Plasma sheet evolution following dual lobe reconnection

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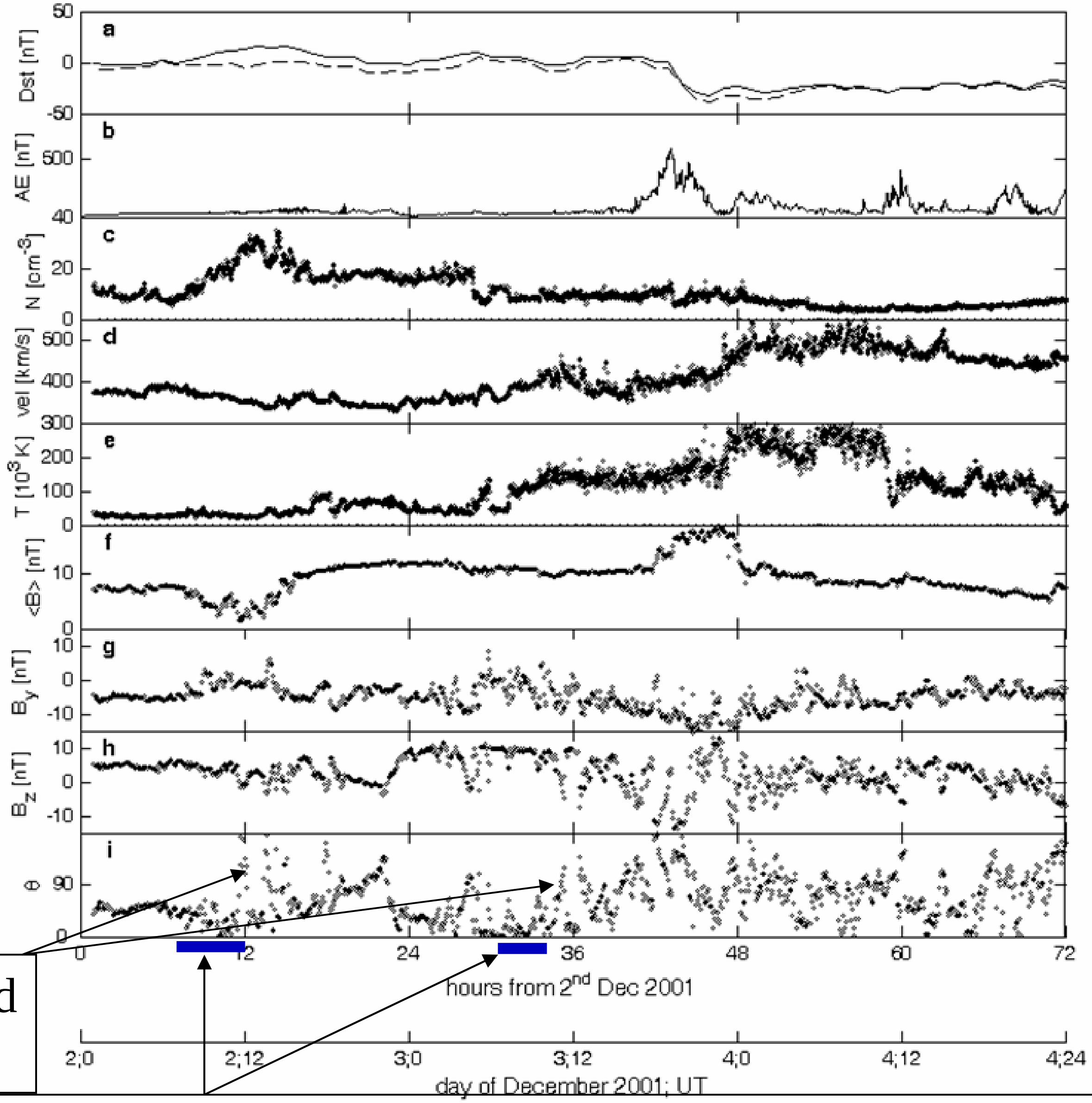
This study has been performed in the framework of the IHY Coordinated Investigation Programs # 10 and #19.

We study two intervals of northward IMF during the 2-4 December 2001 time period.

We use:

- **SuperDARN** ionospheric convection measurements,
- northern hemisphere aurora observations by **IMAGE/FUV,**
- **LANL** data.

December 2-4,2001



IMF southward turnings

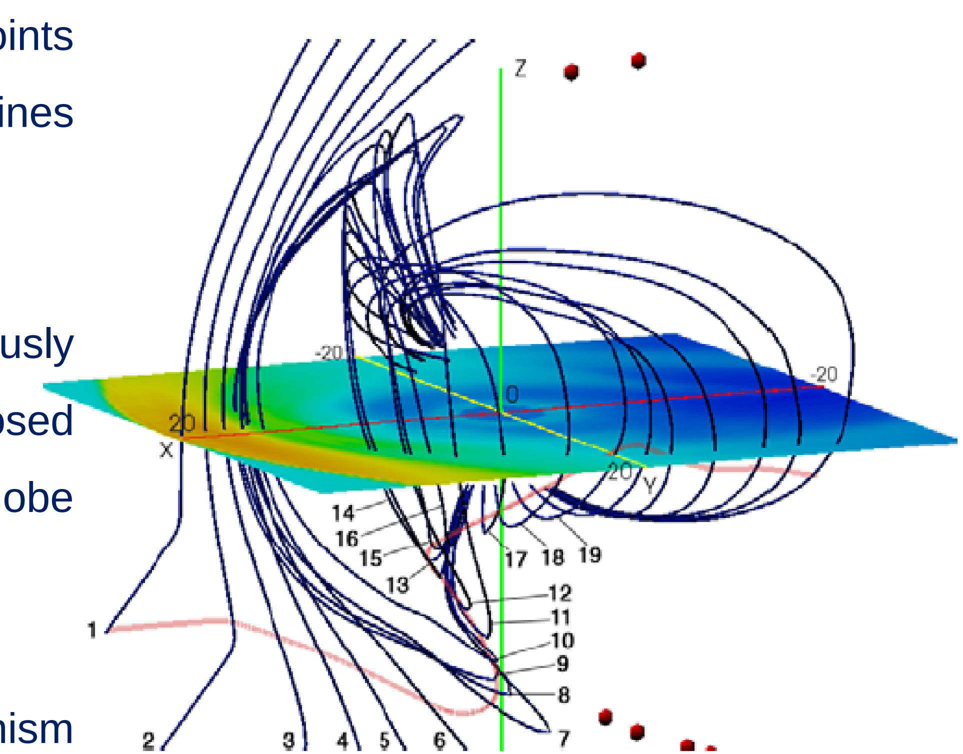
Periods during which dual lobe reconnection is sporadically observed

Dual lobe reconnection

When the interplanetary magnetic field points northward, it can reconnect with lobe field lines tailward of the cusps (lobe reconnection).

When the same IMF lines reconnects simultaneously at the southern and northern lobes, a newly closed magnetospheric field line is generated (dual lobe reconnection).

Dual lobe reconnection is an important mechanism by which solar wind mass is captured in the magnetosphere and a cold and dense plasma sheet (CDPS) is formed.



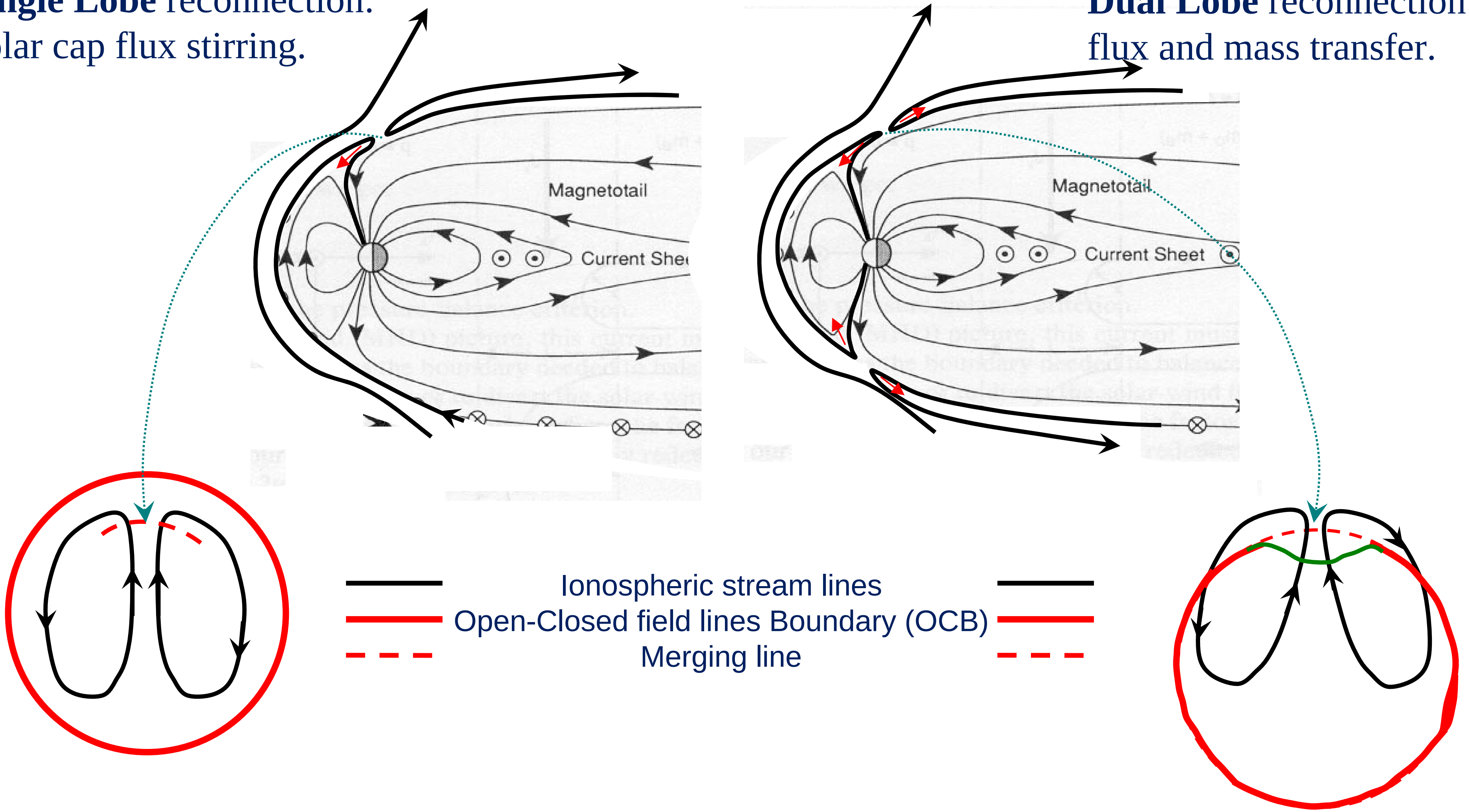
Newly reconnected line sinking in the magnetosphere [from *Li et al.* 2005].

The CDPS plasma can access the geosynchronous orbit from the mid-tail region, being injected after a southward turning of the IMF or a solar wind pressure pulse.

Ionospheric signatures of lobe reconnection

Single Lobe reconnection:
polar cap flux stirring.

Dual Lobe reconnection:
flux and mass transfer.



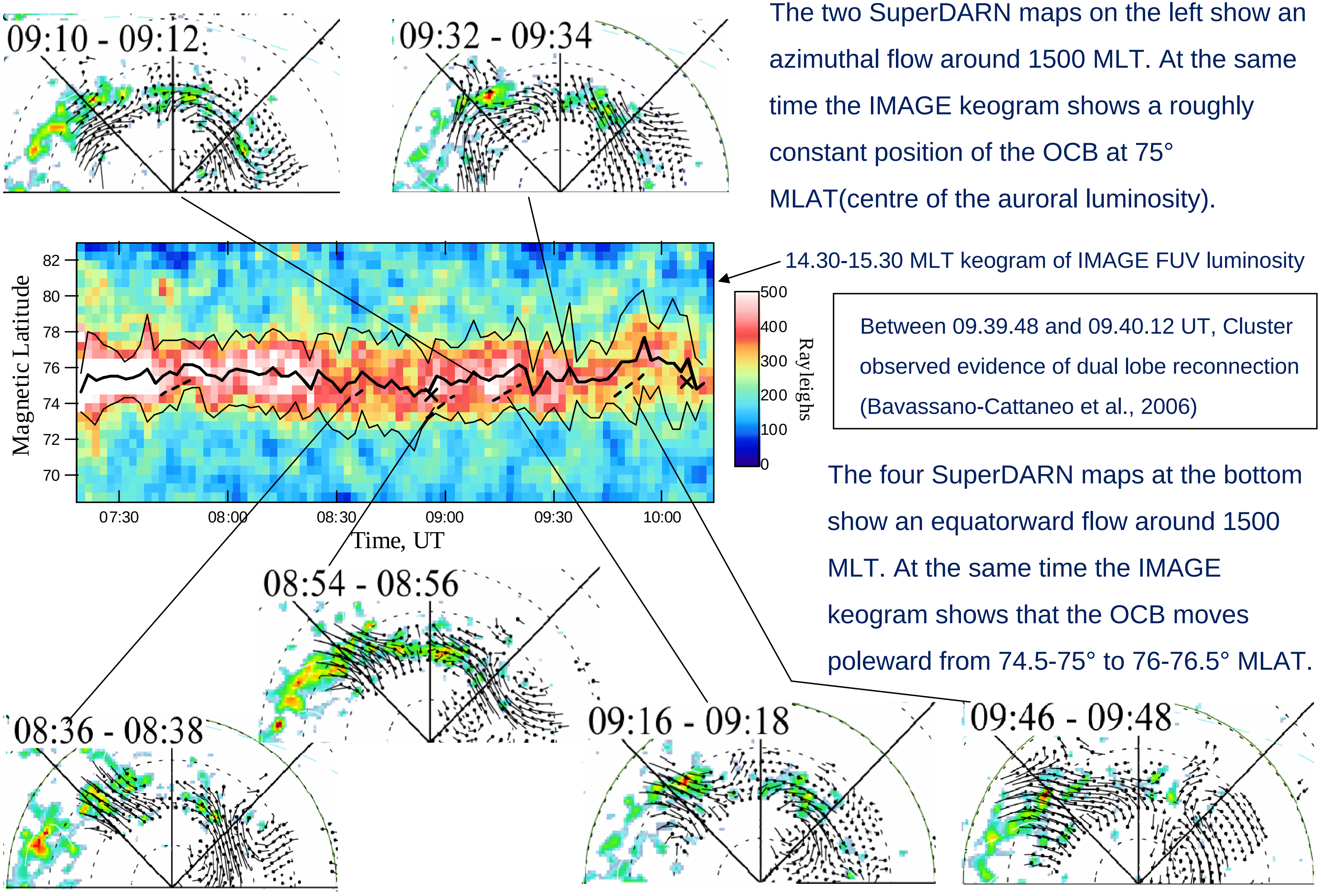
Ionospheric stream lines
Open-Closed field lines Boundary (OCB)
Merging line

- Merging line poleward of OCB
- Sunward flow not crossing the OCB

- Dayside erosion of the polar cap
- Poleward movement of the OCB
- Sunward flow crossing the OCB

December 03, 07:20 – 10:10 UT. SuperDARN and IMAGE data.

The two SuperDARN maps on the left show an azimuthal flow around 1500 MLT. At the same time the IMAGE keogram shows a roughly constant position of the OCB at 75° MLAT(centre of the auroral luminosity).

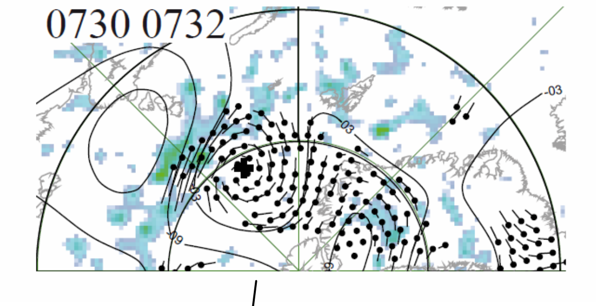


14.30-15.30 MLT keogram of IMAGE FUV luminosity

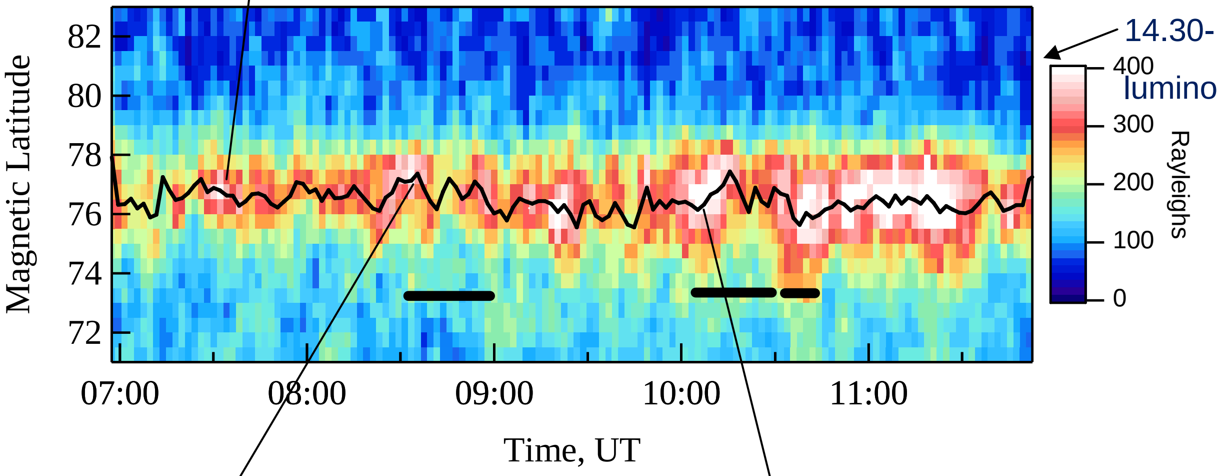
Between 09.39.48 and 09.40.12 UT, Cluster observed evidence of dual lobe reconnection (Bavassano-Cattaneo et al., 2006)

The four SuperDARN maps at the bottom show an equatorward flow around 1500 MLT. At the same time the IMAGE keogram shows that the OCB moves poleward from 74.5-75° to 76-76.5° MLAT.

December 02, 07:00 – 11:52 UT. SuperDARN and IMAGE data.

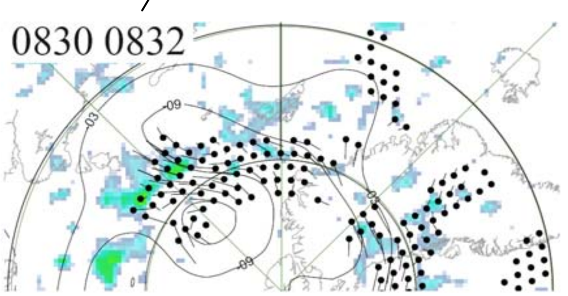


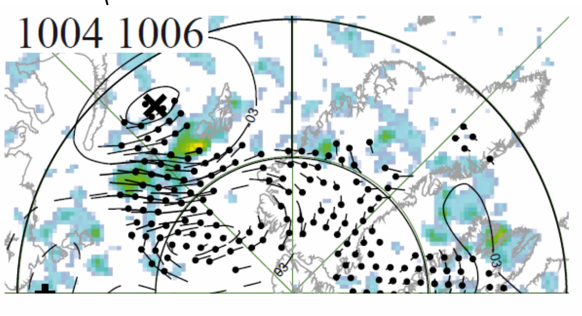
The SuperDARN map on the left shows an azimuthal flow at auroral latitudes around 15.00 MLT. At the same time the IMAGE keogram shows a roughly constant position of the OCB at 75° MLAT(centre of the auroral luminosity).



14.30-15.30 MLT keogram of IMAGE FUV luminosity

DMSP data (not shown) were used to check the location of the auroral oval both for the 02 December event and for the 03 December event.





The two SuperDARN maps at the bottom show an equatorward flow around 1500 MLT. At the same time the IMAGE keogram shows that the OCB moves poleward.

Number of solar wind particles captured in the magnetosphere during dual lobe reconnection

We approximate the re-closed magnetic flux as AB_{geo}.

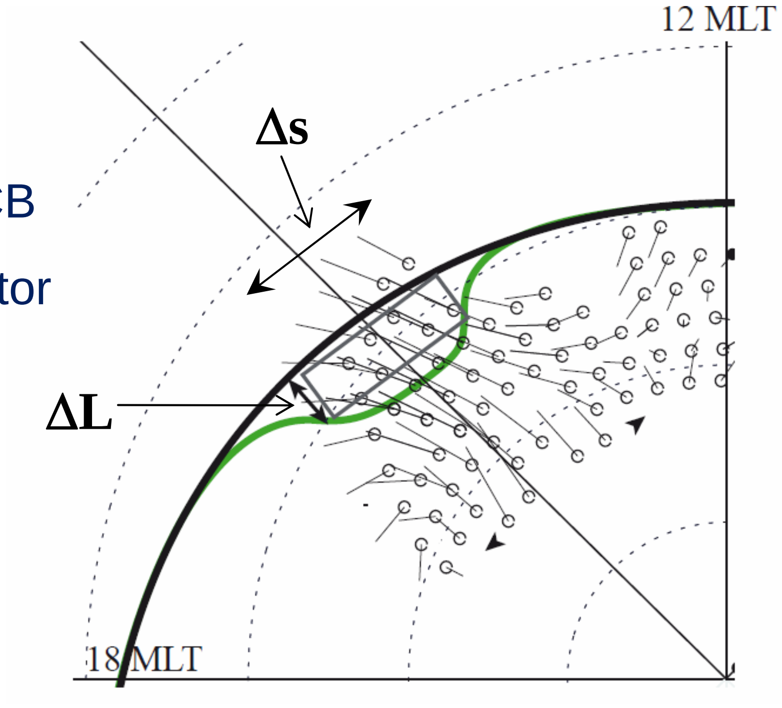
Here B_{geo} is the geomagnetic field and

$A = \Delta L \, \Delta s$,

where ΔL is the poleward displacement of the OCB

and Δs is the azimuthal extension of the MLT sector

where the sunward flow is observed.



Similarly to Imber et al. 2006, we compute

the number of captured solar wind particles as:

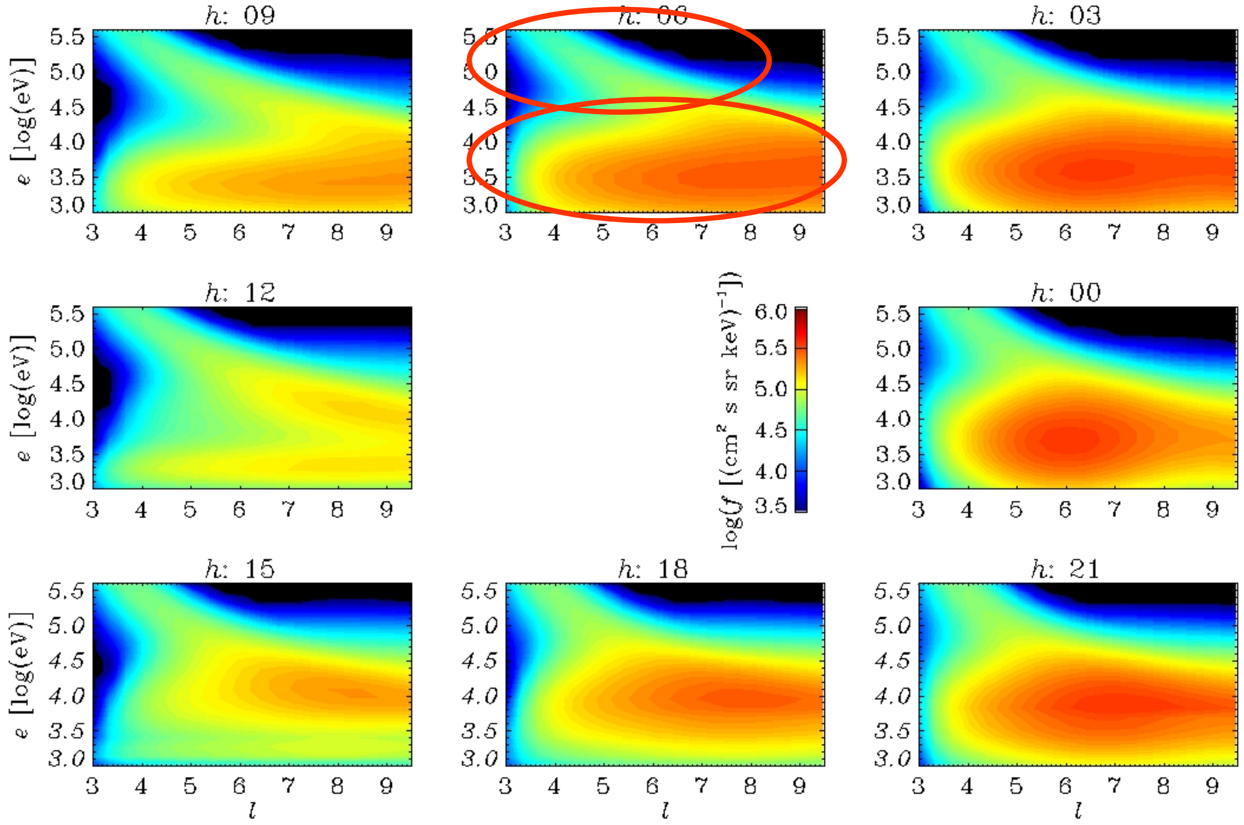
$$N = n_{sw} L \frac{AB_{geo}}{B_{SW}} \approx 2\times10^{30}$$

with $L \approx 20R_E, A \approx .5\times10^5 km^2, B_{sw} \approx 4nT, n_{sw} \approx 14cm^{-3}$

Observations in the magnetosphere

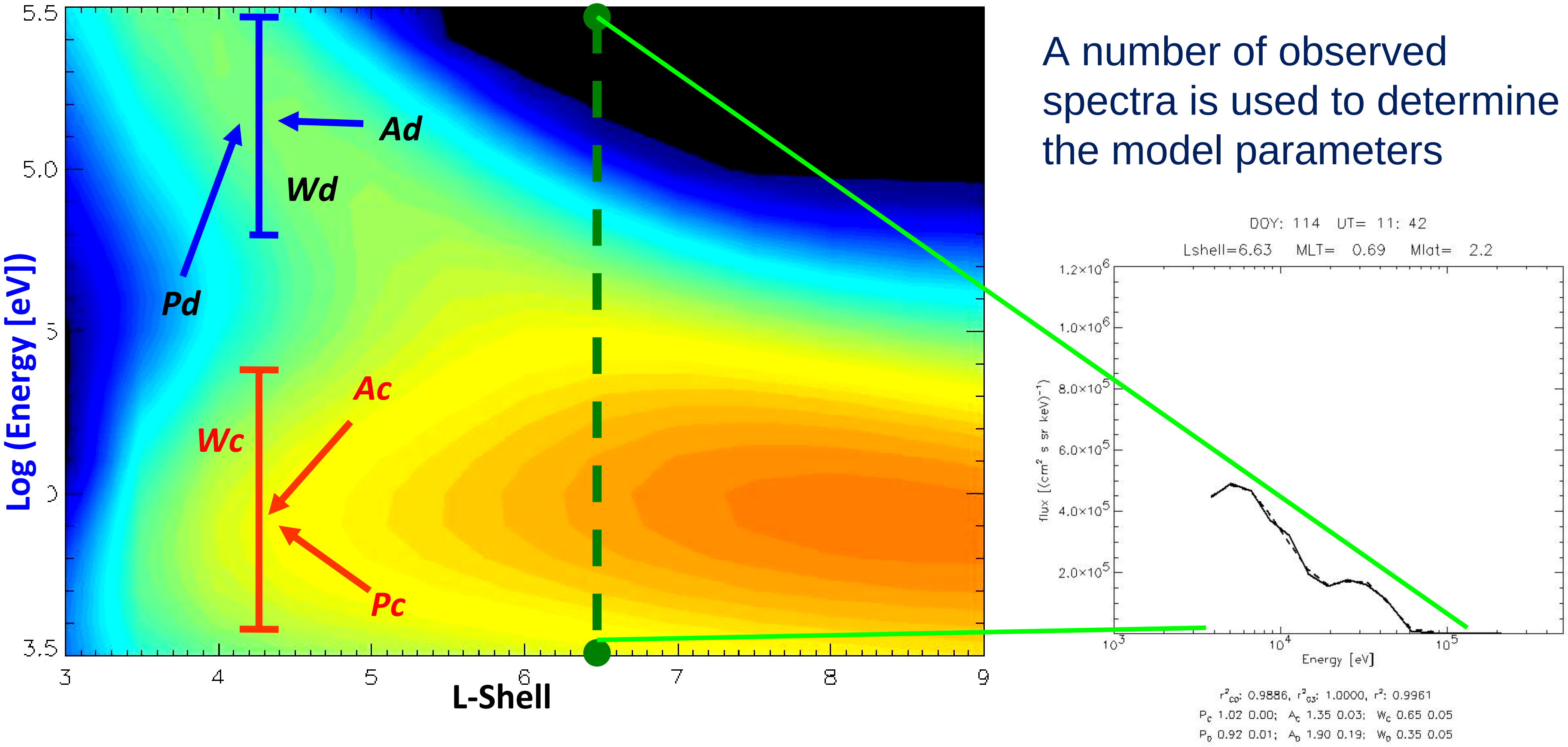
The empirical model by *Milillo et al. (2001)*
is based on AMPTE-CCE/CHEM data for AE<100 nT
and describes the 90^{o} p.a. H^+ fluxes as a function of log(E), L-shell and MLT

Two major H^+ populations are evidenced by the model



EMPIRICAL MODEL - FIT PARAMETERS

Orsini et al. (2004) defined a method for reconstructing
the instantaneous storm-time global magnetosphere by tuning 6 model parameters.
In this study we are interested to the lower energy population, i.e. to W_c, A_c and P_c.



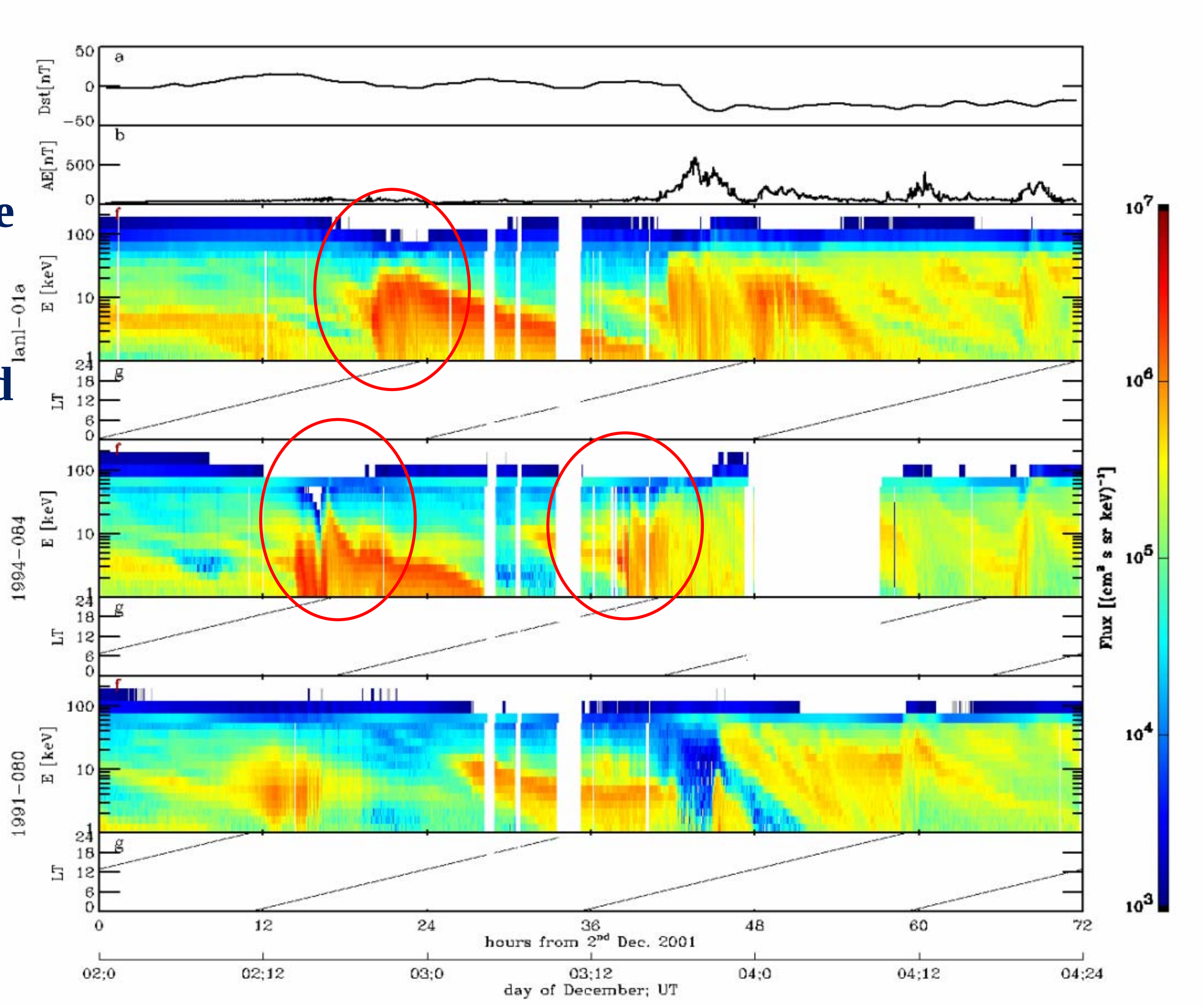
A number of observed spectra is used to determine the model parameters

December 2-4, 2001
LANL data

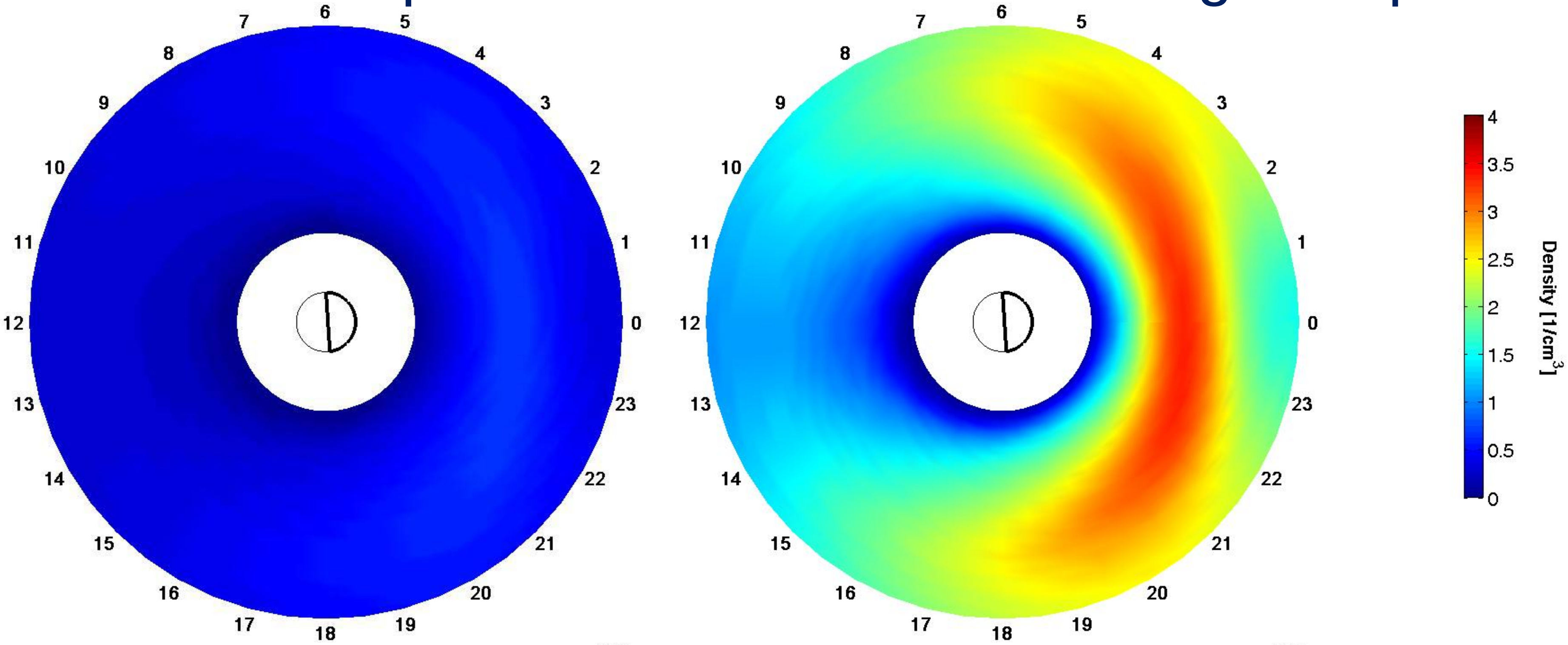
H$^+$ *in situ* data from the LANL satellites: 1991-080, 1994-084 and lanl-01a.

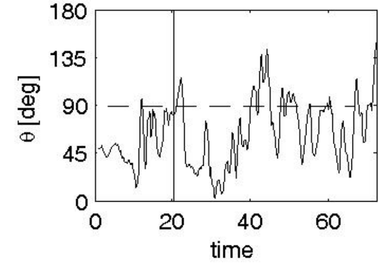
MPA (90° pa) and SOPA (pa averaged)

(L ~ 6.6, E 1-300 keV).



Number of sw particles observed in the magnetosphere





The number of convected particles is the difference between the number of particles at maximum density (2 Dec., 20 UT) and the number of particles before the southward turning of the IMF.

$$N_{conv} = N_{pcle}(t) - N_{pcle}(t_o)$$

$$N_{pcle}(t) = \int \rho(t) \cdot dVol$$

The convected particles

in a volume with 4<L-shell<10 are

N_{conv}=8 10^{29}

Summary and Conclusions

We gave evidence of dual lobe reconnection using SuperDARN and IMAGE/FUV data during two periods of northward IMF on 2-4 December, 2001.

We analyzed the time evolution of the global equatorial proton distribution by applying the *Orsini et al*. [2004] method to the LANL data. This showed that a cold population was injected from the night side into the near Earth magnetosphere at 15 UT on December 2 and at 14UT on 3 Dec, after two southward turnings of the IMF.

We suggest that cold plasma entered the dayside magnetopause during the two northward IMF intervals and then reached the geostationary orbit after the southward turnings of the IMF.

For the first time interval, the number of particles captured in the magnetosphere was independently estimated:
- from the SuperDARN and IMAGE observation of the OCB contraction ($2\ 10^{30}$);
- from LANL data through the Orsini et al. (2004) model ($8\ 10^{29}$).

The two estimates are in close agreement.

Acknowledgments.

- S. B. Mende and the FUV team at UC Berkeley (IMAGE FUV data and FUVIEW software to build the keogram).
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- G. Reeves and M. Thomsen (LANL data).

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