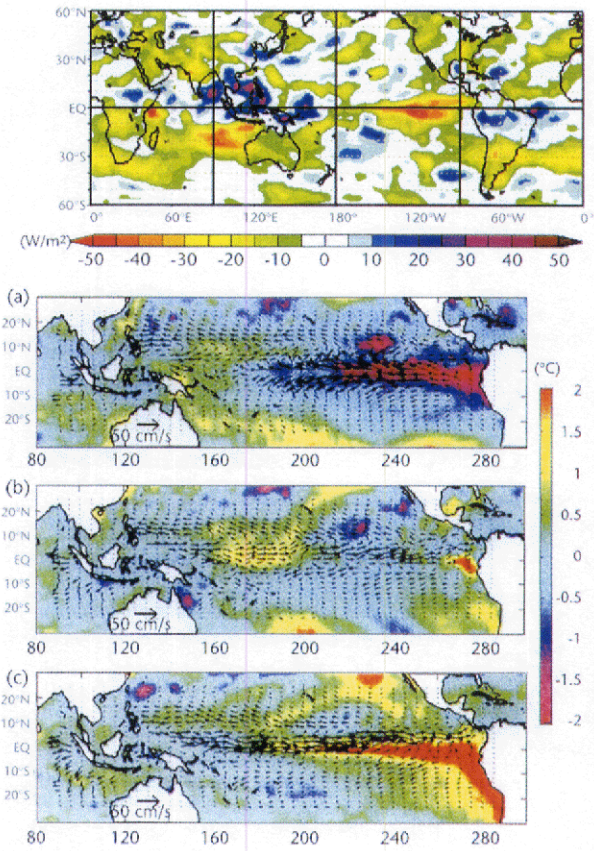
precipitation, over the western equatorial Indian Ocean adjacent to East Africa.

Surface ocean currents over the Pacific Ocean have been estimated using the NSCAT winds (the NSCAT scatterometer was mounted on the ADEOS satellite, which was functioning during the early development of the El Niño event but failed in June 1997) and the sea level topography of the TOPEX/Poseidon satellite. The calculated surface currents and the anomaly of sea surface temperature for December 1996, April 1997 and June 1997 are shown in Figure II.12. The maps provide a view of the impact of the evolving El Niño event on surface ocean currents, particularly of the reversal of the wind-driven westward directed surface current, and the transport of surface water across the Pacific Ocean.

During December 1996, (Figure II.12a) there was a strong wind-driven westward flowing current over the central and eastern equatorial Pacific Ocean. This was consistent with the continuing Trade Winds maintaining an equatorial wind-driven current and the development of a warm pool in the surface layers of the western Pacific Ocean. Northward of the equatorial wind-driven current is the North Equatorial Counter Current that flows eastward.

By April 1997 (Figure II.12b) the equatorial wind-driven surface current had reversed and there was eastward flow across the full width of the equatorial Pacific Basin. Water was being transported from the warm pool in the west towards the east. The eastward flowing equatorial surface current strengthened between April and June 1997 (Figure II.12c) and the advection of warmer water from the west and deepening of the thermocline contributed to strong warming of the eastern equatorial Pacific Ocean. The establishment of a westward flowing wind-driven surface current in the equatorial Indian Ocean west of Indonesia (Figures II.12b and II.12c) was also important in the context of upwelling and subsequent cooling of the sea surface that appeared in the region.

The new satellite instruments and TAO array of buoys that were available during the evolution of the 1997–98 El Niño event have given insights into ocean processes that were previously not possible. Analyses based on these data also allowed testing of other hypotheses that had been developed from careful examination of previous events but for which there were limited data to draw solid conclusions.



The mature phase

The El Niño event continued to evolve during the second half of 1997 and reached its mature phase December 1997 through May 1998. At the time of the mature phase sea levels over the western equatorial Pacific Ocean were at a minimum. For example, the sea level at Pohnpei, Federated States of Micronesia was 24.6 cm below normal during December 1997 while, at the same time, over the eastern equatorial Pacific Ocean sea level was at a maximum and reached 39.3 cm above normal at Santa Cruz, Ecuador.

During the later part of the evolution of the El Niño event many impacts on the tropical atmospheric circulation could be readily identified. By June 1997 the Southern Oscillation Index (SOI) was strongly negative, indicating a reduced cross-Pacific Ocean pressure gradient consistent with the changed sea surface temperature gradient.

Figure II.12
Surface ocean currents (arrows) calculated using TOPEX/Poseidon topography and NSCAT winds from the ADEOS satellite, and with mean anomaly of sea surface temperature (colour) for a) December 1996; b) April 1997; and c) June 1997. Over equatorial latitudes the westward directed wind-driven current prevailing in December 1996 was replaced by an eastward directed current by April 1997 that gained in strength to June 1997. (Lagerloef *et al.*, 1999)