Coordinated Investigation of Antarctic Total Solar Eclipse (TSE) using SuperDARN HF Radars

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Outline

1. **Introduction**
   - Super Dual Auroral Radar Network (SuperDARN)
   - Geometry of the 4th December TSE and coordination of SuperDARN radar.
   - Science goals of the study.

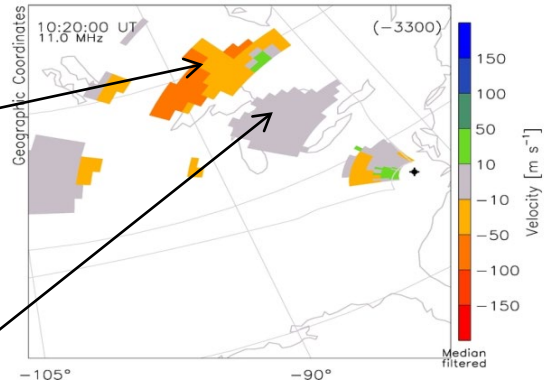
2. **Experiments**
   - Normal Sounding Mode.
   - Special Sounding Mode in 2nd Channel.

3. **Observations and Current Findings**

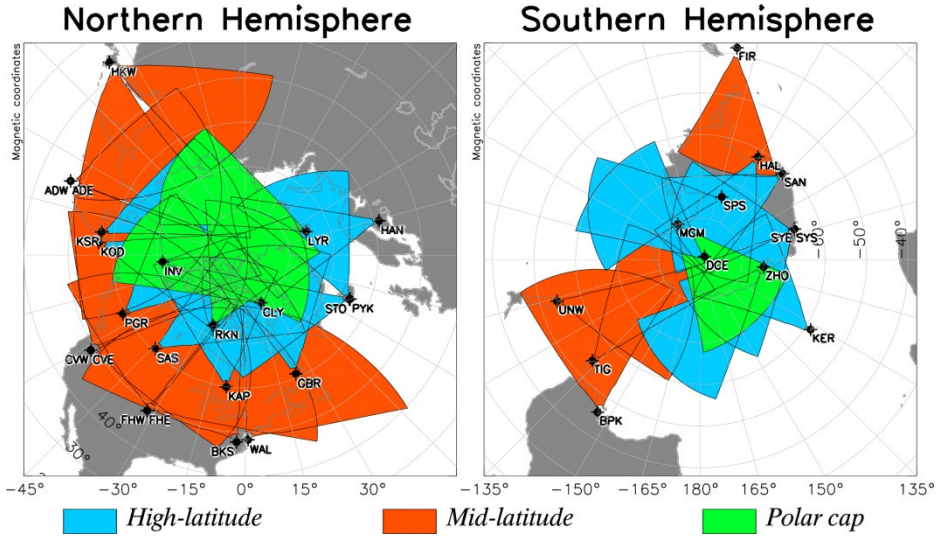
Instruments: SuperDARN HF Radar

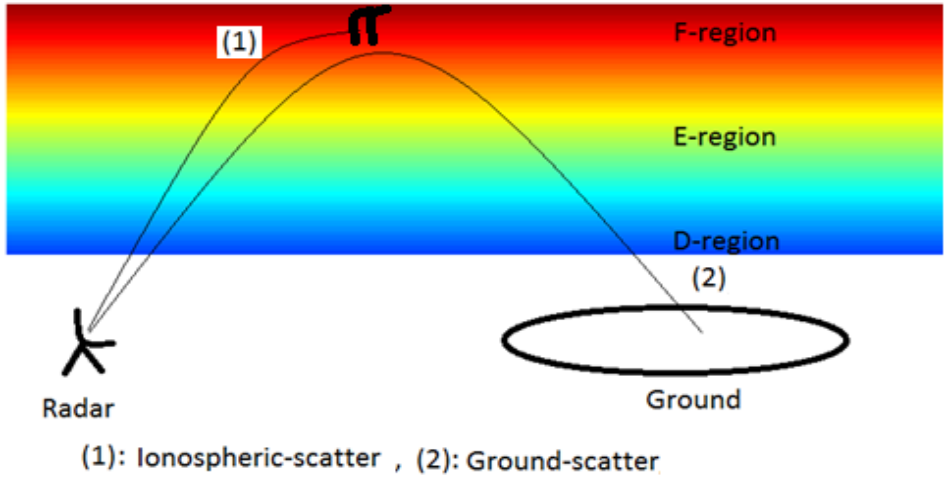
- SuperDARN: An international HF radar network that probes the Earth's upper atmosphere and ionosphere.

