

Modelling of the El Niño Southern Oscillations

The El Niño Southern Oscillations (ENSOs) are a composite weather phenomena originating in the Pacific Ocean which produces lasting teleconnections on the global climate system. El Niño can be approximately 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 ocean.

During El Niño years, strong trade winds are absent to transfer warm water westwards across the Pacific resulting in the water flowing 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. This would benefit South American farmers as there would be an increase in vegetation growth but also the potential for tropical diseases such as malaria and cholera to thrive. At the same time, Australian farmers would struggle to produce crops due to the lack of rainfall. Therefore it would be beneficial to predict when an ENSO event occurs as society could then efficiently plan around it. Modern research has yet to find a reliable model even though the effects are mostly understood.

At the utmost basic level there are discrepancies with the definition of “El Niño”. On a national scale Australia, Peru and the USA employ 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 is extended to the scientific community where there is no single identifiable model for El Niño due to the scale and complexity of the event (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).

The prevalent mechanism amongst both groupings of ideas is the effect of an oscillator on the Pacific climate system. The current main conceptual models are for the coupled system and

In

References

- An, S.-I. (2008), ‘Interannual Variations of the Tropical Ocean Instability Wave and ENSO’, Journal of Climate **21**(15), 3680–3686.
- Bjerknes, J. (1969), ‘Atmospheric teleconnections from the equatorial Pacific’, Monthly Weather Review **97**(3), 163–172.
- Gebbie, G., Eisenman, I., Wittenberg, A. and Tziperman, E. (2007), ‘Modulation of Westerly Wind Bursts by Sea Surface Temperature: A Semistochastic Feedback for ENSO’, Journal of the Atmospheric Sciences **64**(9), 3281–3295.
- L’Heureux, M. L., Takahashi, K., Watkins, A. B., Barnston, A. G., Becker, E. J., Di Liberto, T. E., Gamble, F., Gottschalck, J., Halpert, M. S., Huang, B., Mosquera-Vásquez, K. and Wittenberg, A. T. (2017), ‘Observing and Predicting the 2015/16 El Niño’, Bulletin of the American Meteorological Society **98**(7), 1363–1382.
- Ruddiman, W. F. (2008), Earth’s Climate: Past and Future, 2nd edn, W. H. Freeman and Company.
- Trenberth, K. E. (1997), ‘The Definition of El Niño.’, Bulletin of the American Meteorological Society **78**, 2771–2777.
- Wang, C., Deser, C., Yu, J.-Y., DiNezio, P. and Clement, A. (2017), El Niño and southern oscillation (ENSO): a review, in ‘Coral Reefs of the Eastern Tropical Pacific’, Springer, pp. 85–106.