The 2010 International Space Weather Initiative Workshop,Cairo,Helwan University,Egypt.

OBSERVATIONAL INFRASTRUCTURE OVER ETHIOPIA:SOME PRELIMINARY RESULTS FROM MAGDAS AND GPS.

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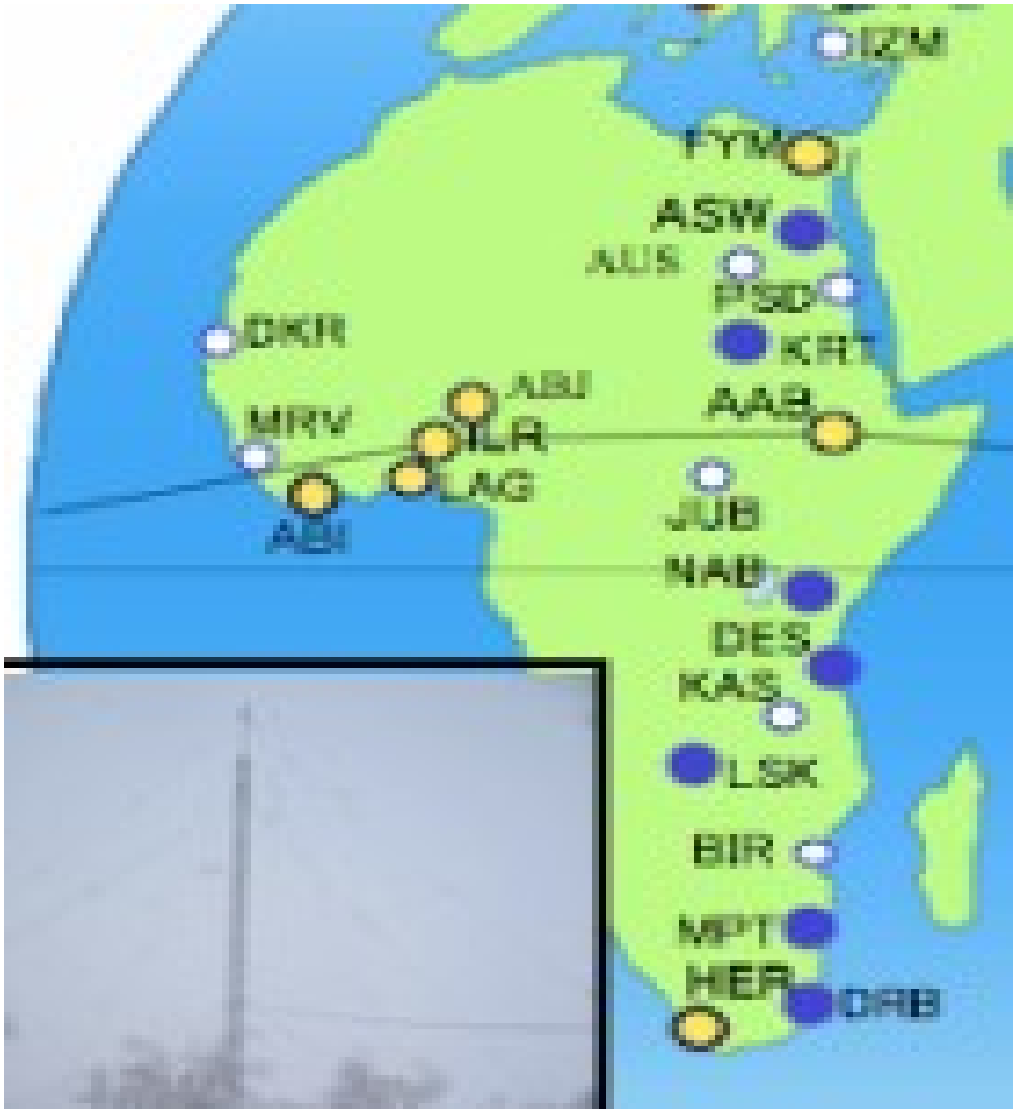
I. OBSERVATIONS FROM MAGDAS AT ADDIS ABEBA (AAB) STATION

- MAGDAS is one of the chains of magnetometer in Africa.
- Consists of flux-gate magnetometer with orthogonal 3-axial ring core sensors.
- Digital data obtained with sampling rate of 16Hz.

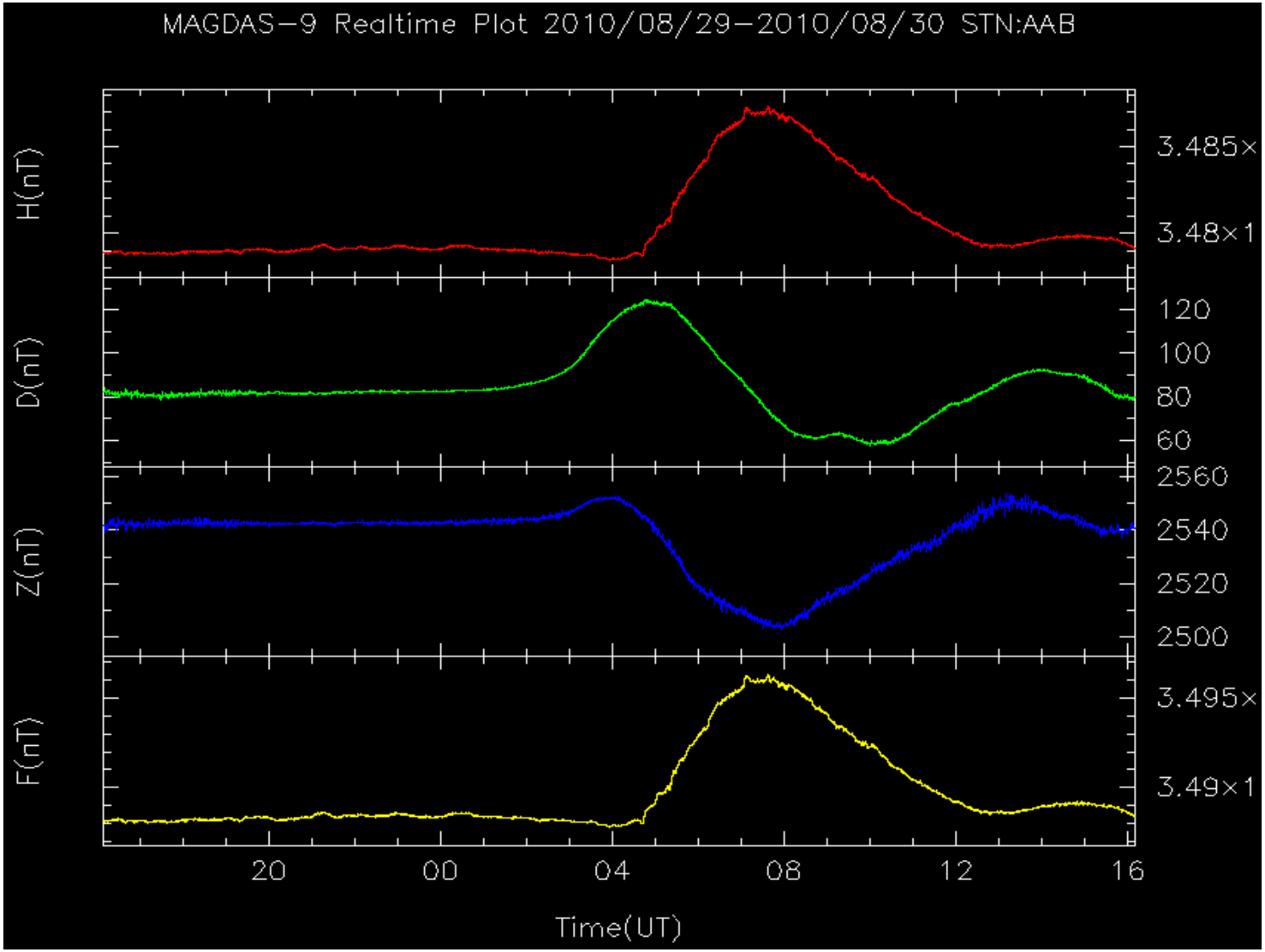
- 14 Stations installed all over Africa.



- One of the Stations at Addis Ababa(AAB)

- Updated to MAGDAS 9 July 2010.
- We get one second and one minute average data, recorded and transferred to SERC, Japan.

Real Time (Quick look) plot



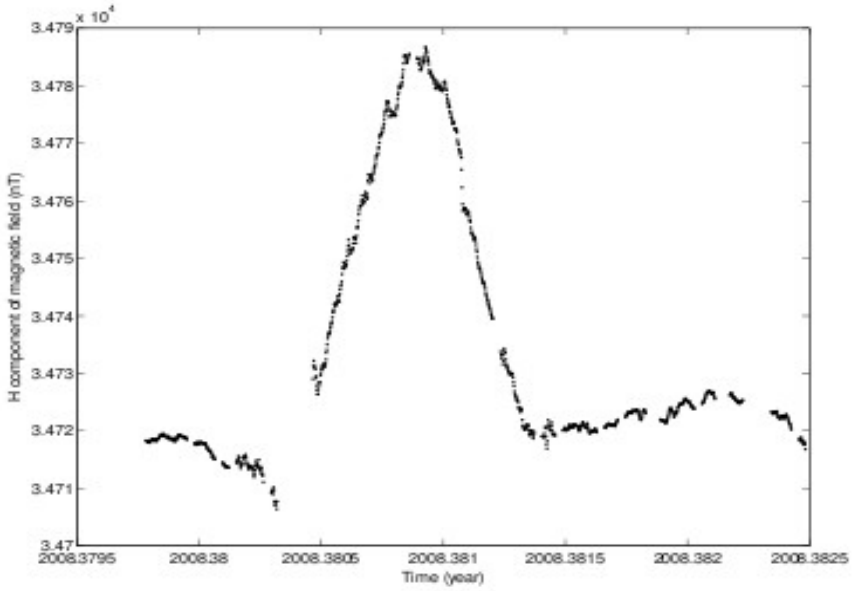
COMPARISON OF H COMPONENT OF AAB AND ILR

- One minute average data of 2008 and 2009 used
- For stations along Equatorial Chain LAG,ILR,AAB.
- And 96 MM Chain. FYM(Egypt),ASW(Egypt),KRT.

