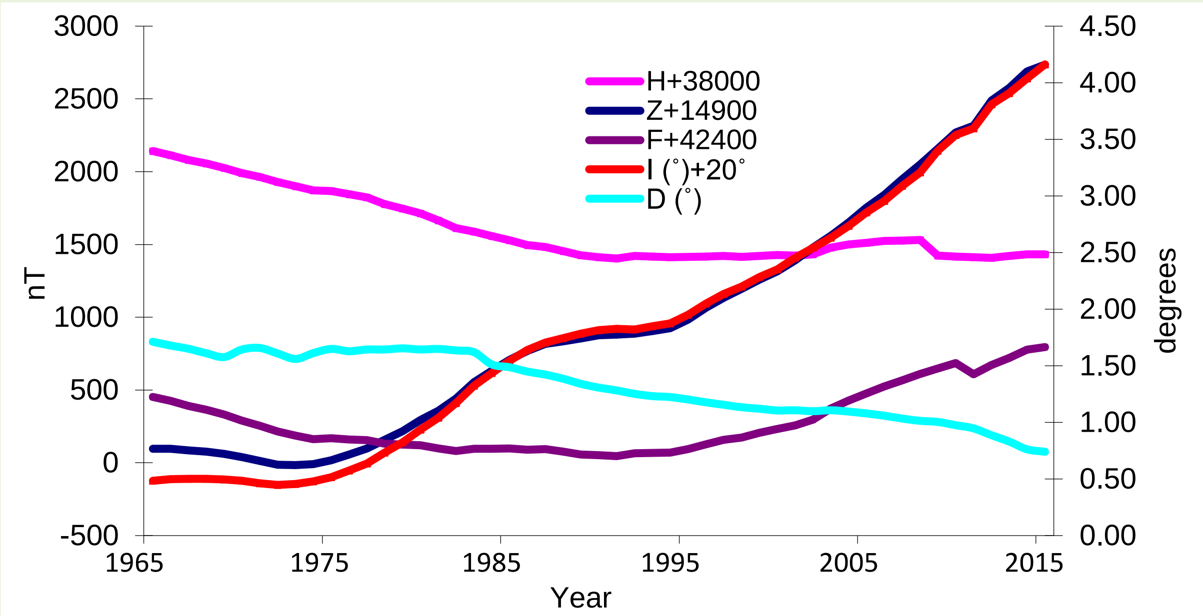
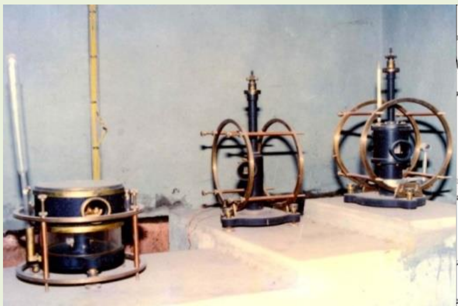
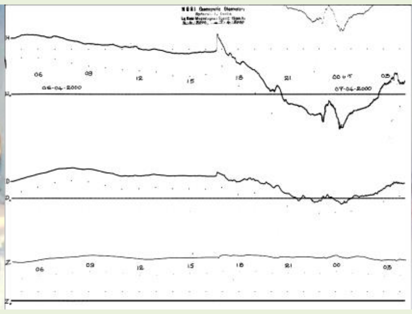
YEAR BOOK 2015

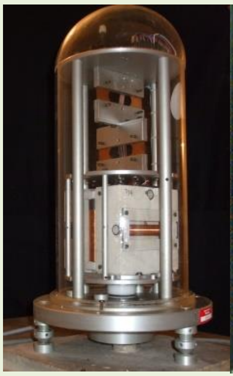
HYB (IMO) AND CPL MAGNETIC OBSERVATORIES

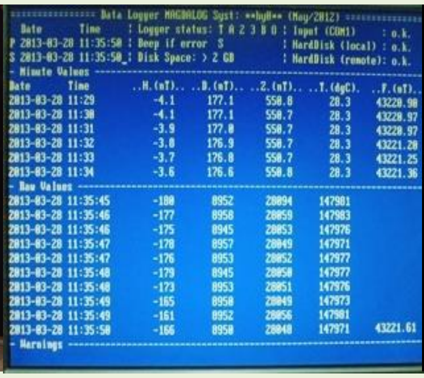
Kusumita Arora, L. Manjula, K.C.S. Rao, N. Phanichandrashekhar

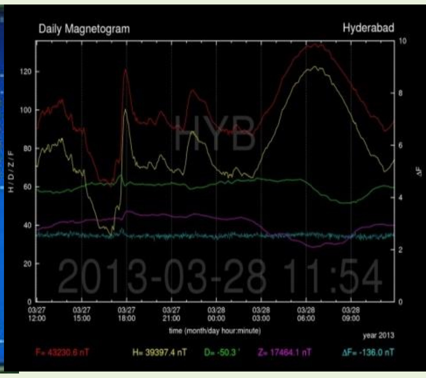












Technical Report No. NGRI-2016-Magnetic Observatory-911

Compiled: L. Manjula
manjulalingala@gmail.com

CSIR-National Geophysical Research Institute
Hyderabad 500007, INDIA
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Geomagnetic Observations

HYB (IMO) and CPL Observatories

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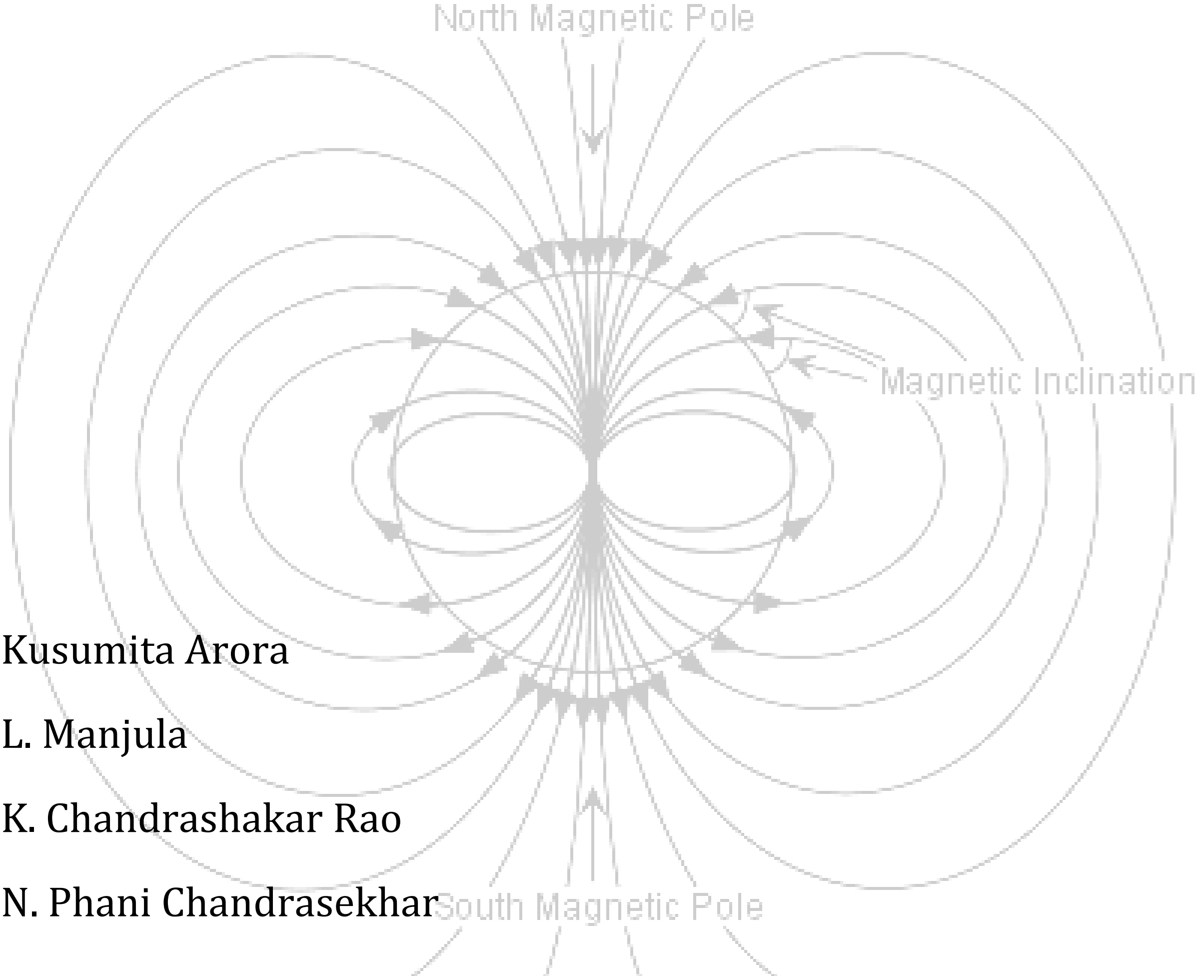

Kusumita Arora

L. Manjula

K. Chandrashakar Rao

N. Phani Chandrasekhar

CSIR-National Geophysical Research Institute

May 2016

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North Magnetic Pole
Magnetic Inclination
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1. Introduction

Hyderabad Magnetic Observatory (HYB) is a key low latitude observatory established in 1964, at NGRI campus in Hyderabad by CSIR-NGRI. Analog data recording, generation of hourly, daily, monthly & yearly means of the H, D & Z components of the magnetic variations and analysis of K indices and activities and storms were published in CSIR-NGRI quarterly bulletins of the Geomagnetic, Geoelectric and Seismological Observatories Bulletin from 1965 to 1970. 1970 onwards till present, the data is being published in the IIG, INDIAN MAGNETIC DATA volumes every year.

In 2007, HYB was upgraded to a digital system with an overlap of 4 years with the earlier analog instruments. From 2009, HYB achieved INTERMAGNET data standards, the raw data are transmitted in real time. This is updated every half an hour directly to INTERMAGNET website (http://www.intermagnet.org/data-donnee/dataplot-eng.php) and (http://www.intermagnet.org/data-donnee/download-eng.php). Quasi-definitive data is reported monthly and Definitive data is reported annually after final cleaning, yearly baselines and yearly means data corrections and analyses to the Edinburgh GIN as per INTERMAGNET specifications. Annual compilation of data from all observatories is completed by INTERMAGNET for use by the global community. Global data from INTERMAGNET are used in near real time to study space weather and annually to study secular variations and changes of the main field.

Monthly Rapid Magnetic Variation data (RMV) are being reported since 2015 to Ebre Observatory, Spain. 2010 onwards with the complete establishment of the digital regime, Quick look plots of H, D & Z components of hourly means data have been added to the data reports for IIG, INDIAN MAGNETIC DATA volumes.

This Yearbook is based on the data acquired for one year at HYB. Besides the basic data description, it includes important details.

(i) Baseline plots with observed & adopted baseline values and table of deviation of H, D & Z, ΔF plots are included as primary QC indicators, hourly means plots with IQ & ID days, daily mean plot of H, D & Z, daily mean tables with maximum & minimum, plots of daily means deviated from monthly standard value, K-index (daily, monthly, yearly sums & daily, monthly, yearly frequencies), Principle magnetic storms including GC & SSCs.

(ii) Annual means values from 1964-2015, a plot of annual mean changes of magnetic components of H, D, Z, F & I.

(iii) Characteristics & data availability plots of remote stations, being operated from HYB.

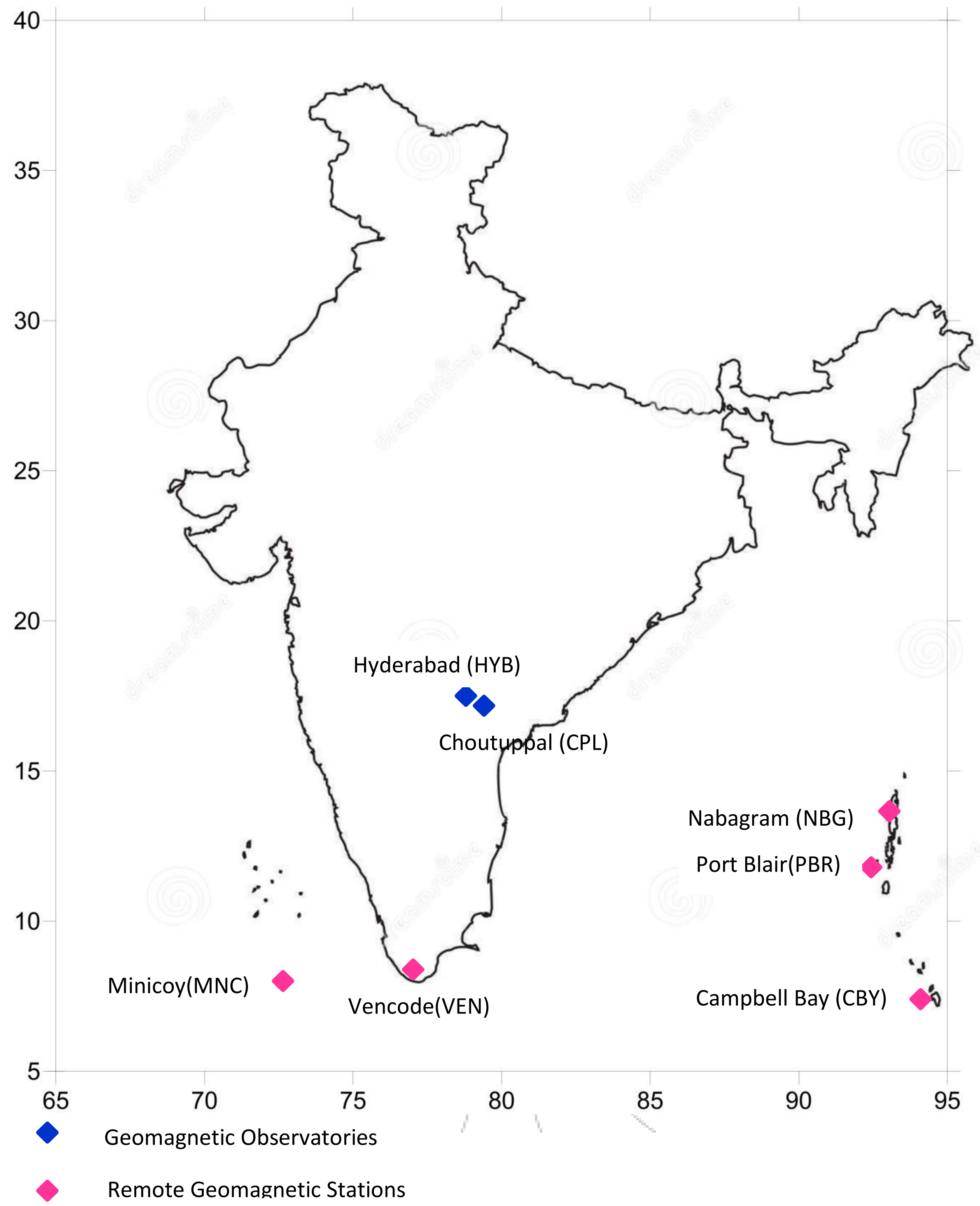


Figure 1.1: Map of Observatories (permanent & semi-permanent) operated by CSIR - NGRI

1.1. Hyderabad Magnetic Observatory (HYB)

A permanent, continuous-recording magnetic observatory was established in December 1964 by the CSIR-National Geophysical Research Institute, Hyderabad, within its campus. It is operated and data is processed, by the National Geophysical Research Institute. The Magnetic Observatory was equipped with La cour variometers (analog) for H, D & Z for normal photographic record of the field variations, VPPM for absolute determinations of H and Z, with QHM and BMZ as secondary absolute instruments. The observatory has served as an international Key Observatory for IAGA since 1978. The location of the observatory is, shown in Figure 1.1:

	Geographic	**Dipole**	**Dip**
Latitude	17° 25' N	7.6° N	07° 17.5'N
Longitude	78° 33' E	148.9° E	78° 33' E

During 1987 India's first digital Magnetic Observatory was established by NGRI in its campus at Hyderabad, equipped with fluxgate and proton sensors of AMOS III and DIM-100. However these new instruments had to be discontinued soon, as measurements did not stabilise.

CSIR-NGRI operated a geo-electric observatory at Choutuppal with induction coil and telluric current measurements for a period of 24 years between 1967 and 1991. Another magnetic observatory was also operated at Ettaiyapuram, near Kanyakumari for a period of 26 years between 1976 and 2002. The latter recorded analogue fluxgate and induction coil measurements. These two sites were discontinued due to increasing anthropogenic noise and deterioration of data quality.

At HYB the classical La Cour magnetometer was upgraded by a digital 3-component fluxgate magnetometer (DFM), of the Danish Meteorological Institute, and an Overhauser Magnetometer (GSM-90) for total field (F) variation in January 2008, under a collaborative project with the Adolf Schmidt Observatory of GeoForschung Zentrum, Germany. The 1-second measurements are transferred by OFC to a computer. These values are averaged to obtain 1-minute data. The real-time magnetogram is displayed on a screen, refreshed every 5 minutes, at the control Room and Headquarters display screen. Absolute measurements are made twice a week using a DI-flux (Declination Inclination magnetometer (DIM) and Overhauser magnetometer to determine Total field (F), Inclination (I) and Declination (D) to obtain Observatory baselines for the components H, D and Z. In September 2009, HYB achieved INTERMAGNET status.

La Cour magnetographs, (D, H and Z variometers), that were in operation since 1964 were continued till July 2011 and later were replaced by a GEOMAG-02M digital 3-component Fluxgate Variometer in August 2011 as a secondary system.

1.1.1 Magnetic Environment of HYB

A detailed magnetic (total intensity) survey of the NGRI Campus was carried out in April-May, 1963 using a Proton Precession Magnetometer. A selected low gradient area of 30,000 sq. ft. was again surveyed in high precision and fine grid of 25 ft. using a Torsion Magnetometer. This showed the area to have horizontal gradient of field as small as 1.5 gammas (nT) & vertical gradient of field in the north-south direction is less than 1.5 gamma & in east west direction, practically negligible per metre. This site has been so chosen that it will be 1000ft away from all buildings, roads and other disturbing influences.

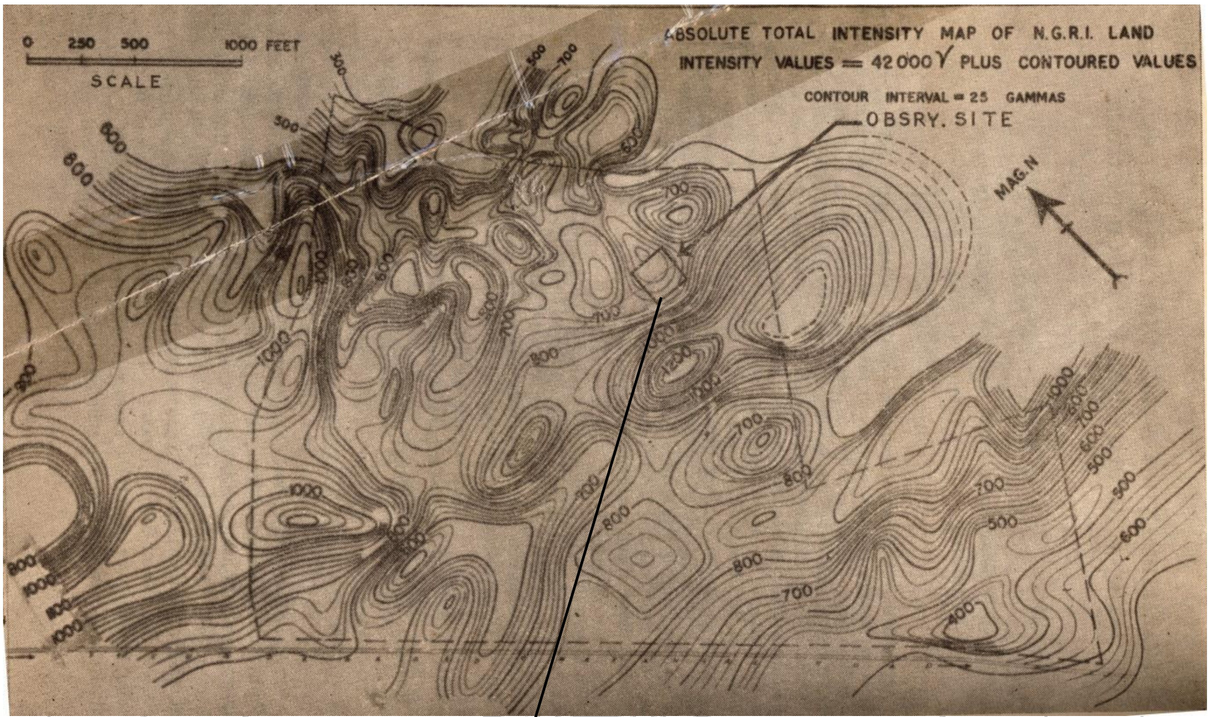


Figure 1.1.1: Absolute total intensity map of NGRI land in 1963. Intensity values are 42,000nT plus contoured values. Contour intervals = 25 nT

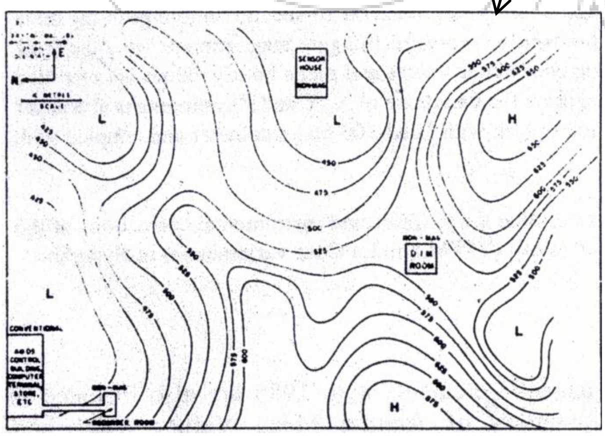


Figure 1.1.2: Contours of total intensity (F) and locations of NGRI's Magnetic Observatory buildings, Hyderabad. Contour values are 42,000nT plus indicated values, based on a detailed magnetic survey on regular grid points with a proton precession magnetometer in September,1984.

1.2 Choutuppal Magnetic Observatory (CPL)

Continuous preliminary recording of magnetic variations commenced at Choutuppal Magnetic observatory in January 2012 in underground, thermally insulated non-magnetic housings and this recording continued till date as a secondary variometer with GEOMAG- 02M (Variometer) & GSM-19 Overhauser till September, 2014. In October, 2014 onwards permanent DFM system (DMI-FGM Variometer & GSM90F1 Overhauser) was installed in the primary variometer housing in the newly constructed double walled non-magnetic Primary Variometer Room. Digital measurements at 1-second sampling are transferred to the data storage computers by OFC cable and 1-min standard digital 3-component variations are continuously recorded within the Choutuppal NGRI campus.

Absolute measurements to determine total field (F), Inclination (I) and Declination (D) are made once a week using a DI-flux (Declination Inclination magnetometer (DIM) and Overhauser Magnetometer (PPM) and reduced to obtain observatory baselines for the components H, D and Z. The location is shown in fig. 1.2.1

	Geographic	**Dipole**	**Dip**
Latitude	17°17.6' N	8.62° N	07° 18.2' N
Longitude	78°55.2' E	152.6° E	78°55.2' E

A detailed magnetic anomaly survey of the entire campus conducted in 1967 was using a Proton Precession Magnetometer. The blue square outline is the designated location for the new Observatory.

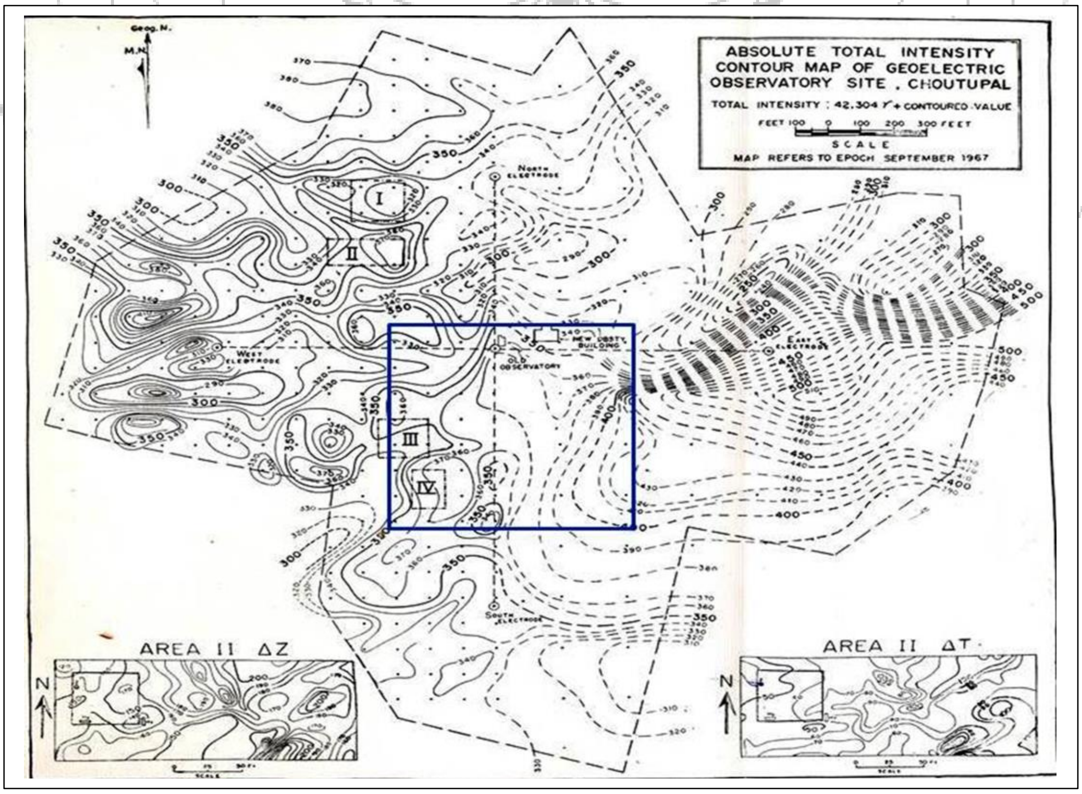


Figure 1.2.1: Contour map of CPL observatory in 1967.

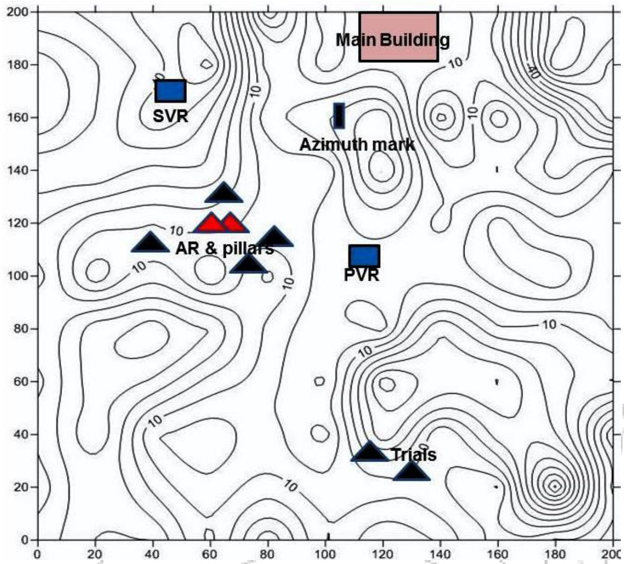


Figure 1.2.2: The area designated for the new Magnetic Observatory was re-surveyed in 2012 with GEOMETRICS Proton precession magnetometer Locations of the instrument buildings and pillars are indicated within the 200m X 200m area.

The west-south room of Main building houses the control room for DFM system and solar power.

AR- absolute room with main absolute pillar indicated in red colour. Rest six pillars for calibration.

PVR- Primary variometer room, here DFM variometer & GSM-90 Overhauser magnetometer were installed and is recording H, D & Z variation data & Total field data continuously.

SVR – Secondary variometer hut with GEOMAG-02M.

1.3 Semi-permanent Stations

CSIR-NGRI commenced equatorial and low-latitude observations at Andaman & Nicobar Islands and southern tip of South India, Kanyakumari during the year 2011 and Minicoy, Lakshadweep islands during 2013 by installing 3-component fluxgate magnetometers. Non-magnetic thermally insulated, weather-proofed wooden huts were constructed for protecting the fluxgate sensor and electronic console (data logger) and reducing effect of the temperature change. These sites are completely unmanned and are visited once in three-four months. During the time of every visit, the data is retrieved and Absolute experiments are carried out to obtain baseline values of H, D and Z components. Locations as given in Figure 1.1 are as below.

Table 1.5: Locations of remote stations

Location	Station Code	Geographic Latitude	Geographic Longitude	Geomagnetic Latitude	Geomagnetic Longitude	Dip Latitude
Campbell Bay	CBY	07° 00' N	93° 52' E	2.46°S	166.23°E	07° 32.8'
Vencode	VEN	08° 15' N	77° 11' E	0.29°S	150.06°E	07° 15.0'
Minicoy	MNC	08° 09' N	73° 18' E	0.04°N	146.01°E	07° 08.2'
Port Blair	PBR	11°24' N	92° 27'E	1.96°N	165.36°E	07° 33.0'
Nabagram	NBG	13° 15' N	92° 57'E	3.63°N	165.50°E	07° 33.3'

2. Infrastructure

An INTERMAGNET Magnetic Observatory consists of a primary variometer sensor room with pillars, absolute room with pillars, secondary variometer sensor room and control room for data monitoring and analyses, as well as Azimuth mark/pole & pillars. These facilities are required to be purely non-magnetic, with stabilized temperature changes; the pillars of absolute measurements have to be isolated from telluric currents. The pillars for the sensors have to be stable and the top covered with marble plate. These pillars are constructed deep enough (2m) below the level and over ground 1.2 m to avoid tilting and freezing. The Azimuth mark is a reference mark of Geographical north (true north). During absolute observations true north is required, so azimuth mark is corrected to true north with correction (which is established by high precision surveys). This reference mark is at least 50 m away from the absolute room.

2.1. Hyderabad Magnetic observatory (HYB)

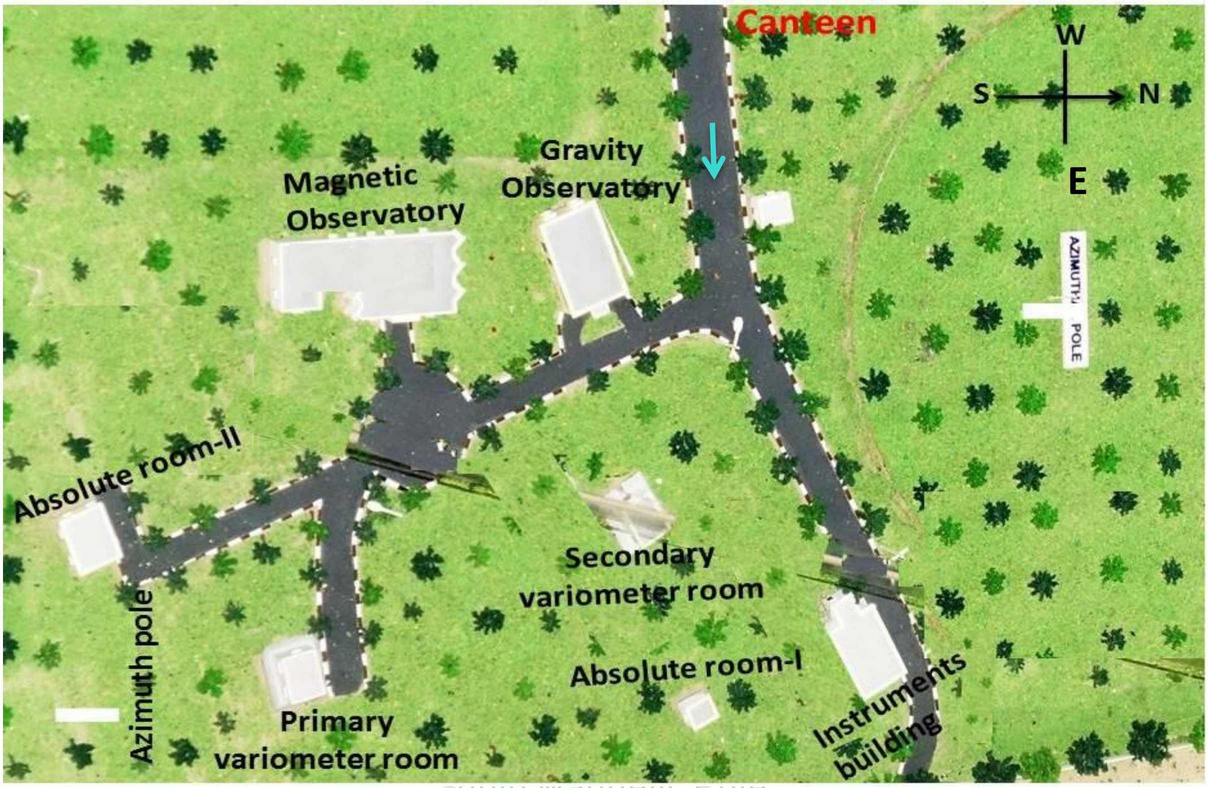


Figure 2.1.1: Layout of the Magnetic Observatory complex in CSIR- NGRI; 1cm is approximately 20 m

The layout of the magnetic observatory complex within the 1.2 sq km NGRI campus is shown in Figure 2.1.1. with Primary and Secondary variometer buildings, two Absolute rooms, one for regular measurements, the other for calibration measurements. Figure 2.1.2 shows the Primary (DFM) variometer building, which is located in a magnetic low, 65 m south of the secondary variometer building with a field gradient of about 5 nT per m. This is a non-magnetic, double walled semi underground room measuring 6.1 m (north and south) X 2.6 m (east and west) at a depth of 2.8 m with an air gap of about a metre on all the four sides and a single walled ground floor room above it, constructed in 1988. Temperature variation of the sensor room is 0.1-0.2°C/day. Annual temperature change was 8.3°C during 2015. The Secondary (GEOMAG) variometer building in Figure 2.1.3 is also a non-magnetic, double walled air-spacing in between and semi underground, measuring 4.4 m (north and south) x 4.4 m (east and west), constructed in 1963. The total height is 10 ft, 5 ft below ground level and 5 ft covered around the outer wall by a thick sloping earth mound. A single walled ground floor room above it measures 4.6 m x 4.6 m. Temperature variation of sensor 0.1-0.3°C/day. The Absolute Room I, shown in Figure 2.1.4 is an over ground room of dimensions 5.8 m x 3.3 m x 4 m located about 26 m east to the Secondary variometer building (La cour). It has two pillars with 2 m (over ground) height separated by 1.5 m. The Absolute room II, constructed in 1988, in Figure 2.1.5 is an over ground room of dimensions 6.1 m x 3.2 m located about 34 m to the southwest of the DFM sensor building. It has one pillar with 1.2 m.

