



2018 WCRP CLiC Annual Report



About CliC

Who we are...

The Climate and Cryosphere Project (CliC) is one of the core projects of the WMO/ISC/IOC World Climate Research Programme (WCRP) (<http://www.wcrp-climate.org>) together with CLIVAR, GEWEX and SPARC. The core projects work closely with the WCRP Joint Planning Staff (JPS) and other working groups of WCRP. The projects organize their work through various focused initiatives, experiments, scientific advisory committees, and panels.

What we do...

The Climate and Cryosphere project encourages and promotes research into the cryosphere and its interactions with the global climate system. It highlights emerging issues, encourages communication between researchers with common interests in cryospheric and climate science, promotes international cooperation, and highlights the importance of this field to policy makers, funding agencies, and the general public. CliC also publishes scientific papers on the role of the cryosphere in the global climate system and recommends directions for future study.

How we work...

The CliC Scientific Steering Group (SSG) is composed of high calibre researchers and has the overall responsibility for planning and guiding the CliC science plan. SSG members are appointed by the WCRP Joint Scientific Committee (JSC), based on recommendations from the CliC SSG. Initial membership is for four years and, as a rule, two extensions of two years each may be recommended. The SSG usually meets once per year.

The CliC International Project Office (IPO) was hosted at the Norwegian Polar Institute in Tromsø, Norway until the end of 2018. Negotiations are currently being held for a new host. The IPO supports the SSG and the CliC community in coordinating and implementing the CliC science projects and tasks. Its functions of international communication and liaison make it the primary point of contact for those wishing to participate in, contribute to, or learn more about CliC activities.

CliC is fortunate to have a large number of leading cryosphere researchers working through regional and national programs, working groups, and expert panels.

Report prepared by Gwénaëlle Hamon with contributions from Fiamma Straneo, James Renwick, Mike Sparrow, Lawrence Hislop, Tin Naish, Sophie Nowicki, David and Denise Holland, Gerhard Krinner, Chris Derksen, Regine Hock, Ben Marzeion, Alexandra Jahn, Dirk Notz, Christina Schaedel, Don Perovich, Marilyn Raphael, Julie Jones, Martin Vancoppenolle, Kazuyuki Saito, Ed Hanna, Riccardo Farneti, Inga Smith, Amy Solomon, John Fyfe, Annette Rinke, John Cassano, Andrew Orr, Günther Heinemann, Fiona Tummon, Michael Karcher, Amélie Bouchat, Sara Aparicio, Letizia Tedesco, Feiteng Wang, Shichang Kang, Heiko Goetzler, Birgit Heim, and Karina von Schuckmann.

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Cover photo courtesy of Lawrence Hislop

Overview from the Co-Chairs

2018 was another exciting and productive year for the CliC community and we are pleased to share this annual report highlighting some of our progress and achievements during the past year. The report also covers the outputs resulting from the WCRP Grand Challenge on “Melting Ice and Global Consequences.”

With an ambitious agenda but using limited resources, CliC had a busy year, including a series of workshops, covering all major components of the CliC Action plan. The year was punctuated by various international conferences, including the SCAR/IASC POLAR2018 in Davos in June where CliC organized pre-meetings and sessions during the Open Science Conference.

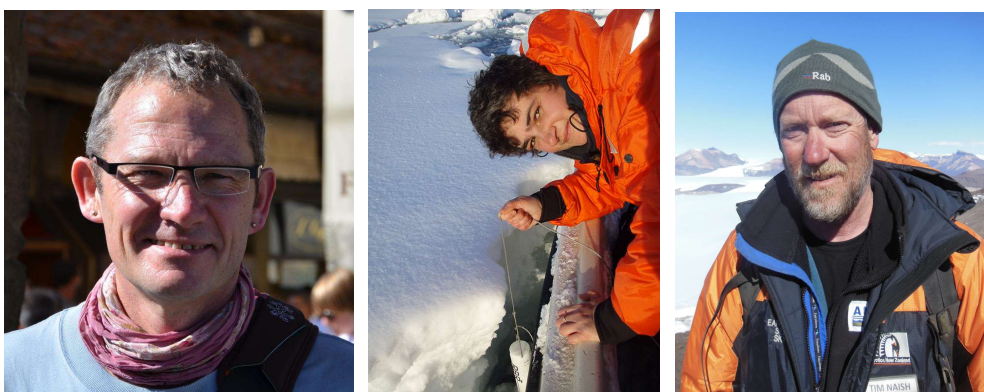
The Grand Challenge “Melting Ice and Global Consequences” (GC) has been moving forward on its initial focus areas. CliC plays an important role in contributing to the GC’s goals by mobilizing the global cryosphere modelling community and supporting the sixth iteration of the WCRP Coupled Model Intercomparison Project (CMIP6). CliC is currently sponsoring model intercomparison projects covering snow, ice sheets, glaciers and sea ice (ESM-SnowMIP, ISMIP6, MISOMIP, GlacierMIP, SIMIP, SCAR-ISMAS). These initiatives are the result of a strategy aimed at tightening the links between the cryospheric research and global modelling communities.

Throughout the year, CliC actively contributed to a number of United Nations and WMO linked initiatives, programs, conferences and events. CliC regularly provides input to the Executive Council Panel of Experts on Polar and High Mountain Observations (EC-PHORS), the Global Cryosphere Watch (GCW) and the Year of Polar Prediction (YOPP). Current and previous SSG-members are also playing active roles the Intergovernmental Panel on Climate Change (IPCC) 6th Assessment Report and Special Report on the Oceans and Cryosphere.

The co-chairs are happy to see the close cooperation between the CliC project office, and the WCRP joint planning staff. The continuous support from the Norwegian Polar Institute to the CliC International project Office from 2003 to 2018 was key in the success of the various CliC activities and is much appreciated by the community.

Word from the new Chair of the WCRP Grand Challenge on Melting Ice and Global Consequences

The WCRP Grand Challenge on Melting Ice and Global Consequences has a new chair, Tim Naish. Tim is a paleoclimatologist from New Zealand with expertise in reconstructing ice sheet dynamics and global sea-level during past warm climates relevant to future projections. He is currently co-chief officer of Scientific Committee on Antarctic Research (SCAR) - Past Antarctic Ice Sheet dynamics (PAIS) project and is leading the development of a new cross-disciplinary SCASR research programme (like a Grand Challenge), called Antarctic Ice Sheets and Sea Level (AISSL). Tim is keen to ensure that as SCAR restructures its strategic research, it is well aligned with WCRP and the Grand Challenge.



From left to right: J. Renwick and F. Straneo, CliC Co-Chairs; T. Naish, GC Chair

Scientific Steering Group (SSG) Members

Chairs

James Renwick, Victoria University of Wellington, New Zealand (1/2017-12/2019)

Fiamma Straneo, Scripps Institution of Oceanography, UCSD, USA (1/2018-12/2020)

Members

Hiroyuki Enomoto, National Institute of Polar Research (NIPR), Japan (1/2016-12/2019)

Shichang Kang, State Key Laboratory of Cryospheric Sciences, Cold and Arid Regions Environmental and Engineering Research Institute, Chinese Academy of Sciences, China (1/2015-12/2019)

Stephen Hudson, Norwegian Polar Institute, Norway (1/2016-12/2019)

Lars H. Smedsrud, University of Bergen, Norway (1/2016-12/2019)

Dario Trombotto Liaudat, Centro Cientifici Tecnológico CONICET Mendoza, Argentina (1/2016-12/2019)

Outgoing Members

Alexandra Jahn, University of Colorado Boulder, USA (1/2014-12/2018)

Sebastian Mernild, Nansen Center, Bergen, Norway (1/2014-12/2018)

WCRP Joint Science Committee Liaisons

Mauricio M. Mata, Federal University of Rio Grande-FURG, Brazil (2014-2018)

Support Team

International Project Office

Lawrence Hislop, Director (2016-2018)

Gwénaëlle Hamon, Executive Officer (2014–present)

WCRP Joint Planning Staff

Mike Sparrow, WCRP Senior Scientific Officer (CLiC Liaison) (2015-present)

The International Project Office

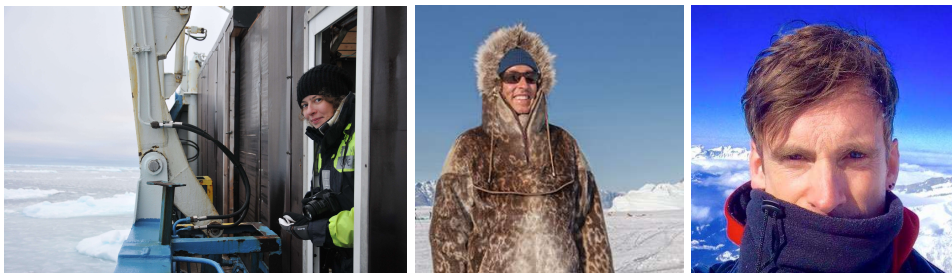
The CliC project office enjoyed another productive year in 2018 with workshops and related events taking place every month of the year. The IPO staff also attended various WCRP events and international meetings.

The project office facilitated 20 workshops throughout the year with total attendance in excess of 400 researchers and the participants coming from over 20 countries and organizations globally. The CliC staff were also fortunate to participate directly in some of these workshops including sessions organized at the SCAR/IASC POLAR2018 Conference in Davos. Attending these meetings helps the IPO link WCRP throughout the cryosphere community and opens networking opportunities and new collaborations with partner organizations.

The CliC website and social media continue to expand rapidly in terms of content and viewership. Our social media feeds on Facebook and Twitter grew again in 2018 (with more than 1950 Likes on Facebook and more than 2900 Followers on Twitter) and we are regularly looking for opportunities to showcase the scientific outputs from our network on partner media channels. CliC also hosted more than 50 online project meetings on its GoToMeeting account.

Links with the other WCRP core project offices are important and we regularly rotate the hosting of online meetings to help coordinate our research more effectively and to manage our activities efficiently. CliC was also represented at the 2018 CLIVAR and GEWEX SSG meetings and at the 2018 WCRP workshop on 'The Earth's Energy Imbalance and its implications (EEI)' and we used the occasions to present CliC's current science plan, recent achievements and prospects for collaboration.

2018 was the last year of the CliC IPO at the Norwegian Polar Institute (NPI). The hosting agreement came to an end after 15 years and the office will move to a new host institution in 2019. Working at NPI offered unique opportunities for collaboration between CliC and many researchers. NPI was an amazing and prestigious work place for several generations of CliC staff and we would like to thank again the whole institute for hosting us. Gwenaelle Hamon, the CliC Executive Officer was hired as a consultant by WCRP to run CliC until it moves later in 2019.



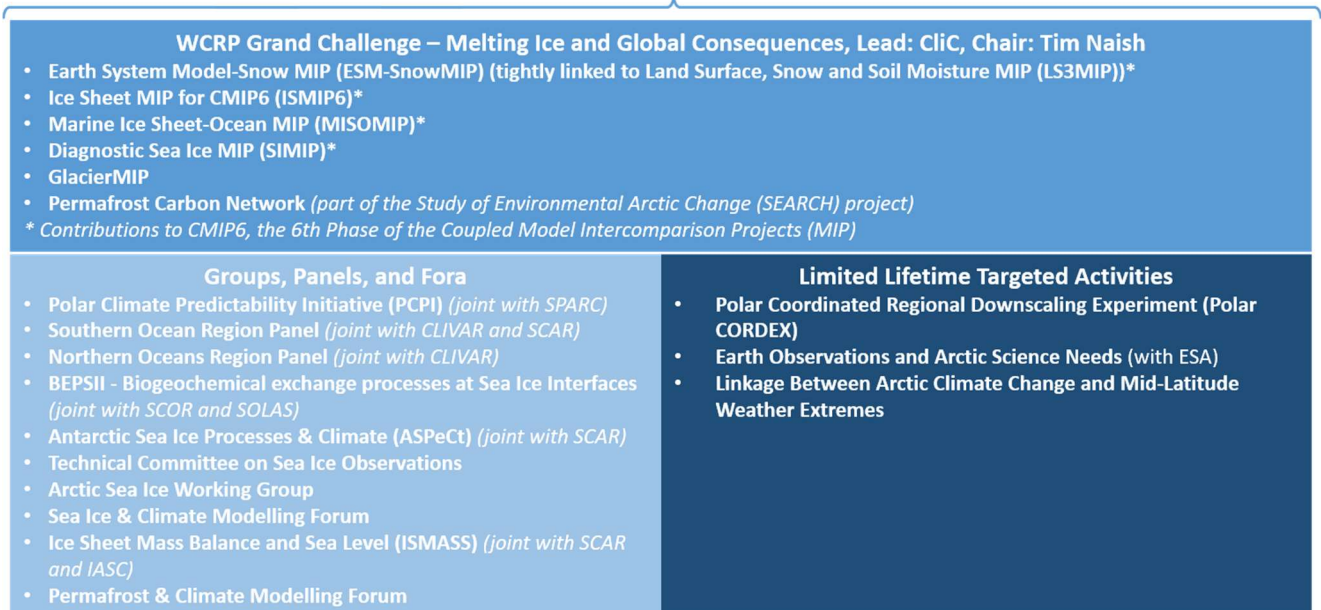
From left to right: G. Hamon, L. Hislop, M. Sparrow

Report Format

The remainder of this report presents the science highlights, publications and future plans of the various projects in the CliC network. Our projects are generally clustered into three activity areas that can be seen in the graphic below. These encompass modelling activities that support the WCRP Grand Challenge on Melting Ice and Global Consequences (contributions to the CMIP6 process), limited lifetime activities that typically have a bounded timespan, and partner projects that CliC co-sponsors with other international organisations. To help present the contributions of these activities we have divided the remainder of this report into the following sections:

- WCRP Grand Challenge - Melting Ice and Global Consequences
- Sea Ice
- Hydrology & Permafrost
- Ice Sheets
- Regional Activities
- Inter-disciplinary Activities

Structure of CliC



WCRP Grand Challenge - Melting Ice and Global Consequences

CliC Contributions to the Intergovernmental Panel on Climate Change (IPCC)

Most activities of the WCRP Grand Challenge on Melting Ice and Global Consequences (ISMIP6, ESM-SnowMIP, SIMIP) contribute to the 6th phase of the WCRP Coupled Model Intercomparison Project (CMIP6). The outcomes of these activities are input to the 5th and 6th Assessment Reports (AR) of the Intergovernmental Panel on Climate Change (IPCC).

