Introduction to the Ionosphere (part 5)

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Major credits to: **Roger Varney**, *SRI International*
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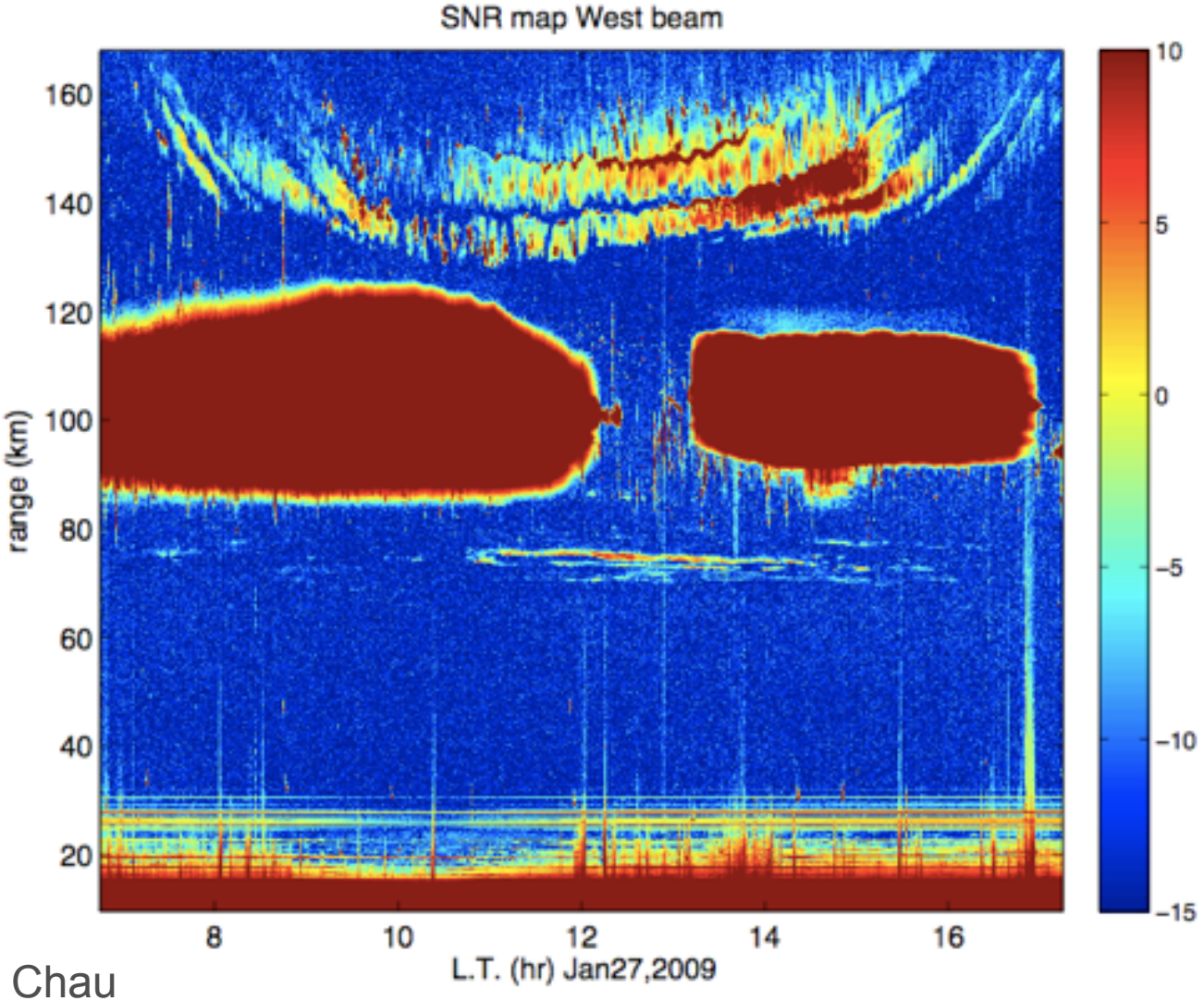
Radio measurements of the upper atmosphere

- Propagation and Reflection Experiments:
  - Consider ionospheric plasma as a continuum
  - Ray-bending and reflection governed by variable index of refraction
- Incoherent Scatter Radar:
  - Consider ionospheric plasma as a collection of electron point targets
  - Assume plasma is stable and near thermodynamic equilibrium
  - Use statistical mechanics to describe scatter
- Coherent Scatter Radar:
  - Consider ionospheric plasma as a heterogenous, structured medium
  - Scatter from turbulence, plasma irregularities, etc.

