**

1. POLENET (NSF-funded) – SERCE and POLENET have co-hosted a number of international training schools in 2015 and 2017, with plans to continue this partnership in 2019
2. WCRP Grand Challenges Sea Level Sciences group – SERCE leadership has provided input to this activity

**Outreach and Capacity Building**

1. Lecture material associated with the 2015 GIA summer school and the 2017 Glacial Seismology Training School is available online, linked from the SERCE News page.
2. Students who were unable to attend the 2015 GIA summer school were provided with the opportunity to participate remotely via an online portal. Their participation was monitored in real-time, and they were able to pose questions to the lecturers just as if they were in the room. We plan to repeat this approach for the 2019 GIA summer school.
3. Capacity building: the vast majority of SERCE funds are directed towards enabling Early Career Researchers or scientists from countries with a developing Antarctic program to participate in medium-sized (30-100 people) workshops. By attending such workshops these scientists will be exposed to both discipline-specific and highly inter-disciplinary cutting-edge science, and they will have the opportunity to network with scientists from a diverse range of research fields.
4. We have recently appointed an ECR rep to increase our visibility to the ECR community, and give scientists from all career stages the opportunity to provide input on the future of Antarctic research.

**SCAR Fellowship Reviewers**

First Name	Last Name	E-mail	Principal Expertise
Matt	King	matt.king@utas.edu.au	Polar Geodesy
Pippa	Whitehouse	pippa.whitehouse@durham.ac.uk	Glacial Isostatic Adjustment modelling



SDM 10

Agenda Item: 4.1.3

Person Responsible: M King and P Whitehouse

## XXXV SCAR Delegates Meeting Davos, Switzerland, 25-26 June 2018

### Membership

#### Leadership

Role	First Name	Last Name	Affiliation	Country	Email	Date Started	Date Term is to End
Joint Chief Officer	Matt	King	University of Tasmania	Australia	matt.king@utas.edu.au	2016	2020
Joint Chief Officer	Pippa	Whitehouse	Durham University	UK	pippa.whitehouse@durham.ac.uk	2016	2020
*ECR Rep	Nadya	Yanakieva	Bulgarian Antarctic Institute	Bulgaria	nadya.yanakieva@gmail.com	2017	2020

\* *Early Career Scientists*

#### Other members

First Name	Last Name	Affiliation	Country	Email
Songtao	Ai	Wuhan University	P.R. China	ast@whu.edu.cn
Meijian	An	Chinese Academy of Geological Sciences	P.R. China	meijianan@live.com
Mike	Bentley	Durham University	UK	m.j.bentley@durham.ac.uk
Rene	Forsberg	Danish Technical University	Denmark	rf@space.dtu.dk
*Natalya	Gomez	McGill University	Canada	natalya.gomez@mcgill.ca
Jacqui	Halpin	University of Tasmania	Australia	Jacqueline.Halpin@utas.edu.au
*Samantha	Hansen	University of Alabama	USA	shansen@ua.edu
Thomas	James	Natural Resources Canada	Canada	tjames@nrcan.gc.ca
Masaki	Kanao	National Institute of Polar Research (NIPR)	Japan	kanao@nipr.ac.jp
Adam	Martin	GNS	New Zealand	a.martin@gns.cri.nz



**SDM** **10**  
Agenda Item: 4.1.3  
Person Responsible: M King and P Whitehouse

**XXXV SCAR Delegates Meeting  
Davos, Switzerland, 25-26 June 2018**

*Anthony	Memin	Géoazur, Université Nice Sophia Antipolis	France	Anthony.MEMIN@unice.fr
Yongcheol	Park	Korea Polar Research Institute (KOPRI)	South Korea	ypark@kopri.re.kr
Frank	Pattyn	Université libre de Bruxelles	Belgium	fpattyn@ulb.ac.be
Mirko	Scheinert	TU Dresden (Technische Universität)	Germany	Mirko.Scheinert@tu-dresden.de
*Dusty	Schroeder	Stanford University	USA	Dustin.M.Schroeder@stanford.edu
Alex	Simms	University of California, Santa Barbara	USA	asimms@geol.ucsb.edu
Terry	Wilson	Ohio State University	USA	wilson.43@osu.edu

\* *Early Career Scientists*

## Requests to the Secretariat

At present I think it is necessary to go through SCAR Secretariat to get new items uploaded to the SERCE webpage. I know that there is work in progress that will enable us to post new material ourselves, and we welcome this additional flexibility.