during March 1997 and was associated with a long-lived intense tropical cyclone, *Justin*, in the Coral Sea south of Papua New Guinea. Not only did the westerly winds persist for most of the month but also the longitudinal extent was approximately 40 degrees. The mean surface wind field over the tropical Indian and western Pacific Oceans for March 1997 is in Figure II.6 and shows the persisting westerly winds northeast of Papua New Guinea.

The spatial extent of higher than normal sea level over the warm pool in the western Pacific Ocean and its subsequent movement eastward can be tracked by analysis of sea level anomalies measured by the TOPEX/Poseidon altimeter in March, April and May 1997 (Figure II.7). The TOPEX/Poseidon image of March is coincident with the December 1996 westerly wind burst that is believed to have generated an eastward propagating Kelvin wave on the thermocline. By the end of April the eastward travelling equatorial Kelvin wave, identified by the equatorial band of above normal sea level, had arrived at the coast of South America. Deflection of the Kelvin waves north and south along the coast occurred during May 1997 as the thermocline deepened, forced by the propagating equatorial Kelvin wave.

The impact of the Kelvin wave on the thermocline and subsurface temperatures can be seen in the pair of equatorial-depth cross-sections of temperature anomaly in Figure II.8. Figure II.8a (for March 1997) shows the Kelvin wave generated by the limited west-wind burst of December 1996 arriving at the coast of South America, causing deepening of the thermocline and a warm anomaly of temperature at depth. There is also further deepening of the thermocline in the central Pacific Ocean (more than 4°C at 200 metres) resulting from the sustained westerly winds during March and the eastward propagation of another Kelvin wave. Figure II.8b (for May 1997)

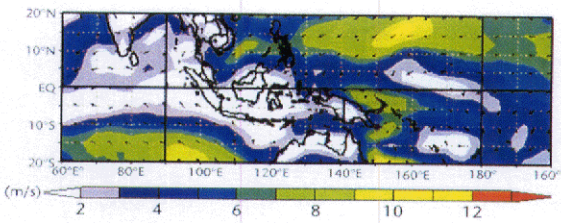

Figure II.6
Monthly vector mean winds at the surface over the Indo-Pacific region for March 1997. The northwesterly winds over the western equatorial Pacific Ocean northeast of Papua New Guinea associated with tropical cyclone Justin may have been an important factor to initiate the 1997–98 El Niño event.
(NOAA/CDC, USA)

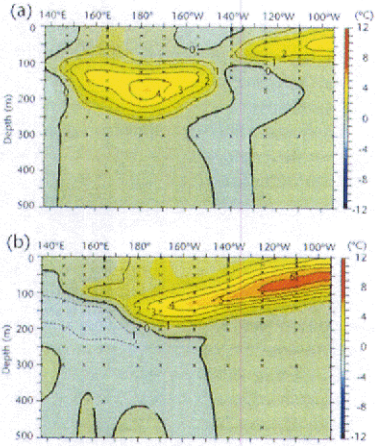

Figure II.8
Anomalies of subsurface temperature across the equatorial Pacific Ocean during a) March 1997; and b) May 1997. The deepening thermocline (as indicated by the warm anomalies of temperature at depth) shows the progress of the Kelvin wave that propagated to the east.
(NOAA/PMEL (TAO Project), USA)

shows that the Kelvin wave generated by the major westerly wind burst of March 1997 arrived at the coast of South America during May 1997. There was significant deepening of the thermocline and warming of the subsurface temperatures across the eastern Pacific Ocean in May 1997.

The monthly mean anomaly of sea surface temperature for March 1997 (Figure II.9a) does not show the progress of the Kelvin wave that was generated by the limited burst in December 1996. The first significant warming in the sea surface is seen at the end of April 1997, when the Kelvin wave reaches the coast of South America approximately two months after being initiated by the westerly wind in early March 1997. The anomalous warming in the

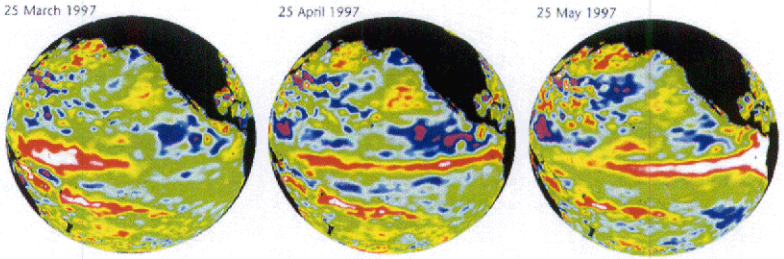

Figure II.7
Sea level anomaly as measured by the TOPEX/Poseidon altimeter during the onset of the 1997–98 El Niño event. The eastward progress of the Kelvin wave across the equatorial Pacific Ocean is identified by the moving pattern of elevated sea level. White is more than 12 cm above normal, and mauve areas are more than 12 cm below normal.
(NASA/JPL, USA)