Coherent Scatter Radar

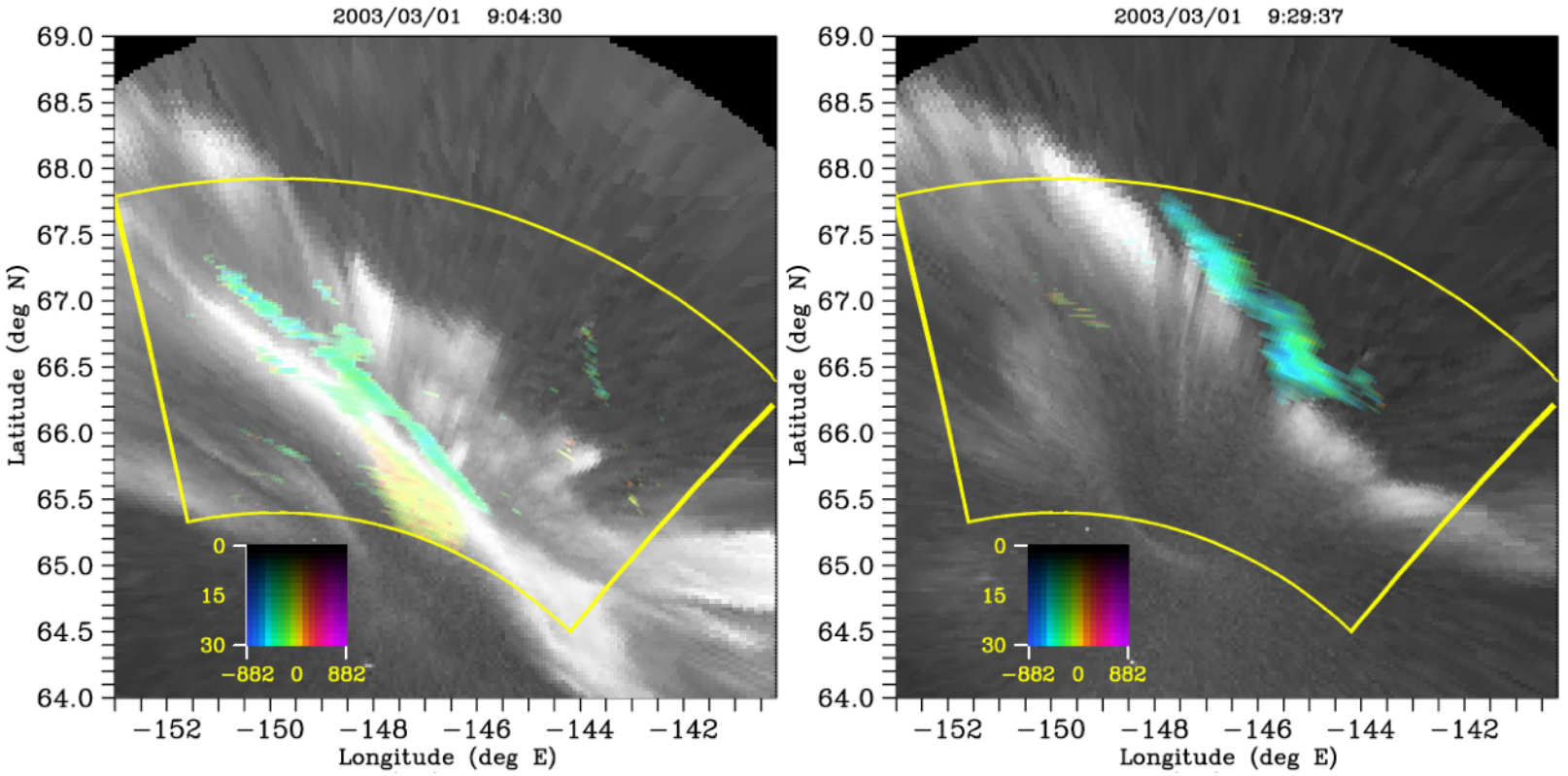
- Any medium with stochastic index of refraction fluctuations can produce coherent scatter.
- Can work in neutral air.
- Works very well in plasmas. Small electron density fluctuations produces significant index of refraction fluctuations.
- Structures must match $\lambda_R/2$ to get constructive interference between the scatter.
- Structures must be aligned $\perp$ to the radar line of sight for constructive interference in the direction back to a monostatic radar.
- Field-aligned irregularities in a plasma are observed when looking $\perp$ to B.

