



# Bridging the Gap: Advancing Space Weather Services for Aviation in Egypt

**Abdalla Shaker**  
Space Environment Engineer  
Egyptian Space Agency



# Outline:

- Space Weather Basics
- Importance of Space Weather for Aviation
- Space Weather Services in Egypt
- Conclusion

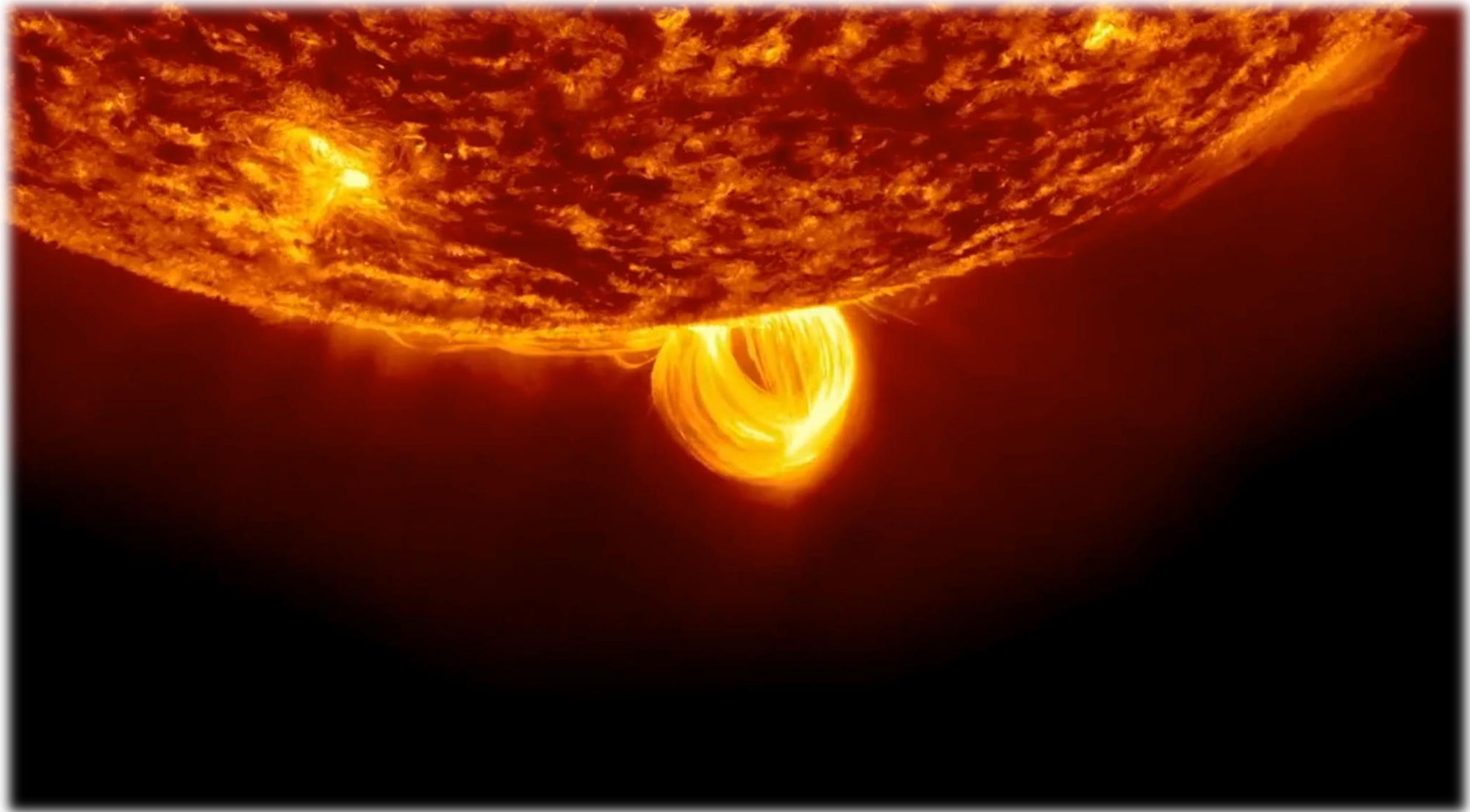
# Space Weather:



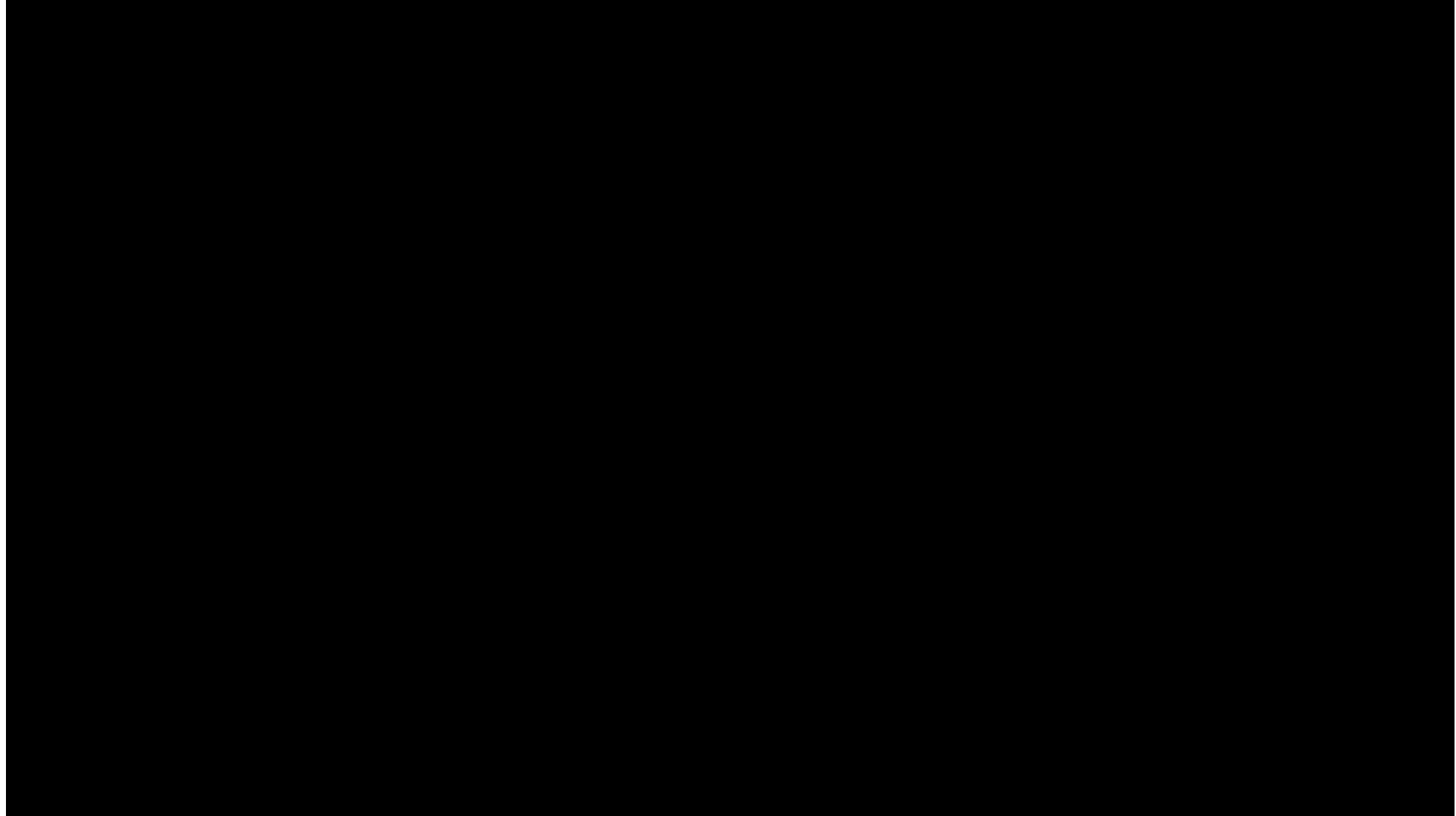
**Space weather** is the physical and phenomenological state of natural space environments. The associated discipline aims, through observation, monitoring, analysis and modelling, at understanding and predicting the state of the Sun, the interplanetary and planetary environments, and the solar and non-solar driven perturbations that affect them; and also at forecasting and nowcasting the possible impacts on biological and technological systems.

