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Turbulent transport of atmospheric electric space charge density

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Abstract : A theoretical relationship has been developed for the dissipation rate of the variance of atmospheric electric space charge density in terms of atmospheric electric space charge density and horizontal wind speed spectra in the inertial sub-range, assuming the dominance of turbulent stress over the fair weather atmospheric electric field. A non-dimensional mean vertical space charge density gradient has been defined in terms of space charge density scale and an expression thereof is obtained as a function of atmospheric stability index. Equations have been obtained which reveal functional relationships between atmospheric electric space charge density parameters and turbulence parameters like eddy diffusion co-efficient, fiction velocity, kinetic energy dissipation rate and stability index pertinent to surface layer similarity theory. Preliminary experiments appear to support the theoretical predictions.

Keywords : Atmospheric electric space charge density variance, dissipation rate, stability index, space charge density scale.

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1. Introduction

When the sun heats the ground or when cold air flows over a warm surface, the lower portion of the atmosphere becomes unstable and turbulent convection results in which the potential energy created by the heating is converted into kinetic energy of the turbulence. In addition, the shear provides another source of turbulent kinetic energy. The accompanying energy loss is accomplished by a cascade of energy from the larger eddies to smaller eddies where the energy is ultimately dissipated. The space charge density fluctuations should also tend to be reduced by the action of molecular diffusivity at smaller eddies. The atmospheric electric space charge density, observed over turbulent time periods (~ a few tens of seconds) is much shorter than the time constant ε_0/σ (~ a few tens of minutes) of atmosphere. It is therefore a transferable quantity like momentum to which concepts used to elucidate the nature of turbulence [1,2] are applicable. This situation arises when a significant amount of space charge resides on aerosols, which occurs when aerosol concentration $Z \gtrsim 10^9$ m^{-3} [3]. In this situation the turbulence induced vertical ionic motion (of the order of 1 ms^{-1}) overwhelms that due to atmospheric electric-field $E(\mu E \approx 0.01$ ms$^{-1})$. Moreover, if the atmospheric electric and turbulent forces do not modify each other, the contribution of each influence may be considered as if the other was not present. Further, the space charge density is a scalar contaminant like temperature and moisture in the atmosphere and it is reasonable to assume that the Monin-Obukov similarity theory [4] is applicable to it also.

2. Spectral decay of atmospheric electric space charge density fluctuations in the turbulent flow

When the space charge density is mixed with turbulent flow in the atmosphere, a spectrum of space charge is produced. Let $\rho(\rho')$ denote fluctuating part (s) of space charge density at any instant of time 't' and position (s) $x(x')$ in space. The equation governing the turbulent transport of the space charge density may be expressed as

$$\frac{\partial \rho}{\partial t} + \frac{\partial u_i \rho}{\partial x_i} = \nu \frac{\partial^2 \rho}{\partial x_i \partial x_i}. \quad (1)$$

In this transport equation we have ignored $\frac{\partial \sigma E}{\partial x_i}$ term for reasons discussed in the introduction. In this equation ν is the molecular diffusivity and U_i the fluctuating part of longitudinal wind velocity. It can be shown that eq. (1)

*Present address : Visiting Faculty, Department of Physics, University of Jammu, Jammu, India leads to the following expression for the space charge density structure function $D_{\rho\rho}(r)\{=\overline{(\rho'-\rho)^2}\}$ in the inertial sub-range [5].

$$D_{\rho\rho}(r) = b_\rho \varepsilon^{-1/3} \chi_\rho r^{2/3}, \quad (2)$$

where b_ρ is a constant pertinent to a scalar contaminent which in the present case is space charge density ρ, $r = | x' - x |$, ε is the rate of dissipation of turbulent kinetic energy and $\chi_\rho = \left(-\frac{1}{2}\frac{\partial}{\partial t}\overline{\rho}^2\right)$ is defined as space charge density variance dissipation rate.

If $P_{\rho\rho}(K)$ denotes the power spectral density of the fluctuating space charge density, where K is the wave number we have

$$P_{\rho\rho}(K) = \frac{1}{2\pi K}\int_0^\infty \frac{dD_{\rho\rho}(r)}{dr}\sin(Kr)\,dr. \quad (3)$$

Evaluation of the integral on right hand side of eq. (3) using eq. (2) and the relation $K = \frac{2\pi n}{\bar{u}}$ [6] leads to

$$P_{\rho\rho}(n) = \frac{\beta_\rho}{(2\pi)^{5/3}}\varepsilon^{-1/3}\chi_\rho \bar{u}^{5/3} n^{-5/3}, \quad (4)$$

where $\beta_\rho = b_t \dfrac{\sin\left(\frac{\pi}{3}\right)}{2\pi}$ (5)

Eq. (4) represents $-5/3$ decay law for atmospheric electric space charge density. Recently, another version of $-5/3$ decay law for space charge density based on Borkowski's method has been presented [7].

