Adaptation of NeQuick model for NavIC

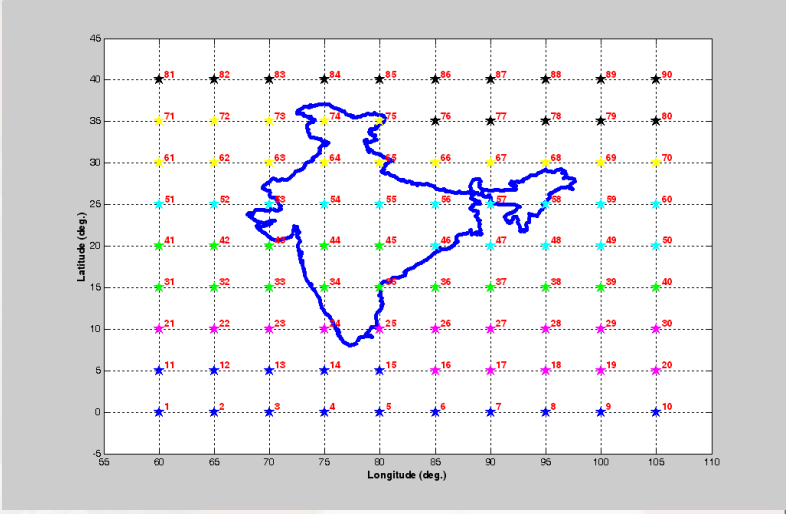
Megha Maheswari
Nirmala S

Indian Space Research Organization (ISRO)

Nequick Model for NavIC

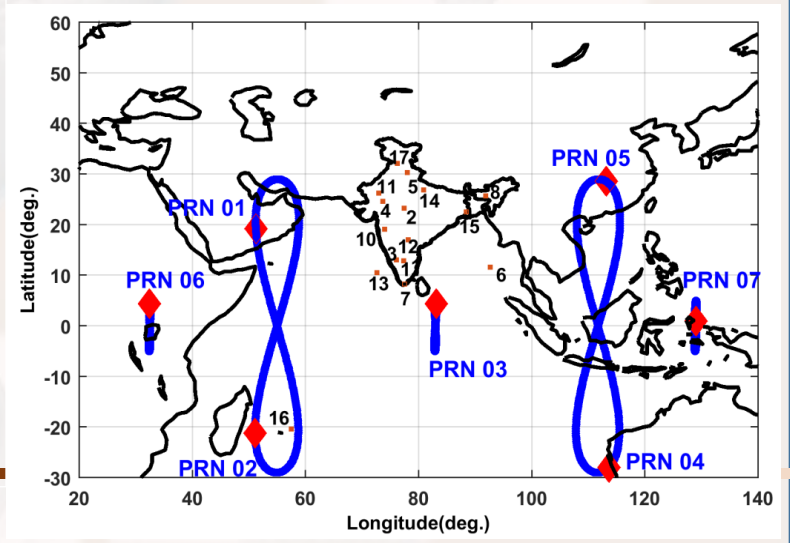
Grid Based Ionospheric Corrections

- NavIC 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 NavIC

Ionosphere coefficients for NavIC (NeQuick-N)

Objective:

To explore the use of NeQuick based ionosphere model for NavIC single frequency users over low latitude region (NeQuick-N)

Approach:

- Generation of broadcast ionosphere coefficients
  - Different statistical estimation methods
- Performance assessment with NavIC measurements over Indian Land mass
  - Performance assessment in estimation period
  - Performance assessment in prediction period
- Modification in NeQuick Model parameters
- Comparison with GIM for NavIC Primary service area
- Comparison the performance of the NavIC and Galileo broadcast parameter wrt GIM over NavIC service area

Nequick Model for NavIC

Generation of broadcast ionosphere coefficient

Base Model:

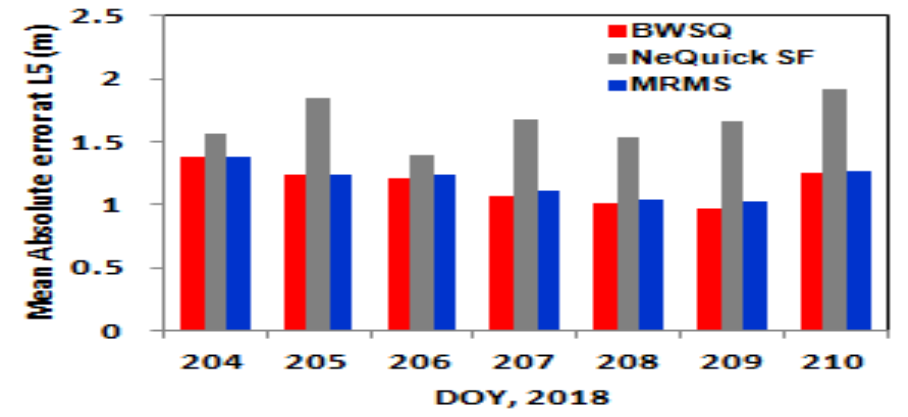
- NeQuick (a semi-empirical model)
- Input: Time, Month, user receiver position, Satellite position, Solar radio flux (SF)
- Output: Total Electron Content along the line of sight

Methods:

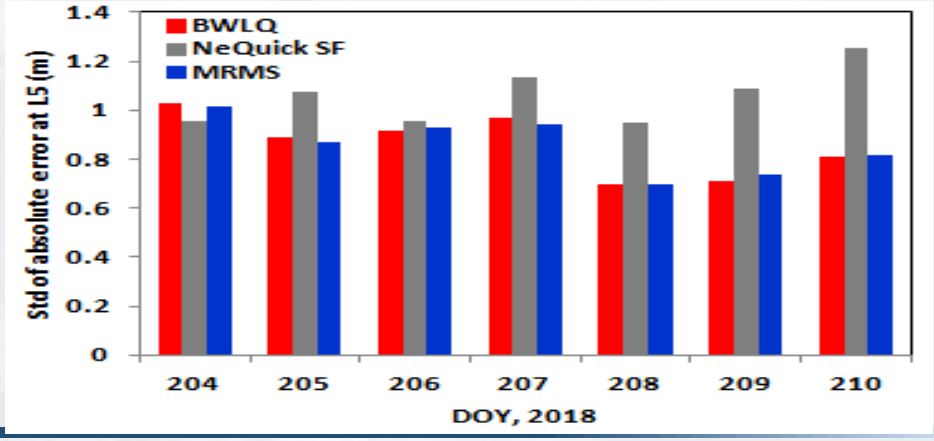
Estimation of ionization parameter with NavIC measurements using:

- 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

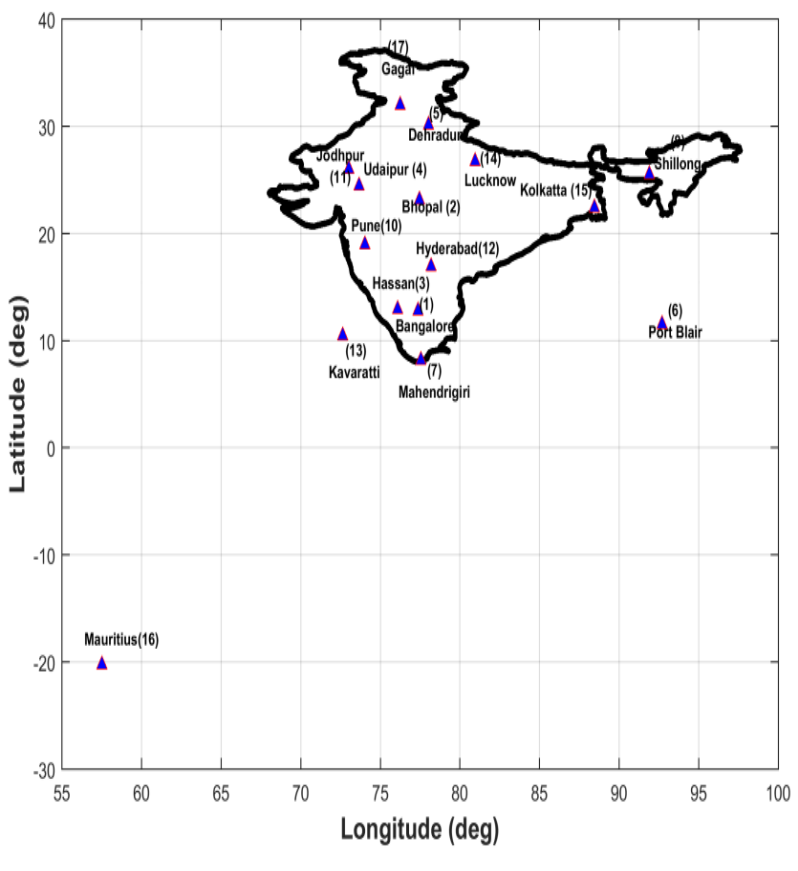


STD of Absolute Error using BWLQ &MRMS

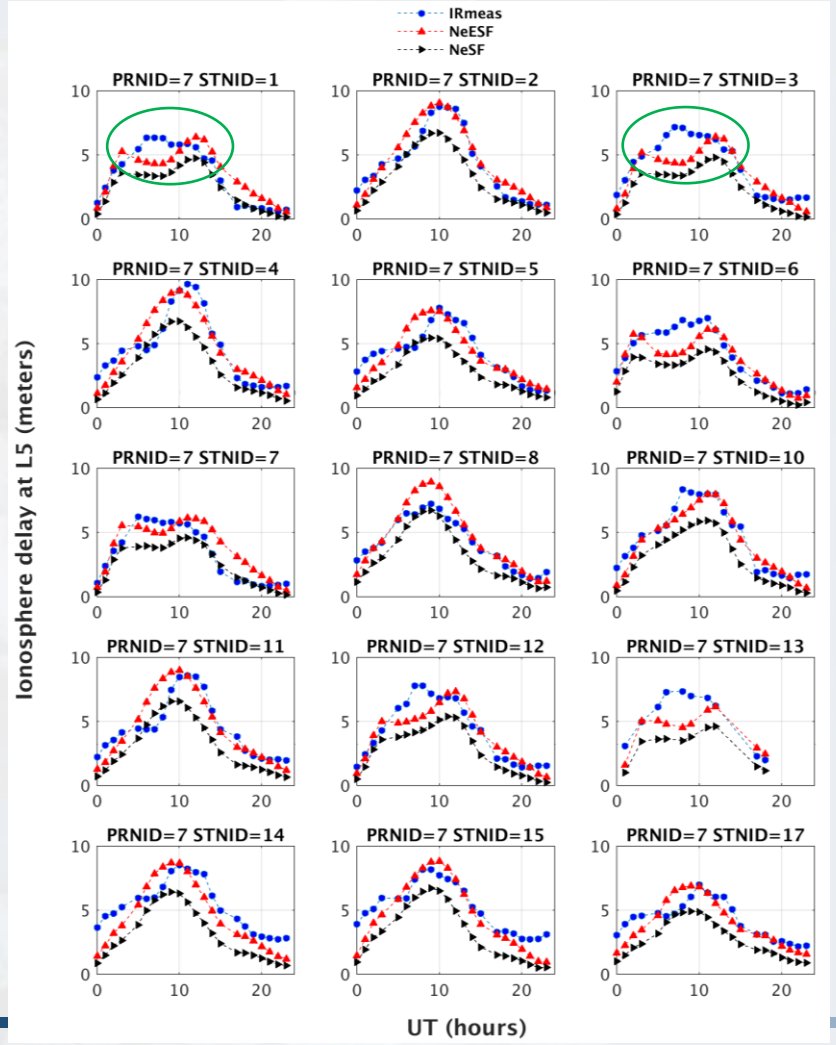


Slant delay variation over NavIC service area

Current NavIC reference receiver ‘s location



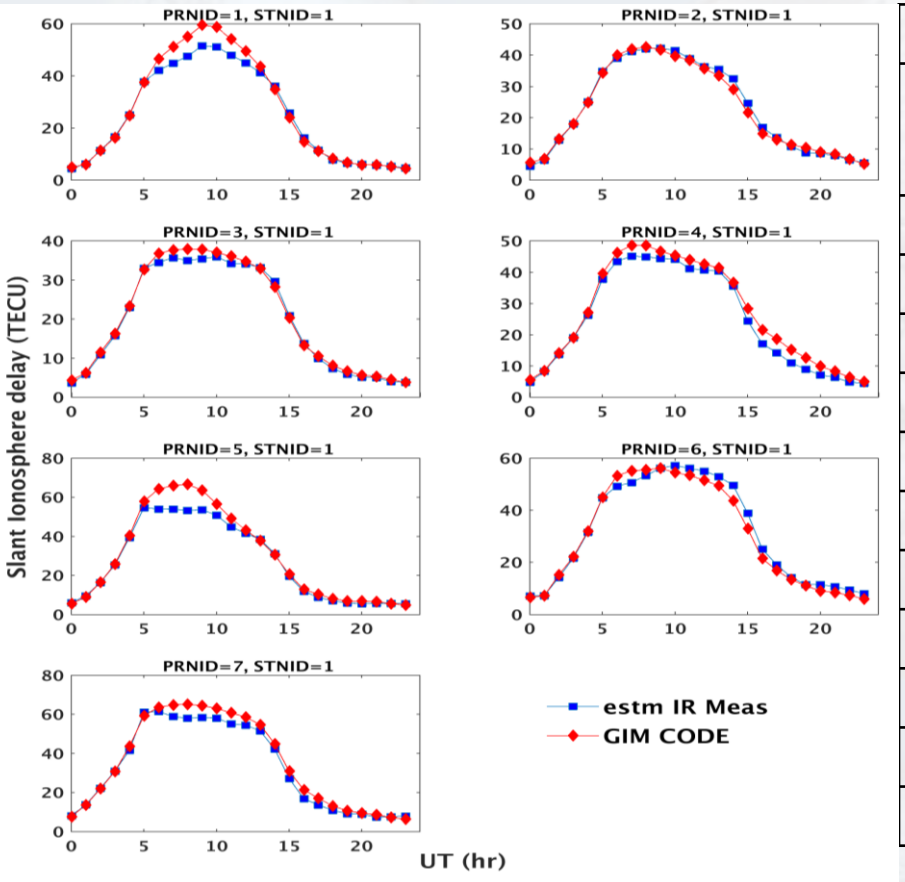
Typical time variation of slant delay



Nequick Model for NavIC

Comparison with GIM (Global Ionosphere Model) data

