Advancing coupled modeling to understand sea level change and inform climate action through the courts

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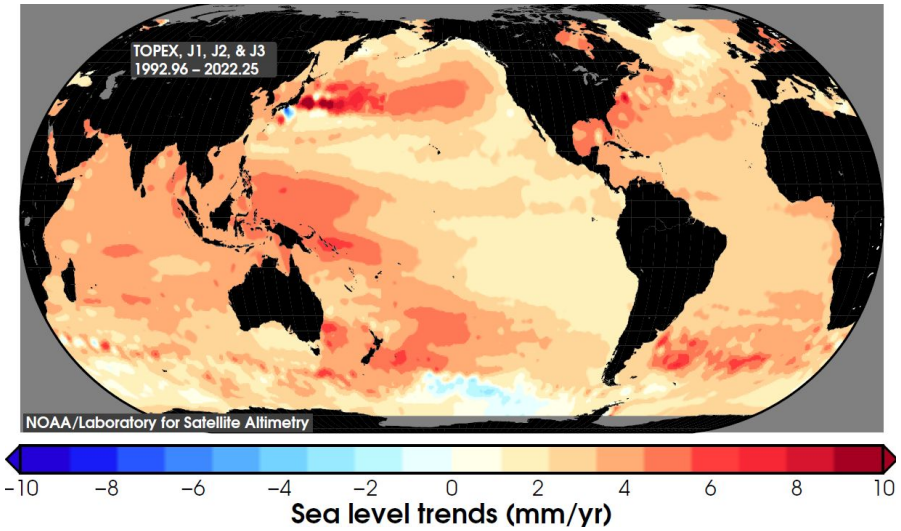
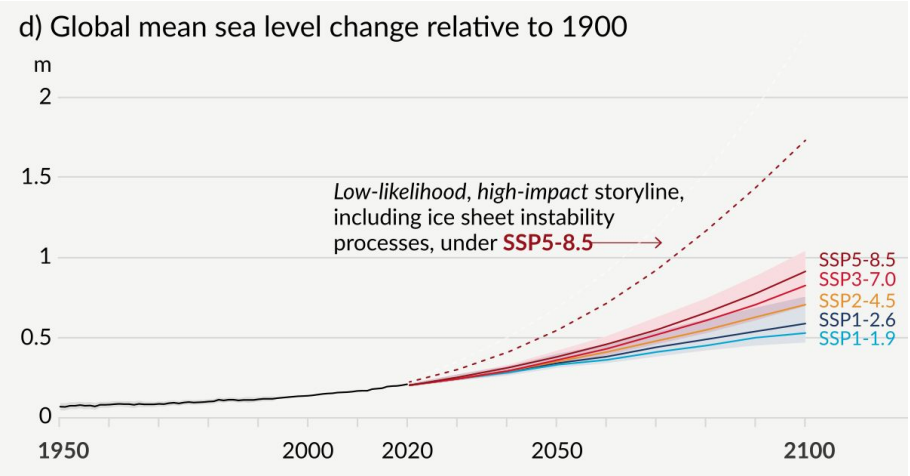
CESM Workshop 2024

Sea level rise

- Long term
- Irreversible on timescales meaningful for human and nonhuman life
- Accelerating over time
- Unevenly distributed across space





Left: NOAA, Right: IPCC AR6 WGI

Sea level rise and climate injustice

- Recognition injustice:
  - SLR presents risk of inundation, forced displacement, salinized freshwater that infringe on the existence rights of human and nonhuman communities
- Distributive injustice:
  - Inequitable impacts with respect to emissions contributions, both in space (AOSIS nations) and time (intergenerational injustice)
  - Risks of overshoot pathways
- Procedural injustice
  - Role of geopolitical power dynamics in shaping global goals and responses

Stike in Vanuatu photo via 350

The Paris Agreement and Climate Justice: Inequitable Impacts of Sea Level Rise Associated With Temperature Targets

