E-O-6

STUDIES ON ATMOSPHERIC ELECTRICAL CONDUCTIVITY RELATED TO RADON AND ITS PROGENY CONCENTRATIONS AT TWO DIFFERENT PLACES IN MYSORE (12^{O} N, 76^{O} E), INDIA

N. Ragini, T.S. Shashikumar, M.S. Chandrashekara, L. Paramesh*

Department of Studies in Physics, University of Mysore
Manasagangotri, Mysore–570 006, India
Tel: +91-821-2419603 Email: lp@physics.uni-mysore.ac.in

Introduction

It is well known that, the atmospheric electrical conductivity is mainly due to the presence of small ions. Natural terrestrial radioactivity and cosmic ray ionization are the major sources of small ion production in the lower levels of the atmosphere. The diurnal variations of ion production rate depend on several different processes such as changes in soil properties, nature of vertical transport of radon isotopes and meteorological parameters. The mobility of large or intermediate ions is very small compare to that of small ions, and their contribution to the conductivity is negligible. In the presence of aerosol particles, the small ion concentration is reduced due to the ion–ion recombination process and attachment of small ions to the aerosol particles. Attachment of small ions to the aerosol particles reduces their mobility and causes a decrease in conductivity of the atmosphere. Due to this inverse relationship between the electrical conductivity and aerosols, the electrical conductivity has been proposed to act as a pollution indicator [1].

Methods of measurements

In the present study atmospheric electrical conductivity of both polarities has been measured using a Gerdien condenser [2]. ^{222}Rn and its short-lived daughter products (^{218}Po, ^{214}Pb, and ^{214}Po) in these locations is measured using Low Level Radon Detection System and Airflow Meter respectively. The ion-pair production rate is estimated from the measured radon and its progeny concentrations [3].

Results and discussions

The measurements of radioactivity and conductivity have been carried out at a height of 1m above the ground level near the department of physics in the university campus (Location 1) and at Maharani's science college in the central part of the city (Location 2). The results of the measurements are shown in Figure 1, Table 1 and 2. It can be observed that in location-2 both ion pair production rate and conductivity are higher compare to location-1 due to higher radon and its progeny concentration. In location-1 the ion par production rate varies from 1.29 to 4.58 with an average value of 2.87 where as the conductivity value varies from 10.40 to 44.50 with an average value of 21.28 showing diurnal variation almost by a factor of 4-5. In location-2 ion pair production rate varies from 1.05 to 6.11 and conductivity varies from 4.4 to 64.5 with an average value of 35.0 showing significant diurnal variation almost by a factor of 14-15.

Concentrations of radon in the outdoor environment are affected not only by the magnitude of the exhalation rates in the general area but also by atmospheric mixing phenomena. During night atmosphere is relatively calm with low winds and little convective motion. Radon exhaled from the soil accumulates near the ground leading to gradual increase

in the concentrations. Radon, its progeny concentration and atmospheric electrical conductivity are higher in the early morning hours generally between 04 and 06 hours. In location-1 the conductivity decrease after sunrise attaining lower values during 8 to 10 hrs. After 10 hours due to heating of soil surface there will be evaporation of water content of the soil surface, which result in slight increase of radon exhalation rate and hence increase of conductivity after. Where as in location-2 lower values of conductivity is observed between 8-12 and around 18 hours. This may be due to decrease of ionization rate and increase of aerosol particles due to vehicular traffic near the measuring station during that time.

Conclusion

The Diurnal variations of atmospheric electrical conductivity are studies over three locations shows similar type of diurnal variations. In location-2 both ion pair production rate and conductivity are higher compare to location-1 due to higher radon and its progeny concentration. In location-2 lower values of conductivity is observed between 8-12 and around 18 hours. This may be due to decrease of ionization rate and increase of aerosol particles due to vehicular traffic near the measuring station during that time.

References

1. Sheftel, V.M., Chernyshev, A.K. and Chernysheva, S.P. (1994), Air conductivity and atmospheric electric field as an indicator of anthropogenic atmospheric pollution. *J. Geophys. Res.* 99: 10793–10795.
2. Dhanorkar, S., Deshpande, C.G. and Kamra, A.K. (1989), Observations of some atmospheric electrical parameters in the surface layer. *Atmos. Environ.* 23: 839–841.
3. Nagaraja, K., Prasad, B.S.N., Madhava, M.S., Chandrashekara, M.S., Paramesh, L., Sannappa J, Pawar, S. D., Murugavel, P. and Kamra. A.K. (2003), Radon and its short – lived progeny: Variations near the ground. *Radiat. Meas.* 36: 413–417.

