BAMS
Meeting Summary

The Community-Based Road to CMIP7 in the Geoengineering Model Intercomparison Project (GeoMIP)

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14th GeoMIP Meeting

What: The Geoengineering Model Intercomparison Project (GeoMIP) held its 14th annual workshop, with almost 70 in-person participants and 15 remote participants for a robust discussion about future experiments and community needs in light of phase 7 of the Coupled Model Intercomparison Project (CMIP7).

When: 10–12 July 2024

Where: Cornell University, Ithaca, New York

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1. Introduction

The 14th GeoMIP meeting was held in Ithaca, New York, USA, 10–12 July 2024, at Cornell University. Issues with visas from Global South countries notwithstanding, it was one of the largest GeoMIP meetings with almost 70 in-person participants (Fig. 1) and 15 remote participants.

The structure of the meeting was heavily shaped by the feedback received during the previous meeting (Visioni et al. 2023a) in Exeter, U.K., in 2023, and especially the observations of the Early Career Meeting that preceded the 2023 plenary meeting, where the early career participants suggested multiple improvements to make the meeting more accessible. The workshop was spread out over 3 days instead of 2 and allowed for more occasions for smaller discussions, structured in six different break-out groups, as well as more open time in the plenary, in order to allow for different voices and perspectives more time to speak.

To facilitate discussions, and make sure early career or first-time participants were up to speed with how GeoMIP works and the goals of the meeting, for the first time, a document outlining the road so far and the necessary decisions that needed to be taken during the meeting was distributed in advance of the meeting (the appendix), something that many participants found very beneficial.

The meeting, after an introduction by the local host and cochairs, started with a series of talks, setting the stage for the discussions to be had. The first four talks involved a series of speakers outlining the challenges of communicating solar radiation modification (SRM) research to policymakers (Jessica Seddon, Yale), a focus on potential integrations between climate model output and Integrated Assessment Models (Pietro Andreoni, Euro-Mediterranean Center on Climate Change), and what insight can be gleaned on

Fig. 1. Photo of all the in-person participants in front of Sage Hall at Cornell University, Ithaca.

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non-cooperative, nonideal deployments, and a discussion of potential research directions and obstacles to SRM research in Africa (Chris Lennard, University of Cape Town). These were followed by another group of talks discussing potential new experiments with GeoMIP (Lauren Wheeler, Sandia National Laboratories) and some early results from the new experiment decided last year and described in Visioni et al. (2024), that is now in the CMIP7 Fast Track (Walker Lee, National Center for Atmospheric Research, NCAR) and from a new proposed experiment (Simone Tilmes, NCAR). Talks were also presented during the morning of the second day, more focused on results from available GeoMIP experiments looking at impacts in South America (Inés Camilloni, University of Buenos Aires) and Africa (Romaric Christel Odoulami, University of Cape Town), followed by some early career participants showing their work and struggles with trying high-resolution simulations of SRM (Jasper de Jong, Utrecht University) and with Marine Cloud Brightening experiments (Haruki Hirasawa, University of Washington). The second morning was concluded by a talk discussing potential microphysical challenges in subgrid processes of plume dispersal (Fangqun Yu, University at Albany).

The two afternoons were dedicated to both breakout groups discussing specific issues of interests and to two poster sessions including 56 posters overall. The breakout groups were "Development and use of emulators for SRM" (chaired by Claudia Wieners, Utrecht University), "Policy relevant or plausible scenarios" (chaired by Jesse Reynolds, the DEGREES Initiative) and "Impact modeling studies and climate geoengineering: Important variables, downscaling, simulations, and bias correction" (chaired by Temitope S. Egbebiyi, University of Cape Town), for the first day, and "Marine Cloud Brightening" (chaired by Jim Haywood, University of Exeter), "Idealized experiments" (chaired by Ben Kravitz, Indiana University), and "Polar SAI simulations" (chaired by Alistair Duffey, University College London) for the second day. The topics had been partly proposed by the cochairs and partly proposed by the community members beforehand. All chairs were volunteers, and they presented a summary on the following morning of the discussions and outcomes of each breakout group. It was particularly pleasing to everyone to see early career researchers, and researchers from all over the world, taking part and chairing each group. Furthermore, it was valuable and conductive to a very useful final discussion to have each group report back, so that some core recommendations and reflections had already been made and could be presented to the broader group, ensuring that everyone was up to speed on what had happened in each group before making decisions.

The second day concluded with a public talk "Carl Sagan, the climate crisis and planetary engineering" by Oliver Morton (The Economist, the DEGREES Initiative) offered to the wider Cornell community and very well attended, which was followed by the customary GeoMIP dinner.

The last day was devoted to final, plenary discussions that touched upon all the issues discussed in the previous days, and, after a lively and cordial discussion, many steps were taken to clarify future steps for GeoMIP.

The community converged on the following points:

1) A series of CMIP7 experiments was decided, with volunteers for each helping to coordinate future discussions. Such experiments are to be described in a *Geoscientific Model Development* paper to be submitted together with all other CMIP7 ones.
   (i) A **G6-1.5K-SAI** experiment for CMIP6 models as described in Visioni et al. (2024) together with a future **G7-1.5K-SAI** using CMIP7 models and included in the fast track. Point of Contact: Walker Lee.
   (ii) The exploration of the possibility for a **G7-1.5K-MCB** experiment, including the proposal of sensitivity experiments to be run by multiple models to understand model behavior and prepare the road for a more definitive experimental protocol that right

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now does not exist. This also includes defining necessary diagnostic variables to be used to understand models' behavior. Point of Contact: Haruki Hirasawa.

