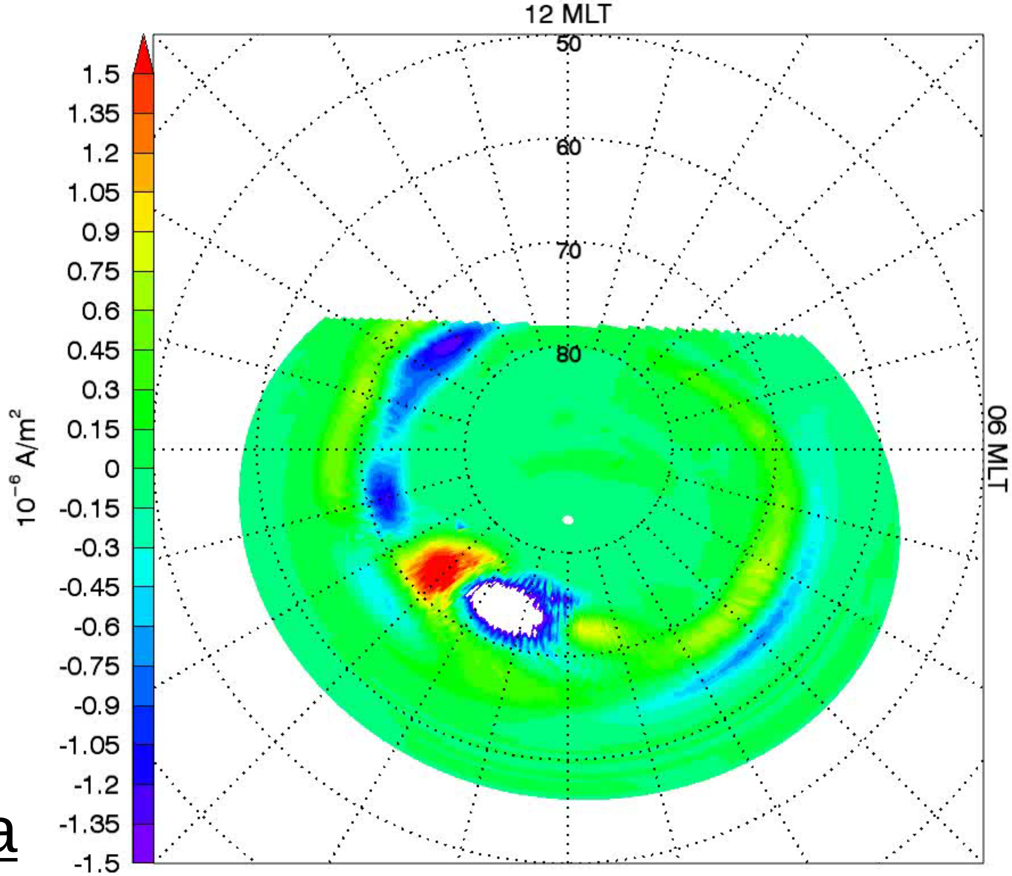
Deriving a map of FAC from SuperDARN and IMAGE/FUV



6 hrs interval on Jan 12, 2002

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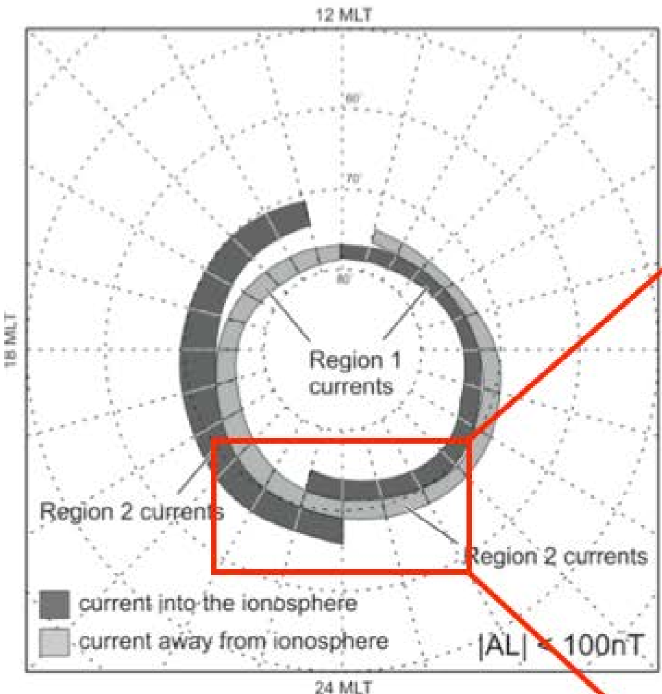
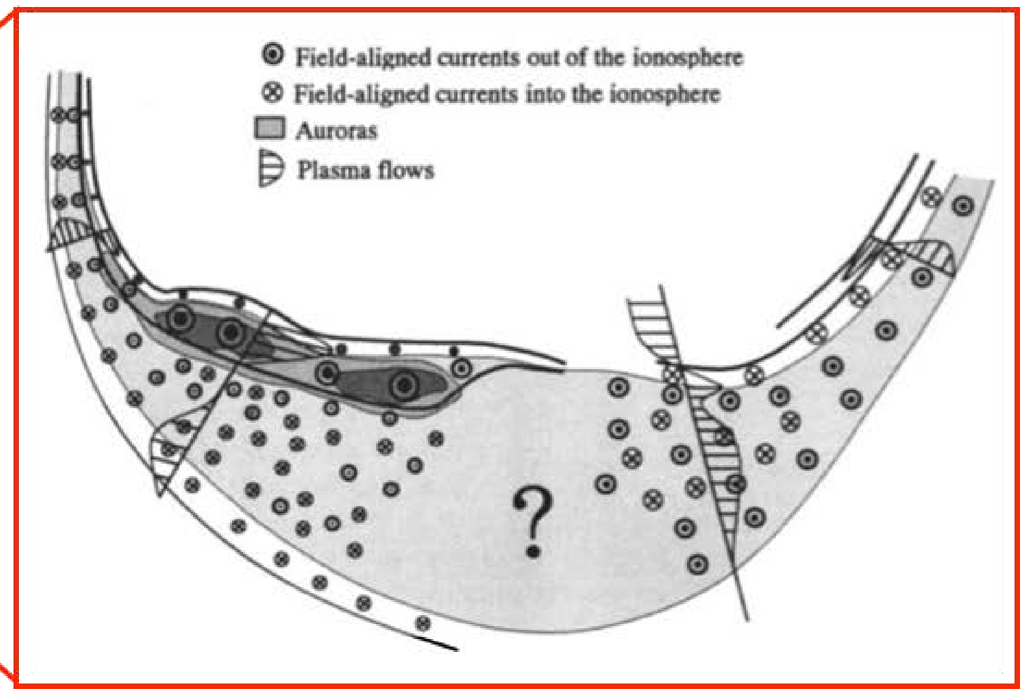
Background + Motivation

