

**The gap in global ionospheric and
heliospheric measurements over Africa:
our proposals for IHY 2007**

By

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IHY2006 – Bangalore - India

Layout of the Work

- 1. Research problems in African countries**
- 2. Ionospheric measurement techniques**
- 3. What we have in Africa**
- 4. An example event**
- 5. Instruments in Egypt**
- 6. Proposals to IHY2007**

Research Problems in Africa

In some developing countries the education systems for scientists and engineers are very good **but after studies no attractive jobs.**

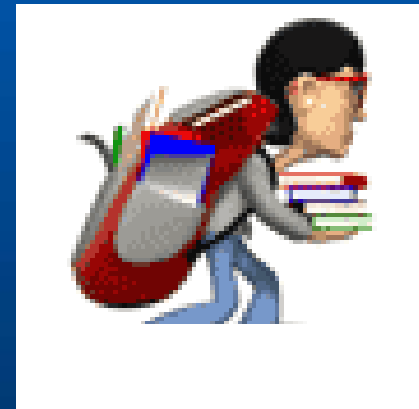
Research Problems in Africa

In some developing countries the education systems for scientists and engineers are very good **but after studies no attractive jobs.**

Consequences:

External brain drain

Emigration to industrialised countries

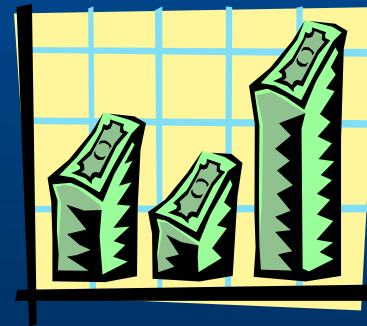


Research Problems in Africa

Internal brain drain

Remuneration for jobs in economy (banks, brokers, ...) are much higher than for scientists at less demanding.

It is more attractive for young people.

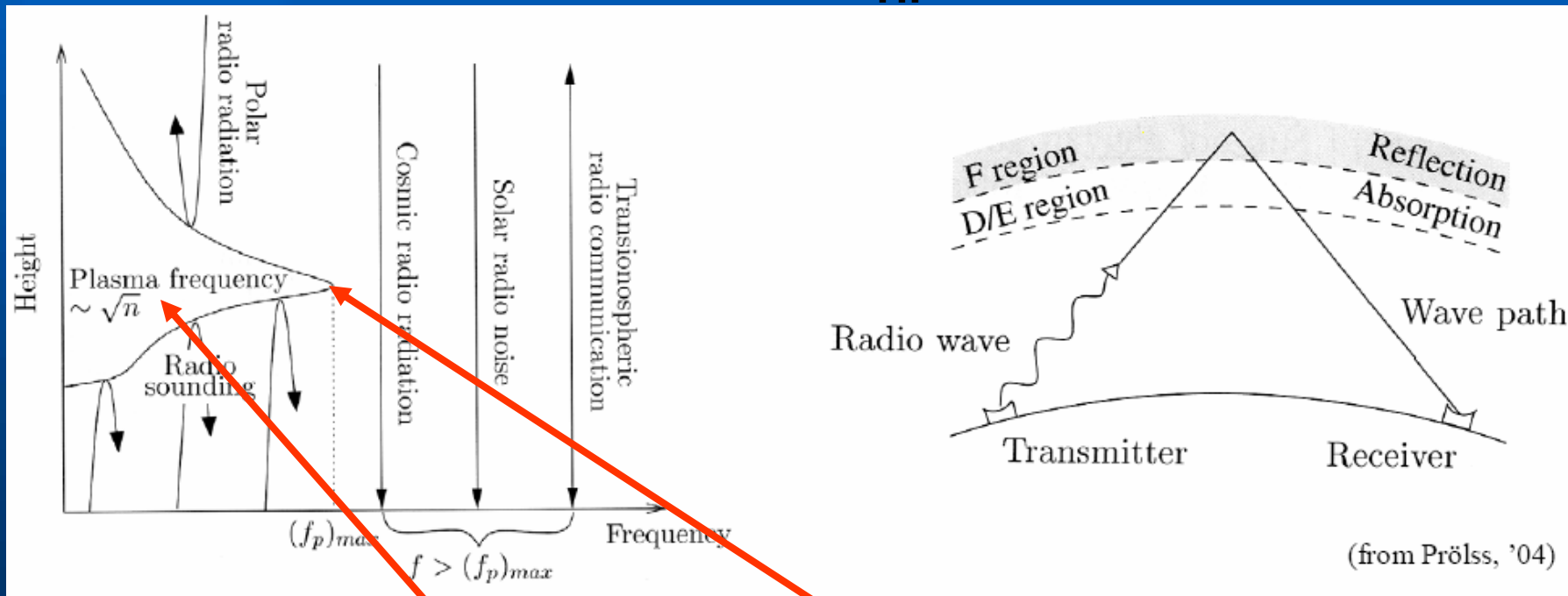


Ionosondes in Africa



Ionospheric Measurements

Reflection of radiowaves ($f_{HF} \sim 3-30$ MHz)

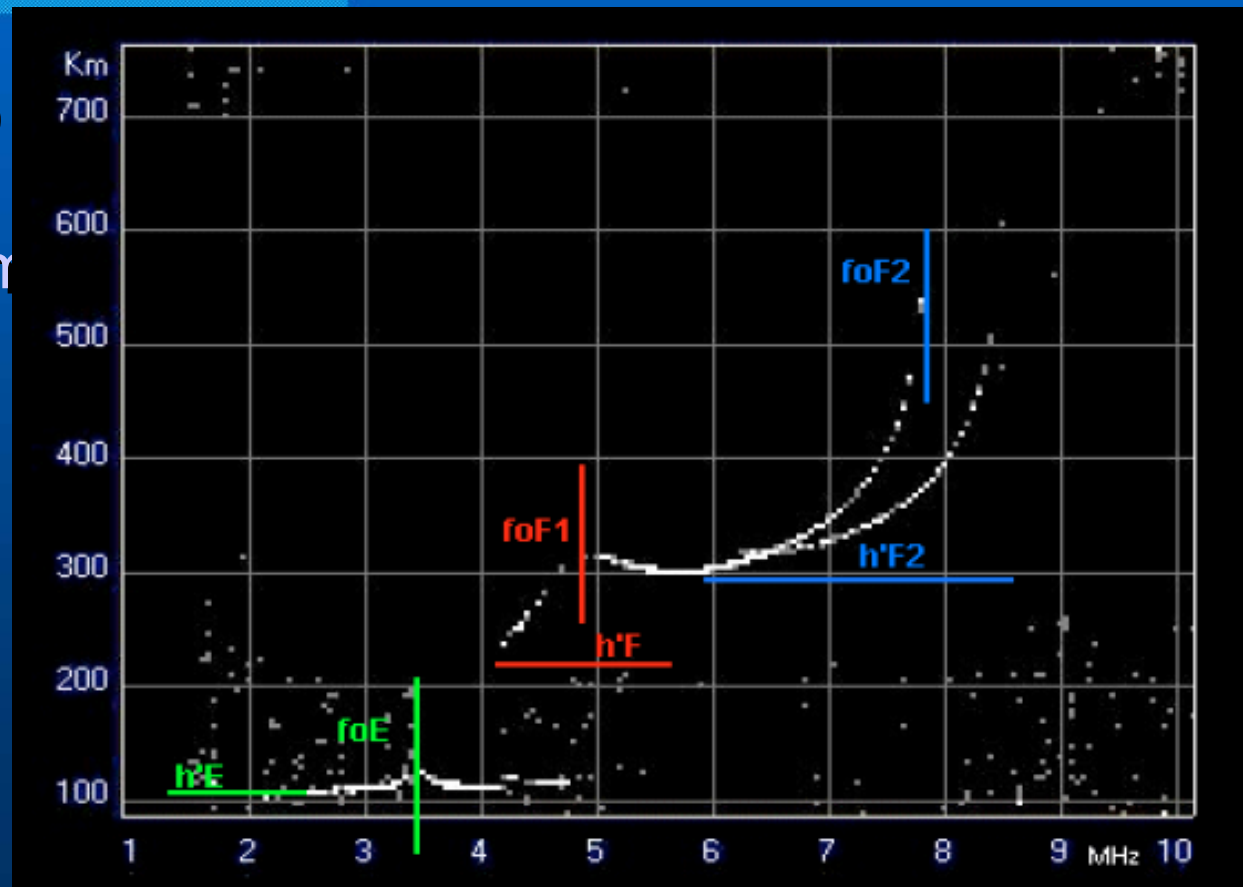


Plasma frequencies Layer peak densities

Ionospheric Measurements

$$[f_p \text{ (Hz)}]^2 = 80.5 N_e \text{ (m}^{-3}\text{)}$$

Example of Ionogram



The worldwide network of ionosondes

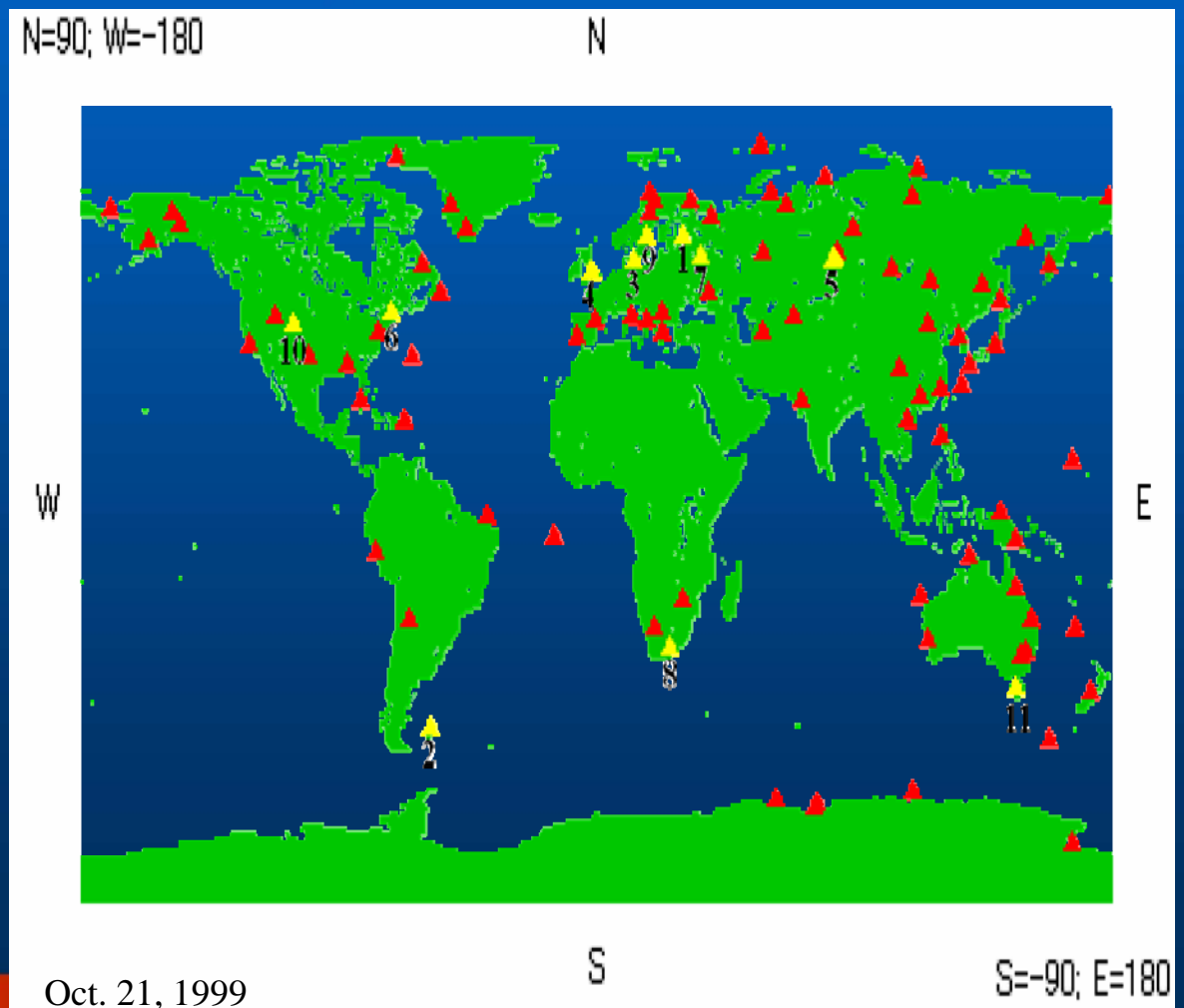
SPIDR: <http://spidr.ngdc.noaa.gov/spidr/index.js>