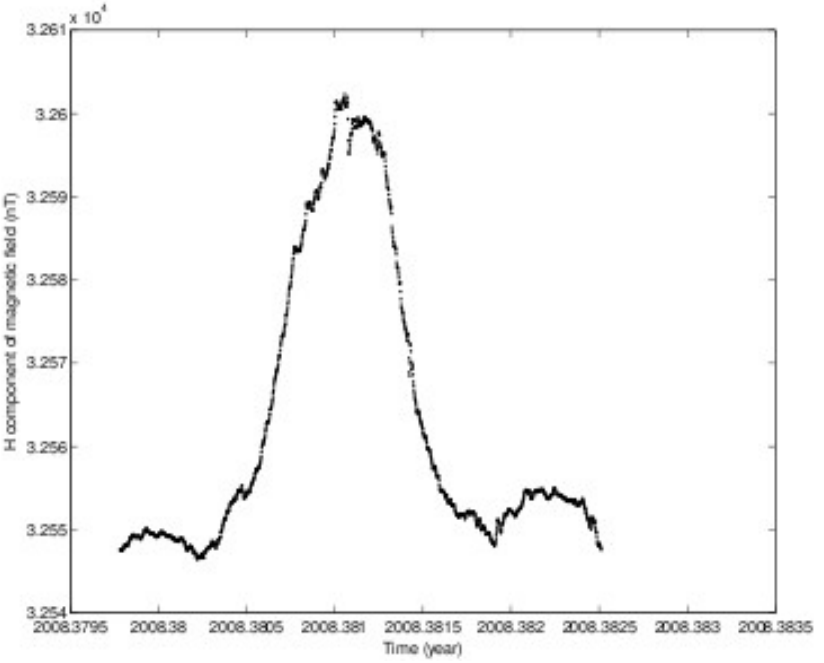
H Component of AAB and ILR Daily Variations.

