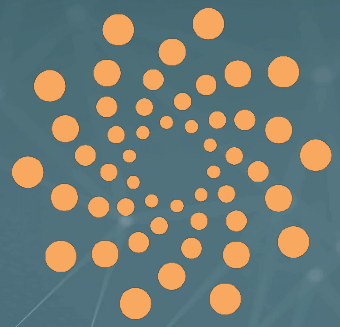


NCI AUSTRALIA

Future Proofing Australia's Research Infrastructure

SC Asia19 March 2019

nci.org.au

Conference Theme

In keeping with the theme of the conference....
HPC Futures – Hyperscalers, Exa, AI, Quantum and Beyond

Will these be part of the the future ?

In short the answer is **YES** – ***HPC Futures*** will be built on ***Hyperscale*** technology, it will need ***EXA***scale compute and data resources, it will require ***AI*** to run and develop new scientific insights. It will need to take advantage of ***Quantum*** computing through continually adapting and integrating new technologies and push ***Beyond*** the boundaries of the current fields using HPC.

How?

How do we know what the future will be?

How do we develop and deploy the infrastructure we need?

How to we prepare and develop our staff and researchers?

In order to understand the future you need a firm grounding on what exists so that you can build on it..

The National Computational Infrastructure today

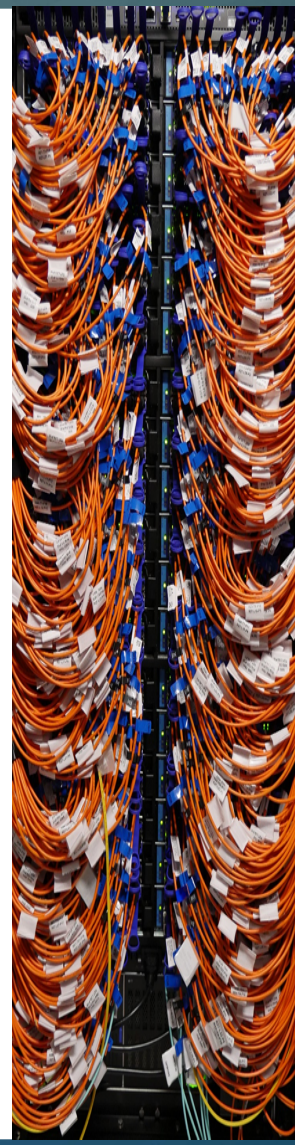
Mission

Provide world-class, high-performance computing and data services for Australian research and innovation

Defining Focus: National and Strategic Capabilities

Operational Values:

- Make world class tier 1 compute and data capabilities easy, transparent and accessible for Australia's scientists
- Be research outcome driven
- Enable high-impact research which advances knowledge, science, technology, and informs policy
- Strategically focus on collaborations that lead to transformative outcomes with national benefits



The NCI …

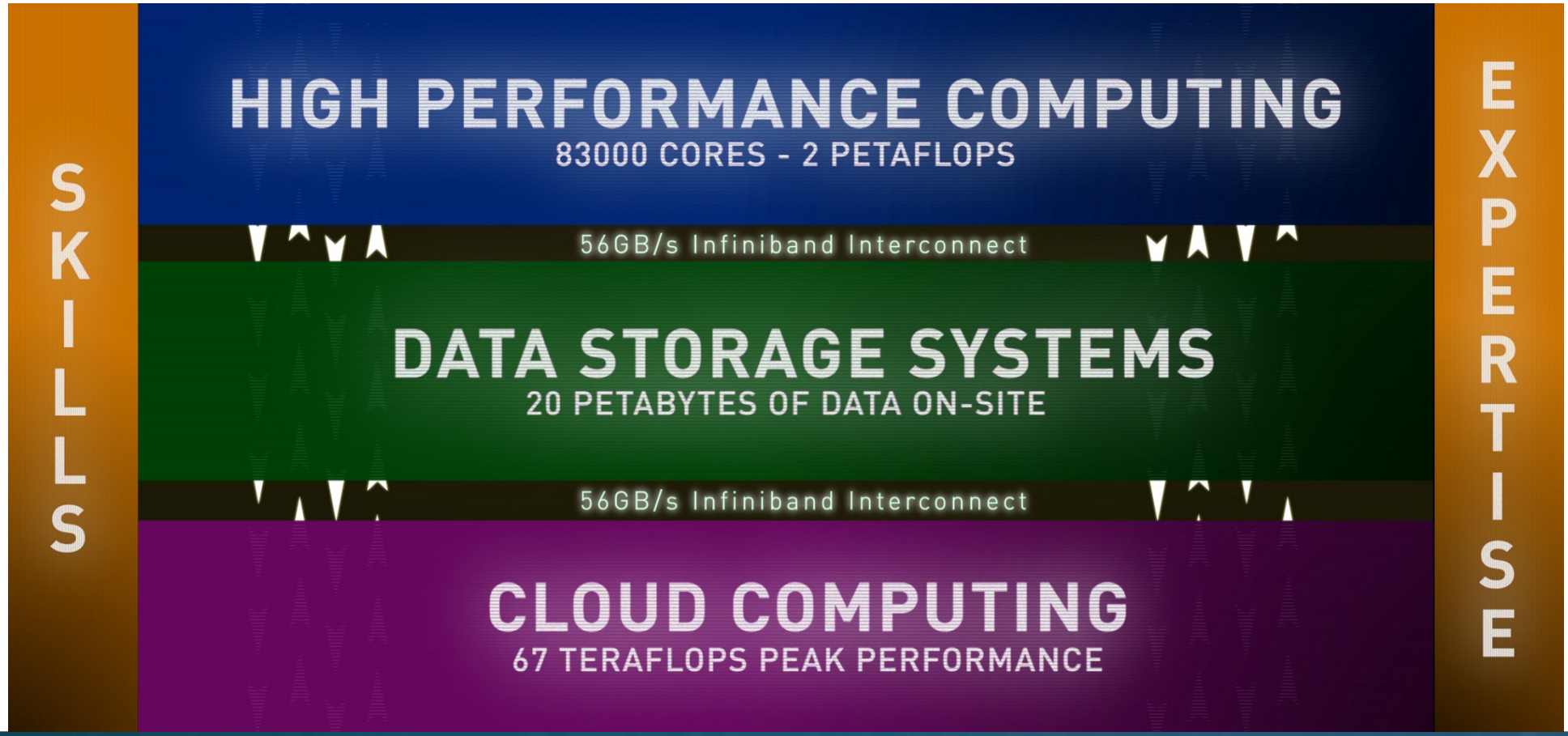
Operates the nation's fastest supercomputer, highest-performance research cloud, fastest filesystems and largest repository of managed, high-performance research data.

