ENSO Cycle: Recent Evolution, Current Status and Predictions

Update prepared by
Climate Prediction Center / NCEP
15 September 2008

Outline

- Overview
- Recent Evolution and Current Conditions
- Oceanic Niño Index (ONI) – "Revised November 2007"
- Pacific SST Outlook
- U.S. Seasonal Precipitation and Temperature Outlooks
- Summary

Summary

• ENSO-neutral conditions are present in the equatorial Pacific Ocean.

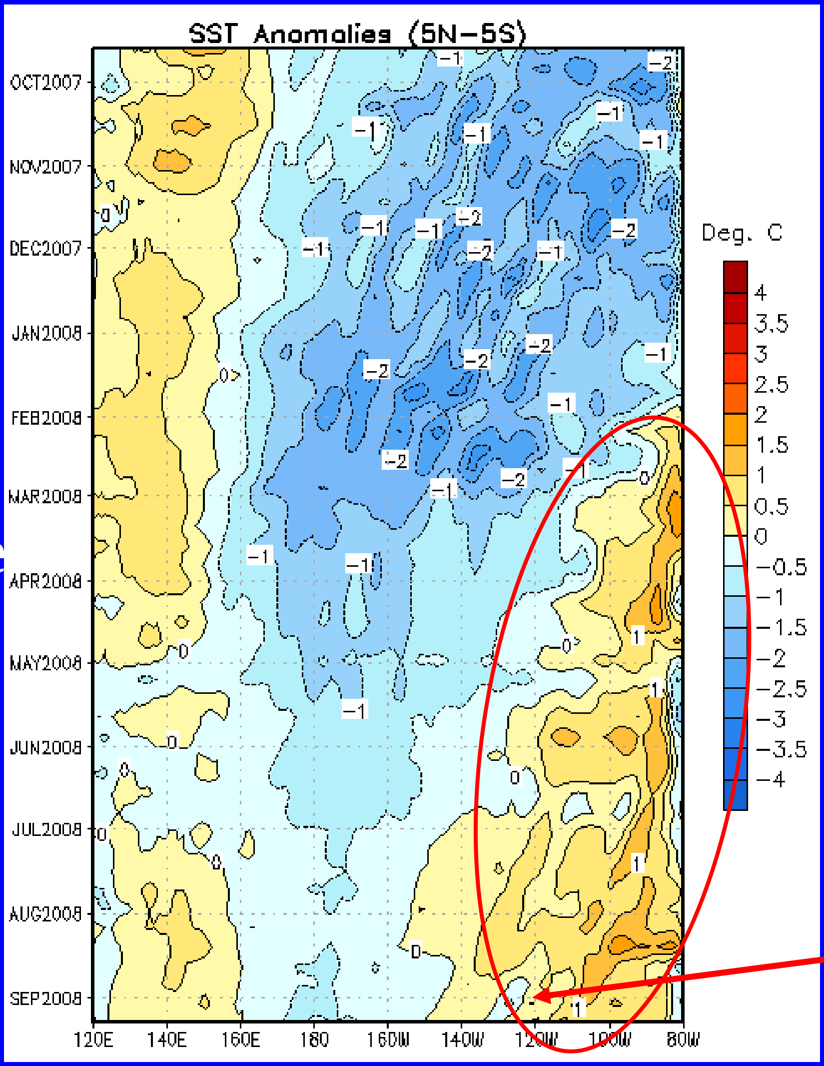
• Equatorial SSTs in the central Pacific Ocean have returned to near-average, while positive SST anomalies have weakened in the eastern Pacific.

• Aspects of the atmospheric circulation and pattern of tropical convection reflect a lingering La Niña signal, particularly over the western and central Pacific.

• Based on recent SST trends and model forecasts, ENSO-neutral conditions are expected to continue through the end of 2008.

Recent Evolution of Equatorial Pacific SST Departures (ºC)

Time



Longitude

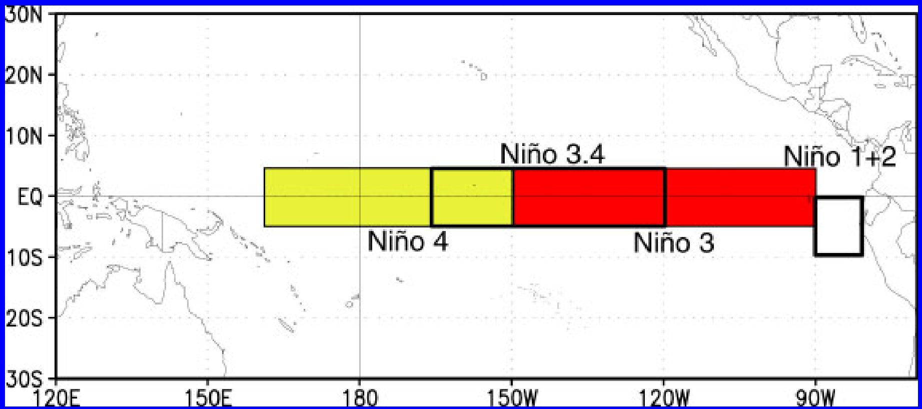
Since February 2008, negative sea surface temperature anomalies have weakened over the equatorial Pacific Ocean, and positive anomalies have expanded westward into the east-central equatorial Pacific Ocean.

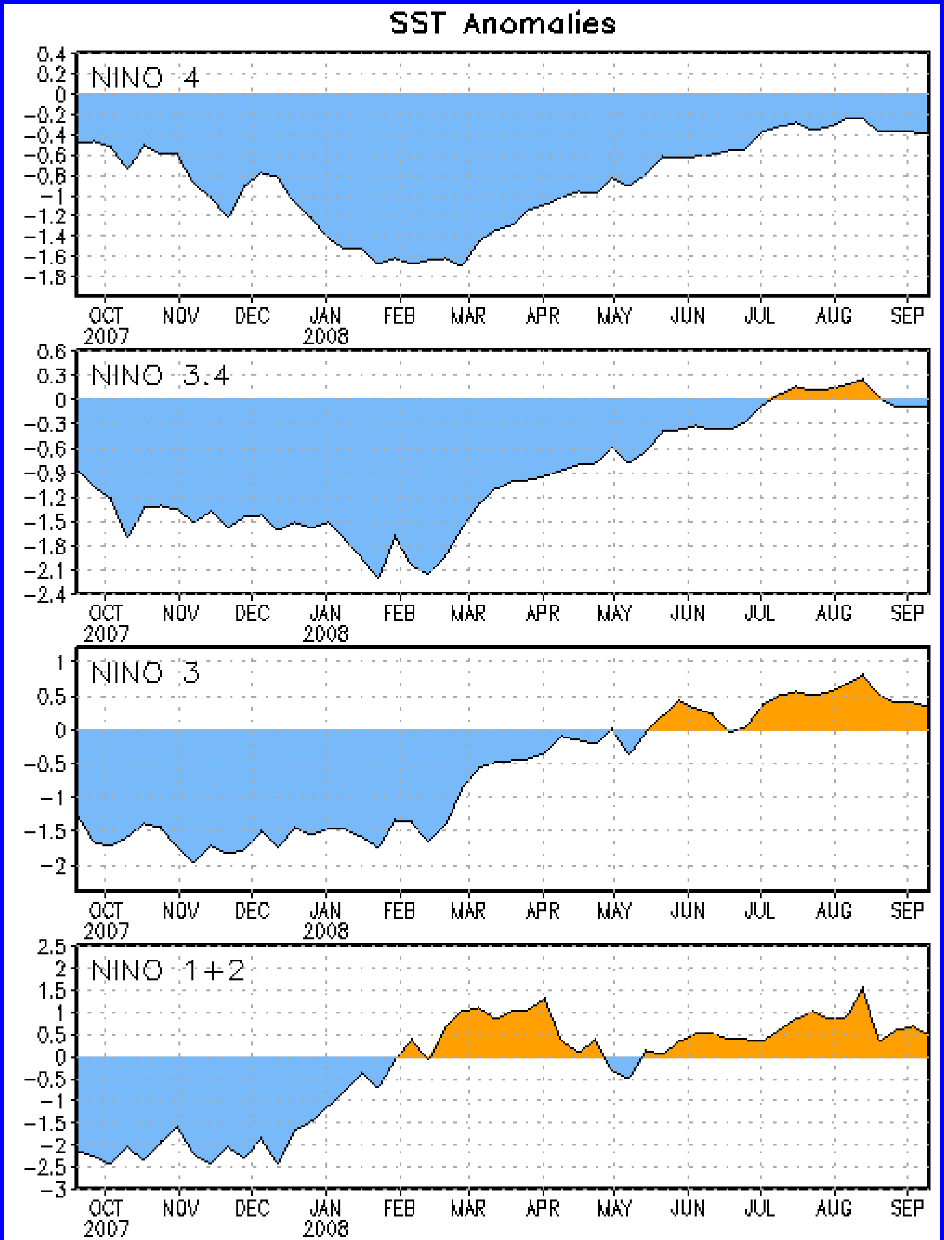
Recently, positive anomalies have weakened over the eastern Pacific.

Niño Region SST Departures (ºC) Recent Evolution

The latest weekly SST departures are:

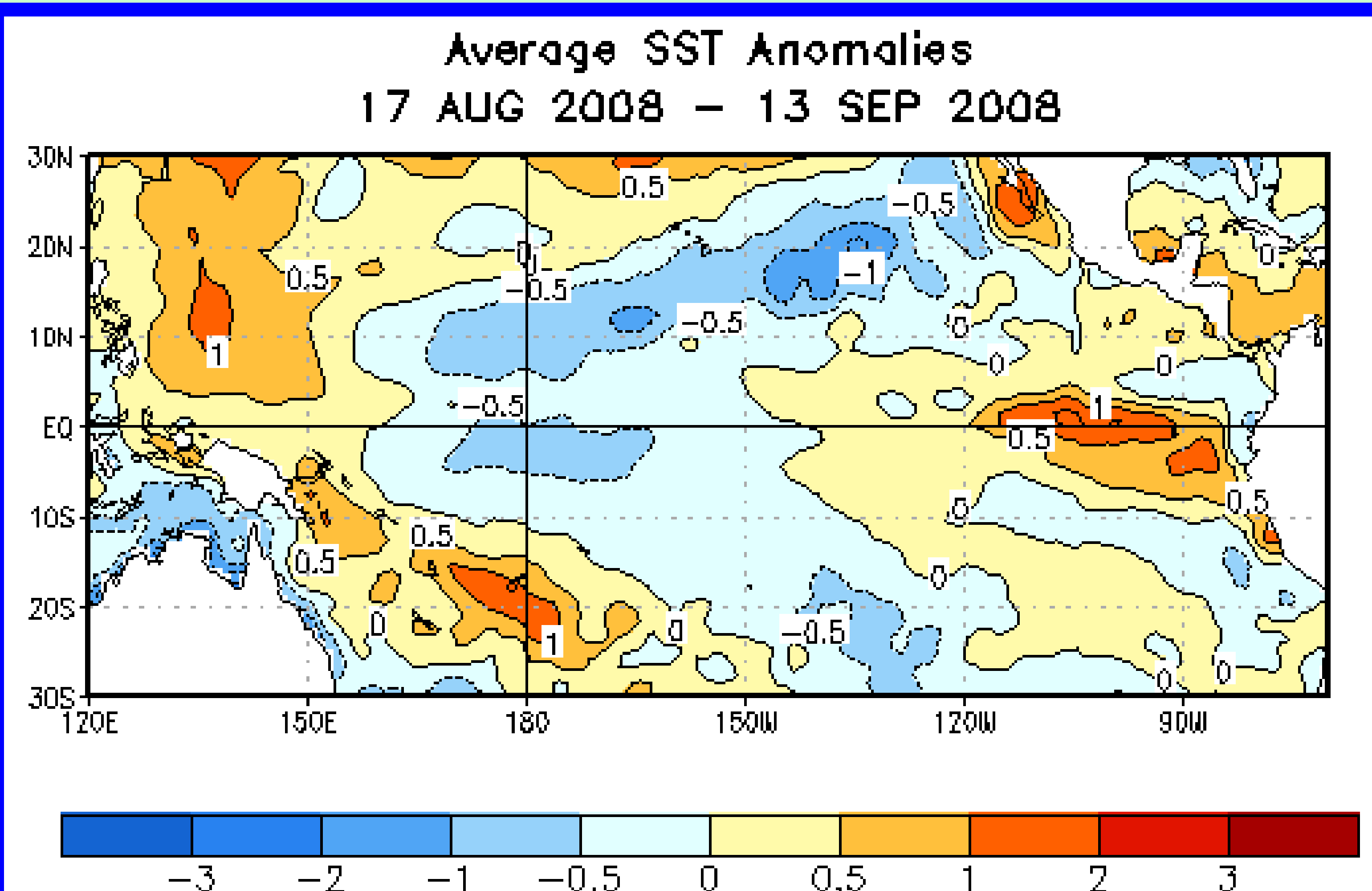
Niño 4	**-0.4ºC**
Niño 3.4	**-0.1ºC**
Niño 3	**0.4ºC**
Niño 1+2	**0.5ºC**



