Quasi-persistent feature of highly structured field-aligned currents in the duskside auroral oval: Conjugate observation by Swarm satellites and ground all-sky imager

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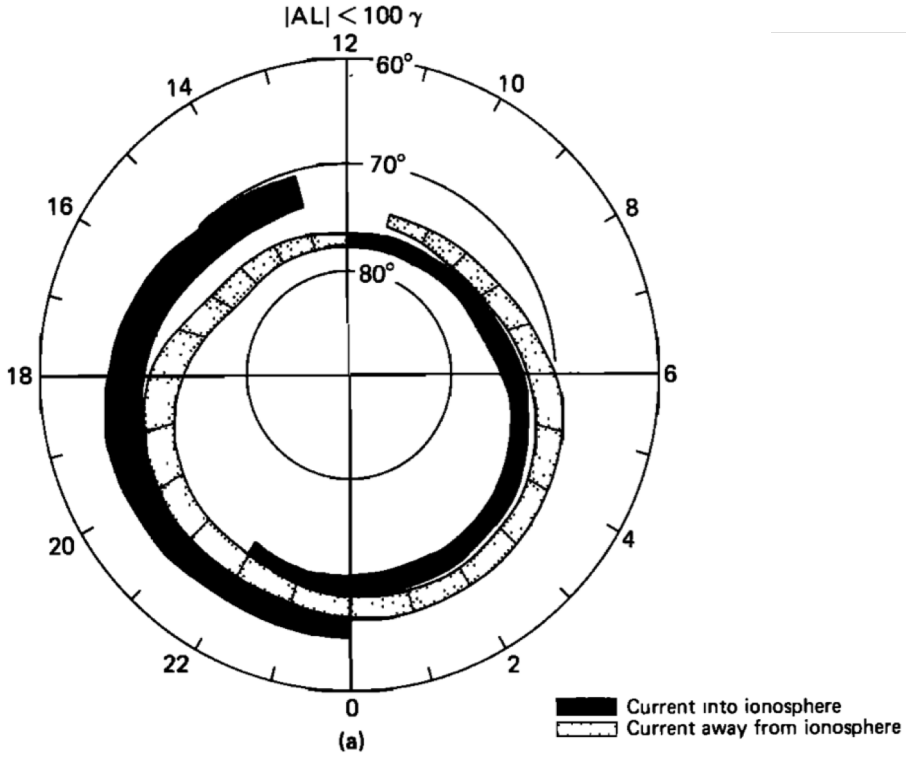
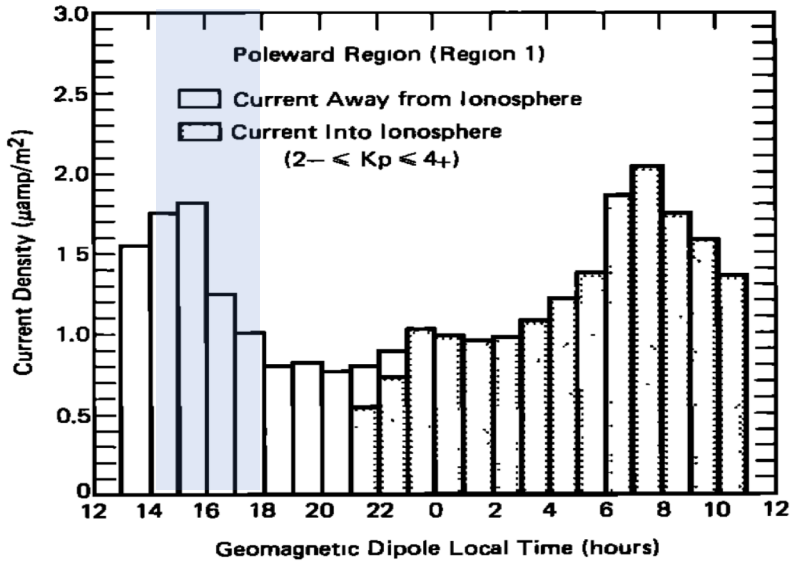
Introduction: FAC in duskside aurora oval



[Iijima and Potemra, 1976b]

Statistical distribution of FAC

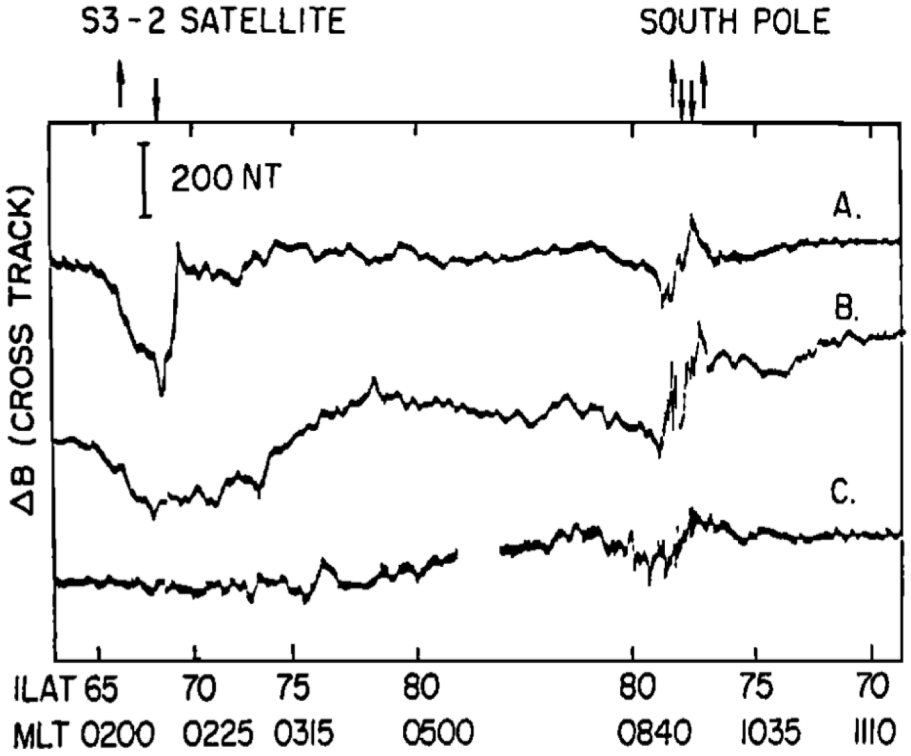


[Iijima et al.,1978]

・Strongest upward current density is located near 1500 MLT

・150eV Electrons precipitations also have peak

Introduction: small-scale magnetic perturbations



A. 8 December 1977 08:55-09 10 UT (2.5, -1.7, -0.4), Kp=0+, ΣKp = 3
B. 9 December 1977 08:51-09 06 UT (2.9, -3.8, 1.4), Kp=0+, ΣKp = 6-
C. 7 December 1977 10:35-10:44UT (1.4, -1.5, 4.7), Kp=0- ΣKp = 6-

[Rich et al., 1987]