Manages this infrastructure and delivers the extensive services built on top of it with a team of ~60 staff: a unique national critical mass of expertise known internationally for their expertise.

NCI today: Services and Technologies

NCI is Australia's most highly-integrated, high-performance compute and data e-infrastructure for research, supported by world-leading expertise.

New mode of data sharing and analysis: compute, datasets and analysis all co-located.



NCI today: Research Engagement and Initiatives

NCI provides frictionless high-performance data services to users, enabling rapid and easy access to data analysis and visualisation solutions.

Supporting the gamut of scientific/technological research




fundamental → strategic → applied → industry

- Physics
- Chemistry
- Mathematics
- Astronomy

- ARC and NHMRC Centres of Excellence

- Environmental science
- Medical research
- Geoscience
- Agriculture
- Materials science

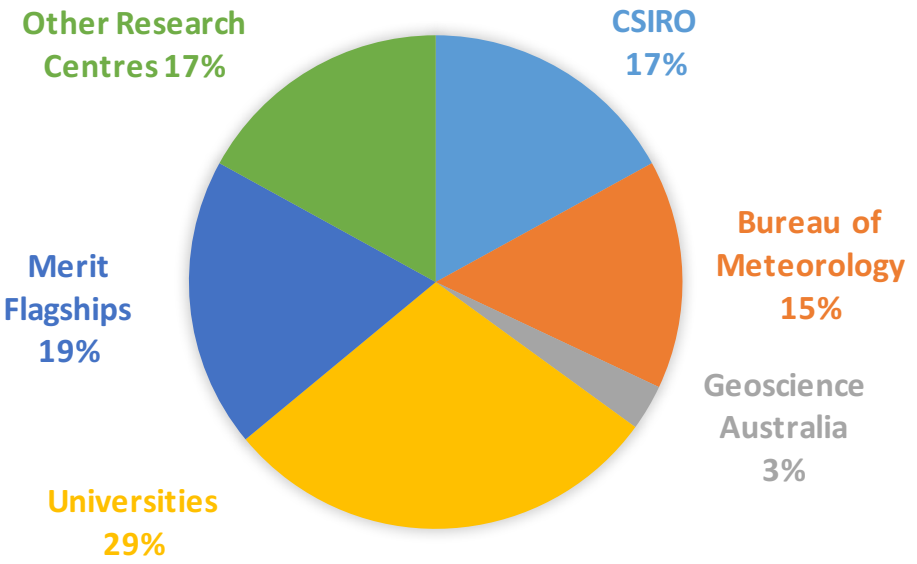
- Weather forecasting
- Extreme weather
- Disaster management/mitigation

- Victor Chang Cardiac Research Institute
- DHI: hydrological modelling

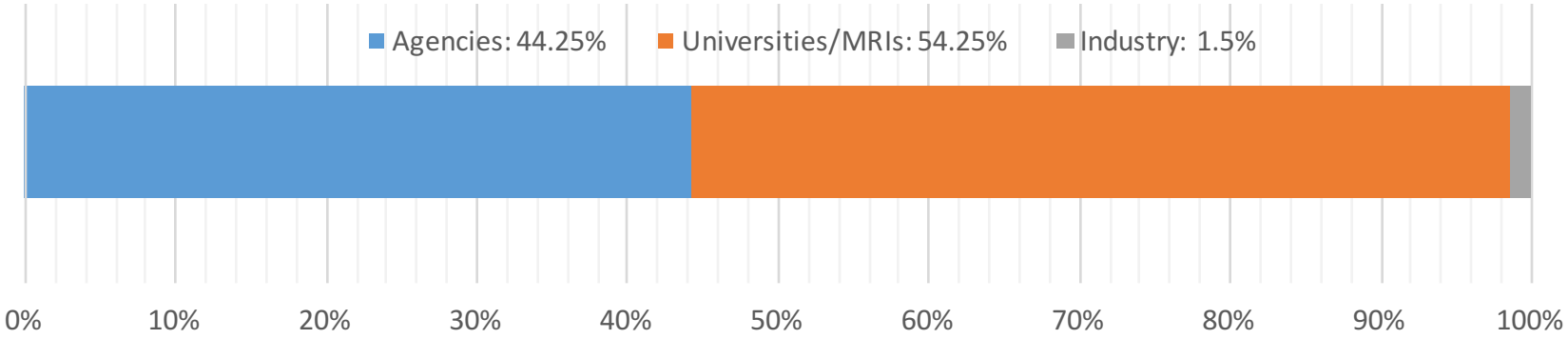
Excellence, Impact and National Benefits

HPC resource usage at NCI

Distribution by Research Organisation



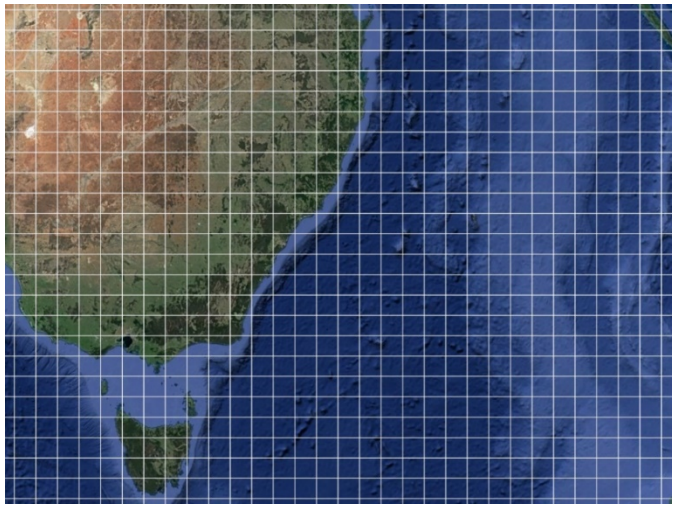
Distribution by Organisation Type



HPC Futures

How do we know what the future is?

