The ionospheric response to Geomagnetic storms in Asia using the GNSS Network

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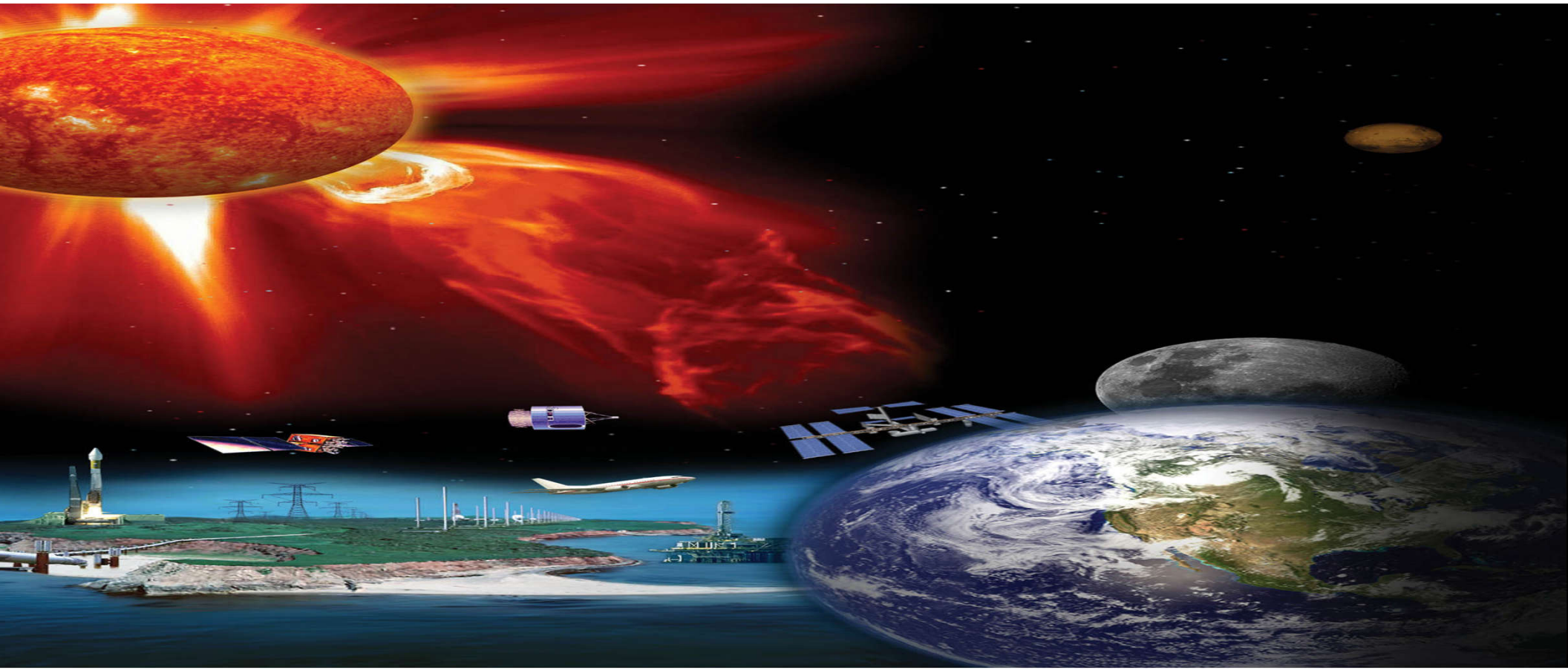
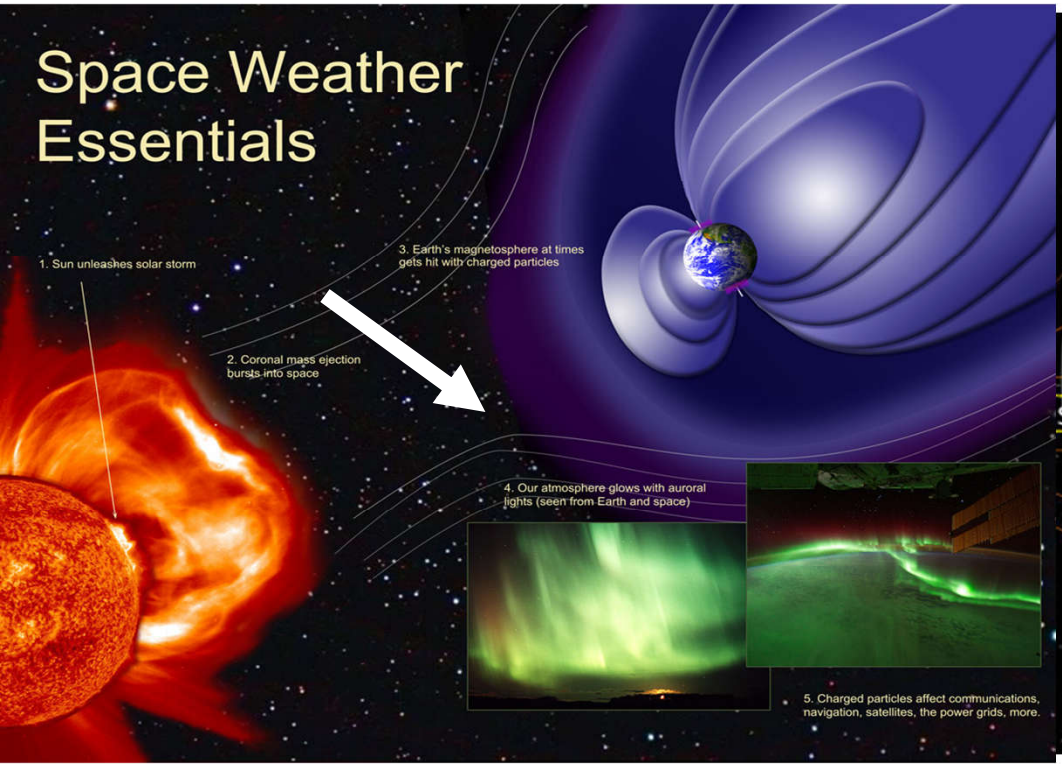
United Nations/Azerbaijan Workshop on the International Space Weather Initiative: The Sun, Space Weather and Geosphere , Baku, Azerbaijan

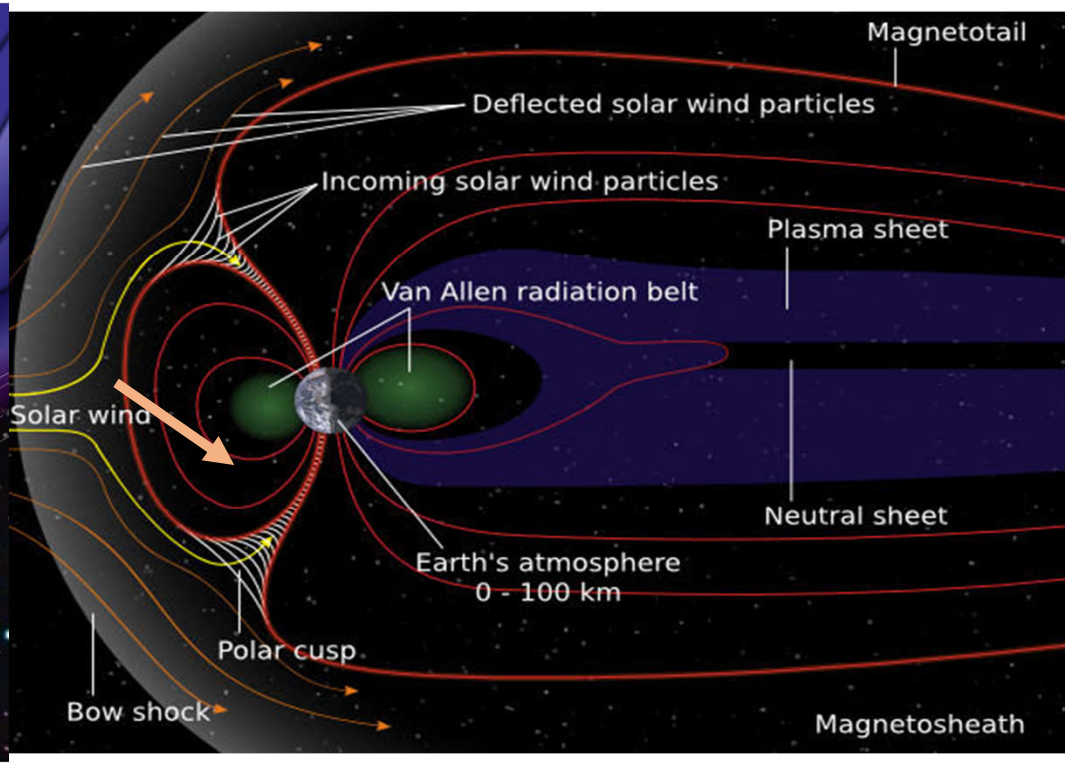
31 October to 4 November 2022.

