



## ENSO Wrap-Up

### Current state of the Pacific and Indian Ocean

## A strong El Niño and record warm Indian Ocean continue

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El Niño continues to strengthen. Recent oceanic and atmospheric indicators are at levels not seen since the 1997–98 El Niño. Persistently weak or reversed trade winds and a strongly negative Southern Oscillation Index (SOI), in conjunction with the ongoing warming in the tropical Pacific Ocean, indicate the El Niño is unlikely to end before early 2016.

Climate models indicate sea surface temperatures in the central tropical Pacific are likely to rise further over the next few months, coming close to, or possibly exceeding, monthly values observed during the 1997–98 event. All models suggest the event will peak around the end of the year, followed by rapid weakening heading into autumn 2016. It is too early to accurately determine the likely pattern beyond autumn, but a continued El Niño is considered the least likely outcome at this stage.

Temperature patterns in the Indian Ocean are continuing to have a strong influence on Australian climate. The whole Indian Ocean remains warmer than average with sea surface temperatures in the southern Indian Ocean the highest on record for winter. Some localised cooling near Indonesia means the Indian Ocean Dipole (IOD) index has been above the +0.4 °C threshold for six weeks. If this continues for at least another fortnight, this will be considered a positive IOD event. Most models indicate this is likely.

El Niño is usually associated with below-average winter–spring rainfall over eastern Australia, and a positive IOD typically reinforces this pattern over central and southeast Australia. However, this pattern has been offset in central and some southern areas by the record warm Indian Ocean. Warmth in the Indian Ocean is likely to continue.

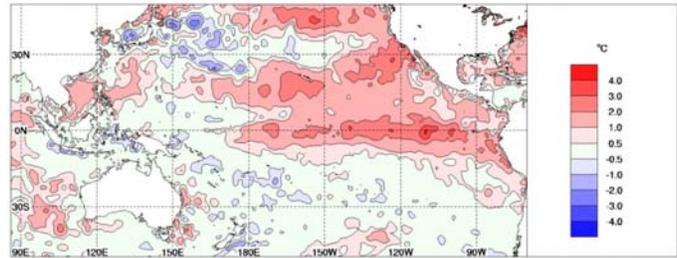
**Next update expected on 29 September 2015 |**

### Weekly sea surface temperatures

Warm anomalies persist along the equator from the South American coastline to the Date Line and across most of the Pacific Ocean east of the Date Line in the northern hemisphere. Compared to two weeks ago, sea surface temperature (SST) anomalies have increased slightly in the western equatorial Pacific and decreased slightly in the central equatorial Pacific. Anomalies have also decreased slightly in the northwest of the Pacific Basin.

Anomalies for the week ending 13 September exceeded +2 °C across most of the equatorial Pacific east of 170°W. The eastern half of the northern Pacific was more than one degree warmer than average, with large areas more than two degrees warmer than average. Warm anomalies were also present along parts of the east coast of Australia, in areas to Australia's west, and across large parts of the Indian Ocean.

All five NINO indices remain above +1 °C this week, and both NINO3 and NINO3.4 remain at or above +2 °C. NINO3 and NINO3.4 were last at these levels during the 1997–98 El Niño.



Index	Previous	Current	Temperature change (2 weeks)
NINO3	+2.0	+2.1	0.1 °C warmer
NINO3.4	+2.0	+2.0	no change
NINO4	+1.2	+1.1	0.1 °C cooler

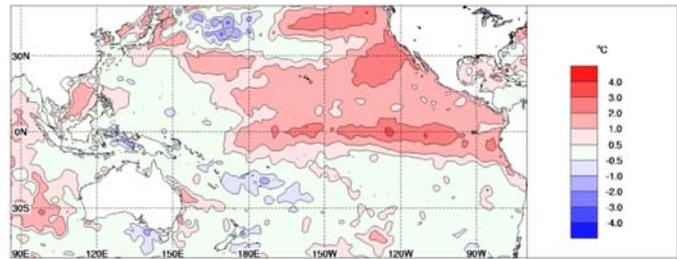
Baseline period 1961–1990.

### Monthly sea surface temperatures

The SST anomaly map for August 2015 shows positive anomalies extended from the South American coastline, across the equatorial Pacific, to just past the Date Line. Compared to July, the area covered by positive anomalies has increased north of the equator, covering most of the northern Pacific Basin east of the Date Line. Anomalies generally remained similar in strength to the previous month. Weak warm anomalies also persisted to Australia's east, and moderate to strong warm anomalies across much of the Indian Ocean.

