中緯度短波レーダー研究会2011.1.31（名古屋大学）

Substorm/storm時の過遮蔽電場
Overshielding electric fields during substorm/storms

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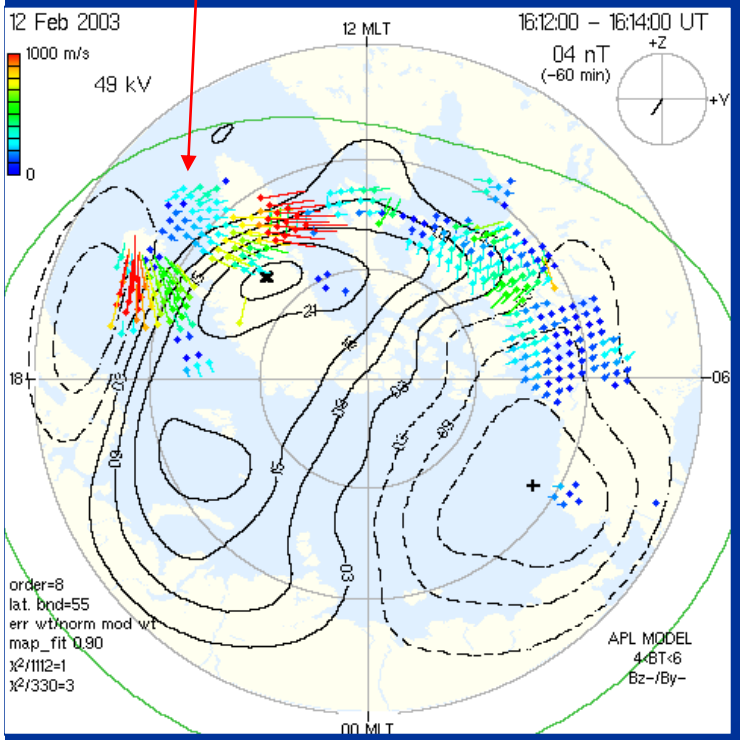
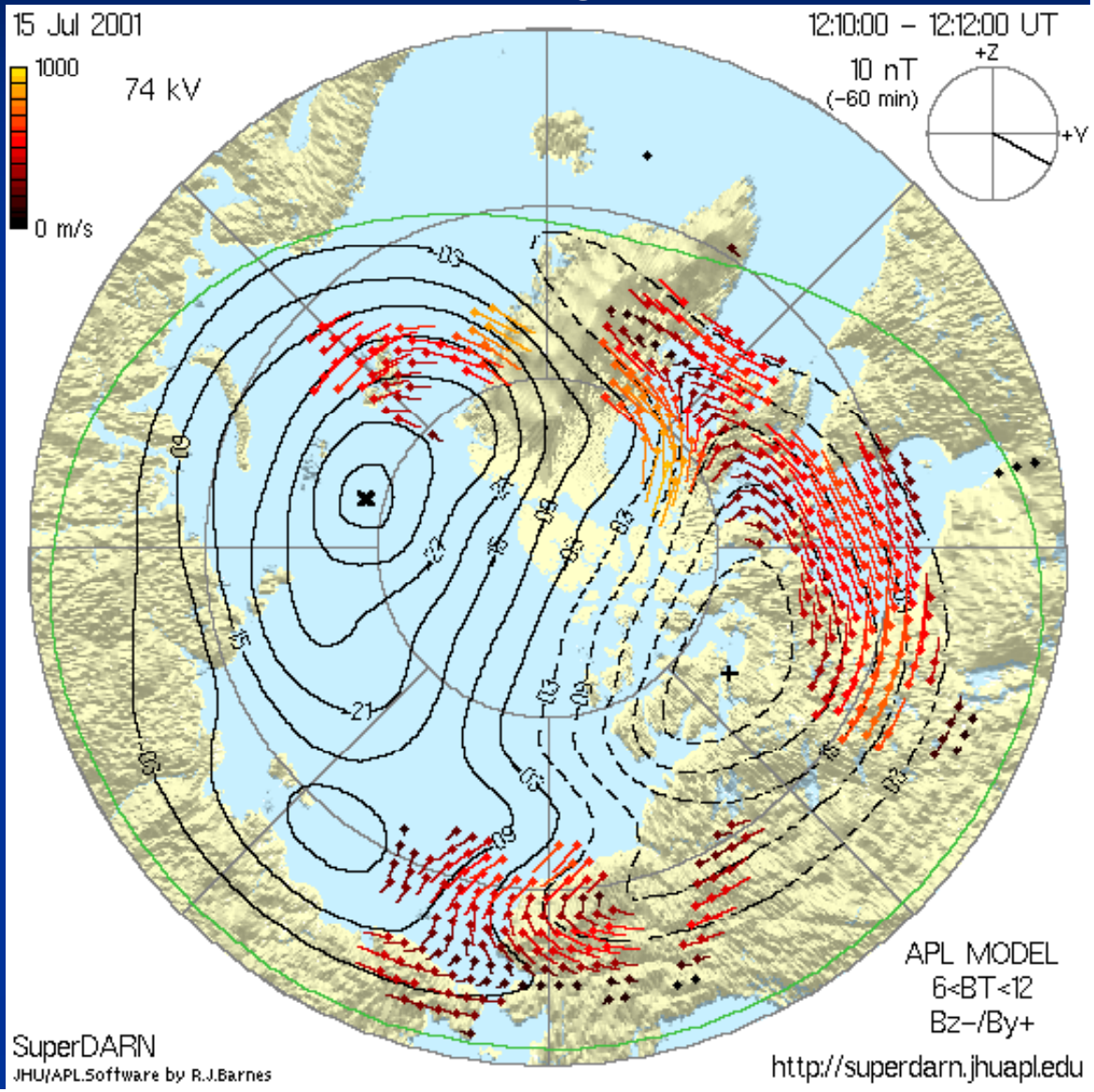
SuperDARN observation of the ionospheric convection driven by the R1 FACs

2-cell convection during the southward IMF

Reversed flow appears during the substorm, which is caused by the R2 FAC.

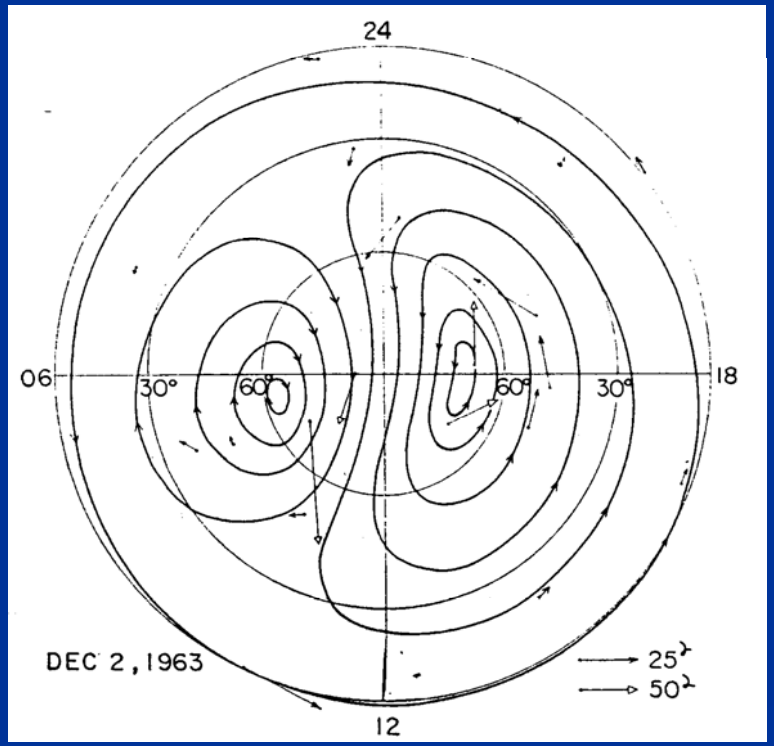


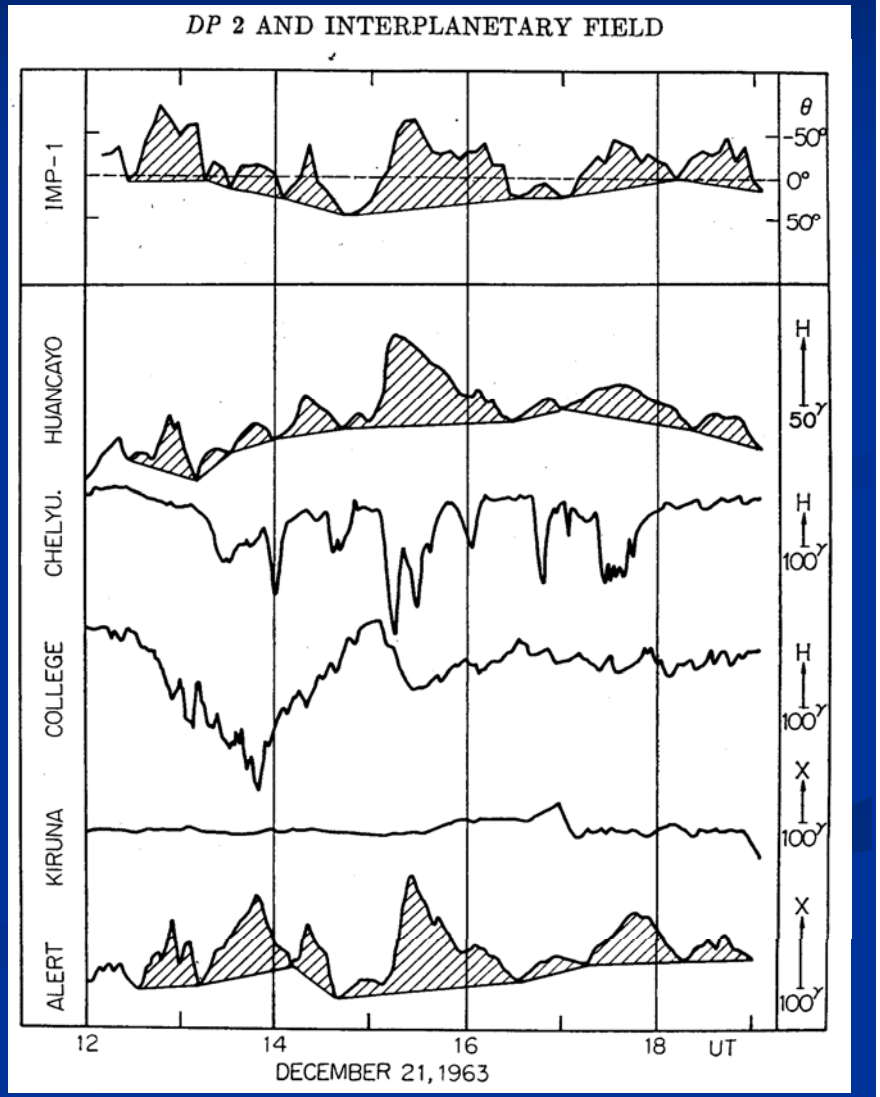


Quasi-periodic DP2 magnetic fluctuations caused by the fluctuating southward IMF

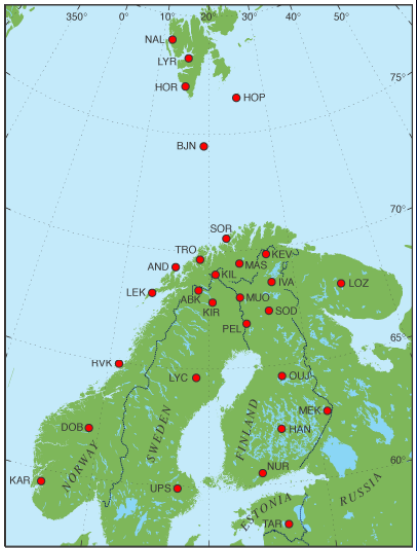
Quasi-periodic DP2 magnetic fluctuations are caused by convection electric fields controlled by the southward IMF.

