Geomagnetic Field Variations from some Equatorial Electrojet Stations

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Abstract. Quiet day variations of the equatorial electrojet along the dip equator from 10 MAGDAS stations show that there could be substantial day to day variability in the electrojet (EEJ) strength. Variations of greater than 80 nT are found in pairs of stations on the same day. The analyses show that the correlation between pairs of stations decreases as a function of increasing distance between them. The results confirm the presence of counter electrojet occurring mainly in the morning and evening hours with strengths of up to 30 nT in certain instances. The data show a longitudinal variability in the EEJ, with results showing strongest EEJ current in the South American sector and weakest in the Malaysian sector.

Keywords: MAGDAS, Electrojet, Dip Equator, Magnetic Index, variability.

Introduction

The equatorial electrojet is narrow belt of intense electric current in the ionosphere confined to about ±3° about the dip equator. This is indicated on a magnetogram as an enhancement of the solar daily variation of the horizontal component of the magnetic field H and solar quiet day variation, SqH. The EEJ has been studied through different experiments: the magnetic effects have been investigated through array of magnetometer [1 – 4] the vertical effects through rocket measurements [5, 6] and satellite measurements [7- 9]. Ionospheric soundings have also allowed the study of Ionospheric plasma instabilities due to the intense electric fields of the EEJ, [10, 11].

The MAGnetic Data Acquisition System (MAGDAS) provides a good data base from an array of magnetometers for the study of the temporal and spatial variation of the magnetic field strength across the globe. Figure 1 is the global distribution of the MAGDAS magnetometer. A full description of the MAGDAS system can be found in [12, 13]. The MAGDAS project is a magnetometer array built along the dip latitude and the 96 and 210 magnetic meridians.

In this paper we discuss the results of the temporal correlation between pairs of MAGDAS stations along the EEJ region.

Materials and Methods

The MAGDAS system record data every second, we however use minute averages of the horizontal intensities from 10 observatories along the dip equator as follows, Table 1. For these observatories data were available for over 70% of the time. The data used in this analysis are for those of year 2007. The contribution of the Sq current to the EEJ was not eliminated for all the data rather a midnight reference value was used in the analysis

Magnetically five quietest days selected from the station data were used for this analysis. The five quietest days used were those published by Geosciences Australia [14]. The daily departure, ΔH, of the horizontal component of the H (nT) from the midnight value is shown in Fig. 2 for five quietest days in Jan. 2007

Results of Analysis

The quiet daily variations of ΔH for all the stations are shown in Figs. 2a,2b,2c and 2d for the quiet days of January 13,07,24 25 and 26, 2007; March 20,21,03,19,09, 2007; June 05, 12, 06, 07,11,2007 and September 13,09,10,11,12,2007. Main inferences from the graphs are:

a. The peak value of ΔH at about local noon which are in agreement with earlier works of [2, 6, 15]
b. There is evidence of counter electrojet lasting for about 1 to 2 hours in Addis-Ababa and Davao.
c. The amplitude of the electrojet is not constant but varies from locality to locality. However, between close pair of stations of DAV – CEB, DAV – YAP, ILR – AAB, the amplitudes are generally comparable.
d. There is the existence of large day to day variability of the EEJ amplitude. For instance on Jan 07, 2007, Fig. 2a, the maximum amplitudes for the stations vary from about 90 nT to about 120 nT i.e. a range of about 30 nT, whereas on the Jan 25, the amplitudes varied from about 40 nT to about 120 nT, a range of about 80 nT, similar features are seen in other Figs. 2b,2c and 2d.
e. The EEJ is symmetrical about 1100LT.
f. Figures 2b and 2d indicates the EEJ is strongest in equinox (March and September) than in solstice (January and June). This is in agreement with the results of [16]

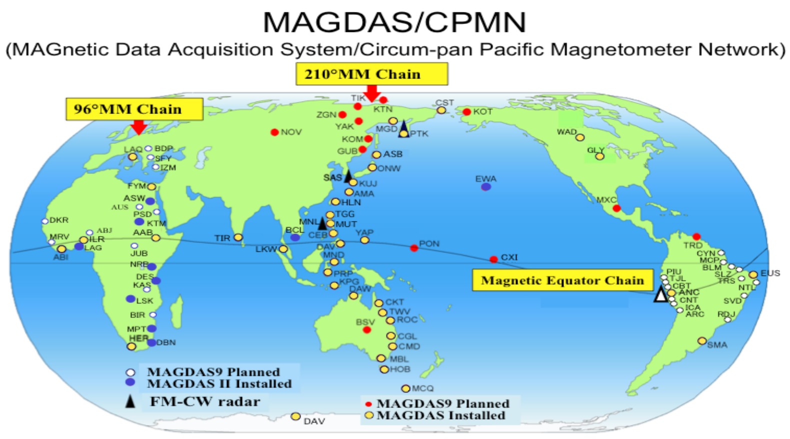

Fig. 1: The global network of the MAGDAS magnetometers [13]

TABLE 1 - Parameters of the stations used in study

S/N	Station	Code	Geographic latitude	Geographic longitude	Geomagnetic latitude	Geomagnetic longitude	Dip latitude
1	Abidjan	ABJ	5.35	-3.08	6.32	69.23	-6.32
2	Addis Ababa	AAB	9.04	38.77	0.18	110.47	0.57
3	Ancon	ANC	-11.77	-77.15	0.77	354.53	0.74
4	Cebu	CEB	10.36	123.91	2.53	195.06	2.74
5	Davao	DAV	7.00	125.40	-1.02	195.54	-0.65
6	Eusebio	EUS	-3.88	-38.43	-3.64	34.21	-7.03
7	Ilorin	ILR	8.50	4.68	-1.82	76.8	-2.96
8	Langkawi	LKW	6.30	99.77	-1.23	170.23	-0.47
9	Triunelvelli	TIR	8.50	77.0	-1.2	146.4	-0.2
10	Yap Island	YAP	9.50	138	1.49	209.06	1.70

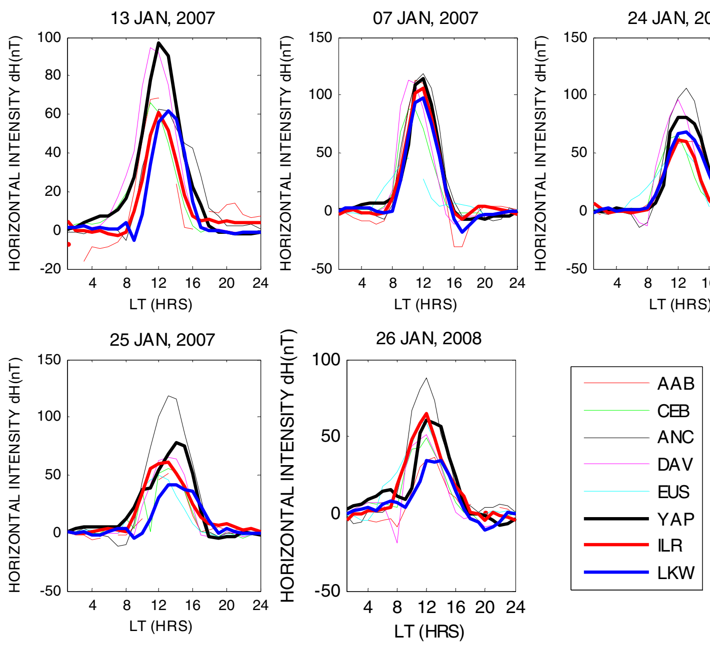

Fig. 2a: Quiet day variation of the horizontal component of the magnetic field dH for Jan 13, 07,24, 25 and 26, 2007.

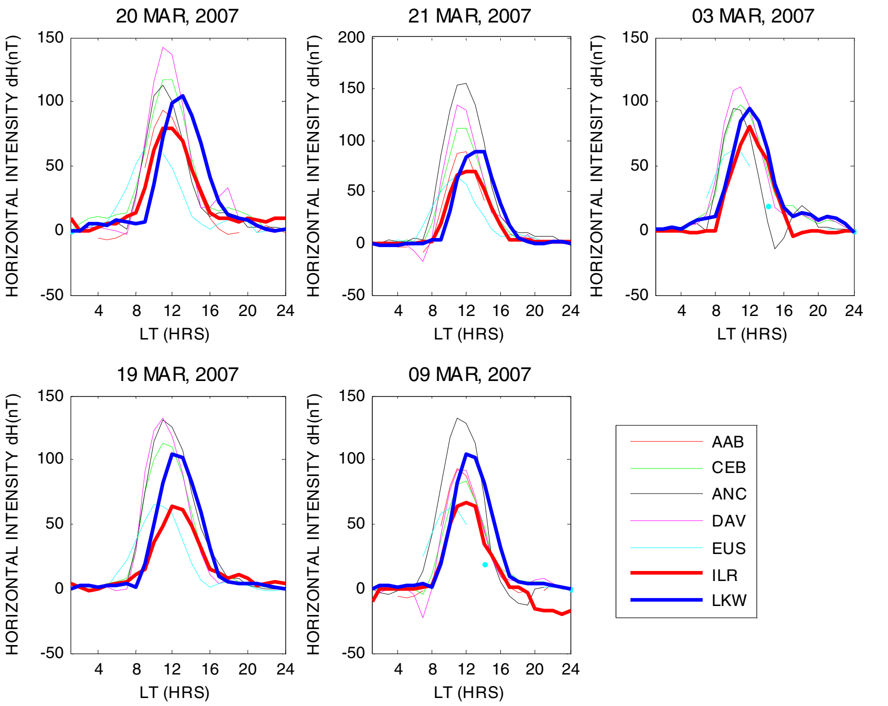

Fig. 2b: Quiet day variation of the horizontal component of the magnetic field dH for March 20,21,03,19,09, 2007

