2016/8/10 @Japanese SD Workshop 2016
13:20-13:40

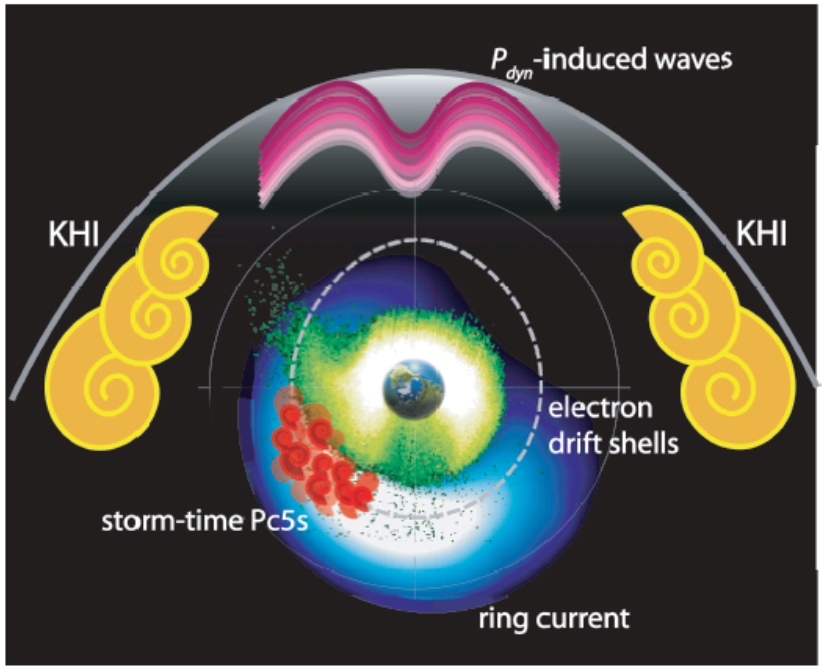
ERG-SuperDARN共同観測による ULF波動研究へ向けて

Mariko Teramoto[1]

1.Japan Aerospace Exploration Agency,

Pc5 pulsations in the inner magnetosphere

ULF pulsations in the inner magnetosphere can be classified as externally and internally driven.



[Ukhorskiy et al. 2009]

Externally driven

- Kelvin-Helmholz instability(KHI)
- Quasi-periodic variations in the solar wind dynamic pressure

Toroidal mode, small m number

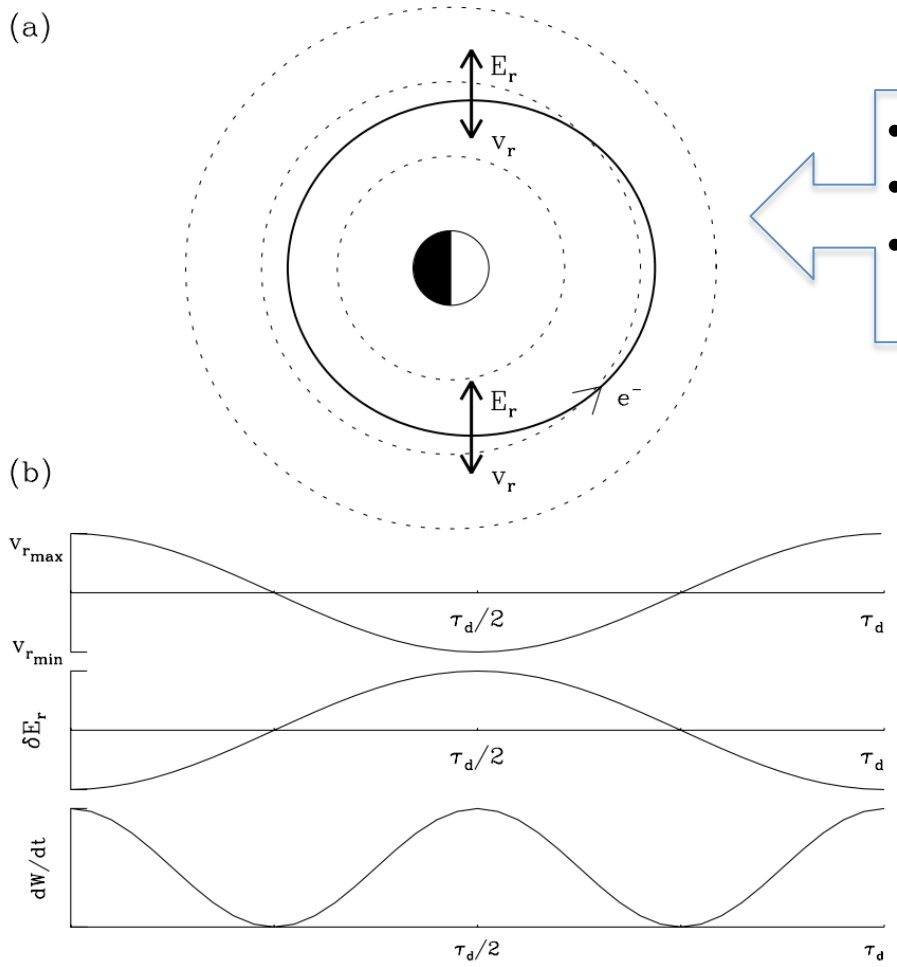
Internally driven

- Low-frequency instabilities of ring current

Poloidal mode, large m-number

Drift resonance Acceleration

Elkington et al.,[1999, 2003]



- m=2
- Toroidal wave of ω
- An electron stating at dusk moving with a drift frequency of ωd=ω.

$$\frac{dW}{dt} = q\vec{E} \bullet v_d + M\frac{\partial B}{\partial t}$$

A net energy increase by the global (low-m number) toroidal mode

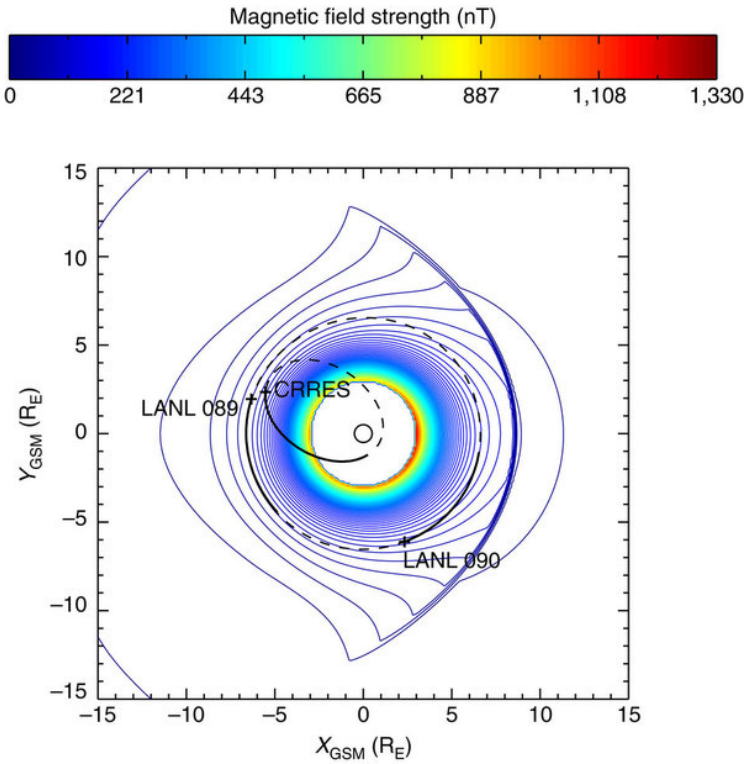
Drift resonance by toroidal mode Pc5 pulsations

