Indian Journal of Radio & Space Physics
Vol 12, April 1983, pp 53-55

Communications

Abnormal Quiet Days & the Effect of Geomagnetic Activity on the Diurnal Variation of Equatorial Geomagnetic Field

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Received 27 *November* 1982, *revised received* 10 *January* 1983

It is shown that a conspicuous noontime positive deviation in the asymmetric component of the H field at equatorial electrojet stations, associated with the solar wind on quiet days with $A_p \sim 5$, does not manifest if 'abnormal quiet days'(AQDs) and hence the influence of counter-electrojet conditions associated with them are taken into consideration. It is pointed out that the noontime positive swing of the asymmetric component in the H field on quiet days with $A_p \sim 5$ at electrojet stations is primarily due to changes in the local ionospheric dynamo region rather than in the solar wind.

The search for and estimation of the influence of currents of non-ionospheric origin on the geomagnetic field is a topic of extensive studies for more than a decade now[1-4]. Bhargava and Yacob[5] reported an appreciable component associated with the solar wind in the diurnal variation of H field at the low latitude station Alibag. Recently, Rangarajan[6] examined the changes in the diurnal variation of H field with the level of geomagnetic activity at the two stations Trivandrum (geogr coord 8°29'N, 76°57'E, dip 0.6°S) and Alibag (geogr coord 18°38'N, 72°52'E dip 24.5°N) in the Indian equatorial region. He found the asymmetric component in H field associated with the solar wind corresponding to quiet days with $A_p \sim 5$ to show striking positive (northward) values for a few hours around local noon, but only at Trivandrum and not at Alibag, i.e. restricted to the electrojet region. He interpreted this interesting feature as a noontime enhancement of the electrojet strength for the particular level of geomagnetic activity ($A_p \sim 5$) and surmised that the enhancement may be brought about by changes in the bulk speed and/or number density of the solar wind.

It has been established that marked depressions in H field lasting for a few hours occur frequently during daytime on quiet as well as very quiet days in the equatorial electrojet regions at different local times, with practically no concurrent changes at stations outside the electrojet belt. These decreases in H field are referred to as 'counter-electrojet' (CEJ) conditions, and are widely considered to represent reductions in electrojet strength brought about by changes in the characteristics (e.g. winds) of the local ionospheric dynamo (90-130 km) region[7,8]. Very recently, Sastri[9,10] showed that the incidence of abnormal $Sq(H)$ phase at equatorial stations (located inside and just outside the electrojet belt), described in terms of the nomenclature of 'abnormal quiet days' (AQDs) introduced by Brown and Williams[11], is essentially due to a suppression of the quiet day Sq and electrojet field around the usual time (1100 hrs LST) of its diurnal maximum, and is closely associated with the CEJ phenomenon. For an electrojet station, AQDs are defined as quiet days on which the diurnal maximum of H field occurred outside the time interval 0930-1230 hrs LST (Ref. 12). The nature of abnormal Sq(H) phase depends on the time of manifestation of CEJ conditions relative to the normal time (around noon) of diurnal maximum of H field. PM AQDs (days with H field maximum later than 1230 hrs LST) would result if CEJ conditions occur just prior to the normal time of diurnal maximum, and if CEJ conditions set in just after the normal time, AM AQDs (days with H field maximum earlier than 0930 hrs LST) occur. It is quiet plausible, therefore, that the noontime northward (positive) swing of the asymmetric component in H field at electrojet stations on quiet days with $A_p \sim 5$ might be due to a noontime decrease in electrojet strength (due to a predominant occurrence of AQDs) on very quiet days ($A_p = 0$-1) in comparison to quiet days. In this communication, we report evidence that strongly supports such an understanding.

Scrutiny of the planetary geomagnetic activity index A_p showed the occurrence of 41 very quiet days with $A_p = 0, 1$ over the period 1959-77. Magnetically quiet days with $A_p = 4, 5$ which were as close as possible to these very quiet days are selected, to maintain the field of internal origin and the variations associated with season and phase of sunspot cycle, while computing the asymmetric component in H field on quiet days Further, in selecting both very quiet and quiet days, days which occurred within 2 days to international

disturbed days (IDDs) are eliminated. A data sample of 39 pairs of very quiet and quiet days became available for study. Examination of the time of diurnal maximum of H field from published data of the electrojet station Trivandrum showed that, out of the 39 very quiet days, 8 days were AQDs (6 PM AQDs, 2AM AQDs). The abnormal $Sq(H)$ phase is found confined to the electrojet region on 5 out of these 8 AQDs. In contrast, none of the 39 quiet days is an AQD, clearly indicating a preferential occurrence of AQDs on very quiet days in the data sample. Following accepted practice[5,6], the original hourly H field data are corrected for non-cyclic variation and the average diurnal variation of H field is evaluated for the two groups of quiet days. The diurnal development of the asymmetric component in H field associated with the solar wind on quiet days with $A_p \sim 5$ is then derived by subtracting the diurnal variation on very quiet days from that on quiet days.

