

Anthea's Q&A: Volumetric Scattering

ISR Summer School 2013

August 2, 2013

Volumetric Scattering – How is this different from point scattering?



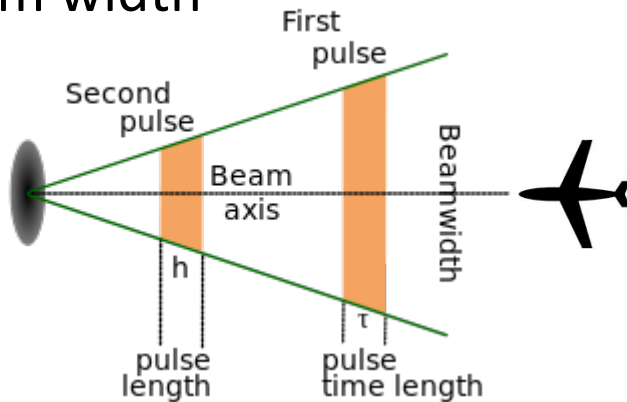
VS.



Volumetric Scattering – How is this different from point scattering?

Point Scattering

- **Working definition:** Does not fill the area corresponding to beam width



- Single scatterer

Volumetric Scattering

- **Working definition:** Fills the volume correspond to beam width (even though individual scatterers may have extremely small cross-sections)

- Many scatterers whose motions are random

Volumetric Scattering – What does it do to the radar equation?

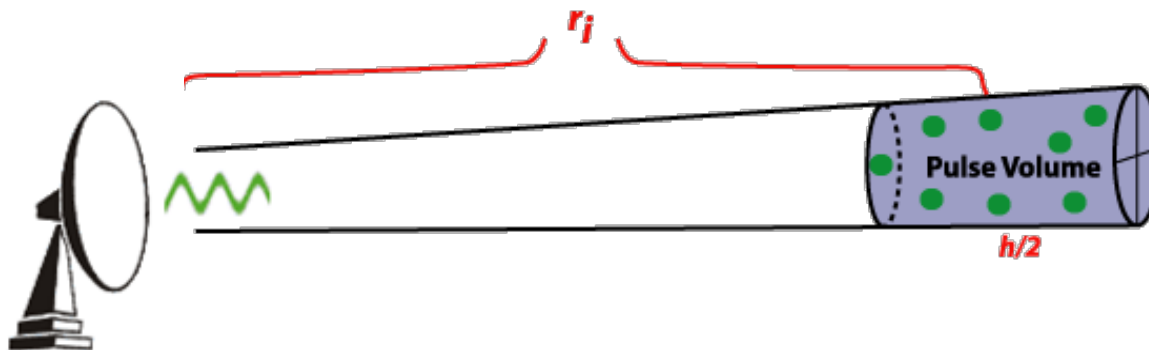
- Hard targets:

$$P_{\downarrow r} \propto P_{\downarrow t} / R^4$$



- Soft targets:

$$P_{\downarrow r} \propto P_{\downarrow t} / R^2$$

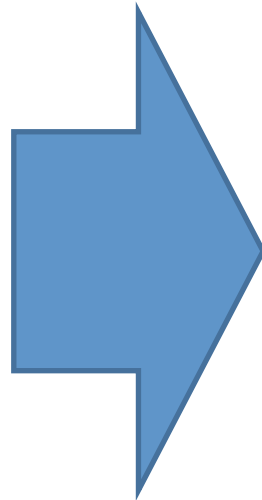


Volumetric Scattering – How is this involved in incoherent scatter radar?

Remember...

Volumetric Scattering

- Fills the volume correspond to beam width
- Individual scatterers may have extremely small cross-sections
- In the case of ISR, individual scatterers are electrons whose motions are random



STATISTICS



Polar Mesospheric Summer Echoes



Alireza Mahmoudian
Edvier Cabassa
Karim Kuyeng
Spencer Hatch
Steven Chen
Zachary Girazian