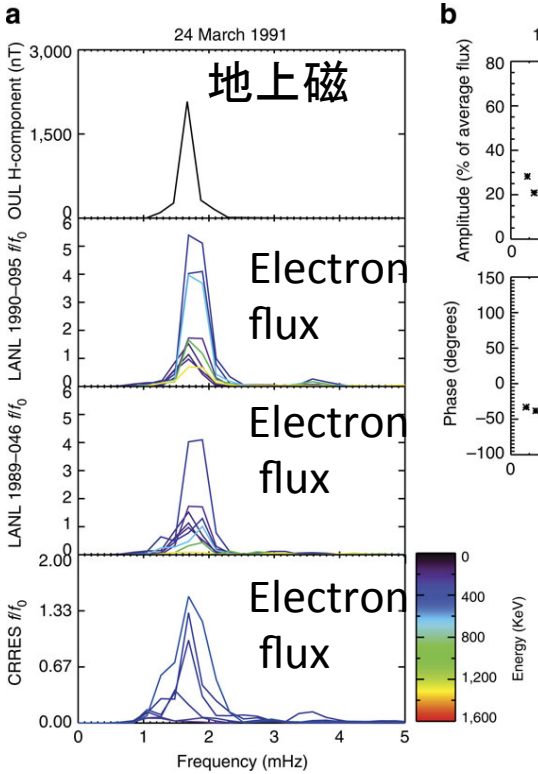
Toroidal-mode wave can accelerate electrons via drift-resonance interaction in the compressed dipole. The resonance condition is

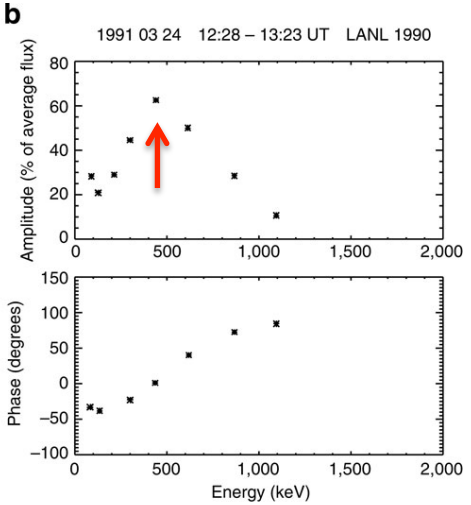
$$\omega - (m \pm 1)\omega_d = 0$$ Elkington et al [1999, 2003]

ω :wave frequency
m :an azimuthal wave number
ω_d :azimuthal drift frequency

Toroidal mode ULF waves were occurred on 24 March 1991 in the compressed magnetosphere 1.5-mHz ULF waves resonated with 315-500keV electron.



