



# Monitoring of Space Weather using the Global Navigation Satellite Systems (GNSS) at the Space Weather Monitoring Center (SWMC), Egypt

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(SWMC)



# Space Weather Monitoring Center (SWMC)



# Space Weather Monitoring Center (SWMC)

Space Science Division, Faculty of Science, Helwan University

1<sup>st</sup> Space Weather science generation ( class **2012** )



Small City!



121,300 Students enrolled (2012) in 22 Faculties

United Nations/Argentina  
Workshop on the Applications of  
Global Navigation Satellite Systems

# The main objectives:

- Establishing an early **warning system** against destructive geomagnetic storms to protect the Egyptian satellites and navigation systems.
- Supply methods to **forecast** the Ionosphere-Magnetosphere by simulation models.
- Provide reliable estimates for the **current status** of the space environment.
- To be a platform that can provide **unique researchers** in Space Weather field through summer schools and trainings.
- To be a part of the forthcoming **Egyptian Space Agency**.



# Research Groups

**Solar physics**

**Cosmic Rays**



**Ionosphere**

**Magnetism**

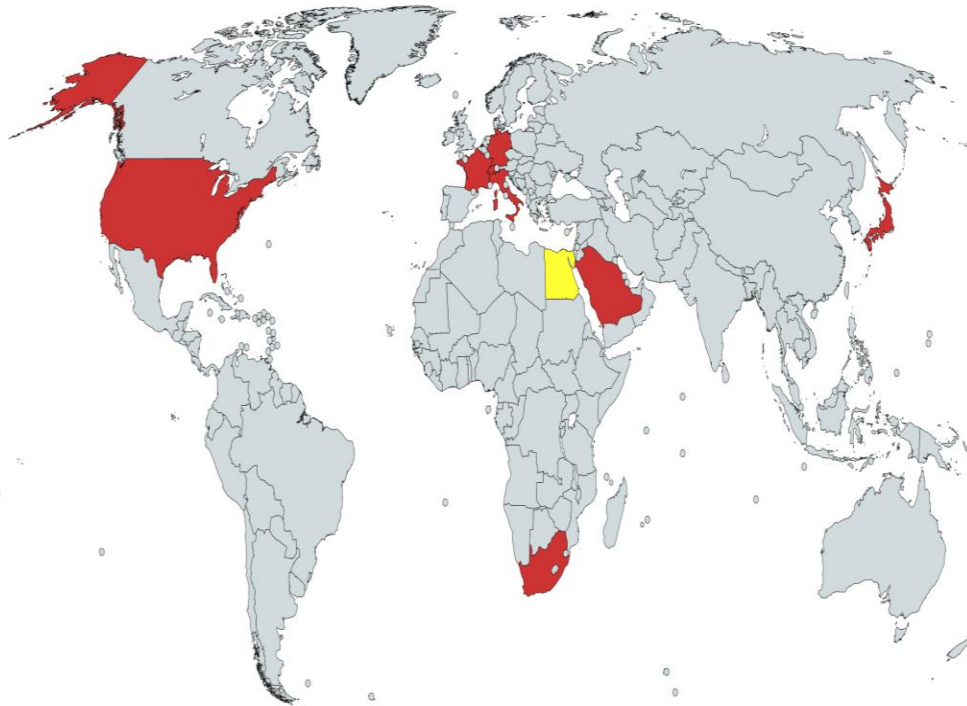




# International Collaborations



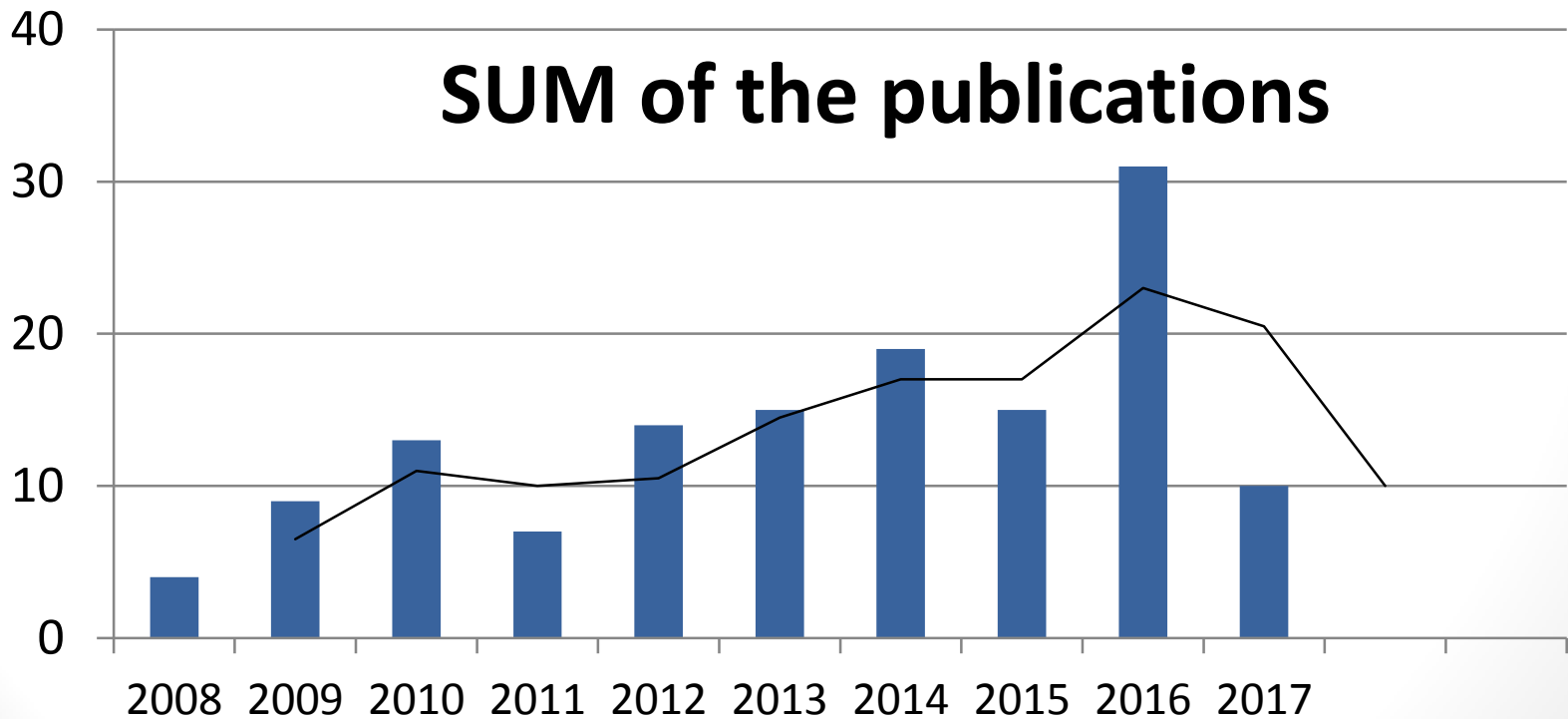
- The map below shows the collaborating countries (red) with (SWMC) in Egypt (Yellow) through projects from 2007 till 2017.



- Kyushu University (Japan)
- Polytechnic University of Milan (Italy)
- The Northern Borders University (Saudi Arabia)
- University of Texas, Boston college and Stanford Solar Center (USA)
- DLR, Neustrelitz (Germany)
- ETH Institute of astronomy, Zurich, and CERN (Switzerland)
- South Africa Space Agency (SA)

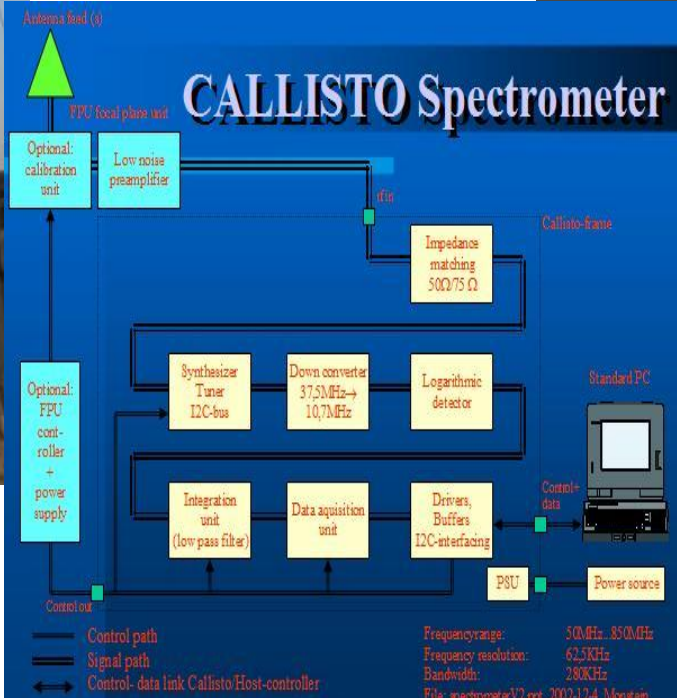
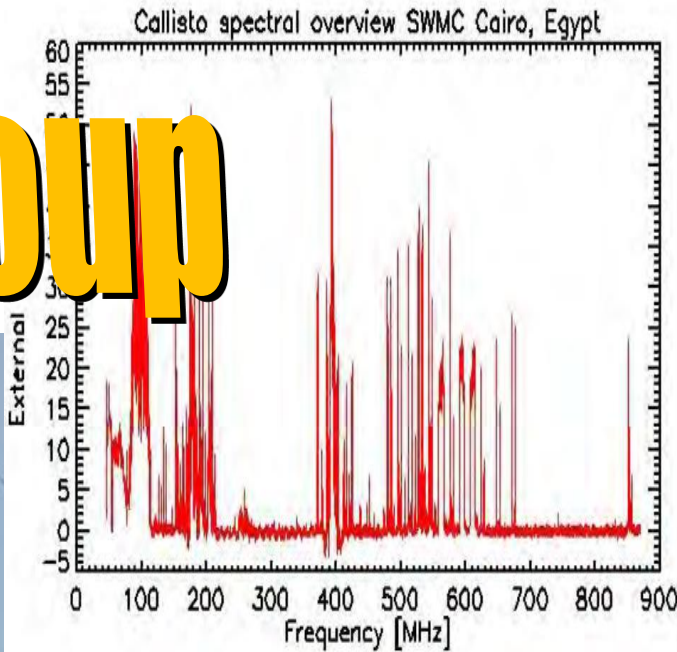
# Research

- Here is a statistical figure indicate the overall number of publications done by the 4 groups of the SWMC from the beginning of the IHY till 2017.