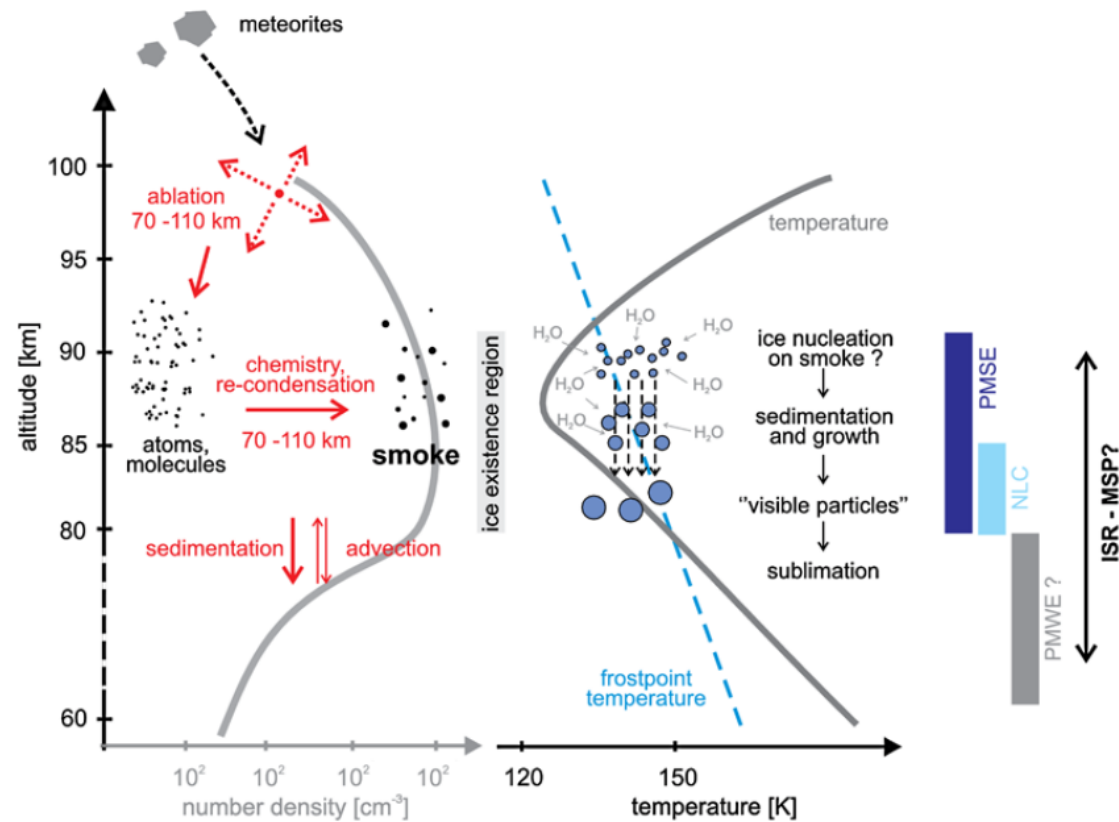
Virginia Tech
Arecibo Observatory
Penn State University
Dartmouth College
SRI International
Boston University

Science Goal

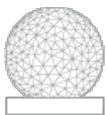
- Monitor time evolution of **Polar Mesospheric Summer Echoes (PMSE)**

What is a PMSE?

- Atypical radar echoes between 80 – 90 km
- Observed near poles during Summer
- Associated with extremely cold mesospheric temperatures



Rapp et al. 2013

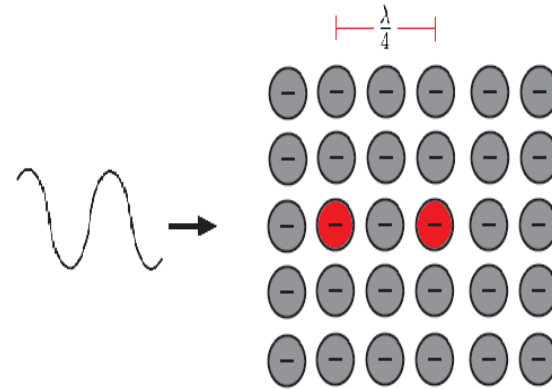


Scattering from a collection of electrons.

Imagine three cases:

1) Homogeneous medium.

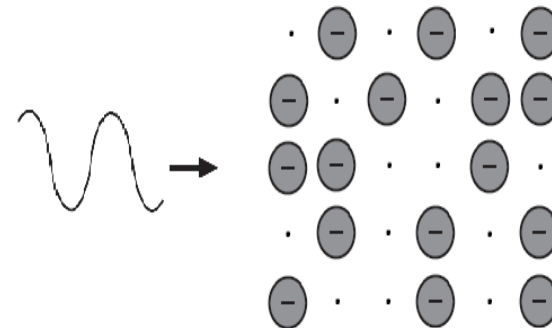
No irregularities, no scattering.



2) Randomly distributed electrons.

Destructive and constructive scattering.

Incoherent scattering.