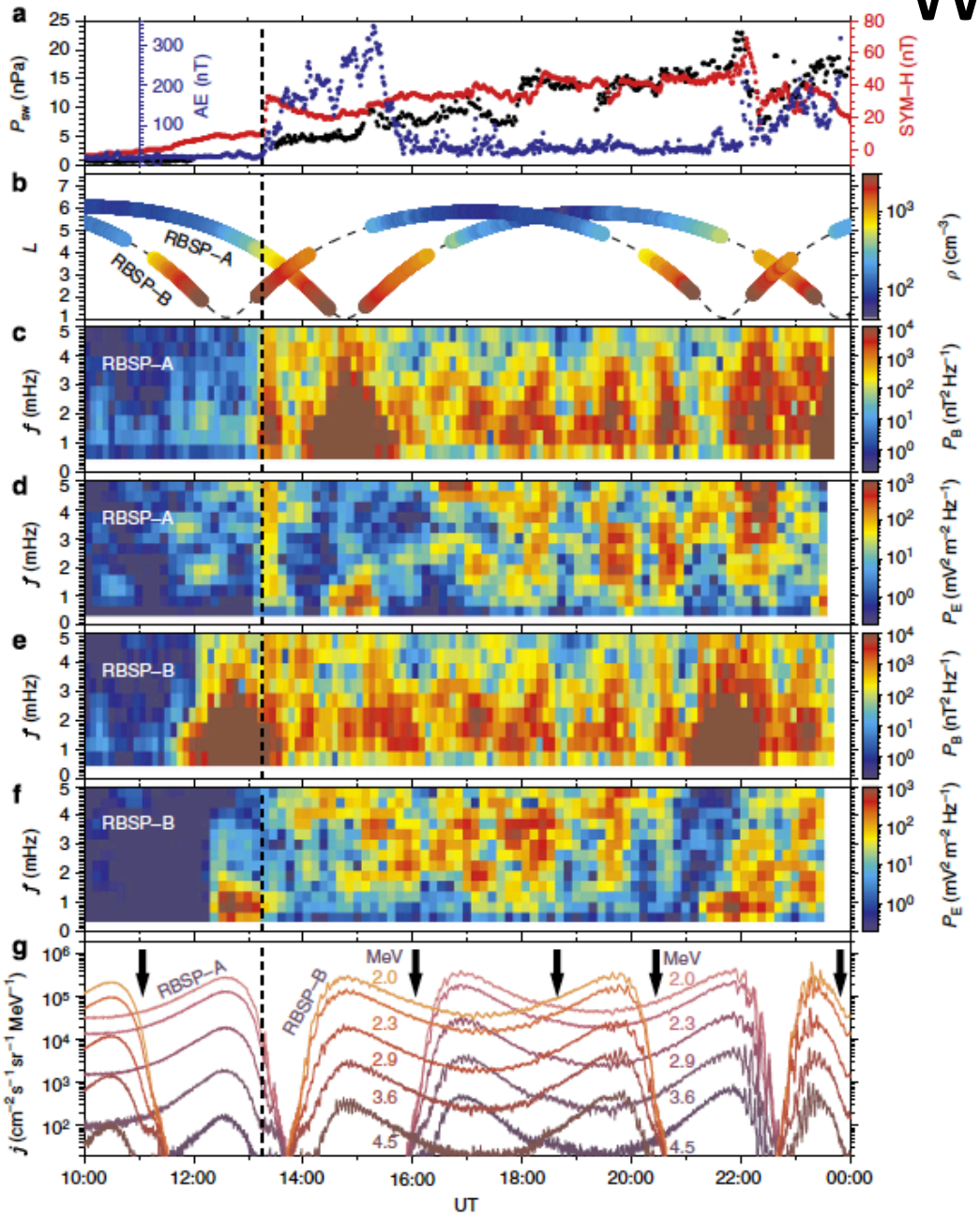


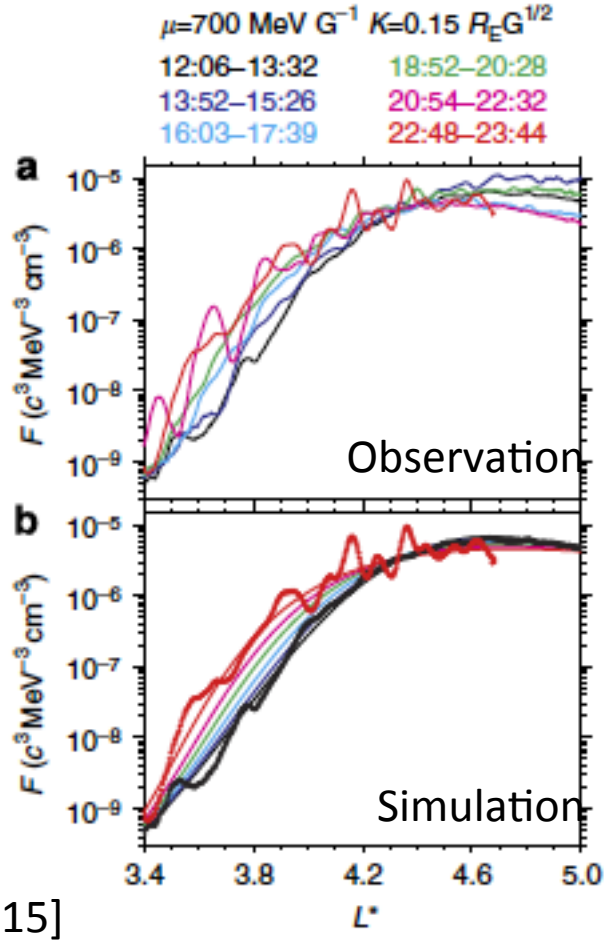


[Mann et al., 2013]

Wave-drift diffusion by low- m ULF

- No VLF chorus waves
- Broad band ULF (m~1)
- The inner edge of the outer belt was transported inward about 0.3 RE



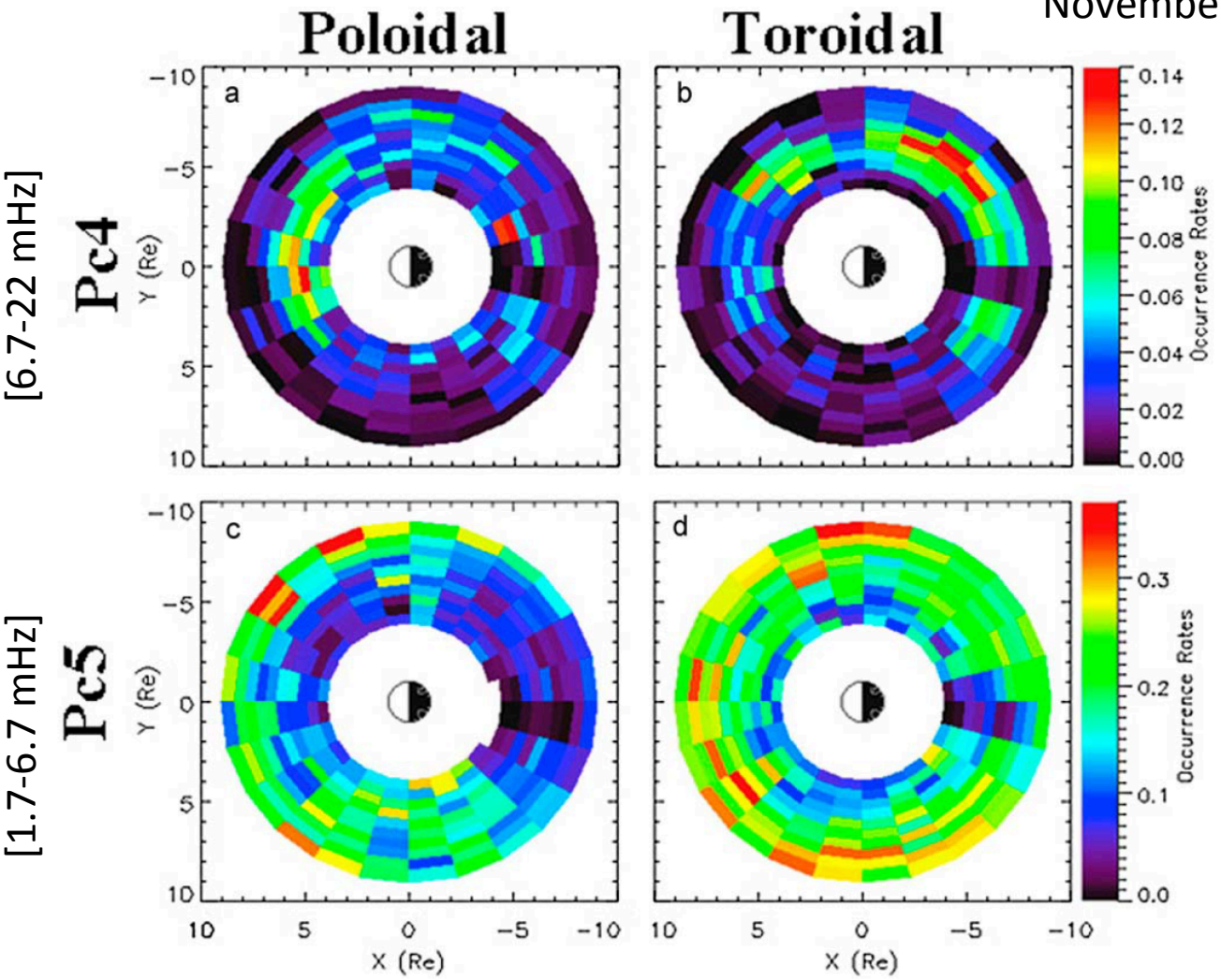


[Su et al., 2015]

Occurrence rate of Pulsation

THEMIS electric field observation

November 2007-December 2008



Toroidal and poloidal Pc4

Dusk: Occurrence rate is low.

