Characterization of locations and durations of ionospheric irregularities causing GNSS signals scintillation over the low latitude regions in Africa:

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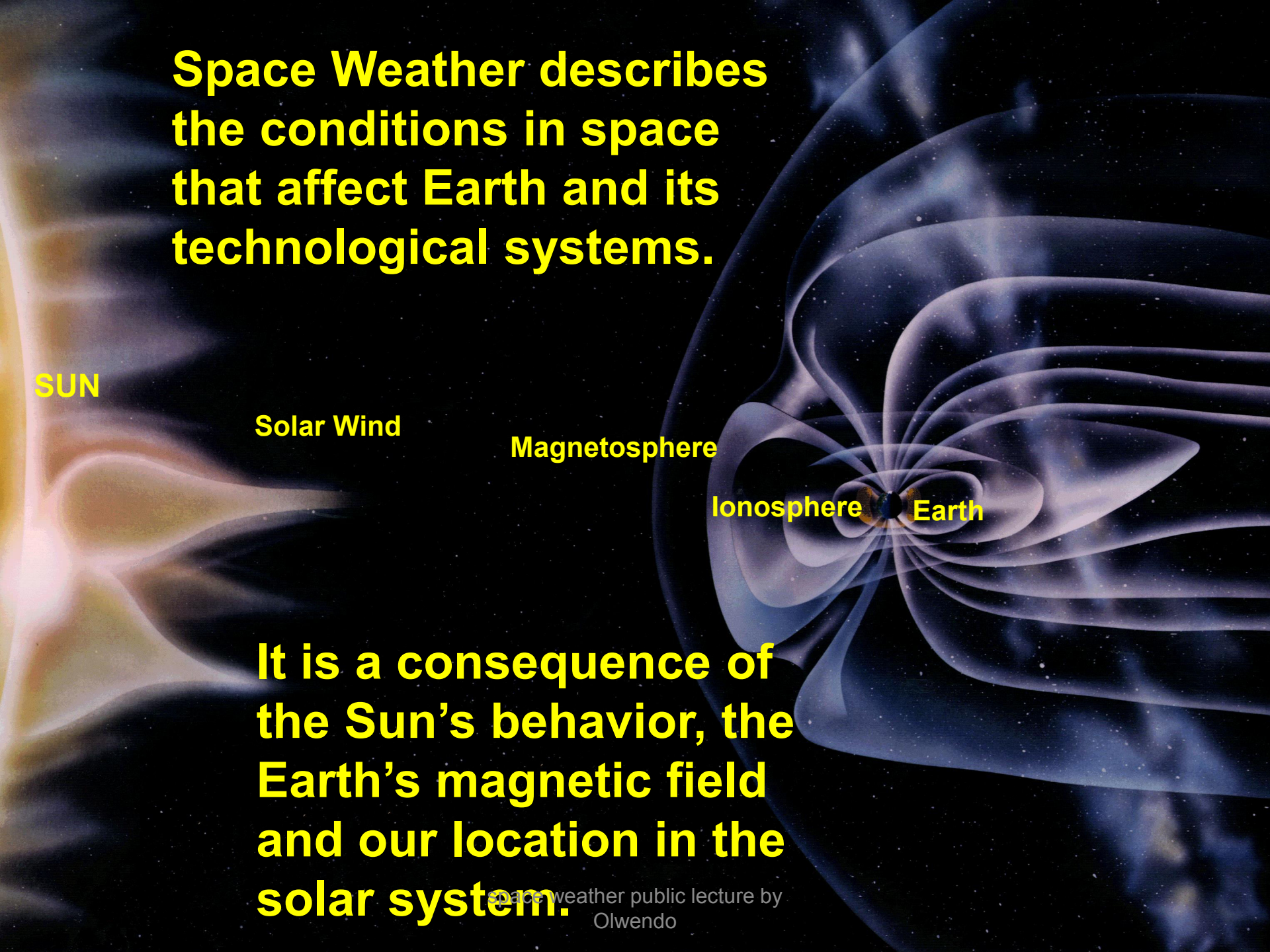
2nd UN/United Arab Emirates High level forum: Space as a driver for socio-economic sustainable development. 6th-9th November, 2017, Dubai, UAE.

Outline

- ✓What is Space Weather?
- ❖The Sun-Earth connection: The main Dynamos
- ✓ Near Earth space environment electrodynamics
- ✓Satellite Technology & application in Scientific Research
- ✓ Results in scintillation observation around the Kenya region
- ✓Ionospheric threats to GNSS signals and applications
- ✓Why bother about ionospheric scintillation?

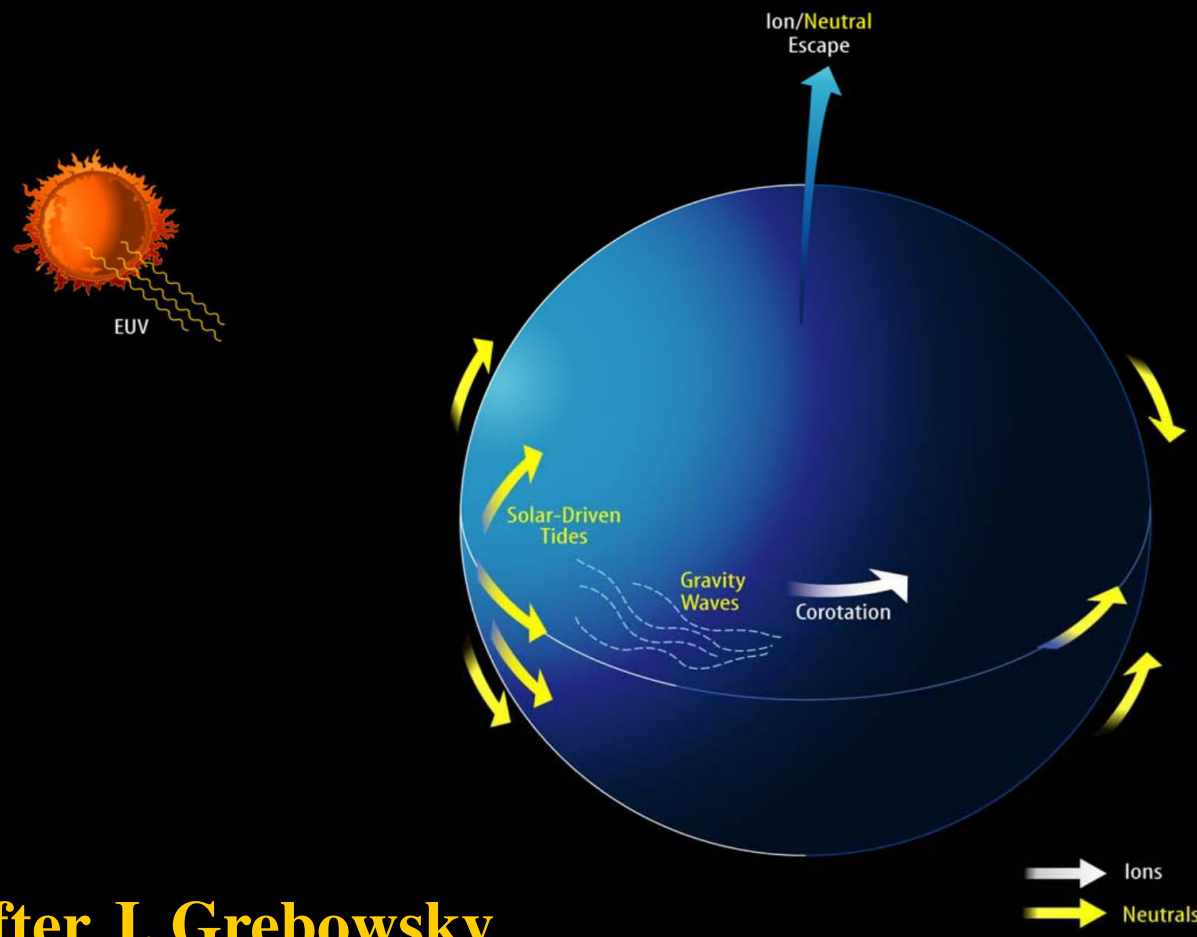
Space Weather describes the conditions in space that affect Earth and its technological systems.



It is a consequence of the Sun's behavior, the Earth's magnetic field and our location in the solar system.

