Climate Forecasting for hydrological extremes: communication and case studies

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Australian Bureau of Meteorology

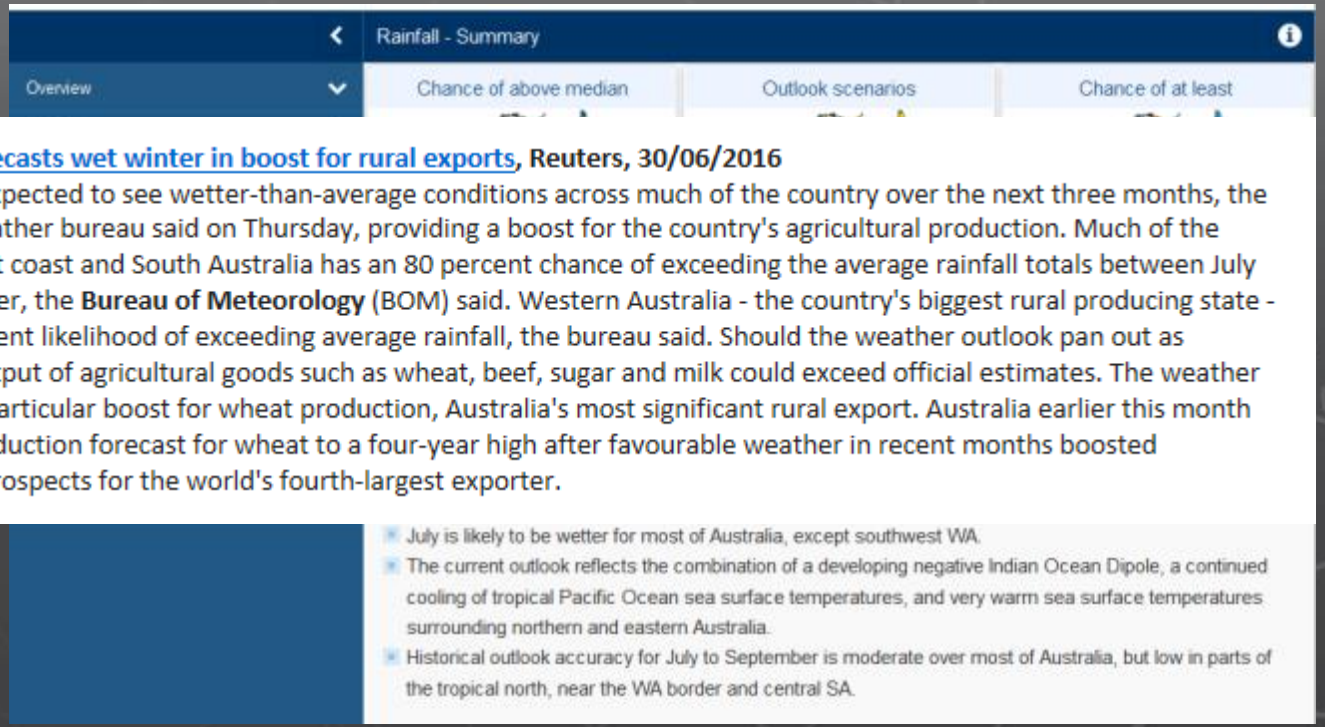
Australian Government
Bureau of Meteorology

Outline

- How to communicate your message
- Case studies

How do people like to see the forecast

Varies acco
to group an
importantly
application



Australia forecasts wet winter in boost for rural exports, Reuters, 30/06/2016

Australia is expected to see wetter-than-average conditions across much of the country over the next three months, the country's weather bureau said on Thursday, providing a boost for the country's agricultural production. Much of the country's east coast and South Australia has an 80 percent chance of exceeding the average rainfall totals between July and September, the **Bureau of Meteorology** (BOM) said. Western Australia - the country's biggest rural producing state - has a 70 percent likelihood of exceeding average rainfall, the bureau said. Should the weather outlook pan out as expected, output of agricultural goods such as wheat, beef, sugar and milk could exceed official estimates. The weather outlook is a particular boost for wheat production, Australia's most significant rural export. Australia earlier this month raised its production forecast for wheat to a four-year high after favourable weather in recent months boosted production prospects for the world's fourth-largest exporter.

https://www.youtube.com/watch?v=OOipYYfsYCw

How do people like to see the forecast

Northern rainfall onset

Issued **30 June 2016** Next issue **28 July 2016**

The northern rainfall onset date occurs when the rainfall total in a particular region reaches 50 mm or more from 1 September. It is considered to be approximately the amount of rainfall required to stimulate plant growth after the dry season.

Rainfall onset | Normal onset | ENSO influences | Outlook accuracy | About the rainfall onset

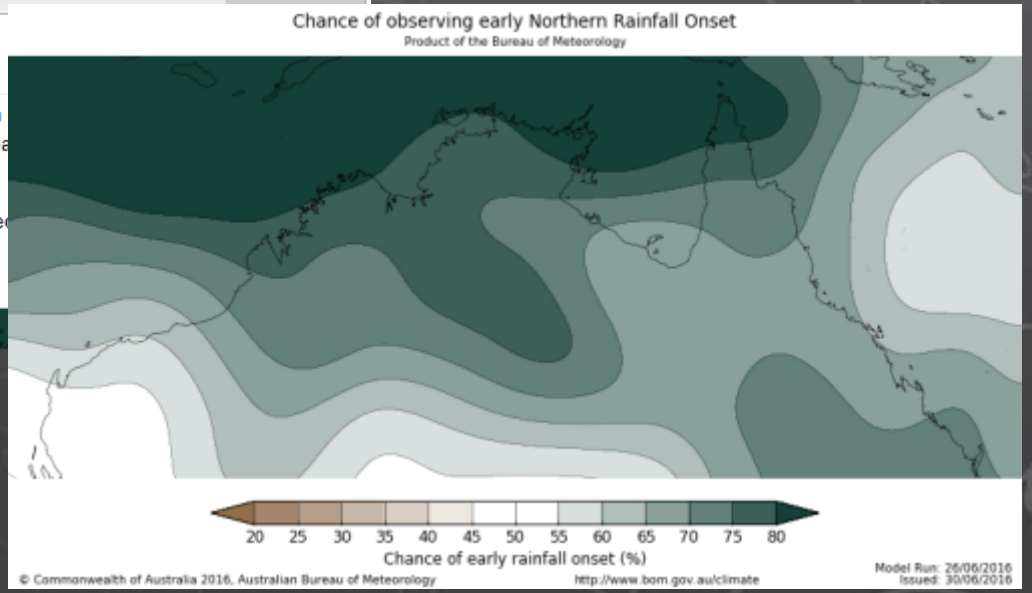
Early onset likely across northern Australia

The chance of an early northern rainfall onset for 2016–17 is higher than average over much
are highest over the Top End of the NT, the Cape York Peninsula, the Kimberley and southea
northern Australia is likely to receive the first rains after the dry season earlier than normal.

Over the Pilbara and the southern NT, chances of an early or late rainfall onset are roughly e

This is the first of three issues for the 2016–17 season.

Map showing the chance of early northern rainfall onset



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http://www.bom.gov.au/climate/rainfall-onset/

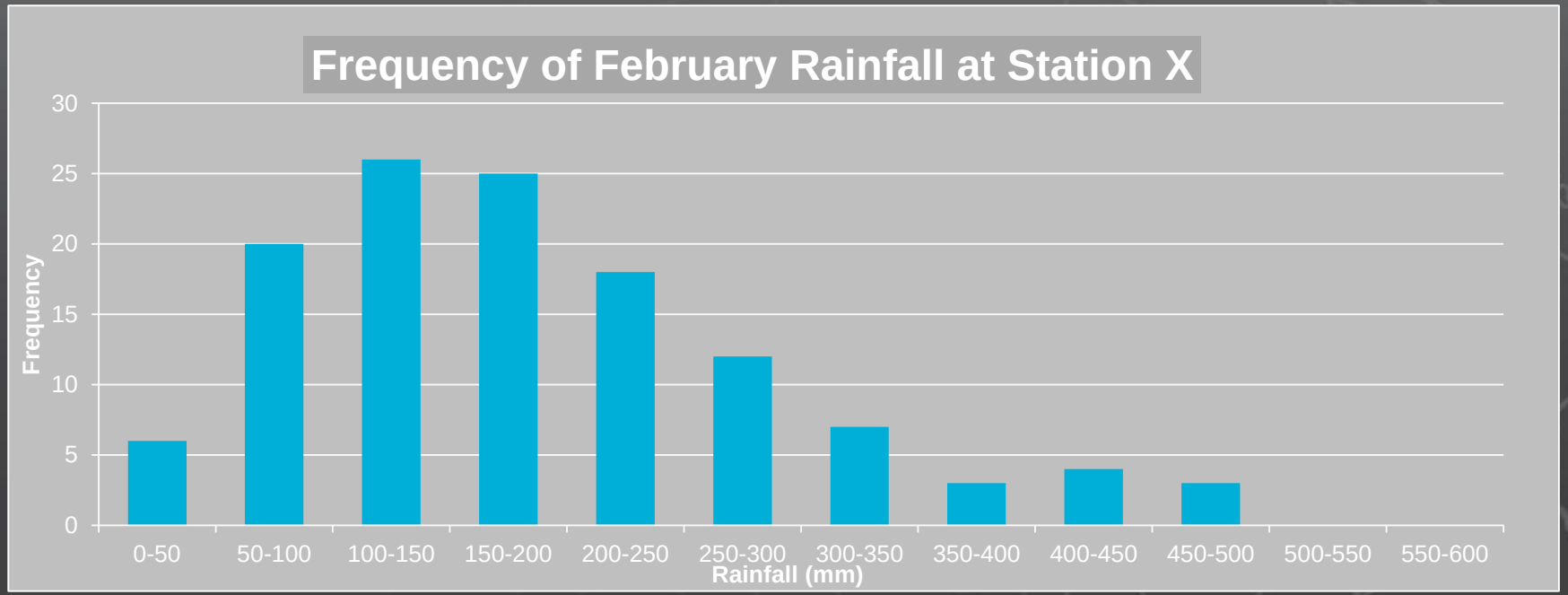
Data without context is meaningless

- Why are statistics useful?
- Take some raw data…

	A	B	C	D	E	F	G
1							
2	232	601	451	111	805	891	322
3	553	563	786	122	367	433	467
4	634	754	512	901	538	608	703
5	276	438	553	585	398	745	67
6							

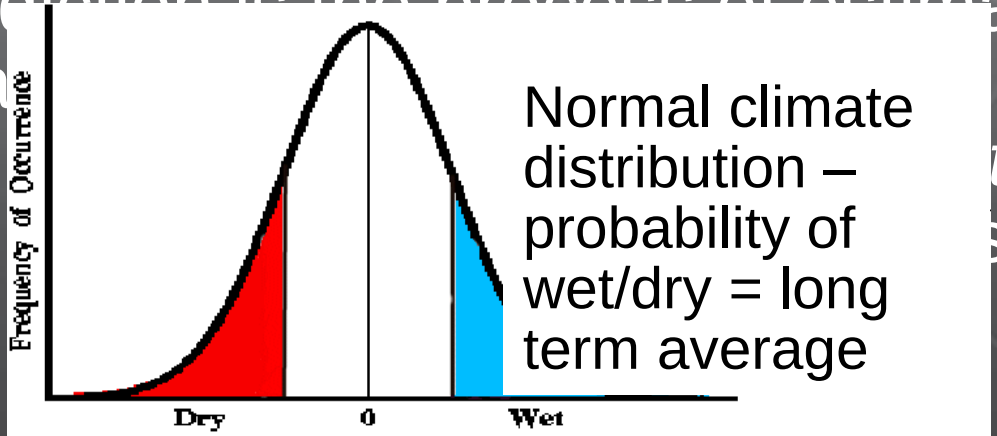
- Arrange it in a useful way
- Get more information from the data you have

We can use statistical methods to describe our data

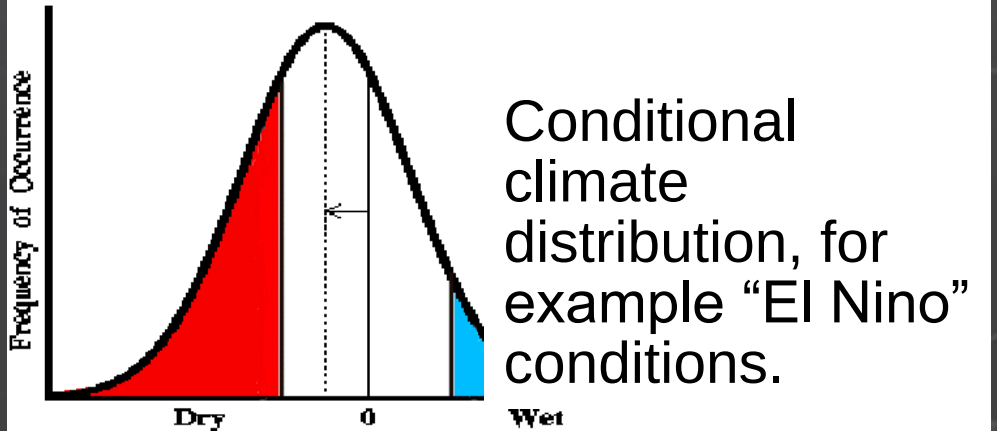


Climate Prediction – this is why we can predict

Climate prediction is the process of estimating the PDF (proba ating the of a climate ternal forcing (e.g ses, etc)



Normal climate distribution – probability of wet/dry = long term average



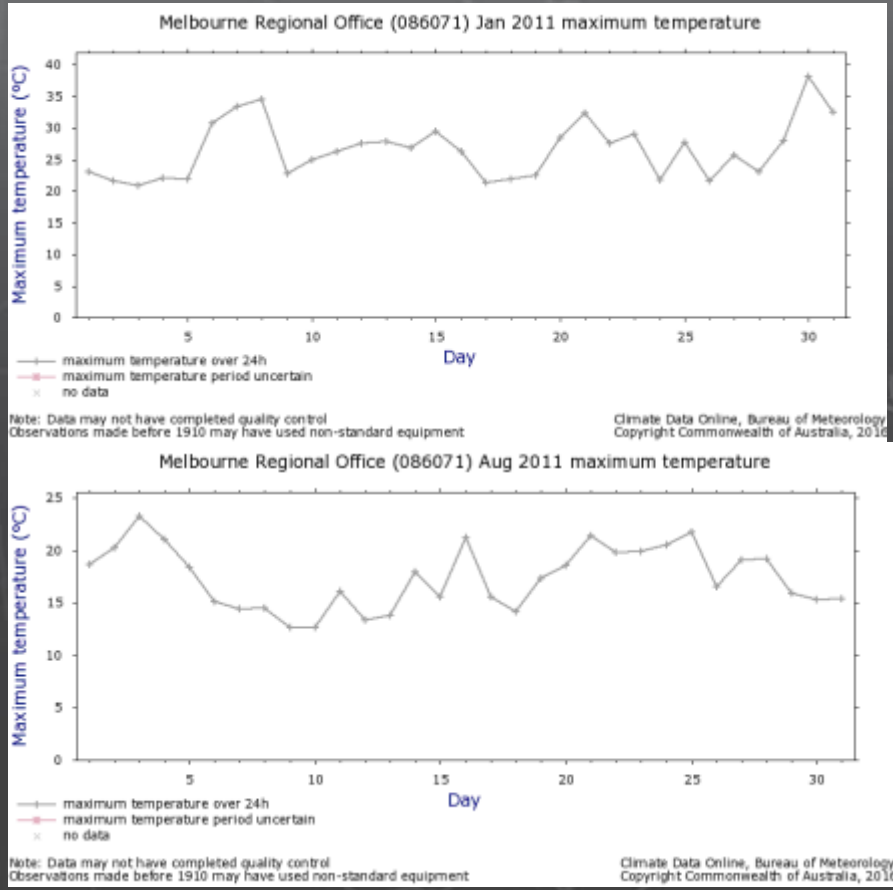
Conditional climate distribution, for example “El Nino” conditions.

Mean vs variability

Summer vs Winter temperatures in Melbourne.

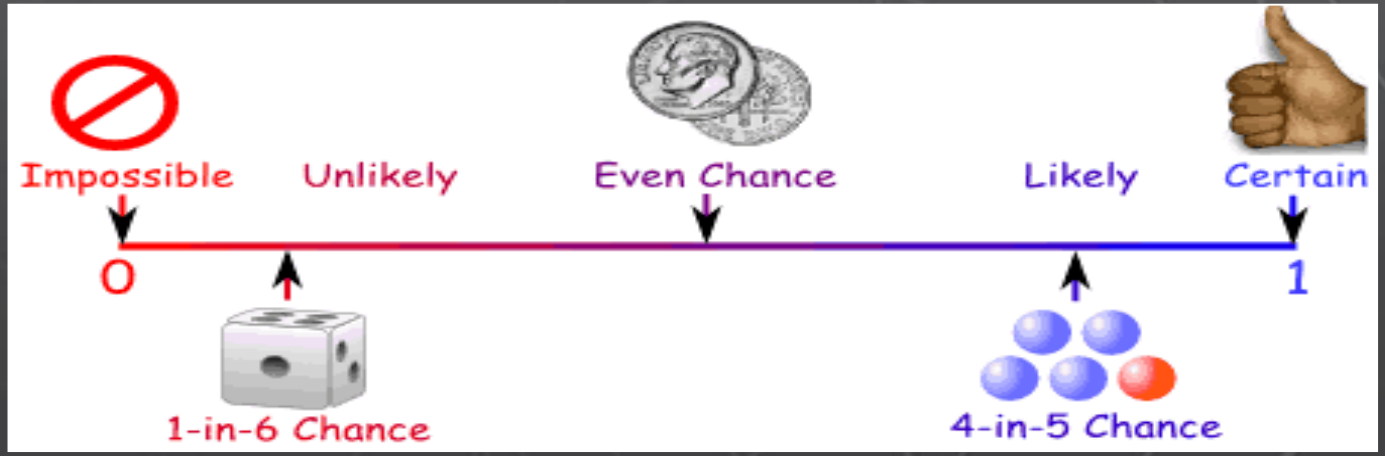
- Physical reasons why summer on average is warmer than winter.

- But I can not tell you what the forecast will be on every day and some summer days might be colder than some winter days.



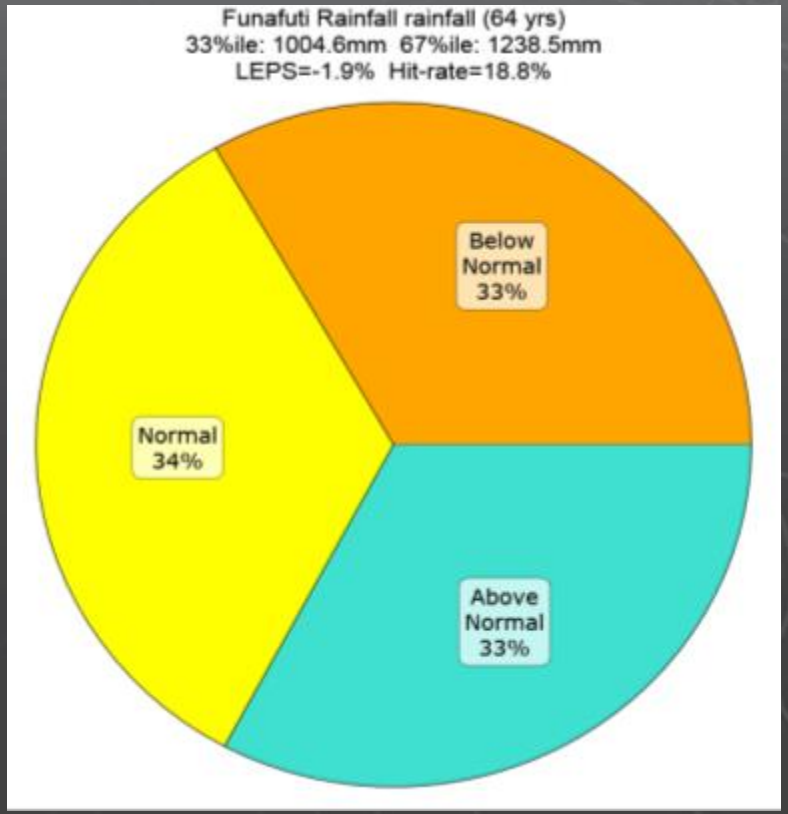
Probability, chance, how likely?

A probability describes the likely occurrence of a particular event. It's conventionally expressed on a scale from 0 (impossible) to 1(certain).



Careful of terminology – For example people will have different ideas of what 'likely' or 'unlikely' means

Terciles - Base Rates..