(from Hargreaves, '92)

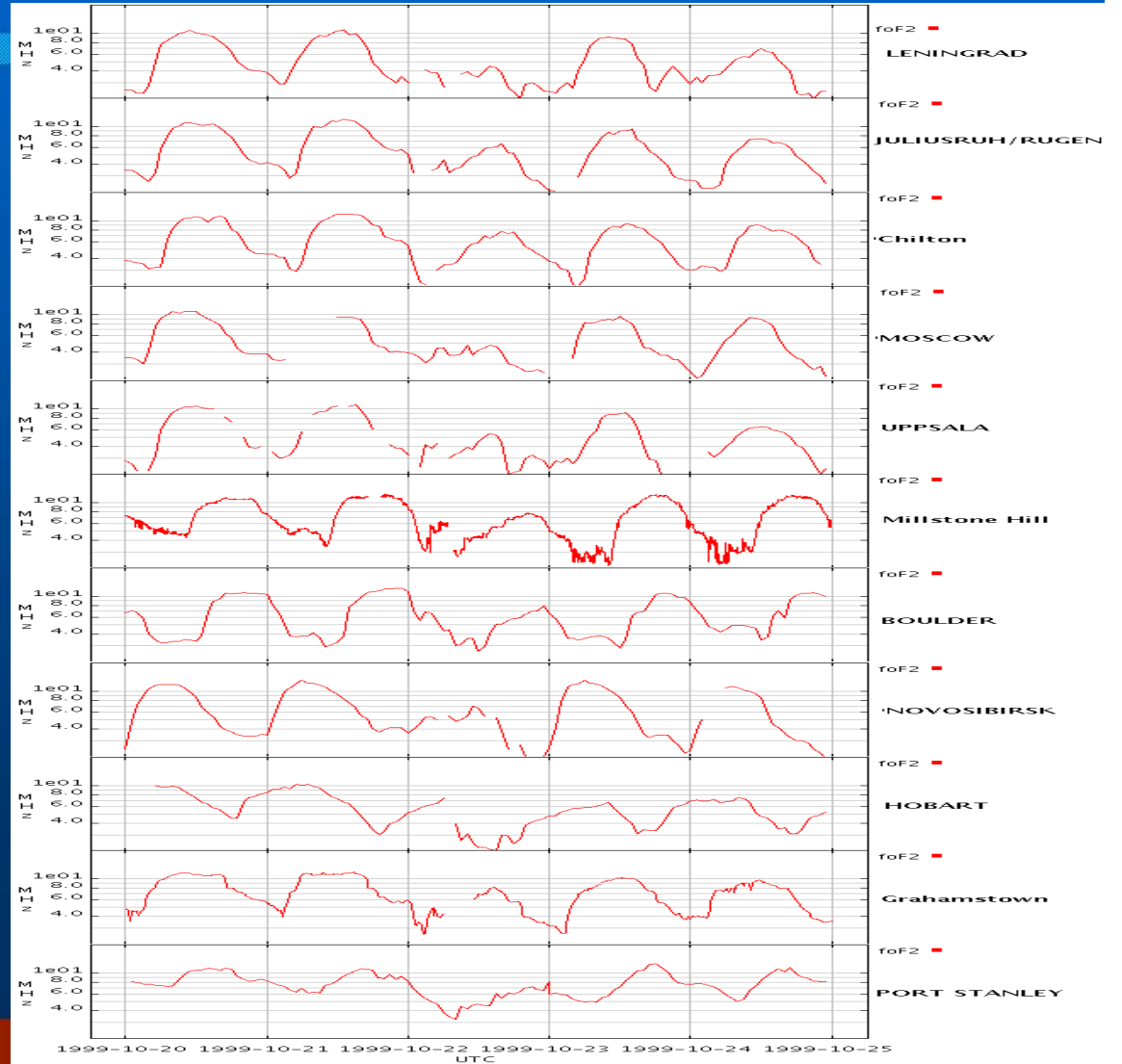
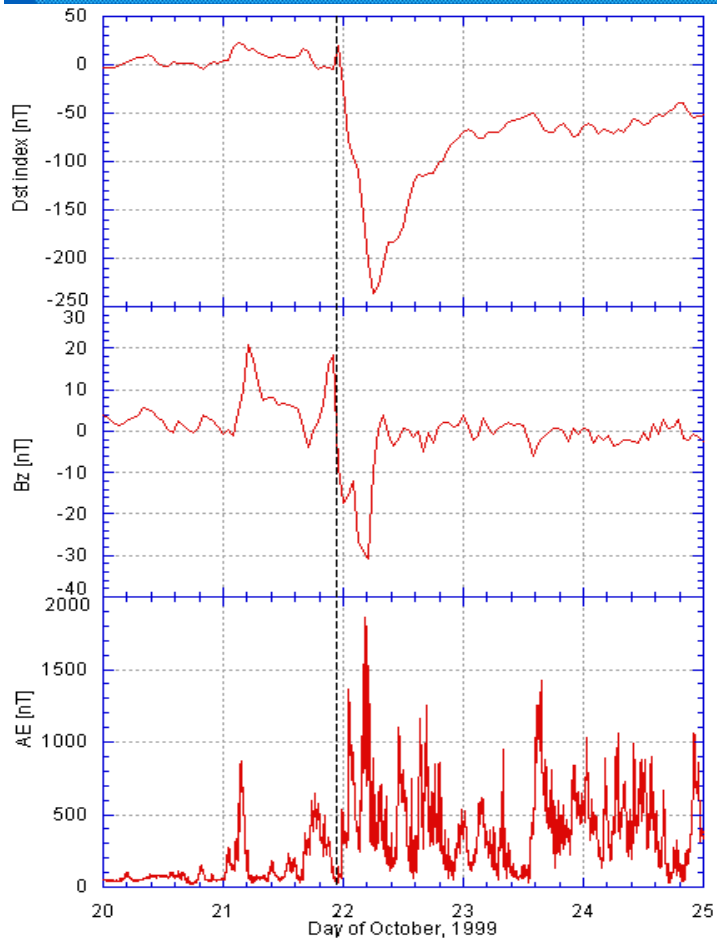
Importance of Establishing a Central Station in Africa

Code	Station	Long.	Latit.
S1	Leningrad	30.7	60
S2	Juliusruh*	13.4	54.6
S3	Chilton	-1.3	51.6
S4	Moscow	37.3	55.5
S5	Uppsala	17.6	59.8
S5	Millstone	-71.5	42.6
S7	Boulder	-105.3	40
S8	Novosibirsk	83.2	54.6
S9	Hobart	147.3	-42.9
S10	Grahamstown	26.5	-33.3
S11	Port-Stanley	-57.9	-51.7

