

Modelling of the El Niño Southern Oscillations

The El Niño Southern Oscillations (ENSOs) are a composite weather phenomena originating in the Pacific Ocean which produce lasting teleconnections on the global climate system. El Niño can be considered to be an oceanic warming event which disrupts the normal Pacific circulation at irregular intervals of 2–7 years, whilst the Southern Oscillations are an inter-annual flip between the tropical sea level pressure between the western and eastern Pacific leading to the weakening and strengthening of the easterly trade winds across the Pacific.

During El Niño years, strong trade winds are absent to transfer warm water westwards across the Pacific, the result is that the water flows back eastwards towards the American continents. This leads to warmer and wetter conditions along the western coastlines of the Americas and dryer conditions in Australia and Indonesia. South American farmers would benefit as there would be increased vegetation growth but at the same time potentially suffer due to the breeding and spreading of tropical diseases such as malaria and cholera. On the other hand, Australian farmers would struggle due to the lack of rainfall. Whilst the effects of the coupled ENSOs can be approximately understood, modern research has yet to find a reliable model which can predict when and how they occur.

This discussion begins with how El Niño is defined and the issues surrounding this. On a national scale Australia, Peru and the USA use different ways to classify an El Niño event (L’Heureux et al. 2017). Each country experiences the effects of ENSO differently therefore each specifies alternative conditions for when an El Niño event is occurring. Whilst they all roughly consider oceanic and atmospheric anomalies to inform their updates, utilising one general definition would provide a better gauge of the severity of an ENSO event therefore enabling proper preparations. This lack of consensus can also be extended to the scientific community where there is no single identifiable model for El Niño nor even a single definition (Trenberth 1997).

Bjerknes (1969) initially identified that El Niño and Southern Oscillations are different aspects of the same phenomena, they proposed that the cause of ENSO is related to a positive ocean-atmosphere feedback loop involving the Walker circulation. This idea forms the basis of two approximate schools of thought on the theoretical origins of ENSOs (Wang et al. 2017). The first suggests El Niño to be a phase of a self-sustained, unstable, and natural oscillatory mode of the coupled ocean-atmosphere system. The second, describes El Niño to be a stable (or damped) mode which is triggered by or interacted with random forcing or noise such as westerly wind bursts, tropical instability waves in the eastern Pacific (An 2008), and Madden-Julian oscillation events (Gebbie et al. 2007).

Exploring individual theories leads to a greater sense of uncertainty as competing hypotheses try to describe different aspects of the ENSO phenomenon. As of yet there is no one true “grand unifying El Niño theory” however the separate theories may provide various possibilities to enable the production of one.

References

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