Department of Agriculture and Food
Government of Western Australia

ENSO SUMMARY – 5th NOVEMBER 2007
'LA NINA CONDITIONS LIKELY TO PERSIST THROUGH TO THE END OF 2008'

Department of Agriculture and Food, Western Australia (DAFWA)
Climate Risks and Opportunities Project (CROP)

Monitoring the ENSO State

Sea surface temperatures (SST) and subsurface temperature anomalies in the eastern equatorial Pacific have exceeded La Niña thresholds in the eastern Pacific for the last three to four months. Consistent with established La Niña conditions the trade winds have remained stronger than normal and cloudiness has been below normal over much of the Pacific.

In October, above normal pressure was measured over much of the Pacific lower to mid-latitudes and this contrasted with below normal pressure over much of Indonesia and southern Australia. Accordingly, all four indices of the Southern Oscillation were positive (Fig. 1; see Appendix 1 for map). However, uncharacteristically for La Niña conditions, above normal atmospheric pressure was recorded near Darwin for the sixth consecutive month. Over this time drought has been recorded over much of Australia as cold SST to the north of Australia appeared to assist sinking motion and reduce moisture inflow into the region. In the last month the SST has warmed dramatically north of Australia and around the Maritime continent. As a result, the SOI now appears to be reaching positive values more consistent with a La Niña. Strongly positive EQSOI values since February (Fig.1) highlight the pronounced La Niña signature along the Equator in 2007.

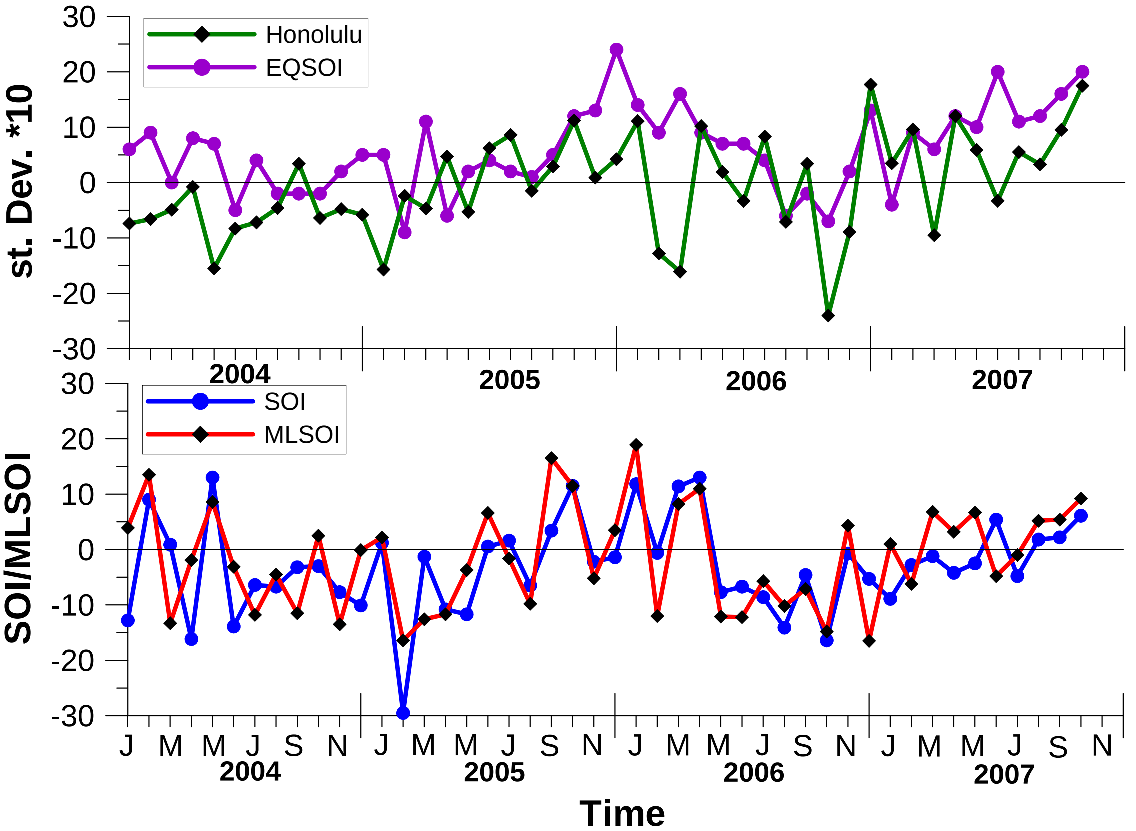


Figure 1. SOI, Midlatitude SOI (MLSOI), Equatorial SOI (EQSOI) and standardised Honolulu MSLP anomalies multiplied by 10.

The MeanSOI

The Southern Oscillation operates over two broad regions of oppositely-varying pressure (Berlage 1966)[1].To represent these two regions, DAFWA monitors a broadscale MeanSOI index (see Appendix 1 for a definition). In Figure 2, the MeanSOI is compared to the SOI, which suggests three advantages of the new index:

1) Less noise to signal ratio.
2) Can indicate ENSO state changes earlier; and
3) Reduced risk of false indications of ENSO events.

