ERRATA

Page	Line	Read	For
22	equation (1)	$\bar{\mathrm{P}}$	P
	9	46.8 γ	4.8γ
	9	21.8 γ	2.8γ
	Fig.3	Upper line : A Lower line : B	

A Note on the Distribution of Dst of the Geomagnetic-north Component

By

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概　　要

最近 S. Cpapman と杉浦教授は磁気嵐の分類につき立派な労作を発表されつゝある．この小文はこれにもとずき Dst の分布に関連して若干の意見をのべた．

1. Any acceptable theory of the geomagnetic storms, even if it is Chapman-Ferrarolike or based on hydromagnetic consideration, should be able to explain at least their basic characteristics of the worldwide distribution, although we have had yet no satisfactory morphology. However, recently, Sugiura and Chapman [1] have published a series of the result of elaborate and excellent statistical works on the new mode of morphology of geomagnetic storms. According to their results, the maximum depression of averaged Dst of the geomagnetic-north component, Hgm, which is measured from the pre-storm level, is distributed against cos Φ as illustrated in Fig. 1, where Φ is the geomagnetic latitude. At first glance it seems that there is no definite relation between two quantities, but merely shown a general tendency of increase of Hgm with increasing cos Φ, whereas Dst has been generally believed to be caused by an equatorial ring current. In the middle latitudes, however, one can notice fairly well a linear relation as shown by Hgm$=\alpha_{m(w)}$. cos Φ in Fig. 1. where suffixes w and m stand for the averaged weak and moderate magnetic storms, respectively. As pointed out by the authors mentioned above, this discrepancy of the distribution between middle and high or equatorial latitudes

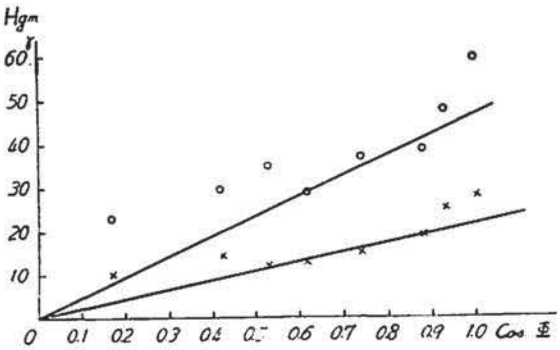

Fig. 1. ○ Moderate storms × Weak storms

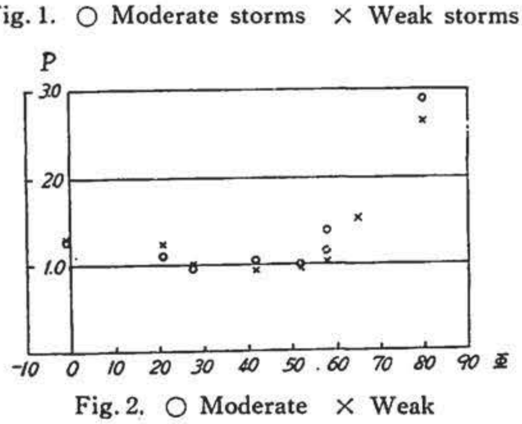

Fig. 2. ○ Moderate × Weak

is entirely independent of the magnitude of storms, because there are no significant differences of the ratio (Hgm)m/(Hgm)w, or the value of P=Hgm/(Hgm)cal. between weak and moderate storms as shown in Fig. 2, where (Hgm) cal. is caculated from $\mathrm{Hgm}=\alpha_{m(w)}.\cos\Phi$. Then, P may be considered as a terrestrial constant. The mean value of Pm and Pw, $\bar{P}$, is called here a distribution coefficient of Hgm and given in Table 1. Thus the relation between Hgm and cos Φ will be expressed all over the world as shown in Fig. 3 by

$$\mathrm{Hgm}=\alpha_{m(w)}\cdot \mathrm{P}\cdot\cos\Phi, \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (1)$$

where α_m is 4.8γ and α_w 2.8γ.

Table 1. Distribution coefficient $\bar{P}$ of Hgm.

Φ	80°	65°	58°	52°	42°	28°	21°	-1°
$\bar{P}$	2.76	1.52	1.22	0.99	1.00	0.98	1.18	1.28

The value of (Hgm) m at Φ=58° so deviates from the line that it seems to contain some irregularities which were not averaged, and so for reference Hgm at 11 hr is shown together in Fig. 2 and Fig. 3 by the broken circular point.

2. On the other hand, if there is a ring current flowing around the earth in the geomagnetic equatorial plane at the distance R from the earth's center, and no terrestrial interactions are considered, the geomagnetic-north component on the earth's surface due to the ring current itself is approximately given by $2\pi(\mathrm{I/R}).\ \cos\Phi$, where I is the total current flowing in the ring. Then, if the ring current is fully responsible for the observed Dst, the following modified expression should be preferred to it,

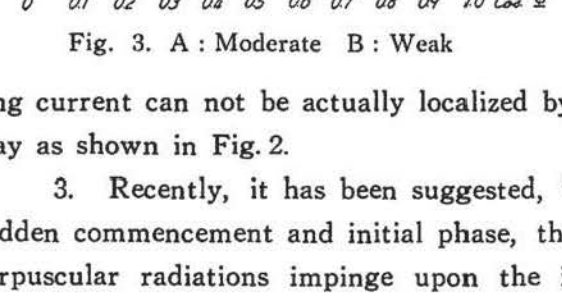

Fig. 3. A : Moderate B : Weak

$$\mathrm{Hgm}=2\pi(\mathrm{I/R}).\ \bar{\mathrm{P}}.\ \cos\Phi\cdots\cdots(2)$$

Of course, this expression will be accepted phenomenologically as due to an equivalent ring current, including terrestrial control on the storms, because the magnetic field due to a simple ring current can not be actually localized by itself on the earth's surface in such a way as shown in Fig. 2.

