

Australia's seasonal forecasting system undergoes surgery

A combination of supercomputer grunt, state-of-the-art modelling, international collaboration and Australian ingenuity is set to bring about a step change in multi-week and seasonal forecasting for Australia.

by Mary O'Callaghan

Stretching from Cape York in the north down to western Victoria in the south, the Great Dividing Range has a huge influence on Australia's climate. For Peter Holding, who farms in the South West Slopes region of New South Wales, near Canberra, it means he has to pay close attention to the forecasts.

'I'm outlaying a lot of money, but if it turns out to be a bumper year and I hadn't planted, I'd stand to lose a lot of money.'

[\[continued on page 2\]](#)



Source: Econnect Communication



Source: Econnect Communication

For Peter Holding, who farms on the South West Slopes in NSW, ACCESS-S will give him the regional forecast detail that POAMA lacks.

Peter confesses to being a big fan of POAMA (the Predictive Ocean Atmosphere Model for Australia), the Bureau of Meteorology's seasonal forecast model on which monthly and seasonal climate outlooks are based. He regularly uses the experimental forecast products that the Bureau releases to registered users on trial periods.

'About once a week I look at the chance of exceeding median rainfall, and I watch as it changes from week to week', he says. 'The trial forecasts look a further two months into the future, so in May I can look out to July–August–September, which is quite important to know how spring is going to go.'

'This year I'm looking at a wetter than normal winter and a slightly wetter than normal spring. That tells me it'll be a good year if I can get a crop in. It's bone dry now and the 13 mm forecast last week didn't eventuate. Without POAMA, you'd say it looks like a drought and you'd wait till it rains before planting. But with POAMA, I know it might get too wet when it does come; it might not dry out enough to get out on the country. So I have a window to plant in now and I'm planting.'

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MANAGING
CLIMATE
VARIABILITY
R & D P R O G R A M

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The leap from POAMA to ACCESS-S

With one property at Harden and another about 50 kilometres west at Cootamundra, Peter Holding admits that POAMA lacks the regional detail he needs in a forecast. 'At Harden, we're lucky enough to be where the rain falls', he says, 'but even when there's a forecast of 10 mm for the South West Slopes, we may get nothing at Cootamundra.'

His wish for more regional detail in the monthly and seasonal forecasts will soon be granted. POAMA's forecasts currently have a 250-kilometre resolution and next year the Bureau will start rolling out forecasts with 60-kilometre resolution.

The upgrade is part of a larger project whereby POAMA will undergo not just a facelift but a complete replacement of its major 'organs'; some new ones will also be added. The upgraded POAMA will be based on ACCESS, the modelling system already in use for seven-day weather forecasts and climate change projections, and will be known as ACCESS-S ('S' for seasonal).

The ACCESS project started about 10 years ago as a partnership between the Bureau, CSIRO, Australian universities and overseas agencies, particularly the UK Met Office (UKMO). Under this partnership, the Bureau is localising the UKMO coupled ocean-atmosphere model to suit Australia's needs and is incorporating it into the ACCESS framework.

More regional detail

The increased resolution is the biggest improvement that ACCESS-S will bring and is only possible because of the Bureau's new supercomputer. 'Our original plan was to go from 250 km to 150 km resolution', says Dr Oscar Alves, the Bureau's Coupled Modelling Team Leader. 'But the outcomes of our Managing Climate Variability project suggested there would be significant benefits in going to 60 km, like the UKMO model, and that's what drove our strategy.'

The increased resolution will also improve the representation of important large-scale climate drivers such as the El Niño - Southern Oscillation, which could lead to better multi-week and seasonal forecast accuracy for Australia.

More accuracy

The ACCESS-S system will ultimately produce forecasts with greater accuracy than POAMA-based forecasts. ACCESS-S will have more up-to-date physics and will better represent not just the atmosphere and oceans but also the land surface, soil temperature and soil moisture, and how these factors interact.

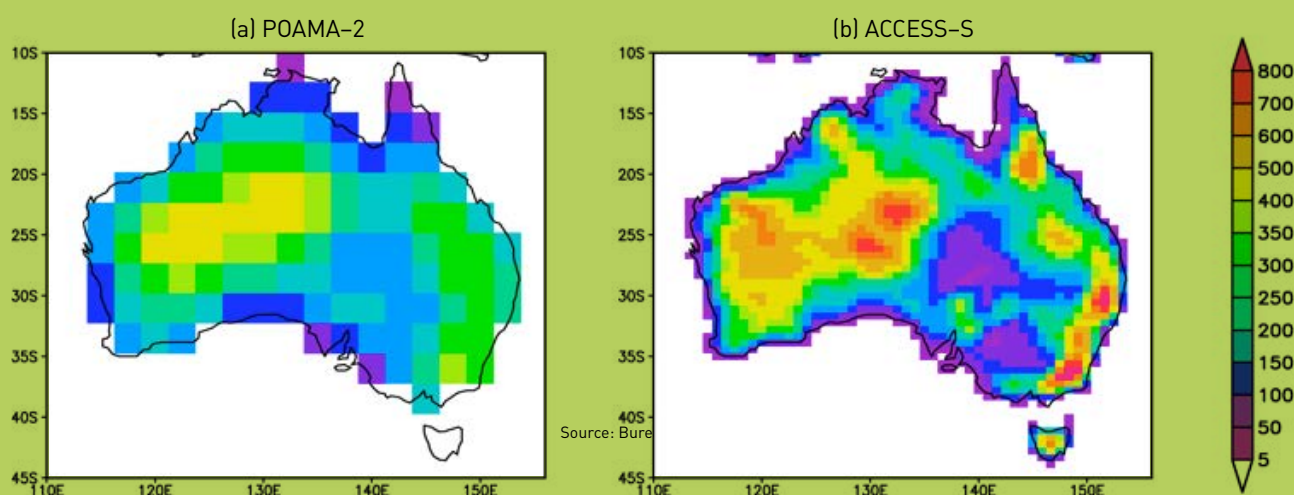
'Soil moisture and vegetation are important for a climate model', says Dr Alves. 'ACCESS-S will use the UKMO's JULES soil model which is state-of-the-art, two generations on from POAMA. For the first time we will also have a sea ice model and a greenhouse gas model, and we will also be able to fully represent the stratosphere.'