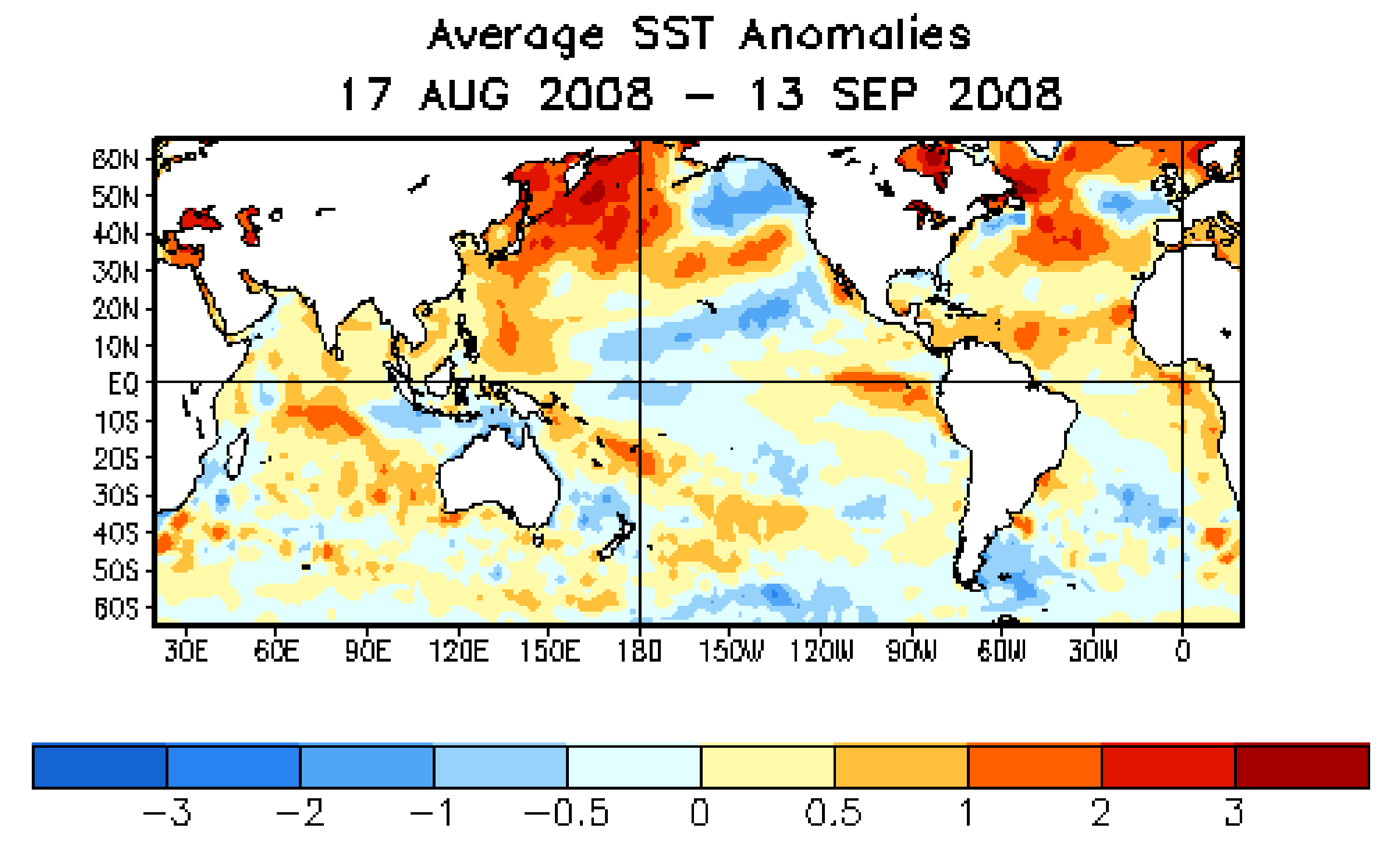


SST Departures (ºC) in the Tropical Pacific During the Last 4 Weeks

During the last 4-weeks, equatorial Pacific SSTs were below-average near the Date Line, and more than 0.5°C above-average east of 120ºW.

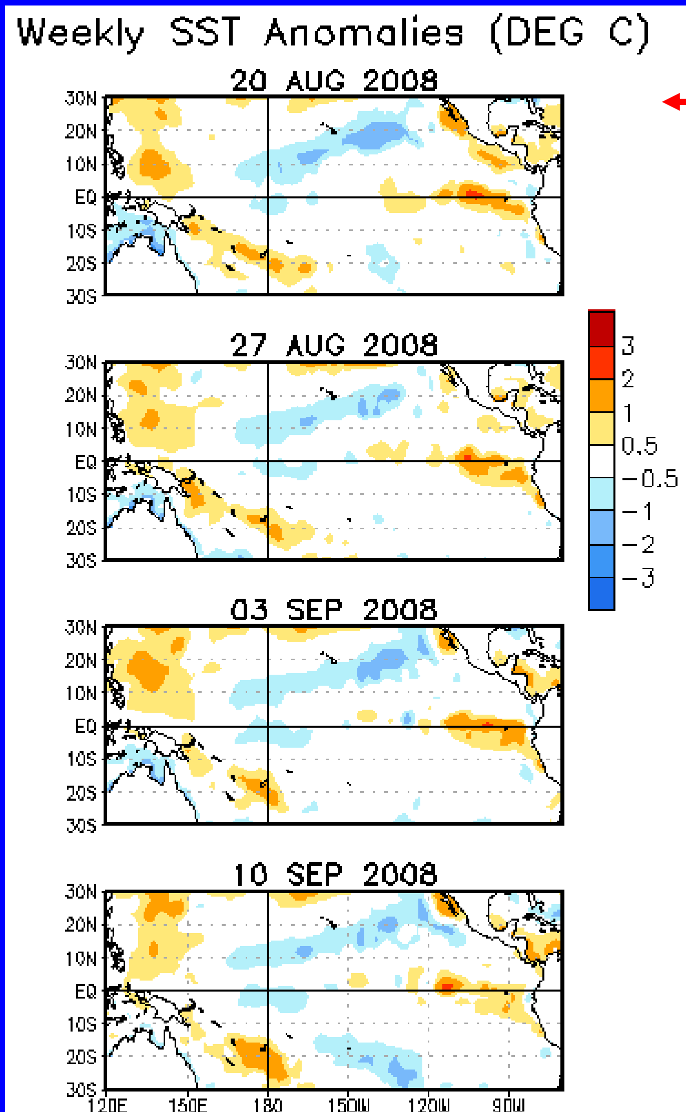


Global SST Departures (ºC)

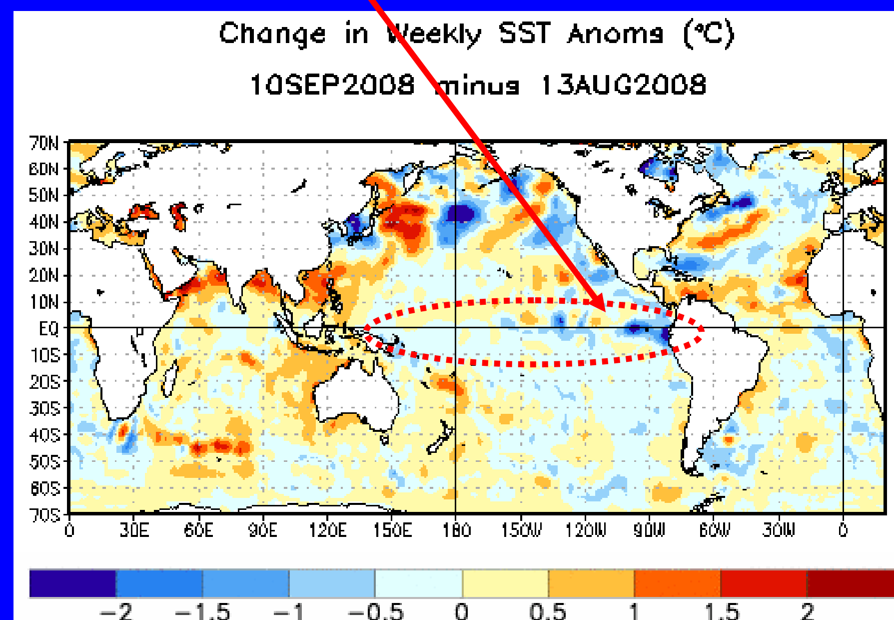


Equatorial SSTs remained below-average near the Date Line and in the eastern Indian Ocean, and above-average in the eastern Pacific and the eastern Atlantic Ocean. Positive anomalies covered much of the North Atlantic and western North Pacific Oceans.

