DYNAMICS OF THE EQUATORWARD BOUNDARY OF THE ION AURORAL OVAL: RADAR OBSERVATIONS

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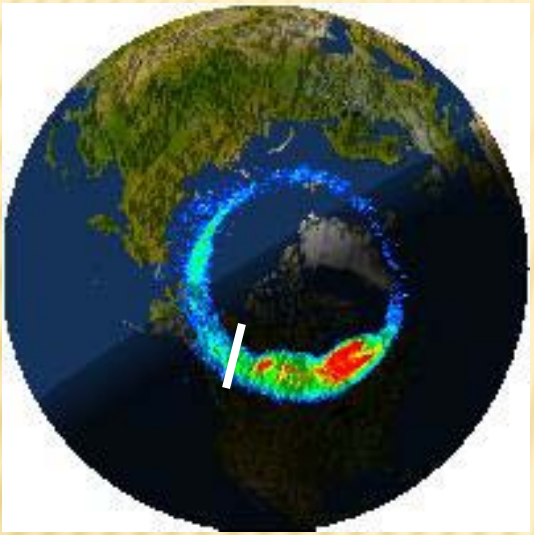
OUTLINE

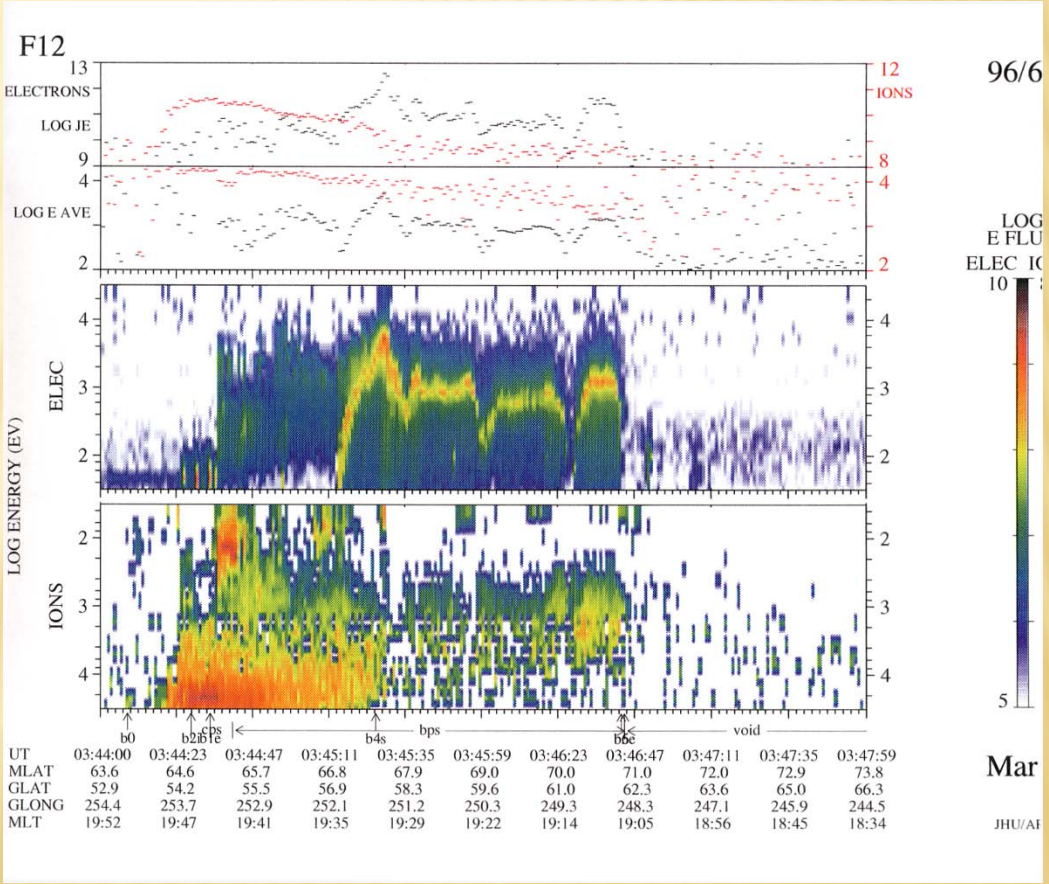
- Introduction and background
- Significance of the boundary
- Techniques to determine the boundary
- New radar technique
- Dynamics of the boundary
  - Substorm onset
  - Response of the boundary to N-S transition of IMF
  - Convection

INTRODUCTION AND BACKGROUND

Auroral oval comprises of precipitating electrons and ions



Polar UVI

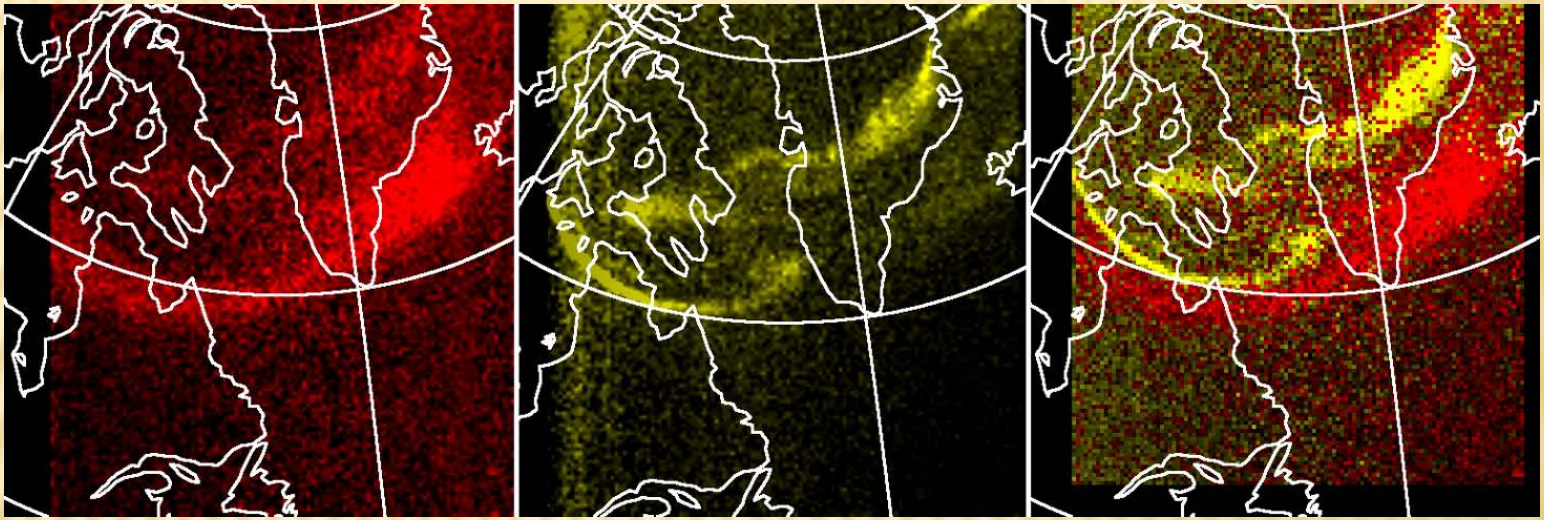


DMSP Particle Spectrogram

In the UV image ion part is missing

PROTON AURORA/DIFFUSE AURORA

Image Satellite



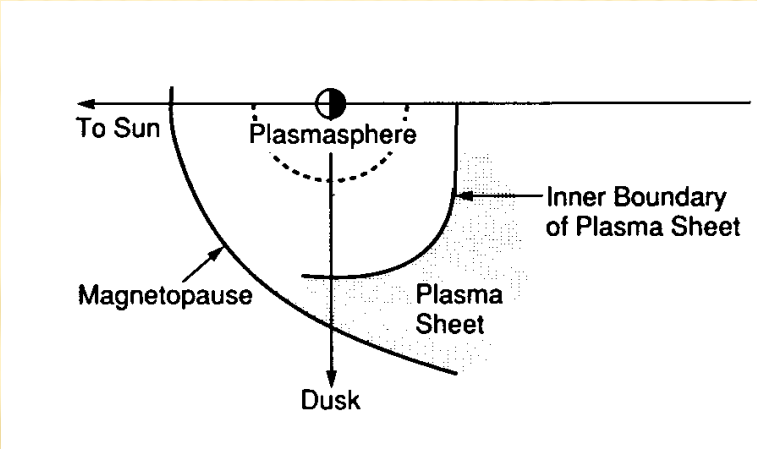
Proton Aurora Electron aurora Proton+electron aurora

In the dusk-midnight sector, on average, ion precipitation is equatorward of electron precipitation

From Mende et al., 2003

INTRODUCTION AND BACKGROUND

- Equatorward boundary of the high-energy ion precipitation represents the inner boundary of the ion plasma sheet – Ion Isotropy boundary – transition from pitch angle scattering to bounce trapping



❖Location of the boundary indicate the state of the inner magnetosphere

❖Stretched tail – Boundary will be at lower latitude

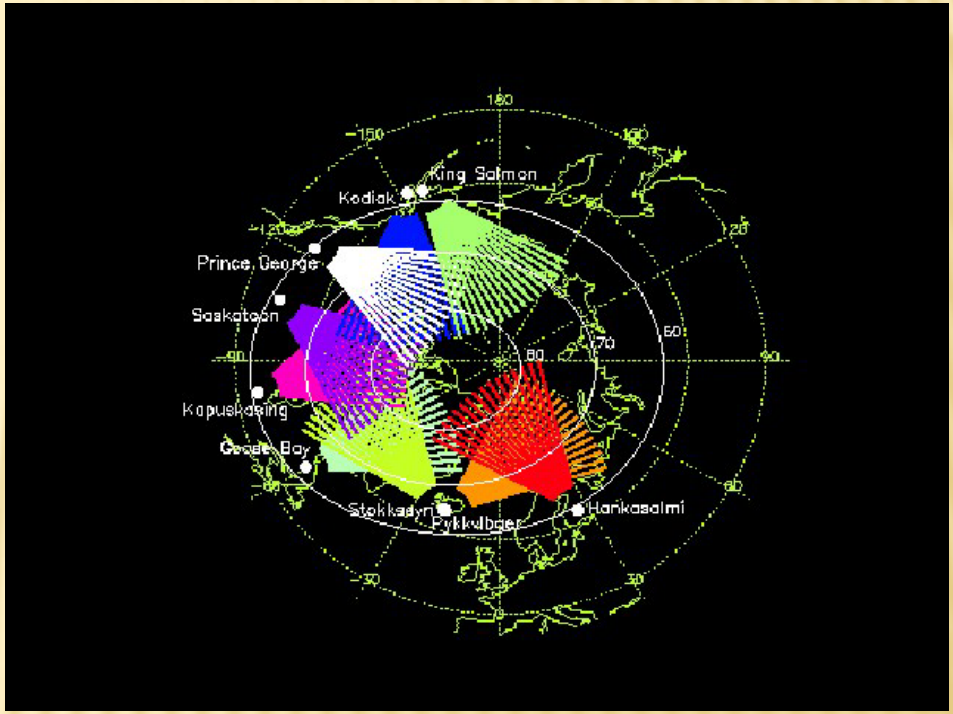
❖Relaxed tail – Boundary will at higher latitude

TECHNIQUES TO MONITOR THE BOUNDARY

- In-Situ particle measurements
  - DMSP class satellites
  - Problem: No temporal and spatial resolution
- Ground based optical measurements – Proton aurora (Hβ)
  - No Spatial resolution
- Satellite based UV imaging
  - Most of the time sensitive to electron precipitation
  - Modern imagers are capable - nothing in orbit now

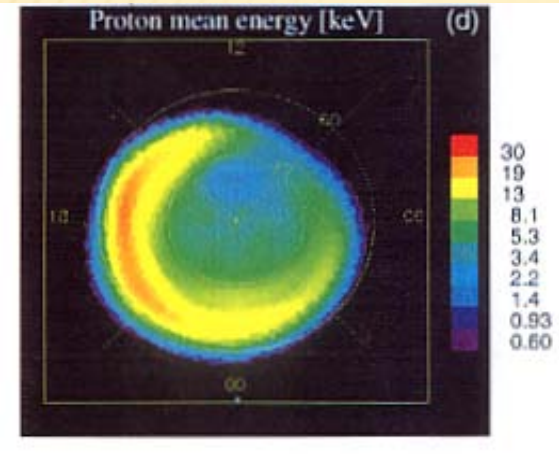
NEW TECHNIQUE – GROUND BASED RADAR

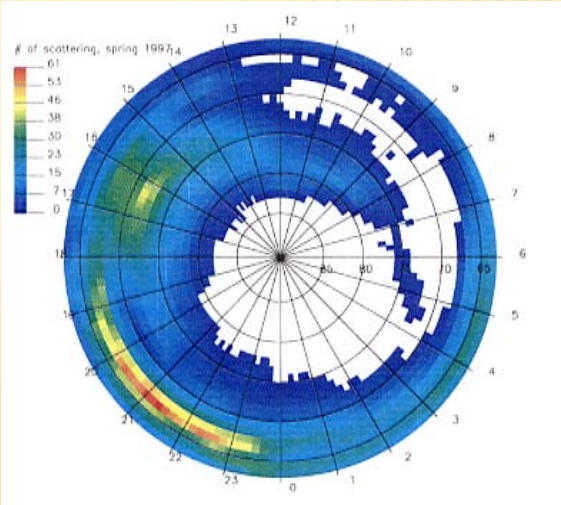
- SuperDARN radars have wide coverage
- Continuous and wide area monitoring capability (whenever irregularities are present)
- A complimentary tool to monitor the dynamics of the proton auroral boundary (if it can monitor)

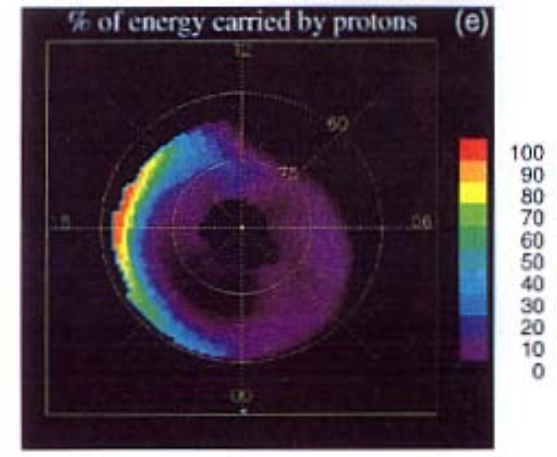


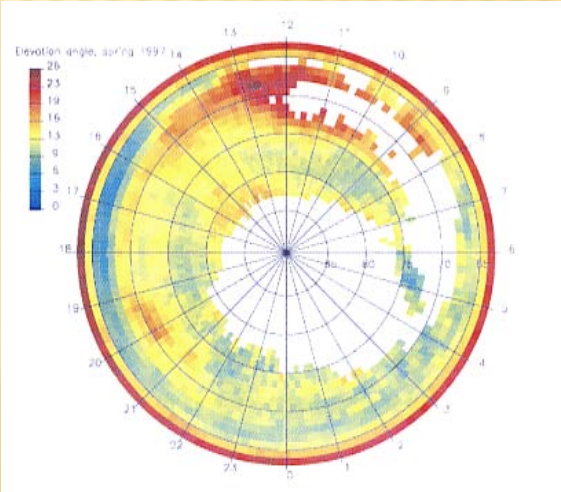
Old SuperDARN map!!

DISCOVERY OF E REGION BACKSCATTER ASSOCIATED WITH ION PRECIPITATION



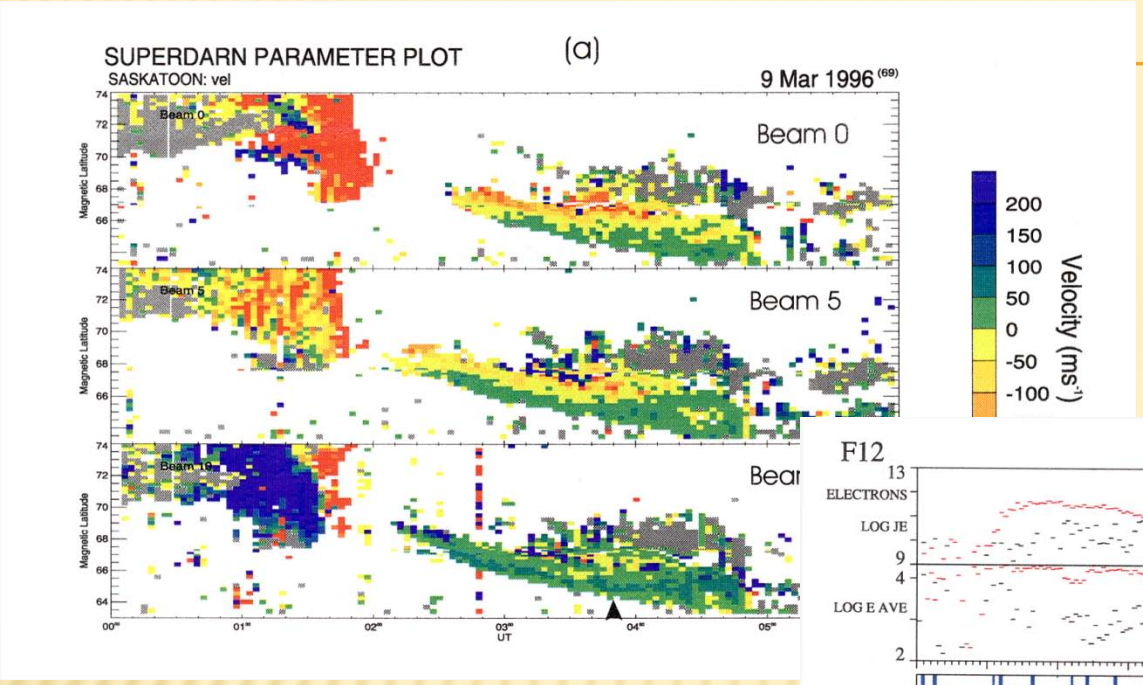


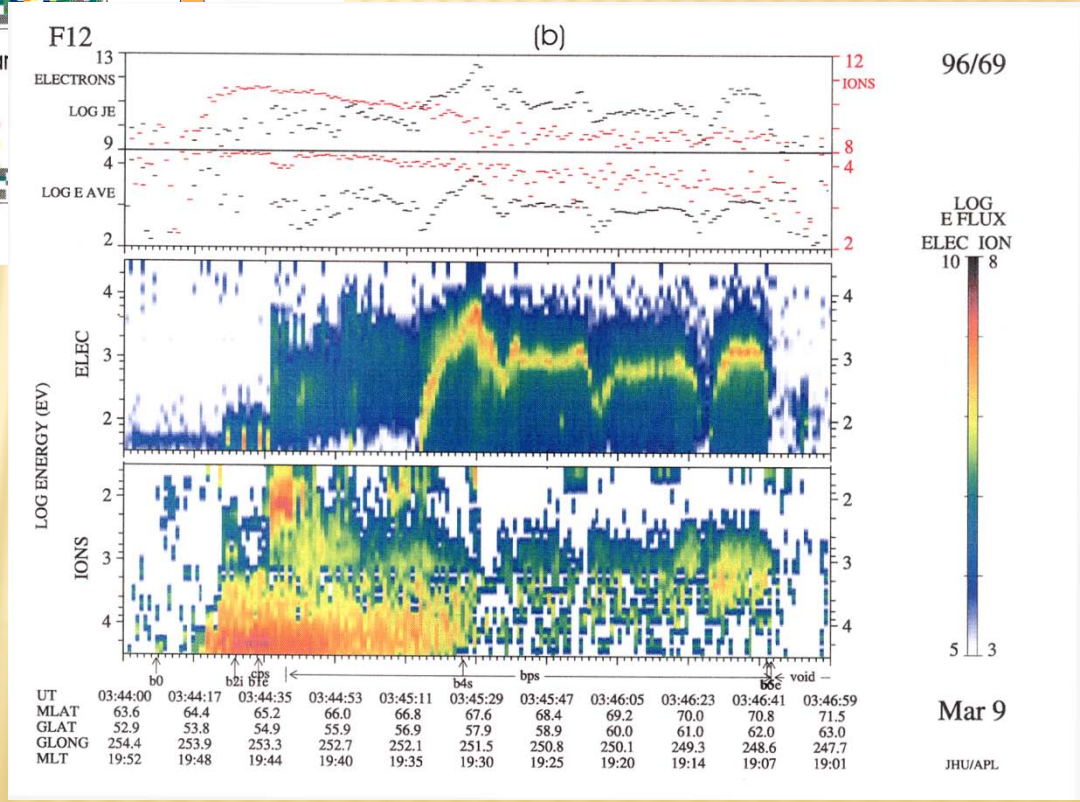




Jayachandran et al. 2000

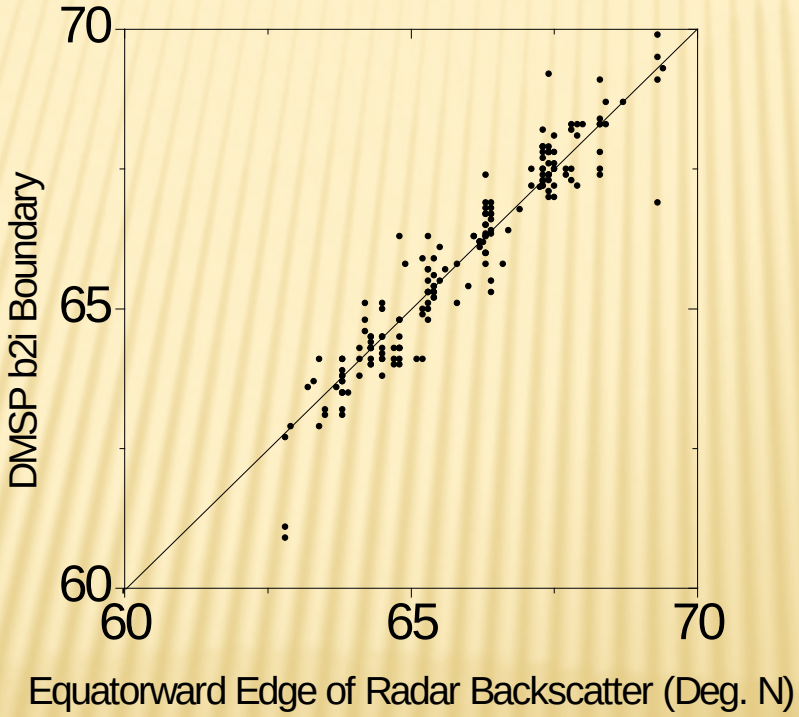
Validation with particle measurements





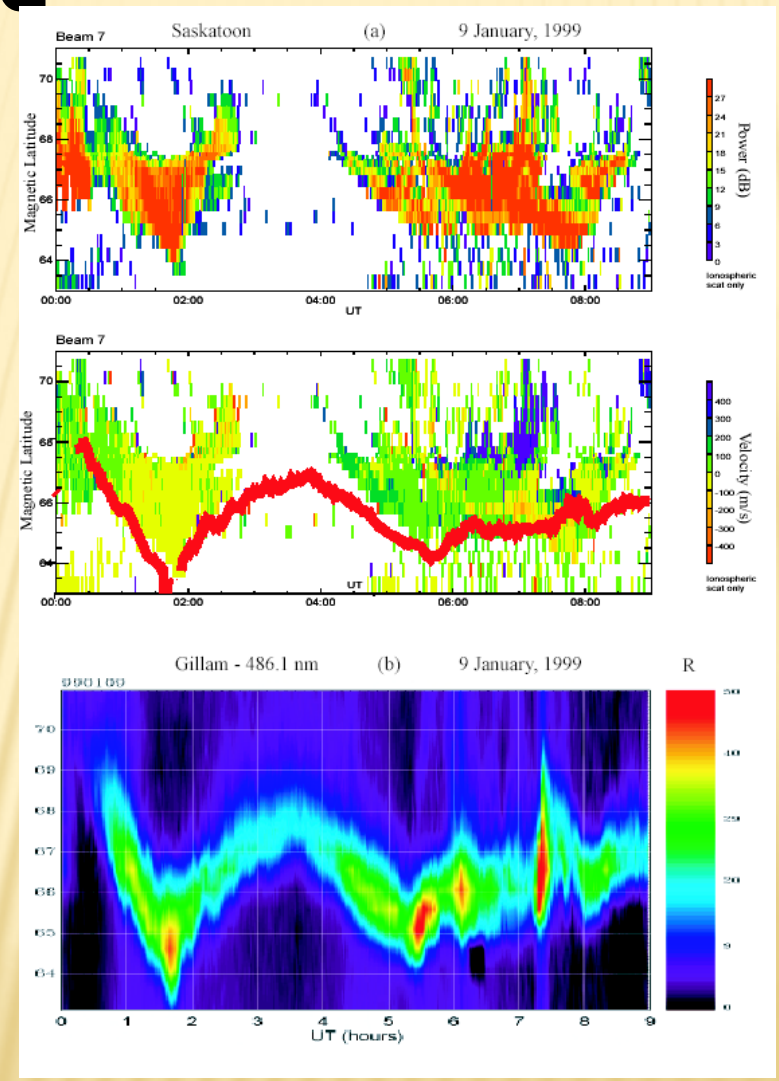
From Jayachandran et al., 2002

Comparison of radar boundary with DMSP particle boundary



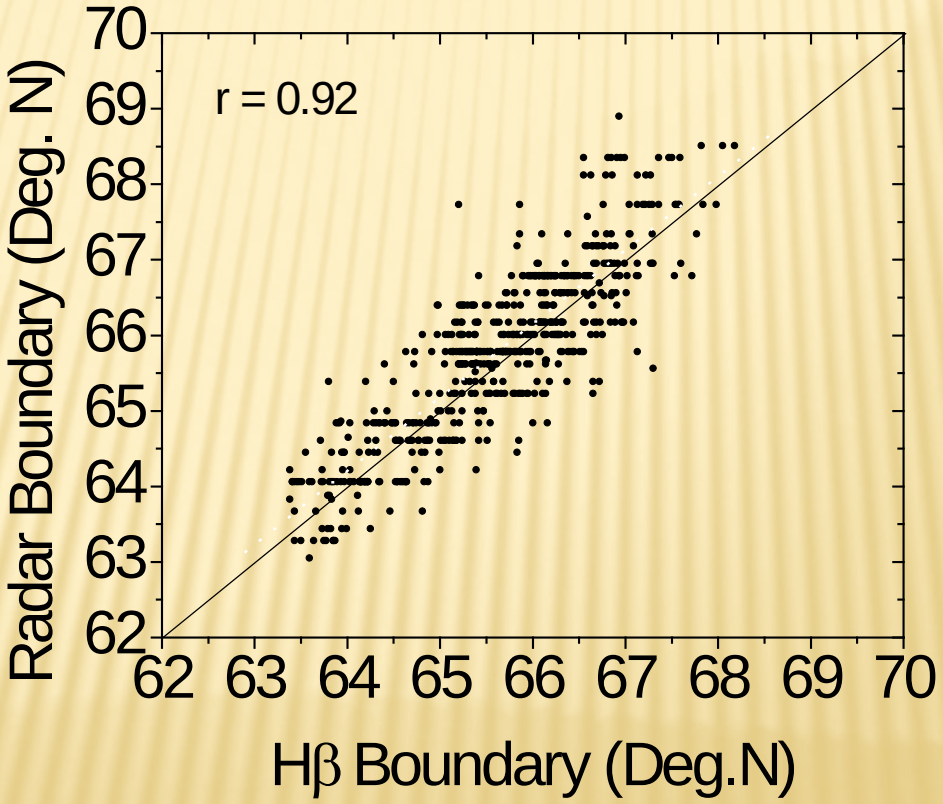
Jayachandran et al., 2002a

Association of radar backscatter with proton aurora



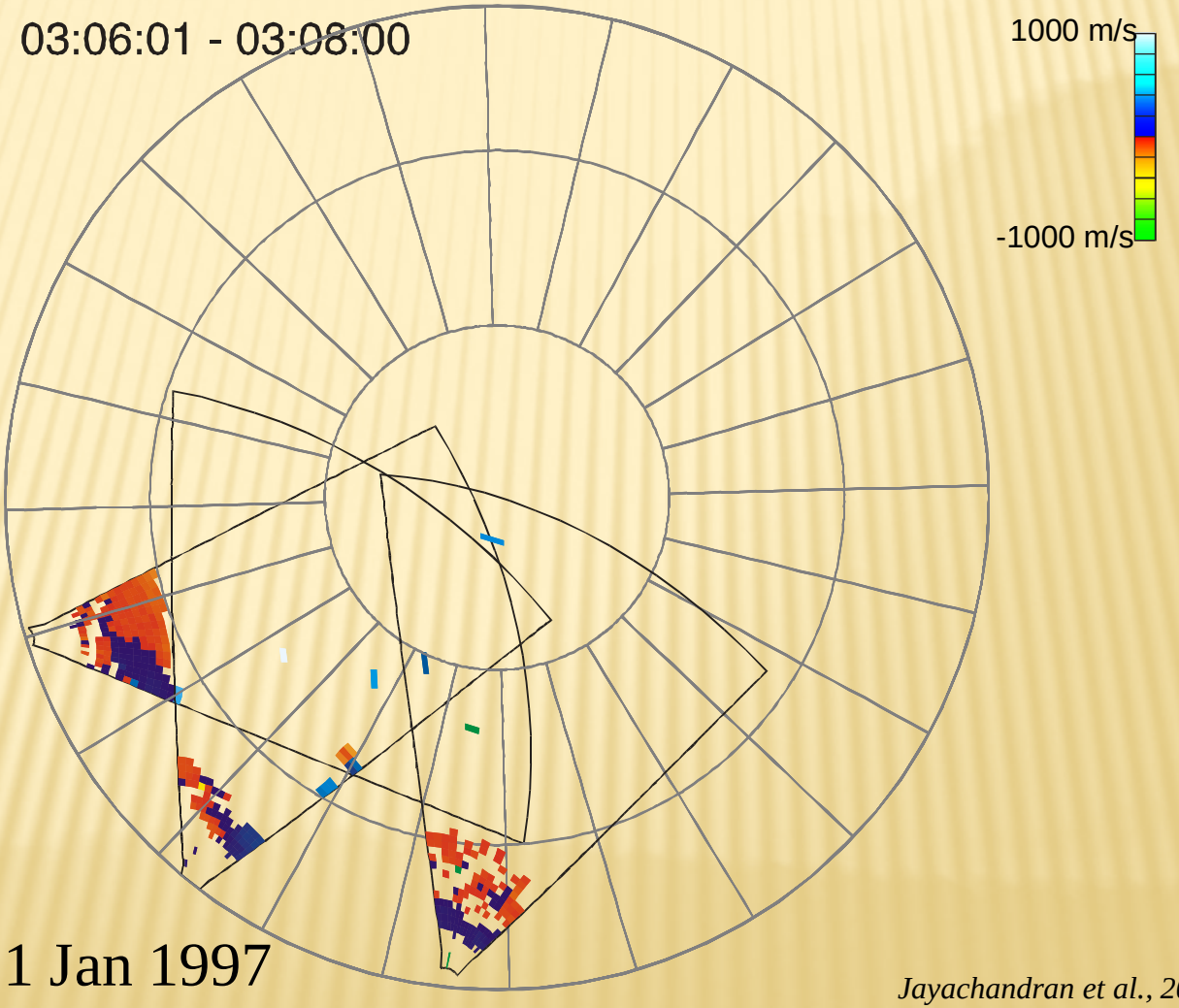
Jayachandran et al., 2002b

Comparison of radar and proton aurora boundary



Jayachandran et al., 2002b

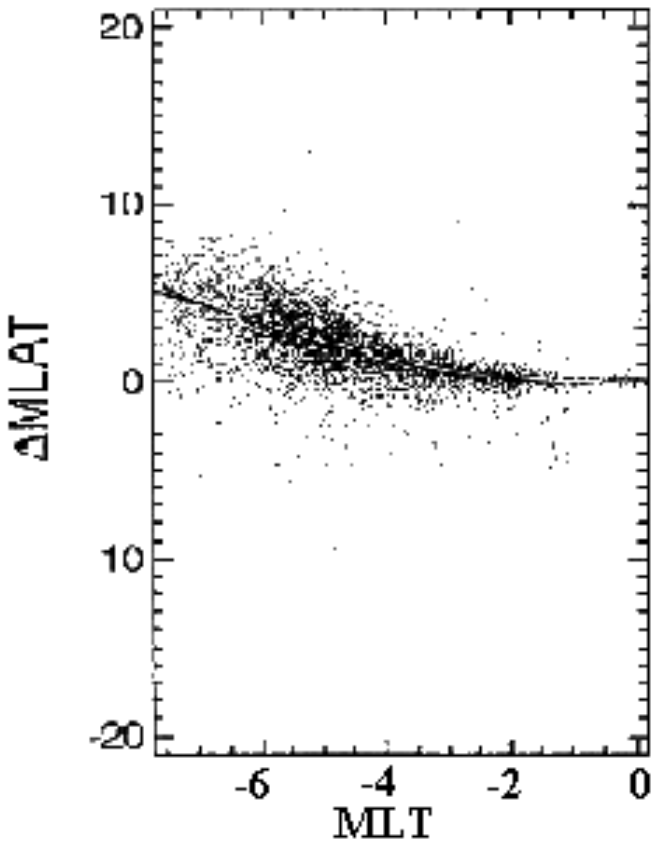
An example of the coverage



SuperDARN - 21 Jan 1997

Jayachandran et al., 2005

VARIABILITY OF THE BOUNDARY



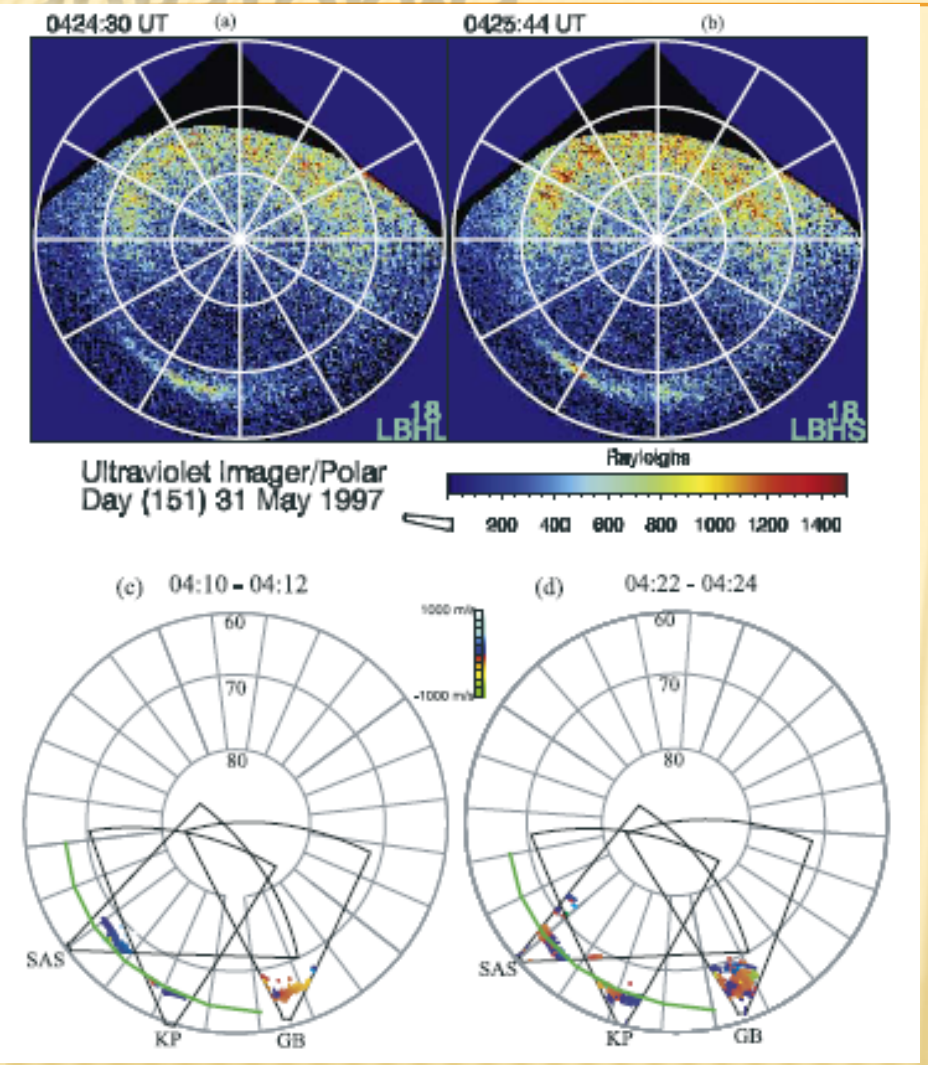
Jayachandran et al., 2006

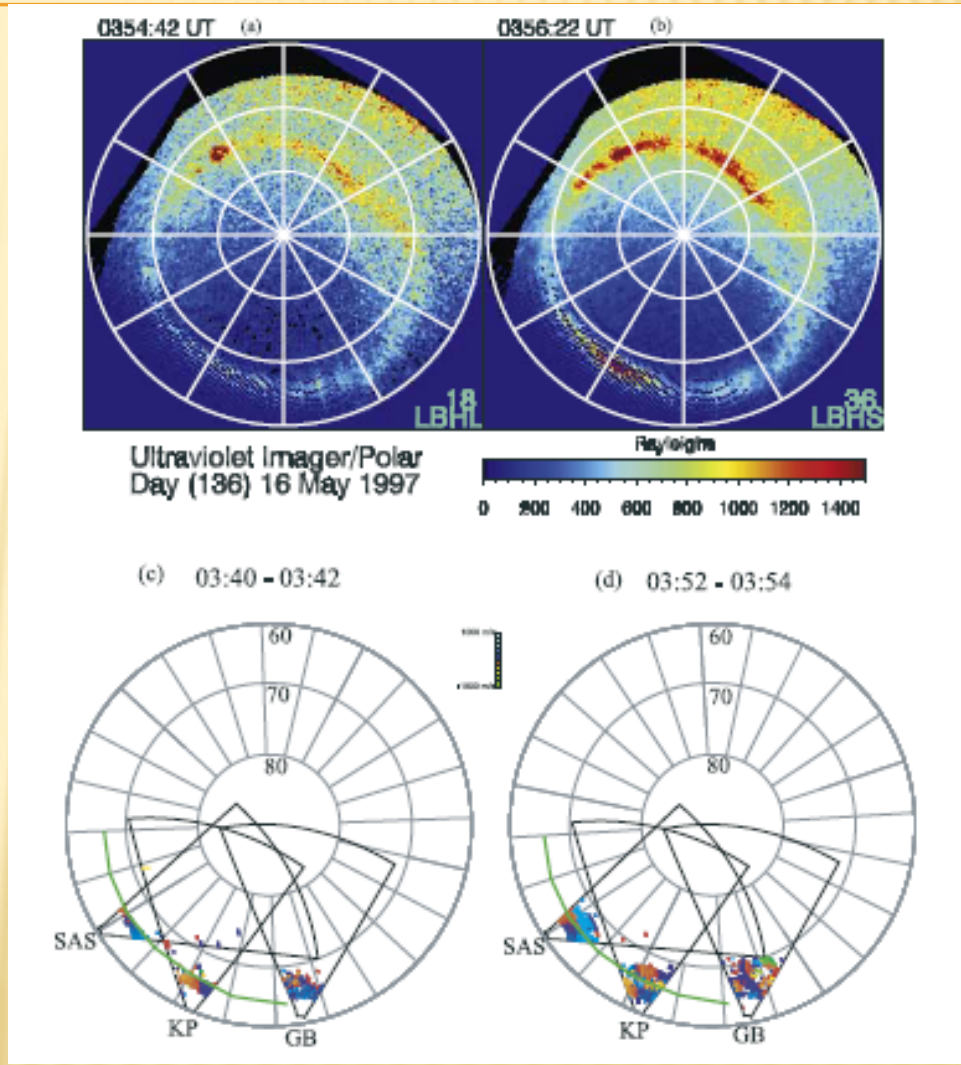
Substorms

Transitions of the IMF

Convection

GLOBAL AND LOCAL EXPANSION DURING SUBSTORMS



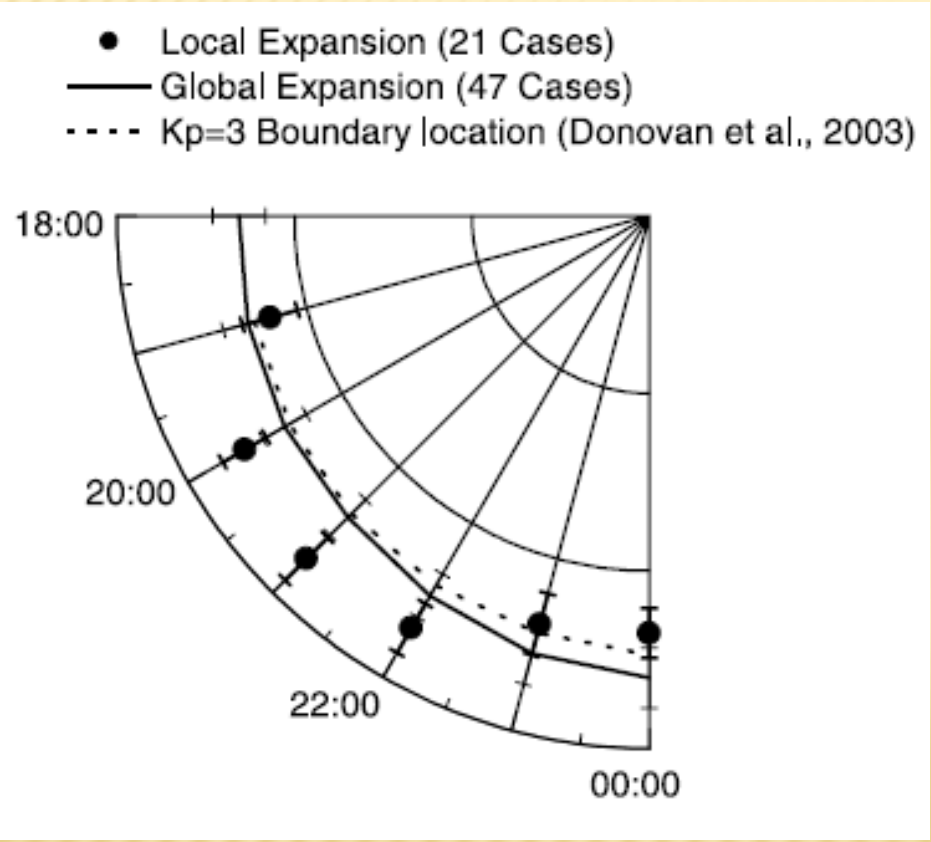


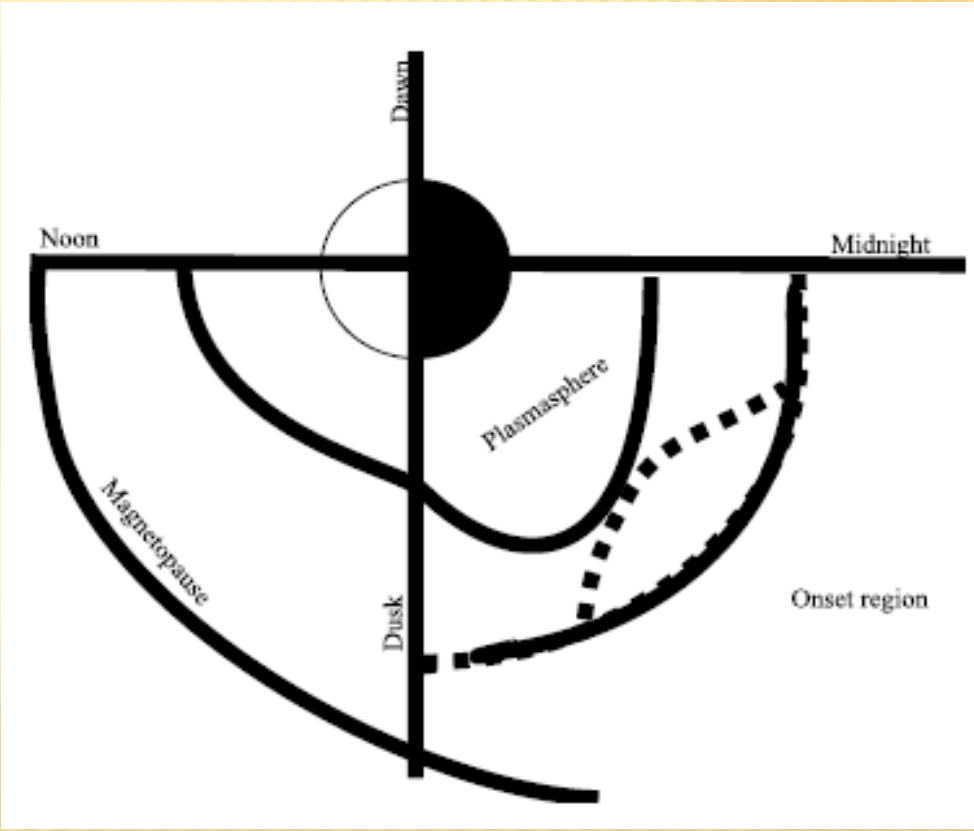
Global

Local

Jayachandran et al., 2005

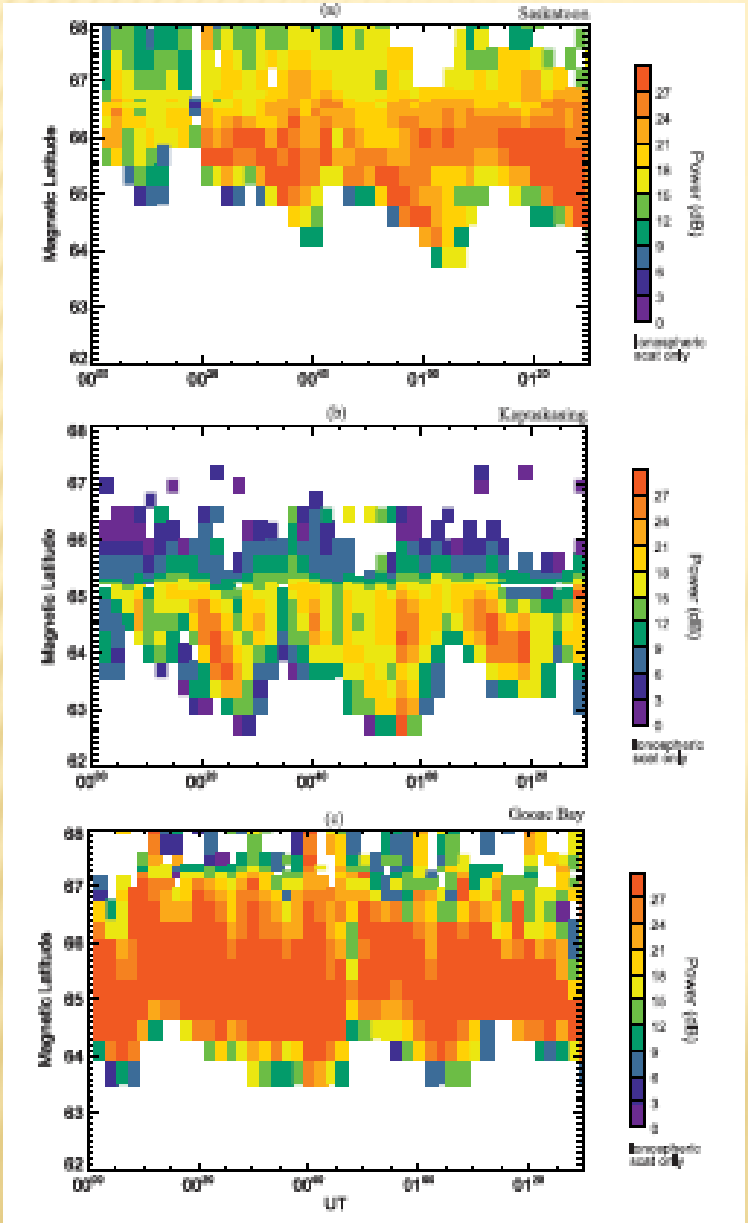
In a nutshell

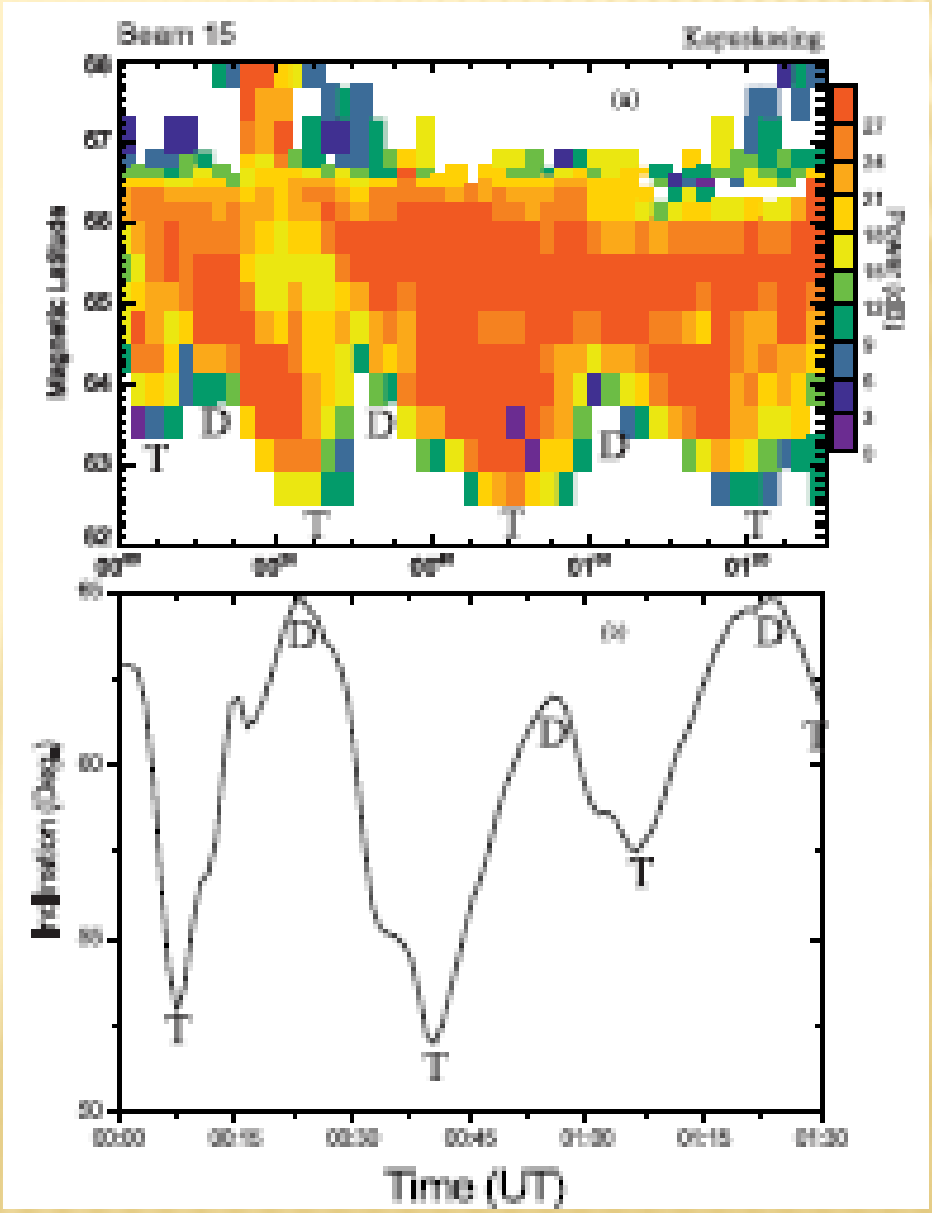




Jayachandran et al., 2005

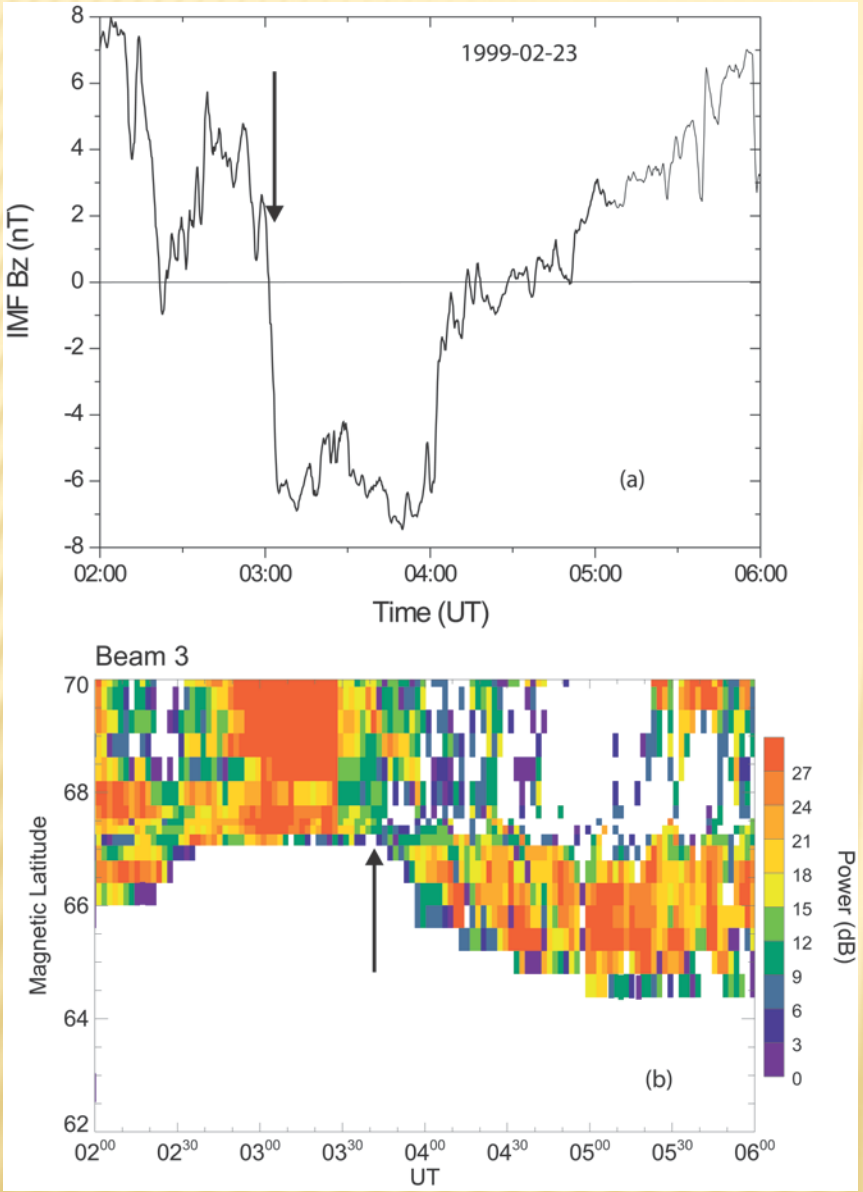
Global oscillation of the boundary

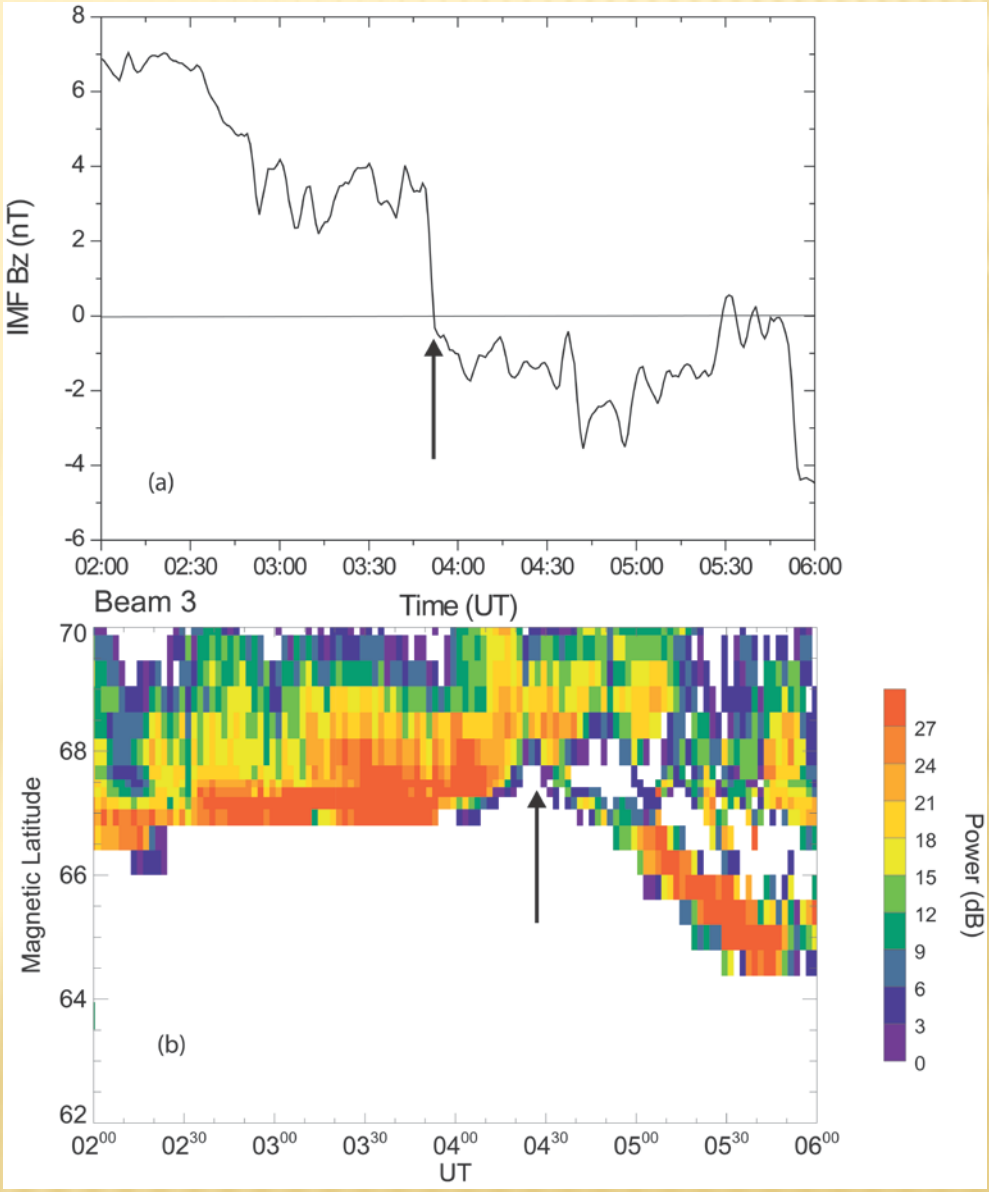


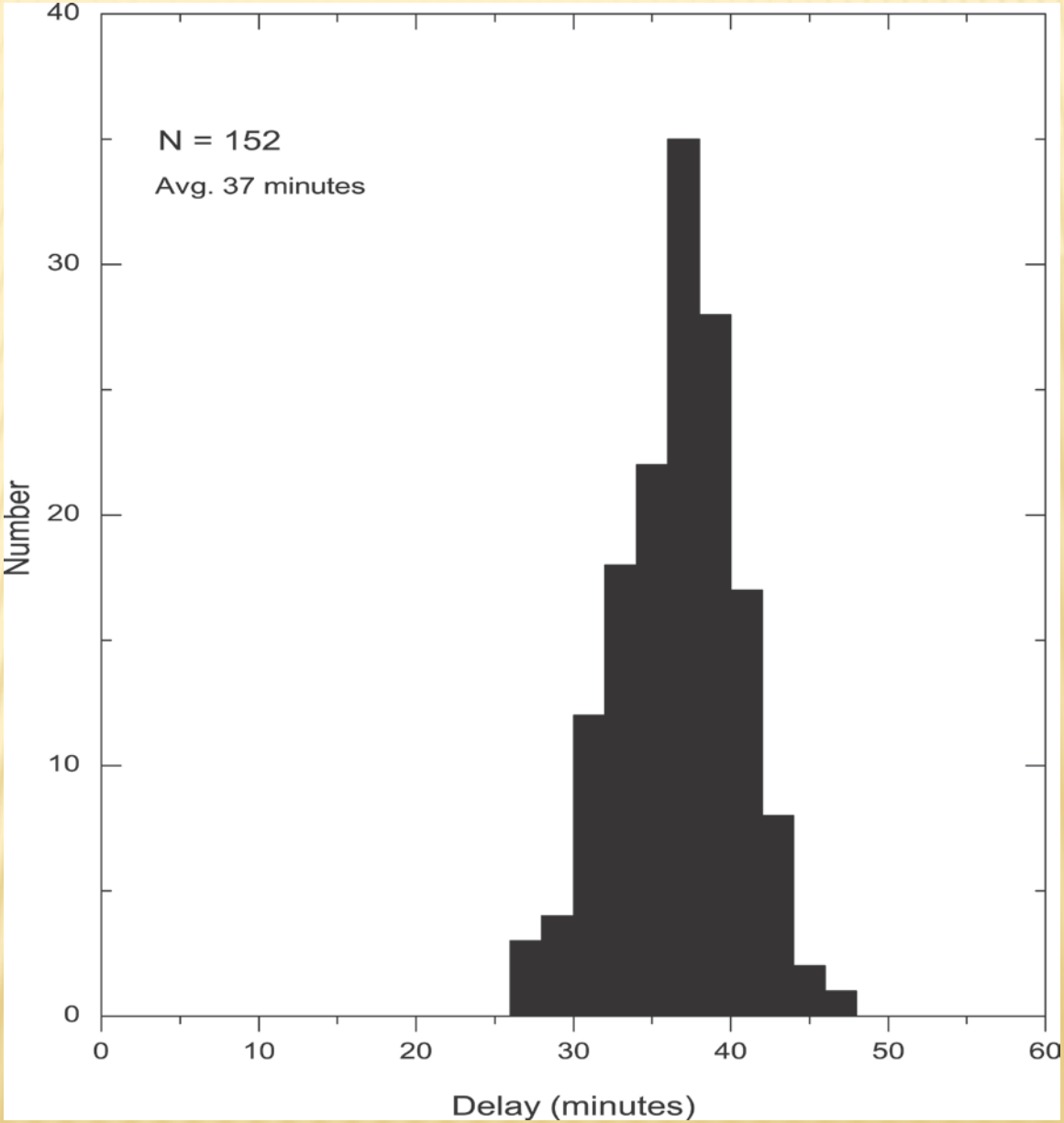


Jayachandran et al., 2007

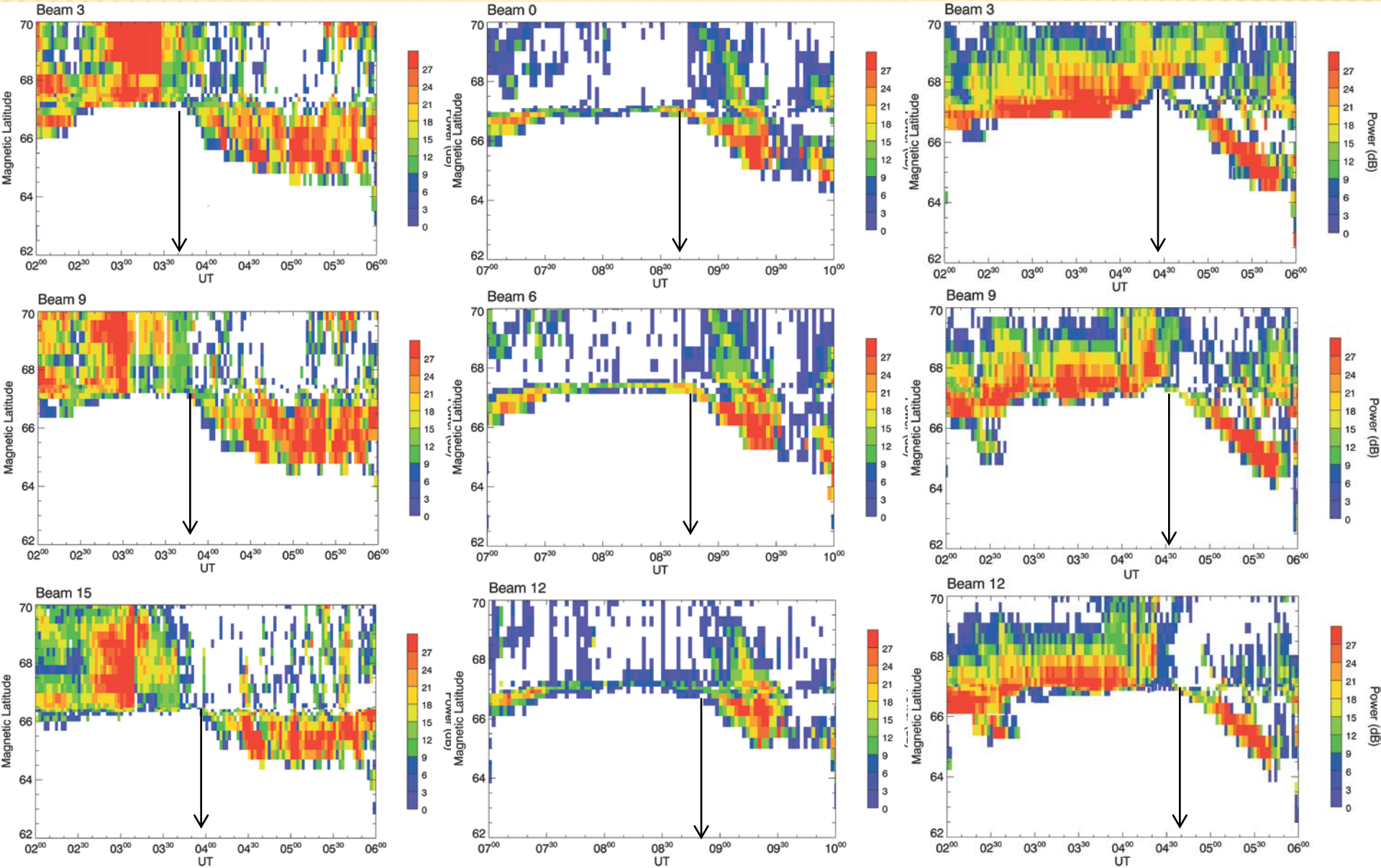
Boundary and IMF transition






N = 152
Avg. 37 minutes
Number
Delay (minutes)
0
10
20
30
40
50
60

Tracking propagation



CONCLUSIONS

- SuperDARN Radars can detect the ionospheric projection of the inner boundary of the ion plasma sheet in the dusk-midnight sector
- For some substorms there is a localised equatorward expansion of the auroral oval prior to the onset
- Localised equatorward expansion occurs near the onset location
- Equatorward boundary of the ion auroral oval moves equatorward in response to the N-S transition of the IMF with a delay
- Expansion seems to propagate from dayside to nightside supporting Lockwood and Cowley Mechanism