Toroidal ULF waves

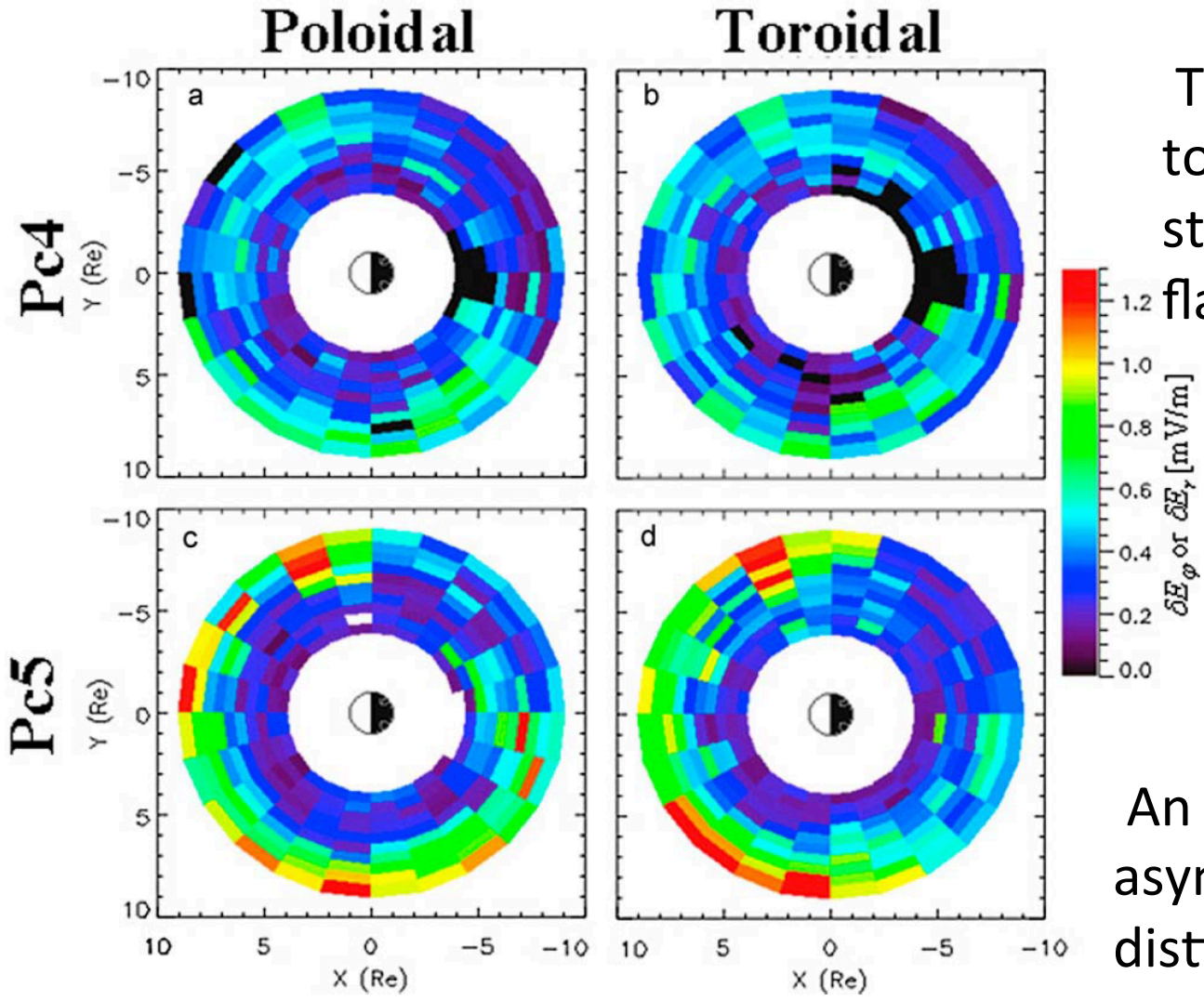
Dawn: Occurrence rate is high.

Poloidal Pc5

Dusk: Occurrence rate is high.

Liu et al., [2009]

Wave power distribution



The wave power of toroidal Pc5 is stronger at the two flank regions,

An overall dawn-dusk asymmetry of ULF can be distinguished

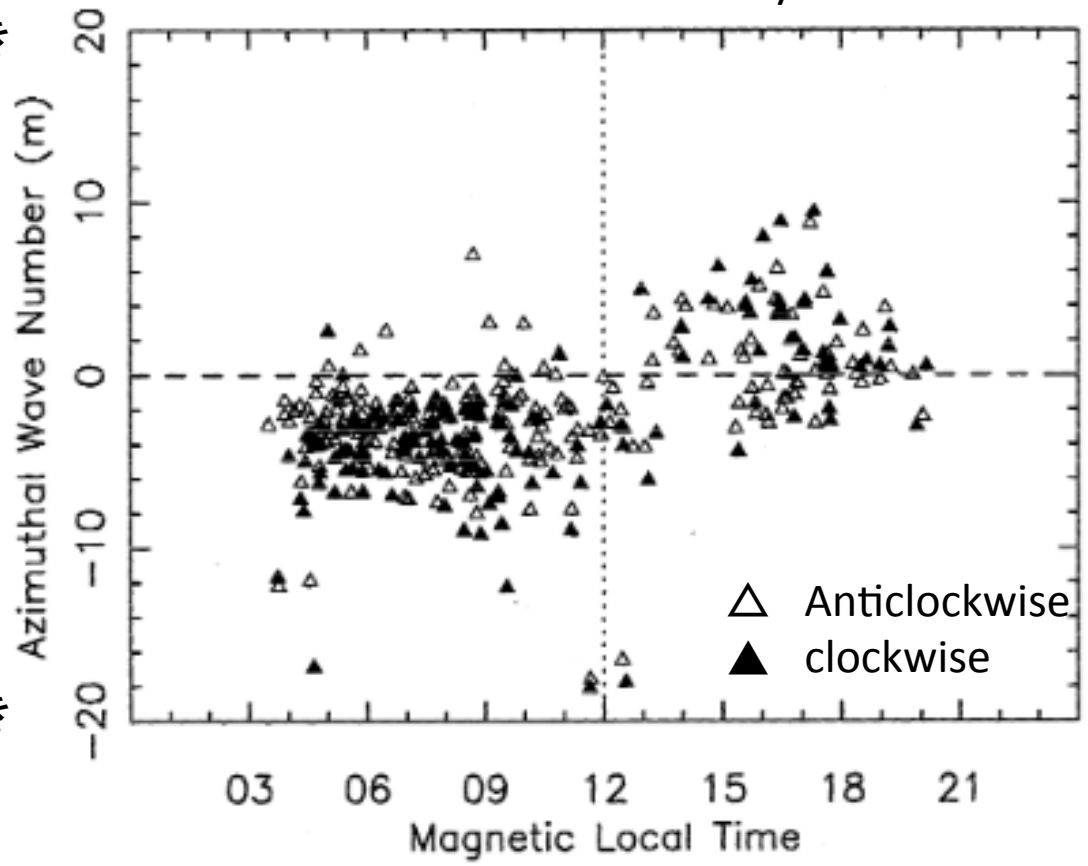
Propagating ULF wave

ULF waves with low-m number are propagating waves.

