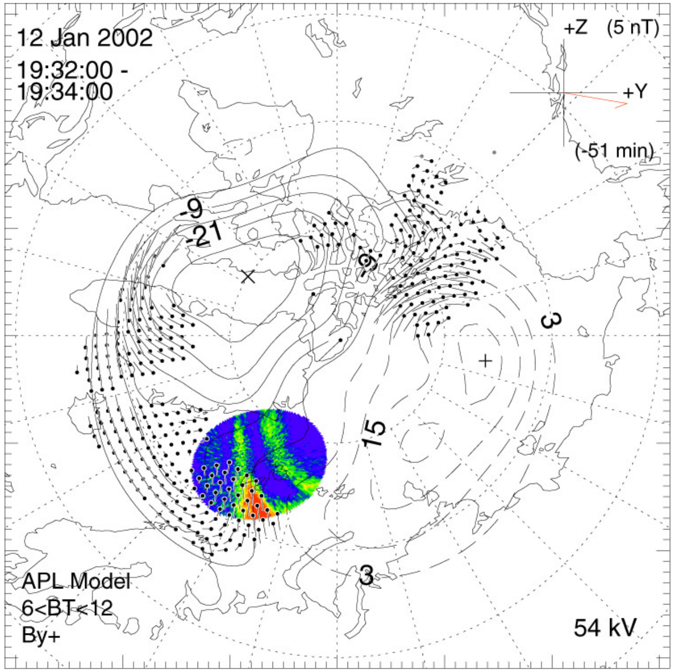
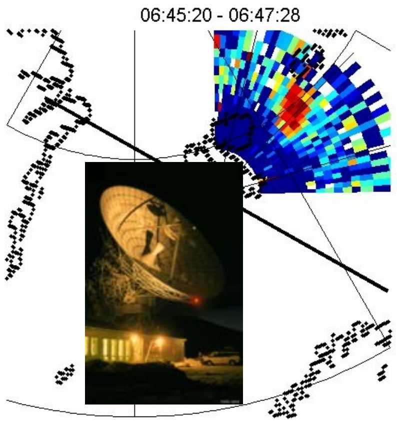
A brief introduction to Polar Cap Patches by Jøran Moen

- **Chapter 4 from the compendium is essential to understand production, loss, and transport of ionospheric plasma!!**
- **Clouds of high electron density form near the cusp inflow region on the dayside. They form and enter the polar cap in association with magnetopause reconnection**
- **Solar EUV ionization is the main production mechanism for high density electron patches. When they enter the polar cap they stay in sharp contrast low-density plasma there**
- **The patches are frozen into the plasma motion (ExB-drift), and convect with the polar cap twin cell flow from day to night.**
- **The patches can be observed by radar and by ground based optics. Recombination of O^+ gives rise to 630.0 and 557.7 nm emissions.**
- **The only way for these patches to exit the polar cap is due to tail reconnection; then they can cross the OCB.**

