Climate Information Services at the Australian Bureau of Meteorology

Australian Government
Bureau of Meteorology

Climate Information Services
Australian Bureau of Meteorology

Yuriy Kuleshov

Australian Government
Bureau of Meteorology

Outline

- GFCS: capacity development of climate information services
- Climate information services at the Australian Bureau of Meteorology:
  - Climate Monitoring
  - Climate Prediction

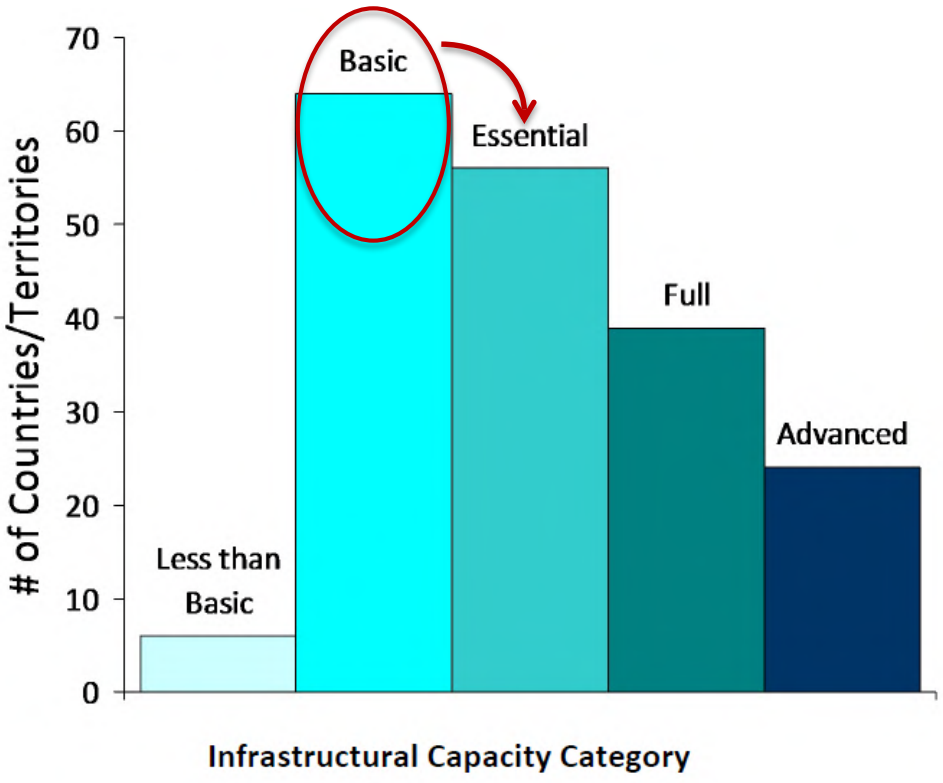
Australian Government
Bureau of Meteorology

GFCS – Capacity Development

Types of climate products and services by category of national climate service provider

Australian Government
Bureau of Meteorology

GFCS – Capacity Development



Profile of national climate service providers as a function of category, October 2010

The target for the first phase of GFCS is to increase the number of countries having access to Essential Climate Services by moving the peak from Basic to Essential.

Australian Government
Bureau of Meteorology

Climate Information Services at the Australian Bureau of Meteorology

Climate Monitoring

Australian Government
Bureau of Meteorology

Climate Data

Australian Government
Bureau of Meteorology

Climate Data – ACORN-SAT

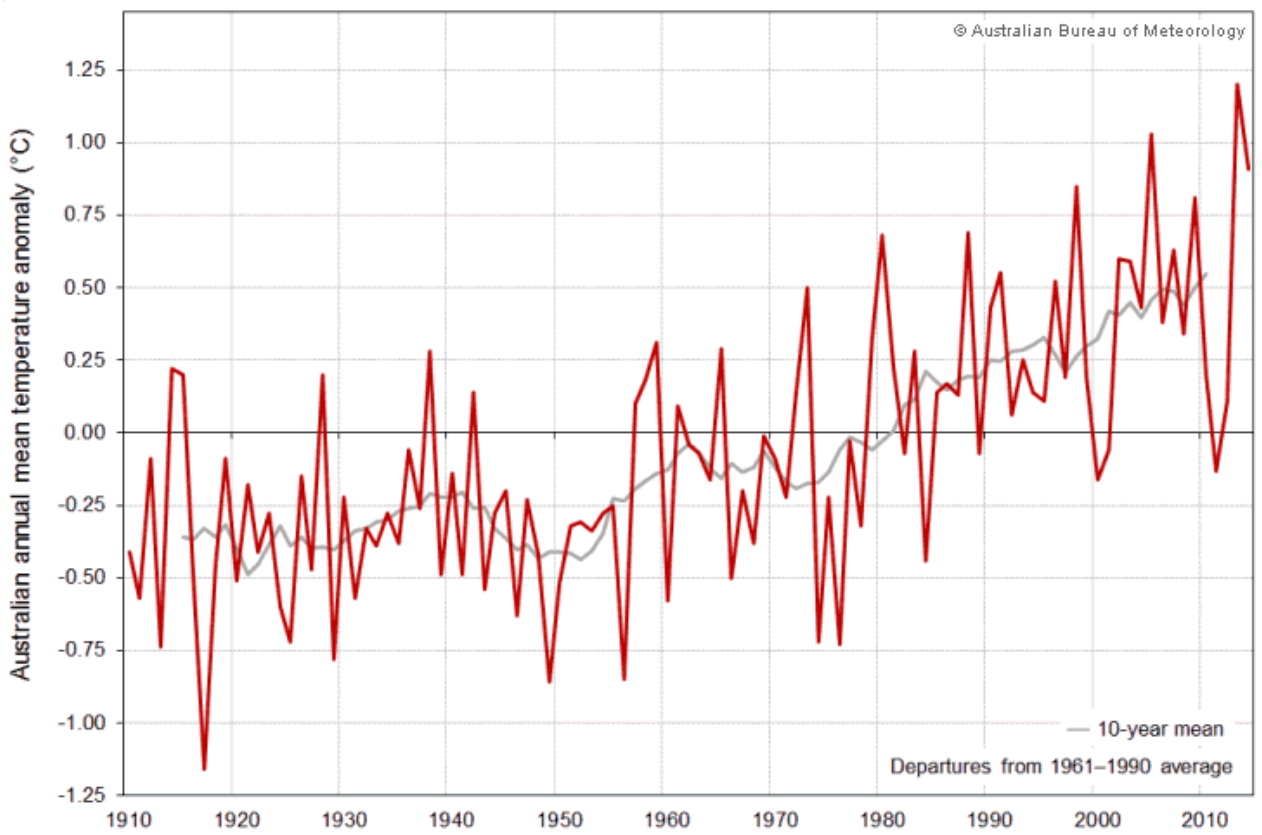
The locations are chosen to maximise the length of record and network coverage across the country. Combined, these stations hold over 100 years of records.

The Australian Climate Observations Reference Network – Surface Air Temperature (ACORN-SAT) dataset has been developed to monitor climate variability and change in Australia.

The ACORN-SAT dataset includes data from 112 locations across Australia which provide homogenised, ground-based temperature records.

Australian Government
Bureau of Meteorology

Climate Data – ACORN-SAT



Annual mean temperature anomalies for Australia (red) with 10-year mean (light grey). Departures are from the 1960–1990 average.

The data is robust and comparable through time, which will enable climate researchers to better understand long-term changes in monthly and seasonal climate, as well as changes in day-to-day weather, such as the frequency of heat and cold extremes.

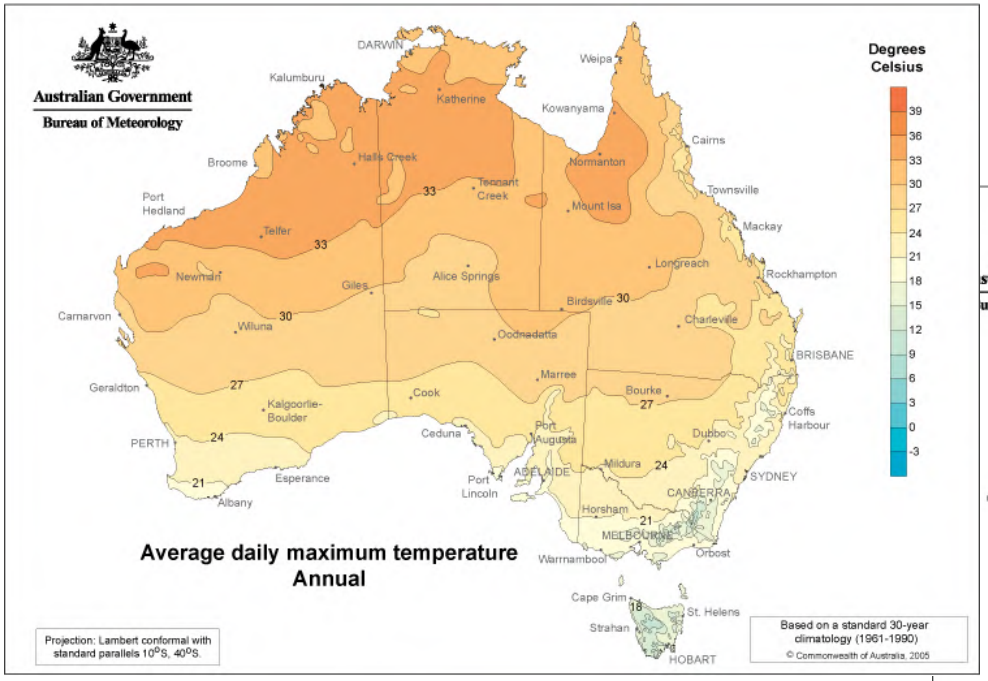
Australian Government
Bureau of Meteorology

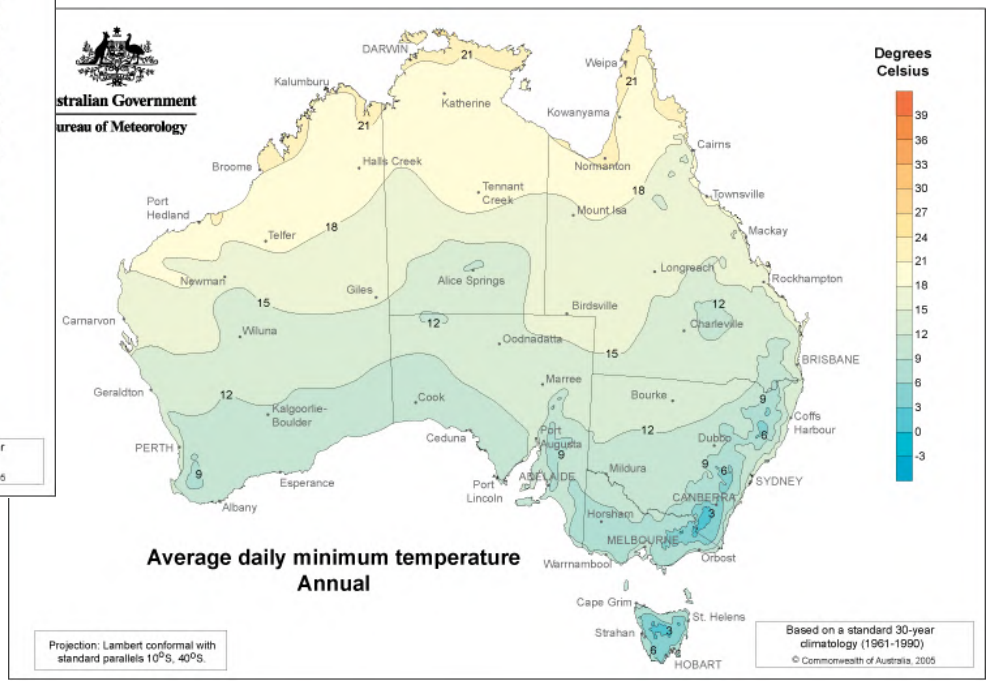
Climate Data – ACORN-SAT

- The ACORN-SAT dataset reaffirms climate trends identified previously by the Bureau.
- The new data show that Australia has warmed by approximately one degree since 1910. The warming has occurred mostly since 1950.
- The frequency of daily temperature extremes has also changed since 1910. The number of weather stations recording very warm night-time temperatures and the frequency with which these occur has increased since the mid 1970s. The rate of very hot daytime temperatures has been increasing since the 1990s.
- The warming in the ACORN-SAT dataset is very similar to that shown in international analyses of Australian temperature data and very closely matches satellite data and warming of sea surface temperatures around Australia. This agreement provides added confidence for decision makers, and reinforces our understanding of the changing climate.