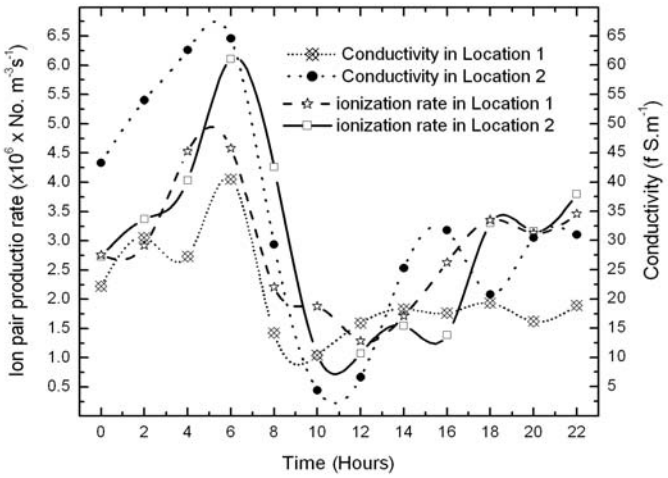

Figure 1. Diurnal variation of ion pair production rate and atmospheric electrical conductivity at two locations in Mysore city.

Table 1. Diurnal variations of radon, its progeny activity concentration, Ionization rate and electrical conductivity in the University Campus, Mysore.

Time (hours)	Concentration (Bqm^{-3})				Ion production rate $x10^6$ ($no.m^{-3}s^{-1}$)	Conductivity ($fS.m^{-1}$)		Ratio of conductivity to Ion production rate
	Rn	RaA	RaB	RaC′		Positive	Negative	
0	11.70	3.07	0.50	0.70	2.76	11.6	10.6	8.0
2	11.75	4.69	0.31	0.06	2.92	15.7	14.8	10.5
4	17.32	7.56	0.52	0.53	4.53	23.2	21.3	9.8
6	17.74	7.75	0.97	0.25	4.58	13.8	13.5	6.0
8	10.03	2.06	0.44	0.40	2.21	7.70	6.50	6.4
10	7.87	1.92	0.32	0.66	1.88	5.30	5.10	5.5
12	5.75	0.79	0.38	0.59	1.29	8.00	7.90	12.4
14	6.67	2.93	0.08	0.10	1.72	9.30	9.00	10.6
16	10.92	3.90	0.58	0.06	2.63	8.30	9.30	6.7
18	14.91	3.40	0.83	0.58	3.36	9.50	9.80	5.8
20	13.31	4.18	0.48	0.22	3.13	8.20	8.00	5.2
22	14.19	4.97	0.48	0.33	3.46	9.70	9.20	5.5
Avg	11.85	3.94	0.49	0.37	2.87	10.9	10.4	7.7
Min	5.75	0.79	0.08	0.06	1.29	5.30	5.10	5.2
Max	17.74	7.75	0.97	0.70	4.58	23.2	21.3	12.4

Table 2. Diurnal variations of radon, its progeny activity concentration, ionization rate and electrical conductivity in Maharani's Science College, Mysore.

Time (hours)	Concentration (Bqm^{-3})				Ion production rate x 10^6 ($no.m^{-3}s^{-1}$)	Conductivity ($fS.m^{-1}$)		Ratio of conductivity to Ion production rate
	Rn	RaA	RaB	RaC′		Positive	Negative	
0	10.37	4.38	2.19	0.31	2.73	21.8	21.5	15.8
2	11.83	6.65	0.89	0.28	3.37	27.1	26.9	16.0
4	12.22	9.89	0.52	0.30	4.04	31.8	30.8	15.5
6	19.71	13.94	1.06	0.37	6.11	32.4	32.2	10.6
8	14.06	9.53	0.28	0.24	4.26	9.8	9.5	6.9
10	4.47	1.33	0.25	0.13	1.05	2.4	2.0	6.6
12	4.70	1.35	0.22	0.07	1.08	3.5	3.1	6.4
14	6.91	1.79	0.20	0.10	1.55	12.8	12.5	22.8
16	5.47	2.26	0.24	0.09	1.39	16.0	15.8	22.9
18	8.13	9.85	0.37	0.21	3.30	10.5	10.3	7.8
20	8.36	8.82	0.74	0.24	3.17	15.4	15.1	9.6
22	8.11	12.46	0.23	0.29	3.80	15.8	15.2	8.2
Avg.	9.45	6.75	0.59	0.21	2.99	17.7	17.3	12.4
Min	3.47	0.33	0.15	0.03	1.05	2.4	2.0	6.4
Max	19.71	13.94	2.19	0.37	6.11	32.4	32.2	22.9