NINO3 and NINO3.4 strengthened, reaching anomalies of +2.0 °C and +1.9 °C respectively for August 2015.

NINO3.4 has now exceeded the peak monthly anomaly of the values reached during the 2002 (+1.6 °C) and 2009 (+1.7 °C) El Niño. However, the current anomaly remains well behind the peak value during either 1982 or 1997 (+2.8 °C and +2.7 °C respectively). Note: peak values are typically recorded late in the year.



Index	July	August	Temperature change
NINO3	+1.9	+2.0	0.1 °C warmer
NINO3.4	+1.5	+1.9	0.4 °C warmer
NINO4	+1.1	+1.1	no change

Baseline period 1961–1990.

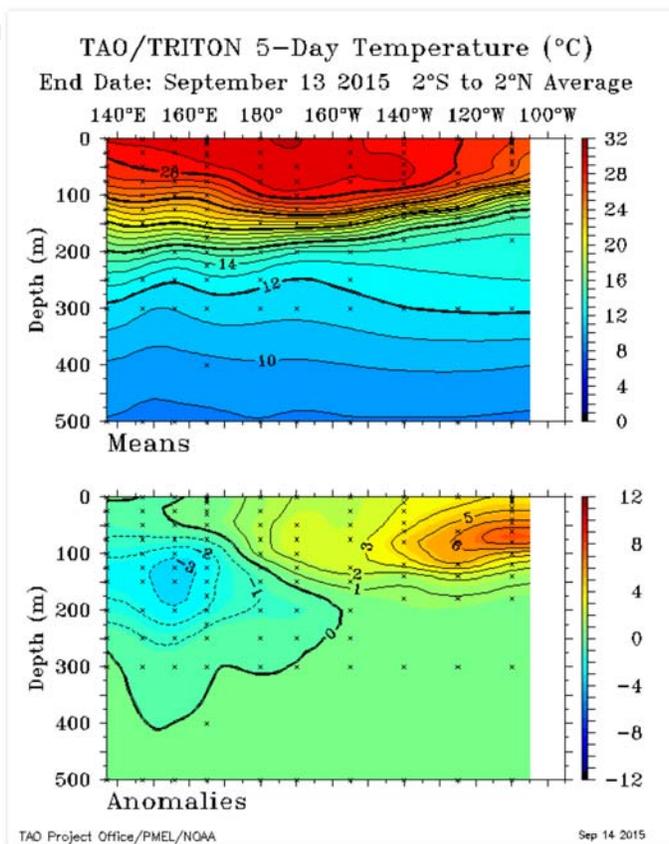
## 5-day sub-surface temperatures

The sub-surface temperature map for the 5 days ending 13 September shows temperatures were warmer than average in the top 150 m of the central to eastern equatorial Pacific and cooler than average below the surface of the ocean in the western equatorial Pacific. Water in far eastern Pacific sub-surface was very much warmer than average, with a large area of anomalies around 75 m depth more than 7 °C warmer than average. Anomalies in this area remain similar to two weeks ago.

Cool anomalies in the western equatorial Pacific have strengthened when compared to two weeks ago. An area around 150 m depth has reached more than 3 °C cooler than average.

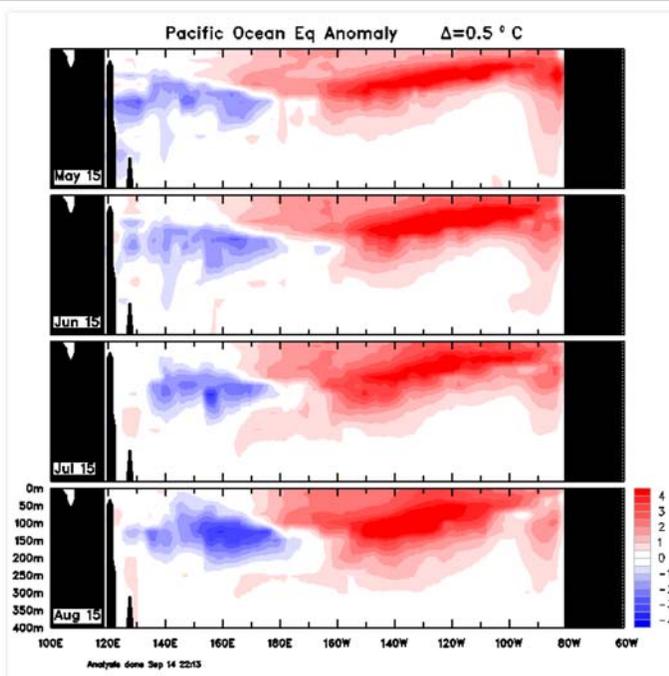
The pattern of warm anomalies in the eastern sub-surface and cool anomalies in the west is consistent with a well-established El Niño.