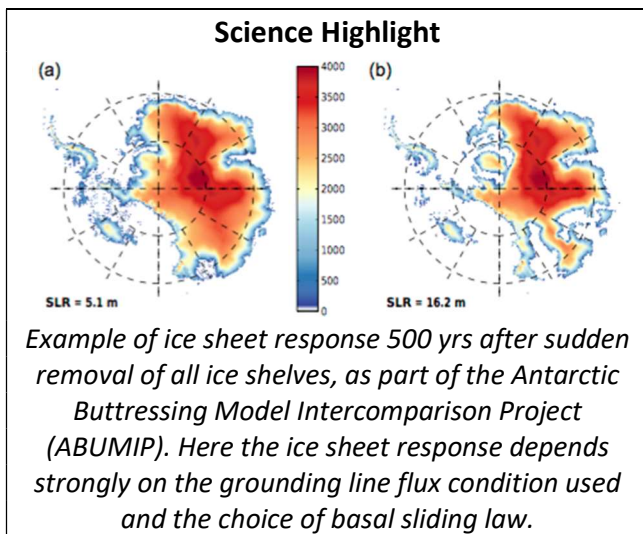
In addition, a number of members of the CliC Leadership are co-authors of the AR6 including CliC Co-chair James Renwick and CliC activities leads Gerhard Krinner (former Co-chair), John Fyfe, Guðfinna Aðalgeirsdóttir, and Dirk Notz.

Other CliC Leadership members are co-authors of the Special Report on the Ocean and Cryosphere in a Changing Climate (SROCC), including CliC SSG members Hiroyuki Enomoto and Shichang Kang, former CliC Co-chair and former Chair of the WCRP Grand Challenge on Melting Ice and Global Consequences Greg Flato, CliC Activities Leads Regine Hock, Ben Marzeion, Chris Derksen, and Ted Schuur.

Ice Sheet Model Intercomparison Project for CMIP6 (ISMIP6)

Introduction

ISMIP6 has the objectives of improving projections of sea level contributed by the Greenland and Antarctic ice sheets, and increasing our understanding of the cryosphere in a changing climate. It maps into the 'Melting Ice and Global Consequences' and 'Regional Sea-level Change' Grand Challenges of the World Climate Research Program. ISMIP6 is an endorsed activity within CMIP6. For more details please visit the website: www.climate-cryosphere.org/activities/targeted/ismip6



2018 Highlights

- 15 modelling groups participated in initMIP-Antarctica, which is led by H. Seroussi
- 12 modeling groups participated in in ABUMIP, which is led by F. Pattyn and N. Golledge.
- Analysis of the initMIP-Antarctica and ABUMIP model simulations.
- Two workshops: Developing process-based projections of the sheets' contribution to future sea level, and annual ISMIP6 PreAGU.
- Formation of focus groups to prepare forcing dataset for ice sheet models, but also to develop new strategies for implementations of atmospheric and oceanic forcing in ISM. The focus groups are interdisciplinary: ice sheet, ocean and atmospheric modelers work together.
- Series of webinars in the Fall 2018 to present the experimental protocol.

- Presentations at EGU, Polar2018, AGU and WCRP SL GC Meeting.

2018 Publications

Goelzer, H., et al.2018: Design and results of the ice sheet model initialization experiments initMIP-Greenland: an ISMIP6 inter-comparison, *The Cryosphere*, [doi:10.5194/tc-12-1433-2018](https://doi.org/10.5194/tc-12-1433-2018).

Plans for 2019 and beyond

- Publications of the initMIP-Antarctica and ABUMIP results.
- Preparation of forcing dataset for ice sheet models and ice sheet model simulations targeting IPCC AR6.
- Workshops at EGU, AGU and large workshop on evaluation of ISMIP6 simulations and implications for sea level projections.



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Marine Ice Sheet Ocean Model Intercomparison Project (MISOMIP)

Introduction

Global sea-level rise is one of the most discussed potential consequences of global warming. The most uncertain aspect of such future sea-level change has to do with the marine based ice sheets, and particularly that of the West Antarctica Ice Sheet (WAIS). Despite its potential importance, current generation global climate models are unable to simulate sea-level change arising from glacier-ocean interaction.

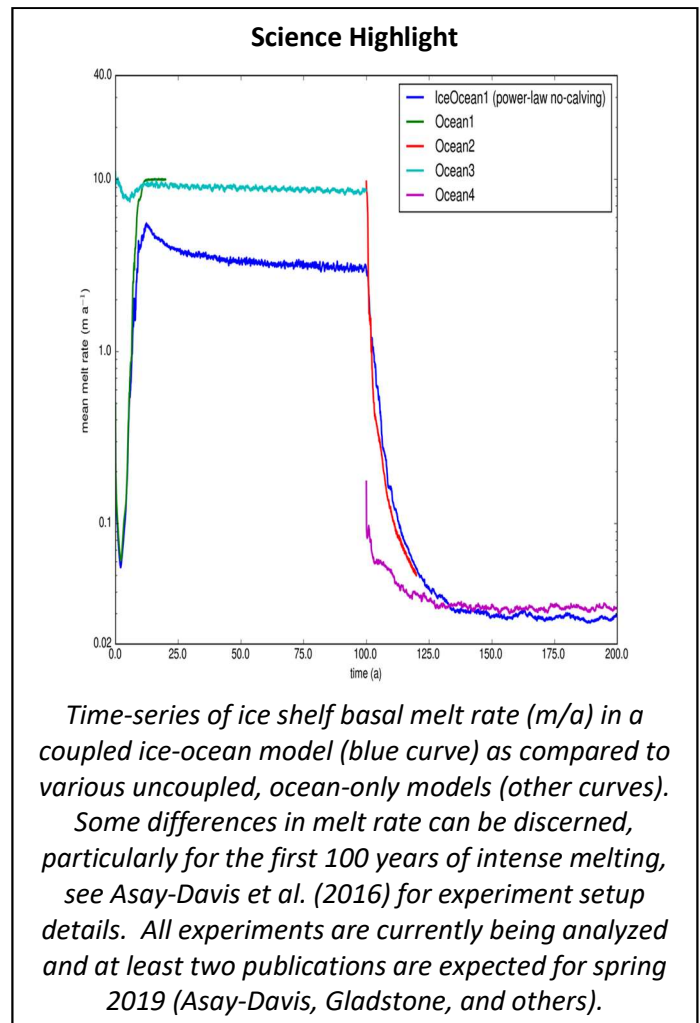
For our third, biennial meeting and as a further step towards remediating this situation, we again brought together the international modeling community with expertise in this area so to advance the state-of-the-art in regional-scale simulations of glacier-ocean interaction. The outcome of this workshop was a review of



progress made since the second workshop and development of new plans towards sustained model intercomparisons. Such a regional-modeling focus continues to build upon the ground work from our second meeting, including discussing appropriate ways to include glacier-ocean interaction in global scale, IPCC class models.

Achievements for 2018

From May 7th to 9th, the CliC project in conjunction with NYU Abu Dhabi, held a third, three-day workshop bringing together a group of approximately 30 international experts on the topic of glacier-ocean interaction and its impact on sea-level rise. Two international graduate students, funded through CliC, were also invited. The workshop was organized by David and Denise Holland.



The three major outcomes of this workshop were: 1) approximately thirty presentations, highlighting the status of ocean-only, ice-only, and coupled ice-ocean numerical experiments (see figure, illustrating one such finding reported at the meeting), 2) planning for a focused, manuscript-writing workshop in spring 2019 to provide key model findings to the community, and 3) a detailed technical report outlining the strategy for future MISOMIP activities, with a focus on realistic, regional simulations in the Amundsen sector or Antarctica.

MISOMIP science management structure consists of two co-chairs, selected by the larger group, one an oceanographer and the other a glaciologist. During the first several years, the co-chair positions have been aptly held by Xylar Asay-Davis and Helene Seroussi. Going forward, the new co-chairs will be Nicolas Jourdain and Jan de Rydt.

Plans for 2019 and beyond

A fourth biennial workshop is planned for Spring 2020 focused on continued implementation of the main findings of the previous workshop, namely: a) advancing disciplinary glacier and ocean modeling intercomparison projects, and b) having these disciplinary projects joined together to advance coupled modeling. The email listserv which was set up as misomip@nyu.edu continues to grow and connect the meeting participants, and other participants who continue to join the project. The broad sweep tentative timeline for activities is:

Project-Start Goals Accomplished:

- Designing/testing the MISOMIP experiments (many groups have already run many of the experiments as part of designing them)
- Deliverable: Experiments defined in a peer-reviewed document: Dr. X. Asay-Davis (GMD) and D. M. Holland and D. Holland (*EOS*).

Mid-Project Goals Now Active:

- Comparison of MISOMIP results between models that have completed the experiments
- Coordinated idealized and regional realistic experiments (using agreed upon region to focus further experiments)
- Deliverable: Papers intercomparing results from MISOMIP

Project-End Goals Upcoming:

- Modeling goal: Provide a set of reference simulations and solutions for model development for future researchers and models

- Science goal: Focus regionally and on processes relating to coupling. Doing perturbations to explore uncertainties or processes.

References for 2018

Asay-Davis, X., S., Cornford, S. L., Durand, G., Galton-Fenzi, B. K., Gladstone, R. M., Gudmundsson, G. H., Hattermann, T., Holland, D. M., Holland, D., Holland, P. R., Martin, D. F., Mathiot, P., Pattyn, F., and Seroussi, H.: Experimental design for three interrelated marine ice sheet and ocean model intercomparison projects: MISOMIP v. 3 (MISOMIP +), ISOMIP v. 2 (ISOMIP +) and MISOMIP v. 1 (MISOMIP1). *Geosci. Model Dev.*, 9, 2471-2497, 2016. <https://doi.org/10.5194/gmd-9-2471-2016>, 2016.

Asay-Davis, X., Adcroft, A., Dinniman, M., Galton-Fenzi, B., Gladstone, R., Goldberg, D., Gwyther, D., Hallberg, R., Hattermann, T., Holland, P., Jordan, J., Jourdain, N., Kusahara, K., Marques, G., Nakayama, Y., Smith, R., Stern, A., and Zhou Q.: Melt rates in ocean models with ice-shelf cavities: results of the second Ice Shelf–Ocean Model Intercomparison Project (ISOMIP+). Manuscript in prep., *The Cryosphere*, 2019.

Asay-Davis, X., R. Gladstone, and MISOMIP1 participants. Results from the first Marine Ice-Sheet and Ocean Model Intercomparison Project. Manuscript in prep., *The Cryosphere*, 2019.

Webpages

<http://www.climate-cryosphere.org/activities/targeted/misomip>
<http://nyuad.nyu.edu/cscl>

Earth System Model-Snow Model Intercomparison Project (ESM-SnowMIP)

Introduction

In past CMIP exercises, land surface processes have not been evaluated separately from the coupled models. In CMIP6, there is now a specific activity aimed at evaluating the quality of the land surface models included in coupled models, called LS3MIP (Land Surface, Snow and Soil moisture Model Intercomparison Project). ESM-SnowMIP is a complementary activity to LS3MIP, focusing on snow and its role in the global climate system. Site-scale simulations at snow measurement sites have been carried out within ESM-SnowMIP and are currently being published as part of an overview paper.

2018 Resulting publications

Krinner, G., Derksen, C., Essery, R., Flanner, M., Hagemann, S., Clark, M., Hall, A., Rott, H., Brutel-Vuilmet, C., Kim H., Ménard, C. B., Mudryk, L., Thackeray, C., Wang, L., Arduini, G., Balsamo, G., Bartlett, P., Boike, J., Boone, A., Chéruy, F., Colin, J., Cuntz, M., Dai, Y., Decharme, B., Derry, J., Ducharne, A., Dutra, E., Fang, X., Fierz, C., Ghattas, J., Gusev, Y., Haverd, V., Kontu, A., Lafaysse, M., Law, R., Lawrence, D., Li, W., Marke, T., Marks, D., Nasonova, O., Nitta, T., Niwano, M., Pomeroy, J., Raleigh, M. S., Schaedler, G., Semenov, V., Smirnova, T., Stacke, T., Strasser, U., Svenson, S., Turkov, D., Wang, T., Wever, N., Yuan, H., and Zhou, W. : ESM-SnowMIP : Assessing models and quantifying snow-related climate feedbacks, *Geosci. Model Dev. Discuss.*, <https://doi.org/10.5194/gmd-2018-153>, in review.

