Nequick Model and Solar flux estimation for IRNSS

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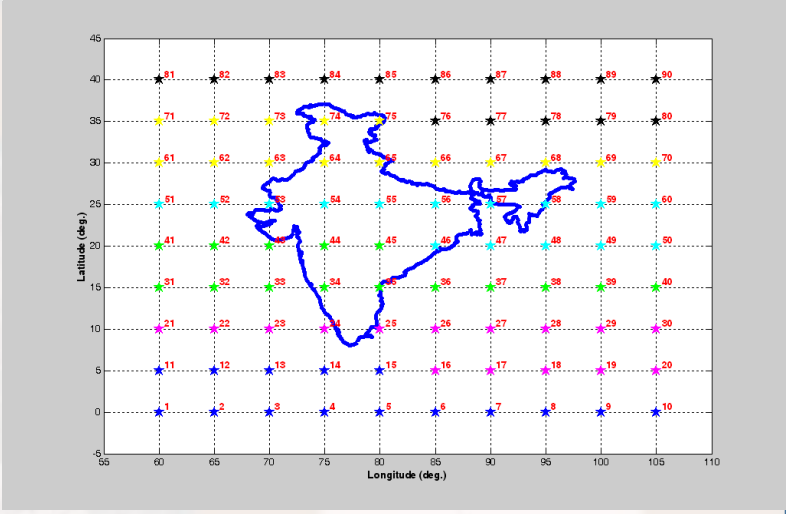
Nequick Model for IRNSS

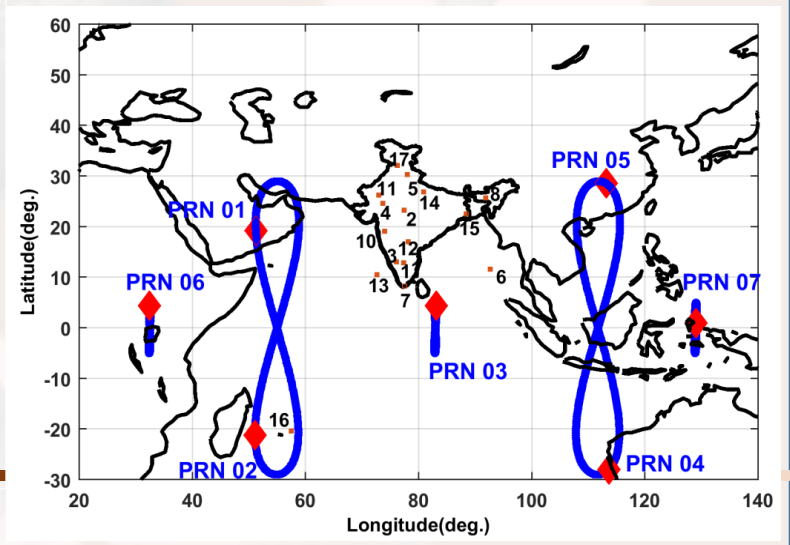
Grid Based Ionospheric Corrections

- IRNSS single frequency users can operate either on L5 or S frequencies
- Ionosphere: Dominant over Indian region & hence impact the single frequency Rx accuracies (L5)
- New Feature: Grid Based Corrections to provide comparable accuracy for single frequency L5 users
- Currently, servicing 90 grids points over Indian region and broadcasted every 5 min.



Co-efficient (Klobuchar like) Based Ionosphere Corrections

- 8 coefficients (α_n,β_n; n = 0 to 3), are provided in sub-frame 4 of the Navigation data.
- α_n are the coefficients of a cubic equation representing the amplitude of the vertical delay
- β_n are the coefficients of a cubic equation representing the period of the model
- Co-efficients are generated and uplink once a using TEC derived from 16 reference stations (IRIMS)



Nequick Model for IRNSS

Galileo like ionosphere coefficients for IRNSS

Objective:

To explore the use of Galileo like ionosphere model for IRNSS single frequency users over equatorial region

Approach:

- Generation of broadcast ionosphere coefficients
  - Different statistical estimation methods
- Performance assessment with IRNSS measurements over Indian Land mass
  - Performance assessment in estimation period
  - Performance assessment in prediction period
- Modification in NeQuick Model parameters
- Comparison with GIM for IRNSS Primary service area

Nequick Model for IRNSS

Generation of broadcast ionosphere coefficient

Base Model:

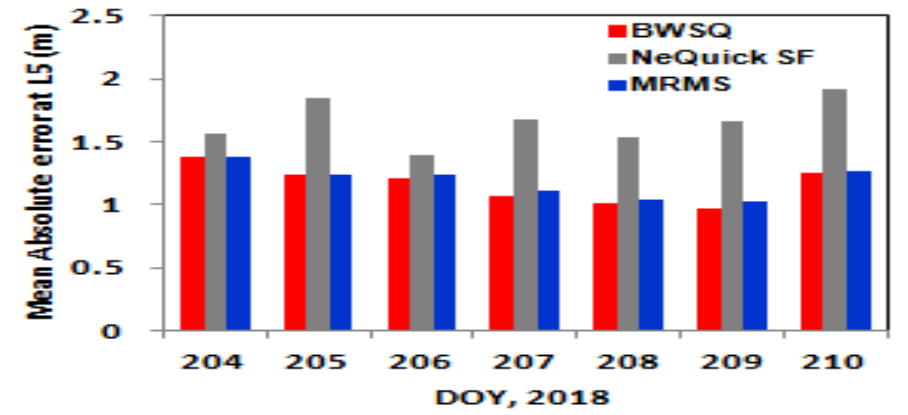
- NeQuick (a semi-empirical model)
- Input: Time, Month, user receiver position, Satellite position, Solar radio flux (SF)
- Output: Total Electron Content along the line of sight

Methods:

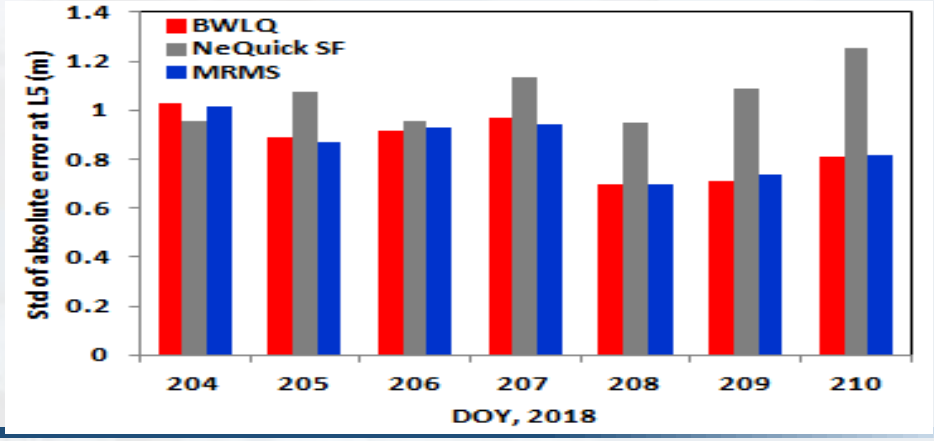
Estimation of ionization parameter with IRNSS measurements using:

- MRMS - Minimum Root Mean Square (Estimation of SF, ESF)
- BWLQ - Weighted Batch Least Square (in terms of 3 coefficients a_0,a_1,a_2)