In October the MeanSOI increased to +12.6. The bi-monthly and seasonal mean values of the index were +10.3 and +8.9 respectively. The consistent difference between the SOI and the MeanSOI in 2007 is unprecedented for recent decades.

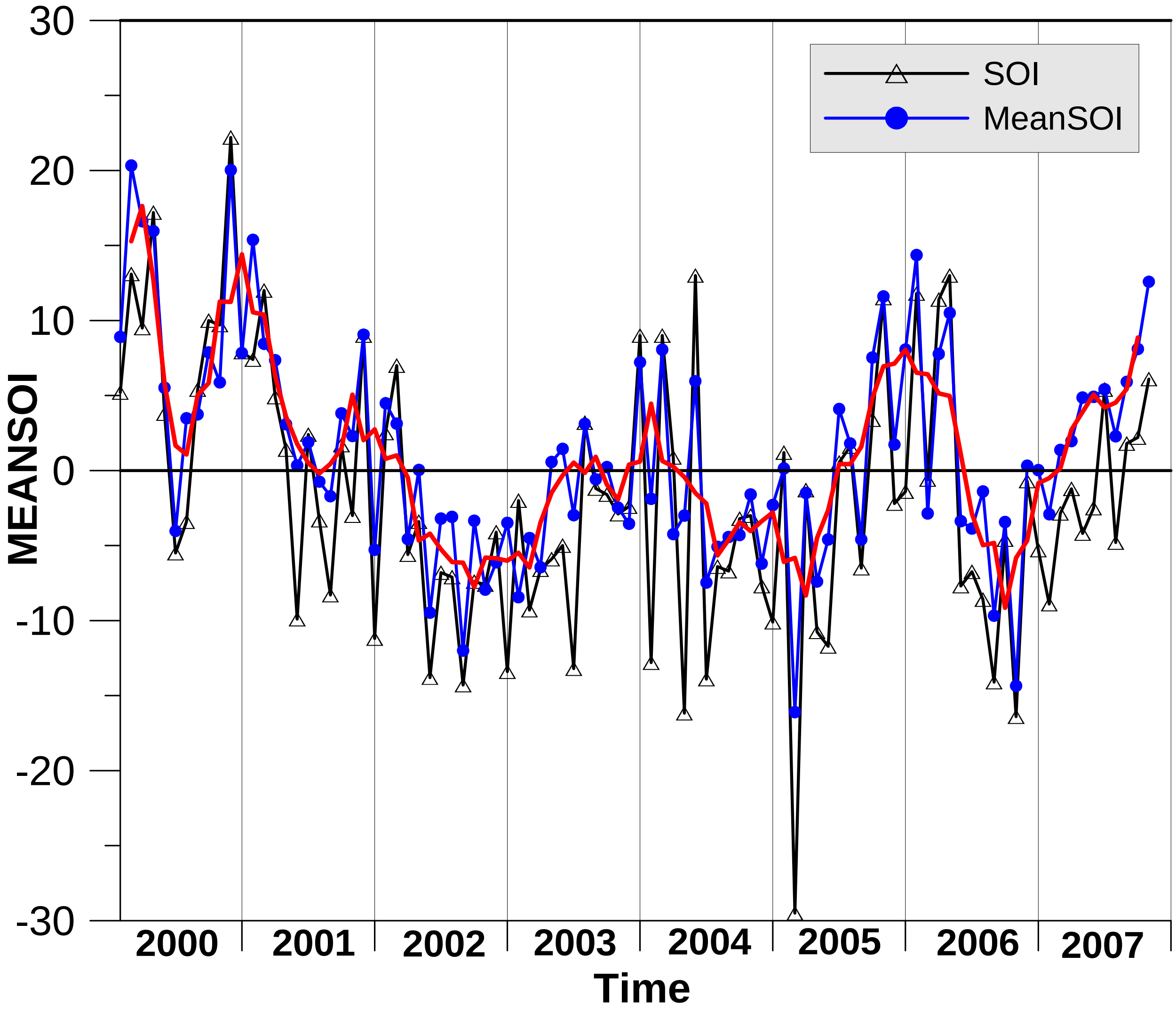


Figure 2. Monthly SOI and MeanSOI values from January 2000 to October 2007. Three month running mean of the MeanSOI is shown in red.

[1] Berlage, H.P. (1966). The Southern Oscillation and world weather. Mededlingen en Verhandelingen No. 88, Koninklikk Meteorologische Instituut, Staatsdrukkerijs-Gravenhage, Nederlands, 152 pp.