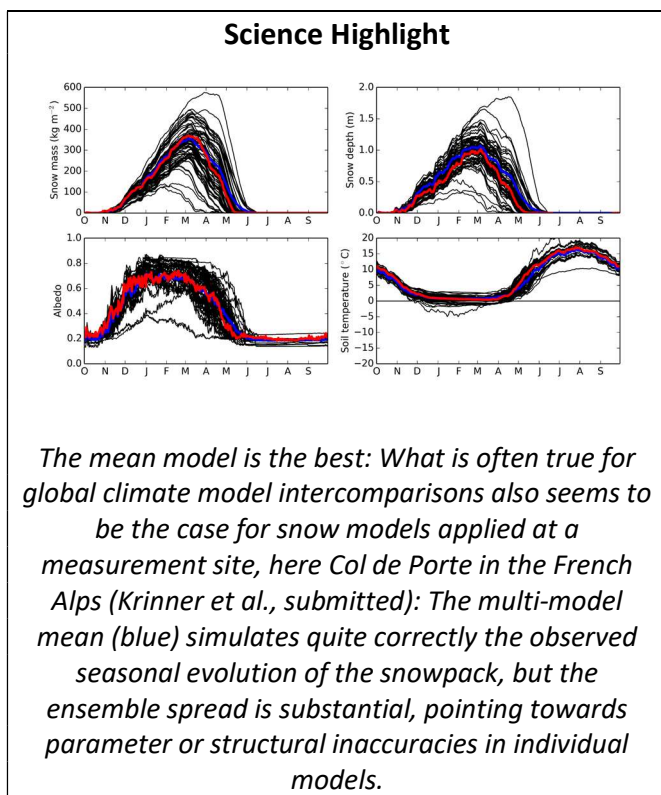
Future activities and developments

In the next year, the LS3MIP global simulations will be run as a part of the CMIP6 exercise, followed by ESM-SnowMIP runs in the following year. In parallel, we are planning a more detailed paper on ESM-SnowMIP site simulations, and a paper describing the site data for future model developments.

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2018 Highlights

In the past year, the reference site simulations defined at snow sites within ESM-SnowMIP have been analysed and described in a recently submitted paper (Krinner et al., submitted). The same paper describes the simulation setup for site-scale sensitivity tests and global simulations planned in ESM-SnowMIP. At the same time, the forcing datasets, in particular the meteorological forcing data, for LS3MIP global offline simulations have been finalized (Kim et al., in prep.), opening the way for the LS3MIP simulations in CMIP6 and complementary ESM-SnowMIP simulations.

GlacierMIP – A model intercomparison of global-scale glacier models

Introduction

GlacierMIP is a model intercomparison project focusing on all glaciers in the world outside the ice sheets. It provides – for the first time – a framework for a coordinated intercomparison of global-scale glacier mass change models, to foster model improvements and reduce uncertainties in global glacier projections. Primary goals are (a) to coordinate a model intercomparison of existing state-of-the-art large-scale glacier models with respect to decadal to century scale glacier mass change projections, and (b) to identify current model deficiencies and data needs, and work towards a new generation of global-scale glacier models that allow more accurate projections

differences in results to either glacier model or climate forcing. Data submission for phase 2 will close on February 15, 2019. The manuscript resulting from phase 2 is scheduled to be submitted in time for the deadline for consideration in the IPCC's AR6.

A GlacierMIP meeting is planned for 2019 but the location is yet to be determined.

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Science Highlight

Global glacier mass loss by 2100 relative to 2015 averaged over all glacier models' multi-GCM means varies from 23±7% (RCP2.6) to 42±11% (RCP8.5) indicating that glaciers will continue to contribute to global sea-level beyond 2100. Regional relative mass changes correlate linearly with relative area changes. Global and regional rates of mass loss show large interannual variations with maximum rates (multi-GCM means, RCP8.5) from three models exceeding 3 mm sea-level equivalent yr⁻¹ around 2080. Projections vary considerably between glacier regions, and also among the glacier models.

2018 Highlights

A paper was submitted to the Journal of Glaciology presenting the results of the model intercomparison of previously published glacier projections. The paper is currently being revised. GlacierMIP results were also presented at several conferences in 2018.

A ½ day GlacierMIP meeting was held the AGU fall meeting in Washington D.C. in December 2018. Almost all participants were able to join the meeting either in person or by skype.

Future activities and developments

In phase 2 of GlacierMIP, the most relevant initial and boundary conditions are harmonized for participating glacier models, allowing a more strict attribution of

Sea Ice and Climate Modeling Forum

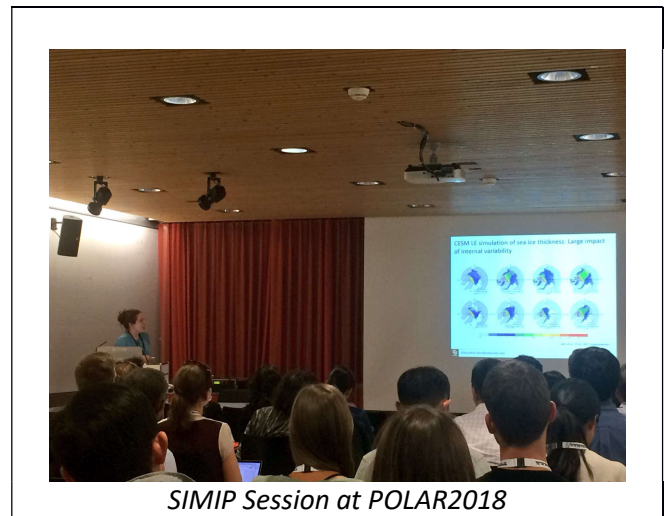
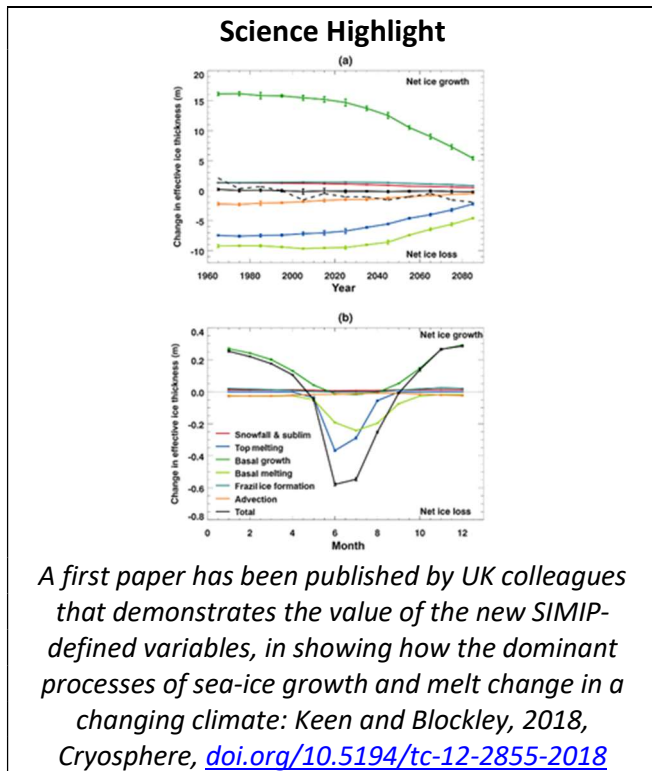
Diagnostic Sea Ice Model Intercomparison Project (SIMIP)

Introduction

The CliC Sea ice and climate modeling forum contributes to a better understanding of the role of sea ice for the changing climate of our planet. This aim is reached through the coordination of large-scale model simulations and the facilitation of conversations between modelers and observers through joint workshops.

Future activities and developments

For 2019, most CMIP6-SIMIP model results are expected to become available. The availability of the data will be closely monitored and its analysis guided through the SIMIP sub groups. In particular, high-profile papers based on SIMIP output will be submitted before the end of 2019, which allows their inclusion into the upcoming IPCC AR6 report. A SIMIP session at IGS Sea Ice in August 2019 will be organized, as well as side discussions on ongoing work with SIMIP colleagues.



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2018 Highlights

Over the past year, further work has been done on preparing the scientific analyses within the CMIP6 sea-ice model intercomparison project (SIMIP). Based on the resulting data call, the upcoming CMIP6 simulations will provide unique insights into the evolution of the polar sea-ice cover. Unfortunately, the start of CMIP6 simulations got delayed, among others because of delays in the availability of forcing scenarios, which also delayed the planned work on analysing CMIP6 output. This means that the SIMIP session at Polar2018 did not have any CMIP6 results. Nonetheless, it was a very successful session that showed new results on progress in the understanding of the evolution of the polar sea ice cover.

Permafrost Carbon Network (PCN)

Introduction

The Permafrost Carbon Network facilitates synthesis of permafrost carbon science and communicates our current understanding to help society respond to a rapidly changing Arctic.

Science Highlight

One science highlight of 2018 is the publication of the second permafrost model intercomparison project in the *Proceedings of the National Academy of Sciences* led by core members of the Permafrost Carbon Network. In this model intercomparison project, changes in permafrost and carbon storage in the northern permafrost region are simulated from 2010 to 2299. The results show that controlling greenhouse gas emissions in the coming decades could substantially reduce the consequences of carbon release from thawing permafrost during the next 300 years.

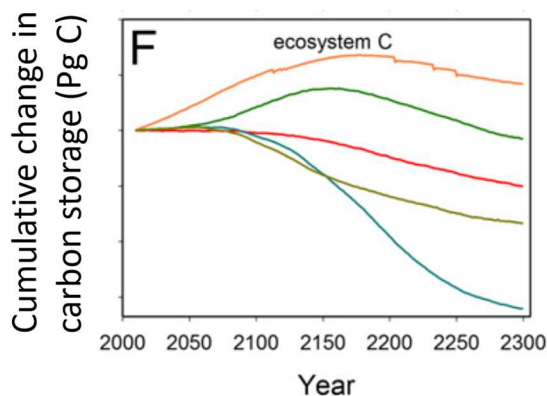


Figure: Changes in simulated ecosystem carbon between 2010 and 2299 for the CCSM4 model RCP8.5 projections. Figure from McGuire et al. 2018

2018 Highlights

The Permafrost Carbon Network hosted two workshops in 2018 on 'Reconciling Historical and Contemporary Trends in Terrestrial Carbon Exchange of the Northern Permafrost-Zone' at the Arctic Data Center and National Center for Ecological Synthesis and Analysis in Santa Barbara, California. This series of two workshops brought together international experts on ecosystem dynamics to synthesize an

observational time series of ecosystem-atmosphere carbon exchange from the 1990s to the present day.

2018 Synthesis publications

McGuire AD et al. (2018) The dependence of the evolution of carbon dynamics in the Northern Permafrost Region on the trajectory of climate change *Proceedings of the National Academy of Sciences*, 115, (15), 3882-3887 <https://doi.org/10.1073/pnas.1719903115>

Lorantý MM et al. 2018 Reviews and syntheses: Changing ecosystem influences on soil thermal regimes in northern high-latitude permafrost regions *Biogeosciences* 15 5287-313. <https://doi.org/10.5194/bg-15-5287-2018>

Future activities and developments

The Permafrost Carbon Network will host its 9th Annual Meeting at AGU in San Francisco, in December 2019. Synthesis leads and co-leads will present updates on synthesis activities and smaller breakout discussions will focus on individual syntheses as well as new emerging topics.



Attending members of the Permafrost Carbon Synthesis Working Group, March 2018. Credit: Ginger Gillquist

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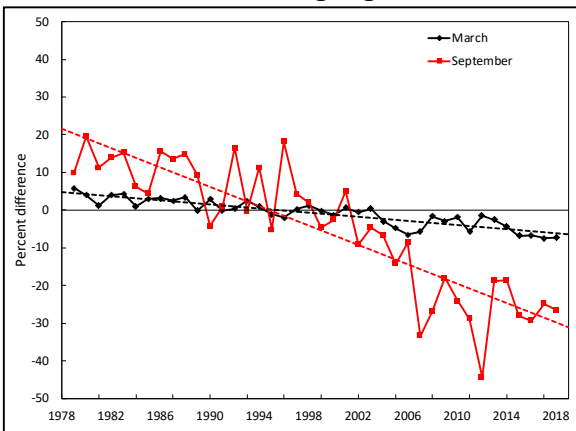
Sea Ice

Arctic Sea Ice Working Group (ASIWG)

Introduction

The goals of the Climate and Cryosphere Arctic Sea Ice Working Group are: i) Develop, standardize, and implement measurement protocols for Arctic sea ice in coastal, seasonal, and perennial ice zones; ii) Integrate surface-based observations with remote sensing and modeling efforts; and iii) Foster connections between international groups involved in sea ice observations, modeling, and remote sensing. The ASIWG has organized workshops, participated in programs, and produced documents addressing these goals.

Science Highlight



Time series of ice extent anomalies in March (month of maximum ice extent) and September (minimum). The anomaly for each year is the difference (in %) in ice extent relative to the mean values for the period 1981-2010. Least squares linear regressions are shown for March (2.7% per decade) and September (12.8% per decade).

2018 Highlights

ASIWG members contributed to defining observational protocols for sea ice measurements during the MOSAiC field campaign (Multidisciplinary drifting observatory for the Study of Arctic Climate). ASIWG members contributed to the Sea Ice Section of the Arctic Report Card and to the Sea Ice Prediction Network; organized special sea ice sessions at the Fall Meeting of the American Geophysical Union; and lectured on sea ice at 2018 Polar Prediction School. Ship based sea ice observations were made on science and tourist cruises using the ASSIST software package. Coordination was facilitated between these activities.

2018 Resulting publications

Holland, M. and D. Perovich, 2017. Sea ice summer camp: Bringing together sea ice modelers and observers to advance polar science, *Bull. Amer. Met. Soc.*, doi.org/10.1175/BAMS-D-16-0229.1

Richter-Menge, and others. 2018. The Arctic (in "[State of the Climate in 2017](#)"). *Bull. Amer. Meteor. Soc.* 99.

Gerland and others, Essential gaps and uncertainties in the understanding of the roles and functions of Arctic sea ice, *Envir.Res.Let.*, under review.

Future activities and developments

Ongoing efforts with MOSAiC, the Arctic Report Card, the Sea Ice Prediction Network, ASSIST software, and citizen scientist outreach will continue. An ASIWG meeting is planned for August 2019 in conjunction with an International Glaciological Society sea ice symposium.



Citizen scientists collecting melt pond data at the North Pole, 25 July 2018.