Australian Government
Bureau of Meteorology

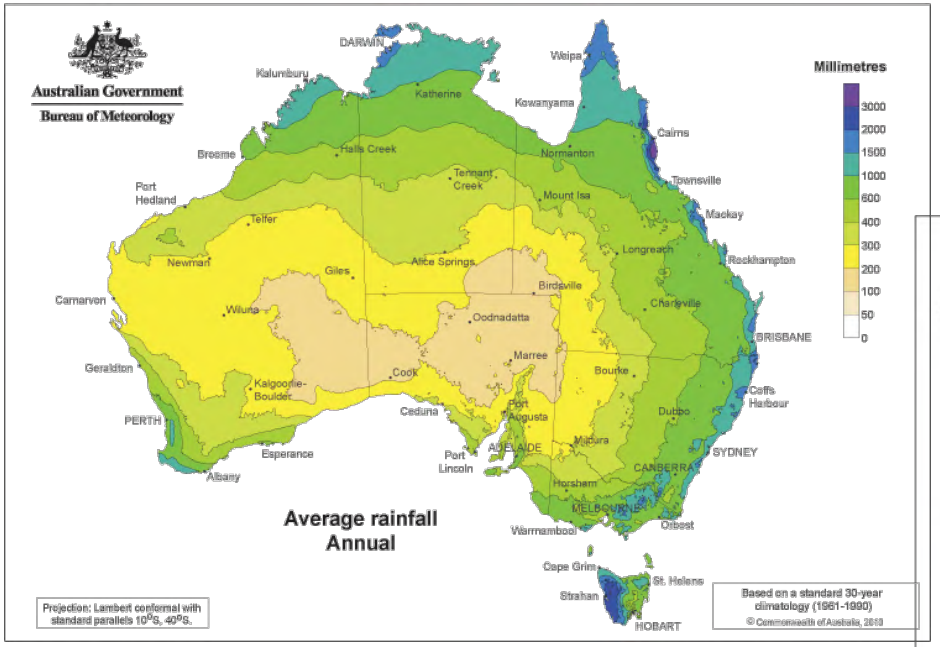
Maps – Average Conditions
Temperature

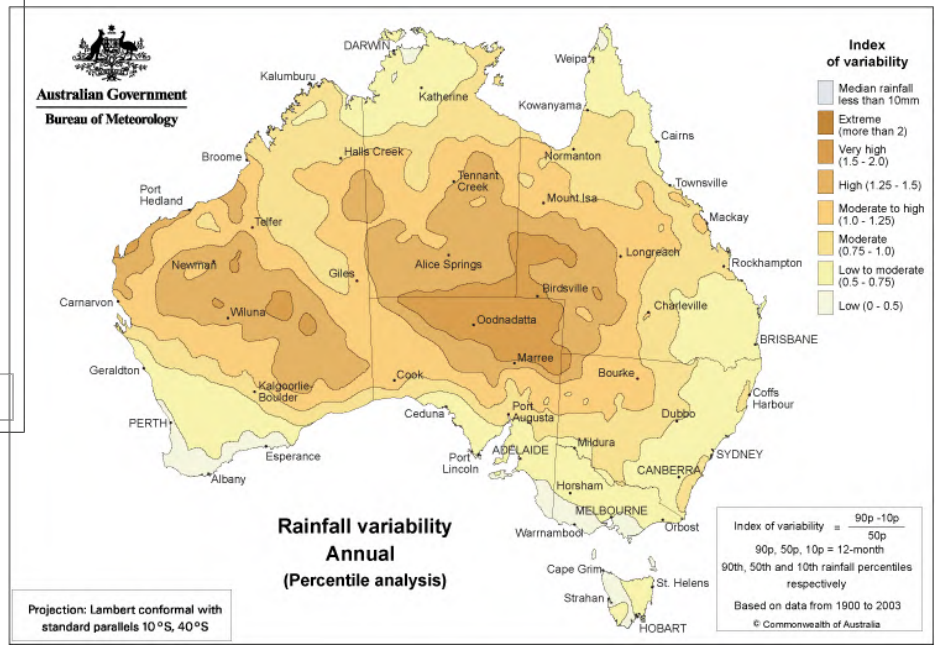




Australian Government
Bureau of Meteorology

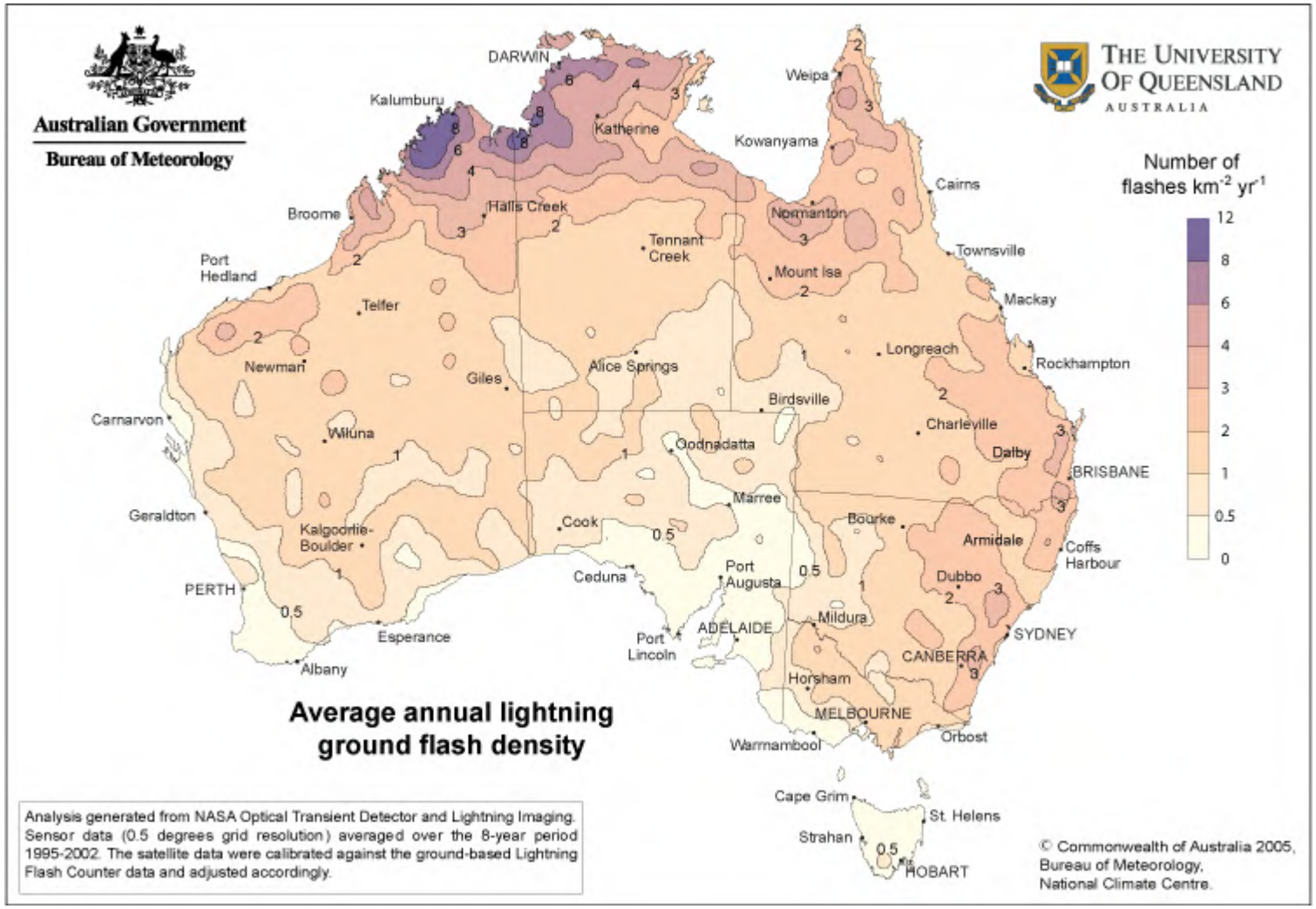
Maps – Average Conditions
Rainfall





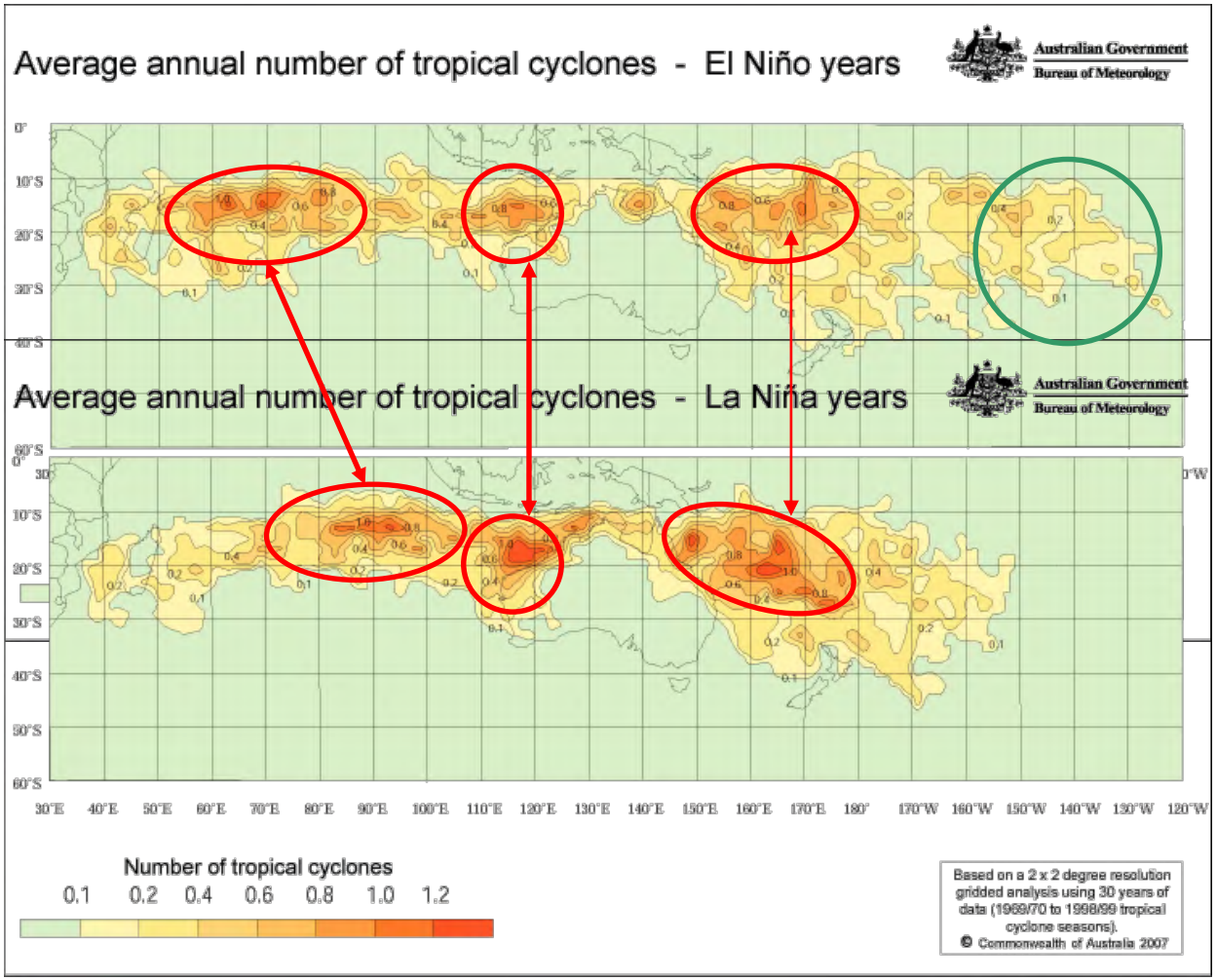
Australian Government
Bureau of Meteorology

Maps – Average Conditions
Lightning



Australian Government
Bureau of Meteorology

Maps – Average Conditions
Tropical Cyclones



Australian Government
Bureau of Meteorology

Climate Information Services at the Australian Bureau of Meteorology

Climate Prediction

Australian Government
Bureau of Meteorology

Climate Information Services at the Australian Bureau of Meteorology

Climate Outlooks

Climate Outlooks:
www.bom.gov.au/climate/outlooks

Monthly Climate Outlook video:
A fresh look …

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

Australian Governn
Bureau of Meteorolo

LA NIÑA IN AUSTRALIA

SPOTTING LA NIÑA

TEMPERATURES
in the tropical Pacific Ocean cool, both at the surface and below

SURFACE PRESSURE
changes across the Pacific; higher in the east, lower in the west

TRADE WINDS
are much stronger than normal

CLOUD
decreases near the Date Line

TYPICAL IMPACTS ON OUR CLIMATE

RAINFALL **INCREASES** IN EASTERN, CENTRAL AND NORTHERN AUSTRALIA

TEMPERATURE **DECREASES** SOUTH OF THE TROPICS (DAYTIME TEMPERATURES)

OTHER IMPACTS

- **MORE** TROPICAL CYCLONES
- **INCREASED CHANCE** OF WIDESPREAD FLOODING
- **LONGER DURATION** HEATWAVES IN SOUTHEAST, BUT LESS INTENSE
- **EARLIER** FIRST RAINS ACROSS NORTHERN AUSTRALIA
- **INCREASED CHANCE** OF INDIAN OCEAN HEATWAVES

WHEN DO THEY OCCUR?

