



ACEAS

Australian Centre for Excellence
in Antarctic Science



ACEAS 2023 ANNUAL REPORT HIGHLIGHTS



Director's Message

ACEAS had a successful second year as an official ARC centre, with our programs and research in 2023 covering a lot of ground.

Despite delays and cancellations within the Australian Antarctic Science fieldwork program, many of our researchers entered their first ACEAS field season, conducting investigations across the Southern Ocean and East Antarctica. They took part in cross-institutional, multidisciplinary voyages aboard CSIRO's RV Investigator, the Alfred Wegener Institute's RV Polarstern, and Australia's icebreaker, the RV Nuyina.

The research and findings from these voyages should start to unfold in the years ahead.

We co-hosted our first Early Career Researcher and PhD training school with the Australian Antarctic Partnership Program (AAPP). More than 40 participants took part at the ANU coastal campus in Kioloa, NSW. The focus for the week was sea ice. The program featured scientific lectures, career guest speakers, professional development and team-building activities.

Our second ACEAS Annual Research Forum for all node members and partners was held in Hobart in early November. In 2024, the forum will switch to a collaborative cross-institutional Australian Antarctic research conference.

Throughout the year, ACEAS research contributed even more evidence of the direct impact of climate change on Antarctica and the Southern Ocean. Our findings continue to highlight the very real urgency of the work we do, with the climate risks emerging from East Antarctica and the Southern Ocean becoming ever clearer through our research, collaborations, and communications.

Matt King – Director

Chair's Message

The dramatic changes happening in the Antarctic were brought to light throughout 2023. These changes underline just how important the work of ACEAS is.

One of the main aims of ACEAS is to get to a point where the impacts of the changes coming out of Antarctica don't surprise us.

Science remains central to all of Australia's ambitions in the Antarctic. It is key in building a national understanding of just how important Antarctica is not just for our environment and coastlines, but also for fisheries, agriculture, weather, and for our regional neighbours.

In 2023, we welcomed the opportunity to brief government representatives and staffers at Parliament House on some of the world-leading science we conduct in partnership with the Australian Antarctic Program Partnership (AAPP).

Having built such successes in such a short time, it is critical that ACEAS remains an enduring centre for excellence in Antarctic science.

Mary O'Kane – Chair



Report Highlights



Employed 29 postdoctoral researchers



Hit 1600+ social media followers



Commenced 7 PhD students



Had 7000+ website visits



Published 53 journal articles



Published 10 papers in high profile journals



120 researchers attended the ACEAS Annual Research Forum



Commenced the Denman Terrestrial Campaign



Almost 100% of ACEAS papers were in top-quartile discipline journals



Committed \$11,000 for potential philanthropic projects with the Antarctic Science Foundation



A commitment from 10 ACEAS staff to work on the Australian Antarctic Science Decadal Plan



Had 24 participants take part in major international fieldwork programs



ACEAS and Australian Antarctic Program Partnership (AAPP) joint briefing to the Antarctic Parliamentary Alliance for 'On Thin Ice'



Jointly hosted a workshop on Antarctic Extremes with AAPP and Securing Antarctica's Environmental Future (SAEF)



Provided assistance to NCRIS ACCESS-NRI to include ice sheet modules within the Australian Earth-System Simulator (ACCESS)



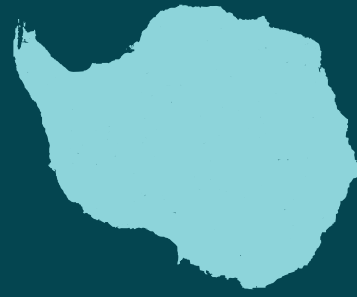
Submission to Developing Australia's Science and Research Priorities and National Science Statement – a National Conversation Starter and the University Accord Consultation Paper



Identified ACEAS research in the Antarctic Treaty Consultative Meeting forum, including these information papers: Increasing evidence of critical sea-level rise with emissions above 1.5°C Paris Agreement limit and Understanding Future Sea-level Change Around Antarctica and Marine Ecosystem Assessment for the Southern Ocean (MEASO) – Key Findings and Recommendations

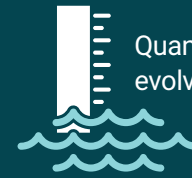
PROGRAM HIGHLIGHTS

P1



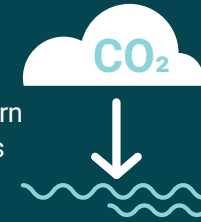
Produced the first continental-scale observations of the Southern Annular Model (SAM) and El Niño/Southern Oscillation (ENSO) fingerprints on changes in ice sheet mass