Contact:

Don Perovich, Thayer School of Engineering, Dartmouth College, USA

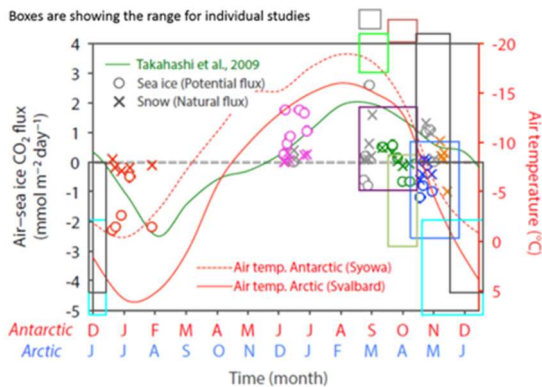
Biogeochemical Exchange Processes at Sea Ice Interfaces (BEPSII)

BEPSII (www.BEPSII.org), coordinates community activities linked to the biogeochemistry of sea ice-influenced environments, with ~120 involved scientists from 15+ countries. BEPSII is endorsed as a SOLAS-CliC forum and as a SCAR Action Group.

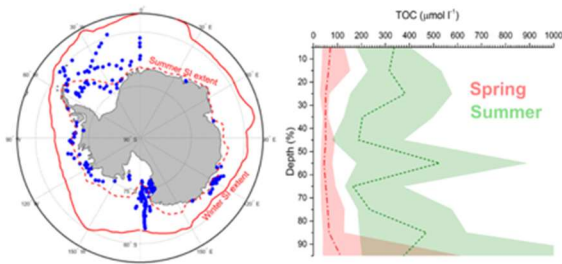
- BEPSII session at IASC/SCAR POLAR2018 conference in Davos (34 contributions)
- ECV-Ice intercalibration experiments on biomass, nutrients, PP (Hokkaido, March), gases (Norwich, fall).
- 5-year activity plan finalized

Science Focus

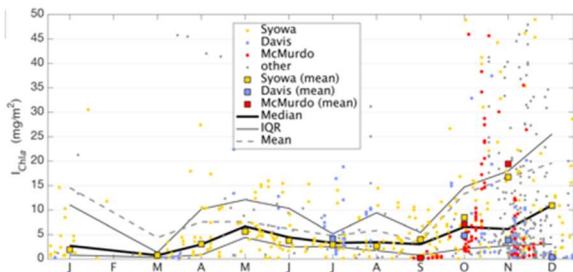
This year, we emphasize new data compilations efforts on sea ice biogeochemical parameters. Such compilation works bridge the gap between process studies and large-scale environmental and climate change studies.



Air-ice CO₂ flux compilation (D. Nomura, University of Hokkaido).



TOC compilation in Antarctic sea ice (F. Deman, Free University of Brussels, F. Fripiat, MPI).



Chl-a compilation from Antarctic fast ice (Meiners, Vancoppenolle et al., JGR 2018)


2018 Highlights

- Joint ECV-Ice - BEPSII Meeting in Davos, Switzerland, June 17, 2018 (~40 participants).



BEPSII workshop attendance @Davos.

2018 Publications

BEPSII [Special feature](#) in  *Elementa: Science of the Anthropocene* finalized (18 accepted contributions).

Future activities and developments

The future activities are being designed, for example:

- Analysis on Arctic sea-ice biogeochemical response to climate change.
- Expert contribution to ongoing discussions on the design of biogeochemistry and ecosystem components of MOSAiC.
- Model intercomparisons (CMIP6, FAMOS, ...)

2019 Agenda

- Annual meeting, Winnipeg, Canada, Aug 16-18, 2019 (before the IGS sea ice conference)
- ECV-Ice gas experiments, Norwich, UK, July, 2019.
- Workshop on Inter-comparison of 1D sea-ice biogeochemical models, May 15-17, 2019, Paris
- Informal Meeting at GRC Polar Marine Science, March 20, 2019, Barga, Italy

CliC BEPSII contacts: Bruno Delille, ULg, Belgium, bruno.delille@ulg.ac.be; Klaus Meiners, UTAS, Australia, klaus.meiners@aad.gov.au; Martin Vancoppenolle, CNRS, Paris, France, martin.vancoppenolle@locean-ipsl.upmc.fr

Antarctic Sea Ice Processes and Climate (ASPeCt)

Introduction

Antarctic Sea ice Processes and Climate (ASPeCt) is an expert group on multi-disciplinary Antarctic sea ice zone research within the SCAR Physical Sciences program. ASPeCt has the key objective of improving our understanding of the Antarctic sea ice zone and its response to climate change. This understanding is to be achieved through focussed field programs, systematic monitoring of the ice cover, analysis of remote sensing and numerical modelling. To this end, in 2017, ASPeCt scientists successfully completed the PIPERS (Polynyas, Ice Production, and seasonal Evolution in the Ross Sea) cruise into the early winter Ross Sea. Funded by the NSF, the cruise was an international effort with ASPeCt scientists from several countries on board making measurements and carrying out experiments. Also, the ASPeCt digital underway ice observation method, version 2 for bridge-based observations was deployed and tested in summer 2016-2017.

2018 Resulting publications

Nakata, K., K. I. Ohshima, S. Nihashi, 2018: Estimation of thin ice thickness and discrimination of ice type from AMSR-E passive microwave data. IEEE Transactions of Geoscience and Remote Sensing PP(99) :1-14

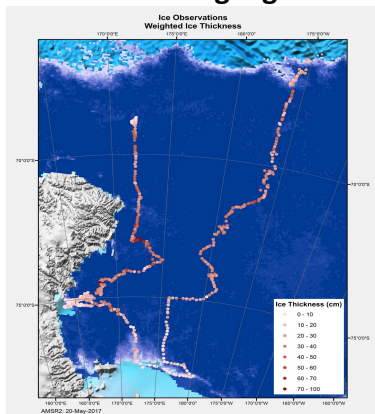
[DOI: 10.1109/tgrs.2018.2853590](https://doi.org/10.1109/tgrs.2018.2853590).

Wongpan, P., K.M. Meiners, P.J. Langhorne, P. Heil, I.J. Smith, G.H. Leonard, R.A. Massom, L.A. Clementson and T.G. Haskell. (2018) Estimation of Antarctic land-fast sea ice algal biomass and snow thickness from under-ice radiance spectra in two contrasting areas. *J. Geophys. Res. Oceans*, <https://doi.org/10.1002/2017JC013711>

Future activities and developments

ASPeCt will hold a workshop at the SCAR 2020 OSC in Hobart, Tasmania. This will be the first full-scale workshop that ASPeCt has had in six years and will highlight the group's achievements as well as establish plans for future group efforts.

Science Highlight



Nathaniel B Palmer PIPERS Cruise Track and Measurement Map 10 April 2017-14 June 2017.

2018 Highlights

ASPeCt's data acquisition strategy has been endorsed for inclusion in YOPP. Data collected by cruises into the ice zone in 2018-2019 will be contributed to the YOPP archives. This will be one of ASPeCt's chief contributions to YOPP.

ASPeCt convened a session (4 well attended sections) on Antarctic sea ice processes and ice shelves status at the SCAR OSC in Davos, Switzerland. Initial reports on the outcomes of the PIPERS cruise were the subject of numerous posters and oral presentations at the SCAR POLAR18 OSC.



ASPeCt scientists who participated in the Side-Meeting at the SCAR OSC in Davos, Switzerland, June 17th 2018.

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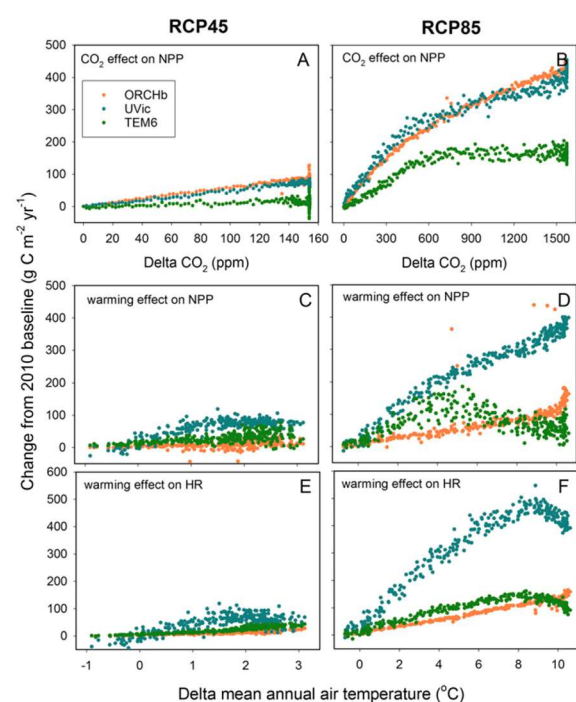
Permafrost

Introduction

The Permafrost & Climate Modeling Forum is an interdisciplinary activity that attempts to represent the modeling of both natural and social processes related to the goals of the Climate and Cryosphere, with frozen ground dynamics modeling as a primary focus. This forum has close ties with Permafrost Carbon Network (PCN), Next-Generation Ecosystem Experiments-Arctic (NGEE), and the Ground Challenge activities (e.g., biogeochemistry).

Science Highlight

Dependence of the evolution of carbon dynamics in the northern permafrost region on the trajectory of climate change by McGuire et al. (2018).



For the RCP4.5 projection, gains in vegetation carbon were largely responsible for the overall projected net gains in ecosystem carbon, while, for the RCP8.5 projection, gains in vegetation carbon were not great enough to compensate for the losses of carbon projected. That substantial net losses of ecosystem carbon would not occur until after 2100 suggests that effective mitigation efforts during the remainder of this century could attenuate the negative consequences of the permafrost carbon–climate feedback.

2018 Highlights

- Past 122-thousand-year frozen ground distribution north of 50°N: Reconstructed advance and retreat (Saito and Machiya, EUCOP2018).

2018 Resulting publications

McGuire et al. Assessing Historical and Projected Carbon Balance of Alaska: A Synthesis of Results and Policy/Management Implications Ecological Applications

[doi: 10.1002/eap.1768](https://doi.org/10.1002/eap.1768).

Parazoo, N. C., Koven, C. D., Lawrence, D. M., Romanovsky, V., and Miller, C. E.: Detecting the permafrost carbon feedback: talik formation and increased cold-season respiration as precursors to sink-to-source transitions, *The Cryosphere*, 12, 123-144, <https://doi.org/10.5194/tc-12-123-2018>, 2018.

Burke EJ et al. CO₂ loss by permafrost thawing implies additional emissions reductions to limit warming to 1.5 or 2 °C. *Environmental Research Letters*, 13, 24024. <https://doi.org/10.1088/1748-9326/aaa138>

Future activities and developments

Mapping and modeling of frozen ground of the Tibetan Plateau (m2TPfg) will work on a synthesis paper targeting to the 2020 ICOP held in Lanzhou.

Contact:

Kazuyuki Maza Saito, JAMSTEC,

ksaito@jamstec.go.jp

A. David McGuire (retired in April), UAF,

adm McGuire@alaska.edu

Ice Sheets

Ice Sheet Mass Balance and Sea Level (ISMASS)

Introduction

The Expert Group on Ice Sheet Mass Balance and Sea Level (ISMASS) is co-sponsored by the Scientific Committee on Antarctic Research, the International Arctic Science Committee (IASC), and the WCRP Climate and Cryosphere Project. The goals of ISMASS are to promote the research on the estimation of the mass balance of ice sheets and its contribution to sea level, to facilitate the coordination among the different international efforts focused on this field of research, to propose directions for future research in this area, to integrate observations and modelling efforts, as well as the distribution and archiving of the corresponding data, to attract a new generation of scientists into this field of research, and to contribute to the diffusion, to society and policymakers, of the current scientific knowledge and the main achievements in this field of science. Further details on the goals of ISMASS can be found in the Terms of Reference at

<http://www.climate-cryosphere.org/activities/groups/ismass>

Science Highlight

Resulting from an ISMASS workshop in Brussels in January 2017, Frank Pattyn and Catherine Ritz led-authored a review paper on the effects of a 1.5degC warmer world on ice sheets (forcing and response), published in Nature Climate Change:

<https://www.nature.com/articles/s41558-018-0305-8>

2018 Highlights

ISMASS organised an international research workshop on Greenland and Antarctic Ice Sheet mass balance - links between observational data and computer model simulations - as part of the POLAR2018 conference in Davos, Switzerland, on 15 June. This included some of the world-leading scientists working in this area. There were two keynote talks: Prof. Tony Payne (University of Bristol) spoke on "Challenges in making useful projections of the future sea-level contributions of ice sheets", while Prof. Andy Shepherd (University of Leeds) gave a very timely rundown of "Satellite observations of ice sheet mass balance". The latter talk was based on a major new research paper on Antarctic Ice Sheet mass balance,

1992-2017, that Prof. Shepherd had lead-published in the journal NATURE the previous day [as a co-ordinator of the second Ice sheet Mass Balance Inter-comparison Exercise (IMBIE2)]. Other talks included the effects on ice sheets of limiting global warming to 1.5degC above pre-industrial levels by 2100 (an unlikely outcome but one that is highly relevant to study for an upcoming interim report of the Intergovernmental Panel on Climate Change). For further details, please see the workshop website at:

<http://www.climate-cryosphere.org/activities/groups/ismass/meetings/1595-ismass-meeting-polar18>



Panel discussion at 15 June 2018 ISMASS workshop at POLAR2018 Davos

2018 Publication

A review paper arising from the January 2017 Brussels workshop is in preparation, intended for submission to *Nature Climate Change*.

Future activities and developments

It is planned to submit a review paper to Earth Science Reviews based on the June 2018 Davos workshop.