I. 2008/05/18.

AAB

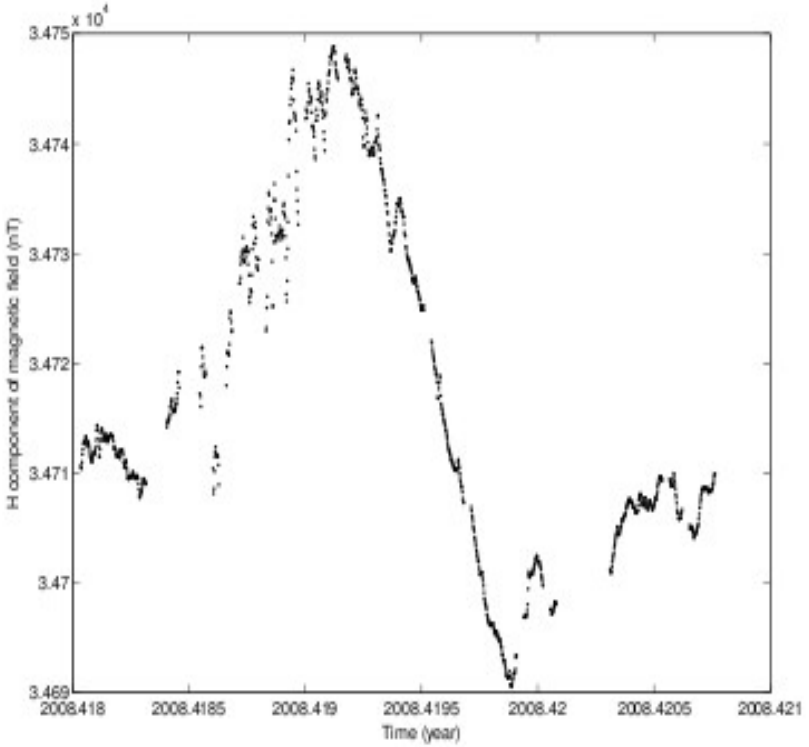


ILR

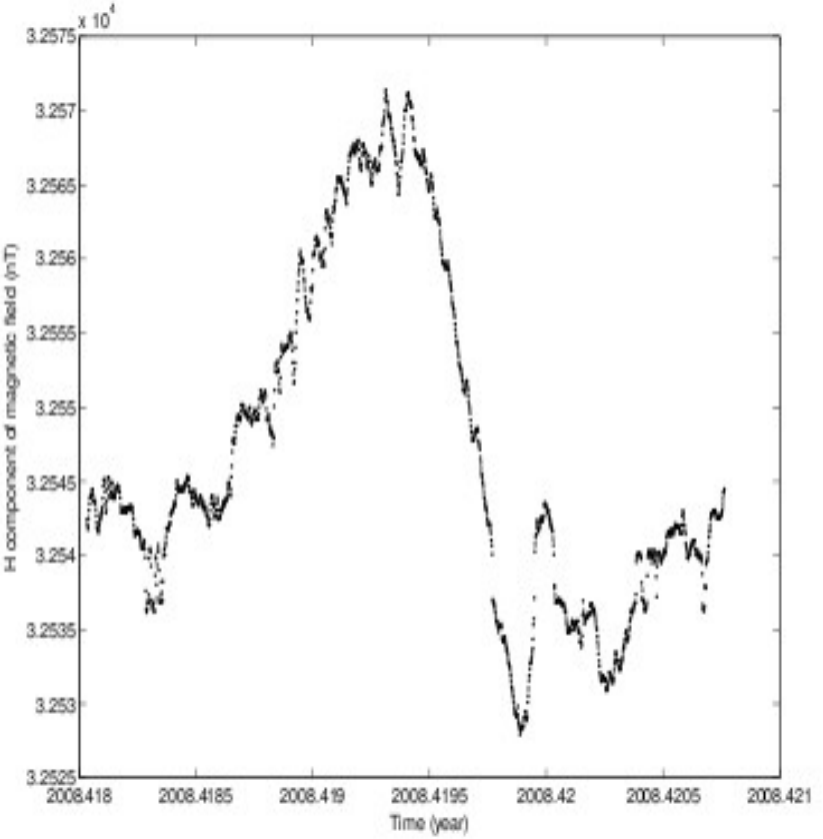


II. 2008/06/01

AAB

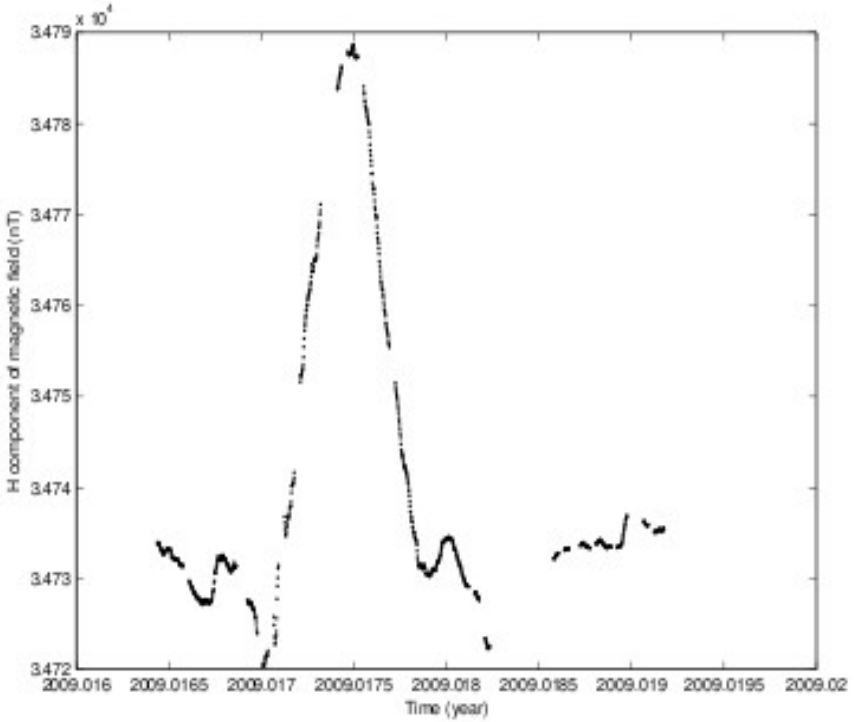


ILR

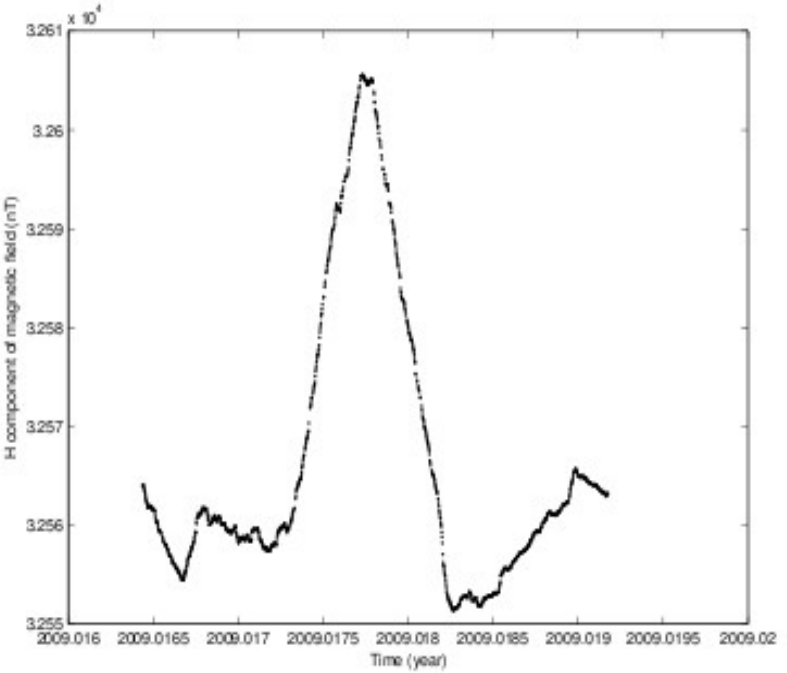


III. 2009/01/06

AAB

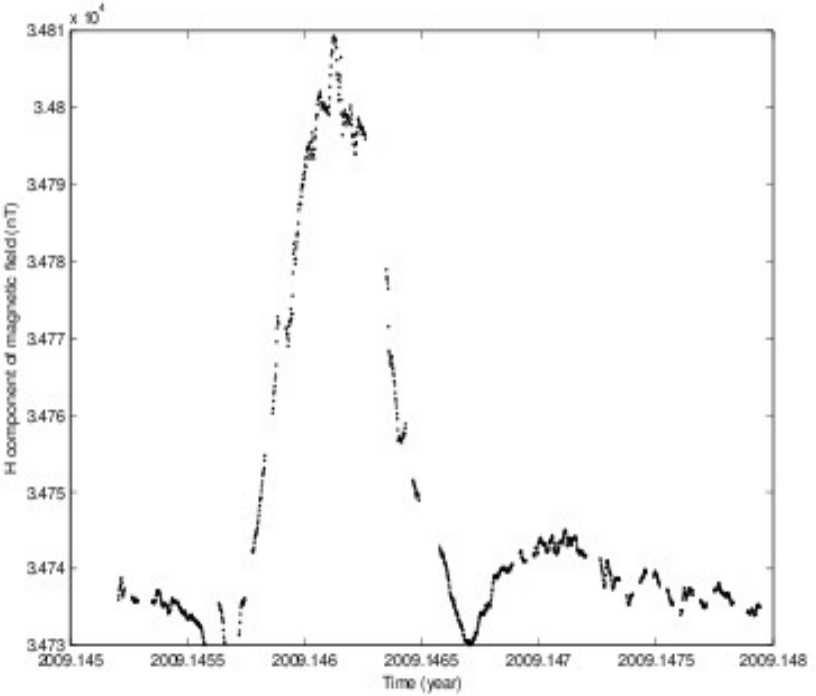


ILR



IV.2009/02/23

AAB



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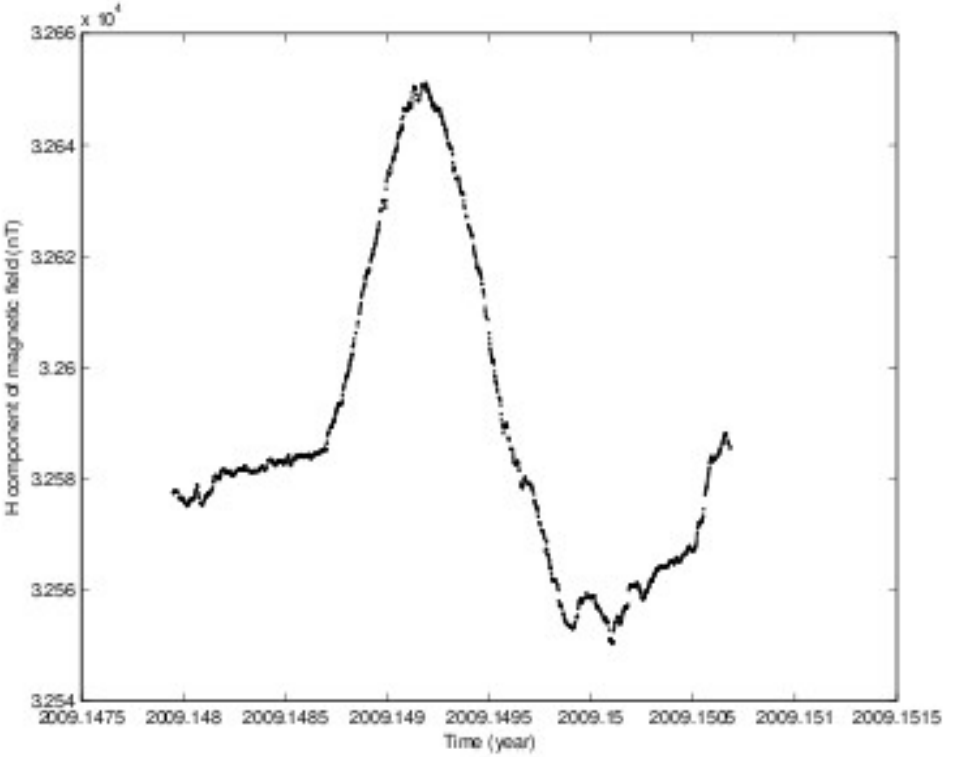


II.GPS TEC

INTRODUCTION

- GPS ,owned and operated by the US Department of Defense and Transportation, is a space based navigation system intended for positioning on earth.
- GPS signals are transmitted on two different frequencies

  $f_1 = 1575.42\text{MHz}$ $f_2 = 1227.6\text{MHz}$
- The linear combination of these frequencies used for removing the IONOSPHERIC effect for positioning
- On the other hand the dispersive property of the Ionosphere provide an opportunity to measure the electron Content.

IONOSPHERIC TEC

- The slant total electron content (STEC) is a measure of the total number of electrons along the ray path.
- The total number of free electrons is proportional to the ionospheric differential delay between f1 and f2 signals.

$$STEC = \int_{reciever}^{satellite} N d\vec{r}$$

- Commonly, STEC is obtained from the dual frequency code measurements given by:

$$STEC = \frac{1}{40.3}\left(\frac{1}{f_1^2} - \frac{1}{f_2^2}\right)^{-1} x\left(R_1 - R_2\right) + TEC_{corr.}$$

$$R_1 = Pseudorange\ at\ f_1$$

$$R_2 = Pseudorange\ at\ f_2$$

Where $TEC_{corr.}$ *is te correction for the reciever Delay*

VERTICAL TEC

- The IEC(TEC) is valid for the line of sight from the receiver to the satellite.
- We can convert it to the vertical by multiplying it with a mapping function:

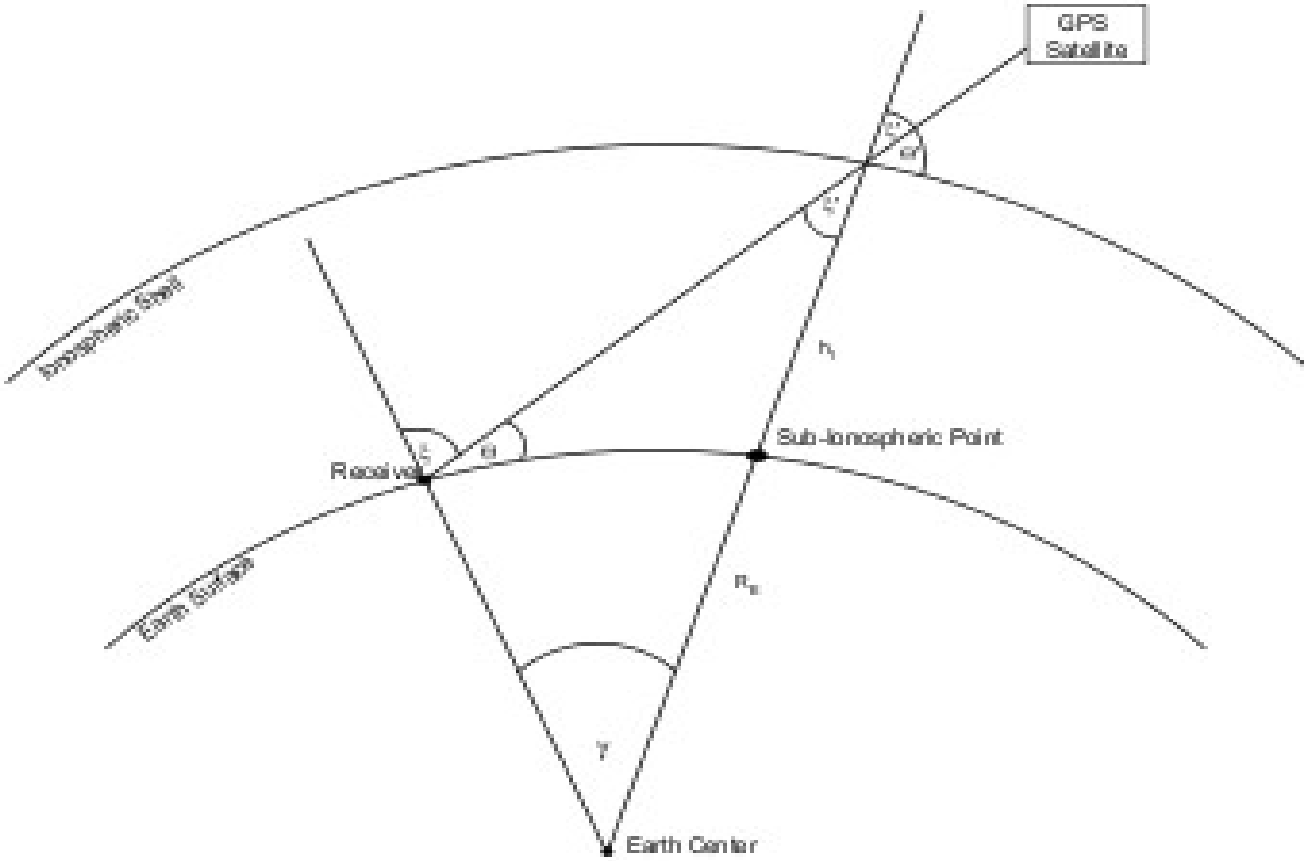
$$E(\Theta) = \sqrt{1 - \left(\frac{\sin(\frac{\pi}{2} - \Theta) R_E}{R_E + h_I} \right)^2}$$