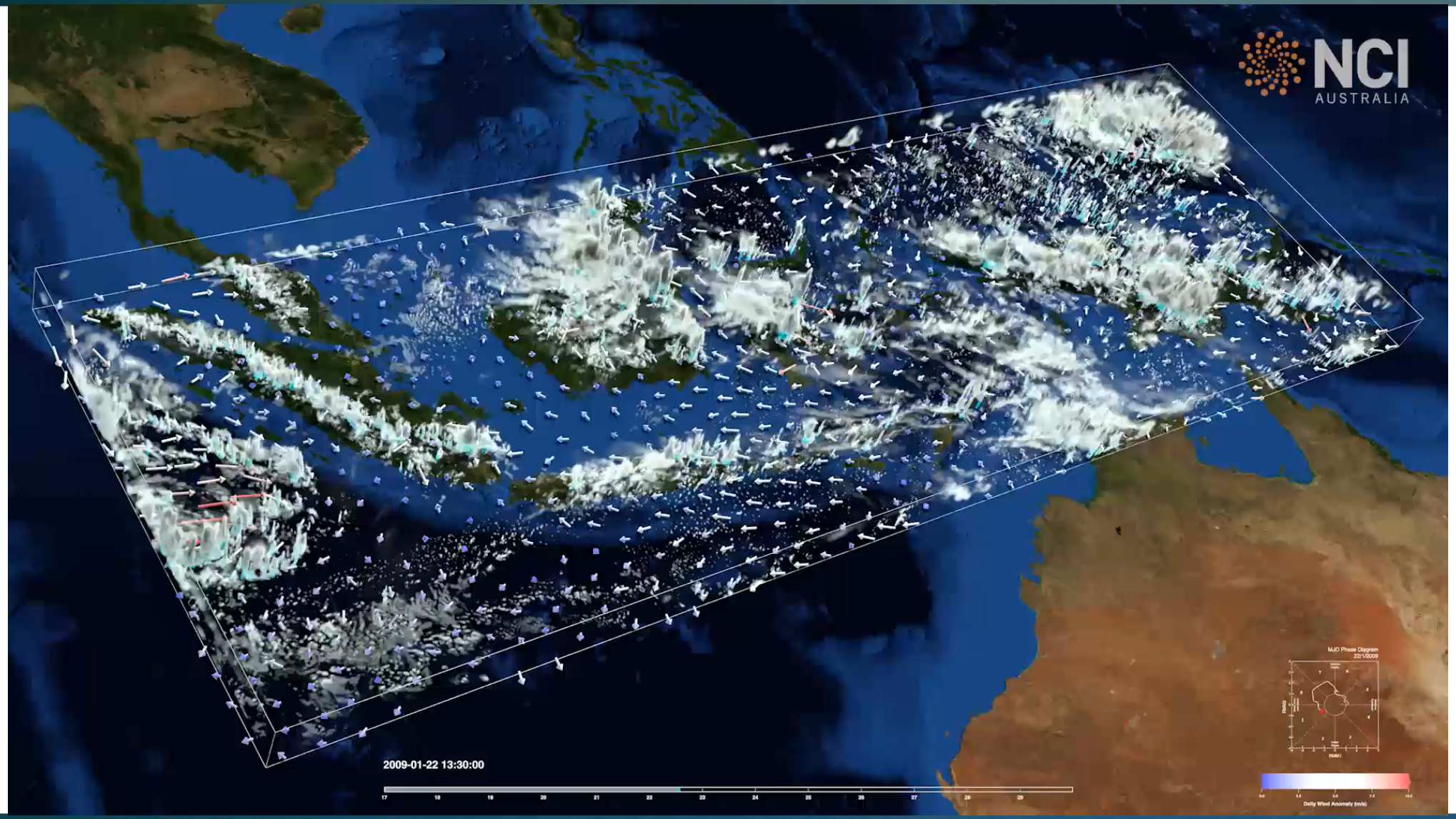
We **DON'T but we can be prepared…**



NCI is research driven and therefore needs to be:

- **Adaptable**
- **Innovative**
- **Collaborative**
- **Support and foster expertise**

Weather patterns of the Maritime Continent



Needs to support the data deluge with well-organized national research collections

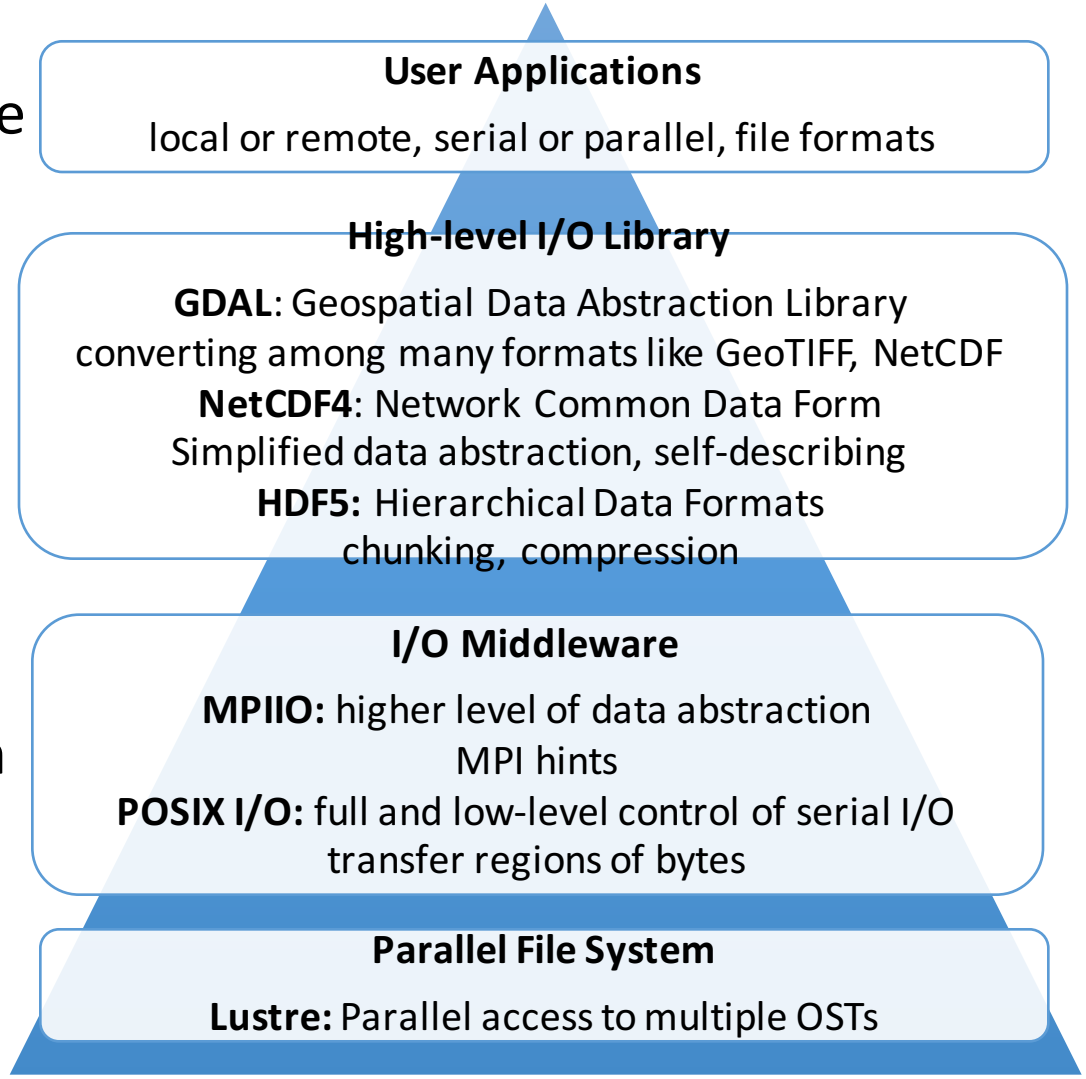
High Performance Data (HPD): data that is carefully prepared, standardised and structured so that it can be used in Data-Intensive Science on HPC." Evans et al, ISESS, 2015.

