(negative values of standard deviation in Figure I.6) indicating more deep convection in the central Pacific Ocean when the SOI is negative and the Walker Circulation is weaker.

Ocean-atmosphere coupling — ENSO

There is a synergy in the behaviour of the ocean and atmosphere across the equatorial Pacific Ocean, particularly the strong coherence between El Niño events and negative phases of the SOI. This has led to usage of the term El Niño/Southern Oscillation, or ENSO. El Niño is the ocean component and the Southern Oscillation is the atmospheric component. The warm phase of ENSO coincides with El Niño (or ocean warming) and negative SOI; the cold phase of ENSO coincides with La Niña (or ocean cooling) and positive SOI.

The prevailing characteristics of the ocean and atmospheric circulations across the equatorial Pacific Ocean arise because of the positive feedbacks from wind stress of the Trade Winds acting on the ocean surface and from the transfer of heat and moisture (latent energy) to the atmosphere. The coupling of the ocean and atmosphere through positive feedbacks assist in maintaining the Walker Circulation of the atmosphere and surface layer characteristics across the equatorial Pacific Ocean as follows:

- The wind stress of the Trade Winds acts to maintain the equatorial cross-Pacific sea surface temperature gradient, particularly through upwelling of cold water in the east.
- In their passage across the Pacific Ocean the Trade Winds accumulate heat and moisture to provide the energy source of convection over the western equatorial Pacific Ocean, Asia and Australasia.
- High surface atmospheric pressure is favoured over the colder water of the eastern Pacific Ocean.
- The cross-Pacific surface atmospheric pressure gradient maintains the strength of the Trade Winds.

During an El Niño event, however, warm surface water spreads eastward across the equatorial Pacific Ocean towards South America. Also, the thermocline deepens in the east and upwelling of cold water is reduced. The combined effect of the influx of warm water and the reduction in upwelling is to produce warmer than normal water in the surface layer of the central and eastern equatorial Pacific Ocean. The reduced equatorial cross-Pacific sea surface temperature gradient weakens the overlying surface atmospheric pressure gradient and the strength of the Trade Winds. The anomalous warm water over the central and eastern equatorial Pacific Ocean is also a source of heat and moisture to the atmosphere and, in the absence of the usual Trade Winds, supports local deep atmospheric convection further east than normal.

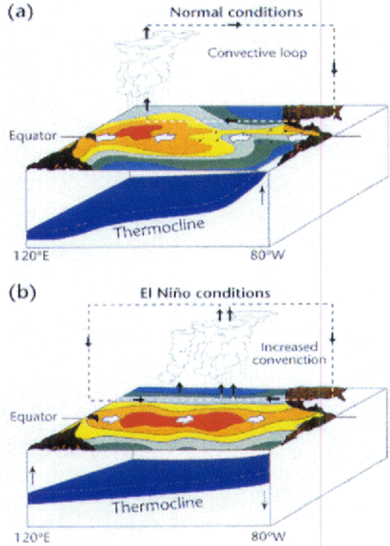

Figure I.7
Stylized graphics of the ocean surface layer and atmosphere across the equatorial Pacific Ocean during a) normal conditions; and b) an El Niño event. During normal conditions there is a well-developed Walker Circulation (the "Convective Loop") in the atmosphere and the thermocline in the ocean surface layer slopes upward toward the east. During an El Niño event the focus of deep atmospheric convection has shifted eastwards, the Walker Circulation has lost its coherent structure, and the slope of the thermocline in the ocean has flattened.
(NOAA/PMEL (TAO Project), USA)

The ocean and atmospheric characteristics that are generally prevailing and those during an El Niño event are shown schematically in Figure I.7. The eastward spread of warm water and the deepening of the thermocline in the east are the significant features of the ocean surface layers during an El Niño event. In the atmosphere the feature of note is the occurrence of deep atmospheric convection further to the east than normal. The contraction of the Walker Circulation is linked to the weakening of the Trade Winds. West of the deep atmospheric convection a reverse circulation is established with surface westerly winds assisting in the convergence of heat and moisture over the warmer than normal water of the central equatorial Pacific Ocean.

El Niño events tend to be linked to the annual cycle. Typically, the onset of