$$VTEC = STECxE(\theta)$$

Where

$h_I = Ionospheeric\ height\ of\ main\ electron\ Concentration$

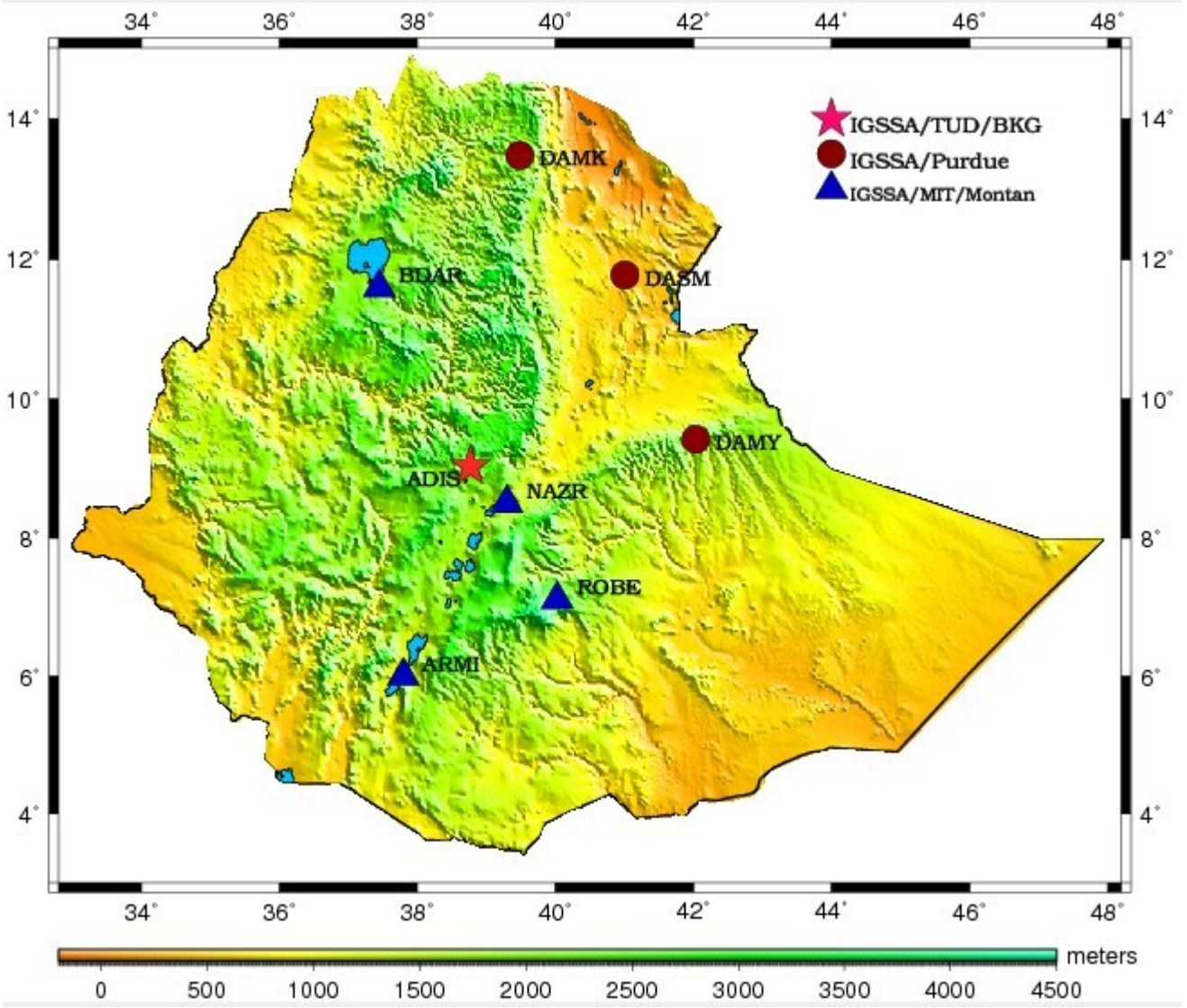
$R_E = Earth\ radius$


GPS
Satellite
Ionospheric Shell
Receiver
Sub-Ionospheric Point
Earth Surface
Earth Center

DATA INPUT & TEC CALCULATION

Matlab TEC calculating code written by Eric Calais and Thomas Dautermann employed

- Rinex GPS Data From Local and IGS stations as as in fig below.
- IGS orbit data
- Broadcast Ephemeris Data
- Ionex data -post processed from CODE university of Bern