A Coupled ENSO Index (CEI*)

ENSO (El Niño Southern Oscillation) is a coupled ocean-atmosphere phenomenon. Past observations suggest that when these two components work together (are coupled), an ENSO event has normally developed. Prior to an El Niño developing, the MeanSOI falls and becomes negative either before, or as, Nino 3 becomes positive, e.g. 2002 (Figure 3). Conversely, for La Niña the opposite occurs. In the case when changes in the SST lead changes in the pressure by more than a month, an uncoupled system normally forms and ENSO conditions do not develop, as in 2001 and 2003. Gergis and Fowler (2005)[2] define a Coupled ENSO Index (CEI) from the combination of the SOI and Nino 3.4 SST. Figure 3 shows an equivalent index (CEI*) based on the combination of the standardised bi-monthly MeanSOI and the standardised monthly Nino 3 SST.

The CEI* illustrates that weak El Niño conditions were recorded in 2006, of similar magnitude to 2002. In March 2007 the ocean and atmosphere reversed their coupling and since then the pressure and oceanic indices have diverged in a manner similar to past La Niña events. A comparison between the curves shows that the oceanic component of this coupled event has recently been stronger than the atmospheric component. The CEI* has now kept on a rising trend for twelve months suggesting that a La Niña of moderate strength is developing.

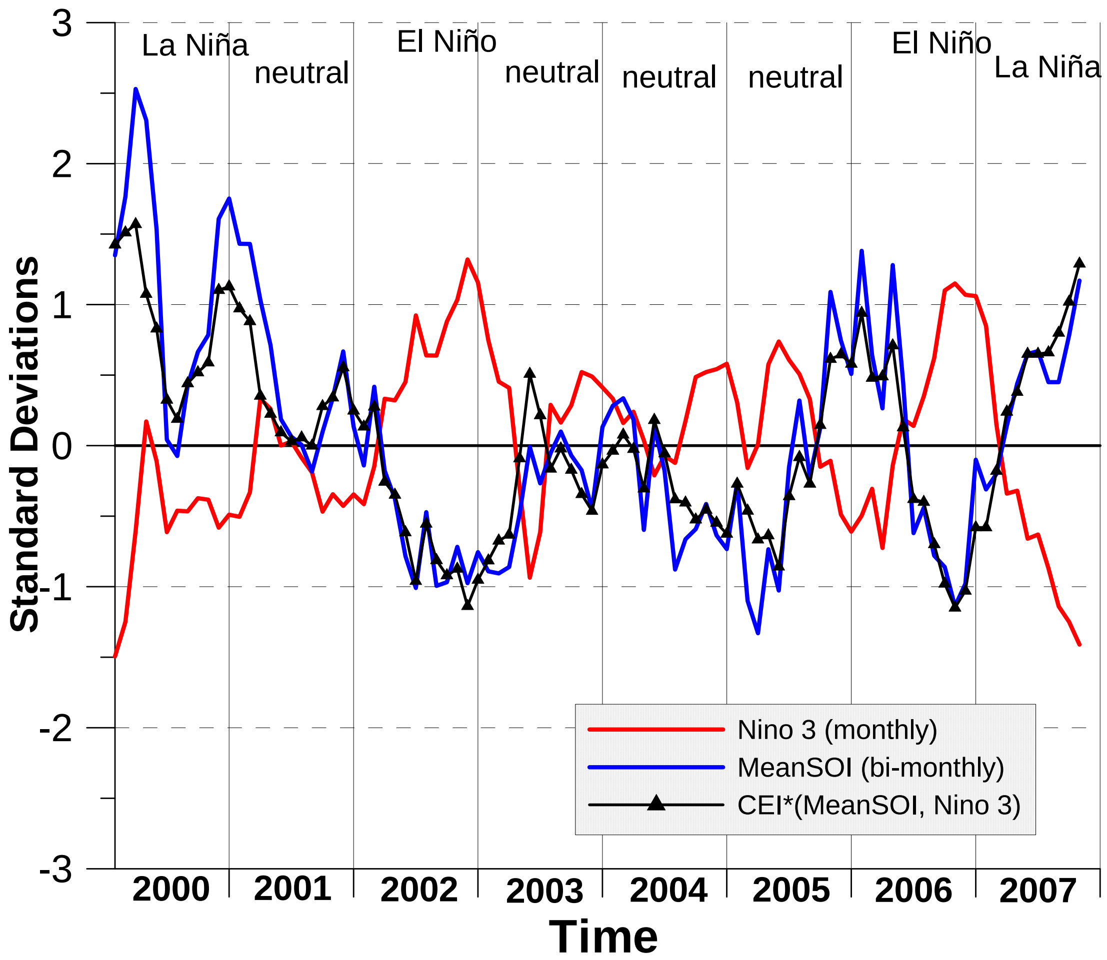


Figure 3. Normalised Nino 3 SST, MeanSOI and a Coupled ENSO Index (CEI*) values.

2 Gergis, J.L. and Fowler, A.M. (2005). Classification of synchronous oceanic and atmospheric El Niño Southern Oscillation (ENSO) events for palaeoclimate reconstruction, *Int. J. Climatol.*, **25,** 1541-1565.