Equatorial electrojet, 150-km echoes, and mesospheric turbulence



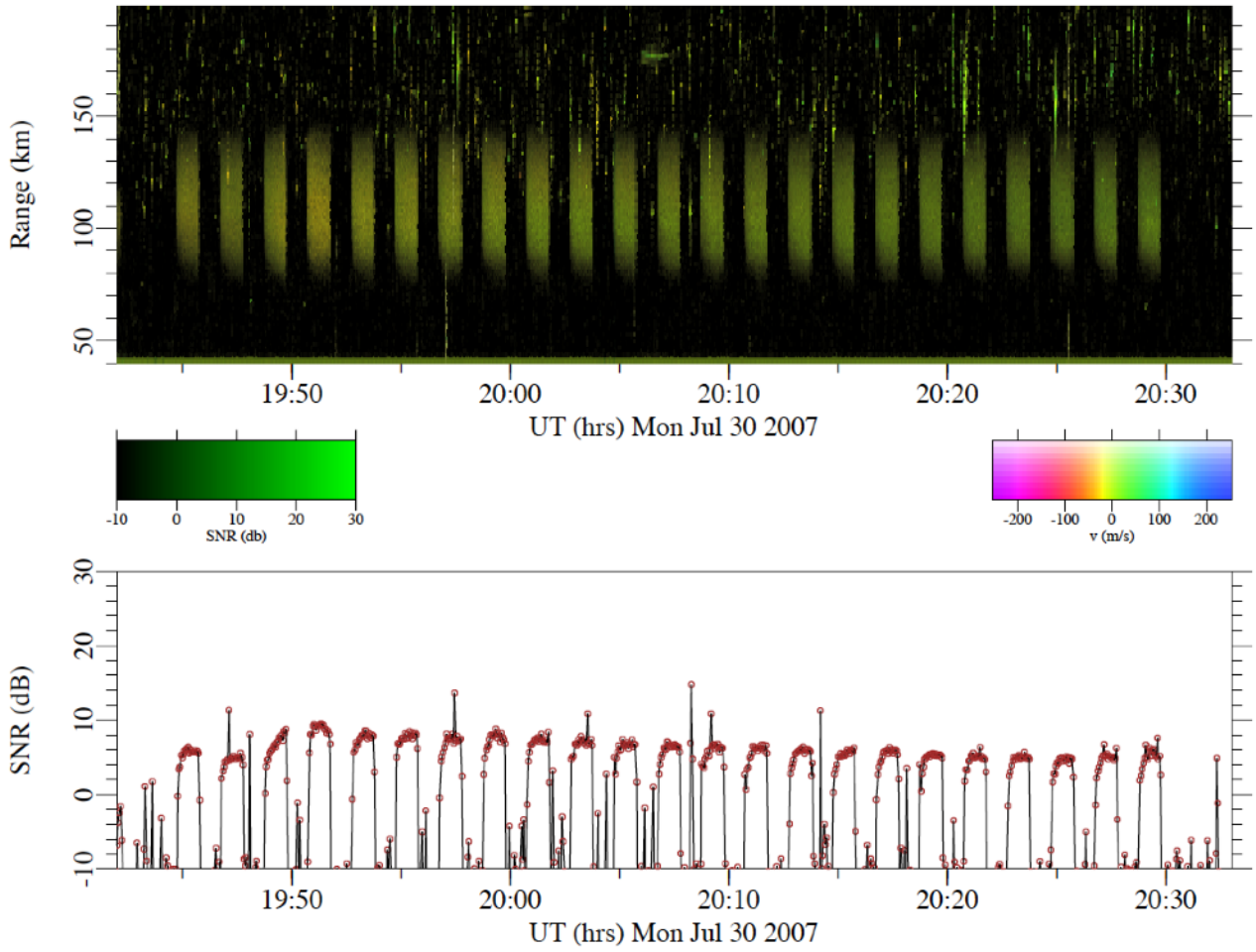
Courtesy J. Chau