Weekly SST Departures (ºC) for the Last Four Weeks



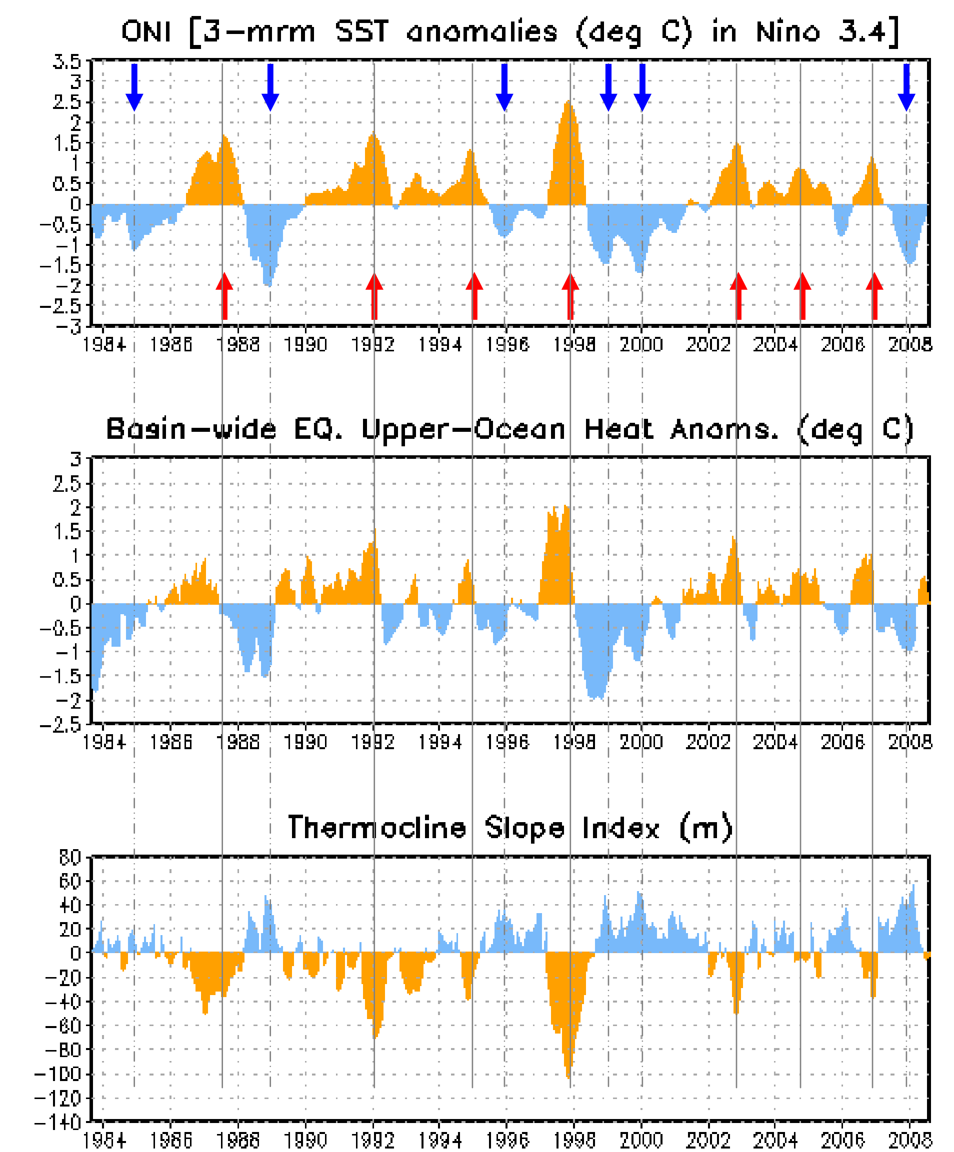
- During August- September 2008, SSTs remained slightly below average near the Date Line, while positive SST anomalies weakened in the eastern Pacific.
- Over the last month, SST anomalies decreased across much of the equatorial Pacific Ocean, but especially in the eastern Pacific.



Upper-Ocean Conditions in the Eq. Pacific

Cold Episodes

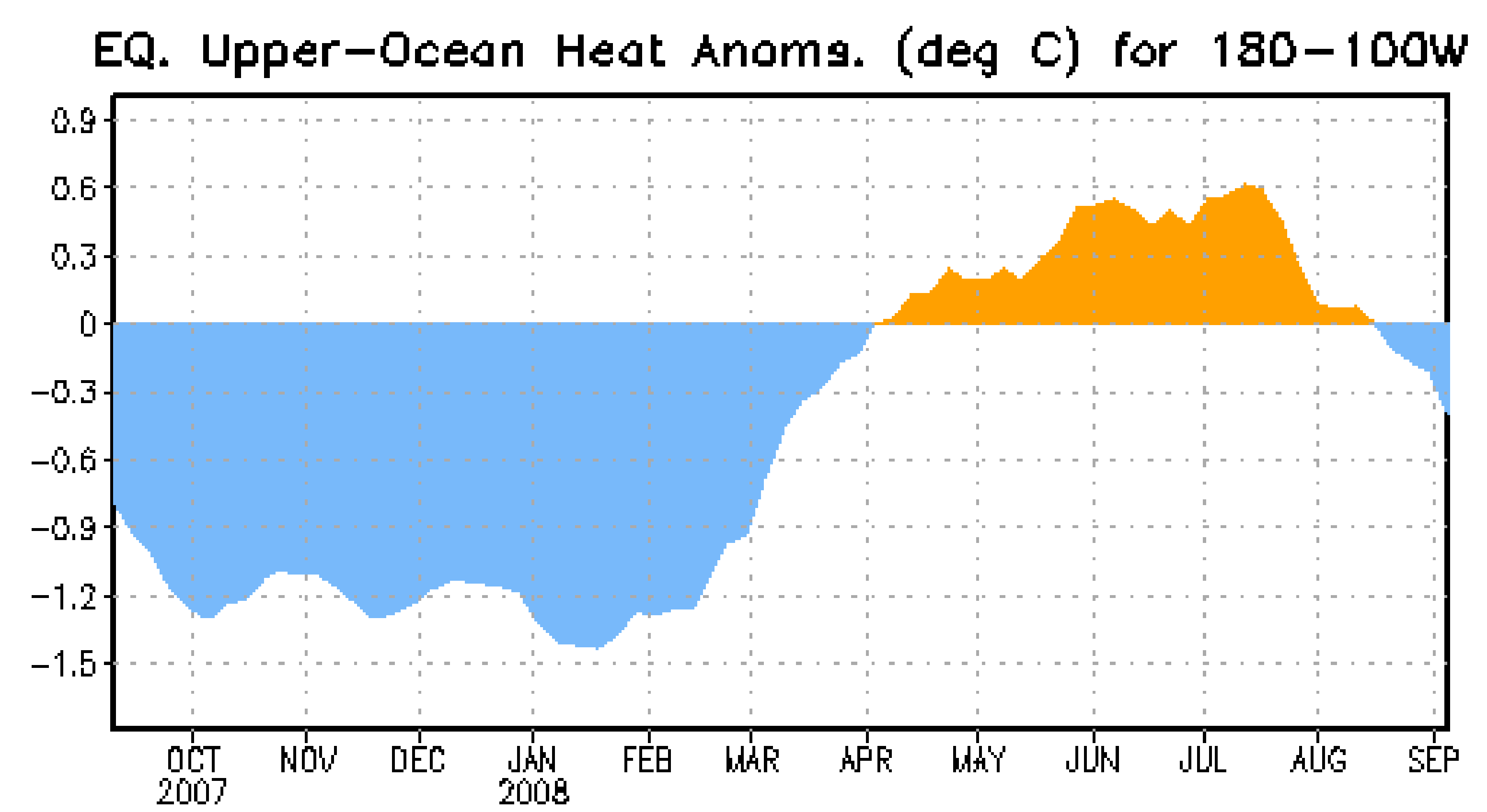
Warm Episodes



- 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.
- Current values of the upper-ocean heat anomalies (near zero) and the thermocline slope index (slightly negative) indicate ENSO-neutral.

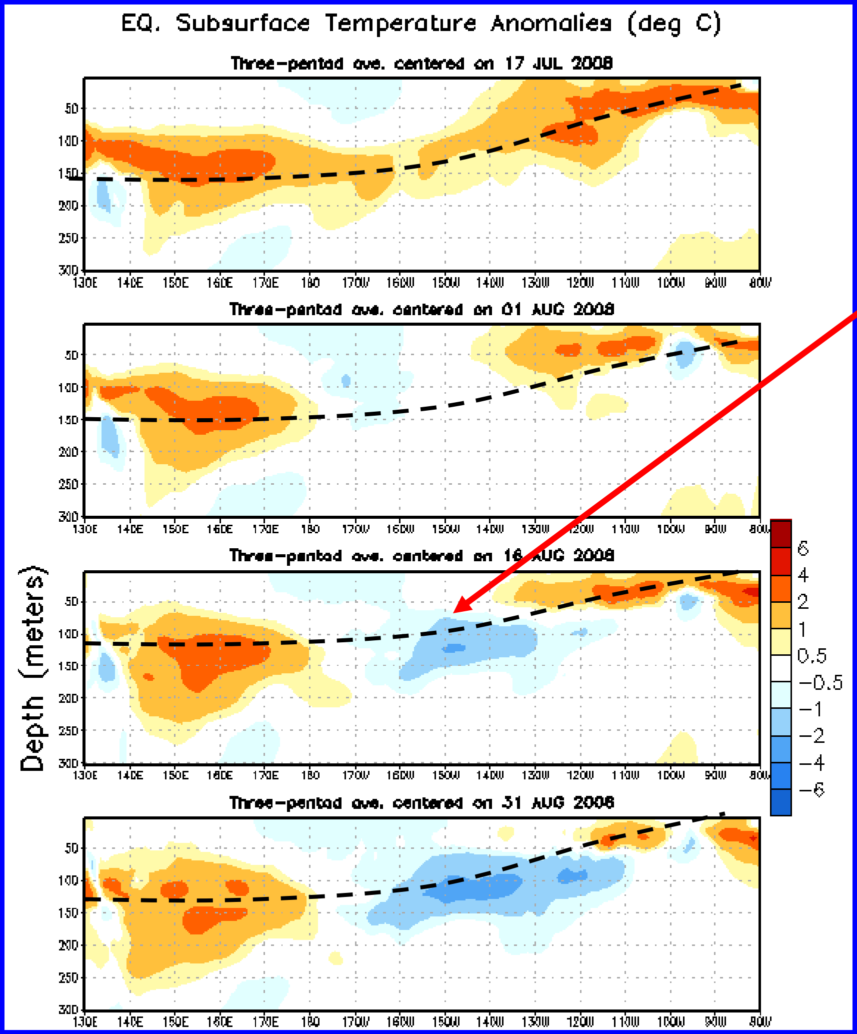
The monthly thermocline slope index represents the difference in anomalous depth of the 20ºC isotherm between the western Pacific (160ºE-150ºW) and the eastern Pacific (90º-140ºW).

Central & Eastern Pacific Upper-Ocean (0-300 m) Weekly Heat Content Anomalies



The upper ocean heat content was below-average across the eastern half of the equatorial Pacific Ocean between January 2007 and March 2008, and above-average from early April 2008 through mid-July 2008. Since mid-August 2008, the heat content has again dropped to below-average values.

