ISRO-IRNSS-PER-19-1

NavIC (IRNSS)

STANDARD POSITIONING SERVICE

PERFORMANCE REPORT

JULY-SEPTEMBER 2019

SATELLITE NAVIGATION PROGRAM

U.R. RAO SATELLITE CENTRE

INDIAN SPACE RESEARCH ORGANIZATION

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ABBREVIATIONS

SPS	Standard Positioning Service
HPE	Horizontal Position Error
PE	Position Error
CEP	Circular Error Probability
drms	Distance root mean square
SV	Space Vehicle
NSAT	Number of Satellites
DOP	Dilution Of Precision

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The performance of the Signals in Space, broadcasted by NavIC (IRNSS) system, is continuously being evaluated for both single and dual frequency users across various locations within the service area. The NavIC (IRNSS) SPS service performance in dual frequency mode for the months of July, August and September 2019 has been provided in this document.

1.2 PERFORMANCE INDICATORS

Table 1 describes the various parameters considered as the indicators of performance.

Table 1: Performance Indicators for NavIC (IRNSS)

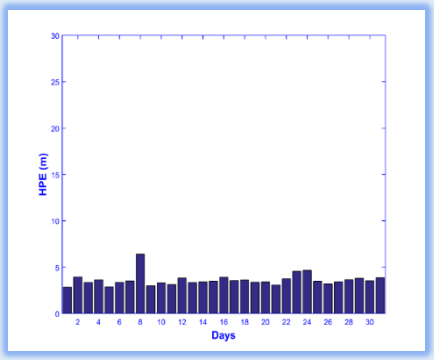
Position Accuracy	Horizontal Position Error (HPE) 3-D Position Error Circular Error Probability (CEP)	HPE is two dimensional in nature and can be quantified in terms of error in latitude and longitude. It is calculated as twice the distance-root-mean-square (2drms) with the probability of 95% in this report. 3-D Position Error describes the overall accuracy by combining the effects of horizontal as well as vertical accuracy. The values taken are 2-sigma with 95% probability. CEP is the radius of a circular region, defined in such a way that, the probability of computed estimates falling inside this region is 50%. CEP can be computed from the scatter plot of latitudinal and longitudinal errors.
Availability	Percentage availability of SVs	The availability of service is computed at any user location as the percentage of time an SV can be used for position computation. This metric has been calculated by examining the status of Alert flag and URE index of each SV at every 30 s interval.
Carrier-to-Noise ratio	Received C/N_0 in L5 band Received C/N_0 in S band	
Satellite Geometry	Dilution of Precision	

CHAPTER 2

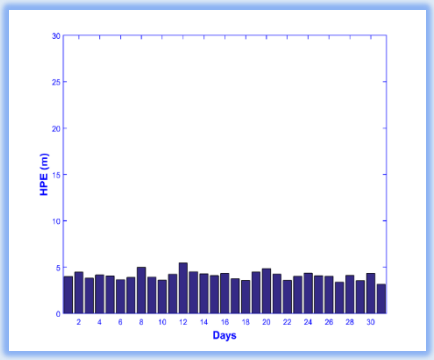
SOUTHERN REGION

2.1. SIGNAL IN SPACE ACCURACY

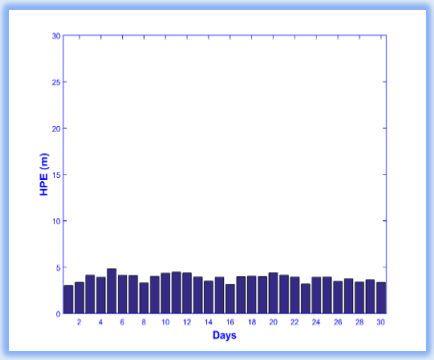
Horizontal Position Error



HPE in July

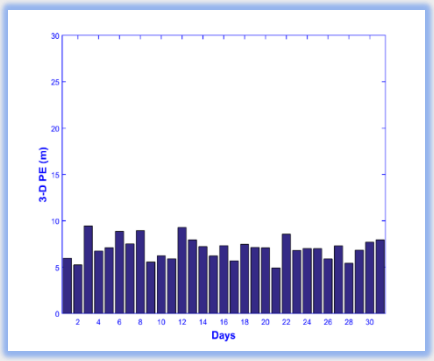


HPE in August

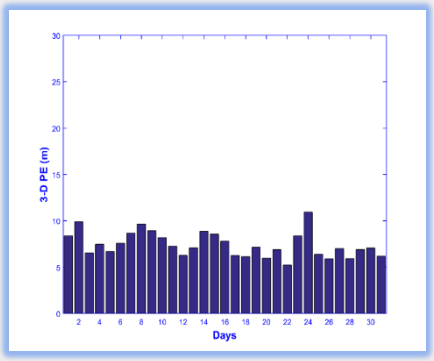


HPE in September

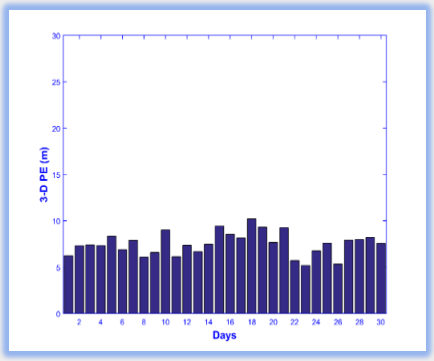
3-D Position Error



PE in July

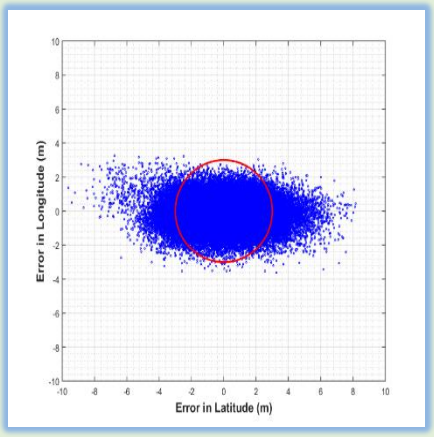


PE in August

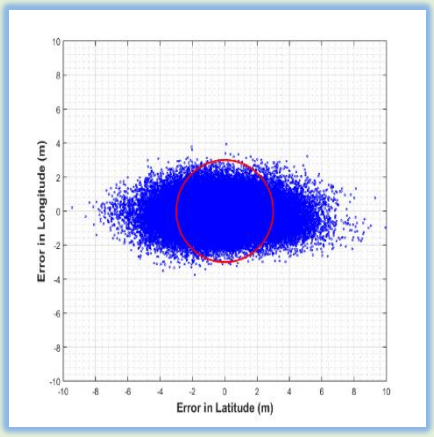


PE in September

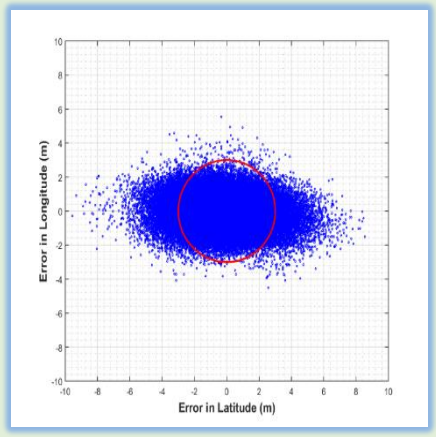
Circular Probability of Error



Scatter Plot for July
CEP: 1.4 m



Scatter Plot for August
CEP: 1.6 m

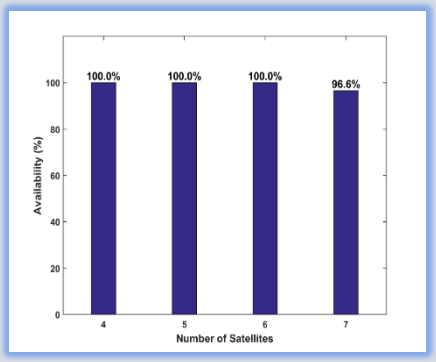


Scatter Plot for September
CEP: 1.5 m

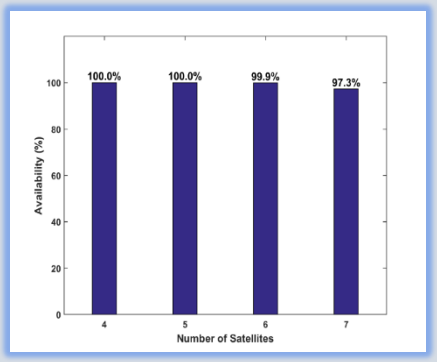
Figure 1: Position accuracy across southern region