USUALLY LA NIÑA DEVELOPS IN **AUTUMN OR WINTER** AND FINISHES THE FOLLOWING AUTUMN

HALF OF ALL LA NIÑA EVENTS HAVE LASTED FOR **2 OR 3 YEARS**

ON AVERAGE THEY OCCUR EVERY **3 TO 7 YEARS**

40% OF **EL NIÑO** EVENTS ARE FOLLOWED BY LA NIÑA

THE 2010–12 LA NIÑA SAW A **5 MM DROP IN GLOBAL SEA LEVEL** AS MORE EVAPORATED SEA WATER RAINED OVER LAND THAN NORMAL

EVERY LA NIÑA IS DIFFERENT

LA NIÑA WINTER AND SPRING RAINFALL

1938

1973

RED = DRIER THAN NORMAL
BLUE = WETTER THAN NORMAL

THERE HAVE BEEN

18 LA NIÑA EVENTS SINCE 1900 **12** HAVE LED TO **WIDESPREAD WET CONDITIONS**

AUSTRALIA'S WETTEST 2-YEAR PERIOD WAS DURING THE **2010–12 LA NIÑA**

Australian Government
Bureau of Meteorology

www.bom.gov.au

ENSO Wrap-Up

Australian Government
Bureau of Meteorology

HOME | ABOUT | MEDIA | CONTACTS | Search

NSW | VIC | QLD | WA | SA | TAS | ACT | NT | AUSTRALIA | GLOBAL | ANTARCTICA

- Climate
- Outlooks
  - Rainfall & temperature outlooks
  - Outlook video
  - El Niño / La Niña
  - Streamflow outlooks
  - Northern rainfall onset
  - Tropical monitoring
  - Tropical cyclone outlook
  - Climate model summary
- Reports & summaries
- Weather & climate data
- Long-term temperature record
- Data services
- Maps – recent conditions
- Maps – average conditions
- Climate change
- Extremes of climate
- About Australian climate

Bureau home ▸ Climate ▸ Watch ▸ ENSO Wrap-Up

Subscribe

ENSO Wrap-Up

Current state of the Pacific and Indian oceans

Issued **8 November 2016** Next issue **22 November 2016**

Overview | Sea surface | Sea sub–surface | SOI | Trade winds | Cloudiness | Outlooks | Indian Ocean

Some La Niña indicators strengthen; negative IOD nears end

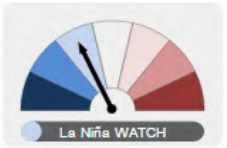
The tropical Pacific Ocean remains El Niño–Southern Oscillation (ENSO) neutral, while the negative Indian Ocean Dipole (IOD) has continued to decay over the past fortnight, and is likely to be near its end.

In the tropical Pacific, some indicators such as cloudiness near the Date Line show La Niña-like characteristics, whereas sea surface temperatures (SSTs) in the central tropical Pacific Ocean and the Southern Oscillation Index (SOI) remain at neutral levels. Recent strengthening of the trade winds in the western tropical Pacific brings the potential for some further cooling of ocean waters. However, this strengthening is likely the result of a Madden–Julian Oscillation (MJO) pulse. Trade winds are likely to weaken in the coming weeks as the MJO passes. Hence it does not appear that the tropical Pacific atmosphere and ocean are currently reinforcing each other, as they would during the developing stages of a La Niña.

Most climate models predict the tropical Pacific Ocean will remain cooler than average, but ENSO-neutral, through until the end of the 2016–17 summer. Only one of eight models suggests the Pacific may briefly reach weak La Niña levels towards the end of 2016. A La Niña developing this late in the calendar year has only occurred once since 1980.

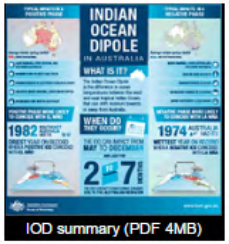
Warmer than average sea surface temperatures to Australia's north suggest that some La Niña-like impacts may occur, even if an event does not fully develop.

The negative IOD event, in place since late May, has weakened over the past fortnight. The monsoon trough has begun to move southward over the IOD region, which changes the wind patterns. This change means the negative IOD event is near its end, and this is supported by model outlooks. Both a negative IOD and La Niña typically contribute to increased rainfall in spring for eastern and central Australia.



ENSO Outlook

Information and video about Indian Ocean Dipole

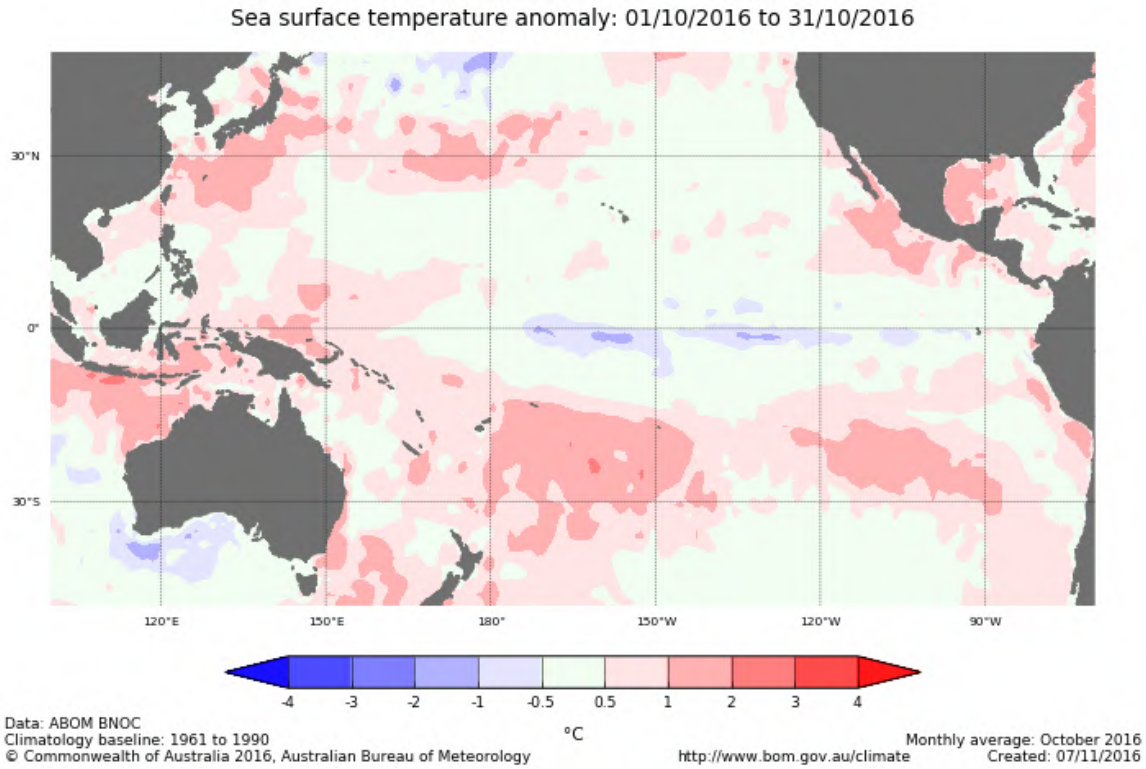


IOD summary (PDF 4MB)

Impact on rainfall: El Niño: average rainfall | El Niño: past events | La Niña: average rainfall | La Niña: past events

Monthly SST anomalies

Australian Government
Bureau of Meteorology



Index	September	October	Temperature change
NINO3	- 0.1 °C	- 0.3 °C	0.2 °C cooler
NINO3.4	- 0.4 °C	- 0.5 °C	0.1 °C cooler
NINO4	0.0 °C	- 0.2 °C	0.2 °C cooler

Baseline period 1961-1990

Weak cool SST anomalies were present along much of the central to eastern equatorial Pacific during October.

Warm anomalies were present in the far western Pacific, across most of the southern Pacific outside of the tropics, and across waters around Australia, Indonesia and most of eastern Asia.

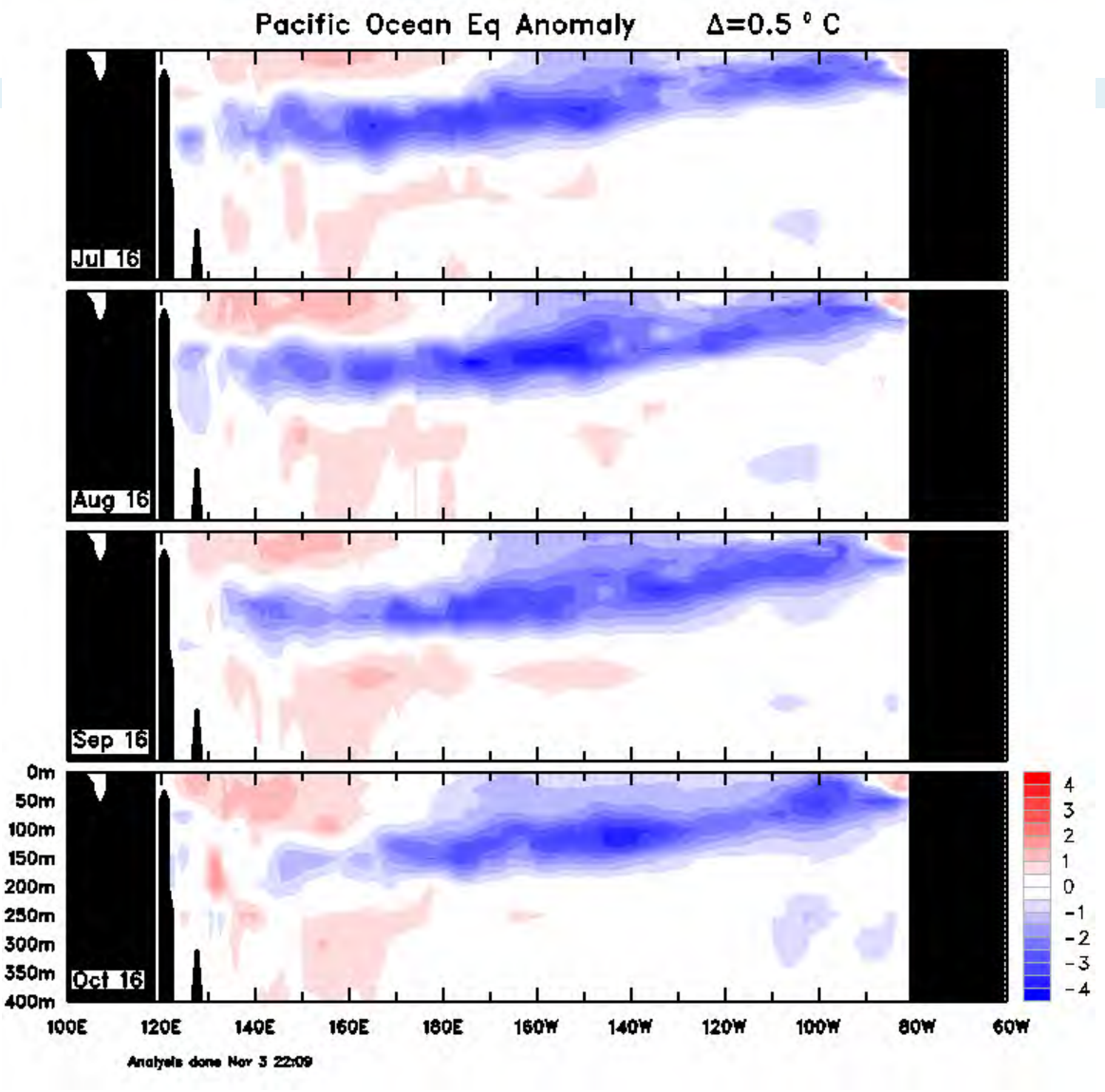
Australian Government
Bureau of Meteorology

Monthly sub-surface temperatures

The four-month sequence of sub-surface temperature anomalies (to October) shows cool anomalies spanned nearly the entire width of the equatorial Pacific Ocean.

