



ENSO Cycle: Recent Evolution, Current Status and Predictions

**Update prepared by
Climate Prediction Center / NCEP
11 July 2011**



Outline

- Overview
- Recent Evolution and Current Conditions
- Oceanic Niño Index (ONI) – **“Revised December 2008”**
- Pacific SST Outlook
- U.S. Seasonal Precipitation and Temperature Outlooks
- Summary



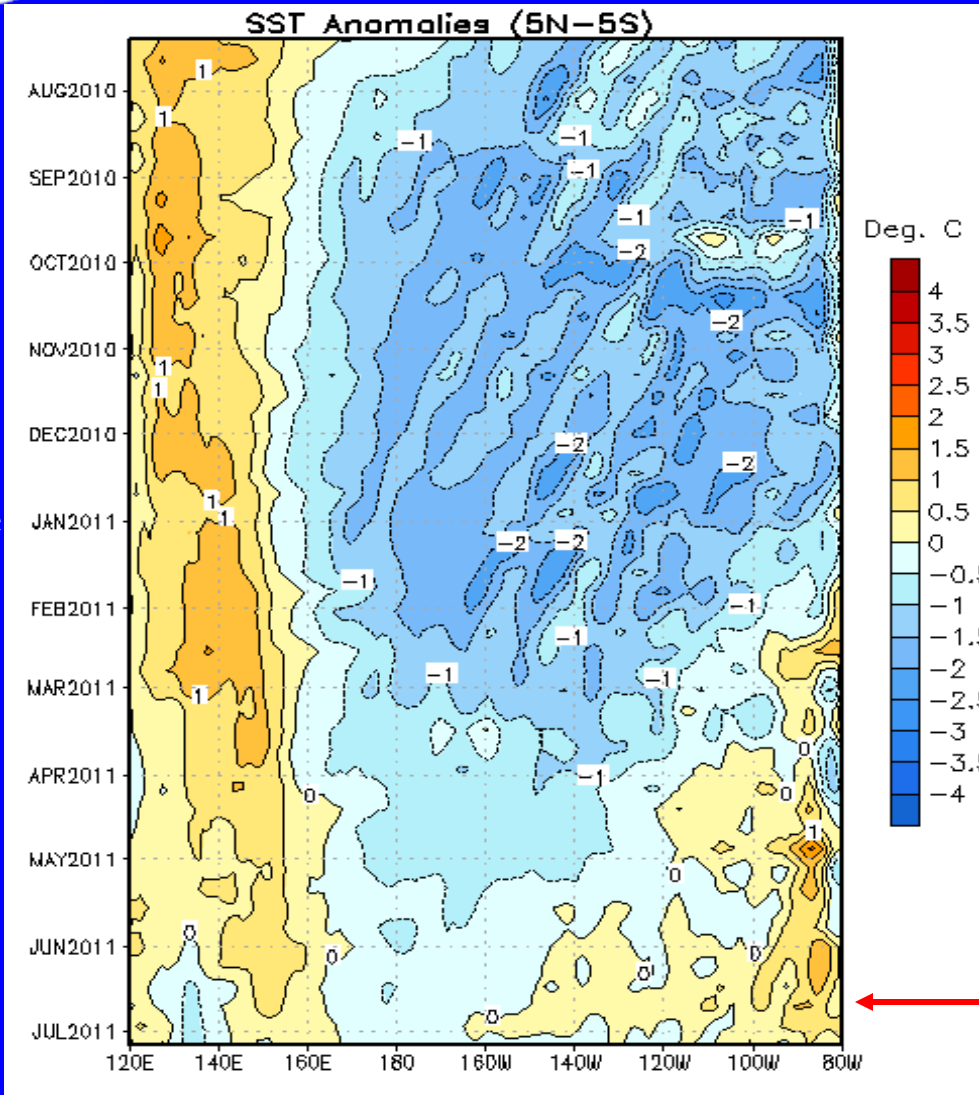
Summary

- **ENSO-neutral conditions are present across the equatorial Pacific.**
- **Sea surface temperatures (SST) are near-average across the central and east-central equatorial Pacific Ocean.**
- **Atmospheric circulation anomalies still reflect aspects of La Niña.**
- **ENSO-neutral conditions are expected to continue into the Northern Hemisphere fall 2011.**



Recent Evolution of Equatorial Pacific SST Departures (°C)

Time



Longitude

Since January 2011, negative SST anomalies have weakened in the central and eastern Pacific.

Recent equatorial SST anomalies are near zero across much of the Pacific, with positive anomalies in the far eastern Pacific.



Niño Region SST Departures (°C) Recent Evolution

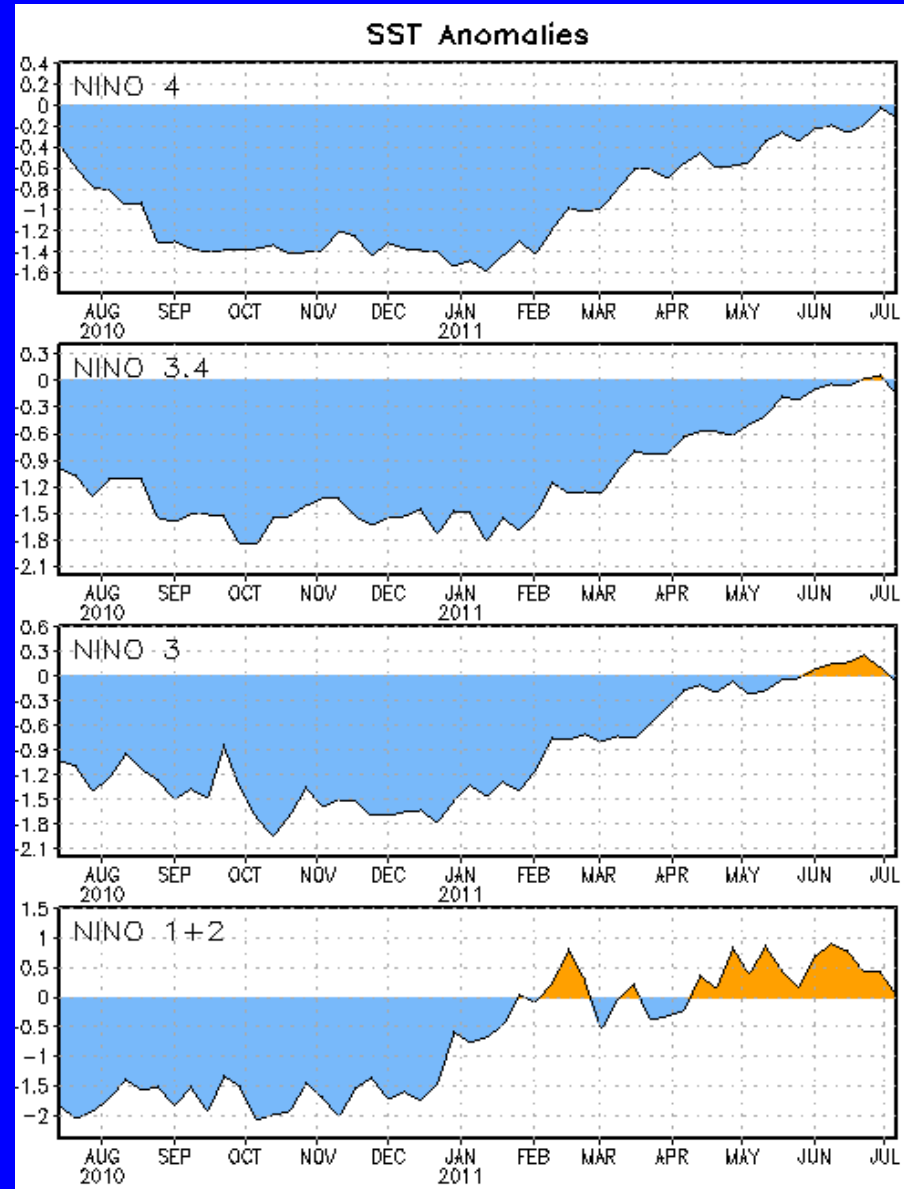
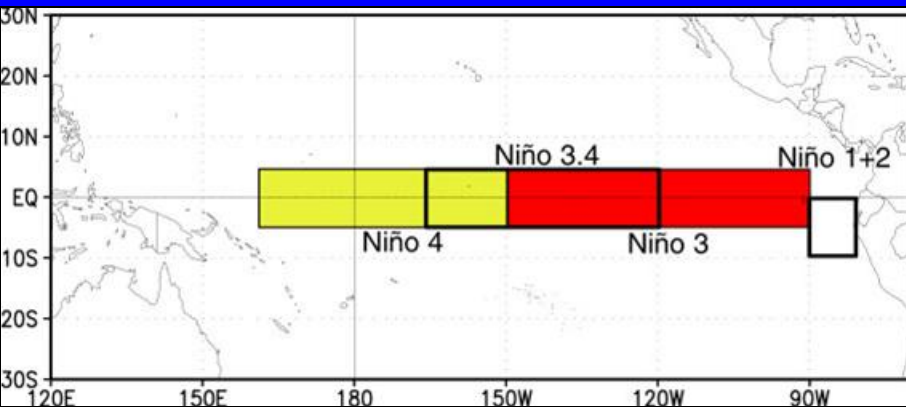
The latest weekly SST departures are:

