中緯度レーダー研究会@名大/STEL 2014.1.28

STAREレーダーとHFドップラーによる高緯度と低緯度電離圏における過遮蔽電場の同時観測

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Region-2 Field-aligned Current System during Substorms

- Gonzales et al. (1979), Fejer et al. (1979) Jicamarca radar
- Ritter and Luehr (2008)　magnetometer on CHAMP satellite
- Tanaka et al. (2010)　 Global MHD simulation
- Hashimoto et al. (2011) global magnetometer network and SuperDARN

Ritter and Luehr (2008)

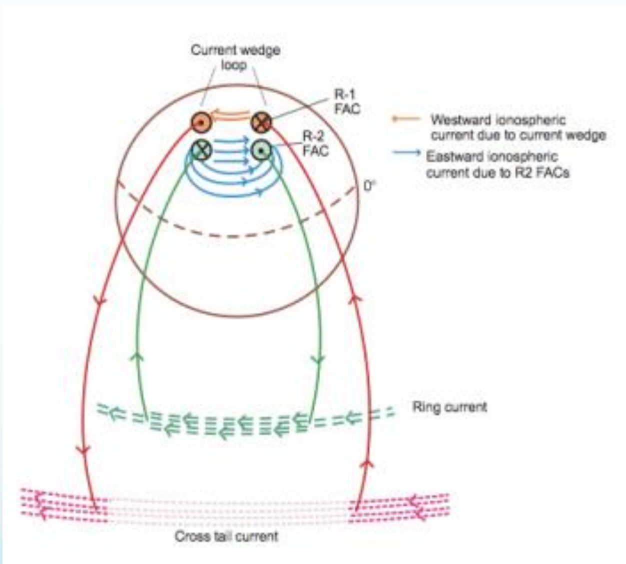
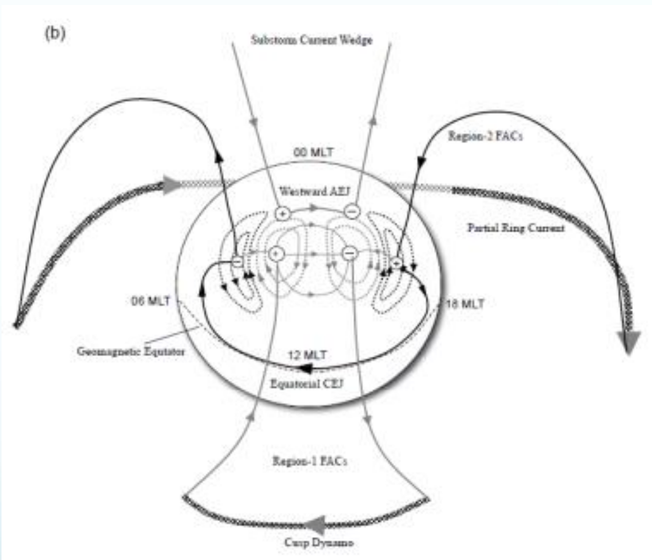


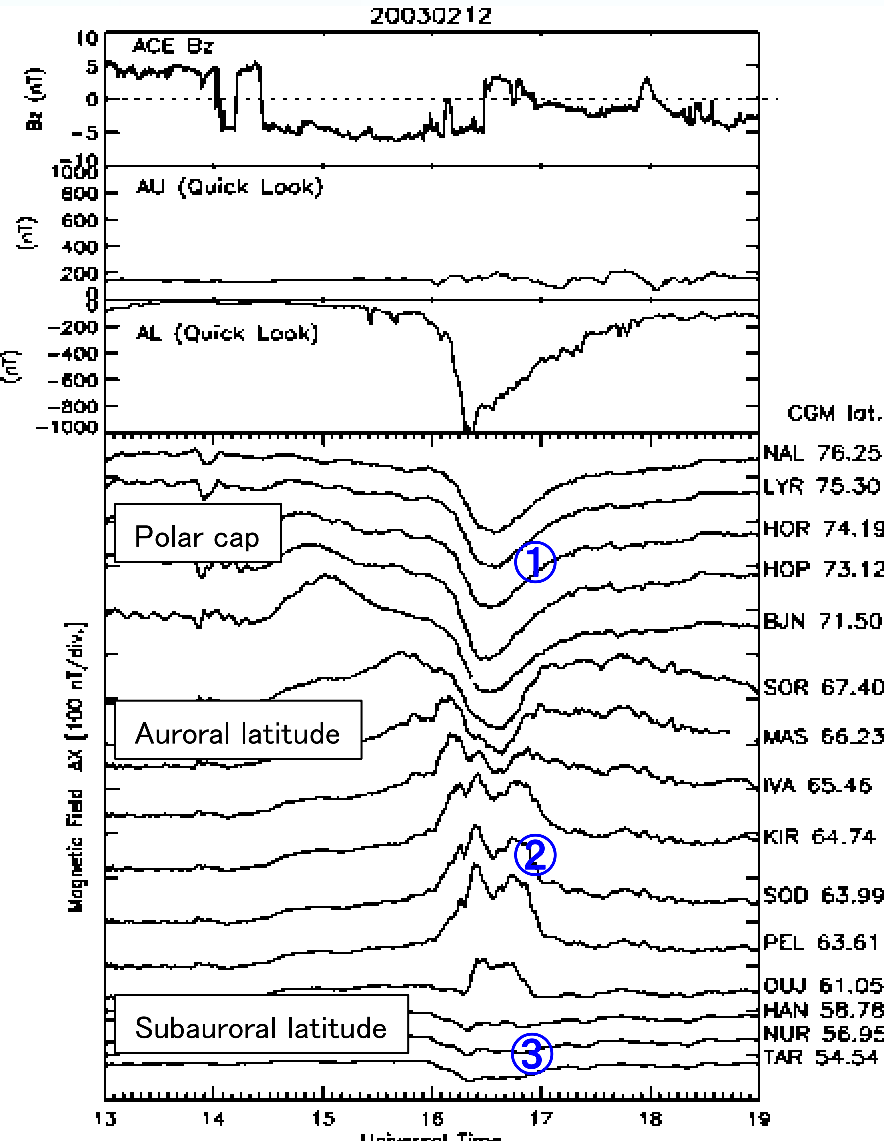
Fig. 15 Improved model of a current system displaying the clo-

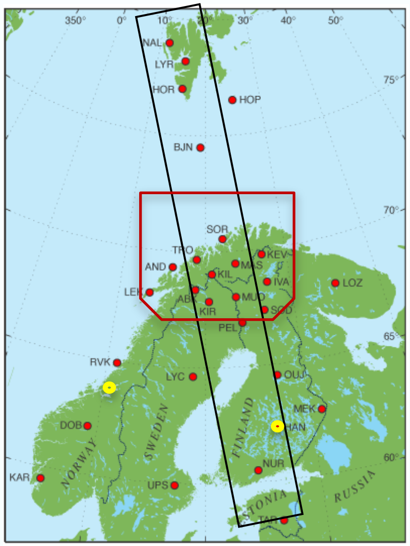
Hashimoto et al. (2011)



動機
1. 昼夜のR2-FAC系の関係
2. サブストーム時のSAPS/SAIDと低緯度赤道の過遮蔽の関係

IMAGE Magnetometer Network





STARE-radar

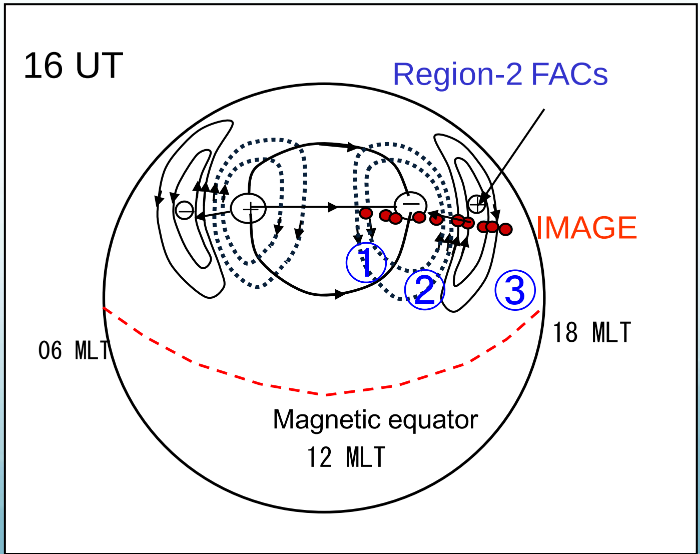
- Hankasalmi (Finland)
- Midtstandan(Norway)

周波数: 140 MHz

距離:495−12000km

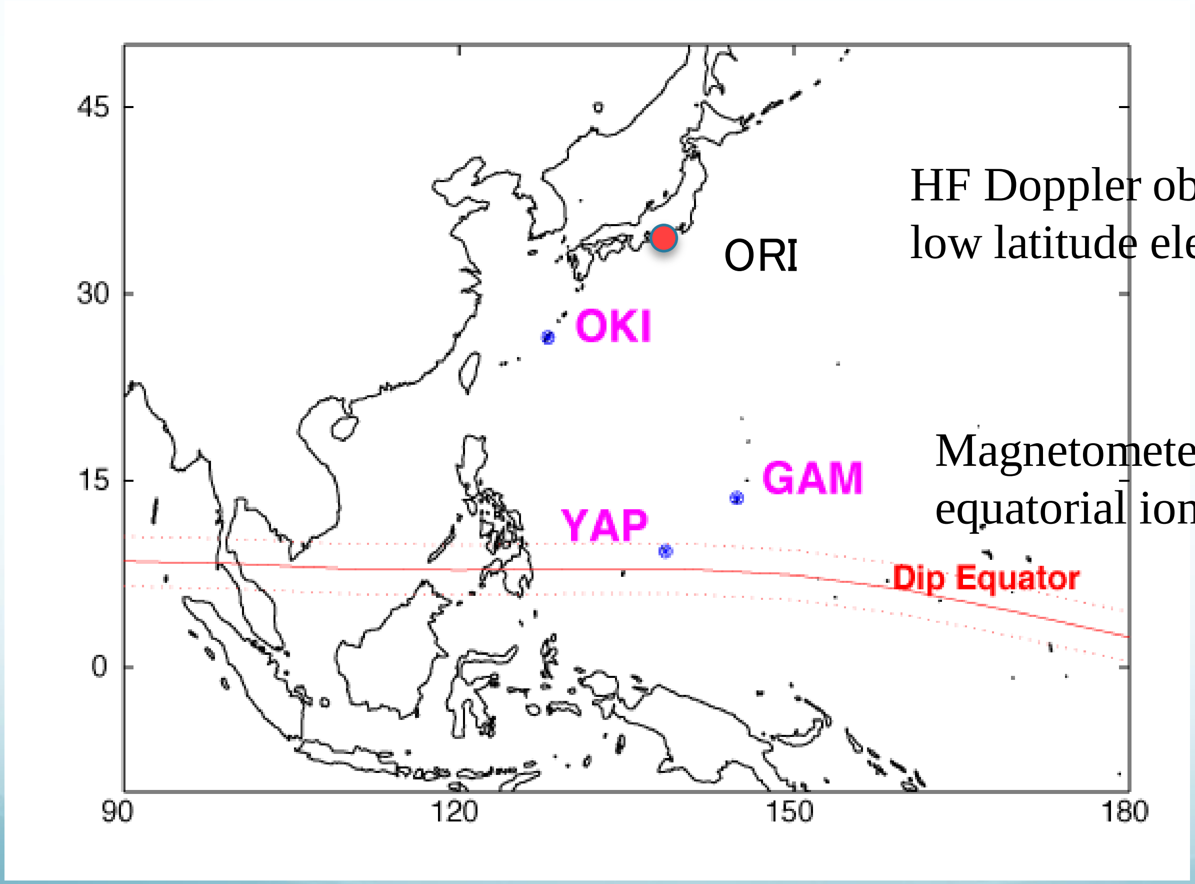
サンプリング: 20sec

期間: 1998−2005



Observation of Electric Field and Currents at mid-Equatorial Latitudes

Polar ionospheric electric field



HF Doppler observation of the low latitude electric field

Magnetometer observation of the equatorial ionospheric currents

EEJ=YAP-OKI

HF Doppler Measurement

$\Delta f = -0.465$ Hz (E=1 mV/m)

$E = 2.15$ mV/m (1 Hz)

$$\Delta f = -\frac{2f}{c}\frac{E}{B}\sin\theta\cos I$$

$f = 5\times10^{6}\,Hz$

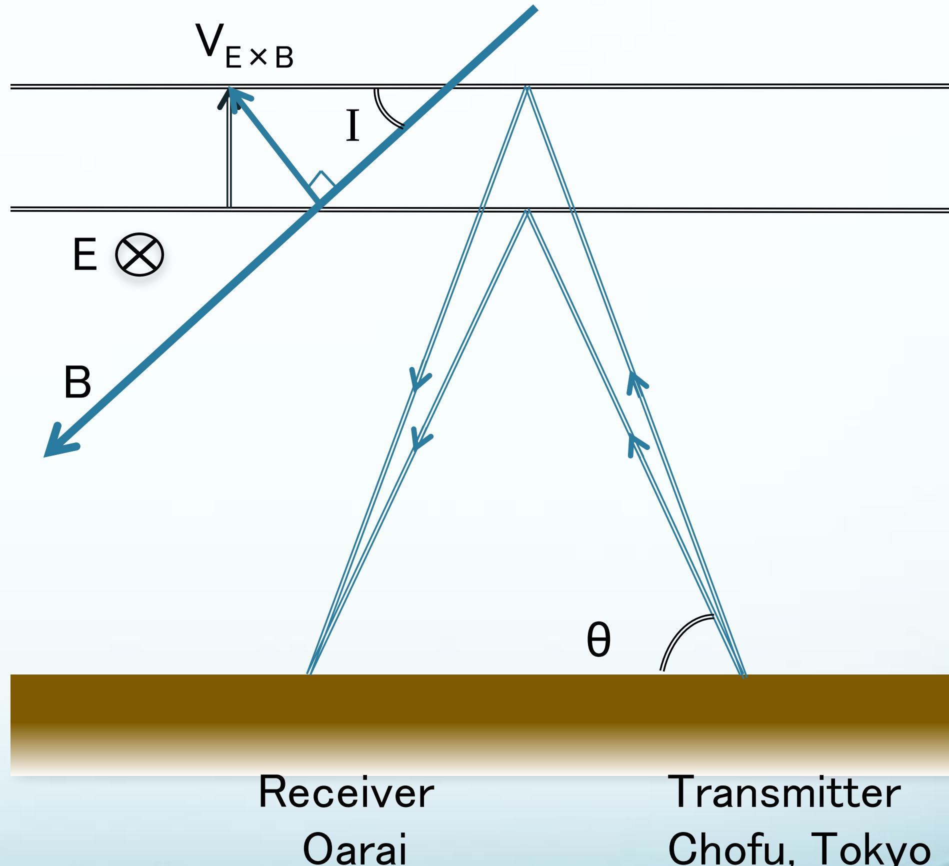
$\theta = 78.2$ degs

$I = 49$ degs

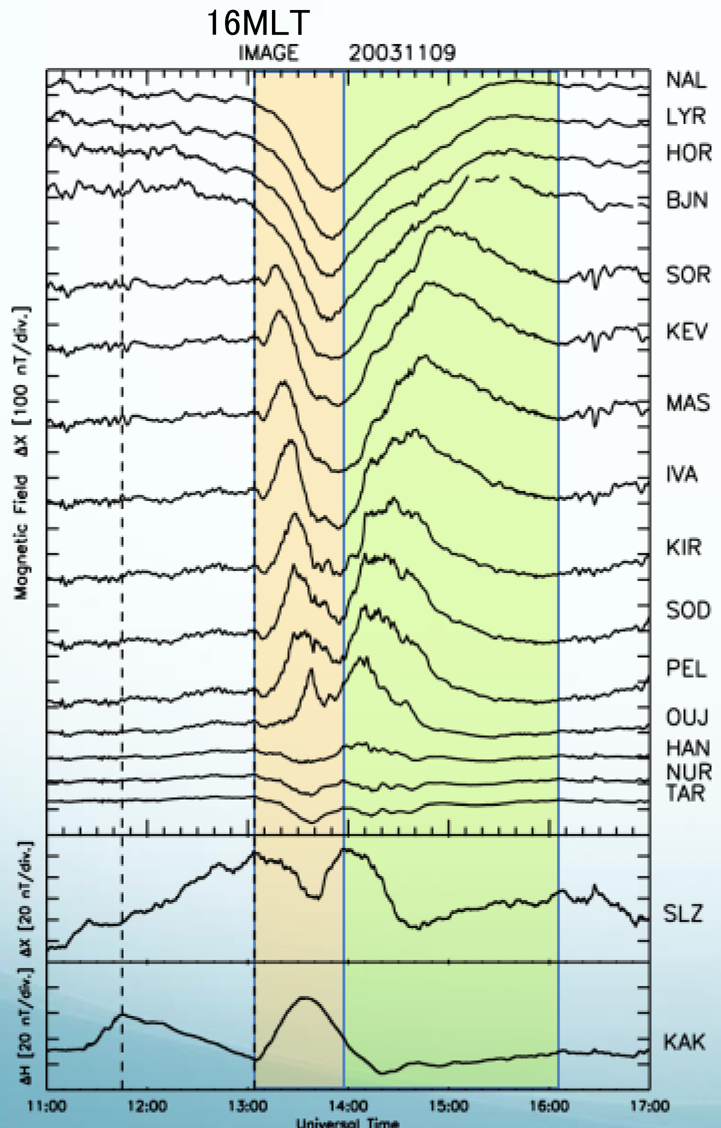
$B = 46000$ nT

distance=120km

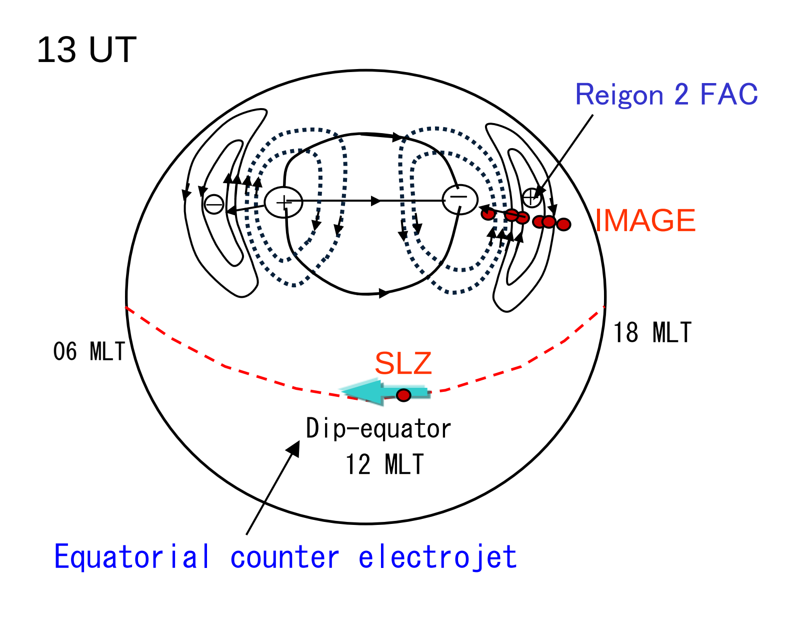
reflection height=300km



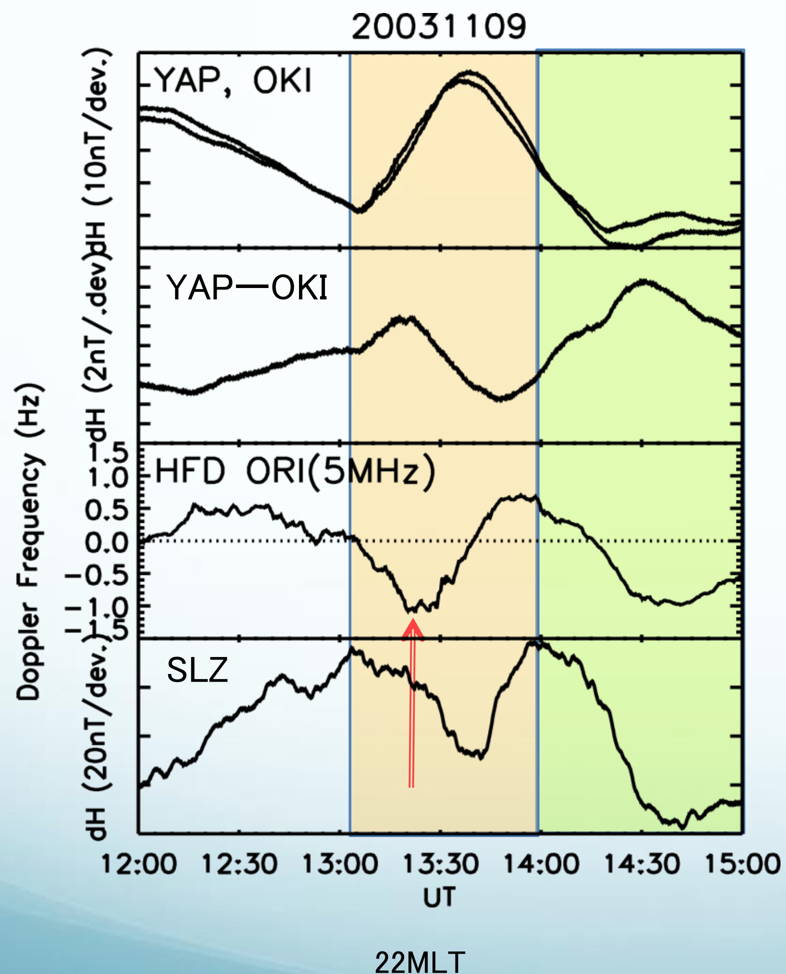
Substorm on 2003/11/09



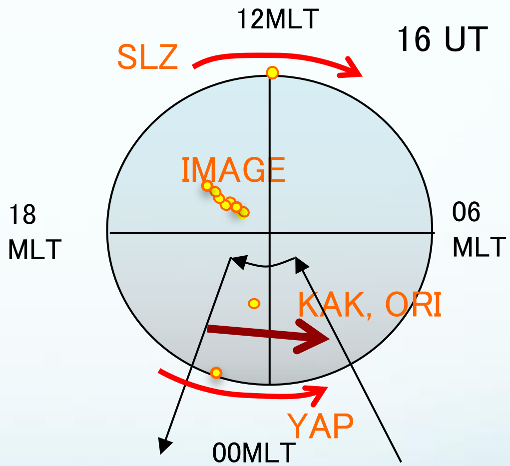
- Eastward auroral electrojets and polar cap currents
- Westward currents in subauroral latitude
- Equatorial counter electrojet on the dayside
- Positive bay at the night side low-latitudes



Nightside EEJ (2003/11/09)



1. Magnetic effects of substorm current wedge
2. Equatorial enhancement in positive bay (nightside-EEJ)
3. Eastward electric field (HFD)
4. Eastward equatorial electrojet (CEJ)



- Increase in R2 FAC
  Eastward 2.1 mV/m

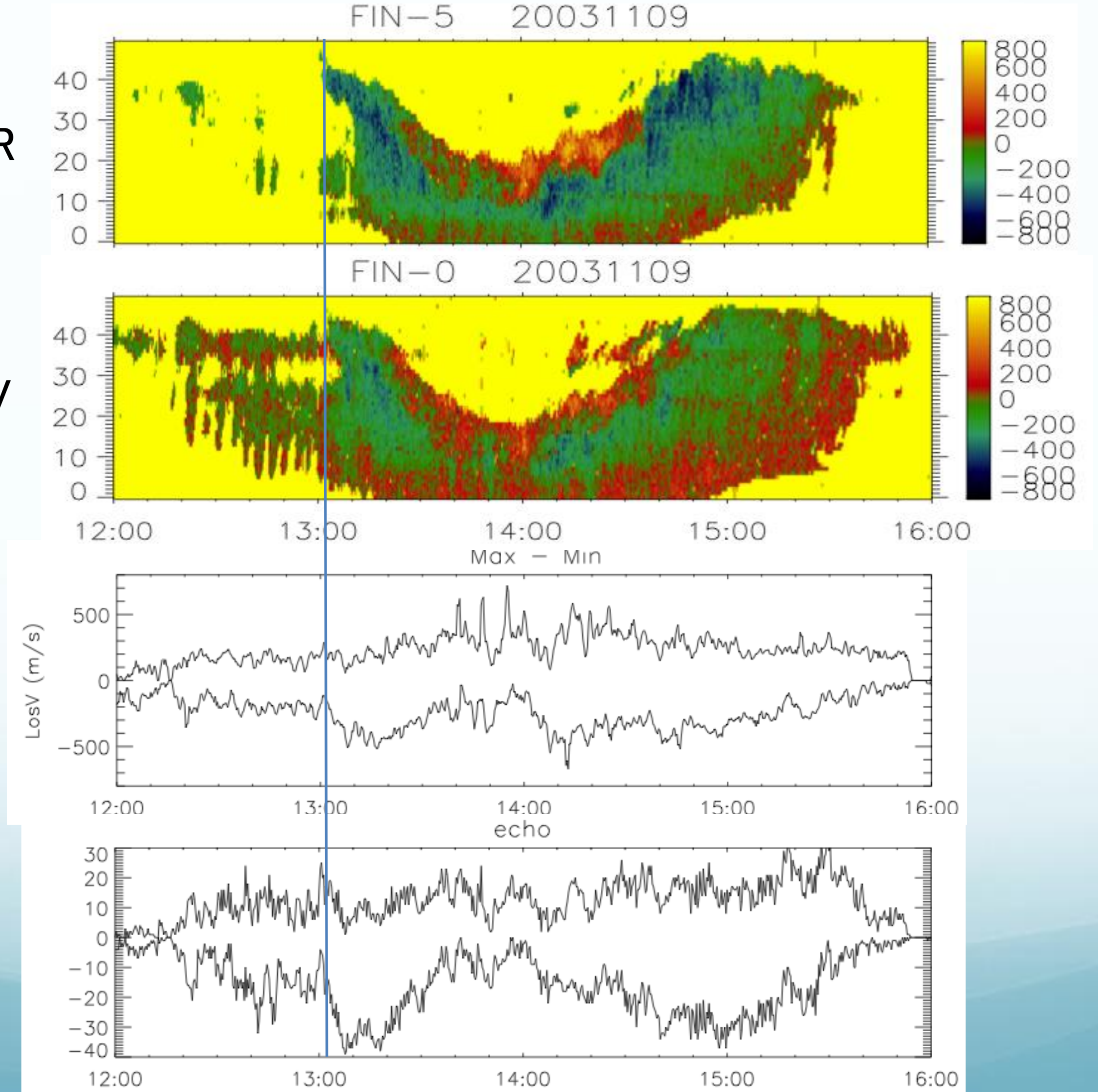
STARE-radar (2003/11/09)

PWR

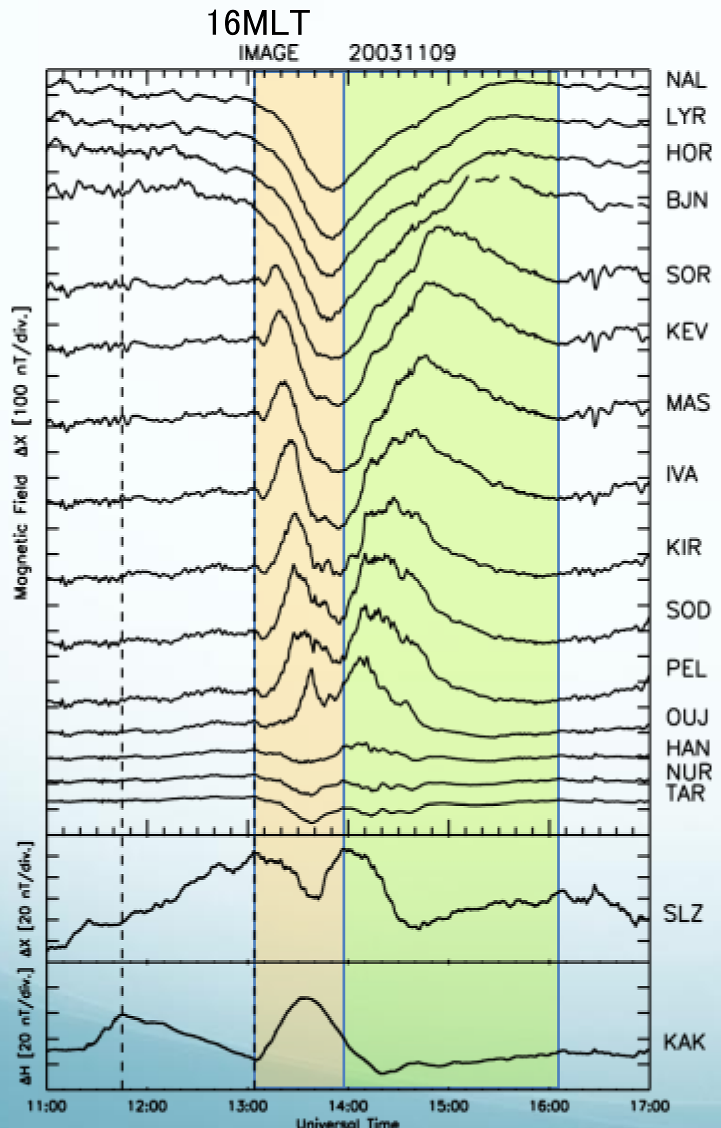
LosV

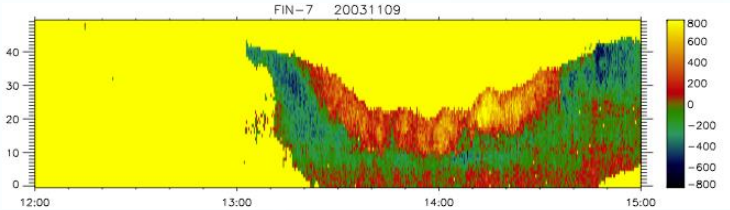
Vmax
Vmin

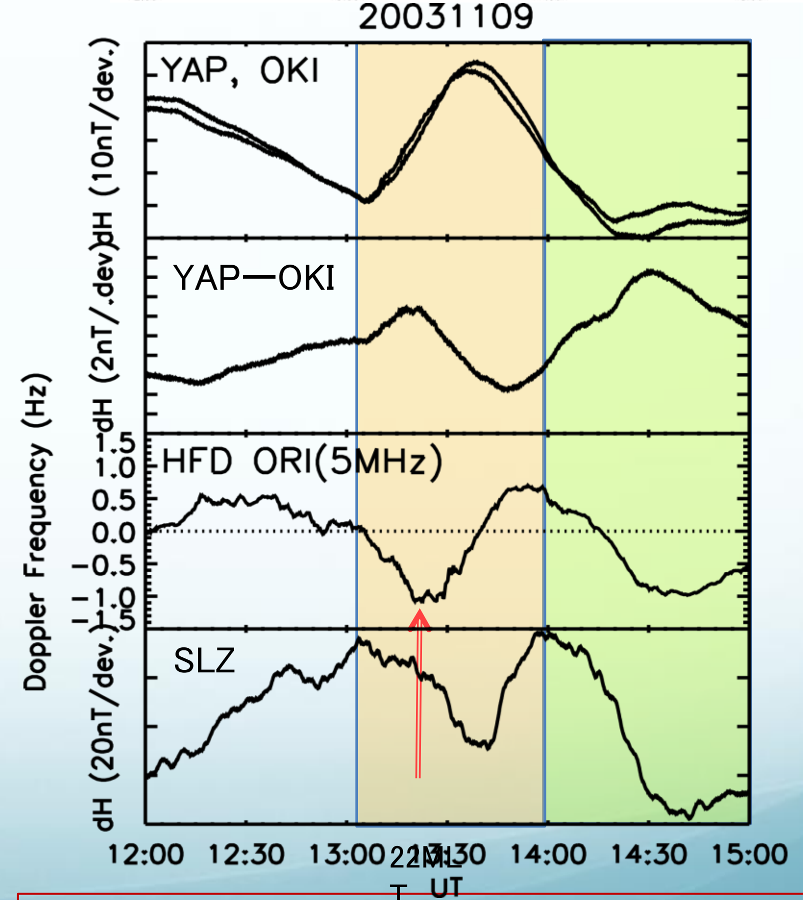
Echo



Substorm on 2003/11/09







Eastward electric field 2.1mV/m

Estimation of Electric Field at the equator

Oarai（27°　mag lat.,　nightside)

Overshielding electric field

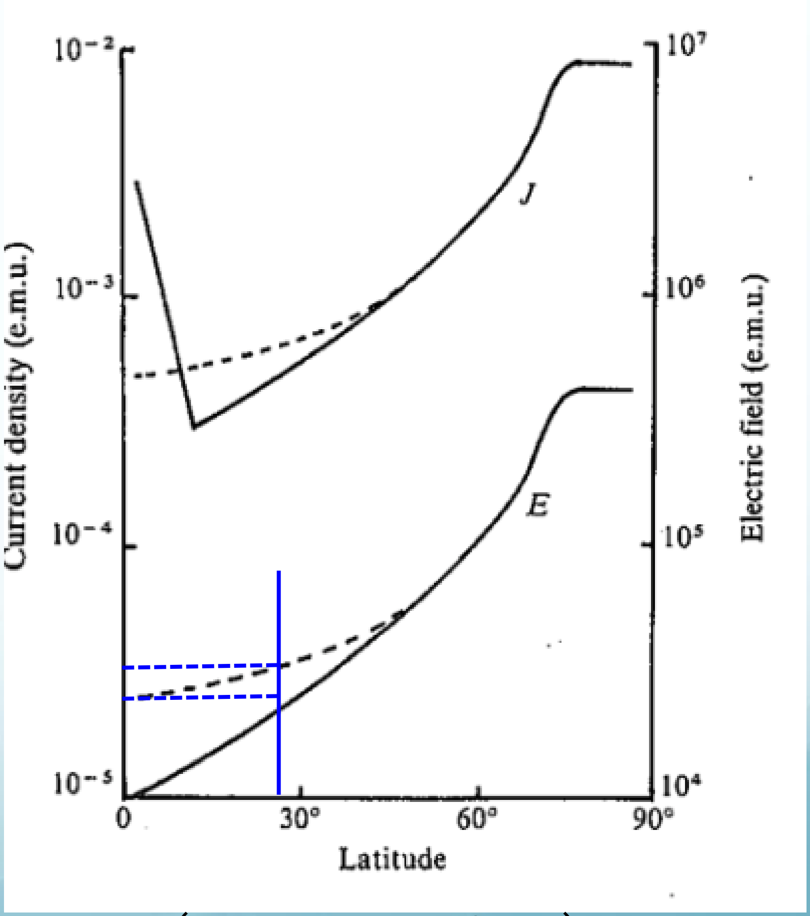
2.1 mV/m

At the magnetic equator

factor : 0.71

1.5 mV/m

Latitudinal attenuations



（Kikuchi et al. 1978）

Electric field at the equator during storm

)304 FEJER ET AL.: EQUATORIAL STORM-TIME ELECTRODYNAMICS

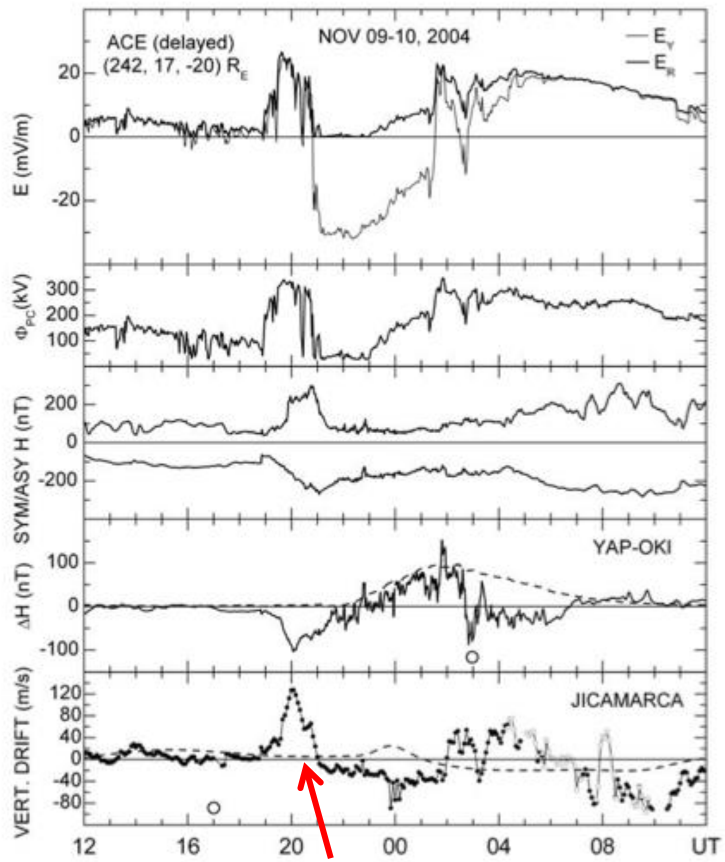


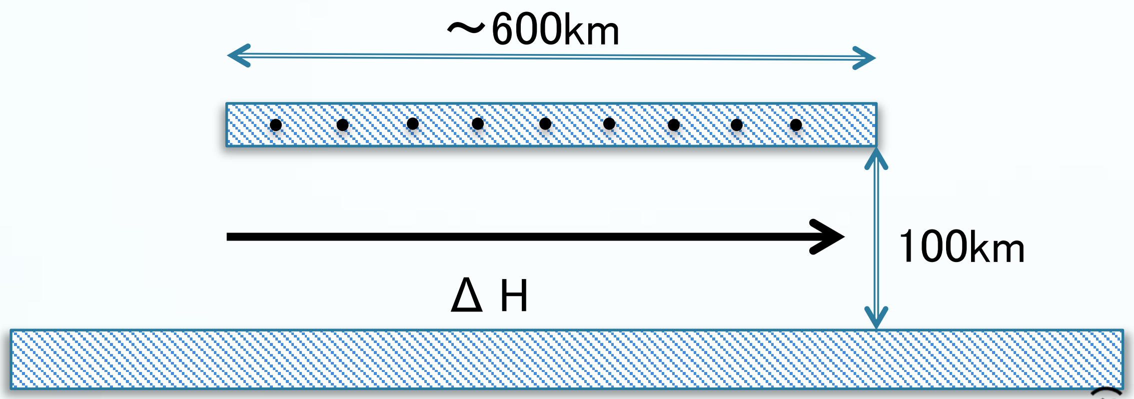
Figure 3. Same as Figure 2, but for 9–10 November 2004. The small circles in the Jicamarca data indicate plasma drifts measured over different height ranges due to the occurrence of strong spread F.

- Fejer et al. (2007) Jicamarca Radar

  storm main phase

  3 mV/m

Estimation of Cowling Conductivity

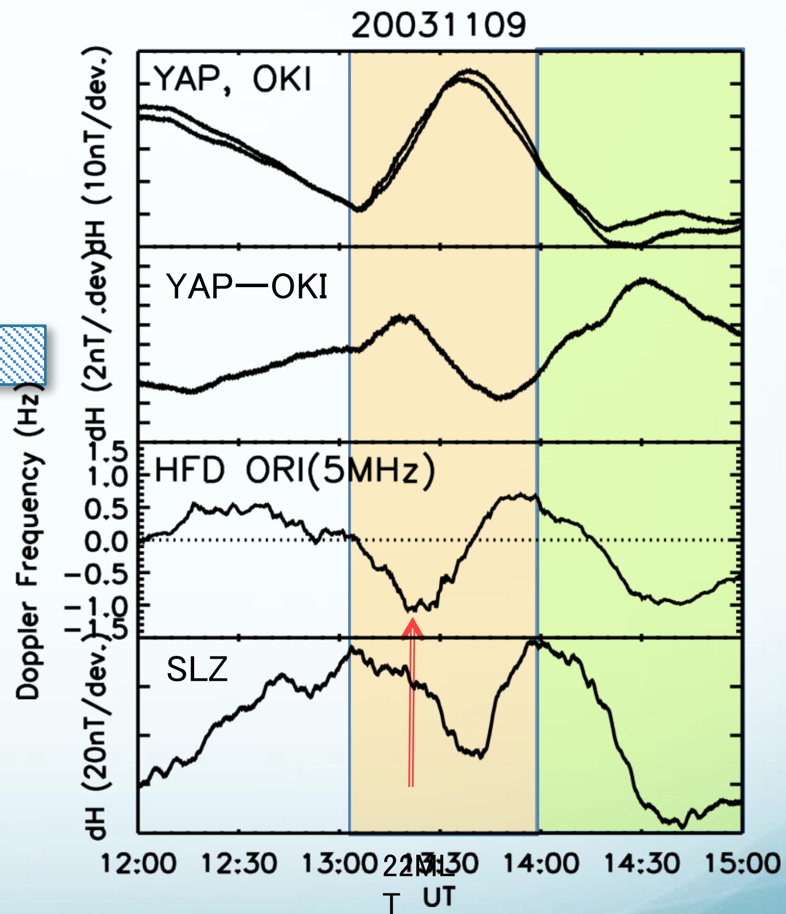


$\Delta H \sim J = \Sigma_3 \cdot E$

$\Sigma_3 = (\mu \cdot E)^{-1} \times \Delta B$

$= \underline{2.1\ (S)}$

($\Delta B =$ 4 nT, E=1.5 mV/m)



まとめ

- サブストームオンセットと同時に過遮蔽(夕→朝)電場が低昼よるの緯度赤道電離圏で同時に強まる。
- 過遮蔽電場は夜側赤道に東向き電流を流し、赤道のポジティブベイには赤道エンハンスメントが現れる。
- 夜側の過遮蔽電場は 1.5 mV/m （November 9, 2003イベント)に達する。
- 昼夜の低緯度・赤道の過遮蔽電場は夕方側オーロラ帯の高速プラズマ流と同時に観測された。