Dusk sector: Eastward
Dawn sector:Westward

Azimuthal m number derived by the SAMNET

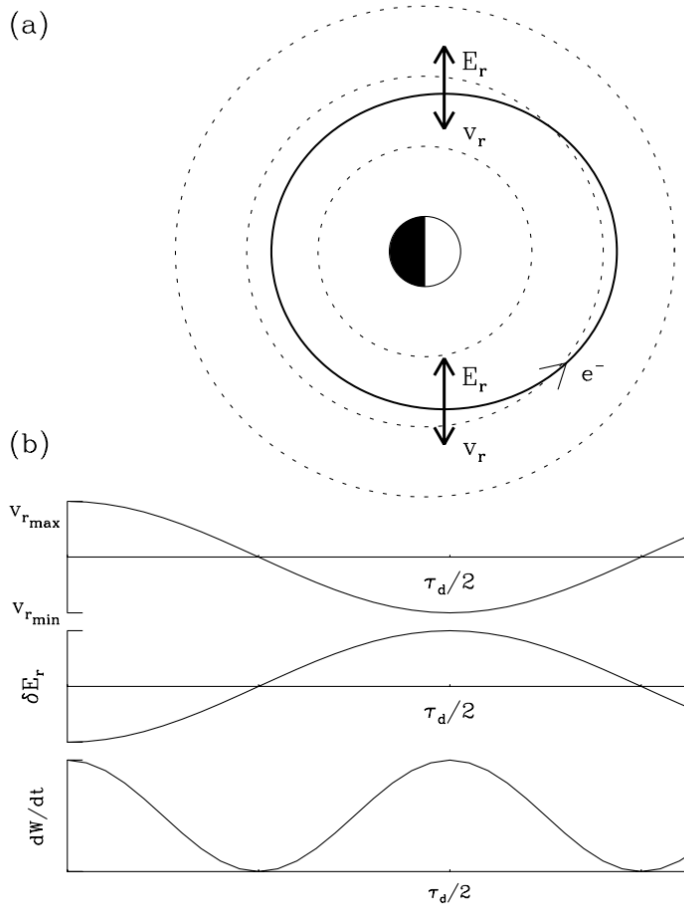
東向き



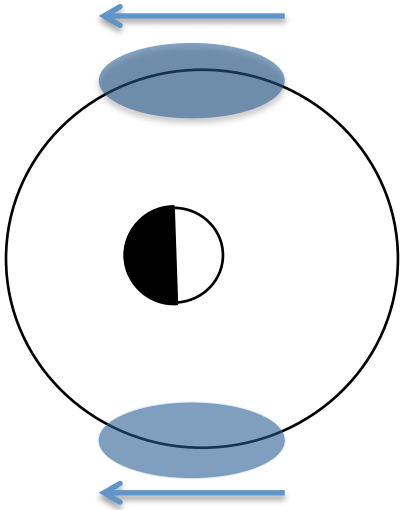
西向き

[Chisham and Orr, 1997]

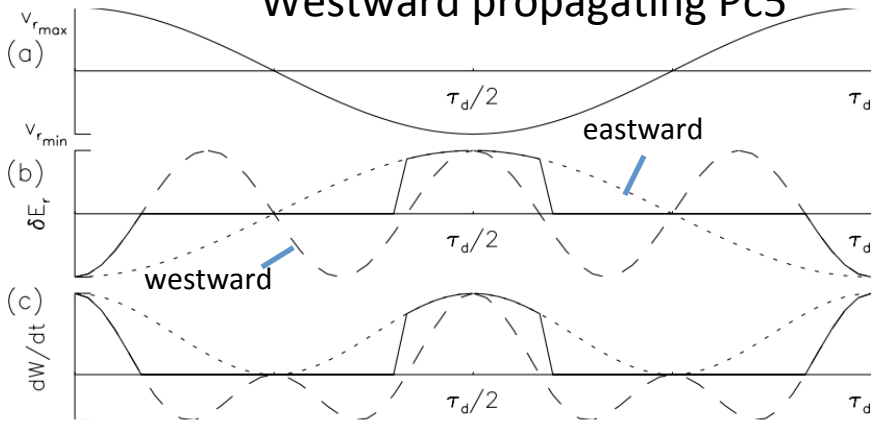
Local Time and propagation Effect



Eastward propagating Pc5



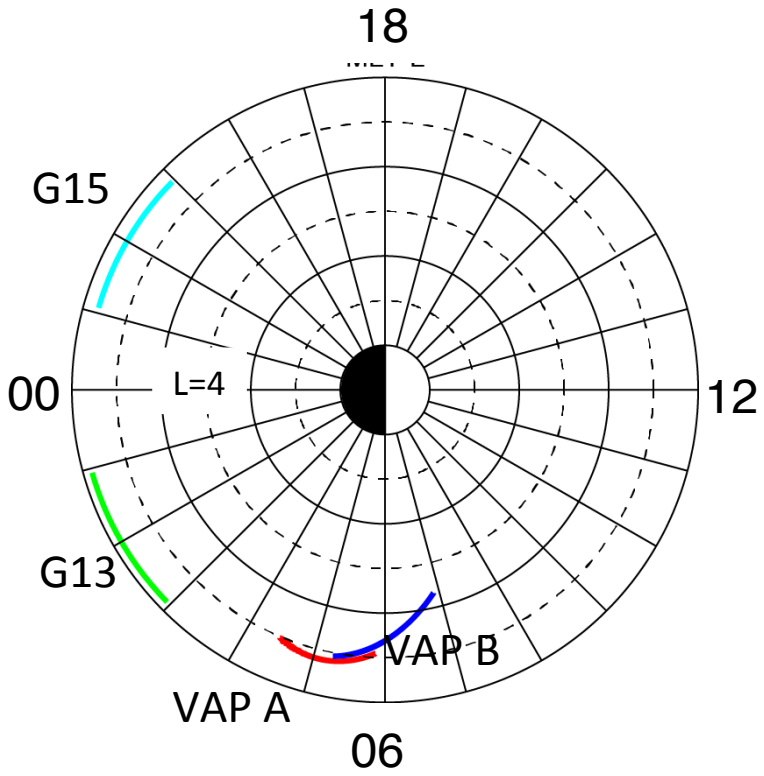
Westward propagating Pc5



In the case of westward propagating ULF waves, a local time asymmetry is in fact required for energization.