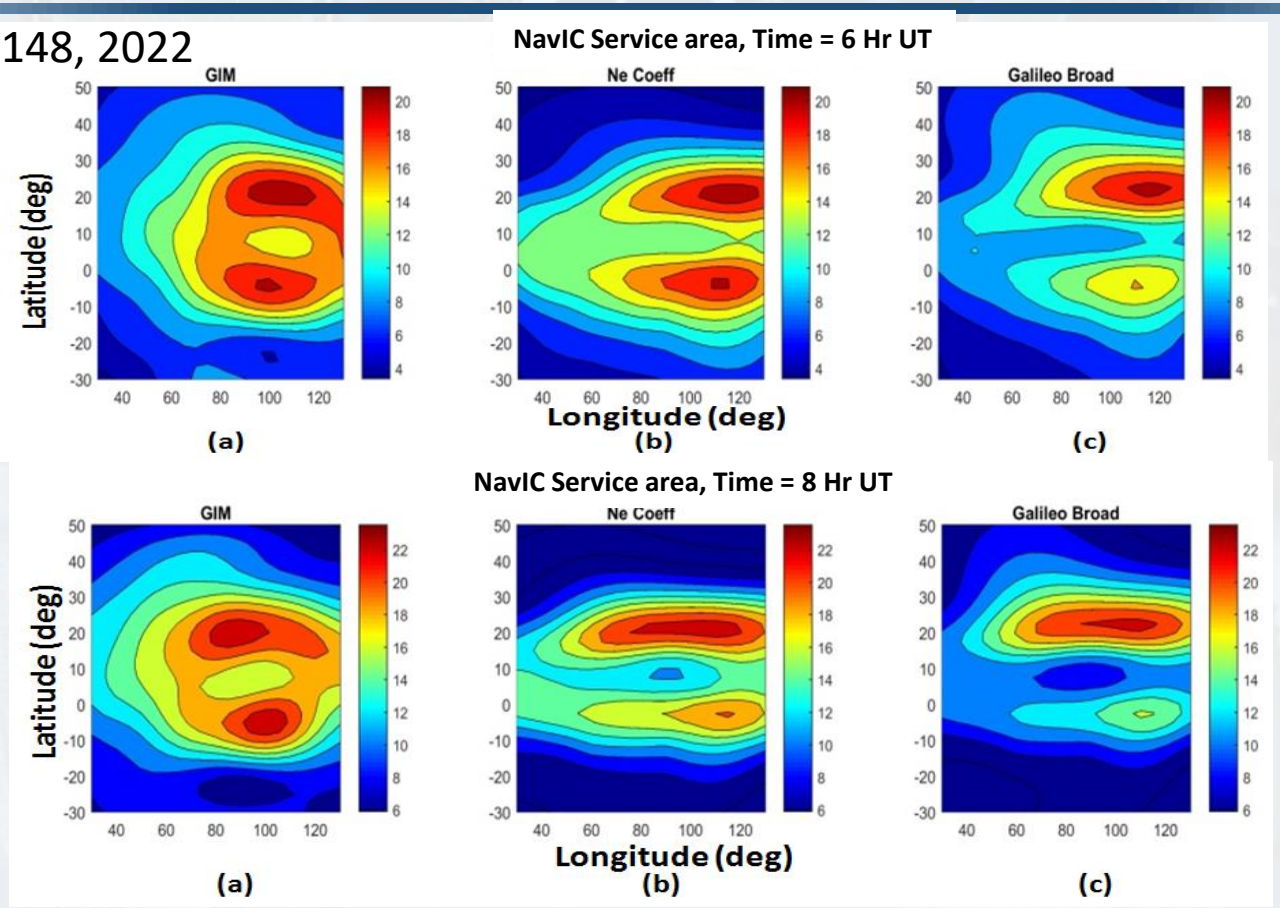
Modified coefficients of foF2 of NeQuick-2 model using NavIC data



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

NavIC coefficients vs Galileo coefficients (NeQuick-N vs NeQuick-G)

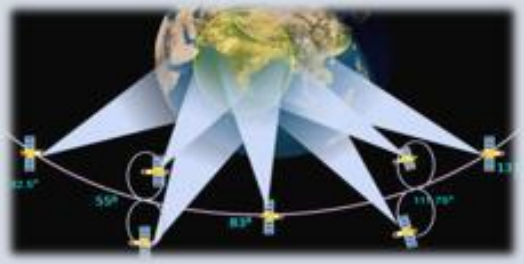
Day number : 148, 2022



➢ NeQuick-N captures the ionosphere equatorial anomaly in better way than NeQuick-G specially below equator with the same user algorithm. It might be due to denser network of NavIC reference stations than Galileo over low latitude region.

Nequick Model for NavIC (NeQuick-N)

- NavIC data ingested to NeQuick for better performance over NavIC 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.
- NeQuick-N performs better than NeQuick-G over NavIC service area.
- Further improvement in NeQuick model by ingesting more ionosphere data using different sources over NavIC service area is planned.



Thank You