

FACs and Substorm Dynamics with Global Magnetometer Arrays and AMPERE

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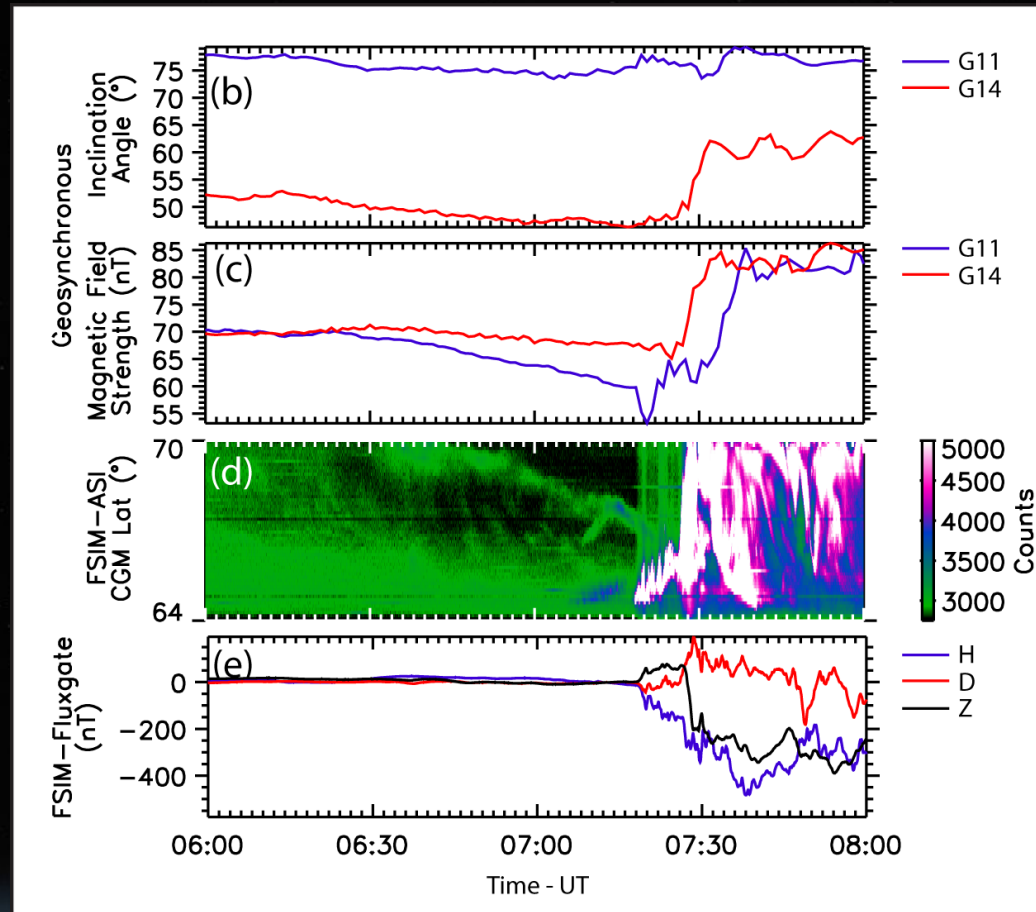
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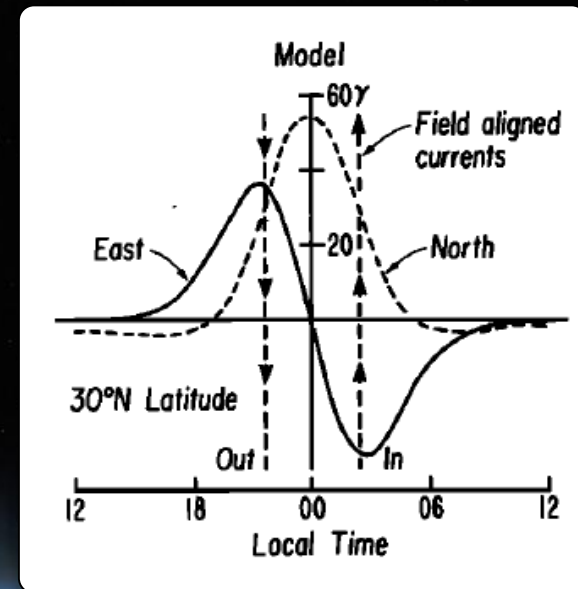
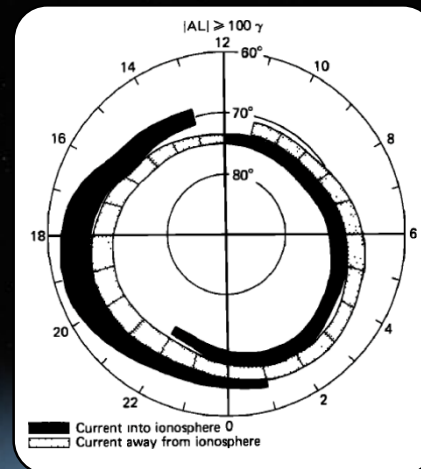
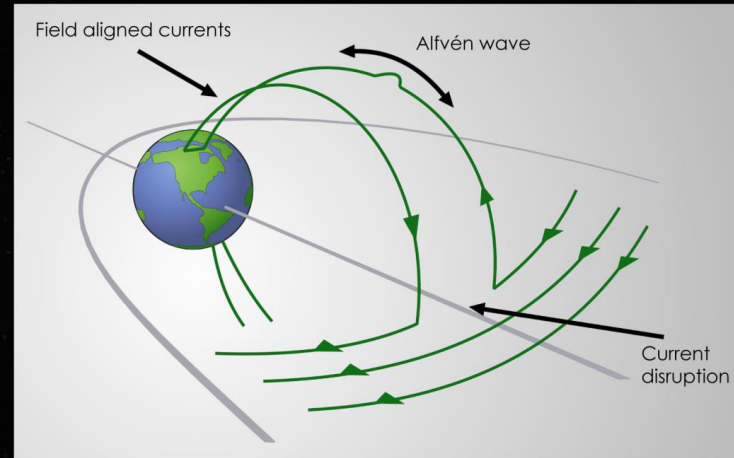
Substorms

- Large scale transition of the magnetotail
 - Dipolarisation
 - Auroral Brightening
 - Electrojet enhancements



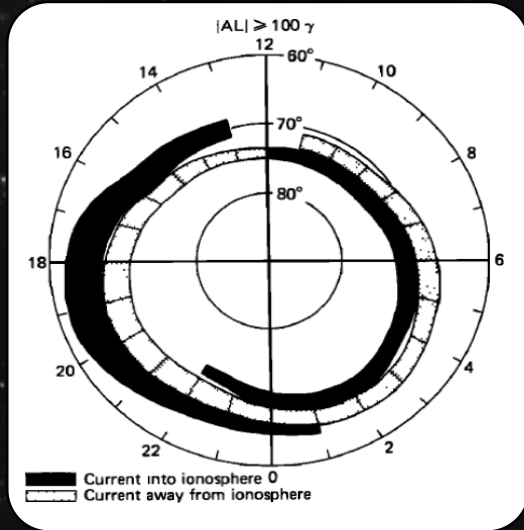
FACs and Substorms

- Formation of the Substorm Current Wedge
- Enhancement in FACs and ionospheric electrojets



[Iijima and Potemra, 1978]

