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

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

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1. Space Weather Monitoring Center (SWMC)

   An Overview

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# Space Weather Monitoring Center (SWMC)

# Space Weather Monitoring Center (SWMC)

Space Science Division, Faculty of Science, Helwan University

1st Space Weather science generation ( class **2012**)

**www.spaceweather.edu.eg/index.html**



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**

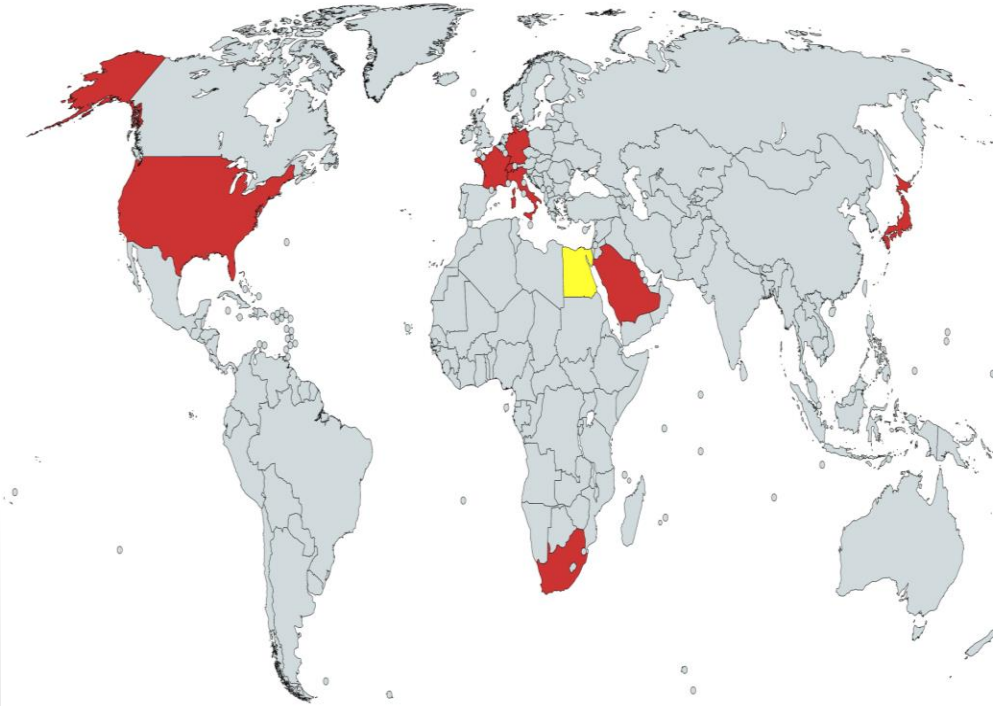
**Cosmic Rays**


**Ionosphere**

**Magnetism**

# International Collaborations

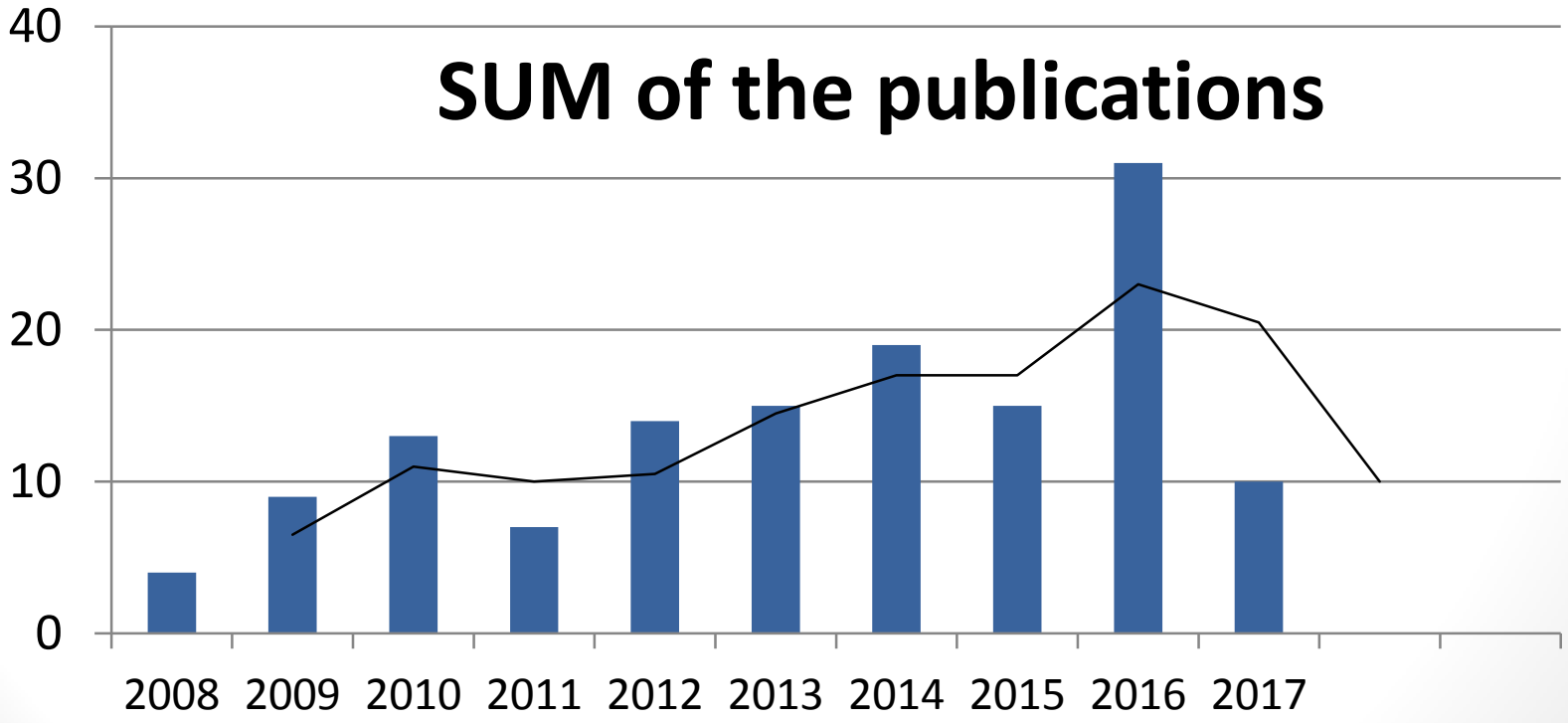
- The map below shows the collaborating countries (red) with (**SWMC**) in Egypt (Yellow) through projects from 2007 till 2017.



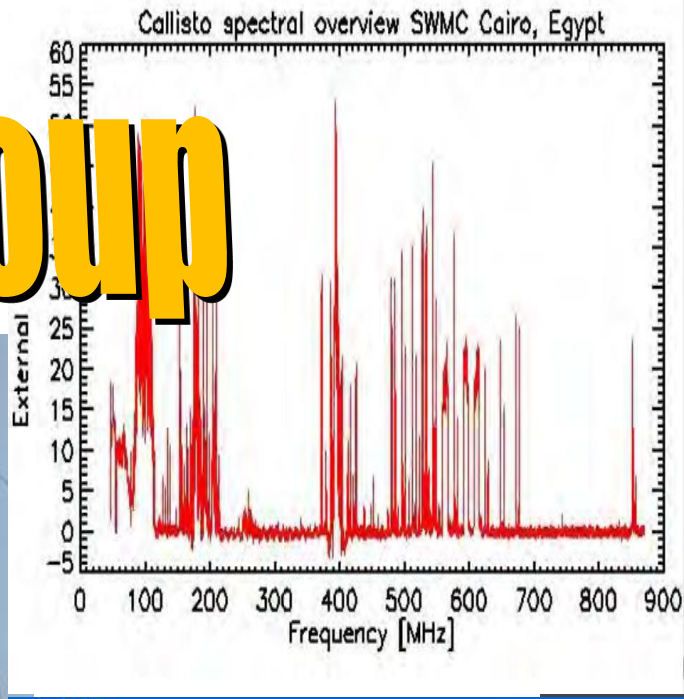
- Kyushu University (Japan)
- Polytechnic University of Milan (Italy)
- The Northern Borders University (Saudi Arabia)
- University of Texas, Boston college and Stanford Solar Center (USA)
- DLR, Neustrelitz (Germany)
- ETH Institute of astronomy, Zurich, and CERN (Switzerland)
- South Africa Space Agency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

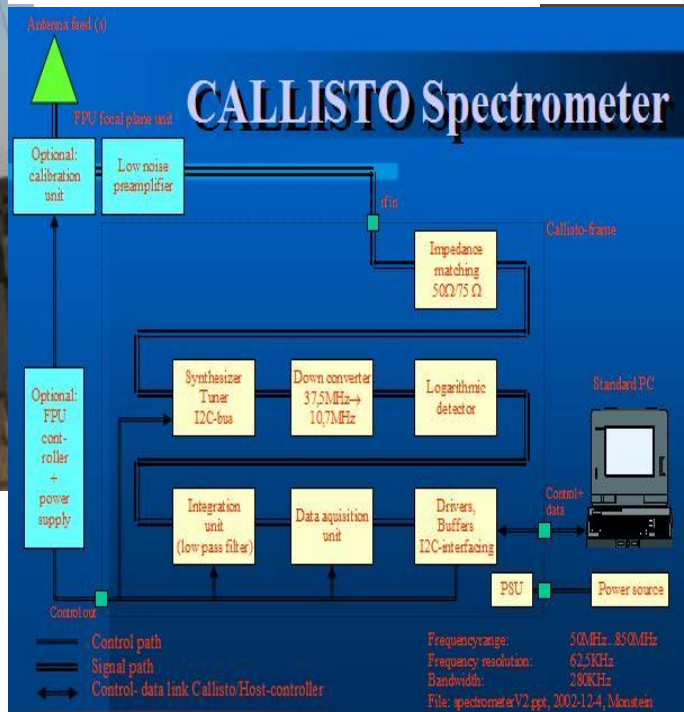
# Research

- 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.

