# IceSked

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Newsletter of Te Puna Pātiotio—Antarctic Research Centre
Te Herenga Waka—Victoria University of Wellington

## A word from our Director

In this issue, we celebrate the success of another field season, as well as numerous high-profile publications and international leadership from our student and early career researchers. We also profile an exciting new initiative to promote women participation in alpine and environmental sciences, with the launching of the Girls* on Ice Aotearoa New Zealand. We plan to lead our first expedition of nine school aged students to Ruapehu in early 2024, and hope it is the first of many.

*Rob McKay*

## Friis Hills reveal another climate secret

### by Richard Levy

Not only are the Friis Hills set in a beautiful region, but they also contain a unique sequence of sediments deposited ~15 million years ago as glaciers advanced and retreated across a landscape that was periodically covered by lakes, rivers, and tundra vegetation. Hard work over five long Antarctic seasons by field teams led by Adam Lewis and Alan Ashworth from North Dakota State University revealed a detailed map and stratigraphy for the Friis Hills. But Adam suspected there were more sediments to be discovered and approached the ARC's Richard Levy and Tim Naish with a suggestion the New Zealanders bring their drilling know-how and experience to bear.

A team from the ARC, GNS Science, Otago University, and North Dakota State headed to the Friis Hills in 2014/15 and collected geophysical data, to find targets for drilling. Alex Pyne and a team from Webster Drilling and Exploration used a helicopter-portable wireline rotary coring rig and innovative chilled compressed air system to ensure permafrost cores remained frozen. An 80 m-thick composite sequence was recovered during the Friis Hills Drilling Project (FHDP) in December 2016. Volcanic tephra that constrain the age of the sediments to between ~15 and 14 million years old. Results from a detailed study of the cores led by former ARC PhD student Hannah Chorley were recently published in *GSA Bulletin* and verify results from other offshore drilling projects and modelling studies that indicate ~400 ppm represents a threshold above which Earth's average climate warms to the point that Antarctica cannot sustain marine-based ice sheets.

But the Friis Hills had more to reveal. With colleagues from the ARC and School of Geography, Environment and Earth Science's (SGEES), Marjolaine Verret has published a study of the beryllium isotopic composition of sediments from the Friis Hills cores and several other locations from the surrounding region in *Nature Geoscience*. Using work from her PhD, undertaken with the supervision of the ARC's Warren Dickinson and SGEES's Kevin Norton, Dr Verret has shown that the high elevation regions of the Dry Valleys remained periodically wet up until ~ 6 million years ago - at least 6 million years later than previously thought. These results indicate the region is potentially sensitive to relatively small increases in temperature with significant implications for the future of the unique ecosystems that occupy the Dry Valleys region today.

Photo by Richard Levy – "Tim Naish stands on Ferrar Dolerite boulder"



## Aerosol explorations on board of the RV Tangaroa

### by Emma de Jong

I sailed onboard the *RV Tangaroa* to the Ross Sea for 6 weeks in January-February 2023. My project was to make a series of ocean and atmosphere measurements to better understand the role of biogenic aerosol in the unique Southern Ocean climate. Southern Ocean biogenic aerosols play an important role in the climate system, yet observations are incredibly limited.

Increasing the observations of biogenic aerosols provided me with the opportunity to head down to the ice for the first time. The goal was to make observations of the chemical and physical composition of aerosols produced from the highly productive Ross Sea to better understand their sources and their ability to seed clouds. The observations also help to validate novel ice core proxies of phytoplankton. Alongside a team from the University of Canterbury, NIWA, and GNS Science, we monitored a series of real-time aerosol instruments, collected 176 aerosol samples, and filtered 42 seawater particulate samples. 12 of the seawater samples were incubation experiment samples, exploring the impact of a 2°C warmer world on the availability of fatty acids to higher trophic levels. The highlight of the trip


Photo by Emma de Jong

was being surrounded by 20 other Antarctic scientists, helping in different areas of science, and doing opportunistic work like the incubation experiments.

*Emma de Jong is an MSc student as the Antarctic Research Centre. Upon seeing Antarctica for the first time Emma described the experience as being "one of the most special feelings I've ever had in my life. I cannot believe how lucky I am to not only be researching something so important but experiencing it in person too. It's an immense privilege, and I will cherish this moment for as long as I can."*

## Unusual sea ice formations in Antarctica

### by Julia Martin

From October to December 2022, project K046 was deployed from Scott Base in Antarctica. Our team of four women - Ruzica, Roberta, Dao, and myself - camped on the sea ice for about four weeks (October to December 2022) to study the physical properties of the snowpack, including drone surveys to understand the role of snow in the atmosphere-sea-ice-ocean system and the potential impact of the snowpack on the sea ice on the background of the changing climate. The expedition was part of the Marsden-funded project "Can snow change the fate of Antarctic Sea Ice".