In the mean 5-day values (upper panel), the thermocline is almost flat. The thermocline sits around the 20 °C region, and is considered mid-point between the warmer surface waters, and cooler subsurface waters. An almost flat thermocline tends to only occur during strong El Niño events.



## Monthly sub-surface temperatures

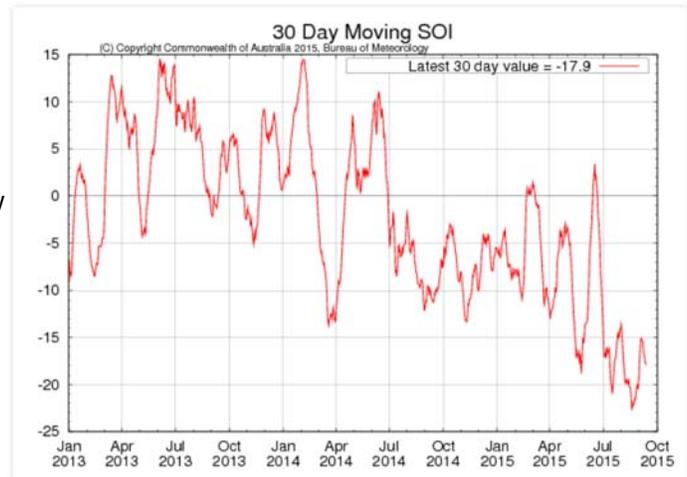
The four-month sequence of sub-surface temperature anomalies (to August) shows a generally consistent pattern of anomalies throughout the past four months. Warm anomalies were evident for August in the top 200 m of the equatorial Pacific sub-surface between about 170°E and the South American coast. Monthly anomalies across large areas of the eastern half of the equatorial Pacific reached more than +4 °C. An area of cool anomalies persisted in the sub-surface of the western equatorial Pacific.



## Southern Oscillation Index

During the past two weeks the Southern Oscillation Index (SOI) rose about 5 points before again declining. The 30-day SOI value to 13 September was  $-17.9$ .

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

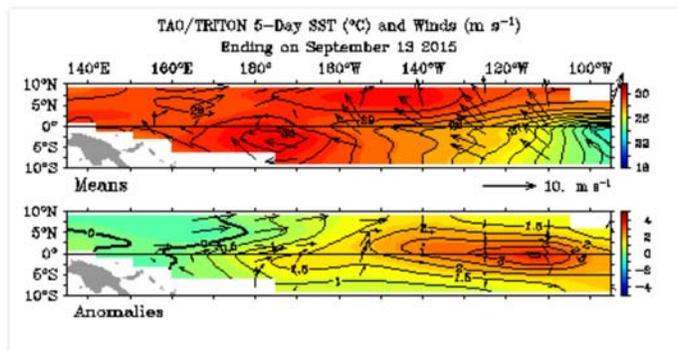


## Trade winds

Trade winds for the 5 days ending 13 September show westerly anomalies were present over the western to central equatorial Pacific, similar to two weeks ago. Trade winds were reversed (i.e. westerly winds) to the north of the equator west of the Date Line.

Trade winds have been consistently weaker than average, and on occasion reversed in direction (i.e. westerly rather than easterly), since the start of 2015.

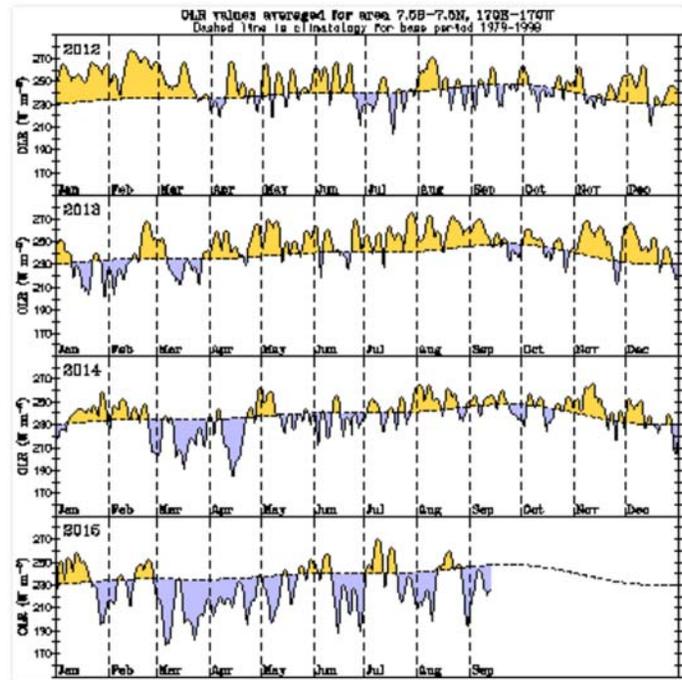
During La Niña events, there is a sustained strengthening of the trade winds across much of the tropical Pacific, while during El Niño events there is a sustained weakening of the trade winds.



