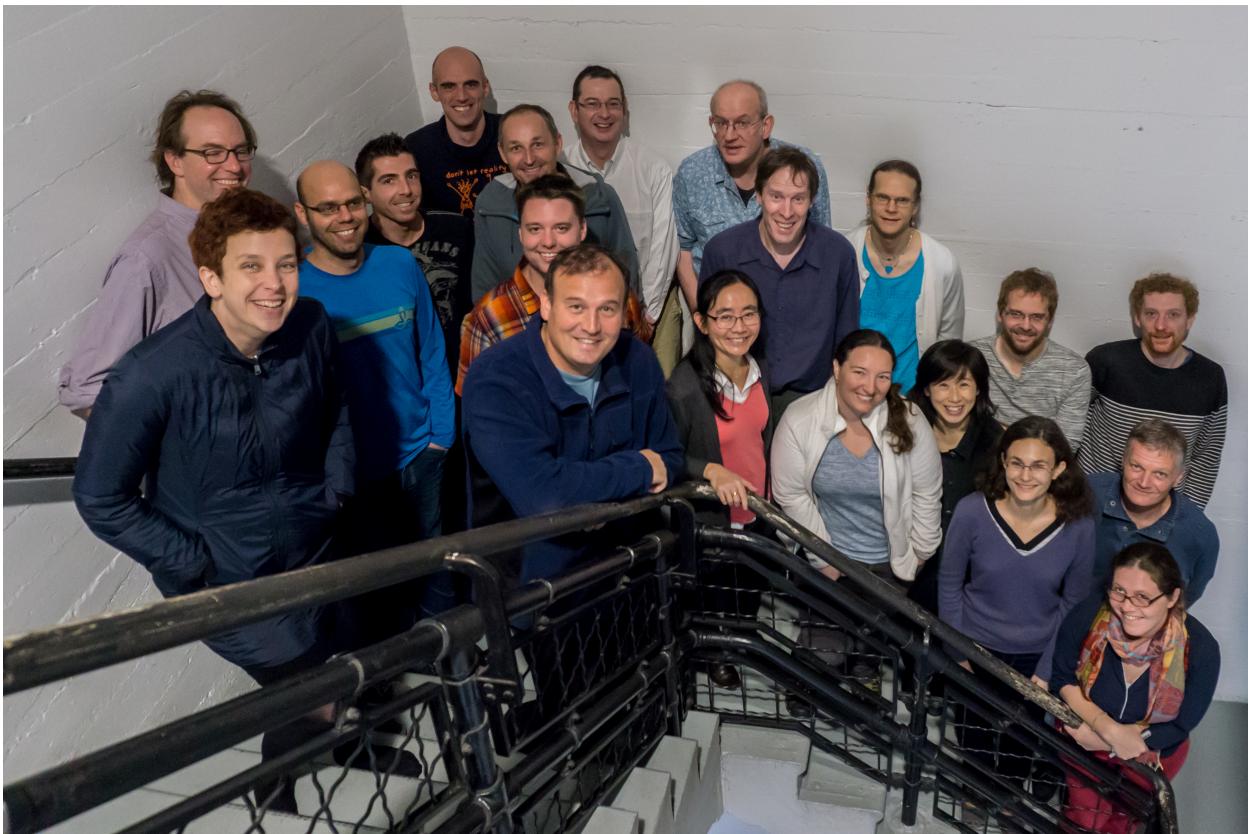




ISMIP6 workshop on initialization, forcing and datasets

12-13 December 2015
Fort Mason Center, San Francisco, USA



ISMIP6 Pre-AGU workshop participants, sheltering from the San Francisco rain.
Photo taken by A. Aschwanden

Front Row: T. Edwards, E. Larour, S. Yang, N. Schlegel, H. Seroussi, S. Nowicki

Middle Row: M. Rückamp, J. Kennedy, W. Lipsomb, A. Abe-Ouchi, G. Krinner

Back Row: T. Neumann, S. Leclec'h, F. Ziemen, O. Gagliardini, C. Jackson, T. Payne, E. Fisher,
A. Shepherd, H. Goelzer

Workshop Sponsors:

- WCRP Climate and Cryosphere Project

CliC is a core project of:



Executive Summary

The Ice Sheet Model Intercomparison Project for CMIP6 (ISMIP6) held a workshop entitled “ISMIP6 initialization, forcing and datasets” the weekend prior to the fall AGU meeting (12-13 December 2015) at the Fort Mason Center, San Francisco, USA. The workshop occurred in a location adjacent to the GrI/OOS meeting (Greenland Ice Ocean Observing System), which allowed a joint session on the morning of the 12th of December (and further interactions during breaks) between ISMIP6 and GrI/OOS to discuss modeling needs versus what is achievable with observations. The ISMIP6 workshop was attended by 25 participants, and approximately consisted of 1/3 observationalists, 1/3 ice sheet modelers, 1/3 ice sheet - climate modelers. CliC was our only sponsor, and the funds received helped the travel of 10 participants.