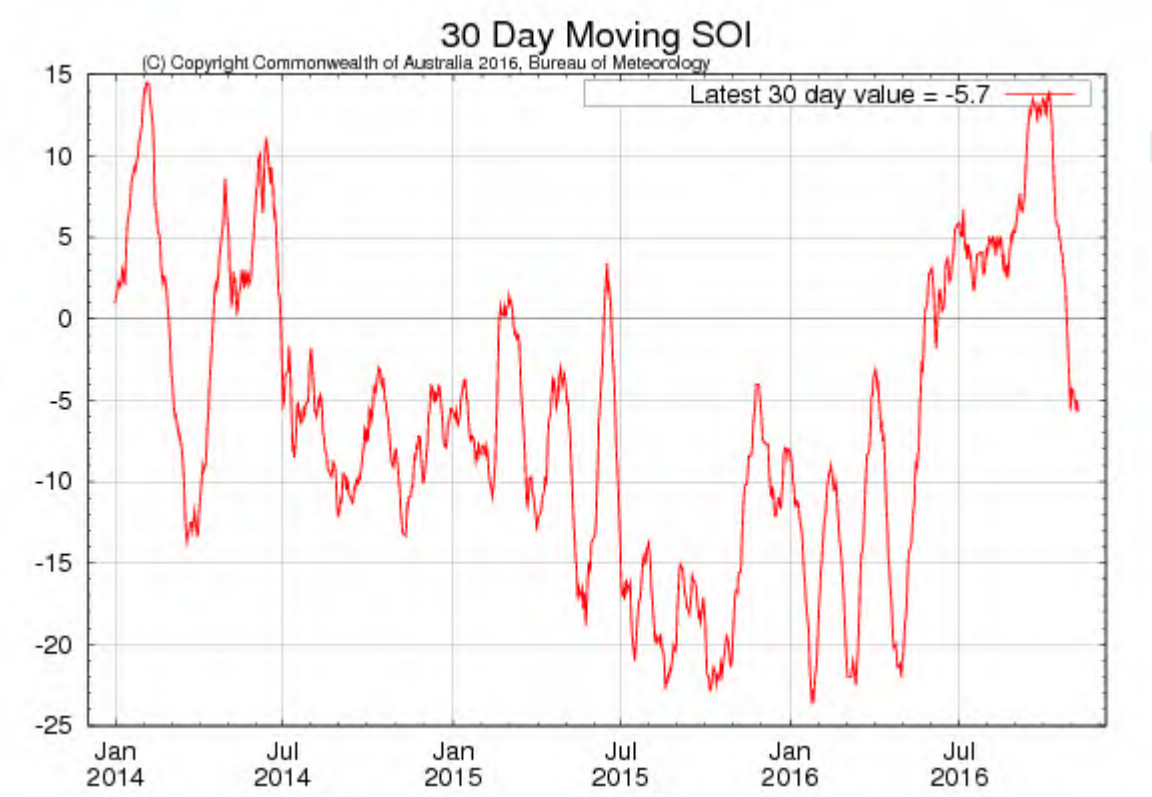
Compared to September, cool sub-surface anomalies west of the Date Line have weakened and were close to average.

Weak warm anomalies persisted in the top 100 m of water west of the Date Line; water in this region has been slightly warmer than average in each month since July.



Australian Government
Bureau of Meteorology

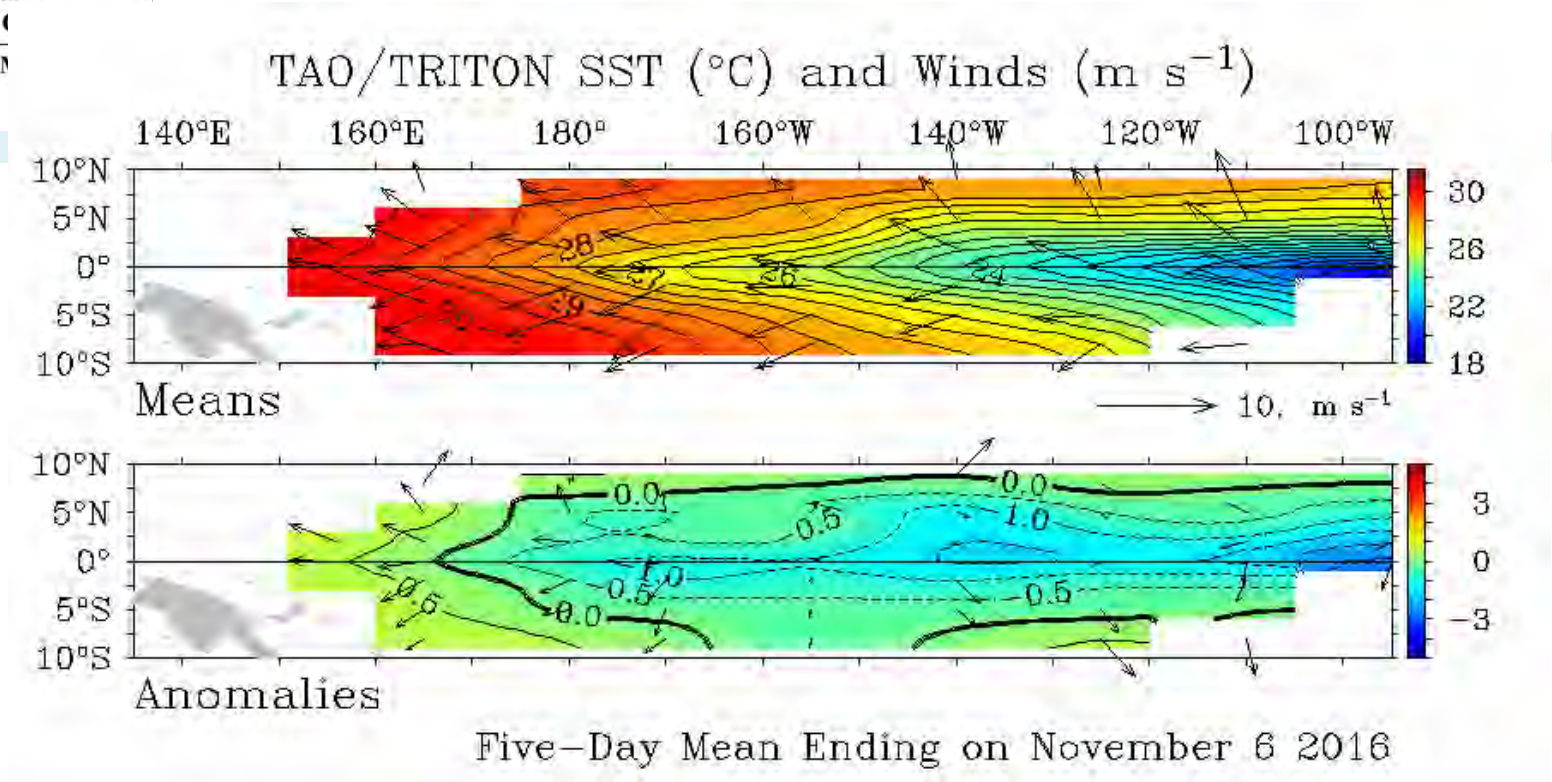
30 Day SOI values



The latest 30-day Southern Oscillation Index (SOI) to 6 November is −5.0; within the neutral ENSO range. SOI values have been within the neutral range since mid-October following a temporary spike when they exceeded La Niña thresholds.

Sustained positive values of the SOI above +7 typically indicate La Niña while sustained negative values below −7 typically indicate El Niño. Values between about +7 and −7 generally indicate neutral conditions.

Trade winds

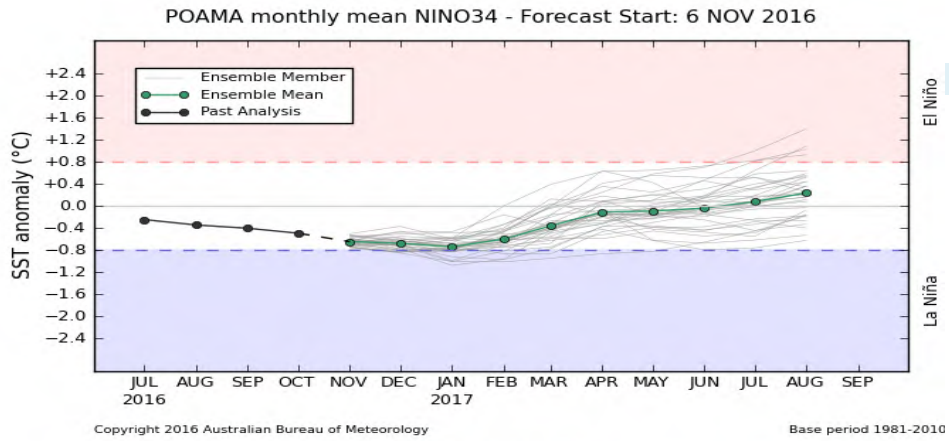


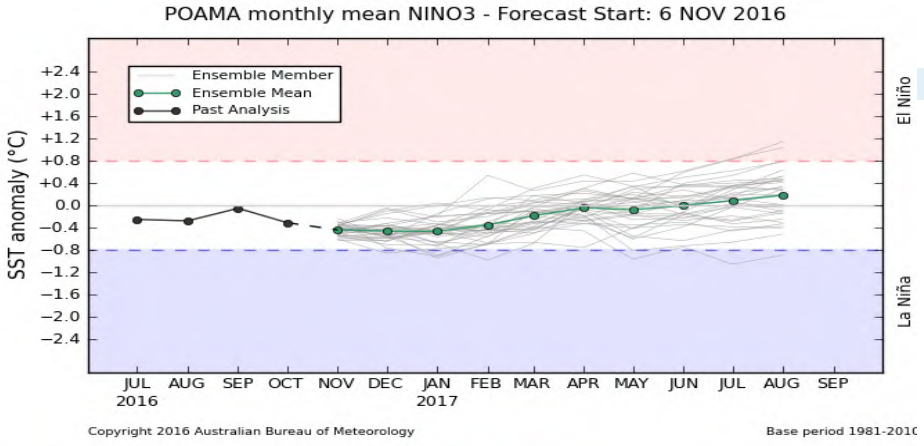
For the 5 days ending 6 November trade winds were stronger than average across the western tropical Pacific Ocean, a pattern which has now continued for more than two weeks. However this is likely the result of a pulse in the Madden–Julian Oscillation (MJO), and forecasts for the progression of the MJO indicate these winds may soon weaken.

During La Niña events, there is a sustained strengthening of the trade winds across much of the tropical Pacific, while during El Niño events there is a sustained weakening, or even reversal, of the trade winds.

POAMA long-range outlook

Australian Government





NINO34 probabilities

Click dates in the first row to see probability graphs

Outlook for month	Dec 2016	Jan 2017	Feb 2017	Mar 2017	Apr 2017	May 2017	Ju
NINO34 (°C)	-0.68	-0.74	-0.60	-0.36	-0.11	-0.10	
Model cool frequency (<–0.8°C)	18.18%	33.33%	18.18%	6.06%	3.03%	3.03%	
Model neutral frequency	81.82%	66.67%	81.82%	93.94%	96.97%	96.97%	
Model warm frequency (>+0.8°C)	0%	0%	0%	0%	0%	0%	

NINO3 probabilities

Click dates in the first row to see probability graphs

Outlook for month	Dec 2016	Jan 2017	Feb 2017	Mar 2017	Apr 2017	May 2017	Ju
NINO3 value	-0.46	-0.47	-0.35	-0.19	-0.04	-0.08	
Model cool frequency (<–0.8°C)	3.0%	9.1%	3.0%	0.0%	0.0%	6.1%	
Model neutral frequency	97.0%	90.9%	97.0%	100.0%	100.0%	93.9%	1
Model warm frequency (>+0.8°C)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	

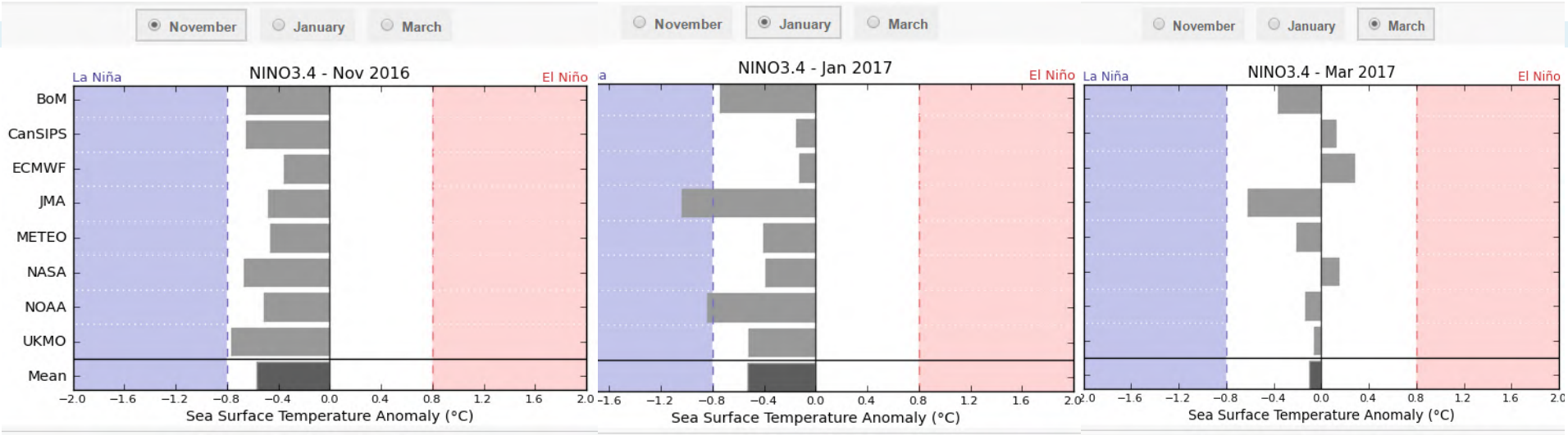
Agency/Source/Provider	Model
BOM - Bureau of Meteorology	POAMA
Meteorological Service of Canada	CanSIPS
ECMWF (EU)	System4
JMA	JMA/MRI-CGCM
METEO-FRANCE	ARPEGE
NASA - GMAO (USA)	GEOS5
NOAA - NCEP (USA)	CFSv2
UKMO	GloSea5

These model forecasts of the El Niño – Southern Oscillation (ENSO) are generated by the Predictive Ocean Atmosphere Model for Australia (POAMA), a dynamical computer model of the climate system run at the Bureau of Meteorology.