Auroral electrojet instabilities



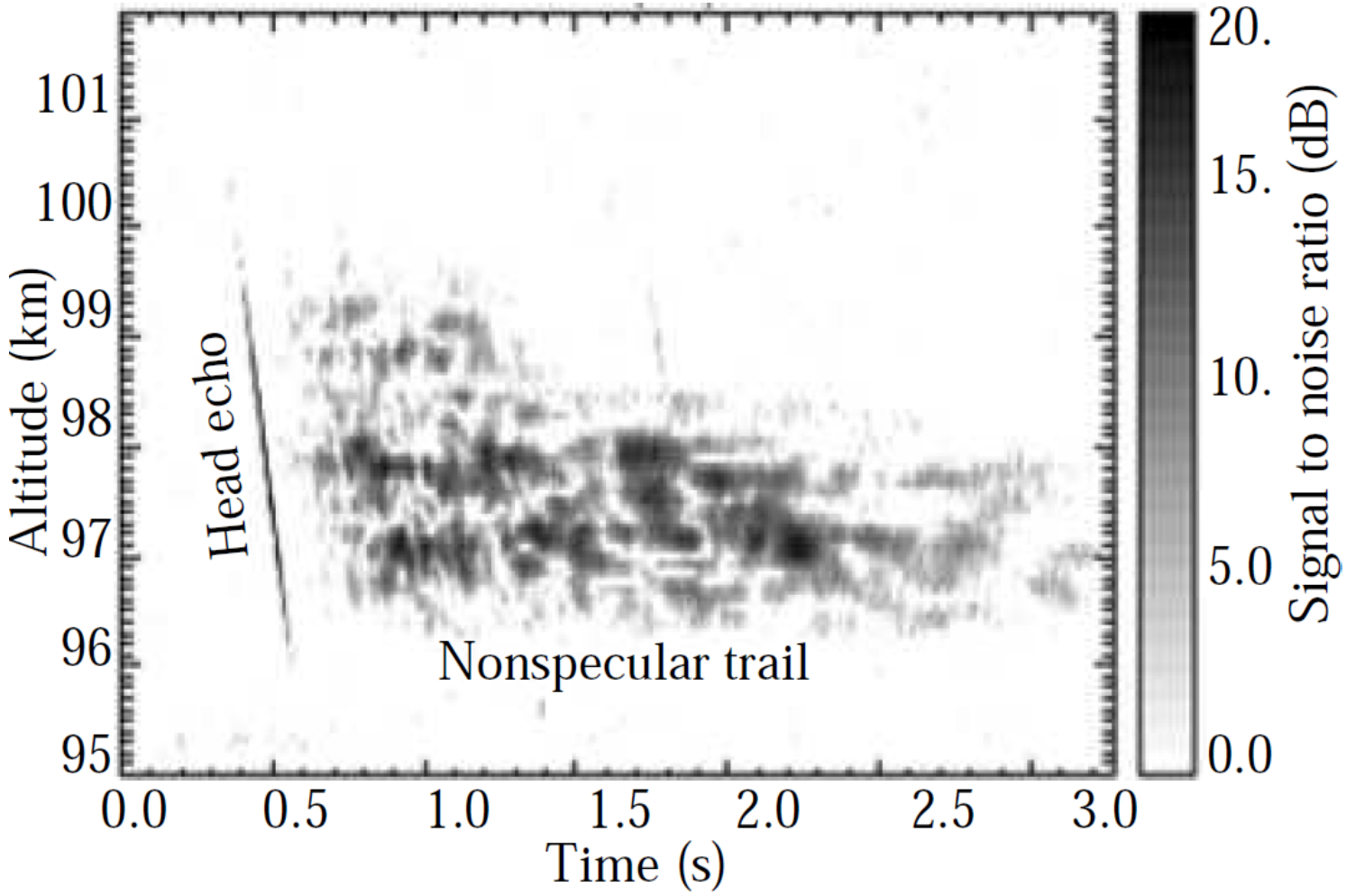
Bahcivan et al, 2006

Ionospheric modification