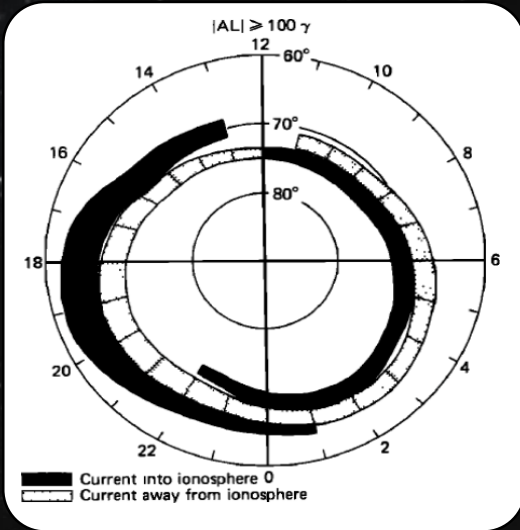
AMPERE



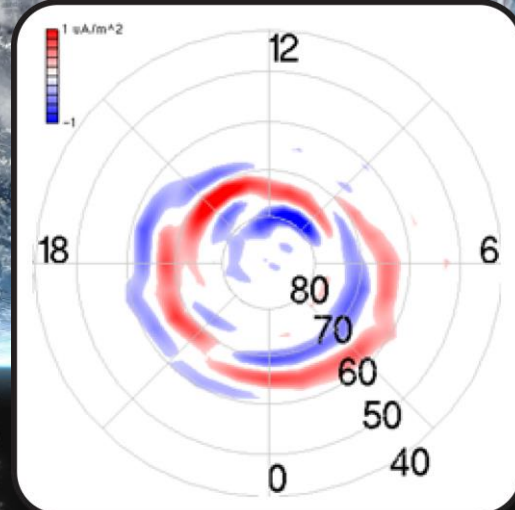
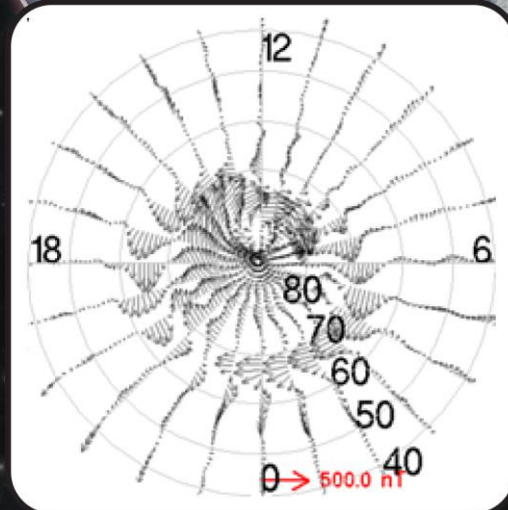
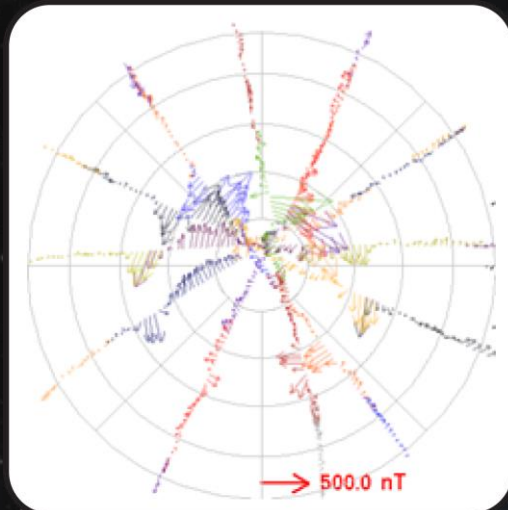
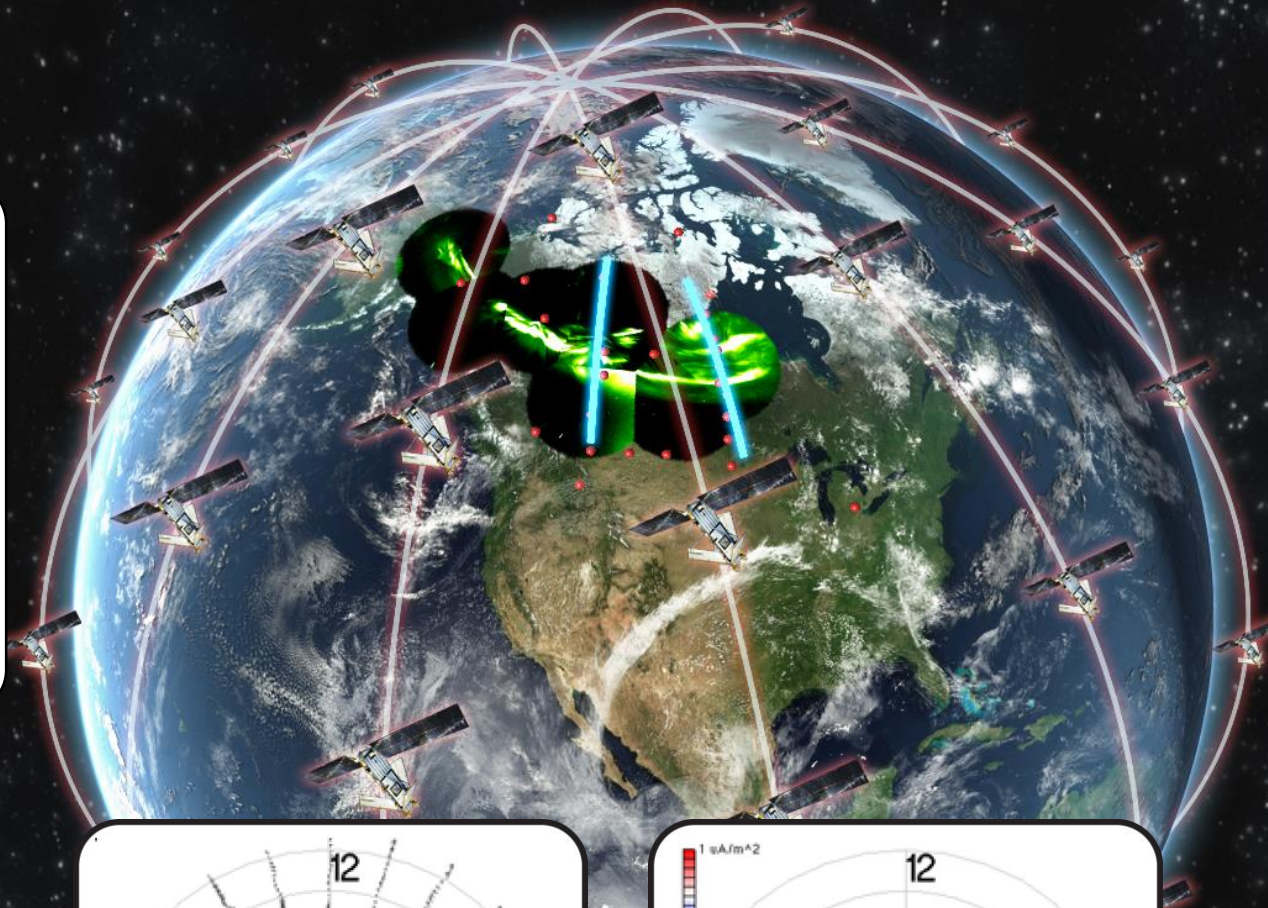
[Iijima and Potemra, 1978]



AMPERE



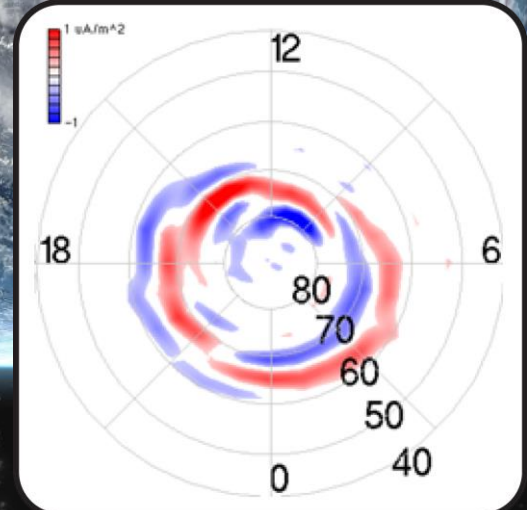
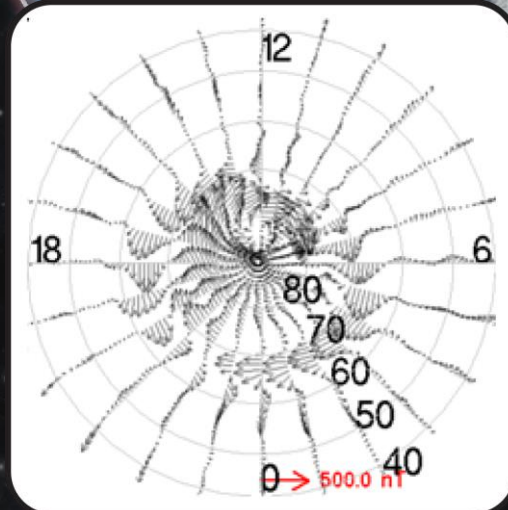
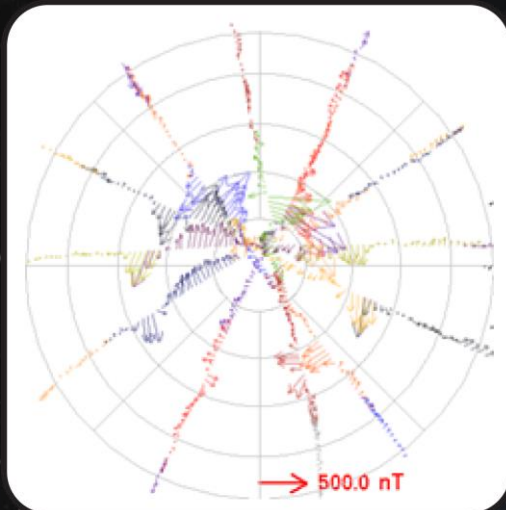
[Iijima and Potemra, 1978]