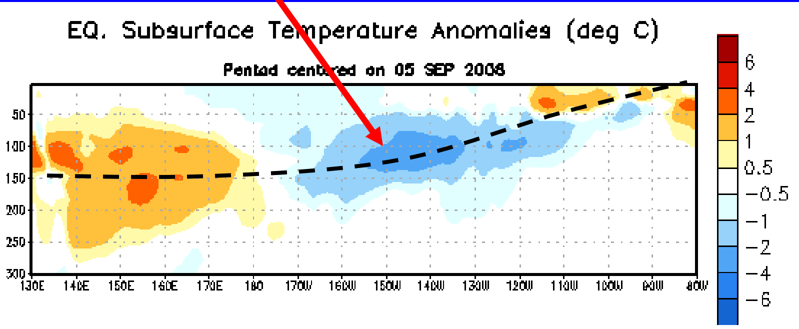
Sub-Surface Temperature Departures (ºC) in the Equatorial Pacific



Time

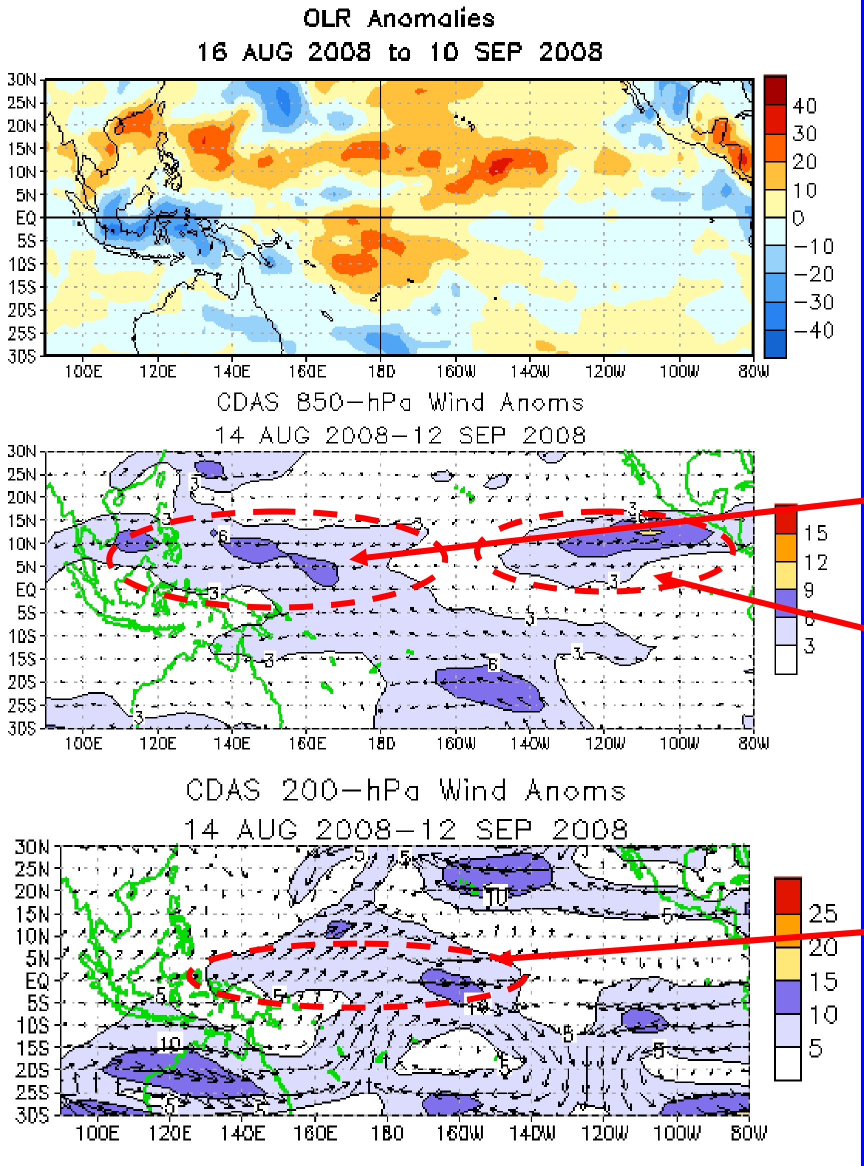
Longitude

- During July – August 2008, the positive sub-surface temperature anomalies at thermocline depth (dashed black line) weakened across the equatorial Pacific. Negative temperature anomalies strengthened in the east- central Pacific.
- The most recent period (below) shows that negative temperature anomalies at thermocline depth have expanded in the east-central Pacific.



Most recent pentad analysis

Tropical OLR and Wind Anomalies During the Last 30 Days



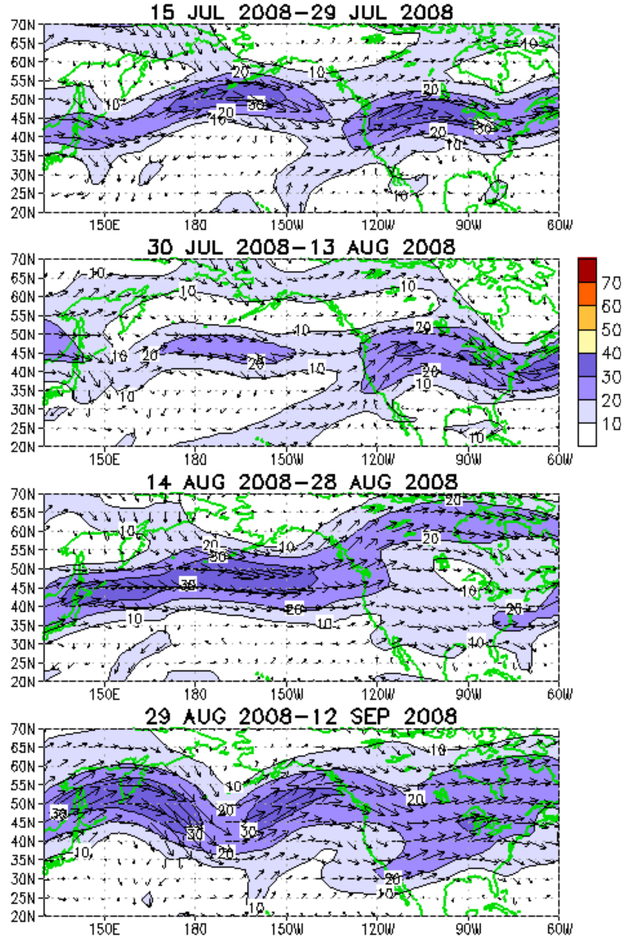
Positive OLR anomalies (suppressed convection and precipitation, red shading) persisted over the central equatorial Pacific. Negative OLR anomalies were observed over Indonesia and Papua New Guinea.

Low-level (850-hPa) easterly wind anomalies persisted over the western equatorial Pacific Ocean. Low-level westerly anomalies continued in the eastern Pacific Ocean.

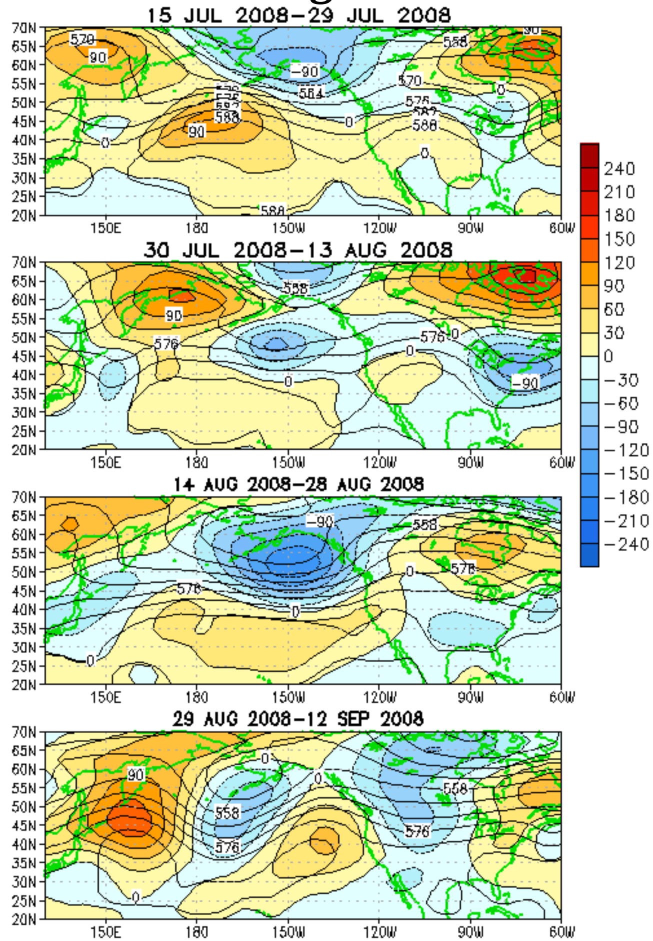
At 200-hPa, westerly wind anomalies continued in the western half of the equatorial Pacific Ocean.

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

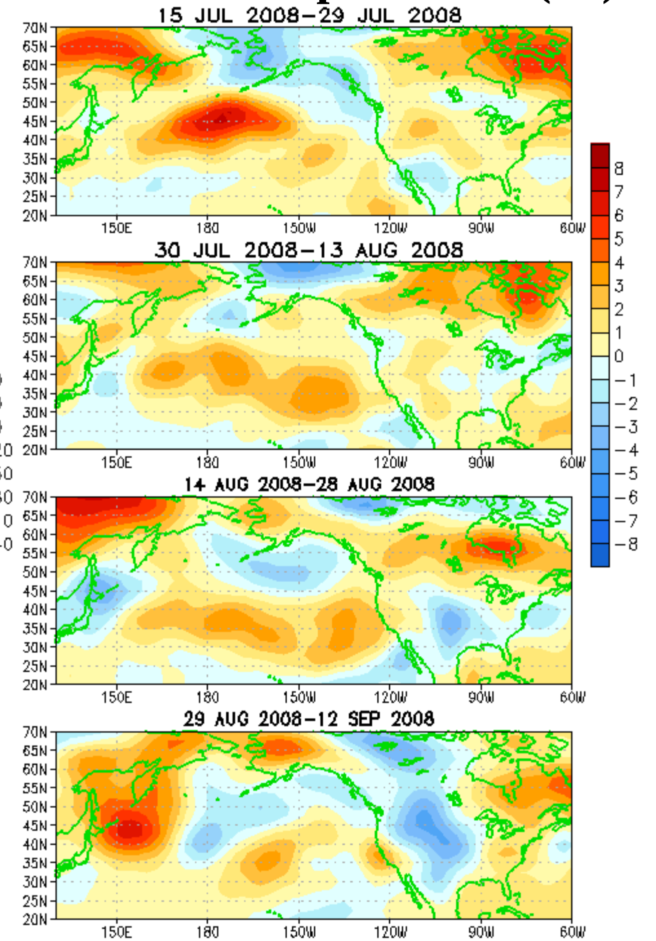
200-hPa Wind



500-hPa Height & Anoms.



925-hPa Temp. Anoms. (°C)

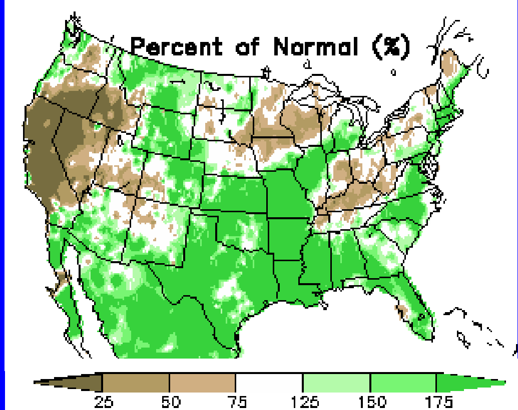


From late July through August, the atmospheric circulation featured a trough in the Gulf of Alaska, an anomalous ridge over eastern or central Canada, and an anomalous trough over the eastern or central United States. The anomalous trough over the United States contributed to the persistence of average-to below-average temperatures over the central or eastern US during August. During the first half of September, the pattern shifted with the anomalous trough focused over western and central North America, bringing below-average temperatures to the region.

