TABLE 3. Equations for Calculated Parameters

Mach Number, M:

$$M = \sqrt{5 * \left[\left(\frac{Q_c}{P_S} + 1 \right)^{(2/7)} - 1 \right]} \qquad (1)$$

M = Mach Number
Ps = Static Pressure
Qc = Differential Pressure

True Air Speed, TAS:

$$TAS(kts) = M * a = M * 38.96695 * \sqrt{T_S} \qquad (2)$$

TAS = True Air Speed (knots)
T_S = Static Air Temperature (°K)
M = Mach Number
a = Speed of Sound

Static Air Temperature, Ts:

$$T_S(°K) = \frac{T_T}{\left[1 + M^2 * \left(\frac{\gamma - 1}{2} \right) \right]} \qquad (3)$$

T_S = Static Air Temperature (°K)
T_T = Total Air Temperature (°K)
γ = 1.4, ratio of specific heat of air at constant pressure and volume

Potential Temperature, θ:

$$\theta(°K) = T_S * \left(\frac{1000}{P_S} \right)^{0.2857142} \qquad (4)$$

θ = Potential Temperature (°K)
T_S = Static Air Temperature (°K)
Ps = Static Pressure (mb)

Water Vapor Equations

Vapor Pressure, e(mb) :

$$e_{water} = 10^{\left[23.5518 - \left(2937.4/T\right)\right]} * T^{(-4.9283)} \quad (5a)$$

$$e_{ice} = 10^{\left[11.4816 - \left(2705.21/T\right)\right]} * T^{(-0.32286)} \quad (5b)$$

T = Static Air Temperature(°K) for Saturation Vapor Pressure

or

T = Dew/Frost Point(°K) for Partial Pressure of Water Vapor

Note:

StatTempDegK and ProjDP parameters recorded in the P-3B data set are substituted to calculate saturation vapor pressure and partial pressure of water vapor , respectively.

TSDEGC and ProjDP parameters recorded in the DC-8 data set are substituted to calculate saturation vapor pressure and partial pressure of water vapor, respectively. Also notice in the DC-8 data set there is a redundant static air temperature measurement, TSCALC, which is calculated by DADS. Although TSDEGC and TSCALC track closely they can diverge by ≈0.8° at the low and high ends of the measurement range.

Specific Humidity, q :

$$q(g/kg) = \frac{0.622 * 10^3 * e}{\left(P_S - 0.377e\right)} \qquad q(ppmw) = \frac{0.622 * 10^6 * e}{\left(P_S - 0.377e\right)} \quad (6)$$

Relative Humidity, % :

w.r.t. water, w.r.t. ice,

$$RH_{water} = \frac{e_{water}}{e_{S_{water}}} * 100 \qquad RH_{ice} = \frac{e_{ice}}{e_{S_{ice}}} * 100 \quad (7)$$