Contacts

Chair: Catherine Ritz (catherine.ritz@univ-grenoble-alpes.fr)

Representatives from member organizations are Frank Pattyn (SCAR), Francisco Navarro (IASC) and Edward Hanna (CliC, ehanna@lincoln.ac.uk).

Regional Activities

SCAR/IASC/CliC Southern Ocean Region Panel (SORP)

Panel overview

The Southern Ocean Region Panel (SORP) is cosponsored by the World Climate Research Programme's Climate and Ocean: Variability, Predictability and Change (CLIVAR) and the Climate and Cryosphere (CliC) projects, and the Scientific Committee on Antarctic Research (SCAR). The SORP serves as a forum for the discussion and communication of scientific advances in the understanding of climate variability and change in the Southern Ocean. It advises CLIVAR, CliC, and SCAR on progress, achievements, new opportunities and impediments in internationally-coordinated Southern Ocean research.

Achievements for 2017-18

SORP organized a panel meeting jointly with the Year of Polar Prediction Southern Hemisphere workshop in June, 29-30 2017 (SORP-12) at the National Centre for Atmospheric Research (NCAR) in Boulder, Colorado, USA and a panel meeting alongside the Polar2018 Conference in June, 15-16 2018 (SORP-13) at Davos, Switzerland. During SORP-13, a joint session from SORP and the Northern Oceans Research Panel (NORP) was organized to discuss future collaborations and common research goals.

Extensive participation in international research coordination and collaboration has occurred with several relevant programmes, including the Southern Ocean Observing System (SOOS), the Ocean Observations Panel for Climate (OOCPC) and the Year of Polar Prediction Southern Hemisphere (YOPP-SH).

The panel has two new members (Robin Robertson and David Bromwich) and an ex-officio representative of SOOS (Matt Mazloff).

National reports were obtained from 10 Countries for 2017 (<http://www.clivar.org/clivar-panels/southern/national-representatives>), which allowed SORP to see opportunities for further cooperation in the Southern Ocean.

Besides having an early career scientist among its panel members (F. Massonnet), early career scientists have been recruited for National Representative roles for Belgium, Germany, New Zealand and the UK. These roles are separate to full panel membership, and provide capacity

building by involving more early career scientists in SORP activities than is possible with the strict fourteen member panel membership.



Participants of the CLIVAR/CliC/SCAR SORP13

Plans for 2019 and beyond

During 2019, SORP members will attend OceanObs'19 in Hawaii, USA. A representation of SORP activities will be of particular importance in order to highlight international advances in the understanding of climate variability and change in the Southern Ocean, promote internationally-coordinated Southern Ocean research and the synergetic approach involving Southern Ocean observing and modeling communities including physical oceanography, cryosphere research, atmospheric science and biogeochemical oceanography.

Also, SORP panel members are contributing to two OceanObs'19 Community White Papers. One is drafted together with SOOS members and other Southern Ocean experts, whereas the second one is in collaboration with all CLIVAR SSG members, panel chairs and RF leaders.

In 2020, the fourteenth meeting of the SORP (SORP-14) will be held in conjunction with the SCAR Delegates' Meeting and Open Science Conference (OSC) in Hobart, Australia. Meeting during the SCAR OSC will provide a unique opportunity for organizing sessions and stimulating discussions with SOOS members.

SORP Co-Chairs:

Inga Smith, inga.smith@otago.ac.nz

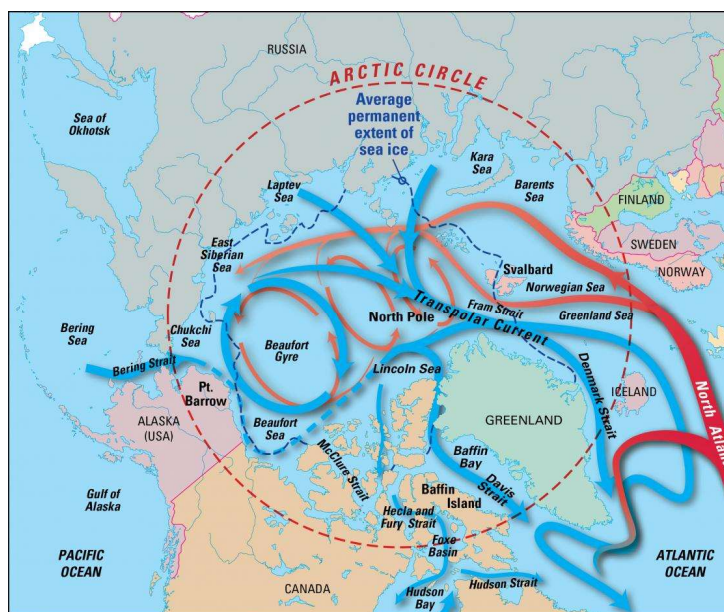
Riccardo Farneti, rfarneti@ictp.it

<http://www.clivar.org/clivar-panels/southern>

CLIVAR /CliC Northern Oceans Region Panel (NORP)

Panel overview

NORP serves as an international forum for coordinating and strategizing activities on the role of the Arctic Ocean in the context of the global climate system from a coupled perspective. NORP facilitates progress in the development of tools and methods to monitor and assess climate variability and change, and evaluate climate predictability of the ocean-atmosphere-ice system in the Arctic and Subarctic Ocean. NORP coordinates efforts to enhance the ability to monitor the coupled system, understand the driving mechanisms of the system change from a coupled process perspective, and predict the evolution of the emerging New Arctic climate. NORP plays a central role in coordinating, monitoring, and evaluating the progress of such activities during and beyond the Year of Polar Prediction..



"Illustration by Jack Cook, Woods Hole Oceanographic Institution"

This image shows the movement of water in the Arctic Ocean. Blue arrows show cold, relatively fresh water and red arrows show warm, salty water that has entered the system from the North Atlantic.

Achievements for 2017-18

NORP was approved by the WCRP JSC on April 3, 2017. The first panel telecon was held on November 27, 2017 and monthly telecons have been held to date.

The 1st session of CLIVAR/CliC NORP was held on 15-16 June 2018, at Congress Centre Davos, Switzerland. NORP is organized into 6 task teams; Arctic ocean reanalyses, Arctic ocean in Arctic amplification, Arctic midlatitude linkages, Anthropogenic and natural forcing, Model errors in Arctic projections, and Greenland ice sheet – ocean interactions. Teams core activities, discussion points, emerging challenges, and deliverables were discussed. Talks to develop coordination with other international groups were presented by Lee Cooper (chair of the IASC Marine Working Group) and Olga Zolina (member of the CLIVAR Climate Dynamics Panel). Scientific presentations were given by Sheldon Bacon and Xiangdong Zhang on Arctic-midlatitude linkages, Amy Solomon on the upcoming MOSAiC year-long drift campaign, Dirk Olonscheck on understanding internal variability of sea ice and surface air temperature, and Ruth Mottram on Greenland Ice Sheet – Ocean Interactions: Emerging Challenges and Opportunities.

Since the 13th session of the CLIVAR/CliC/SCAR Southern Ocean Region Panel (SORP) also occurred in Davos on 14-15 June, a joint session from SORP and NORP was convened on the afternoon of 15 June. During the joint NORP/SORP session processes that cause variability in the Arctic and Southern Oceans, outstanding polar issues, polar-midlatitude linkages, the role of the tropics on the polar regions, and comparison of sea ice behavior at both polar was discussed. It was decided that a topic of mutual interest is the role of freshwater fluxes in polar climate and that a workshop should be organized on this topic in the near future.

A workshop proposal was submitted to the Aspen Global Change Institute (AGCI) entitled, "Role of Freshwater in Polar Ocean Climate Change and Global Linkages". This workshop (if approved) will take place in fall 2019 and will be organized with the CLIVAR/CliC/SCAR Southern Ocean Region Panel. This workshop will bring together experts across the many disciplines involved in the role of freshwater in polar ocean climate change and global linkages, as well as graduate students and post-doctoral scholars working in this research area, to assess the current state-of-knowledge, identify research gaps and observational uncertainty and needs, and map out a strategy for

progress on both regional and global scales. This workshop is designed to develop a research agenda on polar climate change in advance of the upcoming Sixth International Panel on Climate Change Assessment Report. This workshop will bring the polar science community together to advance research on WCRP Grand Challenges “Melting Ice and Global Consequences”, “Weather and Climate Extremes”, “Regional Sea-Level Change and Coastal Impacts”, and “Near-term Climate Prediction”.

Co-chair Amy Solomon gave an invited talk at AGU 2017 on the formation and motivation for the CLIVAR/CliC NORP.

NORP members contributed to the CLIVAR OceanObs19 Community White Paper by writing the section on “Observational challenges and needs in the polar oceans”.

Plans for 2018 and beyond

- 1) Fall 2019 AGCI workshop (described in previous section)
- 2) Pre-AGU 2018 workshop on Greenland Freshwater Fluxes
This workshop will bring together participants across disciplines to discuss two challenges. The first is bridging the scales between freshwater fluxes from Greenland outlet glaciers and fjords to the ocean. The second is developing better freshwater flux forcings from Greenland through parameterizations or transfer functions (present-day and future scenarios) in ocean and other large-scale models. Participants will gather to develop a mutual appreciation of the challenges, identify individual and cross-community needs, highlight potential approaches for improvement, and build cross-community relationships.
- 3) FAMOS 2018 Talk on NORP motivation and near-term scientific objectives.
- 4) EGU 2018 Session on “Changes in the Arctic Ocean, sea ice and subarctic seas systems: Observations, Models and Perspectives”.
- 5) Write white paper on sea-ice ocean metrics for lower-latitude-Arctic interactions for CMIP diagnostics.
- 6) Work with national representatives to secure support for Arctic ocean-sea ice state estimates.

7) Advance studies on Greenland ice sheet – ocean interactions: Advocate for inclusion in CMIP7 and Sea level call in Horizon2020.

8) Coordinate archiving/mirroring of past/future campaign/in-situ data for assimilation and analysis: Coordinate with CLIVAR Global Synthesis and Observations Panel.

Articles published in 2017-18

CLIVAR OceanObs19’ Community White Paper

NORP Co-Chairs:

Amy Solomon

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John Fyfe (until 2018)

john.fyfe@canada.ca

Ruth Mottram

rum@dmi.dk

<http://www.clivar.org/clivar-panels/northern>

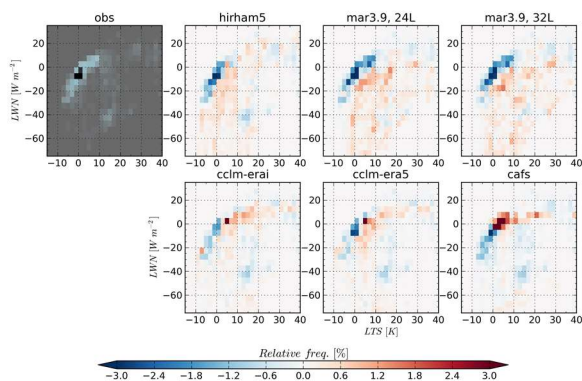
Polar CORDEX

Introduction

Polar CORDEX focuses on both Arctic and Antarctic RCM simulations; details: www.climate-cryosphere.org/activities/targeted/polar-cordex.

Science Highlight

Lower tropospheric stability has an intimate connection with surface net longwave radiation (LWN) and with the surface energy budget. The figure below shows that Arctic RCMs separate into different regimes regarding their stability-LWN relationship. Models on the top row over-represent moderate stability and negative LWN. Models on the bottom row overestimate moderate to strong stability while having overly large LWN. These differences point towards errors in low-level clouds and their associated static mixing.



Surface LWN (Wm^{-2}) as a function of static stability (K) between 925 hPa and the surface. Upper left shows observed relative frequency distribution; other panels show relative frequency distribution differences relative to obs.

2018 Highlights

1) Process-evaluation of multi-model Arctic RCM ensemble based on ACSE2014 campaign data, as a pre-MOSAiC model intercomparison study. Current participating models: CAFS, CCLM, HIRHAM5, MARv3.6, MetUM, RASM, WRF, HCLIM, NICAM.

2) Polar CORDEX meeting at the Institute of Geophysics, Polish Academy of Sciences in Warsaw, Poland, Oct. 17-19, 2018. 30 participants from 12 countries. Presentations on three scientific topic sessions: Process-based studies and coupled modelling, Model evaluation, Impact and projection studies.