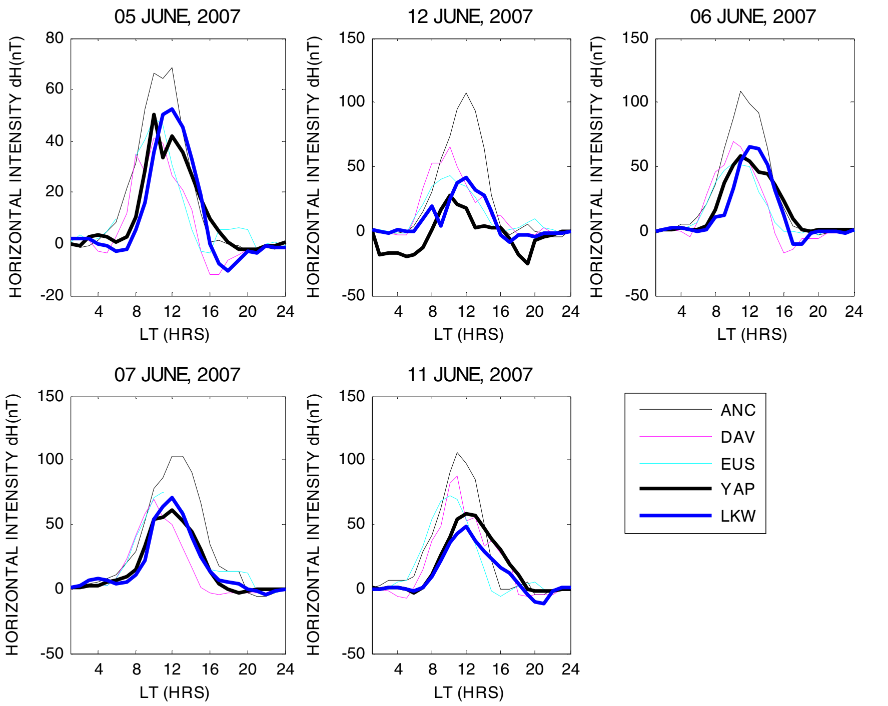

Fig. 2c: Quiet day variation of the horizontal component of the magnetic field dH for June 05,12,06,07, 11, 2007

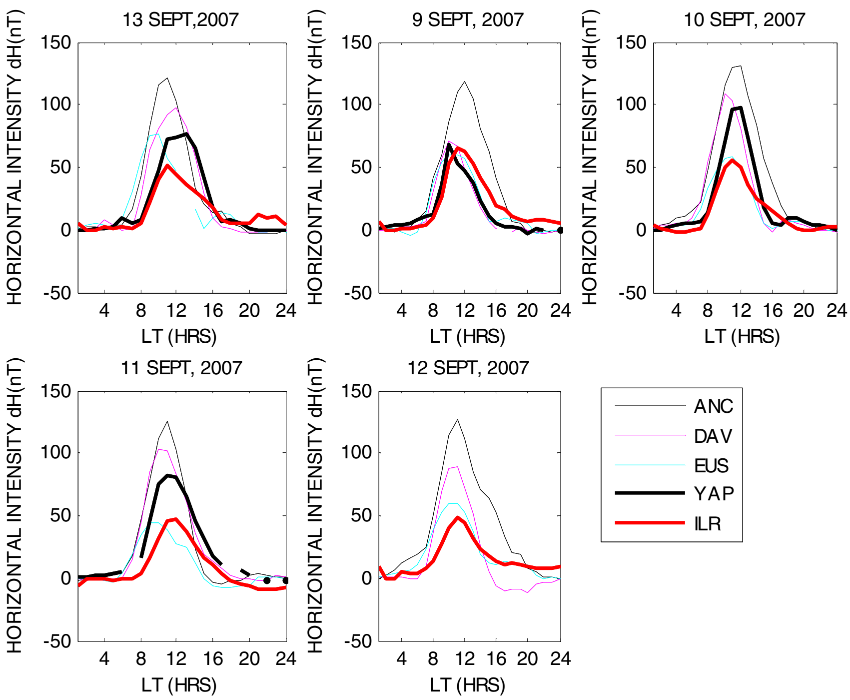

Fig. 2d: Quiet day variation of the horizontal component of the magnetic field dH for September 13, 09, 10, 11, 12, 2007