Large-scale and averaged



Iijima and Potemura, 1978

Meso-scale, time-varying during substorm



Fujii et al., 1994

電離圏の電流密度

$$\mathbf{j} = \sigma_p \mathbf{E}_\perp - \sigma_h \frac{\mathbf{E} \times \mathbf{B}}{B} + \sigma_\parallel \mathbf{E}_\parallel \quad \cdots (1)$$

(1)を高度積分すると

$$\mathbf{J} = \int \mathbf{j} \mathrm{d}h = \Sigma_P \mathbf{E}_\perp - \Sigma_H \frac{\mathbf{E} \times \mathbf{B}}{B} + \Sigma_\parallel \mathbf{E}_\parallel$$

→ 垂直成分: $\mathbf{J}_\perp$

FAC の電流密度は電離圏電流の垂直成分の発散をとり

$$\begin{aligned} \mathbf{j}_{\mathrm{FAC}} &= \nabla \cdot \mathbf{J}_\perp \\ &= \Sigma_P \nabla \cdot \mathbf{E} + \nabla \Sigma_P \cdot \mathbf{E} - (\mathbf{e}_B \times \nabla \Sigma_H) \cdot \mathbf{E} \end{aligned}$$

ジュール加熱率はオームの法則から

$$W = \mathbf{J} \cdot \mathbf{E}_\perp = \Sigma_P E_\perp^2$$

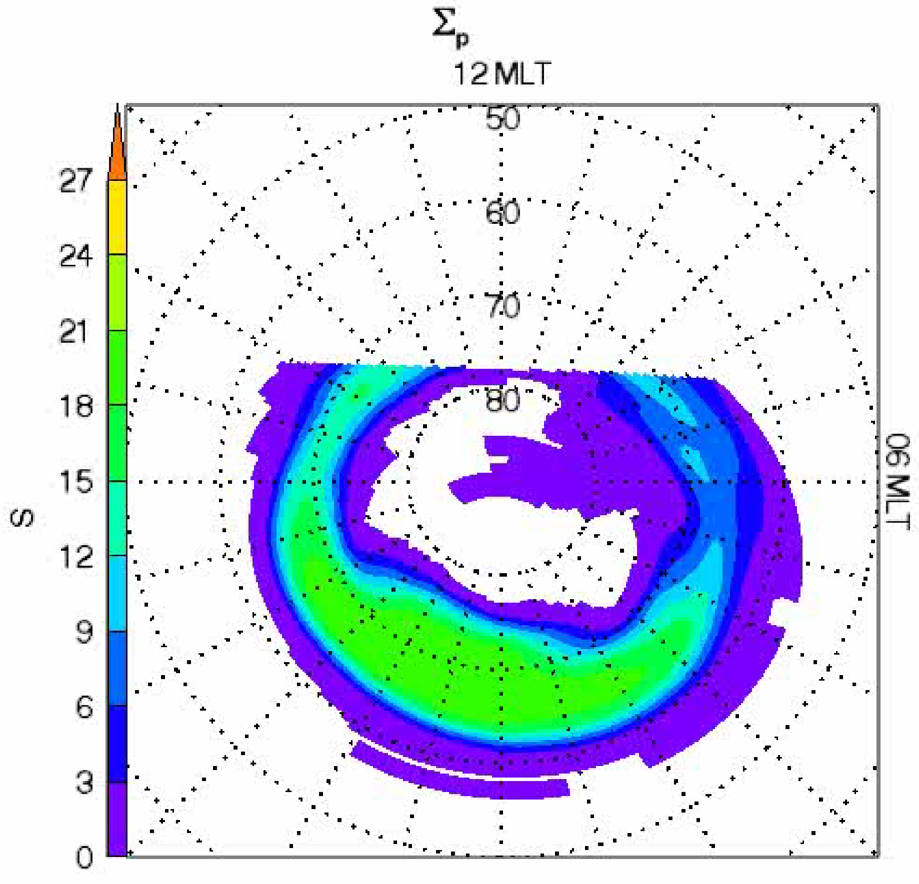
$\mathbf{e}_B$: 磁場の単位ベクトル ⟶ IGRF-11

Σ_H Σ_P : ペダーセン・ホール電気伝導度 ⟶ IMAGE 衛星

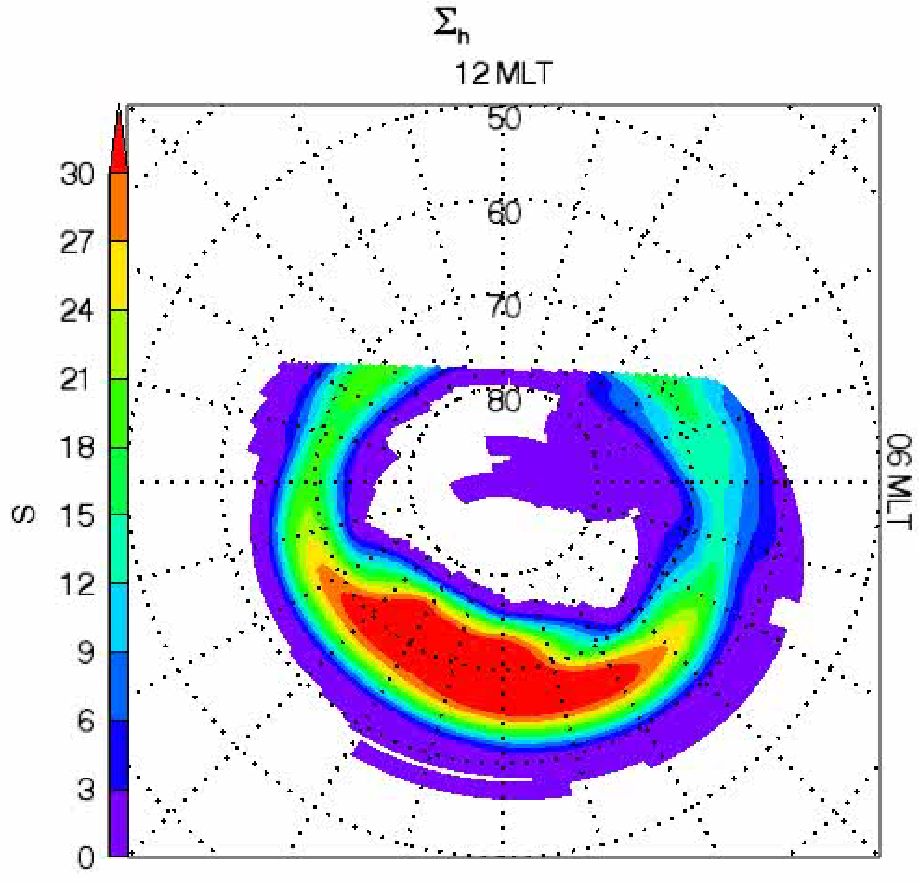
$\mathbf{E} = -\nabla V$

:極域ポテンシャル ⟶ SuperDARN

Conductivity - empirical

