Climatology

Tropical Pacific variations

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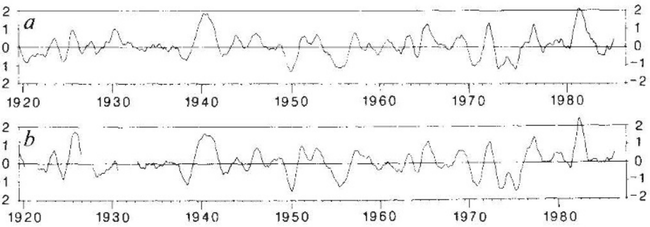
THE tropical Pacific has been the focus of many recent studies of year-to-year climate variability associated with the El Niño–Southern Oscillation, or ENSO, phenomenon[1-3]. The more difficult but equally important task of documenting lower-frequency variability has received far less attention. The potential for man-made climate change adds urgency to the task of establishing the characteristics of the natural climate noise background from which the man-made signals will emerge. On page 216 of this issue[4], Kim Whysall and colleagues describe the results of a study of low-frequency variability in the tropical Pacific, based on a careful processing and analysis of millions of merchant-ship wind observations since 1920.

Until recently, most of the information on decade-scale climate variability was derived from land-based observations. Surface marine data acquired during this century have now been assembled into massive datasets suitable for climate analyses, such as the UK Meteorological Office Main Marine Databank used by Whysall and colleagues in their study. Unfortunately, changing instrumentation, observational procedures and techniques, together with major changes in the distribution of the observations, result in a far from homogeneous dataset. So questions concerning the reliability of observed trends must be addressed in evaluating analysis results, and this has hindered studies of low-frequency variability. Recent studies of climate trends[5,6], however, have made extensive use of the sea-surface temperature observations.

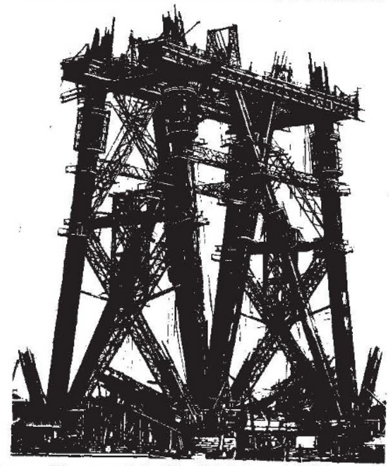
There has been a gradual shift in surface wind measurements, from visual estimates based on the state of the sea (the Beaufort scale) to data obtained from anemometers, now mounted as much as 30–40 m above the ocean surface (V. Cardone, personal communication).



Time series of *a*, surface pressure anomalies for Darwin (12.4°N, 130.9°E); and *b*, the pressure difference between Darwin and Tahiti (17.5°S, 149.6°W). Departures, shown on the ordinate, are normalized by dividing the individual anomaly by the standard deviation of all anomalies for the individual calendar month. The pressure difference is again normalized in the same manner. Values are then smoothed with a 12-month running mean.

100 years ago

BRIDGING THE FIRTH OF FORTH



From *Nature* **36,** 79; 26 May 1887.

Aware of the uncertainty this causes, Whysall and colleagues have organized and summarized the historical wind data in ways that provide a clear documentation of the multi-year variability in the trade-wind systems, as revealed by the marine dataset. The analyses reveal a coherent pattern of variability on the scale of the Pacific basin.

The authors make a strong argument that the low-frequency variations revealed by the data are real. But to establish firmly the credibility of these or any other results derived from the imperfect climate data, it is important to examine their consistency with independent information: surface pressure, sea level and surface temperature data. The authors point out consistent relationships between the analysed wind variations and simultaneous variations in surface temperature associated with ENSO episodes. It is also useful to compare their wind-data time series with two widely used indices of Southern Oscillation variability — the surface pressure at Darwin, Australia, and the pressure difference between Darwin and Tahiti. These time series, shown in the figure, reflect year-to-year pressure fluctuations of opposite sign between the south-east Pacific and the west Pacific–Indian Ocean monsoon region, which are associated with the Southern Oscillation. The pressure variations at these points are an index of the changing equatorial pressure gradient associated with the changes in strength of the equatorial Pacific easterlies shown in Fig. 1 of Whysall *et al.*. Comparison of the pressure indices in the above figure with their Fig. 1, and with the trade-wind time series shown in their Fig. 2, reveals some interesting points.

First, all the series reflect the collapse of the tropical Pacific easterlies around 1940. Southern-Oscillation indices, however, show a complex ENSO event during 1939-41, and a separate weaker event in 1944, whereas the trade-wind series (their Fig. 2) show a more sustained, off-equatorial diminution of the easterlies that seems to last for five years or more.

Second, contrary to the North Pacific trade-wind series (their Fig. 2*a*), the Southern-Oscillation pressure indices do not imply a pronounced increase in the equatorial easterlies during the late 1940s, as compared with their strength during the years preceding the climatic event of the early 1940s. Neither do the indices show the marked trend towards increasing easterlies that is particularly pronounced in the South Pacific trade-wind data between 1950–80, as illustrated by their Figs 2 and 4. This apparent contradiction could result from the fact that the two pressure-index stations are west of the primary area of diminished trade winds, in a region where equatorial wind data are sparse, and trends in the off-equatorial winds appear to have been more meridional (north–south) than zonal. But consistency cannot be ensured without additional analyses.

The difference and similarities between these time series illustrate the difficulty of establishing the pattern of decade-scale climate variability from the limited climate datasets now available and highlights the need to integrate as much information as possible in these analyses. The connection between year-to-year ENSO fluctuations and lower frequency variability is obscure. ENSO evolves primarily from coupled ocean–atmos-phere interactions in the tropical Pacific, but extra-tropical ocean variability, as well as other global forcing mechanisms, are likely to be fundamental in lower-frequency variability, as noted by the authors. The paper by Whysall and colleagues provides benchmark analyses which should stimulate further analyses and exploitation of the rich source of climate information represented by the surface marine dataset. ☐

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