HPC – turning compute into IO-bound problems

HPD – exploiting HPC for data analysis opportunities

HPC and HPD Analysis requires

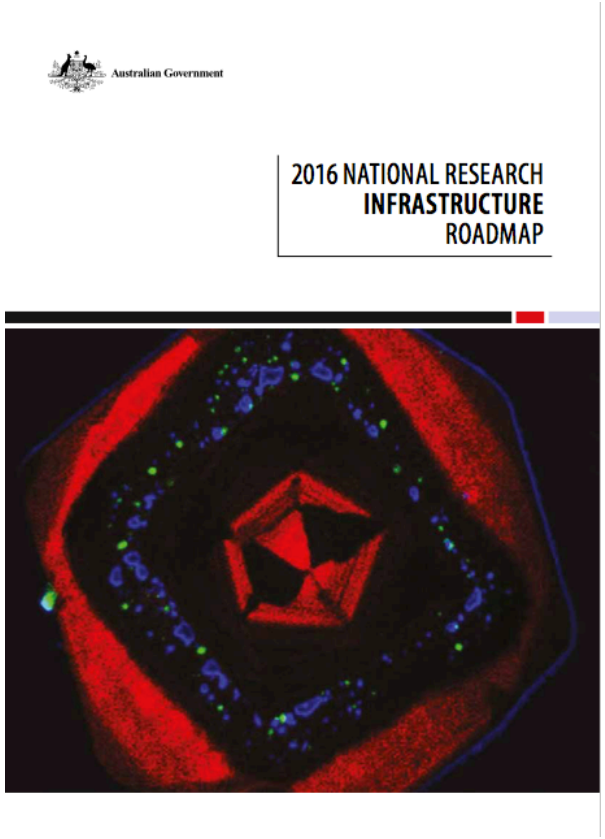
- On-demand direct access to large curated data with fast-and-flexible data access
- Balance between processing power and ability to access data (data scaling)



How do we deploy and develop the infrastructure we need?

nci.org.au

Long term funding



2016 – Urgent case for refunding HPC

- Recommends long term funding for infrastructure
- Need for skill development
- Greater integration of service
- National HPC strategy

NCRIS
National Research
Infrastructure for Australia
An Australian Government Initiative

2018 Capital Investment

- Long term investment $1.9b /12yr
- 5 year contracts
- Review roadmap every 2 years

In the next 5 years…

- $70M NCI renewal of HPC
- $70M Pawsey renewal HPC
- $72M research platforms (cloud & storage)

Collaboration for Sustainability

Over two thirds of our funding comes from partners, who co-invest for a share of resources in return.

- The majority of our partners are publicly-funded research organisations, supporting staff and their collaborators who have requirements that can't be met by the market. We also have a few industry users, accessing resources on a fee-for-service basis.

Collaboration for National Services

AUSTRALIAN ACCESS FEDERATION

Australian Research Data Commons

"Australia has the opportunity to consolidate the gains of the past decade and create a more integrated, coherent and reliable system to deal with the various needs of data-intensive, cross-disciplinary and global collaborative research. "

"The underpinning Australian eResearch infrastructure should include cloud computing, HPC, networks, access, authentication and trusted data repositories."

International Collaboration and Development

Shared science, model evaluation and technical development:

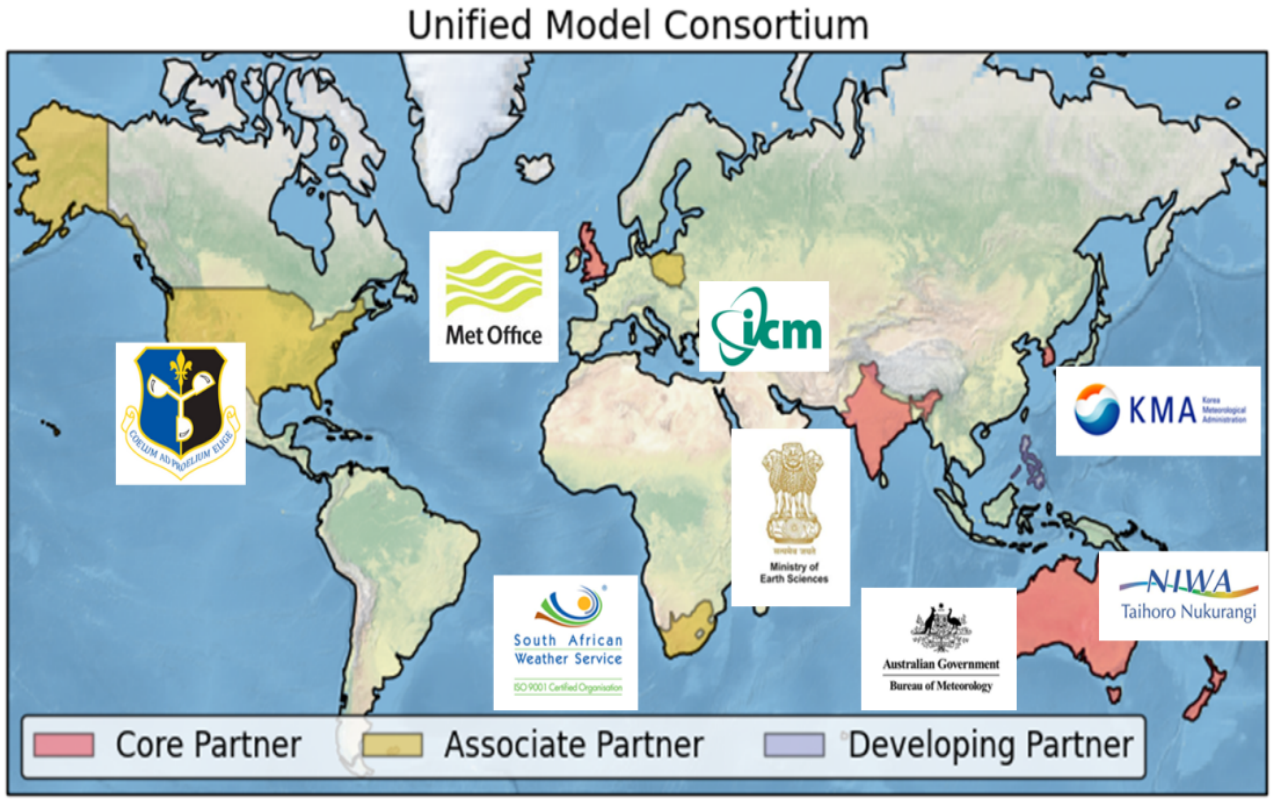
- Joint process evaluation groups
- Technical infrastructure teams
- User workshops & tutorials

A foundation for relationships with other organisations:

- Science & model development
- Weather & climate services
- Jointly growing with businesses

Operational users complemented by:

- research partners in national / international universities & organisations
- capacity building consultancy projects with other partners



Australian Government
Bureau of Meteorology

CSIRO

ARC CENTRE OF EXCELLENCE FOR CLIMATE EXTREMES

How to we prepare and develop our staff and researchers?