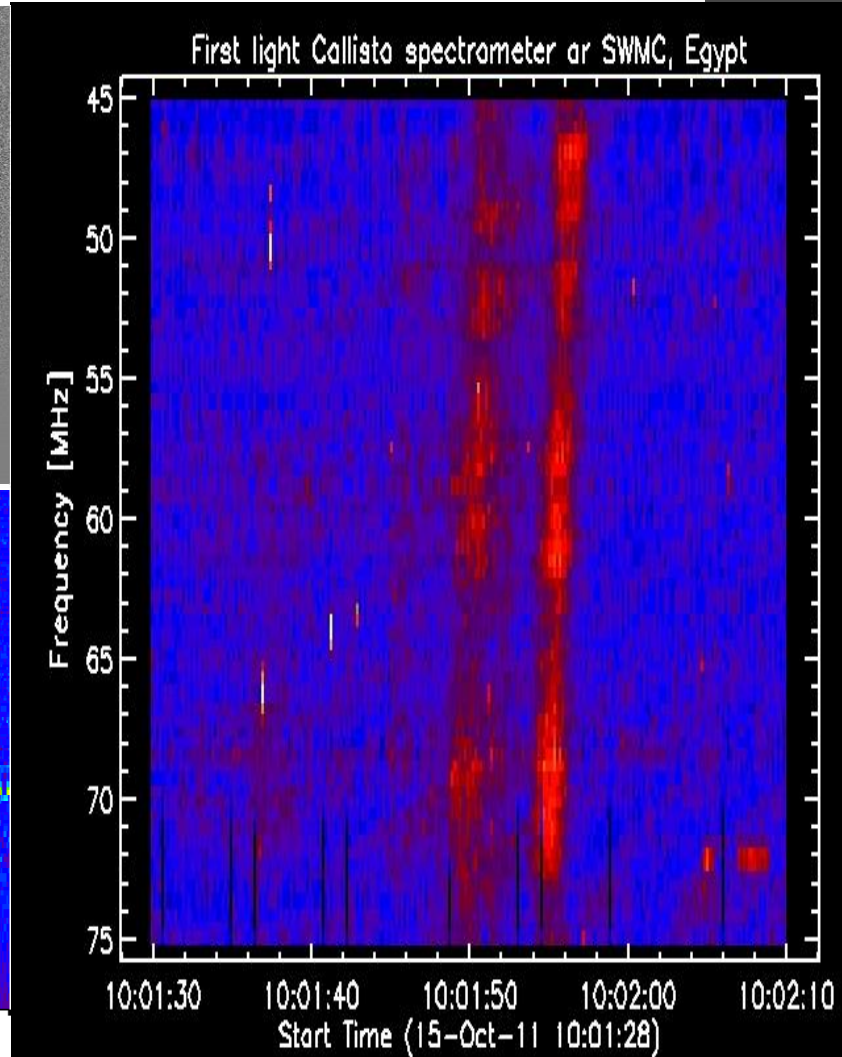
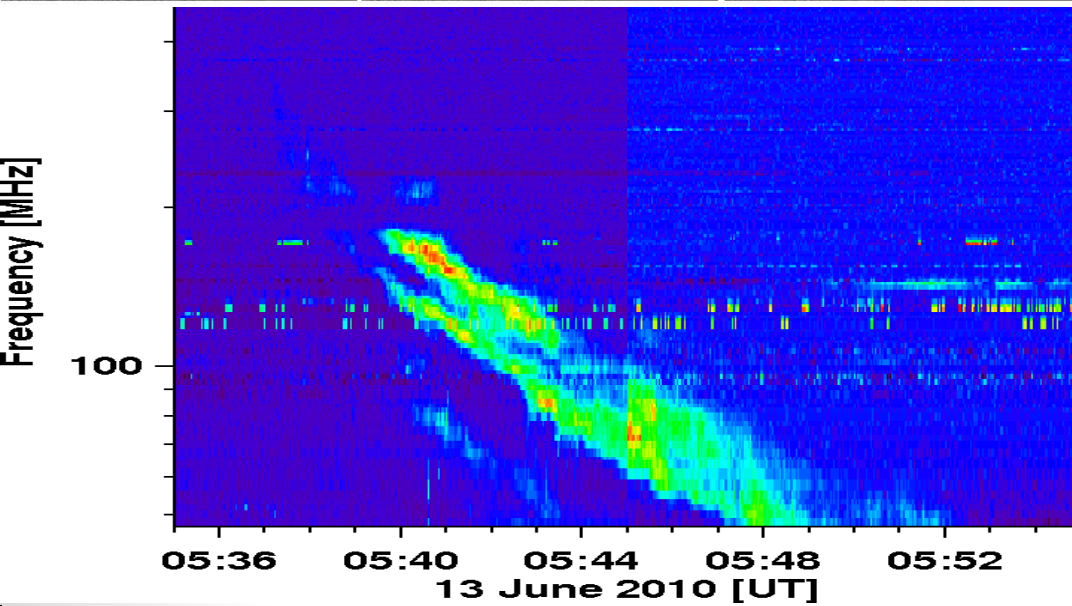
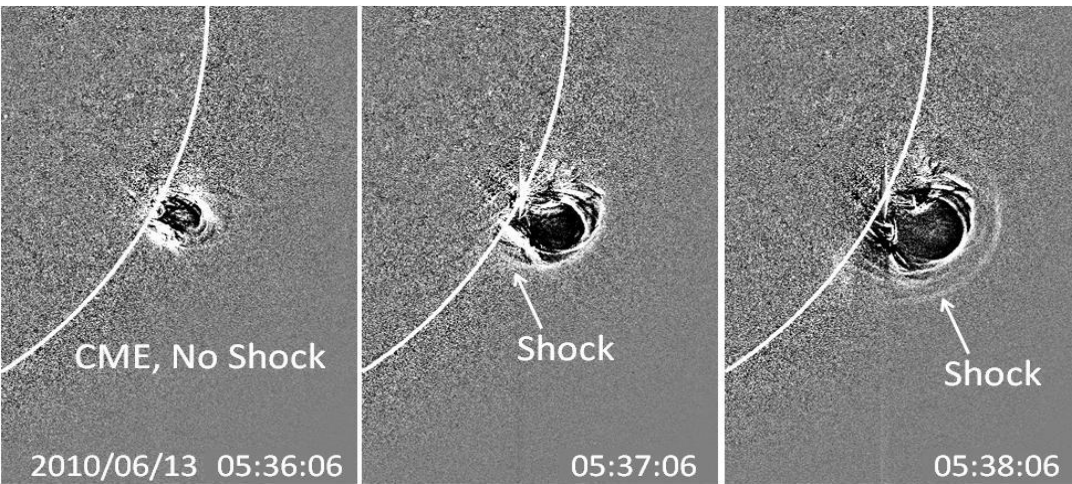




# Solar Physics Group



# What we get from CALLISTO





# Solar Flares detected by Ionospheric Effects (SOFIE) .



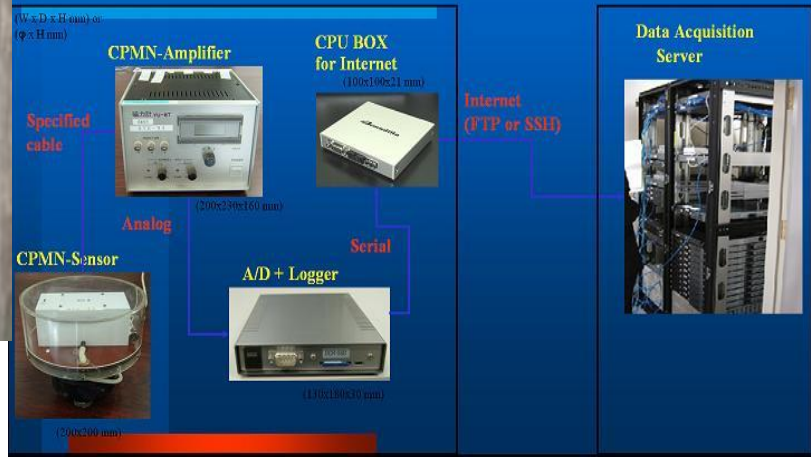
- SOFIE is intended as an educational project directed by DLR\_Project\_Lab Neustrelitz which enables the acquisition of solar radio bursts that emitted during solar flares.
- Therefore the signal strength for very long radio waves or Very Low Frequency (VLF, 3 – 30 kHz) is measured continuously.
- Solar radio bursts affect the signal strength in terms of amplitude variations of the radio wave, that appear as change in the output voltage by the receiver.



# Geomagnetism Group



GMLon,







## Installation of MAGDAS at FYM

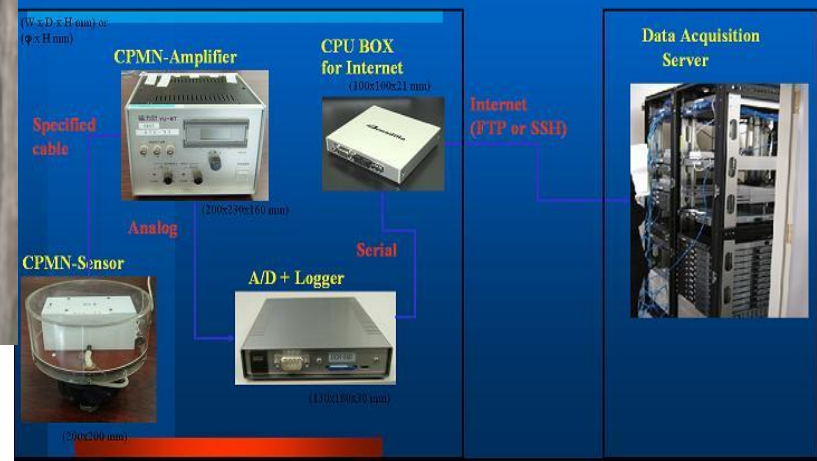




# MAGDAS-II installation at ASW & FYM

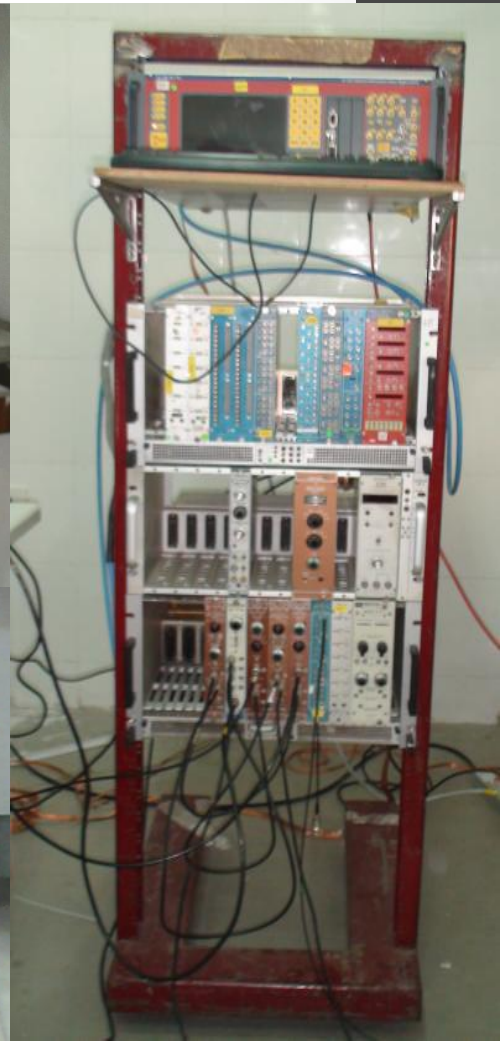
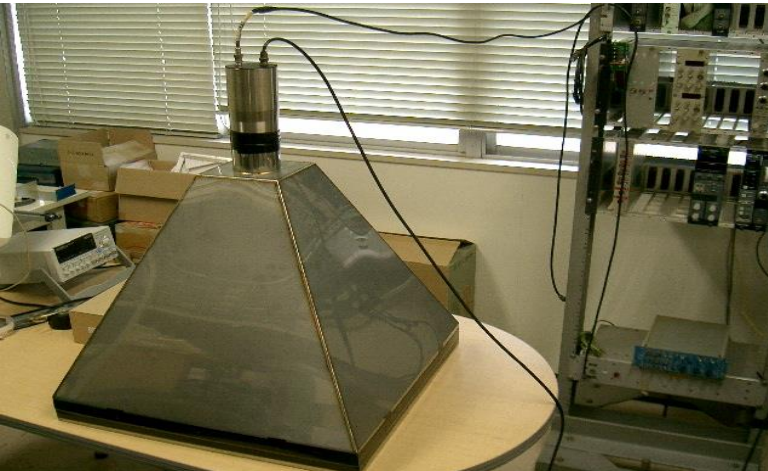


GMLon,





# Cosmic Ray Group



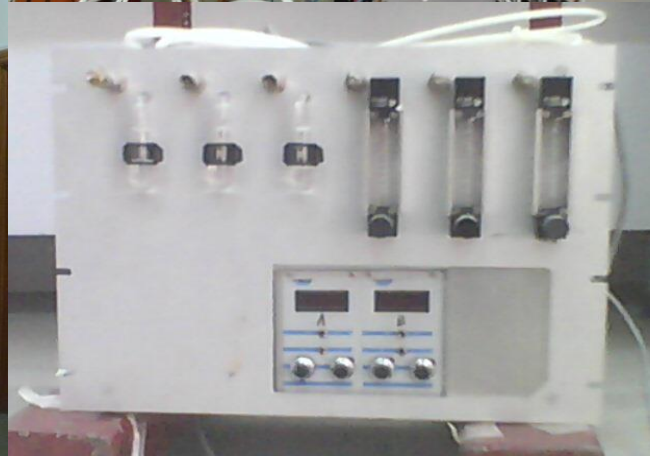
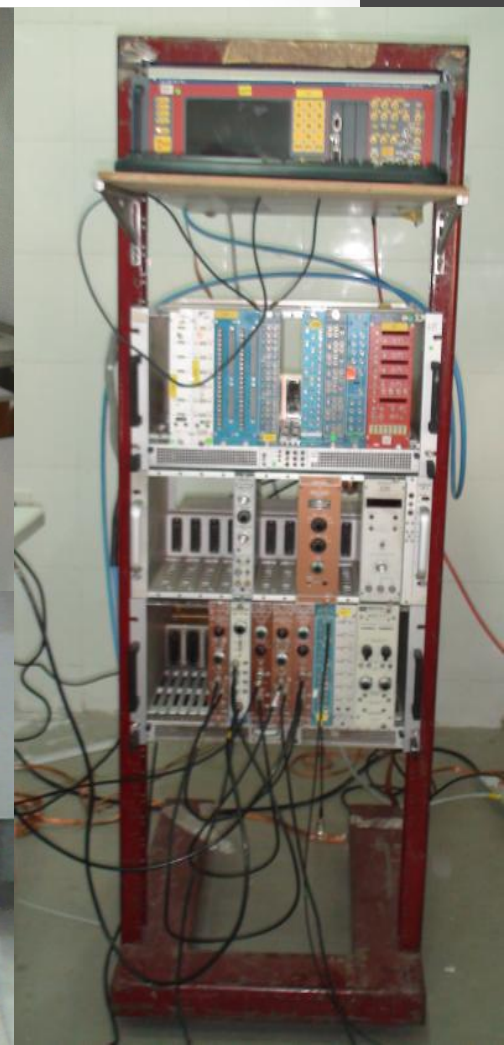
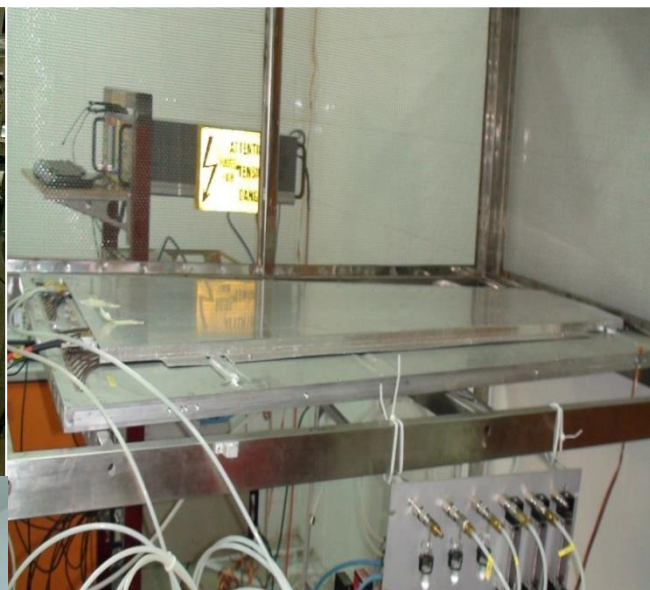
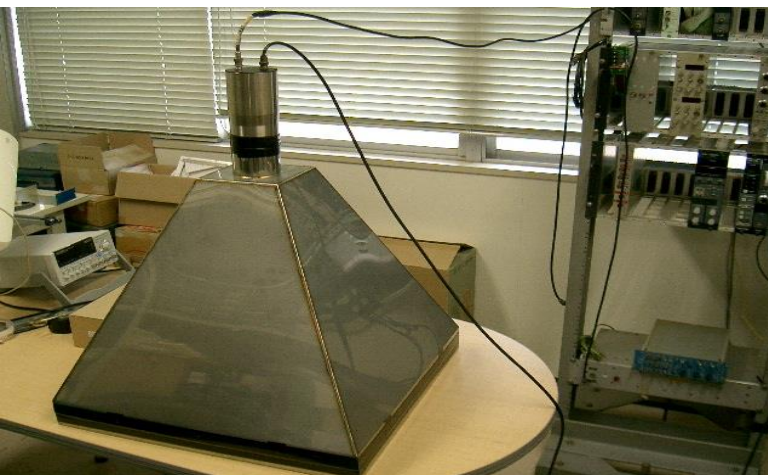


# Joint Project with CERN

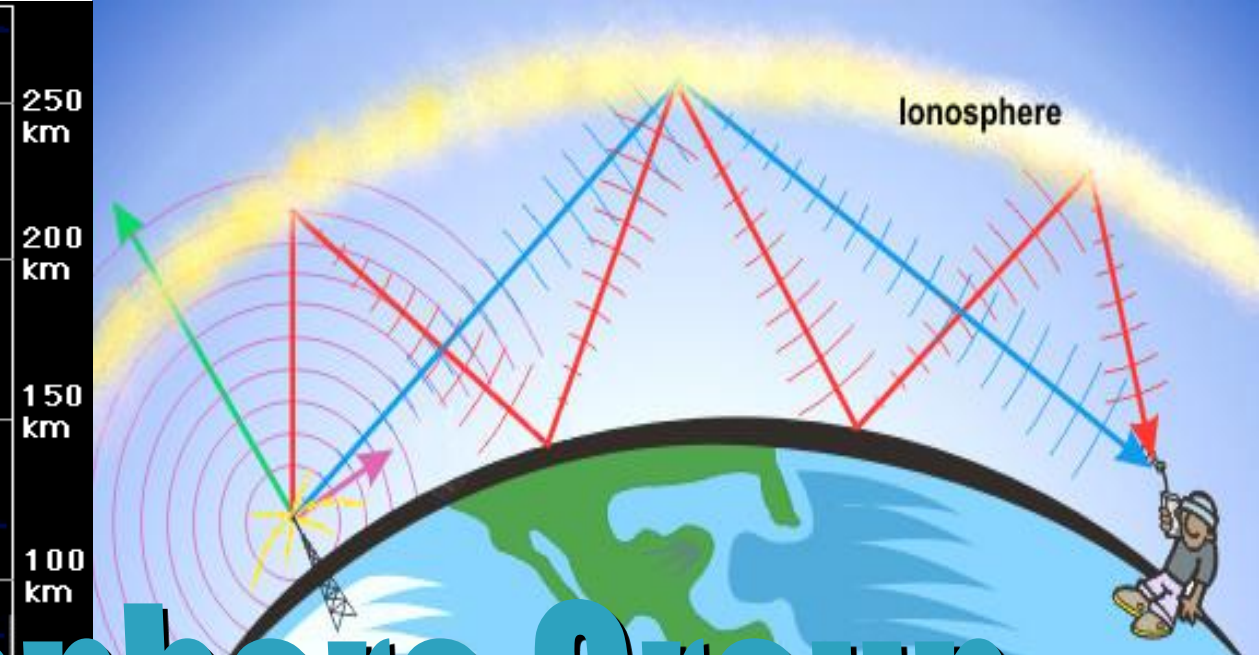
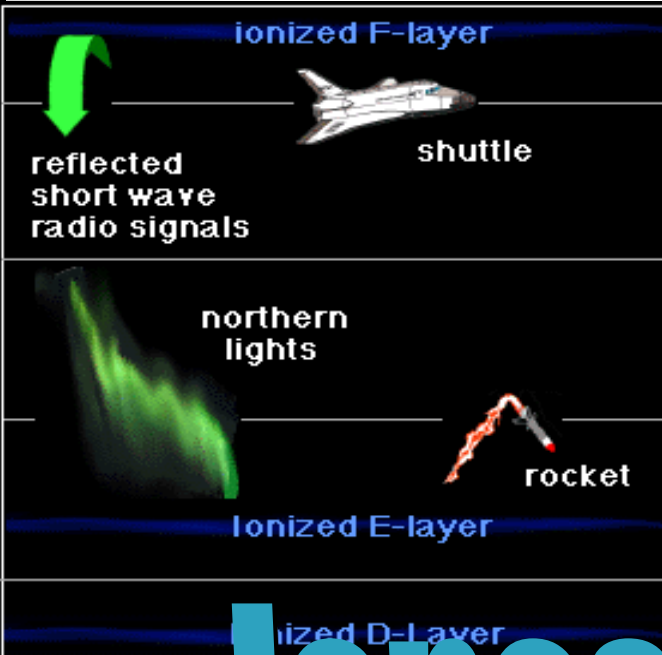




