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Effect of nuclear explosions on the atmospheric potential gradient near the ground

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ABSTRACT. In this paper the available data for atmospheric potential gradient near the ground for Colaba (Bombay) and Poona have been studied and discussed with reference to the ground deposition levels of mixed fission products with a view to find out possible variation of the atmospheric potential gradient on account of nuclear explosions. It is seen that there is no secular change in the atmospheric potential gradient due to nuclear explosions. As evidence in respect of Indian stations is in disagreement with that in respect of certain stations in Europe, further investigation of the problem on a world-wide basis is necessary.

1. Introduction

The possible variation of the atmospheric potential gradient on account of nuclear explosions has been studied by a number of workers such as Harris (1955), Pierce (1957) and Stewart (1960). Harris (1955) compared the records of atmospheric potential gradient from the Tucson Magnetic Observatory with records of the deposition of atomic debris on the ground following the Nevada tests and found that the observed changes were not inconsistent with values computed from theoretical considerations. Later, studies made by Pierce (1957) showed that there was striking decrease in the fine weather potential gradient measured at Eskdalemuir from about 1951 upto 1956, the latest year for which results were then available. Subsequently, values of atmospheric potential gradient upto the end of 1958 at three stations in U.K., *viz.*, Lerwick, Eskdalemuir and Kew together with values from two Portuguese observatories, Lisbon and Oporto, have been discussed by Stewart (1960) and he has found that there is *an unusual decrease* in the values compared to previous years except at Kew where there was no significant change; this has been explained as due to the increased conductivity of air near the ground as a result of the deposition of fission products on the ground.

2. Data utilised and their discussion

In the present note this problem has been examined with reference to the available data for atmospheric potential gradient near the ground for two Indian stations, *viz.*, Colaba (Bombay) and Poona. An increase in the ionisation near the ground caused by fission products from nuclear explosions will increase the conductivity of the air and lower the potential gradient in the lower atmosphere. Vohra and his associates (1960) have studied the ground deposition of fission products from nuclear test explosions at different sampling stations in India for the period 1956—59. One of these sampling stations was Bombay. Table 1 gives the ground deposition levels of mixed fission products for Bombay for 1956—59 obtained by them.

In this table, the yearly potential gradient values of selected "quiet" days based on the departmental records obtained at the Colaba Observatory, Bombay, have also been shown. It will be seen from this table that while the deposition data at Bombay show increase in radio-activity following the atomic tests, the atmospheric potential gradient values near the ground for the corresponding years do not indicate any relationship or secular variation due to nuclear explosions.

The yearly potential gradient values recorded at Colaba and Poona Observatories for some years are given in Table 2.

TABLE 1

Surface fallout and potential gradient at Bombay

Year	Surface fallout (Mc/km²)	Yearly potential gradient values on selected "quiet" days (Volts/metre)
1956	21·6	100
1957	27·7	121
1958	53·8	113
1959	39·6	145

It will be seen that the potential gradient value at Colaba (Bombay) shows an increase and not decrease. The Poona values also do not show any decrease. In a recent paper Yacob (1962) has worked out the monthly mean absolute values of potential gradient based on all days, quiet as well as disturbed, for the 20-year period 1936—1955, and the mean yearly value of potential gradient from these data works out to be 121 V/m. In comparison to this value, the values for the years 1959, 1960 and 1961 are much higher even though there was increased radio-activity during these years.

As regards Poona values, the mean value for 1938 obtained by Sil and Agarwala (1940) was 67 V/m, while the mean value for the years 1957 and 1958 based on records obtained during the I. G. Y. period studied by Sivaraman and Banerjee (1962) was 66 V/m for each of these years. According to Sivaramakrishnan (1962) the normal undisturbed value of potential gradient at Poona is about 90 to 100 V/m. These values of potential gradient do not show any decrease in the value at Poona, compared to previous years, due to nuclear explosions.

TABLE 2

Yearly potential gradient values on selected "quiet" days

Year	Colaba (Bombay)* (Volts/metre)	Poona (Volts/metre)
1938	150	67 **
1952	97	
1953	127	
1954	95	
1955	109	
1956	100	
1957	121	66
1958	113	66
1959	145	
1960	179	
1961	167	

*Based on ten "quiet" days in each month of the year

**Mean value given by Sil and Agarwala (1940) based on hourly values on "quiet" days in each month of the year

3. Conclusion

For Colaba (Bombay) and Poona, therefore, there is no sign of any secular change in atmospheric potential gradient on account of nuclear explosions. As the evidence in respect of Indian stations is in disagreement with that in respect of certain stations in Europe, further investigation of this question on a world-wide basis is necessary in order to get greater insight into the geographical distribution of the effects of deposition of fission products on the ground on account of nuclear test explosions.

4. Acknowledgement

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