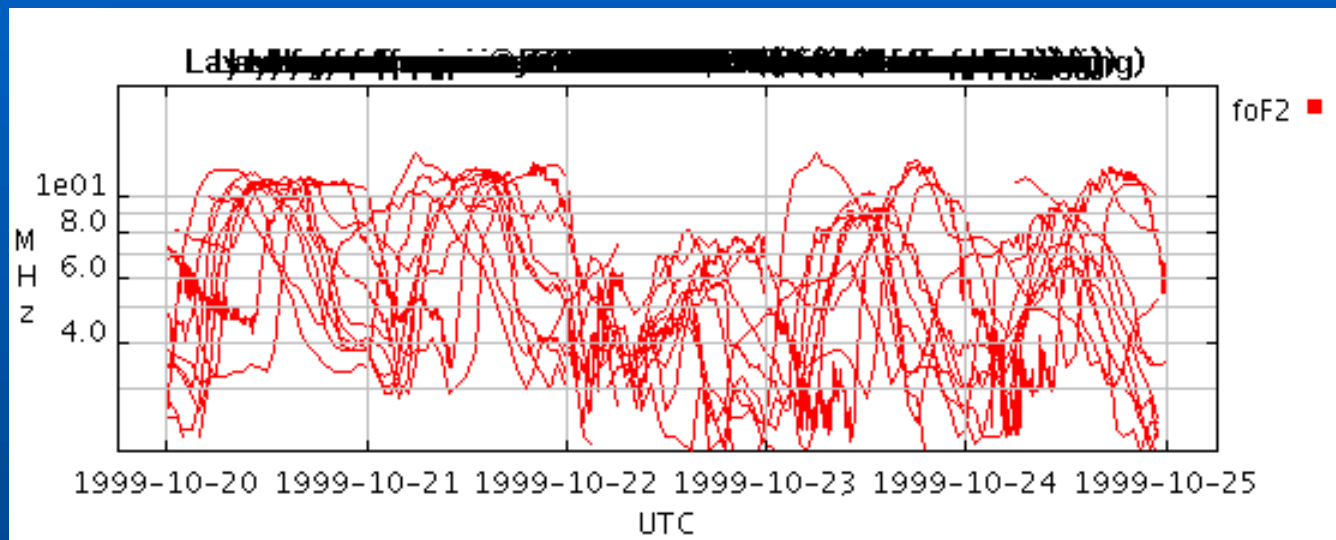
Example Event
11 stations are
triggered



foF2 Layer in MHz



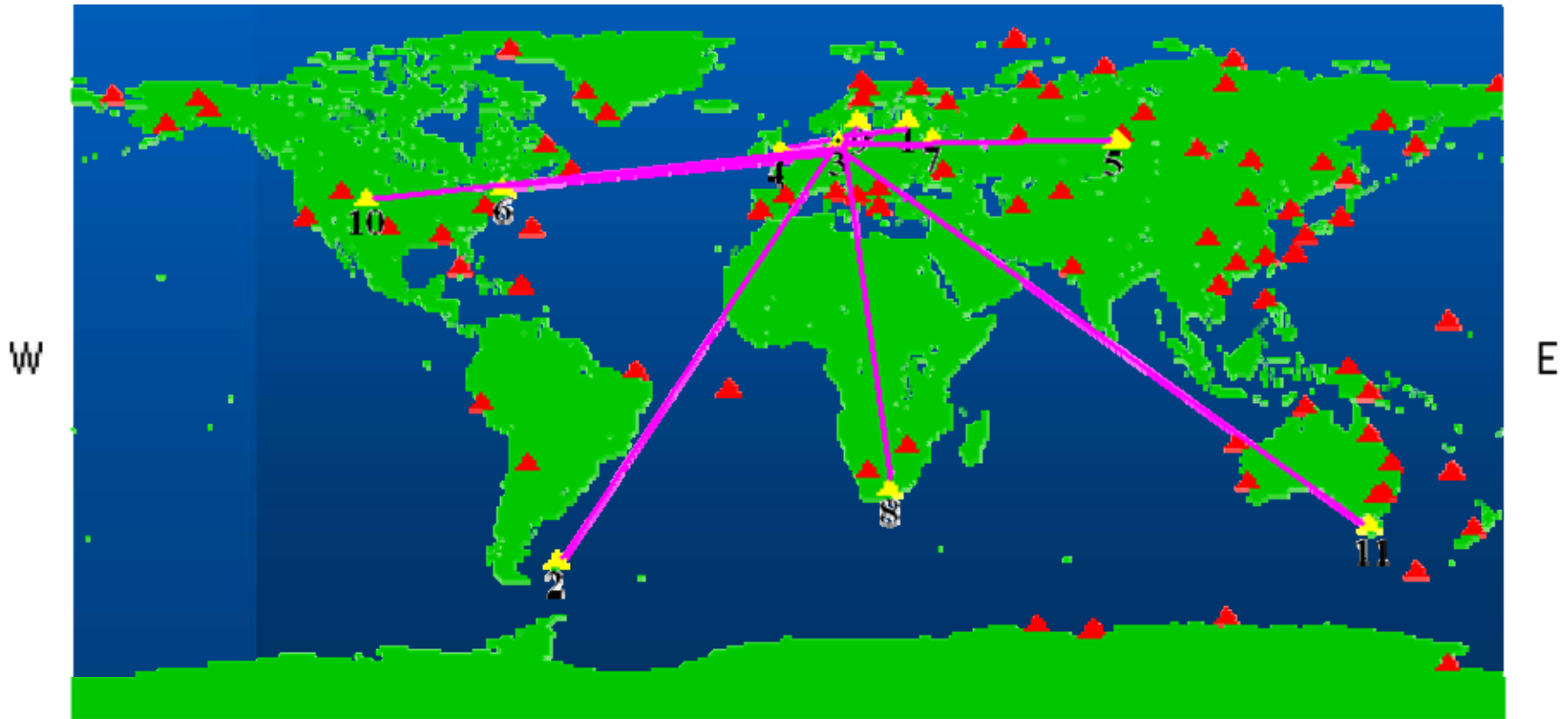
Results from ALL Stations



Normalization to Central Station

N=90; W=-180

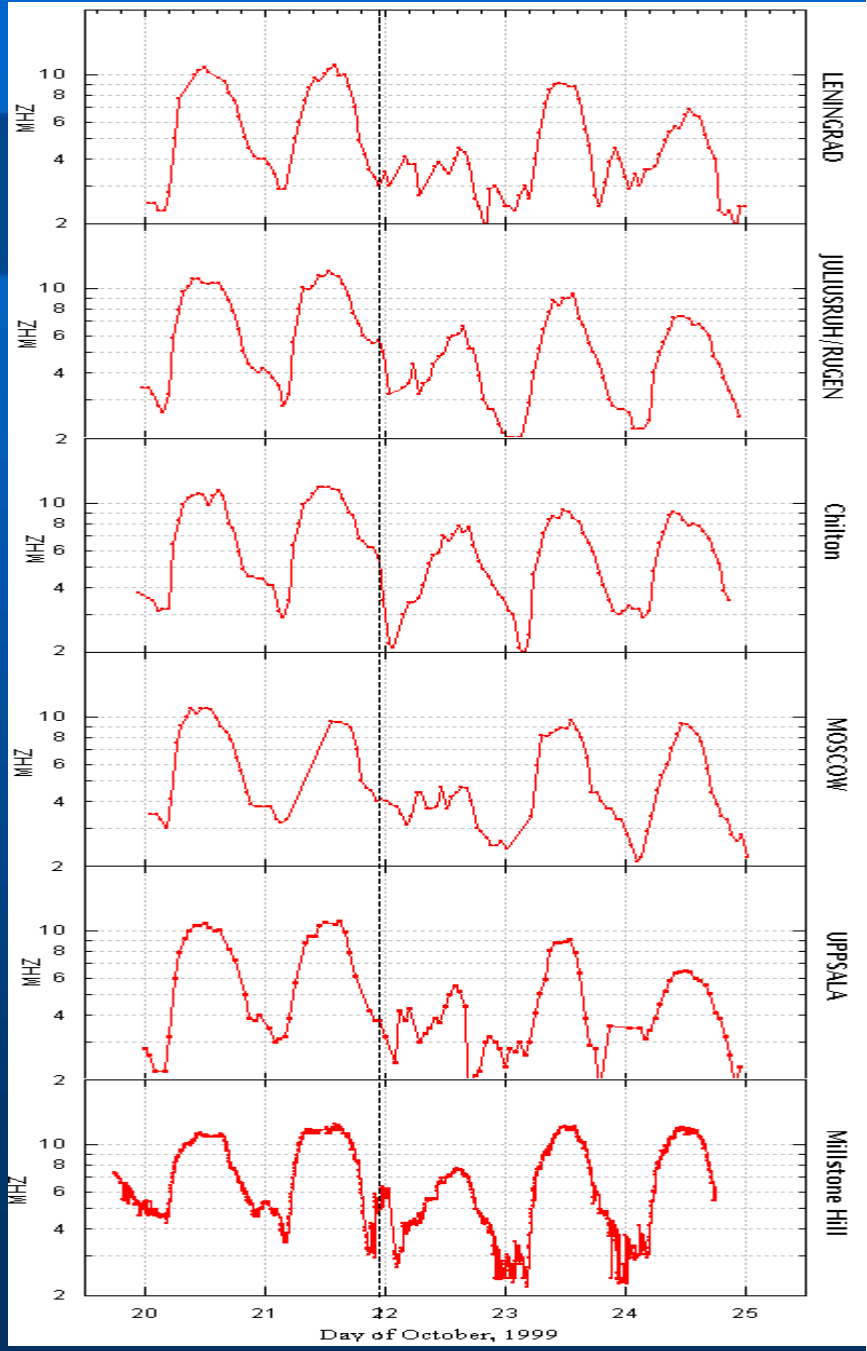
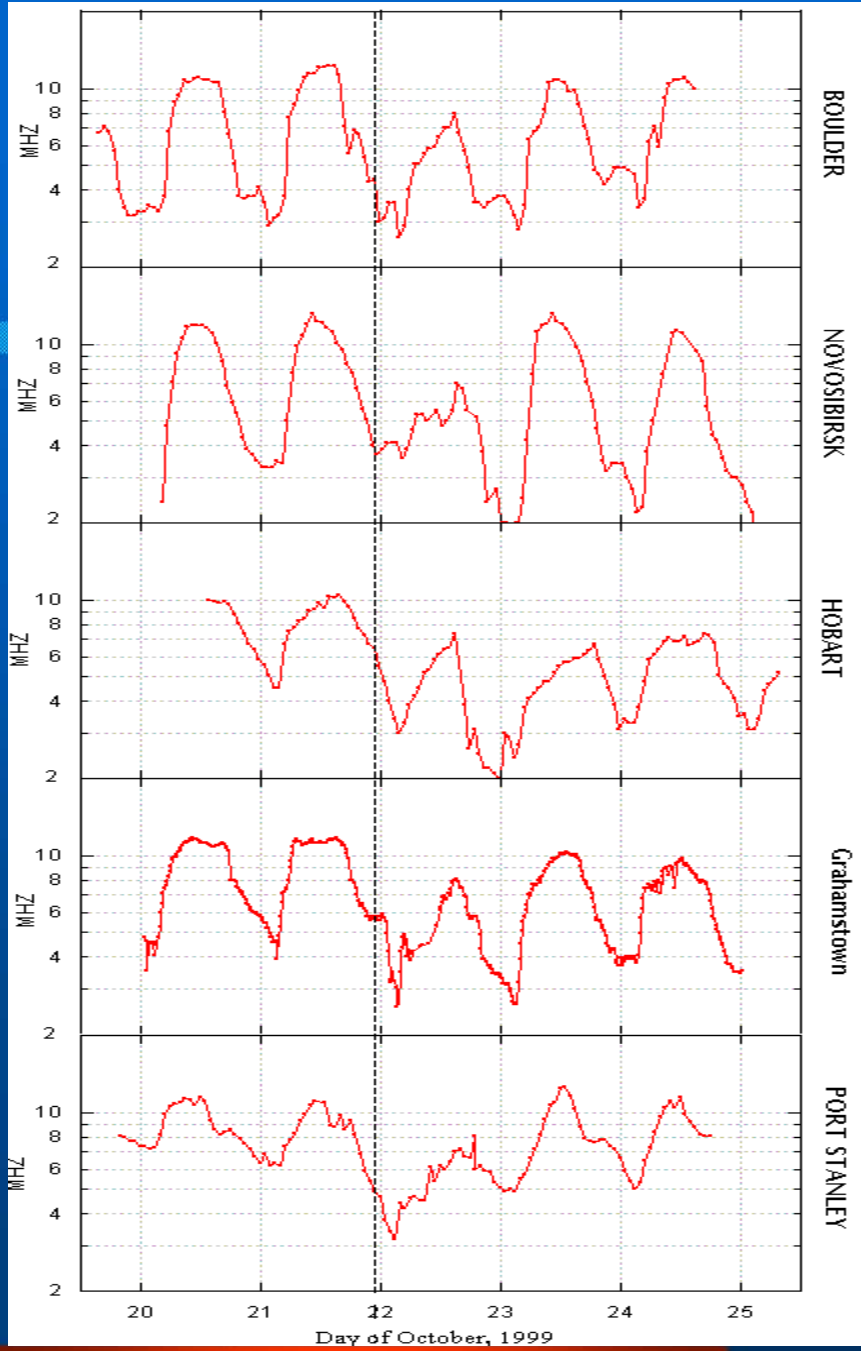
N



E

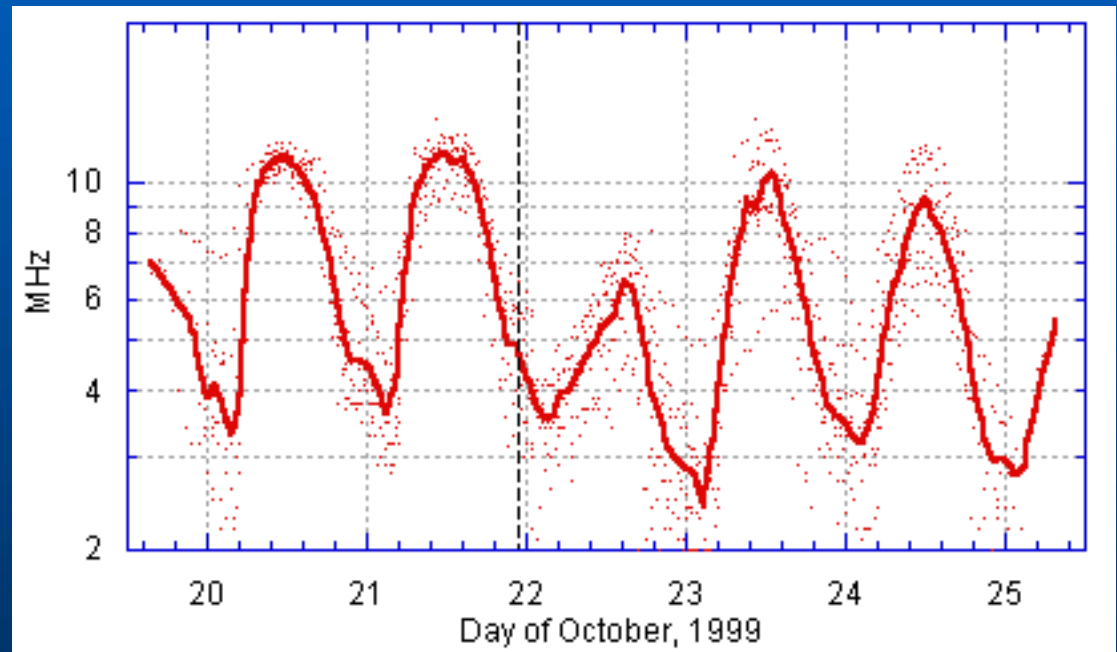
S

S=-90; E=180



Average foF2 of ALL Stations

The mean value of f_oF_2 measured by the 11 stations, the vertical dashed line represents triggering time of SSC main phase.

