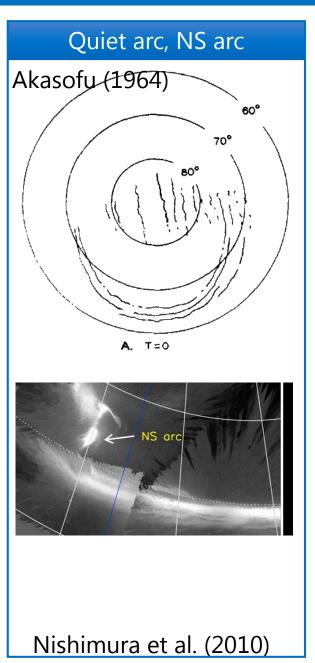
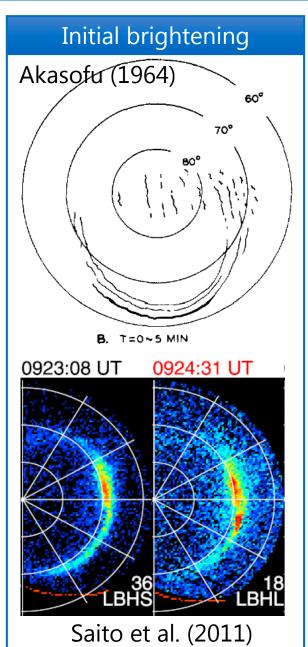
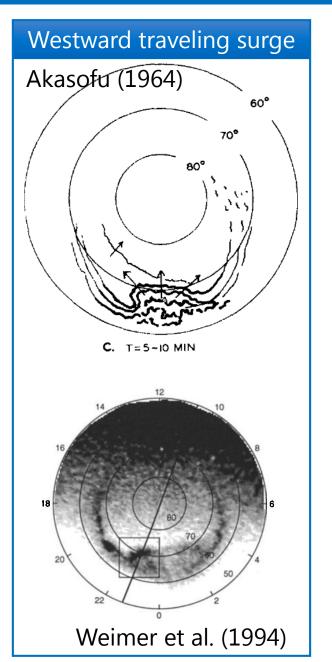
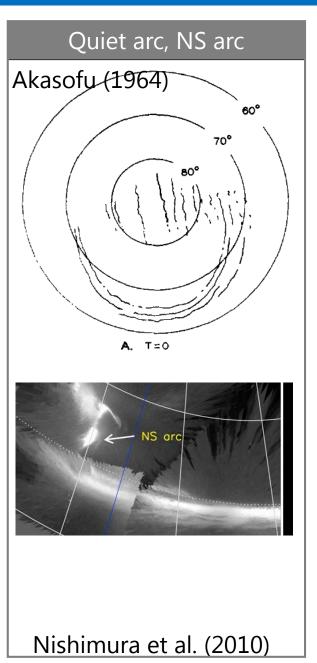
サブストームと対流パターン

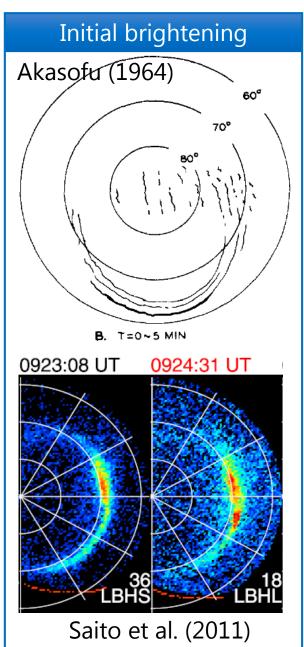
Yusuke Ebihara (RISH, Kyoto University, Japan) Takashi Tanaka (Kyushu University, Japan)

