

Localized polar cap flow enhancement tracing and evolution using airglow patches

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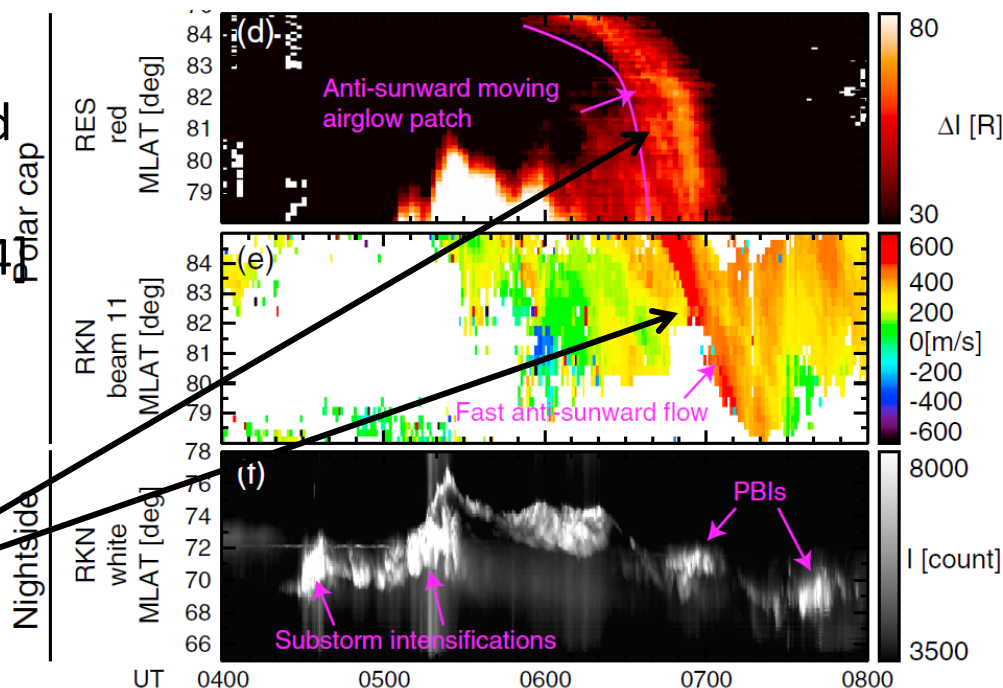
Evidence has shown that longitudinally narrow flows from polar cap region lead to PBIs/streamers [Nishimura et al., 2010; Lyons et al., 2011; Zou et al., 2014]

Radar: limited coverage, l-o-s velocity

ASI: wide coverage, 2-d monitoring

Localized polar cap flow propagates together with an airglow patch

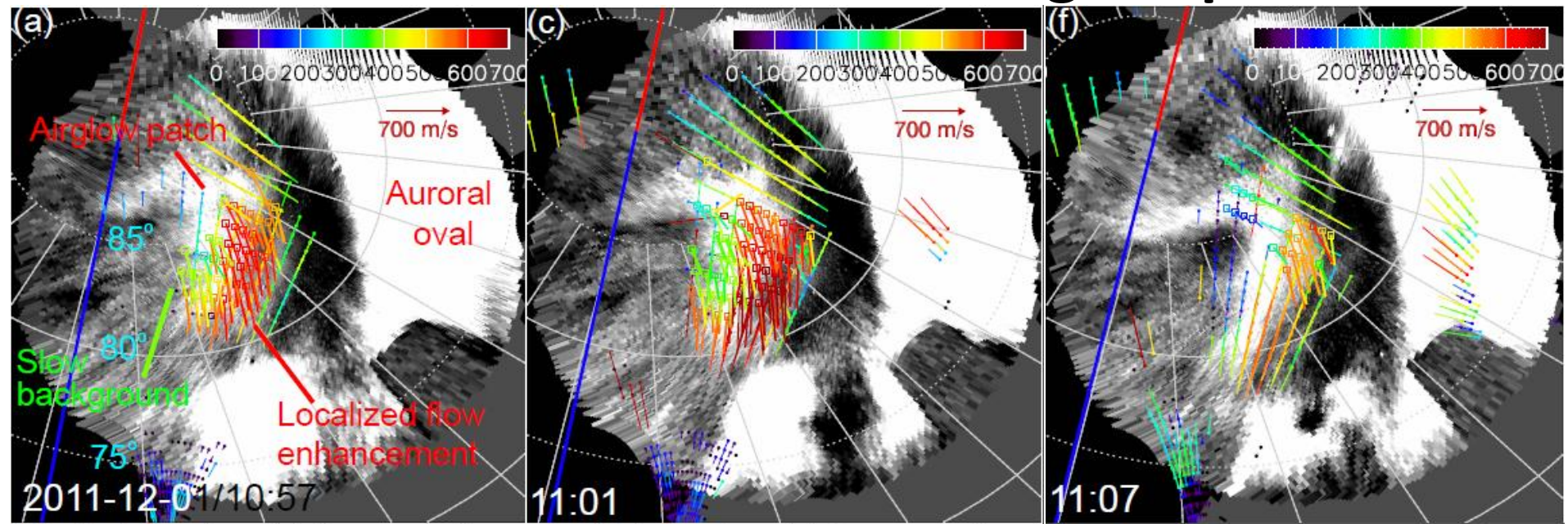
[Nishimura et al. 2014]



How common is the association?

Motivation: Determine statistically whether airglow patches can be used to study the 2-D evolution of localized flow enhancements over polar cap and examine the flow properties.

Flow structures associated with airglow patches



Fast, longitudinally narrow flow enhancement collocated with airglow patch for >10 min (16 min in this case).

Flow width \sim Patch width

Flow direction // Patch motion direction

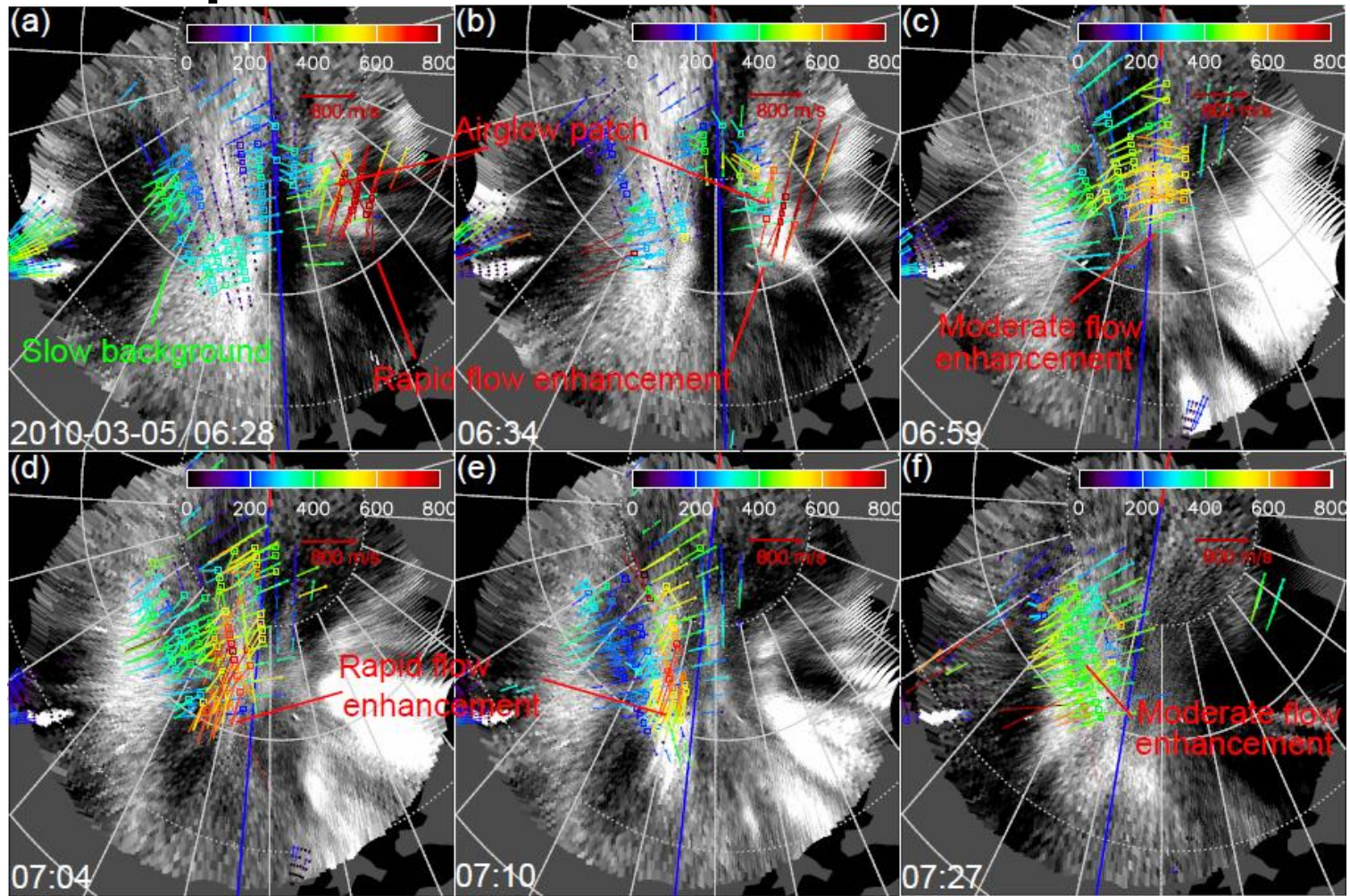
Flow speed: 600-700 m/s, comparable to patch speed

Patch speed: straight line distance/time: 500 m/s

actual speed: >500 m/s due to curved trajectory (blue arrows)

Localized polar cap flow enhancements are associated with airglow patches. The association is steady during their propagation.

Airglow as optical tracer of localized flow enhancements



1. As localized flow enhancements propagated across the polar cap, their velocity and direction can vary significantly over time.
2. The time-dependent flow evolution coincides with, thus is well reflected by airglow propagation.

Airglow can be used as the optical tracer of localized flow enhancements.

Statistics: association rate and flow speed

Database:

propagating patches with good radar coverage

Localized flow enhancement criterion:

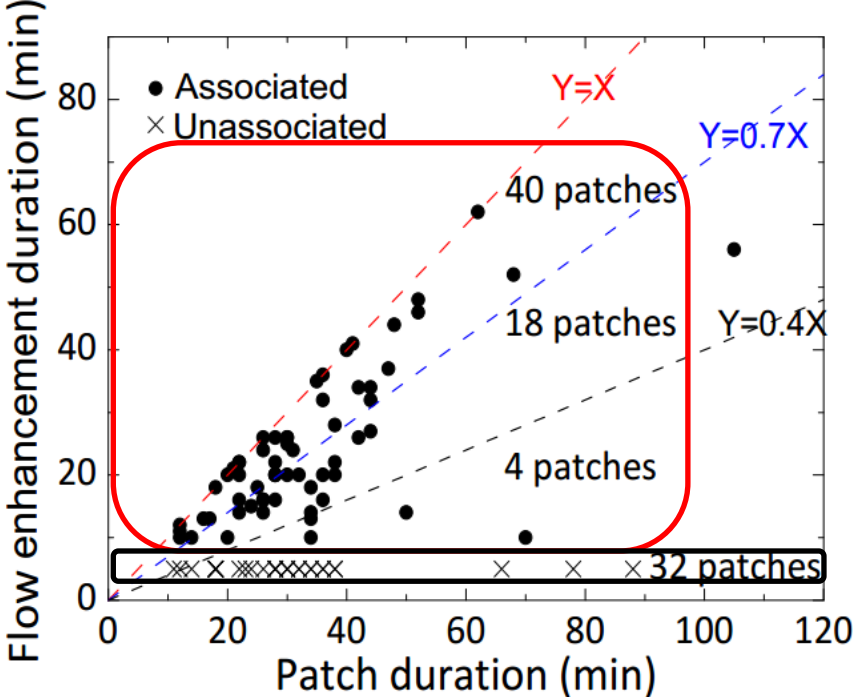
>~200 m/s difference >=10 min

Jan-Mar & Oct-Dec of 2008-2012: **93 patches**

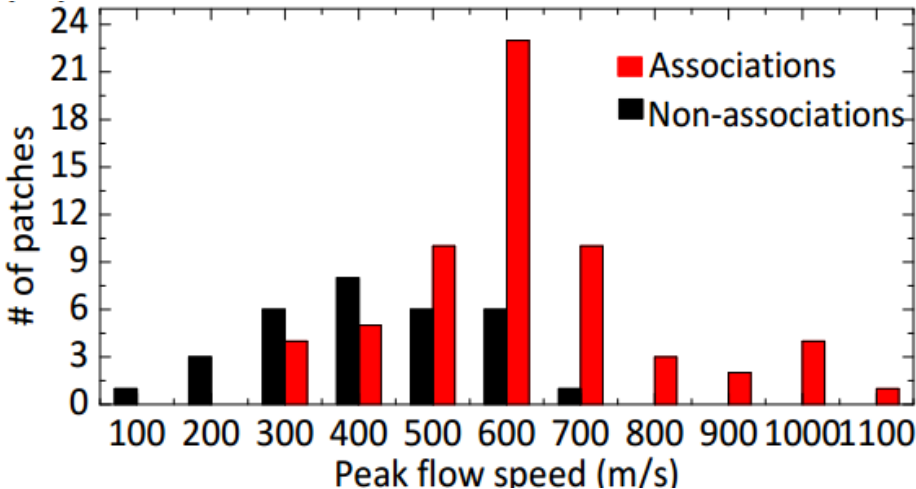
67% associated localized flow enhancements: common association

Flow speed on patches is statistically larger when airglow patches are associated with localized flow structures than not.

Flow enhancement duration vs patch duration



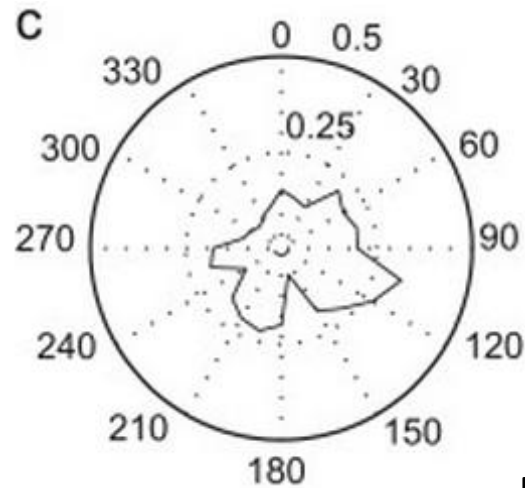
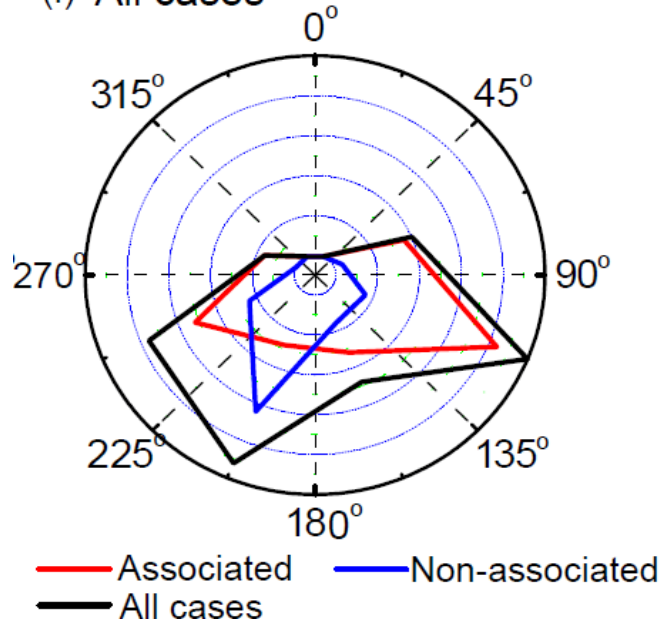
Flow on patches



IMF dependence of localized flow enhancements

Median IMF clock angles for localized flow enhancements

(i) All cases



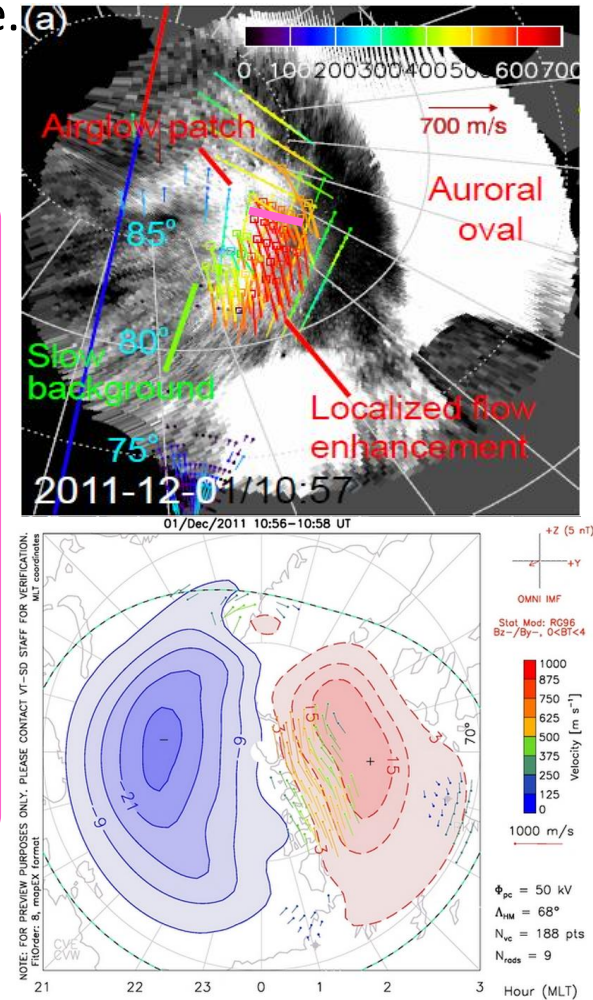
[Xing et al., 2012]

1. Patches with/without flow structures show different IMF dependence
Associated: most likely By-dominated
Unassociated: mostly under $-B_z$ dominated IMF with small $-B_y$
2. The overall clock angle similar to PMAFs.
→ PMAFs likely to be the source of patches and associated flows.

Potential across localized flow enhancements

- Flow potential: product of magnetic field, flow speed and flow width, the magnetic field being derived from a dipole field at pole.
- Polar cap potential: SuperDARN convection maps

	Φ_{pc}	Flow speed	Flow width	Flow potential	%
2011-12-01/10:54-11:08	48	600	200	6.6	14
2009-02-23/7:44-7:53	45	900	200	9.9	22
2011-03-04/4:55-5:08	53	700	100	3.85	7
2011-11-05/8:20-9:02	48	600	300	9.9	21
2011-11-27/6:20-7:11	53	500	300	8.25	16
2012-02-25/5:47-6:27	49	500	600	16.5	34
2012-11-18/7:16-7:50	46	800	400	17.6	38
2010-03-05/7:06	41	800	300	13.2	32



Varying from a few to more than ten kV and can account for ~ 10 -40% of the cross polar cap potential.
 → Substantial