After arriving at Scott Base and reorganizing our cargo, we examined the snow and ice conditions in the McMurdo Sound to mark five distinct measurement areas, each representing the critical features of sea ice formation in 2022. Typically, the sea ice in the McMurdo Sound forms in March and continues to grow until about December. However, in 2022, the sea ice formation was disrupted due to repeated southerly storms, and most ice was blown out regularly. The unusual formation resulted in ice with varying thicknesses and snow conditions. The "old ice" (about 2.5 m thick) began to develop in March 2022, and what we called "new ice" (less than 1.5 m thick) did not form until August 2022. The two zones were separated by a transition zone characterized by thick ridges.


Photo by Julia Martin

After deciding on our survey sites, we moved to our sea ice camp about 6 kilometres southwest of Scott Base. Life on the sea ice was unique - beautiful and harsh at the same time. When weather permitted, we typically made one snow pit per day to capture the temporal evolution of the snowpack during our time on the ice. Since we were particularly interested in the surface properties of the snow, we used drones to map the snow surface topography on a larger scale (200x200 m) and record the snow surface's temperatures with a thermal camera. Another critical parameter for the energy budget of the surface are the variations in the albedo of the snow, e.g. the fraction of light that the snow surface reflects, which we measured with a customised drone. Working with sensitive electronics like drones in polar regions was challenging, but we achieved our goals and successfully fulfilled our measurement program.

*Julia Martin is a current PhD student at the Antarctic Research Centre. Originally from Germany, she will study the impact of the snow cover on the Antarctic sea ice using drone imagery, physical measurements and modelling. The K046 project was her first time in Antarctica, and describes being fascinated by the beauty and roughness of the continent.*



## ARC scientists chart 45 million years of Antarctic temperature change

### by Bella Duncan

A team led by the ARC's Bella Duncan and including Rob McKay, Tim Naish and Richard Levy have used molecular fossils to build a 45 million year long record of Antarctic ocean temperatures. The research 'Climatic and tectonic drivers of late Oligocene Antarctic ice volume', published in *Nature Geoscience*, investigated how Antarctic ocean temperature, atmospheric $CO_2$ and ice volume varied over time to identify key thresholds for significant ice loss. To do this, the team used fossil molecules produced by single celled organisms known as marine archaea, which vary the compounds they produce with changes in ocean temperature. By studying these compounds in marine sediment cores from the Antarctic margin, the team developed the first long-term record of ocean temperature from Antarctica, spanning much of the Cenozoic Era.

A clear link was found between $CO_2$, ocean temperature and the amount of ice on Antarctica, with an exception to this relationship occurring during the late Oligocene 25 to 24 million years ago when Antarctic ice loss instead coincided with a period of ocean cooling. The team suggest this paradox relates to a subsidence event where the West Antarctic land mass started to lower below sea level. This resulted in a more direct oceanic connection with the ice sheets, and as oceans melt ice sheets far more efficiently than the atmosphere, less ice was able to persist. Once West Antarctic lowered below sea level, colder oceans were needed to grow a marine-based ice sheet. These conditions only occurred when $CO_2$ lowered below approximately 400 parts per million (ppm). This indicates marine ice sheets like modern West Antarctica cannot continue to persist when atmospheric $CO_2$ exceeds 400ppm, a threshold we passed in 2013. The team's findings support a threshold response to $CO_2$, below which Antarctica's marine ice sheets grow, and above which ocean warming greatly exacerbates their retreat, with major consequences for global sea level. Bella's research is explained in cartoon form at https://thespinoff.co.nz/science/27-01-2022/returning-to-a-green-antarctica in collaboration with Simone Giovanardi.