The origin of Space Weather:

The Sun



# Solar Cycle from Space

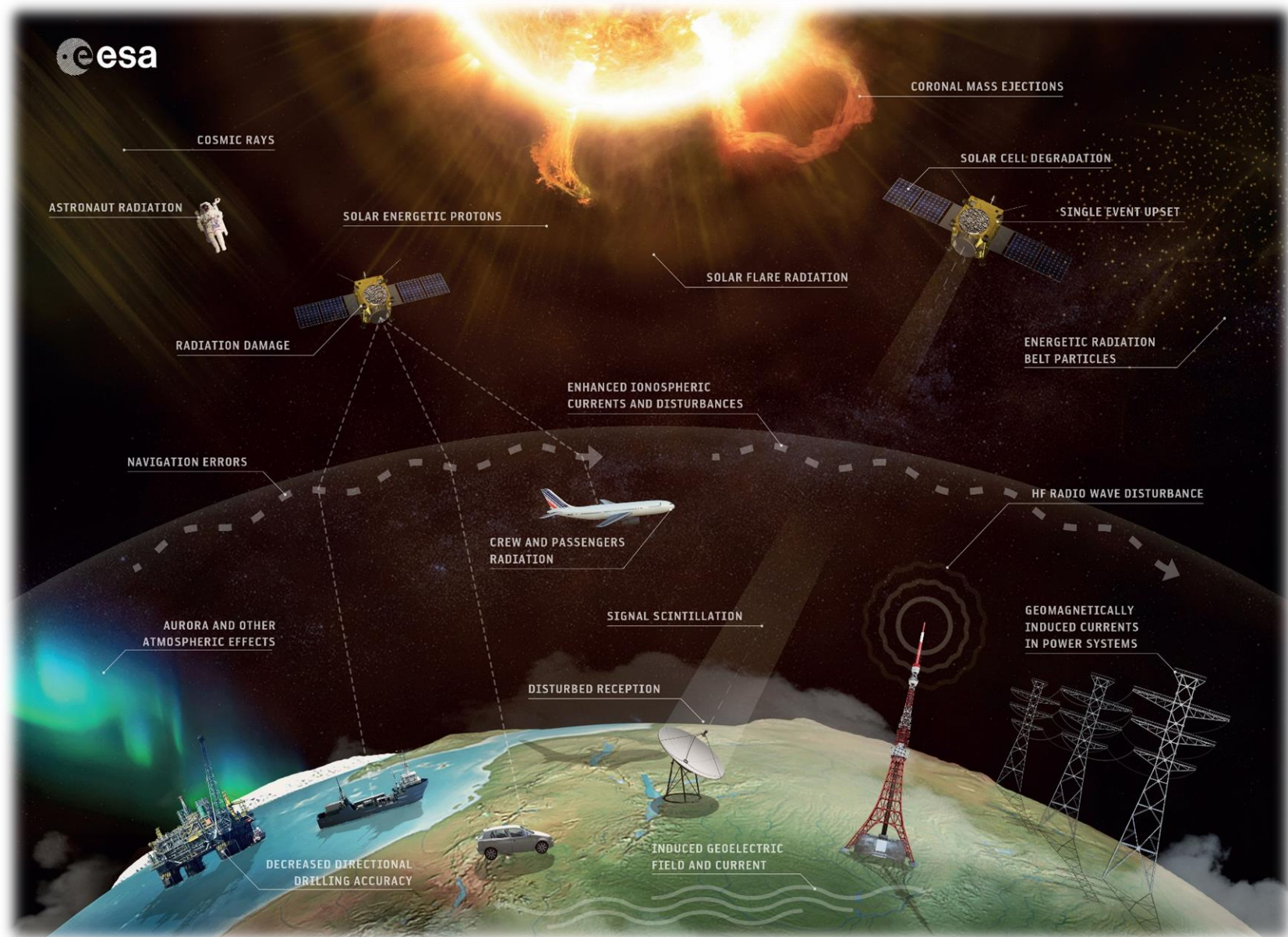


The Sun is a dynamic star: always active and constantly changing.  
The manifestation of solar activity can cause deep disturbances of the physical conditions of the near-Earth space that can last for several days

# Importance of Space Weather:

In economy today, numerous sectors are potentially affected by space weather.

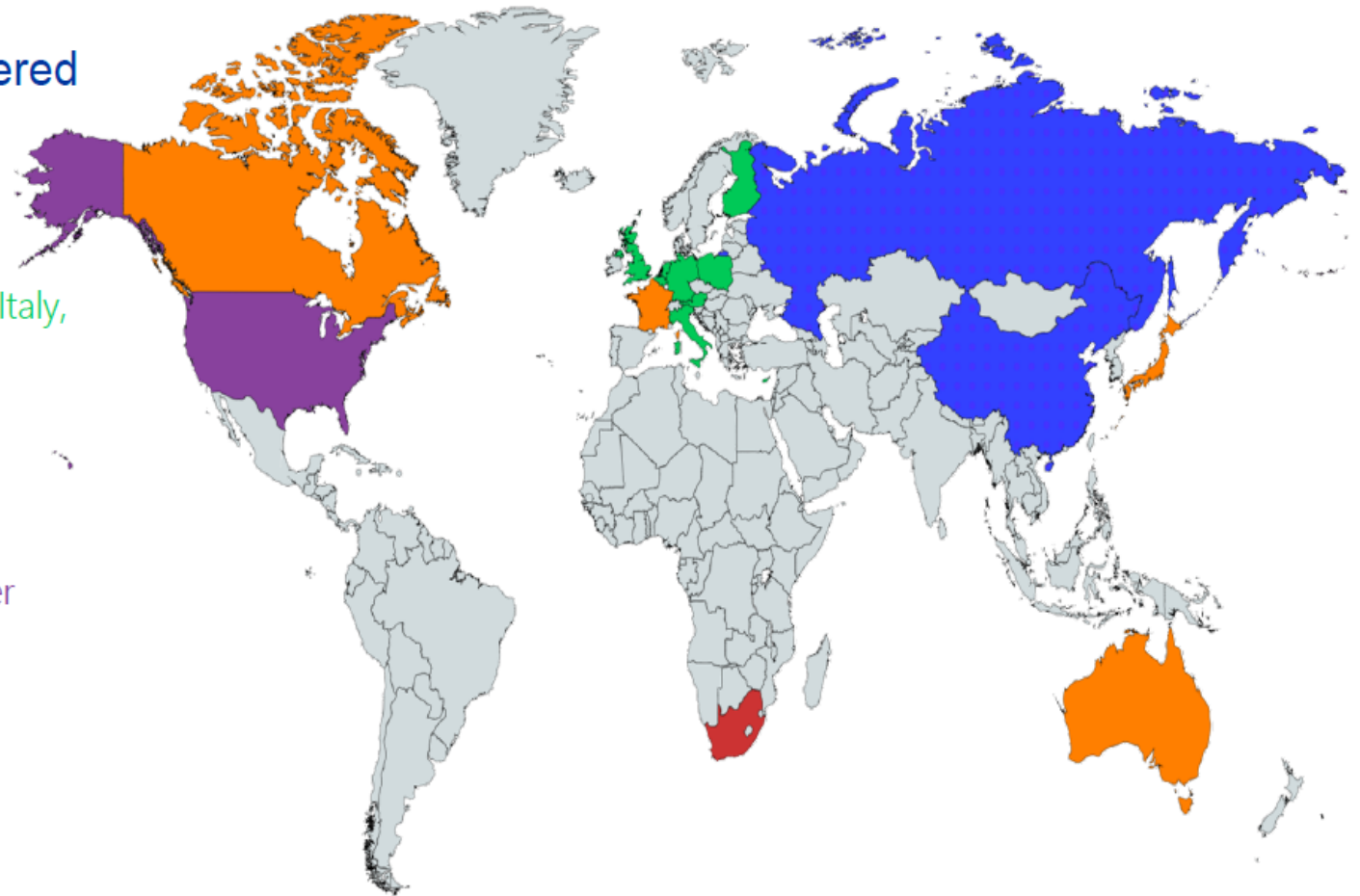
Each of these service domains has a need for **space weather data and services.**



