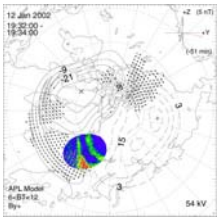
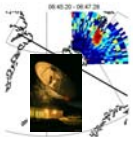
## Polar Cap Patches –

**islands of high electron density, form on the day side and drift towards night side across the polar cap**

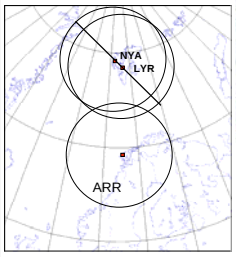
## OUTLINE

- 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



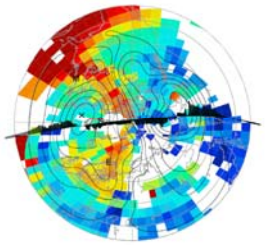


## Core instrumentation for UiO patch studies:





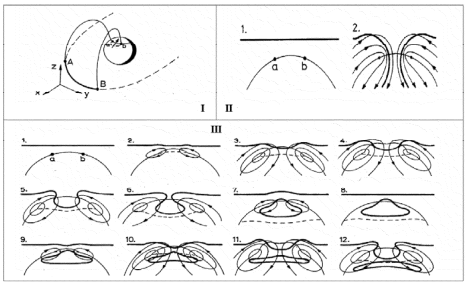
## Polar cap patches:



- 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

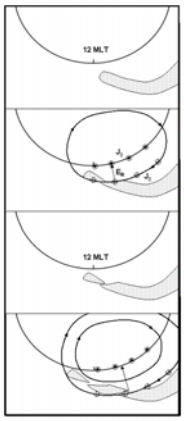
TEC image demonstrating transport of EUV ionized plasma that extends into the polar cap (Foster et al., 2005)

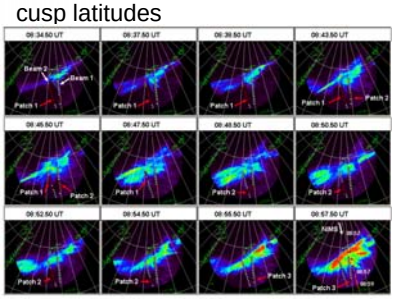
## Patch formation - due to transient magnetopause reconnection



Lockwood and Carlson patch formation model (GRL,1992)

## Patch formation at sub-auroral cusp latitudes

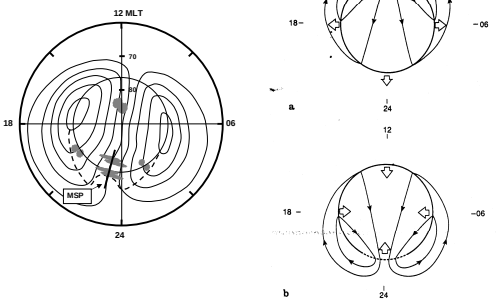


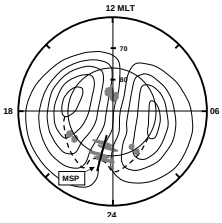
➢Moen et al., Ann. Geophys. 2006 documented formation of patches equatorward of cusp auroral activity.

➢A field aligned current sheet associated with enhanced convection represents a possible cutting mechanism

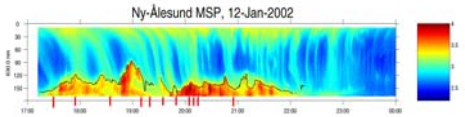
## The only way to exit patches from the polar the polar cap is by tail reconnection




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

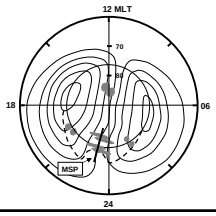


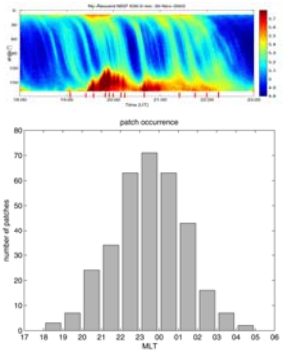

- High-density patches formed in the Canadian/ American cusp sector drift at us at night




## Occurence rate of polar cap patches

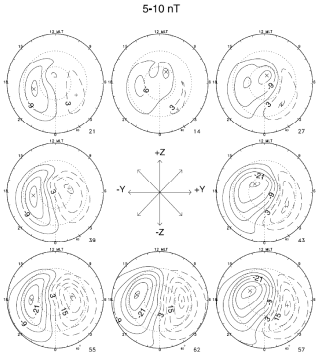
- Eight winters (1997-2005) of MSP data from Ny-Ålesund have been analyzed
- 43 nights, 333 events
- About 60% of the patches exit the polar cap from 22-01 MLT, but patches was observed in the entire MLT range from 18:00-05:00.



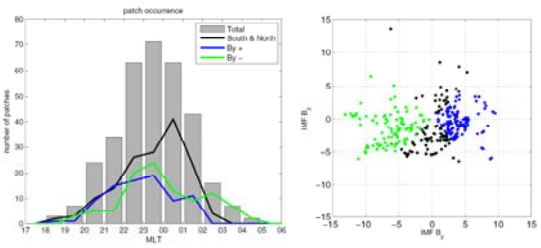




Moen et al., GRL2008

## On the IMF BY assymmetry

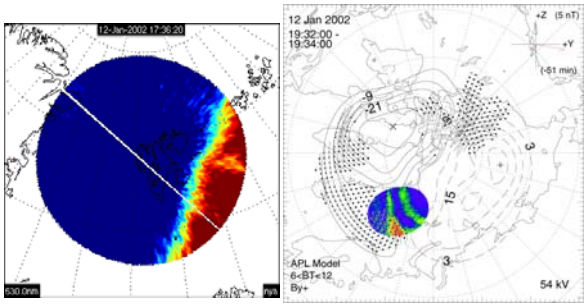



## IMF $B_Y$ asymmetry



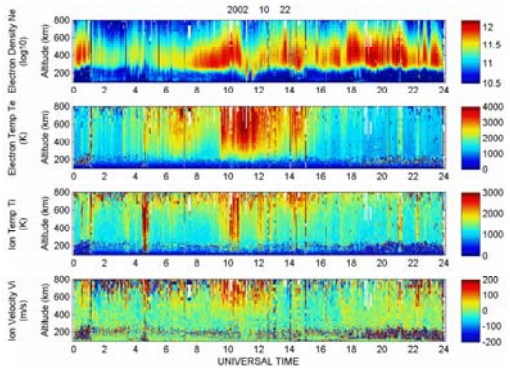

Gulbrandsen et al. (work in progress)

**A new tool for studying tail-reconnection dynamics**

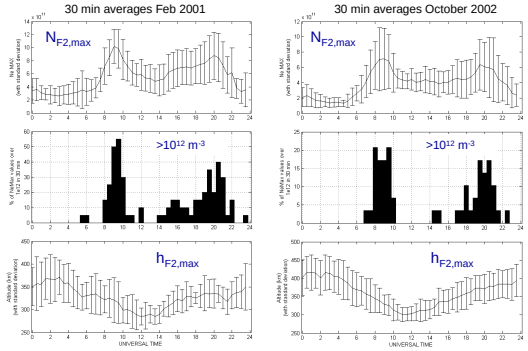



**Gulbrandsen et al. (Work in progress)**

## ESR – 24 hours parameter plot



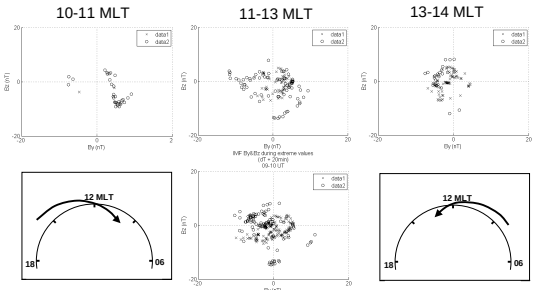

## Monthly average of the diurnal F2 –region variability binned per 30 min




Moen et al. (Work in progress)

## IMF variability on the MLT occurence of extreme values : $N_{F2,max} > 10^{12}$ m$^{-3}$

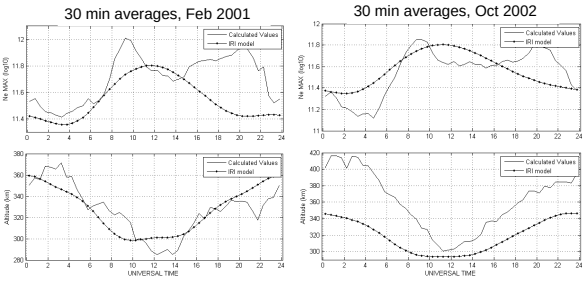
x February 2001
o October 2002




!!! Indicates that pacthes forms independent of IMF BY polarity

Moen et al. (Work in progress)

## Comparison with the IRI-model ionosphere

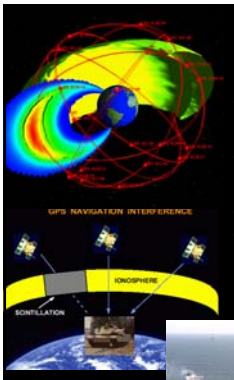



Moen et al. (Ann Geophysicae 2008)

## Conclusions:

- Patches exits the polar cap in the entire MLT range of tail reconnection
- Airglow signatures or patches provides a new tool to study tail reconnection dynamics
- The ESR and the optical study indicates that the occurence rate of plasma patches has no preference for IMF $B_y$.
- The large discrepancy between model and measured F2 region peak density and altitude underlines the need for emipirical models of the polar cap ionosphere – The EISCAT IPY contribution will be important conytriution

## Of relevance to satellite navigation

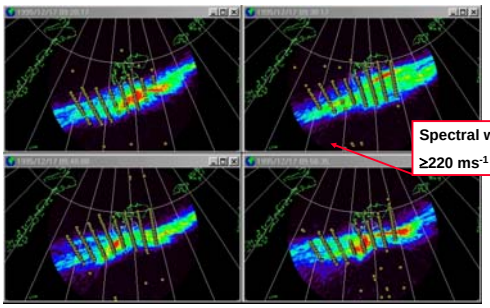



- Turbulence and irregularities in the ionosphere give rise to scintillations in the satellite to ground signal
- The Total Electron Content (TEC) along the path of a GPS signal can introduce a positioning error ( up to 100 m)
- More severe in the arctic regions
- The effects on GPS could be one of the most significant space weather effects due to the planned reliance of this system in the future.

# ICI-2

## Investigation of Cusp Irregularities

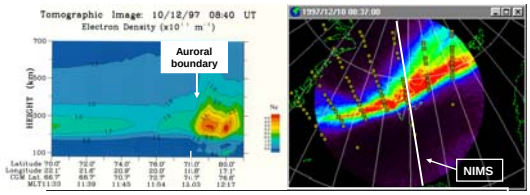
**Correspondence between the optical cusp and HF radar cusp:**




Moen et al., Ann. Geophysicae, 2000

## Original Science Objective:

We want to test the potential role of gradient drift instability to generate decameter scale HF backscatter targits.




**Gradient drift instability growth rate** $\gamma = -\left(\frac{1}{n_0}\right)\left(\frac{\Delta n}{\Delta y}\right)\left(\frac{E}{B}\right)$ ⇨ **3-10 min**

## Science Objectives:

**Original:**

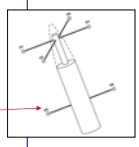
- Observe HF backscatter targets by high-resolution electron density measurements
- Test whether the gradient drift instability is the dominant mode for irregularity formation

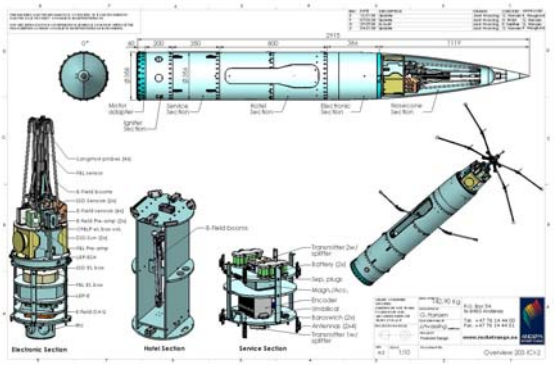
**Additional goals:**

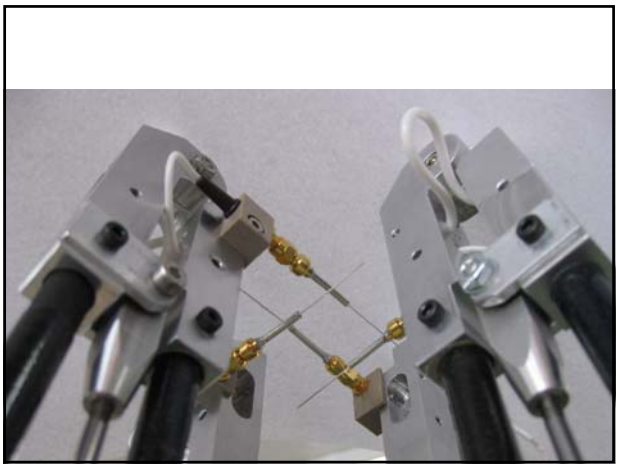
- The role of flow shears and KHI
- Resolve electron beams down to the electron gyro radius
- Wave phenomena

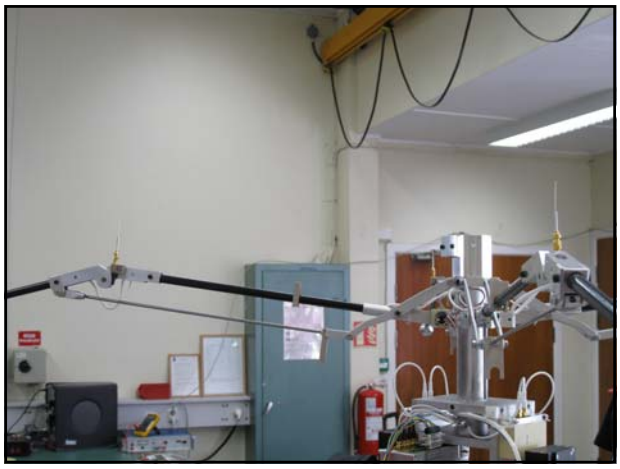
## INSTRUMENTATION on ICI-2

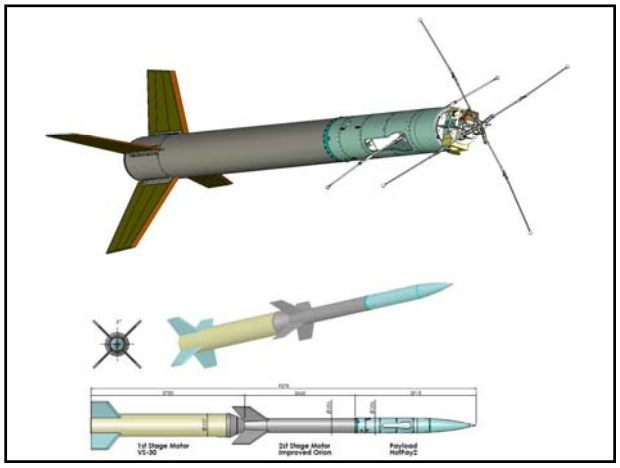
- Fixed Bias Langmuir probe – ISAS/JAXA
- Low energy electron spectrometer (10eV-10keV) - ISAS/JAXA
- Solid state particle spectrometers for electrons and ions – University of Bergen. (>20 keV)
- New Concept Langmuir Probe – UiO.
- AC and DC Electric field + wave experiment, UiO.
- SRADS: Sounding Rocket Attitude Detection System, UiO



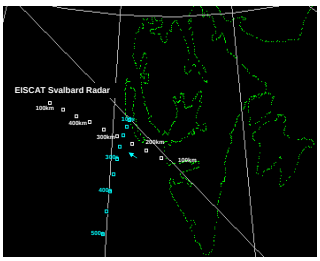









## ICI-2 launch:




**ICI-2 LAUNCH WINDOW:**

28 Nov – 7 Dec 2008

07-11 UT/10-14 MLT

ICI-2 Sonda VS30/Improved Orion

~142 kg / ~350 km apogee

**ICI-2 LAUNCH WINDOW:**

28 November – 7 December 2008 (sun < -10, moon <5)

07-11 UT, 08-12 LT, 10-14 MLT

**OPTIMAL LAUNCH CONDITIONS:**

1) Clear sky and active cusp placed over the nominal trajectory
2) HF radar echoes placed over the nominal trajectory
3) Nominal trajectory intersects the equatorward edge of the HF backscatter boundary
4) EISCAT Svalbard Radar observes enhanced F2 region electron densities

**REQUIREMENT STEP DOWN VERSUS TIME:**

Day 1-3: 1), 2) and 4) have to be met.

Day 4-6: 2) and 4) have to be met

Day 7-10: Either 1) or 2) has to be met