

## The science of climate variability —a 10-year retrospective

by Mary O'Callaghan

Searing heatwaves, devastating cyclones and frightening floods, on the tail of a drought that looked like it would never break—the past decade has seen records smashed all over the country. What have we learnt about the science behind Australia's climate variability?



Severe Tropical Cyclone Yasi approaches the Queensland coast at 1:35pm AEST on 2 February 2011. At 10pm, winds were measured at 250 kilometres per hour, with gusts to 305 kilometres per hour. Hovering in strength between category four and five—the most damaging on the classification scale—Yasi made landfall between Innisfail and Cardwell, south of Cairns, around midnight on 3 February. The 2010–11 cyclone season was extreme, with six tropical cyclones crossing the Queensland coast, three of which were severe.

### Record droughts, heat, floods and cyclones

The 'Millennium Drought' which had begun in 1997 in the south-east, and in 2001 in other parts of the country, dragged on until 2009. In south-east Australia it was the longest and hottest drought on record. The year the drought broke was Australia's second hottest year on record. The late January heatwave that preceded Victoria's Black Saturday was extraordinary and broke records over huge areas.

El Niño had barely packed his bags when one of the strongest La Niña events on record arrived, bringing the shift to wetter conditions. April 2010 to March 2012 was Australia's wettest two-year period on record and the ensuing floods were some of the most widespread on record.

With communities still recovering from Severe Tropical Cyclone Larry in 2006, the 2010–11 cyclone season kicked in—and it was extreme.

'It was a very active season with a big impact on agriculture', says Dr Andrew Watkins, Manager of Climate Prediction at the Bureau of Meteorology's National Climate Centre.

'We had three severe tropical cyclones—Zelia, Bianca and Yasi—and three tropical cyclones crossing the Queensland coast, which is unusual. We also had a very high number [29] of tropical depressions [one category below a cyclone], well above the average. In December 2010, Carnarvon in Western Australia had over 240 mm of rainfall in one day, where the monthly average is about six millimetres.'

In one decade, large parts of eastern Australia went from one extreme to another, as we flip-flopped between El Niño and La Niña events without a breather.

'Normally we expect neutral periods in between', says Dr Watkins, 'but since 2006 we've been continuously in one or the other. The last time we saw such a string of El Niño and La Niña events was 1970–78 and, before that, 1909–18.' [continued on page 2]

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MANAGING  
CLIMATE  
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## A warming trend

Dr Watkins says we are also seeing a clear, long-term warming trend, i.e. an increase in the number of very hot days (above 35 degrees) and a decrease in the number of cooler days. These trends, on top of the natural string of El Niño and La Niña events, are making it hard to determine the cause of individual extreme weather events, he says.

‘Climate variability is being compounded by climate change, making it very difficult to tease out the true driver of an event’, he says. ‘What we do know is that the underlying trends in most variables are changing; the warming trend is increasing the odds of experiencing more extreme events.’

‘We will always have variability’, he says. ‘The Indian Ocean will continue warming and cooling, El Niños and La Niñas will still come and go, and the Southern Annular Mode will continue to vary from north to south. But on top of this, global warming is intensifying high pressure systems and sometimes moving them further south. We are also seeing warming of the tropical oceans, so there is more evaporation and therefore more rainfall, especially in northern Australia.’

## Variability and change—waves and tides

Ten years ago, Dr Peter Hayman (Principal Scientist, Climate Applications, South Australian Research and Development Institute) was always being asked to talk about climate variability.

‘During the 2002 El Niño there was limited interest in discussing climate change’, he says. ‘It was all about variability. Then there was a switch and it was all about climate change. The balance is coming back now where we’re talking about both—people realise that it is the variability that does the damage.’

‘Unfortunately, we get discussion about whether it is climate variability or climate change, as if we can talk about one or the other—that’s unhelpful. It’s like arguing with a child about what knocked down a sandcastle—the wave or the tide. On a rising tide, the waves do more damage. We need to look at them together.’

## Accepting the science

Dr Watkins is pleased that, these days, people are not just talking about the weather; they are also talking about the climate and they want to understand it better.

‘People are definitely asking more questions about climate’, he says. ‘They want to know if the changes they are seeing are natural, and what they should be looking for to help predict their local climate.’

But climate change remains controversial: ‘Some people attribute anything strange to human-induced climate change’, says Dr Hayman, ‘and others remain seemingly unconvinced that the climate is changing. And when you throw in policies to reduce greenhouse gases, people’s views are even stronger.’

‘It is interesting’, he recalls, ‘that when I was first introduced to the concepts of El Niño and La Niña in the early 1990s, and the idea that there was some ability to predict year-to-year climate variability, many farmers and agricultural scientists considered this a controversial idea. In northern New South Wales, where I was based, I was often told that it was silly to consider that El Niño would have an impact south of the Queensland border, and ludicrous that there might be an impact in southern states.’

## Teasing out the drivers

Over the past decade the Bureau has placed more focus on understanding the drivers of Australia’s climate and weather, and Dr Watkins says they’ve come a long way.

‘We knew a lot about El Niño and La Niña—Australia has long been a leader in this area. Now we understand the flavours of El Niño better; for example, the El Niño Modoki, which occurs further west than a traditional El Niño, seems to be having a bigger impact on rainfall in Australia.’

‘We have also known for a long time that the Indian Ocean affects Western Australia. Now we understand it better, especially how the eastern Indian Ocean affects winter/spring rainfall in south-eastern Australia.’

‘And we understand what happens over the oceans south of Australia better too, with the Southern Annular Mode.’

## Forecasting with physics

Understanding the drivers and how they interact is essential for forecasting. The Bureau is continuing to improve the skill of seasonal forecasts using dynamical models that simulate the physics of the oceans and atmosphere, rather than statistical models that use past weather records.

‘Our dynamical predictions using physics are matching, and even slightly ahead of, the predictions of statistical models’, says Dr Watkins. ‘This is important because, with climate change, the past is becoming a less reliable indicator of the future.’

We are still taking small steps but the path is increasingly obvious with dynamical models.’