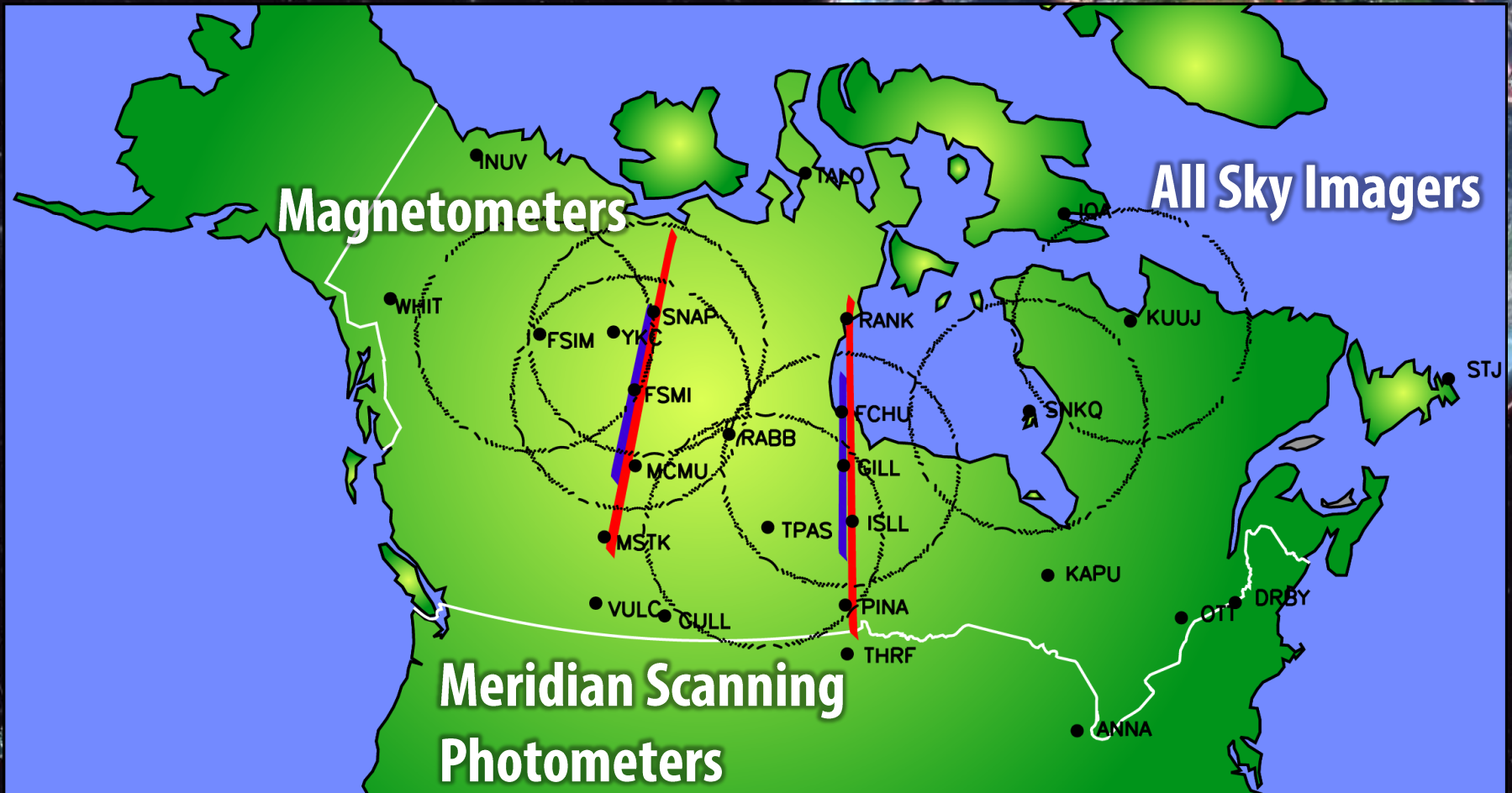
AMPERE

- Derived FACs
 - Amperes law
$$\nabla \times \Delta \mathbf{B} = \mu_0 \mathbf{J}$$
 - Earth's main field is curl free
- Reliable FACs are derived from quasi-stationary time periods

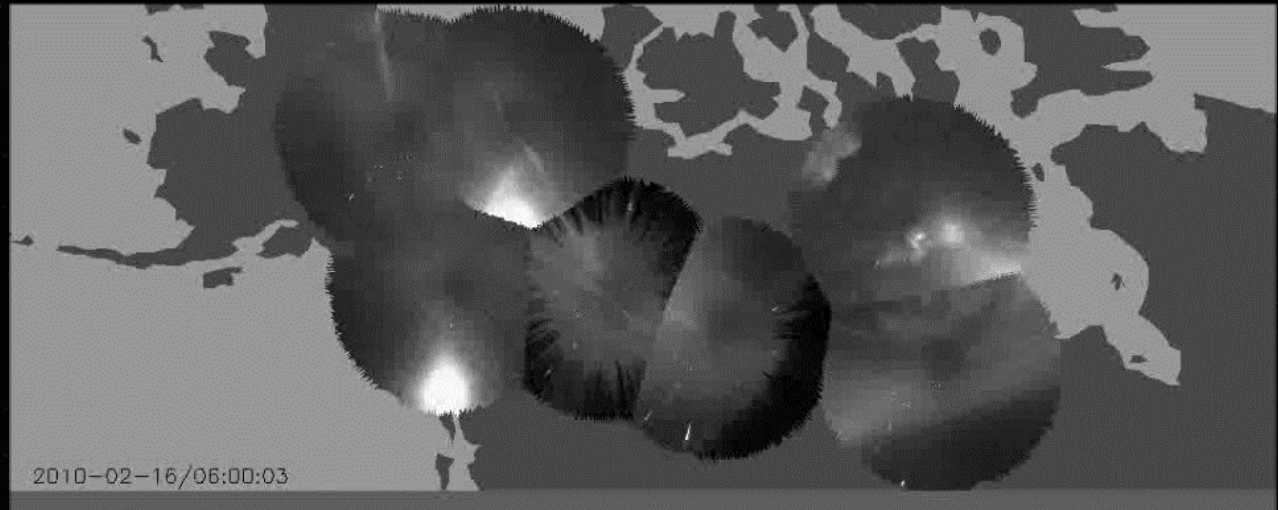
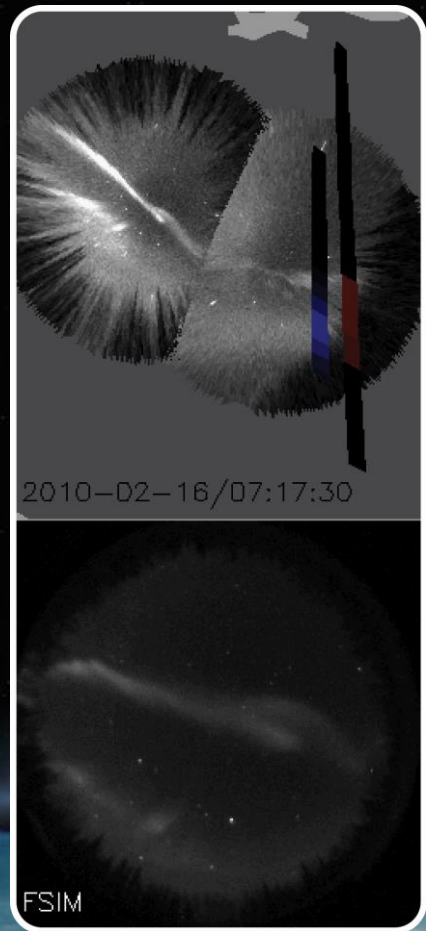
$$\mathbf{B}(\mathbf{r}, t) \rightarrow \mathbf{B}(\mathbf{r})$$



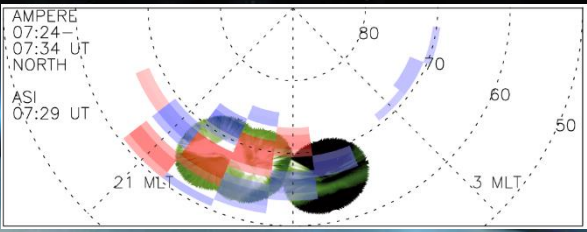
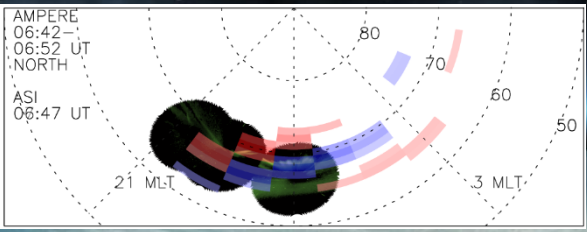
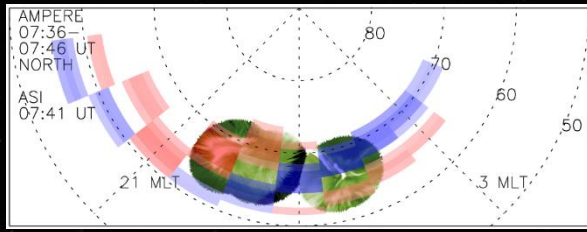
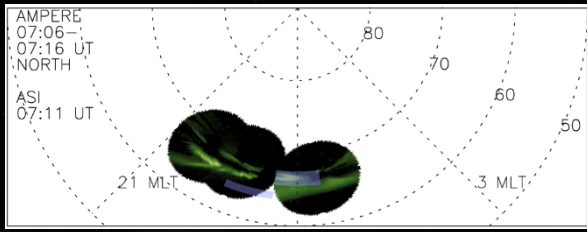
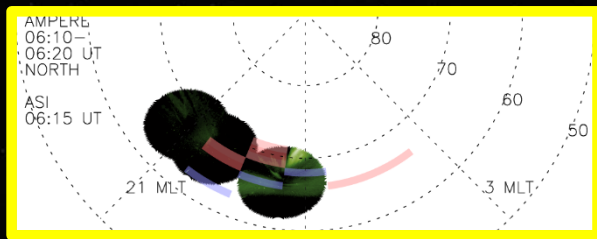
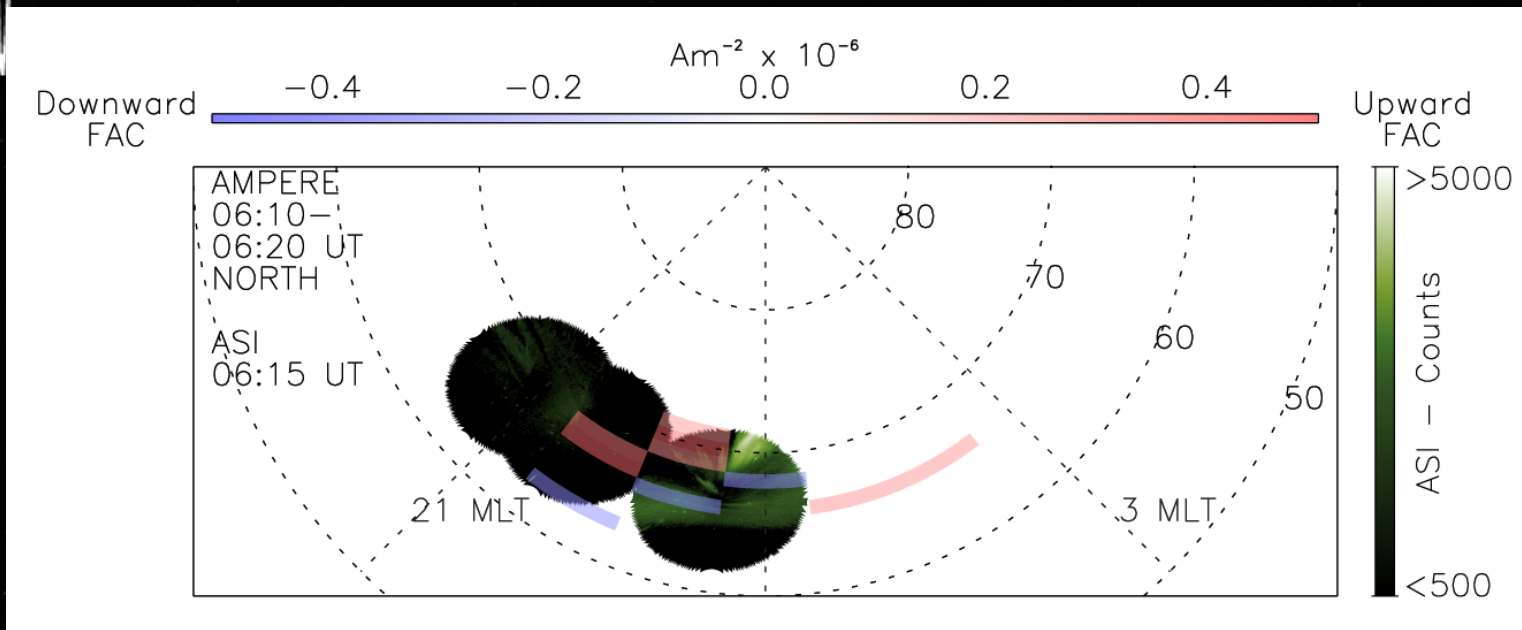
Ground-based