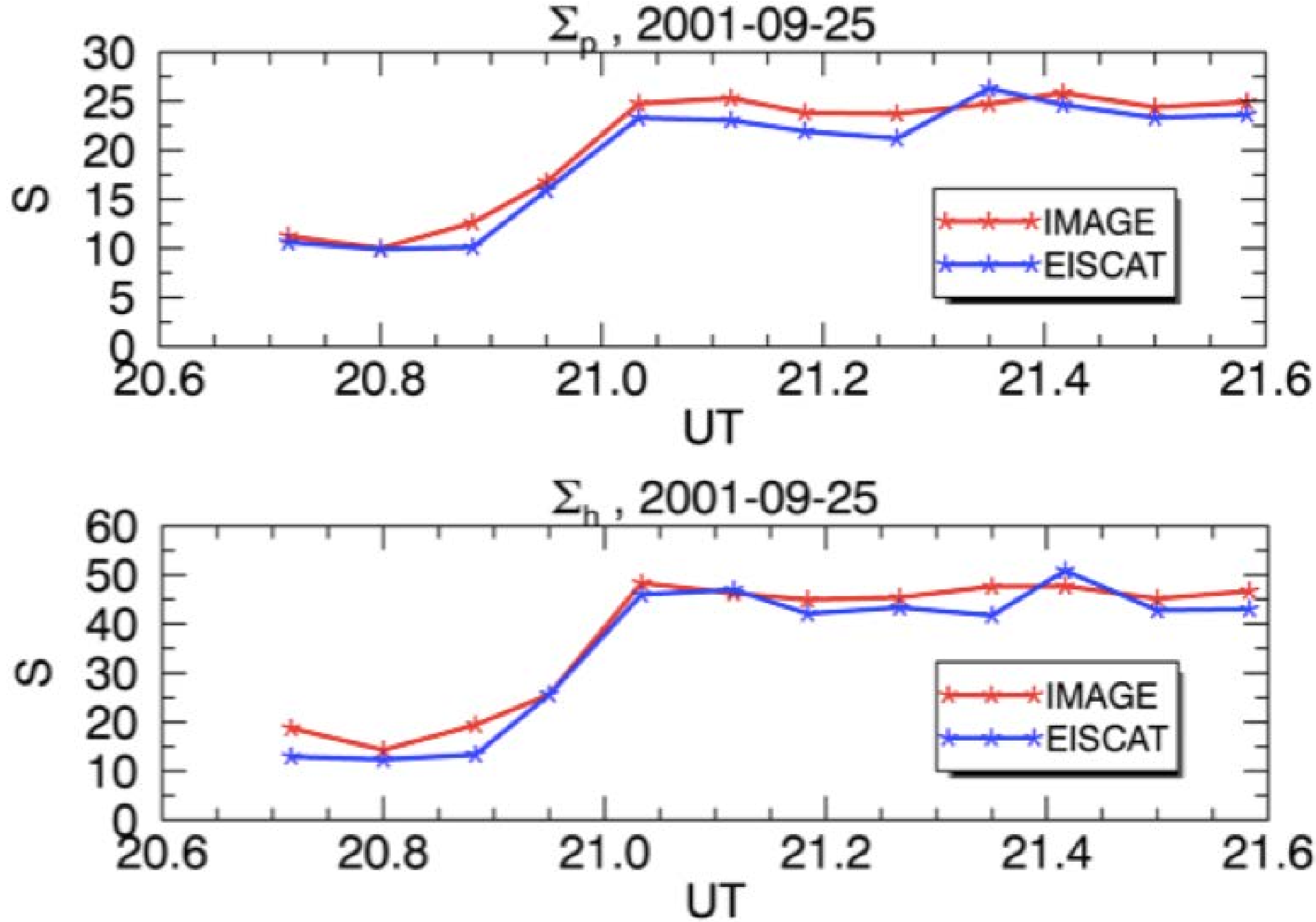


Pedersen

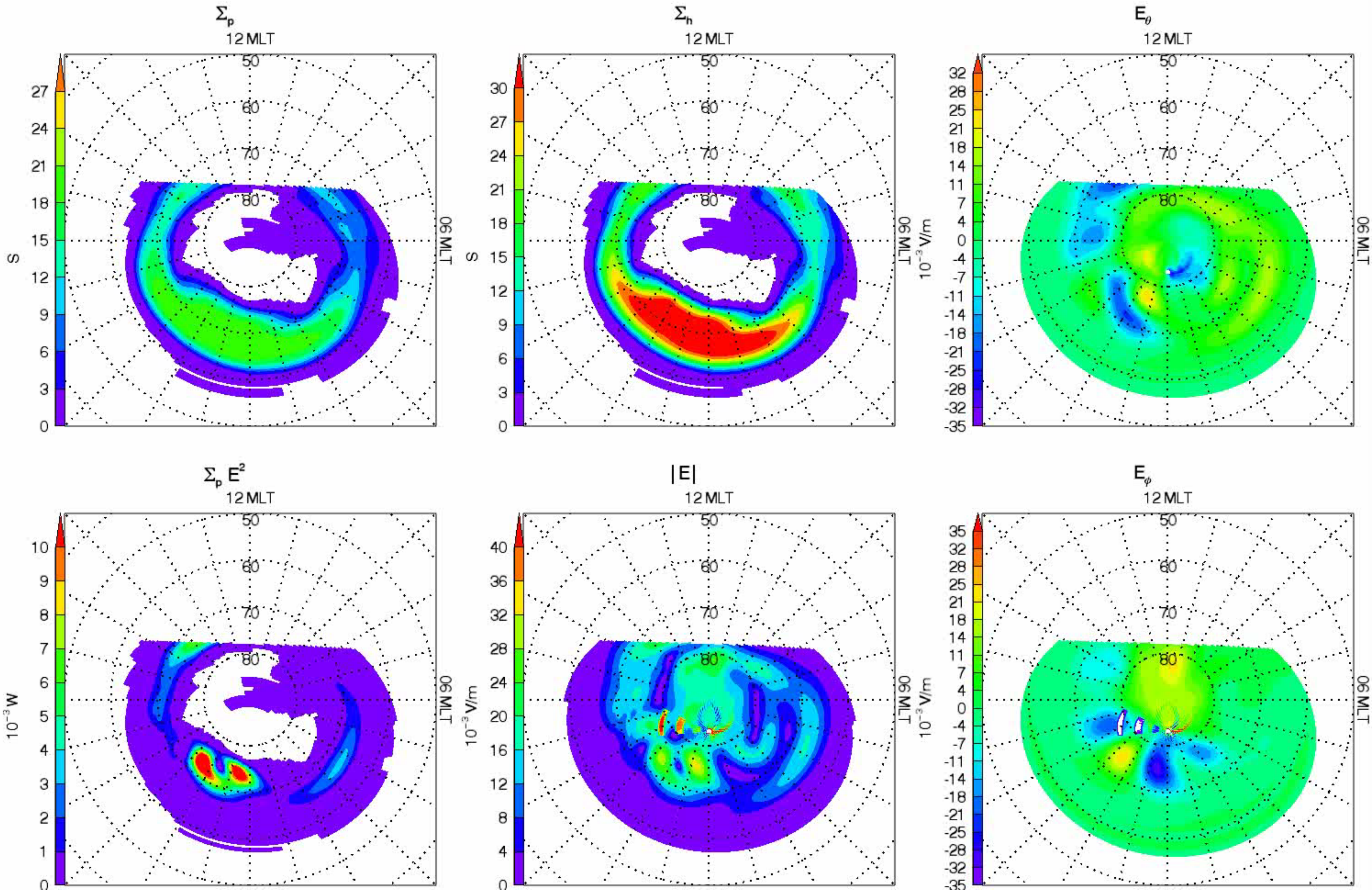


Hall

Validation of the conductivities



Conductivity + Electric field



電離圏の電流密度

$$\mathbf{j} = \sigma_p \mathbf{E}_\perp - \sigma_h \frac{\mathbf{E} \times \mathbf{B}}{B} + \sigma_\parallel \mathbf{E}_\parallel \quad \cdots (1)$$

(1)を高度積分すると

$$\mathbf{J} = \int \mathbf{j} \mathrm{d}h = \Sigma_P \mathbf{E}_\perp - \Sigma_H \frac{\mathbf{E} \times \mathbf{B}}{B} + \Sigma_\parallel \mathbf{E}_\parallel$$

