A Brief History of “Patches”

An Introduction to Polar Cap Patches

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CEDAR – What is a patch? – 6/12/2024

A Brief History of "Patches"

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Why do we care about plasma density variations/structures?

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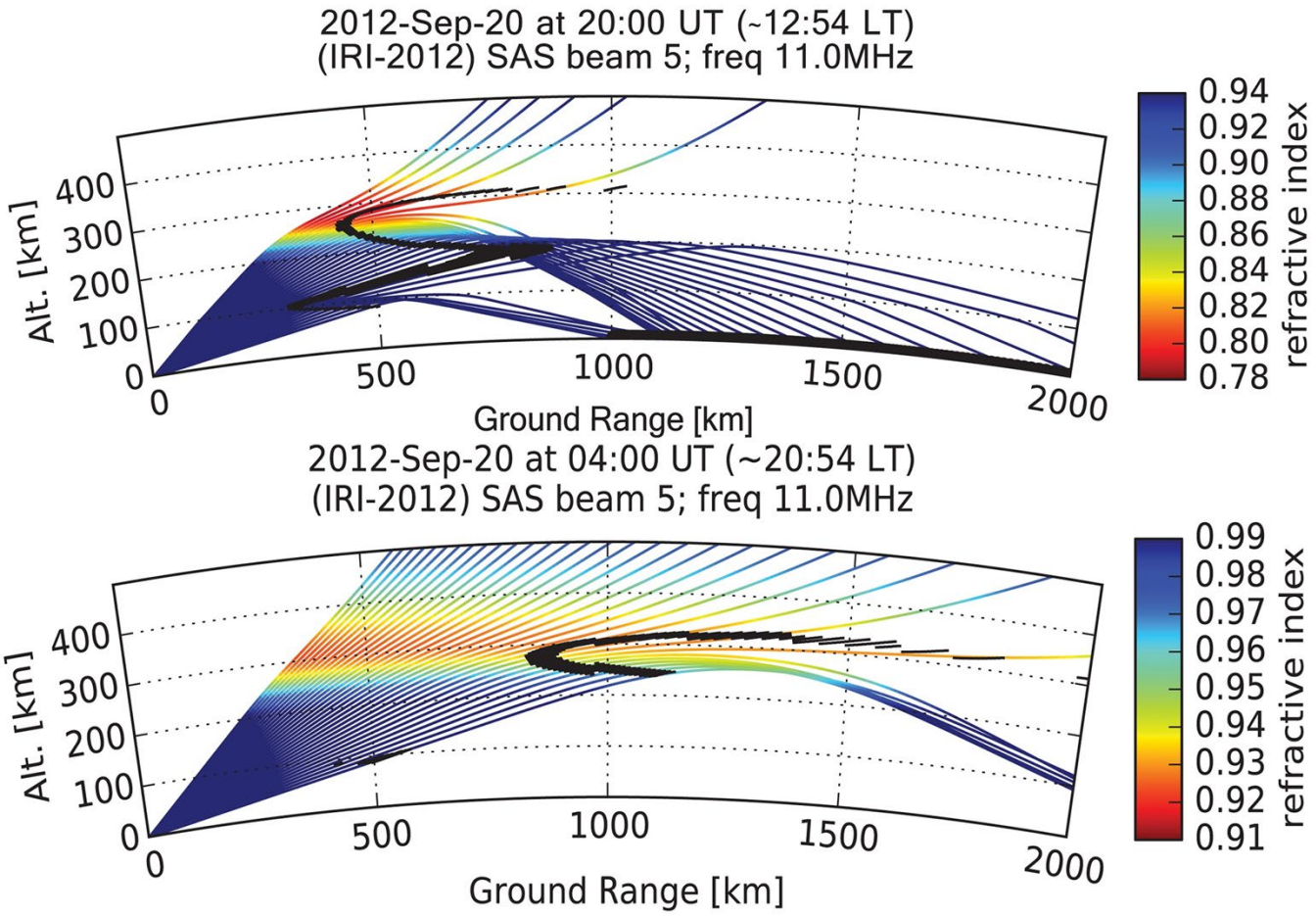
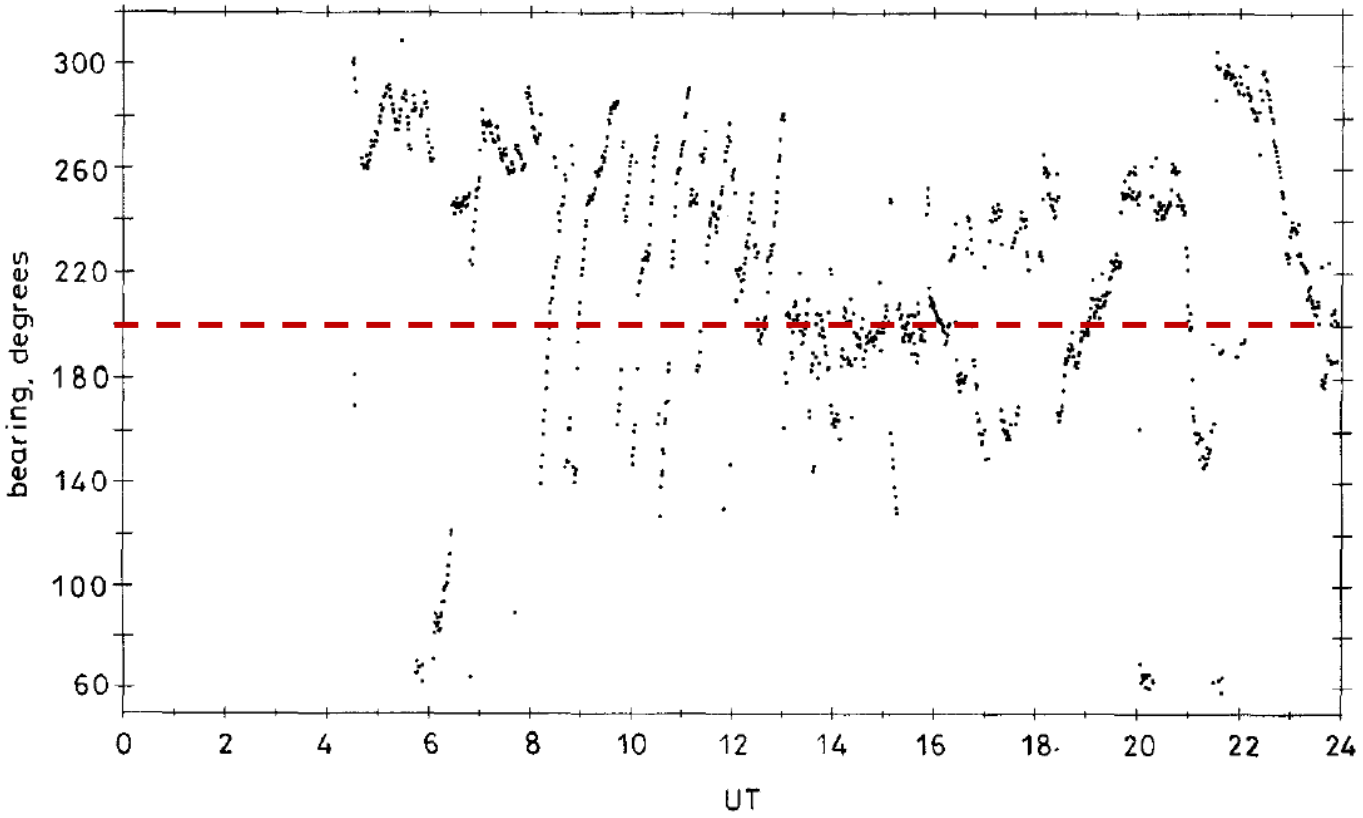


Greenwald et al. [2017]

Plasma density “irregularities” can change radio propagation paths by changing the index of refraction of the atmosphere.