S. Sadal[1,2], R. A. Spector[1], R. DeConto[1], and N. Gomez[3]

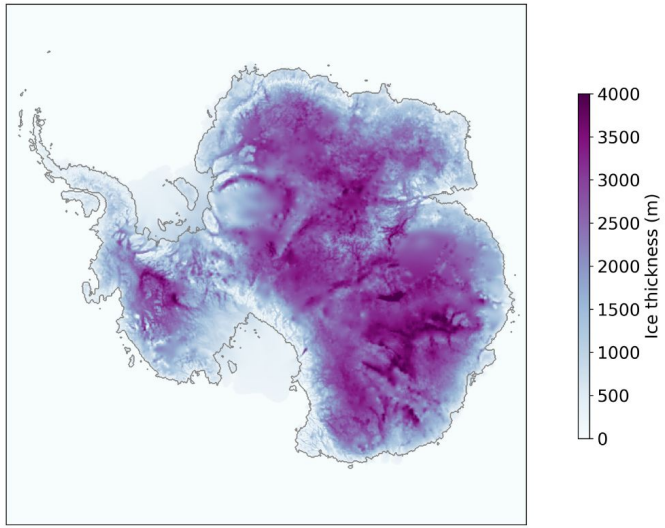
Research updates

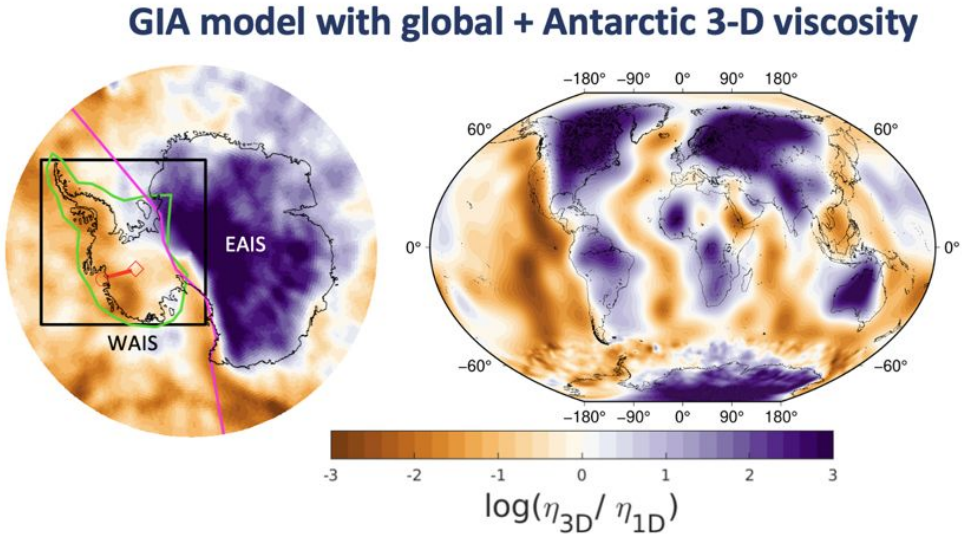
Ruthie Halberstadt

GIA + ice sheet models

Research gap: what influence does 3D Earth structure have on AIS evolution and SL contributions?

- Ice sheet model (PSU3D, DeConto et al., 2021) 3D dynamic-thermodynamic marine based ice sheet model
- GIA model (SEAKON, Latychev et al. 2005) 3D mantle viscosity and lithospheric thickness model input to a 3D GIA model

