



SDM 08  
 Agenda Item: 4.1.1  
 Person Responsible: T  
 Bracegirdle et al.

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

# Antarctic Climate Change in the 21<sup>st</sup> Century (AntClim21)

## Report Author(s)

Tom Bracegirdle (UK), Nancy Bertler (New Zealand), Alia Khan (USA), Gerhard Krinner (France), Paul Mayewski (USA), Marilyn Raphael (USA), Joellen Russell (USA)

**Summary of activities and other important matters from 2016-18** - This has been an exciting period for AntClim21 with a number of activities and developments that all help to build towards the next two years. Many of our activities cut across the three science themes of AntClim21: quantification of Antarctic climate variability; climate model evaluation for the Antarctic region and Antarctic climate projections to 2100 AD and beyond.

Key activities are as follows:

1. The third AntClim21 workshop SCAR2016 in Kuala Lumpur on climate model evaluation for improved climate projections of 21<sup>st</sup> century Antarctic and Southern Ocean climate change.
2. The Steering Committee has been expanded to improve links with two key activities of World Climate Research Programme (WCRP): Climate and the Cryosphere (CliC) and the Polar Coordinated Regional Climate Downscaling Experiment (CORDEX).
3. In 2016 new Chief Officer Tom Bracegirdle.
4. A number of high impact papers have been published.
5. Publication of diagnostics of the mid-latitude circumpolar Southern Hemisphere westerlies at the NCAR/UCAR Climate Data Guide.
6. A major international workshop, the #GreatAntarcticClimateHack (#GACH) was held in San Diego, USA, in October 2017
7. Plans for the POLAR2018 meeting in Davos including a two-day workshop (Past2Projections) and a session in the Open Science Conference.

## Recommendations

None

## Summary Budget 2017 to 2020

|        | 2017   | 2018                  | 2019    | 2020    |
|--------|--------|-----------------------|---------|---------|
|        | Spent  | Allocated             | Request | Request |
| (US\$) | 22,727 | 33,440<br>(remaining) | 21,000  | 21,000  |



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|---------------------|----------------------------|
| SDM                 | 08                         |
| Agenda Item:        | 4.1.1                      |
| Person Responsible: | T<br>Bracegirdle<br>et al. |

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

### Progress and Plans

#### Major Outcomes

1. **Lee et al., 2017, Nature** - One of the most significant outcomes of AntClim21 research on improved climate projections was the cross disciplinary collaboration that resulted in a Nature Article in 2017 (Lee et al., 2017). This paper quantifies the expansion of ice-free habitats in Antarctica under future climate change scenarios and discusses the implications for biodiversity in these regions. The processing and interpretation of the climate model data on future Antarctic climate change for the benefit of cross-disciplinary research is a key aspect of the AntClim21 programme and this paper is an excellent example of this.
2. **Bracegirdle et al, 2018, Journal of Climate** - Discussions at the 2016 AntClim21 workshop in Kuala Lumpur on climate model evaluation for future projections provided the initial idea for this paper. The future change of winds over the Southern ocean is a hugely important topic and this paper identifies a possible key reason why different climate models exhibit a wide range of different changes in the strength of circumpolar westerlies by the year 2100. The major result of this paper is that the reliability of climate model projections of the westerly winds over the Southern Ocean is correlated with their performance at representing sea ice conditions of the present day. This provides a possible route towards reducing the uncertainty in information on wind changes derived from large datasets of output from multiple different climate models, such as those that feed into Intergovernmental Panel on Climate Change (IPCC) reports. It also highlights the importance of interactions between the Southern Ocean and the atmosphere in influencing future climate change in the region.
3. **The creation of a cross a cross-disciplinary community of Antarctic and Southern Ocean scientists research interests relating to climate change and its impacts.** Through our workshops, conference sessions and various other tools such as a mailing list, AntClim21 has steadily built up a diverse network of scientists working on various aspects of Antarctic climate change. Through the novel use of new technology we were able to include 50% remote participation at the #GACH workshop, which opened up opportunities for scientists less able to travel (e.g. due to being early career, having family commitments and working in emerging Antarctic or developing nations). As part of developing this community, we can move beyond providing climate information to non-specialists, but help to empower them to conduct initial investigations from existing climate datasets and also feed their needs back to model developers to help ensure that relevant diagnostics and outputs are provided routinely for impacts studies. Specifically, the #GACH workshop identified community-defined variables that should be provided as routine diagnostics to improve the productivity and widen the scientific scope of Antarctic scientists.

