

RECOMMENDATION ITU-R PN.835-1

REFERENCE STANDARD ATMOSPHERE FOR GASEOUS ATTENUATION

(Question ITU-R 201/3)

(1992-1994)

The ITU Radiocommunication Assembly,

considering

a) the necessity for a reference standard atmosphere for use in calculating gaseous attenuation along an Earth-space path,

recommends

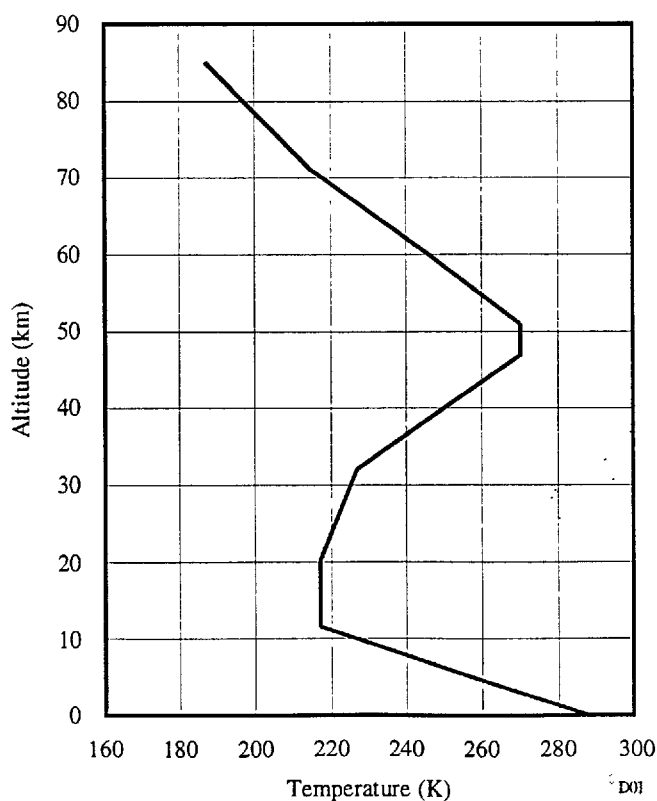
1. that the standard atmosphere in Annex 1 be used to determine temperature, pressure and water-vapour pressure as a function of altitude, for calculating gaseous attenuation, except when more reliable local data are available.

ANNEX 1

1. Temperature and pressure

The reference standard atmosphere is based on the United States Standard Atmosphere, 1976, in which the atmosphere is divided into seven successive layers showing linear variation with temperature, as given in Fig. 1.

FIGURE 1
Reference profile of atmospheric temperature



The temperature T at height h is given by:

$$T(h) = T_i + L_i (h - H_i) \qquad \text{K} \qquad (1)$$

where:

$$T_i = T(H_i) \qquad (2)$$

and L_i is the temperature gradient starting at altitude H_i and is given in Table 1.

TABLE 1

Subscript, i	Altitude, H_i (km)	Temperature gradient, L_i (K/km)
0	0	-6.5
1	11	0.0
2	20	+1.0
3	32	+2.8
4	47	0.0
5	51	-2.8
6	71	-2.0
7	85	

When the temperature gradient $L_i \neq 0$, pressure is given by the equation:

$$P(h) = P_i \left[\frac{T_i}{T_i + L_i (h - H_i)} \right]^{34.163 / L_i} \qquad \text{hPa} \qquad (3)$$

and when the temperature gradient $L_i = 0$, pressure is obtained from the equation:

$$P(h) = P_i \exp \left[\frac{-34.163 (h - H_i)}{T_i} \right] \qquad \text{hPa} \qquad (4)$$

The ground-level standard temperature and pressure are:

$$\begin{aligned} T_0 &= 288.15 \qquad \text{K} \\ P_0 &= 1\,013.25 \qquad \text{hPa} \end{aligned} \qquad (5)$$

Note that above about 85 km altitude, local thermodynamic equilibrium of the atmosphere starts to break down, and the hydrostatic equation, on which the above equations are based, is no longer valid.

2. Water-vapour pressure

The distribution of water vapour in the atmosphere is generally highly variable, but may be approximated by the equation:

$$\rho(h) = \rho_0 \exp (-h / h_0) \qquad \text{g/m}^3 \qquad (6)$$

where the scale height $h_0 = 2$ km, and the standard ground-level water-vapour density is:

$$\rho_0 = 7.5 \qquad \text{g/m}^3 \qquad (7)$$

Vapour pressure is obtained from the density using the equation (see Recommendation ITU-R PN.453):

$$e(h) = \frac{\rho(h) T(h)}{216.7} \qquad \text{hPa} \qquad (8)$$