From eq. (4), we have

$$\chi_\rho = \frac{(2\pi)^{5/3}}{\beta_-} P_{\rho\rho}(n)\,\varepsilon^{1/3}(\bar{u})^{-5/3} n^{5/3}.$$

Kolmogorov's spectral decay law gives

$$\varepsilon^{1/3} = \frac{(2\pi)^{5/6}\rho_{ll}^{(n)} n^{5/6}}{\alpha_1^{1/2}(\bar{u})^{5/6}}, \quad (6)$$

where $\rho_{ll}^{(n)}$ is the power spectral density of the horizontal wind speed and $\alpha_1 \approx 0.5$. Therefore,

$$\chi_\rho = \frac{(2\pi)^{5/2} P_{\rho\rho}(n) P_{ll}^{(n)} n^{5/2}}{\alpha_1^{1/2}\beta_\rho(\bar{u})^{5/2}} \quad (7)$$

The electric parameter χ_ρ called the dissipation rate of space charge density variance, plays a significant role in characterizing the turbulent regime.

The experiments conducted by us support the $-5/3$ decay law. The spectra of atmospheric electric space charge density and wind speed from Run No. 1 are presented in Figures 1 and 2 as typical illustration. Figure 2 depicts non-dimensional version of eq. (4) [see eq. (32)]. The aerosols trapped in the inversion layer adjacent to ground

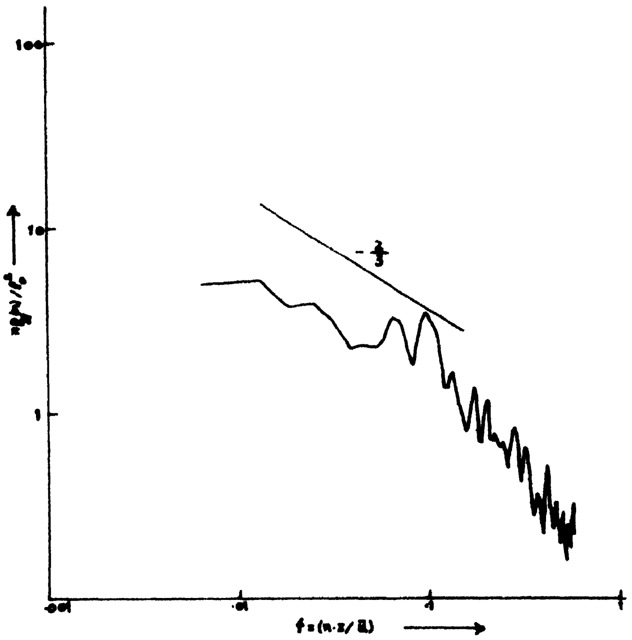

Figure 1. Normalised space charge density spectra as a function of f for Run No. 1 from 13.15 to 13.30 hrs. on 6.11.86.

during early morning hours are lifted to upper layers in the atmosphere during turbulent periods (runs 1 to 5, Table 1). This would cause enhancement in the pollution concentration in the atmosphere and therefore the compliance of $-5/3$ decay law is in agreement with that of [8]. The evidence of the enhancement in the pollution concentration may be inferred from the reduction in the conductivity during these periods at this station [9].

An estimate of β_ρ whose functional form is given by eq. (5) has been carried out in the present study as follows:

From eq. (7) we obtain

$$\beta_\rho \quad \frac{(2\pi)^{5/2} P_{\rho\rho}(n)\,\rho_{ll}^{(n)} n^{5/2}}{\alpha_1^{1/2}\chi_\rho(\bar{u})^{5/2}} \quad (8)$$

We now assume equality of the rate of production and dissipation of space charge density variance *i.e.*,

$$\chi_\rho = -\overline{W\rho}\frac{\partial\bar{\rho}}{\partial z}, \quad (9)$$

where $\overline{W\rho}$ represents the vertical flux of surface space charge density and $\frac{\partial\bar{\rho}}{\partial z}$ is the mean vertical gradient of space charge density. This assumption is more or less supported by the preliminary experimental observations as

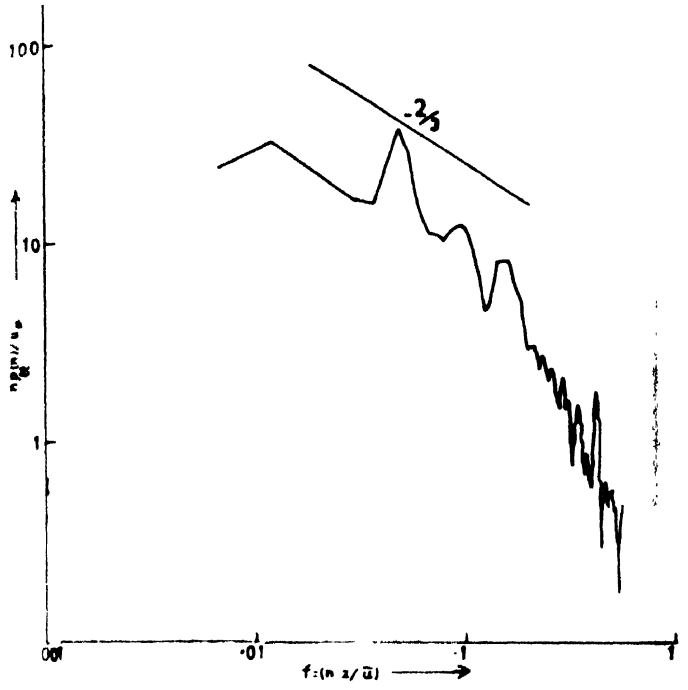

Figure 2. Normalised wind speed spectra as a function of f for Run No 1 from 13.15 to 13.30 hrs. on 6.11.86.

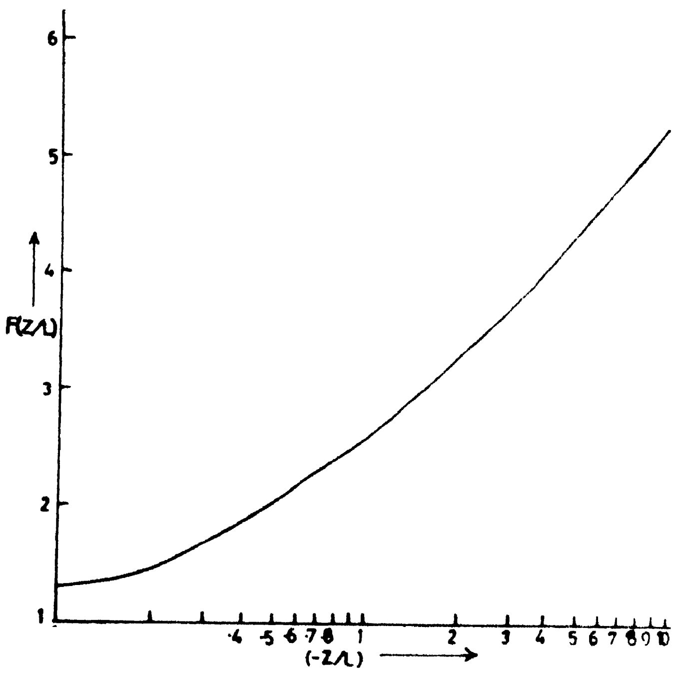

Figure 3. Theoretical plot of $F(Z/L)$ vs (Z/L) in accordance with eq (33).

Table 1. Values of surface layer atmospheric turbulence related electric and meterological parameters.

(1) Run no	(2) Start-end (hours) local time	(3) Date	(4) χ_ρ (Coul. m^{-3})^2 $\times 10^{24}$	(5) $-\overline{UW}$ (ms^{-1})^2	(6) $\overline{W\rho}$ (Coul m^{-2}s^{-1}) $\times 10^{-12}$	(7) β_ρ	(8) u_* (ms^{-1})		(9) $-\rho_*$ (Coul m^{-3}) $\times 10^{-12}$	
							Met-	Elect.	Eqn (11)	Eqn (23)
1	13.15–13.30	06 11.86	38	0.5	1.7	0 93	0.22	0.23	7.7	8 1
2	09.30–09.45	10.10.86	21	0.025	1.3	0 96	0.17	0.14	8.6	9 3
3	10.10–10.15	08.10.86	25	0 08	1.5	0 68	0.28	0 27	5.3	6.0
4	09.32–09.47	03.11.86	31	0.02	1.4	0.65	0.14	0.15	10.0	10 4
5.	10.15–10.30	12.11.86	30	0.04	0 20	1.1	0.20	0.16	8 0	9 3

Table 2. Values of surface layer atmospheric turbulence related electric and meterological parameters.

(1) Run No.	(2) Start-end (hours) local time	(3) Date	(4) ϵ (m^{2}s^{-3})		(5) Z/L		(6) $F(Z/L)$	(7) $-\frac{\partial\rho}{\partial z}$ (Coul m^{-4}) $\times 10^{-12}$	(8) $-W\rho\frac{\partial\rho}{\partial z}$ (Coul^{2}m^{-6}s^{-1}) $\times 10^{-24}$	(9) $\frac{\partial\rho}{\partial z}\frac{kZ}{\rho_*}$	(10) $\frac{1}{\alpha_\rho}\left(1-9\frac{Z}{L}\right)^{-1/2}$	(11) K (m^{2}s^{-1})		(12) J_c (Coul m^{-2}s^{-1}) ($\times 10^{-12}$)
			Met	ELE	Met	ELE						ELE	Met	
1	13.15–13.30	06.11.86	0.020	0.3	–0.16	–0.15	1.42	20.0	34.0	1.0	0.84	0.095	0.096	1.9
2	09.30–09.45	10.10.86	0.02	0.09	–0.19	–0.17	1.48	15.0	19.5	0.69	0.78	0.09	0.08	1.4
3.	10.10–10.15	08.10.86	0.009	0.01	–0.14	–0.15	1.43	16.0	24.0	1.0	0.84	0.10	0.12	1.5
4	09.32–09.47	03.11.86	0.03	0.01	–0.11	–0.10	1.30	15.0	27.0	0.76	0.92	0.085	0.90	2.0
5	10.15–10.30	12.11.86	0.03	0.01	–0.16	–0.18	1.50	17.0	27.2	0.85	0.80	0.10	0.091	1.7

preliminary experimental observations as can be seen by comparing column 4 of Table 1 with column 8 of Table 2. The space charge density gradient $\frac{\partial\rho}{\partial z}$ has been estimated by assuming $\frac{\partial\rho}{\partial z} \approx \frac{\Delta\rho}{\Delta z}$ where $\Delta\rho$ is the difference in the space charge densities measured simultaneously at the height of 0.5 m and 2 m above the surface. Therefore,

$$\beta_\rho = \frac{(2\pi)^{5/2}\, P_{\rho\rho}(n)\, \rho_{ll}^{(n)}\, n^{5/2}}{\alpha_1^{1/2}\, \overline{W\rho}\, \frac{\partial\bar{\rho}}{\partial z}\, (\bar{u})^{5/2}} \tag{10}$$

In this way, we have determined the values of β_ρ from eq. (10) (see Table 1 column 7). Once the constant β_ρ is found χ_ρ can always be obtained by using eq. (7).

The values of the power spectral density $P_{\rho\rho}(n)$ used in eq. (8) have been estimated from power spectra of wind speeds such as depicted in Figure 2.

3. Development of relationships between the parameters of atmospheric electric space charge density and turbulence

In the atmospheric surface layer where wind shear plays a dominant role Monin-Obukov similarity theory applies. Since, the space charge density is a scalar contaminent like heat and moisture in the atmosphere, we may define the flux of space charge density as follows :

$$\psi = \overline{W\rho} = u_*\rho_*, \tag{11}$$

where W is the fluctuating part of the vertical wind velocity, u_* the frictional velocity and ρ_* the scaling parameter for space charge density. The relation between the co-efficient of eddy diffusion K, and the space charge density flux is governed by

$$\psi = -K_\rho \frac{\partial\bar{\rho}}{\partial z}. \tag{12}$$

From eqs. (9), (11) and (12) we have

$$K_\rho = \frac{\chi_\rho}{\left(\frac{\partial\bar{\rho}}{\partial z}\right)^2} \tag{13}$$

The coefficient of eddy diffusion has been estimated from eq. (13) and also by conventional (Meteorological) method by performing field experiements. The two methods more or less agree (see Table 2 column 11). Therefore, our preliminary experiments support the validity of the eq. (4).

Monin-Obukov similarity theory [4] predicts that the gradients of wind speed and scalar contaminants in a turbulent flow, when non-dimensionalised by means of the corresponding scaling parameters, Von-Karman constant and height are functions of only the stability parameter Z/L, where L, the Obukov length is given by

$$L = -\frac{u_*^3\,\bar{\theta}}{k\, g\, \overline{W\theta}},$$

g is the acceleration due to gravity.

It is suggested that the space charge density being a scalar contaminant in the atmosphere, when non-dimensionalised by its scaling parameter, ρ_*, Von-Karman constant k = 0.35 [10] and height z should also be a function of the stability index Z/L. Dimensional reasoning dictates that the dimensionless space charge density gradient should be of the form $\frac{kZ}{\rho_*}\frac{\partial\bar{\rho}}{\partial Z}$.

Therefore,

$$\phi_\rho\left(\frac{Z}{L}\right) = \frac{kZ}{\rho_*}\frac{\partial\bar{\rho}}{\partial Z}. \tag{15}$$

Combining eqs. (9) and (11) we have

$$\rho_* = \frac{\chi_\rho}{u_* \frac{\partial\bar{\rho}}{\partial Z}} \tag{16}$$

Substitution of the values of ρ_* from eq. (16) in eq. (15) yields

$$\varphi_\rho = \frac{kZu_*}{\chi_\rho}\left(\frac{\partial\bar{\rho}}{\partial Z}\right)^2. \tag{17}$$

Eq. (17) may be written in the following form with the aid of eq. (13).

$$\phi_\rho = \frac{kZu_*}{K_\rho} \tag{18}$$

If K_H represents the coefficient of eddy diffusion pertinent to the vertical heat flux in the turbulent atmosphere, we have

$$K_H \frac{\partial\theta}{\partial Z} = u_*\,\theta_* \quad \text{or} \quad K_H = \frac{u_* kZ}{\phi_\theta},$$

where $\phi_\theta = \frac{kZ}{\theta_*}\frac{\partial\theta}{\partial Z}$.

According to [11]

$$\phi_\theta = \frac{1}{\alpha_\theta}\left(1 - 9\frac{Z}{L}\right)^{-1/2} \quad \text{for } \frac{Z}{L} < 0, \tag{19}$$

where α_θ ⋅1.35.

Thus, we may write the expression for K_H as

$$K_H = \alpha_\theta u_* kZ\left(1 - 9\frac{Z}{L}\right)^{1/2}. \tag{20}$$

Therefore, by analogy

$$K_\rho = \alpha_\rho u_* kZ\left(1 - 9\frac{Z}{L}\right)^{1/2}, \tag{21}$$

where α_ρ is a constant corresponding to α_θ and can be determined experimentally. Substituting the expression for K_ρ from eq. (21) into eq. (18) we have

$$\phi_\rho = \frac{1}{\alpha_\rho}\left(1-9\frac{Z}{L}\right)^{-1/2} \quad \text{for } \frac{Z}{L}<0. \tag{22}$$

The values of ϕ_ρ estimated from eq. (22) for $\alpha_\rho = 0.72$ and independently from eq. (17) closely agree as can be seen in columns 9 and 10 of Table 2. Combining eqs. (9), (11) and (15), we get

$$\rho_* = -\left(\frac{kZ\chi_\rho}{u_*\phi_\rho}\right)^{1/2} \tag{23}$$

The negative root is taken for conditions with upward space charge density fluxes. The values of ρ_* estimated with the aid of eq. (23) have been entered in column 9 of Table 1. The values of ρ_* have also been estimated using basic flux eq. (11) for comparison. The closeness of the values of ρ_* through independent equations lends support to the validity of the theoretical relationship expressed by eq. (23). Since the kinetic energy dissipation rate ε expressed in the non-dimensional form

$$\phi_\varepsilon = \frac{kZ\varepsilon}{u_*^3} \tag{24}$$

is a function only of Z/L; it is reasonable to assume that the dimensionless form of the space charge density variance dissipation rate, denoted by ϕ_{χ_ρ} should also be function of only the stability index Z/L.

On the basis of dimensional analysis

(25)

But it can be shown that $\phi_{\chi_\rho} = \phi_\rho$,

$$\text{therefore,} \quad \phi_{\chi_\rho} = \frac{1}{\alpha_\rho}\left(1-9\frac{Z}{L}\right)^{-1/2} \quad \text{for } \frac{Z}{L}<0. \tag{26}$$

From direct measurement [12], it is found that

$$\phi_\varepsilon^{2/3} = 1+0.5\left|\frac{Z}{L}\right| \quad \text{for } -2 \le \frac{Z}{L} \le 0. \tag{27}$$

Therefore, from eqs. (24) and (27) we have

$$u_* = \left[\frac{kZ\varepsilon}{\left(1+0.5\left|\frac{Z}{L}\right|^{2/3}\right)^{3/2}}\right]^{1/3} \tag{28}$$

Eq. (17) may be re-written as

$$u_* = \frac{\chi_\rho\phi_\rho}{kZ}\left(\frac{\partial\bar{\rho}}{\partial Z}\right)^{-2}. \tag{29}$$

Using eqs. (22), (28) and (29) we obtain

$$\varepsilon = \frac{\chi_\rho^3}{\alpha_\rho^3 k^4 z^4\left(\frac{\partial\bar{\rho}}{\partial Z}\right)^6}\left[\frac{1+0.5\left|Z\right|^{2/3}}{1-9\,Z}\right]^{3/2} \tag{30}$$

From eqs. (24) and (25) we obtain

$$\phi_\varepsilon^{-1/3}\phi_{\chi_\rho} = \frac{k^{2/3}\varepsilon^{-1/3}\chi_\rho Z^{2/3}}{\rho_*^2}. \tag{31}$$

With the aid of eq. (31) we recast eq. (4) in non-dimensional form as follows :

$$\frac{nP_{\rho\rho}}{\rho_*^2} = \frac{\beta_\rho}{(2\pi)^{5/3}} k^{-2/3}\phi_\varepsilon^{-1/3}\phi_{\chi_\rho}\bar{u}f^{-2/3}, \tag{32}$$

where $f = (nz/\bar{u})$ is non-dimensional frequency. We may express the product of $\phi_\varepsilon^{-1/3}\phi_{\chi_\rho}^{-1}$ in the following form using eqs. (26) and (27)

$$\phi_\varepsilon^{-1/3}\phi_{\chi_\rho}^{-1} = \alpha_\rho\left[\frac{1-9\frac{Z}{L}}{1+0.5\left|\frac{Z}{L}\right|^{2/3}}\right]^{1/2} = F\left(\frac{Z}{L}\right). \tag{33}$$

Substituting the value of ρ_* from eq. (16) in eq. (32) we have

$$\frac{nP_{\rho\rho}}{\beta_\rho\frac{(kZ)^2}{2\pi}\left(\frac{\partial\bar{\rho}}{\partial Z}\right)^2(2\pi kf)^{-2/3}\bar{u}} = F\left(\frac{Z}{L}\right). \tag{34}$$

The value of $F(Z/L)$ have been computed with the aid of eq. (33) using $\alpha_\rho \approx 0.72$ and the result is depicted in Figure 3. Estimates of $F(Z/L)$, with the aid of eq. (34), are made from (a) measured values of $P_{\rho\rho}$ using a power spectral diagram such as shown in Figure 1 for various runs within the inertial sub-range and (b) the gradient of space charge density. The stability index Z/L is determined from eq. (33) or Figure 3. This yields a new technique *i.e.*, an atmospheric electrical method for the determination of stability index Z/L in the turbulent atmosphere. Simultaneous micrometeorological and atmospheric electric measurements were conducted at Gulmarg field station to test the above prediction. The results are presented in the tabular from (Tables 1 and 2). Entered into column 5 of Table 2 are the values of stability Index Z/L determined by electrical method which more or less agree with the conventional (meteorological) method using eq. (14). Finally, u_* and ε are computed from eqs. (29) and (30) respectively as the stability index Z/L is now determined. These values of u_* and ε are respectively entered in column 8 of Table 1 and column 4 of Table 2 and are close to values obtained by meteorological method using equations (6) and (28).

There is a need for the separation of local convection current density from global ionosphere to earth electric current density [13]. We, therefore, consider it worthwhile to present a suitable expression for the estimation of convection current density in the turbulent atmosphere as an application of the preceding results. The usual definition of convection current density J_c is

$$J_c = K_\rho \frac{\partial \overline{\rho}}{\partial Z}$$

Substituting the values of K_ρ from eq. (13) in the above equation. We have

$$J_c = \frac{\chi_\rho}{\frac{\partial \overline{\rho}}{\partial Z}} \tag{35}$$

Eq. (35) is the required equation for the estimation of the convection current density in the surface layer of atmosphere. The values of convection current density computed from eq. (35) during the five runs presented in Table 2 column 12 show that the convection current density is of the same order of magnitude as conduction current density.

4. Experimental procedure and data analysis

Experiments were carried out by us at Gulmarg Field station during July to November 1986 measuring simultaneously wind velocity, atmospheric temperature and space charge density. Three components of wind velocity were monitored at a height of 1.5 m above the earth's surface using a three dimensional (*u*, *v*, *w*) Gill anemometer from R M Yaung Company USA. The anemometer has threshold velocity of 0.1 ms^{-1} and is suitable for atmospheric turbulence measurements.

Atmospheric temperature was measured at a height of 1.5 m above the ground using a thermistor thermometer [14]. The thermometer response time for full scale deflection is one second. Space charge density was measured by using a filtration method similar to the one devised by [15]. Two space charge collectors were installed to measure the space charge density of air sampled at the heights of 0.5 m and 2 m above the surface of the earth on a mast. The feed-back potentials available from sensing circuits of passive antenna systems at the heights of 2 m and 0.5 m were used to maintain actively the intakes of two space charge apparatus at their ambient potentials [16]. The signals from these collectors were fed to two vibrating reed electrometers from Electronics Corporation of India Limited. The time constant of the electrometers is 0.1 seconds. The out-puts from all the above instruments were recorded on two four channel potentiometeric strip chart recorders from Bausch and Lomb Company having frequency response from DC to 10 Hz. Fair weather measurements were conducted continuously for 24 hours at a low chart speed of 10 cm per hour. Fast recordings of signals at the rate of 10 m per minute were carried out for shorter intervals of 15 minutes just before sun rise, two hours after sunrise, early afternoon, late afternoon and at midnight. However, the data acquisation periods considered for analysis to test the theoretical predictions reported here were about two hours after sunrise and around noon with the objective of considering unstable atmospheric conditions. The recorded signals as ink trace on strip chart were digitised directly from the chart with an opto-electronic equipment facility at M/s Indicos Computer Service Pvt. Ltd. Bombay. A maximum of 15 minutes sampling record was considered for our analysis in order to avoid non stationarity. One second average values, constituting a time series of 900 data points, were used for covariance and power spectral determination [17].

Only those sample periods were taken into account during which the atmospheric electric potential at the height of 2 m did not exceed 240 V with respect to ground. This restriction ensures passive antenna system linearity which lies between −100 V to 250 V [16]. The five 15 minutes runs identified in Tables 1 and 2 by run numbers, the start and end times for the 15 minute period and the date were selected at random from these samples.

5. Conclusions

Expressions for atmospheric electric space charge density spectrum in the inertial subrange in terms of the dissipation rate of atmospheric electric space charge density variance have been derived starting from the equation govering the turbulent transport of electric space charge density in the atmosphere. The spectral decay law for atmospheric space charge density thus established, has experimental support. A method has been proposed for the evaluation of the constant β_ρ contained in the expression for space charge density spectrum. The dissipation rate of atmospheric electric space charge density variance has been determined from the measurement of space charge density and horizontal wind velocity spectra in the inertial subrange. Relationships between atmospheric turbulence parameters and space charge density parameters pertinent to surface layer similarity theory have been established on the basis that electric space charge density in the atmosphere is a conservative quantity within the time domain encompassing atmospheric turbulence and therefore Monin-Obukov similarity theory, valid for momentum, temperature and moisture, should be applicable to atmospheric electric space charge density. An explicit relation for atmospheric stability index Z/L has been developed in terms of the space charge density spectrum and space charge density gradient. This relationship is more or less in agreement with experimental observations and offers a simple and economical method of determining atmospheric stability index by monitoring only one parameter *viz*. atmospheric electric space charge density at two heights in the atmosphere. Functional relationships for turbulent kinetic energy dissipation rate ε and frictional velocity u_* have been obtained in terms of space charge density variance dissipation rate, space charge density gradient and stability index. The eddy diffusion coefficient has been found equal to the ratio between space charge density variance dissipation rate and square of space charge density gradient. Preliminary experiments comprising simultaneous measurements of three components of wind speed, atmospheric temperature and atmospheric electric space charge density appear to support the validity of these relationships, thus providing an atmospheric electrical method for determining these parameters.

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