ENSO: Recent Evolution, Current Status and Predictions

Update prepared by:
Climate Prediction Center / NCEP
22 March 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: La Niña Advisory

La Niña is present.*

Equatorial sea surface temperatures (SSTs) are below average from the west-central to eastern Pacific Ocean.

The tropical atmospheric circulation is consistent with La Niña.

There is a ~60% chance of a transition from La Niña to ENSO-Neutral during the Northern Hemisphere spring 2021 (April-June).*

* 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 November 2019 through April 2020, above-average SSTs were present from the Date Line to the eastern Pacific Ocean. Beginning in mid-May 2020, negative SST anomalies emerged in the east-central and eastern Pacific Ocean. In the last couple of weeks, negative anomalies weakened across the equatorial Pacific Ocean.
Niño Region SST Departures (°C) Recent Evolution

The latest weekly SST departures are:

- Niño 4: -0.4°C
- Niño 3.4: -0.5°C
- Niño 3: -0.2°C
- Niño 1+2: 0.5°C
In the last four weeks, equatorial SSTs were mostly below average from the west-central Pacific to ~110°W. Equatorial SSTs were near-to-above average closer to the coast of South America.
During the last four weeks, equatorial SSTs were mostly below average from the west-central to the east-central Pacific Ocean, in the western Indian Ocean, and in the central Atlantic Ocean.
During the last four weeks, below-average SSTs have weakened across the equatorial Pacific Ocean.
During the last four weeks, the changes in equatorial SST anomalies were positive across most of the 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 (below average) and thermocline slope index (above average) 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).
Subsurface temperature anomalies decreased from March-May 2020, before weakening in June. Starting in mid-July 2020, negative temperature anomalies strengthened and persisted through early February 2021, when the negative anomalies weakened. Beginning in early March 2021, subsurface temperature was near average.
Sub-Surface Temperature Departures in the Equatorial Pacific

In the last two months, negative subsurface temperature anomalies have weakened and now extend from ~100m to the surface.

Since late January, a large area of positive anomalies in the western Pacific has shifted eastward to ~125°W at depth. Also, positive subsurface temperature anomalies from ~25m to the surface have persisted in the far eastern Pacific Ocean.
Tropical OLR and Wind Anomalies During the Last 30 Days

Positive OLR anomalies (suppressed convection and precipitation) extended from the west-central to central Pacific Ocean. Negative OLR anomalies (enhanced convection and precipitation) were evident over the Philippines.

Low-level (850-hPa) easterly wind anomalies were evident across the central and western Pacific Ocean. Westerly wind anomalies were observed over the far eastern Pacific Ocean.

Upper-level (200-hPa) westerly wind anomalies were observed over the central equatorial Pacific Ocean.
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.

During April-June and August-September 2020, negative subsurface temperature anomalies were associated with upwelling Kelvin waves.

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

From late January 2021 through present, both positive and negative subsurface temperature anomalies have shifted eastward.

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 present, easterly wind anomalies mostly persisted over the central and east-central equatorial Pacific Ocean.
Upper-level (200-hPa) Velocity Potential Anomalies

From the beginning of the period until early January 2021, anomalous divergence (green shading) persisted over Africa and the western Indian Ocean.

From the beginning of the period, anomalous divergence has remained over Indonesia.

Since mid-August 2020 through February 2021, anomalous convergence (brown shading) persisted over the eastern 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).
Since late April 2020, positive OLR anomalies have been observed at the Date Line. Positive OLR anomalies strengthened from late November 2020 to late January 2021.

From mid-December 2020 through February 2021, negative OLR anomalies were evident 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.
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 (December 2020 - February 2021) is -1.1° C.
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 Niño 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>0.5</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>-1.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
La Niña is favored through March-May 2021, with a 60% chance of a transition to ENSO-neutral in April-June 2021.
The model averages predict La Niña to continue into the Northern Hemisphere spring 2021, returning to ENSO-neutral during April-June 2021 and continuing through fall 2021.

Figure provided by the International Research Institute (IRI) for Climate and Society (updated 19 March 2021).
The CFS.v2 ensemble mean (black dashed line) predicts a transition to ENSO-neutral in the next month and persisting on the cool side of ENSO-neutral through fall 2021.
Atmospheric anomalies over the North Pacific and North America During the Last 60 Days

From mid-January 2020 to mid-February 2021, anomalous ridging and above-average temperatures were observed over eastern Canada.

From mid-February through mid-March 2021, above-average heights and temperatures were evident over the eastern U.S.

Since mid-January, anomalous ridging over the North Pacific Ocean has been associated with a retracted Asia-Pacific jet stream.
Atmospheric anomalies over the North Pacific and North America During the Last 60 Days

From mid-January 2020 to mid-February 2021, anomalous ridging and above-average temperatures were observed over eastern Canada.

From mid-February through mid-March 2021, above-average heights and temperatures were evident over the eastern U.S.

Since mid-January, anomalous ridging over the North Pacific Ocean has been associated with a retracted Asia-Pacific jet stream.
Atmospheric anomalies over the North Pacific and North America During the Last 60 Days

From mid-January 2020 to mid-February 2021, anomalous ridging and above-average temperatures were observed over eastern Canada.

From mid-February through mid-March 2021, above-average heights and temperatures were evident over the eastern U.S.

Since mid-January, anomalous ridging over the North Pacific Ocean has been associated with a retracted Asia-Pacific jet stream.
U.S. Temperature and Precipitation Departures During the Last 30 Days

End Date: 20 March 2021
U.S. Temperature and Precipitation Departures During the Last 90 Days

End Date: 20 March 2021
The seasonal outlooks combine the effects of long-term trends, soil moisture, and, when appropriate, ENSO.
ENSO Alert System Status: **La Niña Advisory**

La Niña is present.*

Equatorial sea surface temperatures (SSTs) are below average from the west-central to eastern Pacific Ocean.

The tropical atmospheric circulation is consistent with La Niña.

There is a ~60% chance of a transition from La Niña to ENSO-Neutral during the Northern Hemisphere spring 2021 (April-June).*

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