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COMMENT ON "THE SEMIANNUAL VARIATION OF GREAT GEOMAGNETIC STORMS AND THE POSTSHOCK RUSSELL-MCPHERRON EFFECT PRECEDING CORONAL MASS EJECTA" BY N. U. CROOKER, E. W. CLIVER AND B. T. TSURUTANI

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Crooker et al. [1992] showed examples of a pronounced semiannual variation (at a 100% level or more) of great geomagnetic storms (Peak Dst <-250 nT and equivalent thresholds). Another similar example for a range of intense storms (Peak Dst <-100 nT) has also been presented by Gonzalez and Tsurutani [1992].

For a subgroup of such major storms, for which the associated strong southward IMF (B_S) fields reside in the postshock plasma, preceding the driver gas of coronal mass ejections (CMEs), Crooker et al. propose that such strong B_S fields result from a "major increase in the Russell-McPherron polarity effect, through a systematic pattern of compression and draping" of the Archimedean field in the x-y plane. The authors suggest that this effect would lead to a strong semiannual variation in the postshock B_S field intensity, thus contributing to the pronounced semiannual variability of major storms.

The Crooker et al. paper is a good advancement towards understanding the causes of the seasonal variability of intense geomagnetic storms. Stimulated by this work we test in these comments the scenario proposed by Crooker et al., namely that the Russell-McPherron polarity effect is a major contribution to the semiannual variability of intense geomagnetic storms. In a previous work [Clúa de Gonzalez et al., 1993] we have reviewed on the importance of this polarity effect concerning the semiannual variability of geomagnetic activity in general.

For the purpose of our present study we use IMF data related to ten intense storm events (-250 nT < peak Dst < -100 nT) and to five great storm events (peak Dst < -250 nT) studied by Tsurutani et al. [1988] and Tsurutani et al. [1992], respectively. Out of these events seven intense storms and two great storm events served for our study. The other six events were neglected due to the presence of large data gaps in three of them and to the fact that the other three did not occur within equinoctial months (August to October and February to April).

The Russell-McPherron polarity effect [Russell and McPherron, 1973] can be computed through a coordinate transformation from Geocentric Solar Ecliptic (GSE) to Geocentric Solar Magnetospheric (GSM) coordinates using the B_y and B_z components of the IMF. We have performed this transformation for the nine events of our present study. Figures 1a and 1b illustrate this transformation for the events of September 18, 1979 and of February 21, 1979, respectively.

This coordinate transformation can lead to a larger or smaller B_S in GSM coordinates depending on the sign of B_y and on the equinox involved. For instance, a toward polarity ($-B_y$) causes an added projected amplitude to B_S in March, but if the polarity is away ($+B_y$) the net B_S field in GSM coordinates becomes s n example of the latter c

From this coordinate transformation we have seen that the amplitude of (GSM) B_S in our studied events does not change much from that of (GSE) B_S. As observed in Figures 1a and 1b, such a change exists only at a 20% to 30% level, but in both directions, sometimes B_S becomes larger and sometimes smaller in GSM.

In order to quantify the results of this coordinate transformation study we show in Table 1 the integrated B_S value for the main phase interval of each storm in both coordinate systems, together with the (%) increment obtained in GSM coordinates. This table also shows the amplitude of peak B_S in both coordinate systems, together with the (%) increment in GSM. Peak B_S can be considered as being an indicator of the storm intensity since it has been observed to occur only one to two hours before peak Dst (which is the most acceptable indicator of storm intensity). Since it is known that peak Dst depends also on some sustained character of B_S [e. g. Gonzalez and Tsurutani, 1987] both, the

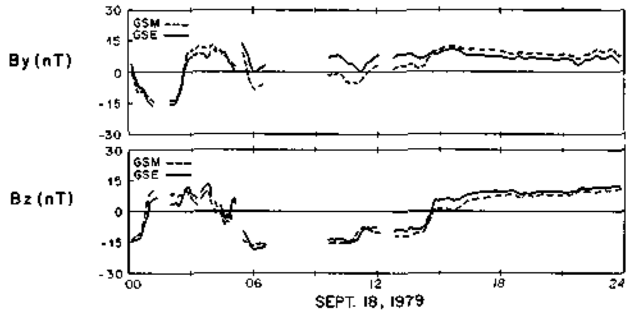

Fig. 1a. IMF B_y and B_z in Geocentric Solar Ecliptic (GSE) coordinates, as measured by the ISEE-3 satellite, and in Geomagnetic Solar Magnetospheric (GSM) coordinates for the intense storm of September 18, 1979.

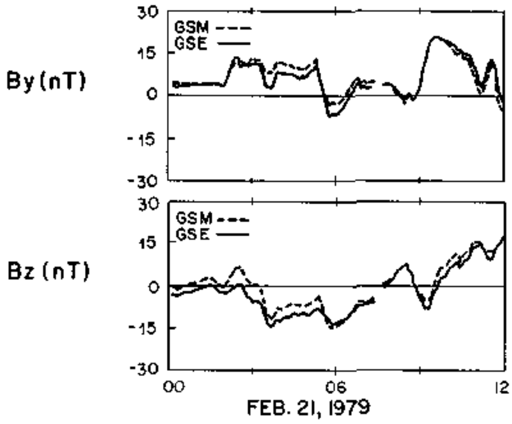

Fig. 1b. The same as in Figure 1a for the intense storm of February 21, 1979.