But the model, he adds, is only half of the story. The other major component is the initialisation system which primes ACCESS-S with the most up-to-date observed conditions of the ocean, land and atmosphere so that it can begin to forecast from the most accurate starting point.

The observations, which come from ships, Argo floating buoys in the ocean, satellites and ground stations, construct a picture of what the ocean, land, ice and atmosphere look like on a given day. They are then quality-controlled and blended with other observations into a format that ACCESS-S can use.

Australia Topography

Resolution increase from 250km to 60km
Able to resolve Dividing Range, Tasmania, east coastal zone



Source: Bureau of Meteorology

The 60-km resolution of ACCESS-S forecasts means more regional detail, especially for Tasmania, southern Victoria and the Great Dividing Range.

The Bureau has always relied on the best complex modelling available worldwide, but the new initialisation system, developed by the Bureau and CSIRO, is a product of Australian ingenuity. 'Much of the initialisation system was developed for POAMA through the support of Managing Climate Variability', says Dr Alves. 'It is a very complicated suite of software that blends the observations with the model.'

More frequent outlooks

The Bureau's POAMA seasonal outlook is published monthly. ACCESS-S will produce forecasts daily and will allow for more frequent updates to forecasts. The main constraint, says Alves, is the human element of interpreting and communicating the forecast. 'We will increase the frequency of seasonal outlooks to twice per month, and ultimately to weekly', he says. 'We will also start to issue fortnightly outlooks to add to the monthly and seasonal outlooks.'

The timeline

By mid-2017 the current suite of seasonal outlook products will be upgraded to the higher resolution. Further upgrades to services, such as more frequent forecasts and multi-week forecasts, will occur between 2017 and 2019. The accuracy of the forecasts will gradually increase with each new version.

'We are calling this first implementation ACCESS-S1', says Dr Alves. 'There isn't enough time to include the initialisation system into S1, but it will be there in ACCESS-S2.' The ACCESS-S1 forecast products are expected to be released in trial mode, running in parallel with the current POAMA products for a while before becoming operational.

New products to meet people's needs

There are several possibilities for new forecast products based on ACCESS-S and the Bureau has already run workshops with people around the country to seek guidance. Along with more frequent seasonal forecasts, the introduction of multi-week products over the next few years was discussed.

The probability of exceeding certain thresholds for a multi-week timescale is one of the new trial products identified at the workshops. But not everyone has the same needs at that timescale: 'While a product such as the chance of exceeding 20 mm next week might make sense to a farmer, the chance of a weekly average temperature exceeding 30 degrees next week makes less sense', says Dr Alves. 'At the moment we are trying to work out what will be most useful for farmers. It might, for example, be the chance of getting three days above 35 degrees, one day above 40 degrees or 20 mm over the next fortnight.'

The regional forecast detail is limited only by the available computer power. 'The 60 km resolution is as high as we can go', explains Dr Alves. 'When you double the resolution, you multiply the number of computer calculations by eight. Similarly, the number of daily forecasts run and the forecast lead time affect the number of calculations required by the computer. So, producing a 12-month forecast is twice as expensive, computationally, as a six-month forecast. So we have to consider how best we can meet people's needs.'

Decision-support tools based on POAMA

CSIRO's Dr Peter McIntosh has developed software that calibrates and downscales POAMA-2 forecast data to the weather-station scale.

'We have daily rainfall, temperature, and solar radiation data for every day for nine months into the future', says Dr McIntosh. 'The data can be used to drive APSIM or any other agricultural software that requires daily weather data.'

He is currently testing the downscaled data with a new version of the crop management tool Yield Prophet®.

'Yield Prophet is a what-if scenario generator', he explains. 'It can tell you the probability of getting a higher yield if you apply more nitrogen. For example, you might have a 60 per cent chance of getting an extra tonne per hectare by applying more nitrogen.'

'Currently with Yield Prophet, the way you decide how much nitrogen to apply is to look at the past weather data. But POAMA allows you to also look at the future. With past history you get averaged values. But in 2016, for example, we've got a good idea there's a wet period coming, so by incorporating the forecast data we get a better estimate of how much nitrogen to apply than if we were just using the historical record.'

Upgrading the software to ACCESS-S1 is on the cards for next year.

For farmer Peter Holding, the prospect of Yield Prophet® being able to factor in the seasonal forecast is a welcome one—he normally does it manually: 'It would be so much more accurate. If we get a wet June and the forecast indicates it's about to turn dry, I could save \$30,000 to \$40,000 by not putting nitrogen on. But if the forecast was for a good spring, I'd probably put more on.'

