

# ENSO: Recent Evolution, Current Status and Predictions



Update prepared by:  
Climate Prediction Center / NCEP  
25 September 2023

# Outline

Summary

Recent Evolution and Current Conditions

Oceanic Niño Index (ONI)

Pacific SST Outlook

U.S. Seasonal Precipitation and Temperature Outlooks

Summary

# Summary

ENSO Alert System Status: **El Niño Advisory**

El Niño conditions are observed.\*

Equatorial sea surface temperatures (SSTs) are above average across the central and eastern Pacific Ocean.

The tropical Pacific atmospheric anomalies are consistent with El Niño.

El Niño is anticipated to continue through the Northern Hemisphere winter (with greater than a 95% chance through January-March 2024).\*

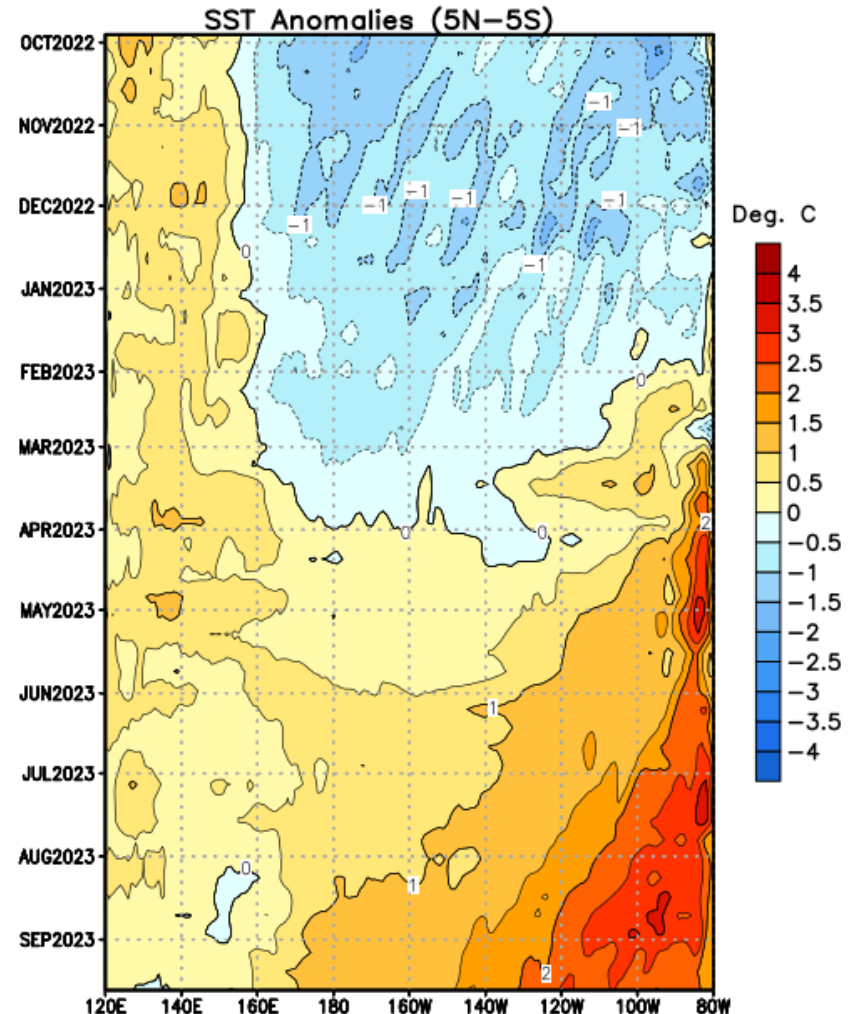
\* Note: These statements are updated once a month (2<sup>nd</sup> Thursday of each month) in association with the ENSO Diagnostics Discussion, which can be found by clicking [here](#).

# Recent Evolution of Equatorial Pacific SST Departures (°C)

Below-average SSTs persisted in the central and eastern Pacific during most of 2022.

Beginning in January 2023, SSTs transitioned from below-average to above-average.

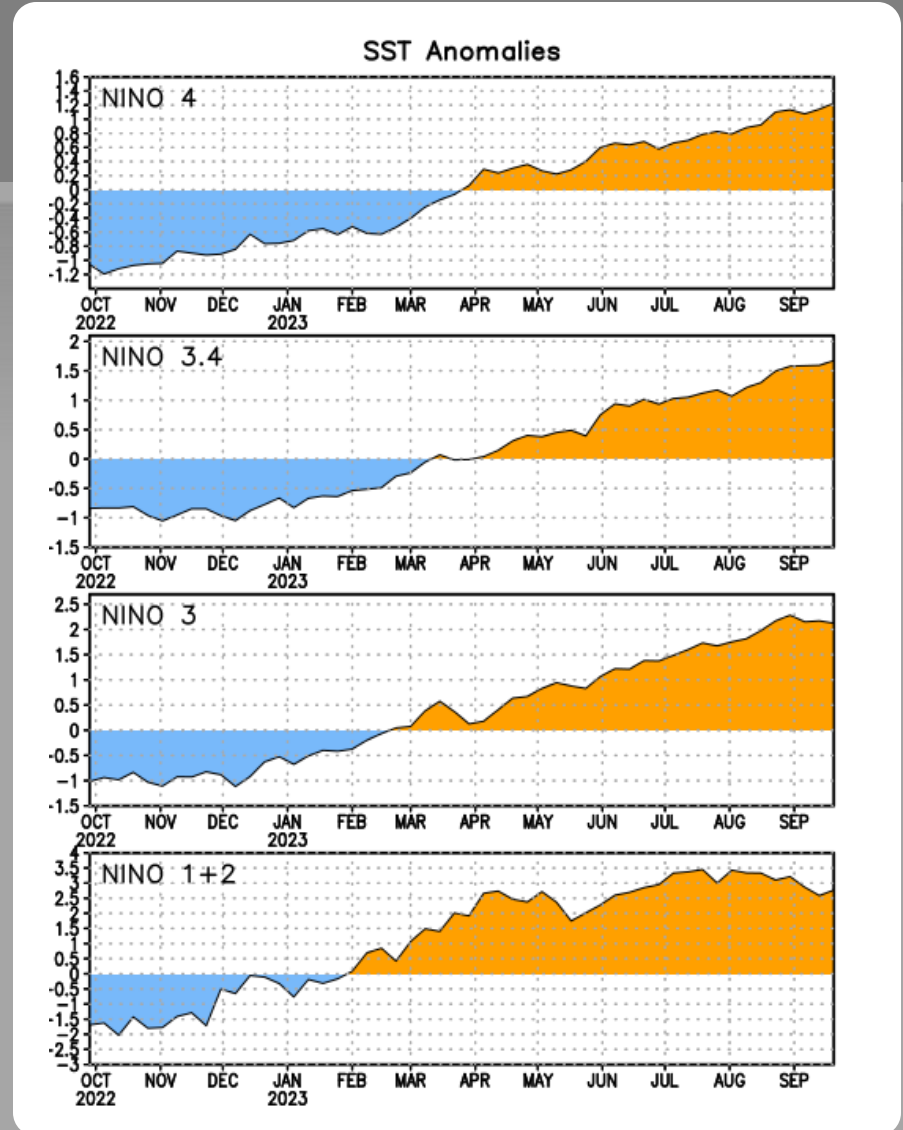
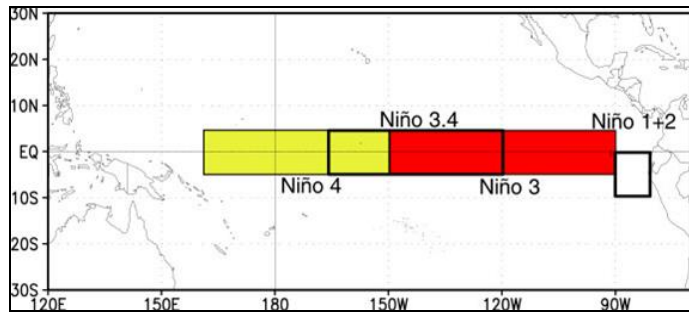
Since March 2023, positive SST anomalies in the eastern Pacific Ocean have gradually expanded westward.



# Niño Region SST Departures (°C) Recent Evolution

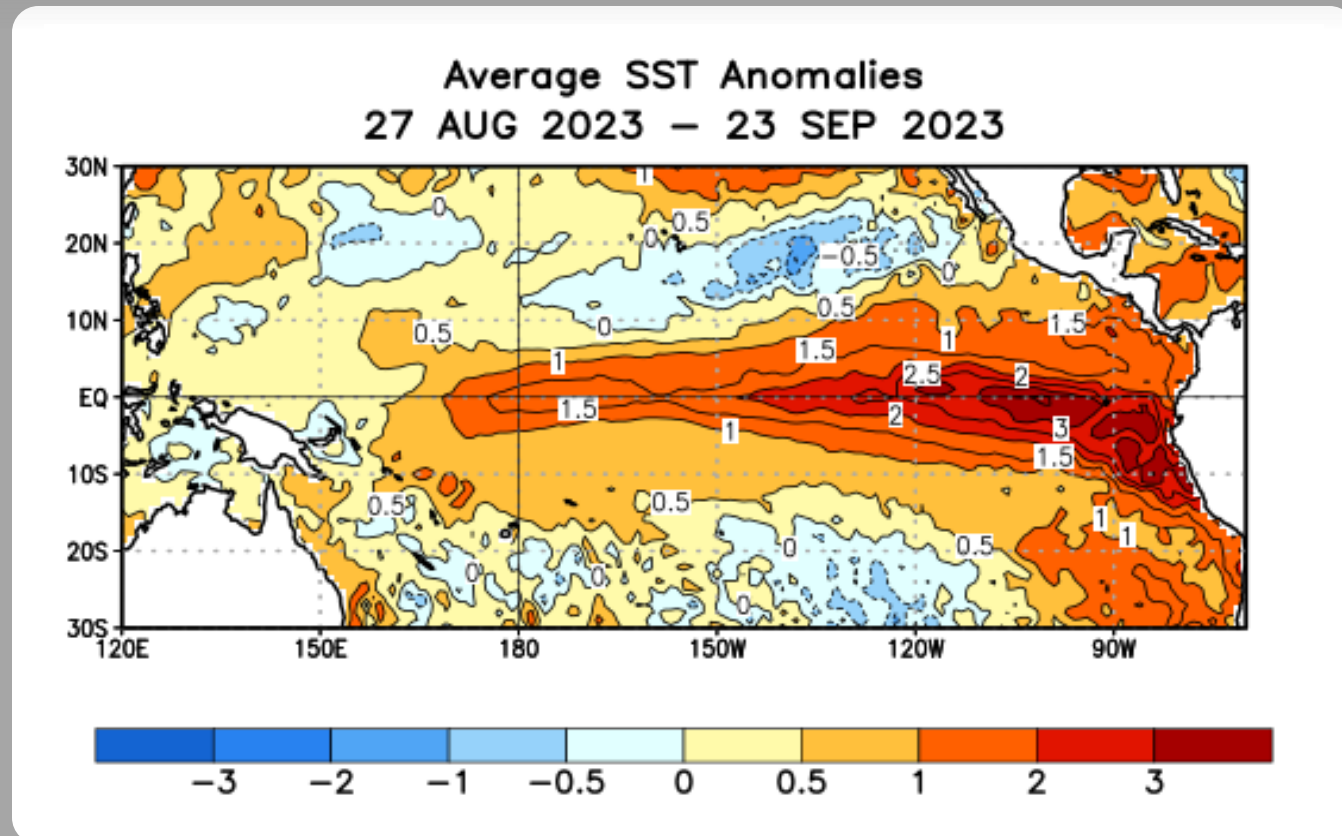
The latest weekly SST departures are:

Niño 4	1.2°C
Niño 3.4	1.7°C
Niño 3	2.1°C
Niño 1+2	2.8°C



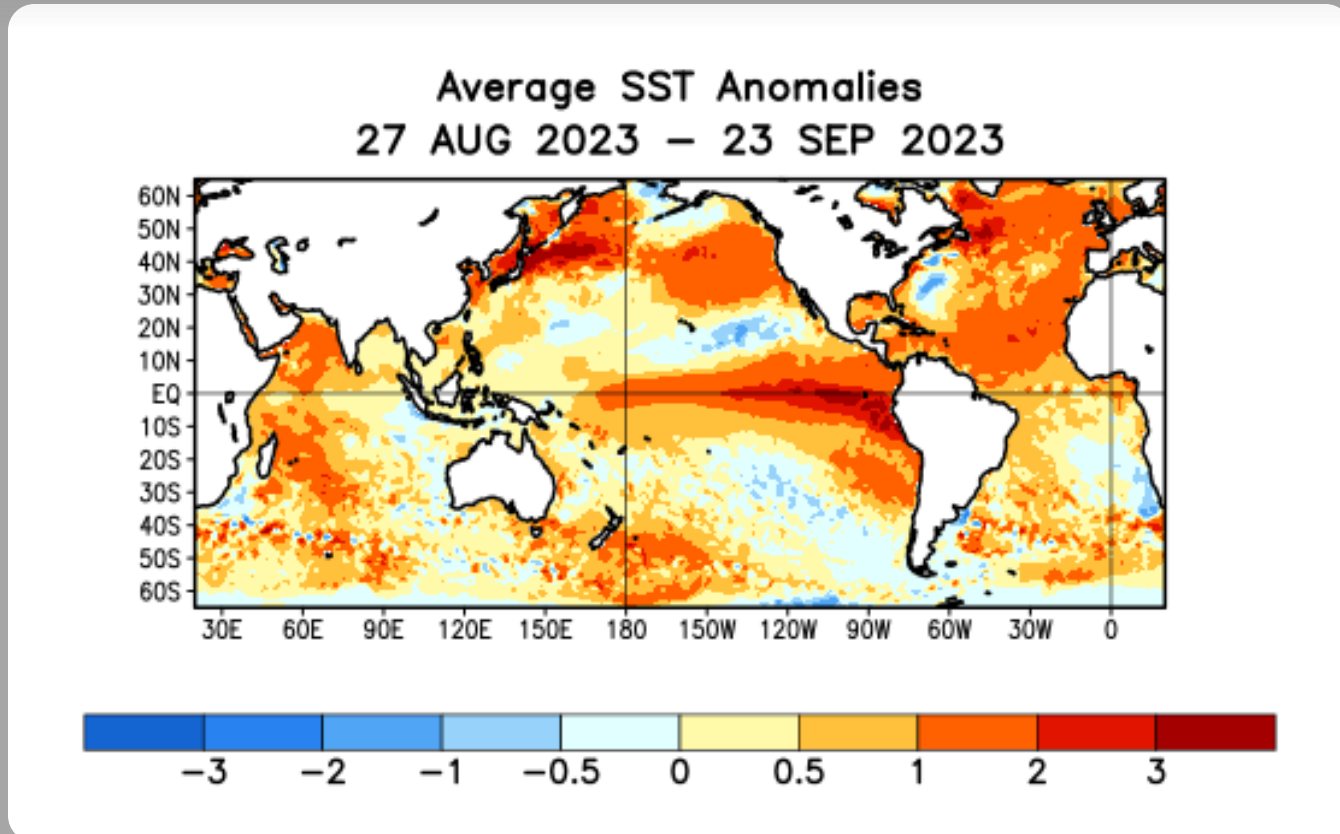
# SST Departures ( $^{\circ}\text{C}$ ) in the Tropical Pacific During the Last Four Weeks

In the last four weeks, equatorial SSTs were above average across most of the Pacific Ocean, with near average SSTs present in the western Pacific Ocean.



# Global SST Departures (°C) During the Last Four Weeks

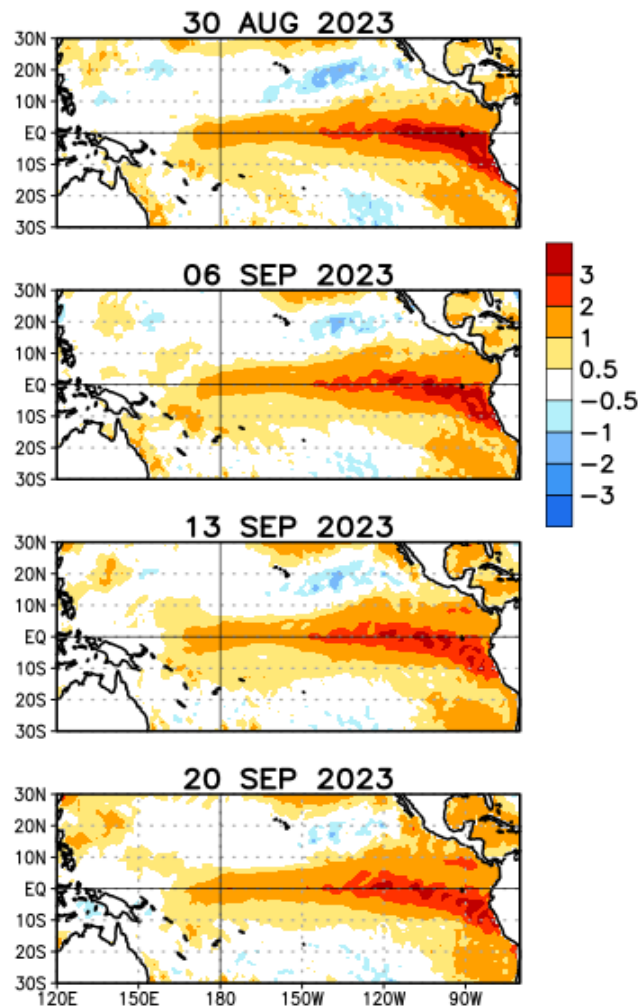
During the last four weeks, equatorial SSTs were above average across most of the Pacific Ocean, in the western Indian Ocean, and across much of the Atlantic Ocean.



# Weekly SST Departures during the Last Four Weeks

During the last 4 weeks, above-average equatorial SSTs persisted across most of the Pacific Ocean, with the strongest anomalies in the eastern Pacific.

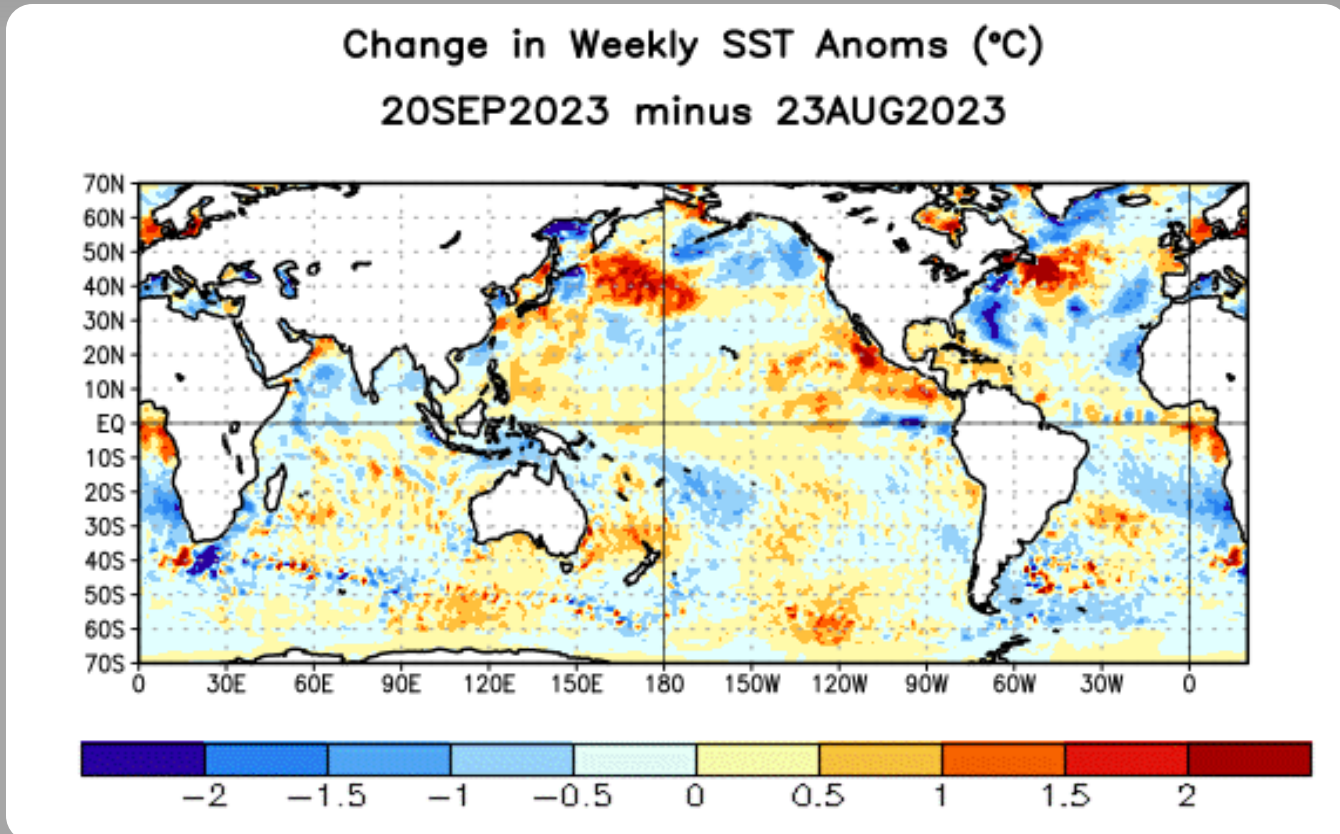
## Weekly SST Anomalies (DEG C)





# Change in Weekly SST Departures over the Last Four Weeks

During the last four weeks, positive SST anomaly changes were evident in the western and east-central Pacific Ocean, and negative changes were observed in the eastern Pacific.