Niño 4 -0.1°C

Niño 3.4 -0.1°C

Niño 3 -0.1°C

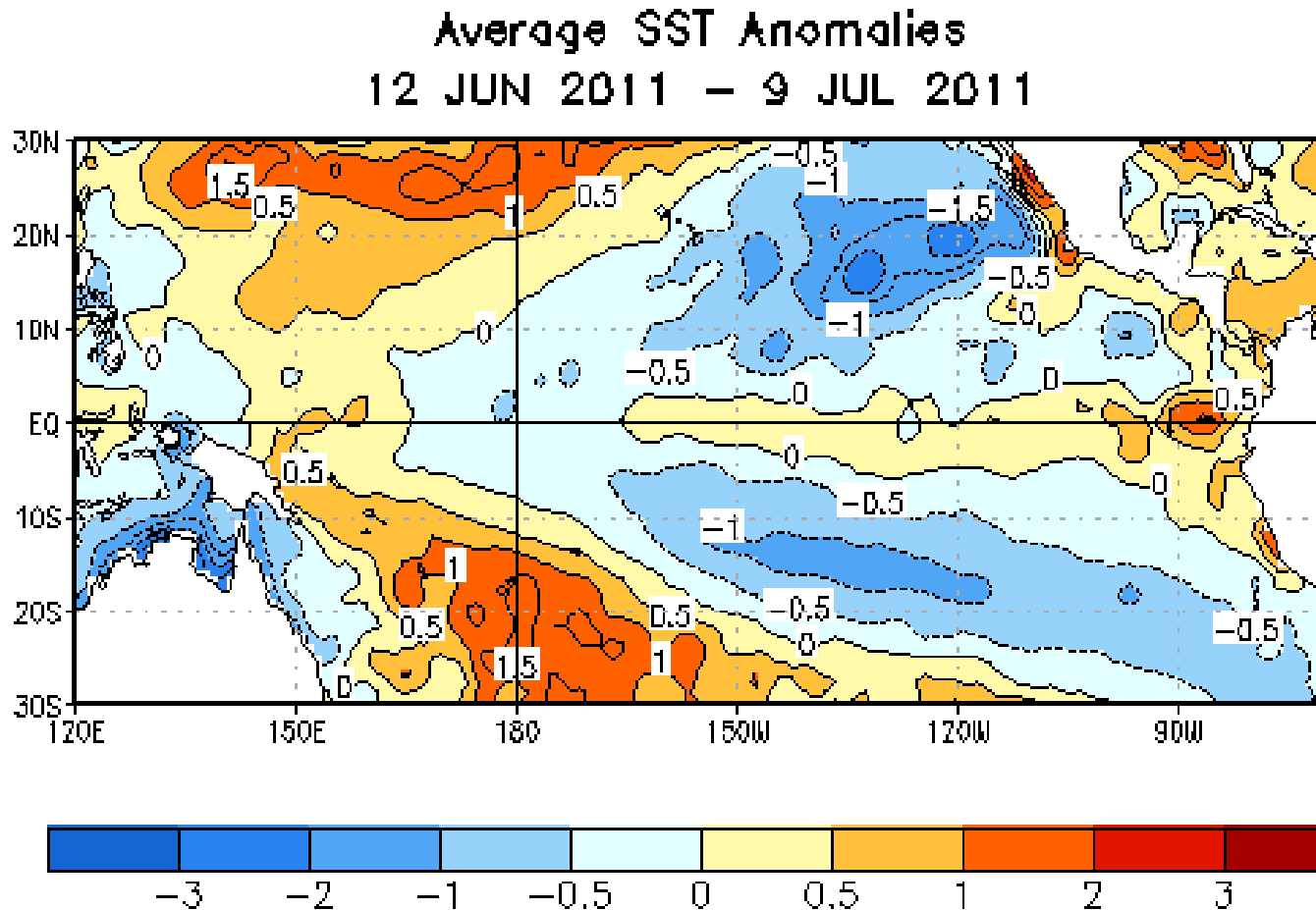
Niño 1+2 0.0°C





SST Departures (°C) in the Tropical Pacific During the Last 4 Weeks

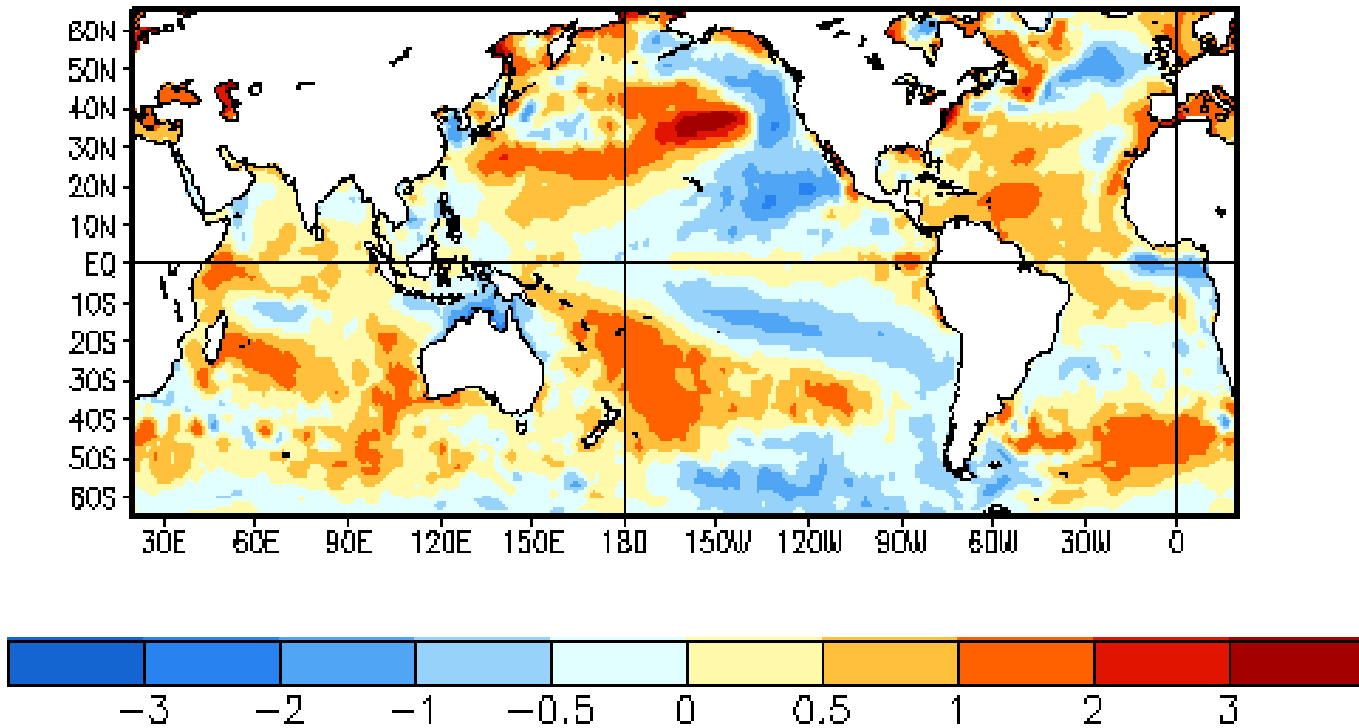
During the last 4-weeks, equatorial SSTs were near-average across the central and east-central Pacific Ocean.





Global SST Departures (°C)

Average SST Anomalies
12 JUN 2011 – 9 JUL 2011

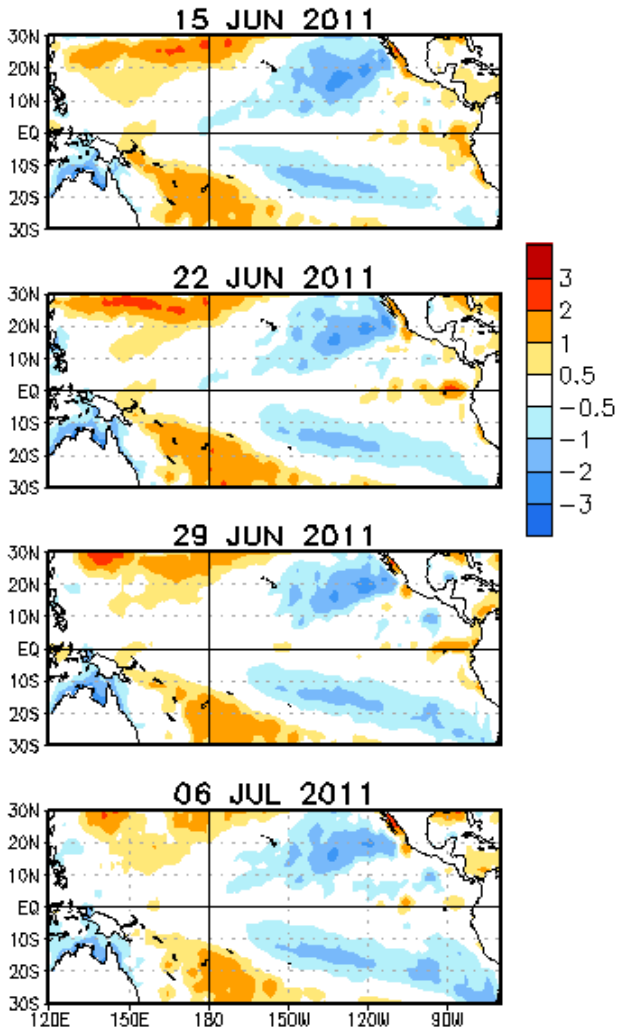


During the last four weeks, equatorial SSTs were above average across the Indian Ocean and western Atlantic Ocean. A horseshoe pattern of above-average SSTs extended from the Maritime Continent into the middle latitudes of the Pacific Ocean. Recently, below-average SSTs have emerged in the eastern equatorial Atlantic Ocean.



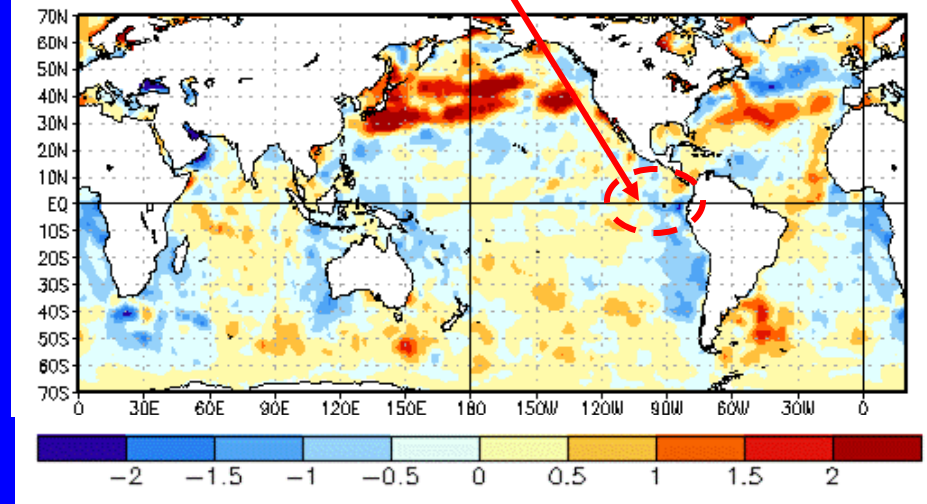
Weekly SST Departures (°C) for the Last Four Weeks

Weekly SST Anomalies (DEG C)



- During the last four weeks, equatorial SSTs were near-average across the Pacific.
- During the last 30 days, a decrease in far eastern Pacific SST anomalies was evident.

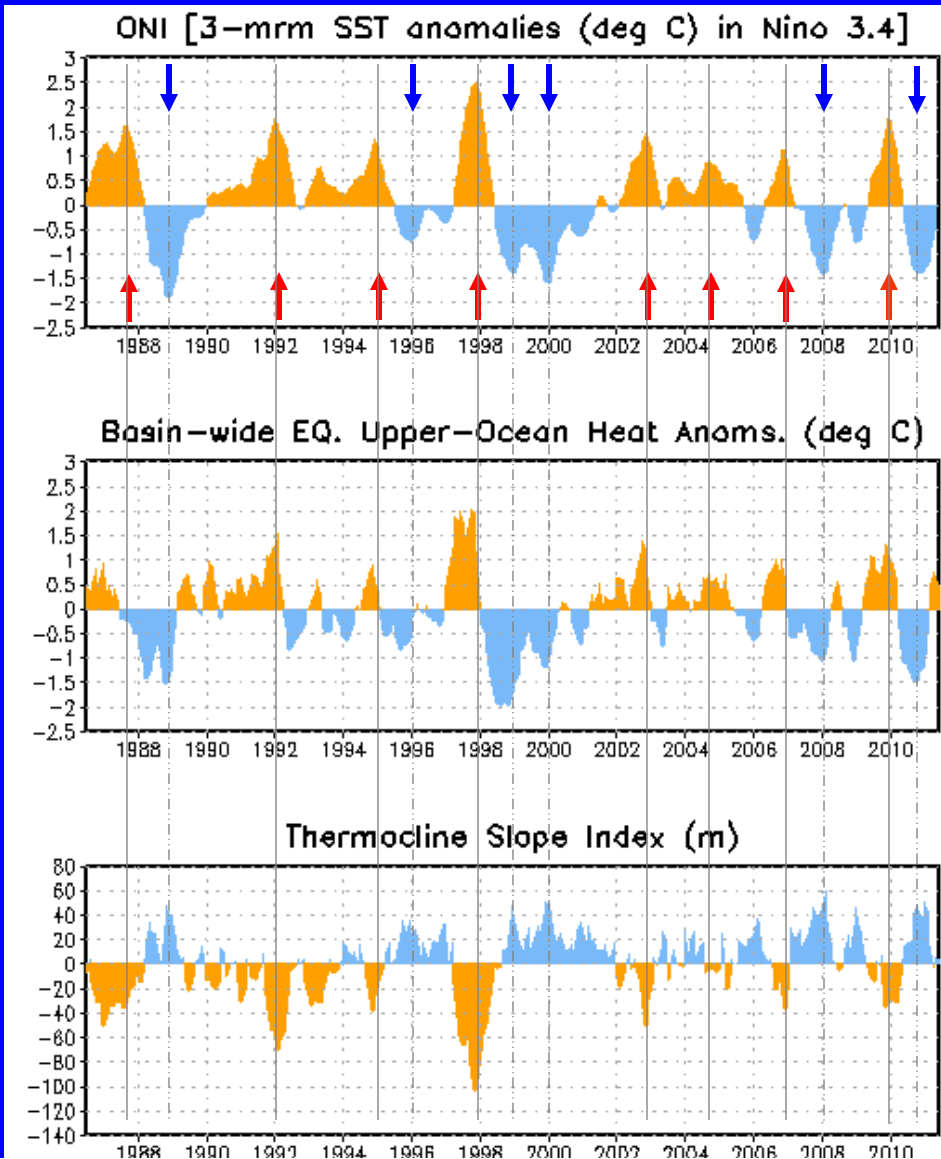
Change in Weekly SST Anoms (°C)
08JUL2011 minus 08JUN2011





Upper-Ocean Conditions in the Eq. Pacific

Cold Episodes ↓
Warm Episodes ↑



- The basin-wide equatorial upper ocean (0-300 m) heat content is **greatest** prior to and during the early stages of a Pacific **warm** (El Niño) episode (compare top 2 panels) and **least** prior to and during the early stages of a **cold** (La Niña) episode.