Fig. 2.1.2: Primary variometer building (DFM system)

Fig. 2.1.3: Secondary variometer building (GEOMAG-02M+GSM19)

Fig. 2.1.4: Absolute room I

Fig. 2.1.5: Azimuth pillar

Fig. 2.1.6: Absolute room II

2.2 Choutuppal Magnetic observatory (CPL)

The magnetic observatory complex is located approximately in the center of the 1 sq km Choutuppal campus. The Primary (DFM) variometer building is located 120 m south of the Main Building. It is a double walled, semi underground building with 1.8m x 3m x 3m dimensions. Overground it is covered with non magnetic weather proof material. Internally two pillars are seperated by 1.8 m with 0.6 m height, Figure 2.2.1. The control room is in the south-west corner room in the Main Building, Figure 2.2.2, where the DFM system data is communicated to the computer. Solar power panels, shown in Figure 2.2.3 are setup at the back of the Main Building and provide clean and uninterpted power supply to the complete DFM variometer system (data recording and data logging PCs).

The installation setup for the GEOMAG-02M & GSM19 secondary system is shown in Figure 2.2.4. These huts are 250m away from main building having 0.6m x 0.6m x 0.6m dimentions. These underground shallow vaults are covered with wooden door and marble stone for temperature control. The GSM-19 sensor is installed on a 0.8 m pillar. The Absolute room is located at 150m south-west away from main building. It is a wooden hut consisting of main pillar with 2 m height (underground+overground), shown in Figure 2.2.5. There are 5 more pillars surrounding the Absolute room and outside it, which are planned for use for regular calibration studies and studies of changing gradients. The Azimuth pillar is situated at the back of the main building and 100 m away from the absolute pillars & 80 m away from the secondary variometer huts, shown in Figure 2.2.7. Precision measurements of the true azimuths have been conducted through stellar observations and GPS observations independantly, by experts from Survey of India, IIG, Mumbai and CSIR-NGRI. The values are given in Table 2.1.

Pillar No.	Latitude	Longitude	Height	Azimuth	Azimuth. Correction
Azimuth Pole	17.29430410	78.91997820	287.9551		
1 (inside hut)	17.29348104	78.91919640	288.0460	222°12'20"	42°12'20"
2 (beside hut)	17.29346470	78.91921526	288.0267	220°57'07"	40°57'07"
3	17.29360162	78.91932514	286.8935	221°35'34"	41°35'34"
4	17.29346814	78.91929173	287.1631	218°05'54"	38°05'54"
5	17.29338335	78.91918532	287.3603	219°25'36"	39°25'36"
6	17.29347839	78.91911894	287.4234	224°48'56"	44°48'56"
7	17.29354652	78.91916603	287.3660	225°40'04"	45°40'04"

Table 2.1: Azimuth Corrections of Absolute pillars of Magnetic Observatory, Choutuppal, NGRI - Campus

Fig. 2.2.1: Primary variometer building (DFM)

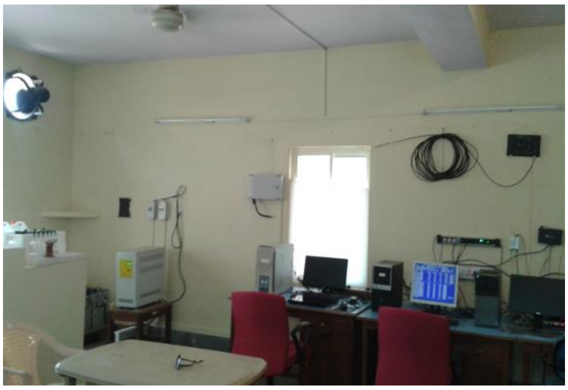


Fig. 2.2.2: DFM control

Fig. 2.2.3: Solar power panel set up

Fig. 2.2.4: Underground vaults with shelters of natural material

Fig. 2.2.5: Absolute hut

Fig. 2.2.6: Azimuth pillar

Fig. 2.2.7: 7 Absolute huts

2.3. Semi-permanent Stations

Variometer stations were setup in the equatorial region of India during 2010-2011 for focussed studies on the Equatorial electrojet. The locations are at Campbell Bay (CBY) in Great Nicobar in the A&N islands, Vencode (VEN) on the mainland at Kanyakumari and Minicoy (MNC) in the Lakshadweep islands (Fig. 1.1 for reference).

CBY (Fig 2.3.1) is located on the island of Great Nicobar, the largest of the Nicobar Islands in the eastern Indian Ocean and ~540 km away from Port Blair by sea route. A semi-permanent Magnetic Observatory was established during the year 2011 in the premises of the Forest check post with the sensor buried in underground vault and electronics installed in the Forest check post room. The power supply to the magnetometer system is made using batteries charged by means of solar panels.

VEN (Fig. 2.3.2) is 60 km away from Kanya Kumari at the southernmost point of peninsular India, Tamil Nadu. The semi-permanent Magnetic Observatory is situated at the premises of Bethany Navajeevan Matriculation School, Puthukkadai village, Kanya Kumari District facilitated by Manonmaniam Sundaranar University, Tirunelveli (Tamil Nadu). The site was established during the year 2010 and the variometer room was constructed at the extreme end of the school premises, which is located at the center of a coconut garden. The site is about 10 km away from the ocean. A non-magnetic thermally insulated building of size (8′ x 6′ x 8′) was constructed. In this a small vault of size (3′ x 2′ x2′) was made to house the sensor unit. In the corner of the building a platform of size (2′ x 2′ x 1′) was made to place the data logger. The power supply to the magnetometer system is made using batteries charged by means of solar panels.

PBR (Fig. 2.3.3) is situated at the premises of the Department of Science and Technology (DST) office, Dollygunj, Port Blair, Andaman Islands. The recording of magnetic field variations commenced during the year 2010. Two non-magnetic thermally insulated wooden hut of dimensions (4′ x 4′) was made for the sensor and electronics. The power supply to the magnetometer system is made using batteries charged by means of solar panels.

MNC (Fig. 2.3.4) is situated at Central Plantation Crops Research Institute (CPCRI) at Minicoy, the southernmost Lakshadweep island. The recording of magnetic field variations commenced in 2013. Two non-magnetic thermally insulated wooden hut of dimensions (4′ x 4′) was made for the sensor and electronics. The power supply to the magnetometer system is made using batteries charged by means of solar panels.

(Fig. 2.3.4) is situated in the Forest nursery area in north Andaman. Two non-magnetic thermally insulated wooden hut of dimensions (4′ x 4′) was made for the sensor and electronics. The power supply to the magnetometer system is made using batteries charged by means of solar panels. The cables are frequently damaged by very large sized rats.

Variometer sensor huts:

Fig. 2.3.1: Campbell Bay (CBY)

Fig. 2.3.2: Vencode (VEN)

Fig. 2.3.3: Port Blair (PBG)

Fig.2.3.4 Minicoy (MNC)

Fig. 2.3.5: Nabagram (NBG)

2.4. Temperature Variations during October 2015

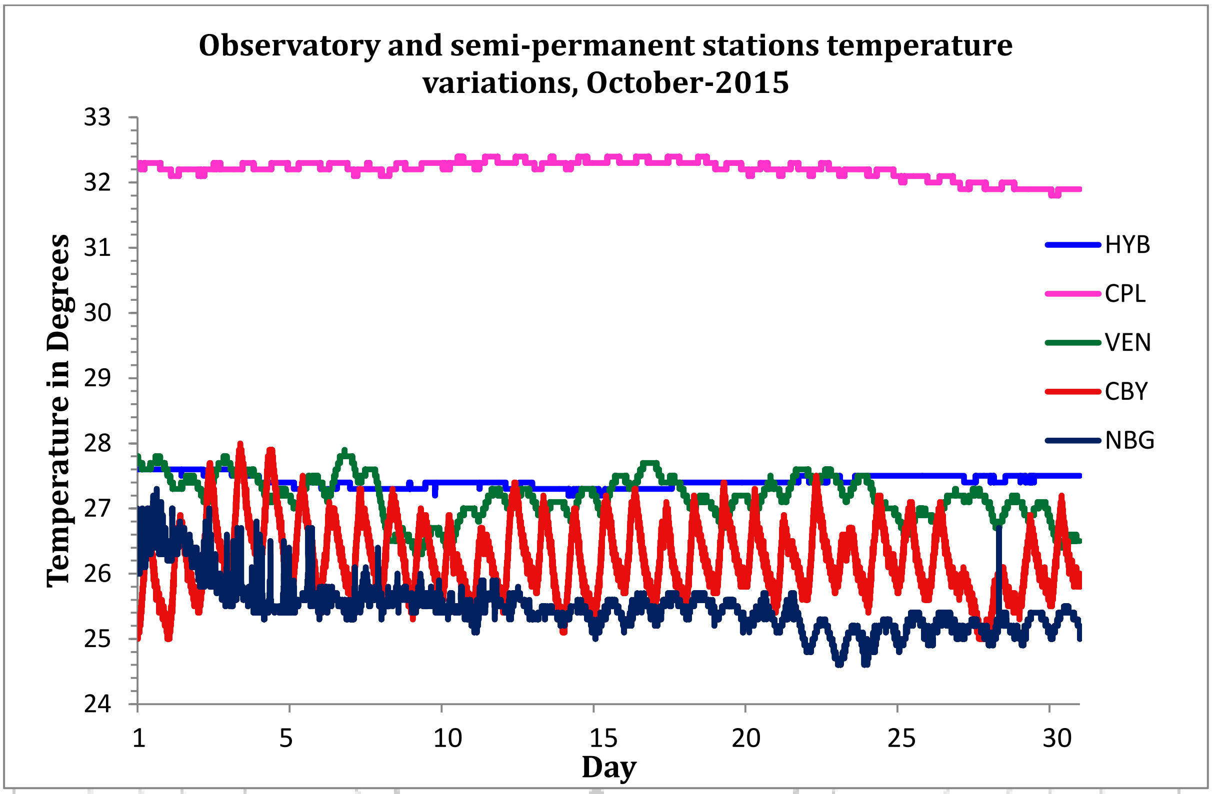


Figure 2.4.1: Temperature variation plot in all stations

Figure 2.4.1 shows the temperature change during a sample month of October 2015 at Observatory and semi-permanent stations. In HYB the maximum temperature change is 0.4C° throughout the month, in CPL it is 0.6C° over the month, in VEN 1.7C°, in CBY 2.7C° and in NBG 2.5C° over the October, 2015. While the observations record temperature changes within 0.5° over the month, the Semi-permanent stations show variations of the range of 2.5°C.

3. Instrumentation

Photographs and specifications of the standard instruments used at various locations are provided in the following pages. A total of 10 variometers, 7 proton precession magnetometers and 4 absolute magnetometers are available.

Fig.3.1: DFM variometer systems two, one in HYB & CPL as primary variometer system

Fig.3.2: Two GSM90 Overhauser are total field magnetometers as primary systems at HYB & CPL

Fig.3.3: Two WILD-T DI-flux magnetometers at HYB & CPL

Fig. 3.4: GEOMAG-02M variometer as secondary system in HYB

Fig. 3.5: GEOMAG-02MO variometer as secondary system in CPL

Fig. 3.6: Two GSM19 Overhauser are total field magnetometers as secondary systems at HYB & CPL

Fig. 3.7: GSM90 Overhauser total field magnetometer for calibration both at HYB & CPL

Fig. 3.8: Four GEOMAG-02M variometers are in field stations

Fig. 3.9: Two MS-27 variometers are in field stations

Fig. 3.10: Two GEOMETRICS PPM (total field magnetometer) for field

Fig. 3.11: THEO-020A absolute magnetometer for field stations

Fig 3.12: THEO-020A & GEOMAG-03 absolute magnetometer for field stations

3.1. Hyderabad Magnetic Observatory (HYB)

Variation Recording:

In 2015 the following recording units were operated and the technical details are listed in Table

- 2 three component flux-gate variometers with digital recording (FGE, GEOMAG)
- 1 scalar Overhauser effect proton magnetometer with digital recording (GSM)

Table 3.1.1: Parameters of the variometer systems and scalar Magnetometers:

3-component variometer:	**DMI FGE (Primary)**	**MS GEOMAG – 02M**
Serial number:	S0314	MS-27/2012
Type:	suspended; linear-core Tri axial fluxgate	suspended, linear core Tri axial fluxgate
Data logger:	Magdalog	GEOMAG-Console
Serial number:	E0377	MS-27/2012
Orientation:	H, D , Z	H, D , Z
Acquisition interval:	1 s	1 s
A/D converter:	ADAM	console
Resolution:	0.1 nT	0.01 nT
Sampling rate:	2 Hz	1 s
Sensitivity :	D=27.14min/V H=313.7nT/V Z=311.8nT/V	
Total-field Magnetometer:	GSM-90	GSM-19
Sensor Serial number:	62716	24577
Logger Serial number:	6092105	2075386
Type:	Overhauser	Overhauser
Acquisition interval:	5 s	5 s
Resolution:	0.01 nT	0.01 nT
Data acquisition system:	Electronics	Its Console
Timing:	GPS	GPS

Three component flux-gate variometer FGE

The FGE variometer is the main vector magnetometer. It is a three component linear core tri-axial flux-gate magnetometer with Cardan's suspension, manufactured by the Danish Meteorological Institute at Copenhagen. The three magnetic elements H, D and Z and the room temperature are recorded. The scale factor of the instrument is 250 nT/V, the measurement range is +/- 2500nT for the magnetic elements. The temperature channel has a scale factor of 1000 K/V with a measurement range of ± 2.5 V. The analogue to digital conversation is carried out by a 20 bit ADC (type CS5506, Crystal) with a sampling rate of 2 Hz by means of a single board computer Z80miniEMUF. The resolution, given by manufacturer as 0.2 nT is completely satisfied by the 20 bit ADC. The time signal for the data logger is given by a DCF77 radio clock.
The variometer was in operation at the same position and in the same manner as in 2014. The 2 Hz momentary values are obtained by means of a single board computer centre.

Overhauser Proton Magnetometer GSM

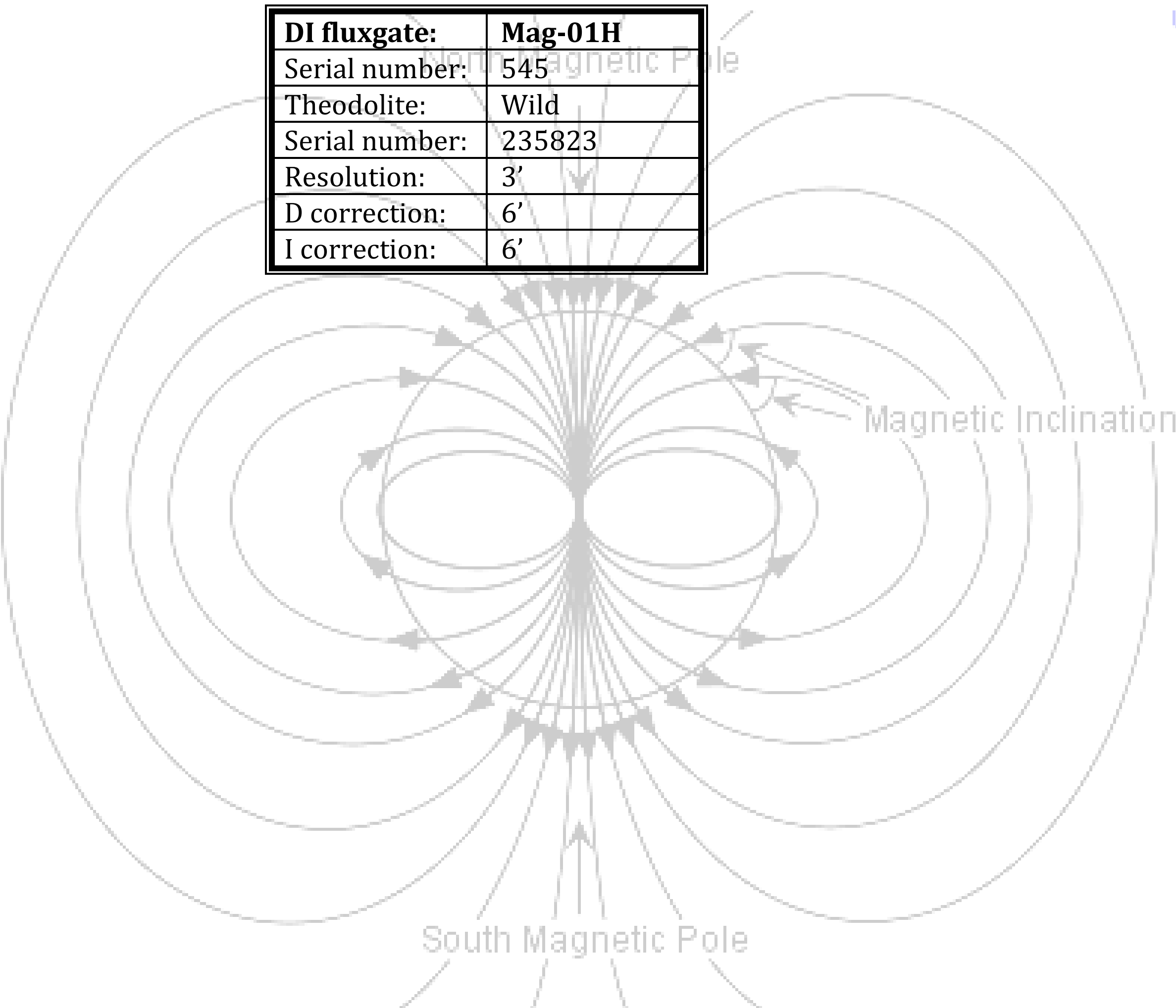
The geomagnetic total intensity (F) was recorded using the GSM Overhauser proton magnetometer manufactured by GEM Systems, Canada. For every 5 seconds, a measurement value of resolution 0.01 nT is generated and transmitted connection cables. From logger the data is further transmitted to the PC by glass fibre cable via OFC.

Absolute Measurements

Throughout the year, the absolute measurements were carried out as follows:
Two absolute measurements are taken using the Wild DI-flux theodolite on pillar No.1 (Absolute room-I) twice per week. The corresponding total field measurement is taken from GSM Overhauser magnetometer located in DFM sensor room. Therefore, the F measurement values, obtained are corrected by means of the corresponding offset to the pillar No.1 (Absolute room-I).

Table 3.1.2: Details of absolute magnetometer

DI fluxgate:	**Mag-01H**
Serial number:	545
Theodolite:	Wild
Serial number:	235823
Resolution:	3’
D correction:	6’
I correction:	6’



3.2. Choutuppal Magnetic Observatory (CPL)

Variation Recording:

In 2015 the following recording units were operated and the technical details are listed in Table

- 2 three component flux-gate variometer with digital recording (FGE, GEOMAG)
- 1 scalar Overhauser effect proton magnetometer with digital recording (GSM)

Table 3.2.1: Parameters of the variometer systems and scalar magnetometers:

3-component variometer:	DMI FGE (Primary)	GEOMAG – 02M
Serial number:	S0376	FM 13/2012
Type:	suspended; linear-core Tri axial fluxgate	Non suspended, linear core Tri axial fluxgate
Data logger:	Magdalog	GEOMAG-Console
Serial number:	026	FM 13/2012
Orientation:	H, D , Z	H, D , Z
Acquisition interval:	1 s	1 s
A/D converter:	ADAM	console
Resolution:	0.1 nT	0.01 nT
Sampling rate:	2 Hz	1 s
Sensitivity :	D=27.14min/V H=313.7nT/V Z=311.8nT/V	
Total-field Magnetometer:	GSM-90	GSM-19
Sensor Serial number:	24575	34742
Logger Serial number:	2075385	3025768
Type:	Overhauser	Overhauser
Acquisition interval:	5 s	5 s
Resolution:	0.01 nT	0.01 nT
Data acquisition system:	Electronics	Its Console
Timing:	GPS clock	GPS clock

Table 3.2.2: Details of absolute magnetometer:

DI fluxgate:	Mag-01H
Serial number:	621
Theodolite:	Wild-T
Serial number:	279220
Resolution:	3’
D correction:	6’
I correction:	6’

3.3. Semi-permanent stations

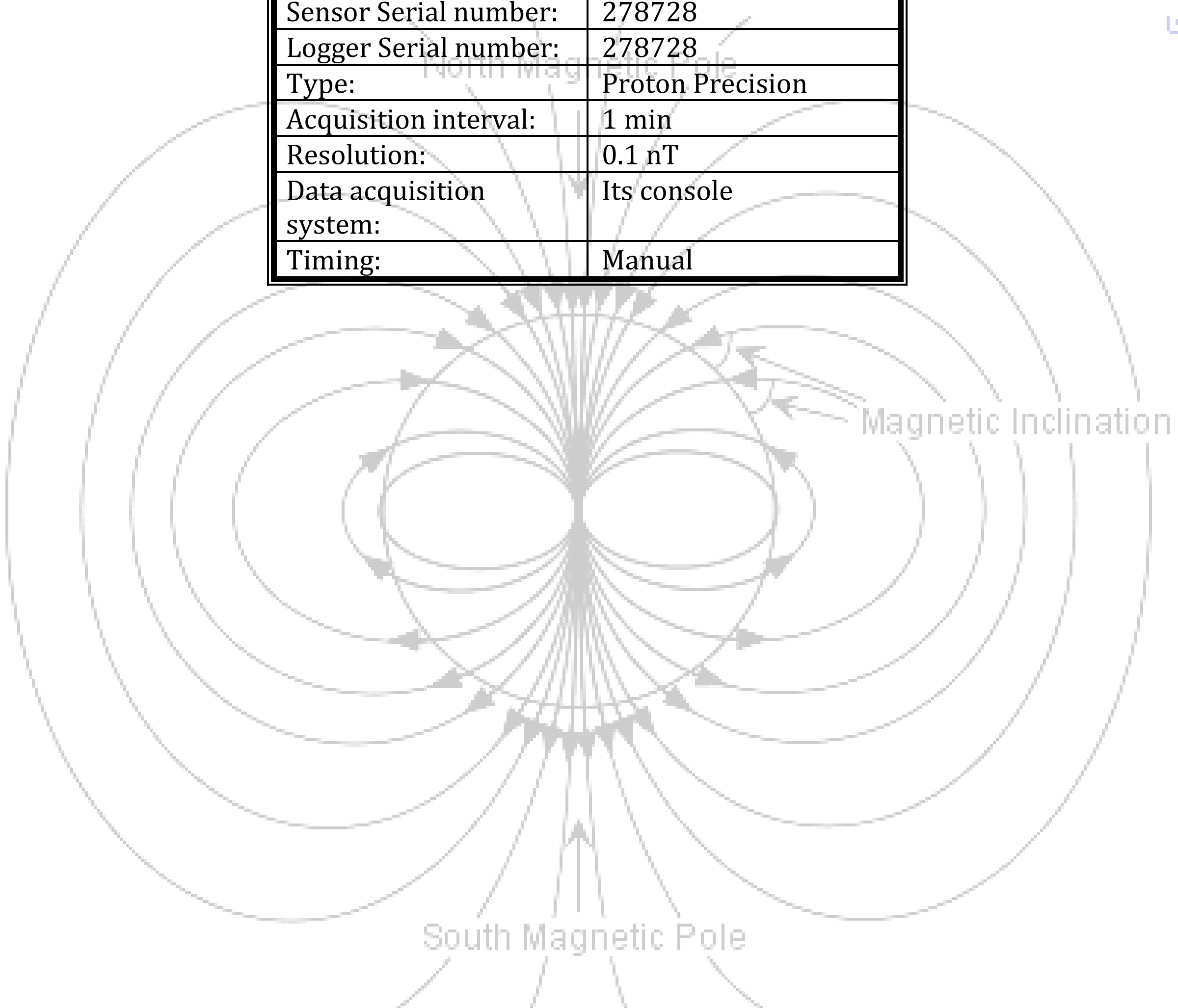
During 2015, we have data at 4 stations they are CBY, VEN, MNC & NBG. The following table gives the detailed information about deployed magnetic instruments.

Table 3.3.2: Parameters of the variometer systems deployed at remote stations:

Specifications	Campbell Bay (CBY)	Vencode (VEN) 01/01/15 to 17/ 11/15	Vencode (VEN) 17/11/15 to 31/12/15	Minicoy (MNC) 01/01/2015 to 08/2015	Minicoy (MNC) 08/2015 to 31/12/2015	Nabagram (NBG)
3-component variometer:	GEOMAG – 02M	GEOMAG – 02M	MS GEOMAG – 02M	MS GEOMAG – 02M	GEOMAG – 02M	GEOMAG – 02M
Serial number:	FM 09/2011	FM 05/2011	MS 28/2012	MS 28/2012	FM 08/2011	FM 05/2011
Type:	Non suspended, linear core fluxgate	Non suspended, linear core fluxgate	suspended, linear core fluxgate	suspended, linear core fluxgate	Non suspended, linear core fluxgate	Non suspended, linear core fluxgate
Data logger:	GEOMAG-Console	GEOMAG-Console	GEOMAG-Console	GEOMAG-Console	GEOMAG-Console	GEOMAG-Console
Serial number:	FM 09/2011	FM 05/2011	MS 28/2012	MS 28/2012	FM 13/2012	FM 05/2011
Orientation:	H, D , Z	H, D , Z	H, D , Z	H, D , Z	H, D , Z	H, D , Z
Acquisition interval:	1 s	1 s	1 s	1 s	1 s	1 s
A/D converter:	console	console	console	console	console	console
Resolution:	0.01 nT	0.01 nT	0.01 nT	0.01 nT	0.01 nT	0.01 nT
Sampling rate:	1 min	1 min	1 min	1 min	1 min	1 min

Table 3.3.1: Details of absolute magnetometers:

DI fluxgate:	GEOMAG-03
Serial number:	1570
Theodolite:	THEO 020A
Serial number:	235823
Resolution:	6’
D correction:	6’
I correction:	6’
Total-field Magnetometer:	GEOMETRICS
Sensor Serial number:	278728
Logger Serial number:	278728
Type:	Proton Precision
Acquisition interval:	1 min
Resolution:	0.1 nT
Data acquisition system:	Its console
Timing:	Manual



3.4. Calibration Reports

3.4.1. Proton precession Magnetometer during 01-02.05.2015

Name of the instruments	GEOMETRICS PPMS (AX865)
Serial No.	278572 & 278728
Calibrated with	GSM90 Overhauser magnetometer of CPL, Primary variometer room
Serial No.	24575
Location	CPL- absolute hut
Pillar	5 & 6
Date of calibration	01.05.2015 to 02.05.2015
Duration of data used	12:10UT to 10:20UT
Data sampling	Minute
No. of sets	One
Name of the Observer	N. Phani Chandrasekar
Results	Satisfactory

Table 3.4.1: Calibration of Geometrics PPMs

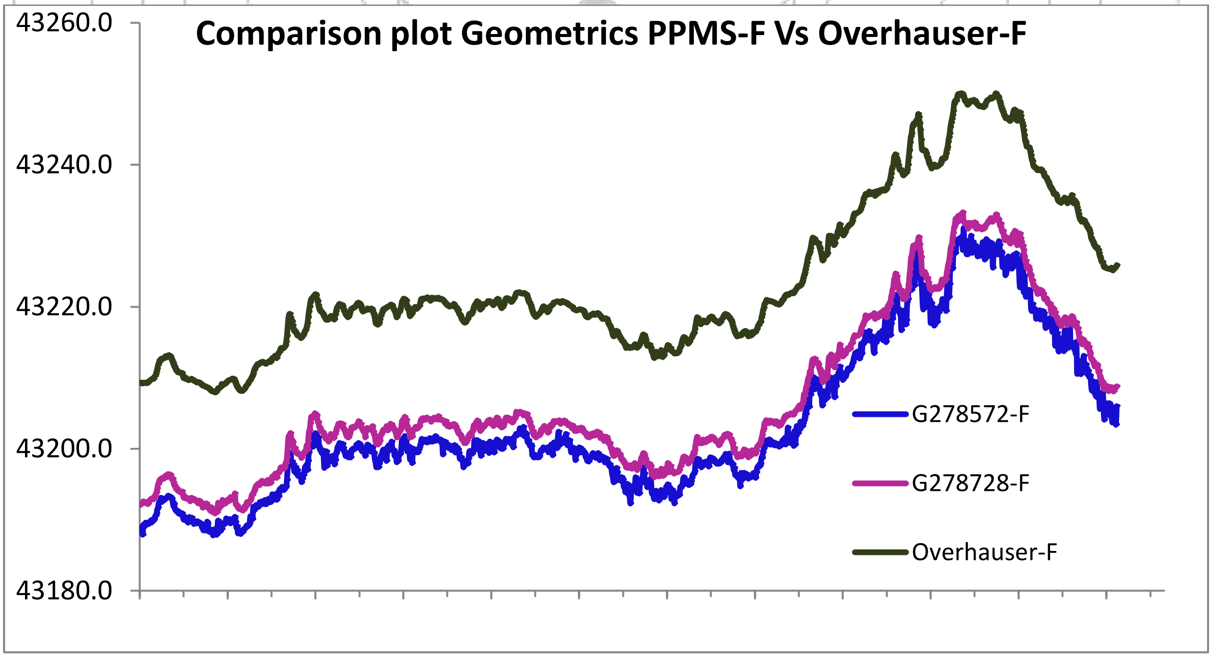


Figure 3.4.1: Comparision plot of GEOMETRICS PPMS Vs GSM90 Overhauser

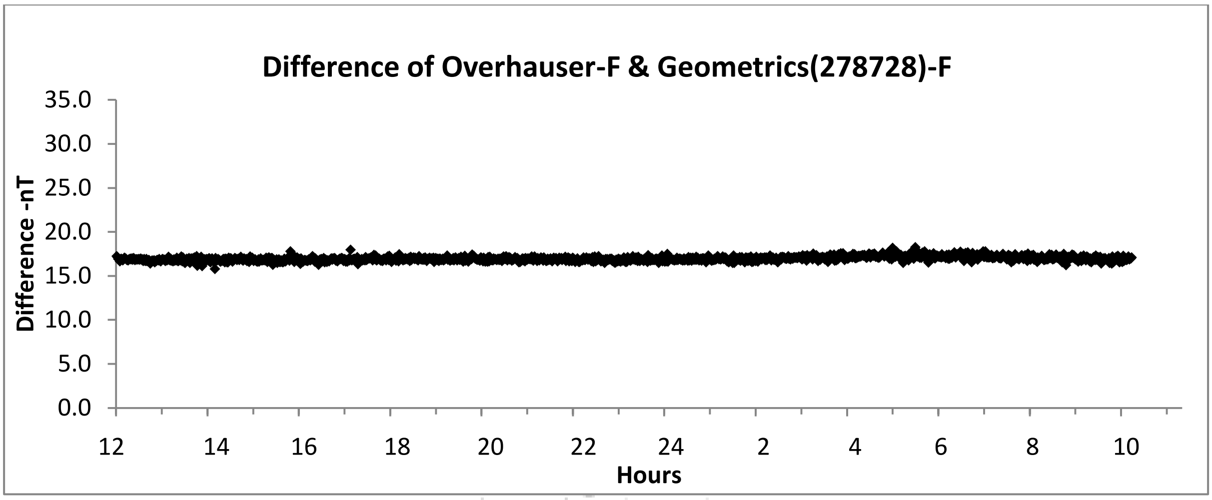


Figure 3.4.2: Difference between Overhauser-F and Geometrics-F(278728)

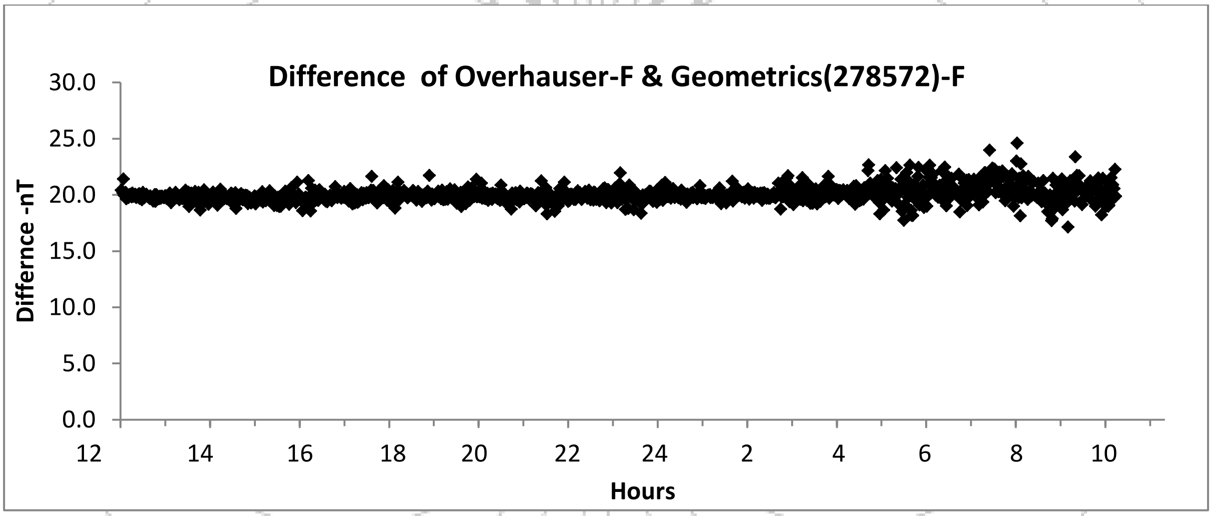


Figure 3.4.3: Difference between Overhauser-F and Geometrics-F(278572)

Report: The test recording data is for 22 hrs. Figure 3.4.1 shows the trends of the total field on 12.10UTof 01.05.2016 – 10.20UT of 02.05.2016. Figure 3.4.1a shows the 1 nT difference between Overhauser-F from DFM sensor room and Geometrics (278572)-F at pillar no. 5. And figure3.4.1b shows the 1.5 nT difference between Overhauser-F from DFM sensor room and Geometrics (278728)-F at pillar no. 6.