34°
36°
38°
40°
42°
44°
46°
48°
14°
12°
10°
8°
6°
4°
IGSSA/TUD/BKG
IGSSA/Purdue
IGSSA/MIT/Montan
DAMK
BDAR
DASM
DAMY
ADIS
NAZR
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500
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2000
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3500
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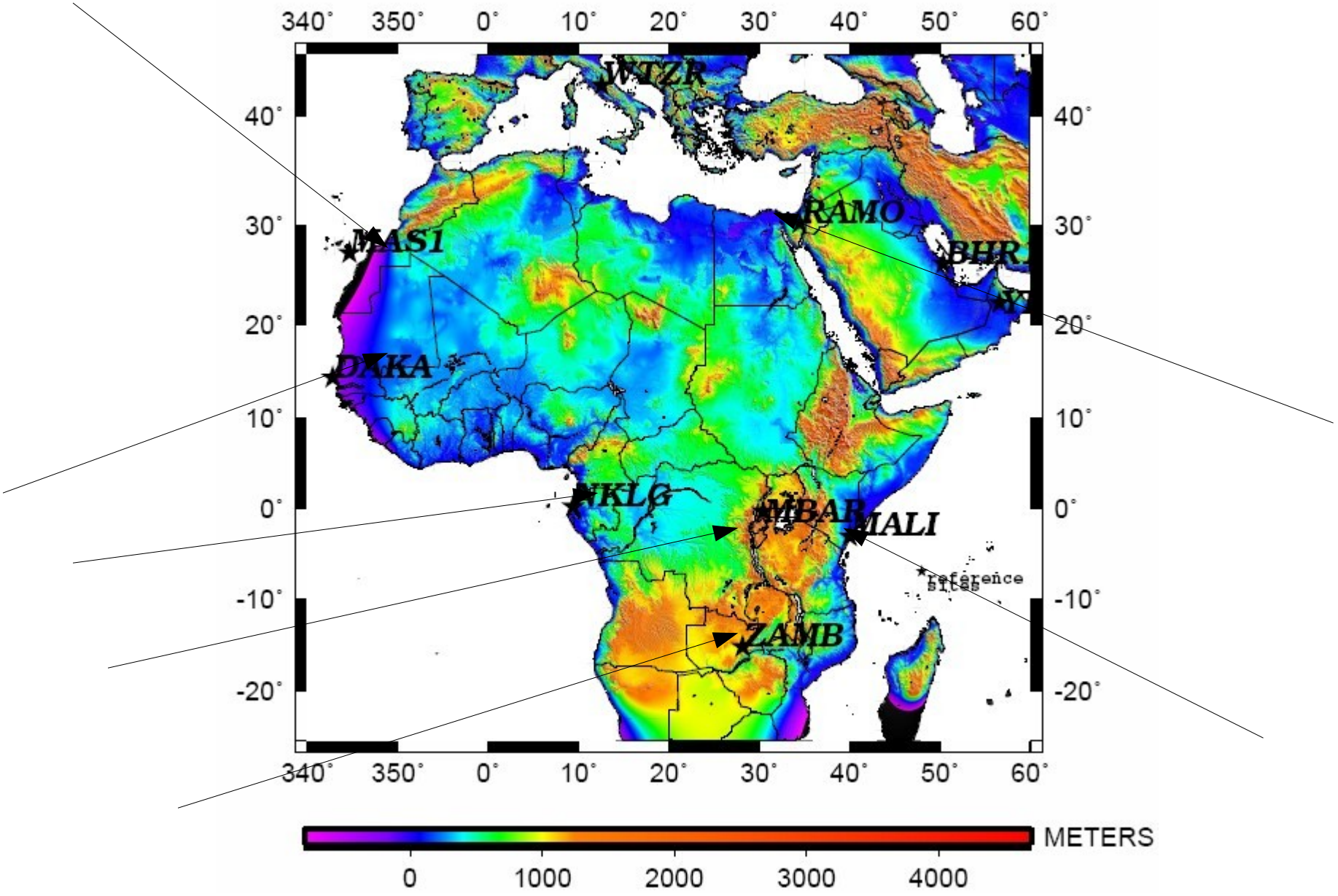
340°
350°
0°
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30°
40°
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-10°
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WTZR
RAMO
MAS1
BHR
DKKA
NKLG
MBAR
MALI
reference sites
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1000
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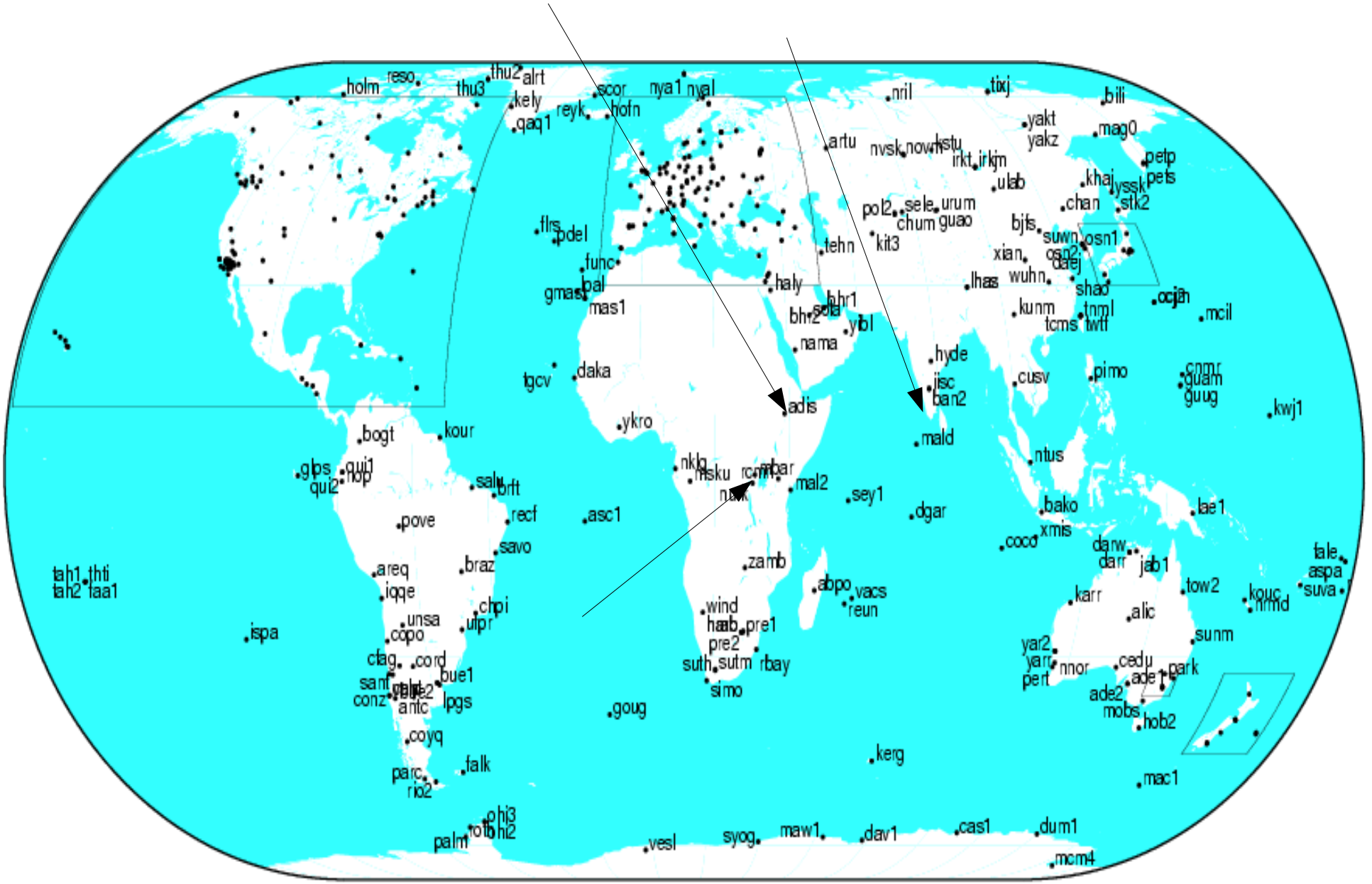
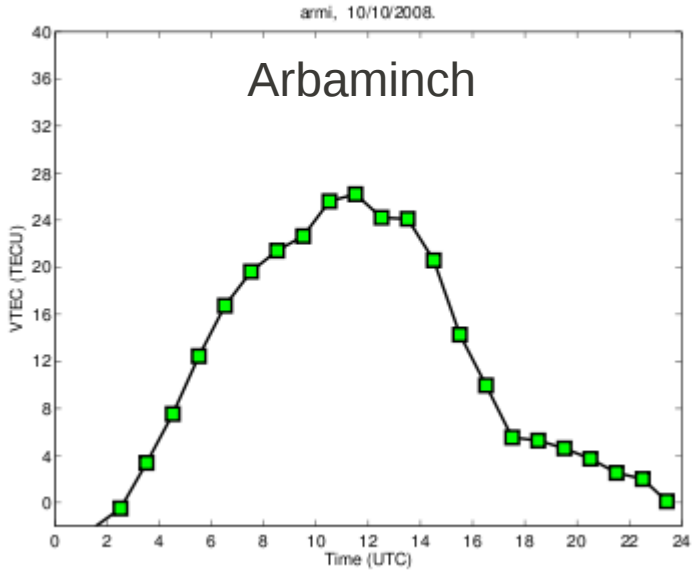


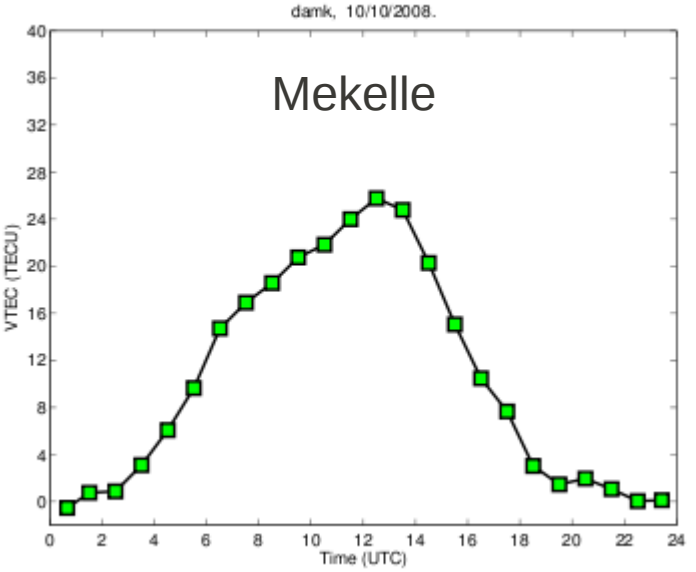
GMT 2010 Apr 19 16:46:04

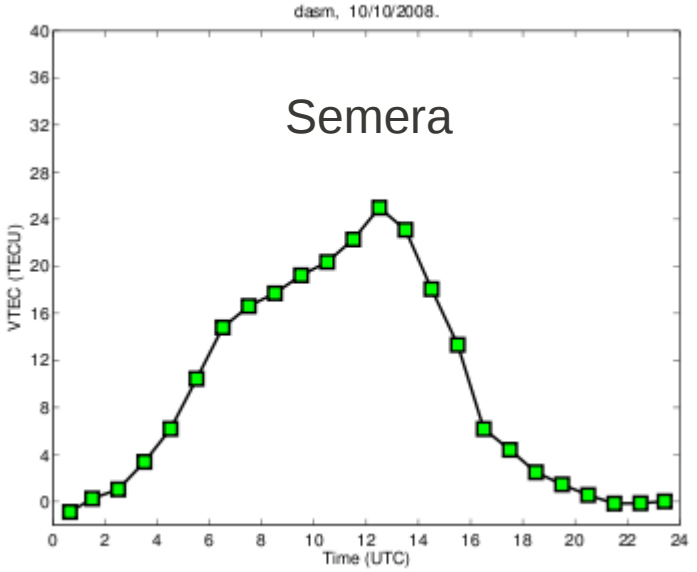
RESULTS

Calibrations have been made for the following TEC(vertical) Variations.

- Diurnal Variations
- Diurnal Variations(IGS)
- Seasonal Variations
- Longitudinal Variations







