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Behavior of the Sq Diurnal Magnetic Variation over Egypt

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Abstract: The diurnal variation of the solar quiet (Sq) in the geomagnetic north-south component (H) and geomagnetic east-west component (D), along the Magnetic Data Acquisition System (MAGDAS) stations in Egypt during year 2009 have been studied. MAGDAS was successfully installed at two stations in Egypt Fayum (FYM) and Aswan (ASW). Several forms of Abnormal Quiet Days (AQDs) have been found in both of Sq (H) and Sq (D). These AQDs of Sq (H) are expected to be related to counter or reversed electrojet while AQDs of Sq (D) is presumably due to the currents of the (2, 3) mode.

Keywords: Solar quiet (Sq), MAGDAS, Abnormal Quiet Days (AQDs).

Introduction

[1] postulated that the daily oscillations in ground magnetic records originate from dynamo action in the upper atmosphere. The daily variation in the magnetic field at the Earth's surface during the geomagnetic quiet condition is generated by the mid-latitude ionospheric current system driven by solar heating and forcing from tidal winds in the E-region of the ionosphere. [2] suggested that the day-to-day variability of Sq is due to the variations in dynamo driving force rather than variations in conductivity. [3] showed a reversal of daily variation at Addis Ababa which was named the 'Counter Electrojet' by [4]. According to [5] the quiet year with the low sunspot number have more abnormal quiet days than the active years. He showed that there are a greater number of abnormal quiet days in winter than in summer in stations located in the southern hemisphere.

Magnetic Data Acquisition System (MAGDAS) was successfully installed at two stations in Egypt. Fayum (FYM) is the first station which enables us to monitor the geomagnetic field over central Egypt [6]. The second station called Aswan (ASW) is successfully installed in Upper Egypt at Aswan city. The PI of the MAGDAS Project, (fig. 1), and the Director of Space Environment Research Center (SERC) is Professor K. Yumoto of Kyushu University, Japan. The goal of MAGDAS is to become the most comprehensive ground-based monitoring system of the earth's magnetic field [7].

Data Set

Data set were obtained from MAGDAS stations in Egypt, FYM and ASW. The geomagnetic and geographic locations of both stations are given in Table (1).

The ten international quietest days were provided by the German Research Center for Geosciences (GFZ) at the website (http://www.gfz-potsdam.de). The data was selected carefully during year 2009 which lies at the solar-activity-minimum year. The data not cover all quiet days in 2009 because of gaps or missed data occurred in both stations.

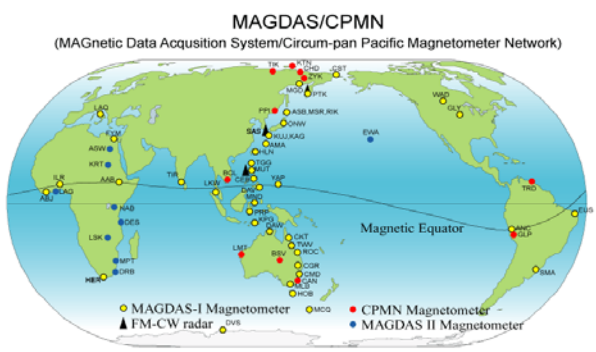

Fig.1. MAGDAS/CPMN (MAGnetic Data Acquisition System/Circum-pan Pacific Magnetometer Network) system of the SERC, Kyushu University [7]

TABLE 1. The geomagnetic and geographic locations of FYM and ASW stations.

Station	Code	G.G Lat.	G.G Long.	G.M Lat.	G.M Long.
Fayum	FYM	29.30	30.88	21.13	102.38
Aswan	ASW	23.59	32.51	15.20	104.24

Observations and results

In this paper H and D component are orthogonal to each other in the geomagnetic coordinate system. The datum line was calculated to be the average value of the night time hours value, however, the determination of the datum level of the geomagnetic quiet daily variation is difficult because of a lack of knowledge on the electromagnetic state of the night-side ionosphere. Some researchers as [8] assume the zero level to be the daily mean of Sq field variations, allowing for some amount of night-side Sq currents. Meanwhile, other researchers as [9] prefer to use the mean of nocturnal values as the zero level.