Mean Absolute Error using BWLQ &MRMS



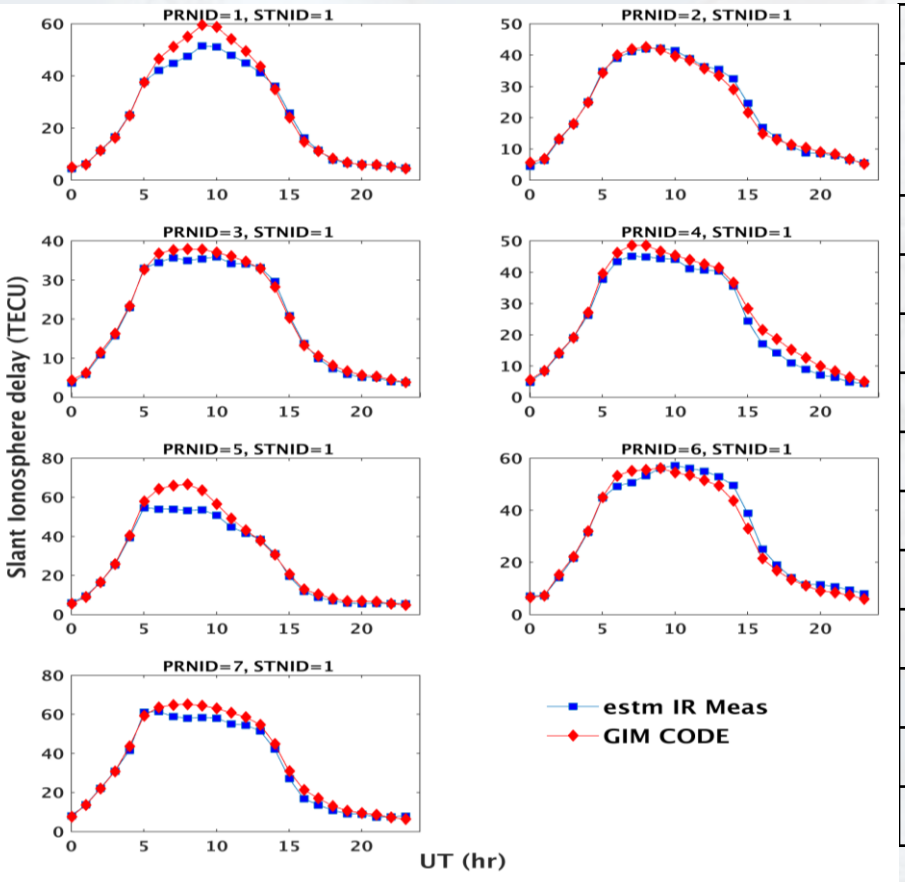
STD of Absolute Error using BWLQ &MRMS



Nequick Model for IRNSS

Comparison with GIM (Global Ionosphere Model) data

Modified coefficients of foF2 of NeQuick-2 model using IRNSS data



Primary Service Area GIM Statistics (L1)				
		% Error Correction		
Year	Day No.	OrgNeESF	ModNeESF	Klob
2018	317	75.02	76.88	61.64
2018	318	62.63	72.63	52.12
2018	319	70.17	78.01	55.94
2018	345	78.02	76.78	62.58
2018	346	75.34	76.88	56.86
2018	347	67.58	74.97	51.35
2019	54	76.79	77.75	63.3
2019	56	73.19	76.96	59.08
2019	202	80.46	84.87	60.72
2019	203	79.65	77.67	70.9
2019	204	78.64	81.45	65.28

Nequick Model for IRNSS

- IRNSS data ingested to NeQuick for better performance over IRNSS service area
- Different statistical methods used to estimated broadcast ionosphere coefficients and few parameters of the base model were modified.
- The overall performance of BWLQ method is better than the MRMS
- However, the base model is not able to capture the shape of the ionosphere peak during noon time in both the methods.
- Further improvement in NeQuick model by ingesting more ionosphere data using different sources over IRNSS service area is planned

