ISRO-IRNSS-PER-19-2

NavIC (IRNSS)

STANDARD POSITIONING SERVICE

PERFORMANCE REPORT

APRIL-JUNE 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 April, May and June 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)

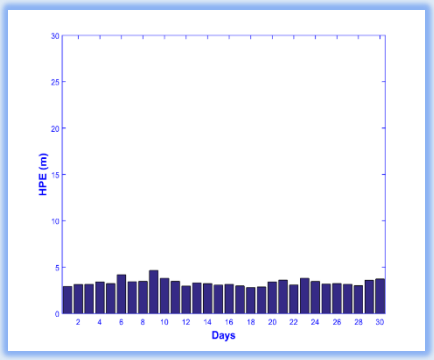
Position Accuracy	Horizontal Position Error (HPE) 3-D Position Error Circular Error Probability (CEP)	HPE is two dimensional in nature and can be quantified in terms of error in latitude and longitude. It is calculated as twice the distance-root-mean-square (2drms) with the probability of 95% in this 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

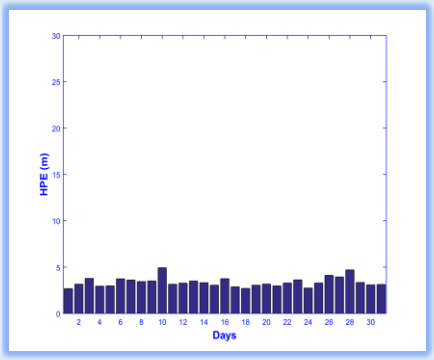
SOUTHERN REGION

2.1. SIGNAL IN SPACE ACCURACY

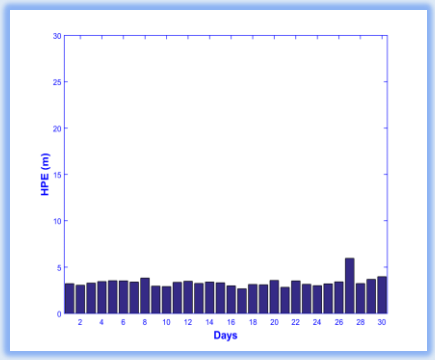
Horizontal Position Error



HPE in April

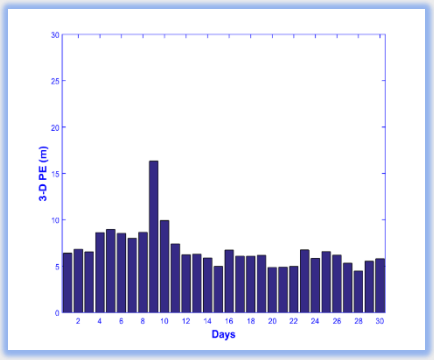


HPE in May

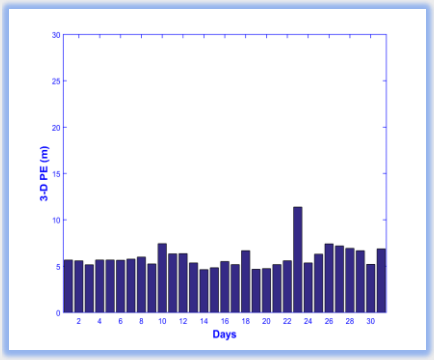


HPE in June

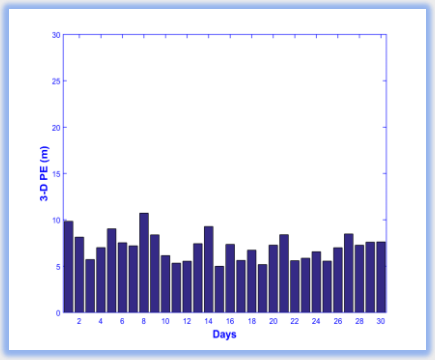
3-D Position Error



PE in April

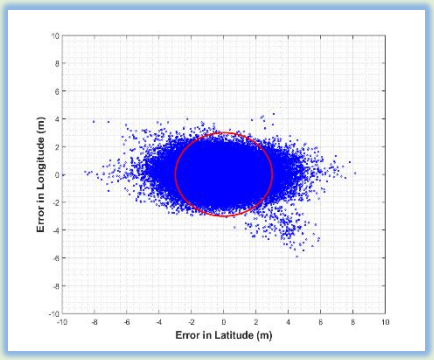


PE in May

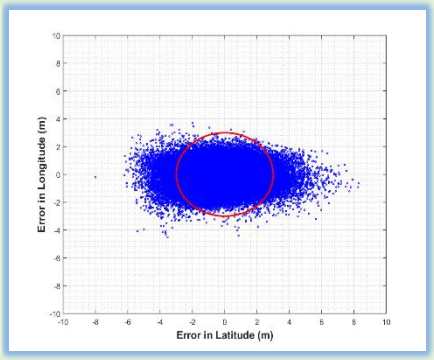


PE in June

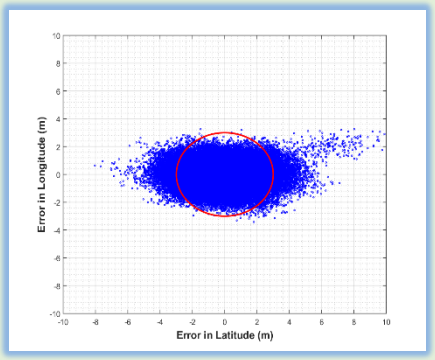
Circular Probability of Error



Scatter Plot for April
CEP: 1.4 m



Scatter Plot for May
CEP: 1.4 m



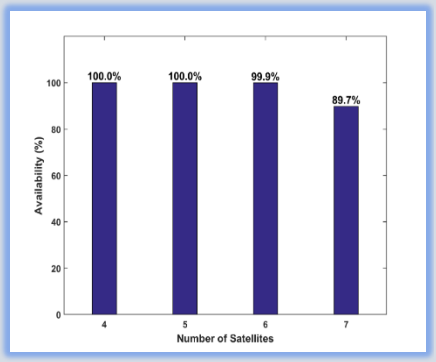
Scatter Plot for June
CEP: 1.4 m

Figure 1: Position accuracy across southern region

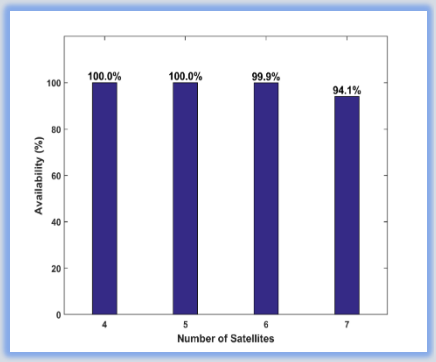
NOTE:

1. The three- dimensional position accuracy performance is better than 10m for 89% of time on April 09, 2019. The observation in 3D-PE plot is due to SV.
2. The three- dimensional position accuracy performance is better than 10m for 93% of time on May 23, 2019. The observation in 3D-PE plot is due to SV.

