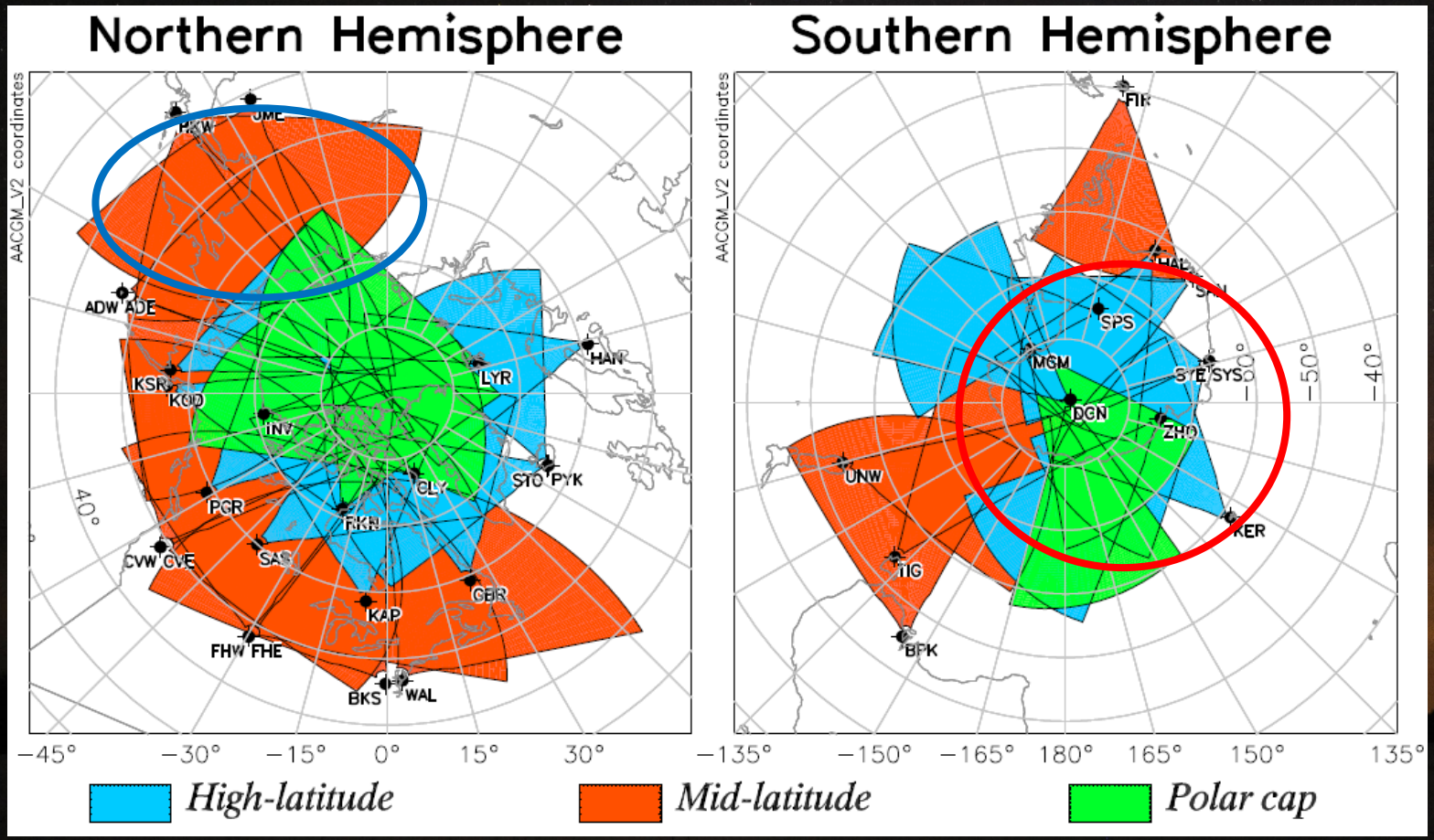
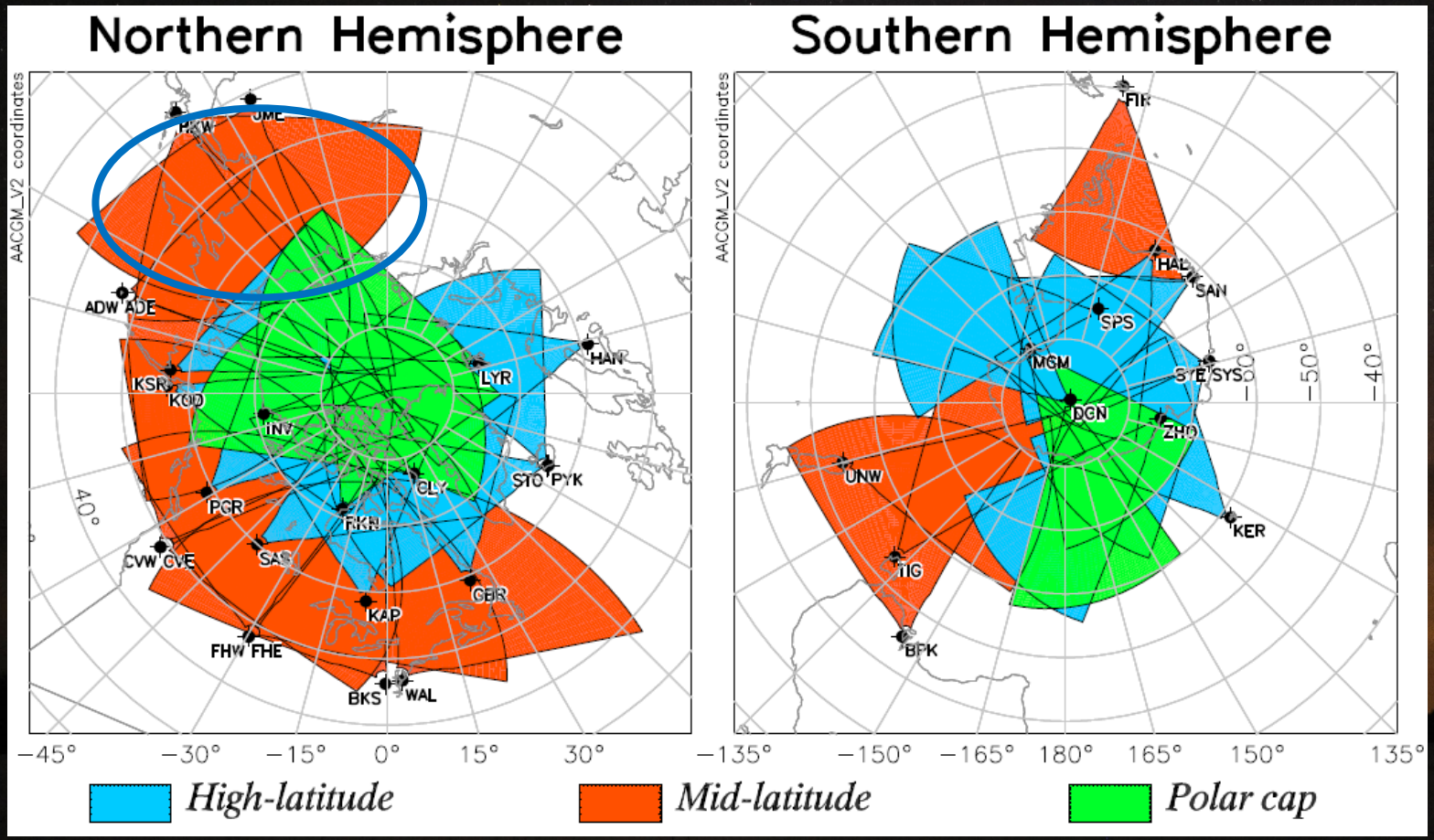
# 極域・中緯度SuperDARN研究集会




世話人: 西谷　望(名大ISEE)・行松　彰(NIPR)

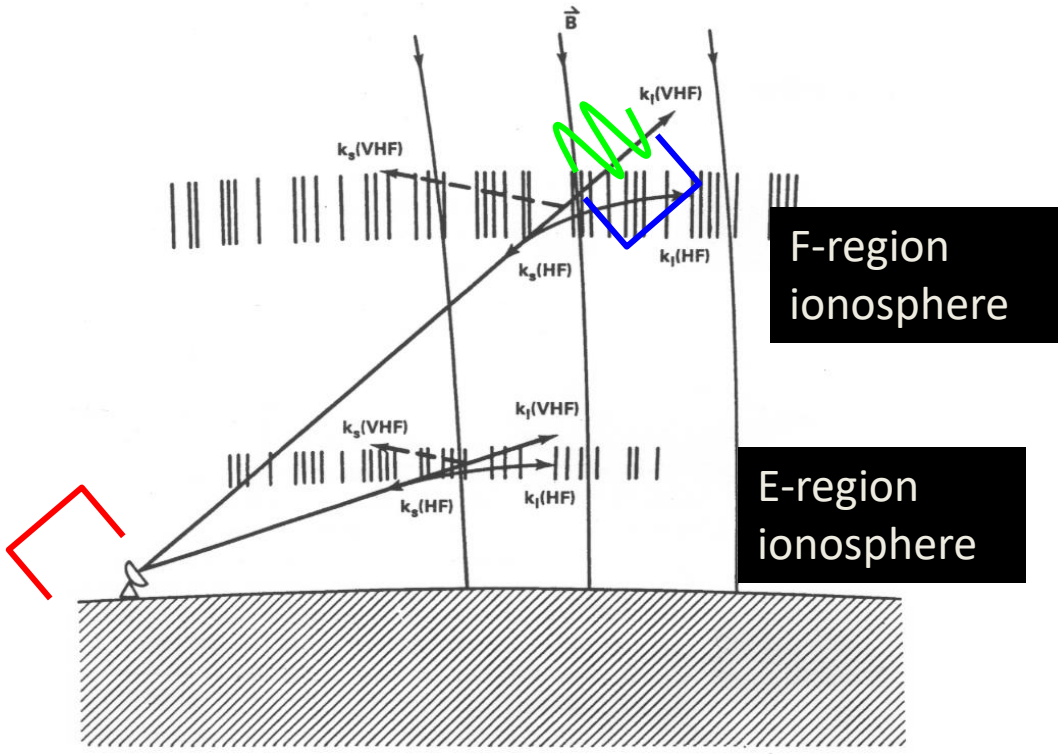
# SuperDARN HOPレーダーの現況報告




西谷　望・堀　智昭(名大ISEE)

Low latitude aurora behind the SuperDARN HOP East radar (2015.3.17 1610 UT)

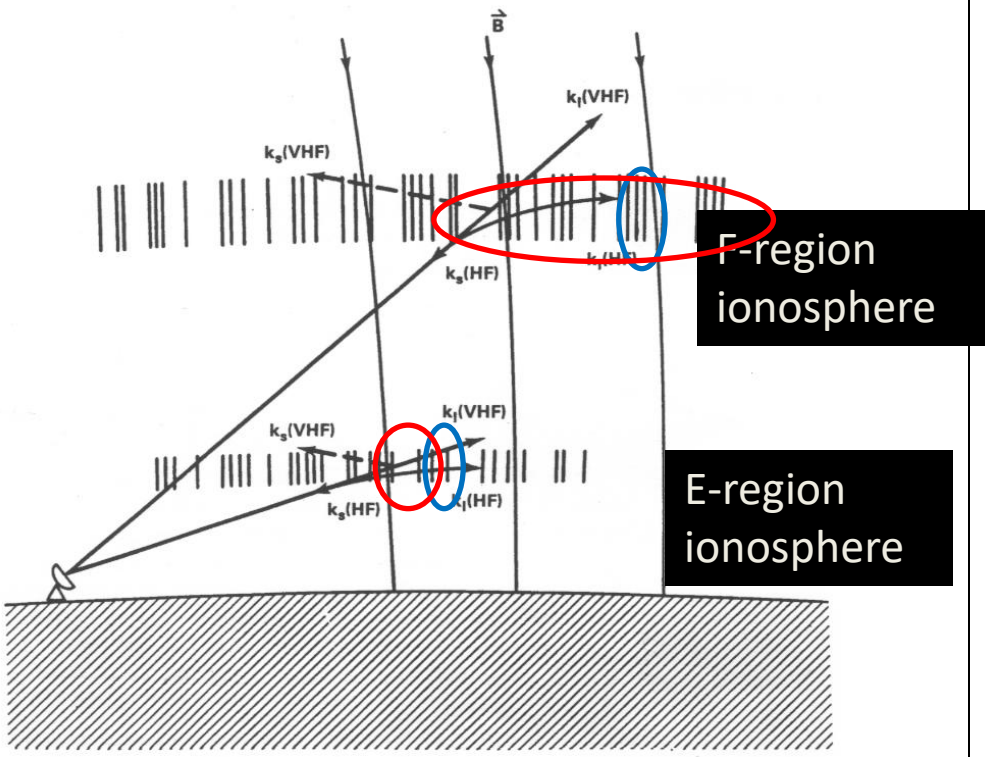
# High Frequency (HF) radar: measurement of ionospheric convection velocity using Ionospheric scatter




Adapted from Greenwald et al., SSR, 1995.

- Emit the radar wave toward the ionosphere.
- Waves are backscattered by ionospheric irregularities.
- Using Doppler shifts, ionospheric convection velocities can be measured.

# High Frequency (HF) radar: measurement of ionospheric convection velocity using Ionospheric scatter



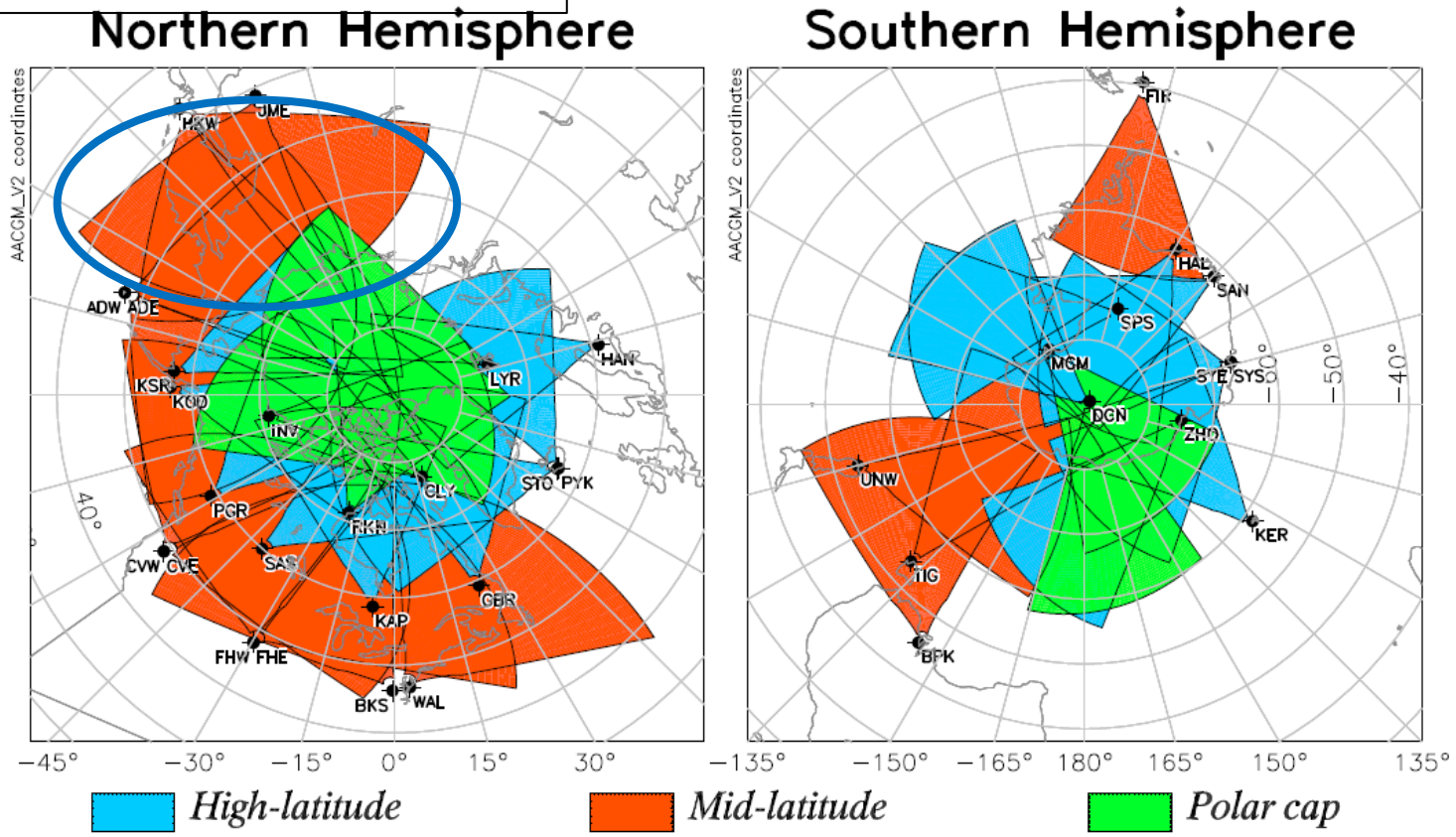

Adapted from Greenwald et al., SSR, 1995.

- Note: at the backscatter region, the radar wave vector should be perpendicular to the ambient geomagnetic field
- Thank to the reflection at ionospheric height, HF radars can cover much wider regions than VHF radars, so that it is possible to monitor ionospheric dynamics over much larger areas – Ray Greenwald magic

# Super Dual Auroral Radar Network (SuperDARN)

From vt.superdarn.org website

Standard temporal resolution: 1-2 min




Number of operating HF radars: 38 (24 in the northern and 14 in the southern hemispheres) as of Nov 01, 2020, operated under the cooperation of about 10 countries

The radars use basically the same hardware architecture, same operation software, same schedule, same data format and same data analysis software, provide important information for the space weather / geospace dynamics studies.

# Thomas and Shepherd (JGR, 2018): SuperDARN in 2004 (left) and in 2016 (right)

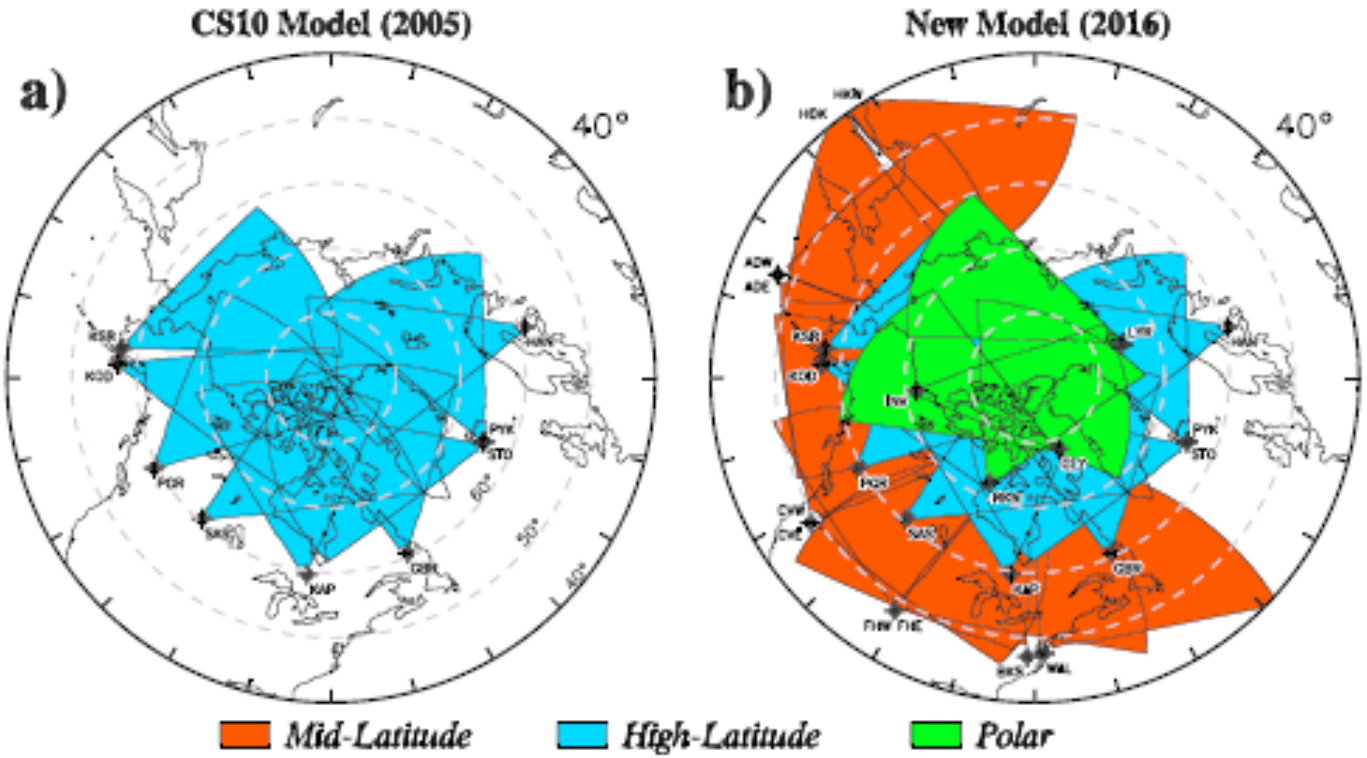


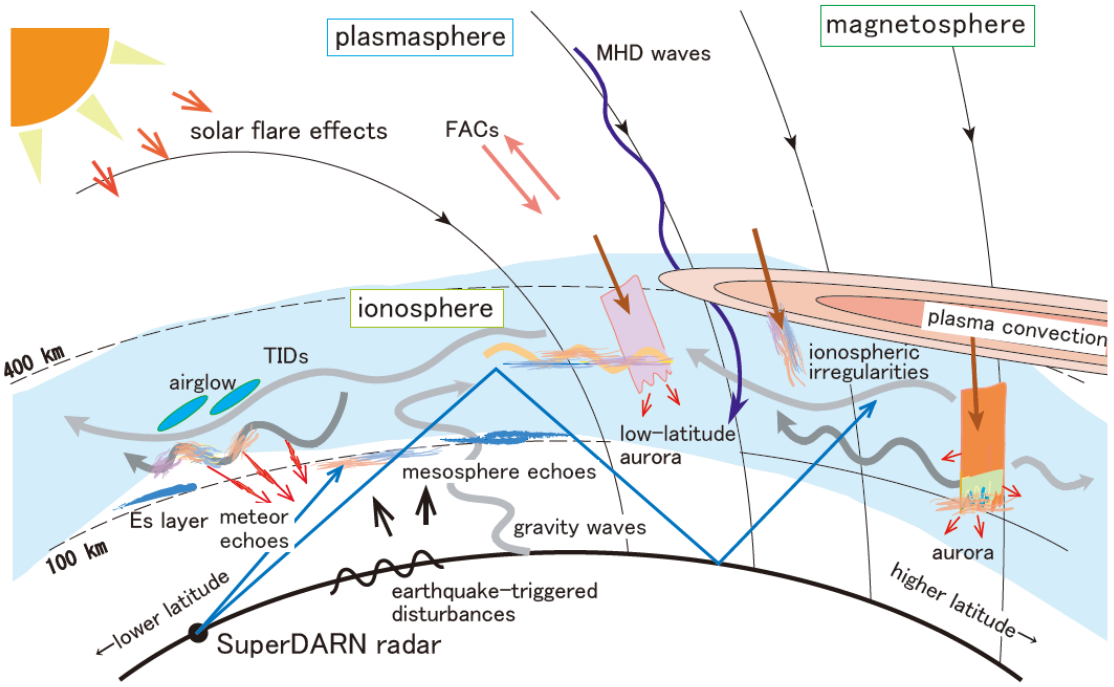

**Figure 2.** Fields of view of the Northern Hemisphere Super Dual Auroral Radar Network radars contributing to the (a) CS10 model and (b) new statistical model in geomagnetic coordinates. Dates in parentheses indicate the final year considered by each model. Mid-latitude, high-latitude, and polar radar fields of view are shaded orange, blue, and green, respectively. Detailed information regarding each radar site is provided in Table 1.

