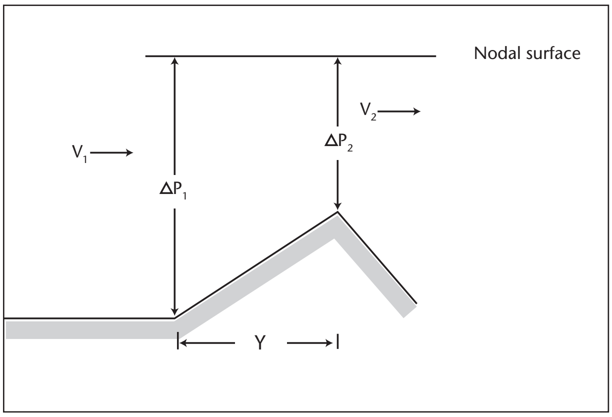

Figure 3.2. Single-layer laminar flow wind model

An approximate relation often substituted for Equation 3.7 is:

$$R \approx \frac{0.0102\overline{V}_1 \Delta P_1 (\overline{w}_1 - \overline{w}_2)}{Y} \tag{3.10}$$

where R is the rainfall rate in mm/h; $\overline{V}_1$ is the mean inflow wind speed in knots; P_1 is the pressure difference between the top and bottom of an inflow layer in hPa; $\overline{w}_1$ and $\overline{w}_2$ are the mean mixing ratios in g/kg, at inflow and outflow, respectively; and Y is the horizontal length of the slope in nautical miles (nmi).

Equation 3.10 is derived from the approximate relation between the mean mixing ratio w and precipitable water W:

$$W \approx 0.0102\overline{w}\Delta P \tag{3.11}$$

where W is in mm; $\overline{w}$ in g/kg; ΔP in hPa; and the coefficient 0.0102 has the dimensions mm/hPa kg/g. Substituting this relation into Equation 3.1 and using larger units of V and Y yields Equation 3.10.

3.2.2.3 Precipitation trajectories

The distribution of precipitation along a windward slope requires construction of snow and raindrop trajectories from the level of their formation to the ground. These trajectories are considered along with streamlines of the airflow over a ridge, as shown in Figure 3.3. The computation of precipitation trajectories is described in the following example of a test of the orographic model against observed storm rainfall.

3.2.3 Test of orographic laminar flow model on an observed storm

The following example of the use of the model was selected from PMP studies for the Sierra Nevada and Cascade Range near the west coast of the United States (United States Weather Bureau, 1961*a*, 1966). Figure 3.4 shows a map of the test area with some of the precipitation stations and generalized terrain. Figure 3.5 shows the smoothed average ground elevation profile used for the computations. The elevations of the precipitation stations are plotted to show how well they fit the profile. The storm period selected for testing was the 6-hour period ending at 8 p.m., 22 December 1955. The 3 p.m. upper-air sounding on 22 December 1955 at Oakland, California, approximately 160 km south-west of the inflow end (south-western side) of the test area, was used for inflow data. Precipitation computations will be shown for the last segment, or the portion of the windward slope near the crest. The following steps are recommended in computing orographic precipitation over the slope.

3.2.3.1 Ground profile

Determine the ground profile of the area under consideration and divide it into segments at each break in the profile. Long segments may be subdivided. In Figure 3.6, since the slope is fairly uniform, the first nine segments, or legs, have been made of equal length 9.7 km (5.2 nmi). The length of the last leg is 6.4 km (3.5 nmi), so the total distance from inflow to outflow is 93.3 km (50.3 nmi).

Convert heights of ground profile (Figure 3.5) to pressures by means of the pressure–height curve constructed from the inflow sounding of pressure, temperature and relative humidity. Plot these

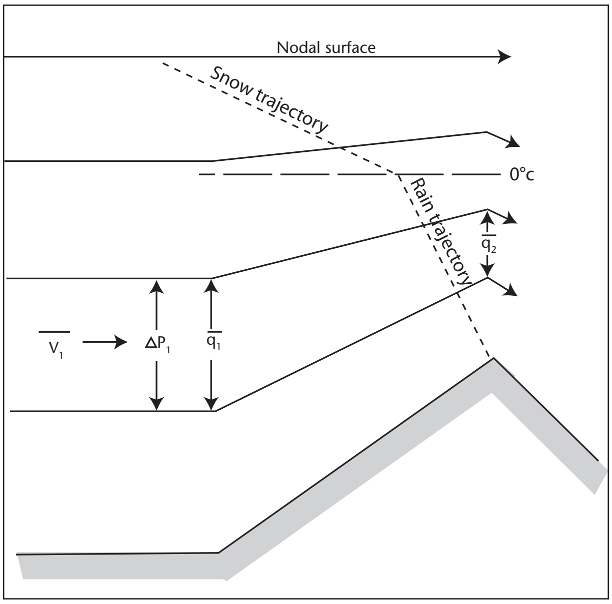

Figure 3.3. Multiple-layer laminar flow wind model