This work adopted the definition of Abnormal Quiet Days (AQDs) for Sq (H) as given by [10] and [11]. They defined AQDs as days on which the diurnal maximum of H component occurred outside the time interval 0930-1230 LT. [12] defined the days when Sq (D) shows eastward field in the morning hours and westward field in the afternoon hours as Normal Quiet Days (NQDs). Meanwhile, the days when Sq (D) shows westward field in the morning hours are defined as Abnormal Quiet Days (AQDs)

Figures 2-9 show some results obtained from ASW and FYM stations. In figure 2 and 6 there are NQDs of the Sq (D). Its variation has maximum value at 0900 LT, changing to westward-directed field around 1000 LT with minima at 1200 LT. Figure 3 and 7 shows AQDs of the Sq (D) which have secondary peak observed in the eastward field around 1700 LT and 1600 LT respectively.

The results as seen in Figure 4 and 8 show the NQDs at Sq (H) with a peak observed around the normal noon hour local time. The diurnal maximum of Sq (H) occurs within the time interval 0930-1230 LT as had earlier been defined. But analysis shows that there is an indication of Sq (H) reduction shown in Figure 5 instead of enhancement. Also in Figure 9 there is similar case where there is a noticeable decreasing in the Sq (H) and with maximum occurring outside the defined time interval (0930-1230 LT).

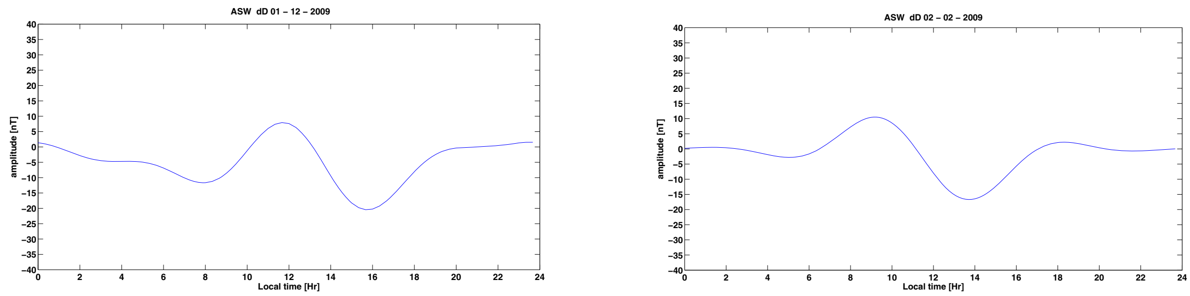

Fig. 2. Normal quiet daily variations of D component at Aswan station in January and February, 2009.

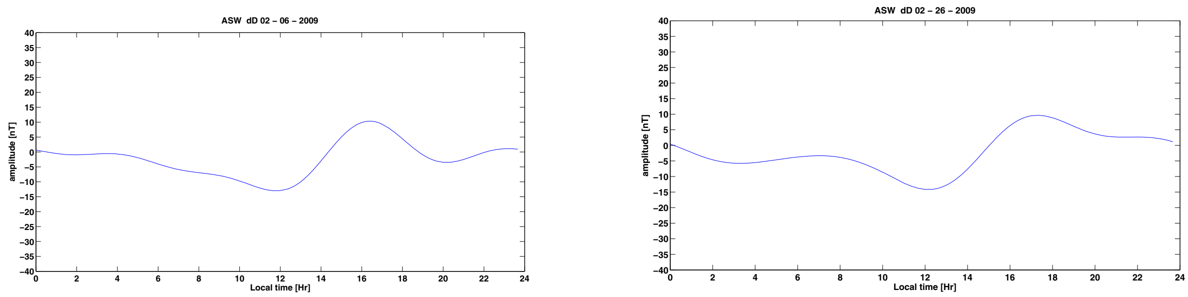

Fig. 3. Abnormal quiet daily variation of D component at Aswan station in February, 2009.

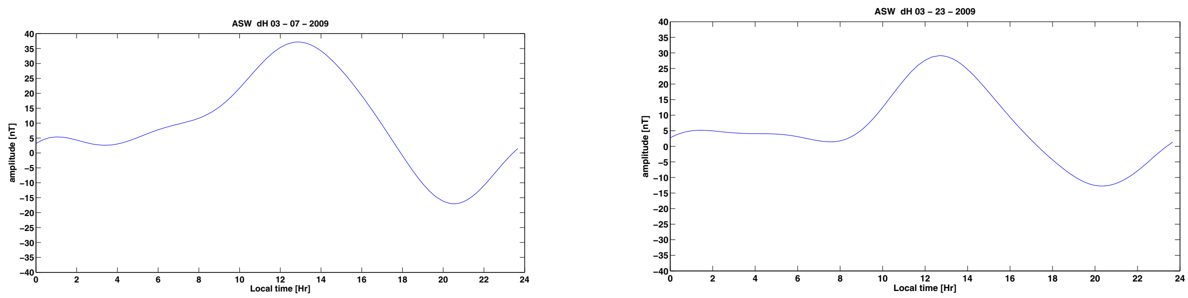

Fig. 4. Normal quiet daily variations of H component at Aswan station in March, 2009