#### Notable Papers

1. *Bracegirdle, T. J., P. Hyder, and C. R. Holmes, 2018: CMIP5 diversity in southern westerly jet projections related to historical sea ice area; strong link to strengthening and weak link to shift. J. Clim., 31, 195–211.*



SDM 08  
Agenda Item: 4.1.1  
Person Responsible: T  
Bracegirdle et al.

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

- The idea for this paper came from discussions at the 3<sup>rd</sup> AntClim21 workshop in Kuala Lumpur.
- Contributes to both Theme 2 (Climate model evaluation) and Theme 3 (improved 21<sup>st</sup> century projections).
- 2. *Gutt et al. (2018) Cross-disciplinarity in the advance of Antarctic ecosystem research. Marine Genomics, 37, 1-17. 10.1016/j.margen.2017.09.006.*
  - AntClim21 jointly funded the workshop from which this publication was produced.
  - This paper contributes to Theme 3 on Antarctic climate projections.
- 3. *Griffiths, H. J., A. J. S. Meijers, and T. J. Bracegirdle, 2017: More losers than winners in a century of future Southern Ocean seafloor warming. Nature Climate Change, 7, 749-755.*
  - This paper represents a collaboration between AntClim21 (Bracegirdle) and AntEco (Griffiths).
  - Contributes to Theme 3.
- 4. *Kahn, A., J. L. Russell and T. J. Bracegirdle. A multi-disciplinary evaluation of Earth system model performance for Antarctica and the Southern Ocean, Eos, in press.*
  - This report on the #GACH workshop is designed to advertise to a wide audience.
  - Contributes to AntClim21 Theme 2.
- 5. *Lee et al. (Nature, 2017, doi: 10.1038/nature22996)*
  - AntClim21 funded attendance at meetings where this work was developed and discussed, in particular SCAR2016 in Kuala Lumpur.
  - Contributes to AntClim21 Theme 3.
- 6. *Mayewski et al. (Quaternary Science Reviews, 2017, doi: 10.1016/j.quascirev.2016.11.017)*
  - AntClim21 dependent since many of the key ideas drew from earlier AntClim21 workshops and large part of the publication fees were contributed by AntClim21.
  - Helps to understand past Antarctic climate variability (Theme 1), which is an important part of improving the quantification of possible future climate trajectories and aligns with the AntClim21 goal of improving projections to 2100 (Theme 3).
- 7. *Bertler, N. A. N et al.: The Ross Sea Dipole – temperature, snow accumulation and sea ice variability in the Ross Sea region, Antarctica, over the past 2700 years, Clim. Past, 14, 193-214, https://doi.org/10.5194/cp-14-193-2018, 2018.*
  - Not directly dependent on AntClim21.
  - Contributes to Theme 1.
- 8. *Russell, J. L., Kamenkovich, I., Bitz, C., Ferrari, R., Gille, S. T., Goodman, P. J., Hallberg, R., Johnson, K., Khazmutdinova, K., Marinov, I., Mazloff, M., Riser, S., Sarmiento, J. L., Speer, K., Talley, L. D. and Wanninkhof, R. (2018), Metrics for the Evaluation of the Southern Ocean in Coupled Climate Models and Earth System Models. J. Geophys. Res. Oceans. Accepted Author Manuscript. . doi:10.1002/2017JC013461*