Prolonged quiet times
→Region 1 almost diminishes
except its near-noon part
Small-scale magnetic perturbations exist
at latitudes where Region 1 disappeared

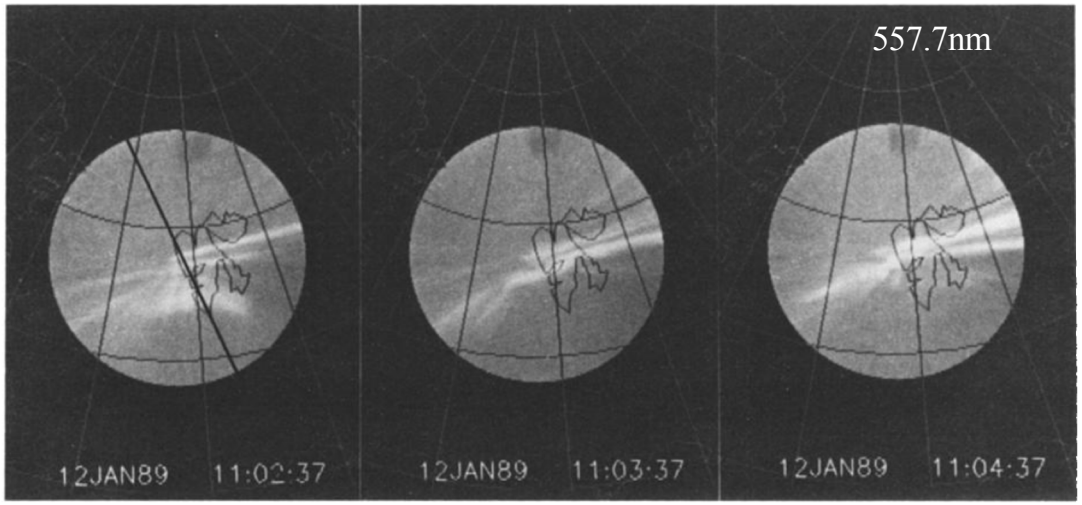
＊Still uncertain

those small-scale magnetic perturbations
reflect a simple remnant of the Region 1
or
phenomena that can be prominent especially
during strongly northward IMF

Introduction: Multiple discreate arc

- Dayside distribution of auroral occurrence/emissions shows a peak at around 1500 MLT

- Multiple discrete arcs found to be typically displayed between 1430 and 1800 MLT [Hu et al., 2009]



[Moen et al ., 1994]

Multiple auroral arc on sunward convection
life time: 2~5 min
width : 10~20km
MLT：1400-1500

1.Magnetosheath plasma injection
2.Kinetic Alfven wave
Magnetopause surface wave(KHI, Pressure wave)

Purpose

Using Swarm's observation data:

- Focus on spatial structure of mesoscale field aligned currents in associate with aurora arc.
- Try to reveal features of meso-scale FACs in the dusk sector where large-scale Region 1/2 current system diminishes .

Data

Swarm satellites(Swarm A and C)

- Magnetic data : 1Hz
  →E-W component (subtracted IGRF)
- Current density : 1Hz
  →calculated from magnetic perturbations

Orbit : polar orbit
Altitude : about 460km

Swarm A and C have been flying side by side with about 10s difference

For simultaneous observation events

The All Sky Imager
(Longyearbyen, Svalbard)

- 630.0nm

DMSP

- Energy flux data of electron and ion

Method：Event selection

Target events:

・Mesoscale currents are prominent and multiple

・Large-scale R1 currents are diminished

Meso-scale field aligned current
Spatial scale ：~10 to 100km (Hasunuma et al., 2008)

⇩

Magnetic perturbation
Period with several seconds to tens of seconds

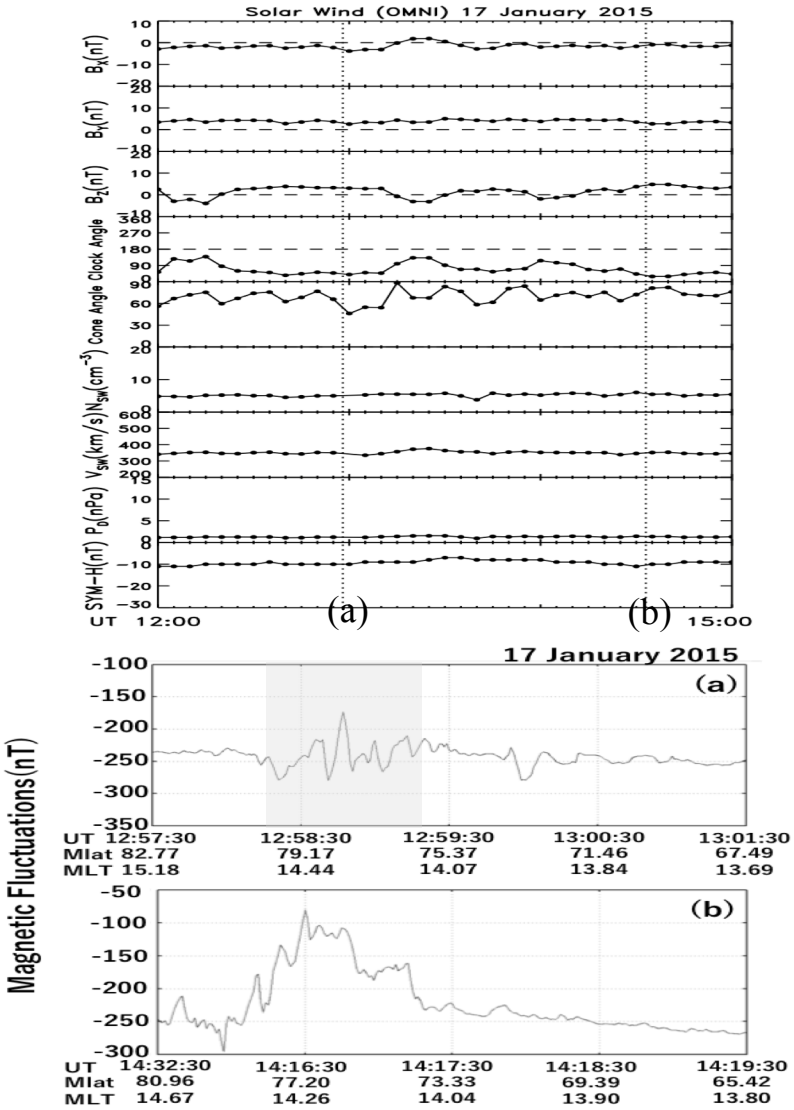
Event search

・November 2014 ~ January 2015

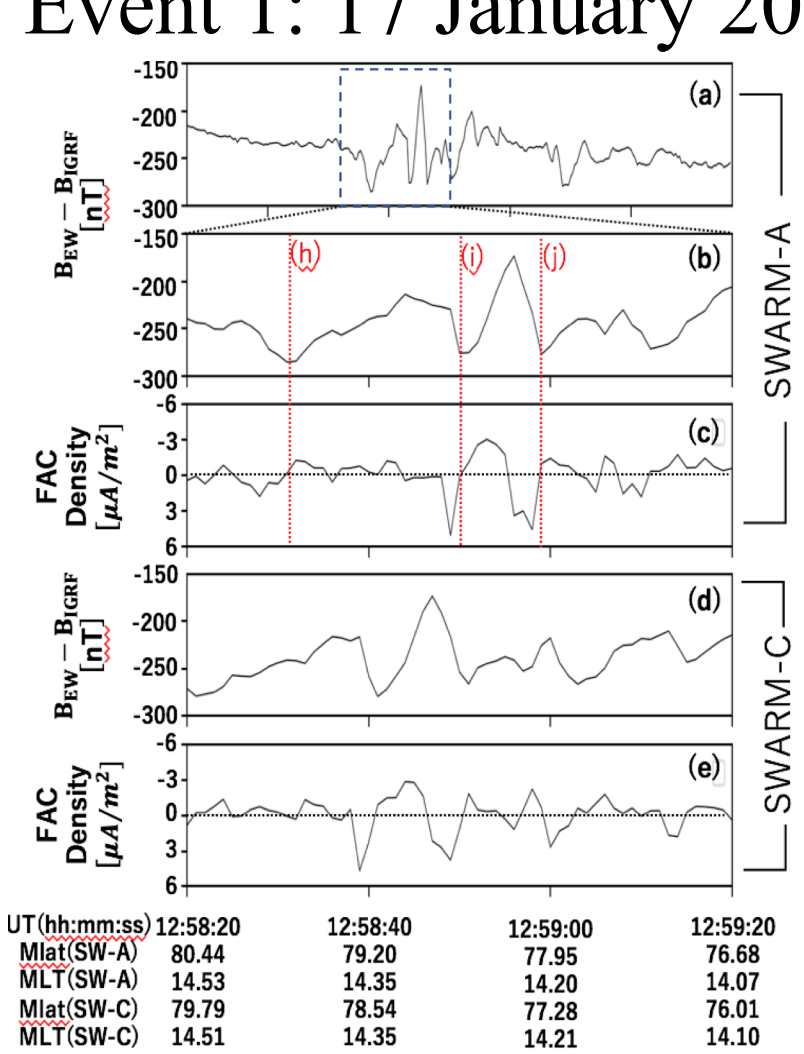
・Dusk part of auroral oval : 1400MLT~1800MLT

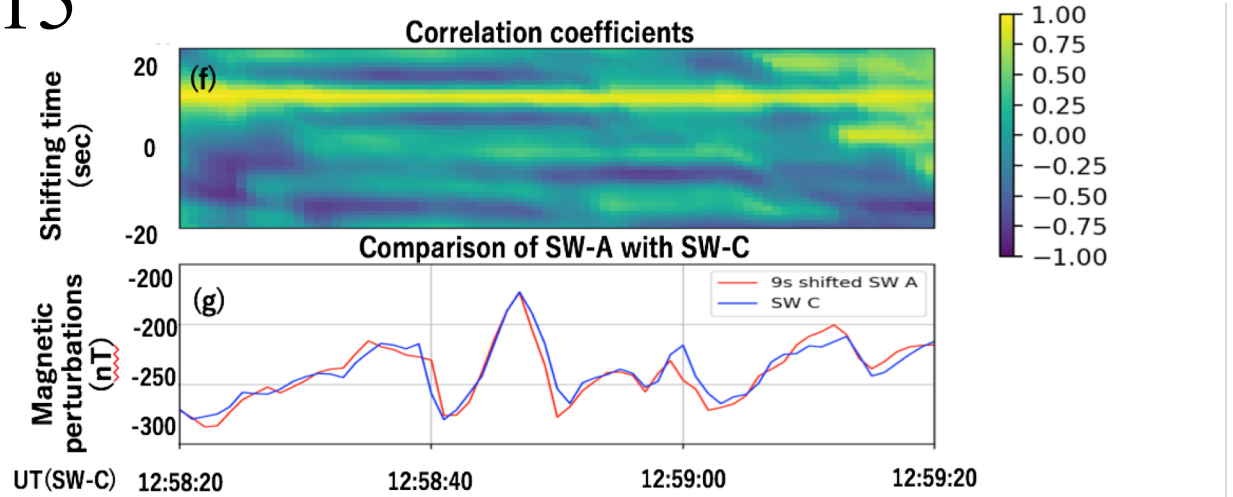
・IMF Bz is positive and stable
(at least 30 minutes before events).

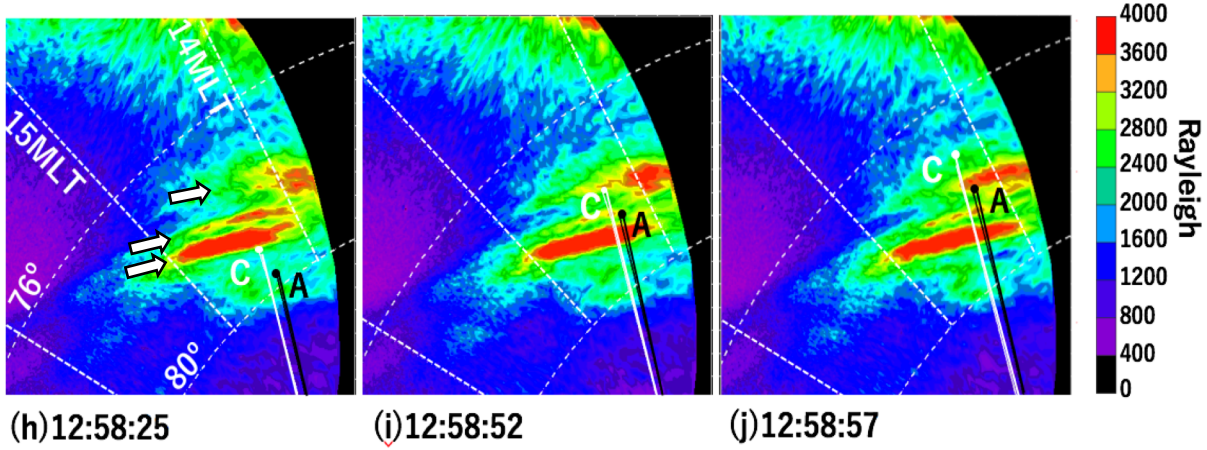
→2 simultaneous observation events



Event 1: 17 January 2015

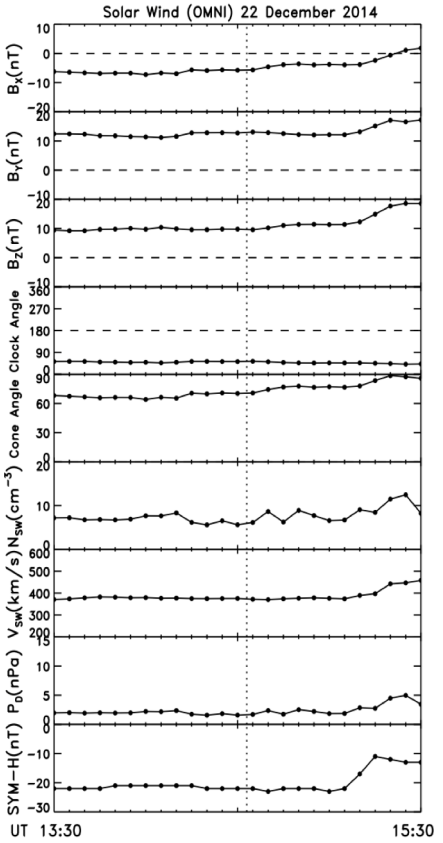


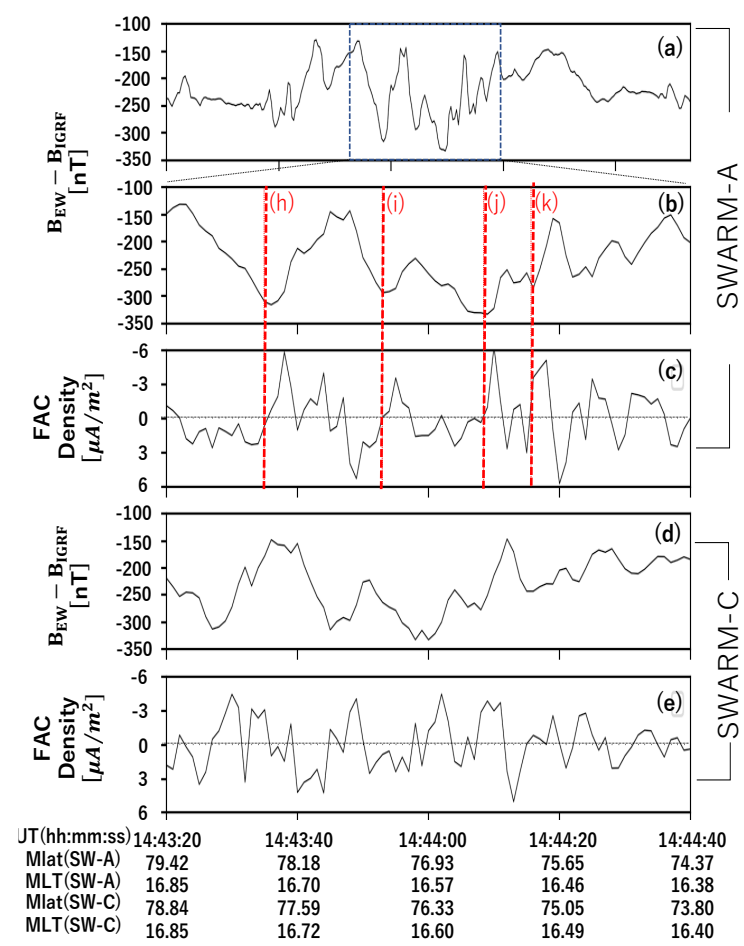


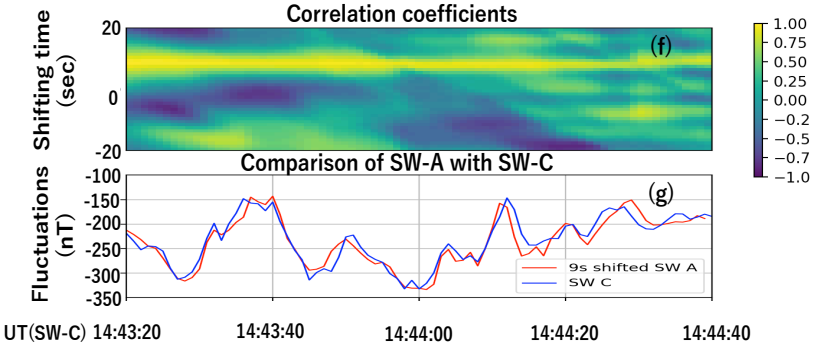


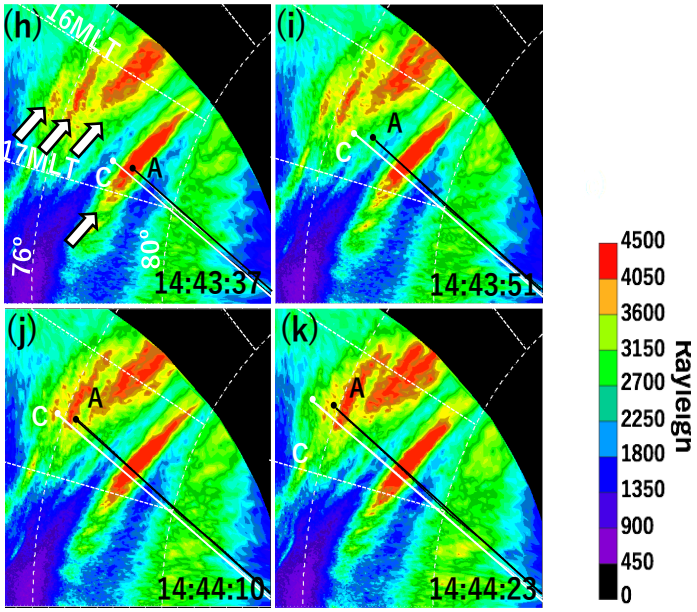
(h)12:58:25 (i)12:58:52 (j)12:58:57

Event 2: 22 December 2014

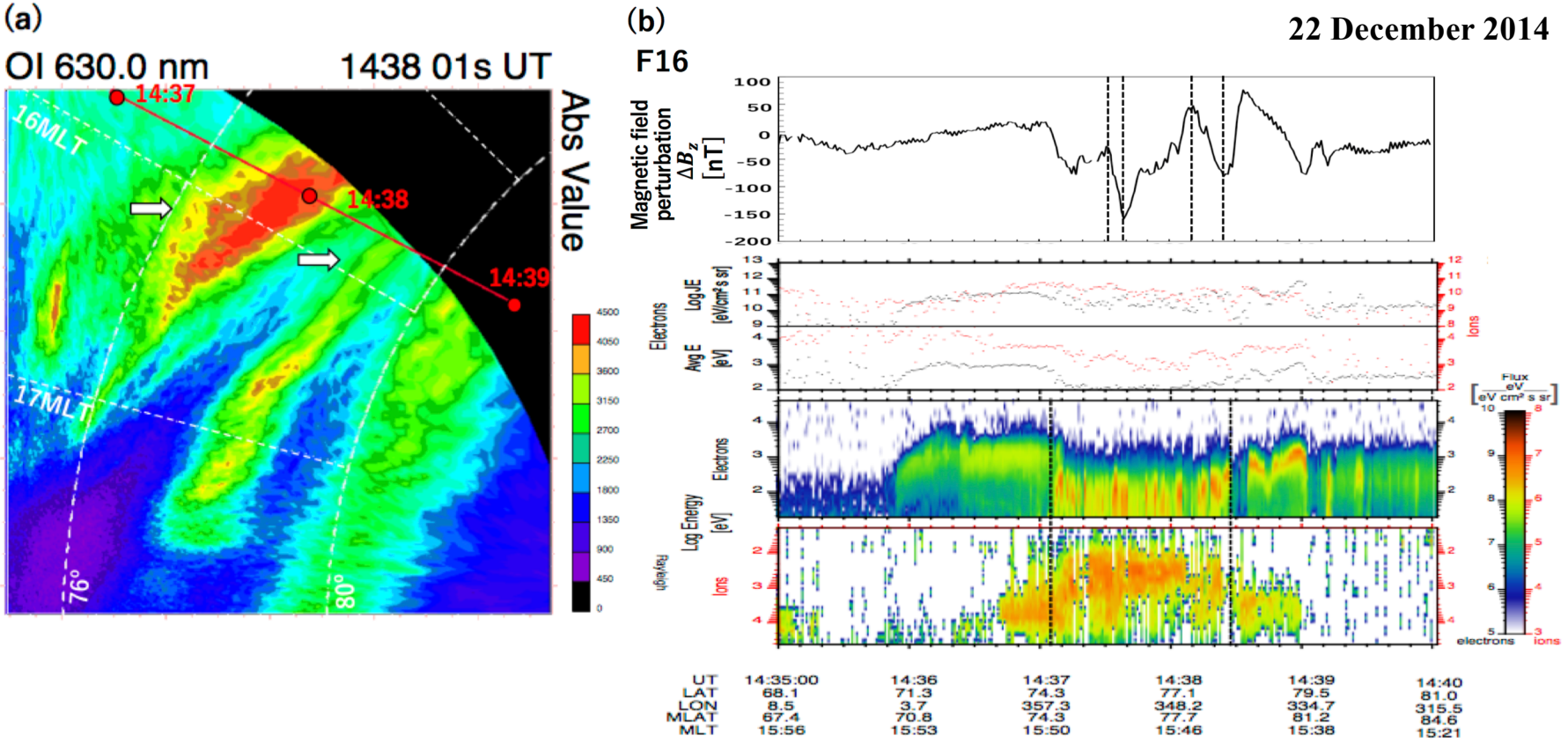






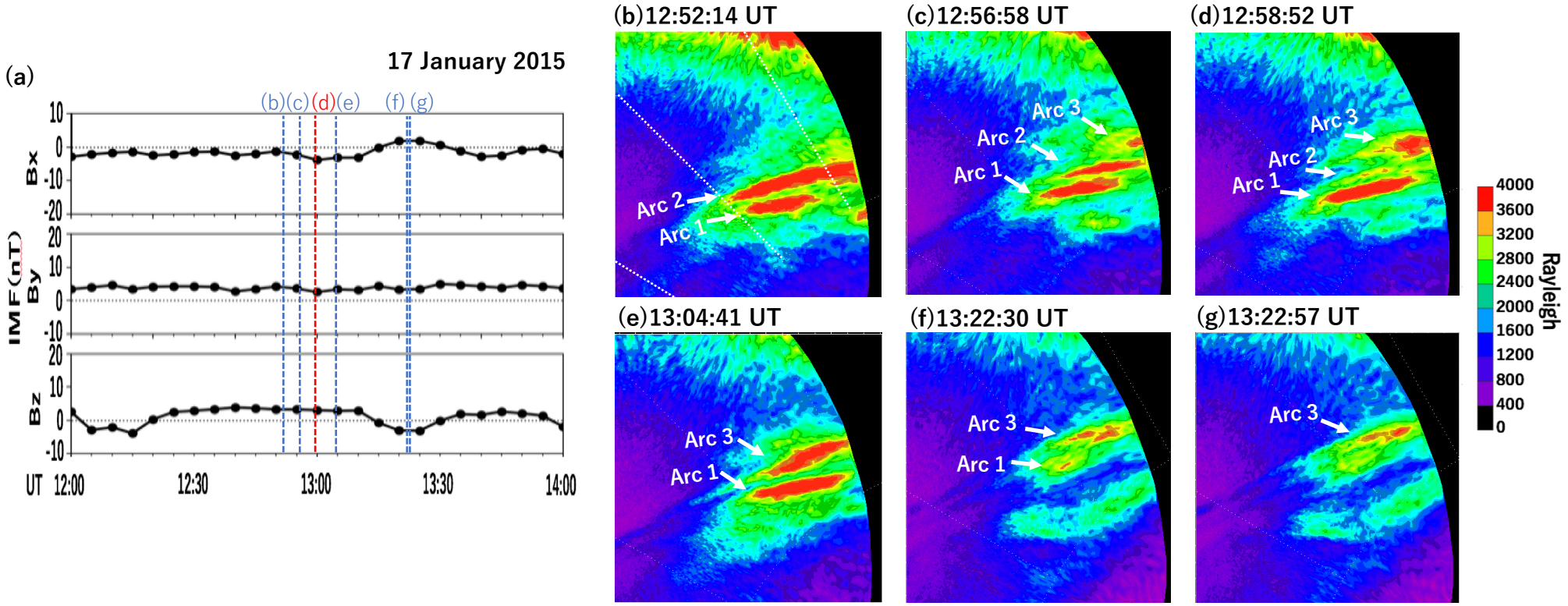


Event 2: Precipitation particle data from DMSP satellite



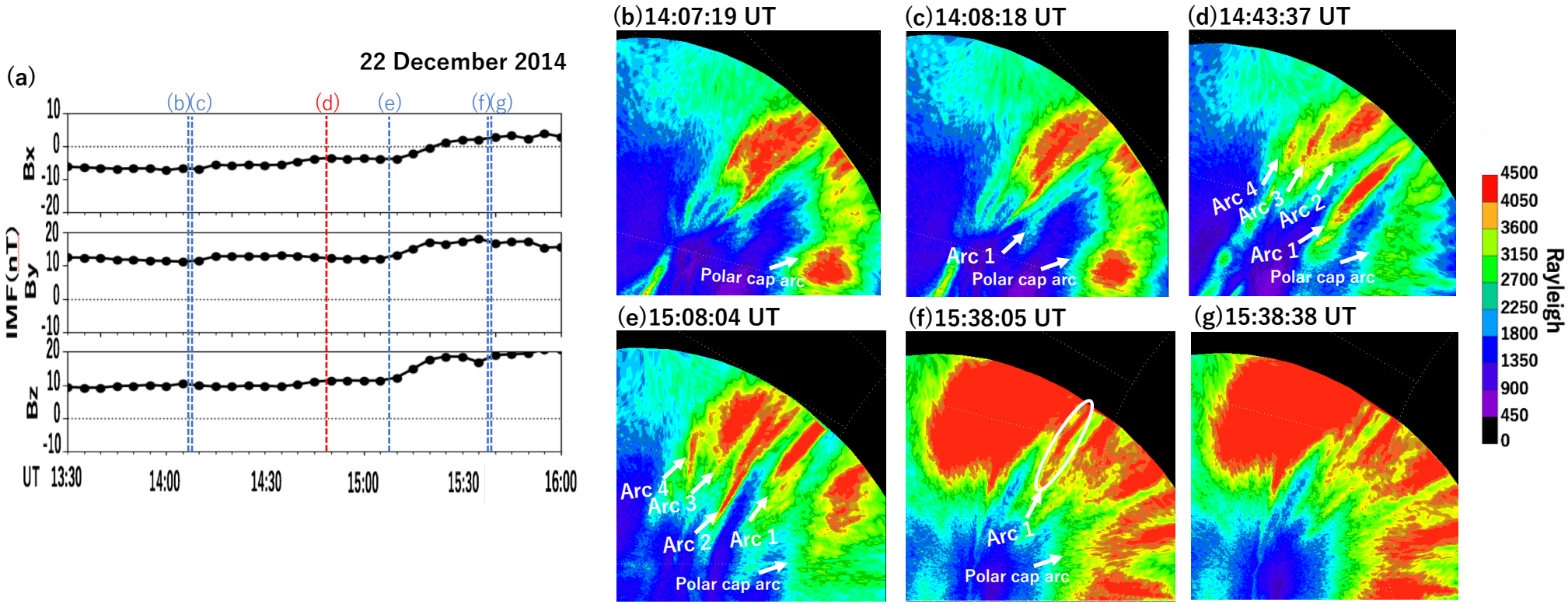
magnetic field lines along which upward FAC flows connect to LLBL

Results: Quasi-persistent feature of multiple arcs



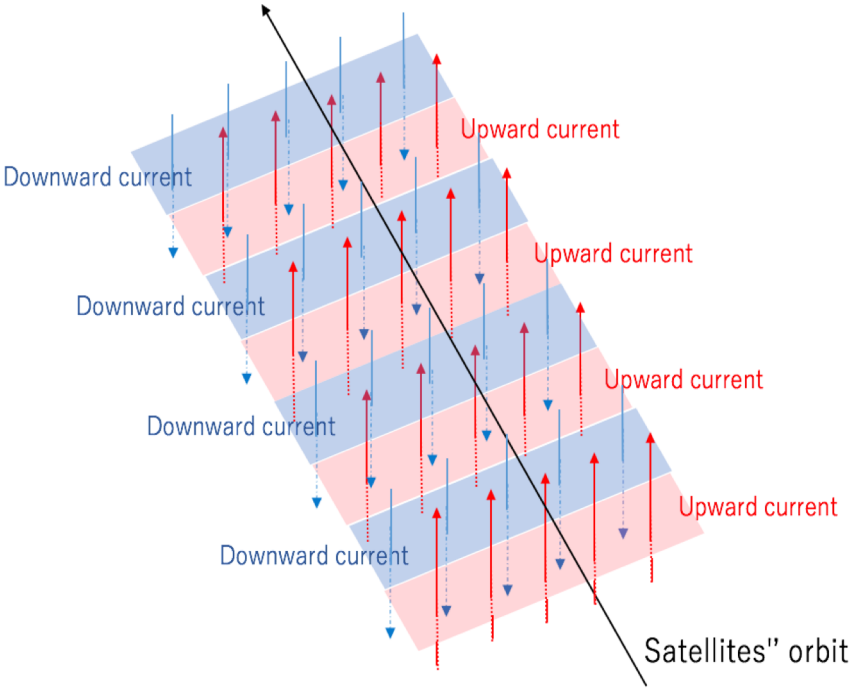
mesoscale aurora continued to exist at least during approximately 30 min

Results: Quasi-persistent feature of multiple arcs

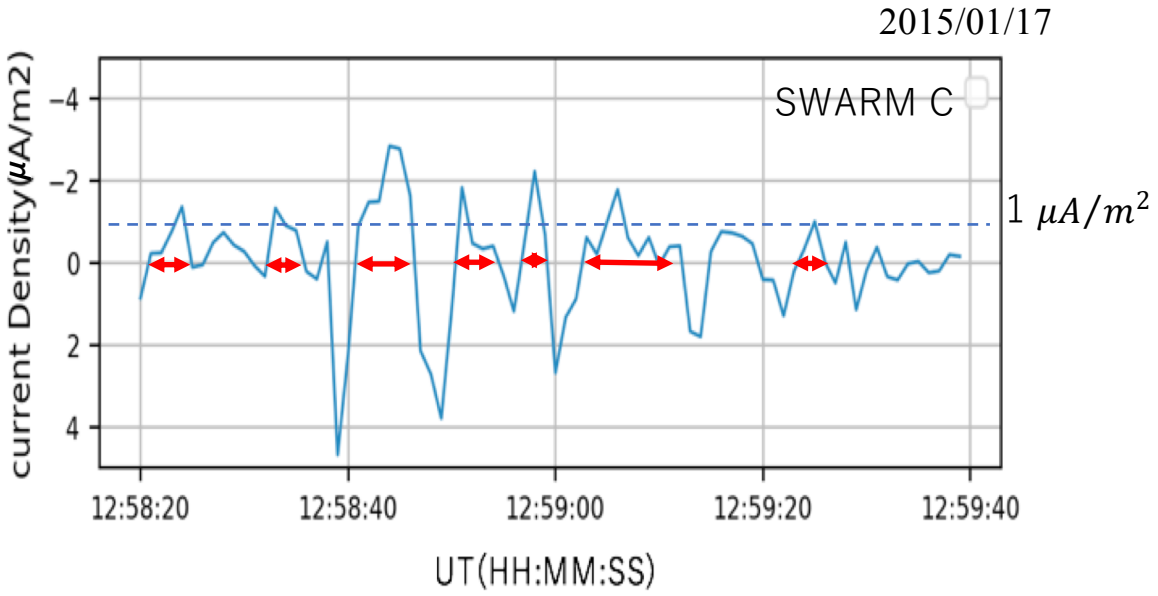


Arc 1 was defined well during 14:07:32 – 15:38:05 UT(more than 90 min).

Results : horizontal width of mesoscale upward FACs



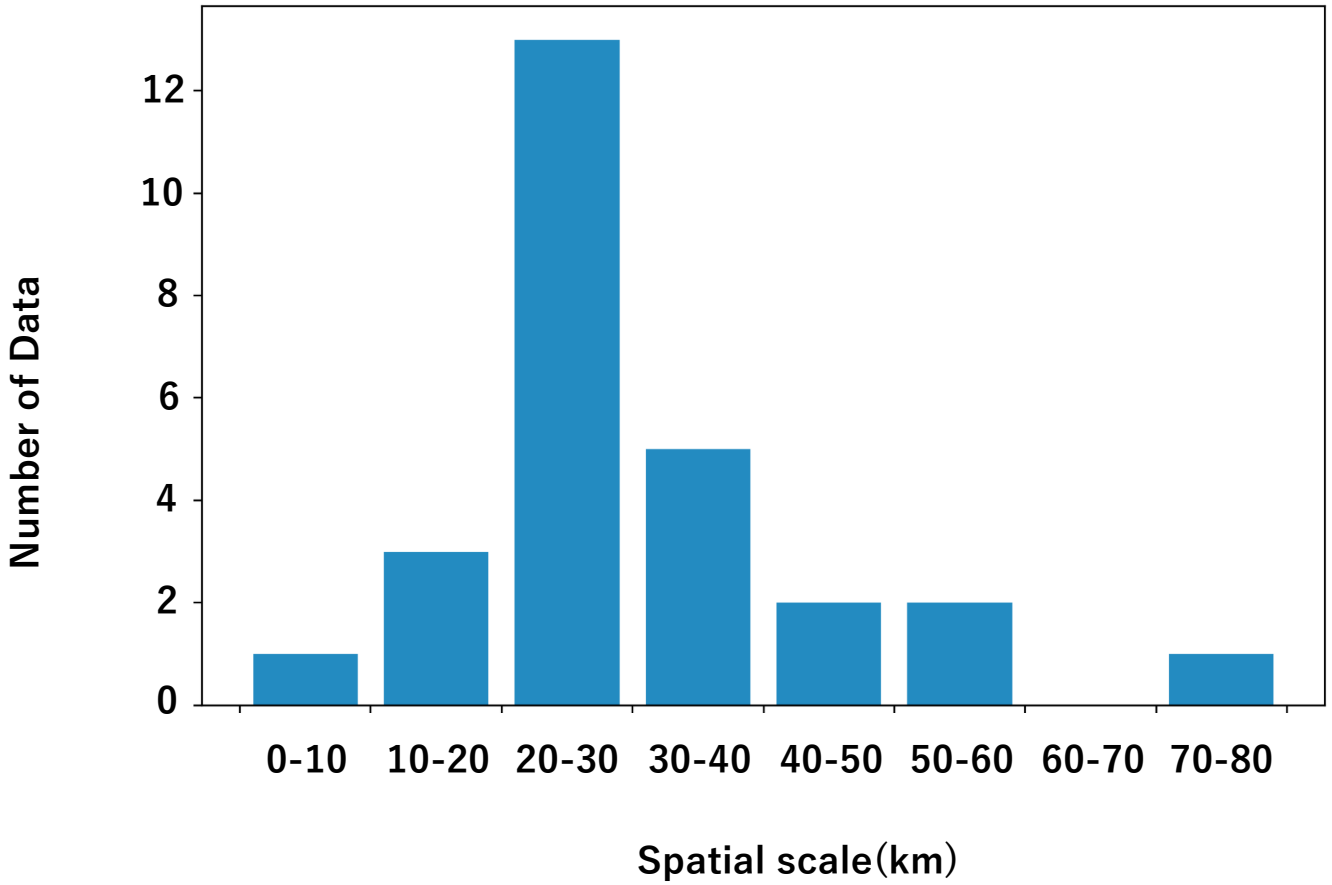
Conceptual figure of multiple mesoscale FACs



$$[Current\ width] = [observation\ time] \times [satellites\ velosity] \times cos\alpha$$

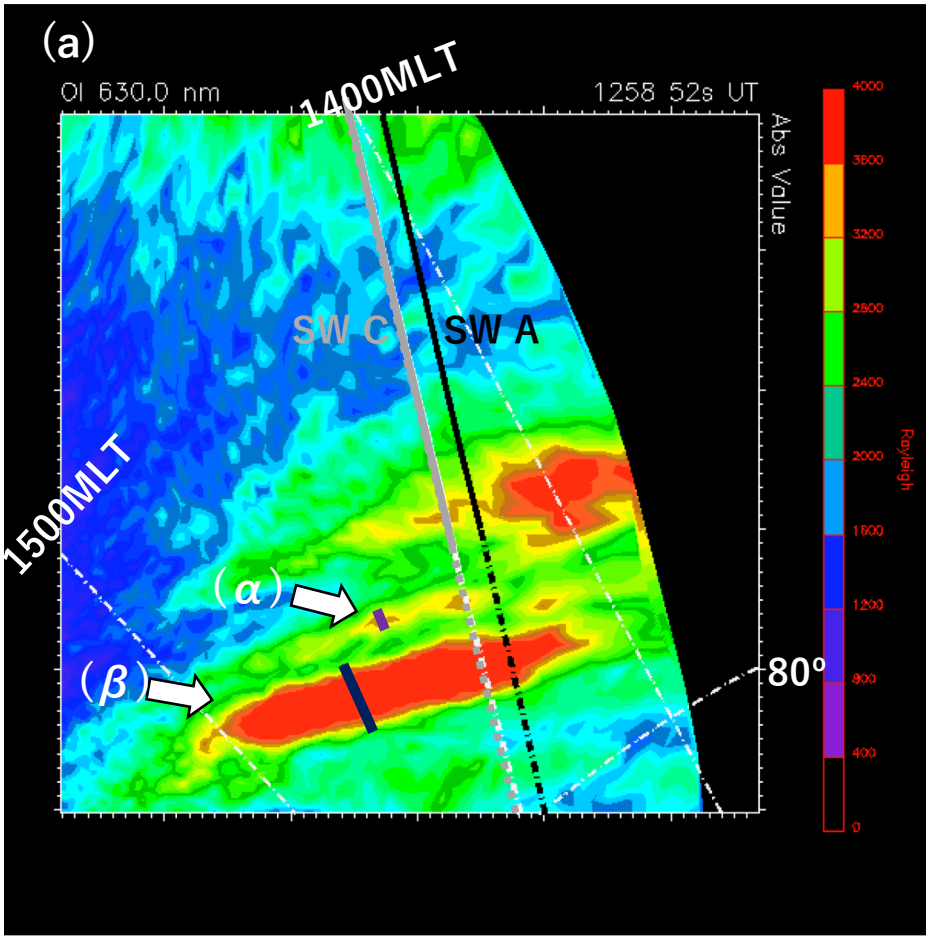
α：angle between MLT meridian and orbit

Results : horizontal width of mesoscale upward FACs

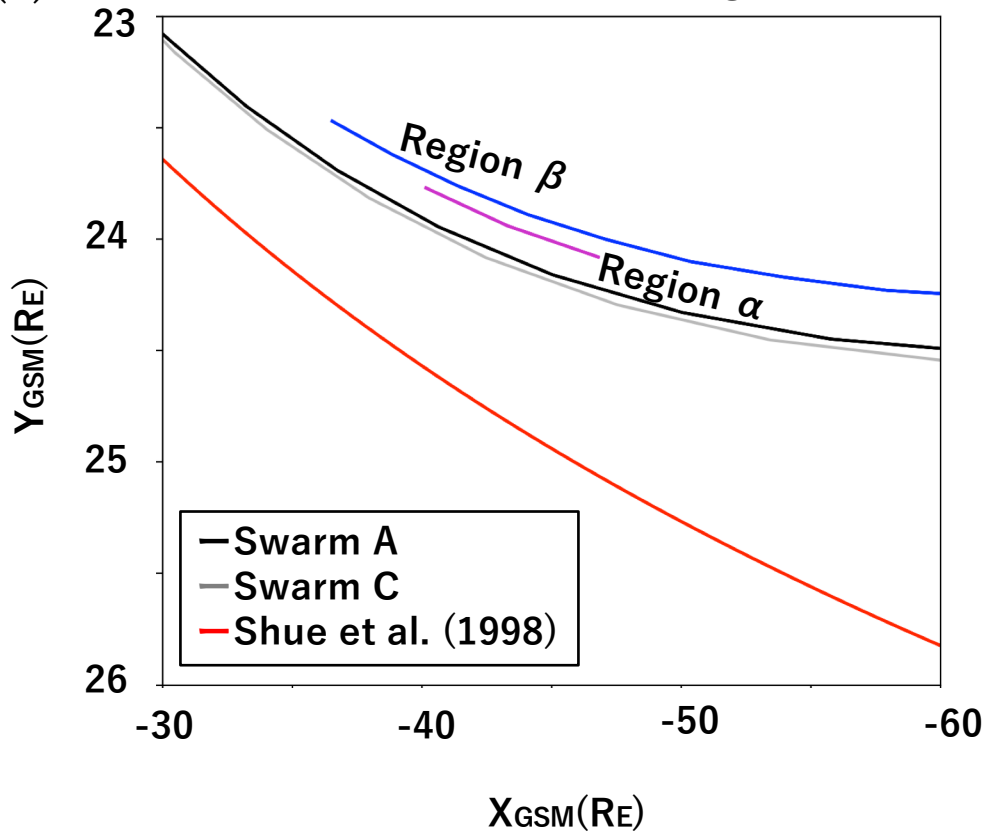


Typical size of the upward FAC region is 20 – 30 km.

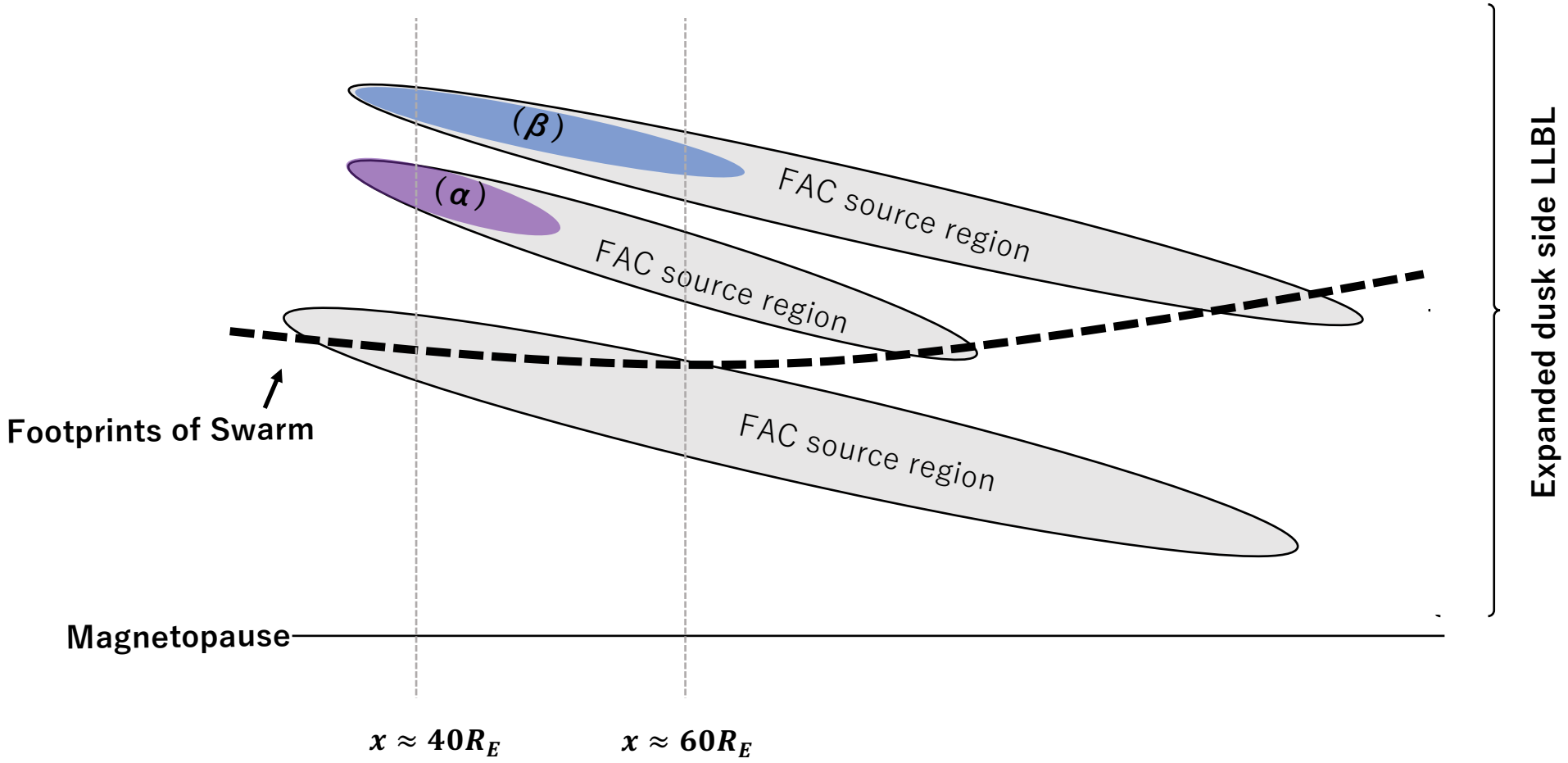
Discussion: Magnetospheric footprints of auroral regions



Tsyganenko-96
IGRF-12



Discussion: Possible configuration of the source for the mesoscale FAC



Conclusion :

1. Small-scale magnetic perturbations are
   due to the mesoscale structure of quasi-static FACs, not dynamic Alfven waves.
   Typical horizontal scale of the mesoscale upward FACs is 20 – 30 km.

2. Each region of the mesoscale upward FACs
   correspond to relatively strong 630-nm aurora emissions.
   Aurora structures showed quasi-persistence;
   existed stably during at least 30 min (17 January 2014) ;~90 min(22 December 2015).
   →highly-structured FACs have quasi-persistent features.

3. Precipitating particle data from DMSP satelliteindicate indicates
   that the source of the precipitating particles is LLBL.
   Tsyganenko magnetic field line model also suggests
   that ionospheric regions of the enhanced auroras are connected to duskside LLBL.

Quasi-persistent multiple FACs are
phenomena that are pertinent to the magnetosphere for strongly northward IMF condition.