The Bureau surveys eight international climate models to examine forecasts for the Pacific and Indian Oceans.

Australian Government
Bureau of Meteorology

Climate model summary
November 2016 to March 2017

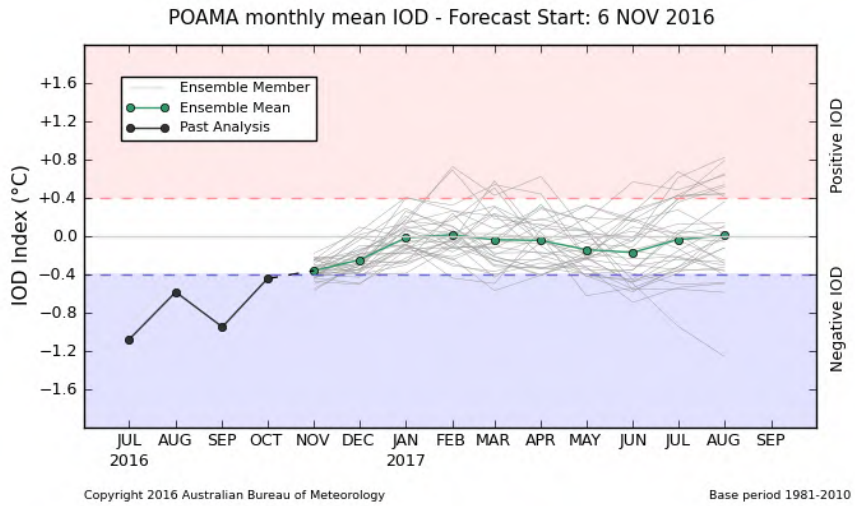


The latest NINO3.4 outlooks (initialised in October/November) suggest temperatures in the central tropical Pacific are likely to remain cooler than average – but ENSO neutral – for the remainder of 2016. However, the JMA model indicates La Niña thresholds may be reached by December and persist until February. Four more models, POAMA, NASA, NOAA and UKMO suggest near La Niña conditions at some point during November to January, but fall just shy of an event. If La Niña was to occur, models currently indicate it is likely to be short-lived and weak.

The all-model average NINO3.4 outlook for each month between November and January is between −0.5 ° C and −0.6 ° C.

Australian Government
Bureau of Meteorology

Indian Ocean Dipole



IOD probabilities

Click dates in the first row to see probability graphs

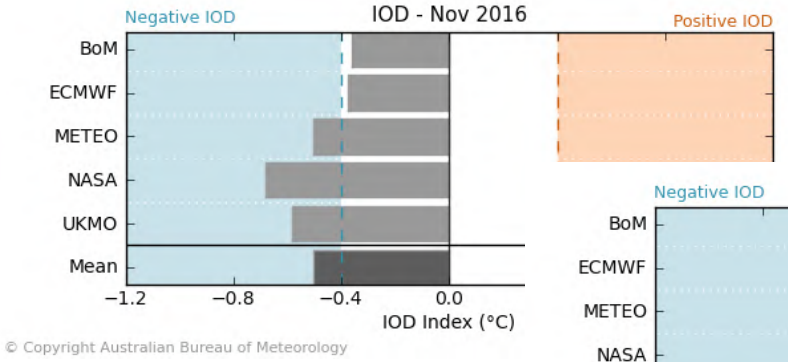
Outlook for month	Dec 2016	Jan 2017	Feb 2017	Mar 2017	Apr 2017	May 2017	Jun 2017
IOD value	-0.25	-0.02	0.01	-0.04	-0.05	-0.14	-0.17
Model cool frequency (<−0.4°C)	12.1%	0.0%	3.0%	12.1%	9.1%	9.1%	30.3%
Model neutral frequency	87.9%	97.0%	90.9%	75.8%	84.8%	90.9%	66.7%
Model warm frequency (>+0.4°C)	0.0%	3.0%	6.1%	12.1%	6.1%	0.0%	3.0%

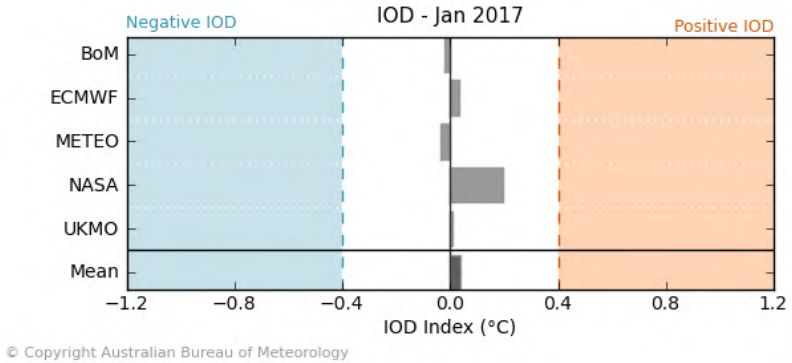
The negative Indian Ocean Dipole (IOD) event is drawing to a close. The weekly index value to 6 November was −0.30 ˚ C. This marks the second week the index value has failed to exceed the threshold for a negative IOD event.

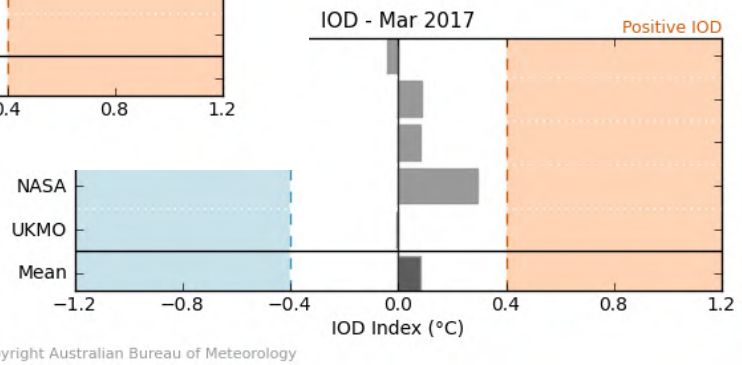
IOD events typically decay during spring.

Australian Government
Bureau of Meteorology

Climate model summary
November 2016 to March 2017







The latest weekly IOD index value to 23 October is −0.6 ° C, continuing at levels consistent with a negative Indian Ocean Dipole event.

The model outlooks surveyed by the Bureau of Meteorology indicate that the negative IOD event will persist through November and return to neutral values by the beginning of the southern summer – consistent with the typical IOD event cycle.

This negative IOD event is considered the strongest such event in at least 50 years.

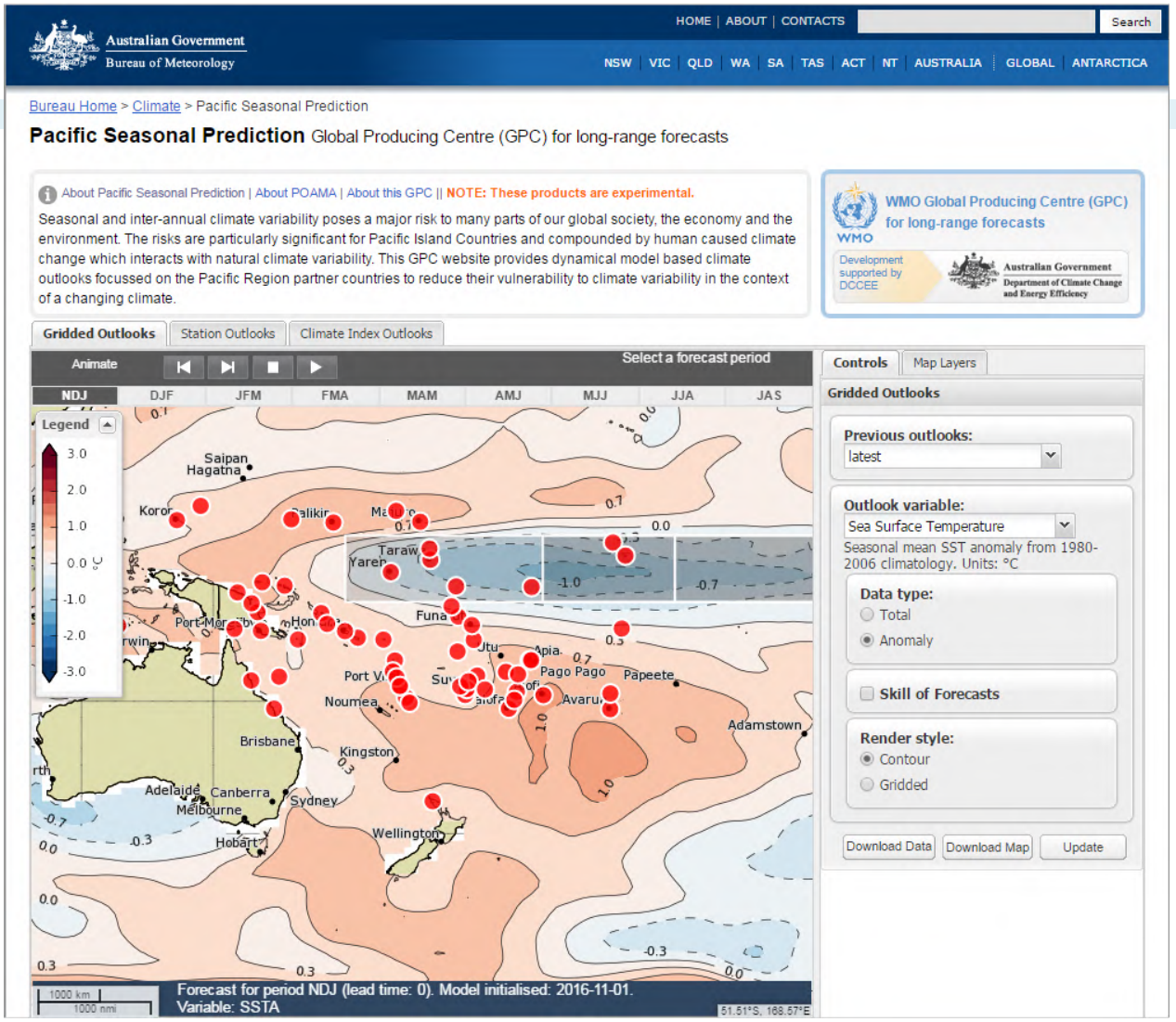
WMO GPC Melbourne climate outlook

Australian Government
Bureau of Meteorology

WMO Global Producing Centre (GPC) for Long-Range Forecasts (LRFs), Melbourne, Australia

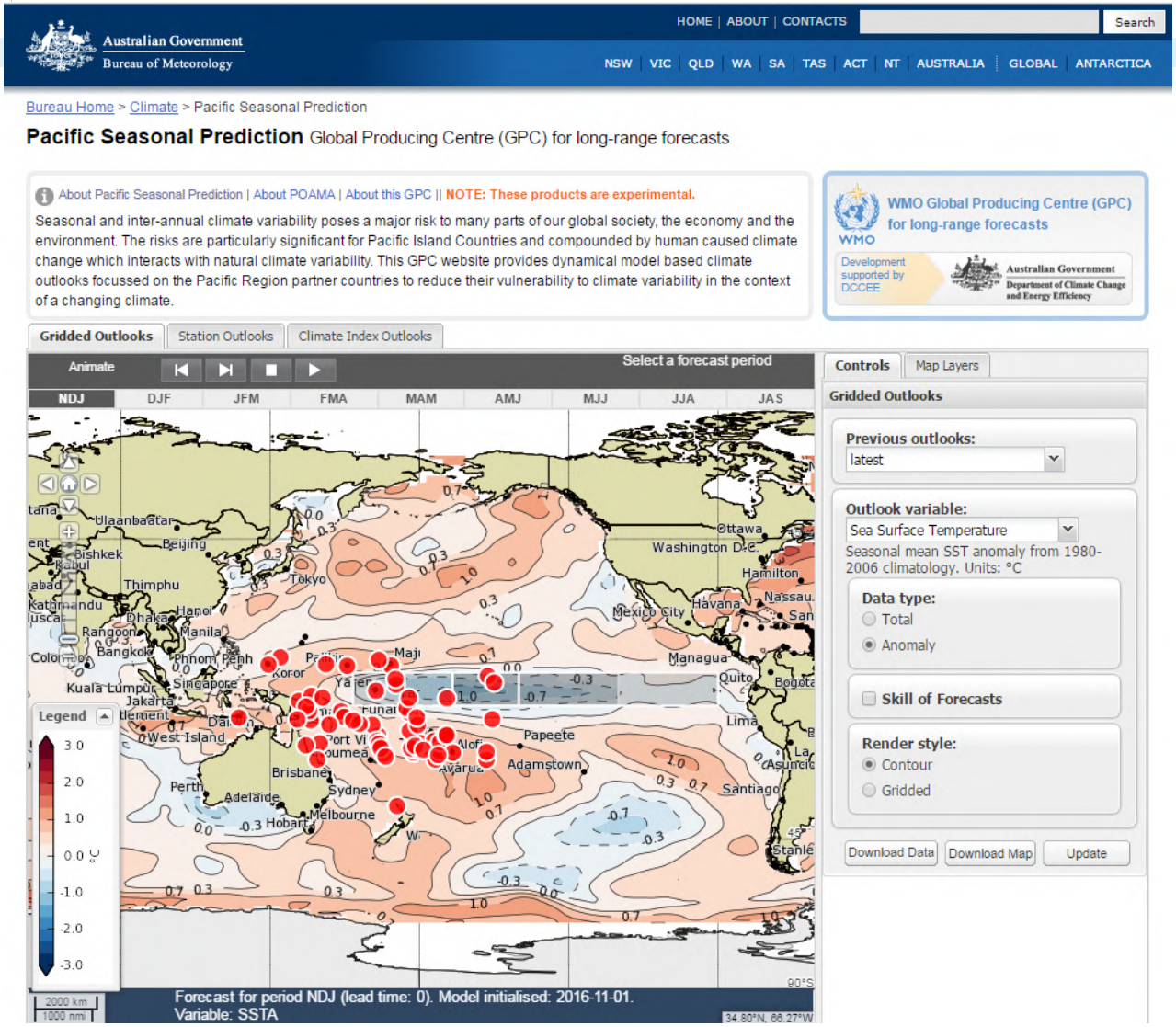
Developed as part of the ICCAI, Pacific Adaptation Strategy Assistance Program (PASAP)