- There are two primary backscatter targets:
  1. Ionospheric scatter: Backscatter from ionospheric irregularity structures.
  2. Ground Scatter: Backscatter from the Earth's surface.



Radar Scan

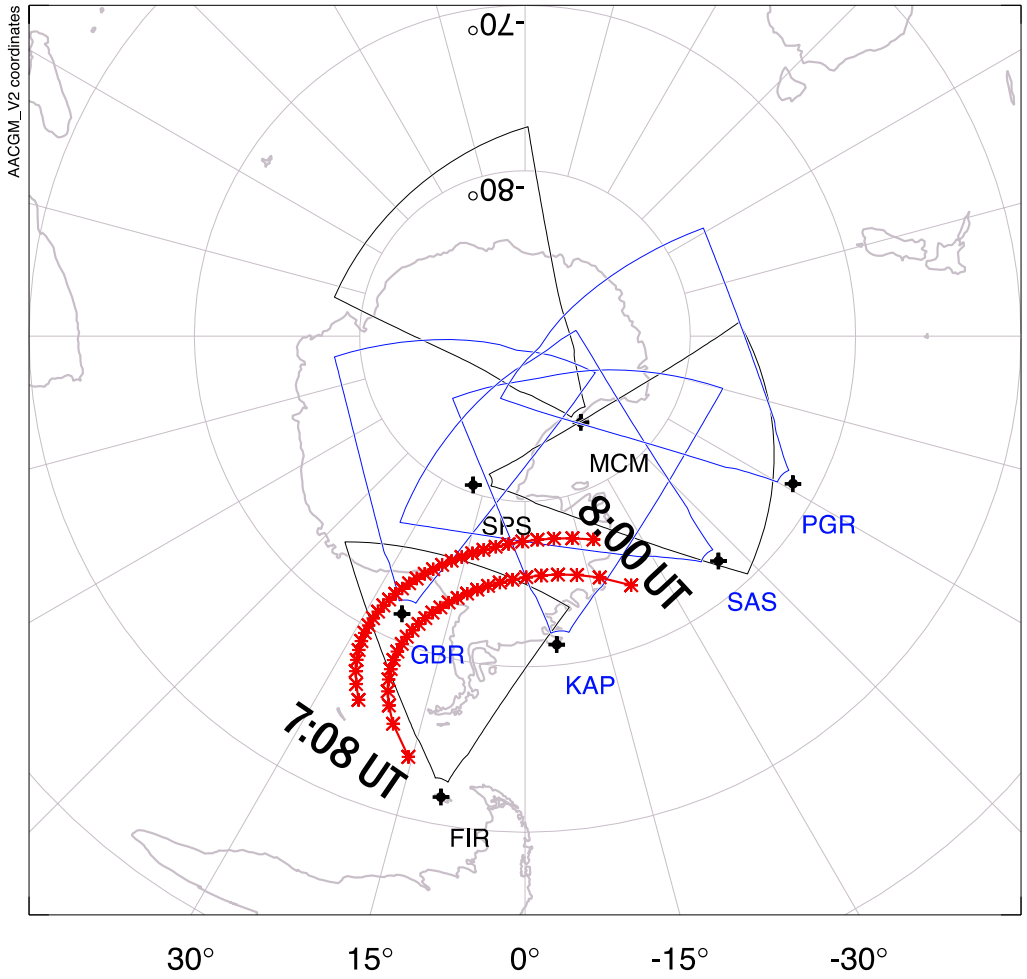




- Ground scatter replicates a ground-to-ground communication link just like a **1-hop radio** link does.

- We acknowledge the use of SuperDARN data. SuperDARN is a collection of radars funded by various national scientific funding agencies across the globe.

Introduction: TSE Geometry and Science Goals



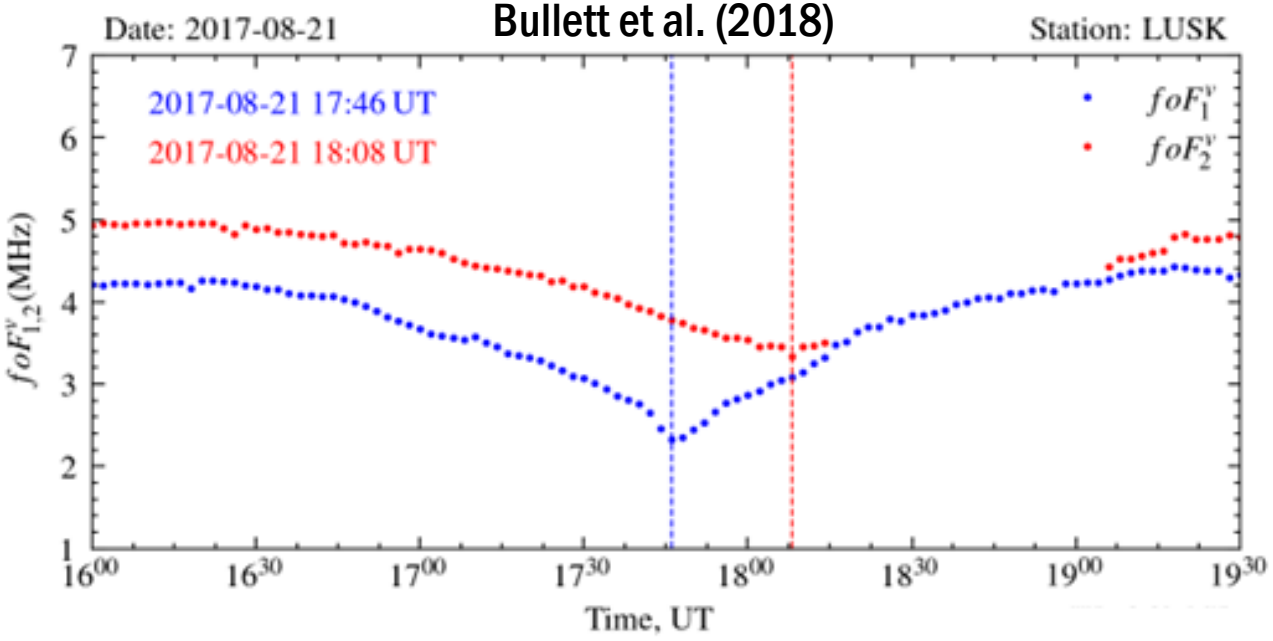
1. We are interested in understanding the HF wave propagation conditions following TSE. Specifically, ionospheric G-condition.

2. We are also interested to investigate ionospheric disturbances in conjugate hemispheres during solar eclipse.

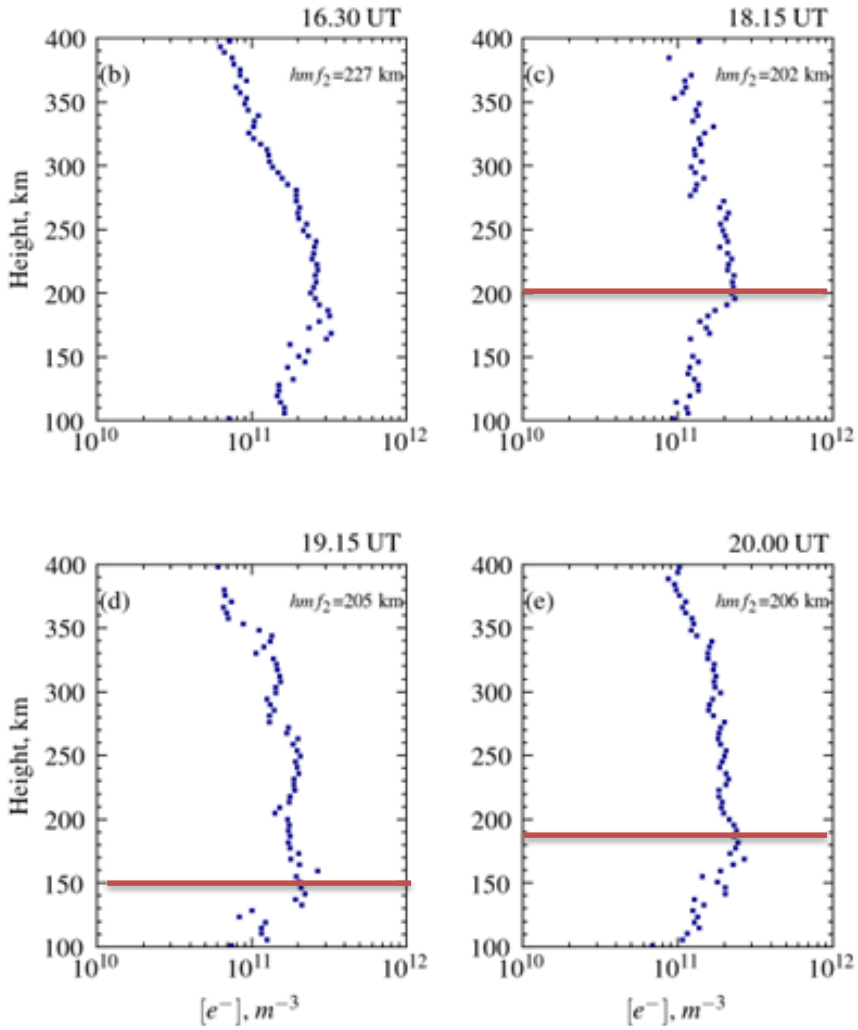
View from the south pole: black FOVs indicate radars in the southern hemisphere; blue FOVs are radars in the northern hemisphere projected along magnetic field lines into the southern hemisphere.

Introduction: Ionospheric G-Condition during 2017 (21st Aug) Great American Eclipse (GAE)

Bullett et al. (2018)

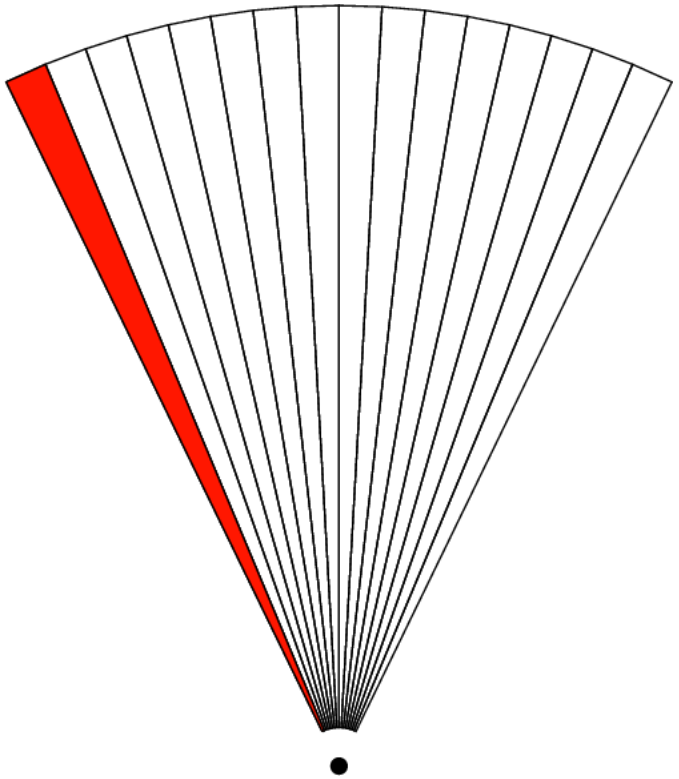


ISR Millstone Hill Data



- Ionospheric G-condition when $foF_1 \geq foF_2$

Experiments: Sounding Modes

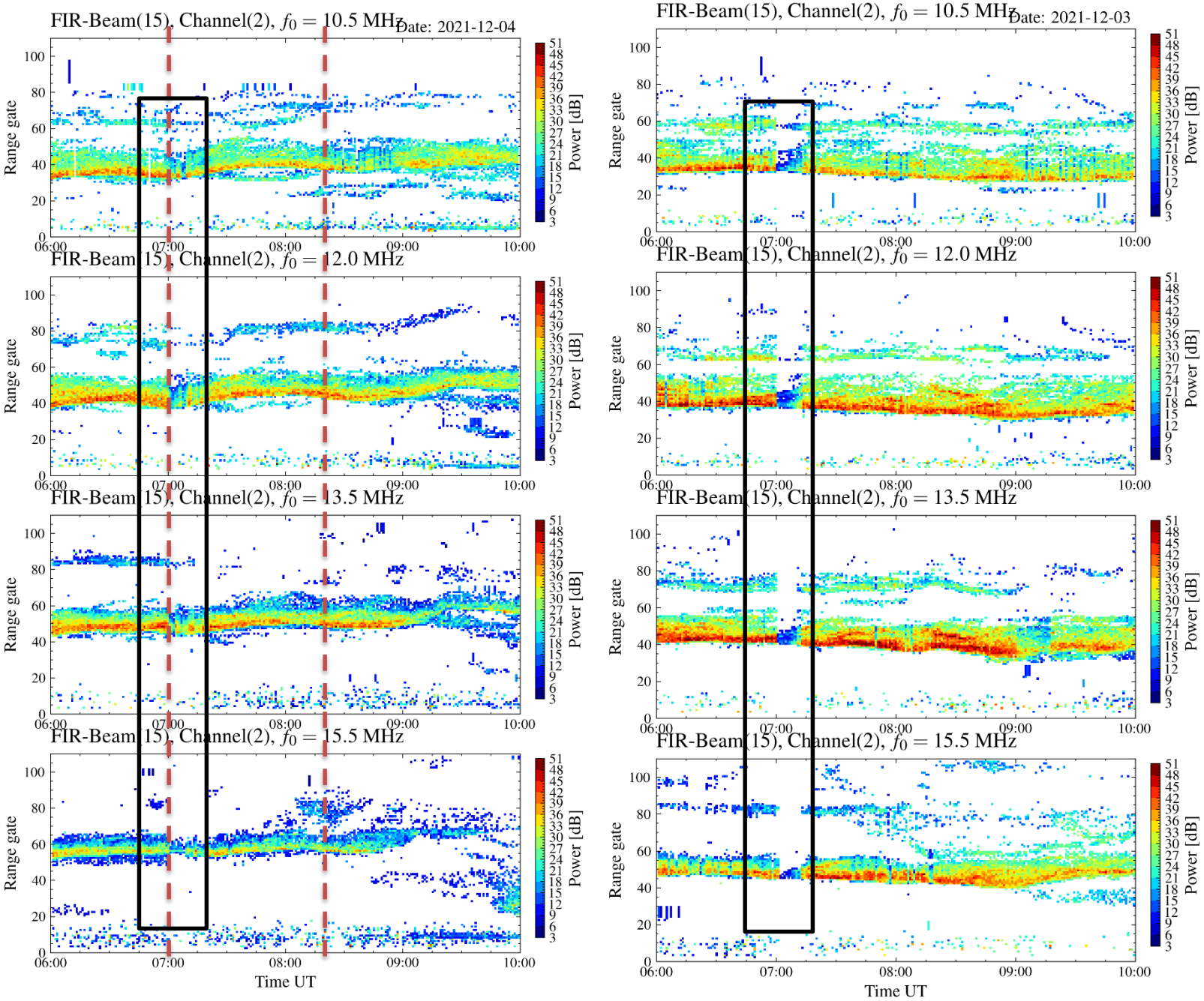


Normal Sounding Mode
Scan Time: 1-minute

- Special Sound Mode:

1. Scan Time: 1-minute
2. Interleaving beams: Only 5 beams $B_{00}, B_{04}, B_{08}, B_{12}, B_{15}$
3. 4 frequencies $f_{0,1,2,3}$
4. 3 sec beam sounding (20 beam sounds in 1 minute)

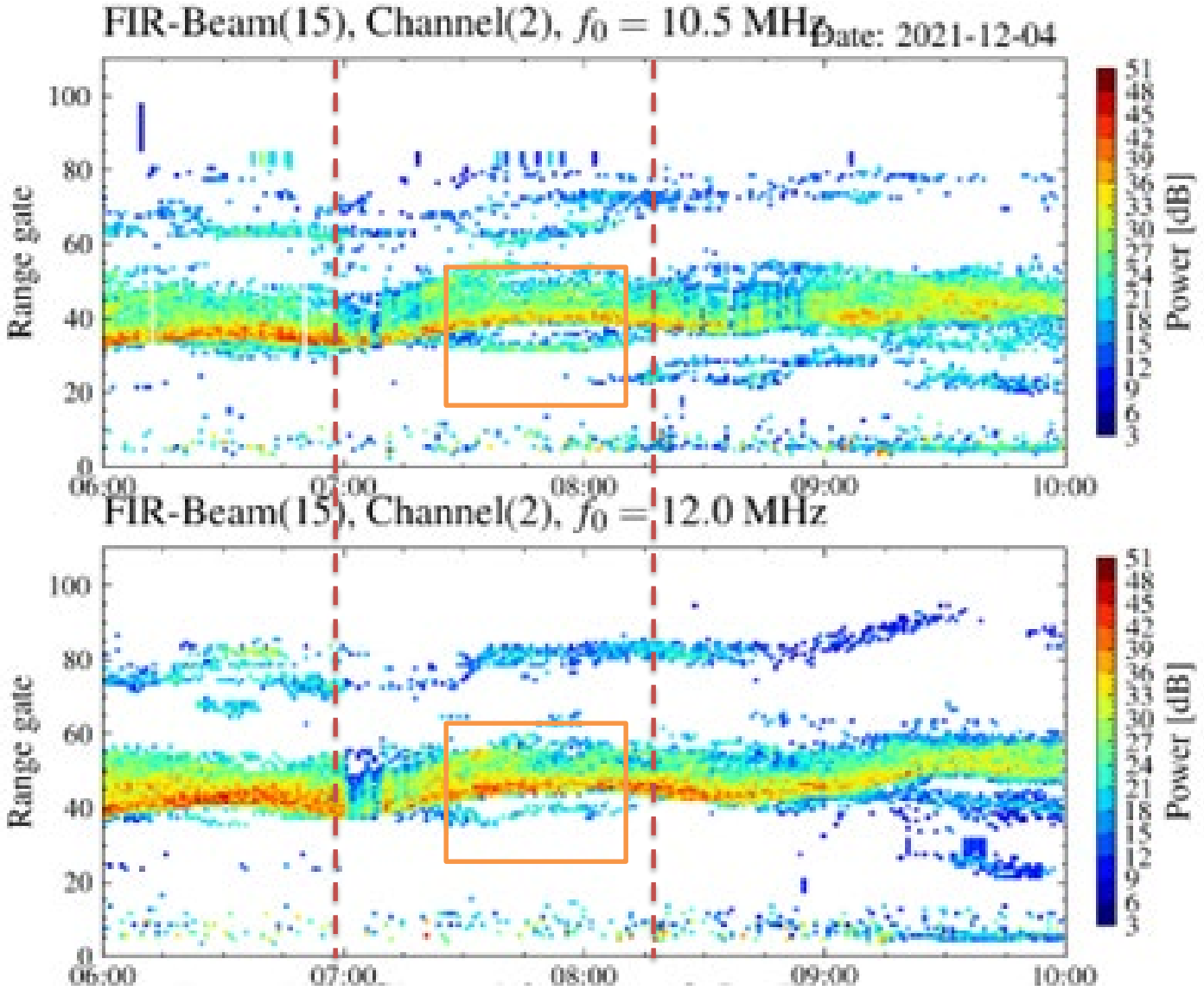
1. Normal mode data should be sufficient for the current research interest on the interhemispheric electrodynamics.
2. To check propagation condition, with help of Dr. Chisham we requested a new mode to run on the channel 2 of the **FIR** radar. This sounding mode enables us to capture propagation mode in the ionosphere.



Observations: Antarctic Radars

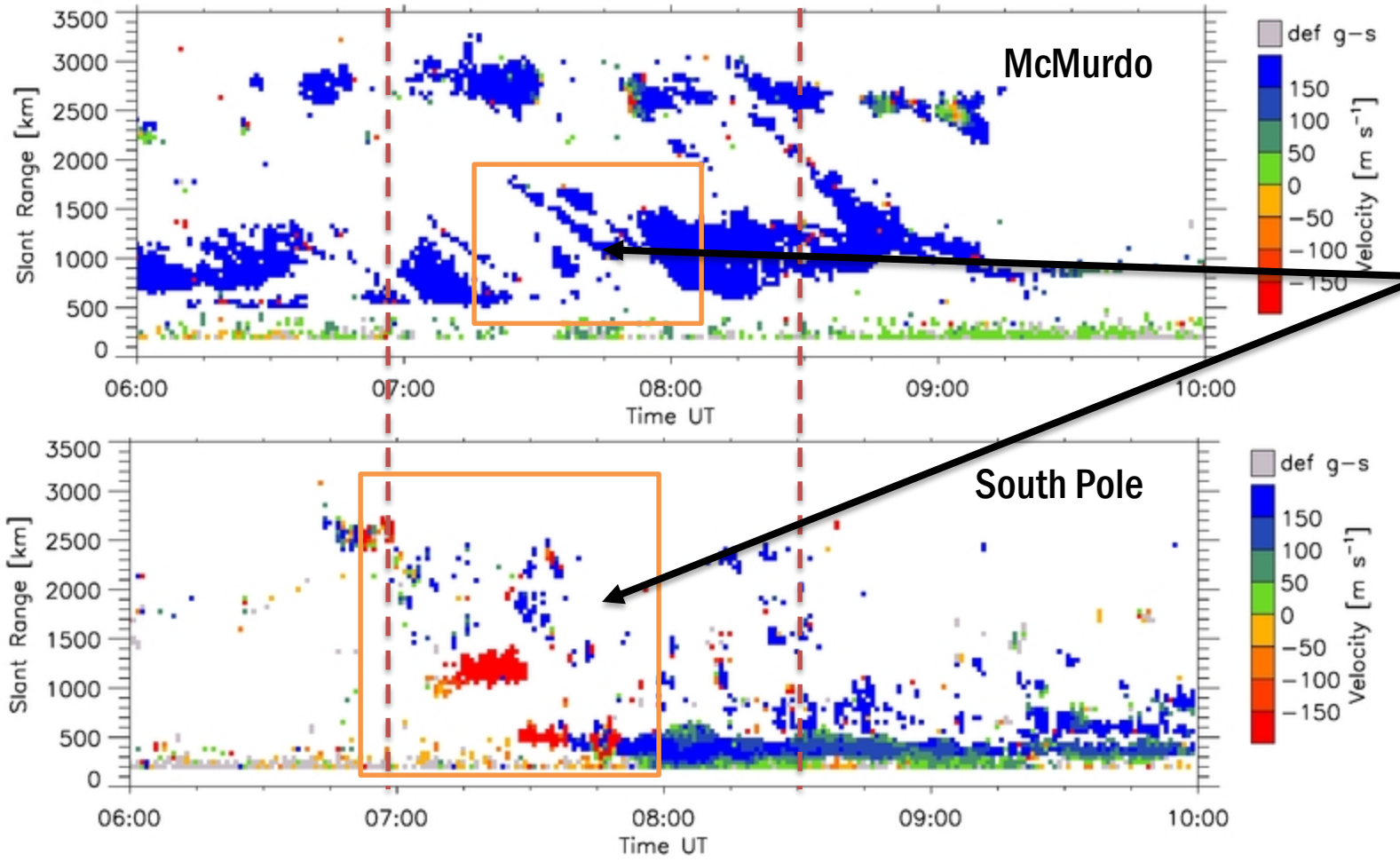
- FIR radar observations, from beam 15 for 4 frequencies (10.5, 12, 13.5, 15.5) MHz.
- Left: Eclipse day, 4 December 2021; Right: Control day, 3 December 2021
- Eclipse duration ~ 7:00 – 8:30 UT.
- We are still working on the effects observed by the radar.
- Eclipse effect before the totality OR interference?

Observations: Bifurcation in Backscatter



- Bifurcations in backscatter typically suggests, different propagation modes.
- It would be great to see what model observes (Ray-Trace through modified ionosphere).