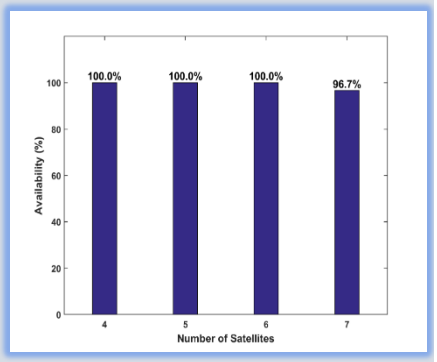
2.2. SATELLITE AVAILABILITY



Availability of NSAT in April



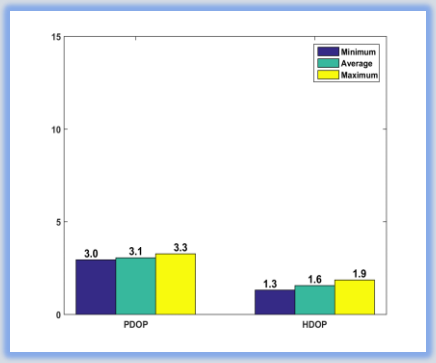
Availability of NSAT in May



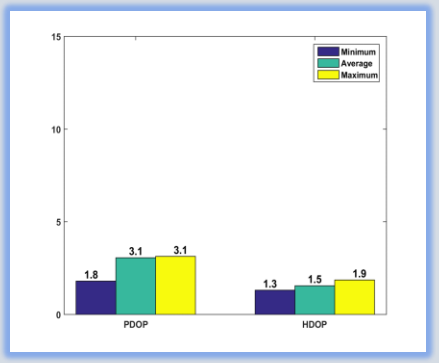
Availability of NSAT in June

Figure 2: Percentage availability of number of SVs for SPS service in southern region

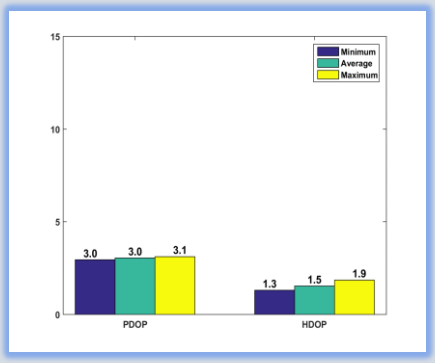
2.3. DILUTION OF PRECISION STATISTICS



DOP in April



DOP in May



DOP in June

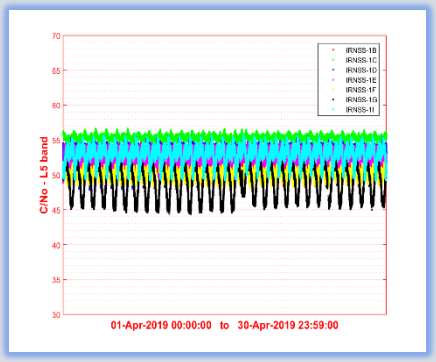
Figure 3: DOP statistics across southern region

NOTE:

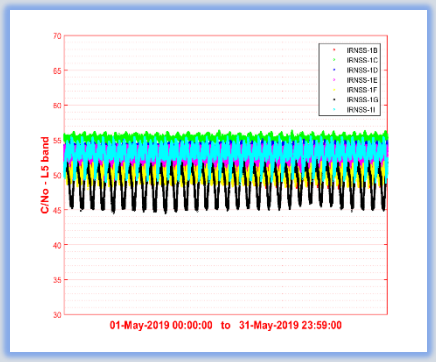
Availability of NSAT: 07 is low in April due to non-availability of one of the SVs for position computation for 58 hrs (approx).

2.4. CARRIER TO NOISE RATIO

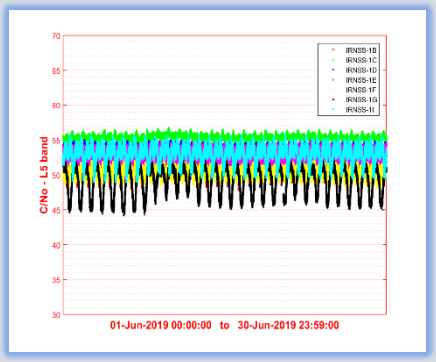
C/N_0 in L5 band



C/N_0 in April

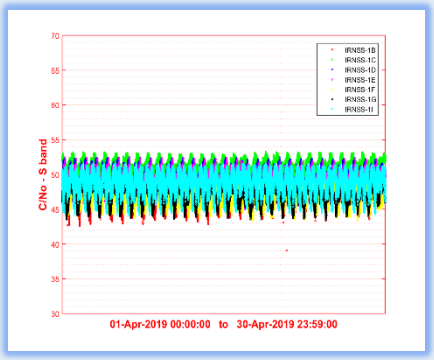


C/N_0 in May

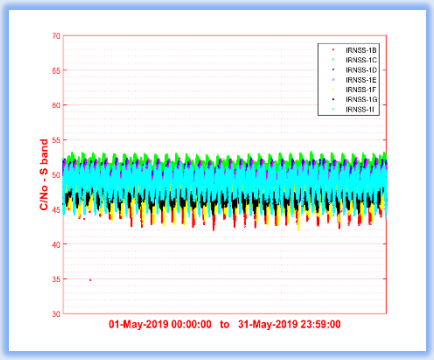


C/N_0 in June

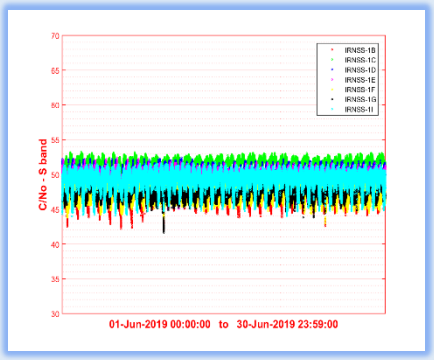
C/N_0 in S band



C/N_0 in April



C/N_0 in May



C/N_0 in June

Figure 4: Received C/N_0 across southern region

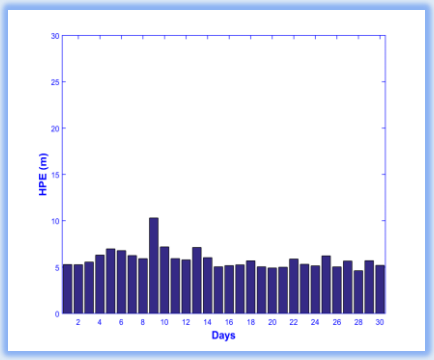
NOTE:

CHAPTER 3

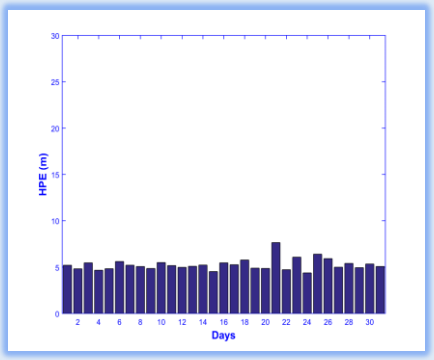
WESTERN REGION

3.1 Signal In Space Accuracy

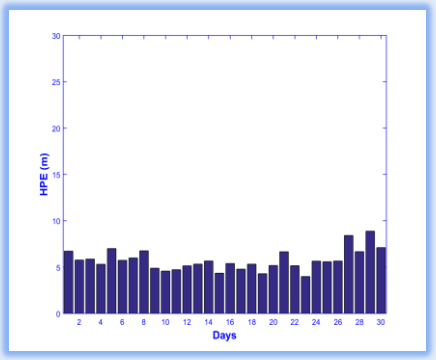
Horizontal Position Error



HPE in April

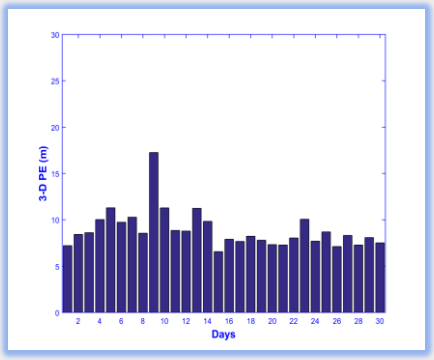


HPE in May

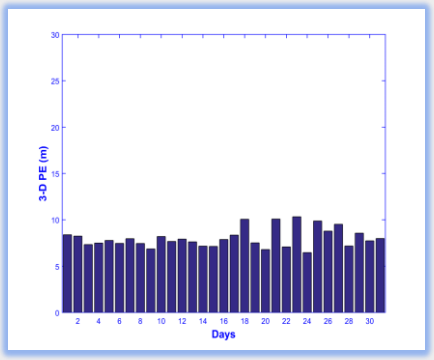


HPE in June

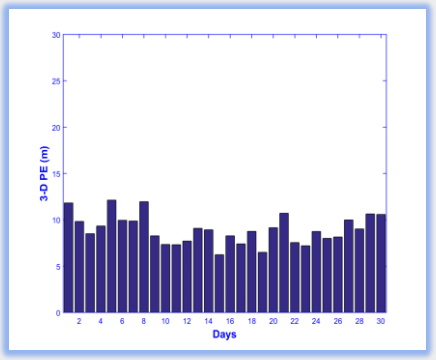
3-D Position Error



PE in April

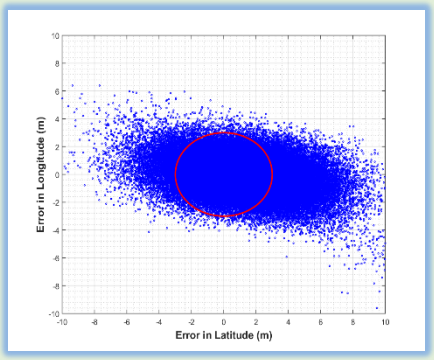


PE in May

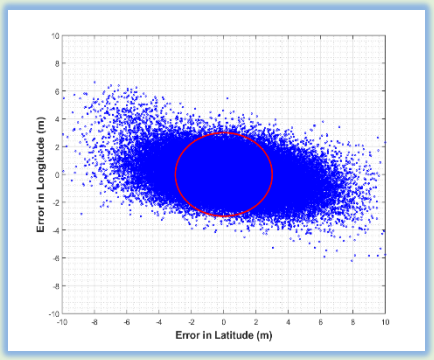


PE in June

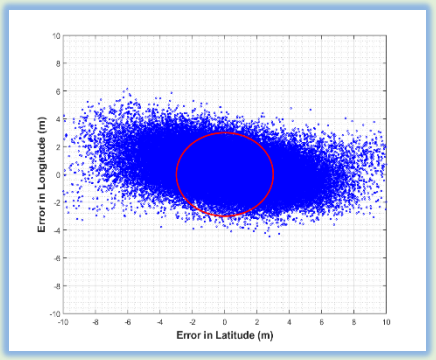
Circular Probability of Error



Scatter Plot for April
CEP: 2.3 m



Scatter Plot for May
CEP: 2.1 m



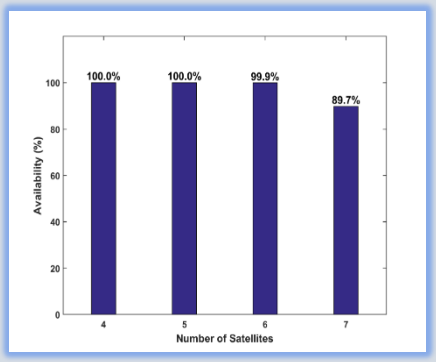
Scatter Plot for June
CEP: 2.3 m

Figure 5: Position Accuracy across western region

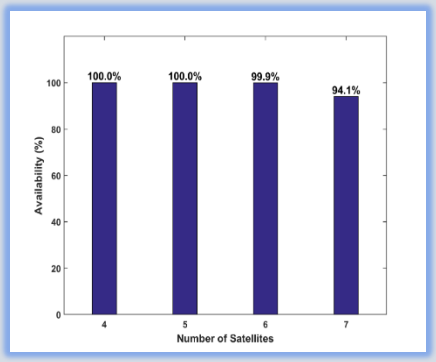
NOTE:

The three- dimensional position accuracy performance is better than 10m for 83% of time on April 09, 2019. The observation in 3D-PE plot is due to SV.

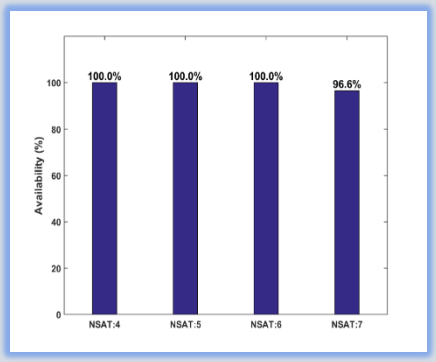
3.2 Satellite Availability



Availability of NSAT in April



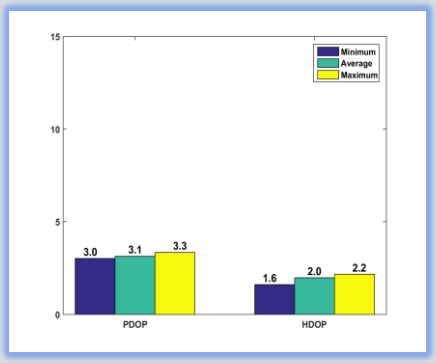
Availability of NSAT in May



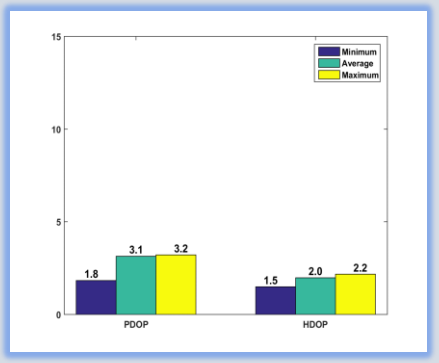
Availability of NSAT in June

Figure 6: Percentage availability of number of SVs for SPS service in western region

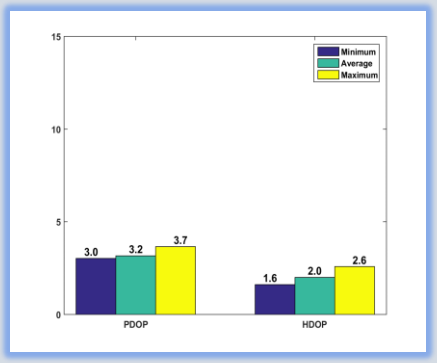
3.3 Dilution of Precision Statistics



DOP in April



DOP in May



DOP in June

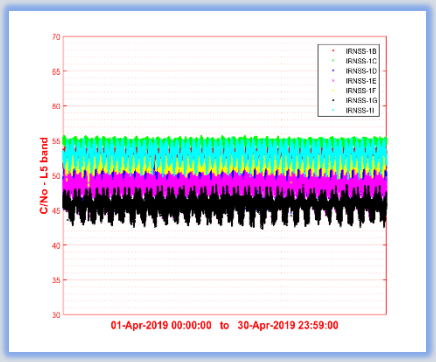
Figure 7: DOP statistics across western region

NOTE:

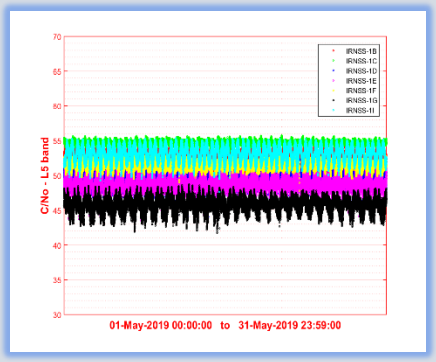
Availability of NSAT: 07 is low in April due to non-availability of one of the SVs for position computation for 58 hrs (approx).