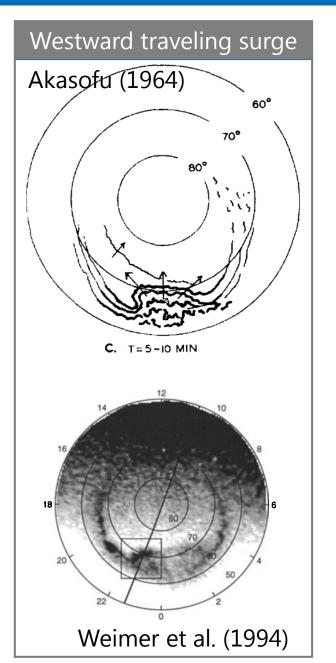




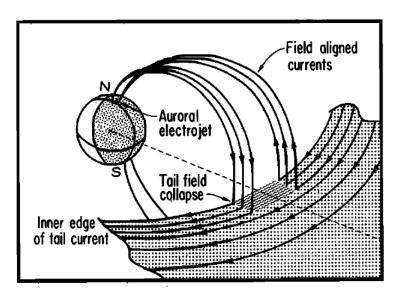






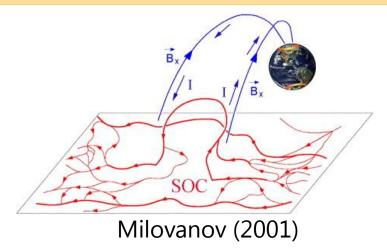


Current wedge電流モデル

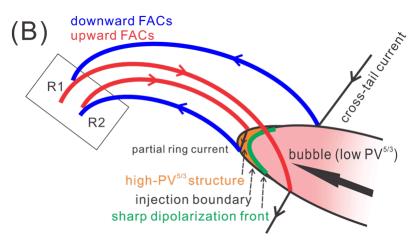


McPherron et al. (1973)

Self-organized branching

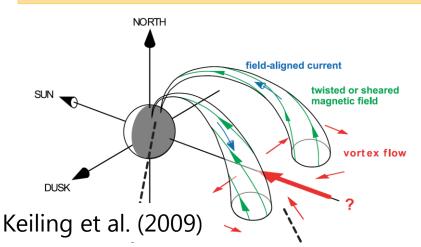


Plasma bubble

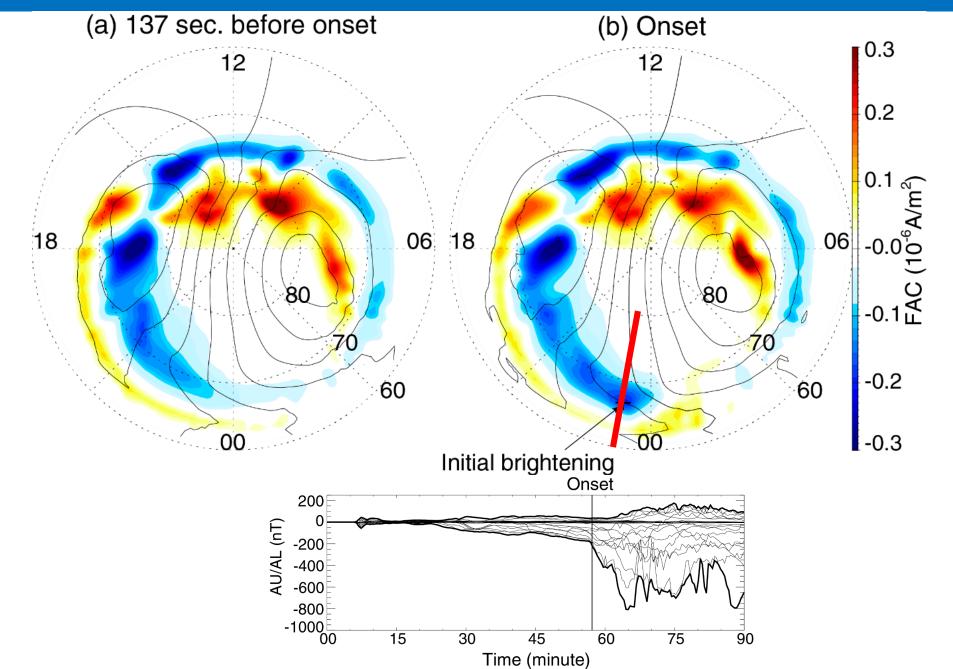


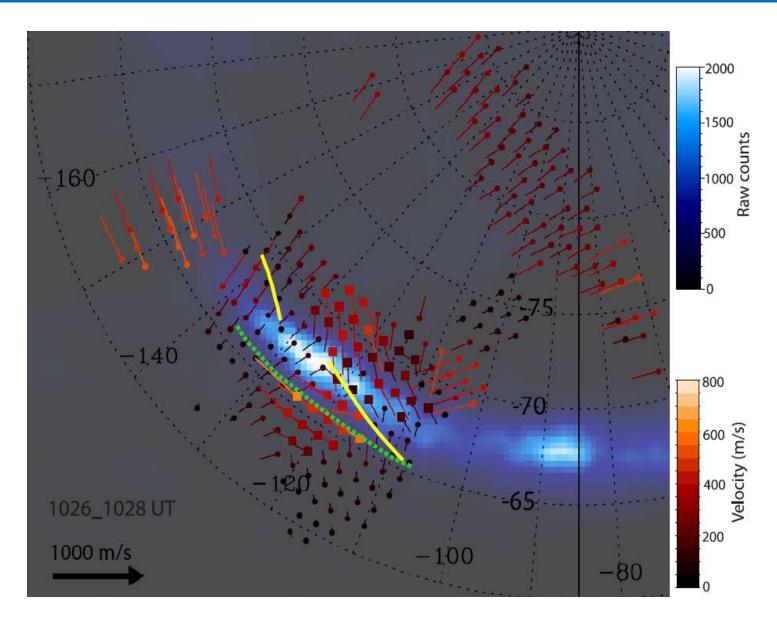
Yang et al. (2012)

Space tornado



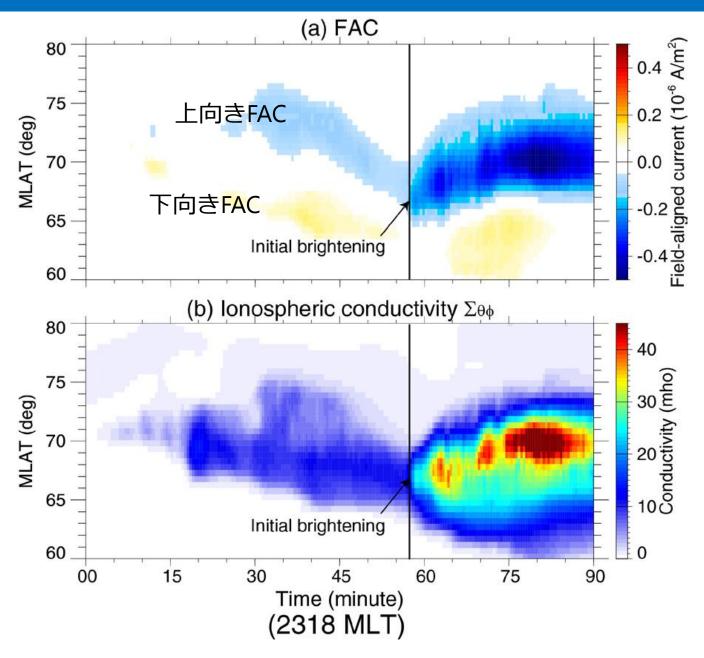
沿磁力線電流





Zou et al. (2009)

沿磁力線電流と電気伝導度(ケオグラム)



FACの考え方

$$\nabla \bullet \mathbf{J}_{\parallel} = -\nabla \bullet \mathbf{J}_{\perp}$$

$$= -\nabla \bullet \left[\frac{\mathbf{B}}{B^{2}} \times \left(\rho \frac{d\mathbf{V}}{dt} + \nabla P \right) \right]$$

$$= -\rho \frac{d}{dt} \left(\frac{\Omega_{\parallel}}{B} \right) - \frac{\mathbf{J}_{\perp} \bullet \nabla B}{B^{2}} + \frac{\mathbf{J}_{in} \bullet \nabla n}{n}$$

$$= \frac{\partial}{\partial t} \left(\frac{\partial \mathbf{J}_{\parallel}}{\partial t} \right) - \frac{\partial \mathbf{J}_{\perp} \bullet \nabla B}{\partial t} + \frac{\partial \mathbf{J}_{lin} \bullet \nabla n}{\partial t}$$

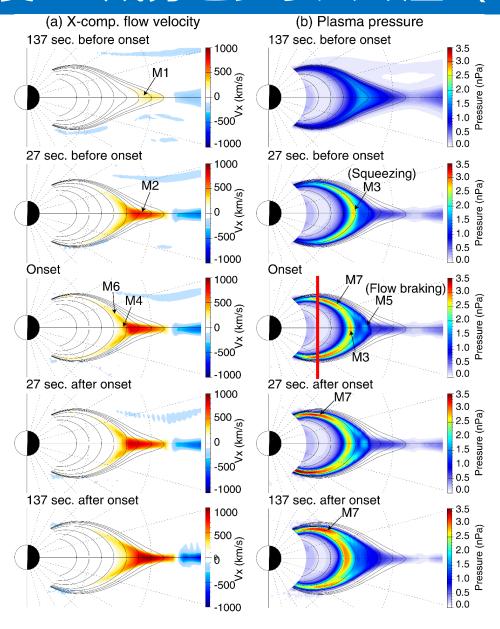
$$J_{\parallel, \text{ionosphere}} = B_{ionosphere} \int \left[\frac{\rho}{B} \frac{d}{dt} \left(\frac{\Omega_{\parallel}}{B} \right) + \frac{\mathbf{J}_{\perp} \bullet \nabla B}{B^{2}} - \frac{\mathbf{J}_{in} \bullet \nabla n}{nB} \right] ds$$

Hasegawa and Sato (1979)

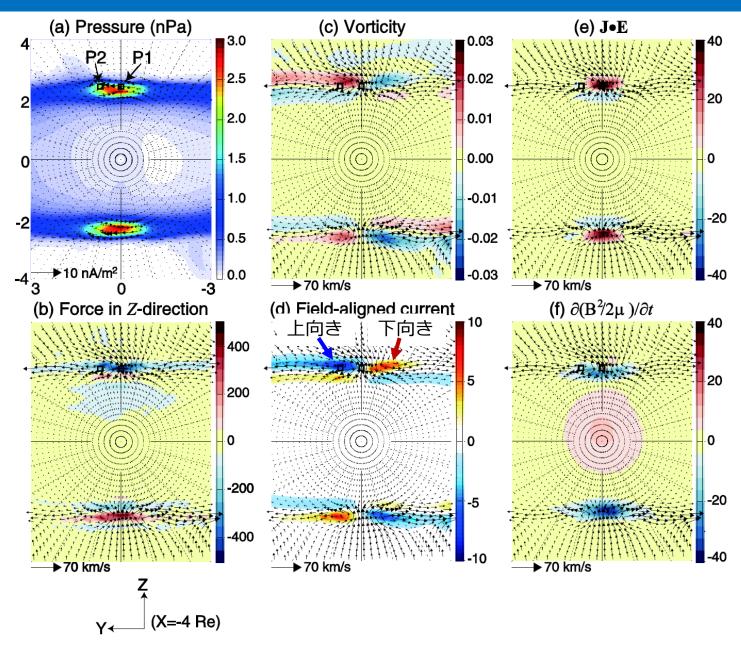
$$\frac{\partial J_{\parallel}}{\partial t} = -\frac{1}{\mu_0} (\nabla \times \nabla \times \mathbf{E})_{\parallel},$$

$$\Box \frac{1}{\mu_0} \mathbf{B} \bullet \nabla \Omega_{\parallel}.$$

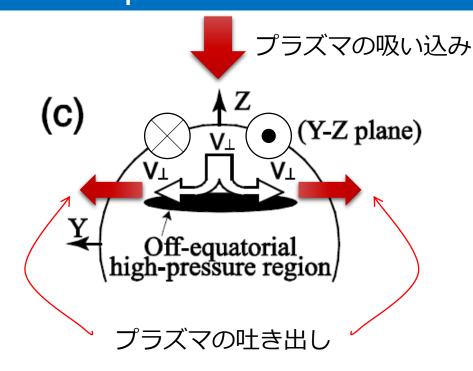
Song and Lysak (2001), Paschmann et al. (2002)

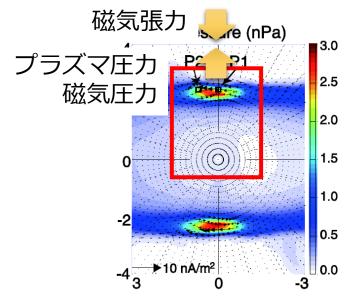


YZ平面図(X=-4 Re)



Off-equatorにおける渦の生成



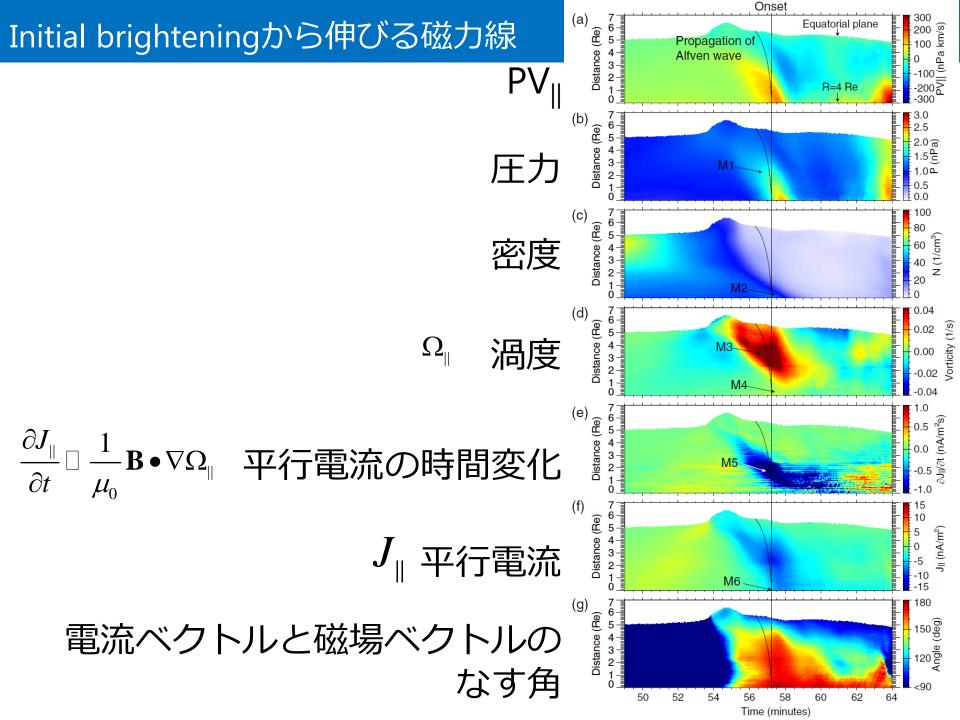


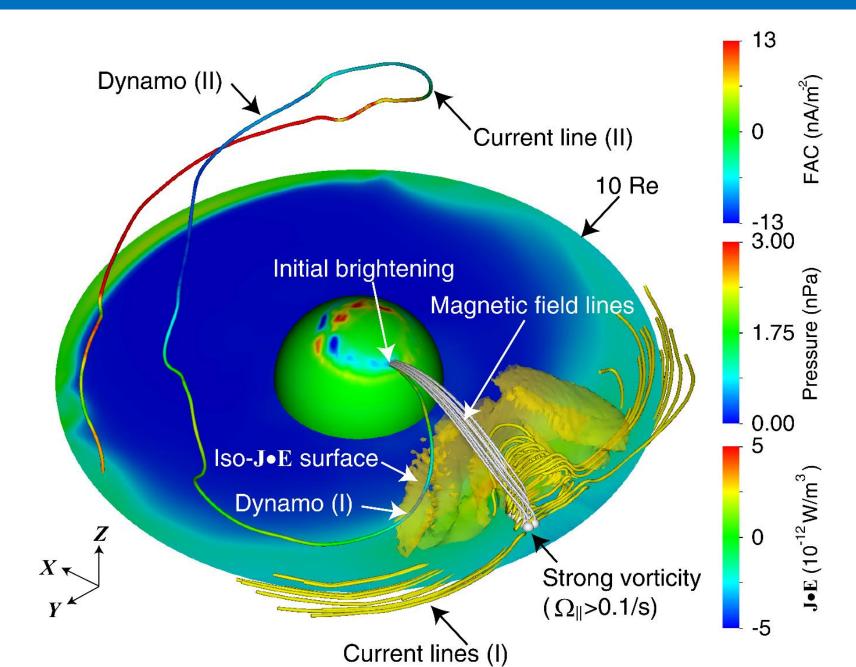
プラズマの吸い込み(北半球)

- 1) プラズマ圧が急増
- 2) 磁場が減少
- 3) 北向きの磁気圧力が減少 (プラズマ圧力の上昇を上回る)
- 4) プラズマは南向きに加速

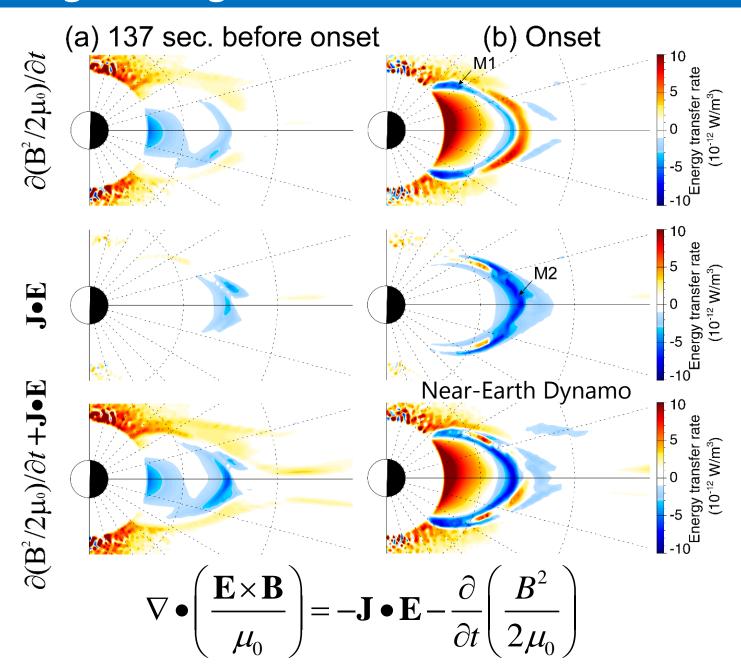
プラズマの吐き出し(午後側)

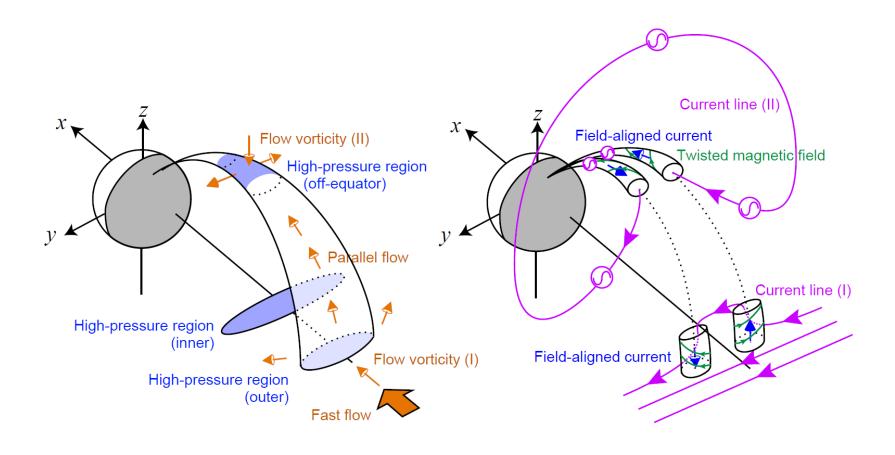
- 1) プラズマ圧が急増
- 2) 磁場が減少
- 3) Y方向の磁気圧力が減少 (プラズマ圧力の上昇を上回る)
- 4) プラズマはY方向に加速

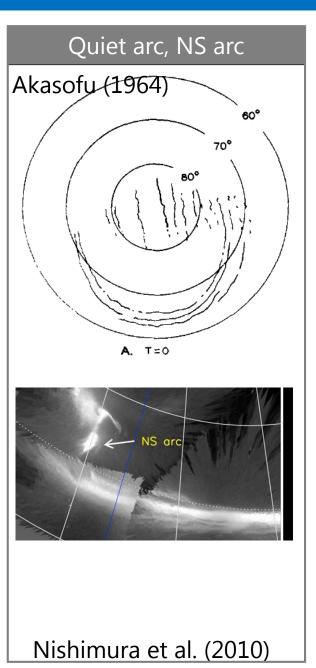


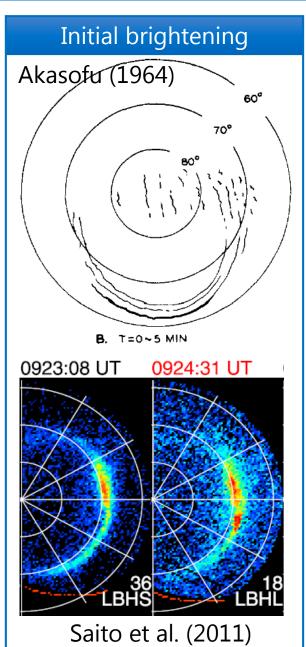


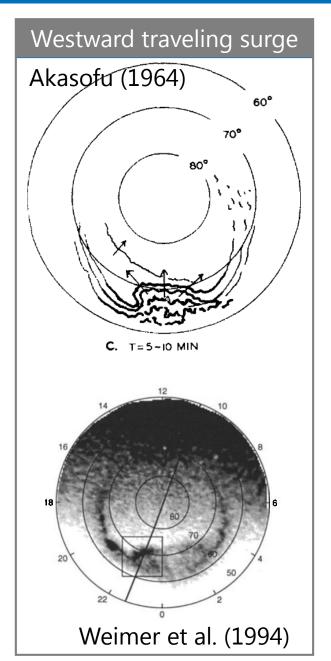
Initial brightening時のダイナモ

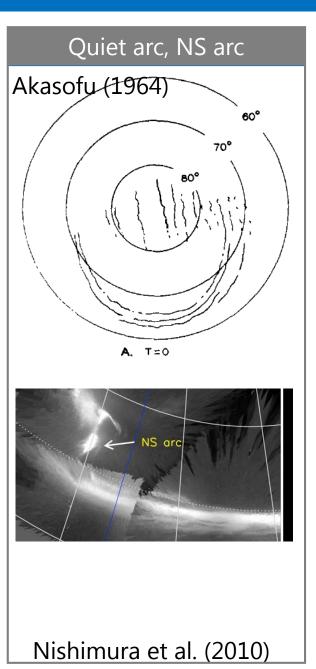


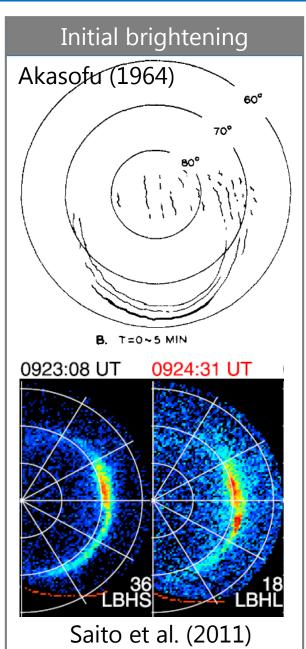


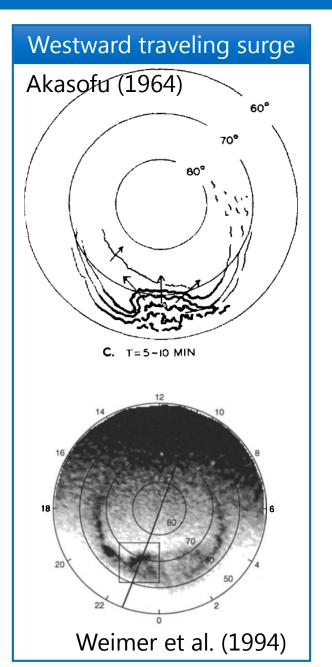




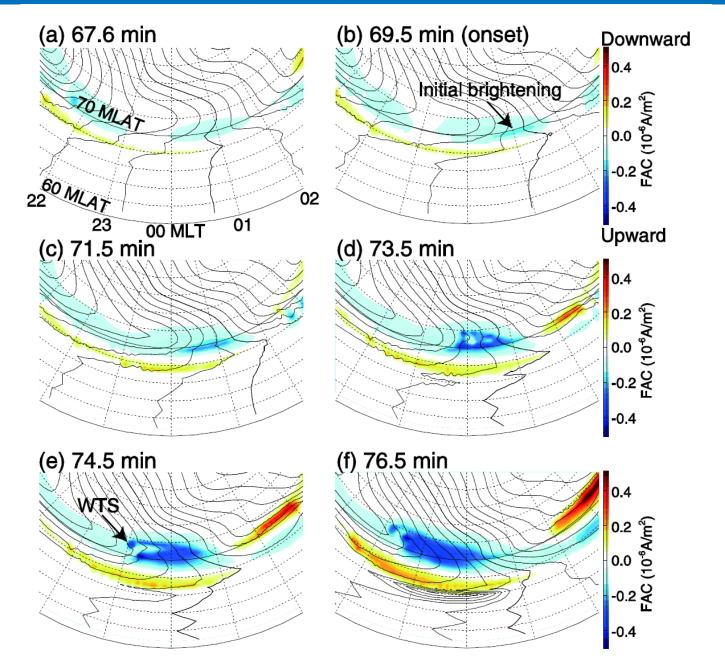








Westward traveling surge (WTS)



まとめ (initial brighteningとWTS)

- NENL形成に伴う張力が地球向きプラズマ流を促す。 ブレーキングに伴って平行流に変換され、低高度に高 圧領域を作る。この高圧領域は強いFACを作る。
 - →Initial brightening
 - 低高度のFACは反磁性電流に打ち勝ち、電離圏と繋がる。
 - 磁気赤道面付近のFACは反磁性電流に打ち負かされ、 電離圏と繋がるようなcurrent wedgeを作る事ができない。
- ■電気伝導度の勾配があるためHall電流が溢れる。 多くは上向きFACに、一部はPedersen電流に接続する。 空間電荷が下部磁気圏のプラズマを動かし、強い上向 きFACを作る。
 - →Westward traveling surge (WTS)
 - WTSヘッドの反時計回りのプラズマフローが重要

Ebihara and Tanaka, Substorm simulation: Insight into the mechanisms of initial brightening, JGR, 2015. Ebihara and Tanaka, Substorm simulation: Formation of westward traveling surge, JGR, submitted. Ebihara and Tanaka, Substorm simulation: Quiet and N-S arcs preceding auroral breakup, JGR, submitted.