The ULF Wave Related Fluctuation of Equatorial Electrodynamics and Its Longitudinal Variability

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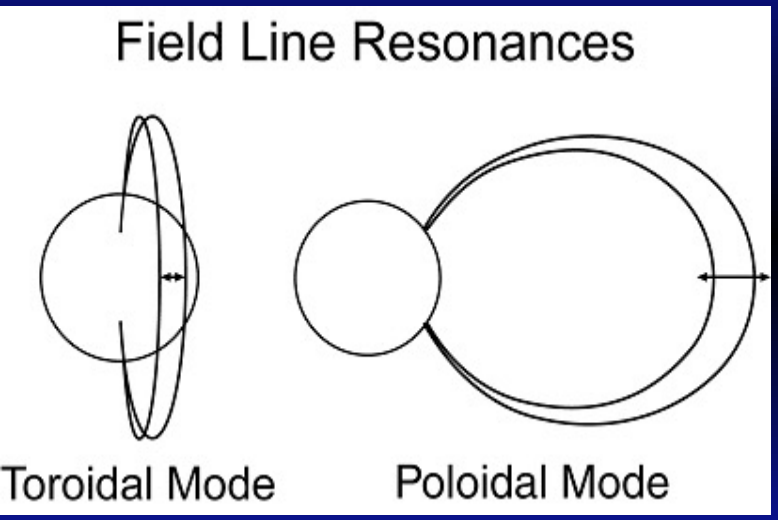
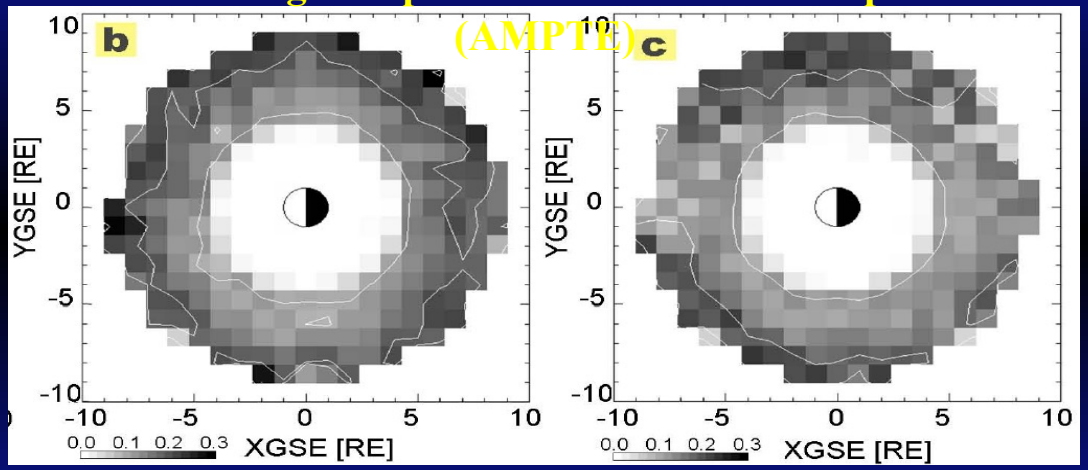
ULF wave related ionospheric density fluctuations

- The periodic SW dynamic pressure oscillations slowly alter the size of the magnetospheric cavity, causing the generation of poloidal ULF wave.
- The change in SW azimuthal flow direction (usually accompanying shocks) can excite Kelvin-Helmholtz (KH) instabilities at the magnetopause, which in turn causes the generation of Toroidal mode ULF wave.



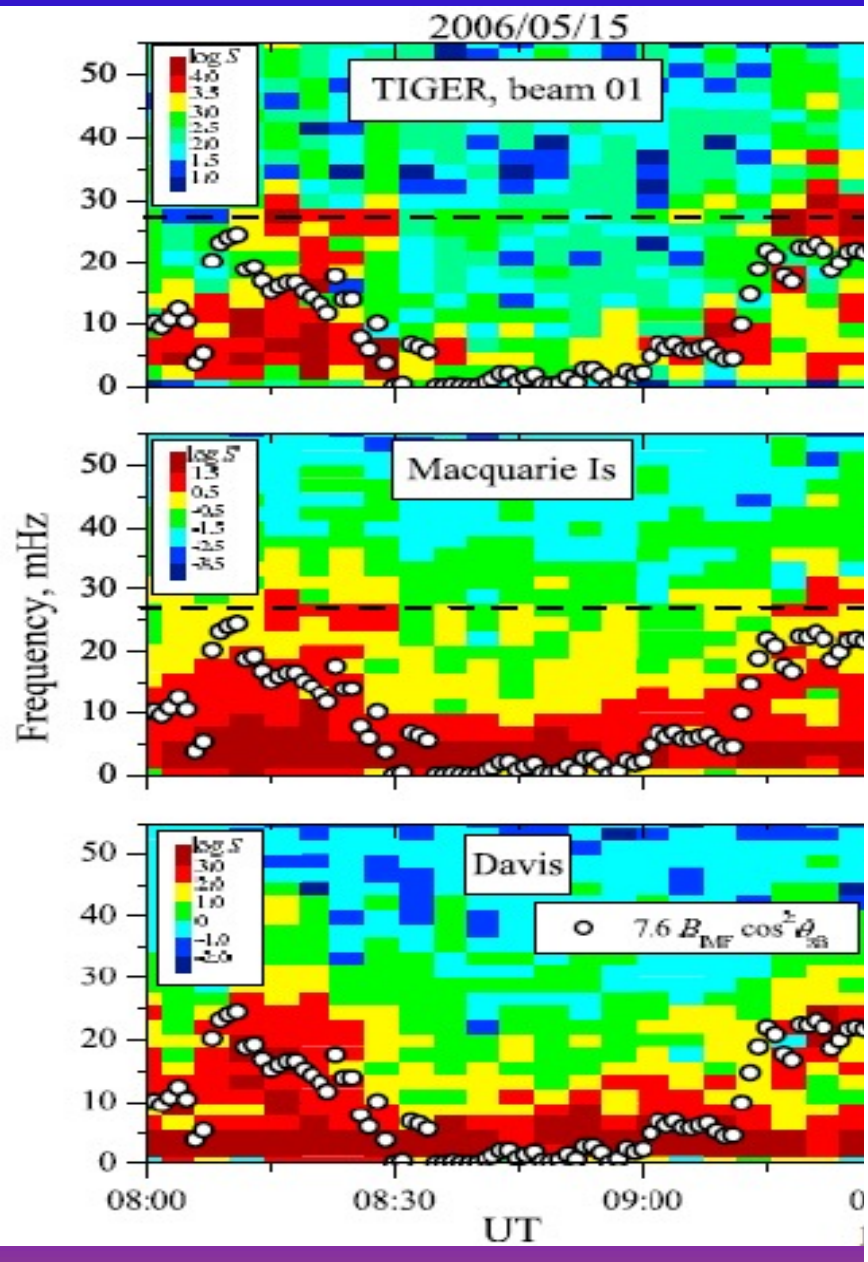
Active Magnetospheric Particle Tracer Explorers (AMPTE)

