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The Mongolian Geospatial Association

ASSESSMENT OF THE GPS RECEIVER IN THE VENEZUELAN REMOTE SENSING SATELLITE TO GET RADIO OCCULTATION INFORMATION

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OUTLINE

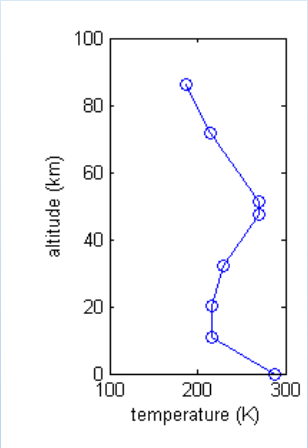
- **RADIO OCCULTATION USING LEO SATELLITES**
  - **ATMOSPHERE REFRACTION INDEX**
  - **OBJECTIVE**
- **VRSS1 GPS RECEIVER**
  - **TELEMETRY ANALYSIS**
- **ASSESSMENT OF VRSS1 GPS RECEIVER**
  - **METHODOLOGY**
  - **ASSESSMENT RESULTS**
- **CONCLUSIONS**

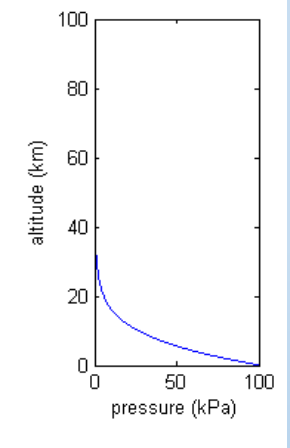
ATMOSPHERE REFRACTION INDEX

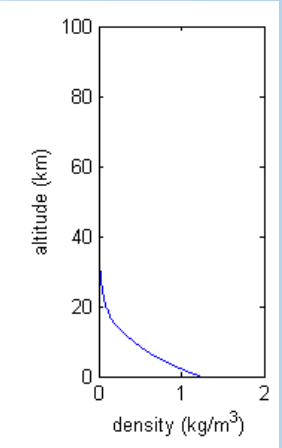
The refractive index of the atmosphere, n, is given by:

$$n = 1 + \frac{0.373e}{T^2} + \frac{77.6 \times 10^{-6} p}{T} - 40.3\frac{N_e}{f^2}$$

e - partial pressure of water vapour (hPa)
T - absolute temperature (K)
p - atmospheric pressure (hPa)
N_e - number density of free electrons (m^{-3})
f - radio frequency (MHz)