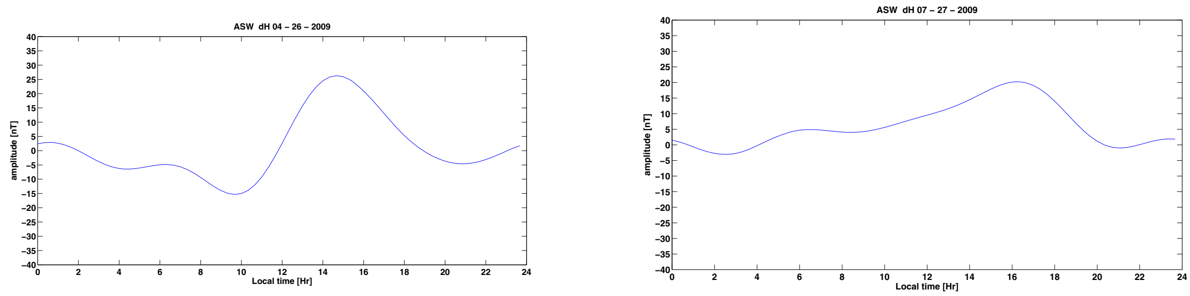

Fig. 5. Abnormal quiet daily variations of H component at Aswan station in April and July, 2009.

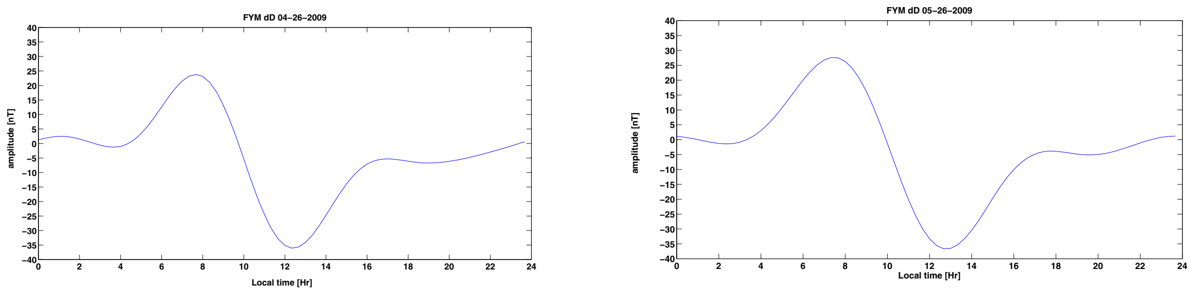

Fig. 6. Normal quiet daily variations of D component at Fayum station in April and May, 2009.

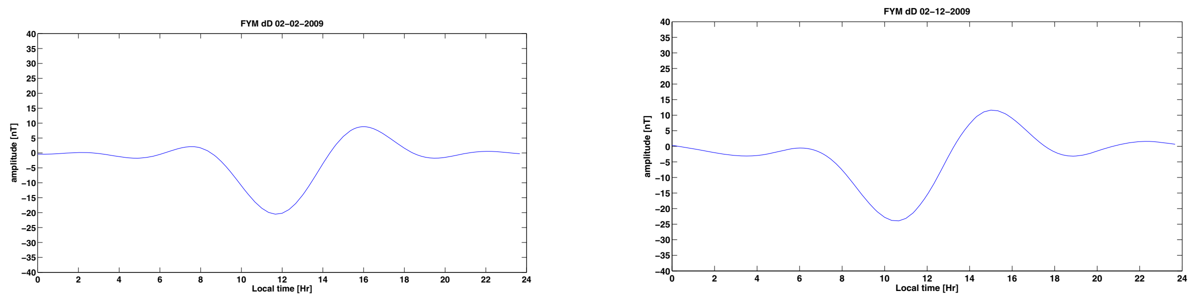

Fig. 7. Abnormal quiet daily variations of D component at Fayum station in February, 2009.