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The rainfall–nitrogen conundrum for grain growers

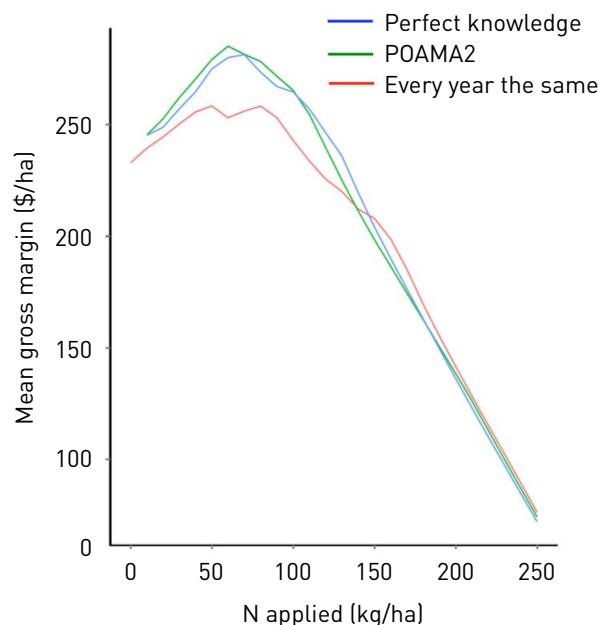
by Jay Nagle-Runciman

Researchers are expert time travellers, using historical data to test the value of using seasonal forecasts.



Source: Daniel Rodriguez

Daniel Rodriguez talks to farmers about fertiliser decisions at his summer grains field day at Gatton in south-east Queensland.



Change in mean gross margin (\$/ha) from applying the same amount of fertiliser every year (red line), compared to deciding the rate of fertilisation based on perfect knowledge i.e. if we knew beforehand what the in-crop rainfall will be (blue line), and using the forecast from POAMA (green line). Results are for wheat grown at Dalby, Queensland.

Seasonal climate forecasts derived from complex models based on up-to-date understanding of the functioning of the climate are showing promise for grain growers.

With Australia's highly variable climate, nitrogen fertiliser applied early in the season could be of little benefit if rain doesn't fall at critical stages in the crop cycle. This makes the rainfall–nitrogen 'marriage' a difficult conundrum for growers.

'Nitrogen fertiliser decisions are difficult because of uncertainty about the coming seasonal conditions', says MCV researcher Dr Peter Hayman of South Australia Research and Development Institute (SARDI).

Growers apply fertiliser hoping to match the demand from the crop. But if the season turns dry, fertiliser is a poor investment.

Excess nitrogen that is not used by the crop can be lost over the fallow period and, in some cases, will leach into the groundwater or be lost as nitrous oxide, a powerful greenhouse gas.

On the other hand, if small amounts of fertilisers are applied and rainfall is significant, growers miss an opportunity as crop growth languishes, and yields and profits dwindle.

Using the benefit of hindsight

Using APSIM (Agricultural Production Systems Simulator), researchers have revealed the value of taking into account measurements of soil water, soil nitrogen and information on dynamic seasonal forecasting to reduce risk and increase efficiency of applying nitrogen.

MCV-funded researchers from SARDI and the University of Queensland simulated what might have happened for growers making fertiliser decisions over the past 30 years at a number of locations across Australia.

Using rainfall forecasts from POAMA, the Bureau of Meteorology's Predictive Ocean Atmosphere Model for Australia, they compared these forecasts with what really happened during those 30 years and investigated the interplay between nitrogen use, soil characteristics and expected rainfall.

Dr Daniel Rodriguez from the University of Queensland says many farmers know the value of information to support their fertiliser decisions.

'In the northern region it is common for our best farmers to sample the soil to determine levels of available water and nitrogen before the rate of fertilisation is decided', he says. 'Now farmers can add seasonal climate forecasts as an additional source of information to support that decision.'

Revisiting past fertiliser decisions with new information

To reveal the value of the information available to support fertilisation decisions, researchers used APSIM to test a few scenarios.

What would have happened, for example, if farmers applied the same amount of nitrogen to a crop every year compared to modifying the amount of fertiliser based on soil water at planting, soil nitrogen at planting and the POAMA-2 forecast?

As expected, researchers found that using additional information to inform nitrogen application decisions significantly reduced the chance of losing money over time, and reduced the risk.

'In Dalby, Queensland, for example, 100 kilograms of nitrogen per hectare is needed each year to maximise profits', says Dr Rodriguez. 'However, similar profits but reduced risk—measured as the chance of farmers making a loss—could be obtained if growers adjusted their fertilisation decisions every year according to values of initial soil water and initial soil nitrogen.'

The simulation showed that growers who modified their fertiliser application rates based on values of soil moisture at planting would obtain similar profits, at lower risk, using only 80 kilograms of nitrogen per hectare.

And when growers further adjusted their fertiliser application rates according to the initial soil nitrogen, they reduced their risks even further while achieving similar profits.

What if decisions were based more on the forecast rainfall, especially in known nitrogen-deficient environments? In South Australia, the MCV team did just that, looking at simulations of top-dressing wheat at Hart in the state's mid-north for the 30 years from 1981 to 2010.

'We found that using POAMA's seasonal forecasts of above or below median spring rainfall as a guide, growers would have been right twice as often as they would have been wrong', says Dr Hayman. 'And under that scenario, where we assume a fairly nitrogen-deficient situation, that's worth about \$10 per hectare.'

Dr Rodriguez adds: 'POAMA, in general, just by telling us that it's likely to be wetter than average or drier than average, and managing nitrogen accordingly, is another piece of information that can help growers reduce risk.'

