Observation of auroral optical emissions through co-located GPS, riometers, magnetometers, and all-sky imager measurements

B. Forte (1), A. J. Gerrard (2), A. Weatherwax (3), S. Skone (4), J. Kinrade (5), G. Bust (6), C. Mitchell (1), Y. Ebihara (7)

(1) University of Bath, UK (b.forte@bath.ac.uk)

(2) The Center for Solar-Terrestrial Research, New Jersey Institute of Technology, Newark, USA

(3) School of Science and Engineering, Merrimack College, North Andover, USA

(4) Schulich School of Engineering, University of Calgary, Canada

(5) Department of Physics, Lancaster University, UK

(6) Applied Physics Laboratory, Johns Hopkins University, USA

(7) RISH, Kyoto University, Japan

The problem: Enhanced phase scintillation in presence of ionisation structures in the auroral ionosphere

Observations at the South Pole: two case studies

09 August 2010 (event A)

31 July 2011 (event B)

09 August 2010 (event A)

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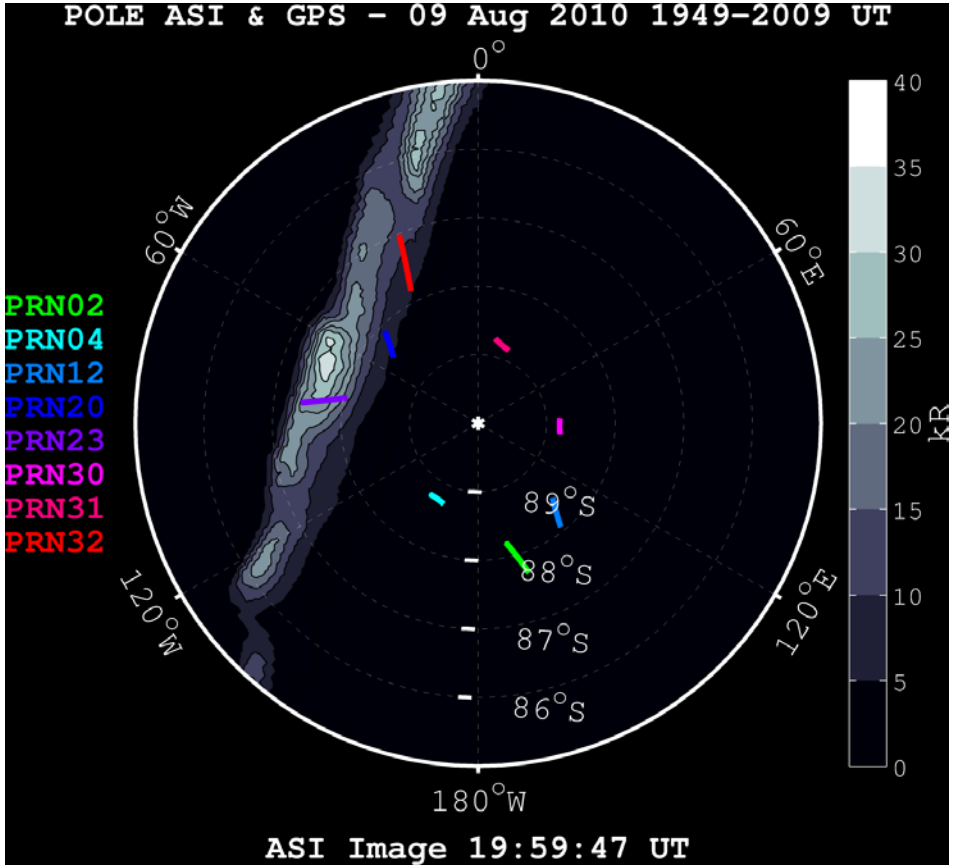
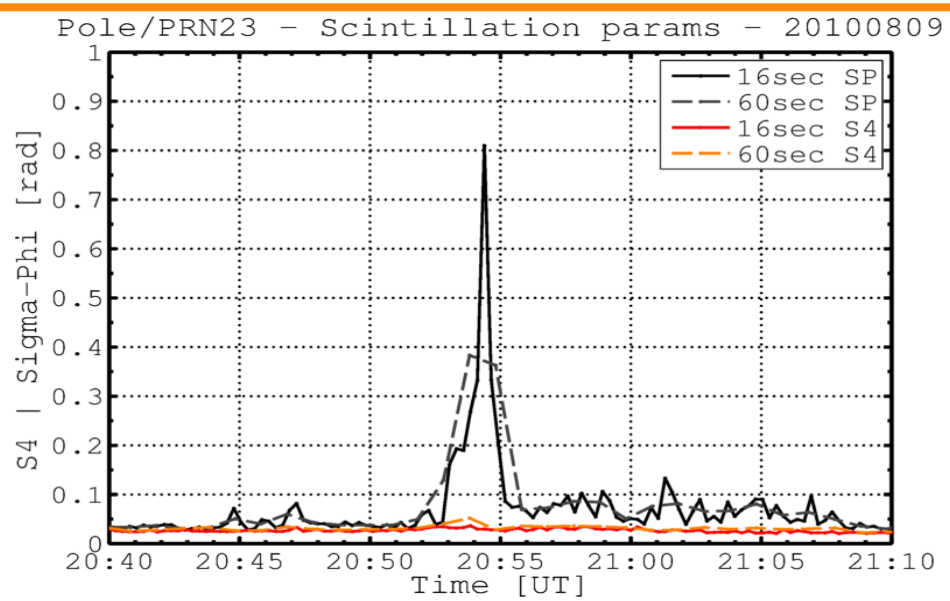
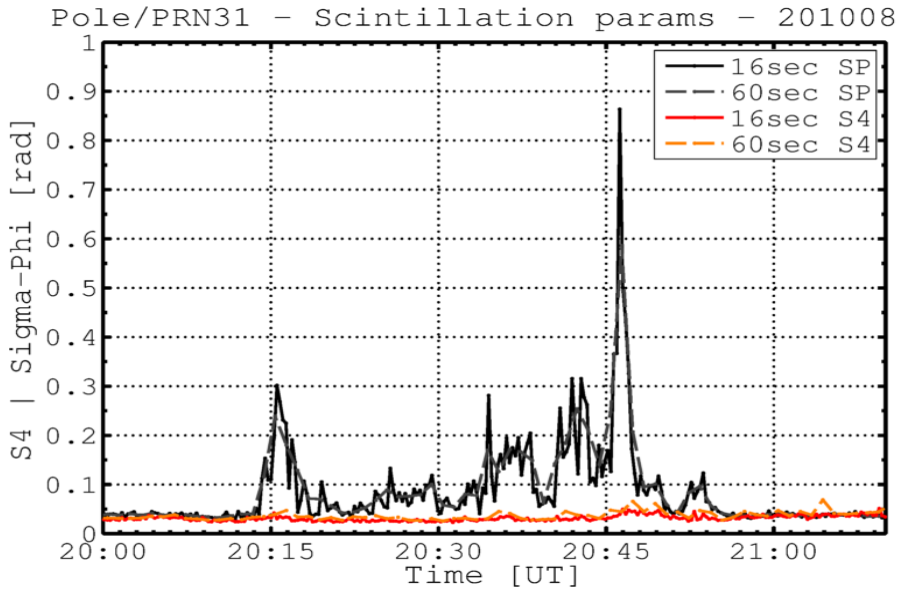
under second review







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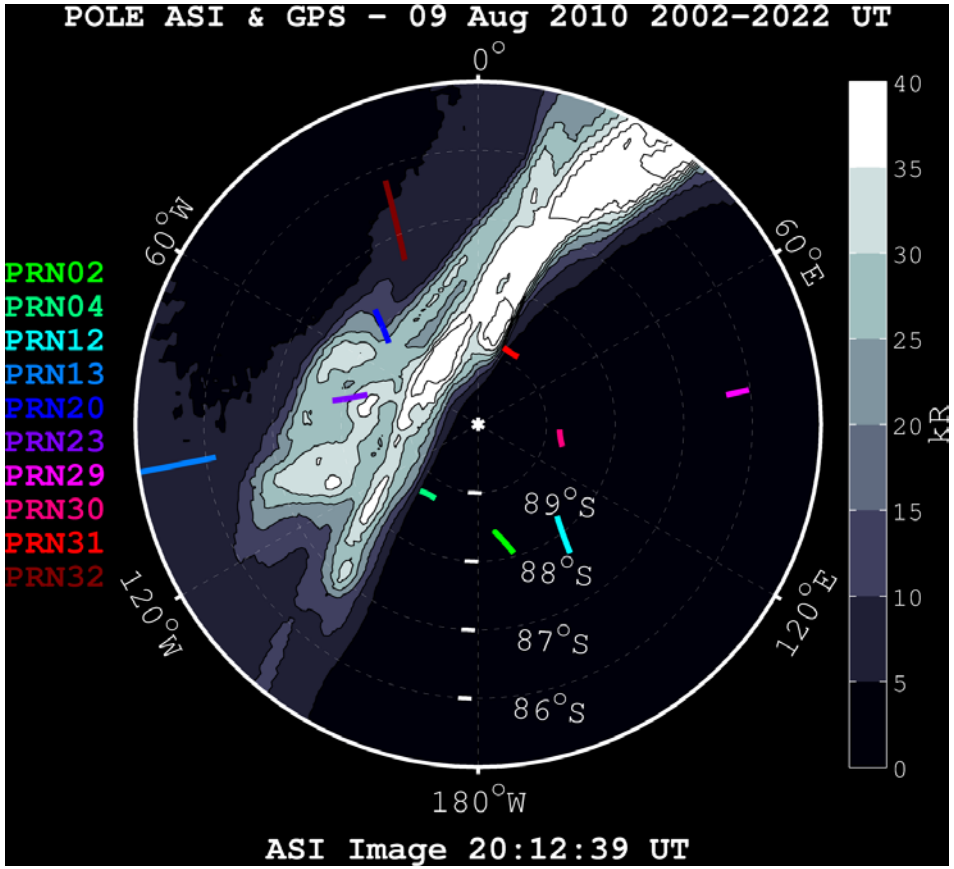

