PAWSEY supercomputing centre

PROJECT LEADER
Professor Jason Evans
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SYSTEMS USED
Magnus and Zeus

HOURS / STORAGE
3,500,000 core hours

AREA OF SCIENCE
Climate

APPLICATIONS USED
Weather Research and Forecasting model

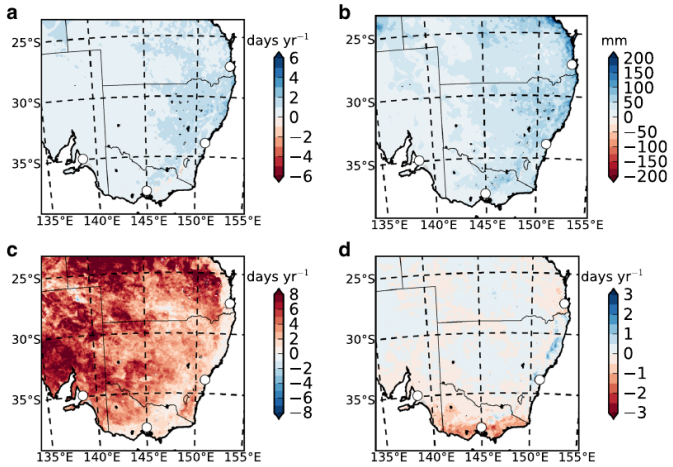
BETTER CLIMATE MODELS TO PROTECT AUSTRALIA

16	3,500,000	12	Up to 10
Team members	Hours Allocated	Simulations	Km resolution models

Climate modelling helps us predict and prepare for the future. Knowing how and when weather changes helps protect our industries and cities.

Professor Jason Evans of the Climate Change Research Centre at the University of New South Wales, and the ARC Centre of Excellence in Climate Extremes, is using Pawsey Supercomputing Centre to create a more exact model of Australia's climate. With more detail, Professor Evans' model shows the changing climate in local areas.

Partner Institution: UNSW AUSTRALIA



*Multi-model mean changes between the present day (1990-2009) and far future (2060-2079) in annual. **a.** Number of very heavy precipitation days (R20mm), **b.** contribution from very wet days (R95). **c.** maximum consecutive dry days (CDD) and **d.** maximum consecutive wet days (CWD). Stippling indicates that the changes are 'significant agreeing' at the 5% level. White circles (left to right): Adelaide, Melbourne, Sydney, Brisbane*

THE CHALLENGE

Professor Evans takes global models that predict how the climate will change in the future, then makes them more precise to map Australia and the surrounding waters in small, multiple square kilometre sections to understand exactly how those sections will look as the climate changes.

"One of the biggest problems with trying to model climate is that there is this huge range of spatial scales that are really important to get climate right. From the micrometre scale of aerosol particles that act as sites for water droplets and ice crystals to form, to the kilometre scale of clouds, to the global scale of winds." said Professor Evans.

As clouds and winds pass over, the weather they produce may change depending on the landscape. Water bodies, vegetation and terrain all play a role in affecting weather. That's why it's important to have a precise model.

"At the moment we map in 50km segments over the whole continent and the oceans around Australia. We get down to 10kms in parts of Australia; mostly in the South East – that's where most of the people live."

Mapping areas at this scale shows the differences in weather. While there might be relatively little temperature difference between one area and another, there can be a big difference in rainfall.

"With rainfall it depends on where you are. Over time, some places will get wetter and others will get dryer. Some places the rainfall average won't change very much at all but there will be changes to the seasonality of when the rain comes. There can also be big changes to the intensity of rain when it comes."

THE SOLUTION

To tackle these vast scales, Professor Evans needed supercomputers and Pawsey Supercomputing Centre was ready to help. The modelling required sending data back and forth across the country, to be processed at Pawsey and partially stored at the Climate Change Research Centre. With such huge data loads, Pawsey's super-fast connection to Australia's Academic and Research Network was vital.

"These models need a lot of compute time to run and they produce a lot of data. There are challenges around data storage, data analysis and assessment. We were continuously transferring data back here from Pawsey. We're very appreciative of the high-speed network they've got across Australia."

Simulations are only as accurate as the data you gather for them. Variations in different climate models often occur because the Earth's climate is interlinked. That means if Professor Evans wants to predict what the climate will be like in one Australian suburb, he needs to know what the climate is like everywhere else on the planet. That's a huge amount of data. To solve this problem, he takes existing climate models that are simplified and refines them with Australian data to get a detailed view of local areas.

"The processes that you need the model to capture occur on scales much smaller than we've been thinking about in the past. We're looking to go to higher resolution to better capture these climate extremes and facilities like Pawsey are absolutely vital. They just can't be captured any other way."

THE OUTCOME

Part of Professor Evans' research is how climate change affects Australian rainfall. Many industries need an accurate understanding of when and where rain will fall to plan their future. A change in rainfall amounts or seasons can wreak havoc on agricultural crops, extreme weather conditions can affect insurance and the water cycle is vital for planning city growth.

"This research gets used in lots of different ways. We partner with water authorities who are interested in two main aspects. One is having security of supply – what happens during dry spells and droughts. Water supplies for Sydney, for instance," said Professor Evans.

"Other industries are much more interested in what's happening with very heavy rainfalls and flooding. For instance, construction codes for street drainage. Street drains should be able to handle the 100-year storm that lasts one hour."

Professor Evans' research doesn't stop here however. The next step is to understand how extreme weather events can affect Australia's water cycle. Fires, extreme heat, rainfall, more intense tropical cyclones and droughts are all predicted to increase. Exploring how these events impact Australia will help us plan to minimise damage.

"We're looking at what the models say about changes in heat waves and fire weather and compound events – multiple extremes occurring in quick succession or at the same time in nearby locations."

With the help of Pawsey Supercomputing Centre, Professor Evans will continue making more precise models of Australia's climate. This knowledge will help us plan for the future to protect our industries, our cities and ourselves.