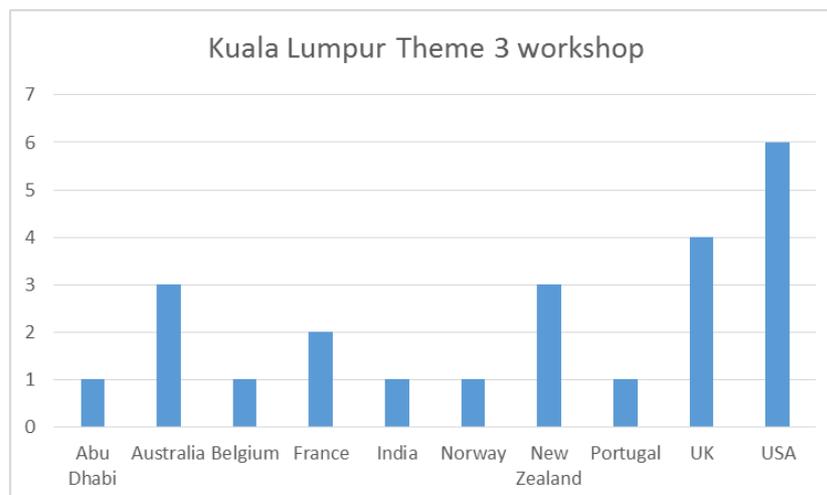
SDM 08  
Agenda Item: 4.1.1  
Person Responsible: T  
Bracegirdle et al.

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

- Not directly dependent on AntClim21.
  - Highly relevant to Theme 2 on model evaluation.
9. Stenni, B., et al. (2017) *Antarctic climate variability at regional and continental scales over the last 2,000 years.*, *Climate of the Past Discussions*, cp-2017-40, *Special Issue: Climate of the past 2000 years: global and regional syntheses and Thomas, E. R., et al.: Regional Antarctic snow accumulation over the past 1000 years*, *Climate of the Past*, 13, 1491-1513, <https://doi.org/10.5194/cp-13-1491-2017>, 2017
- Not directly dependent on AntClim21, contributes to Theme 1.
10. Turner et al. (*Nature*, 2016, doi: 10.1038/nature18645)
- Not directly AntClim21 dependent.
  - Helps to understand past Antarctic climate variability (Theme 1).
11. Emile-Geay, J. et al. (2017), *A global multiproxy database for temperature reconstructions of the Common Era*, *Nature - Scientific Data*, Vol. 4, Article number: 170088 (2017); doi:10.1038/sdata.2017.884
- Not directly AntClim21 dependent
  - Includes many of AntClim21 records and supports community effort to provide a quality assessed data set of temperature reconstructions for the past ~2,000 years.
  - Contributes to Theme 1

#### Main Activities

**The 3<sup>rd</sup> AntClim21 workshop at SCAR 2016 in Kuala Lumpur** - this workshop was focussed on Themes 2 and 3, climate model evaluation and Antarctic climate projection to 2100. It was well attended and brought together a range of disciplines to provide broad perspectives on priorities for the evaluation of climate models.



**Fig. 1. Bar chart of country of employment of participants at the Theme 3 workshop in Kuala Lumpur.**



SDM 08  
Agenda Item: 4.1.1  
Person Responsible: T  
Bracegirdle et al.

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

Key variables for model evaluation were identified across a range of variables in ocean, atmosphere, ice and ecosystems.

**#GreatAntarcticClimateHack.** *Funded mainly by SCAR AntClim21. October 10 – 14, 2017 in La Jolla, CA at the Scripps Institution of Oceanography.*



Comprehensive Earth system models (ESMs) and climate models are the main tools available for quantitative projections of future climate change. The evaluation of climate models at mid-to-high southern latitudes is challenging due to the sparseness and uncertainties in climate reconstructions of present-day climate. This limits the evaluation of ESMs and therefore the degree by which they can be relied on to produce accurate projections of future climate.

The #GACH workshop was aimed discussing and deciding on metrics to help evaluate and thus improve the next generation of IPCC projections with a focus on ESM outputs for Antarctica and the Southern Ocean. Attendees included experts in oceanography, glaciology, atmospheric research, aquatic biogeochemistry, and biology working on past reconstructions, modern observations and future projections. The range of participants included researchers from more than 17 countries and a high proportion of early career scientists (29 from 92).

The workshop was aimed at producing a community-agreed ensemble of metrics that were prioritised using a bottom-up approach of allowing contributors from different disciplines to identify key aspects of model evaluation linked specifically to relevance in their area of expertise. In-depth sessions were conducted on the atmosphere, ocean, sea ice, ice sheets, paleo reconstructions, ecosystems and biogeochemistry. Following on from the workshop, discussions are ongoing with regard to defining tools for implementing the metrics.

