The **2022 ACCESS Community workshop** was held in Canberra over 22-23 June 2022 as a hybrid event. There were 170 registrations for the workshop (107 virtual, 63 in person), including participants from the Bureau of Meteorology (BoM), CSIRO, the Australian Antarctic Division, University of Tasmania, University of Melbourne, Australian National University, Monash University, Murdoch University, University of Sydney and University of New South Wales. The workshop aims and program can be found here.

The workshop included 12 invited science talks from the ACCESS community as well as an invited plenary on "Building a Community Model" by Gokhan Danabasoglu (NCAR/CESM). (Links to the recordings of the science talks are included at the end of this page).

Over the two days, there were also three discussion breakouts that focused on **(1) Community Building (2) Short-term ACCESS-NRI plans and (3) ACCESS-NRI Long-term planning**. We received a very positive feedback from the community, with a strong support to continue providing hybrid and online options and to include more Science talks in future workshops, as well as lots of great suggestions to improve the group discussions.

Overview

The following lists outline the broad conclusions from the ACCESS-NRI Community Workshop, particularly highlighting the feedback that emerged from multiple groups across the community.

Priority tasks for ACCESS-NRI:

- Establish community working groups that will assist with prioritisation and resource allocation.
- Develop model evaluation tools that are modular, well-supported and specific for each domain.
- Establish a repository for consistent and relevant data collections needed by each community, following FAIR principles.
- Design an efficient and well-documented post-processing pipeline to create CMOR-ised output from ACCESS models.
- Create scalable diagnostic utilities, including a supported diagnostic environment, built on a system of data discoverability (along the lines of intake-esm).
- Optimise the performance and configuration of the UM to improve speed, and implement in higher and lower resolution coupled configurations.
- Establish a mechanism to get code into the UM to create a true community model.
- Documentation and training for all software that is developed and/or supported by ACCESS-NRI.
- Run flagship model simulations of key configurations to serve as baselines for the community.
- Distribute information on model cost/efficiency and improve/optimise configurations.
- Users to be given license to contribute code/data/documentation to community.
- Organise future workshops (annual NRI + other communities)

- Flexible, relocatable regional model configurations (atmosphere-land and ocean-sea ice).
- Payu and ROSE/CYLC interoperability (and training/documentation).
- Design and scope out CMIP7 configuration(s)

Longer term ambitions (>2 years):

- Coupled regional ocean-atmosphere configurations
- Include ice sheet model into future ACCESS-ESM (with solid earth?)
- Prepare for exascale, commercial cloud, workforce needs and other disruptors.

The following pages include more detailed feedback, summarising input from individual discussion groups.

Session 1: Community Building

Land

The land modelling community includes users of different land surface models (CABLE, JULES). It was noted, although the community is willing to work together, the collaboration does not currently work well in practice. The lack of collaboration has resulted in diverging versions of CABLE which are problematic. The discussion focused on identifying the common needs, the parts that are broadly model agnostic where the ACCESS NRI can help and bring value.

The following areas were identified:

- Model evaluation/Benchmarking
- Documentation
- Training
- Data collections
- Data assimilation

Model Evaluation:

Identified as essential to allow convergence of CABLE's varied versions.

It should be done in collaboration with the JULES users to ensure that CABLE and JULES are evaluated in the same way.

Documentation and training:

Both CABLE and JULES have a steep learning curve at the start. Any help from the ACCESS-NRI to reduce the take-up time for those models would be appreciated. Better documentation and training for both models is seen as essential for this.

Major points that were made:

- CABLE's documentation needs to be rewritten completely.
- We need documentation and training for a range of users, from people that aren't used to Linux and Fortran to expert developers.
- We need documentation on the configurations that have been tested but also on incompatibilities between different options.

Data collections:

Land modellers need the same datasets. It is seen as advantageous to building a land community to develop common data collections following FAIR practices.

Ocean

The ocean community is well-served by the existing COSIMA community, with regular (almost weekly) user and science forums, monthly Technical Working Group (TWG) meetings, an established code repository on github, an established diagnostics toolbox, reasonable documentation and a community-based long-term development plan.