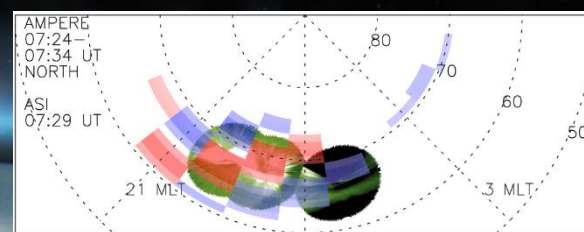
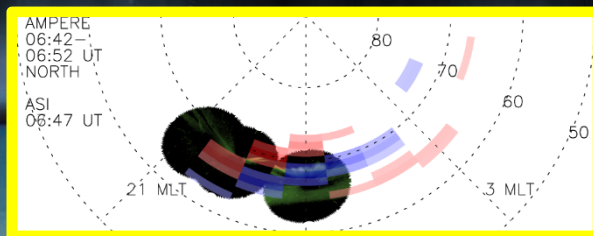
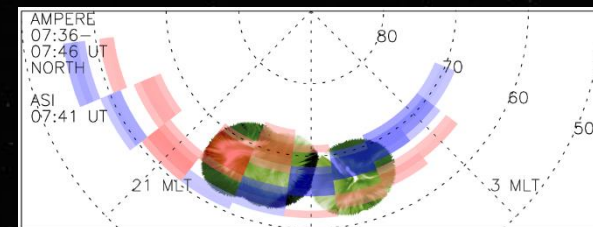
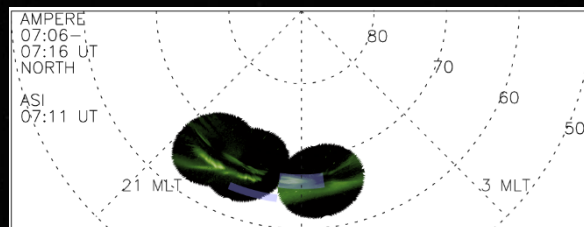
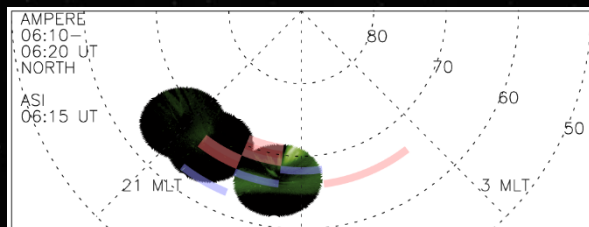
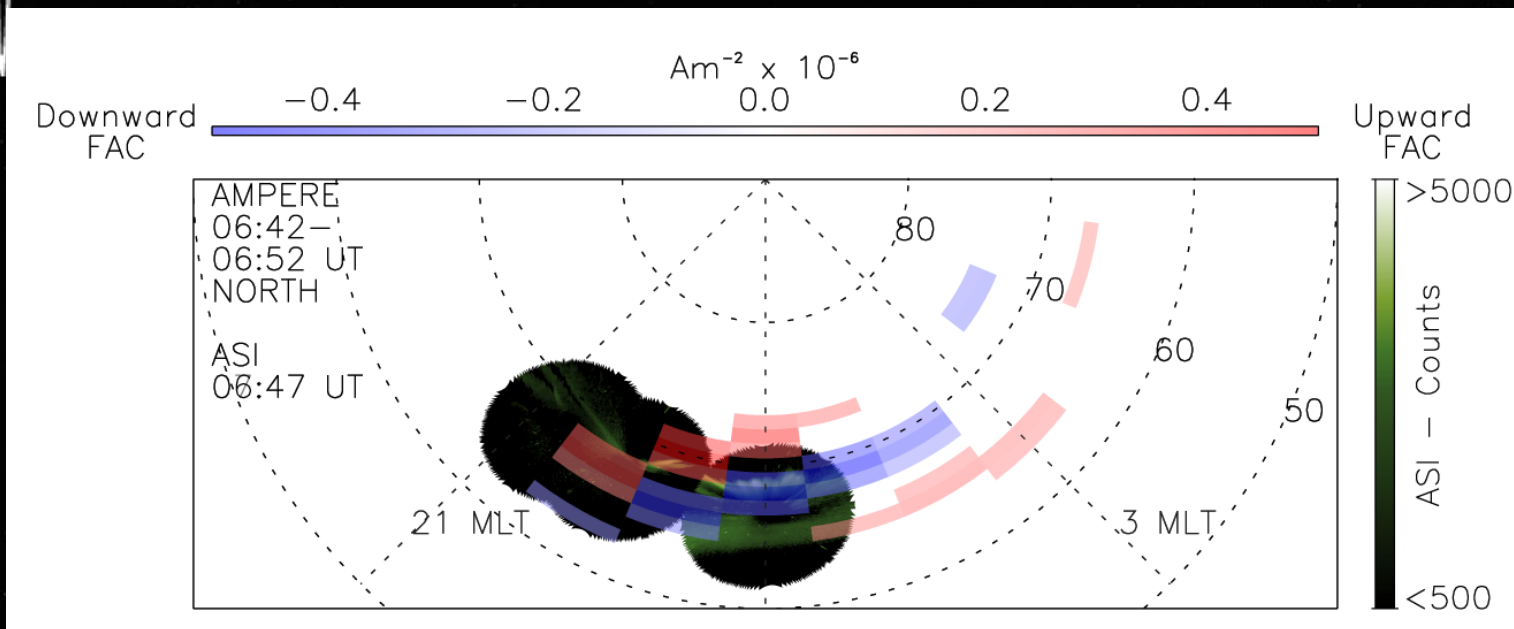
FAC Reductions at Substorm Onset



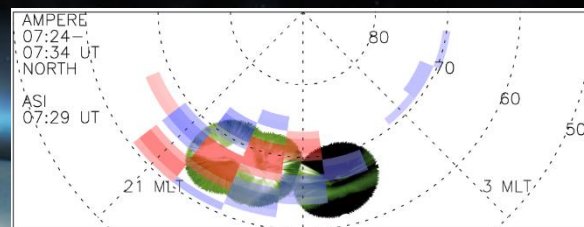
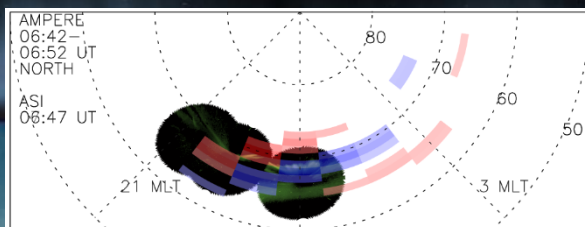
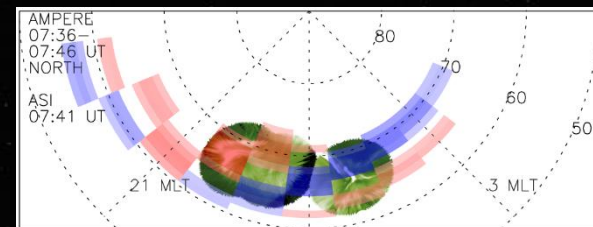
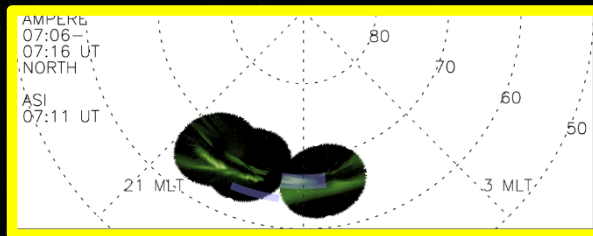
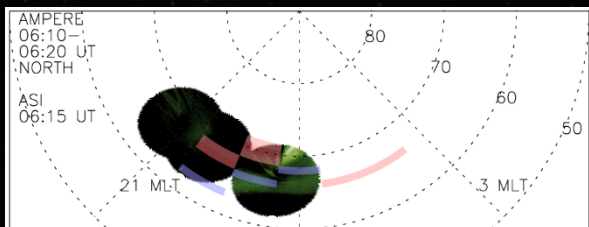
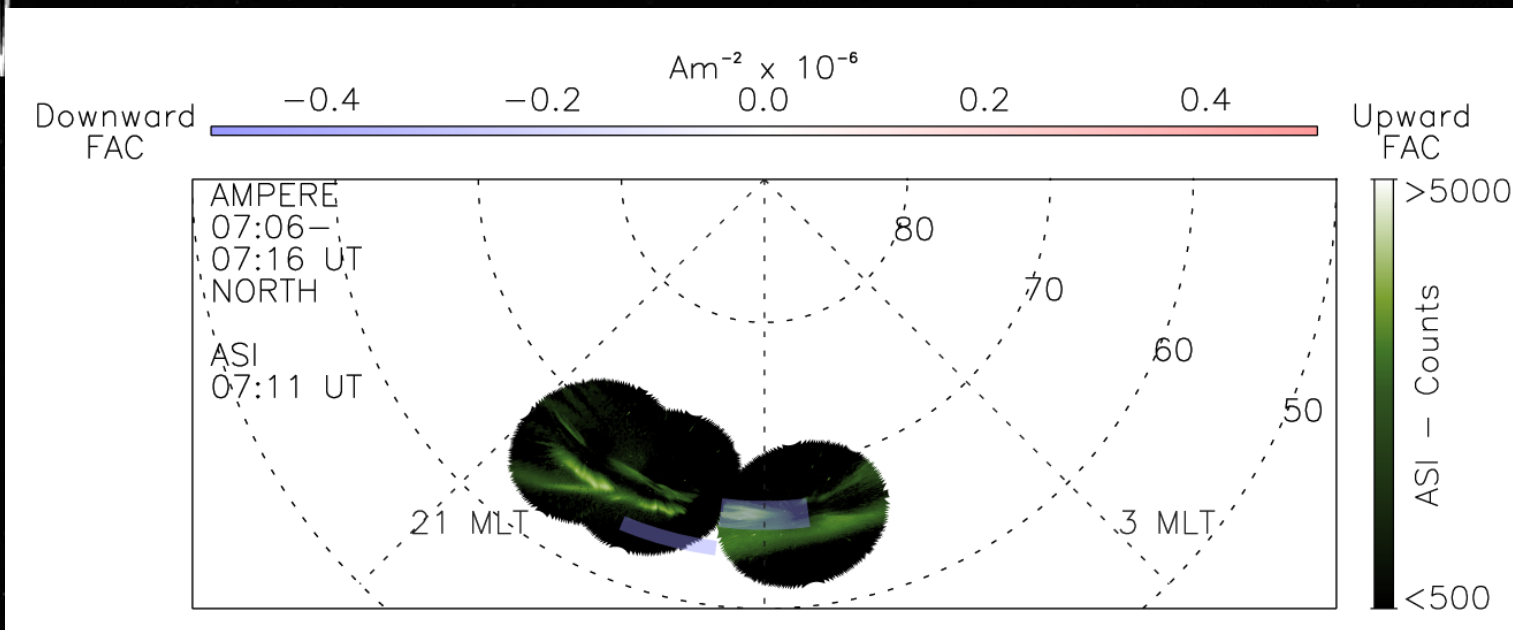
FACs – Growth Phase



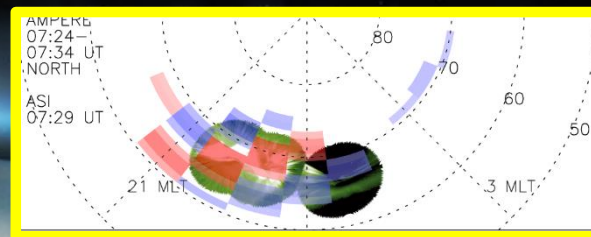
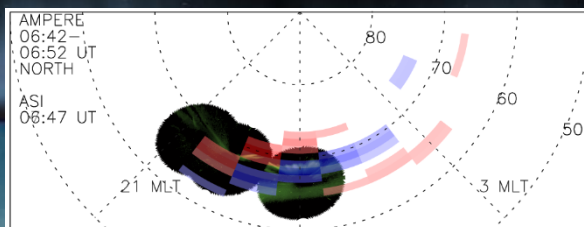
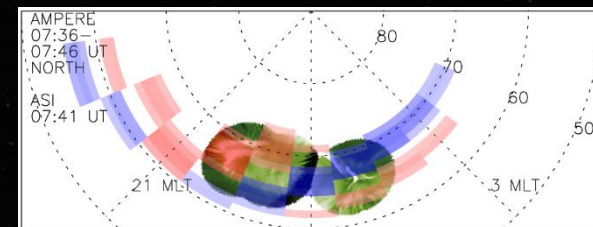
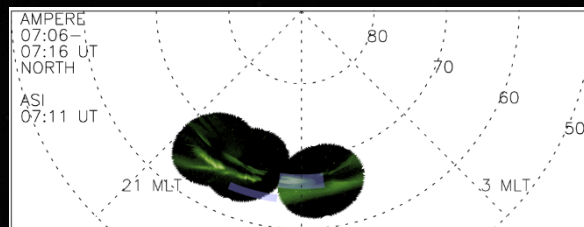
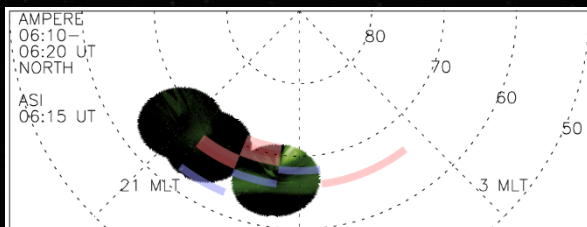
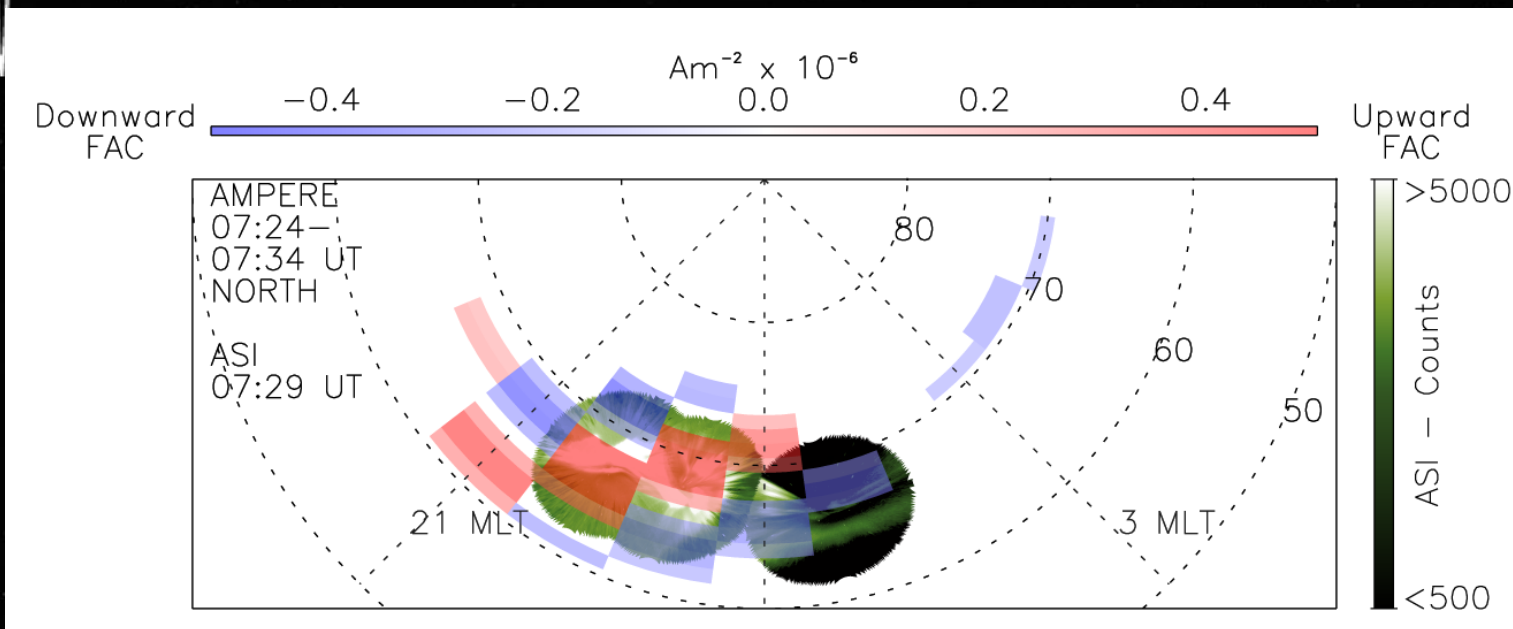
FACs – Growth Phase