→ 垂直成分: $\mathbf{J}_\perp$

FAC の電流密度は電離圏電流の垂直成分の発散をとり

$$\mathbf{j}_{\mathrm{FAC}} = \nabla \cdot \mathbf{J}_\perp$$
$$= \Sigma_P \nabla \cdot \mathbf{E} + \nabla \Sigma_P \cdot \mathbf{E} - (\mathbf{e}_B \times \nabla \Sigma_H) \cdot \mathbf{E}$$

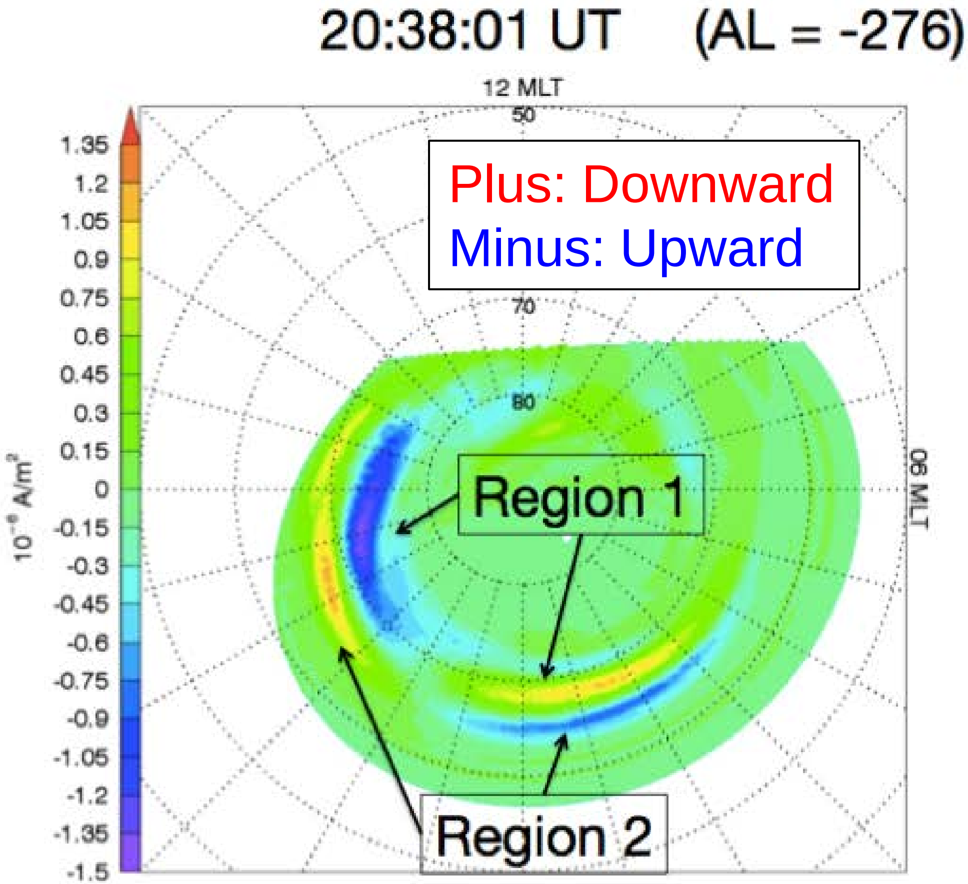
ジュール加熱率はオームの法則から

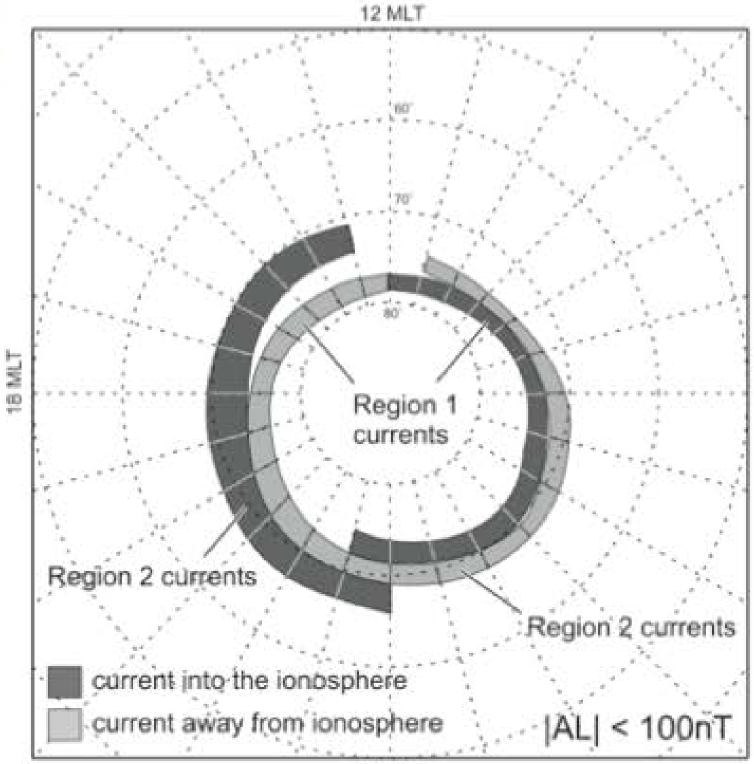
$$W = \mathbf{J} \cdot \mathbf{E}_\perp = \Sigma_P E_\perp^2$$

$\mathbf{e}_B$: 磁場の単位ベクトル ⟶ IGRF-11

Σ_H Σ_P : ペダーセン・ホール電気伝導度 ⟶ IMAGE 衛星

$\mathbf{E} = -\nabla V$:極域ポテンシャル ⟶ SuperDARN





Distribution of FAC

[Iijima and Potemura, 1978]

Averaged FAC density [μA / m²] [Iijima and Potemura, 1978]

	Afternoon to Midnight		Midnight to Forenoon	
	Region 1	Region 2	Region 1	Region 2
|AL| < 100	-1.1	0.6	1.1	-0.7
|AL| ≧ 100	-1.3	0.7	1.6	-1.1

Validation with CHAMP B-field

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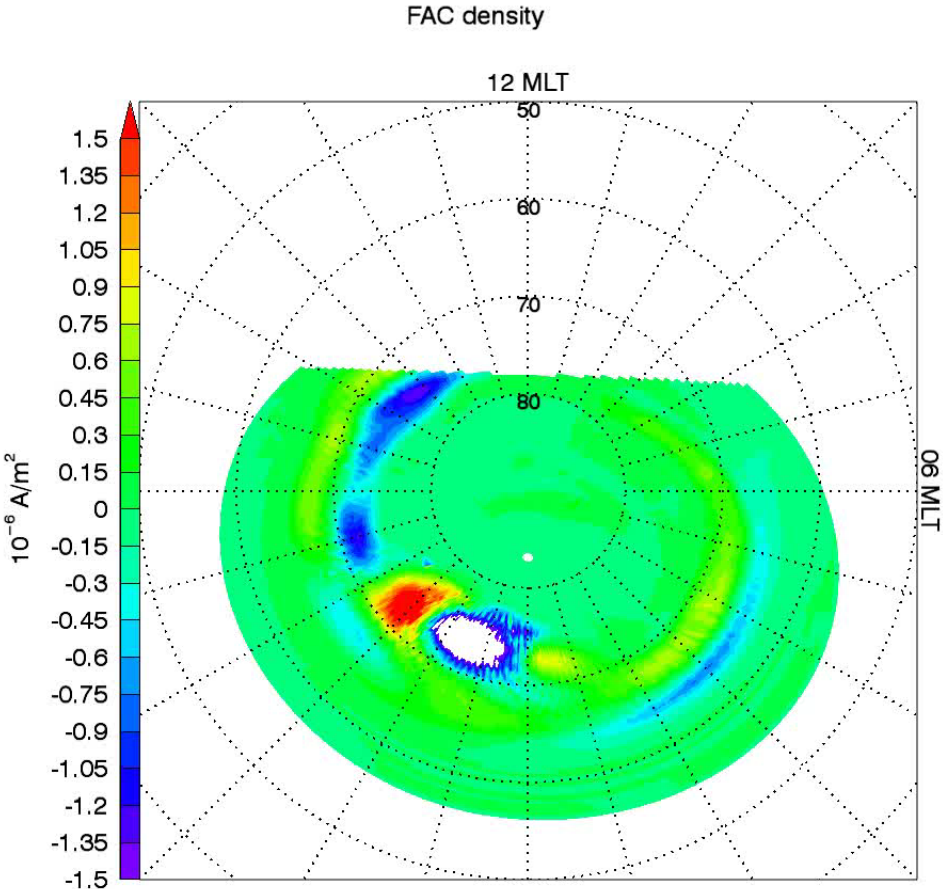
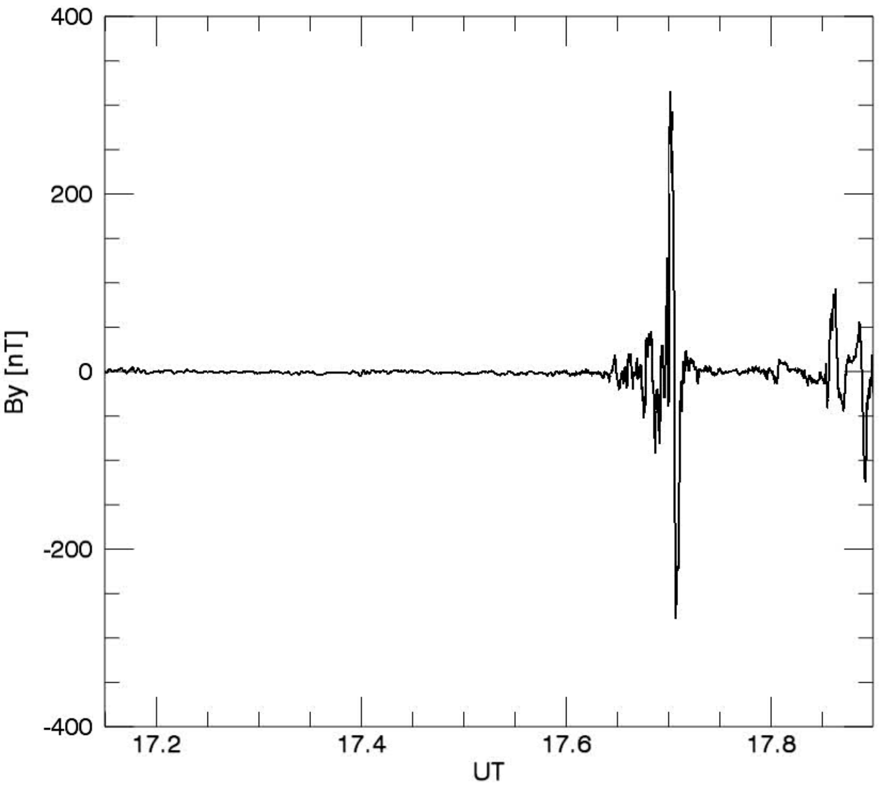
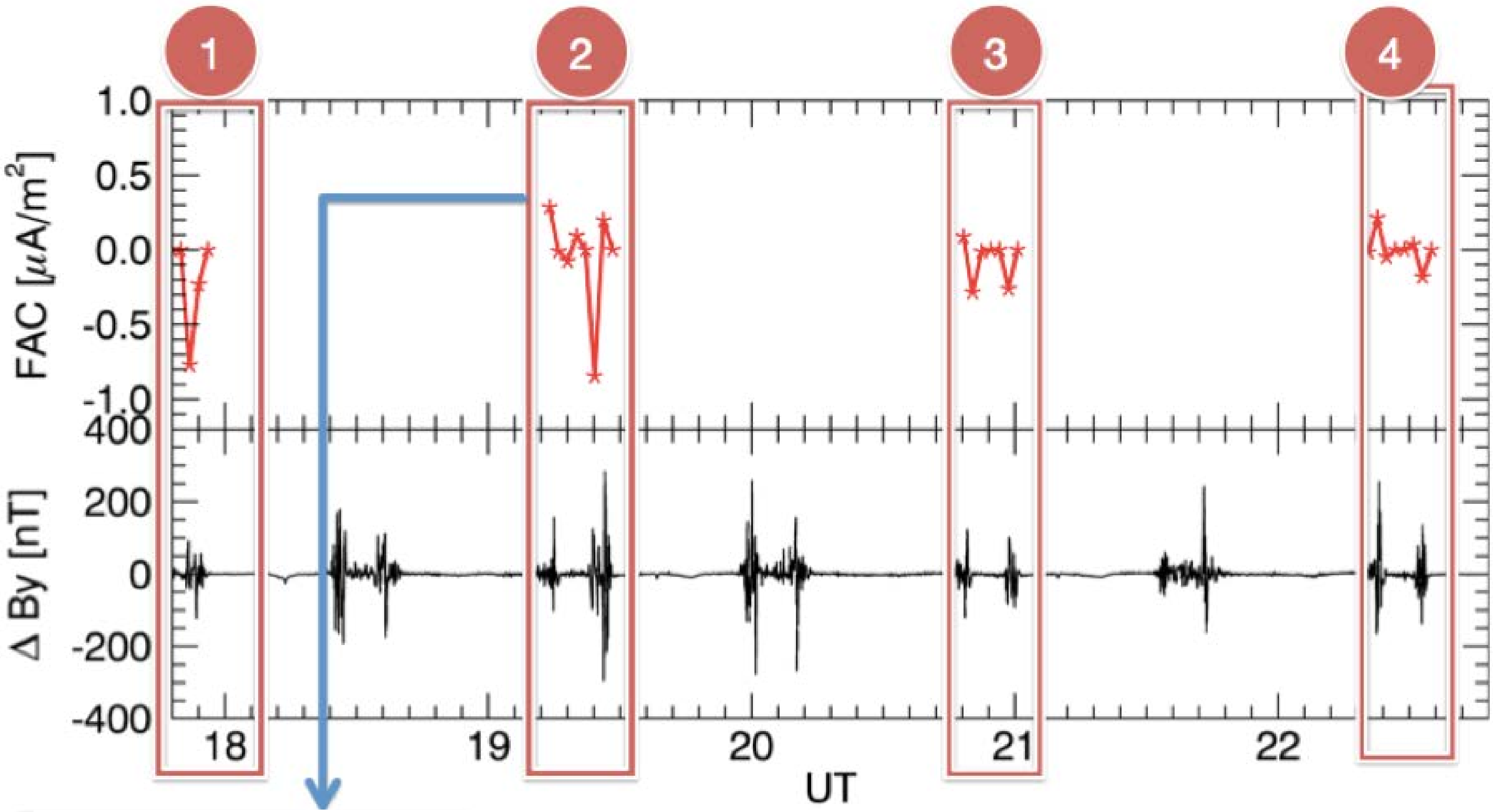


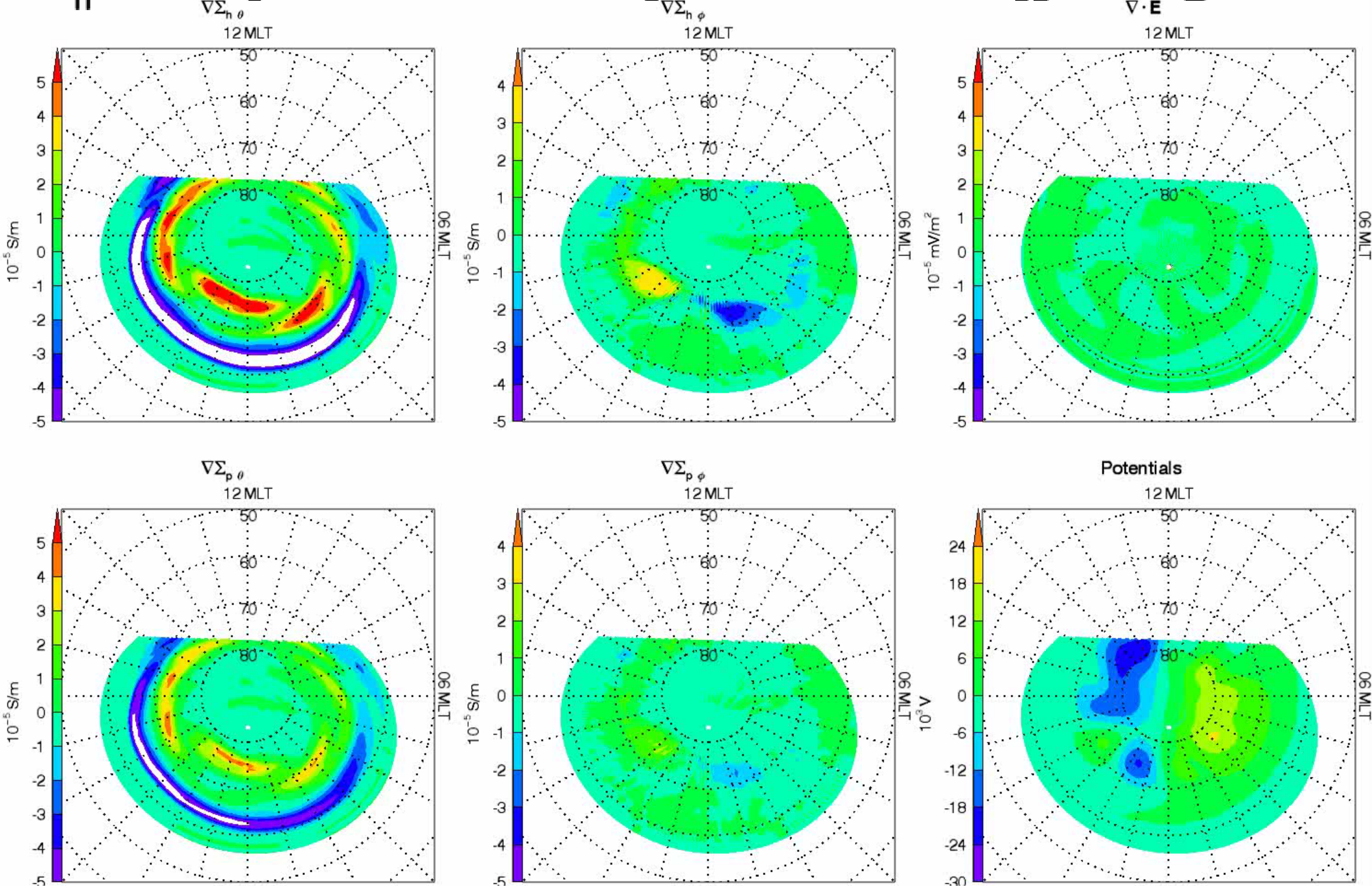


Validation with CHAMP B-field

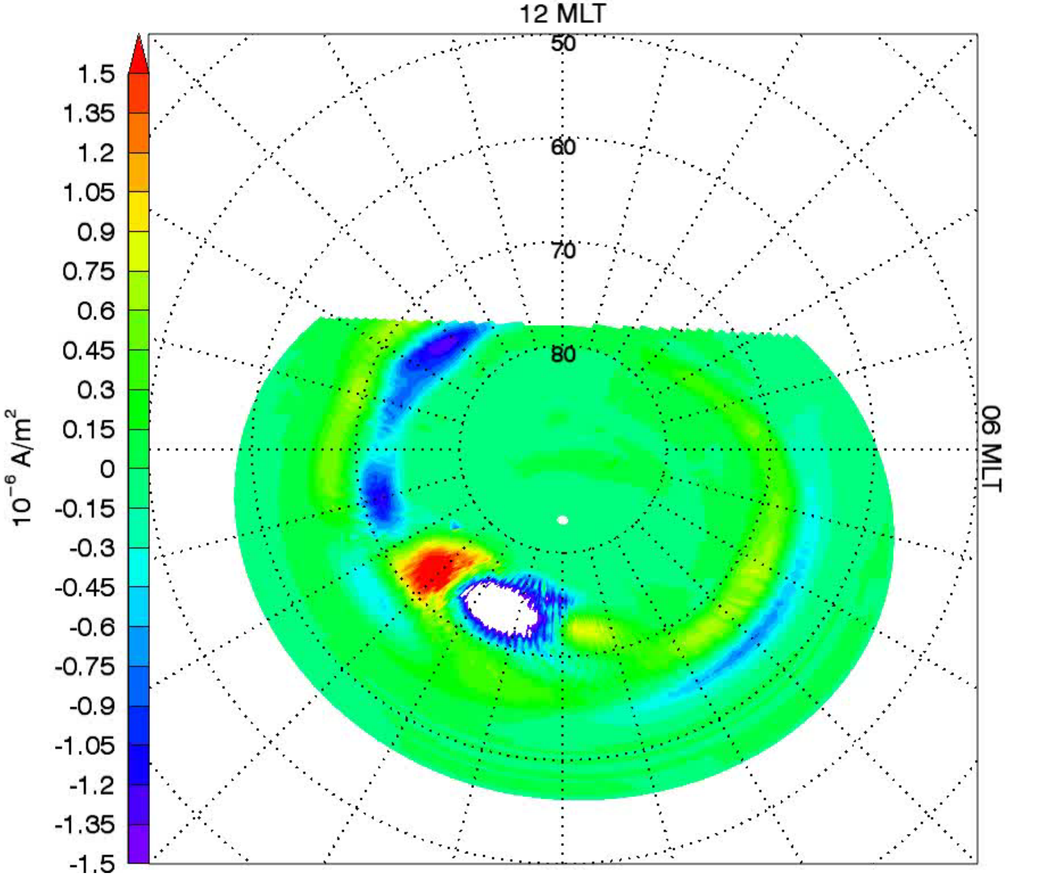


Larger B-field changes in the large FAC region

$$j_{\parallel} = \Sigma_P \nabla \cdot \mathbf{E} + \nabla \Sigma_P \cdot \mathbf{E} + (\nabla \Sigma_H \times \hat{e}_B) \cdot \mathbf{E}$$



Summary



- Now we are trying to derive a map of FAC from SD + IMAGE
- The estimated intensities of FACs are consistent with the values of Iijima and Potemura [1978]
- The estimated spatial distribution of FACs are consistent also with the simultaneous observations of the residual magnetic field by CHAMP
- We will soon start discussing the 2D pattern of FACs during substorm intervals by using these data products