The objectives of the workshop were to i) continue the planning of the ISMIP6 effort and gather information required for the ISMIP6 paper description required for the Geophysical Model Development (GMD) journal special issue on CMIP6 endorsed MIPs, ii) analyze the outcome from the first ISMIP6 experiment (initMIP) that focuses on the impact of initialization methods on sea level projections resulting from ice sheet models, and iii) start building collaboration between ISMIP6 participants and communities that could provide key input to ISMIP6. The sessions were designed with a similar format: introduction of the topics by a member of the ISMIP6 steering committee, presentations by our participants, followed by general discussions. The outcome will be a journal article that present the framework of ISMIP6, which will be submitted to GMD in the spring of 2016, a deadline set by CMIP6.

Background

The Ice Sheet Model Intercomparison Project for CMIP6 (ISMIP6) became a targeted activity of CliC in the summer of 2014, and endorsed by CMIP6 in the summer of 2015. Following the CMIP6 direction, all endorsed MIPs are required to submit a manuscript for publication in the special issue of the journal of Geophysical Model Development (GMD) that describes the CMIP6 effort. The workshop was designed to continue the planning of the ISMIP6 effort, gather information necessary for the GMD manuscript that is due in the spring of 2016 and obtain a community agreement for the ISMIP6 framework and goals.

The workshop was announced on the cryolist and ISMIP6 mailing lists, with cryolist being the major mailing list for the cryospheric community. Participants were selected based on their interest and participation in ISMIP6 and were asked to write a small application describing how they would contribute to the workshop and ISMIP6. The ISMIP6 steering committee organized the workshop, which was sponsored by CliC. The 3000CHF allocated by CliC helped the travel of 10 participants.

Objectives

The primary objective of the workshop was to introduce the ISMIP6 framework to the potential ISMIP6 community and begin forming an ISMIP6 community. ISMIP6 brings for the first time ice sheet modelers from different “groups”, more specifically individuals at i) universities or federal agencies that develop state of the art ice sheet models, ii) climate centers that couple ice sheet models to climate models, and iii) experts in observations of the polar regions.

The second objective was to get community “buy in” to the different aspect of ISMIP6 by presenting the current framework for ISMIP6 and obtaining feedback on the proposed approach. ISMIP6 is now at a stage where more detailed planning of the experimental and modeling approach is required, which requires consensus from the ISMIP6 community. The presentations and discussions will serve as the foundation of the ISMIP6 GMD manuscript mentioned above.

Details

The workshop started with a joint session with the Greenland Ice Ocean Observing System (GrOOOS) on the morning of Saturday 12th December. The motivation for this joint discussion between the ice sheet modeling community and scientists that collect observations is to start the discussion of what the modeling needs are, and what information the observing community can provide to tackle the extremely challenging field of ice-ocean interaction. The GrOOOS workshop was also sponsored in part by CliC, with the goal of bringing the ice sheet and ocean communities closer. To allow for collaborations to form, the two workshops met for lunch on Saturday and Sunday, and for an evening ice breaker on the Saturday evening.

The Saturday afternoon session focused on initMIP, the first intercomparison exercise of ISMIP6 for standalone ice sheet models. initMIP seeks to investigate the impact of initialization methods for ice sheet models. The knowledge gained from this initial experiment will provide crucial information on future experimental design (such as should datasets be identical for each models) and provide an initial indication of whether it is possible to quantify the uncertainty in sea level projection arising from the initial state of ice sheet models. This first experiment is also designed to test the framework that will be used for future ISMIP6 experiments, including the model outputs that need to be saved for comparing the models and the ISMIP6 standard output grid. After an overview of initMIP presented by Heiko Goelzer, the modeling groups that were present (ISSM, PISM, BISICLES, CISM, GISM, Elmer-Ice, IcIES) described their initialization procedure.