### Cloudiness near the Date Line

Cloudiness near the Date Line has remained above-average during the first half of September.

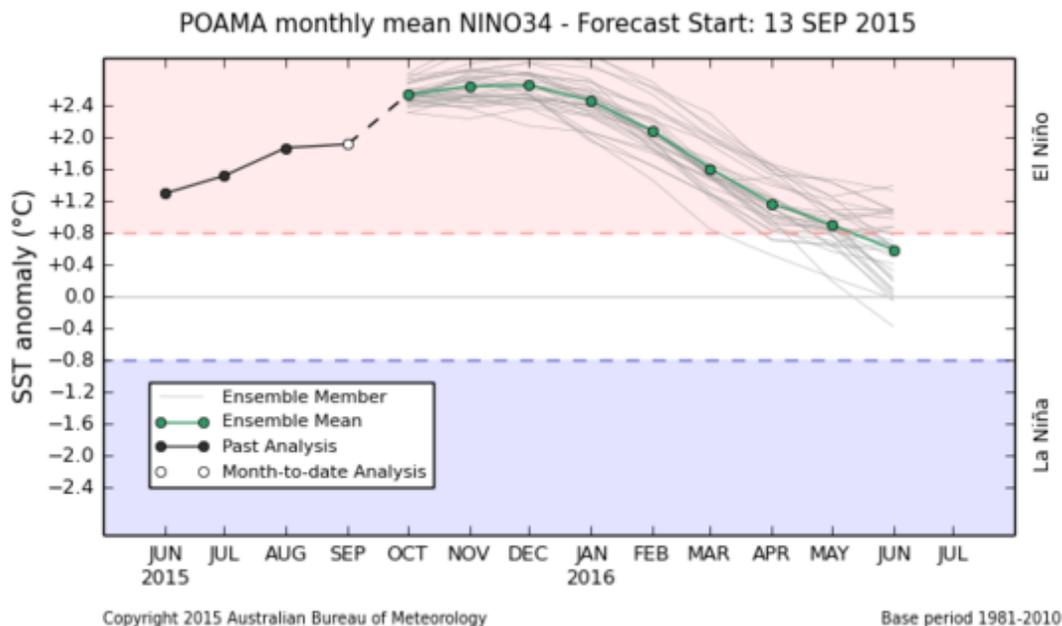
Cloudiness along the equator, near the Date Line, is an important indicator of ENSO, as it typically increases (negative OLR anomalies) near and to the east of the Date Line during El Niño and decreases (positive OLR anomalies) during La Niña.



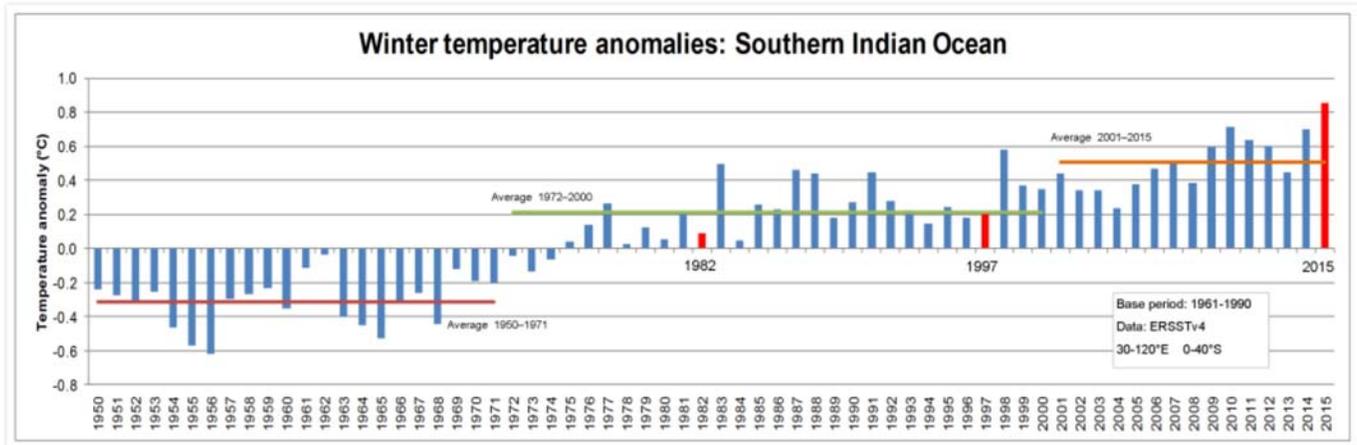
## Model outlooks

Most of the eight international [climate models](#) surveyed by the Bureau indicate there is likely to be some further warming of central Pacific Ocean before the peak value of this event is reached. About half the models indicate the event may plateau during spring and early summer.