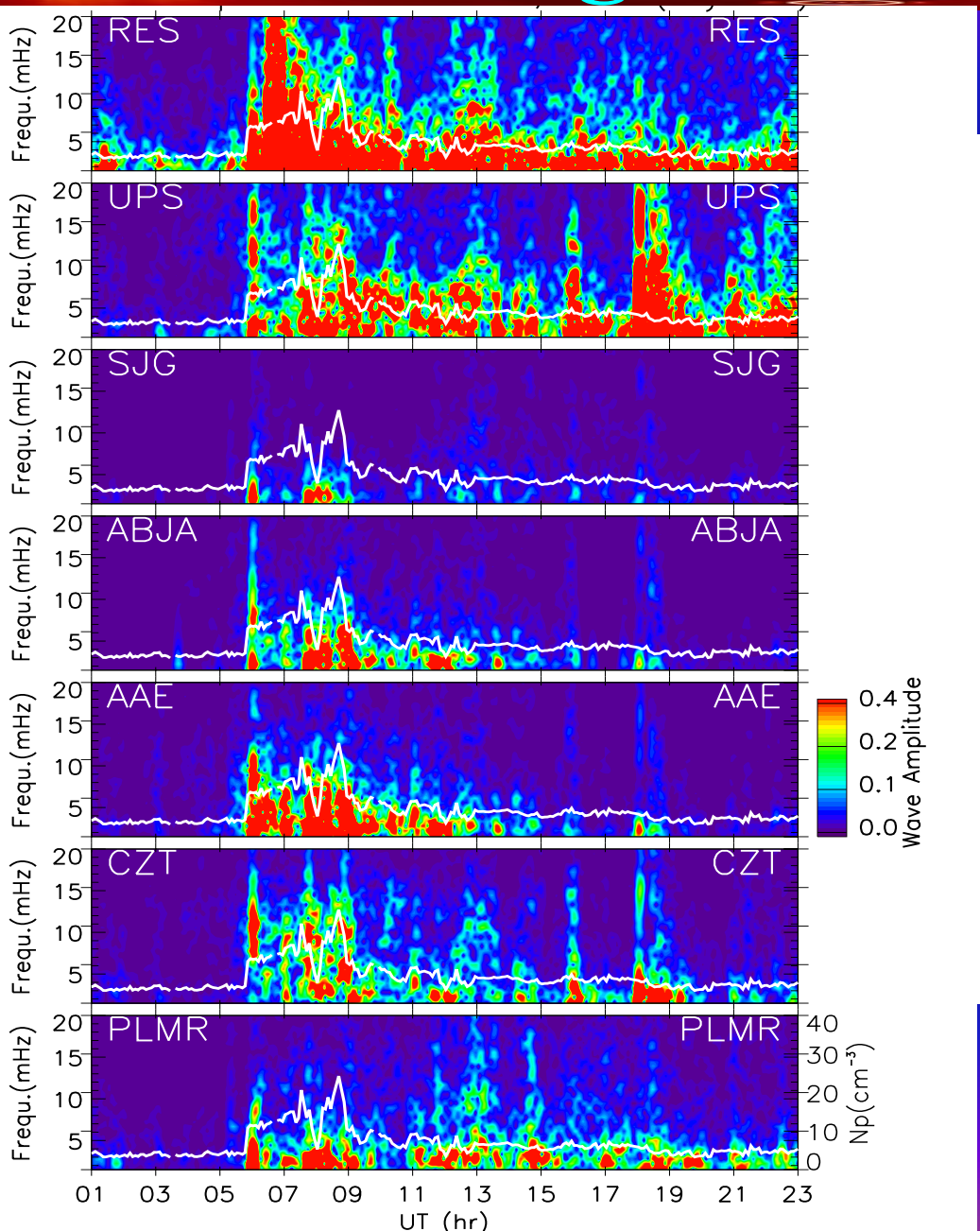


Poloidal Pc5 & Toroidal Pc5 wave occurrence rates [*Agapitov & Cheremnykh*, 2013]