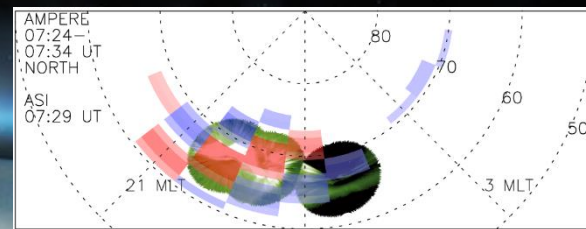
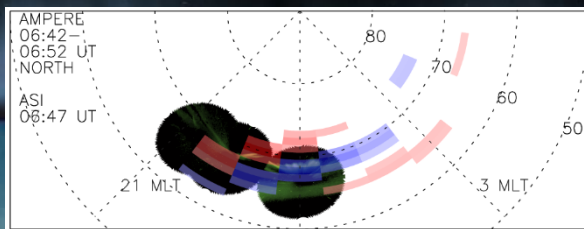
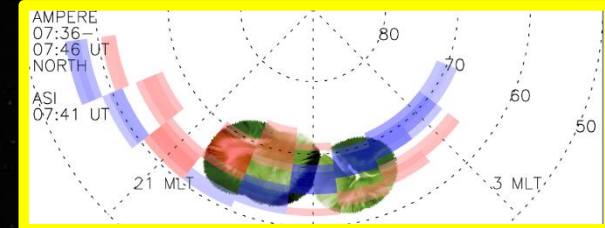
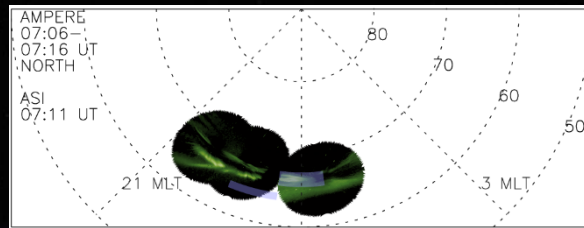
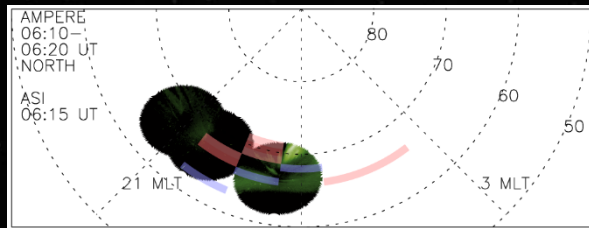
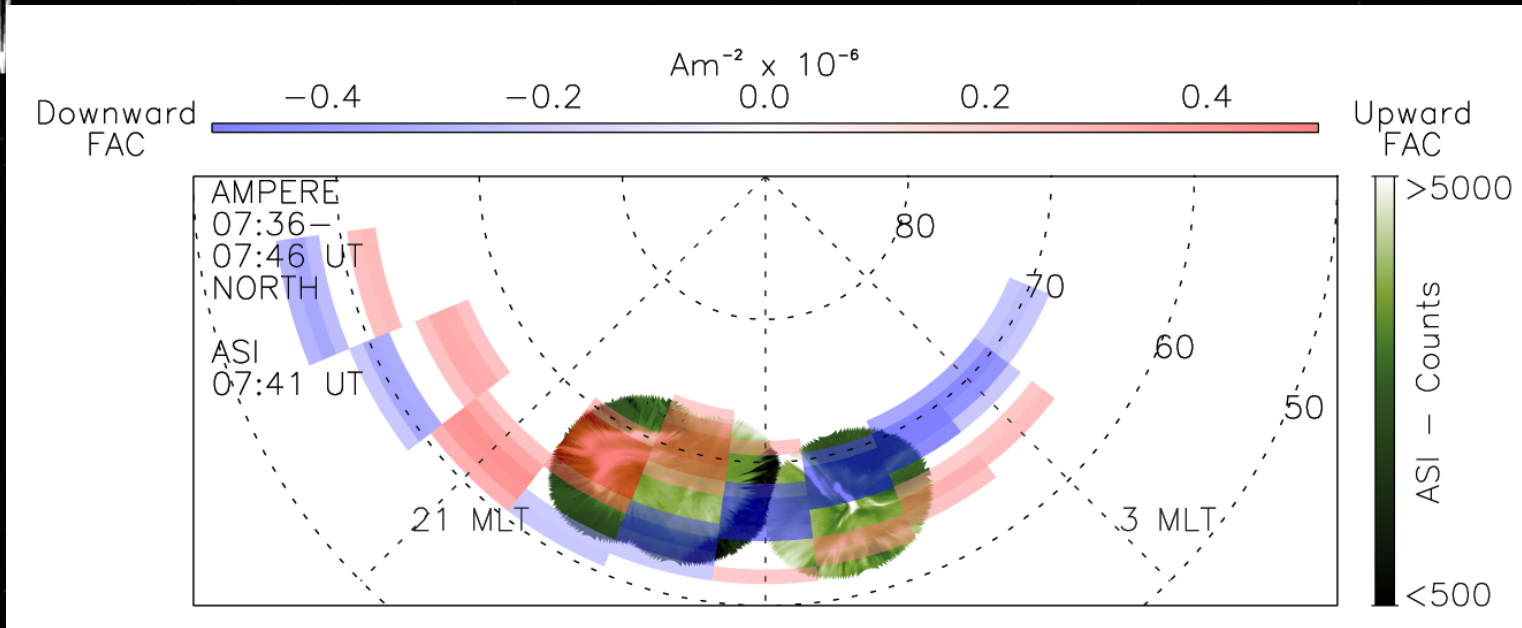
FACs – Pre Onset



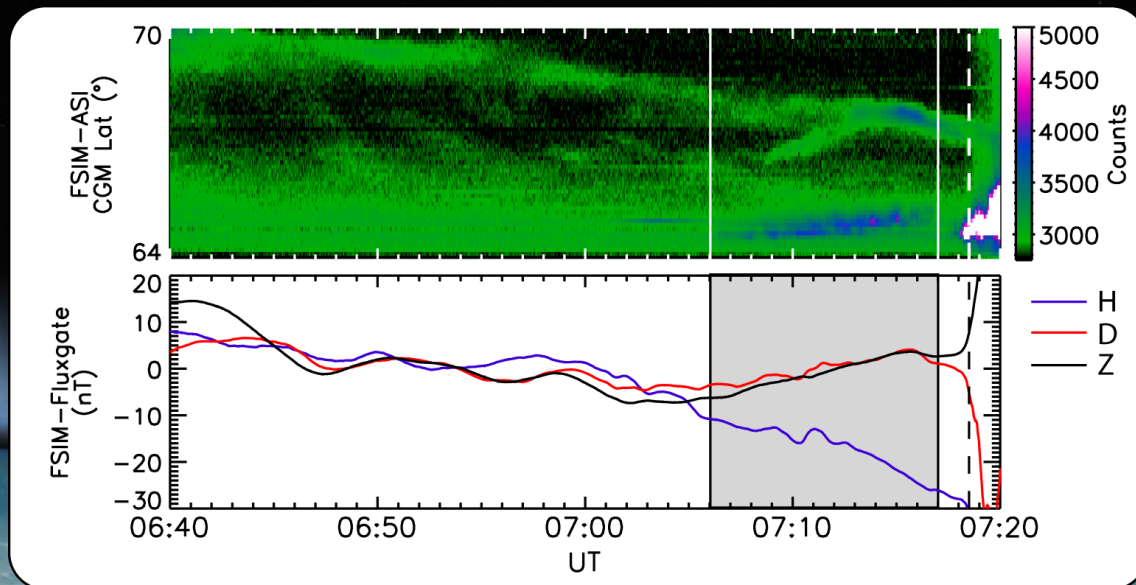
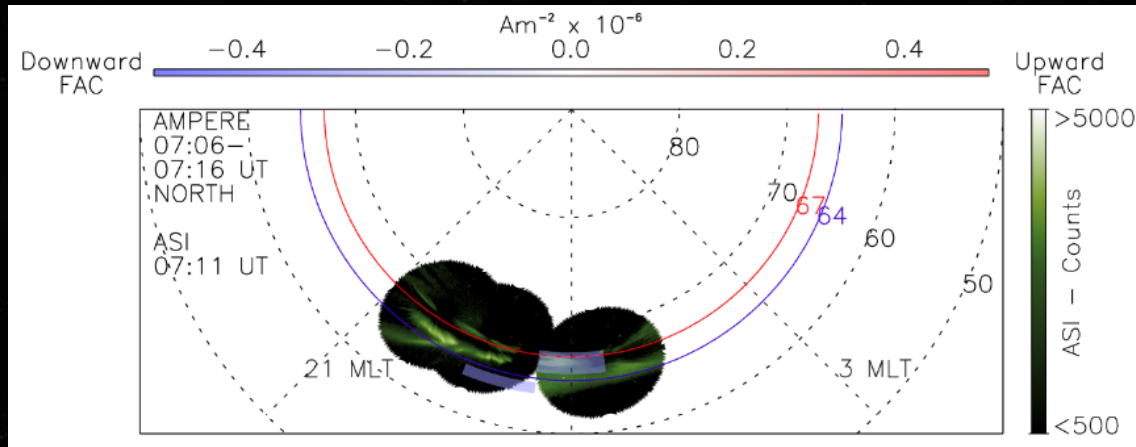
Expansion Phase