Emphasis on Expertise, Skills and Education

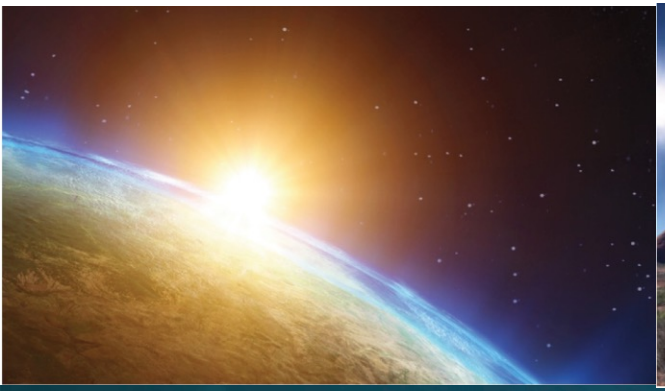
To develop a national computational sciences capability

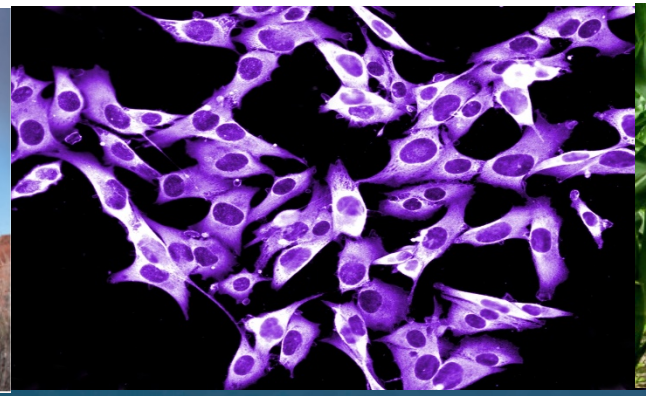
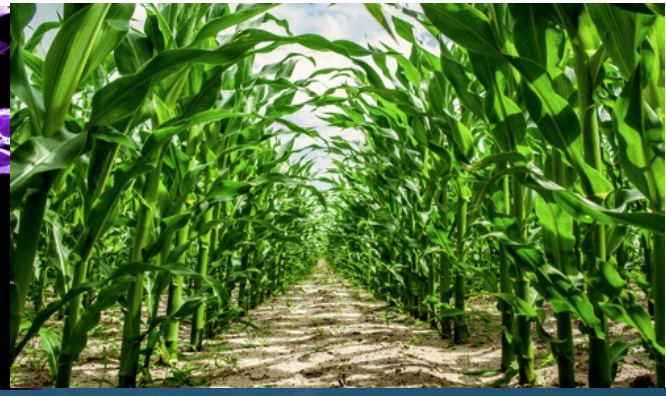
- Aligned with peak facilities – NCI and Pawsey
- Supporting national research priorities though reengineering codes
- Consultancy capability for industries and science agencies
- Supporting industry-focussed on-ramps
- Support for National Centres of Excellence
- Leadership for a vibrant undergraduate and graduate education program to skill a future workforce
- Participation in international HPC collaborations

Conference Theme

HPC Futures *will be built on* ***Hyperscale*** *technology, it will need* ***EXA****scale compute and data resources, it will require* ***AI*** *to run and develop new scientific insights. It will need to take advantage of* ***Quantum*** *computing through continually adapting and integrating new technologies and push* ***Beyond*** *the boundaries of the current fields using HPC.*

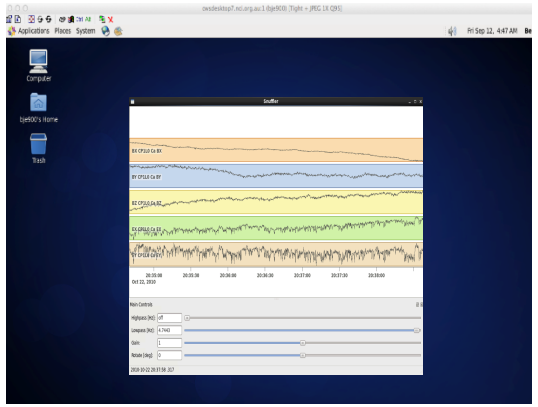
This can only be achieved through **Adaptability, Innovation, Expertise, Collaboration, Collaboration, Collaboration** that is driven by **research outcomes.**



Integrated HPC compute and data-intensive science capability

Compute Intensive: batch & Interactive



Virtual Laboratories

https://store.steampowered.com/app/667970/VTOL_VR/

Portal views

https://uwm.edu/news/creating-an-underwater-milwaukee-harbor-map/

Machine Connected

Data Platform

Fast/Deep Data Access

Data Services

https://www.winpure.com/blog/what-is-the-difference-between-data-and-information/

Server-side functions

Program access

Where are we going?

- From little things big things grow: supercomputing is no longer solely about huge monolithic calculations, but equally about Impact, Integration and (peta; exa)-scale of both the data and the compute.
- Collaborative data projects of institutional, national and global significance: making it work from the simple essentials to the complex bleeding edge.
- Enabling expertise at the interface between science, industry and large scale computing is more than ever in demand. NCI will be pivotal in providing this critical service for university, government and industry sectors as Australia's bridge to HPC/HPD.
- Win-win scenarios for collaboration between national facilties and commercial cloud. This will be all about seamless workload sharing coupled with flexible business models.

Thank You.

Questions?