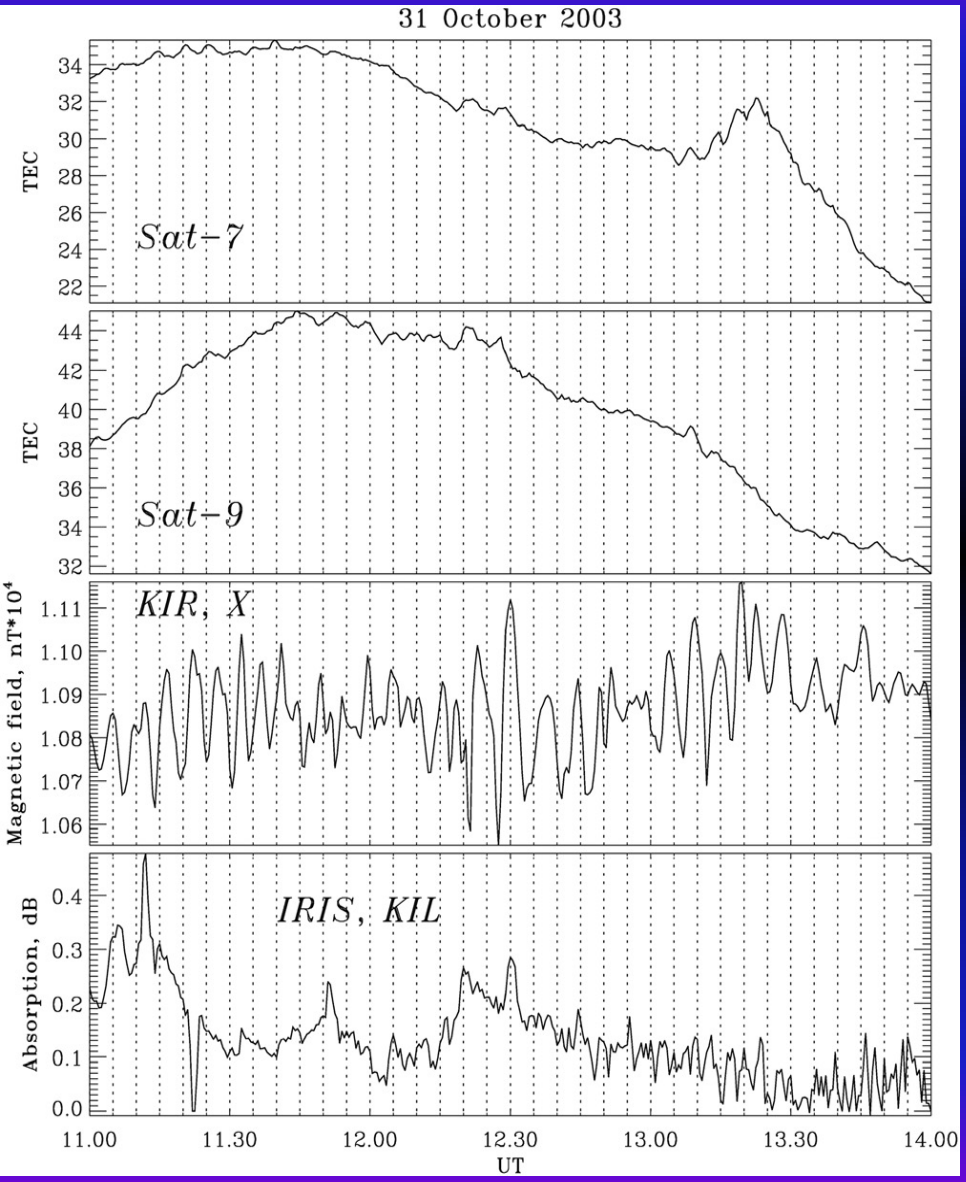
The ULF wave fields drive perturbations in the ionosphere, like FLR on radio sounders at low [*Menket al., GRL,* 2007] and high latitudes [*Mthembuet al., AG,* 2009], electric field oscillations [*Cosgrove et al., AG,* 2010], GPS TEC modulation [*Yizengaw et al., 2013; Pilipenko et al., JGR, 2014*], generation of kilometer scale waves in the ionosphere [*Cosgrove et al., AG,* 2010], etc