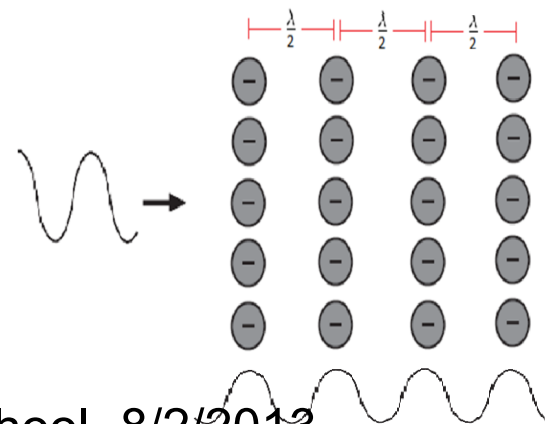


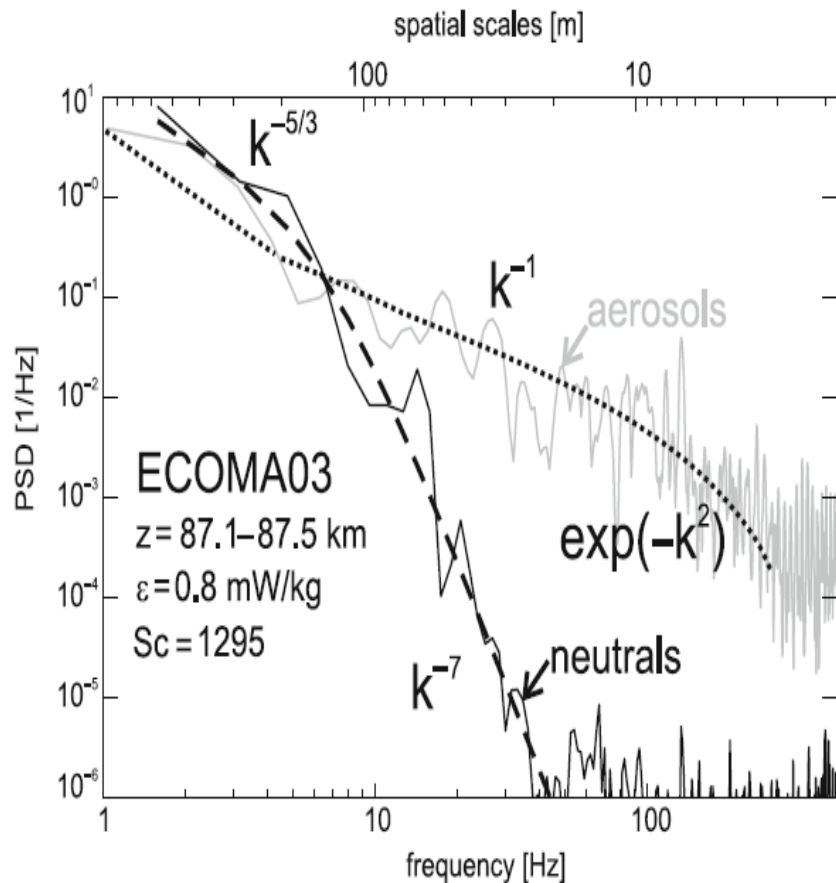
3) Non randomly distributed electrons.

Bragg scattering.

