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Grand Challenge: Melting Ice – Global Consequences

**WCRP Joint Scientific Committee
Nanjing, China**

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**Canadian Centre for Climate Modelling
and Analysis, Climate Research Division**

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Highlights

- Given limited resources, and obvious overlap with CliC, JSC-approved workplan (2016) involved focus on the following topics:
 - thawing permafrost and the potential for enhanced natural emissions of carbon dioxide and methane to the atmosphere;
 - shrinking of mountain glaciers and large ice sheets with consequent sea-level rise and impacts on water resources;
 - declining coverage of sea ice and snow, which will affect marine and ground transportation across the Arctic
- Further, given development of CMIP6, the upcoming IPCC Assessment and Special Reports, and the desire to have Cryosphere research community better engaged, the focus was on establishing targetted activities related to the cryosphere in climate models.



Highlights, cont'd ...

- Three CMIP6-endorsed MIPs that arose from Grand Challenge discussions/impetus are now underway:
 - SIMIP – Sea Ice Model Intercomparison Project, led by Dirk Notz (MPI) and Alexandra Jahn (UC Boulder)
 - ISMIP6 – Ice Sheet Model Intercomparison Project for CMIP6, led by Sophie Nowicki (NASA GSFC), Eric Larour (NASA JPL) and Tony Payne (U. Bristol)
 - ESMSnowMIP component of LS3MIP, led by Gerhard Krinner (CNRS) and Chris Derksen (ECCC)
 - All three have a GMD paper describing the activity
- In addition, GlacierMIP, led by Regine Hock (U. Alaska) and Ben Marzeion (U. Bremen), though not a CMIP6-endorsed MIP, is closely aligned with CMIP6.



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The CMIP6 Sea-Ice Model Intercomparison Project (SIMIP): understanding sea ice through climate-model simulations

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Abstract. A better understanding of the role of sea ice for the
changing climate of our planet is the central aim of the diag-
nostic Coupled Model Intercomparison Project 6 (CMIP6)-

questions that sea ice still poses to the international climate-
research community.



ISMIP6

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Ice Sheet Model Intercomparison Project (ISMIP6) contribution to CMIP6

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Abstract. Reducing the uncertainty in the past, present, and future contribution of ice sheets to sea-level change requires a coordinated effort between the climate and glaciology communities. The Ice Sheet Model Intercomparison Project for CMIP6 (ISMIP6) is a multi-centre effort to evaluate the current state of ice sheet modelling and to identify key areas for improvement. This paper describes the project and its objectives. The project is a multi-centre effort to evaluate the current state of ice sheet modelling and to identify key areas for improvement. This paper describes the project and its objectives.

1 Introduction

Ice sheets constitute the largest and most uncertain potential source of future sea-level rise (Church et al., 2013; Kopp et al., 2013). The Greenland and Antarctic ice sheets currently



Early Success and/or planned activities

- A large European consortium has developed a mission proposal focused on remote sensing of the cryosphere in both the Arctic and Antarctic, and I was invited to participate as they felt it responded directly to scientific needs articulated by this Grand Challenge.

GNSS Transpolar Earth Reflectometry exploriNg system (G-TERN): Mission concept

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- an example of the influence WCRP is having more broadly in motivating new research activities

II. SCIENTIFIC OBJECTIVES

Advancing the understanding of the cryosphere in a changing climate has been identified as a 'Grand Challenge' by the World Climate Research Programme (WCRP). Components of the cryosphere play a central role in several processes that remain an important source of uncertainty in projections of future climate change. Examples of such processes are the prospect of an ice-free Arctic Ocean in contradistinction to Antarctic sea ice increase; the role of ice-sheet dynamics in amplification of Greenlands and Antarctic contribution to the global sea-level rise; the fate of mountain glaciers providing fresh water to hundreds of millions of people worldwide; and the strength of positive feedbacks between the warming climate and natural emissions of greenhouse gases from the thawing permafrost [35]. Furthermore, a particular issue has emerged in past Intergovernmental Panel on Climate Change (IPCC) Assessments [36] as topic of considerable uncertainty: the ability of models to simulate recent declines and future changes in sea ice. Recent studies have linked changes in snow and ice to circulation changes, weather extremes, and the obvious impacts on terrestrial and marine ecosystems, which create a great sense of urgency [37]. For the reasons discussed below, G-TERN primarily aims to contribute to understanding



Early Success and/or planned activities

- All MIP activities have active leadership and engaged communities; all have had multiple planning workshops and are initiating activities based on available CMIP5 model output.
- Nest steps await simulations by modelling centres and availability of CMIP6 output.



Issues and Challenges

- This GC operates with very limited resources and depends on the generous contributions of scientists leading the various intercomparison activities.
- As has been the case from the start, it has been difficult to clearly distinguish between the activities of the cryosphere GC and the CliC core project. In some sense this doesn't matter, but in the future we should avoid such ambiguities to the extent possible.
- I have been leading this GC since its inception (in my capacity as CliC co-chair), but since I am no longer co-chair, I feel it would be better to pass this responsibility on, ideally to someone who can put more time and energy into it, though not much is really needed at this point.