NOTE:

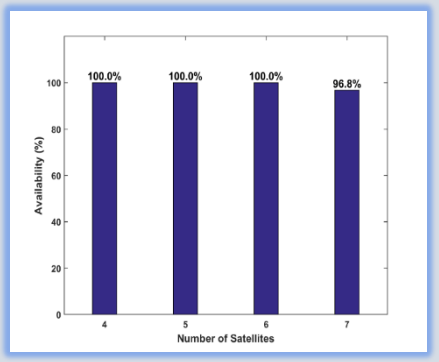
2.2. SATELLITE AVAILABILITY



Availability of NSAT in July



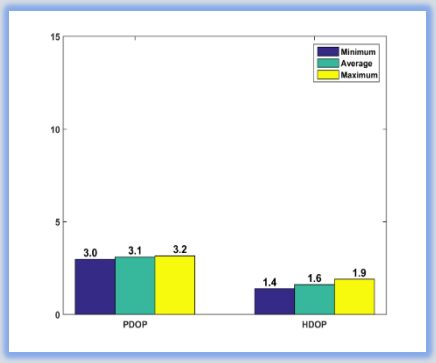
Availability of NSAT in August



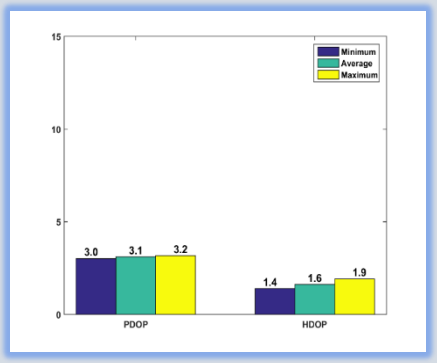
Availability of NSAT in September

Figure 2: Percentage availability of number of SVs in southern region

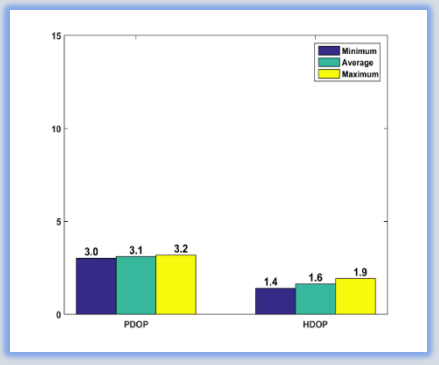
2.3. DILUTION OF PRECISION STATISTICS



DOP in July



DOP in August



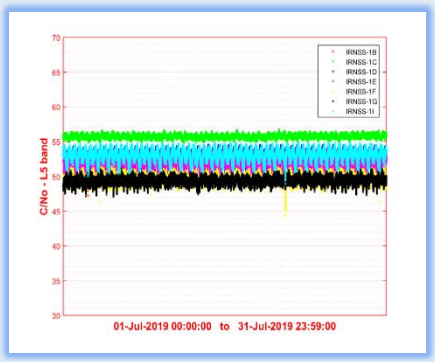
DOP in September

Figure 3: DOP statistics across southern region

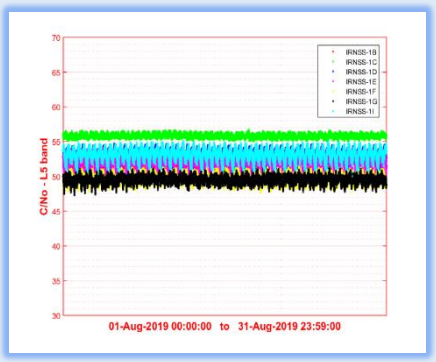
NOTE:

2.4. CARRIER TO NOISE RATIO

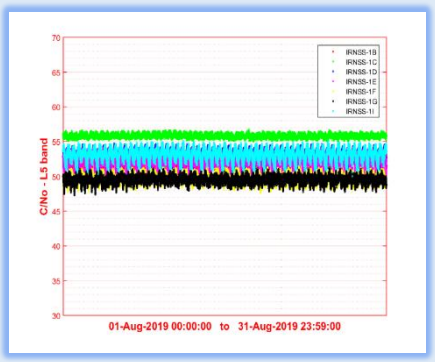
C/N_0 in L5 band



C/N_0 in July

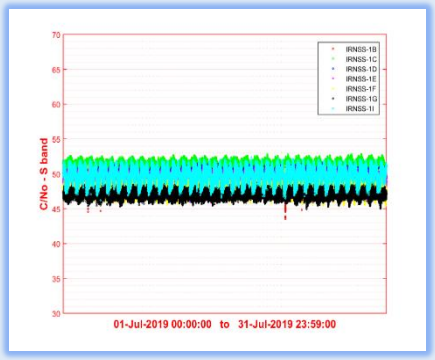


C/N_0 in August

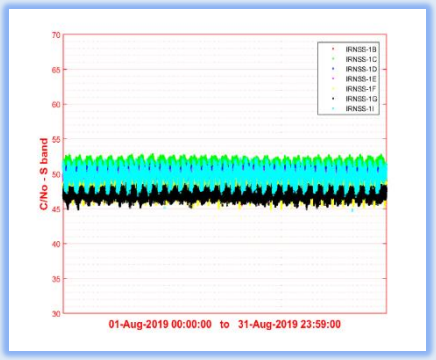


C/N_0 in September

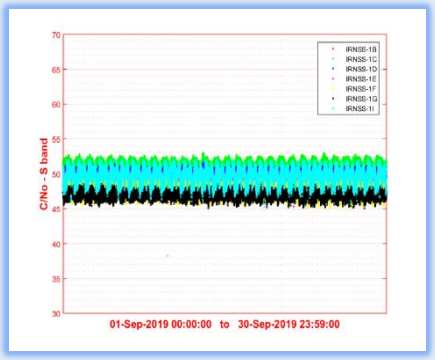
C/N_0 in S band



C/N_0 in July



C/N_0 in August



C/N_0 in September

Figure 4: Received C/N_0 across southern region

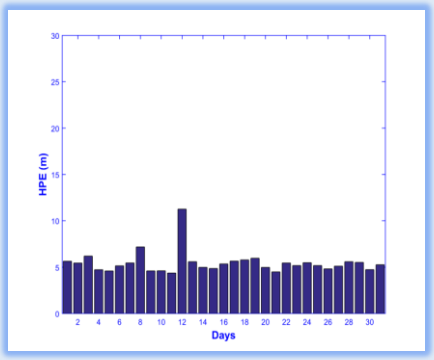
NOTE:

CHAPTER 3

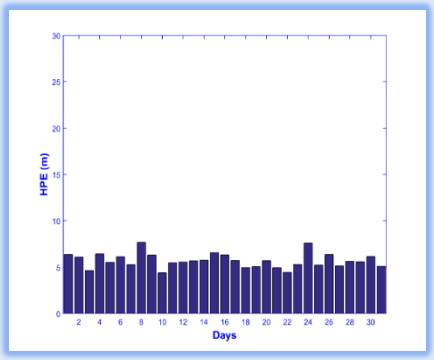
WESTERN REGION

3.1 SIGNAL IN SPACE ACCURACY

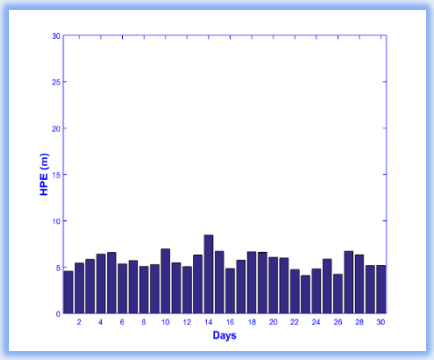
Horizontal Position Error



HPE in July

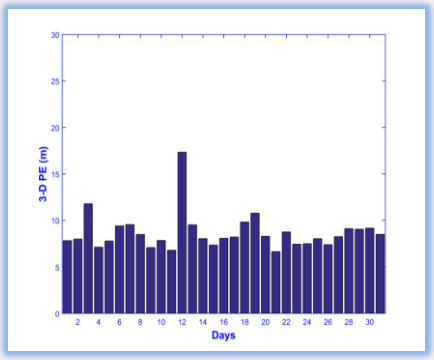


HPE in August

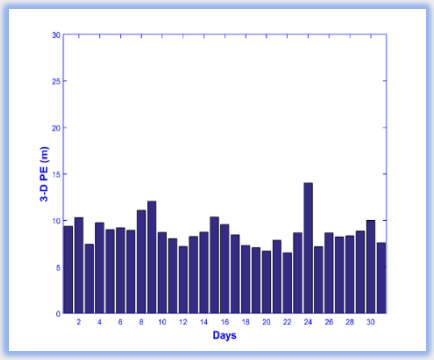


HPE in September

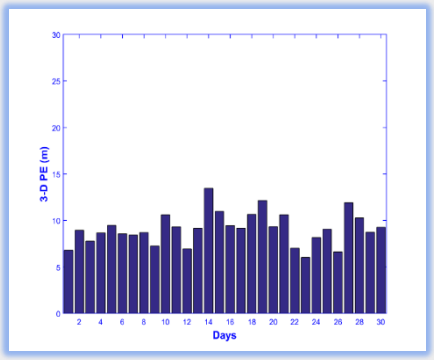
3-D Position Error



PE in July

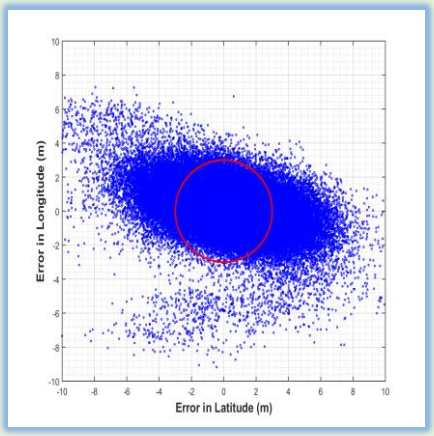


PE in August

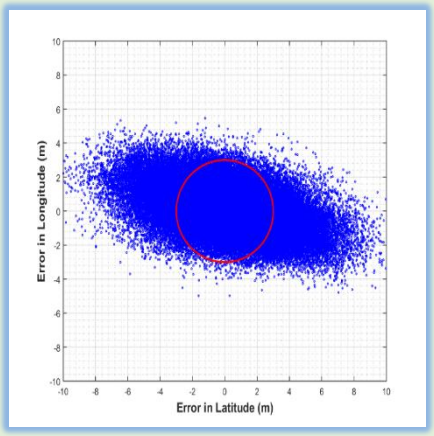


PE in September

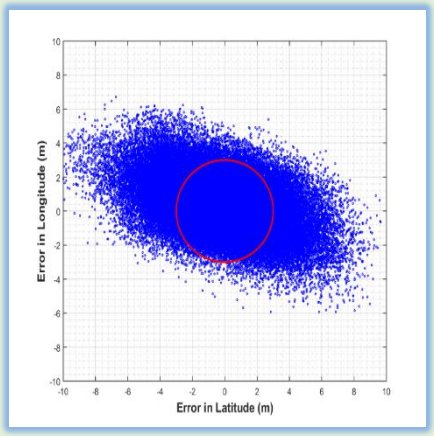
Circular Probability of Error



Scatter Plot for July
CEP: 2.2 m



Scatter Plot for August
CEP: 2.4 m



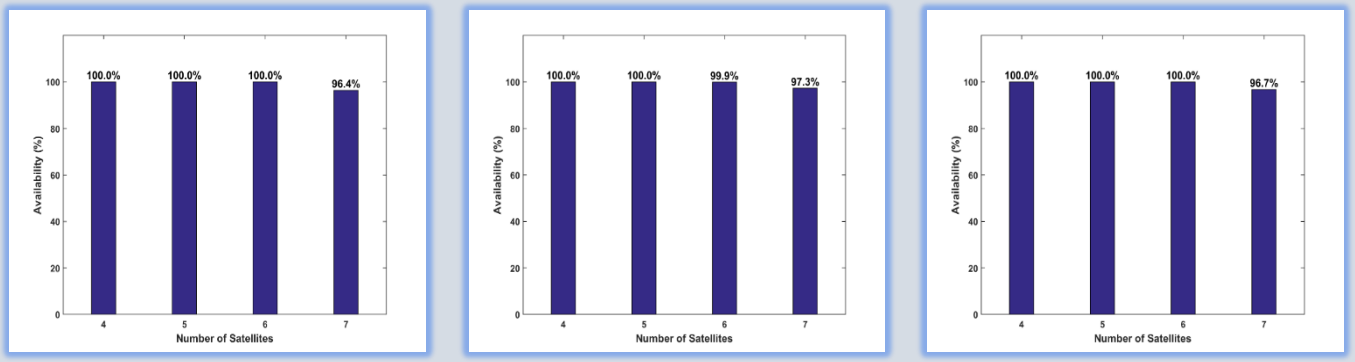
Scatter Plot for September
CEP: 2.4 m

Figure 5: Position accuracy across western region

NOTE:

1. The three- dimensional position accuracy performance is better than 12m for 73% of time on July 12, 2019. The observation in 3D-PE plot is due to SV.
2. The three- dimensional position accuracy performance is better than 10m for 86% of time on August 24, 2019. The observation in 3D-PE plot is due to SV.

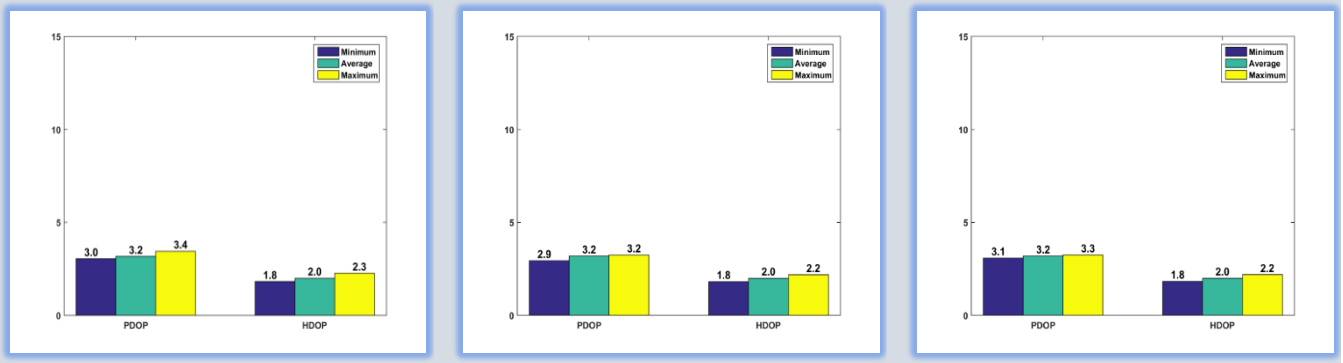
3.2 SATELLITE AVAILABILITY



Availability of NSAT in July **Availability of NSAT in August** **Availability of NSAT in September**

Figure 6: Percentage availability of number of SVs in western region

3.3 DILUTION OF PRECISION STATISTICS



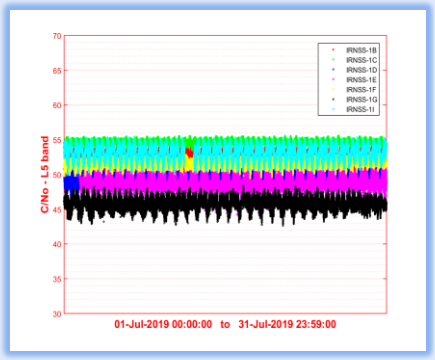
DOP in July **DOP in August** **DOP in September**