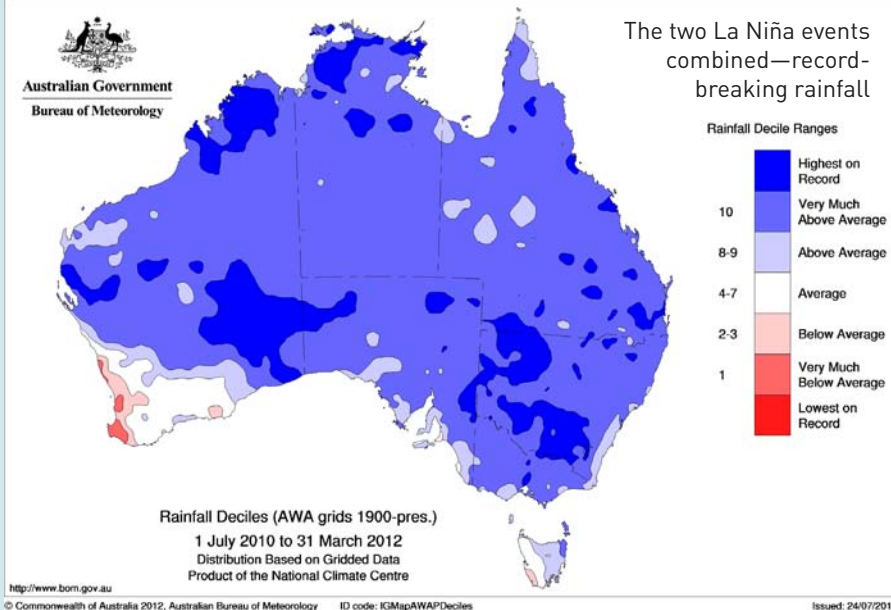
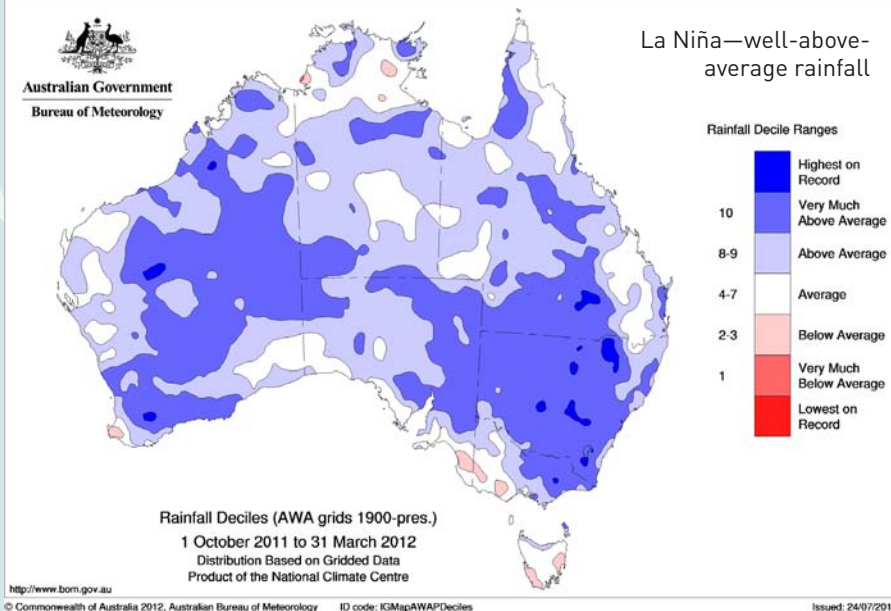
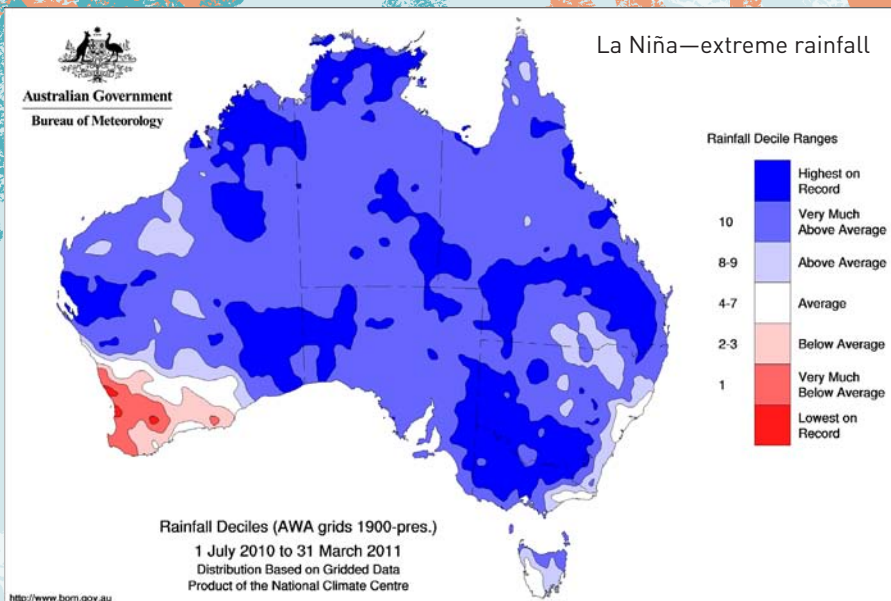
A dramatic change in this past decade, says Dr Hayman, has been the extreme level of confidence people have in the Bureau’s one-to-seven-day forecast. ‘It is a very useful guide and is used in farm planning all the time now. It’s not perfect but it’s certainly very hard to ignore.’



Peter Hayman

Dr Hayman says we need to look at climate variability and change together, using his analogy of trying to decide whether it was a wave or the tide that knocked down a sandcastle.





## Hopes for the next decade

In the early 1970s, the Bureau's one-day weather forecasts were only as good as the four-to-five-day forecasts today, says Dr Watkins. 'It took us 30–40 years to get the level of skill we have today.' He hopes that over the next decade the Bureau will increase its skill at predicting rainfall an additional month ahead, and El Niño and La Niña events an additional two months ahead.