- The slope of the oceanic thermocline is least (greatest) during warm (cold) episodes.

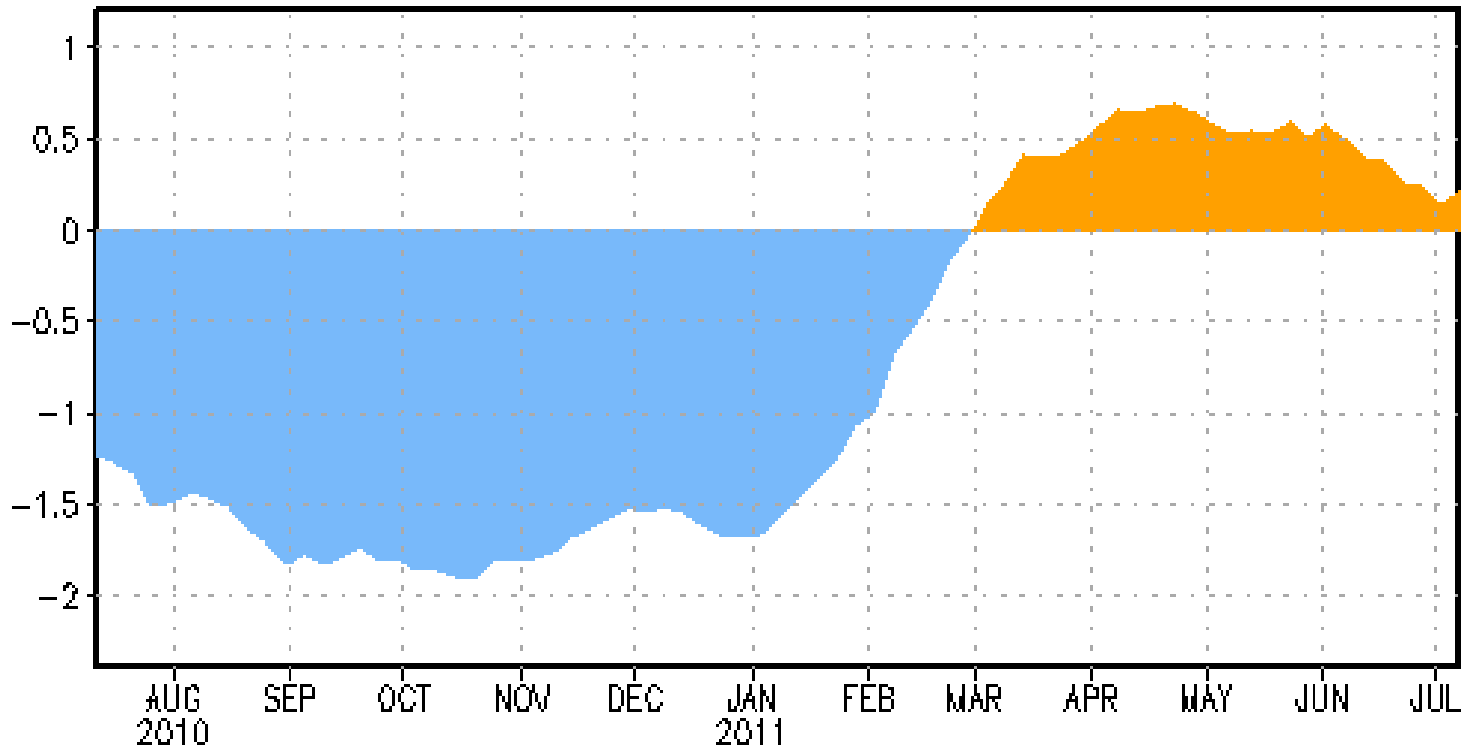
- Recent values of the upper-ocean heat anomalies (positive) and a near-zero thermocline slope index reflect ENSO-neutral conditions

The monthly thermocline slope index represents the difference in anomalous depth of the 20°C isotherm between the western Pacific (160°E-150°W) and the eastern Pacific (90°-140°W).



Weekly Central & Eastern Pacific Upper-Ocean (0-300 m) Average Temperature Anomalies

EQ. Upper-Ocean Heat Anoms. (deg C) for 180-100W



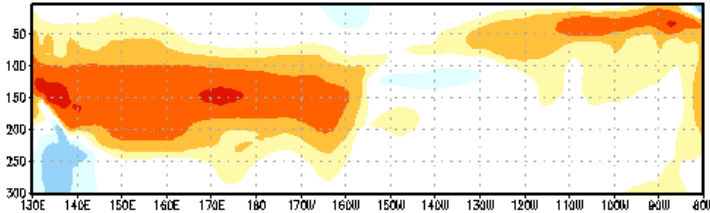
The negative anomalies in the last half of 2010 were consistent with La Niña. In January 2011 the negative anomalies began to decrease in magnitude, with positive anomalies evident since March 2011. Recently, the positive anomalies have been decreasing.



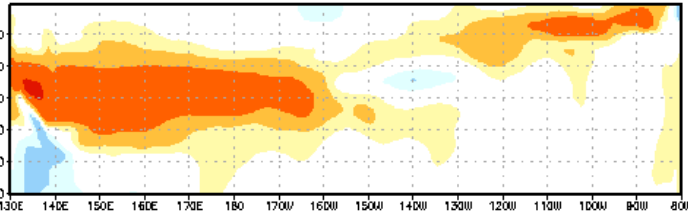
Sub-Surface Temperature Departures (°C) in the Equatorial Pacific

EQ. Subsurface Temperature Anomalies (deg C)

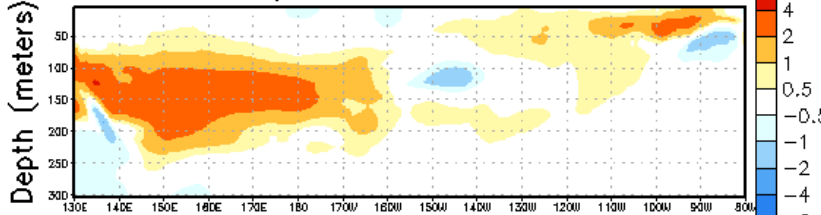
Three-pentad ave. centered on 18 MAY 2011



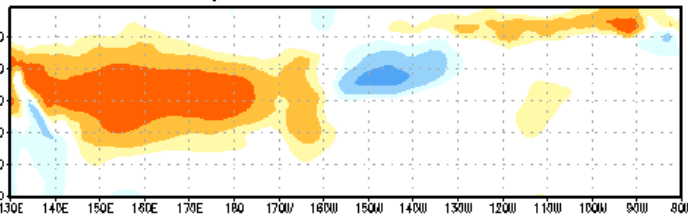
Three-pentad ave. centered on 02 JUN 2011



Three-pentad ave. centered on 17 JUN 2011



Three-pentad ave. centered on 02 JUL 2011



- Since mid May 2011, positive subsurface temperature anomalies (100-300m) have been observed across much of the Pacific Ocean, except in the east-central Pacific where negative anomalies have strengthened.
- In the recent period, the subsurface temperature anomalies show little change.

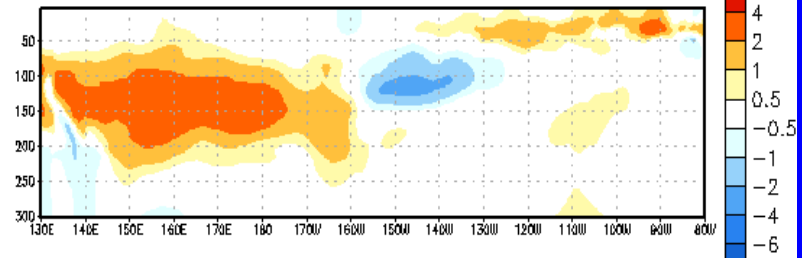
Time



Longitude

EQ. Subsurface Temperature Anomalies (deg C)

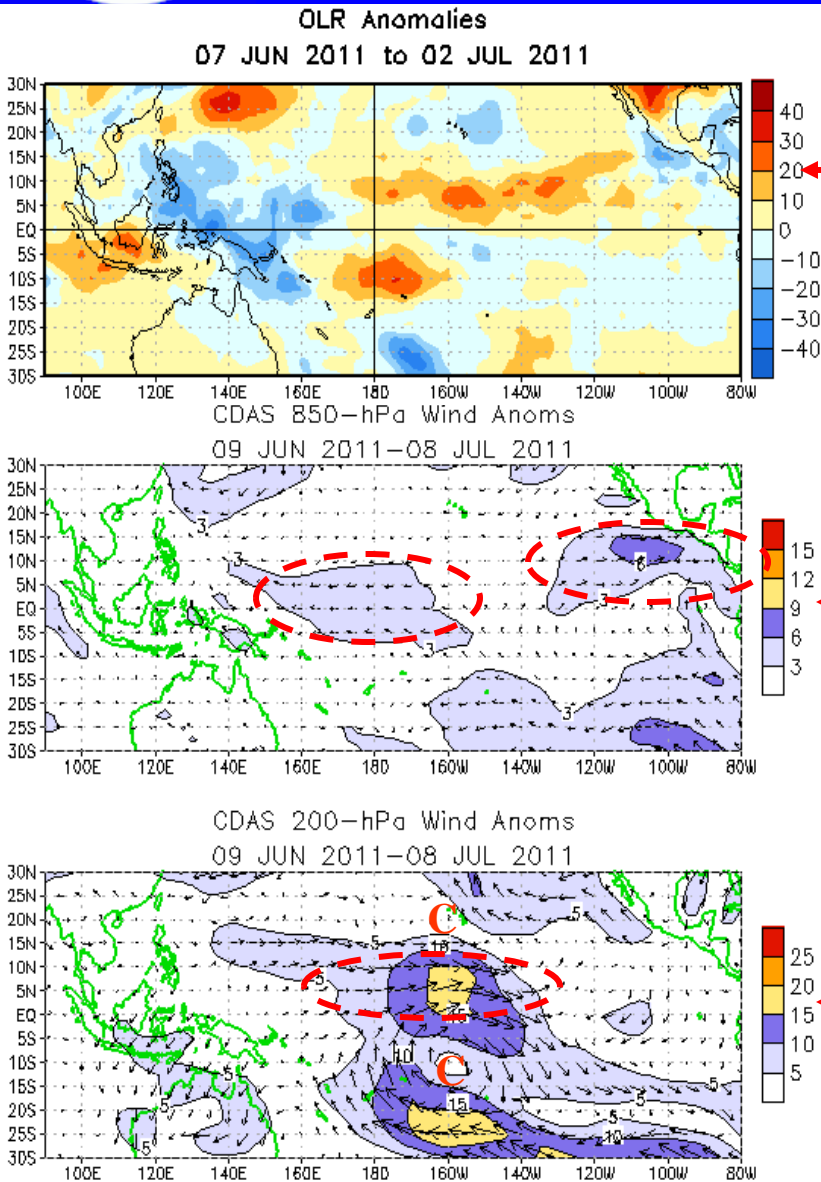
Pentad centered on 07 JUL 2011



Most recent pentad analysis



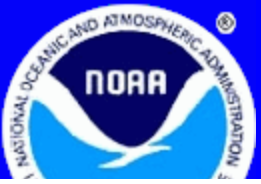
Tropical OLR and Wind Anomalies During the Last 30 Days



Negative OLR anomalies (enhanced convection and precipitation, blue shading) were located over the Philippines, the southwest North Pacific, and over Papua New Guinea. Positive OLR anomalies (suppressed convection and precipitation, red shading) were located near the Date Line, north and south of the equator.