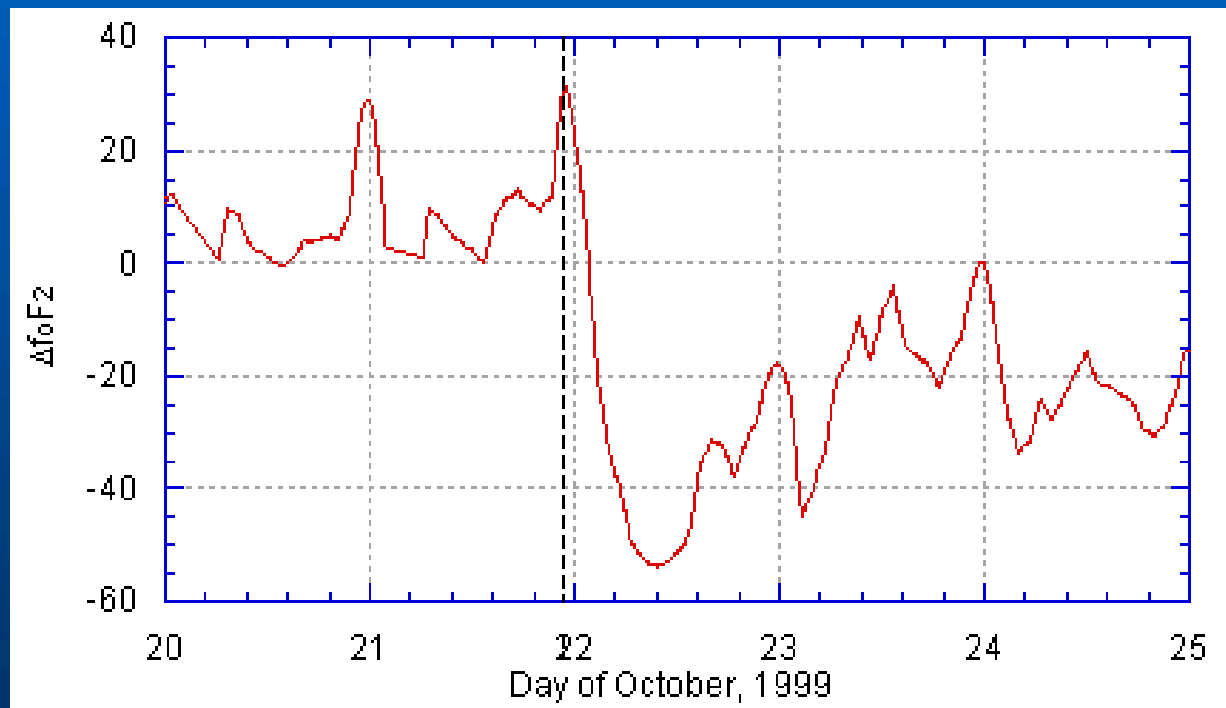


Deviation of foF2

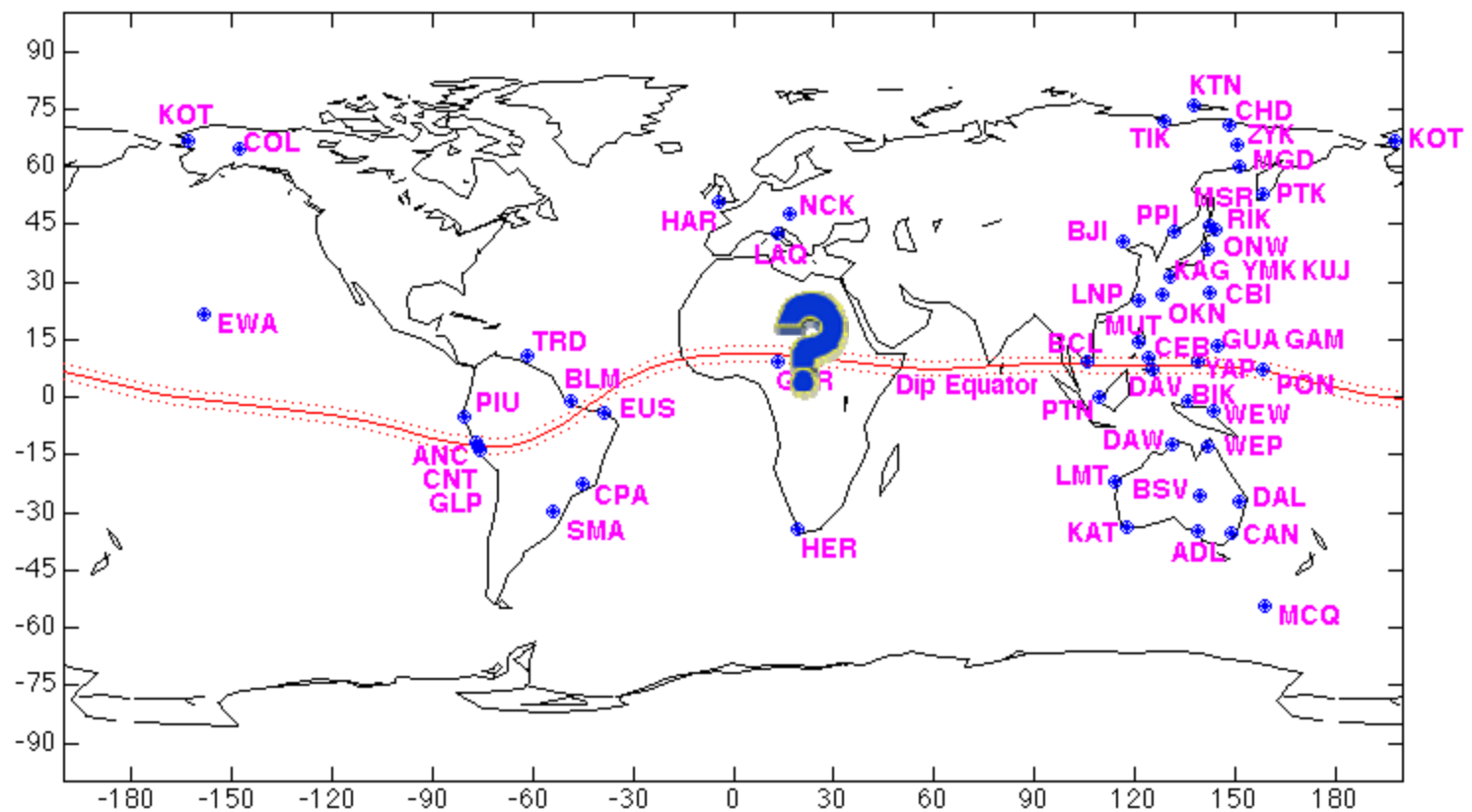
Blagoveshchensky et al.(2003) and Danilov A.D.(2001), according to the equation

$$\Delta foF2 = (f_{dis} - f_{qui}) / f_{qui} \times 100\%$$

where f_{dis} , f_{qui} are the critical frequency of F2 layer during disturbed and quite periods respectively.

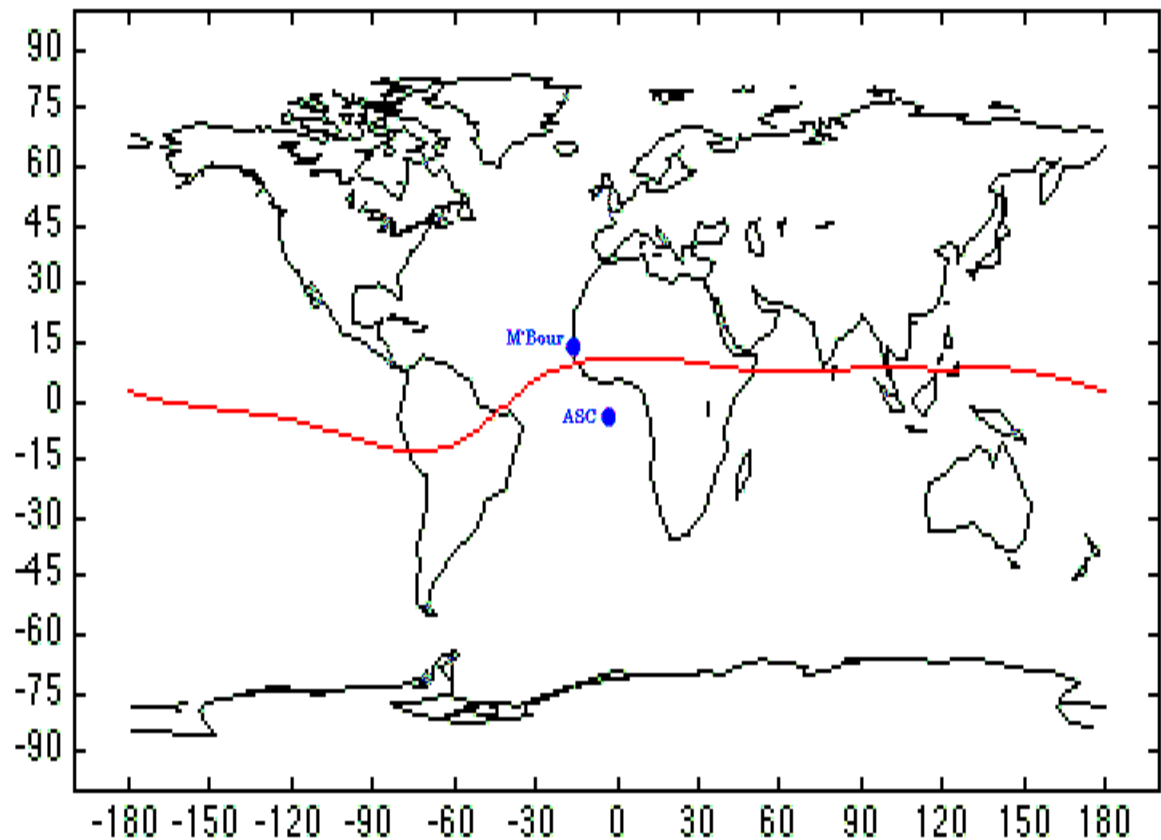


Magnetometers in Africa



Magnetometers Data

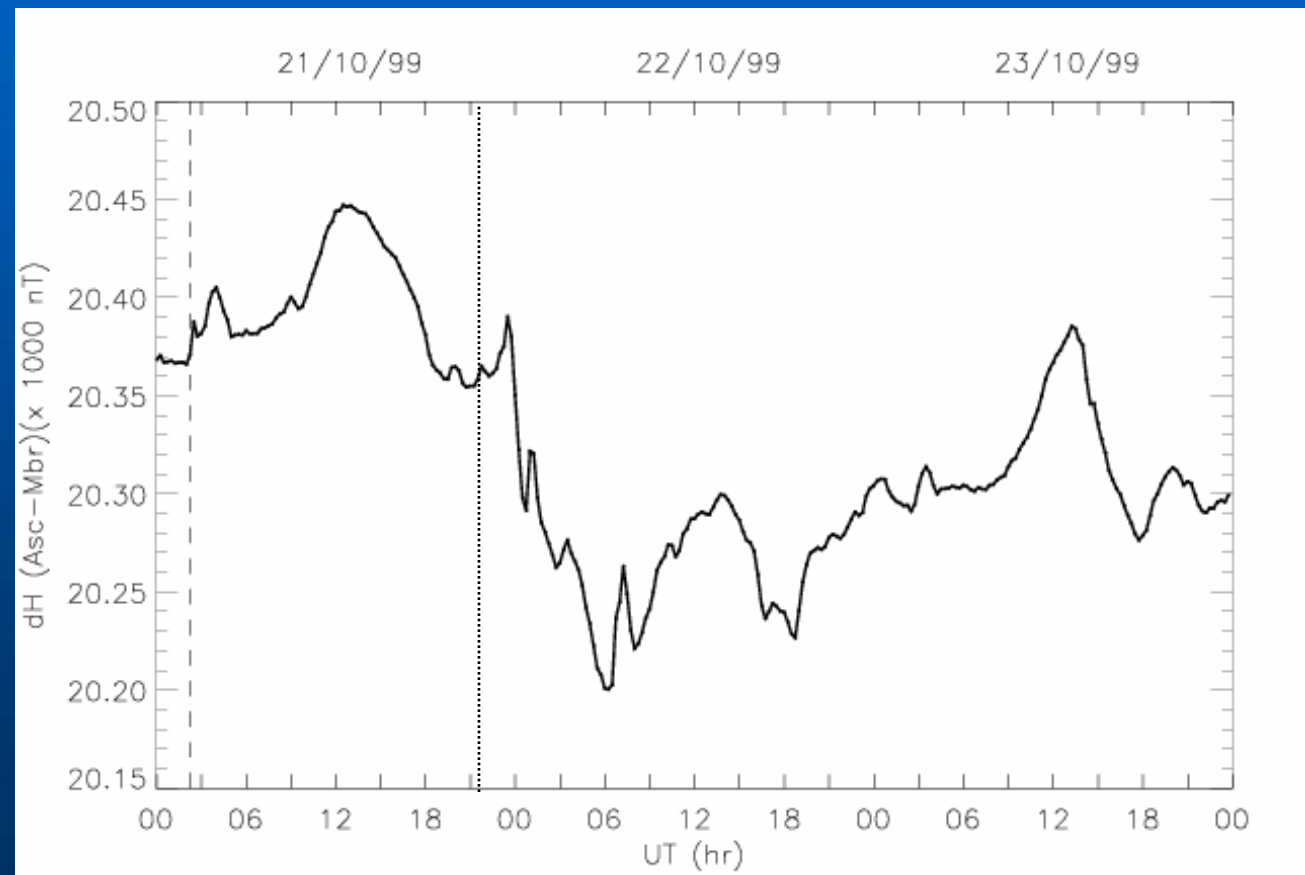
the $\mathbf{E} \times \mathbf{B}$ drift can be estimated using the resulting ΔH ($H_{\text{equator}} - H_{\text{non-equator}}$) value of the H-component field.



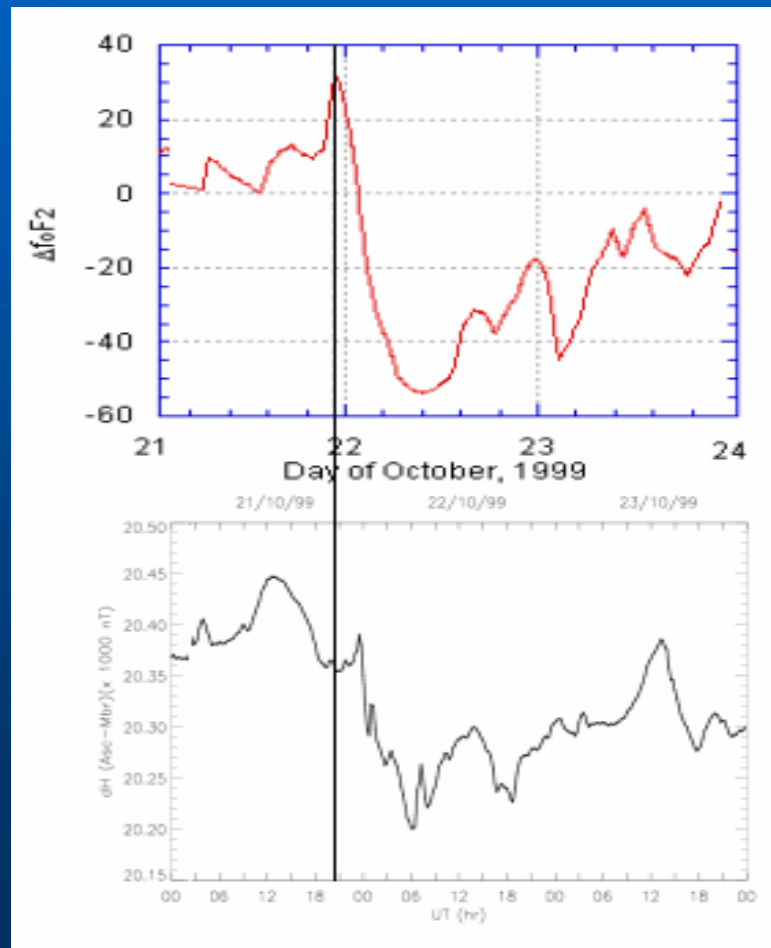
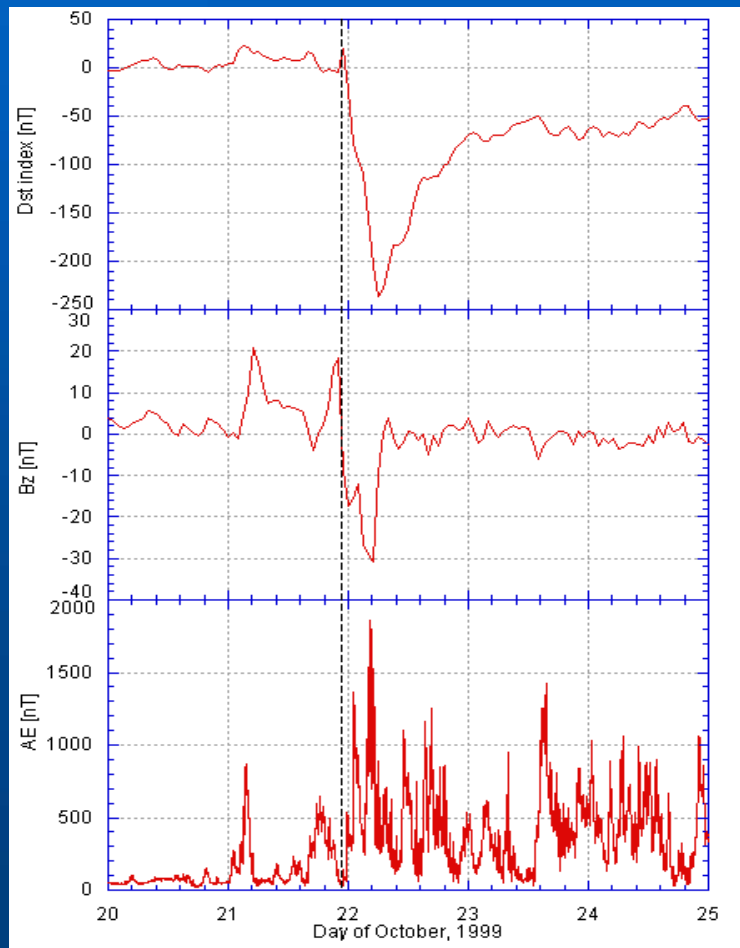
(Yizengaw et al., 2005).

Magnetometers Data

ΔH (horizontal) component is an indicator for the $E \times B$ drift



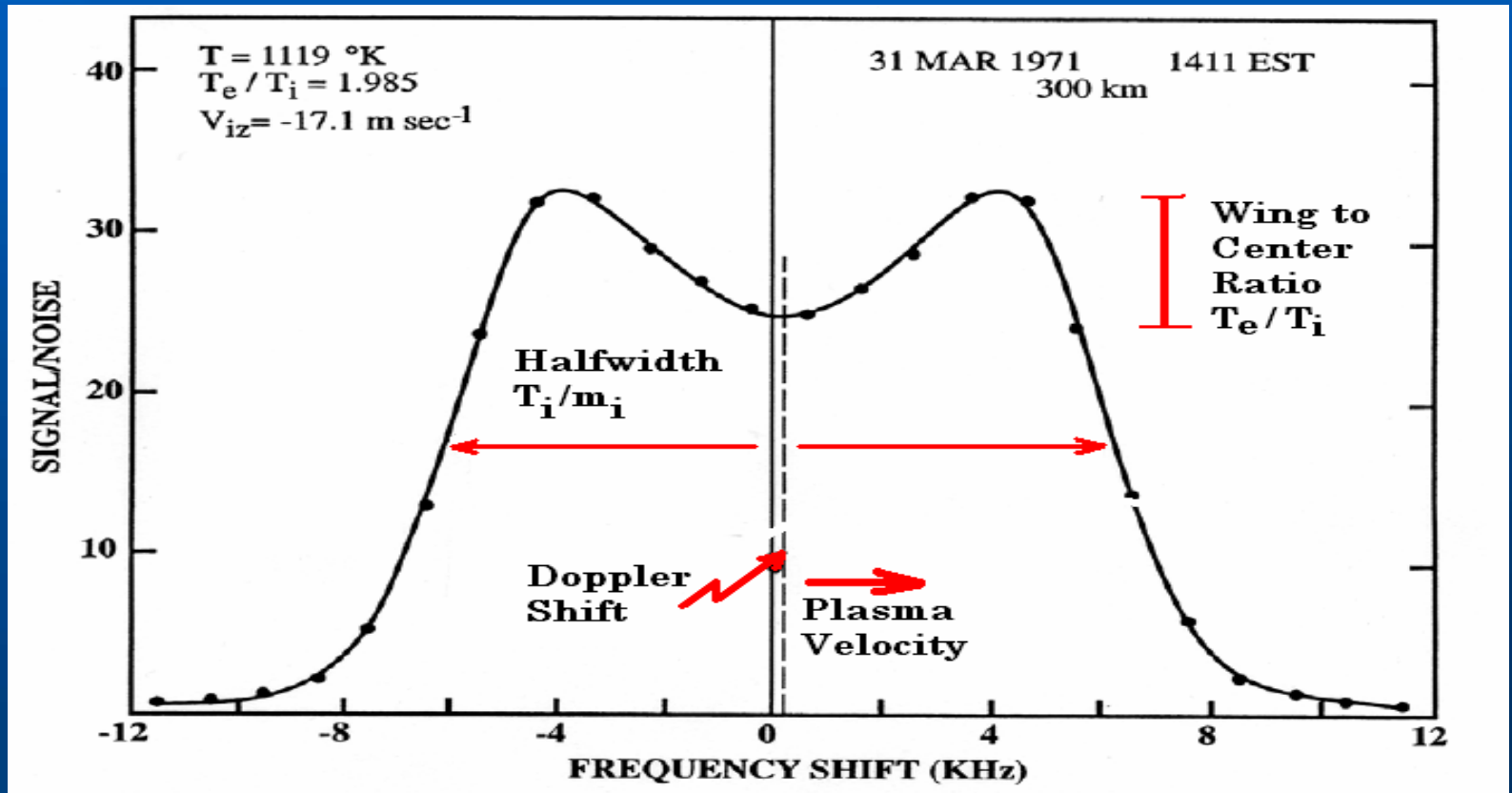
$E \times B$ drift



(A. Mahrous, 2006)

Incoherent scatter Radars (ISRs)

The transmitted signal returns with a “spread in frequency

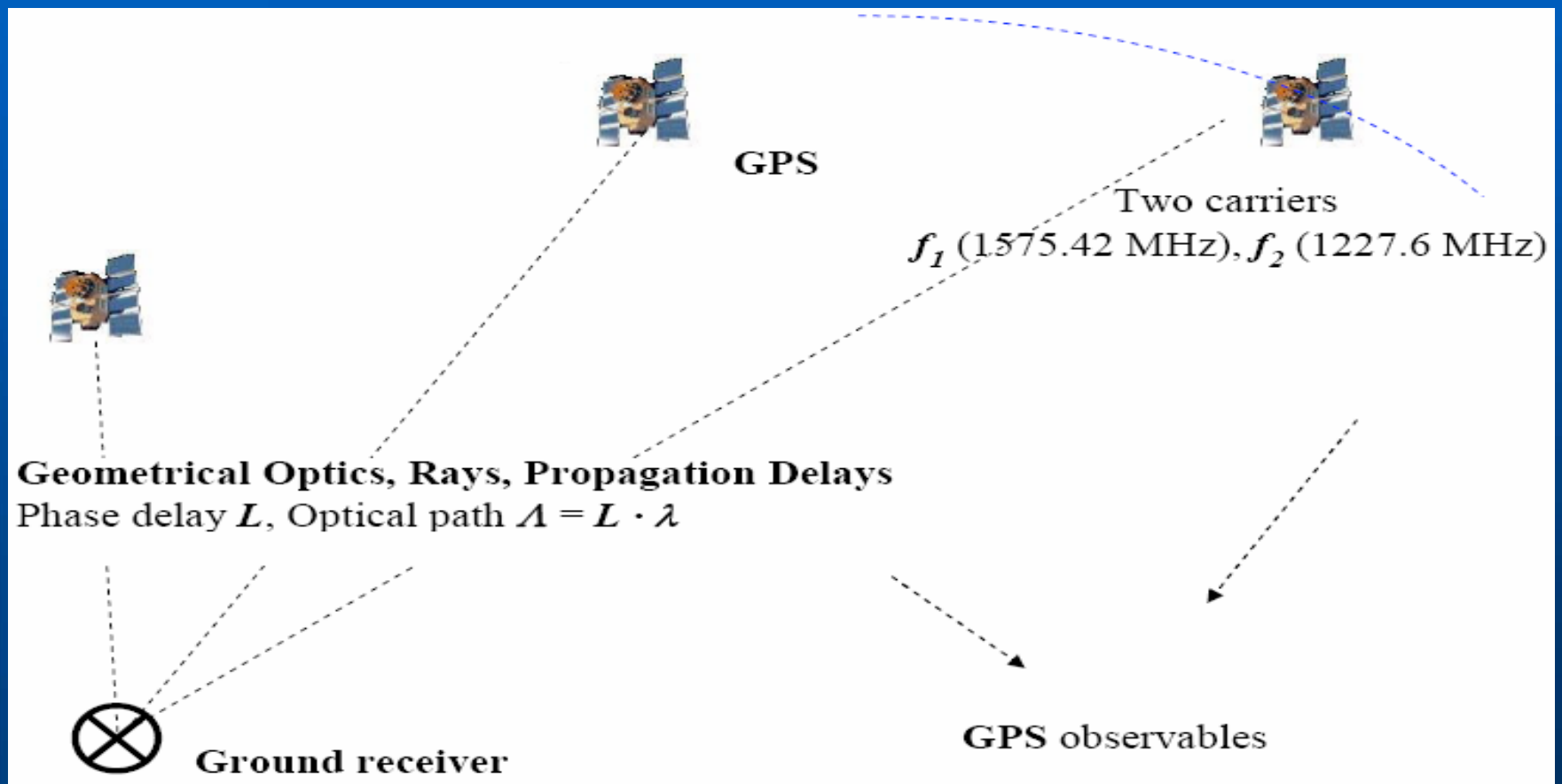


(Adapted from Hunsucker, '91)

Incoherent scatter Radars in Africa



Trans-Ionospheric Radiowaves



Trans-Ionospheric Radiowaves

Refractive index of the medium is given by :

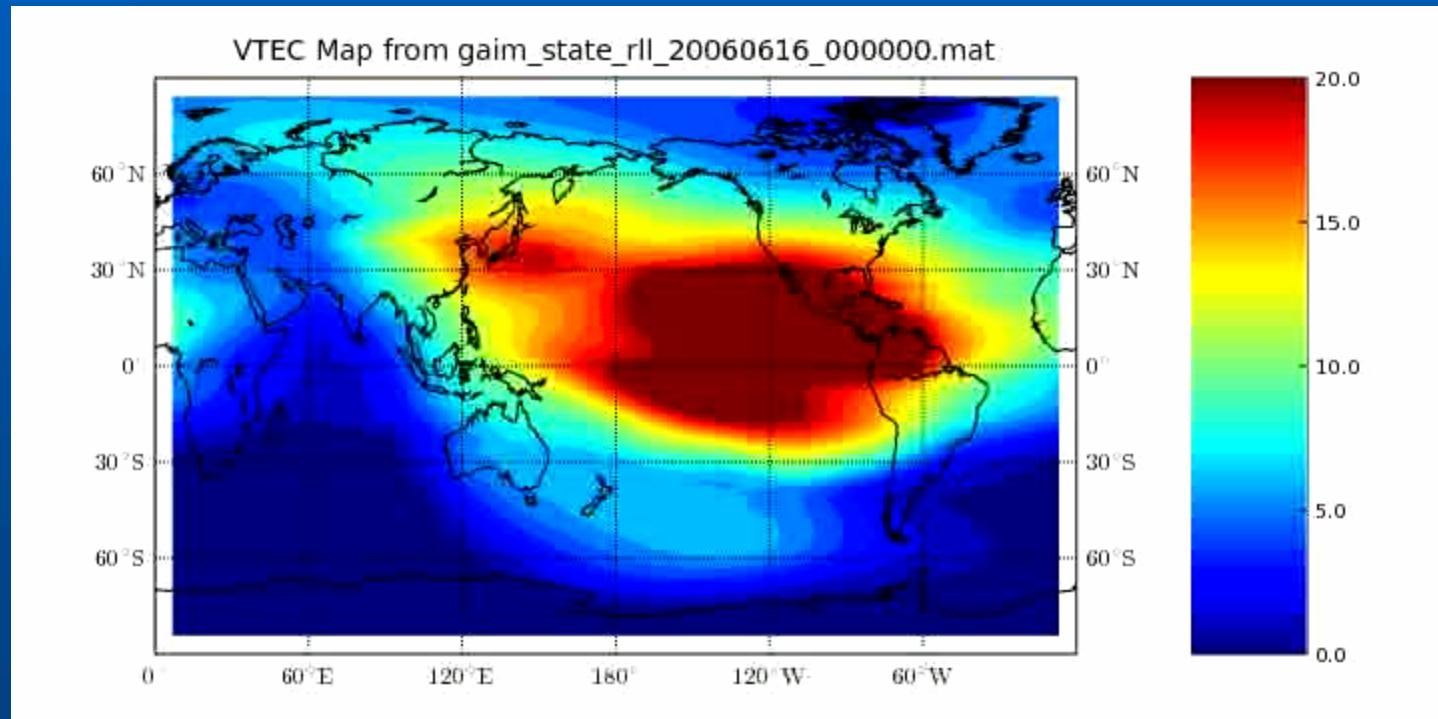
$$n^2 = 1 - \frac{\omega_p^2}{\omega^2}; \text{ if } \frac{\omega_p^2}{\omega^2} \ll 1$$

$$n \approx \underbrace{1}_{\text{vacuum}} - \underbrace{\frac{40.3N_e}{f^2}}_{\text{effect of ionosphere}} \quad (N_e \text{ in m}^{-3} \text{ and } f \text{ in Hz})$$



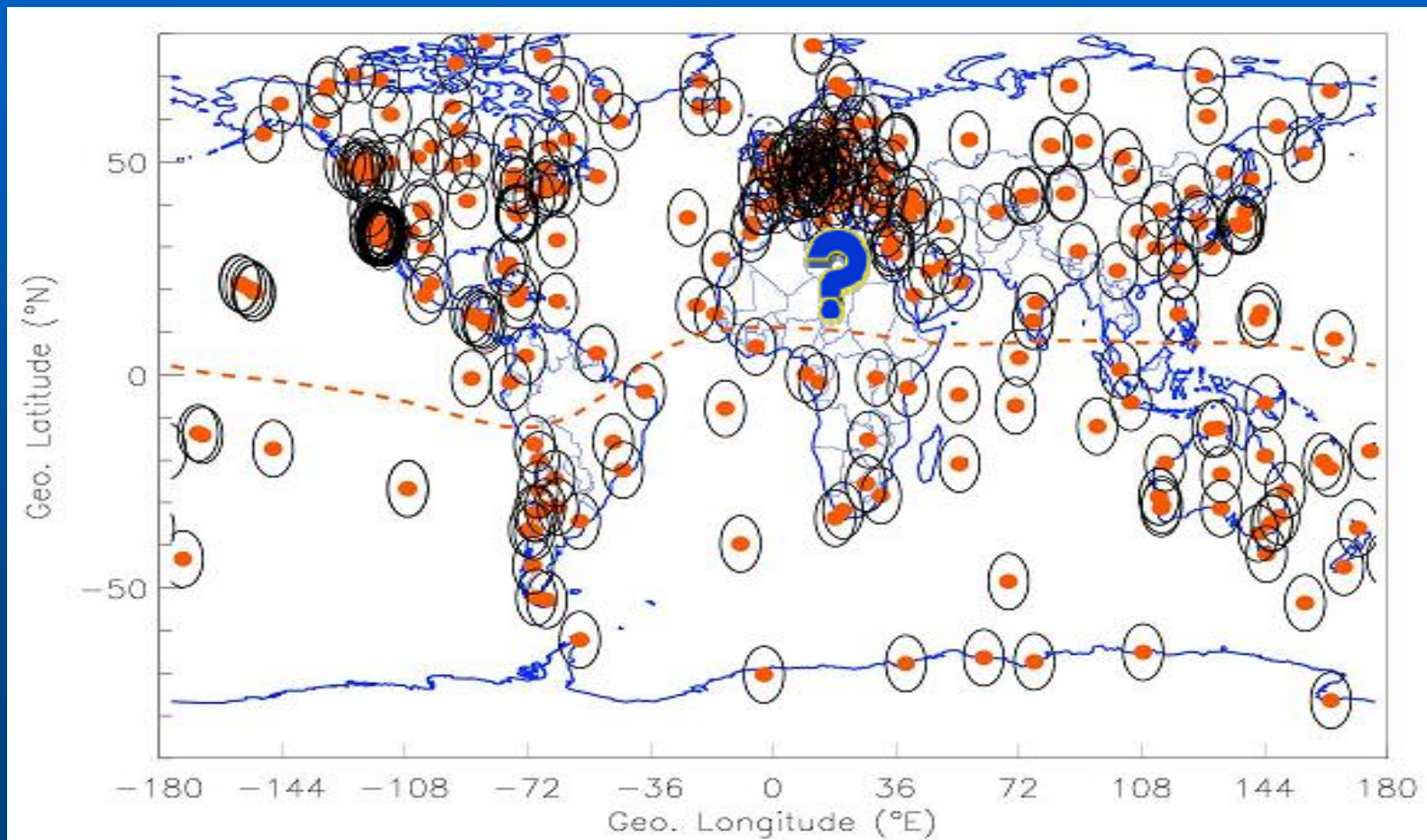
End result: wave is slowed down by plasma Group Delay

Global Ionospheric Maps



(<http://iono.jpl.nasa.gov/gim.html>)

GPS receivers in Africa



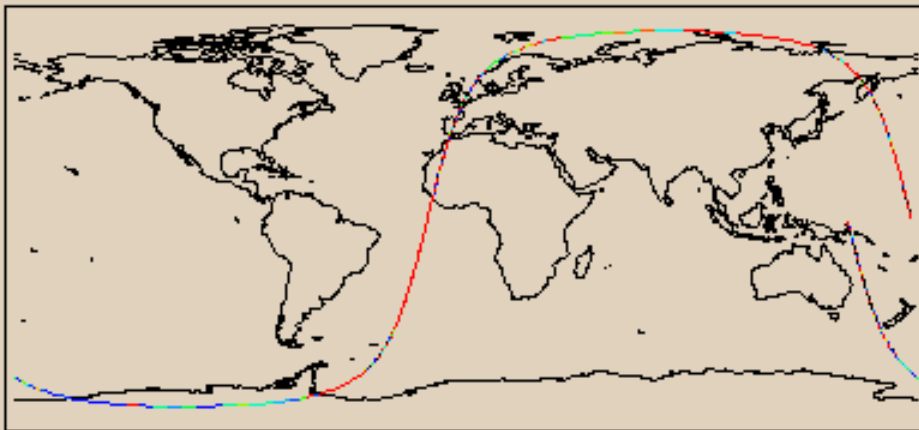
Satellites are Partial Solution



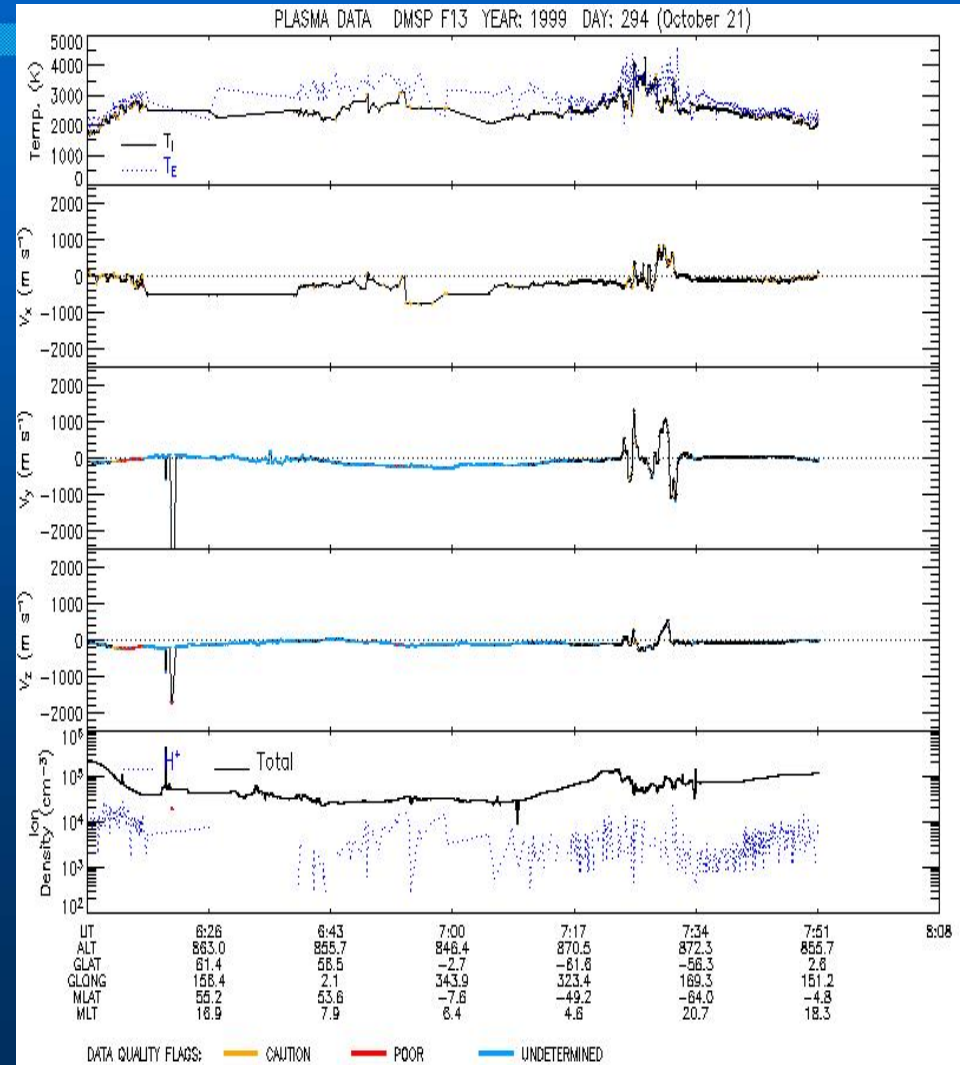
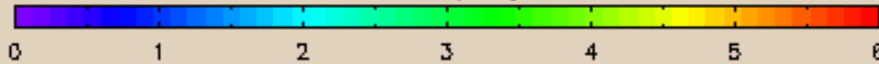
TOPEX & DMSP

DMSP Quite Day 21

F13199910210608 J4 Orbit Track

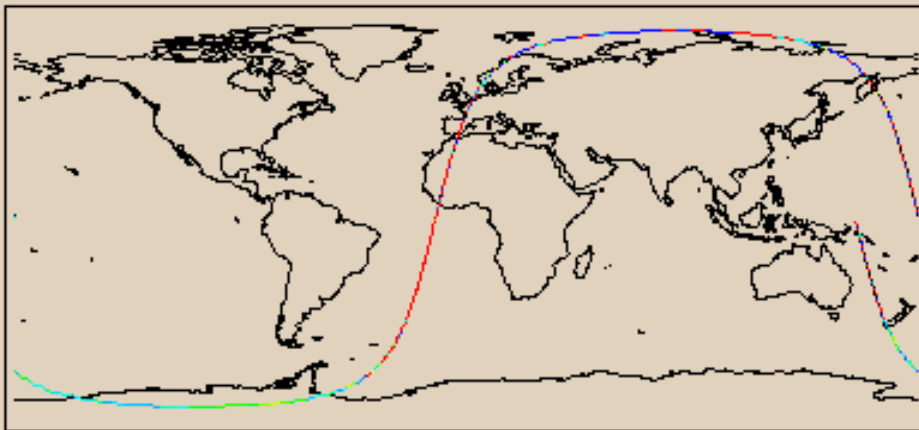


EAVE (keV)

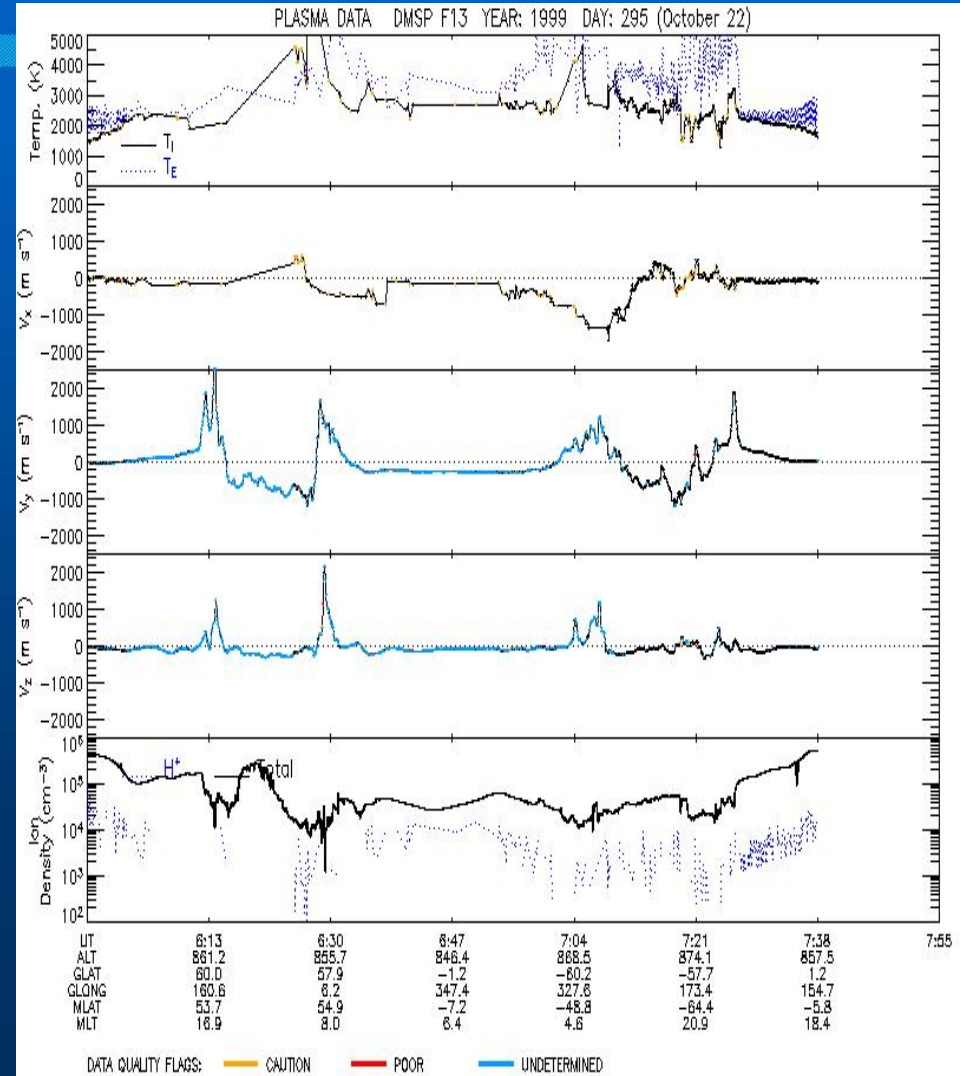
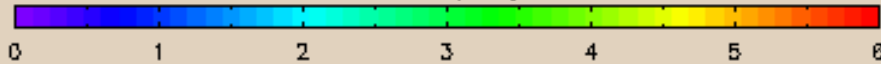