# The biggest customer ever of a Space Weather service /Data: the International Civil Aviation Organization



- Designated ICAO Centers
  - Four Global – Consortiums are considered one center
    - PECASUS (European consortium lead by Finland)
      - Austria, Belgium, Cyprus, Finland, Germany, Italy, Netherlands, Poland, South Africa, United Kingdom
    - ACFJ (Australia, Canada, France, Japan)
    - United States
      - NOAA Space Weather Prediction Center
    - China/Russian Federation Consortium (Beginning 2021)
  - One Regional
    - South Africa

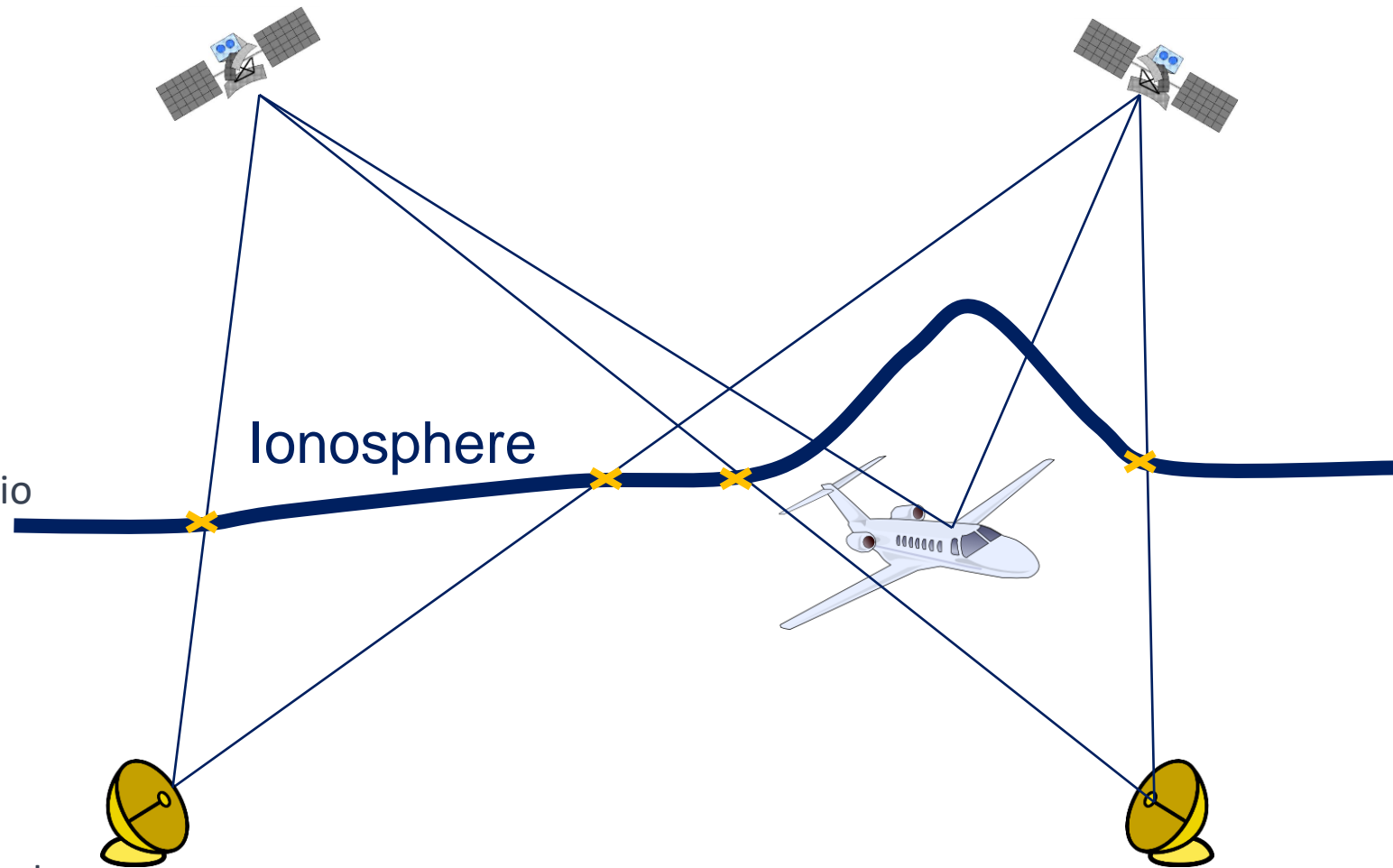


## Space Weather Data

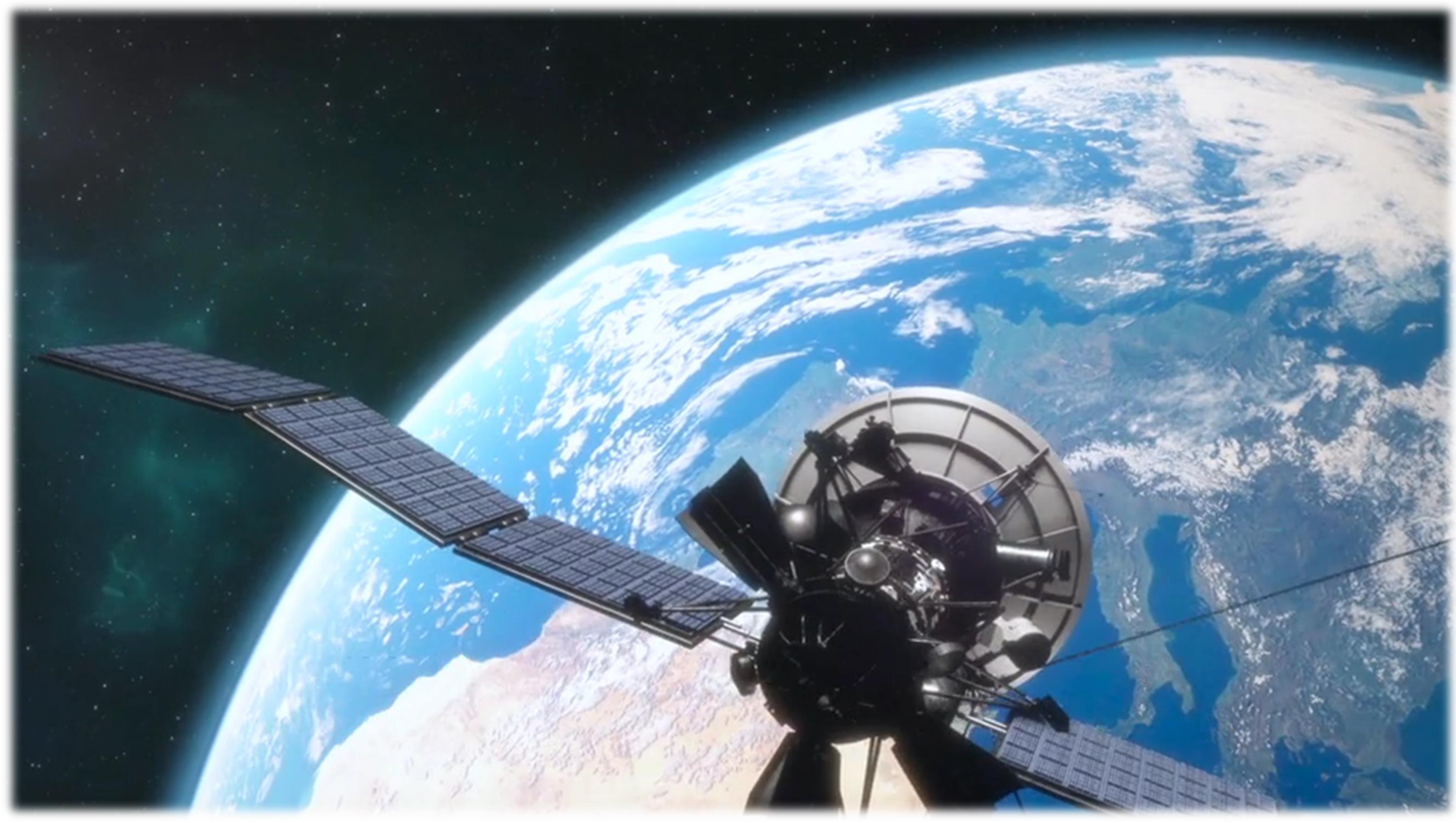
**Vertical Total Electron Content (VTEC)** is the measure of the total number of free electrons in a vertical column of Earth's atmosphere above a specific location.