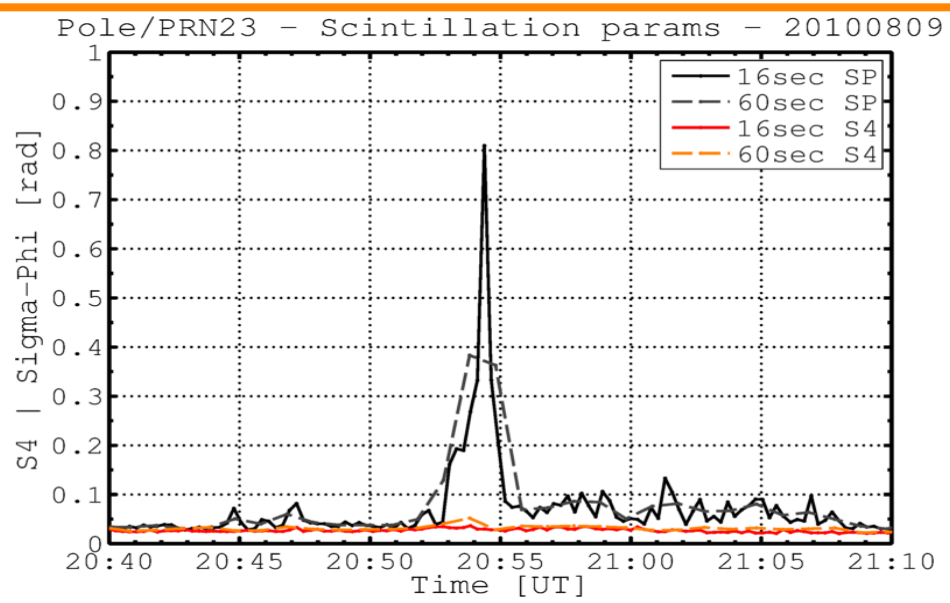

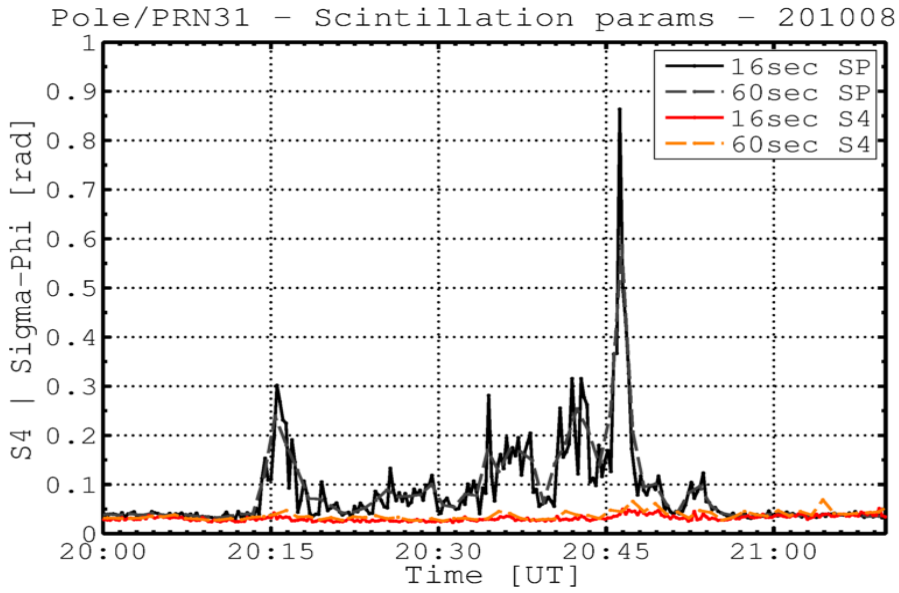

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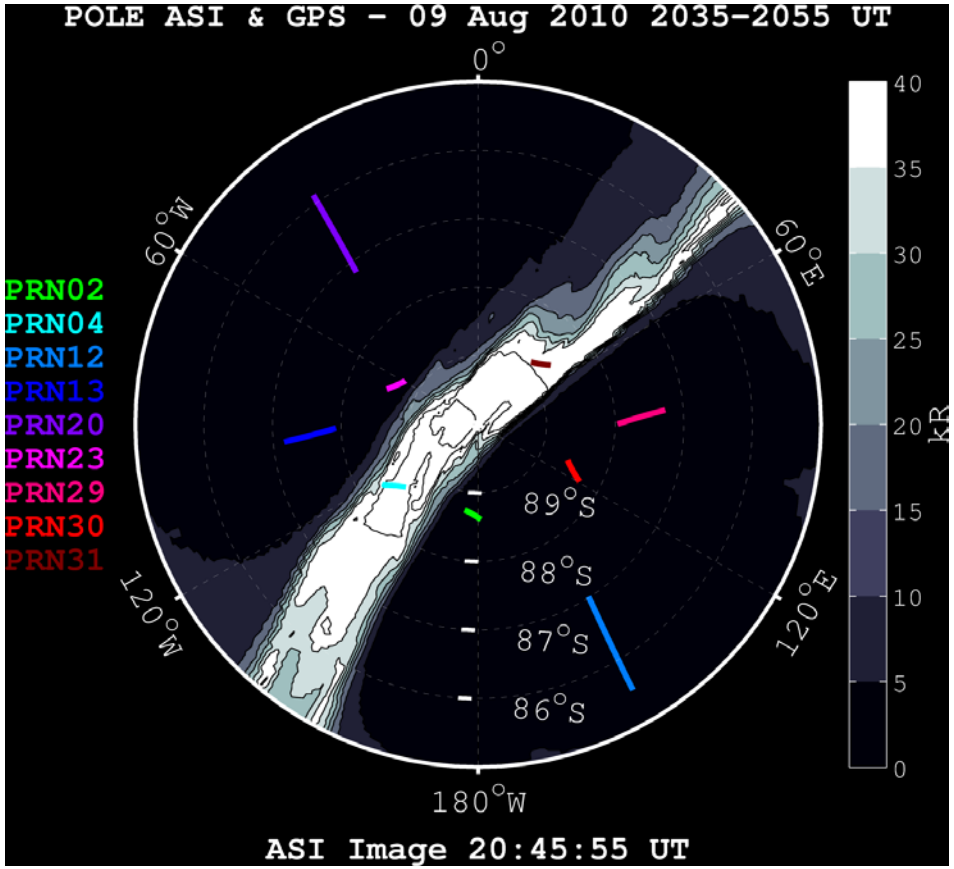