http://poama.bom.gov.au/experimental/pasap/



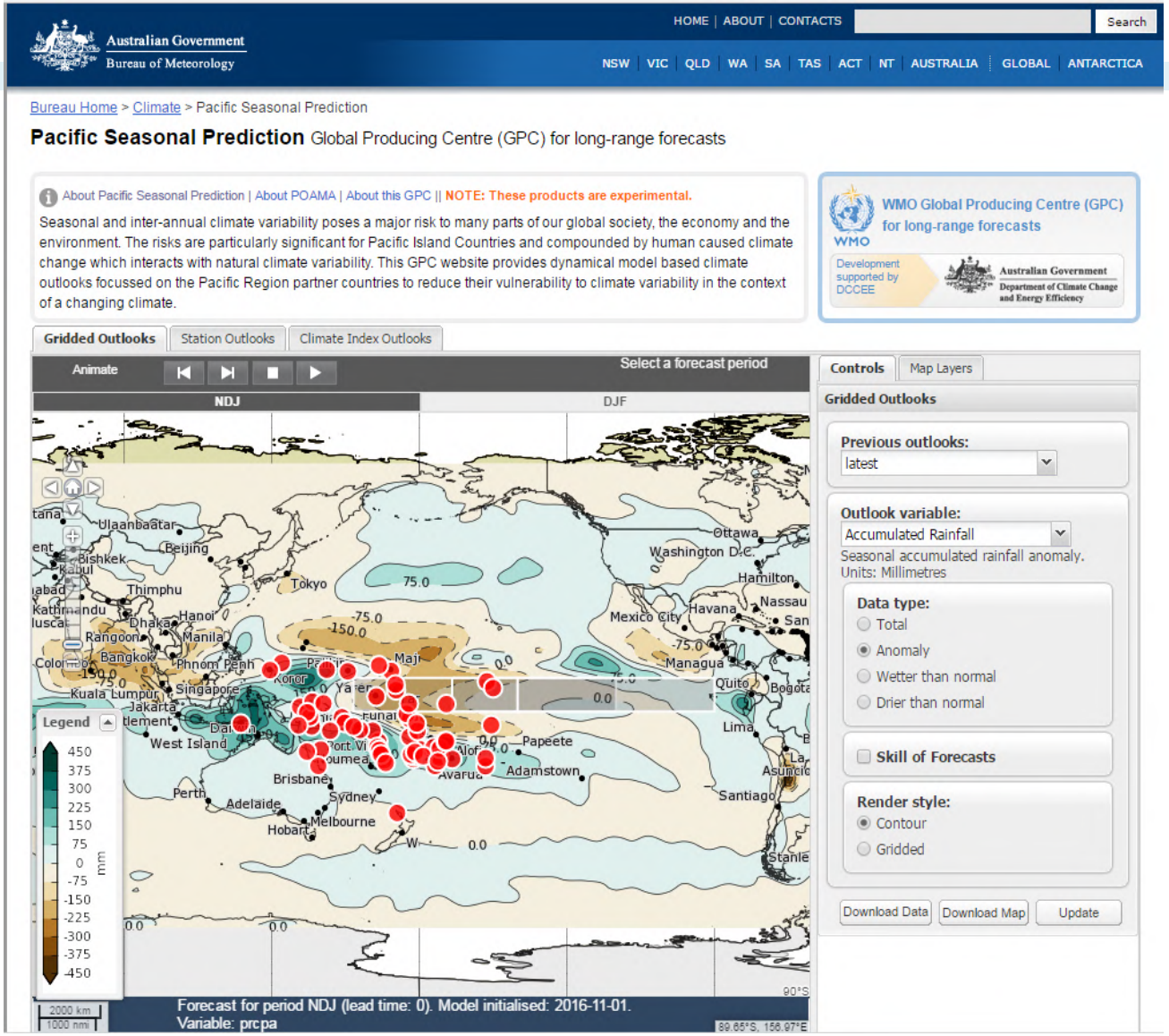
Australian Government
Bureau of Meteorology

November 2016 to January 2017 climate outlook - SSTs



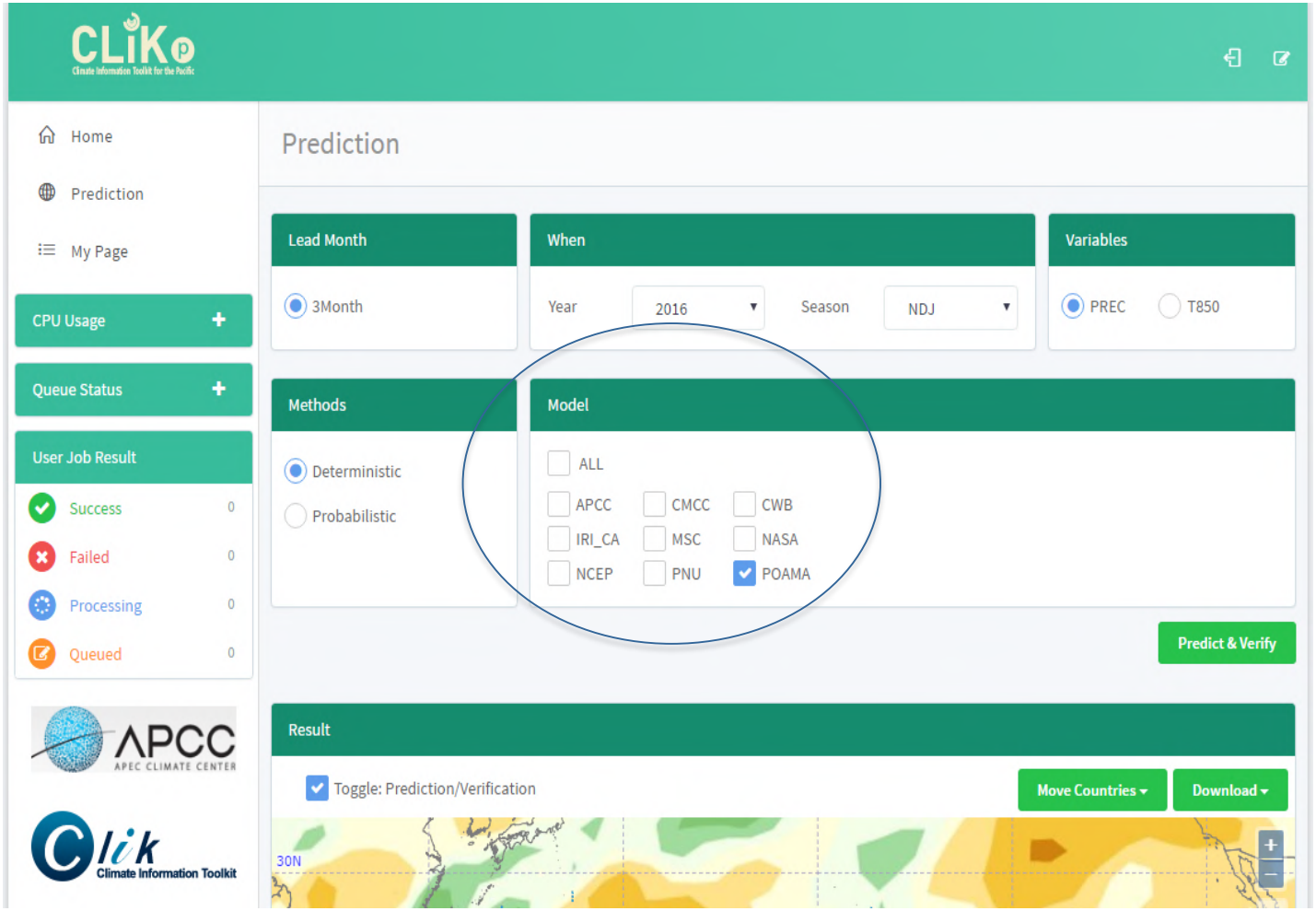
Australian Government
Bureau of Meteorology

