BYTES

THE NEWSLETTER OF THE NATIONAL MODELLING HUB

In a nutshell...

This quarter we report on how 'containerizing' model code can make complex models portable and reproducible, and how we use statistical emulators to help extend the reach and robustness of our numerical models.

As usual we also share some of the exciting news from researchers in the Modelling Hub, including reports from workshops in Japan and Australia, and national recognition for one of the team.

Enjoy the evolving landscape of climate science, and a wide range of modelling community updates, in each edition of BYTES.

As we go to press, we are delighted to welcome Alex Gossart's baby girl, Zoë, into the world. Congratulations Alex!

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The Hub has an open invitation for researchers to visit, in order to enable both national and international connections and exchanges.

If you're interested in visiting the Hub, please get in touch with us: https://www.modellinghub.org

Putting models in a box

In early April 2024, Alena and Alex presented a seminar, in conjunction with their NeSI colleagues Alex Pletzer and Chris Scott, showcasing their collaboration to build their computer code in a container. A software container is a device that makes code usable independently of software updates and machine-specific softwares. Some of the more popular container software options include Singularity and Apptainer. Packaging code within its own environment also allows the code to run on any machine. Just like a pre-packaged frozen meal that contains everything you need for dinner, the container gathers together all the nuts and bolts needed to run the program, as well as the program itself.

For Alex and Alena this approach has become a valuable time-saver. Their coupled model is complex and relies on a lot of software prerequisites. And this means that if the supercomputer goes through a routine upgrade, all the prerequisites as well as the model code itself have to be updated so that the whole software stack will compile properly. Furthermore, while the updating process is underway, it's often impossible to continue running experiments elsewhere because the code is not easily portable to other machines.

With the help of Alex and Scott from NeSI, Alex and Alena have now been able to generate a single 'executable' - a compiled program - that should in principle run on any similar system, with no modification, provided the platform has the same container program installed.

If this kind of approach sounds like something you could make use of, take a look at their webinar here.

Visit to Hokkaido University

In mid May, Alanna embarked on a 9-day trip to Japan to attend a workshop on ice-ocean processes and interactions that was led by the Institute of Low Temperature Research at Hokkaido University. During her time visiting Hokkaido University she met with numerous researchers and Ph.D. students who work in both observation and modelling spaces. Alanna gave a department wide seminar alongside another visiting researcher from the Alfred Wegener Institute in Germany.

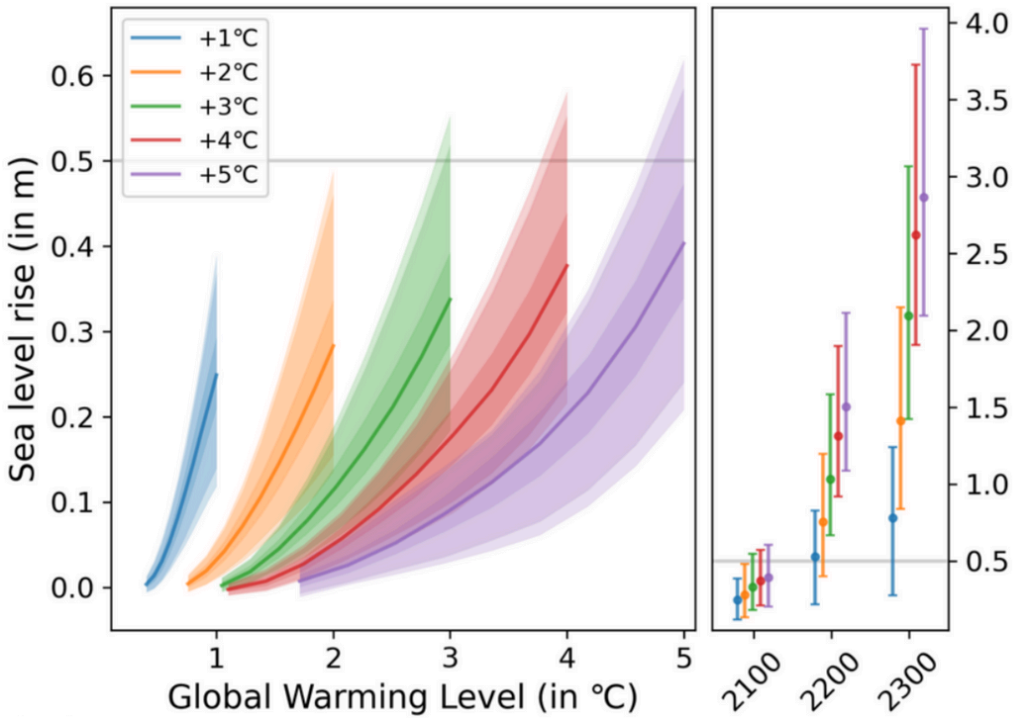
On her journey back to New Zealand she visited the Atmosphere and Ocean Research Institute at Tokyo University to meet with the climate modelling group. There she presented her recently published research and discussed potential collaboration with Earth System Model ice sheet coupling and paleo ice sheet modelling which is a focus of the group.

The trip was incredibly successful in continuing to build positive international relationships, supporting Alanna's career development, and prompting discussion of future collaboration opportunities. This trip was funded by the Antarctic Science Platform Opportunities Fund in support of Alanna's research in coupling an ice sheet model to the New Zealand Earth System Model.

An ice sheet emulator for Greenland

Antarctic ice sheet melting has been steadily increasing for the last two decades, and in future may become the biggest contributor to global sea level rise. To determine how much, and how quickly, Antarctica will contribute to sea level rise, the scientific community runs numerical ice-sheet model simulations forced by future emission scenarios. However, running these simulations is expensive and time-consuming, and it is impossible to account for the full range of uncertainties that arise from the different emission scenarios and from choices of model parameters.

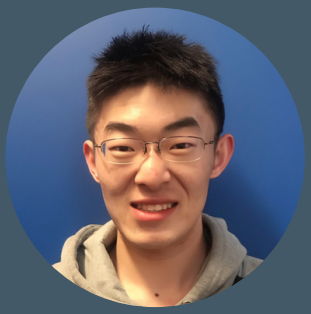
To address this, previous work from Modelling Hub researchers Dan, Mario, and Nick, used a statistical emulator - a mathematical model that tries to determine the relationship between the inputs used by an ice sheet model, and the outputs it then produces. The emulator can be trained on a range of numerical ice-sheet model simulations and then be used to predict 'unmodelled' scenarios, for example, climatic or ice flow conditions that weren't originally considered in the ice sheet model experiments. Once trained, the statistical emulator is much faster than the ice sheet models, meaning that tens of thousands of virtual parameter and climate scenarios can be explored. Then, by using historical observations to identify which of the emulations are consistent with what we know has happened in recent decades, we can calculate the likely future trajectory of ice melt as well as the associated uncertainty.



cont...

Now that Peter Siew has joined the Modelling Hub, the team plan to modify the emulator to also evaluate the potential contribution to sea level of the Greenland Ice Sheet. As well as exploring model parameter and emissions-scenario uncertainties, they will also train the emulator using outputs from all the different groups that contributed to ISMIP6 (the Ice Sheet Model Intercomparison Project for CMIP6). This will allow the emulator to also account for 'structural uncertainty', that is, the range of outcomes that arise from the different physics employed in different models. This new research, along with the previous study, will provide insights for policymakers to take adaptation strategies and mitigation options for the continued threat of sea-level rise.

Looking further ahead, Nick and Peter are working closely with researchers in the Centre for Data Science and Artificial Intelligence to use machine-learning methods to provide a more precise projection of sea level rise on regional scales across a range of timescales and under different emission scenarios.