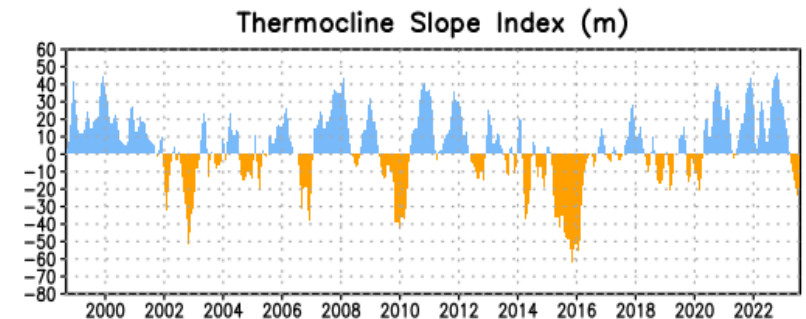
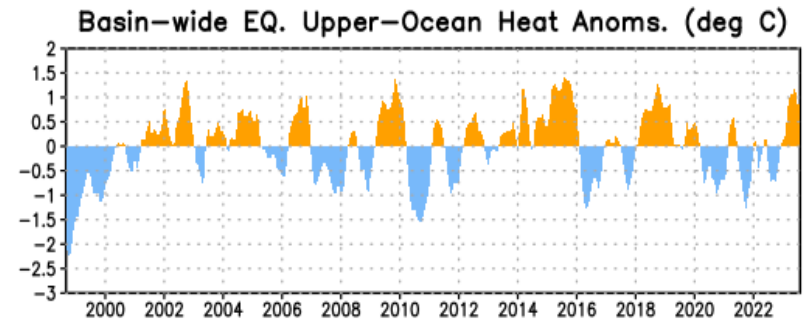
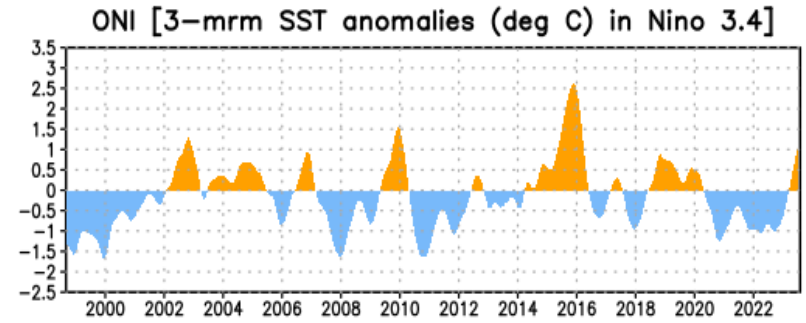
# Upper-Ocean Conditions in the Equatorial Pacific

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.

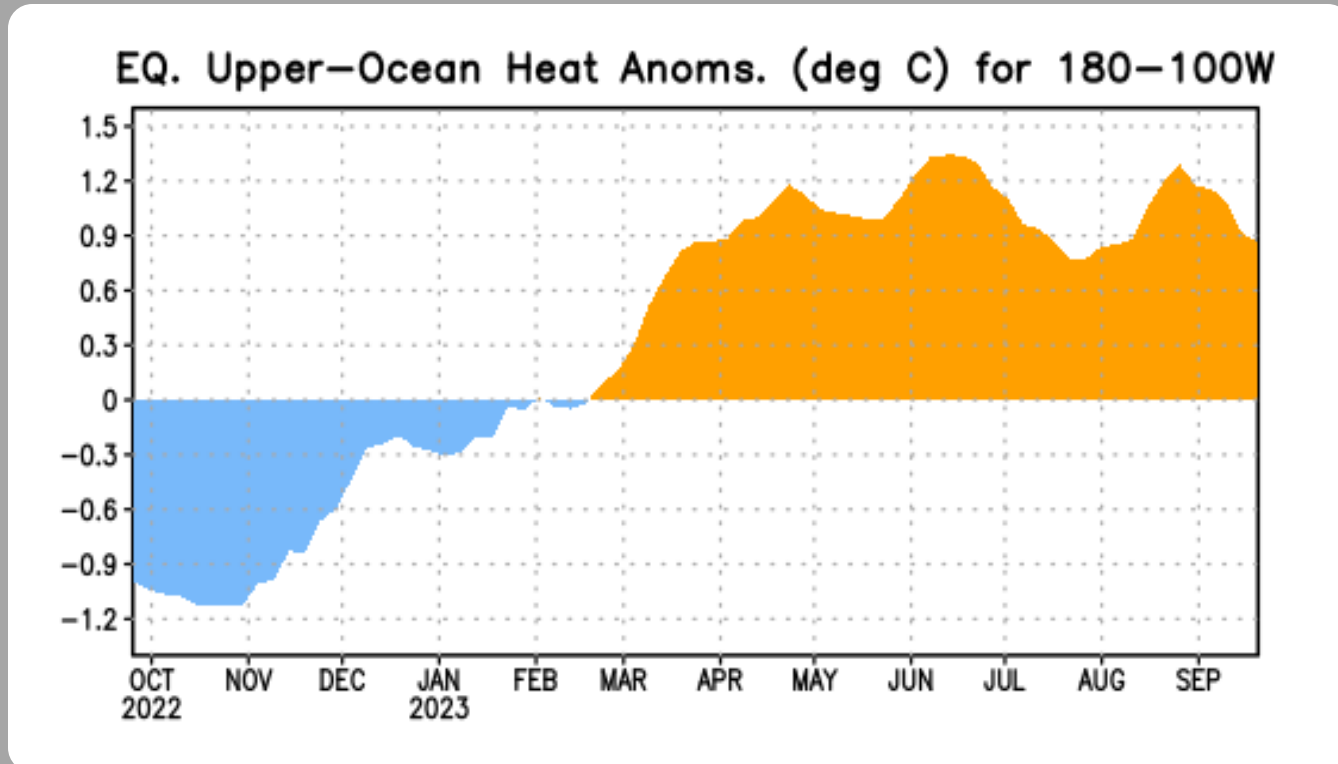
Recent values of the upper-ocean heat anomalies (above average) and thermocline slope index (below average) reflect El Niño.

*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).*



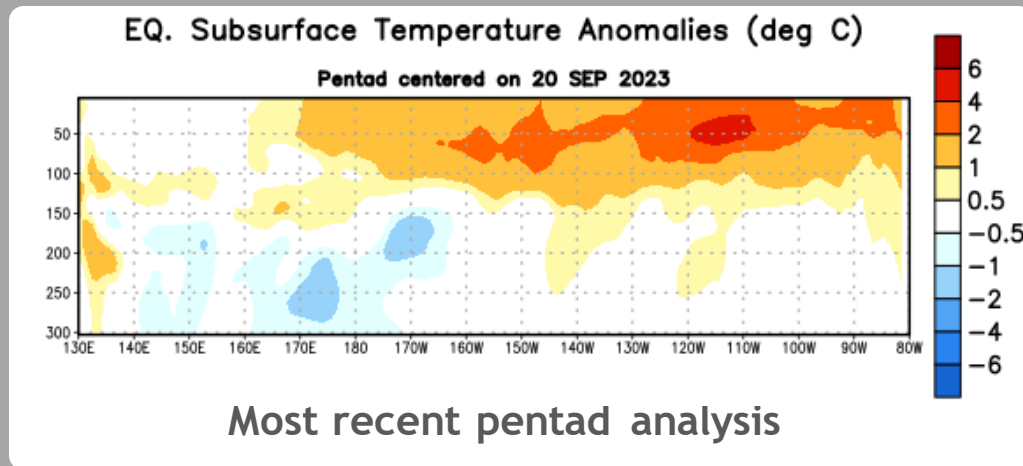
# Central and Eastern Pacific Upper-Ocean (0-300 m) Weekly Average Temperature Anomalies

Subsurface temperature anomalies were negative until mid-February 2023. Subsurface anomalies became positive in February and increased through mid-April 2023 before leveling off. From late May to mid-June 2023, anomalies increased. Anomalies decreased from mid-June to mid-July, increased from late July through August, and decreased again in September.

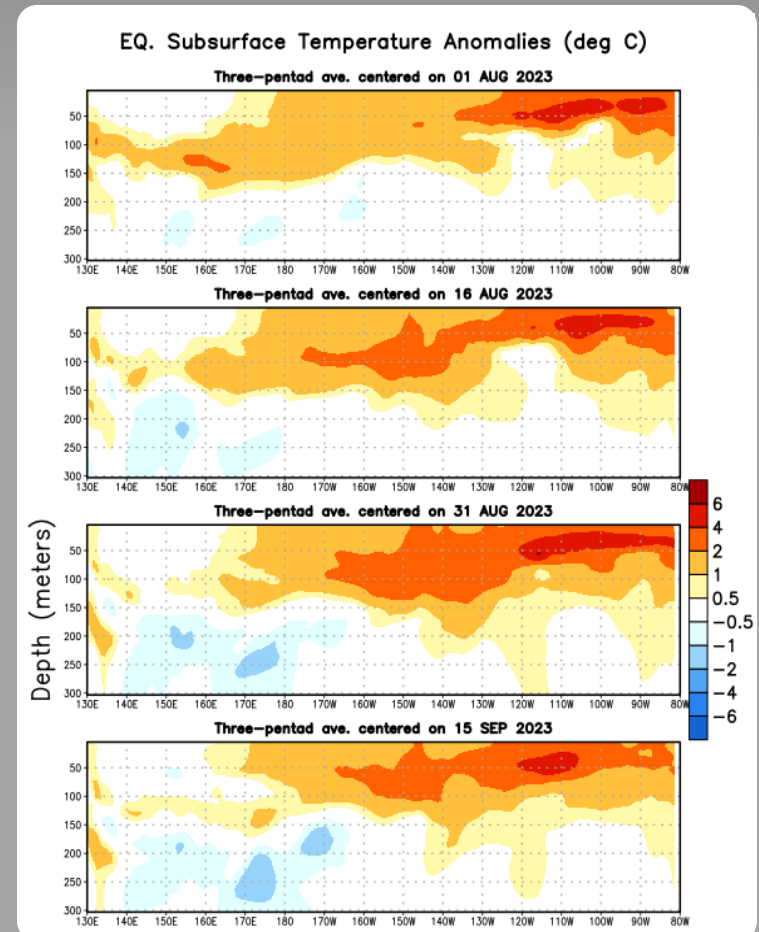


# Sub-Surface Temperature Departures in the Equatorial Pacific

Positive subsurface temperature anomalies dominate most of the equatorial Pacific Ocean.



Positive subsurface temperature anomalies weakened in the western equatorial Pacific, with negative anomalies emerging at depth (150-300m).