All surveyed models indicate that NINO3.4 will remain above El Niño thresholds through the first quarter of 2016. The surveyed models indicate values of NINO3.4 are likely to begin to decline during early to mid-summer, but remain above the threshold value until at least early autumn.



## Indian Ocean Dipole



Timeseries graph of winter SST anomalies

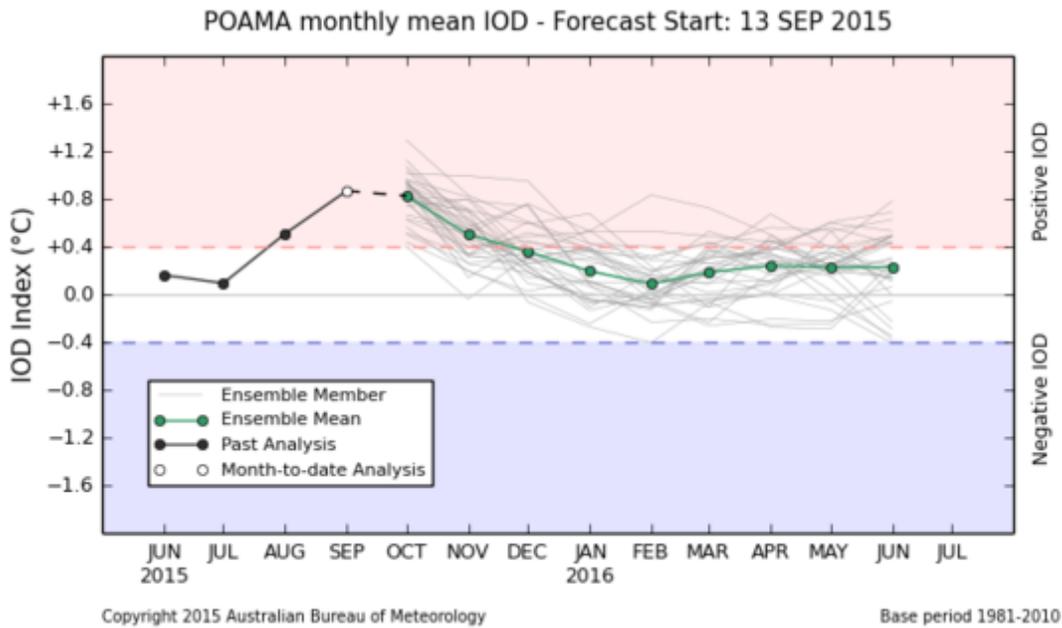
Values of the Indian Ocean Dipole (IOD) index have been at or above the threshold level of  $+0.4\text{ }^{\circ}\text{C}$  for six weeks. The weekly value of the IOD index to 13 September was  $+0.97\text{ }^{\circ}\text{C}$ . This is the highest weekly value since the very strong positive IOD event of 2006.

Sea surface temperatures (SSTs) in the Indian Ocean are warmer than average over much of the basin, and the southern Indian Ocean as a whole has been at record temperatures in recent months (see timeseries of winter anomalies). Typically, a positive IOD event is characterised by cooler-than-average water off the coast of the Indonesian island of Sumatra (see [About the Indian Ocean Dipole](#)).

Positive IOD events are often associated with lower rainfall in parts of central and southeastern Australia. Positive IOD events are more likely to occur during El Niño, which also is typically associated with a reduction in winter–spring rainfall in eastern Australia.

However, sea surface temperatures in the Indian Ocean basin also affect Australia's climate—it's likely that the widespread warm anomalies have moderated the influence of these two climate drivers (see [Climate Outlook](#)).

Most of the five surveyed international [climate models](#) indicate this event is likely to reach the threshold of eight weeks above  $+0.4\text{ }^{\circ}\text{C}$  required for 2015 to be considered a positive IOD year. Positive values of the IOD are likely to decay by early summer.



See also: [IOD forecasts](#)

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