2018 Selected publications

Akperov, et al., 2018: Cyclone activity in the Arctic from an ensemble of regional climate models (Arctic CORDEX), *J. Geophys. Res.*, [doi:10.1002/2017JD027703](https://doi.org/10.1002/2017JD027703)

Glisan, et al., 2018: A metrics-based analysis of seasonal daily precipitation and near-surface temperature within seven CORDEX domains, *Atmospheric Science Letters*, *submitted*

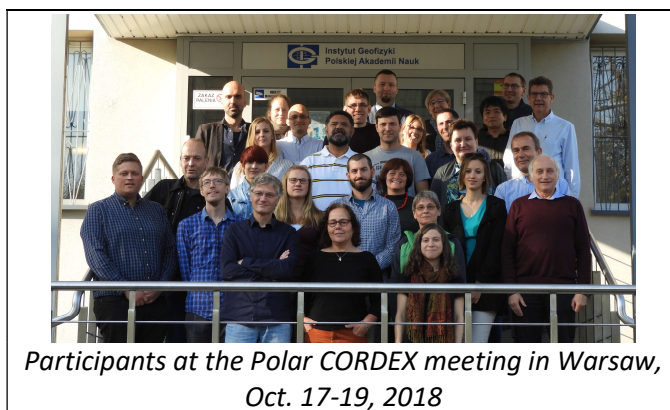
Gutjahr & Heinemann, 2018: A model-based comparison of extreme winds in the Arctic and around Greenland, *Int. J. Clim.*, [doi:10.1002/joc.5729](https://doi.org/10.1002/joc.5729)

Takhsha, et al., 2018: Dynamical downscaling with the fifth-generation Canadian regional climate model (CRCM5) over the CORDEX Arctic domain: effect of large-scale spectral nudging and of empirical correction of sea-surface temperature, *Climate Dynamics*, [doi:10.1007/s00382-017-3912-6](https://doi.org/10.1007/s00382-017-3912-6)

Future activities and developments

Arctic: Pre-MOSAiC model intercomparison study and preparation for MOSAiC modeling participation

Polar region: Contribution to the IPCC AR6 Regional Atlas for future projections



Participants at the Polar CORDEX meeting in Warsaw, Oct. 17-19, 2018

Contact:

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Andrew Orr (BAS, Cambridge, UK; anmcr@bas.ac.uk)

Inter-disciplinary Activities

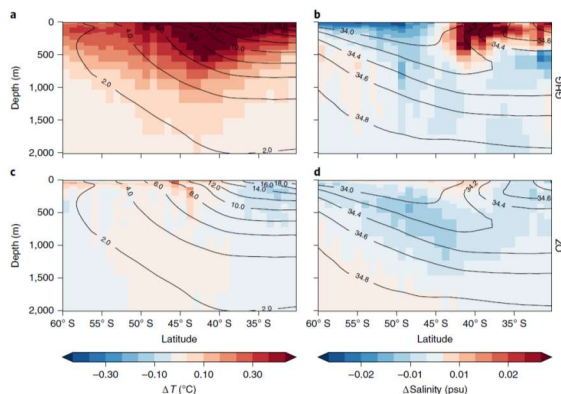
Polar Climate Predictability Initiative (PCPI)

Introduction

The Polar Climate Predictability Initiative (PCPI) aims to advance understanding of the sources of polar climate predictability on timescales ranging from seasonal to multi-decadal. Polar predictability stems from the unique persistence of signals in ice and snow and through exchange with the ocean at all depths and with the stratosphere. PCPI is concerned with the success of modelling and observing the rapid changes seen in the Arctic and the varied changes occurring in the Antarctic. PCPI is investigating the role of the poles in global climate and prediction. We work jointly with the Polar Prediction Project of the WWRP on mutual interests, though our focus tends towards longer timescales.

Science Highlight.

In a paper co-authored by PCPI leads John Fyfe and Sarah Gille, detection and attribution analysis shows that the observed warming and freshening in the Southern Ocean has primarily been driven by anthropogenic greenhouse gas increases, with a secondary influence of stratospheric ozone depletion.



Swart et al (2018) Figure 3. Fingerprints of temperature and salinity change, a-d. Zonal mean temperature (a and c) and salinity changes (b and d) from the ensemble means of CanESM2 single forcing experiments using greenhouse gases and ozone respectively.

2018 Highlights

Activity has increased compared to last year, much of which has been aimed at laying the ground for further activity, through bringing in early career researchers (ECRs) into the initiatives, and

adding to the leadership. Posts were advertised via the Association of Polar Early Career Scientists (APECS). *Theme 1* (Understanding Past Polar Climate Variations) have appointed Alex Jahn from the Institute for Arctic and Alpine Research, CU Boulder, and Sérgio Gonçalves from Rio de Janeiro State University, Brazil. With her expertise in Arctic climates, Alex will contribute to planned activities to hold a workshop on understanding past Arctic climate variations (analogous to the 2015 meeting focusing on the Antarctic). Kyle Clem (Rutgers, New York) joins *Theme 2* (Reanalyses); Marisol Osman (CONICET, Buenos Aires) joins *Theme 3* (Improve understanding of polar predictability on seasonal to decadal timescales); Lettie Roach (Victoria University Wellington) and Clare Eayrs (New York University, Abu Dhabi) have joined *Theme 4* (Assessing Model Performance in Polar Regions), and Anna Fitch (Stockholm University) has joined *Theme 5* (Model Error).

As well as two online meetings in February and April, a number of Initiative leads met during the Polar 2018 conference in Davos, Switzerland.

After serving successfully for several years Hugues Goose and Jen Kay have rotated off Initiative 4 (Assessing model performance in the polar regions). We are currently seeking replacements. In activity related to the PCPI, in April 2018, Gunilla Svensson (lead of Initiative 5, Model error), participated in the APECS Polar Prediction School, at Abisko in Northern Sweden. This school was organized by WMO's Polar Prediction Project, PCPI's sister project.

2018 Resulting publications

Swart, N. C., S. T. Gille, J. C. Fyfe, and N. P. Gillett, 2018. Recent Southern Ocean warming and freshening driven by greenhouse gas emissions and ozone depletion. *Nature Geoscience*, DOI: [10.1038/s41561-018-0226-1](https://doi.org/10.1038/s41561-018-0226-1).

Sigmond, M., J.C. Fyfe, and N. C. Swart, 2018. Ice-free Arctic projections under the Paris Agreement. *Nature Climate Change*, 8, 404-408. doi: [10.1038/s41558-018-0124-y](https://doi.org/10.1038/s41558-018-0124-y)

Goosse, H., J. E. Kay, K. C. Armour, A. Bodas-Salcedo, H. Chepfer, D. Docquier, A. Jonko, P. J. Kushner, O. Lecomte, F. Massonnet, H. Park, F. Pithan, G. Svensson and M. Vancoppenolle. 2018. Quantifying climate feedbacks in polar regions. *Nature Communications*, DOI: [10.1038/s41467-018-04173-0](https://doi.org/10.1038/s41467-018-04173-0)

Hartung, K., G. Svensson, H. Struthers, A. Deppenmeier, and W. Hazeleger, 2018. An EC-Earth coupled atmosphere–ocean single-column model (AOSCM.v1_EC-Earth3) for studying coupled marine and polar processes. *Geosci. Model Dev.*, 11, 4117-4137. <https://doi.org/10.5194/gmd-11-4117-2018>

Future activities and developments

A subset of Initiative leaders will meet at the IUGG 2019 in Montreal to develop plans for an Arctic Workshop on understanding past climate variations.

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2018 CliC Meetings & Workshops

GlacierMIP Meeting at AGU Fall Meeting, December 13, 2018, Washington DC, USA

GlacierMIP held its annual meeting at AGU in Washington D.C. with 17 participants (6 joining via videoconferencing). A paper has been submitted to the Journal of Glaciology analyzing and comparing previously published global-scale glacier projections, and is currently in revision. A deadline of 15 February 2019 was set for submission of new standardized models runs to be submitted in time for possible inclusion in the Sixth Assessment Report of IPCC (AR6). Finally ideas for a proposal for an extension of GlacierMIP were discussed.

ISMIP6 Meeting, at AGU Fall Meeting, December 10, 2018, Washington DC, USA

A meeting of ISMIP6 was held on December 10, 2018, during the AGU Fall Meeting in Washington DC. The meeting focussed on reviewing the experimental protocol for the standalone ice sheet model simulations designed at the ISMIP6 workshop held in the Netherlands in September 2018. The ISMIP6 protocol had to change due to the delay in CMIP6 climate model simulations, such that the first phase of ISMIP6 projections will be based on CMIP5 climate model simulations. During the PreAGU meeting, the revised strategies for implementing atmospheric and ocean forcing were presented and discussed. Topics also discussed include CMIP model selection and how to prepare datasets for inclusion in CMIP6 archive. Guidance for the revised ISMIP6 protocol and how to obtain datasets will be included on the ISMIP6 wiki. In addition, as the ABUMIP runs have been completed, a preliminary analysis of these results were presented and discussed. The meeting was attended by 30 participants with expertise in ice sheet modeling, ocean modeling and atmosphere modeling. To increase collaborations between polar scientists, the meeting was held in the same venue as “Freshwater Fluxes from Greenland”, allowing for informal discussions between the two groups during lunch and coffee breaks.



8th Annual Meeting of the Permafrost Carbon Network, at AGU Fall Meeting, December 9, 2018, Washington DC, USA

The latest and greatest on permafrost carbon science was presented in 18 science speed-talks to an audience of 120 scientists at the 8th Annual Meeting of the Permafrost Carbon Network. Many of these brief presentations laid the foundation for nine breakouts in the afternoon during which details for data collection, spatial data representation, analysis procedures, people to involve, and timelines were discussed.



Current synthesis activities of the Permafrost Carbon Network focus on 1) reducing uncertainty in carbon pools in permafrost and upscale carbon stocks in Arctic river deltas, 2) building a decadal-scale time series of ecosystem-atmosphere arctic/boreal carbon exchange through synthesis, 3) identifying thaw-induced changes to the permafrost microbiome, and 4) improving visibility and outreach opportunities on permafrost carbon to the public and decision makers.

For each of the breakout topics, we will provide a summary and timeline for members of the Permafrost Carbon Network and we will host follow-up discussions via web-communication over the course of 2019 to ensure synthesis progress. During the meeting, we also highlighted the contribution and role of the

Permafrost Carbon Network to the upcoming 2019 'Arctic Futures 2050' conference that will identify needs of scientists and decision makers and improve the dialogue between science and policy.

WCRP workshop: The Earth's Energy Imbalance and its implications (EEI), November 13-16, 2018, Toulouse, France

A workshop had been organized in Toulouse, France on: "The Earth's Energy Imbalance and its implications" during the second week of November 2018. This workshop as grown out of the **CLIVAR RF C-H** activity, aiming that WCRP Core Projects work together for a new WCRP-wide initiative to identify research goals and opportunities for Earth's Energy Imbalance and to strengthen future international scientific collaboration with experts for EEI assessments.



The main objective of the workshop was to initiate a new WCRP-wide activity and to thus strengthen and extend the community on the Earth's energy imbalance through a community wide discussion on links across all the WCRP Core Projects and relevant activities. Synergy research goals and opportunities across various aspects of WCRP and focused on the Earth's energy imbalance have been identified, and all information are made available (<https://atlas.mercator-ocean.fr/s/b43Eo2TYbPGSgPb>).

Annual FAMOS Workshop, October 24-26, 2018, Bergen, Norway

The Forum for Arctic Modeling & Observational Synthesis (FAMOS) focuses on Arctic marine modeling (biogeophysical) and collaborates with marine observationalists, hydrologists, glaciologists, atmospheric scientists, and others. It is funded by the U.S. National Science Foundation (Lead PI: A. Proshutinsky; co-PI: M. Steele). FAMOS has annual fall meetings to discuss ongoing collaborative projects. They are usually held at the Woods Hole Oceanography Institute (WHOI), but took place in Bergen, Norway in 2018. 118 participants from Europe, North America, and Asia discussed new work and ongoing collaborations. It included talks, a poster session, and a reception. The 2nd FAMOS special issue in JGR-Oceans, activities on Climate Response Functions (CRFs), and other collaborations were highlighted. The meeting was preceded by the Annual FAMOS School for new arctic investigators (39 students, 7 lecturers) on October 23.



ASOF/CliC 'Climate Change at the Arctic Gateways' Workshop, October 22-23, 2018, Bergen, Norway

CliC supported the ASOF/CliC workshop 'Climate Change at the Arctic gateways' which took place at the Institute of Marine Research, Bergen, Norway, October 22, 23, 2018. The workshop was dedicated to develop ideas for a model benchmark dataset based on gateway observations from the Arctic. It's objectives were:

- To foster collaboration among diverse research groups toward better understanding of processes in the atmosphere-ice-ocean system and their contribution to physical and biogeochemical cycling within the climate system.
- To identify the key science questions and modelling approaches for which the reference data set shall be developed



- To determine what observations and measurements are available, and identify which observed and derived parameters are best suited to tackle these science questions
 - To develop a plan for setting up a quality checked benchmark dataset that is best suitable as a model reference and most useful for further model development, accessible in a single repository and with full information to data originators and the full original data
 - To develop the outline for a proposal to fund the full implementation of the dataset and its accessibility from a web-portal
- Representatives of the teams which cover all the different Arctic and Subarctic gateways over the past decades presented the current status of the gateway observations. Together with a group of modelling experts which covered a wide range of different model approaches, the benefits, limitations and requirements for setting up a model benchmark database for the gateways were discussed. Key topics were 1) errors and uncertainties in observations and in derived products; 2) the question of how true to reality of sea straits are the data and derived products are for the straits; 3) how well they represent all relevant physical processes.

It became clear that guidance on the quality and processing of the original data and the details of derived products must come from the experts who have been studying each particular gateway. Such important metadata must be provided as completely as possible together with the mooring data and derived data products. This is currently not always the case, not in publications, and more importantly, not in data archives. The need for a complete overview of uncertainties in original data and data products was stressed by the modelling experts, particularly for applications such as data assimilation, but also for model-data comparison/model validation. This need is also of course fundamental to scientific interpretation in purely observational studies. The compilation of a database as such is a routine technical task, but requires additional and well coordinated efforts that is well suited for the purpose, in terms of data provision, data handling and metadata description for the original as well as derived data which for those gateways is not available on any database at present. Once built, however, the database becomes fertile ground for basic physical understanding of observations and for model validation and inter-comparison. Models when evaluated become more versatile tools for addressing fundamental scientific questions. Indeed it is the high value of validated models that provides our motivation for proposing to prepare this benchmark dataset. The next steps will include the search for a funding of such an activity. Details on the workshop will be put on the ASOF website soon: www.asof.awi.de.

Polar CORDEX Meeting, October 17-19, 2018, Warsaw, Poland

The annual Polar CORDEX meeting was held in Warsaw, from 17-19 October 2018. It involved 30 participants from 12 countries, with research interests broadly split between both the Arctic and Antarctic. The meeting included scientific topic sessions on process-based studies, coupled modelling, model evaluation, impacts, and projections. One of the science highlights was a process-based evaluation of a multi-model Arctic regional climate model ensemble based on data from the Arctic Cloud Summer Experiment (ACSE) 2014 campaign. This was a pre-MOSAiC model intercomparison study, and included the CAFS, CCLM, HIRHAM5, MARv3.6, MetUM, RASM, WRF, HCLIM, and NICAM models.



