A Comparison Study of Open/closed Field Line Boundary (OCB) with SuperDARN Coherent HF Radars and Meridian-Scanning Photometer (MSP)

X. Chen, D. A. Lorentzen, L. Baddeley
The University Centre in Svalbard
Introduction

Open/closed Field Line Boundary (OCB)

- The rate of reconnection at the magnetopause [e.g. Milan et al., 2003, 2004]
- The size of polar cap [e.g. Cowley and Lockwood, 1992]
- The creation and destruction of open magnetic flux associated with the dayside and nightside reconnection [e.g. Milan et al., 2007]

OCB Modulated by IMF Conditions

- $B_z$: magnetic reconnection at the dayside magnetopause and in the tail drives a convection cycle [see e.g. Cowley, 1998]
- $B_y$: distort convection cells such that the dusk cell (dawn cell) is dominant for positive (negative) $B_y$ [e.g. G. Chisham et al., 2005]

National Research Council, 2004

NGF Geilo 2013
Instrumentation

- High Altitude: IMAGE FUV Imager
- Low Altitude: DMSP, FAST Satellite [e.g. Newell et al., 1991; Newell and Meng, 1992; Newell et al., 1996]

IMAGE FUV Imager

Workshop Report (2008)
National Research Council

J. Moen et al., 2004
Instrumentation

- F Region: **Super Dual Auroral Radar Network** (SuperDARN) [e.g. Baker et al., 1995, 1997; Chisham et al., 2001, 2002]
- E Region: Incoherent Scatter Radar [e.g. Blanchard et al., 1996, 2001]
- Ground Optical Signature: **Meridian-Scanning Photometers** (MSP), all-sky cameras (ASC) [e.g. Sandholt et al., 1998]

HF Radar **Doppler Spectral Width** Boundary (SWB) [e.g. Milan and Lester, 2001]
MSP Auroral **6300Å Red Line Edge** [e.g. Lorentzen et al., 1996, 2004]
Instrumentation (MSP)

- Time resolution: 16 seconds to assemble meridian scan
- Spatial coverage: N-S gm meridian (32°W of N gg)
- Spatial resolution: 1 angular degree
- Spectral resolution: Typically 0.4 nm
Magnetic Latitude of OCB from HF Radar Doppler Spectral Width

SUPERDARN PARAMETER PLOT
Hankasalmi: width_I

1 Feb 2009
fast stereo normal (ccw) scan mode (153)

0900 00s (032) 9.980 MHz

Width (m s⁻¹)

UNIS

NGF Geilo 2013
Magnetic Latitude of OCB from Cusp 6300Å Auroral Red Line

A pre-defined reference cusp aurora produced by GLOW model [M. G. Johnsen et al., 2012]

\[ H = 763.6 \times e^{-0.0738\alpha} + 262.8, \quad \alpha \leq 98. \]
\[ H = -0.617 \times e^{0.0303\alpha} + 322.0, \quad \alpha > 98. \]
Boundary Comparison with IMF Bz<0 Conditions

IMF Bz<0  By>0

IMF Bz<0  By<0

Difference

Asymmetry

By?
Boundary Comparison with IMF $B_z > 0$ Conditions

- **IMF $B_z > 0$  $B_y > 0$**
  - Single Lobe Reconnection

- **IMF $B_z > 0$  $B_y < 0$**
  - Irregularity?
Preliminary Statistics

MLT ≈ UT + 3h
I(630.0) / I(557.7) > 1
Preliminary Statistics
Advantage:

- Abundant HF Radar Backscatter Data and MSP Auroral Optical Data (CUTLASS Finland and Iceland, 1997-2013; MSP, 1995-2013)
- Unique Observation Location and Neighboring Altitude (Radar Backscatter: F region; Auroral emission: 268km)
- Superb Spatial Resolution (HF Radar: ~1-2 min; MSP: 16 sec)
- GLOW Model to calculate emission altitude and evaluate error with scan angle [M. G. Johnsen et al., 2012]
Task and Challenge:

1. Statistical comparison the latitude boundary difference between 6300Å red line and Spectral Width Boundary (SWB) with MLT.
2. Consider how the IMF and solar wind conditions affect the OCB latitude (IMF Bz) and HF radar SWB threshold (IMF By?), especially how correspond to the dawn and dusk sector, pre and post midnight asymmetry.
3. Compare the difference between dayside and nightside boundary locations.
Thanks for your attention!