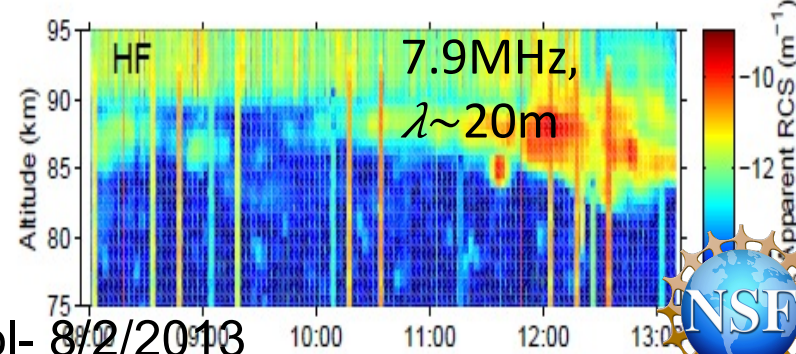
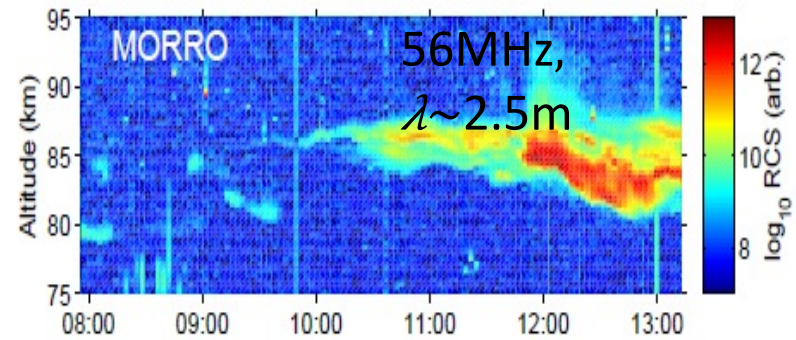
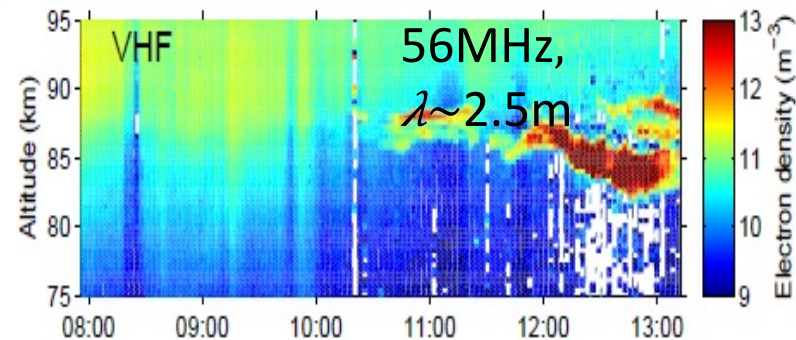
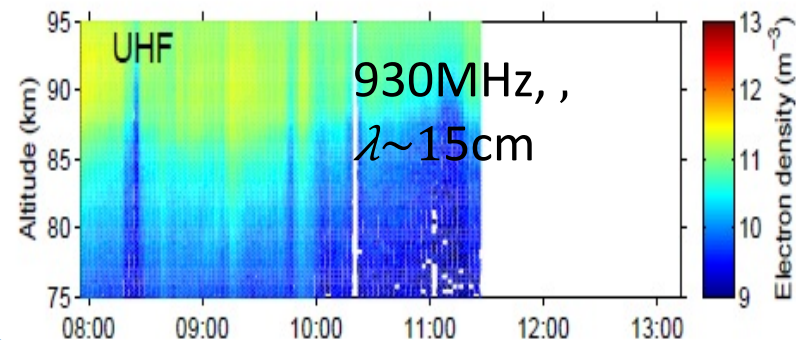
$$\lambda = \lambda_{\text{radar}} / 2$$

Coherent scattering.