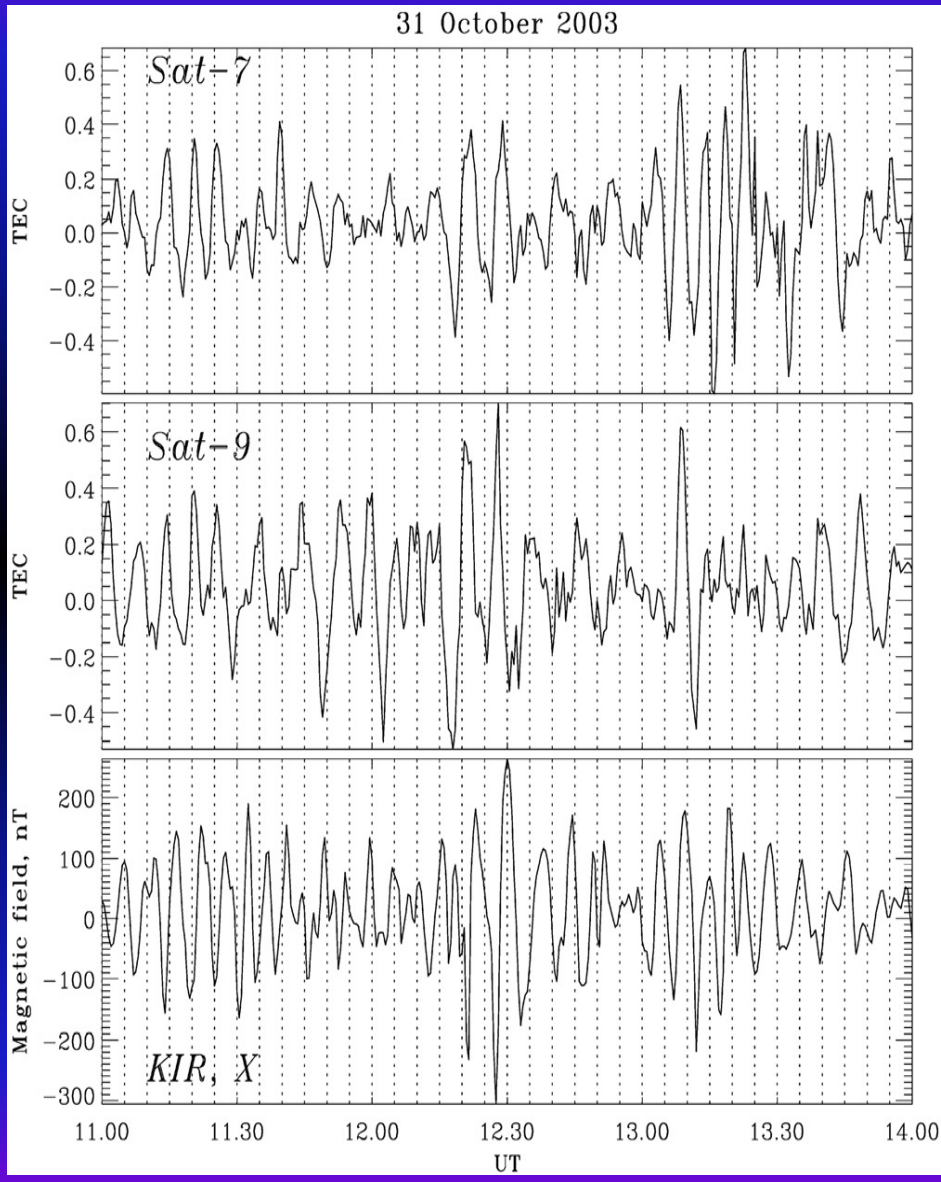
ULF wave signature on the ground





TEC modulation by ULF waves



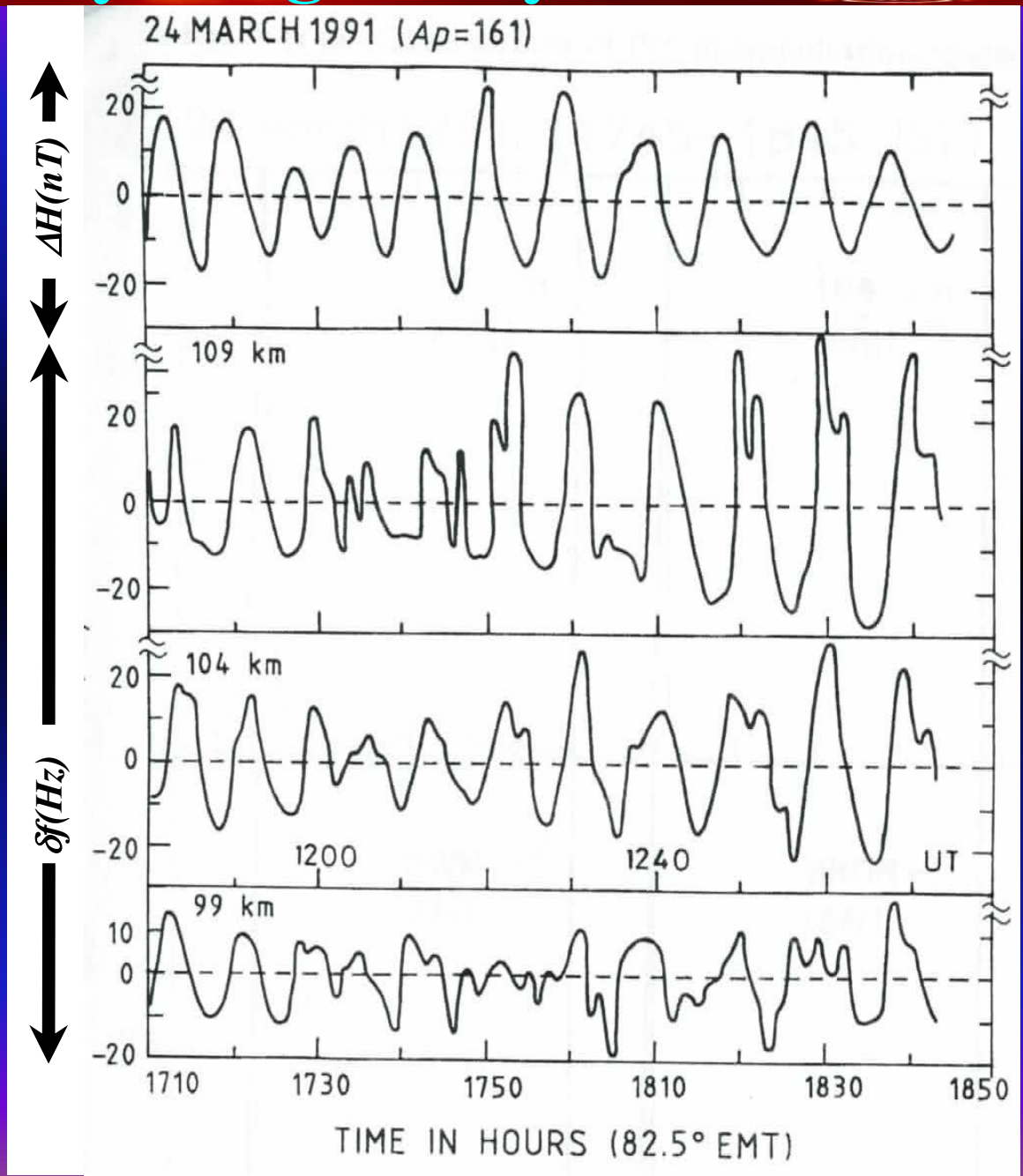


Pilipenko et al., JGR, 2014

ULF wave and density irregularity correlation

Time series of Doppler frequency variation at three different altitudes, observed by 54.95 MHz coherent backscatter radar!

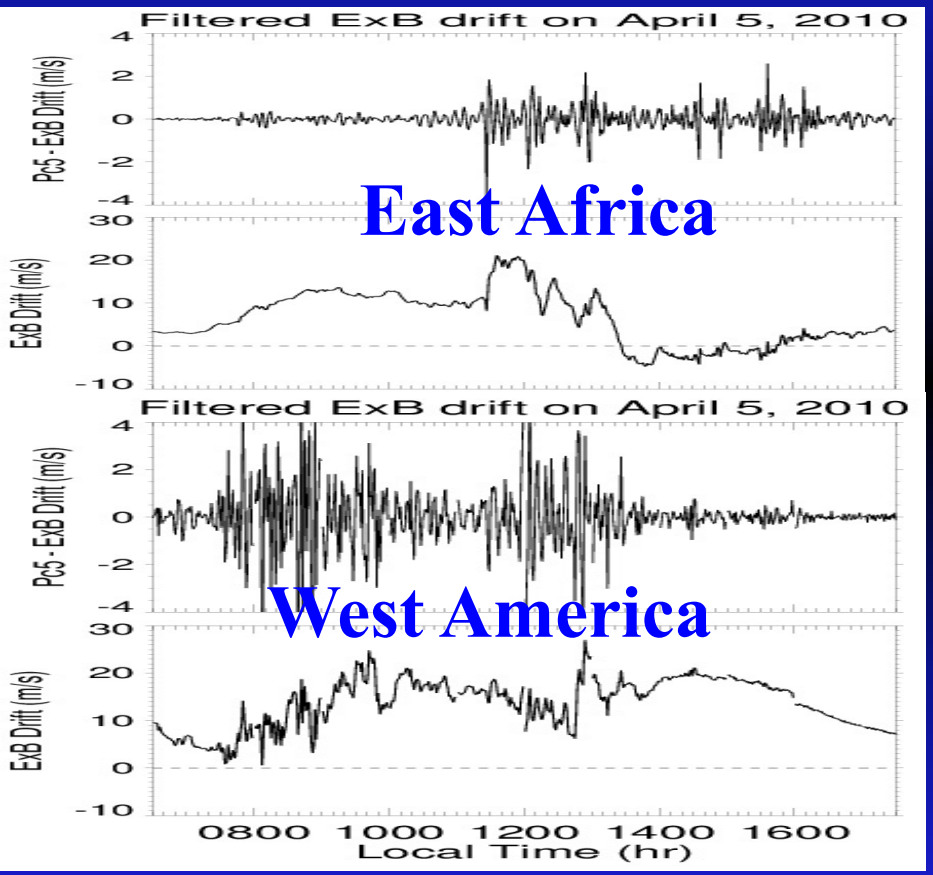
(Reddy et al., AG, 1994)

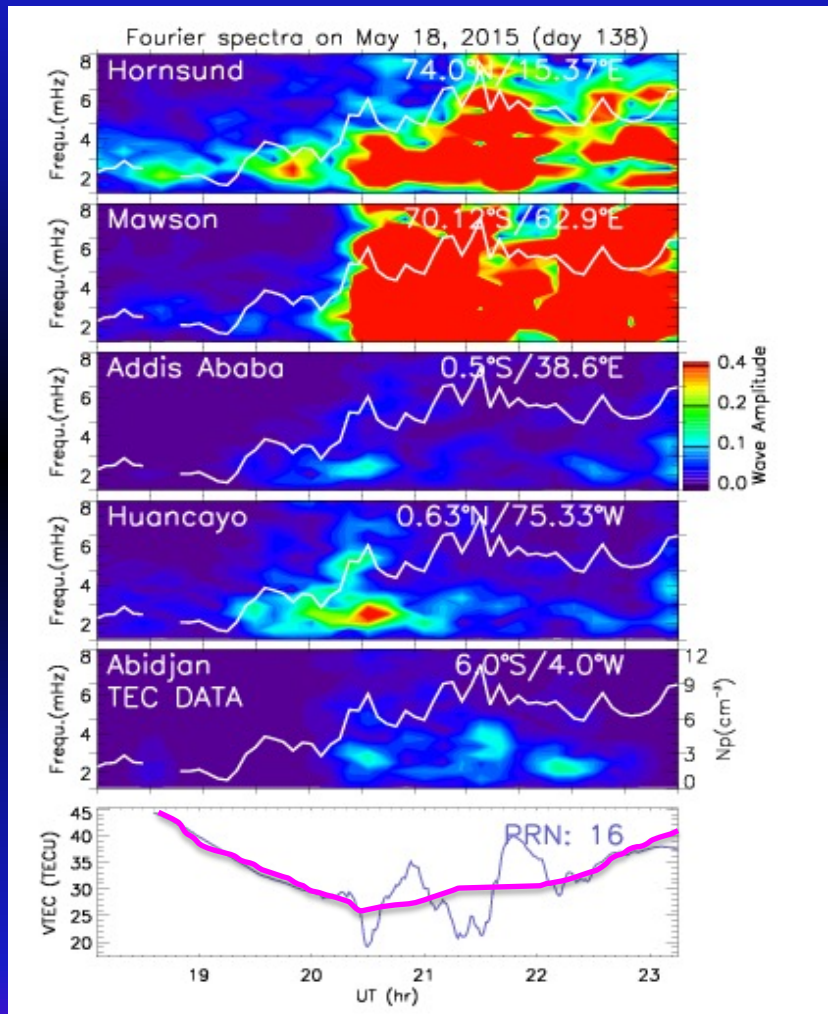


How do ULF wave cause density fluctuation

- When the Alfven/ULF wave enters into the region of magnetized plasma (e.g., ionosphere), it produces electric fields and thus oscillating drift.

$Vz = Ey \cos I / Bo$; I (mag. field inclination)

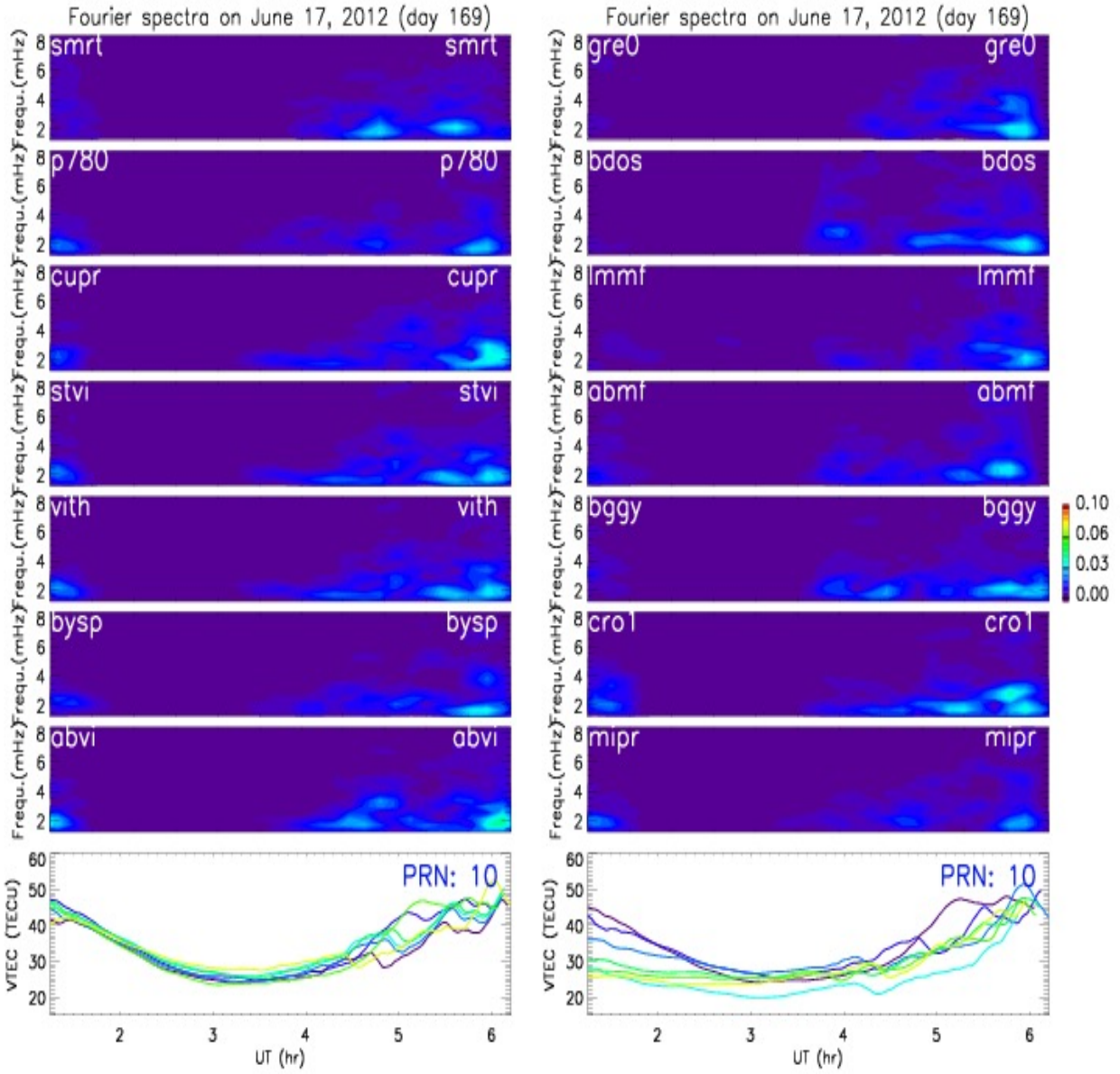


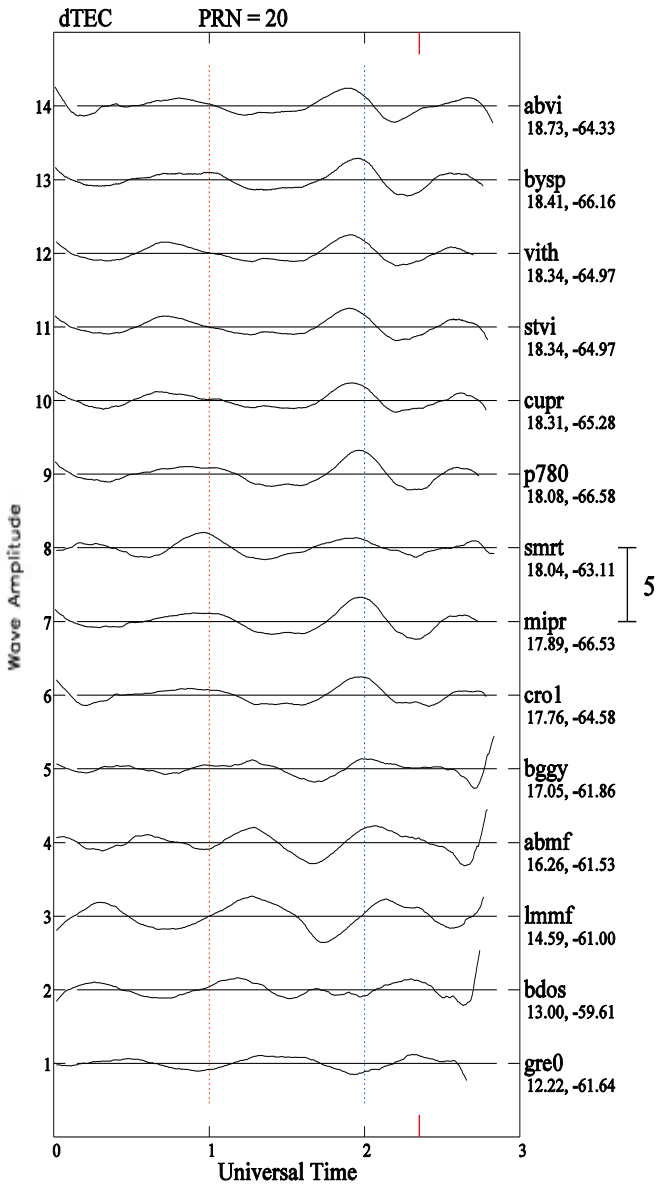


- Causes density fluctuation of magnitude:

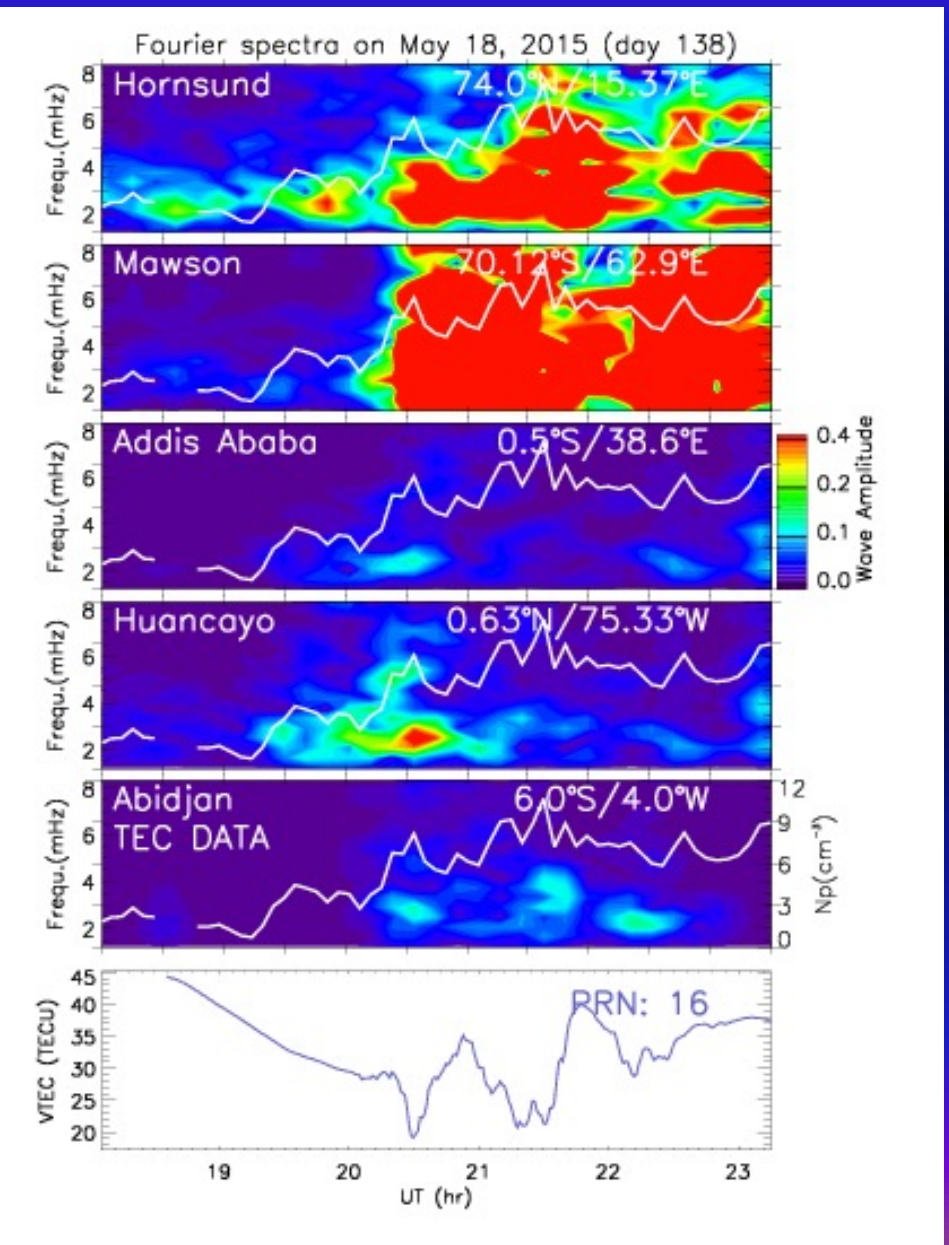
$\Delta N/N = 2\beta Vz/(2\pi f)^2 H_\beta$; ΔN (modulation in density), β (recombination rate), f (frequency of ULF wave), H_β (recombination rate scale height).

