

Paleo sea level and ice sheets for the Earth's future

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The fourth meeting of the current phase of the PALeO constraints on SEA level rise (PALSEA) working group (WG) (2019–2022) (pastglobalchanges.org/palsea) was held in Singapore in July 2022, following the World Climate Research Programme sea level Grand Challenge meeting (pastglobalchanges.org/calendar/129138). The meeting was co-organized by PALSEA, and Aron Meltzner and Adam Switzer, from the Earth Observatory of Singapore (EOS), with support from EOS Director Ben Horton. The meeting focused on pulling together the lessons learnt from both the 2019–2022 phase of PALSEA, as well as the workshops that had gone before since PALSEA's inception in 2008 on the topic of "paleo sea level and ice sheets for the Earth's future". This was the first time that a PALSEA workshop has been held in hybrid format. It was wonderful to reconnect face-to-face with the community, and provide more comprehensive access to the meeting.

The meeting started with a series of optional field trips, with many in-person attendees taking the opportunity to explore the landscapes of Singapore and the sea-level archives studied by the EOS research teams. An early morning boat took participants across the water to St. John's and Lazarus islands to see fields of living and fossil microatolls that provide unique insights into relative sea level (Fig. 1). The mangroves at Pulau Ubin provided a first coring experience for some delegates, where they explored the use of wetland sea-level indicators. A third trip took a stroll through the Sungei Buloh Wetland Reserve, followed by an amazing lunch!

A series of oral presentations, lightning talks and virtual poster sessions filled the following

three days. Many early-career researchers were present at the meeting; for many, it was their first in-person conference due to COVID-19. Following PALSEA tradition, it was wonderful to see these researchers have the opportunity to present their science and explore other ideas, with a safe space to ask questions. Of particular note were significant developments in 3D Earth modeling (building on the 2021 PALSEA workshop), innovative approaches to reconstructing late Quaternary ice-sheet histories, and the application of artificial intelligence to proxy sea-level data. Several presentations also highlighted the improvements in open-access standardised sea-level and ice-sheet databases made by PALSEA and associated projects.

One of the main points of discussion was centred on the role of paleo sea-level and ice-sheet science in understanding the future, as perfectly highlighted by invited speaker Tamsin Edwards. In particular, concern was raised that a statement in IPCC AR6 Chapter 9, taken in isolation, might be misleading: "Given uncertainties in paleo sea level and polar paleoclimate, and limited temporal resolution of paleo sea level records, there is low confidence in the utility of paleo sea level records for quantitatively informing near-term GMSL change" (IPCC 2021).

The audience reported instances where such phrasing was taken out of context, diminishing the importance of paleo-climate research within the broader climate science discipline. We agree that the limitation of paleo data means that its application to modeling decadal climate change may be restricted, however it does not prevent their use in climate modeling on longer timescales. As a

paleo sea-level and ice-sheet community, we concluded that it is essential to report the full AR6 quote where the line above follows with: "Nonetheless, the paleorecord does contextualise sea level and can test projection models" (IPCC 2021). These are the key roles paleoscience can play in the Earth's future – and we must continue communicating this effectively.

PALSEA has now completed this phase as a formal PAGES WG. The outgoing leaders are working with an exciting new team who will lead the international sea-level and ice-sheet community to tackle the research challenges and priorities identified as part of the 2022 meeting. We thank all the participants who engaged in this workshop and the supporting organizations: PAGES, EOS and the International Union for Quaternary Research (INQUA).

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REFERENCES

IPCC (2021) *Climate Change: The Physical Science Basis*. Cambridge



Figure 1: Coral microatolls, such as this example from St John's Island in Singapore which was visited as part of the meeting, are used by the Earth Observatory of Singapore to reconstruct changes in past sea level in the region. Photo credit: Aron Meltzner.