Figure 7: DOP statistics across western region

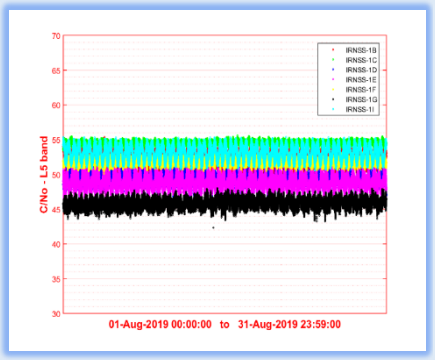
NOTE:

3.4 CARRIER TO NOISE RATIO

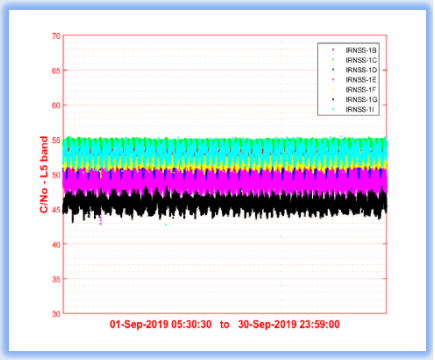
C/N_0 in L5 band



C/N_0 in July

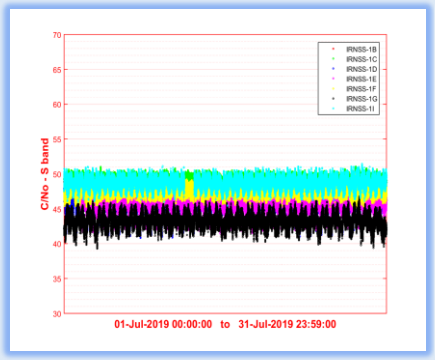


C/N_0 in August

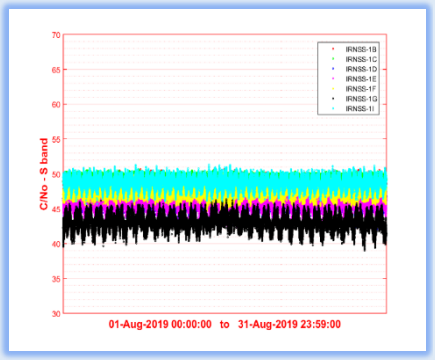


C/N_0 in September

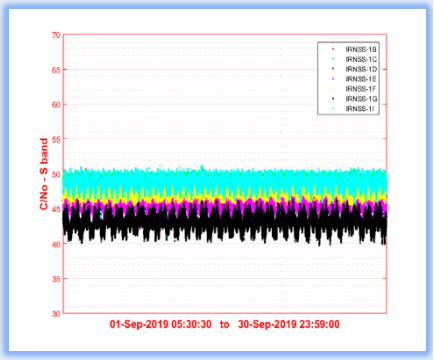
C/N_0 in S band



C/N_0 in July



C/N_0 in August



C/N_0 in September

Figure 8: Received C/N_0 across western region

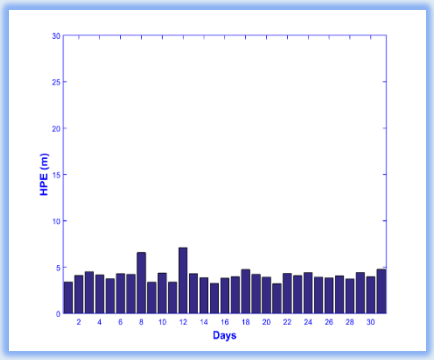
NOTE:

CHAPTER 4

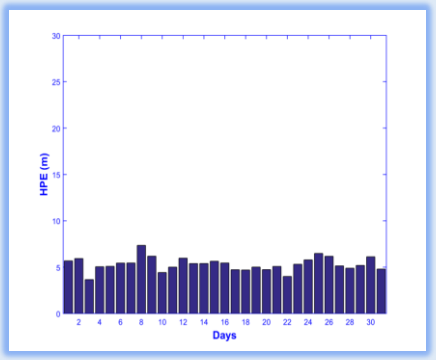
CENTRAL REGION

4.1 SIGNAL IN SPACE ACCURACY

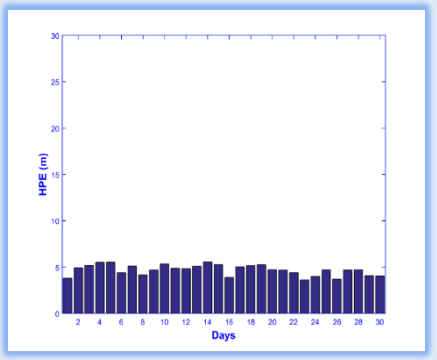
Horizontal Position Error



HPE in July

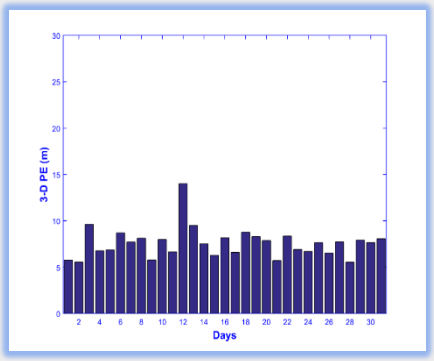


HPE in August

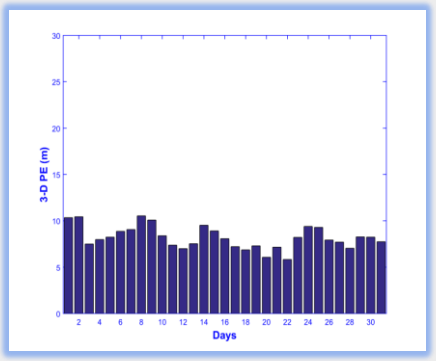


HPE in September

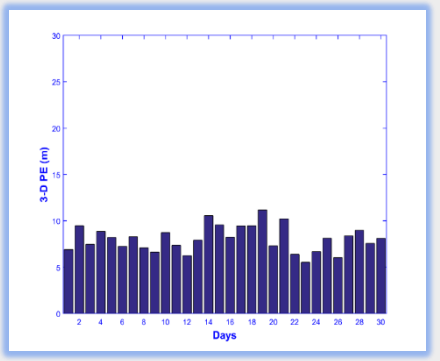
3-D Position Error



PE in July

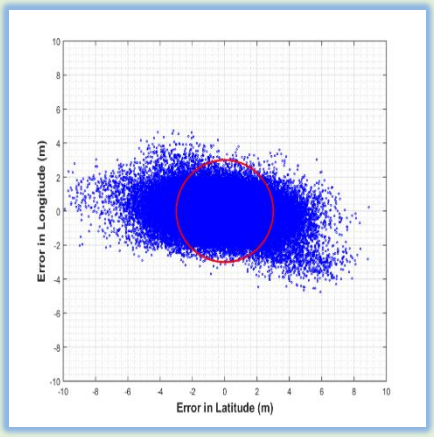


PE in August

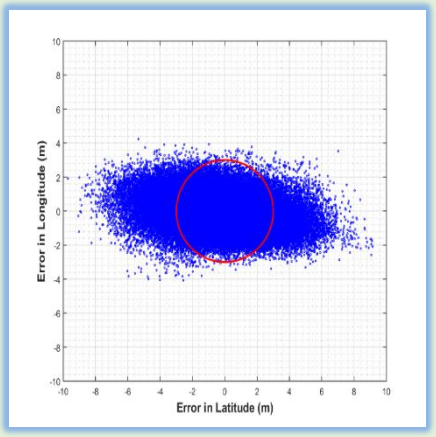


PE in September

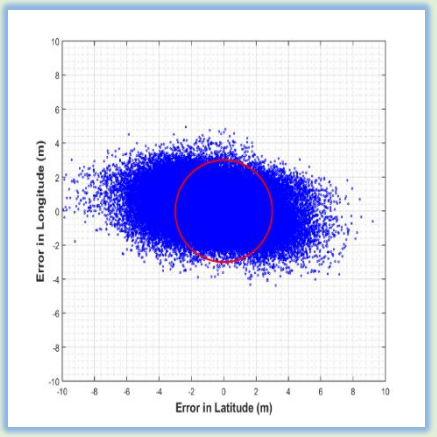
Circular Probability of Error



Scatter Plot for July
CEP: 1.7 m



Scatter Plot for August
CEP: 2.1 m



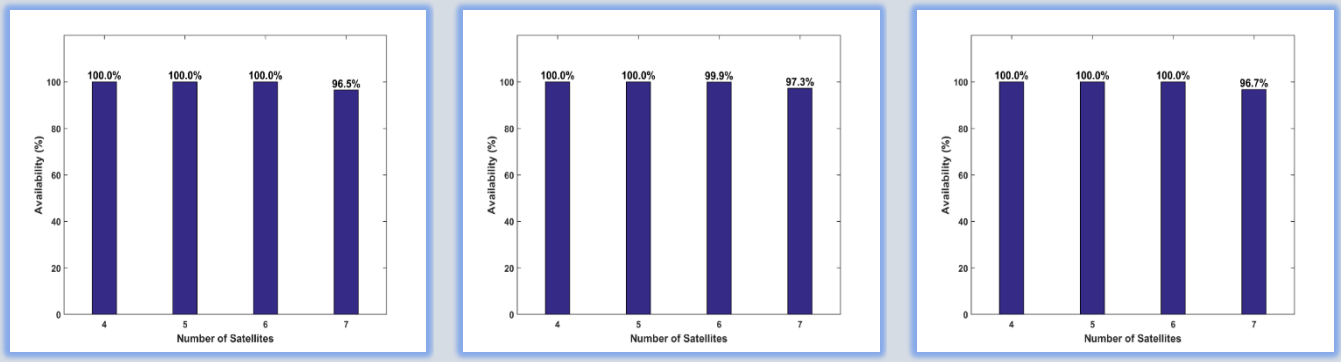
Scatter Plot for September
CEP: 1.9 m

Figure 9: Position accuracy across central region

NOTE:

1. The three- dimensional position accuracy performance is better than 10m for 76% of time on July 12, 2019. The observation in 3D-PE plot is due to SV.

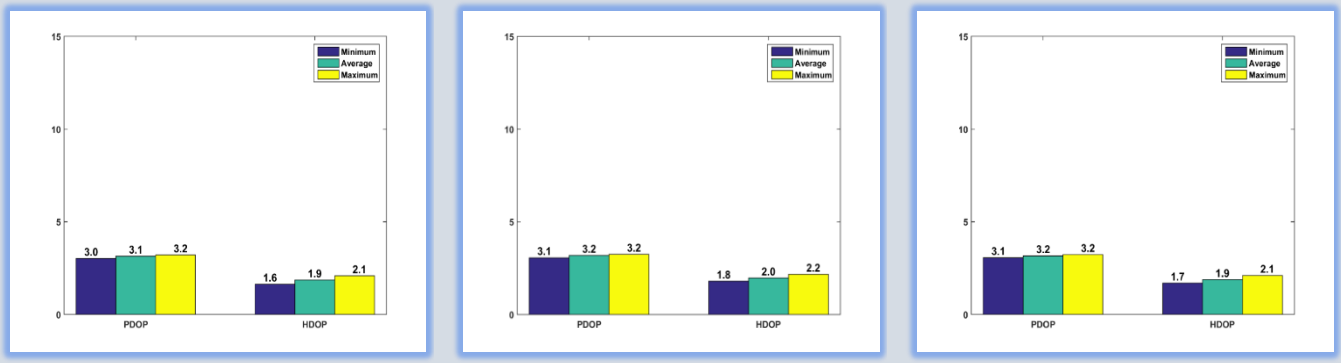
4.2 SATELLITE AVAILABILITY



Availability of NSAT in July | **Availability of NSAT in August** | **Availability of NSAT in September**

Figure 10: Percentage availability of number of SVs in central region

4.3 DILUTION OF PRECISION STATISTICS



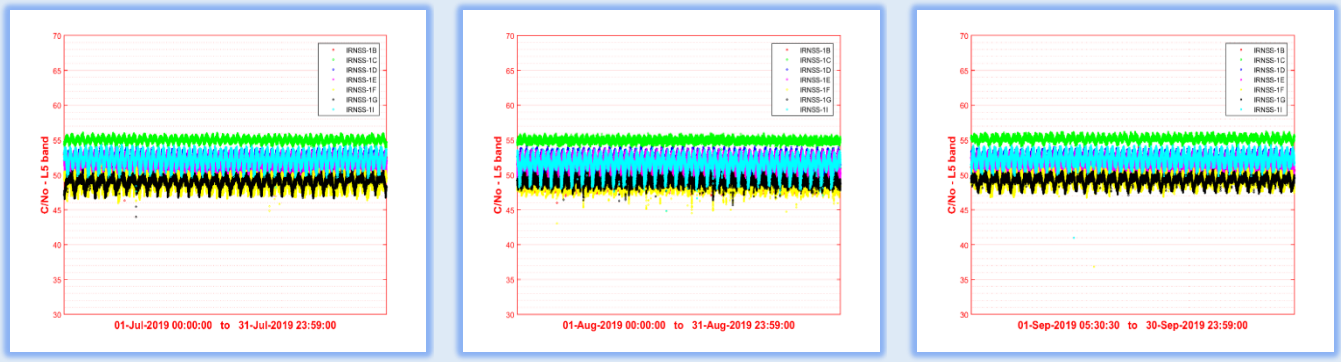
DOP in July | **DOP in August** | **DOP in September**

Figure 11: DOP statistics across central region

NOTE:

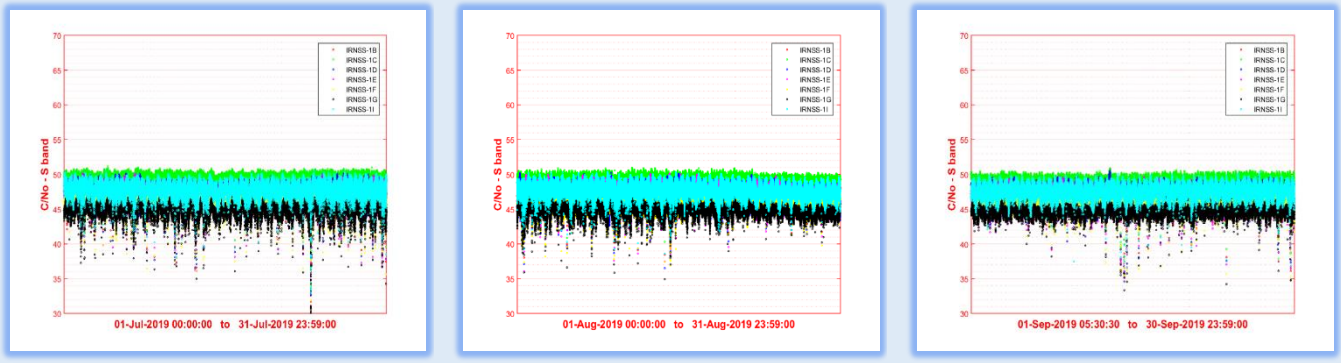
4.4 CARRIER TO NOISE RATIO

C/N_0 in L5 band



C/N_0 in July | C/N_0 in August | C/N_0 in September

C/N_0 in S band



C/N_0 in July | C/N_0 in August | C/N_0 in September

Figure 12: Received C/N_0 across central region

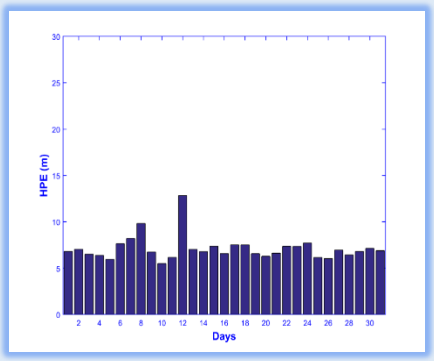
NOTE:

CHAPTER 5

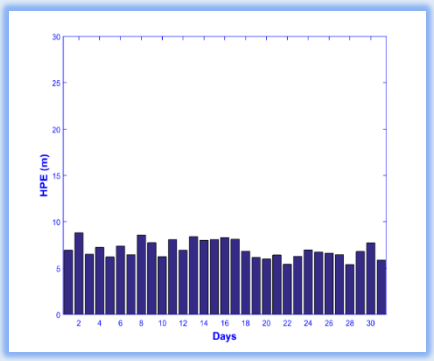
NORTHERN REGION

5.1 Signal In Space Accuracy

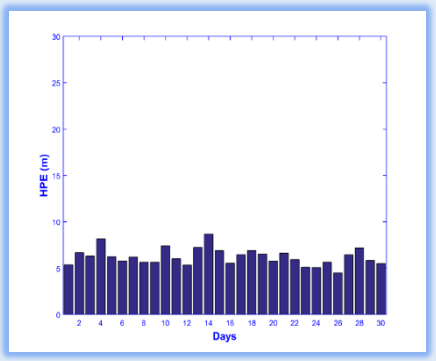
Horizontal Position Error



HPE in July

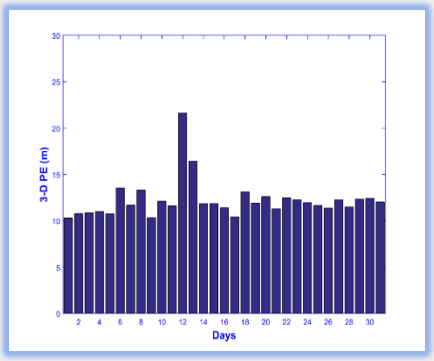


HPE in August

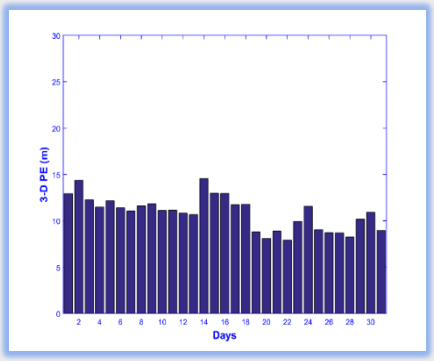


HPE in September

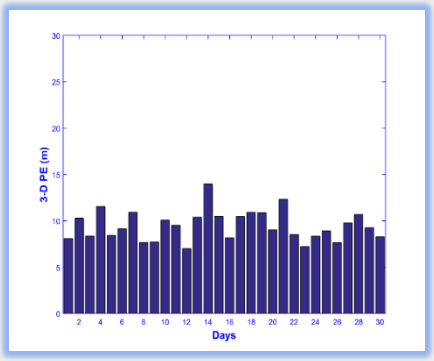
3-D Position Error



PE in July

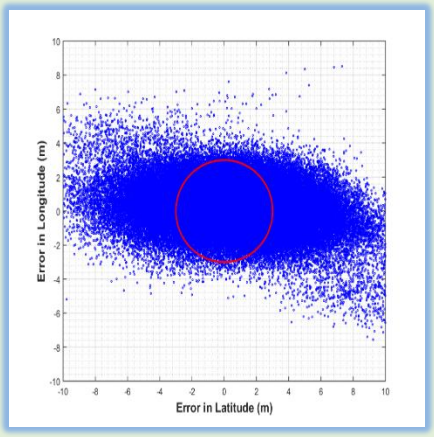


PE in August

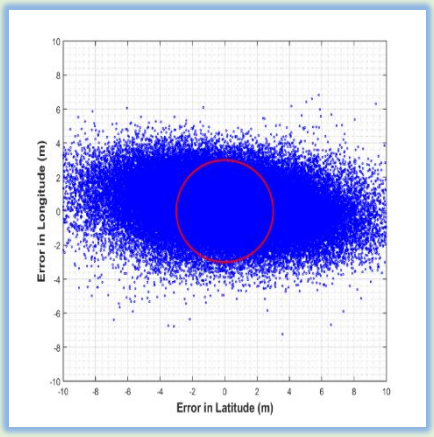


PE in September

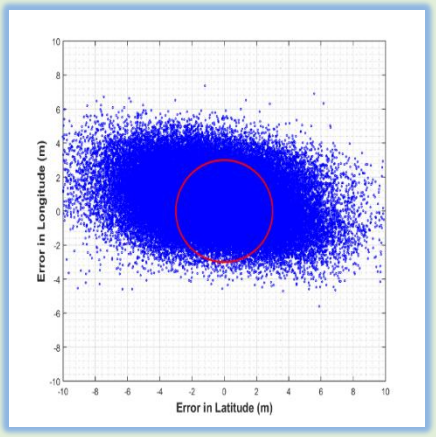
Circular Probability of Error



Scatter Plot for July
CEP: 2.9 m



Scatter Plot for August
CEP: 2.8 m



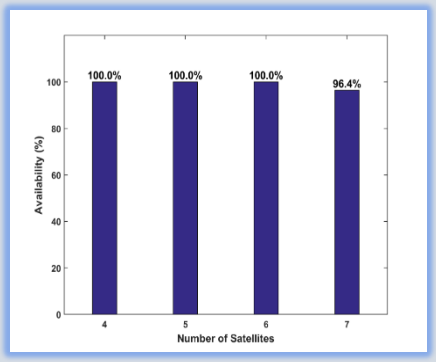
Scatter Plot for September
CEP: 2.6 m

Figure 13: Position accuracy across northern region

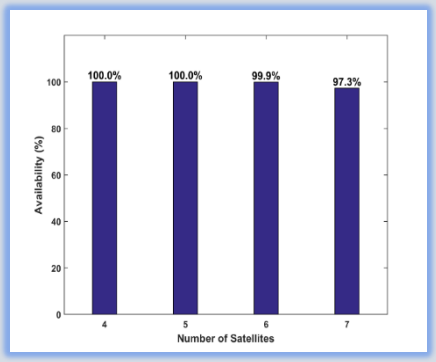
NOTE:

1. The three- dimensional position accuracy performance is better than 15m for 73% of time on July 12, 2019. The observation in 3D-PE plot is due to SV.

