and upwelling and sea surface temperatures rapidly returned to normal. The rapid decline from May 1998 can be seen in the time sections of sea surface temperature (Figure II.14). Also, temperatures recorded by some TAO buoys cooled by about 8°C over a 30-day period in the cold tongue of the central equatorial Pacific Ocean.

By July 1998 colder than normal water along the equator covered the central equatorial Pacific Ocean and further eastward (Figure II.17). Sea surface temperature anomalies off the tropical coast of South America continued to be above normal but the actual sea surface temperatures were again below the threshold of 28°C necessary to support deep atmospheric convection (as seen previously in Figure II.14). Over the Indian Ocean, very warm waters had developed around Indonesia and South East Asia but cooler than normal waters had appeared off the equatorial East African coast, the latter indicating a return of the seasonal south winds and upwelling. The sea surface temperature gradients across the western equatorial Pacific and the Indian Oceans had returned to their normal direction and were stronger than normal, indicating the potential for strengthening of the Walker Circulation and the circulation over the Indian Ocean that supports the Asian summer monsoon.

By June or July 1998 the ongoing influence of the 1997–98 El Niño on the atmosphere was effectively exhausted. In particular, colder than normal waters had appeared in the central equatorial Pacific Ocean and were expanding eastward. Across the central and eastern equatorial Pacific Ocean sea surface temperatures were below the threshold necessary to support deep atmospheric convection. Thus, the linkage that allowed the anomalous energy source of the ocean to force a response in the atmospheric circulation was effectively severed.

An historical comparison

During the 1997–98 El Niño event there were significant changes from normal to the ocean and atmospheric circulations across the tropical Pacific Ocean. In using information about the 1997–98 event for future planning, particularly to mitigate the negative impacts of future events and to adopt sustainable development strategies, it is important to know how the characteristics of the event fit into an historical context.

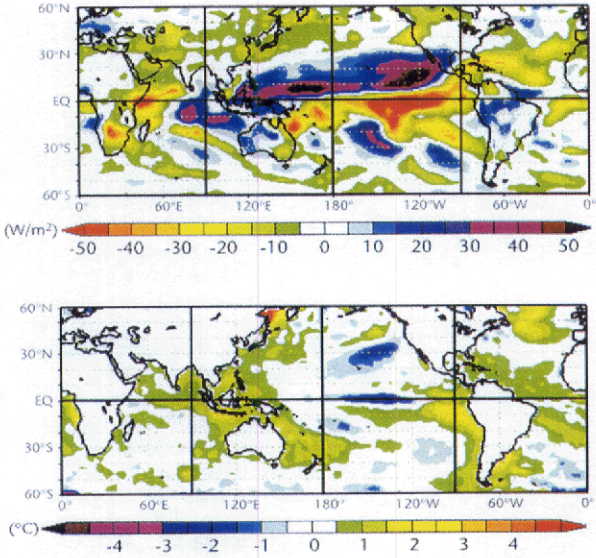

Figure II.17
Anomalies of sea surface temperature for July 1998. Colder than normal water has appeared across the central equatorial Pacific Ocean but warm anomalies persist near the coast of South America.
(NOAA/CDC, USA)

The SOI, sea surface temperatures of the central and eastern equatorial Pacific Ocean, and departures in magnitude of outgoing longwave radiation all respond to an El Niño event. However, each of these indicators is a measure of different characteristics of the climate system of the region. The SOI has proven to be a useful objective characteristic to make quantitative comparisons between events of different years. The value of the SOI as an indicator for comparison is enhanced because of the availability of surface pressure records at Darwin and Tahiti and an historical record with few breaks can be constructed back to the late nineteenth century.

A disadvantage of using SOI for historical comparison is that it is representative of only one characteristic of the El Niño/Southern Oscillation (ENSO), namely the tropical cross-Pacific surface atmospheric temperature gradient. Other characteristics of ENSO are generally not completely in phase with the SOI and it is still not clear what are the most important factors for characterizing socio-economic impacts. Although coupled in a general sense, sea surface temperature fields, wind fields and the location of tropical deep atmospheric convection are not locked to the surface pressure fields. The absence of a universally agreed quantitative definition for El Niño also increases the

Figure II.19
A comparison of the Multivariate ENSO Index for the seven strongest El Niño events since 1950 showing the magnitude, duration and life cycle characteristics of each event.
(Wolter and Timlin, 1998)