3.4.2. DI-flux Magnetometer during 03-04.09.2015

Name of the instrument	DI-Flux magnetometer (THEO-020A + GEOMAG-03 sensor)
Serial No.	1570
Calibrated with	DI-Flux magnetometer (Wild-T + Mag-01H sensor)
Serial No.	235823 & 545
Location	HYB – absolute room
Pier	Pillar no.1 in Absolute room-1 (main pillar)
Date of calibration	03.09.2015 to 04.09.2015
Duration of data used	Two days
Data sampling	Seconds
No. of sets	Eight
Name of the Observer	L. Manjula(◆), N. Phani Chandrasekar (◆)& K. Chandrashekhar Rao (◆)
Results	DI-Flux magnetometer (THEO-020A + GEOMAG-03 sensor) working condition is satisfactory. H=0.8nT, D=0.1min & Z=1.6nT

Table 3.4.2: Calibration of Geomag-03 DIM

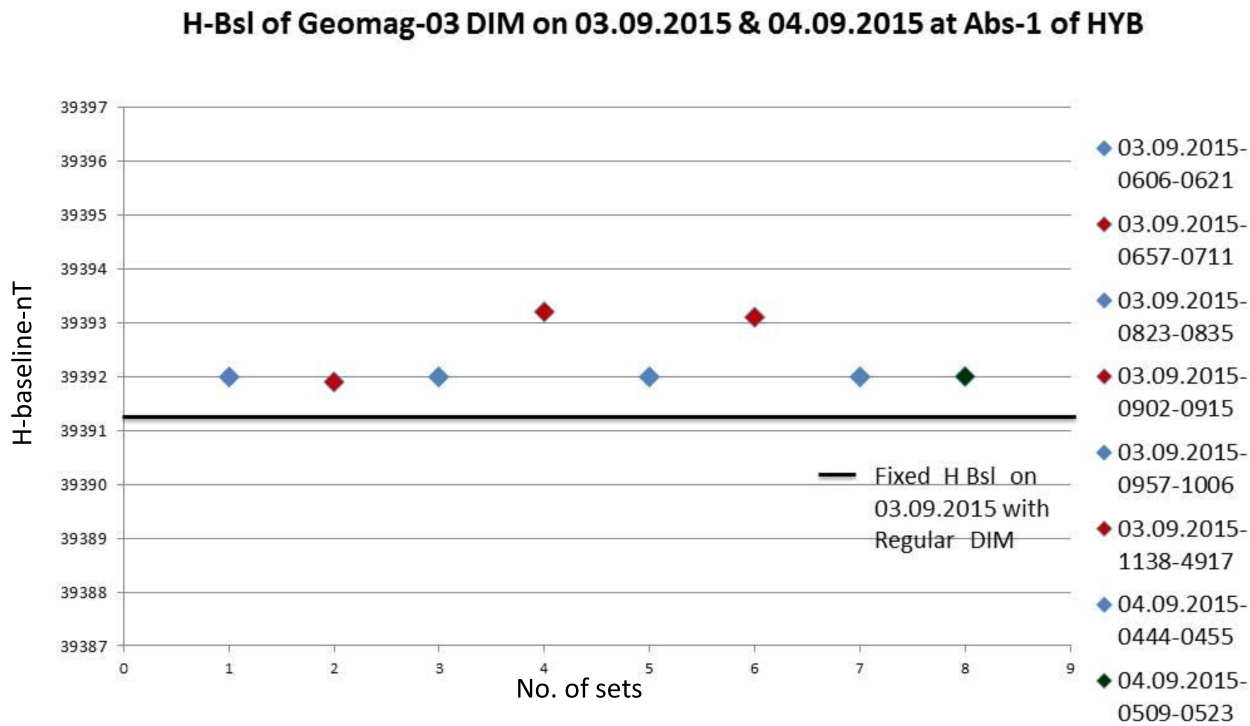


Figure 3.3.3: Comparision plot of GEOMAG-03 DIM with Mag-01H DIM of H Component right legend indates date & time of Observation

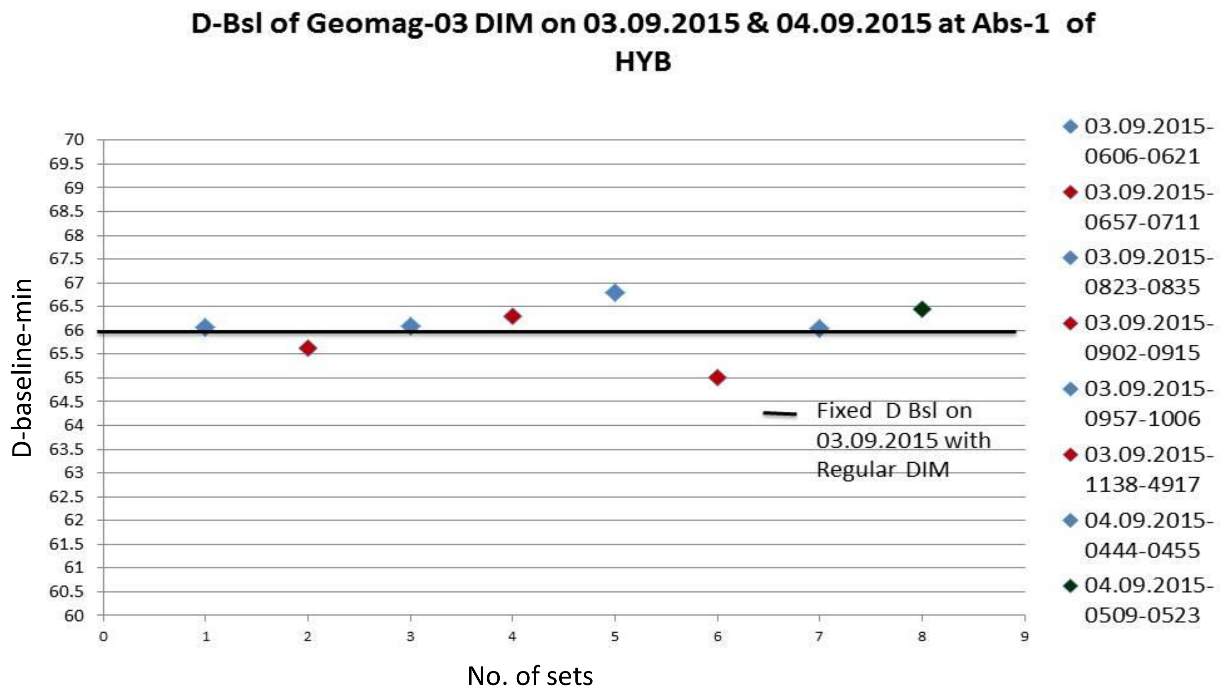


Figure 3.4.2: Comparision plot of GEOMAG-03 DIM with Mag-01H DIM of Declination right legend indates date & time of Observation

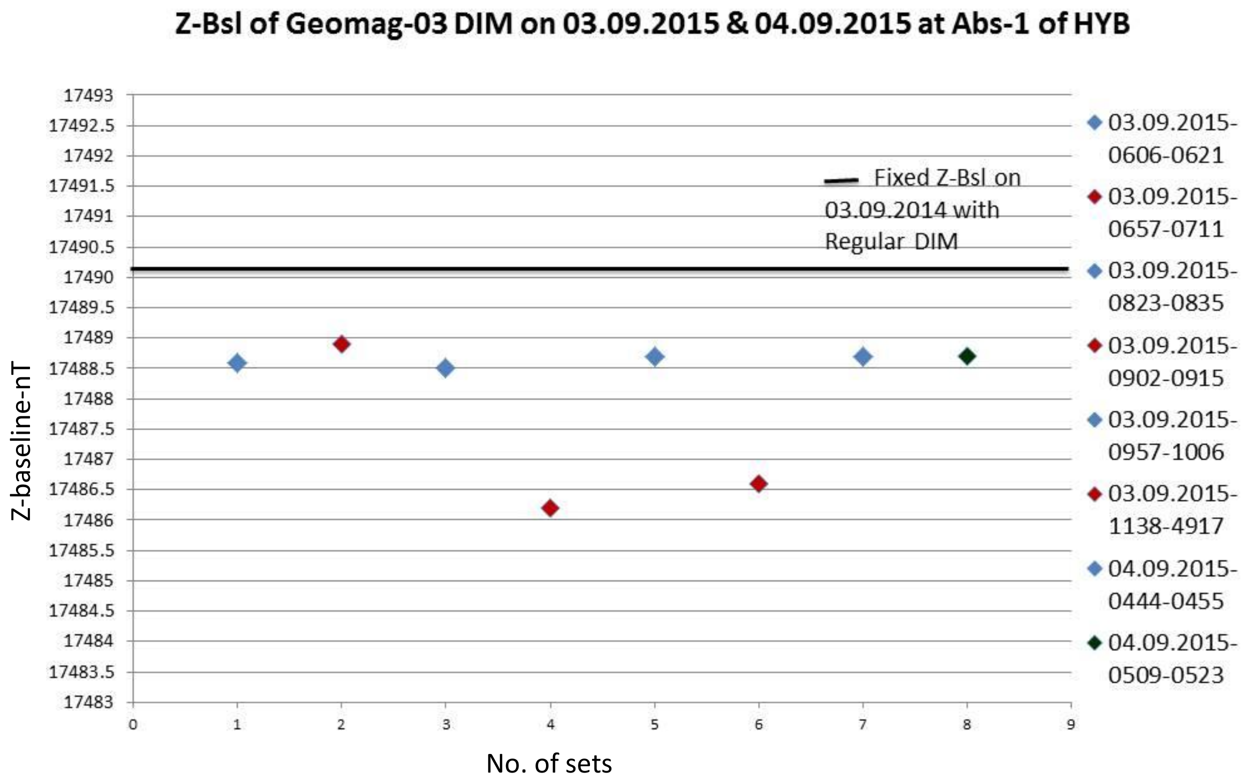


Figure 3.4.3: Comparision plot of GEOMAG-03 DIM with Mag-01H DIM of Z Component right legend indates date & time of Observation

Report: in the above plots the black fixed lines are the baseline values for the respected day with regular (Mag-01H & Wild) DIM and the dots are the absorbed baseline values with the GEOMAG-03 DIM. Fig. 3.4.1 shows the comparison of H baseline dots are separated by 0.8nT from the fixed line and in Fig. 3.4.3 show the comparison of Z baseline dots are separated by 1.6nT from the fixed line. Different coloured dots indicate different observers. Differences with standard baseline are well within acceptable limits, indicating satisfactory performance.

4. Data of Hyderabad Magnetic Observatory (HYB)

During 2015 the recordings and measurements at the NGRI observatory have been continued without interruption. Absolute measurements were taken at least twice per week using the DI-flux theodolite and an Overhauser effect proton magnetometer. The three component fluxgate variometers FGE and GEOMAG and the total field variometer GSM recorded continuously throughout the year. There were no modifications to the sensor locations or the recording equipment in 2015. The NGRI Observatory has continued to participate in the INTERMAGNET project.

Table 4.1: Key Observatory information:

IAGA code	HYB
Commenced operation	1964
Geographic latitude	17° 25' N
Geographic longitude	78° 33' E
Geomagnetic latitude	7.6° N
Geomagnetic longitude	148.9° E
K 9 index lower limit	300nT
Principal pillar	Pillar1, Absolute room 1
Reference mark azimuth	175° 26' 8"
Distance	144 m
Observers	L. Manjula

Table 4.2: Azimuth corrections for the Absolute pillars:

S.No.	Pillar	Azimuth Correction
1.	Pillar1, Absolute Room 1	175° 26’ 08”
2.	Pillar 2, Absolute Room 2	0° 03’ 30”
3.	Pillar 3, Secondary variometer room	-0° 35’ 00”

4.1. Daily Means of H, D, Z & F

These daily mean values are calculated from the recorded H, D & Z variation data of FGE magnetometer. From this daily mean tables the maximum & minimum variations of data monthly wise. In this region (Low latitude) the maximum magnetic field is reflected in the H component but in daily mean data maximum & minimum of the variometer data & total field data are not matching.

Tables 4.1.6 are the daily means of H, D, Z & F components monthly wise with maximum and minimum values.

Daily Mean Values of the Horizontal Intensity

Hyderabad Daily Intervals Calculated in Terms of UTC, H= 39000 + Tabulated Value 2015

Date	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1	429.8	436.1	417.0	460.1 max	449.4	443.9	442.3	441.0	446.8	440.4	433.2	432.6
2	425.3	415.9	410.9	446.0	450.0	454.0	441.7	439.0	452.8	420.1	453.4	431.4
3	415.4	430.3	426.4	441.4	446.7	456.4	447.4	449.8 max	452.2	426.8	439.9	447.2
4	392.3	431.0	439.3	437.4	447.2	458.7	447.1	447.5	424.9	412.6	414.2	451.8
5	401.1	433.7	445.3	446.2	444.1	464.4	402.4 n	452.5	430.7	423.2	428.2	440.0
6	413.9	439.2	446.2	444.4	431.0	467.3	415.2	447.0	433.3	423.6	439.9	427.0
7	378.3 min	428.1	432.5	452.9	442.3	474.6 max	430.9	439.6	412.4	367.1 min	389.3min	434.2
8	404.6	430.0	431.6	449.7	445.7	414.5	436.9	434.8	432.6	386.2	422.3	443.7
9	416.4	-	436.6	443.1	462.1 x	428.7	441.1	440.8	464.4	406.7	405.0	446.7
10	419.2	-	450.2	411.3	437.9	435.5	451.6	442.0	415.6	412.6	413.2	441.0
11	416.8	-	441.0	395.5	413.3	431.1	436.7	439.2	397.9	420.3	431.0	442.4
12	418.9	435.3	438.4	441.2	420.3	457.0	432.6	442.8	415.1	425.5	437.8	443.8
13	424.8	446.5	439.6	449.2	397.3 n	446.8	407.8	419.7	421.4	425.3	443.5	450.2
14	431.1	456.0max	448.7	435.2	425.8	446.4	430.0	442.4	428.5	412.5	435.7	435.8
15	431.9	443.7	448.0	412.7	429.4	431.2	439.6	411.8	423.3	430.9	449.1	424.3
16	427.3	453.0	458.6 max	390.9 min	441.3	437.9	432.2	395.1	439.9	437.7	425.7	434.7
17	429.5	414.0	348.2	402.2	448.2	426.8	434.9	405.3	432.2	441.2	445.8	445.3
18	437.3	405.6 min	339.0 min	429.5	443.8	435.2	440.5	424.7	431.6	419.3	448.0	444.2
19	437.2	424.0	364.4	422.8	424.8	440.9	450.4	415.1	436.0	437.8	440.5	452.8 max
20	445.9	-	390.1	443.4	434.8	456.7	464.8 x	432.1	402.0min	437.6	460.8	371.3
21	451.3ma x	438.2	406.5	429.5	439.1	467.5	456.4	446.6	427.2	444.3	453.7	364.8 min
22	430.9	436.7	405.0	432.7	444.6	436.0	454.6	437.9	438.6	444.6	455.1	417.7
23	434.1	427.4	414.6	437.6	450.4	317.8 min	409.0	425.1	430.8	447.4	457.6	428.8
24	432.7	413.8	417.9	437.3	444.1	389.7	420.6	431.6	437.6	455.7	461.2	439.0
25	439.2	431.4	432.4	448.8	447.6	397.1	424.9	432.0	449.5	460.5 max	467.9 max	446.7
26	422.0	438.0	432.7	455.8	451.7	404.4	432.8	410.5	452.0	450.8	464.6	444.6
27	432.9	453.2	425.6	442.4	446.4	420.9	442.0	372.6 min	455.9	448.3	457.1	442.1
28	435.3	441.6	436.4	435.6	451.3	416.9	431.6	376.1	453.4	462.6	459.9	452.8
29	439.1		419.3	442.4	458.8	432.0	443.5	417.0	441.2	458.0	457.6	450.6
30	429.3		432.2	450.6	459.2	442.5	451.1	436.0	460.9 max	447.4	438.9	452.1
31	431.1		448.6		453.0		439.8	440.1		447.5		417.5
Mean	**425.0**	**433.4**	**423.3**	**435.6**	**441.4**	**434.4**	**436.5**	**428.6**	**431.4**	**431.5**	**441.0**	**435.4**

Table 4.1.6a: Daily Mean Values of the Horizontal Intensity

Daily Mean Values of the Declination (Westerly)

Hyderabad Daily Intervals Calculated in Terms of UTC, D= 0° + ' Tabulated Value 2015

D	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1	44.54	44.12	43.34	43.46	43.56	43.12	43.30 max	42.70	42.46	42.57 max	42.23	42.22 max
2	44.20	44.06	43.68	43.59	43.21	43.27	43.01	42.80	42.29	42.52	42.43	41.73
3	44.50	43.82	43.78	43.51	43.52	43.37	43.15	43.00	43.03 max	42.09	42.46 max	42.14
4	43.85	44.23	43.85	43.60	43.12	43.36	43.00	42.78	42.74	42.28	41.92	41.90
5	44.56	44.14	43.70	43.85	43.44	43.69 max	43.01	43.01	42.65	42.38	42.15	41.90
6	44.22	44.09	43.71	44.20max	43.62	43.57	42.86	42.79	42.65	42.25	42.38	42.07
7	44.20	43.74	43.65	43.77	43.09	43.47	42.99	42.65	42.68	42.35	42.02	41.84
8	44.51	43.88	43.61	43.76	43.38	42.88	43.18	42.84	42.24	41.71 min	42.00	41.93
9	44.06	-	43.96 max	43.64	43.61 max	43.14	42.89	42.65	42.80	41.91	41.64 min	42.21
10	44.33	-	43.60	43.26	43.46	43.11	42.75	42.53	41.94 min	42.08	41.91	41.98
11	44.31	-	43.58	43.22	43.39	43.14	42.68	42.47	42.97	42.40	42.24	41.95
12	44.27	43.90	43.57	43.58	43.35	43.26	42.72	42.86	42.19	42.21	42.31	41.97
13	44.25	43.91	4356	43.27	42.84	43.09	42.52 min	42.68	42.47	42.31	42.06	41.97
14	44.60	44.13	43.53	43.73	43.27	42.81	42.99	42.82	42.47	42.11	42.05	41.58
15	44.26	44.31 max	43.47	43.52	42.78	42.93	42.79	42.43	42.33	42.44	42.05	41.97
16	44.63 max	44.04	43.84	42.94 min	42.69 min	43.16	42.79	42.34	42.66	42.35	42.02	41.99
17	44.05	43.96	42.37 min	43.27	43.36	42.71	43.20	42.40	42.90	42.38	42.06	41.89
18	44.45	43.66	43.10	43.16	43.22	43.19	42.91	42.92	42.52	42.25	42.14	41.89
19	44.15	43.81	43.39	43.14	43.31	43.09	42.99	42.68	42.24	42.56	42.09	42.26
20	44.63 max	-	43.50	43.62	43.05	42.89	42.72	42.74	42.75	42.21	42.36	41.12 min
21	44.18	44.20	43.68	43.53	43.53	43.64	43.06	42.86	42.12	42.30	42.12	41.34
22	44.32	43.83	43.26	43.54	43.54	42.92	42.62	42.29	42.75	42.53	42.18	41.79
23	43.87	44.12	43.63	43.57	43.19	42.34 min	43.12	42.94	42.51	42.16	42.30	41.69
24	44.60	43.57 min	43.43	42.99	43.41	43.42	42.94	43.03 max	42.21	43.37	42.17	41.83
25	44.17	43.63	43.65	43.61	43.51	43.18	42.77	42.48	42.42	42.12	42.18	42.10
26	44.29	43.91	43.24	43.60	43.47	43.14	42.85	42.37	42.25	42.54	42.06	41.83
27	44.06	43.60	43.45	43.80	43.36	43.17	42.88	41.69 min	42.39	42.46	42.16	41.82
28	44.48	43.74	43.63	43.49	43.43	42.79	42.83	42.35	42.49	42.48	42.03	42.02
29	43.77 min		43.22	43.23	43.14	43.27	43.04	42.73	42.71	42.37	41.74	41.99
30	44.44		43.54	43.45	43.54	43.11	42.54	42.40	42.63	42.23	42.22	41.86
31	44.11		43.61		43.34		42.69	42.46		42.43		41.27
Mean	44.29	43.93	43.52	43.50	43.31	43.14	42.90	42.64	42.52	42.29	42.12	41.87

Table 4.1.6b: Daily Mean Values of the Declination (Westerly)

Daily Mean Values of the Vertical Intensity

Hyderabad Daily Intervals Calculated in Terms of UTC, Z= 17000 + Tabulated Value 2015

D	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1	633.4	642.7	650.2 min	661.8	667.2	677.4	690.8 min	703.1	706.7	714.4 min	724.2 min	737.2
2	632.4 min	641.3 min	652.1	660.6	666.4 min	679.5	695.4	703.5	708.5min	714.9	725.4	735.9
3	636.1	643.9	651.7	661.5	672.6	680.2	692.8	697.0 min	705.8	718.0	726.3	735.5
4	634.1	643.3	654.4	655.9 min	672.0	675.3mi n	696.8	701.3	713.1	719.1	728.5	738.8
5	639.9	645.4	653.6	662.4	676.4	680.8	693.1	701.5	713.8	722.0	731.5	738.1
6	636.7	644.3	654.1	664.7	675.5	677.4	694.8	700.6	710.0	720.3	729.8	738.1
7	637.3	641.8	651.5	660.8	671.5	680.0	694.6	700.0	712.8	720.9	730.4	736.4min
8	636.3	644.9	651.3	661.8	671.4	682.4	692.4	701.1	708.4	720.4	730.8	741.7
9	638.6	-	651.5	661.7	673.8	683.0	694.0	702.0	710.0	722.8	729.1	739.5
10	633.3	-	654.2	660.0	673.6	683.8	693.0	706.6	710.1	719.0	731.1	738.4
11	637.2	-	650.8	664.7	673.4	687.1	699.1	708.0	711.2	721.1	730.9	737.6
12	633.4	644.1	654.2	664.2	677.8	682.1	697.0	703.5	710.2	720.2	731.6	739.4
13	632.8	647.1	654.5	665.4	676.5	685.4	691.3	703.3	715.8	718.8	731.2	739.4
14	635.6	647.6	655.2	664.0	677.8	685.7	696.8	703.6	708.4	719.0	730.3	737.1
15	634.0	648.6	655.5	663.9	675.6	685.5	694.3	703.5	711.5	721.3	730.4	743.4
16	636.4	647.0	652.7	665.8	677.3	683.0	697.3	705.3	715.2	722.6	731.7	743.4
17	635.6	646.9	657.0	668.5	676.7	685.0	695.8	710.1	712.4	723.0	732.1	743.4
18	639.7	651.9	660.4	671.6	681.1max	684.1	696.5	706.4	711.9	721.0	732.4	741.8
19	636.0	651.3	659.8	666.0	677.8	687.1	695.1	703.9	711.6	720.5	732.1	742.7
20	639.4	-	658.0	668.2	676.0	689.2	696.9	707.6	709.8	723.2	732.4	740.1
21	637.9	647.5	657.6	670.0	677.1	687.4	700.6	708.1	711.2	720.9	732.8	746.9
22	638.1	650.3	656.5	667.9	674.2	686.0	696.5	708.4	716.0	721.8	732.2	749.0max
23	638.2	648.1	659.5	669.0	678.1	686.9	697.7	705.1	712.7	722.1	734.2	746.0
24	639.4	648.5	662.0max	667.6	674.8	695.6max	696.2	710.5	712.8	721.9	733.2	745.7
25	641.3	651.4	658.8	669.1	676.6	693.3	702.8max	712.3	712.5	720.7	732.1	744.7
26	639.0	652.6 max	657.6	680.9max	679.4	695.1	701.4	711.3	712.6	721.9	736.2	745.4
27	642.5	649.8	658.9	671.8	678.3	690.6	702.5	711.0	713.8	723.2	731.9	745.5
28	641.3	651.7	658.4	672.0	677.1	690.2	697.4	710.2	712.0	722.6	734.8	747.5
29	643.3		660.9	670.3	677.6	692.7	700.4	713.4	717.0max	723.2	732.5	745.1
30	643.9 max		658.1	671.2	678.6	690.8	702.7	712.7max	712.5	722.2	738.1max	746.6
31	643.0		660.9				698.0	708.2		725.5max	737.8	745.6
Mean	637.6	646.9	655.9	665.7	675.5	685.9	697.0	706.0	712.0	721.2	731.8	741.8

Table 4.1.6c: Daily Mean Values of the Vertical Intensity

Daily Mean Values of Total field

Hyderabad Daily Intervals Calculated in Terms of UTC, F= 43000 + Tabulated Value 2015

D	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1	193.2	202.7	188.3	232.4	224.8	224.8	229.9	230.7	232.5	254.6	246.3	234.2
2	188.6	183.6	183.5	219.0	225.0	234.4	229.9	232.0	239.3	236.2	233.9	236.6
3	181.1	187.9	197.5	215.2	224.6	234.5	228.2	227.6	243.7	218.9	252.7	250.7
4	159.2 min	198.2	210.4	209.2	224.8	238.9	235.1	239.2	246.2	225.5	241.2	256.3
5	169.6	201.5	215.5	220.0	223.8	242.7	233.3	237.1	221.5	213.7	218.9	245.2
6	179.9	206.1	214.5	219.2	211.5	246.4	193.2 min	241.3max	225.3	222.6	231.9	233.4
7	147.7	195.0	203.0	225.4	220.1	254.1max	204.9	236.0	228.5	223.3	242.0	239.3
8	171.3	198.0	202.0	222.9	223.2	199.5	218.2	229.7	208.0	171.6 min	196.1 min	250.2
9	183.0	-	206.8	216.8	239.1	212.7	224.4	225.8	227.0	189.9	225.4	252.0
10	183.4	-	220.2	187.1	217.0	220.3	227.8	233.1	164.8 min	207.1	210.5	246.3
11	182.8	-	210.4	174.6	194.4	214.2	239.9	234.8	212.0	213.3	217.9	247.2
12	183.1	202.5	209.5	216.2	202.6	239.2	225.4	230.4	195.4	219.9	234.4	249.3
13	188.3	214.0	210.7	223.9	181.1 min	230.0	219.4	233.6	213.4	224.1	240.4	255.1
14	195.2	222.8max	219.3	210.6	207.6	229.6	199.0	212.6	216.1	224.1	245.2	241.1
15	195.2	212.0	218.7	189.9	210.0	214.7	218.2	233.2	223.8	213.4	238.2	233.2
16	192.0	219.9	227.3max	170.9 min	221.5	221.6	228.2	206.1	220.6	230.6	251.0	242.6
17	193.7	184.3	128.3	182.3	227.6	211.9	220.9	192.8	234.7	236.9	229.7	252.3
18	202.5	178.6 min	121.3 min	208.5	225.4	220.1	223.6	200.6	227.4	239.3	248.3	250.6
19	200.9	195.2	144.2	200.1	206.7	226.1	228.1	217.3	226.8	219.1	250.1	258.8
20	210.2	-	166.9	219.7	215.1	239.8	237.9	210.1	230.0	237.1	243.4	183.5
21	214.6 max	206.6	181.8	207.8	219.4	249.0	252.5max	225.8	199.6	236.0	262.1	180.3 min
22	196.0	206.3	180.0	209.8	223.2	220.6	243.2	239.1	224.6	242.5	255.3	229.4
23	199.0	197.0	189.9	214.7	230.2	116.4 min	242.1	229.9	233.6	243.0	257.4	238.3
24	198.2	184.6	194.0	213.9	223.1	181.0	199.8	220.3	226.5	245.4	259.3	247.5
25	204.9	202.0	205.9	225.0	227.1	188.5	213.9	227.0	233.4	252.5	262.1	254.1
26	188.2	208.5	205.6	231.4	231.9	193.3	216.5	227.0	243.8	257.3	269.9max	252.4
27	199.7	221.2	199.7	220.3	226.6	208.2	224.1	207.2	246.3	249.0	265.2	250.3
28	201.4	211.4	209.3	241.2max	230.6	205.6	230.4	172.4min	249.1max	246.5	259.5	260.8max
29	205.6		194.8	219.7	237.7	218.6	222.2	176.8	248.9	259.7max	261.4	257.8
30	197.0		205.5	227.5	238.4max	228.2	234.0	213.9	235.9	255.2	244.2	259.8
31	198.2		221.5		232.3		239.0	229.4		246.8		227.8
Mean	190.4	202.0	196.3	211.6	220.8	218.8	225.2	221.8	226.7	230.6	243.6	242.6

Table 4.1.6d: Daily Mean Values of the Horizontal Intensity

4.2. Absolute Measurements

Based on simultaneous F observations on variometer and absolute pillars during 18-22 May, 2015 and 9-16 December, 2015 adopted monthly by offset values are prepared for the entire year as in Table 4.2.1 using polynomial fitting.

Table 4.2.1: Offset values for the year 2015 (F value difference from DFM sensor room to absolute pillar1 at absolute room-1):

Date	Offset value
01.01.2015	-135.15
01.02.2015	-134.61
01.03.2015	-134.13
01.04.2015	-133.61
01.05.2015	-133.10
01.06.2015	-132.57
01.07.2015	-132.06
01.08.2015	-131.54
01.09.2015	-131.02
01.10.2015	-130.51
01.11.2015	-130.00
01.12.2015	-129.49

Throughout the year, the absolute measurements were carried out as follows:
Two absolute measurements are taken using the Wild DI-flux theodolite on pillar No.1 (Absolute room-I) twice per week, if required trice in a week. The corresponding total field measurement is taken from GSM Overhauser magnetometer located in DFM sensor room. Therefore, the F measurement values, obtained are corrected by means of the corresponding offset to the pillar No.1 (Absolute room-I). we get the baselines of H, D, Z from absolute values of H, D & Z by removing the respected variations of H, D & Z from FGE variometer.

The deviations ΔH, ΔD and ΔZ of the absolute measurements from the absorved base values are shown in table shows the adopted base values as lines and small squares indicate the actual absolute measurements.

The following is the table of observed baselines H, D & Z (January to December) by means of the Wild-T & Mag-01H DI-Flux magnetometer and the GSM 19 Overhauser effect proton magnetometer, reduced with FGE variometer recordings.