The effect of Geomagnetic storms on the ionosphere



Sun –Earth Connection





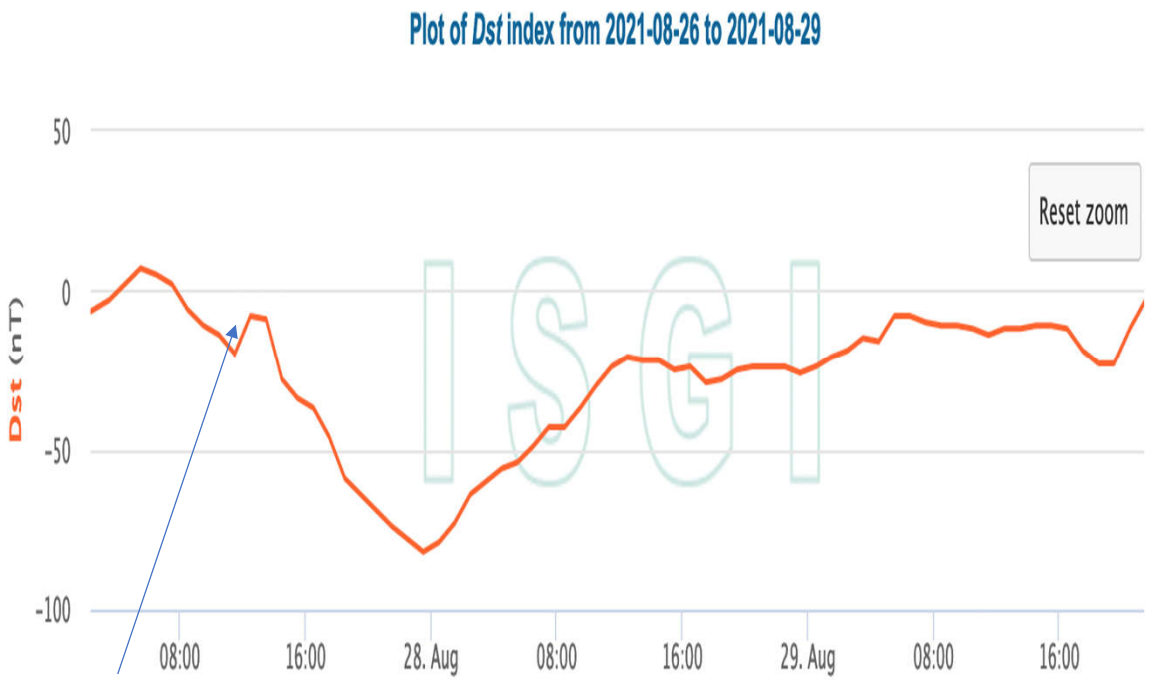
https://crev.info/2018/06/van-allen-belts-protect-earth-solar-wind/

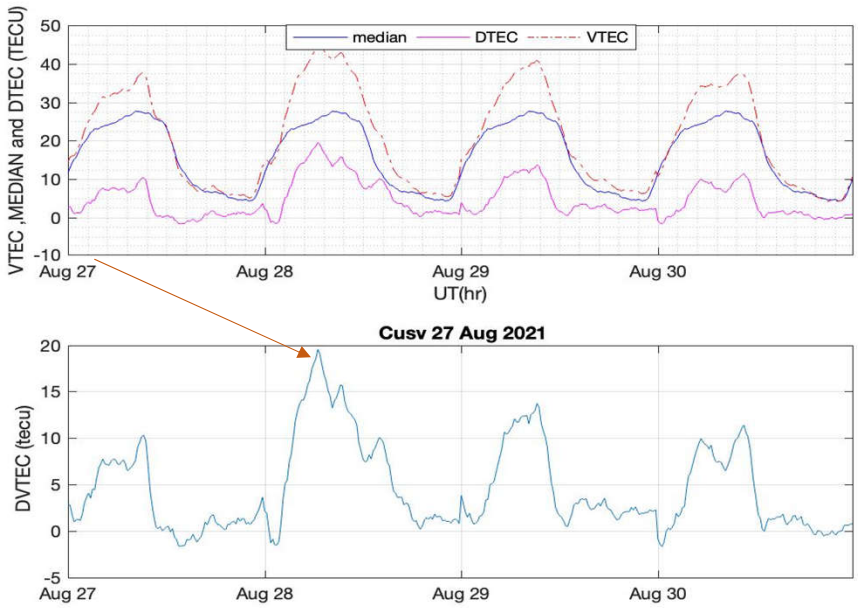
Motivation

- Studying the Earth's ionosphere during storms is critical to understanding how much energy is injected into near-Earth environment and the various processes by which this energy becomes distributed.
- The ionosphere shows an observable fluctuation for geomagnetic storms and can be explained by different mechanisms
- The ionosphere at the equator has many process contributing in its fluctuation, need to be studied in more details

The ionospheric response to Geomagnetic storms

Time from SSC till the maximum absolute DTEC





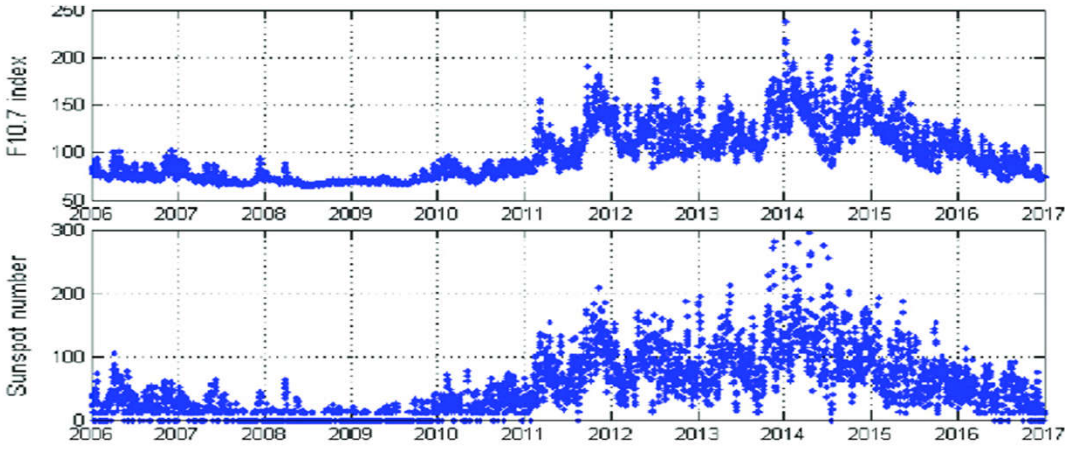
This research Goals:

- Find the ionospheric response correlation with Dst at different periods in solar cycles , compare them to each other