Putting all the information together

As growers already know, in a highly variable environment the best approach is to consider all available information to support investment decisions.

When the researchers ran the APSIM model in central Queensland, they found that both the seasonal forecast and the initial soil water played an important role.

'For central Queensland, we used APSIM to find out what happens if, for example, you plant a sorghum hybrid of a higher yield potential at a higher plant population when POAMA indicates a wetter-than-average season', says Dr Rodriguez. 'Results from APSIM showed that for central Queensland a wetter-than-average forecast from POAMA together with above-average soil moisture conditions at planting provided the right conditions to expect a good season in which to plant a hybrid of higher yield potential at a higher plant population, and to increase investments in crop inputs.'

Dynamical seasonal forecasting adds another arrow to the quiver

The researchers are the first to agree that no approach is perfect. There are varying degrees of accuracy that POAMA can provide in different spots around Australia.

But as the climate changes, it no longer makes sense to rely on the climate patterns of the past to make decisions.

'The information that we do have can help', says Dr Rodriguez. 'POAMA offers another piece of information that farmers can use to support these type of decisions.'

With the Bureau of Meteorology now preparing to launch the ACCESS model (see story on page 1), seasonal forecasting is set to become even more useful for growers looking to make better fertiliser decisions.

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Managing Climate Variability – 25 years on

By Barry White and Peter Hayman

There is much to be learnt from the MCV challenges that have been met and successes achieved, according to Dr Barry White, who coordinated the program for the first half of the journey, and agricultural researcher Dr Peter Hayman, who has been involved in climate applications projects since MCV was launched in 1992.

The early days

MCV was launched as a part of a new national drought policy emphasising self-reliance. The tragic Ash Wednesday bushfire, and the duststorms and extensive drought so prominent in the 1982-83 El Niño had raised the priority given to climate variability research to support improved climate risk management. An increase in farmers' use of fertilisers and chemicals had also made many farming decisions more financially risky.

From a global perspective, the El Niños of 1982-83, 1997-98 and 2015-16 are recognised as three of the most extreme El Niño events for a century. Their regional impacts varied but were most pronounced in parts of the Americas, eastern Africa and south-east Asia in the form of fires, floods and droughts.

The 1982-83 and 1997-98 El Niño events each resulted in record spikes in the rising global temperature trend evident over the past half century. The spike occurred in the final calendar year of the event, as is likely to happen this year.

The evolution of POAMA

In 1989, the Bureau of Meteorology launched seasonal rainfall outlooks based on the Southern Oscillation Index (SOI), which was well established in using atmospheric pressure changes between Tahiti and Darwin to indicate ENSO developments. By the mid-1990s, there was increasing recognition of the need for coupled ocean and atmosphere models to better account for interactions with other possible seasonal climate influences such as climate change, varying ocean warming patterns in the Pacific Ocean, and the effects of the sustained warming of the Indian Ocean. The need was well illustrated by the 2002 drought which was extreme and widespread in Australia but was not a strong El Niño globally.

MCV co-invested with the Bureau and CSIRO who, by 2002, had developed the first version of POAMA. Operational forecasts of ocean temperatures in the designated El Niño areas of the central equatorial Pacific followed. In February 2015, POAMA showed El Niño thresholds likely to be reached by spring. Operational rainfall and temperature forecasts by POAMA were launched in May 2013 for the coming two months and the three month season ahead. Accuracy of the rainfall outlook is expected to be highest in autumn and spring.

Now MCV is involved in the further evolution of POAMA-2 to ACCESS-S which, in a timely and effective international collaboration, will include more components from the UK Met Office. Major improvements to seasonal forecasting are likely from the Bureau's increased supercomputing capacity and from the higher resolution which will allow more local detail.

The three most extreme but different El Niño events

The El Niño footprints as shown by the differing rainfall patterns in Figure 1 demonstrate the importance of taking an informed probabilistic approach to seasonal forecasting—one that is based on the spectrum of climate variability related to the El Niño, and not on specific climate events or an average of El Niño years as portrayed in map (d). The average map is useful for showing how the impacts of an El Niño vary around Australia. But to manage climate risk at a specific location, one requires some understanding of what makes up the average. The maps are for winter-spring rainfall deciles as this is generally the period of maximum El Niño impacts on, for example, wheat yields. Of the three strongest El Niño events globally, the two most recent events, whilst severe in some localised areas, did not result in widespread drought over the critical June-November period. The El Niño impacts were fortunately less severe than might have been expected given the concerns in the Australian and global media.

Seasonal forecasting is coming of age, slowly

Given the challenges and promising progress, it is useful to look back over a longer timeframe and recall the hopes that farmers have had for over a century for long-range forecasting.

In 1882 Sir Charles Todd, the South Australian meteorologist, had asked in relation to seasonal forecasts: "They have them, it is said, in India; why not in Australia?" Why the delay?

A lingering predilection for cycles and sunspots would be one factor, as would more reasonable concerns by the Bureau on limited forecast skill necessitating a probabilistic approach. It should be said that climate research other than the descriptive was often low priority, almost a 'country cousin' of weather forecasting. What can be seen as obvious opportunities for collaboration all too often need an external stimulus.