'I also hope we get to understand the relationship of the Indian Ocean with El Niño and La Niña better', he says. 'For example, when we have a negative Indian Ocean Dipole and a strong El Niño, how much will they cancel each other out? Researchers are still debating how separate they are but most people think they are now related. We will understand their impact better if we understand their relationship.'

Dr Hayman would love to see better medium-term forecasts.

'It's recognised now that managing year-to-year variability is one of the best ways to manage future change', he says, 'although there'll be times when farmers need to make more significant changes to their enterprises. Improving the seasonal forecast, how it is communicated and industry's ability to use it is an important way to manage future change.'

Dr Watkins, too, stresses the importance of communication: 'It's not just about the science—it's about communication as well. I believe the clarity of information about climate variability, and indeed climate change, will have improved out of sight in the next decade. We can all benefit from that.'



April 2010 to March 2012 was Australia's wettest two-year period on record and the ensuing floods were some of the most widespread on record.

# Project updates

The following table lists our current projects.

Project title	Time	Summary of research objectives	Progress to date	Research contact
<b>Multi-week climate outlook products for Australia (Phase 2)</b>	2012–13	Produce a set of web-based tools for a multi-week rainfall forecasting service and make the tools available on the Bureau's Water and the Land website.	Phase 1 of this project produced prototype tools for multi-week forecasting (the period between 7 days and 3 months) using raw experimental data produced by POAMA-1.5. The products were trialled with Climate Champion participants. Phase 2 will continue to improve the prototype tools and develop the web interface.	<b>Dr Andrew Watkins</b> Bureau of Meteorology A.Watkins@bom.gov.au 03 9669 4360
<b>Assessing and managing heat stress in cereals</b>	2008–13	Investigate the meteorology and climatology of spring heat events on the southern grains wheat belt.  Develop a risk-management package for growers.	In this final stage of the project, researchers are examining the likelihood of heat events at different locations and with crop stage to estimate the likely damage in the current and future climates.  An experiment is under way to further understand the interaction between heat and moisture stress.	<b>Dr Peter Hayman</b> South Australian Research and Development Institute peter.hayman@sa.gov.au 08 8303 9729
<b>Investigate teleconnections between climate drivers and regional climate, and model representations of these links</b>	2010–13	Improve Australia's dynamical forecasting by investigating the connection between rain-bearing weather systems and remote climate drivers, including the El Niño-Southern Oscillation, the Indian Ocean Dipole, the Madden Julian Oscillation, subtropical ridge and Southern Annular Mode.	Rossby waves play a key role in the atmospheric teleconnection between climate drivers and local weather systems. However, calculations of the Rossby wave ray path indicate that these waves, generated by convection in the Indian Ocean, cannot propagate into the Great Australian Bight to influence weather systems.  It now appears that Rossby waves carry the signal as far as the southern flank of the subtropical jet, and a different mechanism (based on eddy/mean-flow interaction) is required to get the Indian Ocean signal further south.	<b>Dr Peter McIntosh</b> Centre for Australian Weather and Climate Research Peter.Mcintosh@csiro.au 03 6232 5390
<b>Improving forecast accuracy through improved ocean initialisation</b>	2010–13	Improve predictions of conditions in the Indian Ocean and ultimately predictions of regional climate for western, southern and eastern Australia.	The Predictive Ocean Atmosphere Model for Australia (POAMA) uses sophisticated assimilation techniques to ingest oceanic observations to initialise model forecasts and create analysis estimates of the ocean state at each point in time. The POAMA system now uses new ocean observations (sea-surface temperature and altimeter) and takes account of ocean-atmosphere coupling during the process that ingests ocean observations.  The improvements on forecasts of the Indian Ocean Dipole and regional climate are being evaluated.  It is expected that these improvements will advance the initialisation in data-sparse regions, such as the Indian Ocean, which in turn should improve forecast skill.	<b>Dr Oscar Alves</b> Centre for Australian Weather and Climate Research O.Alves@bom.gov.au 03 9669 4835

Project title	Time	Summary of research objectives	Progress to date	Research contact
<b>Improving multi week predictions</b>	2009–12	Improve POAMA's weather predictions for 2–8 weeks ahead to make them more useful to agriculture and water-management industries.	<p>Research has shown that the new POAMA-2 system produces more skilful and reliable multi-week forecasts of Australian rainfall and temperature compared to POAMA-1.5. The same is true of predictions of key drivers of multi-week variability, such as the Madden-Julian Oscillation and the Southern Annular Mode.</p> <p>This is a valuable step forward for POAMA, particularly since MCV-funded enhancements made to the system to improve the multi-week forecasts are also beneficial to the seasonal forecasts.</p> <p>In the last few months of the project, researchers will continue to add to and refine the multi-week experimental products on the POAMA website, &lt;www.poama.bom.gov.au&gt;</p>	<p><b>Dr Debbie Hudson</b> Centre for Australian Weather and Climate Research D.Hudson@bom.gov.au 03 9669 4796</p>
<b>Understanding frost risk in a variable and changing climate</b>	2010–12	Improve understanding of the variability and changing nature of frost risk at both seasonal and decadal scales for the southern regions of Australia, and implications for the wine and grain industries.	<p>Spatial analysis of frost trends has been completed. Trends in minimum temperatures, number of frosts, cold-wave duration, and frost-season length have been observed.</p> <p>An analysis of the major synoptic drivers of frost is under way. Data from 6 selected climate stations in north-west Victoria for the period 1956–2010 is being examined along with preliminary analyses for NSW and WA locations.</p> <p>The interaction between changing frost risk and changing responses in grain phenology has been assessed for 17 sites across the Victorian region. The probabilities of frost occurrence have been calculated for each site.</p>	<p><b>Dr Steven Crimp</b> CSIRO Steven.Crimp@csiro.au 02 6242 1649</p>
<b>Climate analyser decision-support system tools</b>	2010–12	Deliver a set of next-generation, user-friendly, climate risk management tools that farmers can easily access to query weather data.	<p>A prototype version of CliMate, a smartphone application, has been developed for iPhone. It is currently being tested and will be distributed to a test group in August 2012. An iPad version will follow soon after. Website versions of some analyses will also be developed.</p> <p>A version for Android technologies may follow after version 1 has been user-tested and feedback provided.</p>	<p><b>Dr David Freebairn</b> RPS david.freebairn@rpsgroup.com.au 07 3237 8820</p>
<b>Understanding frost and heat-stress extremes in the Western Australia wheat belt</b>	2010–13	<p>Quantify the extremes and impact of frost and heat stress on the Western Australian wheat belt.</p> <p>Link with the frost and heat-stress projects under way in South Australia and Victoria to improve understanding of frost and heat stress across southern Australia.</p>	<p>Trends in springtime temperatures have been examined for the Western Australian wheat belt. The past 50 years has seen a general warming in spring across the wheat belt, but the changes have been mixed. Locations with stronger warming show a decline in frost risk, while risk has increased where warming has been smaller.</p> <p>Experiments for grain areas of Western Australia have been designed, and an APSIM model has been set up to study temperature extremes and analyse the risk associated with its occurrence. Options for avoiding frost or heat risk will be tested.</p>	<p><b>Dr Ian Foster</b> Department of Agriculture and Food WA ian.foster@agric.wa.gov.au 08 9368 3954</p>