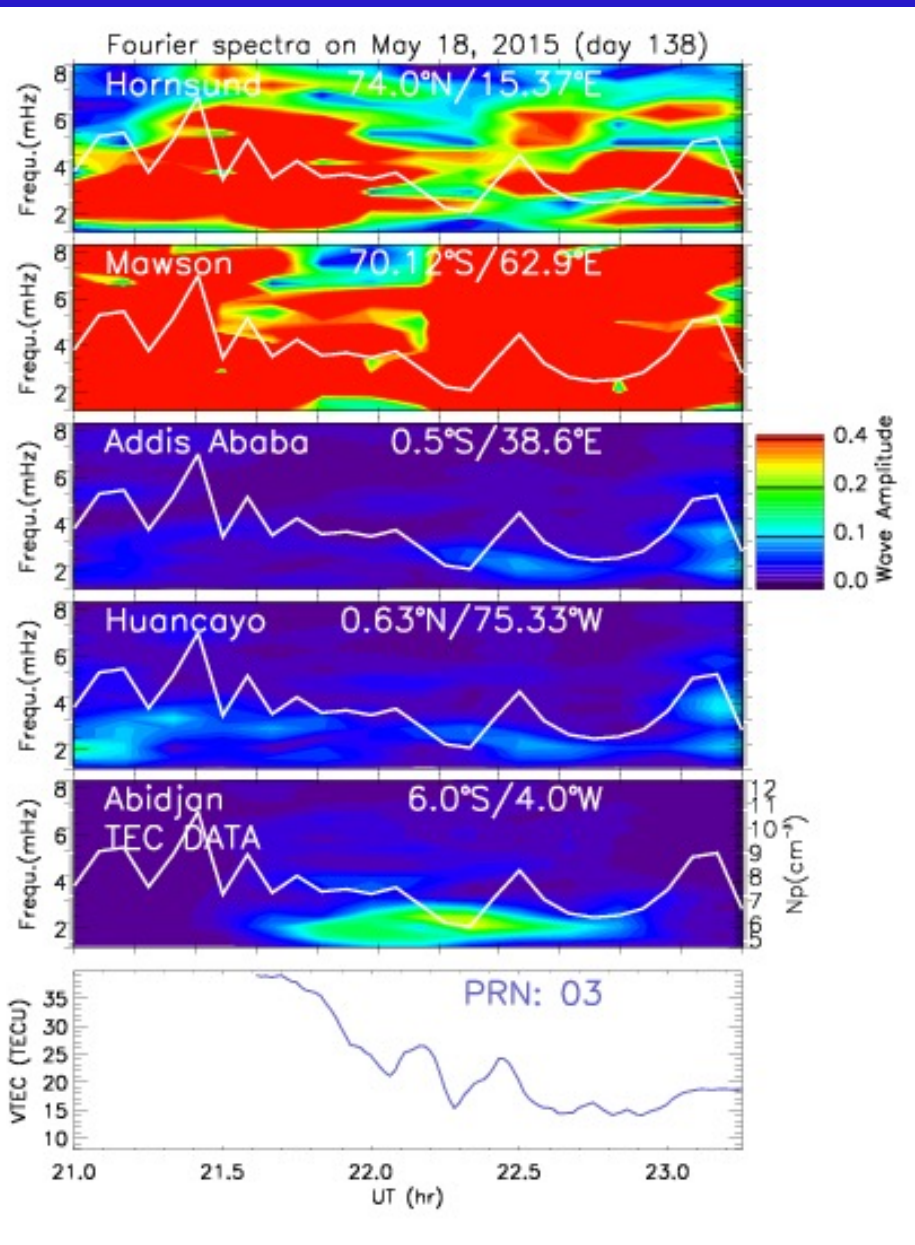
TEC modulation by ULF waves



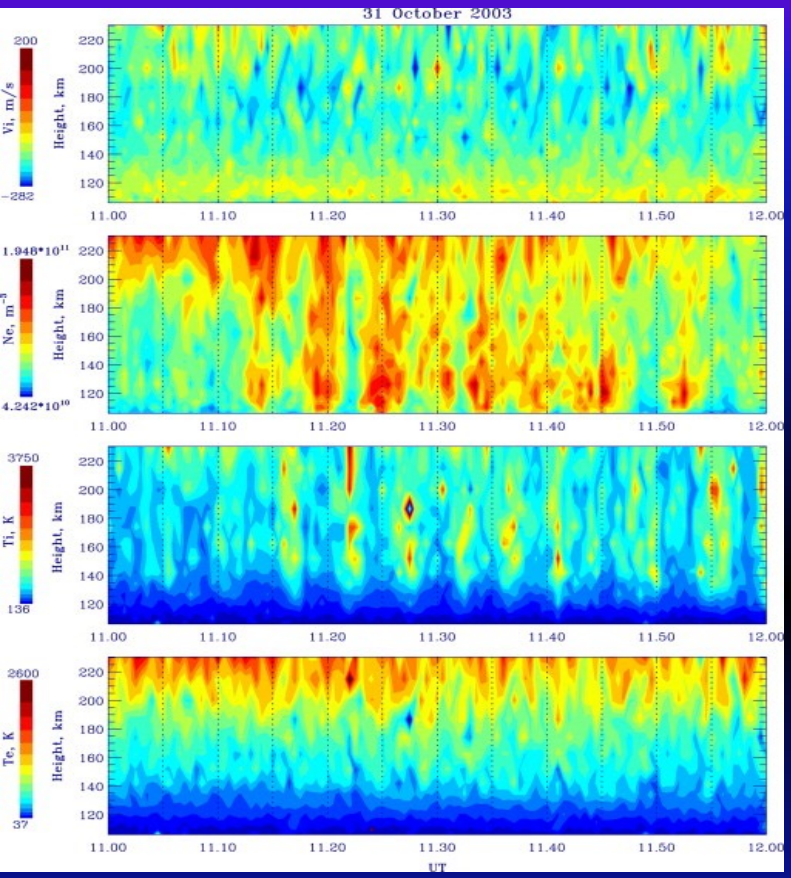


TEC modulation by ULF waves





Other ULF wave modulate mechanism



Pilipenko et al., JASTP, 2014

Through ion heating: dominant mechanisms at high latitude region

At high latitude For example; any typical Pc5 wave of *f* = *3mHz* at *Δβ=0.1mHz→ ΔTi=300K*, may cause *ΔN/N* ~ 0.8% fluctuation (*Pilipenko et al., JGR, 2014).*

This has been demonstrated by radar community that Pc5 waves can modulate the ionospheric E-field, field-aligned current, density, and ionosphere conductance (*Reddy et al., AG, 1994; Pilipenko et al., JASTP, 2014).*

iMAGs (SAMBA-AMBER-MEASURE)

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