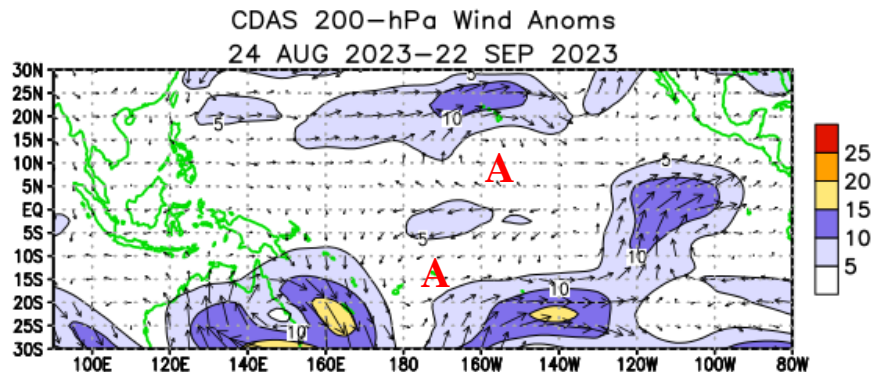
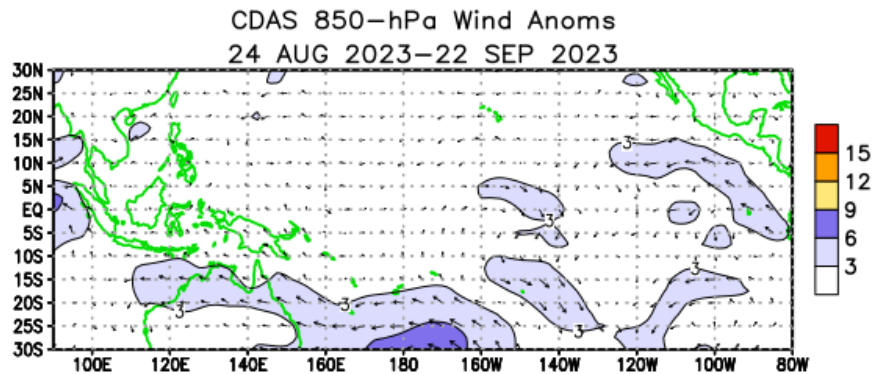
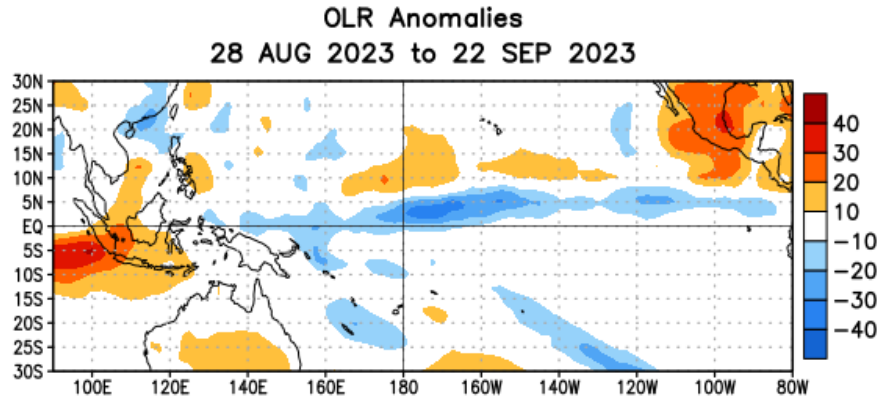


# Tropical OLR and Wind Anomalies During the Last 30 Days

Positive OLR anomalies (suppressed convection and precipitation) were evident near Indonesia. Negative OLR anomalies (enhanced convection and precipitation) were observed from the western Pacific and extend, just north of the equator, into the eastern Pacific Ocean.

Low-level (850-hPa) wind anomalies were westerly over a small area of the east-central equatorial Pacific.

Upper-level (200-hPa) wind anomalies were cross equatorial over the eastern tropical Pacific. Easterly anomalies were present over the central Pacific, with an anomalous anticyclonic couplet straddling the equator.



# 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.

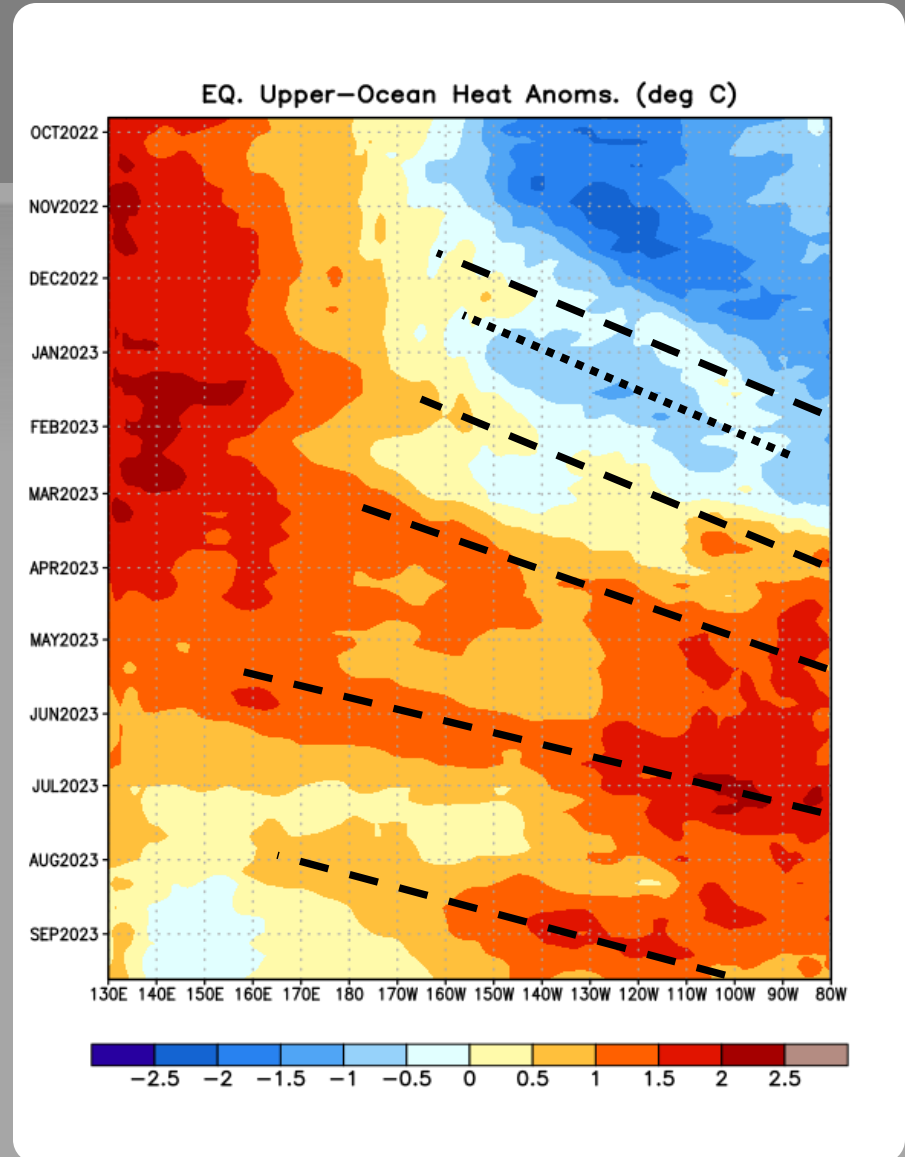
# Weekly Heat Content Evolution in the Equatorial Pacific

Significant equatorial oceanic Kelvin wave activity (dashed and dotted lines) has been present throughout the period shown.

Between late November 2022 and late September 2023, five downwelling Kelvin waves occurred.

Since March 2023, above-average subsurface temperature anomalies have persisted across most of the Pacific Ocean.

Equatorial oceanic Kelvin waves have alternating warm and cold phases. The warm phase is indicated by dashed lines. Downwelling 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 ( $\text{m s}^{-1}$ )

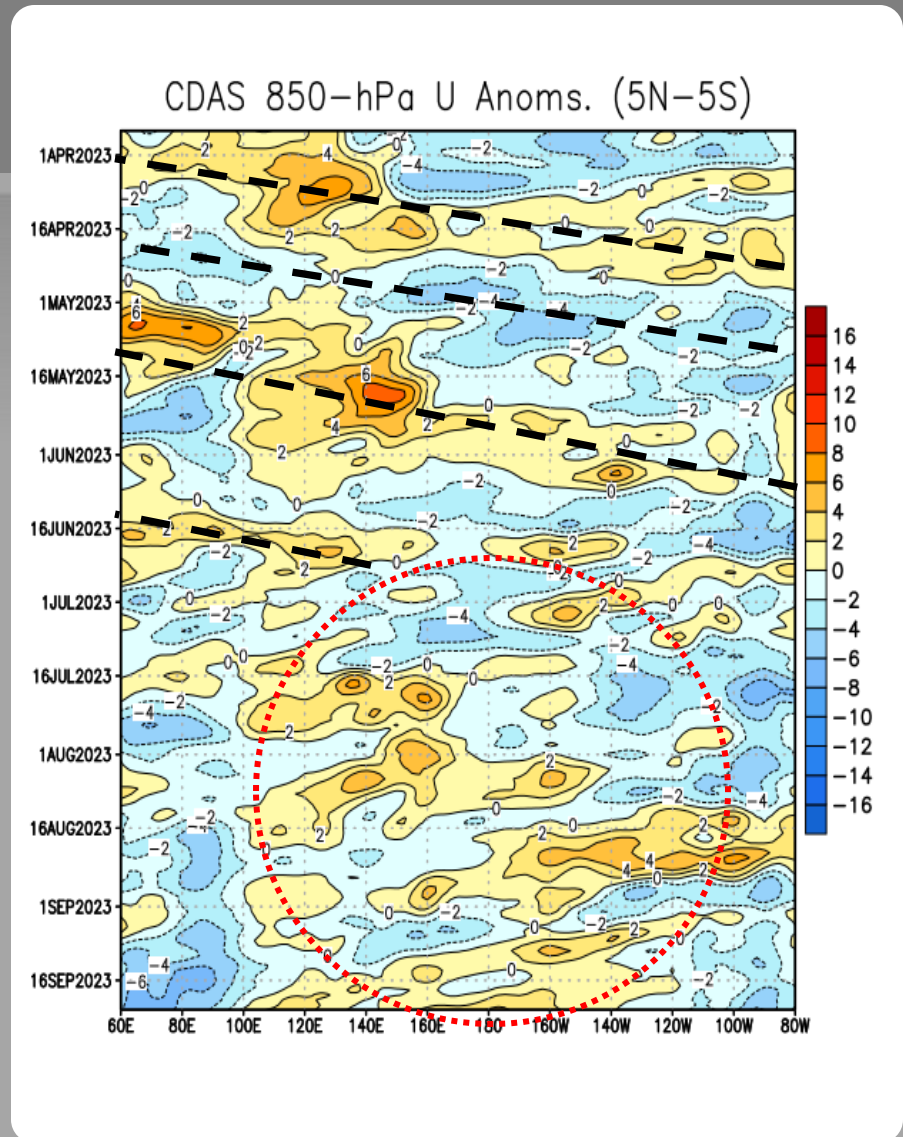
At times, the Madden Julian-Oscillation (MJO) has contributed to the eastward propagation of low-level wind anomalies.