# Farming through a decade of climate challenges —business as unusual

by Sarah Cole

## Meet the Climate Champion commenters



Peter Holding, New South Wales:  
cropping, merino, prime lambs



Paul Miller, South Australia:  
olives, grapes, horticulture



Peter Whip, Queensland:  
beef

Meet other Climate Champion farmers: [www.climatekelpie.com.au/ask-a-farmer/climate-champion-program](http://www.climatekelpie.com.au/ask-a-farmer/climate-champion-program)

Bright reds and yellows on temperature maps quietly allude to record-breaking hot conditions. Soaring blue spikes on rainfall graphs hint at devastating floods.

On-farm, behind the silent graphs and their extreme colours, the past 10 years have served up near-crippling climatic events for those who directly experienced—but successfully farmed through—these climate challenges.

At the recent NCCARF *Climate Adaptation in Action* conference, CSIRO's Dr Mark Howden emphasised this unpredictability. 'Adaptation to climate change is different to dealing with other drivers of change. Climate adaptation in agriculture is business as unusual, but good business nevertheless.'

New South Wales mixed cropper Peter Holding agrees: 'Climate change is over and above normal business pressures—it can be almost too much to face. But fundamentally, people are making changes because they can see those changes work.'

## Knowledge is power—understanding forecasts and climate drivers

'Overall, people are more aware of climatic effects and are probably getting better at dealing with it', says Paul Miller, who grows grapes in South Australia and is involved in the olive industry.

'I think the last 10 years has introduced climate variability and change to a lot of conversations.' Paul believes that information from the Bureau of Meteorology, Managing Climate Variability Program and CSIRO has played a large part in that shift.

Queensland grazier Peter Whip, in his experience as an agribusiness consultant, says that awareness of big influencers of climate such as El Niño and the Madden-Julian Oscillation is still increasing.

This knowledge is built on two decades of research and extension activities in Queensland from the Managing Climate Variability Program (and its predecessor, the Climate Variability in Agriculture Program), and sources such as the Bureau, natural resource management groups and agriculture departments.

Peter also points out how a recent spate of bad fire years has 'woken up' the region: 'The variability is bigger than what we've previously experienced or managed in our lifetime on the land—things we haven't seen yet—and the potential for them to hit us is alarming.'

## Growing confidence in forecasts

Increasing accuracy in Bureau forecasts has provided a boost in farmers' confidence, especially in short-range forecasts. In addition, more frequent and severe extreme events have motivated people to look at and use forecasts in greater depth.

A combination of increasing input costs and a jump in the severity of heat events drove behavioural change for wine grape growers, says Paul Miller. 'The high cost of spraying white clay onto grapes to keep them cooler led growers to use forecasting more and to change their irrigation accordingly.'

In Harden, New South Wales, increasing drought pressures over the past 10 years has led people to invest more time in studying what forecasts are available, says Peter Holding.

'Before, when forecasters said "50 per cent chance of rain", people didn't know what the forecasters were talking about. Now people pay much more attention to percentages', Peter says.

Chris Sounness, a climate specialist with the Victorian Department of Primary Industries, believes that producers are also becoming more comfortable with the level of uncertainty in forecasts. 'The other thing is learning how and when to get value from climate models and seasonal outlooks. People's skill in using them is improving', Chris says.

Regional-scale and multi-week forecasts (from two to eight weeks ahead) remain on the wish list for most producers. However, that hasn't dented the rise in confidence in forecasts in the last decade.

'I can see increasing confidence in people's use of Bureau of Meteorology forecasts. Knowing they can sit down and look at possible cold snaps five to seven days out has helped with that', says Paul Miller.

Peter Holding echoes this: 'The Bureau's forecasts have got more accurate and the information they provide is easier to understand.'

Below: Paul Miller says many growers use simple, traditional budgets to decide when to use frost fans in olive groves.



Photos: Econnect Communication



Left: This tree shows massive flood heights—the light-coloured metal plaques—marked from the time the family of Climate Champion farmer Colin Dunne farmed this property.

Below: Peter Whip finds that tools such as Google Earth can help people understand and manage aspects such as distance to water for their stock.



## Talking about and changing management practices

Australia's historic reputation for adaptive management has continued strongly in the past decade. The practice of no-till farming, for example, has risen rapidly in the last five to 10 years<sup>1</sup>.

Cropping around Harden, Peter Holding says, has got a lot more efficient. 'Stubble management and water-conservation activities are much higher, and we don't tolerate weeds like we used to.'

And although adoption of change in grazing management can be slow, Peter Whip says changes such as wet-season spelling [resting a paddock] or upgraded water systems are gaining traction. 'The best producers are building better water systems to manage stock in big dry periods—systems that would have seemed crazy 10 years ago. But now they're becoming standard.'

Learning 'over the fence' remains as important as always. 'There is more acceptance of these issues; there's more discussion. People are exchanging ideas and carefully evaluating what they'll do', says Paul Miller.

Conservative producers also bring essential skills to taking up new management options. Paul says, 'Sometimes more conservative people can look at how it's done by others, and make it more solid. I think that's a positive.'