**Ionospheric scintillation** refers to rapid and irregular variations in the amplitude and phase of radio signals passing through the Earth's ionosphere.

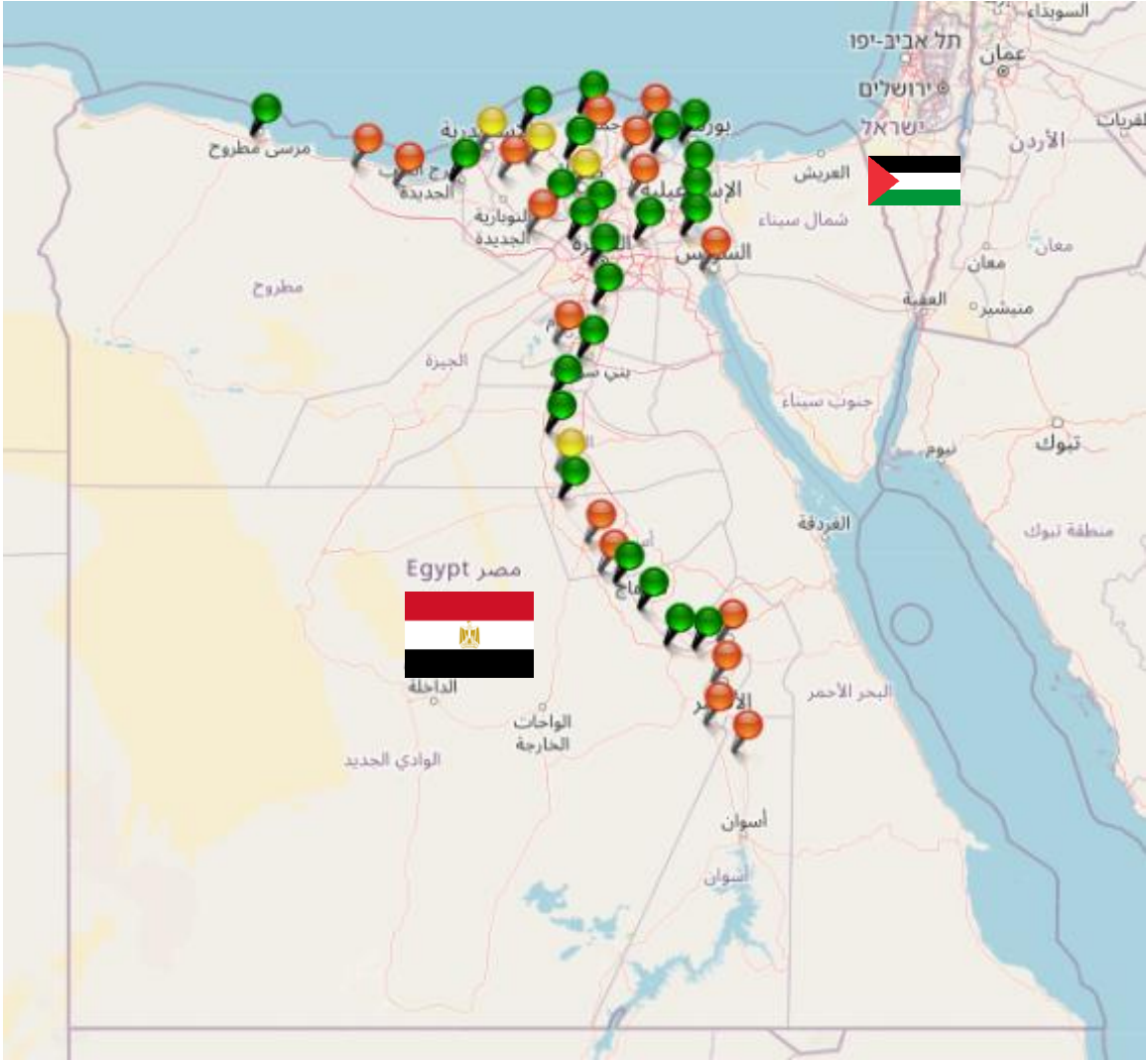
**Vertical Ionospheric Delay: (cm)** is a measure of the delay or bending of radio signals as they pass through the Earth's ionosphere. It is typically expressed in centimeters and represents the extra path length that signals from global navigation satellite systems (GNSS), like GPS, must travel due to the ionosphere's electron density.