Heiko proceeded by showing a preliminary analysis of the results from four models: ISSM, PISM, GISM, and BISICLES for the Greenland ice sheet. It was decided that to reach our goal of a publication by the end of 2016 (with Heiko being lead author), modeling groups should submit preliminary results in time for a workshop at EGU 2016.

This would allow for groups to then revise results if necessary, with a hard deadline of final submission in time for the summer IGS meeting. Many ideas were put forward on how to extend initMIP, but a concern is that ISMIP6/CMIP6 tight deadlines may limit some of the aspect that can be covered with initMIP. It is possible that, based on the outcome of the EGU intercomparison, ISMIP6 will still design additional experiments to explore the uncertainty in projection due to the initial state, but groups would not be required to take part in these additional experiments. However, participation in the current two initMIP forward simulations (control run, ctrl, and imposed anomaly in surface mass balance, asmb) may become the entry card for standalone ice sheet models wanting to contribute to the ISMIP6 projections. The duration of the forward experiment was discussed: 40 yrs versus 100 yrs. The longer duration is comparable to the projections that are of interest to ISMIP6, so longer simulations may be ultimately needed in order assess the uncertainty due to the initialization. Groups agree that the most time consuming aspect of initMIP is obtaining an initial state, but that restarting a model simulation after 40yrs to extend this time period is not challenging. More information about initMIP can be found on the wiki (<http://www.climate-cryosphere.org/wiki/index.php?title=InitMIP>)

The first session of the Sunday morning was focused on a discussion of new datasets that could be useful for ISMIP6. Nicole Schlegel presented a new integrated dataset for the arctic that is being under review in BAMS. This monthly dataset includes for example cloud properties, radiative fluxes, radiation fluxes at the top and bottom of atmosphere on a 2.5x2.5 deg grid. Andy Shepherd presented the new IMBIE2 effort, which compared to IMBIE, will extend i) the number of observations of surface mass balance (new altimetry, InSAR and gravimetry), ii) the observational period, and iii) perhaps include additional surface mass balance models. For this dataset to be of maximum use to ISMIP6, the observed mass change would ideally be split into contribution from dynamics and surface mass balance. ISMIP6 plans to use the IMBIE2 basins for its analysis/model intercomparison. Tom Neumann presented the CmCt (Cryospheric model Comparison tool), a web based tool that is being created at NASA GSFC, with the aim of removing the barriers between model and observations intercomparisons. The tool can be also expanded to allow for quick model to model (and multiple models) intercomparison. At present the tool searches the closest elevation measurement in space and time to a model grid point and is able to calculate a number of statistics. The tool is currently designed for altimetry measurements from ICESat over the Greenland ice sheet, but the plan is to extend it for Antarctica, include more observational datasets and analysis capabilities. Discussions included the need for the tool to be able to cope with unstructured grids, the capability for users to obtain the datasets used in the intercomparison, and perhaps “place it” on top of a data center to allow for more datasets to be included.

The second session on Sunday, led by Bill Lipscomb and Jonathan Gregory, focused on the coupled ice sheet climate model aspect of ISMIP6: 10 climate groups are interested in ISMIP6, with 9 groups aiming for a contribution to the coupled ice sheet-climate model experiments for the Greenland ice sheet. These groups (models) are: NASA GISS (ModelE/PISM), LANL/NCAR (CESM/CISM), JAMSTEC/AORI (MIROC-ESM/IcIES), CNRM/IPSL/LGGE (CNRM/Grisli, maybe CNRM/Elmer), UK Met Office

(HadGEM3/BISICLES), INM (INMCM/VUB), DMI (EC-Earth3/PISM), MPI (MPI-ESM/PISM). Groups that were present (CNRM/IPSL/LGGE, NASA GISS, LANL/NCAR, JAMSTEC/AORI, DMI and MPI) presented their models. Bill introduced the proposed experimental framework for the coupled aspect of ISMIP6, along with some suggested ground rules: i) spin up procedure will not be dictated by ISMIP6, but left for groups to decide, ii) the SMB from climate models should be computed using an energy based method, iii) the surface type and the surface elevation of the climate model are dynamic, iv) changes in ice sheet mass should affect the ocean temperature and salinity, v) ice sheets are free to go where the forcing wants them to go. In the CMIP6 proposal, two model configurations were proposed: “forcedISM” and “withISM”. The former refers to a standalone ice sheet model forced by output from the AOGCM, while the later refers to the case where the ice sheet model is run interactively with the AOGCM. Comparing the output from these two configurations allows ISMIP6 to quantify the effects of climate feedbacks, while the standard DECK experiments will allow comparison to the AOGCM without interactive ice sheets. There were no objections to the suggested ground rules and evaluation strategy, apart that it may be necessary to have an additional experiment to fully assess the impact of ice sheet models on climate models. This experiment would be optional and involve AOGCM runs only where the ice sheet topography is replaced with the topography from the coupled ice sheet-climate model simulation.

The next session, led by Tony Payne, focused on the standalone ice sheet model aspect of ISMIP6, with contributors being based at universities or federal agencies (in other words, a different group than the ice sheet models used in climate centers, discussed above). ISMIP6 will not place constraints on input datasets or physical parameters used in these ice sheet models. It is proposed that the IMBIE2 datasets and basins are the focus of the evaluation of ISMIP6 model runs, and used in a manner similar to Ritz et al. (2015). Groups taking part in the Antarctic experiments may be required to run the MISOMIP experiments (Asay-Davis et al., under review). . A lively discussion followed as to whether models should be weighted and/or excluded based on the MISOMIP outcome. To allow ice sheet models to use fine resolution for Antarctica, ISMIP6 may ask for basin contributions instead of the whole ice sheet. Possible approaches for obtaining atmospheric and oceanic forcings were reviewed by Tony, and the conclusion is that ISMIP6 should provide SMB and perhaps surface runoff, along with ocean temperature and salinity. Melting rates and calving rates may not be prescribed by ISMIP6, allowing for groups to infer these rates the way that they see most fit, a reflection of the current scientific uncertainty on how to obtain oceanic forcing. An additional experiment that would provide sub-ice shelf melting rates to be applied directly instead of ocean temperature and salinity was also suggested to assess the impact of the parameterization choice to convert ocean properties away from the ice shelf cavity into basal melting rates under the floating ice.

The final session covered an introduction by Eric Larour of the current state of uncertainty quantification for ice sheet models. This emerging field includes for example: i) adjoint methods, ii) sampling and forward sensitivities, and iii) Bayesian/ensemble/other approaches. A good discussion followed on what the

challenges are (i.e. spatial scale, temporal resolution, parameter scale, reconciliation of the different approaches etc), or what could be asked to participants (i.e. should sensitivity to a given parameter be asked, how to select parameters needs to be further investigated). Given that there are so many options, it was decided that a questionnaire will be drafted by Eric and Tamsin to enquire about the type of experiments that groups are able to carry out, and whether there is interest in a suggested ISMIP6 uncertainty quantification exercise. The last presentation was given by Ayako Abe-Ouchi on the ISMIP6-PMIP4 joint effort. The goal would be to link the last interglacial (LIG, 140-115 kyr before present) sea level to future sea level. The ice sheet models would use a forcing that is derived from the AOGCMs taking part in the PMIP4 LIG experiment, but the implementation, and participating models are likely to be different than the ones discussed previously. This is because the LIG experiment targets paleo ice sheet system models who need to be capable of running long transients and transient paleo initializations. The implication is that the ground rules may therefore have to be distinct for this experiment. Ayako will continue being the lead of this experiment.

Concluding Remarks

In conclusion, the workshop was the first ISMIP6 workshop that covered all the components of ISMIP6, and that brought together different members of ISMIP6 (ice sheet modelers, climate modelers, and dataset providers). The goals were to present the ISMIP6 framework, obtain feedback and “buy in” from the community, gather information that is required for the “ground rules” of ISMIP6, and discuss components that will need to be included in the ISMIP6 GMD description manuscript. The discussions highlighted areas that need to be revisited for example, the ISMIP6 data request, and how to better link/differentiate all the different aspects of ISMIP6. The success of ISMIP6 will require regular workshops, and it is proposed that ISMIP6 workshop occur at each major conference that ISMIP6 members are likely to attend.

Appendices

Participant List Table (Early Career Researchers are indicated with an *)

Name	Email	Affiliation	Nationality
Participants that received CliC travel funding			
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Bill Lipscomb	lipscomb@lanl.gov	LANL, USA	USA
Tony Payne	A.J.Payne@bristol.ac.uk	U Bristol, UK	UK
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Final Agenda

Location of ISMIP6 meeting: Room 210, Landmark Building C, Fort Mason.