Month	Day	Time in UT	Horizontal Intensity H/nT	ΔH/nT	Declination (Westerly) D	ΔD/'	Vertical intensity Z/nT	ΔZ/nT	F ΔF/nT
Jan	01	03:27	39392.56	0.02	1°05.86'	-0.03	17491.70	-0.12	-135.20
Jan	07	04:45	39392.61	0.05	1°05.81'	-0.05	17491.82	0.12	-135.09
Jan	20	06:38	39392.81	0.20	1°05.88'	0.07	17491.72	-0.08	-134.87
Jan	28	04:28	39392.85	0.04	1°05.85'	-0.03	17491.97	0.25	-134.58
Feb	06	04:31	39392.89	0.04	1°05.83'	-0.02	17491.87	-0.10	-134.51
Feb	12	04:59	39392.98	0.09	1°05.82'	-0.01	17492.16	0.29	-134.42
Feb	23	04:34	39393.18	0.20	1°05.83'	0.01	17492.08	-0.08	-134.27
Feb	26	04:37	39393.22	0.04	1°05.83'	0.00	17492.10	0.02	-134.28
Mar	02	04:53	39393.38	0.16	1°05.87'	0.04	17492.26	0.16	-134.06
Mar	04	04:38	39393.35	-0.03	1°05.86'	-0.01	17492.23	-0.03	-134.09
Mar	16	04:57	39393.49	0.14	1°05.82'	-0.04	17492.24	0.01	-133.73
Mar	27	04:27	39393.63	0.14	1°05.85'	0.03	17492.29	0.05	-133.72
Apr	06	09:42	39393.82	0.19	1°05.87'	0.02	17492.25	-0.04	-133.58
Apr	10	11:22	39393.87	0.05	1°05.86'	-0.01	17492.33	0.08	-133.66
Apr	22	05:48	39394.04	-0.17	1°05.89'	0.02	17492.34	0.01	-133.34
Apr	28	05:53	39394.12	0.08	1°05.86'	-0.03	17492.31	-0.03	-133.19
May	07	04:19	39394.19	0.05	1°05.89'	0.03	17492.43	0.12	-133.10
May	12	04:30	39394.27	0.08	1°05.90'	0.01	17492.33	-0.10	-132.89
May	22	11:47	39394.33	0.06	1°05.86'	-0.04	17492.54	0.24	-132.69
May	25	11:47	39394.45	0.12	1°05.85'	-0.01	17492.56	0.02	-132.65
June	01	04:38	39394.40	-0.05	1°05.84'	-0.01	17492.92	0.36	-132.57
June	09	04:45	39394.63	0.23	1°05.86'	0.02	17493.21	0.29	-132.47
June	15	04:52	39394.86	0.23	1°05.89'	0.03	17492.99	-0.22	-132.33
June	25	04:49	39395.33	-0.47	1°05.93'	0.04	17492.33	-0.66	-132.32
July	03	04:34	39395.30	-0.03	1°05.86'	-0.07	17492.50	0.17	-132.04
July	16	04:25	39395.54	0.24	1°05.85'	-0.01	17492.64	0.14	-131.87
July	24	04:37	39395.53	-0.01	1°05.88'	0.03	17492.51	-0.13	-131.74
July	31	04:30	39395.65	0.12	1°05.89'	0.01	17492.26	-0.25	-131.72
Aug	03	05:04	39395.78	0.23	1°05.90'	0.01	17492.34	0.08	-131.54
Aug	14	04:40	39395.80	0.02	1°05.92'	0.02	17493.43	1.09	-131.36
Aug	20	04:33	39395.81	0.01	1°05.86'	-0.06	17493.33	-0.10	-131.15
Aug	27	04:17	39395.91	0.10	1°05.91'	0.05	17493.41	0.08	-131.19
Sept	03	04:45	39396.04	0.13	1°06.09'	1.18	17492.44	0.03	-131.04
Sept	14	11:56	39396.11	0.07	1°05.91'	-1.18	17493.05	0.61	-130.80
Sept	26	06:24	39395.79	-0.32	1°06.00'	0.08	17494.11	1.06	-130.80
Oct	08	06:46	39396.25	-0.46	1°06.09'	0.09	17493.48	-0.63	-130.50
Oct	14	04:26	39396.31	0.06	1°05.97'	-0.12	17493.80	0.32	-130.38
Oct	26	04:10	39396.29	-0.02	1°05.98'	0.01	17493.80	0.00	-129.95
Oct	30	04:59	39396.63	0.34	1°05.97'	-0.01	17493.08	-0.72	-130.33
Nov	03	04:25	39396.67	0.03	1°05.94'	-0.03	17493.21	0.13	-129.80
Nov	10	04:50	39396.79	0.12	1°05.99'	0.05	17493.81	0.60	-129.88
Nov	16	05:10	39396.96	0.17	1°05.98'	-0.01	17493.77	0.04	-129.63
Nov	23	04:23	39397.10	0.14	1°05.76'	-0.22	17493.47	-0.30	-129.67
Dec	03	05:07	39397.09	-0.01	1°05.60'	-0.16	17493.46	0.01	-129.57

Dec	11	04:17	39397.75	0.66	1°05.67'	0.07	17492.99	-0.47	-129.24
Dec	21	04:26	39396.57	-1.18	1°05.81'	0.14	17494.28	1.29	-129.02
Dec	31	04:28	39397.99	-1.42	1°05.79'	-0.03	17492.85	-1.43	-129.03

Table 4.1.5: Observed baselines H, D & Z (January to December) by means of the Wild- T & Mag-01H DI-Flux magnetometer and the GSM 19 Overhauser effect proton magnetometer, reduced with FGE variometer recordings.

4.2.1. Baseline values

In figure 4.3.1 black colour small squares indicates observed baseline values, the red line is the adopted baselines for all days. This adopted baselines are reduced using polynomial for the observed baseline values. This adopted values are added to daily variations of Magnetic field.
During 2015, 65 absolute observations carried out. Out of that 35 observations are considered for the baseline construction for 2015. Remarkable changes are observed in the H & Z baselines which are not seen naturally (i.e. 5.5nT change in H & 2nT change Z over year). It is because of offset of total field value which is the correction from DFM sensor room to absolute pillar changed abnormally due to the environmental pollution like rapid urbanisation and introduction of Hyderabad Metro Rail project in the vicinity. D baseline changed 0.2 min throughout the year.

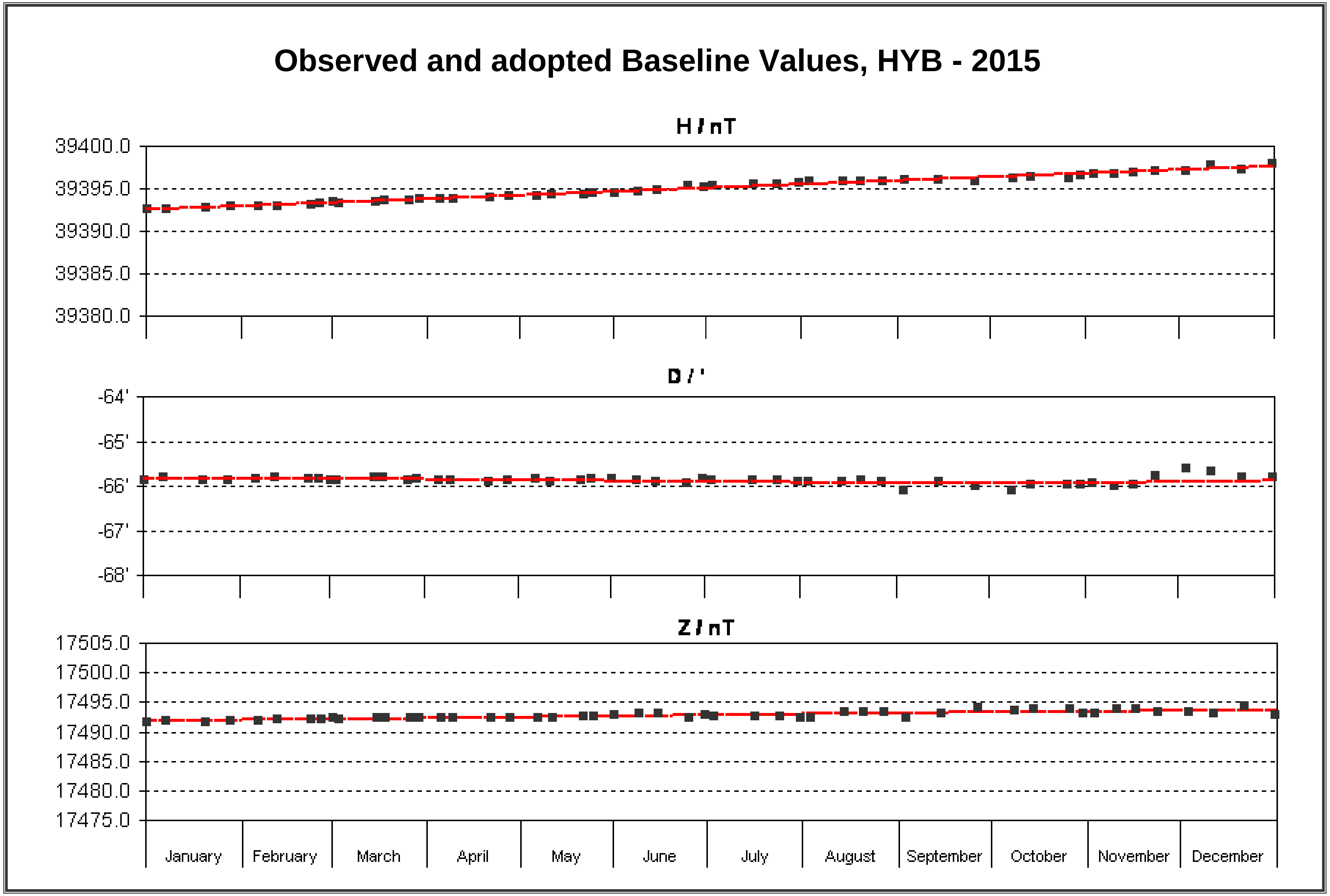
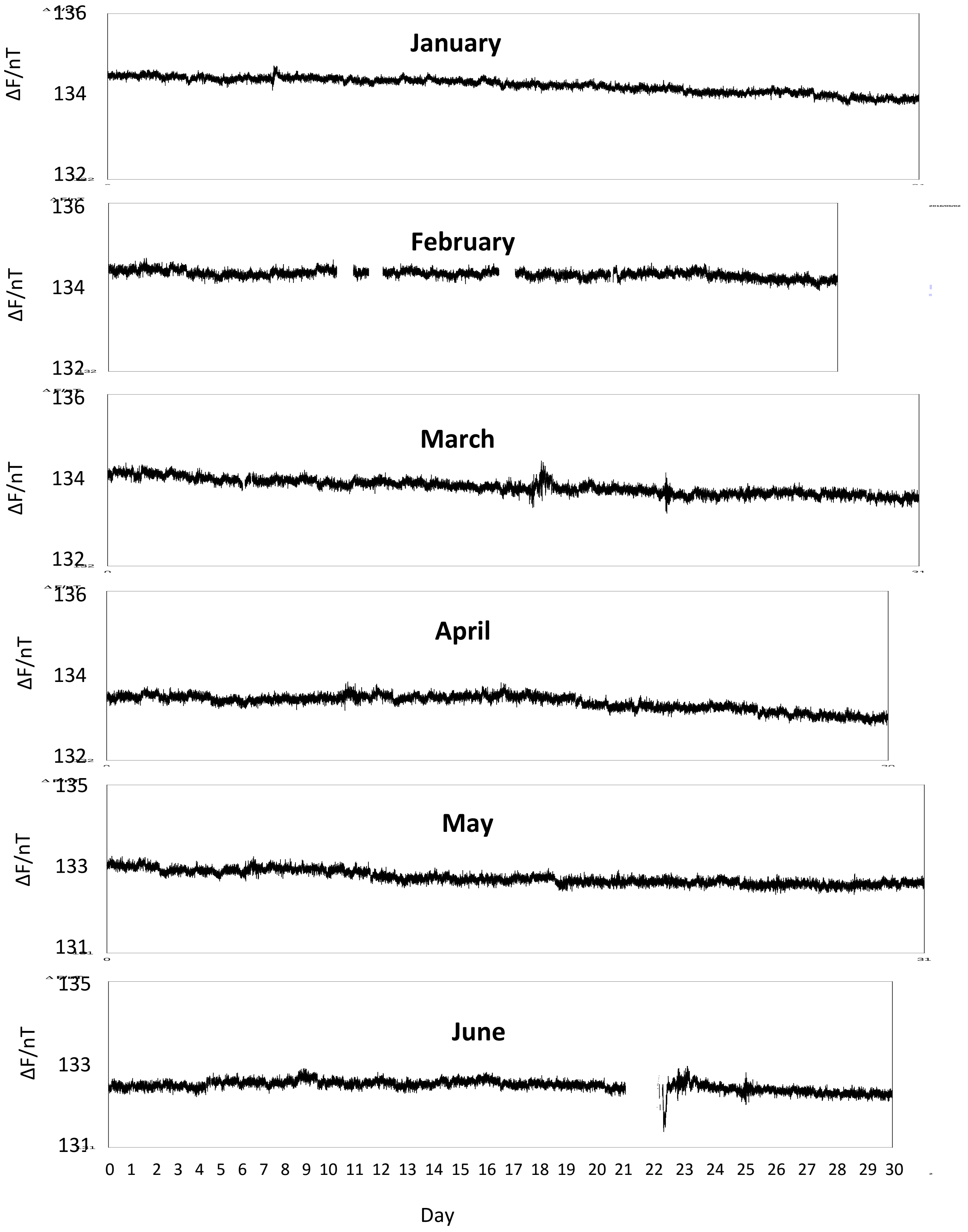


Figure 4.2.1: FGE Variometer baselines

4.3. Monthly ΔF plots of HYB



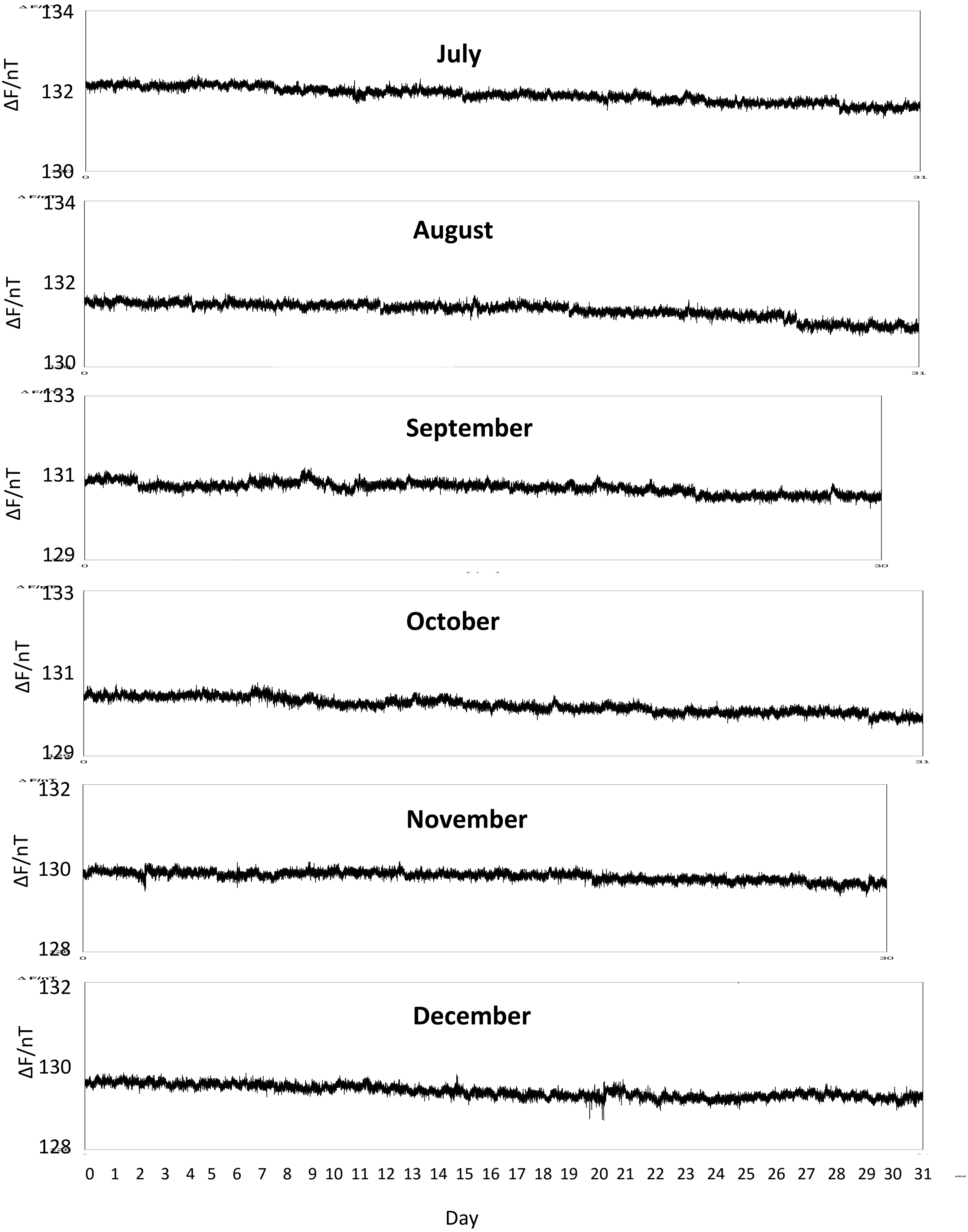


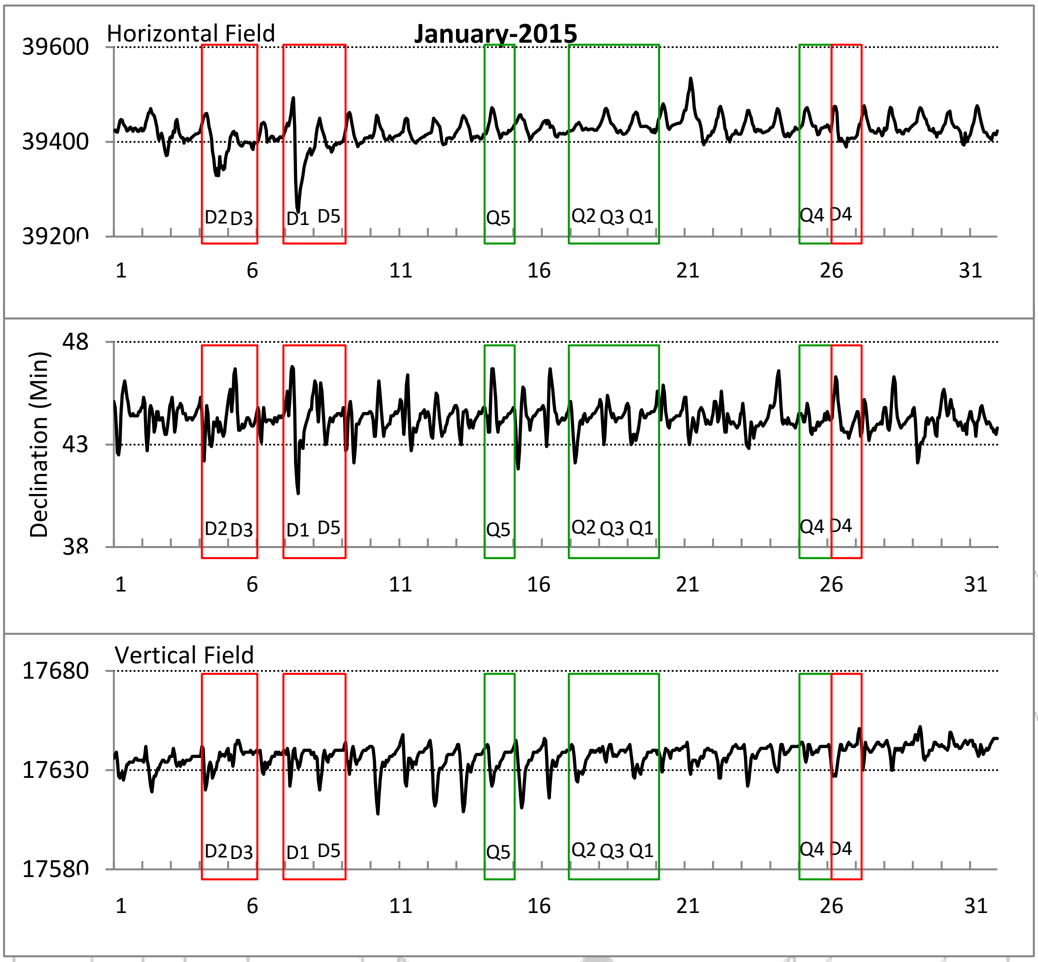
Figure 4.3.1: Monthly ΔF plots of HYB

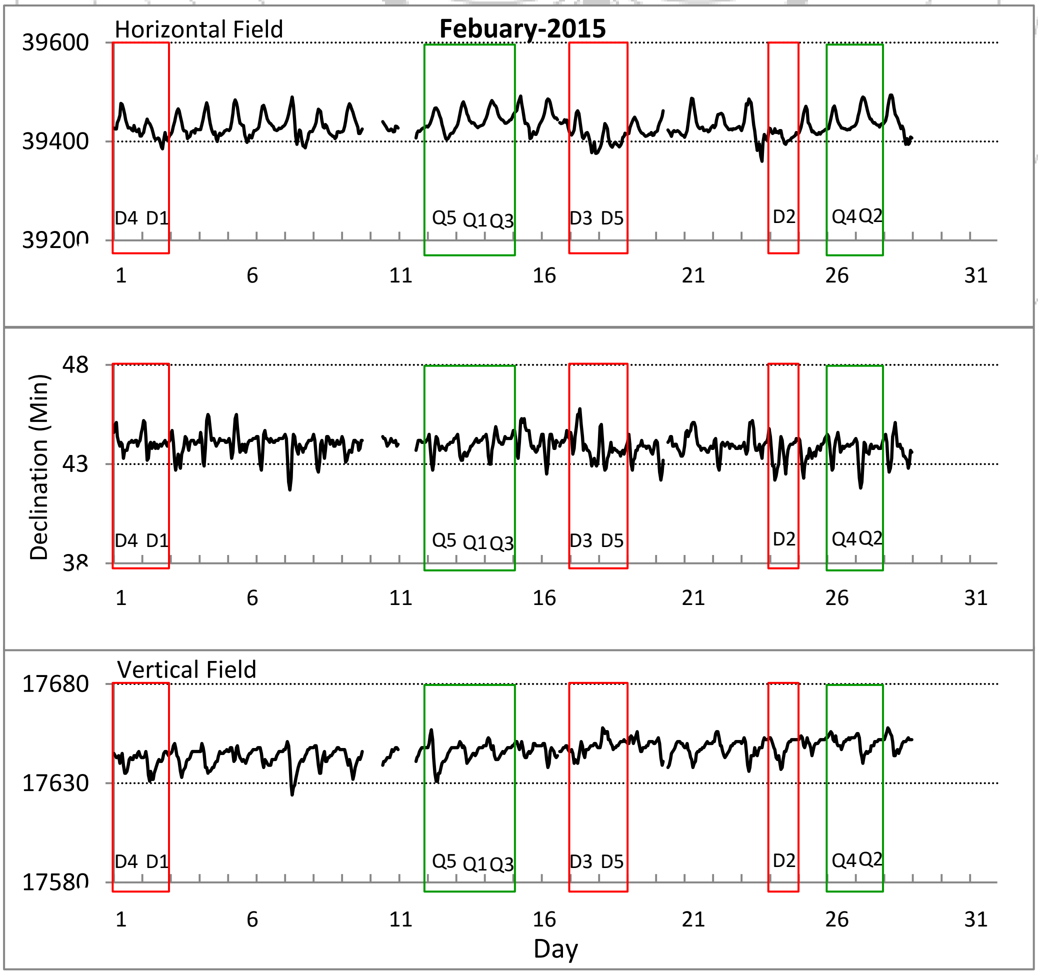
4.3. Monthly ΔF plots:

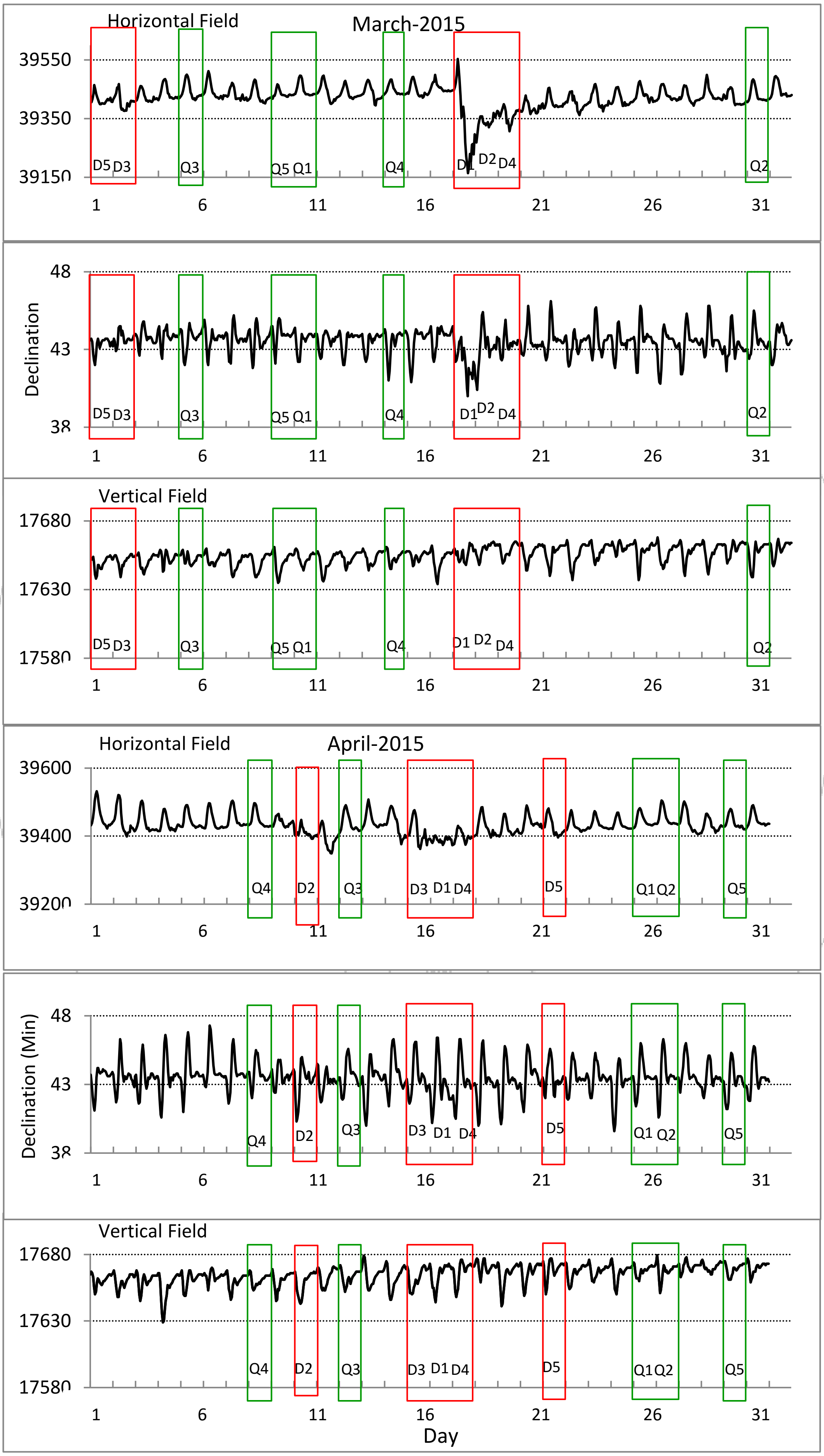
ΔF is the difference between the recorded total field and calculated total field from the variometer recording system means from H & Z. These plots are indicators of the quality of scalar data (Total field) as well as vector data (fluxgate data). During highly active days the ΔF plots also having disturbances, shifting can be noticed. These ΔF plots use to check the FGE & GSM data quality. From ΔF is the difference between calculated F (Total field) from H & Z component and direct recorded F (total field). The difference between these two should be constant. If it is varying, we have to check the data recording systems. If we look at the HYB ΔF plots, the ΔF value is gradually deceasing from 135.4nT to 129.01nT throughout the year; it is due to the artificial disturbances. In HYB observatory the environmental magnetic pollution is effecting more on scalar recording system i.e. total field magnetometer (GSM) when comparing to tri axial fluxgate magnetometer (vector recording system) which H, D & Z variation data. Due to this reason the baselines of 2015 of HYB observatory are affected a lot when compare to the CPL baseline.

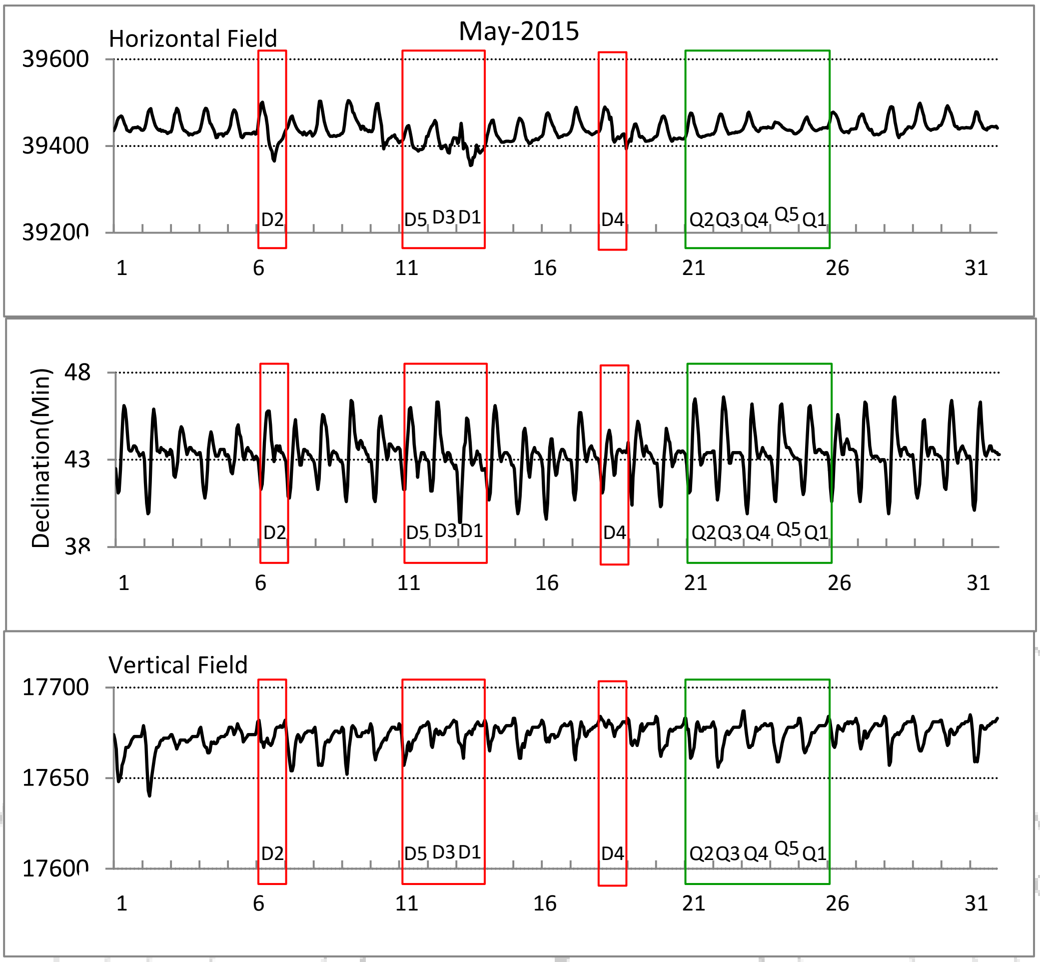
If we look at the CPL ΔF plots (Figure 6.3.1:), changes in daily ΔF are observed but overall change throughout the year is 0.7nT. in CPL observatory there is no magnetic pollution but problem in stability of tri axial fluxgate magnetometer. In CPL observatory the scalar data is good.