This workshop was particularly timely, since data are due to become available from the World Climate Research Programme's Climate Model Intercomparison Project Phase 6 (CMIP6) this year (2018). CMIP6 will provide a major part of the data for analysis that will feed into upcoming IPCC reports including the upcoming Sixth Assessment Report (AR6). A major step forward compared to previous CMIP exercises is that routine benchmarking of each model will be conducted alongside the release of data from each model. A contributor to this advance is the Earth System Model eValuation Tool (ESMValTool). A subset of the metrics identified at the #GACH workshop are planned to be implemented as part of an Antarctic and Southern Ocean contribution to ESMValTool. Key metrics identified are: winds over Antarctica and the Southern Ocean (katabatics, wind stress curl); speed and strength of the Ross and Weddell Sea gyres; ocean pH; Southern Ocean water masses; and



|                     |                         |
|---------------------|-------------------------|
| <b>SDM</b>          | <b>08</b>               |
| Agenda Item:        | 4.1.1                   |
| Person Responsible: | T<br>Bracegirdle et al. |

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

variability and growth and production of sea ice. Overall it is hoped that this activity will raise the standard of model evaluation by helping a broader range of researchers participate in CMIP6 analysis and access diagnostics more relevant to their science needs.

### Finalization Activities

One of our key aims of meeting at POLAR2018 is to plan activities for SCAR 2020, therefore detailed plans will become available then. At this stage our aim is to include the following:

- A session on 21<sup>st</sup> century climate change from CMIP6 Earth System Models at the Open Science conference.
- A workshop/event to showcase our main findings and products and explain them to the SCAR community.

### Expected Final Outcomes

**Paper on Antarctic climate projections from CMIP6** - It has now been over 10 years since Bracegirdle et al. (2008) was published. This paper summarised the broad-scale 21<sup>st</sup> century Antarctic climate change of the main atmospheric variables (temperature, precipitation, wind, sea ice) and circulation patterns (Southern Annular Mode, Semi-annual Oscillation). The paper has been widely cited in studies across different disciplines in the SCAR community and beyond. However, output from new climate model experiments as part of CMIP6 will be available this year. This provides an opportunity to refine the analysis of Bracegirdle et al. with the most up-to-date science and modelling advances. This CMIP6 dataset will be a major part of the science input for the next full IPCC Assessment Report (AR6) and therefore such a study would potentially have wide impact. In addition to incorporating advances in science and modelling capabilities, this paper would also be produced as more of a community-led exercise than Bracegirdle et al. (2008) both in terms of the variables chosen for analysis and the authorship contributions. This will utilise the community recommendations and researcher network of the 3<sup>rd</sup> workshop (at SCAR 2016 in Kuala Lumpur) and 4<sup>th</sup> workshop (#GACH in 2017). The target timeline is to submit this manuscript during 2019 as an original science contribution to a major peer review journal. The authorship will largely be created from the community of Antarctic researchers developed by AntClim21.

*Full reference: Bracegirdle, T. J., Connolley, W. M., & Turner, J. (2008), Antarctic climate change over the twenty first century, J. Geophys. Res. - Atmos., 113(D3), doi: 10.1029/2007jd008933.*

**Community diagnostics for Earth System Model evaluation** - A large proportion of the current generation of climate models can be classed as earth-system models (ESMs), whereby in addition to the well-established coupled dynamical representation of the atmosphere and ocean, they include representations of the global carbon cycle, dynamic vegetation, atmospheric chemistry, ocean bio-geo-chemistry and even continental ice sheets. As the complexity of these ESMs



**SDM**                    **08**  
 Agenda Item:            4.1.1  
 Person                    T  
 Responsible:            Bracegirdle  
                                  et al.

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

increases, so does the complexity of their analysis and evaluation. Key questions across a range of variables are:

- Which variables should be used to define the skill of ESMs in representing Antarctic and Southern Ocean climate system?
- How do we make the best use of the range of observational and longer-term proxy climate data available for Antarctic ESM evaluation?
- How do we select which are the best performing models for climate projections of future change?