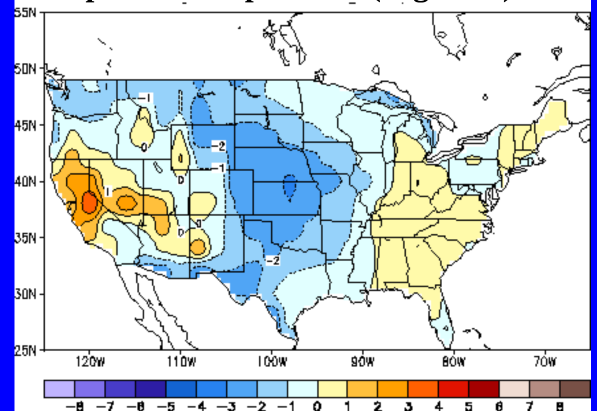
U.S. Temperature and Precipitation Departures During the Last 30 and 90 Days

Last 30 Days

30-day (ending 14 Sept 2008) % of average precipitation

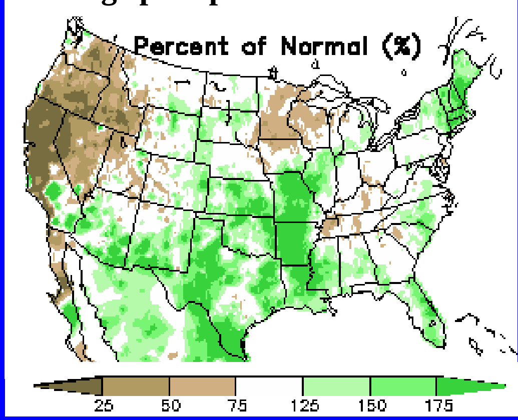


30-day (ending 13 Sept 2008) temperature departures (degree C)

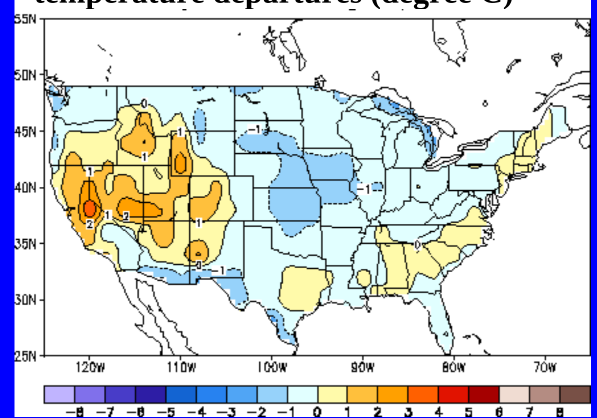


Last 90 Days

90-day (ending 14 Sept 2008) % of average precipitation



90-day (ending 13 Sept 2008) temperature departures (degree C)



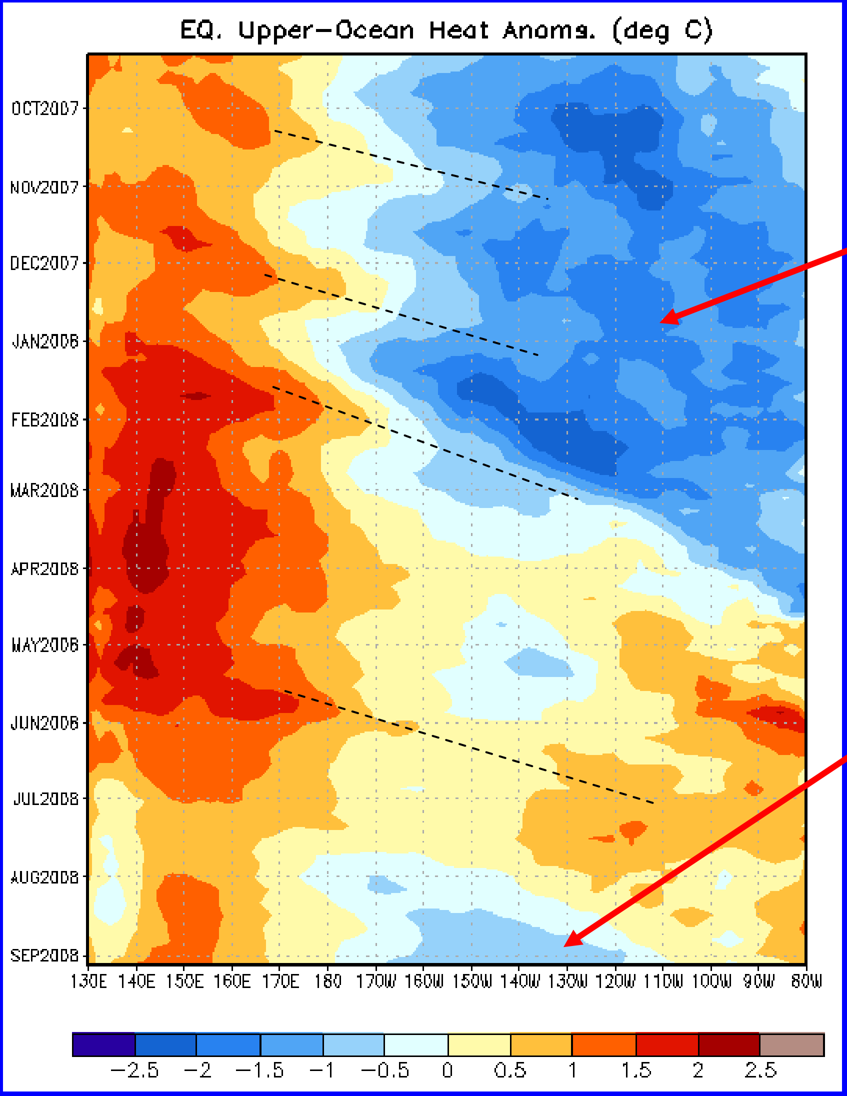
Intraseasonal Variability

- 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.
  - Several Kelvin waves have occurred during the last year (see next slide).

Weekly Heat Content Evolution in the Equatorial Pacific

Time



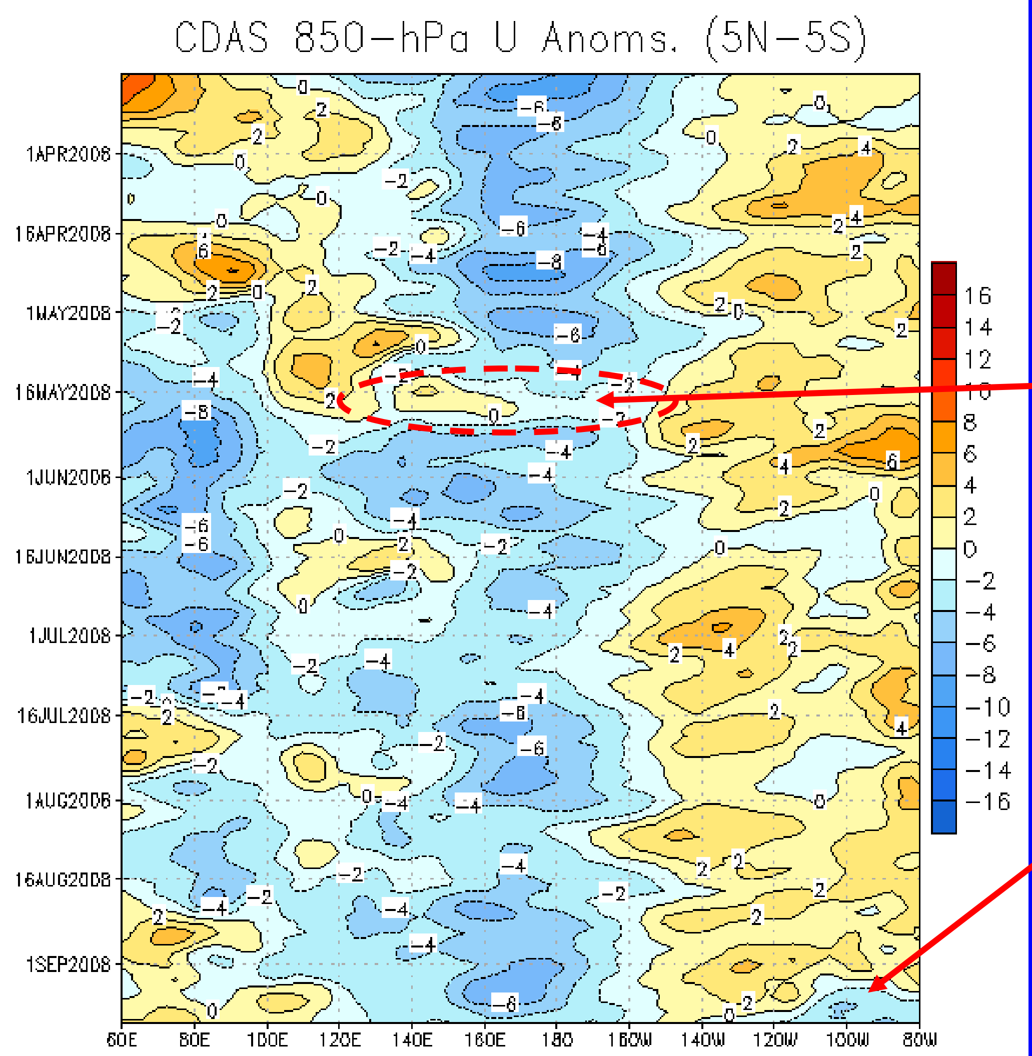
Longitude

- During July- February 2007, negative subsurface temperature anomalies persisted across the central and eastern equatorial Pacific. The upper-ocean heat content was affected by weak oceanic Kelvin wave activity during the period.

- Negative heat content anomalies strengthened in the east- central equatorial Pacific, while positive anomalies have weakened in the eastern equatorial Pacific.

- 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})



Time

Longitude

Westerly wind anomalies (orange/red shading).

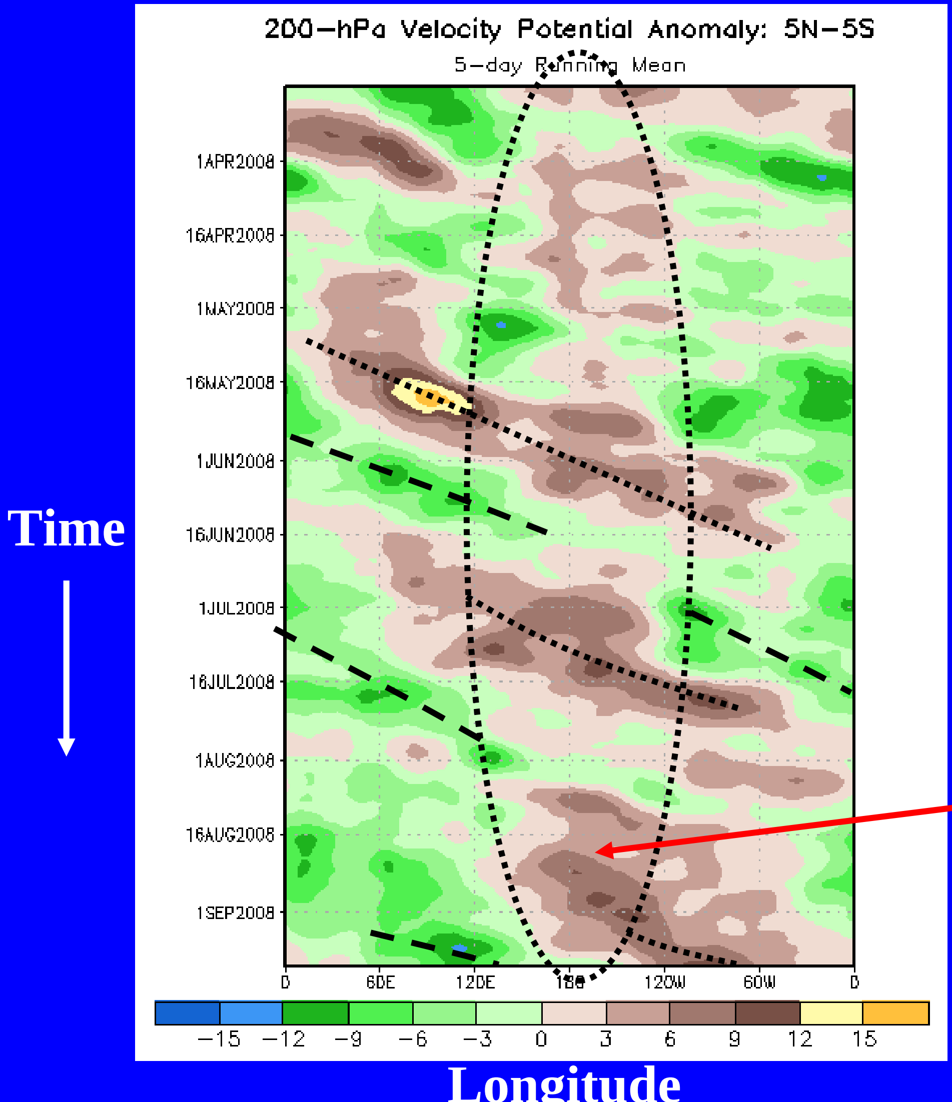
Easterly wind anomalies (blue shading).

