3.2.1.2.2.1.1 GPS Tropospheric Delay Model

A simple model for the tropospheric delay function is

$$\Delta\rho_{\text{TROP}} = \frac{Z\, e^{-(h/H)}}{\sin E} \qquad \text{(meters)} \qquad \text{[Eq. 3-88]}$$

where

h = the user altitude above WGS-84 ellipsoid (meters),

H = the tropospheric scale height (6900 meters),

E = the elevation angle to the satellite (90^0 is vertical),

Z = zenith troposphere delay constant (nominally 2.235 meters).

A more sophisticated model will be used if detailed meteorological conditions are available. It is the Hopfield wet/dry model (references [3, 8, 9]) which calculates the tropospheric delay as a function of elevation angle E (angle from horizontal to the GPS satellite), receiver altitude h (meters), meteorological measuring station altitude h_{station} (meters), atmospheric pressure p (millibars), Kelvin temperature T_K (= T_{celsius} + 273.15), and relative humidity RH (a fraction between 0 and 1) using the formula

$$\Delta\rho_{\text{TROP}} = f_{\text{dry}}(E)\, Z_{\text{dry}} + f_{\text{wet}}(E)\, Z_{\text{wet}} \qquad \text{(meters)} \qquad \text{[Eq. 3-89]}$$

where

$$Z_{\text{dry}} = (2.276 \times 10^{-3})\, p, \qquad \text{(zenith dry component path delay, meters)}$$

[Eq. 3-90]

$$Z_{\text{wet}} = \frac{470\, e_0^{\,1.23}}{T_K^{\,2}} + \frac{10230\, e_0^{\,1.46}}{T_K^{\,3}} \qquad \text{(zenith wet component path delay, meters),}$$

[Eq. 3-91]

$$e_0 = (RH)\,(35.65)\; 10^{[7.617 - (2285\, /\, T_K)]} \qquad \text{(partial vapor pressure)}$$

[Eq. 3-92]

and the mapping functions for non-zenith angles have the simplified form

$$f_{\mathrm{dry}}(E) = f_{\mathrm{wet}}(E) = \frac{\exp\left(-\frac{h - h_{station}}{H}\right)}{\sin E} \qquad \text{[Eq. 3-93]}$$

where

H = the tropospheric scale height (6900 meters).

Note that the mapping functions above are limited to angles $E \geq 5^0$.