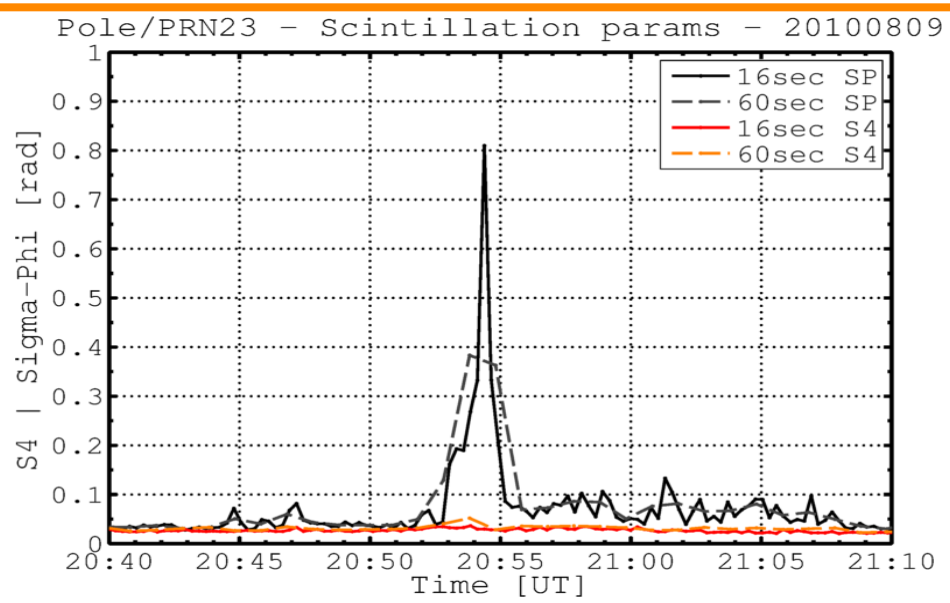

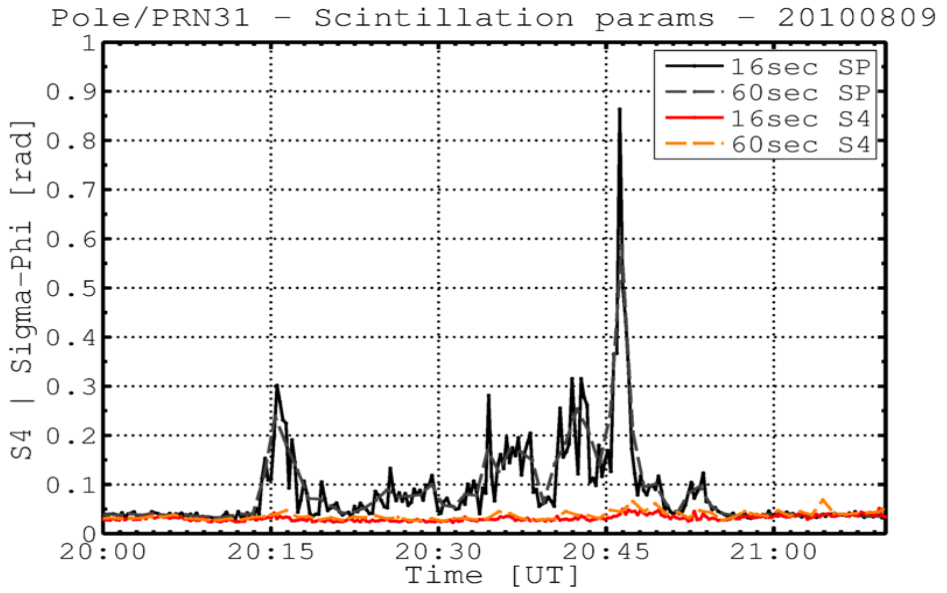

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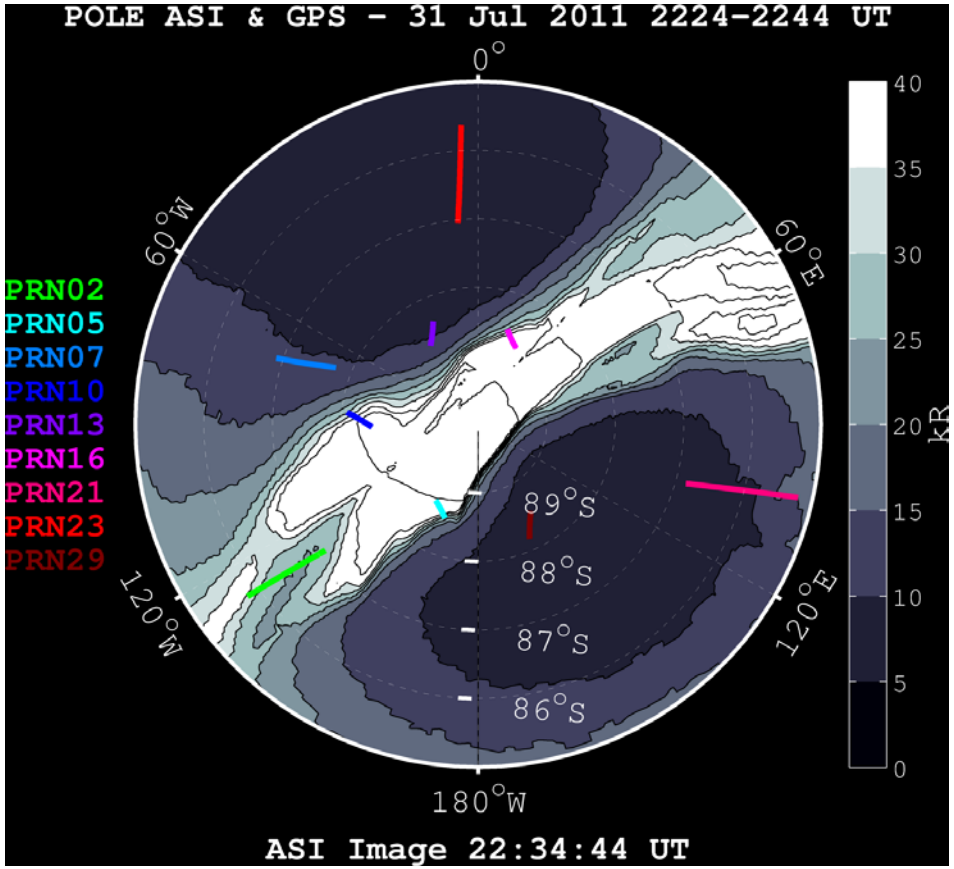

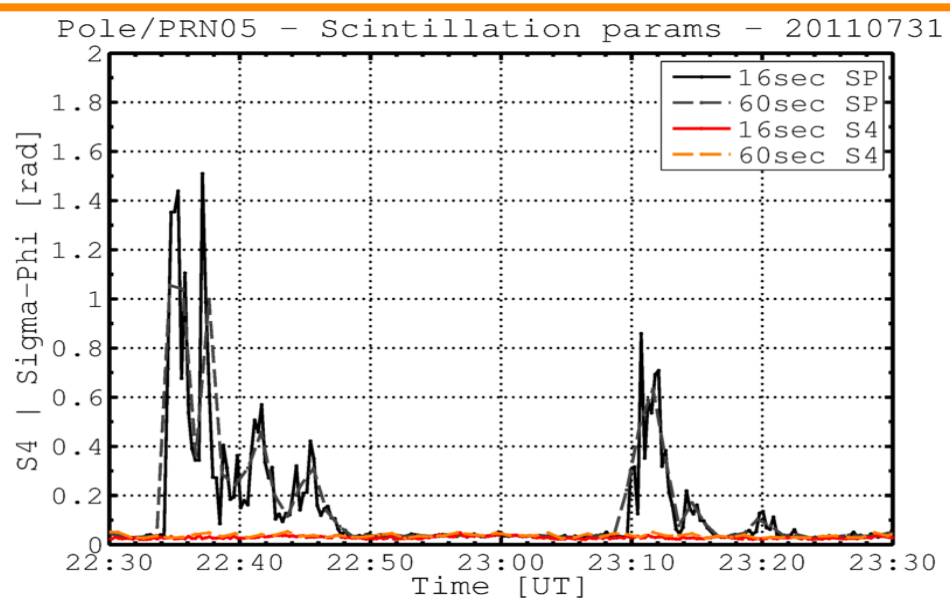

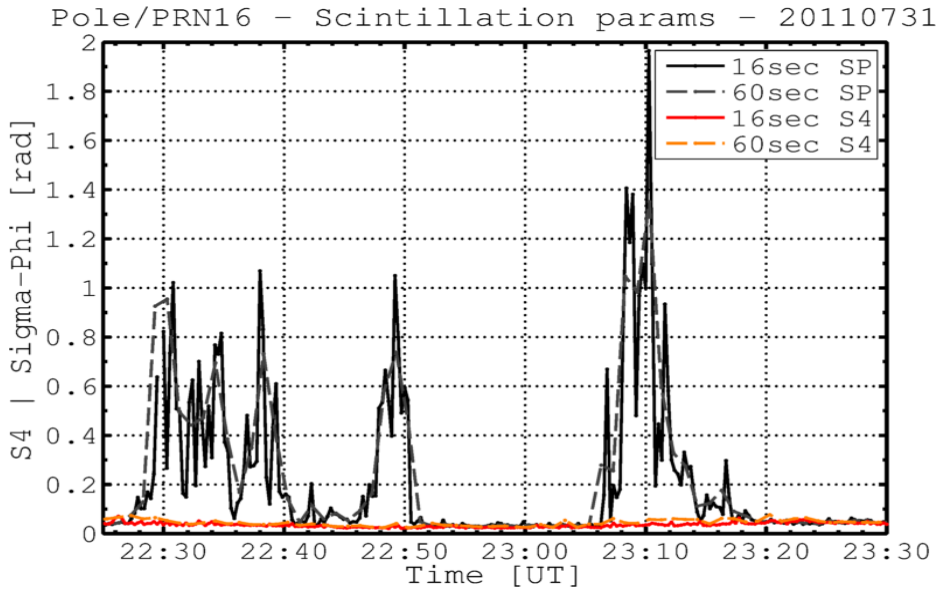

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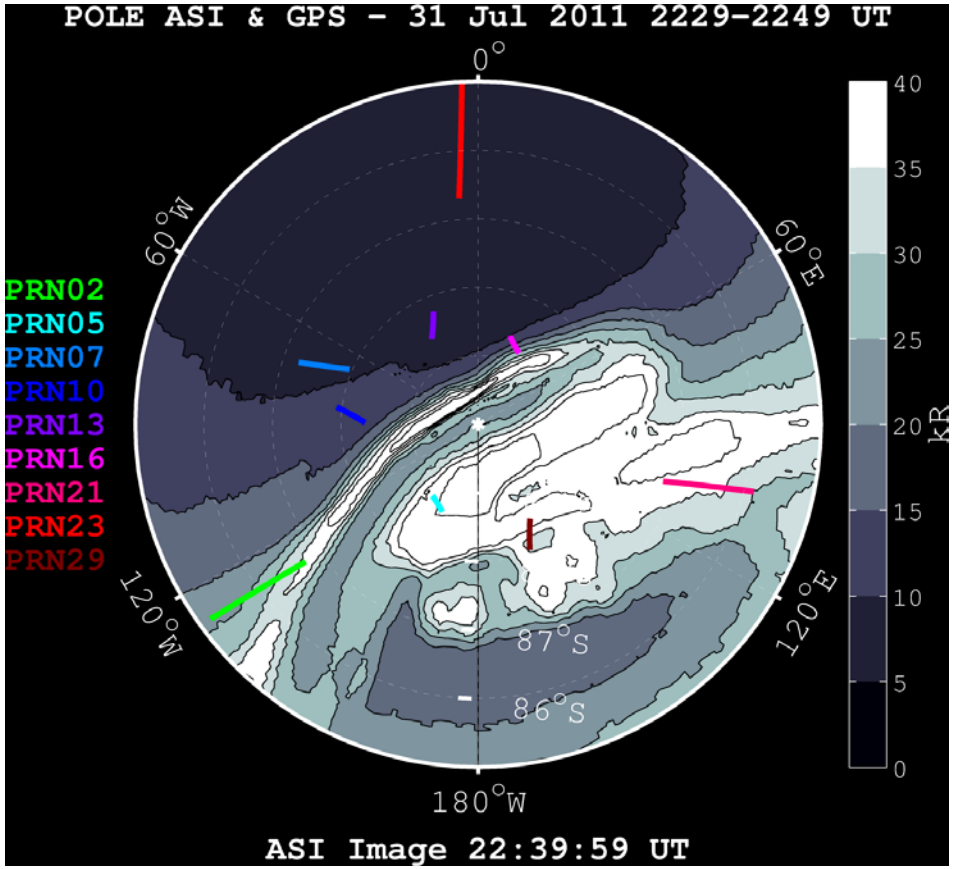