[Elkington, 2003]

Pc5 pulsations occurred in the recovery phase of geomagnetic storm



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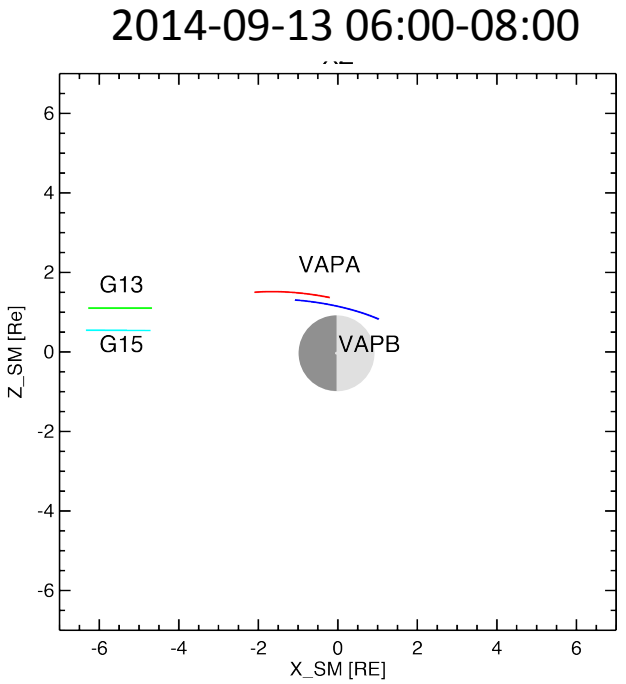
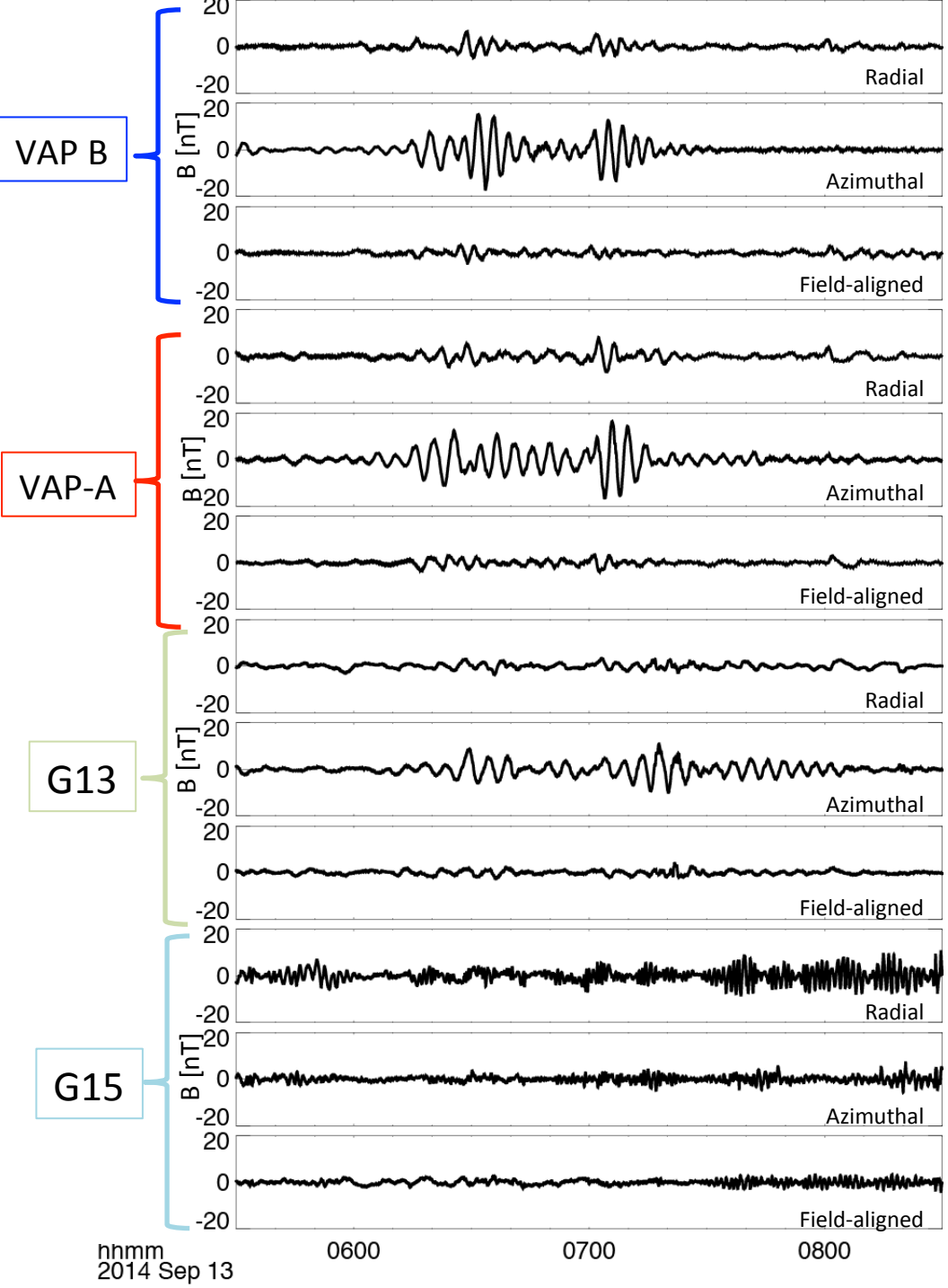


[Teramoto et al., JpGU 2016]

VAP-A and VAP-B were located on the dawnside off the equatorial plane.
GOSE 13, 15 were located in the post and pre midnight sector, respectively.



Localized toroidal Pc5

[Teramoto et al., JpGU 2016]