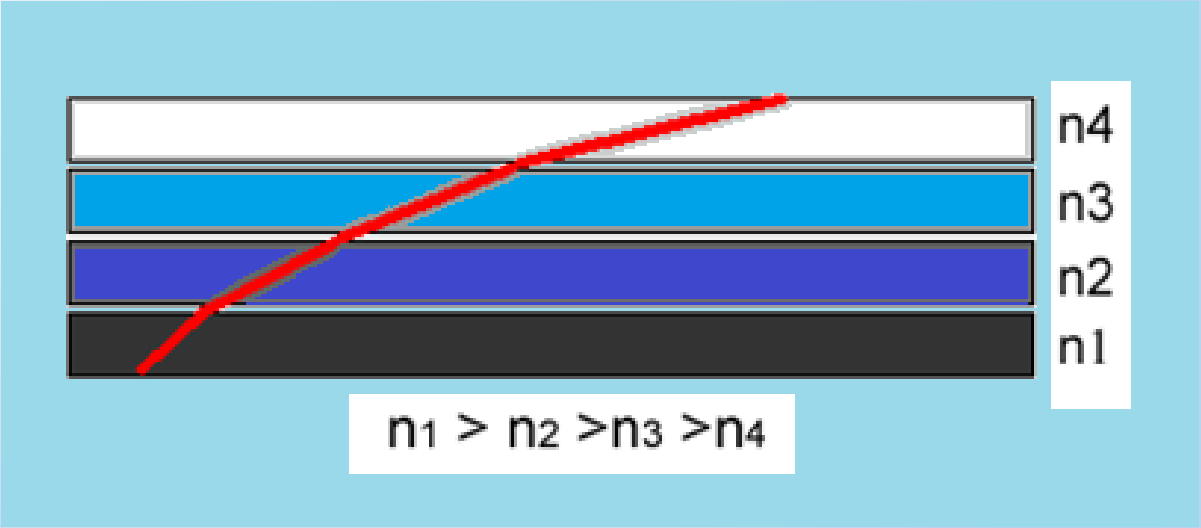


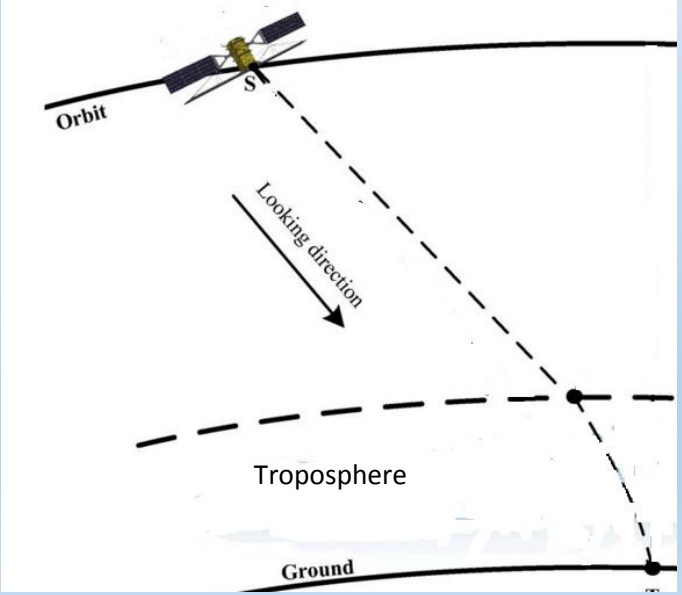


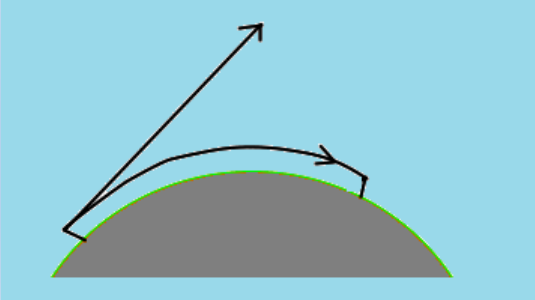


ATMOSPHERE REFRACTION INDEX INFLUENCE IN RADIO PROPAGATION

$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{n_2}{n_1}$$

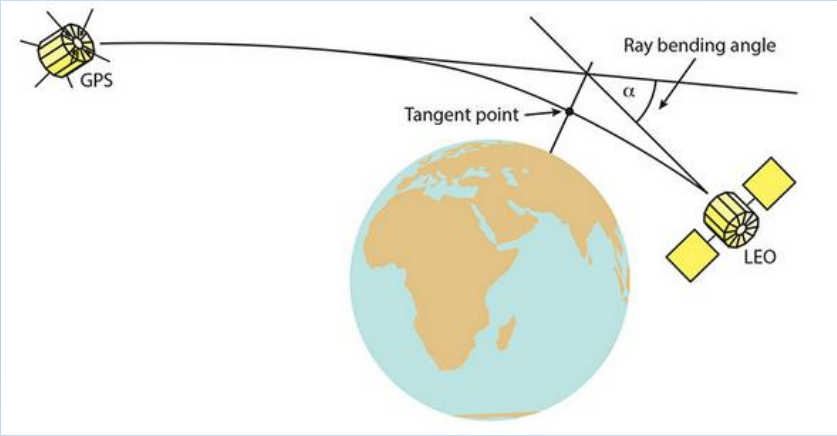






RADIO OCCULTATION USING LEO SATELLITES

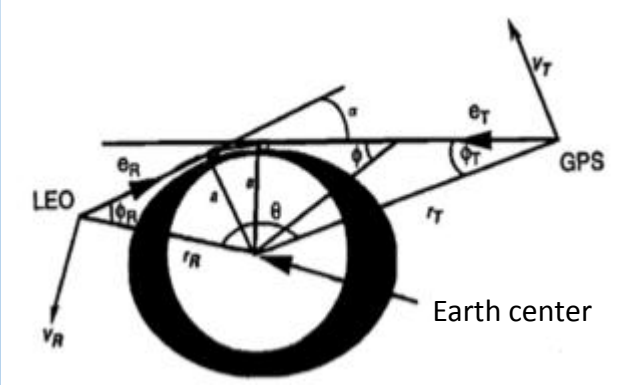
The basic principle behind the radio occultation technique: radio signals from the GPS satellite are received by the orbiting satellite. The ray path is characterized by its impact parameter and bending