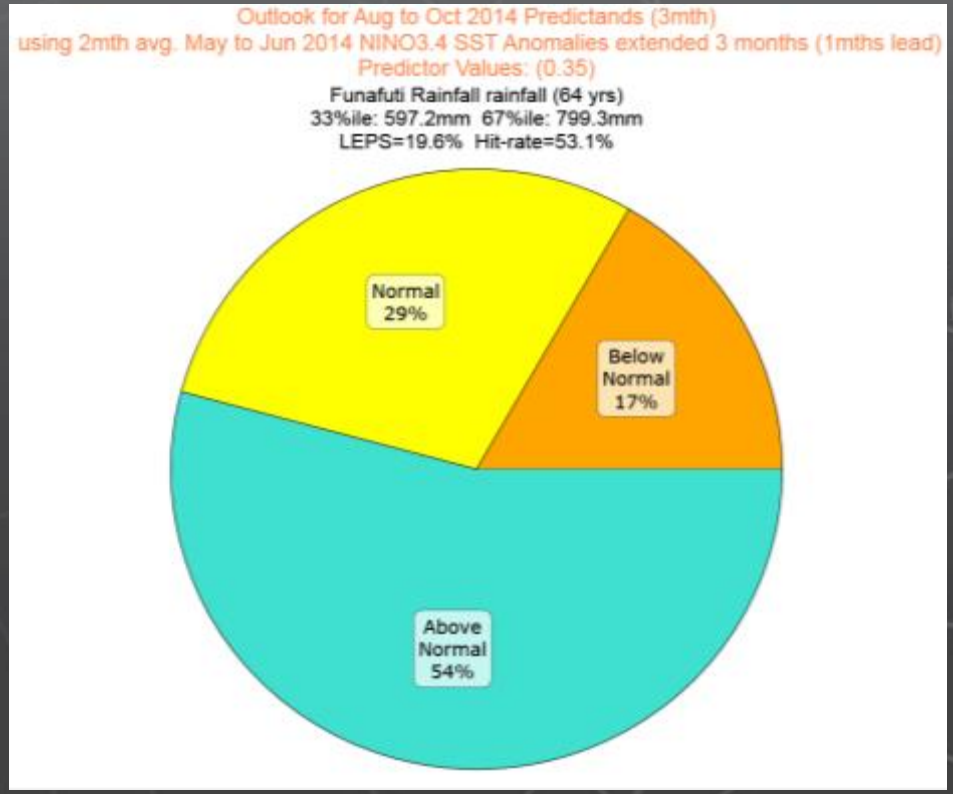


Interpreting Terciles

54% chance of rainfall being ‘above normal’.

But…

Still a 46% chance of rainfall not being ‘above normal’!



Probabilities – other factors may influence risk level

- Five blue stones
- Three yellow stones
- Two orange stones

Guess what you will pick out.

What if you had to risk money on the outcome – would this change your decision?

A climate-market matrix with an estimate of years of occurrence added

Likely years of occurrence per decade		2.5	5	2.5
	Climate Scenario / Market prices	High	Normal	Low
3	Optimal conditions	+++	++	+
4	Average conditions	++	+	=
3	Poor conditions	+	=	-

Numbers are indicative only and may vary from location to location and enterprise to enterprise

Terciles divide the data into three

Terciles divide data into three categories that have the same chance of occurring in the long term.

33%ile: 1004.6mm 67%ile: 1238.5mm

Example 1*:* 63 years of Dec - Feb rainfall at Funafuti:

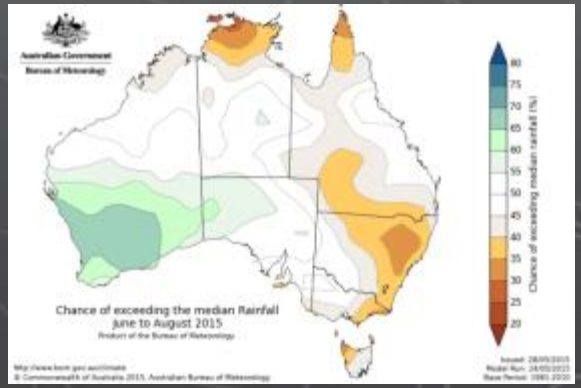
21 years were below-normal (tercile 1) < 1004.6 mm,

21 years had rainfall near-normal (tercile 2) 1004.6 – 1238.5 mm, and

21 years above-normal (tercile 3) > 1238.5 mm.

Comprehension – chance of exceeding median

- Example: True or False
  - It will rain across less than 40% of NSW, true or **false** (9 of 100 answered incorrectly)
  - Northeast NSW can expect 30 to 40% of its median rainfall, true or **false** (27 of 97 answered incorrectly)
  - The chance of exceeding median rainfall is between 30 and 40% over much of northeast NSW, **true** or false (10 of 100 answered incorrectly)
  - There is a 60 to 70% chance that rainfall will be lower than the median over much of northeast NSW, **true** or false (43 of 100 answered incorrectly)
  - 30 to 40% of Bureau climatologists think it will be a dry winter in northeast NSW, true or **false** (19 of 99 answered incorrectly)

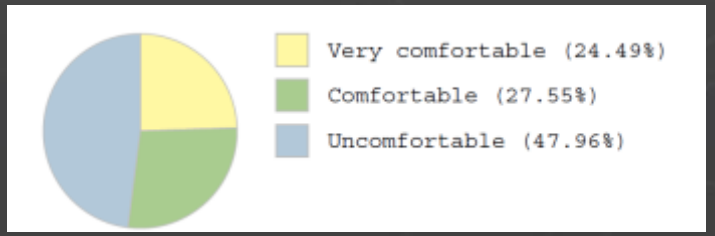


Comprehension – chance of exceeding median

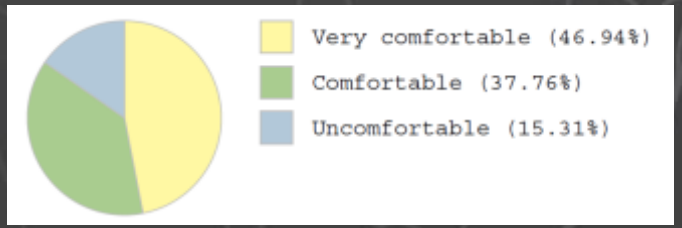
- Accuracy map – reasonably high level of comprehension (rate of incorrect response ranged from 10 to 30%)
- Tercile map – comprehension also pretty good, but people not comfortable with the word "Tercile"

How comfortable are you with the Bureau using the following terms:

Tercile:



Median:

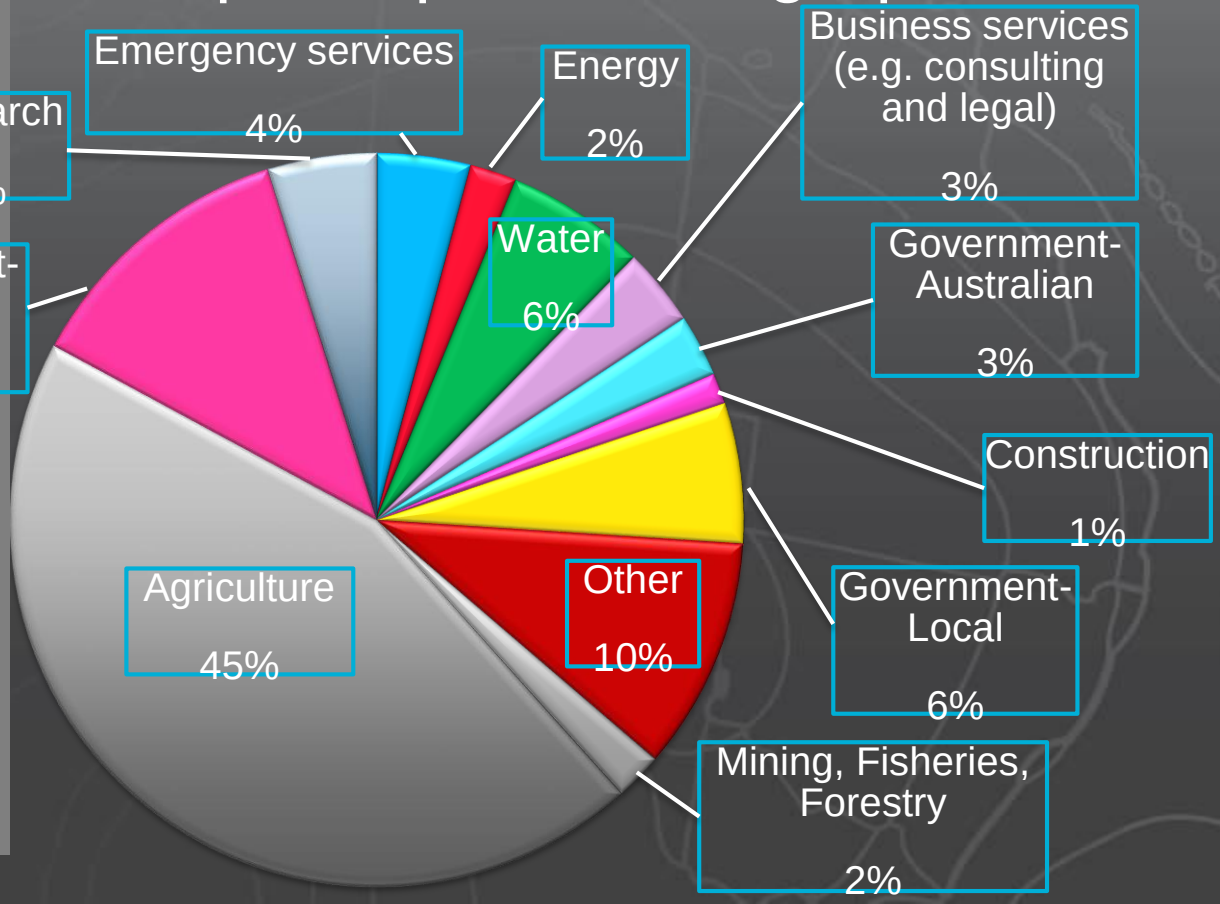


Climate outlooks workshops – participant demographics

- Brisbane
- Perth
- Orange
- Canberra
- Melbourne
- Birchip
- Longreach
- Darwin

(Aug 2015 – Jun 2016)

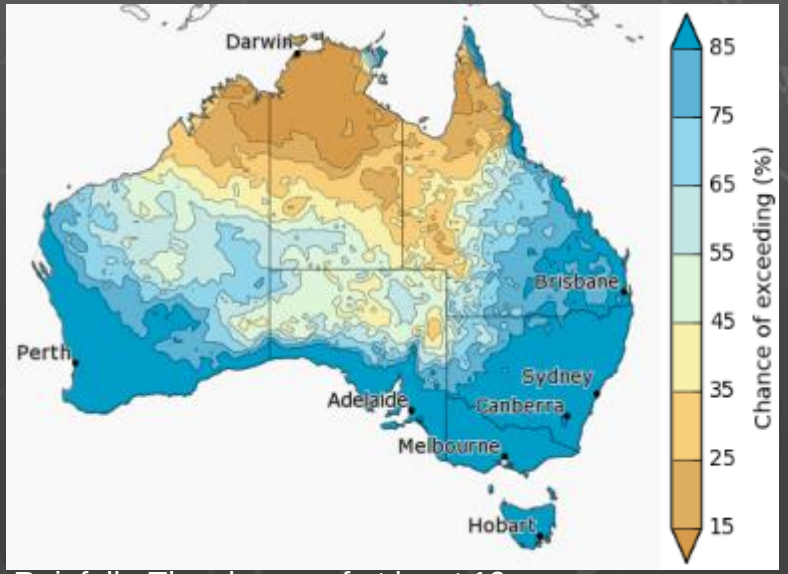
Approx. 18 attendees per workshop



Feedback – Rainfall

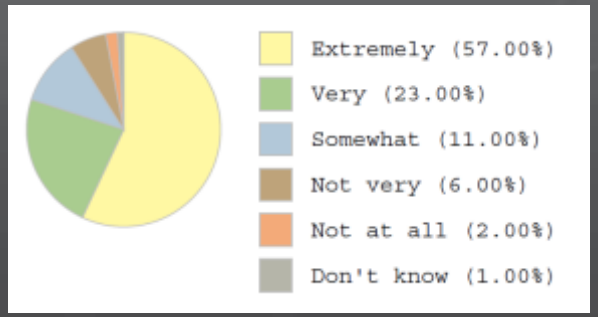
- Rainfall is the most used outlook parameter
  - User-selected threshold most desired.
  - Chance of extreme heavy rainfall also requested

- Common decisions relate to:
  - When/what to plant
  - How much to plant
  - When to harvest
  - How much stock to carry
  - Irrigation schedule
  - When/what spray to use
  - When to authorise controlled burns
  - When to re-surface roads
  - When to store sandbags (local council)
  - When to move equipment
  - How much time to allow for a job

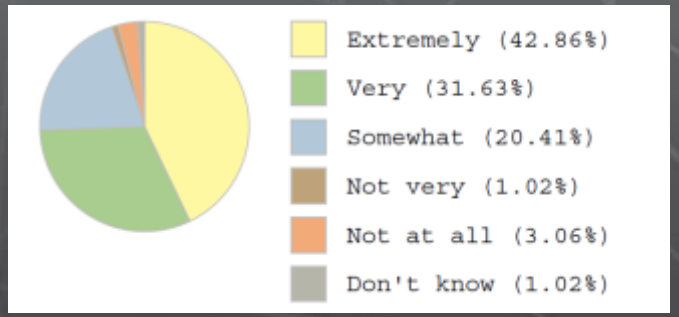


Rainfall - The chance of at least 10mm

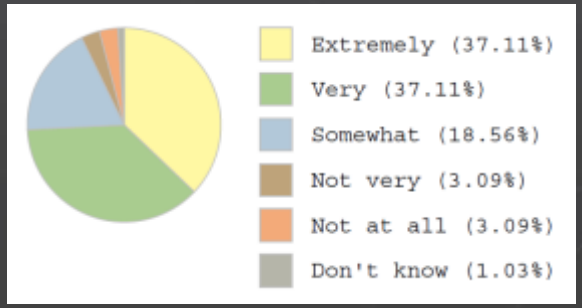
Weather forecast for the next 7 days - usefulness by time of year



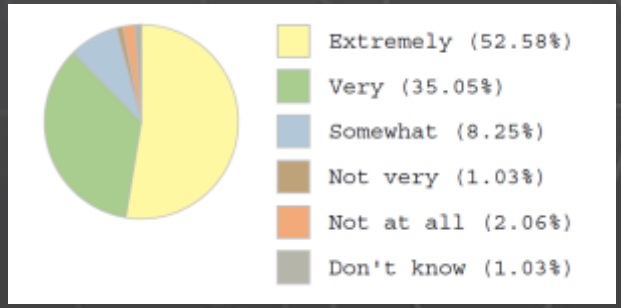
Summer



Autumn

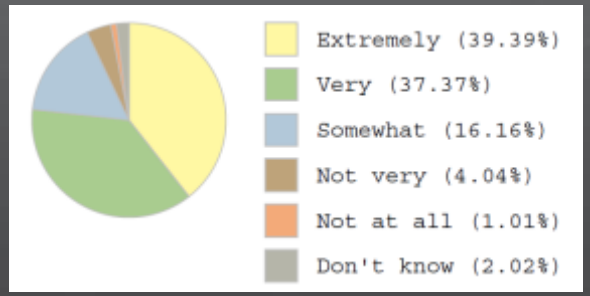


Winter

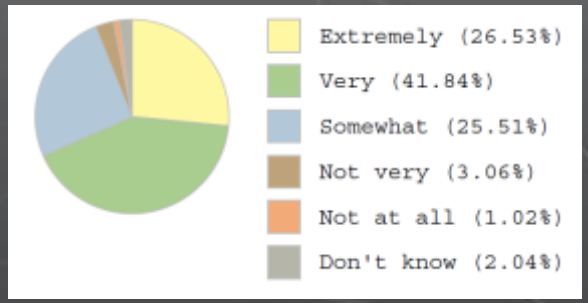


Spring

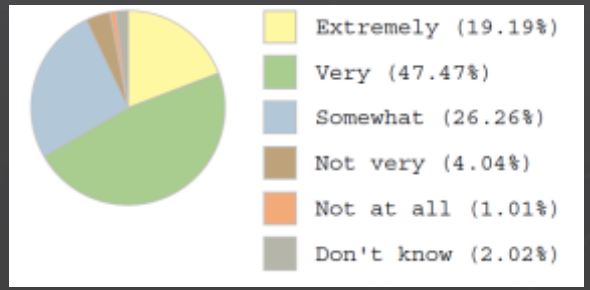
Outlook for weeks beyond 7 day forecast - usefulness by time of year



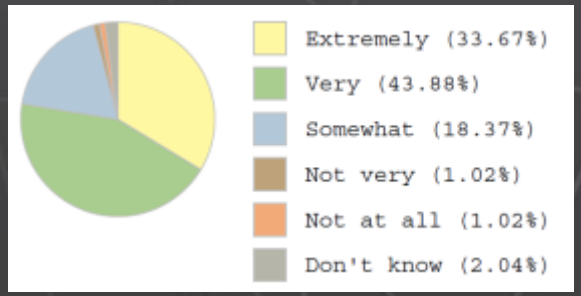
Summer



Autumn

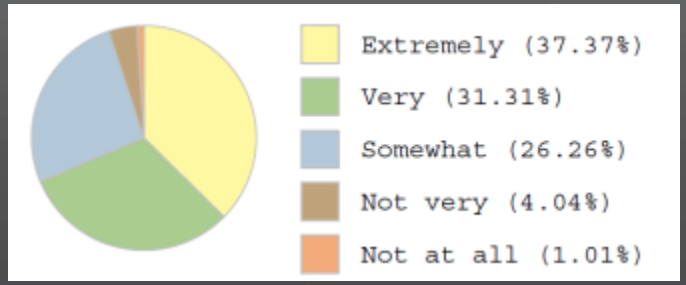


Winter

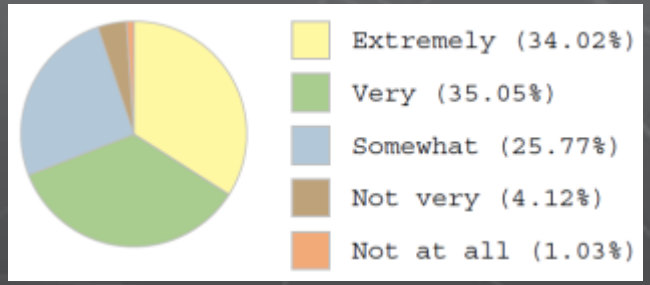


Spring

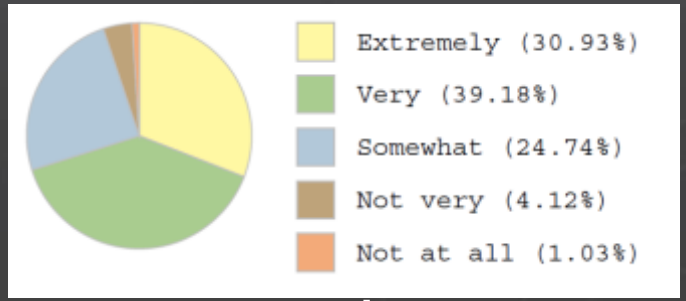
Outlook for the coming three months - usefulness by time of year



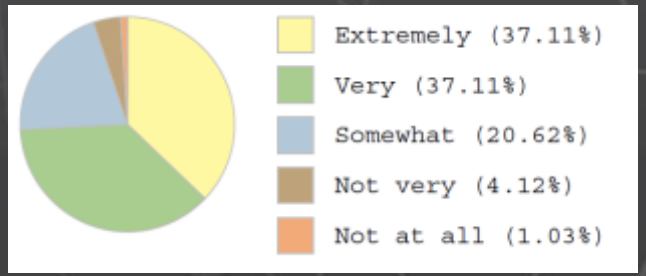
Summer



Autumn



Winter



Spring

Suggestions for improvement..

A lot of the data presented is too technically difficult to read.
Be nice to have a longer 3 month lead time forcast
Climate outlooks are readily available and easy to interpret but are for a limited range of parameters at present.
Current products are useful, but there is scope to improve service through greater focus on timescales of 1-4 weeks.
Forcast rain fall can disappear quickly, also Dof Ag WA and the BOM can differ, why
Generally meets needs but always looking for better, more reliable advance warning of wet weather.

Not readily accessible i.e. obtuse/dense/clumsy as if presented for knowledgeable boffins not users. It needs to be in a format that can be used straightaway with out effort to interpret further with a prerequisite meteorological degree!

Climate Sensitive Decisions

Climate sensitive decision:	When to harvest mangoes
Your business/organisation:	Mango farmer
Weather/climate element/index of interest (circle):	(Rainfall) Maximum Temperature Minimum Temperature Wind speed (Heat wave) Evapotranspiration Other_____
Do you have a critical threshold? Please provide detail on why it is critical:	Ideally, we need no rainfall, with X amount of days previously, with little to no rainfall. A heatwave would hinder picking.
Which forecast period do you require to make this decision (circle, it's ok to circle more than one option)	(Seven day weather forecast) (The weeks beyond the 7 day forecast (i.e. outlook for next week or the week after)) (Forecast for the coming month) Forecast for the coming season Forecast for the coming six months Forecast for the coming 12 months
What time of year do you make this decision?	August - October
What is the value of this decision (optional)	If mangoes get wet, they get black spots, reducing their selling price (~50% reduction - $X dollars per box)

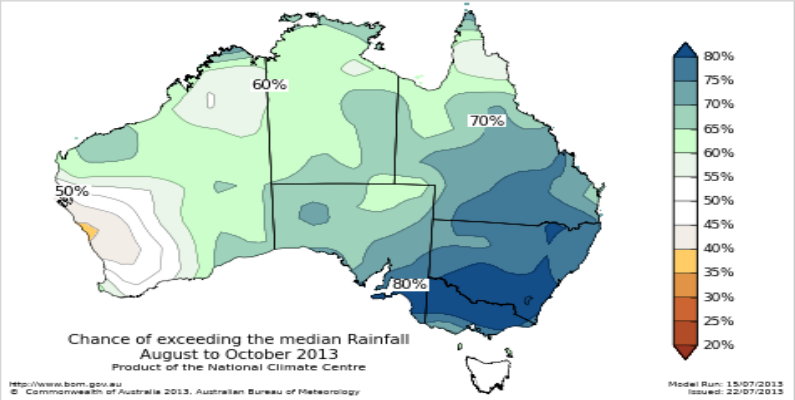
- Fill in decision sheet

Don't assume you know what the stakeholder wants – I had assumed every farmer wants rain but at some times of year this will not be the case!