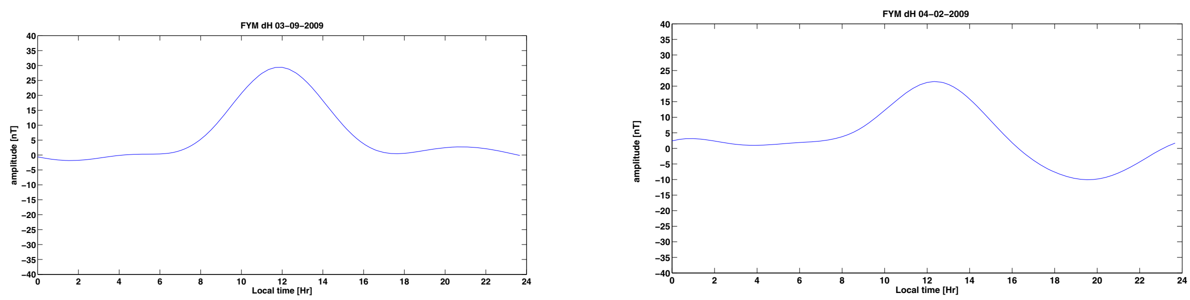

Fig. 8. Normal quiet daily variations of H component at Fayum station in April, 2009.

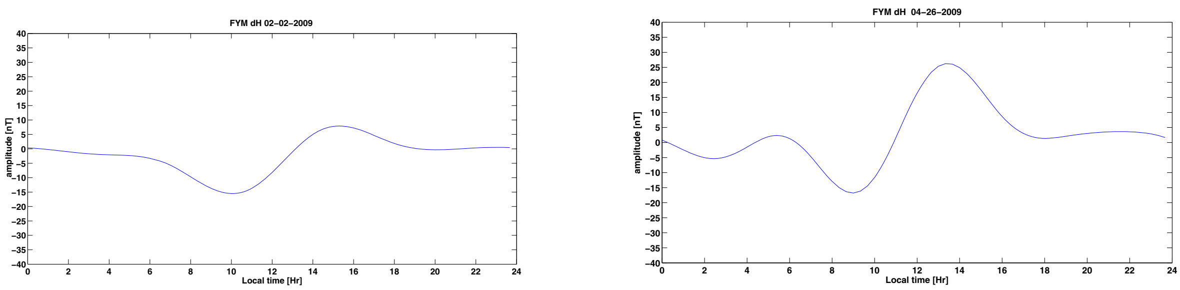

Fig. 9. Abnormal quiet daily variations of H component at Fayum station in February and April 2009.

TABLE 2. Information about the days used in this study.

	FYM station	ASW station
Total number of days used in this study	36	53
Normal variation in H component	32 (88.9%)	27 (50.9%)
Abnormal variation in H component	4 (11.1%)	26 (49.1%)
Normal variation in D component	31 (86.1%)	43 (81.1%)
Abnormal variation in D component	5 (13.9%)	10 (18.9%)

Several forms of AQDs have been found in this study. The decreasing of the Sq (H) is due to counter or reversed electrojet especially at ASW station which has lower latitude than FYM station. [3] was the first to observe this type of abnormality in the Sq (H) at Addis Ababa. Most noon and after noon depression observed had been explained as effect due to counter electrojet by several workers e.g. [13], [14] and [15]. AQDs in Sq (D) (Figs 3 and 7) show a secondary peak observed around 1600 LT. It is presumably related to the currents of the (2, 3) mode resembling the north-south current flow pattern of the “invasion” from the southern hemisphere to the northern one on some of the abnormal quiet days in February [16].

Summary and Conclusion

The solar quiet (Sq) in the geomagnetic north-south component (H) and geomagnetic east-west component (D), along the Magnetic Data Acquisition System (MAGDAS) stations in Egypt were studied. The results show several forms of abnormal quiet days (AQDs) in both of Sq (H) and Sq (D). The percentage of AQDs of Sq (H) at ASW is 49.1% but the percentage of AQDs of Sq (H) at FYM is 11.1%. These AQDs of Sq (H) are expected to be related to counter or reversed electrojet which was explained by several workers e.g. [3], [13], [14] and [15].

The percentage of AQDs of Sq (D) at ASW is 18.9% but the percentage of AQDs of Sq (D) at FYM is 13.9%. The AQDs of Sq (D) is presumably expected to be related to the currents of the (2, 3) mode [16]. The results of Sq (D) show more or less a harmony with the Indian region [12].

Acknowledgments

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