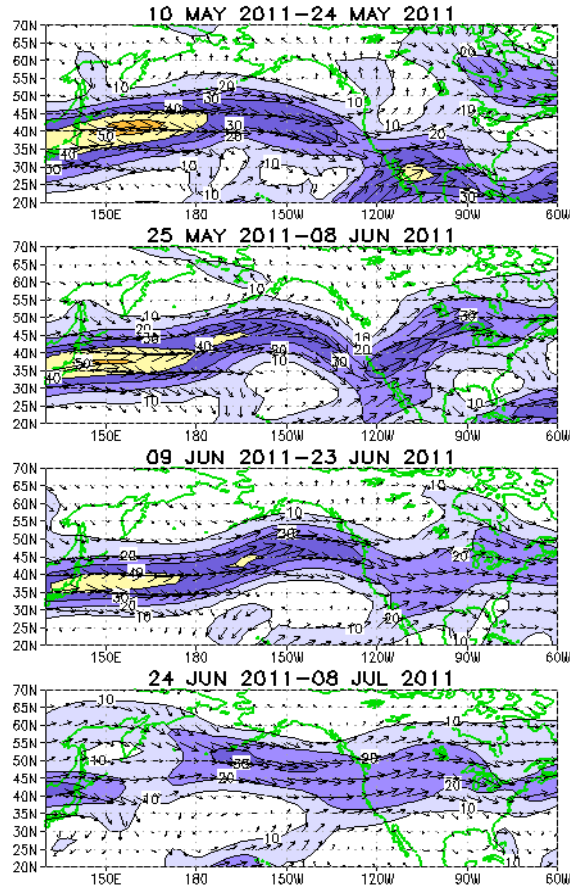
Low-level (850-hPa) easterly anomalies were observed over the west-central tropical Pacific. Anomalous westerlies were evident across the eastern tropical Pacific, centered north of the equator.

Upper-level (200-hPa) westerly anomalies were observed over much of the central Pacific. Anomalous cyclonic circulation centers remain in the subtropics of both hemispheres.

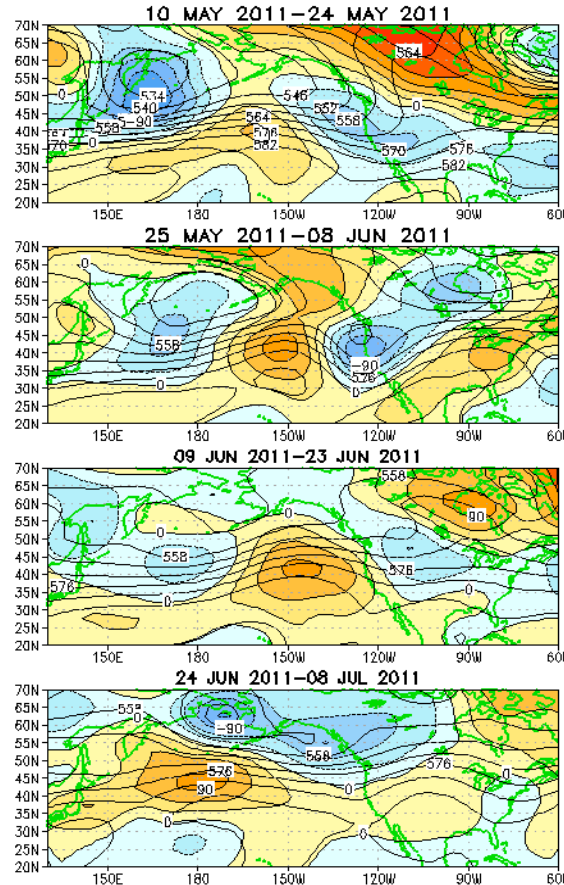


Atmospheric Circulation over the North Pacific & North America During the Last 60 Days

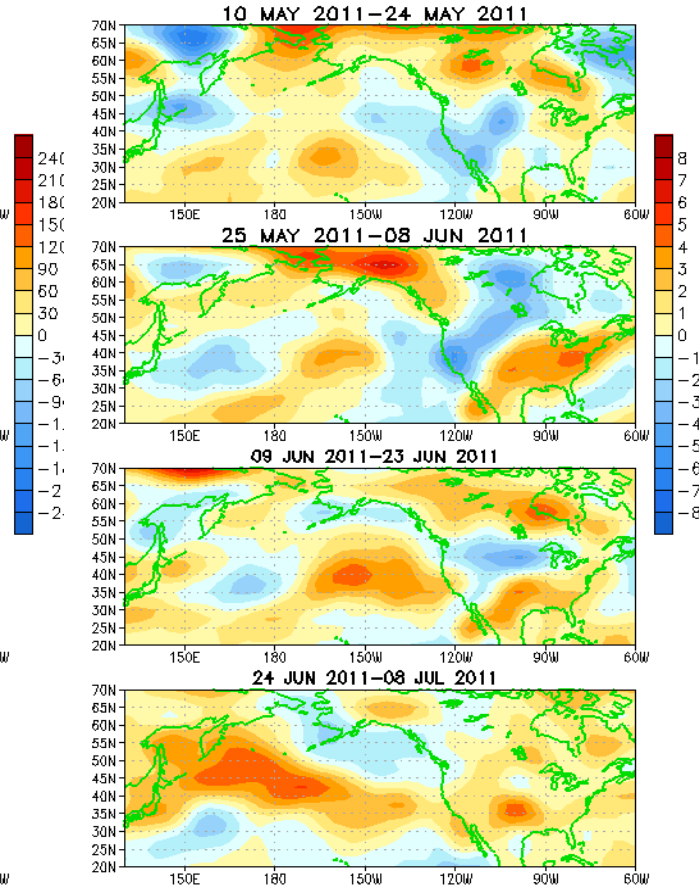
200-hPa Wind



500-hPa Height & Anoms.



925-hPa Temp. Anoms. (°C)



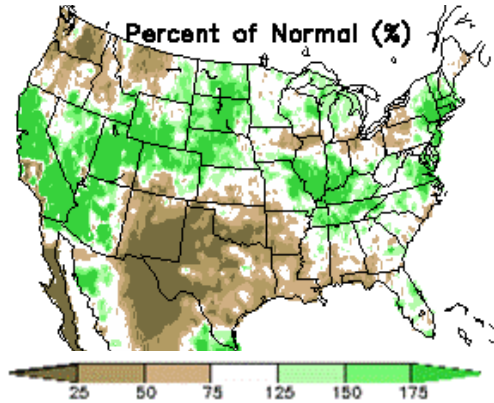
From mid May through mid July, 500-hPa heights were below-average near western N. America and/or over the northern U.S./southern Canada, which contributed to the prevalence of below-average temperatures over the Pacific Northwest and the northern tier of states. Meanwhile, during most of the period, ridging and above-average temperatures prevailed over the southeastern United States.



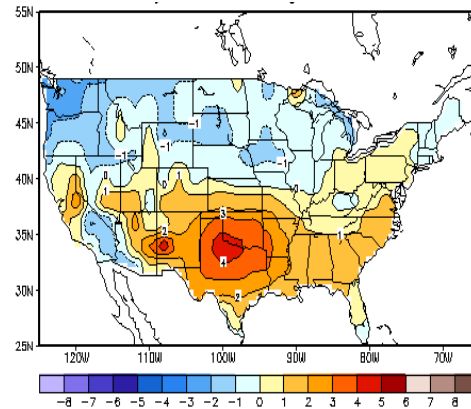
U.S. Temperature and Precipitation Departures During the Last 30 and 90 Days

Last 30 Days

30-day (ending 10 July 2011) % of average precipitation

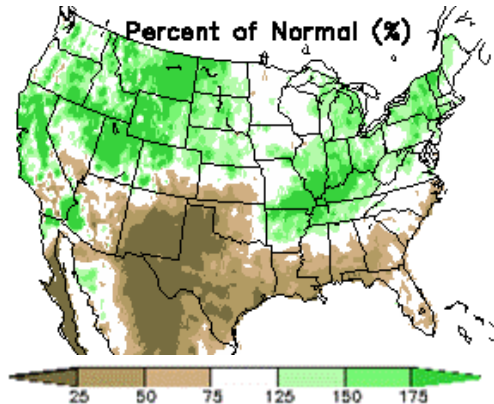


30-day (ending 9 July 2011)
temperature departures (degree C)

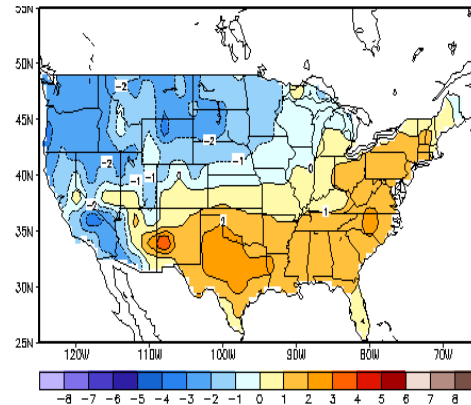


Last 90 Days

90-day (ending 10 July 2011) % of average precipitation



90-day (ending 9 July 2011)
temperature departures (degree C)