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Professor Sean Smith *NCI.Director@anu.edu.au*
Director NCI

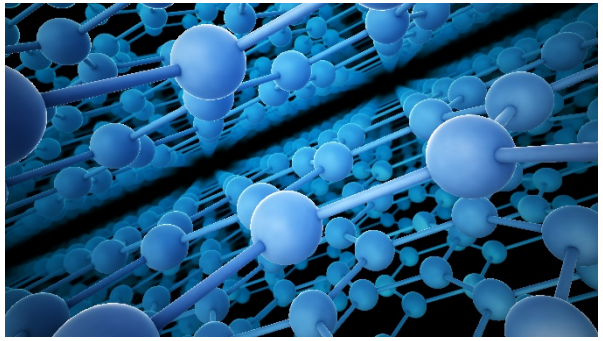
Mr. Allan Williams *Allan.Williams@anu.edu.au*
Associate Director (Services & Technologies)

National Research Priorities: Advanced Manufacturing

Industrial catalysis using nanoparticles

NCI facilities help research how different kinds of nanoparticles play a role in catalysing chemical reactions. This is incredibly important for industrial uses where catalysts are used in many different processes. Finding ways to produce healthy and safe catalysts is important for developing future industries.

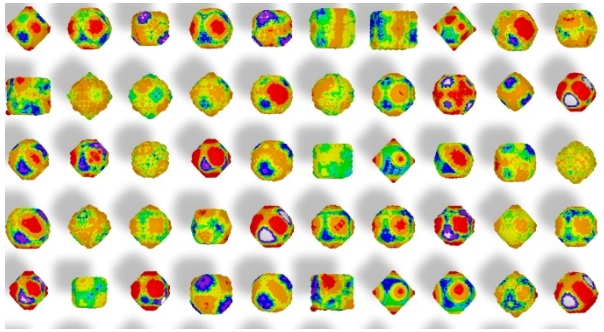
Professor Tiffany Walsh,
Deakin University



Nanomaterials leading to advanced materials

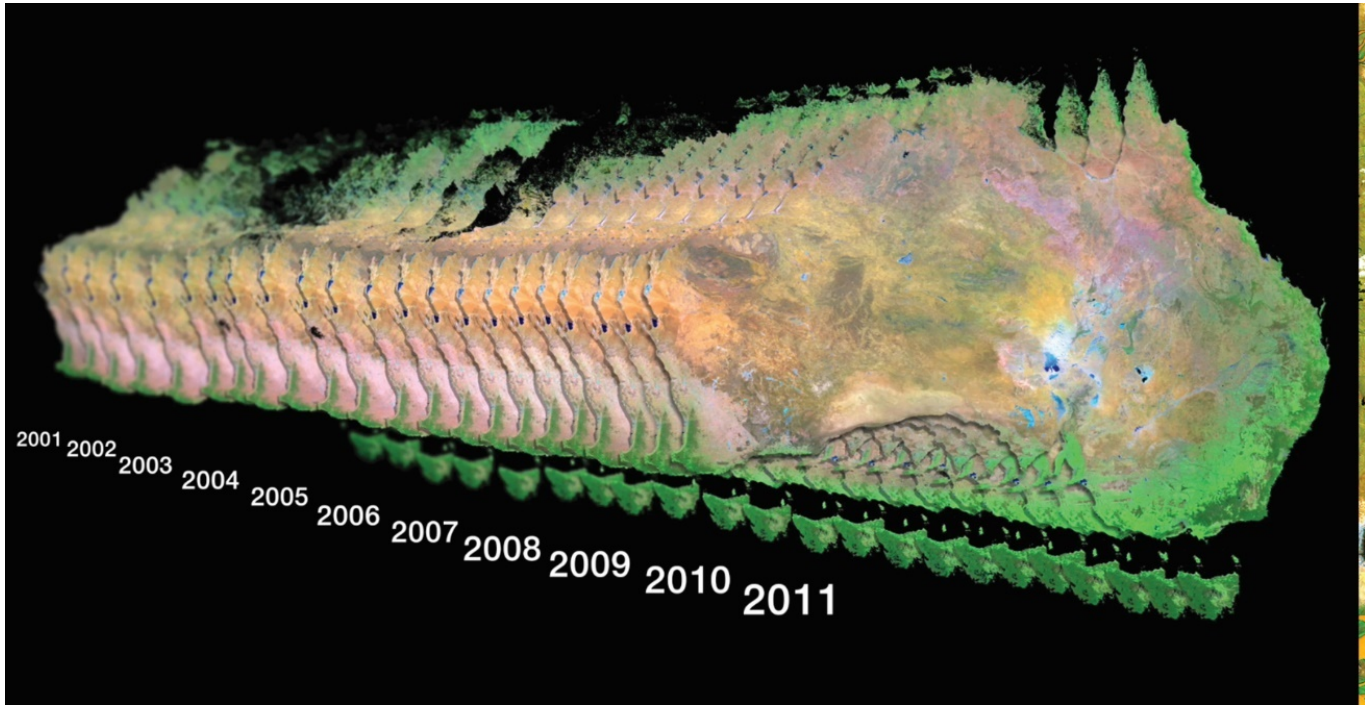
Raijin is being used to model diamond nanoparticle structures, carbon nanotubes, nanowire, and nano-textured surfaces. This has led to the development of a brain tumour treatment new optoelectronic devices, and new night-vision detectors.

Dr. Amanda Barnard, CSIRO
Professor Chennupati Jagadish, The Australian National University
Dr Bjorn Sturmberg, ARC CoE for Ultrahigh-bandwidth Devices for Optical Systems

