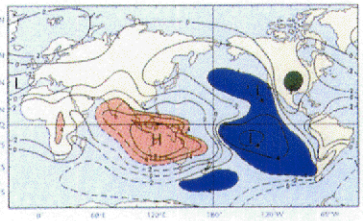

Figure I.5
Correlation between surface atmospheric pressure anomaly at Darwin, Australia and other available data points around the globe.
(Trenberth, 1976)

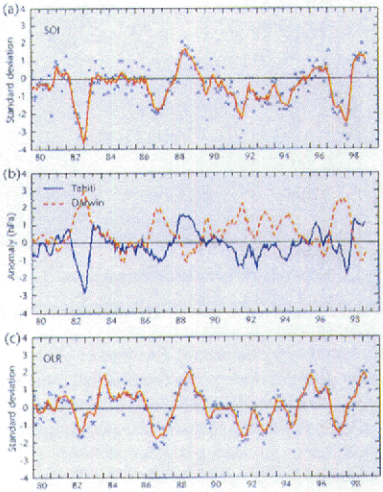

Figure I.6
Monthly and filtered values of a) Southern Oscillation Index (SOI); b) Darwin and Tahiti surface atmospheric pressure anomaly (hPa); and c) standard deviation of outgoing longwave radiation (OLR) over the central equatorial Pacific Ocean (160°E–160°W).
(NOAA/NCEP, USA)

Circulation and the associated "see-saw" of the cross-Pacific surface atmospheric pressure gradient are known as the Southern Oscillation.

More recent studies based on long historical records have quantified the large-scale spatial coherence of seasonal and longer-term surface pressure anomalies. An example is the correlation between the annual mean surface atmospheric pressure anomaly at Darwin, Australia with the annual mean surface atmospheric pressure anomaly at all other available data locations (Figure I.5). The extensive area of positive correlation confirms that surface atmospheric pressure values over the region from south Asia to northern Australia tend to vary in unison. The analysis also identifies a large area over the central and eastern Pacific Ocean where surface atmospheric pressure values rise and fall in unison but out of phase with those of south Asia and northern Australia.

In those years when surface atmospheric pressure is lower than normal over Asia and northern Australia it tends to be higher than normal over the central and eastern Pacific Ocean (a strengthening of the Walker Circulation). Similarly, during years when surface pressure is higher than normal over Asia and northern Australia it is lower than normal over the central and eastern Pacific Ocean (a weakening or reversal of the Walker Circulation). The analysis of Figure I.5 is based on annual mean data and confirms that the Southern Oscillation is associated with interannual variability of the climate system.

For each phase of the Southern Oscillation there is spatial variability in the anomaly pattern of climate indicators, particularly of rainfall, because of the day-to-day weather systems. The summer monsoon of Asia tends to be weaker than normal when the Walker Circulation is weak and, on average, there will be fewer rain events and longer dry spells. Historical climate records demonstrate, however, that even during a weak monsoon some areas will receive average or above average rainfall as a result of a few very active weather disturbances and their generally limited spatial impact.

The Southern Oscillation represents a departure from long-term average of the seasonal circulations of the tropics. By averaging over periods from a month to a season the fluctuations of the day-to-day weather systems and the intraseasonal Madden-Julian Oscillation are smoothed out and the signal represents the climate anomaly.

By convention, the strength of the Southern Oscillation is now measured by the normalized difference in surface atmospheric pressure anomaly between Tahiti and Darwin. This is the Southern Oscillation Index, or SOI*. Negative values of the SOI represent a weak cross-Pacific surface pressure gradient, or even a reversal, while a positive SOI is associated with a strong cross-Pacific pressure gradient and Walker Circulation.

The series of graphs in Figure I.6 underscores the overall coherence of the year-to-year variability of climate parameters across the equatorial Pacific Ocean. The out-of-phase behaviour of surface atmospheric pressure anomaly at Tahiti and Darwin reflects the "see-saw" behaviour and contributes to the variation of the Southern Oscillation Index. The standard deviation of outgoing longwave radiation (OLR) reflects the waxing and waning of tropical convection over the equatorial central Pacific Ocean averaged between 160°E and 160°W. OLR values are below normal

*SOI: There are slight differences in the value of SOI calculated at some climate centres because of the period of years used to calculate the long-term mean and standard deviation. Also the Troup SOI used in some countries is 10*SOI.