ENSO: Recent Evolution, Current Status and Predictions

Update prepared by:
Climate Prediction Center / NCEP
28 June 2021
Outline

Summary
Recent Evolution and Current Conditions
Oceanic Niño Index (ONI)
Pacific SST Outlook
U.S. Seasonal Precipitation and Temperature Outlooks
Summary
ENSO Alert System Status: Not Active

ENSO-neutral conditions are present.*

Equatorial sea surface temperatures (SSTs) are near average across most of the Pacific Ocean.

ENSO-neutral is favored through the Northern Hemisphere summer (78% chance for the June-August season) and fall (50% chance for the September-November season).*

* Note: These statements are updated once a month (2nd Thursday of each month) in association with the ENSO Diagnostics Discussion, which can be found by clicking here.
During September 2020 to March 2021, the core of the strongest negative SST anomalies shifted from the eastern to the central Pacific Ocean. Since early March 2021, equatorial SSTs have gradually returned to average over most of the Pacific Ocean.
Niño Region SST Departures (°C) Recent Evolution

The latest weekly SST departures are:

- Niño 4: 0.0°C
- Niño 3.4: 0.0°C
- Niño 3: 0.0°C
- Niño 1+2: 0.2°C
SST Departures (°C) in the Tropical Pacific During the Last Four Weeks

In the last four weeks, equatorial SSTs were near average across most of the equatorial Pacific Ocean.
Global SST Departures (°C) During the Last Four Weeks

During the last four weeks, equatorial SSTs were near average across most of the equatorial Pacific Ocean. Equatorial SSTs were above average in the eastern Atlantic Ocean.
During the last 4 weeks, SSTs have remained near average across most of the equatorial Pacific Ocean.
Change in Weekly SST Departures over the Last Four Weeks

During the last four weeks, the changes in equatorial SST anomalies were positive in the eastern Pacific Ocean.
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 (near-to-above average) and thermocline slope index (near average) reflect ENSO-neutral.

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

Starting in mid-July 2020, negative subsurface temperature anomalies strengthened and persisted through early February 2021, when the negative anomalies weakened. Beginning in mid-March 2021, subsurface temperature was above average. Since early May 2021, the positive anomalies have weakened.
Sub-Surface Temperature Departures in the Equatorial Pacific

In the last two months, positive subsurface temperature anomalies extended across most of the Pacific Ocean.

Small areas of negative subsurface temperature anomalies have emerged in the east-central Pacific at depth.
Positive OLR anomalies (suppressed convection and precipitation) were located near the Date Line and over parts of Indonesia and Southeast Asia.

Low-level (850-hPa) easterly wind anomalies were evident over parts of the eastern equatorial Pacific Ocean.

Upper-level (200-hPa) westerly wind anomalies were observed over a small region of the eastern equatorial Pacific Ocean.
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.

From August 2020 to February 2021, negative subsurface temperature anomalies persisted in the eastern half of the Pacific Ocean.

During March through May 2021, positive anomalies shifted eastward in association with two downwelling Kelvin waves.

In the last couple of weeks, subsurface temperatures were mostly near average across the central and eastern 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 upwelling and cooling occur in the trailing portion.
At times, the Madden Julian Oscillation (MJO) has contributed to the eastward propagation of low-level wind anomalies.

From late August 2020 through May 2021, easterly wind anomalies mostly persisted over the central and east-central equatorial Pacific Ocean.

In the last couple of weeks, westerly wind anomalies have persisted over the east-central equatorial Pacific Ocean.
Upper-level (200-hPa) Velocity Potential Anomalies

From the beginning of the period through present, anomalous divergence (green shading) generally remained over Indonesia, while anomalous convergence (brown shading) persisted over the eastern Pacific Ocean.

In the last week, anomalous convergence emerged over the western Pacific Ocean.

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 late April 2020 through March 2021, positive OLR anomalies persisted around the Date Line.

From mid-December 2020 through February 2021, negative OLR anomalies were evident over Indonesia.

Recently, positive anomalies were evident over the Indian Ocean, the western Pacific, and the Date Line.

Drier-than-average Conditions (orange/red shading)
Wetter-than-average Conditions (blue shading)
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.
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 (March - May 2021) is -0.7°C.
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 Niño 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 overlapping 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].

<table>
<thead>
<tr>
<th>Year</th>
<th>DJF</th>
<th>JFM</th>
<th>FMA</th>
<th>MAM</th>
<th>AMJ</th>
<th>MJJ</th>
<th>JJA</th>
<th>JAS</th>
<th>ASO</th>
<th>SON</th>
<th>OND</th>
<th>NDJ</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>-0.8</td>
<td>-0.8</td>
<td>-0.6</td>
<td>-0.3</td>
<td>0.0</td>
<td>0.3</td>
<td>0.5</td>
<td>0.6</td>
<td>0.7</td>
<td>1.0</td>
<td>1.4</td>
<td>1.6</td>
</tr>
<tr>
<td>2010</td>
<td>1.5</td>
<td>1.2</td>
<td>0.8</td>
<td>0.4</td>
<td>-0.2</td>
<td>-0.7</td>
<td>-1.0</td>
<td>-1.3</td>
<td>-1.6</td>
<td>-1.6</td>
<td>-1.6</td>
<td>-1.6</td>
</tr>
<tr>
<td>2011</td>
<td>-1.4</td>
<td>-1.2</td>
<td>-0.9</td>
<td>-0.7</td>
<td>-0.6</td>
<td>-0.4</td>
<td>-0.5</td>
<td>-0.6</td>
<td>-0.8</td>
<td>-1.0</td>
<td>-1.1</td>
<td>-1.0</td>
</tr>
<tr>
<td>2012</td>
<td>-0.9</td>
<td>-0.7</td>
<td>-0.6</td>
<td>-0.5</td>
<td>-0.3</td>
<td>0.0</td>
<td>0.2</td>
<td>0.4</td>
<td>0.4</td>
<td>0.3</td>
<td>0.1</td>
<td>-0.2</td>
</tr>
<tr>
<td>2013</td>
<td>-0.4</td>
<td>-0.4</td>
<td>-0.3</td>
<td>-0.3</td>
<td>-0.4</td>
<td>-0.4</td>
<td>-0.4</td>
<td>-0.3</td>
<td>-0.3</td>
<td>-0.2</td>
<td>-0.2</td>
<td>-0.3</td>
</tr>
<tr>
<td>2014</td>
<td>-0.4</td>
<td>-0.5</td>
<td>-0.3</td>
<td>0.0</td>
<td>0.2</td>
<td>0.2</td>
<td>0.0</td>
<td>0.1</td>
<td>0.2</td>
<td>0.5</td>
<td>0.6</td>
<td>0.7</td>
</tr>
<tr>
<td>2015</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.7</td>
<td>0.9</td>
<td>1.2</td>
<td>1.5</td>
<td>1.9</td>
<td>2.2</td>
<td>2.4</td>
<td>2.6</td>
<td>2.6</td>
</tr>
<tr>
<td>2016</td>
<td>2.5</td>
<td>2.1</td>
<td>1.6</td>
<td>0.9</td>
<td>0.4</td>
<td>-0.1</td>
<td>-0.4</td>
<td>-0.5</td>
<td>-0.6</td>
<td>-0.7</td>
<td>-0.7</td>
<td>-0.6</td>
</tr>
<tr>
<td>2017</td>
<td>-0.3</td>
<td>-0.2</td>
<td>0.1</td>
<td>0.2</td>
<td>0.3</td>
<td>0.3</td>
<td>0.1</td>
<td>-0.1</td>
<td>-0.4</td>
<td>-0.7</td>
<td>-0.8</td>
<td>-1.0</td>
</tr>
<tr>
<td>2018</td>
<td>-0.9</td>
<td>-0.9</td>
<td>-0.7</td>
<td>-0.5</td>
<td>-0.2</td>
<td>0.0</td>
<td>0.1</td>
<td>0.2</td>
<td>0.5</td>
<td>0.8</td>
<td>0.9</td>
<td>0.8</td>
</tr>
<tr>
<td>2019</td>
<td>0.7</td>
<td>0.7</td>
<td>0.7</td>
<td>0.5</td>
<td>0.3</td>
<td>0.5</td>
<td>0.3</td>
<td>0.1</td>
<td>0.2</td>
<td>0.3</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>2020</td>
<td>0.5</td>
<td>0.5</td>
<td>0.4</td>
<td>0.2</td>
<td>-0.1</td>
<td>-0.3</td>
<td>-0.4</td>
<td>-0.6</td>
<td>-0.9</td>
<td>-1.2</td>
<td>-1.3</td>
<td>-1.2</td>
</tr>
<tr>
<td>2021</td>
<td>-1.0</td>
<td>-0.9</td>
<td>-0.8</td>
<td>-0.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ENSO-neutral is favored through the Northern Hemisphere summer, with chances of La Niña increasing into the fall and winter 2021-22.
The dynamical and statistical model averages predict ENSO-neutral to continue through winter 2021-22.
The CFS.v2 ensemble mean (black dashed line) predicts ENSO-neutral followed by weak La Niña conditions during late fall and winter 2021-22.
Atmospheric anomalies over the North Pacific and North America During the Last 60 Days

During mid-May to early June, below-average heights and temperatures were observed over the southeastern U.S.

Since late May, above-average heights and temperatures were evident across the western U.S.
Atmospheric anomalies over the North Pacific and North America During the Last 60 Days

During mid-May to early June, below-average heights and temperatures were observed over the southeastern U.S.

Since late May, above-average heights and temperatures were evident across the western U.S.
Atmospheric anomalies over the North Pacific and North America During the Last 60 Days

During mid-May to early June, below-average heights and temperatures were observed over the southeastern U.S.

Since late May, above-average heights and temperatures were evident across the western U.S.
U.S. Temperature and Precipitation Departures During the Last 30 Days

End Date: 26 June 2021
U.S. Temperature and Precipitation Departures During the Last 90 Days

End Date: 26 June 2021
The seasonal outlooks combine the effects of long-term trends, soil moisture, and, when appropriate, ENSO.
**Summary**

ENSO Alert System Status: Not Active

ENSO-neutral conditions are present.*

Equatorial sea surface temperatures (SSTs) are near average across most of the Pacific Ocean.

ENSO-neutral is favored through the Northern Hemisphere summer (78% chance for the June-August season) and fall (50% chance for the September-November season).*

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