Pacific-Australia Climate Change Science and Adaptation Planning Program (PACCSAP)

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Large-scale climate features in the western tropical Pacific

The Pacific Ocean covers almost a third of the Earth's surface, and the presence of large-scale climate features and different-sized landmasses leads to profound year-to-year variation in the climate of the many small island nations dotted throughout this expanse of water.

What large-scale features drive the climate of the western tropical Pacific?

The major large-scale climate features of the western tropical Pacific are the El Niño Southern Oscillation (ENSO), the South Pacific Convergence Zone (SPCZ), the Intertropical Convergence Zone (ITCZ) and the West Pacific Monsoon (WPM) (Fig. 1). These features affect the regional pattern and seasonal cycle in rainfall, winds, tropical cyclone tracks, ocean currents, nutrients and many other aspects of the climate and the environment in general.

El Niño Southern Oscillation

The El Niño Southern Oscillation is the major influence on climate variability in the western tropical Pacific. It particularly affects the year-to-year risk of droughts, extreme rainfall and floods, tropical cyclones, extreme sea levels and coral bleaching. During normal conditions, when ENSO is in its 'neutral' phase, the equatorial trade winds (wind system which occupies most of the tropics) blow across the Pacific from east to west, meeting with the warm waters of the West Pacific Warm Pool and leading to strong convection (rising air) and high rainfall. Under these conditions, ocean temperatures are cooler in the east due to upwelling bringing cold waters to the surface.

An El Niño event is one extreme of ENSO, and typically occurs every two to seven years. During an El Niño (Fig. 2, left panel), the trade winds are weaker and ocean upwelling in the east is reduced, leading to warming of the surface temperatures of the central and eastern tropical Pacific Ocean. These changes lead to convection moving away to the east, and the strength and position of the ITCZ and the SPCZ change, as does the timing of the WPM. During an El Niño event, many countries experience different rainfall and temperatures to their 'normal' (mean condition) climate. El Niño events and associated impacts usually last for about one year but can occasionally continue for several years.

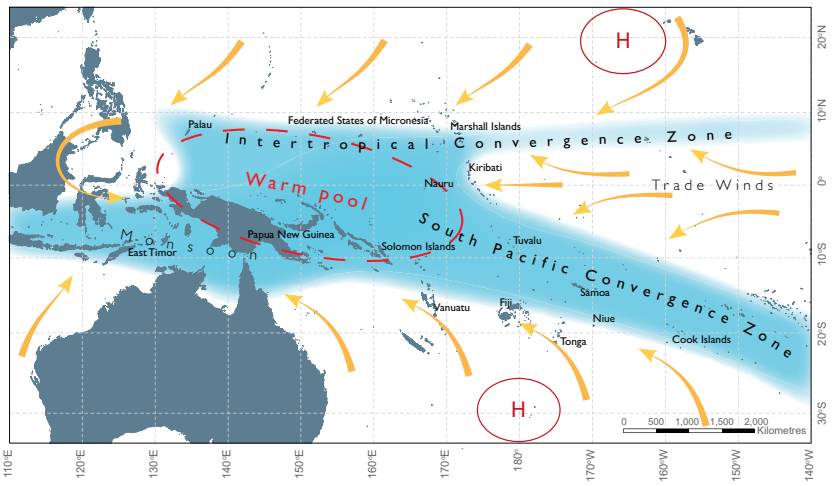

Figure 1: Average positions of the SPCZ, ITCZ, WPM and other important climate features in the western tropical Pacific, November–April (yellow arrows, near surface winds; blue shading, bands of rainfall; red dashed oval, West Pacific Warm Pool; red H, typical position of moving high pressure systems).

During some years, the opposite extreme phase of ENSO occurs, called La Niña. In contrast to El Niño, La Niña events (Fig. 2, right panel) tend to bring stronger trade winds and cooler ocean temperatures to the central and eastern tropical Pacific due to enhanced upwelling, with rainfall patterns shifting as a result (Fig. 3).

In any year, extreme ENSO events usually begin to develop around May or June and end around March the next year. While such events tend to follow a typical pattern of development, the strength and timing of each event is different.

South Pacific Convergence Zone

The South Pacific Convergence Zone is a band of high rainfall that affects most countries in the South Pacific, stretching west from the Solomon Islands to east of the Cook Islands. It is strongest in the Southern Hemisphere's summer/wet season (November to March). The year-to-year variability of the SPCZ is dominated by the impact of ENSO events, moving north and east in the Pacific during El Niño events, and south and west during La Niña events. The western tropical portion of the SPCZ lies over the warm sea-surface temperature of the West Pacific Warm Pool, which drives strong convection in the overlying atmosphere and helps draw trade winds across the Pacific.

Intertropical Convergence Zone

The Intertropical Convergence Zone is a persistent east-west band of converging low-level winds, cloudiness and rainfall stretching across the Pacific just north of the equator. It affects most countries across the tropical North Pacific, and is strongest in the Northern Hemisphere summer/wet season (April to October). Like the SPCZ, the ITCZ is strongly affected by ENSO. The ITCZ tends to move towards the equator in El Niño years and to the north in La Niña years, affecting rainfall in northern tropical Pacific countries.