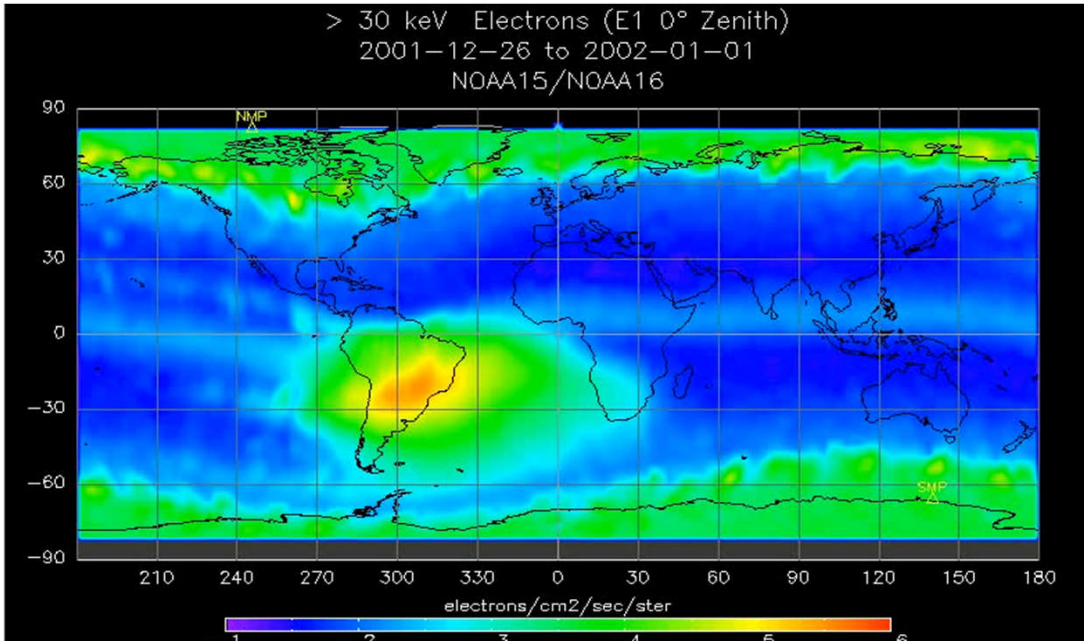
- See if there is any other parameters affect this relation.

Introduction

- F10.7 flux are best for monitoring the level of solar activity because solar emissions at these wavelengths are very sensitive to conditions in the upper chromosphere and at the base of the corona.
- Electrons and protons with energies of tens and hundreds of keV penetrate from the magnetosphere into the mesosphere and ionosphere at altitudes ranging from 50 to 1000 km.
- The penetration of electrons with energies higher than 30 keV from the ERB(The Earth's radiation belt) into the low-latitude ionosphere to occur sporadically, regardless of magnetic storms



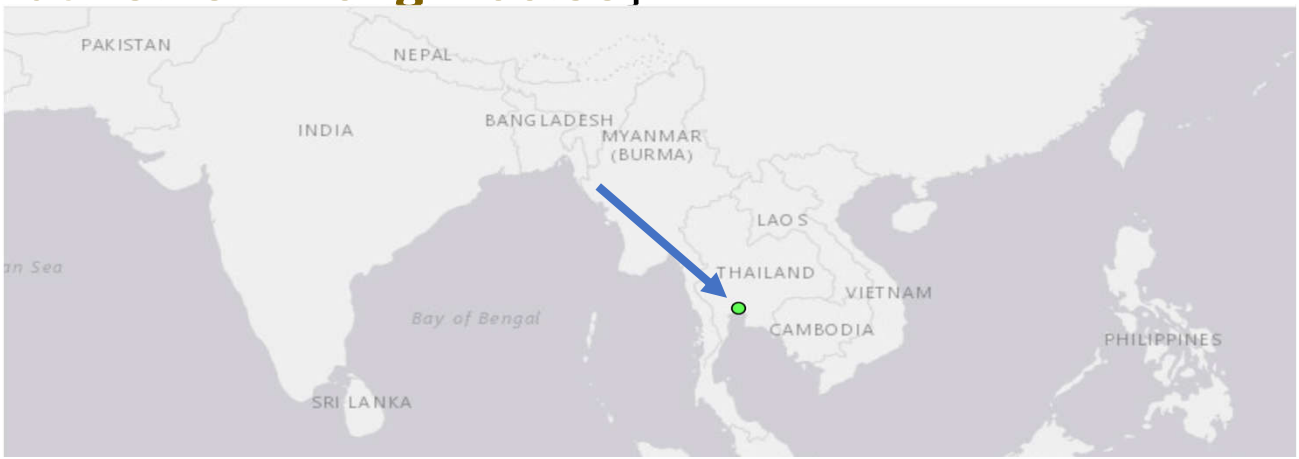
TY - JOUR et al ,2019 .DO - 10.1016/j.asr.2019.01.049
Advances in Space Research



Station used in this study

1- COCO station [**Lat -12.68 Long 96.83**]

2- CUSV station [**Lat 13.73 Long 100.53**]



Methodology

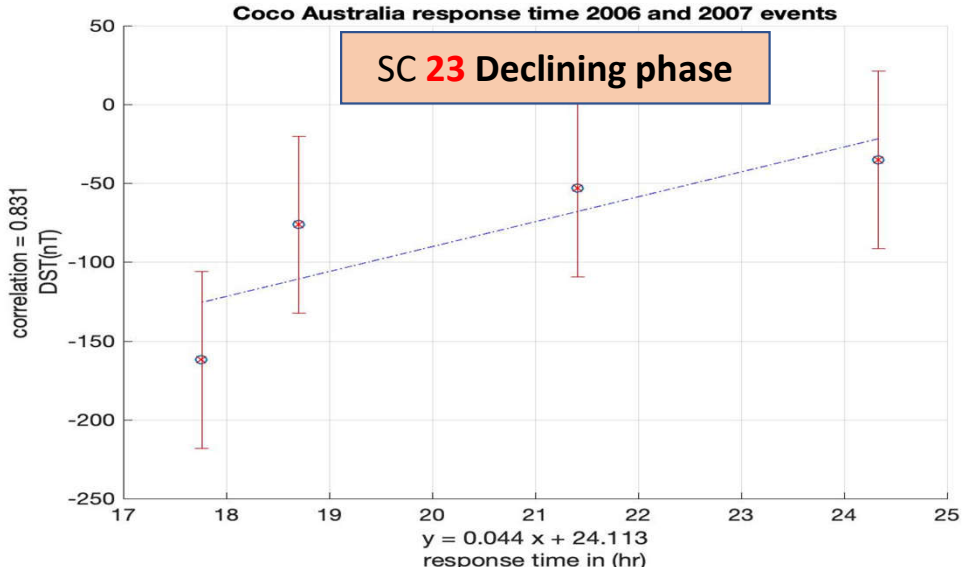
In this research we show a correlation (peason's correlation) for the response time and the Dst and we show an error bars for uncertainty.

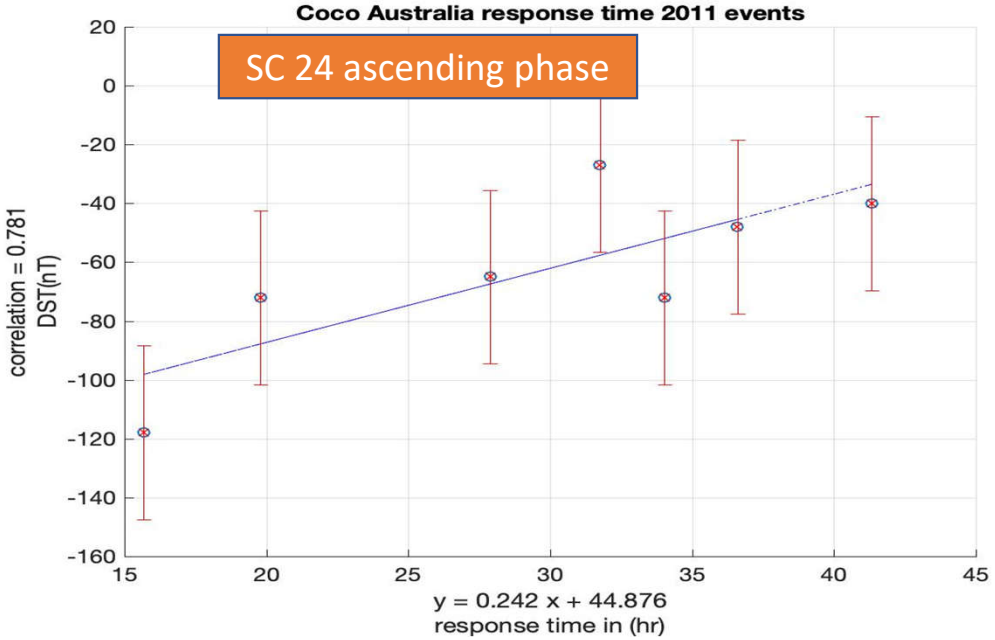
$$\rho_{X,Y} = \frac{\mathbb{E}[XY] - \mathbb{E}[X]\mathbb{E}[Y]}{\sqrt{\mathbb{E}[X^2] - (\mathbb{E}[X])^2}\sqrt{\mathbb{E}[Y^2] - (\mathbb{E}[Y])^2}}.$$

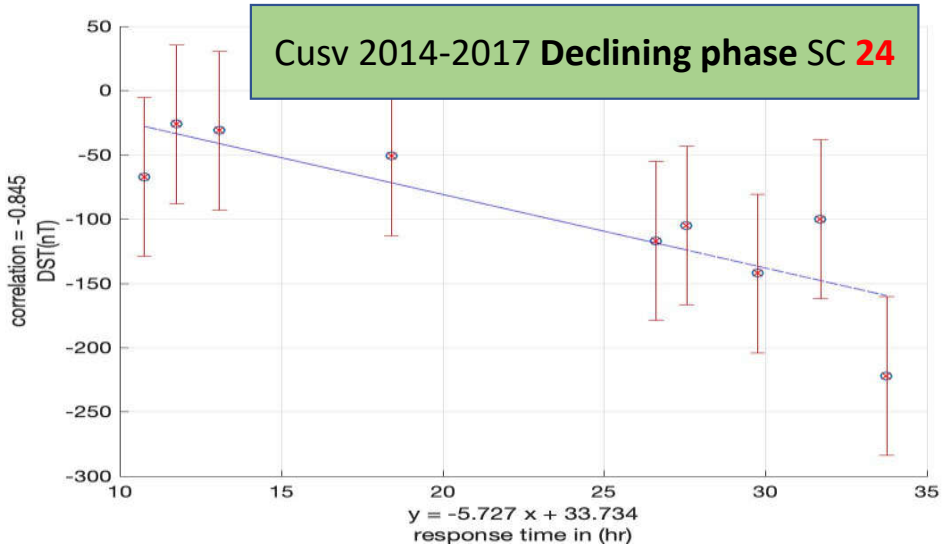
Peason's correlation coefficient does not exist when either σ_X or σ_Y are zero, infinite or undefined.

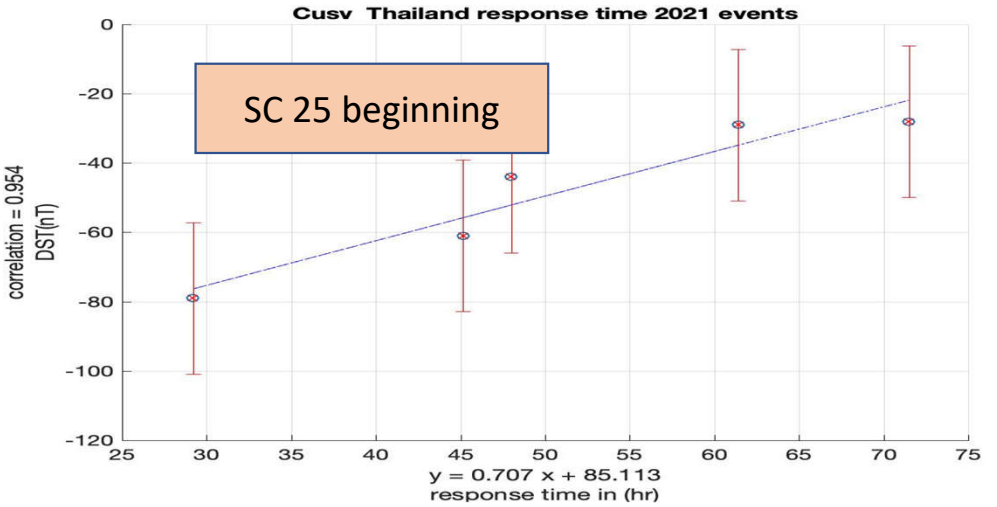
I will try to find if there is any solar activity parameters has a high contribution for the ionospheric disturbance

RESULTS


Coco Australia response time 2006 and 2007 events
SC 23 Declining phase
correlation = 0.831
DST(nT)
y = 0.044 x + 24.113
response time in (hr)

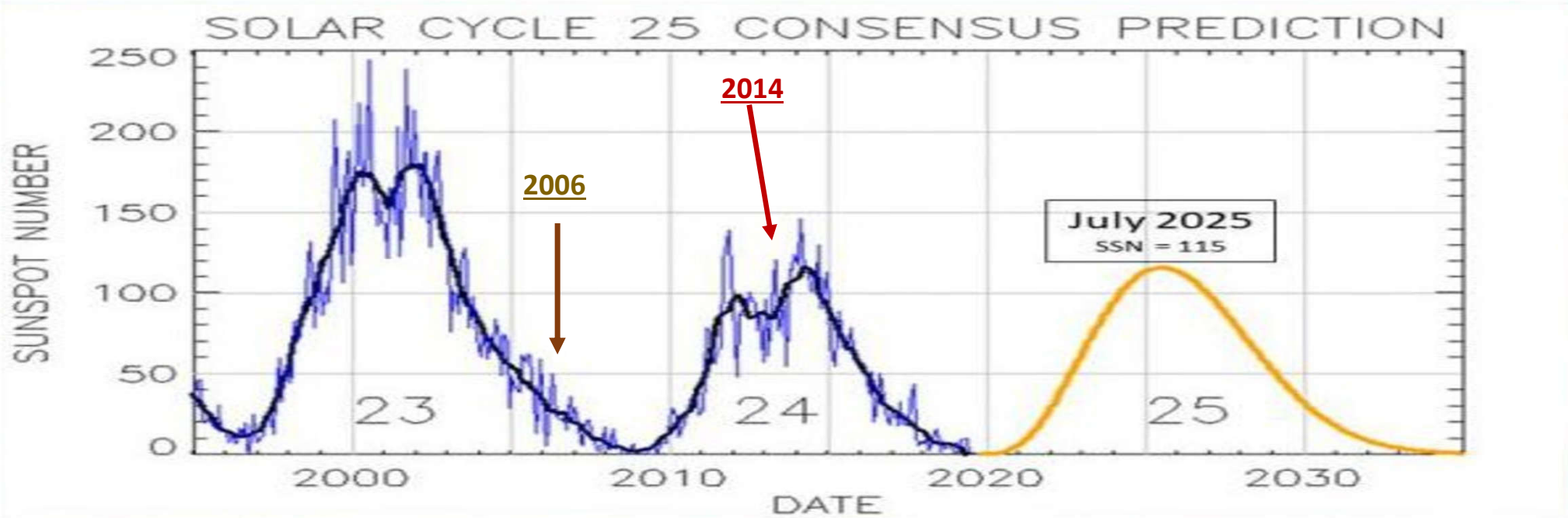

Coco Australia response time 2011 events
SC 24 ascending phase
correlation = 0.781
DST(nT)
y = 0.242 x + 44.876
response time in (hr)


Cusv 2014-2017 Declining phase SC 24
correlation = -0.845
DST(nT)
y = -5.727 x + 33.734
response time in (hr)