The steady rise in the CEI* in 2007 has been a key indicator of a transition to La Niña conditions (Fig. 4a), compared to transitions to neutral conditions where the CEI* rose slowly, or decreased mid-year (Fig. 4b).

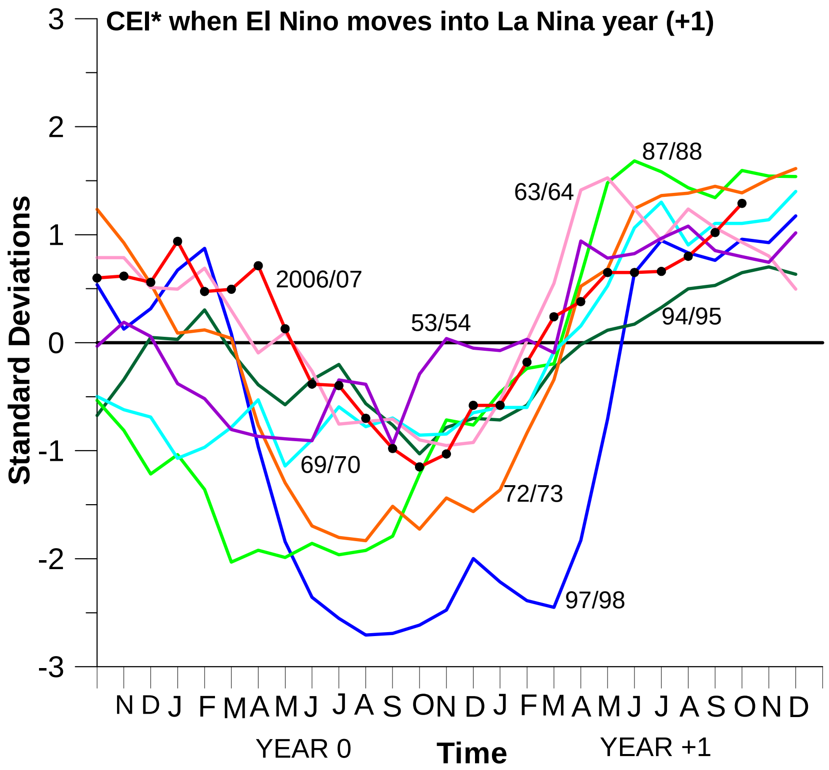


Figure 4a. Time series of monthly CEI* values for transitions from El Niño to La Niña.

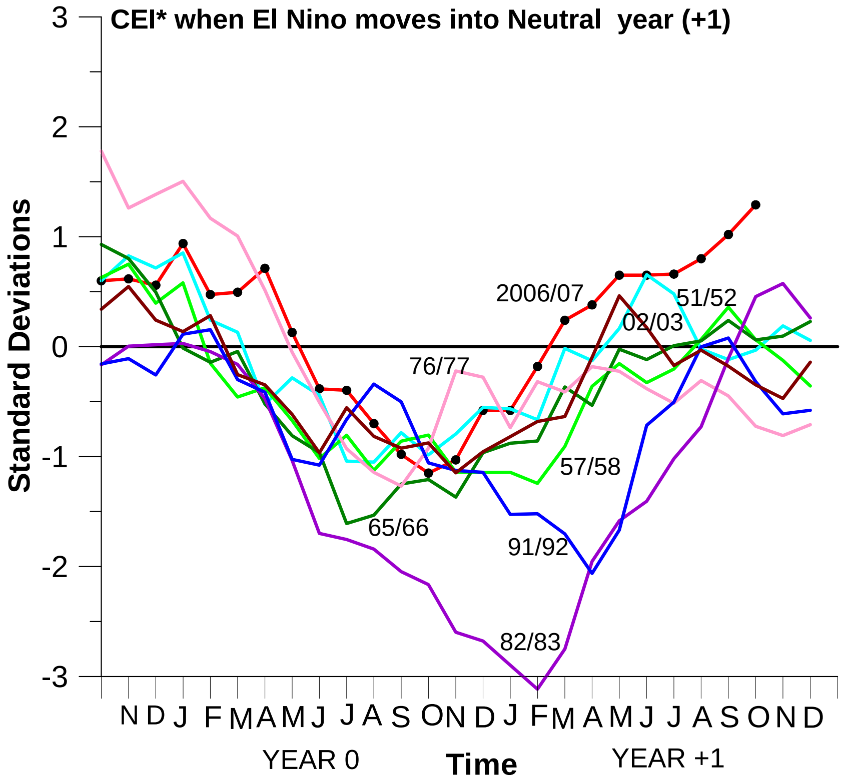


Figure 4b. Time series of monthly CEI* values for transitions from El Niño to neutral.

El Niño Prediction Index (EPI)

Future SST changes in the eastern equatorial Pacific can be indicated by an El Niño Prediction Index (EPI) which is finalised once a year in November. In Figure 5 the EPI is plotted against the change in SST in Nino 3 over the **following** year, i.e. point plotted is year after EPI is recorded.