## Computers and smartphones complement traditional management

Has online weather information drawn people to using computers more to manage climate risk? Paul Miller thinks so. But he believes that most producers use standard cost-benefit tools, instead of specific climate variability-oriented tools.

'Farmers I know are mostly not using more complex tools than Excel. For instance, when people use frost fans in olive groves, there are lots of costs. For decisions about when to turn them on and off, people use a traditional financial analysis to decide what temperature to start the fans.'

However, the control that comes from having better tools available has helped people talk about climate risk, Paul says. 'If it's coming at you with no way to deal with it, it is normal for people to deny anything's happening. If there are tools, people are more accepting.'

Peter Whip agrees: 'Everyone needs a system that works for them. Most people still have a notebook that they use, but a guy I know has stock numbers on his iPhone.'

The Australian Bureau of Statistics estimates that 20 per cent of farms used the internet for business operations in 1999; this skyrocketed to 66 per cent in 2007–08.

And tools such as Google Earth are giving landholders unexpected benefits, Peter says. Having a bird's-eye view of a property can show up degraded areas. 'That may change how a grazier spells that paddock, or manages stocking rates or distances to water.'

## What of the next 10 years?

Chris Sounness believes that the next decade will bring many changes in farm-business models, and that producers will work hard to make their technology work well for them. 'But the challenge is extreme events. They will still be strong drivers. Predicting them is hard, and they cause the most heartache', he says.

Paul Miller predicts that producers will just 'get on dealing with it, and maybe even find more opportunities.'

Certainly, red-shaded and spiked temperature and rainfall maps will continue in Australia's future—but there is much optimism about agriculture's capacity to successfully adapt.

<sup>1</sup> Llewellyn, RS & D'Emden, FH 2009, *Adoption of no-till cropping practices in Australian grain growing regions*, GRDC, Canberra.



# Computer grunt gives seasonal forecasting the edge

by Alison Binney

Ten years ago, seasonal forecasting in Australia was done using a fraction of the real-time data and computer resources scientists have access to now.

Today, global data gathered from ships, satellites and ground stations provides a healthy snapshot of what the ocean, land and atmosphere look like at any given moment.

This snapshot of data is used to create a picture of the most recent conditions and then a computer model is used to generate a future picture, or a prediction.

This computer model uses mathematical equations based on the laws of physics.

'The level of seasonal-forecast skill over Australia from our model is higher than we ever anticipated 10 years ago', says Dr Oscar Alves, a Bureau of Meteorology scientist who leads the seasonal prediction efforts at the Centre for Australian Weather and Climate Research.

But as Dr Alves will also say: 'The maximum level of predictability has not yet been achieved in seasonal forecasting.'

**'Stonking great computers' can sway the odds on prediction**

'Prediction is very difficult, especially about the future, but at least we have stonking great computers to sway the odds', reports Dr Andrew Watkins in an article published on The Conversation <[www.theconversation.edu.au](http://www.theconversation.edu.au)> earlier this year.

Dr Watkins, Manager of Climate Prediction Services at the Bureau of Meteorology, is candid about the capabilities of seasonal forecasting.

'As the saying goes: climate is what you expect, weather is what you get. And indeed that's pretty much it—climate is just the averaging of weather over time', he says.

His message about computers significantly helping scientists understand 'the averaging of weather over time' is no throwaway line.

The World Meteorological Organization also pays special tribute to the contribution computers are making to long-range forecasts.

'The process of computing long-range forecasts [forecasts ranging from 30 days up to two years] on the global scale requires huge amounts of computer power, along with a very specialised knowledge', states its website <[www.wmo.int](http://www.wmo.int)>.

Australia's Bureau of Meteorology is one of 12 'global producing centres' that produce long-range forecasts for the World Meteorological Organization.

**Access to real-time data up-front**

The team of climate scientists at the Bureau and CSIRO have been working together for about 13 years on dynamical models to improve seasonal forecasting for Australia—primarily for agriculture and marine applications.

Dr Debbie Hudson, Senior Research Scientist at the Bureau of Meteorology, says the advances in computer technology have significantly improved the task of getting the real-time data at the very beginning of a forecast.

'When we start a forecast, we have to start with the most up-to-date conditions of the ocean, land and atmosphere.

'Computers have allowed us to improve how we use these observations to initialise our forecasts and update our forecasts more frequently', says Dr Hudson.

If there are errors in the initial calculations, the errors will snowball when used to predict future conditions—otherwise known as 'chaos', where the initial errors grow.

**Argo floats feed the computer models**

So while the computers do the maths to process the data to make the predictions, they still need real-time data to start with.

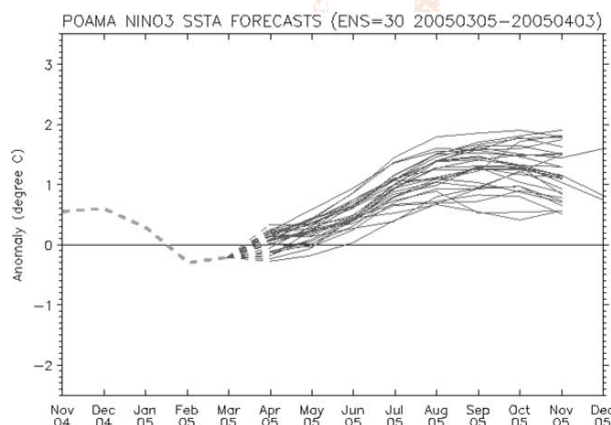
Oceans store a wealth of real-time information that scientists can use to initialise their forecasts.

At the date of publication, there are 3518 Argo floats free-drifting in the world's oceans.

Argo floats are nifty ocean-faring devices—the first one was deployed 12 years ago—which allow for continuous monitoring of the temperature, salinity and velocity of the upper 2000 metres of ocean.

Dr Hudson says: 'The ocean is a key component for seasonal prediction—it is changes in the ocean that have the biggest influence on Australia's climate a season ahead.'

Observations, like those from Argo floats, need to be quality-controlled and blended with other observations in a format that can be used by the model. This process is called 'data assimilation' and is very computationally demanding.