The COSIMA community can likely function as an ACCESS-NRI working group with only minor modifications, and is suggested as a potential template for working groups in other domains. The key elements of such a template are:

- Regular meetings and workshops;
- Low barrier to entry for data analysis and running/changing the model;
- Shared datasets

Priorities for COSIMA development in the medium term, that could be adopted by ACCESS-NRI, include:

- A shift towards regional modelling, which will enable closer interaction with the coastal community and potentially future regional coupled models;
- Cavities under ice shelves (in progress, early days);
- Optimal use of new methods in vertical regridding via the ALE-VLR algorithm in MOM6;
- Incorporation of icebergs and fast ice;
- Addition of tides to COSIMA models;

- Better use of metadata and data structures;
- Addition of surface waves in climate models.

Atmosphere

The atmosphere community is currently quite fragmented with a number of smaller communities that vary by:

- model (UM, WRF)
- scale (regional vs global)
- research (i.e., universities) and operations (i.e., BOM, CSIRO)

Discussion across all 3 atmosphere breakout groups demonstrated a strong interest in the need for:

- Establishing an atmospheric working group for the community
- Improved documentation and training/support resources (centralised, high quality, easy to use)

Additional discussion included:

1. Flexible km-scale regional model of high interest;

2. Atmosphere modelling community uses a variety of tools. They could coalesce on ACCESS (UM) but it needs to be easier to start, run and do science with.

3. Desire for "WRF-like" capability of running real/idealised case studies (similar to compsets for global model);

4. Flexible and easy to use modelling system, tools, diagnostics;

5. Need for more community flagship simulations in order to help define and achieve improvements to the models;

6. Need for more consistency in how information is exchanged (atmosphere modelling is mainly small groups of researchers);

7. Concern fundamental community philosophy - is ACCESS a true community model? Getting improvements into the model is restricted by the Met-Office (so our changes are not possible / switches are not possible);

    - ACCESS-NRI to facilitate the ability to negotiate a process to improve the UM code trunk where we develop parameterisations (should we have our own Australian branch for ACCESS / tracking of our improvements) [this goes to the heart of ownership - i.e. the UM 'owns' it so it doesn't feel like a community model when our changes are ignored].

        - BOM need to engage with UKMO on package testing to be able to get anything adopted. Hard to also do the local researcher collaboration.

        - NRI could have more weight with UKMO than BOM alone by representing wider community.
        - No mechanism for reporting model evaluation back to BOM except via individual contacts.

8. It was recognised that there is currently the capability for science with models, but not for not for serious model development which is where the ACCESS-NRI can help.

Coupled

There is a need to develop a coupled model community to prioritise experiments and to set development goals. An example of such communities includes the CESM working groups, which include interactions between scientists, programmers, developers. Process Evaluation Group or Climate Process Teams could also be formed when key issues are identified. The working group could also frame science goals, such as investigating biases across the differing coupled models (same atmos, different ocean). This group could host workshops that include both training (e.g. new-user tutorials) and coupled modelling science.

Australia includes a number of different modelling communities (e.g. BoM, CAFE, ACCESS-CM); we can start by focussing on achieving common needs for each of these communities. For example:

- User training in common needs, such as Cylc, Rose, github;
- Training to run supported model configurations;
- Developing coherent and useful documentation (on github for interactivity) on models, diagnostics and experiment types (e.g. pacemakers);
- Management of post-processing utilities and better conversion of output;
- Support for single model (e.g. AMIP or single-column) configurations;
- Support for the latest version of the UM, with all the required ancillary files;
- Distributing information on model expense/efficiency for different configurations.

The speed of the ACCESS-ESM1.5 is really an issue for many applications (esp. paleo). If we could speed up the atmosphere (possibly via low-resolution configurations that use the same code base) that would be very useful (for very long runs, or ensembles of ~1000 year runs). It could also benefit from support for drastic changes to boundary conditions (land surface cover, continental position, changing ice sheets), or to run selected PMIP configurations.

It should be recognised that there are three clear types of user who will benefit from ACCESS-NRI efforts:

- Those who can process model output and run a standard experiment;
- Those who alter input, boundary conditions;
- Those that modify code and develop models.

Each of these user types is important and needs to be catered for by ACCESS-NRI. In particular, it would be nice to have more people trained in the third category, so that they can contribute to development of new code and configurations.

Additional assorted ideas include:

- Embedding NRI staff within research community for specific projects;
- Co-design with the NESP ACCESS project;
- Make model components modular;
- Support for Payu;
- Discussion lists for searchable past issues;
- Model development workshop;
- Having a large ensemble of generic experiments.

Ice

An Australian Ice Sheet Modelling Community has begun to form over last year. This community holds potential benefits for the ACCESS community, particularly relating to effects Antarctic and Greenland ice shelf melt on sea level, ocean circulation, ocean ecosystems and future climate trajectories. The initial goal should be to incorporate ice sheets into ACCESS-ESM (e.g., as is done for CESM). There is no clear agreement on which ice sheet model would be best suited to this task, nor how to address the complexities involved in coupling with a solid Earth model.

There is an identified and well-integrated community of ice sheet/sea level researchers who are unified in the value and benefit to adding an ice sheet and sea level model in ACCESS and have begun working on priorities. Recent investments in this area (e.g. SAEF, ACEAS) provide an imperative to make progress on this issue, and there is a clear and strong national interest in this development to allow research into coupled climate-ice sheet behaviour.

A high priority is to form a scientific working group with clear terms of reference and a mandate to provide recommendations and priorities to ACCESS-NRI within a defined timeframe. Membership of this group should include representatives from regional, atmospheric, coupling, and ocean modelling communities. The working group should examine:

- End-user needs in a domestic context;
- Regional model setups, including atmosphere/ocean interaction;
- Parameterisation of surface processes (blowing snow, ablation, sublimation, melt and refreeze)
- Inclusion of small glaciers, as well as Antarctica and Greenland;
- Facilitating workshops to develop understanding of international modelling plans, improving understanding of surface mass balance over ice sheets and understanding the existing coupling framework within ACCESS.

Session 2: Short-term plans

Global

Although people expressed some interest in the high-resolution global models (ACCESS-CM2-025 and ACCESS-CM2-N216-025), there were questions whether these models would truly be used by the community.

A flexible version of the global atmospheric model (ACCESS-AMX) is seen as very useful. It would have to update quickly in line with the UM version. Some challenges for this model have been noted around: land surface, chemistry, simpler versions (aquaplanet, SCM).

Concerns that were raised include:

- We first need to properly release the CMIP6 models and configurations, in a fashion that is accessible to everyone in the community.
- Need to have low resolution model versions to have fast models as well as high resolution models.
- Need to have better documentation and training. People currently are not always aware of what is available (models, configurations).
- A unified way to produce ancillary files for the models.
- Lack of short-term plans for the ocean modelling

Different parts of the community have different interests:

- Bureau/seasonal/NWP coupled teams perspective: ACCESS-AMX, GC5
- University perspective: Release (documentation, support, forcing/IC datasets, canned data for tests etc.)

Infrastructure

The discussion focused on all aspects of the infrastructure: data infrastructure, data assimilation, configurations, models, software modules, platforms and documentation. Parts of all these infrastructure aspects are already covered by the community. The role of ACCESS NRI is viewed as bringing scattered efforts together or developing new approaches.

Data infrastructure:

The view was to help researchers work on reproducible workflows rather than bitwise reproducibility of simulations.

- Provide the community with guidelines for data processing/management (e.g Australian Climate Data Guide).

- Help with data discoverability and quality with developing intake(-esm) catalogues, QC/QA tools (cf checker, checksum, versioning)
- Develop scalable post-processing tools - archiving tools, analysis tools (e.g. COSIMA cookbook), CMORising tools (e.g. APP4)
- Empower the community to create records of simulations/configs/output data by providing tools to create documentation and databases of model configurations and outputs of existing simulations.

Possible challenge: is the ocean community moving towards Julia over Python?

Model development:

We need more communication and coordination around model development. For this reason, using public platforms such as Github is preferable over private platforms such as SVN.

Standard configurations need to be clearly released with proper benchmarking, test data and documentation. ACCESS-NRI should provide training for every piece of software that is documented. ACCESS-NRI should resource training specifically.

We need to speed up the release of newer versions for all models to the community.

Possible challenge: Contributing to the UM model is complicated, can ACCESS NRI define a process to help Australian researchers contribute to the UM?

Software modules:

Centralised support for software modules and environments (e.g. ~access, conda/analysis3) is needed to ensure the reproducibility and document the provenance of a workflow.

Possible challenge: Moving to containerisation?

Platforms:

We are currently focusing on NCI's platforms (HPC, OOD).

Possible challenges: How do we increase access to international collaborators, other Universities, government agencies?

Should ACCESS NRI investigate alternative hardware: commercial cloud, accelerators?

Evaluation

The group mainly discussed the creation of a model evaluation system by the ACCESS NRI.

A lot of existing tools have been identified: Aura, ESMVal Tool, PCMDI metrics, PMP, Ilamb, METPlus, modelevaluation.org, Climate Variability Diagnostics Package (CVDP, integrated to ESMValTool).

The group raised the following points for consideration:

- How much do we need to consider what is done at UKMO?
- Is there an existing package to evaluate extremes?
- Should we contribute to existing package(s) or build our own?
- Need a modular system that can be expanded easily by researchers and that runs entirely at NCI for a quick turnaround without moving data.

Regional

The community would value a regional configuration with a relocatable domain more than a big flagship configuration such as AUS2200.

A relocatable domain is advantageous as it will respond to the needs of more users. But for this, ACCESS NRI would need to deliver an automated way to produce the initial and boundary conditions from a variety of input data sources. It could be based on AUS2200.

The accessibility of a regional model is also seen as very important to improve. Ideally, anyone could get a standard regional configuration running within a day. For this, documentation and training/tutorials need improvements.

The model development workflow also needs to be improved. Currently, it is too frequent that improvements made by individual researchers do not find their way in a shared configuration. The community also needs a library of software for regional modelling with ACCESS.

Session 3: Long Term Plans

The aim of the final session was to discuss the longer-term strategy for the community and provide input for the ACCESS-NRI Strategic Plan. Discussion topics focused on:

- What would be your preferred line-up of models and climate tools in 5 years? In 10 years?
- What are the biggest challenges facing the climate modelling community in 5 years? In 10 years?
- What is the most important role ACCESS-NRI could play over this time frame?
- What is the biggest potential disruptor to your modelling workflow in the coming 5 years?

Key takeaways for the longer-term included:

More advanced models:

- **Getting new science into future model developments:**
    - Ice sheet/shelf with solid earth components
    - CABLE with urban in ACCESS
    - Carbon cycle & chemistry
    - Paleo-relevant processes

- **Improved regional coupled models (e.g., higher-resolution, 2-way nesting)**

    - Flexibility within configurations (plug & play between components, resolution options)

    - A clear and consistent model hierarchy, including idealised models
    - Improved benchmarking with more diagnostics and evaluation tools, driven by better observational data streams, to feed back onto the model development process
    - Incorporating machine learning into our model development processes
    - Improved efficiency and throughput of models

- **Ways ACCESS-NRI can support the community:**

    - Documentation and uptake of the models
    - Training and support
    - Growing expertise in our community and upskilling the next generation of researchers
    - Community building, transparent decision-making processes and collaborations
    - Diagnostics: more complex models means more complex post-processing and analysis
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- **Big challenges ahead:**

    - Preparing for new and emerging technologies, especially HPC hardware
    - Increasing complexity in the model development (i.e., modelling new science)
    - Unstructured grid models, such as LFRIC
    - Training and upskilling the community and workforce to support ACCESS
    - Storage: we cannot store all data, we will need to be able to:

        - Reliably reproduce any simulation
        - Subsample model output to save space
        - Analyse model output in real time

- **Disruptors:**

    - Changes to hardware and resource constraints
    - Varying institutional priorities and objectives
    - Proliferation of configurations or models limiting the depth of support for each model
    - Workforce disruptions