The final value of the EPI for 2007 was +0.50. This suggests that the most likely change over the next year will be minimal (1< x >-1), i.e. a continuation of cool conditions (Figure 5). In November 2006, the EPI was +0.96 and the marked cooling that followed has been consistent with that seen in the year following an El Niño (plotted as blue diamonds). For positive values of the EPI there is a low chance of El Niño conditions following in the next year, i.e. only two cases where El Nino develops (1951, 1994), or a 3% (2/67) chance.

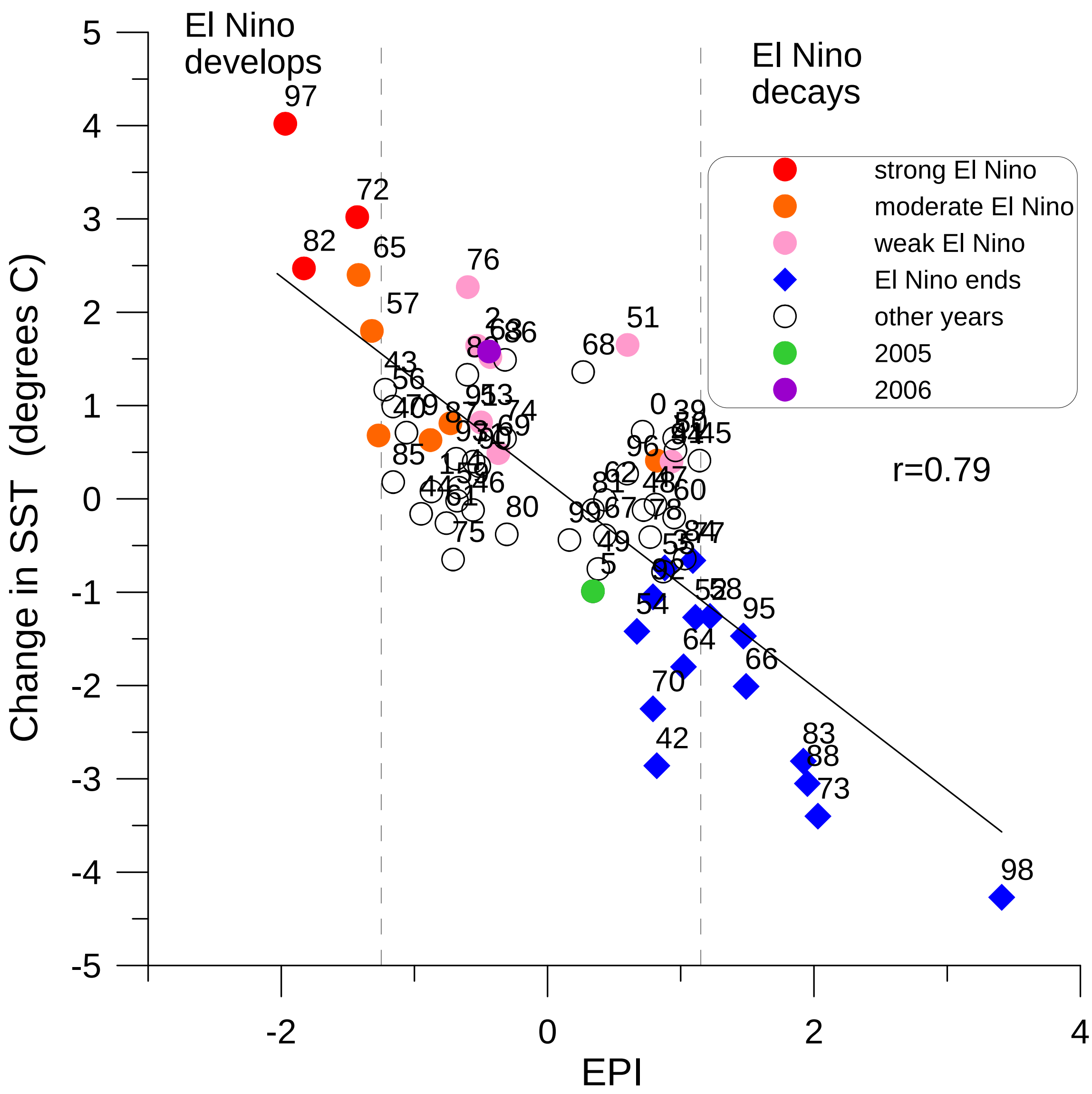


Figure 5. **Change in Nino 3 SST (from September-December one year to the same interval a year later) versus the EPI either: a) in El Niño – the largest positive standardised Nino 3 anomalies (July-September, or August-October); or b) non-El Niño conditions – the largest standardised seasonal pressure anomalies over south-eastern Australia (Alice Springs and Mildura) between July-September. Note: Year is labelled the year after the EPI is measured, e.g. very low EPI in 1996 preceded large warming that culminated at the end of 1997.**

Analogue years

Table 1 lists the five closest analogue years determined by the experimental ENSO Sequence System (ESS). The five variables that are factored into the analogue selection function are listed, along with the monthly weights for each variable. These weights are determined using a 'weighted space search' with the model calibrated to predict the mean CEI* in the following September-December. All five variable rankings are combined, with their monthly weights, to give an overall rank and similarity score. The similarity score uses a "closeness of fit" technique and measures how closely the five variables compare to the present pattern through a weighted sum of standard differences. This measure ranges from -2 (no similarity) to +2 (highly similar sequences) and acts like a standardised Z score.

