SPORT

The Scintillation Prediction Observations Research Task: An International Science Mission using a CubeSat

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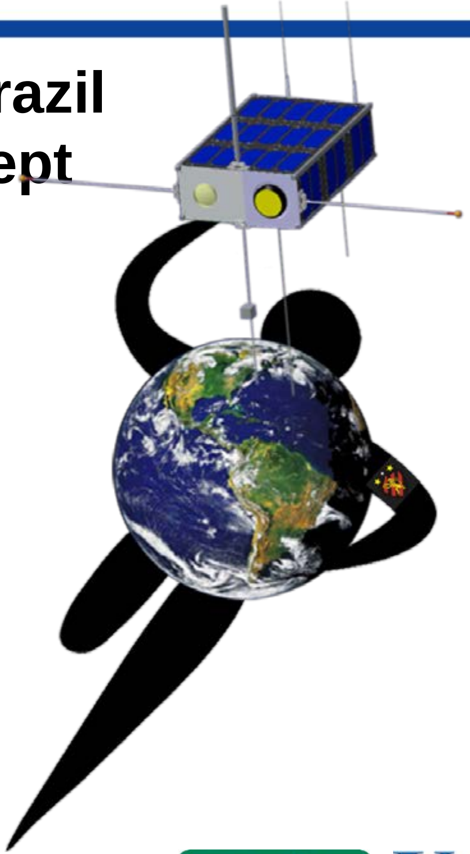
SPORT

- **Joint United States / Brazil Science Mission Concept**

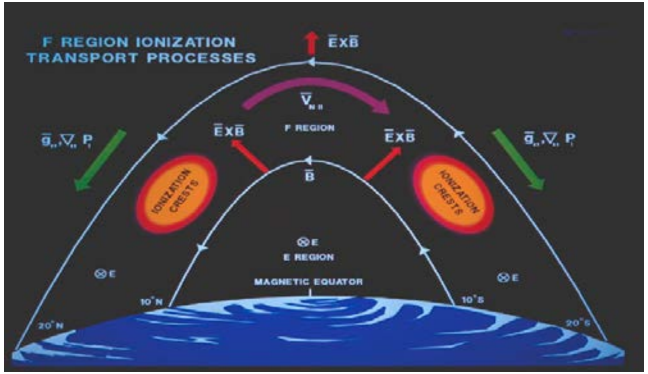


- **United States**
  - Science Instruments
- **Brazil**
  - Spacecraft
  - Operations

Joint Science Data Analysis

Science

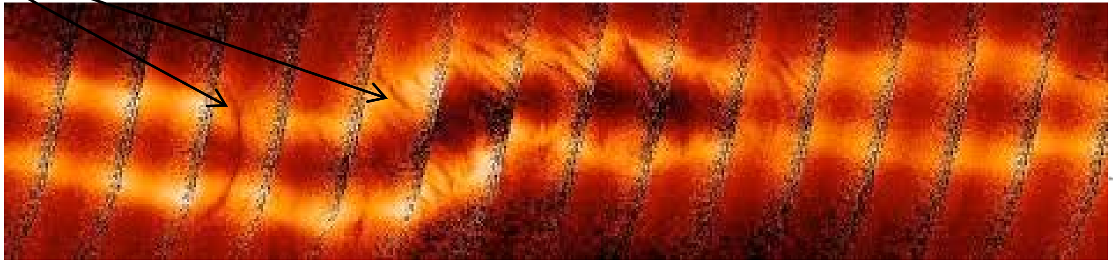
- **The equatorial ionization anomalies**



Bela Fejer, The Equatorial Ionosphere: A Tutorial
CEDAR Meeting, Seattle Washington, 2015

- **Plasma Bubbles**

GUVI (Same Local Time, Different Longitudes)



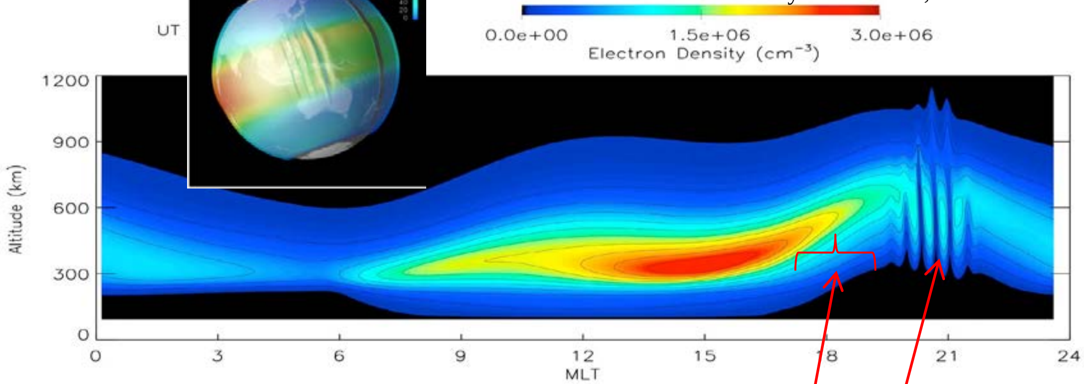
Why do bubbles form and sometimes not at Different Longitudes?

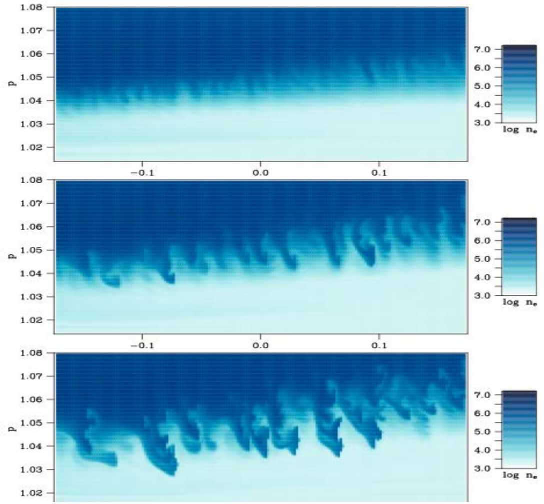
Kil, Hyosub, et al. "Coincident equatorial bubble detection by TIMED/GUVI and ROCSAT-1." Geophysical research letters 31.3 (2004).

Plasma Bubbles

About 1.5 Hours to form a bubble

Dr. Joseph Huba and Dr. Glenn Joyce NRL
Plasma Physics Division, SAMI3 Model

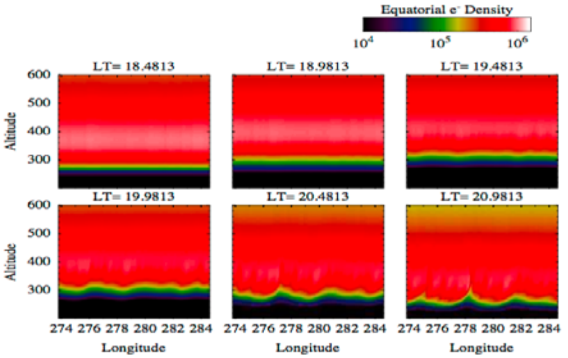




What is the state of the ionosphere here?

That leads to bubbles here ?

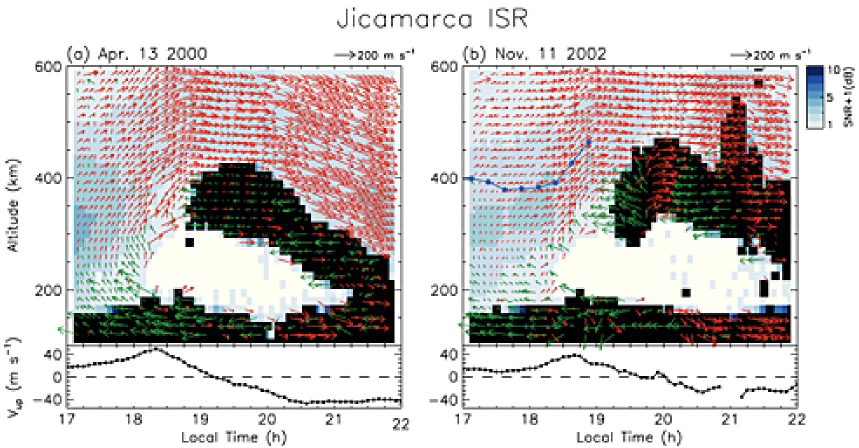
When bottom side seeding perturbations seem to always be present

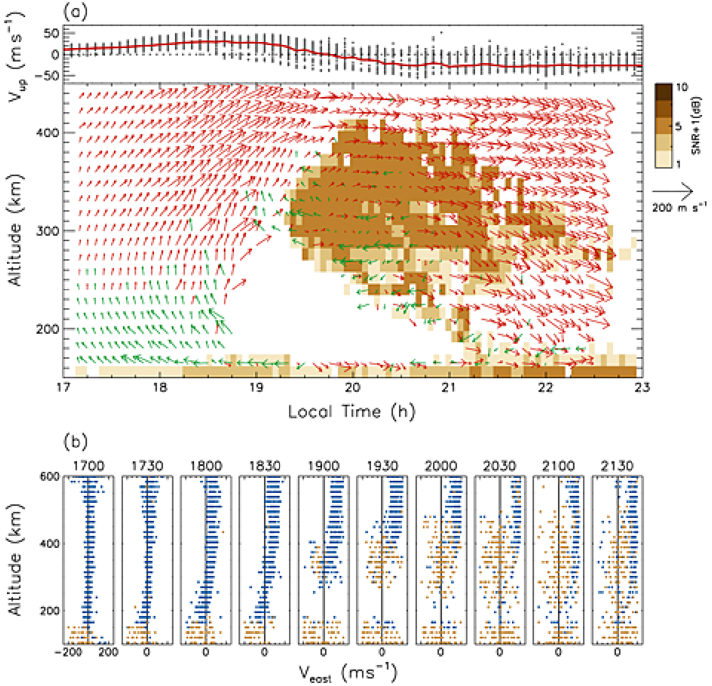


Retterer, J. M., and P. Roddy. "Faith in a seed: on the origins of equatorial plasma bubbles." Annales Geophysicae. Vol. 32. No. 5. Copernicus GmbH, 2014.

Motion of Ionosphere (From Radar)

Morphology of the post-sunset vortex in the equatorial ionospheric plasma drift



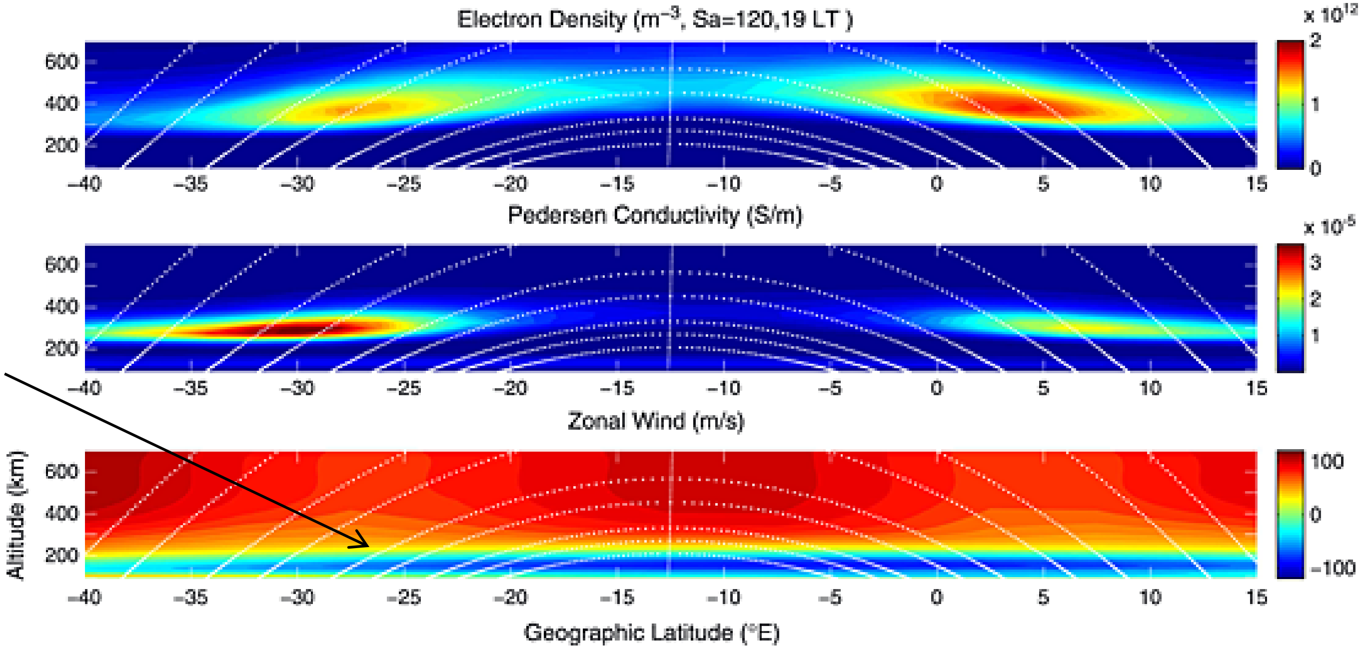


Geophysical Research Letters
Volume 42, Issue 1, pages 9-14, 8 JAN 2015 DOI: 10.1002/2014GL062019
http://onlinelibrary.wiley.com/doi/10.1002/2014GL062019/full#grl52441-fig-0001

AEROSPACE UTD UAH The University of Alabama in Huntsville UtahStateUniversity

Neutral Winds and Conductivities

The importance of winds in different regions to triggering EPB particularly wind shears on the bottom of the ionosphere

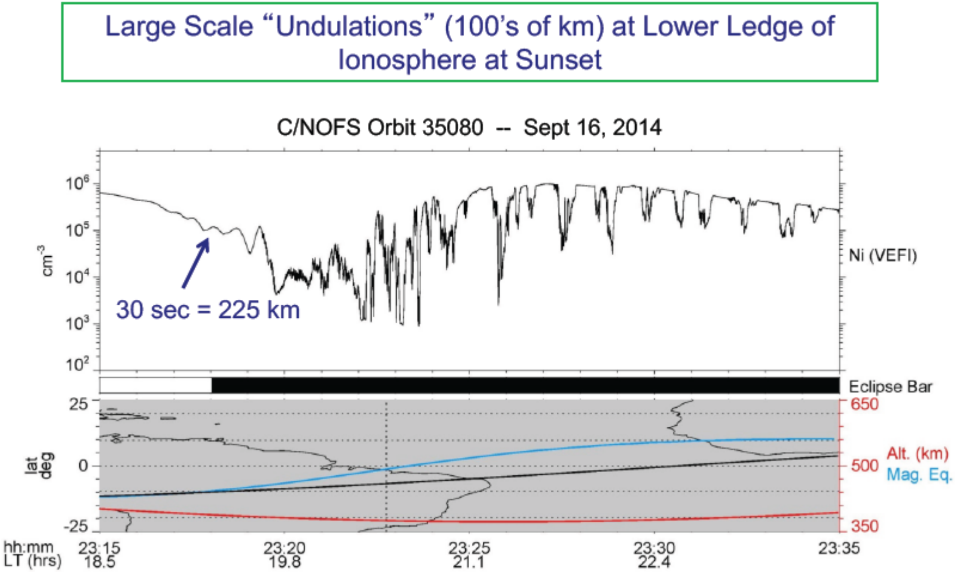


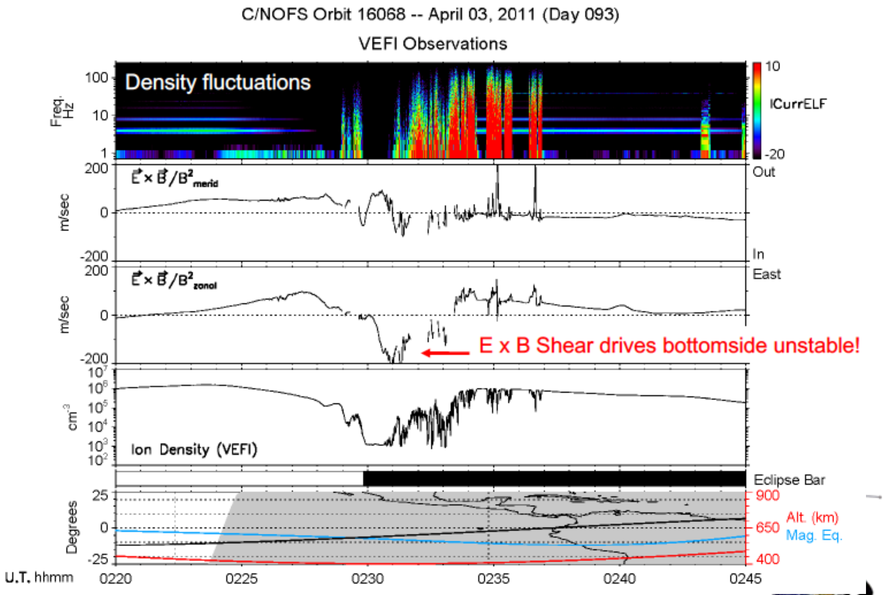
Vertical Wind Shear

[Electrodynamics of the equatorial evening ionosphere: 1. Importance of winds in different regions](http://onlinelibrary.wiley.com/doi/10.1002/2014JA020934/full#jgra51625-fig-0001)
Authors A. D. Richmond, T.-W. Fang, A. Maute First Published: 7 March 2015 Vol: 120, Pages: 2118–2132 DOI: 10.1002/2014JA020934
http://onlinelibrary.wiley.com/doi/10.1002/2014JA020934/full#jgra51625-fig-0001

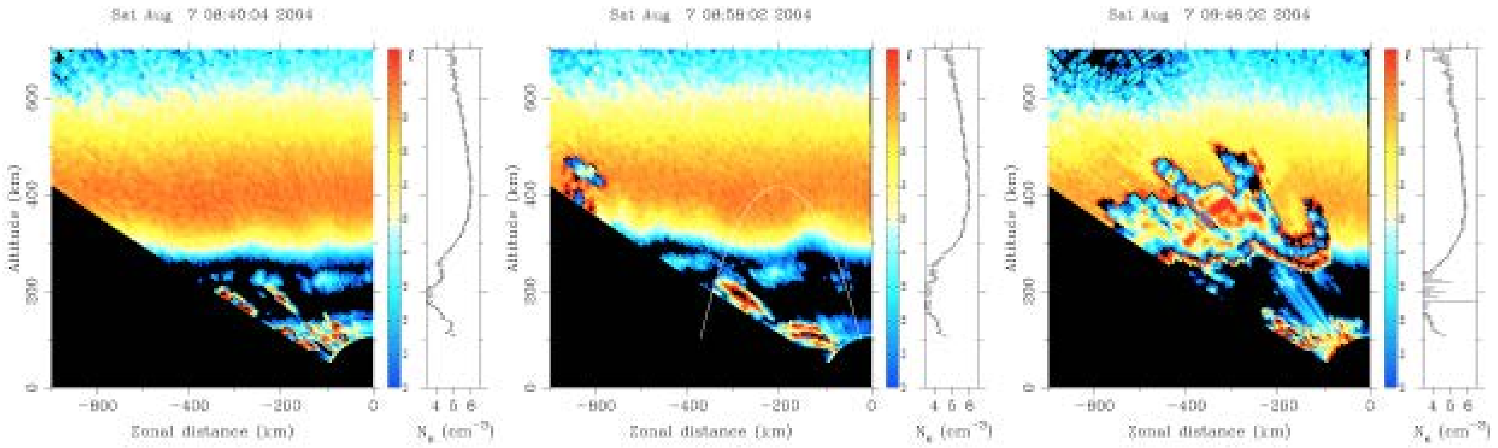
C/NOFS Observations

Pfaff, R. F., et al. (2017), Measurement of reversals in the horizontal plasma drifts below the elevated, low latitude F-region at sunset and their implication for the creation of large scale plasma undulations and spread-F irregularities, Journal of Geophysical Research.





Bubbles Lead to Scintillations



David Hysell Altair Observations

Not all plasma bubble depletions are associated with scintillations?

Old Bubbles?

New Bubbles?

Science Goals

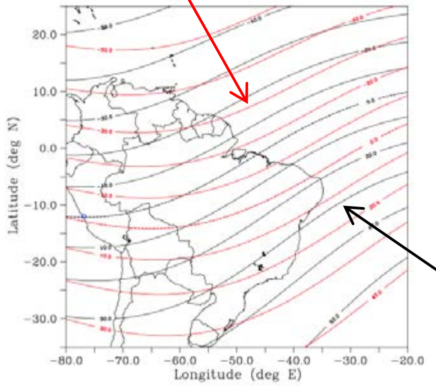
1) **What is the state of the ionosphere that gives rise to the growth of plasma bubbles that extend into and above the F-peak at <u>different longitudes</u>?**

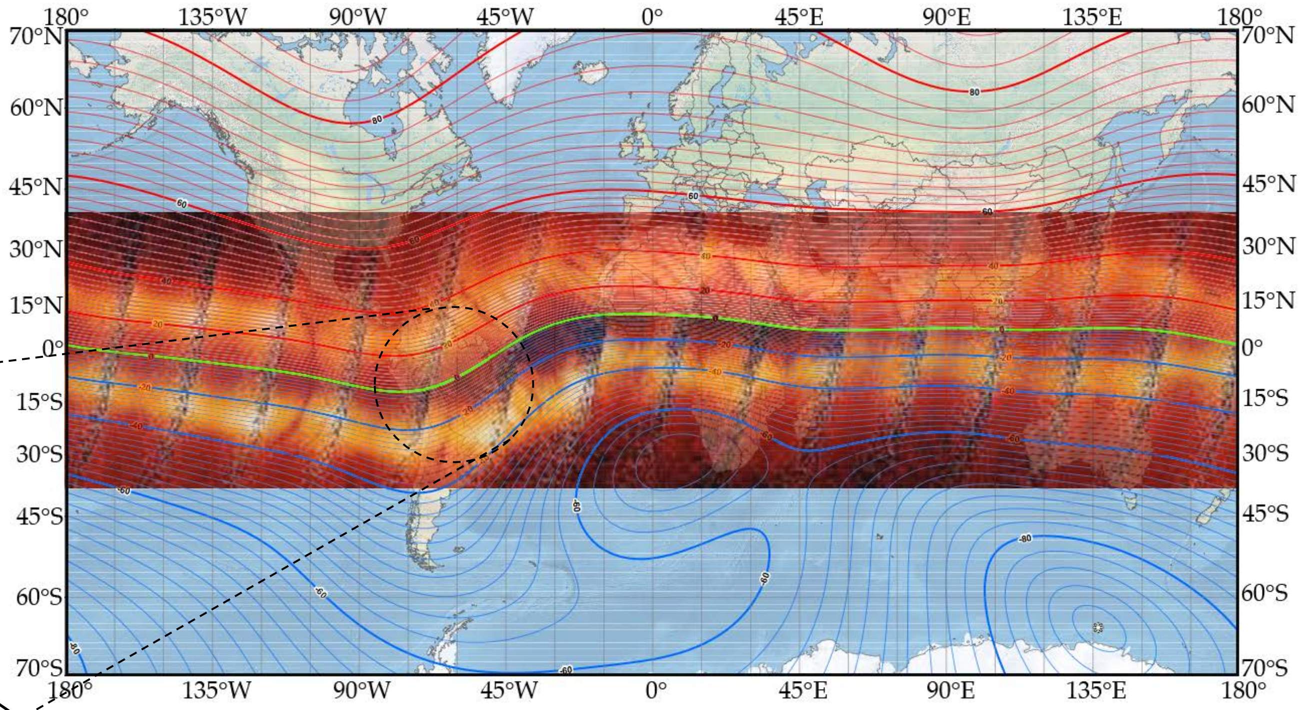
2) **How are plasma irregularities at <u>satellite altitudes</u> related to the radio scintillations observed passing through these regions?**

Magnetic Field

Most ground/radar observations come from the American sector of unique magnetic geometry

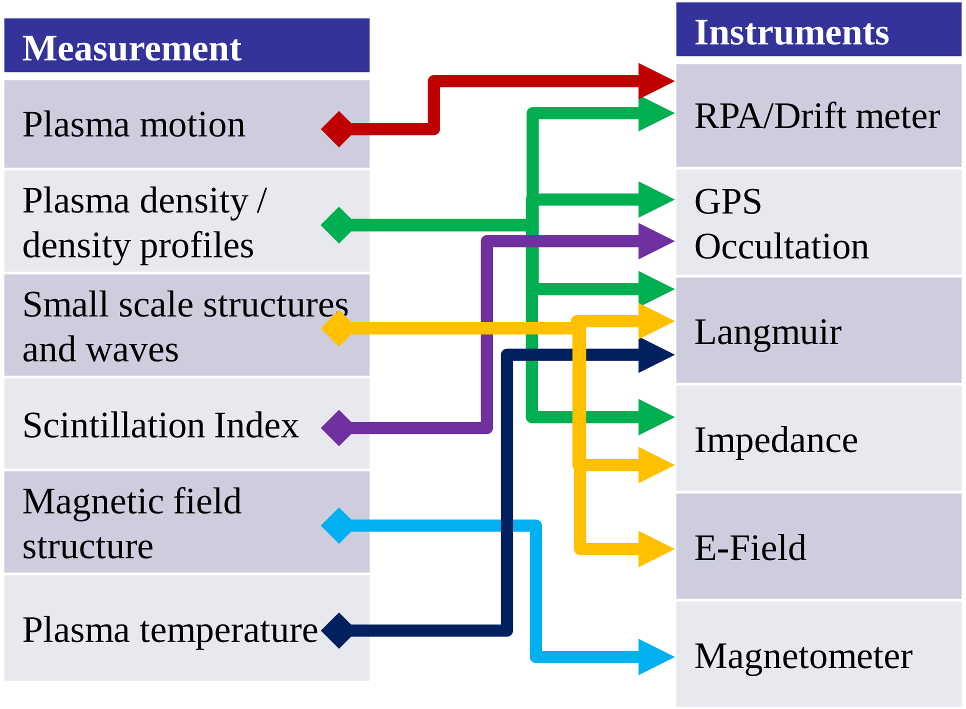
IRGF 1960

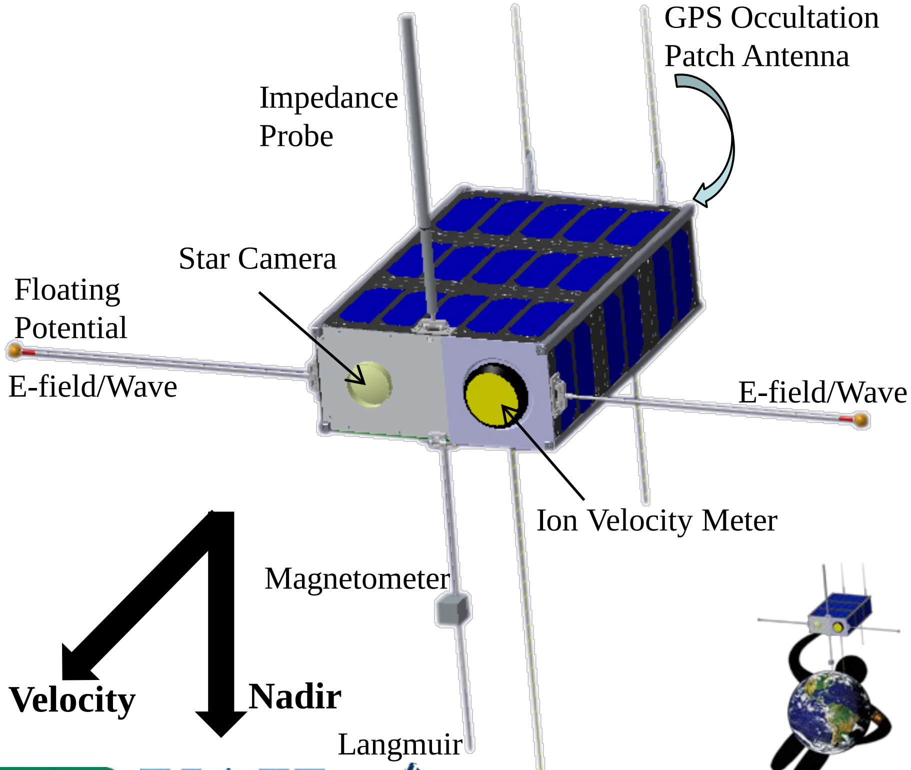




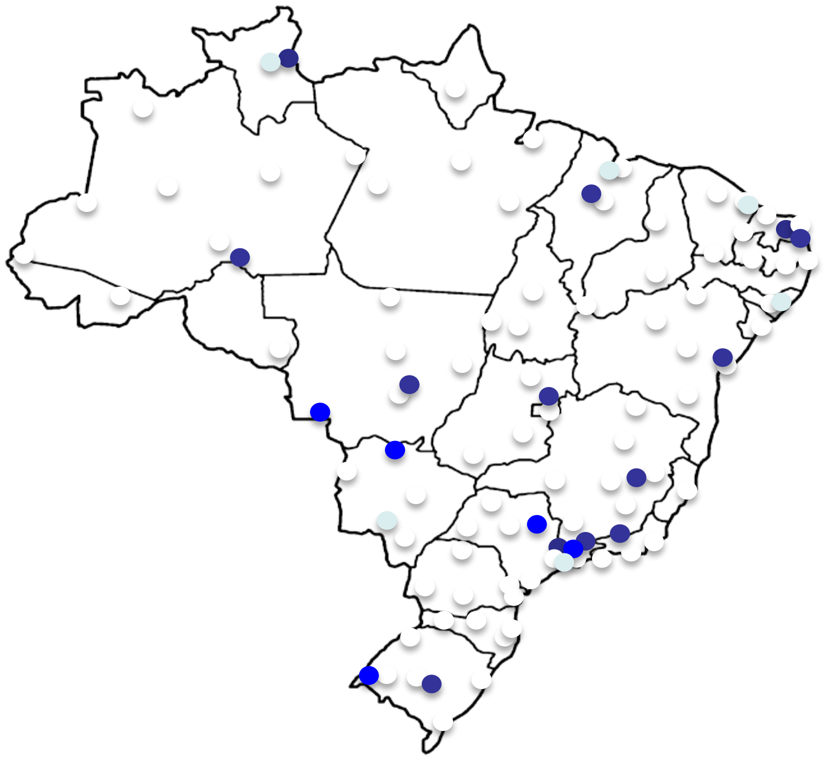
IRGF 2010

Measurement and Instrumentation



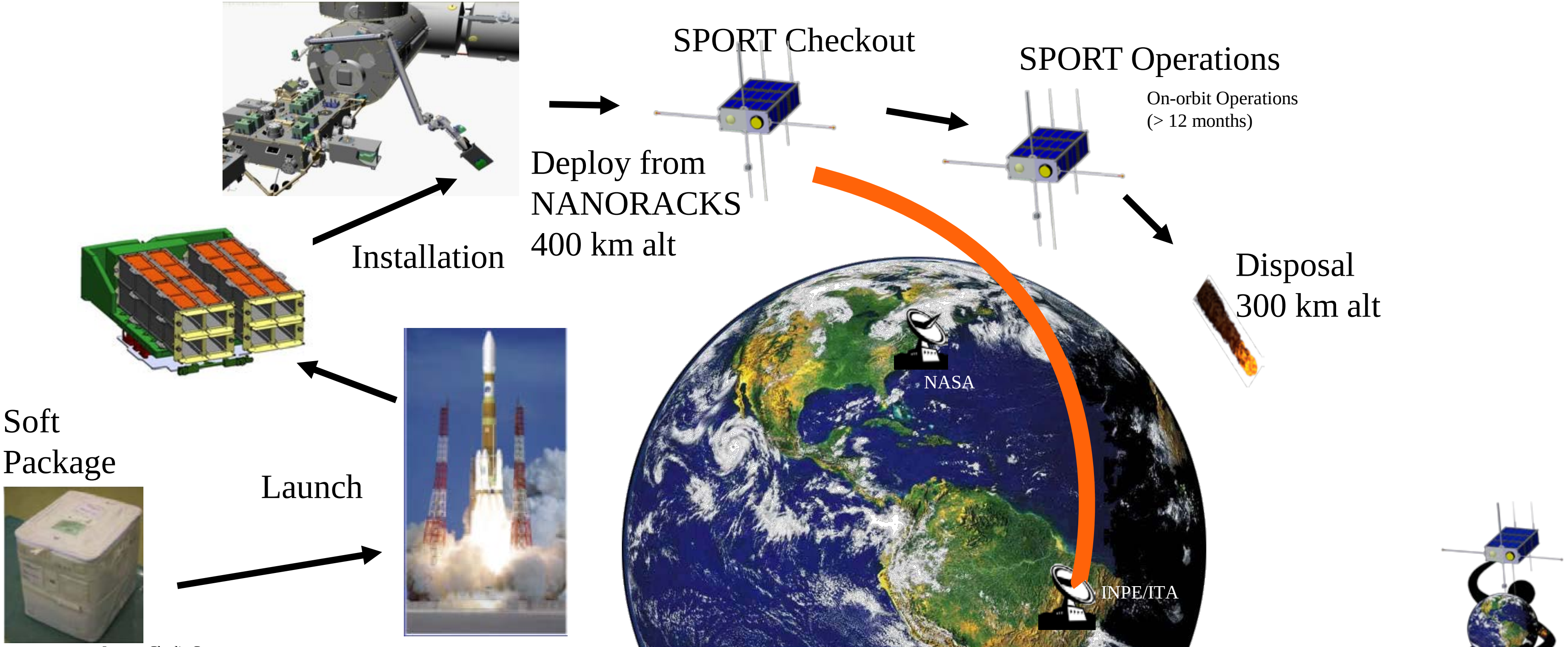


Ground Network



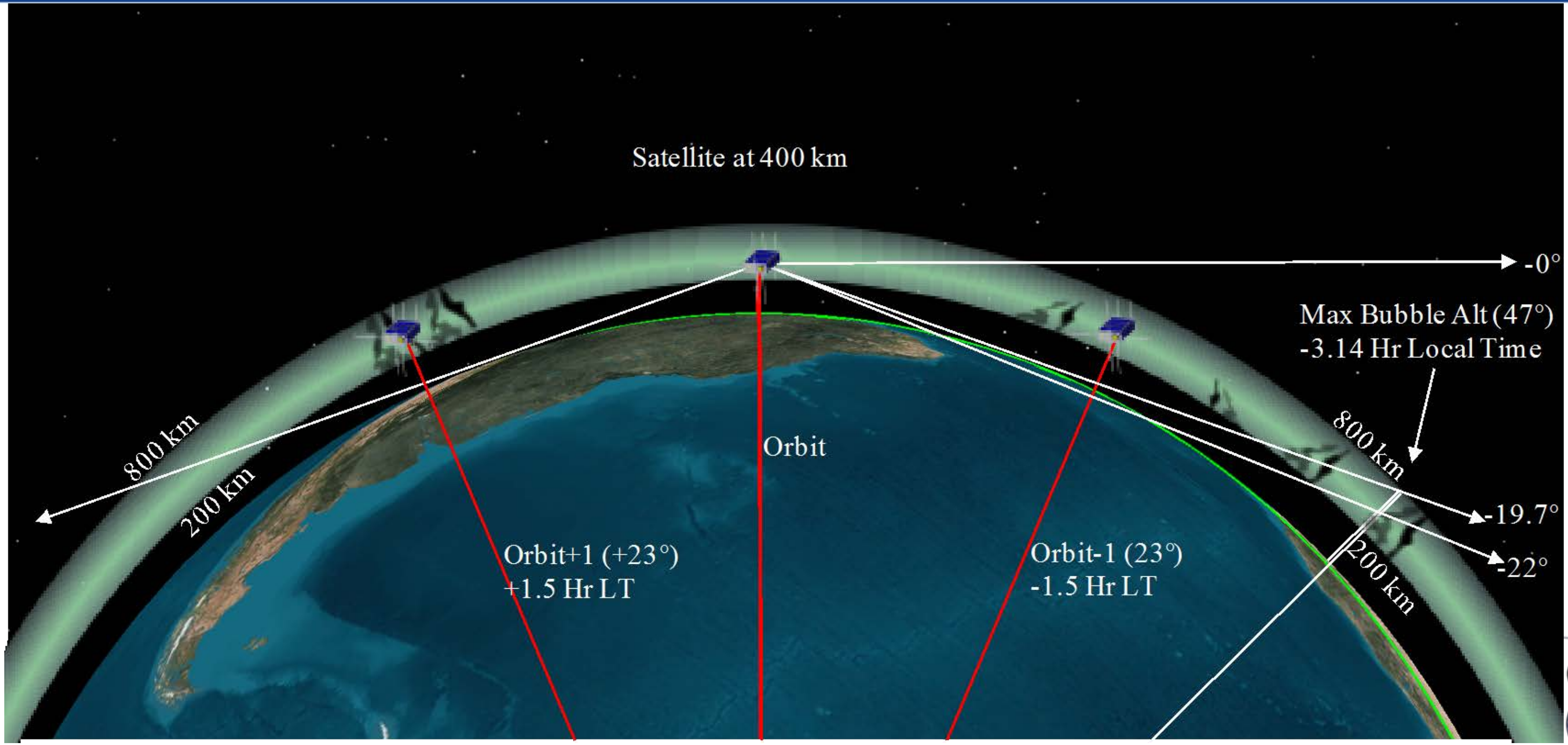
- Magnetometers
- Scintillation sensors
- TEC stations
- Imagers
- Ionosondes

Mission ConOps



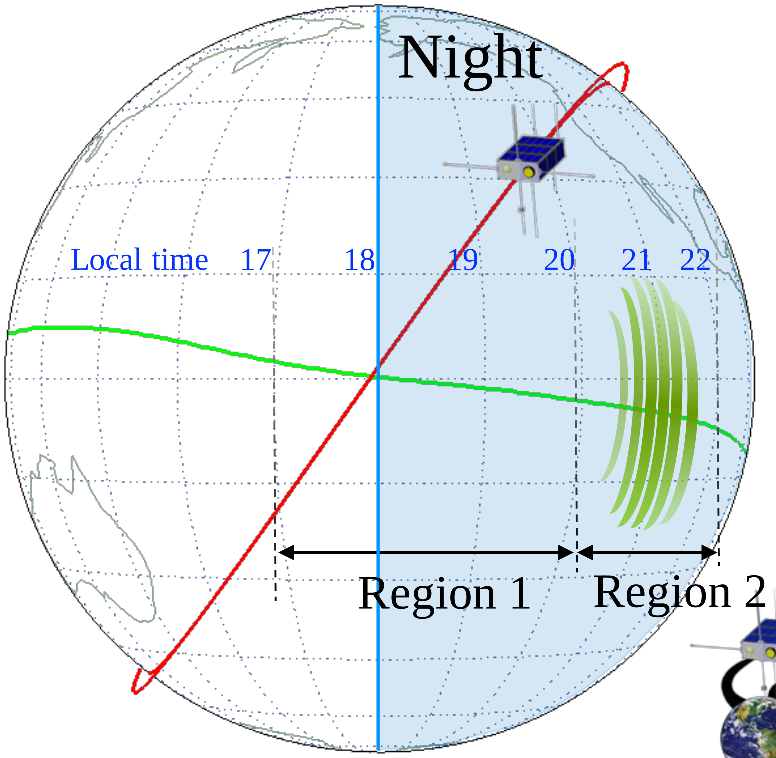
Images: Charlie Gray

GPS Radio Occultation and Scintillation

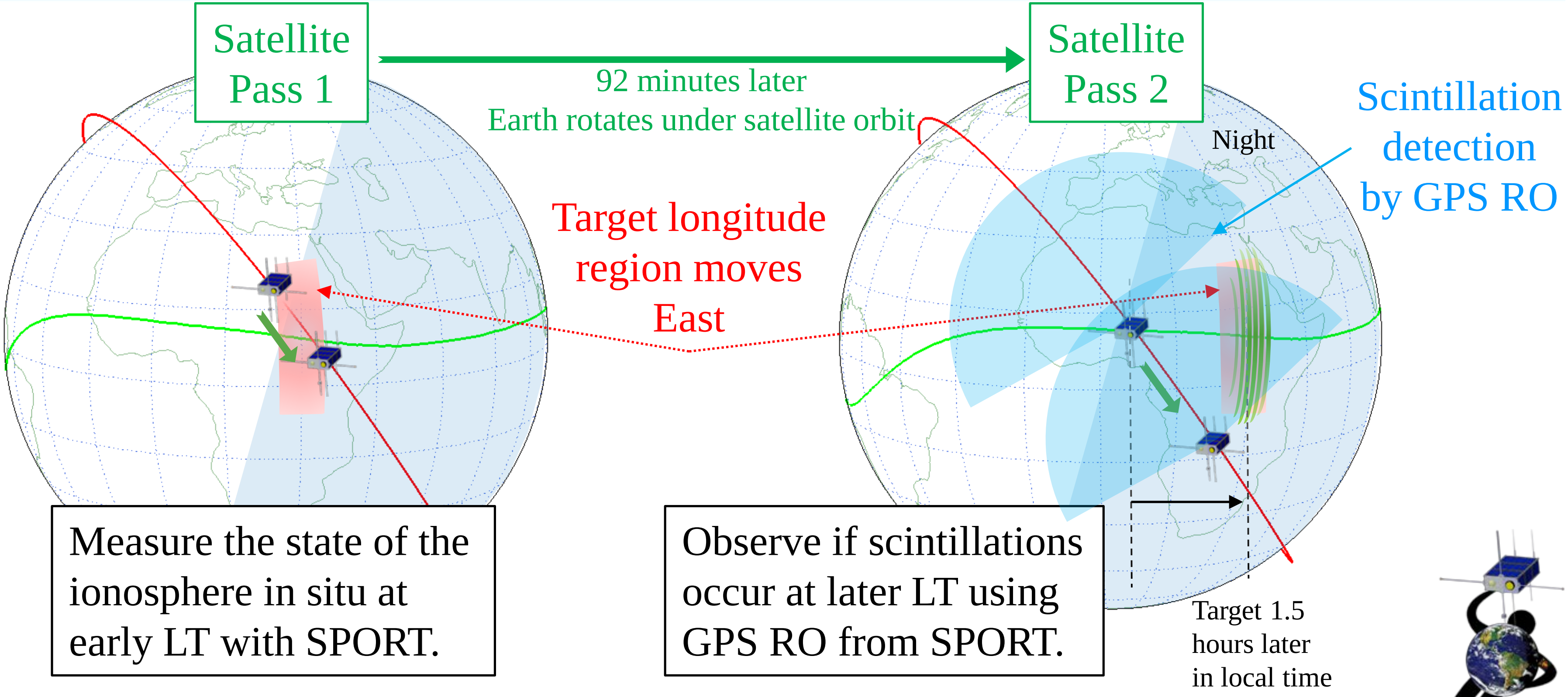


SPORT Methodology

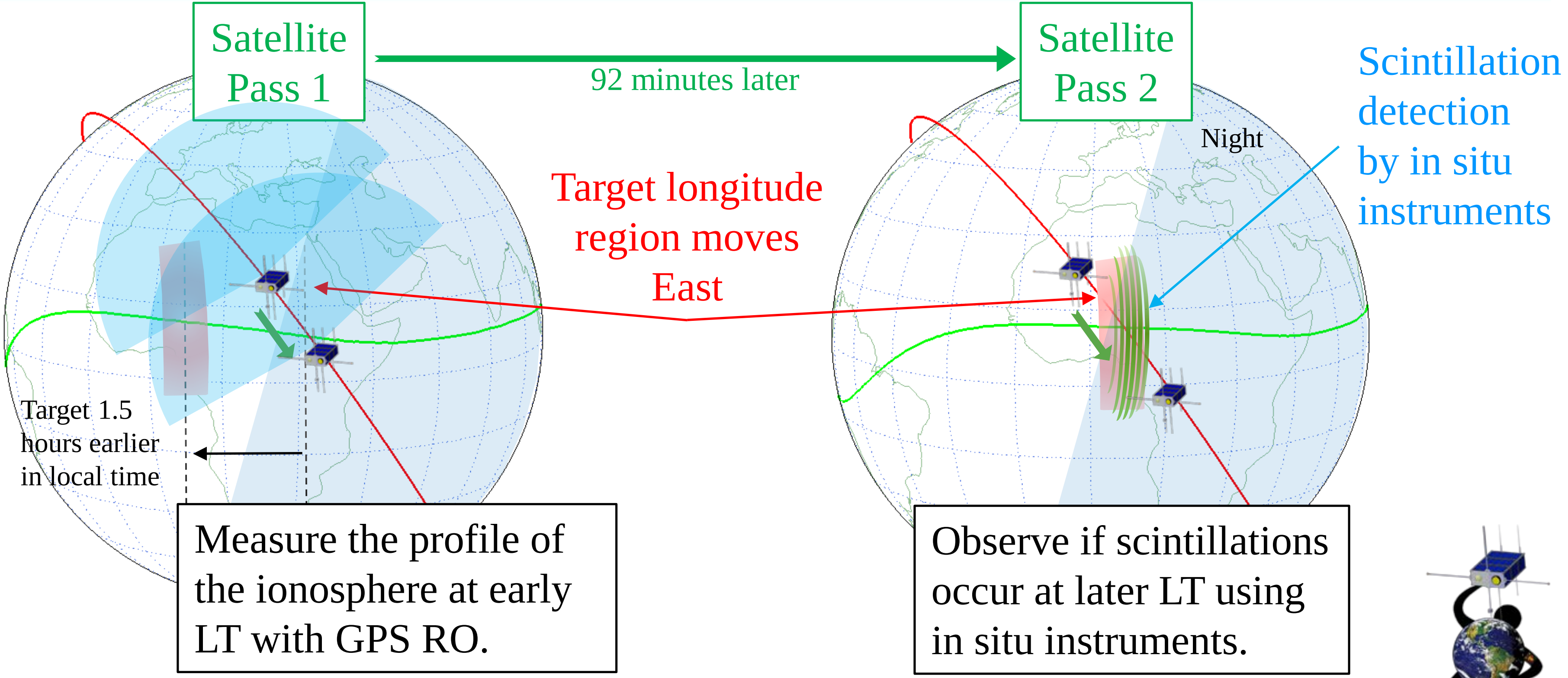
- **The state of the ionosphere at early local times is related to the occurrence of scintillations at later local times.**
  - How does this relation vary with longitude?
- **Use case studies when SPORT ascending or descending node is within 17 to 24 LT sector.**
- **Examine ~15 degree longitude sectors**



Methodology Strategy 1

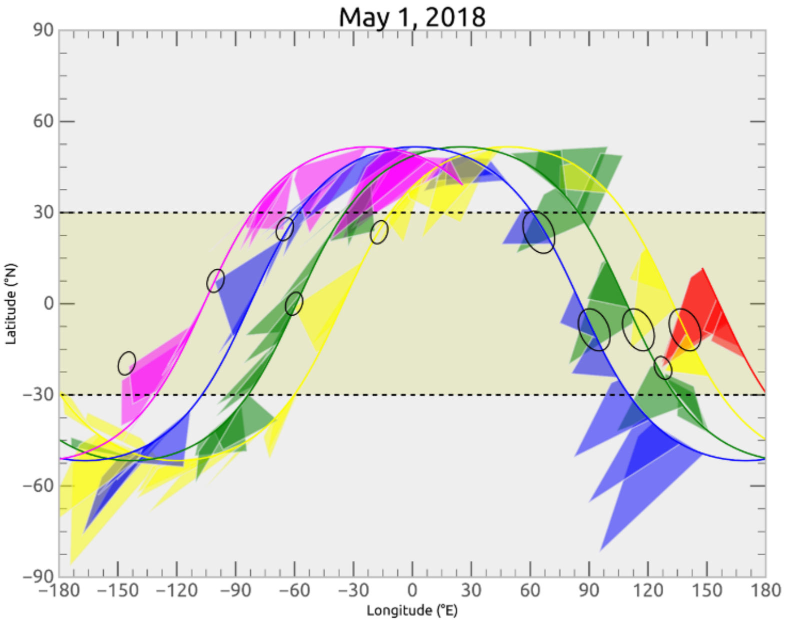


Methodology Strategy 2



How often are ideal occultation

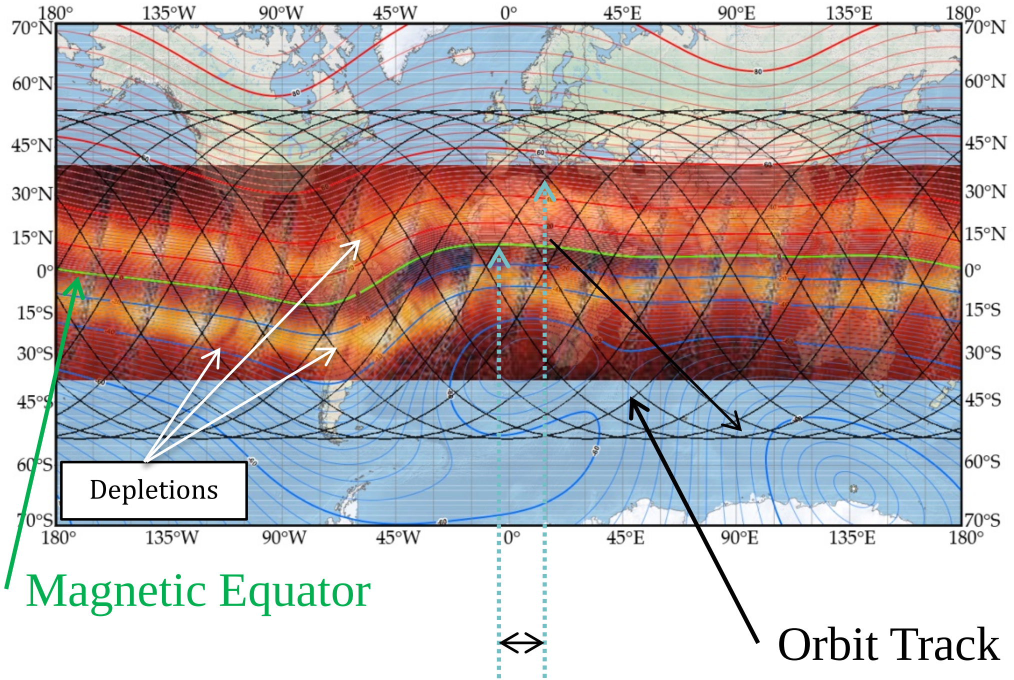
- **Study using SPORT in ISS orbit.**
- Over one orbit in the region within ±30°
  - ~2 profiles over the previous orbit traces
  - ~2 profiles occur over successive orbit traces.



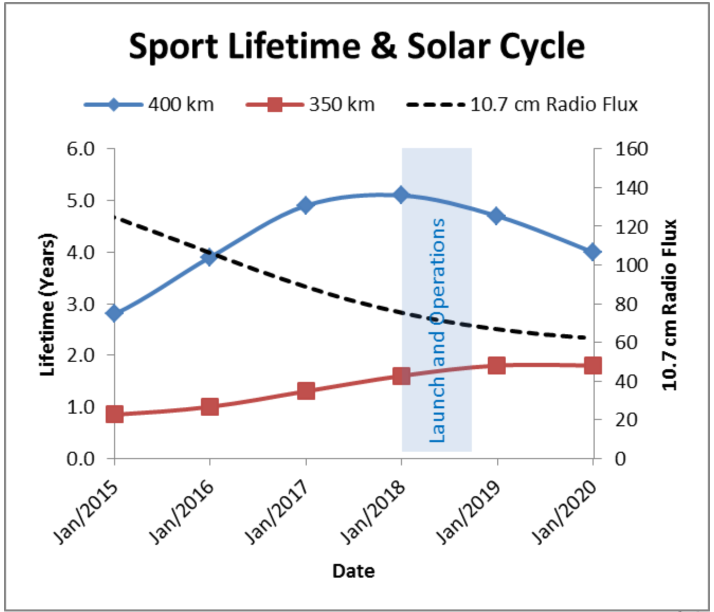
Conclusions

- **CubeSat missions can be developed with a full/regular suite of science instruments.**
- **Mid inclination ISS orbits allow for the deconvolution of local time and longitude at low-latitudes**
- **A String of pearls mission to increase time resolution**

SPORT Mission and ORBIT



20° latitude or 1.3 hr LT across an EIA arc

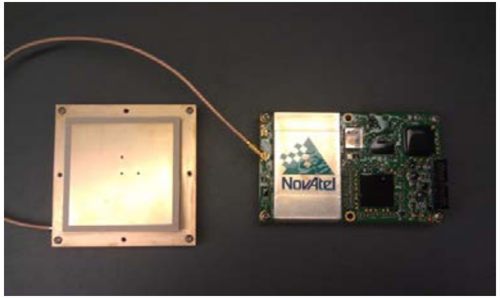


Launch from ISS, 400 km Alt
~3 year life

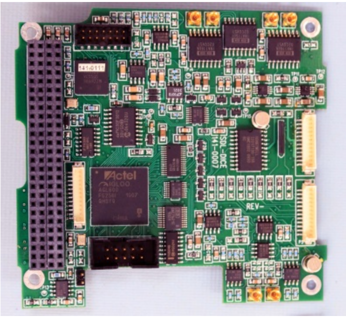
SPORT Instruments

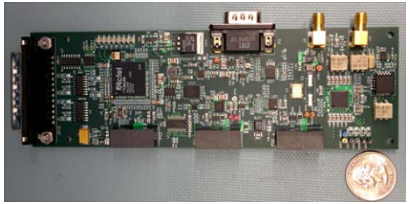
Ion Velocity Meter
UTD

GPS Occultation
Receiver
Aerospace

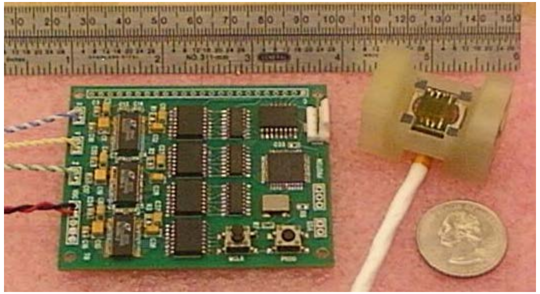


Langmuir, E-field,
Impedance Probe
USU



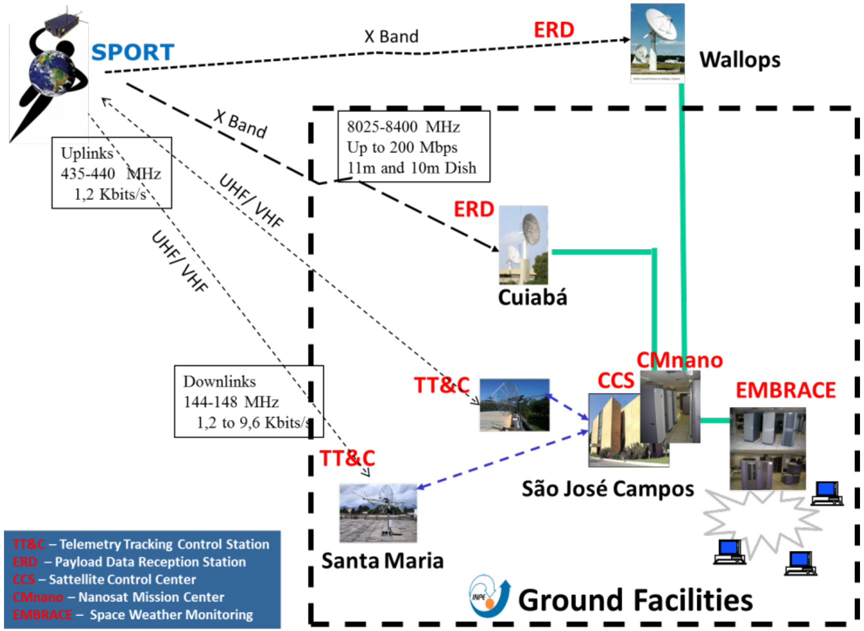


Fluxgate Magnetometer
NASA Goddard



SPORT Telemetry

Channel Name	Duty %	Rate Hz	Bit Rate bps	Alongtrack km
Ion Velocity Meter			**1824**	
Drifts	100%	2.00	288	3.83
Composition Sweeps	100%	2.00	1536	3.83
GPS RO			**16000**	
Dayside Tracking	50%	1.00	1000	7.66
Nightside Tracking	50%	50.00	15000	0.15
Langmuir Probe			**1984**	
DC Probe	100%	40.00	960	0.19
IV Sweeps	100%	0.04	491.52	191.43
Floating Probe Sweeps	100%	0.04	491.52	191.43
N_e Wave Power	100%	0.04	40.96	191.43
E-Field			**1321**	
DC field	100%	40.00	1280	0.19
E-Field Wave Power	100%	0.04	40.96	191.43
Impedance Probe			**197**	
I & Q Sweep	20%	0.04	196	191.43
Tracking	20%	40.00	192	0.19
Fluxgate Magnetometer			**2880**	
DC field	100%	40.00	2880	0.19
Star Imager			**1500**	
Star Subimage	100%	1.00	1500	7.66
Other			**2624**	
Science GPS timeing	100%	40.00	2560	0.19
Science Housekeeping	100%	0.10	64	76.57
Rate collected on orbit			**31210**	



50 Mbit/second Downlink giving a safety factor of 14