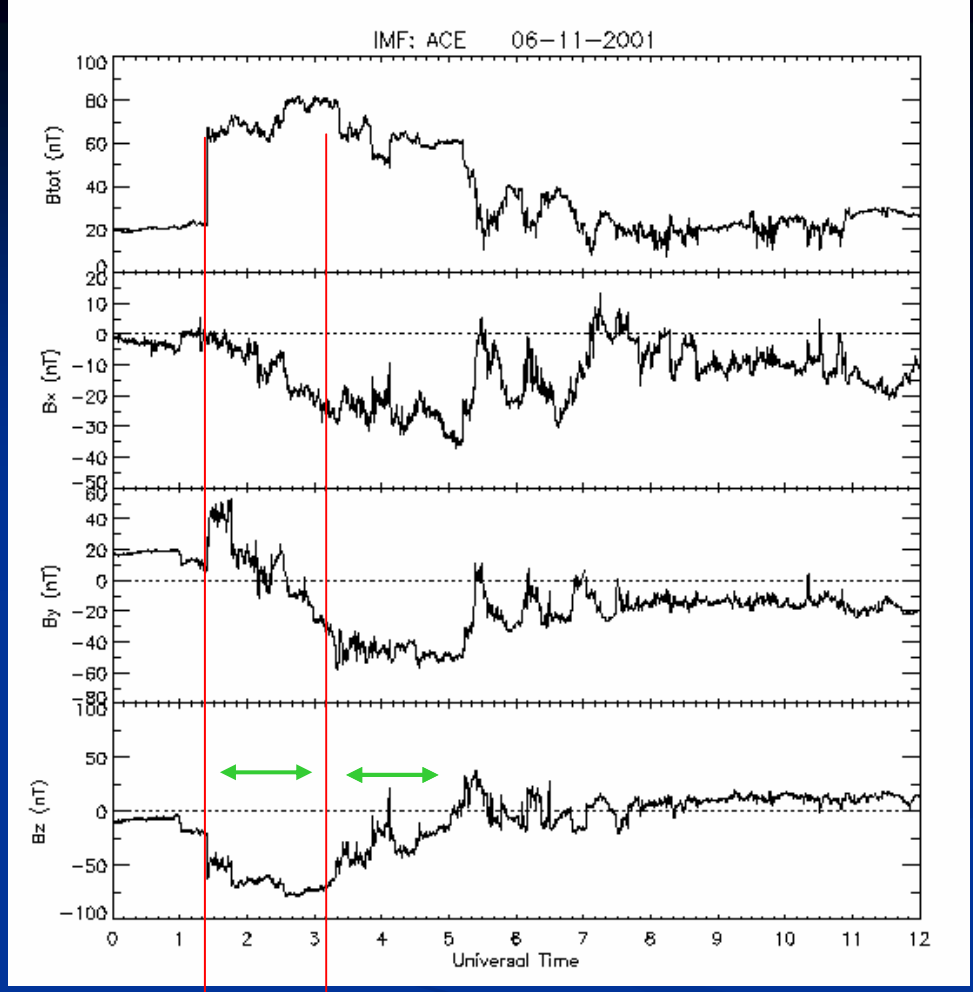
中緯度短波レーダー研究会（名古屋、2007.2.19)

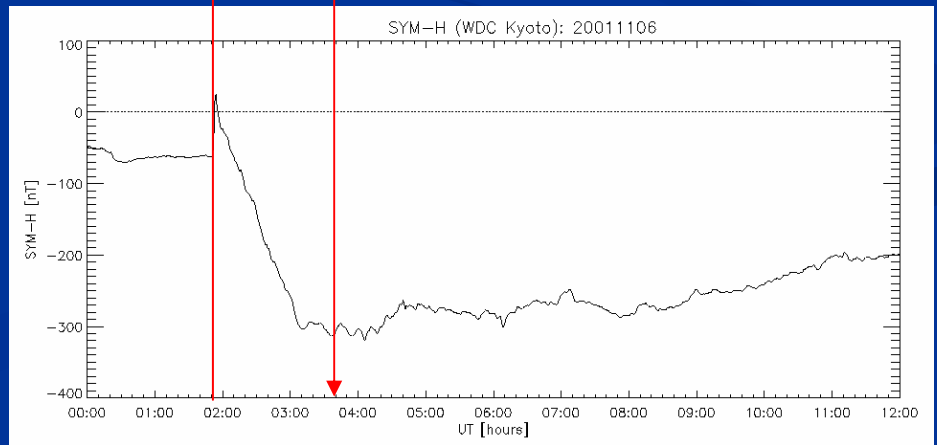
中低緯度で観測される磁気嵐時の電場

菊池崇（名大STEL、NICT）、橋本久美子（吉備国際大学）、北村健太郎、野崎憲朗（NICT）

Geomagnetic storm on November 6, 2001

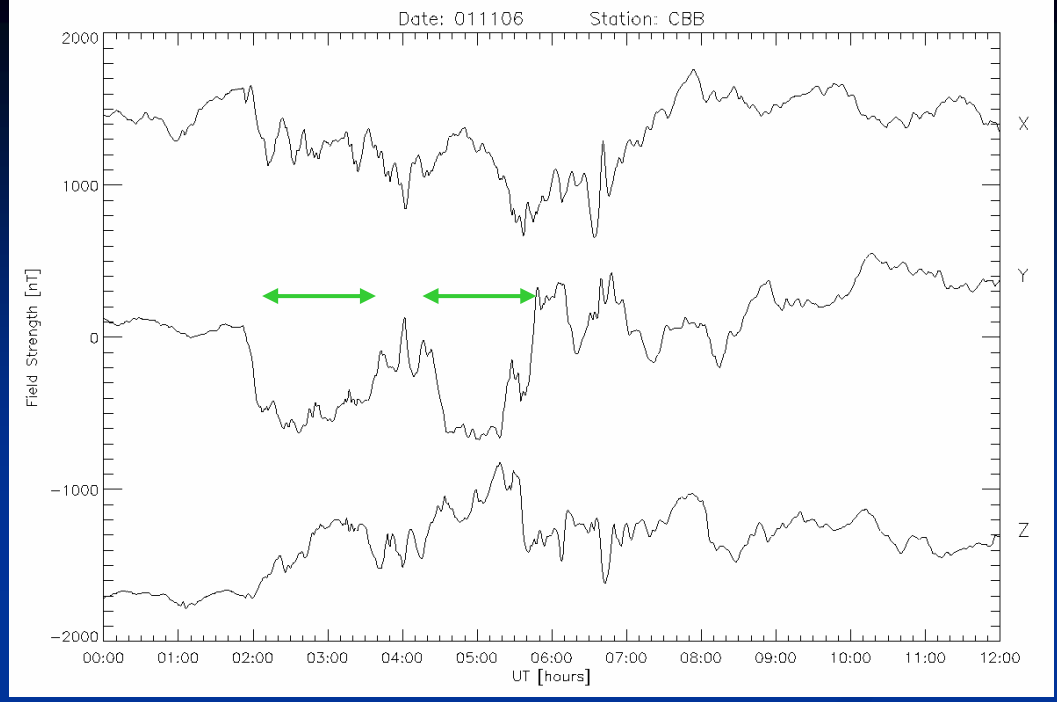
-77.0 nT at 0240 UT



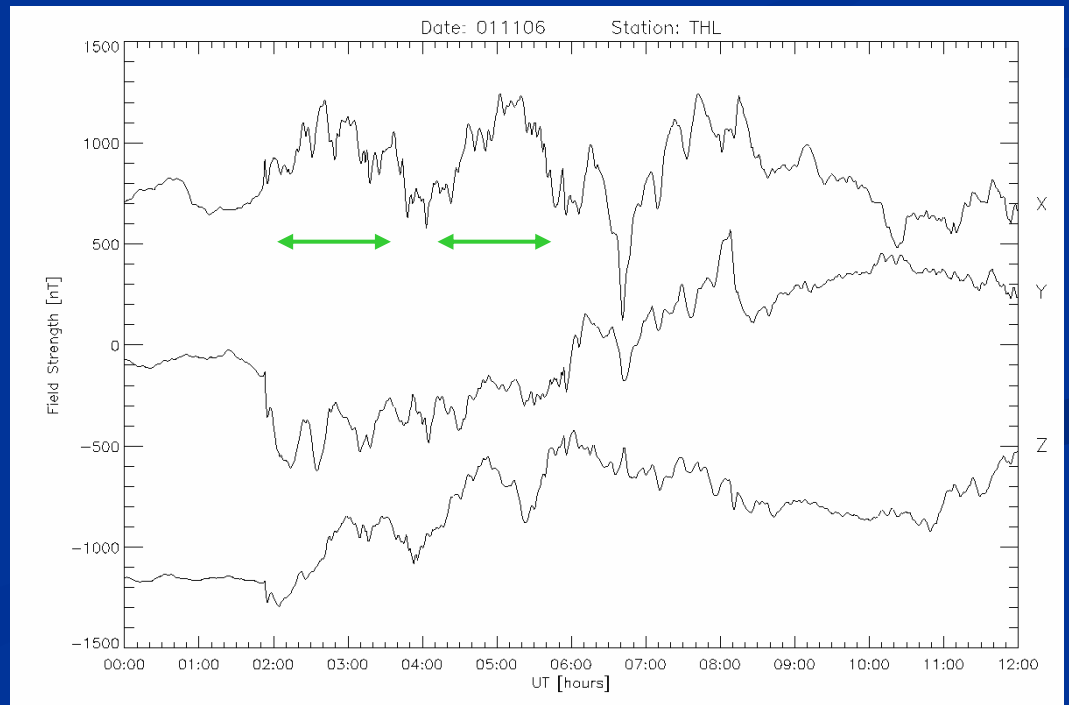


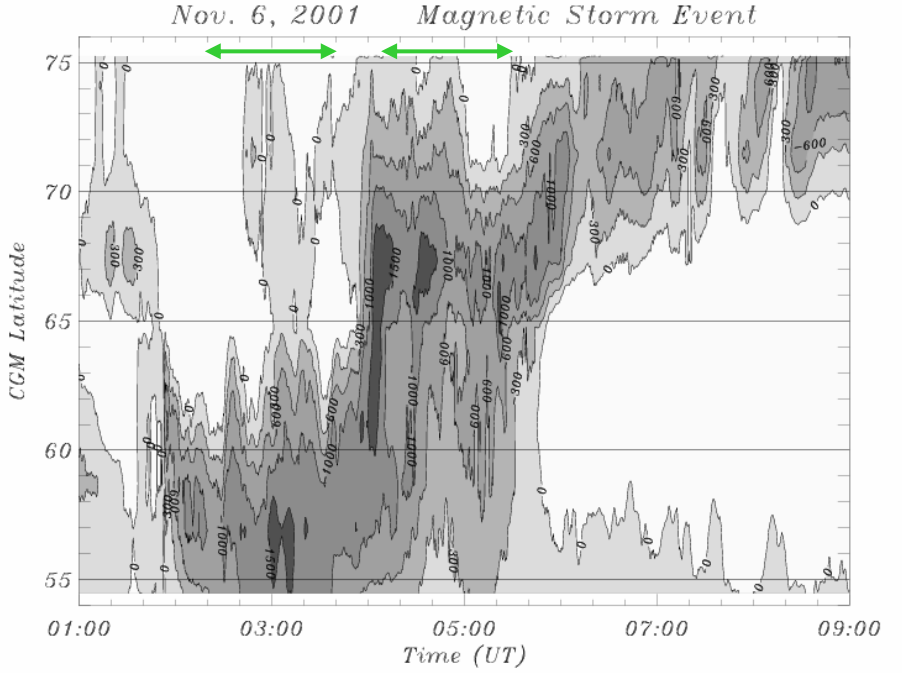
Polar cap magnetometers

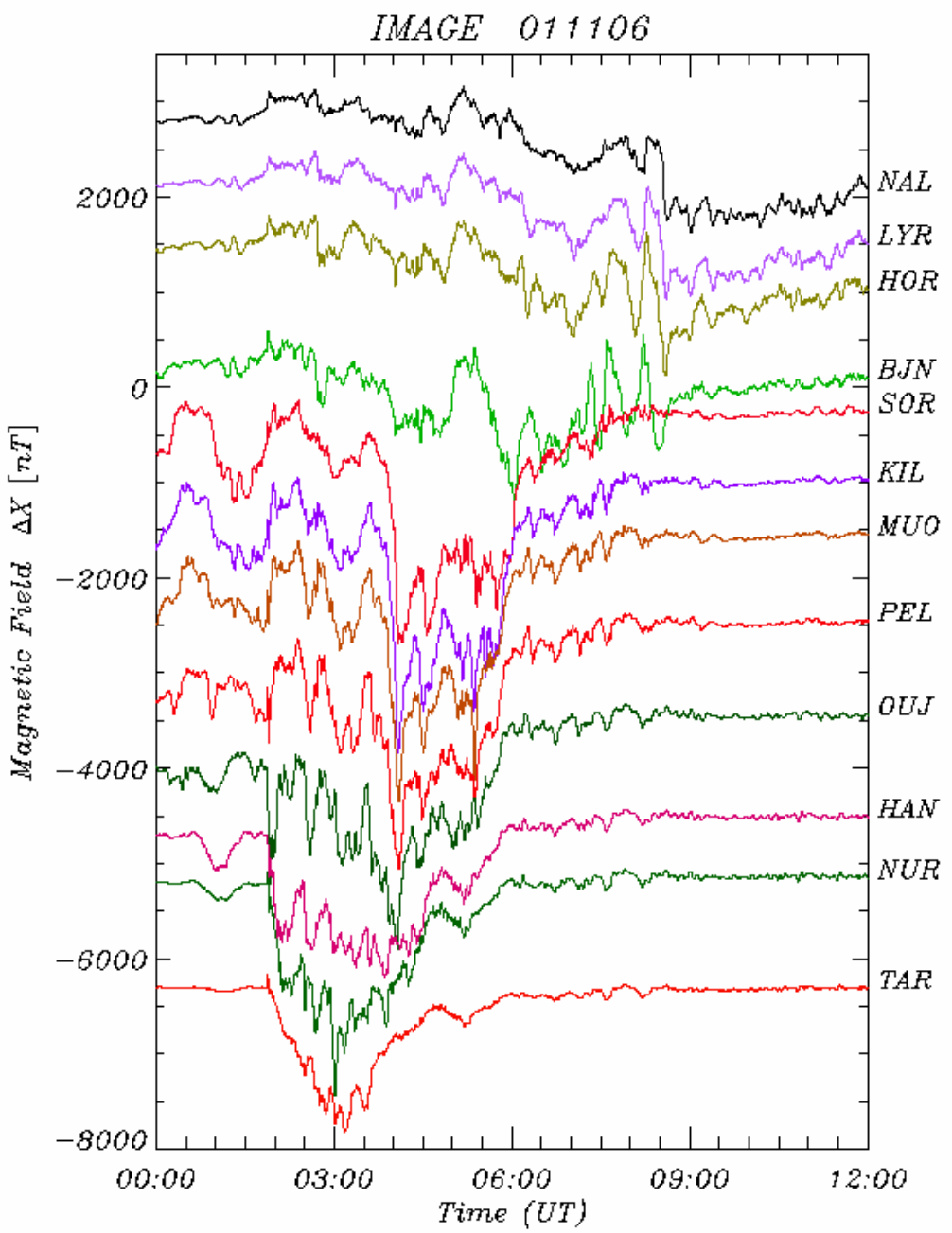
The Y component at Cambridge Bay is negative during the period 02-06 UT (18-22 MLT). The negative magnetic deflections may be caused by the R1 FACs flowing out from the ionosphere in the evening sector. Two time intervals of the magnetic deflection correspond to those of the strong southward IMF.



The X component at Thule is positive during the period 02-06 UT (23-03 MLT). The positive magnetic deflections may be caused by the R1 FACs flowing into the ionosphere in the morning and out in the evening sector. Two time intervals of the magnetic deflection correspond to those of the strong southward IMF.







Westward electrojets in the dawn sector

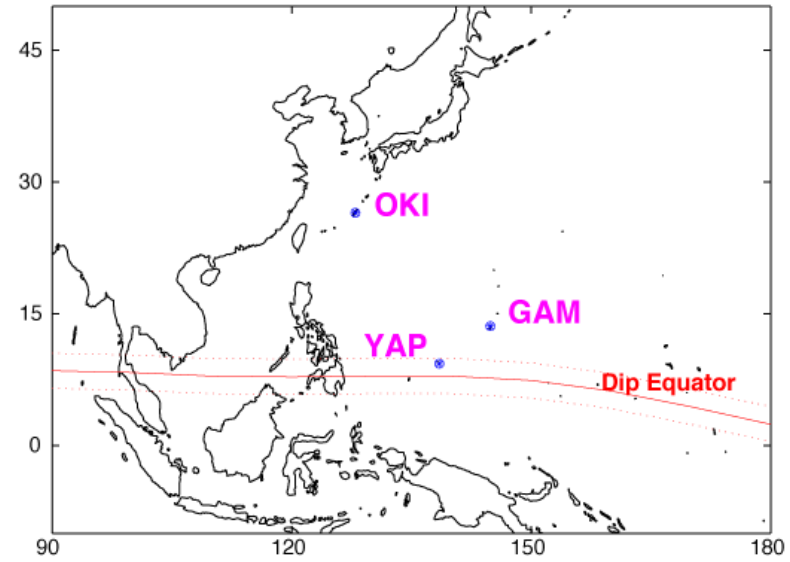
IMAGE magnetometers detected westward auroral electrojets (> 2000 nT) during the period of 02 - 06 UT (0430-0830MLT). The AEJ was located at mid latitude centered at 57 degs during 02 – 04 UT, while the AEJ moved poleward to 67 degs during 04 – 06 UT. These two AEJ events were caused by the increases in the PCP. The rapid poleward shift of the AEJ may have been caused by the decrease in the PCP at around 04 UT, which was caused by the decrease in the southward IMF.

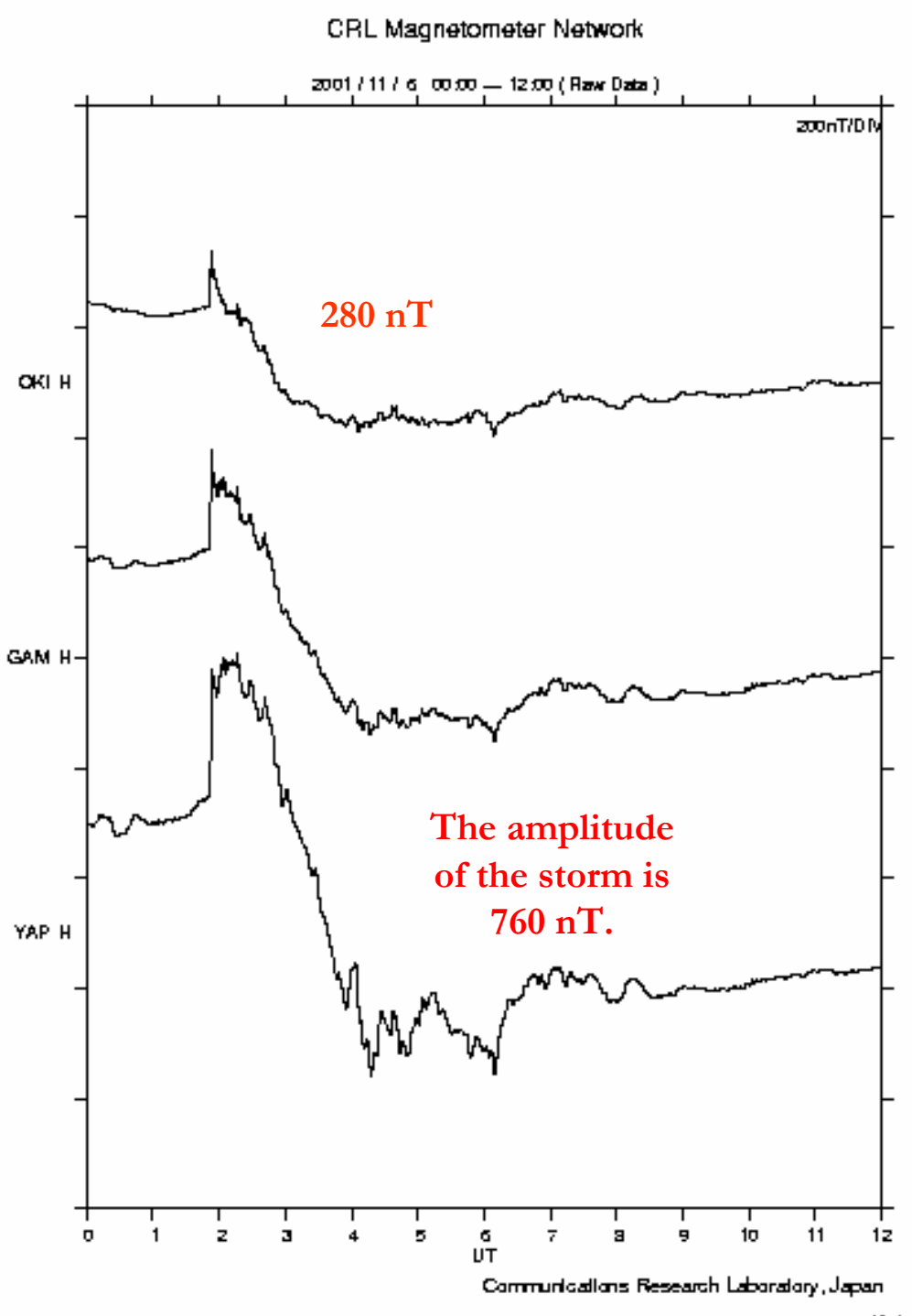
06 MLT

Geomagnetic storms at low latitude and equator

The geomagnetic storm was amplified at the dayside dip equator with an enhancement ratio of 2.7, as a result of combined effects of the DP2 and CEJ.

NICT Space Weather Monitoring magnetometers

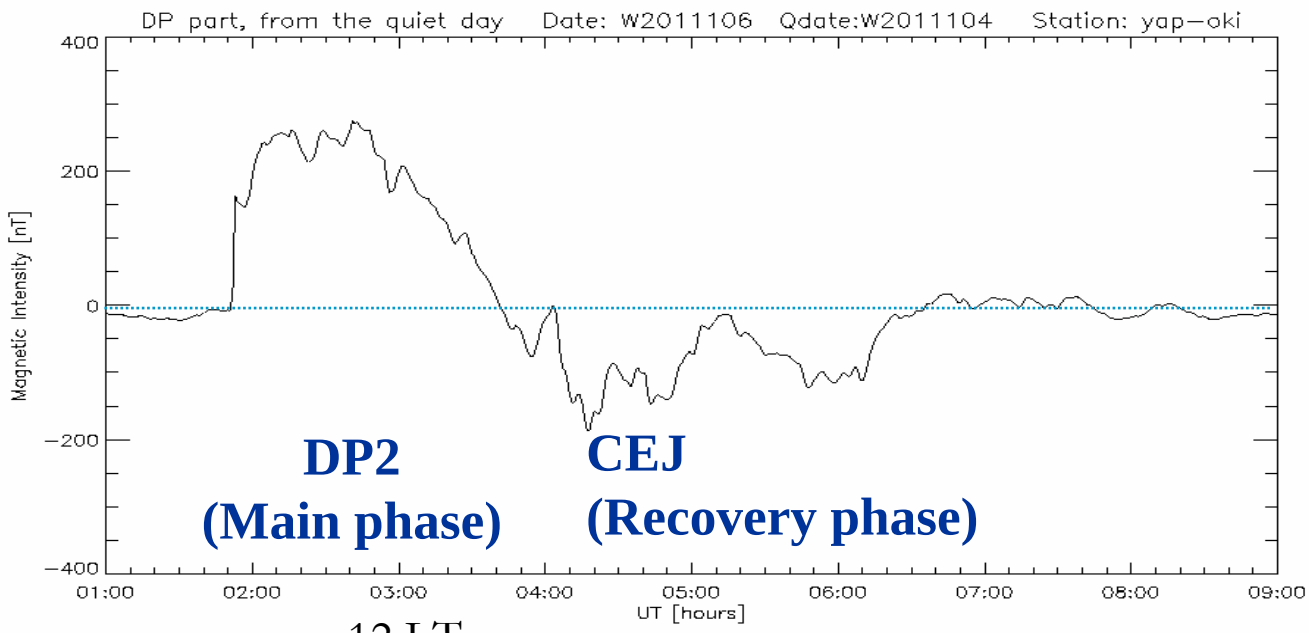




DP2 and CEJ at the dayside dip equator (YAP)

The DP2 developed during the storm main phase, while the CEJ during the storm recovery phase.

The size of the diurnal variation is 220 nT.



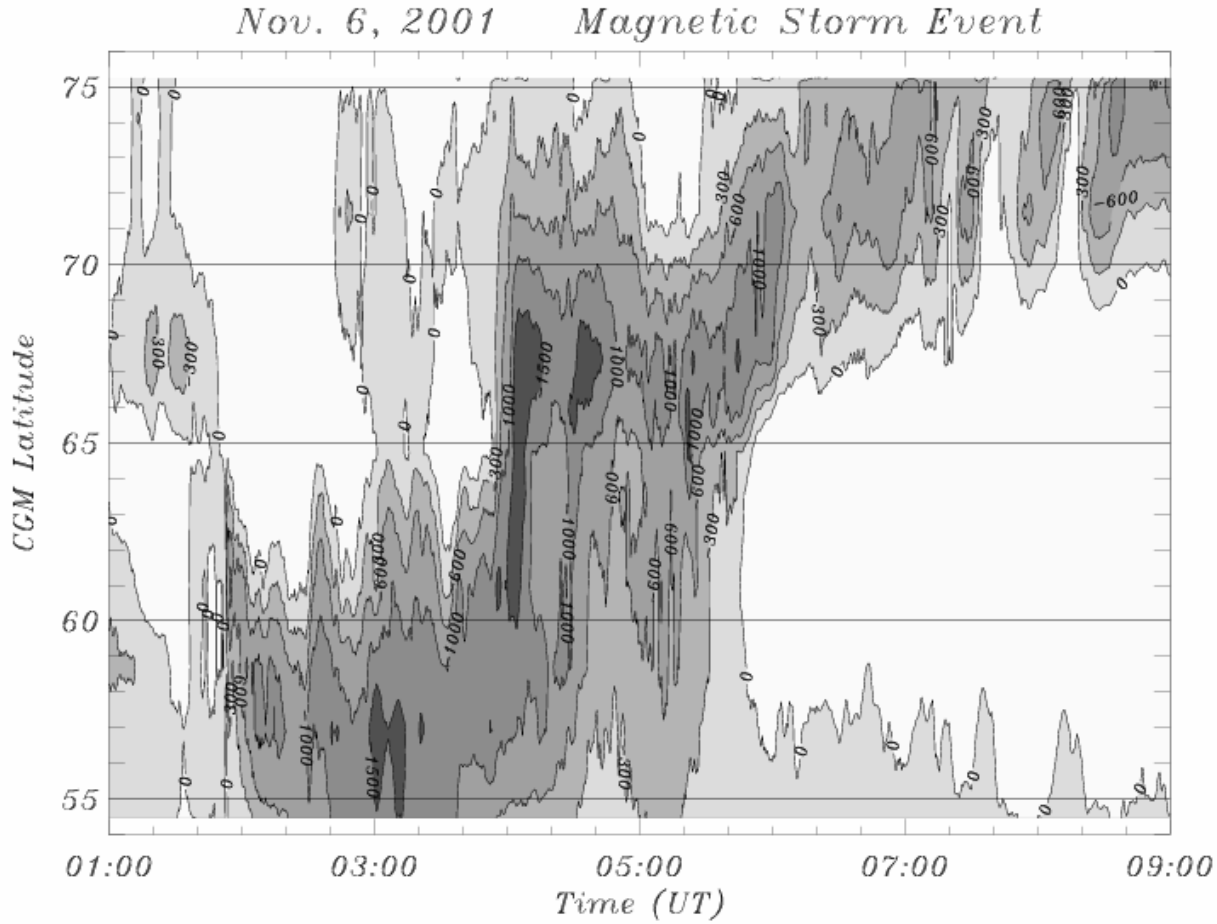
12 LT

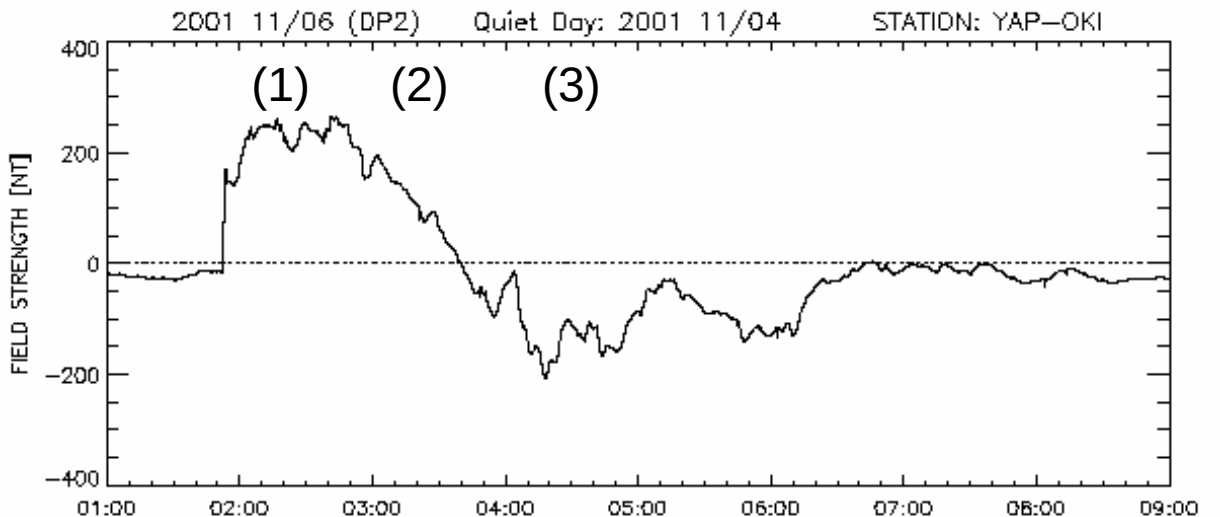
Relationship between the auroral electrojts and the equatorial DP2&CEJ

(1) Equatorial DP2 developed concurrently with the westward auroral electrojet centered at 57 degs during the whole period of the storm main phase.

(2) Shielding electric field developed one hour after the storm onset, intensifying the auroral electrojet and reducing the equatorial DP2.

3) Overshielding occurred when the auroral electrojet shifted poleward by 10 degs. The auroral electrojet remained intense, but the overshielding electric field overwhelmed the convection electric field at the equator.

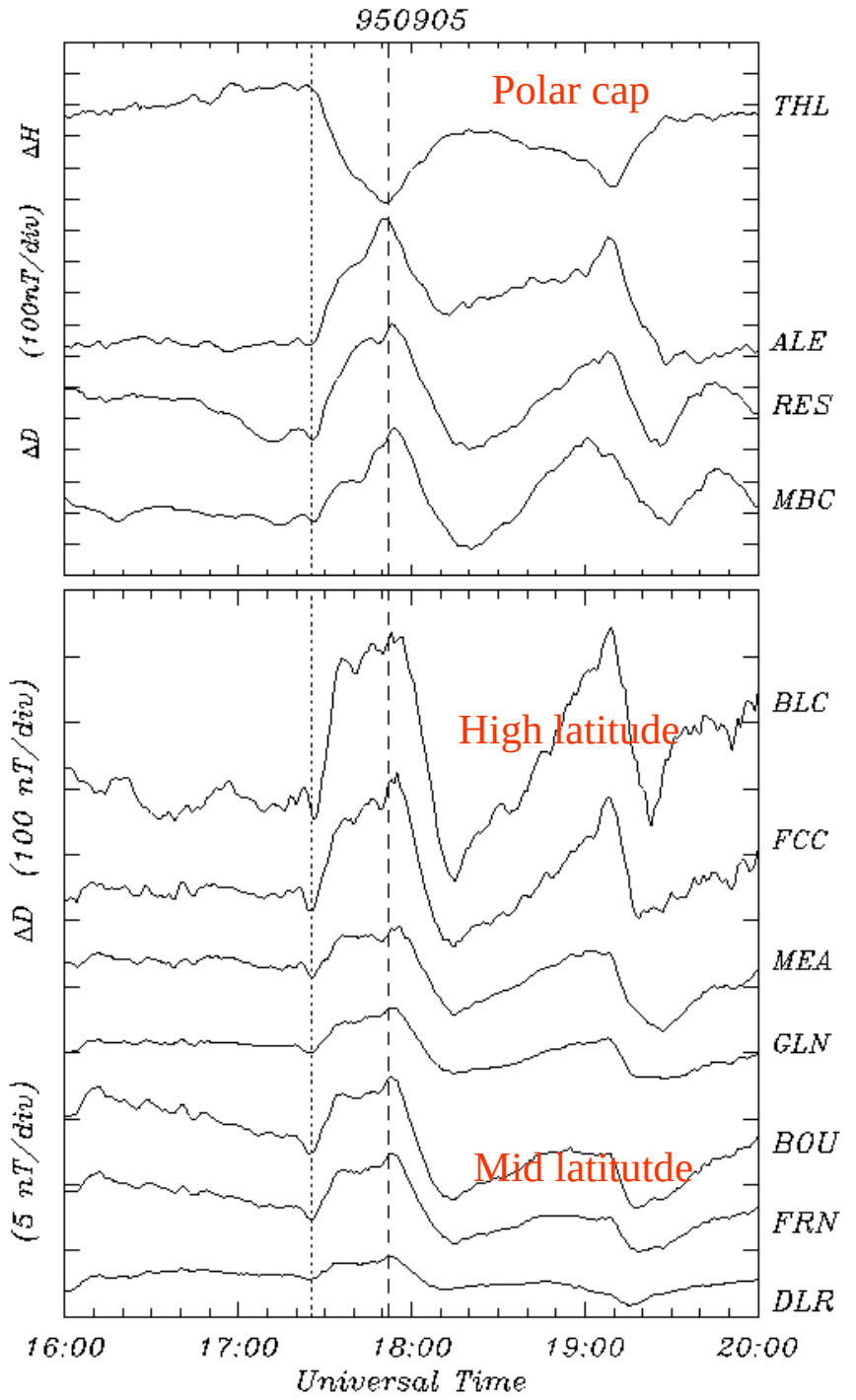




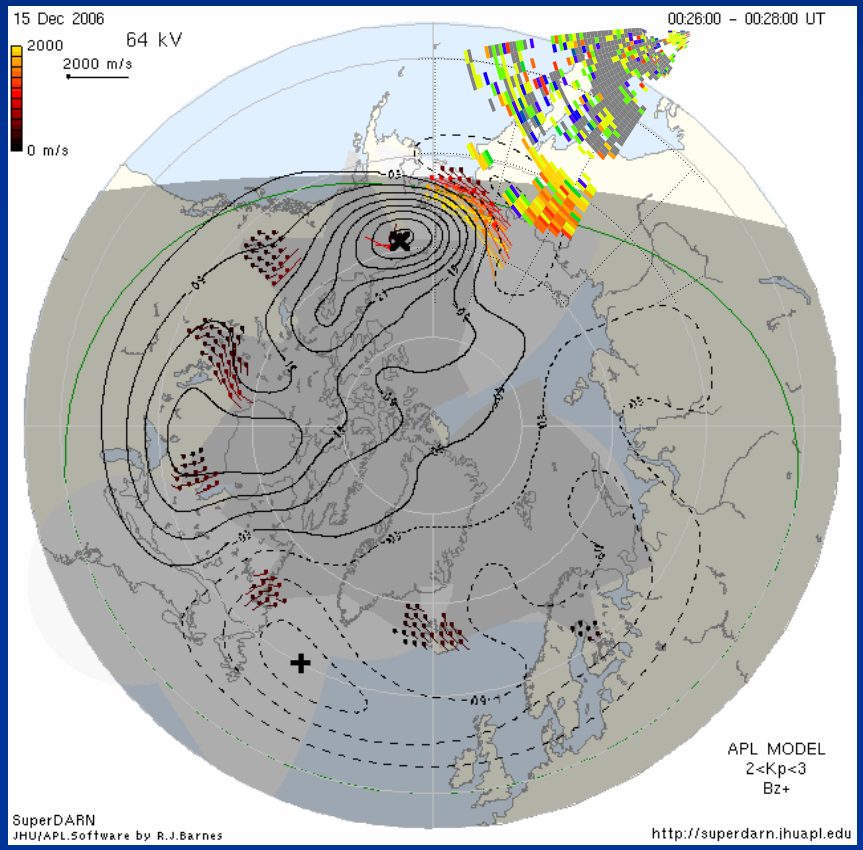
対流電場が中低緯度へ侵入

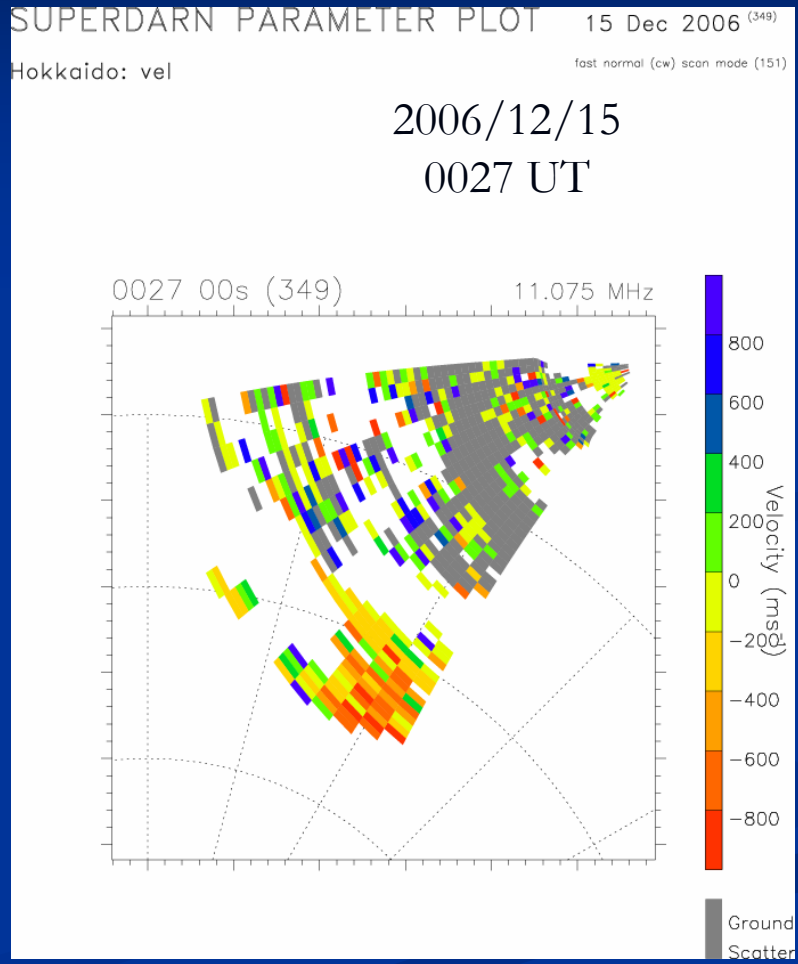
Hashimoto et al. (JGR 2002)

Baker Lake (BLC, 74.26° N, 326.55° E GM)
Fort Churchill (FCC, 69.25° N, 331.56° E GM),
Meanook (MEA, 62.28° N, 304.99° E GM),
Glenlea (GLN, 60.08° N, 328.53° E GM),
Boulder (BOU, 49.18° N, 319.15° E GM),
Fresno (FRN, 43.11° N, 303.24° E GM),
Del Rio (DLR, 38.93° N, 325.92° E GM).

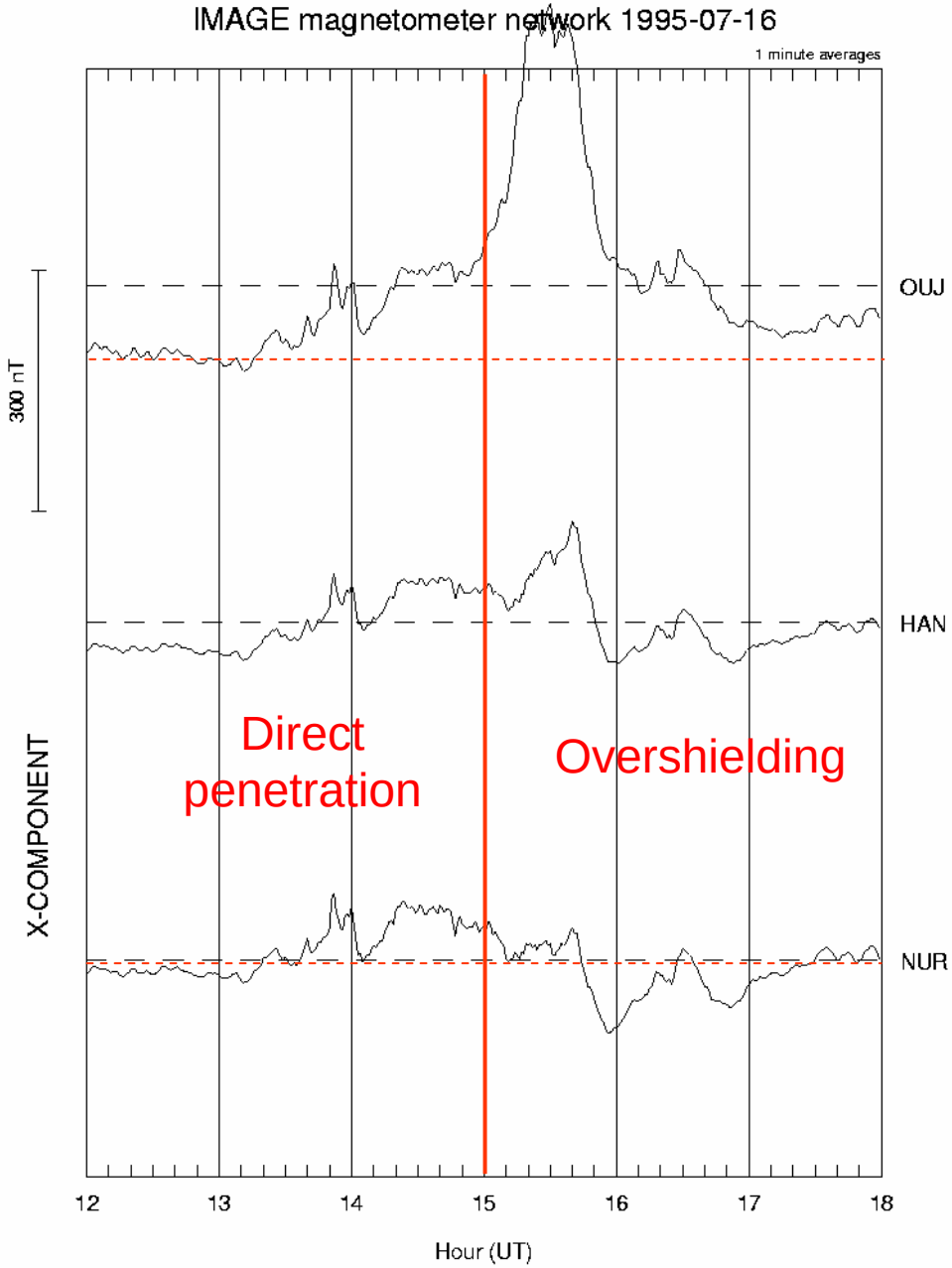


Stormtime fast flow observed by the King Salmon radar (left) and the Hokkaido radar (right)

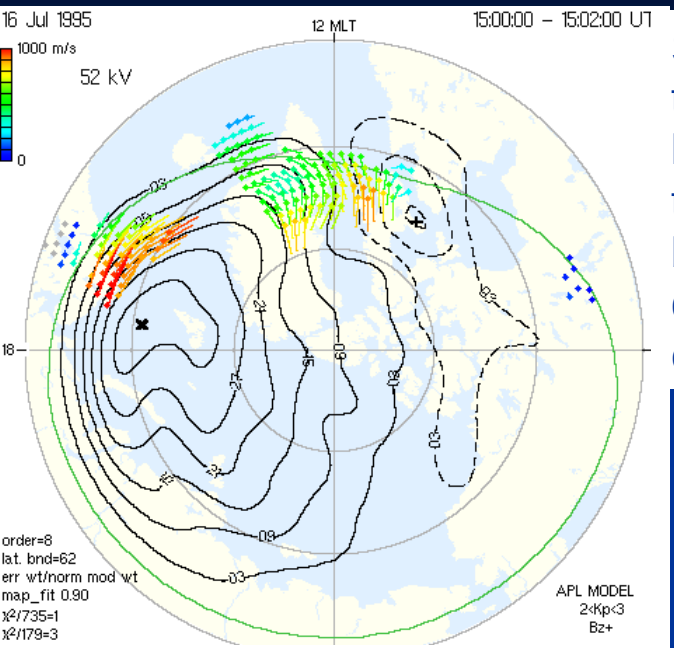


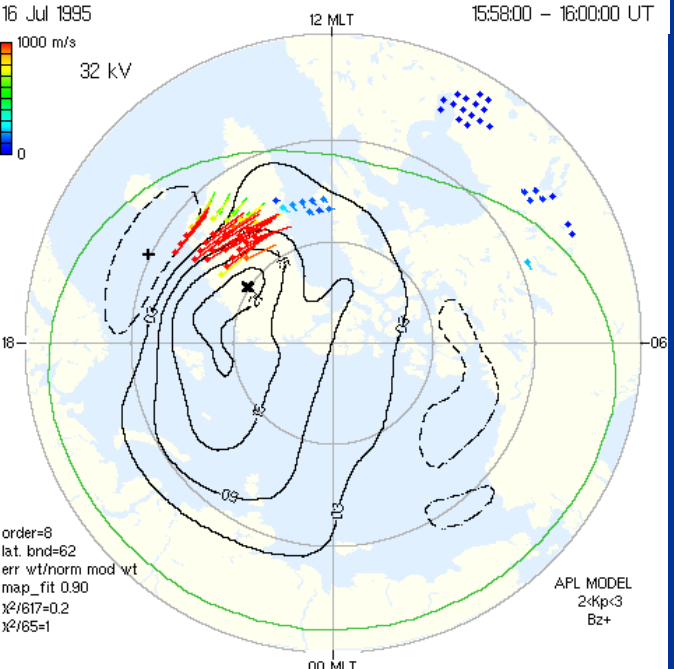


対流電場の急減による中緯度のOvershielding

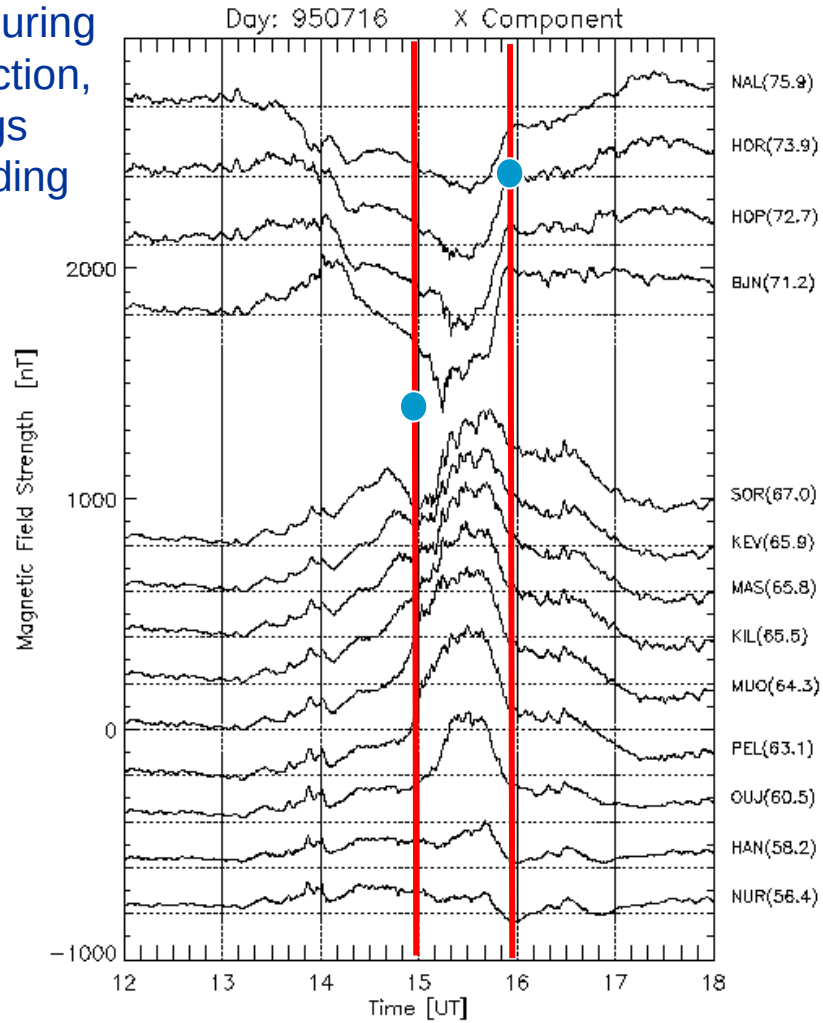


Poleward shift of the auroral oval during the overshielding event





Sunward convection in the afternoon sector was located at 67 degs during the growth of convection, but moved to 73 degs during the overshielding event.

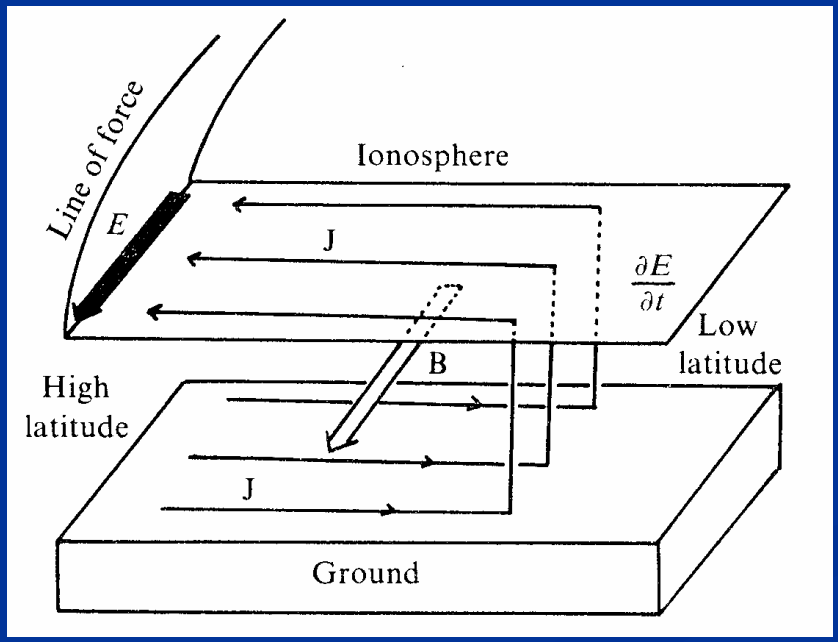


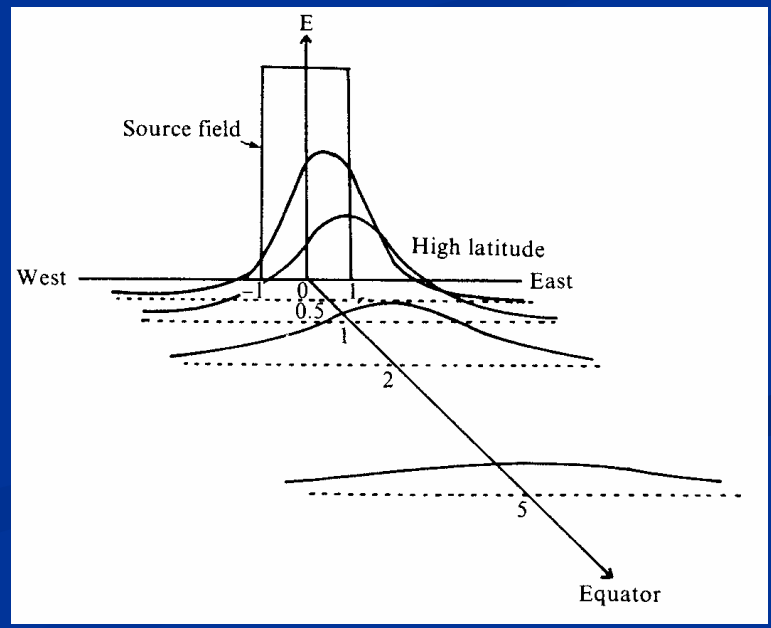
中緯度への電場侵入機構

The TM0 mode waves in the Earth-ionosphere waveguide transport electric currents in the ionosphere and at the surface of the ground, which are connected by the wave front current of the TM0 mode waves.

The transmitted electric field suffers from geometrical attenuation, but the induced currents are enhanced at the dayside equator by the Cowling effect.

(Kikuchi and Araki, 1979)





Poynting flux in the 3-layered Earth-ionosphere waveguide

Upward Poynting flux in the fully ionized ionosphere

$$S_{z,M}(x,z) = \frac{\Sigma_A}{(\Sigma_A + \Sigma_I)^2} H_{yV}^2(x) \cdot U\left(t - \frac{z}{V_a}\right)$$

Upward Poynting flux in the conducting ionosphere

$$S_{zI}(x,z) = \frac{\Sigma_A + \Sigma_I - \sigma z}{(\Sigma_A + \Sigma_I)^2} H_{yV}^2(x)$$

Horizontal Poynting flux in the waveguide

$$S_{xV}(x) = Z_0 H_{yV}^{\ 2}(x) = E_{zV}^{\ 2}(x) / Z_0$$