(iii) There was a broad agreement from the community that it might not be worthwhile running again a G1 experiment (4xCO_2 baseline with a matching solar dimming, Kravitz et al. 2021), whereas early results discussed last year and shown during the meeting proved that a G2-like experiment might be more worthwhile, given the focus of the future SAI simulations. Therefore, there is a proposal for a **G2-SAI** experiment under the idealized 1pCO_2 DECK experiment (1% increase in CO_2 concentrations per year, Eyring et al. 2016), to be divided in a **G2-SOLAR** (with the same goal achieved through a broad solar reduction, to be run in addition or stand-alone for models without an interactive sulfur cycle), a **G2-SAI-1DOF** (including injections at 30°N and 30°S with the single goal being maintaining global mean surface temperatures (GMST) at preindustrial control levels, similar to the G6-1.5K-SAI strategy, with DOF standing for Degrees of Freedom), and a **G2-SAI-3DOF** [including injections at 30°N, 15°N, 15° and 30°S with three temperature goals of maintaining GMST, interhemispheric and equator-to-pole temperature gradient at piControl levels, as in the ARISE experiment (Richter et al. 2022)]. Point of Contact: Simone Tilmes.

(iv) A **G7** experiment with high-latitude, low-altitude injections following early work by Lee et al. (2023) and Smith et al. (2022) to be better defined following sensitivity analyses and exploring the potential to include in the codesign of the experiment indigenous communities in the Arctic and the potential to explore deployment strategies that might be possible with existing aircraft. Points of Contact: Alistair Duffey and Lauren Wheeler.

(v) **Single injection locations** of fixed magnitude (12 Tg SO_2) at various latitudes (60°N, 30°N, 15°N, Equatorial, 15°S, 30°S and 60°S) as described in the testbed in Visioni et al. (2023b); these are not intended to describe realistic deployment scenarios but rather to explore model differences and to aid in training emulators of climate models. Point of Contact: Daniele Visioni.

(vi) Potential for a timeslice experiment for the last 20 years of a G6-1.5K-SAI experiment in high-resolution modeling versions or following a similar protocol as those in the Detection and Attribution Model Intercomparison Project (DAMIP; Gillett et al. 2016) experiments.

2) The "Policy relevant or plausible scenarios" breakout group had many suggestions about the need to engage with policymakers more directly when devising future scenarios, while also noting that, as a community, scientists might not have the right training to do that. However, at this workshop, some people with more expertise were already present, and expanding GeoMIP base to include people who might have such expertise might be a good way to codesign scenarios that achieve the highest impact.

3) Together with discussions about modeling experiments, the breakout groups had a substantial focus on data needs for the people analyzing the data. While CMIP7 efforts are underway to better define variables that models need to provide in order to facilitate downstream impact assessments [see Juckes et al. (2024) and the Thematic Variables Working Group for CMIP7, in which GeoMIP is involved], there were also discussions of more specifics needs for GeoMIP. In particular, two themes emerged:

(i) The interest of many groups to build climate emulators that include SRM. This is a rather new thing for GeoMIP, but the community could offer support both in terms of simulations that could be used to inform the emulator development and in terms of output needs from the users, as well as advising in terms of making output available widely. Many noted that emulators that just focus on global mean surface temperature or precipitation without emulators for other impacts of climate intervention

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can be misused if made public without context. There was a broad agreement over the fact that emulators for forcing variables used for impacts assessment can be very useful. Claudia Weiners has expressed interest to organize a meeting devoted to this topic in 2025.

(ii) The need to find more accessible ways to make data—both direct model output and postprocessed results—available, through the building of a dedicated platform. This need arises from the difficulties in accessing the Earth System Grid (ESG) system that stores CMIP6 data, especially as many variables are too large to be downloaded by the often very slow Internet in many Global South countries that constitute a large portion of the user base for GeoMIP. There is also a need to have an accessible platform for GeoMIP data that is not part of CMIP6, for testbed experiments or variables that have not been uploaded through the ESG. Such a system, together with promoting transparency, could also be used to store code, postprocessed data, and emulators and in general make geoengineering research output more widely available. Conversations are ongoing to better define what would be needed to make such a platform a reality.

(iii) The location for the next GeoMIP workshop, the 15th annual one, has been decided and will be Cape Town, South Africa, in May 2025. It will coincide with the first DEGREES Global Forum (https://www.degrees.ngo/globalforum/), with which GeoMIP will partner.

2. Conclusions

The GeoMIP community is growing, as already noted in previous meetings, both in size and in the variety of interests that it serves. To meet the new challenges arising, there is clearly a need to broaden the activities that are included in GeoMIP, which also requires a major volunteer effort from many in the community. This meeting has clearly been an example of how that is happening, given the proactiveness of many of the participants to help, engage, and lead the various streams and future projects that are arising from the community.

It is great that some of the participants have already shared their own reflection of the meeting, focusing in particular on the inclusion of Global South scientists in the meeting. At the following links, the reader can find the reflections by both the Alliance for Just Deliberation on Solar Geoengineering (https://sgdeliberation.org/takeaways-from-the-14th-annual-meeting-of-the-geoengineering-model-intercomparison-project/) and the DEGREES Initiative (https://www.degrees.ngo/record-number-of-global-south-scientists-attend-geomip-2024/).

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APPENDIX

Preparatory Material for the GeoMIP Meeting

This is the material that was sent to the participants in May 2024, with the possibility for input, in order to arrive prepared to the GeoMIP meeting.

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