Fig. 1 depicts the diurnal development of the asymmetric component in H field on quiet days. A striking noontime northward (positive) deviation of the asymmetric component is apparent, confirming the earlier work of Rangarajan[6]. The asymmetric component is now recomputed deleting from the data sample the 8 AQDs from the group of very quiet days. The result that the asymmetric component thus computed does not exhibit the short-lived northward deviation around local noon can be clearly seen from Fig. 1. The fact that the presence of AQDs in the group of very quiet days in the data sample significantly alters the behaviour of the asymmetric component in the H field on days with $A_p \sim 5$ may also be seen from the development of asymmetry corresponding to AQDs in the data sample, shown in the lower panel of Fig. 1 It is thus evident that once the influence of CEJ conditions associated with the occurrence of AQDs is eliminated, the asymmetric component in H field corresponding the A_p level ~ 5 assumes predominantly negative values. Another data sample is formed by picking out a second quiet day for each of the 39 very quiet days of the first data sample to confirm this behaviour. A fresh data set of 27 pairs of very quiet and quiet days became available. In this second data set, unlike in the first one, out of the 27 quiet days 4 were AQDs (2PM AQDs and 2 AM AQDs), and in the group of corresponding quiet days 3 were AQDs (1 PM AQD and 2 AM AQDs), i.e. the occurrence of AQDs and hence the influence of CEJ conditions associated with them are more or less the same for the two groups of quiet days. Out of the 7 AQDs in the second data set, 6 are found confined to the electrojet region. So, if the noontime positive swing of the asymmetric component in H field on quiet days is due to the influence of CEJ conditions associated with the occurrence of abnormal $Sq(H)$ phase on very quiet days, as anticipated and as evidenced from the analysis of the first data set, then the asymmetric component derived from the second data set should not exhibit such a feature, irrespective of whether AQDs are included or excluded from the sample. That this is the situation becomes evident from Fig. 2 which shows, in the same format as Fig. 1, diurnal variation of asymmetric component for the second data sample.

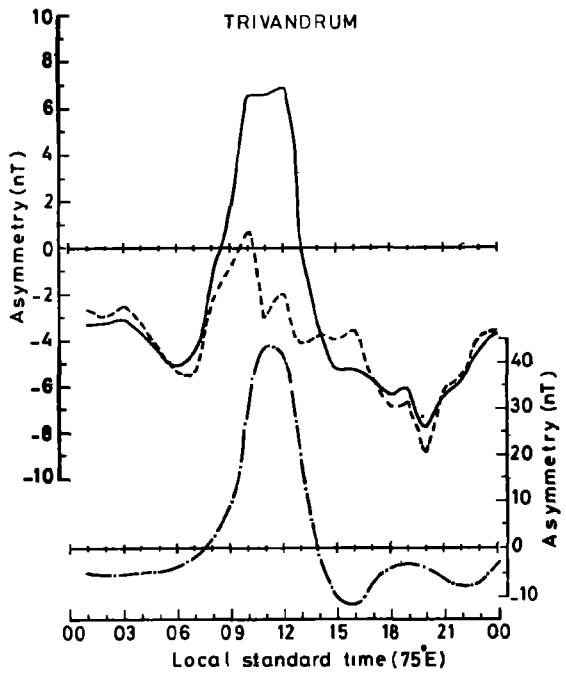

Fig 1—Diurnal development of the asymmetry in H field at equatorial electrojet station Trivandrum on quiet days with $A_p \sim 5$, derived as the difference of average diurnal variation (computed from 39 days) on quiet days from that on extremely quiet days with $A_p = 0\text{-}1$ (solid curve) [The dashed curve represents the development of the asymmetry when AQDs are deleted from the group of extremely quiet days in the data sample. The curve(- - -)in the lower panel represents the development of the asymmetry corresponding to AQDs in the data sample]

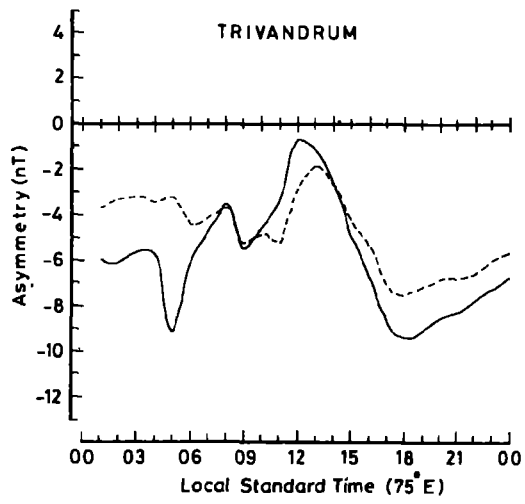

Fig. 2—Same as in Fig. 1 but for another data sample

The results obtained here thus suggest that the shortlived noontime positive swing of the asymmetric component in H field at electrojet stations on quiet days with $A_p \sim 5$ is not due to an enhancement of electrojet strength on quiet days, but is due to a reduction of electrojet strength on extremely quiet days ($A_p = 0$-1) associated with the occurrence of AQDs in that region. It is difficult to offer an explanation at the moment as to why the asymmetric component for days with $A_p = 8$-10 does not exhibit a noontime peak when the electrojet weakens on very quiet days due to CEJ effects. It is possible that with increase in level of geomagnetic activity, disturbance effects of non-ionospheric origin dominate the diurnal variation of H field.

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