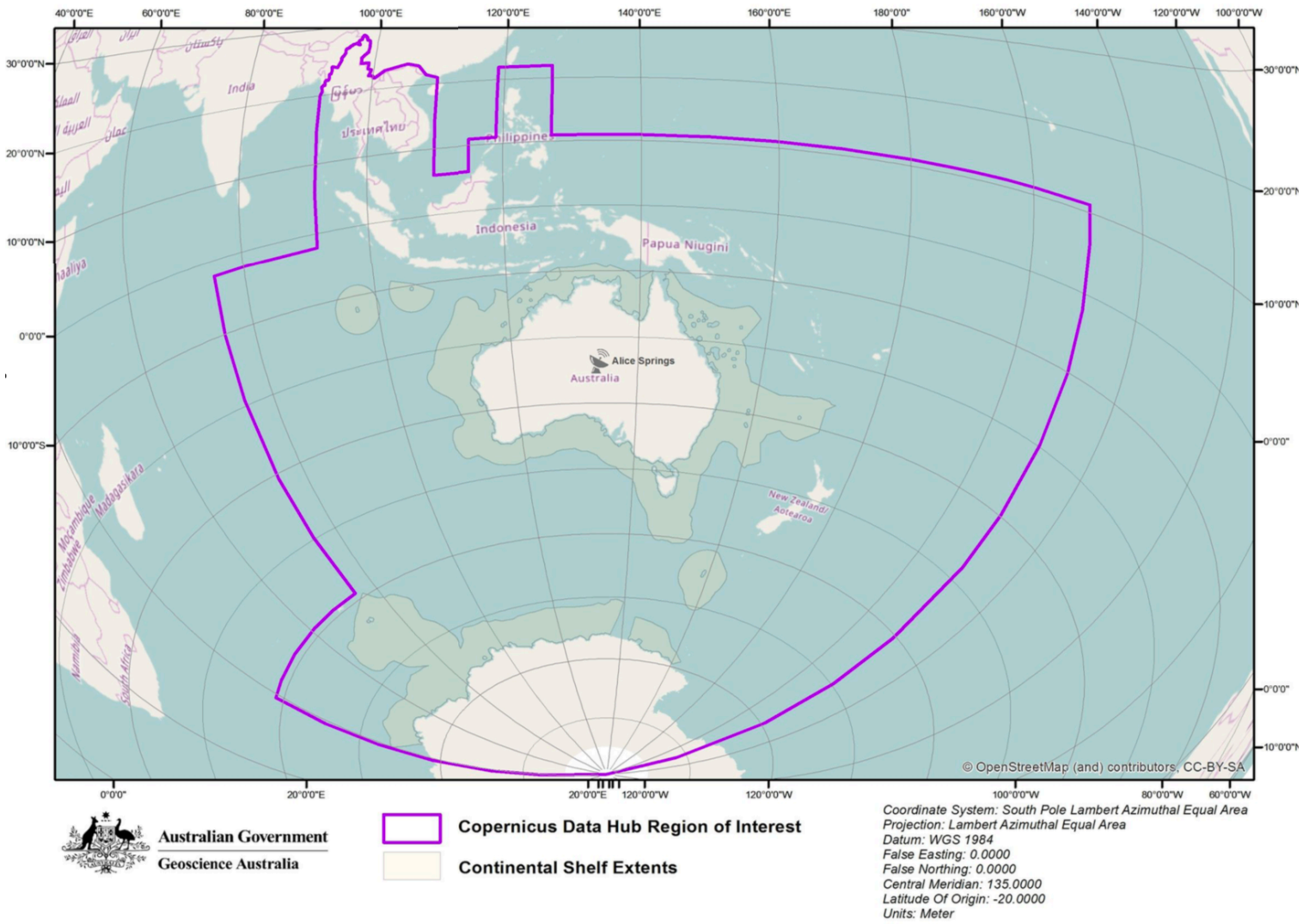


Big Data

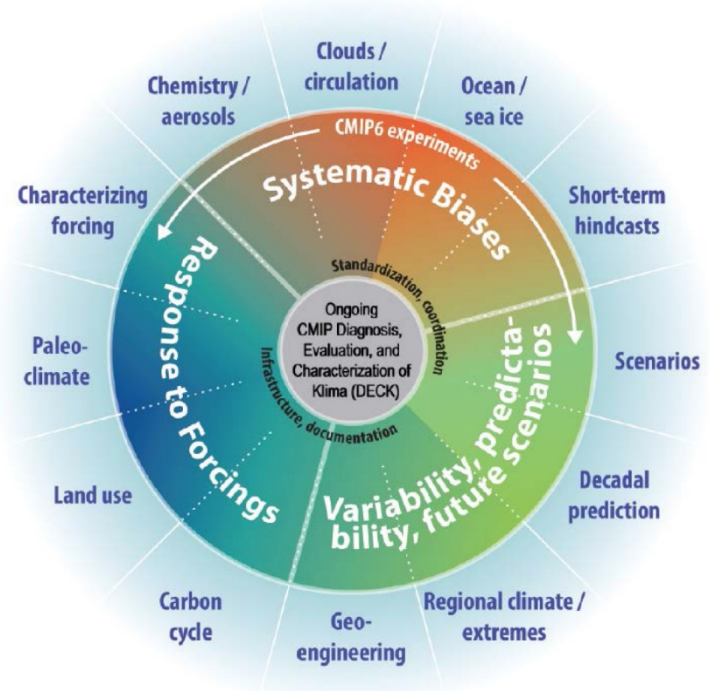
- Data-intensive science
  - Digital Earth Australia— continental-scale earth observations from space
  - Decades of images from the US Landsat satellites
  - Daily images from EU, Japanese and US satellites are now accessible



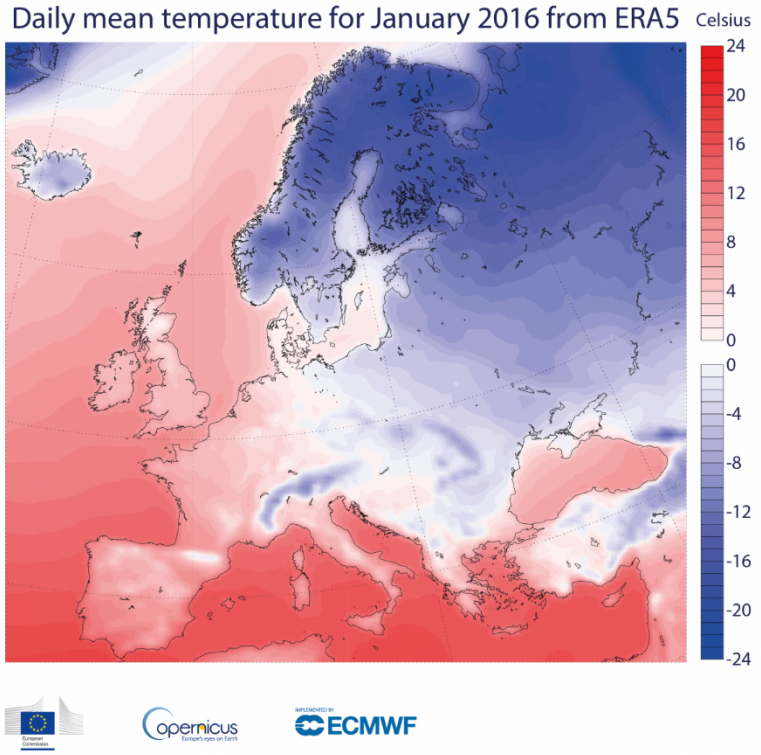
Copernicus Hub – Region of interest



Current large data deluges that are well-organized as national research collections