3.4 Carrier to Noise Ratio

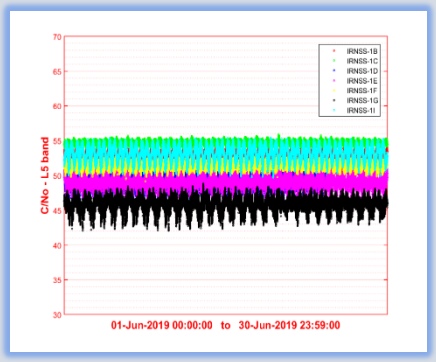
C/N_0 in L5 band



C/N_0 in April

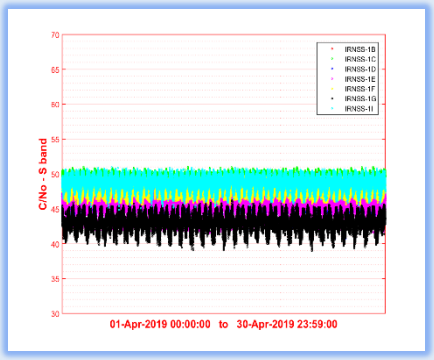


C/N_0 in May

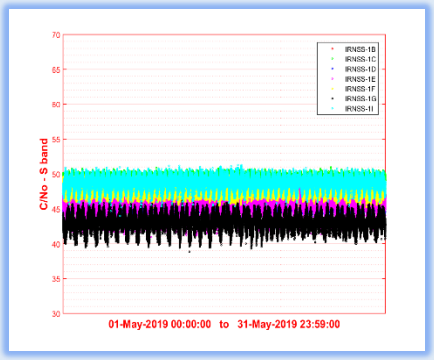


C/N_0 in June

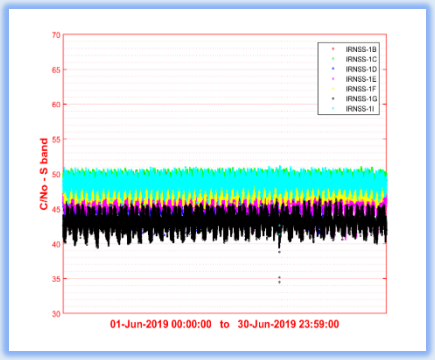
C/N_0 in S band



C/N_0 in April



C/N_0 in May



C/N_0 in June

Figure 8: Received C/N_0 across western region

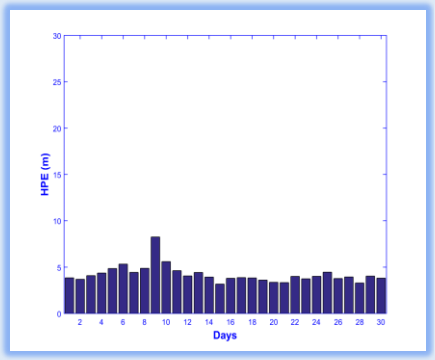
NOTE:

CHAPTER 4

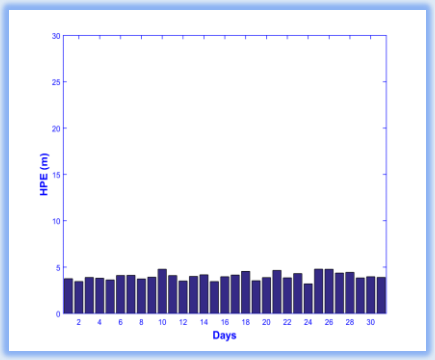
CENTRAL REGION

4.1 SIGNAL IN SPACE ACCURACY

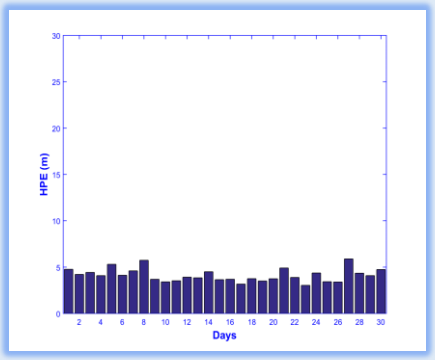
Horizontal Position Error



HPE in April

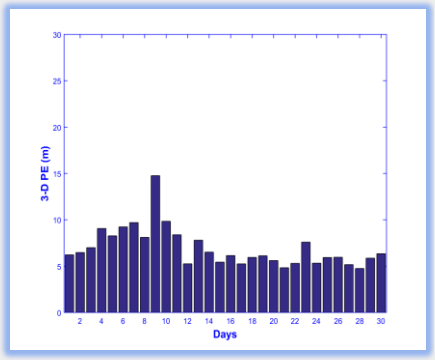


HPE in May

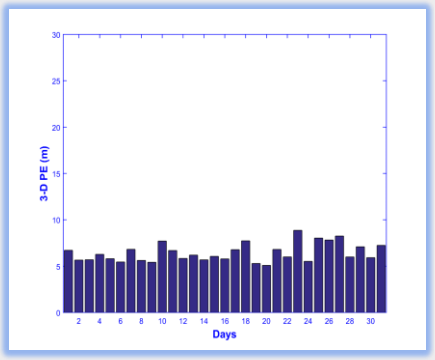


HPE in June

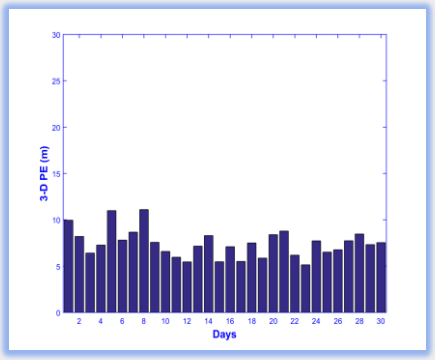
3-D Position Error



PE in April

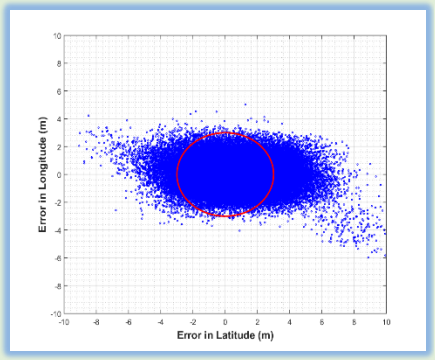


PE in May

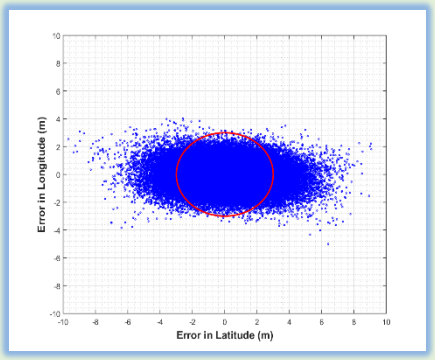


PE in June

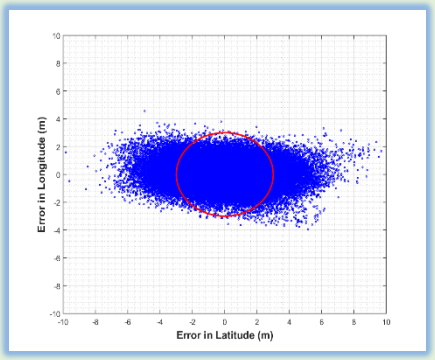
Circular Probability of Error



Scatter Plot for April
CEP: 1.7 m



Scatter Plot for May
CEP: 1.7 m



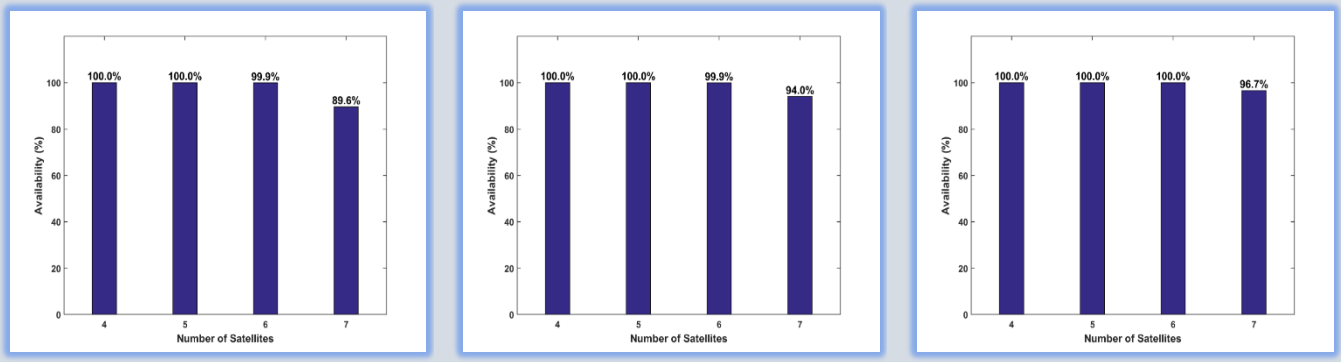
Scatter Plot for June
CEP: 1.7 m

Figure 9: Position Accuracy across central region

NOTE:

The three- dimensional position accuracy performance is better than 10m for 97% of time on April 09, 2019. The observation in 3D-PE plot is due to SV.