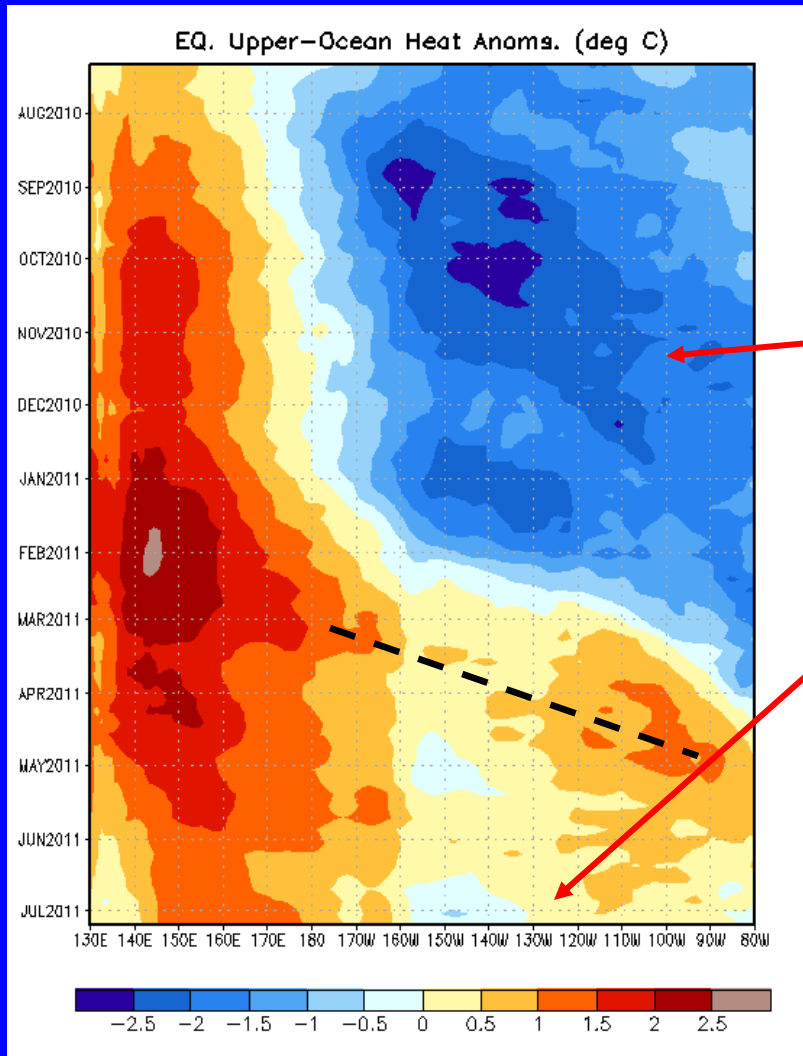


Intraseasonal Variability

- **Intraseasonal variability in the atmosphere (wind and pressure), which is often related to the Madden-Julian Oscillation (MJO), can significantly impact surface and subsurface conditions across the Pacific Ocean.**
- **Related to this activity**
 - **significant weakening of the low-level easterly winds usually initiates an eastward-propagating oceanic Kelvin wave.**



Weekly Heat Content Evolution in the Equatorial Pacific



- From May 2010- January 2011, negative heat content anomalies extended across the equatorial Pacific in association with La Niña.

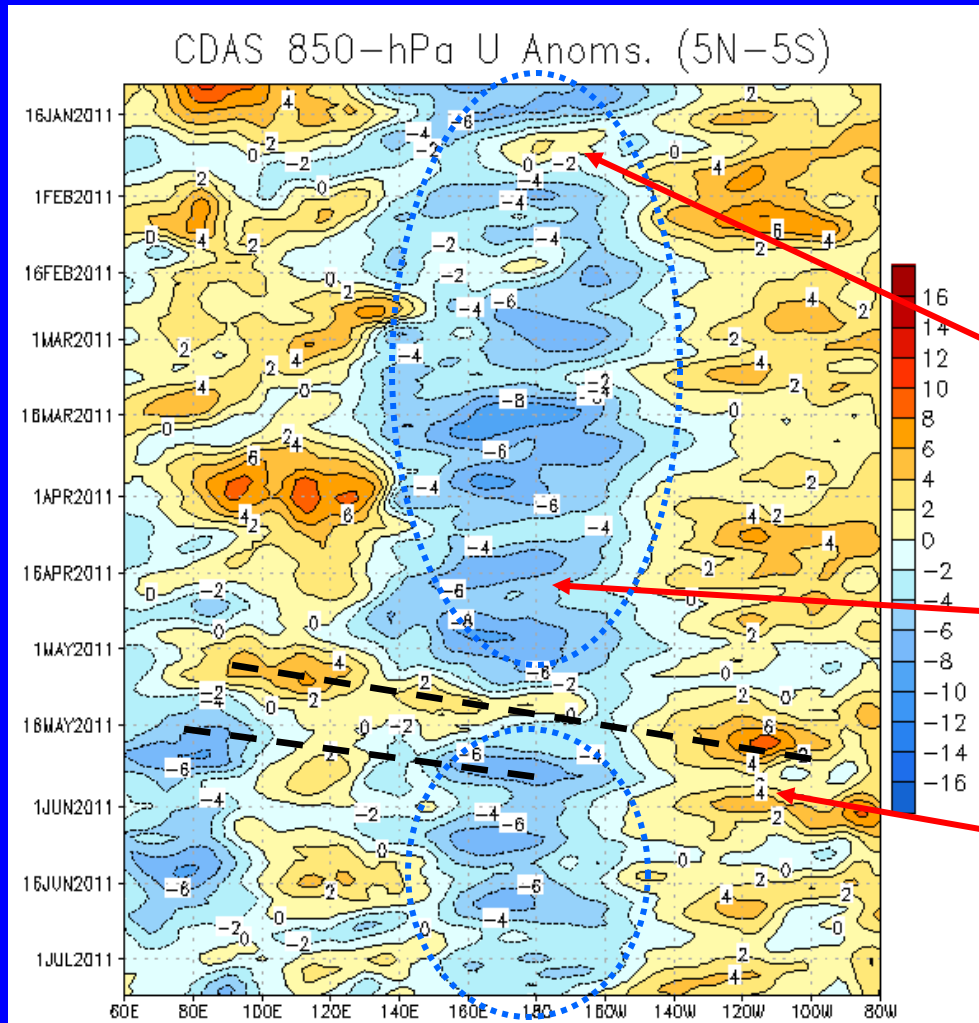
- Since February 2011, the heat content has been above-average, especially across the western Pacific.

- Recently, a weakening of the positive heat content anomalies is evident.

- Oceanic Kelvin waves have alternating warm and cold phases. The warm phase is indicated by dashed lines. Down-welling and warming occur in the leading portion of a Kelvin wave, and up-welling and cooling occur in the trailing portion.



Low-level (850-hPa) Zonal (east-west) Wind Anomalies (m s^{-1})



Westerly wind anomalies (orange/red shading).

Easterly wind anomalies (blue shading).

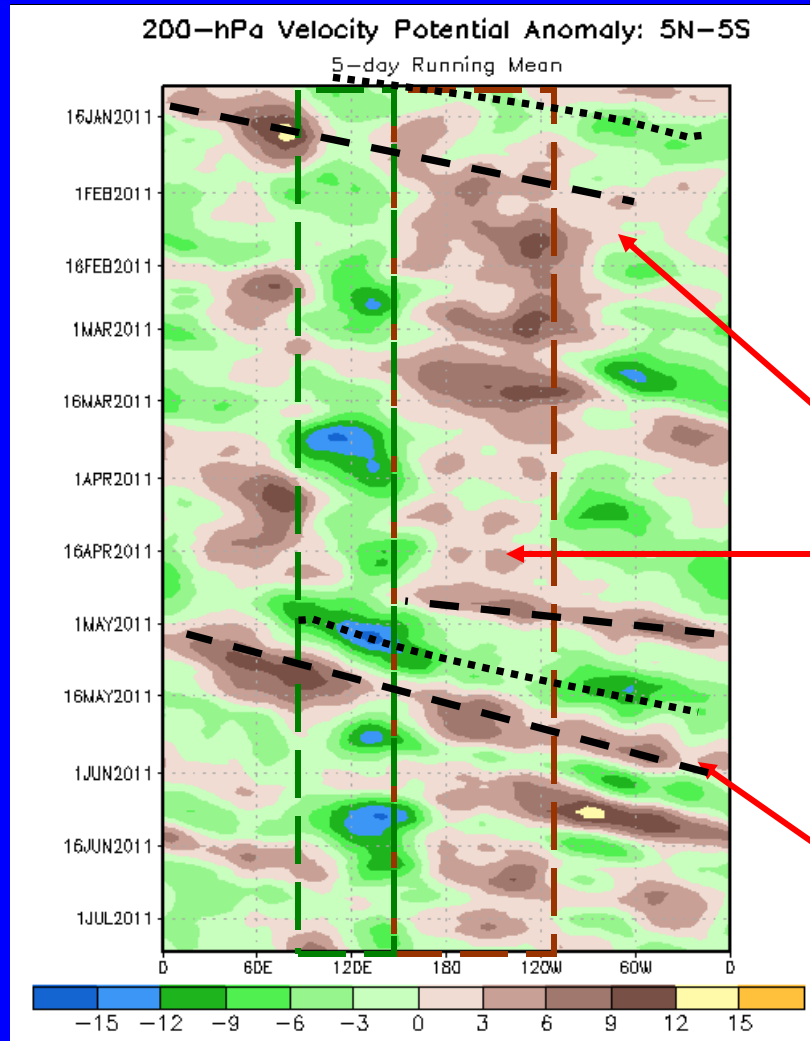
In late January 2011, weakening of the easterly wind anomalies (light blue) and weak westerly wind anomalies (yellow) occurred in conjunction with Madden Julian Oscillation (MJO) activity.

Since March 2010, low-level easterly wind anomalies have persisted over the western and central equatorial Pacific.

During May 2011, the MJO contributed to increased variability across the western and central Pacific Ocean.



200-hPa Velocity Potential Anomalies (5°N-5°S)



Positive anomalies (brown shading) indicate unfavorable conditions for precipitation.

Negative anomalies (green shading) indicate favorable conditions for precipitation.

During January 2011, MJO activity influenced the pattern of velocity potential anomalies.

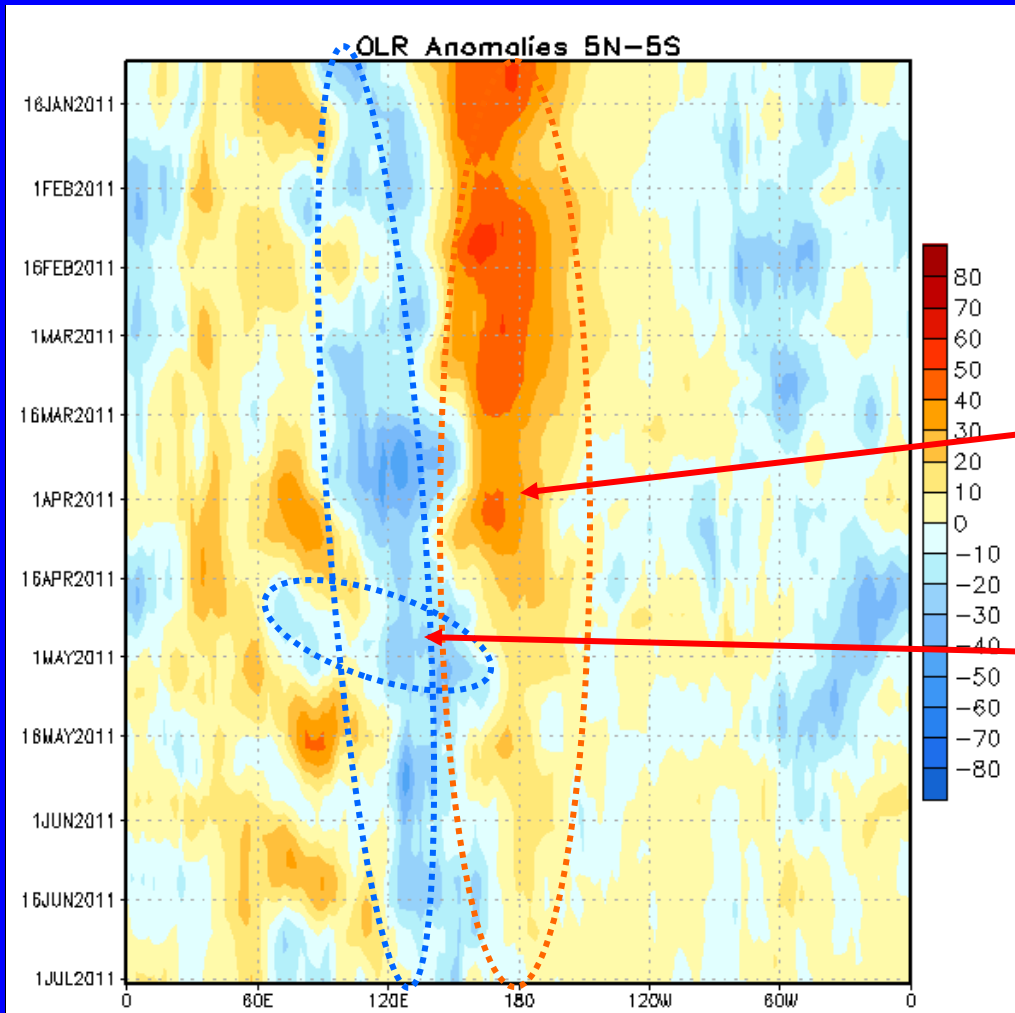
Since May 2010, persistent upper-level convergence anomalies (brown) were evident over the central Pacific, while anomalous upper-level divergence (green) generally prevailed over the Maritime Continent.