These are difficult questions with a range of answers that depend, for example, on the scientific discipline and the specific question being addressed by the use of ESM output. The multi-disciplinary activities and workshops are therefore crucial to developing comprehensive community-led answers to these questions that will be of use to the Antarctic science community and also have influence on the diagnostic choices made by ESM developers and data curators. A key goal of AntClim21 is to develop a set of ESM community-agreed diagnostics and recommendations for the evaluation of ESMs focussed on the above questions. Further, for broader dissemination and impact, efforts are currently being made by AntClim21 to have key diagnostics included in major diagnostic tools and datasets, such as ESMValTool and the Climate Data Guide.

#### Significant Deviations from the Implementation Plan

None

## Budget

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

| Year (YYYY) | Purpose/Activity                                    | Amount (in USD) | Contact Name    | Contact Email  |
|-------------|---|-----------------|-----------------|--|
| 2018        | POLAR2018 Past2Projections workshop                 | \$20,000        | Tom Bracegirdle | <a href="mailto:tjbra@bas.ac.uk">tjbra@bas.ac.uk</a> |
| 2018        | POLAR2018 Delegates meeting                         | \$1,000         | Tom Bracegirdle | <a href="mailto:tjbra@bas.ac.uk">tjbra@bas.ac.uk</a> |
| 2018        | Joint AntClim21/CLIVASH workshop                    | \$5,000         | Tom Bracegirdle | <a href="mailto:tjbra@bas.ac.uk">tjbra@bas.ac.uk</a> |
| 2018        | Publication fees                                    | \$2,000         | Tom Bracegirdle | <a href="mailto:tjbra@bas.ac.uk">tjbra@bas.ac.uk</a> |
| 2019        | Planning/writing meeting for 2100/synthesis paper   | \$10,000        | Tom Bracegirdle | <a href="mailto:tjbra@bas.ac.uk">tjbra@bas.ac.uk</a> |
| 2019        | Publication fees                                    | \$2,000         | Tom Bracegirdle | <a href="mailto:tjbra@bas.ac.uk">tjbra@bas.ac.uk</a> |
| 2019        | Conference attendance (e.g. aCMIP6-related meeting) | \$2,000         | Tom Bracegirdle | <a href="mailto:tjbra@bas.ac.uk">tjbra@bas.ac.uk</a> |
| 2020        | SCAR 2020 activities                                | \$15,000        | Tom Bracegirdle | <a href="mailto:tjbra@bas.ac.uk">tjbra@bas.ac.uk</a> |



SDM 08  
Agenda Item: 4.1.1  
Person Responsible: T  
Bracegirdle et al.

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

### Briefly describe what the funds will be used for and the desired results

For the above meetings and workshops the majority of funds will be used to support travel and accommodation of attendees. The 2018 publication fees are to support a publication relating to #GACH and the 2019 publication fees are to support the updated “2100” Antarctic climate projections paper.

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

2018: 20%  
2019: 20%  
2020: 20%

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

2018: 10%  
2019: 20%  
2020: 20%

## Linkages

### Direct support from outside organisations

1. University of Arizona for travel to #GACH for Joellen Russell and several participants (about \$6,000).
2. University of Arizona for in-kind for #GACH as follows: technical support; promotional material; online course management, cloud computing, teleconferencing equipment.
3. Natural Environment Research Council / British Antarctic Survey (\$2,500) for travel support of Tom Bracegirdle to #GACH
4. Antarctic Research Centre, Victoria University for travel support for N. Bertler to attend #GACH (\$3,500) and PAIS Meeting (as AntClim21 representative) in Trieste (\$4,000)

### Major collaborations

#### Within SCAR

- PAIS, AntERA, Serce, AntEco
- ACCE
- SCATS
- SOOS
- READERS (Met, Ice, Ocean)
- Quantarctica

#### Outside SCAR

- IPCC: Gerhard Krinner (AntClim21 Steering Committee member) and Nick Golledge (AntClim21 member) will be a lead authors on AR6 and Rob DeConto (member) is a lead author on the 1.5C report.



SDM 08  
 Agenda Item: 4.1.1  
 Person Responsible: T  
 Bracegirdle et al.