Location of GrIOOS meeting: The FireHouse, Fort Mason

Fort Mason: 2 Marina Blvd, San Francisco, CA 94123, <http://fortmason.org>

Saturday December 12th

8:30-9:00 breakfast joint with GrIOOS

9:00-10:40 GrIOOS Session 1: Why an Observing System

Review of basic understanding of ice forcing ocean and vice versa; identify the long-term needs

Chairs: Patrick Heimbach; I. Joughin

1. Introduction and Goals (Straneo, 20 min)
2. Glacier retreat/advance – (G. Hamilton/T. Moon – 10 min)
- 3 Ocean forcing glaciers
 - i) Theory/Modeling/Observations of submarine melting (A. Jenkins)
 - ii) Ice sheet Modeling: Impact of ocean variability (T. Payne)
4. Glaciers forcing ocean (Sutherland/Heimbach)
5. Atmospheric forcing of glacier setting – (A. Ahlstrom)
6. Impact of glacier changes on the marine ecosystem – (A. Rosing-Asvid)

10:40-11:00 Coffee Break

11:00-12:30 GrIOOS Session 2: What have we learned - glacier/fjord projects?

Chairs: F. Straneo; G. Hamilton

Brief reviews (3 slides) of glacier/fjord experiments – less on results and more on:

- i) what are the characteristics of the site (glacier/ocean) studies
- ii) what are the main findings in relation to long-term observations
- iii) comments on methodology (what worked, what did not)
 - Ummanaq (**Catania**/Sutherland/Stearns)
 - Nuuk Fjord/Glacier (**Mortensen**)
 - Store Glacier (**Hubbard**)
 - Upernivik (**Ahlstrom**)
 - Bowdoin (**Sugiyama**)
 - Alison/Hayes (**Porter**)
 - Qanaaq –(**Rodehacke** summarizes DMI work)
 - Helheim/Sermilik F. (Hamilton/Stearns/Straneo)
 - Kangerlugssuaq (**Inall**)
 - Jakobshavn (**Holland**)
 - Petermann – **Mix**
 - 79 North – (Straneo summarizing AWI plans)

Lunch 12:30-13:30 joint with GrIOOS

13:30 to 15:00 ISMIP6 Session 1: Focus on initMIP - Part 1

Lead: Heiko Goelzer. Note taker: Helene Seroussi

The first experiment for the standalone ice sheet models participating in ISMIP6, initMIP, focuses on the uncertainty in sea level projection due to the methods used to initialize ice sheet models.

Talk + discussion led by Heiko Goelzer:

- Overview of initMIP + goals
- Presentation from groups that are here on their model / approach: ISSM (via Nicole, Helene), PISM (via Andy Achswanden), BISICLES (via U of Bristol), CISM (via Joe Kennedy and Bill Lipscomb), GISIM (via Heiko), Elmer (via Olivier), GRISLI (via Catherine), IcIES (via Saito and Ayako)

Break 15:00-15:30

15:30-17:30 ISMIP6 Session 2: Focus on initMIP - Part 2

Lead: Heiko Goelzer. Note taker: Helene Seroussi

Talk + discussion led by Heiko Goelzer:

- Example of result from all groups that have submitted a few days before the meeting
- Thoughts/Discussion of how to continue with initMIP (ex: if 95% are using the same bed: encourage the other 5% to use the same bed).
- What is needed to get a paper?

17:00-20:00 -Joint Reception with GrIOOS: location GrIOOS venue

Sunday December 13th

9:00-10:00 ISMIP6 Session 3: Datasets for ISMIP6

Lead Sophie Nowicki. Note taker: Helene Seroussi

Goal is to start thinking about new observational dataset and tools for ISMIP6

Talks + discussion led by Sophie Nowicki:

- IMBIE2 by Andy Shepherd
- GEWEX dataset by Nicole Schlegel
- CmCt (Cryospheric model Comparison tool) by Tom Neumann
- Open discussion on datasets: are there datasets that ISMIP6 should suggest to Obs4MIPs, are there datasets that are missing, etc

10:00-10:30 Break + Picture for CliC Report

10:30-12:30 ISMIP6 Session 4: Focus on Coupled Ice Sheet Climate Models Aspect of ISMIP6

Leads: Bill Lipscomb + Jonathan Gregory. Note taker: Helene Seroussi

Goal is to polish the strategy for ISMIP6/ iron out / find missing pieces that are needed for the ISMIP6 GMD description paper will be due in spring 2016.