Built new understandings of local wind effects on ocean circulation and stratification in the Antarctic region via a high-resolution global ocean-sea ice model



Quantified how sea-level projections evolved from IPCC AR5 to AR6

Drew upon an eddy-rich ocean model to reveal a reduced capacity for the Southern Ocean to mitigate atmospheric CO₂ as Southern Hemispheric westerlies trend stronger and polewards



Analysed satellite sea ice records to reveal a potential regime shift in the Antarctic sea ice system

Developed new projections of an accelerated warming response of the abyssal overturning circulation driven by meltwater and other climate anomalies



P2

Gathered observations of internal wave interactions in the Southern Ocean



Collaborated with the Australian Antarctic Partnership Program (AAPP) to deploy 21 satellite loggers on elephant seals at Macquarie Island to profile the Pacific Sector of the Southern Ocean



Developed a new mechanistic and spatially resolved model of Antarctic krill distribution and abundance that can be used to inform sustainable fishery management

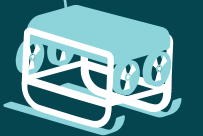


Combined paleo-proxy records and numerical modelling to reveal that sea-ice decrease at the beginning of the last deglaciation significantly contributed to high latitude warming

Collaborated with Antarctica New Zealand and NIWA to deploy and test the new ACEAS under-ice remotely operated vehicle (ROV) at Cape Evan—delivering world-first hyperspectral imagery of the seafloor



Collaborated with AAPP and UBC Canada to collect samples and conduct incubation experiments on the RV Investigator's Multidisciplinary Investigations of the Southern Ocean (MISO) voyage



P3



Used high-resolution phase-change simulations to investigate Antarctic ice-ocean interactions—providing insights into ice shelf mass loss in a changing climate

Revealed previously unknown features of East Antarctic continental shelf bathymetry via 500,000+ individual seal dive data sets



500 YRS

Deployed Rapid Access Ice Drilling (RAID) as part of the Denman Terrestrial Campaign to reach ice depths of 200 metres with the aim of reconstructing the past of climate history for the Denman Glacier region

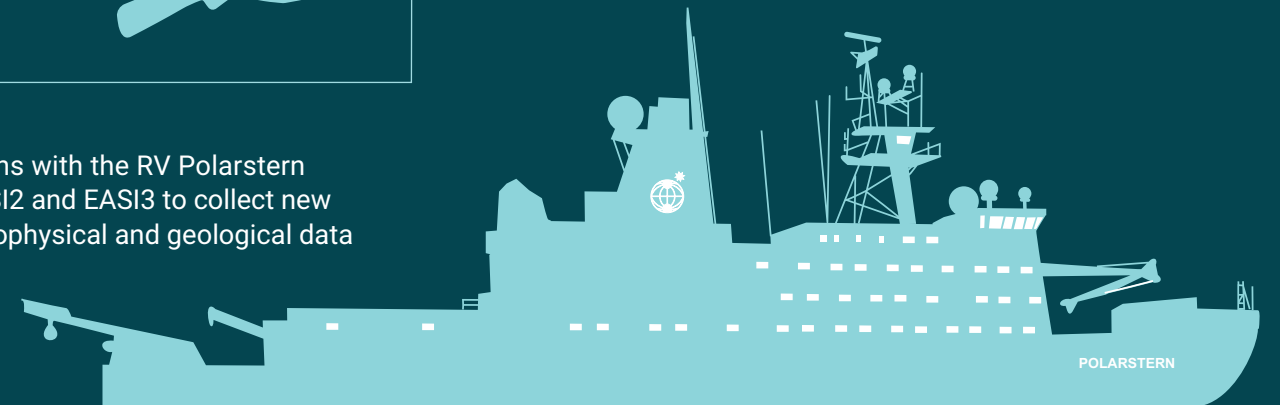


Conducted a major review of Antarctica's sedimentary basins and their influence on ice sheet dynamics

As part of the Denman Terrestrial Campaign (December 2023–February 2024), collected data to understand the status and processes of the Denman-Scott Glacier System, its interactions with adjacent ocean, and potential to contribute to future sea level rise



Collaborations with the RV Polarstern voyages EASI2 and EASI3 to collect new geodetic, geophysical and geological data





ACEAS Research

Deep ocean currents around Antarctica headed for collapse

ACEAS researchers Prof Matt England and Dr Adele Morrison were part of an international study that found the deep ocean circulation around Antarctica could be headed for collapse.