# Egyptian GNNS Map

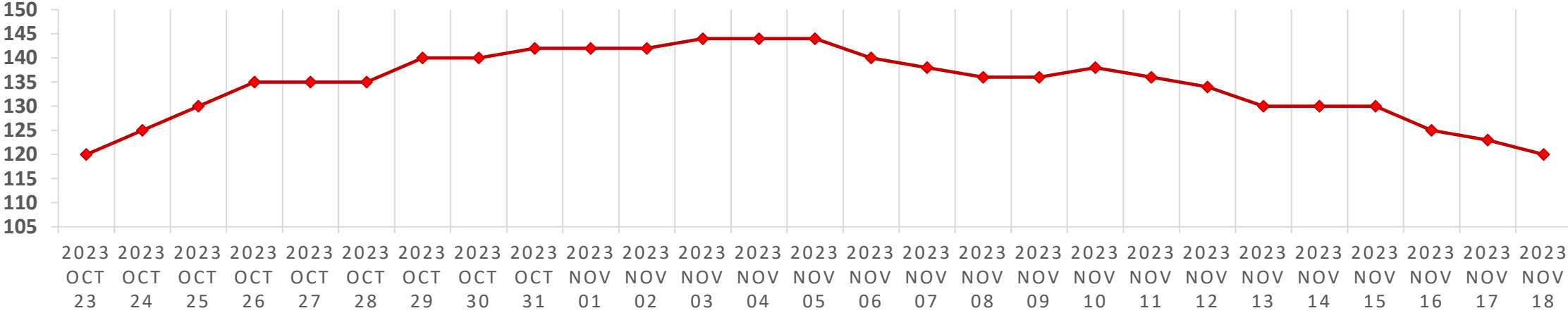


# Egypt Airports Map

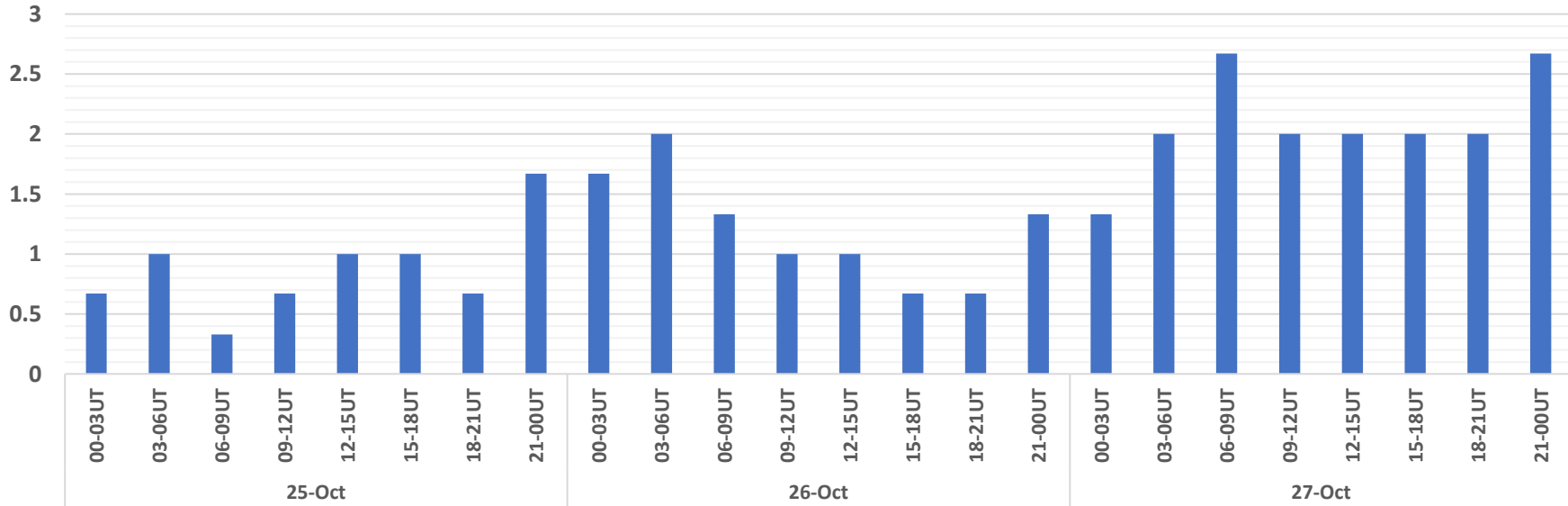


# Solar Activity Prediction Report:

## RADIO FLUX 10.7 CM



## Kp index

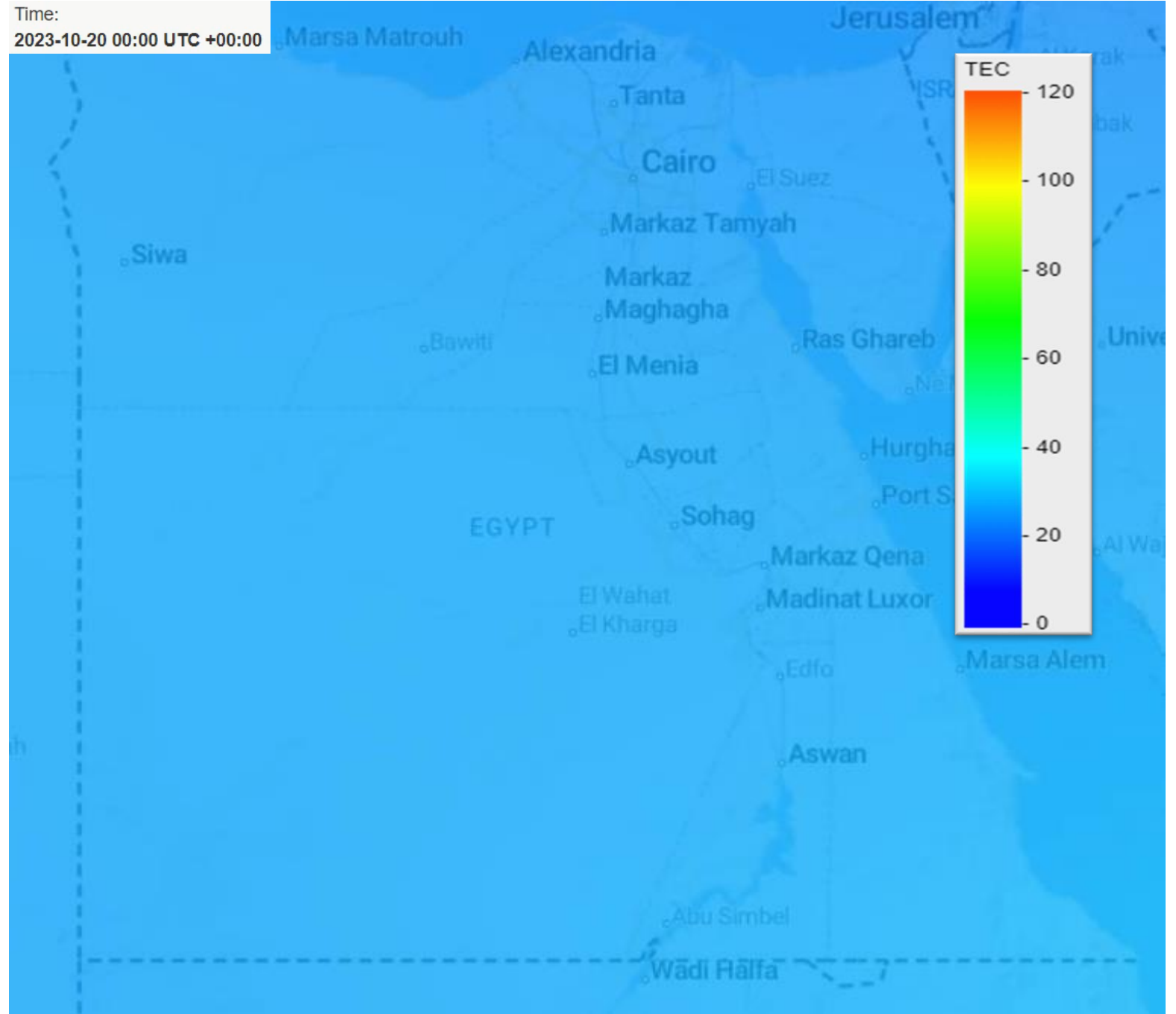