Talk + discussion led by Bill Lipscomb:

- *Overview of coupled aspect of ISMIP6*
- *Groups that are there can present themselves with a few slides: DMI (Shuting Yang), ModelE (Elizabeth Fischer), MPI (Florian Ziemen), CISM (Bill Lipscomb), MIROC-ESM (Ayako Abe-Ouchi)*
- *Overview of responses from questionnaire of climate modeling groups participating in ISMIP6.*

Note: We also need to be clear about / decide what goes into the GMD paper. There are at least two major exercises here – the coupled and the standalone (perhaps we will need to take different approaches for Greenland and Antarctica as well). Can we fit both into one paper?

12:30-13:30 Lunch

13:30-15:30 ISMIP6 Session 5: Focus on Standalone Ice Sheet Model Aspect of ISMIP6

Lead: Tony Payne. Note taker: Helene Seroussi

Idea here is to polish the strategy for the standalone ice sheet model component of ISMIP6 (maybe not all the details but have all major methodological issues are sorted).

Discussion led by Tony Payne:

- 1/ to what extent do we want to include ensembles of experiments with an ice sheet model? this would involve repeating ice-sheet model runs for a given scenario/AOGCM forcing combination to explore, for instance, the effect of parameter values. how many members of such an ensemble would be possible? what parameters should we be varying in the ensemble?
- 2/ how should we be forcing the standalone ice sheet models? what variables are required from the AOGCMs for SMB and ocean melt forcing?
- 3/ how tightly defined should we make other datasets such as bedrock elevation?
- 4/ duration of the experiment. need we go further than 2100? how?
- 5/ should we provide standard parameterizations of poorly resolved processes such as sub-shelf melt, ice-shelf break up and calving?

Break 15:30-16:00

16:00 – 18:00 ISMIP6 Session 6: ISMIP6 Uncertainty quantification, link with PMIP & other business

Note taker: Helene Seroussi

ISMIP6 and uncertainty quantification – Lead: Eric Larour

Link with PMIP (Paleo Model Intercomparison Project) – Lead: Ayako Abe-Ouchi

ISMIP6 other business: Action Plan for ISMIP6 + deadlines + targets, data request – Lead: Sophie Nowicki

Useful links

ISMIP6 website: <http://www.climate-cryosphere.org/activities/targeted/ismip6>

ISMIP6 wiki: http://www.climate-cryosphere.org/wiki/index.php?title=ISMIP6_wiki_page

Acronyms

AGU: American Geophysical Union

AOGCM: Atmosphere-Ocean General Circulation Model

AORI: Atmosphere and Ocean Research Institute

BISICLES: Berkeley Ice Sheet Initiative for Climate Extremes

CESM: Community Earth System Model

CISM: Community Ice Sheet Model

CliC: Climate and Cryosphere

CMIP6: Climate Model Intercomparisons Project 6

CNRM: Centre National de Recherches Météorologiques

DMI: Danish Meteorological Institute

EC-Earth: European Earth System Model

GISM: Greenland Ice Sheet Model

GISS: Goddard Institute for Space Studies

GrOOS: Greenland Ice-Ocean Observing System

HadGEM3: Hadley Centre Global Environment Model version 3

IcIES: Ice sheet model for Integrated Earth system Studies

initMIP: initial Model Intercomparison Project

INM: Institute of Numerical Mathematics

INMCM: Institute of Numerical Mathematics Climate Model

IPSL: Institut Pierre Simon Laplace

ISMIP6: Ice Sheet Model Intercomparison Project for CMIP6

ISSM: Ice Sheet System Model

JAMSTEC: Japan Agency for Marine Earth Science and Technology

LANL: Los Alamos National Lab

LGGE: Laboratoire de Glaciologie et Géophysique de l'Environnement

LIG: Last InterGlacial

MIROC-ESM: Model for Interdisciplinary Research on Climate - Earth System Model

MISOMIP: Marine Ice Sheet Ocean Model Intercomparison Project

MPI: Max Planck Institute

MPI-ESM: Max Planck Institute-Earth System Model

NASA: National Aeronautics and Space Administration

NCAR: National Center for Atmospheric Research

PISM: Parallel Ice Sheet Model

PMIP4: Paleo Model Intercomparison Project 4

VUB: Vrije Universiteit Brussel