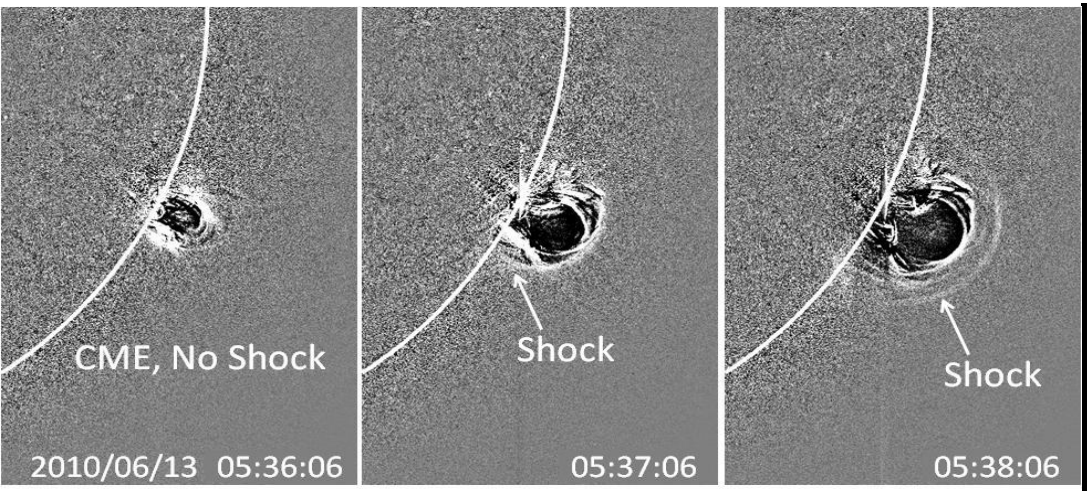


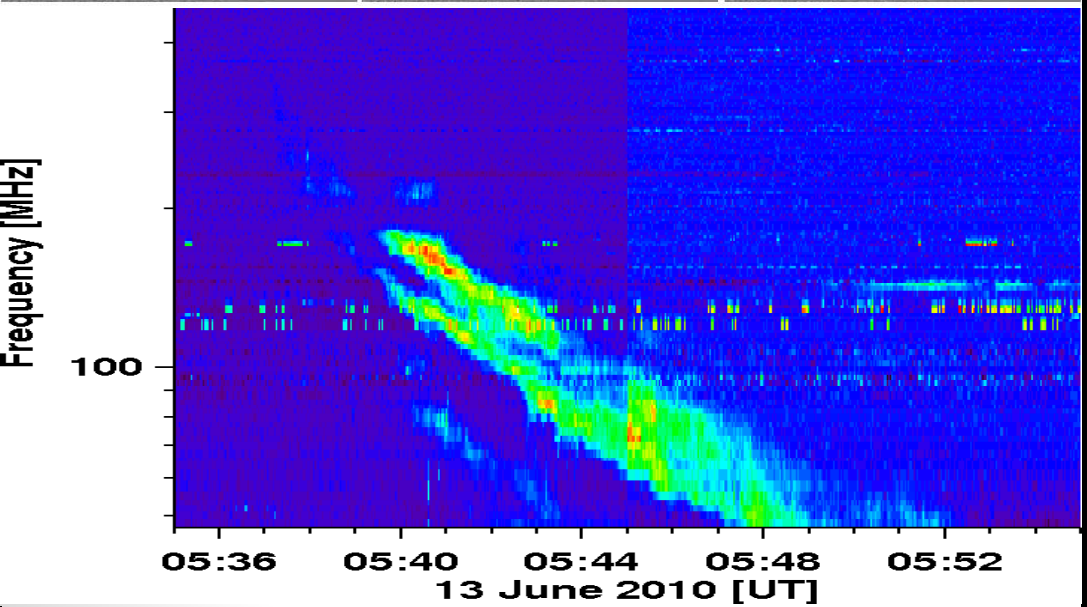
# Solar Physics Group

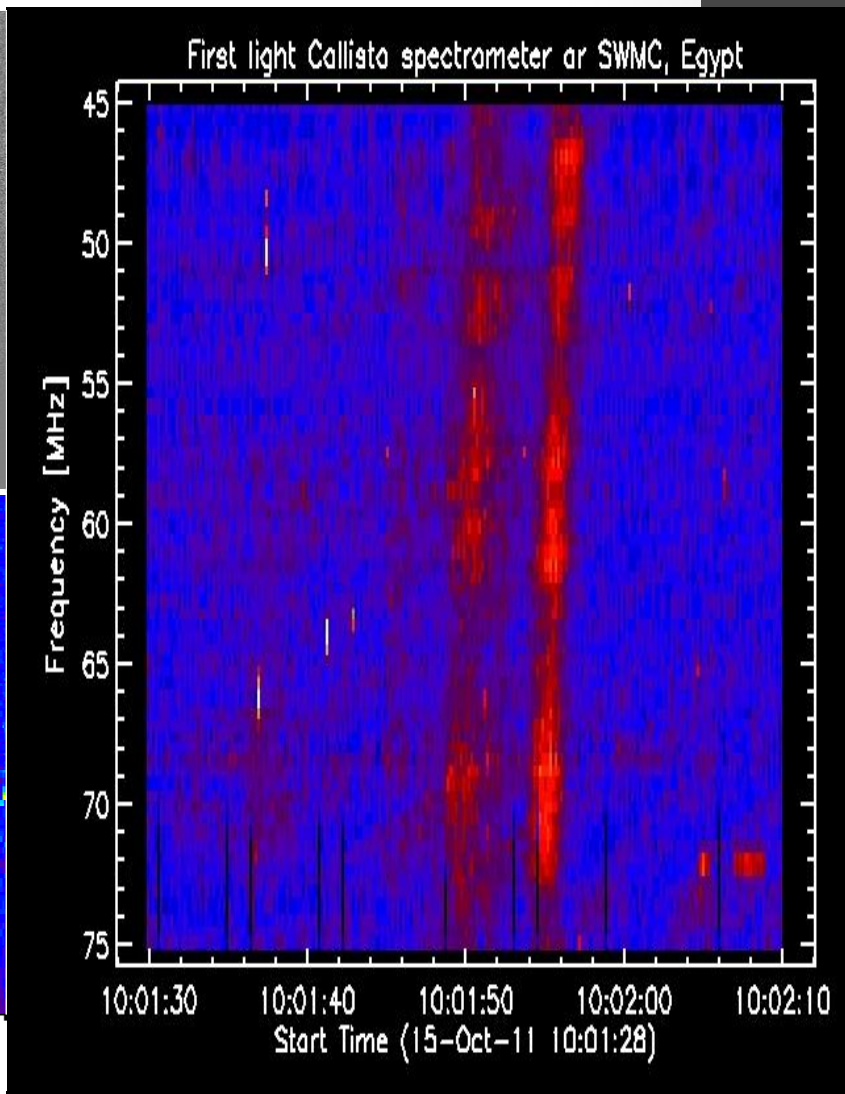


# What we get from CALLISTO

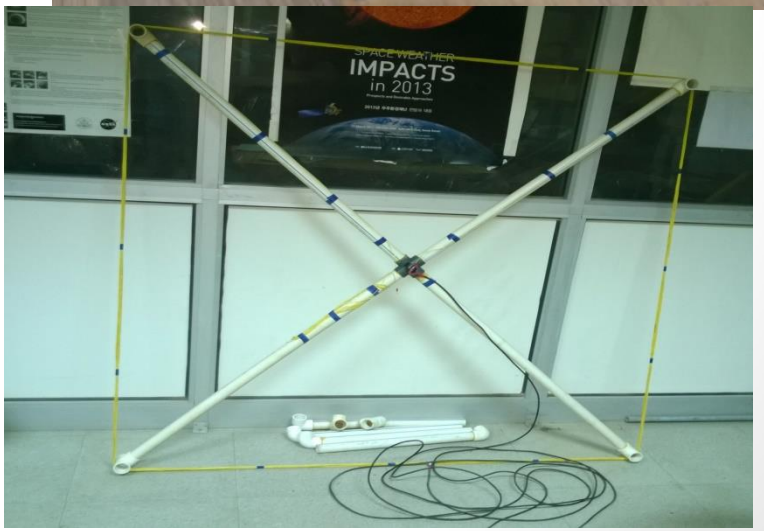


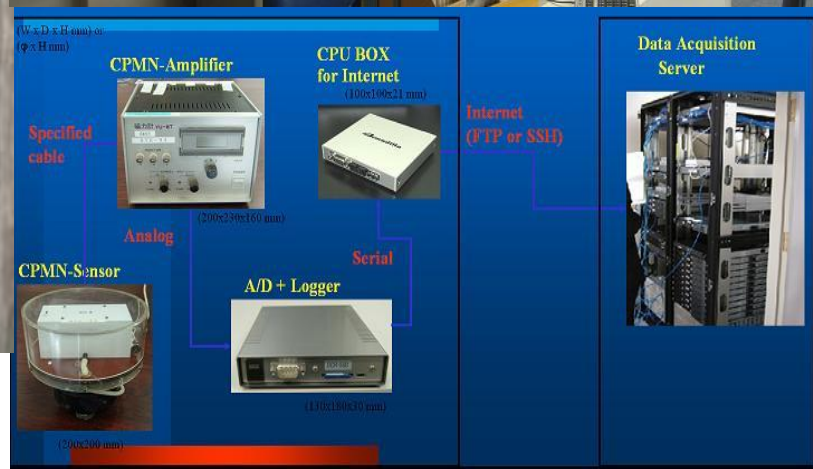
# SOlar Flares detected by Ionospheric Effects (SOFIE) .