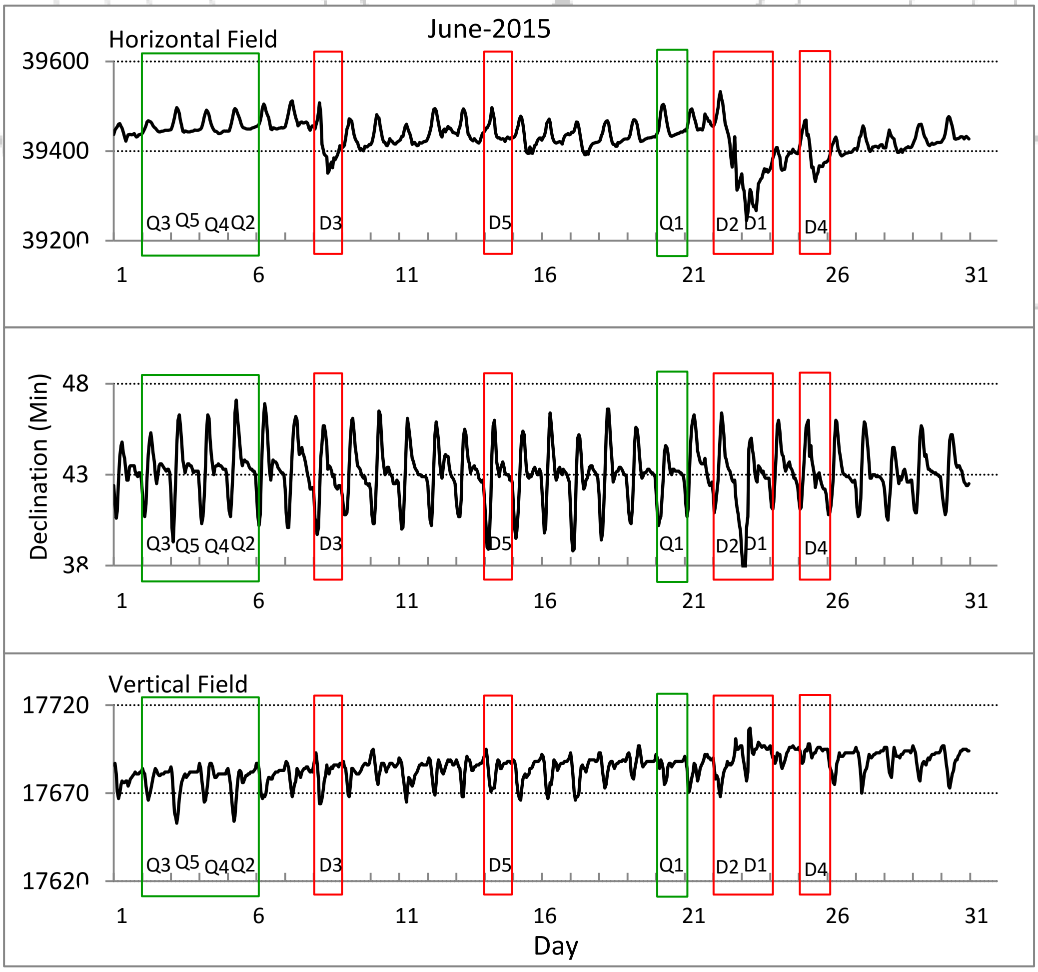
4.4. Hourly means of H, D & Z with IQ & ID days

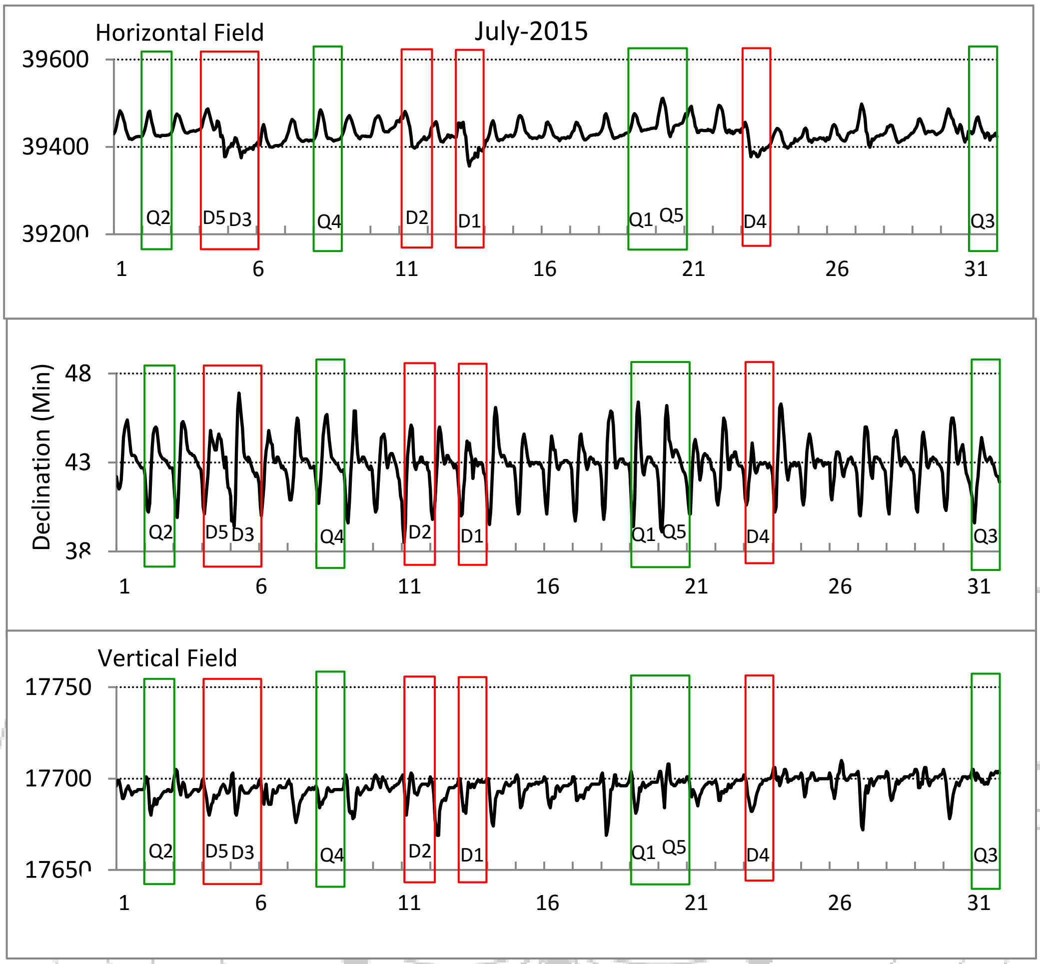


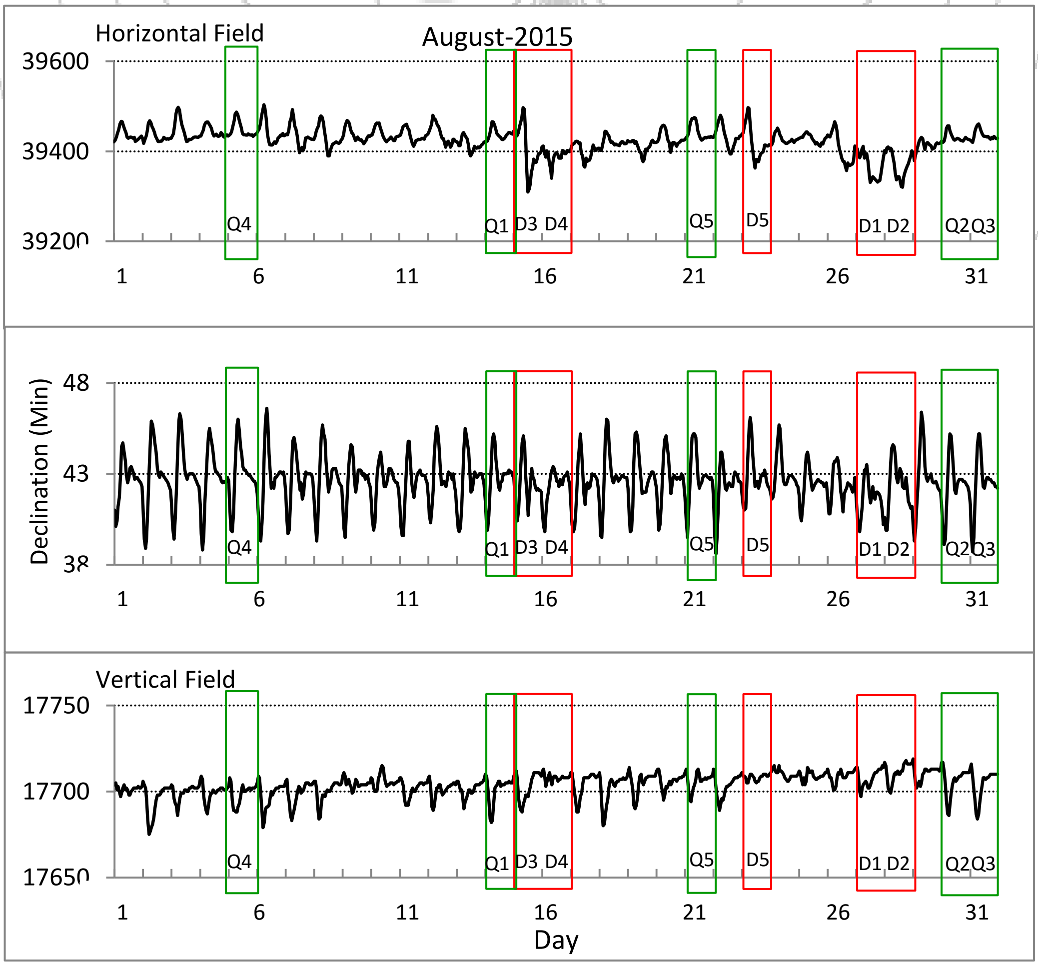


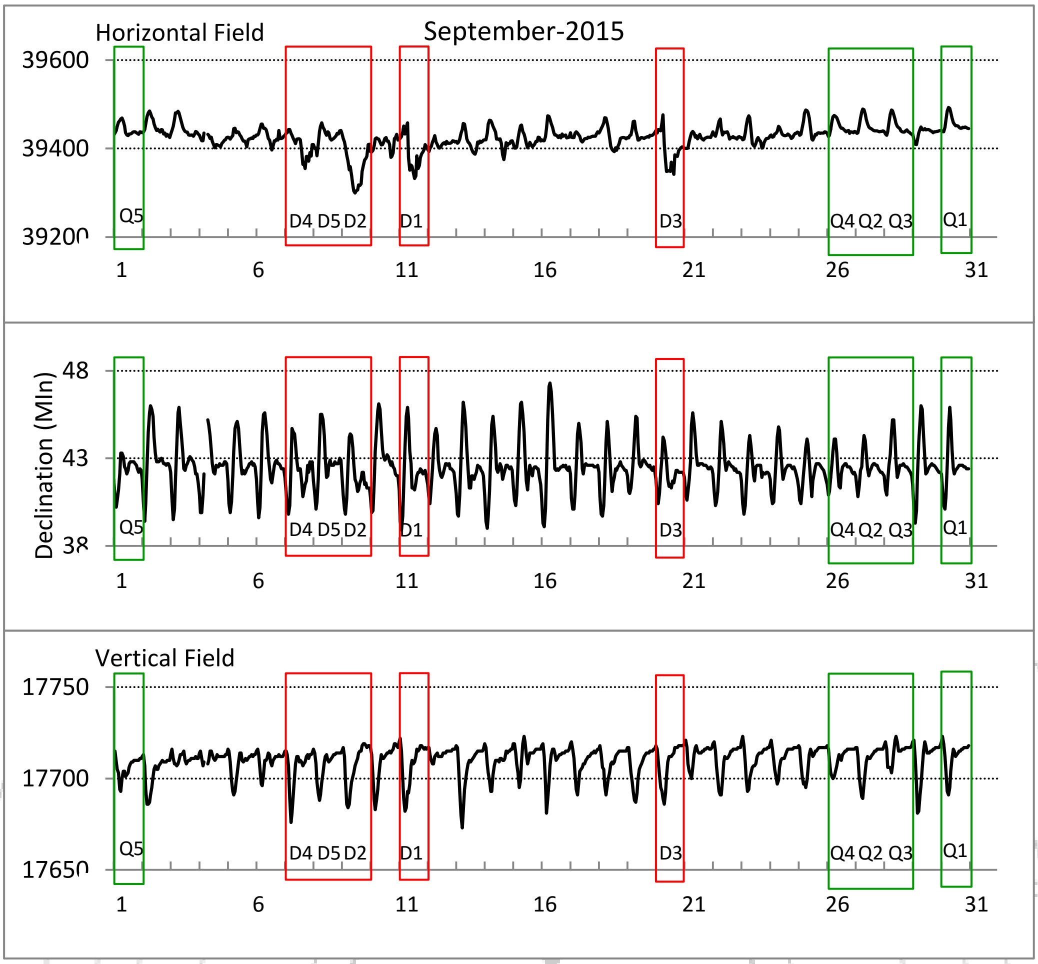

Horizontal Field
March-2015
39550
39350
39150
D5 D3
Q3
Q5 Q1
Q4
D1 D2 D4
Q2
1
6
11
16
21
26
31
Declination
48
43
38
Vertical Field
17680
17630
17580
Horizontal Field
April-2015
39600
39400
39200
Q4
D2
Q3
D3 D1 D4
D5
Q1 Q2
Q5
Declination (Min)
Day

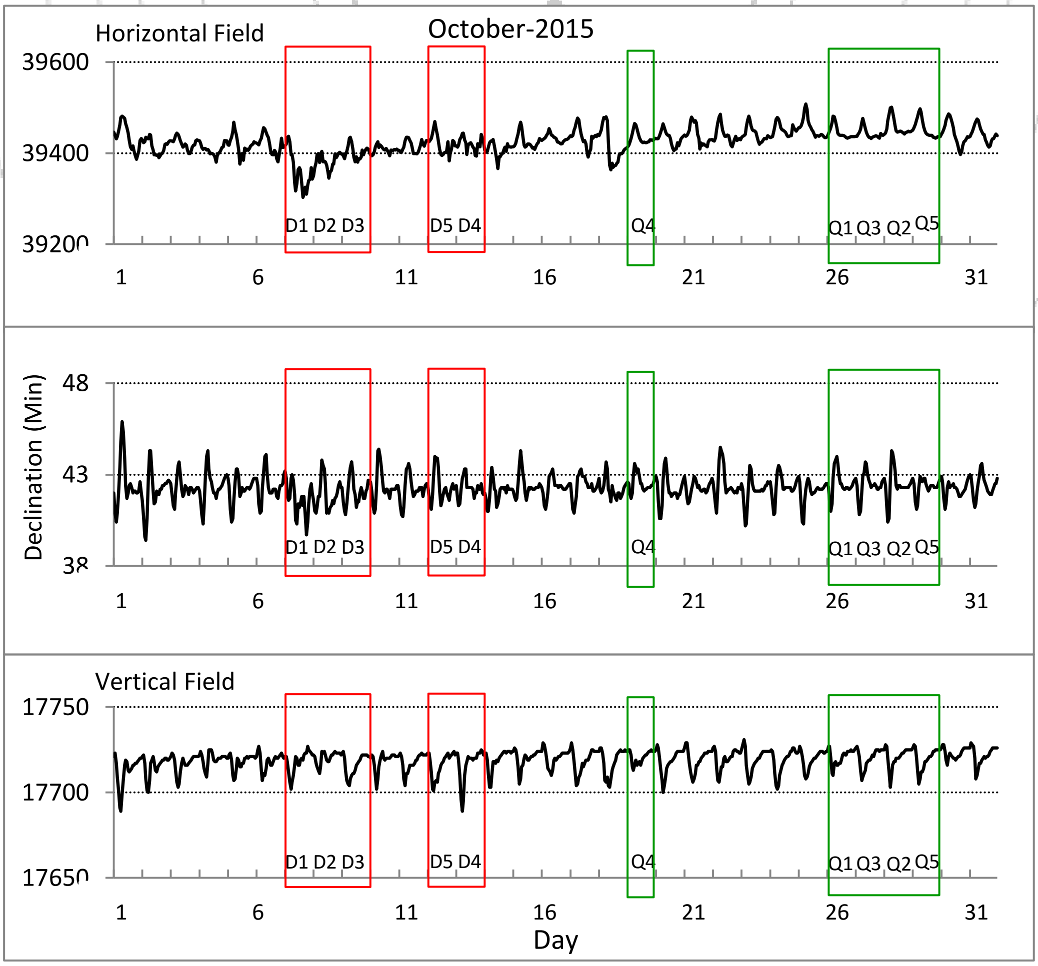

May-2015
Horizontal Field
39600
39400
39200
D2
D5 D3 D1
D4
Q2 Q3 Q4 Q5 Q1
1 6 11 16 21 26 31
Declination(Min)
48
43
38
Vertical Field
17700
17650
17600


June-2015
Horizontal Field
39600
39400
39200
Q3 Q5 Q4 Q2
D3
D5
Q1
D2 D1
D4
1 6 11 16 21 26 31
Declination (Min)
48
43
38
Vertical Field
17720
17670
17620
Day


Horizontal Field
July-2015
39600
39400
39200
Q2
D5 D3
Q4
D2
D1
Q1 Q5
D4
Q3
1
6
11
16
21
26
31
Declination (Min)
48
43
38
Vertical Field
17750
17700
17650


Horizontal Field
August-2015
39600
39400
39200
Q4
Q1
D3 D4
Q5
D5
D1 D2
Q2 Q3
1
6
11
16
21
26
31
Declination (Min)
48
43
38
Vertical Field
17750
17700
17650
Day


September-2015
Horizontal Field
39600
39400
39200
Q5
D4 D5 D2
D1
D3
Q4 Q2 Q3
Q1
1
6
11
16
21
26
31
Declination (Min)
48
43
38
Vertical Field
17750
17700
17650


October-2015
Horizontal Field
39600
39400
39200
D1 D2 D3
D5 D4
Q4
Q1 Q3 Q2 Q5
1
6
11
16
21
26
31
Declination (Min)
48
43
38
Vertical Field
17750
17700
17650
Day

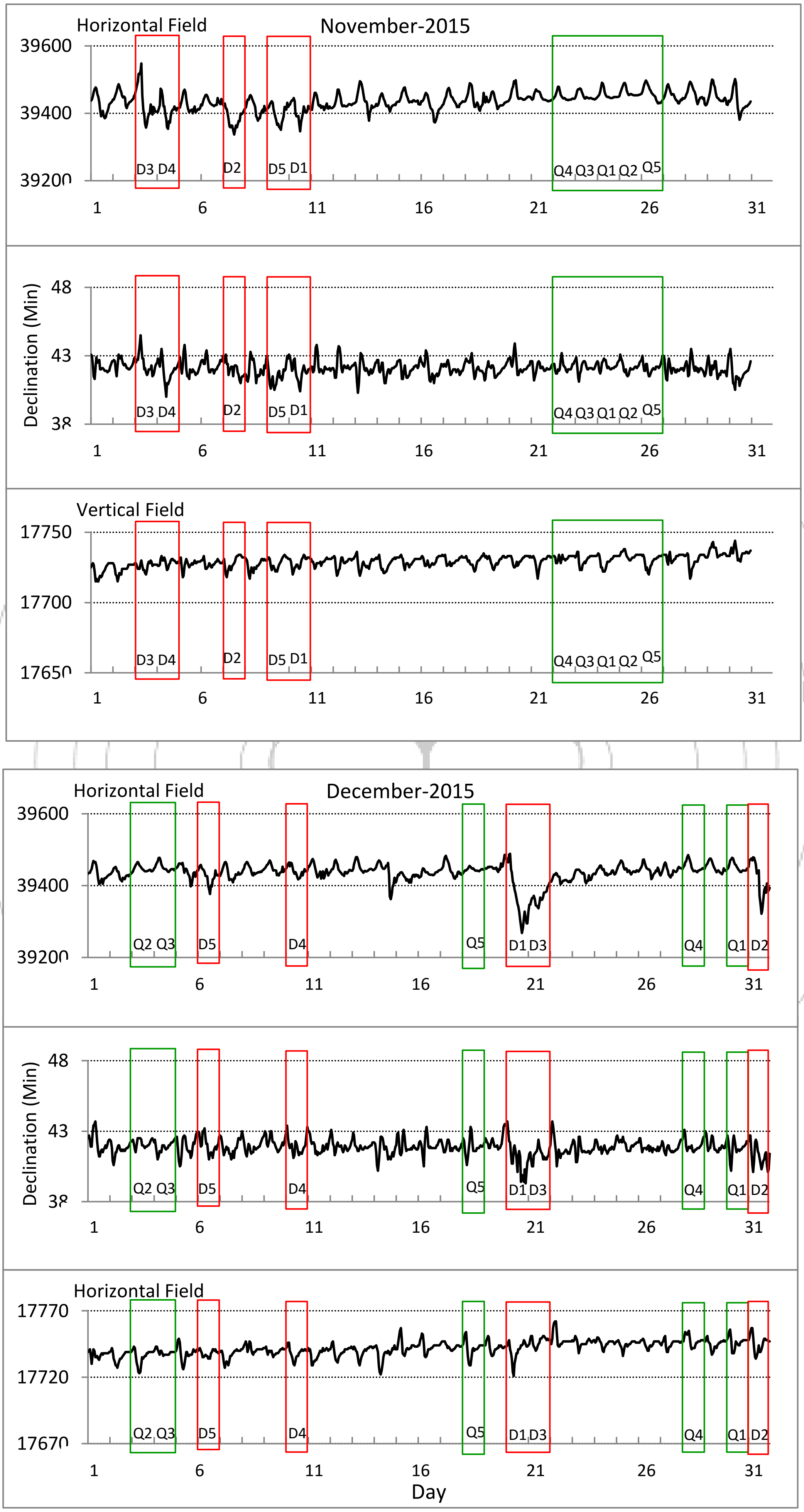


Figure 4.4.1: Hourly mean quick look plots

Hourly mean plots of magnetic components H, D & Z with IQ & ID days (Figure 4.4.1)

These plots it offer quick view of the magnetic variations throughout the year and effects of solar activities. Magnetic variations change seasonally. The variations are maximum during summer season and the daily amplitude is also maximum. But in winter magnetic daily variation is more or less 40nT. Magnetically quite days seen more in number in winter. These are clearly seen in plots.

Daily mean plots (Figure 4.5)

These are the quick look of daily mean values from this plots it can be noticed the magnetic field changes throughout the year easy to study the quiet and disturbed days.

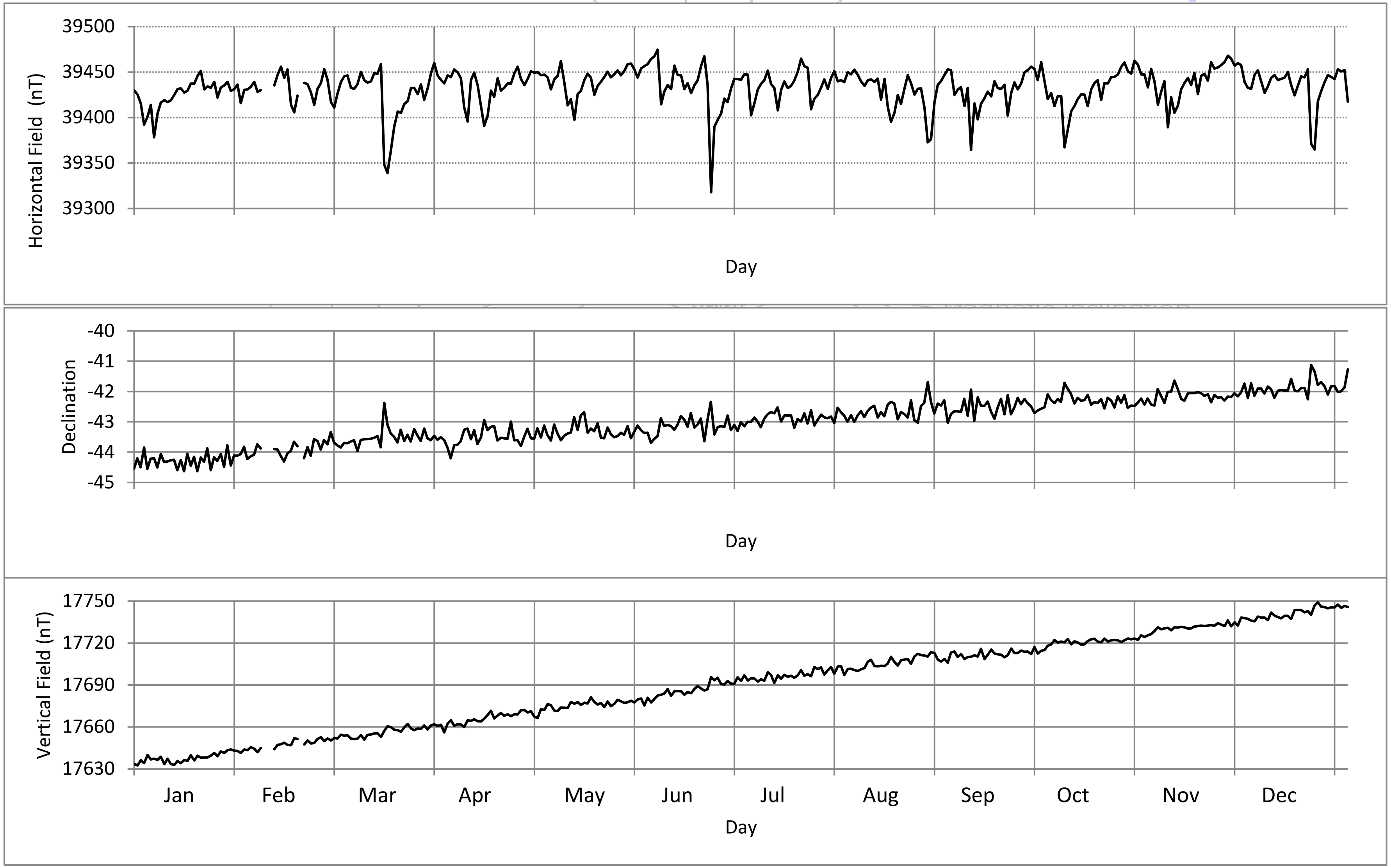
H: minimum (39317nT in June) and maximum (39474nT in June) of daily mean value is observed in the month of June in which magnetic activity is high. Rate of annual change of H is 10nT. It is very slow this year.

D: minimum (41.12min in December) and maximum (44.63min in January) of daily mean value are noticed. During 2015, Declination was gradually decreased. Rate of annual change of D was 2.3min.

Z: minimum (17632nT in January) and maximum (17749nT in December) of daily mean value are observed. Z is increasing rapidly and rate of annual change was 180nT. There is not significant changes are observed in the month of June & March in which magnetic actives are high.

4.5. Annual Variations based on Daily Means

Hyderabad 2015



4.6. Monthly and Annual Means values of HYB, 2015

Month	D	I	H(nT)	Z(nT)	F(nT)
Jan	0° 44.29'	24° 06.14'	39425.0	17637.6	43190.4
Feb	0° 43.93'	24° 06.54'	39433.4	17646.9	43202.0
Mar	0° 43.52'	24° 07.54'	39423.3	17655.9	43196.3
Apr	0° 43.50'	24° 07.84'	39435.6	17665.7	43211.6
May	0° 43.31'	24° 08.36'	39441.4	17675.5	43220.8
Jun	0° 43.14'	24° 09.34'	39434.4	17685.9	43218.8
Jul	0° 42.90'	24° 10.08'	39436.5	17697.0	43225.2
Aug	0° 42.64'	24° 10.99'	39428.6	17706.0	43221.8
Sep	0° 42.52'	24° 11.33'	39431.4	17712.0	43226.7
Oct	0° 42.29'	24° 11.99'	39431.5	17721.2	43230.6
Nov	0° 42.12'	24° 12.45'	39441.0	17731.8	43243.6
Dec	0° 41.87'	24° 13.36'	39435.4	17741.8	43242.6
Year	**0° 42.62'**	**24° 09.66'**	**39433.1**	**17689.8**	**43219.2**

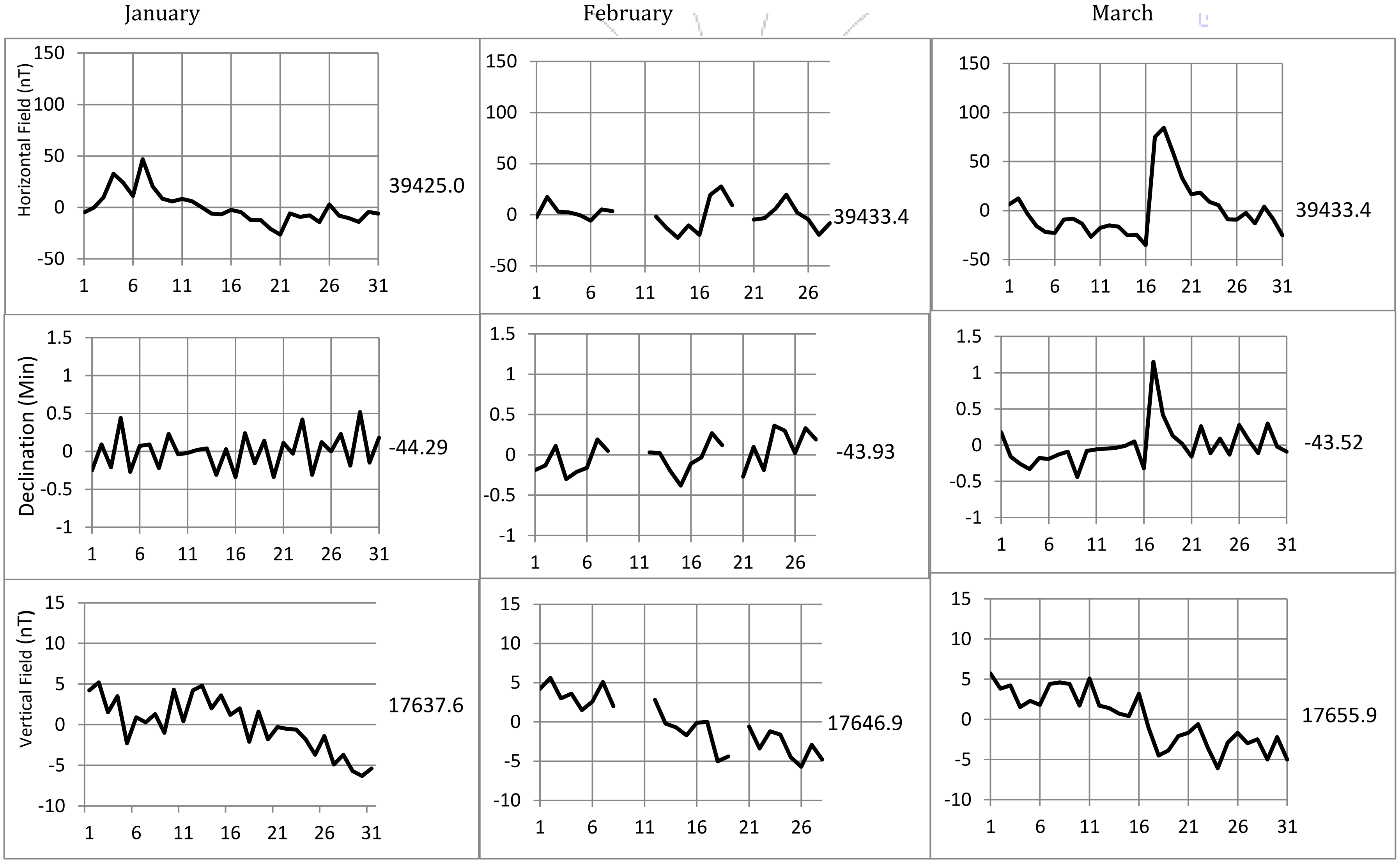
4.7. Deviation of the Monthly means from the Annual mean values of HYB, 2015

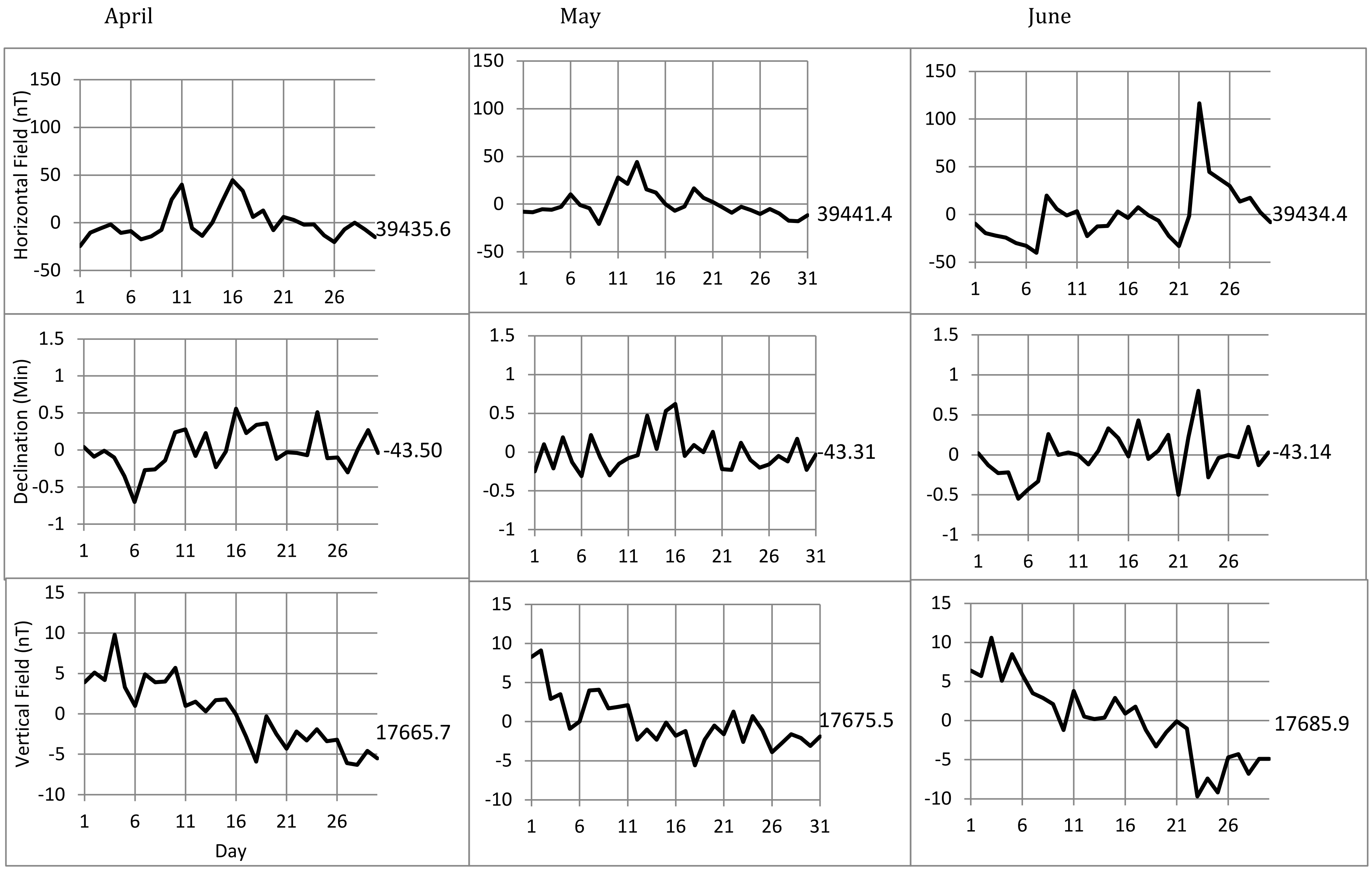
Month	D (')	I (')	H (nT)	Z (nT)	F (nT)
Jan	-1.67	3.52	8.10	52.20	28.80
Feb	-1.31	3.12	-0.30	42.90	17.20
Mar	-0.90	2.12	9.80	33.90	22.90
Apr	-0.88	1.82	-2.50	24.10	7.60
May	-0.69	1.30	-8.30	14.30	-1.60
Jun	-0.52	0.32	-1.30	3.90	0.40
Jul	-0.28	-0.42	-3.40	-7.20	-6.00
Aug	-0.02	-1.33	4.50	-16.20	-2.60
Sep	0.10	-1.67	1.70	-22.20	-7.50
Oct	0.13	-2.33	1.60	-31.40	-11.40
Nov	0.50	-2.79	-7.90	-42.00	-24.40
Dec	0.75	-3.70	-2.30	-52.00	-23.40

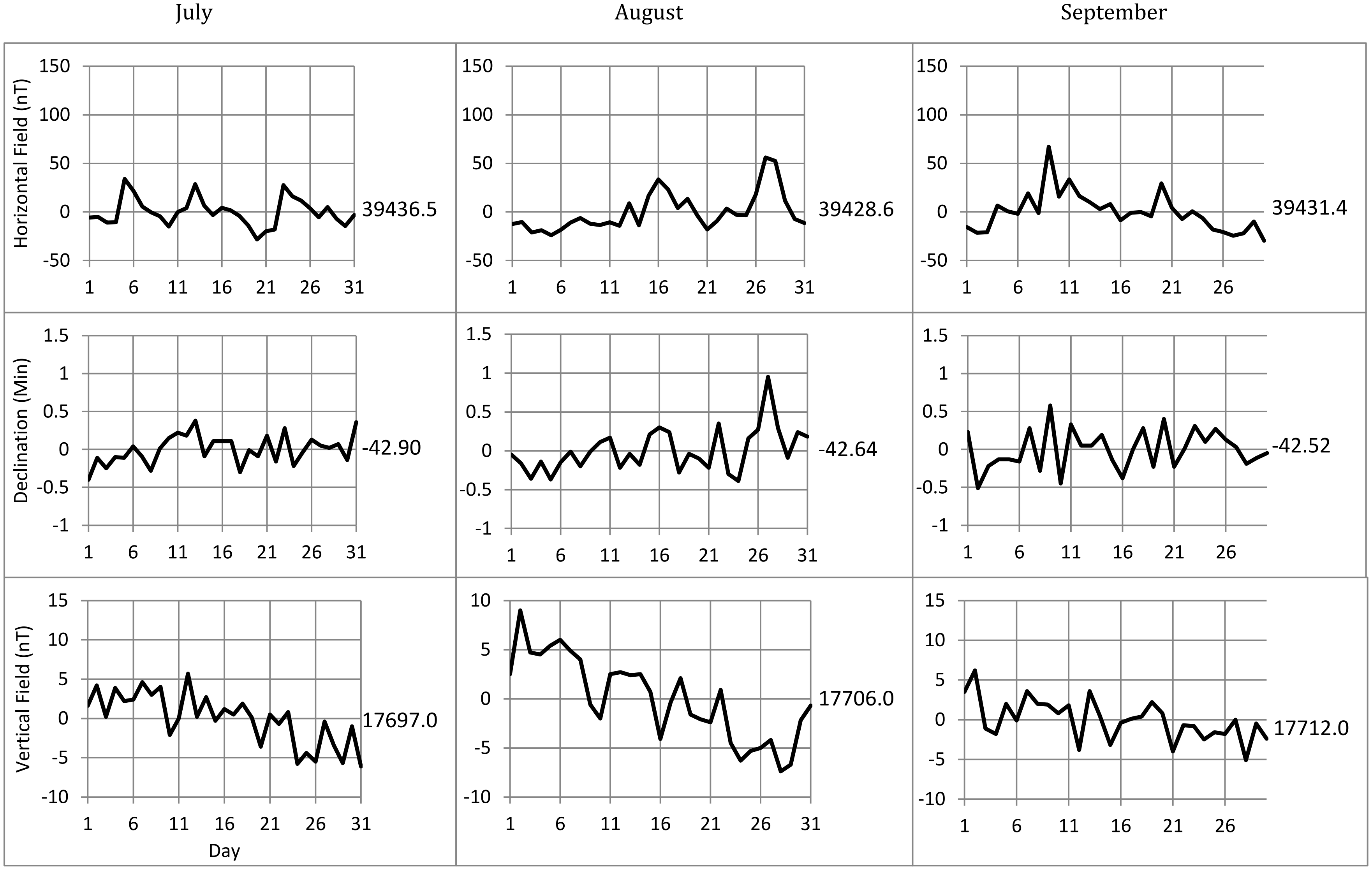
4.8. Deviations of Daily mean from monthly mean of Magnetic components

From this deviation plots it can easy to recognise most disturbed (it may be natural or artificial), quiet days. Maximum field (nT) positive deviations are observed in the magnetically active days in the Horizontal component and in Declination. It is understood that maximum daily mean is generally observed from high magnetically active/disturbed days. Maximum field negative deviations are observed in magnetically quiet days and days prior to magnetically active days in H component. Positive deviation of Vertical component (Z) is gradually increasing from January to December. When maximum field positive deviation is noticed in H component it is reflected as a Maximum number of high field negative deviations are observed in Z.

