On the Air - Earth Current

By

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概　　要

I. G. Y. 期間中 Kasemier の方法で空地電流を測定した。測定は多くの困難さがあつて充分ではなかつたが，

1) 静おん日の現象は旬平均ではオームの法則にしたがつている。

2) 伝導電流の日変化は関川氏が計算したものと大体一致している。

3) 対流電流の日変化は約 0.05m/sec の上昇気流と空間電荷から説明され得る。

と云うようなことが分つたので報告するが，さらに完全な測定により充分な議論をもつ機会があたえられることを希望する。

During I. G. Y.(July 1957-1958), the air-earth current was observed directly by Kasemier's method at Kakioka Magnetic Observatory (36° 14′ N, 140° 11′ E). The results are reported here briefly.

1. Equipment.

The outline of this equipment is shown in Fig. 1. As to the more detail, see reference (1).

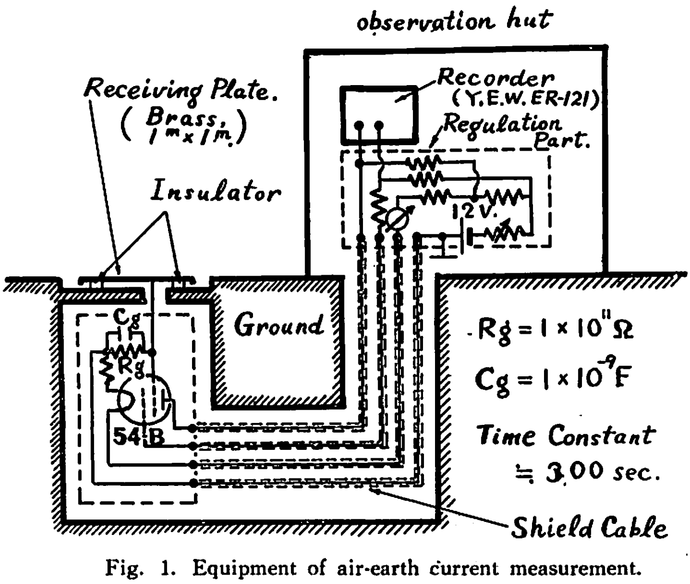

Fig. 1. Equipment of air-earth current measurement.

2. The difficulties in the observation.

We had met with the following difficulties in this observation.

(1) The effect of the field change is not negligible. The time constant of the input impedance of this equipment is shorter than the expected from the relaxation time in the lowest atmosphere. But, this effect may be small in the hourly mean values which are estimated and used in the usual studies.

(2) The leakage. The atmospheric electrical observations are always accompanied with these difficulties because of out-door equipments. In this observation, the receiving plate is mounted near the ground, so this trouble is severe especially.

(3) An abnormal change at night. An example of this change is shown in Fig. 2. As the record shows, the air-earth current is negative during night and change, rapidly into positive at sunrise. This seems to be caused by dew deposit on the receiving plate.

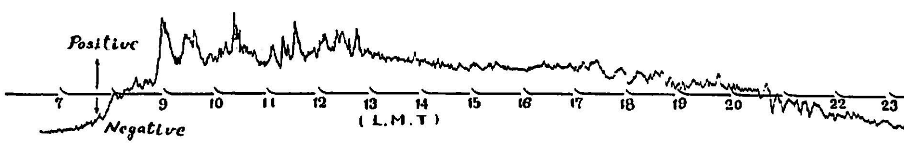

Fig. 2. An example of abnormal change, 16. Aug., 1958, Kakioka.

(4) The contamination of receiving plate with radioactive substance. The receiving plate was polished by sand-paper once or more a month. But this effect could not be neglected as it will be described afterwards.

3. Ohm's law

By the simultaneous observation of three elements, atmospheric electrical potential gradient, conductivity and air-earth current, it may be made sure whether atmospheric electrical change is done in accordance with Ohm's law or not.

$$\text{Ohm's law} \;:\; I=\lambda\times E \tag{1}$$

I : Air-earth current; λ ; Conductivity; E : Potential gradient.