November 2016 to December 2017 climate outlook – Accumulated Rainfall



Australian Government
Bureau of Meteorology

APCC – CLiKP

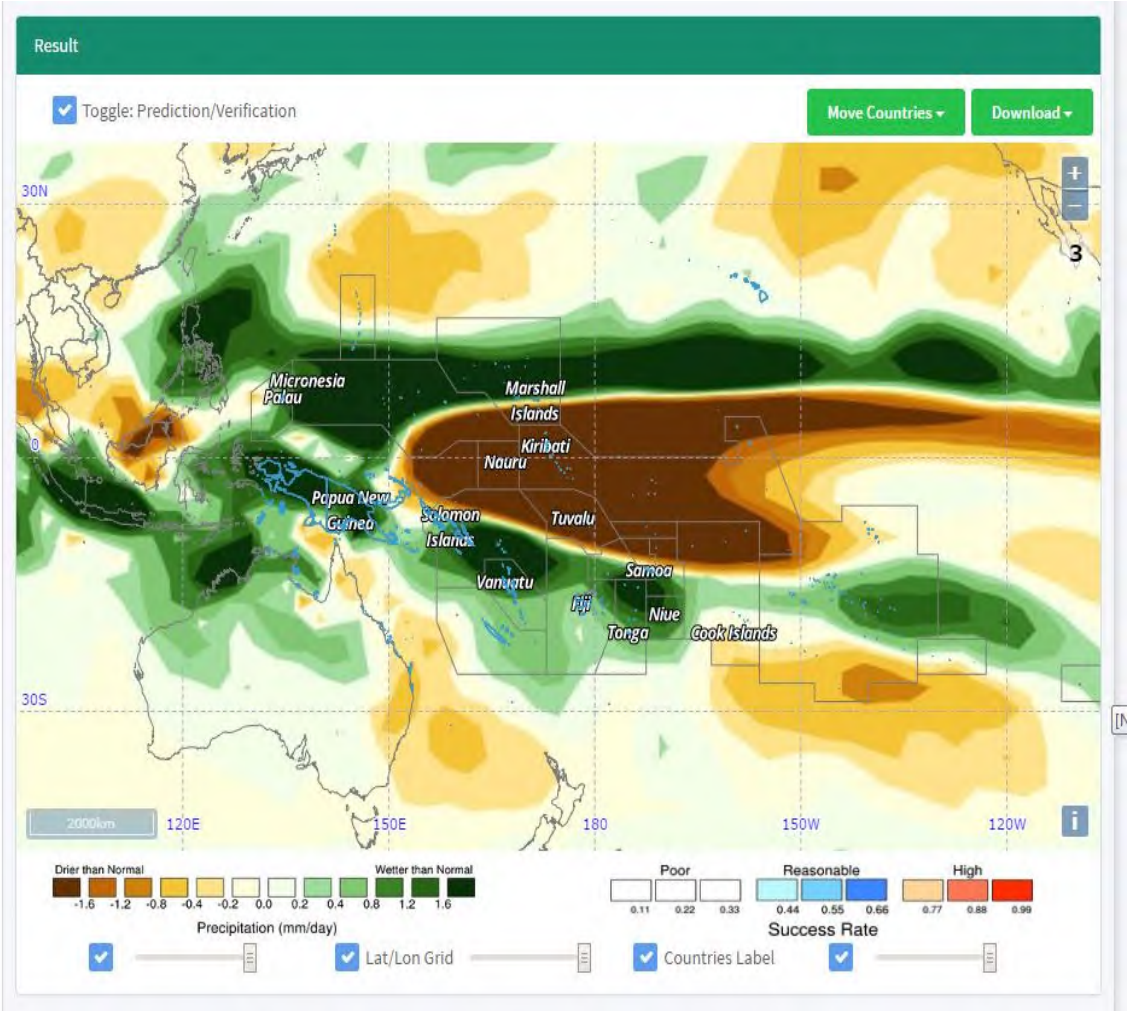


Australian Government
Bureau of Meteorology

APCC – CLiKP - POAMA

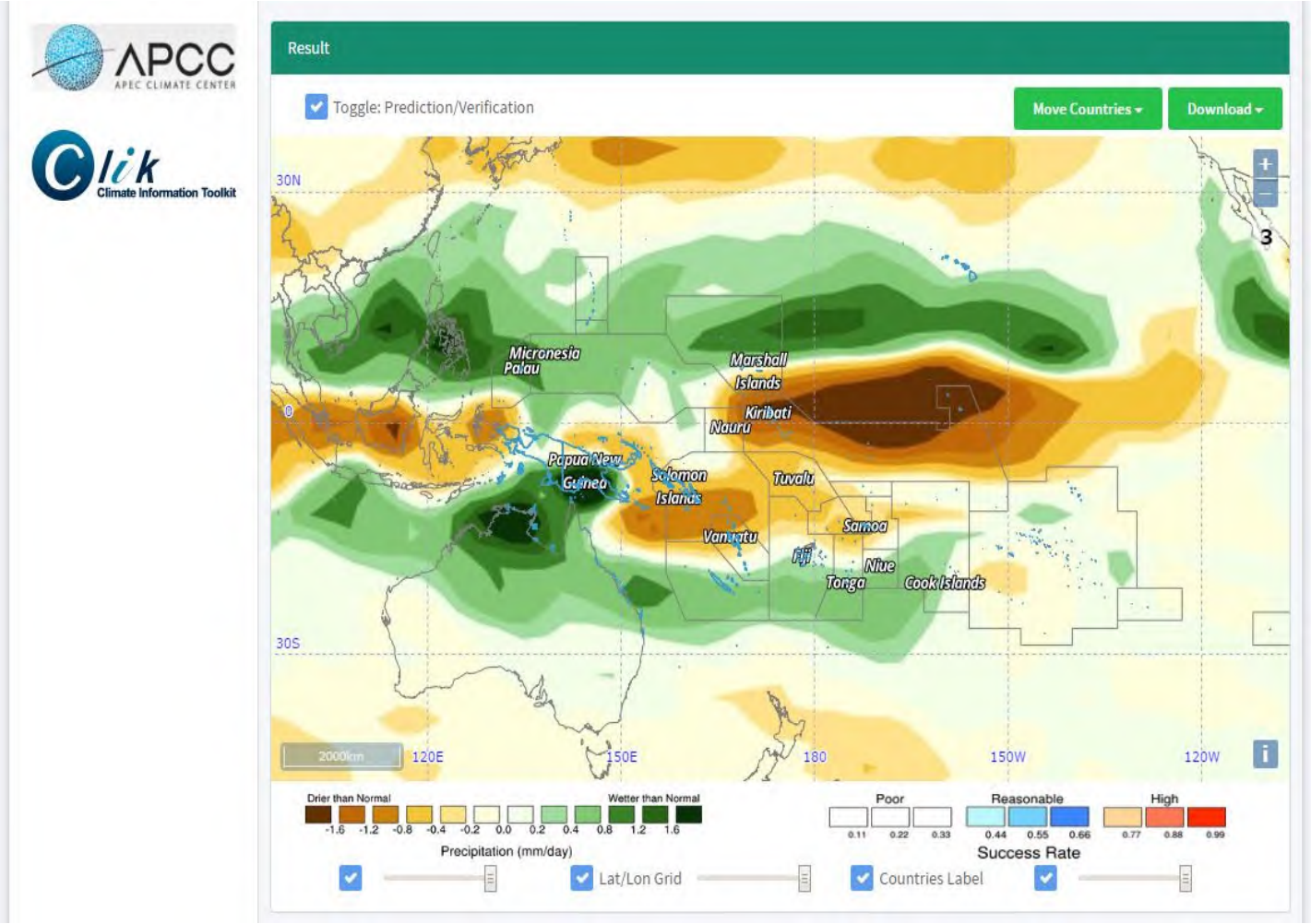
APCC
APEC CLIMATE CENTER

Clik
Climate Information Toolkit



Australian Government
Bureau of Meteorology

APCC – CLiKP - CWB

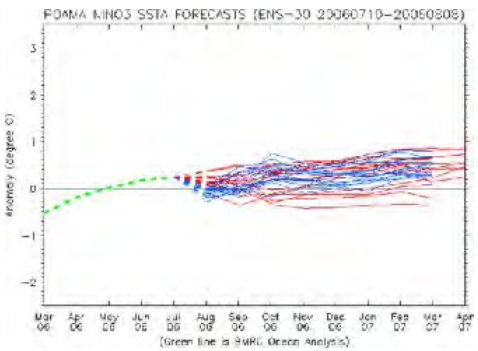


ACCESS-S – the Bureau next generation subseasonal-seasonal forecast system

Australian Government
Bureau of Meteorology

POAMA1
2002-2006

- Operational ENSO forecasts



POAMA1.5
2007-2011

Improvement in **atmosphere and land initial conditions**

- Operational ENSO and IOD forecasts
- Experimental probabilistic forecasts for AUS seasonal mean rainfall and temperature

POAMA2
2012-2016

Improvement in **ocean ICs and atmosphere and land ICs**

- Operational monthly and seasonal AUS climate forecasts
- Various experimental climate forecast products – MJO, SAM, subtropical ridge, coral bleaching risk, heat extremes… etc.

ACCESS-S1

- The Global Seasonal forecast system version 5 using Global Coupled configuration 2 (**GloSea5-GC2**) imported from the UKMO
- Locally developed **ensemble generation scheme**

Plan to replace POAMA2 by mid-2017

Australian Government

POAMA-2 vs ACCESS-S1

	POAMA-2	ACCESS-S1
Atmospheric model	Bureau Atmospheric Model (BAM)	Latest UKMO atmospheric model (GA6 version of the UKMO UM)
Atmospheric resolution	Horizontal: ~250 km (T47) Vertical: 17 levels (5 levels in the stratosphere)	Horizontal: 60 km in the midlatitudes (N216) Vertical: 85 levels (fully resolved stratosphere)
Land surface model	Simple bucket model for soil moisture and 3-layers for soil temperature.	State-of-the-art land surface model (Joint UK Land Environment Simulator; JULES) with 4 soil levels.
Ocean model	Australian Community Ocean Model based on Modular Ocean Model (MOM version 2) ~13 years old	Latest NEMO ocean model (Nucleus for European Modelling of the Ocean)
Ocean resolution	Horizontal: ~200 km x 100 km Vertical: 25 levels	Horizontal: 25 km Vertical:75 levels
Sea ice model	No sea ice model (climatological sea ice is prescribed).	Latest sea ice model developed by the USA and UK (Los Alamos sea ice model; CICE)
Model Physics	>10 years old	Latest from UK Met Office and collaborators

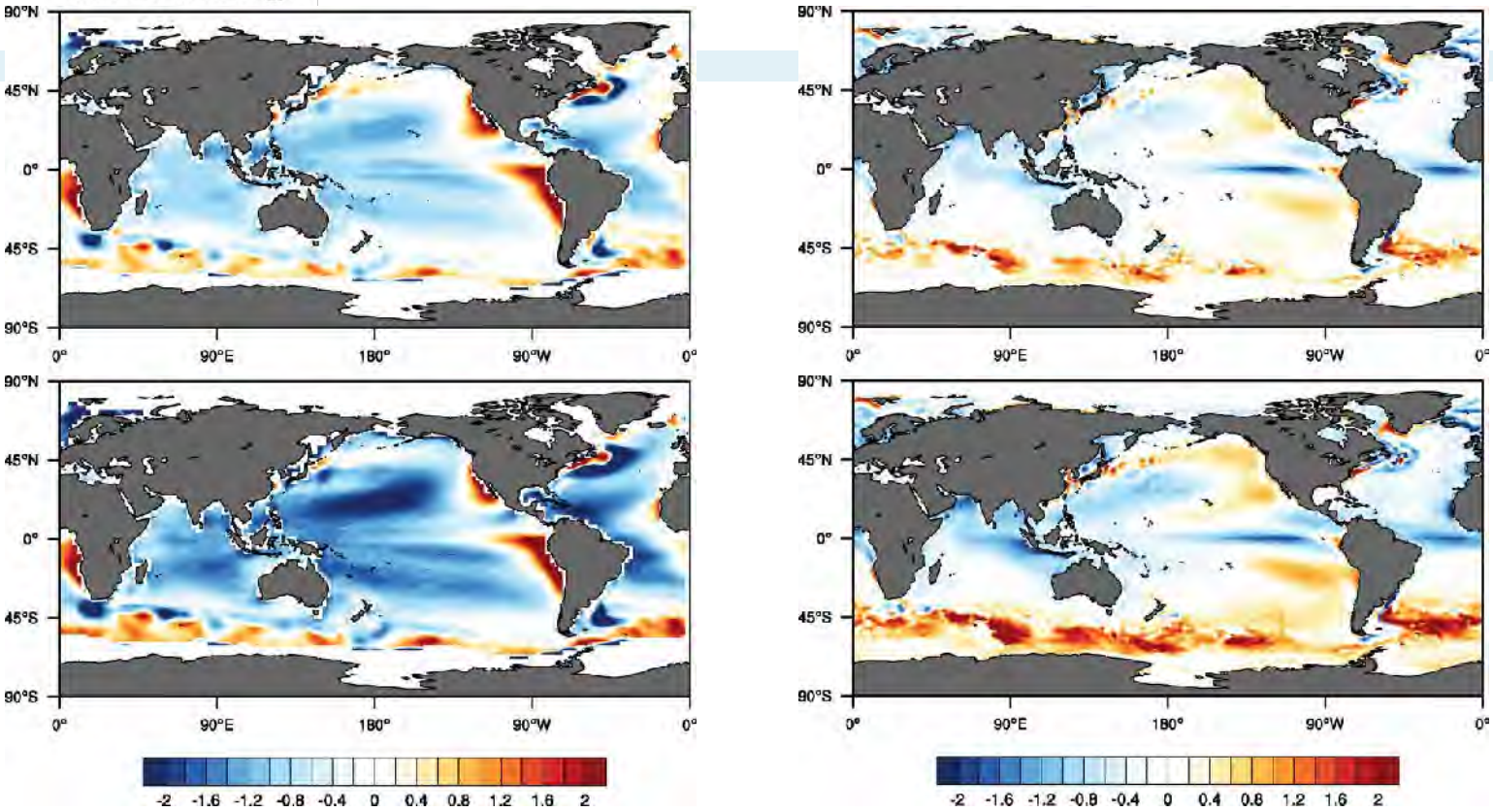
taken from Shi et al. (2016)

Australian Government
Bureau of Meteorology

Mean SST bias

POAMA2

ACCESS-S1



LT 1

LT 4

Systematic bias in SST is less severe in ACCESS-S1

Cold bias along the equator and northern and eastern Indian Ocean → negatively impact the forecast amplitude of ENSO and IOD