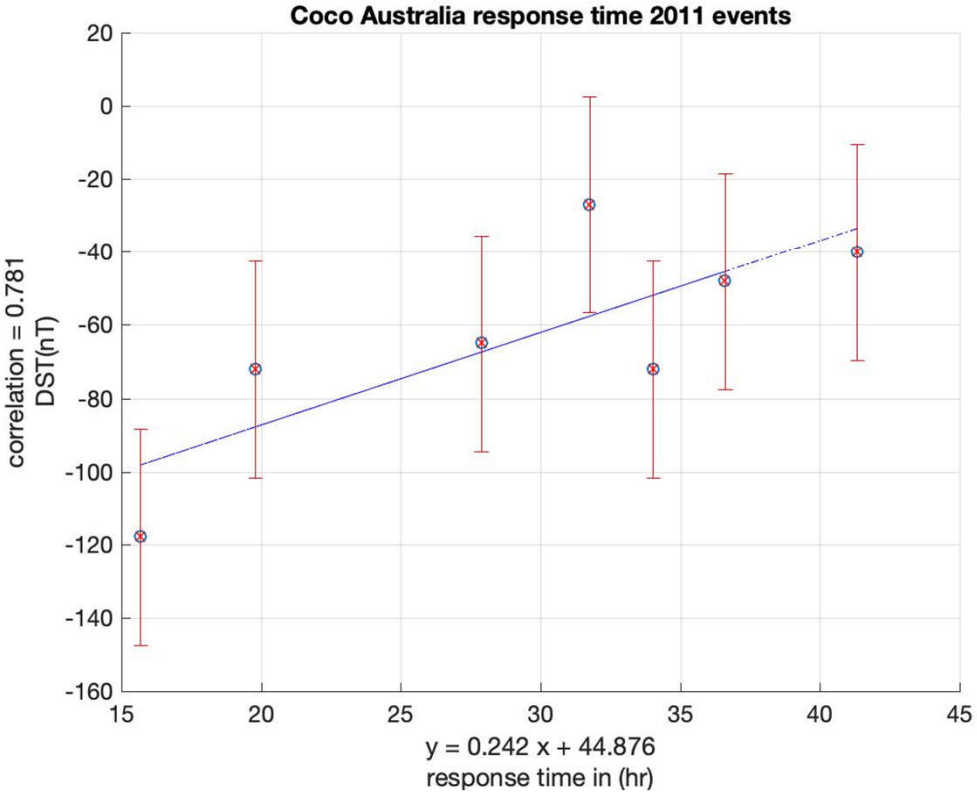

Cusv Thailand response time 2021 events
SC 25 beginning
correlation = 0.954
DST(nT)
y = 0.707 x + 85.113
response time in (hr)

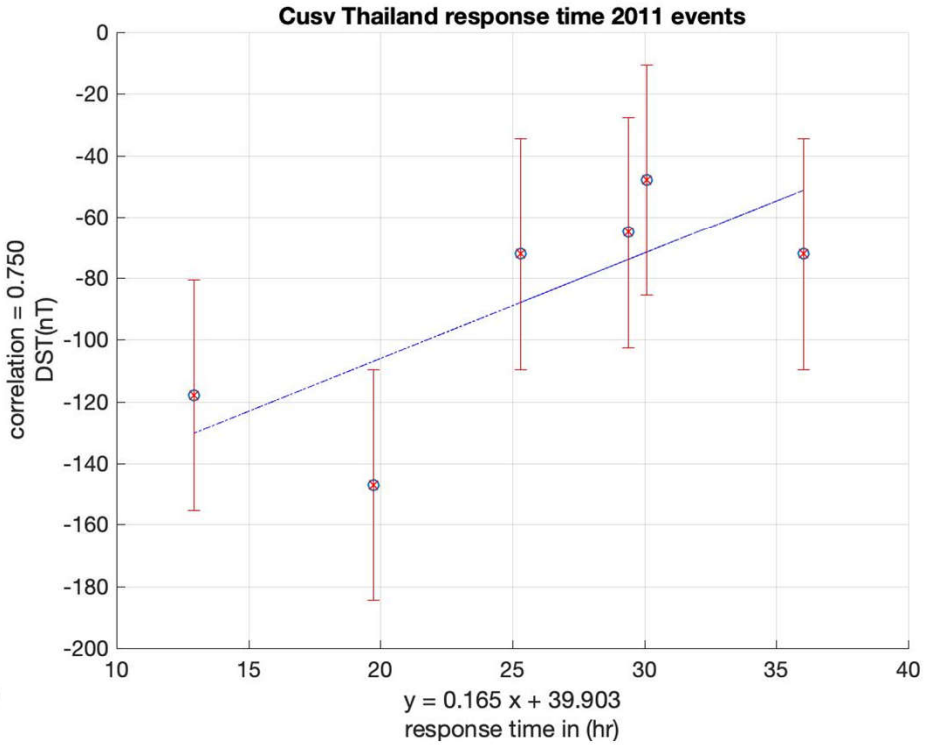
Issues to care about

- All the relation was going directly linear except 2014-2017! WHY?
- Is CUSV station have the same behavior as COCO station ?

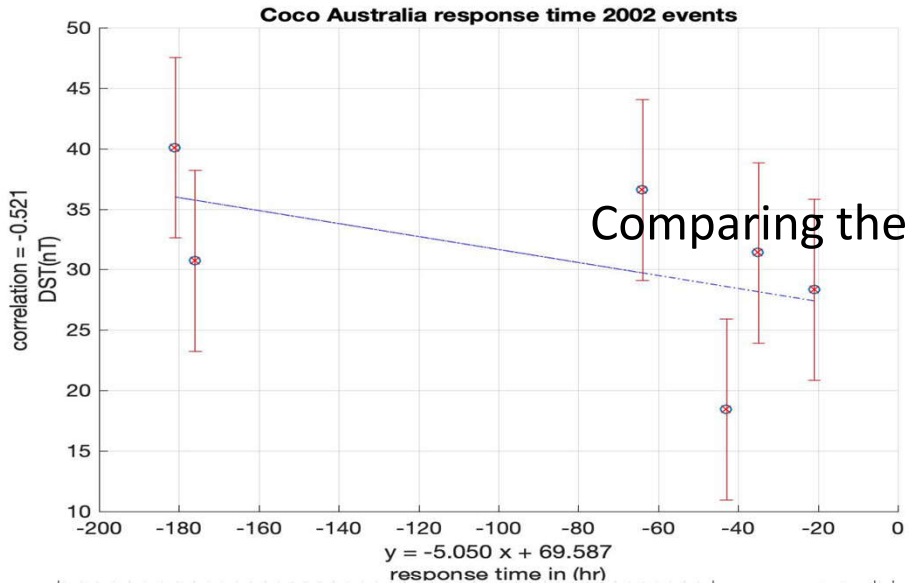


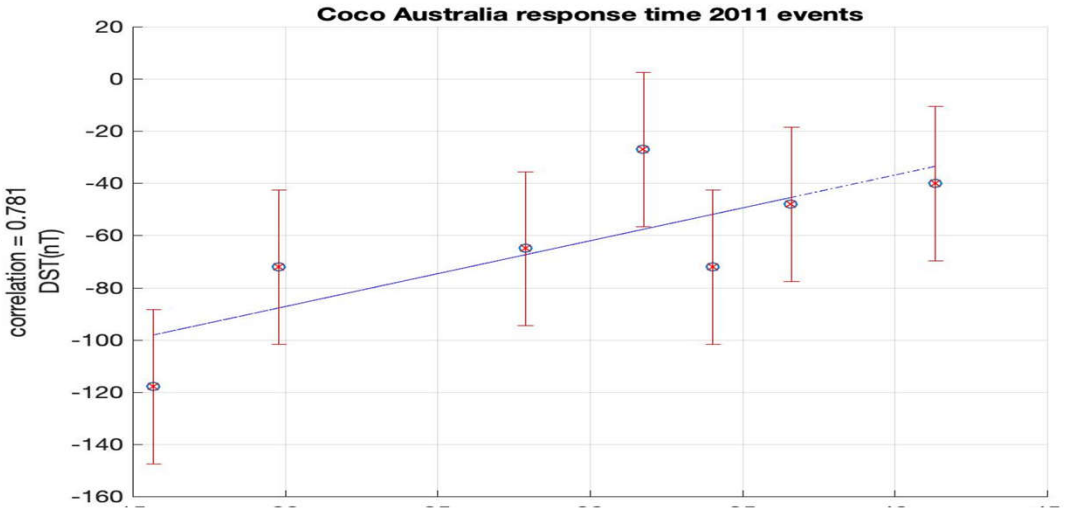
Comparing the CUSV and coco station correlation

