1 Unit conversion

Table 1: Main barometric units used before the adoption of the Metric System.

Name	Value in mm	Sub-units
Swedish inch	29.69	1/10 to 1/100 inch
Paris inch	27.07	Lines (1/12 inch) and Points (1/4 to 1/16 line)
Vienna inch	26.34	Lines (1/12 inch) and Points (1/4 to 1/16 line)
Rijnland inch	26.15	Lines (1/12 inch) and Points (1/4 to 1/16 line)
English inch	25.40	1/10 to 1/100 inch
Castilian inch	23.22	Lines (1/12 inch) and Points (1/4 to 1/16 line)

Table 2: Main thermometric units used before the adoption of the Metric System.

Name	Conversion to Celsius
Fahrenheit	$(T_F - 32) \times 5/8$
Réaumur	$T_R/0.8$

2 Reduction to 0°C

Since the mercury expands and shrinks depending on the temperature, observations made with a mercury barometer must be corrected accordingly:

$$L_0 = (1 - \gamma T)L_{mm} \tag{1}$$

where γ is the thermal expansion coefficient of mercury at 0°C (1.82×10^{-4} K^{-1}), T is the temperature of the barometer in °C, L_{mm} is the original observation in mm of mercury and L_0 is the observation reduced to 0°C. The "neutral" temperature of 0°C is dictated by international standards.

3 Conversion to pressure units

The conversion of pressure readings from mm to hPa follows from the hydrostatic equation:

$$P_0 = \rho g_n L_0 \cdot 10^{-5} \tag{2}$$

where P_0 is the absolute pressure in hPa, $\rho = 1.35951 \times 10^4$ kg m^{-3} is the density of mercury at 0°C, $g_n = 9.80665$ m s^{-2} is the standard gravity acceleration and L_0 is the barometric reading in mm (corrected for temperature).

4 Correction for local gravity

Gravity acceleration varies with latitude and altitude, therefore a correction is needed based on the geographical coordinates of the barometer:

$$P_n = \frac{g_{\varphi,h}}{g_n} P_0 \tag{3}$$

where $g_{\varphi,h}$ is the local gravity acceleration.

One can estimate the local gravity from the latitude φ and elevation h (in m above sea level), assuming flat terrain around the station:

$$g_{\varphi,h} = [9.80620 \cdot (1 - 0.0026442 \cdot \cos 2\varphi - 0.0000058 \cdot \cos^2 2\varphi) - 0.000003086 \cdot h]. \tag{4}$$

5 Reduction to mean sea level

To use pressure observations for synoptic analysis, one should reduce them to sea level:

$$SLP = P_n \cdot \exp\left(\frac{\frac{g_{\varphi,h}}{R} \cdot h}{T_S + a \cdot \frac{h}{2}}\right) \tag{5}$$

where $R = 287.05$ J kg^{-1} K^{-1} is the gas constant for dry air, $a = 6.5 \times 10^{-3}$ K m^{-1} is the standard lapse rate of the fictitious air column below the station, and T_S is the outside temperature at the station in K.