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Thermospheric temperature model

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The temperature at thermospheric heights (above 80 km) can be expressed in terms of exospheric temperature as a function of geo-potential height. Again, it may be assumed to be dependent on *G* function as mentioned by Hedin (1983). Taking data of a quiet day of $F_{10.7}=98.4$ at 11.00 hours IST measured by rocket borne experiment supplied by PRL, Ahmedabad, the work of Chakravarty and Mondal (1985) has been extended to fit the temperature from 80 to 120 kms at the dip equatorial regions. The exospheric temperature has been taken to be 858.2°K.

According to Rishbeth and Garriot (1959) the geopotential height corresponding to an altitude z is given by

$$z^* = \frac{R_E.z}{R_E+z} \tag{1}$$

where R_E is the radius of the earth commonly taken to be 6370 kms.

Since the reference level is taken to be 80 kms, hence the geo-potential height could be written as

$$\rho = \frac{(z-80)(R_E+80)}{(R_E+z)} \tag{2}$$

As in Chakravarty and Mondal (1985), the expression for temperature at a geo-potential height $\rho(T\rho)$ could be given by

$$T_\rho = T_a-(T_a-T_0)\exp(-\tau\rho) \tag{3}$$

where T_a is exospheric temperature, τ is the constant of proportionality, T_0 is the temperature at an altitude of 80 kms i.e. geo-potential height zero. Eliminating τ, the relation used by Chakravarty and Mondal (1985) above 110 kms is

$$T_\rho = T_a-(T_a-T_0)\exp\left[\frac{\left.\frac{dT\rho}{d\rho}\right|_{\rho=0}.\rho}{T_a-T_0}\right] \tag{4}$$

Jacchia (1971) is a similar model applicable from 120 kms.

In the present work, this temperature model has been verified with data from PRL (1987). Evidently, temperature calculated from this model deviates below 110 kms. The temperature T_ρ from eq. (4) becomes widely different as we go below 110 kms as shown in the table. Hence, to use this model below 110 kms some additional terms are to be introduced in it to fit the data. It may be mentioned that appropriate terms in *G* function may be applicable to fit the same data. In

Table I. The temperatures at different altitudes obtained from different formulae.

Altitude in kms	Geo-potential height (ρ) in kms	$T_a - T_p$ from eq. (4)	$T_a - T_p$ from eq. (5)	T in °K from eq. (4)	T in °K from eq. (5)	T in °K data from PRL
80	0	1050.0	675.2	-191.8	183.0	183.0
90	9.986	925.0	675.2	66.8	183.0	183.0
100	19.94	794.0	664.3	-54.2	193.9	193.9
110	29.86	660.0	616.3	198.2	241.9	241.9
120	39.77	527.7	527.7	330.5	330.5	330.5
130	49.63	419.8	419.8	438.4	438.4	438.4
140	59.46	319.5	319.5	538.7	538.7	538.7
150	69.26	237.1	237.1	621.1	621.1	621.1
160	79.03	173.1	173.1	685.7	685.7	685.7
170	88.76	123.6	123.6	734.6	734.6	734.6
180	98.49	85.6	85.6	772.6	772.6	772.6
190	108.1	53.8	53.8	804.4	804.4	804.4
200	117.9	29.6	29.6	828.6	828.6	829.6
210	127.5	11.4	11.4	847.8	847.8	847.8
220	137.1	0	0	858.2	858.2	858.2

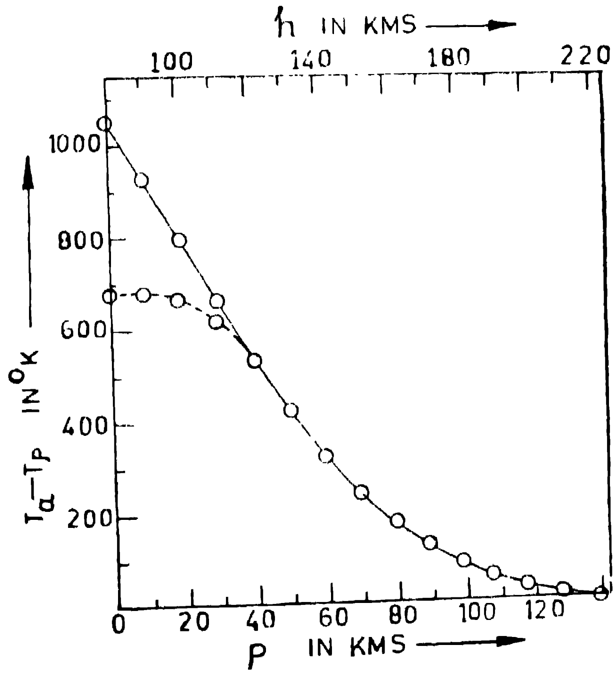

Figure 1. Variation of temperature interval ($T_a - T_p$) with geo-potential height (ρ). Solid curve from relation (4) and dotted curve from relation (5).

this work, a fitting term has been added to eq. (4) for altitudes below 110 kms. Relation (4) then, takes the form

$$T_\rho = T_a - (T_a - T_0)\exp\left[-\frac{\left.\frac{dT_\rho}{d\rho}\right|_{\rho=0}.\rho}{T_a - T_0}\right] + [35 + 10{\cdot}5(30-\rho)] \qquad (5)$$

Figure 1 shows the variation of temperature interval $(T_a - T_\rho)$ with geo-potential height ρ. Solid curve is obtained with eq. (4) while the dotted one with eq. (5). It is observed from the table that the temperature calculated from eq. (4) tally with the observed data above 110 kms while those calculated from eq. (5) below 110 kms well fits the observed data.

In conclusion, it may be pointed out that eq. (4) may be used above 110 kms while eq. (5) is applicable to regions below it.

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References

Chakravarty B and Mondal N K 1985 *Indian J. Phys.* **59B** 304
Hedin A E 1983 *J. Geo-phys. Res.* **88** 10, 170
Rishbeth H and Garriot O K 1969 *Int. Geo Ser.* **14** 7
PRL 1987 *Rocket Borme Data* (Ahmedabad India March 1987)