# Wide Energy Electron Precipitation and their Impacts on the Atmosphere during the Pulsating Aurora

## EISCAT & Van Allen Probes observations

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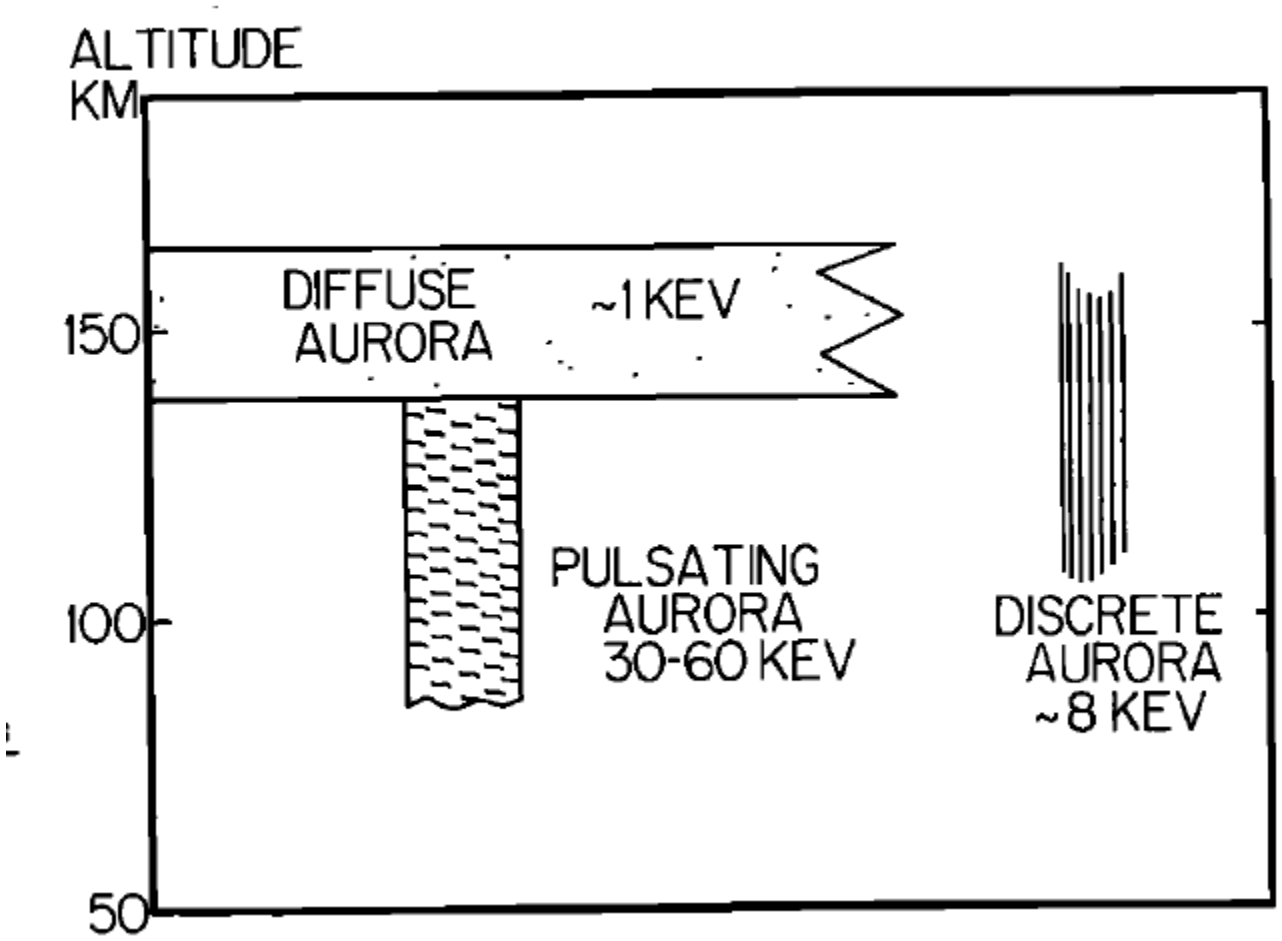
Miyoshi et al. (2015), Energetic electron precipitation associated with pulsating aurora: EISCAT and Van Allen Probes observations, *J. Geophys. Res.*

# Height profile of aurora




Brown+, 1976

Electron energy of pulsating aurora is
higher than typical diffuse aurora.

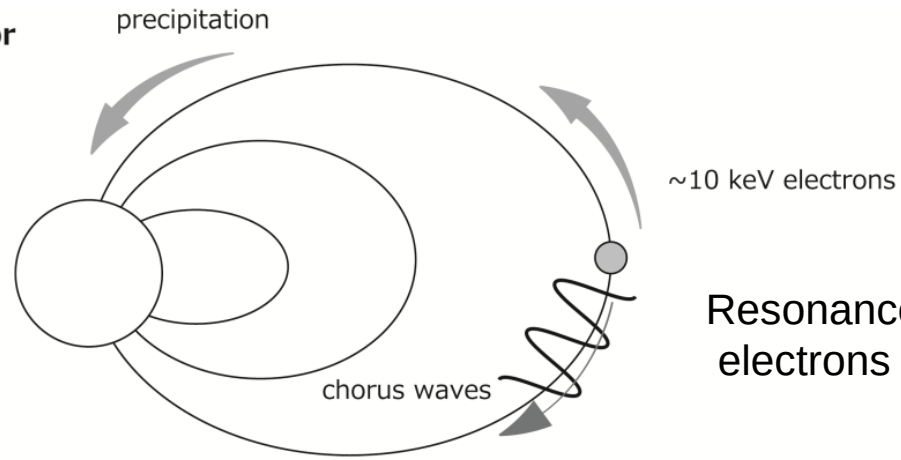
# model of pitch angle scattering of wideband energy electrons associated with pulsating aurora (Miyoshi+, JGR, 2010, 2015)

**Propagating chorus waves: Resonant with broadband energy electron is possible.**

**(a) Resonance near the equator**

~10 keV electrons

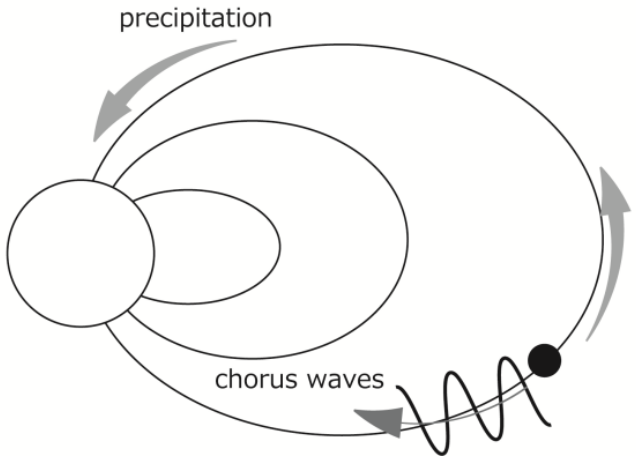
(Pulsating aurora)




Resonance with ~10 keV electrons near the equator

**(b) Resonance at the higher latitude**

sub-relativistic/relativistic electrons



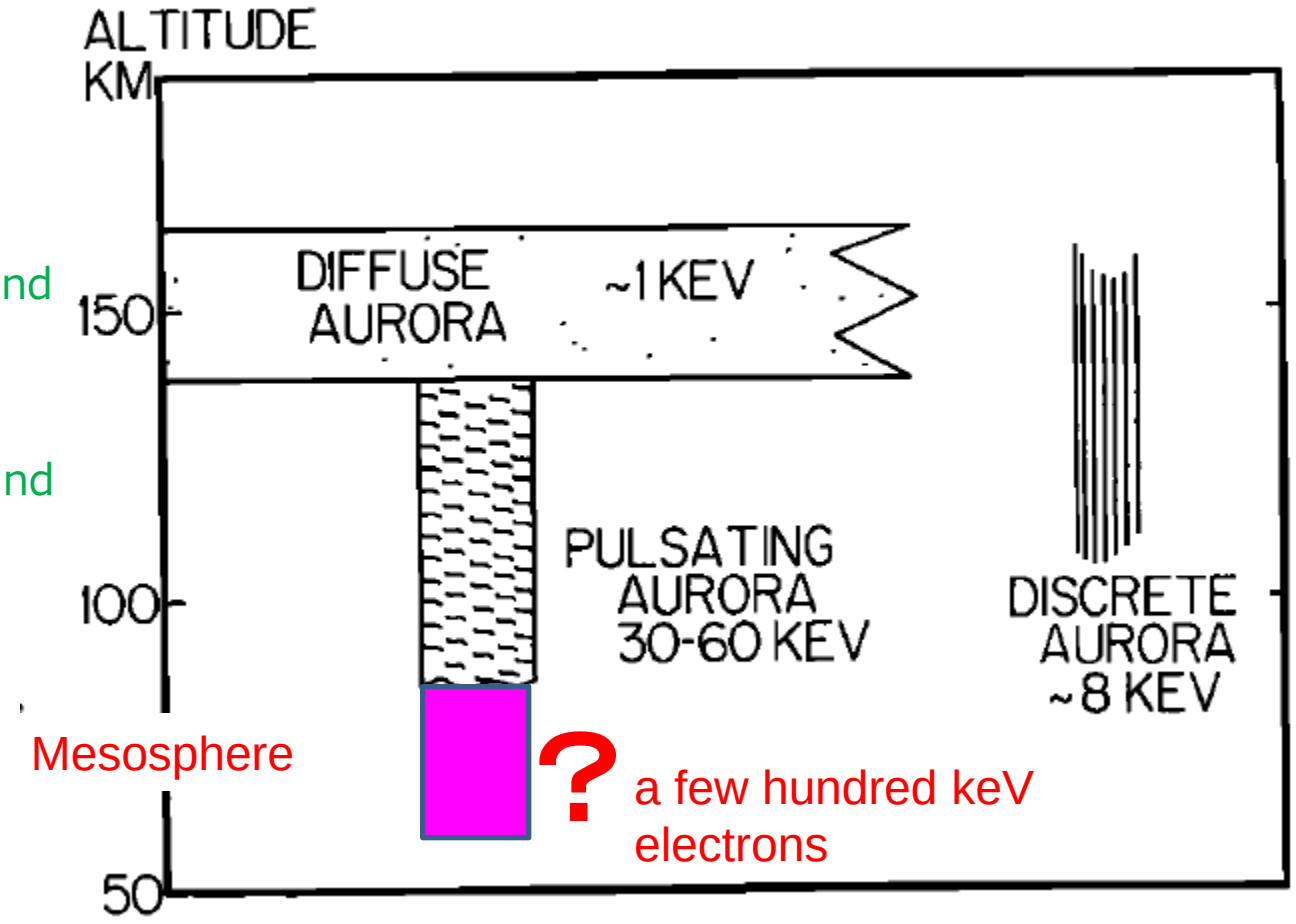

Resonance with >200 keV electrons at the mid-latitudes

Miyoshi+, JGR, 2015

# Our model suggests..

ECH
Upper-band
chorus

Lower-band
chorus



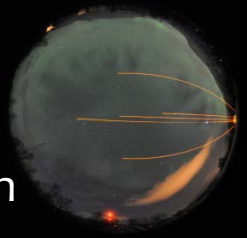

Brown+, 1976

# How do we identify the precipiation?

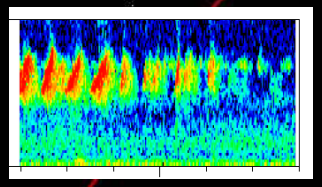
**Process at magnetosphere / Consequence at ionosphere**

Pulsating aurora

PsA (ionosphere)
Electron precipiation



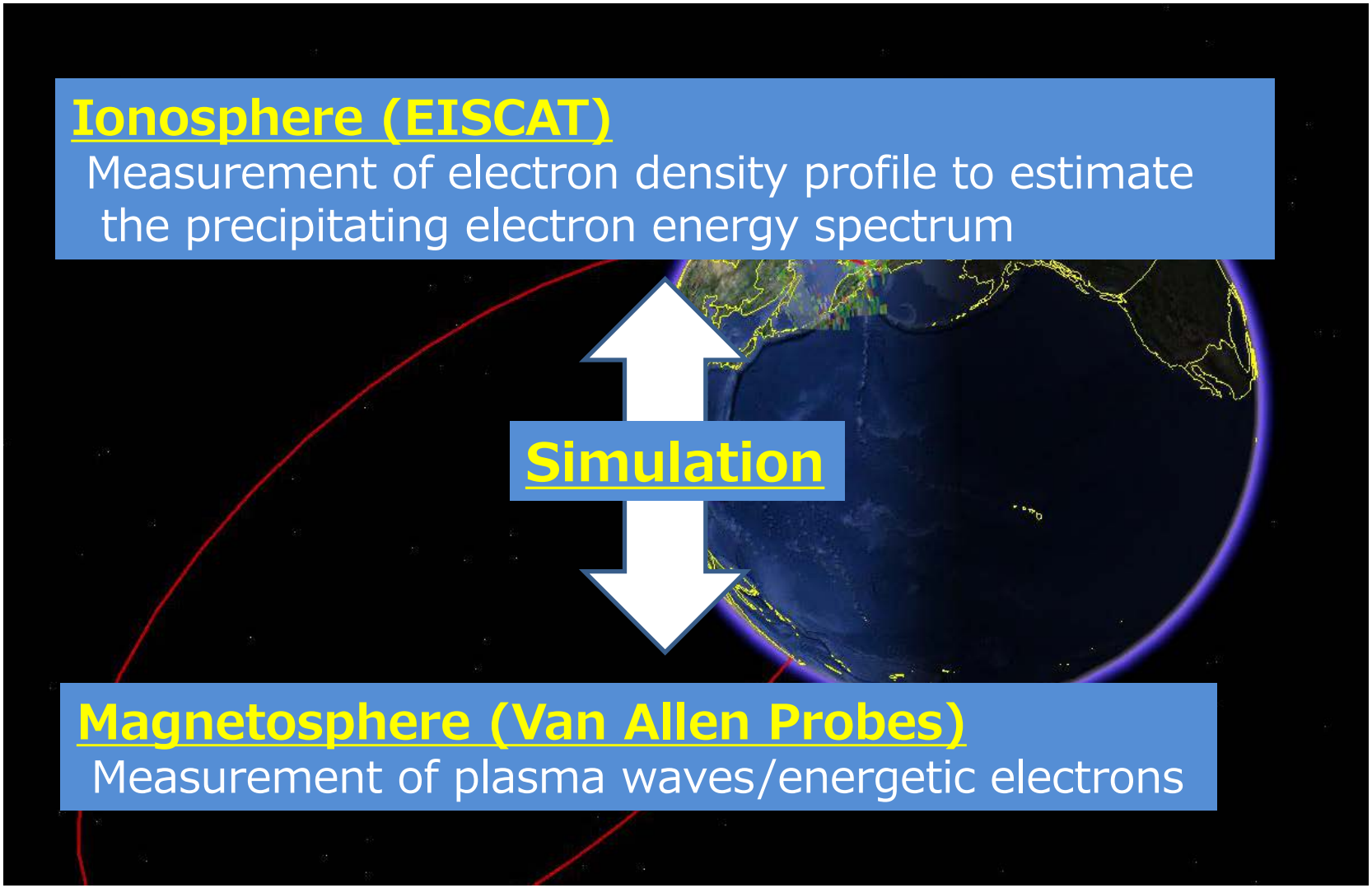
Energetic electron precipitation.
Optical Emission of the PsA.



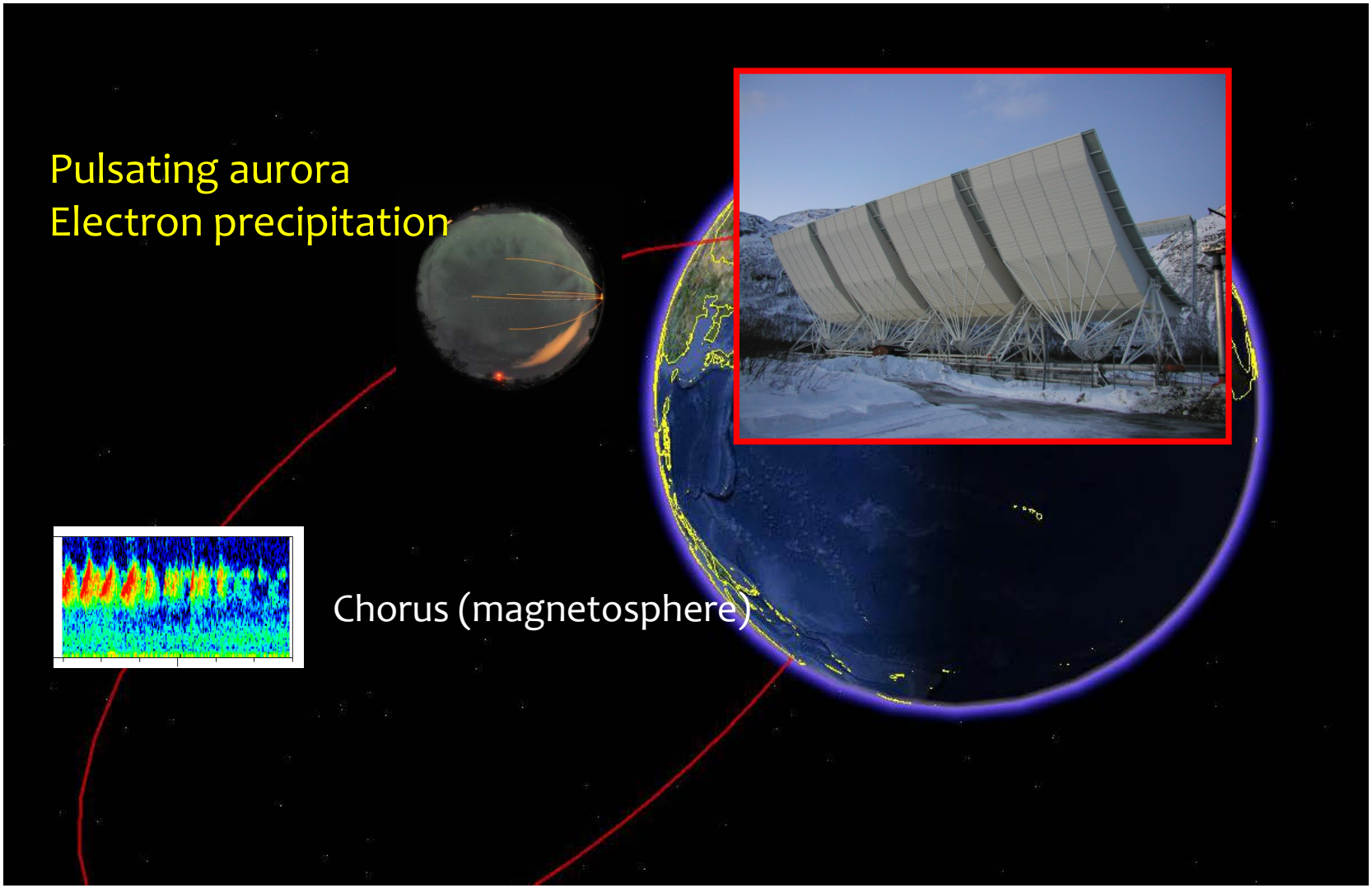
Chorus (magnetosphere)

Pitch angle scattering of energetic electrons by plasma waves at the magnetosphere

# Strategy of this study



# 2. Observation at Ground (EISCAT)



# 2. Observation at Ground (EISCAT)

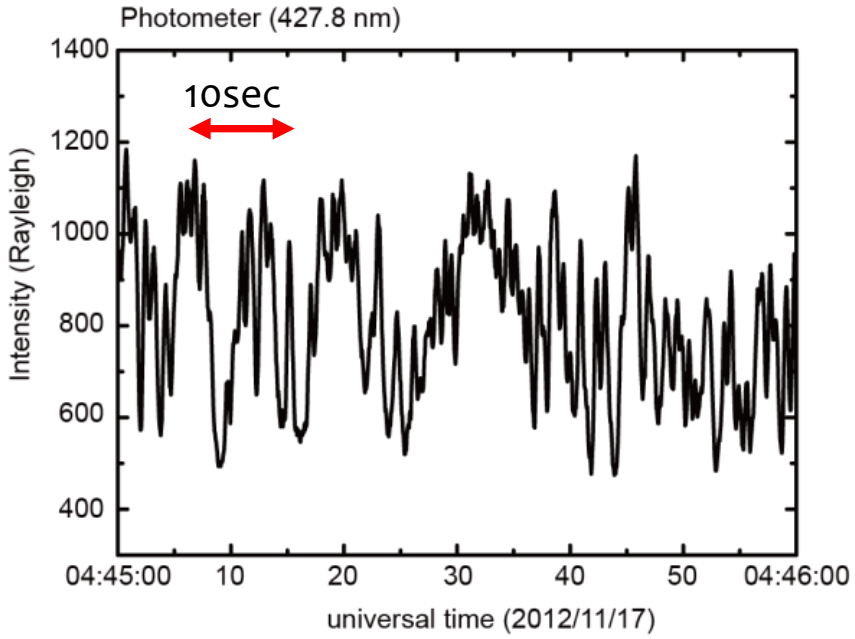
EISCAT: European Incoherent Scatter Radar

EISCAT VHF radar (224 MHz)
Tromsø, Norway (Invariant Latitude: 66.12)

2012/11/17 04:40-05:00 UT

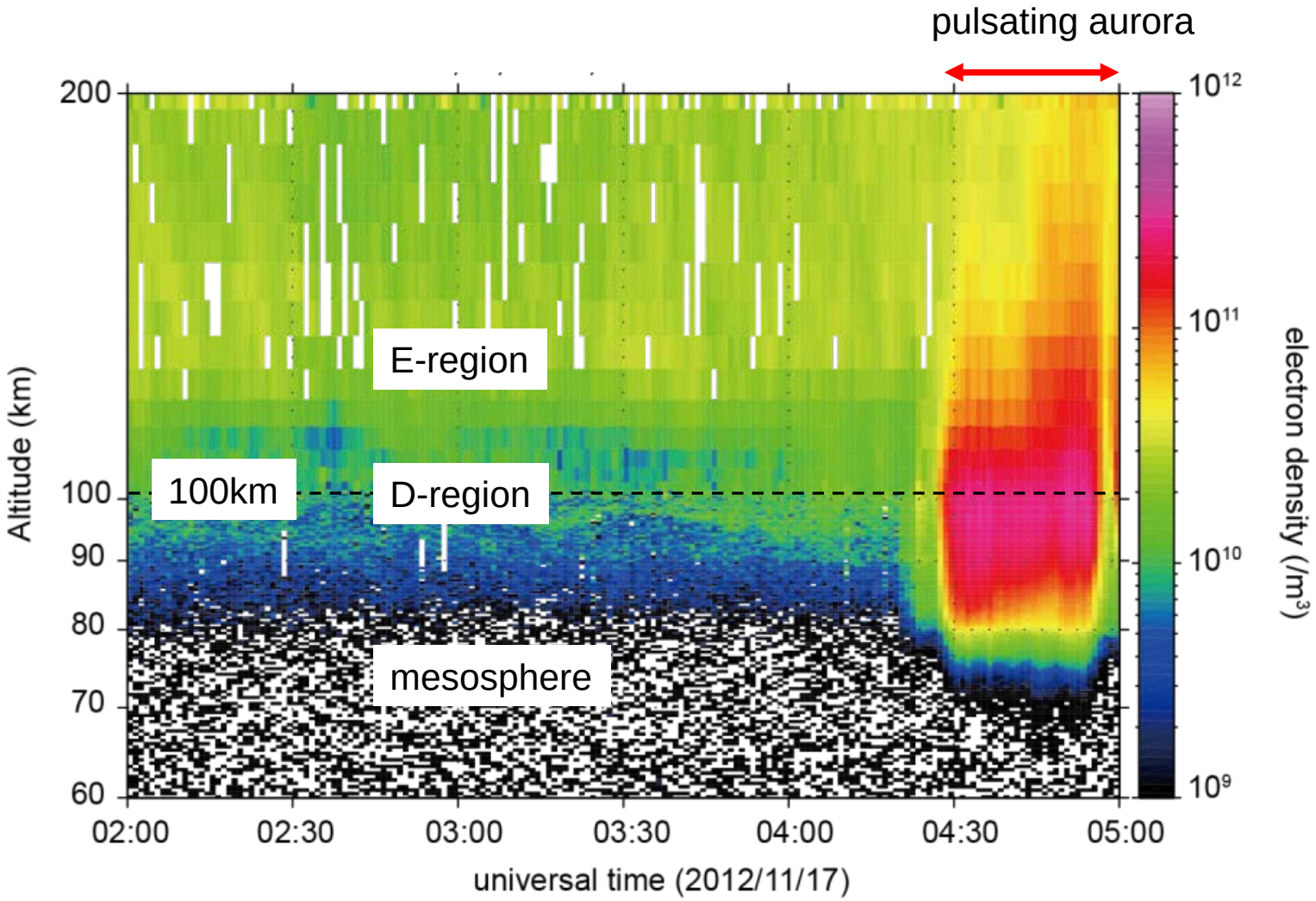
(STEL digital camera at Tromsø)

Photometer at magnetic zenith

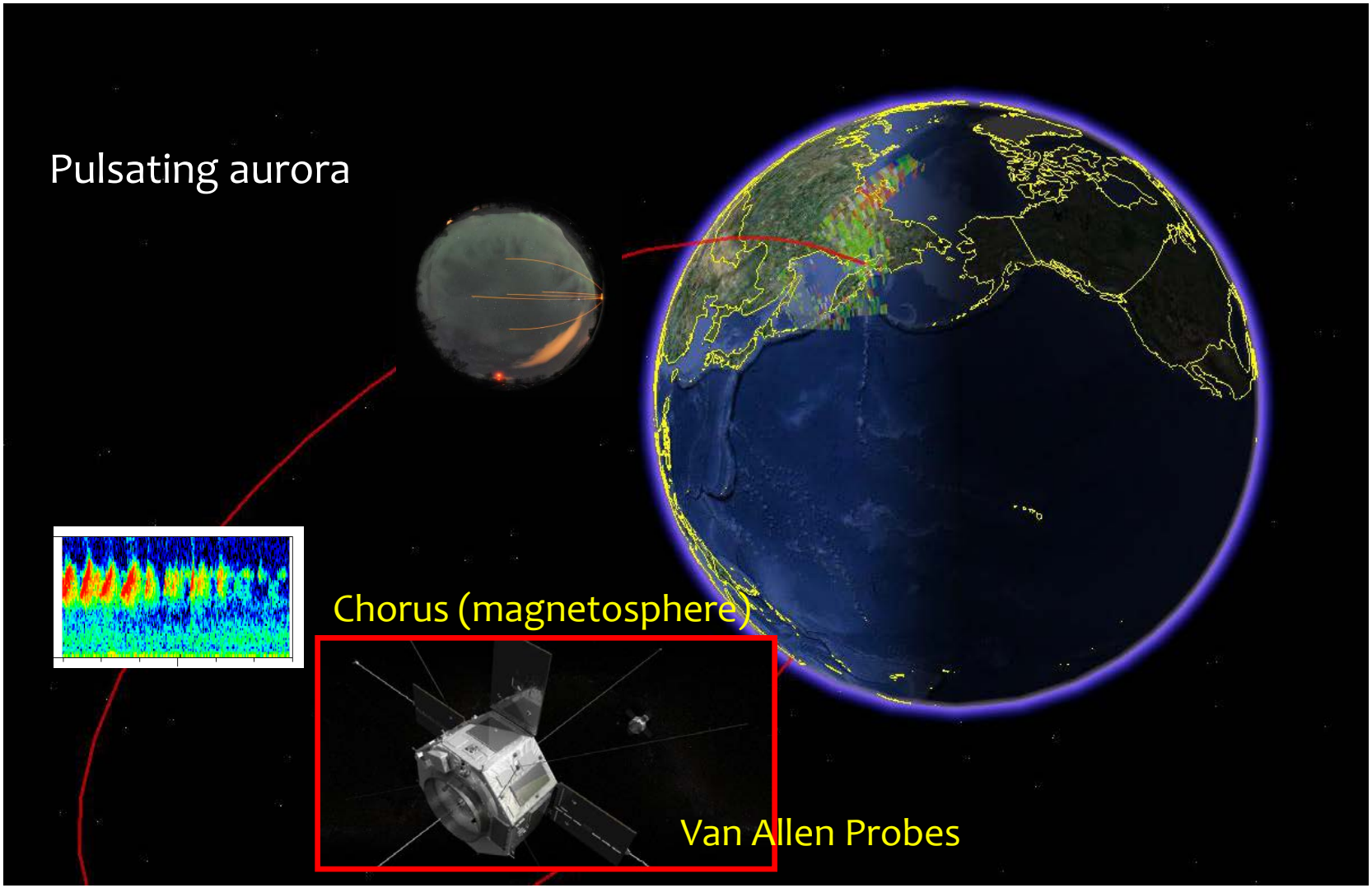



- PsA were observed at MLT 07:00 on November 17, 2012.

# Electron density profile from the EISCAT VHF radar during pulsating aurora



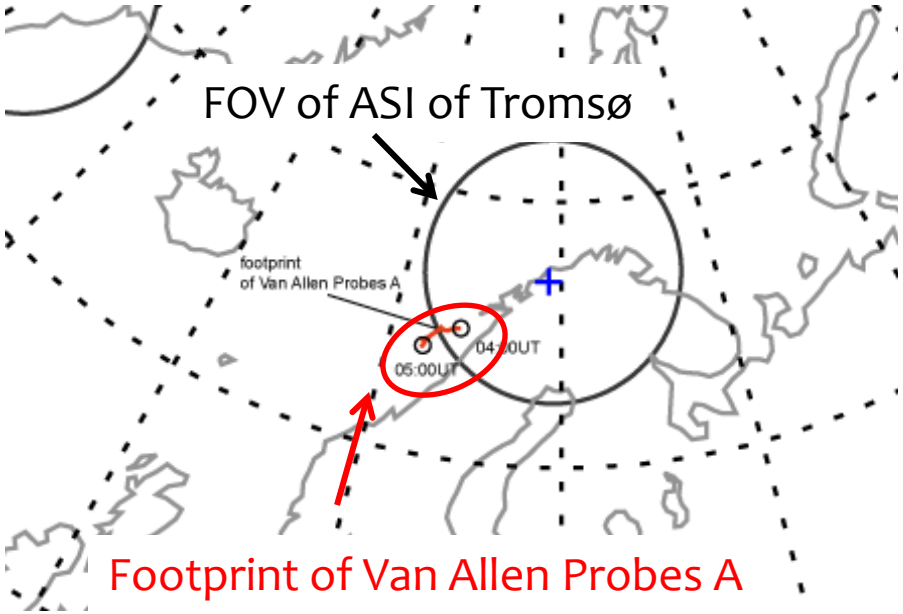
# 3. Observation at Space (Van Allen Probes)

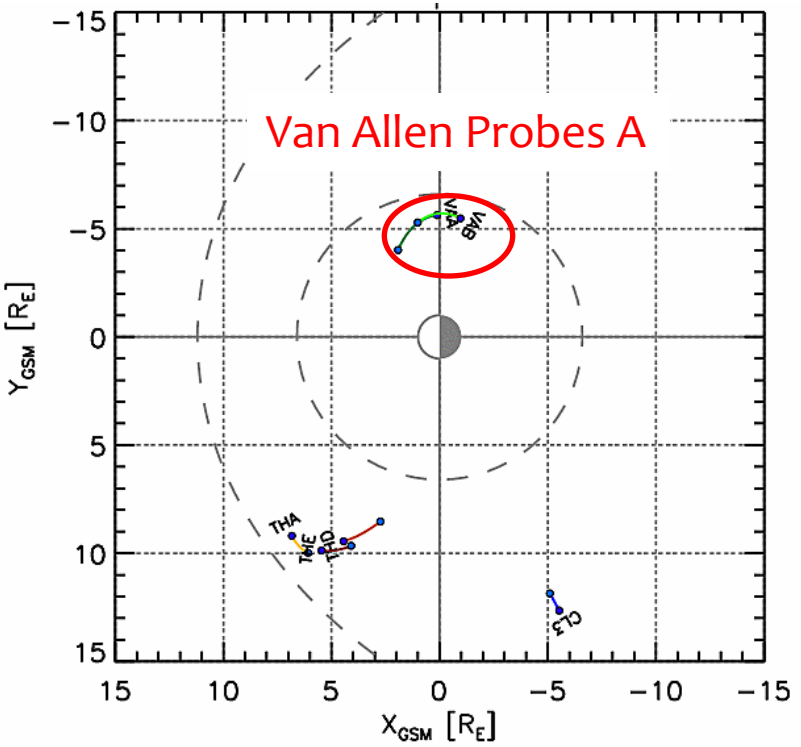


# 3. Observation at Magnetosphere (Van Allen Probes)

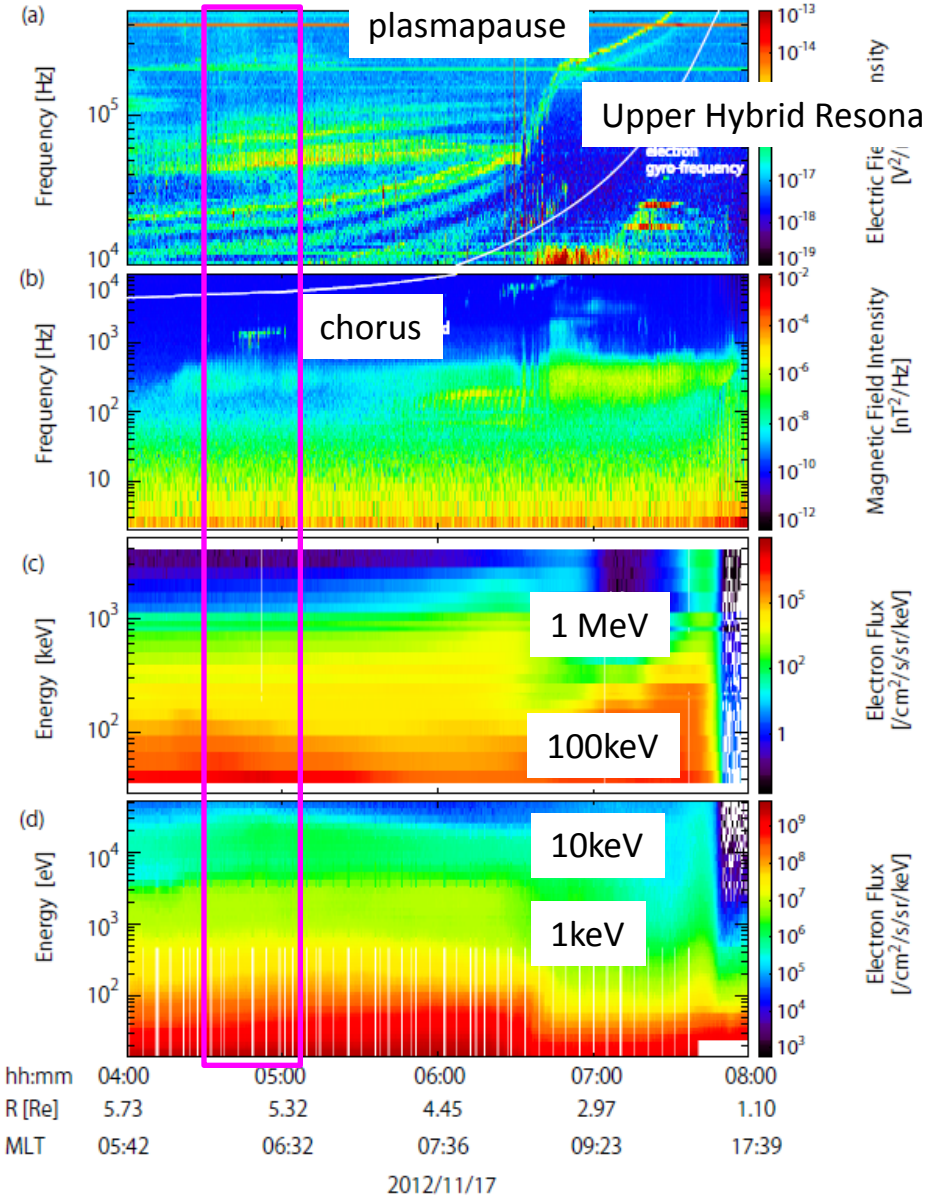
During the pulsating aurora,

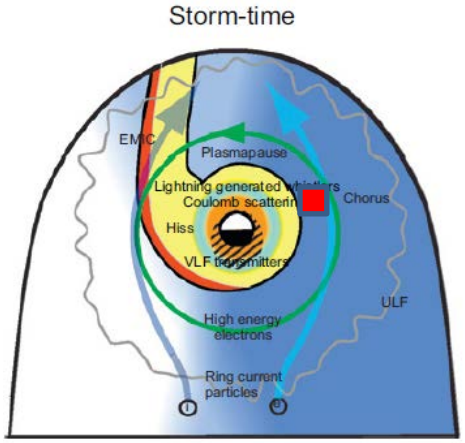
Van Allen Probes-A was traversing outside the plasmapause,
and the footprint of the satellite was near Tromsø.



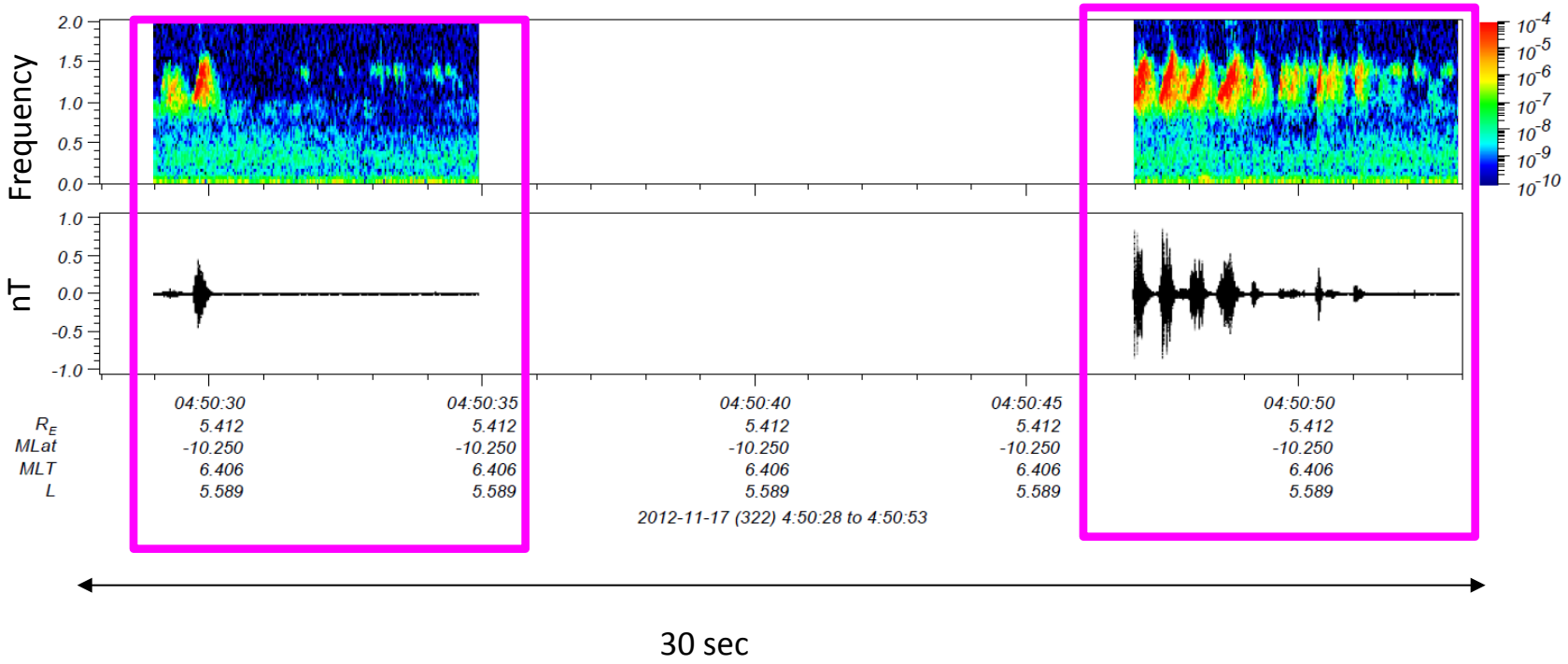



# 3. Observation at Magnetosphere (Van Allen Probes)



# Plasma Wave Observations by Van Allen Probes




30 sec

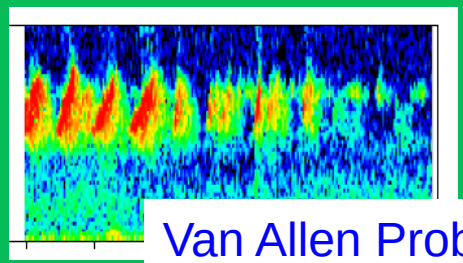
During the PsA event, Van Allen Probes-A identified rising tones of lower-band chorus in the magnetosphere.

Can these rising tone chorus cause precipitations of wideband energy electrons that were observed by EISCAT?

# 4. Simulation

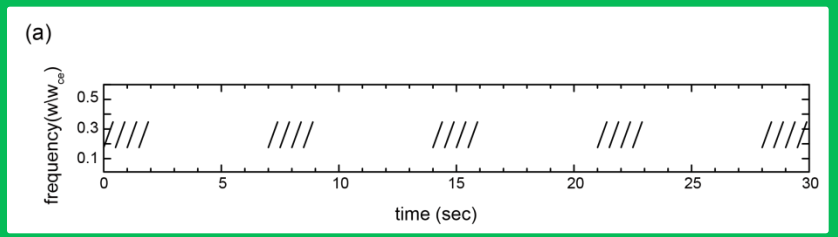
**Simulation Input:** Van Allen Probes observation
**Simulation Output:** Comparison with EISCAT

## Observed chorus



Van Allen Probes

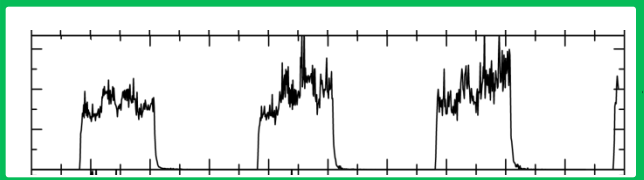
## Chorus model for input




## Test-Particle Simulation

Test-particle simulation. The observed fp/fc is used in the model.

## Precipitated flux at ionospheric altitude

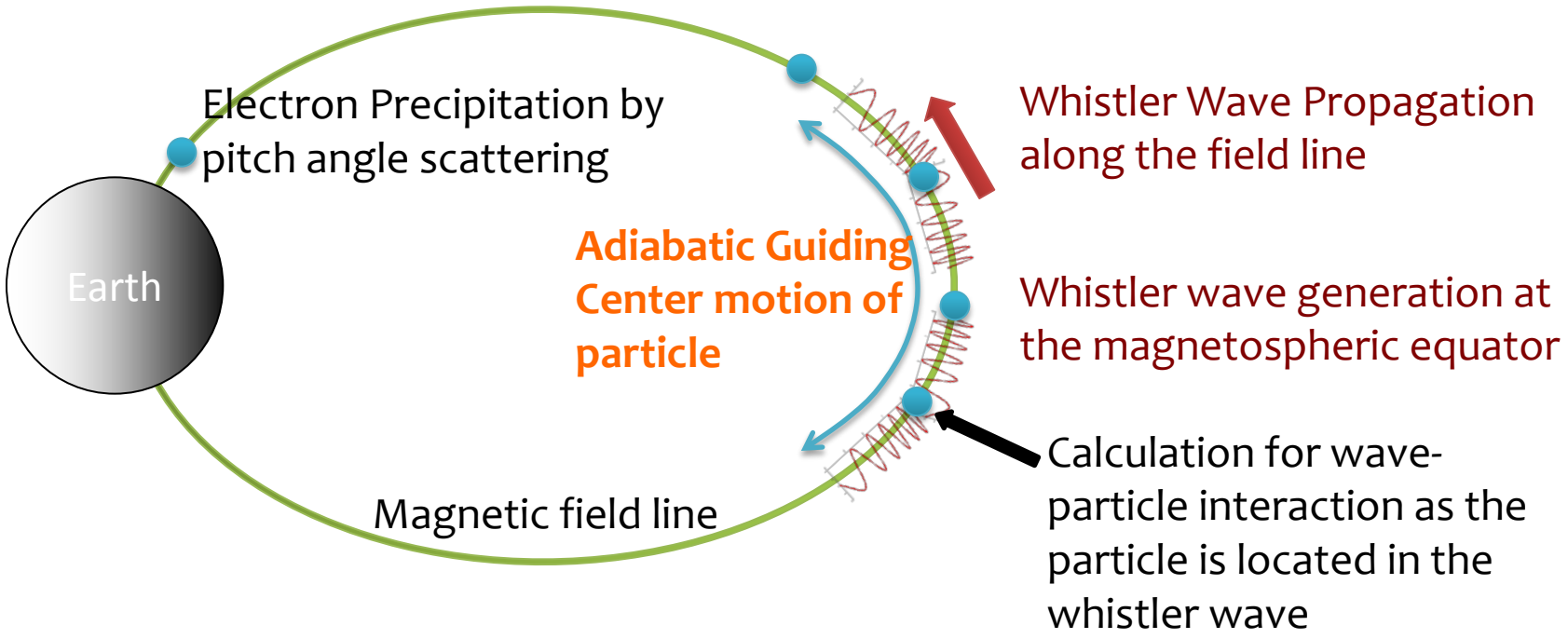


comparison with EISCAT

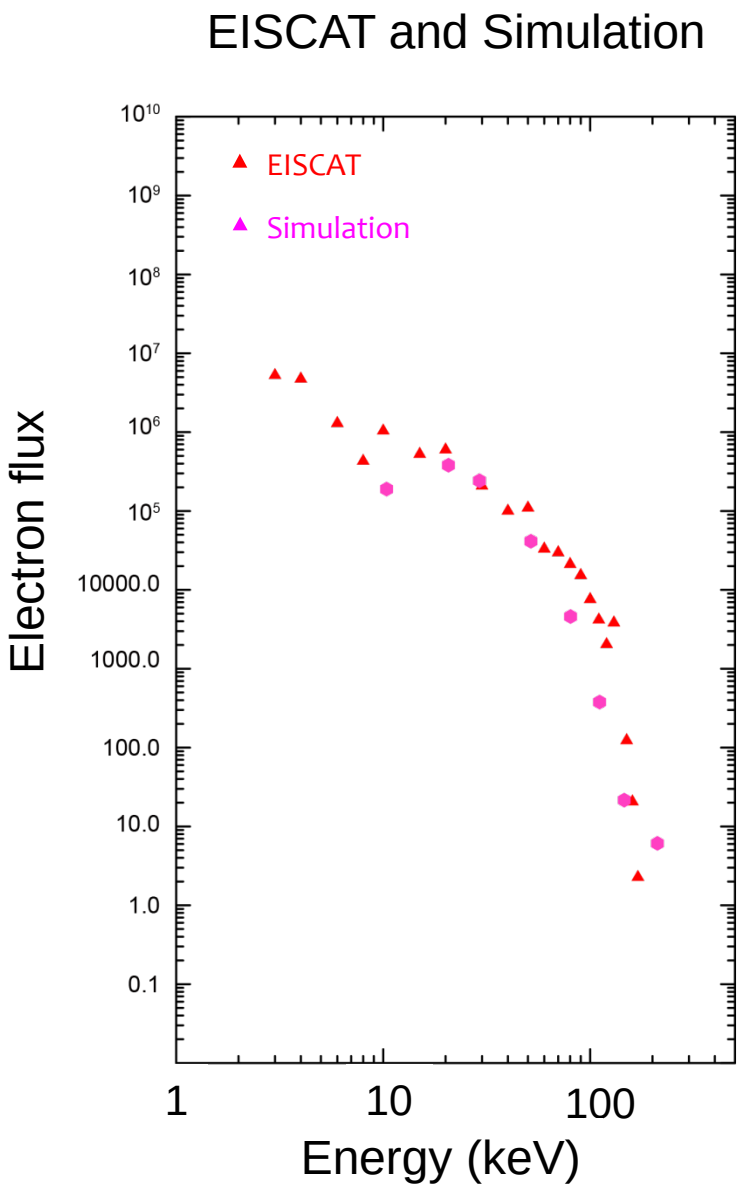
# 4. Simulation: GEMSIS-RBW [Saito, Miyoshi, Seki, JGR, 2012]

We solve the equation of motion for each particles and equation of waves considering the dispersion relation of whistler mode waves.

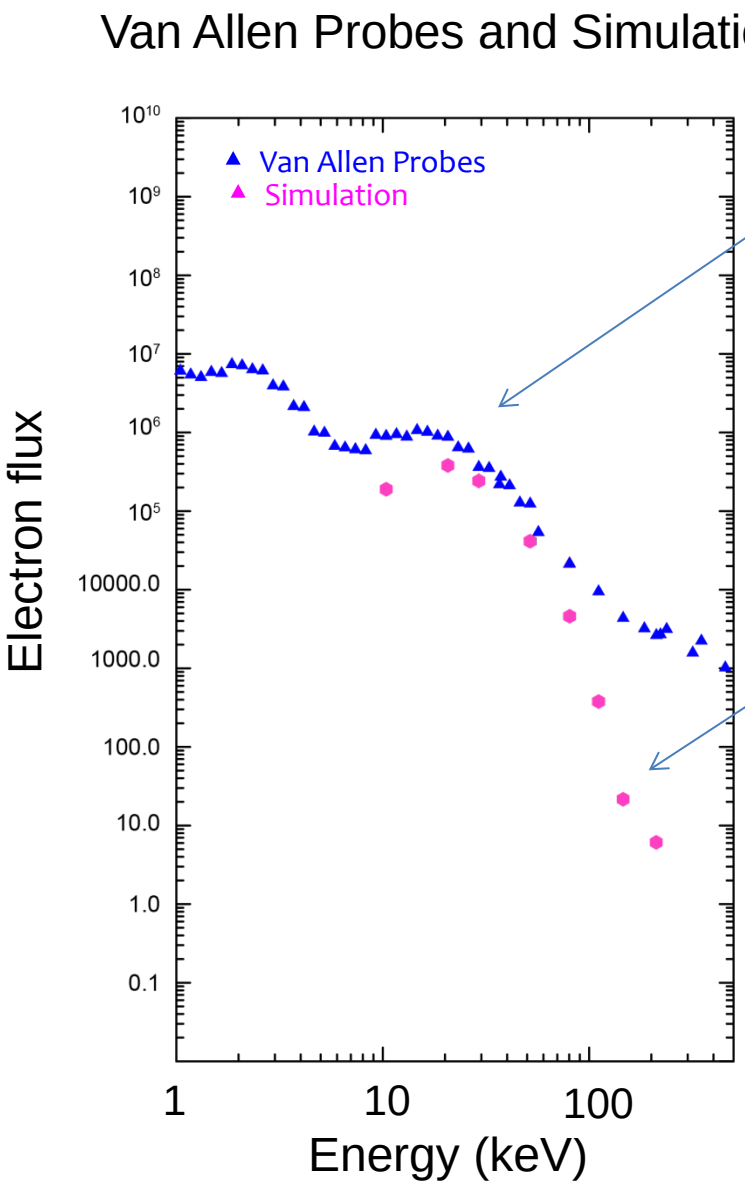
number of particles: > 5 x $10^5$



# Electron energy spectrum : Simulation/Observations



# Electron energy spectrum : Simulation/Observations



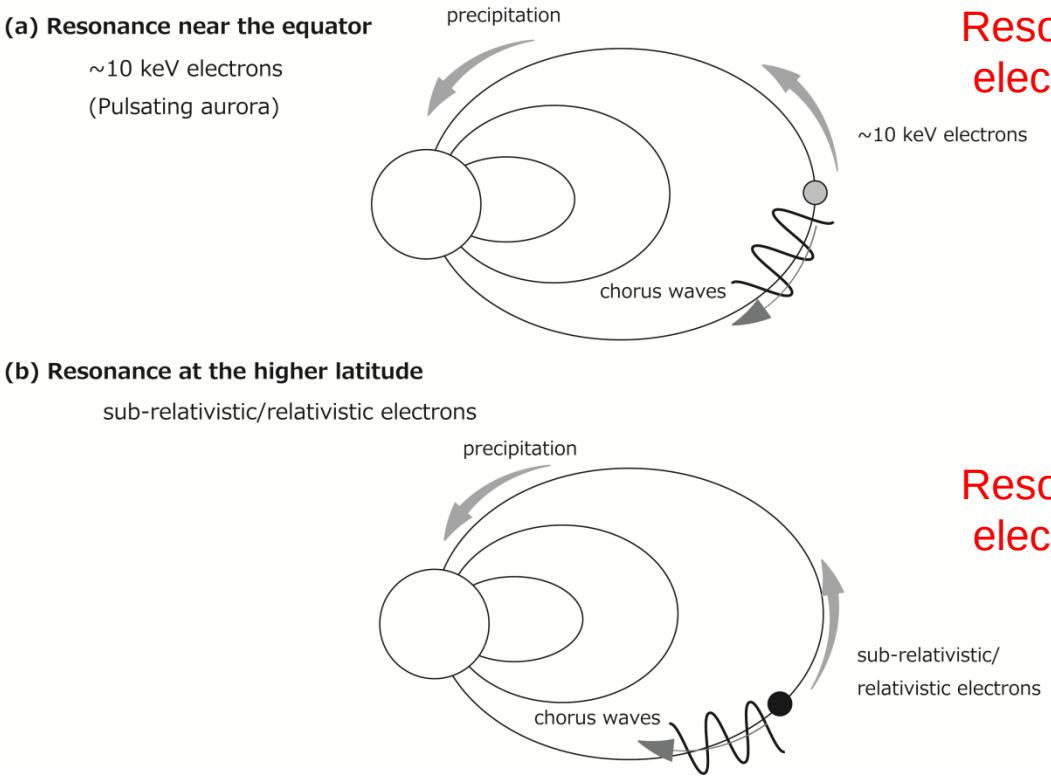

Comparative flux between magnetosphere and ionosphere:
**strong diffusion (- 80 keV)**

Precipitating flux is smaller than trapped flux
**weak diffusion (~ 100 keV)**

Propagation latitude controls the highest energy of precipitating electrons.

# 5. Summary

**Our model has predicted the precipitation of the wideband energy electron (~keV – MeV) associated with the pulsating aurora.**

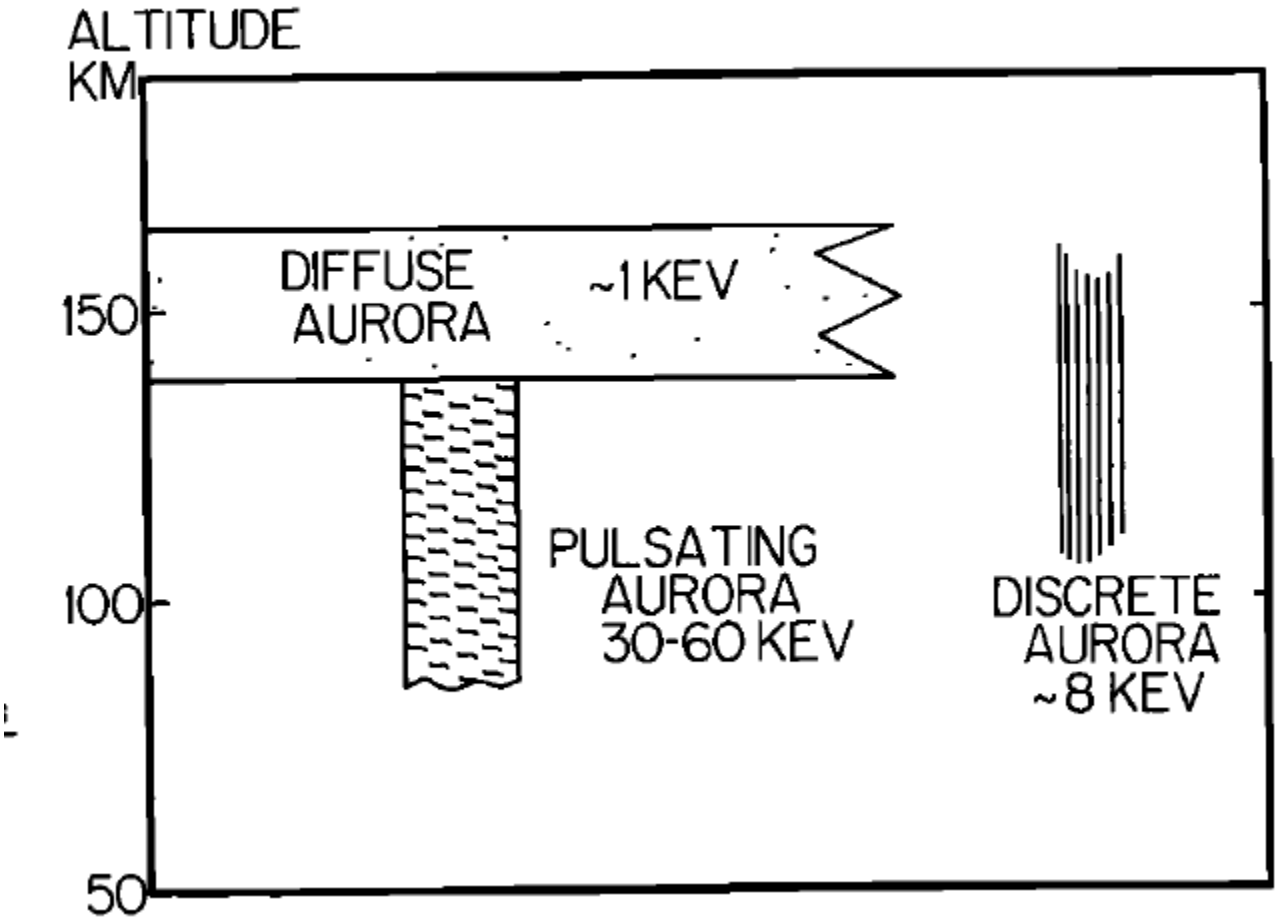



Resonance with ~10 keV electrons near the equator

Resonance with >200 keV electrons at the mid-latitudes

This study confirmed the wideband energy electron precipitations due to the propagating whistler mode waves, which cause significant effect on the depression of the ozone at the middle atmosphere (Miyoshi+, JGR, 2015).

# 6. Summary




Optical measurements

Brown+, 1976

# Future Direction


**Japanese new geospace satellite ERG will be launched in 2016.**

New observations, ERG, EISCAT-3D, other new observations provide

new findings on a coupling between magnetospehre and atmosphere.