Melting ice around Antarctica makes the nearby ocean waters less dense, which slows the Antarctic overturning circulation. The study modelled the amount of Antarctic deep water produced under the IPCC 'high emissions scenario' until 2050.

"If global carbon emissions continue at the current rate, then the Antarctic overturning will slow by more than 40 per cent in the next 30 years—and on a trajectory that looks headed towards collapse."

With a collapse of this deep ocean current, the oceans below 4000 metres would stagnate.

PAPER: Qian Li, et al. (2023). *Nature*. 'Abyssal ocean overturning slowdown and warming driven by Antarctic meltwater'. DOI: [10.1038/s41586-023-05762-w](https://doi.org/10.1038/s41586-023-05762-w)

[Full story here](#)

Seals uncover new ocean depths in East Antarctica

Dr Clive McMahon and Professor Mark Hindell were part of the ACEAS elephant seal tagging project. This involved attaching small satellite-linked devices to seals, so they measure temperature, salinity and depth as they swim.

"The information we're receiving via seal dives is enormously valuable, to improve our understanding of the oceanographic processes that affect Antarctica's role in global climate."

The data from the dives have revealed new underwater features and will also help scientists measure icesheet melt rates.

PAPER: Clive R. McMahon, et al. (2023). *Communications Earth & Environment*. 'Southern Ocean pinnipeds provide bathymetric insights on the East Antarctic continental shelf'. DOI: [10.1038/s43247-023-00928-w](https://doi.org/10.1038/s43247-023-00928-w)

[Full story here](#)

Climate drivers are behind Antarctic melt that caused recent sea level rise

A study led by Professor Matt King found Antarctica has melted at an average rate of about 150 billion tonnes per year for the past 20 years. The study also found this rate has short term 'bumps and wiggles' that are directly related to the climate drivers El Niño Southern Oscillation and Southern Annular Mode.

"While we already knew that these climate drivers have an impact on the Antarctic Ice Sheet, this is the first time their precise fingerprints have been comprehensively and precisely observed."

As Antarctica continues to lose mass into the oceans, these findings elevate the understanding of the complex relationship between climate variability and Antarctica's contribution to sea level.

PAPER: Matthew A. King, Kewei Lyu, Xuebin Zhang. (2023). *Nature Geoscience*. 'Climate variability a key driver of recent Antarctic ice-mass change'. DOI: [10.1038/s41561-023-01317-w](https://doi.org/10.1038/s41561-023-01317-w)

[Full story here](#)



Spotlight on our researchers

Rebecca McGirr

**ANU Postdoctoral Research Associate
Mass Balance (remote sensing, modelling)**

Rebecca uses space gravity data to measure the impacts of modern climate change on the mass of water stored as continental ice within the East Antarctic Ice Sheet. She assesses what spatial and temporal resolutions can be achieved via current remote sensing data—and how to best mitigate the impacts of glacial isostatic adjustment on mass balance estimates in polar regions. These results will help her accurately estimate high spatio-temporal resolution changes in mass balance in East Antarctica, along with the associated contributions to global sea level in the past two decades.

Maurice Huguenin

**UNSW Research Associate
Coupled Ocean-Atmosphere-Ice Feedbacks at the Antarctic Margin**

Maurice investigates the interactions between the atmosphere, sea ice and ocean circulation around the Antarctic margin. He uses high-resolution models to perform perturbation simulations to investigate the impact of interannual to decadal climate variability on subsurface shelf temperatures, the formation of Dense Shelf Water and export of Antarctic Bottom Water.



Madelaine Rosevear

**UniMelb Postdoctoral Research Associate
Ice-ocean Interactions**

Madelaine investigates the currently poorly understood ocean processes that are responsible for melting Antarctic ice shelves. She uses a high-resolution ocean model to target the processes that are expected to drive elevated heat transport to the ice—such as internal wave activity—and quantify their effect on ice shelf basal melting. She will combine new and existing results from her work to develop and implement a new parameterisation for basal melting. This can be used in large-scale ocean and climate models to improve the accuracy of future climate and sea-level projections.



Australian Government
Australian Research Council

The Australian Centre for Excellence in Antarctic Science is a
Special Research Initiative funded by the Australian Research Council



**Australian
National
University**



UNSW
SYDNEY



THE UNIVERSITY OF
MELBOURNE



**Curtin
University**



THE UNIVERSITY OF
WESTERN
AUSTRALIA



UNIVERSITY OF
CANBERRA