4.8.1. Deviations of Daily means from the Monthly Mean of components H, D & Z, 2015




April
May
June
Horizontal Field (nT)
Declination (Min)
Vertical Field (nT)
Day
39435.6
39441.4
39434.4
-43.50
-43.31
-43.14
17665.7
17675.5
17685.9


July
August
September
Horizontal Field (nT)
Declination (Min)
Vertical Field (nT)
Day
39436.5
39428.6
39431.4
-42.90
-42.64
-42.52
17697.0
17706.0
17712.0

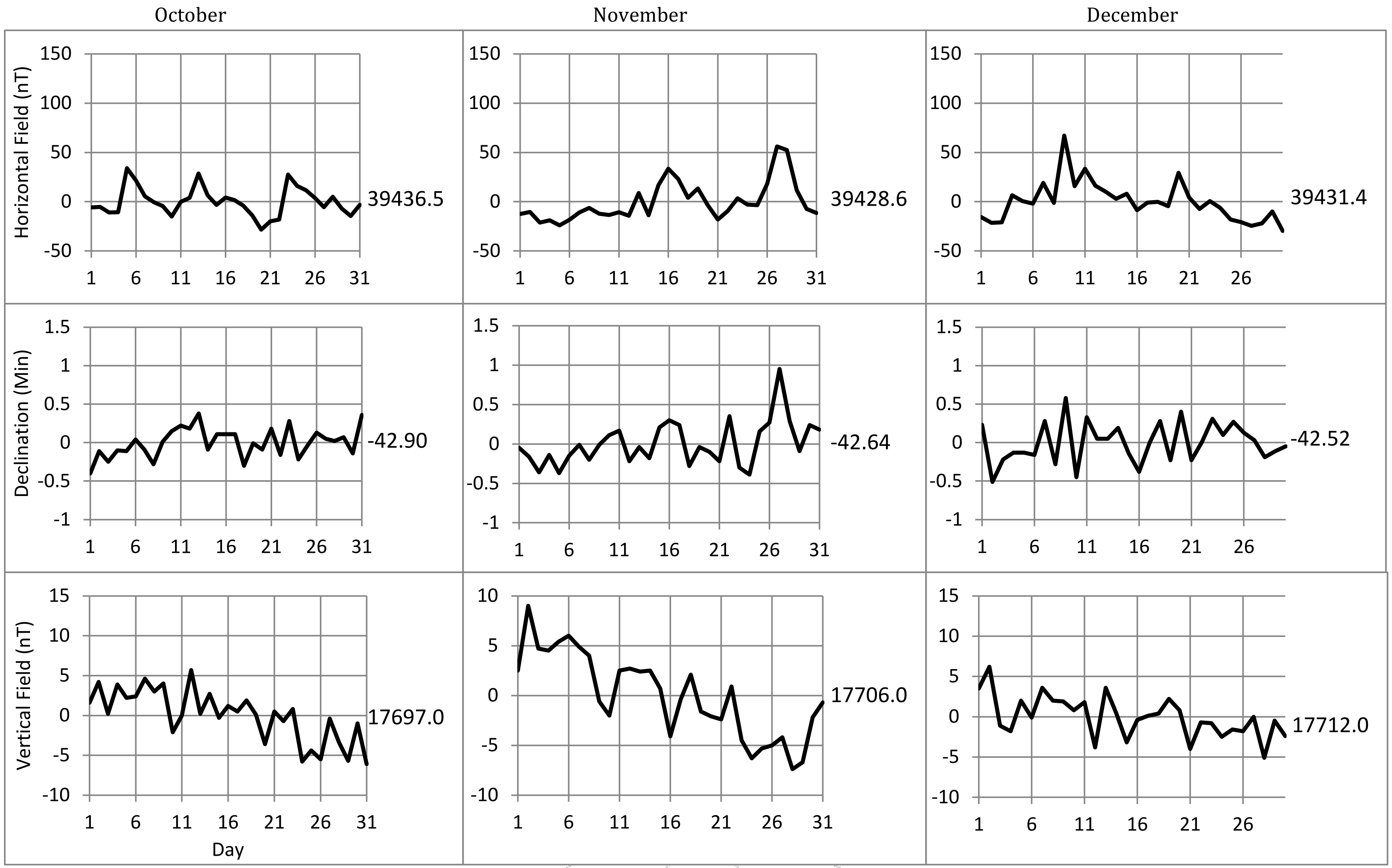


Figure 4.8.1: Deviations of daily means from the monthly mean of magnetic components.

4.9. Daily K-indices & daily sum

2015 1 1	2	2	2	2	2	3	3	2	18
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2015 1 3	4	5	4	3	2	2	1	0	21
2015 1 4	2	3	2	3	4	5	3	4	26
2015 1 5	3	3	3	2	2	1	3	3	20
2015 1 6	2	3	3	4	2	3	4	2	23
2015 1 7	3	5	7	7	5	2	2	4	35
2015 1 8	4	4	3	2	3	3	2	2	23
2015 1 9	2	3	2	2	2	2	2	1	16
2015 1 10	1	3	3	2	2	3	2	1	17
2015 1 11	2	2	3	2	2	1	2	2	16
2015 1 12	1	3	1	2	3	3	2	1	16
2015 1 13	2	3	2	2	3	2	2	2	18
2015 1 14	2	3	2	2	3	2	2	1	17
2015 1 15	2	2	2	2	3	2	1	1	15
2015 1 16	2	3	3	2	1	0	2	1	14
2015 1 17	1	1	1	2	1	1	1	2	10
2015 1 18	2	1	1	1	2	2	1	1	11
2015 1 19	2	1	1	1	1	1	2	2	11
2015 1 20	2	2	2	2	1	0	1	2	12
2015 1 21	3	4	4	2	3	4	3	3	26
2015 1 22	2	3	2	3	3	2	3	2	20
2015 1 23	2	2	2	2	2	2	2	1	15
2015 1 24	1	2	1	1	3	3	3	2	16
2015 1 25	1	2	1	1	2	3	2	2	14
2015 1 26	3	3	3	4	3	4	2	1	23
2015 1 27	2	3	4	2	2	2	3	3	21
2015 1 28	3	2	2	2	2	2	2	1	16
2015 1 29	2	2	1	3	2	2	3	2	17
2015 1 30	2	2	3	2	1	3	5	3	21
2015 1 31	2	2	2	2	2	2	3	3	18

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2015 2 10	-	-	-	-	1	2	2	3	
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2015 2 13	1	1	1	1	1	1	1	1	08
2015 2 14	1	1	2	1	2	1	2	1	11
2015 2 15	1	3	2	2	3	3	2	1	17
2015 2 16	1	2	1	2	-	2	3	3	
2015 2 17	3	4	3	2	3	4	4	3	26
2015 2 18	3	3	2	2	2	2	3	2	19
2015 2 19	2	2	2	1	1	2	2	2	14
2015 2 20	1	2	2	2	2	2	1	2	14
2015 2 21	2	1	2	1	1	2	2	2	13
2015 2 22	2	2	2	1	2	2	1	2	14
2015 2 23	2	3	3	3	4	5	4	4	28
2015 2 24	4	4	3	3	2	1	1	2	20
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2015 2 26	2	1	2	2	1	1	1	1	11
2015 2 27	2	1	1	1	2	2	2	2	13
2015 2 28	1	2	2	2	3	3	4	3	20

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2015 3 6	2	3	3	3	2	2	3	3	21
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2015 3 9	3	2	2	1	0	2	1	1	12
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2015 3 16	3	5	5	3	3	4	2	2	27
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2015	9	25	2	2	2	3	3	2	1	1	16
2015	9	26	2	1	1	1	1	2	3	2	13
2015	9	27	2	2	1	1	1	1	1	0	9
2015	9	28	2	2	1	1	1	1	2	1	11
2015	9	29	3	3	2	1	1	0	1	0	11
2015	9	30	3	2	1	1	0	0	1	1	9

2015	10	1	3	2	1	1	3	3	3	4	20
2015	10	2	3	3	3	2	3	3	3	1	21
2015	10	3	2	3	2	2	3	2	2	1	17
2015	10	4	3	1	2	2	3	2	2	3	18
2015	10	5	3	4	3	5	4	2	1	1	23
2015	10	6	2	3	2	2	2	4	5	4	24
2015	10	7	4	4	5	6	5	5	5	5	39
2015	10	8	4	5	5	3	4	4	5	3	33
2015	10	9	3	3	2	3	4	4	3	3	25
2015	10	10	2	2	3	2	2	3	1	2	17
2015	10	11	2	2	2	1	3	2	4	3	19
2015	10	12	2	2	3	3	2	5	4	4	25
2015	10	13	2	2	3	4	2	4	4	4	25
2015	10	14	3	3	3	4	4	3	4	1	25
2015	10	15	2	2	2	2	1	2	2	2	15
2015	10	16	2	2	2	1	2	1	0	1	11
2015	10	17	2	2	2	2	4	3	4	2	21
2015	10	18	2	3	5	5	3	3	3	1	25
2015	10	19	1	1	2	2	1	0	2	2	11
2015	10	20	1	1	2	2	2	2	3	2	15
2015	10	21	2	2	2	4	4	3	2	2	21
2015	10	22	3	3	3	1	1	2	3	2	18
2015	10	23	2	2	2	1	2	2	2	2	15
2015	10	24	2	2	2	2	1	1	4	2	16
2015	10	25	2	3	3	2	3	2	1	1	17
2015	10	26	2	2	2	1	0	0	0	0	7
2015	10	27	1	2	2	1	1	0	2	2	11
2015	10	28	1	3	2	1	0	1	1	1	10
2015	10	29	1	2	1	1	1	1	1	2	10
2015	10	30	1	2	2	1	2	3	2	2	15
2015	10	31	1	1	1	2	2	2	2	2	13

2015	11	1	1	3	2	3	4	2	2	2	19
2015	11	2	2	2	2	1	4	3	1	3	18
2015	11	3	4	5	7	4	5	4	5	4	38
2015	11	4	2	5	4	4	4	3	3	3	28
2015	11	5	2	2	2	3	3	4	3	2	21
2015	11	6	3	1	2	2	2	3	5	4	22
2015	11	7	3	3	4	3	4	3	4	2	26
2015	11	8	2	2	2	3	3	3	4	3	22
2015	11	9	2	2	3	3	3	4	4	4	25
2015	11	10	2	4	4	5	5	4	3	3	30
2015	11	11	3	2	2	3	3	4	3	1	21
2015	11	12	2	2	2	2	1	2	1	1	13
2015	11	13	2	2	1	2	5	5	3	3	23
2015	11	14	2	2	2	1	3	2	2	2	16
2015	11	15	2	2	2	2	2	2	3	2	17
2015	11	16	2	2	3	2	3	3	2	2	19
2015	11	17	2	2	2	2	1	2	2	2	15
2015	11	18	1	2	2	2	2	3	5	4	21
2015	11	19	2	2	3	3	2	1	1	1	15
2015	11	20	2	3	4	2	1	1	1	2	16
2015	11	21	2	2	1	1	1	0	1	1	9
2015	11	22	1	2	2	2	1	1	1	1	11
2015	11	23	2	2	1	0	1	0	0	1	7
2015	11	24	1	2	1	1	0	0	0	0	5
2015	11	25	1	1	1	0	0	0	0	0	3
2015	11	26	2	1	1	1	0	2	2	1	10
2015	11	27	2	2	2	2	2	2	2	2	16
2015	11	28	2	2	1	2	2	2	3	3	17
2015	11	29	2	3	3	3	2	2	3	4	22
2015	11	30	3	5	5	3	2	1	2	2	23

2015	12	1	2	2	2	4	4	4	2	1	21
2015	12	2	1	2	2	2	3	3	2	0	15
2015	12	3	2	1	1	1	1	1	2	2	11
2015	12	4	1	2	2	0	1	1	0	2	9
2015	12	5	1	2	3	3	2	4	4	3	22
2015	12	6	2	2	2	4	4	3	4	2	23
2015	12	7	2	2	2	3	4	4	4	1	22
2015	12	8	2	2	2	3	3	1	1	2	16
2015	12	9	2	1	1	1	3	2	4	2	16
2015	12	10	3	4	3	3	3	4	4	3	27
2015	12	11	2	2	2	3	4	5	4	3	25
2015	12	12	2	2	2	1	2	3	2	1	15
2015	12	13	2	2	1	2	2	1	0	1	11
2015	12	14	1	1	2	1	4	6	6	5	26
2015	12	15	3	3	2	2	3	3	3	3	22
2015	12	16	2	2	3	1	0	0	1	1	10
2015	12	17	1	2	2	2	2	3	4	2	18
2015	12	18	2	1	2	2	1	1	2	2	13
2015	12	19	1	1	1	0	3	5	5	4	20
2015	12	20	4	5	3	3	4	5	6	4	34
2015	12	21	4	3	3	3	4	3	3	3	26
2015	12	22	3	2	4	4	2	1	2	2	20
2015	12	23	2	2	2	2	3	3	3	3	20
2015	12	24	2	2	2	3	3	2	3	2	19
2015	12	25	2	1	2	2	3	3	2	2	17
2015	12	26	2	2	2	2	3	3	3	4	21
2015	12	27	3	2	2	1	3	3	3	2	19
2015	12	28	2	3	2	3	2	2	0	1	15
2015	12	29	2	2	1	1	2	2	3	3	16
2015	12	30	1	2	1	1	2	1	1	2	11
2015	12	31	4	3	3	5	6	6	4	4	35

4.10. PRINCIPAL MAGNETIC STORMS 2015

YEAR 2015 MO	DA	STORM TIME UT START HR	MIN	UT END MO	DA	HR	OBS	TYPE	SUDDEN COMMENCEMENT AMPLITUDES D(')	H(nT)	Z(nT)	DEGREE OF ACTIVITY	MAXIMAL ACTIVITY ON K-SCALE 0 TO 9 MO	DA	3 HOUR PERIOD	K INDEX	RANGES D (')	H (nT)	Z (nT)
01	01	12	00		08	23		..				S		07	3,4	7	8	278	25
	11	00	00		13	24		..				M		11	3	3	4	67	38
														12	2,5,6				
														13	2,5				
	21	00	00		22	24		..				MS		21	2,3,6	4	3	157	21
	26	00	00		28	03		..				M		26	4,6	4	3	91	27
														27	3				
	26	08	34		--	--		SC	-0.1	15	01	-							
	30	00	00		30	24		..				M		30	7	5	3	82	11
02	01	00	00		03	24		..				M		01	3,8	4	3	96	22
														02	7				

YEAR 2015 MO	DA	STORM TIME UT START HR	MIN	UT END MO	DA	HR	OBS	TYPE	SUDDEN COMMENCEMENT AMPLITUDES D(')	H(nT)	Z(nT)	DEGREE OF ACTIVITY	MAXIMAL ACTIVITY ON K-SCALE 0 TO 9 MO	DA	3 HOUR PERIOD	K INDEX	RANGES D (')	H (nT)	Z (nT)
	07	00	00		08	23		..				M		07	3,4	4	3	107	28
	15	03	00		18	24		..				M		17	2,6,7	4	3	122	16
	23	04	00		25	10		..				M		23	6	5	3	141	19
	28	12	00		02	24		..				M		02	3	6	3	110	19
					03									03					
03	03	18	00		08	18		..				M		04	4,5	4	4	123	22
														07	6				
	15	15	00		25	24		..				S		17	2,3,5	7	7	429	32
	17	04	45		--	--		SC	-0.4	47	05	-							

YEAR 2015 MO	DA	STORM TIME UT START HR	MIN	UT END MO	DA	HR	OBS	TYPE	SUDDEN COMMENCEMENT AMPLITUDES D(')	H(nT)	Z(nT)	DEGREE OF ACTIVITY	MAXIMAL ACTIVITY ON K-SCALE 0 TO 9 MO	DA	3 HOUR PERIOD	K INDEX	RANGES D (')	H (nT)	Z (nT)
04	02	03	00		03	15		..				M		02	2,3	4	5	129	20
														03	1				
	09	02	13		11	23		SC	-0.7	07	01	M		10	1,2	5	5	124	45
	14	06	00		17	21		..				M		15	4,7	5	7	141	34
	20	15	00		21	23		..				M		21	4,5	4	4	97	29
05	06	01	41		08	09		SC	0	12	01	M		06	6	5	5	150	32
	09	10	00		10	24		..				M		10	4	4	5	114	20
	11	21	00		14	03		..				M		13	2	5	8	123	23
	18	00	00		19	09		..				M		18	8	5	4	107	12
06	07	18	00		09	06		..				MS		08	2,3	6	7	170	33
	13	21	00		16	09		..				M		14	1	4	7	109	31
														15	5				
														16	1				

YEAR 2015 MO	DA	STORM TIME UT START HR	MIN	UT END MO	DA	HR	OBS	TYPE	SUDDEN COMMENCEMENT AMPLITUDES D(')	H(nT)	Z(nT)	DEGREE OF ACTIVITY	MAXIMAL ACTIVITY ON K-SCALE 0 TO 9 MO	DA	3 HOUR PERIOD	K INDEX	RANGES D (')	H (nT)	Z (nT)
	22	05	44		26	13		SC	0	22	03	S		22	7	8	10	258	43
	22	18	32		--	--		SC	-0.6	121	04	-							
07	04	12	00		06	12		..				M		04	7,8	4	8	101	25
														05	1,2,4				
														06	2				
	10	15	56		14	06		SC	0	2	0	M		10	8	4	8	133	37
														11	1,2				
														13	1,2,3,7				
	30	12	00		31	24		..				M		30	8	4	5	62	10
														31	6				
08	06	00	00		08	21		..				M		07	3,5,6	4	8	116	35
														08	1				
	15	00	00		18	12		..				MS		15	4	7	6	220	29

YEAR 2015		STORM TIME					OBS	TYPE	SUDDEN COMMENCEMENT AMPLITUDES			DEGREE OF ACTIVITY	MAXIMAL ACTIVITY ON K-SCALE 0 TO 9				RANGES		
		UT START		UT END															
MO	DA	HR	MIN	MO	DA	HR			D(')	H(nT)	Z(nT)		MO	DA	3 HOUR PERIOD	K INDEX	D (')	H (nT)	Z (nT)
	15	08	28		--	--		SC	0	34	2	-							
	22	10	00		23	24		..				M		23	2,3	5	5	143	8
	26	00	00		29	24		..				MS		26	8	5	8	165	25
														27	3,8				
														28	5,6				
09	05	00	00		17	15		..				M		11	3	7	9	147	52
	20	00	00		23	24		..				MS		20	3	6	6	164	38
10	01	00	00		02	24		..				M		01	8	4	7	100	35
	05	00	00		10	24		..				MS		07	4	6	6	179	40
	17	12	00		25	24		..				M		18	3,4	5	2	137	26
	24	18	54		--	--		SC	-0.1	18	1	-							

YEAR 2015		STORM TIME					OBS	TYPE	SUDDEN COMMENCEMENT AMPLITUDES			DEGREE OF ACTIVITY	MAXIMAL ACTIVITY ON K-SCALE 0 TO 9				RANGES		
		UT START		UT END															
MO	DA	HR	MIN	MO	DA	HR			D(')	H(nT)	Z(nT)		MO	DA	3 HOUR PERIOD	K INDEX	D (')	H (nT)	Z (nT)
11	03	00	00		11	24		..				MS		03	3	7	5	236	20
	06	18	18		--	--		SC	-0.2	33	2	-							
	18	09	00		19	15		..				M		18	7	5	1	60	14
	30	00	00		30	24		..				M		30	2,3	5	3	126	16
12	05	03	00		07	24		..				M		05	6,7	4	3	93	25
														06	4,5,7				
														07	5,6,7				
	09	13	00		12	06		..				M		11	6	5	3	63	17
	14	13	20		15	24		SC	0	12	1	M		14	6,7	6	2	131	24
	19	16	16		22	24		SC	-0.3	37	2	S		20	7	6	5	261	45
	31	00	49		01	24		SC	-0.1	13	0	MS		31	5,6	6	3	178	25
					01/2016														

Table 4.10.1: Upper K index limit:

K	H Range (nT)
0	< 3
1	< 6
2	< 12
3	< 24
4	< 42
5	< 72
6	< 120
7	< 198
8	< 300
9	>300

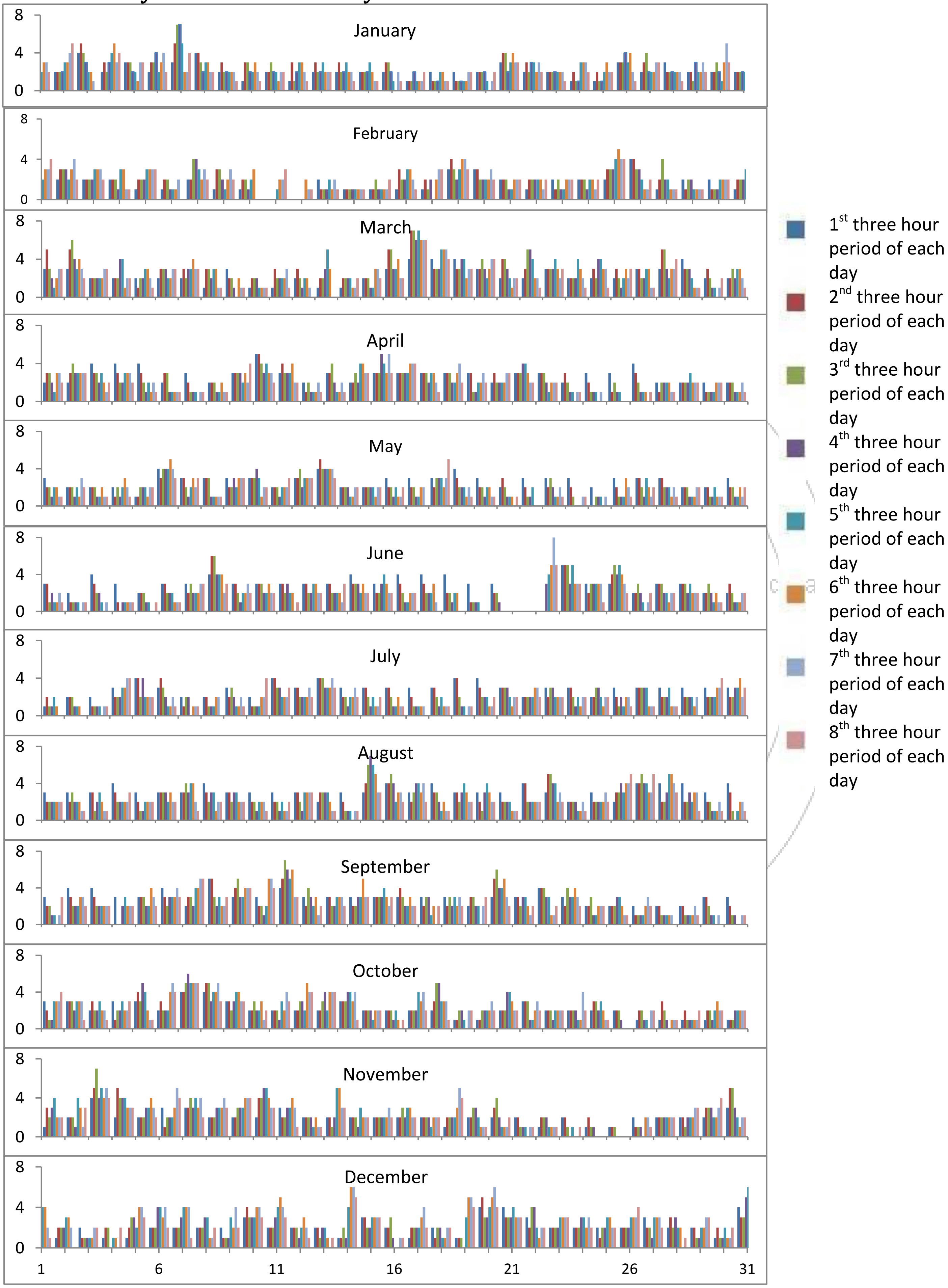
4.9. K-index frequencies daily & daily sum:

The maximum K daily sum is 49 in the month of March, 17th which is most magnetically disturbed day during 2015. The next maximum K daily sum is 39 observed in September, 10th & October, 7th. Minimum K daily sum is 3 in the month of November 25th & next is 5 on November, 24th. The best quite day in 2015 is November, 25th.

4.10. Principle magnetic storms 2015:

During 2015, 49 storms are observed. 13 sudden commencements are noticed. From this it is observed that 160 days are disturbed days over 2015. The maximum K is 8 on 7th hour period of June 22nd. It means in 7th three hour period H range is around 250nT. The maximum H range is 429nT during the storm from 15-17 march and maximum K is 7 is repeated in same day in 2, 3, 5 three hour periods. In this year 4 severe storms are recorded.

4.11. Daily K- indices monthly wise 2015



4.12. Monthly K- index frequencies

January

UT K=	00-03	03-06	06-09	09-12	12-15	15-18	18-21	21-24	S
0	-	-	-	-	-	2	-	1	3
1	5	3	7	4	5	4	5	10	43
2	19	12	12	20	14	13	14	12	116
3	5	12	8	4	10	9	9	5	62
4	2	2	3	2	1	2	2	2	16
5	-	2	-	-	1	1	1	1	6
6	-	-	-	-	-	-	-	-	-
7	-	-	1	1	-	-	-	-	2
8	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-

February

UT K=	00-03	03-06	06-09	09-12	12-15	15-18	18-21	21-24	S
0	-	-	-	-	-	-	-	1	1
1	12	6	4	10	8	7	8	7	65
2	11	13	14	11	10	11	7	12	86
3	3	5	5	4	7	8	7	5	44
4	1	2	3	1	1	1	4	2	15
5	-	-	-	-	-	1	-	-	1
6	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-

March

UT K=	00-03	03-06	06-09	09-12	12-15	15-18	18-21	21-24	S
0	-	-	-	-	1	1	1	2	5
1	5	1	0	5	4	5	8	11	39
2	14	9	16	10	10	8	9	7	83
3	8	15	8	10	7	12	10	7	77
4	4	1	2	4	6	3	1	3	24
5	-	4	3	1	2	1	1	0	12
6	-	-	1	1	-	1	1	1	5
7	-	1	1	-	1	-	-	-	3
8	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-

April

UT K=	00-03	03-06	06-09	09-12	12-15	15-18	18-21	21-24	S
0	-	-	-	-	-	4	2	2	8
1	-	4	4	12	13	6	7	11	57
2	12	6	11	11	6	8	11	11	76
3	13	18	12	5	7	9	7	4	75
4	4	1	3	1	4	3	2	2	20
5	1	1	-	1	-	-	1	-	4
6	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-

May

UT K=	00-03	03-06	06-09	09-12	12-15	15-18	18-21	21-24	S
0	-	1	-	1	1	3	2	3	11
1	1	2	5	18	10	13	10	12	71
2	10	18	19	7	14	8	13	9	90
3	17	9	4	2	4	5	4	6	51
4	3	0	3	3	2	1	2	-	14
5	-	1	-	-	1	1	1	1	6
6	-	-	-	-	-	1	-	1	3
7	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-

June

UT K=	00-03	03-06	06-09	09-12	12-15	15-18	18-21	21-24	S
0	-	-	1	-	1	6	4	4	16
1	-	3	3	9	10	5	8	8	46
2	5	8	13	12	10	8	10	11	77
3	16	14	8	6	3	7	5	4	63
4	6	1	-	2	3	2	-	-	14
5	1	1	2	-	2	1	-	1	8
6	-	1	1	-	-	-	-	-	2
7	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	1	-	1
9	-	-	-	-	-	-	-	-	-

July

UT K=	00-03	03-06	06-09	09-12	12-15	15-18	18-21	21-24	S
0	-	-	-	-	1	2	2	5	10
1	1	3	6	12	10	15	10	10	67
2	7	15	17	11	15	9	13	10	97
3	18	8	7	7	5	4	4	3	56
4	5	5	1	1	-	1	2	32	18
5	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-

August

UT K=	00-03	03-06	06-09	09-12	12-15	15-18	18-21	21-24	S
0	-	-	-	1	-	1	-	-	2
1	-	-	5	6	5	5	7	12	40
2	3	14	15	9	12	13	14	13	93
3	19	12	6	9	6	8	7	4	71
4	9	4	1	5	6	2	3	-	30
5	-	1	3	-	1	-	-	-	9
6	-	-	1	-	1	-	-	-	2
7	-	-	-	1	-	-	-	-	1
8	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-

September

UT K=	00-03	03-06	06-09	09-12	12-15	15-18	18-21	21-24	S
0	-	-	-	-	1	4	1	2	8
1	-	1	4	8	7	3	8	3	34
2	7	12	10	10	7	9	8	15	78
3	17	10	9	10	11	6	9	7	79
4	5	3	3	1	3	4	2	2	23
5	1	3	1	-	1	3	4	1	12
6	-	-	1	1	-	1	-	-	3
7	-	-	1	-	-	-	-	-	1
8	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-

October

UT K=	00-03	03-06	06-09	09-12	12-15	15-18	18-21	21-24	S
0	-	-	-	-	2	3	2	1	8
1	7	4	3	10	6	4	5	8	47
2	15	15	17	12	9	10	9	13	100
3	7	9	8	3	7	8	6	4	52
4	2	2	-	3	7	8	6	4	27
5	-	1	3	2	1	2	3	1	13
6	-	-	-	1	-	-	-	-	1
7	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-

November

UT K=	00-03	03-06	06-09	09-12	12-15	15-18	18-21	21-24	S
0	-	-	-	2	3	4	3	2	14
1	5	3	7	5	6	4	6	7	43
2	20	19	13	11	8	9	7	10	97
3	4	4	4	9	6	7	8	6	48
4	1	1	4	2	4	5	3	5	25
5	-	3	1	1	3	1	3	-	12
6	-	-	-	-	-	-	-	-	-
7	-	-	1	-	-	-	-	-	1
8	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-

December

UT K=	00-03	03-06	06-09	09-12	12-15	15-18	18-21	21-24	S
0	-	-	-	2	1	1	3	1	8
1	7	6	6	8	3	7	3	6	46
2	17	19	18	8	8	4	7	12	93
3	4	4	6	9	11	10	7	7	58
4	3	1	1	3	7	4	8	4	31
5	-	1	-	1	-	3	1	1	7
6	-	1	-	1	-	3	1	1	5
7	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-