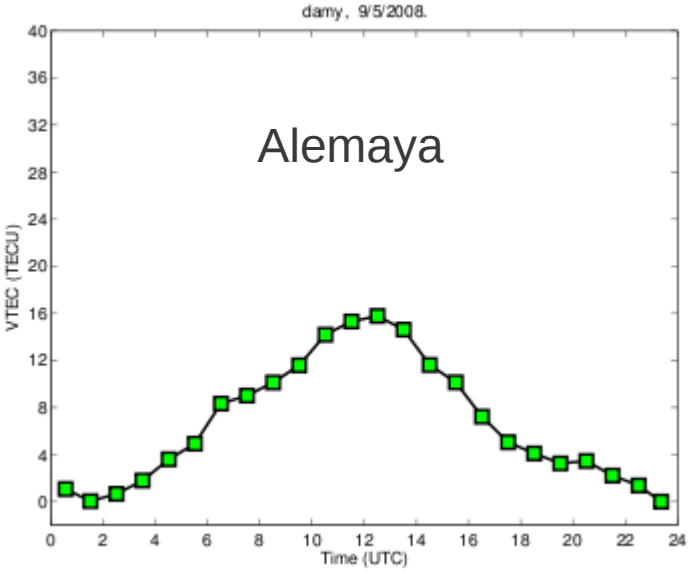
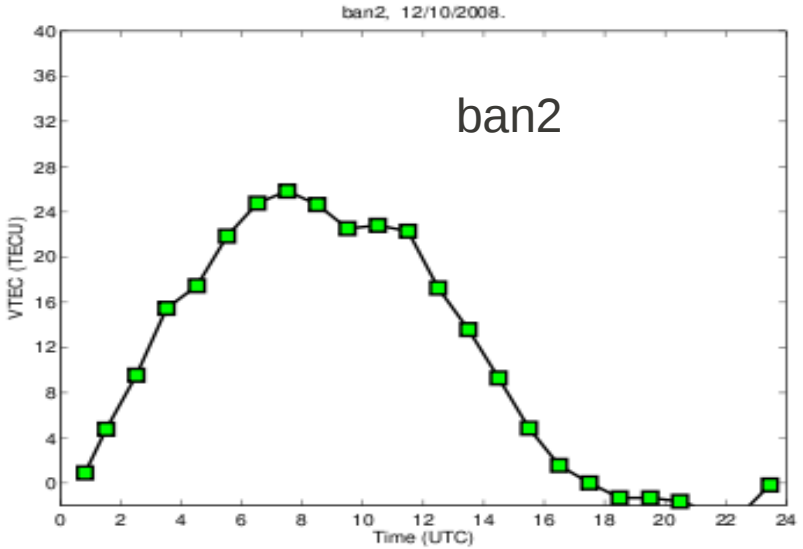
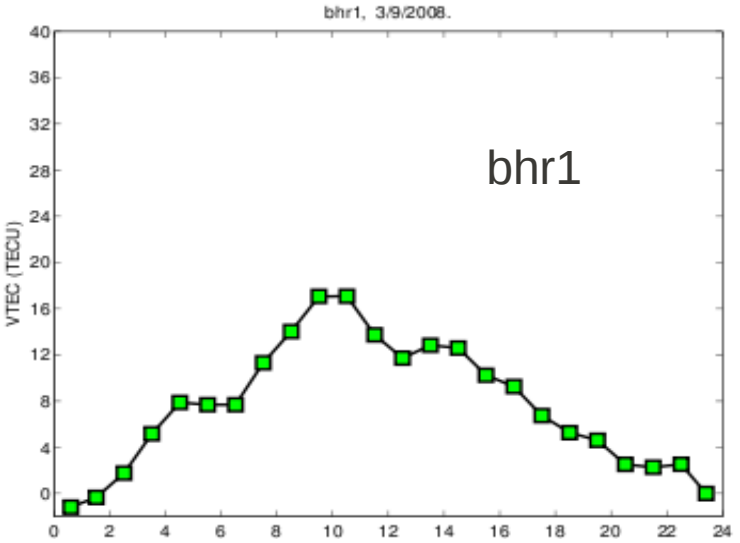
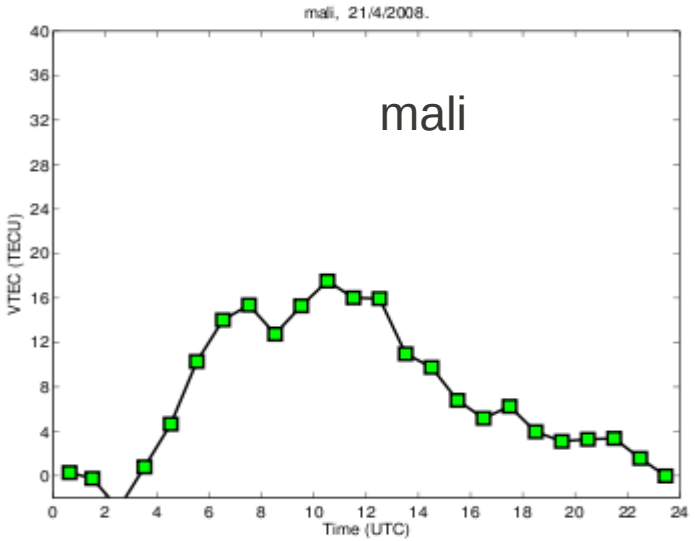


Fig. Diurnal Variations of TEC for local Stations







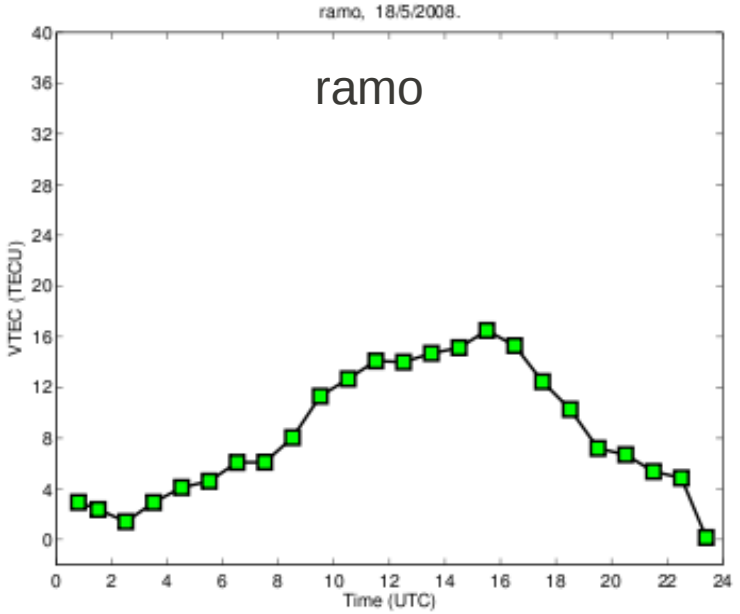
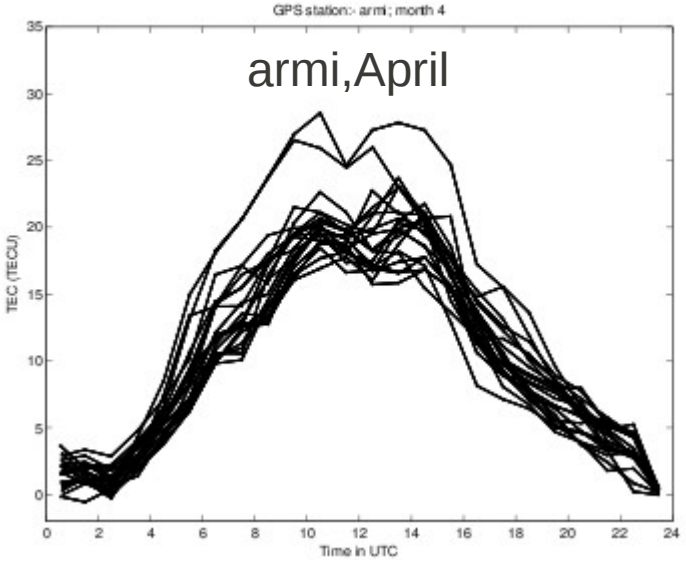
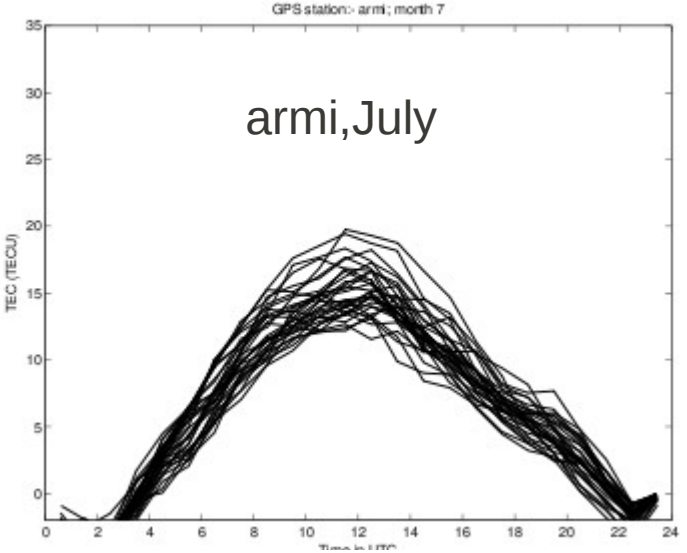


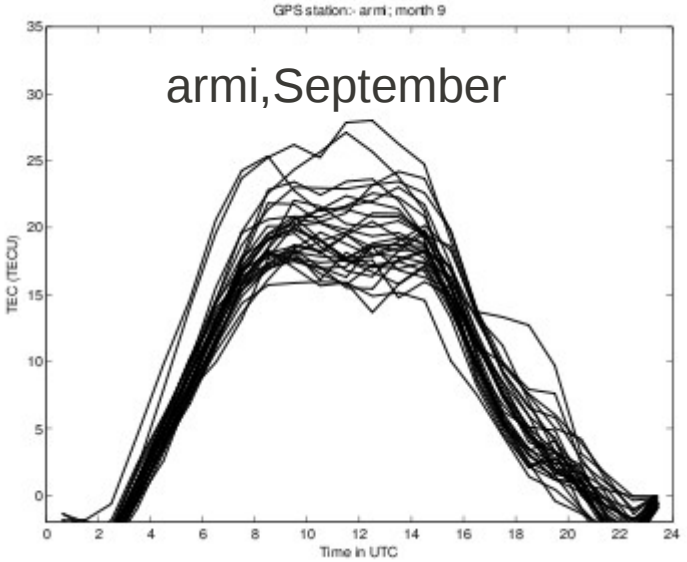
Fig. Diurnal Variations for Igs stations.