During May 2011, the eastward shift of the velocity potential anomalies reflected the MJO.



Outgoing Longwave Radiation (OLR) Anomalies

Time



Longitude

Drier-than-average conditions (orange/red shading)

Wetter-than-average conditions (blue shading)

Since April 2010, negative OLR anomalies have been observed near the Maritime Continent and positive OLR anomalies have prevailed over the western and central Pacific.

The eastward shift of negative OLR anomalies from the Indian Ocean to the western Pacific is consistent with the MJO.



Oceanic Niño Index (ONI)

- The ONI is based on SST departures from average in the Niño 3.4 region, and is a principal measure for monitoring, assessing, and predicting ENSO.
- Defined as the three-month running-mean SST departures in the Niño 3.4 region. Departures are based on a set of improved homogeneous historical SST analyses (Extended Reconstructed SST – **ERSST.v3b**). The SST reconstruction methodology is described in Smith et al., 2008, *J. Climate*, vol. 21, 2283-2296.)
- Used to place current events into a historical perspective
- NOAA's operational definitions of El Niño and La Niña are keyed to the ONI index.



NOAA Operational Definitions for El Niño and La Niña

El Niño: characterized by a *positive* ONI greater than or equal to +0.5 C.

La Niña: characterized by a *negative* ONI less than or equal to -0.5 C.

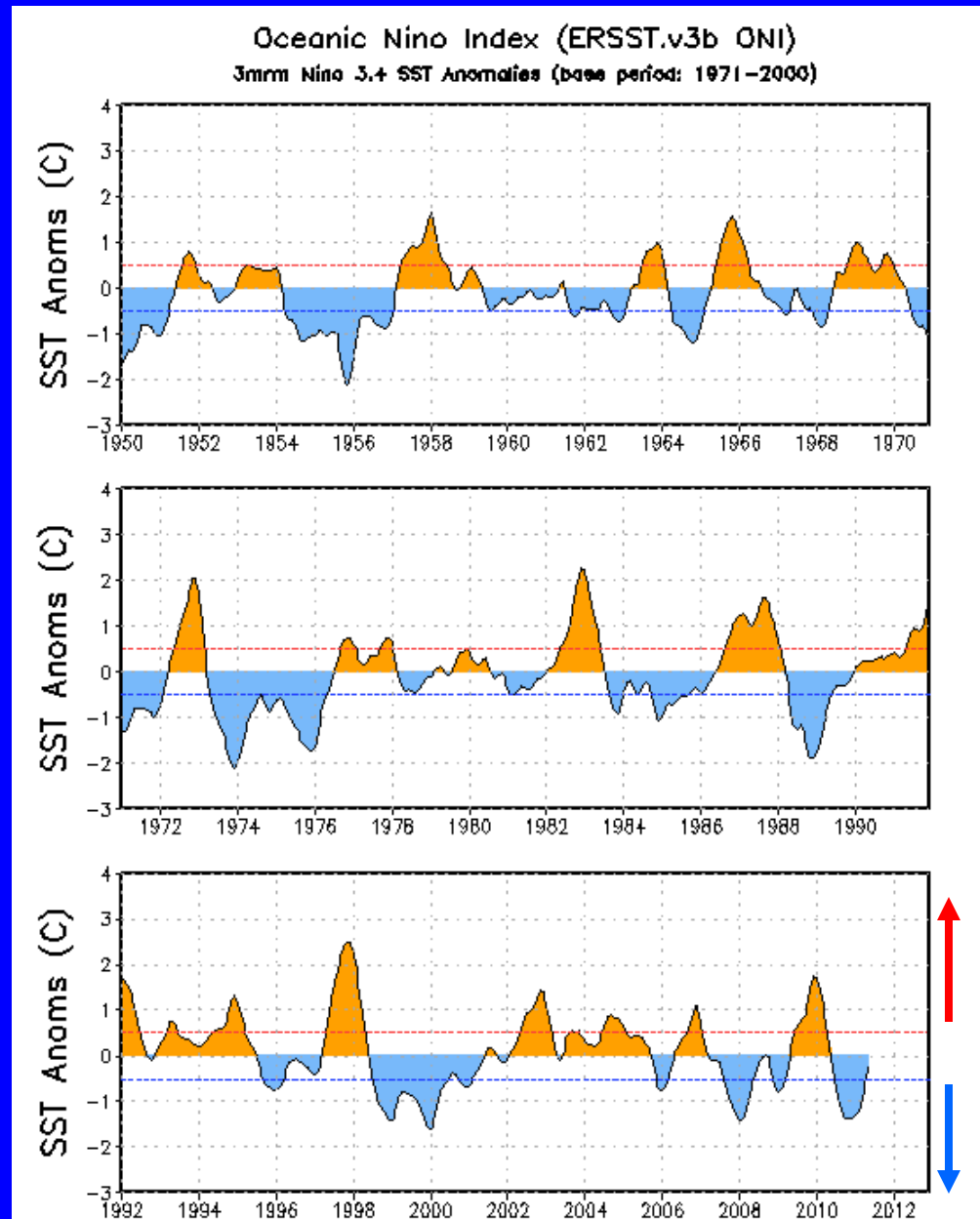
By historical standards, to be classified as a full-fledged El Niño or La Niña episode, these thresholds must be exceeded for a period of at least 5 consecutive overlapping 3-month seasons.

CPC considers El Niño or La Niña conditions to occur when the monthly Niño3.4 OISST departures meet or exceed +/- 0.5°C along with consistent atmospheric features. These anomalies must also be forecasted to persist for 3 consecutive months.



ONI (°C): Evolution since 1950

The most recent ONI value (April – June 2011) is -0.2°C .





Historical El Niño and La Niña Episodes

Based on the ONI computed using ERSST.v3b

Highest		Lowest	
<u>El Niño</u>	<u>ONI Value</u>	<u>La Nina</u>	<u>ONI Value</u>
JAS 1951 - NDJ 1951/52	0.8	ASO 1949 – FMA 1951	-1.7
MAM 1957 – MJJ 1958	1.7	MAM 1954 – DJF 1956/57	-2.1
JJA 1963 – DJF 1963/64	1.0	ASO 1962 – DJF 1962/63	-0.8
MJJ 1965 – MAM 1966	1.6	MAM 1964 – DJF 1964/65	-1.1
OND 1968 – MJJ 1969	1.0	NDJ 1967/68 – MAM 1968	-0.9
ASO 1969 – DJF 1969/70	0.8	JJA 1970 – DJF 1971/72	-1.3
AMJ 1972 – FMA 1973	2.1	AMJ 1973 – MAM 1976	-2.0
ASO 1976 – JFM 1977	0.8	SON 1984 – ASO 1985	-1.0
ASO 1977 - DJF 1977/78	0.8	AMJ 1988 – AMJ 1989	-1.9
AMJ 1982 – MJJ 1983	2.3	ASO 1995 – FMA 1996	-0.7
JAS 1986 – JFM 1988	1.6	JJA 1998 – MJJ 2000	-1.6
AMJ 1991 – JJA 1992	1.8	SON 2000 – JFM 2001	-0.7
AMJ 1994 – FMA 1995	1.3	ASO 2007 – AMJ 2008	-1.4
AMJ 1997 – AMJ 1998	2.5	JJA 2010 – MAM 2011	-1.4
AMJ 2002 – FMA 2003	1.5		
MJJ 2004 – JFM 2005	0.9		
JAS 2006 - DJF 2006/07	1.1		
MJJ 2009 – MAM 2010	1.8		

NOTE:

After updating the ocean analysis to ERSST.v3b, a new La Niña episode was classified (ASO 1962-DJF 1962/63) and two previous La Niña episodes were combined into one single episode (AMJ 1973- MAM 1976).



Historical Pacific warm (red) and cold (blue) episodes based on a threshold of +/- 0.5 °C for the Oceanic Nino Index (ONI) [3 month running mean of ERSST.v3b SST anomalies in the Nino 3.4 region (5N-5S, 120-170W)], calculated with respect to the 1971-2000 base period. For historical purposes El Niño and La Niña episodes are defined when the threshold is met for a minimum of 5 consecutive over-lapping seasons.

Year	DJF	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS	ASO	SON	OND	NDJ
1950	-1.7	-1.5	-1.3	-1.4	-1.3	-1.1	-0.8	-0.8	-0.8	-0.9	-0.9	-1.0
1951	-1.0	-0.9	-0.6	-0.3	-0.2	0.2	0.4	0.7	0.7	0.8	0.7	0.6
1952	0.3	0.1	0.1	0.2	0.1	-0.1	-0.3	-0.3	-0.2	-0.2	-0.1	0.0
1953	0.2	0.4	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4
1954	0.5	0.3	-0.1	-0.5	-0.7	-0.7	-0.8	-1.0	-1.2	-1.1	-1.1	-1.1
1955	-1.0	-0.9	-0.9	-1.0	-1.0	-1.0	-1.0	-1.0	-1.4	-1.8	-2.0	-1.9
1956	-1.3	-0.9	-0.7	-0.6	-0.6	-0.6	-0.7	-0.8	-0.8	-0.9	-0.9	-0.8
1957	-0.5	-0.1	0.3	0.6	0.7	0.9	0.9	0.9	0.9	1.0	1.2	1.5
1958	1.7	1.5	1.2	0.8	0.6	0.5	0.3	0.1	0.0	0.0	0.2	0.4
1959	0.4	0.5	0.4	0.2	0.0	-0.2	-0.4	-0.5	-0.4	-0.3	-0.2	-0.2
1960	-0.3	-0.3	-0.3	-0.2	-0.2	-0.2	-0.1	0.0	-0.1	-0.2	-0.2	-0.2
1961	-0.2	-0.2	-0.2	-0.1	0.1	0.2	0.0	-0.3	-0.6	-0.6	-0.5	-0.4
1962	-0.4	-0.4	-0.4	-0.5	-0.4	-0.4	-0.3	-0.3	-0.5	-0.6	-0.7	-0.7
1963	-0.6	-0.3	0.0	0.1	0.1	0.3	0.6	0.8	0.9	0.9	1.0	1.0
1964	0.8	0.4	-0.1	-0.5	-0.8	-0.8	-0.9	-1.0	-1.1	-1.2	-1.2	-1.0
1965	-0.8	-0.4	-0.2	0.0	0.3	0.6	1.0	1.2	1.4	1.5	1.6	1.5
1966	1.2	1.0	0.8	0.5	0.2	0.2	0.2	0.0	-0.2	-0.2	-0.3	-0.3
1967	-0.4	-0.4	-0.6	-0.5	-0.3	0.0	0.0	-0.2	-0.4	-0.5	-0.4	-0.5
1968	-0.7	-0.9	-0.8	-0.7	-0.3	0.0	0.3	0.4	0.3	0.4	0.7	0.9
1969	1.0	1.0	0.9	0.7	0.6	0.5	0.4	0.4	0.6	0.7	0.8	0.7
1970	0.5	0.3	0.2	0.1	0.0	-0.3	-0.6	-0.8	-0.9	-0.8	-0.9	-1.1
1971	-1.3	-1.3	-1.1	-0.9	-0.8	-0.8	-0.8	-0.8	-0.8	-0.9	-1.0	-0.9
1972	-0.7	-0.4	0.0	0.2	0.5	0.8	1.0	1.3	1.5	1.8	2.0	2.1
1973	1.8	1.2	0.5	-0.1	-0.6	-0.9	-1.1	-1.3	-1.4	-1.7	-2.0	-2.1
1974	-1.9	-1.7	-1.3	-1.1	-0.9	-0.8	-0.6	-0.5	-0.5	-0.7	-0.9	-0.7
1975	-0.6	-0.6	-0.7	-0.8	-0.9	-1.1	-1.2	-1.3	-1.5	-1.6	-1.7	-1.7



Historical Pacific warm (red) and cold (blue) episodes based on a threshold of +/- 0.5 °C for the Oceanic Nino Index (ONI) [3 month running mean of ERSST.v3b SST anomalies in the Nino 3.4 region (5N-5S, 120-170W)], calculated with respect to the 1971-2000 base period. For historical purposes El Niño and La Niña episodes are defined when the threshold is met for a minimum of 5 consecutive over-lapping seasons.