Based on October data, four of the top five ranked analogues selected by the ESS have La Niña type conditions persisting (1948, 1954, 1995) or developing over the next 12 months (1947) (Table 1). Compared to a month ago the La Niña year of 1970 was replaced with the La Niña year of 1948, though 1970 should still be closely monitored as it has the most similar 9-month sequence of the CEI* compared to 2007. It is worth noting that when the neutral analogue of 1961 is compared to 2007 it had both: 1) smaller CEI* and ETI values, and 2) the opposite trend in the MeanSOI over the last six months.

Table 1. Most similar analogues ranked according to similarity score

Overall rank	Year	Similarity score	1. CEI 9-month sequence rank	2. CEI current month (rank)	3. EPI El Nino Prediction Index (rank)	4. ETI ENSO Transition Index 4-mo (rank)	5. Largest trend MeanSOI - 6 months (rank)
Month weight			**0.50**	**0.05**	**0.39**	**0.04**	**0.02**
1.	1947*	1.09	3	0.67 (17)	0.71 (11)	0.87 (11)	4.89 (8)
2.	1995*	1.01	11	0.65 (18)	0.62 (6)	0.48 (8)	6.46 (1)
3.	1954*	1.00	2	0.8 (13)	0.88 (21)	1.03 (15)	5.15 (6)
4.	1961	0.96	10	0.33 (30)	0.42 (4)	0.14 (22)	-2.72 (33)
5.	1948*	0.91	22	0.83 (11)	0.4 (5)	0.3 (16)	4.1 (14)
Current year	2007		-	1.29	0.50	0.67	6.14

* La Niña conditions present through much of the following year.

The analogue years suggest that the seasonal MeanSOI should remain positive for at least the next 12 months (Fig. 6). Both 1947 and 1948 had different pressure patterns to what has been observed in 2007, so appear less suitable as analogues of the Southern Oscillation.

The analogue years suggest that Nino 3 SST anomalies should weaken over Austral summer (boreal winter), but strengthen again later in 2008 (Fig. 7).

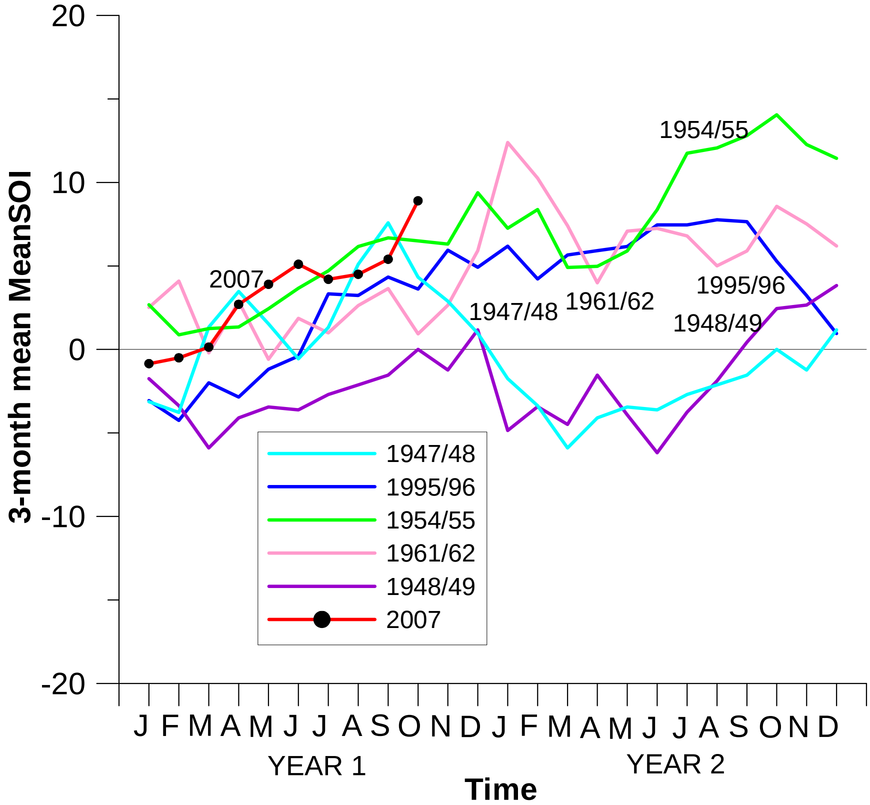


Figure 6. Time series of seasonal MeanSOI values for analogues selected by the ESS.

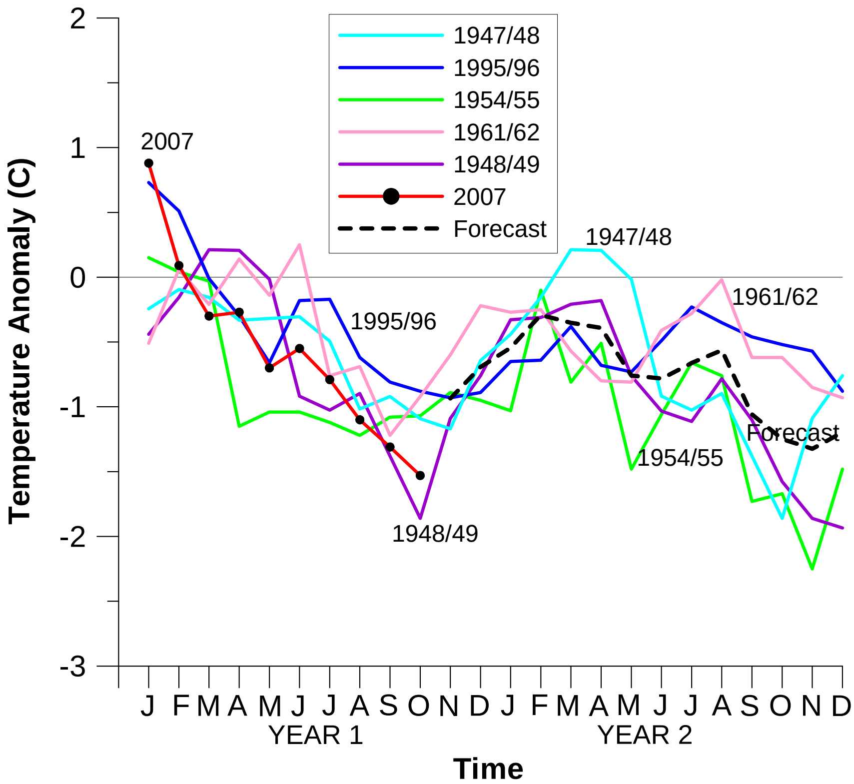


Figure 7. Time-series of Nino 3 SST anomalies for the most similar analogues to the present broad-scale circulation. The forecast of future SST changes is based on a simple mean of the five analogues and is shown with a dashed dark line.

In early November 2006, most atmosphere/Ocean models indicated that neutral to slightly warm conditions were likely by mid-2007. Since that time Nino 3 SST anomalies have followed the middle of the DAFWA analogue projections until June, before exceeding the minimum of the expected range in the last few months (Fig. 7).

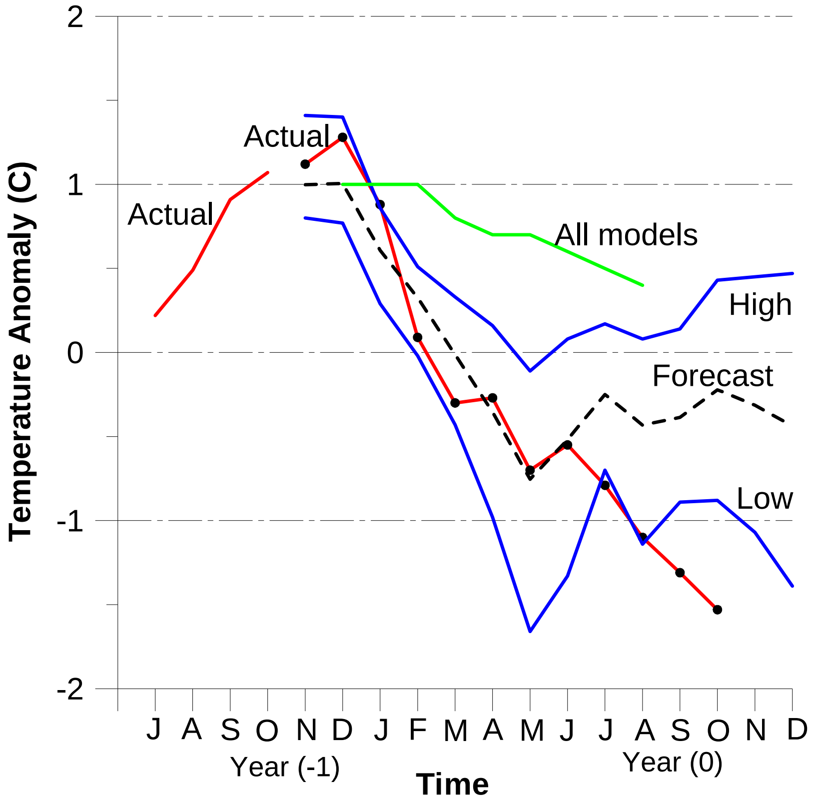


Figure 7. Predictions of Nino 3 SST anomalies based on selected analogues on the 7th November 2006, along with verification values since that time (red line). "All model" represents the average of all operational ENSO models summarised in the IRI ENSO Prediction Plume –15th November 2006. However, a direct comparison with "All models" is difficult as the seasonal mean for the Nino 3.4 region is plotted (compared to monthly values of Nino 3 from ESS).

