El Niño/Southern Oscillation Events and Their Associated Midlatitude Teleconnections 1531–1841

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Abstract

This paper reports on an investigation into the chronology of El Niño/Southern Oscillation (ENSO) events during the period from the arrival of Europeans in Peru in 1531 until the year 1841 when conventional barometric data became available in the tropical regions. A number of probable ENSO events can be dated from anecdotal reports of significant rainfall in the coastal desert of northern Peru. In many of the years with anomalous Peruvian rainfall it is also possible to use various types of proxy data to identify aspects of the global teleconnection patterns usually associated with tropical ENSO events.

1. Introduction

Studies of the Southern Oscillation, the El Niño phenomenon and their associated effects throughout the global atmosphere have proliferated over the last two decades (see Cane, 1983, and Rasmusson and Wallace, 1983, for recent reviews). Observational investigations have largely concentrated on fairly recent periods with relatively abundant data. Naturally enough, curiosity has also developed about the chronology of El Niño/Southern Oscillation (ENSO) events in the more-distant past. A number of recent papers have addressed this issue or have proposed methods to do so. Quinn et al. (1978) employed various types of data from the tropical Pacific region (barometric pressure, rainfall and sea-surface-temperature measurements) to construct a chronology of ENSO events back to 1841. None of the records of conventional data used by Quinn et al. exists before 1841. However, Quinn et al. did date some probable ENSO years back to 1726 from anecdotal reports of significant rainfall in the normally dry coastal areas of northern Peru.

Another group of investigations has dealt with ways of using biological and geological objects, such as corals, glacial ice, and ocean-bottom cores to establish the chronology of ENSO events. Thompson et al. (1984) observed that cores taken from the Quelccaya ice cap in Peru showed that the annual snow accumulation is suppressed during major ENSO events. They actually correlated their ice-core data with the known occurrences of ENSO only over the last two decades, but they note that their approach might be employed to help establish the dates of major ENSO events as early as 1500 years before the present.

Schrader and Pisias (1985) have examined the microfloral composition of cores of varved sediments from the Guaymas Basin. They determined that the presence of certain microfloral assemblages in their cores could be related to the occurrence of major ENSO events. This kind of analysis would appear to have the potential for providing information concerning the ENSO phenomenon over some thousands of years.

Shen and Boyle (1984) have shown that the chemical composition of the annual growth rings of coral skeletons from the Galapagos Islands is anomalous in major ENSO years. In particular, the cadmium concentration in the coral shells is observed to be reduced in ENSO years. These anomalies presumably reflect changes in the ocean chemistry caused by the suppression of equatorial upwelling during ENSO events. Shen and Boyle have applied their analysis only for the last two decades, but their technique does have the potential for unveiling the history of equatorial upwelling in the more distant past.

A somewhat different approach to inferring the chronology of ENSO events has been discussed recently by Lough and Fritts (1985). They correlated time series of measured ring widths from a large number of trees in the extratropical regions of both hemispheres with an observed index of the Southern Oscillation based on tropical barometric measurements during the period 1853–1961. They then applied these results to earlier tree-ring data to infer the Southern Oscillation index in each year from 1600. By itself such a method cannot produce a perfectly reliable chronology of low-index years (corresponding to ENSO events) since the midlatitude circulation patterns are not observed to take precisely the same form during each individual tropical ENSO event (e.g., Dickson and Livezey, 1984; Emery and Hamilton, 1985; Yarnal and Diaz, 1986).

The present paper extends the work of Quinn et al. (1978) by presenting a more-complete survey of the historical sources concerned with Peruvian rainfall. The resulting chronology of ENSO events is then compared with various types of proxy data to determine if there are hints of the usual anomalous global-scale weather patterns during the individual tropical events. The present study provides benchmarks for comparison with the results that will be obtained with the various geochemical techniques as they are applied to the more-distant past.

2. Peruvian rainfall

Perhaps the most dramatic local meteorological manifestation of ENSO events are the February–April rain showers in

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