mixing brings heat to the surface to offset longwave radiation loss. The sea surface temperature responds more slowly to seasonally varying solar radiation than does the land because of the very high thermal capacity of water and the ability to transfer heat through the mixed layer.

Neighbouring land and water bodies heat and cool at different rates as a consequence of the differing processes for absorption of solar radiation and emission of longwave radiation. Land will become relatively hotter in summer and cooler in winter causing temperature and pressure gradients in the overlying atmosphere across the boundaries. Air will blow inland from the relatively cooler ocean as the land heats in summer and will blow toward the sea as the land cools in winter. The relative distribution of land and sea has a significant influence on the global climate and its seasonal cycle because of the different responses of land and ocean surfaces to varying solar radiation.

The annual average sea level pressure and wind field distribution over the oceans is shown in Figure A.3. But the patterns do not reflect the seasonal variability within the annual cycle. Notwithstanding, there are clear signals of dominant processes in the Asia-Pacific region. In the Pacific Ocean there is mean high pressure in the subtropics of both hemispheres and relatively strong easterly flow (the Trade Winds) in equatorial latitudes. Across the central and eastern Pacific Ocean the mean latitude of convergence of air from each hemisphere (the intertropical convergence zone — ITCZ*) is at about 10°N. In the Indian Ocean there are average high pressure and anticyclonic winds in the Southern Hemisphere but no corresponding region of mean high pressure in the Northern Hemisphere. Easterly wind in the equatorial latitudes throughout the year is not a persisting feature of the Indian Ocean.

The ocean surface layer

The oceans also have characteristic processes that are important for climate. Of particular relevance are processes that modify the sea surface temperature and the rate of transfer of heat between the ocean and the atmosphere. Many of these processes arise out of the interaction between the atmosphere and oceans at the interface.

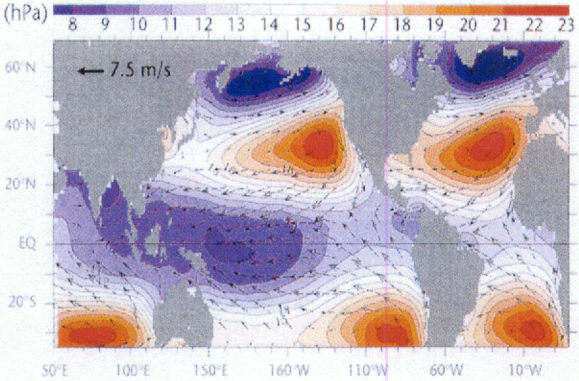

Figure A.3
Annual average sea level pressure (1 000 hPa) wind field.
(Adapted from Harrison and Larkin, 1996)

The upper layer of the ocean is a region of near-uniform temperature with depth because wind blowing over the water surface generates waves and turbulence. The mixing action distributes heat through the layer. The depth of this 'mixed layer' is governed by accumulation of heat and by the speed and resulting turbulence of the prevailing wind. It is characteristically of the order of 100 to 200 metres in the tropics.

The thermocline is the narrow layer that separates the relatively warm mixed surface layer from the colder underlying ocean. The thermocline is characterized by a decrease of temperature with depth. Because of the strong temperature gradient and stability of the thermocline, the characteristics of the colder and denser deep water can be quite different from the warmer and less dense mixed surface layer. The thermocline is important for ocean dynamics because its depth largely determines the properties of the long ocean waves (internal waves**) that can propagate at the density boundary.

The ocean surface layer characteristics can be seen in Figure A.4, a mean longitude-depth section across the equatorial Pacific Ocean for June. The thermocline is clearly identified as the layer of closely packed isotherms or strong temperature gradient that rises from the west to the east.

Wind blowing over the ocean surface generates wind-driven currents. The anticyclonic mid-latitude gyres of the North and South Pacific Oceans, the North and South Atlantic Oceans and the Indian Ocean reflect the regions of prevailing atmospheric high pressure and their anticyclonic wind circulation (see Figure A.3). The Trade Winds blowing across the Pacific Ocean cause a generally westward directed equatorial wind-driven ocean current and a

* ITCZ: The intertropical convergence zone is the equatorial region where winds flowing outward from the subtropical high pressure regions of each hemisphere meet. The ITCZ moves northward and southward with the annual march of solar heating and is furthest south early in the calendar year.

** Internal waves: In the tropics, Kelvin waves on the equator and Rossby waves away from the equator are two models of internal waves that are important in the dynamics of the ocean processes associated with El Niño.