Summary

Atmospheric and oceanic conditions in the Pacific Ocean are now consistent with a developing Niña of moderate strength. Lingering high pressures over Australia have meant that the oceanic indicators of this ENSO event have had a stronger signal than the Southern Oscillation. A recent warming of SST to the north of Australia has coincided with more consistent "La Niña values" of the SOI. DAFWA analogue years suggest that cool to La Niña type conditions are likely to persist until the end of 2008. The majority of the modelled ENSO projections from other organisations are predicting La Niña conditions to persist into early 2008.

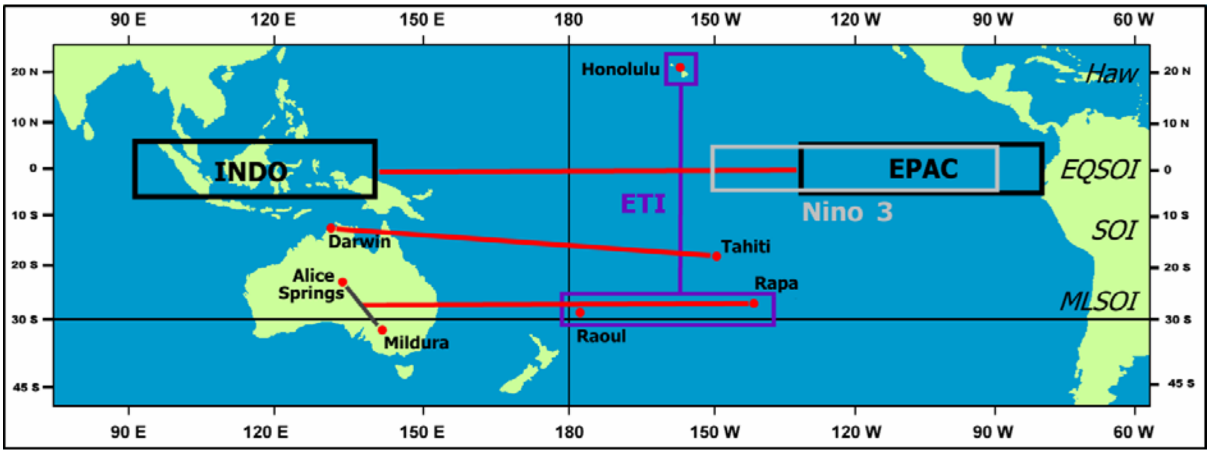
Also see:

http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/enso_advisory/index.shtml

http://www.bom.gov.au/climate/enso/

http://iri.columbia.edu/climate/ENSO/currentinfo/SST_table.html

Appendix 1



The MeanSOI is a measure of the Southern Oscillation and is the average of the EQSOI along the equator, the SOI (near 15°S), the Mid-latitude SOI (MLSOI) near 30°S, and standardised pressure anomalies at Honolulu, Hawaii (21°N, 158°W). The ENSO transition Index (ETI) monitors pressure changes in the north and south central Pacific that precede ENSO events early in the year, i.e.

MeanSOI = ((EQSOI + SOI + MLSOI + 0.5*(Honolulu sd MSLPA*10))/3.5

where MSLPA is mean sea level pressure anomalies. Such an index gives equal weighting to the seven regions where MSLP is measured in the Indo Pacific region, i.e. Darwin, Tahiti, Indonesia (INDO), the eastern equatorial Pacific (EPAC), south-eastern Australia, Rapa Island and Tahiti. The physical basis for a 'broad-scale' measure of the Southern Oscillation is discussed in Stephens et al. 2007[3]. The MLSOI is a measure of the strength of the South Pacific trough in the central south Pacific and measures the pressure difference between southeastern Australia (Alice Springs/Mildura) and Rapa Island (after van Loon and Shea, 1985[4]).

The ENSO Transition Index (ETI) is a measure of the strength of the North and South Pacific ridges and is calculated by:

ETI = (((Rapa sd MSLPA + Raoul sd MSLPA)/2) + (Honolulu sd MSLPA)) /2

Acknowledgements

Data for Raoul, Rapa Island, and Australian stations were kindly provided by NIWA Climate Services, Meteo-France and the Australian Bureau of Meteorology respectively. The EQSOI and Nino 3 SST were obtained from the Climate Prediction Centre (CPC) website, whilst Honolulu pressure was purchased from the National Climatic Data Centre (NCDC) website.

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[3] Stephens, D.J., M.J. Meuleners, H. van Loon, M.H. Lamond, and N.P. Telcik (2007). Differences in atmospheric circulation between the development of weak and strong warm events in the Southern Oscillation. *J. Climate,* **20,** 2191-2209.

[4] van Loon, H. and D.J. Shea (1985). The Southern Oscillation. Part 4, The precursors south of 15°S to the extremes of the oscillation. *Mon. Wea. Rev*., **113,** 2063-2074.