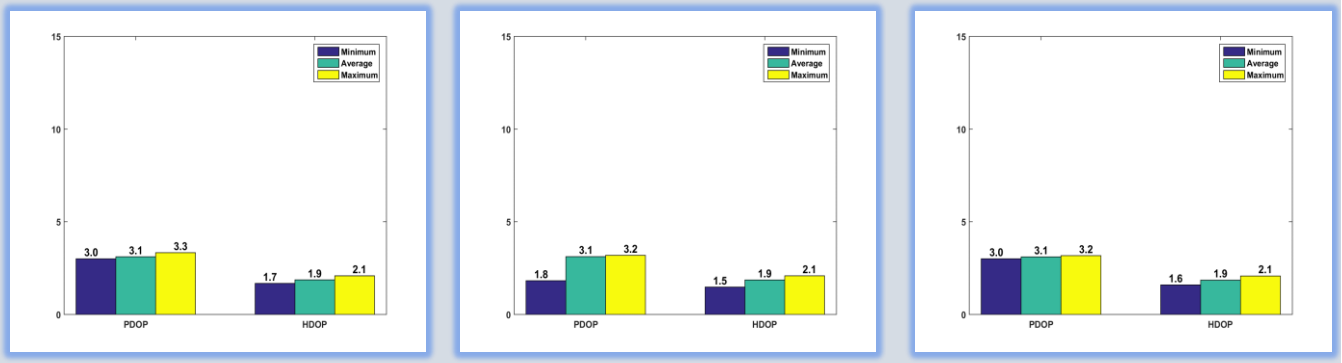
4.2 SATELLITE AVAILABILITY



Availability of NSAT in April **Availability of NSAT in May** **Availability of NSAT in June**

Figure 10: Percentage availability of number of SVs for SPS service in central region

4.3 DILUTION OF PRECISION STATISTICS



DOP in April **DOP in May** **DOP in June**

Figure 11: DOP statistics across central region

NOTE:

Availability of NSAT: 07 is low in April due to non-availability of one of the SVs for position computation for 58 hrs (approx).

4.4 Carrier to Noise Ratio

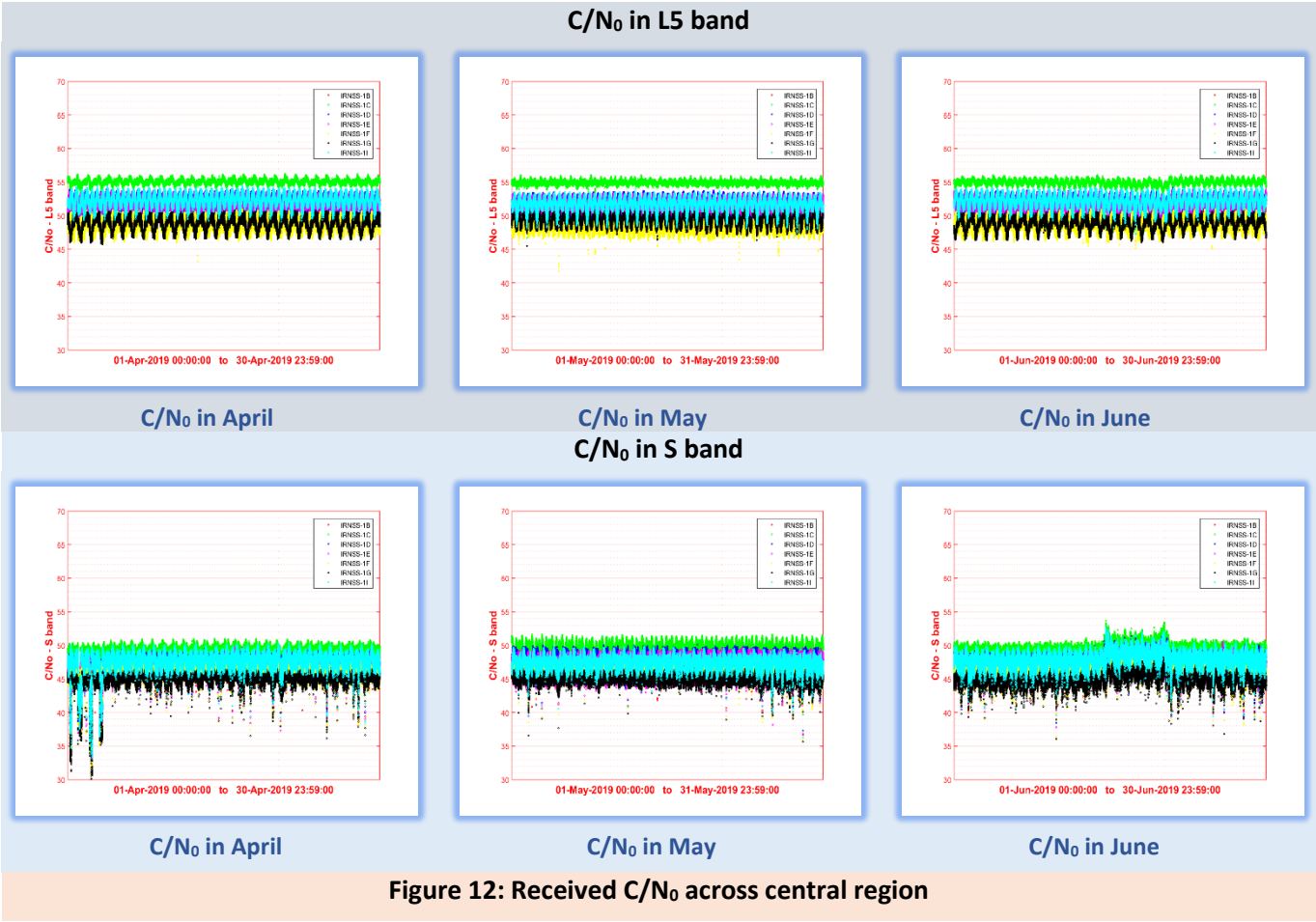


Figure 12: Received C/N_0 across central region

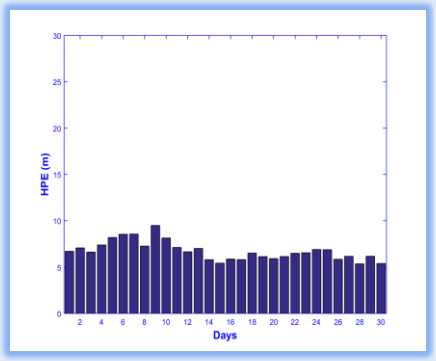
NOTE:

CHAPTER 5

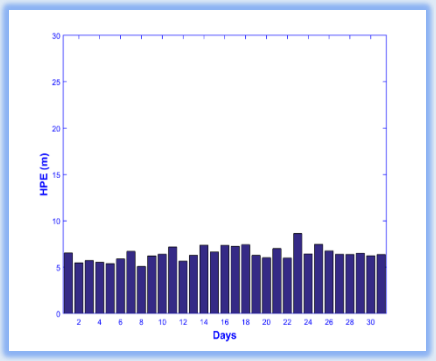
NORTHERN REGION

5.1 SIGNAL IN SPACE ACCURACY

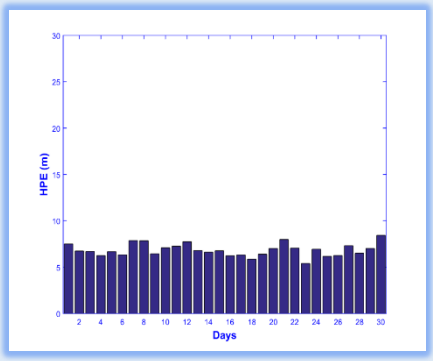
Horizontal Position Error



HPE in April

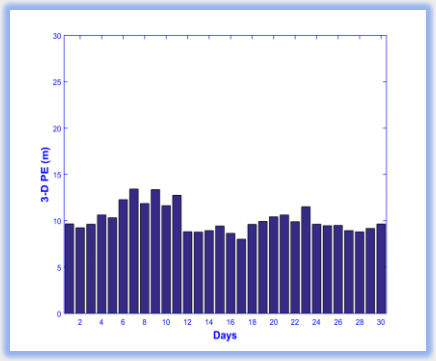


HPE in May

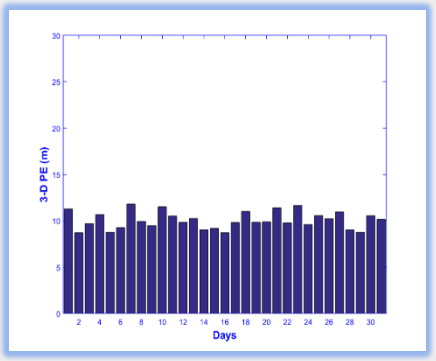


HPE in June

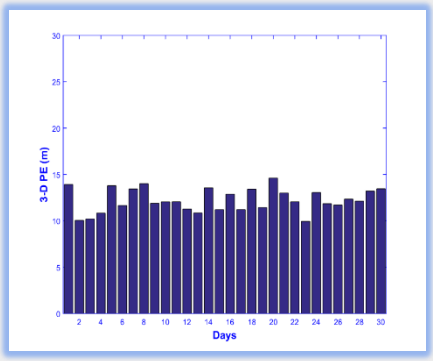
3-D Position Error



PE in April

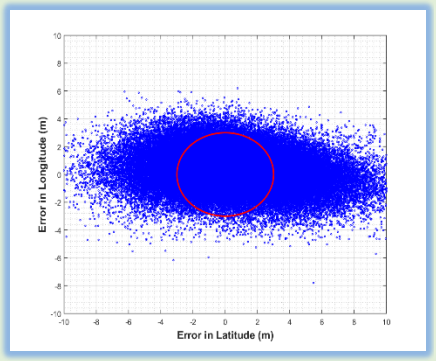


PE in May

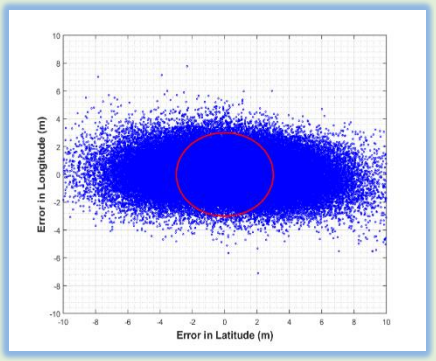


PE in June

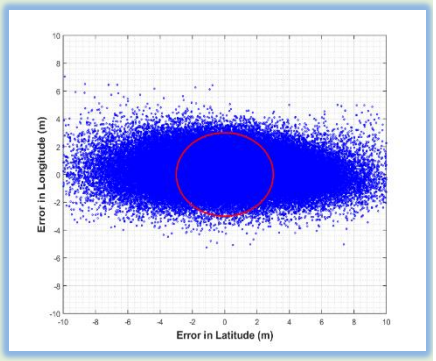
Circular Probability of Error



Scatter Plot for April
CEP: 2.7 m



Scatter Plot for May
CEP: 2.7 m



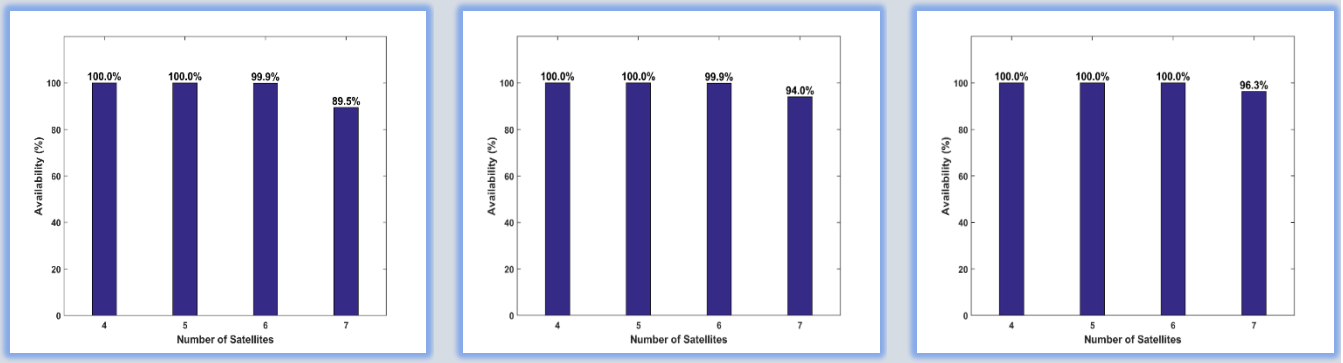
Scatter Plot for June
CEP: 2.7 m

Figure 13: Position Accuracy across northern region

NOTE:

1. The three- dimensional position accuracy performance is better than 10m for 87% of time on April 09, 2019. The observation in 3D-PE plot is due to SV.
2. The three- dimensional position accuracy performance is better than 10m for 89% of time on May 23, 2019. The observation in 3D-PE plot is due to SV.

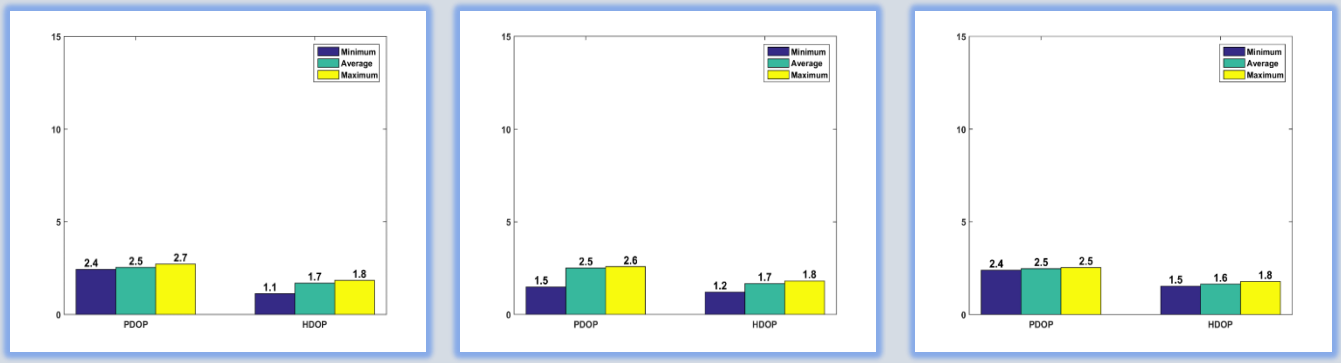
5.2 Satellite Availability



Availability of NSAT in April | **Availability of NSAT in May** | **Availability of NSAT in June**

Figure 14: Percentage availability of number of SVs for SPS service in northern region

5.3 Dilution of Precision Statistics



DOP in April | **DOP in May** | **DOP in June**

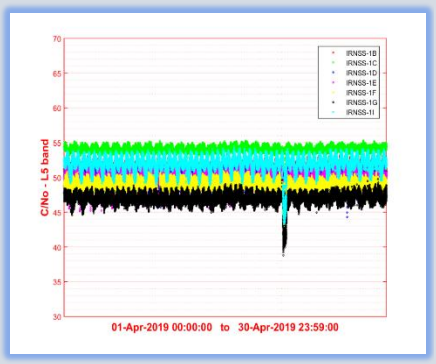
Figure 15: DOP statistics across northern region

NOTE:

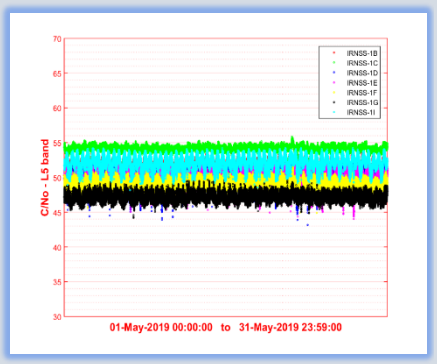
Availability of NSAT: 07 is low in April due to non-availability of one of the SVs for position computation for 58 hrs (approx).