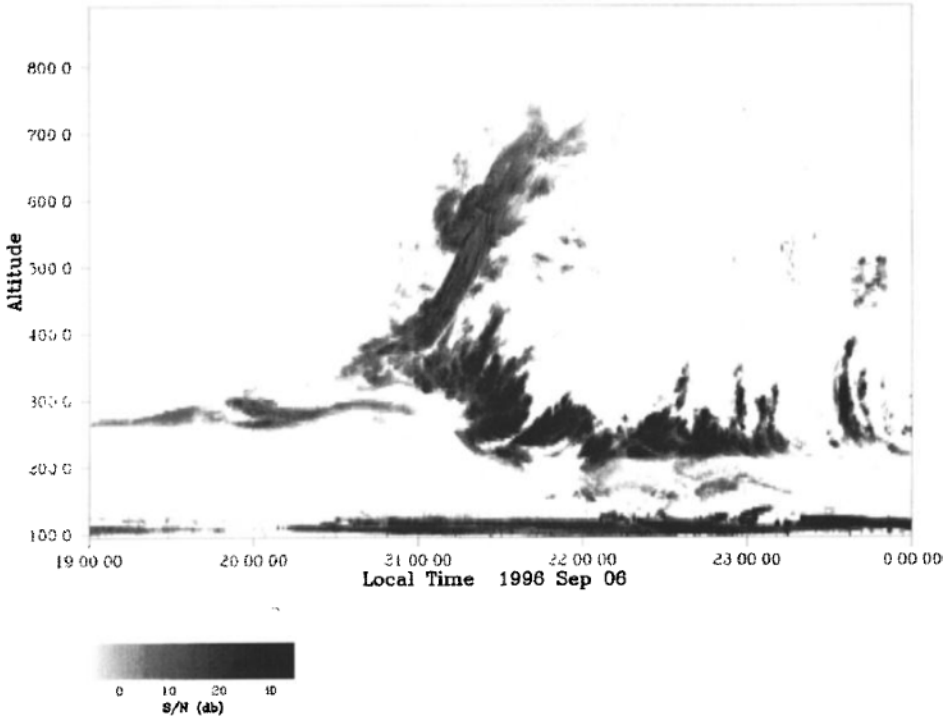
Hysell, 2008

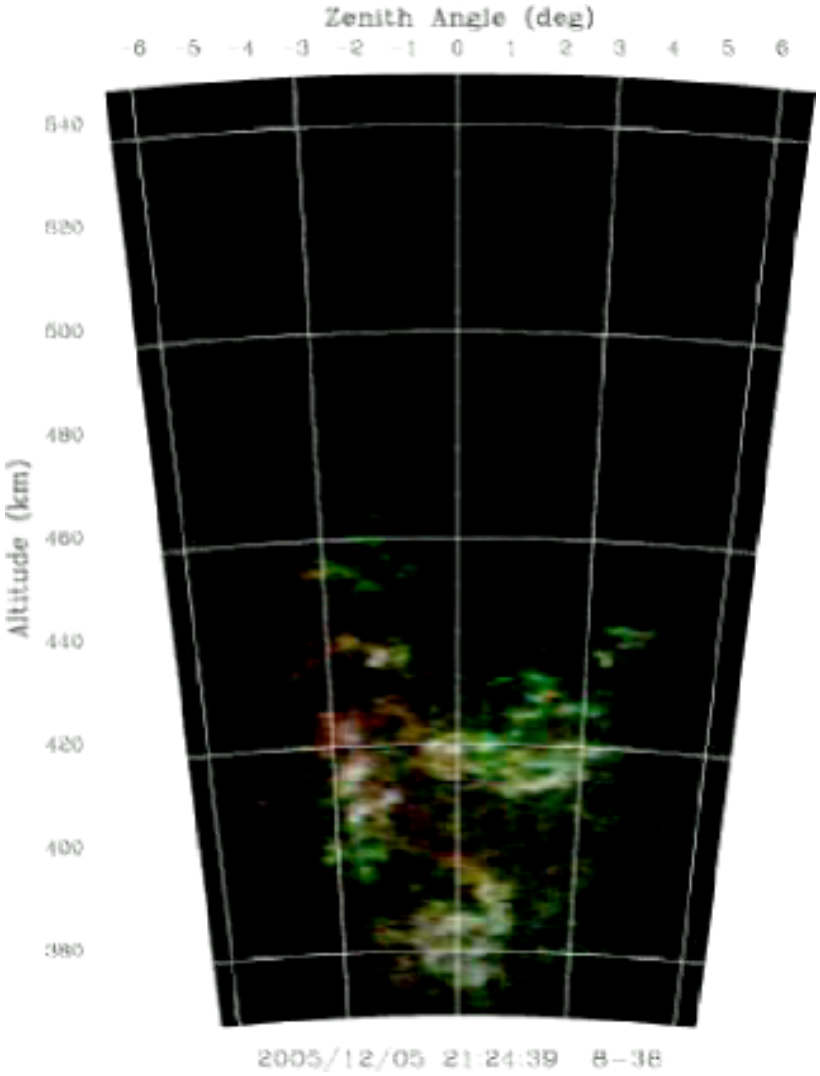
Meteors and meteor trails



Dimant and Oppenheim (2006)