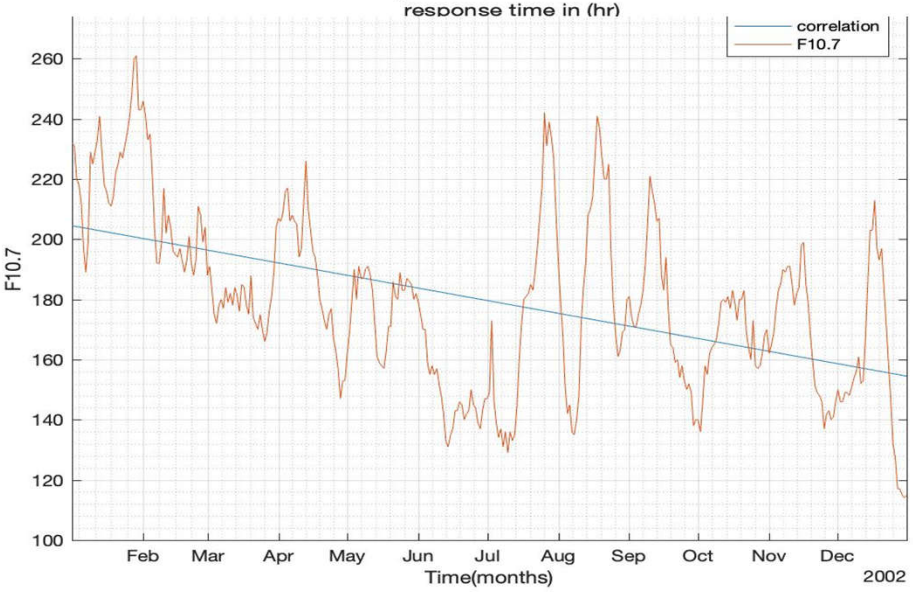


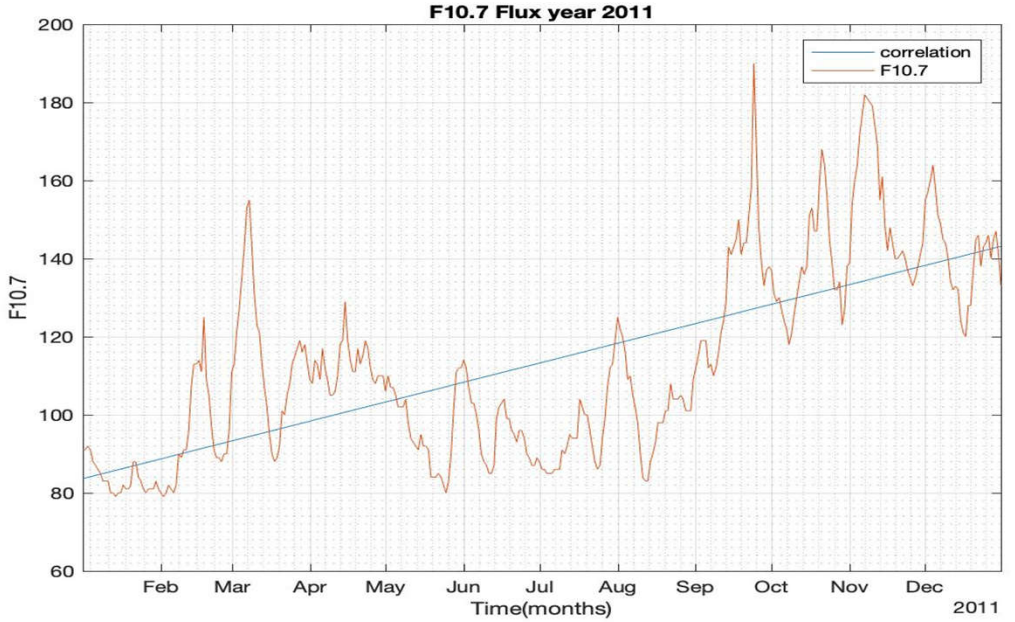


Comparing the

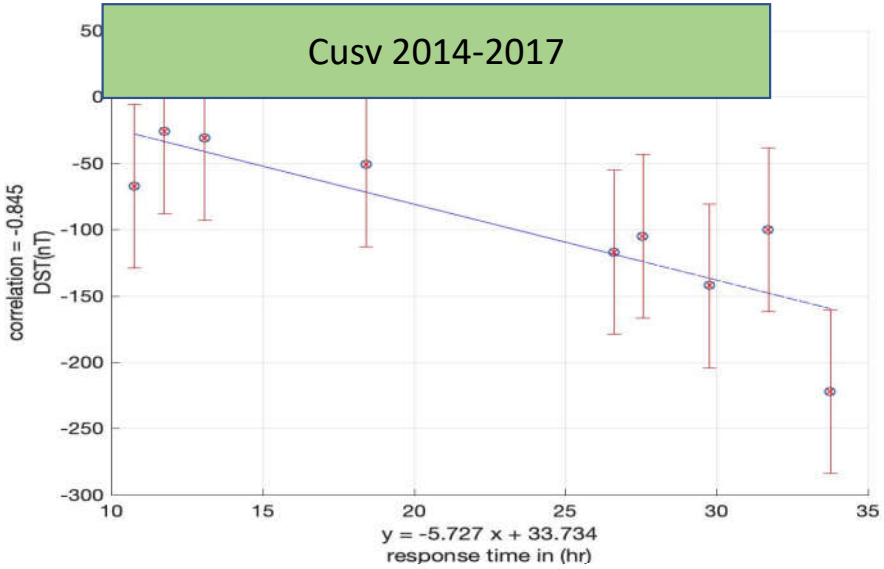


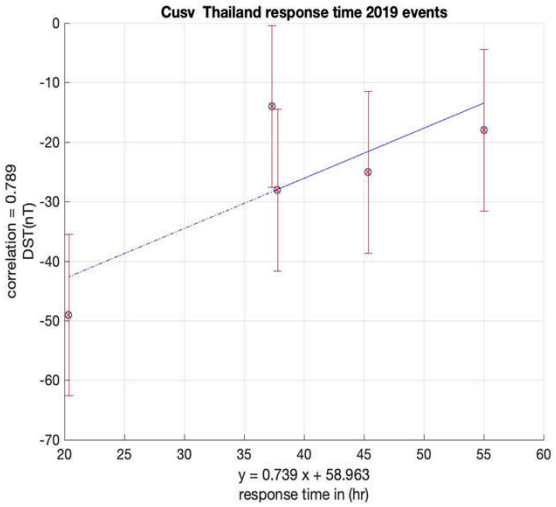


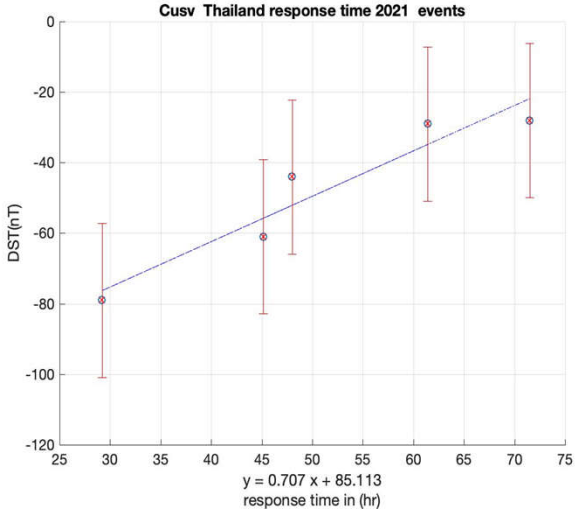


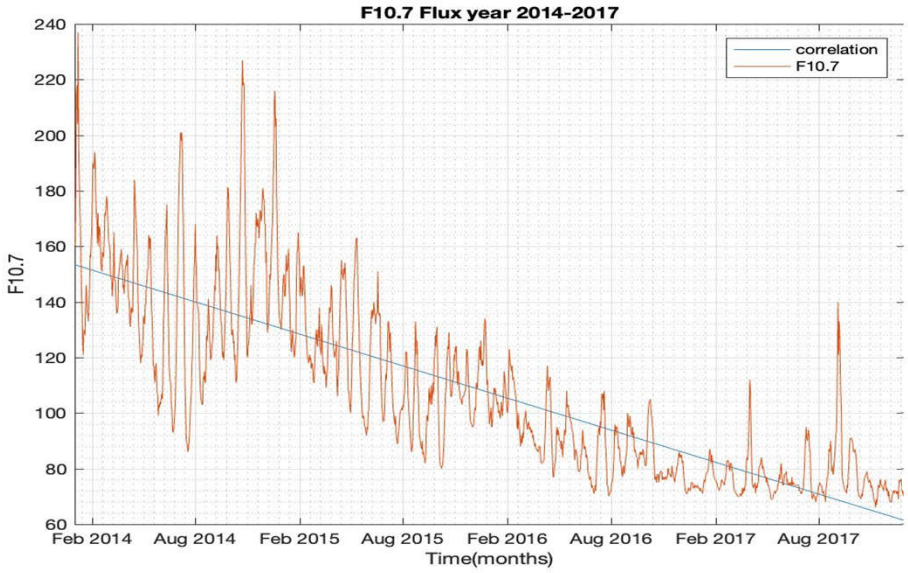


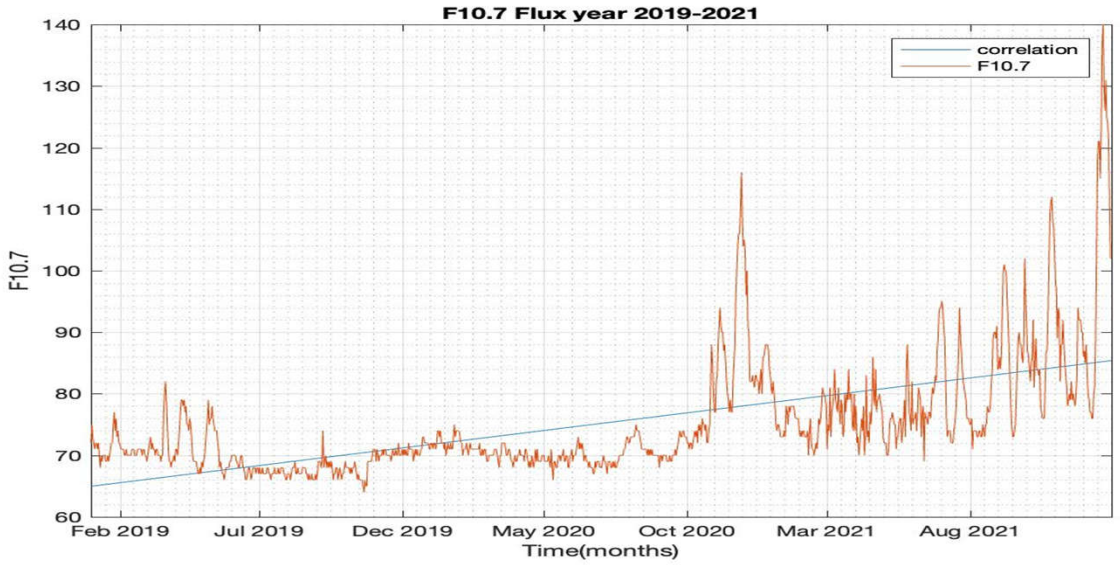