DMSP Disturbed Day 22

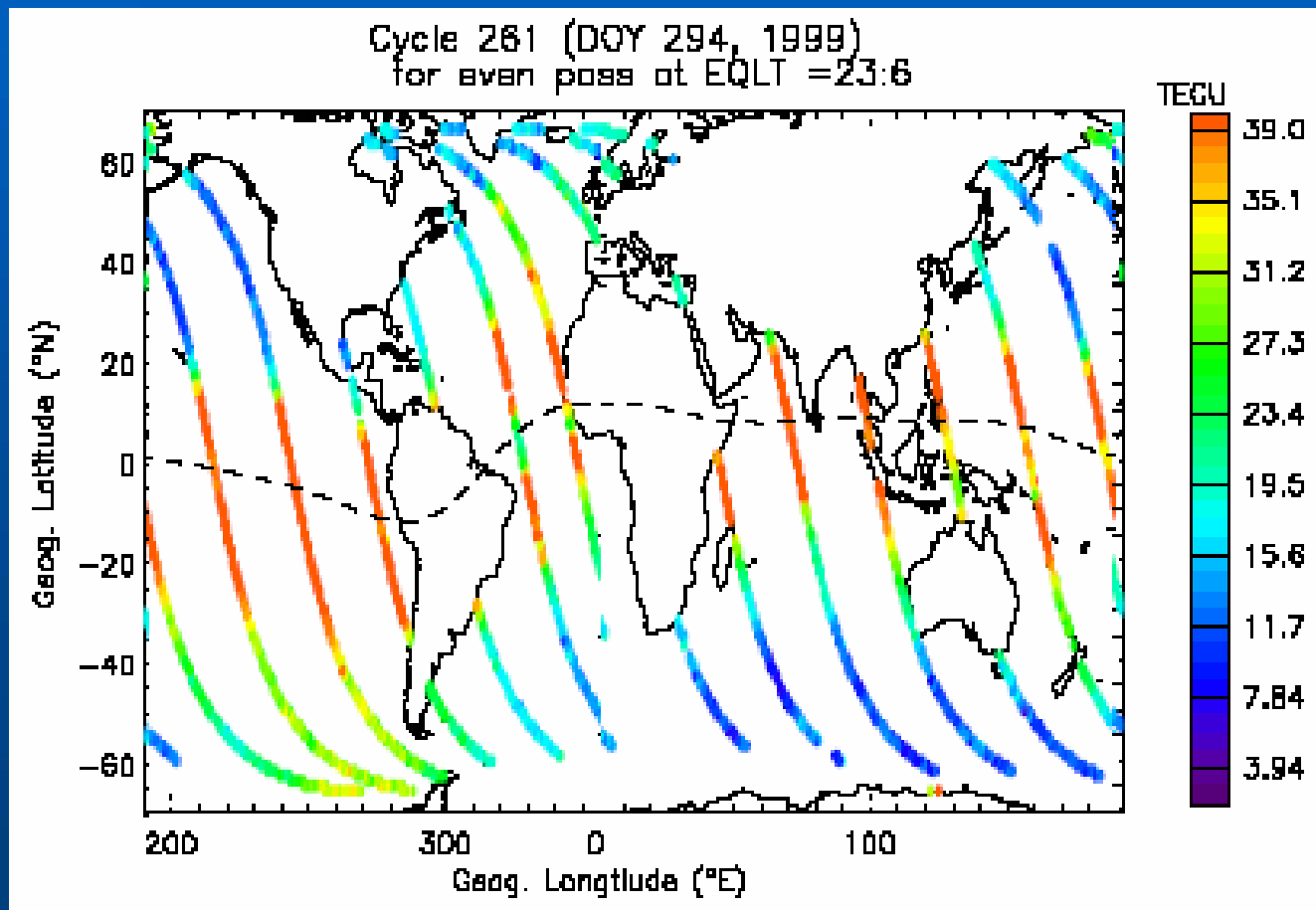
F13199910220555 J4 Orbit Track



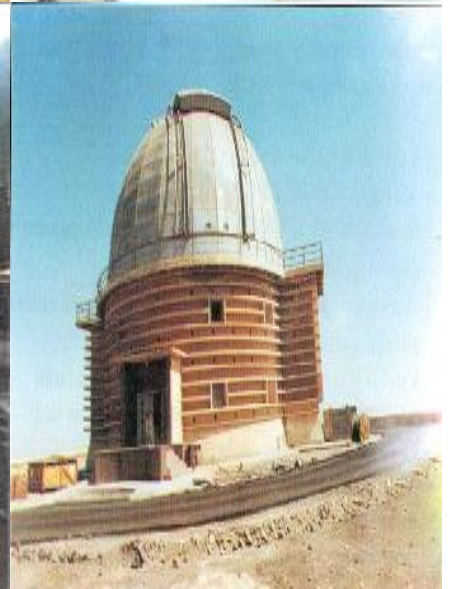
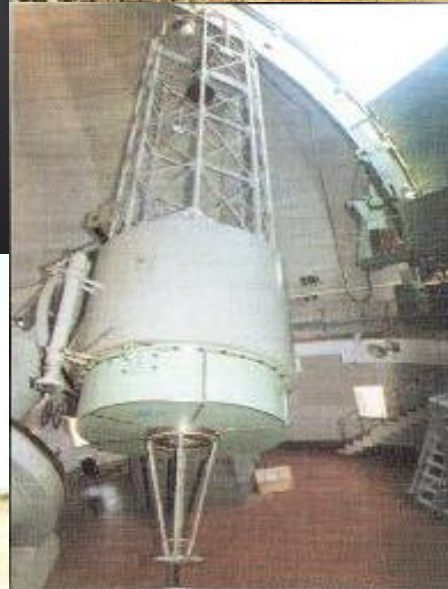
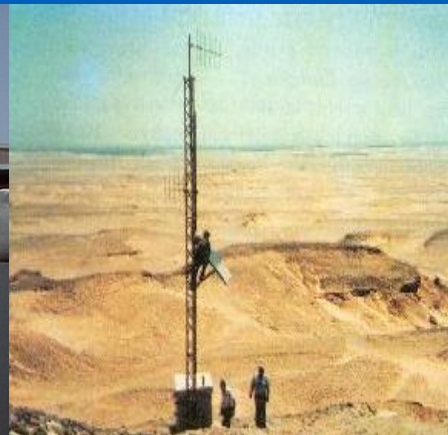
EAVE (keV)



TOPEX results



Some Instruments in Egypt



Misallat Geomagnetic Station



Established in 1960



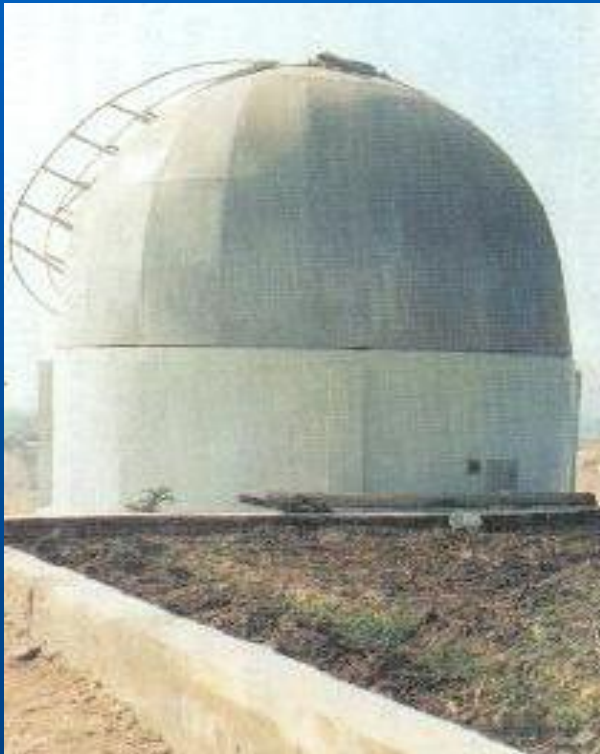
Kew Magnetometer, Dover Dip Circle, Schuster
- Smith magnetometer (for H, Z Component)

Aswan Seismological Station

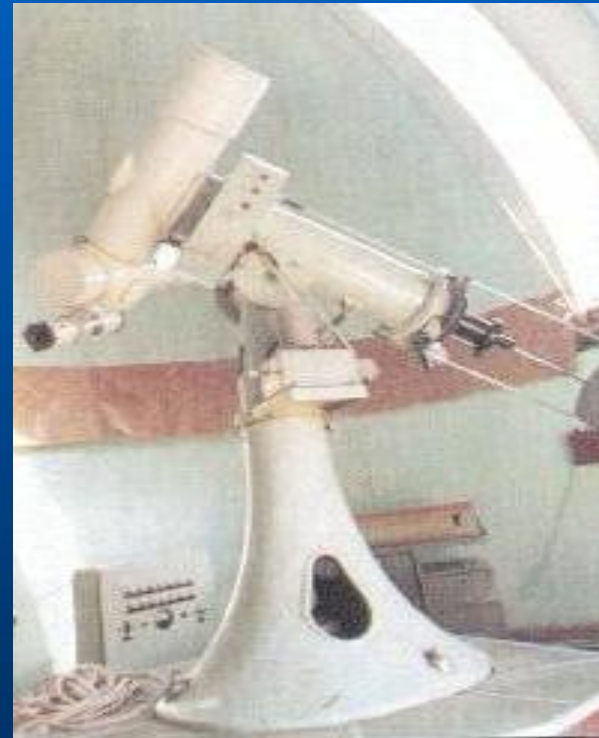


Established in 1990

Helwan Solar Station



Established in 1975

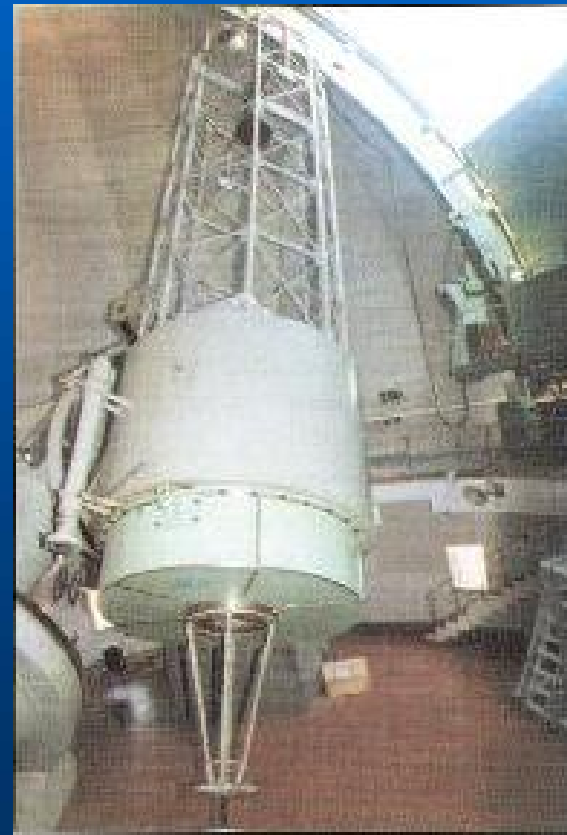


15/255 cm Zeiss Telescope

Kattamia Astronomical St.

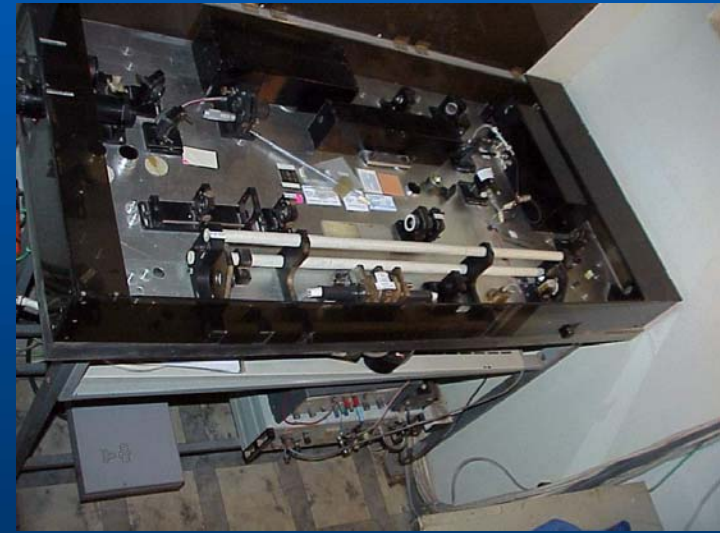


Established in 1962



74" Reflecting Telescope

Laser Ranging Satellite Station



Summary



Proposals to IHY2007

One of the main goals of IHY is to promote space science activities in developing countries, therefore, new instruments including (GPS receivers, magnetometers) are urgently needed to be installed in Africa. As a result, this could provide attractive research facilities and scientific infrastructure at home countries of the African researchers.

research@home.africa

Many thanks to

India

Hosting

Year

2007

IHY2007