LandMIP Meeting, October 10-12, 2018, Toulouse, France

Within CMIP6, several projects focus on the role of the land surface in the climate system. LUMIP (Lawrence et al., 2016) investigates the role of past and future land use changes, while C4MIP (Jones et al., 2016) analyses the role of the coupled carbon cycle. LS3MIP (van den Hurk et al., 2016), co-funded by CliC,

focuses on the role of soil moisture and snow. These three “Land MIPs” held a common workshop in October 2018 in Toulouse to coordinate their experiments and the common analyses with CMIP6.

Over the three days of the workshop, first results from preliminary simulations were presented and discussed. For example, preliminary results from CNRM-CM for a Tier1 LS3MIP simulation showed that prescribed snow and soil moisture in a future simulation could lead to very strong anomalous freshwater fluxes to the oceans, inducing a rapid AMOC shutdown in these simulations. It was therefore decided to swap priorities between this Tier1 simulation and a simulation with prescribed oceanic boundary conditions that was initially planned as a Tier2 experiment. This change has implications on the planning of ESM-SnowMIP, which will build of LS3MIP experiments and will adjust its simulation protocol accordingly. Much discussion was further devoted to the analysis strategy especially concerning the reference land-only simulations with prescribed meteorological forcing. In a separate breakout session, the articulation between LS3MIP and ESM-SnowMIP was discussed and refined.

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15th International Circumpolar Remote Sensing Symposium (ICRSS), September 10-15, 2018, Potsdam, Germany

100 participants from 16 countries attended the 15th International Circumpolar Remote Sensing Symposium (ICRSS), which took place from 10 to 14 September 2018 in Potsdam, Germany. Under the theme ‘Polar Regions in Transformation – Climatic Change and Anthropogenic Pressures’, the largest ICRSS to date demonstrated the importance of providing a multi-disciplinary platform for remote sensing applications on sea ice, ocean, inland ice, land and atmosphere in the polar environments, both Arctic and Antarctic. The symposium and adjoint workshops provided insights into current applied research and best practices, the presentation of new technology and the advancement of international co-operation in the circumpolar regions of the world.



The 15th ICRSS hosted 54 oral presentations, 6 keynotes, 1 evening lecture, 38 poster contributions and 5 workshops. Partners and Sponsors of the 15th ICRSS included AWI, REKLIM, USGS, CliC, EUMETSAT, Deutsche Gesellschaft für Polarforschung DGP, International Permafrost Association IPA; GeoResearch Centre Potsdam GFZ, University Potsdam, Geo.X, and ProWissen Potsdam e.V. CliC supported Young Researchers

and was acknowledged by the presentation of the FrostByte videos during the ICRSS programme. The winner of the public FrostByte competition got a book prize sponsored by Springer.

ISMIP6 workshop: “Developing process-based projections of the ice sheets’ contribution to future sea level”, September 11-13, 2018, Sassenheim, The Netherlands

The Ice Sheet Model Intercomparison Project for CMIP6 (ISMIP6) held a workshop on September 10-13th 2018 in Sassenheim, The Netherlands. The workshop’s goal was to review and finalize the experimental framework for projections of the Greenland and Antarctic ice sheet’s contribution to sea level change. The focus was on experiments with ice sheet models that are driven offline from output from CMIP climate models. The meeting was attended by 60 participants with expertise in ice sheet modeling, climate modeling, polar ocean and polar atmosphere. The meeting was organized by Heiko Goelzer with support from the Institute for Marine and Atmospheric research Utrecht (IMAU), the National Aeronautics and Space Administration (NASA), The Netherlands Earth System Science Center (NESSC), The European Geosciences Union (EGU), and the World Climate Research Programme (WCRP) via the Climate and Cryosphere (CliC) Project.



Topics that were presented and discussed include: A review of the ISMIP6 effort and what we have learned from our first set of experiments and model simulations (initMIP Antarctica, initMIP Greenland, ABUMIP). How to translate changes in ocean characteristic from CMIP models into sub-shelf melt rates or retreat rates for ice sheet model forcing? And for the atmosphere, how to obtain surface mass balance and temperature for input to ice sheet models? How to select and evaluate ocean and atmospheric models, which type of observations matter and can reanalysis fill the gap? How to sample the uncertainty in sea level projection? How to design an experimental framework that fits the needs of the IPCC and other end user? How to best collaborate with other groups that could benefit ISMIP6, and vice versa, such as the CMIP6 endorsed Polar CORDEX? The end results of the workshop are increased collaboration between scientists of many disciplines, along with a roadmap, forcing datasets and a draft experimental protocol that will be polished in the coming months and reviewed during the annual ISMIP6 PreAGU workshop. Our goal is to start the standalone ice sheet model simulations in early 2019 so that ISMIP6 can deliver projections of the ice sheet’s contribution to sea-level change in time for IPCC AR6.

International Workshop on Cryospheric Changes and Their Regional & Global Impacts, July 31-August 1, 2018, Dunhuang, China

The International Workshop on Cryospheric Changes and their Regional and Global Impacts, co-sponsored by the State Key Laboratory of Cryospheric Science of the Northwest Institute of Eco-Environment and Resources (NIEER), the Chinese Academy of Sciences, the People’s Government of Dunhuang City, the International Association of Cryospheric Sciences (IACS), the World Climate Research Programme (WCRP)’s Climate and Cryosphere (CliC) Project, the University of Alaska Fairbanks and others, was successfully held from July 31st to August 1st 2018, in Dunhuang, China.



More than 260 experts from China, the United States, Australia, New Zealand, Switzerland, Norway, France, Ecuador, Mongolia, and Nepal attended the conference. Prof. Dahe Qin, representative of the supporting

agencies, hosted the opening ceremony. Mr. Taibin Jia, Mayor of Dunhuang; Prof. Regine Hock, President of the International Association of Cryospheric Sciences (IACS), and Prof. Shichang Kang, Director of the State Key Laboratory of Cryospheric Science also gave opening speeches.

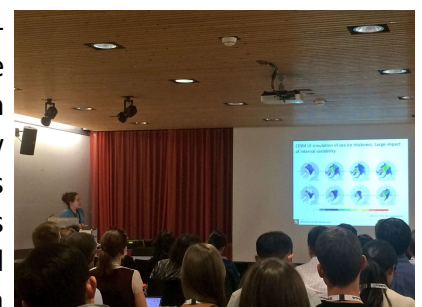
The workshop included one main conference, three special sessions, and three side meetings, with a total of 75 oral presentations. The participants discussed three major themes: 1) the changing processes and mechanisms of the cryosphere, 2) the interactions between the cryosphere and other spheres, and 3) the service functions of the cryosphere and sustainable development. The side meetings addressed the issues of the sustainable development of Dunhuang, the Arctic cryosphere monitoring and research, and the in situ monitoring of Antarctica.

The participation of young scientists in the workshop was strongly encouraged. IACS granted the Best Youth Report Award to five participants: Yi Zhao from Nanjing Normal University, Pandey Avash from the International Centre for Integrated Mountain Development in Nepal, Bo Su from Beijing Normal University, as well as Puyu Wang and Jiao Yang from the Northwest Institute of Eco-Environment and Resources.

This Workshop promoted the need to further develop cryosphere science and the importance of international cooperation and exchange of information and knowledge. The cryosphere is a negative-temperature sphere of certain thickness and with a continuous distribution on the epigeosphere. As one of the five major spheres in the climate system, it plays a key role in global changes. Cryospheric science has become an important branch of climate and Earth systems research. The cryosphere being highly sensitive to climate change and the feedbacks associated with it being important, research on these topics has become central in the study of the climate system, global changes, and sustainable development. Global warming already has an impact on the cryosphere in general, as well as repercussions on environmental safety in cold regions, engineering, constructions and facilities safety, economic and social systems if the climate keeps changing, the impacts on the cryosphere will increase.

Session organized by the Sea Ice and Climate Modelling Forum at POLAR2018, June 22, 2018, Davos Switzerland

The Sea Ice and Climate Modelling Forum had a very productive, cutting-edge, and diverse session on sea ice modeling (OS4) at POLAR2018 in June 2018. Presentations were arranged under four major themes, starting with talks on sea ice projections, with a focus on an ice-free Arctic under the low IPCC scenarios and projections of Arctic melt season properties. This was followed by presentations on new and improved sea ice process understanding, using sea ice modeling as a tool, covering both Arctic and Antarctica processes. Over lunch, participants joined an informal SIMIP lunch outside the conference center, to discuss ideas for upcoming sea ice analysis. After lunch, there were presentations on sea ice prediction, ranging from updates on the annual SEARCH Sea Ice Outlook to various methods of sea ice prediction and a detailed analysis of predictive skill and predictability barriers. The end of the day was reserved for talks on exciting new sea ice model developments, with implications for improving all earlier discussed aspects of sea ice modeling. There was a lively discussion and a very engaged and diverse audience, with a full room throughout the day. After the final oral session, there was a large (~30 posters) and very exciting and well attended poster session. CliC sponsored APECS travel grants for three early-career scientists to present in this session and attend POLAR2018, with several others acknowledging APECS travel grants from other sources in their presentations.



General open BEPSII science meeting, prior to SCAR/IASC POLAR 2018, June 15-17, 2018, Davos, Switzerland

In 2018 the BEPSII annual meeting was held for 3-full days just prior to POLAR 2018 in Davos, Switzerland. The meeting also included a 2-day Foresight workshop funded by Euromarine, entitled: "Arctic sea-ice change: insight into near-future changes in Arctic sea-ice biogeochemistry and associated ecosystems", which is leading to a Foresight paper currently in preparation and authored by several BEPSII members. During the meeting every task leader of the 5 WGs presented updates, achievements and ongoing developments. WG1 on Methodologies is currently shaped by the SCOR WG-ECVice (2017-2021) and include several already executed and other ongoing/planned inter-calibration experiments. WG2 on Technology and Data collection is fostering activities relative to buoys and mass-balance stations and strengthening links to e.g. SOOS (Southern Ocean Observing System). WG3 on Modelling and Observations is particularly interacting with the MOSAiC implementation plans at the moment. WG4 on Synthesis is progressing with a few paper preparations, such as on conceptual model developments of land-ocean-sea ice interactions and a review on sympagic-pelagic coupling. The WG5 on Outreach presented several new products (logo, website, BEPSII slide, BEPSII leaflet, SCAR BEPSII mailing list), and the planning of the BEPSII field school in spring 2019 at CHARS station (Cambridge Bay, Canada) is progressing. The next BEPSII meeting will be held in 2019 in conjunction with a relevant conference, a usual. Current options are SOLAS-Japan (21-25 April), GRC-Italy (17-22 March), IGS-Canada (18-23 August).



ISMASS Workshop, prior to SCAR/IASC POLAR 2018, June 15-17, 2018, Davos, Switzerland

Prof. Edward Hanna of the School of Geography lead an international research workshop on Greenland and Antarctic Ice Sheet mass balance - links between observational data and computer model simulations - as part of the POLAR2018 conference in Davos, Switzerland, on 15 June. This included some of the world-leading scientists working in this area. There were two keynote talks: Prof. Tony Payne (University of Bristol) spoke on "Challenges in making useful projections of the future sea-level contributions of ice sheets", while Prof. Andy Shepherd (University of Leeds) gave a very timely rundown of "Satellite observations of ice sheet mass balance". The latter talk was based on a major new research paper on Antarctic Ice Sheet mass balance, 1992-2017, that Prof. Shepherd had lead-published in the journal NATURE the previous day [as a participant in the second Ice sheet Mass Balance Inter-comparison Exercise (IMBIE2), Edward is one of about 80 co-authors on this paper]. Other talks included the effects on ice sheets of limiting global warming to 1.5degC above pre-industrial levels by 2100 (an unlikely outcome but one that is highly relevant to study for an upcoming interim report of the Intergovernmental Panel on Climate Change).



1st session of the CLIVAR/CliC Northern Ocean Region Panel (NORP), prior to SCAR/IASC POLAR2018, June 15-16, 2018, Davos, Switzerland

The 1st session of the CLIVAR/CliC Northern Ocean Region Panel (NORP) was held on 15-16 June 2018 in Davos, Switzerland. The meeting was held alongside the POLAR2018, a joint event from SCAR and IASC (International Arctic Science Committee). And a joint session from SORP (CLIVAR/CliC/SCAR Southern Ocean Region Panel) and NORP was convened in the afternoon of 15 June.



As its first face-to-face meeting, the panel's co-chair, John Fyfe gave an overview of NORP, which aims to:

- Be a forum for coordinating activities on the role of the Arctic Ocean and neighboring seas in the global coupled climate system;
- Facilitate progress in developing new tools and methods to observe and model the Arctic Ocean and neighboring seas.

NORP invited relevant representatives from partner projects including: ASOF (Thomas Haine); FAMOS (Andrey Prosentinsky); SORP (Inga Smith); IASC (John Fyfe); PCPI (Marilyn Raphael), SEARCH (Marika Holland); PPP (Matthieu Chevallier); CDP (Olga Zolina); MOSAiC (Amy Solomon), and more.

Regarding the scope of the panel, the discussion concluded that the panel should focus primarily on the physical climate system instead of covering too broad. The NORP is based around the formation of several task teams. Much of the meeting time was dedicated to the reporting from all task teams and the discussions on redefining them, with updated tasks and action items. Opportunities, overlaps and synergies with partnership projects/groups were also discussed, for example the Arctic storm tracks responses to the diabatic signals with CDP, cross membership with IASC and its fellowship programme.