- 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

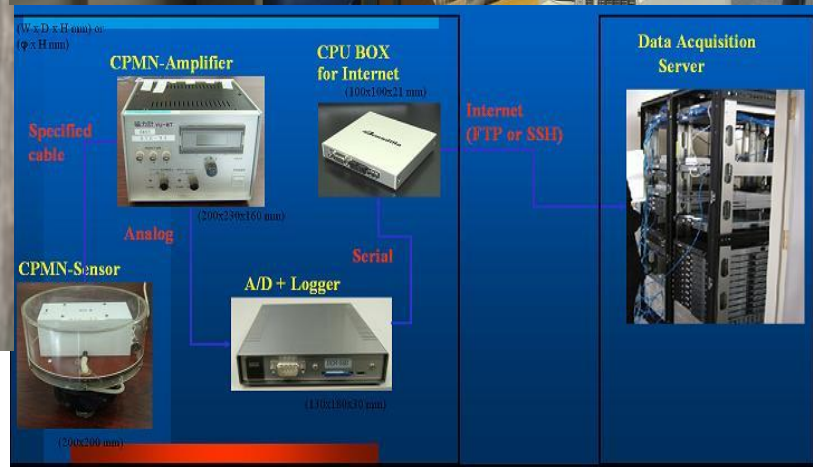

GMLon,



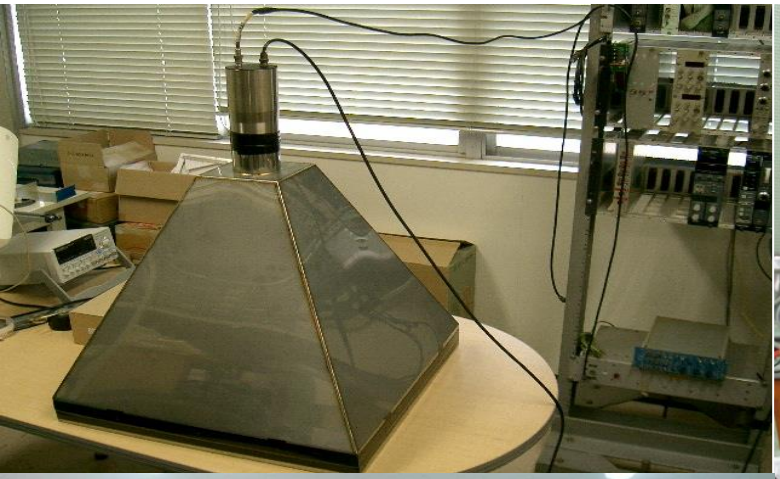
# Installation of MAGDAS at FYM

# MAGDAS-II installation at ASW & FYM


GMLon,

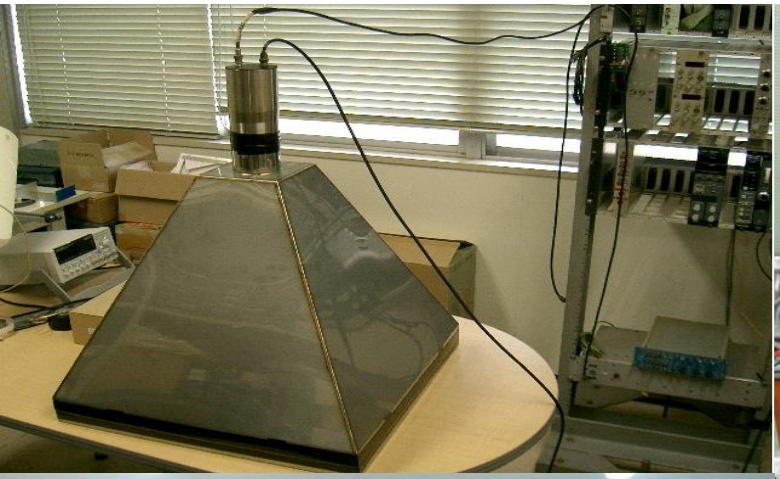


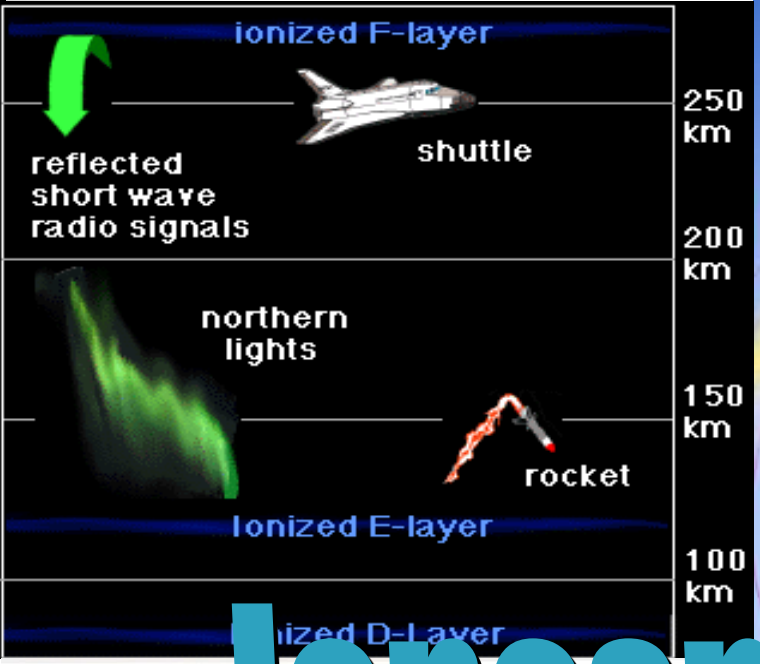
# Cosmic Ray Group

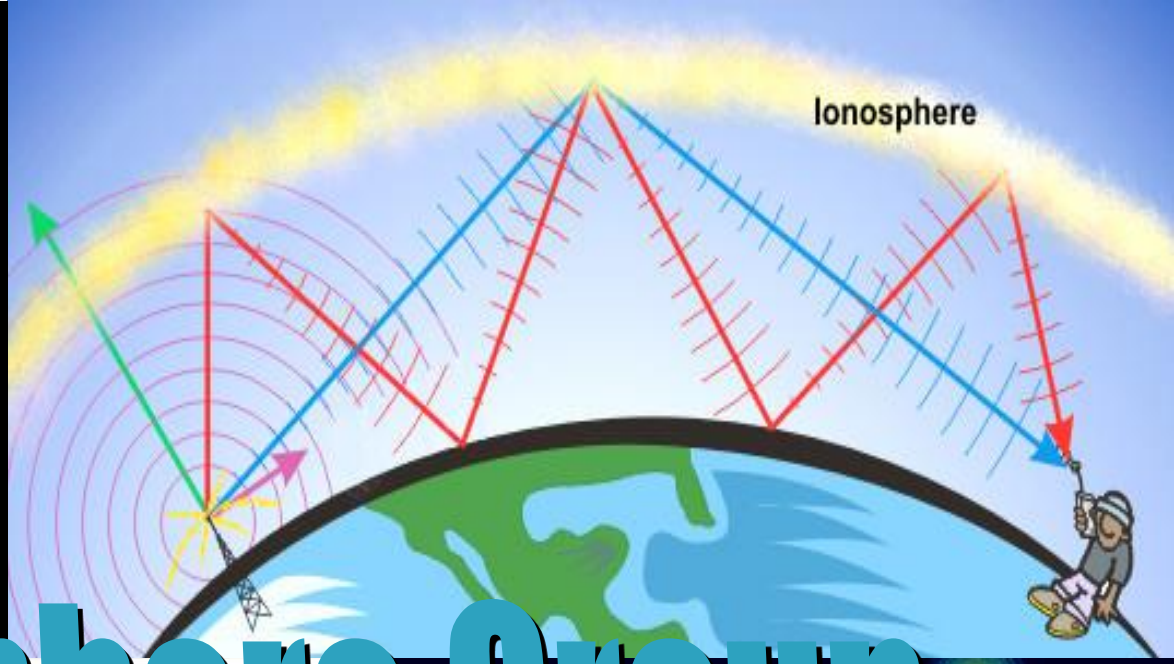


# Joint Project with CERN

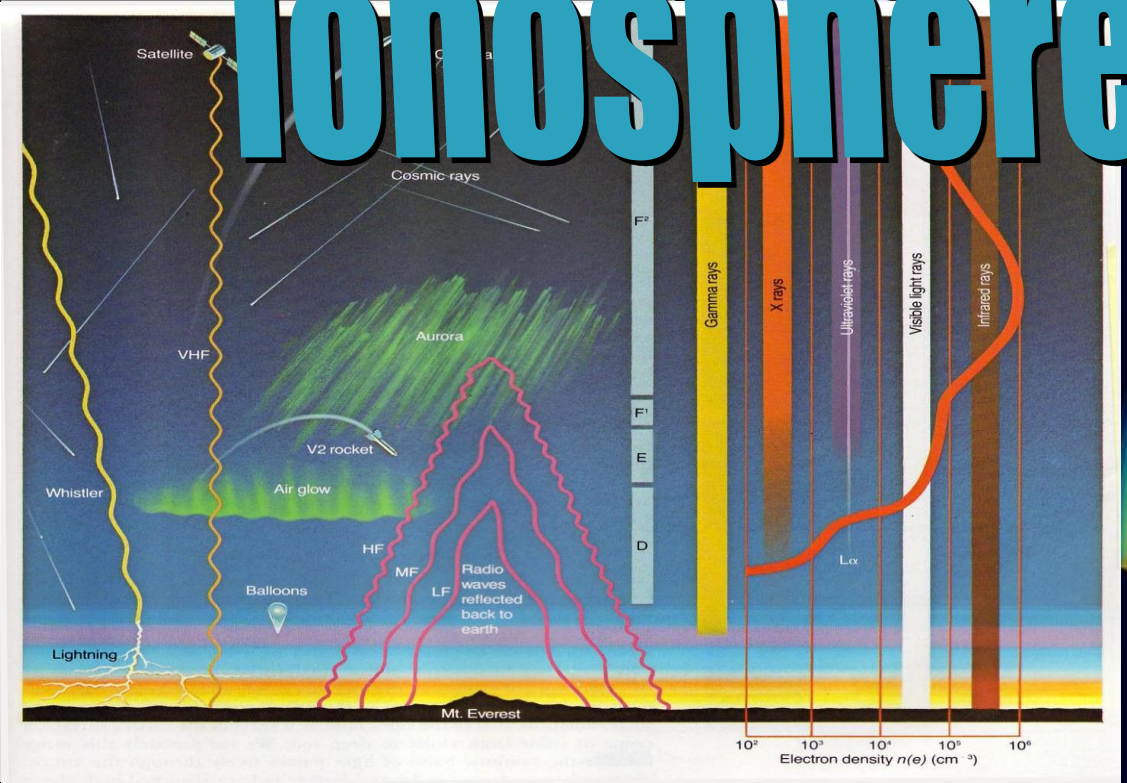
# Testing of RPC at SWMC Lab.