Year	DJF	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS	ASO	SON	OND	NDJ
1976	-1.6	-1.2	-0.8	-0.6	-0.5	-0.2	0.1	0.3	0.5	0.7	0.8	0.7
1977	0.6	0.5	0.2	0.2	0.2	0.4	0.4	0.4	0.5	0.6	0.7	0.7
1978	0.7	0.4	0.0	-0.3	-0.4	-0.4	-0.4	-0.4	-0.4	-0.3	-0.2	-0.1
1979	-0.1	0.0	0.1	0.1	0.1	-0.1	0.0	0.1	0.3	0.4	0.5	0.5
1980	0.5	0.3	0.2	0.2	0.3	0.3	0.2	0.0	-0.1	-0.1	0.0	-0.1
1981	-0.3	-0.5	-0.5	-0.4	-0.3	-0.3	-0.4	-0.4	-0.3	-0.2	-0.1	-0.1
1982	0.0	0.1	0.1	0.3	0.6	0.7	0.7	1.0	1.5	1.9	2.2	2.3
1983	2.3	2.0	1.5	1.2	1.0	0.6	0.2	-0.2	-0.6	-0.8	-0.9	-0.7
1984	-0.4	-0.2	-0.2	-0.3	-0.5	-0.4	-0.3	-0.2	-0.3	-0.6	-0.9	-1.1
1985	-0.9	-0.8	-0.7	-0.7	-0.7	-0.6	-0.5	-0.5	-0.5	-0.4	-0.3	-0.4
1986	-0.5	-0.4	-0.2	-0.2	-0.1	0.0	0.3	0.5	0.7	0.9	1.1	1.2
1987	1.2	1.3	1.2	1.1	1.0	1.2	1.4	1.6	1.6	1.5	1.3	1.1
1988	0.7	0.5	0.1	-0.2	-0.7	-1.2	-1.3	-1.2	-1.3	-1.6	-1.9	-1.9
1989	-1.7	-1.5	-1.1	-0.8	-0.6	-0.4	-0.3	-0.3	-0.3	-0.3	-0.2	-0.1
1990	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.4
1991	0.4	0.3	0.3	0.4	0.6	0.8	1.0	0.9	0.9	1.0	1.4	1.6
1992	1.8	1.6	1.5	1.4	1.2	0.8	0.5	0.2	0.0	-0.1	0.0	0.2
1993	0.3	0.4	0.6	0.7	0.8	0.7	0.4	0.4	0.4	0.4	0.3	0.2
1994	0.2	0.2	0.3	0.4	0.5	0.5	0.6	0.6	0.7	0.9	1.2	1.3
1995	1.2	0.9	0.7	0.4	0.3	0.2	0.0	-0.2	-0.5	-0.6	-0.7	-0.7
1996	-0.7	-0.7	-0.5	-0.3	-0.1	-0.1	0.0	-0.1	-0.1	-0.2	-0.3	-0.4
1997	-0.4	-0.3	0.0	0.4	0.8	1.3	1.7	2.0	2.2	2.4	2.5	2.5
1998	2.3	1.9	1.5	1.0	0.5	0.0	-0.5	-0.8	-1.0	-1.1	-1.3	-1.4
1999	-1.4	-1.2	-0.9	-0.8	-0.8	-0.8	-0.9	-0.9	-1.0	-1.1	-1.3	-1.6
2000	-1.6	-1.4	-1.0	-0.8	-0.6	-0.5	-0.4	-0.4	-0.4	-0.5	-0.6	-0.7
2001	-0.6	-0.5	-0.4	-0.2	-0.1	0.1	0.2	0.2	0.1	0.0	-0.1	-0.1



Pacific Niño 3.4 SST Outlook

- A majority of the ENSO models, and all three multi-model outlooks, predict ENSO-neutral conditions (Niño-3.4 SST anomalies between -0.5 C and $+0.5\text{ C}$) to continue into early 2012.

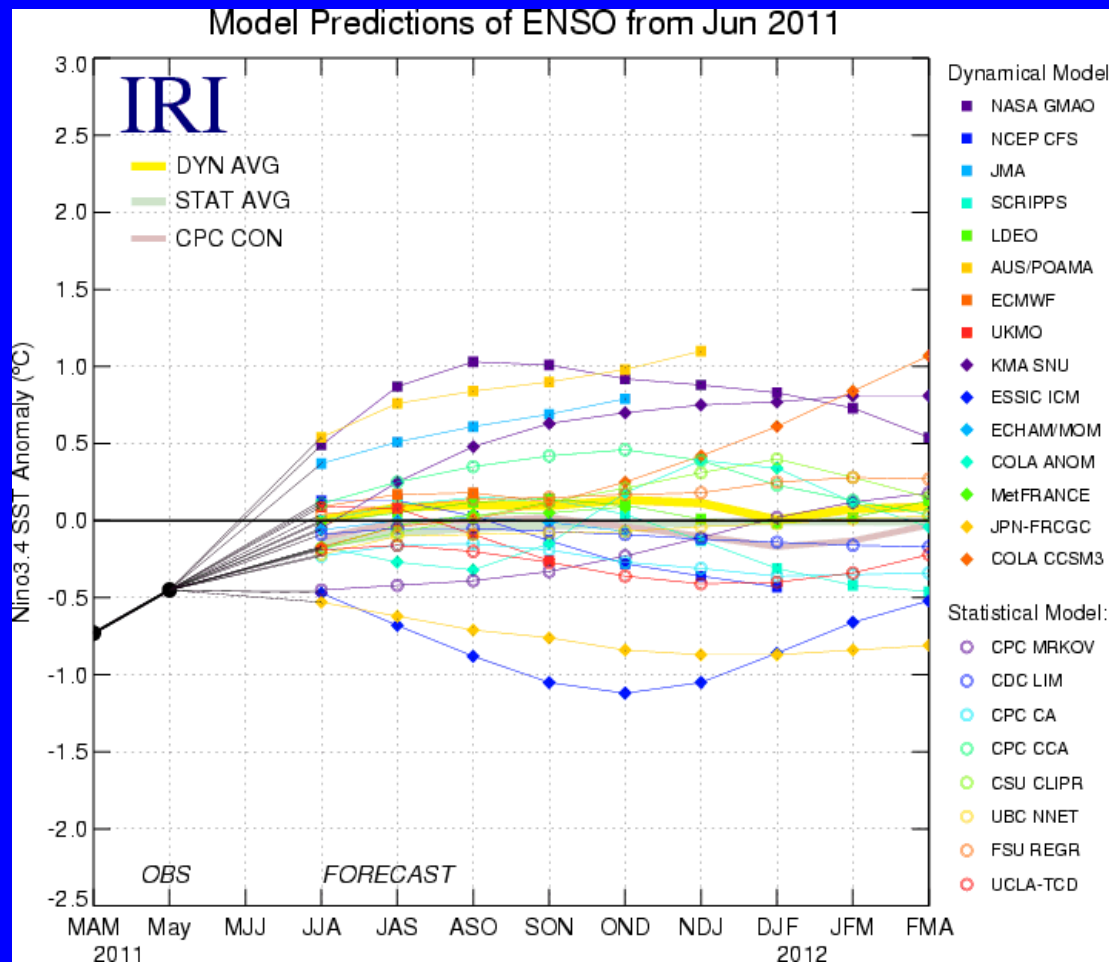
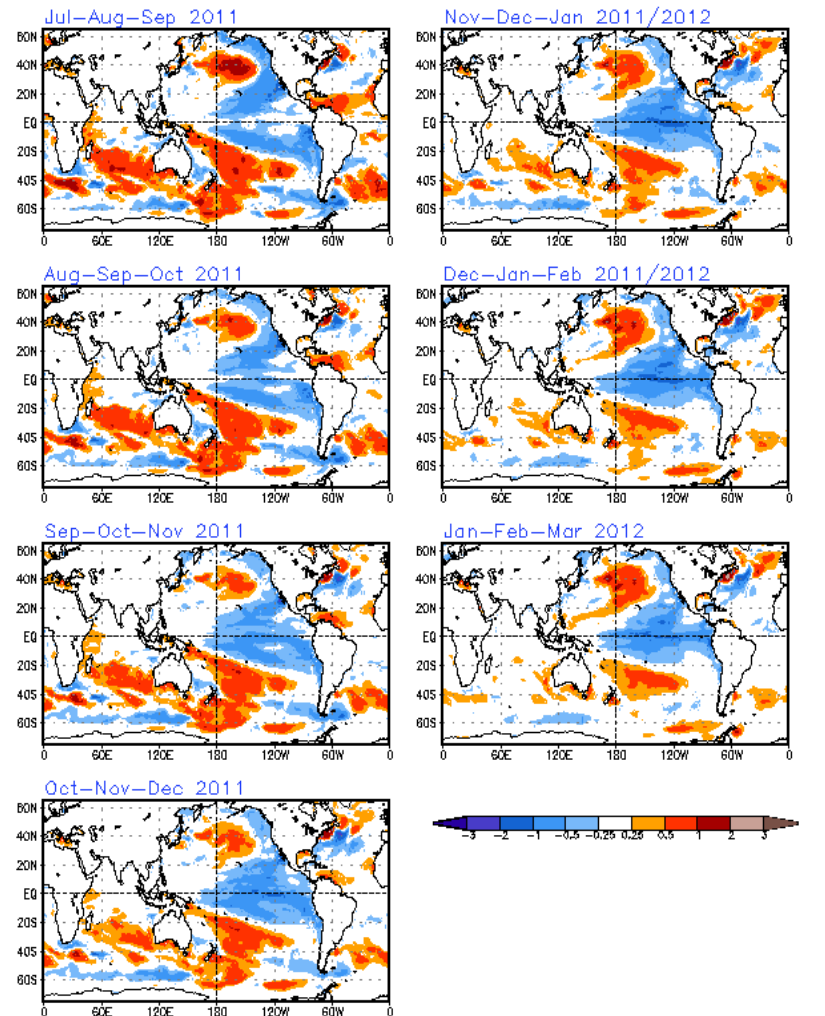