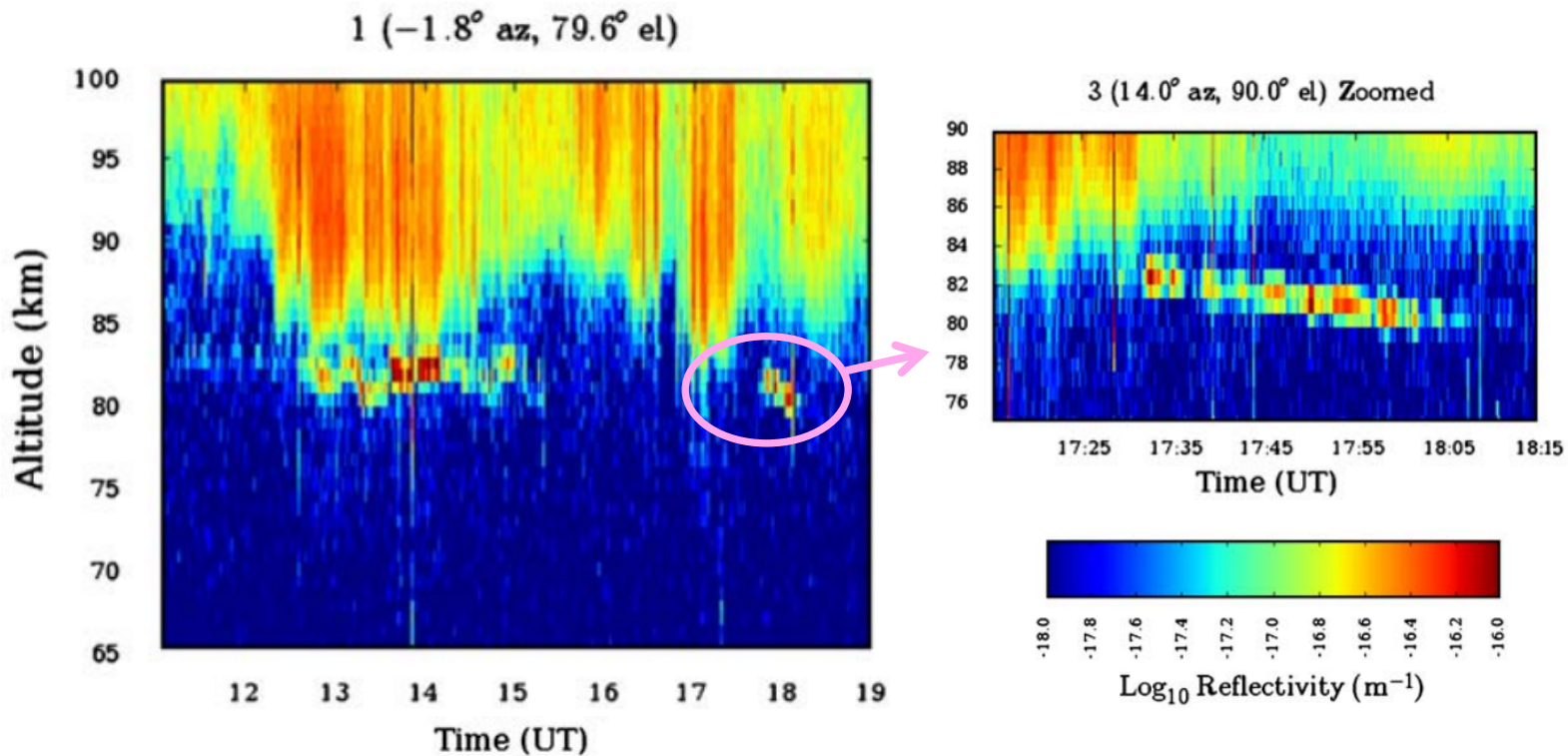




PFISR
(449.6MHz)
 $\lambda \sim 30\text{cm}$



PMSE Signature