Climate & Weather model data

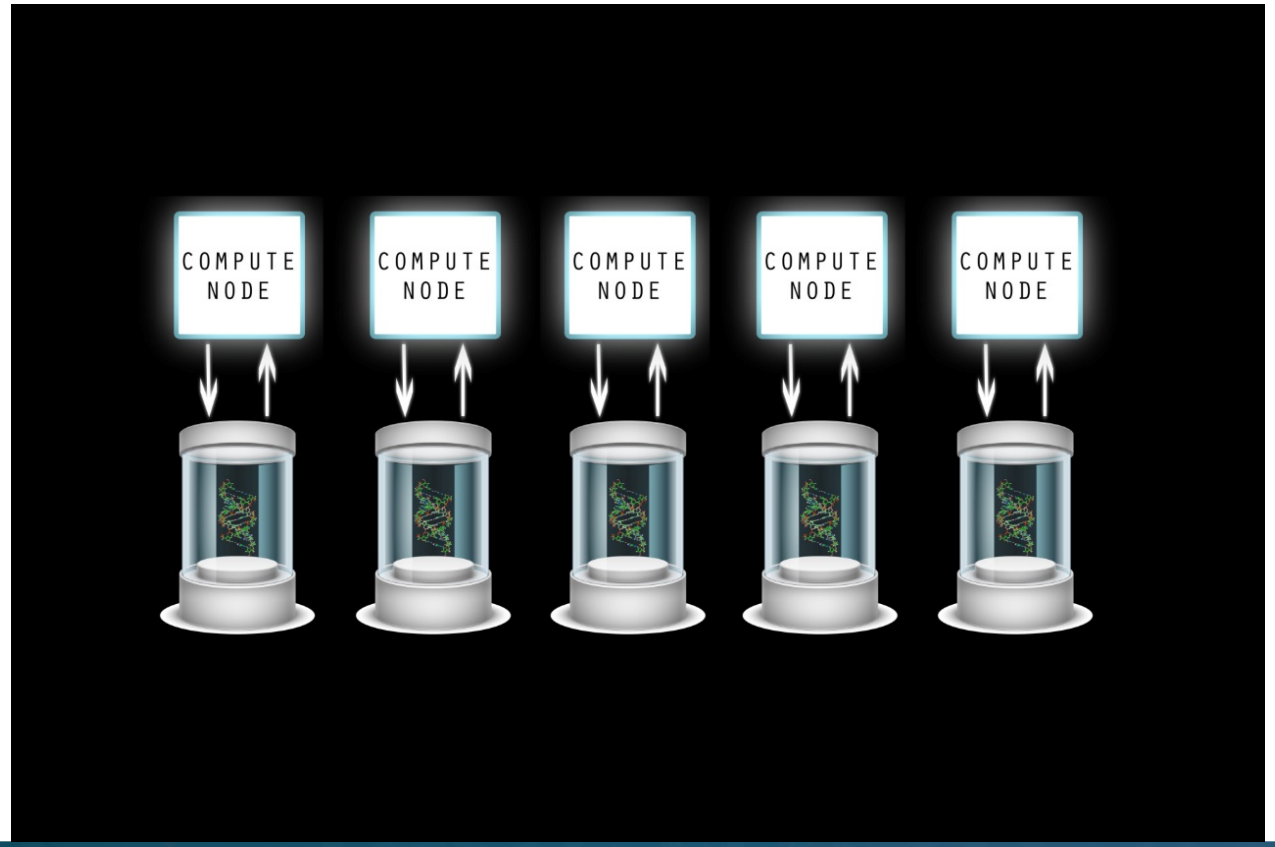


Reanalysis data

Satellite Observations

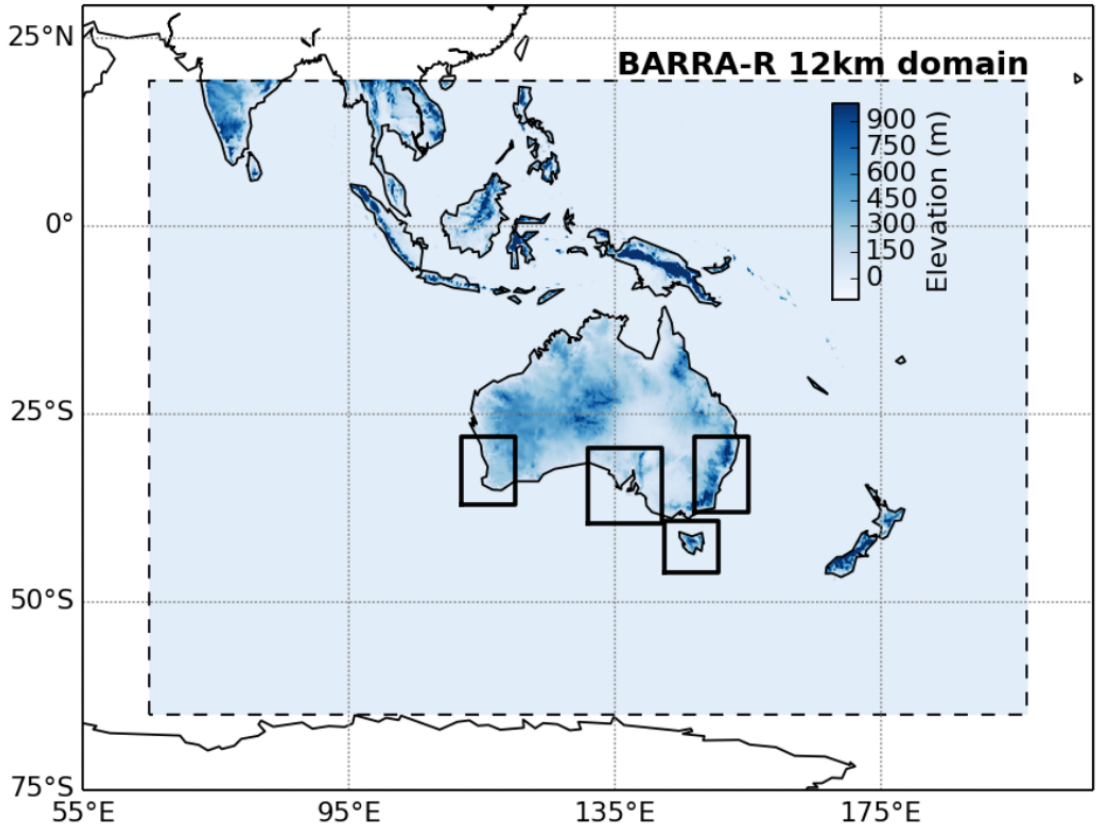
Data-intensive science

- Genomics works with large genetic datasets that a single computer would take years to analyse
- A supercomputer can analyse many genomes simultaneously: we performed a world first alignment of 1200 human genomes overnight



Bureau of Meteorology Re-Analysis Program:

The reanalysis over the Australian domain is provided with a resolution of approximately 12 km and extends over 70 levels up to 80 km into the atmosphere. For a small number of subdomains, the 12-km reanalysis is downscaled to a 1.5 km resolution.



12 KM GRID
COVERING AUSTRALIA,
NEW ZEALAND AND SURROUNDS
(1.5 KM OVER SOME SUB-DOMAINS)

70 LEVELS
IN THE ATMOSPHERE
(THE TOP LEVEL IS AT 80 KM)

4 SOIL LEVELS DOWN TO 3 M

ANALYSED HOURLY EVERYDAY
OVER 25 YEARS 1990–2016