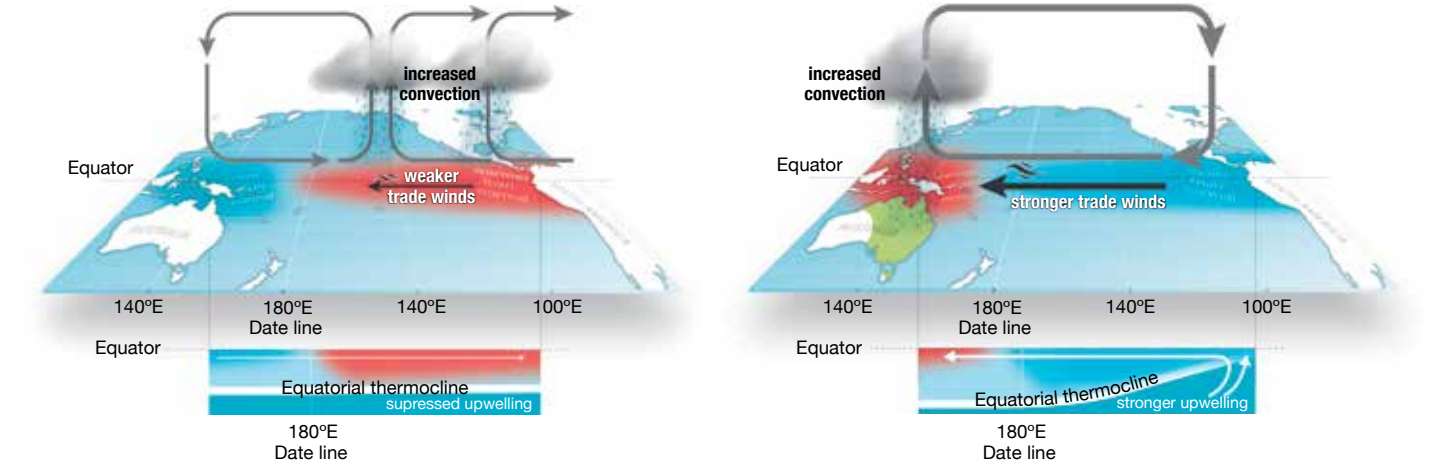

Figure 2: ENSO phases in the tropical Pacific Ocean: El Niño (left) and La Niña (right)

West Pacific Monsoon

The West Pacific Monsoon is driven by large temperature differences between the land and the ocean. Its arrival usually brings a switch from very dry to very wet conditions for countries within its influence. The WPM is often described as a seasonal shift (reversal) in the prevailing direction of surface winds in the western Pacific. It moves northward to mainland Asia during the Northern Hemisphere summer/wet season, when it affects countries in the western north tropical Pacific like Palau. It moves southward to northern Australia during the Southern Hemisphere summer/wet season, affecting East Timor, Papua New Guinea and the Solomon Islands.

Building resilience for a more sustainable future

Understanding the large-scale features that influence climate variability in the western tropical Pacific is essential to understanding how the climate across the region may change in the future. Such knowledge helps to inform climate adaptation planning and preparedness, and supports resilient development in vulnerable local communities.

The timely provision of reliable scientific understanding and evidence to inform decision-making will enable more effective and efficient adaptation planning: an essential requirement for securing sustainable development in the region.

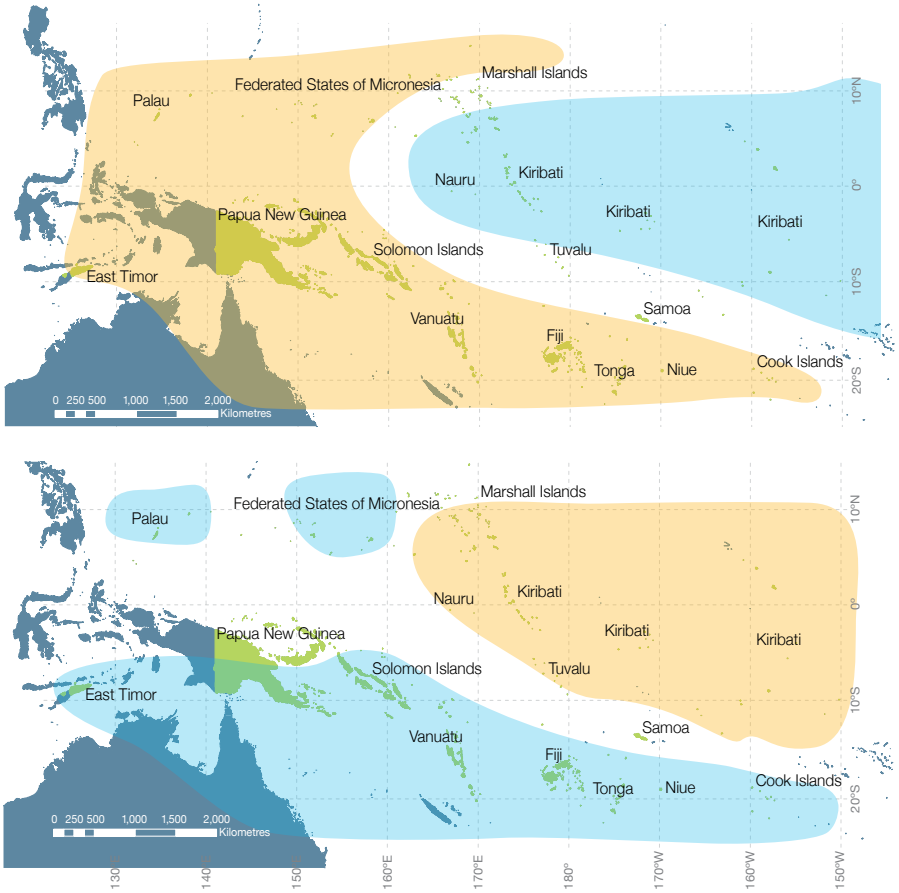

Figure 3: Typical changes to rainfall patterns during El Niño (top) and La Niña (bottom) events in the western tropical Pacific (blue shading, wetter than average; yellow shading, drier than average).

Other fact sheets in the series include:

- Climate extremes in the western tropical Pacific
- Climate variability and climate change in the western tropical Pacific
- Sea-level rise in the western tropical Pacific
- Ocean acidification in the western tropical Pacific

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