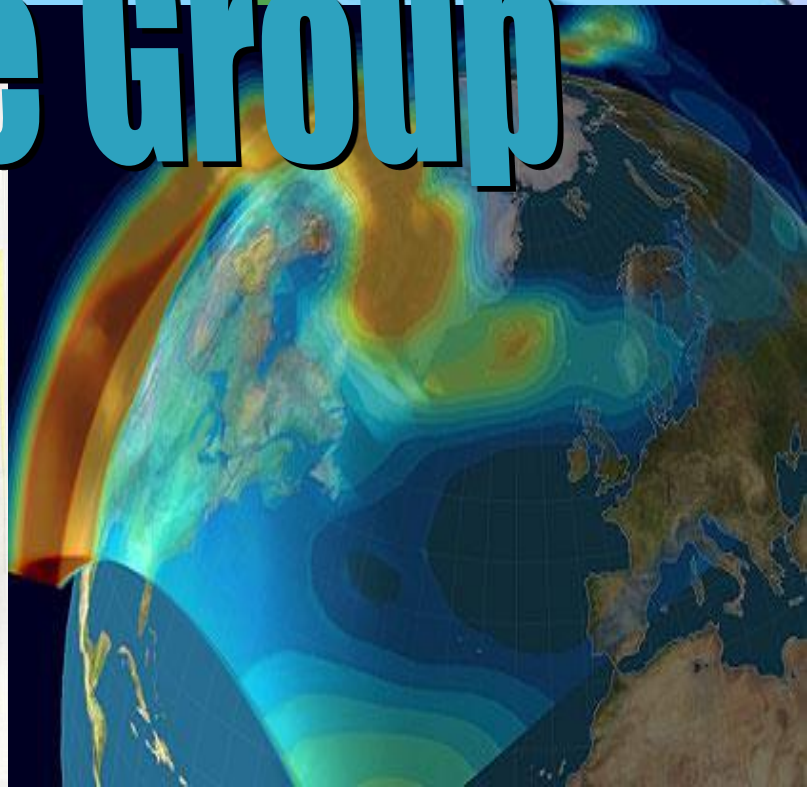




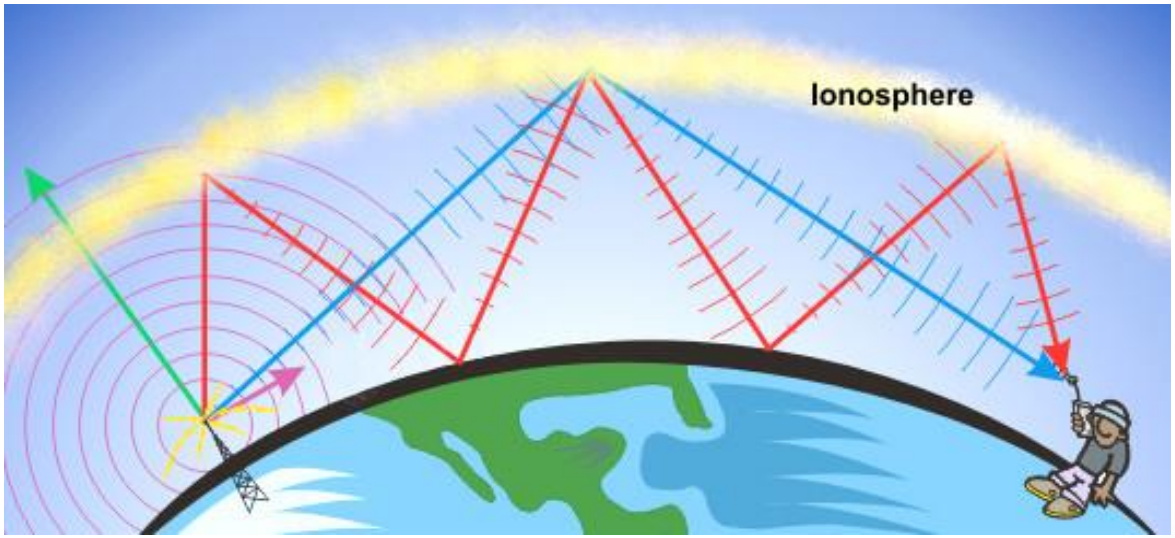

# Ionosphere Group



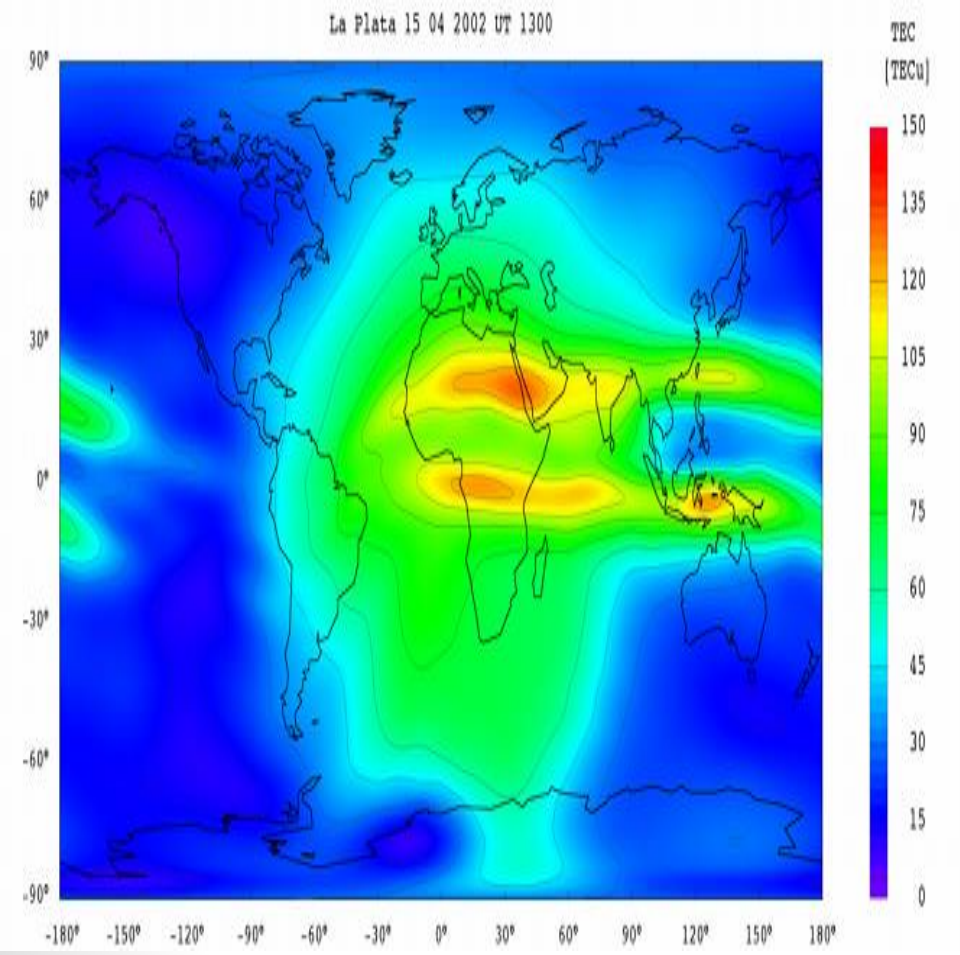



# Ionosphere group

- 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 ?



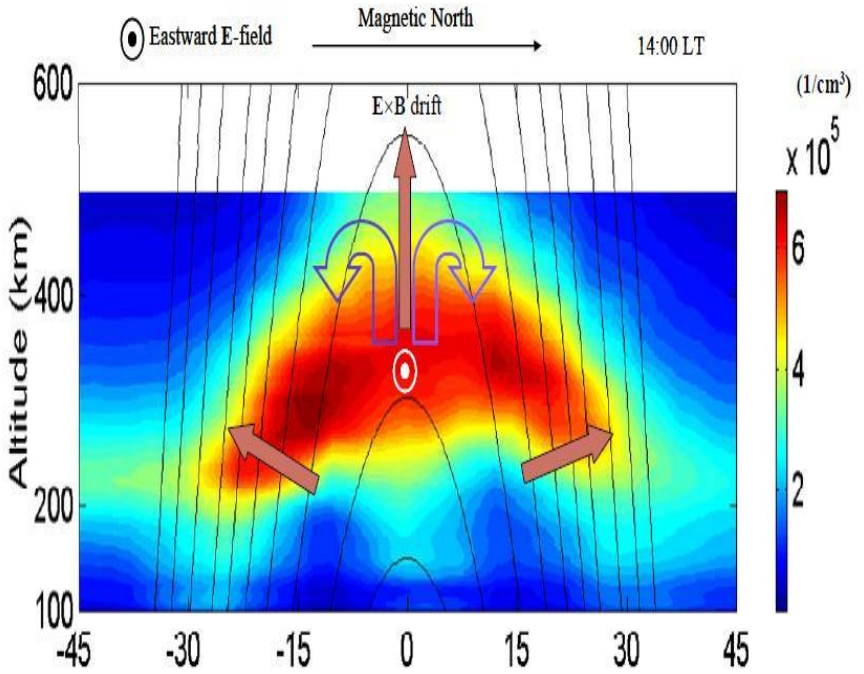
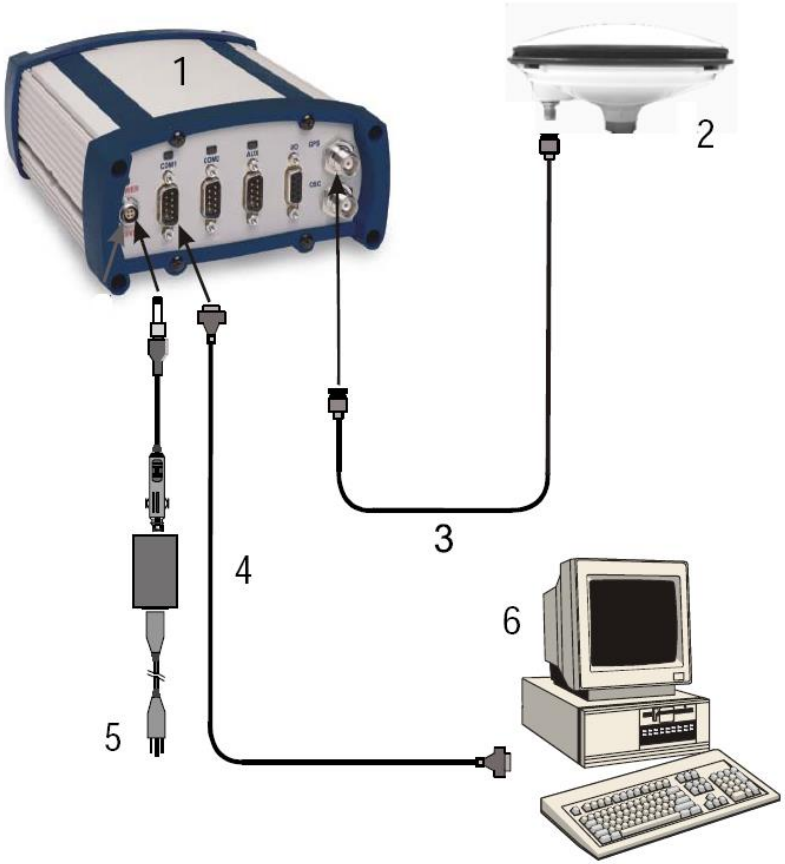




**Figure 1.5.** Contour is the altitude profile of plasma density at 14LT, black lines are magnetic field lines and arrows stand for the directions of ion drifts [courtesy of Liu and Lin, 2006].