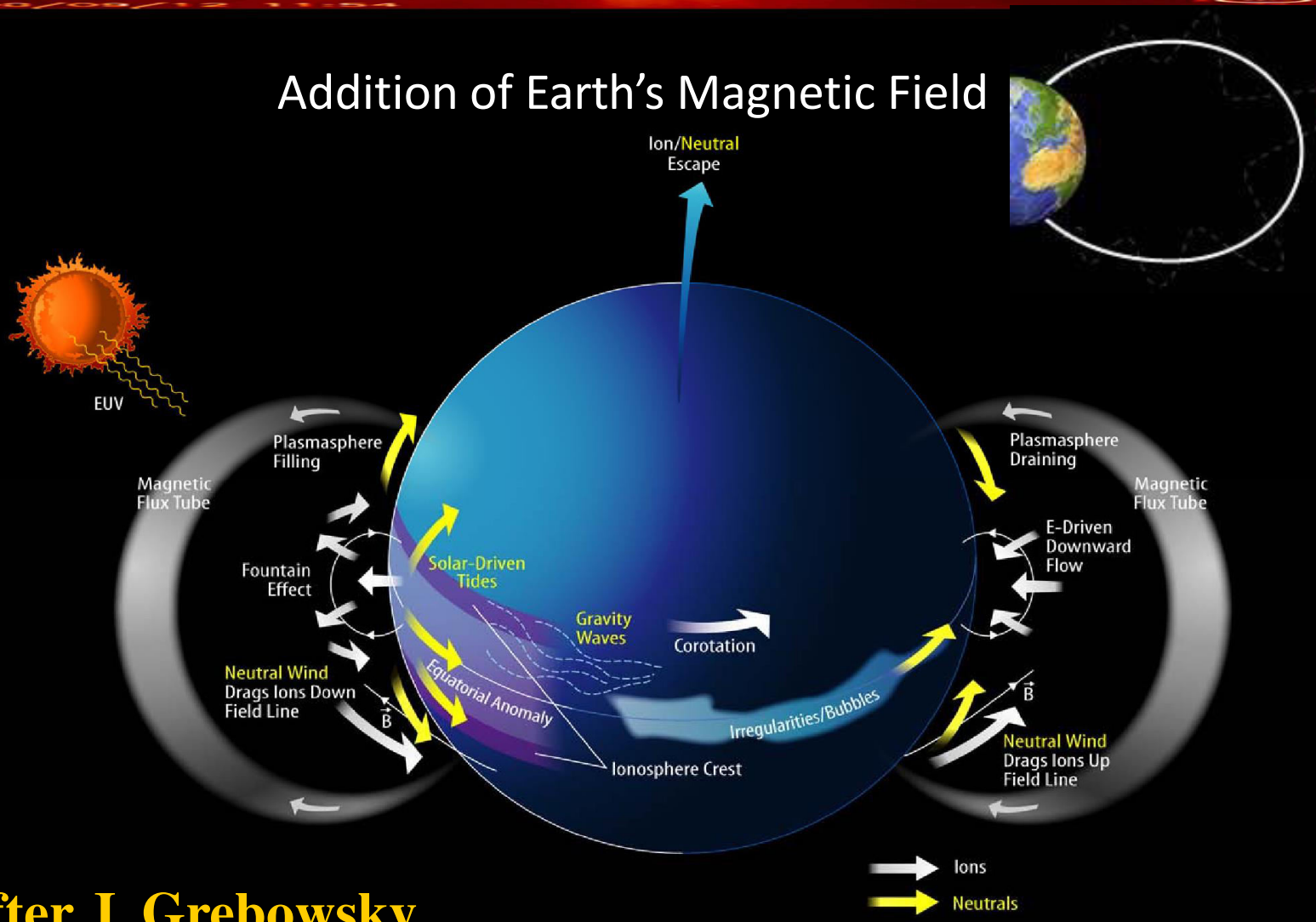
M-I coupling

Solar EUV Effects: No Magnetic Fields



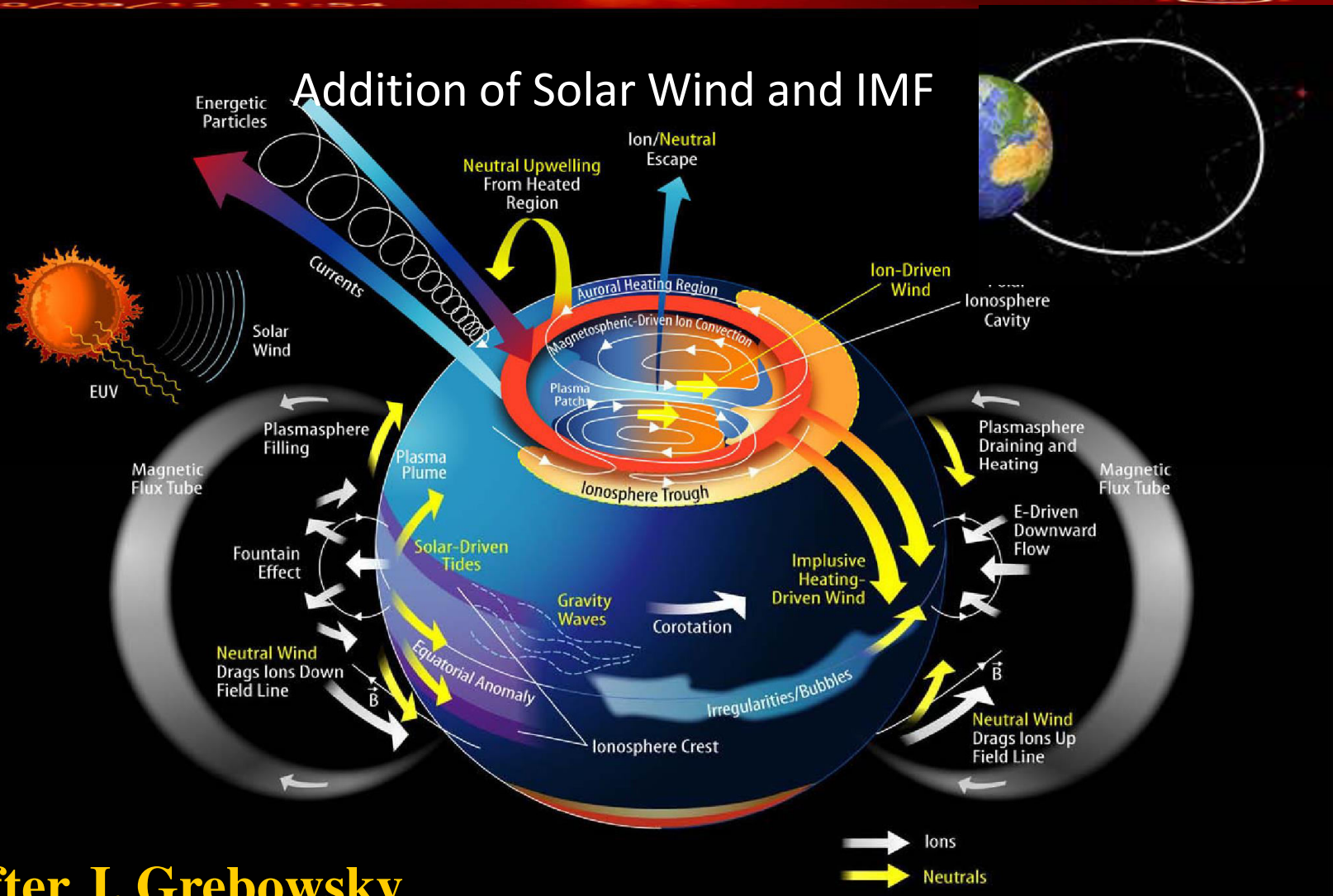
After J. Grebowsky

M-I coupling



After J. Grebowsky

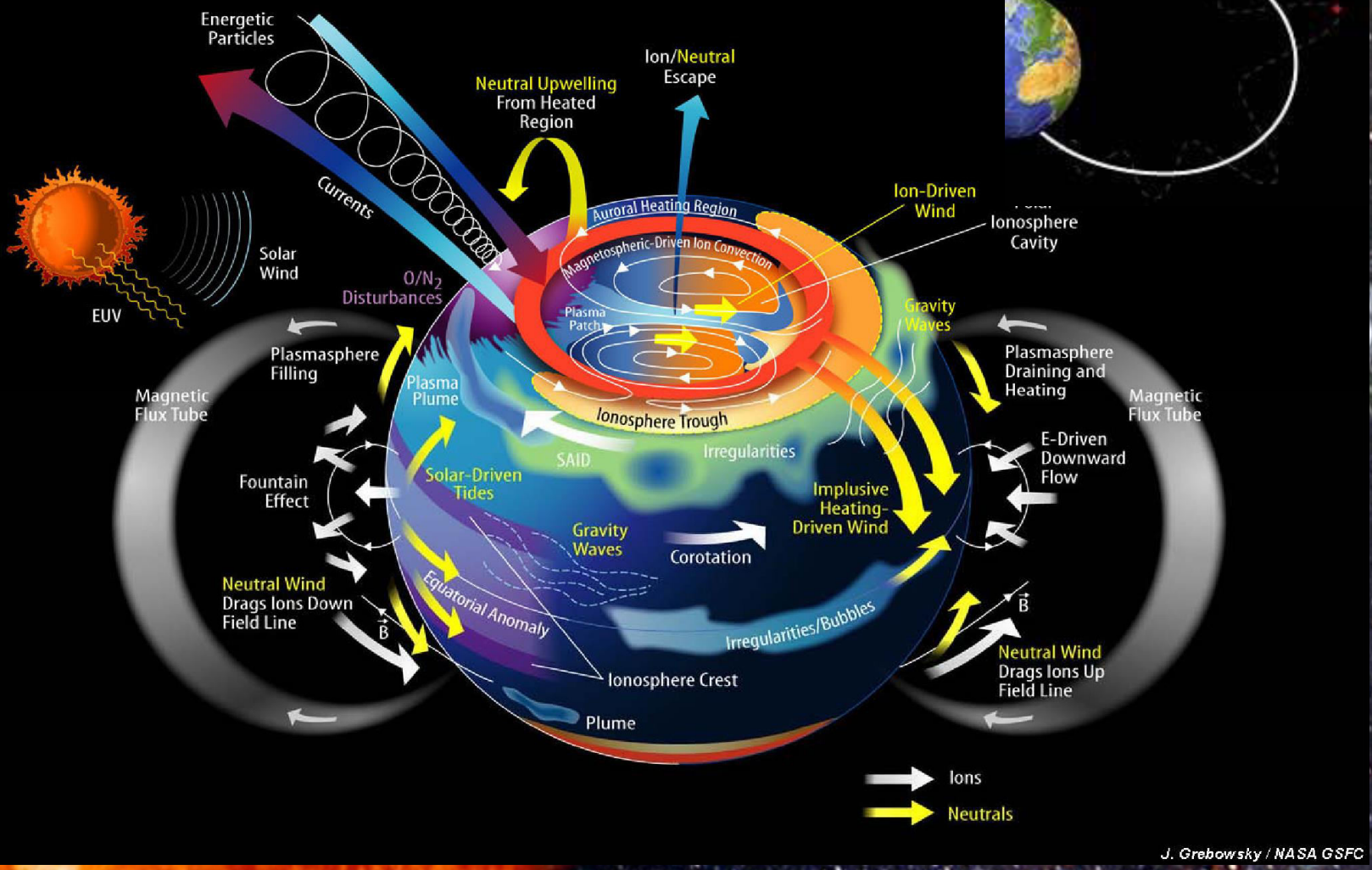
M-I coupling



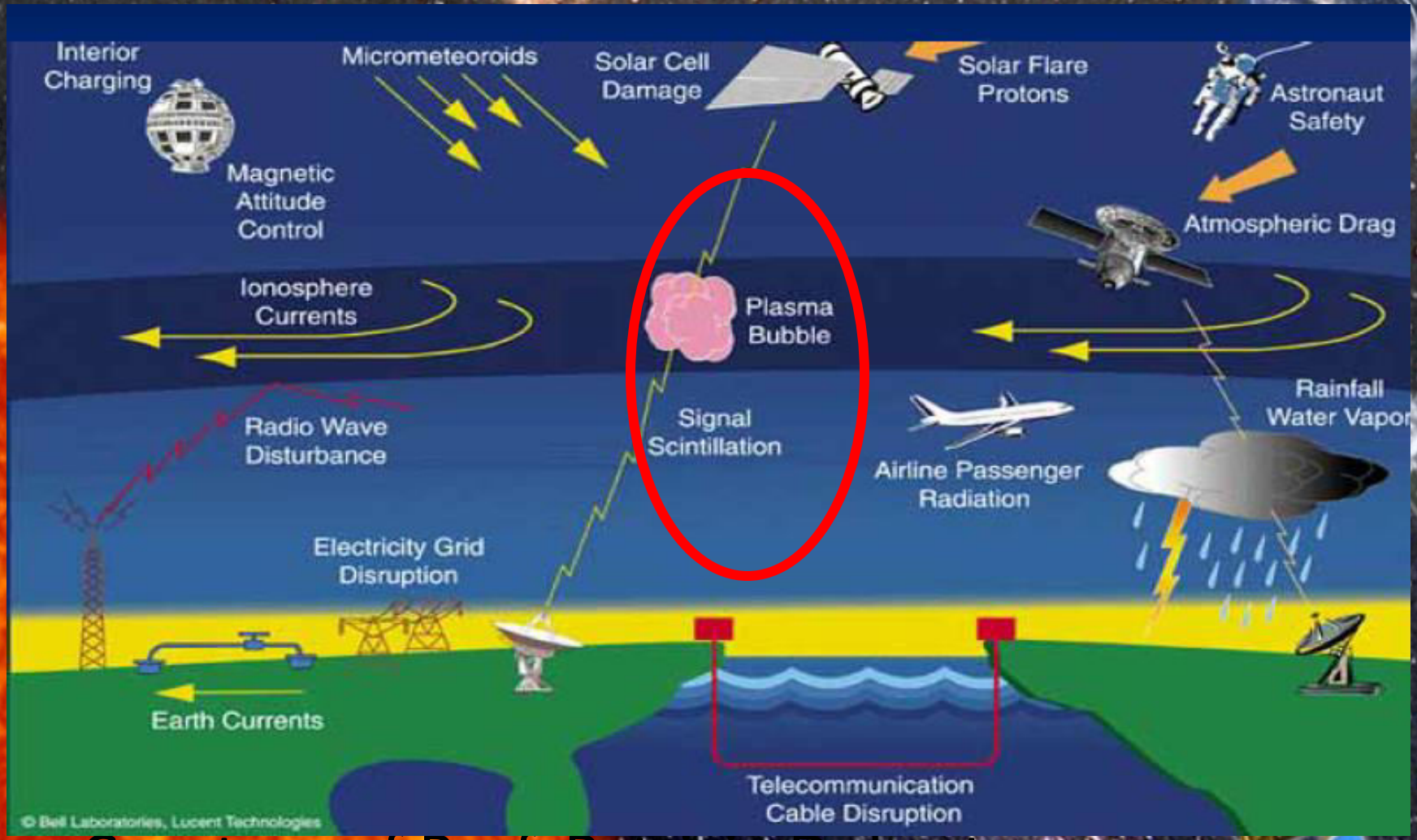
After J. Grebowsky

M-I coupling gets messy

During Geomagnetic Storms



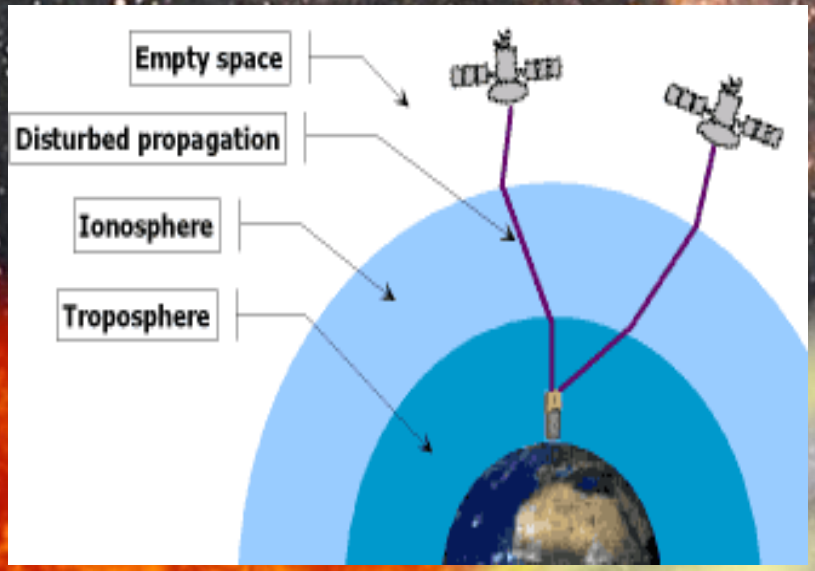
Near earth space weather events

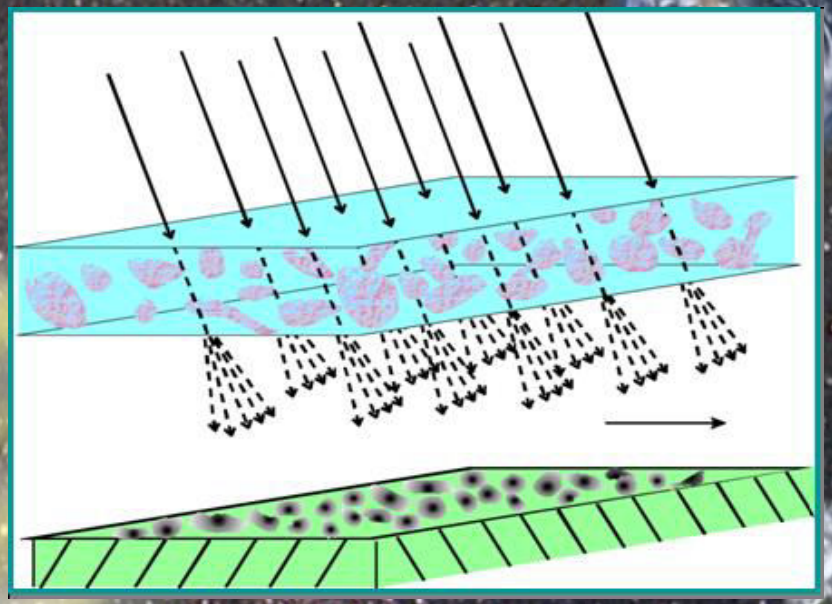


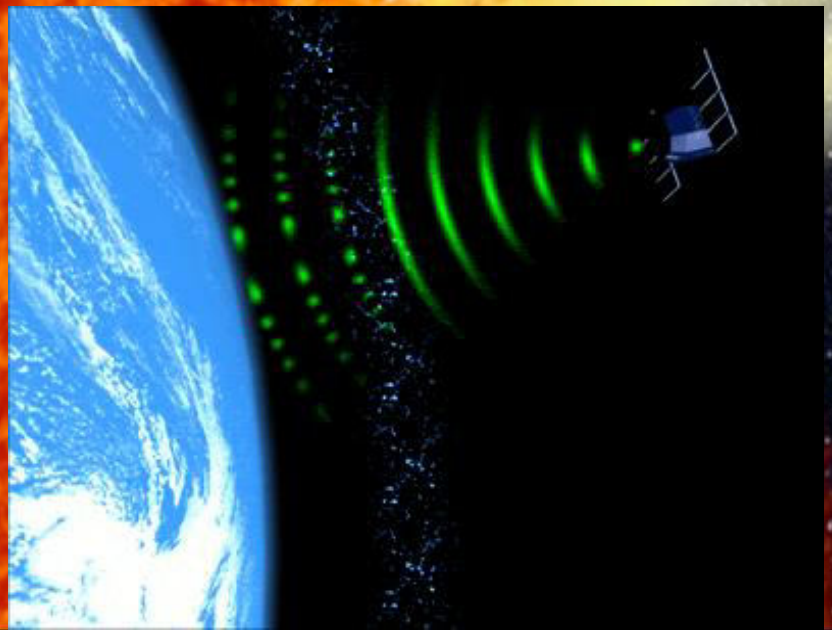
- Courtesy of Prof. Patricia Doherty

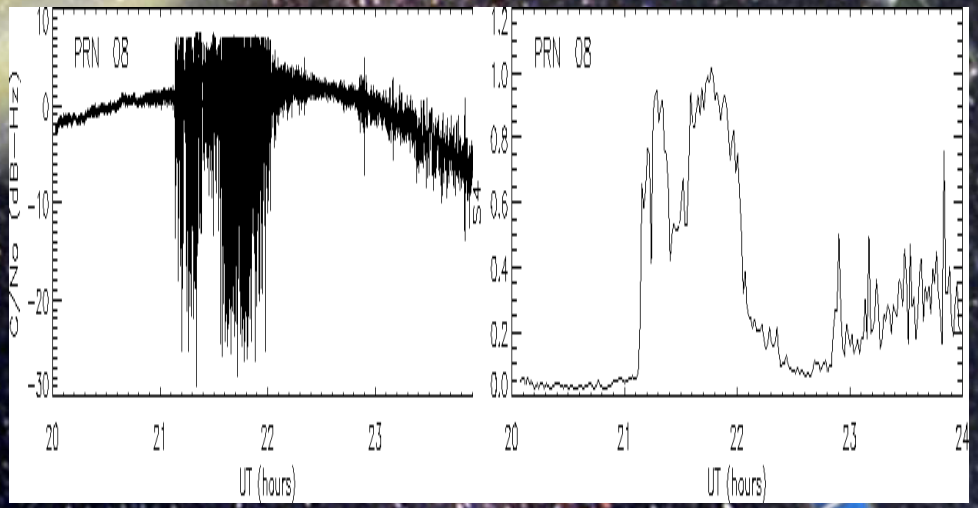
Ionospheric Measurements from GNSS Observables

Ionospheric Irregularities

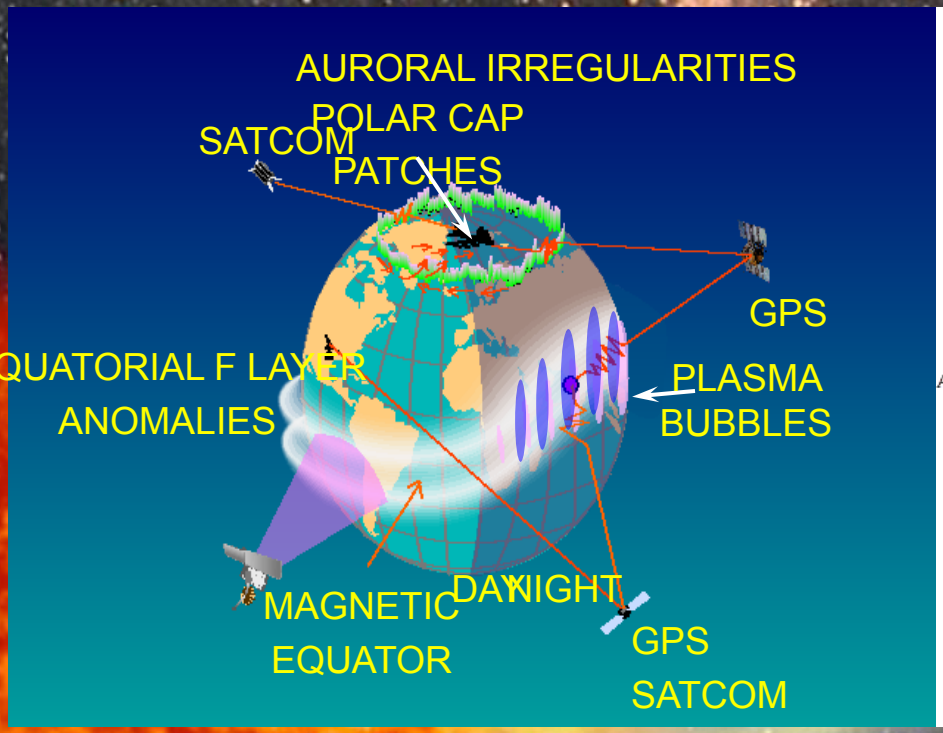


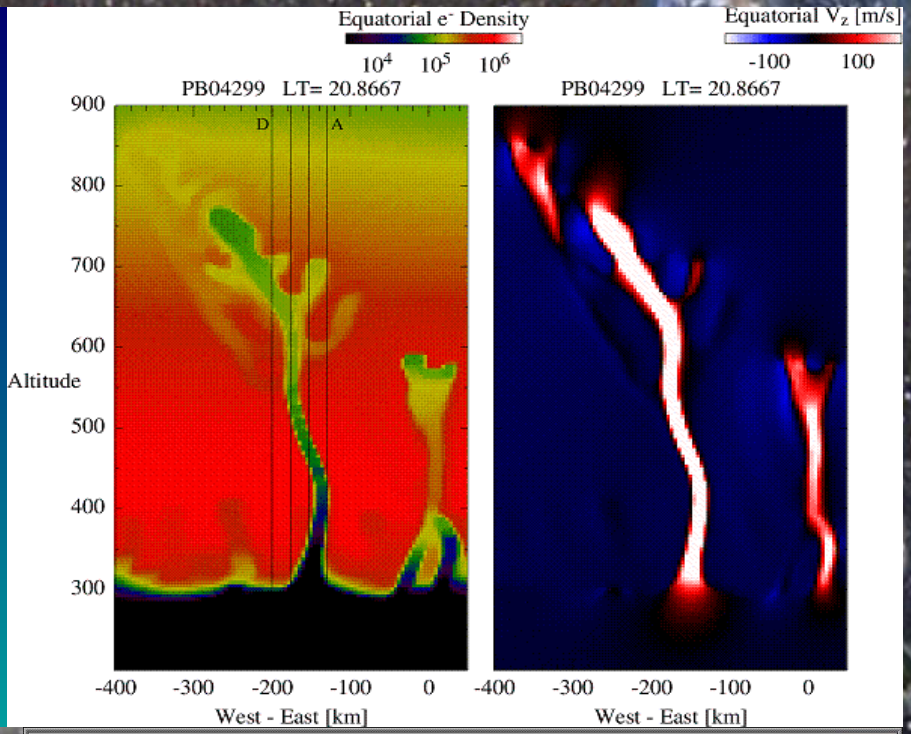






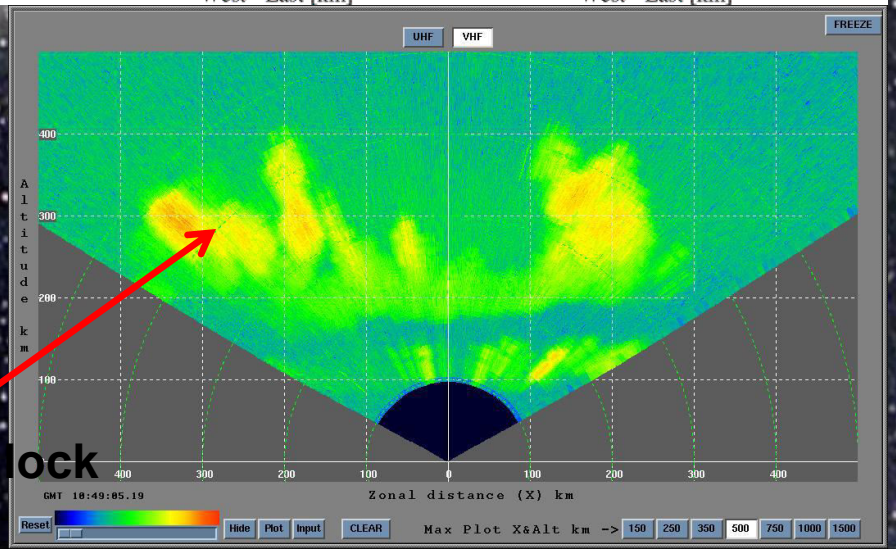
Where do scintillation occur and Why?





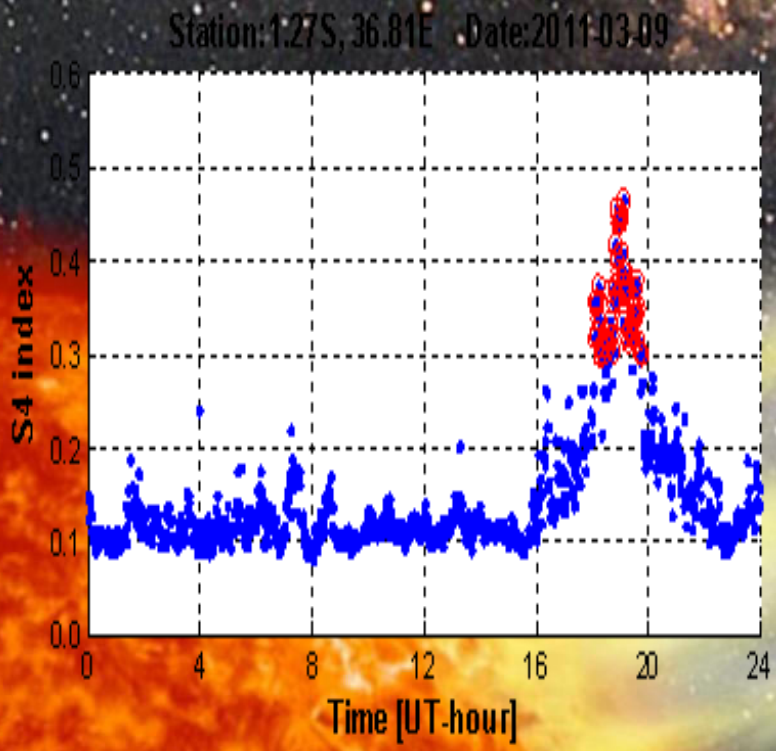
Caton, (2012) ISWI Barhir Dar

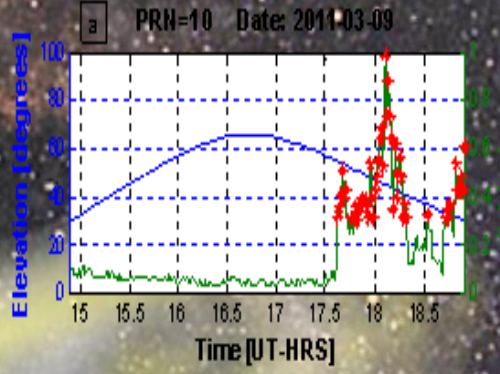
Coherent scatter radar scan From J. M. Retterer

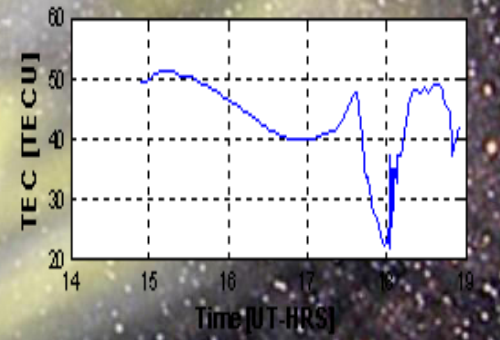


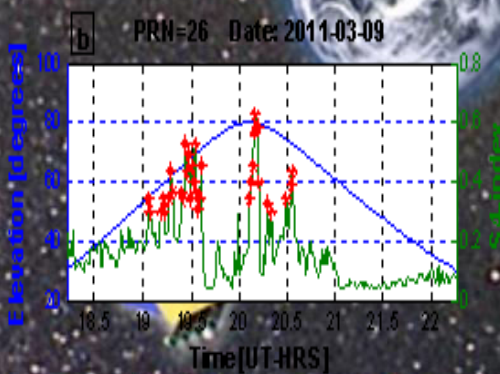
Satellite signals along the bubbles: phase lock

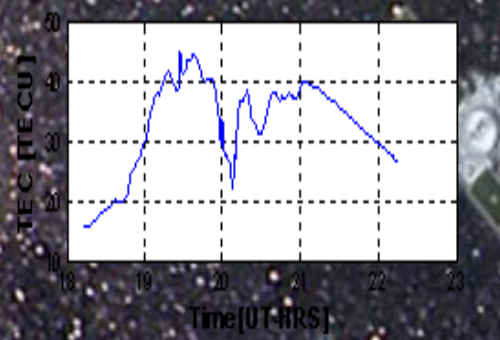
Diurnal Variations of S4 and what it means

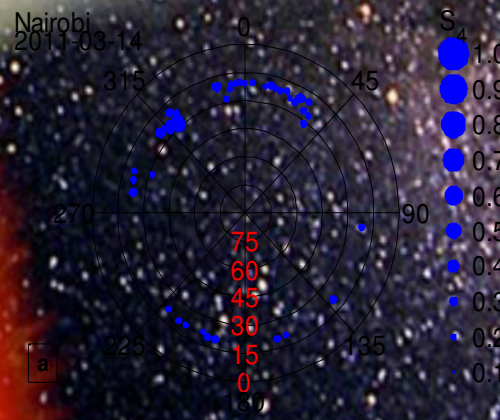








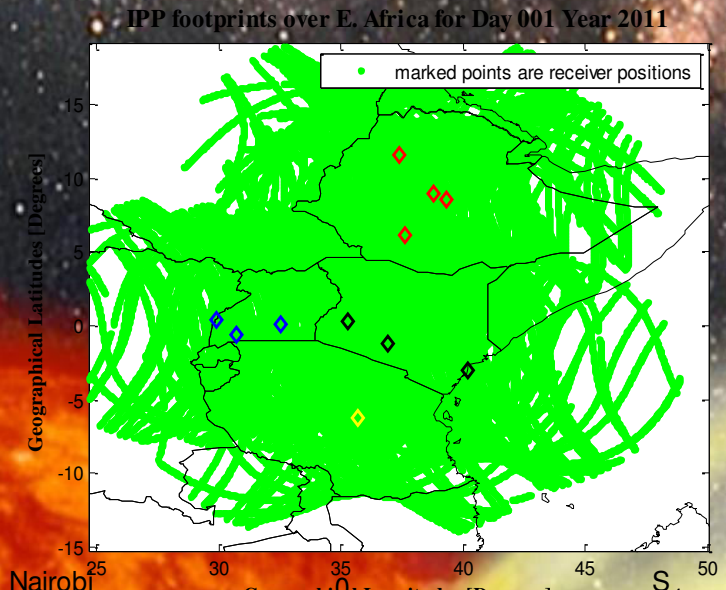


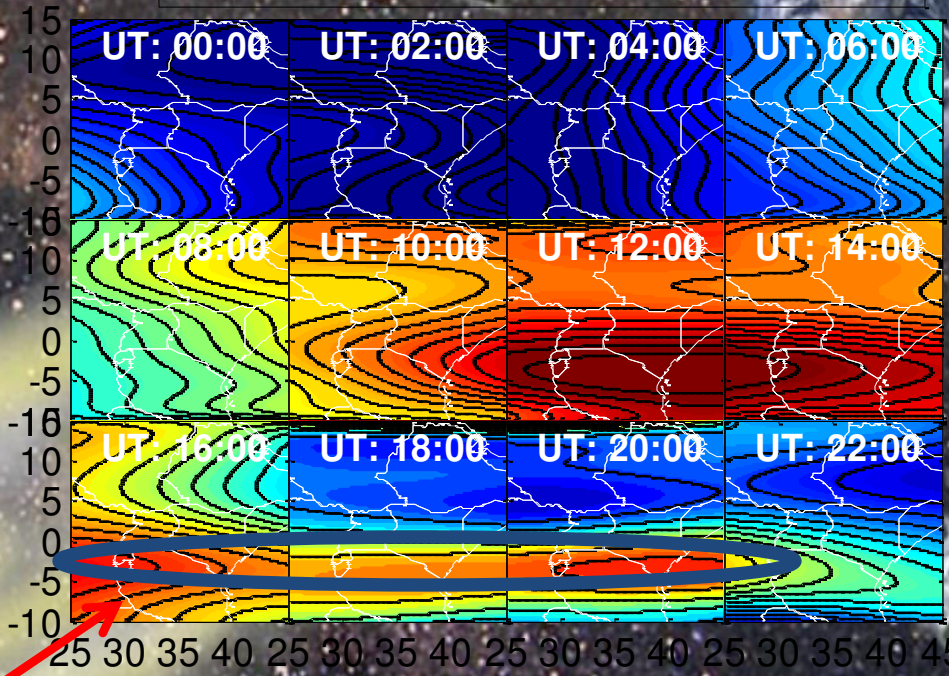


Depletion in TEC are signatures of plasma density irregularities in the ionosphere- Plasma Pubbles

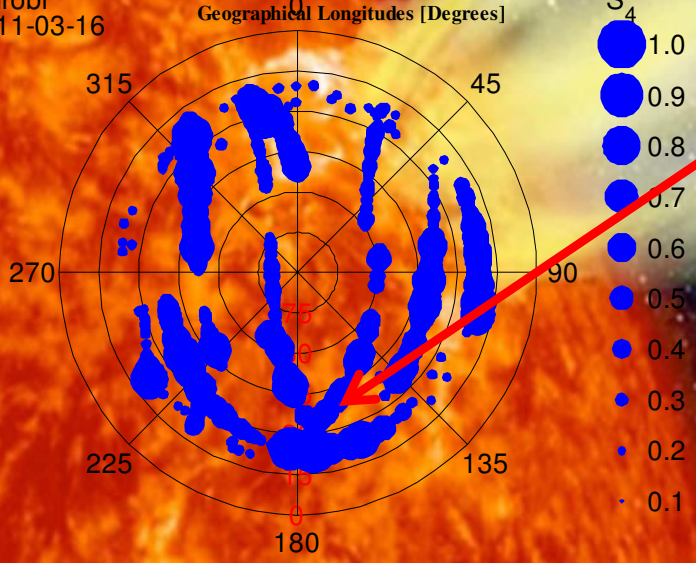
Olwendo et al. 51(2013), 1715-1726, ASR

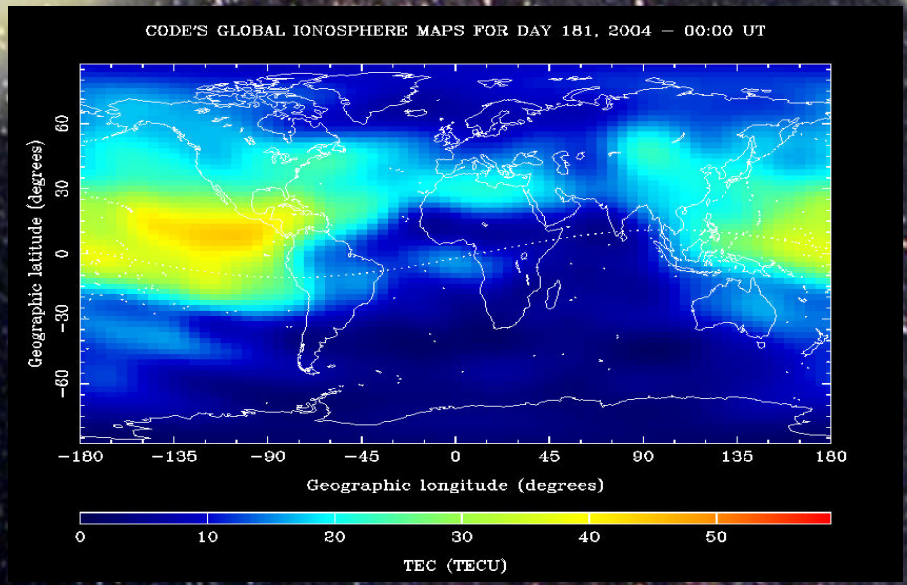
Spatial distribution of irregularities and the ionization anomaly crests





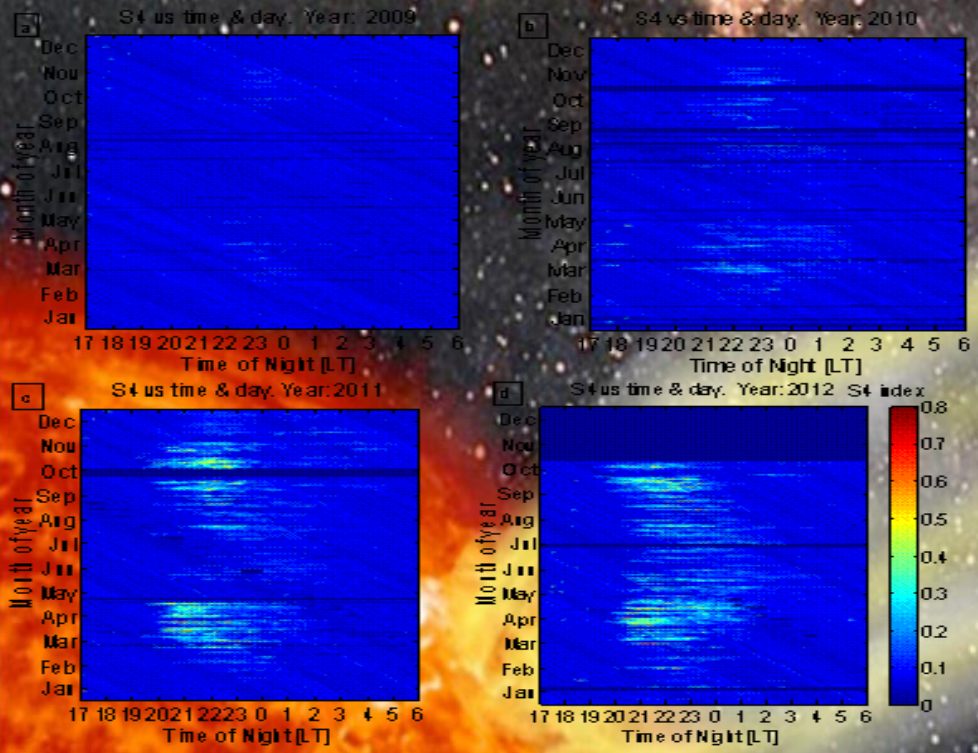
Nairobi
2011-03-16



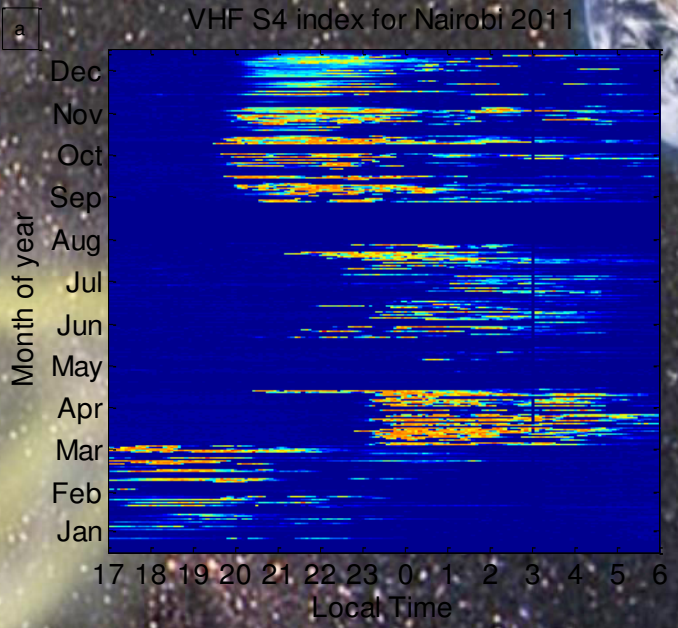


Climatology: Diurnal and Seasonal Variation of S4 index

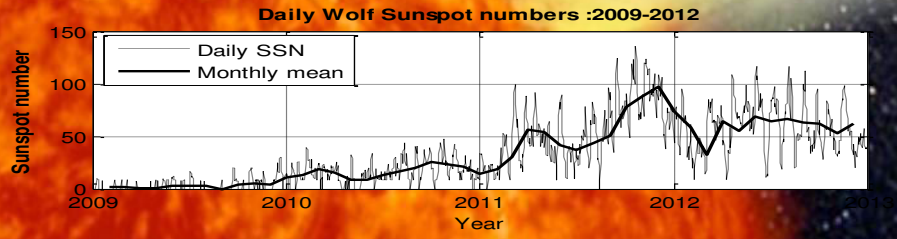
L-band Scintillation

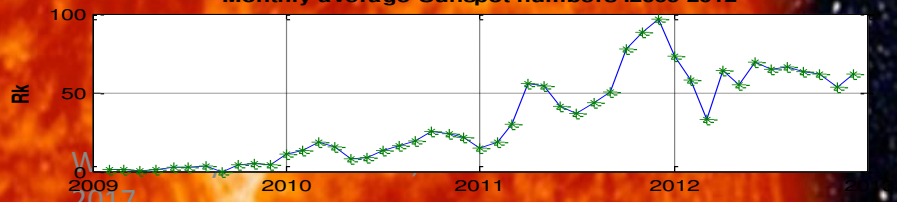


VHF Scintillation



Occur all year round and persist till morning hours

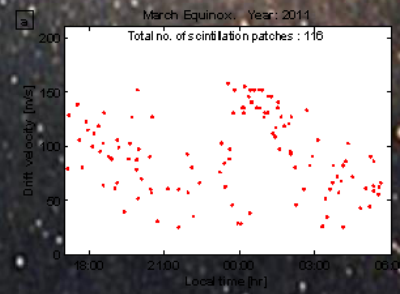


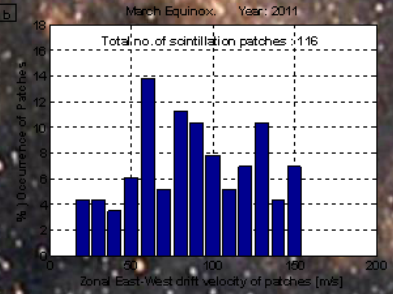


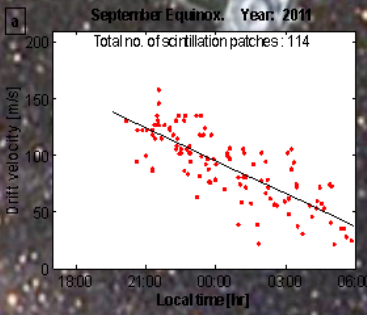
Olwendo et al. 51(2013), 1715-1726, ASR

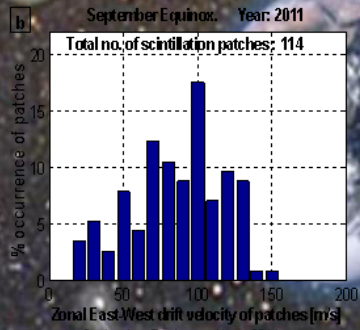
Olwendo et al., 138-139(2016), 9-22, JASTP

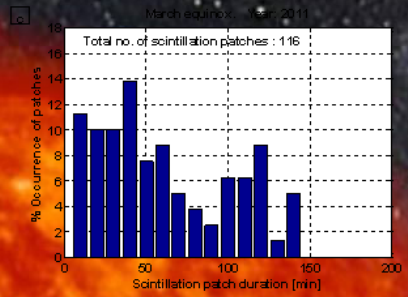
Durations and dimensions

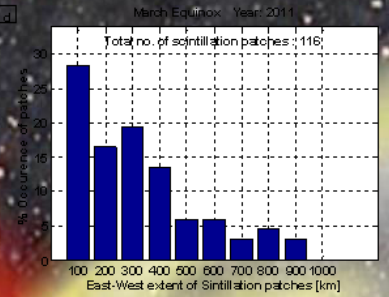


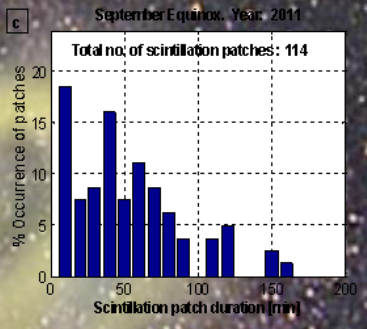


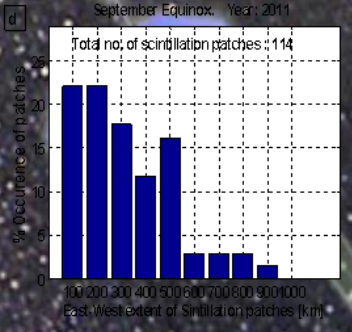


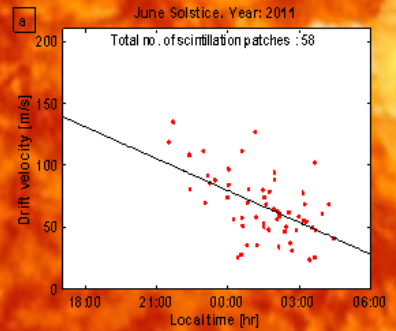


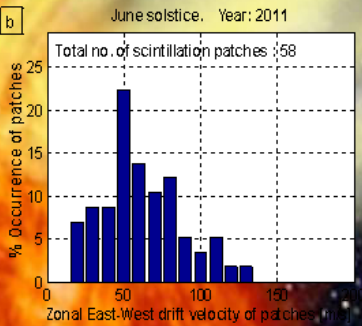


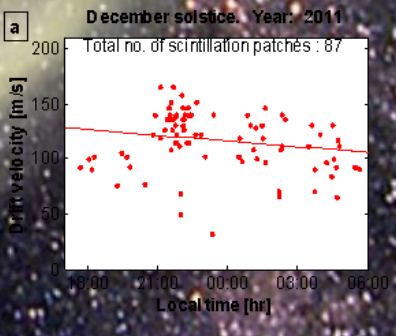


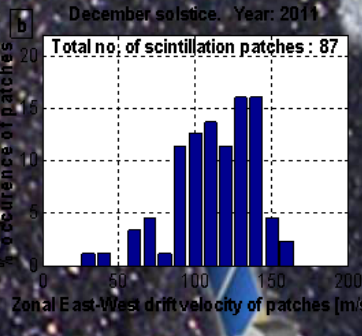


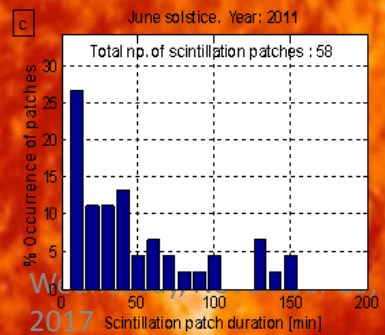


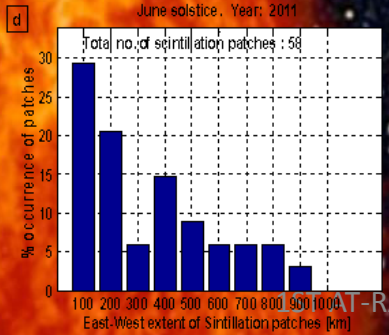


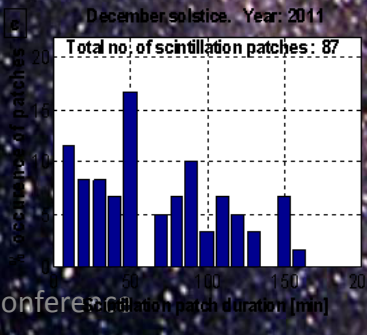


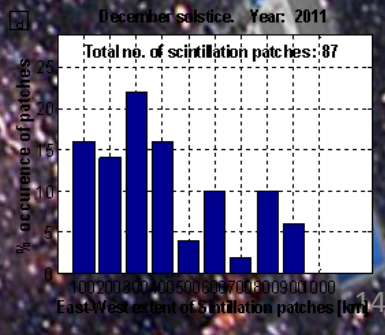




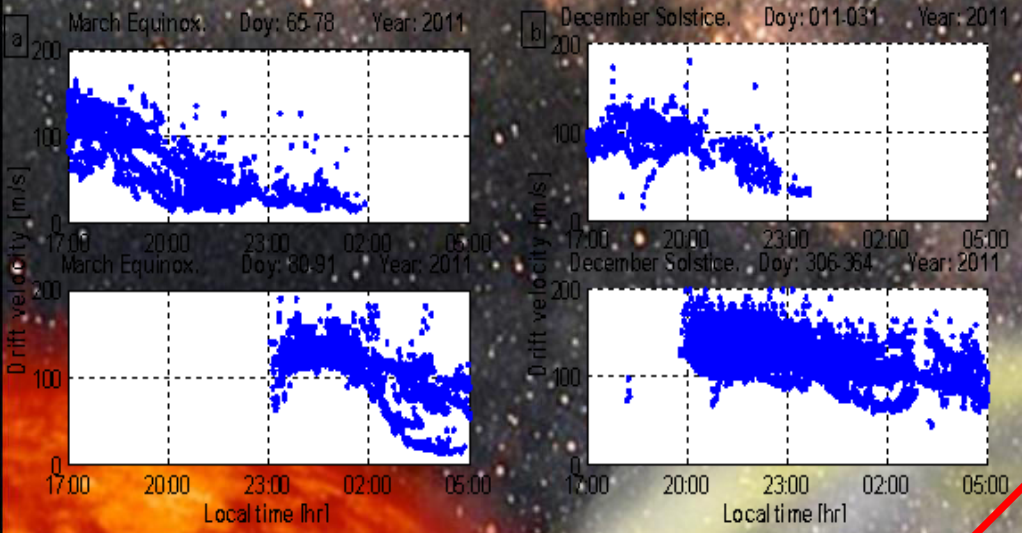


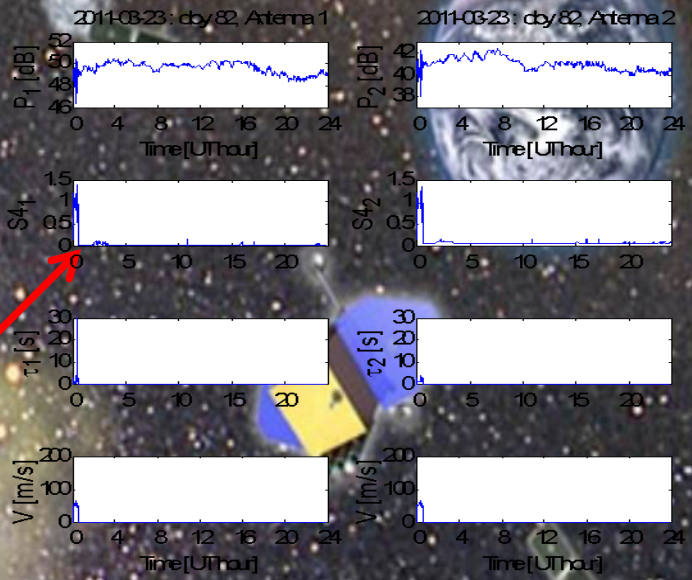




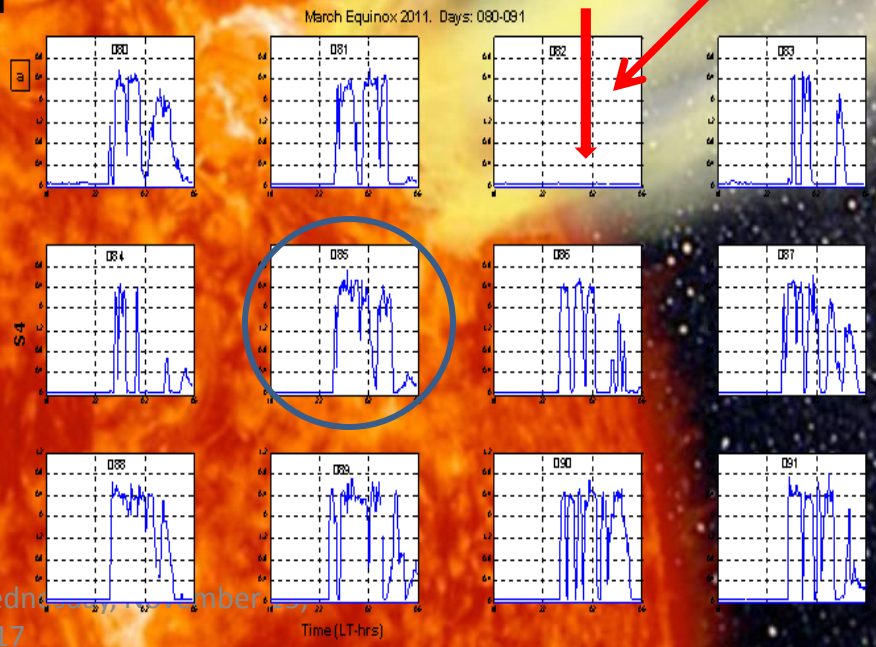


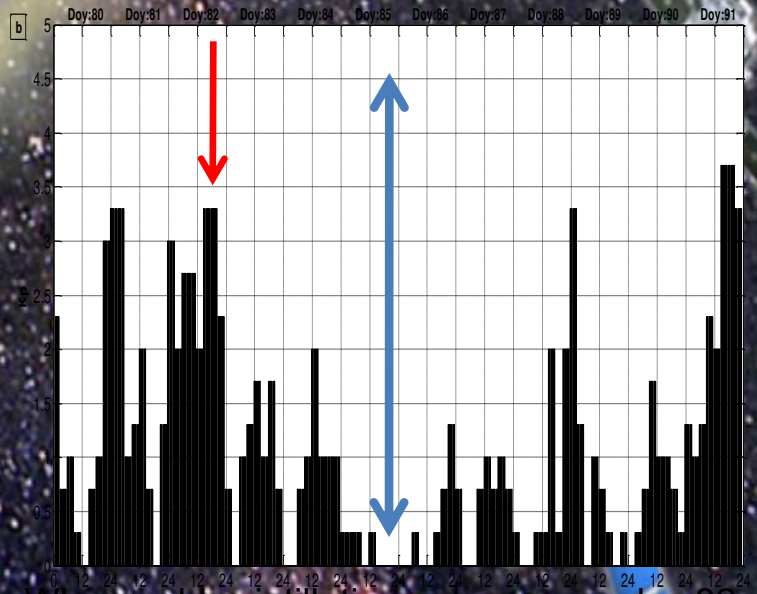
March equinox and December solstice: Post-midnight scintillation occurrence





Olwendo et al., 138-139(2016), 9-22, JASTP



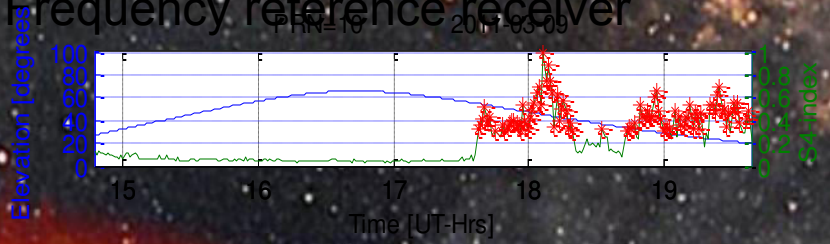


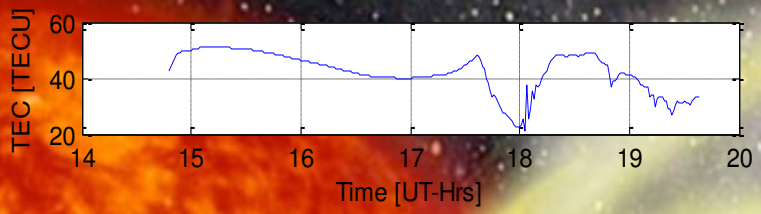
Why would scintillation not occur on day 82 when Kp>3 and again why would it occur on day 85 when Kp is nearly ~0

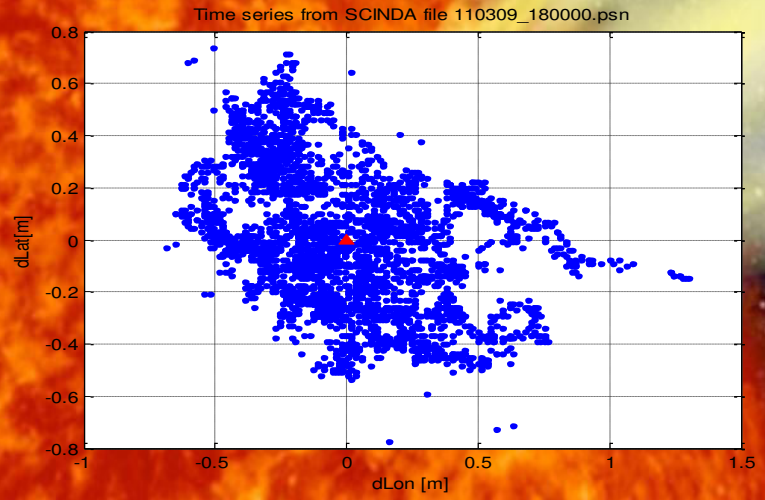
Why should we bother with scintillation?-Errors in Precise Positioning

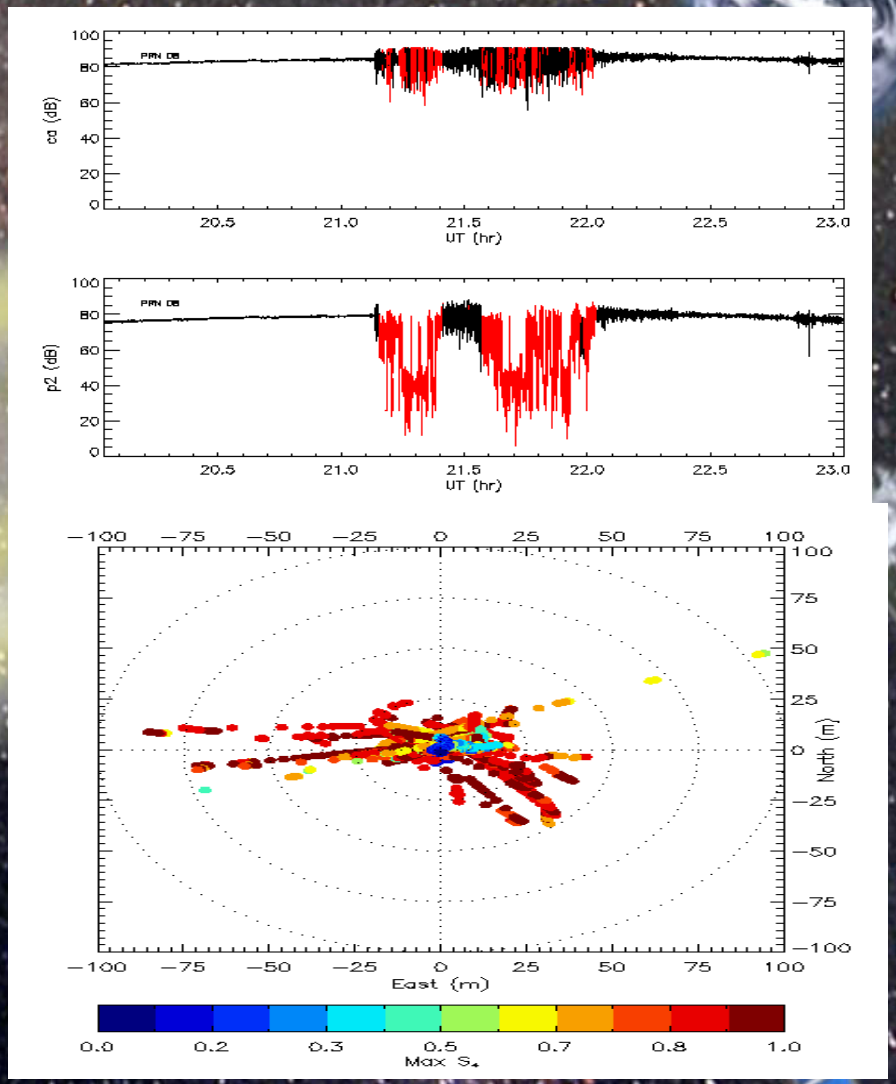
Positioning errors in Dual Frequency reference receiver

solar max 2002 16, March, Ascencio Island station









Courtesy Patricia Doherty, 2009, ICTP workshop

Summary on Ionospheric threats:

- Daytime spatial and temporal gradients over low latitude.

- Depletions –spatial and temporal gradients that induce ranging errors (post-sunset).

- Scintillation-patches of irregularities that can induce ranging errors and loss of lock (post-sunset).

- Other spatial gradients:Post-midnight enhancements, Geomagnetic storms

- All threats are highly variable in Local time, day-to-day, season, geographic location, geomagnetic activity, SOLAR ACTIVITY!

How do we handle ionospheric Threats?

- Work on space weather specification, modelling and forecasting remains a basic research with great public purpose and societal benefits.
- Future space exploration and most modern human endeavors will require major advances in physical understanding and improved transition of space research to operations
- We need to improve on infrastructure that will support Forecasting and now casting of space environment in near real time to the users -more work needed.

THE END! Thank you for listening.