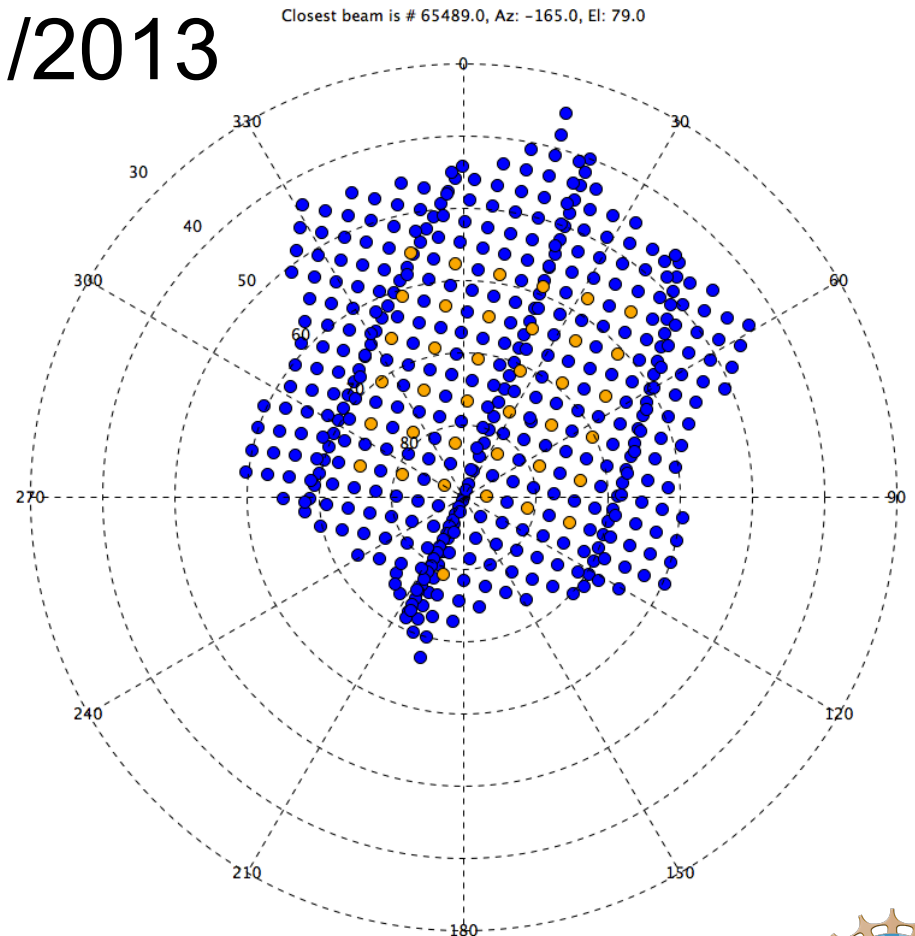


Nicolls et al. 2009

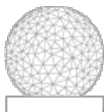
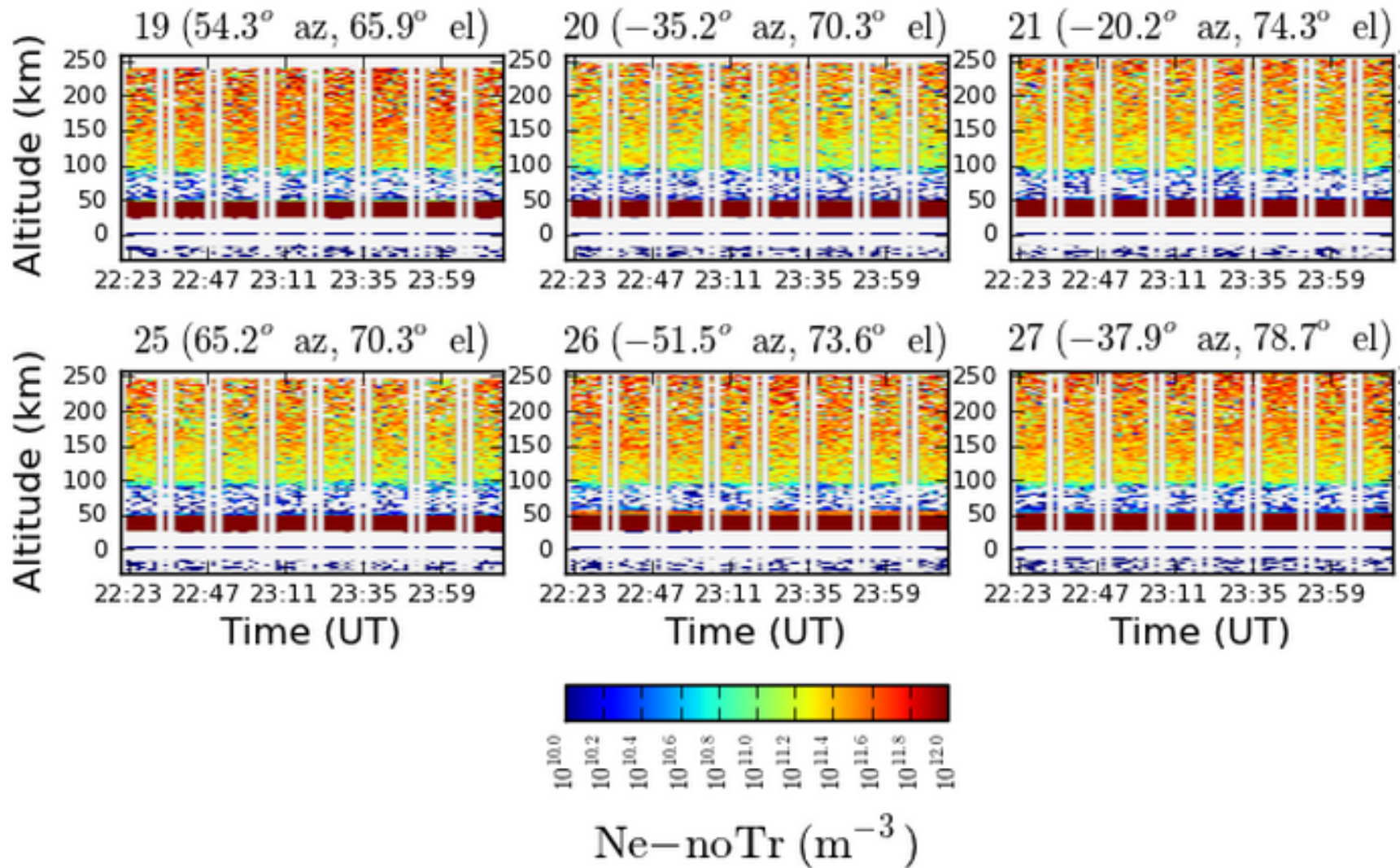