3. Recently, it has been suggested, based on the precise investigations of the sudden commencement and initial phase, that in the auroral zone some of the solar corpuscular radiations impinge upon the ionosphere as early as the time of the commencement of the magnetic storm, while in the magnetic equatorial belt there exists an intimate connection between the variations of Sq and abnormal enhancements of SC or initial phase in daytime hours. [2] On the other hand, the sharp

increase of $\overline{P}$ in high and especially in equatorial latitudes remind one at once of a similar distribution of the electrical conductivity of the ionosphere. So, as far as the terrestrial control on the effect of the ring current is concerned, it is natural to consider that the distribution coefficient $\overline{P}$ may depend mainly upon the increased ionization in the ionospheres during the main phase.

The height-integrated electrical conductivity of the ionosphere has been estimated by several authors from the dynamo-theoretical point of view, among which T. Sato [3] assigned the range 2—4 to the ratio of that in the auroral latitude to that in the middle one on disturbed days. His estimation is approximately equal to $\overline{P}$. At Huancayo ($\Phi=-1^{\circ}$) the averaged range of the horizontal intensity is larger about two times that in the immediately outer zone of a narrow belt of $\pm 7^{\circ}$ from the magnetic equator. [4] Recently several authors tried to formularize the S_q-field inclding larger amplitude near the magnetic equator by using new data of ionospheres by rockets and others. Some one estimated or assumed the effective conductivity in the equatorial belt as large as two or three times, and others a few times [5], that in the middle latitude. Concerning the electrical state of the outer atmosphere, which may play an important role for the phenomena of earth-storms, we have yet little quantitative knowledge to be discussed.

4. If the above equivalent ring current changes its radius in accordance with the magnetic intensity observed on the earth's surface, the ratio of the total current for moderate and weak storms Im/Iw is given by (1) and (2), and shown in Table 2 with respect to Rm/Rw. The cases of Rm/Rw<1 will be more practicable considering the southward shifting of the auroral zone with increasing intensity of magnetic stoms.

Table. 2.

Rm/Rw	1/4	1/2	1	2	3
Im/Iw	0.54	1.08	2.15	4.30	6.45

In the same way the relation between Mr/M and R/a is calculated in Table 3, where the magnetic moment of the ring is $Mr=\pi R^2 \cdot I=1/2 \cdot Hr \cdot R^3$, and $M=Ho \cdot a^3$ that of the earth, and a the radius of the earth.

Table 3.

Mr/M		1/50	1/30	1/20	1/10	1/5
R/a	m	3.1	3.7	4.2	5.3	6.7
	w	4.0	4.7	5.4	6.9	8.6

5. As to Dst of the initial phase, the maximum deviations from the pre-storm level, (Hgi) m and (Hgi) w, are scaled out from the Sugiura's original graphs and reproduced in Fig. 4. Except Huancayo the correlation between (Hgi) m and cos Φ is statistically highly significant, while for (Hgi) w it is less significant. One may, however, have approximately following linear expressions in the middle latitudes,

$$(Hgi)m=12.3\gamma\cdot\cos\Phi,\quad (Hgi)\,w=14.4\gamma\cdot\cos\Phi \quad\cdots\cdots\cdots(3)$$

The values of P's calculated from (3) are abnormally larger at Huancayo than in any other latitude. They show no significant difference between main and initial phases for moderate storms contrary to the case for weak storms as given in Table 4. In respect to this interesting point Sugiura's next paper on the great storm will afford an important suggestion to the origin of the geomagnetic storm.

Table. 4.

P Huancayo	Moderate	Weak
Main Phase	1.30	1.27
Initial Phase	1.21	1.81

For the sake of simplisity, if the raise of the initial phase be assumed to the effect of Chapman's infinite perfectly conducting plane approaching the earth with a normal velocity to the earth's dipole axis, the expectable geomagnetic-north component on the earth's surface is given by,

$$Hgi\sim M\cdot\cos\Phi/(2d+a)^3, \quad\cdots\cdots(4)$$

where d is the distance between the center of the earth and the assumed perfectly conducting plane. The value of $v=d/a$ at the maximum deviation of the initial phase is estimated from (3) and (4), or Fig. 4, and given in Table 5. If the plane comes to a stop at the distance d, the estimated equivalent number of ions per c.c are about 2 protons for storms in such a scale as treated here. [6]

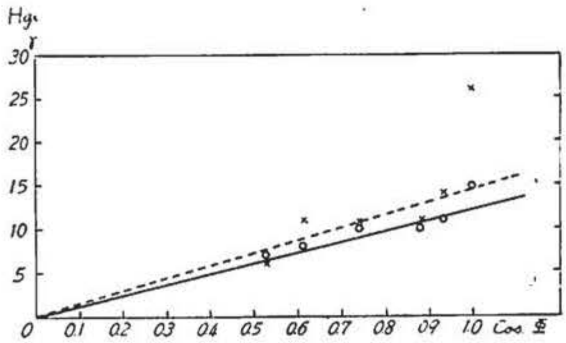

Fig. 4. A(×) Weak storms
B(○) Moderate storms

Table. 5.

	Weak	Moderate
v	6.0	6.3

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