appropriate storm transposition limits should be determined (sections 2.5 and 6.1.5).

6.1.2 DAD analysis

A DAD analysis of all the major storm rainfalls should be completed. The standard procedure for making these analyses is described in the *Manual for Depth–Area–Duration Analysis of Storm Precipitation* (WMO-No. 237). Since rain gauge networks may be sparse in tropical regions, maximum use must be made of indirect measurements to supplement observed rainfall amounts. Satellite measurements can provide valuable information on both areal extent of rain areas and the magnitude of the rainfall (Barrett and Martin, 1981; Falansbee, 1973; Negri and others, 1983; Scofield and Oliver, 1980).

Some completed studies provide basic information that can be utilized in other regions. Kaul (1976) has provided information on maximum point precipitation for Indonesia. Extreme point rainfalls in Jamaica have been listed by Vickers (1976). Heavy rainfalls from hurricanes that occurred in the United States have been summarized for the period 1900–1955 by Schoner and Molansky (1956). Schoner (1968) used this and other unpublished studies to examine the climatic regime of hurricanes in coastal regions of eastern United States. Several studies (Dhar and Bhattacharya, 1975; Dhar and Mandal, 1981; Dhar and others, 1980) provide information on extreme rain events in India.

6.1.3 Moisture maximization

Moisture maximization in temperate climates has relied on two assumptions: first, the atmosphere in major storms is saturated and can be represented by the pseudo-adiabatic lapse rate that is determined by the surface dewpoint; second, the maximum moisture available over a region can be determined from the surface dewpoint assuming a saturated atmosphere with a pseudo-adiabatic lapse rate (Riedel and others, 1956, United States Weather Bureau, 1960). These assumptions may not be valid in all tropical regions.

For rain situations, several investigations have found differences between precipitable water estimated from surface dewpoints and that computed from radiosonde observations. Clark and Schloellar (1970) found observed precipitable water to be approximately 1.5 cm less than indicated by dewpoint data for rain days. In the Hawaiian Islands, Schwarz (1963) found the difference to be approximately 2.0 cm for rain days. In Malaysia, Mansell-Moullin (1967) also found that the surface dewpoint overestimated the precipitable water measured by a radiosonde.

Miller (1981) examined the assumption of a saturated atmosphere with a pseudo-adiabatic lapse rate during maximum moisture conditions using the precipitable water records at Merida, Mexico, for the periods January 1946 to December 1947 and October 1956 to December 1972, inclusive. For these periods, the maximum observed precipitable water for each half-month (Ho and Riedel, 1979) was compared with the precipitable water computed from the surface dewpoint at the time of the radiosonde ascent, assuming a saturated atmosphere with a pseudo-adiabatic lapse rate. Figure 6.1 shows this comparison for the layer from the surface to 500 hPa. A correlation coefficient for the relation shown is significant at the 5 per cent level. A similar relation (Figure 6.2) shows a comparison for the layer between the surface and 850 hPa.

Two comparisons are shown in Figure 6.2:

(a) when the maximum precipitable water was observed in the layer from the surface to 850 hPa;
(b) when the maximum precipitable water was observed in the layer from the surface to 500 hPa.

For most observed values in Figure 6.2, the precipitable water based upon the surface dewpoint slightly underestimates that computed from radiosonde observations. Only at the extreme upper end of the relation does the surface dewpoint tend to overestimate observed values.

The comparisons discussed in the preceding two paragraphs are not conclusive, but this limited evidence suggests that the assumption of a saturated atmosphere with a pseudo-adiabatic lapse rate based upon a surface dewpoint may not always be valid in the tropical climates for either storm or maximum moisture situations. In the region where PMP is to be estimated, similar comparisons between surface moisture measurements and precipitable water computed from rawinsonde observations should be made for both storm and maximum moisture conditions before storms are moisture maximized. As part of these investigations, studies should be made to determine the layer of the moist air inflow most critical for the precipitation process in major storms. It may be more realistic to base the moisture adjustment on variations in a particular layer of the atmosphere, rather than the total column.