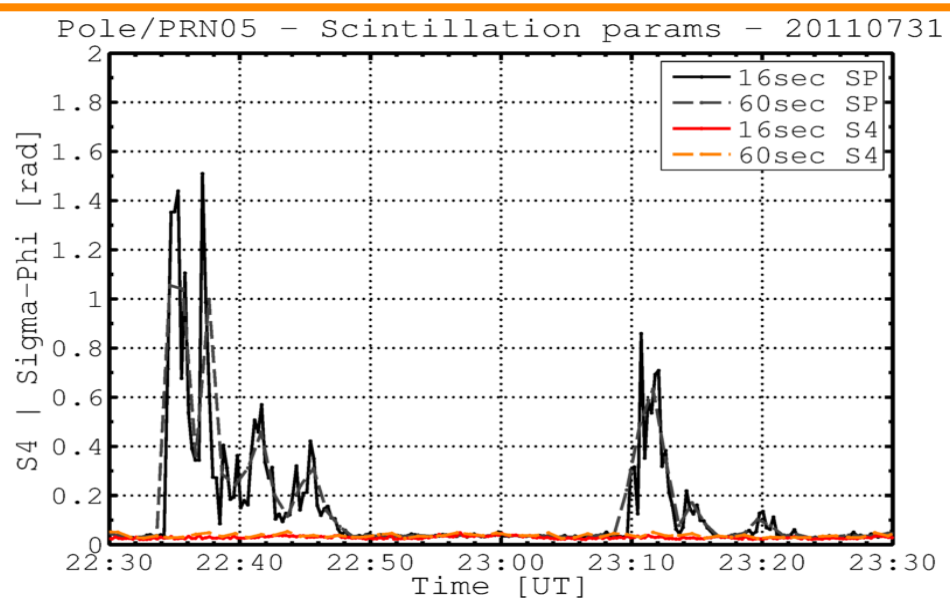

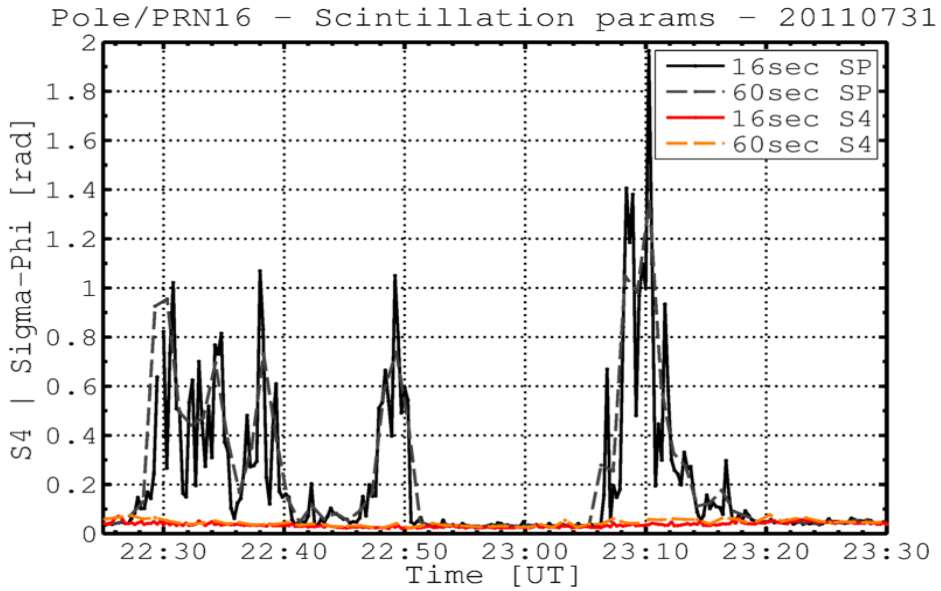

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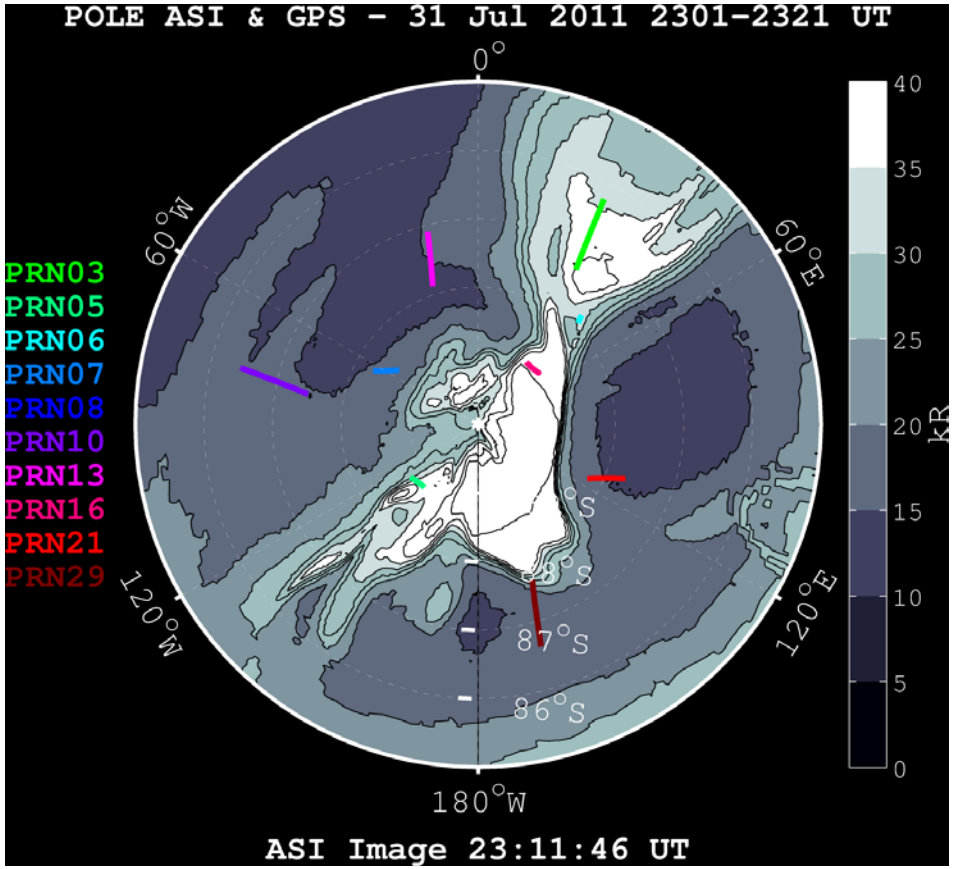