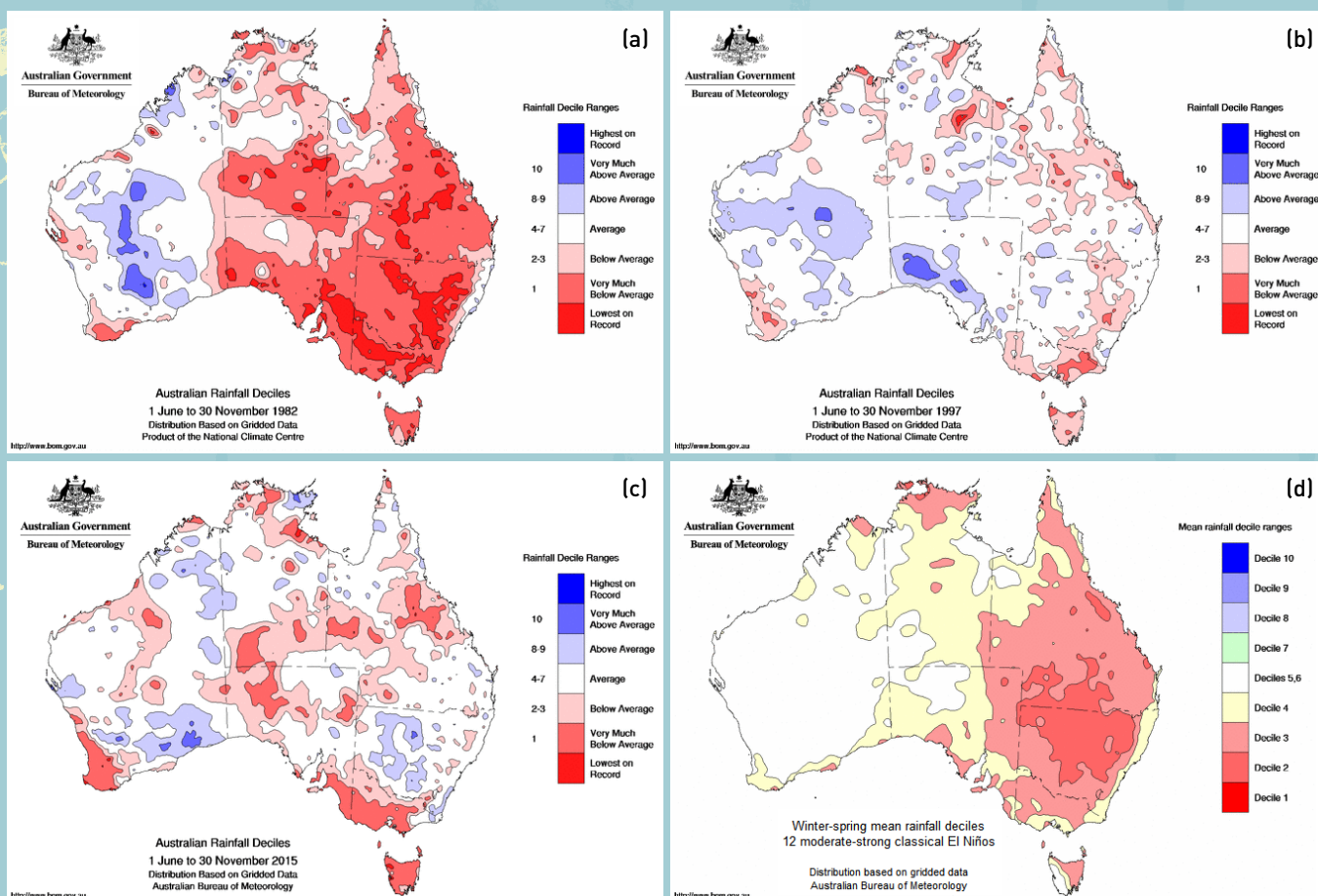


Figure 1. Winter-spring rainfall deciles for : (a) 1982, (b) 1997, (c) 2015, the three most extreme El Niño events for a century in terms of global impacts, and (d) the average of 12 moderate-strong El Niños. The red areas are where rainfall was extremely low; blue areas are the corresponding high rainfall areas.

The 1982-83 El Niño triggered new collaborative research

Research by Dr Neville Nicholls, then at the Bureau, was the catalyst. He had increased people's confidence in the enduring value of the Southern Oscillation Index (SOI) by validating an SOI-related forecast by Quayle in 1910. Nicholls's work inspired a highly productive collaboration with Queensland agricultural researchers. Dr Graeme Hammer championed the linking of crop simulation models to seasonal forecasts to test the effects of changing management strategies; likewise Dr Greg McKeon with grazing models. Dr Jeff Clewett launched a new version of Rainman in 1991. And in 1992 Dr Roger Stone published the five-phase system for SOI forecasts, which were to form the basis of studies in many regions and industries of forecast value. (MCV has a current project to eventually make POAMA-based data accessible for research on forecast value.)

The early priority given to national collaborative and capacity-building projects was demonstrated by the involvement of 30 R&D organisations in the 13 projects funded. For example, the ambitious National Drought Alert project (based on the spatial pasture model AussieGRASS) was built up from submissions from all major organisations involved in managing rangelands.

Getting the message across

Conveying forecasts as probabilities was an early problem. There were no obvious precedents. MCV has always aimed to work through the two-way links of climate science to applied research and extension and, just as importantly, through the reverse links. Feedback from farmers in the MCV Climate Champion program has been important in this respect.

MCV has survived and evolved over 25 years thanks to core funding from federal government and contributions from Rural RDCs which, though valued, have often been ad hoc. Most of the RDCs have contributed to MCV at some stage in what is an exemplary model of a national collaborative program—a program that can bring a rigorous national focus where needed to regional and industry priorities.

MCV's ability to attract outstanding and committed researchers has been a highlight. The recipe for the program's most successful projects has been collaboration between organisations combined with undramatic but painstaking contributions over many years. There are of course challenges for a small stop-start program, particularly relating to equitable funding, free-riding and to overheads. Nevertheless, MCV's survival can be attributed in large part to the ongoing support of the major partner, the Grains R&D Corporation.

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Project updates

The following table lists our current MCV projects across the four themes of the program:

1. Climate forecasting research
2. Climate forecasting services
3. Climate risk management for agriculture
4. Climate knowledge and communication

Project title	Time period	Summary of research objectives	Progress to date	Research contact
Improved skill for regional climate in the ACCESS-based POAMA-3 model	June 2014 to February 2017	Determine the value of POAMA forecasts in the wheat and cotton industries using case study locations in NSW, and for rangeland grazing sites in northern Australia	<p>We have acquired and installed the most recent coupled model code from the UK Met Office. Referred to as Global Coupled Model version 2 (GC2), it includes improvements to clouds, convection and other physics, and offers improved forecast performance for weather and climate.</p> <p>We have run hindcasts to assess forecast performance for the Australian climate. Our assessment showed benefits of building the next system based on GC2, but also some limitations, which will be addressed in ACCESS-S1.</p>	<p>Dr Harry Hendon Bureau of Meteorology h.hendon@bom.gov.au 03 9669 4120</p>
Themes 1 and 2				
POAMA seasonal forecast value	June 2014 to February 2017	Determine the value of POAMA forecasts in the wheat and cotton industries using case study locations in NSW, and for rangeland grazing sites in northern Australia	<p>For wheat, we have shown that even with substantial starting soil moisture, seasonal climate forecasts can still be valuable at around \$50/ha, with a payoff time of 3 to 8 years.</p> <p>In the cotton industry, methods of using seasonal climate information are less well known, but we found that rainfall forecasts for dryland cotton can be used to determine row spacing, with a potential value of \$50–\$100/ha. Temperature forecasts for irrigated cotton can be used for determining risk of crop failure, extended seasonal conditions and input requirements.</p> <p>For extensive rangelands grazing, we found that using seasonal forecasts to derive pasture growth or live-weight gain is more valuable than using direct rainfall or temperature forecasts.</p>	<p>Dr Peter McIntosh CSIRO Marine and Atmospheric Research Peter.McIntosh@csiro.au 03 6232 5390</p>
Themes 1, 2 and 4				
Can advances in mid-term weather forecasts reduce emissions from nitrogen fertiliser?	July 2013 to June 2016	Investigate potential for recent advances in dynamic weather forecasts to cost-effectively reduce N2O emissions, and assess how different fertiliser regimes can mitigate emissions under forecast scenarios	<p>We linked weather and climate forecasts to nitrogen fertiliser decisions in the grains, dairy and sugar industries at five case study sites in Queensland, South Australia and New South Wales. These sites experience a range of climatic conditions and soil characteristics relevant to nitrogen emissions.</p> <p>We linked POAMA climate forecasts into three commonly-used simulation models: APSIM, DAIRYMOD and DAYCENT. The value of information was based on outcomes that are economic (yield and pasture production) and environmental (nitrous oxide). For nitrogen top-dressing in the mid-north of South Australia, we found the value of using POAMA forecasts to be worth about \$10/ha.</p> <p>We do not recommend the use of forecasts for managing nitrogen fertiliser as an Emissions Reduction Fund offset method. However, using forecasts as a component of other fertiliser methods has potential to reduce N2O emissions and manage nitrogen-use efficiency.</p>	<p>Dr Clemens Scheer Queensland University of Technology clemens.scheer@qut.edu.au 07 3138 7636</p>
Themes 2 and 3				
ClimateDogs Go National	October 2015 to October 2016	Modify the ClimateDog animations, which currently have a Victorian focus, to ensure audiences across Australia can easily access and make use of this climate communication tool	<p>The awarded ClimateDog animations illustrate how the behaviour of different climate drivers—represented as the dogs—affects Victoria's weather. This project aims to create national versions of the dogs.</p> <p>We have worked with Bureau of Meteorology scientists to apply the latest scientific understanding of each climate driver to the national dogs. The national climate dogs are expected to be published on Climate Kelpie by the end of 2016.</p>	<p>Graeme Anderson Department of Economic Development, Jobs, Transport & Resources, Victoria graeme.anderson@depi.vic.gov.au 03 5226 4821</p>
Theme 4				
Australian CliMate development	December 2015 to November 2017	Maintain and develop the CliMate application for multiple devices, add more functionality including linking to POAMA seasonal forecasting, and evaluate how CliMate adds value to decision making using feedback from farmers	Maintain and develop the CliMate application for multiple devices, add more functionality including linking to POAMA seasonal forecasting, and evaluate how CliMate adds value to decision making using feedback from farmers	<p>Prof. Yahya Abawi University of Southern Queensland Yahya.Abawi@usq.edu.au 07 4631 2675</p>
Themes 2, 3 and 4				

R&D for Profit projects

MCV partners (Cotton Research and Development Corporation, Grains Research & Development Corporation, Meat & Livestock Australia, Rural Industries Research and Development Corporation and Sugar Research Australia) are collaborating with the Australian Government to deliver research and development through the Rural R&D for Profit program. The focus of the research is improved use of seasonal forecasting to increase farmer profitability. The program has three priority areas, which have been developed into distinct projects:

1. Valuing the forecast
2. Using the forecast
3. Enhancing the ACCESS-S model

The following table provides an overview of each project.

Project	Project aim	Project overview
Valuing the forecast		
Project 1a Case studies	Identify the unrealised potential of seasonal forecasting, and apply forecast information in a way that maximises farm business decision-making.	The focus of the case studies is to provide assessments of forecast value by looking at decision-making environments across a range of agricultural industries and locations. The project will integrate existing biophysical models for each industry with economic modelling to assess where, when and how climate forecasts offer value.
Project 1b Global climate model (GCM) analysis	Identify the seasonal forecast models that provide the greatest skill to relevant industry sectors in a given region at a particular time.	A number of GCMs produce seasonal climate forecasts that farmers can access. However, there has been little work to identify which model produces the best forecast for a particular industry sector within a region at a particular time of the year. Drawing on the outputs of Project 1a, this project will focus on the spatial and temporal requirements of forecasts relevant to the target sectors, and access the skill of GCMs to provide forecasts to meet these requirements.
Using the forecast		
Project 2a Community of practice	Increase farmers' ability to manage with a variable climate by establishing a group of people with a common interest in using seasonal forecasts in decision making.	An Australian seasonal forecasting community of practice (CoP) will be instigated for Australian farmers, their advisers, and extension and adoption experts. The CoP will engage with leading seasonal climate scientists and draw on information tailored to communicate the value of seasonal climate information, and how to use it most effectively. This will deliver to farmers improved collaboration, greater value from existing expertise and resources, an improved flow of science to advisors and farmers, and more discussion channels for seasonal climate variability projects.
Project 2b Develop and tailor products, tools and services	Provide the resources to enable information to be packaged and presented in ways that maximise uptake by farmers and advisers.	This project will consider the outputs of Project 1 to determine farmer and adviser information needs. From this, products, tools and services will be developed in collaboration with farmers, advisers and extension specialists, to meet those needs.
Enhancing ACCESS-S		
Project 3 Enhancing ACCESS-S	Improve the predictive capabilities of ACCESS-S for rural Australia by reducing model biases relating to Indian Ocean and tropical atmospheric convection.	The main goal of this project is to understand and reduce the main systematic errors in ACCESS-S that reduce the quality of seasonal predictions for farmers. This will be achieved by improving the treatment of convection in ACCESS-S, which will increase accuracy in forecasts, particularly at longer lead times. Reducing atmospheric biases in the Indian Ocean and related tropical regions will lead to better prediction skill in the southern and western parts of Australia that are directly affected by the Indian Ocean.

Farmers making better decisions with Bureau products

by Jenni Metcalfe

Rob Holmes is a consulting agronomist for irrigated cotton and dryland cropping, working from Moree in northern New South Wales. He's also a relatively new recruit to the MCV Climate Champion program.

'I got involved in the program so I could learn about how climate and weather work', he says. 'Forecasting and knowing how models work is the next big input into making farming more efficient, so I very much want to be part of that. I would like to advise my clients using even richer information.'

Rob is now one of the many advisors benefitting from the Bureau of Meteorology's climate products developed over the past 10 years with MCV support (see box). WATL is his daily point of entry into the Bureau's online data and forecasts.

Summary of Bureau products and services where MCV has contributed

- WATL (Water and the Land): www.bom.gov.au/watl
- POAMA rainfall and temperature outlooks: www.bom.gov.au/climate/outlooks/#/overview/summary/
- POAMA predictions of ocean climate drivers including El Niño/La Niña and the Indian Ocean Dipole: www.bom.gov.au/climate/enso/
- Northern rainfall onset: www.bom.gov.au/climate/rainfall-onset/
- Climate and Water Outlook video: www.bom.gov.au/climate/outlooks/#/overview/video

'WATL is the site where I make my day-to-day decisions. Do I recommend spraying today or tomorrow? When will the wind be in the right direction? What is happening with temperatures and frost?

'It's what I need to know for the next one to five days.'

Not far from Rob, at Garah, grain and lamb producer **Bill Yates** is working 17,000 hectares. Bill has been a participant in the MCV Climate Champion program since its inception in 2010. WATL is so important to Bill's operation that nearly all his staff have WATL's radar and 0-4 day rainfall forecasts loaded on their smartphones.

'We use WATL many times a day when a change or rain event looks like it is approaching, mainly to see how much rain is forecast and when', says Bill. 'This year we continued to sow chickpeas deep—about 20 cm—into moist subsoil because of the dry soil surface and the high prices for pulses.'

'We made that call based on the WATL rainfall forecast which showed that a major rain event that might drown or waterlog the chickpeas was unlikely.'



Rob Holmes, a consulting agronomist in northern NSW, says understanding how modelling works is the next big step in farming more efficiently.

Like Rob, Bill is keenly interested in POAMA's predictions of ocean climate drivers, and checks them every month.

'I look, in particular, at the graph of predicted sea surface temperature', says Bill. 'The models predicted a sharp cooling, but I see it's actually now happening slower than predicted which means it is now entering ENSO neutral territory.'

Rob also checks what's happening with the climate drivers, especially ENSO, on a monthly basis and uses the WATL website: 'It is a great tool for me starting conversations with my clients about farming risk and if they are prepared for it.'

Once or twice a week, Rob accesses POAMA's rainfall and temperature outlooks, which is currently a Bureau research tool rather than a public product.

'I use the POAMA outlooks mainly to get a heads up on potential rain systems that might be two to four weeks away. This is helpful for planning sowing and harvesting.'

Below: Bill Yates (left) and son Andrew use WATL to make day-to-day decisions on their 17,000 ha property at Garah in north-eastern NSW.



Below: Robert Quirk, like other sugarcane growers in northern NSW, uses POAMA outlooks to plan his planting and harvest times.



Photos: Econnect Communication

Another long-term MCV Climate Champion, Robert Quirk, says he and other sugarcane growers in northern New South Wales use POAMA outlooks to plan their planting and harvest times.

‘We harvest our cane in five rotations—20 per cent each month—and the rainfall outlook can help growers to plan when to harvest the wetter fields compared to the better drained fields’, Robert says.

Ian MacGibbon, an MCV Climate Champion from central Queensland who produces mainly beef with some sugar, makes the most use of the Bureau’s tools during the wet season.

‘We need to manage our work weeks and months ahead so we are prepared for rain events and don’t get caught out’, Ian says. ‘This is particularly important for our cattle work and in the lead up to cattle sales.’

‘We also made a decision this year [2016] to work some of our country to plant new sugarcane. This was based on the Bureau’s prediction of the likelihood of the Burdekin dam getting water running into it over the wet season, which proved correct.’

‘Before seeing this prediction, the dam was down to 40 per cent and we were considering restricting our planting operations.’

Both Ian MacGibbon and Robert Quirk pay close attention to the Bureau’s northern rainfall onset advice.

‘We watch it very closely’, says Robert. ‘An early start to the monsoon season, before mid-November, will mean a wet season for northern New South Wales canegrowers.’

Robert’s farm is only half a metre above sea level, so a wet season will mean he needs to pay close attention to boosting drainage.

But, like most other farmers, Robert would like even more accurate long-term forecasts to give him that extra flexibility in his decision-making.

‘The more we know about the climate, and what is coming, the better’, he says.

The good news for Robert and other farmers is that the Bureau is constantly upgrading its products and services, many of which have benefitted from MCV support. For example, by early 2017 they will deliver more frequent climate outlook updates, with twice-monthly seasonal outlooks, which will eventually become weekly. Other services on the way include:

- multiweek forecasts for rainfall and temperature (in 2017)
- outlook data suitable for use in agricultural models (likely in late 2017)

The Bureau is also moving to a new climate outlook model, ACCESS-S (see story on page 1), which will take the resolution of its forecasts from the current 250 kilometres down to 60 kilometres, enabling features such as the Great Dividing Range to be better taken into account. With MCV funding, the Bureau is upgrading the ACCESS-S model for Australian conditions.

Western Australia grain grower Simon Wallwork says it’s important for farmers to engage with the Bureau’s tools and services so they can be flexible in their decision-making.

‘I use WATL on a daily basis for an idea of what rain is likely over the coming eight days. Every two months I look at the POAMA rainfall outlooks and a couple of times a year I check up on the climate drivers. I have found the climate outlook video to be very well presented with simple messages.’

‘All of these tools help me to make short-term decisions about fertiliser use, what to sow and when. They also give me a longer-term feel for the season and the likely risk.’

‘Accessing this information over time gives me a broader understanding of the climate which adds to my experience as a farmer.’

[\[continued on page 12\]](#)

POAMA Long-range outlook

Between 1 September 2012 and 30 November 2015, there were 163,000 unique page views, an average of 128 per day. The page was viewed more often during the El Niño and La Niña periods of 2014–15 and 2012 than during neutral years such as 2013.

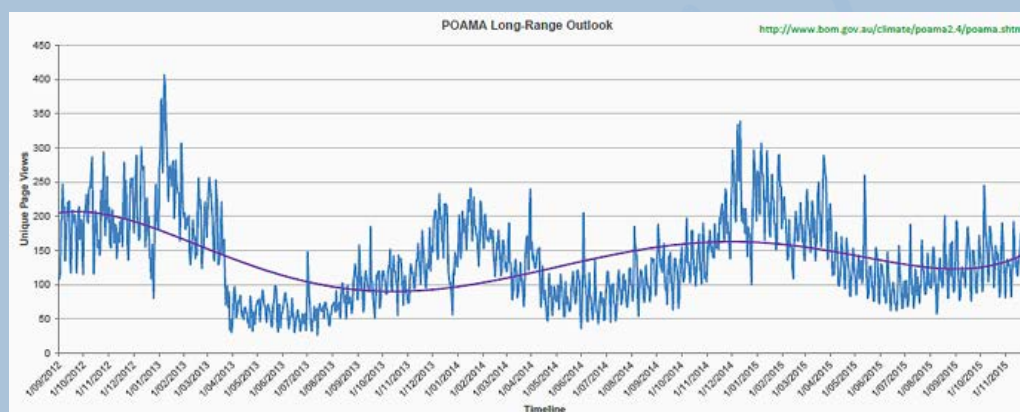


Figure 1. Unique page views for the POAMA long-range outlook webpage

Beekeepers use POAMA to locate flowers for their bees

MCV Climate Champions [Des and Jenan Cannon](#) keep bees in south-eastern New South Wales and are particularly interested in POAMA's rainfall and temperature outlooks.

'We like to look at the 3-month rainfall outlook for May to July', says Des. 'The current outlook [May 2016] gives me some reassurance that some decent rain will fall in that area this winter, which will be good for the spotted gum. At the moment it is flowering, but it needs some rain to carry it through the winter. I have just taken the bees down to a major flowering of spotted gum near Batemans Bay, located on the NSW south coast.'

'My ability to use the Bureau's outlooks to check medians against expected above medians and also against past accuracy I find very useful, both for rainfall and temperature.'



Des and Jenan Cannon with honey extracting equipment

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