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integrated value of B_S (during the main phase) as well as its peak value, need to be inspected in order to search for basic differences in the coordinate transformation study.

From an event to event basis the level of increase, or decrease, in peak B_S from GSE to GSM never exceeds a 25% level in Table 1. This is also the case with the integrated value of B_S, with exception of the event of September 29, 1978. Although with data gaps this event seems to support the validity of the Crooker et al. scenario, for which the Russell-McPherron effect could have contributed with a 43% increment through a sustained B_S effect.

Discussion

Our present test study, involving nine intense and great storms, has shown that one of these events seems to correspond to the scenario proposed by Crooker et al., at least at a level of confidence by which one can suggest that the Russell-McPherron polarity effect is an important contribution towards explaining the seasonal variability of this class of storms.

However, since the majority of the studied events showed only a small variability in the sustained and peak B_S values when transforming from GSE to GSM coordinates, we are forced to conclude that additional mechanisms need to be researched in order to understand the seasonal variability of intense storms. This conclusion supports the well known idea that other (e.g. axial, reconnection efficiency) effects need to be also considered, in addition to the Russell-McPherron polarity effect [e. g. Green, 1984; Crooker and Siscoe, 1986; Clúa de Gonzalez et al., 1993] when dealing with the origin of the seasonal variability of geomagnetic activity.

Figure 2 shows a monthly distribution of the large and long duration (GSE) B_S fields that were argued to be the cause of the intense storms studied by Tsurutani et al. [1988]. Although limited in statistics this distribution suggests that mechanisms of the "axial" type can add an important contribution to the seasonal distribution of intense storms, thus supporting the conclusion given above.

One additional aspect involved in the Crooker et al. scenario deserves some consideration. This refers to the geometry of draping. Crooker et al. assume that draping occurs in the x-y plane. However, since the B_S and B_Y components of the (GSE) IMF typically have similar amplitudes and in some instances the B_S field amplitude is even almost totally equal to that of the full IMF, one can argue that draping in the x-z plane can become more important than that in the x-y plane, as suggested by Tsurutani et al. [1992].

TABLE 1

A.- Intense Storms (peak Dst < -100 nT)

EVENT	peak B_Z (nT) GSE	peak B_Z (nT) GSM	Incr. (%)	$\int B_Z.dt$ (nT-hr) GSE	$\int B_Z.dt$ (nT-hr) GSM	Incr. (%)
Aug. 28*, 78	-22.0	-24.5	11.4	-36.2	-39.9	10.2
Sep. 29 *	-26.0	-22.1	-15.0	-35.2	-50.3	43.2
Feb. 21, 79	-14.1	-15.7	11.3	-40.0	-31.4	-21.5
Mar. 10	-12.4	-15.0	21.0	-50.6	-58.2	15.0
Mar. 29	-9.7	-10.9	12.4	-72.1	-67.0	-7.1
Aug. 29	-13.8	-12.1	-12.3	-73.3	-86.2	17.7
Sep. 18*	-19.3	-17.4	-9.8	-53.9	-59.3	10.1

(*) With data gaps

B.- Great Storms (peak Dst < -250 nT)

EVENT	peak B_Z (nT) GSE	peak B_Z (nT) GSM	Incr. (%)	$\int B_Z.dt$ (nT-hr) GSE	$\int B_Z.dt$ (nT-hr) GSM	Incr. (%)
Apr. 13, 81	-30.7	-23.2	-24.4	-105.3	-94.5	-10.2
Sep. 6, 82	-20.8	-20.3	-2.4	-116.5	-120.5	3.5

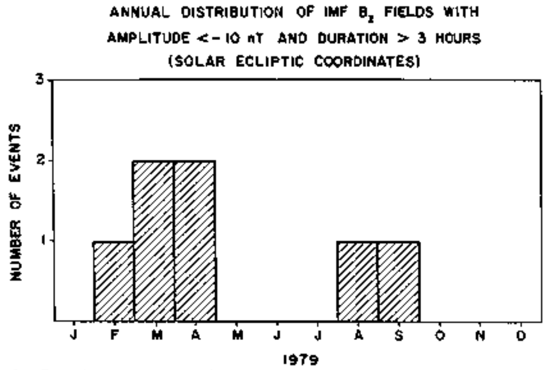

Fig. 2. Semiannual distribution of the IMF B_Z component, in GSE coordinates, with amplitudes <-10 nT and duration > 3 hours for the year 1979, as observed by the ISEE-3 satellite.

In conclusion, we have shown the data for the peak and integrated B_S values of nine intense and great storm events, in both GSE and GSM coordinates. We note that in the cases studies, there is little difference between the B_S values as measured in GSE and GSM coordinates and conclude that the Russell-McPherron mechanism cannot explain (just by itself) the seasonal dependence of intense storms, for which the variation is the largest. We feel that other mechanisms should be explored and investigated as well.

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