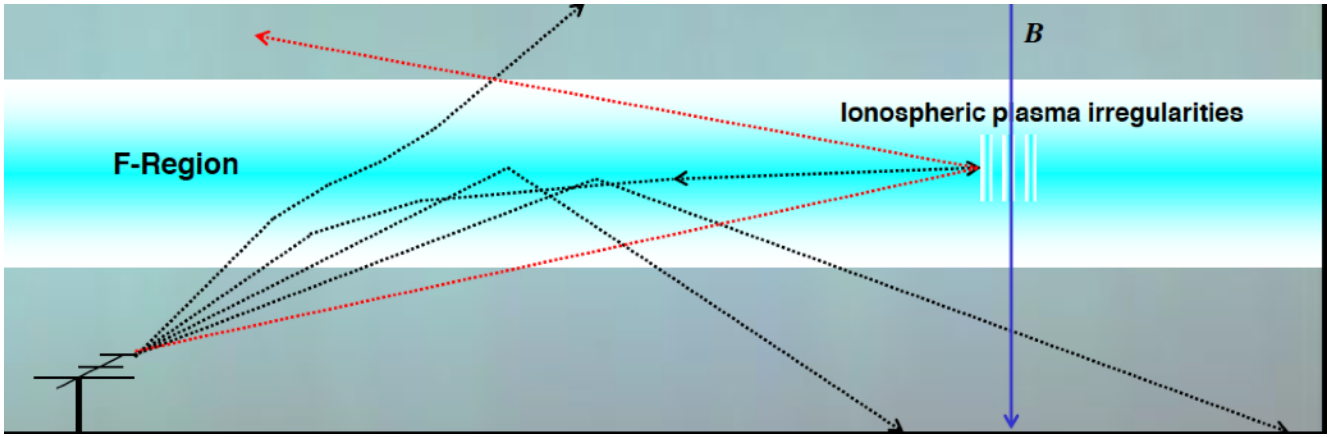
Equatorial spread F

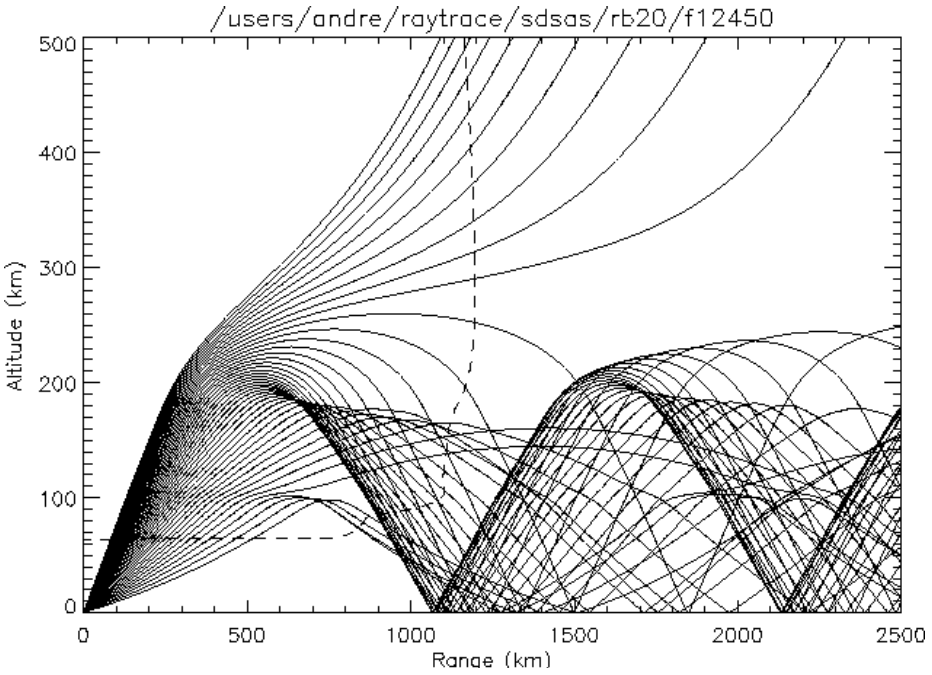




Hysell and Burcham, 1998

SuperDARN


B
Ionospheric plasma irregularities