4.14. K Index frequencies monthly & Yearly sum

K	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly
0	3	1	5	8	11	16	10	2	8	8	14	8	**94**
1	43	65	39	57	71	46	67	40	34	47	43	46	**589**
2	116	86	83	76	90	77	97	93	78	100	97	93	**1086**
3	62	44	77	75	51	63	56	71	79	52	48	58	**736**
4	16	15	24	20	14	14	18	30	23	27	25	31	**257**
5	6	1	12	4	6	8	-	9	12	13	12	7	**90**
6	-	-	5	-	3	2	-	2	3	1	-	5	**21**
7	2	-	3	-	-	-	-	1	1	-	1	-	**8**
8	-	-	-	-	-	1	-	-	-	-	-	-	**1**
9	-	-	-	-	-	-	-	-	-	-	-	-	**-**

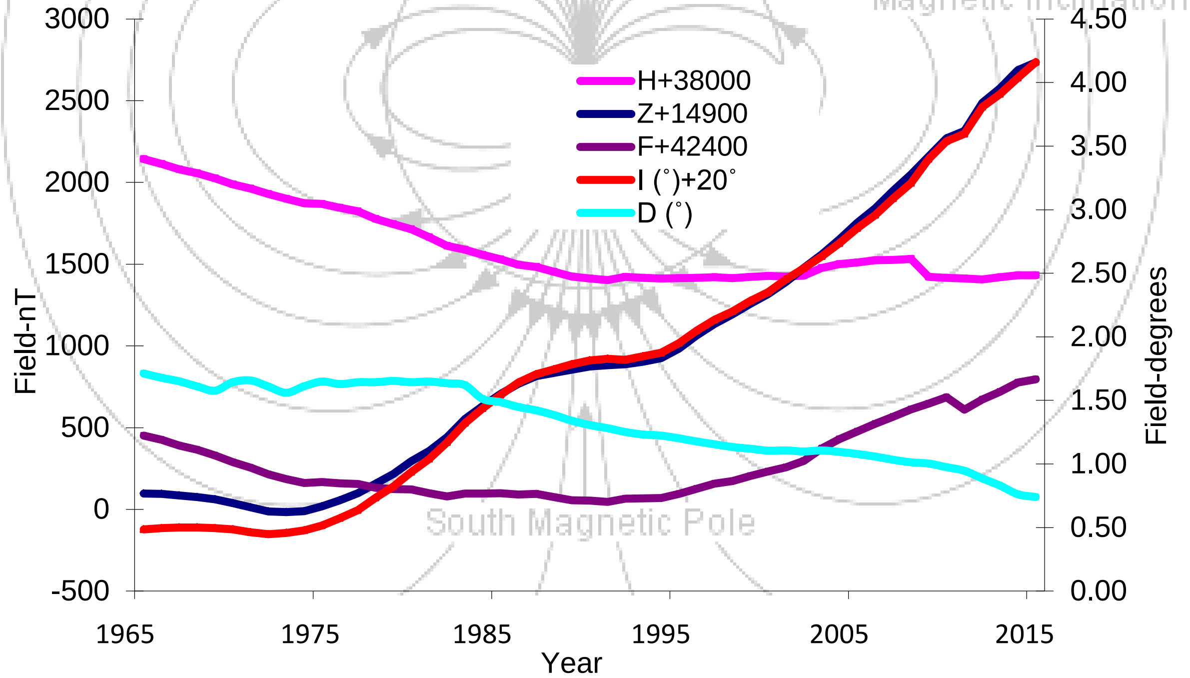
5. Annual mean values

Hyderabad Magnetic Observatory from 1965-2015

Year	D	I	H (nT)	Z (nT)	F (nT)
1965	01°42.7'	20°29.1'	40142	14997	42852
1966	01°40.7'	20°29.8'	40114	14995	42825
1967	01°39.0'	20°30.0'	40081	14986	42791
1968	01°36.6'	20°30.0'	40056	14976	42764
1969	01°34.6'	20°29.7'	40026	14961	42731
1970	01°38.6'	20°29.1'	39989	14939	42688
1971	01°39.4'	20°27.7'	39963	14912	42655
1972	01°36.5'	20°26.8'	39929	14887	42614
1973	01°33.6'	20°27.4'	39900	14883	42585
1974	01°36.7'	20°28.7'	39872	14890	42562
1975	01°38.9'	20°30.9'	39868	14918	42568
1976	01°37.7'	20°34.4'	39846	14956	42560
1977	01°38.6'	20°38.2'	39824	14998	42555
1978	01°38.6'	20°44.0'	39777	15057	42531
1979	01°39.2'	20°49.4'	39746	15117	42524
1980	01°38.6'	20°56.2'	39714	15194	42521
1981	01°38.9'	21°02.4'	39665	15258	42498
1982	01°38.1'	21°10.2'	39613	15341	42480
1983	01°37.2'	21°19.3'	39588	15452	42497
1984	01°30.7'	21°26.2'	39557	15532	42497
1985	01°29.2'	21°32.6'	39529	15606	42498
1986	01°26.9'	21°38.4'	39496	15668	42490
1987	01°25.3'	21°42.3'	39482	15716	42495
1988	01°23.1'	21°44.6'	39454	15735	42476
1989	01°20.4'	21°47.0'	39425	15755	42456
1990	01°18.4'	21°48.8'	39413	15775	42453
1991	01°16.9'	21°49.6'	39403	15781	42446
1992	01°15.1'	21°49.2'	39422	15787	42466
1993	01°13.9'	21°50.9'	39417	15804	42467
1994	01°13.4'	21°52.5'	39412	15824	42470
1995	01°12.1'	21°57.0'	39414	15884	42494
1996	01°10.6'	22°02.9'	39417	15964	42527
1997	01°09.3'	22°08.0'	39421	16034	42557
1998	01°08.0'	22°12.8'	39414	16094	42573
1999	01°07.2'	22°17.2'	39422	16158	42605
2000	01°06.3'	22°21.4'	39428	16216	42632
2001	01°06.4'	22°27.1'	39424	16291	42657
2002	01°05.9'	22°32.4'	39431	16378	42697
2003	01°06.4'	22°37.9'	39478	16460	42772
2004	01°05.7'	22°44.1'	39501	16552	42829
2005	01°04.7'	22°51.3'	39510	16653	42876

Year	D	I	H (nT)	Z (nT)	F (nT)
2006	01°03.5'	22°57.4'	39525	16741	42924
2007	01°02.0'	23°05.3'	39526	16848	42967
2008	01°00.8'	23°12.5'	39531	16949	43011
2009	01°00.2'	23°23.9'	39423	17058	43047
2010	00°58.5'	23°32.3'	39417	17170	43086
2011	00°56.8'	23°35.8'	39413	17216	43009
2012	00°53.2'	23°48.5'	39407	17388	43073
2013	00°50.3'	23°54.5'	39420	17475	43120
2014	00°45.7'	24°02.3'	39432	17588	43177
2015	00°44.4'	24°09.7'	39432	17634	43195

5.1. Secular Variation of the Geomagnetic Components 1965-2015



6. Data of Choutuppal Magnetic Observatory

6.1. Data & Observations

During 2015 the DFM variometer along with GSM-90 Overhauser recording stated in February at Primary variometer room which is constructed newly. For first 40 days data is from secondary variometer i.e. GEOMAG-02M and GSM-19 Overhauser. During 2015 we have uninterrupted data from CPL Observatory.

Table 6.1.1: Key Observatory information:

IAGA code	(CPL)
Commenced operation	2012
Geographic latitude	17° 17.6' N
Geographic longitude	78° 55.2' E
Geomagnetic latitude	8.62° N
Geomagnetic longitude	152.6° E
K 9 index lower limit	300 nT
Principal pier	Pillar -1
Reference mark azimuth	42° 22.31'
distance	100 m
Observers	Mr. KCS Rao/ L. Manjula

6.2. Baseline values

The base values of the FGE variometer (the observatory main variometer) were determined by means of useful adoptions from the absolute measurement results (table 6.2.2). For every day an adopted base value exists of every recorded element (H, D, Z). The deviations ΔH, ΔD and ΔZ of the absolute measurements from the absorved base values are shown in table 6.2.2. Fig. 6.2.1 shows the adopted base values as lines and small squares are the results of the absolute measurements.

Table 6.2.2: Absolute measurement results (January to June) by means of the Mag-01H DI-Flux & Wild-T1 theodolite and the GSM 19 Overhauser effect proton magnetometer, reduced with FGE variometer recordings.

Month	Day	UT	Horizontal intensity		Declination (Westerly)		Vertical intensity		ΔF/nT
			H/nT	ΔH/nT	D	ΔD/'	Z/nT	ΔZ/nT	
January	15	06:54	39366.62	0.00	0°54.34'	0.00	16833.43	0.00	-33.83
January	30	06:54	39366.62	0.00	0°54.34'	0.00	16833.43	0.00	-33.83
February	08	06:54	39366.62	0.00	0°54.34'	0.00	16833.43	0.00	-33.83
February	18	06:54	39366.82	0.00	0°54.34'	0.00	16833.43	0.00	-33.83
February	24	10:32	39367.02	0.20	0°54.20'	-0.14	16833.63	0.20	-33.42
March	03	05:19	39366.63	-0.39	0°54.30'	0.10	16832.83	0.20	-33.71
March	17	05:32	39366.63	0.00	0°54.30'	0.00	16832.83	0.00	-33.60
April	01	10:30	39366.99	0.36	0°54.31'	0.01	16832.90	0.07	-33.56
April	15	06:36	39366.30	-0.66	0°54.22'	-0.09	16833.00	0.10	-34.47
April	28	05:53	39366.52	0.22	0°54.19'	-0.03	16833.07	0.07	-33.85
May	12	06:54	39366.77	0.25	0°54.12'	-0.07	16833.05	-0.02	-33.81
May	27	06:15	39366.49	-0.28	0°54.18'	0.06	16833.11	0.06	-33.92
June	03	06:48	39366.41	-0.08	0°54.11'	-0.07	16833.08	-0.03	-33.76
June	11	07:18	39366.40	-0.01	0°54.11'	-0.00	16832.68	-0.40	-33.85
June	24	05:53	39366.52	0.12	0°53.91'	-0.20	16832.62	-0.06	-33.89
July	02	10:09	39366.11	-0.41	0°54.07'	0.16	16832.78	0.16	-33.94
July	16	06:13	39366.52	0.41	0°53.87'	-0.20	16832.53	-0.25	-33.85
July	30	06:02	39366.39	-0.13	0°53.93'	0.06	16832.53	0.00	-33.90
August	05	07:30	39366.30	-0.09	0°53.99'	0.06	16832.60	0.07	-33.92
August	20	06:44	39366.27	-0.03	0°53.98'	-0.01	16832.75	0.17	-33.69
September	03	06:10	39366.43	0.16	0°53.97'	-0.01	16832.84	0.09	-34.24
September	13	05:55	39366.17	-0.26	0°54.07'	0.10	16832.66	-0.18	-33.63
September	24	06:51	39366.76	0.59	0°53.96'	0.11	16832.31	-0.35	-33.37
October	14	06:23	39366.44	-0.32	0°54.04'	0.08	16833.30	-0.01	-34.14
October	24	01:06	39366.37	-0.07	0°54.06'	0.02	16832.92	-0.38	-34.01
November	03	06:13	39365.90	-0.47	0°54.02'	-0.04	16832.54	-0.38	-33.93
November	13	04:19	39365.80	-0.10	0°54.14'	0.12	16832.92	-0.08	-33.94
November	18	05:23	39365.71	-0.09	0°53.96'	-0.18	16832.63	-0.29	-33.75
December	02	05:14	39365.80	0.09	0°54.08'	0.12	16833.00	0.37	-34.04
December	15	08:35	39365.96	0.16	0°54.16'	-0.08	16832.98	-0.02	-34.15
December	25	06:34	39366.27	0.31	0°54.25'	0.09	16832.54	-0.44	-33.82
December	31	11:22	39366.27	0.00	0°54.26'	0.01	16832.30	-0.24	-33.74

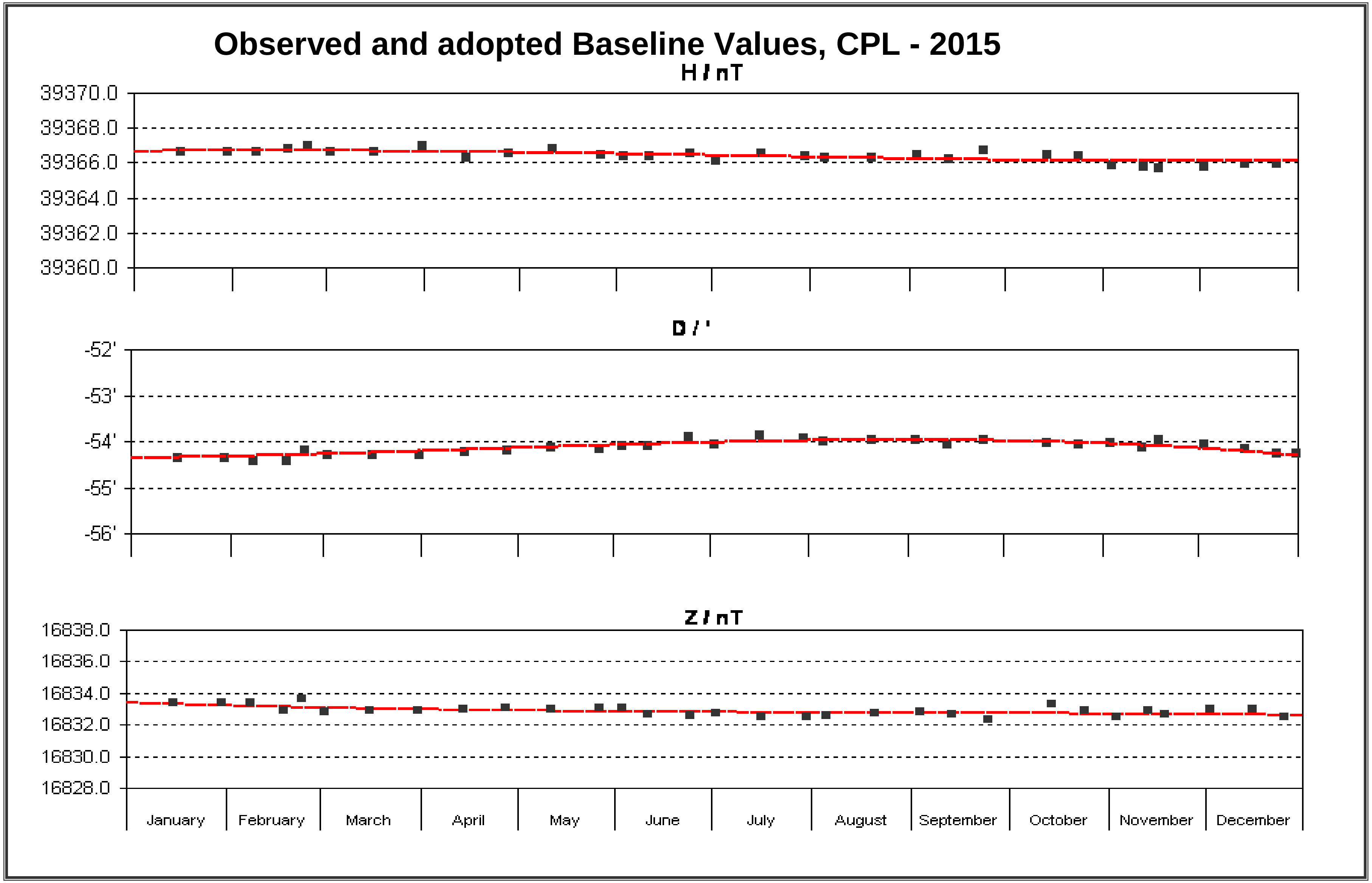
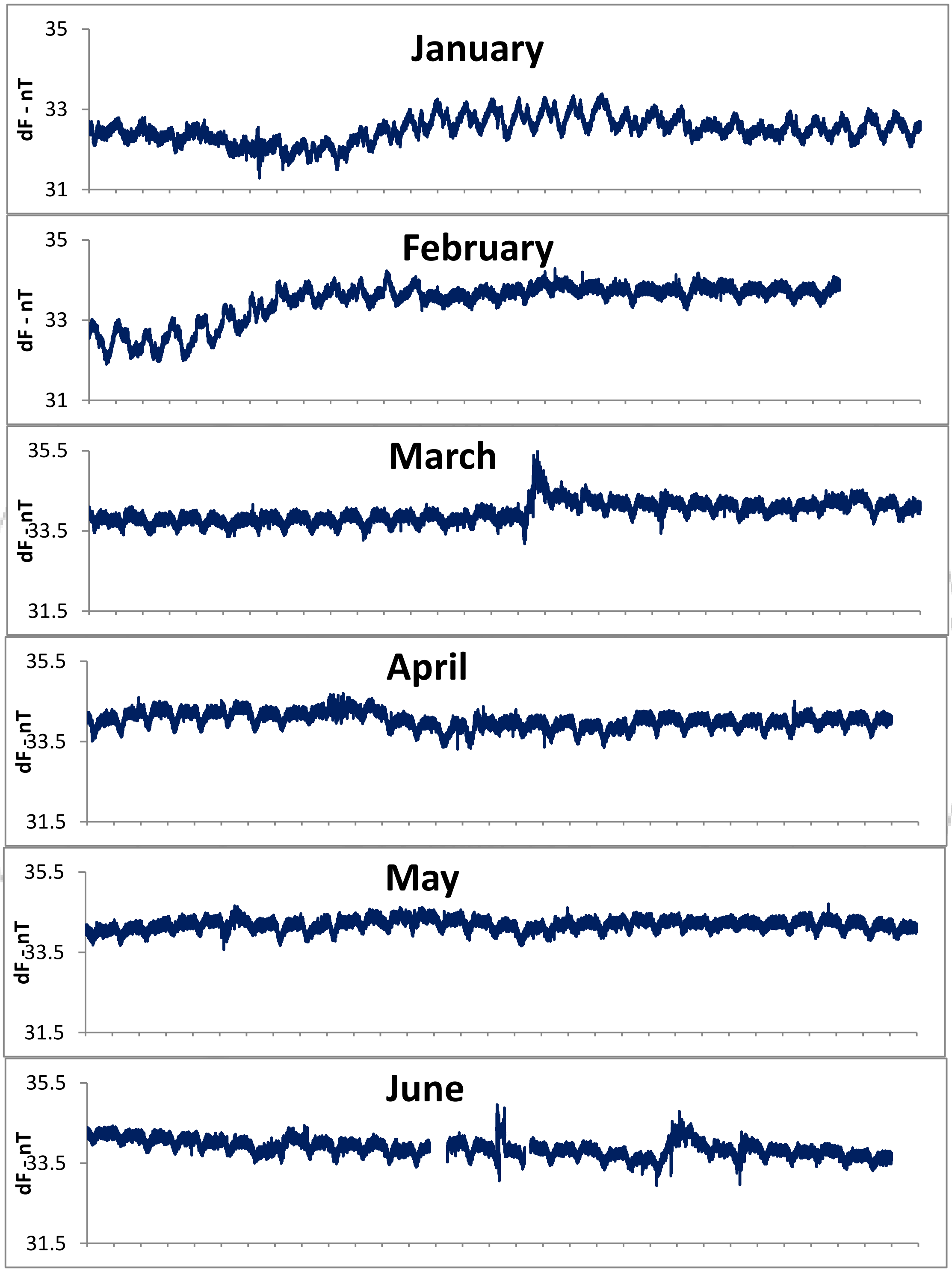
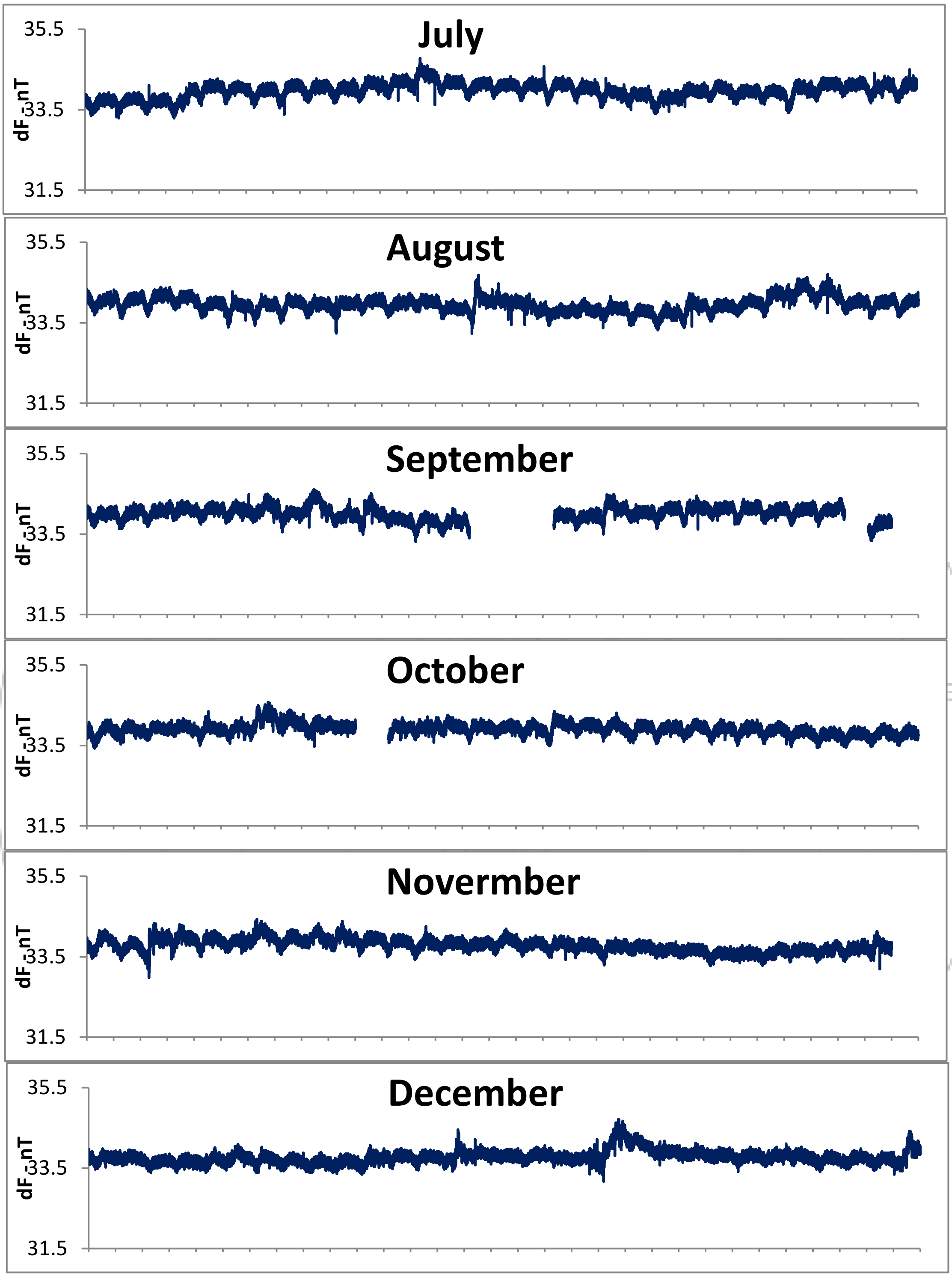


Figure 6.2.1: Observed & Adopted baselines

6.3. Monthly ΔF plots, 2015 CPL





6.3.1: Monthly ΔF plots of CPL Observatory

7. Data of Semi-permanent stations

7.1. Data availability

During 2015, the 3 component variometer data availability of the Semi-permanent magnetic stations of CSIR-NGRI, shown in the following figure. The coloured diamond shapes indicates data availability in respective months, different colours are different stations.

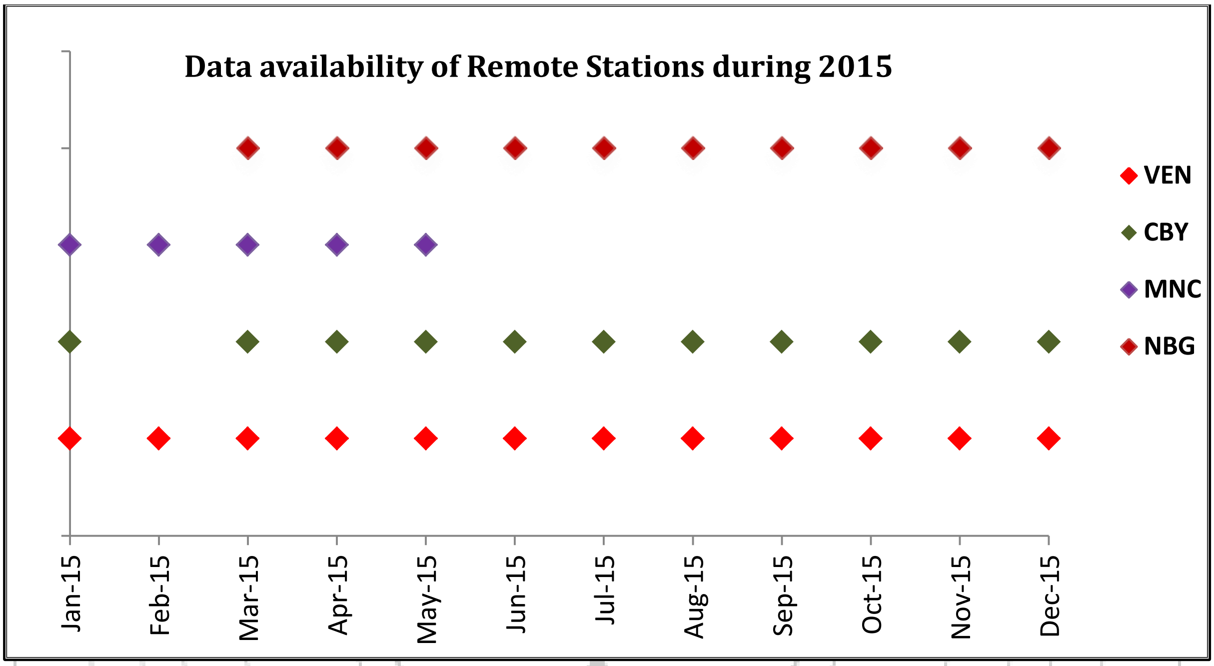
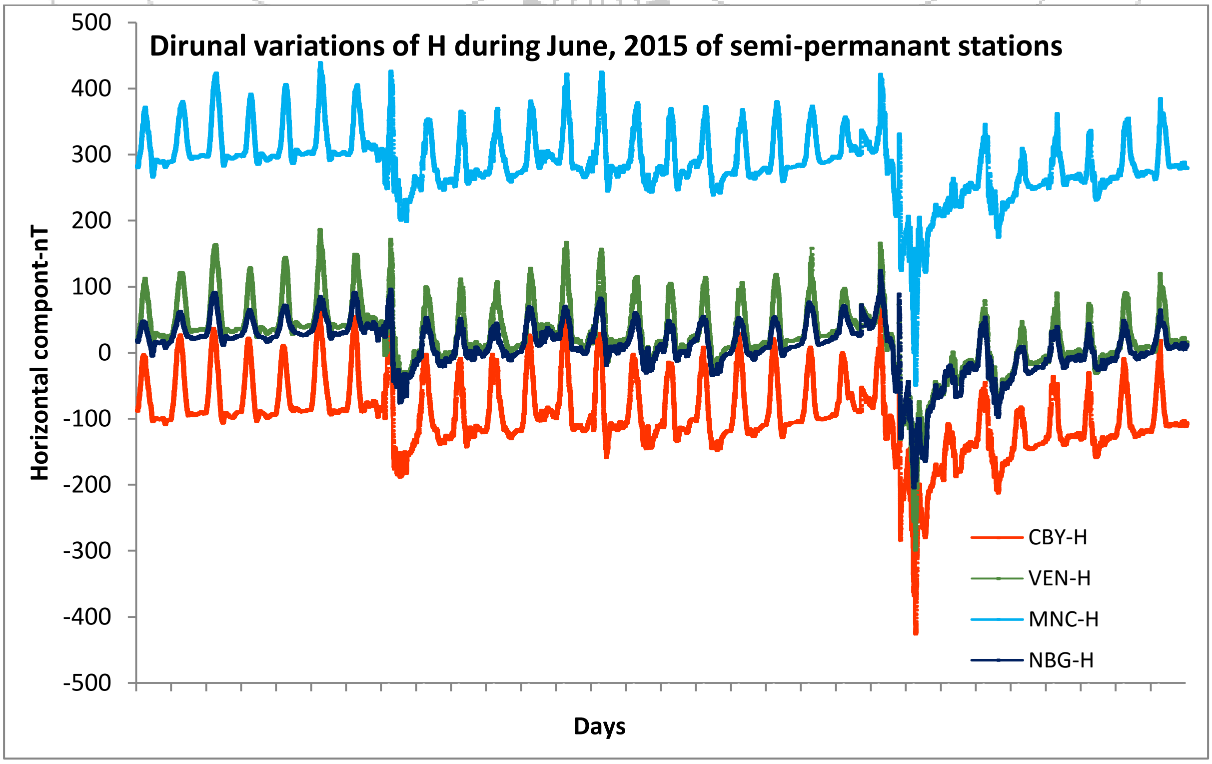


Figure 4.3.1: plot of data availability of remote stations.

7.2. Diurnal variation of H, D & Z during June 2015 at semi-permanent stations



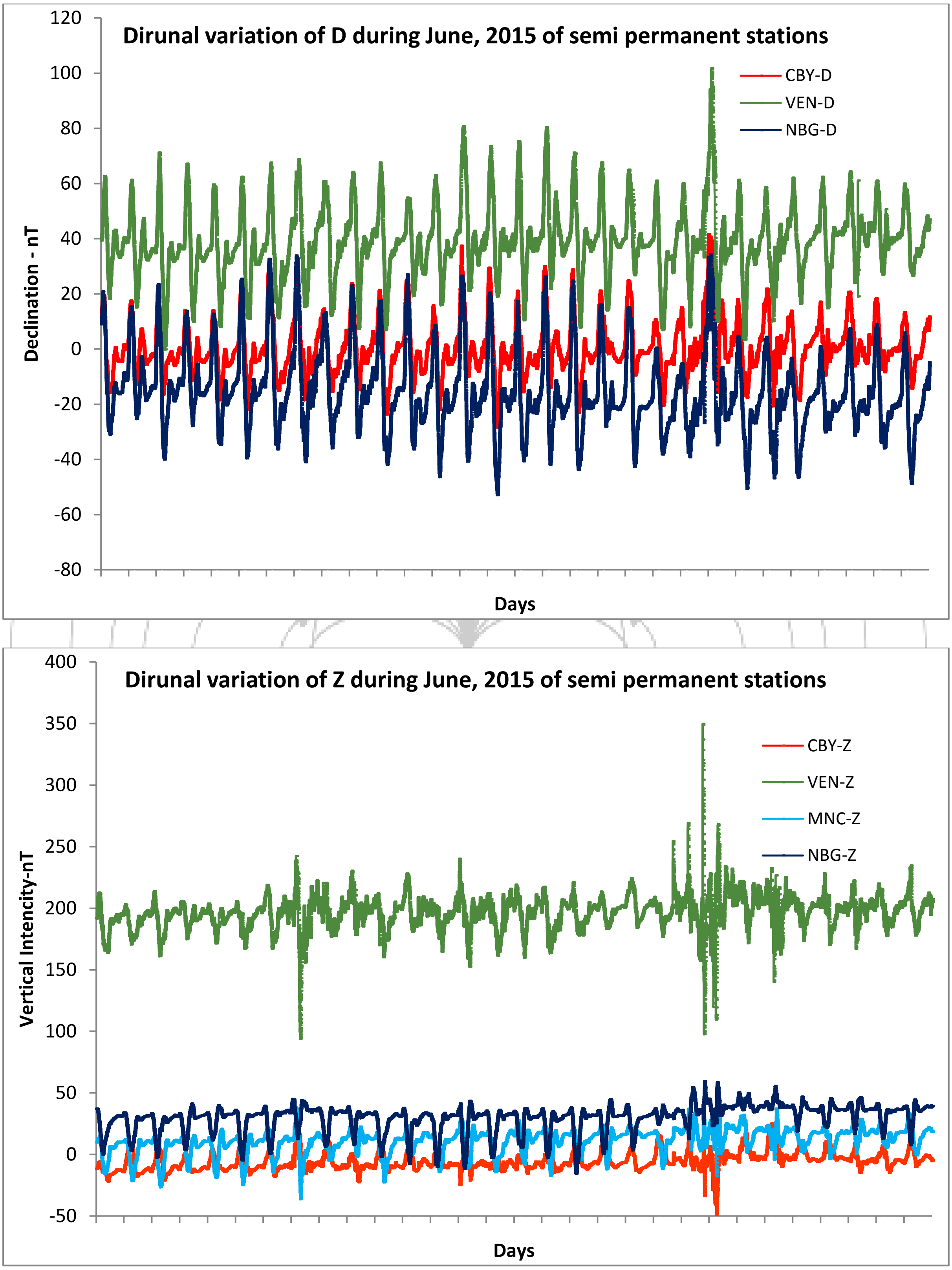


Figure7.2.1: diurnal variations of H, D & Z of Semi-permanent stations during June, 2015

7.2. Characteristics plots

Plots of induction arrows of CBY & VEN

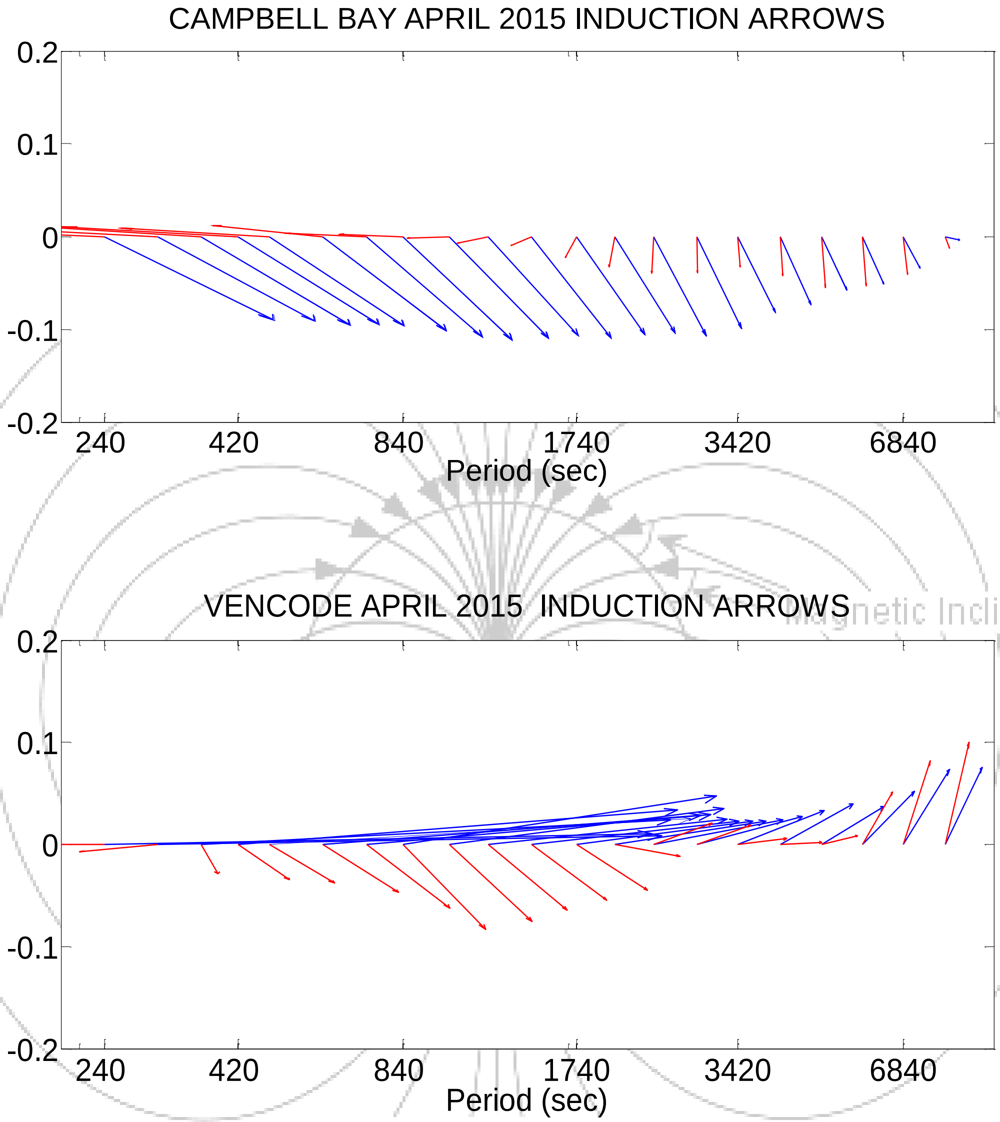


Figure 7.3.1: Induction arrows plots

The above plots are indicative of the subsurface conductance structures which generate the induction vectors. It is evident that the environments of CBY and VEN are significantly different.