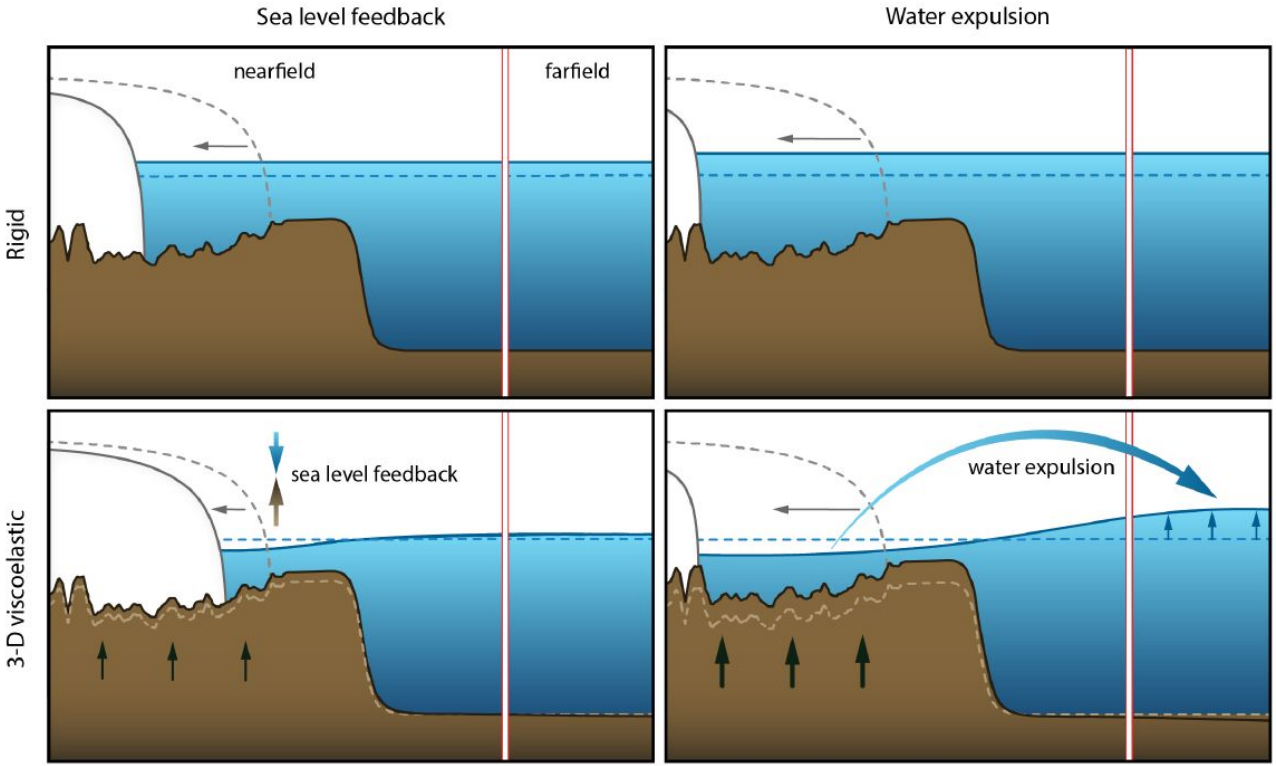




Viscosity structure at 120 km, Gomez et al., in review

Sea level feedback

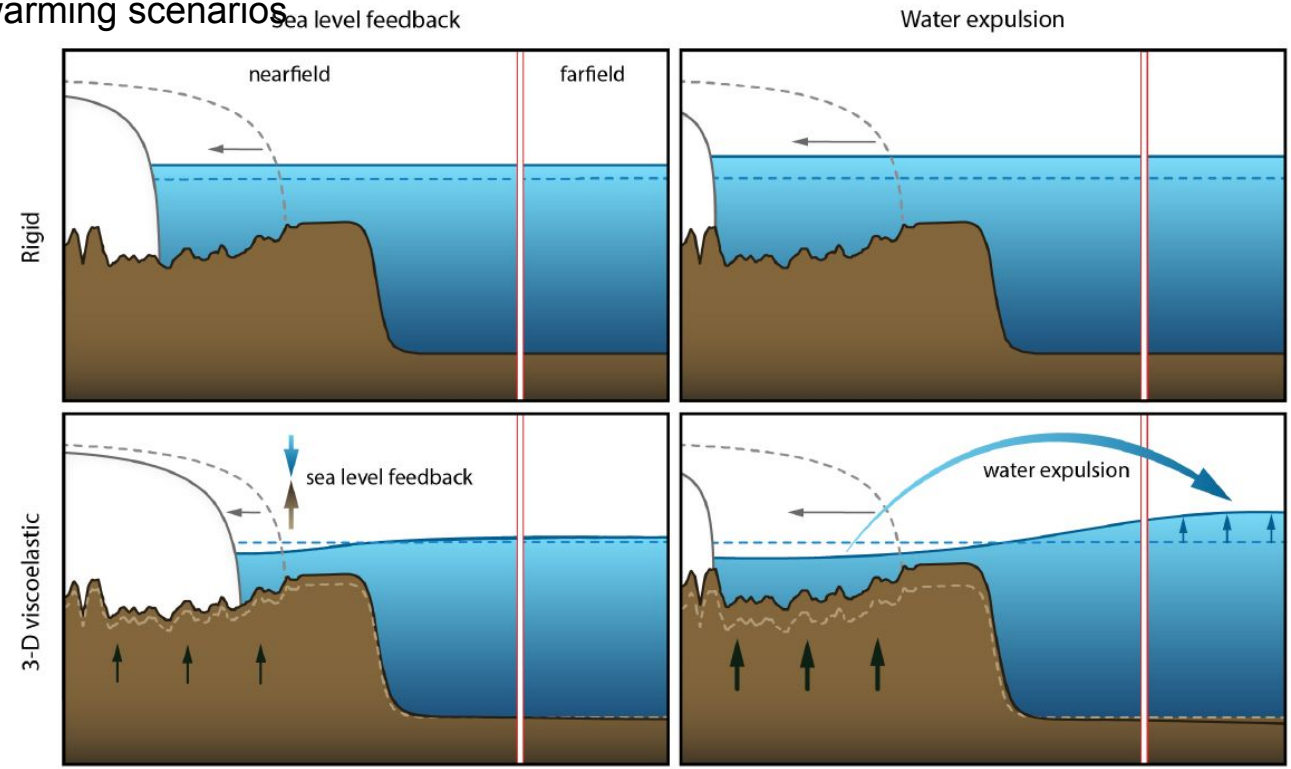
“the sea-level feedback”: ice flux is sensitive to the thickness of ice at the grounding line, which is proportional to water depth so a fall in sea level reduces the ice discharge across the grounding line.



Gomez et al., in review

Sea level feedback

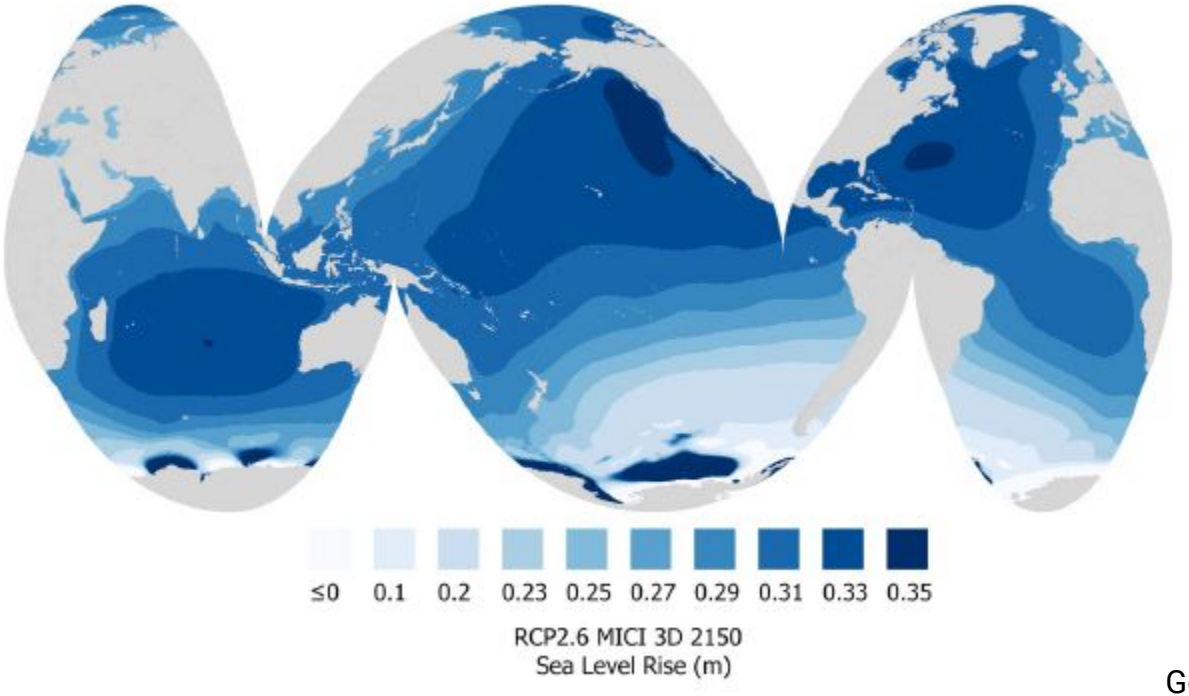
Uplift of the solid Earth due to ice unloading reduces the contribution of Antarctica to sea-level rise under low warming but amplifies it under high warming scenarios



Gomez et al., in review

Spatially variable sea level projections

Gravitational, rotational, and Earth deformational effects lead to spatial variable SLR from ice sheet mass loss (ex. Gomez et al., 2010; Roffman et al., 2023)

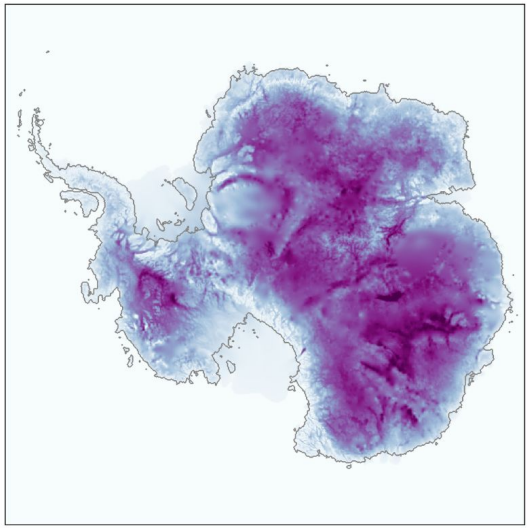


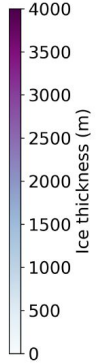
Gomez et al., in review

Climate + ice sheet models

Research gap: how does ice sheet meltwater impact climate, and how does meltwater-perturbed climate impact ice sheet evolution?

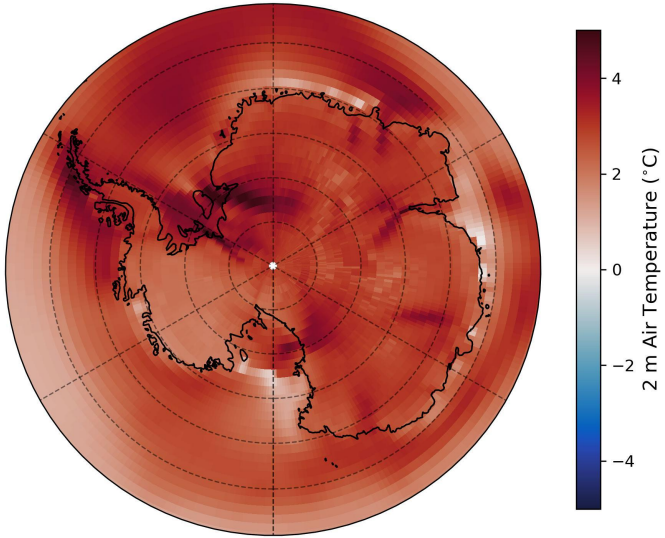
- Ice sheet model (PSU3D) provides combined liquid & solid ice loss rates at all locations around continent
- Climate model (CESM1.2) provides annual averaged subsurface 400 m ocean temps, monthly 2 m air temp & precipitation
- Data is exchanged between the two models each model year



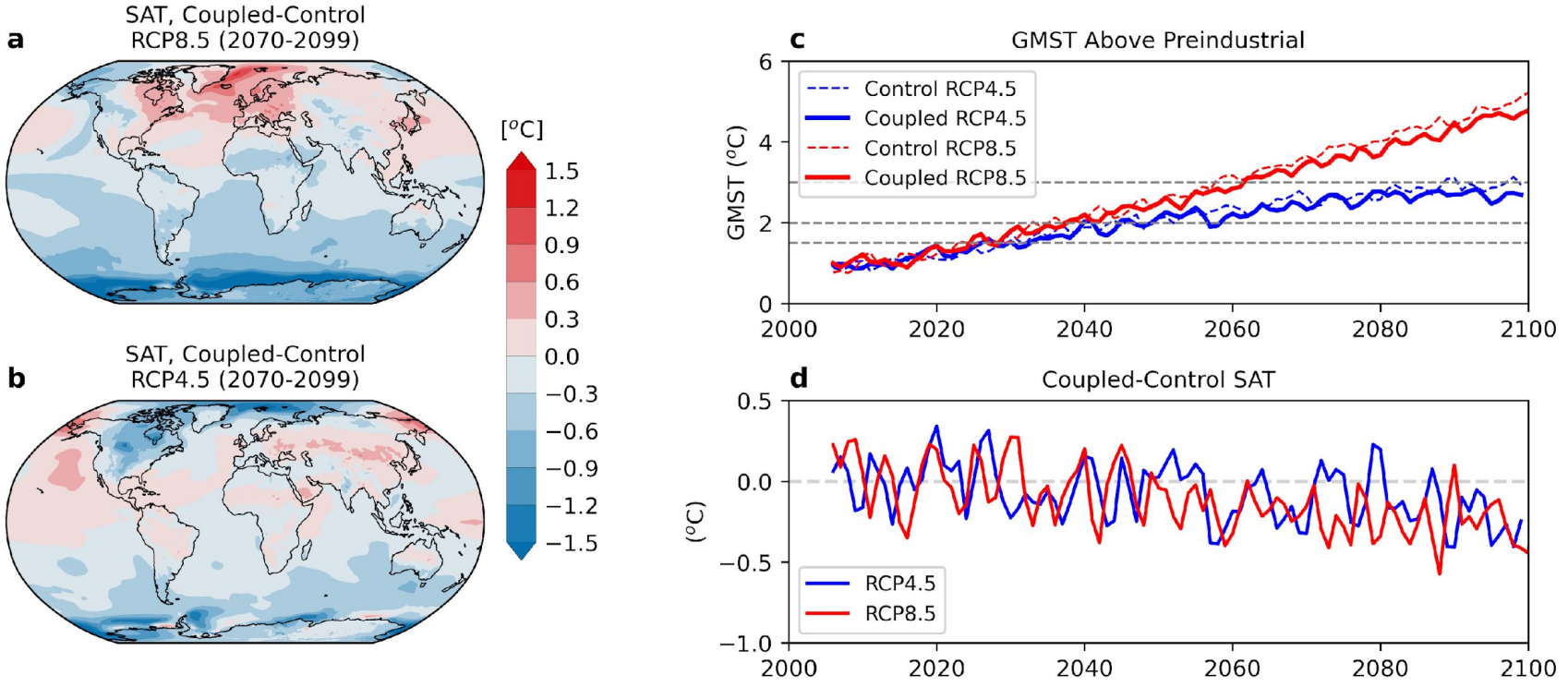


Meltwater quantities

2 m Air temperature,
400 m ocean temperature,
Precipitation

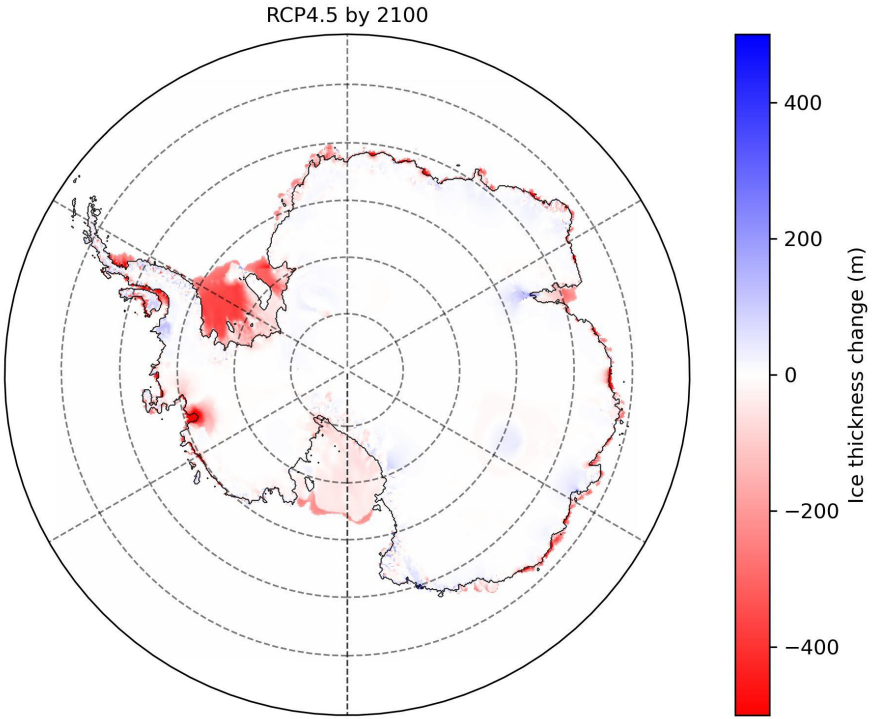


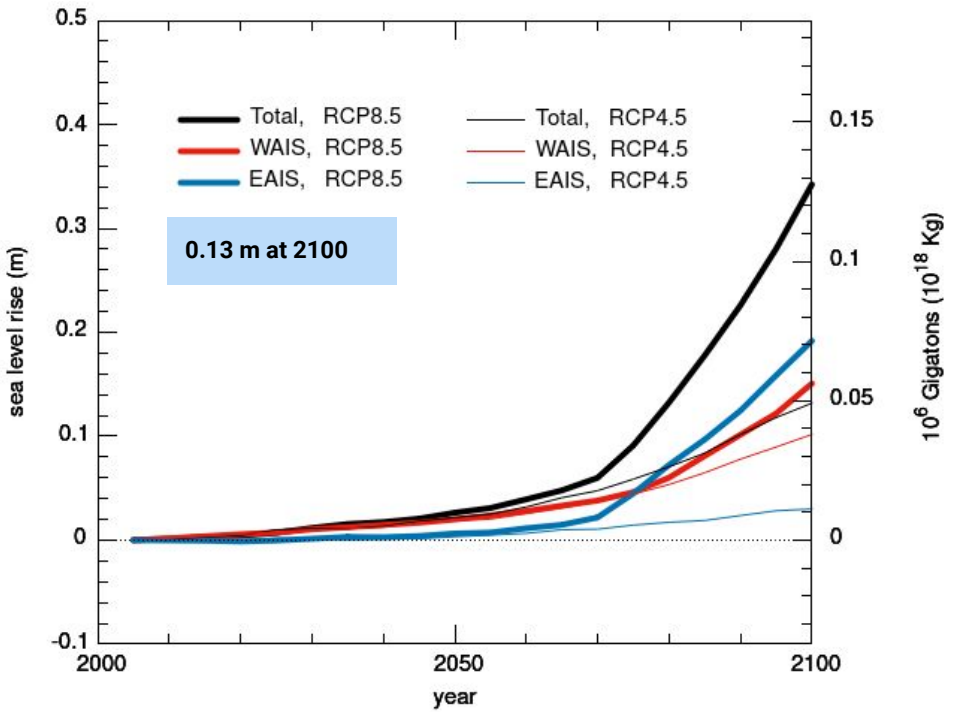
Meltwater impact on CESM



Sadai et al., in reivew

AIS sea level projections

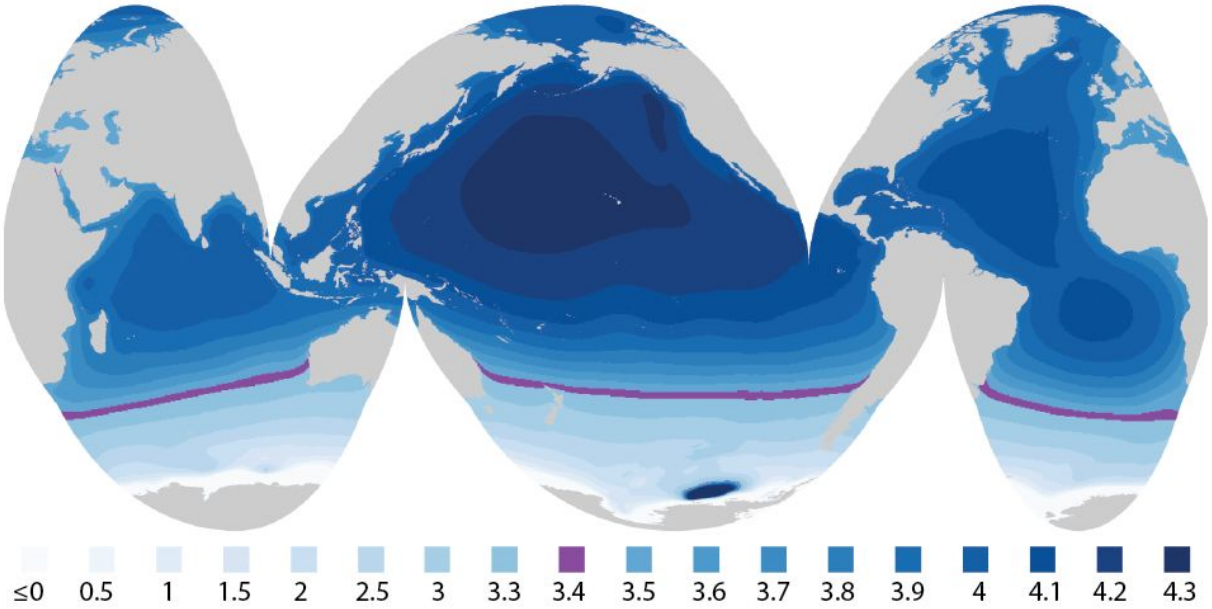




Sadai et al., in review

Climate + ice sheet + GIA models

Regionally experienced sea level rise can be up to 0.9 m higher than the global mean



RCP8.5 2200

Sadai et al., in review

Climate litigation relies on research

Litigation trends

- Rights-based litigation- insufficient action violates plaintiffs rights to life, health, food, water, liberty, cultural heritage
- Domestic policy enforcement
- Mitigation action and Paris Agreement compliance
- Corporate liability, responsibility, greenwashing

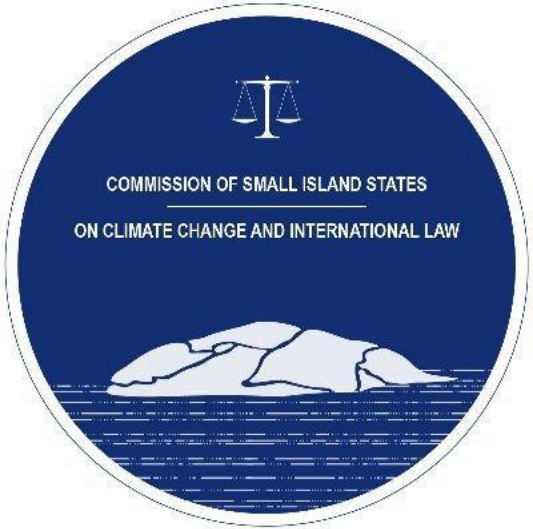
Image via IG @OurIslandsOurHome

The Torres Strait 8: Yessie Mosby, Nazareth Fauid, Stanley Marama, Kabay Tamu, Keith Pabai, Nazareth Warria, Daniel Billy, Ted Billy. Photo 350 Australia.

Setzer & Higham, 2023

ITLOS Advisory Opinion

International Tribunal for the Law of the Sea



Case initiated Dec. 2022, briefs submitted summer 2023, oral arguments Sept. 2023, opinion issued May 2024

What are the specific obligations of State Parties to the United Nations Convention on the Law of the Sea:

(a) **to prevent, reduce and control pollution** of the marine environment in relation to the deleterious effects resulting from climate change which are caused by anthropogenic greenhouse gas emissions into the atmosphere?

(b) to **protect and preserve** the marine environment in relation to climate change impacts, including ocean warming and **sea level rise**, and ocean acidification?

(paraphrased)

ITLOS Advisory Opinion outcomes

Notable Advisory Opinion outcomes:

- Anthropogenic GHGs are marine pollution
- Obligations under the Paris Agreement are not sufficient to meet State obligations under UNCLOS
- All States must participate in mitigation, but those with the most resources must do more (CBDR-RC)
- Due to irreversible impacts precautionary principle must prevail States must enact national policy and regulate private actors

ITLOS/Press 350
21 May 2024

INTERNATIONAL TRIBUNAL FOR THE LAW OF THE SEA
TRIBUNAL INTERNATIONAL DU DROIT DE LA MER

Press Release

TRIBUNAL DELIVERS UNANIMOUS ADVISORY OPINION IN CASE NO. 31

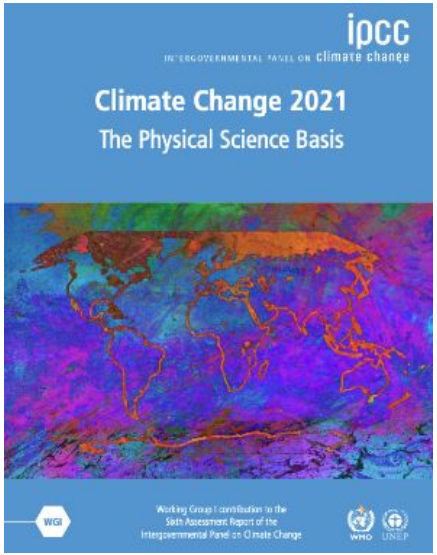
REQUEST SUBMITTED TO THE TRIBUNAL BY THE COMMISSION OF SMALL ISLAND STATES ON CLIMATE CHANGE AND INTERNATIONAL LAW

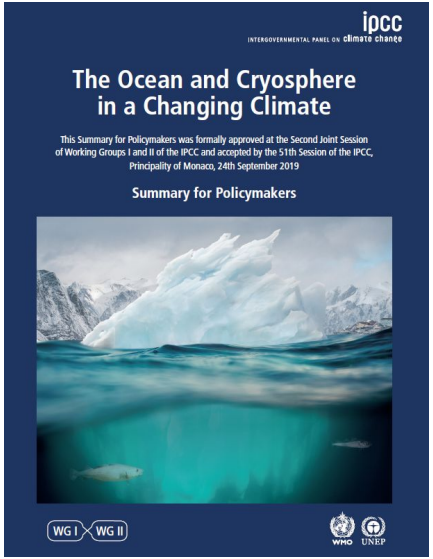
Sea level science informed the case

“Convention [on the law of the sea] imposes a general obligation on States Parties to protect and preserve the marine environment. It applies to all maritime areas and can be invoked to combat any form of degradation of the marine environment, including climate change impacts, such as ocean warming and sea level rise, and ocean acidification”

Scientific evidence cited in the AO:

- AR6 WGI:
  - GHG pollution drives climate impacts including sea level rise
  - current SLR at 0.2 m 1901-2018
  - SLR irreversible over centuries to millennia
  - Ice loss and thermal exp as notable drivers
- AR6 WGII:
  - notes existential threat to islands
- SROCC:
  - sea level impacts
  - ELSE risk, from cyclones, storm surge, precip rates, exacerbated by non-climatic human activities at land and sea

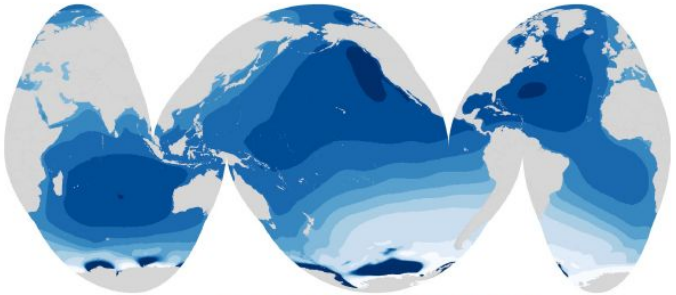




Research and litigation needs

Sea level modeling advances needed

- Coupled marine based ice sheets and 3D GIA models to capture ice-ocean-climate-solid earth interactions
- Model simulations and analysis that aid attribution
- Accessible data
- Applied work (as defined by communities and end users) relevant to adaptation, loss and damage



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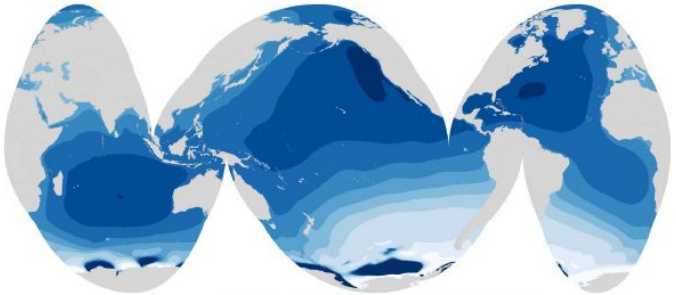

Sea level researchers can advance climate litigation in a variety of ways:

- Lend your expertise to helping write amicus briefs
- Serve as expert witnesses
- Your current work may already be relevant to supporting current and upcoming cases
- Your future work could help fill research gaps

The UCS Science Hub for Climate Litigation

Resources and Opportunities for Experts

Research on the Record

How Your Expertise Can Hold Climate Polluters Accountable

Thank You

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