Different Needs of Users

Rainfall | Outlook accuracy | Rainfall averages | About the outlook

Wetter conditions likely for most of mainland Australia



Larger view | PDF(2MB) | Wider Australian region | Old colours

Summary

- A wetter than normal season is likely for most of mainland Australia
- The Kimberley, parts of western WA, and Tasmania have no strong tendency towards being wetter or drier than normal
- The main climate drivers for this outlook include a negative Indian Ocean Dipole, a neutral-to-cool tropical Pacific, and warm sea surface temperatures around most of Australia
- Outlook accuracy is moderate over most of Australia except the interior of WA.

Details

The chance of exceeding the median rainfall for August to October is more than 60% over most of mainland Australia. The chance rises to more than 80% over southeast SA, southern NSW and most of Victoria. Such odds mean that for every ten years with similar climate patterns to those currently observed, about six to eight August to October periods would be expected to be wetter than average over these areas, while about two to four would be drier. However, it should be noted that rainfall is typically low at this time of year over tropical Australia, and contributes to only a small part of the annual total.

The chance of receiving a wetter or drier than normal August to October is roughly equal (i.e., close to 50%) over the Kimberley, western WA, parts of the Cape York Peninsula, and Tasmania.

Climate influences

A negative Indian Ocean Dipole (IOD) event is in progress, and is expected to persist through spring 2013. A negative IOD during

When communicating your forecast

No acronyms.

- ENSO is an exception to this rule.
- SCO should not be used. It can be shortened to ‘the outlook.’
- Do not use ‘JFM’ – use Jan-Mar period.

***Main point upfront**.*

- *This can be qualified with another sentence if required*

State location first:

- Good: “Northern Australia is expected to be warmer than average…”
- Bad: “It will be warmer than average in Northern Australia…”

Short sentences.

- One key point per sentence (i.e. try to avoid double/triple barrelled sentences)

Don’t refer to ‘confidence’ and ‘outlook’ in the same sentence.

Current	Other or preferred options
Odds	Likelihood or likely Chance
Probability or probabilities	Likelihood Chances (ok to use in some instances)
Anomalies	May need phrase to describe. Difference from average or normal
Favoured	Likely
Median	Normal / Usual / **Average**
Percent consistent	Past accuracy
Chance of exceeding median	Chance above average
A return to neutral conditions.	Balanced Stable with no El Nino or La Nina influence

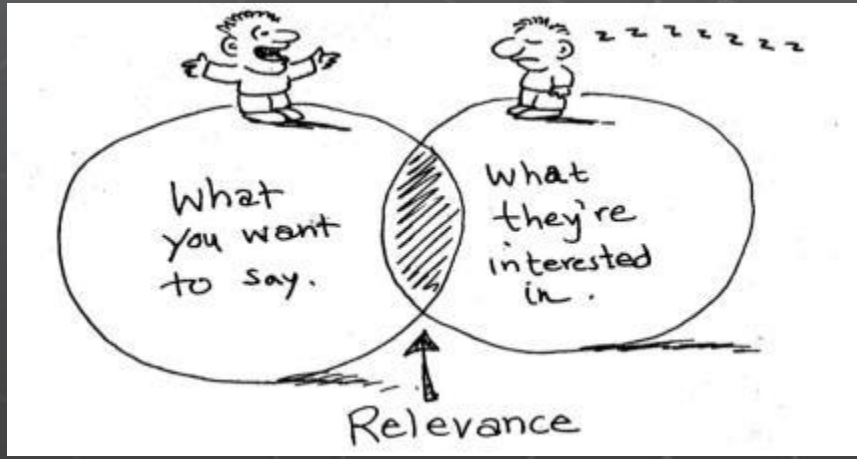
Communicating forecasts

Stacking the odds in your favour

https://www.youtube.com/watch?v=8Y5poxiwEQM&feature=youtu.be

Why does audience matter?

- Because we want to make sure the right people hear what we're saying!
    - If we don't think about who we are trying to reach, we won't adapt our communication to suit their needs – and then they won't listen.



Writing for an audience

- Keeping your audience in mind while you write can help you make good decisions about:
  - What information to include
  - Which main points to focus on
  - How to organise and prioritise your ideas
  - What kind of words and language to use
  - The best kind of examples and photos to support your story

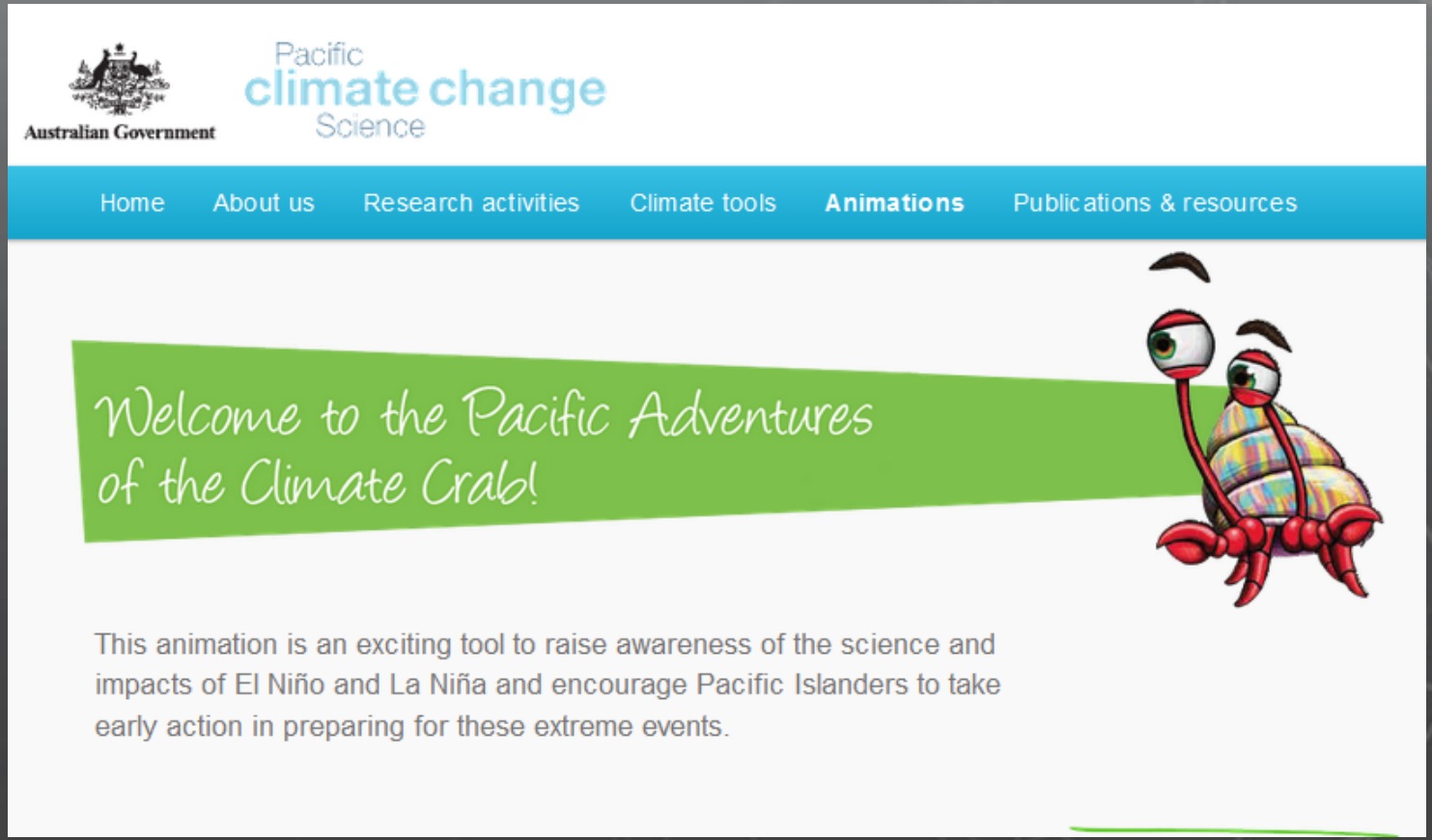
Communicating forecasts

Potentially a serious topic but:

- Can talk in language people will understand
- Scientific concepts with relatable examples
- **<u>Actions</u> for people to take**

http://www.pacificclimatechangescience.org/wp-content/uploads/2013/08/CloudNasara_English_large.mp4

http://www.pacificclimatechangescience.org/wp-content/uploads/2013/07/CloudNasara_English_small.mp4

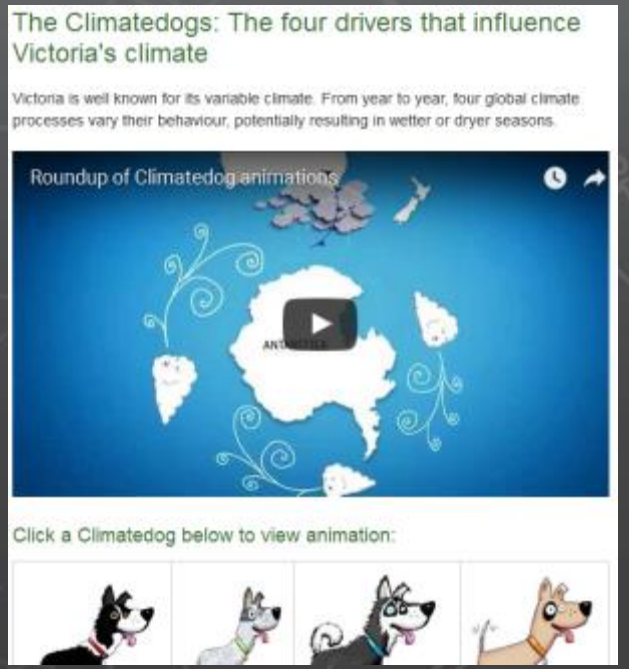


http://www.pacificclimatechangescience.org/animations/climatecrab/

Communicating climate: audience and education

Aimed at an agricultural audience

Educating on climate drivers affecting Australian rainfall

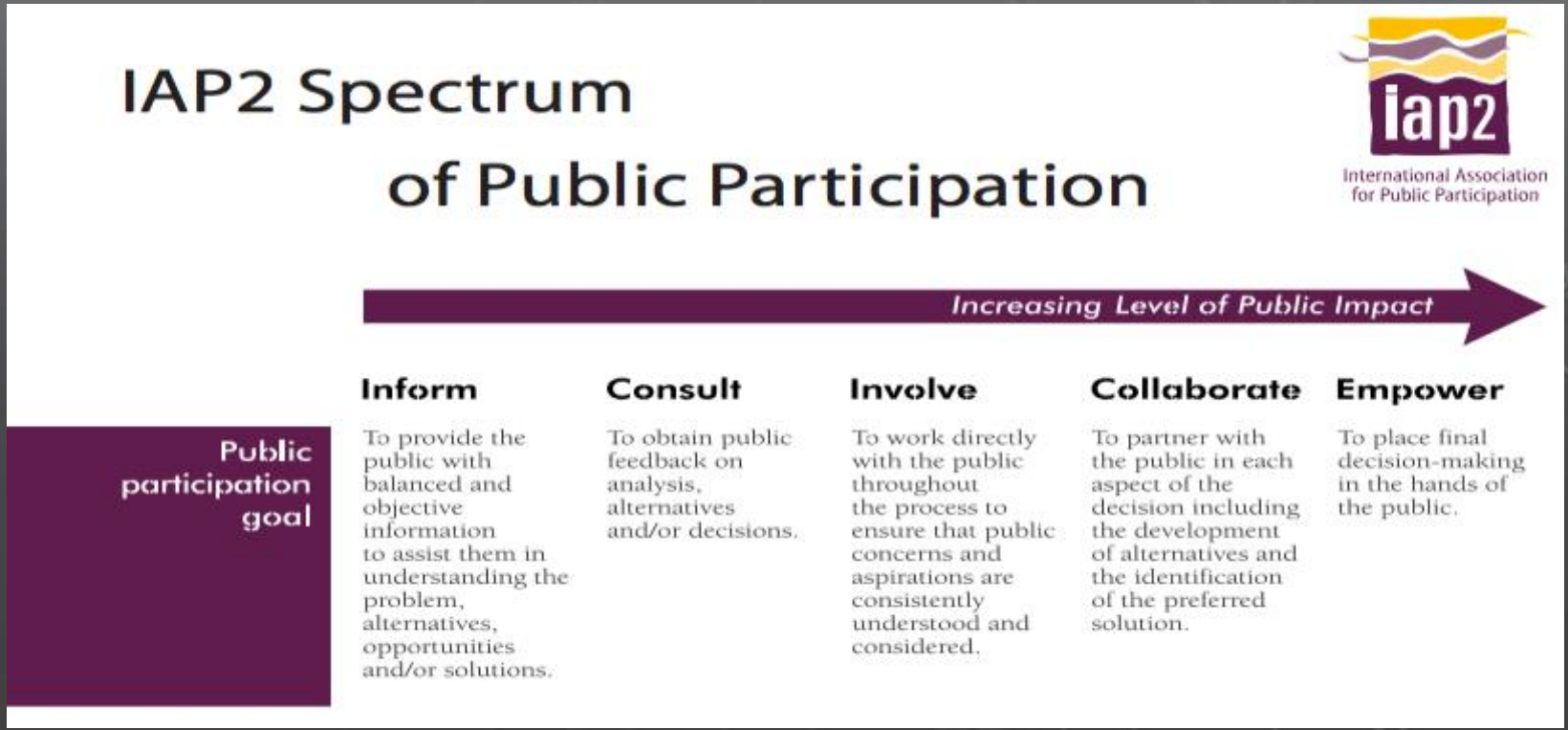


http://agriculture.vic.gov.au/agriculture/farm-management/newsletters-and-updates/the-break,-the-fast-break-and-the-very-fast-break-newsletters

http://us3.campaign-archive2.com/?u=f44262ae409950c15c3de4c99&id=2d4e712c73

http://agriculture.vic.gov.au/agriculture/farm-management/weather-and-climate/understanding-weather-and-climate/the-climatedogs-the-four-drivers-that-influence-victorias-climate

Stakeholder Engagement



Stakeholder Engagement

What stakeholders and why?

How will you **get** the information to them?
How will they **understand** the information?
How could they **use** the information?

Stakeholder Engagement: seasonal streamflow forecasts

https://www.youtube.com/watch?time_continue=4&v=7WOKXMOV2fk

Water forecasts: Case study Icon Water

Using the Bureau's streamflow forecasting, Icon Water confidently removed temporary water restrictions

- Icon Water helped the Bureau in experimental phase to refine products
- Case study to highlight the use of forecasts in decision making
- Forecasts provide reduced uncertainty after the millennium drought.

Seasonal Streamflow Forecast Service influencing water decisions

The 1997–2009 millennium drought placed severe stress on water security in the Australia Capital Territory. Temporary water restrictions were in effect between 2003 and 2010, with more severe restrictions active from 2006 to 2010.

To determine if temporary water restrictions are necessary, Icon Water considers many factors, such as:

- current conditions such as weather, water storage levels, consumption and inflows;

- historic consumption and inflow;

- available forecasts and projections; and

- how frequently changing restriction levels affect communities and businesses.

Australian Government
Bureau of Meteorology

Bureau's forecast using the following process:

• Three-month 10th, 50th and 90th percentile forecasts are selected for chosen locations.

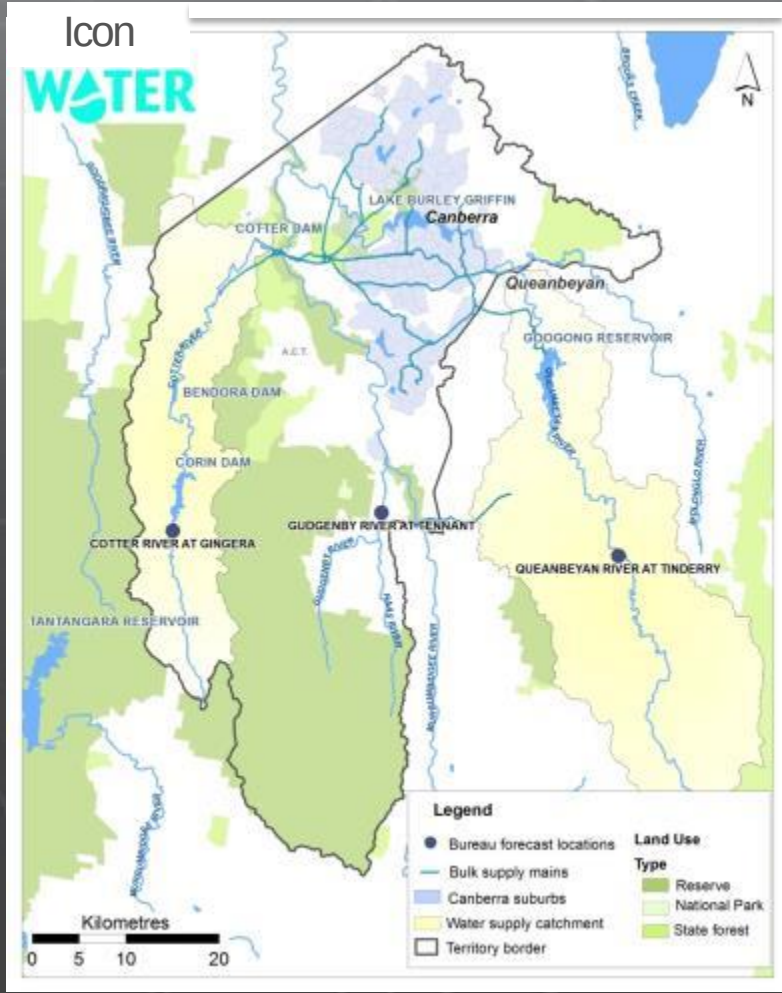
• Forecasts are converted to monthly inflows using disaggregation factors specific to each month and location.

• These flows are incorporated into Icon Water's water supply planning model, along with estimates of water demand. Icon

• Operational and environmental rules are applied to projected storage levels from each of the forecasts.

• Data are overlaid onto two year water storage projections developed from their historic reference climate via the same water supply model.

• Projections then inform Icon Water's strategic operational decisions.



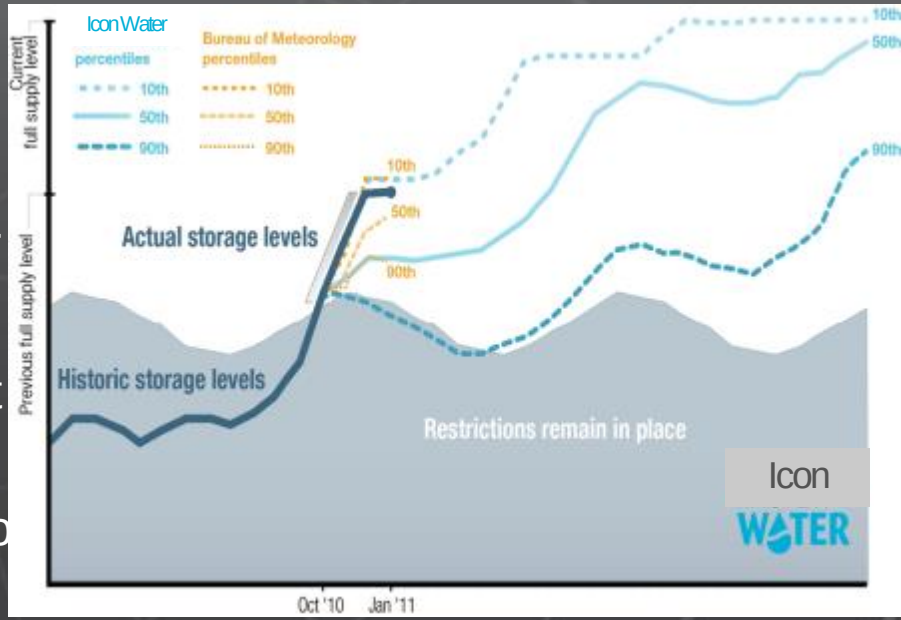
Australian Government
Bureau of Meteorology

Removing restrictions

The Bureau provided Icon Water with seasonal streamflow forecasts. Icon Water converted these into water storage forecasts and overlaid them onto the historic reference period.

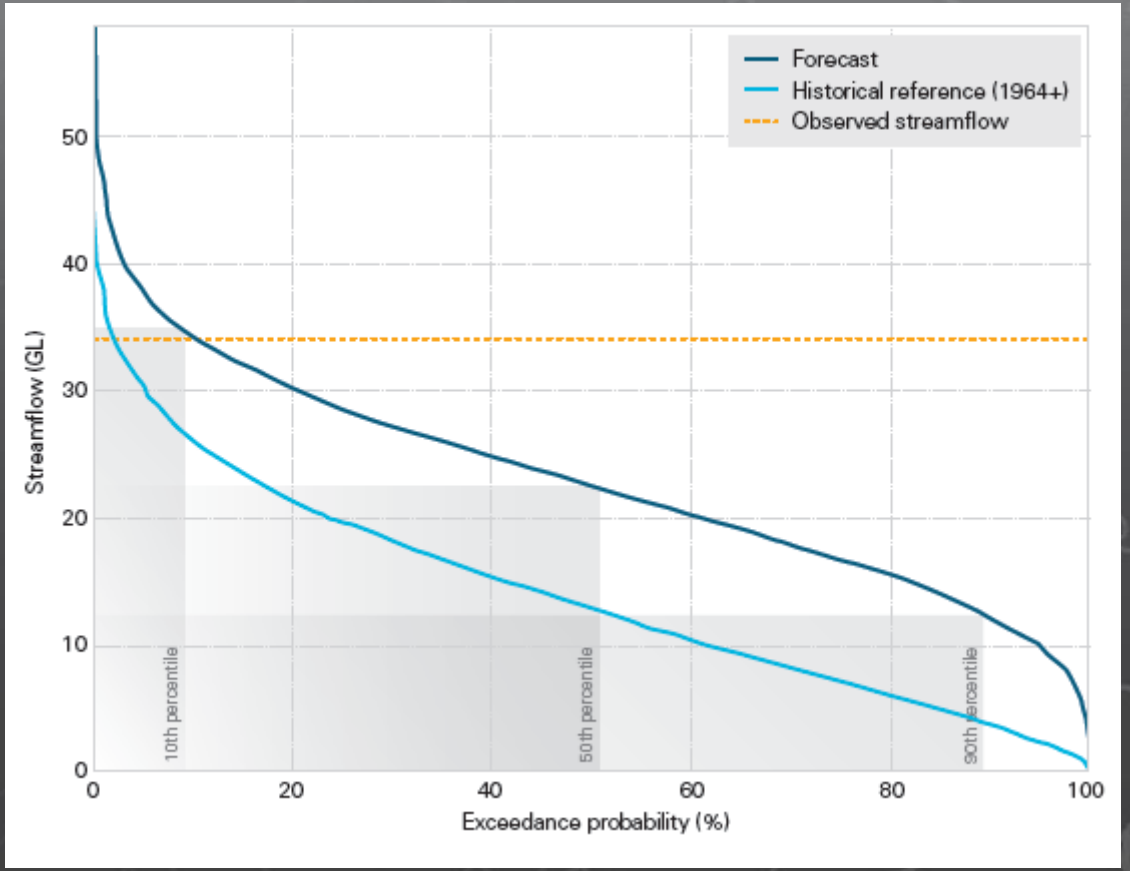
The forecasts were much less variable than historical data. Importantly, the Bureau's streamflow forecasts did not indicate that water storages would decline below the level needed to keep restrictions in place. In fact, the forecasts showed there was a high chance that storage levels would increase.

This provided Icon Water with the confidence to remove water restrictions in October 2010.



*Note: Expected full supply level used in scenarios increased periodically between November 2010 and February 2012. This was due to the planned enlargement of the Cotter Dam.

Seasonal streamflow forecasts are issued monthly by the Bureau that forecast three months ahead and predict how much water will flow into a stream or catchment. They are based on probabilities—that is the likelihood or chance of a given volume of water flowing into a stream based on recent climate and catchment conditions.

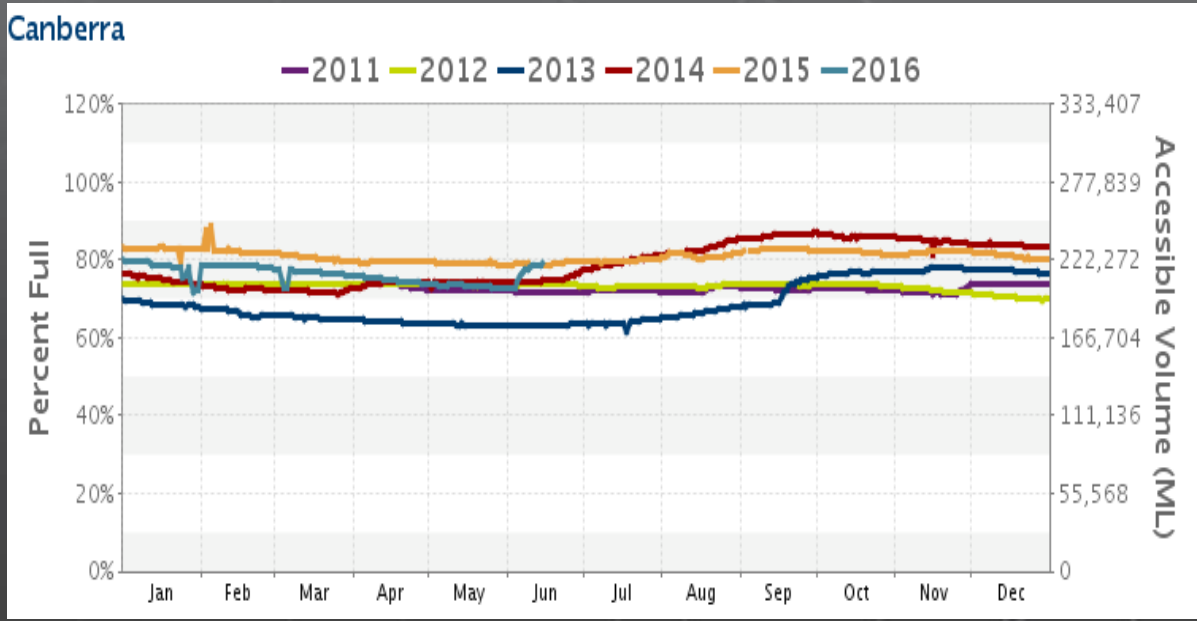


The October to December 2010 seasonal streamflow forecast for Gingera. The 10th, 50th and 90th percentile forecasts—or exceedance probability—are converted to monthly inflows by Icon Water.

Remove restrictions

In October 2010, storage levels had sufficiently recovered so Icon Water could consider removing temporary water restrictions.

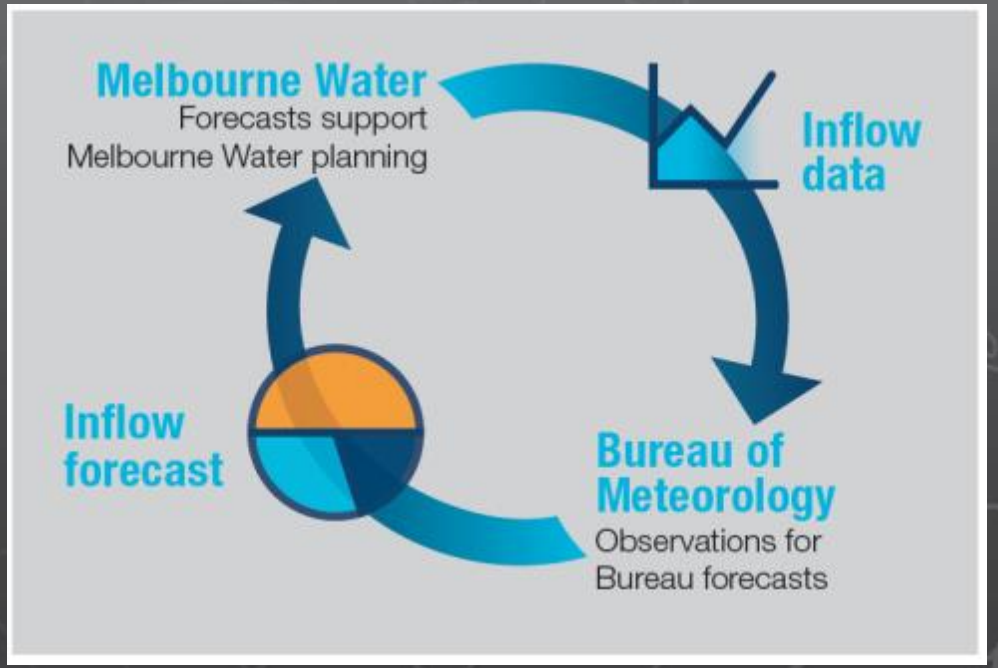
The Bureau's Seasonal Streamflow Forecast Service reduced the range of likely outcomes and the decision to remove water restrictions had a lower risk than the projections based on historic climate indicated.



Melbourne water forecast

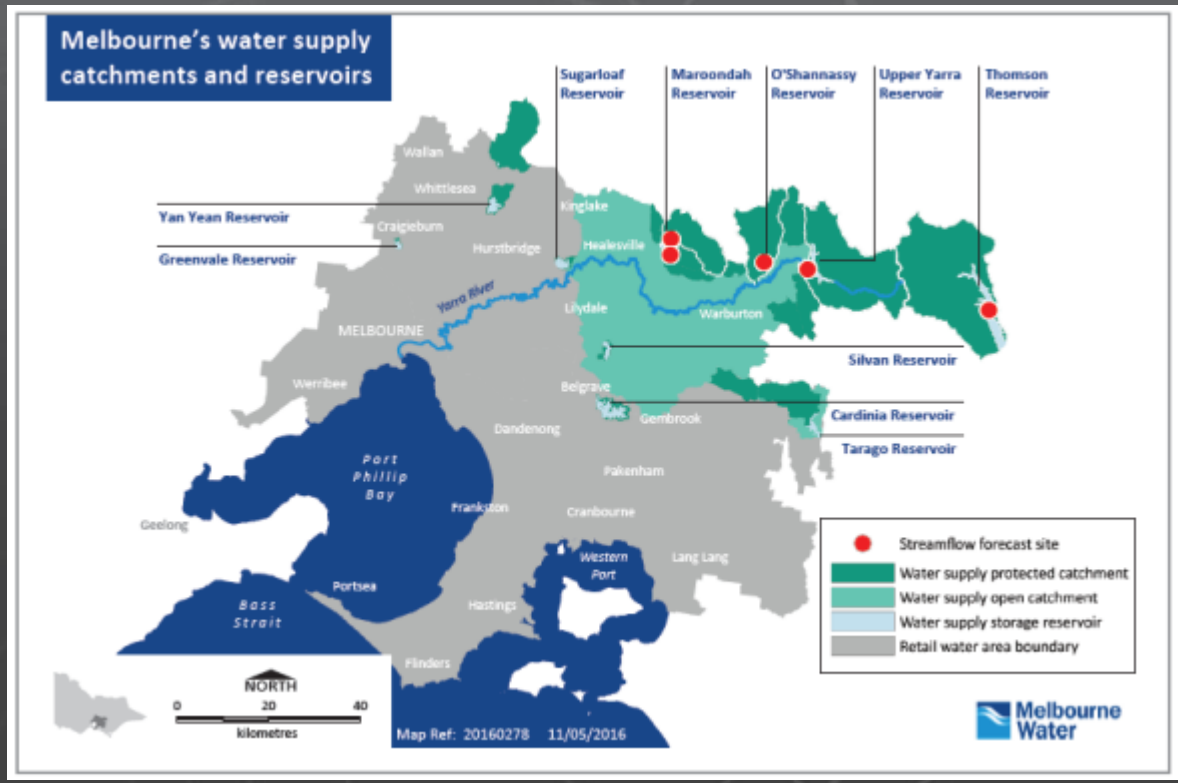
The Bureau of Meteorology's seasonal streamflow forecasts provide Melbourne Water with:

- improved information to aid water resource management for Melbourne.
- Forecasts indicate the likely volume of catchment inflows into the city's major water supply reservoirs for the next three months.



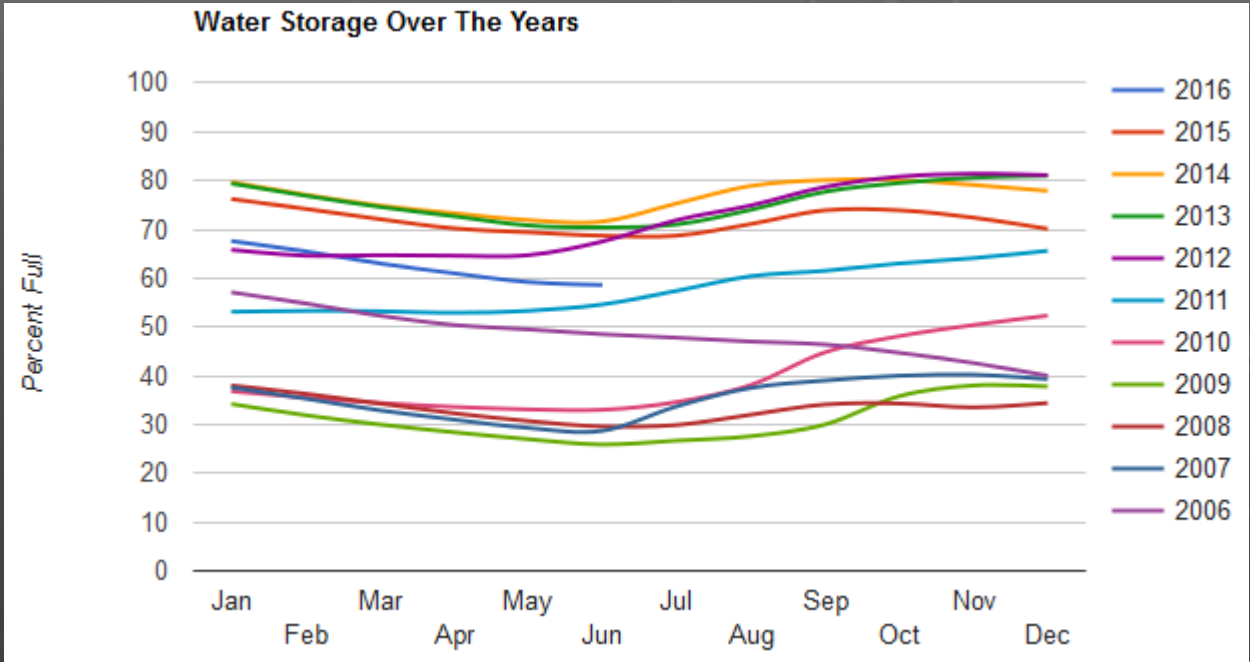
Stakeholder engagement improving products

Melbourne Water, offered insight for the Bureau on how the forecasts can support decision-making within the water industry, and enabled better communication on forecast performance.



Managing more with less

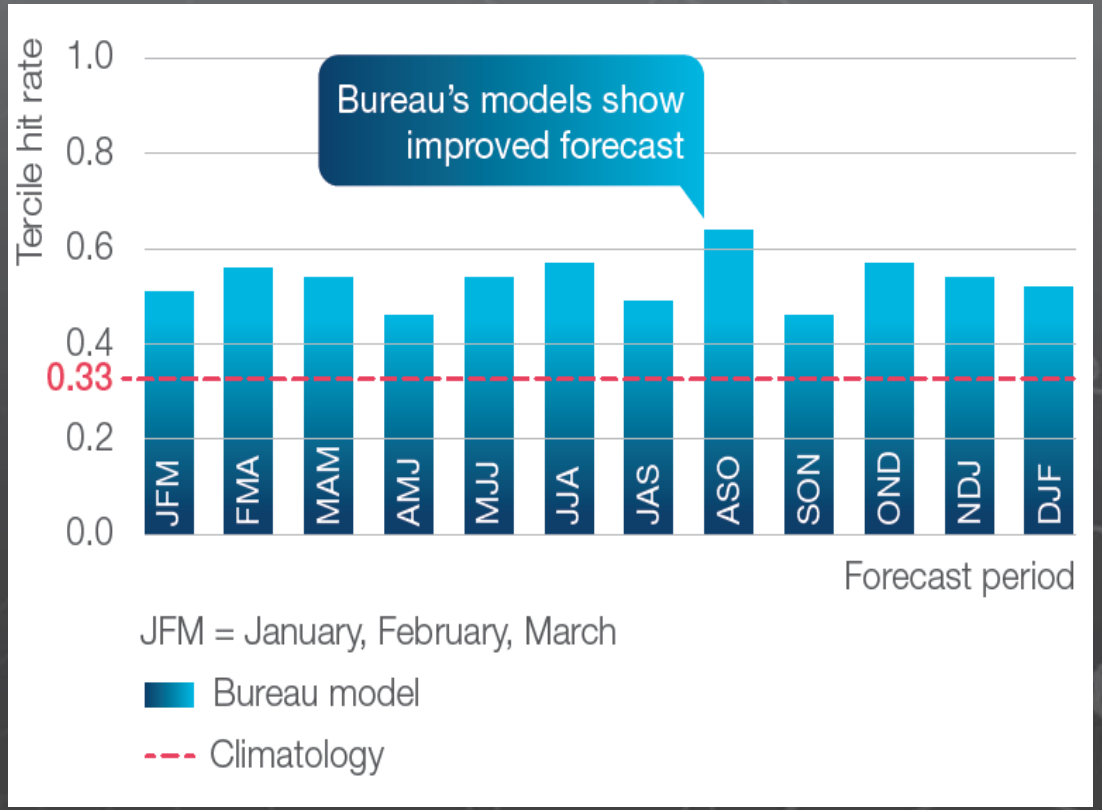
Severity of the 1997–2009 Millennium Drought—combined with projected impacts due to a changing and variable climate, population growth and urban development—posed challenges to Melbourne's water resource management.



http://www.melbournewater.com.au/waterdata/waterstorages/Pages/Storages-over-the-years.aspx

Forecast skill – better than chance

Tercile hit rate represents the number of times the forecast matched what was observed for the total inflow to the Thomson Reservoir (1950–2010). The dotted red line represents the chance (0.33 or one in three) of a correct forecast (of either low, near-median, or high flows) when using only historical data. The blue bars show the forecast was correct more often when using the Bureau's forecasts.



Further examples of forecast value

WaterNSW: guidance on future storage levels in Burrinjuck and Blowering Reservoirs; assist with decisions about water delivery to Murrumbidgee irrigators

Goulburn Murray Water: use in filling policy for Lake Eildon and to plan decisions on water harvesting for Waranga Basin

Department of Mines and Energy (NT): more certainty of future flows to help mines plan controlled releases

COSPPac Climate Application Projects, Samoa: Using Climate Outlooks to provide Water Storage Forecasts for the Afulilo Hydropower Scheme

Project report

Jason Smith, Tony Falkland and Grant Beard

COSPPac: http://cosppac.bom.gov.au/

Australian Government
Bureau of Meteorology

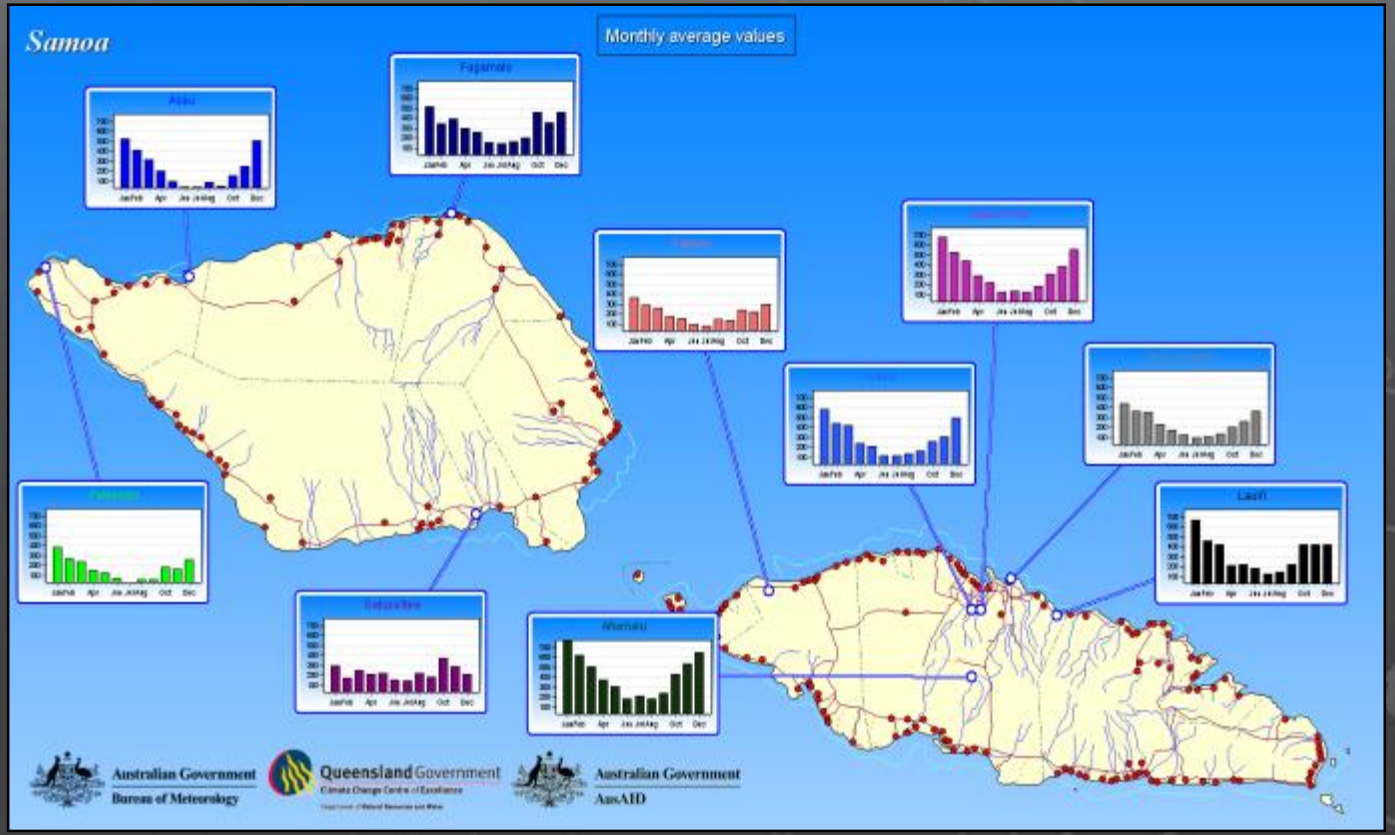
A variable climate

The seasonal climate cycle in Samoa is influenced by the position and strength of the South Pacific Convergence Zone (SPCZ).

Samoa experiences distinct wet and dry seasons, with the wet season running from November to April and the dry season from May to October.

Typically defined dry and wet seasons

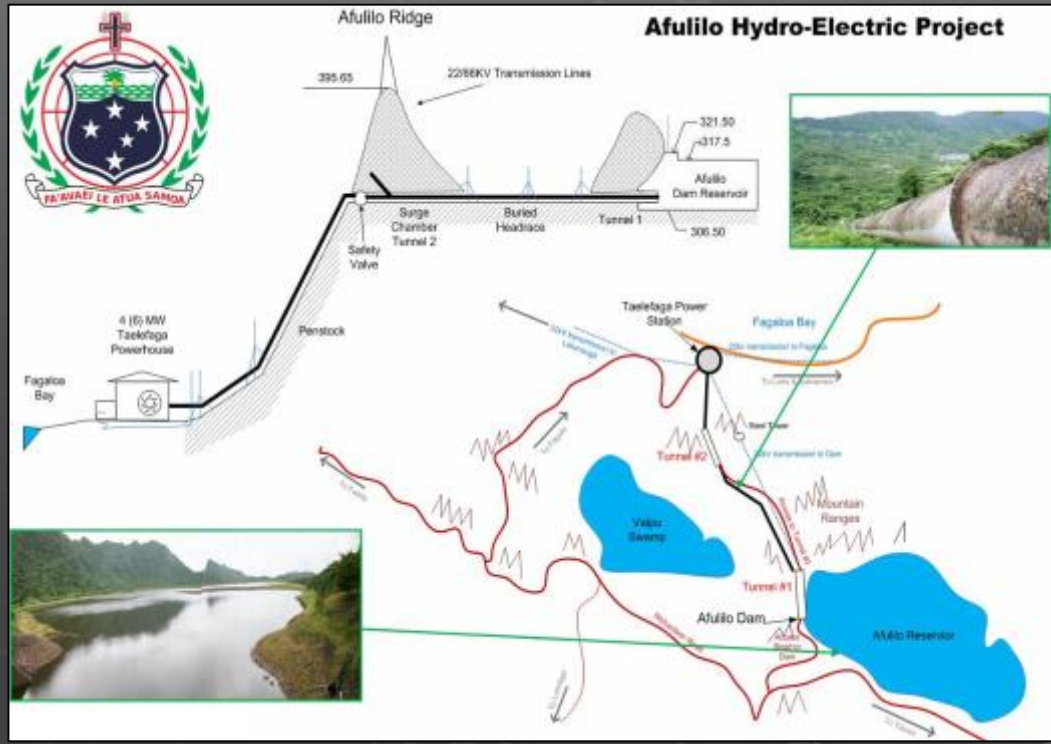
Seasonal and spatial rainfall variability across Upolu and Savai'i.



Despite the small geographical size of Upolu, the rugged topography of the islands along with the prevailing southeasterly trade winds result in substantial rainfall variability across the island. Apia, on the north coast of Upolu, receives an average annual rainfall of around 3,000 mm, whilst the Afulilo catchment located in the south eastern highlands at an elevation of 350 m above sea level records an average annual rainfall of around 5,000 mm

The amount of energy provided by the Afulilo hydropower scheme varies substantially from year to year due to the effect of climate variability, specifically ENSO, on water availability. In any particular year, the proportion of energy provided by the Afulilo hydropower scheme varies between 10% and 25% of total demand.

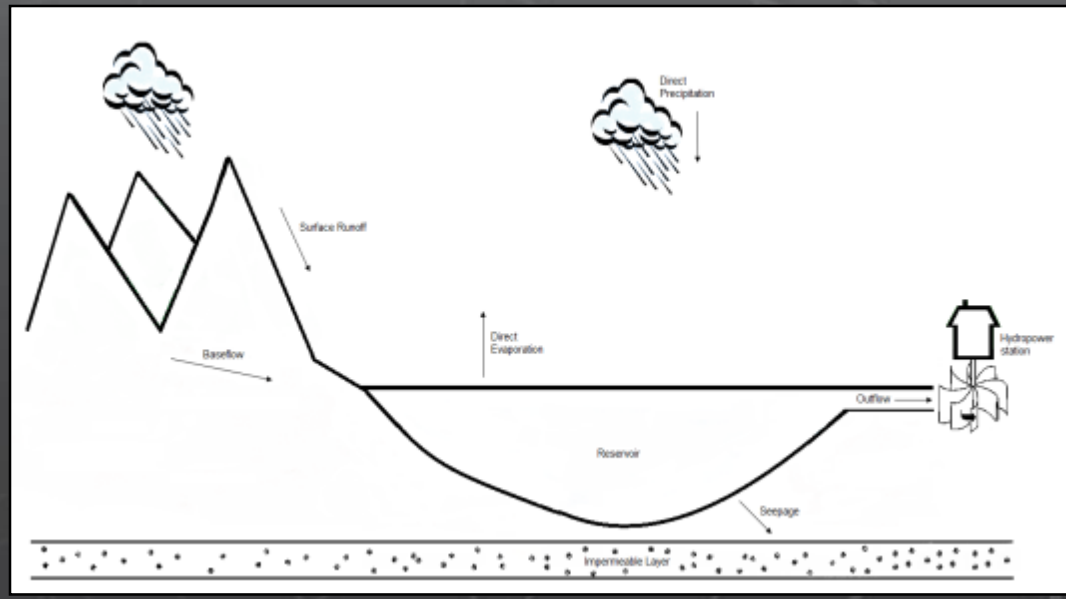
The hydraulic residence time of the reservoir is around 3 – 4 months. The time that it will take for an average single particle of water that has entered the reservoir to leave the reservoir (assuming the reservoir is well-mixed).



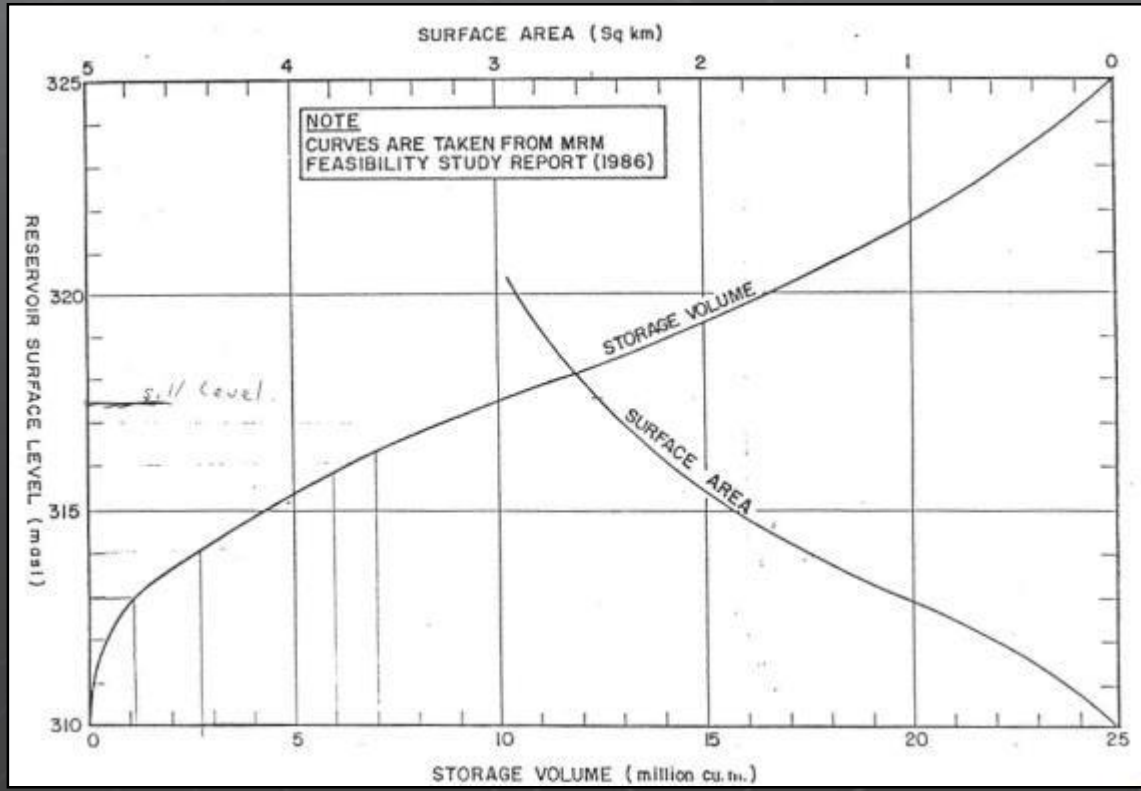
The hydrological cycle associated with a typical hydropower reservoir

The water balance model would incorporated six key inflow/outflow components:

- Direct rainfall on reservoir.
- Direct evaporation from reservoir.
- Runoff from catchment into reservoir.
- Outflow from reservoir to hydropower station.
- Direct seepage from reservoir into ground.
- Spillway flow from reservoir (when reservoir full).



The surface area of the reservoir is essential to calculating the direct rainfall and evaporation at each time step as well as the remaining catchment area available for surface runoff.

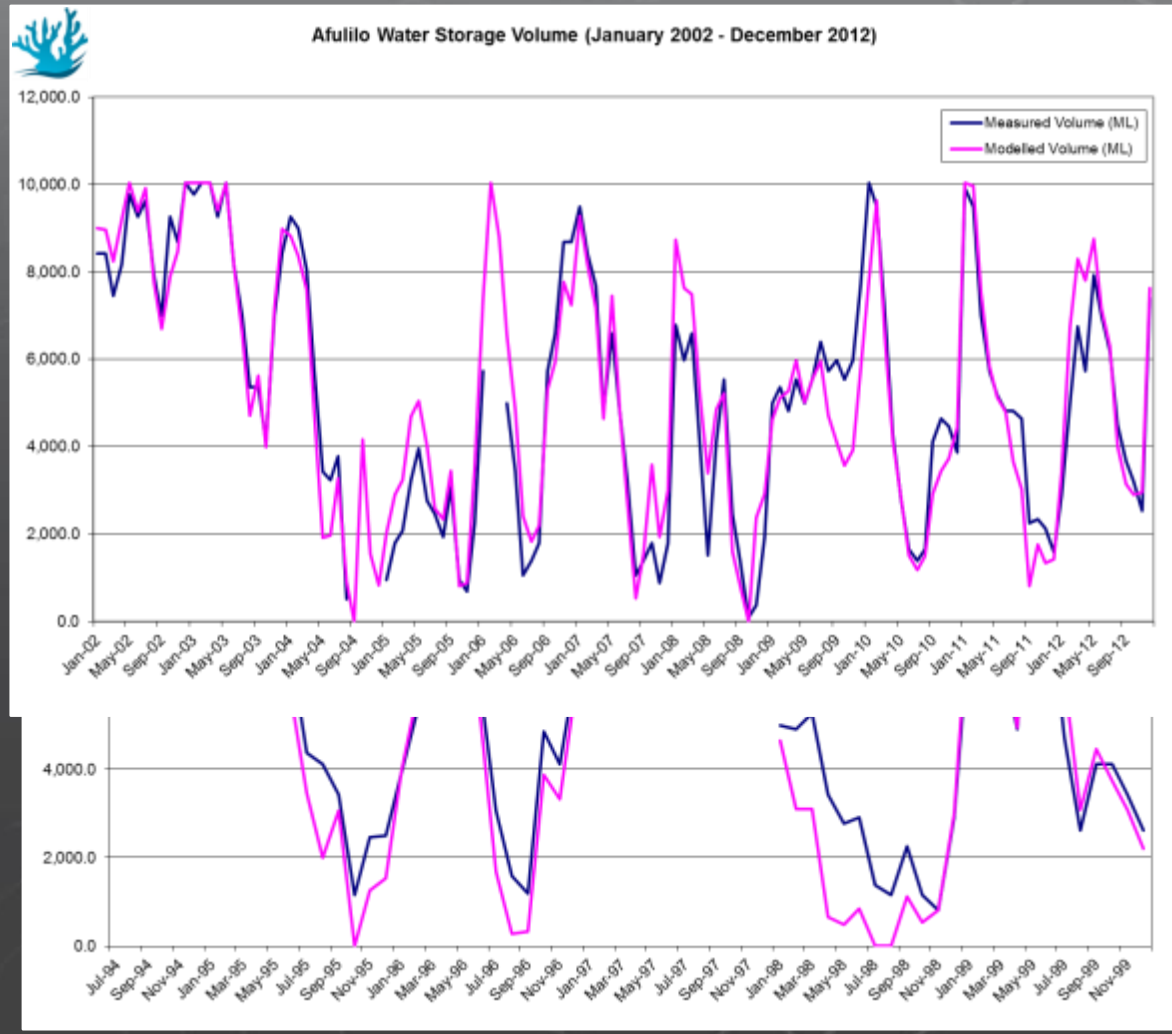


You need data

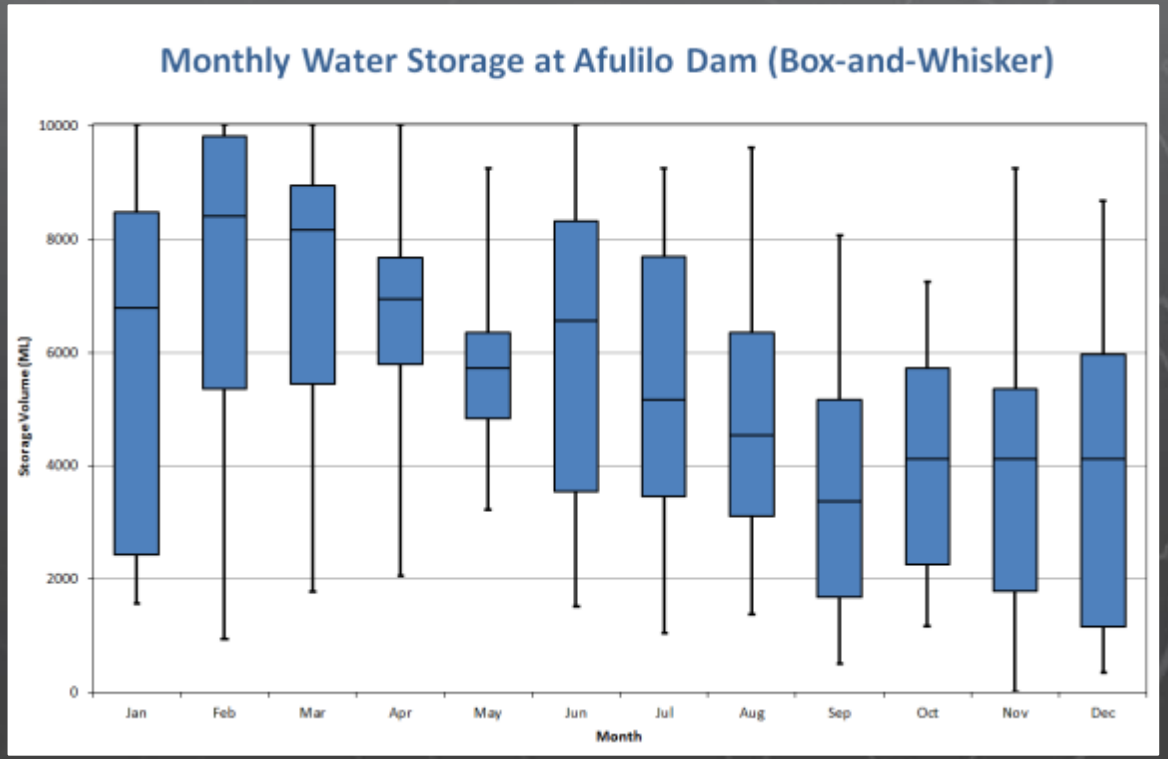
Monthly water storage volume over the calibration period (Jul 1993 – Jun 1999).

Monthly water storage volume over the validation period (Jan 2002 – Dec 2012).

Rainfall data for the period 1993 – 2011 was also obtained



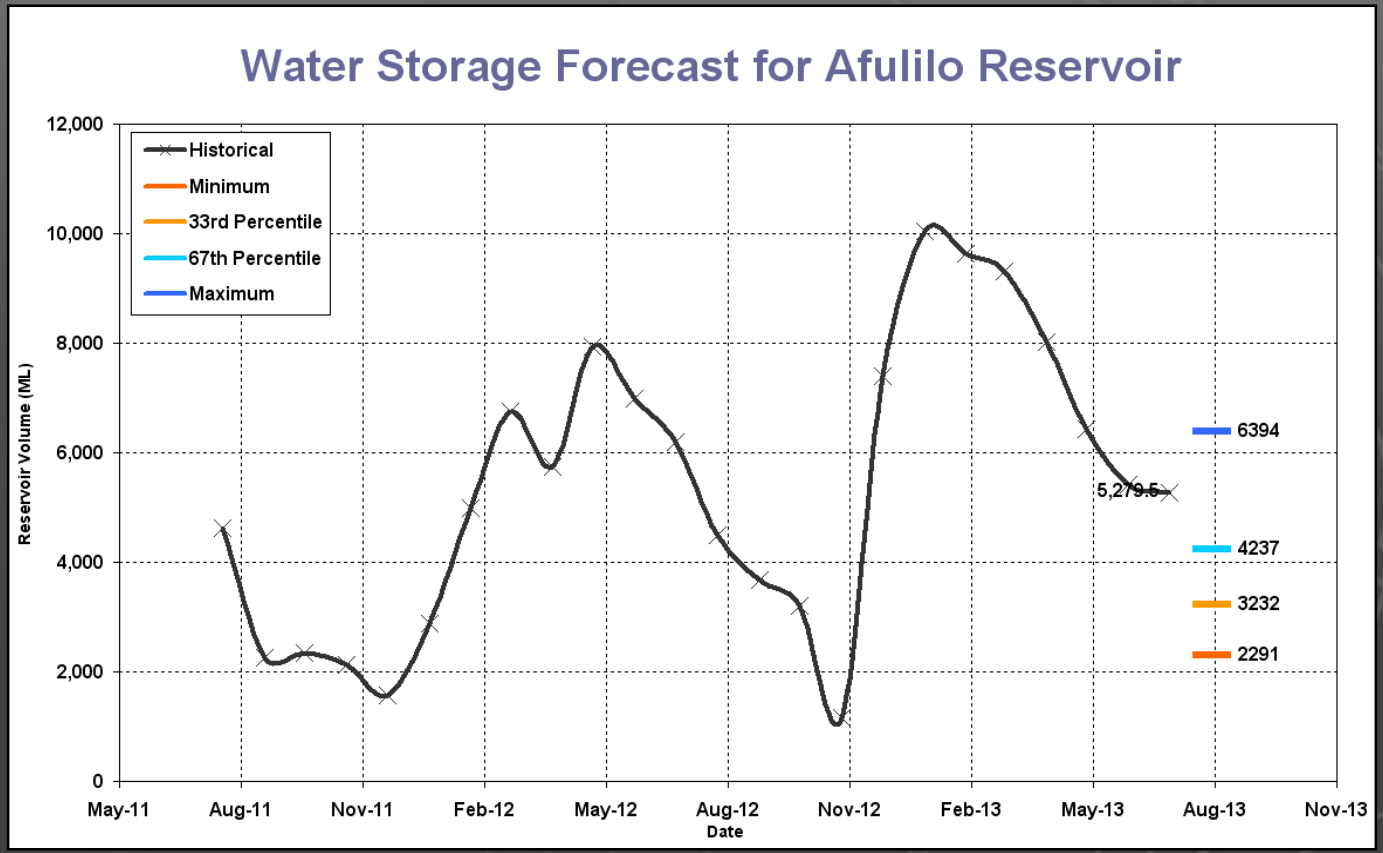
Historical variability examined



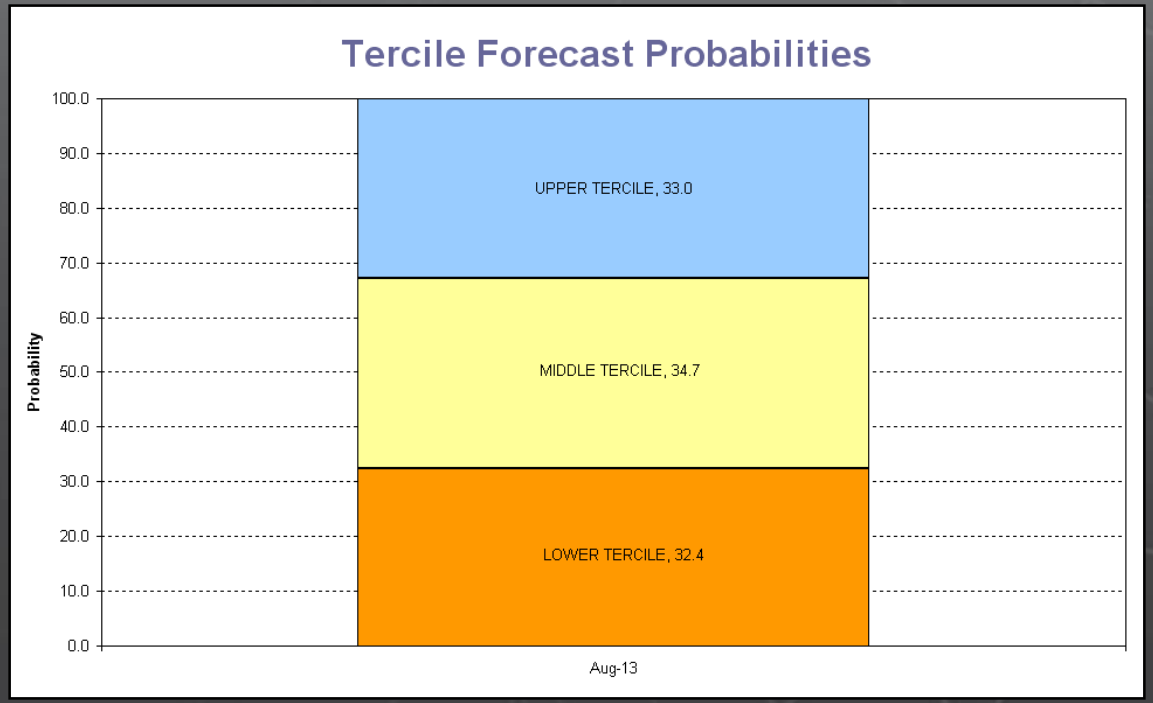
The primary purpose of calibrating a water balance model for the Afulilo Reservoir was so that this model could be used to improve the provision and utility of climate information to the EPC. The SMD currently provides seasonal (3-monthly) tercile rainfall forecasts to stakeholders. These show the percentage chance that the rainfall for the coming season will be below normal (below 33rd percentile), normal (between 33rd and 67th percentile) or above normal (above 67th percentile). Along with the rainfall forecast, the forecast also provides a measure of confidence in the form of a LEPS score, with forecasts typically being more confident in the wet season (November – April) and less confident in the dry season (May – October).

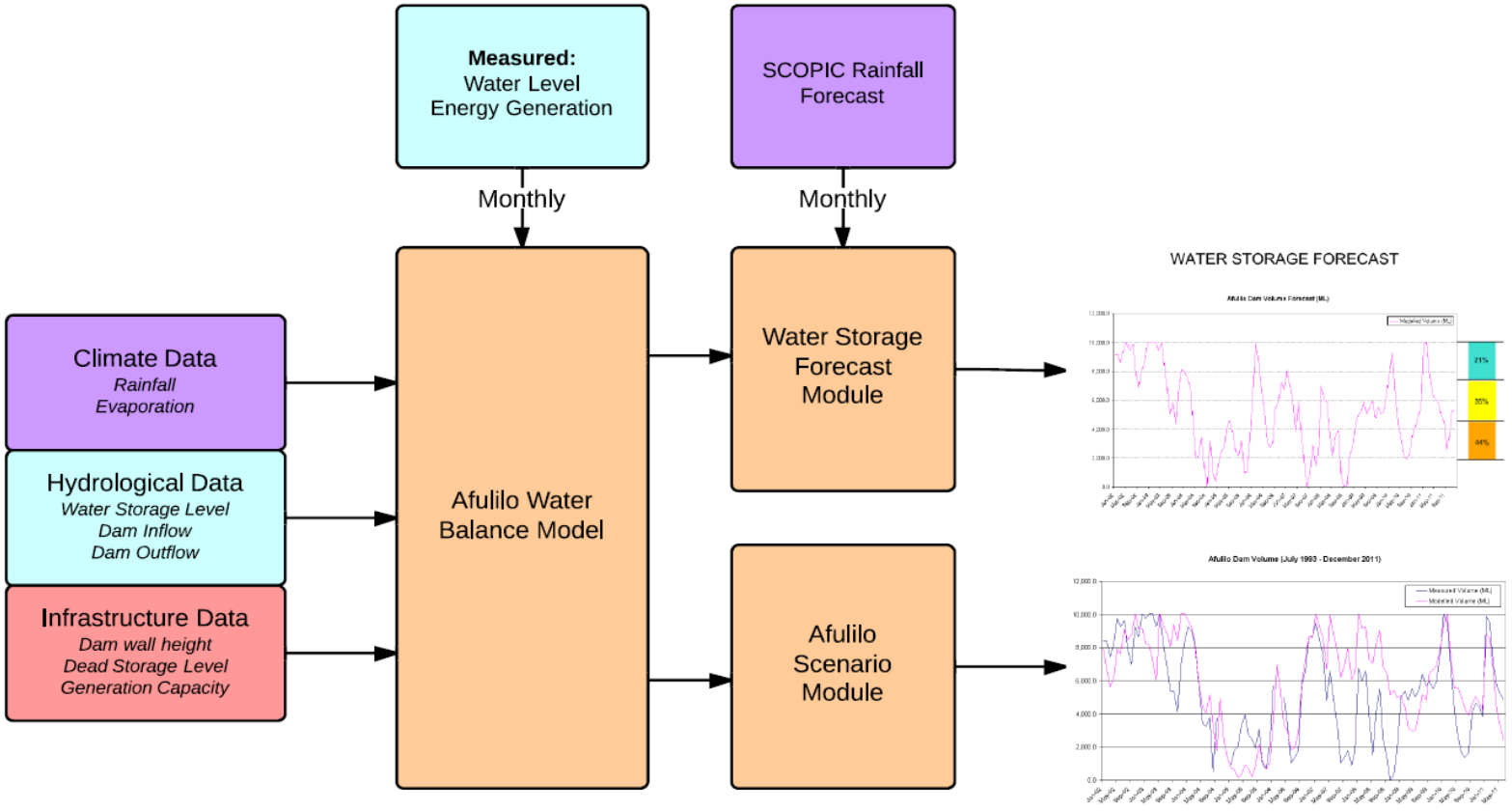
The two primary variables which effect reservoir water storage are rainfall and energy generation. Energy generation is controlled directly by energy managers at the EPC depending on generation capacity and water availability considerations, leaving rainfall as the only uncontrolled variable. Therefore, the calibrated water balance model has allowed us to quantify the response of reservoir water storage to changes in rainfall and energy generation.

Forecast for storage



No large swings




Measured:
Water Level
Energy Generation
SCOPIC Rainfall Forecast
Monthly
Monthly
Climate Data
Rainfall
Evaporation
Hydrological Data
Water Storage Level
Dam Inflow
Dam Outflow
Infrastructure Data
Dam wall height
Dead Storage Level
Generation Capacity
Afulilo Water Balance Model
Water Storage Forecast Module
Afulilo Scenario Module
WATER STORAGE FORECAST
Afulilo Dam Volume (July 1993 - December 2011)

support the future development of these new hydro-power plants", he says.

Salesa Nihmei, Climate and Meteorology Officer at the Secretariat of the Pacific Regional Environment Programme, says they now want to use the example provided by the relationship between Samoa's National Meteorological Division and EPC to demonstrate the value of investing in climate prediction services:

"We really want other interested sectors to understand there has to be an investment on both sides. If seasonal forecasting is going to deliver real value you need data from the Met Service, but you also need good data from their partner organizations. The different organizations that want to benefit from climate prediction services really need to make an investment from their side to be able to develop relevant models that will help to improve decision-making", he says.

Mr Nihmei says the real benefits of climate prediction will only start to flow when different sectors see the financial benefits and decide to commit real investment into co-developing products and services: "Once these organizations can see how they are able to save money then their managers will really be able to buy into it. The National Met Services will then be able to provide improved services because the different SIDS Governments will be able to clearly see the economic benefits", he says.

Climate Prediction for Small Island Nations

Managing risks, maximizing opportunities

World Meteorological Organization, 2016 **WMO-No. 1171**

http://public.wmo.int/en/resources/library/climate-prediction-small-island-nations-managing-risks-maximizing-opportunities

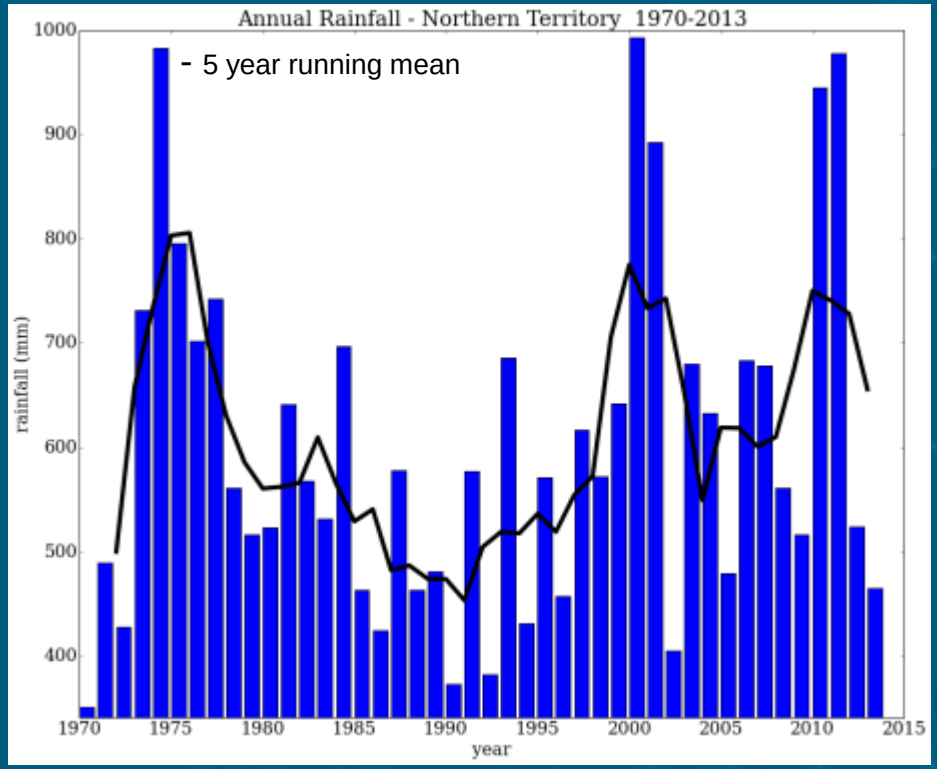
Stakeholder engagement could simply be a regular briefing

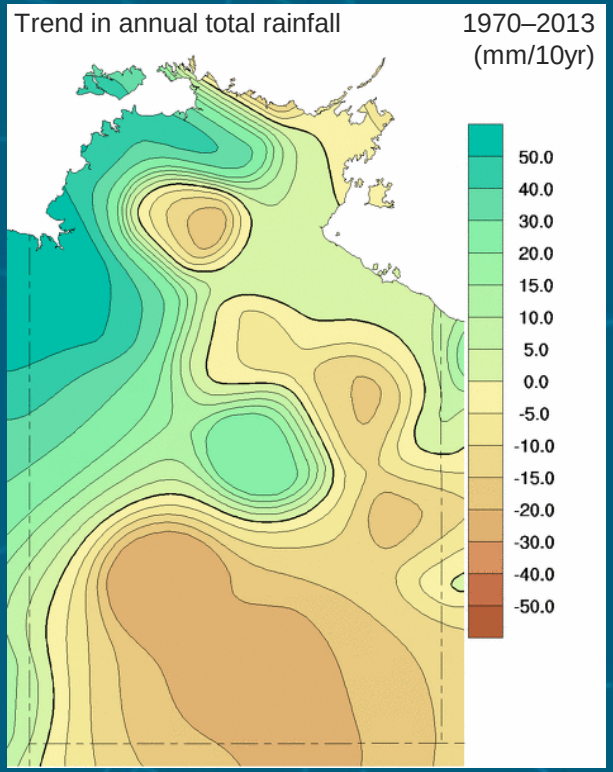
The following information is a briefing on the 2014-2015 Wet Season rainfall outlook that was given to a stakeholder in Northern Australia.

Includes:

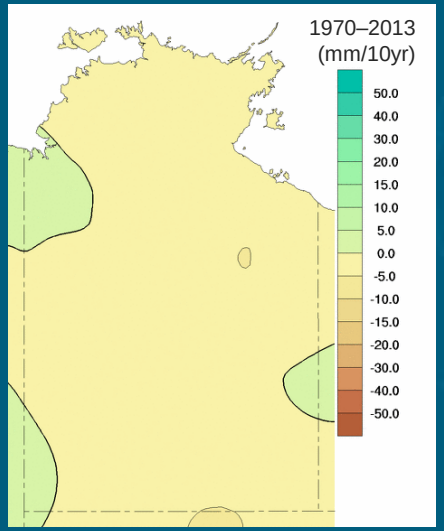
- Observations and past examples including for a nearby station
- Education on climate and climate drivers for the region
- An outlook

last 40 years do not show consistent trend

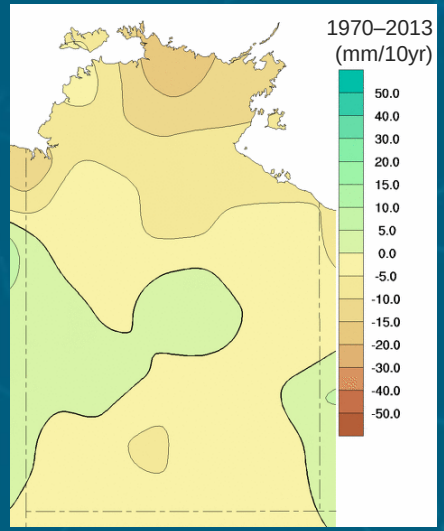




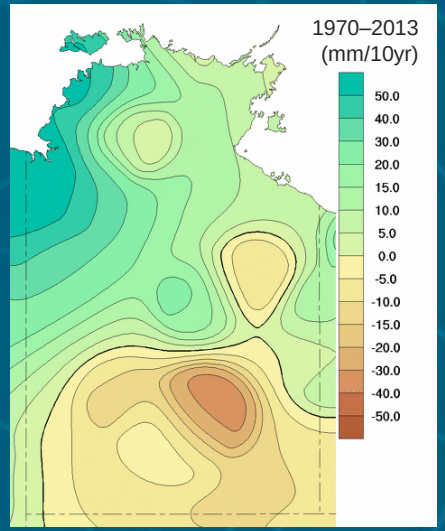
How has seasonal rainfall pattern changed over last 40 years?



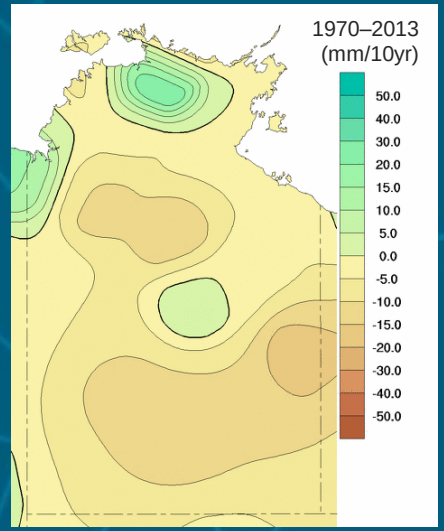
Dry season (Jun–Aug)



Build-up (Sep–Nov)



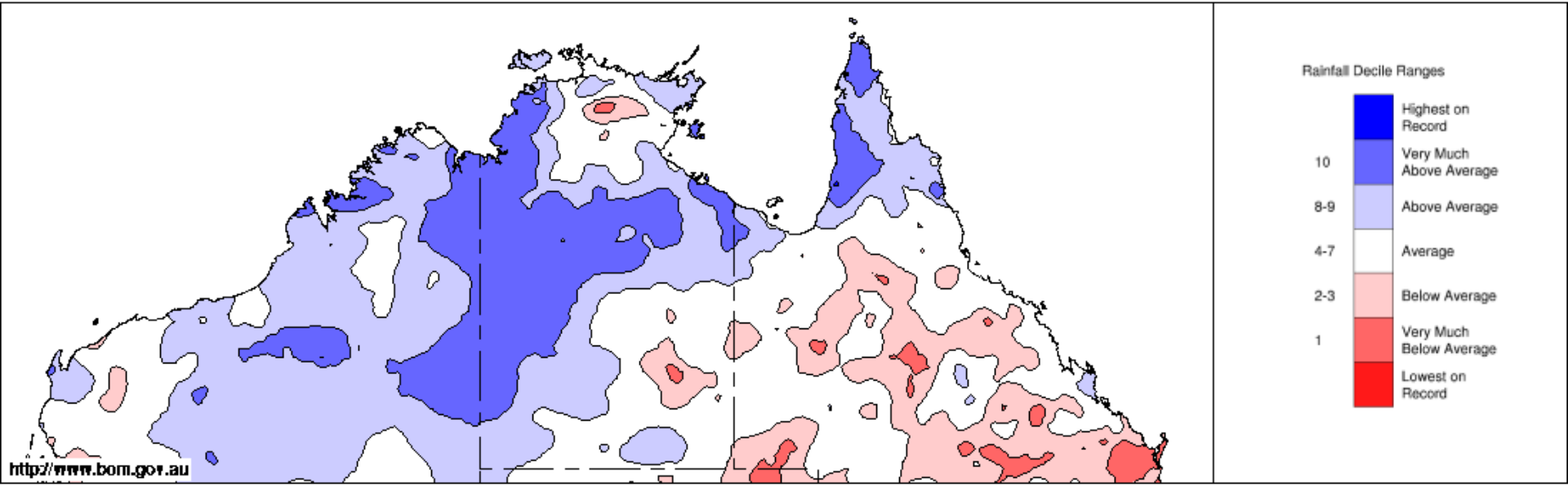
Wet season (Dec–Feb)



End of wet (Mar–May)

Rainfall Deciles (AWA grids 1900-pres.) 1 October 2013 to 30 April 2014

Distribution Based on Gridded Data
Product of the National Climate Centre



 ID code: IGMapAWAPDeciles Issued: 22/10/2014

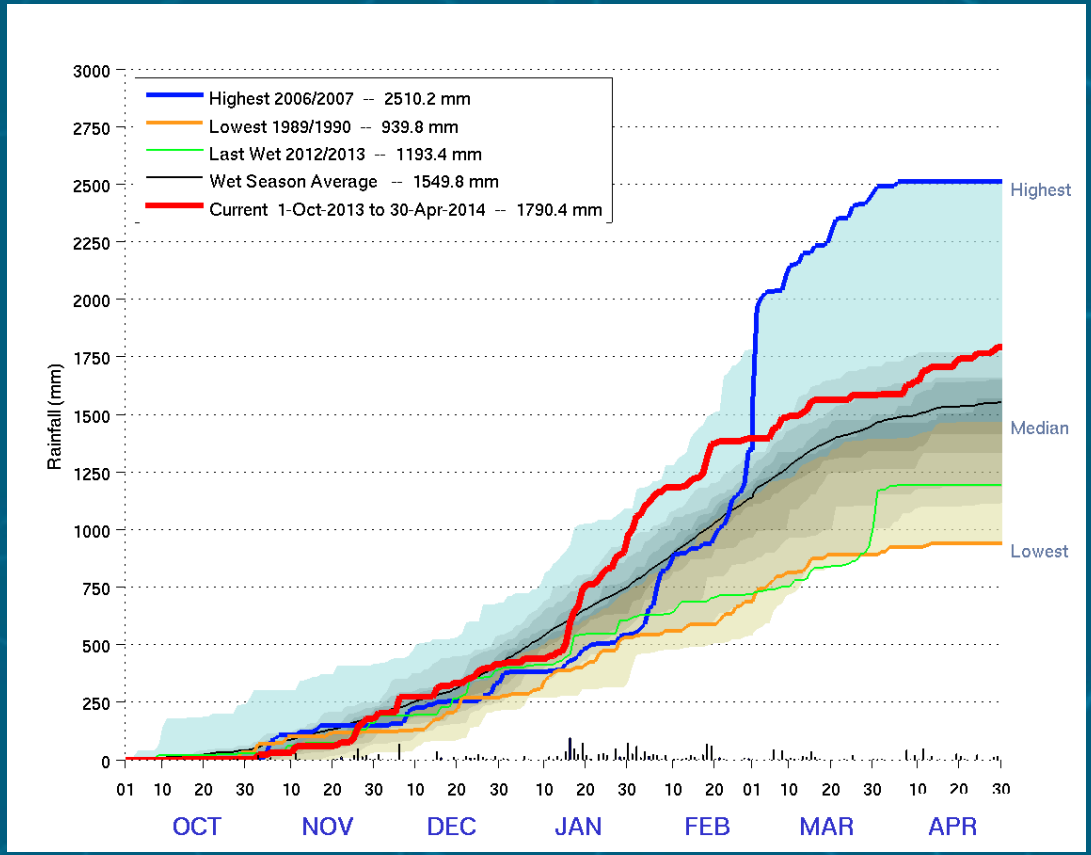
2013–2014 wet season at a Northern Australian Station

1790.4 mm total rainfall

240.6 mm above average

Dominated by 5 weeks of monsoon

- 13 January to 20 February



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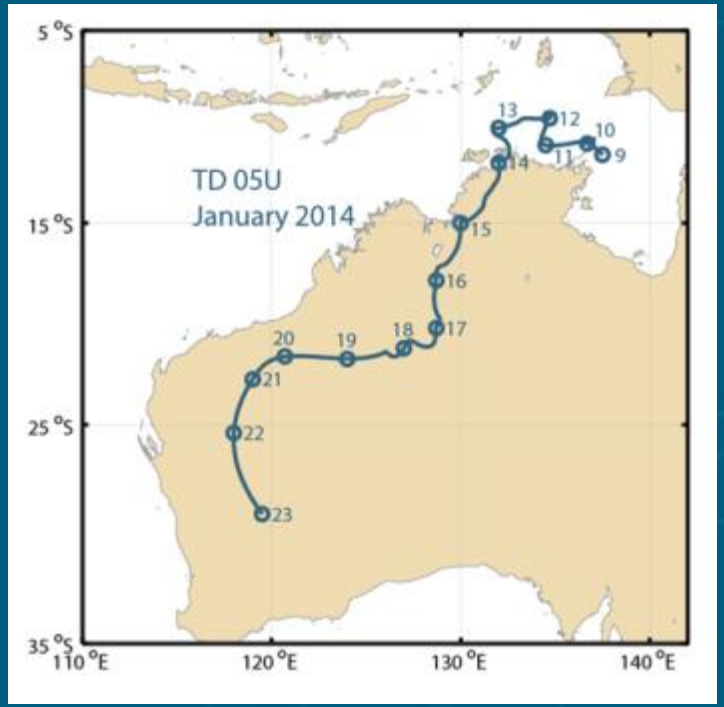
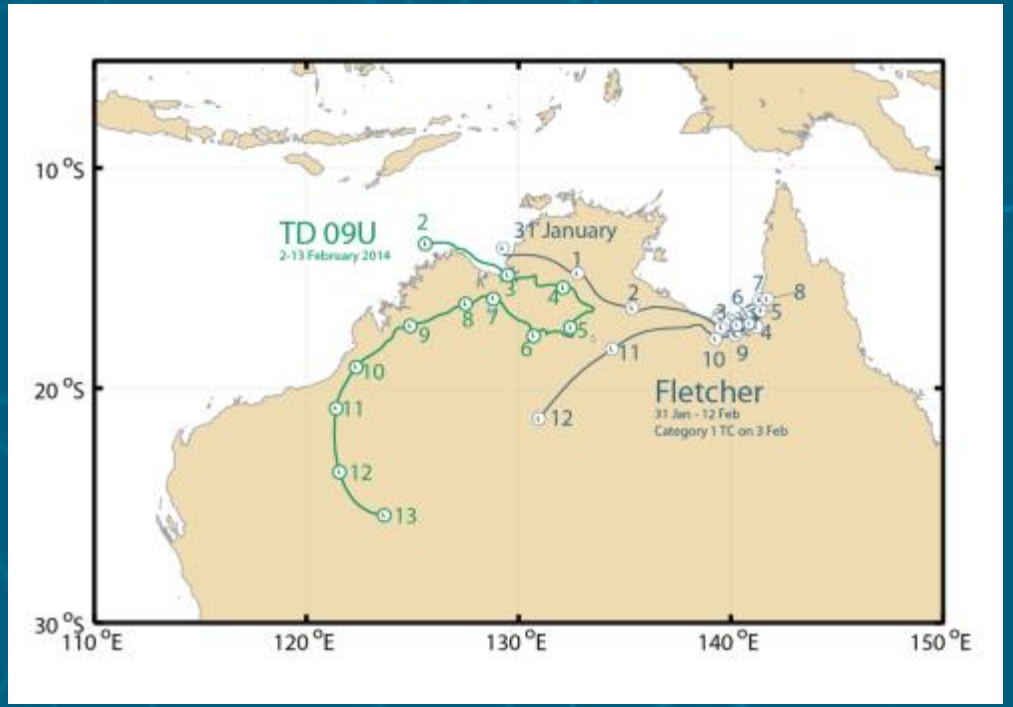
Tropical cyclones 2014-15





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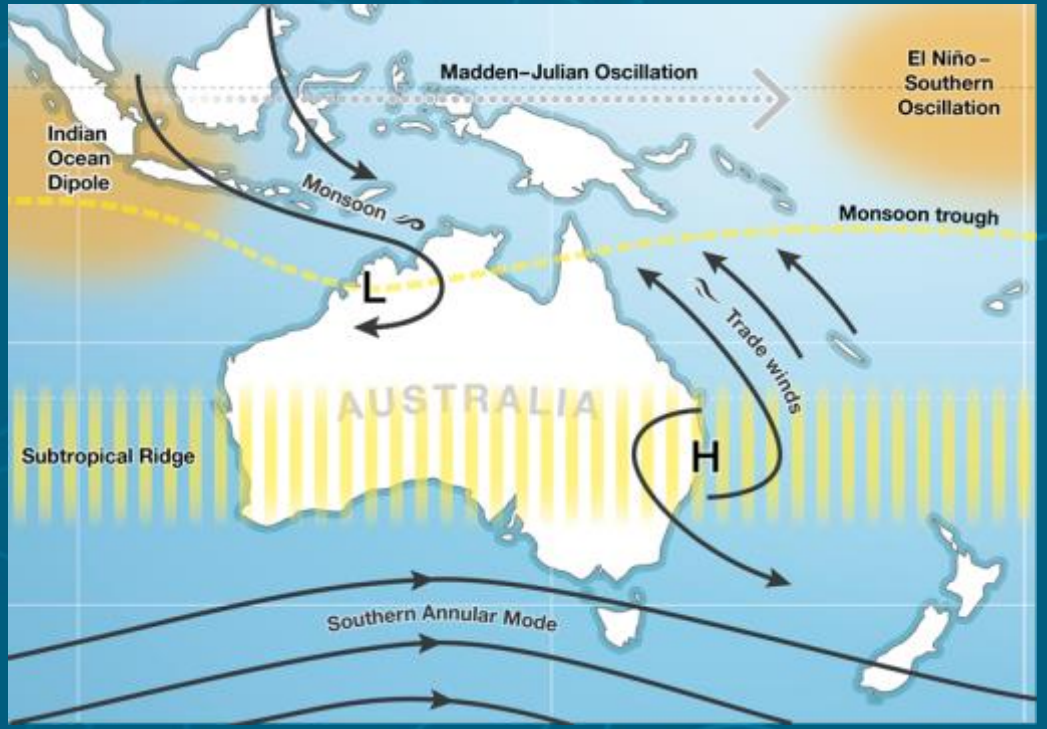
What drives wet season rainfall variability?

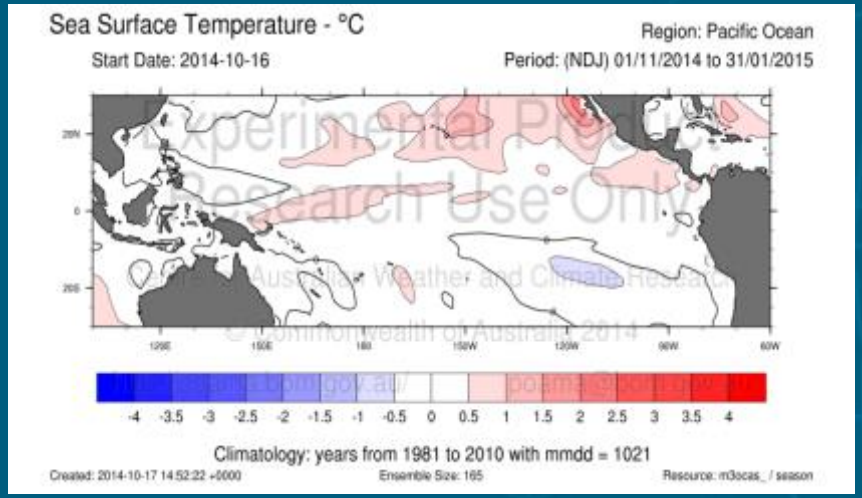
Weekly time scales
- Strength and position of monsoon trough
- Tropical cyclones

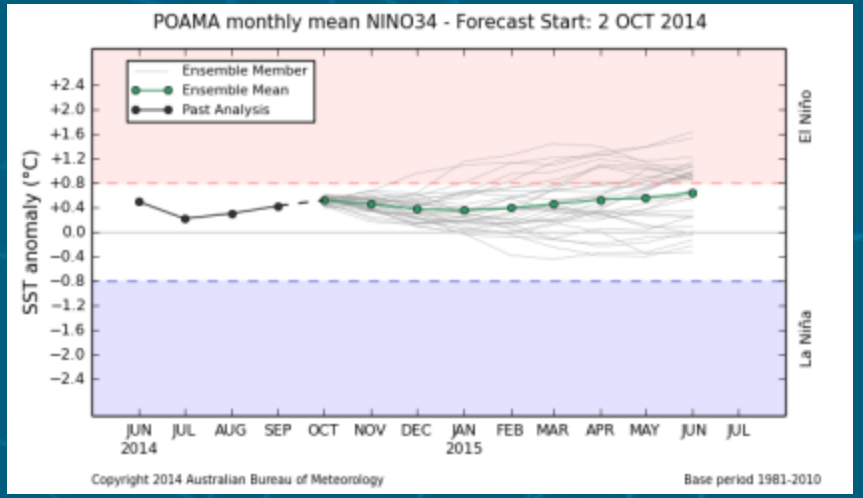
Multi-weekly to monthly
- Madden–Julian Oscillation

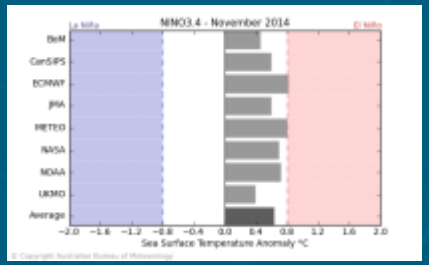
Multi-monthly to seasonal
- Indian Ocean Dipole
- El Niño–Southern Oscillation

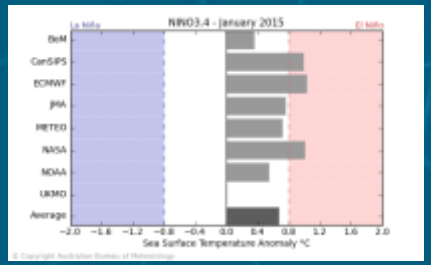


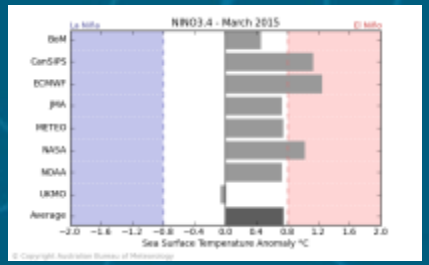
ENSO forecasts











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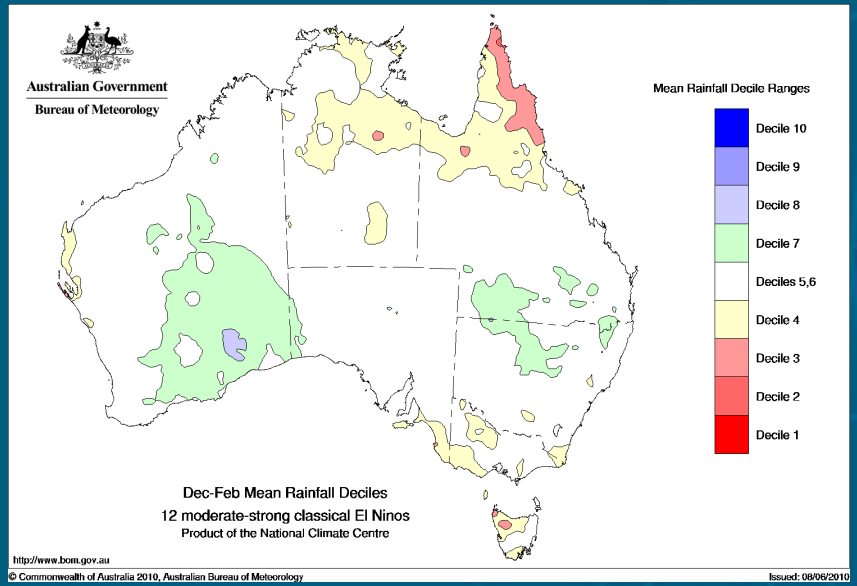
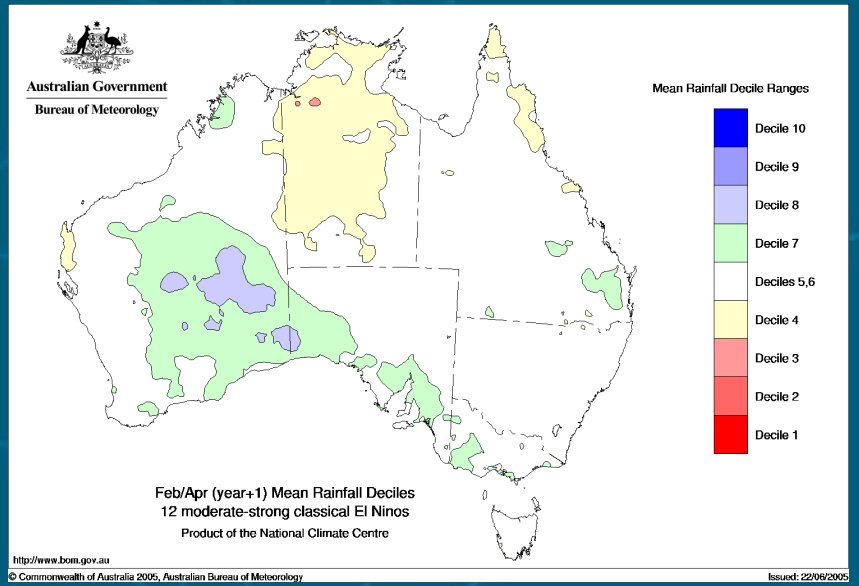
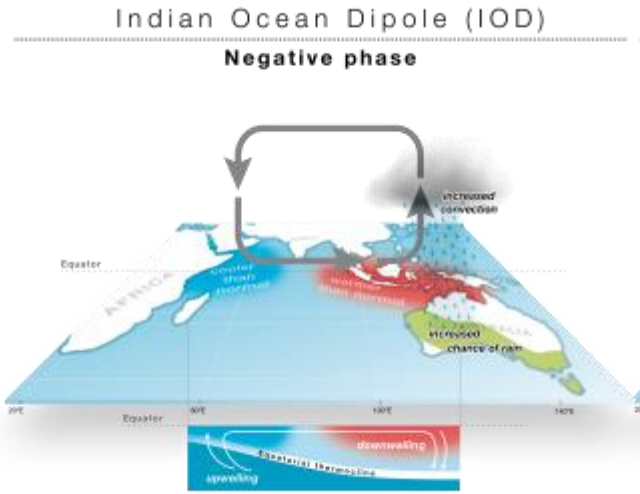
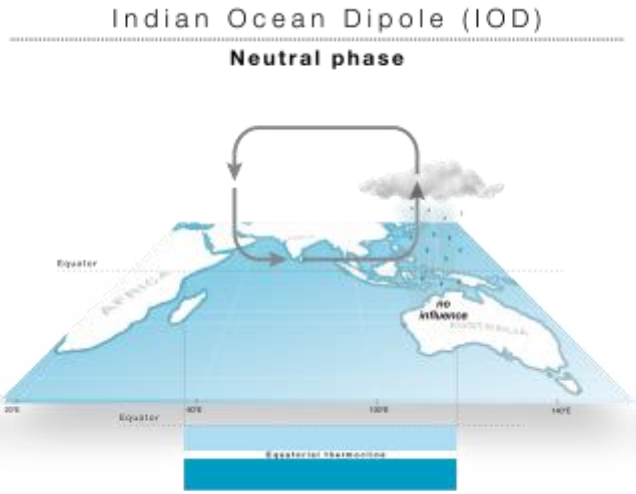
Impacts of El Niño

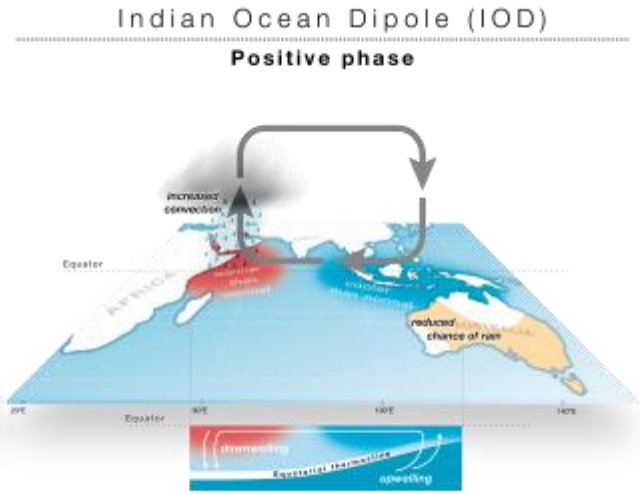




What is the Indian Ocean Dipole?

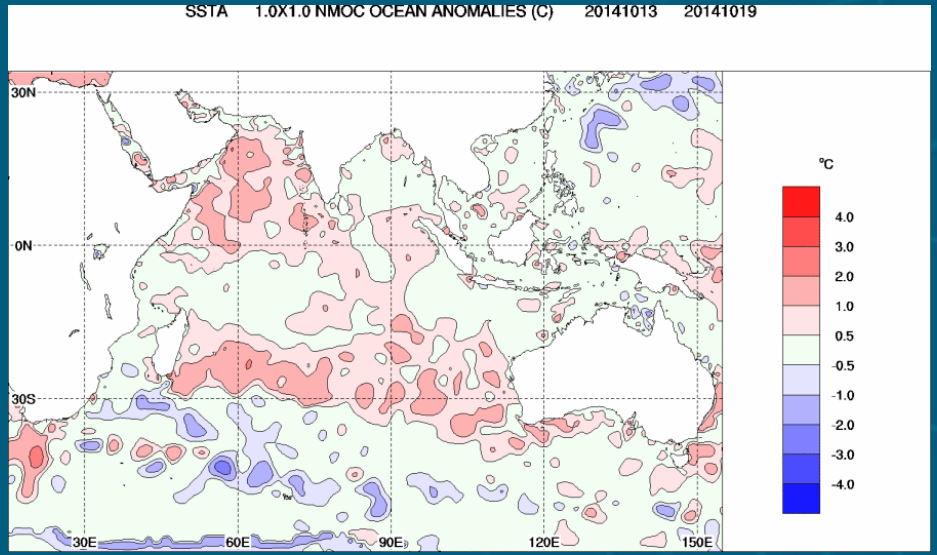




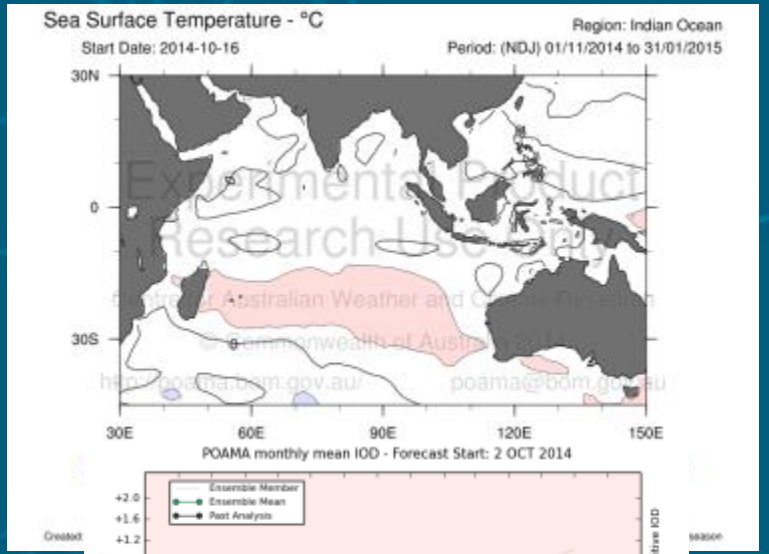


Indian Ocean

Current Conditions



forecast



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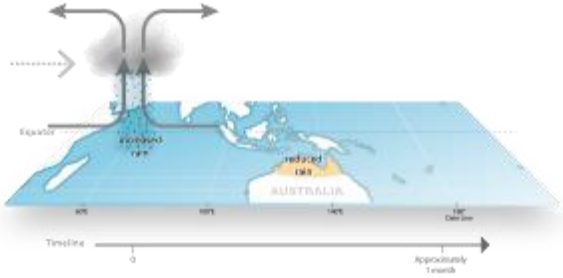
What is the Madden–Julian Oscillation?

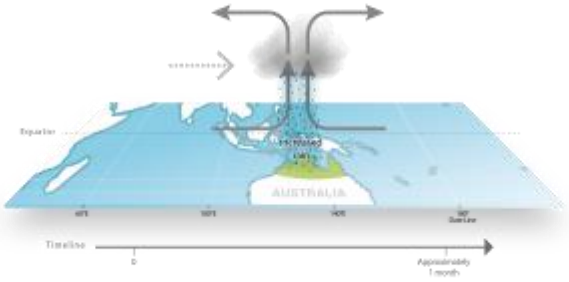
Madden–Julian Oscillation (MJO)

Example cycle: Week 1



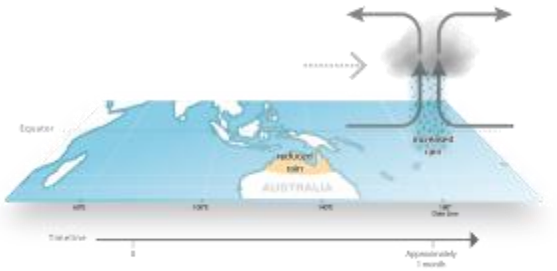
Madden–Julian Oscillation (MJO)

Example cycle: Week 2-3

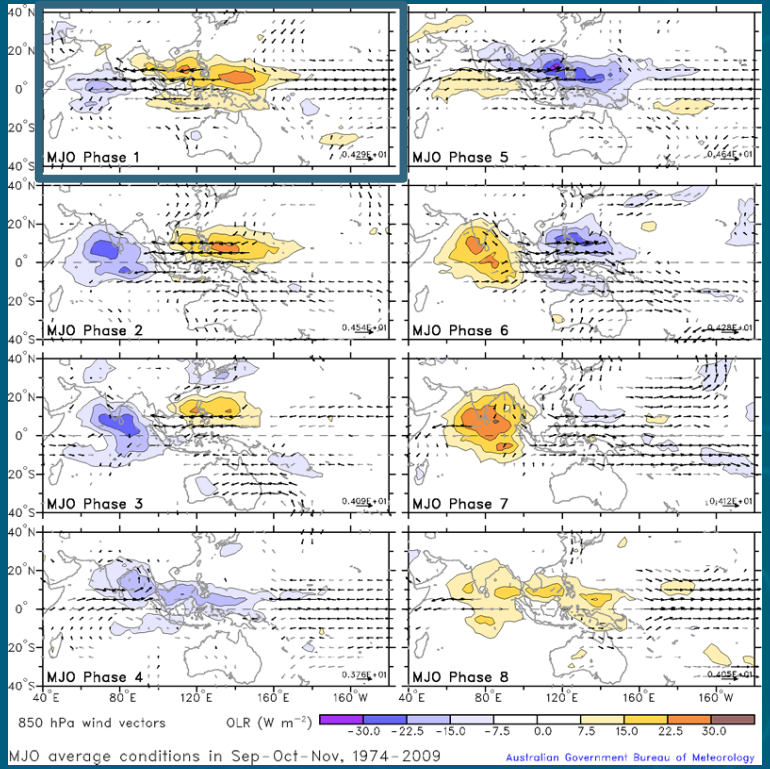


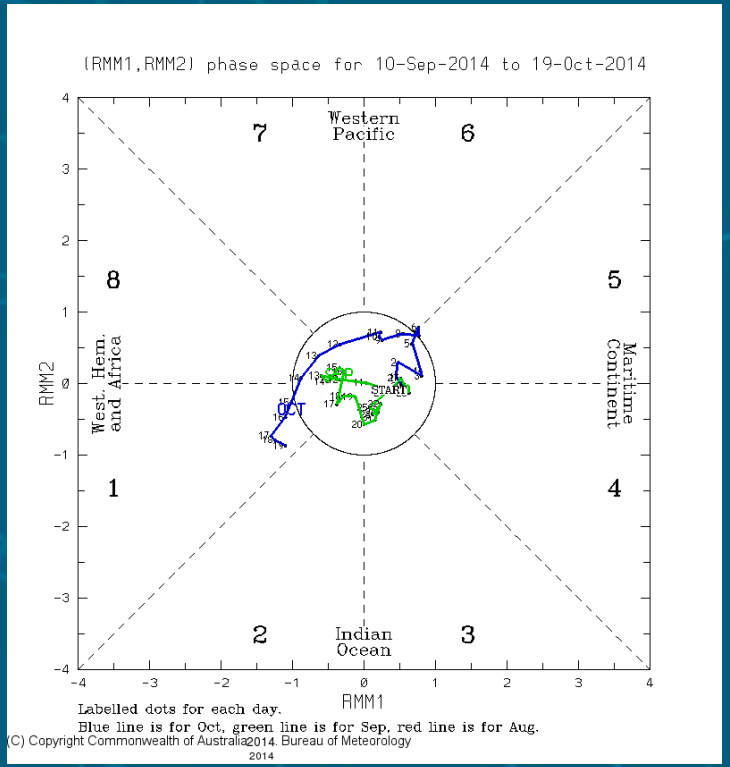
Madden–Julian Oscillation (MJO)

Example cycle: Week 4-5



Current Conditions





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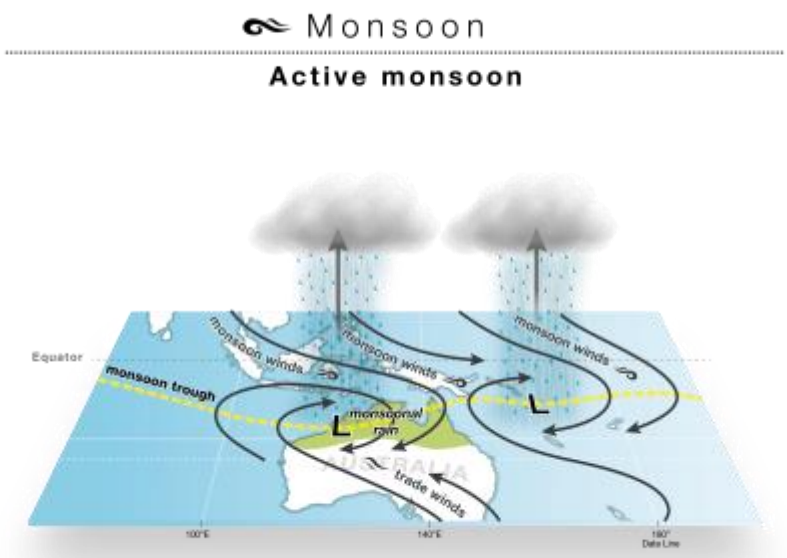
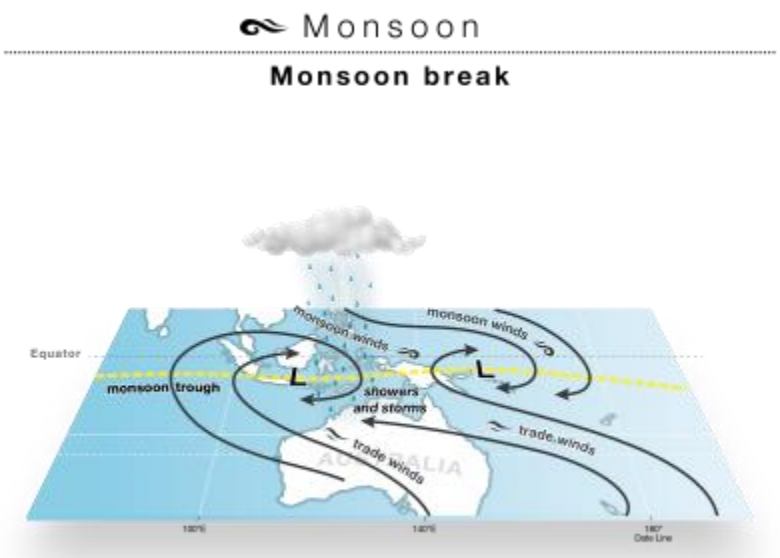
Bureau of Meteorology

North Australian Monsoon





Tropical Cyclone outlook
Northern Australia

- Average cyclone activity expected
  - Average = 2-3 tropical cyclones
    - » 1 coastal crossing
  - Most = 5 tropical cyclones
  - Fewest = 0 tropical cyclones

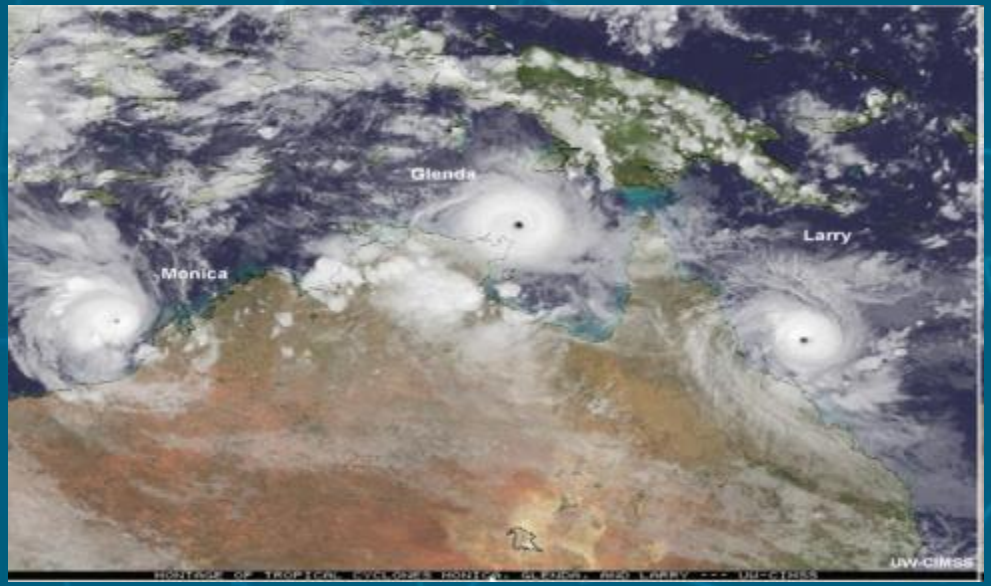
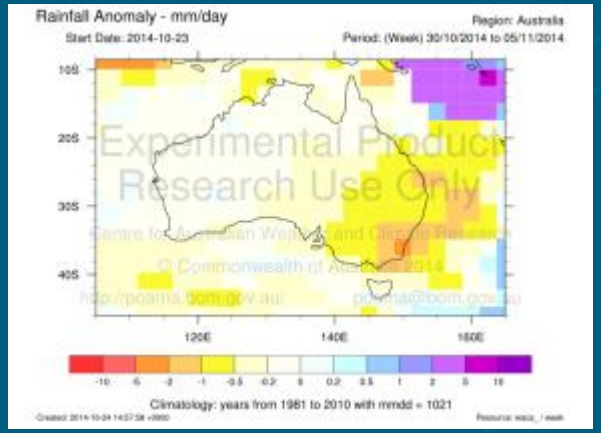
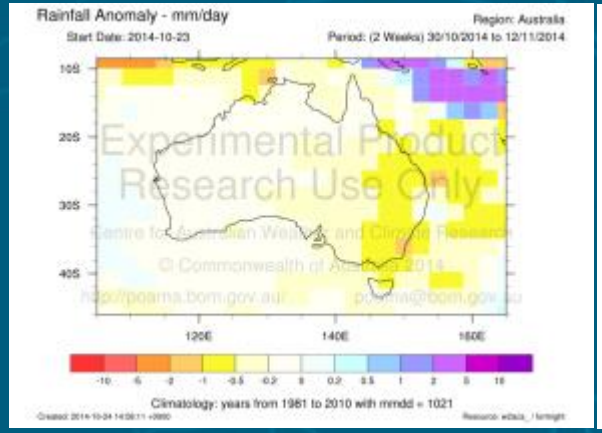
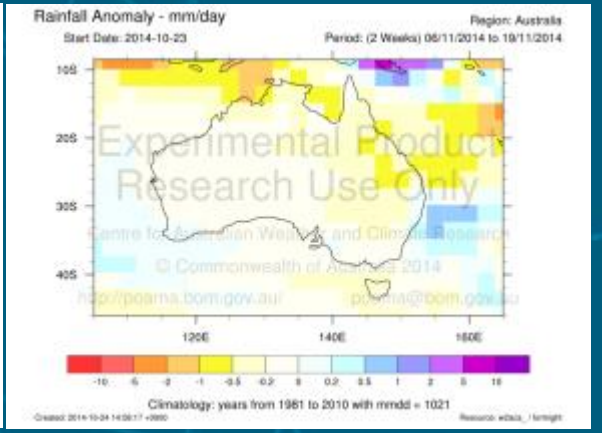


Image created by C. Velden and T. Olander (CIMSS/University of Wisconsin)

Multi-week rainfall forecast

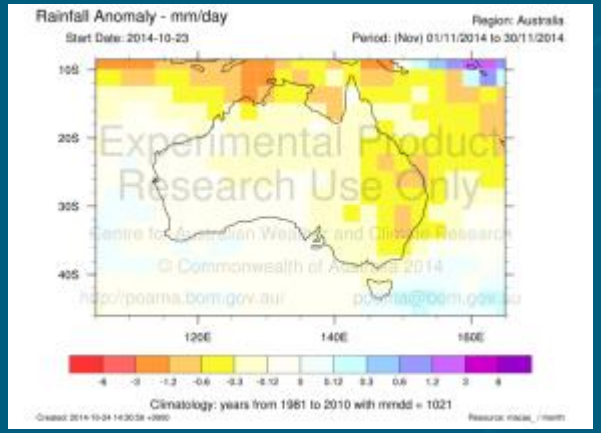


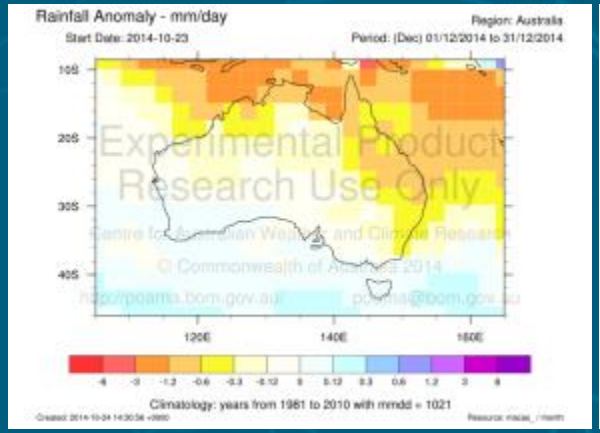




Australian Government
Bureau of Meteorology

Monthly


Rainfall Anomaly - mm/day
Region: Australia
Start Date: 2014-10-23
Period: (Nov) 01/11/2014 to 30/11/2014
10S
20S
30S
40S
120E
140E
160E
Experimental Product
Research Use Only
Climatology: years from 1981 to 2010 with mmdd = 1021


Rainfall Anomaly - mm/day
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10S
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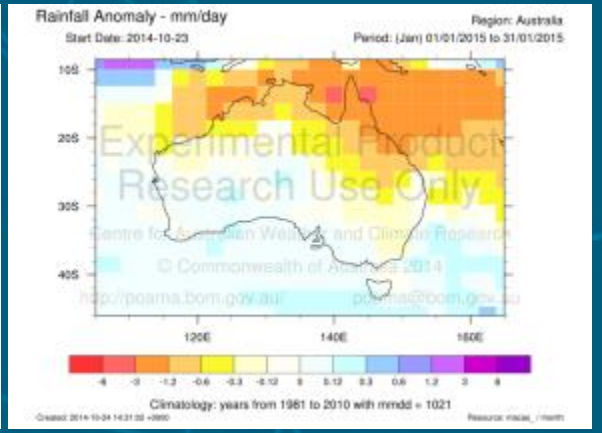
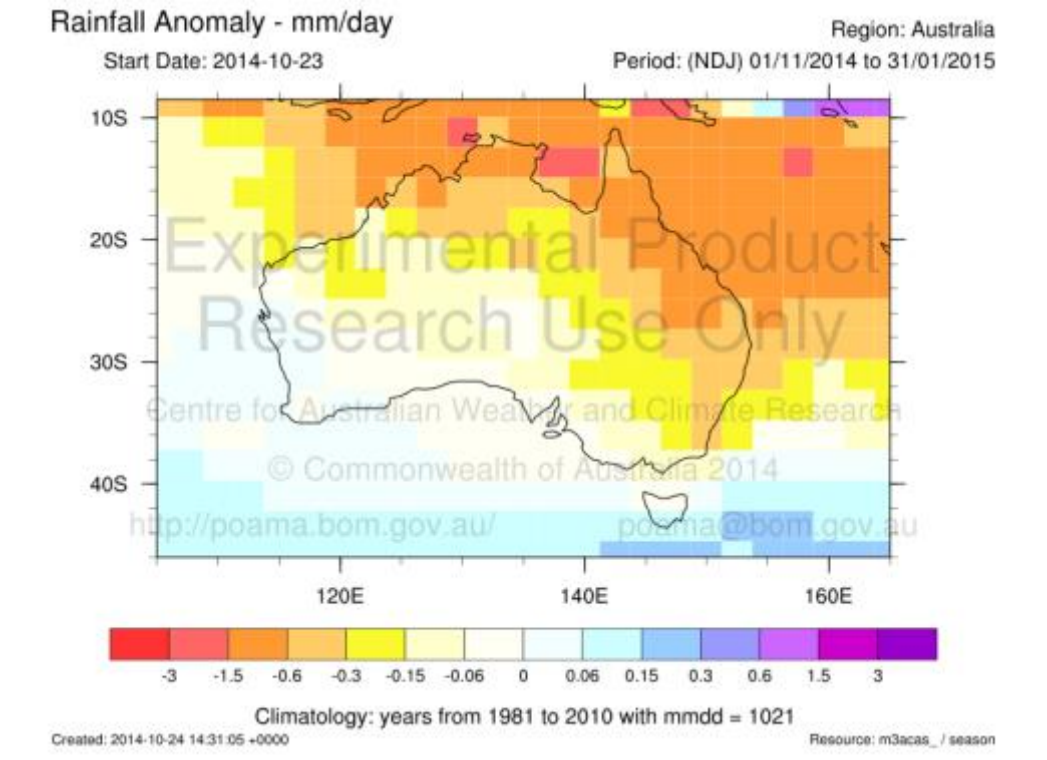

Rainfall Anomaly - mm/day
Region: Australia
Start Date: 2014-10-23
Period: (Jan) 01/01/2015 to 31/01/2015
10S
20S
30S
40S
120E
140E
160E
Experimental Product
Research Use Only
Climatology: years from 1981 to 2010 with mmdd = 1021

Seasonal Climate Outlook

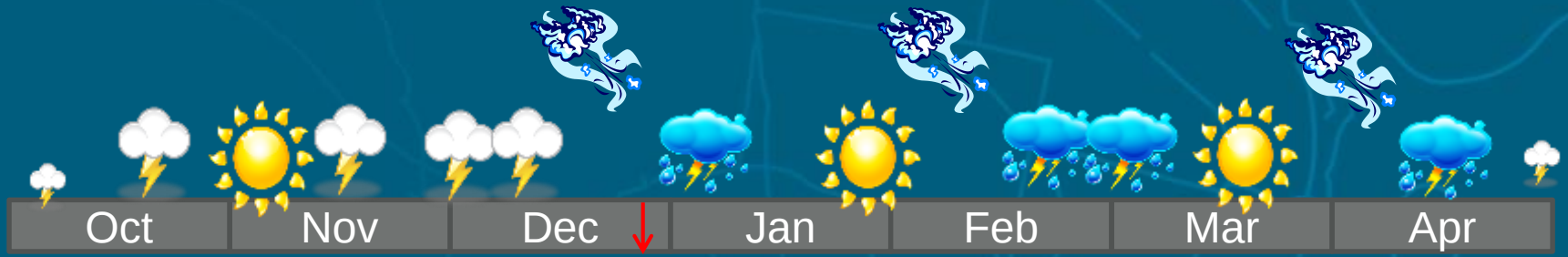


A typical wet season

Build-up period: October–December
Hot, humid
Isolated thunderstorms

First onset of the monsoon usually in late December

Burst (active) and break (inactive) periods can last from a few days to a few weeks



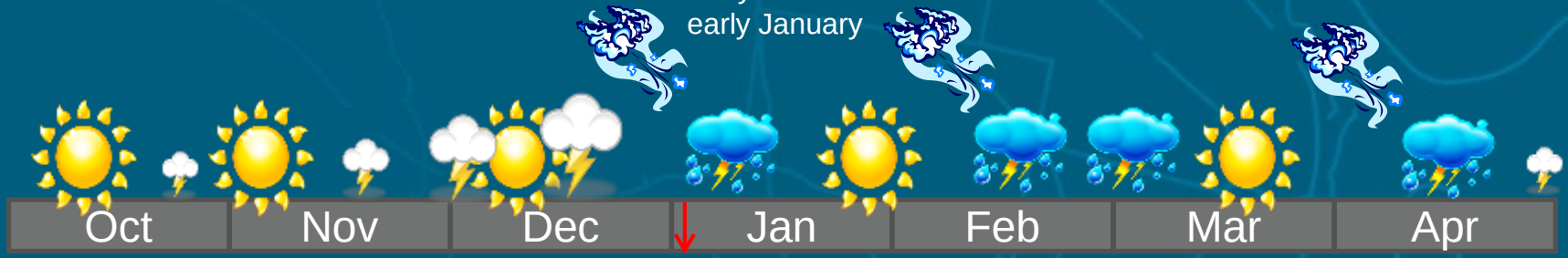
Overview of likely conditions for wet season 2014-15

Less rainfall than normal for the build-up months.

Monsoon onset anytime between mid-December and mid-January.

likely to be in early January

Typical wet season conditions are most likely for the second half of the wet season



Thank you

Questions?