

El Niño and La Niña: Tracing the Dance of Ocean and Atmosphere

National Academy of Sciences, March 2000 – http://funnel.sfsu.edu/courses/gmo405/F11/articles/EINinoLaNina_NAS.pdf

Name _____ Date _____ Period _____

Read the article and answer the following questions on a separate sheet of paper.

1. What phenomenon does the term "El Niño-Southern Oscillation" refer to today? What is La Niña? According to the article, how frequently do they occur? [Note: this value is only an average—the phenomena don't actually occur with a single frequency but rather more irregularly.]

2. What new sources of information have helped scientists better to understand these phenomena? What other development has led to better understanding and some ability to forecast these phenomena?

Of Weather and Climate

3. In the tropical Pacific Ocean, how do the westward-blowing trade winds affect (a) ocean circulation in the tropics; (b) ocean surface temperatures in the tropics; and (c) precipitation patterns in the tropics?

[Note that this article oversimplifies. Other than the effects of upwelling on surface temperatures in the eastern equatorial Pacific, why else are surface temperatures warmer in the western side of the equatorial Pacific Ocean than in the eastern side?]

Starting with the Atmosphere

4. What pattern of air pressures (the Southern Oscillation) in the tropical Pacific did Gilbert Walker describe in a paper published in 1928?

5. How did this pattern relate to Indian monsoons? Where else did Walker find connections? Did scientists at the time understand why these connections existed?

6. What confluence of events (and when did it occur) spurred new research into ENSO events?

A Meteorologist Looks at the Sea

7. In the 1960s, Jacob Bjerknes, a meteorologist working at the University of California at Los Angeles, analyzed newly available data and identified an atmospheric circulation in the tropical Pacific that he called the Walker circulation. What was the structure of this circulation, and how is it connected to equatorial sea-surface temperatures under "normal" (non-ENSO and non-La Niña) conditions?

8. How does the Walker circulation change during ENSO events?

9. Starting in the 1970s, what new tool began to contribute to understanding of ENSO events?

Oceanography's Perspective

10. Why did systematic measurements of ocean conditions lag behind such observation of the atmosphere? When did more extensive monitoring of the oceans begin?

11. [In the low and middle latitudes, heating of the sea surface by the sun, together with vertical mixing, creates a layer of water (the surface layer) that is warmer than the water below. A transitional layer separating the surface layer from the deeper, cold water is called the *thermocline*.]

In 1975, what did Klaus Wyrtki discover that the trade winds do to the surface layer in the tropical Pacific Ocean? As part of this effect, what are the consequences in the western equatorial Pacific for the height of the sea surface and the depth at which the top of the thermocline is found? What are the consequences in the eastern Pacific for the depth at which the top of the thermocline is found and for biological productivity?

12. When the trade winds weaken or fail, what happens to (a) the surface layer (and hence the depth of the top of the thermocline); (b) sea-surface surface temperatures; and (c) biological productivity in the eastern equatorial Pacific? Are the responses immediate?

13. When were computer modelers able to reproduce the main oceanic aspects of observed ENSO events (as long as they knew what the winds were)?

Wakeup Call

14. Why did scientists miss the early signs of the development of the severe ENSO event of 1982-83, and hence failed to predict it?

Need for More Comprehensive Data

15. What was the TOGA program, what spurred its creation, and what was its objective? What is the Tropical Ocean-Atmosphere (TAO) array?

16. How has this program contributed to our understanding of the dynamics of tropical Pacific climate?

The Power of an Interdisciplinary Approach

17. What is the difference between statistical models and dynamical models?

18. What two technologies were key to predicting the severe 1997/98 ENSO event?