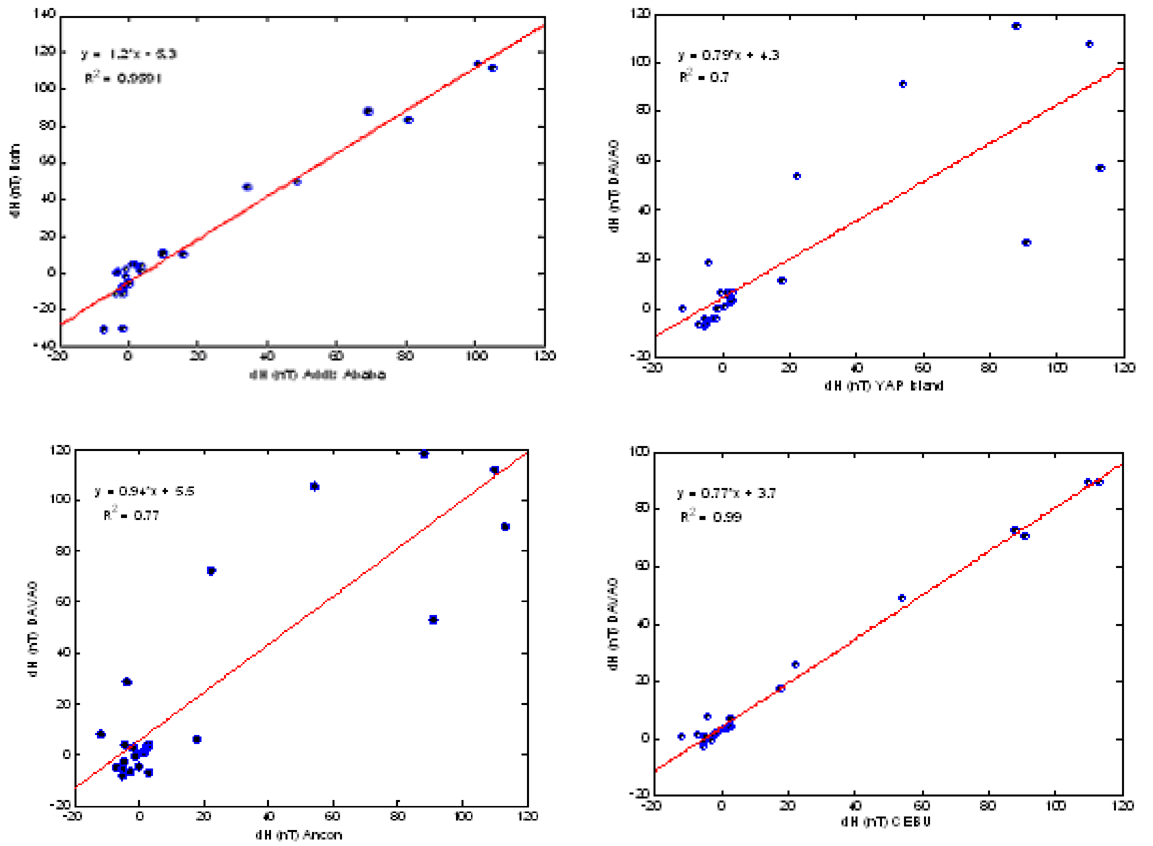

Fig. 3: Correlation between close and distant pairs of equatorial electrojet stations.

EEJ between pairs of Stations

In Fig. 3 we compare the hourly value of EEJ between close and distant pair of stations. For close pairs of Stations; ILR –AAB and CEB-DAV, there exists strong correlation between the EEJ strength, with a coefficient greater than 0.9 in most cases, however, the correlation weakens as the distance between the pairs of stations increases dropping to about 0.45 for DAV and EUS. This may indicate there could be some local effects on the strength of the EEJ.

Discussion and Conclusion

The results show that along the dip equator shows there could be substantial day to day variability in the EEJ strength, where differences could be up to 80 nT in certain cases, this is also corroborated with decreasing level of correlation between pairs of stations as the distances increases. Local effects on the strength of the EEJ could be further investigated. This may provide further insights to the EEJ sources, its build up and decay over the course of a day. The results show that the EEJ is strongest in the South American sector (ANC and EUS) with average pre noon peak ≥ 100 nT for all the months in consideration and weakest in the Malaysian sector of Langkawi (LKW) with average pre noon peak of about 70 nT.

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