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Fitting the world into a computer. GCMs simulate changes in the earth system through representing its components (e.g. atmosphere, ocean, land surface, hydrosphere) as a grid and solving complex mathematical equations within each of those grid boxes. Source: Satellite image originally processed by the Bureau of Meteorology from the geostationary satellite GMS-5 of the Japan Meteorological Agency.

Global Circulation Models – the key to future forecasting?

The next generation of seasonal climate forecasting is likely to come from Global Circulation Models (GCMs). Their potential is being investigated by the Managing Climate Variability R&D Program as a significantly more accurate replacement for Australia's primary seasonal forecasting tool – the Southern Oscillation Index (SOI).

Where the SOI is a simple correlation between the pressure ratio between Darwin and Tahiti (one of the most important drivers of the Australian climate system), GCMs have the potential to model many more features of the earth's climate system, offering more accurate forecasts with longer lead times.

Managing Climate Variability Program Coordinator Rohan Nelson said GCMs potentially offered "a whole new step forward" in seasonal climate forecasting.

"The technologies we have are mostly based on the El Niño Southern Oscillation, which gives us three-month forecasts," Dr Nelson said. "We now suspect that we have gone about as far as we can with this technology. Furthermore, climate change has an impact on the forecasts – the SOI is a fixed system in a changing environment.

"Australian farmers have for some time been saying that they want more accurate forecasts and lead times longer than three months. GCMs are an emerging technology with potential to meet this need."

The earth's climate is driven by solar radiation which, in turn, drives ocean and atmospheric circulation – GCMs attempt to model and forecast this process. GCMs might, for example, look at all the drought years in which records have been kept, examine what extenuating climatic circumstances existed and mathematically log these as likely portents for droughts generally.

Dr Nelson said GCMs attempt to take into account as many variables as possible to forecast climate.

"To calibrate a GCM we need significantly more information than the SOI can provide us with," he said. "As computing power and data collection accelerates, so will GCMs, which is why it has been identified as the most likely replacement for the SOI-based technologies."

A problem with GCMs is the current capacity to draw these climatic factors together – and on a scale that works at a regional level. GCMs work on a 200-kilometre grid of the entire earth's surface, which provides a better picture of overall influencers and drivers of climate.

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'GCMs have the potential to model many more features of the earth's climate system ...'



WhopperCropper: taking the ‘risk’ out of risk management?

Imagine creating a crop on the computer. You could do it easily if you knew all the things that made it grow, how many days of sunshine, for example and how much nitrogen, rainfall etc.

Now transfer this concept to the paddock. The problem is that on the farm all those factors which help grow a crop can vary from paddock to paddock and from year to year one crop-growing factor can influence another. Change it a little, and it might change the yield. But what happens when lots of these factors change?

The WhopperCropper decision-support tool has been developed to find out. It works out the potential yield ranges using local weather data and selectable combinations of different soil types, input levels and climate forecasts. It is now being tested nationally.

WhopperCropper is a tool used by agricultural advisors which generates risk information on yield and economic outcomes for desired input combinations. The project is one of four Grains Research and Development Corporation-funded projects currently underway in the Managing Climate Variability R&D Program.

And because it can be used to create simulated crops, it can help farmers see how tweaking one factor can change another and how this might work in the paddock.

Users can feed in information such as crop variety, maturity type (early, medium, late), sowing date, density, nitrogen fertiliser rates, soil water-holding capacity (eg 100mm, 150mm, 200mm) and soil water

content at sowing (1/3 full, 2/3 full and full) and add climate scenarios to see how this might affect yield.

The climate scenarios (usually Southern Oscillation Index phases) are drawn from 100-year climate records. Costs and grain prices can be entered to predict gross margins. In addition to yield and gross margin there are 50 other output options that can be displayed.

Agricultural consultants and farmers from north of Dubbo to central Queensland have successfully used WhopperCropper, loaded with soil types and climate records specific to their region. Now, this reach is being extended into Victoria, southern NSW, South Australia and Western Australia, with collaboration underway between researchers, agronomists and farmers to secure more detailed regional information about those factors influencing crop growth.

Howard Cox, a senior agronomist with the Queensland Department of Primary Industries and Fisheries helped devise the program.

“It’s not about predicting the coming year’s yields,” he said. “We can’t do that because we don’t know what the rainfall will be – it’s about using historical weather data and modelling the combined effects of soil, inputs and climate forecasts to see what factors can be changed to reduce risk.”

WhopperCropper software will be developed for cropping districts Australia-wide through the Managing Climate Variability Program. It will be commercially available nationally via the Nutrient Management Systems Pty Ltd network.

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Targeting tree establishment using seasonal climate forecasts

If you plant trees in a drought year (El Niño) around St George in Queensland the chances are that almost half of them will die.

Plant them in a La Niña (wet) year and the chances are that only one in five will die. Why do they die?

Is it because of soil moisture, their siting, the time they were planted, how they were planted, the variety chosen or a combination of these factors? How much did the climate contribute to their demise?

CSIRO scientists funded by the Managing Climate Variability R&D Program and the NSW Environmental Trust are trying to work this out. The project, *Increasing success of tree management by using seasonal climate forecasts*, aims to obtain robust trial data on tree establishment in relation to interactions between site conditions, climate and management.

What researchers suspect is that climate contributes significantly and if it can be more accurately forecast, and growers can adapt their management appropriately, then seedlings and direct-sown seeds might have a greater chance of surviving.

A study has revealed little data exists that could reliably shed light on this. So CSIRO scientists and Greening Australia researchers are collecting data from plantings in South Australia’s northern agricultural zone, Victoria’s Wimmera and Western Australia’s wheatbelt.

Future field trials are planned at CSIRO’s Gungahlin site near Canberra and at Wellcamp, near Toowoomba in Queensland.

CSIRO scientist Sonia Graham who is overseeing trials due to finish in two years, said they will examine more closely the relationship between contributing factors.

“It’s pretty well known that climate is one of the key factors affecting a tree’s chances of surviving,” she said. “But what isn’t known is how much climate affects survival in relation to other factors.”

In the meantime, tree planting guidelines, are now available on Greening Australia’s website (www.greeningaustralia.org.au).

“The guidelines give some suggestions for linking tree planting with seasonal climate forecasts,” senior CSIRO scientist Dr Mark Howden said.

“For example, if a drought year is predicted, you would plant drought-tolerant species, consider enhancing pre-planting weed control, plant less area, allow for supplementary waterings and you could get a better result.”

Greening Australia’s technical capacity manager Dave Carr says the research and guidelines could help tree planters and especially direct-seed sowers cut losses and save them money and time.

“Tree nurseries tend to grow a percentage of seedlings on order and some speculatively,” Mr Carr said. “If they can improve the demand estimate based on climate forecasts, come the end of the season they may not be throwing out an oversupply.”

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Adaptability the key to climate change: report

Agricultural systems are already showing considerable capacity to adapt to climate change, however better information on climate risk parameters is needed for those making large, long-term investments – such as in dedicated irrigation systems, slow-growing cultivars and processing facilities – a major report has found.

The report, *Climate Change – Risk and Vulnerability*, released by the Australian Greenhouse Office in late July, found that changes in land management practices, crop and cultivar choice and selection of animal species and technologies to increase efficiency of water use are being utilised to change the geographic and climate spread of agricultural activities.

Agricultural systems deemed to be most at risk included those already stressed – either economically or biophysically, as a result of land degradation, salination or loss of biodiversity; those at the edge of their

climate tolerance; and those where large investments are being made such as irrigation and processing.

The report suggested the period through to 2030, and to a lesser extent 2050, is the one that is most relevant today for decisions about adaptation strategies. This is because most decisions that could be affected by climate risks involve assets and business systems whose economic life falls within or near this time horizon.

Adaptation strategies to increase resilience of the agriculture sector would become increasingly important in the face of climate change. The Cairns region in Far North Queensland, the Murray-Darling Basin and south-west Western Australia were identified as highly vulnerable regions requiring priority adaptation planning and response.

The following table summarises the report's key findings in regard to the adaptive capacity to climate change for two major agricultural industries in Australia.

Industry	Value	Adaptive capacity
Extensive Livestock (sheep and cattle)	<ul style="list-style-type: none">Export earnings per annum: \$8 billion	<ul style="list-style-type: none">The extensive livestock industry is vulnerable to the impacts of climate change with few adaptive options available across most rainfall zones.Capacity to adapt will largely be through the introduction of drought-tolerant pasture species and animal breeds.There is a potential to reduce the risks associated with climate change through access to multiple holdings located in widely different climatic zones. Potential also exists to maintain high productivity through the use of intensive feedlots to finish stock before sale.Extensive livestock industries located in the more marginal temperate regions of Australia are at greatest risk to the impacts of climate change.Increased pressure on poorly productive pastures could also have serious NRM issues such as increased surface run-off causing soil erosion, and reduced soil water storage leading to further declines in pasture production.
Annual broadacre crops	<ul style="list-style-type: none">Export and domestic earnings per annum: \$8 billion	<ul style="list-style-type: none">The broadacre cropping industry has few options to adapt to the impacts of climate change and relies very strongly on the ability to obtain a good return in one year out of three.The introduction of drought tolerance into new plant varieties will increase the adaptive capacity of agriculture within a limited range of increased temperature and reduced soil moisture conditions.Improved water use efficiency through better soil management such as no-till will increase the capacity of the industry to adapt to small changes in climate.

Source: The Allen Consulting Group/Australian Greenhouse Office

The full *Climate Change – Risk and Vulnerability* report can be downloaded from the Australian Greenhouse Office web page.

<http://www.greenhouse.gov.au/impacts/publications/risk-vulnerability.html>

Climate variability the focus on the Eyre Peninsula

Managing climate variability was scrutinised at the Grains Research and Development Corporation (GRDC) Updates held across South Australia's Eyre Peninsula in August.

GRDC Southern Regional Panel chair David Shannon said climate variability was an issue of increasing importance to grain growers and researchers.

"Growers across southern Australia have been struggling with the greater variation in climate," Mr Shannon said. "Even in a medium rainfall environment like the Eyre Peninsula, greater climate variability is a priority challenge.

"Managing climate variability is a major focus of research funded by the GRDC, which is aimed not only at enabling more accurate long-term forecasting but also at providing growers with the knowledge and means of managing climate risk more effectively.

"Buckleboo grower Michael Schaefer and Cummins grower Shane Nelligan delivered presentations on what's being done on their farms to reduce cropping risks in a variable climate."

Drought-resistant wheat varieties were also a focus of the Update series, which is considered one of the key tools for growers in managing climate risk.

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Managing Climate Variability R&D Program

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The key to applying this to seasonal climate forecasting is the ability to translate it to the regional level.

CSIRO's Climate Program Director Bryson Bates said GCMs might be able to provide useful regional forecasts but it was too early to tell. Dr Bates said CSIRO and the Bureau of Meteorology had been working to "downscale" global GCM techniques to infer local rainfall and temperature.

"In future this might enable us to make GCM based forecasts for specific locations where climate monitoring stations already exist."

Dr Bates said GCM-based forecasts offered two potential advantages over climate forecasting techniques that rely on the SOI.

"In many parts of Australia, climate is affected by the Indian and/or Southern Oceans, not just the equatorial Pacific. Also current statistical methods do not vary with time and may become less reliable under the enhanced Greenhouse effect."

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Climate CRC update

The partners in the unsuccessful bid for a CRC for Climate Risk Technologies met in Brisbane recently to wind up their partnership. There was some discussion of a possible rebid given that last year's bid had made it through to the final round in a highly competitive process. The Managing Climate Variability Program along with many of the original partners recognised that a CRC could still help fill an increasing need for improved climate risk management. However there were a number of aspects that would still need to be considered and no decision was made on a possible rebid.

Courtesy Barry White

Climate – a never trending story?

Summary reports from the World Meteorological Organisation (WMO) Expert Group meeting are now available. As reported in the last *Climag*, the Brisbane meeting hosted by Queensland Department of Primary Industries and Fisheries earlier this year came up with a wide range of practical suggestions to make climate science more relevant to decision makers. The reports recognise that the majority of the world's population are directly exposed to what many see as the increasing impacts of climate variability.

Climate science will be more relevant if there is greater recognition of how the information fits. One example the Expert Group considered was when there were significant trends in climate data. The official climate average will usually be based on a thirty year period. But for a user interested in declining frost frequency, what is needed is an average that represents the current climate.

For unpublished proceedings of the Brisbane WMO meeting go to: <http://www.apsru.gov.au/wmoetbne/>

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Further information about the program can be found at the website www.managingclimate.gov.au

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