Cusv 2014-2017



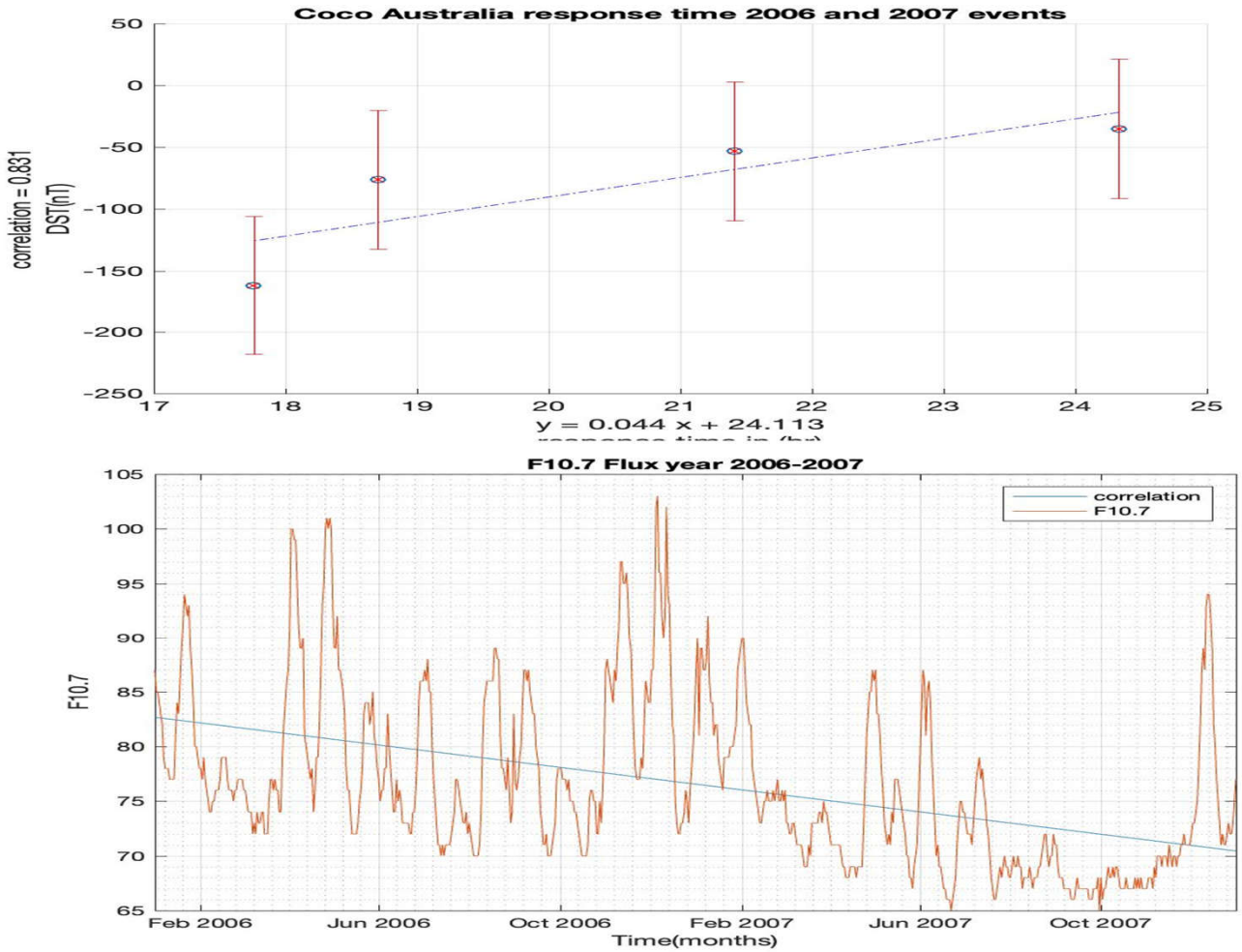








Obstacle

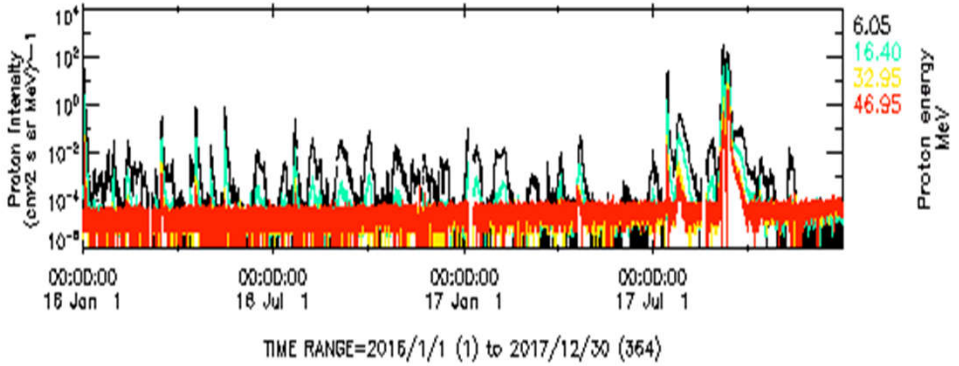


- **There is an obvious irregular behavior for the 2006-2007 correlation rather than the previous shown periods through the different SC , which need further research and explanation**