# Iono Map - EgSA :

10 Min – Real Time data

TEC Map over Egypt

20 – Oct. 2023

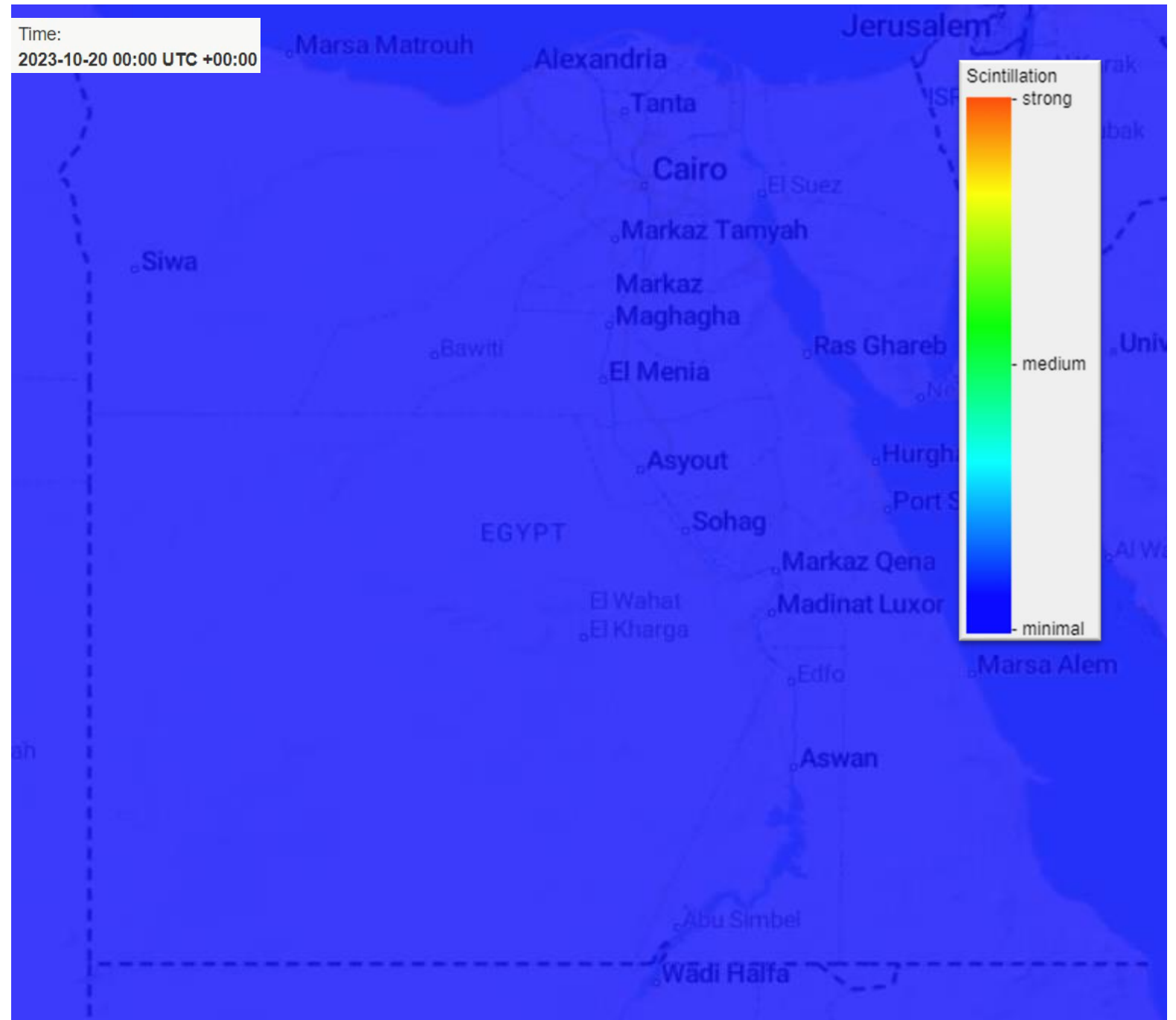


# Iono Map – EgSA :

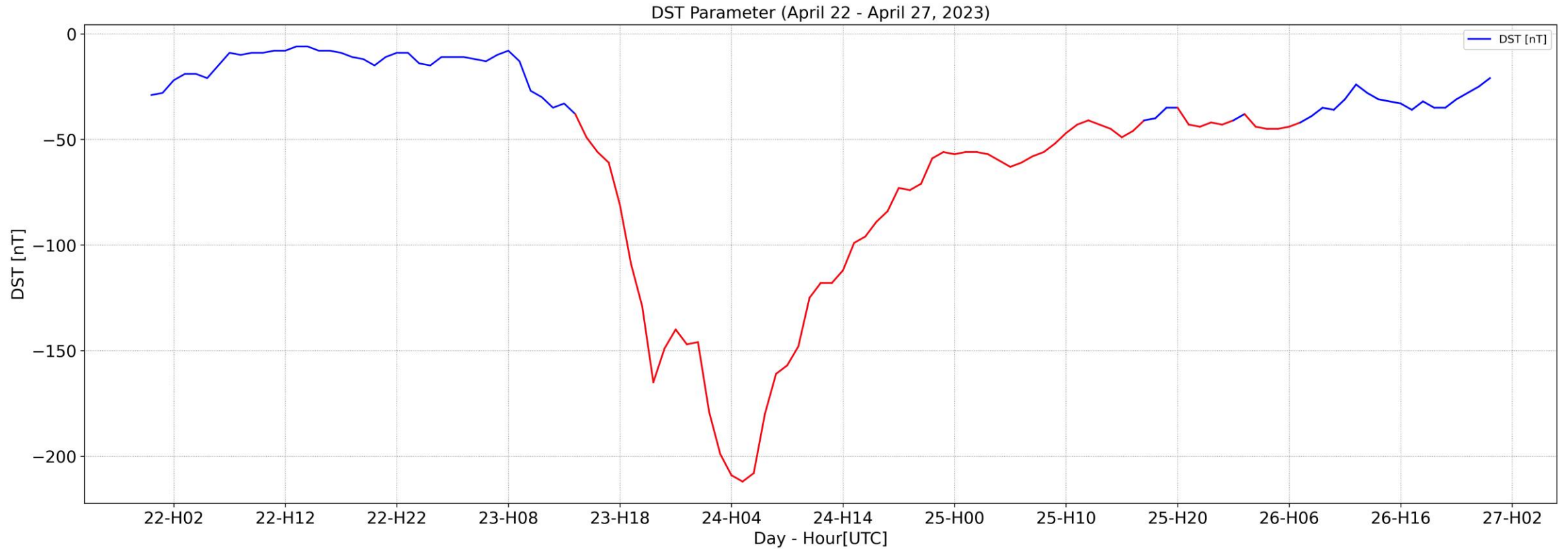