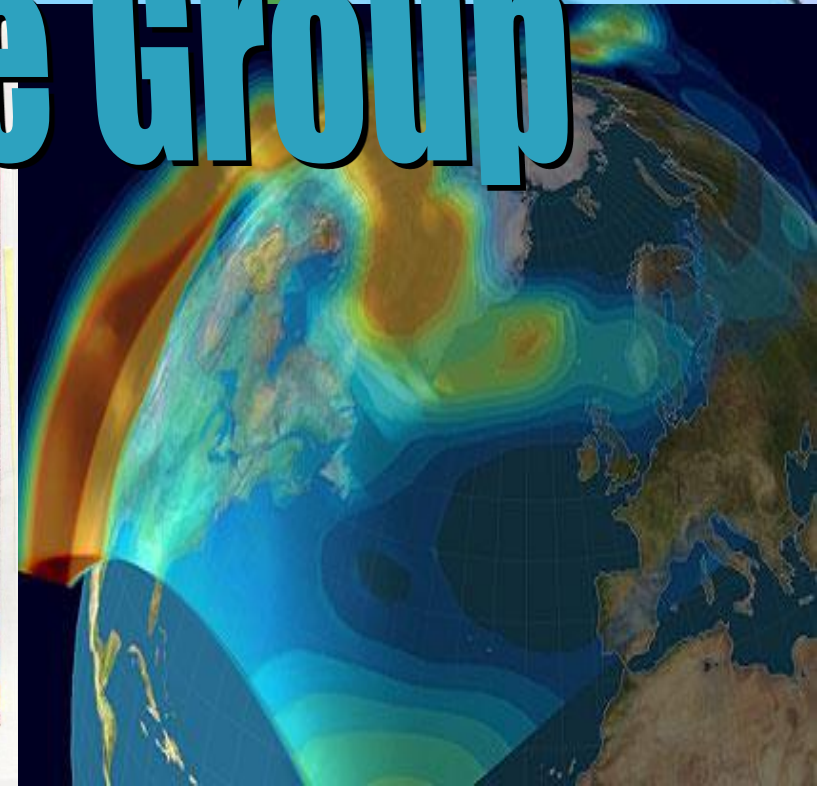
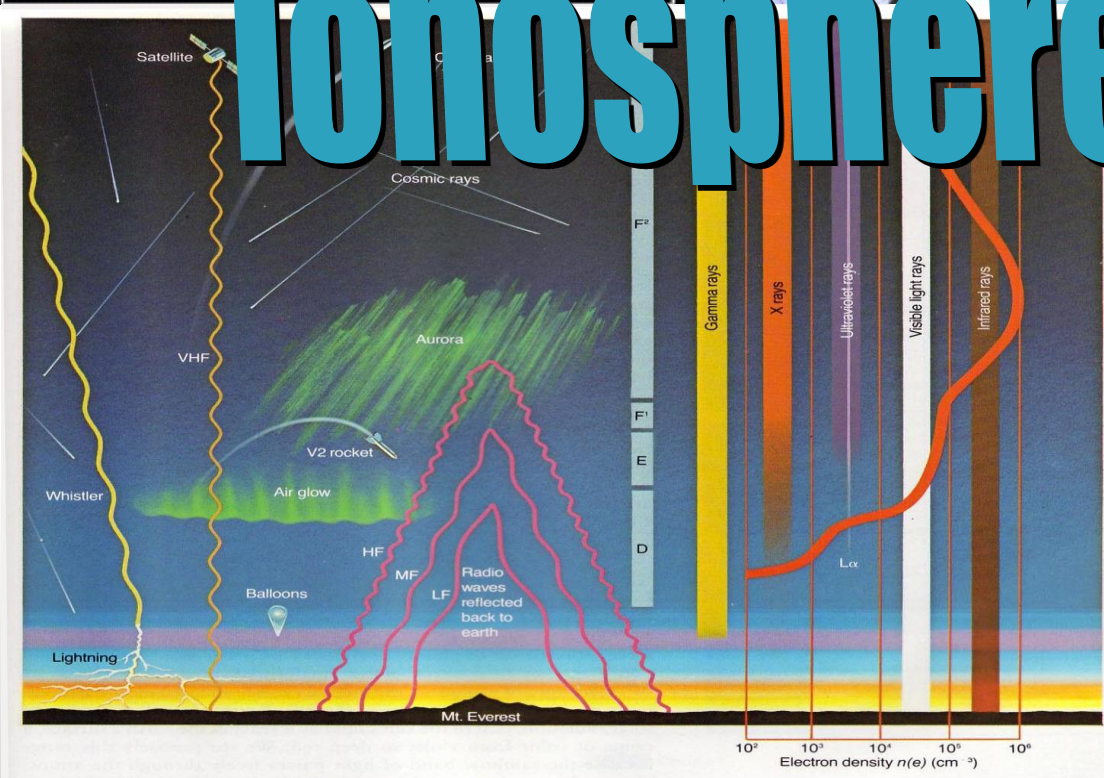
# Testing of RPC at SWMC Lab.





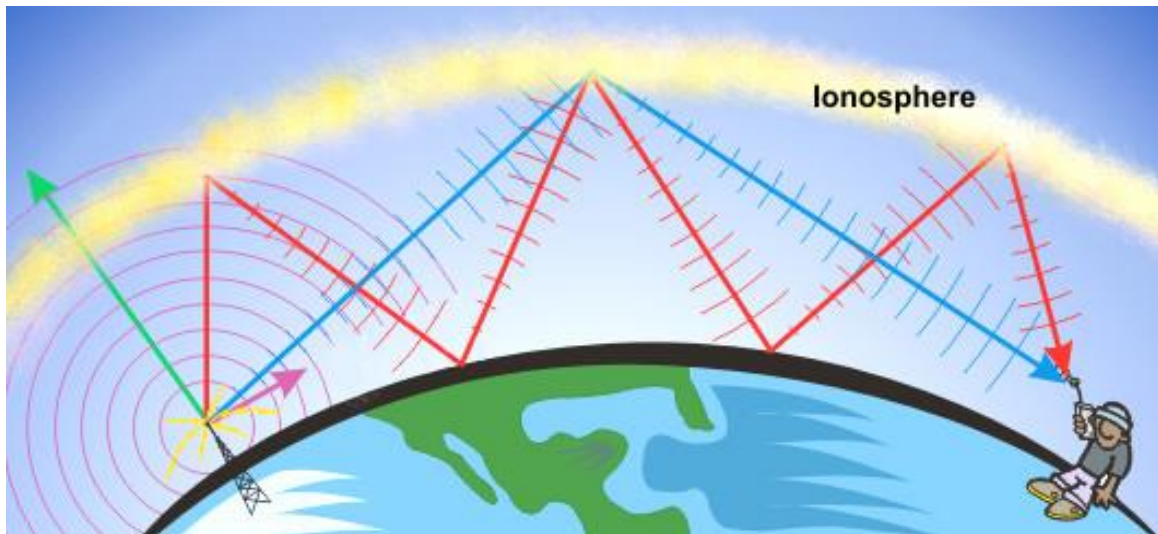


# Ionosphere Group



# Ionosphere group

- It is responsible for monitoring and understanding of the ionosphere layer behavior through the Total electron content (TEC) and irregularities specially over Egypt.
- The group goal is the Ionospheric tomography and Ionospheric forecasting.





# Ionospheric Monitoring over Africa, Why ?



La Plata 15 04 2002 UT 1300

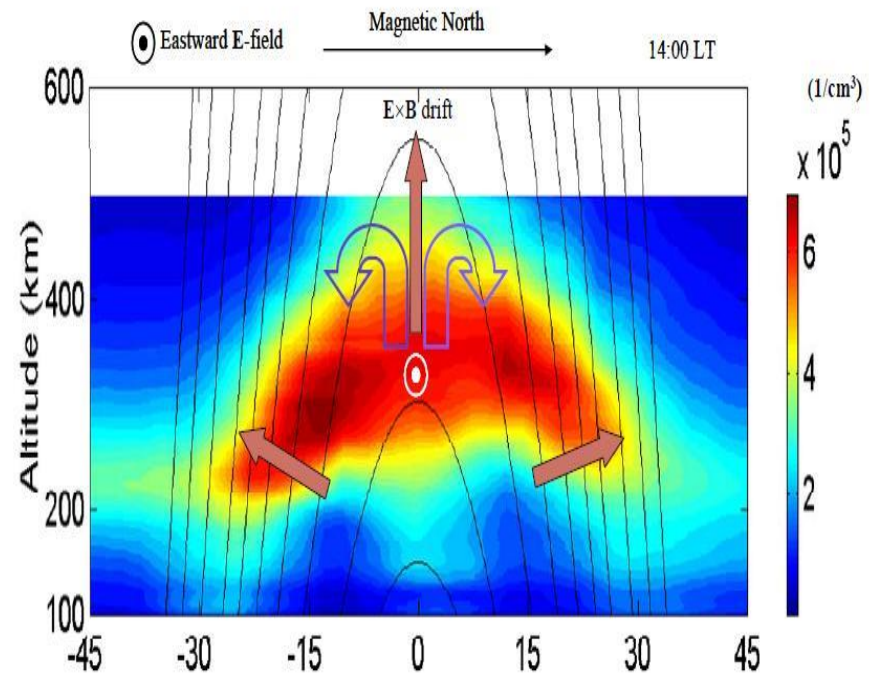
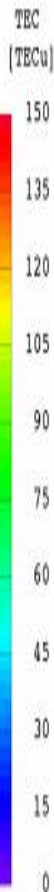
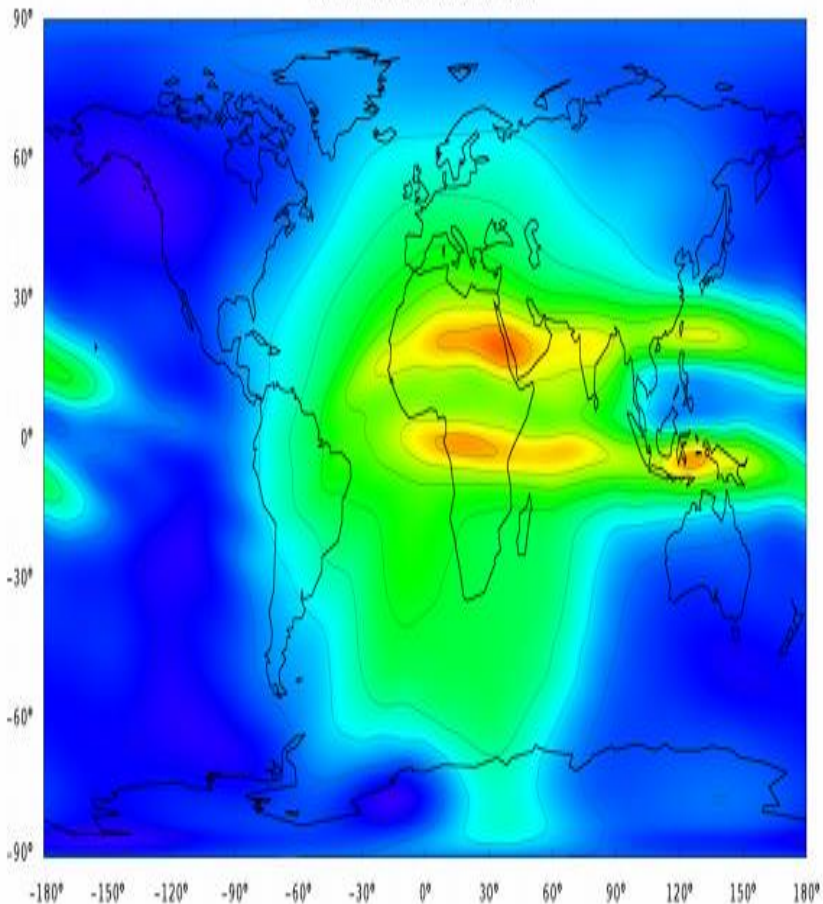
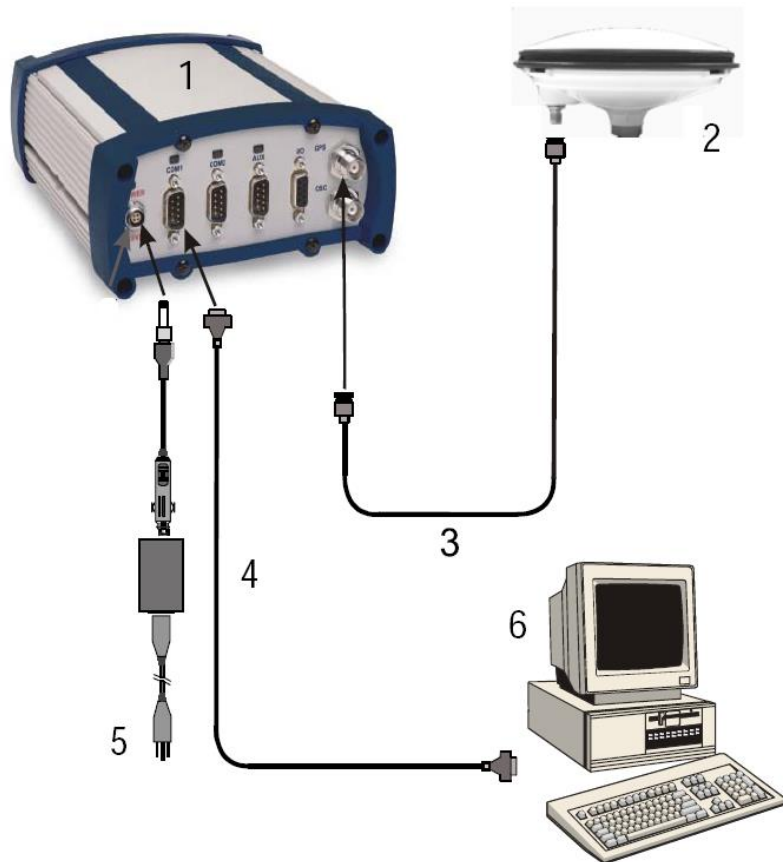


Figure 1.5. Contour is the altitude profile of plasma density at 14LT, black lines are magnetic field lines and arrows stand for the directions of ion drifts [courtesy of Liu and Lin, 2006].



# GPS System at Helwan (SCINDA)



1: GPS receiver

2: GPS dual frequency antenna

3: Antenna cable (30 meter maximum)

4: Serial cable

5: Power cable

6: Personal computer running Linux



**GPS dual  
frequency antenna**

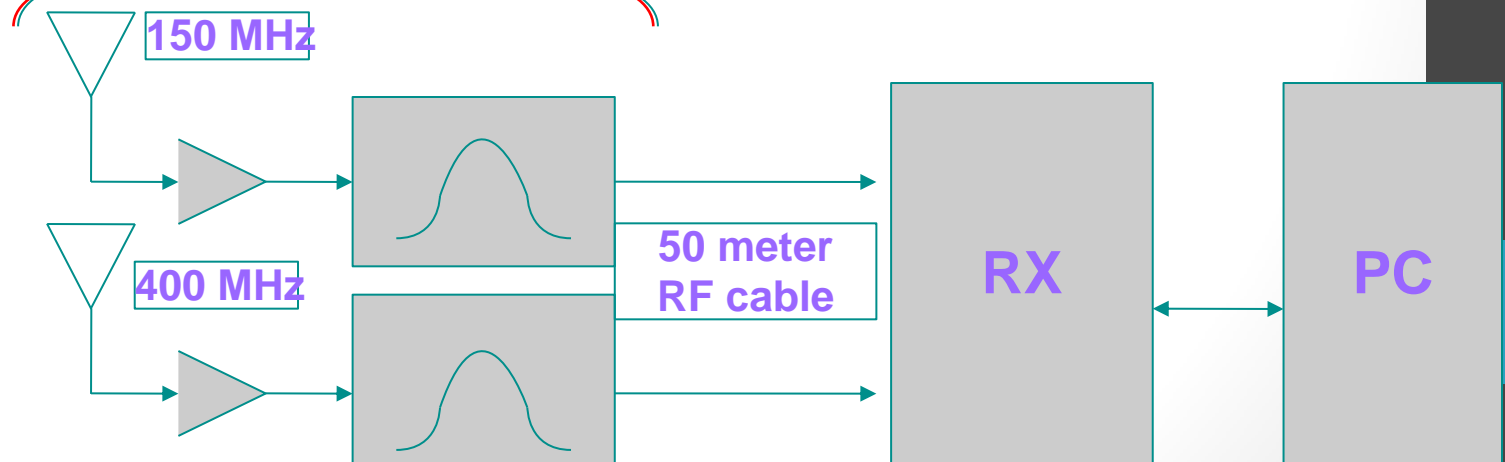
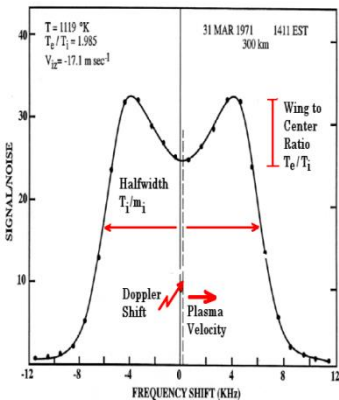


**Helwan University**



# Coherent Ionospheric Doppler Radar (CIDRs)

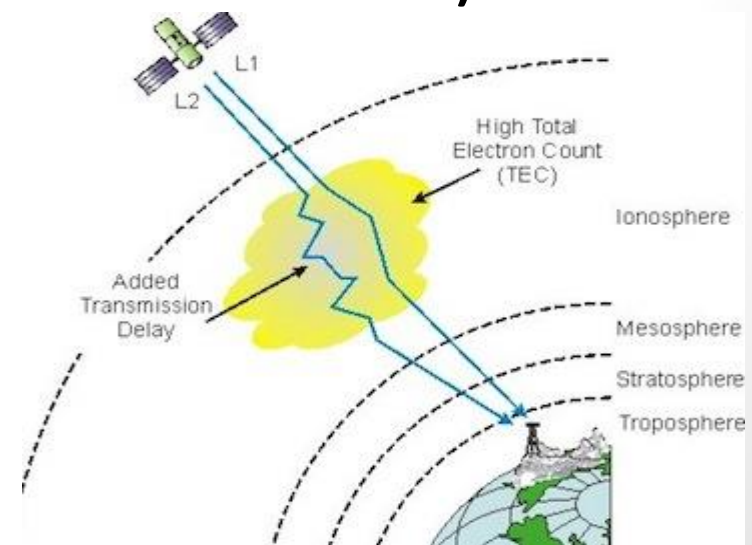
- Designed to track 150/400MHz LEO beacons (Transit/NIMS, GFO)
- Provides relative TEC and phase scintillation measurements at 50 Hz
- Useful for examining spatial structure with a relatively sparse receiver network and conducting ionospheric tomography



# Ionosphere group work using GNSS:

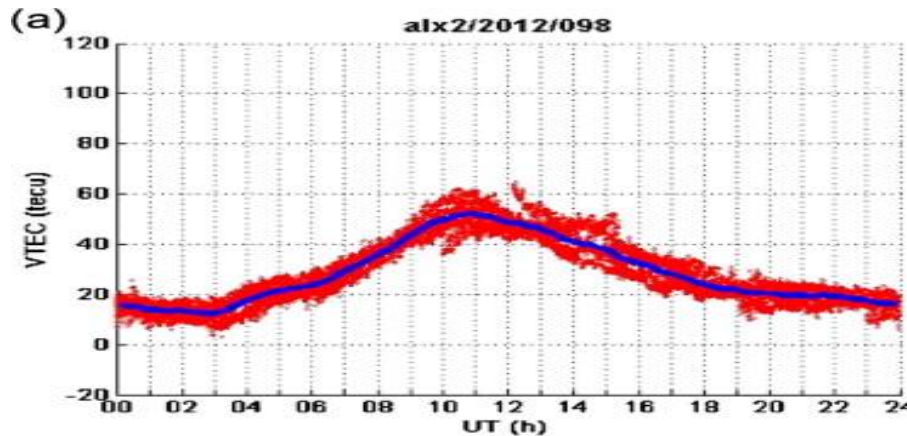
We can monitoring the Space Weather effect on Ionosphere using the Global Navigation Satellite Systems (GNSS):

1. Ionosphere Mapping (TEC)
2. Ionospheric phenomena (Gravity waves)
3. Ionospheric phenomena (Travelling Ionospheric Disturbances "TID")
4. Ionospheric irregularities level (Rate of TEC"ROTI" )
5. Amount of water vapor.

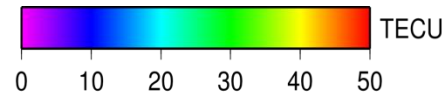




# 1. Ionosphere Mapping (TEC)

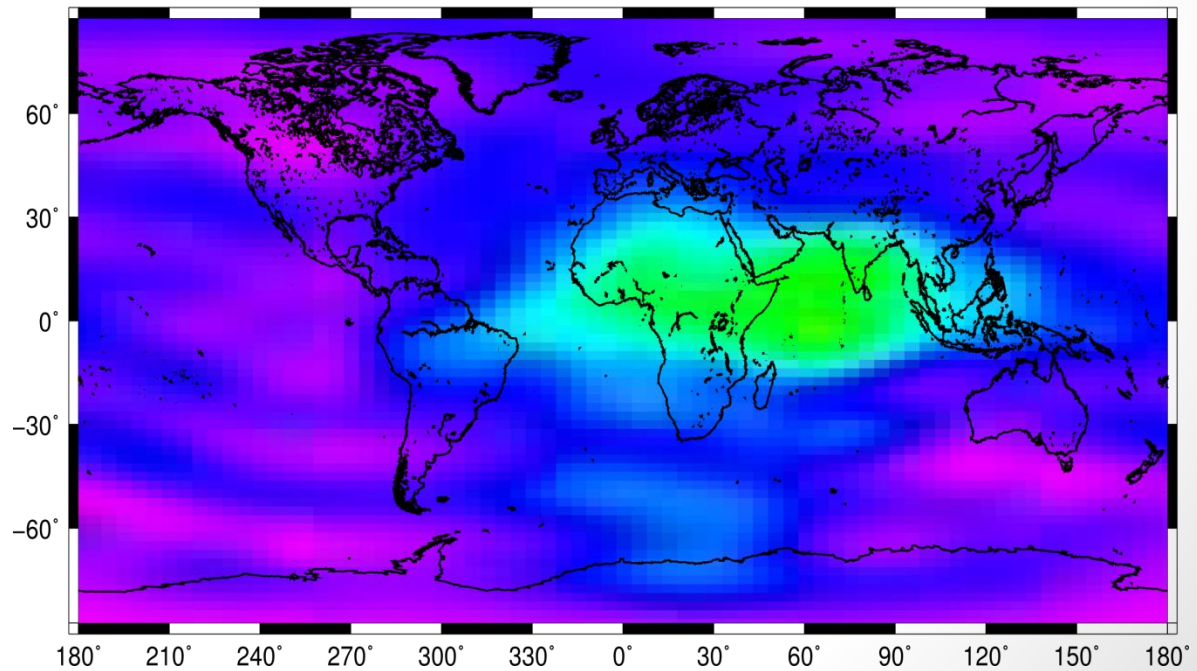


## VTEC measurements

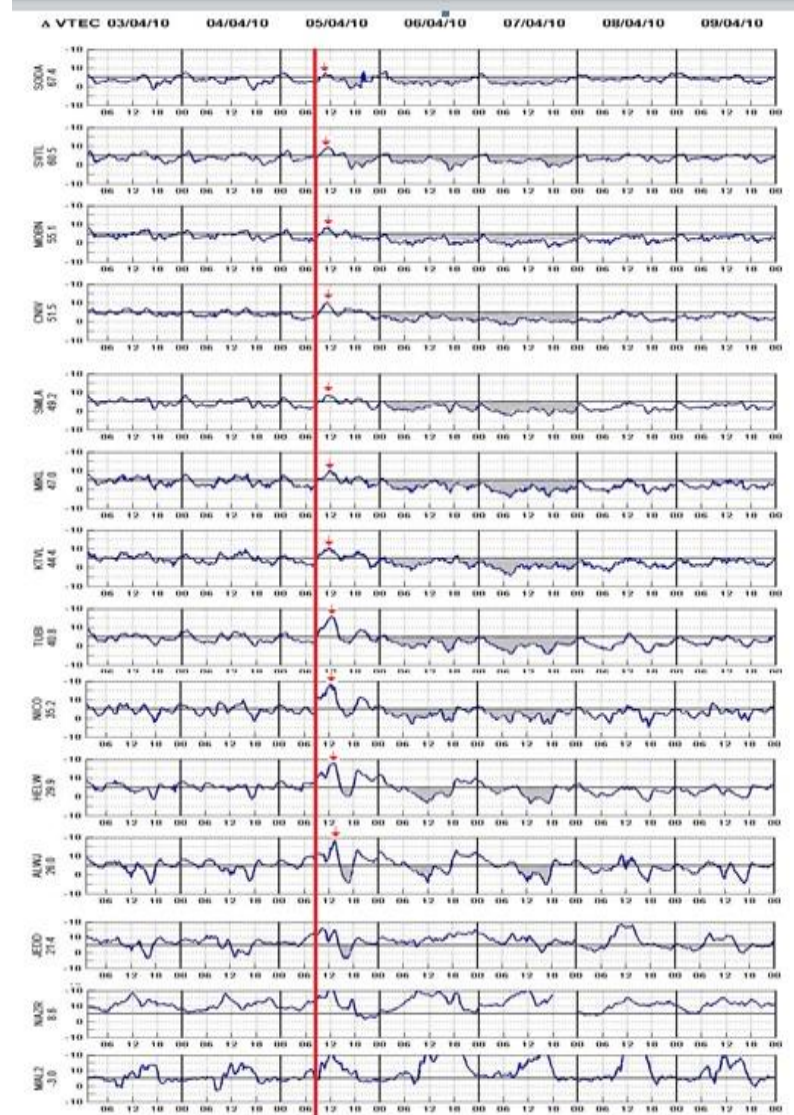
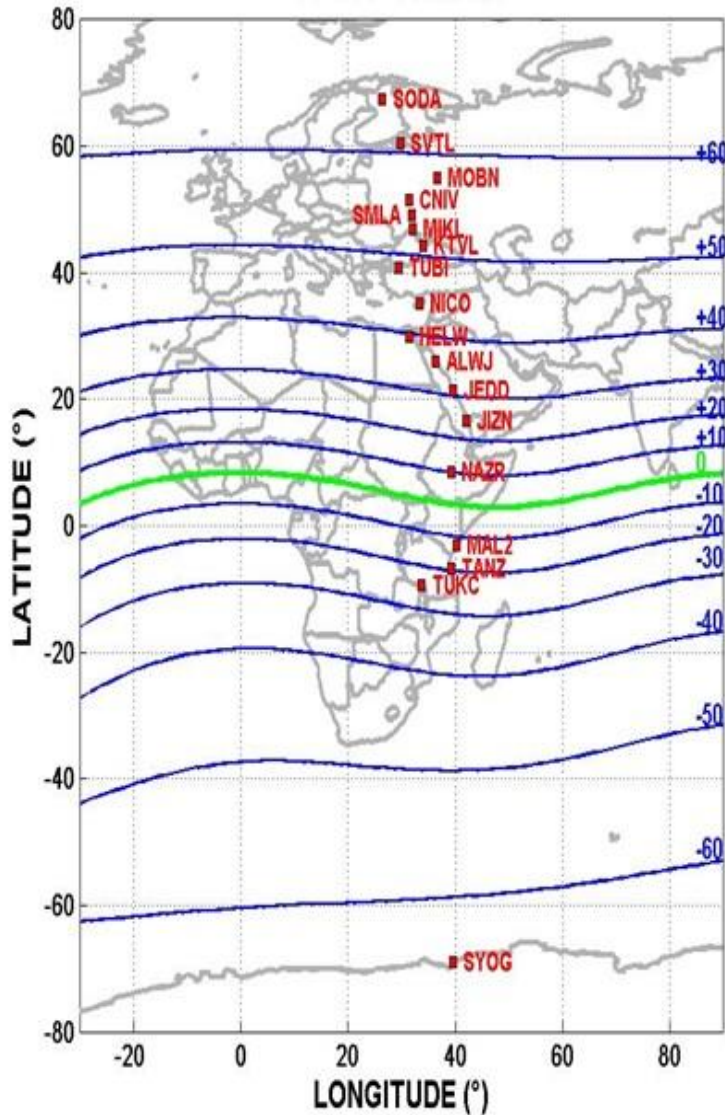


03/21/2009  
12h (UT)

## Global Ionospheric Maps (GIM)

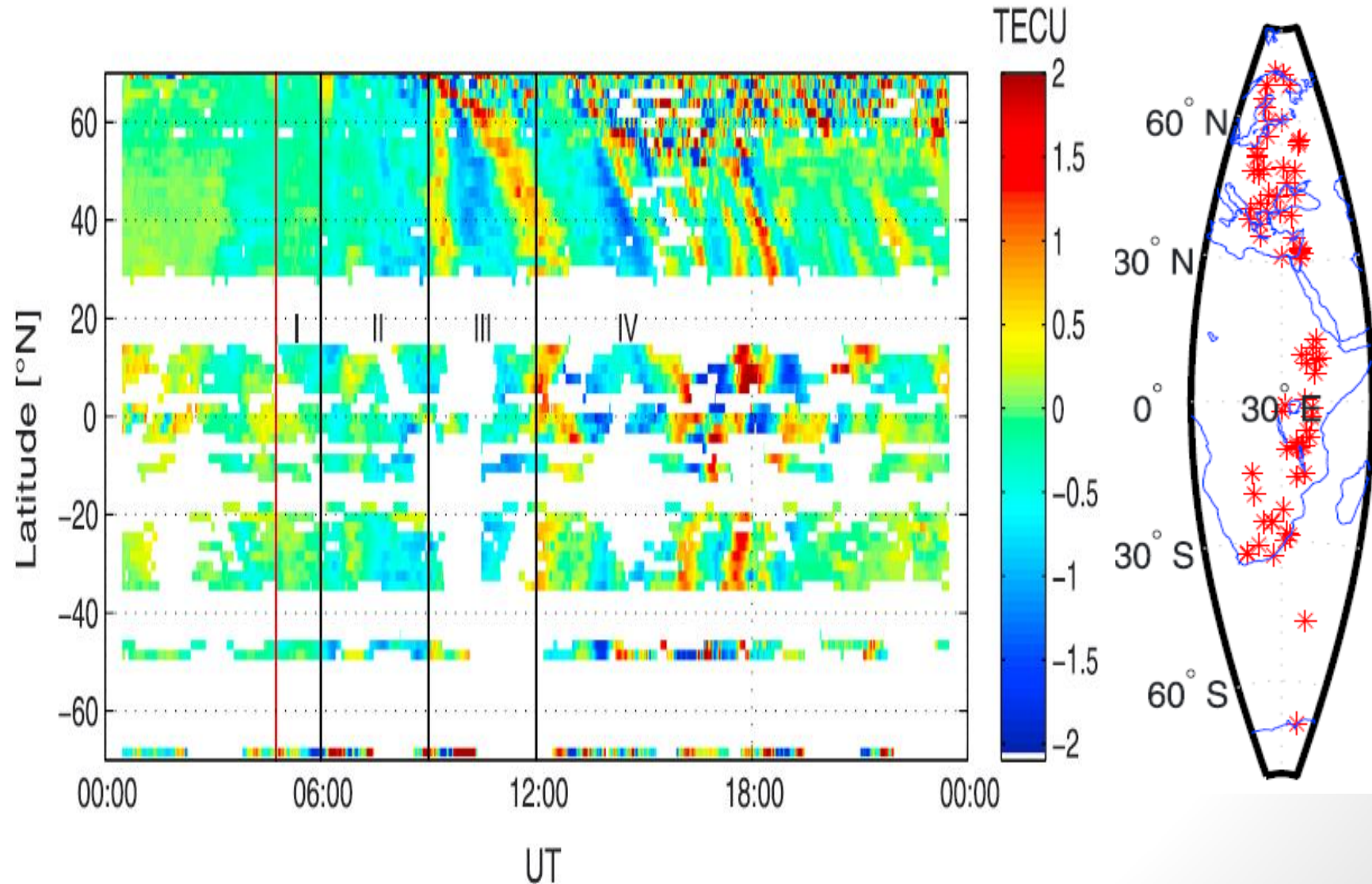


# 2. Ionospheric phenomena (Gravity waves)



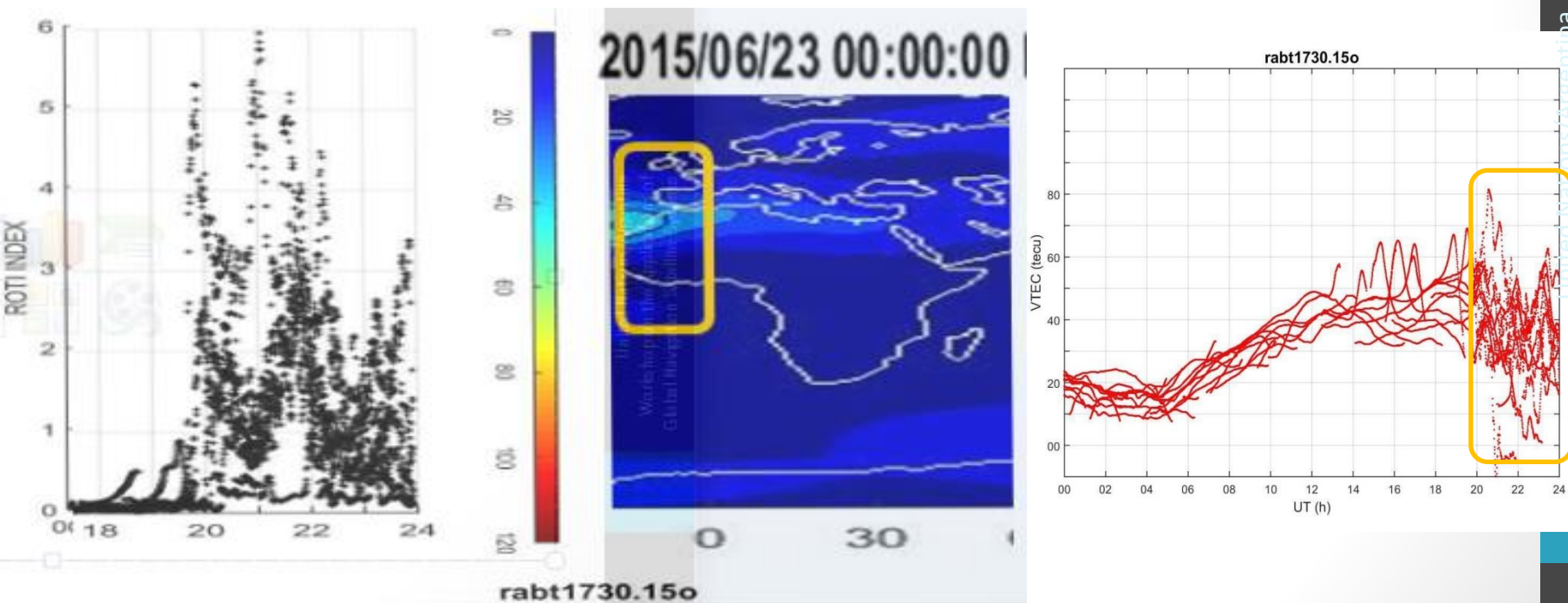


# 3. Ionospheric phenomena (Travelling Ionospheric Disturbances “TID”)

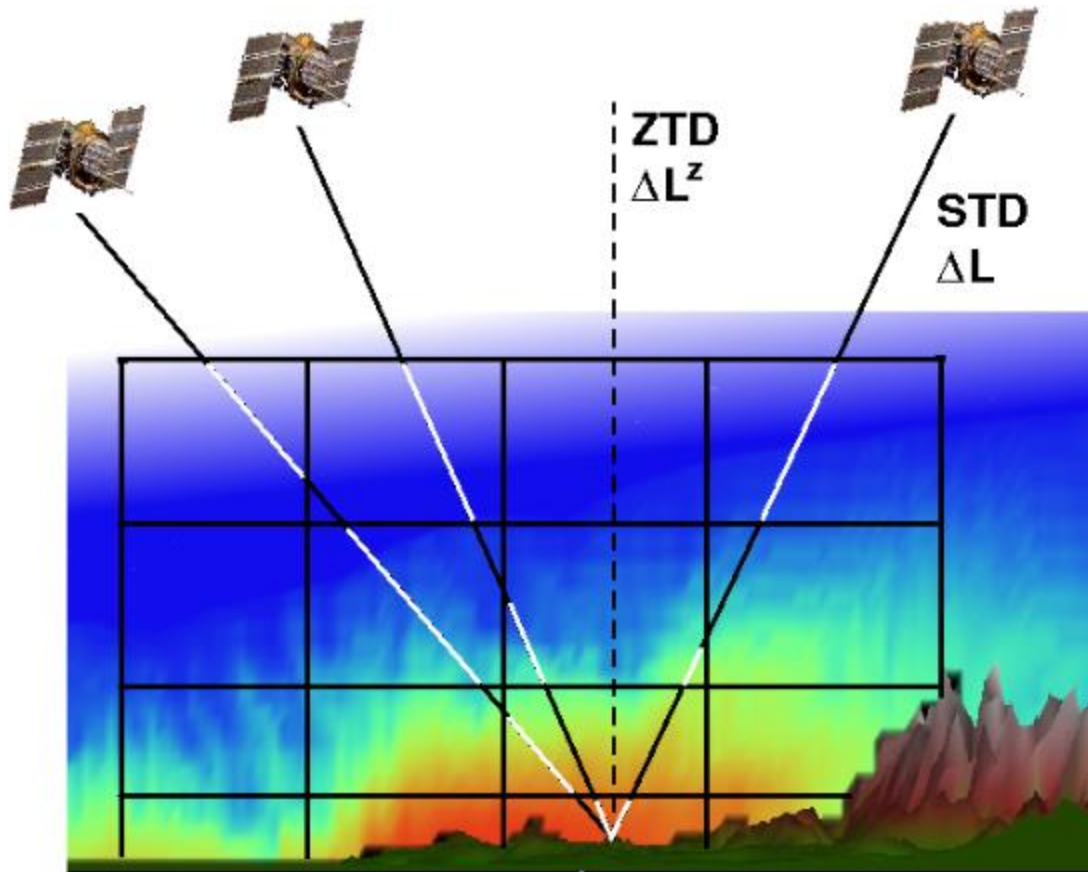


# 4. Ionospheric irregularities level (Rate of TEC"ROTI" )

As indicator for plasma bubbles



# 5. Amount of water vapor



# Current status of IG GNSS related work

- Observing Ionospheric phenomena during quiet, disturbed time.
- Comparing GNSS results with different models and different data sets.