Bearing angle of communication link from Qaanaaq to Alert



Warrington et al., [1997].

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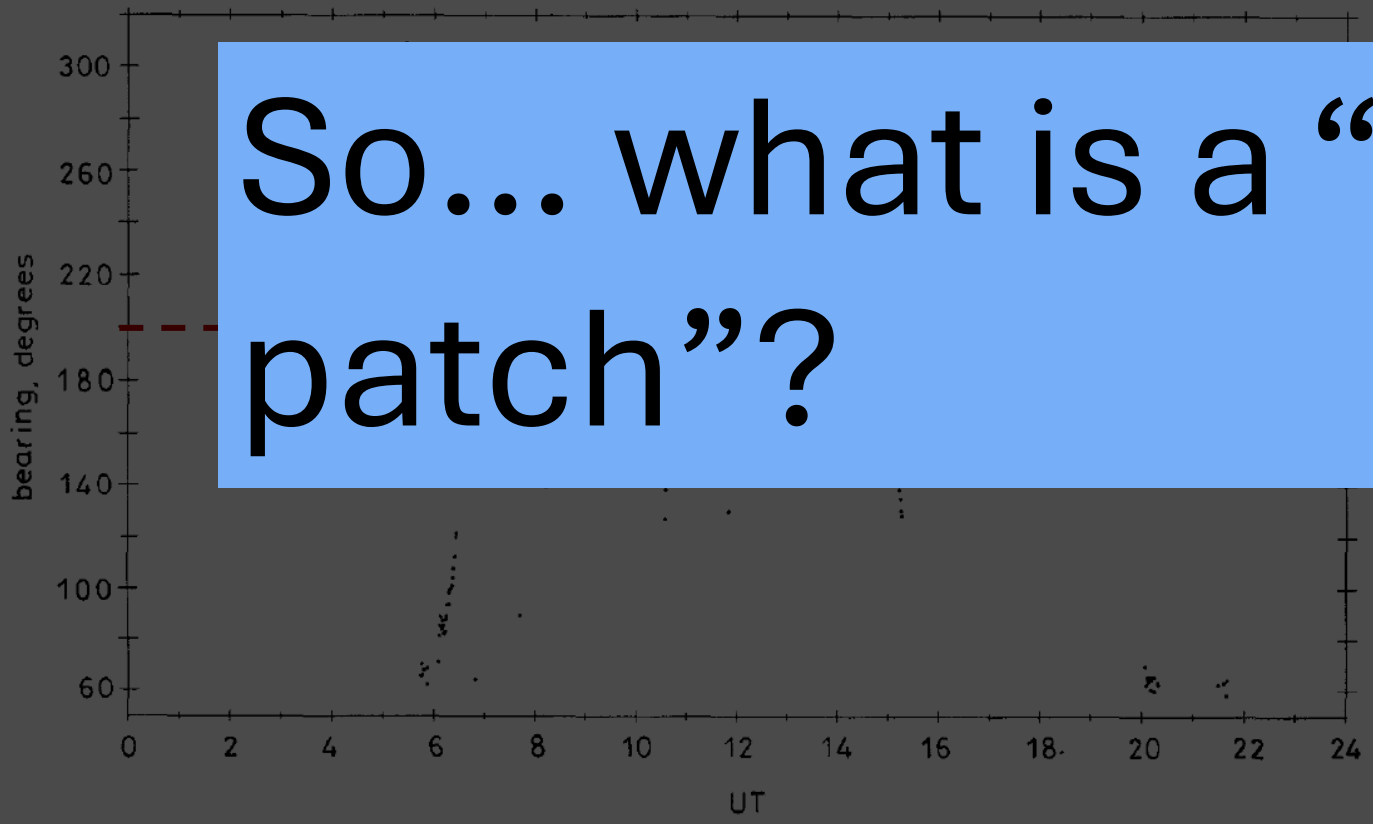
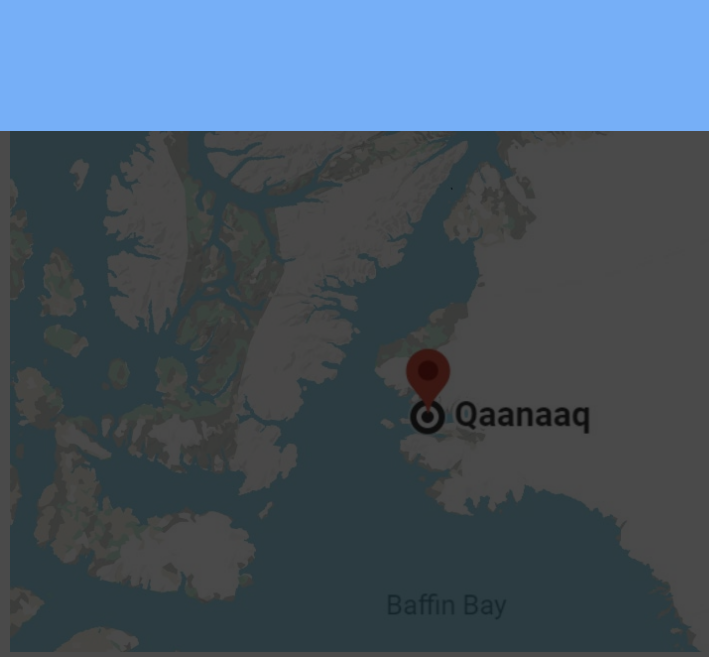
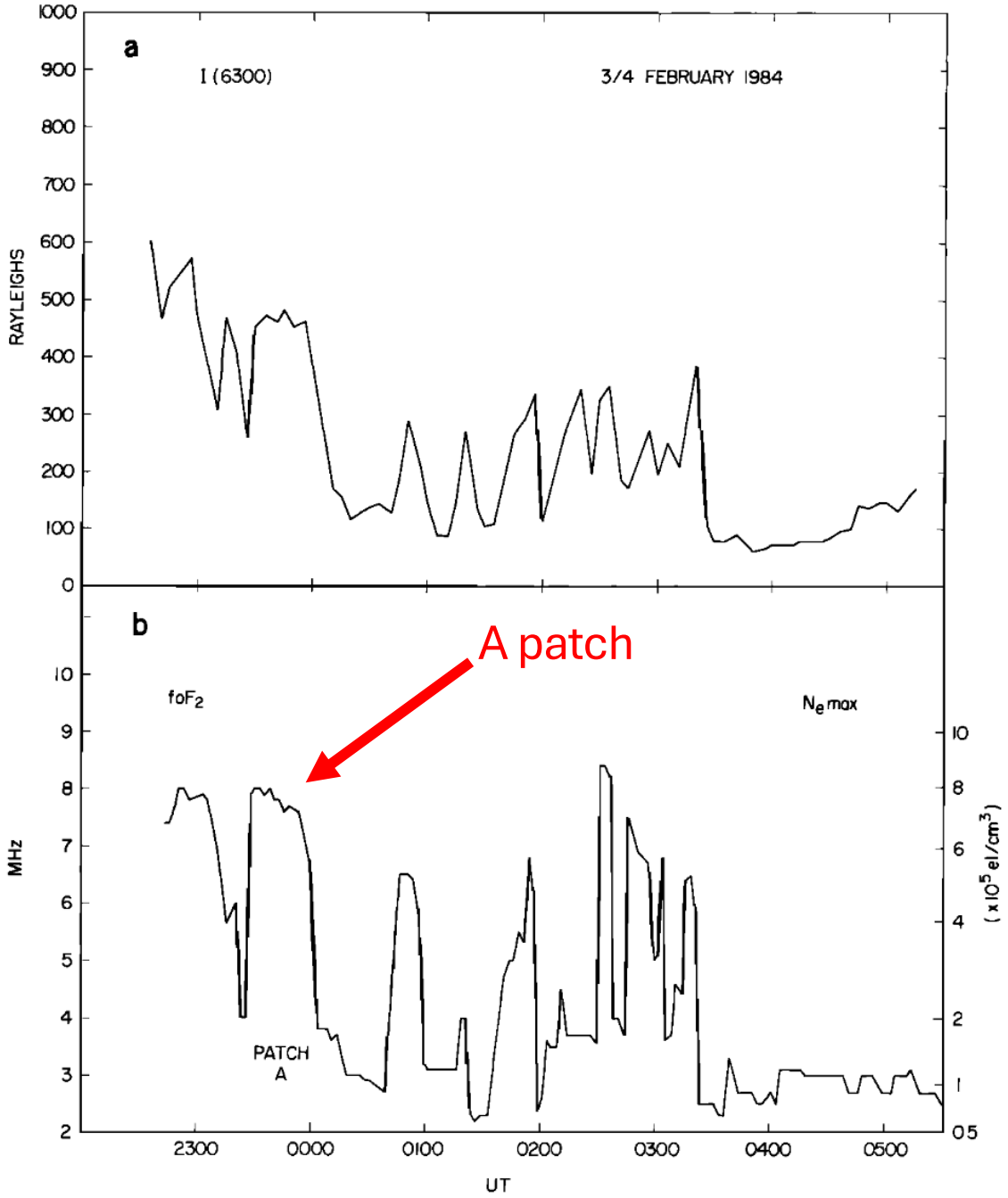


Warrington et al., [1997].

"Irregularities" can change radio propagation paths by changing the index of refraction

So… what is a "polar cap patch"?

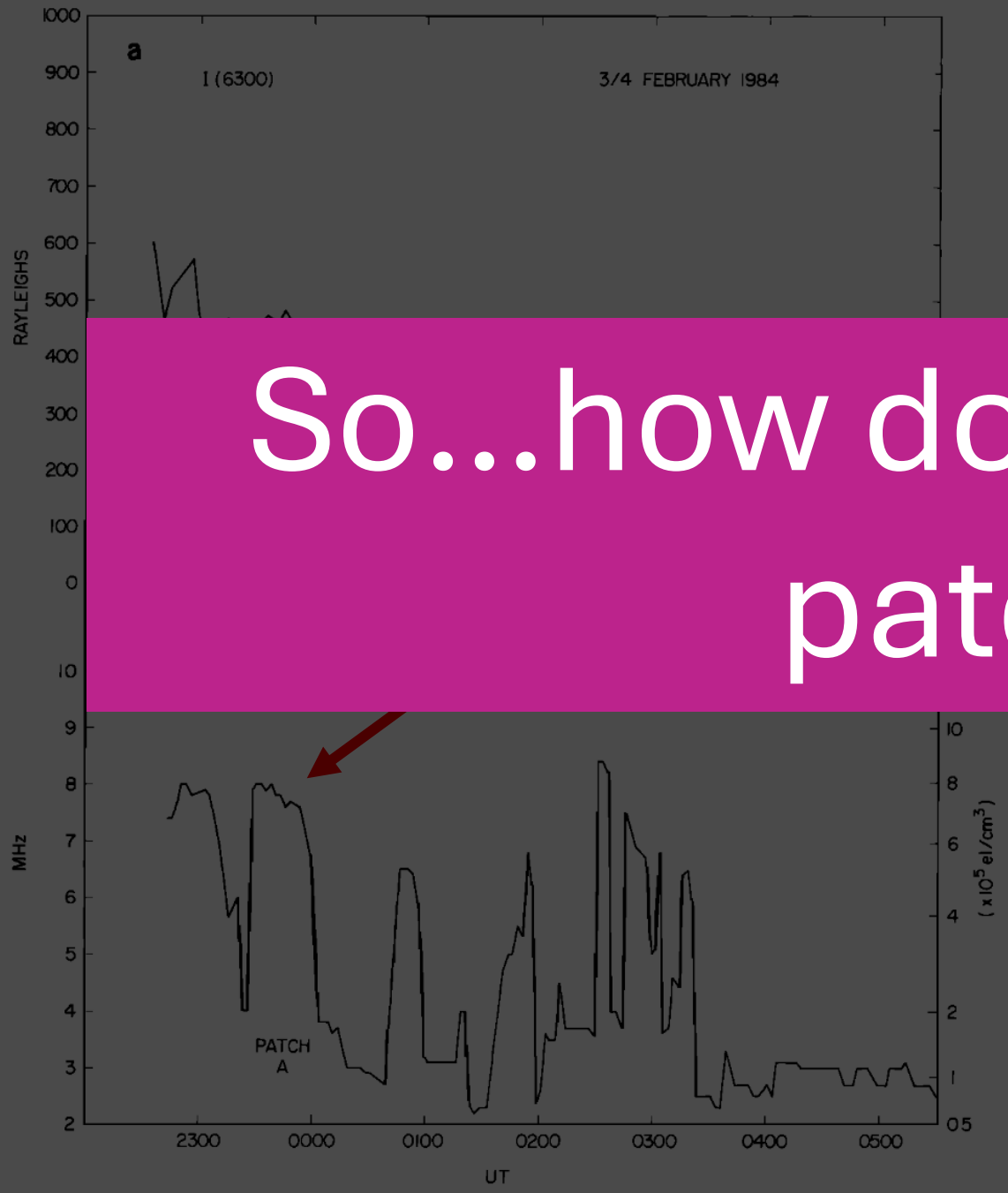




A “polar cap patch” is a plasma density irregularity that occurs in the polar cap.

It needs to have a plasma density at least twice the “background” [Crowley et al., 1996].

Weber et al., [1986]



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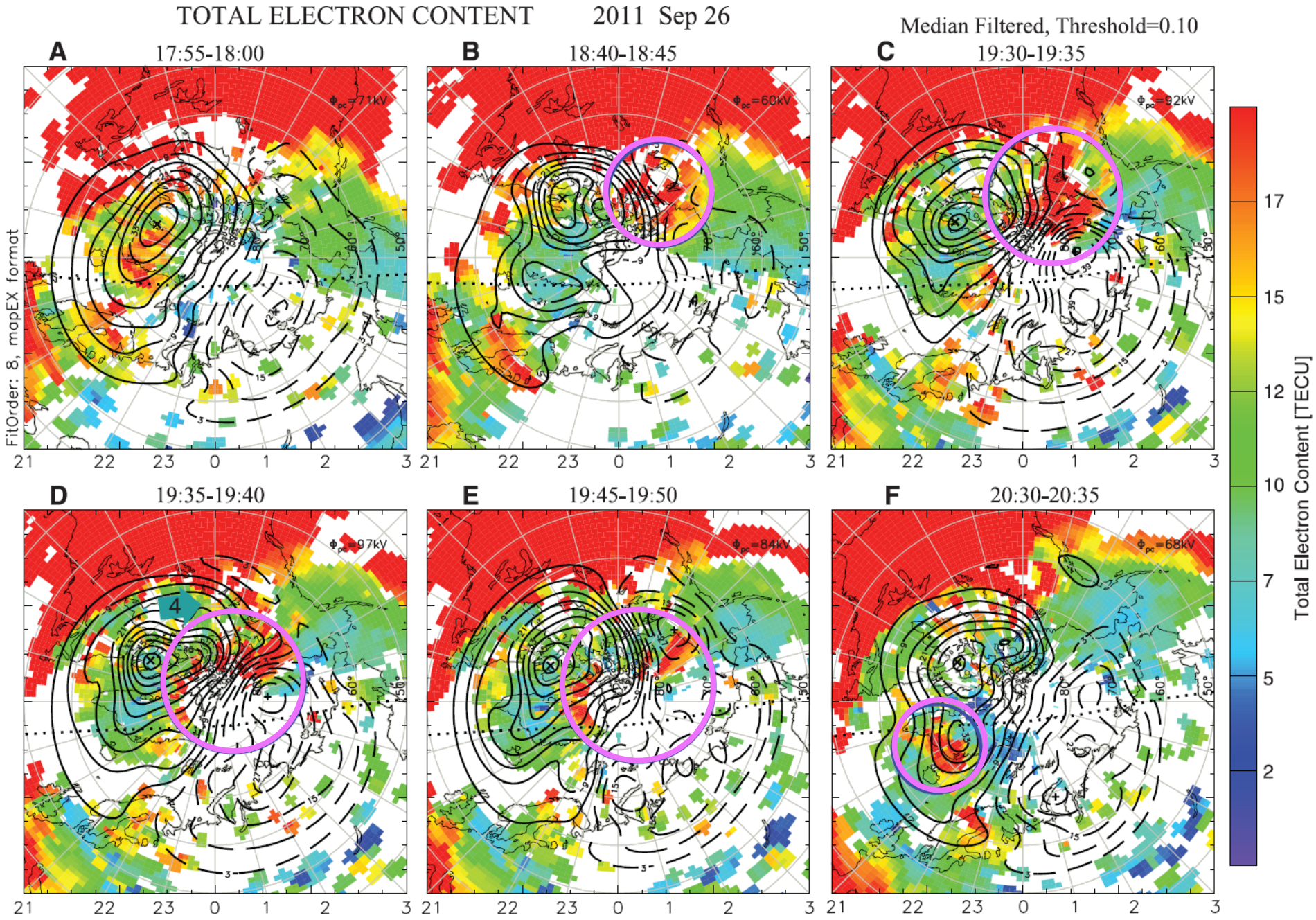
So…how do we make a patch?

Weber et al., [1986]

Plasma density enhancements are transported through the high-latitude ionosphere via plasma convection streams.

Relatedly, plasma from “tongues of ionization” can be chopped into patches.

Zhang et al., [2013]



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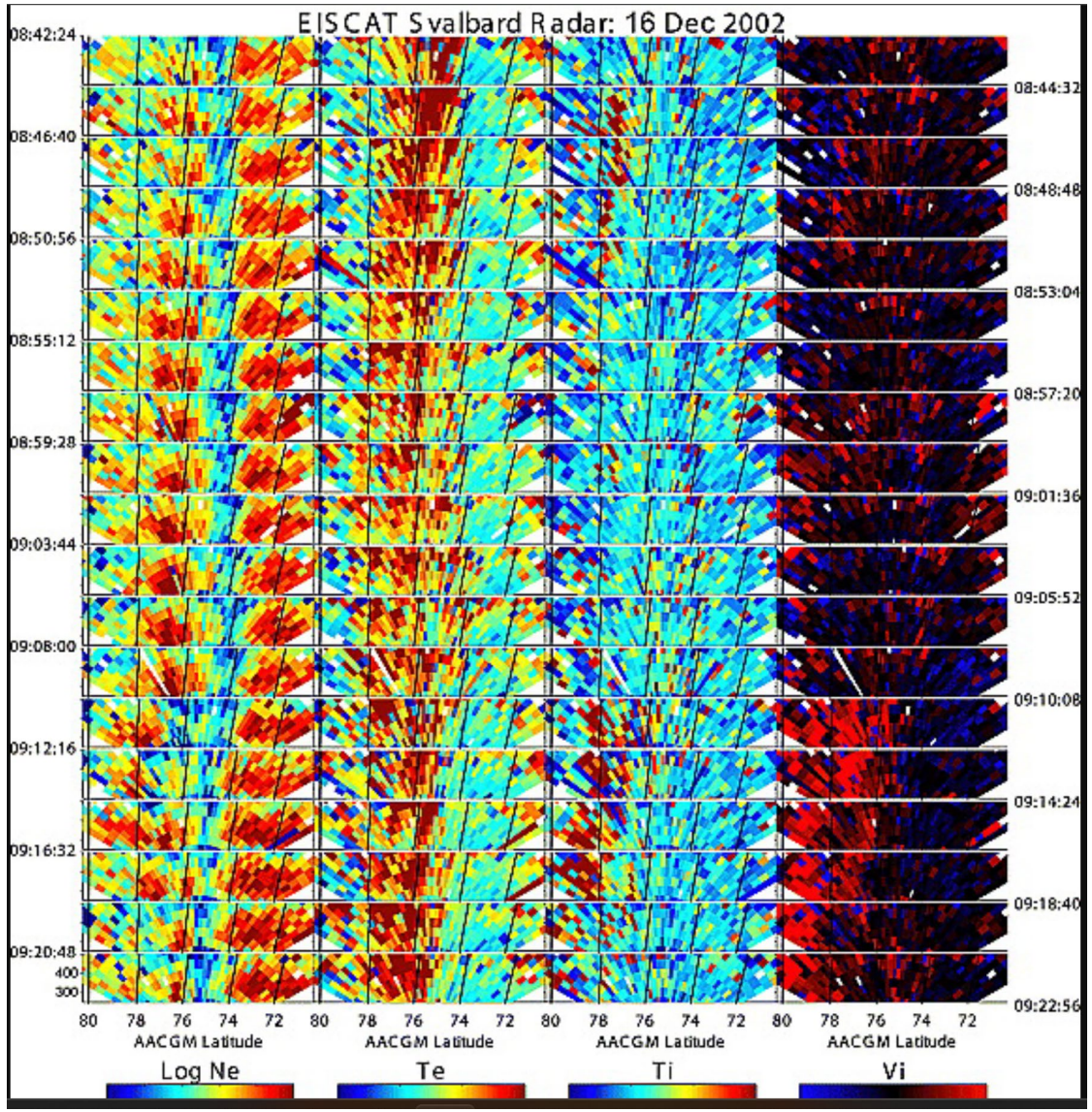
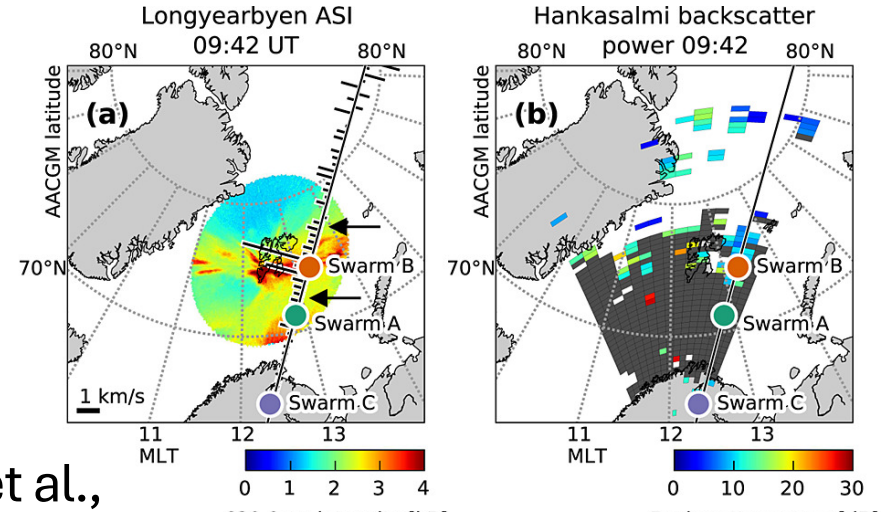
or……

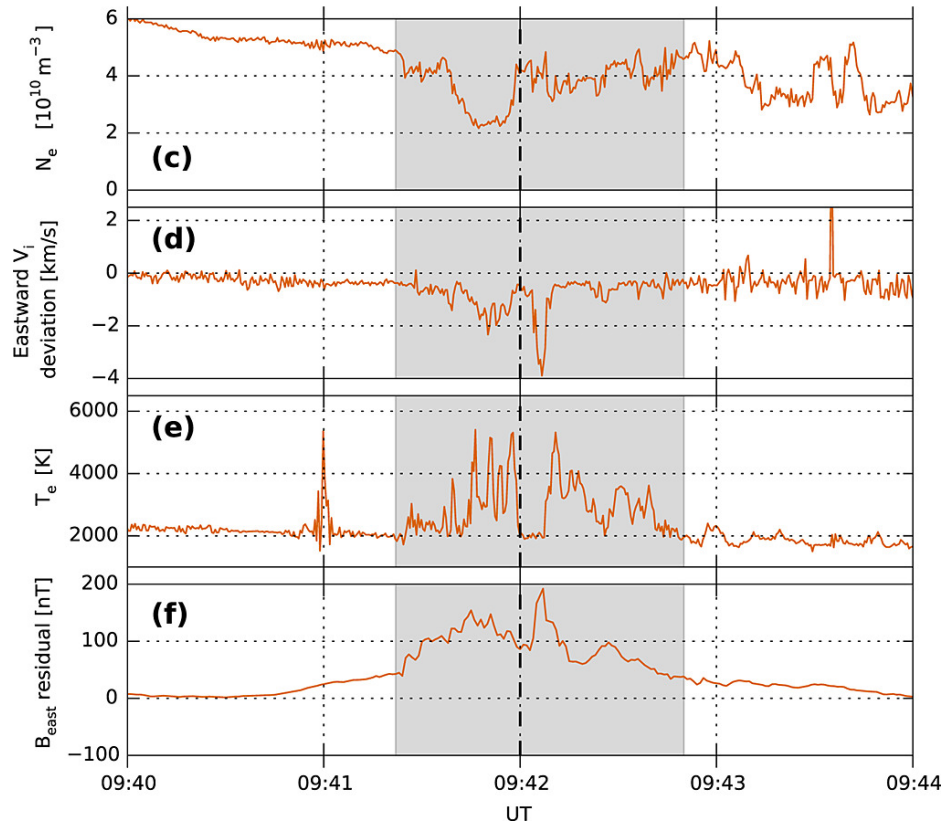
Patch initialization via precipitation.



Oksavik et al., [2006]



Goodwin et al., [2015]



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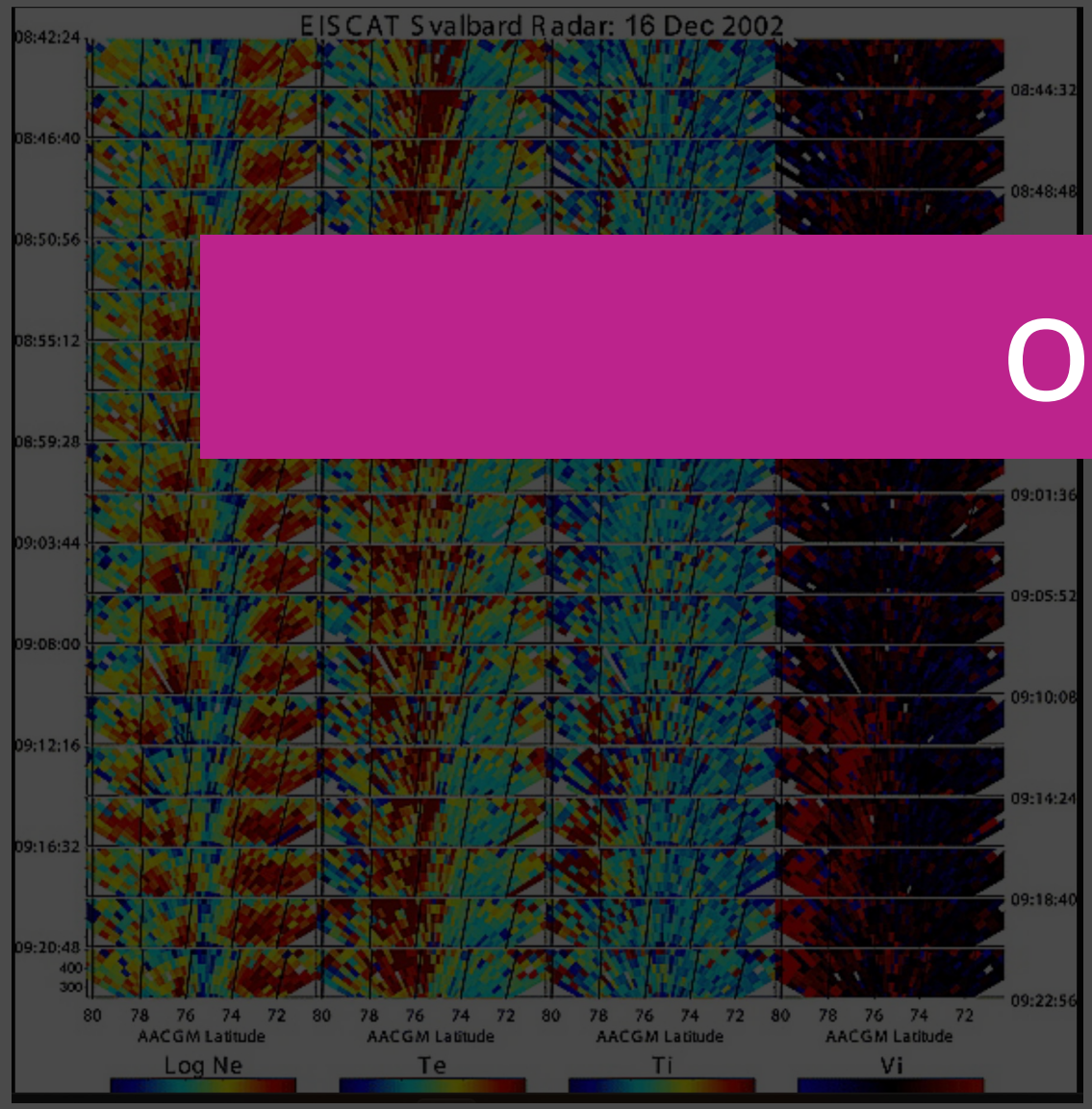

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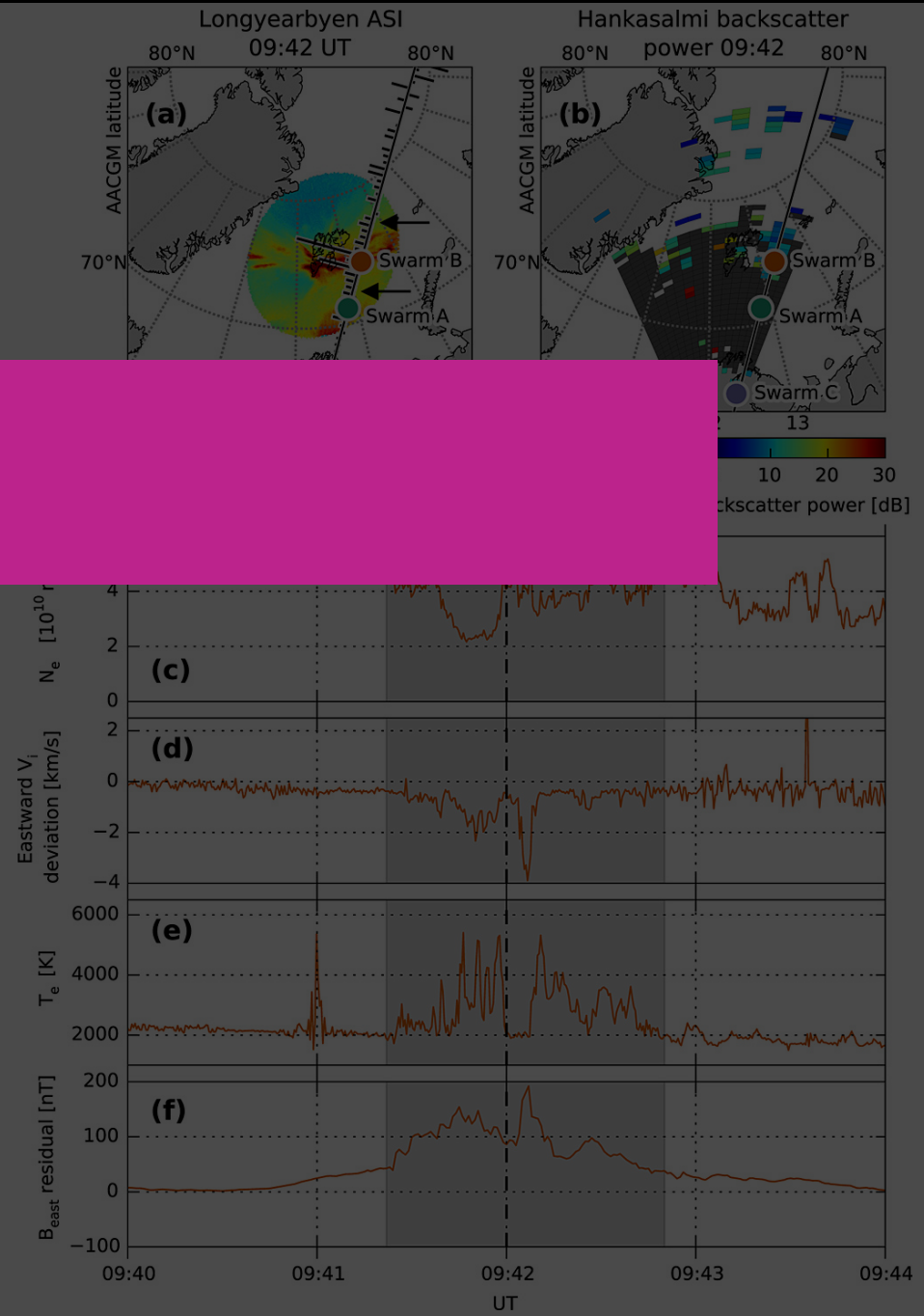
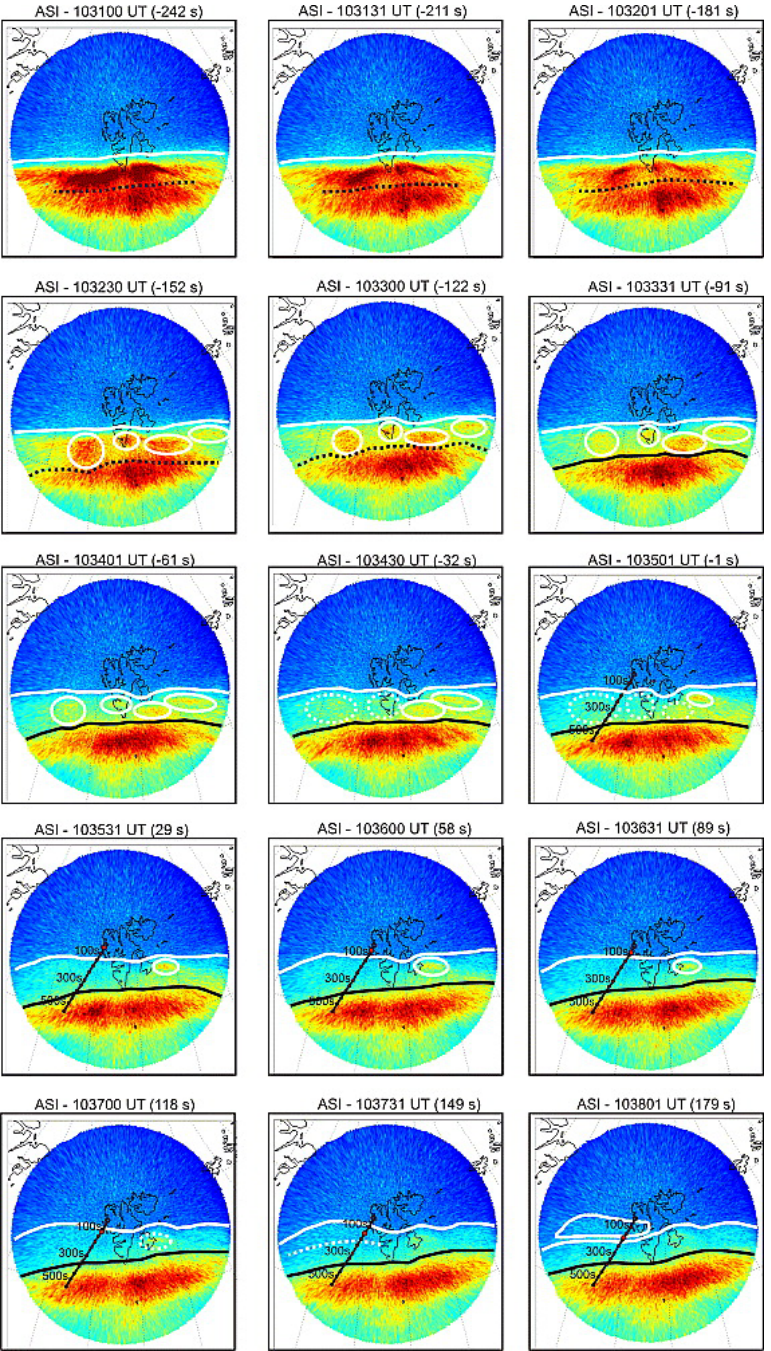
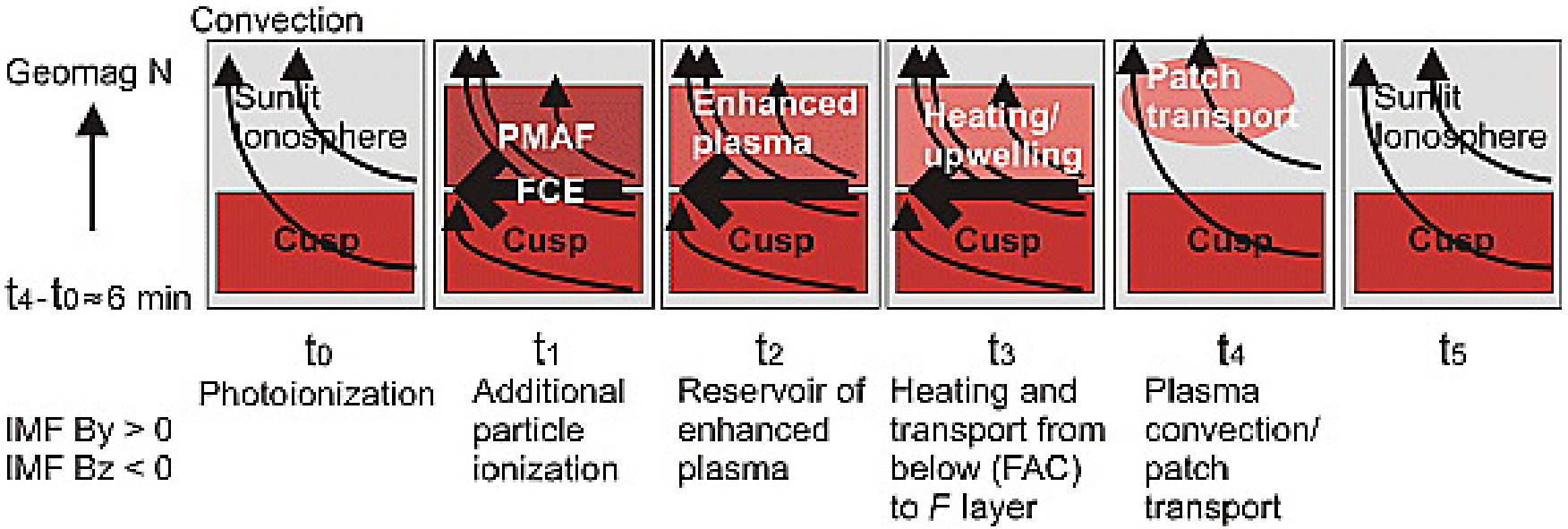
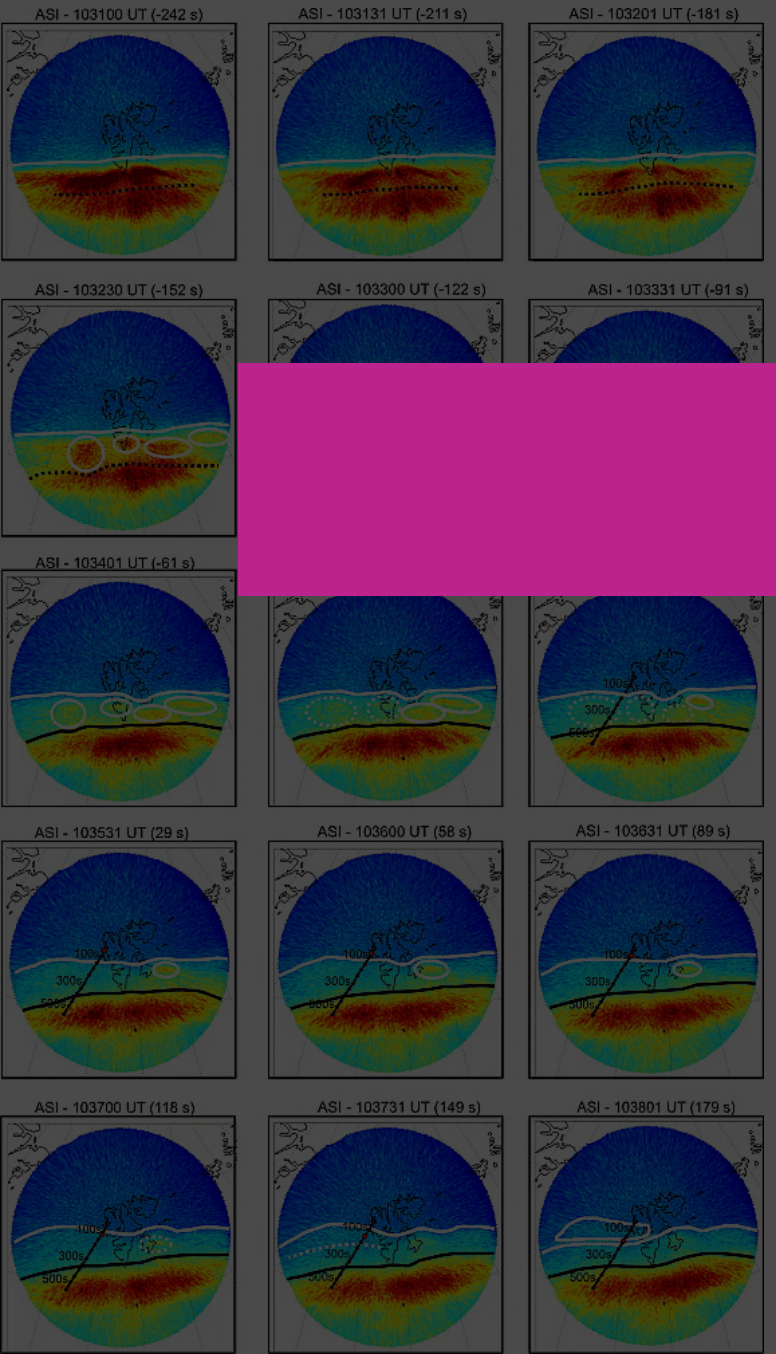




Poleward-Moving Auroral Forms (PMAFs) can evolve into patches.



Lorentzen et al., [2010]



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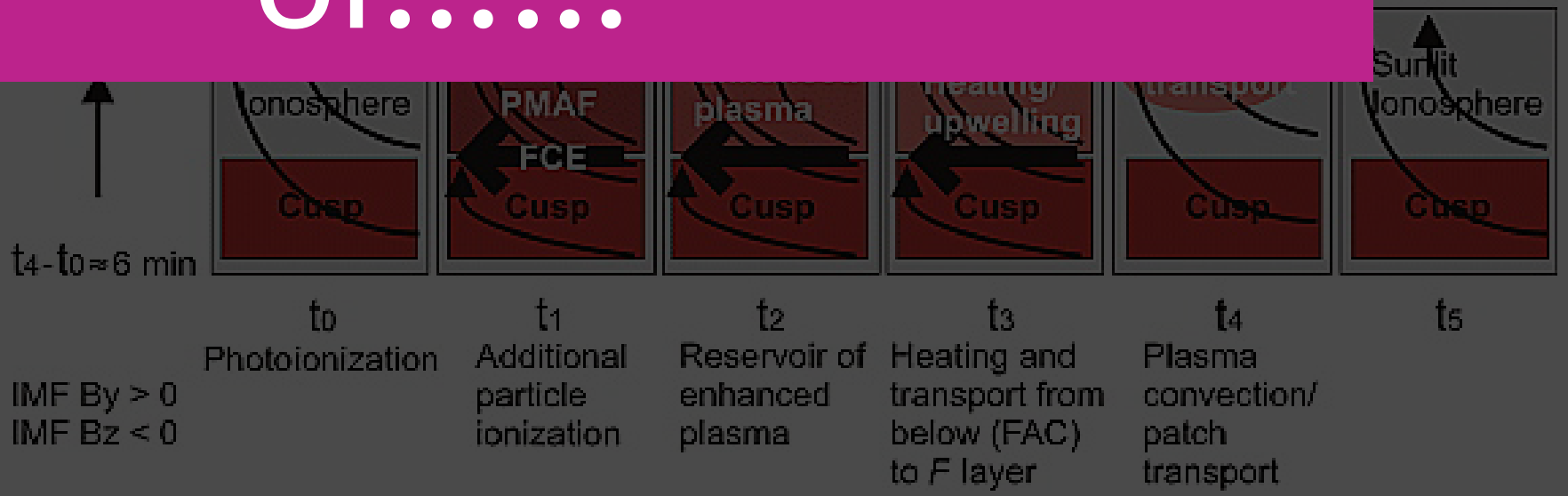

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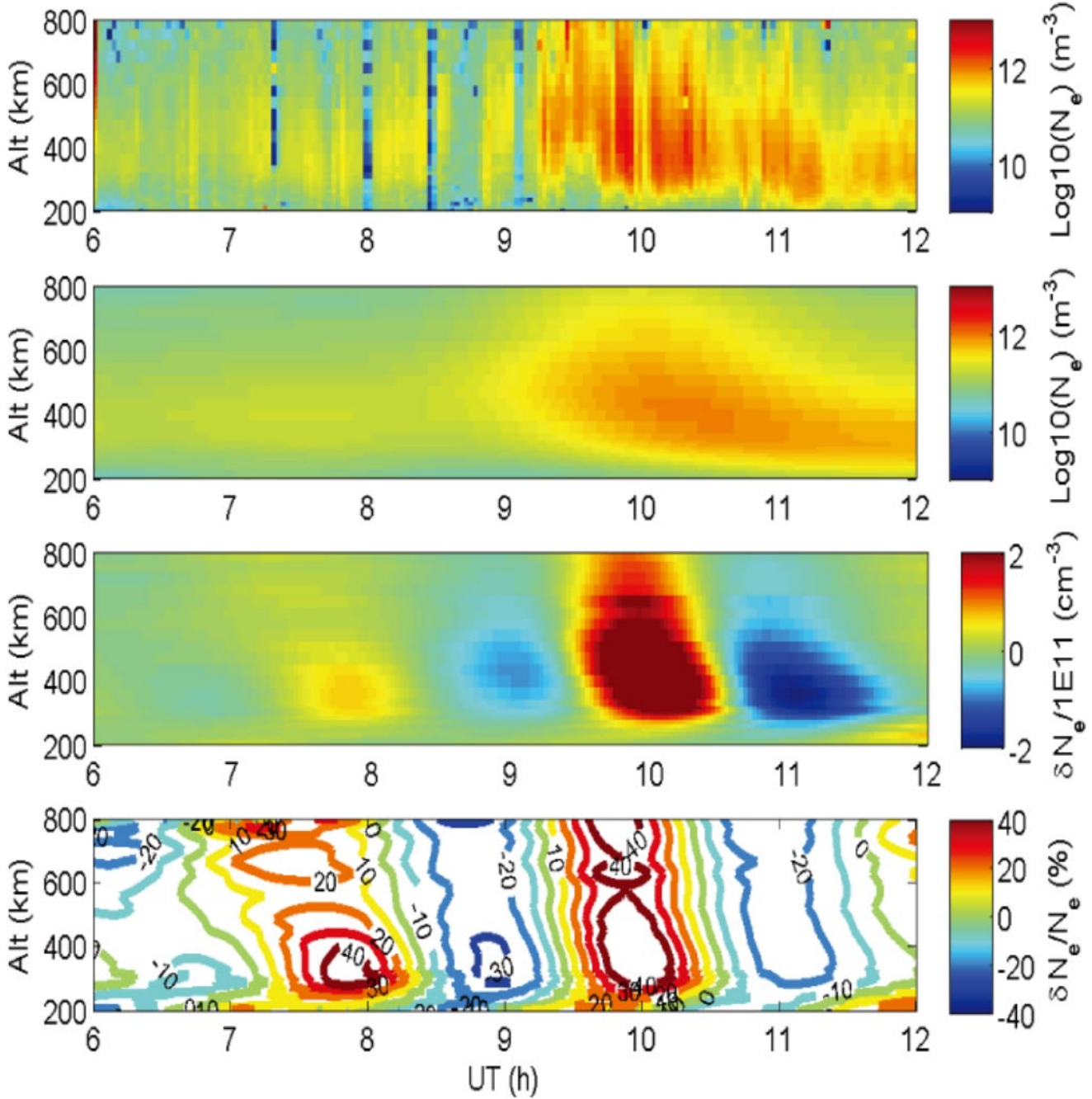
Waves (such as atmospheric gravity waves/traveling ionospheric disturbances) can propagate into the polar cap, creating plasma density variations.



Cai et al., [2011]

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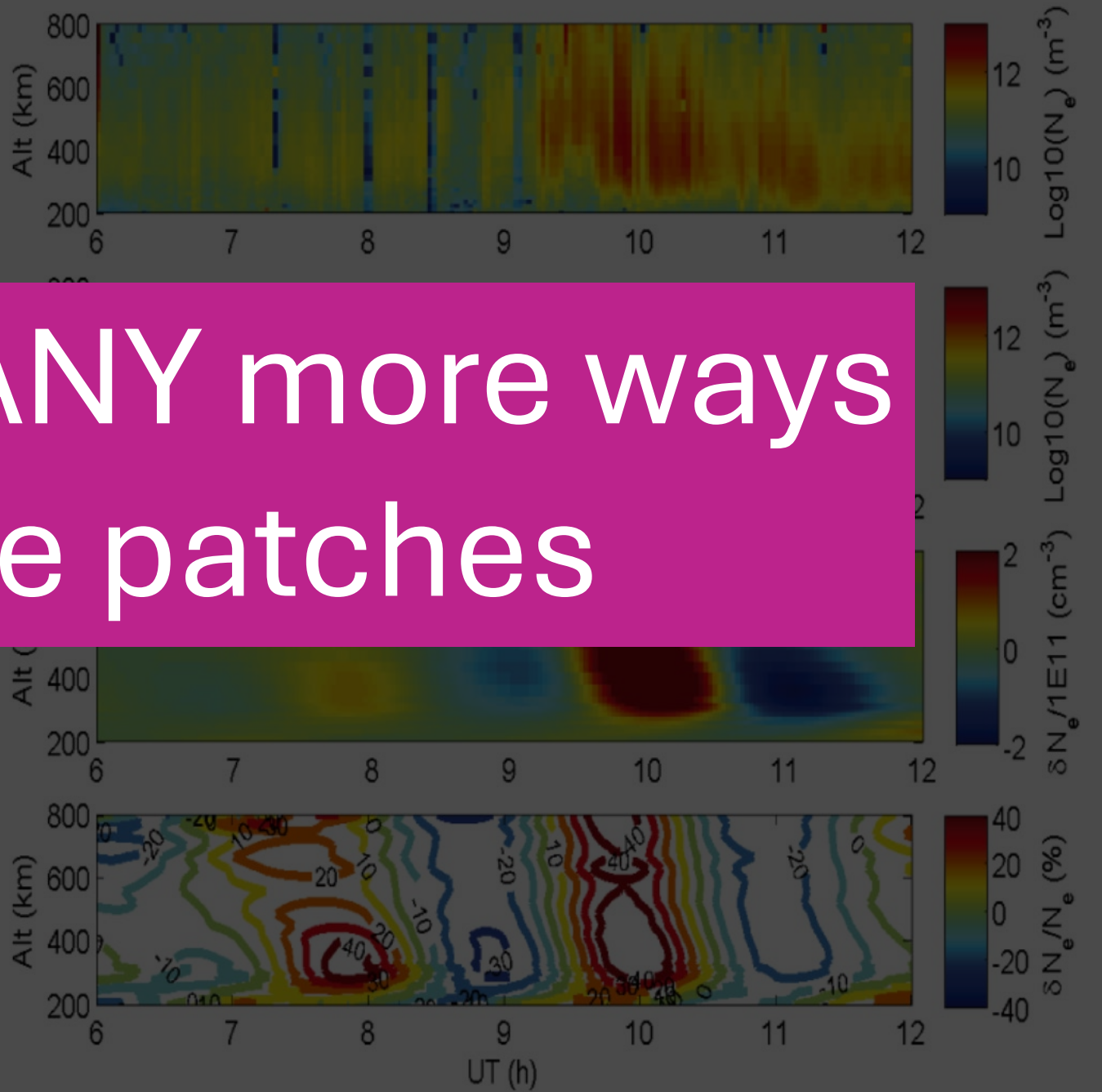
There are MANY more ways to create patches



Cai et al., [2011]

Patch problems:

- If there are so many different ways that patches can be created, is it fair to group them together?
  - Should patches generated from “coupling from below” be grouped with patches generated from “coupling from above”?
  - Should patches with different properties (such as “hot patches” and “cold patches”) be lumped together?
- What is the “background” plasma density?
  - Should we be worried that the “background” depends on the instrument?
  - What happens if the plasma density background is only 1.9 times the plasma density background?
- Are “airglow patches” the same as “patches”?

Do we need an update?