Observations

- 23:00 – 01:00 UT 7/31/2013
- 37 beams
- Barker Code and AC

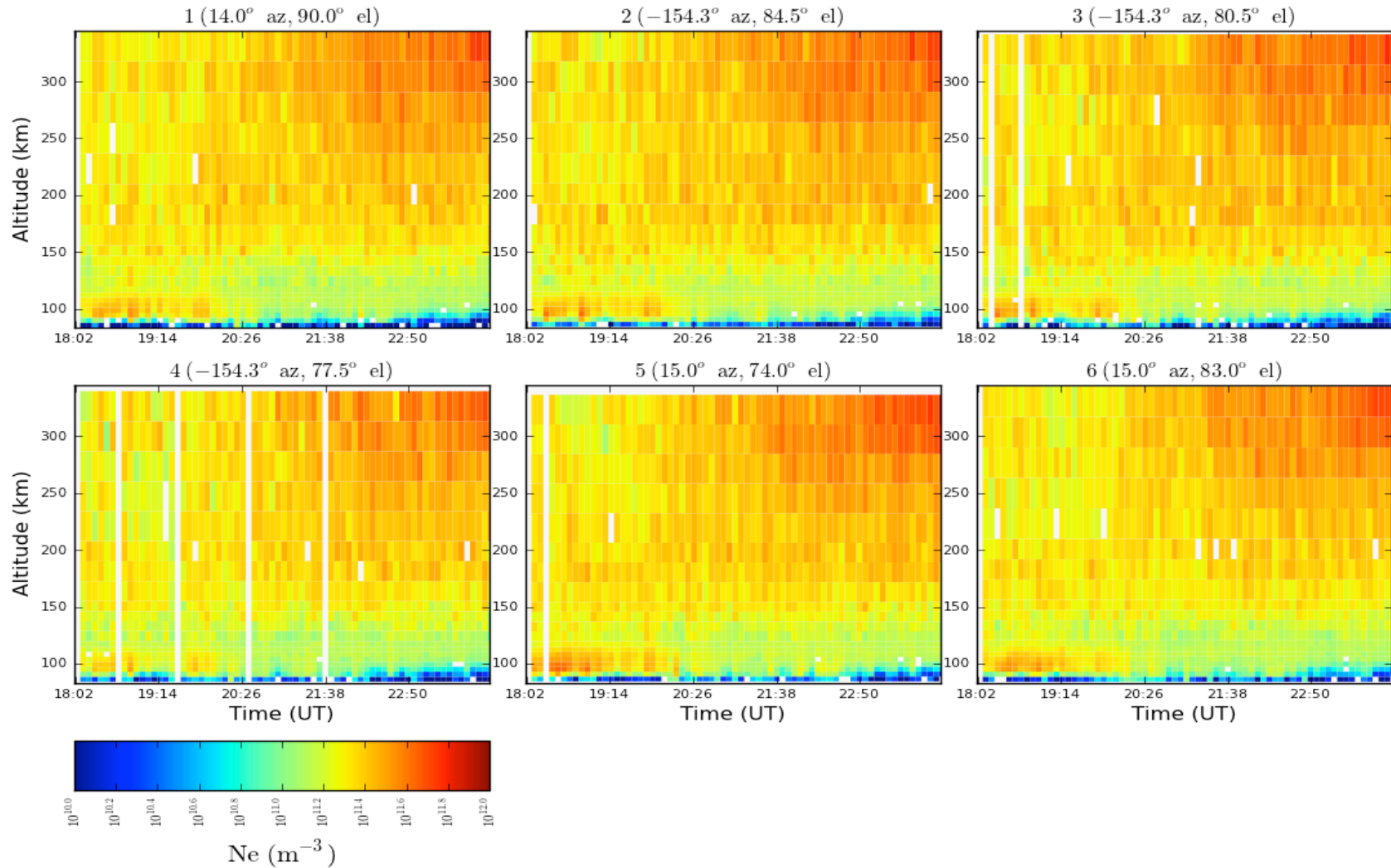


PMSE Detection?