8. Data requests

1) ----- Forwarded Message -----
From: webmaster@intermagnet.org
To: karora@ngri.res.in
Sent: Monday, November 2, 2015 6:32:39 PM
Subject: INTERMAGNET data requests report for HYB

Summary Report for HYB
Files downloaded from Ottawa INTERMAGNET FTP Server
Processed logs from 2015-10-01 UT to 2015-10-31 UT
Generated at : 2015-11-02 13:01:40
#---

IMO : HYB

Requests for IAGA2002 (variation) files : 134
Requests for IAGA2002 (quasi-definitive) files : 813
Requests for IAGA2002 (provisional) files : 1
Total : 948

Requests for minute files : 948
Total : 948

Sampling rate : minute
|-- Requested by : imagusgs
| |-- IAGA2002 (variation) files : 134
|-- Requested by : imagpots
| |-- IAGA2002 (quasi-definitive) files : 31
| |-- IAGA2002 (provisional) files : 1
|-- Requested by : imagsolov
| |-- IAGA2002 (quasi-definitive) files : 629
|-- Requested by : imagbgs
| |-- IAGA2002 (quasi-definitive) files : 153

Summary Report for HYB
Files downloaded from Ottawa INTERMAGNET Web Server
Processed logs from 2015-10-01 UT to 2015-10-31 UT
Generated at : 2015-11-02 13:01:42
#---

2) IMO : HYB

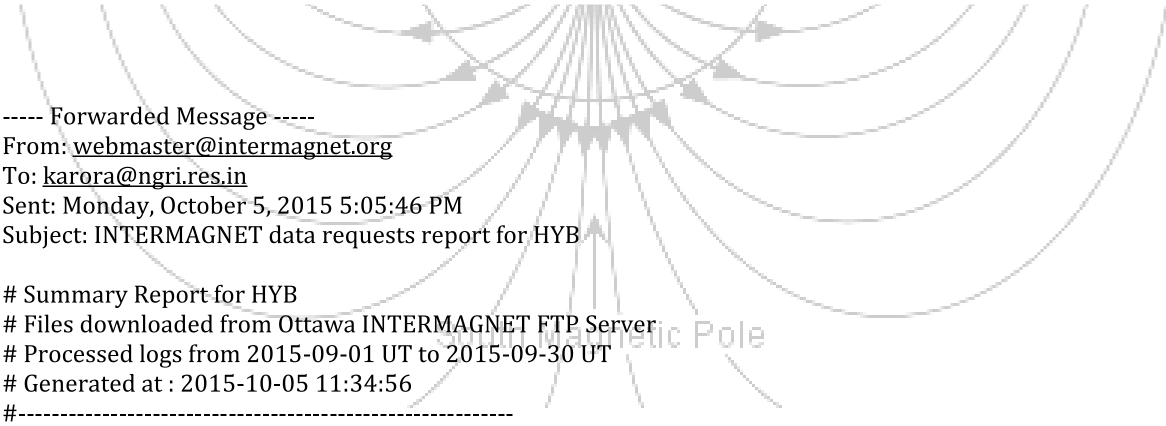
Requests for IAGA2002 (quasi-definitive) files : 103
Requests for IAGA2002 (definitive) files : 21
Requests for IAGA2002 (provisional) files : 13
Requests for IAGA2002 (variation) files : 730
Total : 867

Requests for minute files : 867
Total : 867

Sampling rate : minute
|-- Requested by : zhiqing@nssc.ac.cn
| |-- IAGA2002 (quasi-definitive) files : 31
|-- Requested by : juanrozu@gmail.com
| |-- IAGA2002 (quasi-definitive) files : 61
|-- Requested by : dalex@jupiter.ss.ncu.edu.tw
| |-- IAGA2002 (definitive) files : 21
| |-- IAGA2002 (quasi-definitive) files : 3

|-- Requested by : popperlf@163.com
| |-- IAGA2002 (provisional) files : 10
|-- Requested by : afa05@fayoum.edu.eg
| |-- IAGA2002 (quasi-definitive) files : 1
|-- Requested by : ryledup@gmail.com
| |-- IAGA2002 (provisional) files : 3
|-- Requested by : katyushka245@narod.ru
| |-- IAGA2002 (quasi-definitive) files : 2
|-- Requested by : liuxc@cea-igp.ac.cn
| |-- IAGA2002 (variation) files : 730
|-- Requested by : kozyreva@ifz.ru
| |-- IAGA2002 (quasi-definitive) files : 3
|-- Requested by : diana.ionescu@geodin.ro
| |-- IAGA2002 (quasi-definitive) files : 2

--
Kusumita Arora
Pr. Scientist & Project Leader
Magnetic Observatory
CSIR-NGRI
Hyderabad-500007
Tel no: +91-40-27012783



----- Forwarded Message -----
From: webmaster@intermagnet.org
To: karora@ngri.res.in
Sent: Monday, October 5, 2015 5:05:46 PM
Subject: INTERMAGNET data requests report for HYB

Summary Report for HYB
Files downloaded from Ottawa INTERMAGNET FTP Server
Processed logs from 2015-09-01 UT to 2015-09-30 UT
Generated at : 2015-10-05 11:34:56
#---

3) IMO : HYB

Requests for IAGA2002 (variation) files : 33
Total : 33

Requests for minute files : 33
Total : 33

Sampling rate : minute
|-- Requested by : imagusgs
| |-- IAGA2002 (variation) files : 33

Summary Report for HYB
Files downloaded from Ottawa INTERMAGNET Web Server
Processed logs from 2015-09-01 UT to 2015-09-30 UT
Generated at : 2015-10-05 11:34:58
#--

4) IMO : HYB

Requests for IAGA2002 (quasi-definitive) files : 10
Requests for IAGA2002 (provisional) files : 43
Requests for IAGA2002 (definitive) files : 761
Requests for IAGA2002 (variation) files : 168
Total : 982

Requests for minute files : 982
Total : 982

Sampling rate : minute
|-- Requested by : aliaa.afify@gmail.com
| |-- IAGA2002 (quasi-definitive) files : 1
|-- Requested by : phaninelapatla@gmail.com
| |-- IAGA2002 (provisional) files : 2
|-- Requested by : nfchao@whu.edu.cn
| |-- IAGA2002 (provisional) files : 1
|-- Requested by : virginia@univap.br
| |-- IAGA2002 (provisional) files : 3
|-- Requested by : liuxc@cea-igp.ac.cn
| |-- IAGA2002 (definitive) files : 730
|-- Requested by : siva14293@gmail.com
| |-- IAGA2002 (variation) files : 168
| |-- IAGA2002 (definitive) files : 31
|-- Requested by : dalex@jupiter.ss.ncu.edu.tw
| |-- IAGA2002 (quasi-definitive) files : 7
|-- Requested by : veronicadce@gmail.com
| |-- IAGA2002 (provisional) files : 1
| |-- IAGA2002 (quasi-definitive) files : 2
|-- Requested by : mojaipur@iigs.iigm.res.in
| |-- IAGA2002 (provisional) files : 31
|-- Requested by : yara_ahmed1792@yahoo.com
| |-- IAGA2002 (provisional) files : 1
|-- Requested by : labelk@163.com
| |-- IAGA2002 (provisional) files : 4

--
Kusumita Arora
Pr. Scientist & Project Leader
Magnetic Observatory
CSIR-NGRI
Hyderabad-500007
Tel no: +91-40-27012783

----- Forwarded Message -----
From: webmaster@intermagnet.org
To: karora@ngri.res.in
Sent: Thursday, July 2, 2015 4:51:36 PM
Subject: INTERMAGNET data requests report for HYB

Summary Report for HYB
Files downloaded from Ottawa INTERMAGNET FTP Server
Processed logs from 2015-06-01 UT to 2015-06-30 UT
Generated at : 2015-07-02 11:14:28
#--

5) IMO : HYB

Requests for IAGA2002 (variation) files : 58
Requests for IAGA2002 (quasi-definitive) files : 2
Total : 60

Requests for minute files : 60
Total : 60

Sampling rate : minute
|-- Requested by : imagusgs
| |-- IAGA2002 (variation) files : 58
|-- Requested by : imagbgs
| |-- IAGA2002 (quasi-definitive) files : 2

Summary Report for HYB
Files downloaded from Ottawa INTERMAGNET Web Server
Processed logs from 2015-06-01 UT to 2015-06-30 UT
Generated at : 2015-07-02 11:14:30
#--

6) IMO : HYB

Requests for IAGA2002 (provisional) files : 74
Requests for IAGA2002 (quasi-definitive) files : 575
Total : 649

Requests for minute files : 649
Total : 649

Sampling rate : minute
|-- Requested by : phaninelapatla@gmail.com
| |-- IAGA2002 (provisional) files : 5
|-- Requested by : ganglu@ucar.edu
| |-- IAGA2002 (quasi-definitive) files : 14
|-- Requested by : vnicol14@yahoo.com
| |-- IAGA2002 (quasi-definitive) files : 30
| |-- IAGA2002 (provisional) files : 35
|-- Requested by : lfalberca@iqs.es
| |-- IAGA2002 (quasi-definitive) files : 4
|-- Requested by : katyushka245@narod.ru
| |-- IAGA2002 (quasi-definitive) files : 484
| |-- IAGA2002 (provisional) files : 26
|-- Requested by : geows@iris.washington.edu
| |-- IAGA2002 (quasi-definitive) files : 3
|-- Requested by : kramerk@nv.doe.gov
| |-- IAGA2002 (quasi-definitive) files : 6

|-- Requested by : aliaa.afify@gmail.com
| |-- IAGA2002 (quasi-definitive) files : 32
| |-- IAGA2002 (provisional) files : 8
|-- Requested by : sheetalkaria1@gmail.com

----- Forwarded Message -----
From: webmaster@intermagnet.org
To: kusumita@ngri.res.in
Sent: Thursday, August 1, 2013 9:06:38 PM
Subject: INTERMAGNET data requests report for HYB

Summary Report for HYB
Files downloaded from Ottawa INTERMAGNET FTP Server
Processed logs from 2013-07-01 UT to 2013-07-31 UT
Generated at : 2013-08-01 15:33:56
#---

7) IMO : HYB

Requests for IAGA2002 (variation) files : 27109
Requests for IAGA2002 (quasi-definitive) files : 609
Requests for IAGA2002 (definitive) files : 90
Total : 27808

Requests for minute files : 27808
Total : 27808

Sampling rate : minute
|-- Requested by : imagusgs
| |-- IAGA2002 (variation) files : 27109
|-- Requested by : imagdtu
| |-- IAGA2002 (quasi-definitive) files : 517
| |-- IAGA2002 (definitive) files : 90
|-- Requested by : imagbgs
| |-- IAGA2002 (quasi-definitive) files : 92

Summary Report for HYB
Files downloaded from Ottawa INTERMAGNET Web Server
Processed logs from 2013-07-01 UT to 2013-07-31 UT
Generated at : 2013-08-01 15:33:58
#---

8) IMO : HYB

Requests for IAGA2002 (variation) files : 377
Requests for IAGA2002 (definitive) files : 365
Total : 742

Requests for minute files : 742
Total : 742

Sampling rate : minute
|-- Requested by : ganglu@ucar.edu
| |-- IAGA2002 (variation) files : 11
|-- Requested by : kumbhersalam@yahoo.com
| |-- IAGA2002 (definitive) files : 365
|-- Requested by : raj_h60@rediffmail.com
| |-- IAGA2002 (variation) files : 366

---------- Forwarded message ----------
From: <webmaster@intermagnet.org>
Date: Tue, Dec 1, 2015 at 8:41 PM

Subject: INTERMAGNET data requests report for HYB
To: kusumita.arora@gmail.com

Summary Report for HYB
Files downloaded from Ottawa INTERMAGNET FTP Server
Processed logs from 2015-11-01 UT to 2015-11-30 UT
Generated at : 2015-12-01 15:11:29
#--

9) IMO : HYB

Requests for IAGA2002 (variation) files : 52
Requests for IAGA2002 (quasi-definitive) files : 63
Requests for IAGA2002 (provisional) files : 3
Requests for IAGA2002 (definitive) files : 578
Total : 696

Requests for minute files : 696
Total : 696

Sampling rate : minute
|-- Requested by : imagusgs
| |-- IAGA2002 (variation) files : 52
|-- Requested by : imagbgs
| |-- IAGA2002 (quasi-definitive) files : 63
| |-- IAGA2002 (provisional) files : 3
|-- Requested by : imagsolov
| |-- IAGA2002 (definitive) files : 578

Summary Report for HYB
Files downloaded from Ottawa INTERMAGNET Web Server
Processed logs from 2015-11-02 UT to 2015-11-30 UT
Generated at : 2015-12-01 15:11:32
#--

10) IMO : HYB

Requests for IAGA2002 (quasi-definitive) files : 1747
Requests for IAGA2002 (definitive) files : 3302
Requests for IAGA2002 (provisional) files : 4
Total : 5053

Requests for minute files : 5053
Total : 5053

Sampling rate : minute
|-- Requested by : kozyreva@ifz.ru
| |-- IAGA2002 (quasi-definitive) files : 10
| |-- IAGA2002 (definitive) files : 15
|-- Requested by : dwelling@umich.edu
| |-- IAGA2002 (quasi-definitive) files : 4
|-- Requested by : lfalberca@iqs.es
| |-- IAGA2002 (quasi-definitive) files : 21
|-- Requested by : shamilalakmal@gmail.com
| |-- IAGA2002 (definitive) files : 1461
|-- Requested by : Baba4onok@bigmir.net
| |-- IAGA2002 (definitive) files : 1826
| |-- IAGA2002 (quasi-definitive) files : 1366
|-- Requested by : ryabovasa@mail.ru
| |-- IAGA2002 (quasi-definitive) files : 2
|-- Requested by : phaninelapatla@gmail.com
| |-- IAGA2002 (provisional) files : 2
|-- Requested by : dmitri_epishkin@mail.ru

| |-- IAGA2002 (provisional) files : 1
| |-- IAGA2002 (quasi-definitive) files : 46
|-- Requested by : katyushka245@narod.ru
| |-- IAGA2002 (quasi-definitive) files : 296
|-- Requested by : mahenderastro@gmail.com
| |-- IAGA2002 (provisional) files : 1
|-- Requested by : ryabovasva@mail.ru
| |-- IAGA2002 (quasi-definitive) files : 2

---------- Forwarded message ----------
From: <webmaster@intermagnet.org>
Date: Fri, Apr 1, 2016 at 6:23 PM
Subject: INTERMAGNET data requests report for HYB
To: kusumita.arora@gmail.com

Summary Report for HYB
Files downloaded from Ottawa INTERMAGNET FTP Server
Processed logs from 2016-03-01 UT to 2016-03-31 UT
Generated at : 2016-04-01 12:52:59
#---

11) IMO : HYB

Requests for IAGA2002 (provisional) files : 785
Requests for IAGA2002 (quasi-definitive) files : 619
Requests for IAGA2002 (definitive) files : 731
Requests for IAGA2002 (variation) files : 538
Total : 2673

Requests for minute files : 2673
Total : 2673

Sampling rate : minute
|-- Requested by : imaginpe
| |-- IAGA2002 (provisional) files : 70
|-- Requested by : imagbgs
| |-- IAGA2002 (quasi-definitive) files : 529
| |-- IAGA2002 (provisional) files : 580
|-- Requested by : imagpots
| |-- IAGA2002 (quasi-definitive) files : 90
| |-- IAGA2002 (provisional) files : 135
| |-- IAGA2002 (definitive) files : 731
|-- Requested by : imagrong
| |-- IAGA2002 (variation) files : 522
|-- Requested by : imagusgs
| |-- IAGA2002 (variation) files : 16

Summary Report for HYB
Files downloaded from Ottawa INTERMAGNET Web Server
Processed logs from 2016-03-01 UT to 2016-03-31 UT
Generated at : 2016-04-01 12:53:03
#---

12) IMO : HYB

Requests for IAGA2002 (quasi-definitive) files : 1321
Requests for IAGA2002 (provisional) files : 68
Requests for IAGA2002 (definitive) files : 1846
Requests for IAGA2002 (variation) files : 4
Total : 3239

Requests for minute files : 3239
Total : 3239

Sampling rate : minute
|-- Requested by : zsheng93@foxmail.com
| |-- IAGA2002 (quasi-definitive) files : 33
|-- Requested by : lakshmiramprasath@gmail.com
| |-- IAGA2002 (provisional) files : 4
|-- Requested by : lrp34006@gmail.com
| |-- IAGA2002 (quasi-definitive) files : 4
| |-- IAGA2002 (provisional) files : 2
|-- Requested by : talk2ocleen@yahoo.com
| |-- IAGA2002 (definitive) files : 13
|-- Requested by : sanaz.nourbakhsh.1@outlook.com
| |-- IAGA2002 (provisional) files : 2
|-- Requested by : sanaz.nourbakhsh@outlook.com
| |-- IAGA2002 (provisional) files : 1
|-- Requested by : andrei11vorobev@gmail.com
| |-- IAGA2002 (variation) files : 4
| |-- IAGA2002 (quasi-definitive) files : 10
| |-- IAGA2002 (definitive) files : 3
|-- Requested by : kcsrao18ngri@gmail.com
| |-- IAGA2002 (provisional) files : 1
|-- Requested by : champion_chb@126.com
| |-- IAGA2002 (definitive) files : 365
| |-- IAGA2002 (quasi-definitive) files : 182
|-- Requested by : jovenho@163.com
| |-- IAGA2002 (definitive) files : 1095
|-- Requested by : 879144166@qq.com
| |-- IAGA2002 (quasi-definitive) files : 1026
|-- Requested by : danielshamambo@gmail.com
| |-- IAGA2002 (quasi-definitive) files : 16
| |-- IAGA2002 (provisional) files : 2
|-- Requested by : tharani012@gmail.com
| |-- IAGA2002 (provisional) files : 1
|-- Requested by : mehrdad.moradi7070@gmail.com
| |-- IAGA2002 (provisional) files : 1
|-- Requested by : jjcurto@obsebre.es
| |-- IAGA2002 (definitive) files : 1
|-- Requested by : sumeshgopinath@gmail.com
| |-- IAGA2002 (quasi-definitive) files : 6
|-- Requested by : 307013584@qq.com
| |-- IAGA2002 (definitive) files : 3
|-- Requested by : songchk@126.com
| |-- IAGA2002 (definitive) files : 366
| |-- IAGA2002 (quasi-definitive) files : 31
| |-- IAGA2002 (provisional) files : 54
|-- Requested by : zolot@iszf.irk.ru
| |-- IAGA2002 (quasi-definitive) files : 13

---------- Forwarded message ----------
From: <webmaster@intermagnet.org>
Date: Mon, May 2, 2016 at 8:01 PM
Subject: INTERMAGNET data requests report for HYB
To: kusumita.arora@gmail.com

Summary Report for HYB
Files downloaded from Ottawa INTERMAGNET FTP Server
Processed logs from 2016-04-01 UT to 2016-04-30 UT
Generated at : 2016-05-02 14:31:18
#--

13) IMO : HYB

Requests for IAGA2002 (provisional) files : 56
Requests for IAGA2002 (quasi-definitive) files : 417
Requests for IAGA2002 (variation) files : 733
Total : 1206

Requests for minute files : 1206
Total : 1206

Sampling rate : minute
|-- Requested by : imagbgs
| |-- IAGA2002 (provisional) files : 2
| |-- IAGA2002 (quasi-definitive) files : 1
|-- Requested by : imagrong
| |-- IAGA2002 (variation) files : 733
|-- Requested by : imaginpe
| |-- IAGA2002 (provisional) files : 54
|-- Requested by : imagpots
| |-- IAGA2002 (quasi-definitive) files : 416

Summary Report for HYB
Files downloaded from Ottawa INTERMAGNET Web Server
Processed logs from 2016-04-01 UT to 2016-04-30 UT
Generated at : 2016-05-02 14:31:19
#--

14) IMO : HYB

Requests for IAGA2002 (provisional) files : 77
Requests for IAGA2002 (quasi-definitive) files : 44
Requests for IAGA2002 (definitive) files : 733
Total : 854

Requests for minute files : 854
Total : 854

Sampling rate : minute
|-- Requested by : eslam.hamza.1000@facebook.com
| |-- IAGA2002 (provisional) files : 1
|-- Requested by : yyx8425061@163.com
| |-- IAGA2002 (provisional) files : 9
|-- Requested by : zsheng93@foxmail.com
| |-- IAGA2002 (quasi-definitive) files : 6
|-- Requested by : isahiom@hotmail.com
| |-- IAGA2002 (quasi-definitive) files : 1
|-- Requested by : india.ajesh@gmail.com
| |-- IAGA2002 (quasi-definitive) files : 31
| |-- IAGA2002 (provisional) files : 66
|-- Requested by : brett.carter@rmit.edu.au
| |-- IAGA2002 (quasi-definitive) files : 1
|-- Requested by : coisson@ipgp.fr
| |-- IAGA2002 (quasi-definitive) files : 3
|-- Requested by : kcsrao18ngri@gmail.com
| |-- IAGA2002 (quasi-definitive) files : 2
| |-- IAGA2002 (provisional) files : 1
|-- Requested by : lilianola@yahoo.com
| |-- IAGA2002 (definitive) files : 731
|-- Requested by : drfreez@ya.ru
| |-- IAGA2002 (definitive) files : 2

9. Publications from Hyderabad & Remote Magnetic Observatories

Kusumita Arora, K. Chandrashakhar Rao, L. Manjula, Suraj Kumar, Nandini Nagarajan (2015), The new magnetic observatory at Choutuppal, Telangana, India, Journal of Indian Geophysical Union Special Vol.2/2016, pp:67-75.

Nandini Nagarajan, Habiba Abbas and L. Manjula (2015), Secular Variation Studies in the Indian Region – Revisited, Journal of Indian Geophysical Union Special Vol.2/2016, pp:120-126.

K. Saratchandra, N. Rajendra Prasad, T.S. Sastry, Nandini Nagarajan (2015), Calibration Experiments Conducted at ETT observatory, 1980-2000, Journal of Indian Geophysical Union Special Vol.2/2016, pp:80-86.

*Chandrasekhar,N.P., Kusumita Arora and Nandini Nagarajan (2014b),*Characterization of Seasonal and Longitudinal variability of EEJ in the Indian region, Journal of Geophysical Research-Space Physics, 119, doi:10.1002/2014JA020183, pp:01-18.

*Chandrasekhar,N.P., Kusumita Arora and Nandini Nagarajan (2014a),*Evidence of short spatial variability of the Equatorial Electrojet at close longitudinal separation, Earth Planets and Space, Vol.66:110, pp: 01-15.

*Kusumita Arora, N. Phani Chandrasekhar, Nandini Nagarajan and Ankit Singh (2014a),*Correlations between Sunspot numbers, interplanetary parameters and geomagnetic trends over solar cycles 21-23, Journal of Atmospheric and Solar Terrestrial Physics, Vol. 114, pp:19-29.

N. Phani Chandrasekhar and S. Thinesh Kumar (2014), Influence of Interplanetary magnetic field on Equatorial Electrojet- Observations from South India, Journal of Indian Geophysical Union, v.18, no.1, pp: 109-118.

N. Phani Chandrasekhar, Kusumita Arora and Nandini Nagarajan (2012), New Observations from remote Equatorial stations in the southernmost parts of India, Proceedings of the XVth IAGA Workshop on Geomagnetic Observatory instruments, Data acquisition and Processing- San Fernando, Cadiz, Spain, pp:131-138.

9.1. List of Scientific works presented at National & International Symposiums from Hyderabad & Remote Magnetic Observatories

Kusumita Arora, Nandini Nagarajan, K.Chandrashakar Rao, S.R. Sannasi, N. Phani Chandrasekhar., L. Manjula, K. Saratchandra Habiba Abbas, Hyderabad Magnetic Observatory – 50 years of experiments, observations and standards, Presented at International Association of Geomagnetism and Aeronomy (IAGA-2014), Hyderabad.

N. Phani Chandrasekhar, Kusumita Arora, Nandini Nagarajan, K.ChandraShakar Rao, S.R.Sannsi, Suraj Kumar and L.Manjula, Magnetic data acquisition from remote sites in the northern Indian Ocean, Presented at International Association of Geomagnetism and Aeronomy (IAGA-2014), Hyderabad.

N. Phani Chandrasekhar, Kusumita Arora and Nandini Nagarajan, Observations of equatorial electrojet monitored at sites in northern Indian Ocean, Presented at International Association of Geomagnetism and Aeronomy (IAGA-2014), Hyderabad.

N. Phani Chandrasekhar, Kusumita Arora and Nandini Nagarajan, Correlation study between the ground derived EEJ strength within 15º longitude and the EEJ-2.0 model, Presented at Indian Geophysical Union (IGU-2014), Hyderabad.

N. Phani Chandrasekhar, Kusumita Arora, Nandini Nagarajan, Characterization of seasonal and longitudinal variability of Equatorial electrojet in the Indian region, Presented at International Union of Geodesy and Geophysics, 22nd June – 2nd July, Prague, Czech Republic.

N. Phani Chandrasekhar, Archana, R.K., and Nandini Nagarajan, Variability of Equatorial Counter Electrojet observations in the Indian region, Presented at International Union of Geodesy and Geophysics, 22nd June – 2nd July, Prague, Czech Republic.

Archana, R.K., N. Phani Chandrasekhar and Nandini Nagarajan, Evaluation of Prompt penetration effects on Counter electrojet events at two Equatorial sites in the Northern Indian Ocean, Presented at Indian Geophysical Union 52nd Annual convention, 03-05th November, 2015,Goa.

10. Acknowledgements

We thank the Director, CSIR-NGRI for the extended support for the continued work and progress of the INTERMAGNET Observatory at Hyderabad. Establishment of a new observatory in Choutuppal is made possible by Director, CSIR-NGRI and Project Director, HEART (PSC0203).

We thank the GFZ, Potsdam, Germany for their on-going collaboration, and support in data processing & played a key role in setting up the new primary variometer through an on-going GFZ-NGRI collaboration.

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We thank the Information group for their support in the preparation of this volume.

We thank Mr. K. Saratchandra, T.O-5 (Retired), for his untiring efforts for Choutuppal Observatory and data processing.

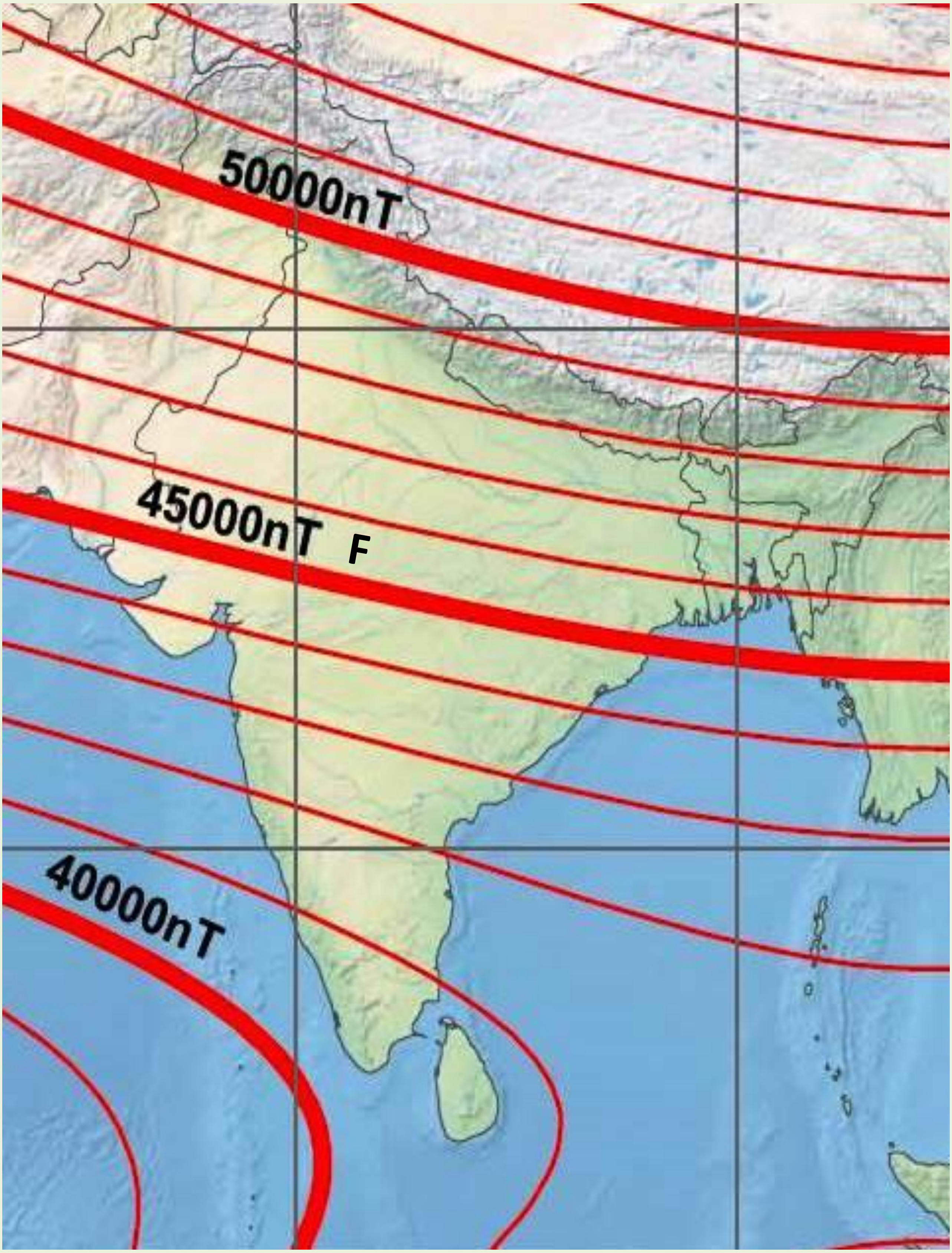
We thank our Civil engineering, Electrical section, pump house, for their contribution towards establishing the CPL Observatory

11. References

Sankar Narayan, P.V. (1967)- Establishment of a magnetic observatory at the National Geophysical Research Institute, Bull. NGRI, 2, 115-112.

B. J. Srivastava, S.N. Prasad, D. Pandurangam, N.P. Rajendra Prasad and Y.N.T.S. Rao (1988)- Establishment of NGRI's digital magnetic observatory (AMOS III) at Hyderabad, India, Geophysical research Bulletin, vol.26, No.1.

Kusumita Arora, K. Chandrashekhar Rao, L. Manjula, Suraj Kumar and Nandini Nagarajan (2016), The new magnetic observatory at Choutuppal, Telangana, India, JIGU Special vol.-2/2016, 67-75.



https://www.ngdc.noaa.gov/geomag/WMM/data/WMM2015/WMM2015_F_MERC.pdf