(Nishida, JGR 1968)

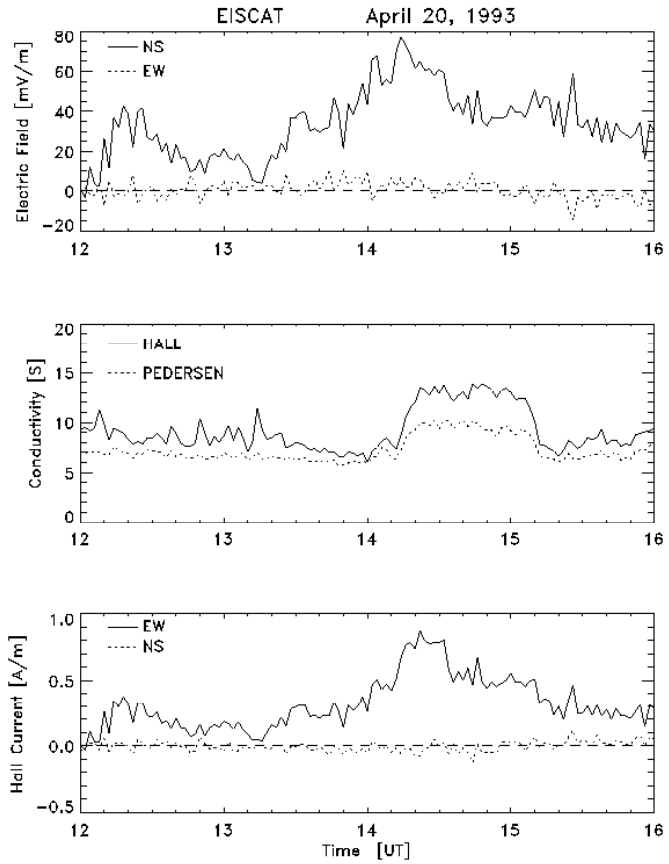




Convection electric field and DP2 currents during the growth phase

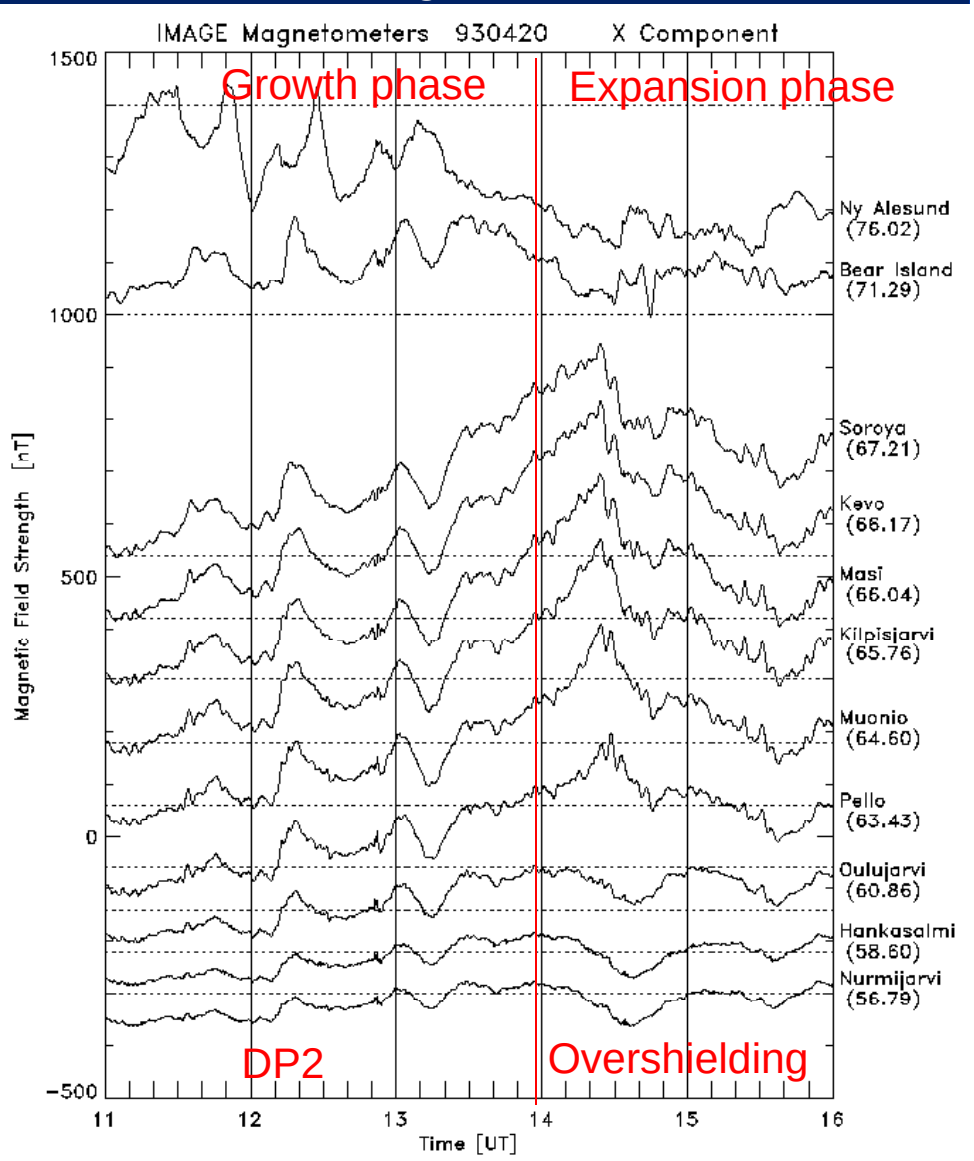


EISCAT



(Kikuchi et al., JGR 1996)

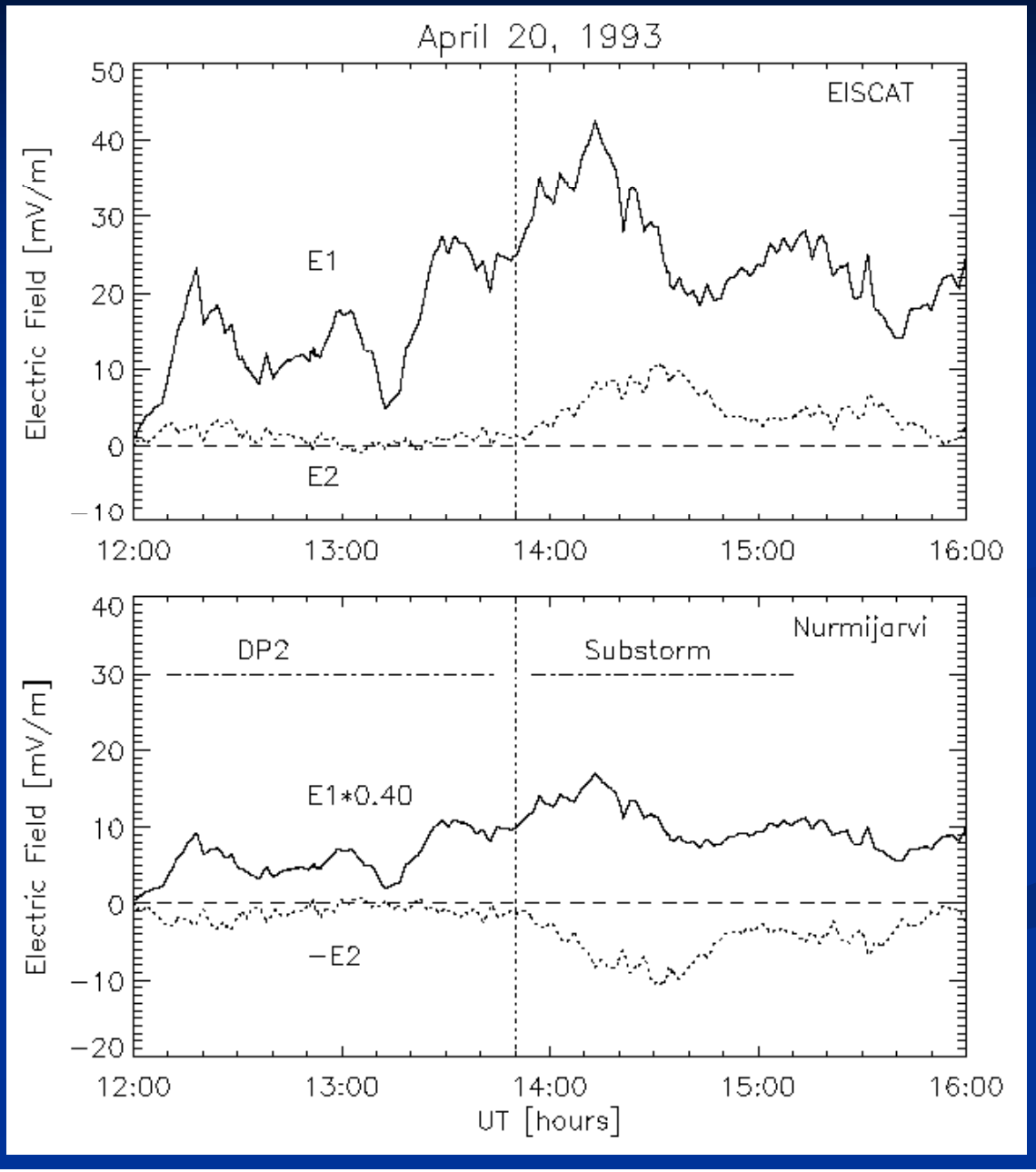
IMAGE Magnetometer chain



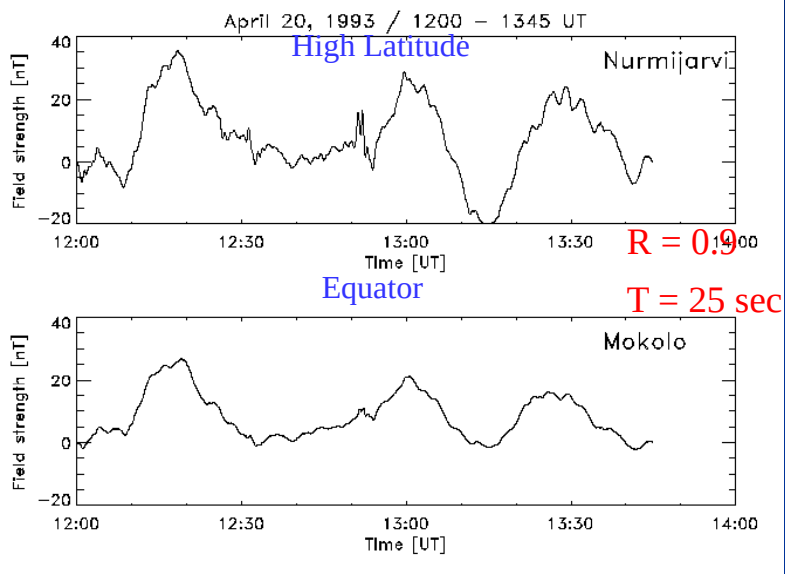
Convection electric field (solid line) and shielding electric field (dotted line) at auroral (EISCAT) and mid latitudes (Nurmijarvi) during the substorm

The R2 FAC electric field can overcome the R1 FAC electric field, when the R1 FACs decay rapidly.

(Kikuchi et al., JGR 2000)

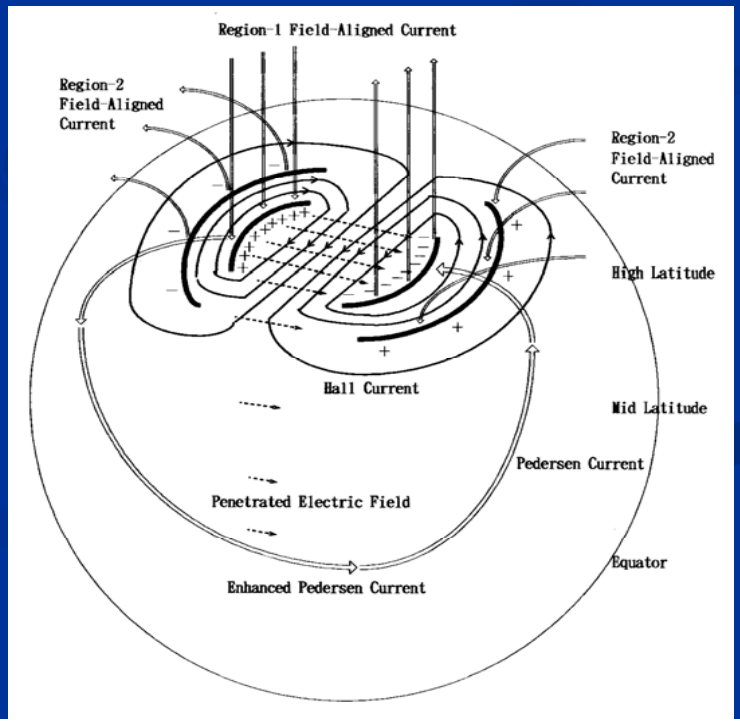


High coherency of the DP2 fluctuations at high latitude and equator (R1 FACs - EEJ circuit)



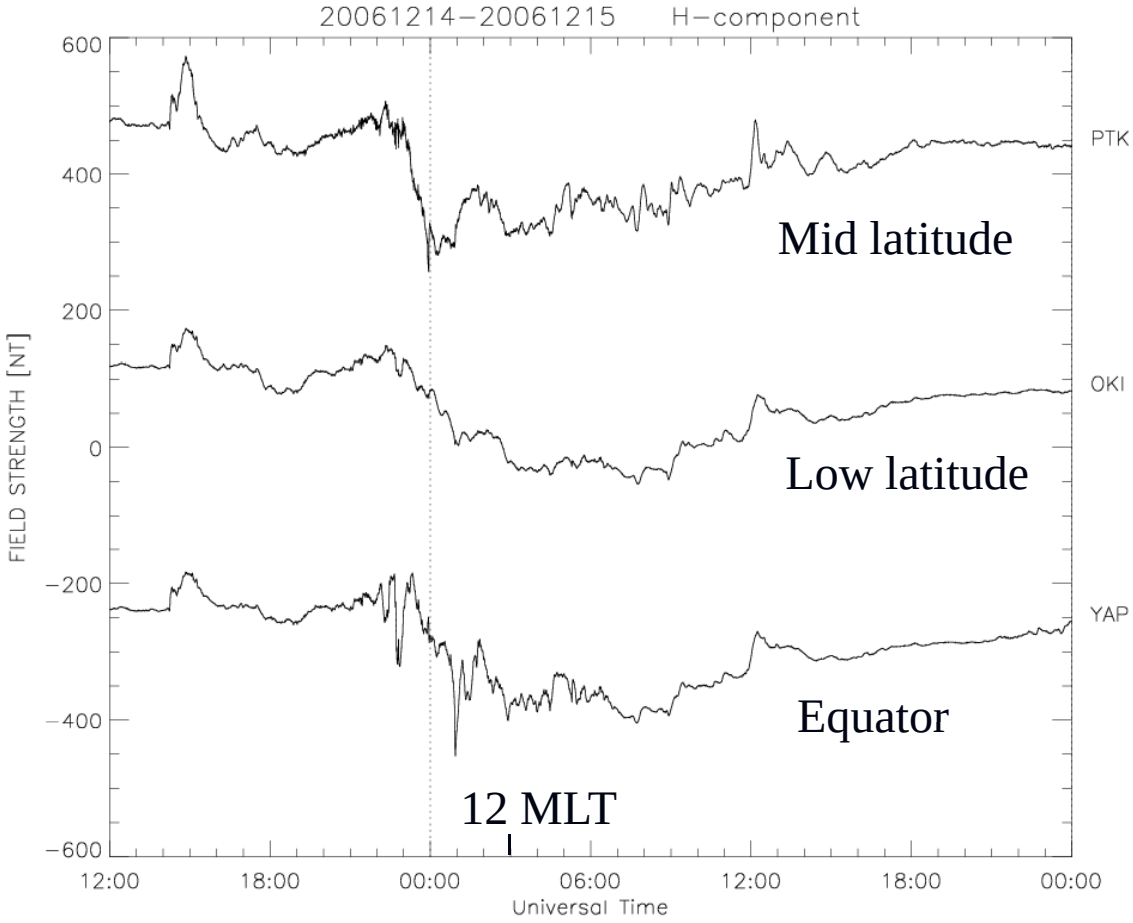
(Kikuchi et al., JGR 1996)

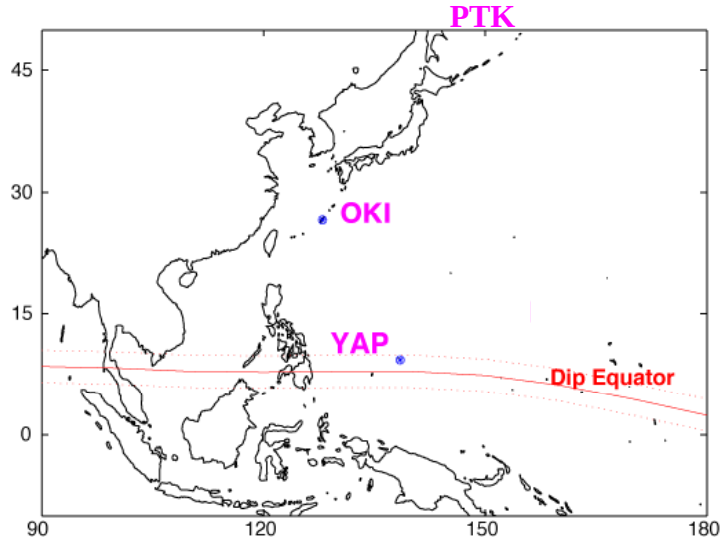
The excellent correlation between the high latitude and equatorial DP2 suggests near-instantaneous transmission of the electric field and current to the equator.



A current circuit is completed between the R1 FACs and the equatorial currents.

Geomagnetic storm at mid-to-equatorial latitudes on December 14-15, 2006



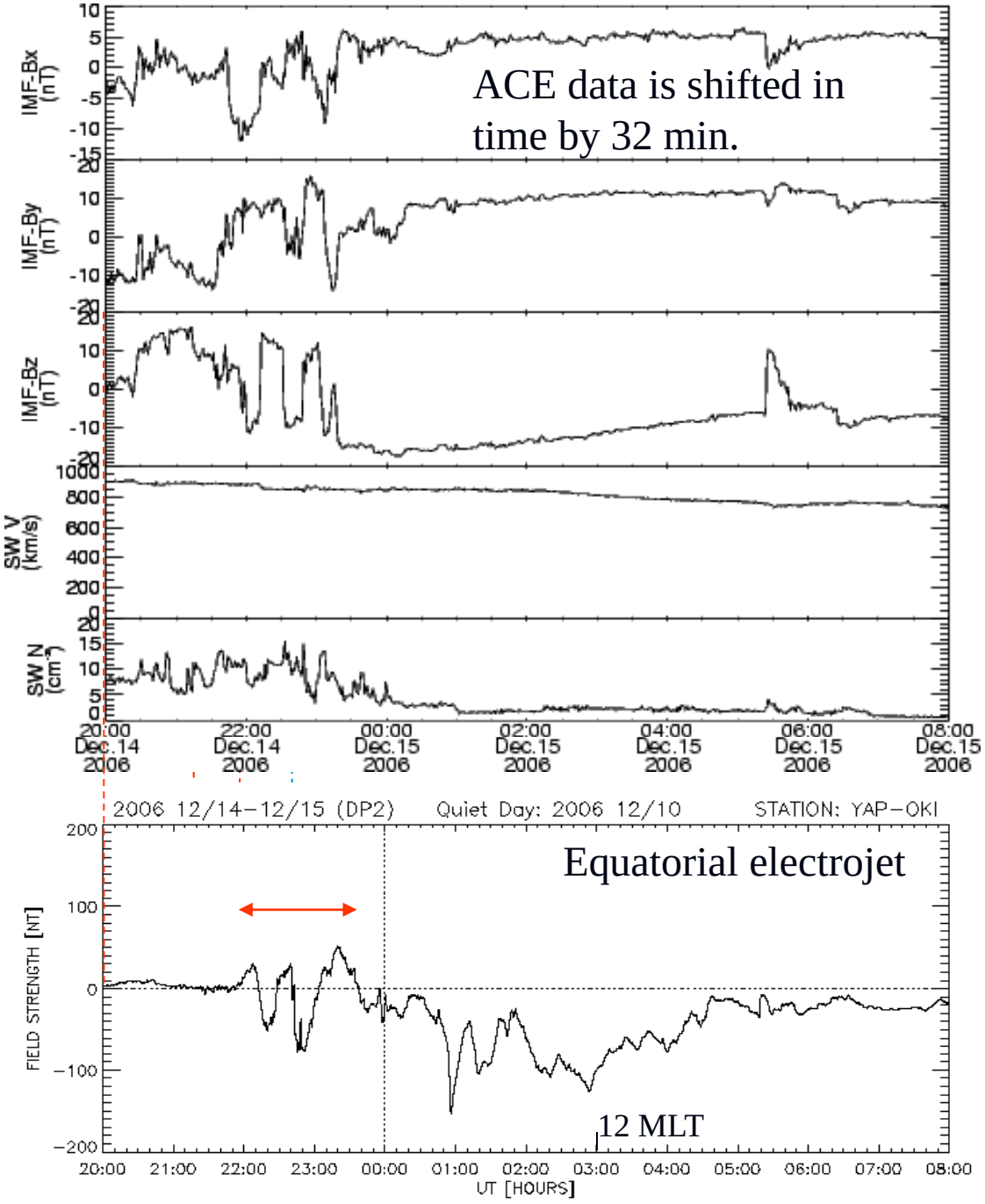


NICT space weather monitoring magnetometer stations

STATION		GEOGRAPHIC LAT	GEOGRAPHIC LON	GEOMAGNETIC LAT	GEOMAGNETIC LON	LT
PTK	Paratunka, Russia	52.94	158.25	45.58	221.13	UT+10.6
OKI	Okinawa, Japan	26.75	128.22	16.87	198.41	+8.4
YAP	Yap, Micronesia	9.49	138.09	0.38	209.21	+9.2

Quasi-periodic DP2 fluctuations on December 14, 2006

DP2 fluctuations are composed of EEJ and CEJ, followed by long-lasting CEJ.

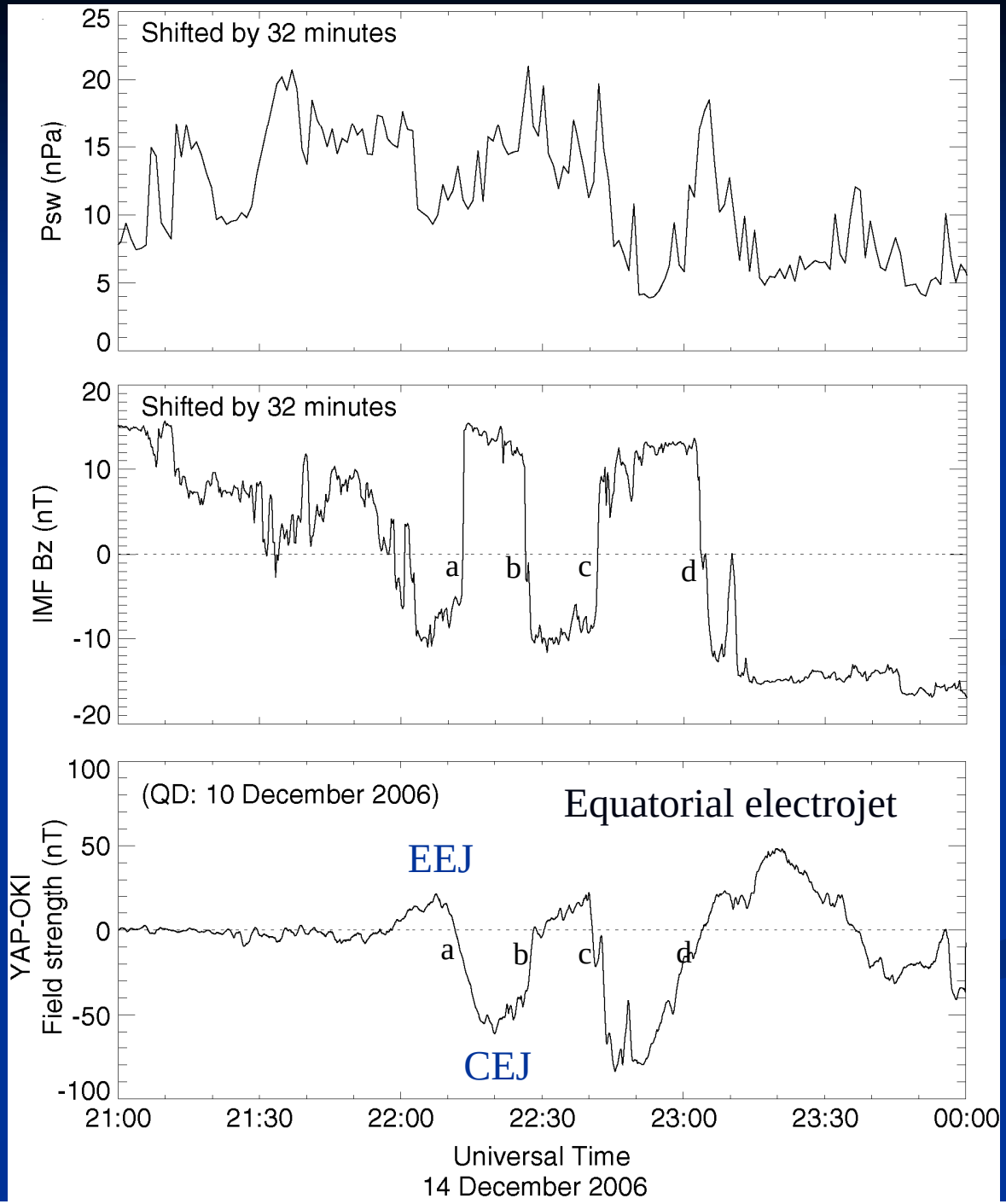


Comparison of the DP2 fluctuations with the IMF

We shifted the time axis of ACE by 32 min behind, then we see clear correspondence between the IMF Bz and the DP2 fluctuations.

The southward IMF caused the EEJ, while the northward IMF caused the CEJ.

(Kikuchi et al., JGR 2010)



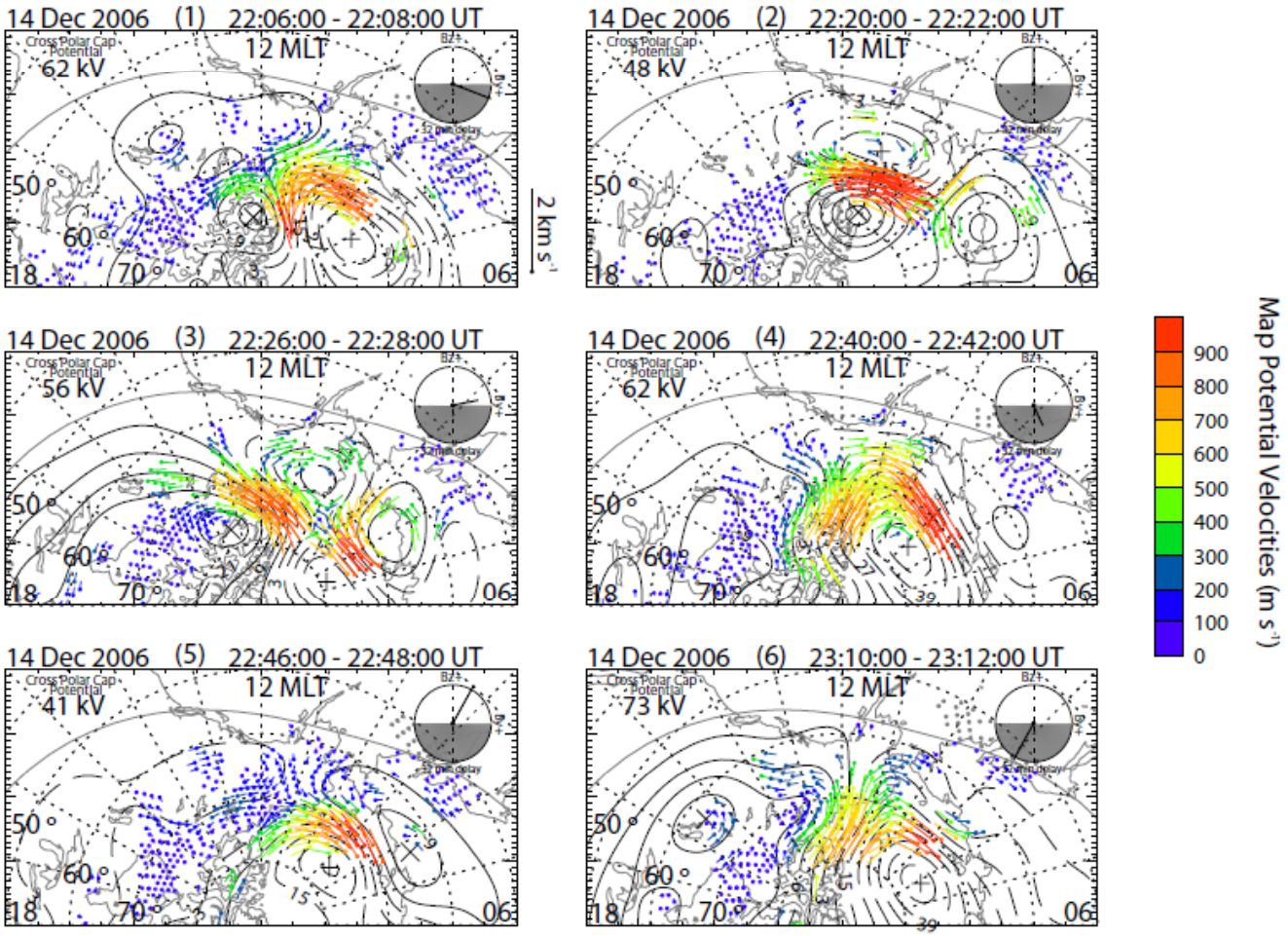
SuperDARN observations of two-cell/multi-cell convection vortices for the southward/northward IMF

The convection is in two-cell pattern for southward IMF (Figures (1), (4), (6)). The electric field is associated with the R1 FACs, which penetrates to the equatorial ionosphere, and causes the EEJ.

Reversed flow vortices appear equatorward of the two-cell convection vortices for northward IMF (Figures (2), (3), (5)). The reverse vortices must be associated with the R2 FACs, which causes the CEJ at the equator.

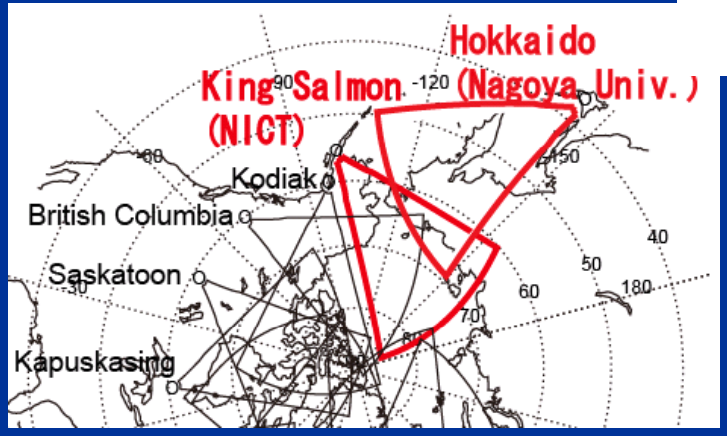
(Kikuchi et al., JGR 2010)

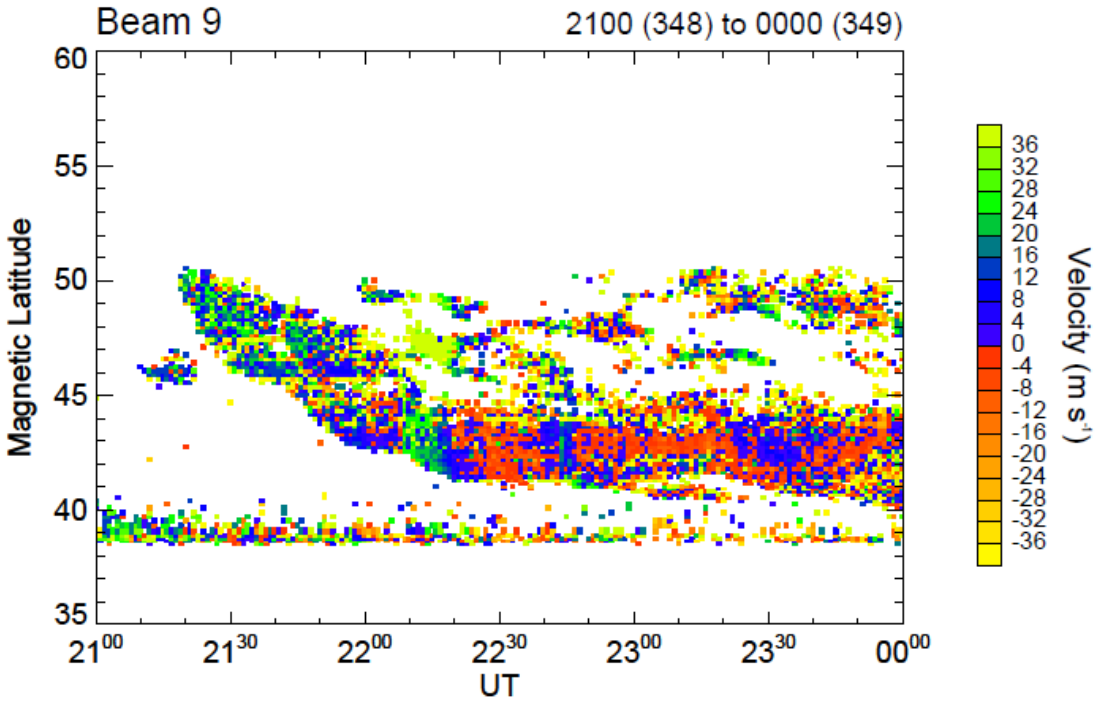
The reverse vortices should be caused by the R2 FACs

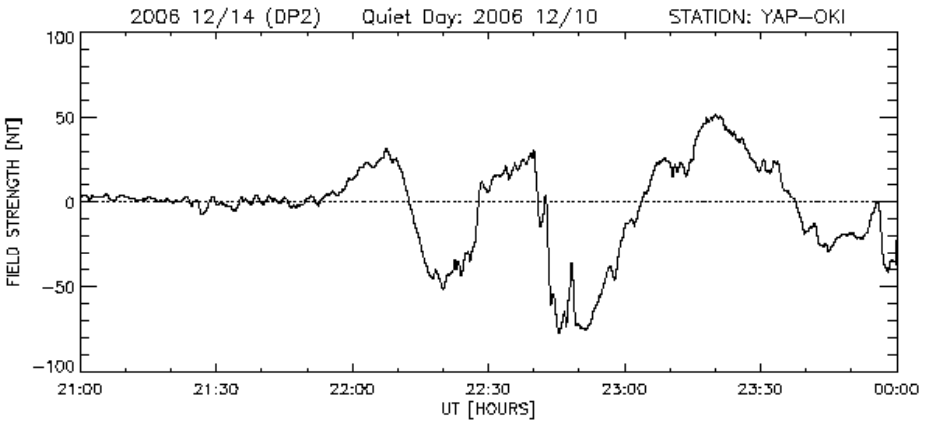


Line of sight velocity from the Hokkaido HF radar

Hokkaido radar detected poleward and equatorward flows during the DP2 fluctuation event, corresponding to the two-cell pattern and the reverse vortex in the morning sector







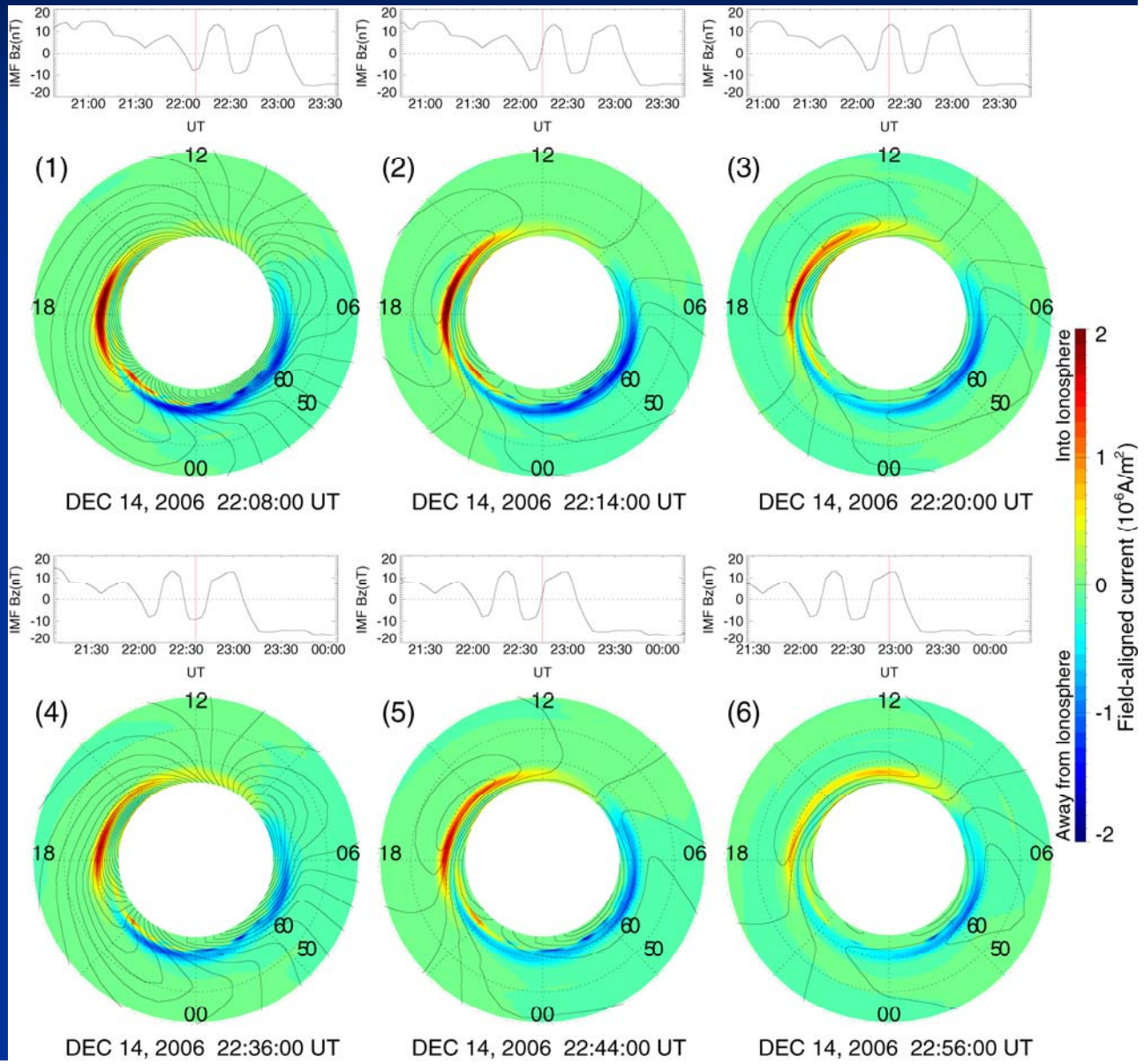
Electric potential patterns calculated with the Comprehensive Ring Current Model (CRCM)

(ACE data is shifted in time by 32 min)

The R2 FACs are indicated with warm/cool color for downward/upward currents, and the contours describe the equi-potentials associated with the given polar cap potential and the calculated R2 FACs.

The contours are in two-cell pattern during the southward IMF (1, 4), and is dominated by the R2 FACs, when the IMF was northward (3, 6).

(Kikuchi et al., JGR 2010)

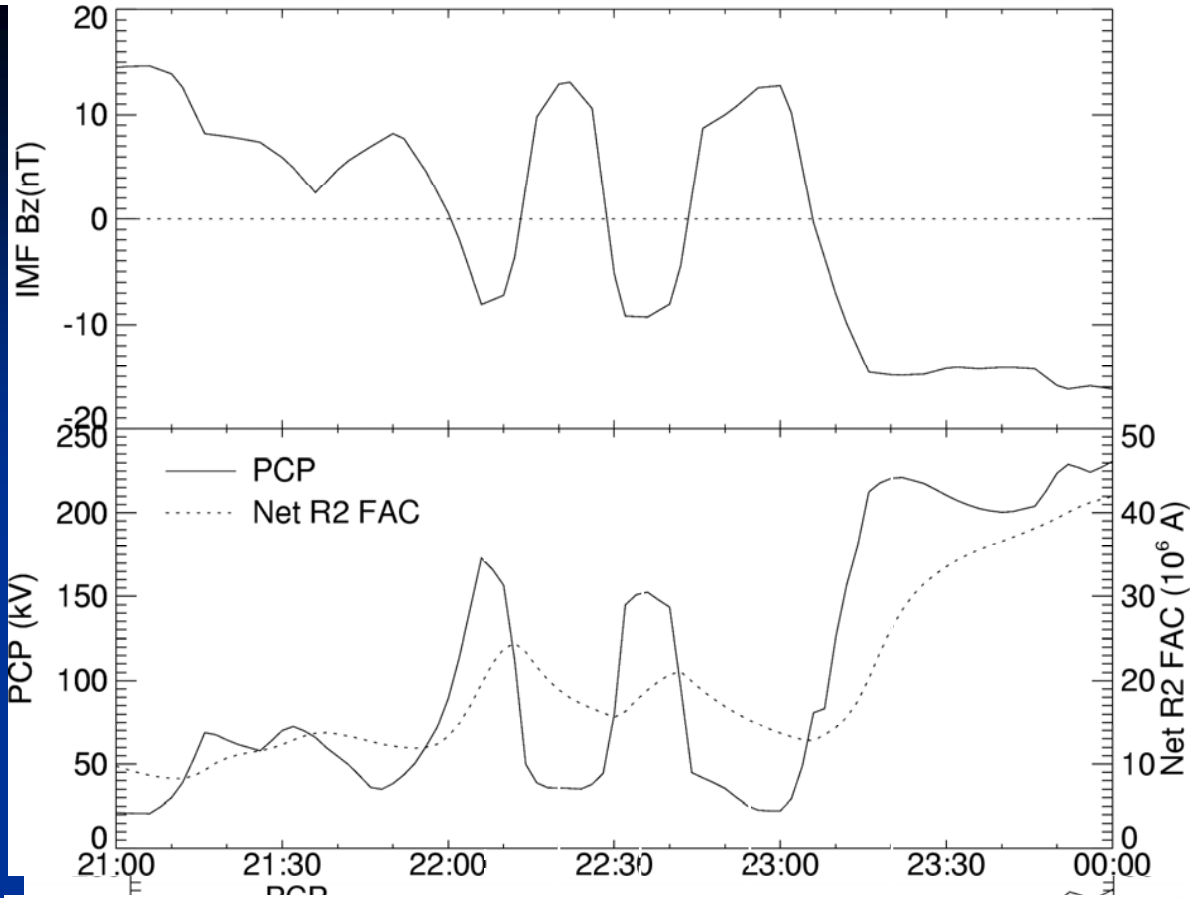


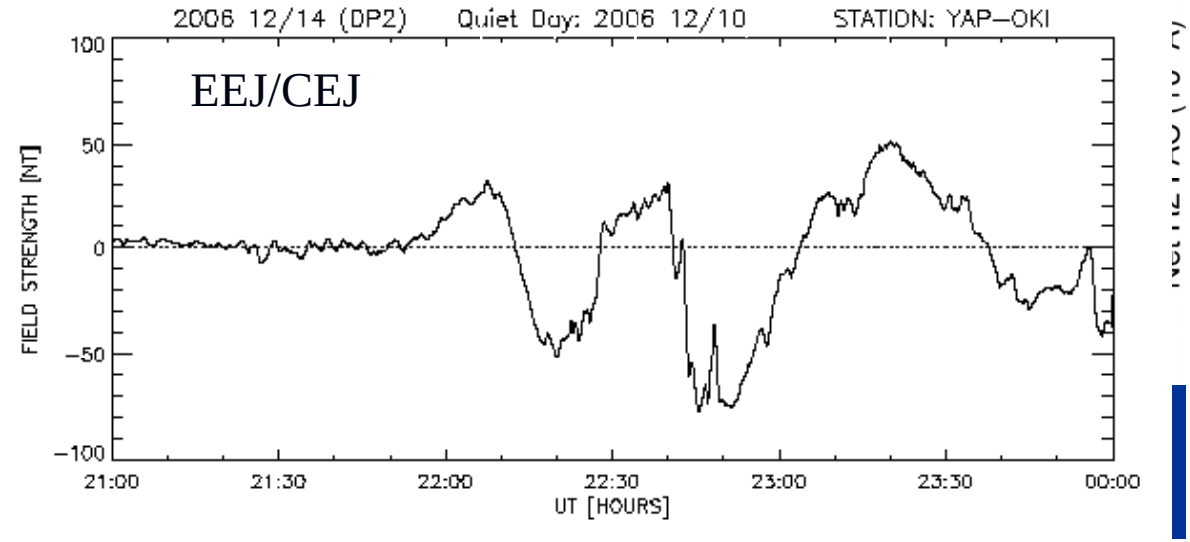
Temporal variations of the PCP and net R2 FACs calculated with the CRCM (solid and dotted curves in the middle panel)

The R2 FACs grow and decay slowly, even when the polar cap potential (PCP) changes rapidly.

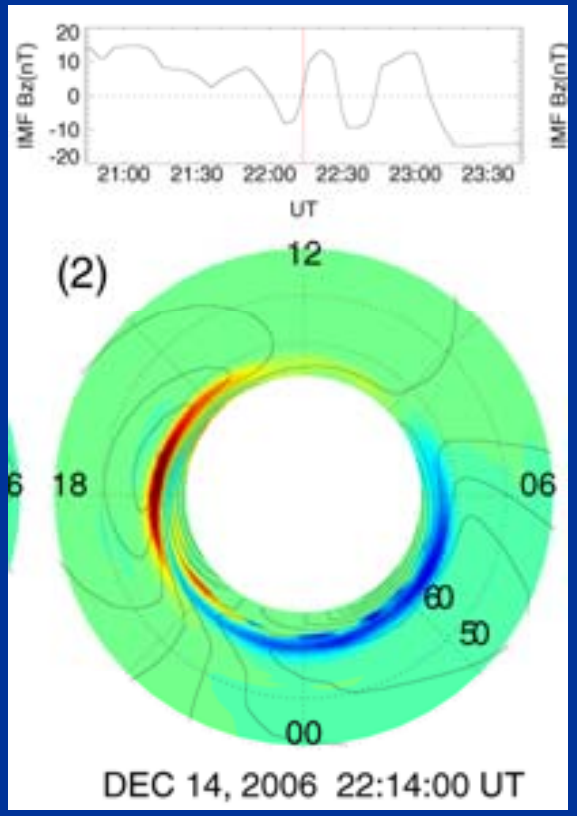
As a result, the shielding electric field associated with the R2 FACs becomes dominant, when the PCP decreases substantially.

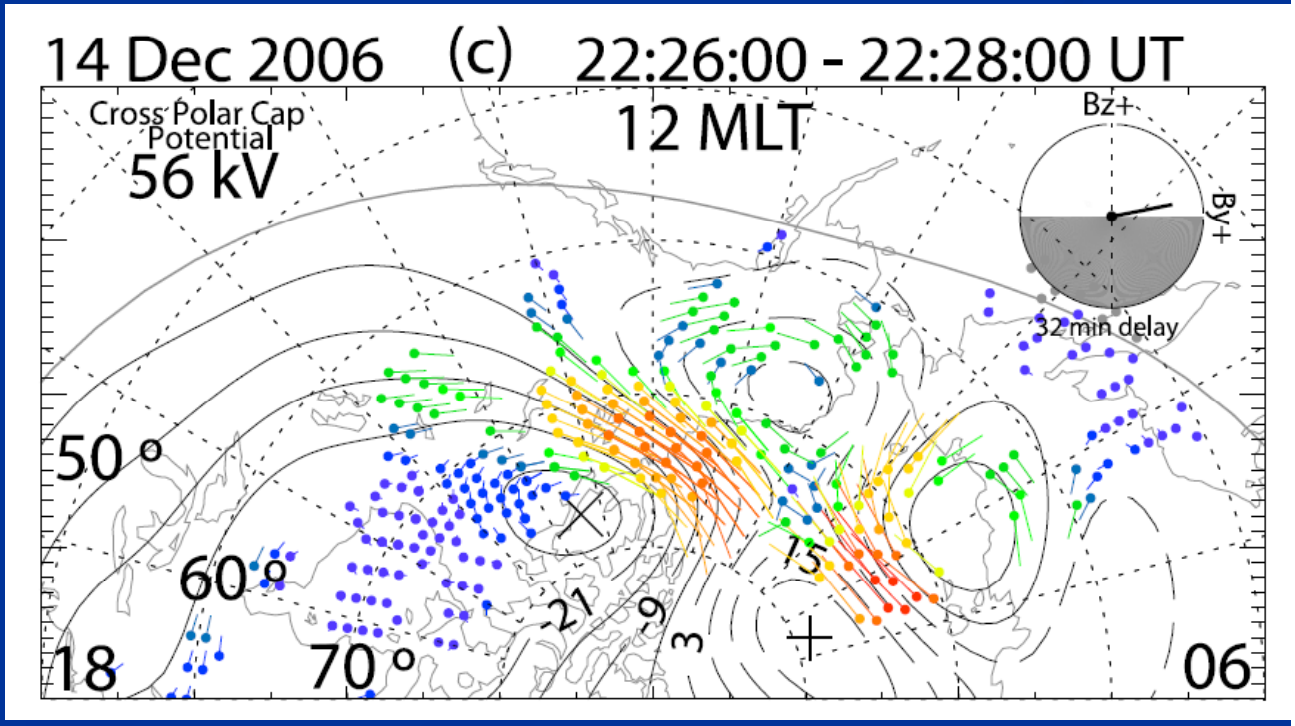
(Kikuchi et al., JGR 2010)





Reversed convection vortices equatorward of the large-scale two-cell convection vortices (IMF Bz > 0)



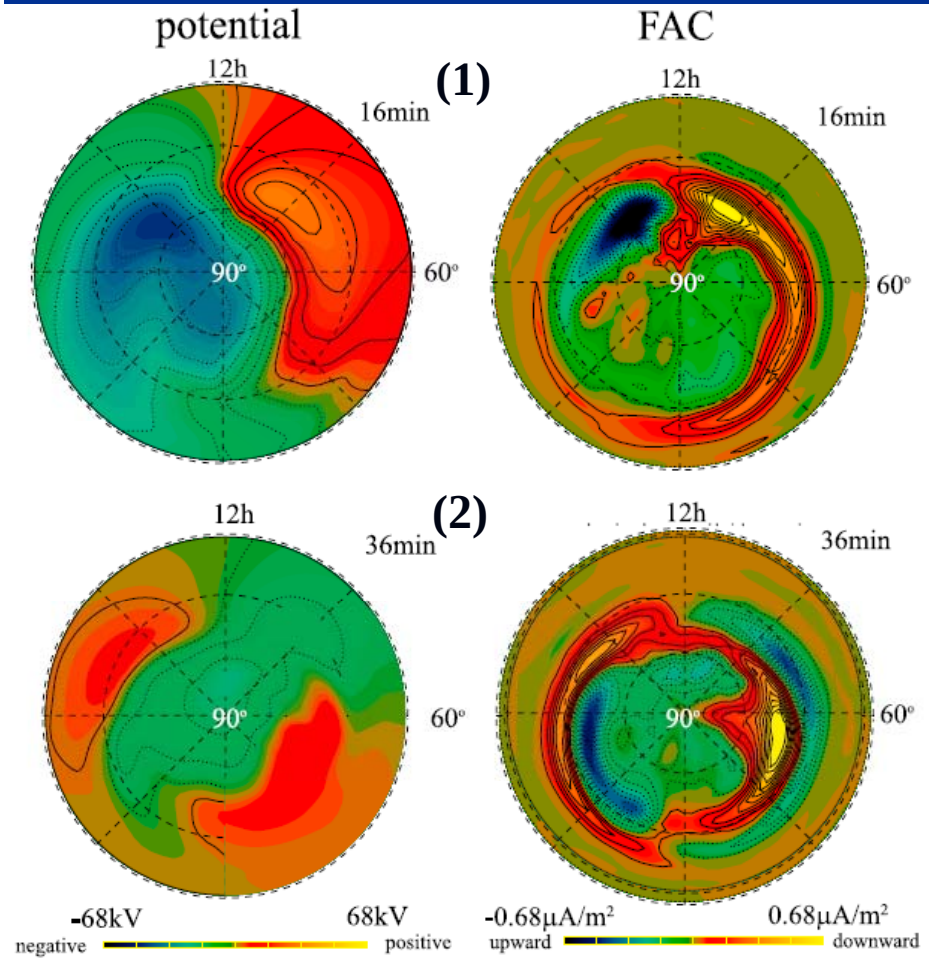


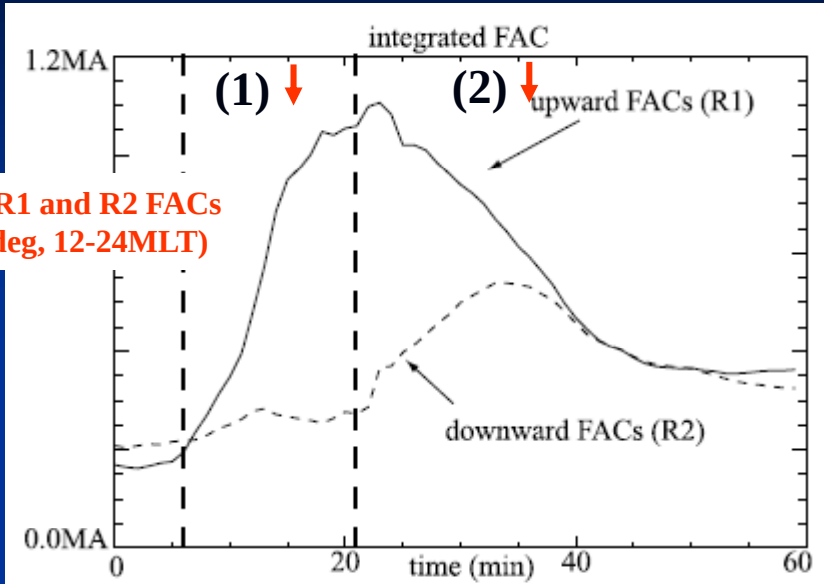
MHD simulation of the R1 and R2 FACs

Southward IMF

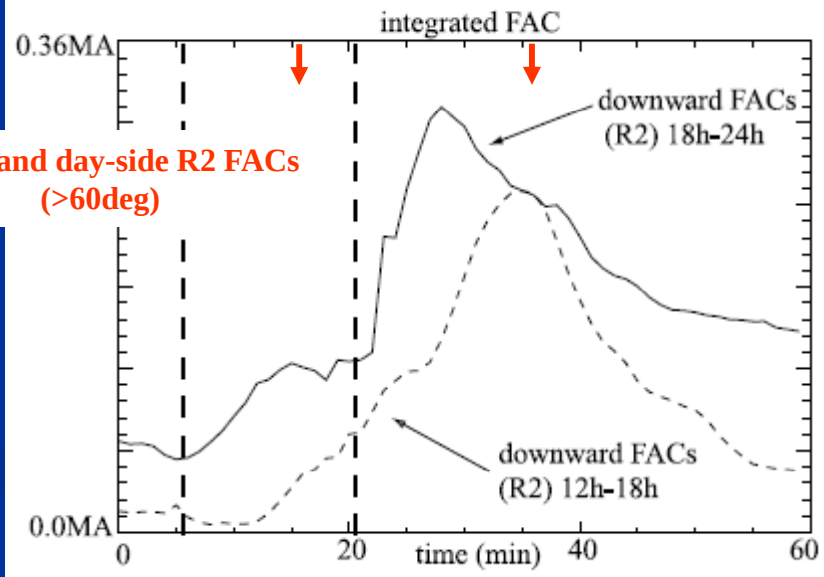
Northward IMF

The R2 FACs develop on the nightside and also on the dayside with a lag of 5-15 min in peak time from the R1 FACs.





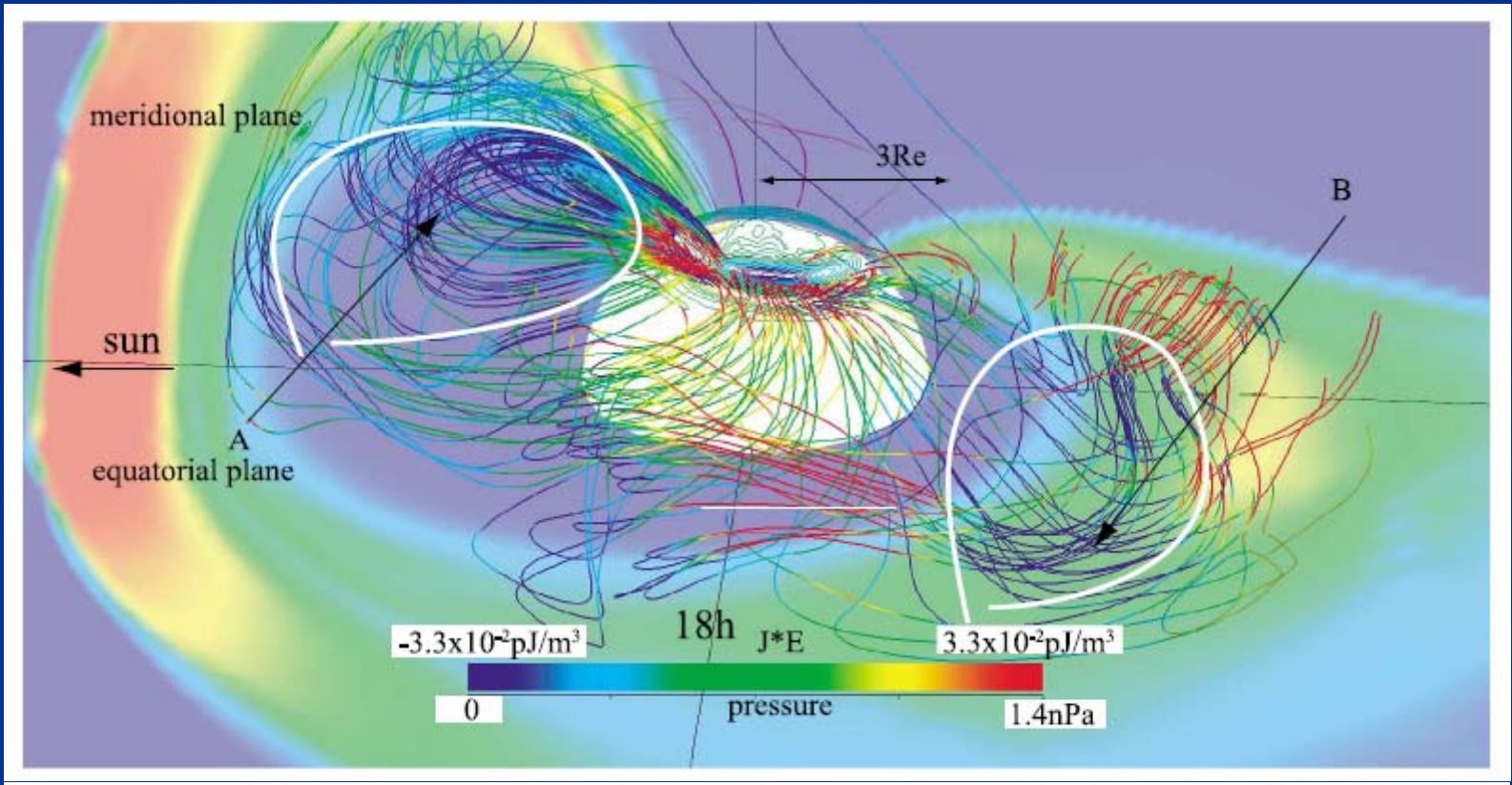
Total R1 and R2 FACs (>60deg, 12-24MLT)



Night- and day-side R2 FACs (>60deg)

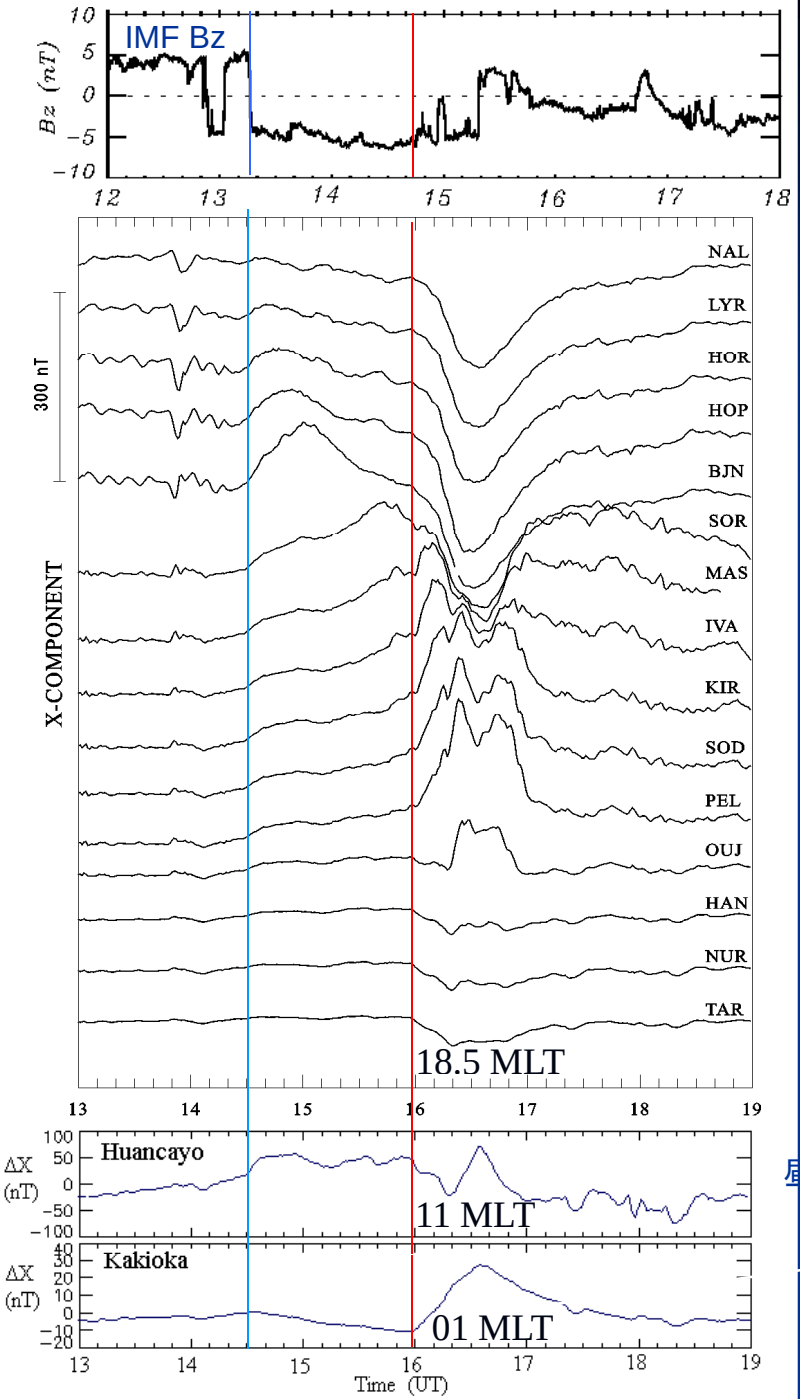
(Fujita, Kikuchi, and Tanaka, JGR 2010)

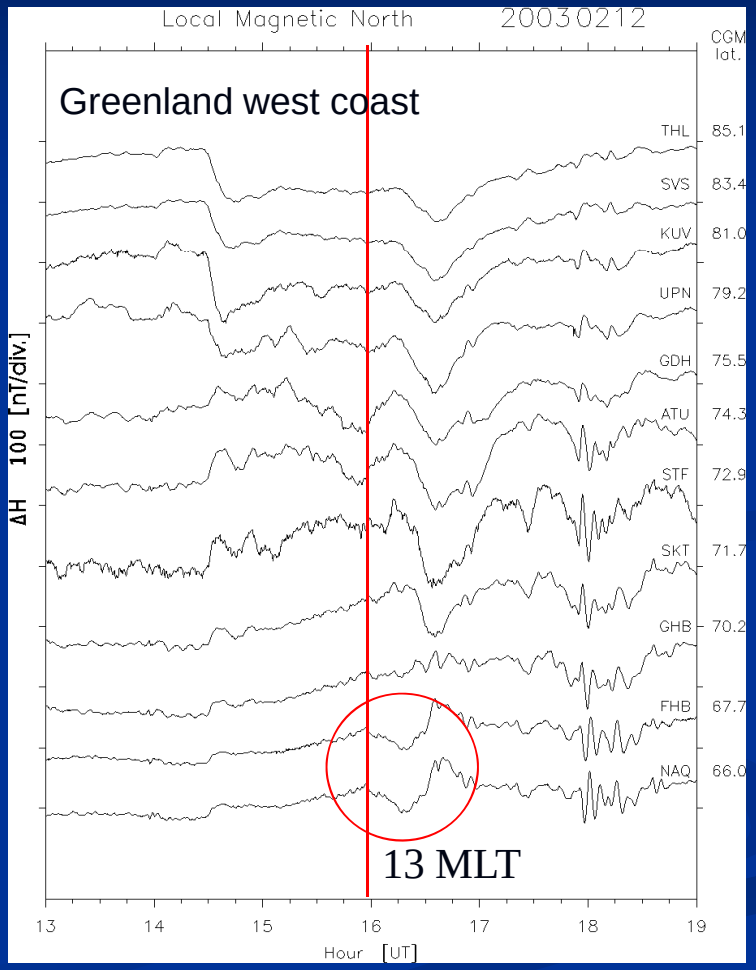
Dynamos of the R2 FACs on the day- and night-sides (MHD simulation)



(Fujita, Kikuchi, and Tanaka, JGR 2010)

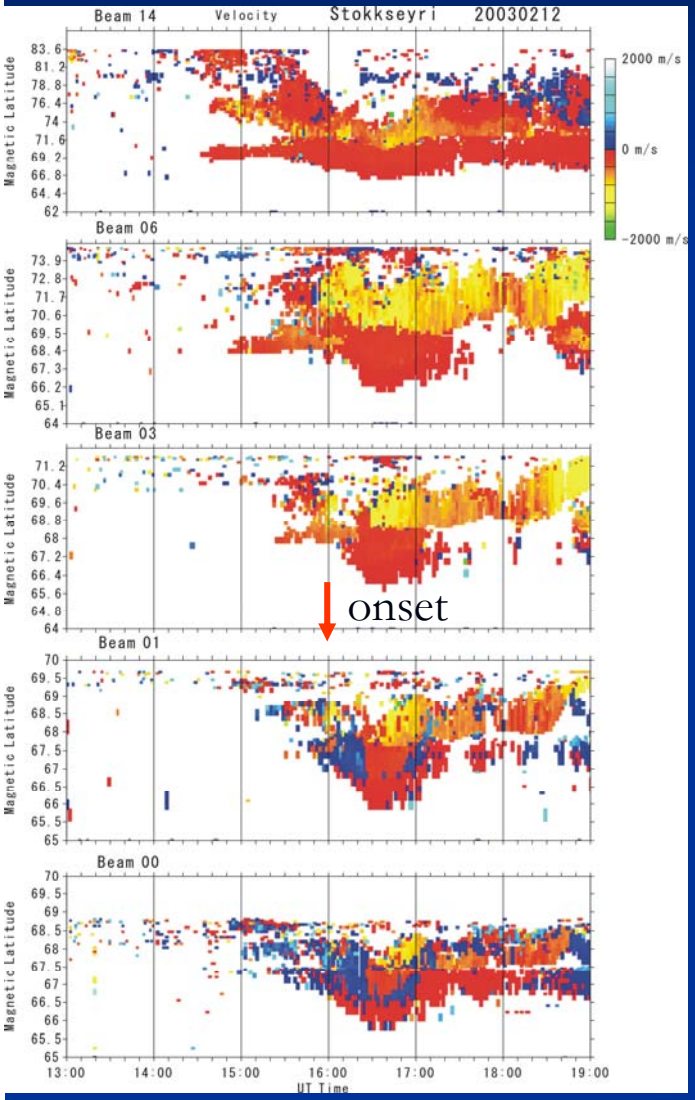
Overshielding currents at subauroral-to-equatorial latitudes during the expansion phase



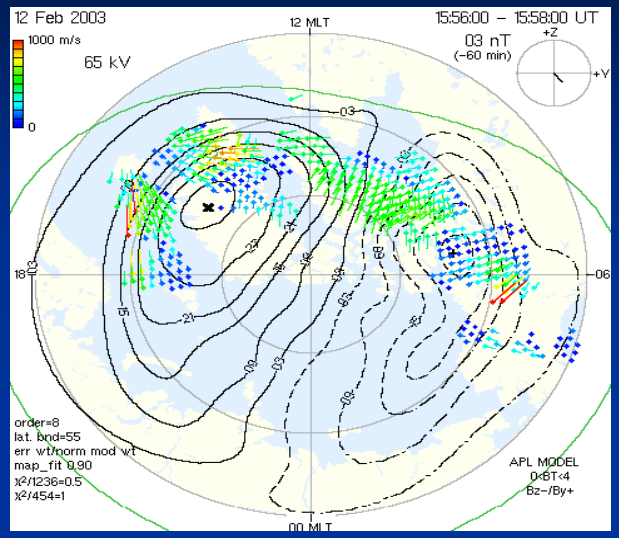


(Hashimoto et al., submitted)

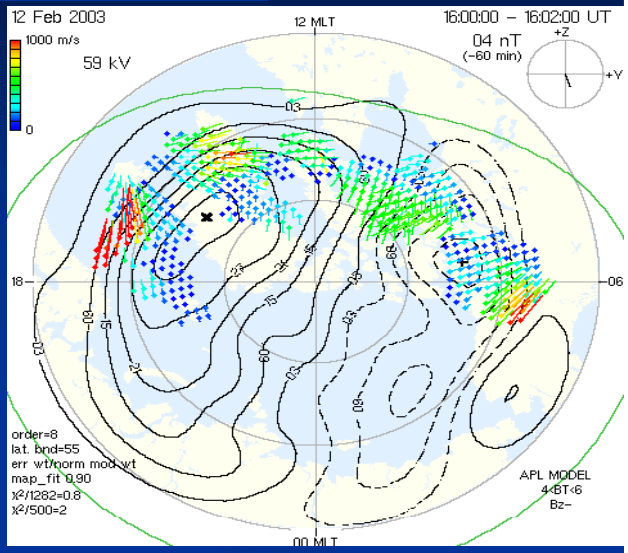
Ionospheric convection during the growth and expansion phases



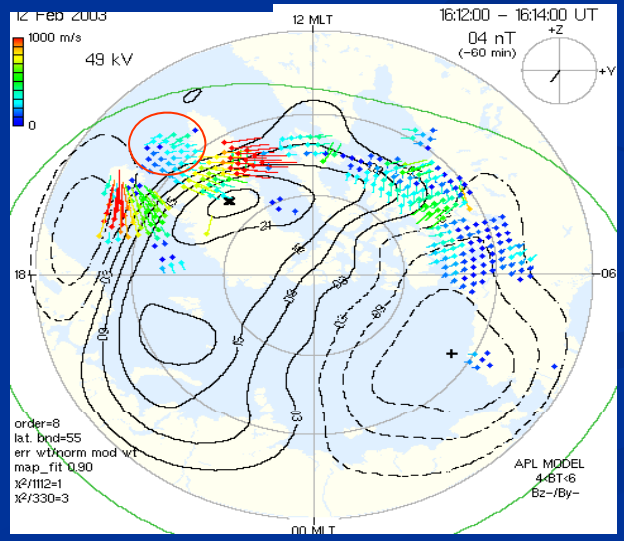
1556-1558 UT



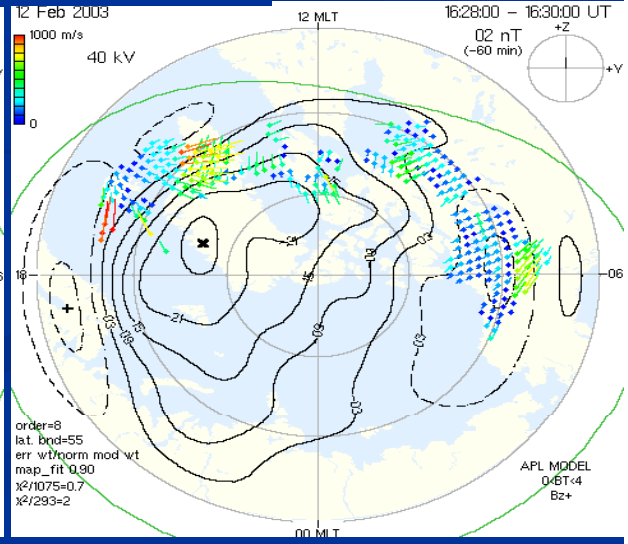
1600-1602 UT



1612-1614 UT



1628-1630 UT



Dynamos of electric field and currents in the magnetosphere-ionosphere system

- Southward IMF (R1 FACs)
- Partial ring current (R2 FACs)
- Northward IMF (dayside R2 FACs)
- Substorm (R2 FACs)
- Solar wind dynamic pressure (PRI, MI, PC5)
- Kelvin Helmholtz instability (PC5) ?
- BBF (Pi2) ?