Differentiating with time, the following equation is obtained.

$$\frac{1}{I}\frac{dI}{dt}=\frac{1}{\lambda}\frac{d\lambda}{dt}+\frac{1}{E}\frac{dE}{dt} \tag{2}$$

Therefore, if the change is in accordance with Ohm's law, the variation of the three elements will satisfy the equation (2). The percentage variations of the ten day's mean of each elements in the undisturbed daytime (12h-14h L. M. T.) are shown in Fig. 3. Fig. 4 is a scatter diagram which shows a relationship of $(E-I)$ and λ. It may

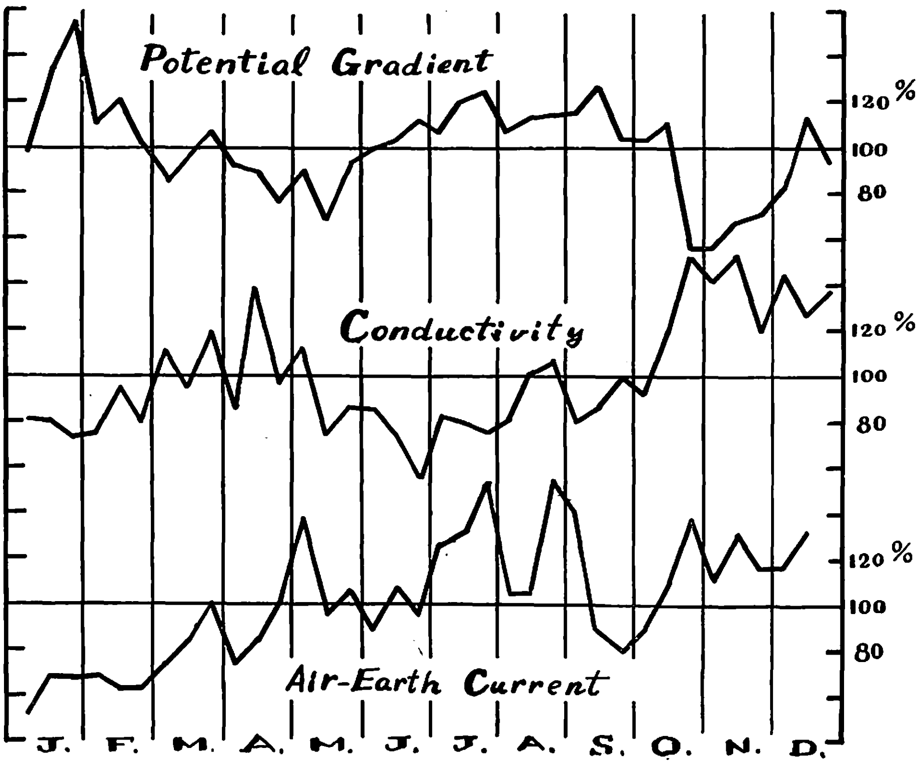

Fig. 3. percentage variation of the ten day's mean.

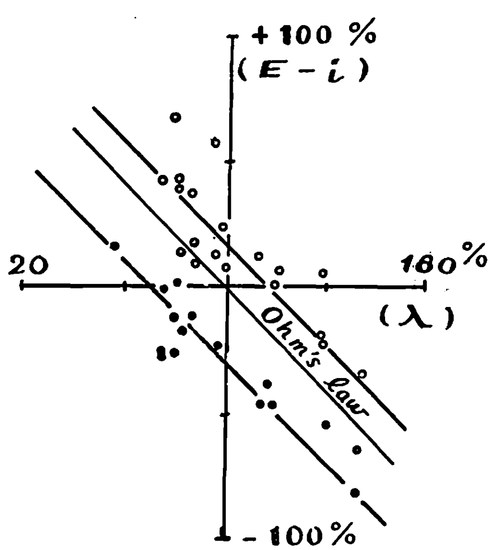

Fig. 4. The Relationship of (E-i) and λ.
○ : first group (no contamination)
● : second group (contaminated)

be seen that 1) there are two groups and 2) Ohm's law is held in both groups.

The radioactivity of fall-out dust in Japan during 1958 is shown in Fig. 5. In this figure, the hatching indicates the periods which the second group in Fig. 4 was observed. These periods correspond roughly to the periods of strong radioactivity. So, it may be supposed that the receiving plate is contaminated with some radioactive substances when the second group is observed.