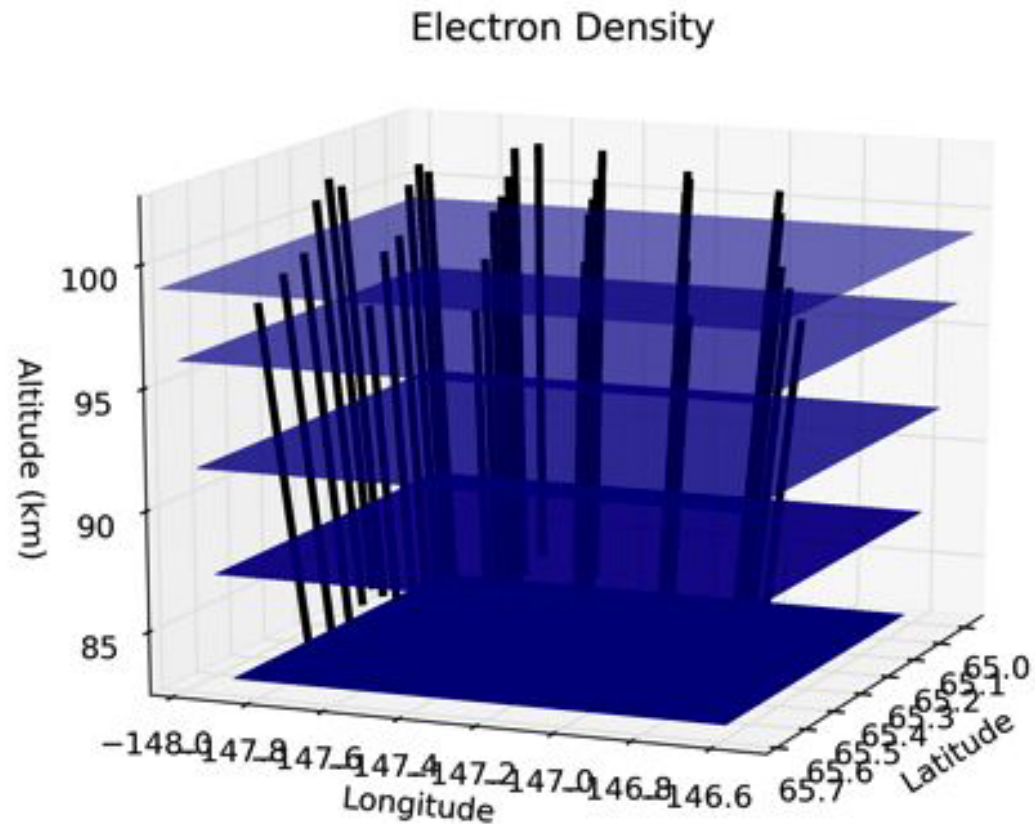


AC mode data

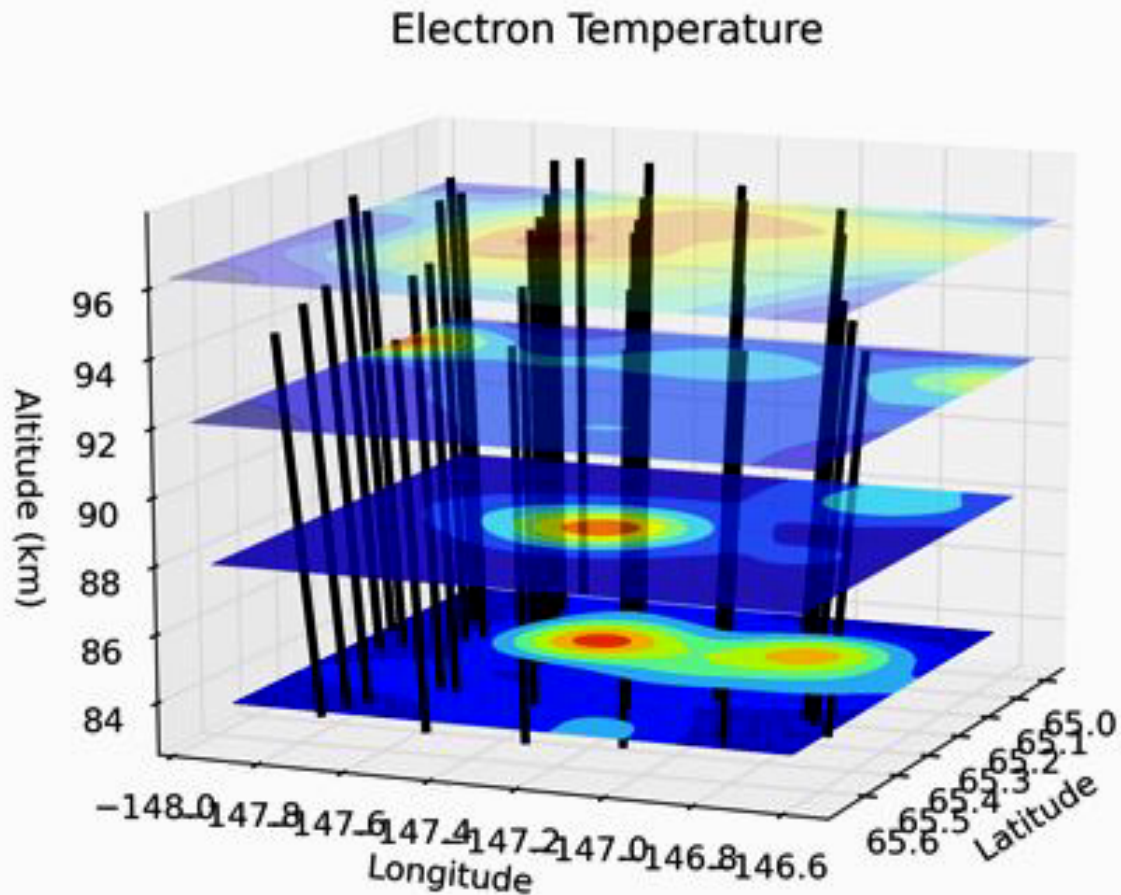
6-24-2013 18.019 UT - 6-25-2013 0.000 UT



Time evolution of N_e



Time evolution of T_e



Conclusions

- Failed to detect a PMSE
- Explored time and space evolution of N_e and T_e

Thank you!

- NSF, SRI, MIT Haystack Observatory
- All the instructors



You don't want to play this game unless you
know your target

Or in the words of Jean-Claude Van Damme....

Don't hunt what you can't kill.