Figure II.11
Monthly mean anomaly of outgoing longwave radiation for June 1997. Enhanced outgoing longwave radiation (blue to mauve shading) indicating reduced tropical deep atmospheric convection extends from southern India through the islands of Indonesia and the Philippines to east of Papua New Guinea. Reduced outgoing longwave radiation (orange to red shading) identifies increased tropical deep atmospheric convection over the central and eastern equatorial Pacific Ocean. Increased deep atmospheric convection can also be seen over the western equatorial Indian Ocean.
(NOAA/CDC, USA)

The anomaly of vector wind and anomaly of sea surface temperature during October 1997 are shown in the maps in Figure II.13. By that time the area of warmer than normal water over the eastern equatorial Pacific Ocean had expanded further and anomalous westerly winds directed towards the warmer water had appeared over the western equatorial Pacific Ocean. The outgoing longwave radiation pattern of June 1997 (see Figure II.11) persisted through the second half of 1997, indicating reduced convection over the region of Indonesia and Papua New Guinea, and enhanced convection over the warmer waters of the central and eastern equatorial Pacific Ocean.

The breakdown of the Walker Circulation of the Pacific Ocean can be inferred by the enhanced convection over the central and eastern equatorial Pacific Ocean, the reduced convection (subsidence) over Indonesia and westerly wind anomalies over the western equatorial Pacific Ocean. Similarly, the establishment of a reverse circulation over the Indian Ocean can be inferred from the subsidence over Indonesia, convection over the western Indian Ocean and strengthened easterly winds along the equator.

As the atmospheric circulation changed, the easterly winds that became established across the Indian Ocean induced a wind-driven current in the surface layers of the Indian Ocean. Offshore upwelling of cold water was indicated west of Sumatra, although thick smoke from fires may have biased the satellite instrument measurements towards colder values. The positive anomaly of sea surface temperature in the coastal waters off equatorial East Africa was possibly linked to the changed circulation and a failure of seasonal upwelling of cold water off the Somali coast.

The development of a reverse zonal atmospheric circulation across the Indian Ocean, apparently linked to the El Niño and the reversed zonal atmospheric circulation over the equatorial Western Pacific Ocean, has significance for the weather and climate of the basin and surrounding countries. However, only few upper-air, surface and ocean subsurface data are available from across the Indian Ocean and the nature of linkages between El Niño and regional climate anomalies can only be inferred. Better observations are essential to support research if understanding of the processes that will lead to better climate predictions for surrounding countries is to be achieved.

The eastward shift of deep atmospheric convection across the tropical Pacific Ocean can be related to eastward movement of warm water and the raising of the sea surface temperature during the evolution of the El Niño event. Under usually observed tropical conditions, deep atmospheric convection does not occur except in regions of surface wind convergence and where sea surface temperatures exceed a threshold of about 28°C to 29°C.* This threshold of sea surface temperature is not usually exceeded over the central and eastern equatorial Pacific Oceans.

*Over the tropical oceans, where there is an abundant source of latent energy, converging air that has a temperature above about 28°C to 29°C and is lifted to condensation will generally rise buoyantly to the high atmosphere in deep convective clouds because of the release of latent energy. Below about 28°C to 29°C the surface air will not achieve sufficient buoyancy (except in regions of lowered surface pressure) and deep convective clouds will not develop. Over the tropical Pacific Ocean deep atmospheric convection is usually observed over the warm waters of the west and along the intertropical convergence zone.

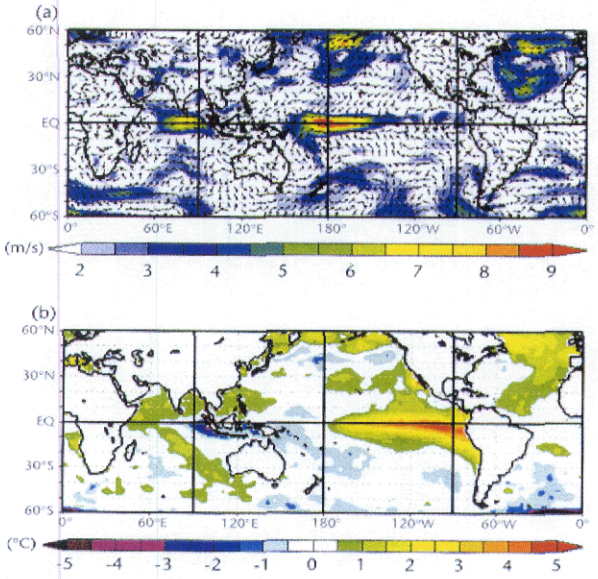

Figure II.13
Anomalies of a) surface wind; and b) sea surface temperature for October 1997 during the developing El Niño event. The westerly wind anomalies of the western equatorial Pacific are associated with a breakdown of the Walker Circulation. The anomalous easterly winds across the equatorial Indian Ocean are apparently associated with a reverse zonal atmospheric circulation.
(NOAA/CDC from NCEP/NCAR reanalysis, USA)