F-Region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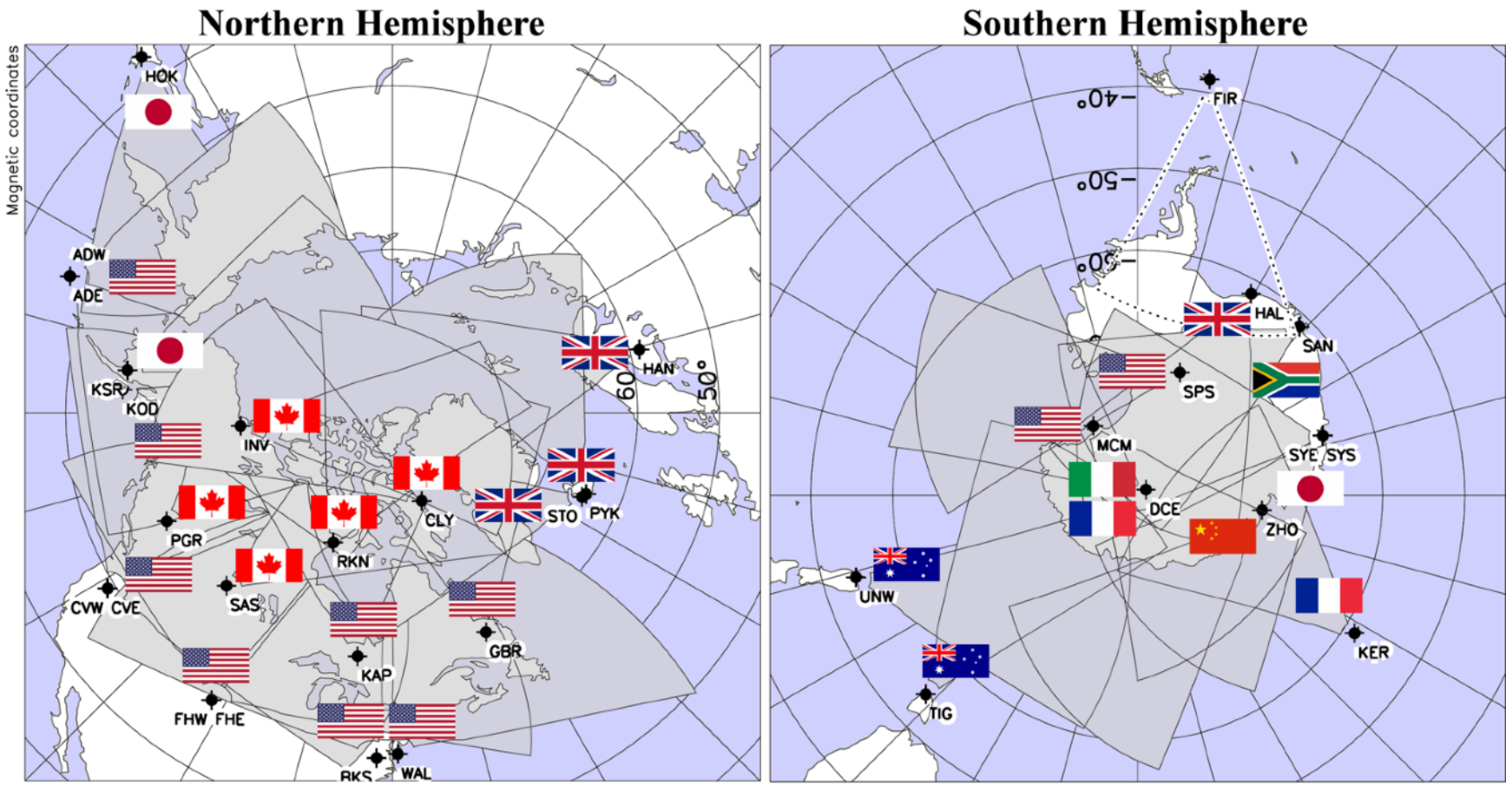
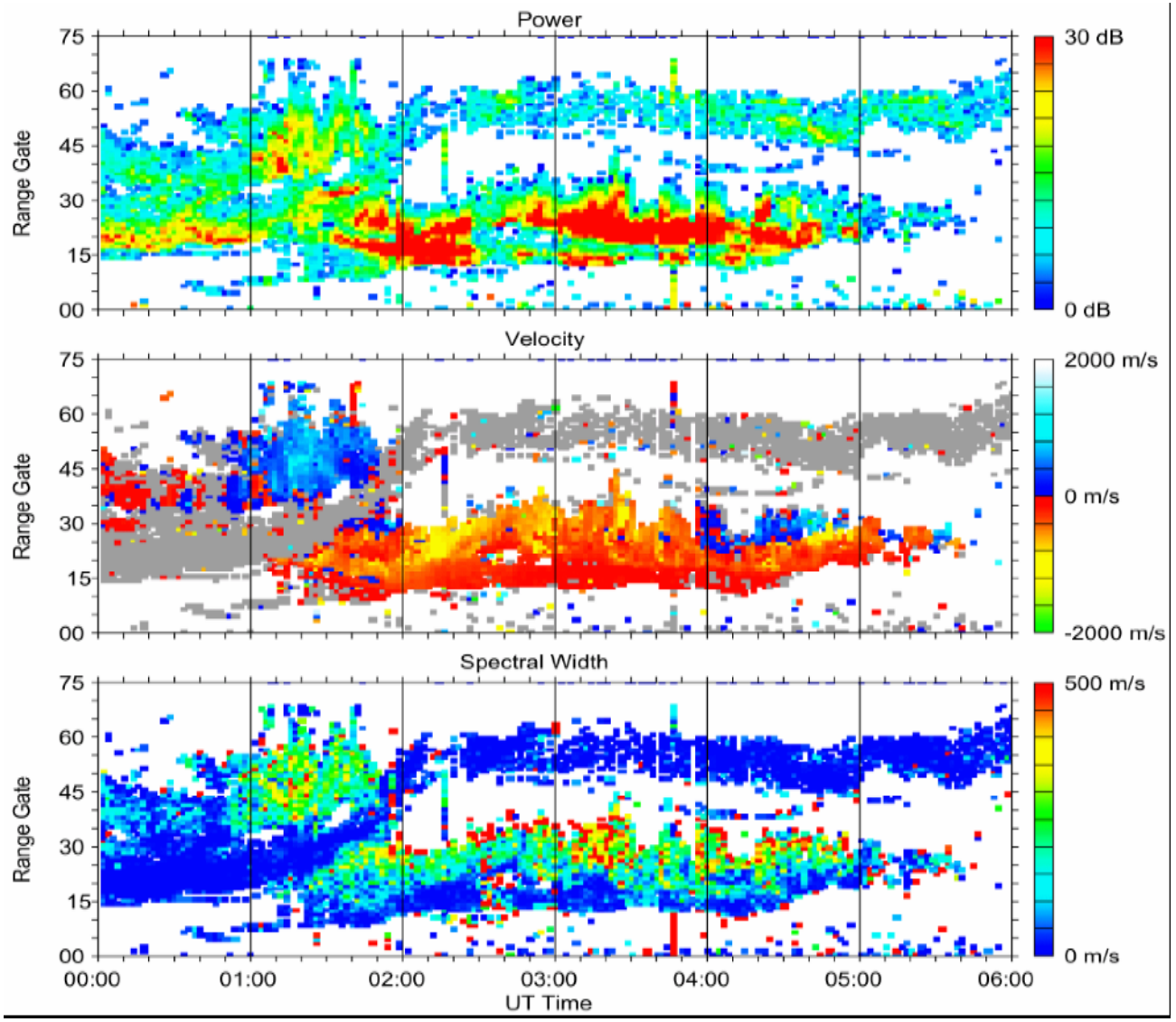
Altitude (km)
0
100
200
300
400
500
0
500
1000
1500
2000
2500
Range (km)