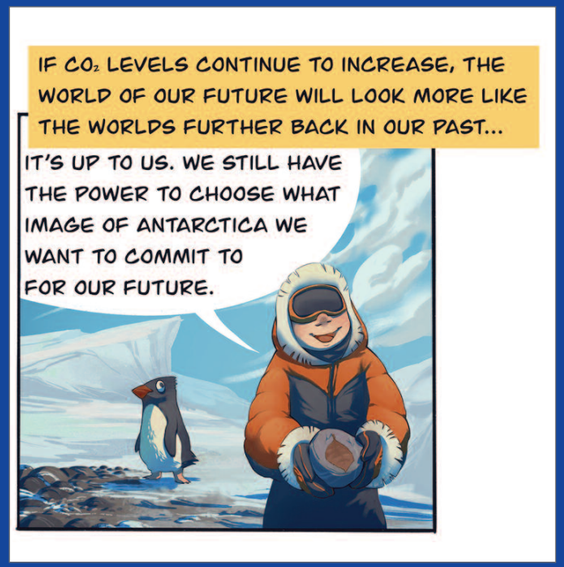


Illustration by Simone Giovanardi

## WRCP – The World Climate Research Program

### by Lauren Vargo

**Understanding the WCRP:** The World Climate Research Program (WCRP) is an international organization that helps to coordinate and support climate-related research around the world. The WCRP structure includes six 'Core Projects' (enduring research communities). Those most relevant to us in the ARC are Climate and Cryosphere (CliC), Climate and Ocean Variability, Predictability and Change (CLIVAR), and Earth System Modelling and Observations (ESMO). Each project is its own community, Scientific Steering Group, strategic plan, joint initiatives with other Core Projects, as well as funding opportunities.

**Antarctic Research Centre involvement in the WCRP:** I first became involved in the WCRP in 2020 as a representative for the Australia and New Zealand Regional Focal Point group. Our aim was to consult with our local climate research communities to increase the efficacy of the WCRP. While there are many climate researchers in New Zealand, I found that only those who were already involved in the WCRP communities a) knew about the WCRP, and b) had interest in engaging.

In January 2022, I joined the CliC Scientific Steering Group. The best part of my experience in CliC has been reviewing applications for CliC Early Career Researcher Fellowships, and then seeing the impacts of these fellowships. In 2022, I helped to select fellows whose projects included 1) developing forecasts for the early warning of glacier-related hazards, 2) training students to monitor glacier change in the Kashmir Mountains, and 3) better understanding snowpack in the Kashmir Mountains. Through my involvement with CliC, I have also become the New Zealand national delegate to the WCRP, housed by the Royal Society Catalyst Fund. My involvement in the WCRP came from suggestions and encouragement of the ARC's Tim Naish and SGEES's James Renwick. Tim has formerly been involved in CliC and the Grand Challenges but is notably now on the Joint Scientific Committee, the governance group that provides scientific guidance to the WCRP.

# Girls* on ICE

## by Lauren Vargo

Girls* on Ice Aotearoa New Zealand is newly established as a branch of Inspiring Girls* Expeditions and hosted by Te Puna Pātiotio—Antarctic Research Centre. The program offers 11-day, tuition-free expeditions that incorporate Earth science, art, and outdoor exploration for 15 and 16-year old girls*. We aim to inspire passion, participation, and empowerment for girls* in professions of science, art, and wilderness exploration. We seek to create space for girls* and women to grow and thrive in historically male-dominated fields.

Te Hauhunga is the reo Māori name of Girls* on Ice Aotearoa. Hauhunga can mean 'frosty', a reference to the role of ice in the expeditions, or it can be translated as 'a pale green variety of greenstone.' Like greenstone, our students are considered taonga or a treasure. Additionally, 'hauhunga' can be broken down into two component words: 'hau' (vitality, vital essence) and 'hunga' (a group) – suggesting 'a vibrant group'. Overall, Te Hauhunga conveys how valued our students are as they grow in confidence and vitality exploring Aotearoa's icy environments.

Photo by Lauren Vargo

Photo by Hannah Mode - "overlook hike out 2 PC Hannah Mode"

Our first expedition will take place on Mount Ruapehu in January 2024. During the expedition, students will explore New Zealand's unique landscape of Mount Ruapehu, the North Island's highest active volcanic peak. A team of nine girls* will learn about the ever-changing nature of snow and ice, use art to observe the landscape, and engage in practical field work. We will work together to create a positive and educational experience for the leaders and participants alike, developing our knowledge of the land, and forming life-long friendships.

Participants are selected through an application process, which will open in August 2023. More details are available on our webpage (https://www.inspiringgirls.org/goi-aotearoa-nz), where you can sign up for updates, including announcements about the application process (wgtn.ac.nz/girls-on-ice-signup). We are particularly grateful to alumni and donors that have already helped to kickstart this program. You can help support its long-term future by donating here. (https://www.wgtn.ac.nz/engage/giving/priorities/environment-sustainability/support-young-women-to-explore-the-sciences).

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