# Review of the accomplishments of mid-latitude SuperDARN

(Nishitani et al., 2019, https://doi.org/10.1186/s40645-019-0270-5)

1. Introduction
2. Convection
3. Ionospheric Irregularities
4. HF Propagation Analysis
5. Ion-Neutral Interactions
6. MHD waves
7. Future directions

Suppl. Historical overview

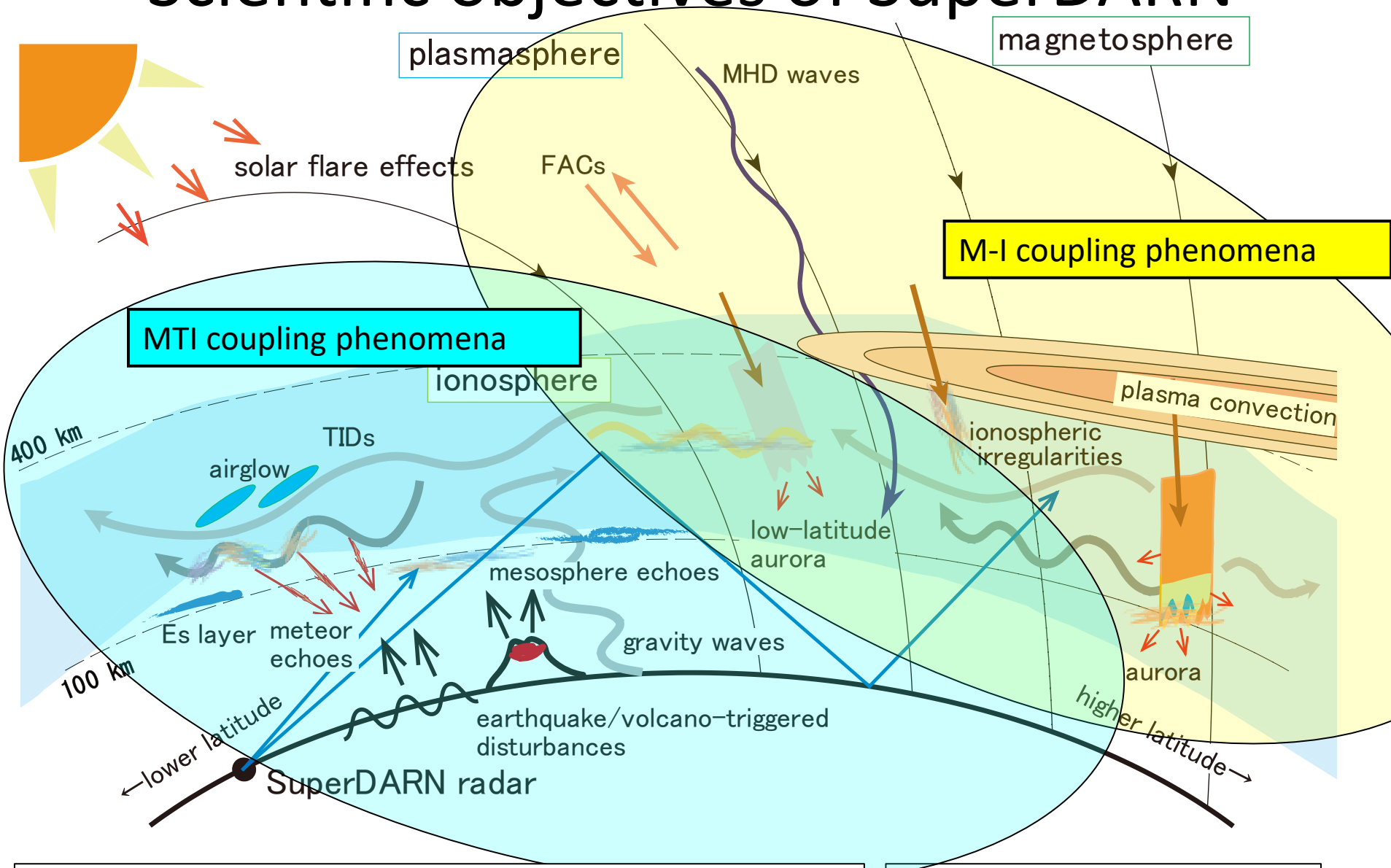



PEPS Most Cited Paper Award 2021 –
13k downloads (SpringerOpen),
222 citations (google scholar)

2025/03/19

Published: 18 March 2019, correction published: 30 July 2019

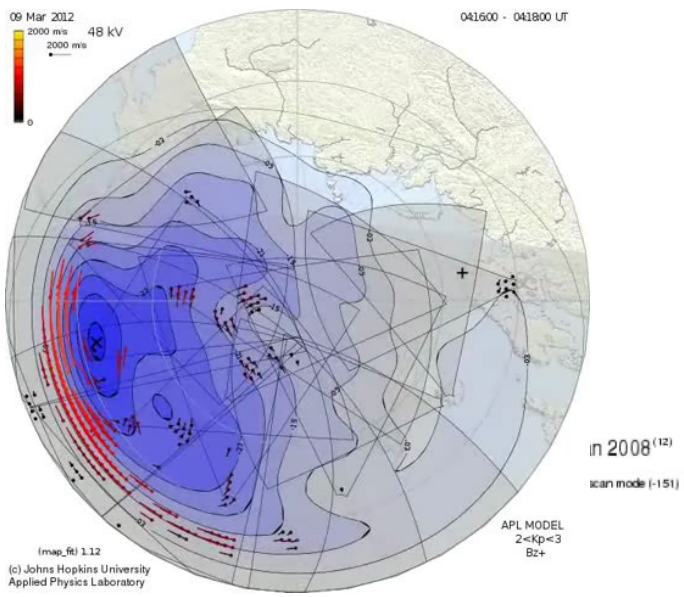
# Scientific objectives of SuperDARN



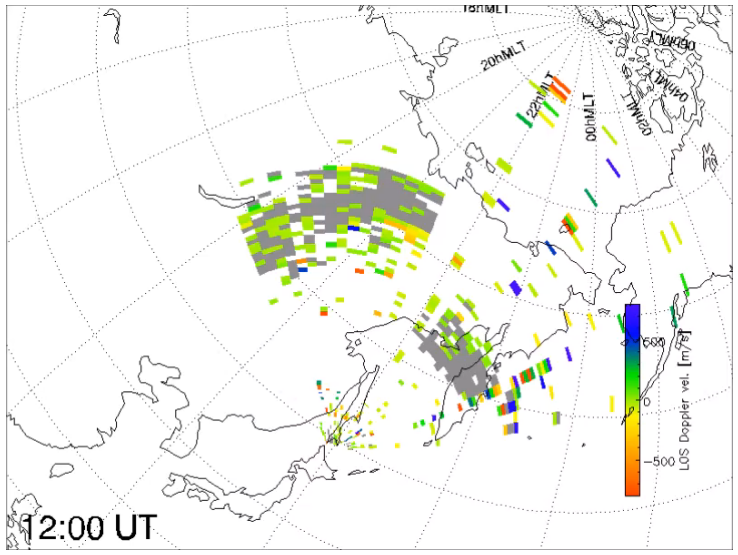

It is important to identify the effects both from above and below the ionosphere.

Modified from Nishitani et al. (PEPS, 2019)

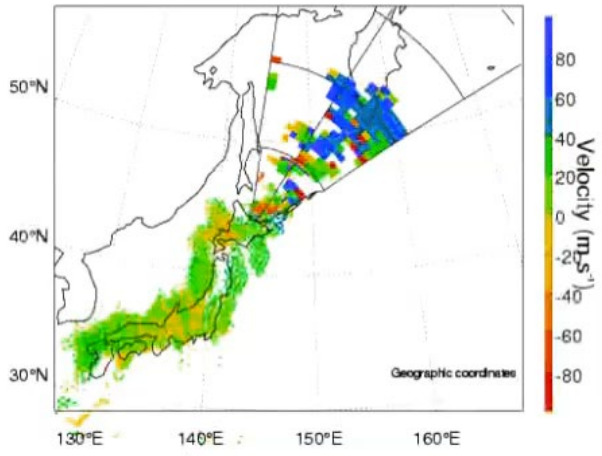
# Examples of SuperDARN radars observations



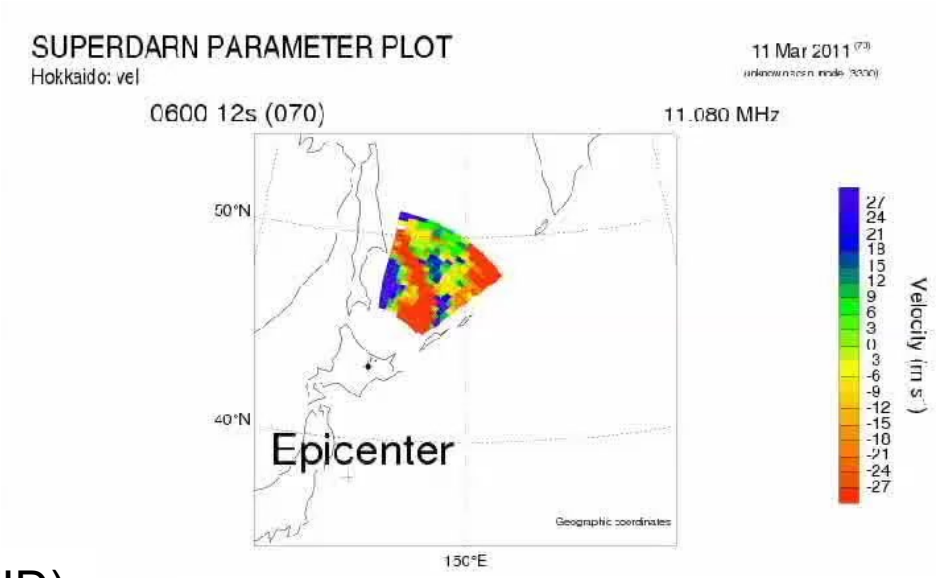

Global convection (SuperDARN)




Sub-Auroral Polarization Streams




Traveling Ionospheric Disturbances (TID) (+GEONET)




Coseismic Ionospheric Disturbances

# Ionospheric scatter (a,b) and ground / sea scatter (c) echoes

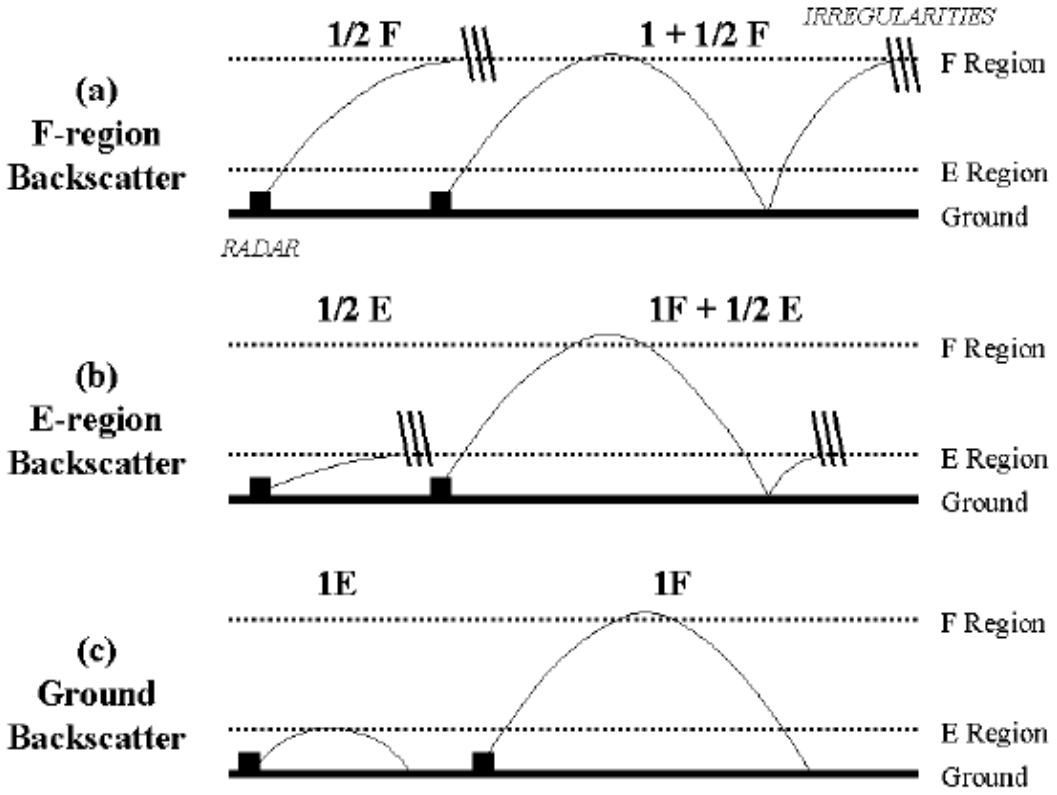


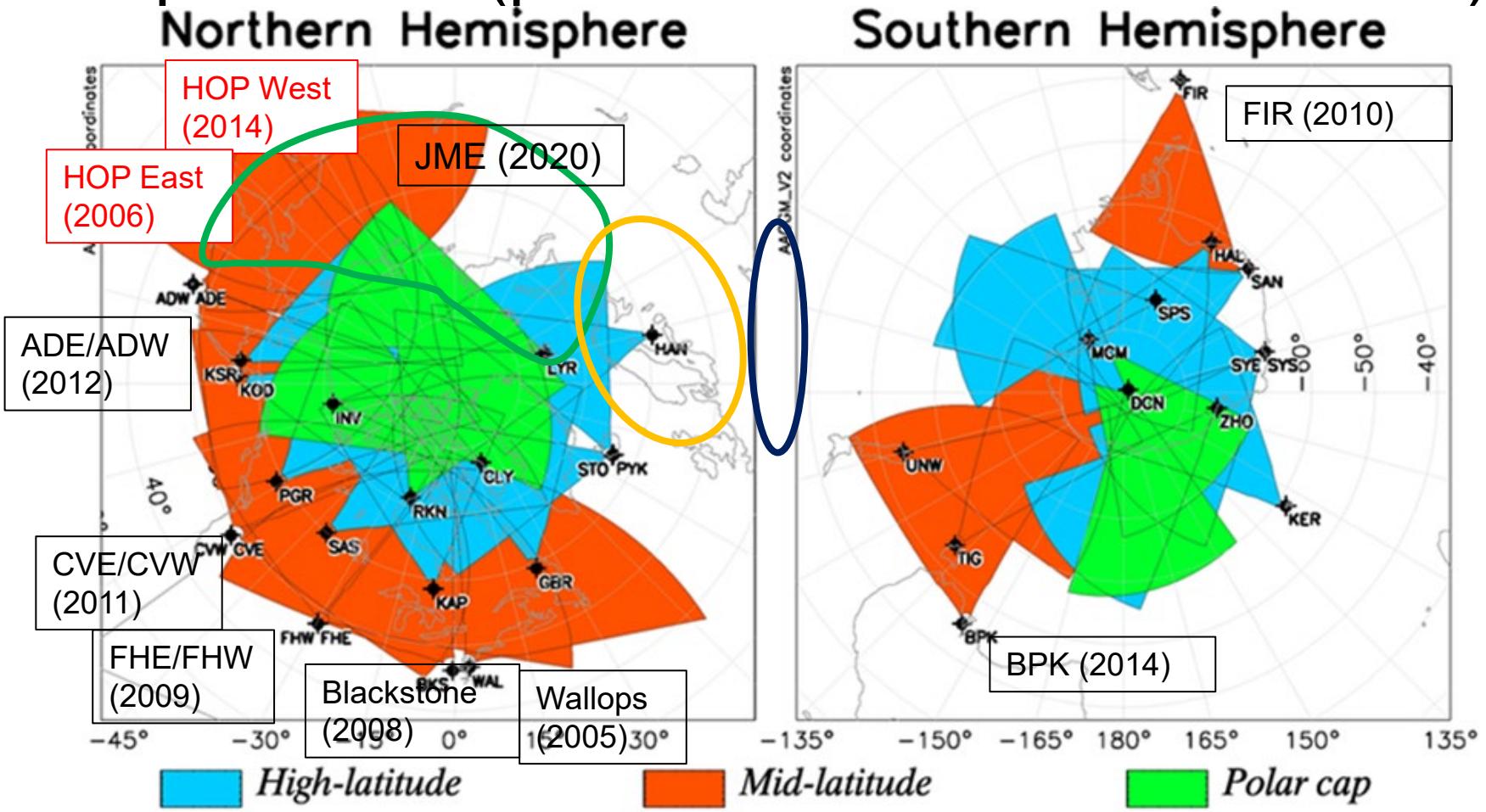

**Fig. 1.** Schematic diagram representing the typical propagation modes of SuperDARN HF radar signals backscattered from **(a)** F-region irregularities, **(b)** E-region iregularities, and **(c)** the ground.

Chisham and Pinnock, Ann. Geo., 2002

# SuperDARN history: high-, mid- and low/equatorial latitudes

| Region | Auroral lat. | Mid-lat. | Polar lat. | Low / eq. lat. |
|---|---|---|---|---|
| 1980s | First HF radar at Goose Bay (1983) Greenwald et al. (1985) – design | | | |
| 1990s | Official beginning of SuperDARN (1995) Greenwald et al. (1995) – Overview of SuperDARN | | | |
| 2000s | Chisham et al. (2007) – review of (mainly high-lat.) SuperDARN | First mid-latitude SuperDARN at Wallops (2005) | First PolarDARN at Rankin Inlet (2007) | |
| 2010s | | Nishitani et al. (2019) – review of mid-latitude SuperDARN | | |
| 2020s - | | | | First equatorial SuperDARN in 2020s? |

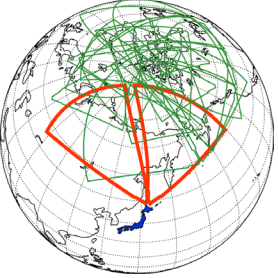
# Further Expansion of (mid- and low-latitude) SuperDARN (planned or under construction)




China

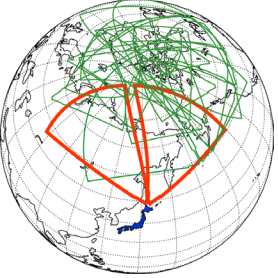
Europe

USA-Nigeria



# SuperDARN HOP radars (- Jul 2024)

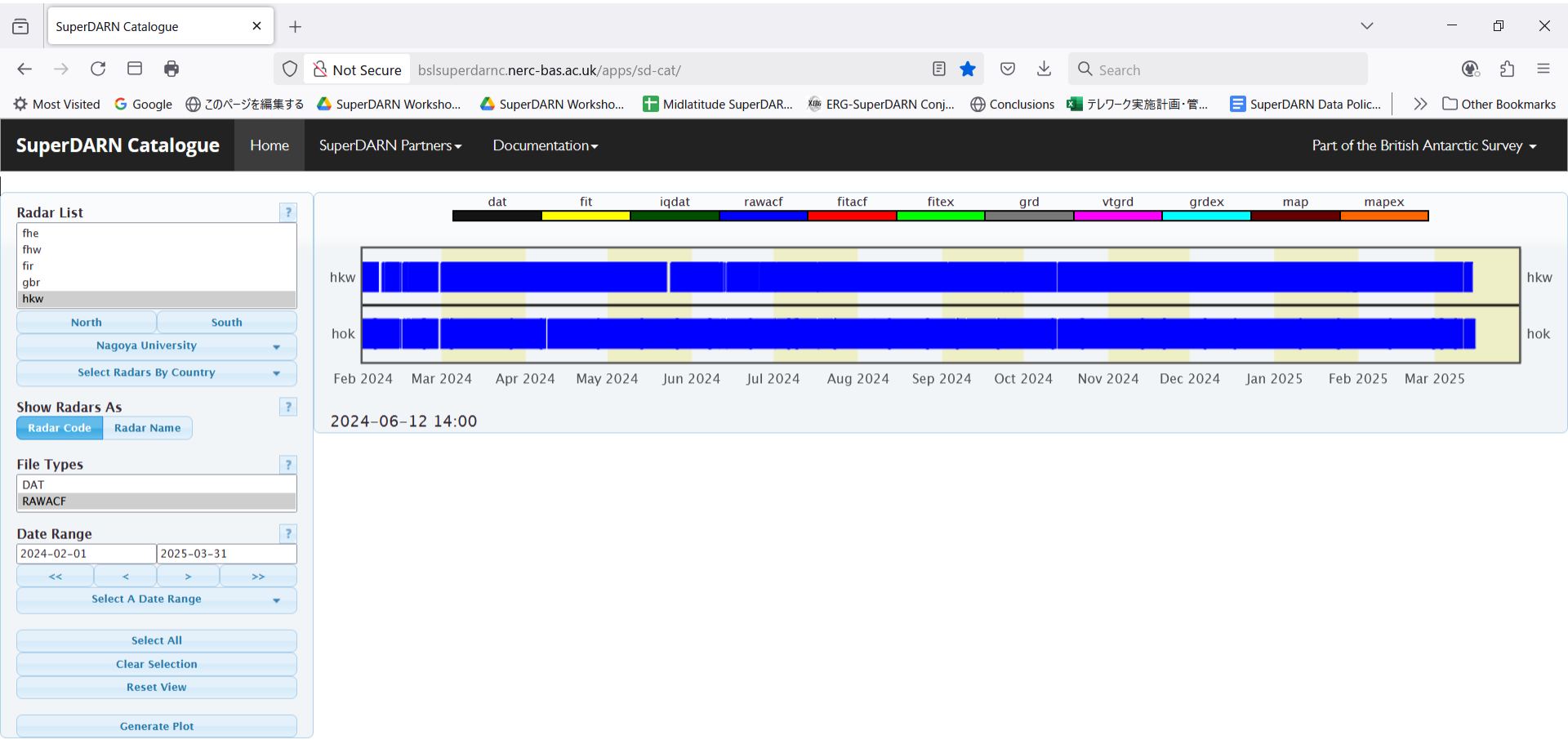
- Visit to the radar site (Jul 16-19). All the antennas were working properly, without serious problems (first time in recent years).
- 2 HKW transmitters looked faulty (F6@12/20MHz and F7@20MHz and F6) in their receiver LPF performance. All the transmitters' power were appropriate although some of them looked unstable (sometime enough power, sometimes no power).
- The plan of implementing a full imaging capability at the HOK radar is in progress (we get Kakenhi funding from 2022 FY).
- Erroneous connection was found at HKW BASBOX (ChA, Tx out -> Tx/Rx). It was corrected on Jul 18.
- The network to the radar site often becomes faulty (Jun – Jul).



# SuperDARN HOP radars (Aug 2024-Jan 2025)

- Visit to the radar site (Sep 23-26) again. All the antennas were working properly, without serious problems.
- 2 HKW transmitters looked faulty (F6 / F9) (V/F and REL error lamps were on) but the POW lights were on. I suppose that it is OK.
- In January 2025, the synth unit became faulty, but it recovered by itself. We still do not know the reason for the fault.
- The plan of implementing a full imaging capability at the HOK radar is in progress (we get Kakenhi funding from 2022 FY).
- The network to the radar site often becomes faulty, although it is relatively stable recently.
- On February 14 (yesterday) we visited the site and confirmed that all the instruments were working properly.

# HOP radars archive (2024.02-2025.03)




Author: British Antarctic Survey - UK Polar Data Centre, NERC 2017

# Implementation of imaging capability on some of the SuperDARN radars

- Several SuperDARN groups, including Nagoya Univ. (HOP East), are working on the plan of implementing a receiver on each antenna input and making post beam forming, so that temporal and spatial resolutions are improved by several times.
- There is still no standard way to achieve this.
- After the completion of such implementation, a new issue arises – how to handle / distribute a huge amount of data?

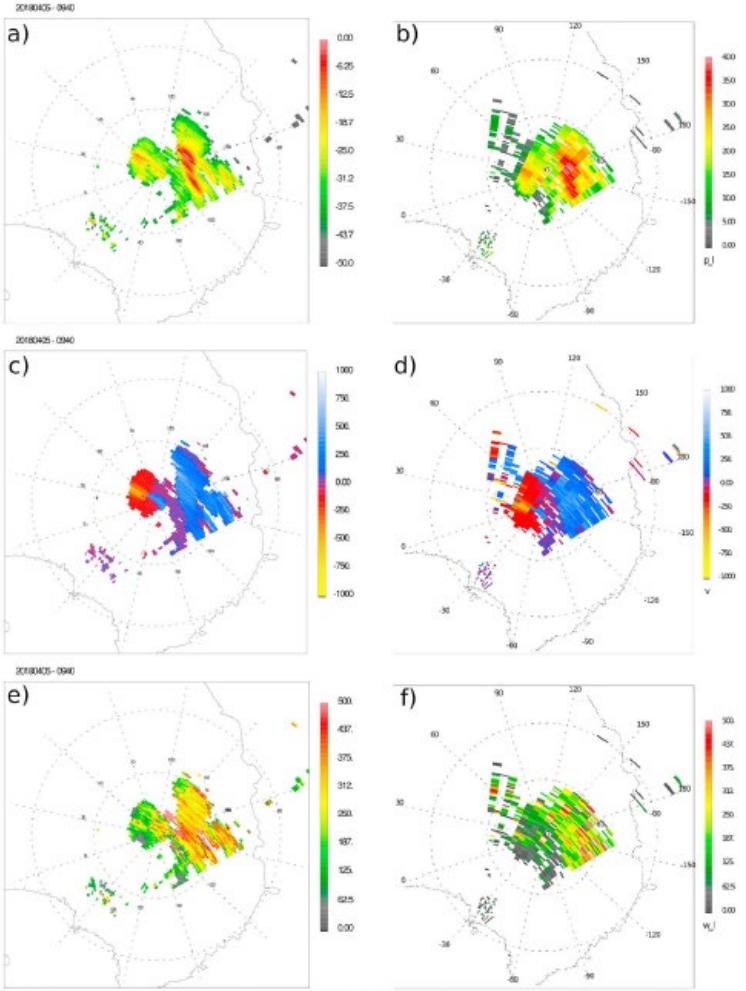
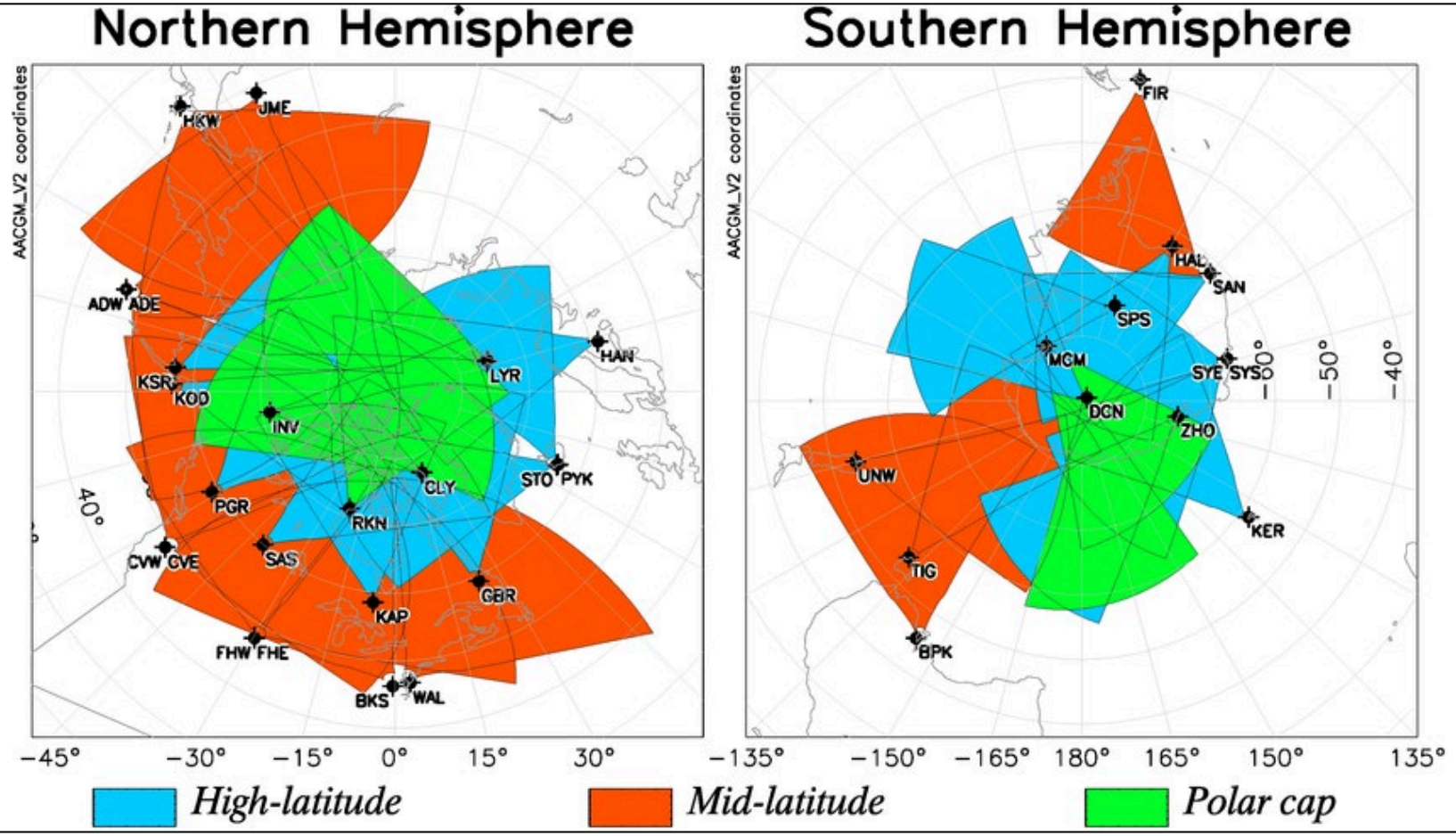



**Figure 9.** Left column shows imaging analysis, and right column shows standard Super Dual Auroral Radar Network processing of the same observations from the McMurdo radar at 0940 UT on 5 April 2018. The top row (panels a and b) shows signal-to-noise ratio, the middle row (panels c and d) shows velocity in meters per second, and the third row shows spectral width in meters per second.

See Nishitani et al., SGPESS 2023, R011-P05

Bristow et al., RS, 2019

# Super Dual Auroral Radar Network (SuperDARN)

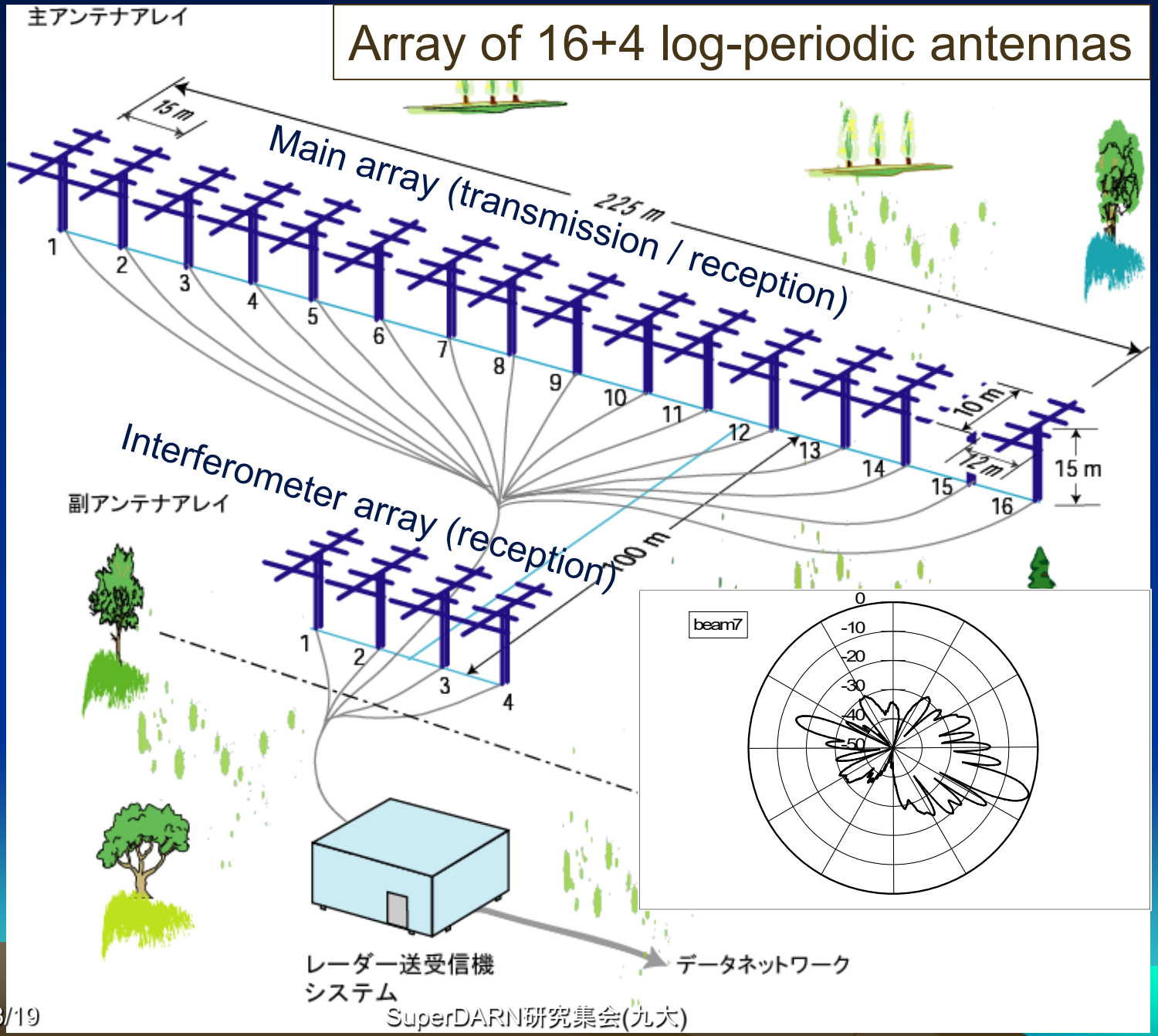



Number of operating HF radars: 38 (24 in the northern and 14 in the southern hemispheres) as of Jul 01, 2020, operated under the cooperation of about 10 countries

Standard temporal resolution: 1-2 min (Nyquist freq.: 4-8 mHz)

The radars use basically the same hardware architecture, same operation software, same schedule, same data format and same data analysis software

# Array of 16+4 log-periodic antennas



# Beam forming

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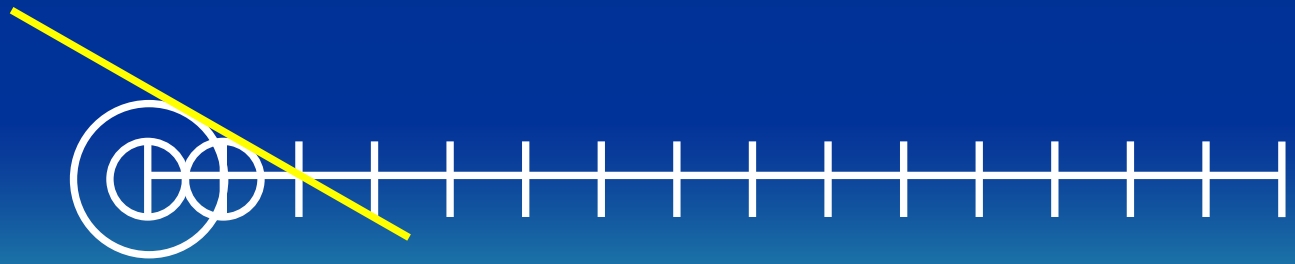
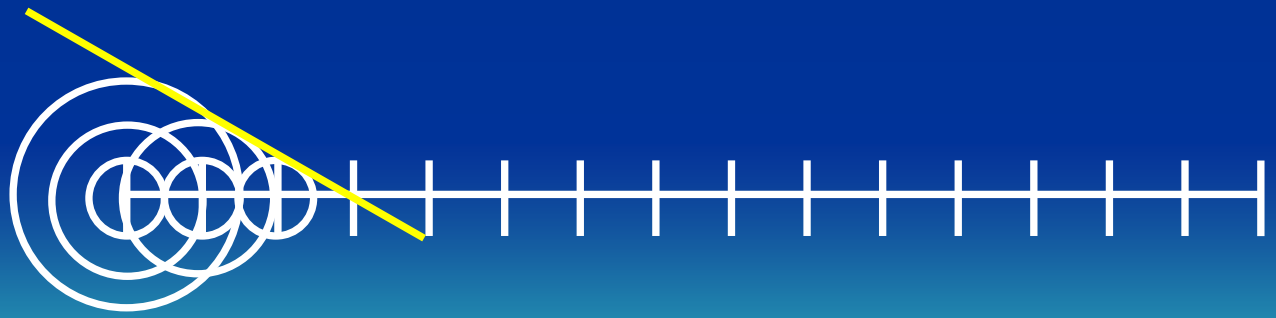
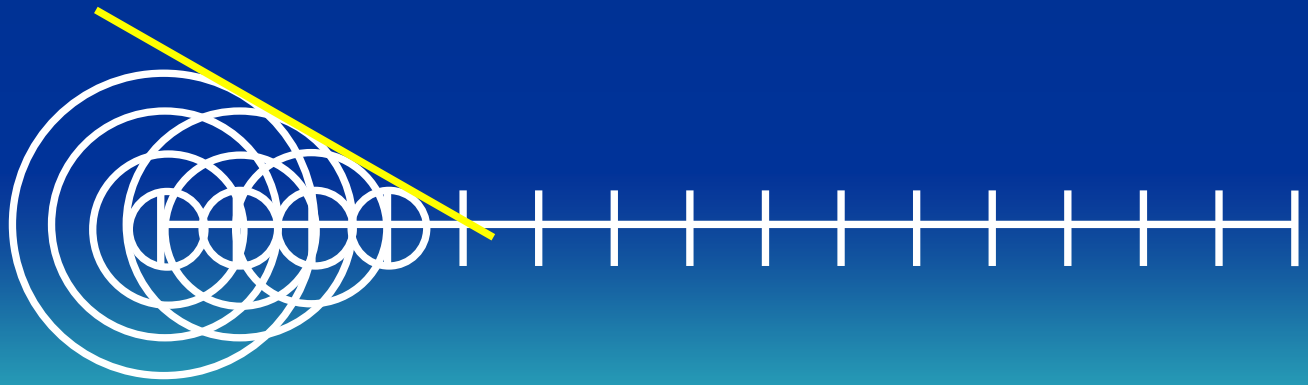
# Beam forming



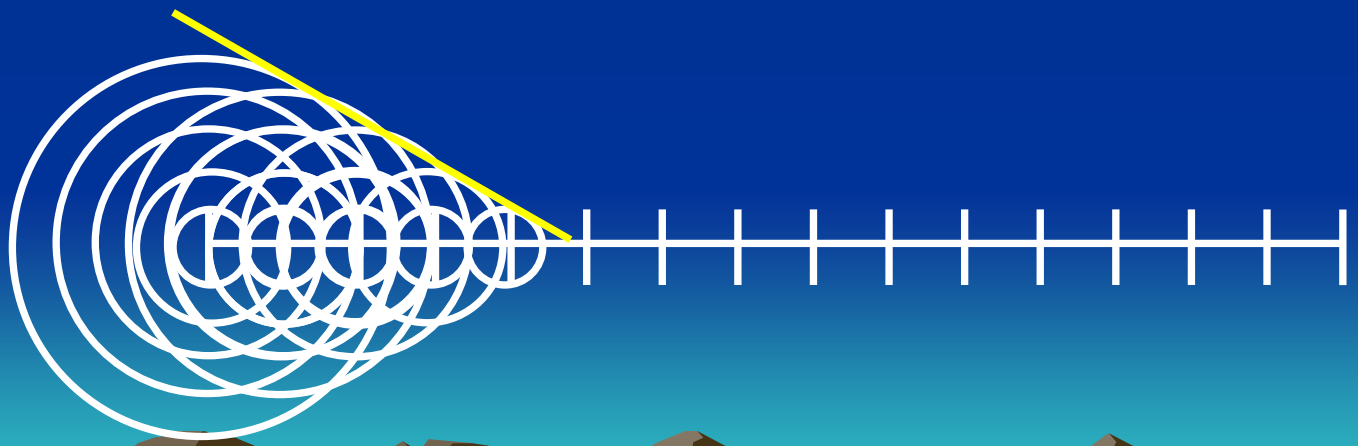
# Beam forming



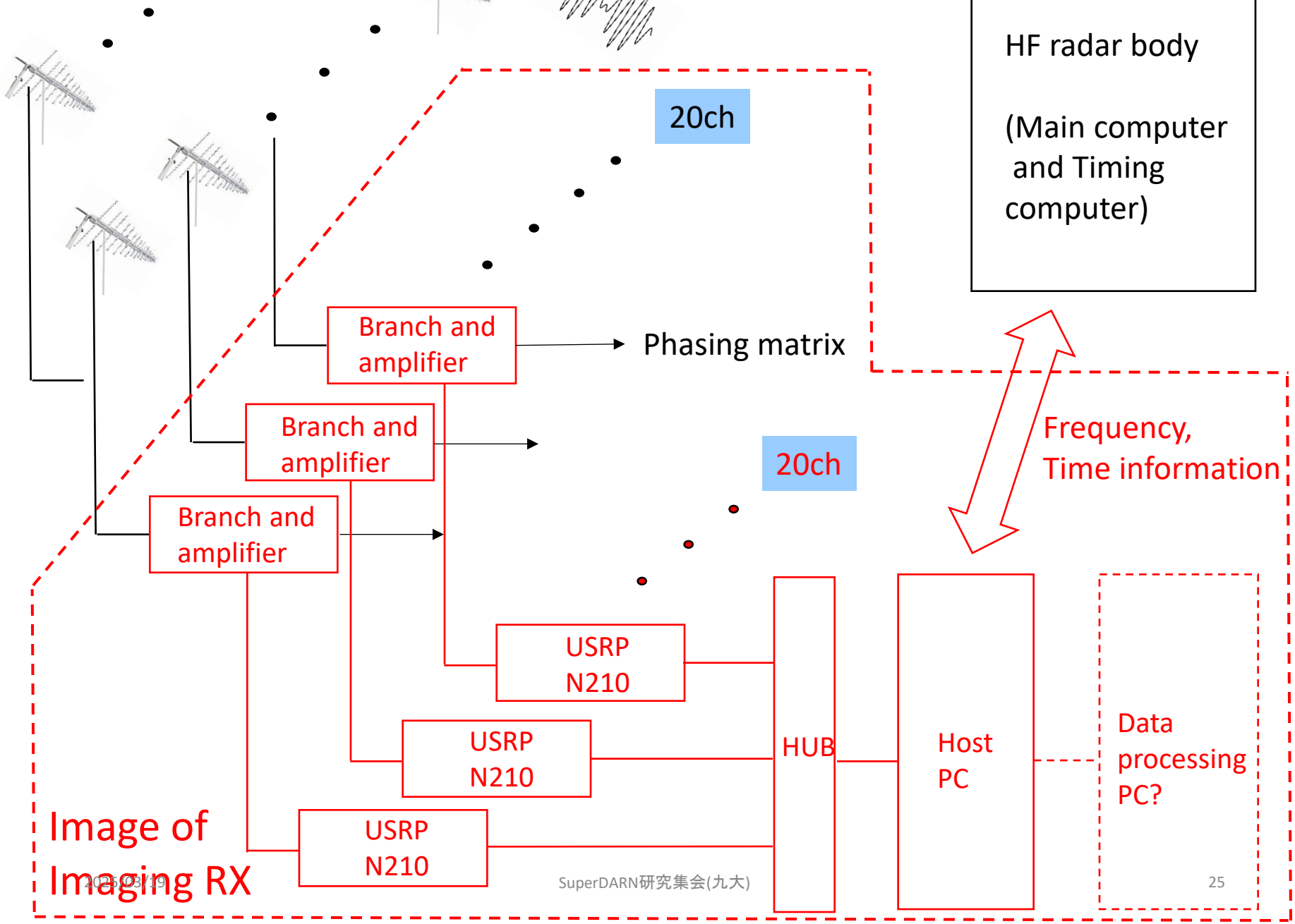
# Beam forming



# Beam forming

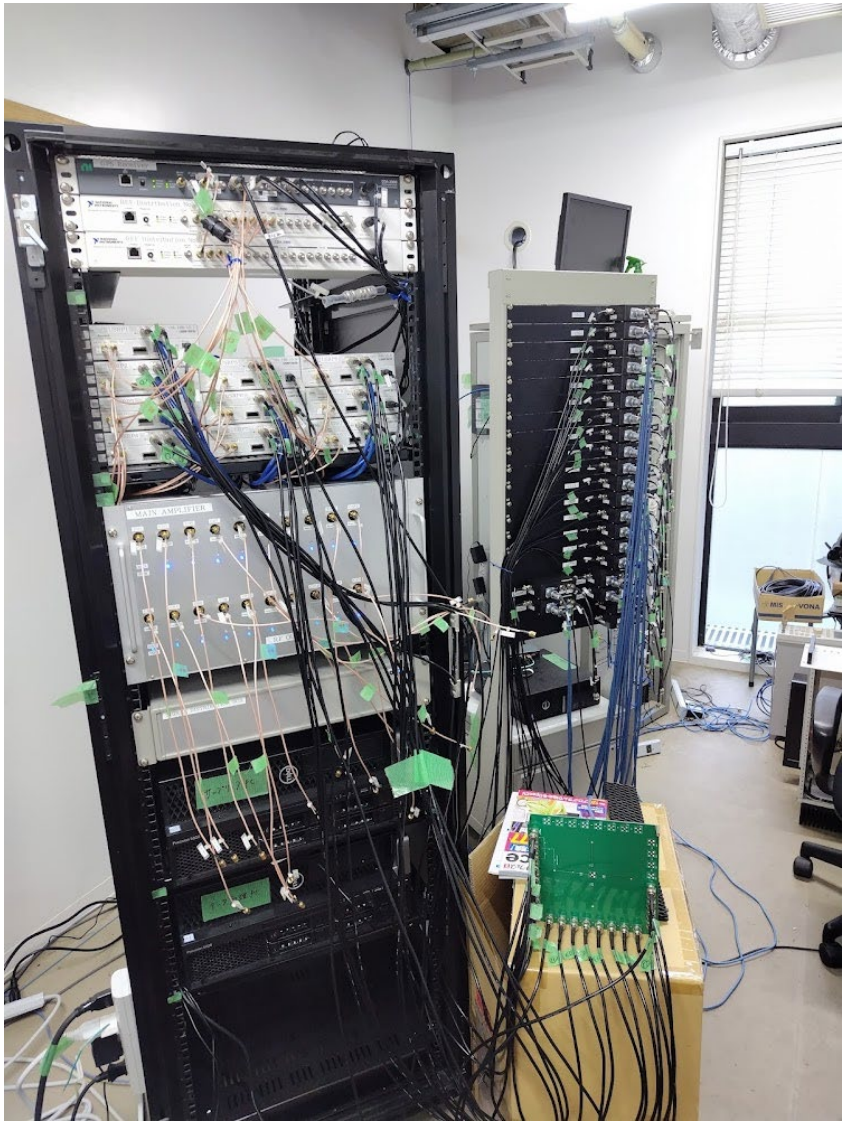


# Plan of installing full-spec imaging receivers



# Progress of the imaging system

- We almost completed the production of:
  - Head amplifier x20
  - Main amplifier box x1
  - Signal splitter box x1
  - Interface box x1
  - Etc.

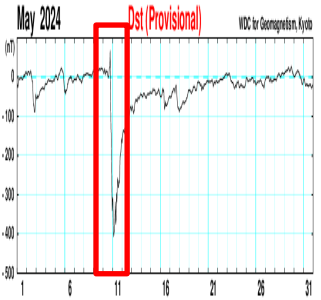


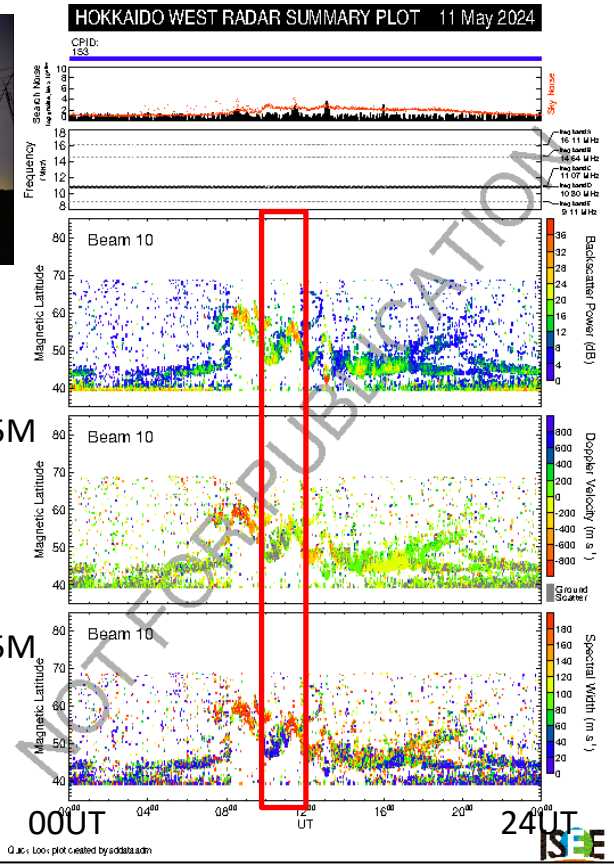
2025.2.21

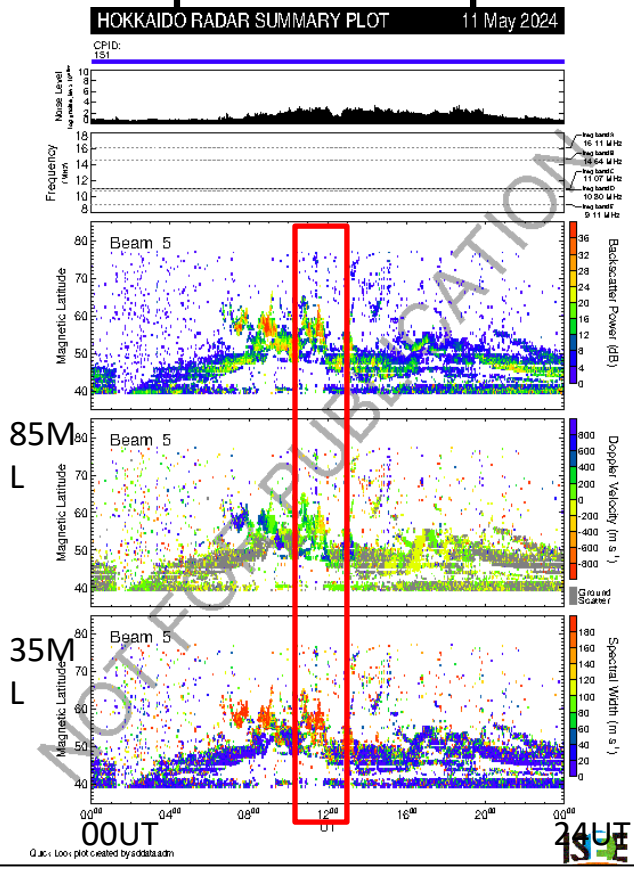
# May 11, 2024

LT=UT+9 hrs

# Hokkaido West / East quicklook plots

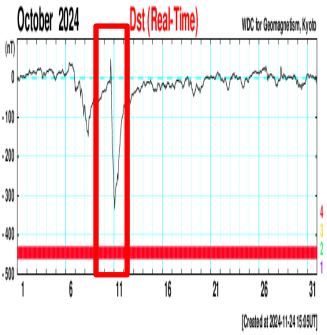



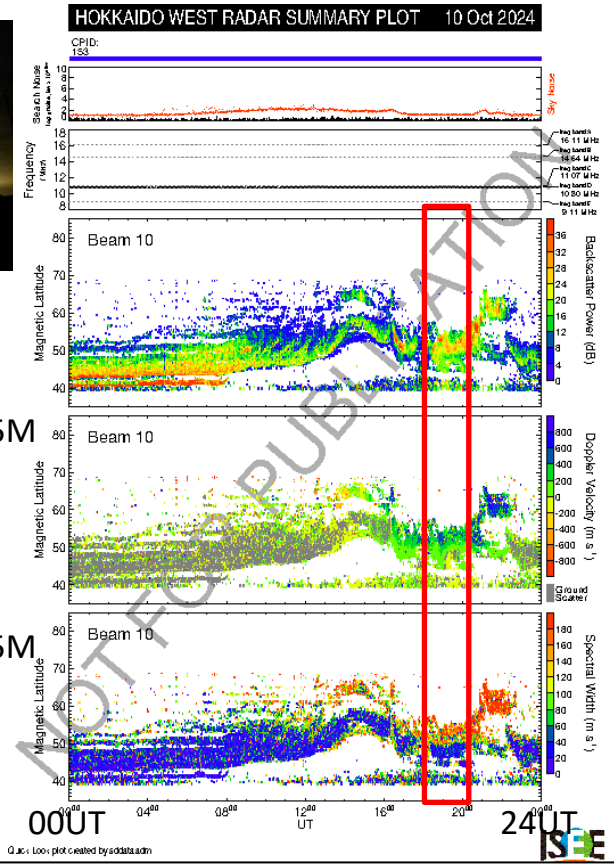

SuperDARN Quicklook plots at: http://cicr.isee.nagoya-u.ac.jp/hokkaido/

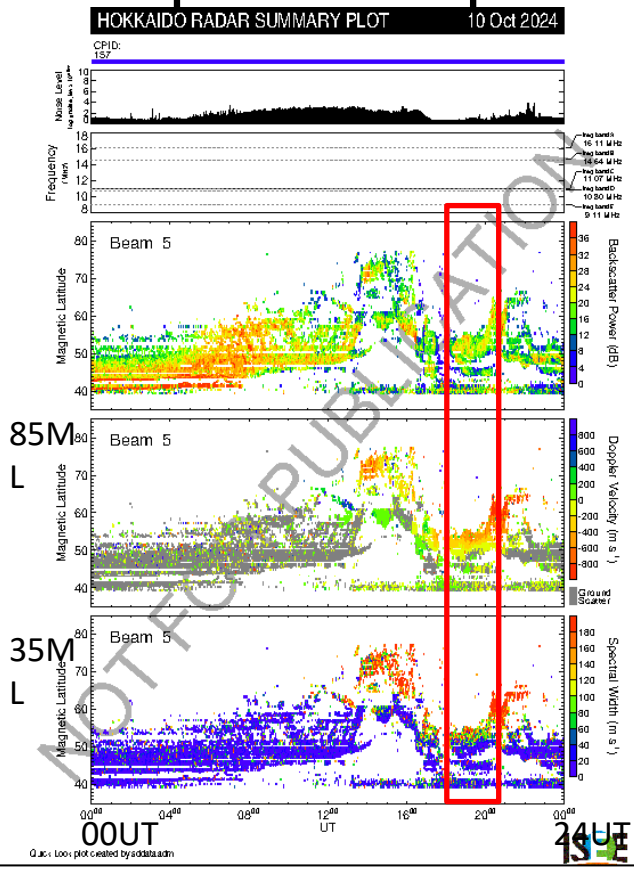
# Oct 10, 2024

LT=UT+9 hrs

# Hokkaido West / East quicklook plots

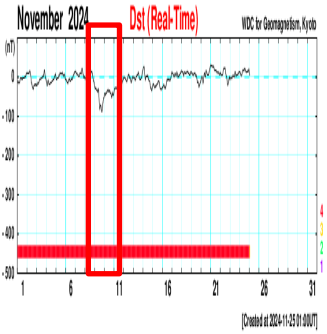



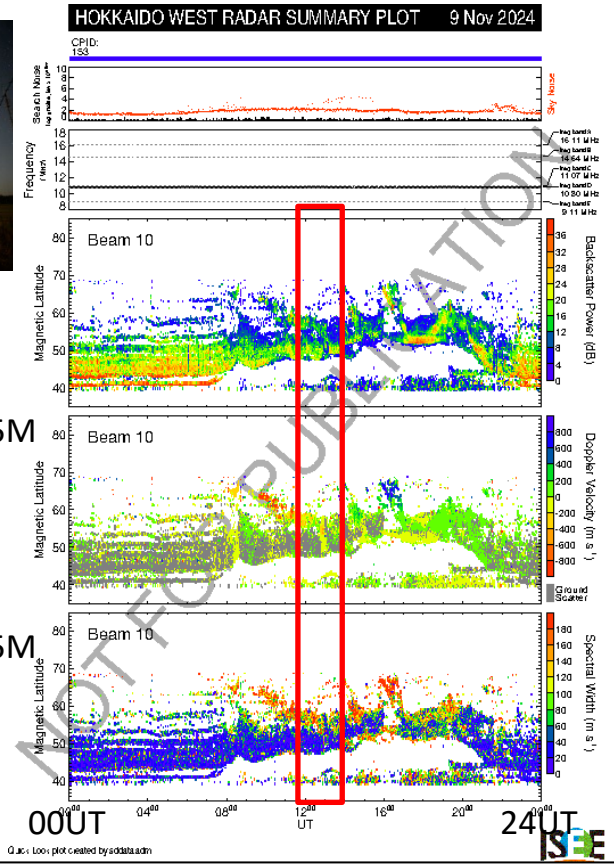

SuperDARN Quicklook plots at: http://cicr.isee.nagoya-u.ac.jp/hokkaido/

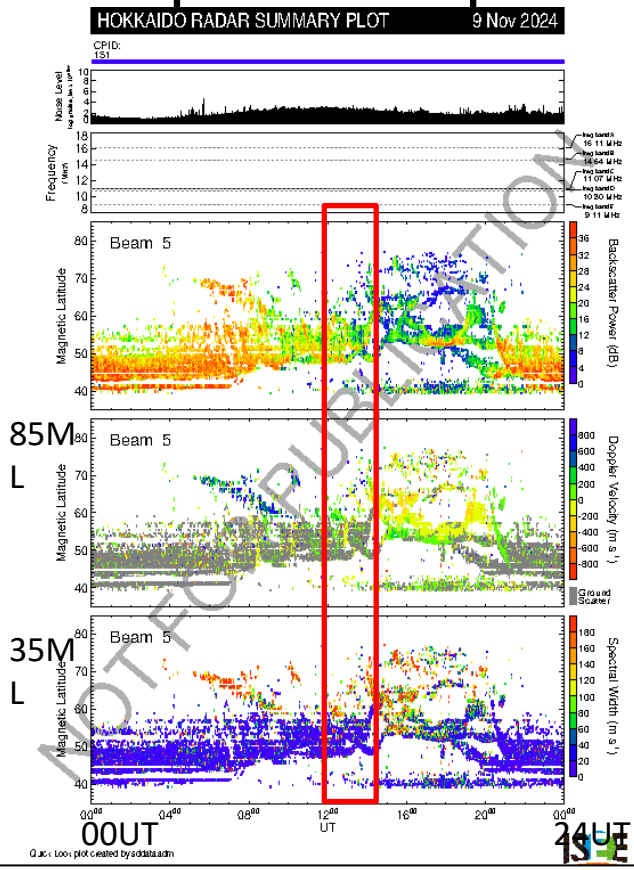
# Nov 09, 2024

LT=UT+9 hrs

# Hokkaido West / East quicklook plots

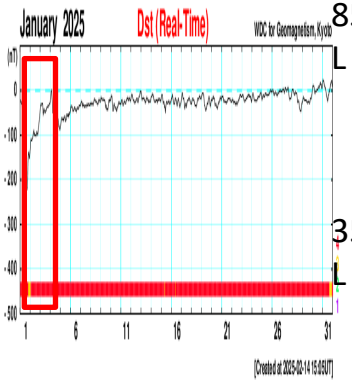



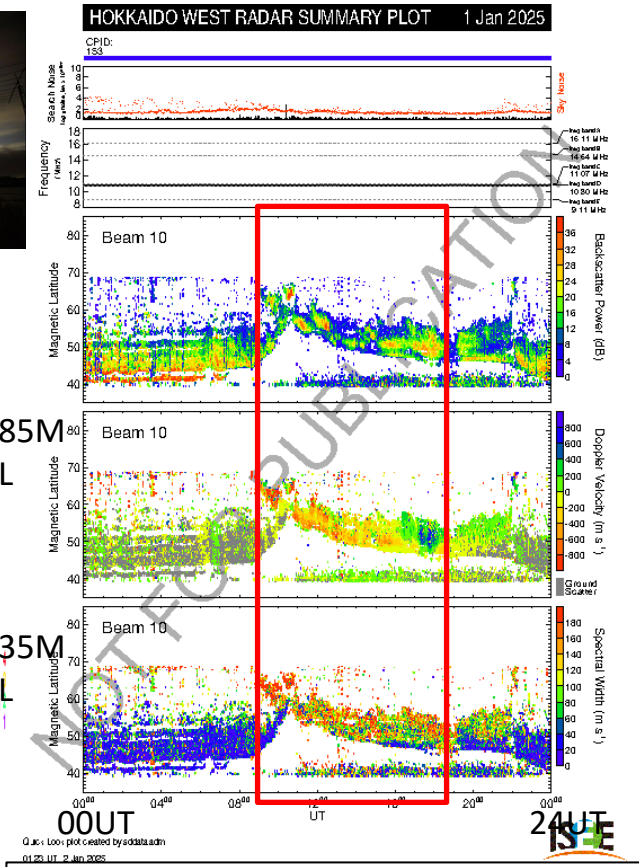

SuperDARN Quicklook plots at: http://cicr.isee.nagoya-u.ac.jp/hokkaido/

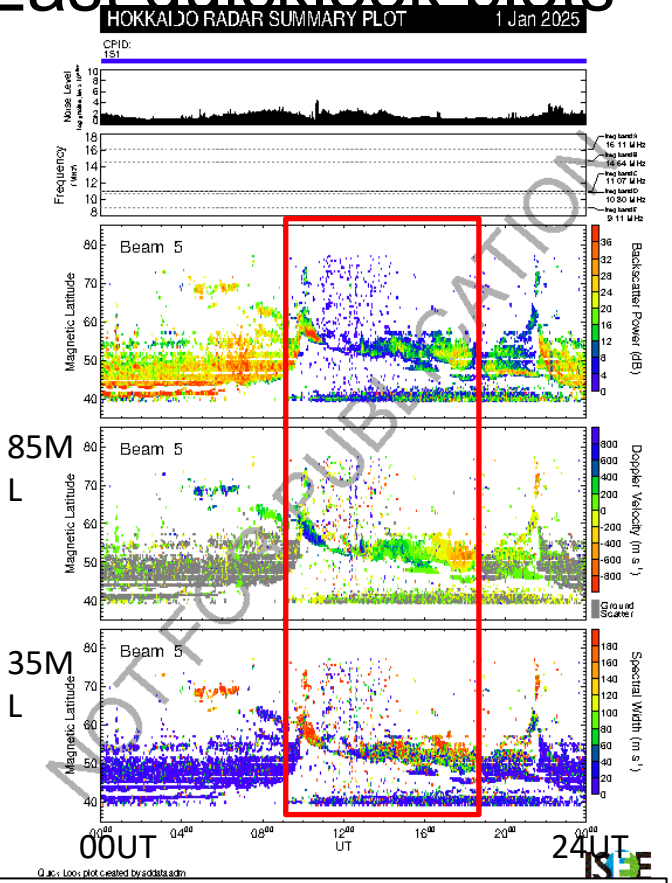
# Jan 01, 2025

LT=UT+9 hrs

# Hokkaido West / East quicklook plots


SuperDARN Quicklook plots at: http://cicr.isee.nagoya-u.ac.jp/hokkaido/

# Summary

- SuperDARN Hokkaido East / West radars have been operating pretty well.
- We are funded for the development of the imaging receiver system (2022-2027FY). The system is under development.
- Topics during this meeting:
  - **Mar 19**
  - **Nishitani et al., Overview of HOP radars (this talk)**
  - **Yukimatu et al., Overview of Syowa SENSU radars**
  - **Hayashi et al., Global electromagnetic responses to isolated substorms**
  - **Hatakeyama et al., Reconnection rate and CPCP from the model magnetosphere**
  - **March 21**
  - **Nakano et al., Polar convection modeling by the magnetosphere simulator and SuperDARN**
  - **Hosokawa et al., DUSE with ULF waves**
  - **Hori et al., 2023 Fall Arase-SD campaign: initial results**
  - **Watanabe et al., Nightside convection during northward IMF**
  - **Hayamizu et al., Development of HOK radar imaging data processing software**
  - **Hashizume et al., Analysis of USA receiver data of the HOK radar**
  - **Nishitani et al., Convection Associated with low-latitude aurora events**

# SuperDARN Executive Council meeting (March 10, 12-15 UT@Zoom)

- 1. Updates for the SuperDARN 2025 (Mike R. will join the meeting for the first 20 minutes)
  2. Updates for the SuperDARN 2026
  3. Discussion of the new SuperDARN Executive Council chair
  4. Report from the Data Policy Task Force / the meeting with Jesper and Rob, which Aurélie was going to present during the last PIs virtual meeting
  5. Issue of hardware.dat, AACGM, etc. (raised by Simon)
  6. Discussion of the MoU between SuperDARN and IMCP
  7. Discussion of WG and TF updates / possible new WG / TF (e.g., hardware WG / refractive index TF)
  8. Discussion of hardware purchase sourcing issue
  9. Discussion for the SuperDARN 2027?
  10. AOB

Subject: New Chair of The SuperDARN Executive Council
Date: Mon, 17 Mar 2025 18:51:07 +0900
From: Nozomu Nishitani

Dear SuperDARN colleagues,

It is usually the role of the pre-existing chair to send out this kind of message, but since the sad passing of Kathryn McWilliams,
Aurélie and I, the deputy chairs, are sending this message on her behalf.

On 10th March, the SuperDARN PI Executive Council elected a new chair.
We are delighted to announce that Dr. Gareth Chisham of the British Antarctic Survey has been unanimously elected.
The new deputy chairs will be announced soon.

Congratulations to Gareth!

Best regards,

Aurélie Marchaudon and Nozomu Nishitani