Charge Transfer in the Atmosphere by Point Discharge

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1. Introduction

It is generally believed that the total effect of point-discharge currents under a thunderstorm is to bring the net negative charge to the earth's surface. Since different parts of the earth have different thunderstorm activities at various times of the year, they are expected to contribute varying quantities of charge to the earth. Moreover, it is doubtful whether sea surfaces, polar regions and deserts contribute any charge by point discharge as compared to other continental places. Since most of the data available for charge transfer, is confined to higher latitudes and especially because tropical regions are expected to contribute larger quantities of negative charge to the earth by the process of point discharge, it is decided to calculate the net charge brought to 1 km^2 area of the earth for a period of one year at this station.

An artificial point was erected 15.8 m high in the atmosphere and its signal was amplified with a differential type of d.c. amplifier and fed to a strip-chart pen recorder. The point was approximately at the same height as other neighbouring trees.

2. Calculations

The point-discharge current was recorded during a period of one year i.e. from May, 1966 to April, 1967. The areas of the graphs were measured and from there the charge brought to 1 km^2 area of the earth was calculated for each month separately. Table 1 shows the positive and negative charges for each months. From November to February there was no case of point discharge.

The total gives a negative balance of 21.4 mC for the whole year and the ratio of nega-

Table 1

Month	Positive mC	Negative mC
May, 1966	5.40	7.18
June, 1966	10.77	6.14
July, 1966	16.24	22.01
August, 1966	12.18	22.55
September, 1966	5.83	12.69
October, 1966	17.76	10.32
November, 1966	0	0
December, 1966	0	0
January, 1967	0	0
February, 1967	0	0
March, 1967	15.98	21.67
April, 1967	0.36	3.36
Total	84.52	105.92

tive to positive charge to be 1.25. Others who found this ratio for other regions were: *Wormell* (1927) at Cambridge, 2.0; *Whipple and Scrase* (1936) at Kew, 1.7; *Yokouti* (1939) in Japan, 2.1; *Lutz* (1944) at Munich, 2.03; *Chalmers and Little* (1947) at Durham, 1.36; and *Allsopp* (1952) in South Africa, 2.2.

As mentioned in a previous publication (*Kamra*) dust storms produce large negative fields which eventually give rise to point discharge, if we include such cases too, the ratio of negative to positive charge rises to 2.45.

To convert the current through a single point into current density, the effective separation of points has been calculated by using the method of *Chalmers* (1953). It is assumed that all the points to give the same current as from the erected point, are spaced in rectangular arrays with a separation d . It is also assumed that current below a thundercloud consists only of point-discharge current and is equal to the total current of -0.5 amp. above the thundercloud as observed by *Gish and Wait* (1950).

Considering the *Simpson and Robinson* (1936) model of the thundercloud and taking our point to be beneath the centre of the cloud, the field is calculated at 0, 0.1, 0.2 etc. Kms from the point till the field becomes less than the critical to start point discharge. For each ring of width 0.1 km the average field and from that the current per point in that ring is calculated using the relation of *Whipple and Scrase* (1936). The number of points in terms of d , in each ring, being known the total point-discharge current from different rings can be calculated. In our calculations the sum of currents in the central area of positive potential gradients is $+\frac{0.38}{d^2}$, in the surrounding area of negative potential gradients, $-\frac{69.30}{d^2}$ and in the outer area of positive potential gradients, $+\frac{25.77}{d^2}$. So the total point-discharge current below the cloud is $-\frac{43.15}{d^2}$ which should be equal to -0.5 amp. So that the value of d is 9.3 m and thus the total negative charge received per km² of the earth per year is 248 C.

3. Discussion

Thus the negative charge brought down to earth by point discharge in tropical regions is not very much greater than at other continental areas. This unexpected result confirms the theoretical prediction of *Chalmers* (1951) that the total point-discharge current below a thundercloud is independent of the heights of the points. Whether this result shall also hold at sea surfaces, deserts and poles, is yet to be observed as no such estimate for such places is available to the author's knowledge.

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