Symmetry and asymmetry of interhemispheric dayside ionospheric convection seen by the SuperDARN Kerguelen and Hankasalmi radars

A. Marchaudon¹, J.-C. Cerisier², R. C. Fear³, S. E. Milan³, and M. Lester³

(1) LPC2E, CNRS and Université d’Orléans, France
(2) LPP, Ecole Polytechnique, CNRS and Université Pierre et Marie Curie-Paris 6, France
(3) RSPPG, Leicester University, UK.

Abstract – We have identified excellent conjugated observations in the cusp regions by Hankasalmi (Northern Hemisphere) and Kerguelen (Southern Hemisphere) SuperDARN radars. First, we have studied the location of the boundary between low and high spectral width in both hemispheres and have compared the location of the northern spectral width boundary with the open-closed magnetic field boundary obtained from particles precipitation measured by low-altitude spacecraft. Second, we have identified conjugated pulsed ionospheric flows characteristics of sporadic magnetopause reconnection events. These observations are perfectly conjugated. However, the number, the velocity, and the shape of these ionospheric structures are very different in both hemispheres. We investigate the causes for these different properties, with respect to season and interplanetary conditions.

Reconnection properties from ionospheric observations

Ionospheric convection signatures
- Continuous antisunward convection starts ~ 06:49 UT at Hankasalmi and at Kerguelen (1st vertical line)
- Pulseling Ionospheric Flows (PIFs) start ~ 07:08 UT at Hankasalmi and ~ 07:12 UT at Kerguelen (concomitant with the first sharp IMF-Bz inversion) (2nd vertical line)
- Similar appearance time of cup echoes at Hankasalmi and Kerguelen for continuous reconnection
- ~ 4 min delay for pulsed ionospheric flows onset between Hankasalmi and Kerguelen (Alfvén propagation time along field lines with different lengths)
- ~ 20 min delay between continuous and sporadic reconnection onsets (caused by IMF variations?)

Comparison of pulsed ionospheric flows (PIFs) between hemispheres
- Higher velocities at Hankasalmi than at Kerguelen
- PIFs at Kerguelen displaying clear time-lag (latitude) dispersion vs more patchy velocity enhancements at Hankasalmi
- 3 PIFs around 07:15, 07:25 and 07:50 UT are observed quasi-simultaneously in both hemispheres

Ionospheric flow signatures
- 1st row of maps at 07:12 UT: very similar cup convection direction in both hemispheres, mainly antisunward (due to the dominant negative IMF-Bz)
- 2nd row of maps at 07:34 UT: different cup convection direction, mainly antisunward at Hankasalmi despite a non-zero IMF-Bz, but showing also simultaneously dawnward and duskw ard bifurcations at Kerguelen
- 3rd row of maps at 07:52-54 UT (time of 3rd PIF event): different cup convection direction, mainly antisunward at Hankasalmi despite a non-zero IMF-Bz but dawnward and antisunward at Kerguelen
- 4th row of maps at 08:06 UT: similar cup convection direction, mainly dawnward and antisunward in both hemispheres despite a positive IMF-Bz, which should favor a duskw ard flow at Kerguelen
- Cup convection does not follow usual pattern (as given by the IMF-Bz component), especially during PIFs in the Northern Hemisphere
- Are these unusual cup convection flows due to the particular magnetosphere-solar wind configuration (negative dipole tilt and negative elevation angle) or caused by badly constrained maps due to sparse data?

Scientific perspectives
- Cause of cup convection flow asymmetries between hemispheres and cause of PIFs differences (shape, velocity amplitude):
  - difference in ionospheric conductivities caused by different solar illumination between hemispheres (quasi-solstice season)
  - deviation of the reconnection line from subsolar point due to dipole tilt and IMF-Bz component and/or IMF-Bx component
- Precise electrodynamics study of cup injections with FAST data (SuperDARN and FAST comparison)