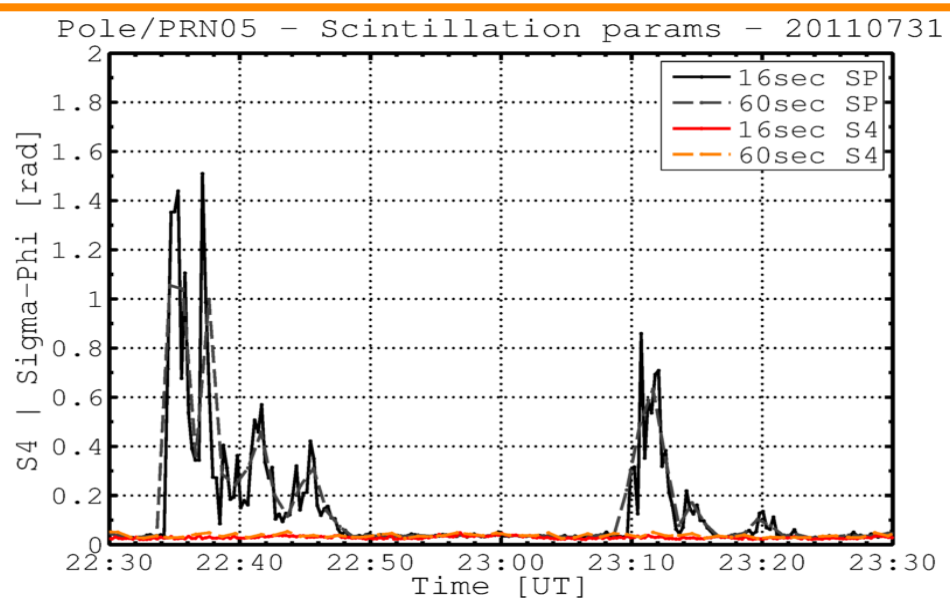

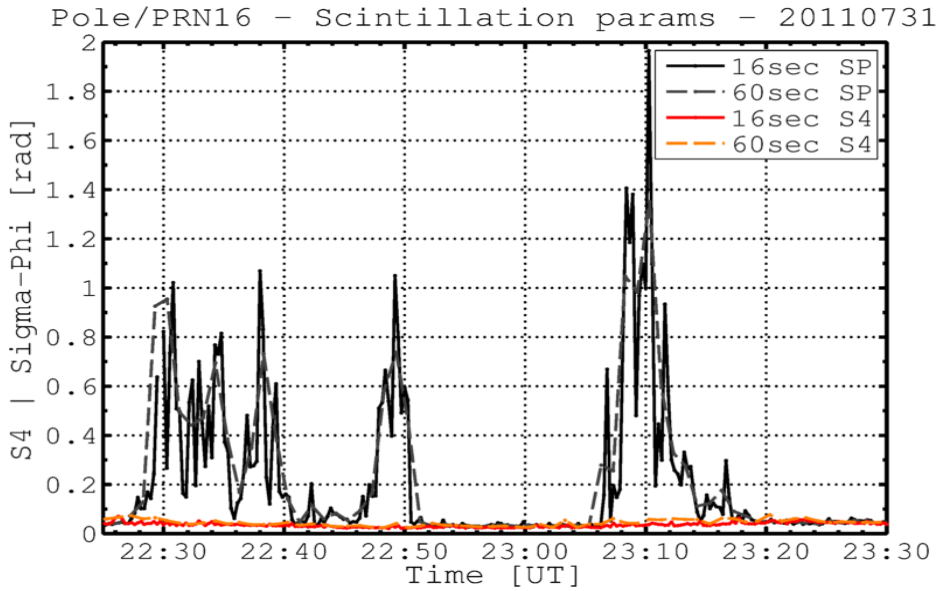

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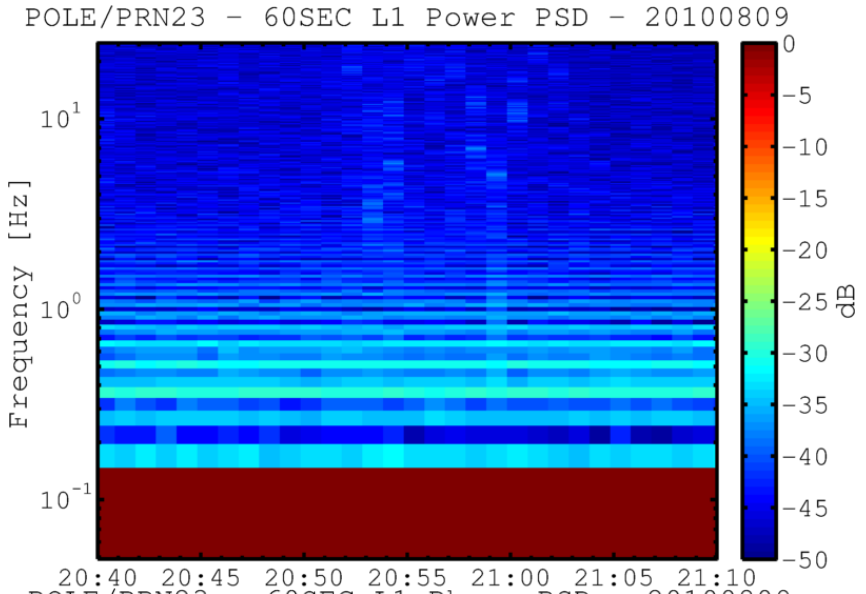
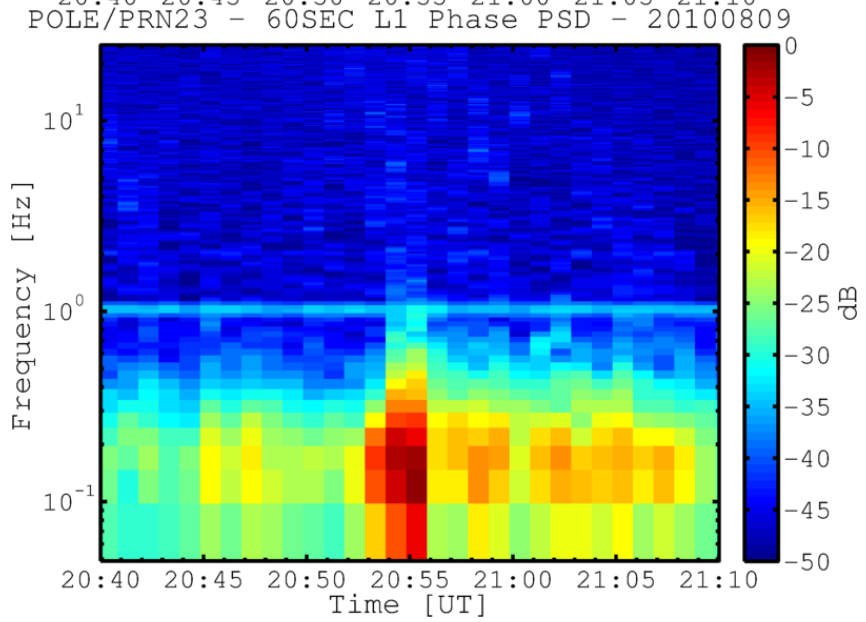
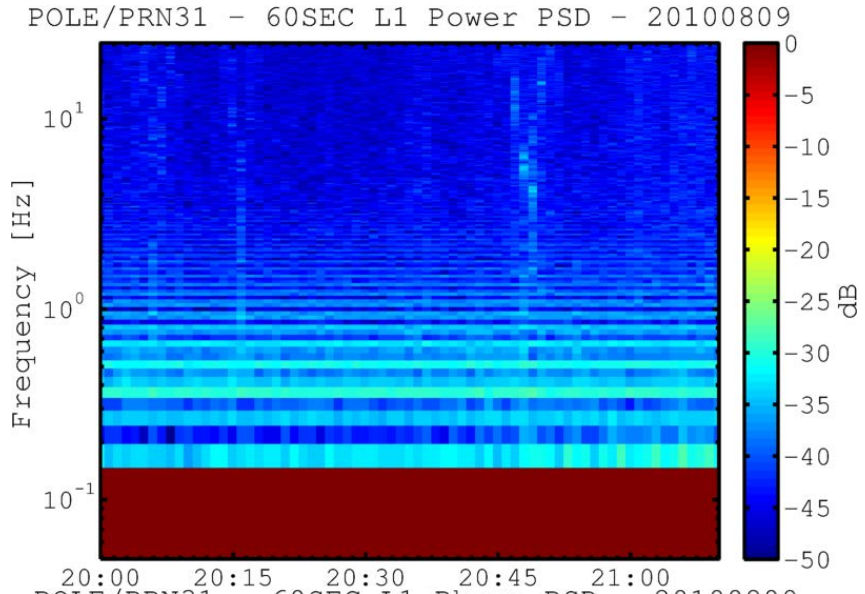
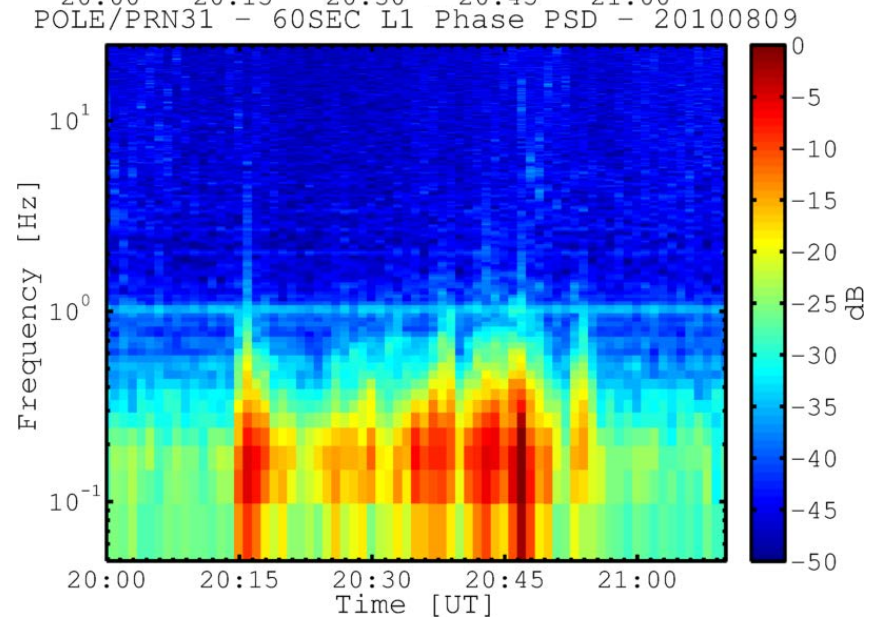


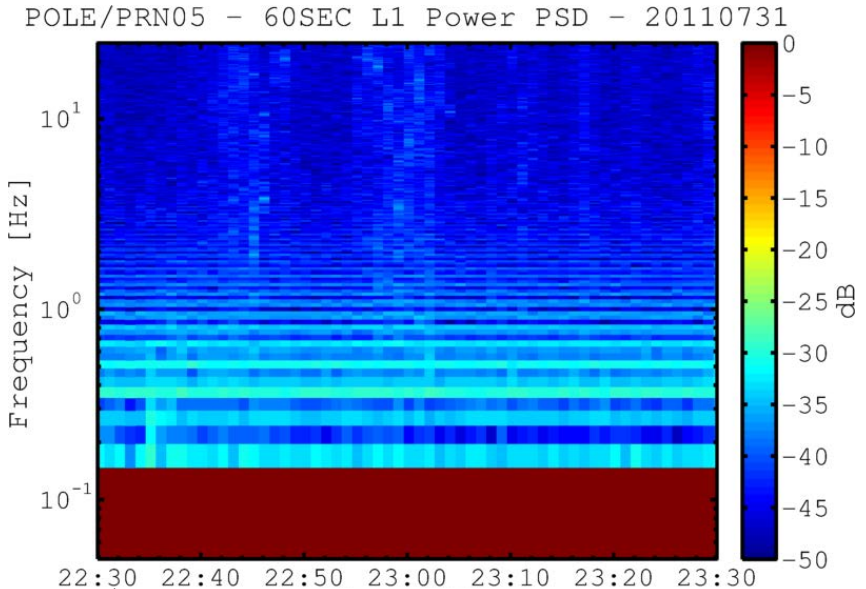


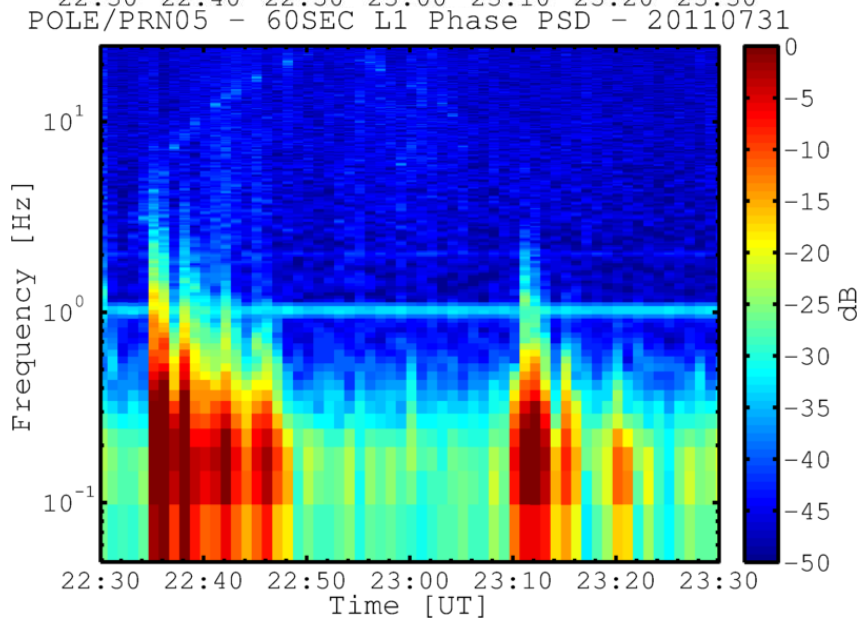


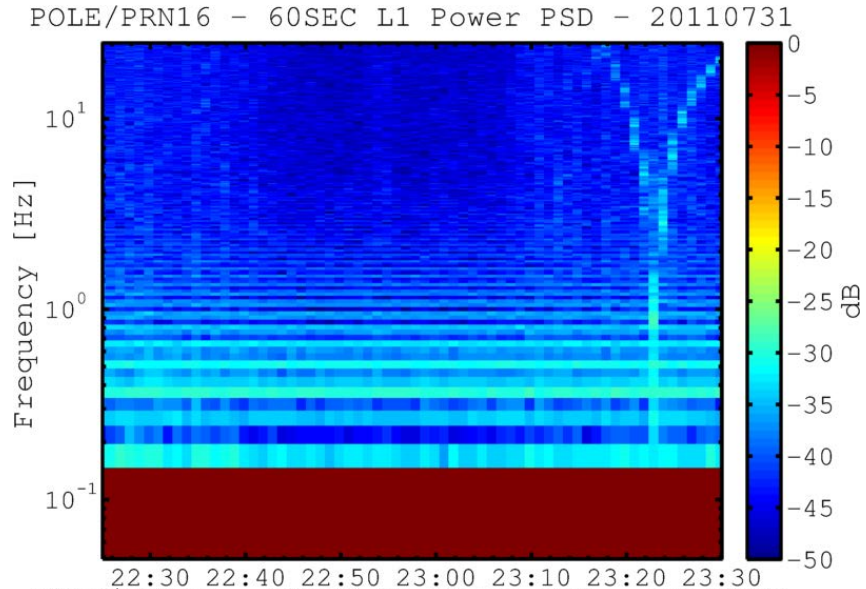


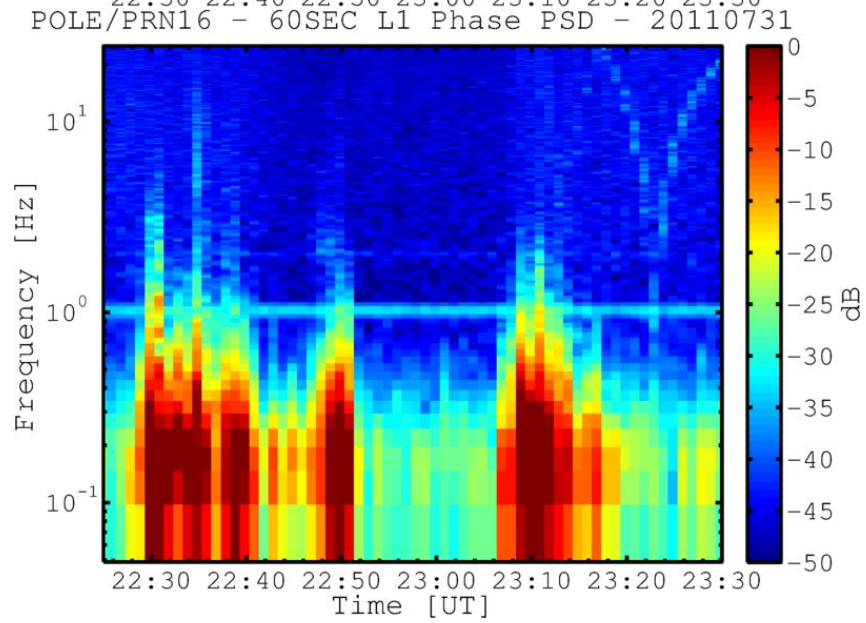
31 July 2011 (event B)