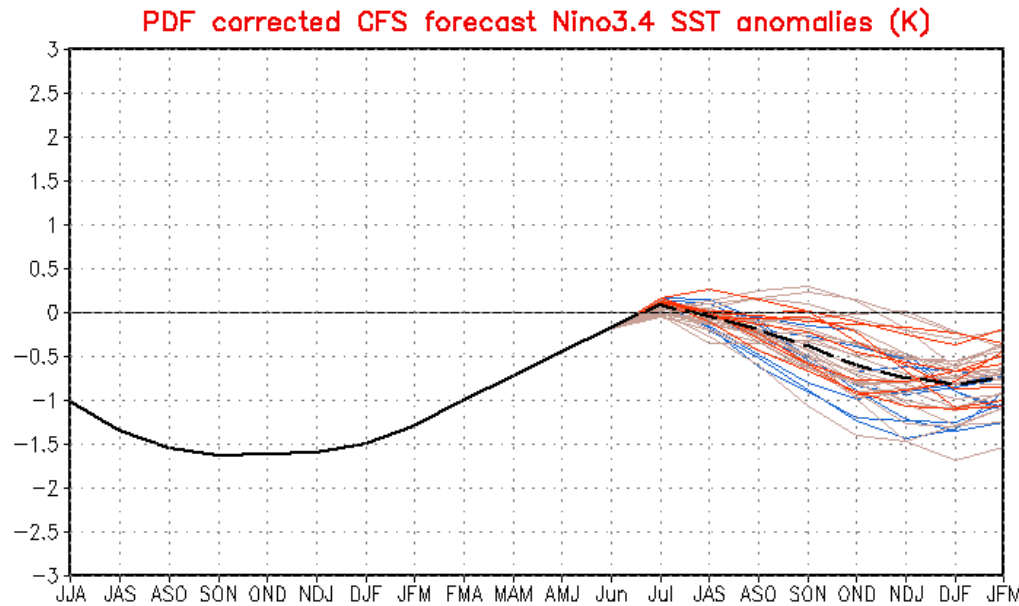
Figure provided by the International Research Institute (IRI) for Climate and Society (updated 14 June 2011).



SST Outlook: NCEP CFS.v1 Forecast Issued 10 July 2011



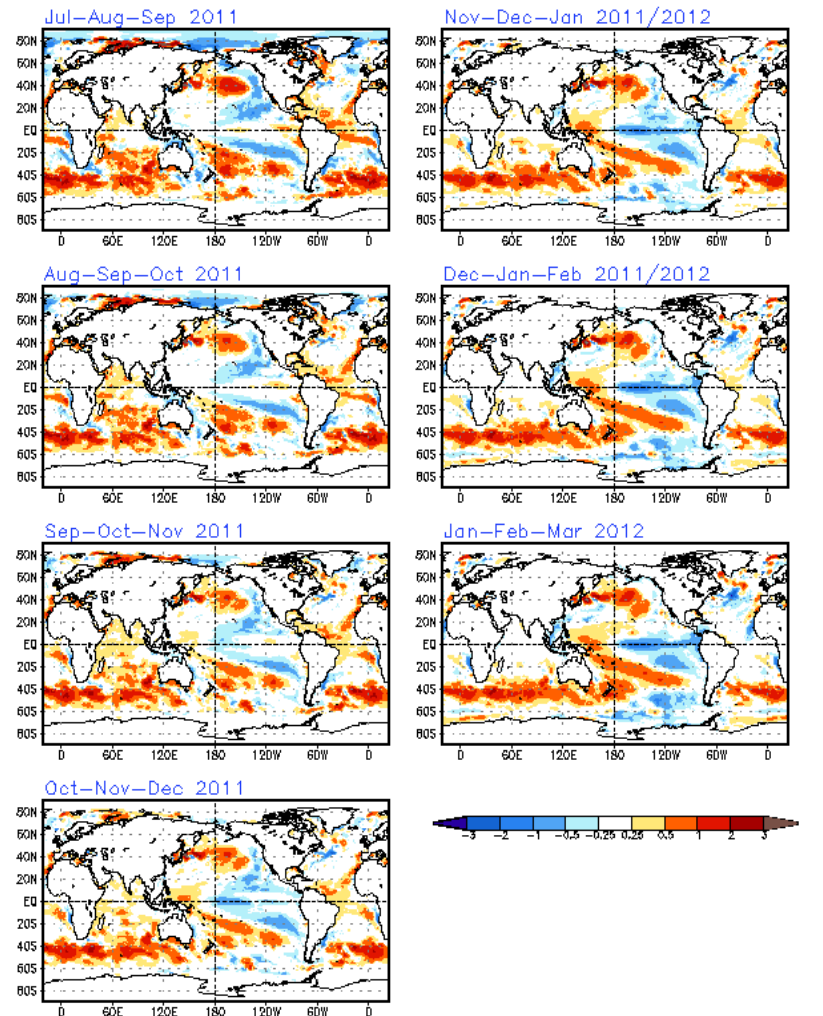
The CFS.v1 ensemble mean (black dashed line) predicts La Nina conditions during Northern Hemisphere fall 2011.



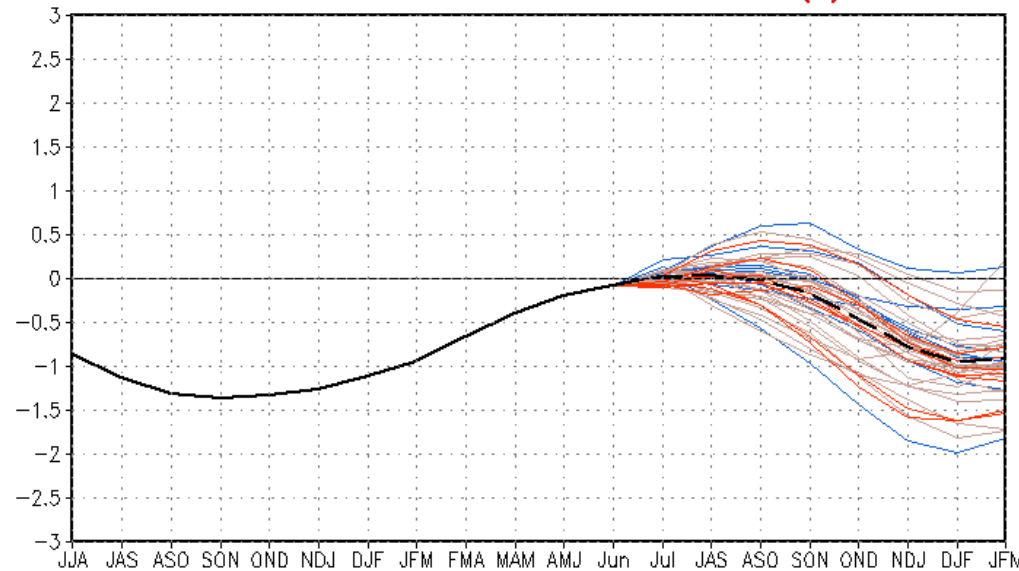


SST Outlook: NCEP CFS.v2 Forecast Issued 11 July 2011

The CFS.v2 ensemble mean (black dashed line) predicts La Nina conditions during the late Northern Hemisphere fall 2011.



CFSv2 forecast Nino3.4 SST anomalies (K)



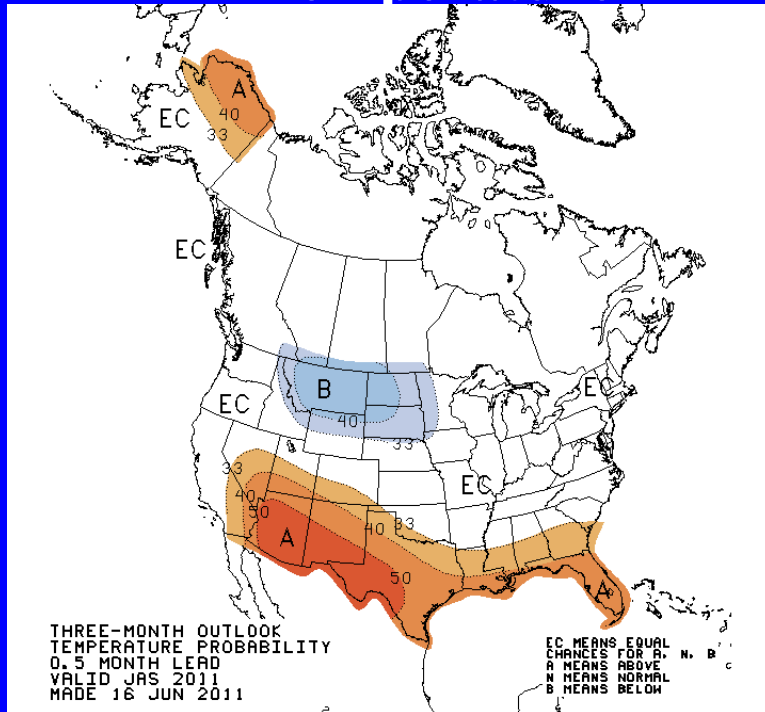
CFS.v2 is now operational. More information on version 2 is available at <http://cfs.ncep.noaa.gov/cfsv2/docs.html>



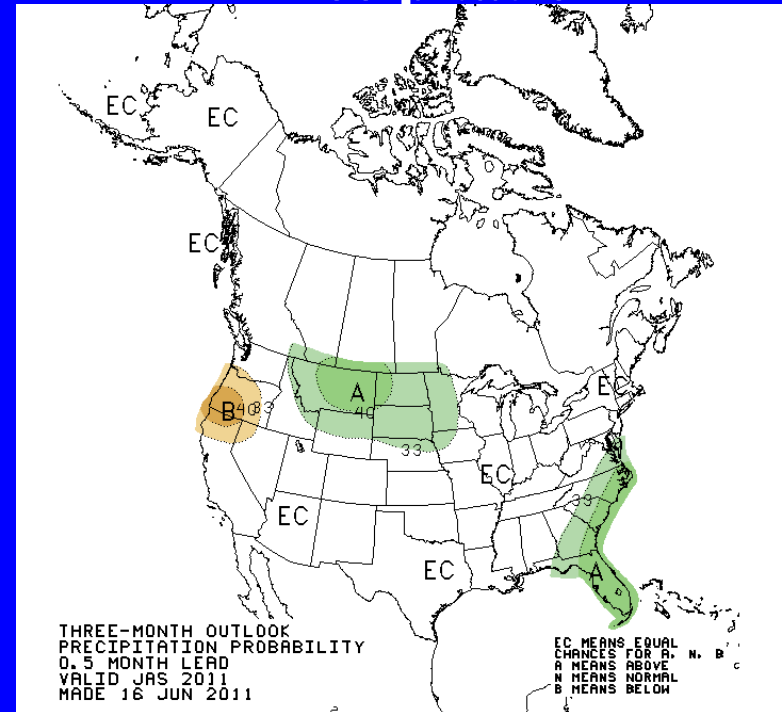
U. S. Seasonal Outlooks

July – September 2011

Temperature



Precipitation



The seasonal outlooks combine the effects of long-term trends, soil moisture, and, when appropriate, the ENSO cycle.



Summary

- **ENSO-neutral conditions are present across the equatorial Pacific.**
- **Sea surface temperatures (SST) are near-average across the central and east-central equatorial Pacific Ocean.**
- **Atmospheric circulation anomalies still reflect aspects of La Niña.**
- **ENSO-neutral conditions are expected to continue into the Northern Hemisphere fall 2011.**