SHORT COMMUNICATION

ENSO an earth science concept

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ABSTRACT

The major year-to-year climate signal on Earth is the El Nio–Southern Oscillation (ENSO) cycle, which alternates warm El Nio and cold La Nia occurrences. ENSO is caused by interactions between the ocean and the atmosphere in the tropical Pacific, but its environmental and social effects are seen all over the world. With the intense El Nio of 1997–1998 as a catalyst, research into the origins and repercussions of ENSO has exploded in recent years. These initiatives demonstrate the range of ENS-O's effect on the Earth system, as well as the potential for social benefit from its forecasting. Many interconnected problems about ENSO dynamics, effects, predictions, and applications, on the other hand, remain unsolved Research into these challenges will not only advance a wide range of scientific fields, but it will also give a chance to educate the general public and policymakers on the relevance of climate variability and change in the modern world.

Key Words: *Oscillation; ENSO; PNA; TNH; CO2*

INTRODUCTION

The development of the ENSO observation system, theoretical knowledge of the processes responsible for the ENSO cycle and its global teleconnections, seasonal climate forecast models, and an elaboration of ENSO's human components took place from the early 1980s to the mid-1990s. Then, in 1997–1998, the unprecedented drew global attention to the ENSO cycle, its global ramifications, and socioeconomic implications. Interest in ENSO soared in both the academic community and the general public, fueled by the magnitude of this event, which was by some metrics the strongest of the twentieth century. ENSO has long been a fruitful area for multidisciplinary research due to its cat's cradle of interrelated scientific and socioeconomic challenges. Research into its causes and repercussions is becoming increasingly important in light of efforts to design informed policies for sustainable development and environmental stewardship. This page discusses recent achievements in ENSO research and applications, as well as ongoing trends and problems [1]. As atmospheric pressure rises in the western Pacific and falls in the eastern Pacific during El Nio, the trade winds diminish along the equator. Warm water from the western Pacific migrates eastward, reducing upwelling, resulting in abnormal warming in the central and eastern Pacific. As El Nio develops, the Bjerknes feedback is now in reverse, with decreased trade winds and SST warming tendencies along the equator supporting each other. At the start of El Nio, weakened trade winds cause basin-scale waves in sea level, upper ocean currents, and temperatures to spread eastward and westward around the equator. These waves first aid in the development of abnormally warm SSTs. They operate differently after passing across the basin and reflecting off the eastern and western edges. at the height of El Nio, upwelling favourable waves caused by wind forcing to eventually shut off the warming. Equatorial wave-induced cooling thus provides a delayed negative feedback that causes El Nio to fade away and, if powerful enough, La Nia to emerge [2].

The size and duration of individual ENSO events, as well as the interval between them, are controlled by a mix of Bjerknes and equatorial wave feedbacks. The mean seasonal cycle also serves as an ENSO pacemaker, with the biggest SST anomalies often occurring near the year's end.

This foundational knowledge of ENSO does not mean that it is a simply cyclic event. The amplitude, length, temporal history, and spatial organisation of the transition between warm and cold episodes are all irregular. This irregularity has been attributed to either the ocean-atmosphere system's nonlinear chaotic dynamics or stochastic weather noise, such as episodic "westerly wind bursts" and other kinds of intraseasonal atmospheric variability.

El Nio and La Nia have substantial differences in their life cycles, one of which is that nonlinear processes prefer stronger El Nios than La Nias. The skewed distribution of ENSO SST anomalies toward larger extreme warm versus cold values may be due to these differences [3]. From the mid-1970s to the late 1990s, there was a trend for more and stronger El Nios than La Nias, which has been suggested as evidence for a decadal modulation of ENSO.

One proposed explanation is that the ENSO cycle interacts with the Pacific Decadal Oscillation (PDO), but it might also be that the ENSO cycle fluctuates arbitrarily on decadal time periods. Precipitation patterns in the tropical Pacific have shifted as a result of El Nio warming in the central Pacific. Drought is common in Australia, Indonesia, and surrounding nations, whereas the central Pacific island states and the west coast of South America are frequently swamped with torrential rainfall. Changes in the position and intensity of this rainfall, as well as the corresponding latent heat release into the atmosphere, cause significant teleconnections in atmospheric circulation and weather patterns outside of the tropical Pacific. Tropical storm frequency, intensity, and spatial dispersion [4]. Hurricanes in the Atlantic, for example, tend to be fewer and weaker during moderate to powerful El Nio events while becoming stronger and more numerous during La Nia events. These year-to-year variations translate into a 3-to-1 increased chance of a big Atlantic hurricane striking the United States during La Nia years vs El Nio years, with proportionally higher economic losses. El Nio and La Nia have the most constant impacts from event to event in the tropical Pacific and adjacent areas, where the atmosphere reacts immediately to SST forcing.