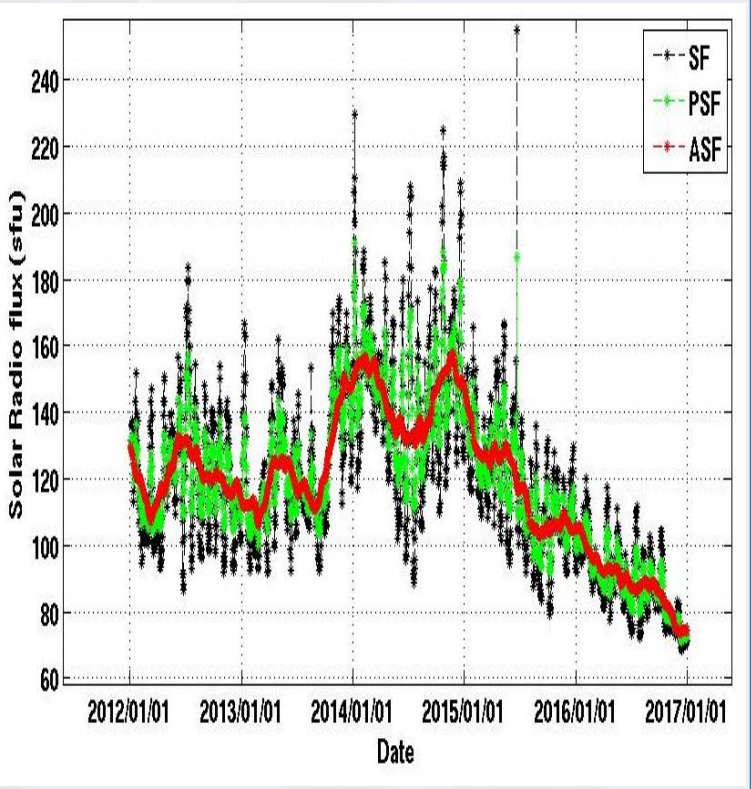
Solar Flux (F10.7) estimation using IRNSS

Objective and Scope

- To estimate Solar radio flux (F10.7), as one of the IRNSS generated ionosphere products
- User can use the estimated flux for various space weather applications
- Can be used to fine tune the ionosphere models which depend on the solar flux values (e.g: NeQuick, IRI etc.) over equatorial region
- It can also be utilized to study behaviour of ionosphere over equatorial region.

Solar Flux (F10.7) estimation using IRNSS

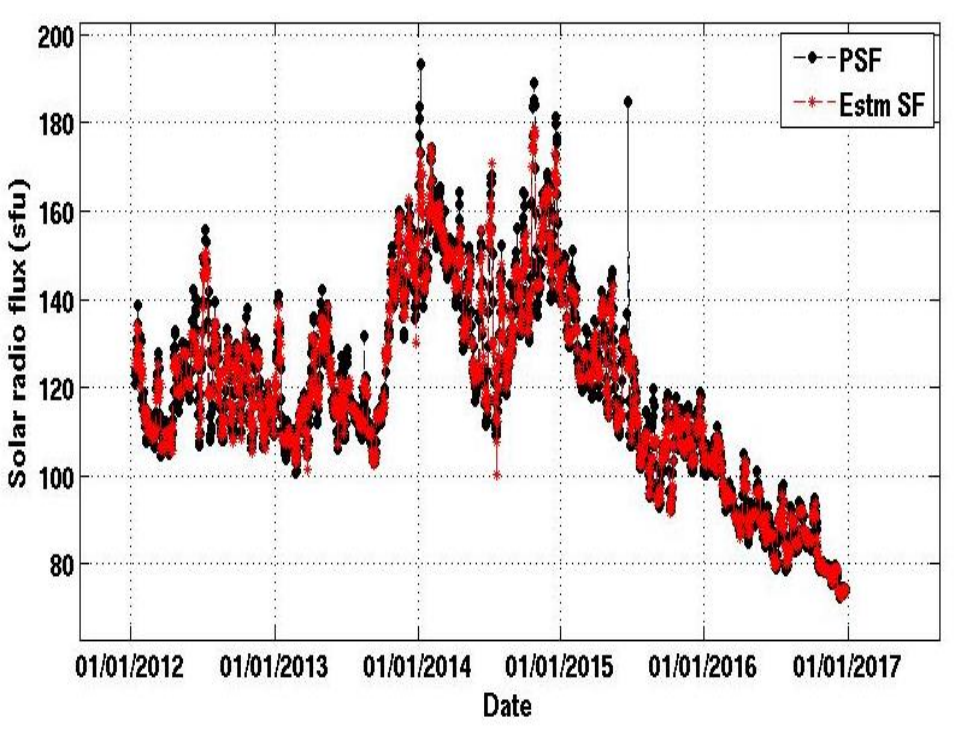
- It is a measure of extreme UV radiation coming from sun and directly responsible for earth's ionosphere activities
- Iono delay from GNSS signals is a function of SF, season, time of day and earth geomagnetic field
- Thus SF can be generated as a function of day of year from dual frequency ionosphere data
- The algorithm is verified first using GPS ionosphere products and solar flux measured in Penticton Radio Observatory