5.4 Carrier to Noise Ratio

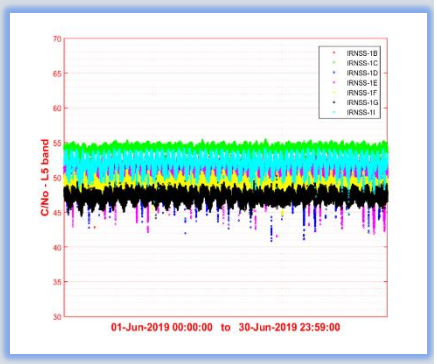
C/N_0 in L5 band



C/N_0 in April

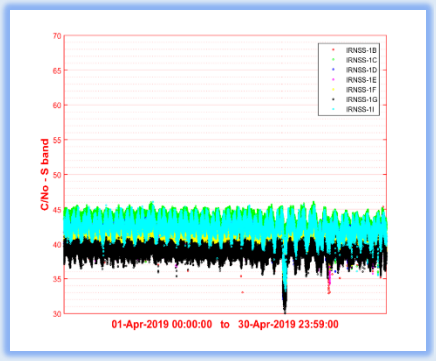


C/N_0 in May

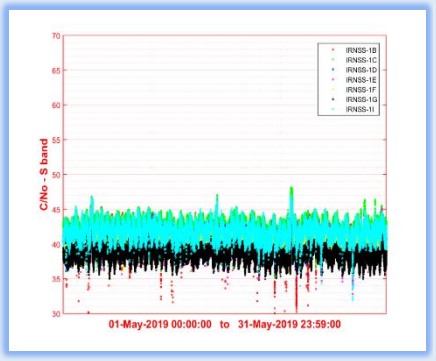


C/N_0 in June

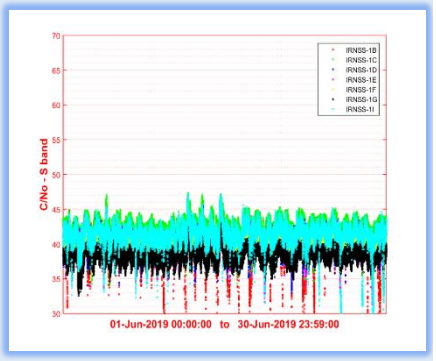
C/N_0 in S band



C/N_0 in April



C/N_0 in May



C/N_0 in June

Figure 16: Received C/N_0 across northern region

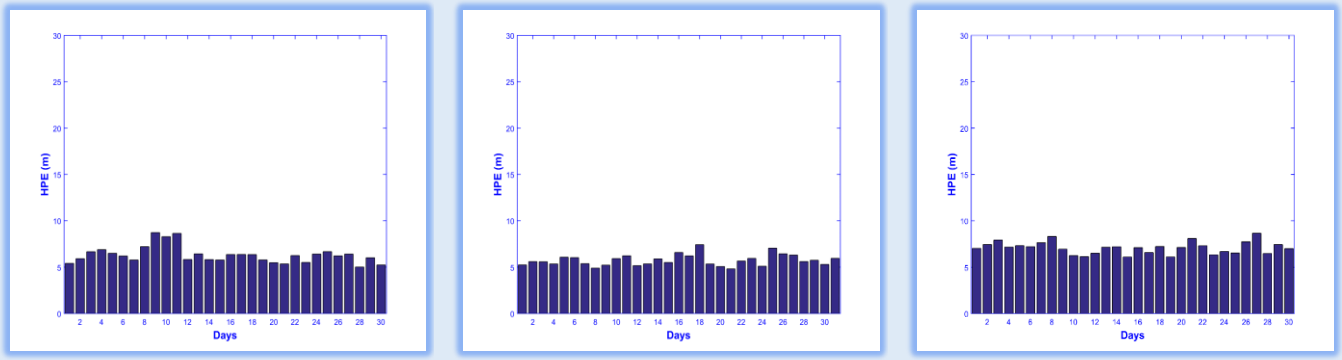
NOTE:

CHAPTER 6

EASTERN REGION

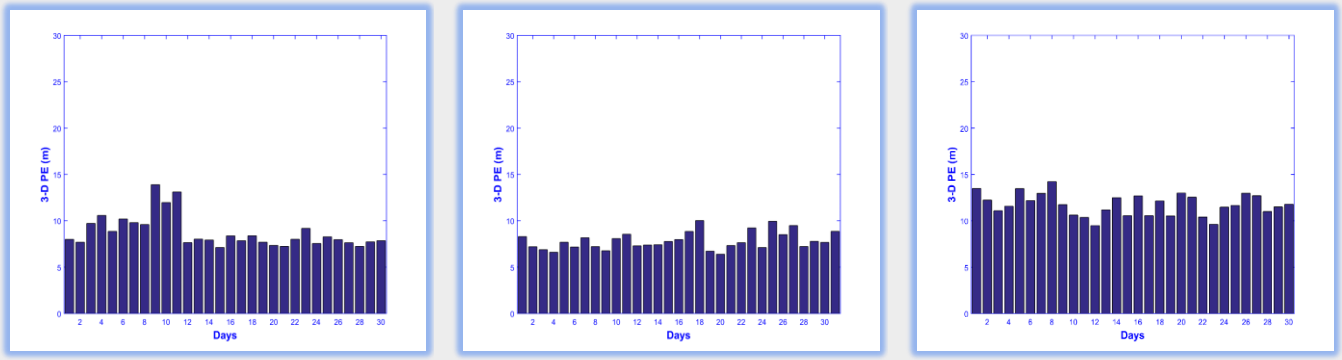
6.1 Signal In Space Accuracy

Horizontal Position Error



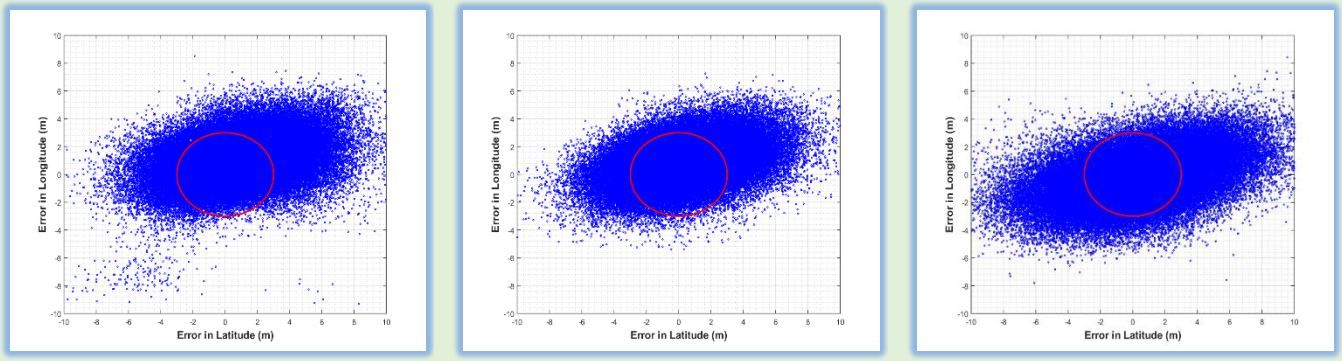
HPE in April | **HPE in May** | **HPE in June**