From May- June 2008, intraseasonal (MJO) activity weakened the easterly anomalies across the central equatorial Pacific (dashed oval in figure).

Low-level (850-hPa) easterly wind anomalies have persisted since January 2007 over the equatorial Pacific between 150ºE and 150ºW.

Recently, easterly wind anomalies have emerged in the eastern Pacific.

200-hPa Velocity Potential Anomalies (5ºN-5ºS)



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

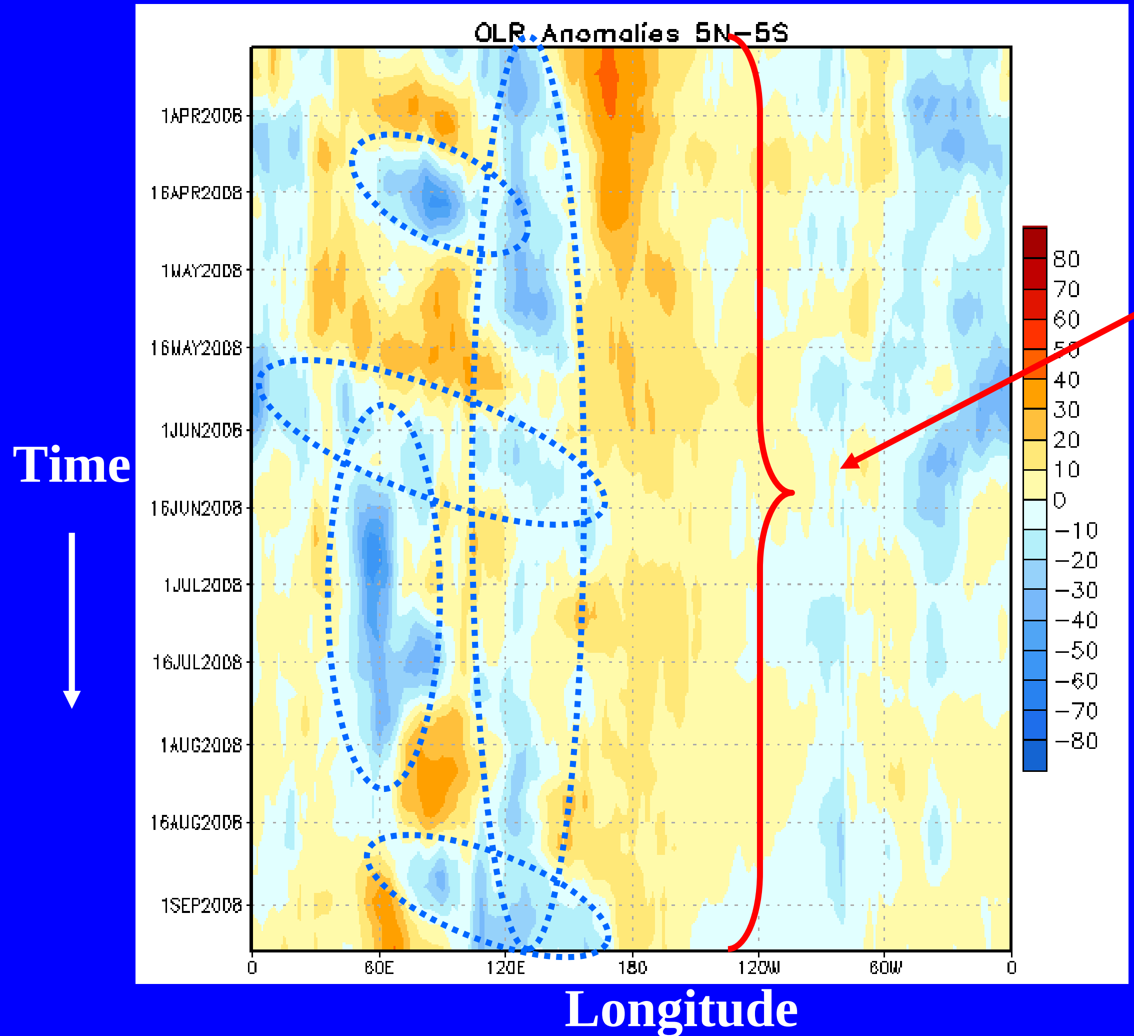
Negative anomalies (green shading) indicate favorable conditions for precipitation.

Moderate-to-strong MJO activity was present during mid-May – mid-July2008.

Consistent with a lingering La Niña pattern, negative velocity potential anomalies (associated with suppressed convection) have been dominant near the Date Line.

Recently, the MJO has re-developed as evidenced by the eastward shift in the velocity potential anomalies.

Outgoing Longwave Radiation (OLR) Anomalies



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

Wetter-than-average conditions (blue shading)

Since February 2007, convection has been suppressed across the central equatorial Pacific Ocean.

Convection has occasionally been enhanced over the western equatorial Pacific and central Indian Ocean.

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.v3). The SST reconstruction methodology is described in Smith et al., 2007, *J. Climate*, *in press*.**
- **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.

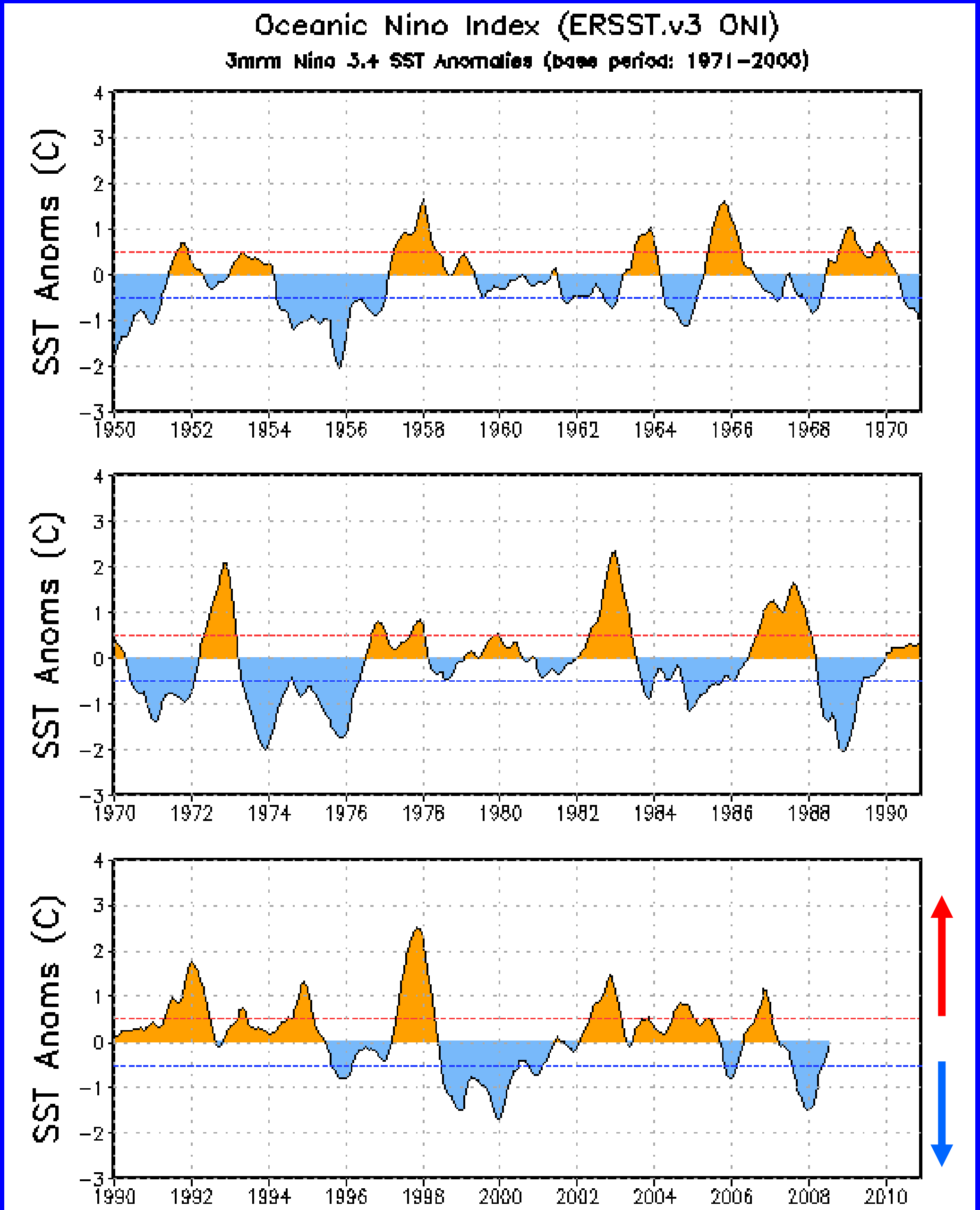
La Niña: characterized by a ***negative*** ONI less than or equal to -0.5°C.

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 SST departures meet or exceed +/- 0.5°C along with consistent atmospheric features.

ONI (ºC): Evolution since 1950

The most recent ONI value (June – August 2008) is -0.1ºC.



El Niño

neutral

La Niña

Historical El Niño and La Niña Episodes

Based on the ONI computed using ERSST.v3

NOTE:

After upgrading the ocean analysis to ERSST.v3, the following weak ENSO episodes no longer meet the NOAA criteria for an ENSO episode:

El Nino:

FMA 1993-JJA 1993

La Nina:

ASO 1961-MAM 1962

ASO 1983- DJF 1983/84

El Niño	Highest ONI Value
JAS 1951 - NDJ 1951/52	0.7
MAM 1957 – MJJ 1958	1.6
JJA 1963 – DJF 1963/64	1.0
MJJ 1965 – MAM 1966	1.6
OND 1968 – MJJ 1969	1.0
ASO 1969 – DJF 1969/70	0.7
AMJ 1972 – FMA 1973	2.1
ASO 1976 – JFM 1977	0.8
ASO 1977 - JFM 1978	0.8
AMJ 1982 – MJJ 1983	2.3
ASO 1986 – JFM 1988	1.7
AMJ 1991 – JJA 1992	1.8
JJA 1994 – FMA 1995	1.3
AMJ 1997 – MAM 1998	2.5
AMJ 2002 – FMA 2003	1.5
JJA 2004 – JFM 2005	0.9
JAS 2006 - DJF 2006/07	1.2

La Nina	Lowest ONI Value
ASO 1949 – FMA 1951	-1.8
MAM 1954 – DJF 1956/57	-2.0
MAM 1964 – JFM 1965	-1.1
NDJ 1967/68 – MAM 1968	-0.9
JJA 1970 – DJF 1971/72	-1.4
AMJ 1973 – JJA 1974	-2.0
ASO 1974 – AMJ 1976	-1.8
SON 1984 – ASO 1985	-1.1
AMJ 1988 – AMJ 1989	-2.0
ASO 1995 – FMA 1996	-0.8
JJA 1998 – MJJ 2000	-1.7
SON 2000 – JFM 2001	-0.7
JAS 2007 – AMJ 2008	-1.5

Historical Pacific warm (red) and cold (blue) episodes based on a threshold of +/- 0.5 ºC for the Oceanic Nino Index (ONI) [3 month running mean of ERSST.v3 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**	**-1.4**	**-1.4**	**-1.3**	**-1.2**	**-0.9**	**-0.8**	**-0.8**	**-0.8**	**-0.9**	**-1.0**
1951	**-1.1**	**-0.9**	**-0.7**	-0.4	-0.2	0.1	0.3	**0.5**	**0.6**	**0.7**	**0.7**	**0.6**
1952	0.3	0.2	0.1	0.1	0.0	-0.2	-0.3	-0.3	-0.1	-0.2	-0.2	-0.1
1953	0.1	0.3	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.3	0.3	0.2
1954	0.3	0.2	-0.2	**-0.6**	**-0.8**	**-0.8**	**-0.8**	**-1.1**	**-1.2**	**-1.1**	**-1.1**	**-1.0**
1955	**-1.0**	**-0.9**	**-0.9**	**-1.0**	**-1.1**	**-1.0**	**-1.0**	**-1.0**	**-1.4**	**-1.8**	**-2.0**	**-1.7**
1956	**-1.2**	**-0.7**	**-0.6**	**-0.6**	**-0.5**	**-0.5**	**-0.6**	**-0.8**	**-0.8**	**-0.9**	**-0.8**	**-0.7**
1957	**-0.5**	-0.1	0.3	**0.6**	**0.7**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**1.2**	**1.5**
1958	**1.7**	**1.5**	**1.1**	**0.7**	**0.5**	**0.5**	0.4	0.2	0.0	0.0	0.2	0.4
1959	0.4	0.5	0.4	0.2	0.1	-0.2	-0.4	-0.5	-0.4	-0.3	-0.2	-0.3
1960	-0.3	-0.3	-0.3	-0.1	-0.1	-0.1	0.0	0.0	0.0	-0.2	-0.2	-0.2
1961	-0.1	-0.2	-0.2	-0.1	0.1	0.2	0.1	-0.3	-0.6	-0.6	-0.5	-0.4
1962	-0.5	-0.5	-0.4	-0.5	-0.4	-0.3	-0.2	-0.3	-0.4	-0.6	-0.7	-0.7
1963	-0.6	-0.3	0.0	0.1	0.1	0.3	**0.7**	**0.9**	**0.9**	**0.9**	**1.0**	**1.0**
1964	**0.9**	0.4	0.0	**-0.5**	**-0.7**	**-0.7**	**-0.7**	**-0.8**	**-1.0**	**-1.1**	**-1.1**	**-1.0**
1965	**-0.8**	**-0.5**	-0.2	0.0	0.3	**0.7**	**1.0**	**1.3**	**1.5**	**1.6**	**1.6**	**1.5**
1966	**1.2**	**1.1**	**0.8**	**0.5**	0.3	0.2	0.2	0.0	-0.2	-0.2	-0.3	-0.3
1967	-0.4	-0.5	-0.6	-0.5	-0.2	0.0	0.0	-0.2	-0.4	-0.5	-0.4	**-0.5**
1968	**-0.7**	**-0.8**	**-0.8**	**-0.7**	-0.4	0.0	0.3	0.3	0.3	0.4	**0.7**	**0.9**
1969	**1.0**	**1.0**	**0.9**	**0.8**	**0.6**	**0.5**	0.4	0.4	**0.6**	**0.7**	**0.7**	**0.6**
1970	**0.5**	0.3	0.2	0.1	0.0	-0.3	**-0.6**	**-0.7**	**-0.7**	**-0.7**	**-0.8**	**-1.1**
1971	**-1.3**	**-1.4**	**-1.2**	**-0.9**	**-0.8**	**-0.8**	**-0.8**	**-0.8**	**-0.8**	**-0.9**	**-1.0**	**-0.9**
1972	**-0.7**	-0.3	0.0	0.3	**0.6**	**0.8**	**1.1**	**1.4**	**1.6**	**1.8**	**2.1**	**2.1**
1973	**1.8**	**1.2**	**0.5**	0.0	**-0.5**	**-0.8**	**-1.0**	**-1.2**	**-1.4**	**-1.7**	**-1.9**	**-2.0**
1974	**-1.8**	**-1.6**	**-1.2**	**-1.1**	**-0.9**	**-0.7**	**-0.5**	-0.4	**-0.5**	**-0.7**	**-0.8**	**-0.7**
1975	**-0.6**	**-0.6**	**-0.7**	**-0.8**	**-0.9**	**-1.1**	**-1.3**	**-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 ^{o}C for the Oceanic Nino Index (ONI) [3 month running mean of ERSST.v3 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**	**-0.9**	**-0.6**	**-0.5**	-0.2	0.1	0.3	**0.6**	**0.8**	**0.8**	**0.8**
1977	**0.6**	**0.5**	0.3	0.2	0.2	0.4	0.4	0.4	**0.5**	**0.7**	**0.8**	**0.8**
1978	**0.8**	**0.5**	0.0	-0.3	-0.4	-0.3	-0.3	-0.4	-0.4	-0.3	-0.2	-0.1
1979	-0.1	0.0	0.1	0.2	0.1	0.0	0.1	0.2	0.3	0.5	0.5	0.6
1980	0.5	0.4	0.3	0.2	0.3	0.3	0.2	0.0	-0.1	0.0	0.0	0.0
1981	-0.2	-0.4	-0.4	-0.3	-0.2	-0.3	-0.3	-0.3	-0.2	-0.1	-0.1	0.0
1982	0.0	0.1	0.2	0.4	**0.7**	**0.7**	**0.8**	**1.0**	**1.5**	**1.9**	**2.2**	**2.3**
1983	**2.3**	**2.1**	**1.6**	**1.3**	**1.0**	**0.7**	0.3	-0.1	-0.5	-0.7	-0.9	-0.7
1984	-0.4	-0.2	-0.2	-0.3	-0.4	-0.4	-0.3	-0.2	-0.2	**-0.6**	**-0.9**	**-1.1**
1985	**-1.0**	**-0.9**	**-0.8**	**-0.8**	**-0.8**	**-0.6**	**-0.6**	**-0.5**	**-0.6**	-0.4	-0.4	-0.4
1986	-0.5	-0.5	-0.3	-0.2	-0.1	0.0	0.2	0.4	**0.6**	**0.9**	**1.0**	**1.2**
1987	**1.2**	**1.3**	**1.2**	**1.1**	**1.0**	**1.2**	**1.5**	**1.7**	**1.6**	**1.5**	**1.2**	**1.1**
1988	**0.7**	**0.5**	0.1	-0.3	**-0.9**	**-1.3**	**-1.4**	**-1.2**	**-1.3**	**-1.6**	**-2.0**	**-2.0**
1989	**-1.8**	**-1.6**	**-1.2**	**-0.9**	**-0.7**	-0.4	-0.4	-0.4	-0.4	-0.3	-0.2	-0.1
1990	0.1	0.1	0.3	0.3	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.4
1991	0.4	0.4	0.3	0.3	**0.6**	**0.8**	**1.0**	**0.9**	**0.9**	**0.9**	**1.3**	**1.6**
1992	**1.8**	**1.7**	**1.5**	**1.4**	**1.2**	**0.9**	**0.5**	0.2	-0.1	-0.1	0.1	0.3
1993	0.4	0.4	0.5	0.7	0.7	0.7	0.4	0.3	0.3	0.3	0.3	0.3
1994	0.2	0.2	0.2	0.3	0.4	0.4	**0.5**	**0.5**	**0.7**	**0.9**	**1.3**	**1.3**
1995	**1.2**	**0.9**	**0.6**	0.3	0.2	0.1	-0.1	-0.2	**-0.5**	**-0.6**	**-0.8**	**-0.8**
1996	**-0.8**	**-0.7**	**-0.5**	-0.3	-0.2	-0.2	-0.1	-0.2	-0.1	-0.2	-0.3	-0.4
1997	-0.4	-0.3	-0.1	0.3	**0.8**	**1.3**	**1.7**	**2.0**	**2.2**	**2.4**	**2.5**	**2.5**
1998	**2.3**	**2.0**	**1.4**	**1.1**	0.4	-0.1	**-0.7**	**-1.0**	**-1.1**	**-1.2**	**-1.4**	**-1.5**
1999	**-1.5**	**-1.2**	**-0.9**	**-0.8**	**-0.8**	**-0.8**	**-0.9**	**-1.0**	**-1.0**	**-1.2**	**-1.4**	**-1.7**
2000	**-1.7**	**-1.4**	**-1.0**	**-0.8**	**-0.6**	**-0.6**	-0.4	-0.4	-0.4	**-0.5**	**-0.7**	**-0.7**
2001	**-0.7**	**-0.5**	-0.4	-0.3	-0.1	0.1	0.1	0.0	0.0	-0.1	-0.1	-0.2

Historical Pacific warm (red) and cold (blue) episodes based on a threshold of +/- 0.5 ºC for the Oceanic Nino Index (ONI) [3 month running mean of ERSST.v3 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
2002	-0.1	0.1	0.2	0.4	**0.6**	**0.8**	**0.9**	**0.9**	**1.1**	**1.3**	**1.5**	**1.4**
2003	**1.2**	**0.9**	**0.5**	0.1	-0.1	0.0	0.3	0.4	0.5	0.5	0.6	0.4
2004	0.4	0.2	0.2	0.2	0.3	0.4	**0.7**	**0.8**	**0.9**	**0.8**	**0.8**	**0.8**
2005	**0.6**	**0.5**	0.4	0.5	0.5	0.5	0.5	0.3	0.2	-0.1	-0.4	-0.8
2006	-0.8	-0.6	-0.3	-0.1	0.2	0.3	0.4	**0.5**	**0.7**	**0.9**	**1.2**	**1.1**
2007	**0.8**	0.4	0.1	-0.1	0.0	-0.1	-0.2	**-0.5**	**-0.8**	**-1.1**	**-1.2**	**-1.4**
2008	**-1.5**	**-1.4**	**-1.1**	**-0.7**	**-0.5**	-0.4	-0.1					
2009												
2010												
2011												
2012												
2013												
2014												
2015												
2016												
2017												
2018												
2019												
2020												
2021												
2022												
2023												
2024												
2025												
2026												
2027												

Pacific Niño 3.4 SST Outlook

A majority of ENSO forecasts indicate ENSO-neutral conditions will continue through Northern Hemisphere spring 2009.