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

- World Meteorological Organization (CMIP, Greenhouse Gas Bulletin)
- SOCCOM
- ESMValTool

## Outreach and Capacity Building

### Outreach

1. Eastbourne Kea Scouts visited Ice Core Facility: Nancy Bertler hosted 20 Scouts and their parents to the ice core facility to learn about Antarctic climate change research including international efforts such as AntClim21. 7 August 2017.
2. N.Bertler gave a public presentation at the War Memorial Hutt City Library (23 March, 2018) on 'Future Sea Level Rise and Implications for New Zealand' which highlighted the work by AntClim21, attended by ~50 participants
3. Eos Arcticle (Kahn, A., J. L. Russell and T. J. Bracegirdle. A multi-disciplinary evaluation of Earth system model performance for Antarctica and the Southern Ocean, Eos, in press.), since this is aimed at a general-interest wide audience.
4. *New Zealand Herald*, 05 Nov 2017, interview by Jamie Morton with Nancy Bertler, Richard Levy, Jocelyn Turnbull, Alarming climate report bodes badly for Paris goals - NZ scientists.  
[http://www.nzherald.co.nz/nz/news/article.cfm?c\\_id=1&objectid=11940654](http://www.nzherald.co.nz/nz/news/article.cfm?c_id=1&objectid=11940654))

### Media

5. *95 bfm Radio*; 14 July 2017, interview by Laura Kvigstad with Andrew Mackintosh and Nancy Bertler on Ice Ice Broken - implications of the one trillion tone iceberg that calved off the Antarctic Peninsula. (<http://www.95bfm.com/bcast/ice-ice-broken>)
6. *National Radio*, Interview Blog by Jacob McSweny with Nancy Bertler on 'Huge new climate database charts 2000 years of temperature', 12 July 2017, (<http://www.radionz.co.nz/news/national/335001/huge-new-climate-database-charts-2000-years-of-temperatures>)
7. *TVNZ Breakfast*, 12 July 2017, Interview by Jack Tame with Nancy Bertler on 'Climate Data Treasure Chest'

### Capacity building

8. AntClim21 provided a travel grant for early-career participation at the Past2Projections workshop at POLAR2018 in Davos.
9. Of the 92 #GACH participants, 29 were early career researchers.

### SCAR Fellowship Reviewers

| First Name | Last Name   | E-mail   | Principal Expertise               |
|------------|-------------|--|-----------------------------------|
| Nancy      | Bertler     | <a href="mailto:Nancy.Bertler@vuw.ac.nz">Nancy.Bertler@vuw.ac.nz</a> | Paleoclimate Reconstructions      |
| Tom        | Bracegirdle | <a href="mailto:tjbra@bas.ac.uk">tjbra@bas.ac.uk</a>                 | Polar meteorology and climatology |



SDM 08  
 Agenda Item: 4.1.1  
 Person Responsible: T  
 Bracegirdle et al.

## 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 |
|--------------------------|------------|-------------|-----------------------------------|-------------|--|---|---------------------|
| Chief Officer            | Tom        | Bracegirdle | BAS                               | UK          | <a href="mailto:tjbra@bas.ac.uk">tjbra@bas.ac.uk</a>                       | From Oct-2016 (SC Theme Leader 2012-2016) | 2020                |
| Theme 1 leader           | Paul       | Mayewski    | University of Maine               | USA         | <a href="mailto:Paul.Mayewski@maine.edu">Paul.Mayewski@maine.edu</a>       | 2012                                      | 2020                |
| Theme 2 leader           | Nancy      | Bertler     | Victoria University of Wellington | New Zealand | <a href="mailto:Nancy.Bertler@vuw.ac.nz">Nancy.Bertler@vuw.ac.nz</a>       | From Oct-2016 (Chair 2012-2016)           | 2020                |
| Theme 3 Leader           | Joellen    | Russell     | University of Arizona             | USA         | <a href="mailto:jrussell@email.arizona.edu">jrussell@email.arizona.edu</a> | 2012                                      | 2020                |
| SC member                | Marilyn    | Raphael     | University of California          | USA         | <a href="mailto:Raphael@geog.ucla.edu">Raphael@geog.ucla.edu</a>           | 2017                                      | 2020                |
| SC member                | Gerhard    | Krinner     | CNRS                              | France      | <a href="mailto:Gerhard.krinner@cnrs.fr">Gerhard.krinner@cnrs.fr</a>       | 2017                                      | 2020                |
| *Early-career/APECS Rep. | Alia       | Khan        | University of Colorado - Boulder  | USA         | <a href="mailto:Alia.khan@colorado.edu">Alia.khan@colorado.edu</a>         | 2012                                      | 2020                |

