ENSO Cycle: Recent Evolution, Current Status and Predictions

Update prepared by
Climate Prediction Center / NCEP
12 October 2010

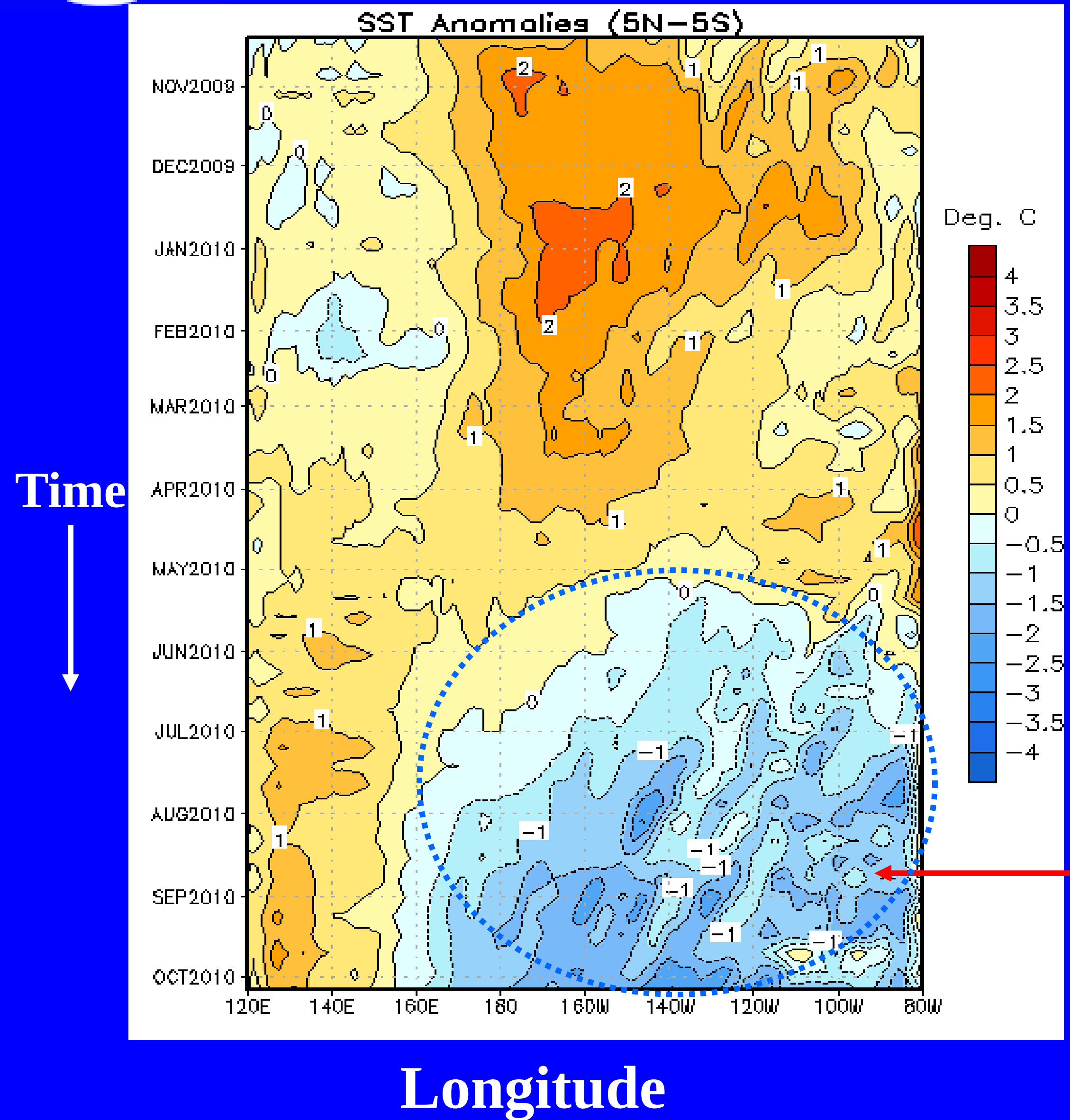
Outline

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

Summary

- La Niña is present across the equatorial Pacific.
- Negative sea surface temperature anomalies persist across much of the Pacific Ocean.
- La Niña is expected to last into the Northern Hemisphere spring 2011.

Recent Evolution of Equatorial Pacific SST Departures (ºC)



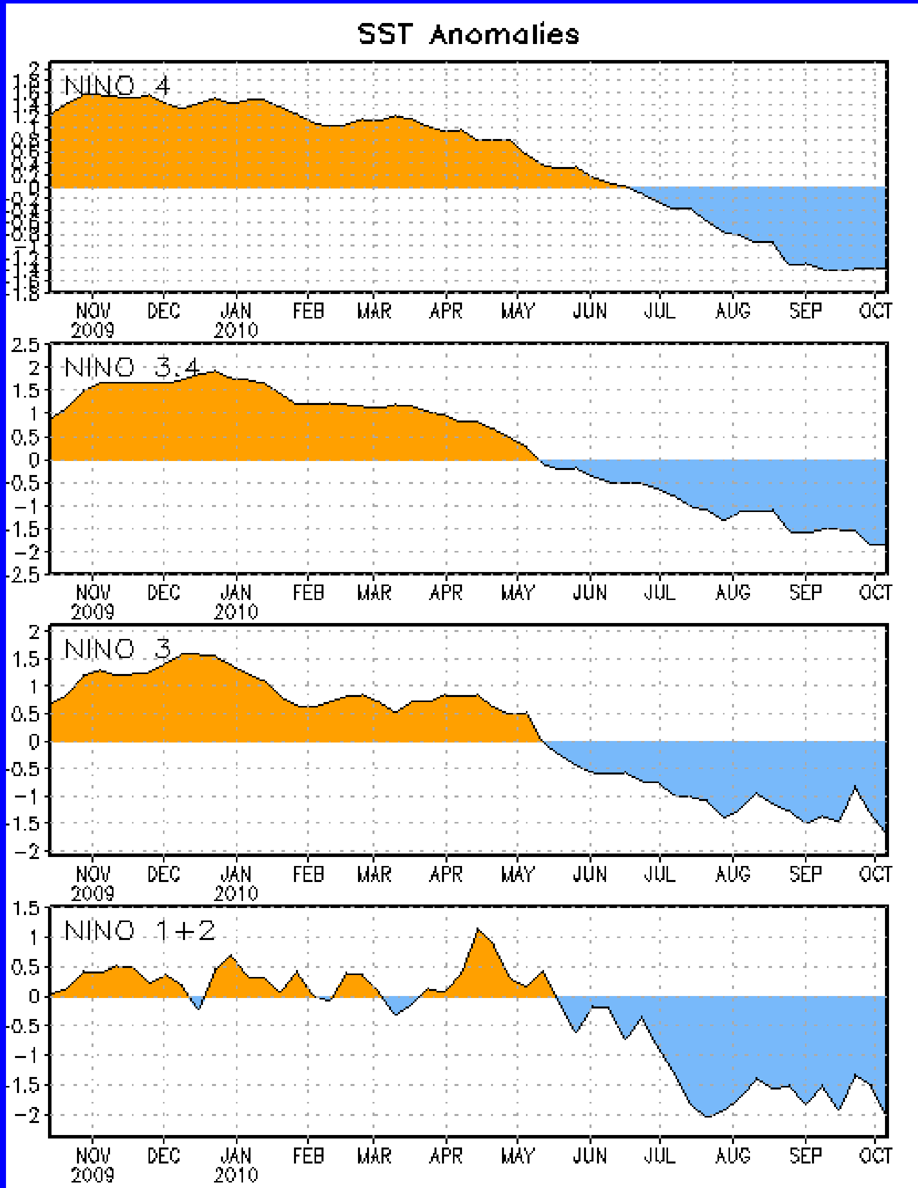
During March and April 2010, positive SST anomalies have decreased across much of the equatorial Pacific.

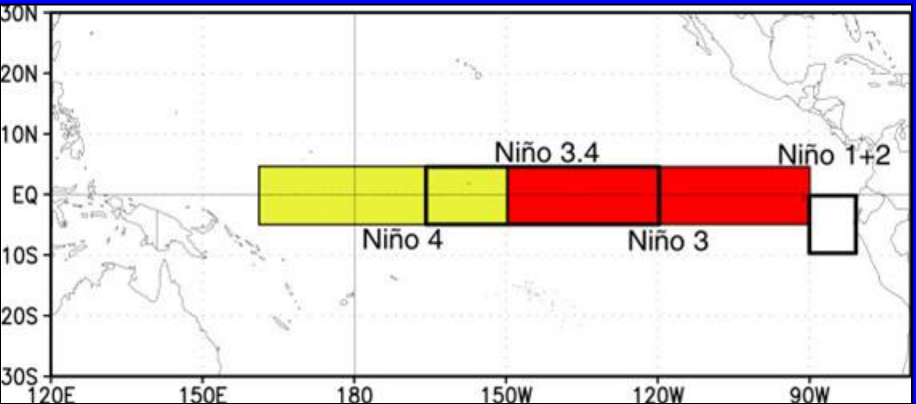
Beginning in May 2010, negative SST anomalies strengthened across the much of the equatorial Pacific.

Niño Region SST Departures (ºC) Recent Evolution

The latest weekly SST departures are:

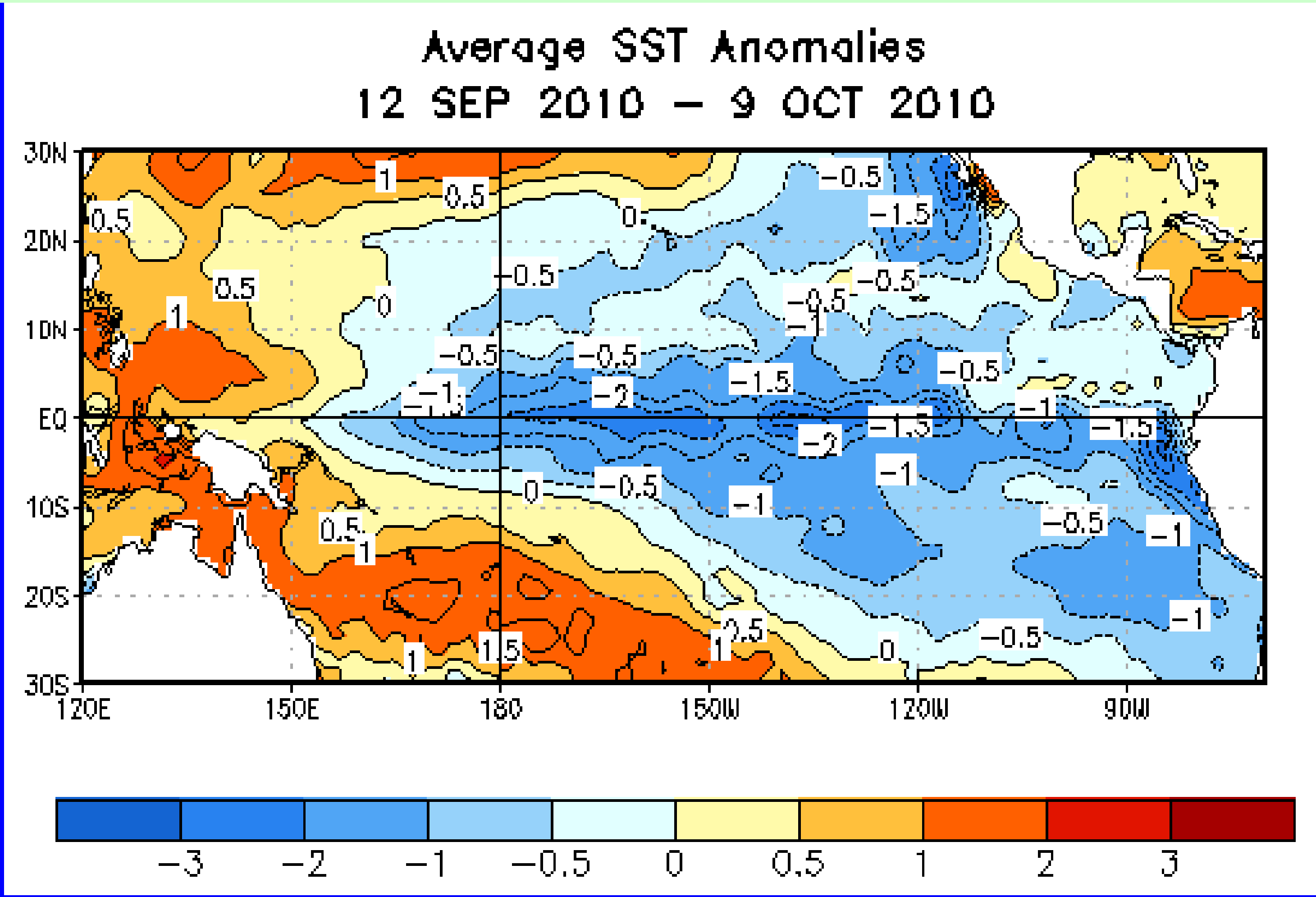
Niño 4	**-1.4ºC**
Niño 3.4	**-1.8ºC**
Niño 3	**-1.7ºC**
Niño 1+2	**-2.1ºC**



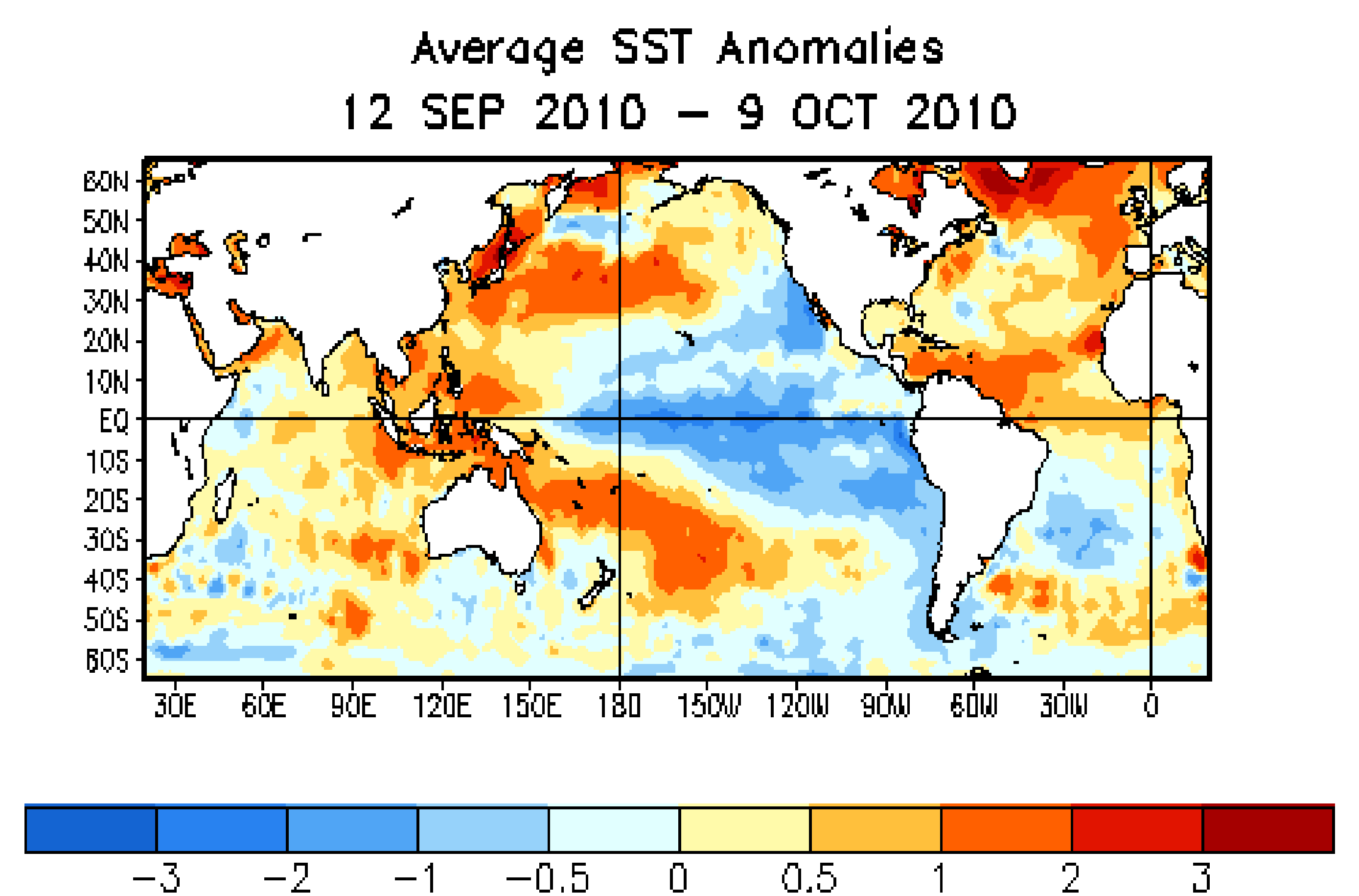


SST Departures (ºC) in the Tropical Pacific During the Last 4 Weeks

During the last 4-weeks, SSTs were at least 1.0°C below average between 165°E and the South American coast, with departures more than 2.0°C below average east of the International Date Line.

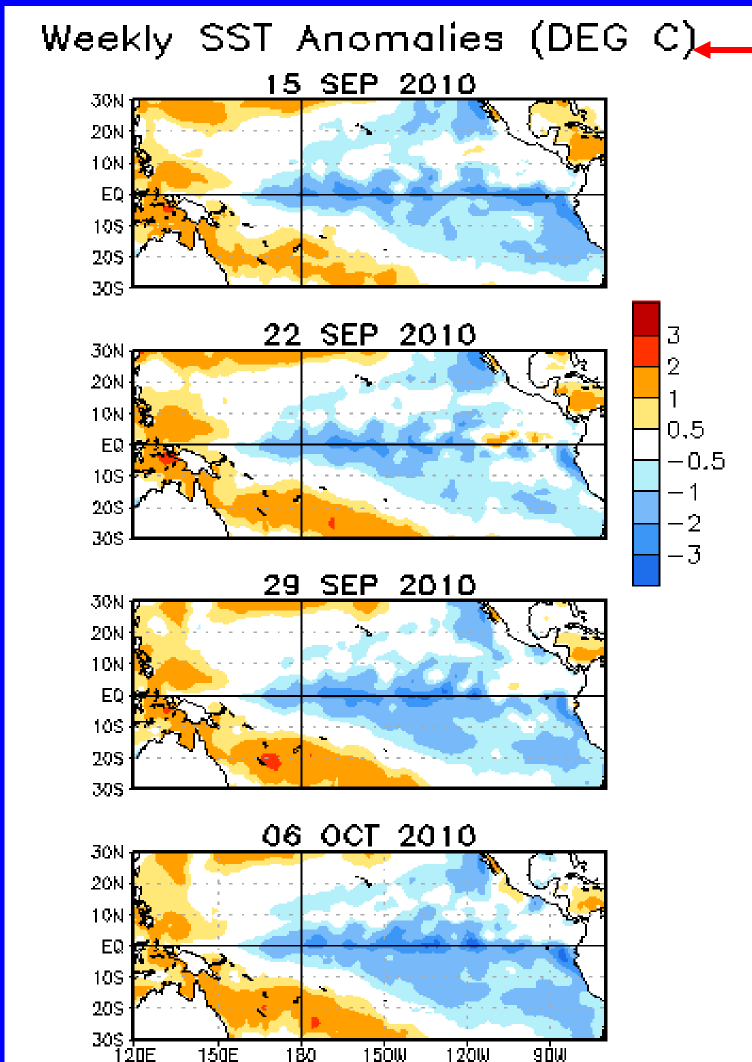


Global SST Departures (ºC)



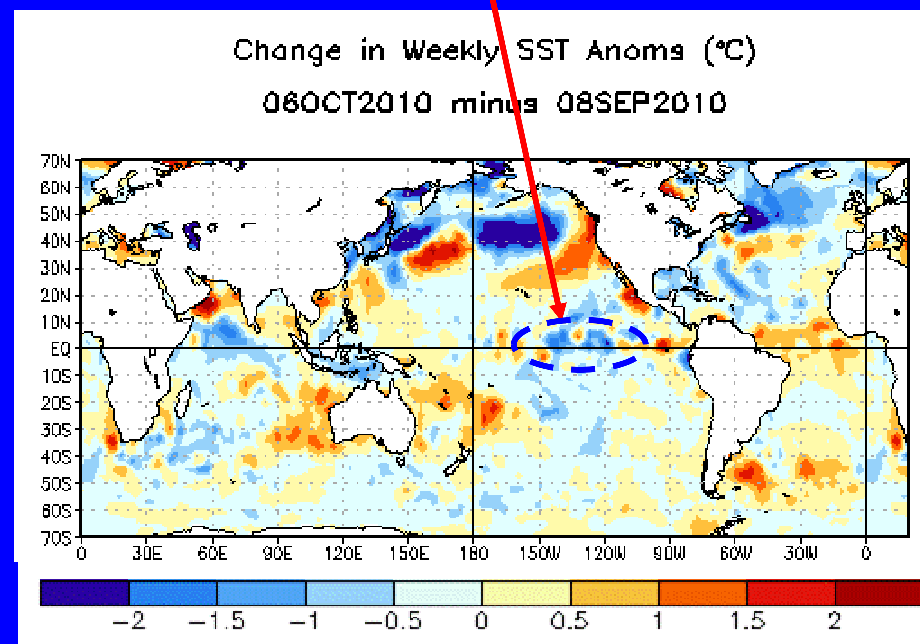
During the last four weeks, equatorial SSTs were above-average across the Indian, Atlantic, and far western Pacific Oceans. Equatorial SSTs were below-average across much of the Pacific and in the far western Indian Ocean. Also, SSTs in the North Atlantic (south of Greenland) were well above-average.

Weekly SST Departures (ºC) for the Last Four Weeks



- During the last four weeks, equatorial SST anomalies have been negative across much of the Pacific.

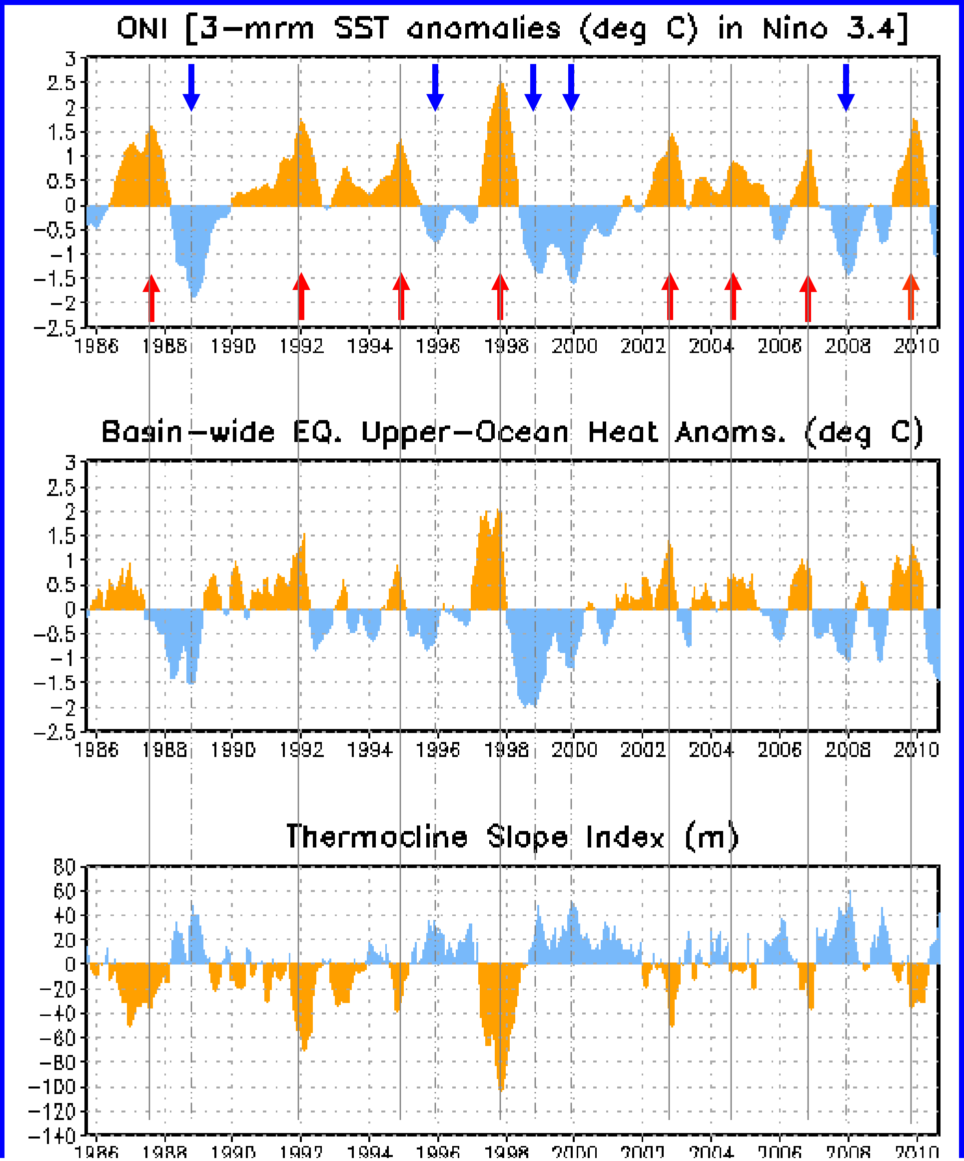
- During the last 30 days, negative SST anomalies strengthened in the east-central equatorial Pacific.



Upper-Ocean Conditions in the Eq. Pacific

Cold Episodes ↓

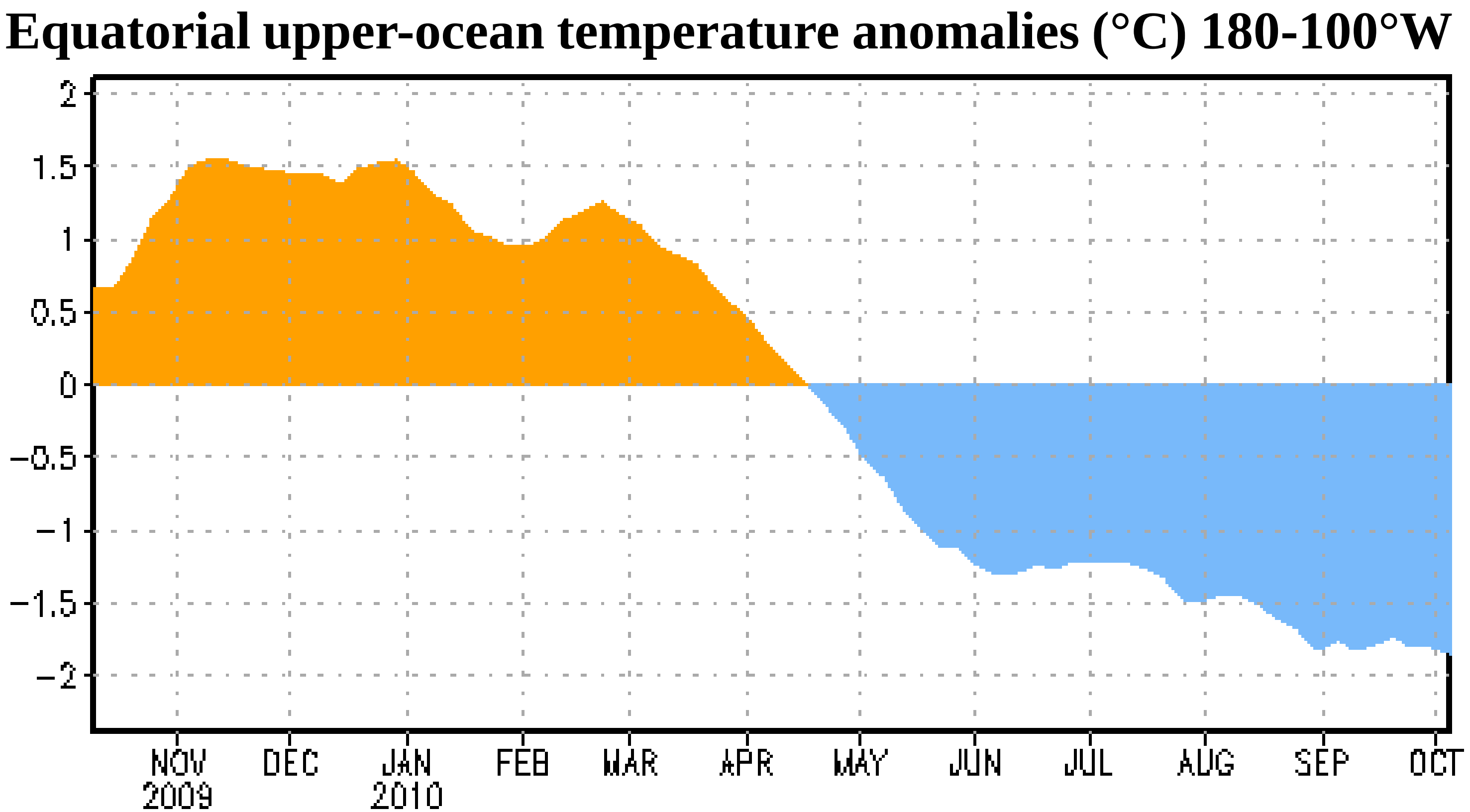
Warm Episodes ↑



- **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.**
- **Recent values of the upper-ocean heat anomalies (negative) and the thermocline slope index (positive) reflect La Niña.**

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).

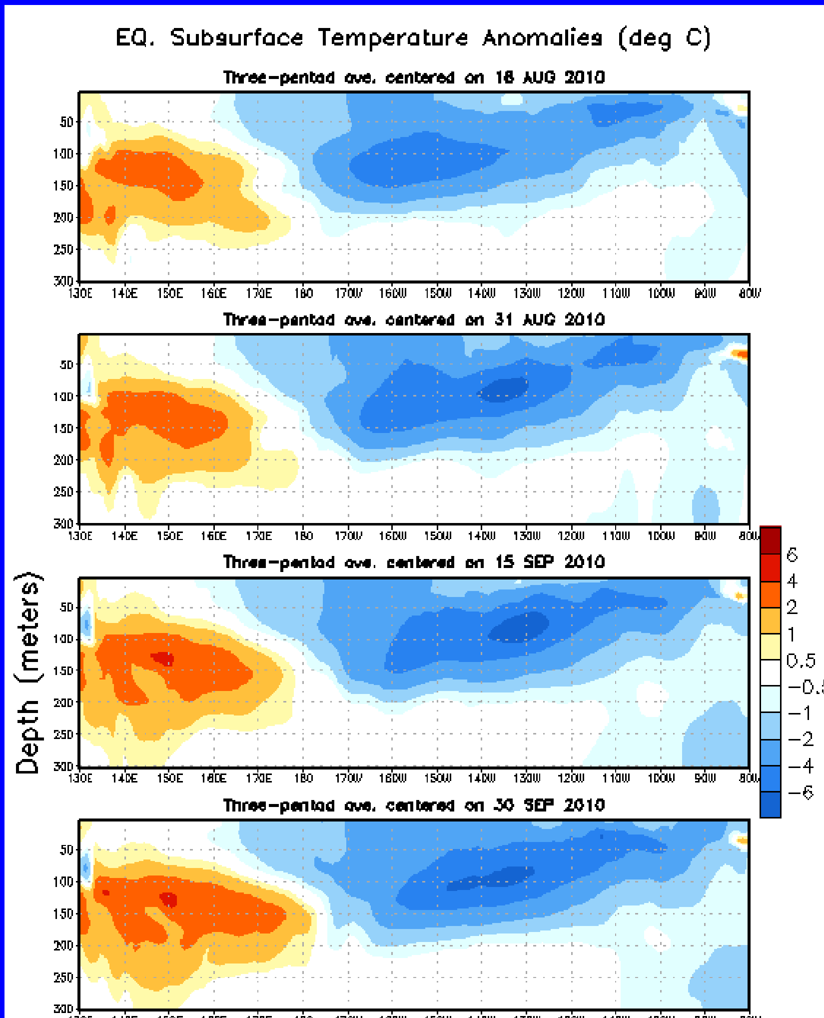
Weekly Central & Eastern Pacific Upper-Ocean (0-300 m) Average Temperature Anomalies



The upper-ocean temperature anomalies increased sharply during October 2009 in association with the strengthening of El Niño. The anomalies decreased beginning in late February 2010, becoming negative in late April. The large negative anomalies since June 2010 are consistent with the development and strengthening of La Niña.

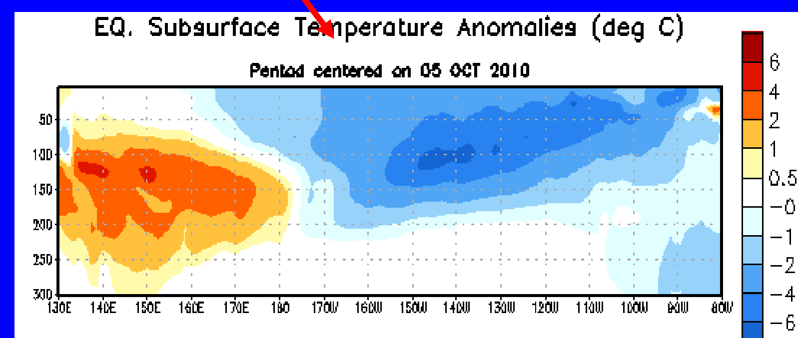
Sub-Surface Temperature Departures (ºC) in the Equatorial Pacific

Time



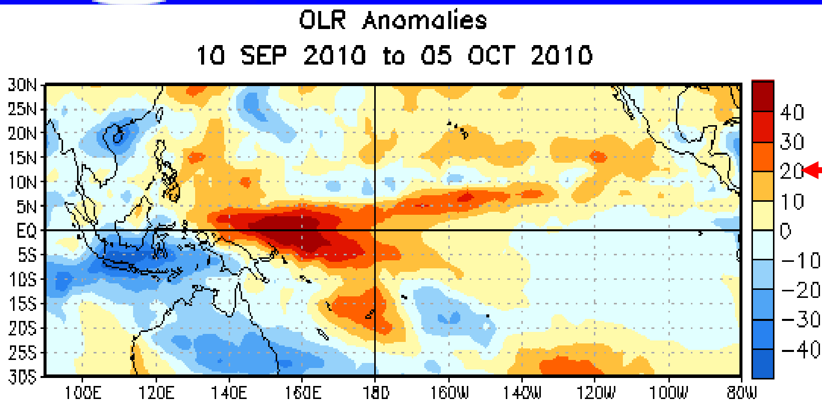
Longitude

- Since May 2010, negative subsurface temperature anomalies have dominated the central and eastern equatorial Pacific.
- The most recent pattern of subsurface temperature anomalies is similar to those observed in late August, except with stronger anomalies in the western Pacific (positive) and averaged between 180°-140°W (negative).

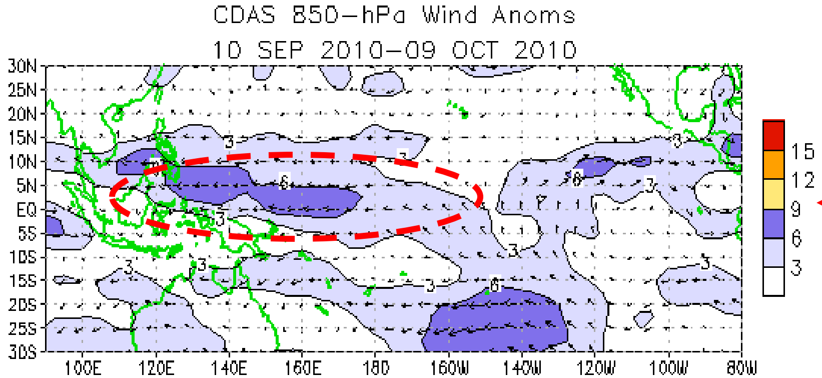


Most recent pentad analysis

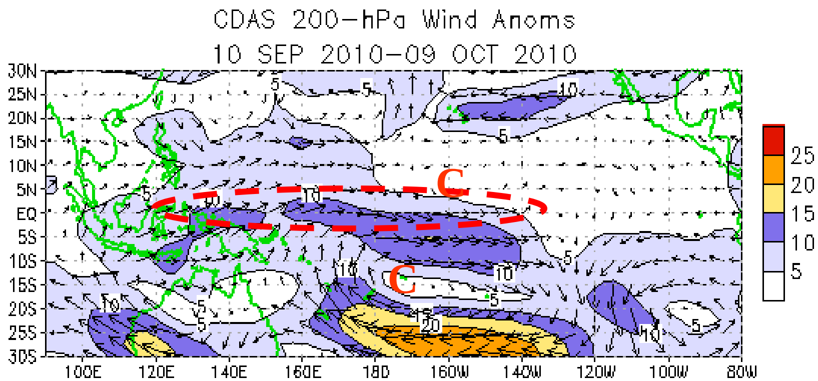
Tropical OLR and Wind Anomalies During the Last 30 Days



Negative OLR anomalies (enhanced convection and precipitation, blue shading) were located over Indonesia and Australia. Positive OLR anomalies (suppressed convection and precipitation, red shading) were located over the western and central equatorial Pacific.



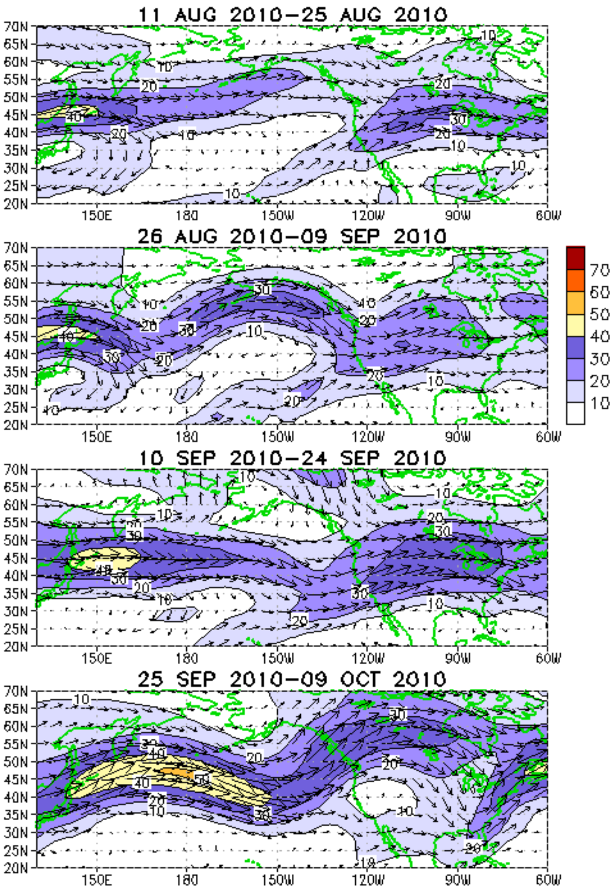
Low-level (850-hPa) easterly anomalies were observed over the western and central equatorial Pacific.



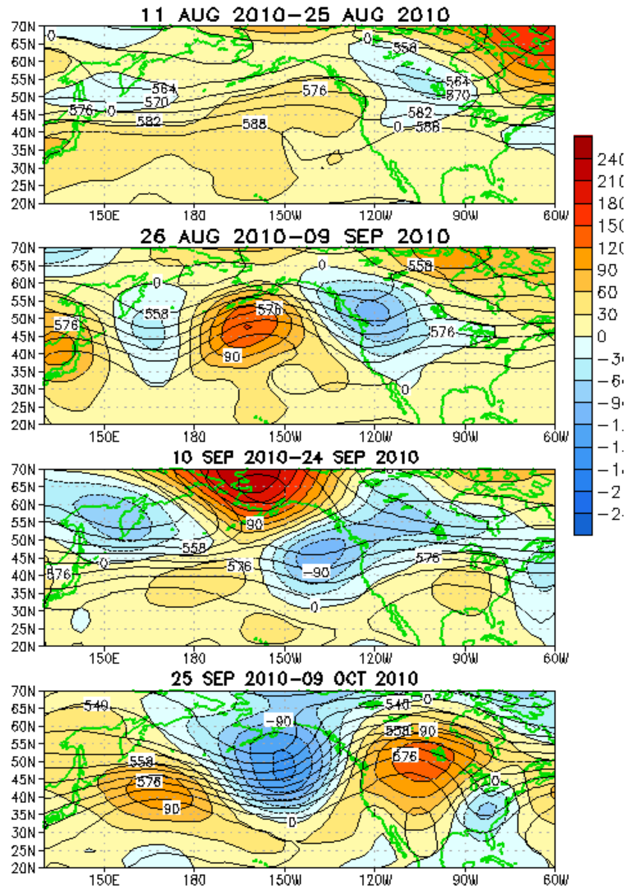
Upper-level (200-hPa) westerly anomalies were observed over much of the western and central equatorial Pacific. A cyclonic couplet was evident in the subtropics of both hemispheres, which is consistent with La Niña.

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

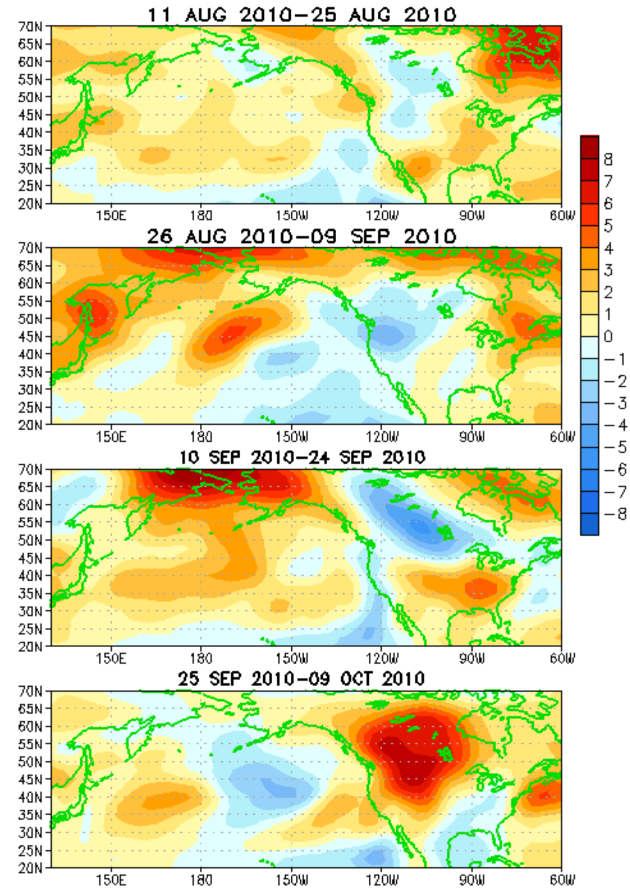
200-hPa Wind



500-hPa Height & Anoms.



925-hPa Temp. Anoms. (^{o}C)

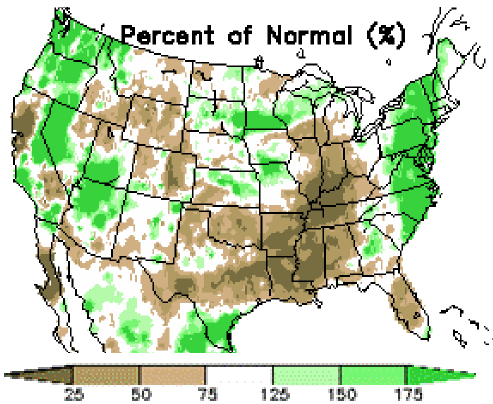


During August through mid-September, a persistent 500-hPa anomalous ridge was evident over the North Pacific. Downstream of the ridge, an anomalous trough has varied in position over western Canada and the northwestern United States, resulting in below-average temperatures over those regions. During late September an anomalous ridge and above-average temperatures developed over western North America, while a trough and below-average temperatures was evident over the eastern United States .

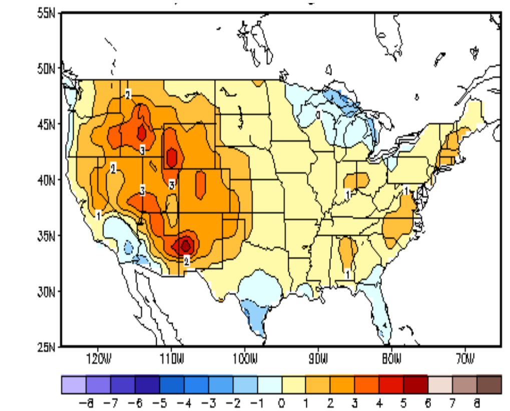
U.S. Temperature and Precipitation Departures During the Last 30 and 90 Days

Last 30 Days

30-day (ending 11 Oct 2010) % of average precipitation

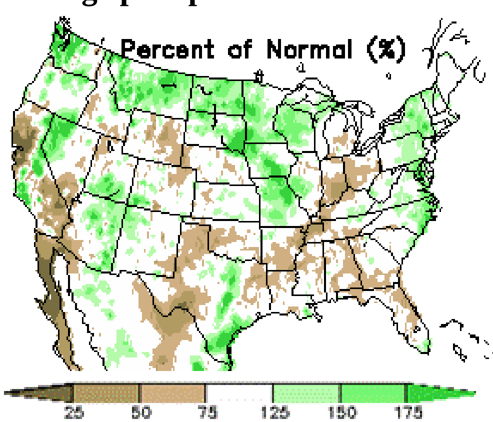


30-day (ending 10 October 2010) temperature departures (degree C)

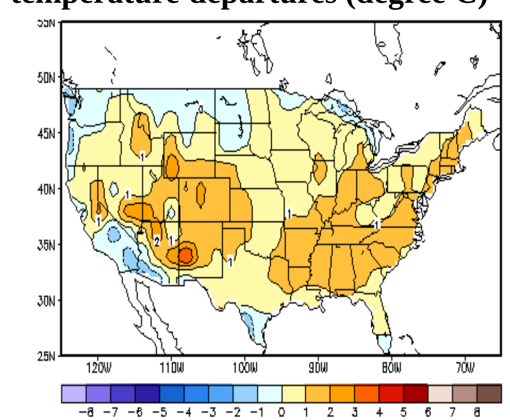


Last 90 Days

90-day (ending 11 Oct 2010) % of average precipitation



90-day (ending 10 October 2010) temperature departures (degree C)



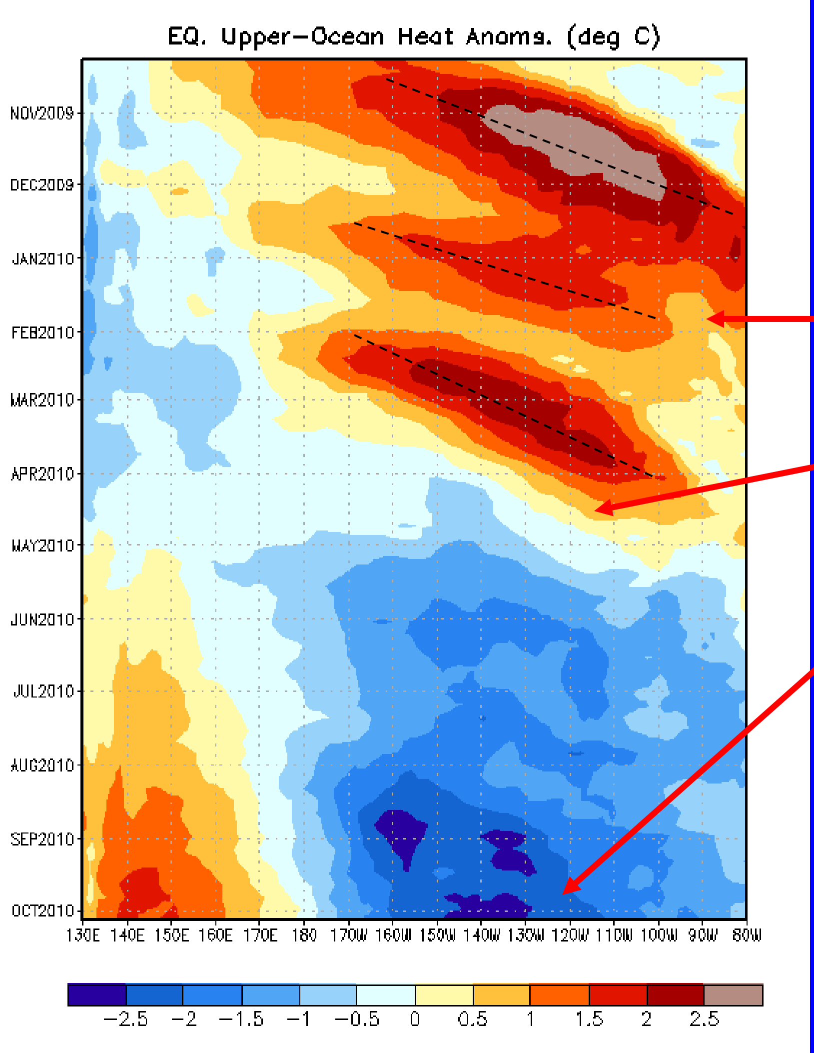
Intraseasonal Variability

- 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



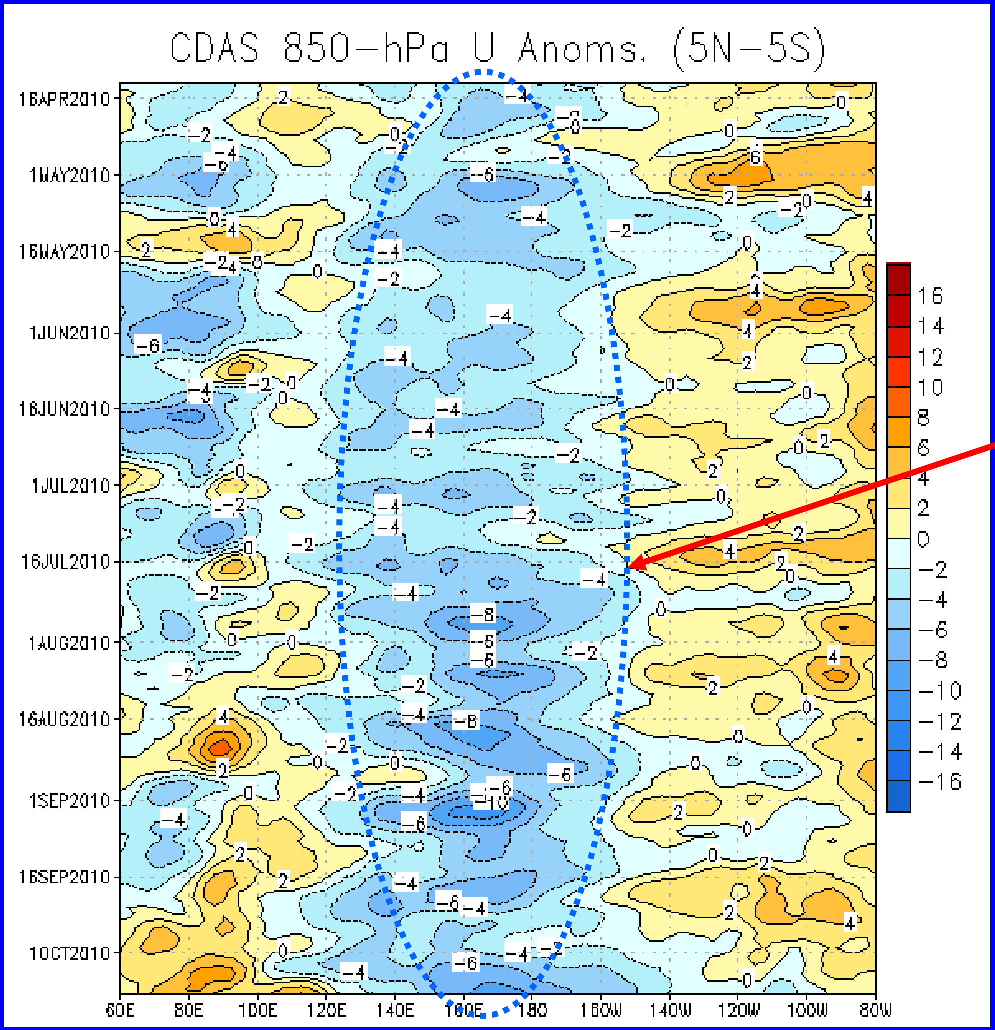
Longitude

- From November 2009- February 2010, three oceanic Kelvin waves contributed to the change in heat content across the eastern half of the Pacific.
- During April 2010, heat content anomalies decreased across the Pacific in association with the upwelling phase of the Kelvin wave.
- Currently, negative heat content anomalies extend across the equatorial Pacific in association with La Niña.

•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



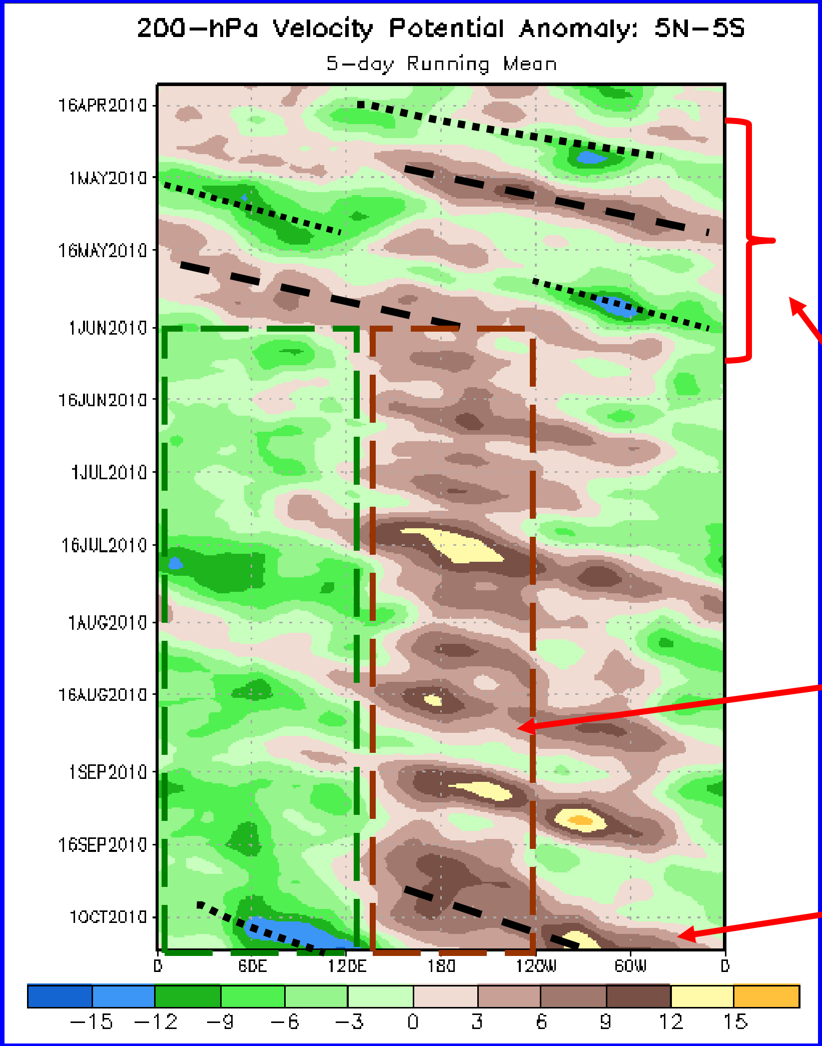
Longitude

Westerly wind anomalies (orange/red shading).

Easterly wind anomalies (blue shading).

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

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



Time

Longitude

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

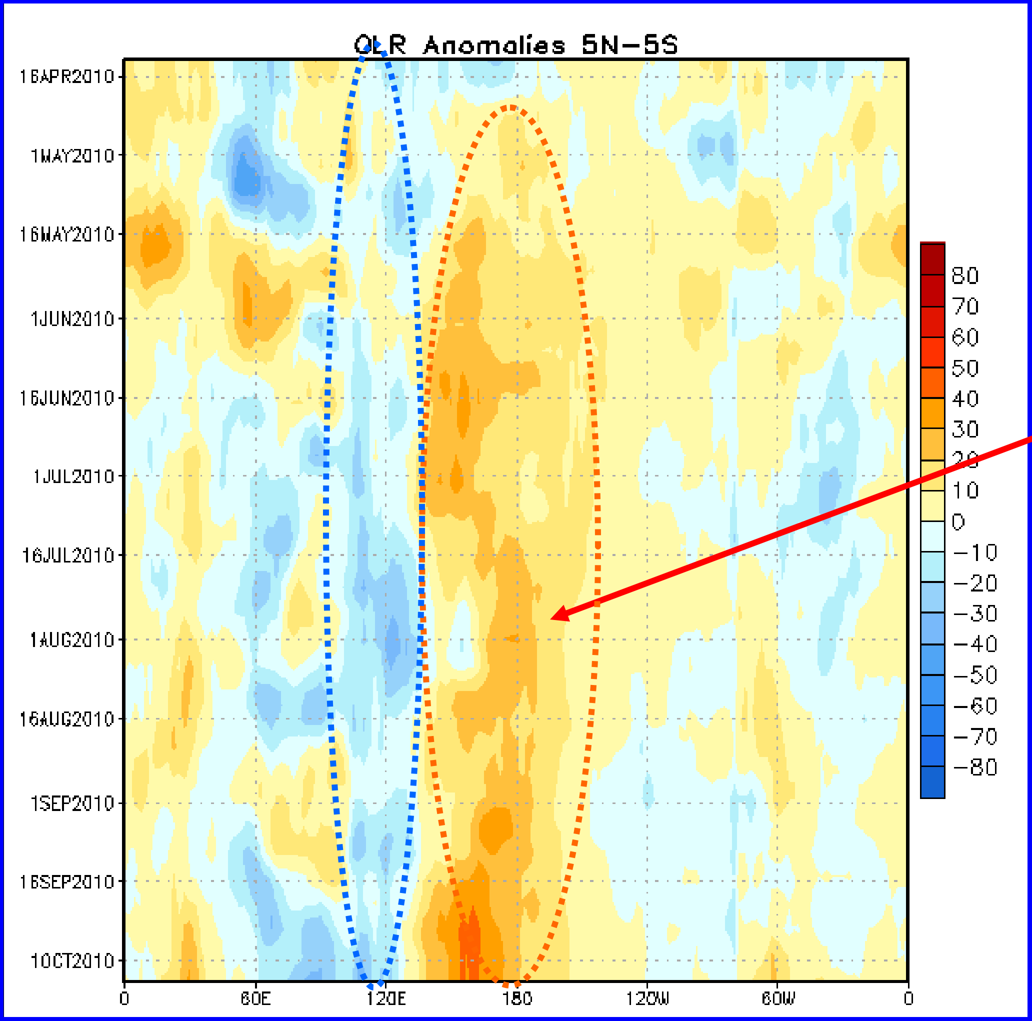
Negative anomalies (green shading) indicate favorable conditions for precipitation.

During late March - early April 2010 and parts of May 2010, weak MJO activity was evident.

Since late May, persistent upper-level convergence anomalies (brown) have been evident over the central Pacific, while anomalous upper-level divergence (green) has generally prevailed over the Indian Ocean and Maritime Continent.

MJO activity strengthened during the beginning of October 2010.

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.

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

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

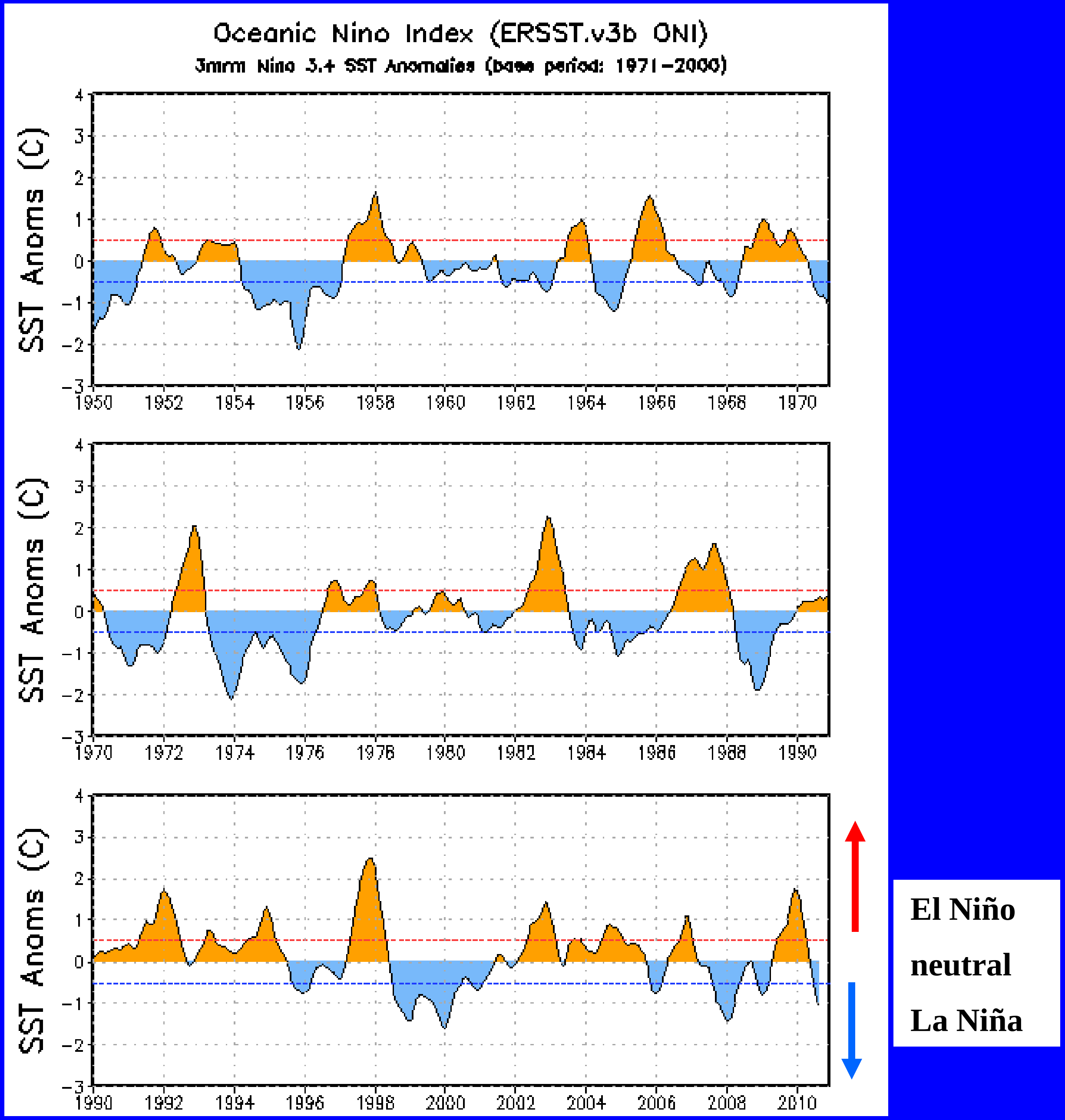
<u>La Niña:</u> characterized by a *negative* ONI less than or equal to -0.5 C.

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

CPC considers El Niño or La Niña <u>conditions</u> 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 (ºC): Evolution since 1950

The most recent ONI value (July–September 2010) is -1.0ºC.



Historical El Niño and La Niña Episodes

Based on the ONI computed using ERSST.v3b

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).

El Niño	Highest ONI Value
JAS 1951 - NDJ 1951/52	0.8
MAM 1957 – MJJ 1958	1.7
JJA 1963 – DJF 1963/64	1.0
MJJ 1965 – MAM 1966	1.6
OND 1968 – MJJ 1969	1.0
ASO 1969 – DJF 1969/70	0.8
AMJ 1972 – FMA 1973	2.1
ASO 1976 – JFM 1977	0.8
ASO 1977 - DJF 1977/78	0.8
AMJ 1982 – MJJ 1983	2.3
JAS 1986 – JFM 1988	1.6
AMJ 1991 – JJA 1992	1.8
AMJ 1994 – FMA 1995	1.3
AMJ 1997 – AMJ 1998	2.5
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

La Nina	Lowest ONI Value
ASO 1949 – FMA 1951	-1.7
MAM 1954 – DJF 1956/57	-2.1
ASO 1962 – DJF 1962/63	-0.8
MAM 1964 – DJF 1964/65	-1.1
NDJ 1967/68 – MAM 1968	-0.9
JJA 1970 – DJF 1971/72	-1.3
AMJ 1973 – MAM 1976	-2.0
SON 1984 – ASO 1985	-1.0
AMJ 1988 – AMJ 1989	-1.9
ASO 1995 – FMA 1996	-0.7
JJA 1998 – MJJ 2000	-1.6
SON 2000 – JFM 2001	-0.7
ASO 2007 – AMJ 2008	-1.4

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.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 ºC 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

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.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
2002	-0.1	0.1	0.2	0.4	**0.7**	**0.8**	**0.9**	**1.0**	**1.1**	**1.3**	**1.5**	**1.4**
2003	**1.2**	**0.9**	**0.5**	0.1	-0.1	0.1	0.4	0.5	0.6	0.5	0.6	0.4
2004	0.4	0.3	0.2	0.2	0.3	**0.5**	**0.7**	**0.8**	**0.9**	**0.8**	**0.8**	**0.8**
2005	**0.7**	**0.5**	0.4	0.4	0.4	0.4	0.4	0.3	0.2	-0.1	-0.4	-0.7
2006	-0.7	-0.6	-0.4	-0.1	0.1	0.2	0.3	**0.5**	**0.6**	**0.9**	**1.1**	**1.1**
2007	**0.8**	0.4	0.1	-0.1	-0.1	-0.1	-0.1	-0.4	**-0.7**	**-1.0**	**-1.1**	**-1.3**
2008	**-1.4**	**-1.4**	**-1.1**	**-0.8**	**-0.6**	-0.4	-0.1	0.0	0.0	0.0	-0.3	-0.6
2009	-0.8	-0.7	-0.5	-0.1	0.2	**0.6**	**0.7**	**0.8**	**0.9**	**1.2**	**1.5**	**1.8**
2010	**1.7**	**1.5**	**1.2**	**0.8**	0.3	-0.2	-0.6	-1.0				
2011												
2012												
2013												
2014												
2015												
2016												
2017												
2018												
2019												
2020												
2021												
2022												
2023												
2024												
2025												
2026												
2027												

Pacific Niño 3.4 SST Outlook

• Nearly all models indicate that La Niña (Niño-3.4 SST anomalies -0.5 C or less) will persist at least into the Northern Hemisphere spring 2011. Many models forecast La Niña to strengthen through November 2010 – January 2011 before beginning to weaken.

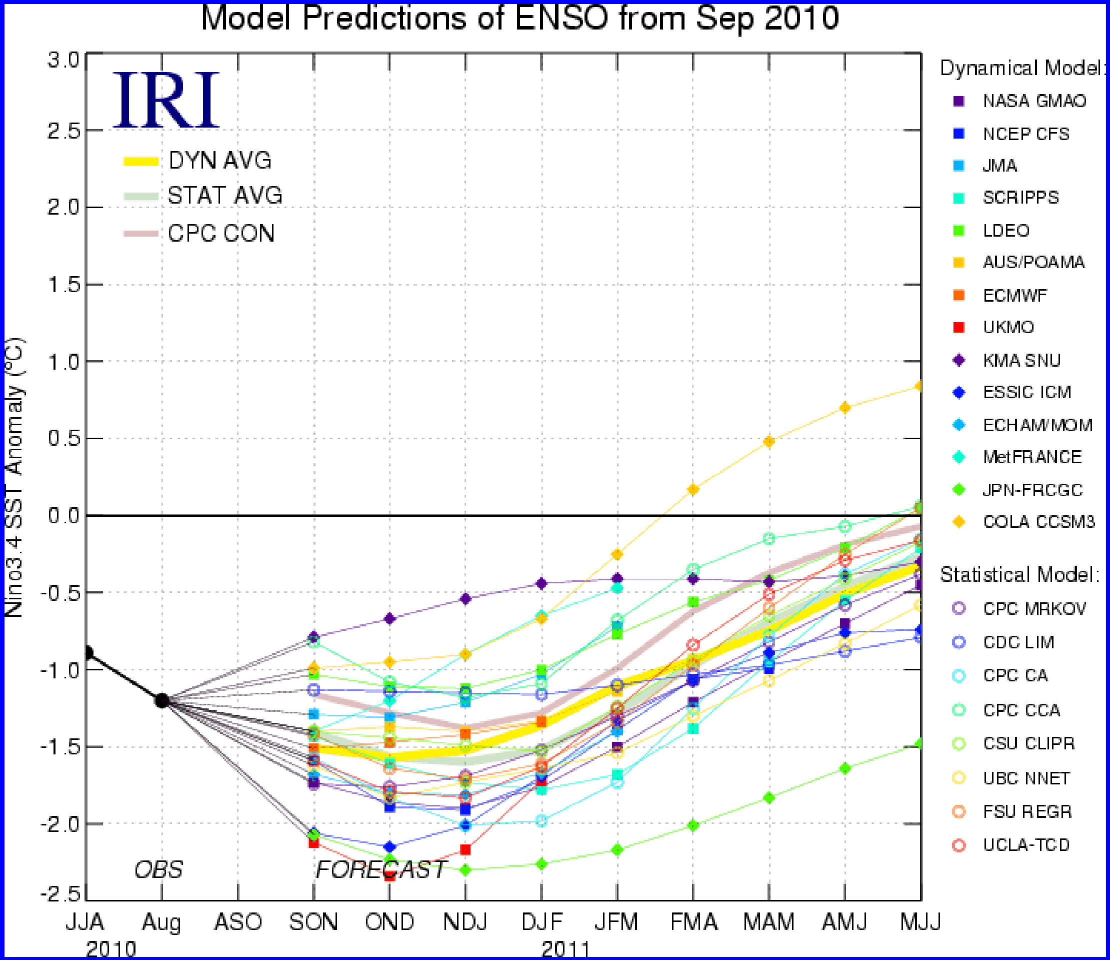
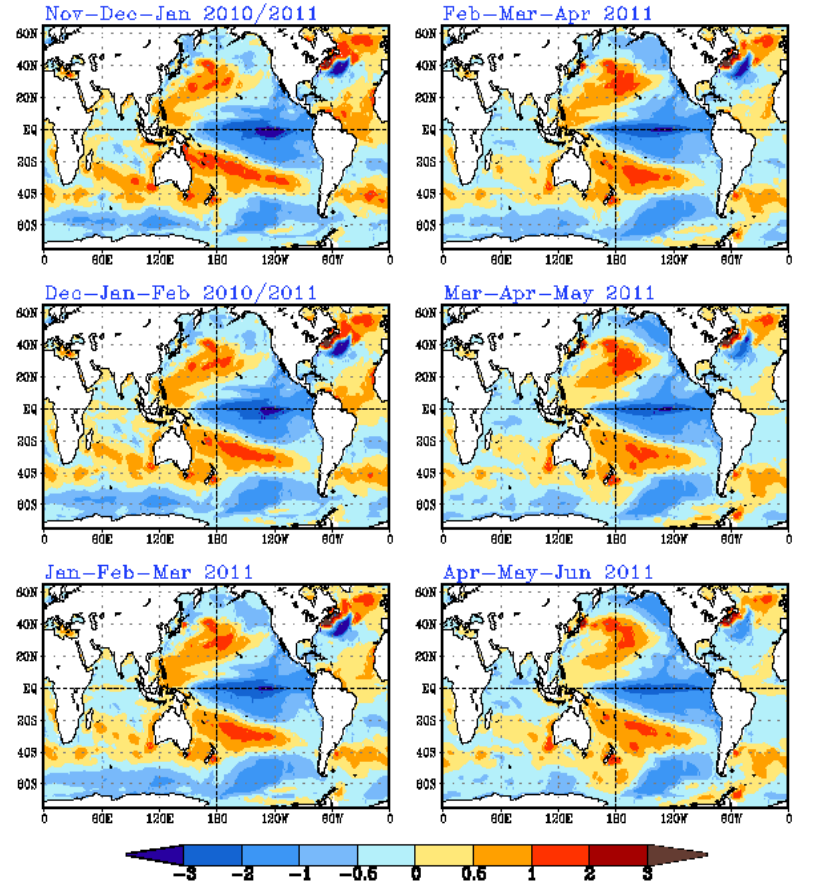


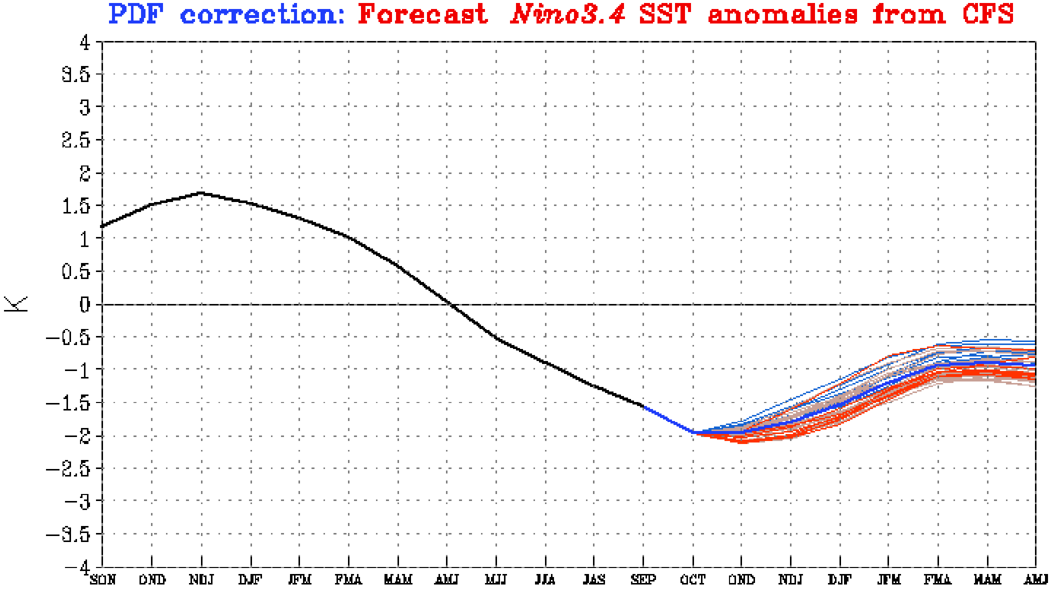
Figure provided by the International Research Institute (IRI) for Climate and Society (updated 14 September 2010).

SST Outlook: NCEP CFS Forecast Issued 11 October 2010



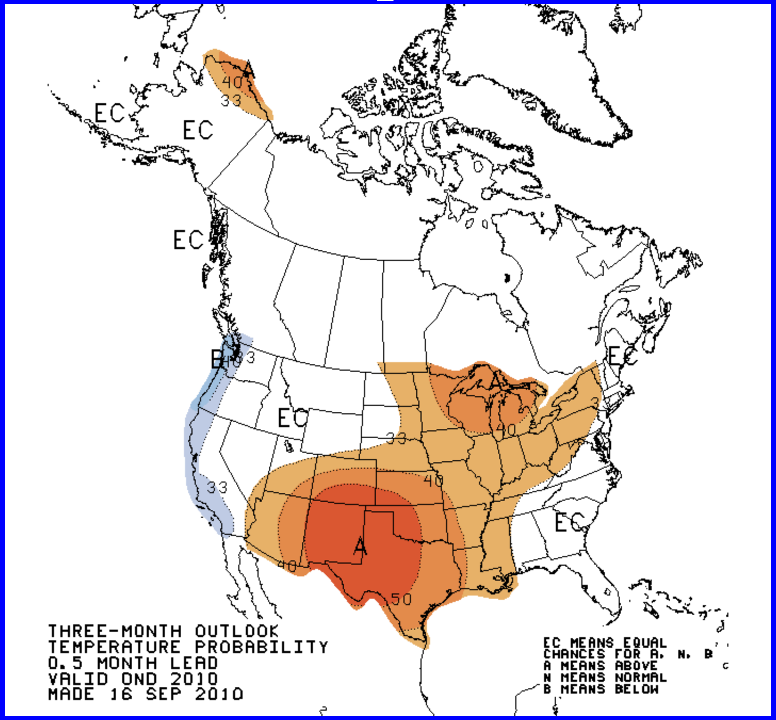
Please note the anomalies displayed above are now PDF corrected in order to match the index shown on the right.

The CFS ensemble mean (heavy blue line) predicts La Niña conditions through Northern Hemisphere spring 2011.

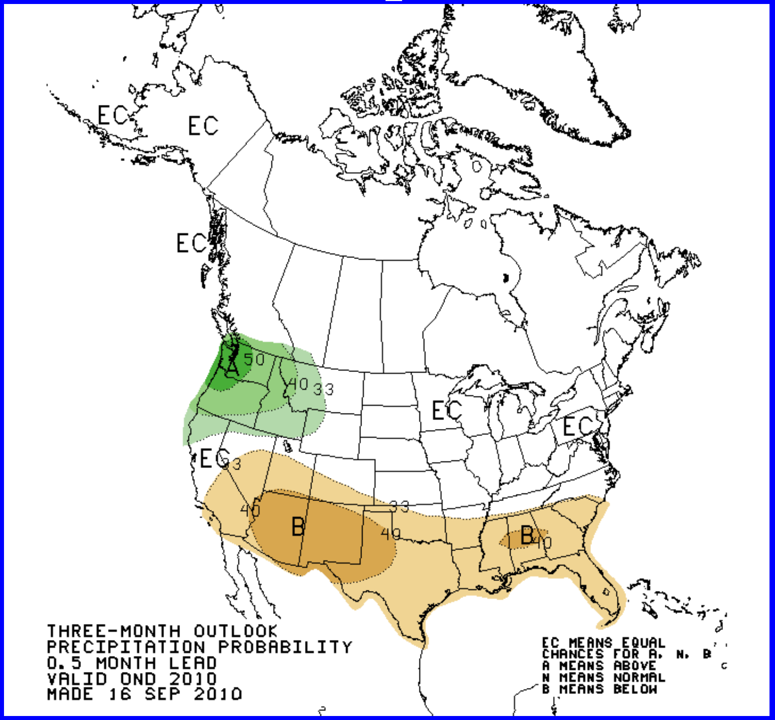


U. S. Seasonal Outlooks
October - December 2010

Temperature



Precipitation

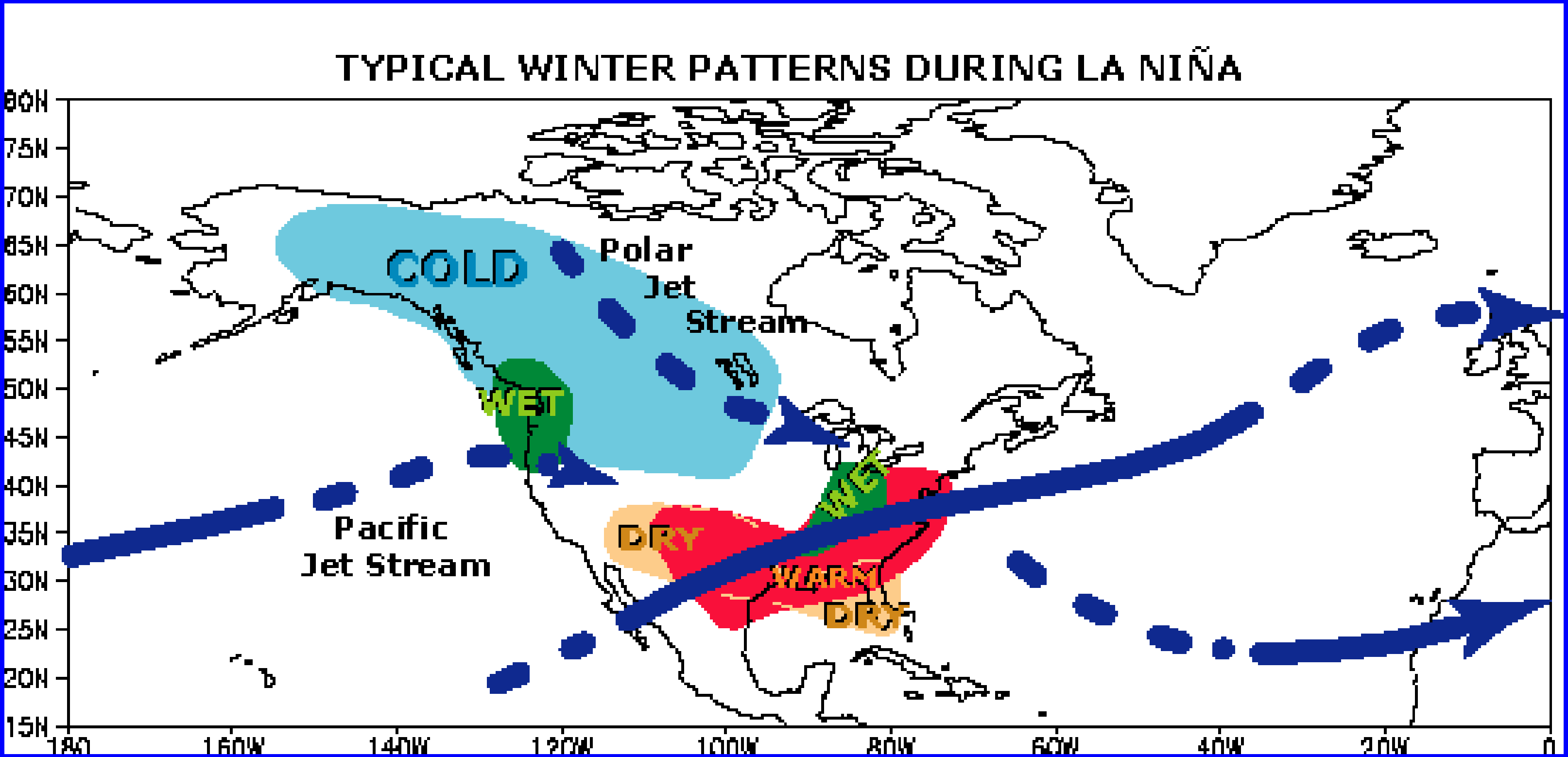


The seasonal outlooks combine the effects of long-term trends, soil moisture, and, when appropriate, the ENSO cycle.

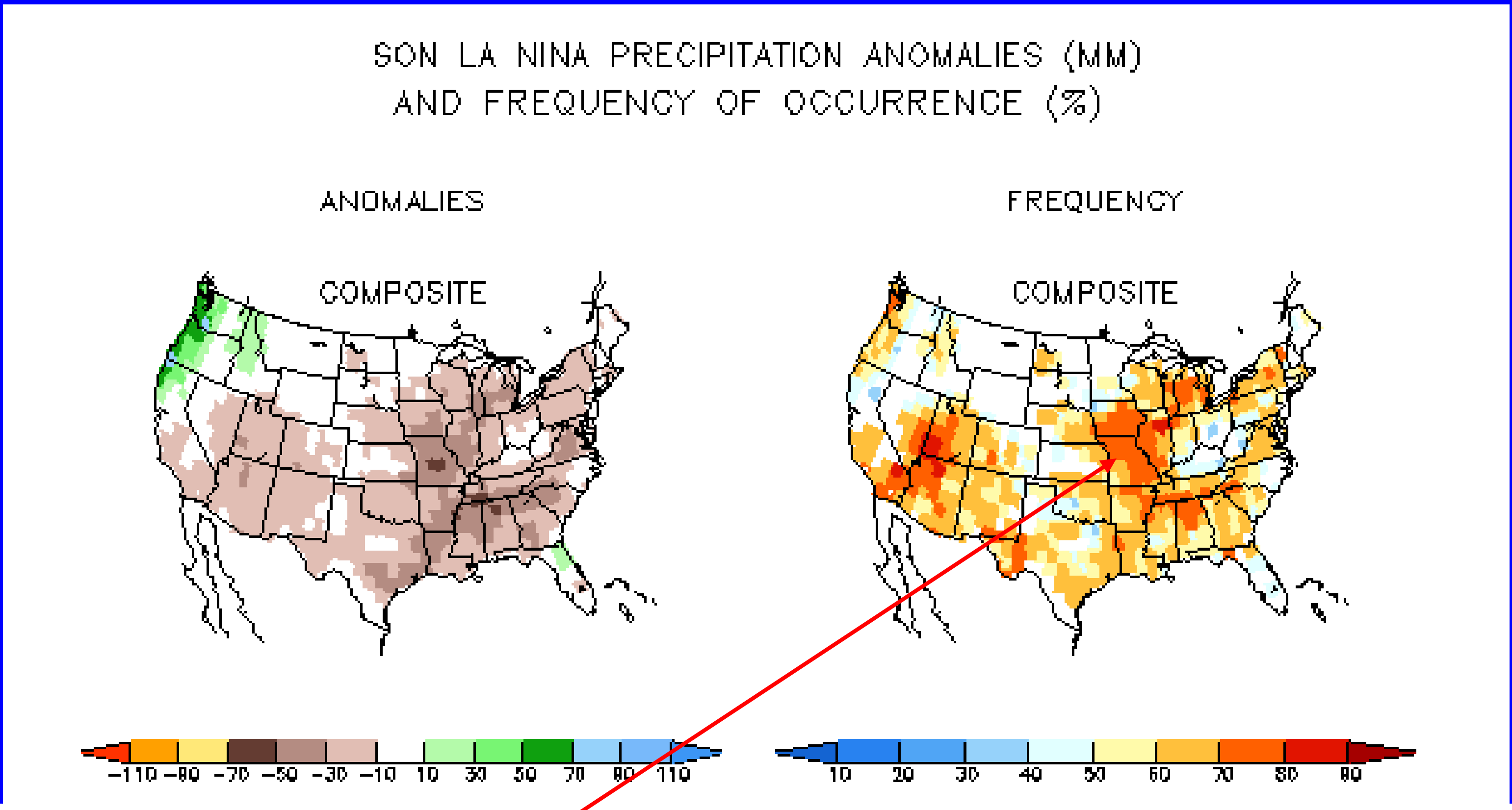
Summary

- La Niña is present across the equatorial Pacific.
- Negative sea surface temperature anomalies persist across much of the Pacific Ocean.
- La Niña is expected to last into the Northern Hemisphere spring 2011.

Typical US Temperature, Precipitation and Jet Stream Patterns during La Niña Winters



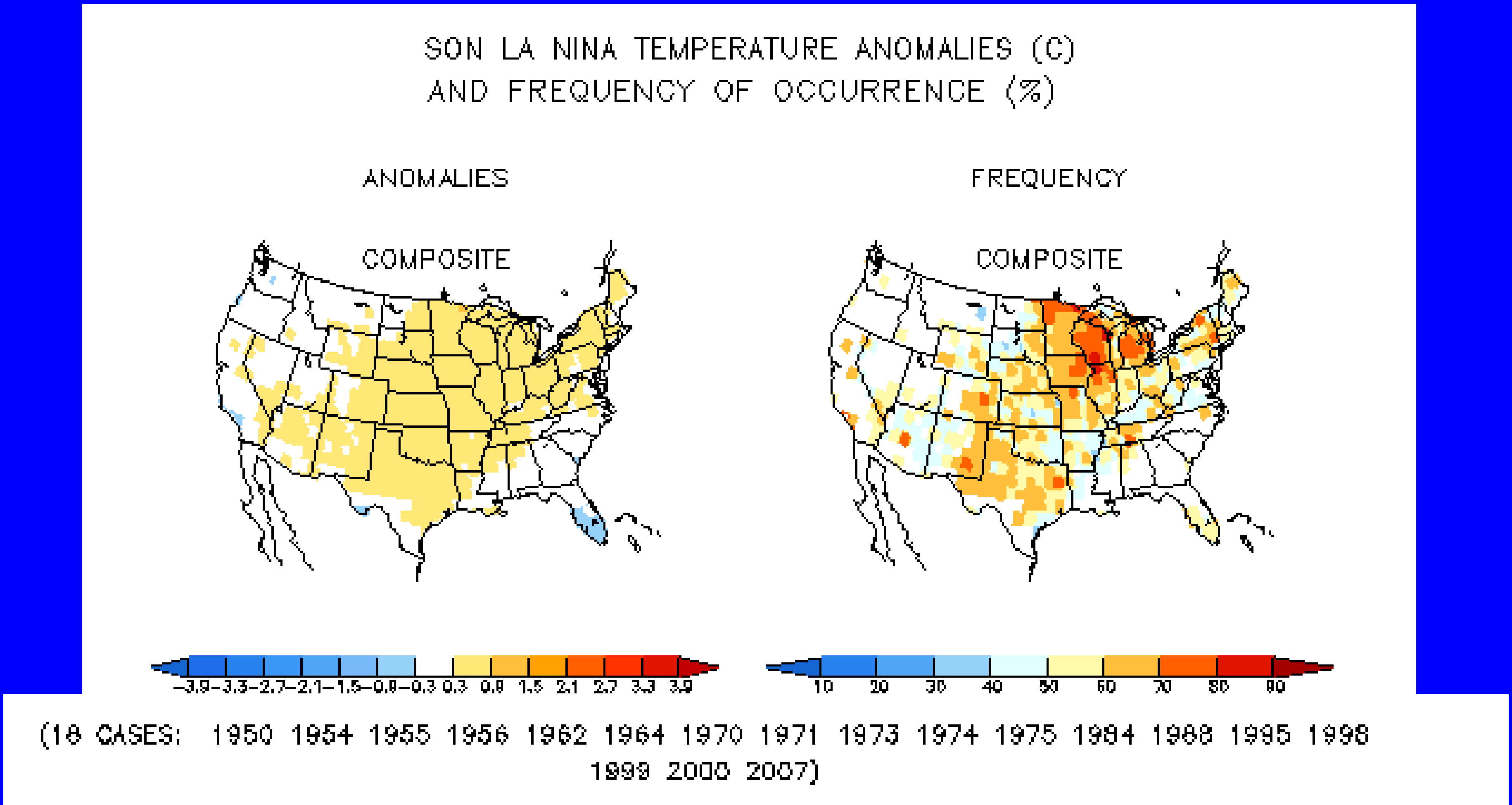
U.S. Precipitation Departures (mm) and Frequency of Occurrence (%) for La Niña during Sep.-Nov.



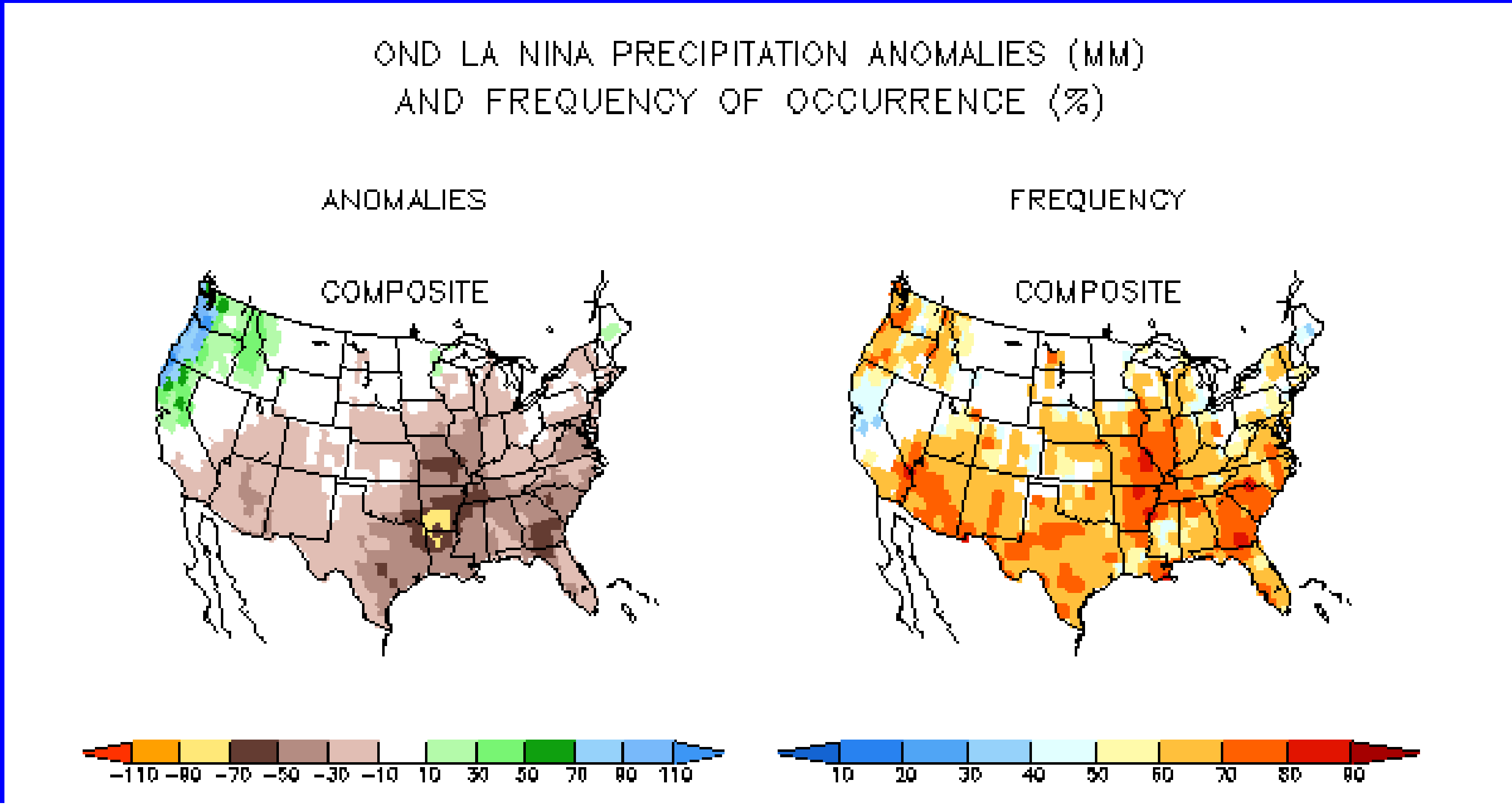
(18 CASES: 1950 1954 1955 1956 1962 1964 1970 1971 1973 1974 1975 1984 1988 1995 1998 1999 2000 2007)

FREQUENCY (right panel) indicates the percentage of La Niña years that the indicated departure (left panel) occurred. For example, below-average seasonal precipitation over the Middle Mississippi Valley occurred in 70%-80% of the La Niña years.

U.S. Temperature Departures (C) and Frequency of Occurrence (%) for La Niña during Sep.-Nov.

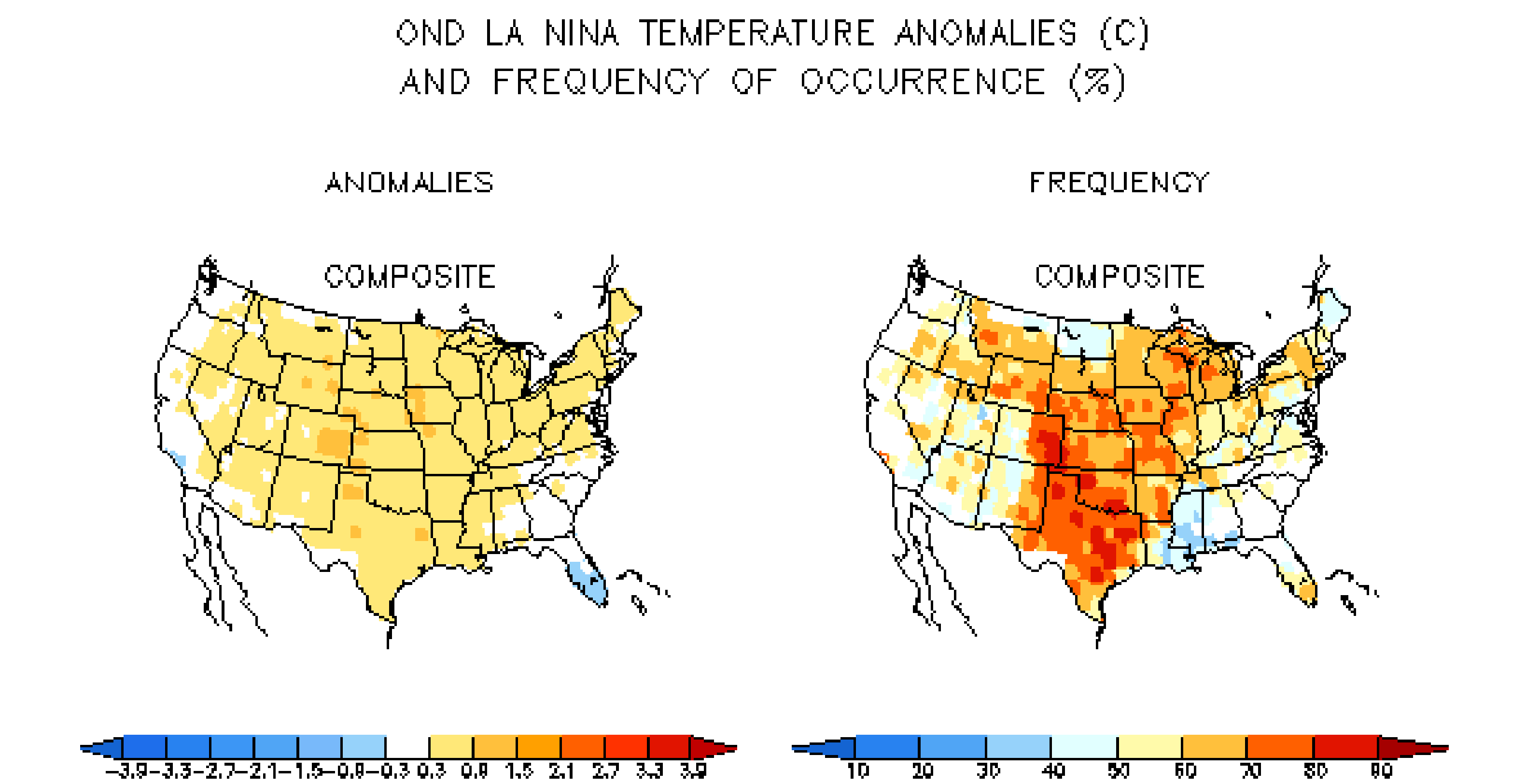


U.S. Precipitation Departures (mm) and Frequency of Occurrence (%) for La Niña during Oct.-Dec.



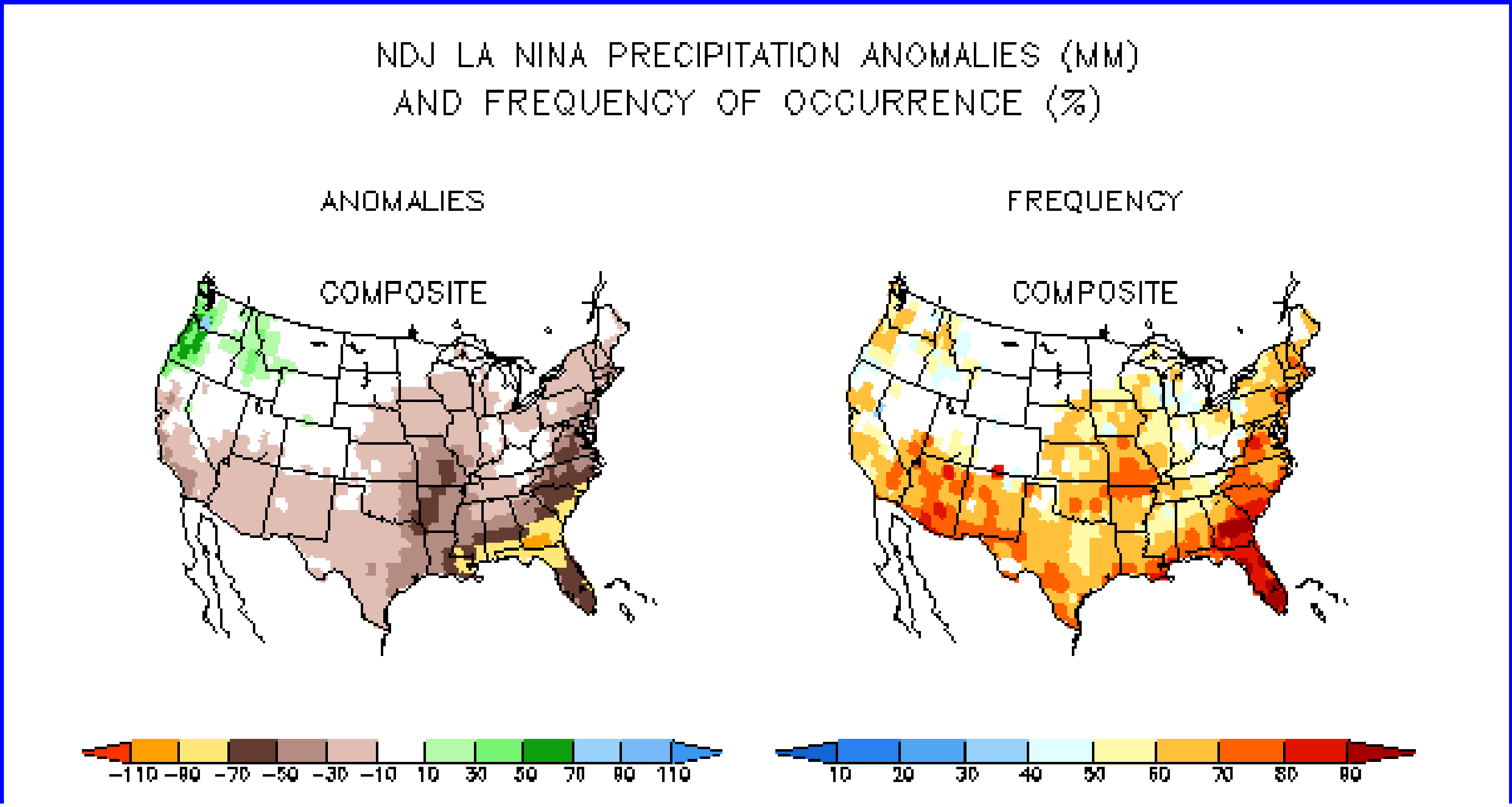
(18 CASES: 1950 1954 1955 1956 1962 1964 1970 1971 1973 1974 1975 1984 1988 1995 1998 1999 2000 2007)

U.S. Temperature Departures (C) and Frequency of Occurrence (%) for La Niña during Oct.-Dec.



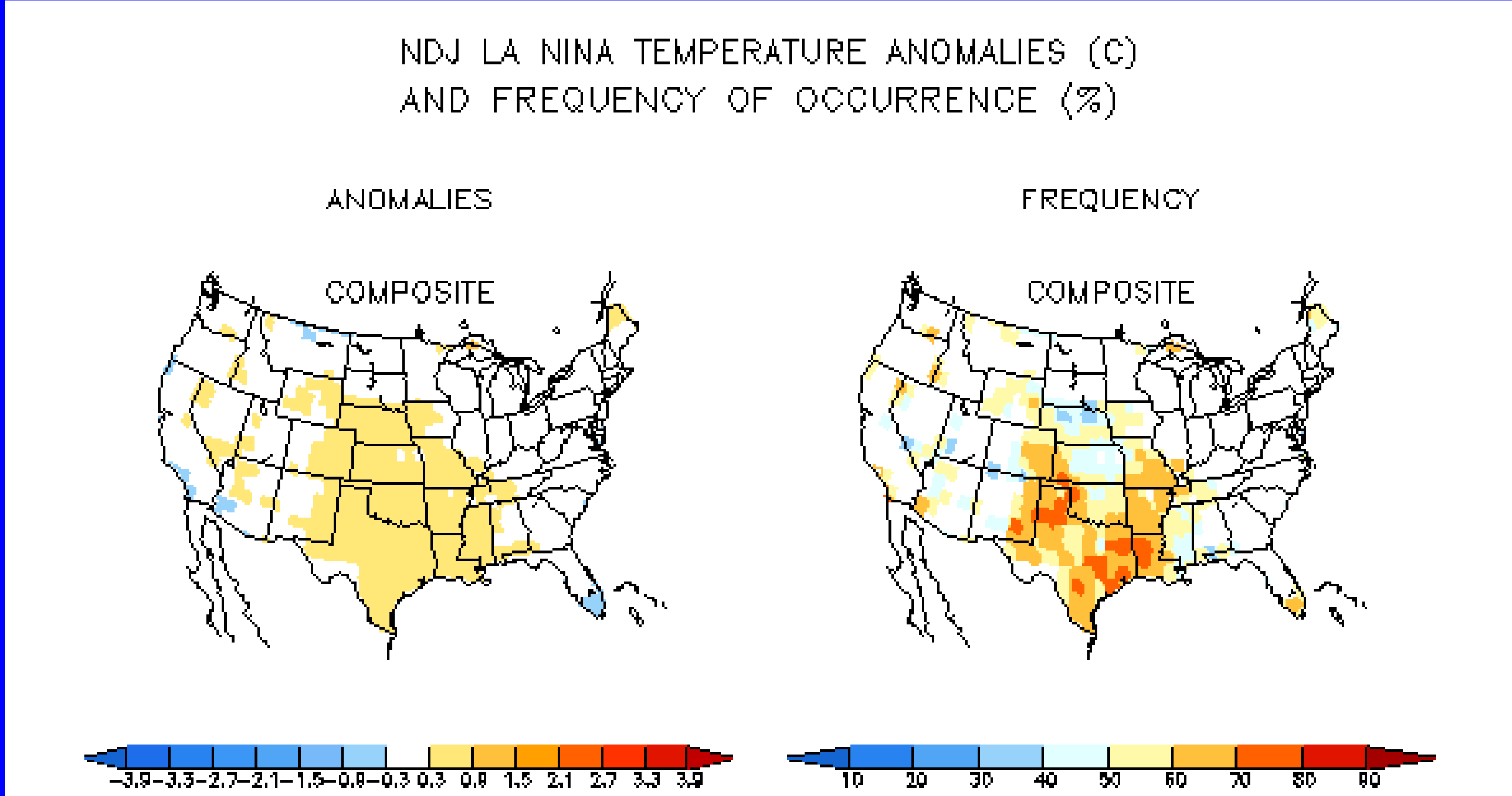
(18 CASES: 1950 1954 1955 1956 1962 1964 1970 1971 1973 1974 1975 1984 1988 1995 1998 1999 2000 2007)

U.S. Precipitation Departures (mm) and Frequency of Occurrence (%) for La Niña during Nov.-Jan.



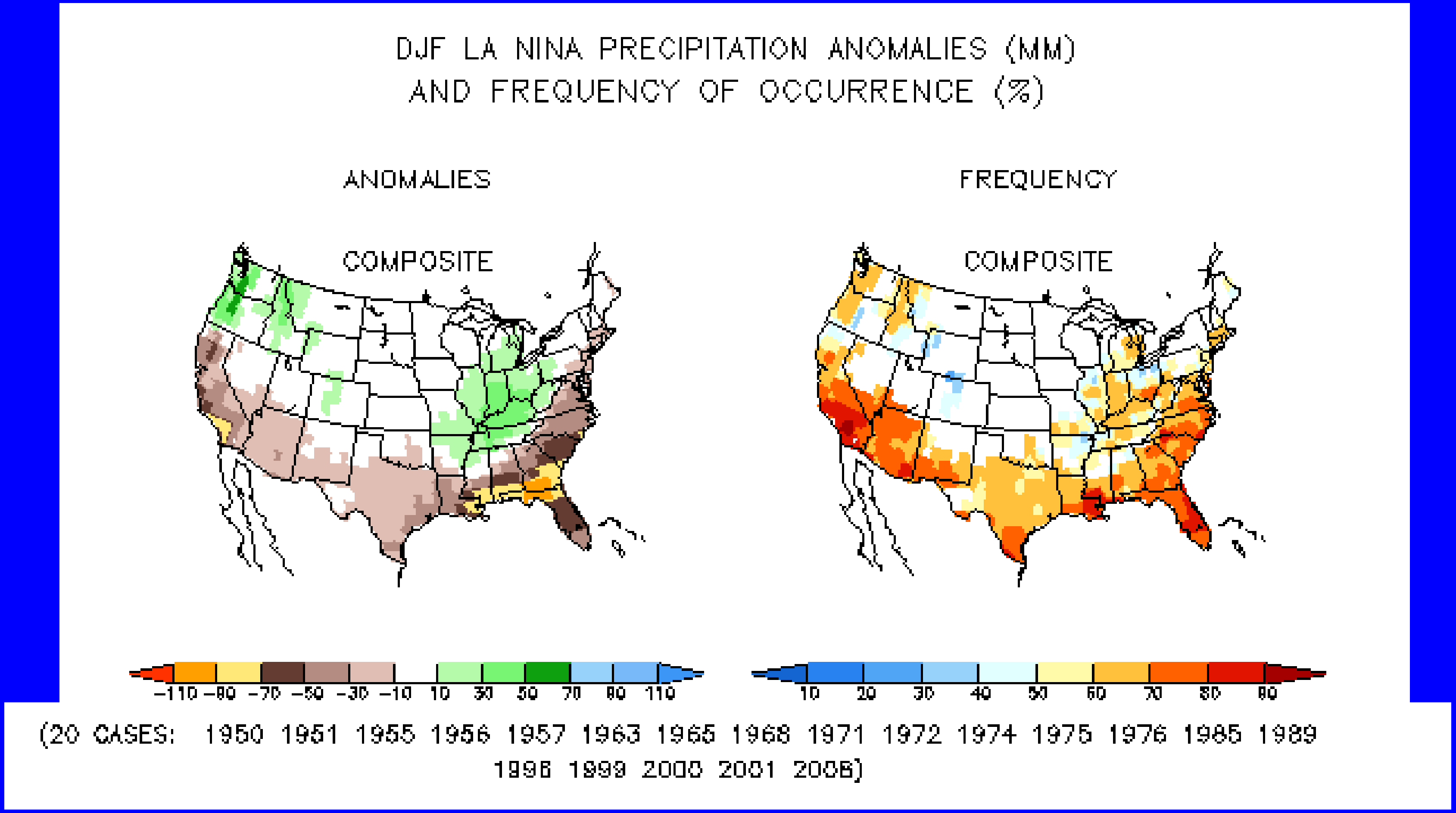
(19 CASES: 1950 1954 1955 1956 1962 1964 1967 1970 1971 1973 1974 1975 1984 1988 1995 1998 1999 2000 2007)

U.S. Temperature Departures (C) and Frequency of Occurrence (%) for La Niña during Nov.-Jan.



(19 CASES: 1950 1954 1955 1956 1962 1964 1967 1970 1971 1973 1974 1975 1984 1988 1995 1998 1999 2000 2007)

U.S. Precipitation Departures (mm) and Frequency of Occurrence (%) for La Niña during Dec.-Feb.



U.S. Temperature Departures (C) and Frequency of Occurrence (%) for La Niña during Dec.-Feb.