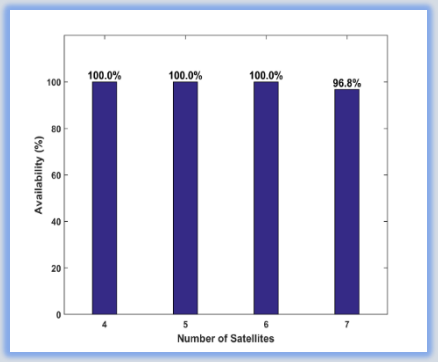
5.2 Satellite Availability



Availability of NSAT in July



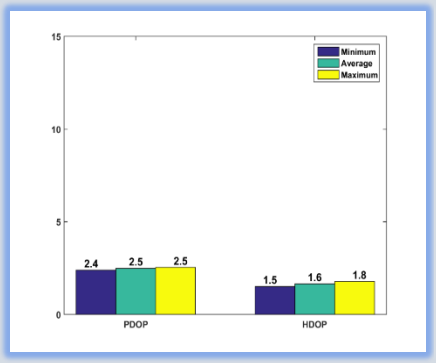
Availability of NSAT in August



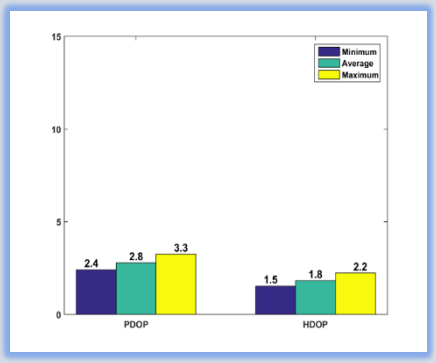
Availability of NSAT in September

Figure 14: Percentage availability of number of SVs in northern region

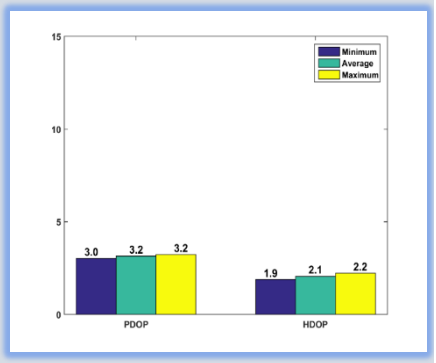
5.3 Dilution of Precision Statistics



DOP in July



DOP in August



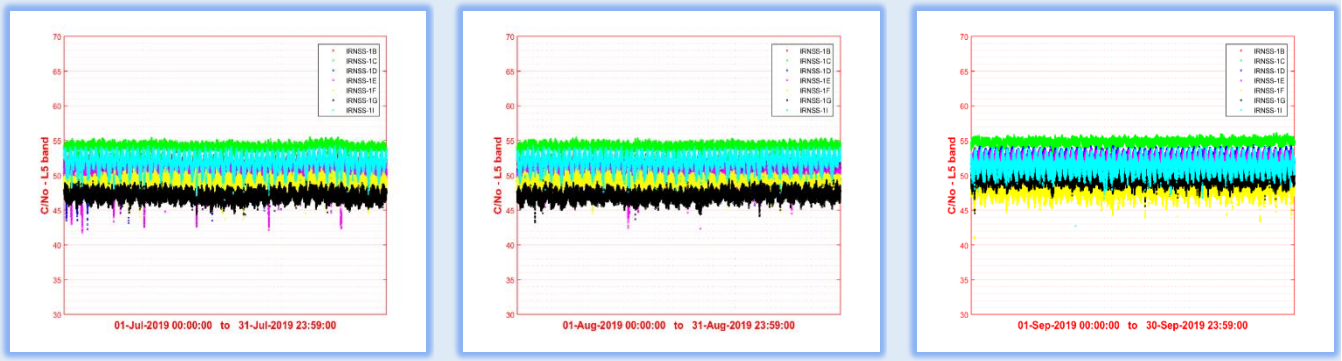
DOP in September

Figure 15: DOP statistics across northern region

NOTE:

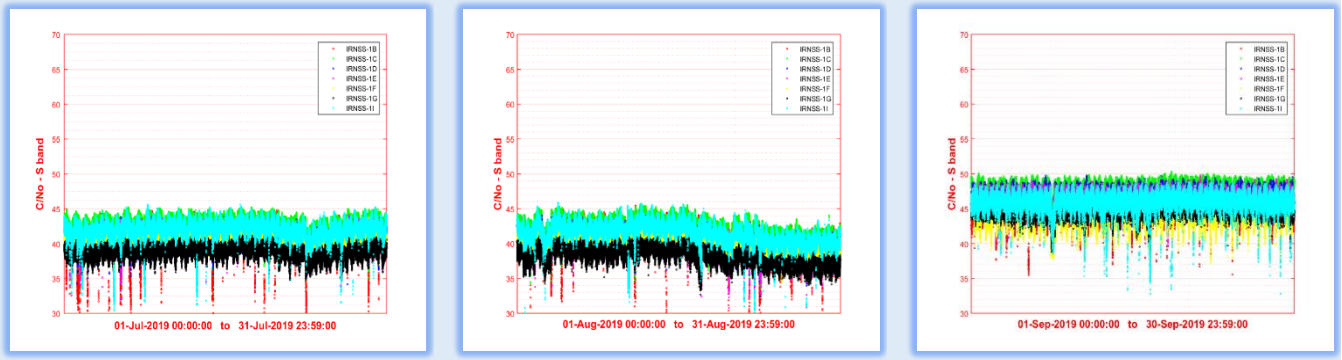
5.4 Carrier to Noise Ratio

C/N_0 in L5 band



C/N_0 in July | C/N_0 in August | C/N_0 in September

C/N_0 in S band



C/N_0 in July | C/N_0 in August | C/N_0 in September

Figure 16: Received C/N_0 across northern region

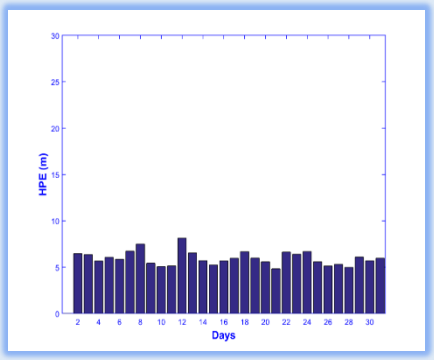
NOTE:

CHAPTER 6

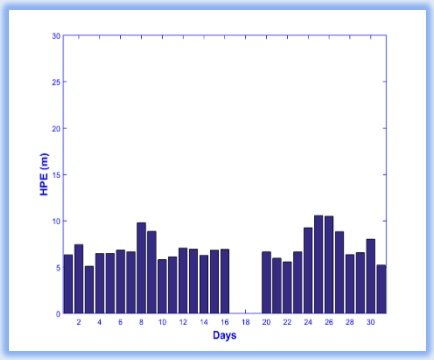
EASTERN REGION

6.1 SIGNAL IN SPACE ACCURACY

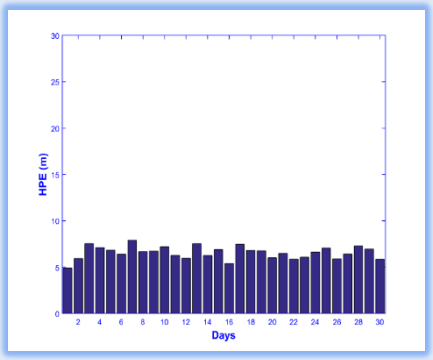
Horizontal Position Error



HPE in July

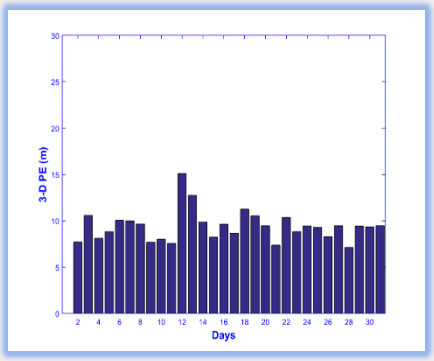


HPE in August

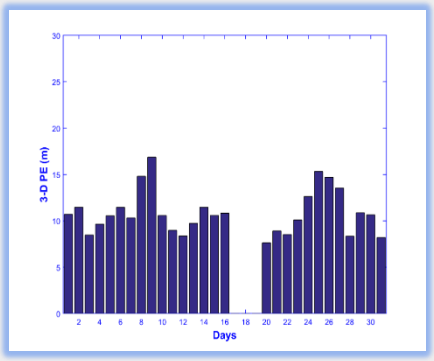


HPE in September

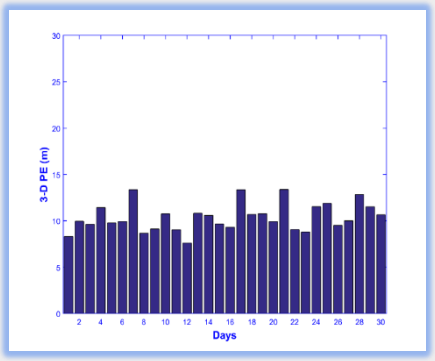
3-D Position Error



PE in July

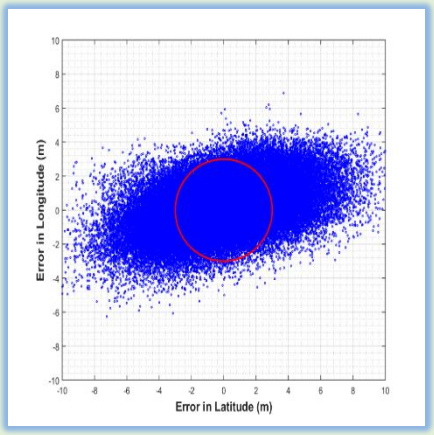


PE in August

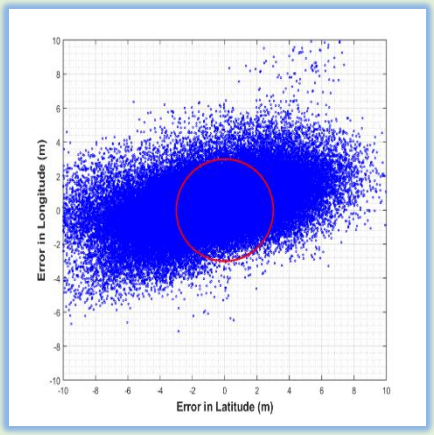


PE in September

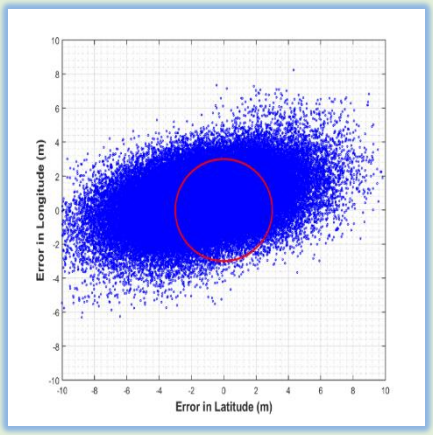
Circular Probability of Error



Scatter Plot for July
CEP: 2.5 m



Scatter Plot for August
CEP: 2.8 m



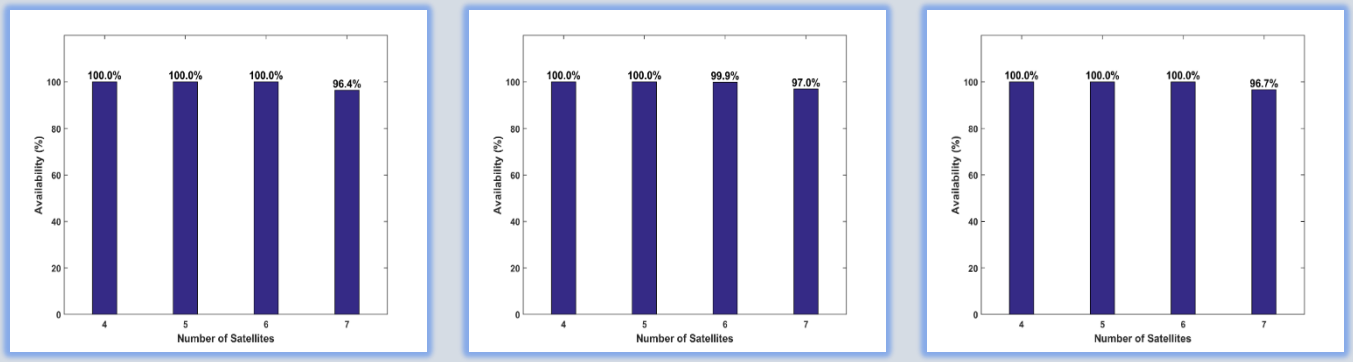
Scatter Plot for September
CEP: 2.8 m

Figure 17: Position accuracy across eastern region

NOTE:

1. Data not available for analysis on July 01, 2019.
2. The three- dimensional position accuracy performance is better than 12m for 83% of time on July 12, 2019. The observation in 3D-PE plot is due to SV.
3. Data not available for analysis on July 17, 2019 to July 19, 2019.

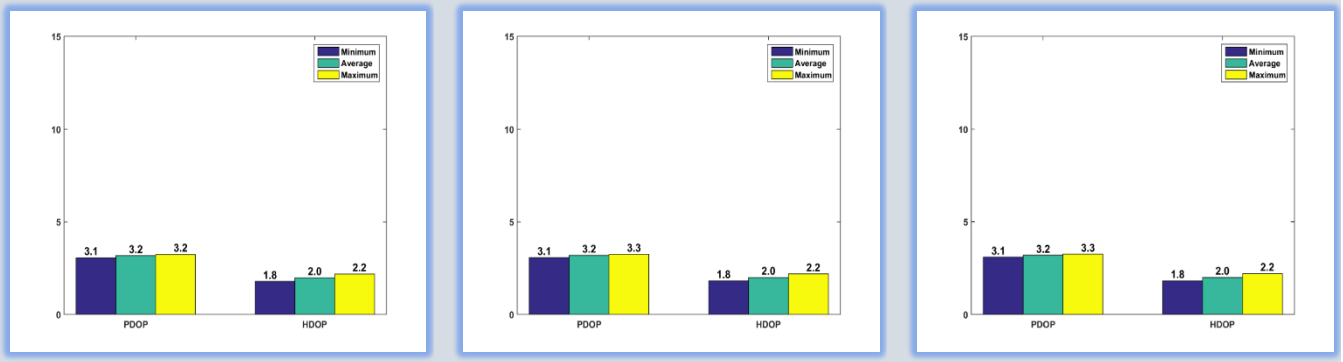
6.2 Satellite Availability



Availability of NSAT in July | Availability of NSAT in August | Availability of NSAT in September

Figure 18: Percentage availability of number of SVs in eastern region

6.3 Dilution of Precision Statistics



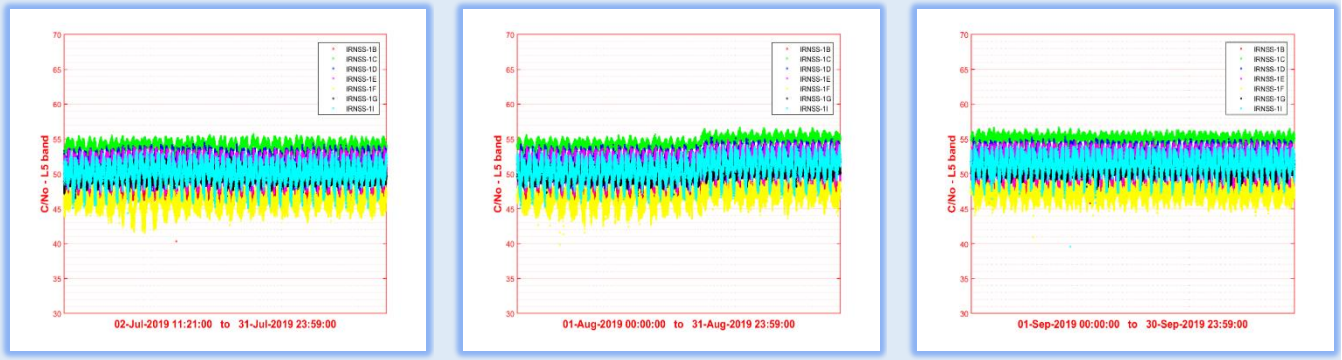
DOP in July | DOP in August | DOP in September

Figure 19: DOP statistics across eastern region

NOTE:

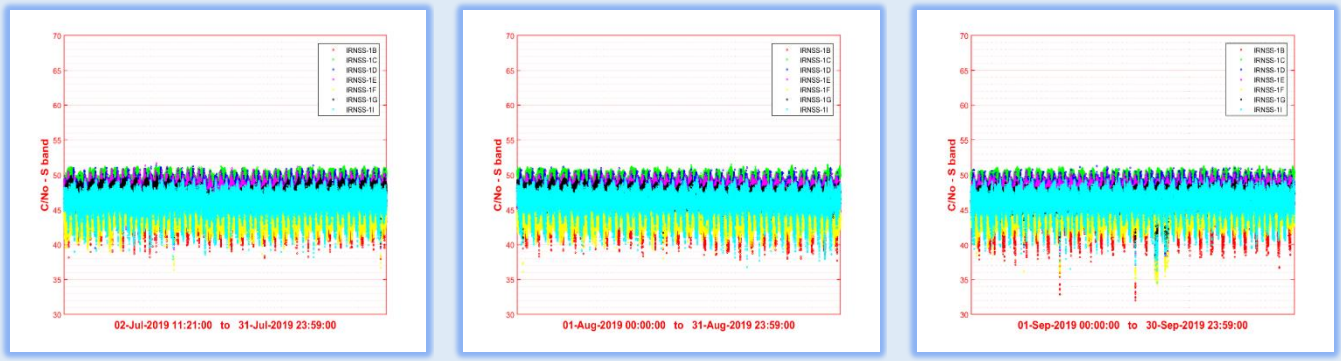
6.4 Carrier to Noise Ratio

C/N_0 in L5 band



C/N_0 in July | C/N_0 in August | C/N_0 in September

C/N_0 in S band



C/N_0 in July | C/N_0 in August | C/N_0 in September

Figure 20: Received C/N_0 across eastern region

NOTE: