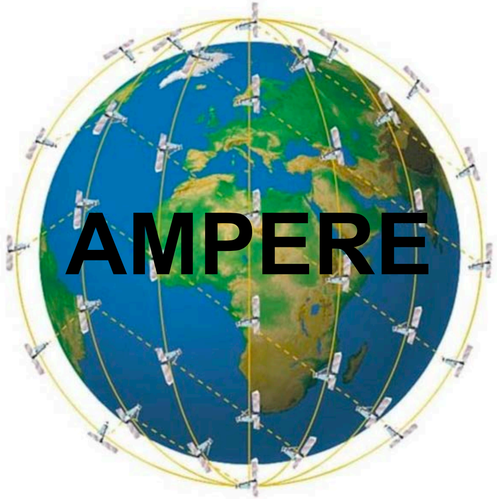


Iridium Communications

Small-scale* Poynting flux

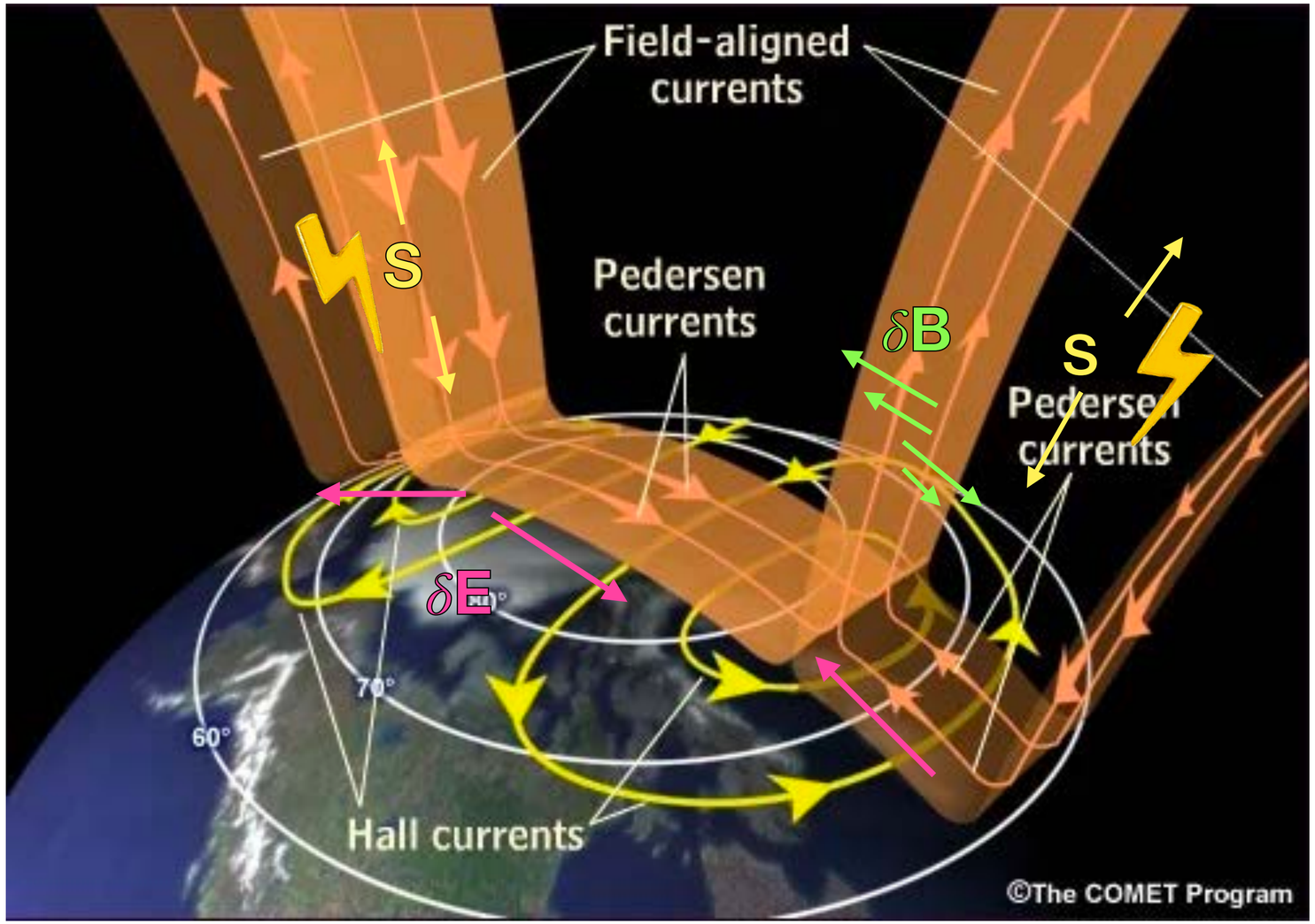
Daniel Billett, K. A. McWilliams, J. K. Burchill, D. J. Knudsen, C. J. Martin, P. V. Ponomarenko, S. K. Vines

SuperDARN Canada

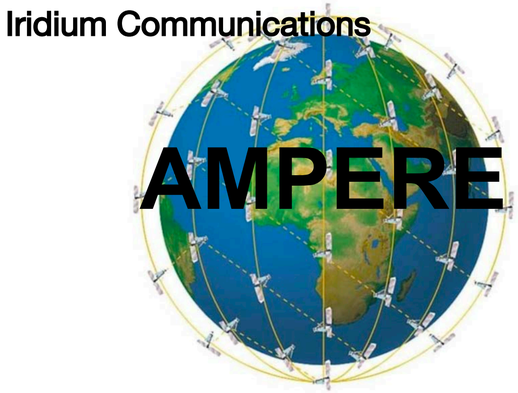
University of Saskatchewan

The quasi-static* system

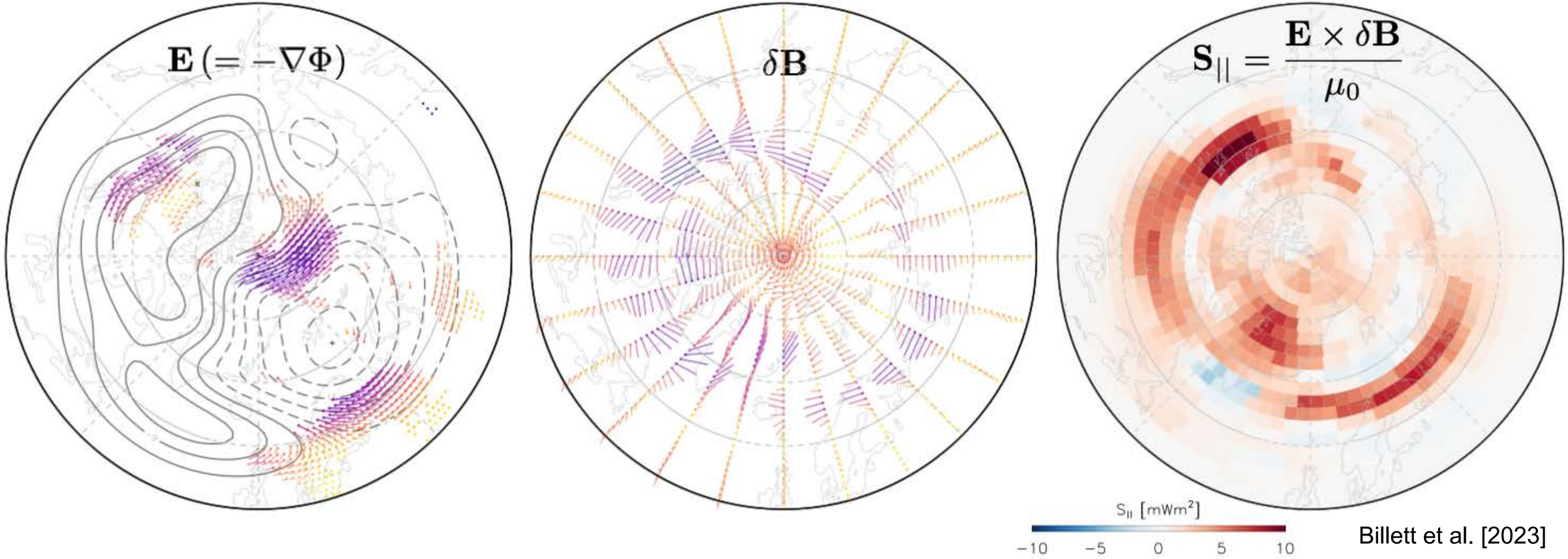
*or: large-scale, DC, big picture, field-aligned currents, convection, etc



Quasi-static Poynting flux



Polar Poynting flux pattern

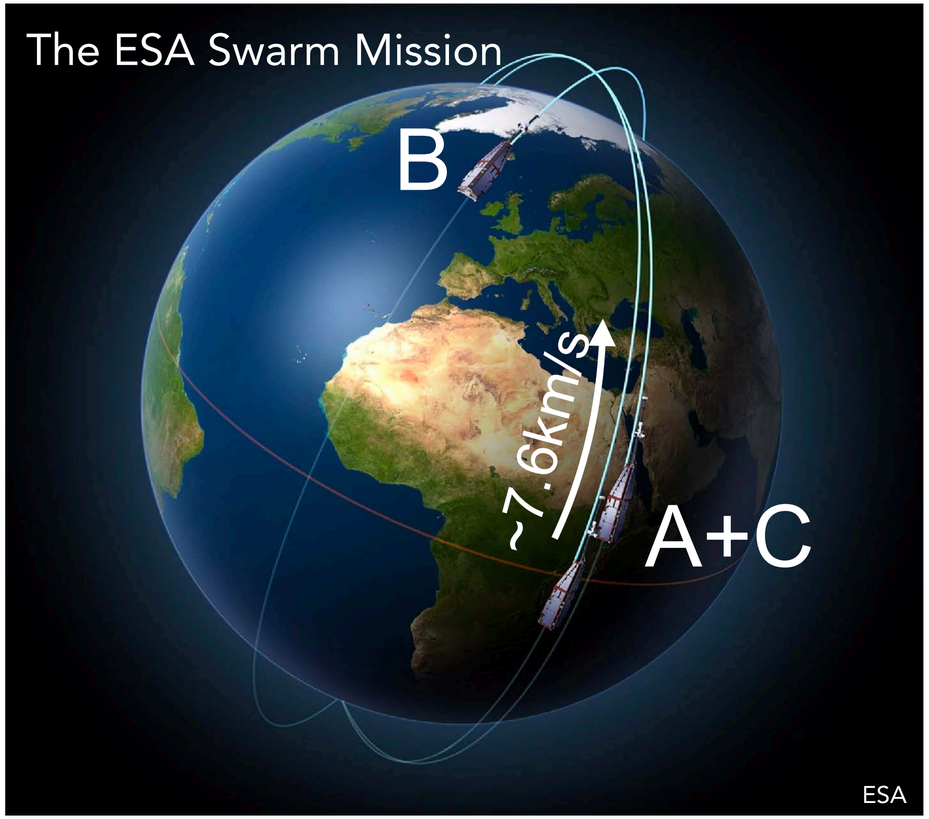


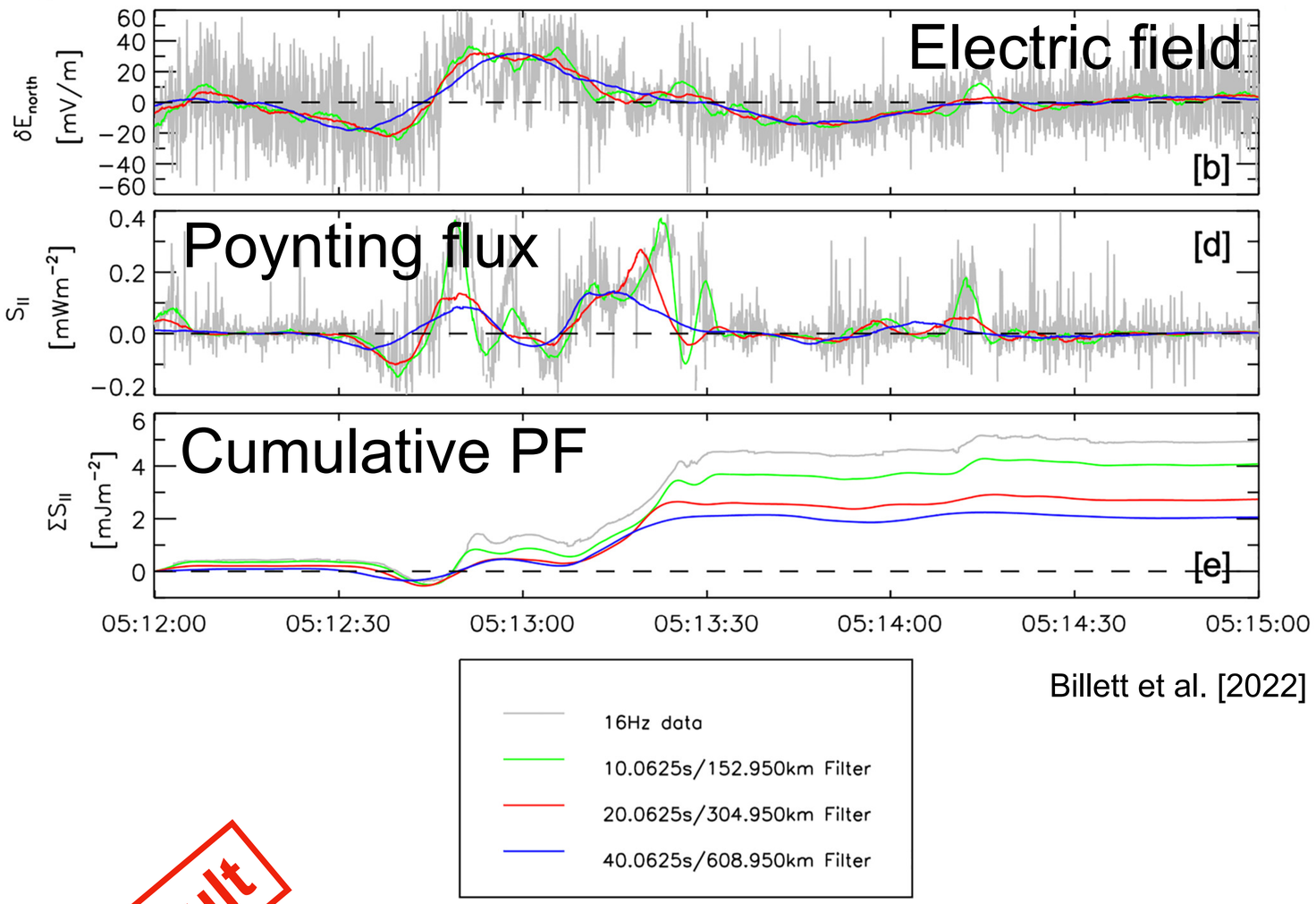
Billett et al. [2023]

The small-scale system

?

What do the satellites see? Swarm case study





Billett et al. [2022]

Result

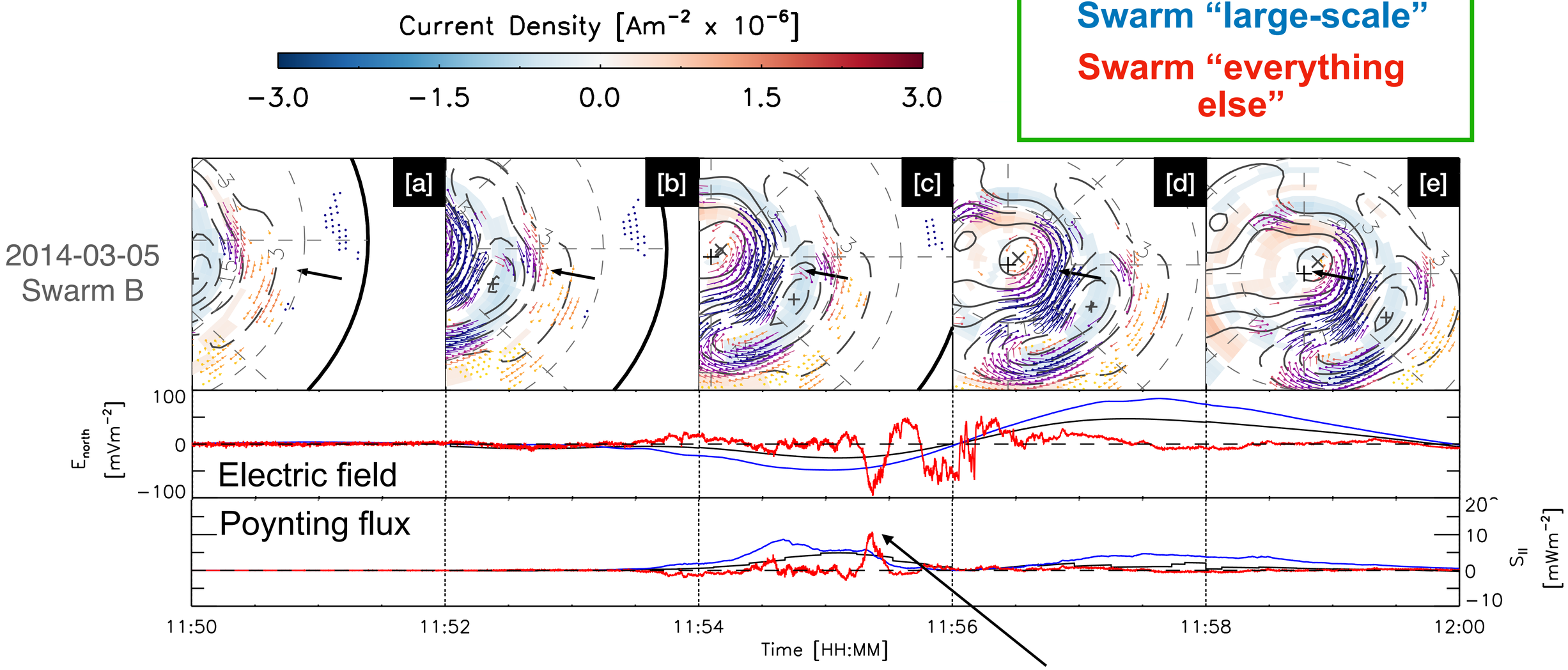
The smaller scales we look at, the more Poynting Flux we see

Seeing embedded structures

SuperDARN/AMPERE "large-scale"

Swarm "large-scale"

Swarm "everything else"



So this is the "invisible" Poynting Flux

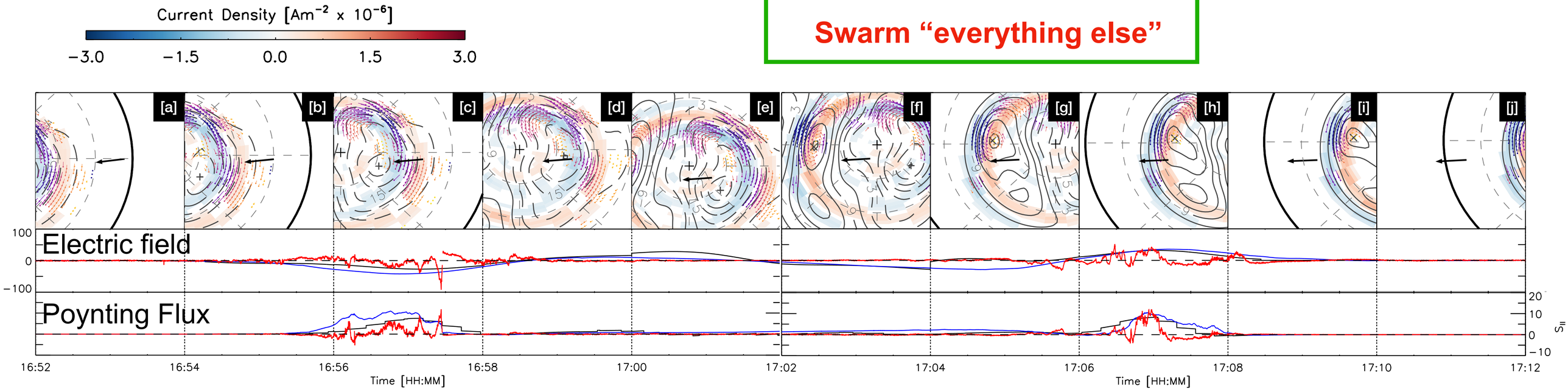
SuperDARN - AMPERE - Swarm comparisons: Steady convection

Swarm B: 2014-02-18

SuperDARN/AMPERE "large-scale"

Swarm "large-scale"

Swarm "everything else"



Dawnside FACs

Duskside FACs

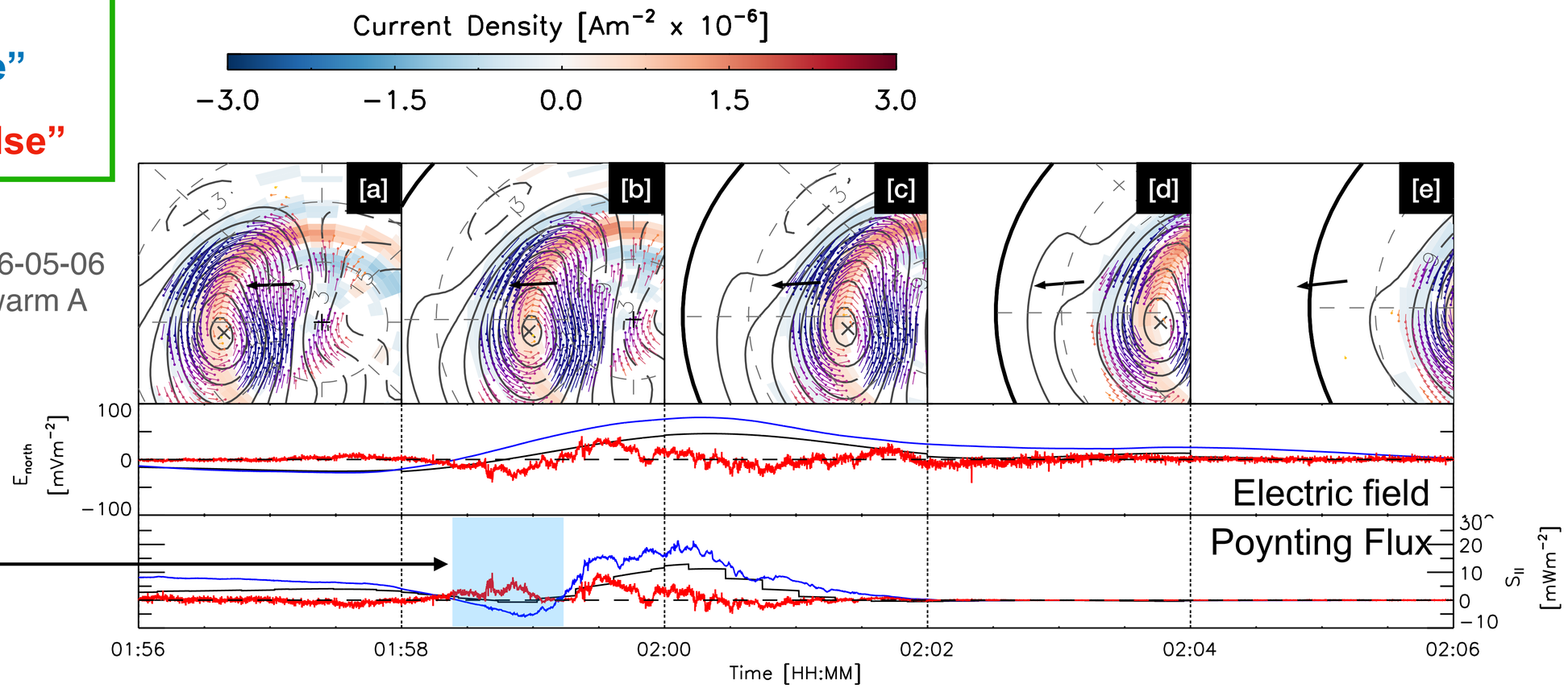
Upward Poynting flux: Small scales balancing the large?

SuperDARN/AMPERE "large-scale"

Swarm "large-scale"

Swarm "everything else"

2016-05-06
Swarm A



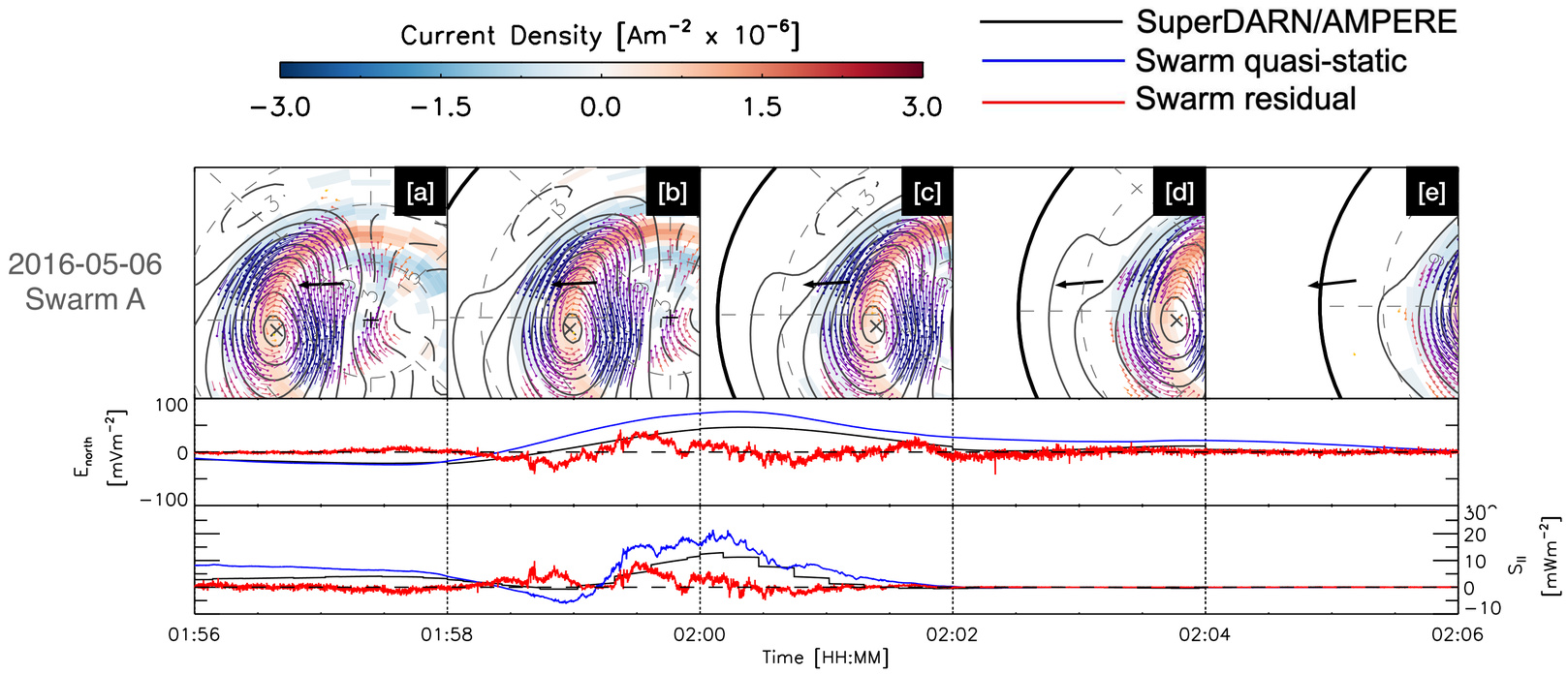
Upward driving on **large-scales**, balanced by **downward** driving on **smaller scales**

Net = 0

Duskside FACs

Summary

Capturing **large-scale** dynamics is vital for understanding **everything else**



Geophysical Research Letters

Research Letter | Open Access

Multi-Scale Ionospheric Poynting Fluxes Using Ground and Space-Based Observations

D. D. Billett, K. A. McWilliams, P. V. Ponomarenko, C. J. Martin, D. J. Knudsen, S. K. Vines

First published: 24 May 2023 | https://doi.org/10.1029/2023GL103733

Extra slide: Comparisons EXTREME Kp 7+

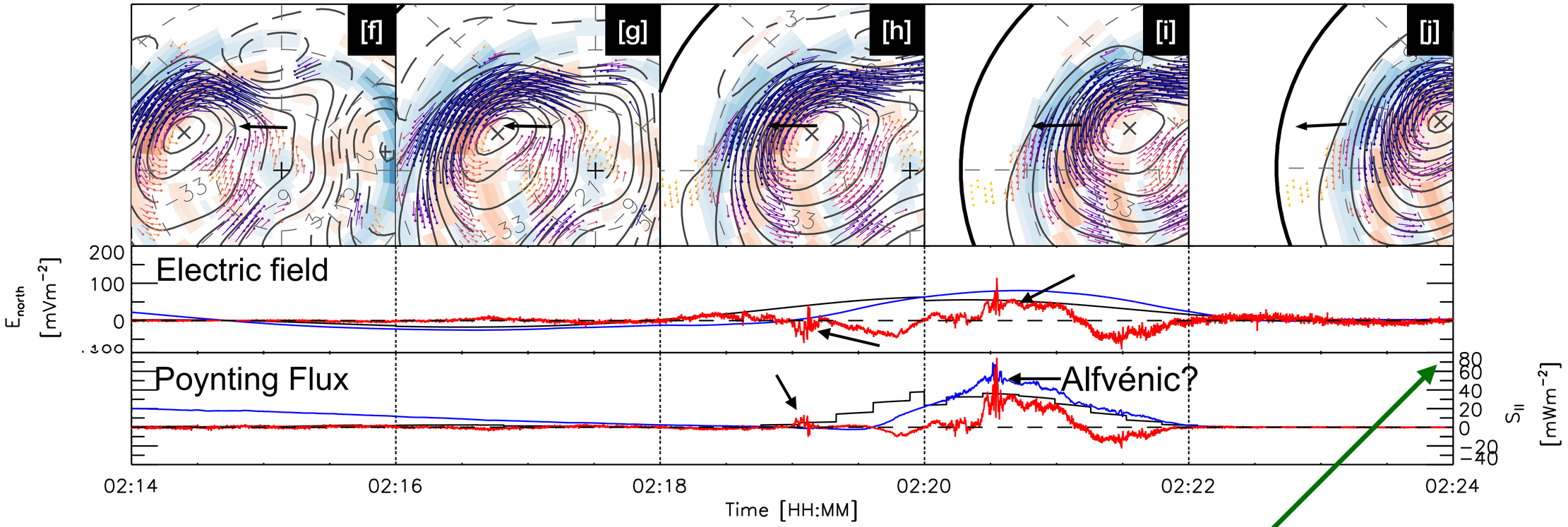
SuperDARN/AMPERE "large-scale"

Swarm "large-scale"

Swarm "everything else"

Swarm A, 2016-05-08

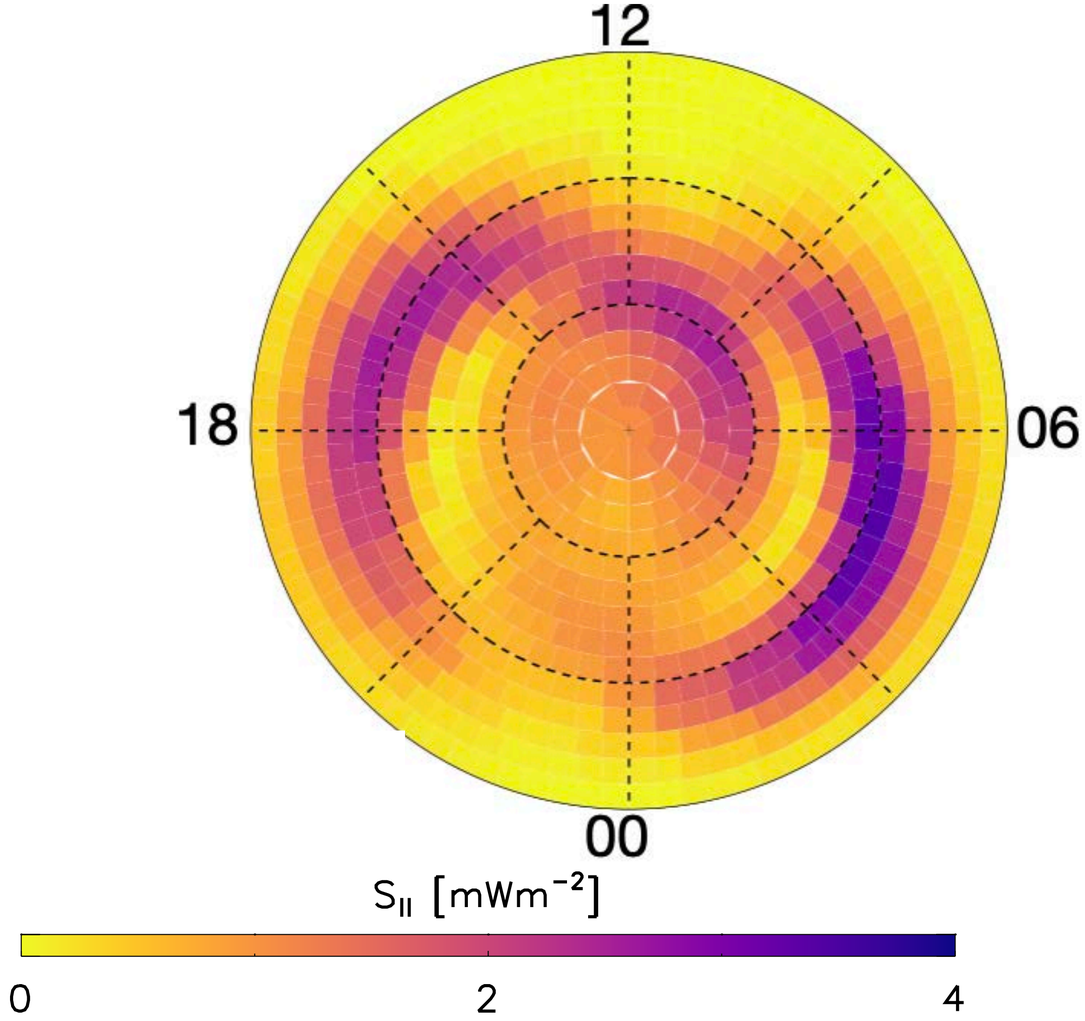
Duskside FACs



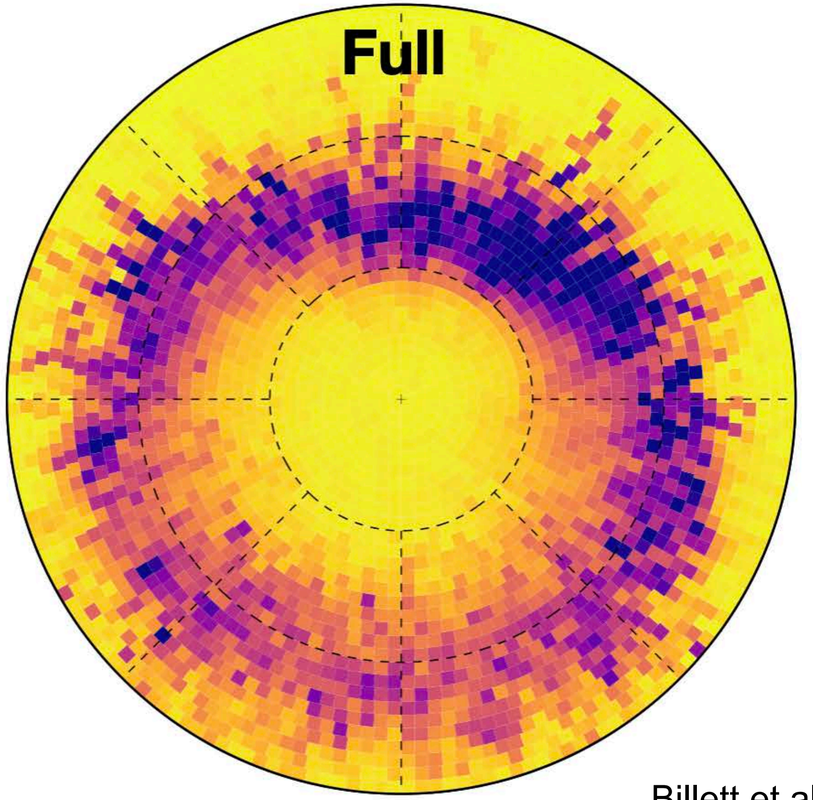
Look at those magnitudes!

Extra slide: Poynting flux from SuperDARN/AMPERE vs Swarm

SuperDARN **E** and AMPERE δ**B** fields:



Swarm **E** and δ**B** fields:

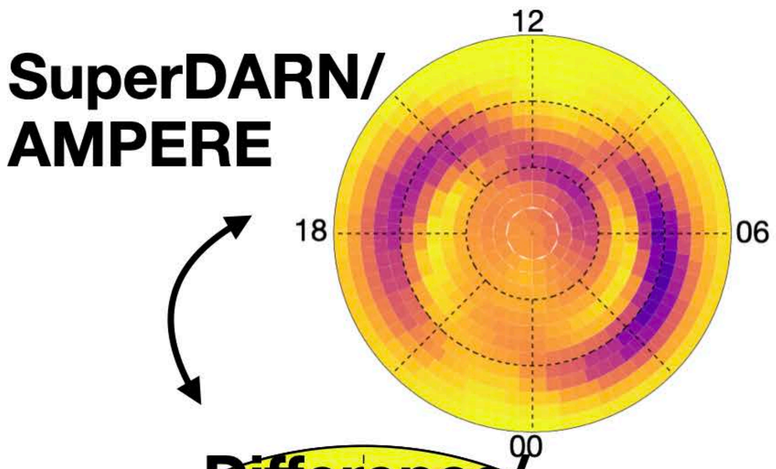


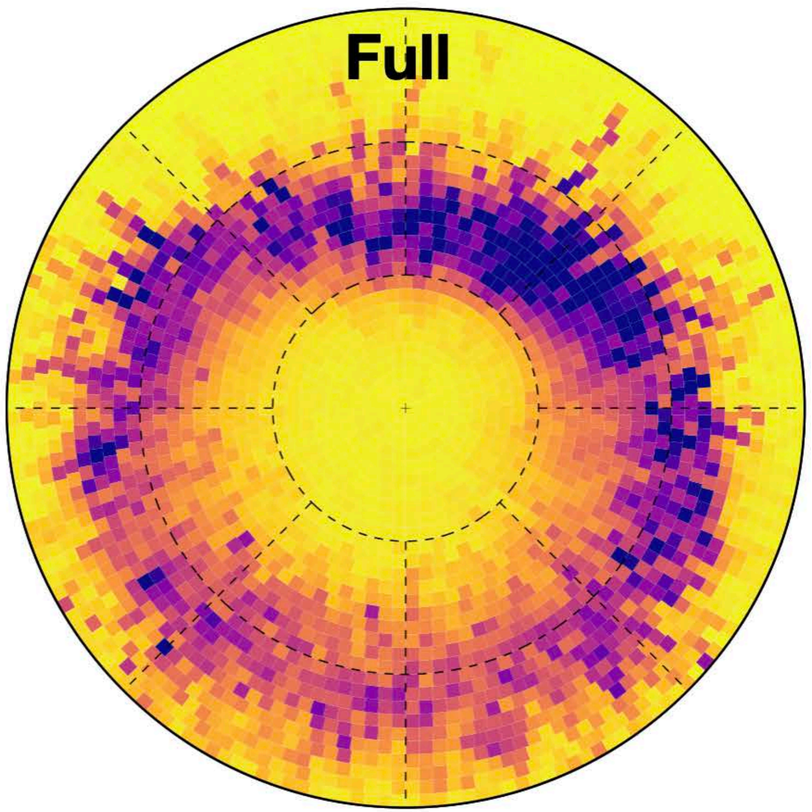
Billett et al. [2021]

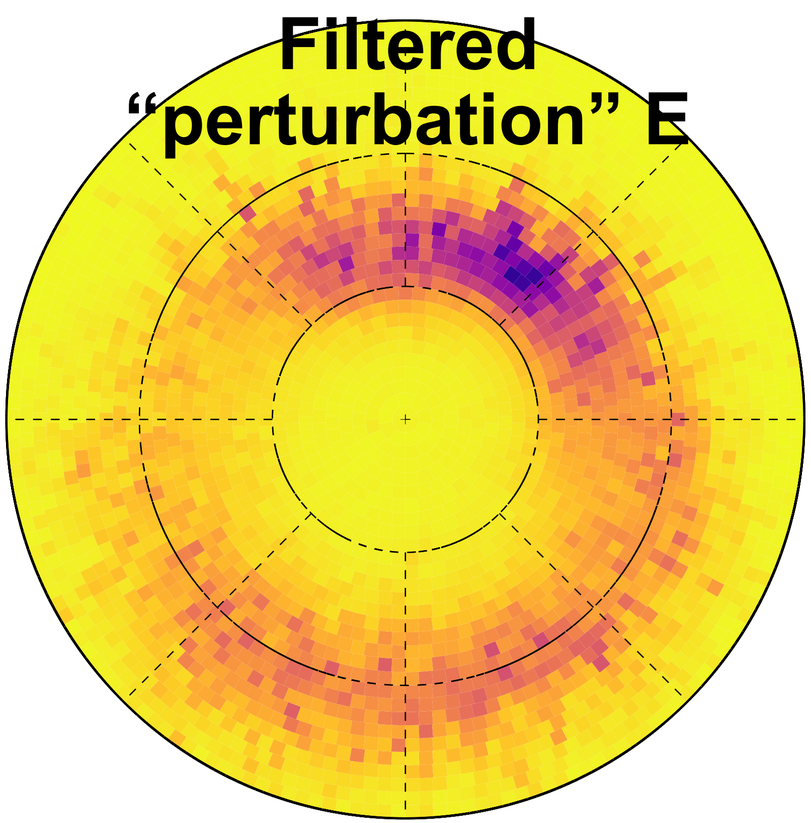
…why don't these match?

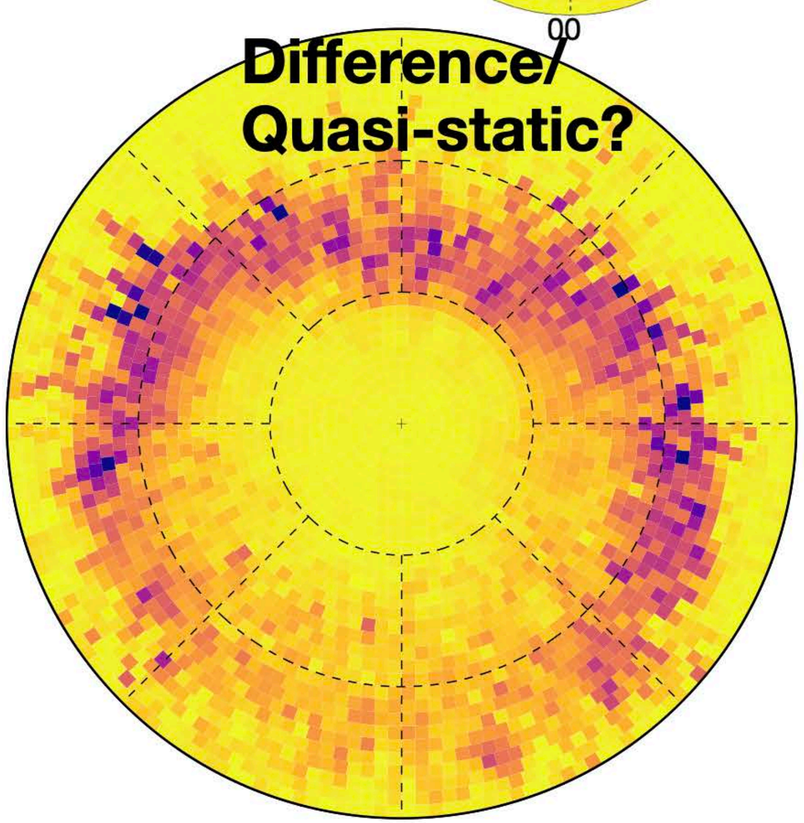
Extra slide: Making SuperDARN and Swarm match

The “full” Poynting flux will contain the perturbation and quasi-static components…





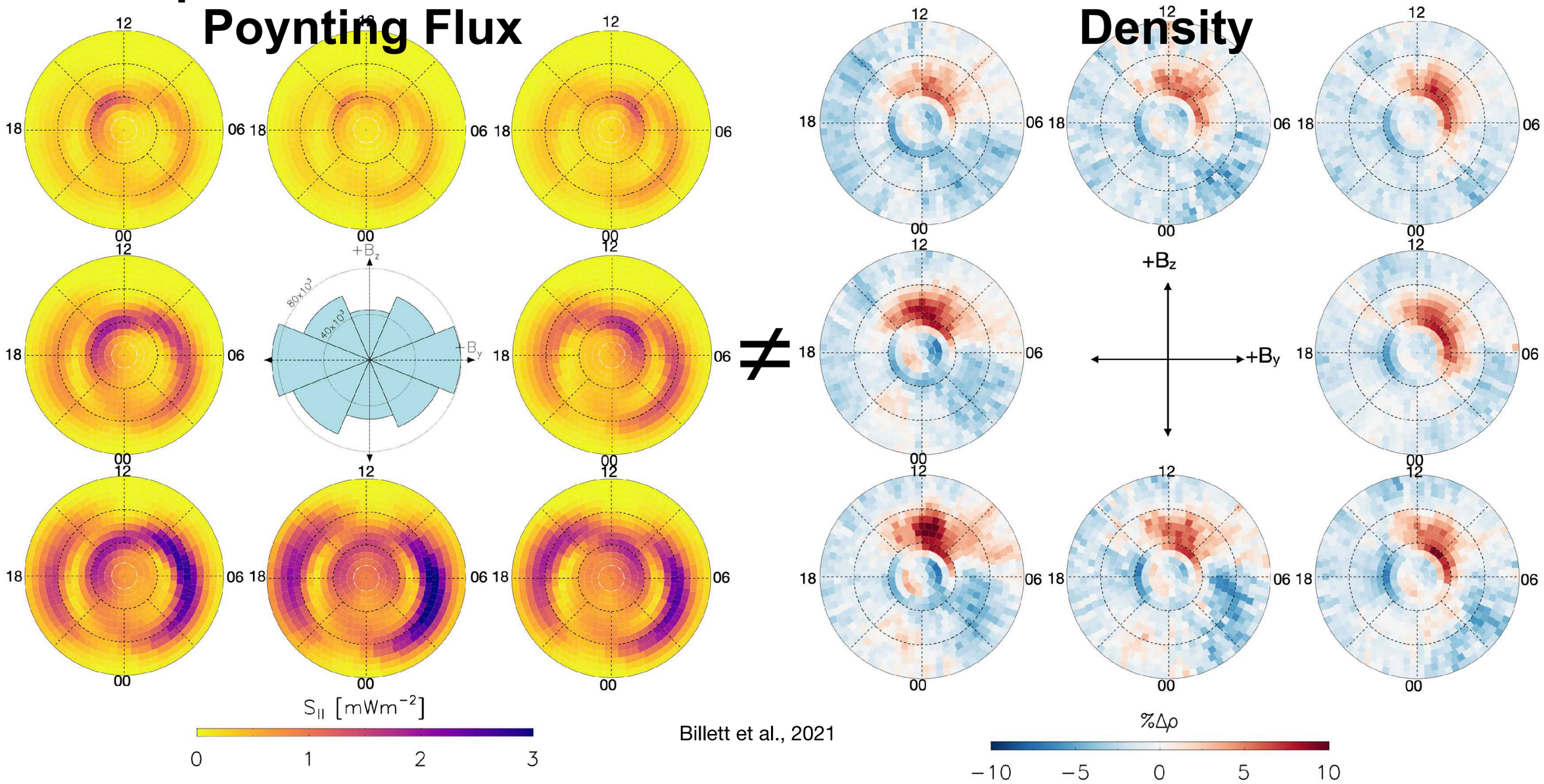




Extra slide: Project CHAMPERE

SuperDARN/AMPERE Poynting Flux

CHAMP Perturbation Neutral Density



Billett et al., 2021