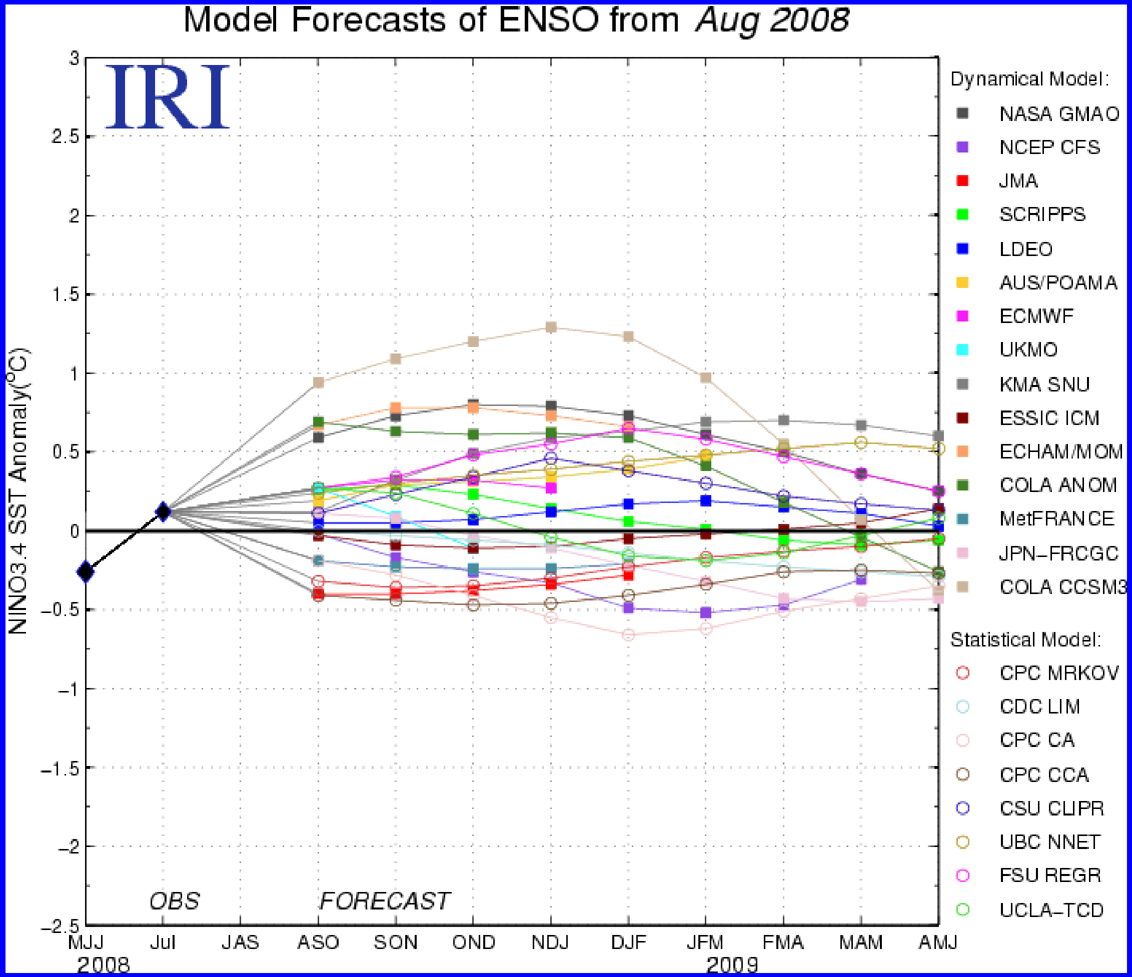
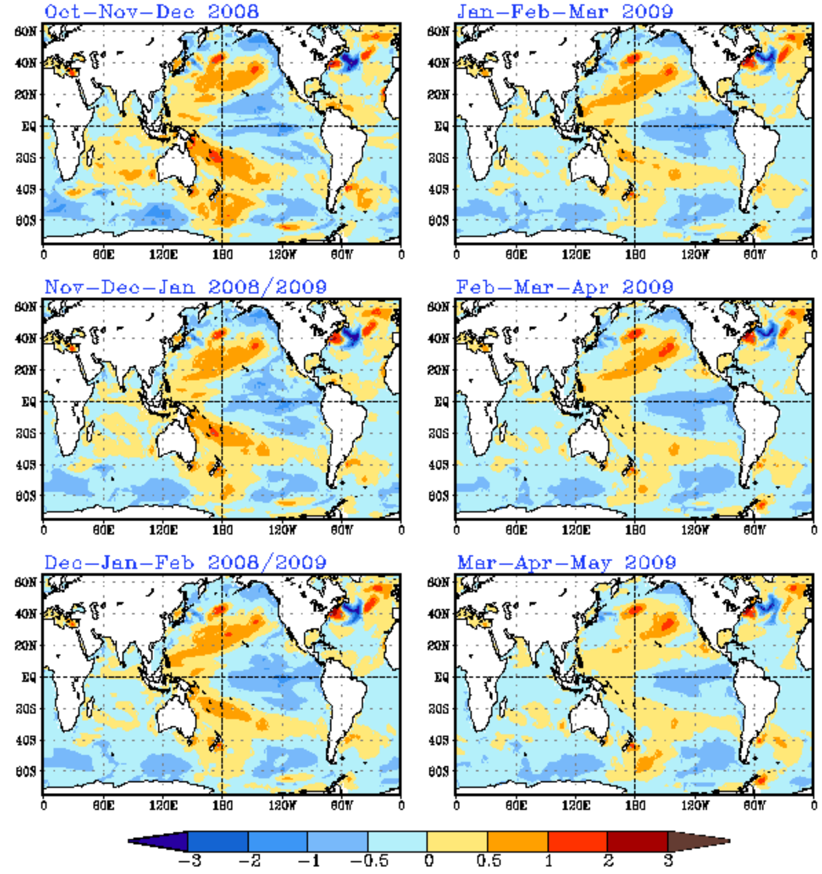
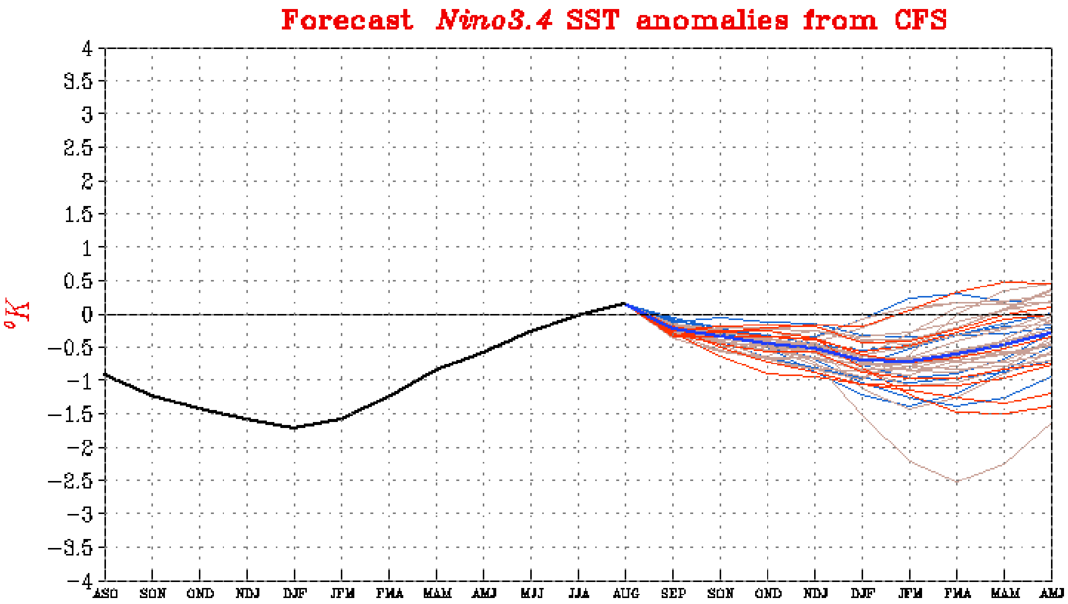


Figure provided by the International Research Institute (IRI) for Climate and Society (updated 19 August 2008).

SST Outlook: NCEP CFS Forecast Issued 14 September 2008

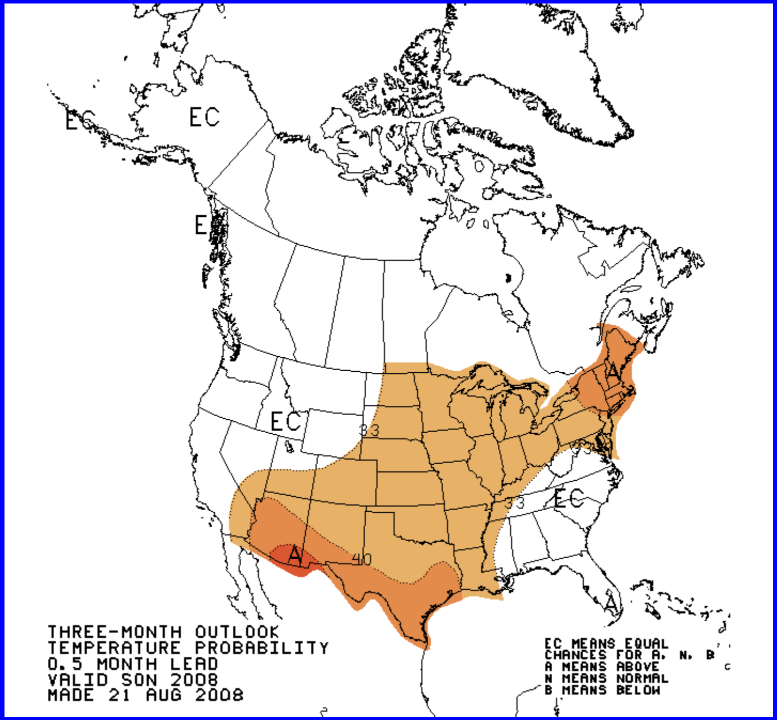


The CFS ensemble mean (heavy blue line) indicates ENSO-neutral conditions through 2008 followed by weak La Niña conditions in early 2009.

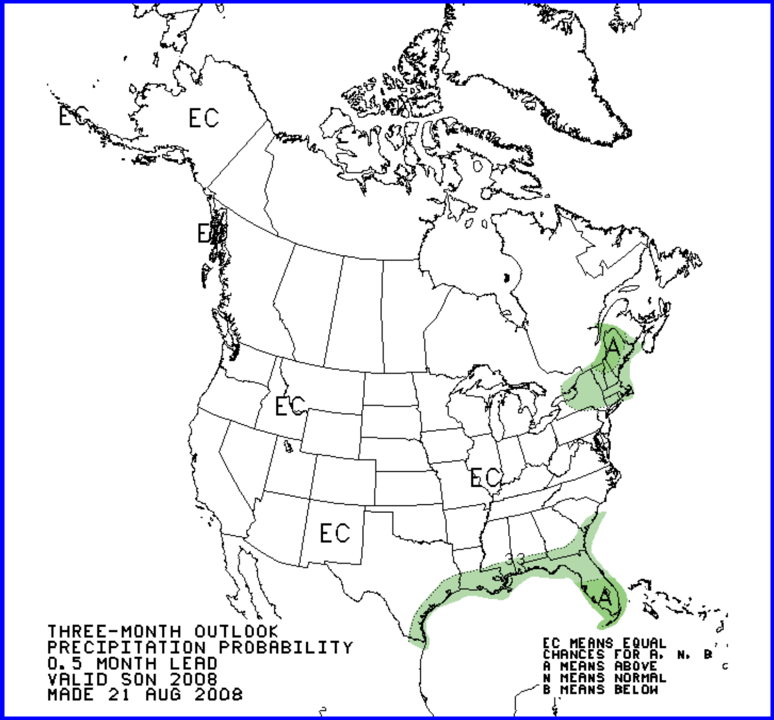


U. S. Seasonal Outlooks
September – November 2008

Temperature



Precipitation



These seasonal outlooks combine long-term trends and soil moisture effects.

Summary

• ENSO-neutral conditions are present in the equatorial Pacific Ocean.

• Equatorial SSTs in the central Pacific Ocean have returned to near-average, while positive SST anomalies have weakened in the eastern Pacific.

• Aspects of the atmospheric circulation and pattern of tropical convection reflect a lingering La Niña signal, particularly over the western and central Pacific.

• Based on recent SST trends and model forecasts, ENSO-neutral conditions are expected to continue through the end of 2008.