Forte et al, 2016
under second review









Ionisation levels

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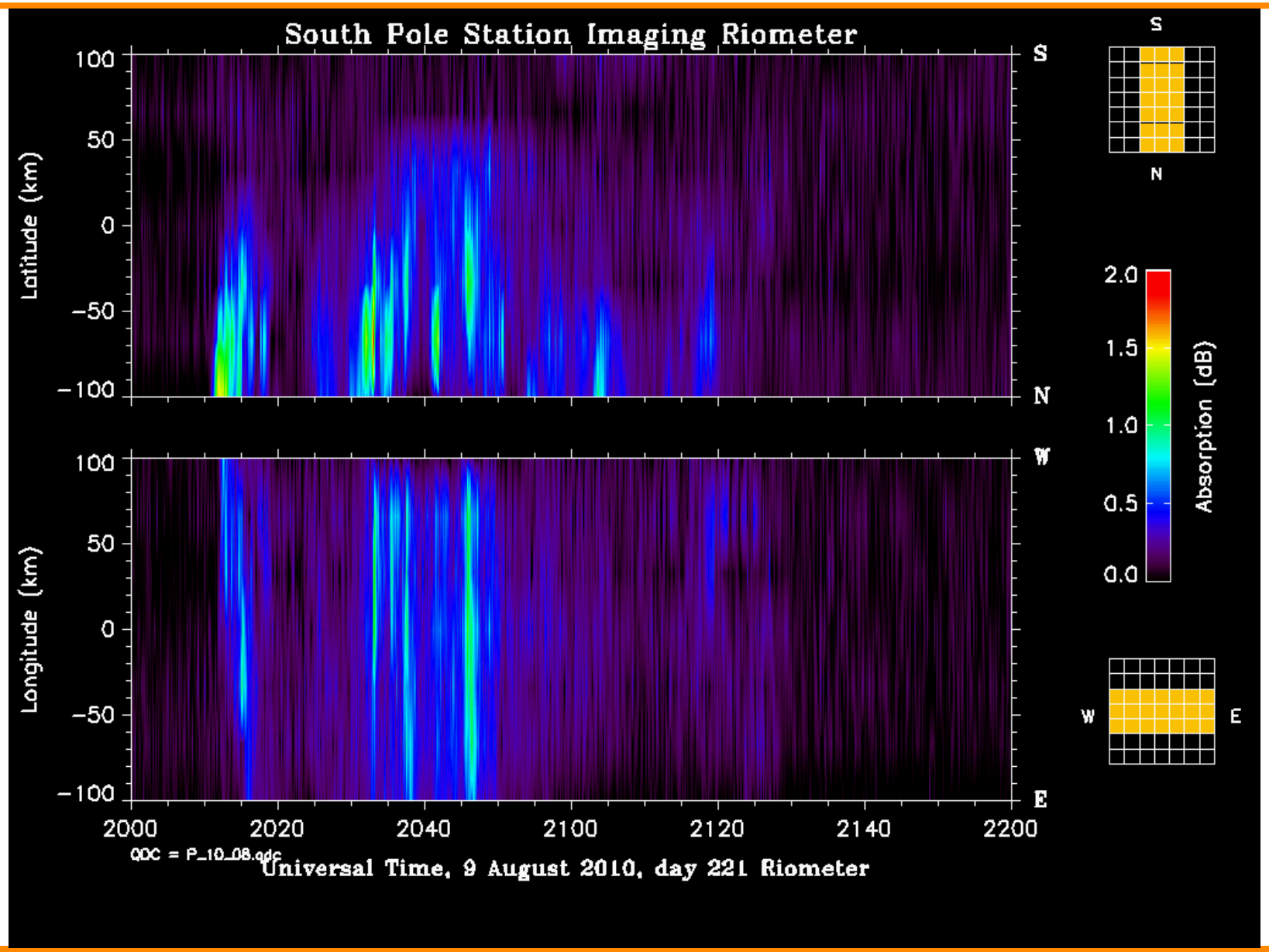

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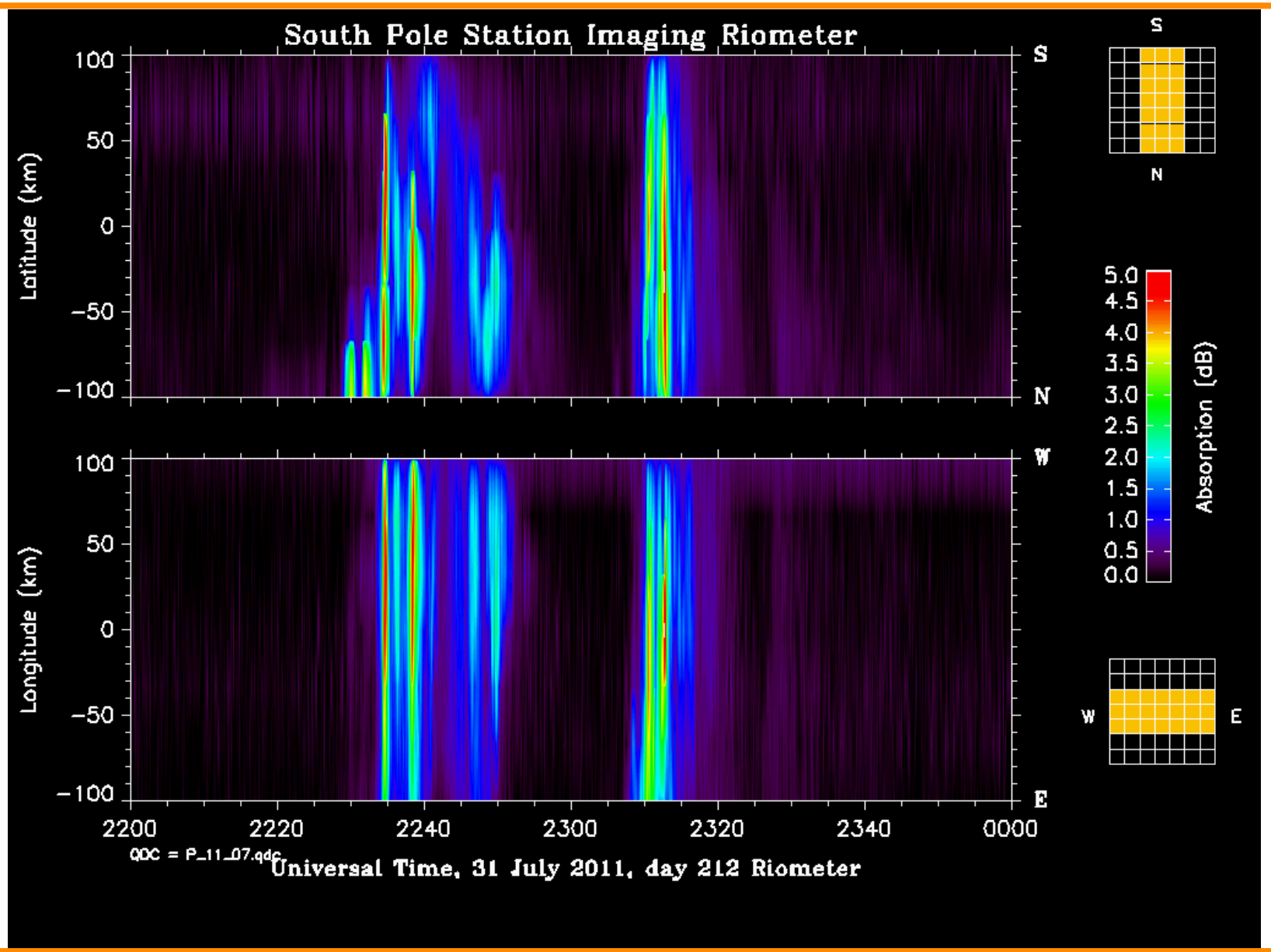