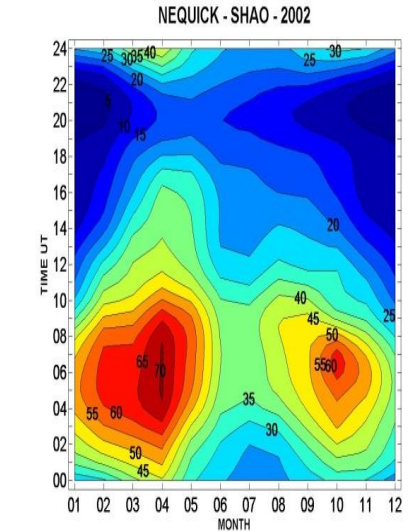
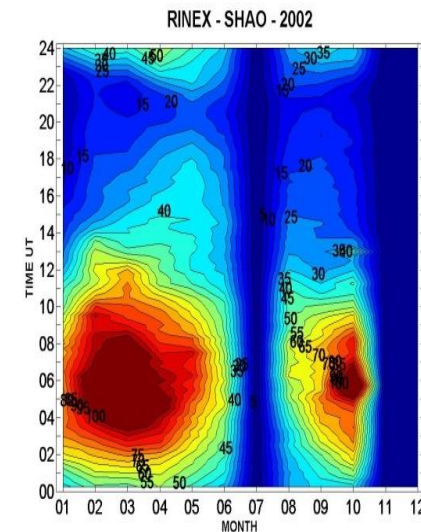
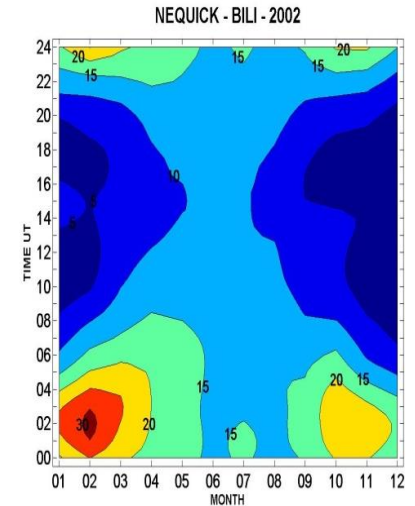
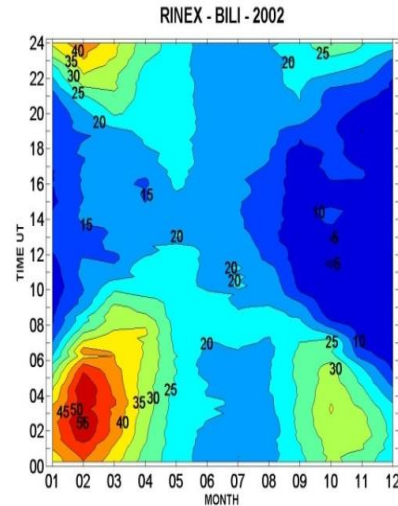
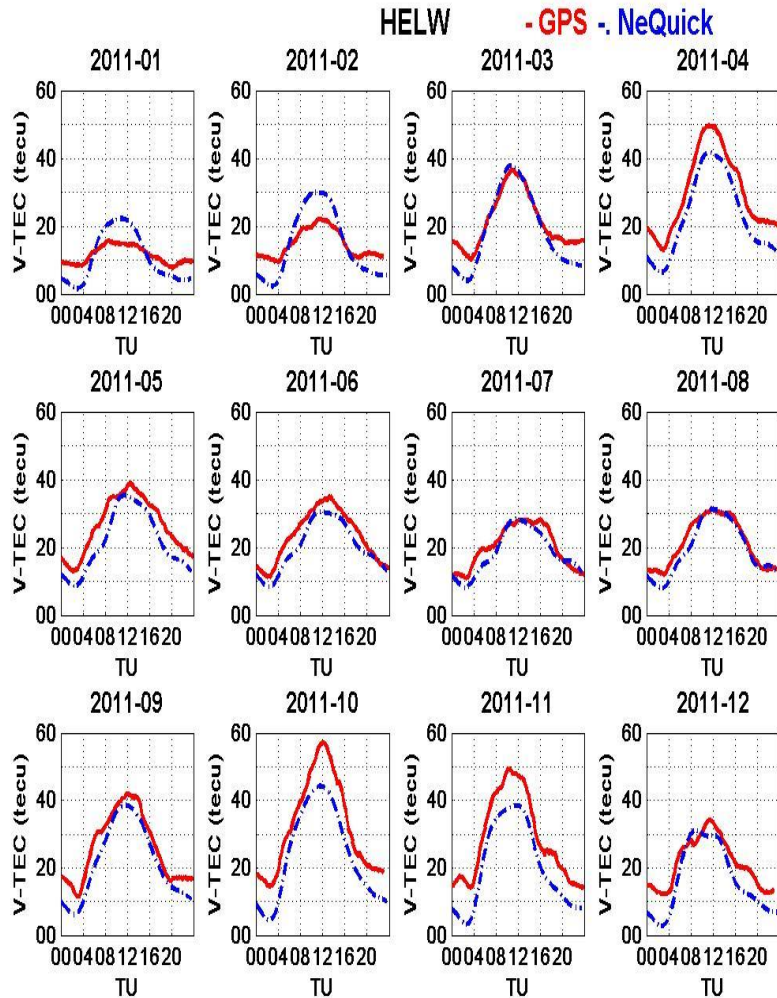
# Future work of IG GNSS related work

- **Ionosphere mapping by multiple data sets (complementary work) with GNSS (covering gaps)**
- **Ionospheric Forecasting**





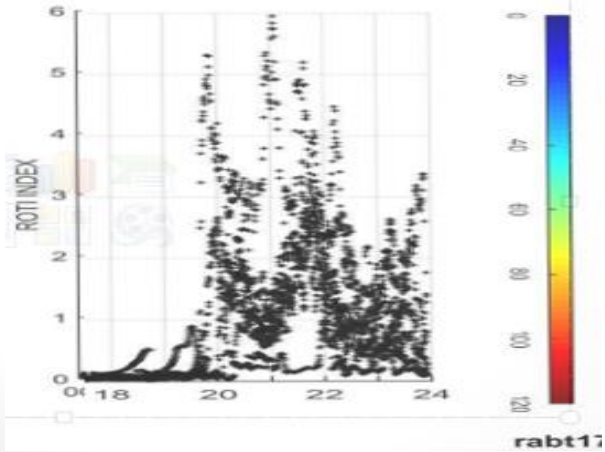
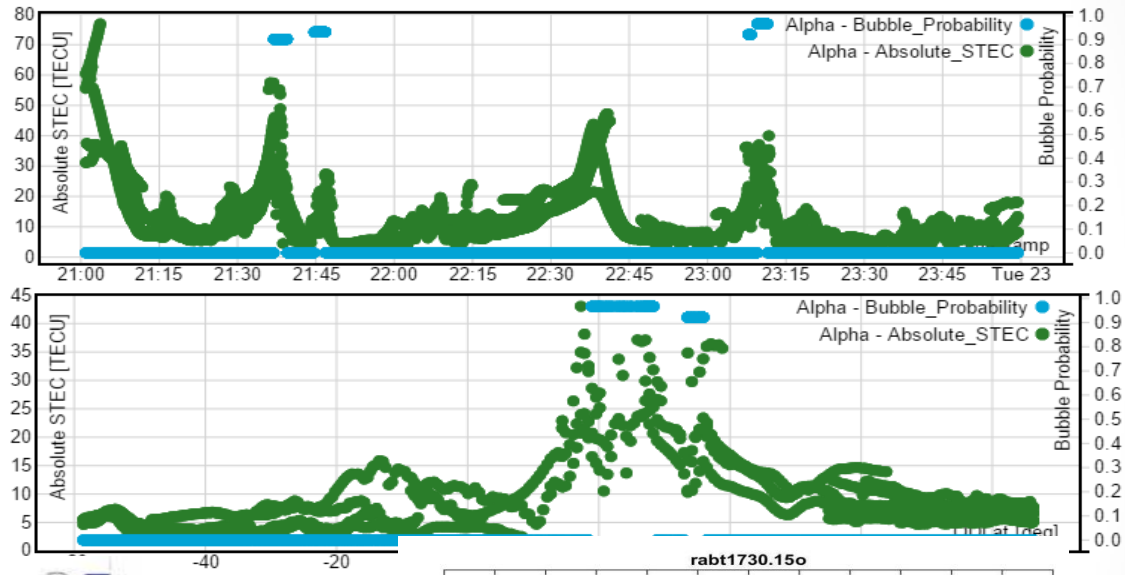
# NeQuick & GPS-TEC Comparison



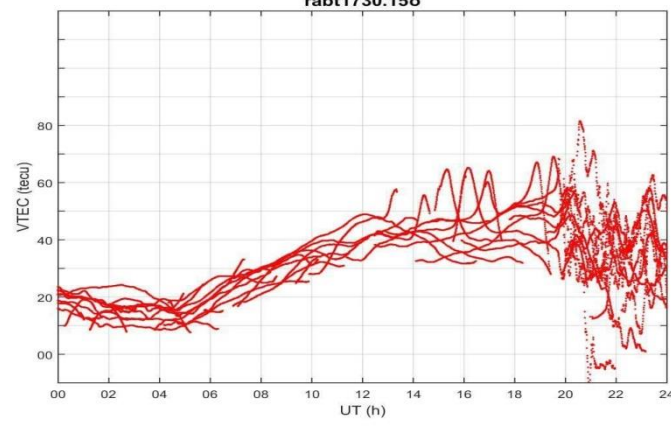
# GNSS vs SWARM



**SWARM/A**



**GNSS**





# Capacity building and outreach activities at (SWMC)

SWMC hosted very remarkable events from the beginning of the IHY:

1. The “First Workshop of the International Space Weather Initiative (ISWI)” meets Nov. 6<sup>th</sup> through 10<sup>th</sup> and is convened by UN/NASA/Jaxa.



## The International Space Weather Initiative

Published: Nov 8, 2010

Top Stories

1 Comet ISON to Fly By Mars



## 2. International Workshop on Space Weather and Space Navigation (Oct 2017)





# An Annual Space Weather Summer School (SWSS)

- From 2010 till 2017 we had six successful | local Space Weather Summer Schools (SWSS) were held at (SWMC)
- About +200 of undergraduate students and researchers participated.





# Future

- We had a contract now the Egyptian Metrological Authority to establish a Space Weather Warning Center there as recommended from the WMO.
- We have already started with a two weeks training on Space Weather and Climate change for the (EMA) members (March 2018).



# Future

- We are going to launch the first space weather student activity (space weather club “SWC”).
- International Space Weather Week.

## International Space Weather Week (ISWW)

### Problem:

As we have a Lack of Space Weather outreach for the public, few numbers of researchers seek working on Space Weather field and awareness shortage of Space Weather hazards for both the public and governmental basis.

### Idea:

Setting up an international annual event to distribute the knowledge of Space Weather elements (Sun, Magnetosphere, Atmosphere), its applications and hazards for the public, and attract the kids and students to this field earlier as they would be the Space Weather researchers of the future. As well as to enrich the Space weather scientific community by giving a chance for young researchers to explore this field through lectures and hand on sessions.

### Aim:

- Teach students around the world how to monitor the space weather.
- Encourage the usage of space weather application for scientific and economic development.
- Demonstrate space weather vital role to reach the public and governmental support for space weather projects.
- Enhance international cooperation in space weather education disciplines.
- Better/simple understanding of Space weather impact on the society for public and students.
- Inspire early year's student by this field.

### Targeted groups:

- Kids [G1].
- Elementary, junior, and high school students (special needs student are encouraged to be targeted) [G2].
- Youth, and public [G3].



# Thanks for attention

Thanks United Nations/Argentina  
For Everything 😊

**Ayman Mahrous**

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