# GPS System at Helwan (SCINDA)




1: GPS receiver

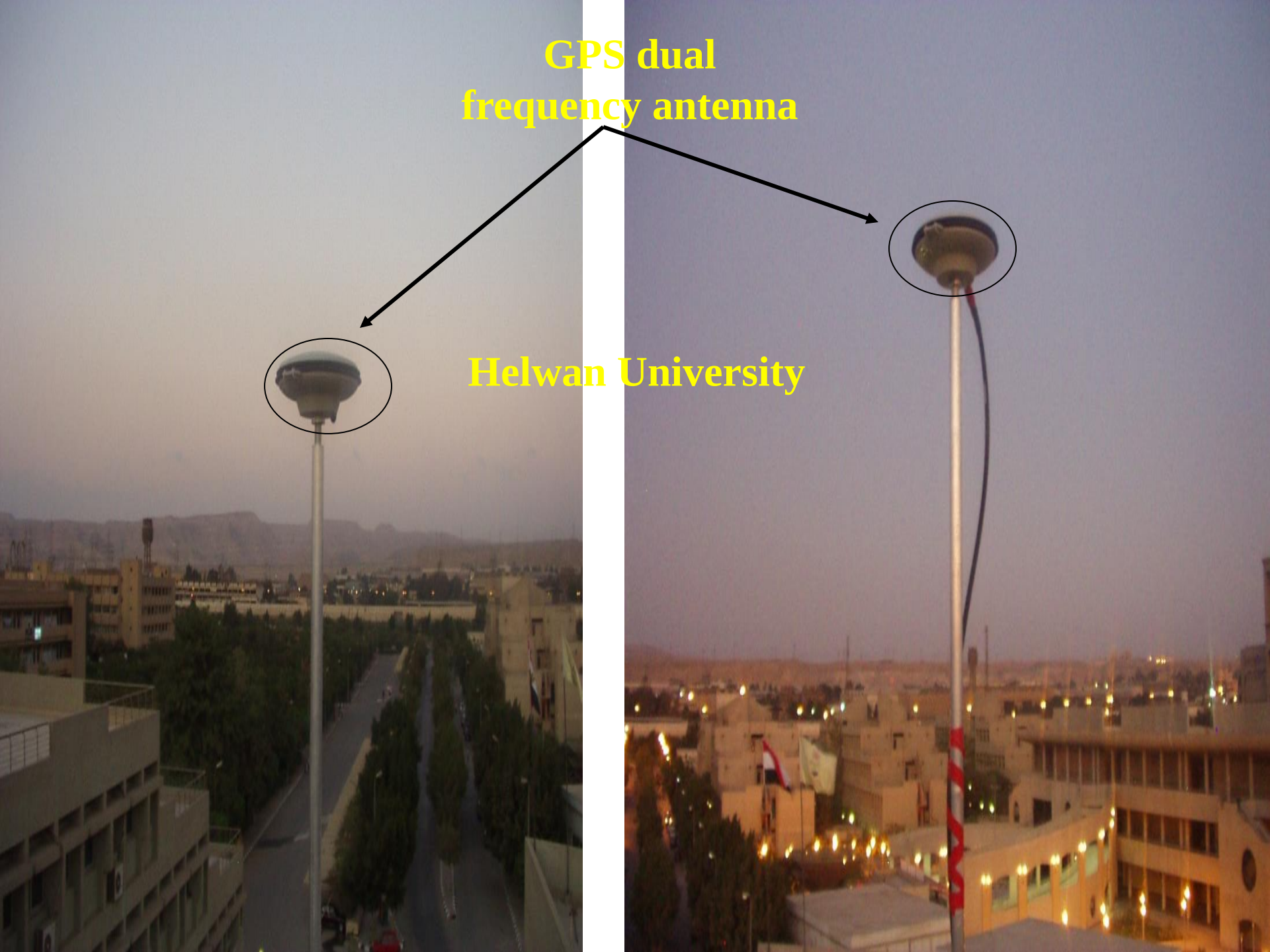
2: GPS dual frequency antenna

3: Antenna cable (30 meter maximum)

4: Serial cable

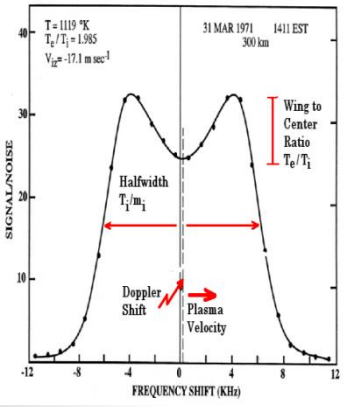
5: Power cable

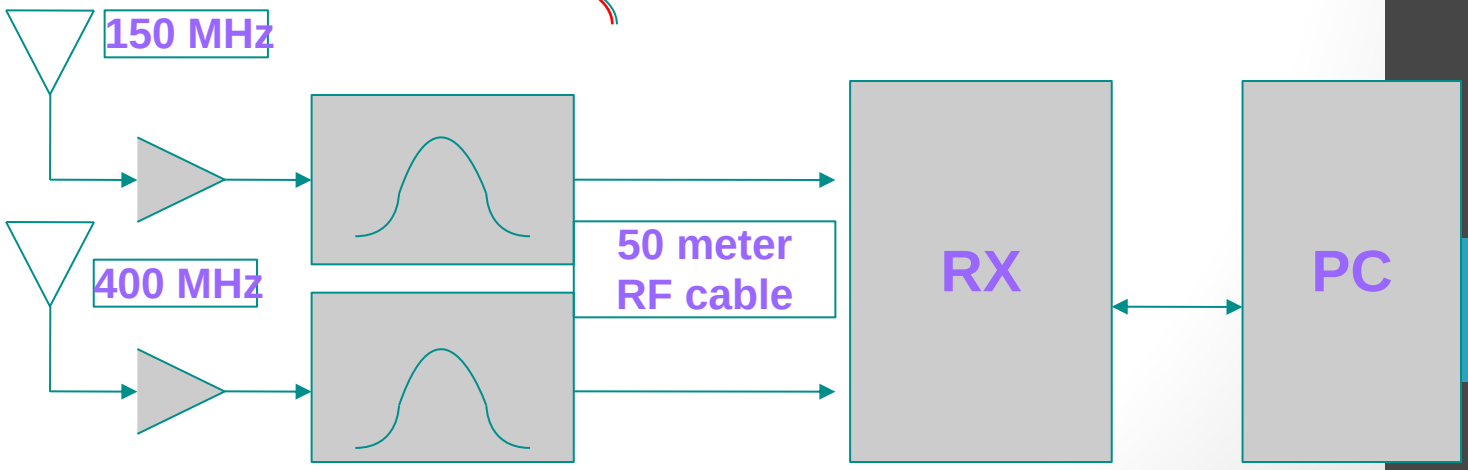
6: Personal computer running Linux


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

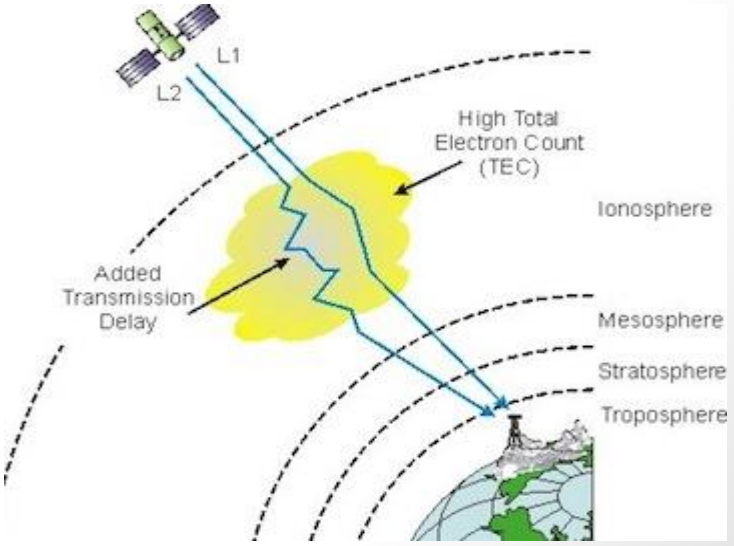



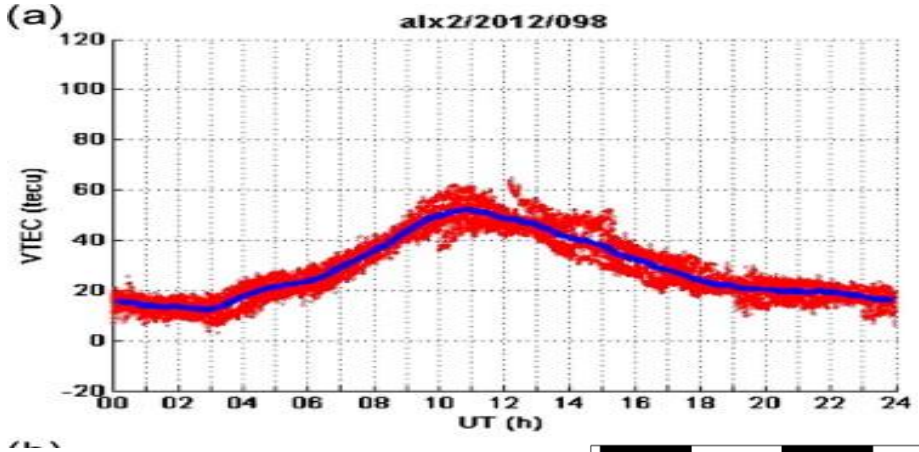
# Ionosphere group work using GNSS:

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

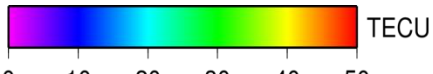
1. **Ionosphere Mapping (TEC)**
2. **Ionospheric phenomena (Gravity waves)**
3. **Ionospheric phenomena (Travelling Ionospheric Disturbances "TID")**
4. **Ionospheric irregularities level (Rate of TEC"ROTI" )**
5. **Amount of water vapor.**