3-D Position Error



PE in April | **PE in May** | **PE in June**

Circular Probability of Error



Scatter Plot for April
CEP: 2.6 m

Scatter Plot for May
CEP: 2.4 m

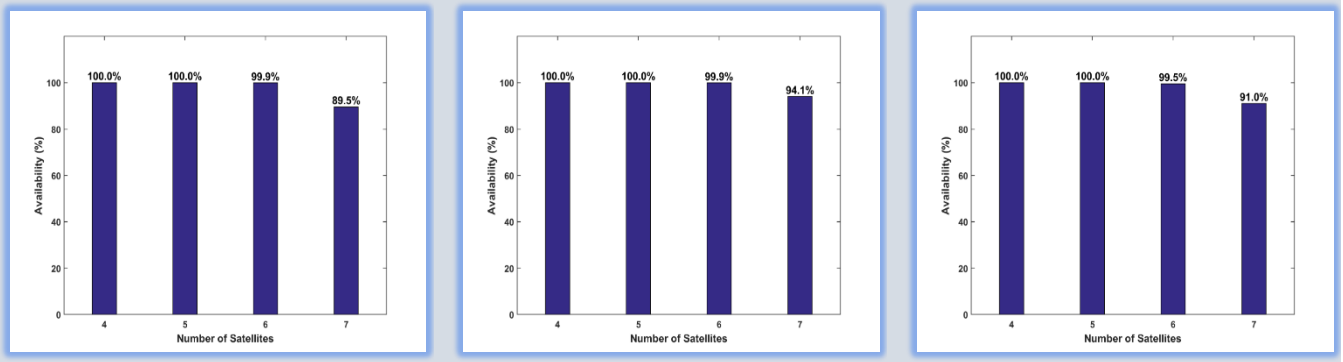
Scatter Plot for June
CEP: 2.9 m

Figure 17: Position Accuracy across eastern region

NOTE:

The three- dimensional position accuracy performance is better than 10m for 86% of time on April 09, 2019. The observation in 3D-PE plot is due to SV

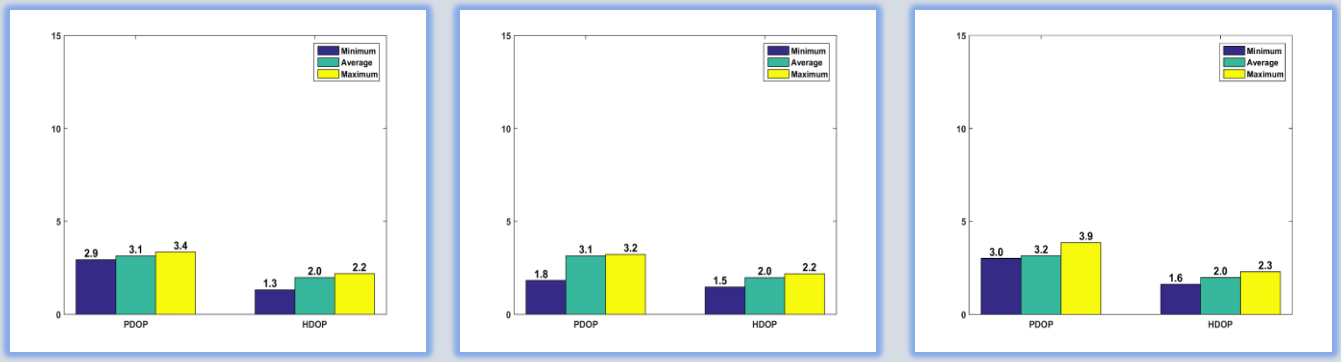
6.2 Satellite Availability



Availability of NSAT in April **Availability of NSAT in May** **Availability of NSAT in June**

Figure 18: Percentage availability of number of SVs for SPS service in eastern region

6.3 Dilution of Precision Statistics



DOP in April **DOP in May** **DOP in June**

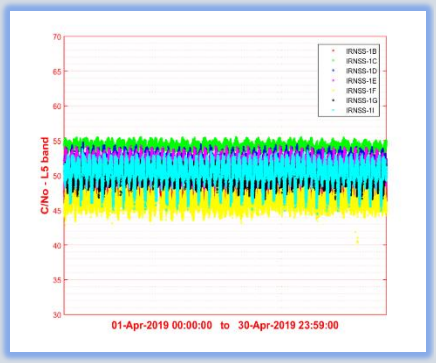
Figure 19: DOP statistics across eastern region

NOTE:

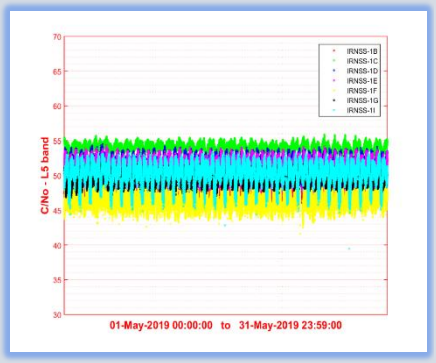
Availability of NSAT: 07 is low in April due to non-availability of one of the SVs for position computation for 58 hrs (approx).

6.4 Carrier to Noise Ratio

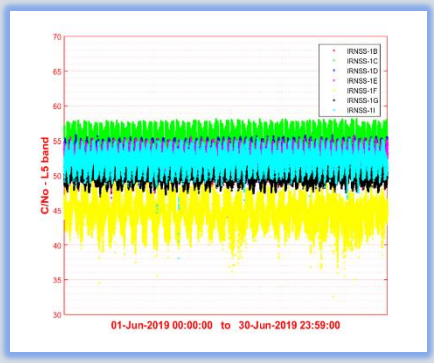
C/N_0 in L5 band



C/N_0 in April

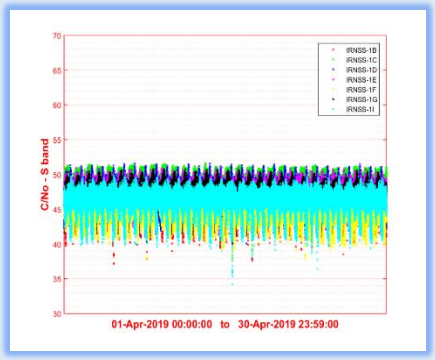


C/N_0 in May

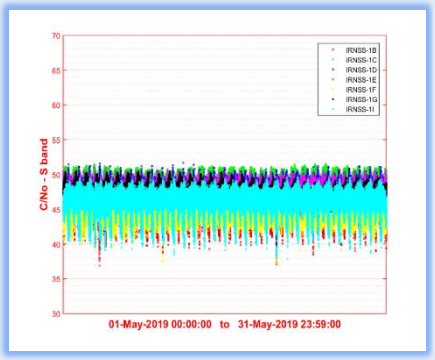


C/N_0 in June

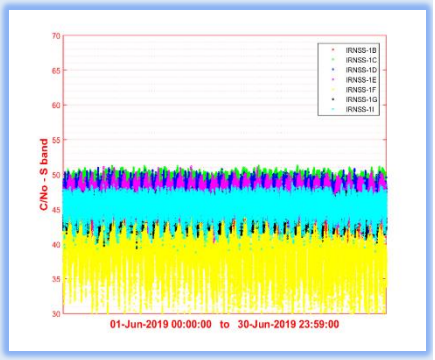
C/N_0 in S band



C/N_0 in April



C/N_0 in May



C/N_0 in June

Figure 20: Received C/N_0 across eastern region

NOTE: