While modification of non-orographic PMP is used more often than the orographic separation method, it is being described in less detail because descriptions have been published in reports on studies made for the Hawaiian Islands (Schwarz, 1963), the Tennessee River basin (Schwarz, 1965; Zurndorfer and others, 1986), the region between the Continental Divide and the 103rd meridian (Miller and others, 1984*b*) and the Mekong River basin (United States Weather Bureau, 1970). The orographic separation method could not be used in these study areas for the reasons cited below.

In the Hawaiian Islands, isolated peaks or short ridges are relatively ineffective in lifting moist air as required by the orographic model. Observations indicate that streamlines are diverted horizontally as well as being lifted vertically in such terrain.

The Tennessee River basin includes multiple ridges at various angles to moisture inflow directions. Critical inflow directions vary from south-west to south-east. Moisture inflow from any direction in this range can produce heavy rainfalls in some portion of the basin. Another obstacle to the use of the orographic model here is the relatively large variability of storm wind direction with height, so simple wind profiles, as used effectively for the Sierra Nevada slopes in California, are not appropriate.

The orographic model could not be used for the Mekong River basin for several reasons. In regions near the tropics, precipitation variation with topography is different from that in middle latitudes. Atmospheric moisture is near saturation levels, and slopes are important in setting the locations for heavy rains. Also, atmospheric instability is generally greater. Laminar wind flow across mountain barriers, which results in the heaviest rainfalls near the highest elevations, is not supported by observations. Another obstacle is that typhoons, which set the level of PMP for durations up to 3 days, show no simple relation between wind speed and rainfall, so that maximization for wind is difficult.

The orographic portion of the region between the Continental Divide and the 103rd meridian is composed of the eastward facing slopes of the Rocky Mountains. The laminar flow model could not be used in this region for two reasons. First, examination of the vertical wind profile in storms shows the wind veers from easterly in the lowest several hundred metres to south-west to west near the nodal surface. The laminar flow model assumes a nearly constant wind inflow direction. Second, storms in this region have a stronger convective component than is compatible with the laminar flow concept.

Modification of non-orographic PMP for orography as used in a study for the Tennessee River basin above Chattanooga, Tennessee (Schwarz, 1965), is described below. The procedures as used in generalized estimates of PMP for the Tennessee River basin (Zurndorfer and others, 1986), the United States between the Continental Divide and the 103rd meridian (Miller and others, 1984*b*) and for thunderstorm rainfall in the Columbia River basin in north-western United States (United States Weather Bureau, 1966) are described in Chapter 5. The procedures used in the Hawaiian Islands (Schwarz, 1963) and the Mekong River basin (United States Weather Bureau, 1970), are described in Chapter 6, which discusses procedures appropriate for tropical regions.

3.4.2 Tennessee River basin above Chattanooga, Tennessee

A study for the Tennessee River basin covered the 55 426 km^2 area above Chattanooga, Tennessee and a 20 668 km^2 sub-basin in the lower portion just above Chattanooga (Schwarz, 1965). Topography of the larger basin varies from the rugged mountains of the southeastern portion with peaks above 1 500 m to a relatively smooth central valley extending from south-west to north-east. Northwest of the valley lies a series of parallel ridges extending from south-west to north-east with peaks to about 1 000 m. Chief moisture sources are the Gulf of Mexico about 600 km to the south, and the Atlantic Ocean about 500 km to the southeast. A typical orographic rainfall pattern for southwesterly winds is shown in Figure 3.18. The values shown are ratios of orographic to non-orographic precipitation as estimated from a study of several major storms.

The approach described below is the one used for estimating PMP for these two basins. Other approaches could have been used with equally valid results.

3.4.2.1 Topographic effects

A major consideration in assessing topographic effects was whether they would produce a net increase or decrease of average basin PMP as compared with that to be expected if there were no mountains. Increases, of course, would be related to slopes exposed to moisture inflow, while decreases would be associated with sheltered or lee areas. The question is: what would be the net effect on the basin as a whole?