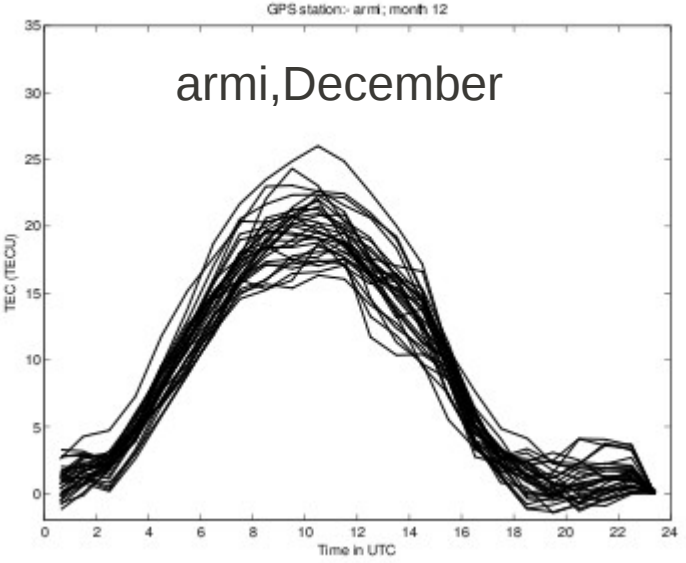
Monthly Plottings

Clearly show the Diurnal Variations.

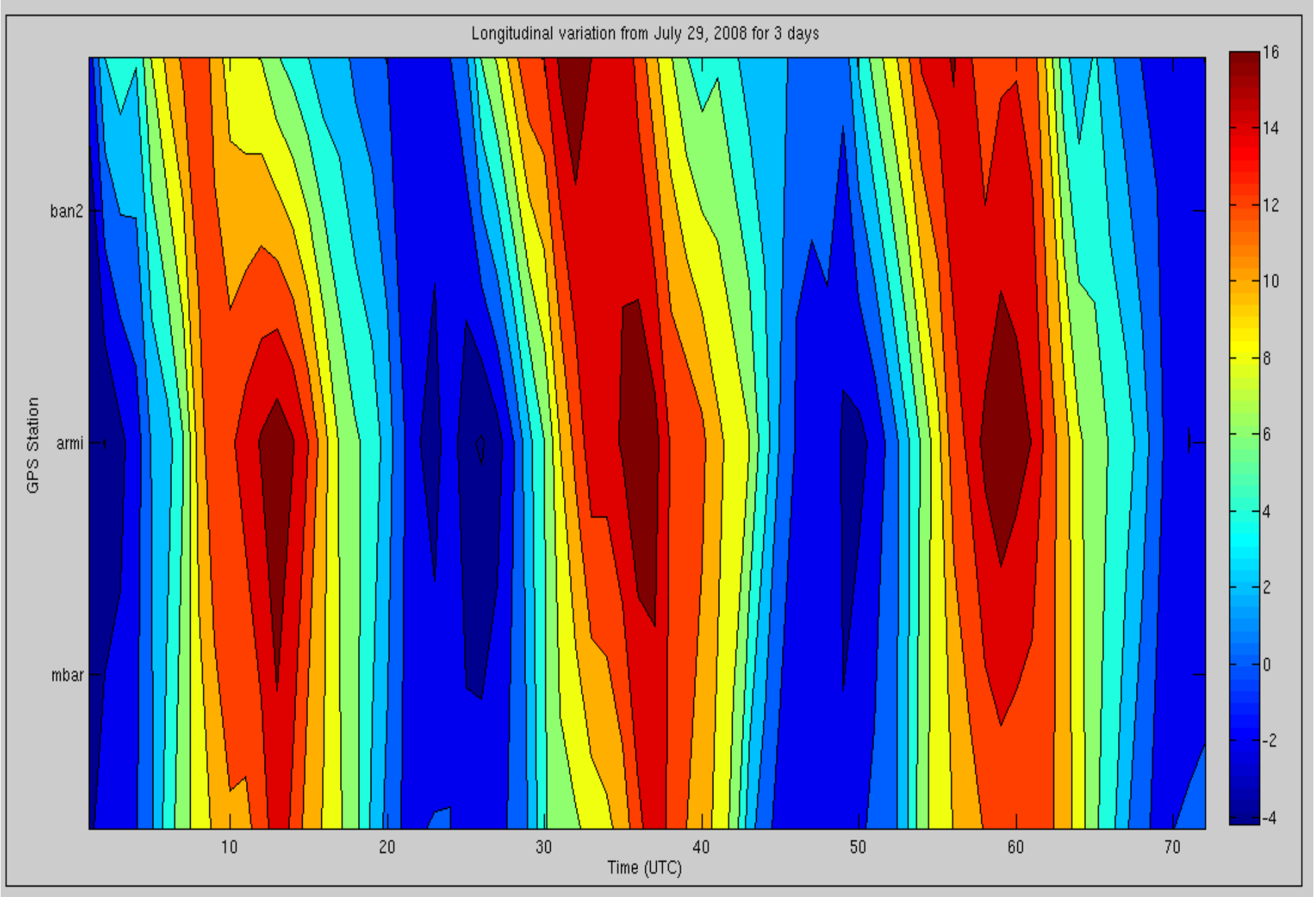




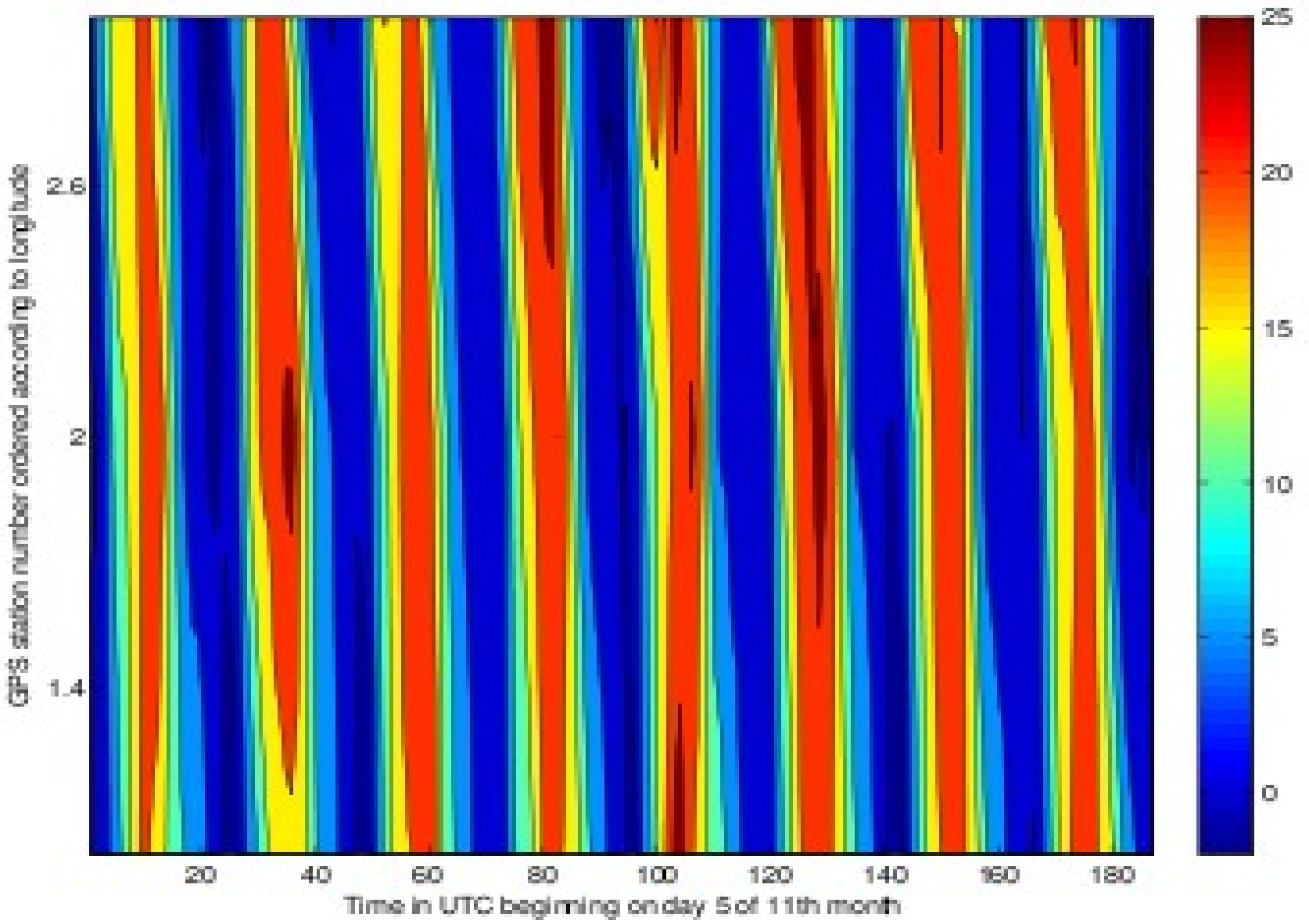




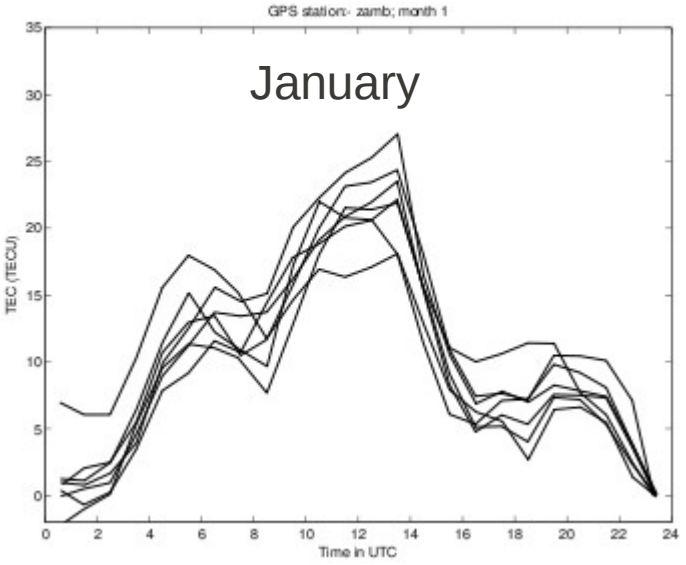
Longitudinal Variations
Sites ban2,armi,mbar taken