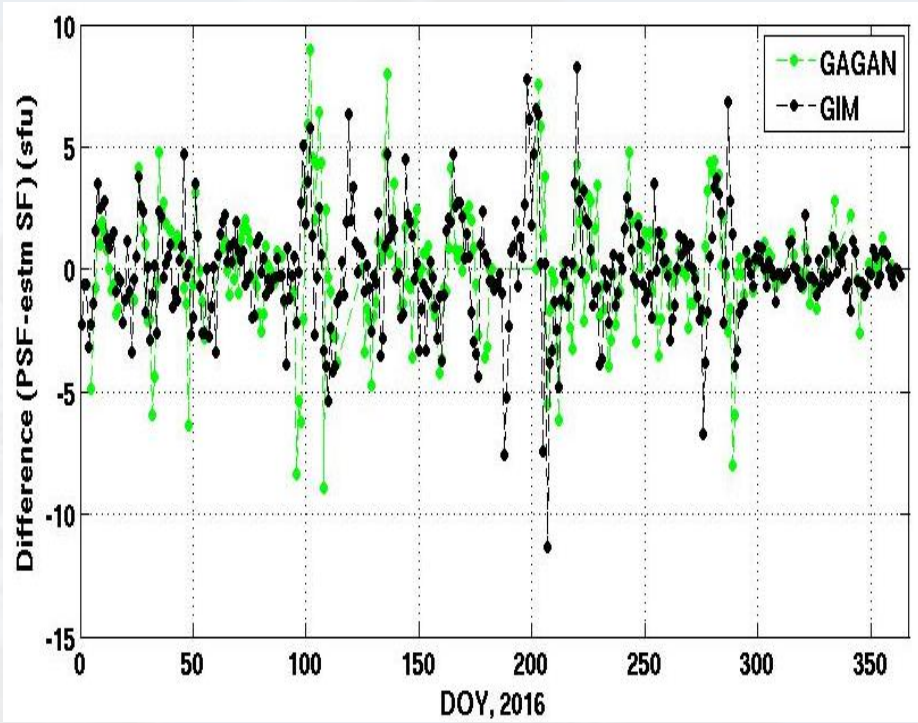
Observatory solar radio flux (SF), average solar flux (ASF) and processed solar radio flux (PSF) in black, red and green colours respectively for the period January 2012 to December 2016 (in SFU)

Solar Flux (F10.7) estimation using IRNSS

Re-construction of Solar Flux using GNSS data

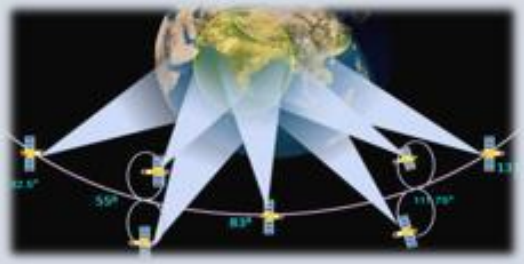


Variation of PSF (black) and computed SF (red) using GIM data from January 2012 to Dcemeber 2016



Difference (in sfu) between PSF and computed SF using GIM (black) and GAGAN (green) data for year 2016

Presently, error in the estimation is more for very high range of SF value (generally >130 SFU) as compare to the moderate SF



Thank You