Weak scattering approximation

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under second review

1-D PSD for received intensity:

$$\Phi_I(k) = 4\Phi_\phi(k) sin^2\left(\frac{k^2 r_F^2}{4\pi}\right)$$

where:

$$k_F = \frac{\sqrt{2}\pi}{r_F}$$

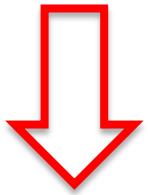
$$d_F = \sqrt{2\lambda z}$$

Fresnel frequency of the problem:

$$\nu_F = \frac{V^{REL}}{d_F}$$

where:

$$V^{REL} = V^{SAT} - V^{IONO}$$



Solve for V^{IONO}

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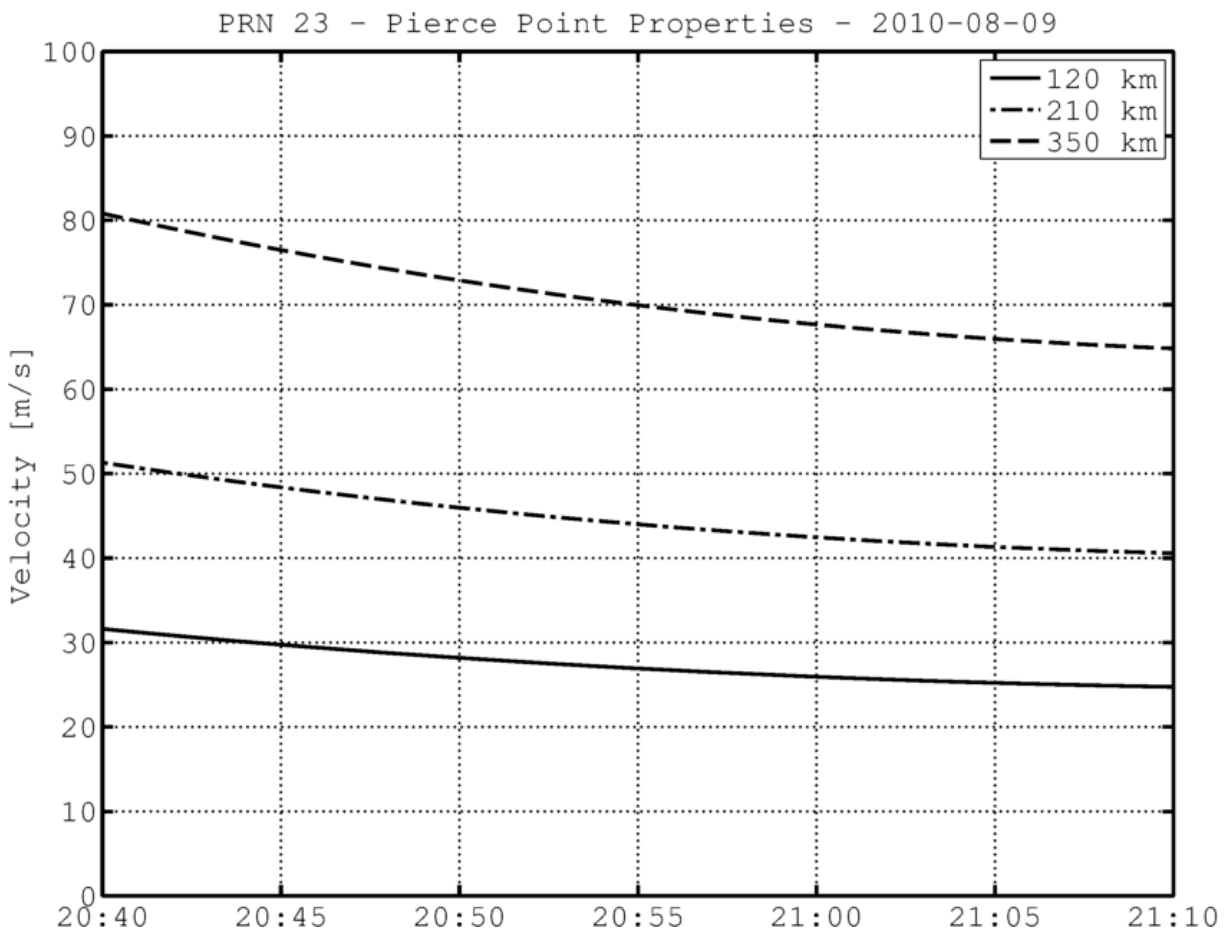