4. Convectional air-earth current.

One of the subjects of this obse-

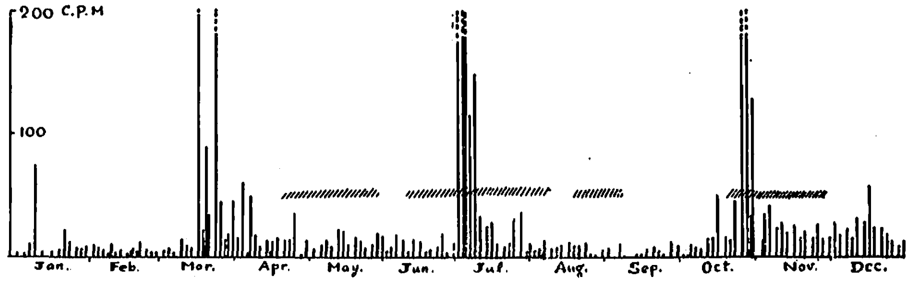

Fig. 5. The radioactivity of foll-out dust in Japan 1958. hatching : the second group (in Fig. 4) was observed.

rvation is a research of convection current. But, by some difficulties in the observation, it is not able to discuss satisfactorily the convection current. Here, its diurnal vari-

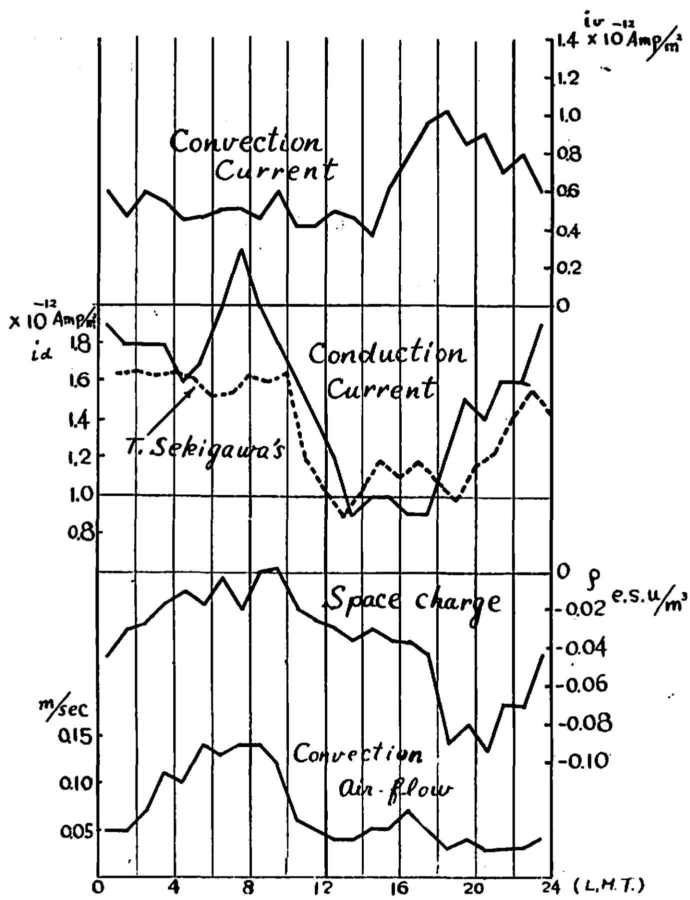

Fig. 6. The diurnal variation of conduction, convection current, and space charge and convection air-flow at Kakioka,1958.

ation is discussed briefly.

The convection current is calculated as follow;

$$i=I-(E\times\lambda) \tag{3}$$

i : convection current; I : observed air-earth current;

$E\times\lambda$: conduction current.

The data at the time when it is not disturbed by hydrometeor, thunder and sand storm are used. And, the mean value is obtained by graphically estimating with an assumption that the distribution of occurrence frequency of each element are same to Gaussian error distribution. These results are shown in Fig. 6. In this figure, the conduction current which have been calculated by T. Sekikawa (2) is also shown for comparison.

Generally, convection current is expressed as follows

$$i=-k\frac{d\rho}{dt} \tag{4}$$

ρ : space charge, k : exchange coefficient.

Since the gradient of space charge was not observed, as the first approximation, the convection air flow is calculated and used as follows,

$$i=-w\rho \tag{5}$$

W : convection air flow.

The observed space charge and the air flow are shown in Fig. 6.

The air flow is up-ward and about 0.05 m/sec.

These matters are very interesting,but, by some difficulties in observation, it is not able to discuss sufficiently. The author hopes to have next chance to observe the air-earth current without any difficulties.

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Reference

1) M. Misaki, M. Kawamura and G. Kondo : On the measurement of the Air-Earth Current at Kakioka : Memoirs of the Kakioka Magnetic Observatory Vol. 8. No. 2, p. 33.

2) T. Sekigawa : On the Diurnal Variation of Air-Earth Current at Kakioka; Memoirs of the Kakioka Magnetic Observetory Vol. 8, No. 1, p. 75.