Longitudinal Variability of Density Irregularity and Electrodynamics

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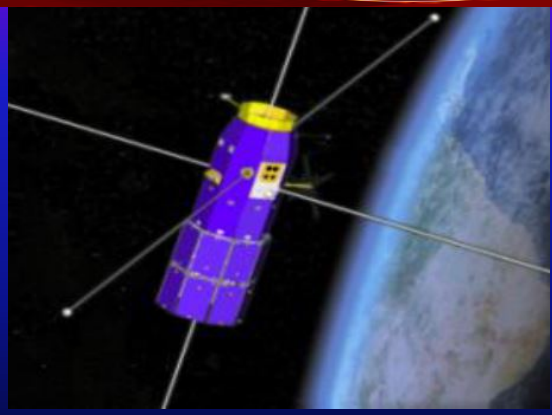
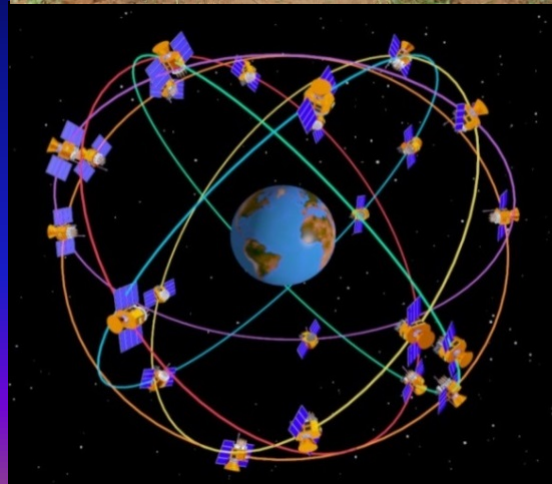
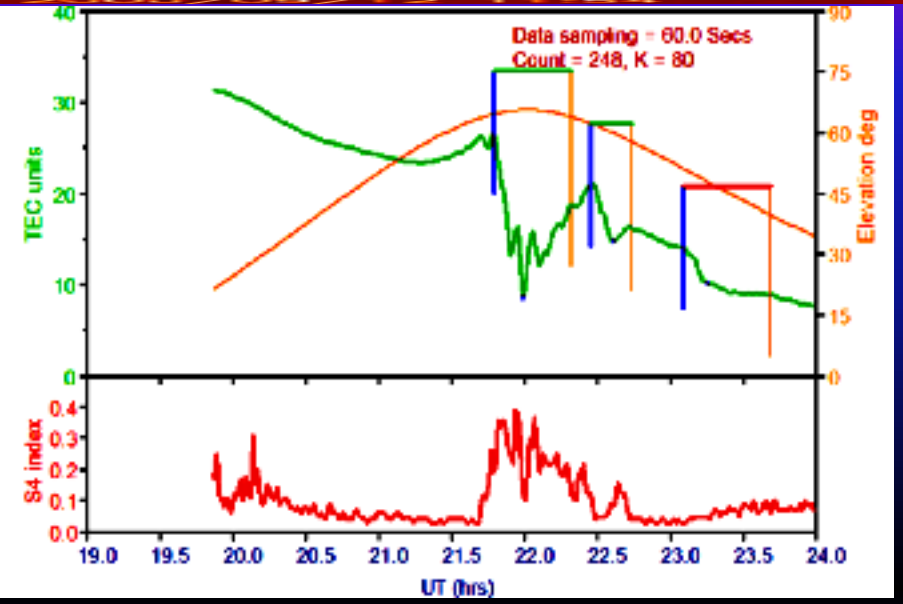
Outline

- How does the Longitudinal variability of the bubbles behave at different local time and seasons?
  - Ground-based GPS receivers !
  - C/NOFS PLP density
- How about the longitudinal variability of equatorial vertical drift velocity?
  - Ground-based magnetometers
  - C/NOFS IVM drift velocity



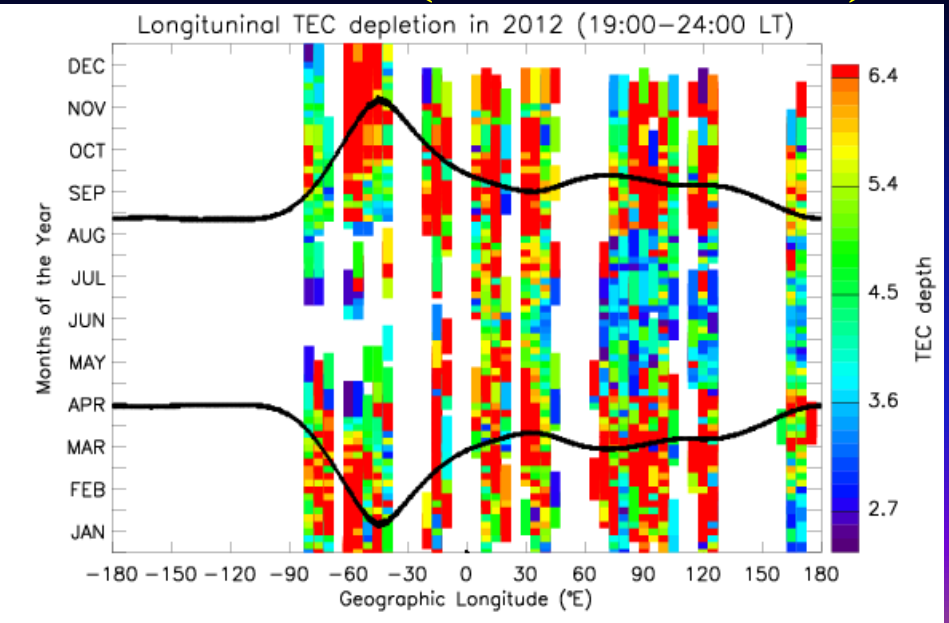


Longitudinal variability of bubbles

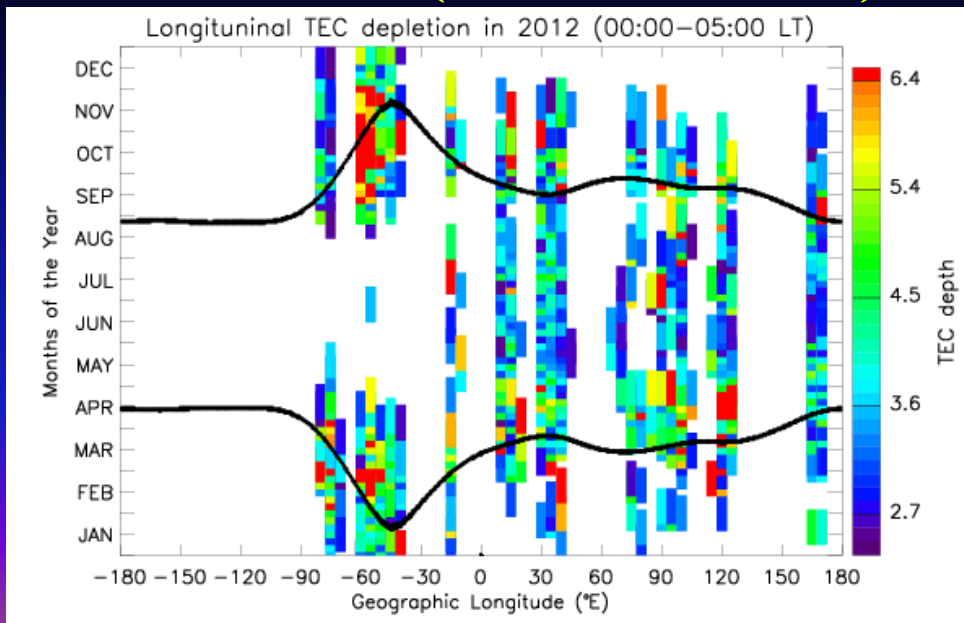


Bubble detection technique from the ground-based observations (Seemala et al., 2011)

Dusk sector (1900 – 2400 LT)

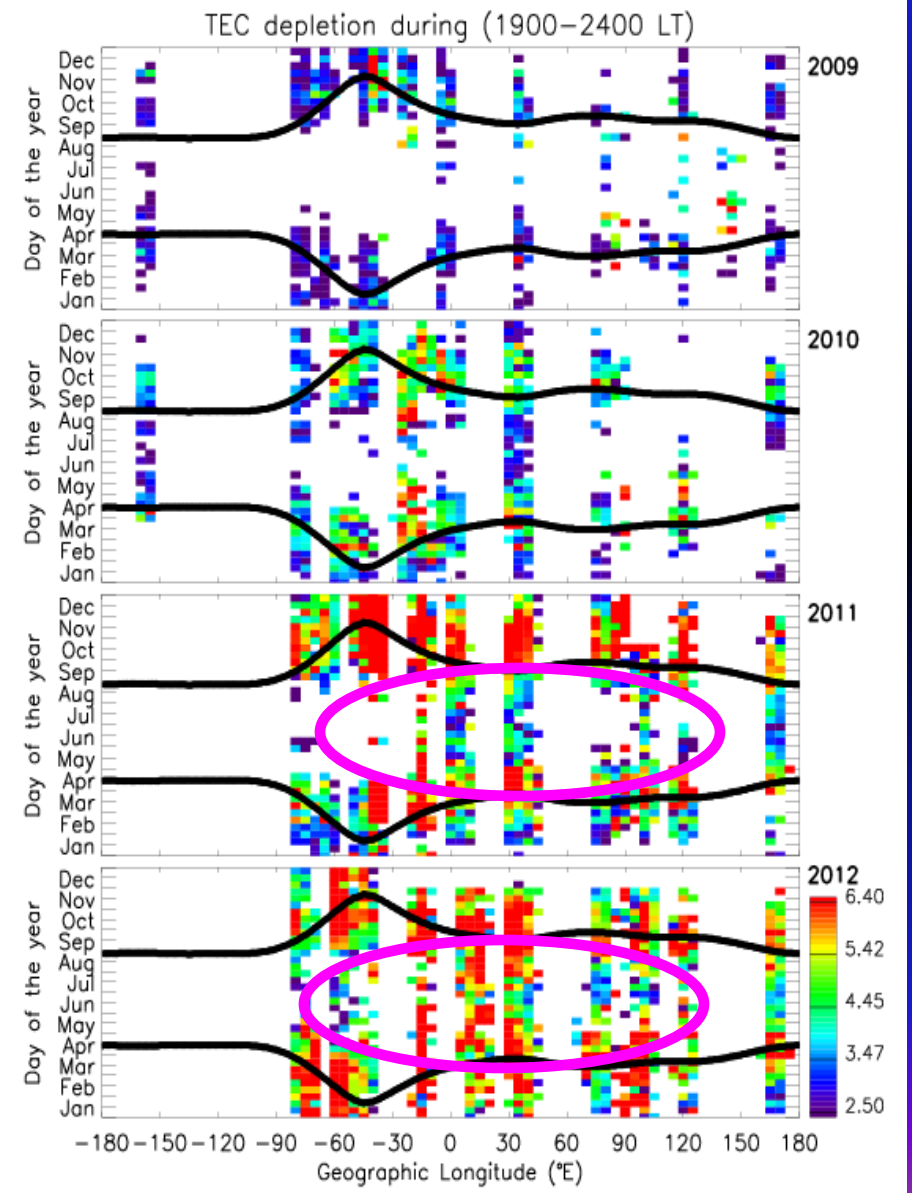


Dawn sector (0000 – 0500 LT)

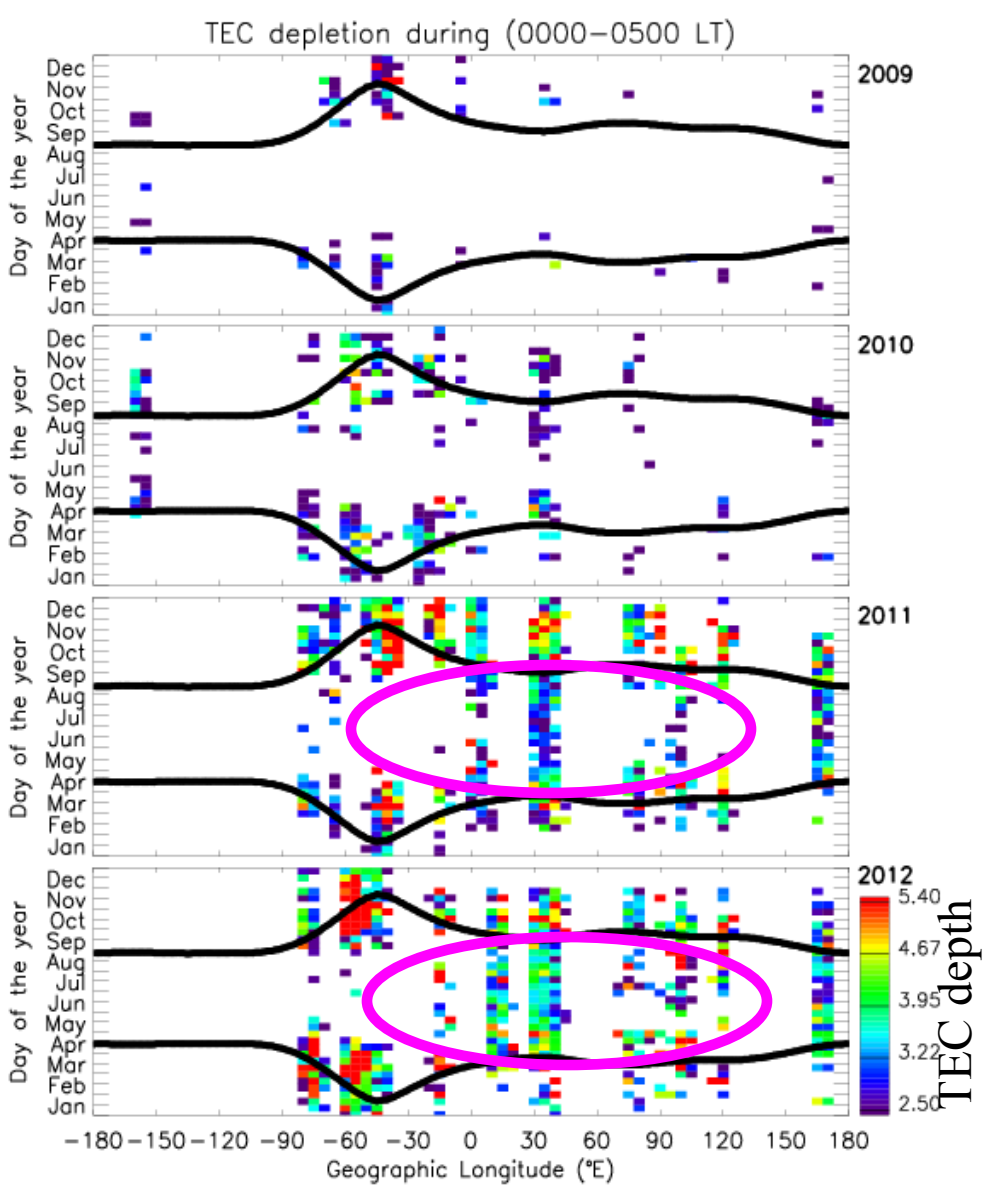


Longitudinal variability of bubbles

Dusk sector (1900 – 2400 LT)

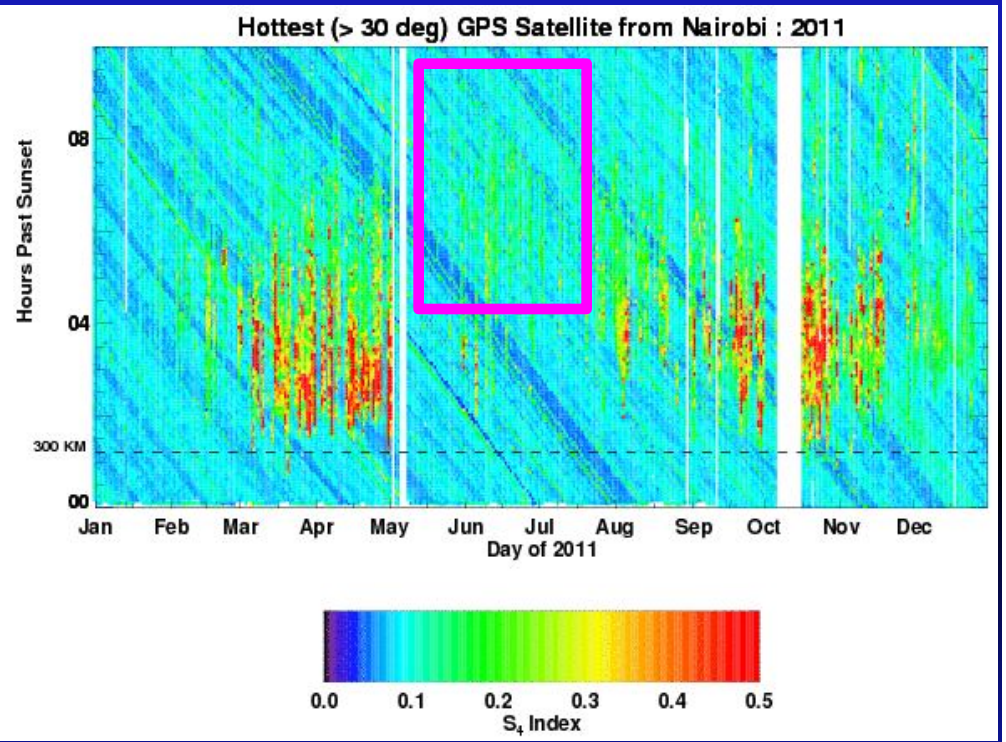


Dawn sector (0000 – 0500 LT)



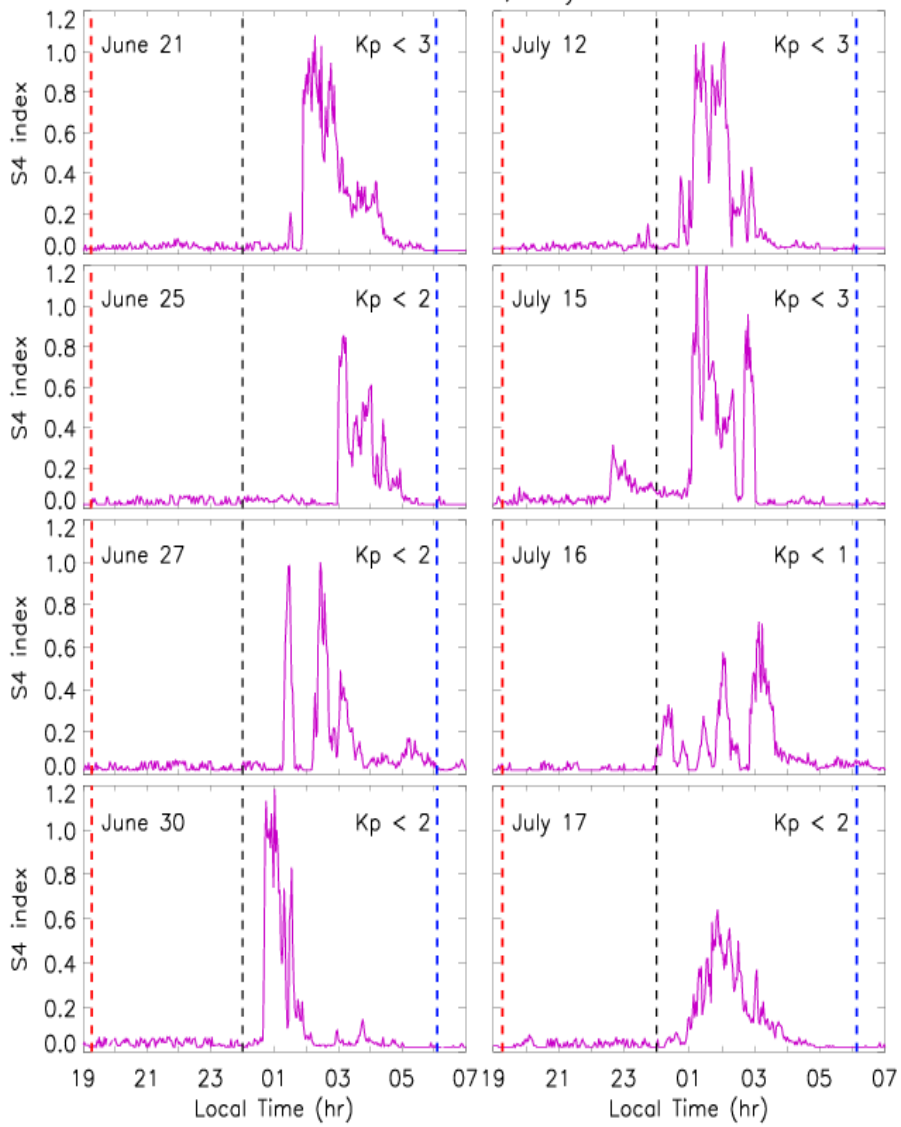
Sometimes GPS may not detect everything

GPS scintillation observations



Courtesy to Keith Groves

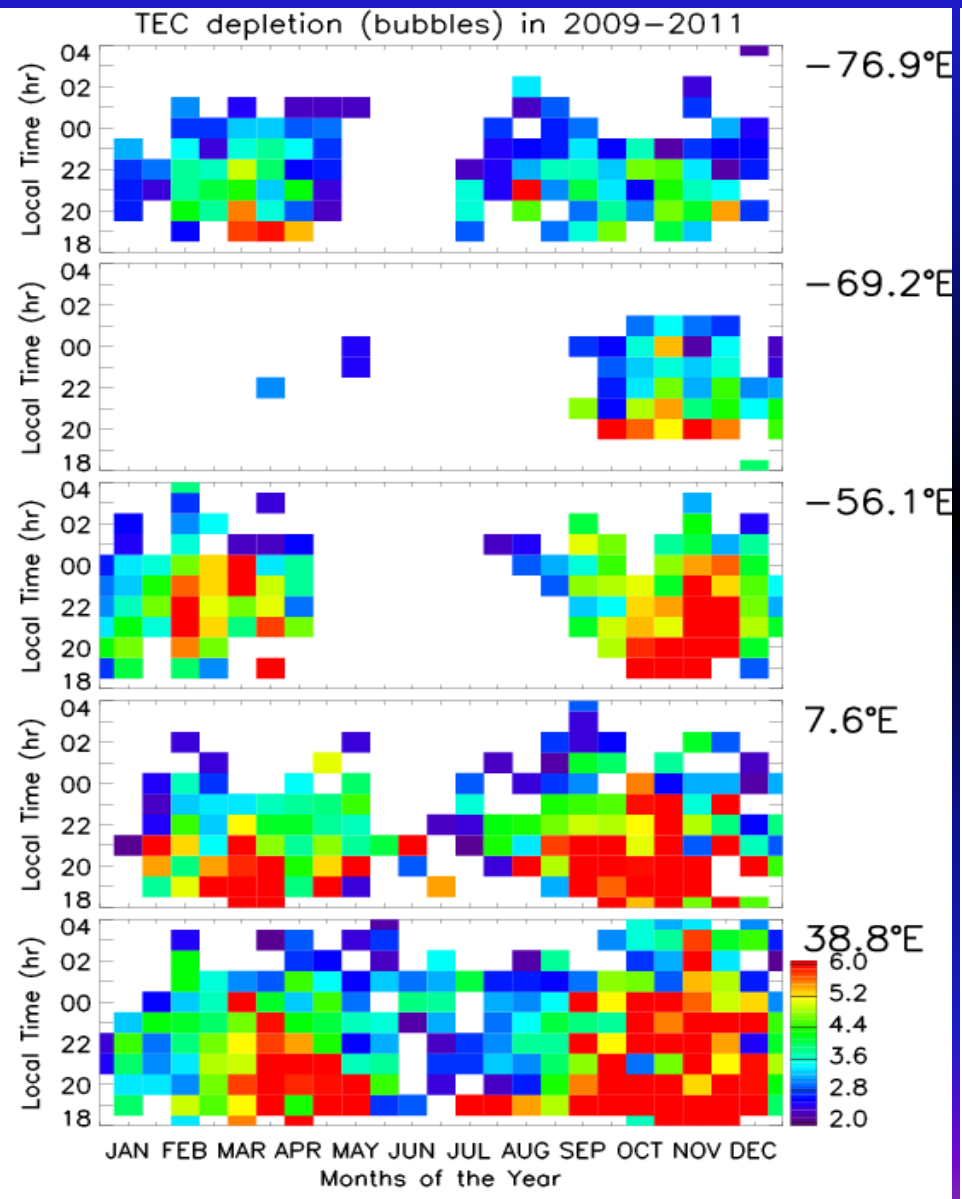
250 MHz scintillation observations



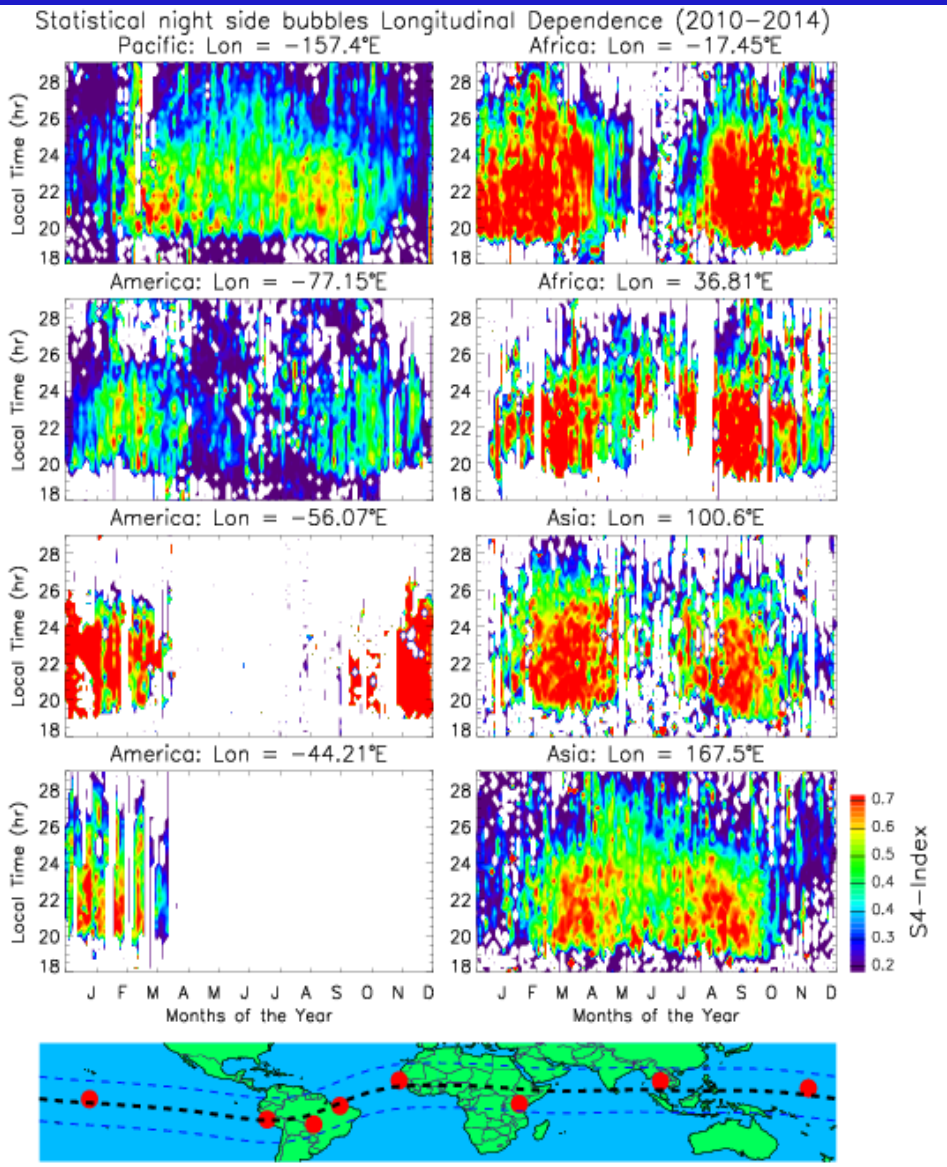
Yizengaw et al., GRL, 2013

Longitudinal variability of Scintillations/bubbles

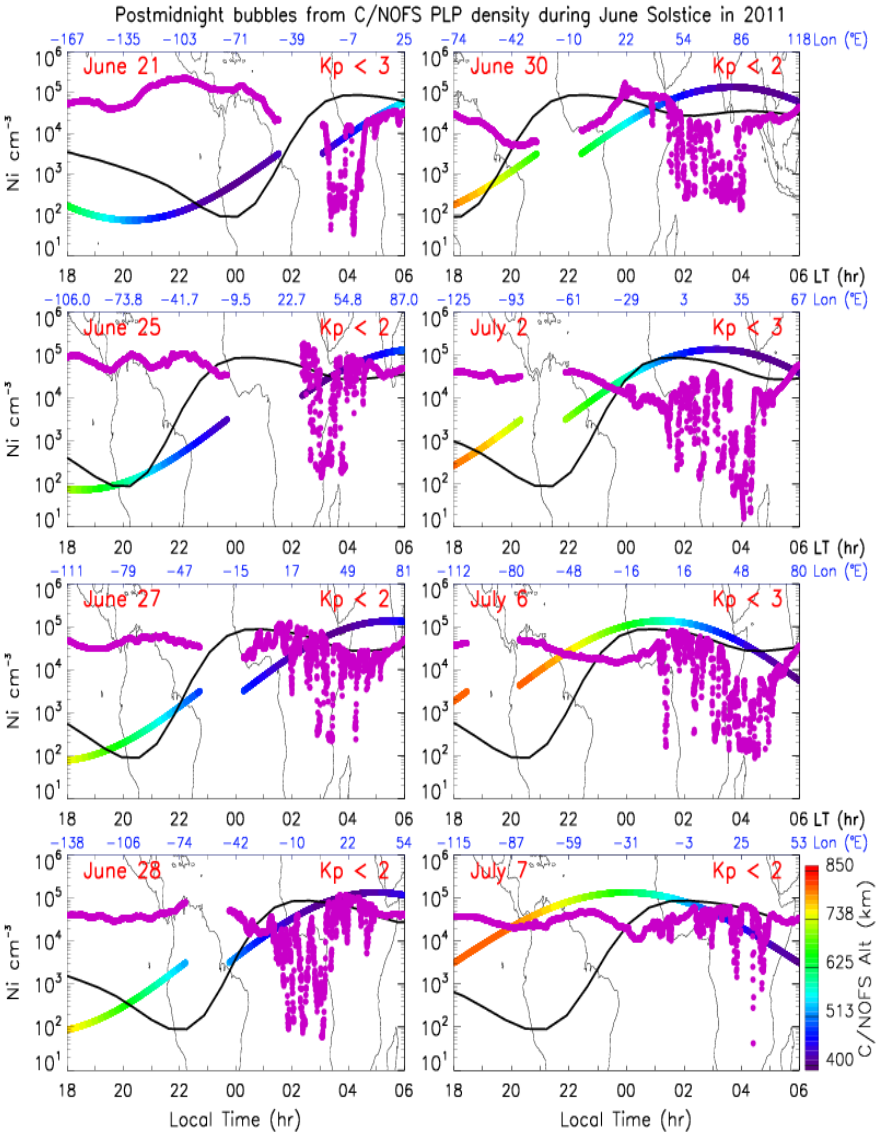
Bubbles from GPS TEC (2009-2012)

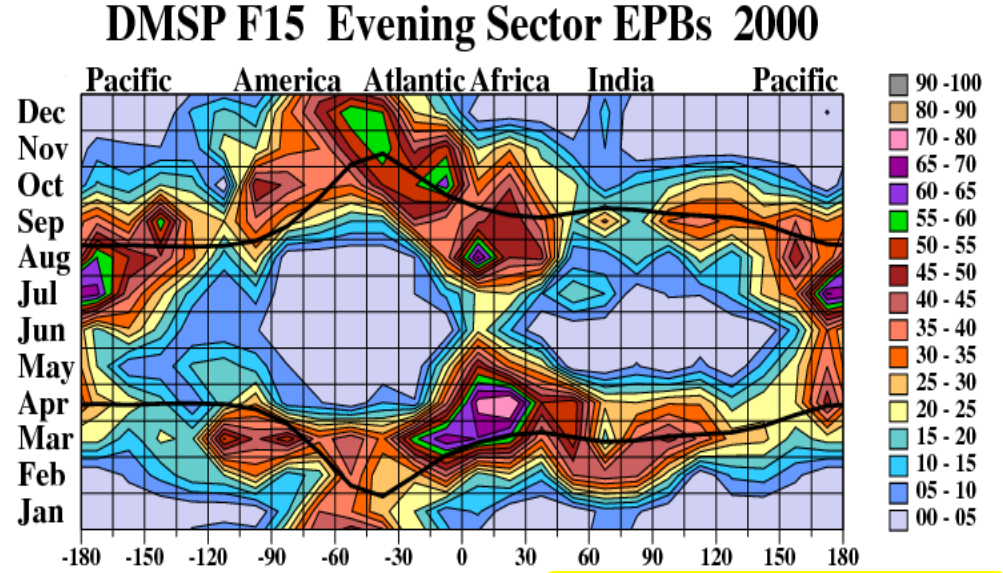


Scintillation from UHF data (2010-2014)

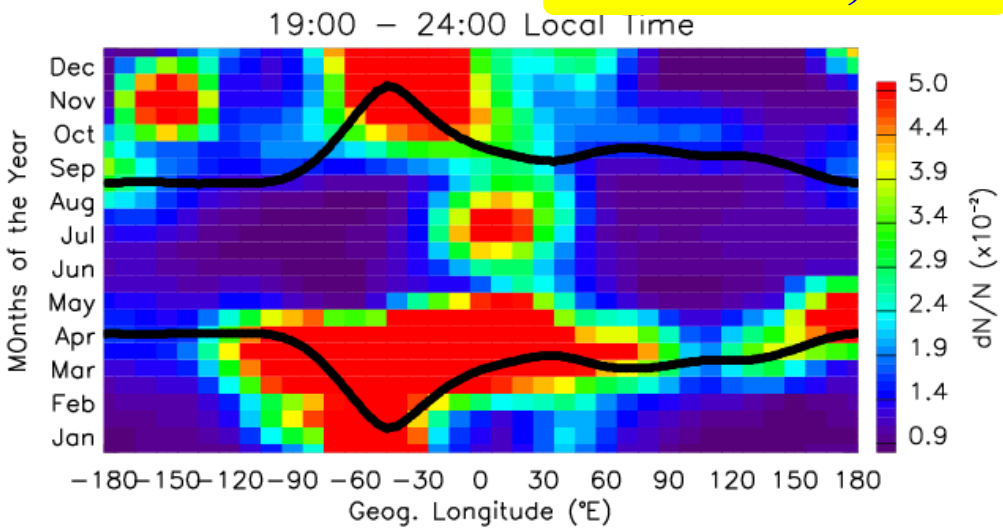


Longitudinal variability of bubbles from space





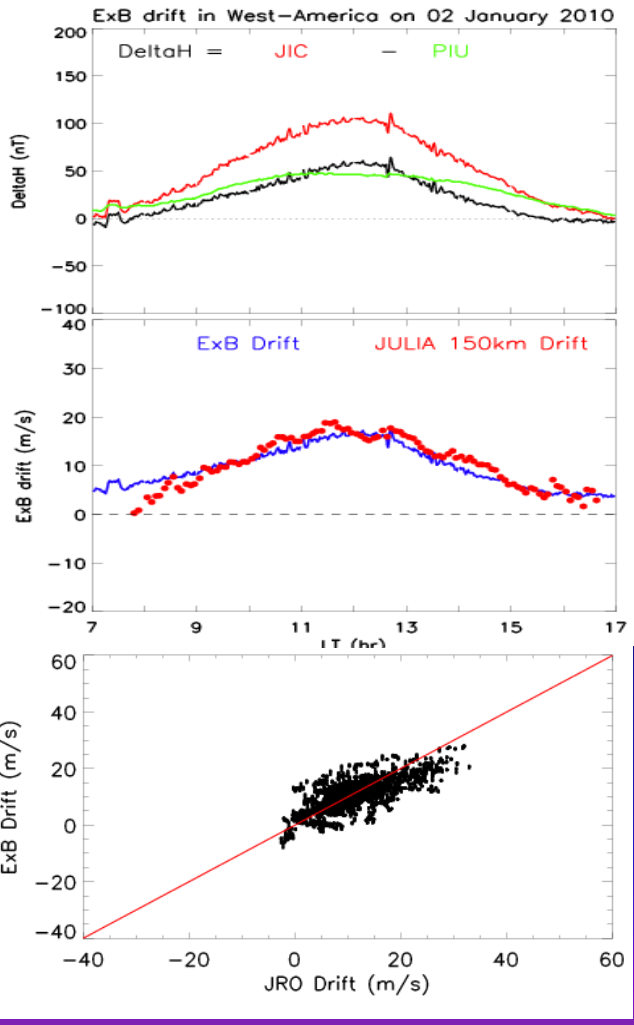
Gentile et al., 2011

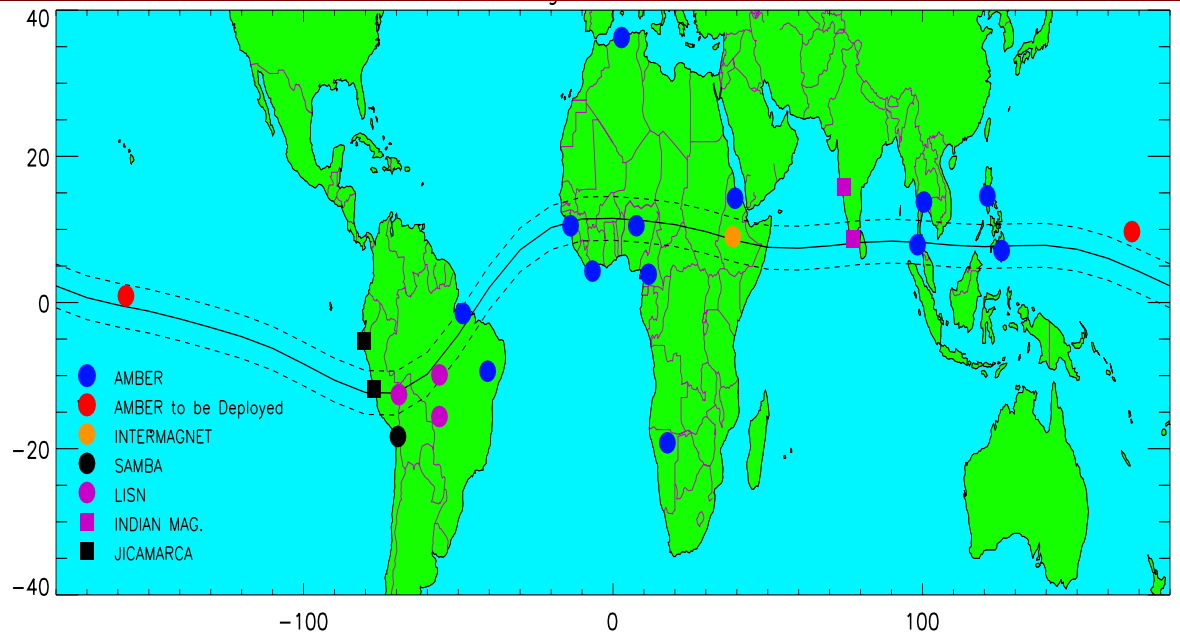


C/NOFS Observations

Potential Problem: What causes this strong longitudinal variability of density irregularity/Scintillations/Bubbles? Is it electrodynamics or neutral winds?

AMBER Magnetometer Network and Longitudinal Variability of electrodynamics





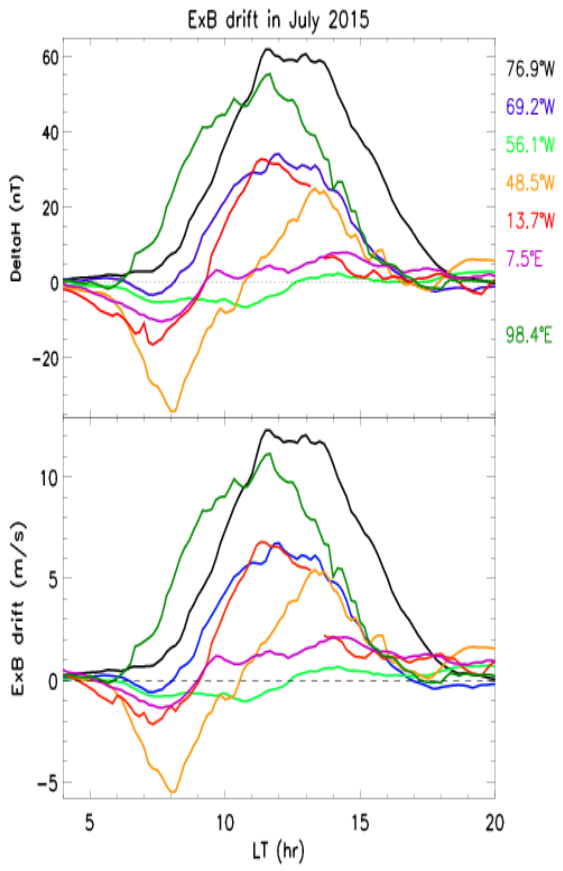
- **Magnetometer at off the equator**

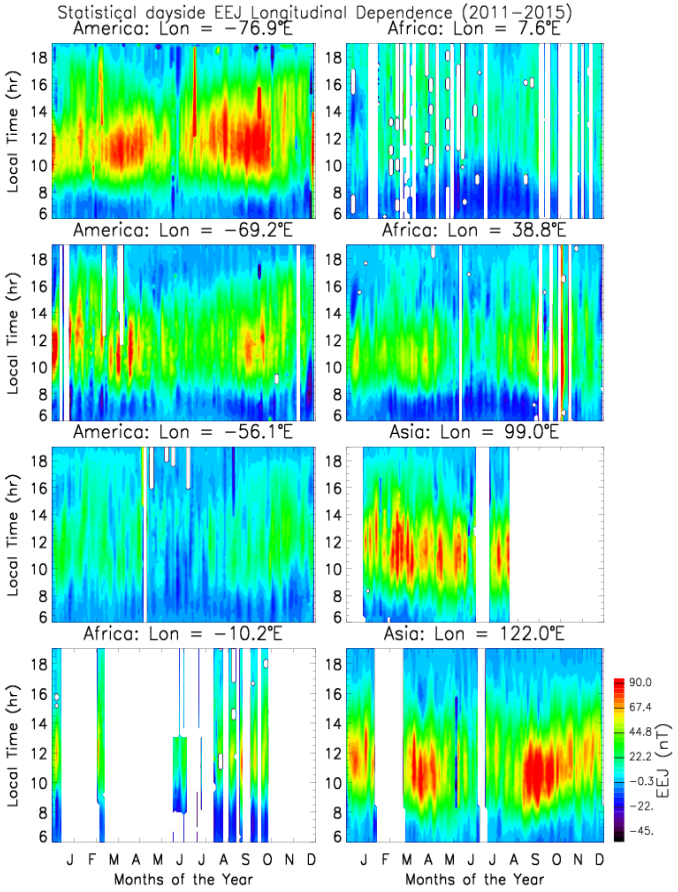
$$B_{Obs} = B_{main} + B_{SQ} + B_{FAC} + B_{RC} + B_{MP}$$

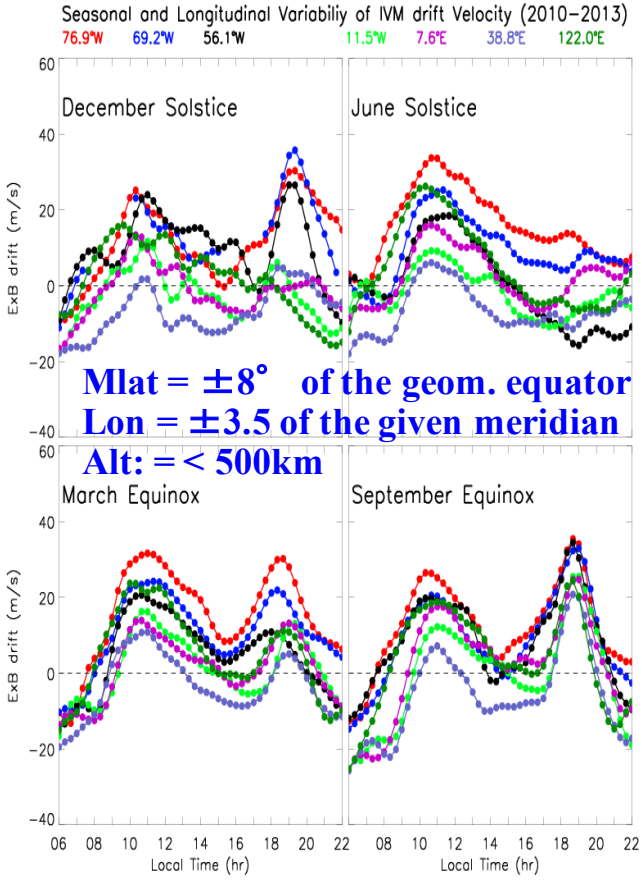
- **Magnetometer at the equator**

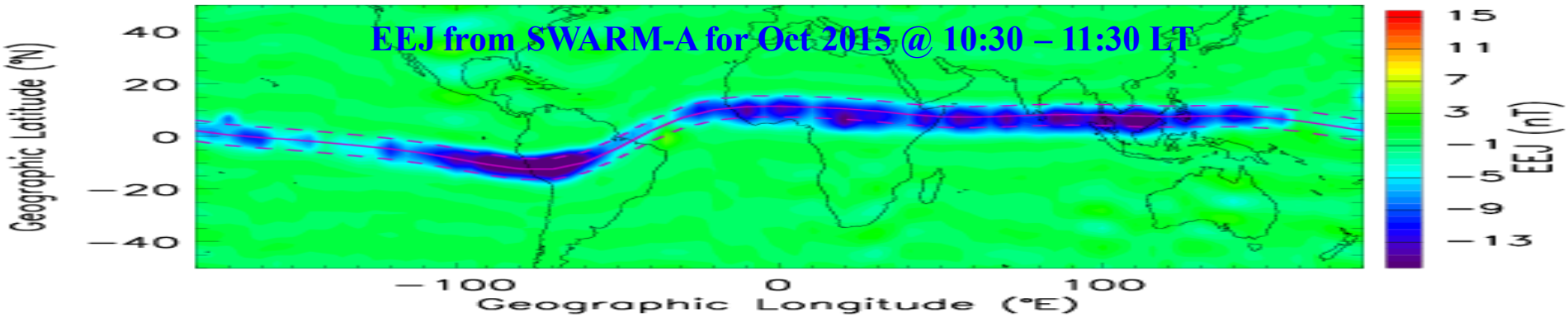
$$B_{Obs} = B_{main} + B_{SQ} + B_{FAC} + B_{RC} + \mathbf{B_{EJ}} + B_{MP}$$

Longitudinal variability of EEJ and Drift

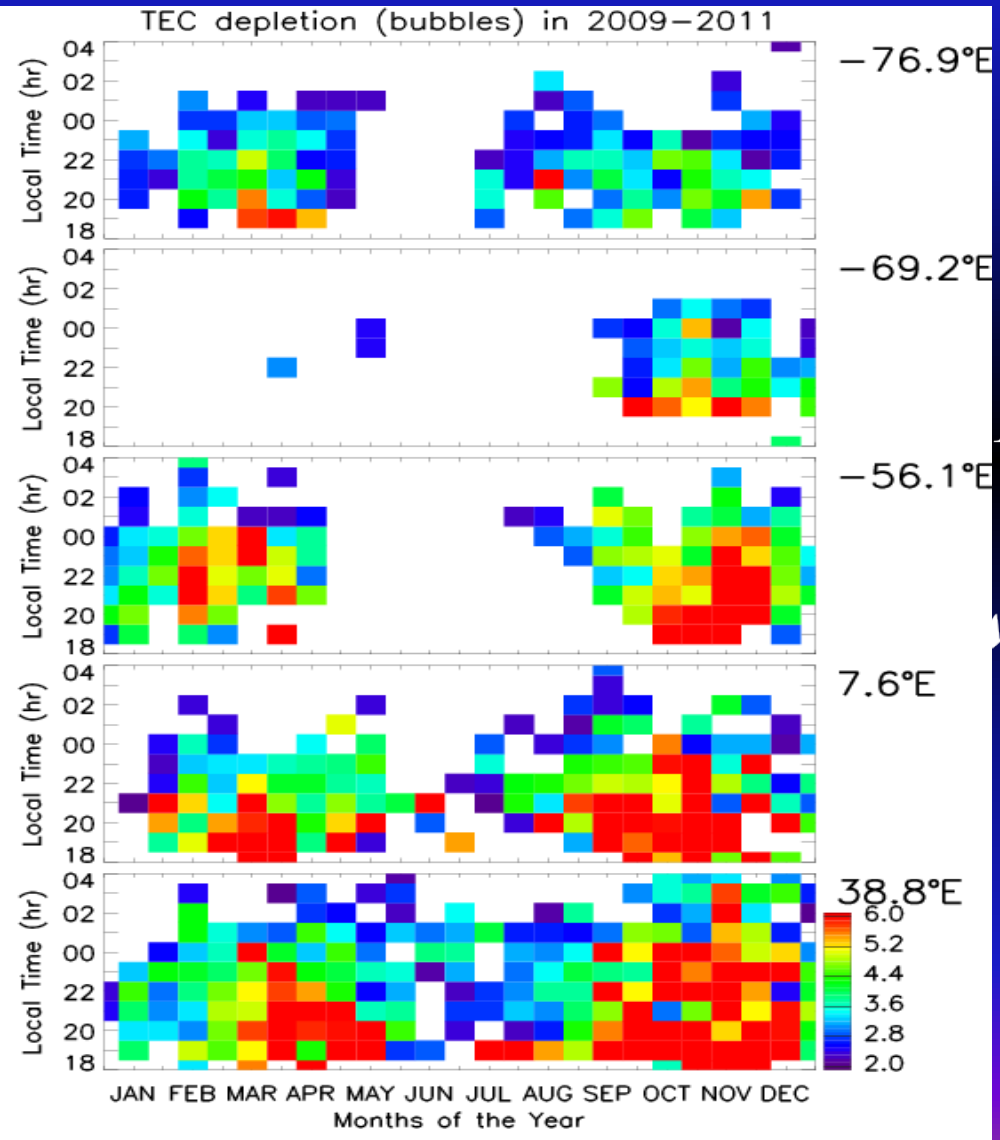


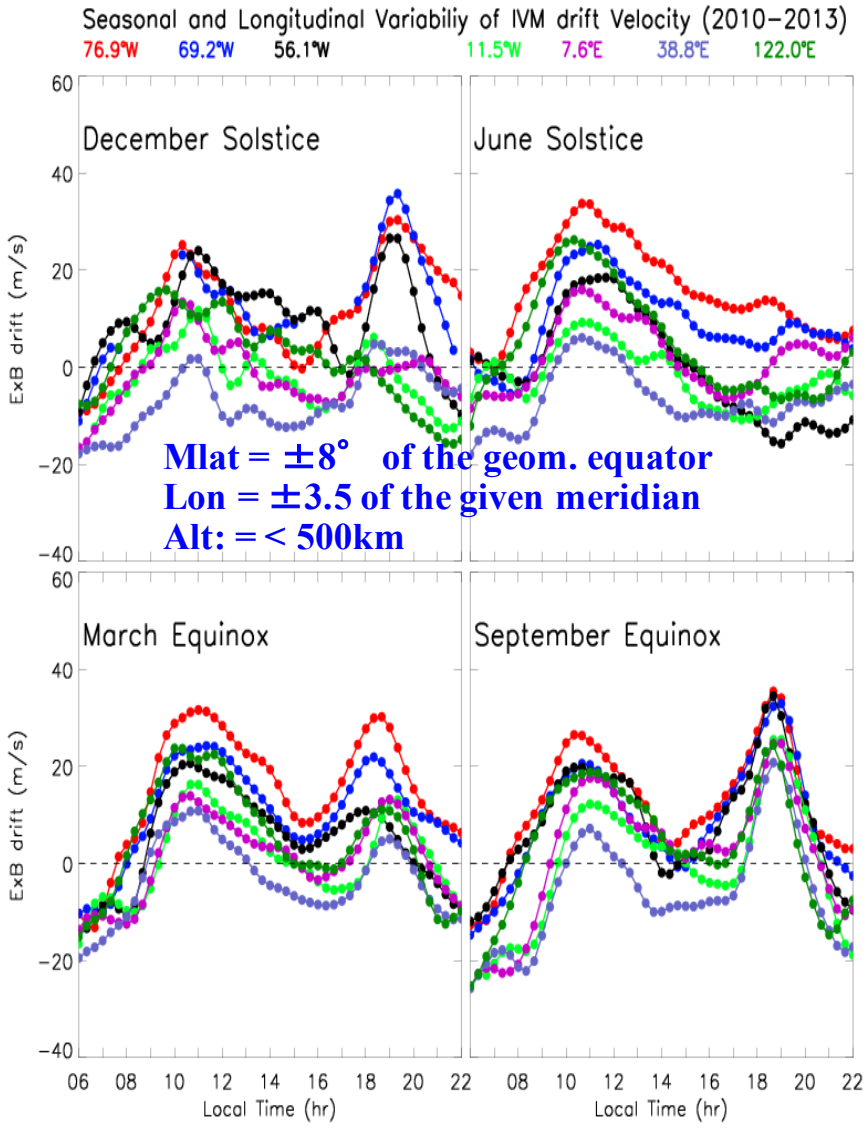






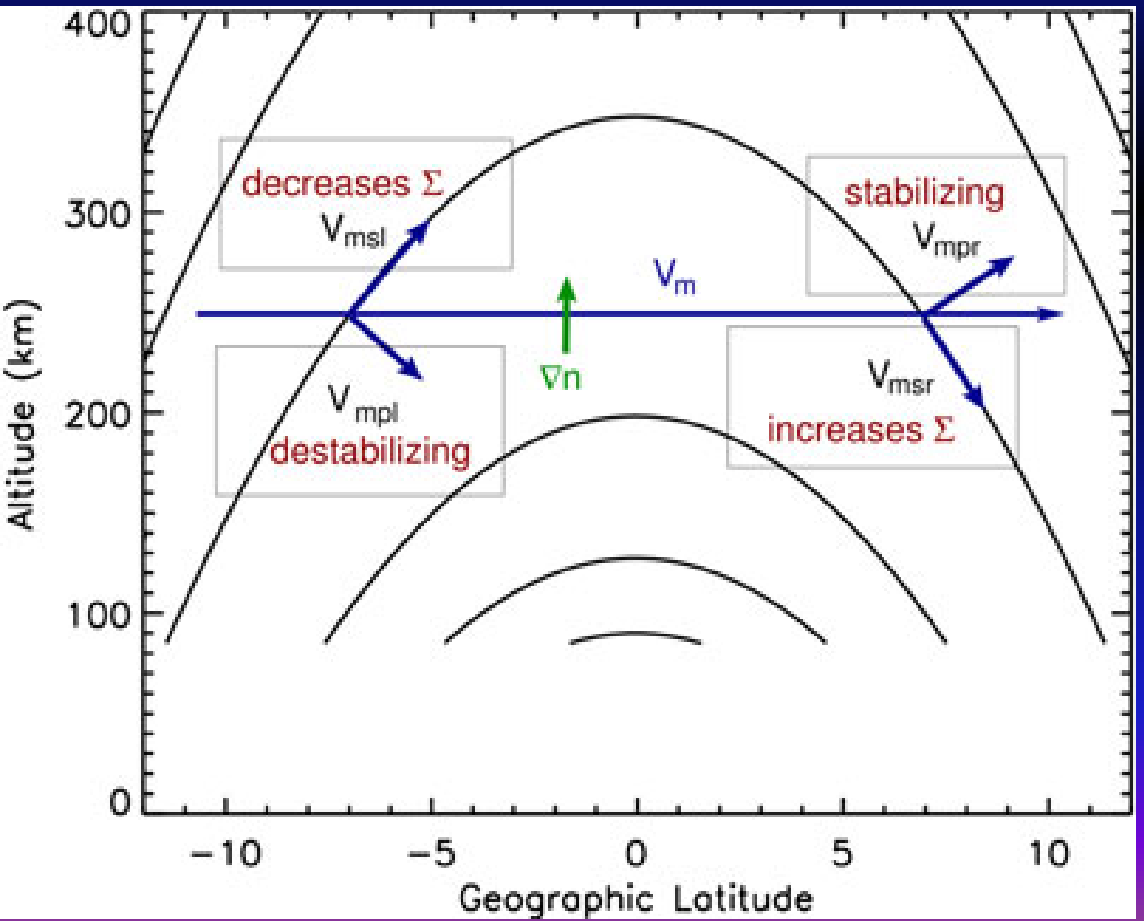
What cause the enhancement of Rayleigh-Taylor instability growth rate?





Potential questions?

- If not the drift, then what could it be? Would it be the neutral winds that cause the long lasting bubbles in Africa? If it is the neutral wind, why the orientation and magnitude of the wind in the African sector is unique compared to other longitudes?

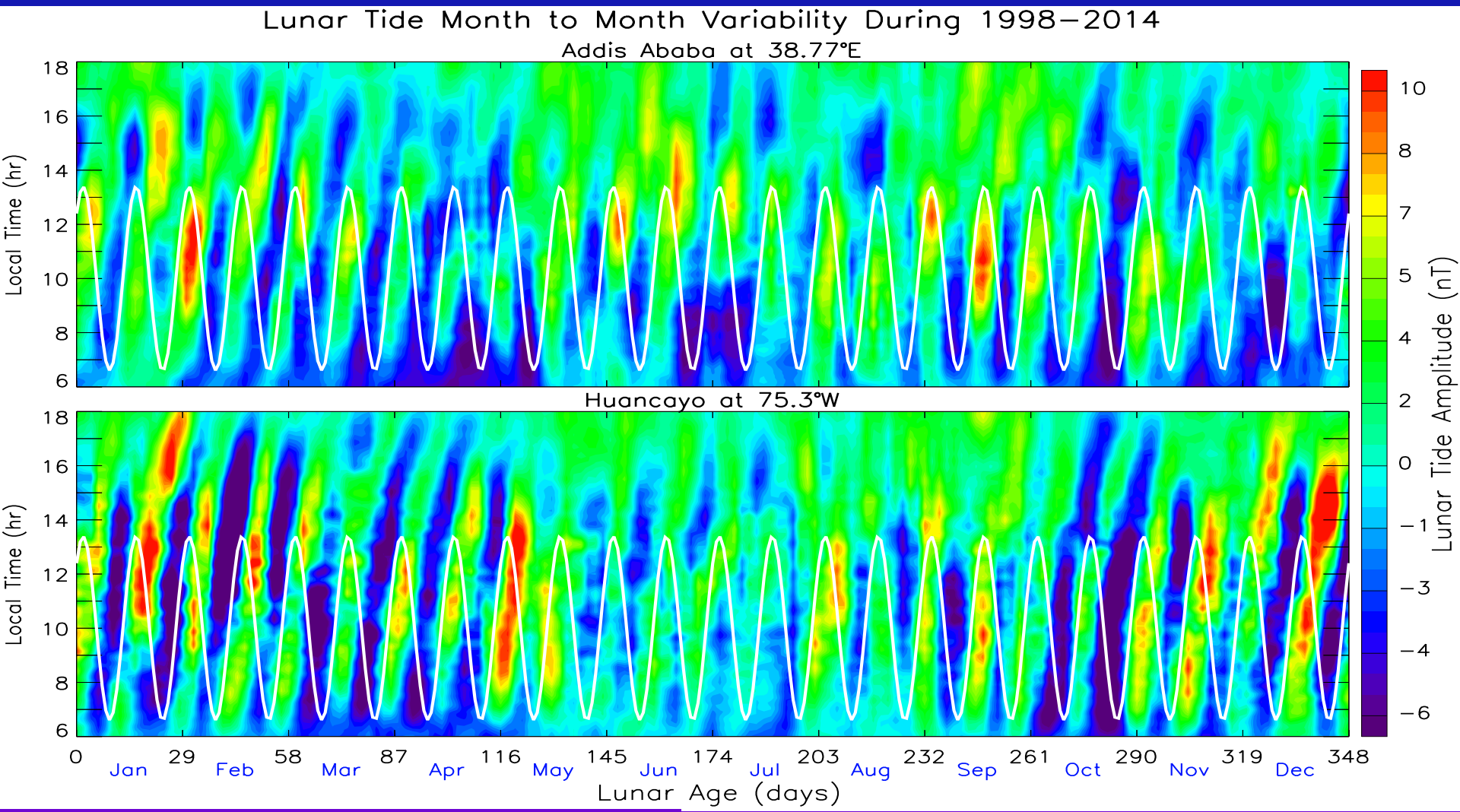


- Equatorward meridional wind decrease conductivity and increase RTI growth rate

- Poleward meridional wind increase conductivity and decrease RTI growth rate

Huba and Krall, GRL, 2013

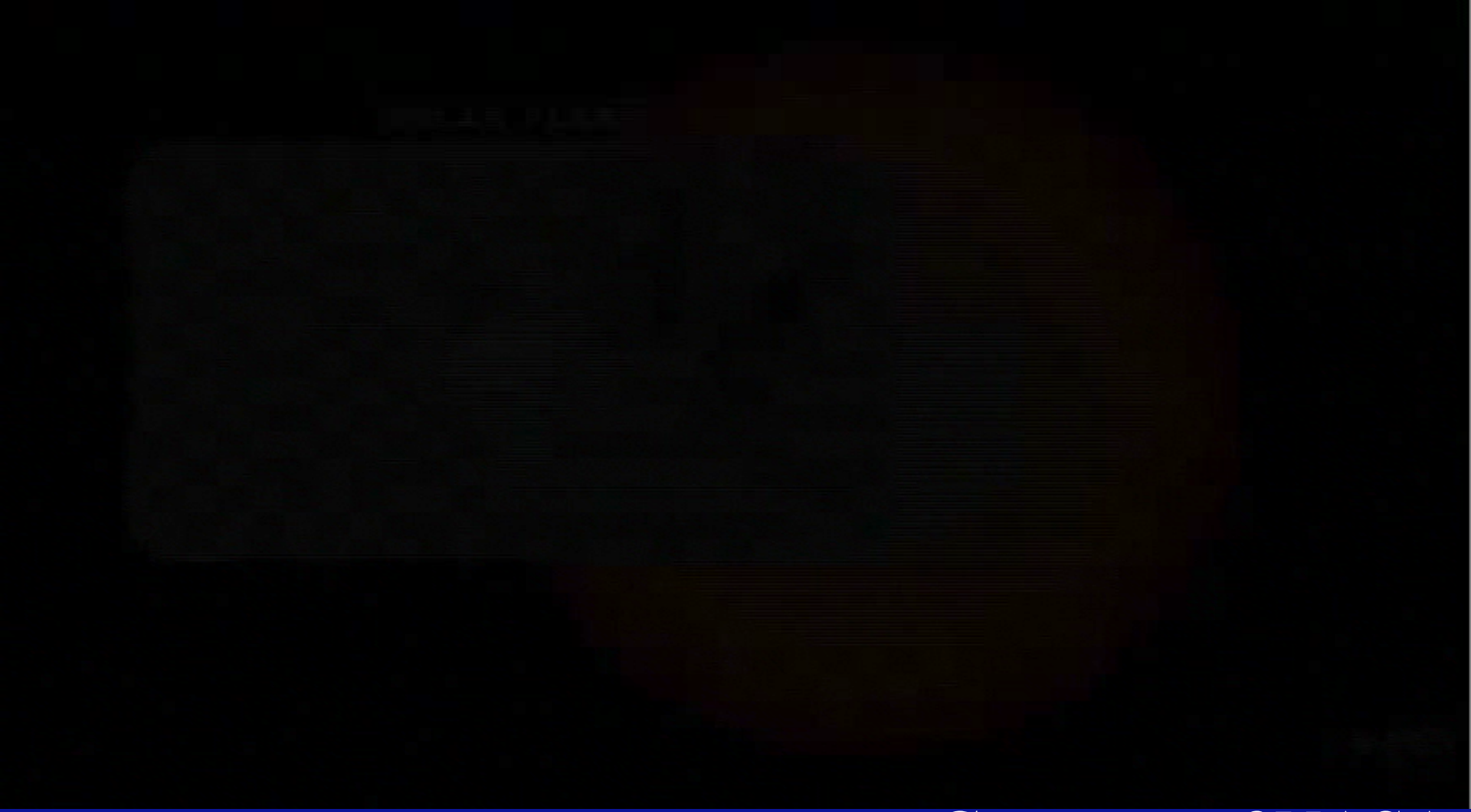
Even the Lunar Tide Shows Significant Longitudinal and Seasonal Variability



Yizengaw and Carter., AG, 2016

Summary with lots of open questions!

- The magnitude and direction of the vertical drift (both dayside and evening sector) show significant longitudinal differences, stronger in the American and Asian than African sectors, what cause this longitudinal differences?
- Both ground- and space-based observations show clear longitudinal and seasonal variability of bubbles/irregularities structures, stronger in the African sector, which is opposite to the vertical drift longitudinal variability trend. If not the drift that cause the longitudinal bubbles distribution difference, then what could it be? Would it be the neutral winds that cause the long lasting bubbles in Africa? If it is the neutral wind, why the orientation and magnitude of the wind in the African sector is unique compared to other longitudes?
- Both ground- and space-based observations show clear longitudinal and seasonal variability of the discrete post-midnight bubbles, stronger in the African sectors. The question is what cause such strong discrete post-midnight bubbles?

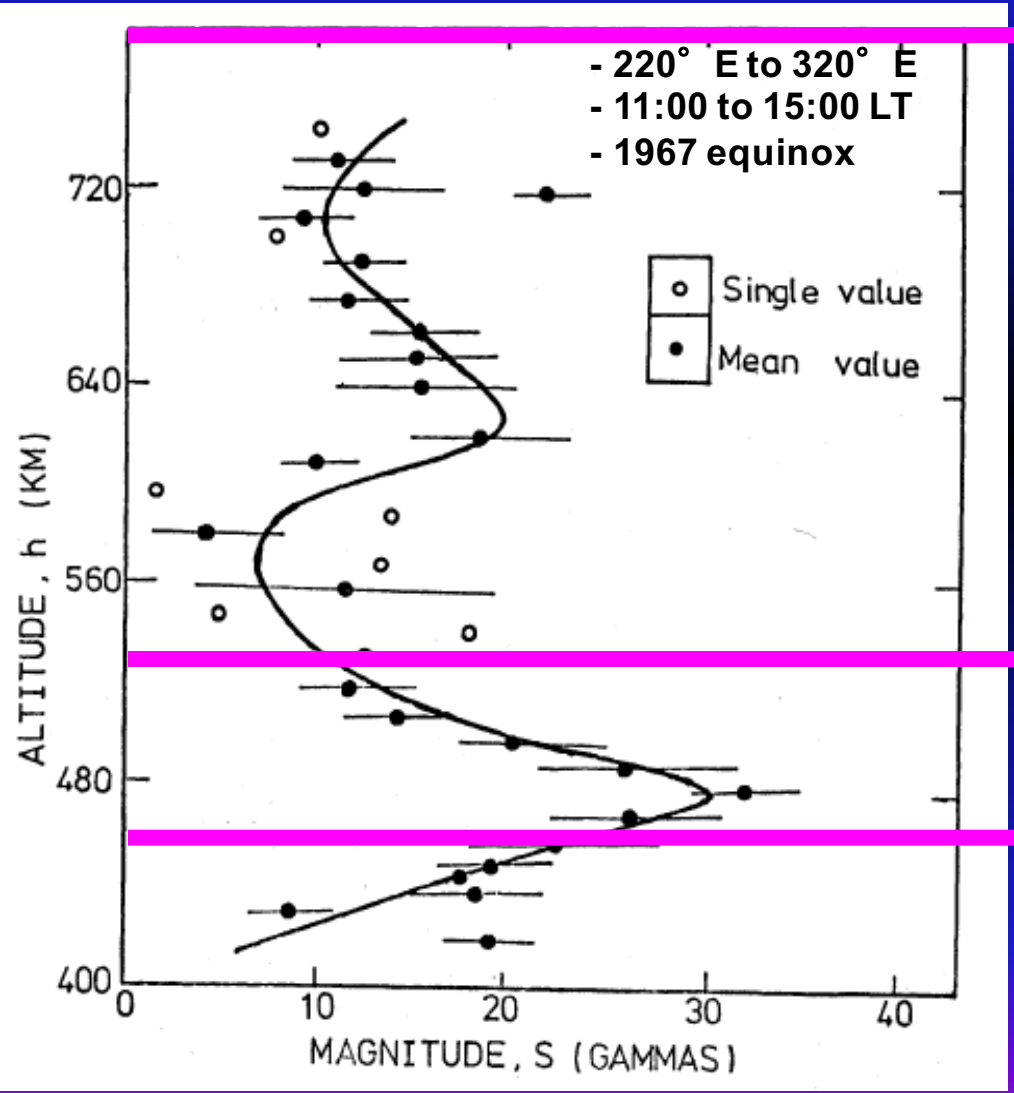


Courtesy of NASA

Thank you!

Altitude variability of Electrodynamics

Altitude variation of the EEJ magnitude estimated from the Polar Orbiting Geophysical Observatory (POGO) satellite



DMSP 16 at ~ 870km altitude
Suitable Local time coverage
16:00 – 17:00 LT

SWARM B at ~ 530km altitude
Suitable Local time coverage
10:30 – 11:30 LT

SWARM A at ~ 460km altitude
Suitable Local time coverage
10:30 – 11:30 LT

Onwumechili, JGG, 1985

Electrodynamics at different altitudes

SWARM A @ 11:00 LT **SWARM B @ 11:00 LT** **DMSP 16 @ 16:30 LT**