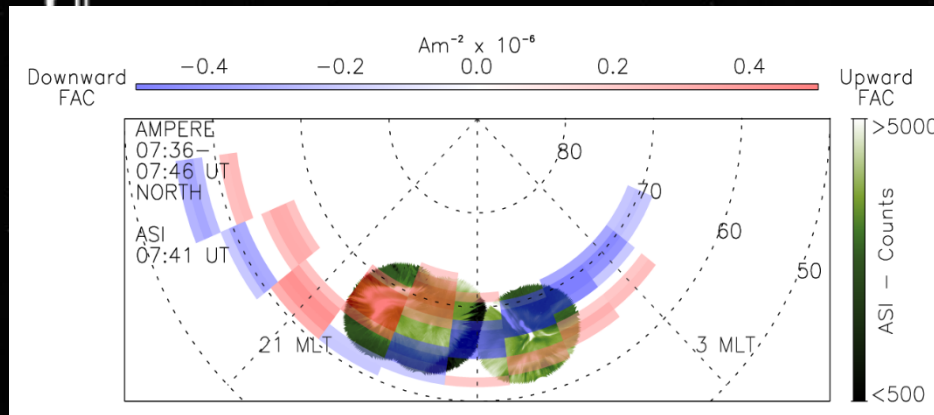
FACs – Expansion Phase



Reduction in FAC

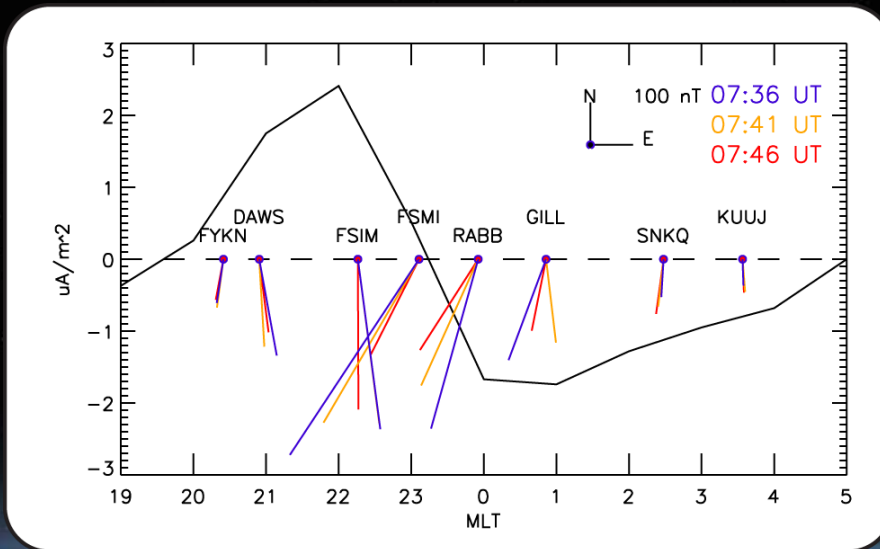
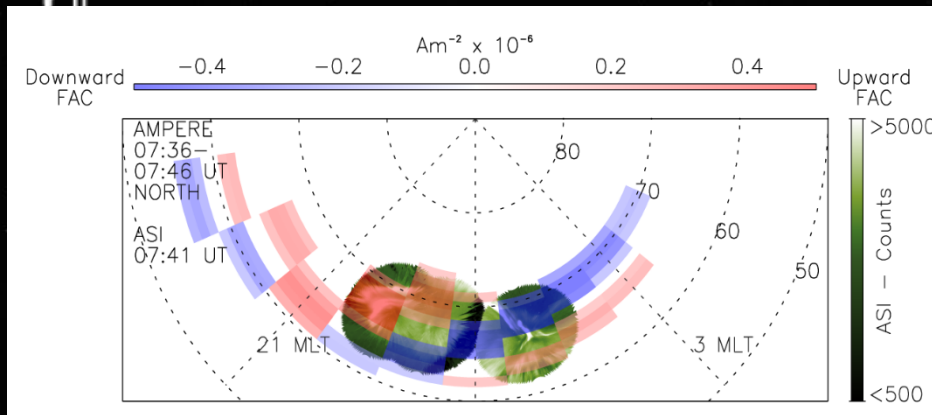


The Substorm Current Wedge



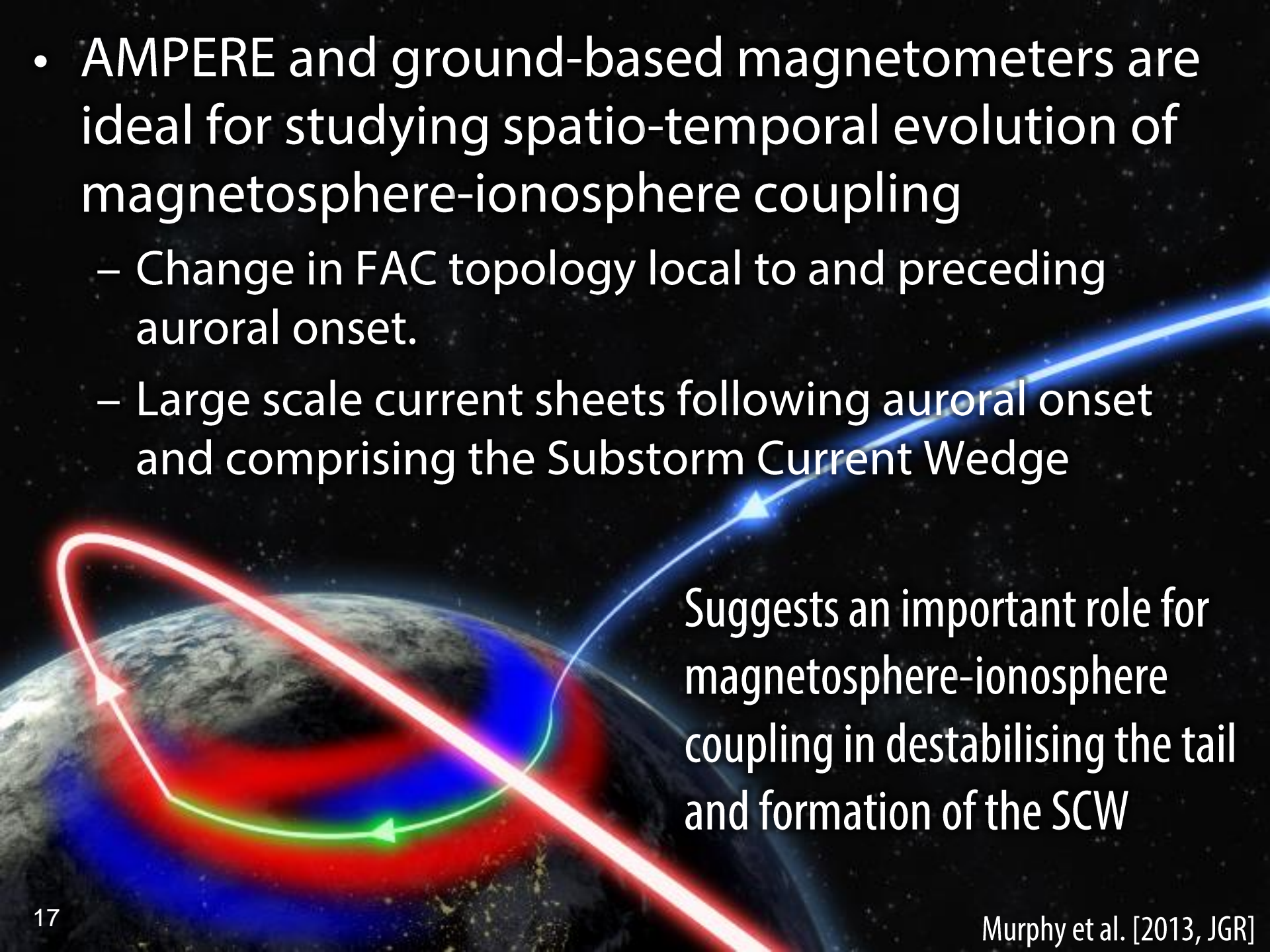
- Upward FAC region associate with westward traveling surge

The Substorm Current Wedge



- Upward FAC region associate with westward traveling surge
- Structured FACs
- Integrated structure consistent with SCW [McPherron et al. 1973]
 - Downward FAC in the east
 - Upward FAC in the west
 - Enhanced bipolar east-west magnetic bays

- AMPERE and ground-based magnetometers are ideal for studying spatio-temporal evolution of magnetosphere-ionosphere coupling
 - Change in FAC topology local to and preceding auroral onset.
 - Large scale current sheets following auroral onset and comprising the Substorm Current Wedge

A diagram of Earth's magnetosphere showing current sheets and auroral arcs. The Earth is shown on the left, with a red and blue auroral oval. A large red current sheet is shown in the magnetosphere, and a blue current sheet is shown in the tail. A green current sheet is shown in the ionosphere. A blue arc is shown in the tail, and a red arc is shown in the ionosphere. The background is a starry space.

Suggests an important role for magnetosphere-ionosphere coupling in destabilising the tail and formation of the SCW

A photograph taken from the International Space Station (ISS) showing the Earth's horizon and the aurora borealis (Northern Lights) in shades of green and purple. The solar panels of the ISS are visible on the right side of the frame.

THANK YOU

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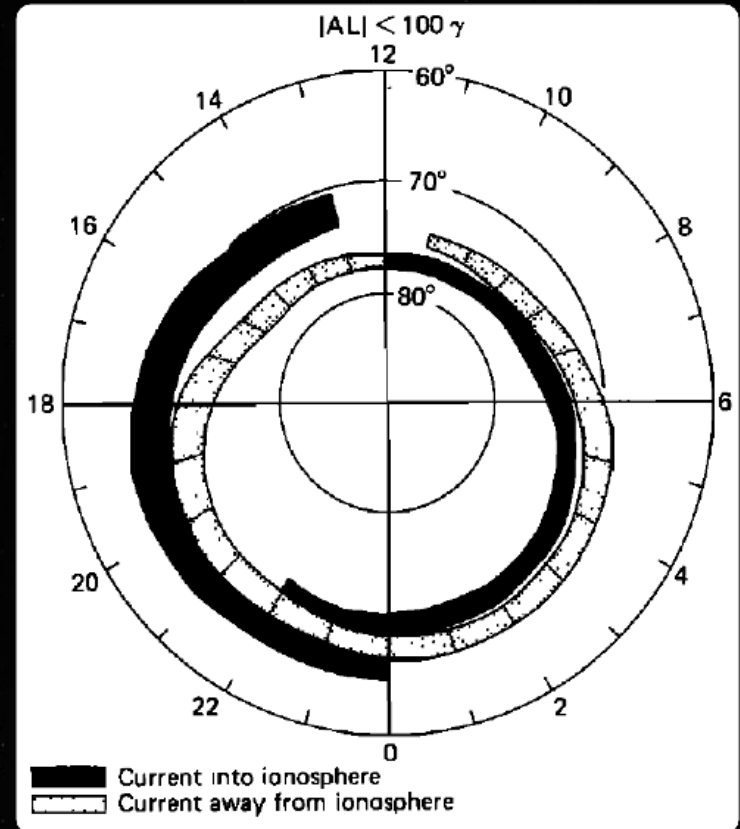
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Field Aligned Currents

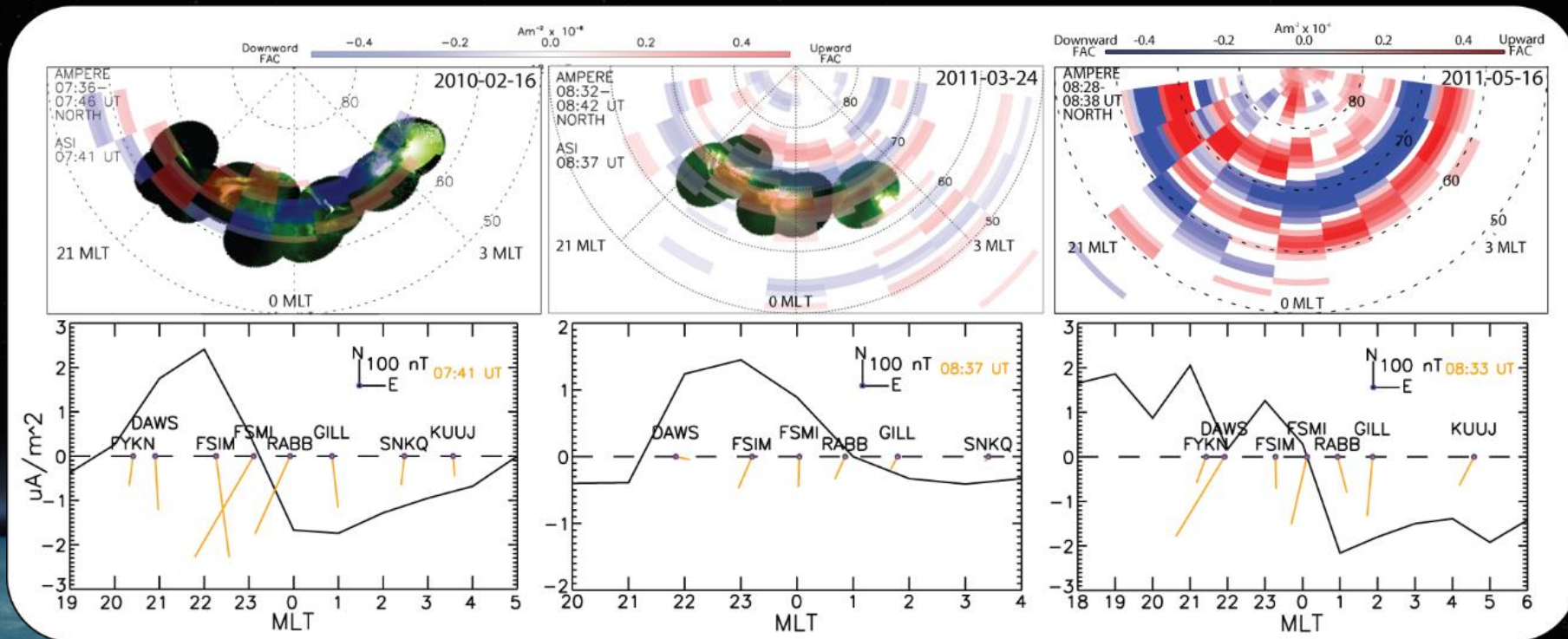
- Responsible for coupling the ionosphere and magnetosphere
- Historically inferred by single point measurements



[Iijima and Potemra, 1978]

The Substorm Current Wedge

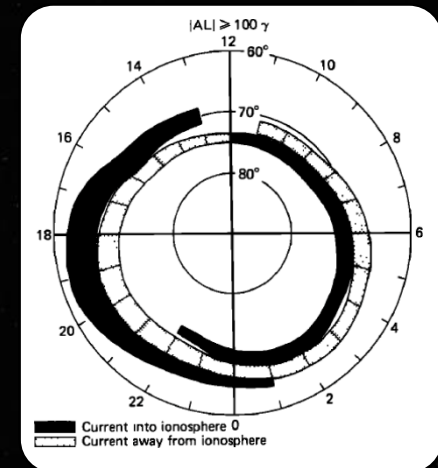
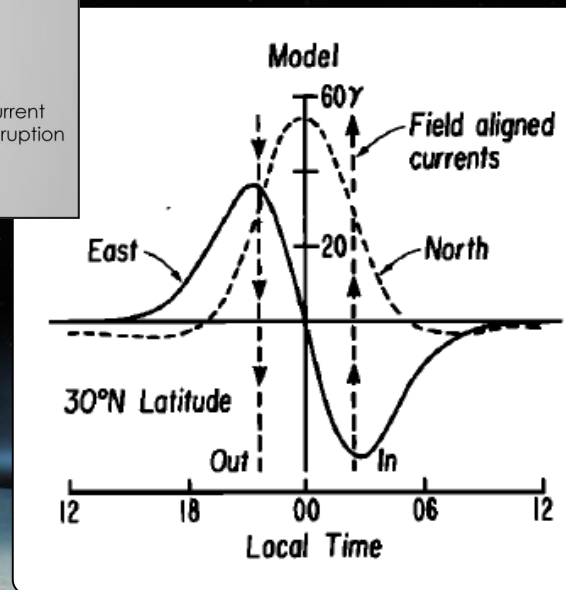
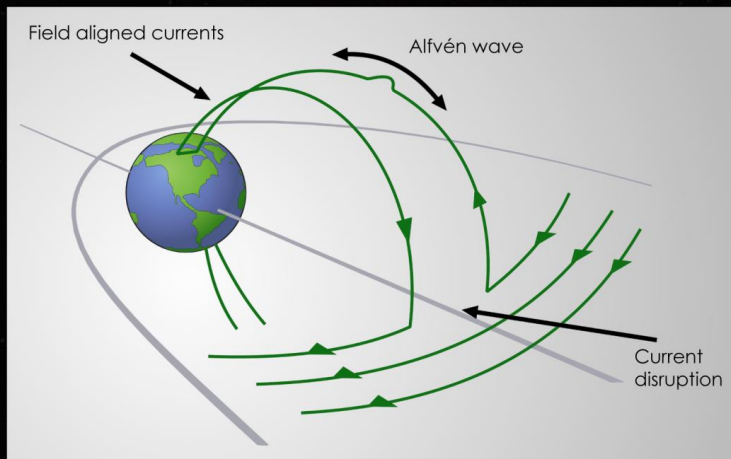
- Structured FACs observed during multiple substorms
- Consistent with the McPherron et al. [1973] SCW
- Demonstrates regions of downward FAC are associated with discrete aurora



C. 2D SCW structure

Murphy et al. [2013, *accepted*]

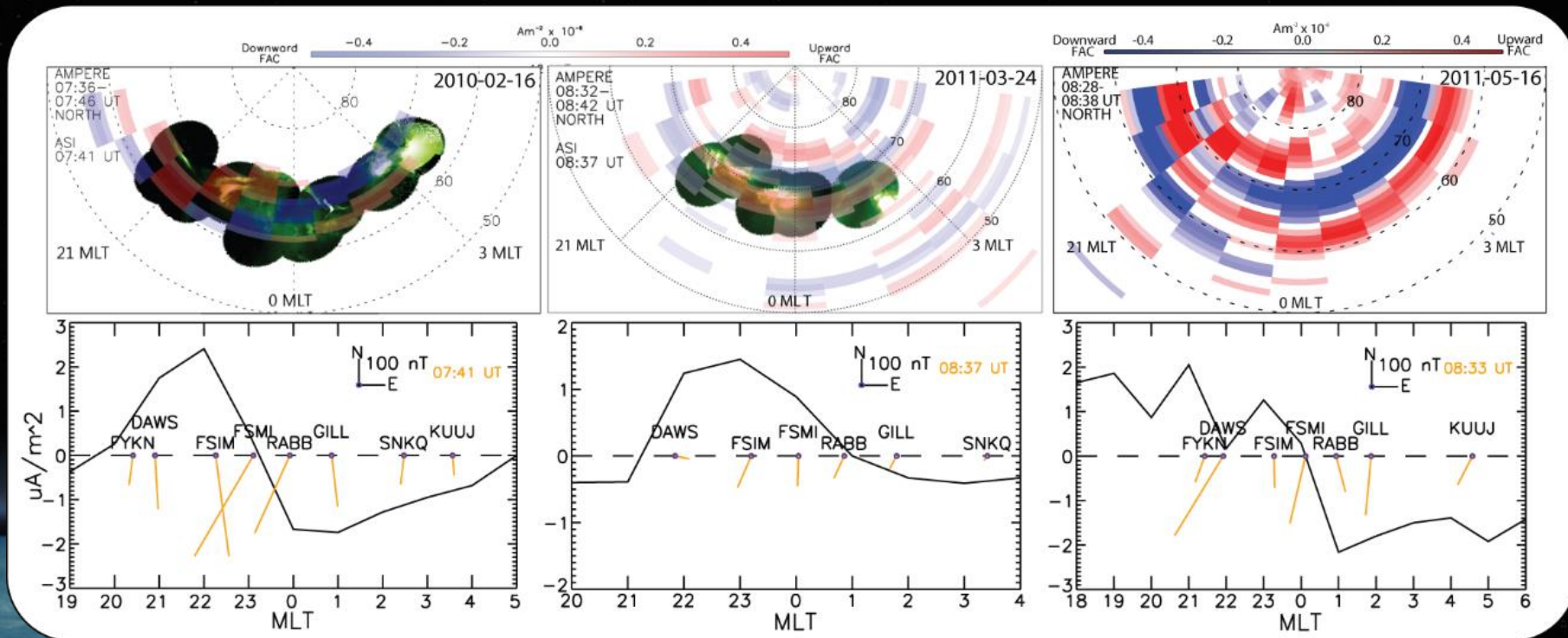
- First 2-Dimensional Structure of FACs and SCW



[Iijima and Potemra, 1978]

C. 2D SCW structure

Reveals new and complex two-dimensional structure of the SCW



Reduction in FAC

- Change in FAC topology local to and preceding auroral onset.
- Only *7 minutes later* does the aurora break-up and the geosynchronous field dipolarise.
 - Suggests an important role for magnetosphere-ionosphere coupling in destabilising the tail.