Warm bias in the Southern Ocean SST → reported to be reduced in GC3

Australian Government
Bureau of Meteorology

Mean rainfall bias

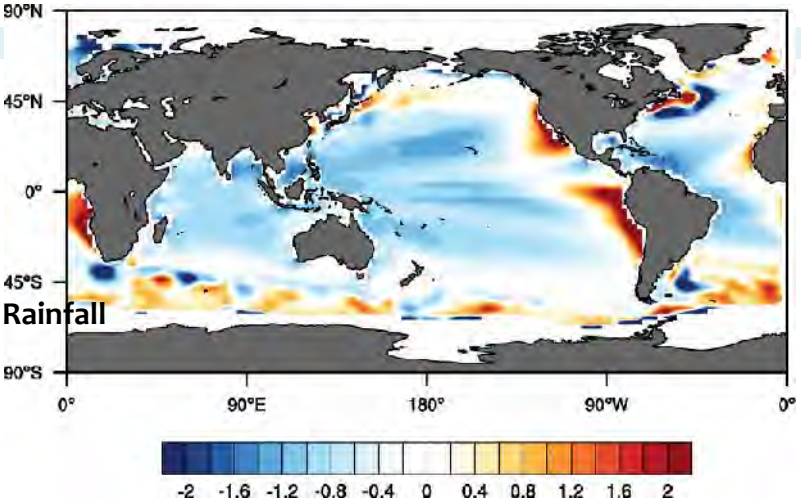
SST

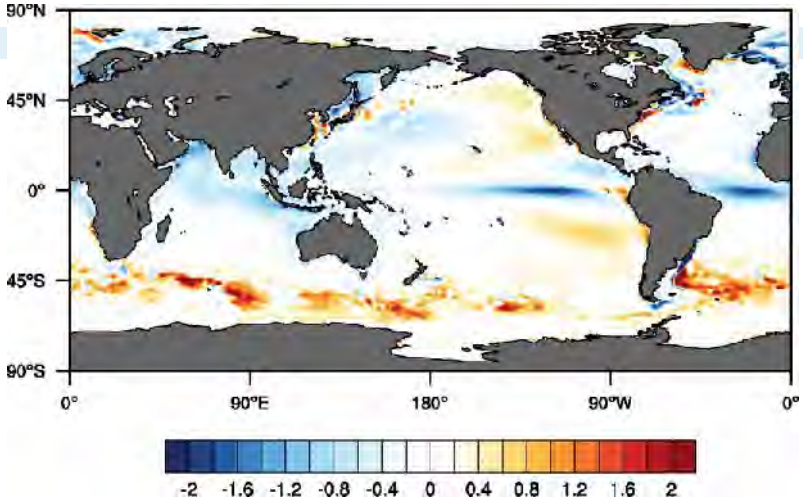
POAMA2

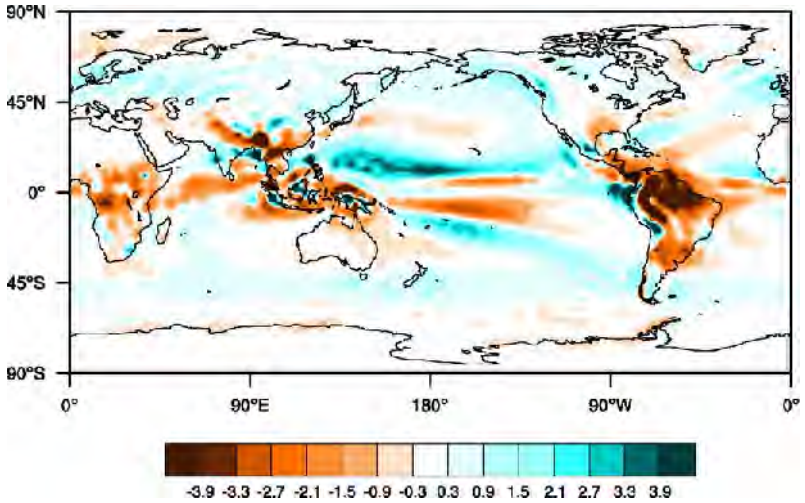
ACCESS-S1

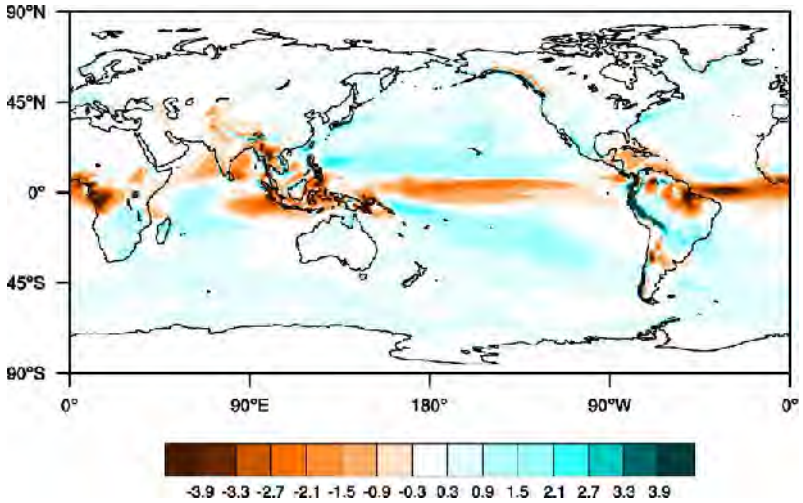
Rainfall

LT1





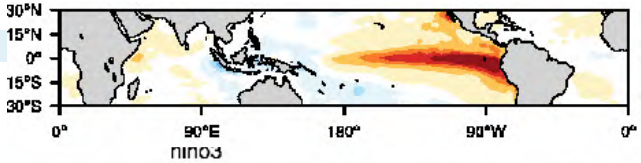




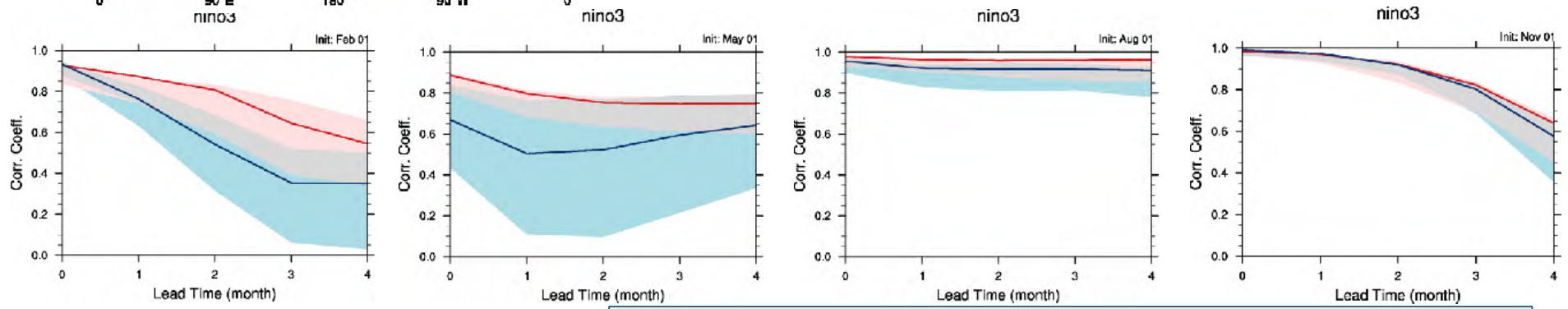
Australian Government
Bureau of Meteorology

Forecast skill to predict ENSO

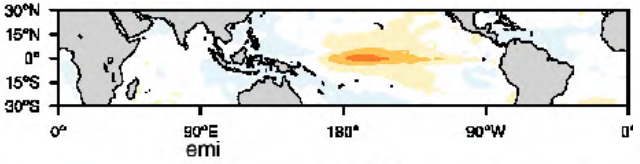
EP El Nino



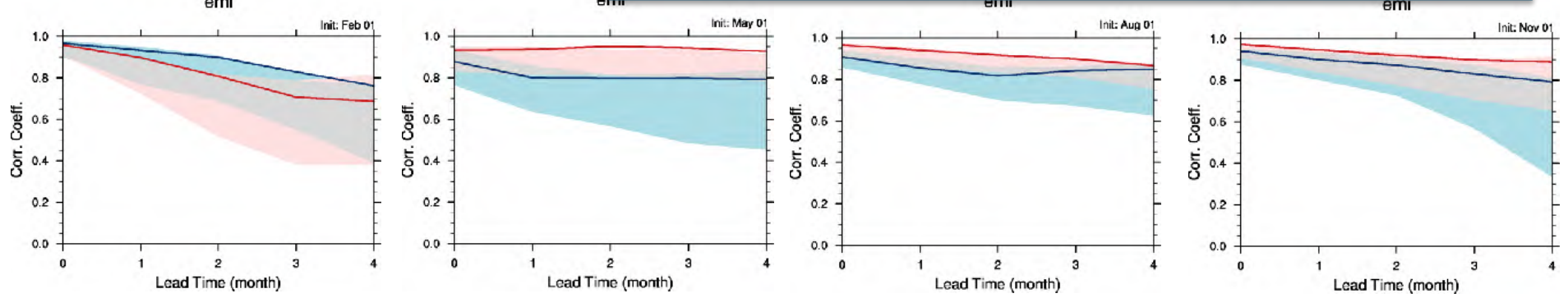
Significant improvements in predicting eastern Pacific ENSO for boreal spring and summer when skilful ENSO forecasts have been very difficult



CP El Nino



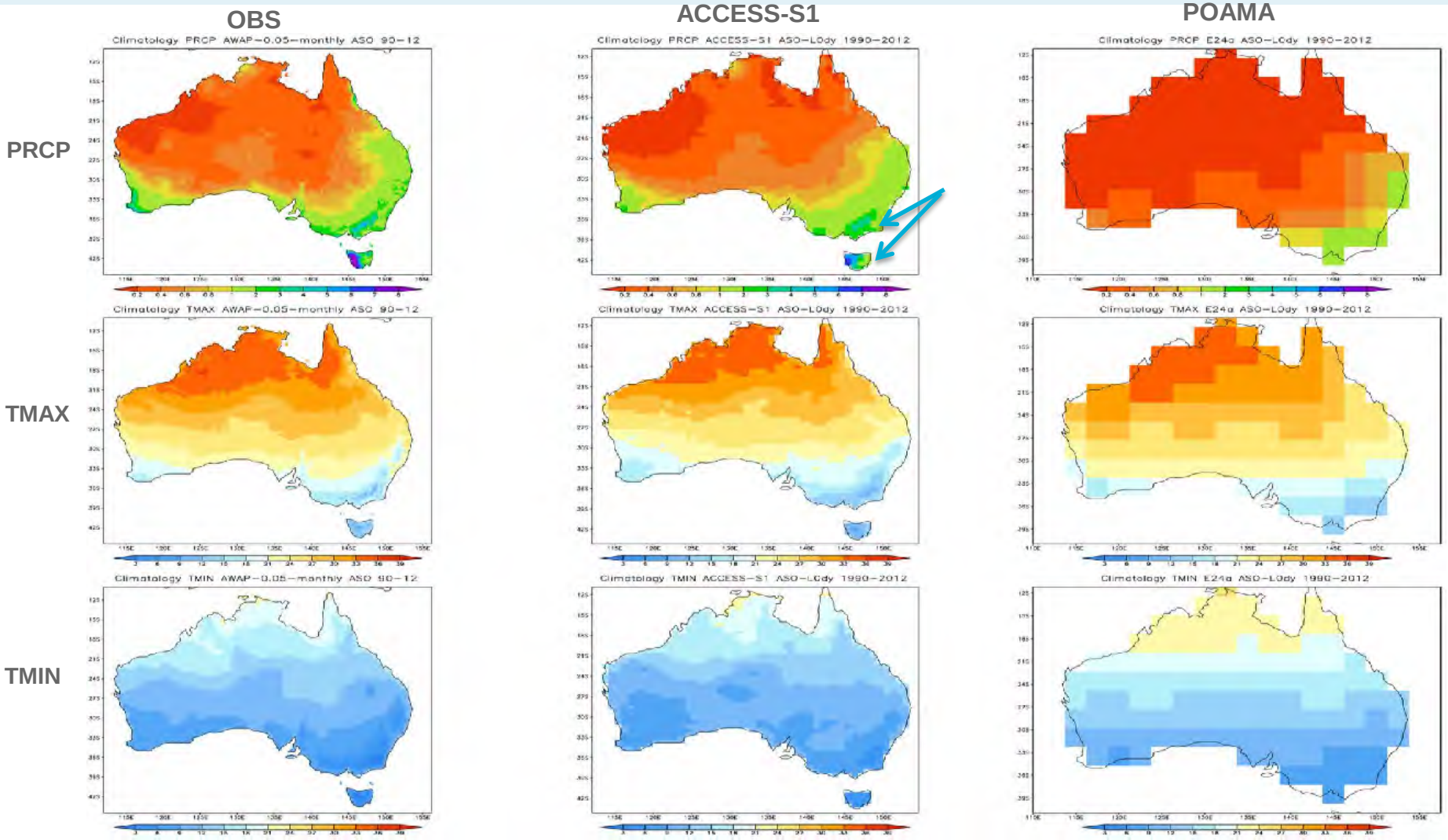
Improvements in predicting central Pacific ENSO → potentially great news for AUS rainfall forecasts as central Pacific SSTs are important for northern and eastern AUS rainfall in austral winter and spring



Australian Government
Bureau of Meteorology

Improved mean state over Australia

ACCESS-S1 has much more regional detail and less bias



Australian Government
Bureau of Meteorology

Summary

ACCESS-S

•the BoM's next generation sub-seasonal to seasonal climate forecast system

• A number of state-of-the-art features compared to POAMA2

-high resolution, latest model physics, sophisticated land surface model, interactive sea-ice model…etc

ACCESS-S1

•Significantly improved forecasts for the occurrence of ENSO, IOD, SAM and MJO

•ACCESS-S1 has much better mean state (much more regional detail and less bias) than the POAMA across Australia and globally

However,

•Forecast ENSO and IOD to be overly strong → likely associated with the cold mean state bias along the equatorial eastern Pacific and over the tropical eastern Indian Ocean

Australian Government
Bureau of Meteorology

Further information

Climate information: www.bom.gov.au/climate

Water information: www.bom.gov.au/water

Stay up-to-date on El Niño: www.bom.gov.au/climate/enso/

Subscribe to e-news: www.bom.is/enviro-news