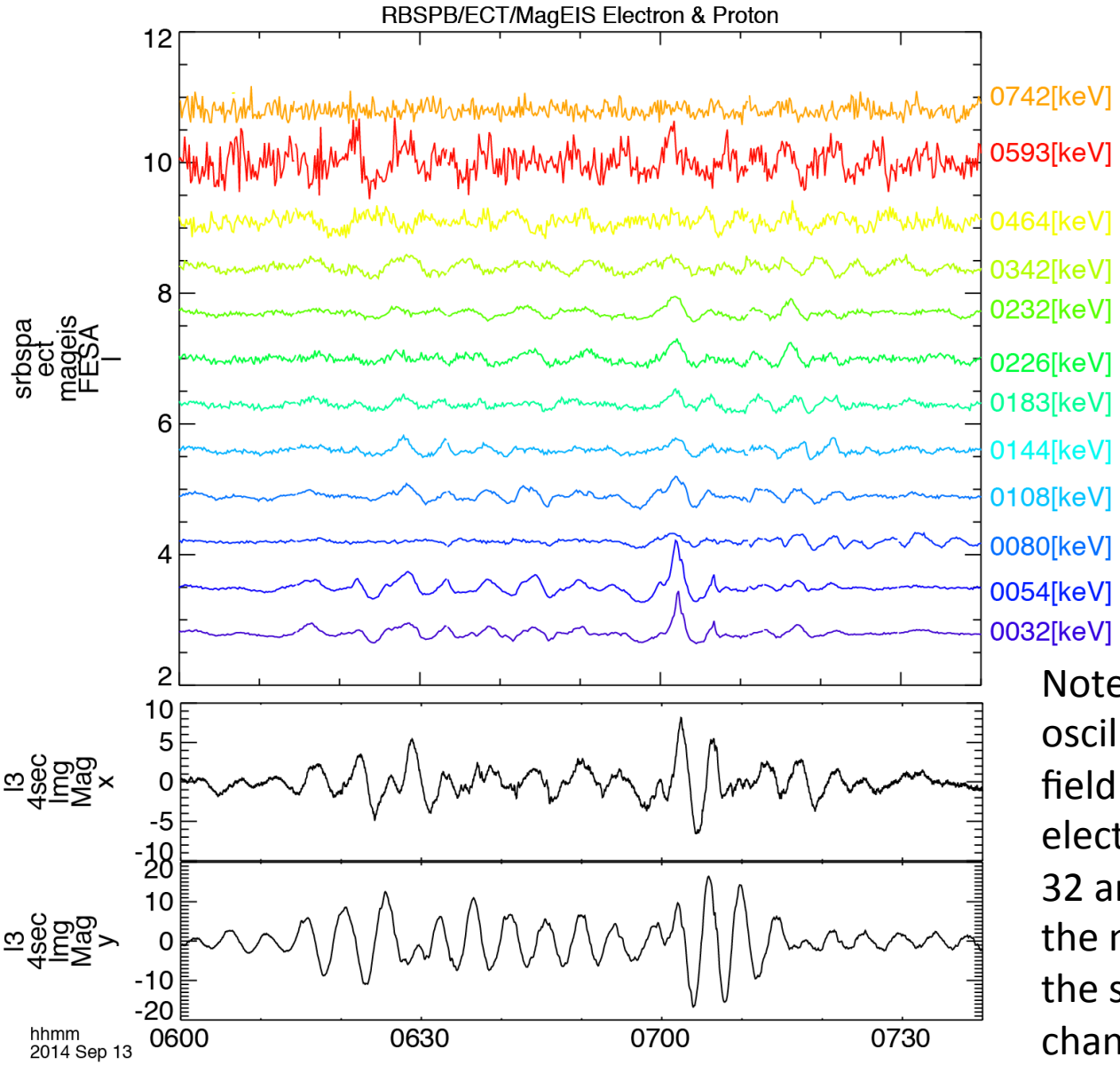
VAP-A, VAP−B (dawn)
GOES 13 (post midnight)

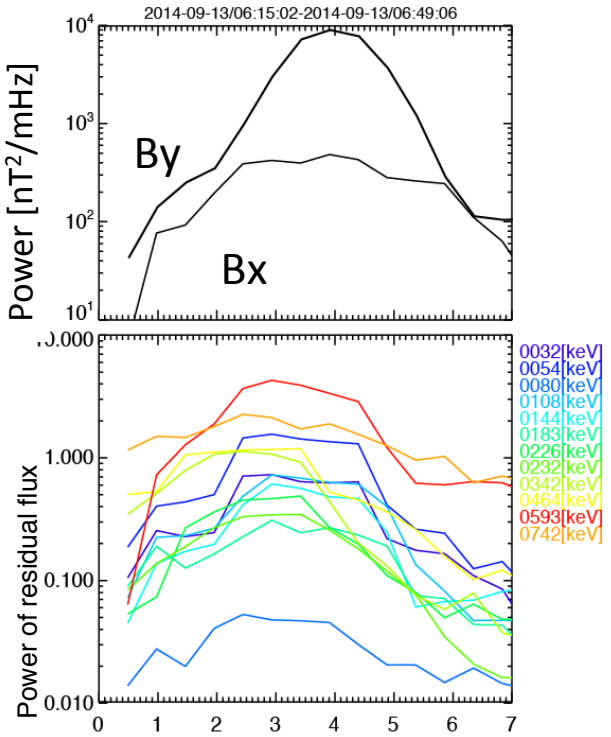
Toroidal ULF waves
m number~4-8 (westward)

GOES 15 (pre midnight)
Poloidal ULF waves
with the amplitude of ~ 20 nT

No Toroidal Pc5

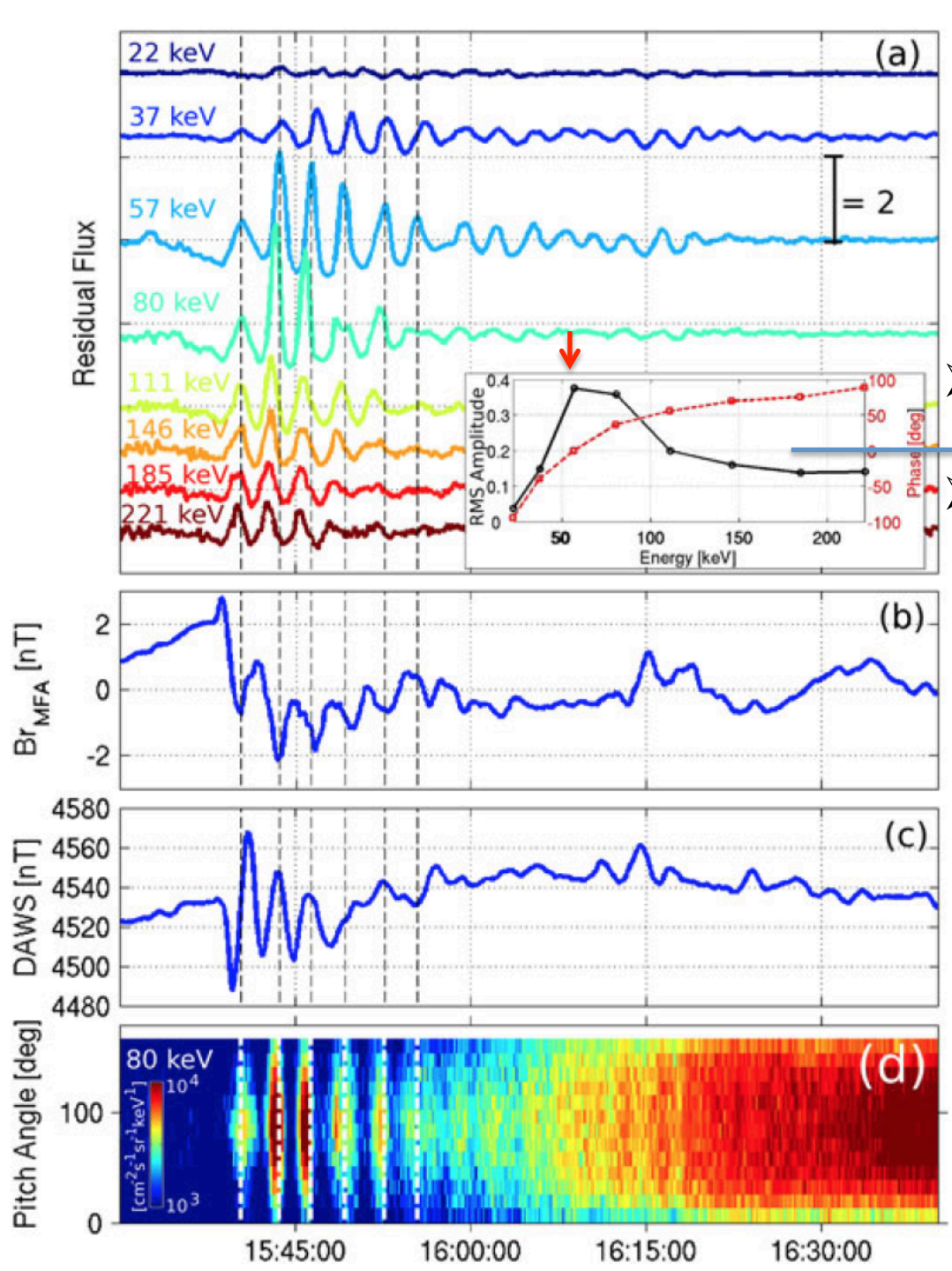
Drift resonance





Note the monochromatic ULF oscillations in the toroidal magnetic field at the same frequency as the electron flux modulations between 32 and 593 keV.

the normalized flux modulations are the strongest in the 593 keV energy channels and weaker at energies above and below this range.



Drift resonance by High-m number ULF waves

VAPs-A (@L~6, MLT~6,Mlat~6°)

- Fundamental poloidal mode at 5.5 mHz with m~40
- The drift resonant interaction is observed.(peak modulation @60keV)

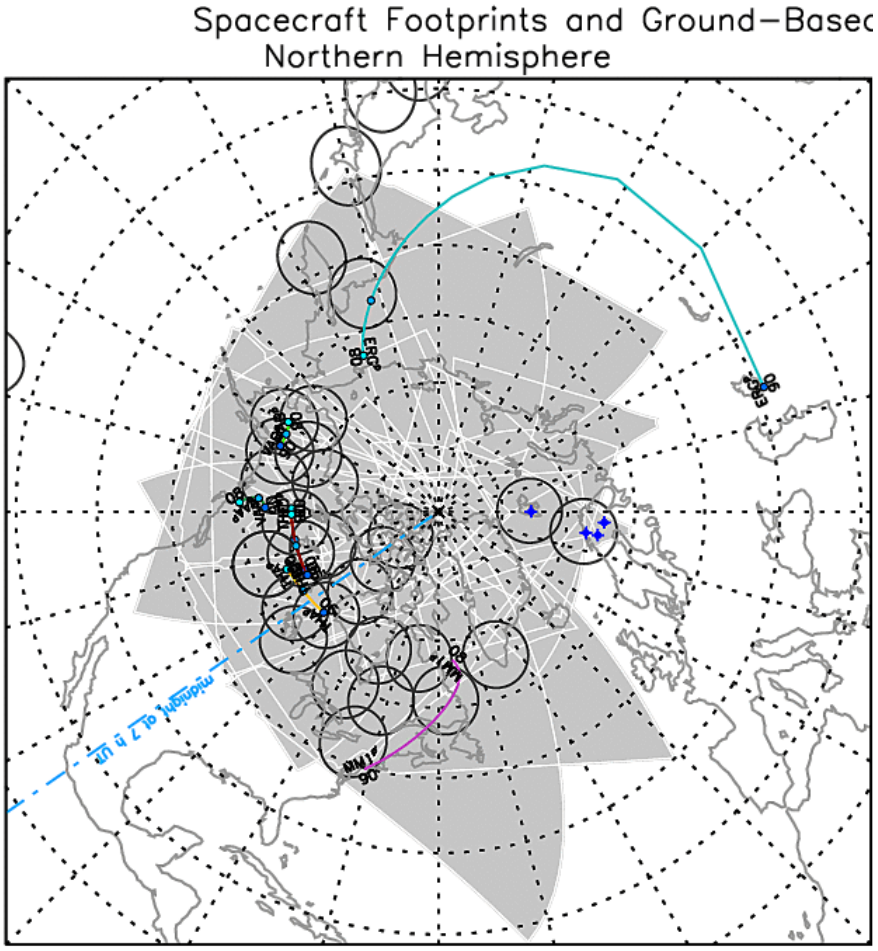
VAPs-B (@L~6, MLT~7)

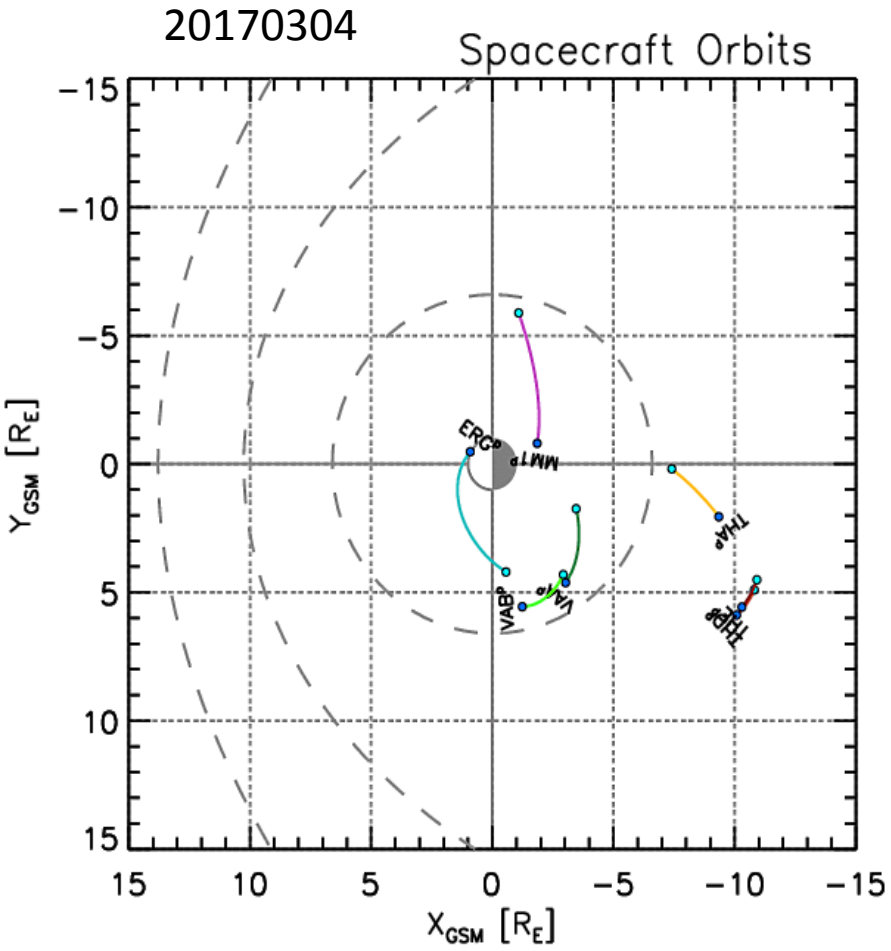
- No poloidal mode at 5.5 mHz。
- transverse ULF at 12 mHz.

It is important of localized wave-particle interactions for understanding energetic particle dynamics.

ULF study with conjugate observations of ERG-SD

How dose ‘localized ULF’ affect radial transport?





衛星打ち上げ直後からが狙い目！