'A lot of the major advances in our forecast skill over the last 10 years have been due to improving these assimilation methods which are used to initialise the forecast—all with thanks to bigger and better computers,' says Dr Hudson.

But, while the amount of available real-time data has increased and improved the ability of forecasts to have better initial data, there are still significant gaps in our observing system.

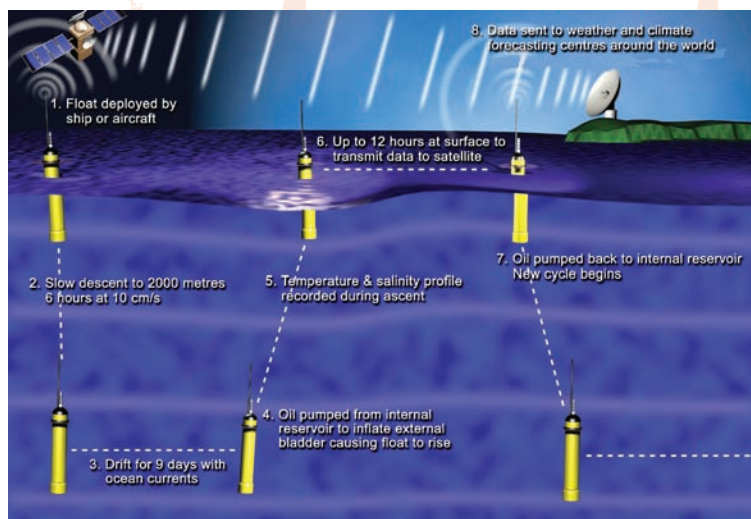
## Enter stage left, the Predictive Ocean Atmosphere Model for Australia

The Predictive Ocean Atmosphere Model for Australia, POAMA, is a computer-based model that assimilates real-time data at the start of a forecast and then predicts the future state of the ocean and atmosphere.

The model was first developed in 2002 by the Bureau of Meteorology and the CSIRO Division of Marine Research. Its initial focus was for the prediction of El Niño and La Niña events.

Scientists are continuing to develop this model and test its ability to produce accurate forecasts by assessing its predictions of past events.

'For the first version of POAMA we could only run a single forecast for each past event', says Dr Hudson. 'This limited our ability to develop regional rainfall and temperature products for Australia.'



'Thanks to advances in computing power, we can now run an ensemble of forecasts, or multiple forecasts, not only for a real-time event but also for past events. We now re-run the model for the past 30 years, making nearly 100 forecasts every month—that's over 35 000 forecasts', says Dr Hudson.

This ability to run an ensemble of forecasts for past events, commencing with development of POAMA version 1.5 (released in 2007), meant that scientists could begin to explore the capability of doing seasonal forecasts for Australian climate using dynamical models, rather than statistical models.

Ensembles provide us with the most likely outcome of an event, as well as an indication of the level of uncertainty in a given forecast.

'This is very important for seasonal prediction because there is considerable uncertainty in seasonal predictions—some due to natural uncertainty such as the 'chaos' factor and some due to model and observational errors', says Dr Hudson.

## Where to from here?

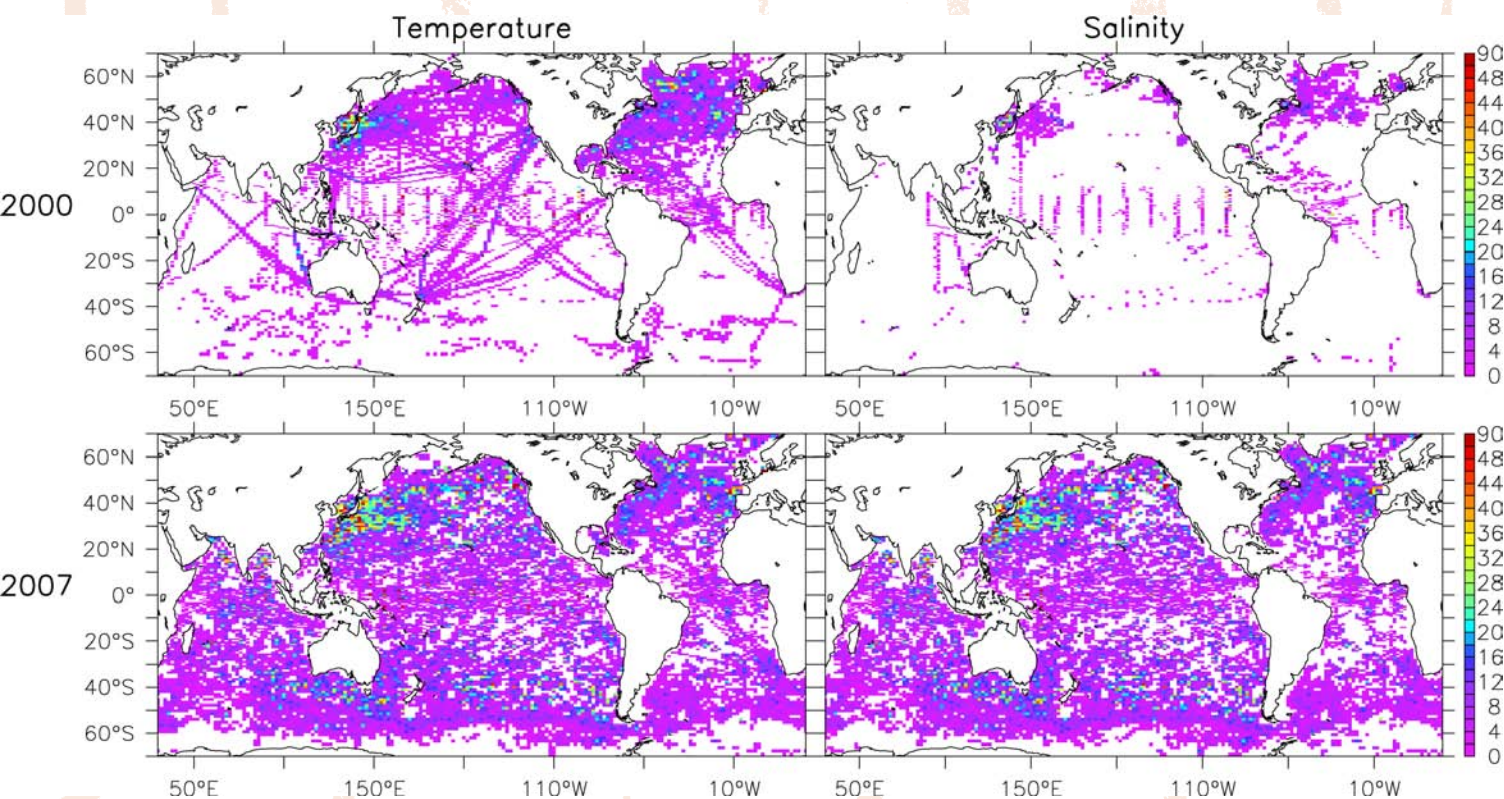
The next generation of supercomputers will enable scientists to use new ocean observations and to run models with much finer regional detail.