# 1. Ionosphere Mapping (TEC)

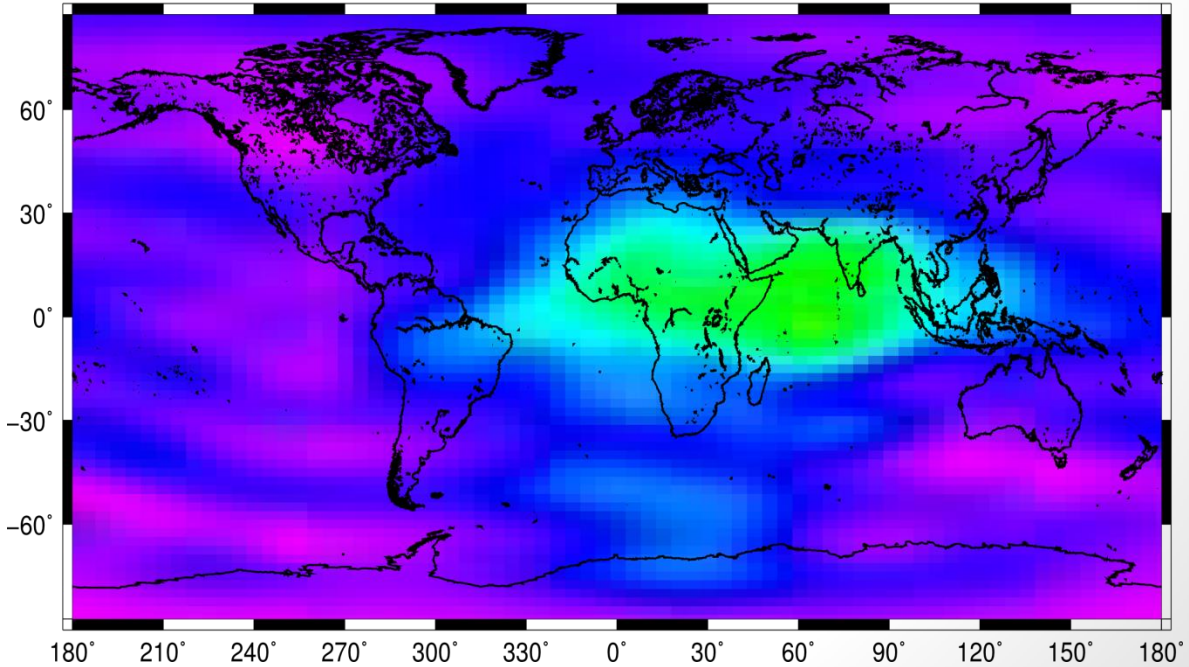



**VTEC measurements**

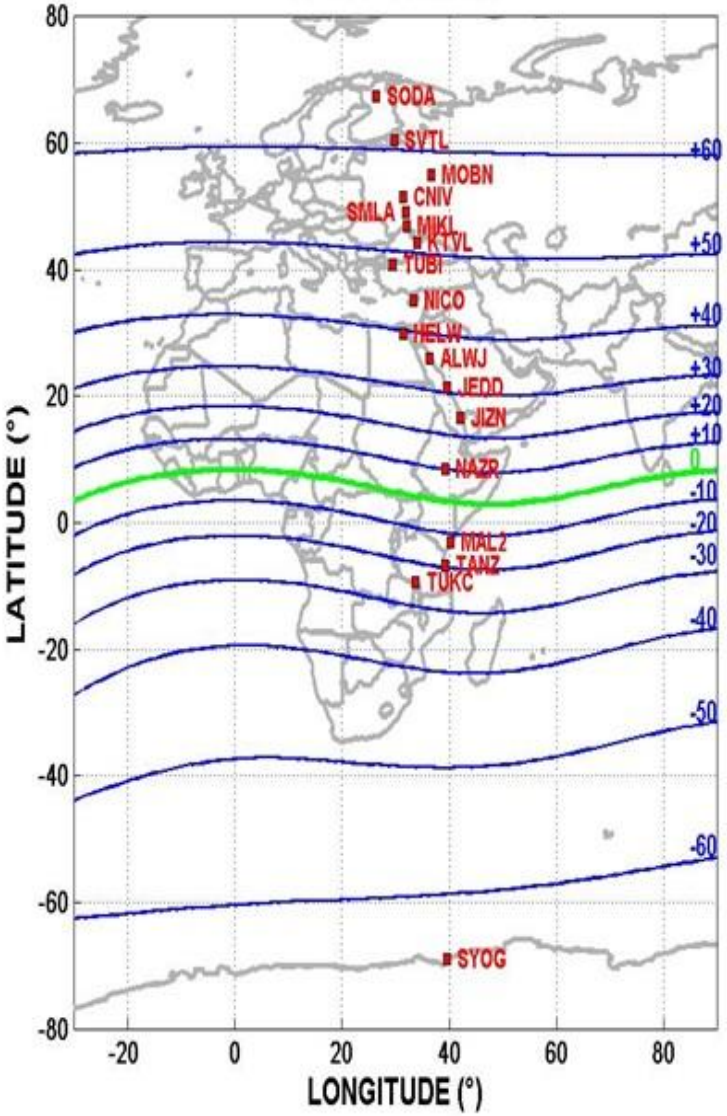


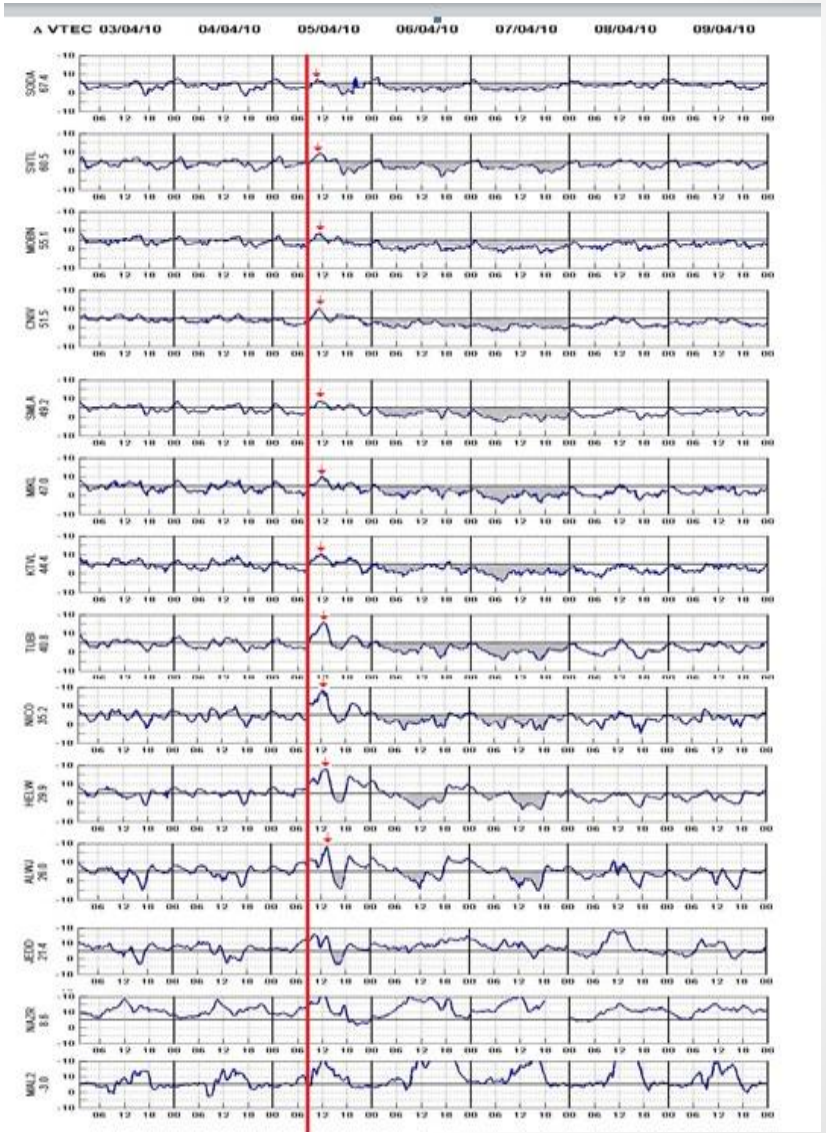

**03/21/2009**
**12h (UT)**

**Global Ionospheric Maps (GIM)**



# 2. Ionospheric phenomena (Gravity waves)

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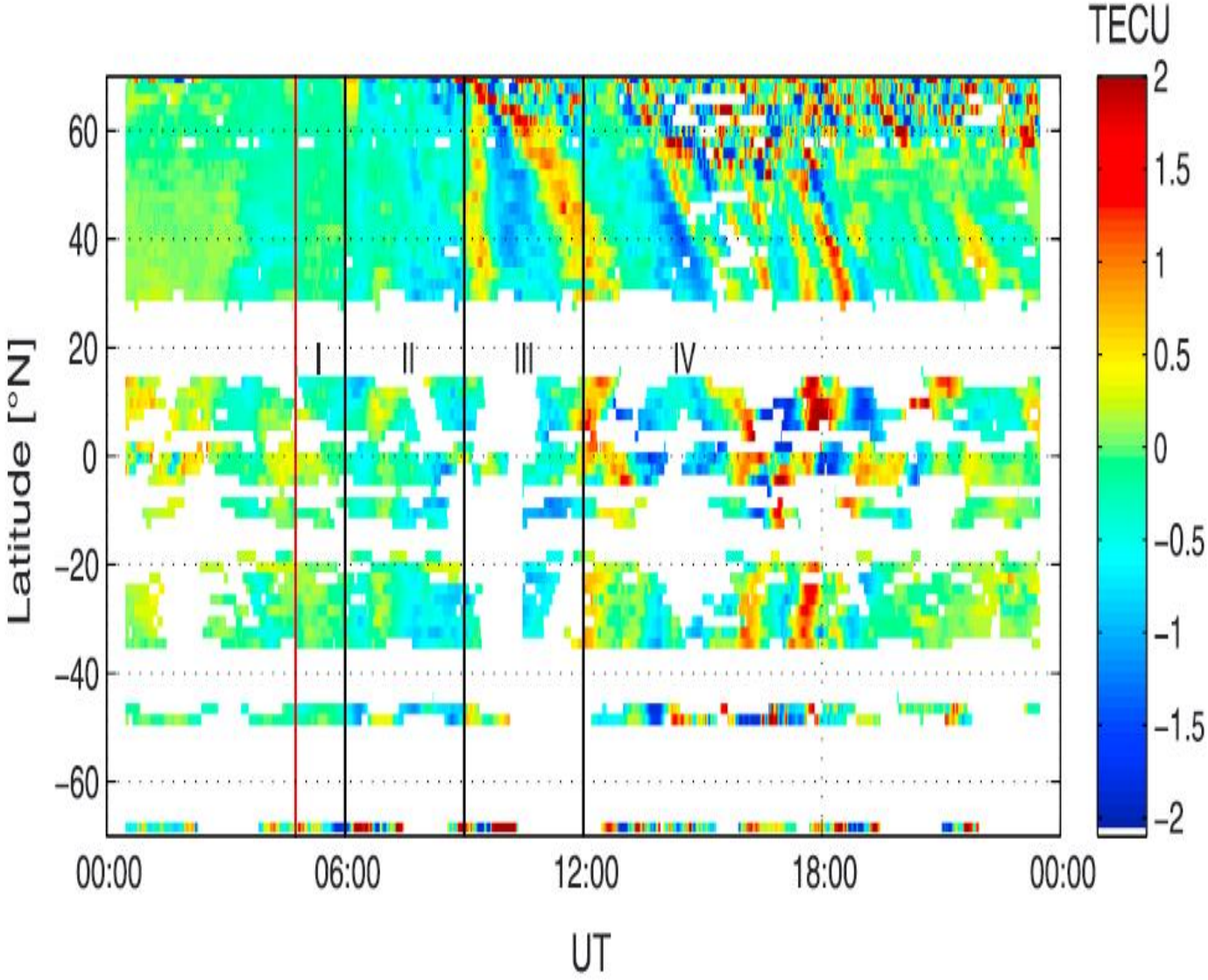
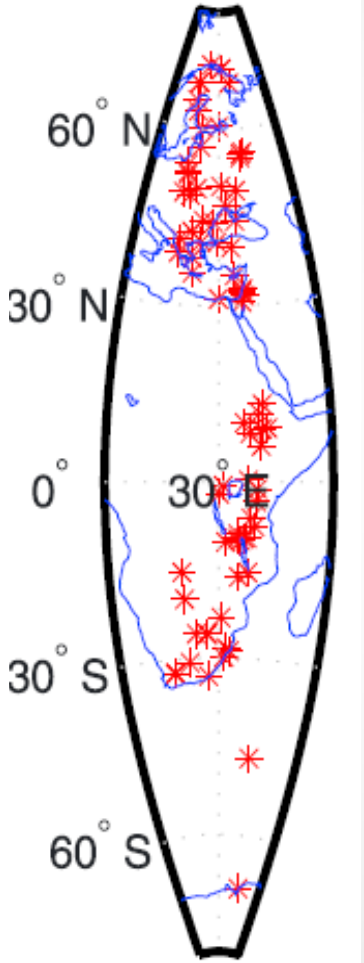
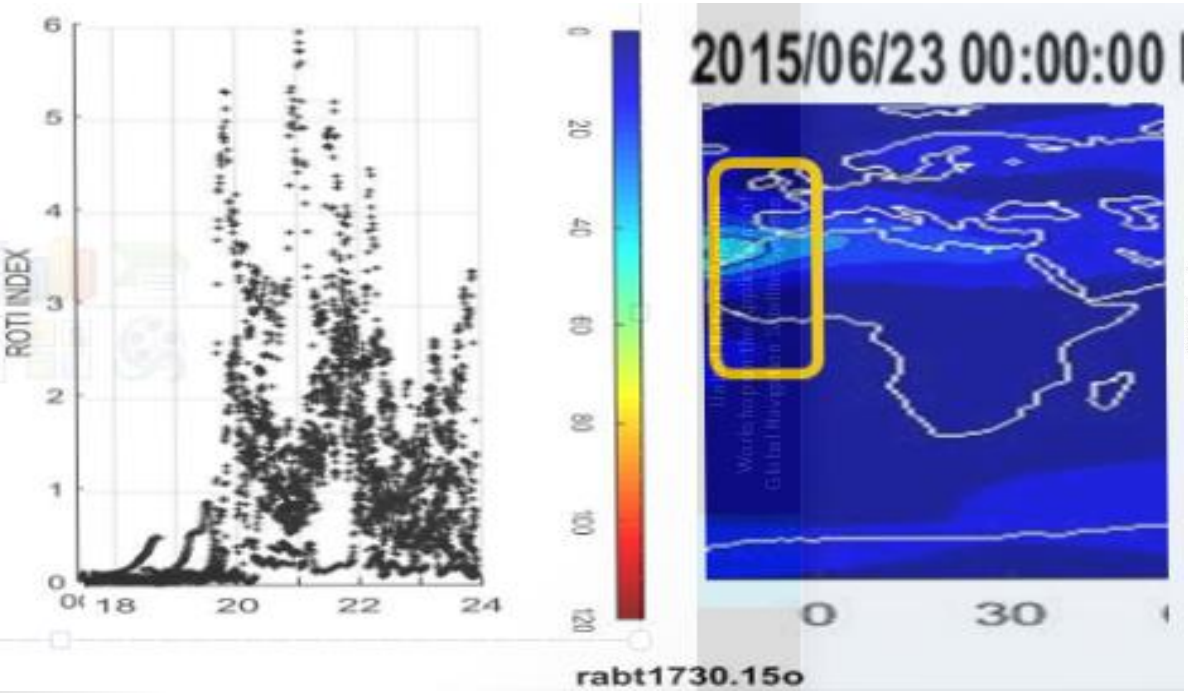
# 3. Ionospheric phenomena (Travelling Ionospheric Disturbances “TID”)

