A.4.2.4 Tropospheric Model

Because tropospheric refraction is a local phenomenon, all users will compute their own tropospheric delay correction.

The tropospheric delay estimate takes the form:

$$TC_i = -\left(d_{hyd} + d_{wet}\right) \cdot m(E_i) \quad \text{(A- 1)}$$

[d_{hyd}, d_{wet}] are calculated from the receiver's height and estimates of five meteorological parameters: pressure [P (mbar)], temperature [T (K)], water vapor pressure [e (mbar)], temperature lapse rate [β (K/m)] and water vapor "lapse rate" [λ (dimensionless)].

Values of each of the five meteorological parameters, applicable to the receiver latitude [ϕ] and day-of-year [D] (starting with 1 January), are computed from the average and seasonal variation values given in Table A-2. Each parameter value [ξ] is computed as:

$$\xi(\phi, D) = \xi_0(\phi) - \Delta\xi(\phi) \cdot \cos\left(\frac{2\pi(D - D_{\min})}{365.25}\right) \quad \text{(A- 2)}$$

where D_{min}=28 for northern latitudes, D_{min}=211 for southern latitudes, and ξ_0, $\Delta\xi$ are the average and seasonal variation values for the particular parameter at the receiver's latitude. For latitudes $|\phi| \leq 15°$ and $|\phi| \geq 75°$, values for ξ_0 and $\Delta\xi$ are taken directly from Table A-2. For latitudes in the range $15° < |\phi| < 75°$, values for ξ_0 and $\Delta\xi$ at the receiver's latitude are each pre-calculated by linear interpolation between values for the two closest latitudes [ϕ_i, ϕ_{i+1}] in Table A-2:

$$\xi_0(\phi) = \xi_0(\phi_i) + \left[\xi_0(\phi_{i+1}) - \xi_0(\phi_i)\right] \cdot \frac{(\phi - \phi_i)}{(\phi_{i+1} - \phi_i)} \quad \text{(A- 3)}$$

$$\Delta\xi(\phi) = \Delta\xi(\phi_i) + \left[\Delta\xi(\phi_{i+1}) - \Delta\xi(\phi_i)\right] \cdot \frac{(\phi - \phi_i)}{(\phi_{i+1} - \phi_i)} \quad \text{(A- 4)}$$

TABLE A-2 METEOROLOGICAL PARAMETERS FOR TROPOSPHERIC DELAY

	Average				
Latitude (°)	P_0 *(mbar)*	T_0 *(K)*	e_0 *(mbar)*	β_0 *(K/m)*	λ_0
15° or less	1013.25	299.65	26.31	6.30e-3	2.77
30	1017.25	294.15	21.79	6.05e-3	3.15
45	1015.75	283.15	11.66	5.58e-3	2.57
60	1011.75	272.15	6.78	5.39e-3	1.81
75° or greater	1013.00	263.65	4.11	4.53e-3	1.55
	Seasonal Variation				
Latitude (°)	ΔP *(mbar)*	ΔT *(K)*	Δe *(mbar)*	$\Delta\beta$ *(K/m)*	$\Delta\lambda$

15° or less	0.00	0.00	0.00	0.00e-3	0.00
30	-3.75	7.00	8.85	0.25e-3	0.33
45	-2.25	11.00	7.24	0.32e-3	0.46
60	-1.75	15.00	5.36	0.81e-3	0.74
75° or greater	-0.50	14.50	3.39	0.62e-3	0.30

Zero-altitude zenith delay terms [z_{hyd}, z_{wet}] are calculated as:

$$z_{hyd} = \frac{10^{-6} k_1 R_d P}{g_m} \tag{A- 5}$$

$$z_{wet} = \frac{10^{-6} k_2 R_d}{g_m(\lambda+1) - \beta R_d} \cdot \frac{e}{T} \tag{A- 6}$$

where k_1 = 77.604 K/mbar, k_2 = 382000 K^2/mbar, R_d = 287.054 J/kg/K, and g_m = 9.784 m/s^2.

[d_{hyd}, d_{wet}] are calculated as:

$$d_{hyd} = \left(1 - \frac{\beta H}{T}\right)^{\frac{g}{R_d \beta}} \cdot z_{hyd} \tag{A- 7}$$

$$d_{wet} = \left(1 - \frac{\beta H}{T}\right)^{\frac{(\lambda+1)g}{R_d \beta} - 1} \cdot z_{wet} \tag{A- 8}$$

where g = 9.80665 m/s^2 and the receiver's height, [H] is expressed in units of meters above mean-sea-level.

The tropospheric correction mapping function for satellite elevation, $m(E_i)$, is calculated as:

$$m(E_i) = \frac{1.001}{\sqrt{0.002001 + \sin^2(E_i)}} \tag{A- 9}$$

This mapping function is valid for satellite elevation angles of not less than 5°.

Residual Tropospheric Error

The model for the residual error for the tropospheric delay estimate for satellite i is:

$$\sigma_{i,tropo}^2 = \left(\sigma_{TVE} \cdot m(E_i)\right)^2 \tag{A- 10}$$

where the tropospheric vertical error is σ_{TVE} = 0.12 m