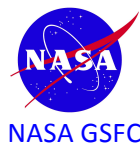


Investigating El Niño and its impacts

| Talking points & <i>engaging questions</i> | Visuals |
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| <p><i>What do you think about when you hear ‘El Niño’?</i></p> <p>2 min video gives an overview of the periodic climate pattern called El Niño. The physical oceanography that drives biological changes is briefly explained. After this overview, we’ll look at each data set in depth. [Play video]</p> <p><i>What do you think about ‘El Niño’ now?</i></p> | <p>ClimateBits: El Niño</p>  |
| <p><i>You may have heard that El Niño affects our weather. How would you describe the difference between weather and climate?</i></p> <p>“Climate is what you expect. Weather is what you get.”</p> <p>Earth’s climate is a balance between heat gained from the sun near the equator and heat lost at the north and south poles. Here ocean currents at the sea-surface are colored by temperature. These are primarily driven by surface winds and the unequal heating of Earth by the sun.</p> <p><i>Can you point out any ribbons of ocean currents that are a different temperature than the surrounding water?</i></p> <p>- Warmer currents: Earth’s rotation and the prevailing winds cause ocean currents to carry warm water away from the equator toward the north and south poles by western boundary currents. Examples of these fast-moving currents: Gulf Stream in the Atlantic, Kuroshio near Japan.</p> <p>- Cooler currents: where winds push water westward and cause upwelling of colder, deep water along the equator and on the east side of the ocean basins.</p> <p><i>Where do you notice the warmest sea surface temperatures?</i></p> <p>- The warm pool in the west Pacific (red) has temperatures hotter than 30°C (86°F).</p> | <p>Sea-surface currents & temperature</p>  |



Daily sea surface temperature (SST) anomalies over the past year (departures from the 30 year average) show where the ocean became warmer or cooler. Scale is in celsius: $5^{\circ}\text{C} = 9^{\circ}\text{F}$ change.

- Western boundary currents (e.g. Gulf Stream along the East Coast of the United States) are noticeable.

In the Pacific ocean, are the temperatures near the equator warmer or cooler than normal? In the east? In the west?

- El Nino events occur when warmer water from the west Pacific moves east, along the equator, to the central and east Pacific (west coast of Ecuador, Peru). These events generally start around May and last about a year when the event is strong.

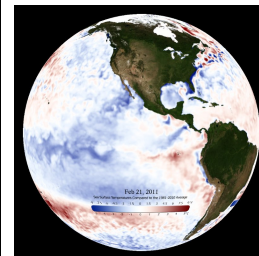
- La Nina events are the reverse pattern when cooler water moves east to the central and east Pacific.

How would you describe the patterns and shapes you see in the water along the equator? Are they moving fast or slowly?

- Tropical Instability Waves are the wavy pattern just north of the equator that move from east to west fairly quickly.

- By contrast, when the west Pacific warm pool moves eastward during a strong El Nino, the event lasts about a year.

Sea-surface temperature anomaly
Real-time



These monthly images indicate chlorophyll, the green pigment in plants. Phytoplankton in the ocean form the base of the marine food web and half of the oxygen we breathe.

What do plants in the ocean need to grow?

- Phytoplankton need sunlight and nutrients to bloom. Unlike on land, there is never a shortage of water in the ocean!

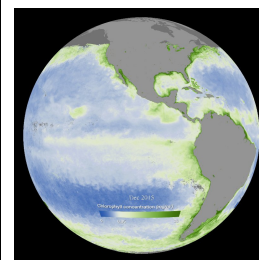
Where do nutrients in the ocean come from?

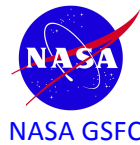
- From land run-off, river outflow, mineral dust blowing over the ocean, and water upwelled from the deep ocean. Most nutrients in the ocean are in deep water where the sun doesn't shine and they cannot be used.

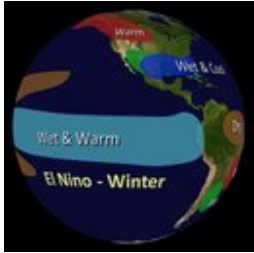
- Deep-water nutrients rise to the sun-lit surface through upwelling to fertilize phytoplankton blooms.

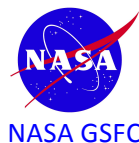
- During an El Nino event, the warm pool moves east and deepens the surface layer, reducing upwelling along the equator in the central and east Pacific.

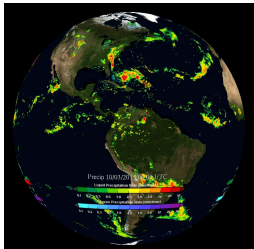
Ocean Color (monthly)
Real-time





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| <p><i>Do you notice high chlorophyll (more green) along the equator in the central and east Pacific?</i></p> <p>- During an El Niño - such as the strong one that peaked around December, 2015 - upwelling stops, phytoplankton lose their source of nutrients and chlorophyll concentrations decline. <i>This color change can be very subtle to our eyes, but spells life or death for the food web there.</i></p> <p>- Less phytoplankton can mean famine for animals in the central and eastern Pacific. For hundreds of years, fishermen off Peru noticed that fish disappear some years around Christmas, thus 'El Niño' for Christ child.</p> | |
| <p>The impacts of El Niño and La Niña vary by season. Here are four maps that show the northern hemisphere winter (Dec-Feb) and summer (Jun-Aug) typical conditions during El Niño and La Niña, but no two El Niño or La Niña events are alike.</p> <p><i>Which season looks like it usually impacts weather most?</i></p> <p>- Northern Hemisphere winter normally has the biggest impacts.</p> <p><i>2015/16 was a strong El Nino year. Do you remember what the weather was like where you were that winter?</i></p> <p>- El Niño winters are typically linked to:</p> <ul style="list-style-type: none"> • drought in the west Pacific (i.e. Indonesia, northern Australia, southeast Asia) • extra rain in the east Pacific (i.e. Galapagos) • more rain in the southern United States • cooler in the southern United States • warmer in the Pacific northwest • dry weather in southeast Africa and Madagascar <p>- El Niño summers are typically linked to:</p> <ul style="list-style-type: none"> • dry weather in central America (e.g. Panama canal ship size was limited in 2015 due to low water level) • drought from Indonesia through north and east Australia • dry weather in India (less rain and delayed monsoons) <p><i>Remember: these maps are based on averages; no two El Niño or La Niña events are alike!</i></p> <p>- La Niña is basically the opposite pattern and response.</p> <p>- El Niño and La Niña events last about a year.</p> <p><i>Where might we expect to see drought this year?</i></p> | <p>El Nino and La Nina seasonal impacts</p>  |



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| <p>This drought imagery is based on the analysis of vegetation health and stress, not soil moisture conditions. The index serves as a reliable proxy measurement for drought worldwide. Yellow areas indicate areas under moderate drought conditions; red indicates areas experiencing extreme drought conditions. <i>Deserts and snow covered areas are not included in the analysis.</i></p> <p><i>Is the current drought risk what we expect to see?</i></p> | <p>Drought Risk – Real-time</p>  |
| <p>Getting too much precipitation or too little can drastically affect your community no matter where you live.</p> <p>This animation shows precipitation for the last month.</p> <p><i>Can you point out where there may have been too much or too little moisture this month?</i></p> <p><i>Do you think the tropical Pacific looks like an El Niño pattern?</i></p> <ul style="list-style-type: none"> - In the tropical Pacific, precipitation follows the west Pacific warm pool and shifts eastward along the equator - During El Niño (warm phase): more tropical storms (typhoons) in the Pacific - During La Niña (cool phase): fewer tropical storms in the Pacific <p><i>What do you notice away from the tropical Pacific?</i></p> <ul style="list-style-type: none"> - During El Niño: fewer tropical storms (hurricanes) in the Atlantic - During La Niña: more tropical storms in the Atlantic <p><i>Is there much rain over the United States? South America? Africa? Australia?</i></p> | <p>Precipitation – Real-time</p>  |
| <p>Final point: Scientists still have a lot to learn about how ocean circulation drives changes in weather from year to year. As with the stock market, past performance is no guarantee of future results. The more we know, the more we can prepare.</p> | |

The dynamics of the subsurface equatorial Pacific during El Niño/neutral/ La Niña conditions are demonstrated in this tank activity: https://youtu.be/r_cQuWmamW4

References and more information: <http://climatebits.umd.edu/ElNinoInfo.html>