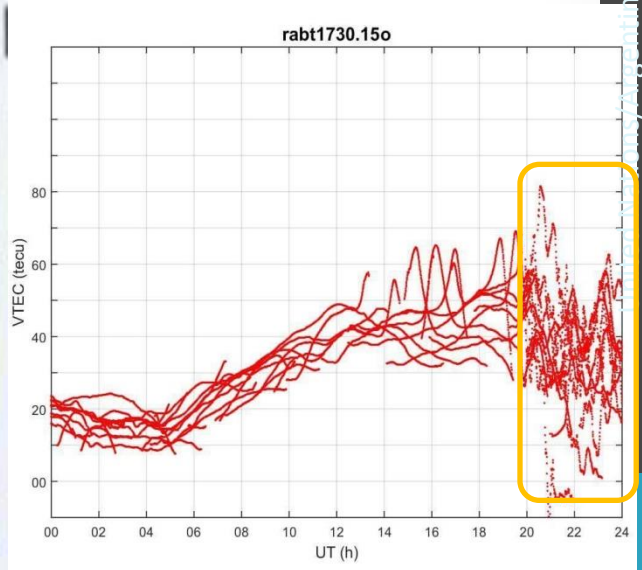


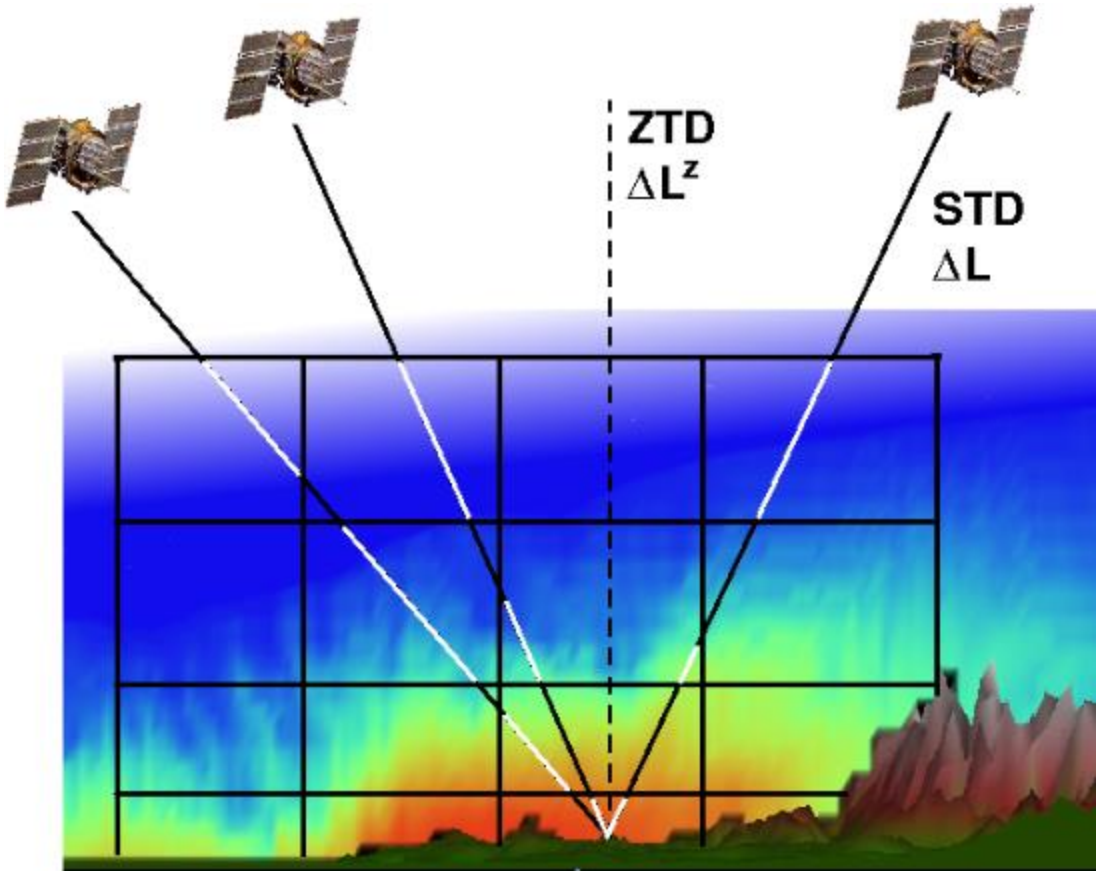
# 4. Ionospheric irregularities level (Rate of TEC"ROTI" )

As indicator for plasma bubbles



# 5. Amount of water vapor



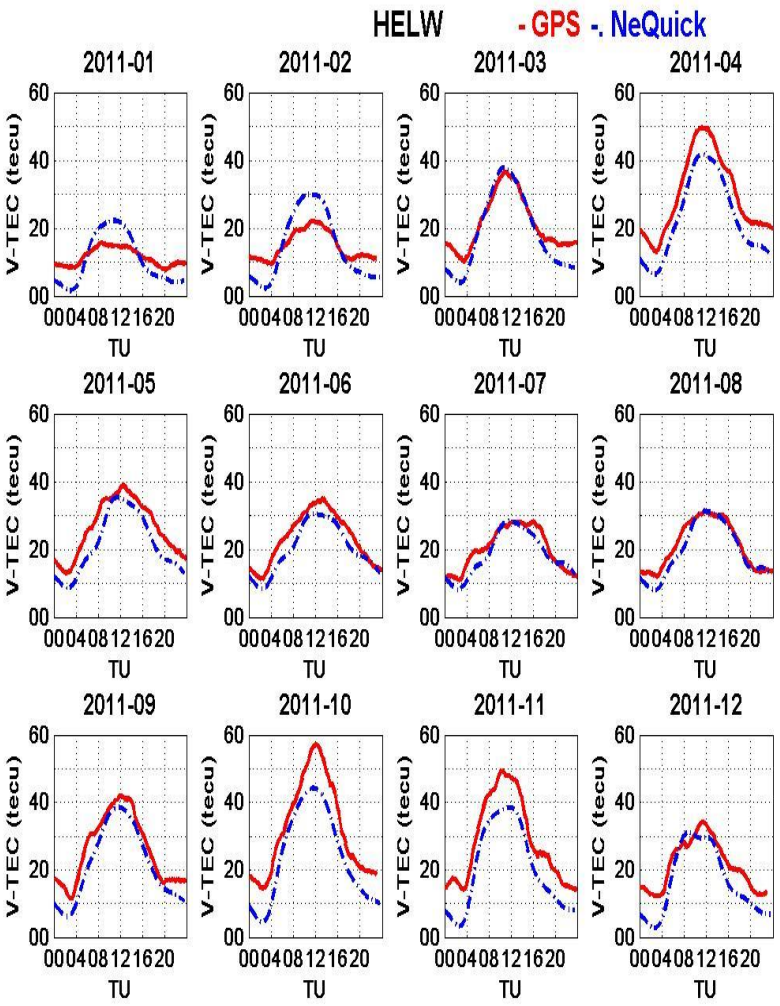
# Current status of IG GNSS related work

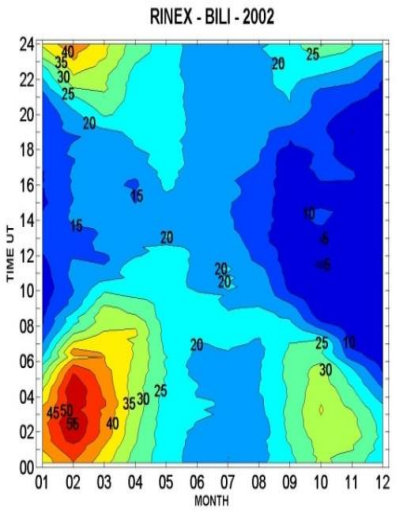
- Observing Ionospheric phenomena during quiet, disturbed time.
- Comparing GNSS results with different models and different data sets.