10 Min – Real Time data

Scintillation Map over Egypt

20 – Oct. 2023

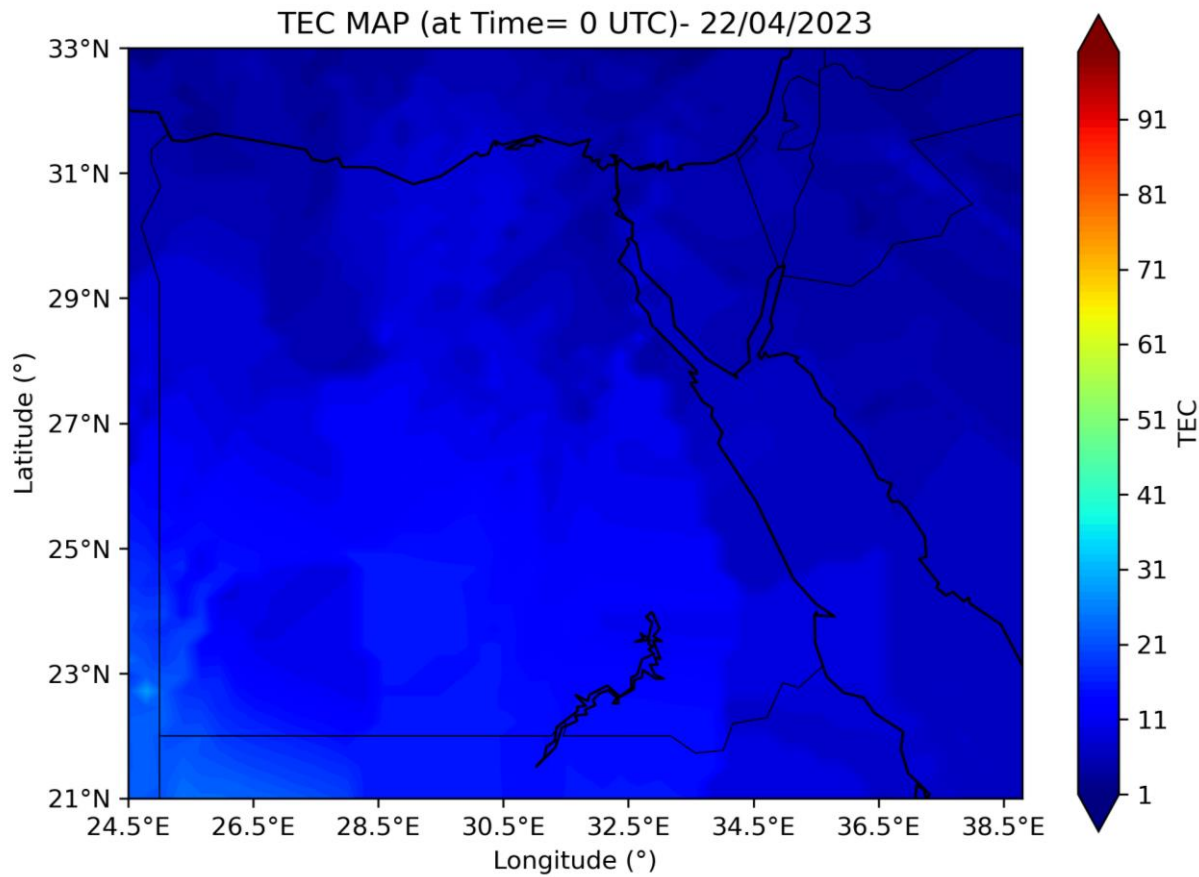


# A Case Study : Example of Space Weather Weekly Report



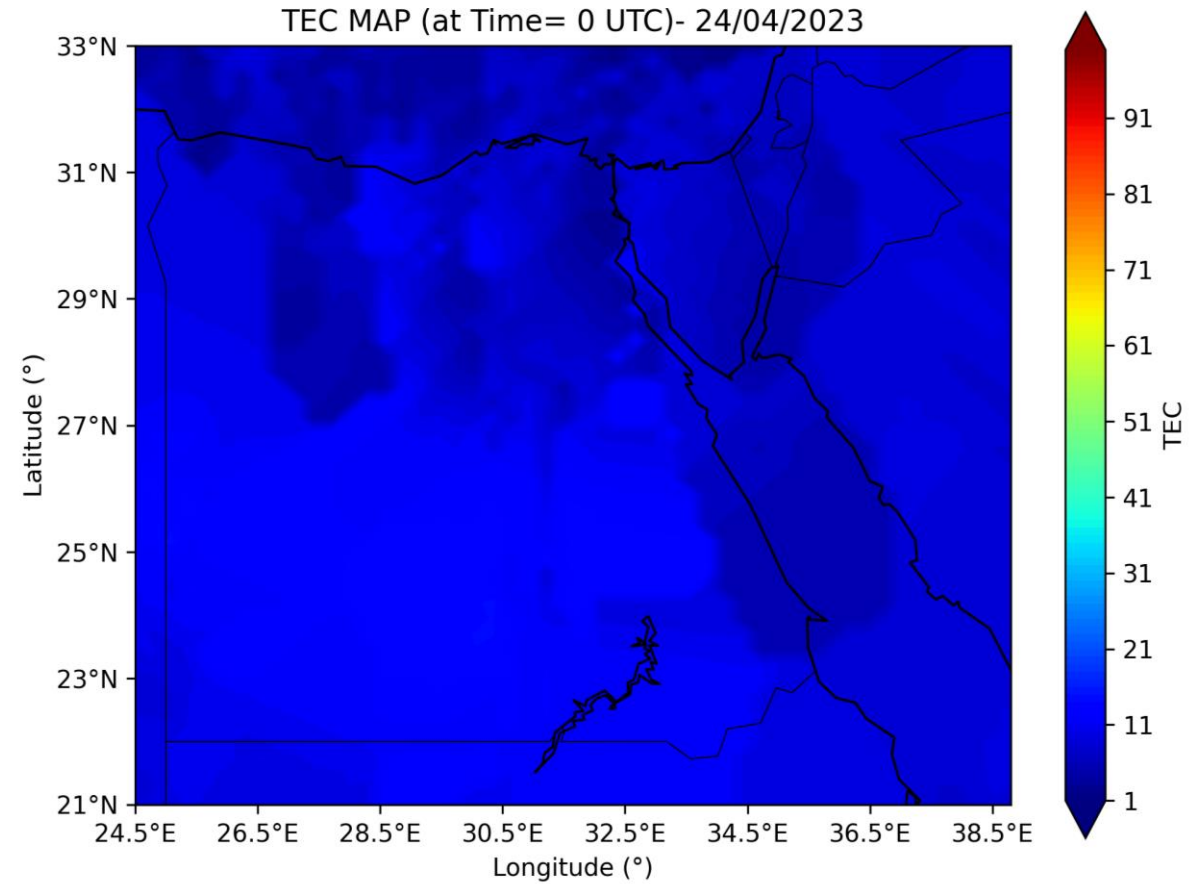
# A Case Study :