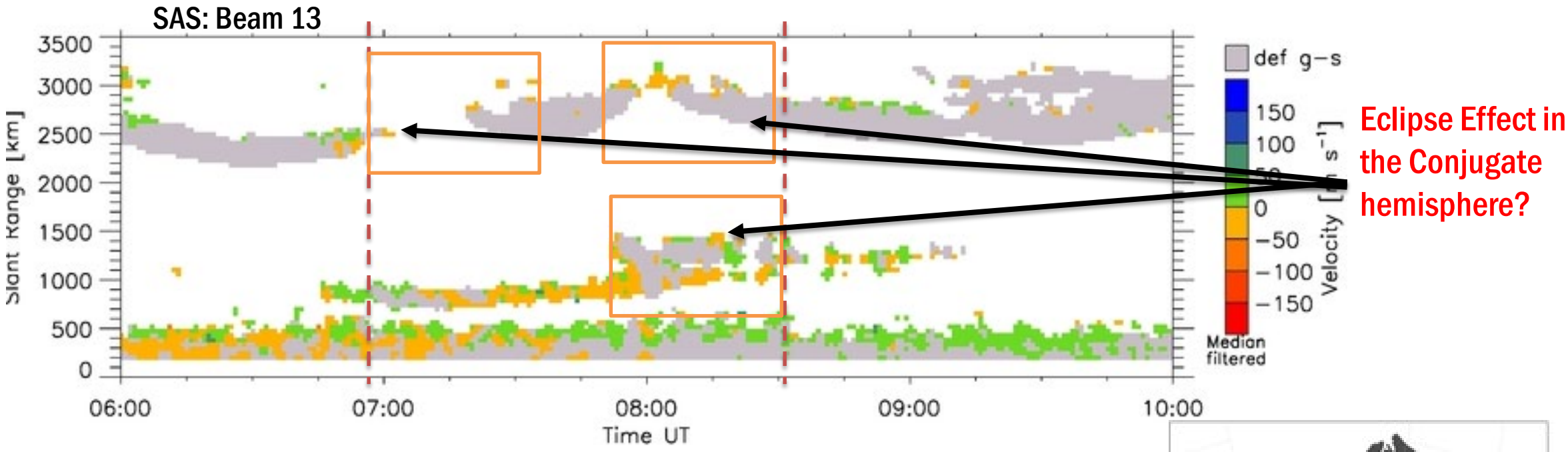
Observations: Antarctic Radars



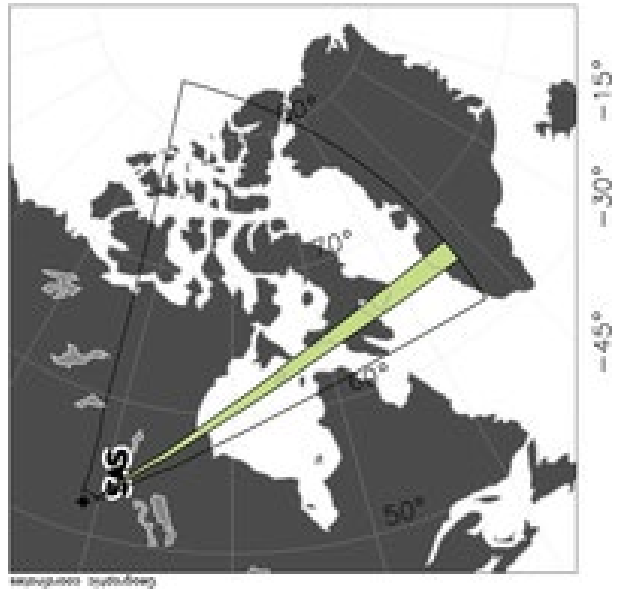
Sudden disappearance / appearance of the ionospheric echoes: Eclipse Effect?

- Observations from two other stations from the southern hemisphere.
- We are not sure about any significant Eclipse effect here.

Observations: Northern Conjugate Radars



- Drop in back scatter counts at far ranges and increase in near ranges. Do we also see two different propagation modes?
- Transport via magnetic field lines might cause this effect, this needs validation using other magnetospheric satellite instruments and modeling.



Thank you!

Questions?

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For more on G-Condition please visit poster:
SOLA-9: Origination of Ionospheric G-condition following a Total Solar Eclipse
Tuesday's Poster