

# Instabilities and thresholds in Antarctica

SCAR INSTANT Conference Organizing Committee\*

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Current deep uncertainties in the projected global mean sea-level rise result from knowledge gaps in the physical processes involved in the response of the Antarctic Ice Sheet (AIS) to global warming in the coming decades to centuries (Fox-Kemper et al. 2021). Many of the ice shelves fringing Antarctica are at risk of rapid thinning, or collapse, due to oceanic and atmospheric warming, with likely impacts on the position of the ice-sheet grounding line. It is critical for the ice-sheet community to determine whether Antarctica's margins have already crossed a tipping point, and if so, when and how much mass loss will take place. A multi-disciplinary approach is required to advance the state of knowledge on tipping points spanning a large range of spatio-temporal scales and components of the polar-climate system. This is the overarching objective of the SCAR Instabilities and Thresholds in Antarctica (INSTANT) Scientific Research Programme (Colleoni et al. 2022).

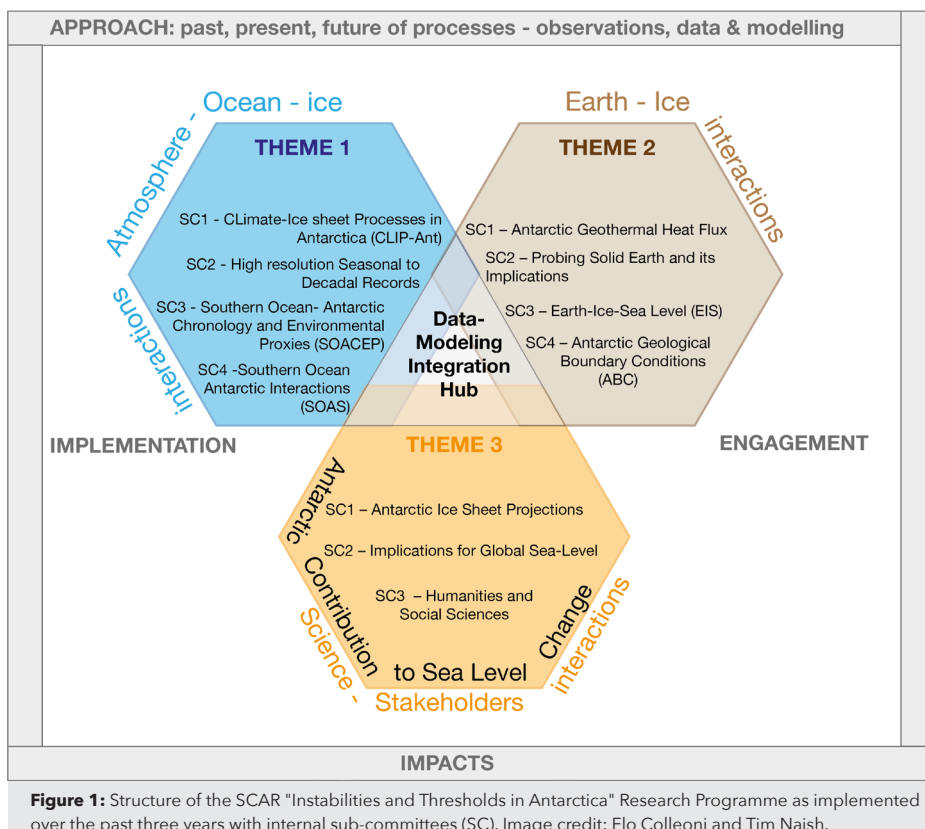
Launched in February 2021, INSTANT held its first in-person conference in Trieste, Italy, in September 2023. The conference had two main objectives: foster multidisciplinary science, and promote and support early-career scientists' (ECS) engagement in networks. The first objective was achieved via morning plenaries dedicated to each INSTANT theme (Fig. 1): Atmosphere-ocean-AIS interactions from past to future; Earth-AIS

interactions; AIS contribution to sea-level projections. Participants were therefore exposed to cutting-edge research across themes, disciplines and techniques, and this continued with open poster sessions. Afternoon community-driven workshops were organized by INSTANT subcommittees and INSTANT partner initiatives (Fig. 1). A mini-symposium on the last day of the conference - Melting Ice and Rising Seas, telling stories and engaging people - enabled interaction with policy-makers, stakeholders and practitioners, as well as indigenous advocates, writers and journalists. The conference demonstrated the need to discuss these important societal matters. Addressing the second objective, ECS led two workshops: one on how to handle a multidisciplinary science career, the second on translating science to policy. The INSTANT Programme thanks its sponsors who funded the attendance of 43 ECS. Many pre-conference and post-conference workshops also took place.

This was the first in-person conference dedicated to Antarctic research since the pandemic (the last SCAR Open Science Conference was online in 2022). Nearly 300 scientists from 25 countries participated; one third of whom were ECS ([shorturl.at/izBCZ](https://shorturl.at/izBCZ)). The outcomes from the conference emphasize the urgent need to close the knowledge gap on:

- (1) The physics driving ice-sheet grounding line dynamics, subglacial hydrology (and role of geothermal heat flux), and ice-shelf calving. These are all important mechanisms for understanding and computing ice-sheet instabilities and mass loss from Antarctica, but are currently heavily parameterized in models;
- (2) The physical processes at the interface between the ice sheet and the ocean, which are still poorly known due to the paucity of observations;
- (3) Surface-mass balance over the Antarctic Ice Sheet and surface melting, which remain poorly constrained because observations are very localized in space and time;
- (4) The impact of glacial-isostatic adjustment on ice-sheet instabilities, which is still poorly understood because our knowledge of the lithosphere and mantle rheology underneath the ice remains limited, and these processes are not always captured in dynamic models;
- (5) Ice-sheet instabilities over multi-centennial timescales, to determine whether some Antarctic ice shelves have crossed their tipping point. The timespan of satellite observations indicating a rapid thinning of West Antarctic ice shelves is too short, so paleoclimatic evidence is needed to provide constraints on a longer timescale.

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The key themes emerging from this conference are the need to advance science collectively by sharing data and models with the community, and the need to maintain global and regional observational networks (for example to avoid gaps in satellite programs, or the dismantling of geodetic networks). Both require international coordination and sharing of research infrastructures and strengthening of cooperation between the member states of the Antarctic Treaty. The conference was endorsed by the UN Ocean Decade. Recording from the INSTANT Conference is available on the YouTube channel of the SCAR INSTANT Programme.

### ACKNOWLEDGEMENTS

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### REFERENCES

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