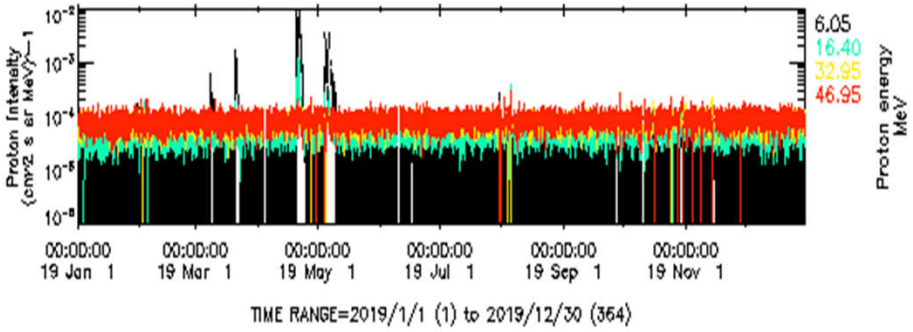
Proton Intensity and He statis(SOHO Satellite)

- **Comparing the proton intensity for the different period used in the study and finding the cause for the irregular behavior of 2006-2007**

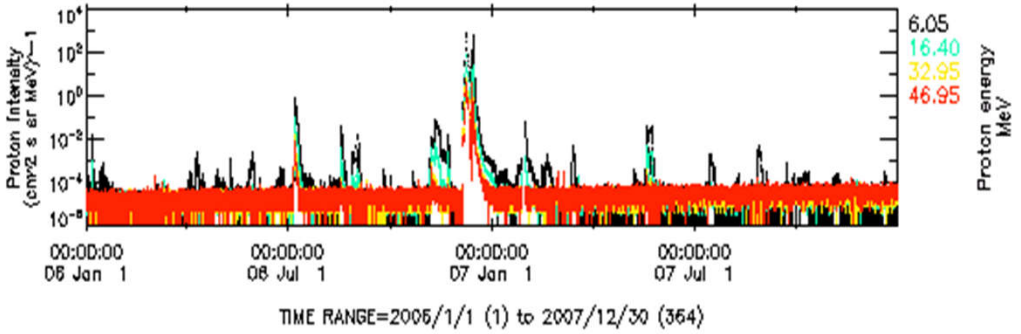
2016-2017



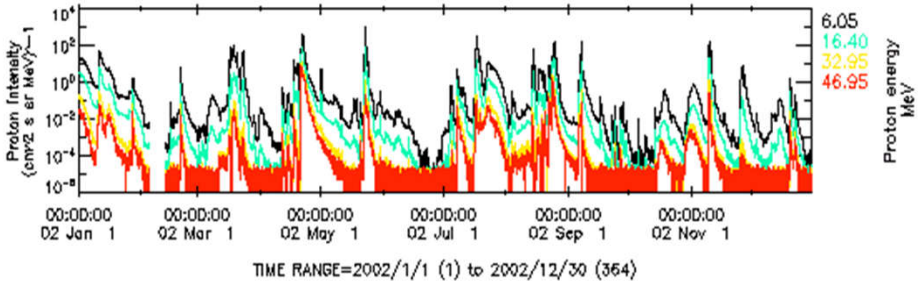
2019



2006-2007

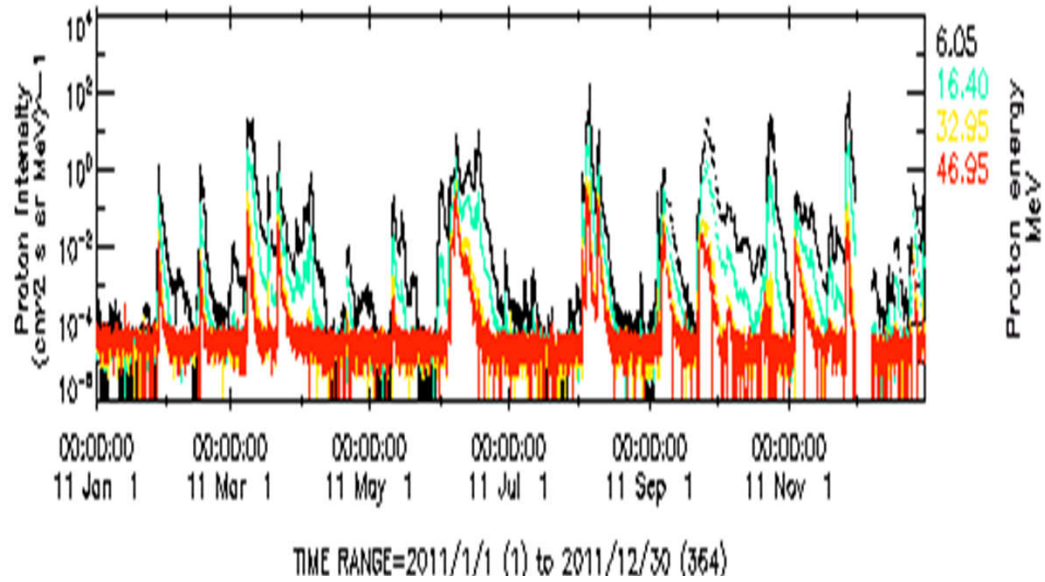


2002

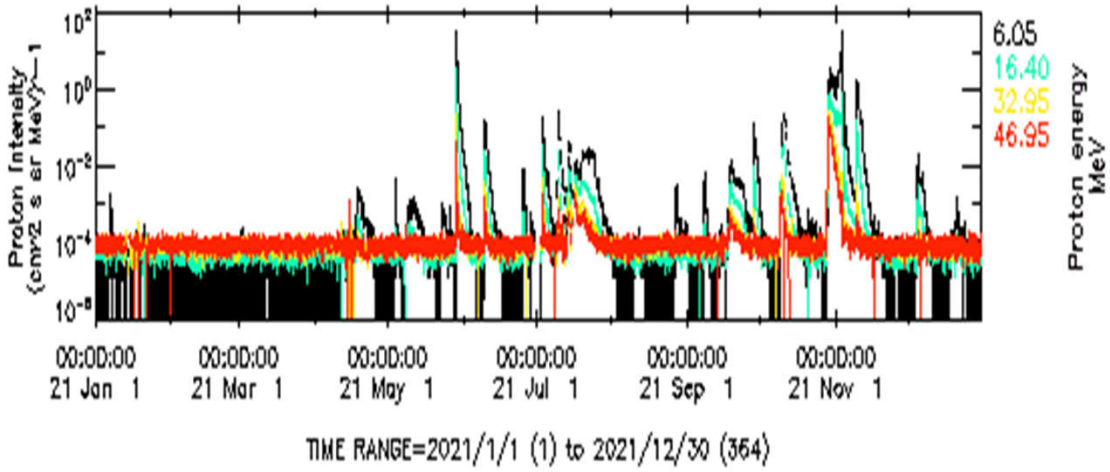


- The 2011 is the beginning of SC 24 as well as 2021 is the beginning of SC 25
- The proton intensity fluctuation shown is higher in 2011 rather than 2021

2011



2021



Discussion:

- We found a good correlation values with different periods(2002,2006-2007,2011,2014-2017,2019 and 2021).
- Linear correlation found between the correlation deduced and F10.7 Flux except for 2006-2007
- The irregular behavior for 2006-2007 appear to be due to the lack of proton intensity during this time
- The correlation 2002 need more explanation and it is subject for more research for non linear behavior .

conclusion

- The presented study shows relations for response time and Dst in SC 23,24 and beginning of SC 25.
- The response time found to be 1~2 days average 27 hr since the SSC
- The F10.7 show the same linear behavior for COCO station(Asia) and CUSV (Asia) during most the discussed periods
- The analysis shows that F10.7 can be used as variable in the response time and Dst correlation
- The correlation presented has values vary from **0.54 to 0.985** , which is a very good correlation
- The diffusing behavior for *2006 and 2007* events is due to proton intensity minimum during this activity
- From the showed study , it is obvious that the proton intensity affect the linearity for F10.7 flux and ionospheric response time versing Dst relation.

Data sources and Link:

- https://omniweb.gsfc.nasa.gov/ftpbrowser/ace_sis_flux_all_hr_st.html
- https://cdaweb.gsfc.nasa.gov/cgi-bin/eval3.cgi
- https://isgi.unistra.fr
- **https://cddis.nasa.gov/archive/gnss/data/daily/**

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