During the joint session with SORP, co-chairs from both panels briefed the meeting on their terms of reference. Many research aspects of common interests were identified in the open discussion from the panel members. It was desirable to seek possible interactions and synergies among SORP and NORP task teams, in aspects such as the link with CLIVAR Climate Dynamics Panel, projects on observing system design (future design of buoy and radiosonde) in the Antarctic and Arctic (MOSAIC, the Multidisciplinary drifting Observatory for the Study of Arctic Climate in the Arctic and SOOS in the Southern Ocean). The next proposed joint activity from SORP and NORP is the 2021 CLIVAR/CliC summer school or workshop supported by ICTP in Trieste, Italy. Topic and location are yet to be determined by the panel co-chairs.

13th session of the CLIVAR/CliC/SCAR Southern Ocean Region Panel (SORP), prior to SCAR/IASC POLAR2018, June 14-15, 2018, Davos, Switzerland

The 13th session of the CLIVAR/CliC/SCAR Southern Ocean Region Panel (SORP) was held on 14-15 June 2018 in Davos, Switzerland alongside the POLAR2018 conference and the first session of the CLIVAR/CliC Northern Ocean Region Panel (NORP). A joint session from SORP and NORP was convened on the afternoon of 15 June. The main topics of discussion centered on SORP's present and future collaborations with SOOS (Southern Ocean Observing System) and the newly-established NORP. In particular, the establishment and design of SORP task



teams was discussed, and how they can complement existing task teams in SOOS and NORP. Progress of some relevant projects with SORP members taking lead or playing roles in were reported, including SOMIP (Southern Ocean Model Intercomparison Project), AntClim21, FAFMIP (Flux Anomaly Forced Model Intercomparison Project), and SIPN-South (Sea Ice Prediction Network Southern Ocean). Finally, SORP members defined their role in the SOOS-led OceanObs'19 whitepaper "Defining requirements and facilitating implementation of an integrated observing system for the Southern Ocean."

ESA Cryosphere Remote Sensing Course 2018, June 11-16, 2018, Longyearbyen, Svalbard

As part of the Earth Observation (EO) Science for Society, the European Space Agency (ESA) organized the Cryosphere Remote Sensing Training Course 2018. This course, devoted to train the next generation of cryosphere scientists, took place from 11 to 16 June 2018, just 1000 km away from the North Pole, in Longyearbyen, Svalbard. Located halfway between Norway and the North Pole, and home to polar bears, Svalbard's rugged yet fragile landscape offers a unique setting for a cryosphere-related course and close contact to the heart of a relevant part of the infrastructure for Earth observation missions in low polar orbits due its favourable location for satellite communication (78° N).



During the 6-day course, 60 participants from all over Europe (and Canada) gathered at the northernmost institution for research and education in the world — the University Centre in Svalbard, UNIS — and took theory and practical classes lectured by Principal Investigators and Scientists from leading universities and research institutions. A broad range of topics were covered, providing an advanced understanding of theoretical principles, algorithms processing and data products as well as hands-on practice with tools and methods for cryosphere-focused satellite data. Students also had the opportunity to network and present their own work through a northern-lightning talk in a very special ice-breaking event – at KSAT ground station. Finally, a boat trip to Tunabreen also offered the unique opportunity to get a closer look at the polar landscape and to learn from researchers who conduct in-situ research and data collection.

Rising Coastal Seas on a Warming Earth III Workshop, May 7-9, 2018, Abu Dhabi, UAE

Global sea-level rise is one of the most discussed potential consequences of global warming. The most uncertain aspect of such future sea-level change has to do with the marine based ice sheets, and particularly that of the West Antarctica Ice Sheet (WAIS). Despite its potential importance, current generation global climate models are unable to simulate sea-level change arising from glacier-ocean interaction.



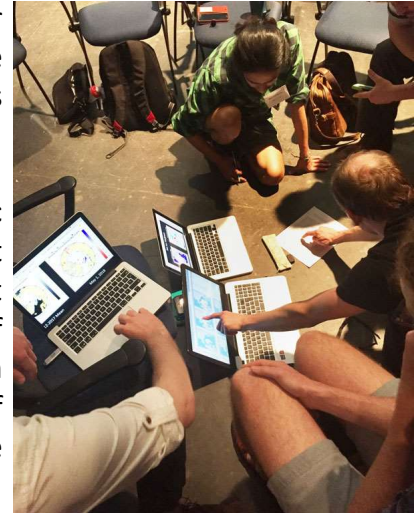
For a third, biennial meeting, and as a step towards remediating this situation, the Marine Ice Sheet Ocean Modelling Intercomparison Project (MISOMIP) again brought together the international modeling community with expertise in this area so to advance the state-of-the-art in regional-scale simulations of glacier-ocean interaction. The key outcomes of this workshop was a thorough review of progress made since project inception in 2014, and development of new plans towards future, sustained model Intercomparison. A new and exciting, Amundsen Sea sector regional-modeling focus building has been

outlined in a technical report, including discussions of appropriate ways to include such glacier-ocean interaction technology in global scale, IPCC class models.

5th Polar Prediction Workshop (PPW), May 7-9, 2018, Montreal, Canada

Held in Montreal (Quebec, Canada) on 7-8-9 May 2018, the 5th Polar Prediction Workshop (PPW) brought together 75 participants from the academic, governmental, non-profit, and industry sectors to discuss research and operational activities related to Arctic sea-ice prediction.

While oral and poster presentations highlighted recent advances in Arctic prediction systems and their evaluation, the workshop also hosted its first end-user panel, providing a tribune for forecast end-users to present valuable feedback to the scientific community about their needs in terms of sea-ice products. Specifically, the need for ice pressure and ice motion information (on a weekly to daily time scale), as well as forecasting of beginning/end of open-water season for specific navigation routes were identified as pressing needs by the end-users.



Another major outcome of the Polar Prediction Workshop 2018 was a consensus forecast statement for the September 2018 sea-ice conditions. Based on a review of observed conditions for winter 2018, breakout groups were tasked with specifying the ice cover conditions in the marginal Arctic seas and drawing the September minimum ice-edge. The resulting consensus forecast agreed fairly well with early model forecast contributions also submitted at the workshop, with medium/high confidence for higher sea-ice cover in the Beaufort Sea and lower sea-ice cover in the Chukchi Sea. Breakout groups also identified higher sea-ice cover along the Eurasian coastline due to lower coastal divergence and positive ice thickness anomalies this spring, but uncertainty in the model forecasts for this region were high.

Supported by the Marine Environmental Observation Prediction and Response (MEOPAR) Network, the Canadian Ice Service, and the Climate and Cryosphere (CliC) project, results of the Polar Prediction Workshop 2018 activities were used as input for the Forecasting Regional Arctic sea ice from a Month to Season (FRAMS) meeting and the first Pan-Arctic Regional Climate Outlook Forum (PARCOF-1) meeting, both held shortly after the PPW.

The workshop presentations, documents, and videos are now available for reference at ppw2018.com

Arctic/Subarctic Ocean Flux Study (ASOF) Workshop, April 25-27, 2018, Paris, France

On 25th April - 27th April 2018 The Arctic/Subarctic Ocean Flux Study ASOF held its yearly workshop at the Sorbonne Université in Paris (previously Université Pierre et Marie Curie, UPMC), locally organized by LOCEAN (Laboratoire d'Océanographie et du Climat).



With about 40 presentations and 50 participants from international research institutions the workshop dealt with updates on the most recent observational campaigns in the Arctic and Subarctic region, as well as research results based on observations and numerical models. In addition to the overarching science issues driving ASOF, the workshop aimed at gathering information on the possibility of

producing a revised Arctic heat budget, and the state of knowledge regarding documentation and understanding of downstream effects of Arctic outflows. On a basin-wide scale presentations covered the status of budgets for volume, heat and salt, the identification of drivers for the exchanges between the basin. Contributions on regional developments dealt with the most recent developments of fluxes across the gateways, and in the interaction of glaciers and the ocean as well as the relevance of small scale mixing processes for the exchanges. The agenda and presentations are available on the ASOF website.

Polar Prediction School 2018, April 17-27, 2018, Abisko, Sweden

The second Polar Prediction School 2018 on weather and climate prediction in the polar regions took place from 17 - 27 April 2018 at Abisko Scientific Research Station in Sweden. It was organized by the EU Horizon 2020-funded APPLICATE project, in cooperation with the World Meteorological Organisation's Polar Prediction Project (PPP), the Association of Polar Early Career Scientists (APECS) and other partners. This school, for early career scientists, included a combination of polar weather and climate lectures with practical exercises on modelling and field meteorology as well as soft skill training. Each of these components forms a crucial pillar of the prediction problem as addressed during the Year of Polar Prediction; and the motivation for combining these was to provide participants with a complete overview of the components required to understand and predict polar weather. Amongst others, the young scientists launched radiosondes and held a mini intense observational period. Videos summarizing the work of the students are available on the APECS and APPLICATE websites.



The Polar Prediction School 2018 was attended by 29 early career researchers (focus on advanced graduate students, PhD students, and postdoctoral researchers) from around the world. An international set of 13 instructors taught the sessions. As during the first Polar Prediction School in 2016, classes were held at the Abisko Scientific Research Station in Sweden, where the instructional facilities are conveniently located in an environment well suited to Arctic observations. For more detailed information, please also see the APECS and the APPLICATE websites.

14th European Polar Low Working Group (EPLWG) meeting: Polar lows and mesoscale weather extremes, April 5-6, 2018, Trier, Germany

The workshop attracted 30 scientists from China, France, Germany, Japan, Norway, Russia, UK, and USA to present most recent findings on polar low research. The workshop summarized our present understanding of polar lows and mesocyclones as well as mesoscale weather extremes in the Arctic and Antarctic. This includes e.g. mesoscale weather phenomena such as katabatic winds, tip jets, boundary layer fronts, and cold air outbreaks in polar regions. The workshop had the following main themes: Polar low studies using satellite data and in-situ data; climatological aspects of polar lows; polar lows in reanalyses and model simulations; environments for polar low genesis and operational aspects; polar mesoscale weather phenomena and air-sea-ocean interactions. The workshop was concluded by a round table discussion resulting in recommendations for future research and actions.



Polar Organizations provide travel support for ECRs to attend POLAR2018

In February 2018, the Association of Polar Early Career Scientists (APECS) in cooperation with the International Arctic Science Committee (IASC), the Scientific Committee on Antarctic Research (SCAR), the Tinker Foundation, the US National Science Foundation, the University of Alaska Fairbanks, the UK Science & Innovation Network Nordics, the Antarctic Science Ltd. and the Climate and Cryosphere (CliC) Project of the World Climate Research Programme (WCRP) announced the availability of travel awards for POLAR2018 (15 - 26 June 2018, Davos, Switzerland), including Arctic Science Summit Week 2018 & IASC Business Meetings, XXXV SCAR Biennial Meetings, SCAR/IASC Open Science Conference, and 2018 Arctic Observing Summit. We received a total of 346 applications for this process and due to the high quality of the applications it was very difficult to make a decision. All applications were reviewed by two reviewers each via a blind review process. Final recipients were then determined from the resulting ranked list keeping in mind as wide as possible country spread.



Through this generous financial support from all contributing organizations, we were able to fund 91 applicants from 27 countries (Australia, Austria, Belgium, Brazil, Canada, Chile, China, Czech Republic, Denmark, France, Germany, Iceland, India, Italy, Japan, New Zealand, Norway, Poland, Portugal, Russia, South Africa, South Korea, Spain, Sweden, Turkey, the United Kingdom and the United States). All recipients have been notified and have accepted their awards. Congratulations to all recipients!

This article was taken from the APECS website.

Arctic Sea Ice Prediction Stakeholders Workshop at Arctic Frontiers, January 22, 2018, Tromsø, Norway

An Arctic Sea Ice Prediction Stakeholders Workshop was held as a side-event at the Arctic Frontiers 2018 Conference (<http://www.arcticfrontiers.com/>) on January 22, 2018, from 15:00 to 18:30, at the Radisson Blue Hotel, in Tromsø, Norway.

The event was organised by the Climate and Cryosphere (CliC) project of the World Climate Research Programme (WCRP), the University College London (UCL), the Arctic Research Consortium of the U.S. (ARCUS), the Norwegian Ice Service - MET Norway, the Bjerknes Centre for Climate Research - Bjerknessenteret – UiB, the Research Council of Norway, and EU-PolarNet.

The Arctic sea ice prediction community has advanced rapidly in the past decade with many new sea ice forecast products and services which are targeted for different user groups. However, it is still unclear how well end users are able to integrate information from these services into their navigational planning and how they use sea ice forecast information. To improve the uptake and usability of sea ice information supplied by the operational community, there is a need for better engagement and dialogue with a broad range of Arctic stakeholders and a need to tailor new products and services to end user specific requirements.

The organising committee for the Arctic Frontiers workshop assembled a cross-section of forecasters from Europe and North America along with key representatives from the private sector to discuss emerging issues and highlight opportunities. The workshop focused on creating an engaging dialogue and gathering feedback from all participants in order to get a better understanding of current and future user needs.



Some of the overarching questions addressed at the workshop included:

- What is the economic value of current forecasting systems?
- How are forecasts used in decision making, and if not, then why?
- What are the limits and opportunities associated with current forecasting systems?

Going forward the event organisers are looking to establish cooperation opportunities with the participants and to develop a longer-term strategy for continued engagement between these communities. There are many opportunities for improvements in the reliability of sea ice forecasts and an eagerness amongst users to help tailor products that suit their needs. Such dialogue and enhancements should lead to better informed stakeholder decision making, safer passage of vessels and sustainable economic development.

More about the outcomes of the workshop at:

https://blogs.helmholtz.de/polarpredictionmatters/2018/04/engaging_users_of_sea_ice_forecasts/

www.climate-cryosphere.org