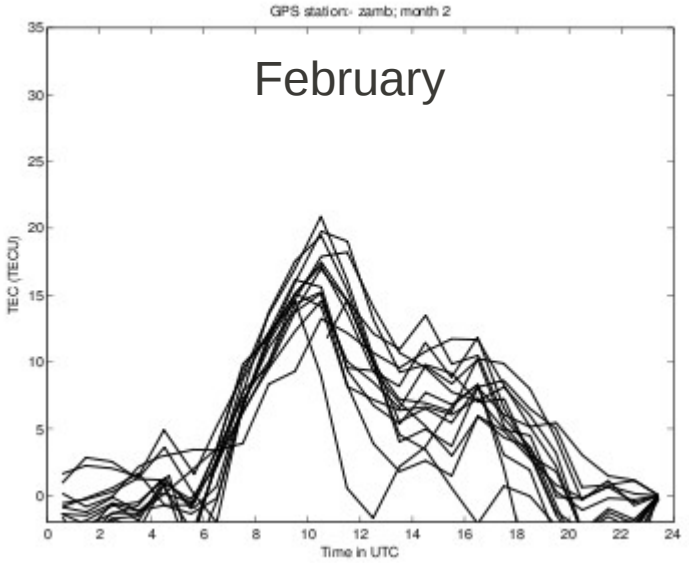


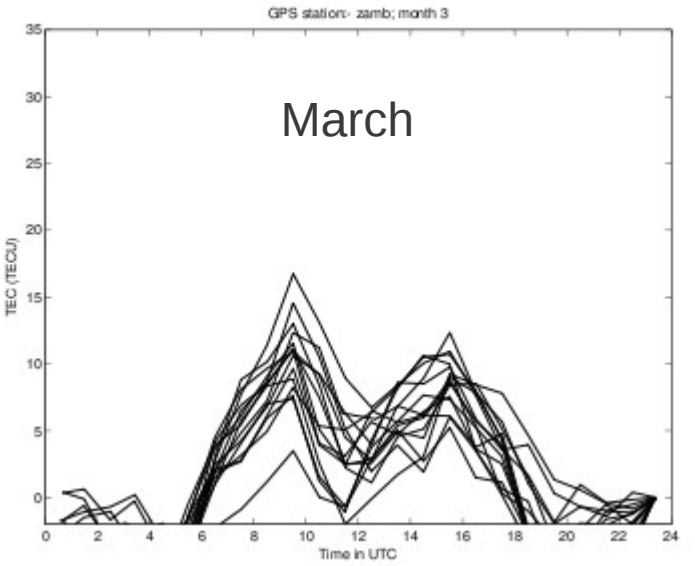
Day(Red) night TEC Variation 8 days

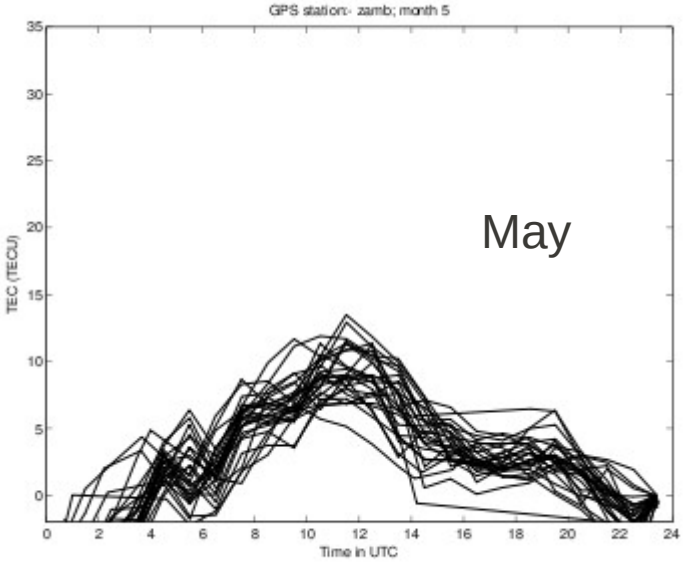


Seasonal Variation
For zamb station(S hemisphere)

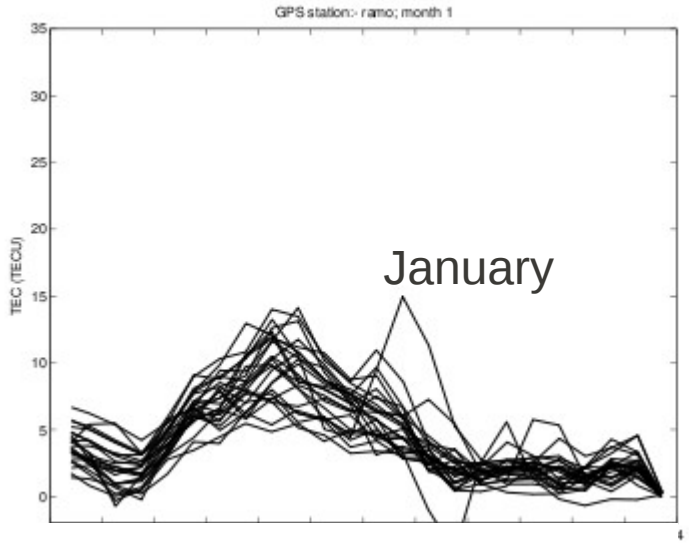


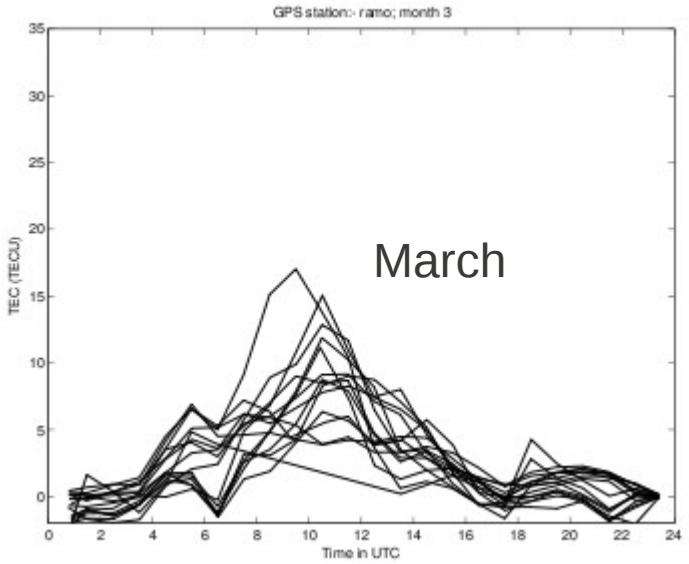


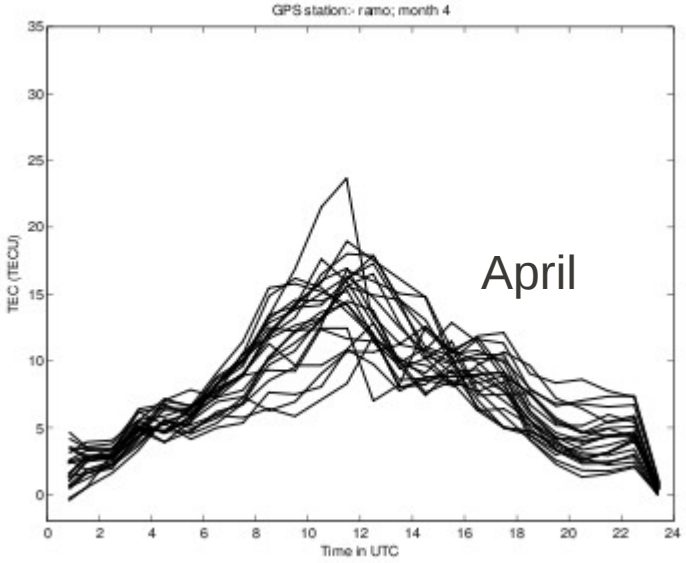


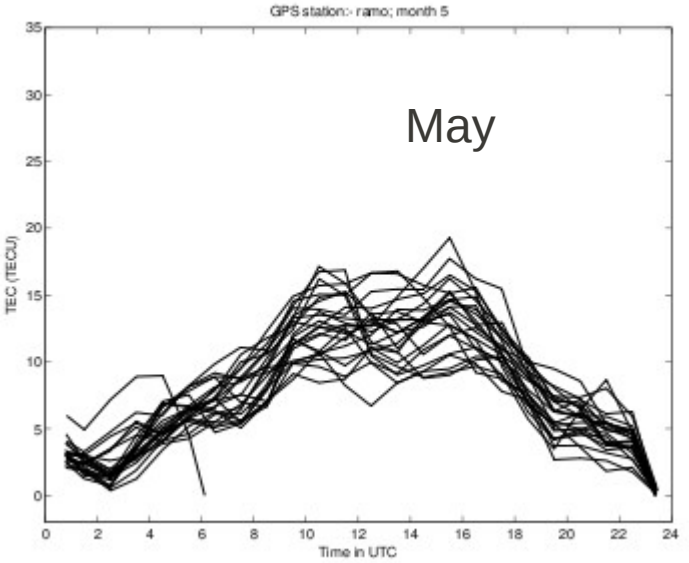


Seasonal Variation: Ramo(Northern Hemisphere)









Summary and Feature Works

These are preliminary works

- In the future 2D Ionospheric Tomography over Ethiopia(My thesis work)
- Ne-Quick Model
- Comparison with Magnetic activity from two stations(AMBER and MAGDAS)

Thank you for Your Kind Attention