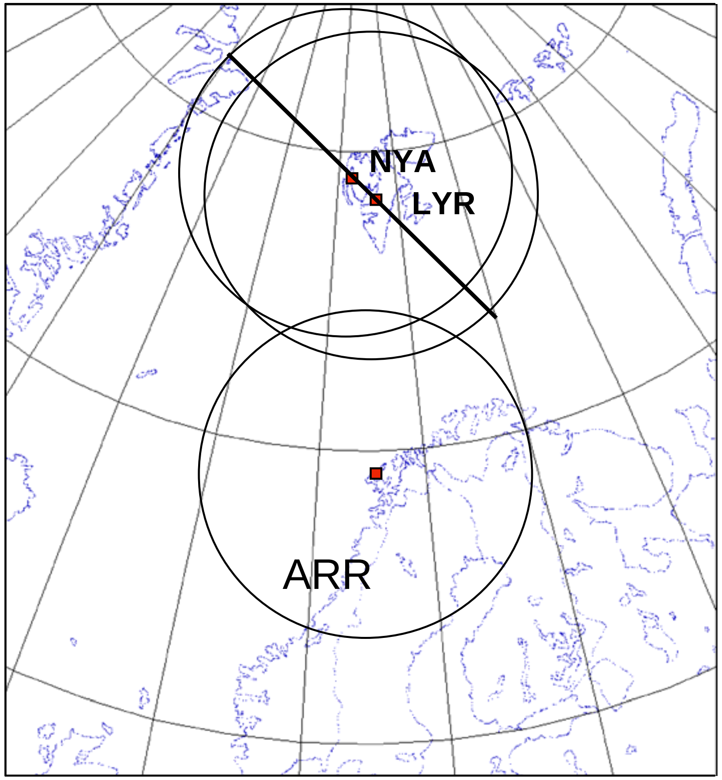
OUTLINE

- Background on polar cap patches
- 630 nm airglow observations in the 18-06 MLT sector
- Combined all-sky and SuperDARN convection maps
- ESR observations of F2-N_{max} variability and relationship to patches

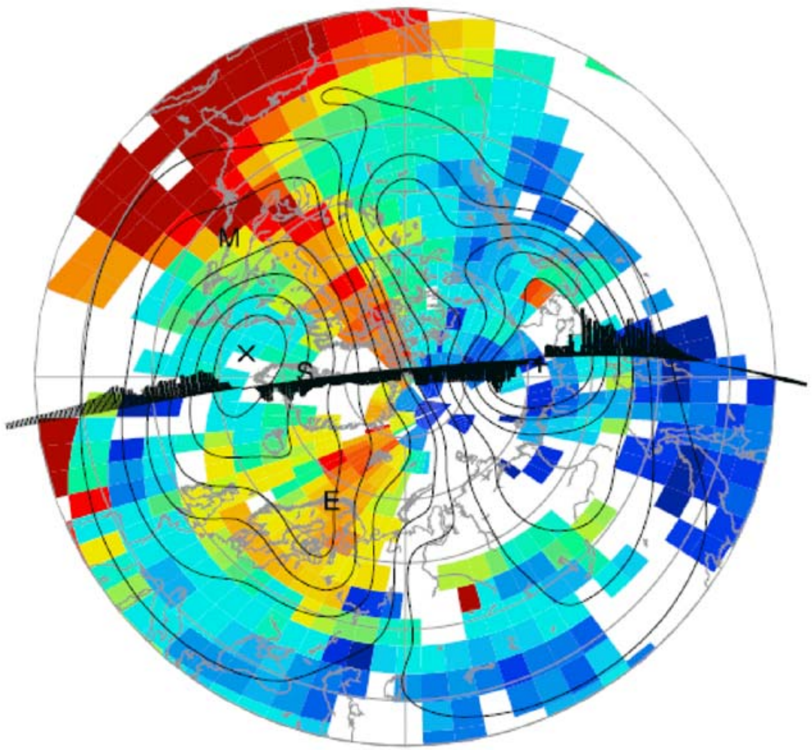




Core instrumentation for UiO patch studies:



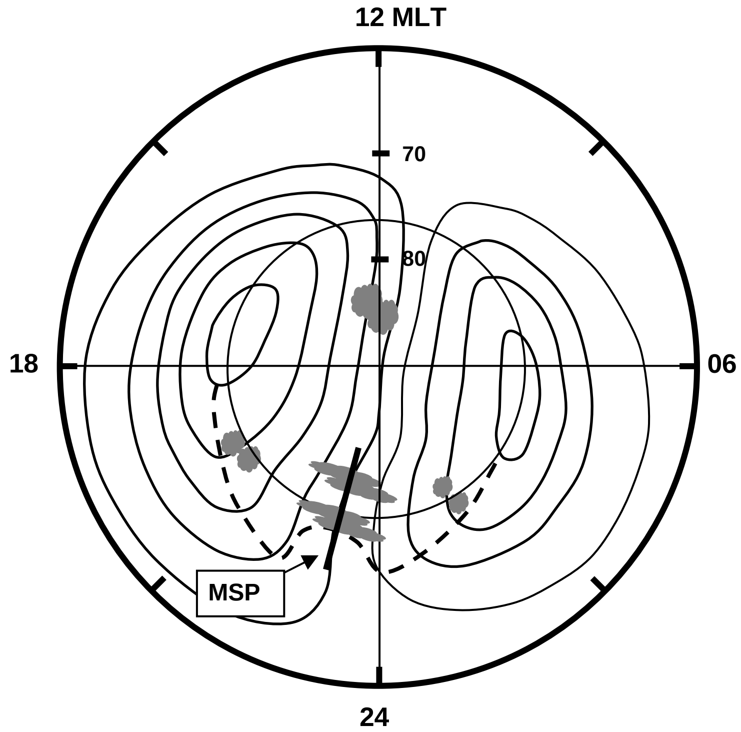
Polar cap patches:

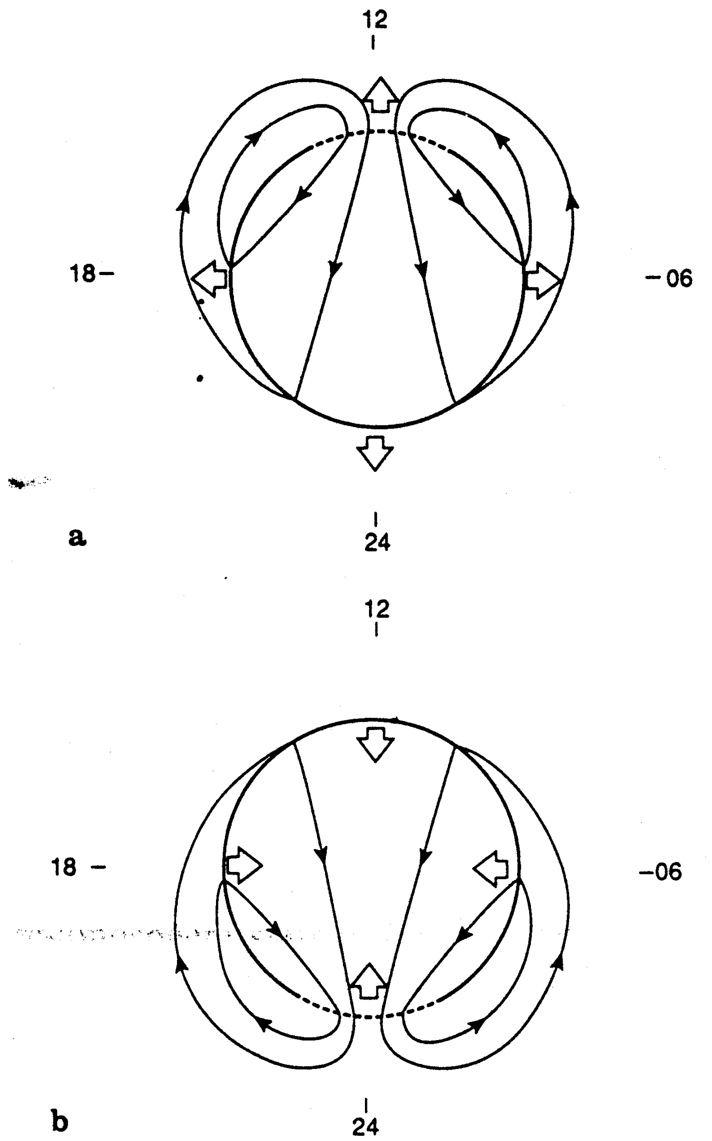


- Major source:
  Solar EUV ionized plasma
- Patch definition by density:
  $N_e = 2 \times N_{eo}$
- By airglow intensity:
  Recombination of O^+
  50R above 630nm background
- Horisontal scale
  100-1000 km
- Altitude of Airglow emissions:
  ~300 km

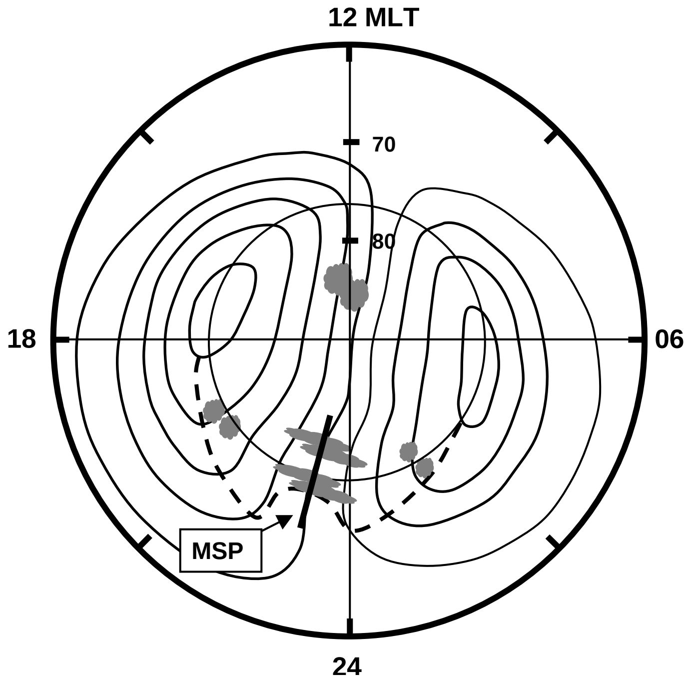
TEC image demonstrating transport of EUV ionized plasma that extends into the polar cap (Foster et al., 2005)

The only way to exit patches from the polar the polar cap is by tail reconnection

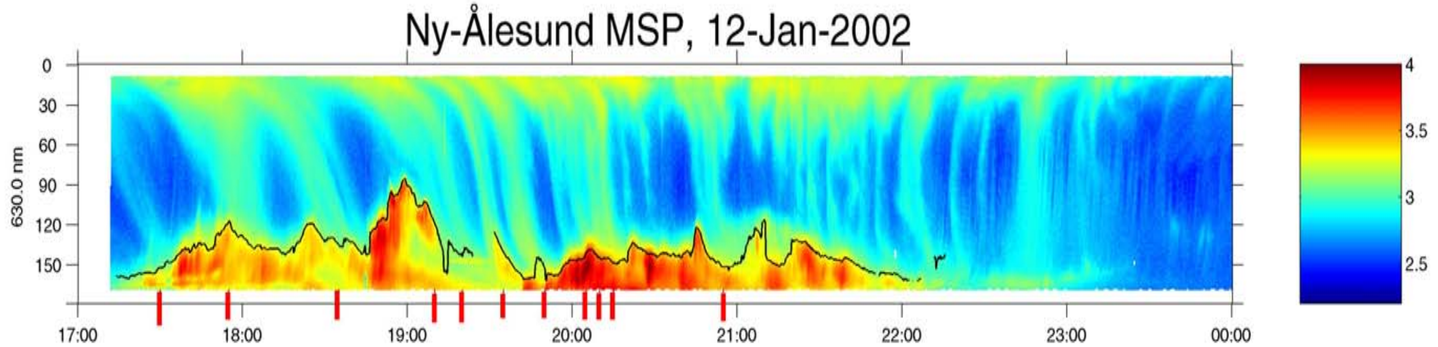




Svalbard – is an ideal platform for studying airglow patches at night

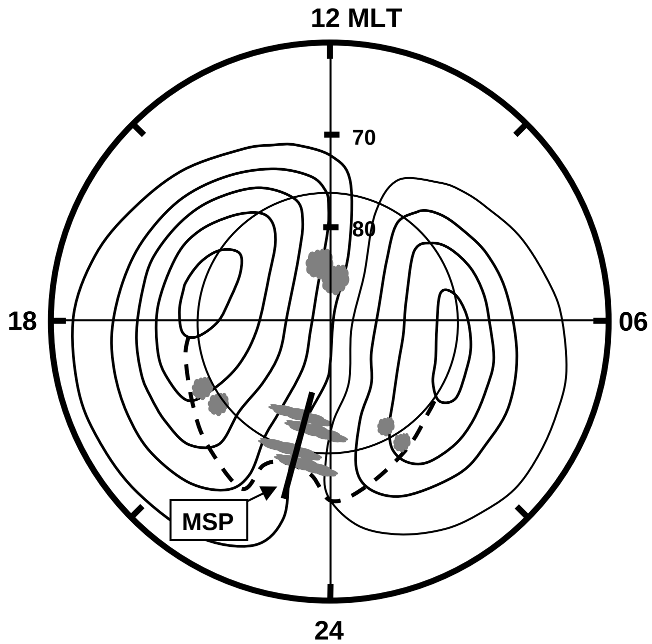


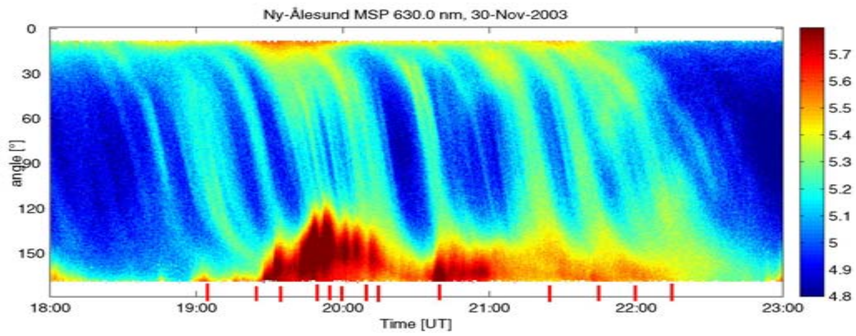
- High-density patches formed in the Canadian/ American cusp sector drift at us at night

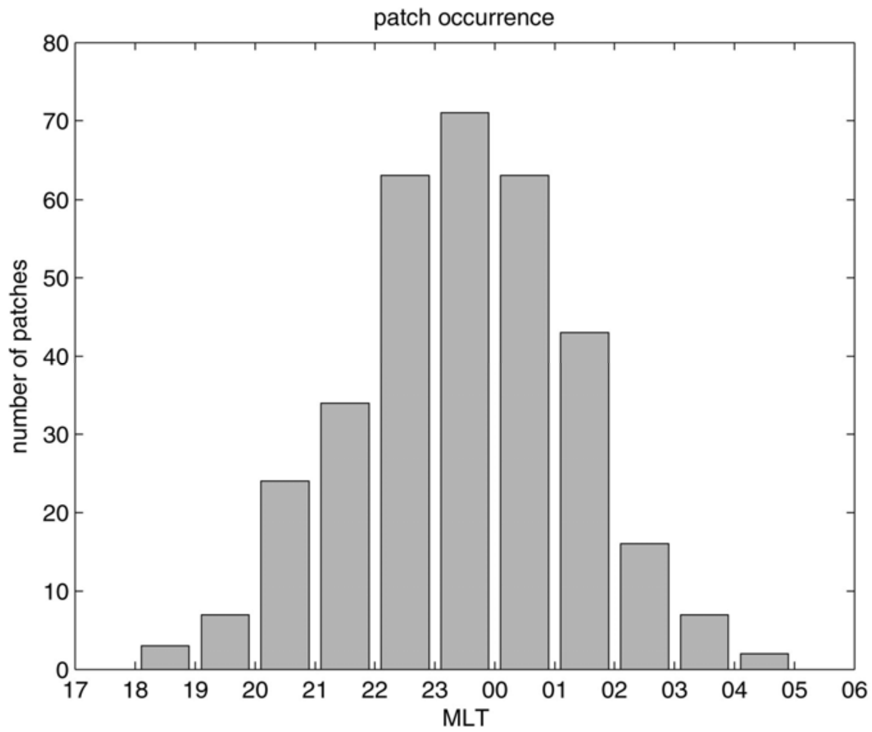


Occurence rate of polar cap patches

- Eight winters (1997-2005) of MSP data from Ny-Ålesund have been analyzed
- 43 nights, 333 events
- About 60% of the patches exit the polar cap from 22-01 MLT, but patches was observed in the entire MLT range from 18:00-05:00.

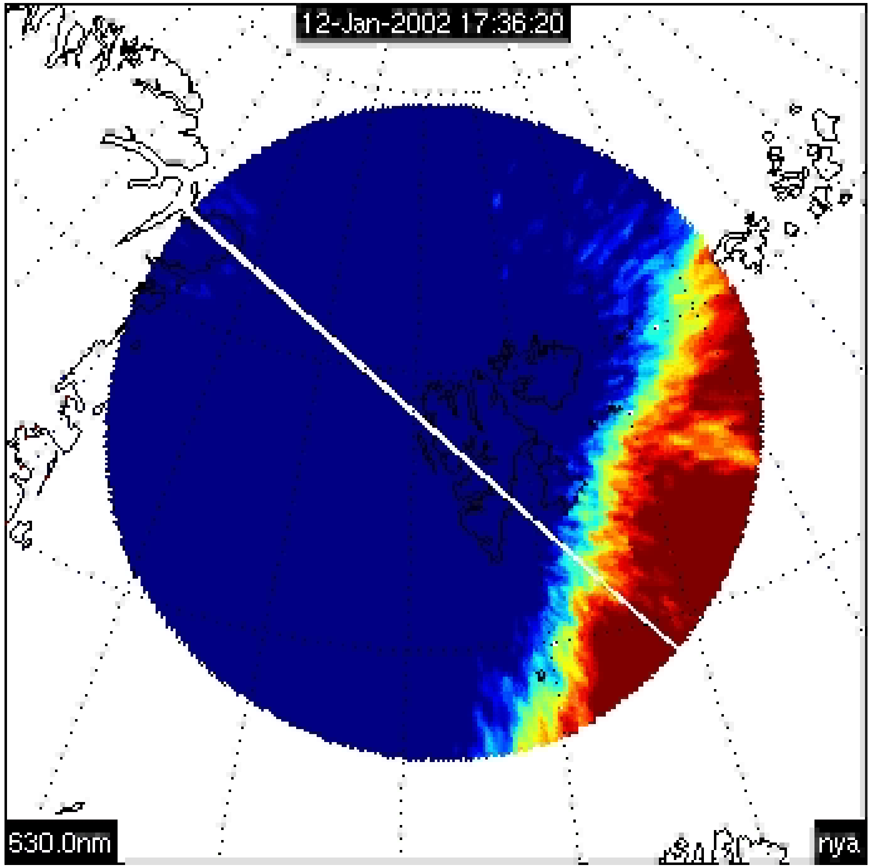


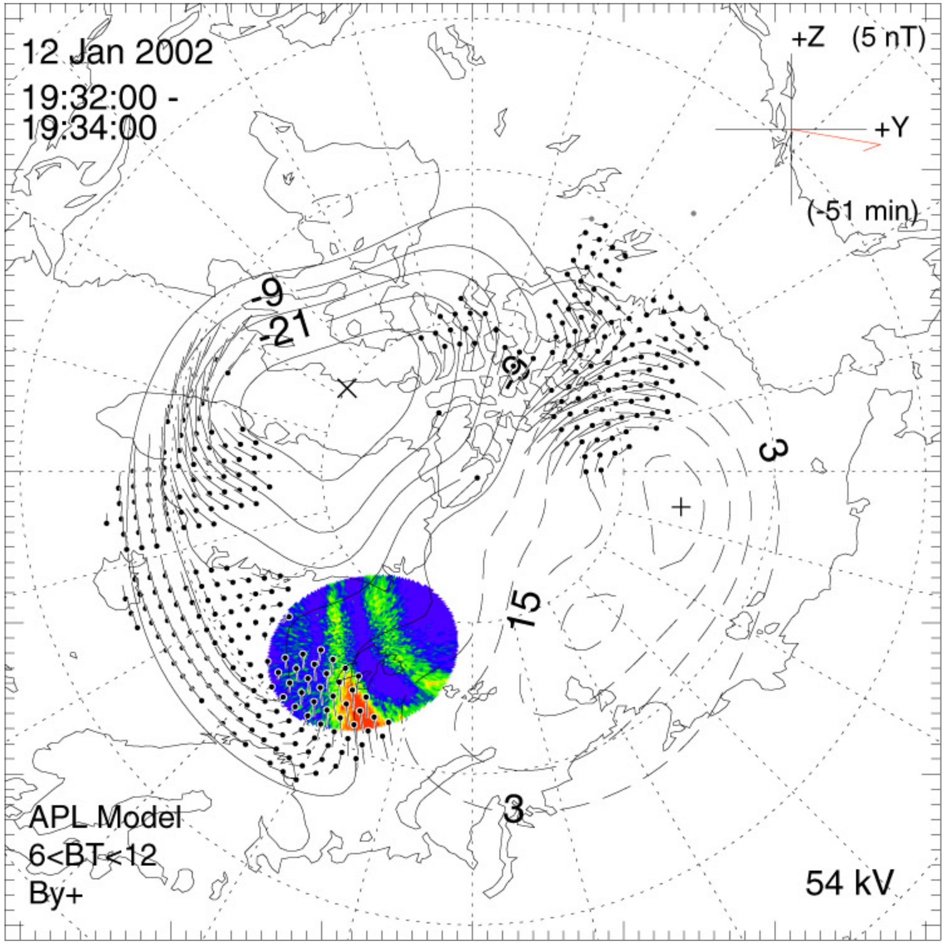




Moen et al., GRL2008

A new tool for studying tail-reconnection dynamics

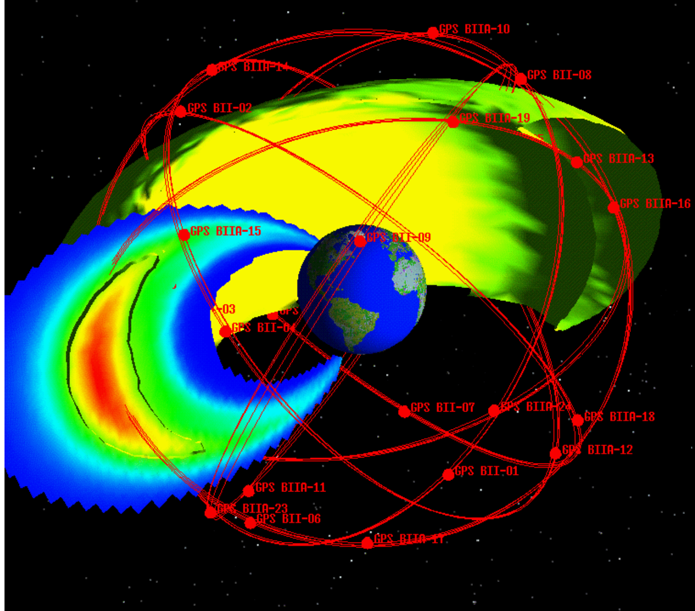




Gulbrandsen et al. (Work in progress)

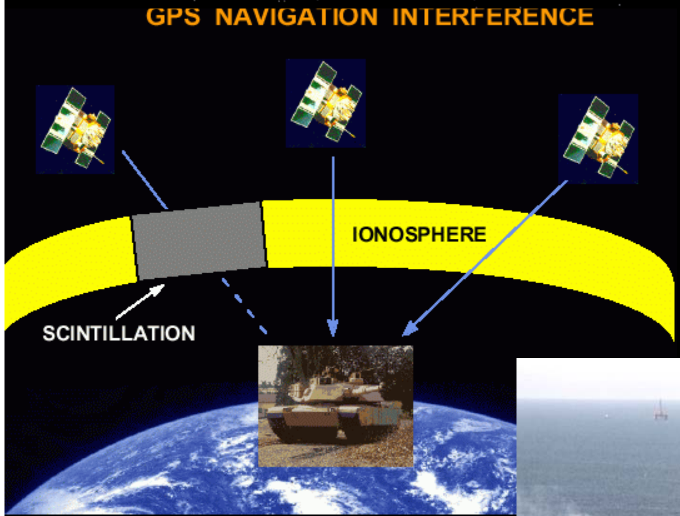
NOTE:

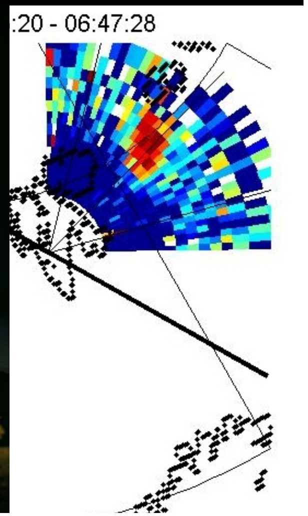
- Patches exit the polar cap in the entire MLT range of tail reconnection (18-05 MLT)
- All-sky and radar tracking of patches provides a new tool to study tail reconnection dynamics. I.e. to observe how thet cross the OCB – the poleward border of the night-time auroral oval.
- As high density plasma clouds tend to be turbulent, they are an important space weather phenomenon for communication and navigation systems. See next slide.
- With the ICI-series of sounding rockets, UiO specializes on in-situ measurements of polar cap patches. ICI-3 will be launched from Svalbard winter 2011, and ICI-4 is planned to fly over Svalbard near solar maximum in 2014.



Of relevance to satellite navigation

- Turbulence and irregularities in the ionosphere give rise to scintillations in the satellite to ground signal
- The Total Electron Content (TEC) along the path of a GPS signal can introduce a positioning error (up to 100 m)
- More severe in the arctic regions
- The effects on GPS can be one of the most important space weather phenomena for Norway as the Barents sea opens for offshore activities and the East-West passage is likely to open due to sea ice meltdown





ICI-2

Investigation of Cusp Irregularities