## During Normal / Quite Days



**Vertical Total Electron Content**

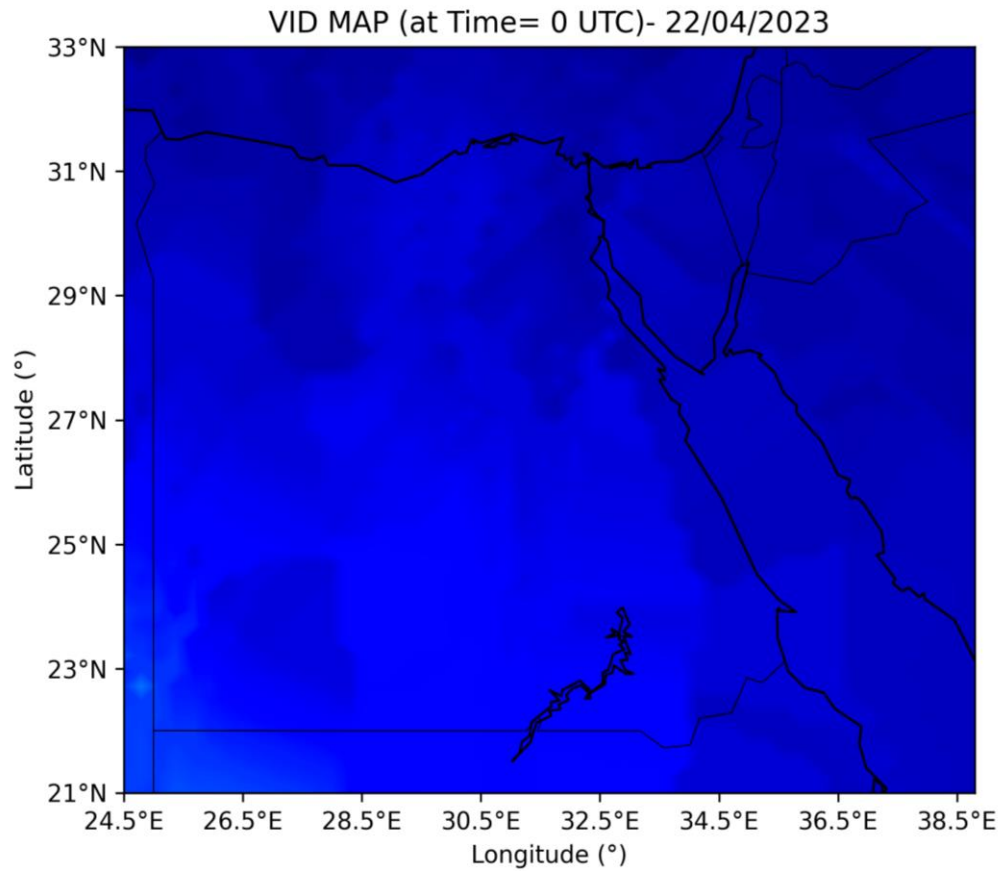
## During Storm / Disturbed Days



**Vertical Total Electron Content**

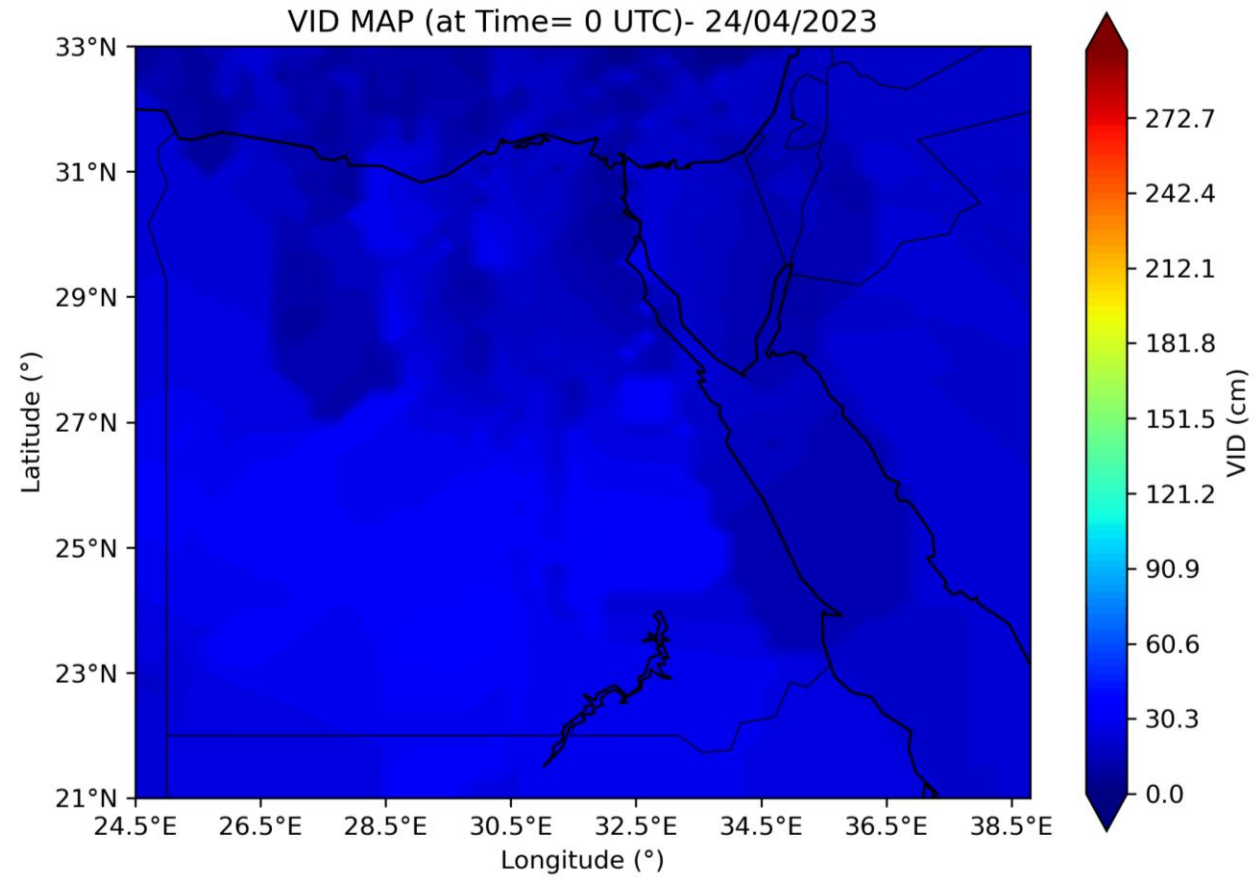
# A Case Study :

## During Normal / Quite Days



Vertical Ionospheric Delay

## During Storm / Disturbed Days

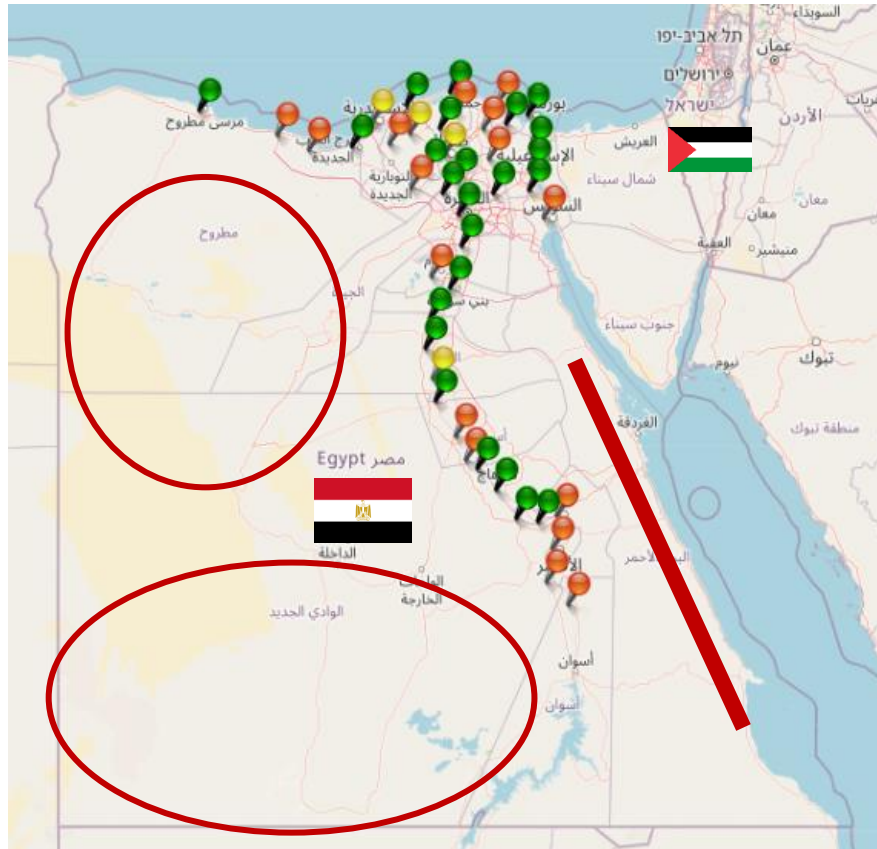


Vertical Ionospheric Delay



## Future Work:

### Second Phase of GNSS Network:

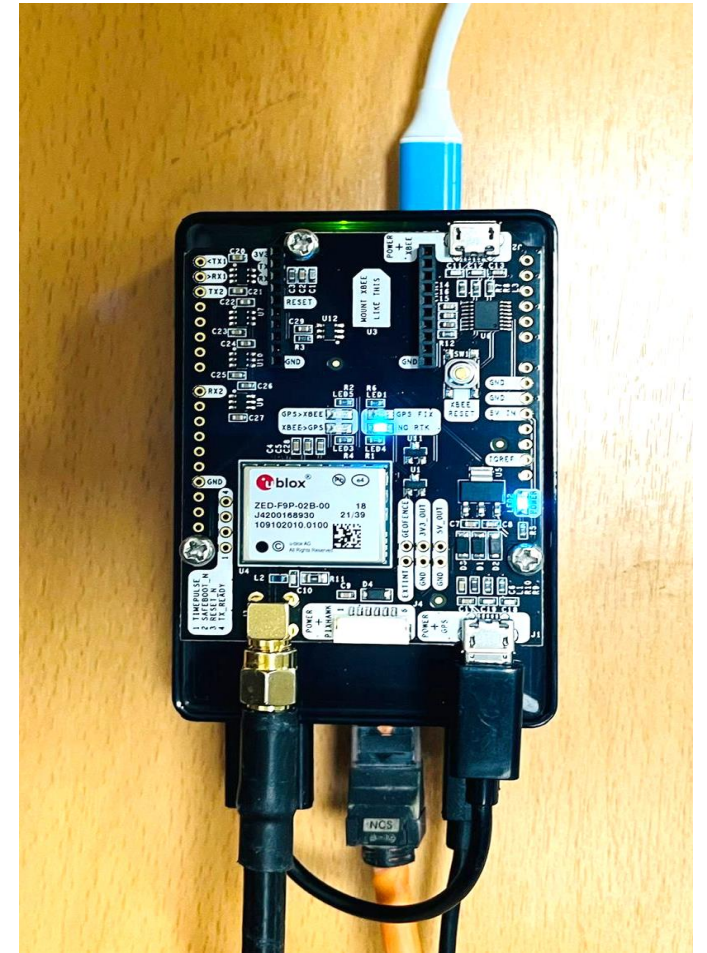


### Low-Cost GNSS Receivers Network :

Orange Pi

GNSS Antenna

Ublox GNSS Receiver



CARO Station

## Conclusions

- The ionosphere is one of the most challenging error sources
  - › Disturbances are difficult to predict and dramatically increase the magnitude of the ranging errors
  - › Require extensive data sets to examine full range of possible behavior
  - › Methods exist to achieve safe vertical guidance of aircraft



Thank You for Your Attention

Abdalla Shaker  
Abdulla.shaker@egsa.gov.eg