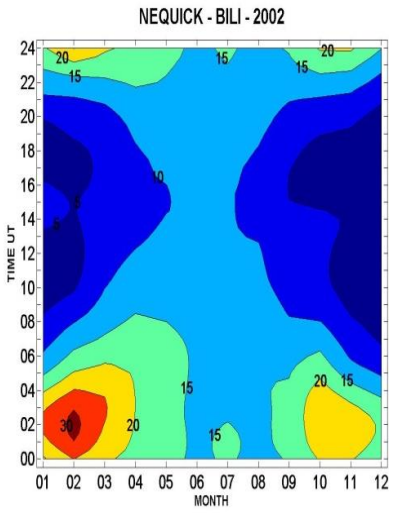
# Future work of IG GNSS related work

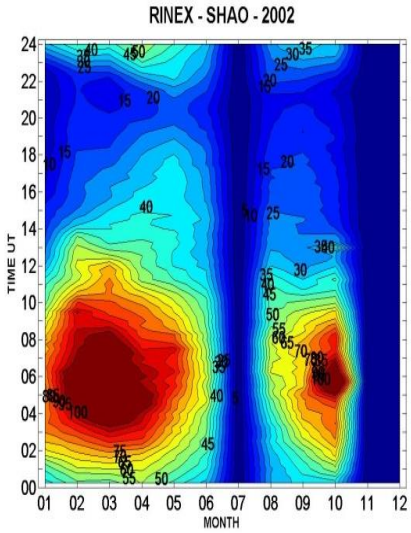
- **Ionosphere mapping by multiple data sets (complementary work) with GNSS (covering gaps)**
- **Ionospheric Forecasting**

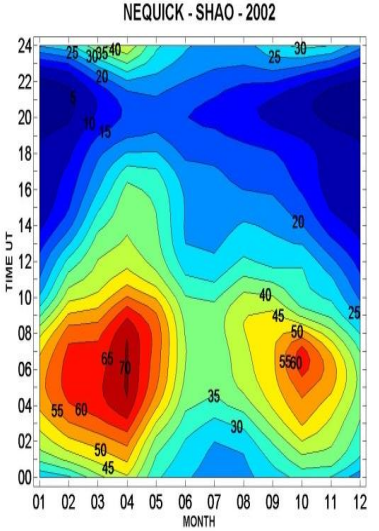
# NeQuick & GPS-TEC Comparison



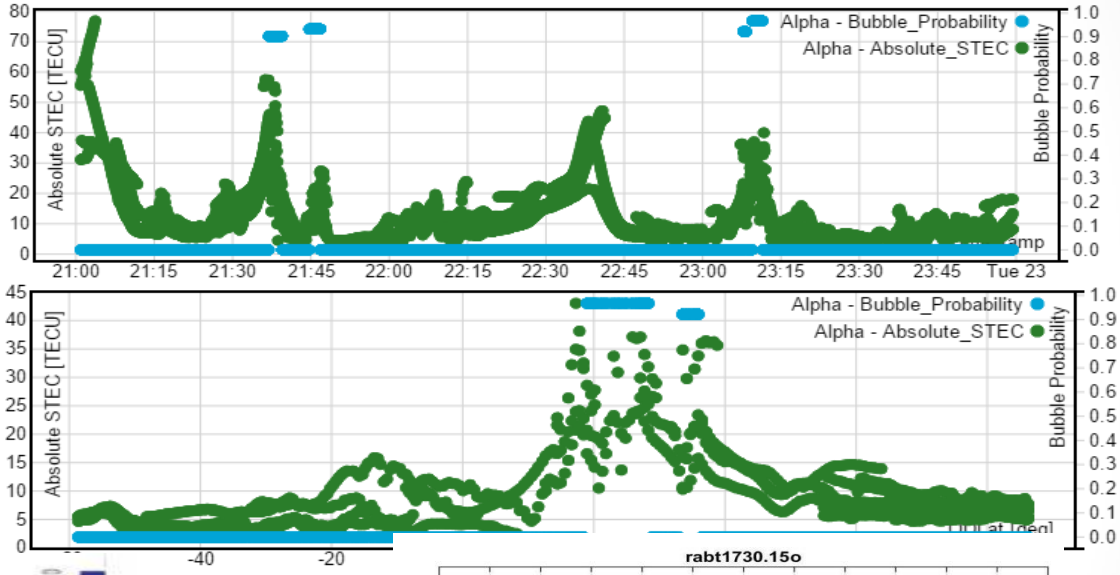



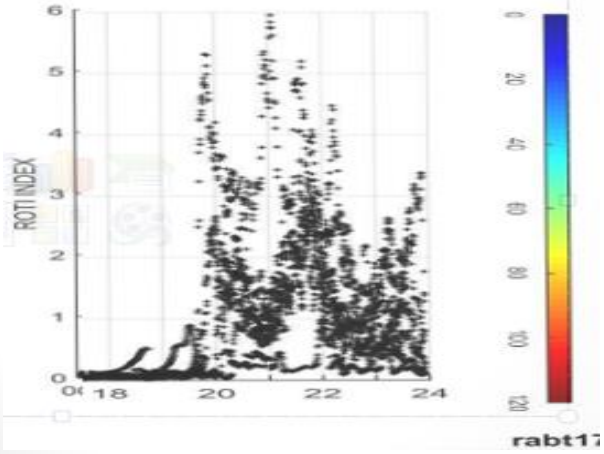



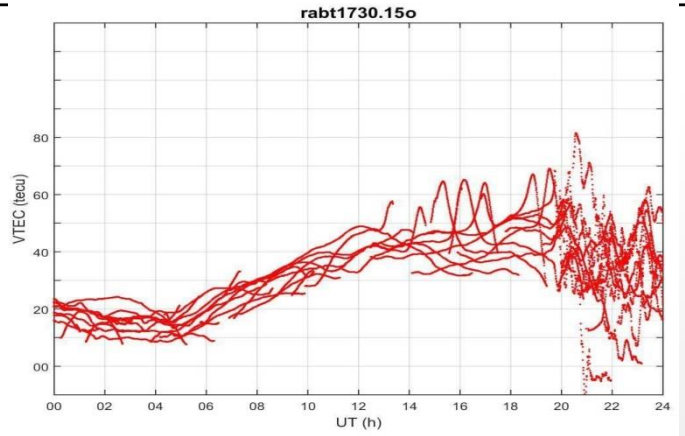
# GNSS vs SWARM

**SWARM/A**




**GNSS**

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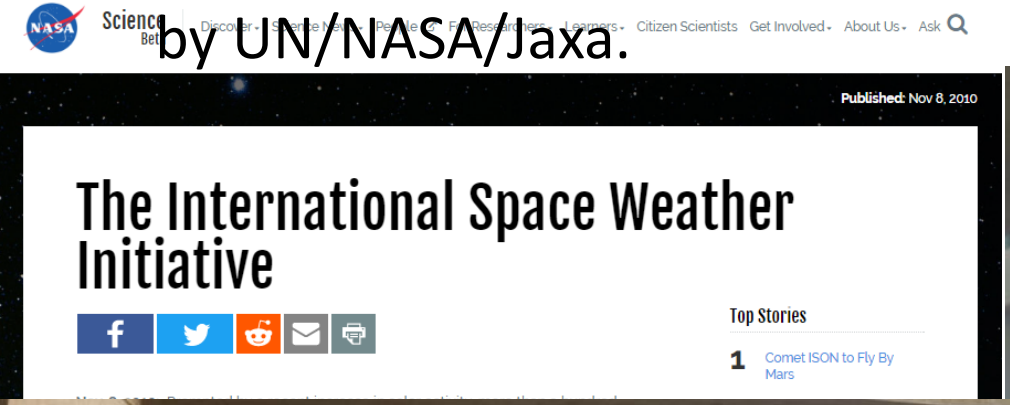
# Capacity building and outreach activities at (SWMC)

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

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




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

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

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

# An Annual Space Weather Summer School (SWSS)

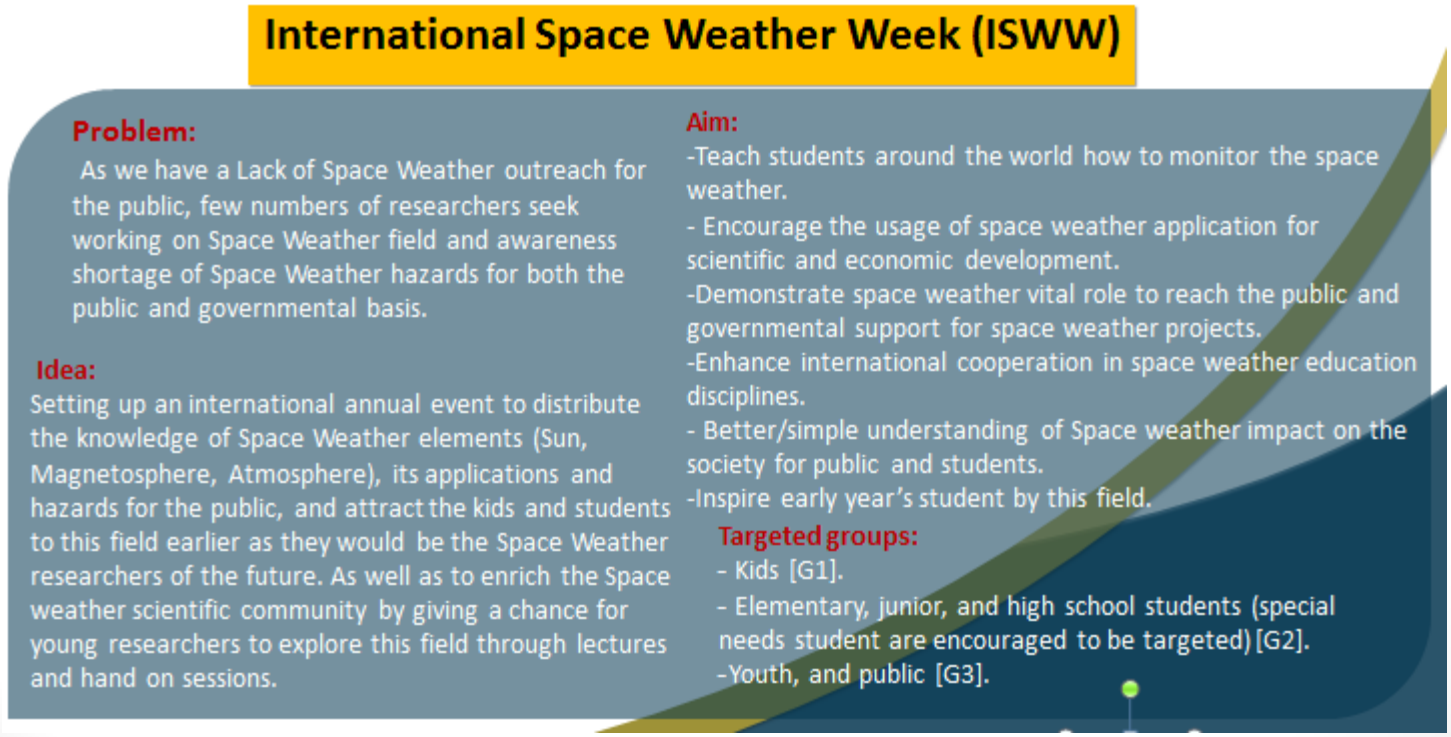
- From 2010 till 2017  we had six successful l local Space Weather Summer Schools (SWSS) were held at (SWMC)
- About +200 of undergraduate students and researchers participated.

# 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 lunch the first space weather student activity (space weather club “SWC”).
- International Space Weather Week.

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***www.spaceweather.edu.eg/index.html***