As Dr Alves says: 'More computing power also means a larger ensemble of forecasts, which will enable us to better forecast the likelihood of extreme events.' See the cover story on how climate variability has manifested over the past 10 years.

'Through partnerships, such as those with the Managing Climate Variability Program, we hope to start exploring the interfacing of POAMA to various risk-management tools.'

Scientists will also look at providing a seamless set of forecast products, from weeks to months, for use in agriculture. See the report on new developments for the Bureau's Water and the Land website, page 10.

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www.poama.bom.gov.au



# WATL they think of next?

## Bureau striving for 'a seamless prediction service'

It may not be 10 years old, but the Bureau of Meteorology's Water and the Land website has quickly established itself as one of Australian farmers' favourite websites.

Affectionately known by its acronym, WATL, (pronounced the same as the wattle tree), it was launched in 2006 to supersede the very popular but ageing SILO (Specialised Information for Land Owners) website—one of the first climate agricultural portals for farmers.

'SILO had been a popular website for farmers, particularly the Meteogram product [weather forecast graphs for the next seven days, produced daily; at its peak, accessed by several hundred subscribers]. However, it was becoming dated, was text-heavy and not as user-friendly as farmers wanted', says Dr Andrew Watkins, Manager of Climate Prediction Services at the Bureau of Meteorology's National Climate Centre.

Dr Watkins was one of the forefathers of WATL. He recounts how it may not have evolved if it wasn't for a passionate team.

'We had a lot of good input from everyone across the Bureau, most of whom volunteered their time. I think most were attracted by the cause as well as the collaborative nature of the project, which allowed us to look at the problems from a combined climate, weather and water perspective.'

Dr Watkins also credits the many times he and his colleague, Vernon Carr (National Manager, Public and Agricultural Weather Services) spent at field days chatting with farmers to see what Bureau products people on the land liked and didn't like, and what products they had on their wish list.

'Farmers particularly have an uncanny ability to think outside the box and don't tend to hold back in telling you what they think', says Dr Watkins.

'We had both collected a lot of valuable and novel information from these personal discussions over the years and this project has allowed us to turn experience into something really useful.'

Photo: Dr A. Watkins



Above: The original WATL team at the launch on 22 August 2006 (L-R): Chermelle Engel, Alasdair Hainsworth, Matt Doyle, Vanessa Webb, Vernon Carr, John Phan, Julie Evans, Beth Ebert, Fernando Longo, Andrew Watkins.

Below: The current WATL team (L-R): Nigel Whitehead, Joe Jelbart, Vernon Carr, Andrew Watkins, Neal Moodie, Courtney Wheeler, Tony Baxter.



Photo: Dr A. Watkins

For instance, Dr Watkins noted that one of the products to come out of the field-day discussions was the Forecast Wind tool, which farmers wanted for their spraying regimes.

'We wouldn't have thought of it unless we spoke with farmers.'

While there have not been any new products on WATL in the past year, it doesn't mean the team is slowing down.

Recent work has been under way developing multi-week rainfall forecasts from dynamical models, in an attempt to bridge the gap between seven-day weather forecasts and three-month seasonal outlooks. These will become available via WATL in 2013.

'Our ultimate goal is to have a seamless prediction service for all those living and working on the land.'

Apart from this, Dr Watkins says the team have a number of other ideas for WATL products, most of which have been passed to them by farmers. These include:

- growing-degree day information to assist farmers to assess when their crops may reach maturity
- evapotranspiration forecasts to assist irrigators to water with greater precision
- likelihood of weather risk situations culminating in plant diseases (brown rot) or heat stress for livestock

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## Some of the tools inside WATL

**Rainfall forecast:** click on a map, zoom in to a region and see the forecasted amount of rain and chance of rain for the next seven days or three-month outlook.

**Wind forecast:** see wind forecasts from a high-resolution computer model up to a week ahead to help with scheduling sprayings.

**Frost-potential forecast:** check how long it will remain under critical minimum temperatures overnight to evaluate frost risk.

**Evapotranspiration tool:** check how much moisture has evaporated over the past seven days. A proposed seven-day forecast will help with scheduling irrigations.



# Climate is what you expect, weather is what you get

by Ian McClelland,  
Chair, Managing Climate Variability

This week I heard a senior Bureau forecaster give an optimistic forecast for the following day for north-western Victoria on the ABC's Country Hour. The next day on the same program some farmer callers complained bitterly about the lack of accuracy of the forecast for them, and asked: 'How can the Bureau forecast the seasonal forecast when they get tomorrow's forecast wrong?'

In fact, the forecast was not wrong for everyone, but it was wrong for a few farmers in some areas who unfortunately missed getting what they expected or hoped for. This whole story raises the question: do we want forecasters to say what they think, or should they always protect farmers from being over-optimistic? I think they should say what they think.

The fact is that the accuracy of short-term forecasts has improved enormously over the last few years. Now four-day forecasts have a similar accuracy to the one-day forecasts of a few years ago. A fair accuracy to seven days has also been achieved.


These forecasts are based on a plethora of data, which is collected and put into models that drive the physical dynamics that determine what will happen over time. These are the synoptic systems we see on weather maps. Small errors in data can change the result enormously. However, when correct data is complemented with the appropriate physics, chaos is minimised and excellent forecasts result. This is the weather that we experience.

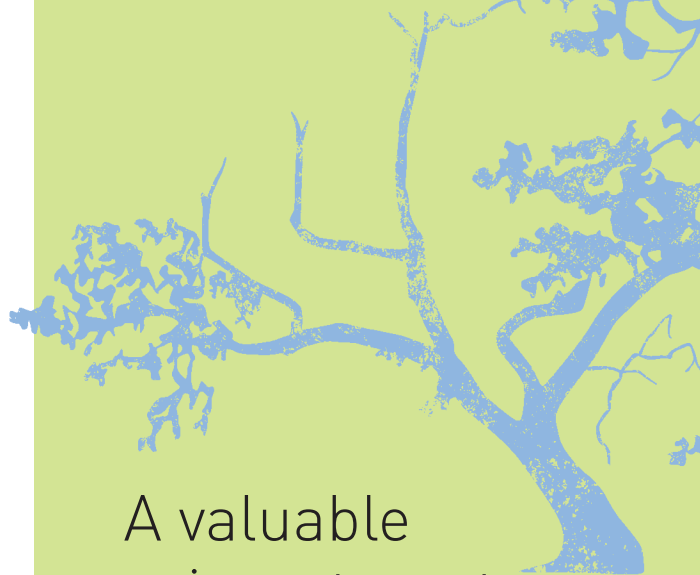
The difference between short-term forecasts as described above and multi-week or seasonal forecasts is that the starting data is based on climate indicators, or drivers, that determine whether the season will be wetter or drier in the future. These include ocean temperatures, atmospheric conditions, prevailing winds, historic records and the inherent characteristics of the seasons.

The forecasters don't pretend to be able to predict the weather on certain days in the future but can provide probabilities of wetter or drier, hotter or colder, or more or fewer frosts in future periods.

The accuracy can be as high as 70 per cent but, typically, seasonal forecasts try to achieve up to 60 per cent predictability. As Dr Watkins says, 30 per cent of future forecasts will never be able to be accurately predicted. They are based on chaos or random variability that has no logic or predictability.

Does 60 per cent accuracy of future weather conditions help us make decisions on our farms? Dr Watkins suggests having even a slight predictability edge over tossing a coin can be a huge advantage. Being able to finesse farm plans to be either slightly more confident, or conversely more conservative, can make huge differences to profitability.

For me, the Bureau's short-term Water and the Land website and POAMA seasonal forecasts can no longer be ignored in my farm decision-making—not because I believe they are infallible, but because the information they provide gives me an advantage in making better decisions. 



## A valuable investment into the unknown

by Beverley Henry,  
Science Coordinator,  
Managing Climate Variability

Australia has one of the most variable rainfalls in the world and is the driest inhabited continent. This combination means that it is subject to extreme seasonal conditions—in particular, serious droughts. No sector feels the impact of this more directly than primary production.

In general, farmers have responded with innovation and determination to these extreme and uncertain conditions. However, increasingly narrow terms of trade and growing expectations that farmers demonstrate environmental stewardship exacerbate the need for improved seasonal forecasts and practical information and tools. With climate change projected to bring even greater variability and more intense extremes, these needs will grow.

Joint investment by Research and Development Corporations (RDCs) for managing climate variability was initiated in response to the severe drought of the early 1990s—one that particularly affected eastern Australia for half a decade. Average production by rural industries fell by about 10 per cent, at an estimated cost of \$5 billion to the country.

Since then, this partnership of RDCs continues to help primary producers limit the variability in their farm income and environmental risks due to climate variability. The Managing Climate Variability Program (MCV) is now well-positioned to build on more than 10 years of investment in improved operational seasonal forecasts and tools for agriculture.

Farm business and management decisions are influenced by many factors—perception about the potential of the coming season is a strong driver of confidence, direction and eventual profitability. Climate forecasts of sufficient accuracy and timeliness can translate many 'toss of the coin' on-farm decisions to more favourable, better-informed odds of matching cropping or stocking with seasonal conditions.

[continued on page 12]



The Bureau of Meteorology, as other meteorological organisations around the world did, recognised that delivering accurate, regionally-relevant forecasts required a dynamical model simulating the physical atmospheric and oceanic processes that drive variations in climate. The result was the Predictive Ocean and Atmosphere Model for Australia (POAMA).

MCV's investment has ensured that the needs of agriculture are incorporated into POAMA's ongoing development so that primary producers will be able to access the most up-to-date forecast products at regional scales and time frames relevant to agriculture. Examples of breakthroughs to date include:

- developing multi-week (two to eight weeks ahead) forecasts requested by farmers for decisions in areas such as fertiliser applications and stock movements
- incorporating the Madden-Julian Oscillation, allowing better outlooks for the start and strength of the wet season in northern Australia
- improving representation of temperature extremes for heat-stress and frost predictions

Building on this investment will enable further improvement in accuracy towards the 70 per cent sought by farmers, more detailed forecasts for an eight-to-sixteen-week time frame and user-friendly representation of the level of skill of a forecast. Importantly, continued investment by MCV will help make a range of climate forecasting products routinely available on the Bureau's Water and the Land webpage, developed as a result of earlier MCV projects.

Just as understanding of El Niño and La Niña has improved ability to predict seasonal rainfall and helped with early warnings of droughts and floods over recent years, MCV's strategic investment with research, industry and farmer partners is contributing to better climate risk management in agriculture.

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**Grains  
Research &  
Development  
Corporation**



**Australian Government**

**Department of Agriculture,  
Fisheries and Forestry**

**Rural Industries Research and  
Development Corporation**

**Sugar Research and  
Development Corporation**

Managing Climate Variability is a collaborative program between the Grains, Rural Industries and Sugar Research and Development Corporations; the Australian Government through the Department of Agriculture, Fisheries and Forestry; and Meat & Livestock Australia.

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For more information on Managing Climate Variability, visit  
www.managingclimate.gov.au

The Grains Research & Development Corporation is the managing agent for MCV.

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