Because of interference from weather noise or other regional types of climate variability, impacts are more pronounced but less consistent at higher latitudes and in other ocean basins distant from the Pacific. Long-term variations in the structure and amplitude of ENSO SST anomalies, as well as changes in atmospheric circulation that affect far-field responses to tropical Pacific SST forcing, may cause teleconnections to change over time [5]. As a result, while El Nio and La Nia frequently cause systematic seasonal shifts in regional weather patterns that favour drought, flood, heat waves, and extreme events, the actual implications for any specific ENSO episode may differ from what is expected.

ECOSYSTEM

Changed environmental circumstances caused by El Nio and La Nia have an impact on worldwide patterns of primary production (plant carbon fixation), with consequences that ripple up the food chain in both marine and terrestrial ecosystems. In reaction to reduced upwelling, primary output in the tropical Pacific, which represents for 10% of total primary production in the world ocean, declines dramatically during El Nio. Marine animals, sea birds, and commercially valuable fish species all suffer from lower production, which has an impact on mortality, fertility, and geographic spread. The impact of El Nio on Pacific ecosystems stretches from the open

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ocean to the west coastlines of North and South America, affecting both benthic and pelagic populations. Furthermore, atmospheric teleconnections can have an impact on marine ecosystems outside of the tropical Pacific, such as in the Southern Ocean, where ENSO affects krill abundance and distribution, a keystone species in the Antarctic marine environment [6]. El Nio-damaged populations, particularly those at higher trophic levels, may take several years to fully recover. A typical example is the collapse of the Peruvian anchovy fishery during the El Nio in 1972–1973.

In the early 1970s, the fishery was the world's largest, with harvests of over 12 million metric tonnes. However, a decade of overfishing had weakened the anchovy stocks' ability to survive large environmental shocks.

When water temperatures rose and the food chain was disrupted, this laid the ground for a catastrophic upheaval in the ecology. Anchovy harvests were reduced by an order of magnitude over the next 20 years, a reduction aided by a decadal trend toward higher tropical Pacific temperatures in the mid-1970s [7].

Tropical corals are bleached as a result of high temperatures associated with powerful El Nio episodes. During the 1997–1998 El Nio, when 16 percent of the world's reef-building coral died, the most enormous and widespread episode of bleaching occurred. Decadal warming trends in tropical ocean temperatures, presumably connected to global warming, contributed to this bleaching by raising background temperatures on which El Nio SST anomalies were superimposed, contributing to the bleaching.

Natural climate archives, such as corals and lake sediments, show that ENSO's strength has fluctuated dramatically over time. Changes in the Earth's radiation balance caused by significant volcanic eruptions, variations in solar output, and the Earth's precession around its axis, for example, have all influenced the ENSO cycle over the past 130,000 years. Permanent El Nio–like conditions existed in the tropical Pacific 3 to 5 million years ago, when atmospheric CO2 levels were comparable to those today, during the warm Pliocene. Furthermore, evidence points to a more active ENSO cycle during the Eocene "hothouse" 35 to 55 million years ago, when atmospheric CO2 concentrations reached levels double those of pre-industrial times.

The ENSO cycle, its impacts on the Earth system, and its socioeconomic consequences have sparked a surge of interest in the first years of the twenty-first century. The powerful El Nio of 1997–1998 sparked this interest, which was aided by research achievements over the previous two decades. ENSO is the most powerful and predictable natural variation of Earth's climate on a year-to-year basis, affecting physical, biological, chemical, and geological processes in the oceans, atmosphere, and on land. It gives a conceptual framework within which to coherently understand seemingly unrelated phenomena in widely different parts of the globe as a significant component of Earth's intricate climate puzzle. The ENSO cycle, its impacts on the Earth system, and its socioeconomic consequences have sparked a surge of interest in the first years of the twenty-first century. The powerful El Nio of 1997–1998 sparked this interest, which was aided by research achievements over the previous two decades. ENSO is the most powerful and predictable natural variation of Earth's climate on a year-to-year basis, affecting physical, biological, chemical, and geological processes in the oceans, atmosphere, and on land. It gives a conceptual framework within which to coherently understand seemingly unrelated phenomena in widely different parts of the globe as a significant component of Earth's intricate climate puzzle.

CONCLUSION

Tropical vegetation was found to be in a changing rise state, with an overall increasing range of 4.46 percent, with the most substantial and dramatic greening trends occurring in the Indian Peninsula, the Gulf of Guinea coast, and the Amazon River estuary. ENSO has the potential to significantly improve or degrade vegetation in at least 10% of tropical areas, particularly in East Africa, Southern Africa, and Indonesia. Due to restricted water resources, shrubs are the most widely afflicted areas (32.08 percent). The greening effect of ENSO is mostly achieved by increased precipitation, while the deterioration effect is more strongly linked to temperature increases.

The VERI varied throughout time, indicating that the ENSO's influence on vegetation shifted after 2000, implying that the beneficial effect of cold events for tropical vegetation was diminished while the inhibitory effect was amplified. These findings may aid in a better understanding and response to ENSO's effects on tropical vegetation in the context of global change.

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