Dr Yaowen Zheng

Ph.D candidate update - Yaowen Zheng

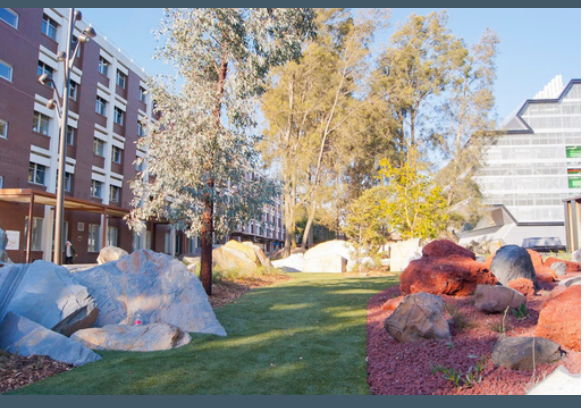
In March, former Modelling Hub-affiliated Ph.D student Yaowen Zheng successfully defended his thesis entitled, "Understanding surface melt in Antarctica and implications for future ice sheet evolution".

His examiners - Ruth Mottram, Poul Christoffersen, and Shaun Eaves, particularly commended Yaowen on the high level of his research and the complexity of data processing that he grappled with to produce his results. Having completed some minor revisions, Dr. Zheng is now taking up a new role at the British Antarctic Survey, working with Tom Bracegirdle and others on extreme climate events in Antarctica. Congratulations Yaowen, and good luck!

Prof Nick Golledge elected to the Academy of the Royal Society of New Zealand

In April, Modelling Hub co-leader Nick Golledge was admitted as a Fellow into the Royal Society Te Apārangi. Fellows are elected to the Academy, 'for their distinction as world leaders in their areas of research and scholarship', and Nick's citation particularly acknowledged his, 'profound advances in understanding how the Antarctic Ice Sheet will respond to a warming climate'. The ceremony was held at the Royal Society offices in Wellington, and included signing the Fellows' book and presentations from all the new members.

Nick with Prof. Geoff Chase, Academy Executive Committee Chair.



Monash University, Melbourne

Australia-NZ collaboration

Also in March, Modelling Hub researchers Liz and Nick joined other ASP members from across NZ to visit Monash University in Melbourne, Australia. The meeting was organized as part of a collaborative initiative seeking to identify common areas of interest between Australian and New Zealand Antarctic researchers.

The three-day workshop brought together experts from a wide range of disciplines and both reflected on previous work and looked ahead to future plans. During the meeting an agreement was reached that the group would work together to build a program of research focused on the Wilkes Subglacial Basin in East Antarctica, an area that could potentially contribute many metres to global sea level if it melted.

NATIONAL MODELLING HUB

RESEARCH TEAM

ALENA MALYARENKO

Ice Shelf cavities, Ross ice sheet, The Terra Nova Bay Polynya

ALANNA ALEVROPOULOS-BORRILL

Ice sheet modelling, Ice-ocean interaction

ALEX GOSSART

Surface mass balance processes, Ross Sea, Terra Novay Bay

DAN LOWRY

Ice sheet dynamics, Ice shelf-ocean interactions, surface mass balance

LIZ KELLER

Carbon cycle dynamics, changes in Antarctica on global climate

MARIO KRAPP

Statistical modelling, dynamical systems, complexity

STEFAN JENDERSIE

Ocean circulation around Antarctica, ice shelves, polar oceanography

NICK GOLLEDGE

Glaciology, climate change, numerical modelling of Earth systems

PETER SIEW

Artificial Intelligence and machine learning

ABOUT THE HUB

The National Modelling Hub was set up as a partnership between NIWA, VUW and GNS, funded by the Antarctic Science Platform (ASP). Now, the Hub incorporates researchers from VUW, GNS Science and University of Canterbury, all of whom are funded through a range of research programmes. The work of the Hub is coordinated by Nick Golledge and Liz Keller, Co-Chairs of the ASP Modelling and Future Projections Working Group.

The Hub has seven active PhD students: Béatrice Désy, Frank MacKenzie, Huiling Zou, Ihanshu Rane, Nikhil Hale, Prasad Shelke and Vincent Charnay.

Victoria University of Wellington Te Herenga Waka | Te Puna Pātiotio Antarctic Research Centre | GNS Science Te Pū Ao | NZ SEA RISE Te Tai Pari o Aotearoa | Antarctic Science Platform | Ministry of Business, Innovation & Employment Hīkina Whakatutuki | University of Canterbury Te Whare Wānanga o Waitaha Christchurch New Zealand | NIWA Taihoro Nukurangi

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