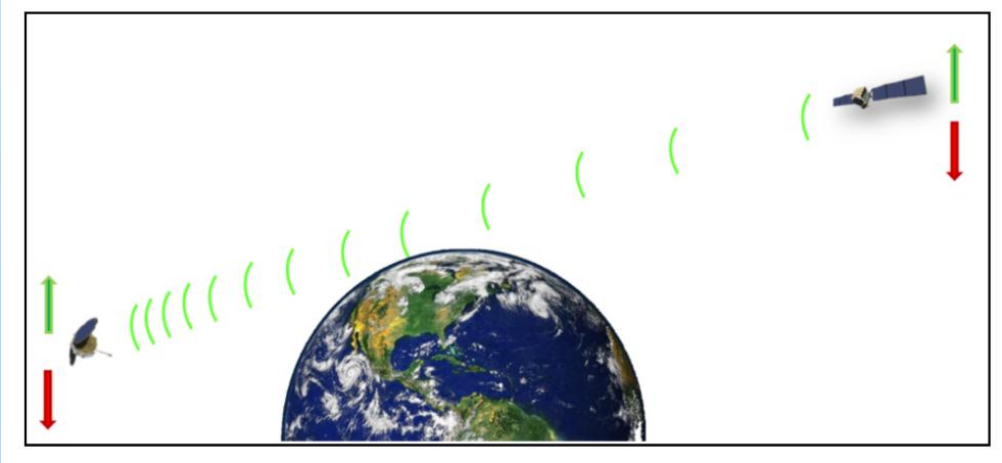


Source: https://www.ecmwf.int/en/about/media-centre/news/2019/experts-review-use-inter-satellite-observations-weather-forecasting

RADIO OCCULTATION USING LEO SATELLITES

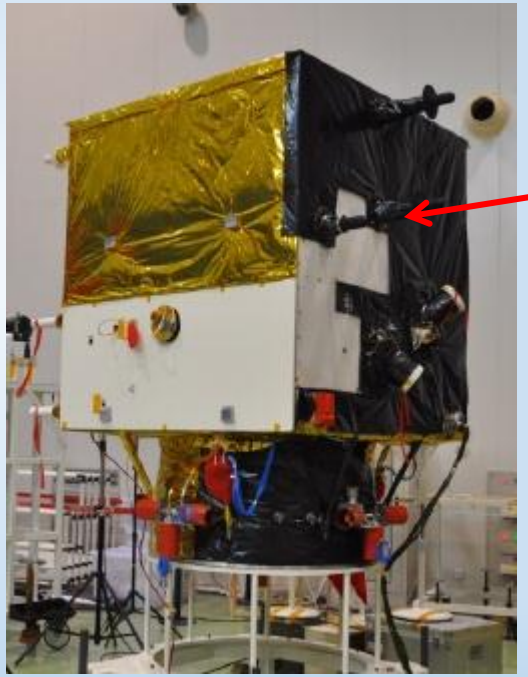
Main Objective: The inversion of the measured signal to get vertical profiles of atmospheric parameters using the VRSS1 (Venezuelan Remote Sensing Satellite).





VRSS1 GPS RECEIVER

Main Question: The GPS Receiver can be used in radio occultation estimation?



GPS
Antenna

VRSS1 ASSEMBLY

VRSS1 TELEMETRY ANALYSIS

NO	PARAMETER SYMBOL	TELEMETRY PARAMETER	DATA WORDS/BITS	DATA TYPE	WORD LENGTH	PARAMETER DESCRIPTION & PROCESSING Method	WORK VALUE RANGE
5.	TMG35	Run status code and satellites number	W8 W9 W10	DS	3	D23-D20: GPS SV number used in PVT solution. D19-D0:Run status code	SV number: 0-12
19.	TMG49	Predicted SV number	W36 W37 W38 W39	DS	4	Display by bit: B31-B0:every bit represents one SV number: 1—predicted，0—unpredicted	Predicted SV number is not more than 12.

GPS-TM35_2016062515_2016062515.txt: Bloc de notas

Archivo Edición Formato Ver Ayuda

Time	GPS-TM35
2016-06-25 15:06:26.657	10485760
2016-06-25 15:06:42.656	10485760
2016-06-25 15:06:58.655	10485760
2016-06-25 15:07:14.654	10485760
2016-06-25 15:07:30.653	10485760
2016-06-25 15:07:46.652	10485760
2016-06-25 15:08:02.651	10485760
2016-06-25 15:08:18.900	10485760
2016-06-25 15:08:34.650	11534336
2016-06-25 15:08:50.649	11534336
2016-06-25 15:09:06.648	11534336
2016-06-25 15:09:22.647	12582912
2016-06-25 15:09:38.646	12582912
2016-06-25 15:09:54.645	12582912
2016-06-25 15:10:10.644	12582912
2016-06-25 15:10:26.643	12582912

GPS-TM49_2016062515_2016062515.txt: Bloc de notas

Archivo Edición Formato Ver Ayuda

Time	GPS-TM49
2016-06-25 15:06:26.657	1179682240
2016-06-25 15:06:42.656	1179682240
2016-06-25 15:06:58.655	1179682240
2016-06-25 15:07:14.654	1179682240
2016-06-25 15:07:30.653	1179682240
2016-06-25 15:07:46.652	1179682240
2016-06-25 15:08:02.651	1179682241
2016-06-25 15:08:18.900	1179682241
2016-06-25 15:08:34.650	1179682241
2016-06-25 15:08:50.649	1179682241
2016-06-25 15:09:06.648	1181779393
2016-06-25 15:09:22.647	1181779393
2016-06-25 15:09:38.646	1180730817
2016-06-25 15:09:54.645	1180730817
2016-06-25 15:10:10.644	1180730821
2016-06-25 15:10:26.643	1180730821

VRSS1 TELEMETRY ANALYSIS

No	Parameter Symbol	Telemetry Parameter	Data Word/Bits	Data Type	Word Length	Parameter Description & Processing	Word
5.	TMG35	Run status code and satellites number	W8 W9 W10	DS	3	D23-D20: GPS SV number used in PVT solution. D19-D0: Run status code	SV number: 0-12
19.	TMG49	Predicted SV number	W36 W37 W38 W39	DS	4	Display by bit: B31-B0: Every bit represents one SV. Number: 1-predicted, 0-unpredicted.	Predicted SV number is not more tan 12

Parameter	Date	Time	Decimal	Binary
TMG35	25/06/2016	15:06:26.657	10485760	10100000000000000000000
TMG49	25/06/2016	15:06:26.657	1179682240	01000110010100001000010111000000

PRN-07, PRN-08, PRN-09, PRN-11, PRN-16, PRN-21, PRN-23, PRN-26, PRN-27 and PRN-31

ASSESSMENT METHODOLOGY

The first step comprises the procedure of representing the orbit precision making use of the VRSS-1 orbital parameters through the TLE (Two Lines Elements) of the satellite in correspondence with the time period of the telemetry provided by the control earth station.

Simultaneously, the simulation of the GPS constellation was carried out using the status almanac with the same time interval to check the positioning relationship with the received satellites and their respective capture.

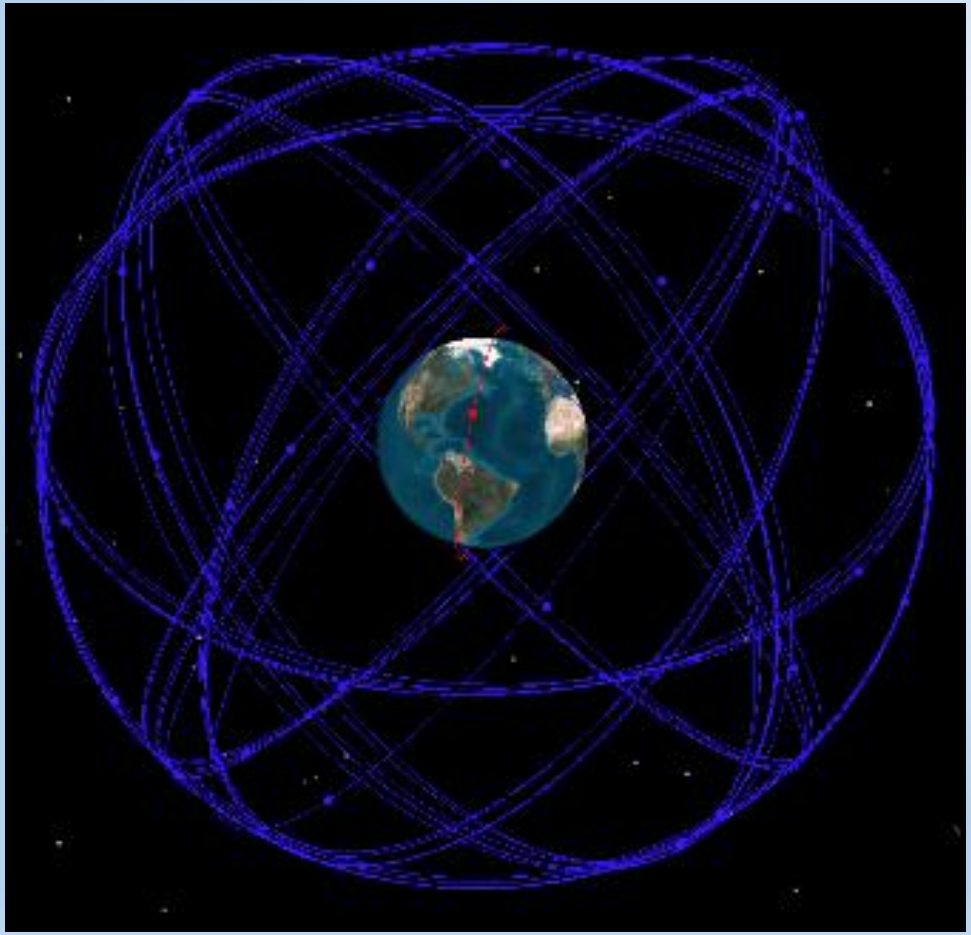
METHODOLOGY

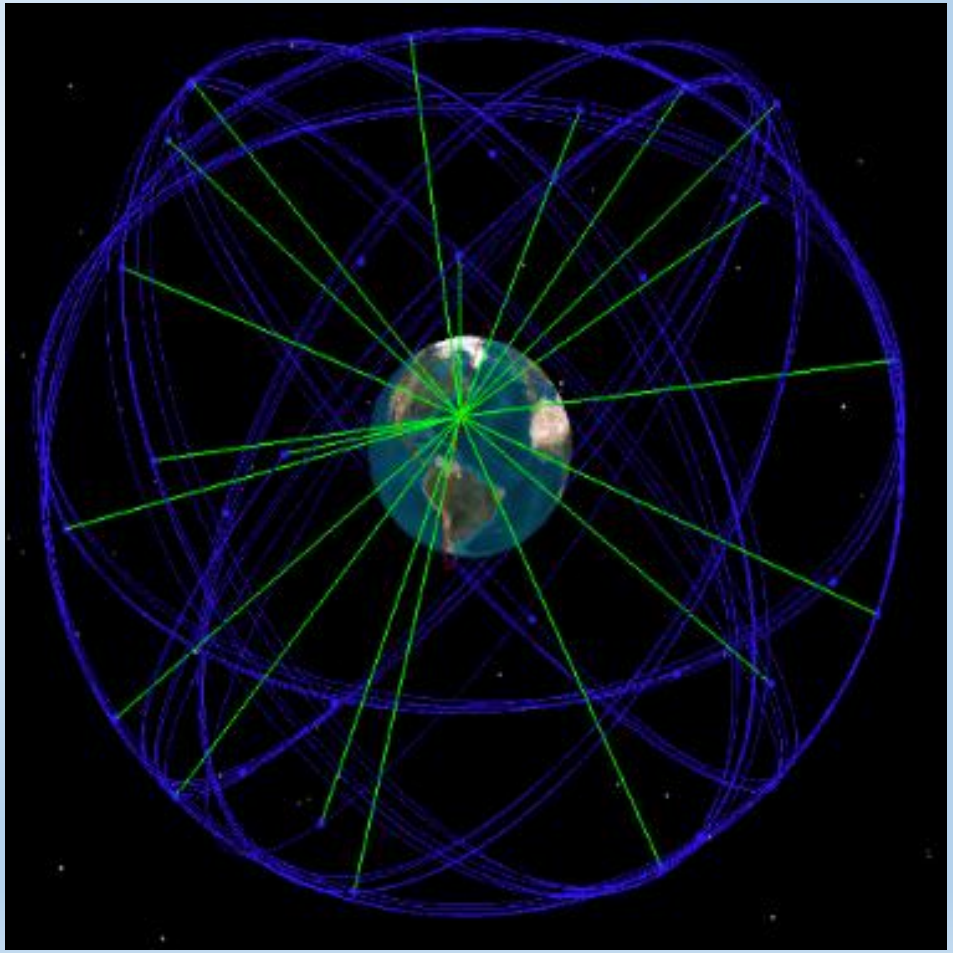
OCCULTATION SIMULATION

The VRSS1 navigation information received was compared with the simulations. This information was analyzed and used not only to determine VRSS-1 navigation coordinates based on GPS satellites, but also to represent radio occultation geometry. knowing the positions and speeds of the GPS and VRSS-1 in the simulation and the Doppler Effect data, *the angle of curvature of the signal and the impact parameter for each ray can be estimated*.

METHODOLOGY

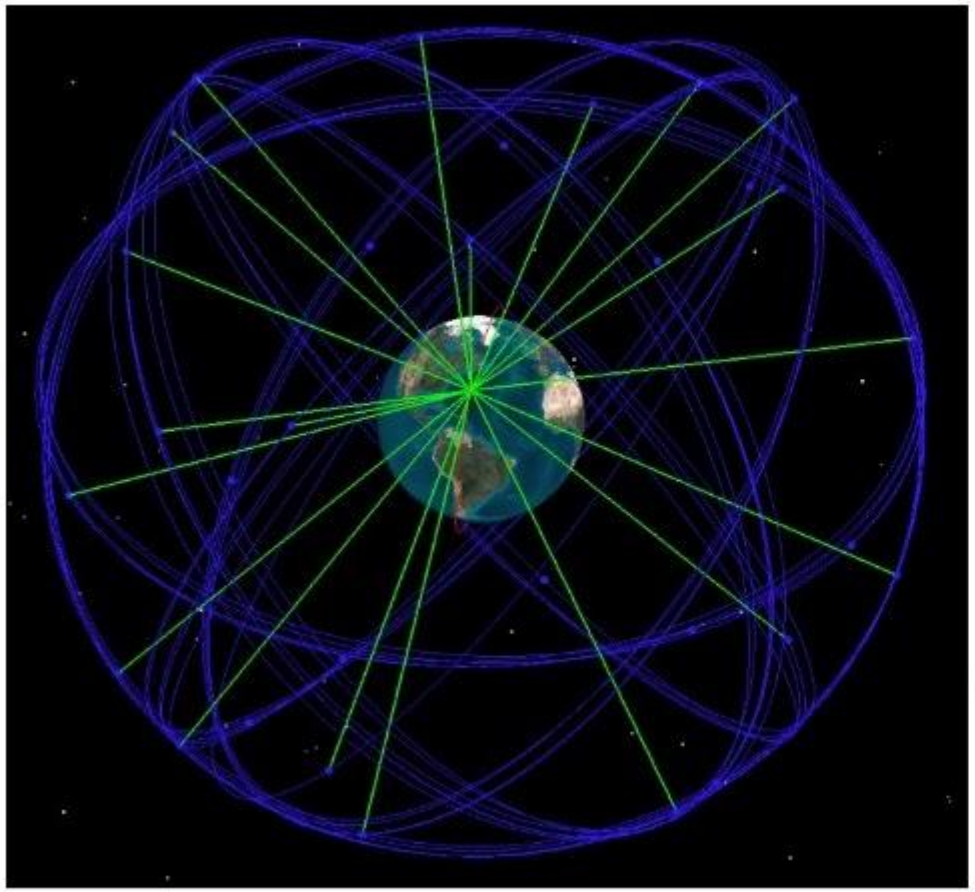
VRSS1 Orbit, GPS Constellation and Telemetry Analysis

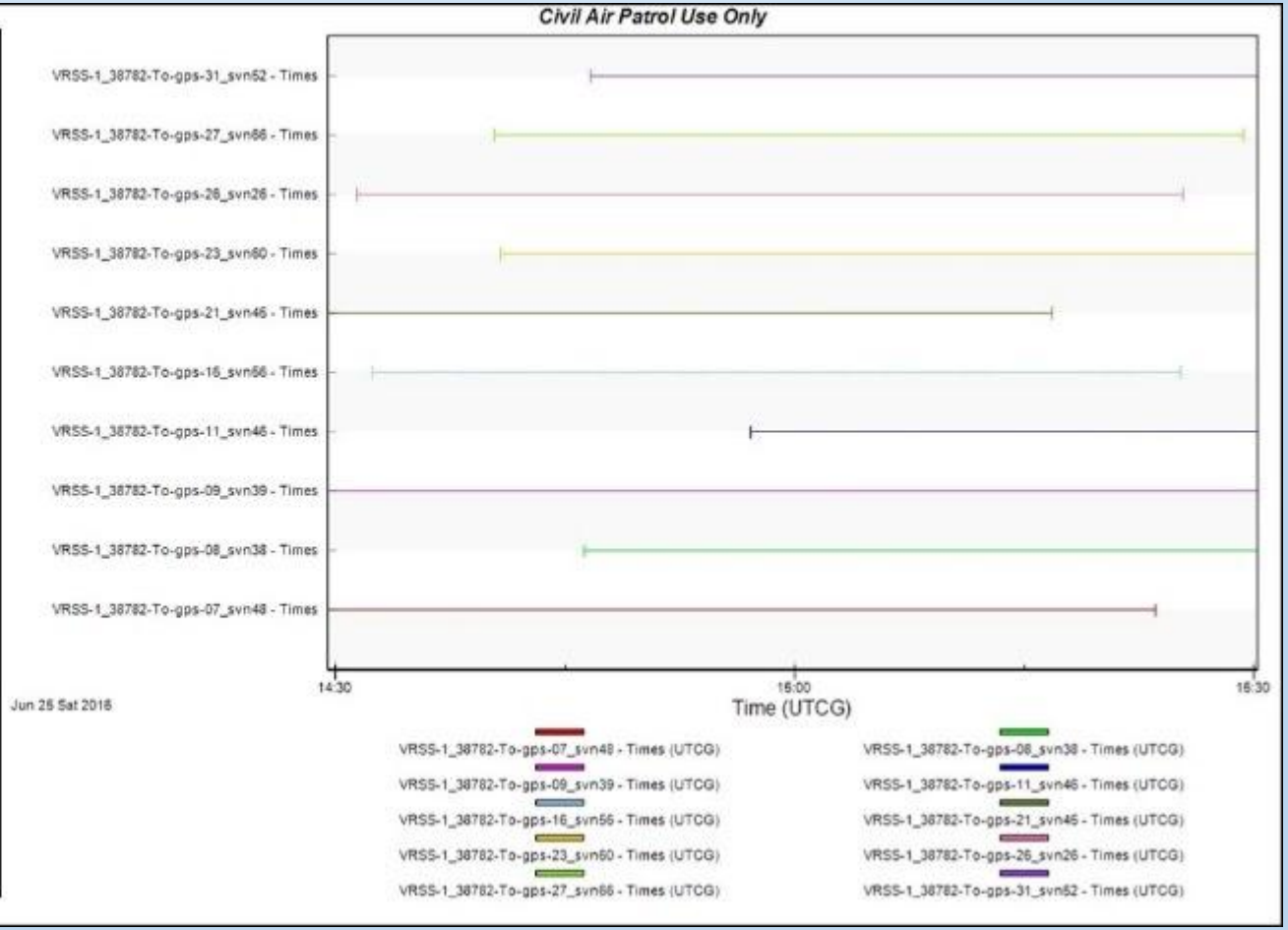




RESULTS

Time in Telemetry Analysis



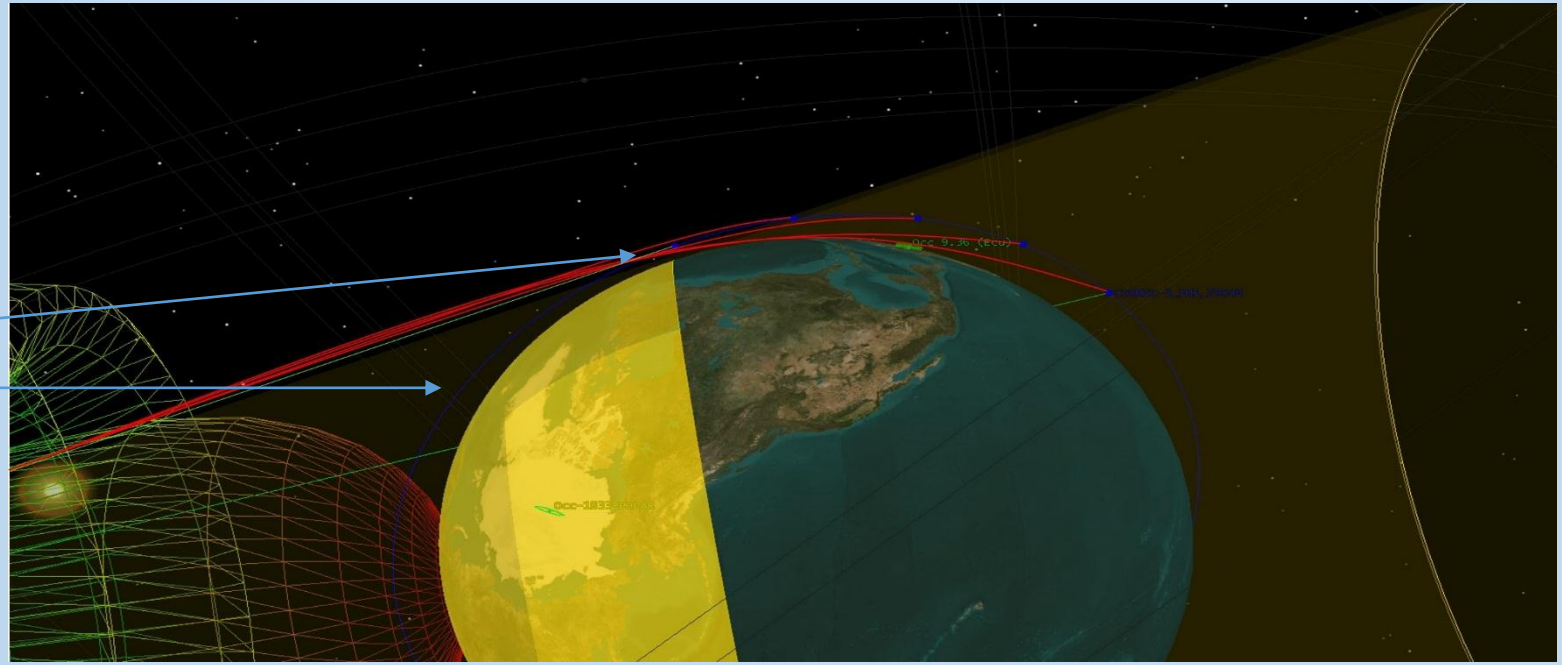


METHODOLOGY - RESULTS

OCCULTATION SIMULATION

Lost Signal

Signal Received



CONCLUSIONS

The work allowed us to know how proceed to apply the radio occultation method in one LEO Satellite.

Even though the GPS Receiver could not satisfy the expectations between the simulation and the telemetry received for radio occultation the work showed us the importance of this to be considered in the future space projects.

THANKS….

QUESTIONS?

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