An eastward propagating pattern of westerly and easterly wind anomalies was clearly evident through mid-June 2023.

Since mid-July 2023, westerly wind anomalies have become more predominant over the equatorial Pacific Ocean.

Westerly Wind Anomalies (orange/red shading)

Easterly Wind Anomalies (blue shading)





# Upper-level (200-hPa) Velocity Potential Anomalies

From the beginning of the period to mid-June 2023, eastward propagation of anomalies were clearly evident.

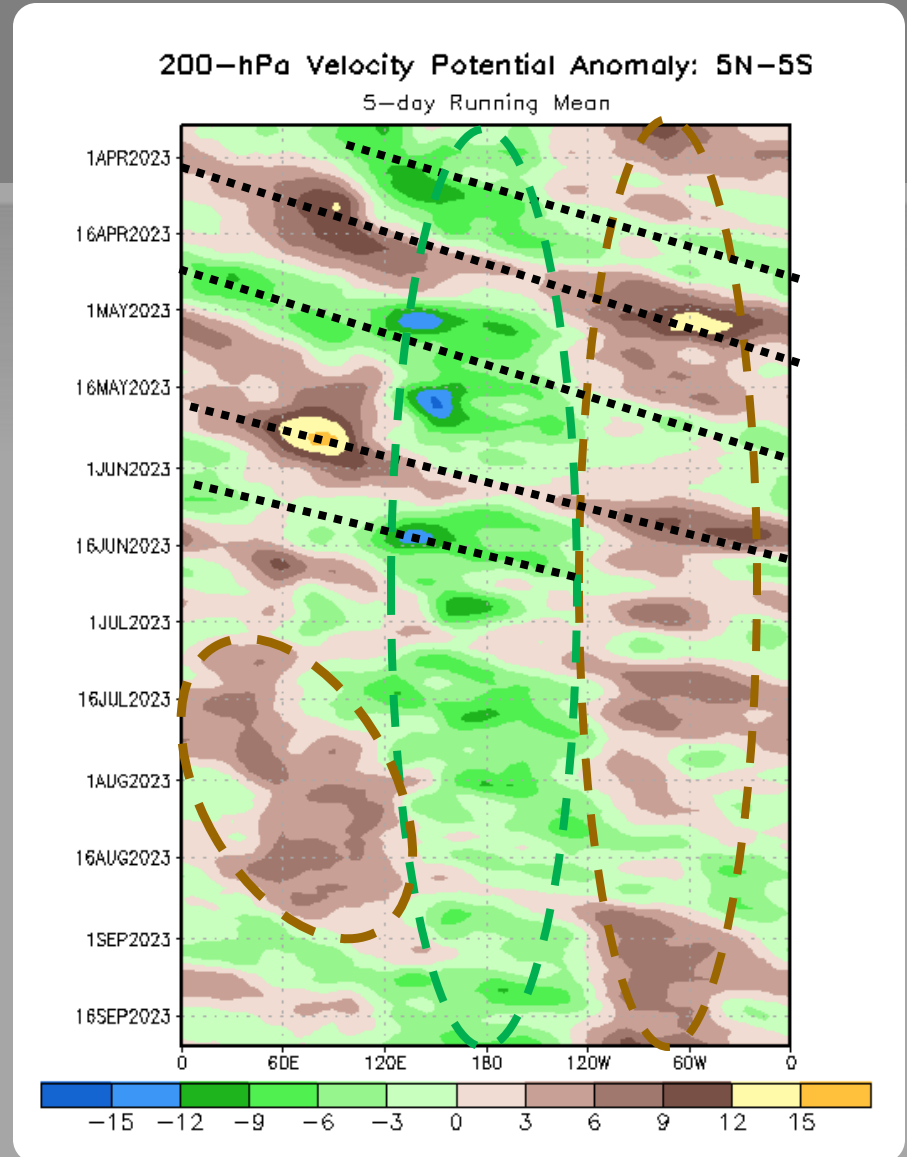
Since mid-March 2023, anomalous divergence (green shading) has generally persisted near the Date Line.

While not as persistent, anomalous convergence (brown shading) has mostly remained over the far eastern Pacific Ocean and South America.

Unfavorable for precipitation (brown shading)

Favorable for precipitation (green shading)

Note: Eastward propagation is not necessarily indicative of the Madden-Julian Oscillation (MJO).



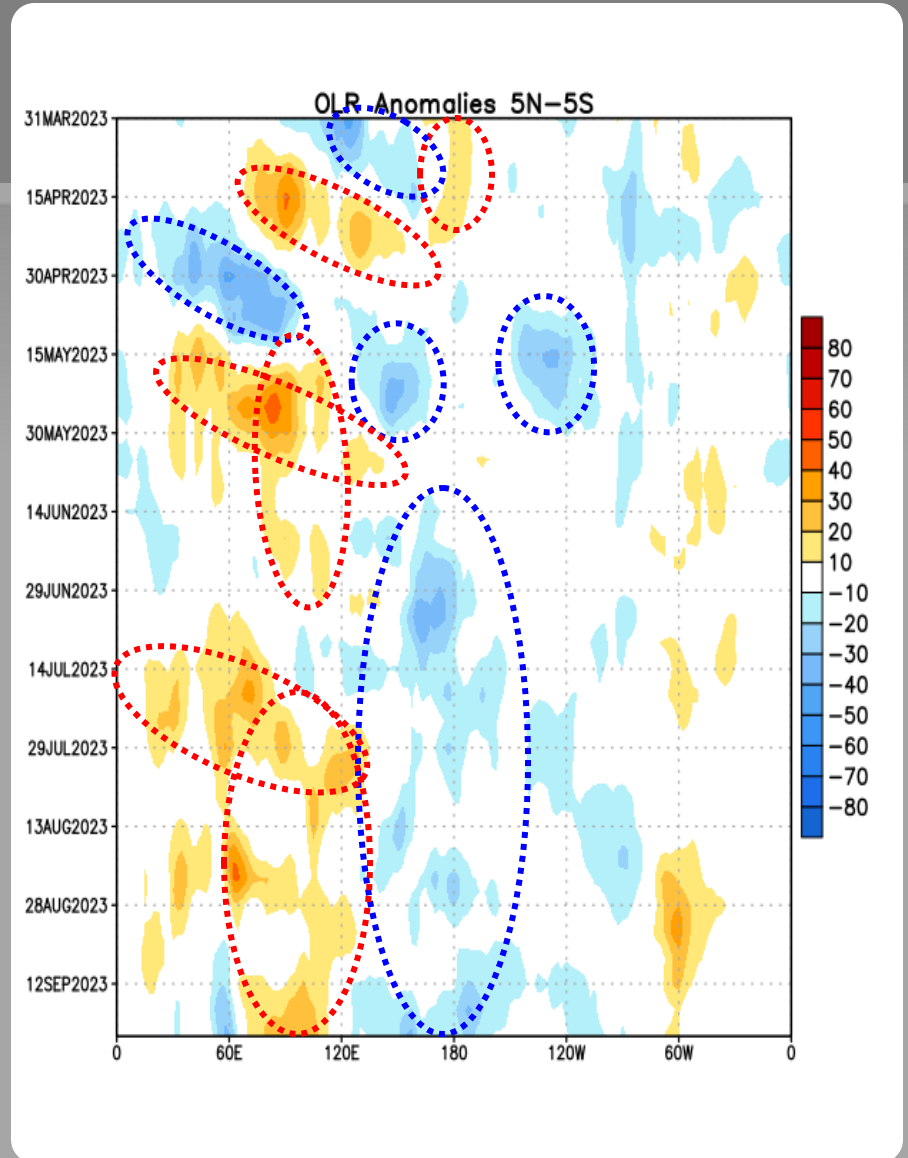
# Outgoing Longwave Radiation (OLR) Anomalies

From the beginning of the period through April 2023, positive OLR anomalies were evident over the western and/or central Pacific Ocean.

Since early May 2023, negative anomalies have mostly persisted over the western and central equatorial Pacific Ocean.

Since mid-July 2023, positive OLR anomalies have mostly persisted over Indonesia.

Drier-than-average Conditions (orange/red shading)  
Wetter-than-average Conditions (blue shading)



# 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.v5). The SST reconstruction methodology is described in Huang et al., 2017, J. Climate, vol. 30, 8179-8205.)

It is one index that helps to place current events into a historical perspective.

Note: a different SST dataset is used for weekly SST monitoring (slides #4-9) and is using OISSTv2.1 (Huang et al., 2021).

# NOAA Operational Definitions for El Niño and La Niña

El Niño: characterized by a positive ONI greater than or equal to  $+0.5^{\circ}\text{C}$ .

La Niña: characterized by a negative ONI less than or equal to  $-0.5^{\circ}\text{C}$ .

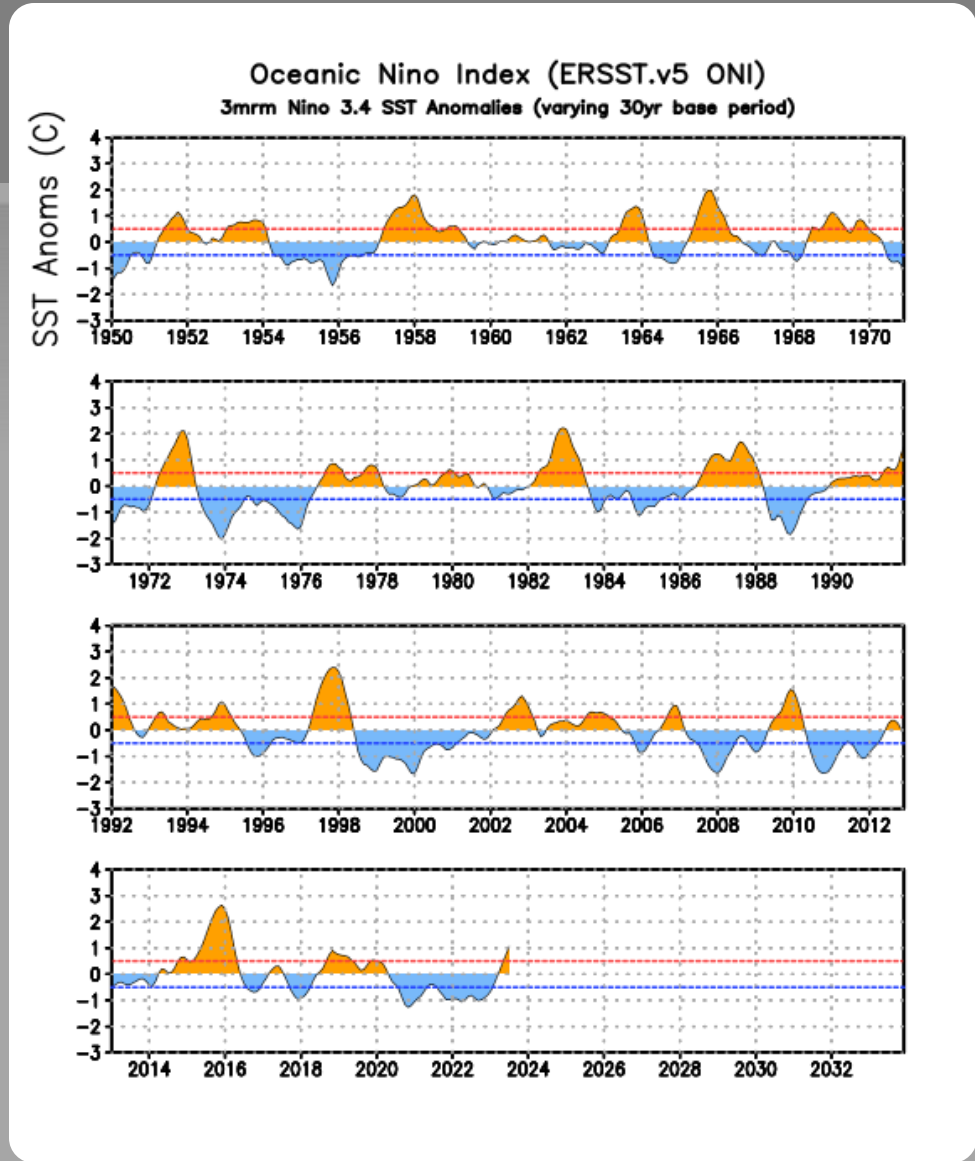
By historical standards, to be classified as a full-fledged El Niño or La Niña episode, these thresholds must be exceeded for a period of at least 5 consecutive overlapping 3-month seasons.

CPC considers El Niño or La Niña conditions to occur when the monthly Niño3.4 OISST departures meet or exceed  $\pm 0.5^{\circ}\text{C}$  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 (June - August 2023) is 1.1°C.

El Niño ↑  
Neutral  
La Niña ↓



# Historical El Niño and La Niña Episodes Based on the ONI computed using ERSST.v5

Recent Pacific warm (red) and cold (blue) periods based on a threshold of +/- 0.5 °C for the Oceanic Nino Index (ONI) [3 month running mean of ERSST.v5 SST anomalies in the Nino 3.4 region (5N-5S, 120-170W)]. For historical purposes, periods of below and above normal SSTs are colored in blue and red when the threshold is met for a minimum of 5 consecutive over-lapping seasons.

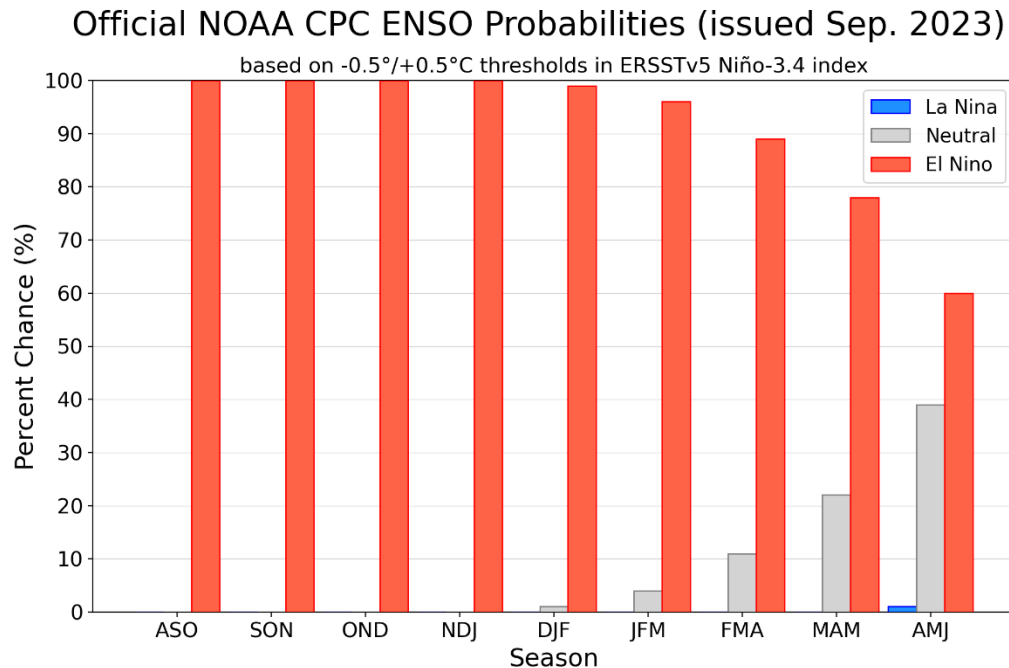
The ONI is one measure of the El Niño-Southern Oscillation, and other indices can confirm whether features consistent with a coupled ocean-atmosphere phenomenon accompanied these periods. The complete table going back to DJF 1950 can be found [here](#).

Year	DJF	JFM	FMA	MAM	AMJ	MJJ	JJA	JAS	ASO	SON	OND	NDJ
2011	-1.4	-1.2	-0.9	-0.7	-0.6	-0.4	-0.5	-0.6	-0.8	-1.0	-1.1	-1.0
2012	-0.9	-0.7	-0.6	-0.5	-0.3	0.0	0.2	0.4	0.4	0.3	0.1	-0.2
2013	-0.4	-0.4	-0.3	-0.3	-0.4	-0.4	-0.4	-0.3	-0.3	-0.2	-0.2	-0.3
2014	-0.4	-0.5	-0.3	0.0	0.2	0.2	0.0	0.1	0.2	0.5	0.6	0.7
2015	0.5	0.5	0.5	0.7	0.9	1.2	1.5	1.9	2.2	2.4	2.6	2.6
2016	2.5	2.1	1.6	0.9	0.4	-0.1	-0.4	-0.5	-0.6	-0.7	-0.7	-0.6
2017	-0.3	-0.2	0.1	0.2	0.3	0.3	0.1	-0.1	-0.4	-0.7	-0.8	-1.0
2018	-0.9	-0.9	-0.7	-0.5	-0.2	0.0	0.1	0.2	0.5	0.8	0.9	0.8
2019	0.7	0.7	0.7	0.7	0.5	0.5	0.3	0.1	0.2	0.3	0.5	0.5
2020	0.5	0.5	0.4	0.2	-0.1	-0.3	-0.4	-0.6	-0.9	-1.2	-1.3	-1.2
2021	-1.0	-0.9	-0.8	-0.7	-0.5	-0.4	-0.4	-0.5	-0.7	-0.8	-1.0	-1.0
2022	-1.0	-0.9	-1.0	-1.1	-1.0	-0.9	-0.8	-0.9	-1.0	-1.0	-0.9	-0.8
2023	-0.7	-0.4	-0.1	0.2	0.5	0.8	1.1					

# CPC Probabilistic ENSO Outlook

Updated: 14 September 2023

El Niño is favored through Northern Hemisphere winter 2023-24, with chances exceeding 95% through January-March 2024.



# IRI Pacific Niño 3.4 SST Model Outlook

The majority of models indicate El Niño will persist through the Northern Hemisphere spring 2024.

At its peak (November-January), nearly all models suggest a moderate-to-strong El Niño (ONI values at or greater than 1.0°C).

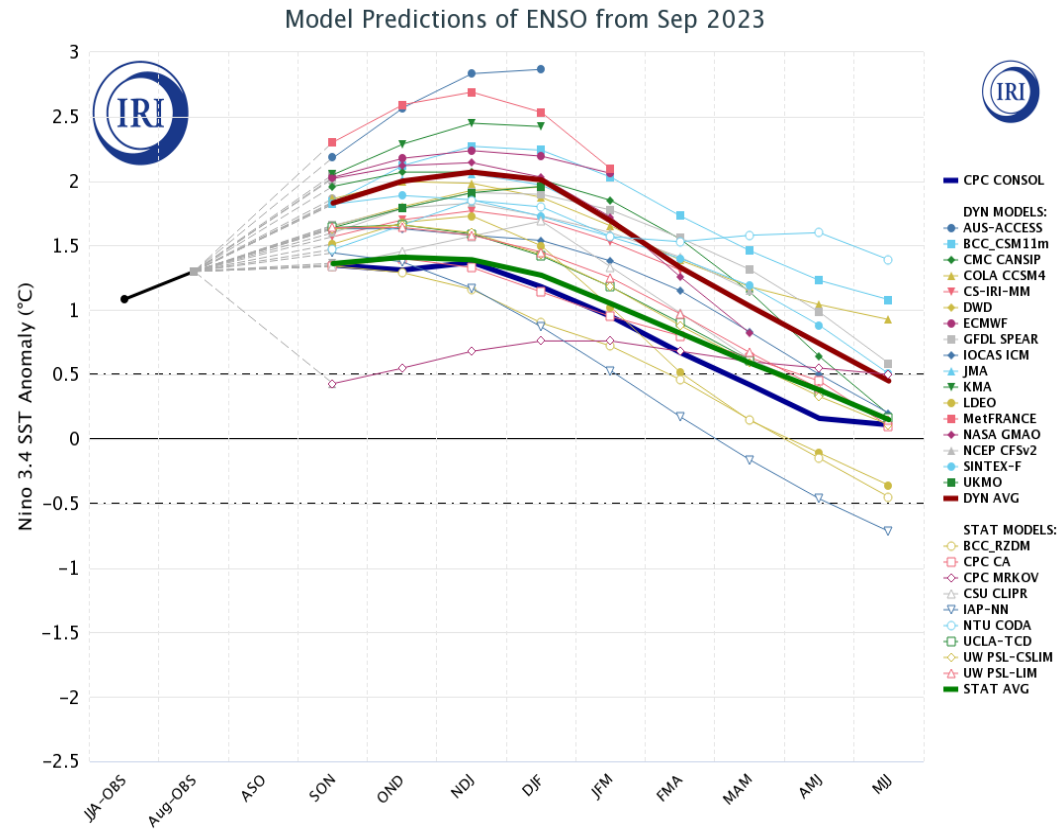


Figure provided by the International Research Institute (IRI) for Climate and Society (updated 20 September 2023).

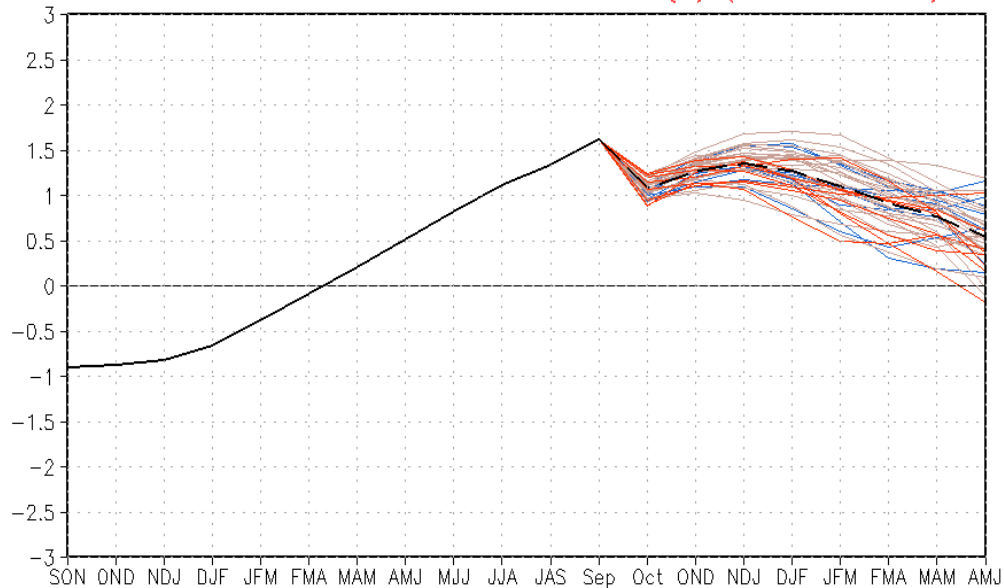


# SST Outlook: NCEP CFS.v2 Forecast (PDF corrected)

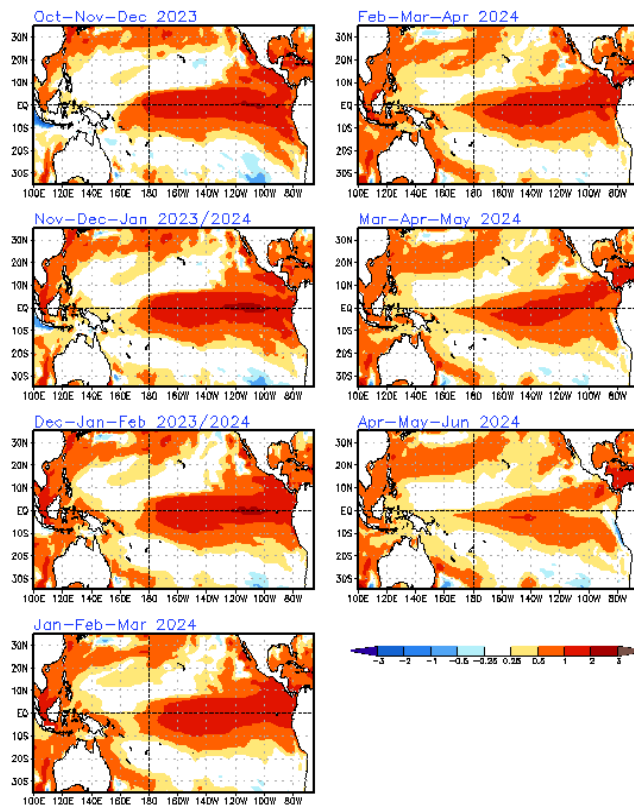
Issued: 25 September 2023

The CFS.v2 ensemble mean (black dashed line) indicates El Niño will continue through the Northern Hemisphere winter 2023-24. A moderate strength El Niño is favored (ONI between 1.0°C and 1.5°C).

CFSv2 forecast Nino3.4 SST anomalies (K) (PDF corrected)



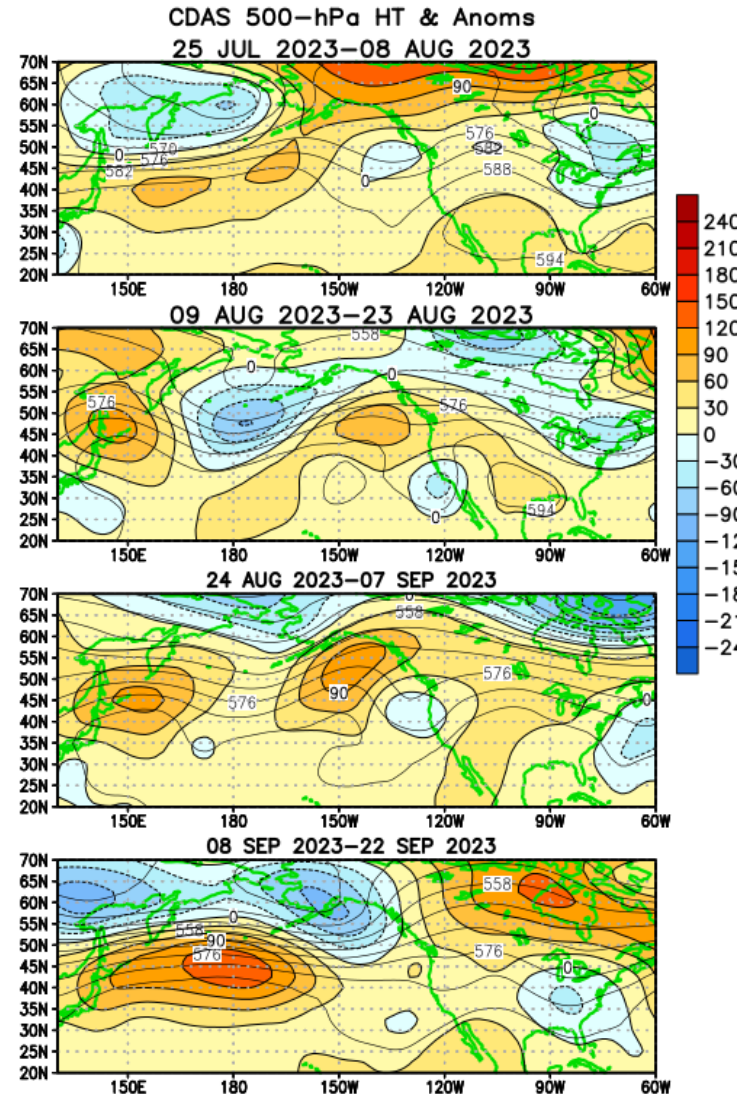
- Latest 8 forecast members
  - Earliest 8 forecast members
  - Other forecast members
  - Forecast ensemble mean
  - NCEI Olv2.1 daily analysis
- (Climatology base period: 1991–2020)



# Atmospheric anomalies over the North Pacific and North America During the Last 60 Days

From late July through late August, anomalous troughs (and below-average temperatures) were evident near the Great Lakes and/or northeastern U.S.

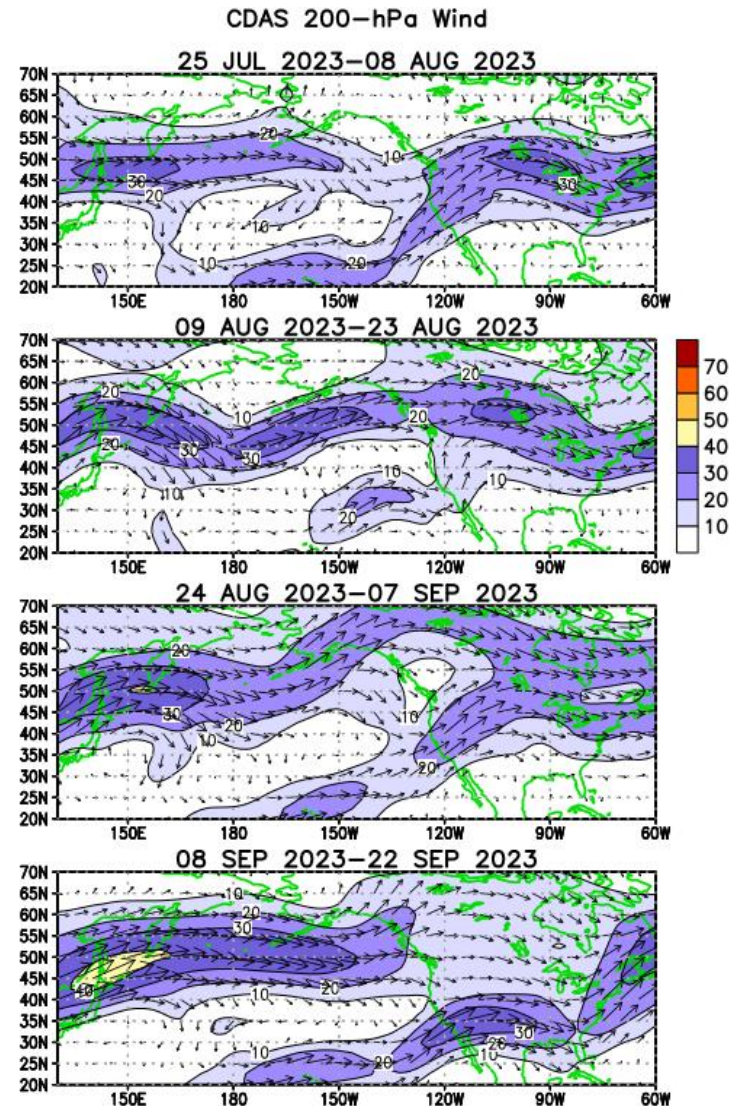
From late July to late September, an anomalous ridge (and above-average temperatures) has persisted in the south-central and/or southwestern U.S.



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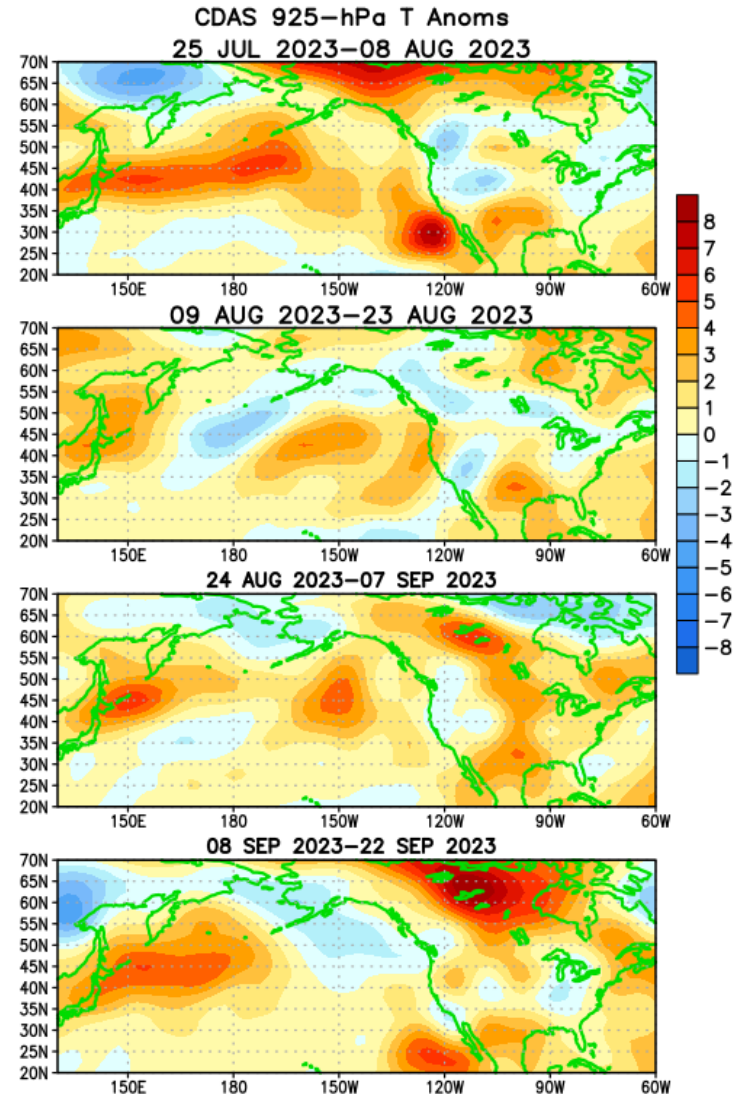
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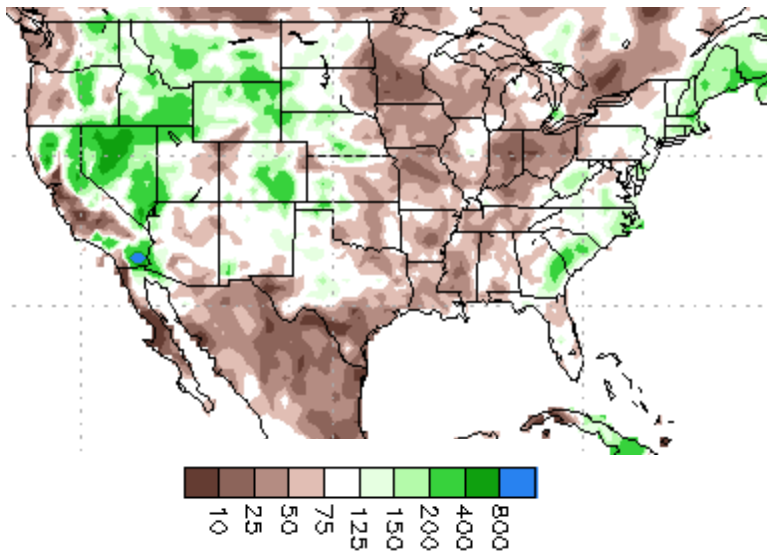
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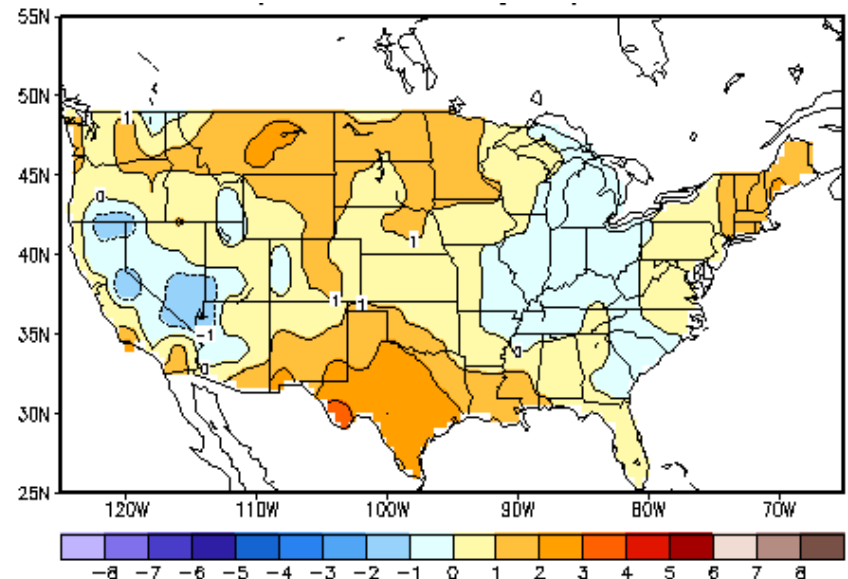
# U.S. Temperature and Precipitation Departures During the Last 30 Days

End Date: 23 September 2023

### Percent of Average Precipitation



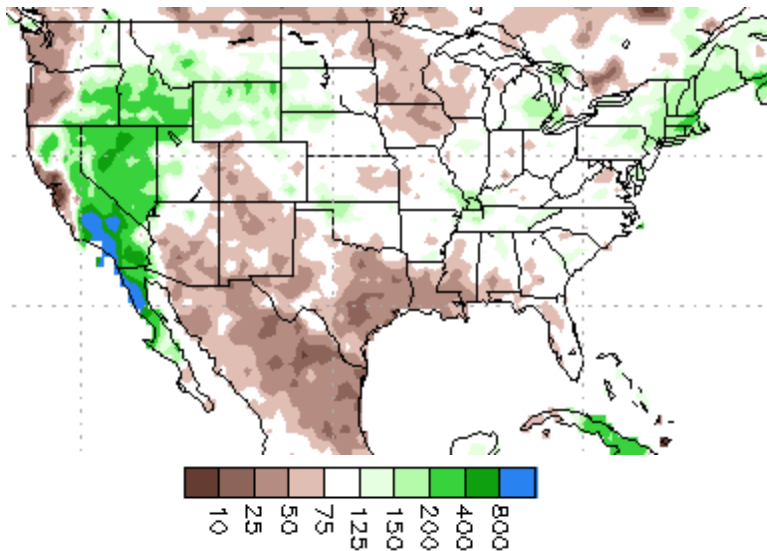
### Temperature Departures (degree C)



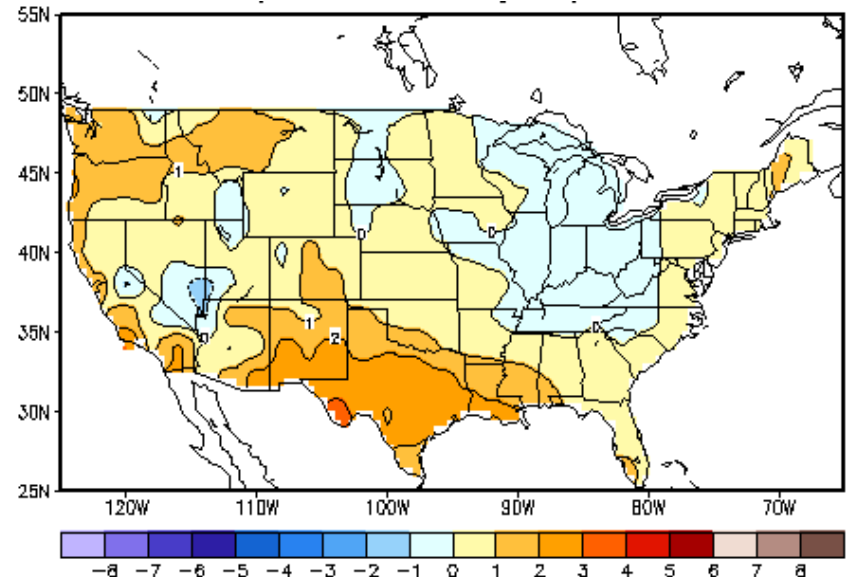
# U.S. Temperature and Precipitation Departures During the Last 90 Days

End Date: 23 September 2023

Percent of Average Precipitation



Temperature Departures (degree C)



# U. S. Seasonal Outlooks

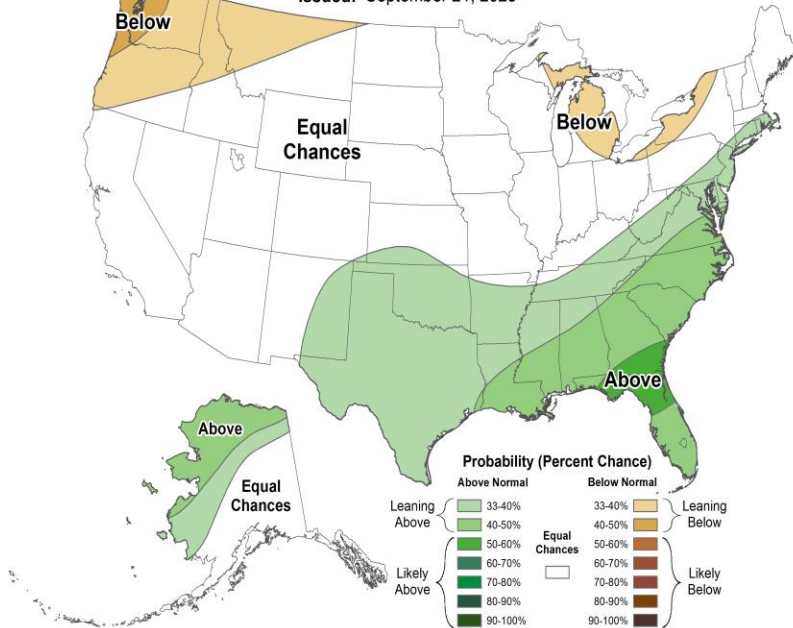
October - December 2023

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

## Precipitation

### Seasonal Precipitation Outlook

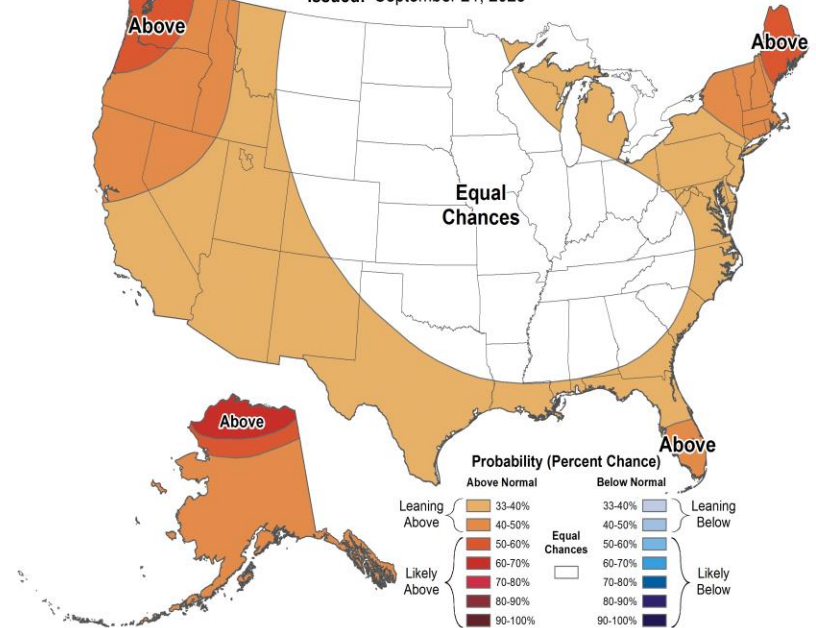
Valid: Oct-Nov-Dec 2023  
Issued: September 21, 2023



## Temperature

### Seasonal Temperature Outlook

Valid: Oct-Nov-Dec 2023  
Issued: September 21, 2023



# Summary

ENSO Alert System Status: **El Niño Advisory**

El Niño conditions are observed.\*

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The tropical Pacific atmospheric anomalies are consistent with El Niño.

El Niño is anticipated to continue through the Northern Hemisphere winter (with greater than a 95% chance through January-March 2024).\*

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