*\*Early Career Scientists*

#### Other members

| Name                 | Affiliation                   | Country     | Email  |
|----------------------|-------------------------------|-------------|--|
| Ainley, David        | Harvey Ecology                | USA         | <a href="mailto:dainley@harveyecology.com">dainley@harveyecology.com</a>                             |
| Birkel, Sean         | University of Maine           | USA         | <a href="mailto:sbirke61@maine.edu">sbirke61@maine.edu</a>   |
| Bodeker, Greg        | Bodeker Scientific            | New Zealand | <a href="mailto:greg.@bodekerscientific.com">greg.@bodekerscientific.com</a>                         |
| Bowman, Jeff         | UCSD                          | USA         | <a href="mailto:jsbowman@ucsd.edu">jsbowman@ucsd.edu</a>   |
| Carleton, Andrew     | Pennsylvania State University | USA         | <a href="mailto:amc7@psu.edu">amc7@psu.edu</a>   |
| Catherine Ritz       | LGGE                          | France      | <a href="mailto:Catherine.ritz@lgge.obs.ujf-grenoble.fr">Catherine.ritz@lgge.obs.ujf-grenoble.fr</a> |
| Chown, Steven        | Monash University             | Australia   | <a href="mailto:Steven.Chown@monash.edu">Steven.Chown@monash.edu</a>                                 |
| Comiso, Joey         | NASA                          | USA         | <a href="mailto:Josefino.c.comiso@nasa.gov">Josefino.c.comiso@nasa.gov</a>                           |
| De Santis, Laura     | University of Trieste         | Italy       | <a href="mailto:ldesantis@ogs.trieste.it">ldesantis@ogs.trieste.it</a>                               |
| DeConto, Rob         | University of Massachusetts   | USA         | <a href="mailto:deconto@geo.umass.edu">deconto@geo.umass.edu</a>                                     |
| Ding, Qinghua        | University of Washington      | USA         | <a href="mailto:qinghua@u.washington.edu">qinghua@u.washington.edu</a>                               |
| England, Matthew     | University of New South Wales | Australia   | <a href="mailto:M.England@unsw.edu.au">M.England@unsw.edu.au</a>                                     |
| Escutia, Carlota     | University of Granada         | Spain       | <a href="mailto:escutia@ugr.es">escutia@ugr.es</a>   |
| Ferreira, David      | University of Reading         | UK          | <a href="mailto:d.g.ferreira@reading.ac.nz">d.g.ferreira@reading.ac.nz</a>                           |
| Fogt, Ryan           | Ohio University               | USA         | <a href="mailto:fogtr@ohio.edu">fogtr@ohio.edu</a>   |
| Fogwill, Christopher | University of New South Wales | Australia   | <a href="mailto:c.fogwill@unsw.edu.au">c.fogwill@unsw.edu.au</a>                                     |



SDM 08  
 Agenda Item: 4.1.1  
 Person Responsible: T  
 Bracegirdle et al.

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

|                       |  |             |  |
|-----------------------|--|-------------|--|
| Fyfe, John            | University of Victoria   | Canada      | <a href="mailto:John.Fyfe@ec.gc.ca">John.Fyfe@ec.gc.ca</a>                                     |
| Goodwin, Ian          | Macquarie University   | Australia   | <a href="mailto:ian.goodwin@mq.edu.au">ian.goodwin@mq.edu.au</a>                               |
| Gooseff, Mike         | CU-Boulder   | USA         | <a href="mailto:Michael.Gooseff@Colorado.EDU">Michael.Gooseff@Colorado.EDU</a>                 |
| Gutt, Julian          | AWI  | Germany     | <a href="mailto:Julian.Gutt@awi.de">Julian.Gutt@awi.de</a>                                     |
| Hellmer, Hartmut      | Alfred Wegener Institute   | Germany     | <a href="mailto:Hartmut.Hellmer@awi.de">Hartmut.Hellmer@awi.de</a>                             |
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**Requests to the Secretariat**

None