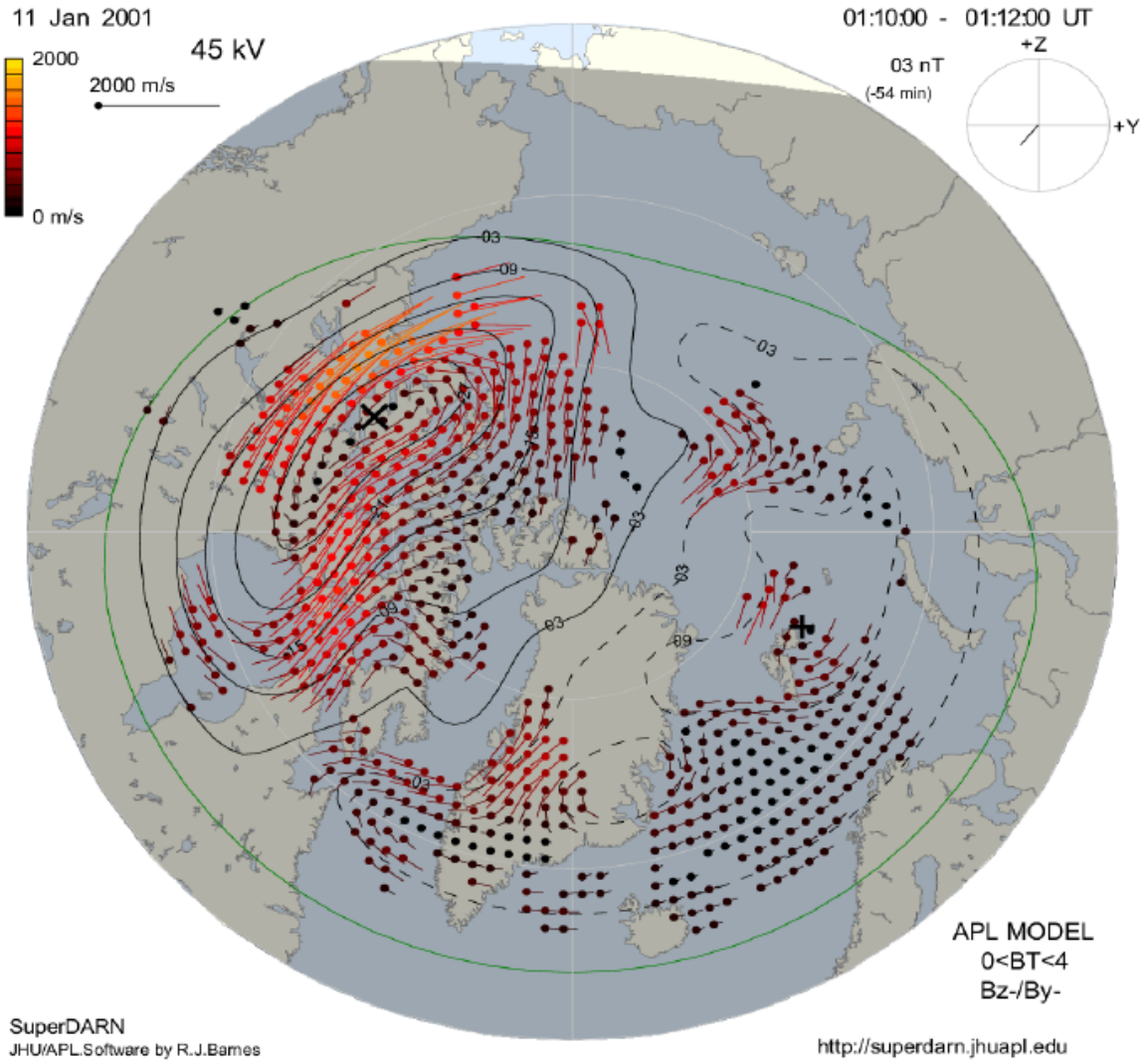
SuperDARN


Northern Hemisphere
Southern Hemisphere
Magnetic coordinates
HOK
ADW
ADE
KSR
KOD
INV
PGR
CVW
CVE
SAS
RKN
CLY
STO
PYK
HAN
GBR
KAP
FHW
FHE
RKS
WAL
60°
50°
FIR
HAL
SAN
SPS
MCM
SYE
SYS
DCE
ZHO
UNW
TIG
KER

SuperDARN data



SuperDARN data



Literature

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- Kelley, M. C.: The Earth's Ionosphere, Academic Press, 1989
- H. Risbeth and O. K. Garriot: Introduction to Ionospheric Physics, Academic Press, 1969
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