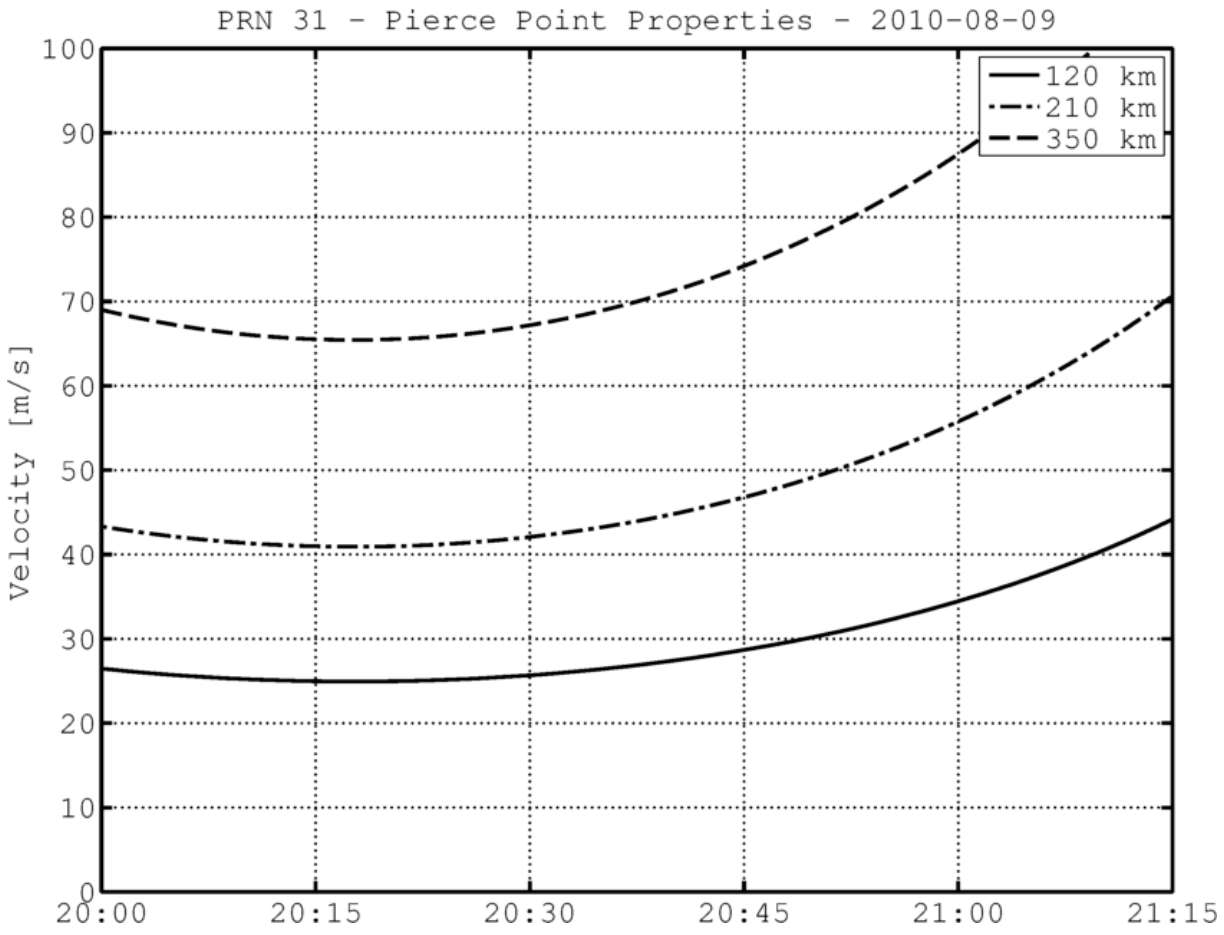

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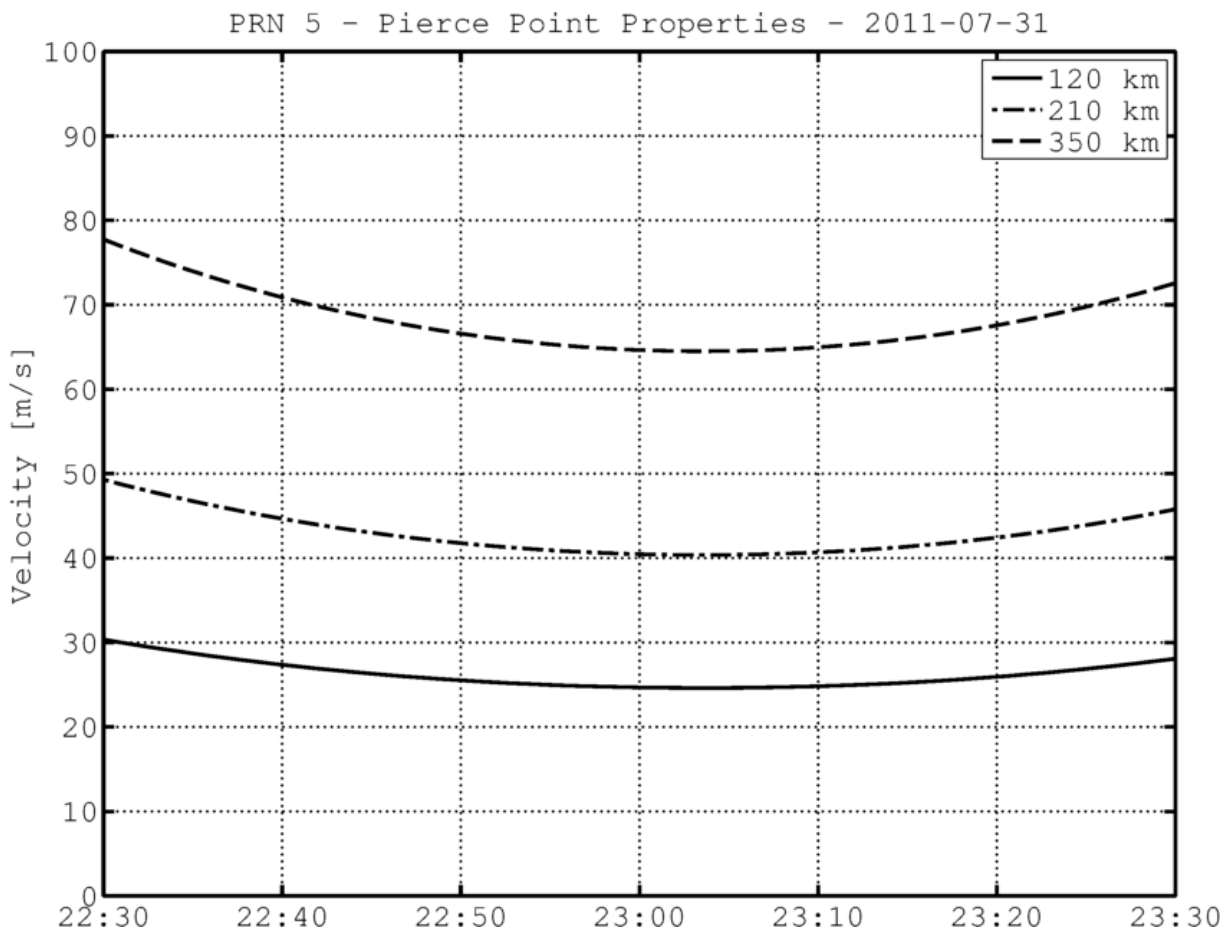
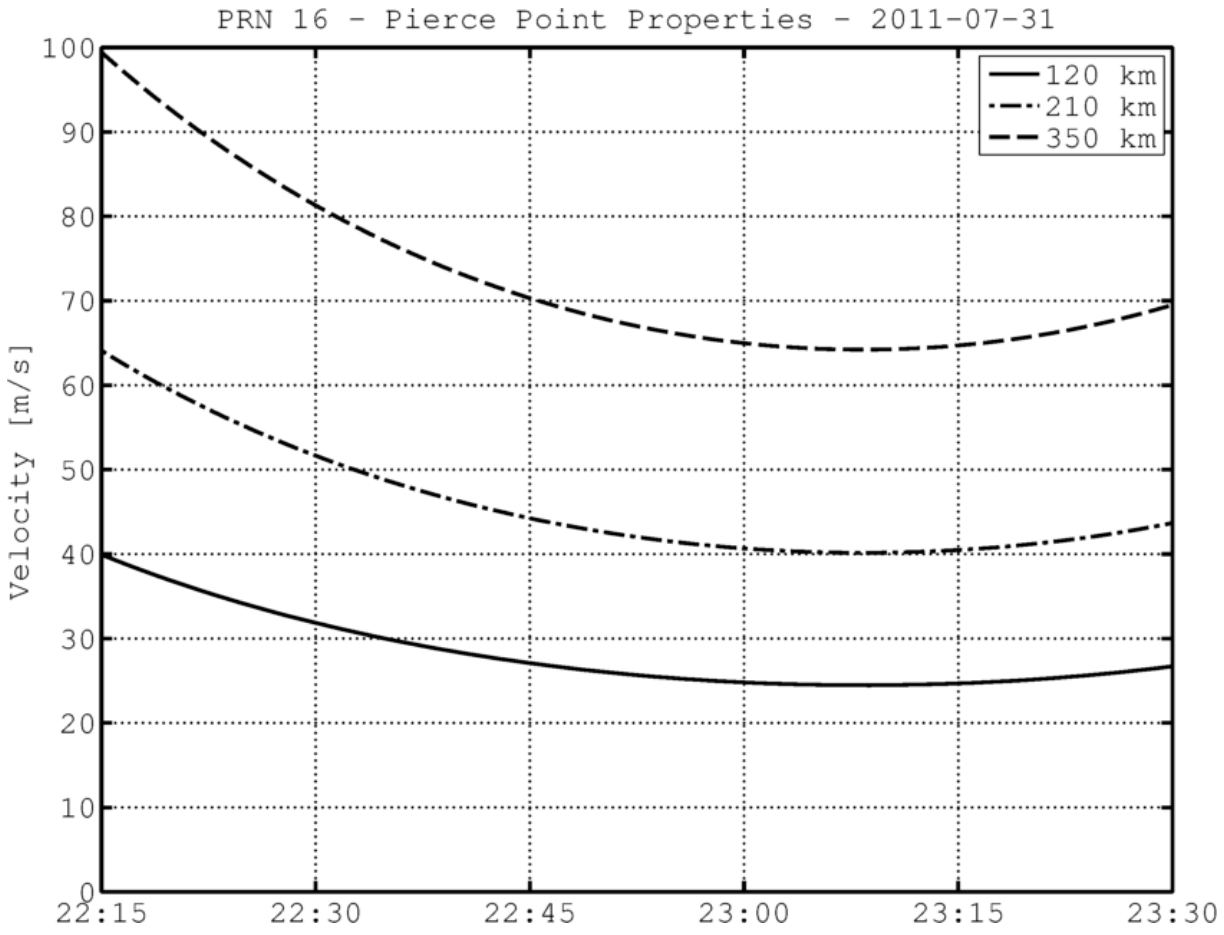
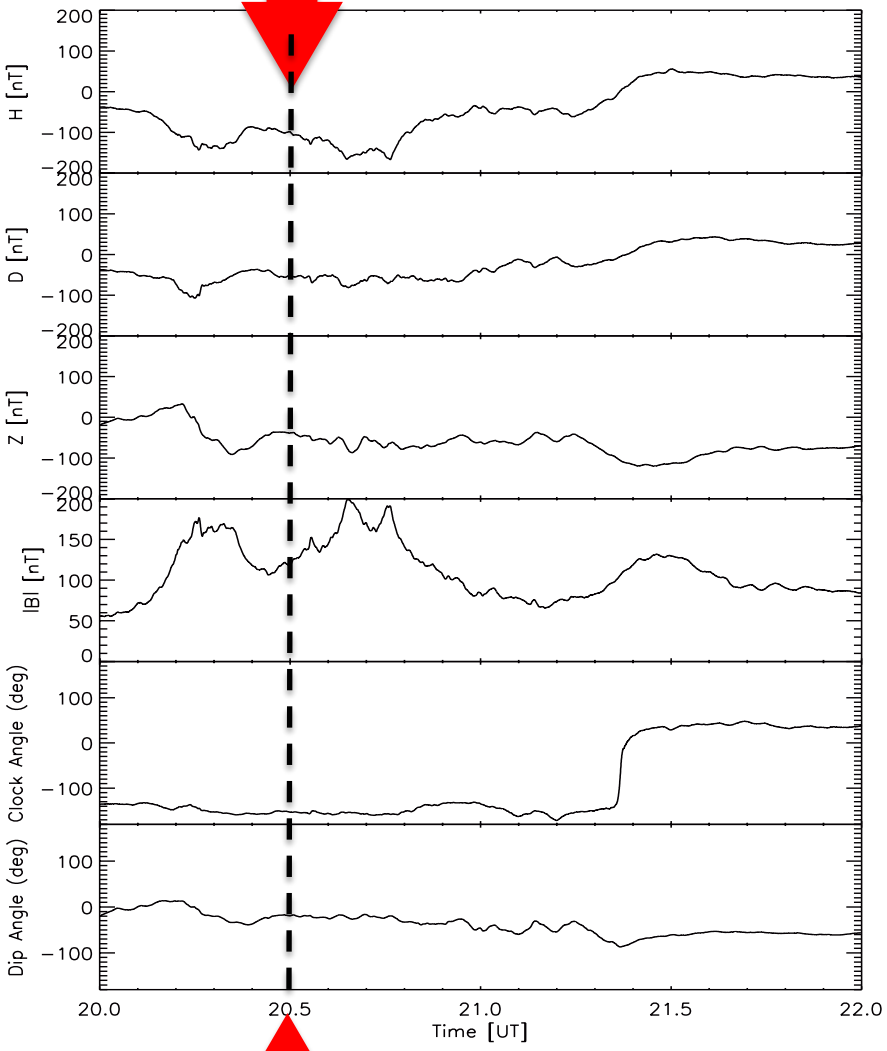
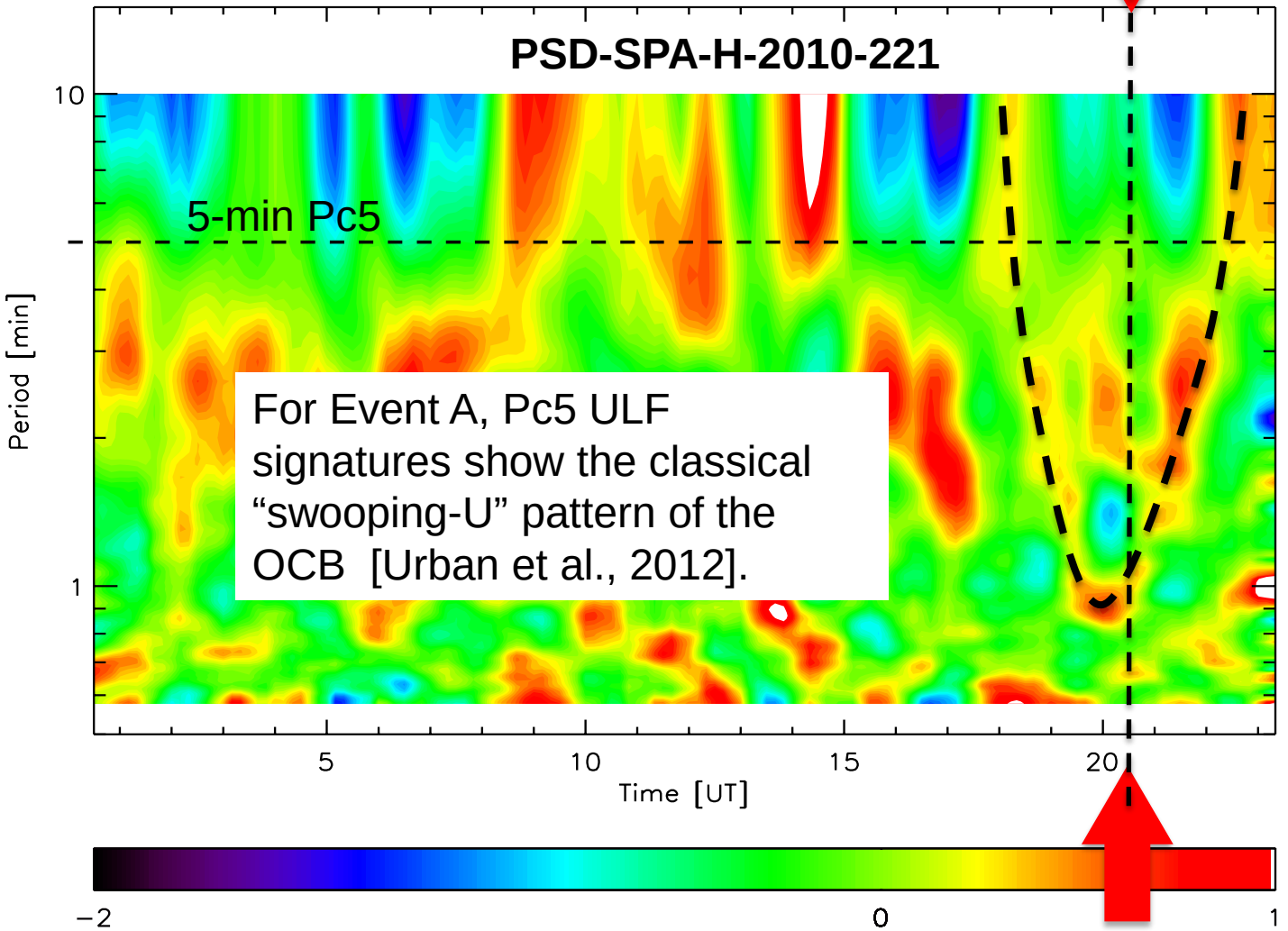




Magnetic Conditions

09 August 2010 (event A)





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under second review

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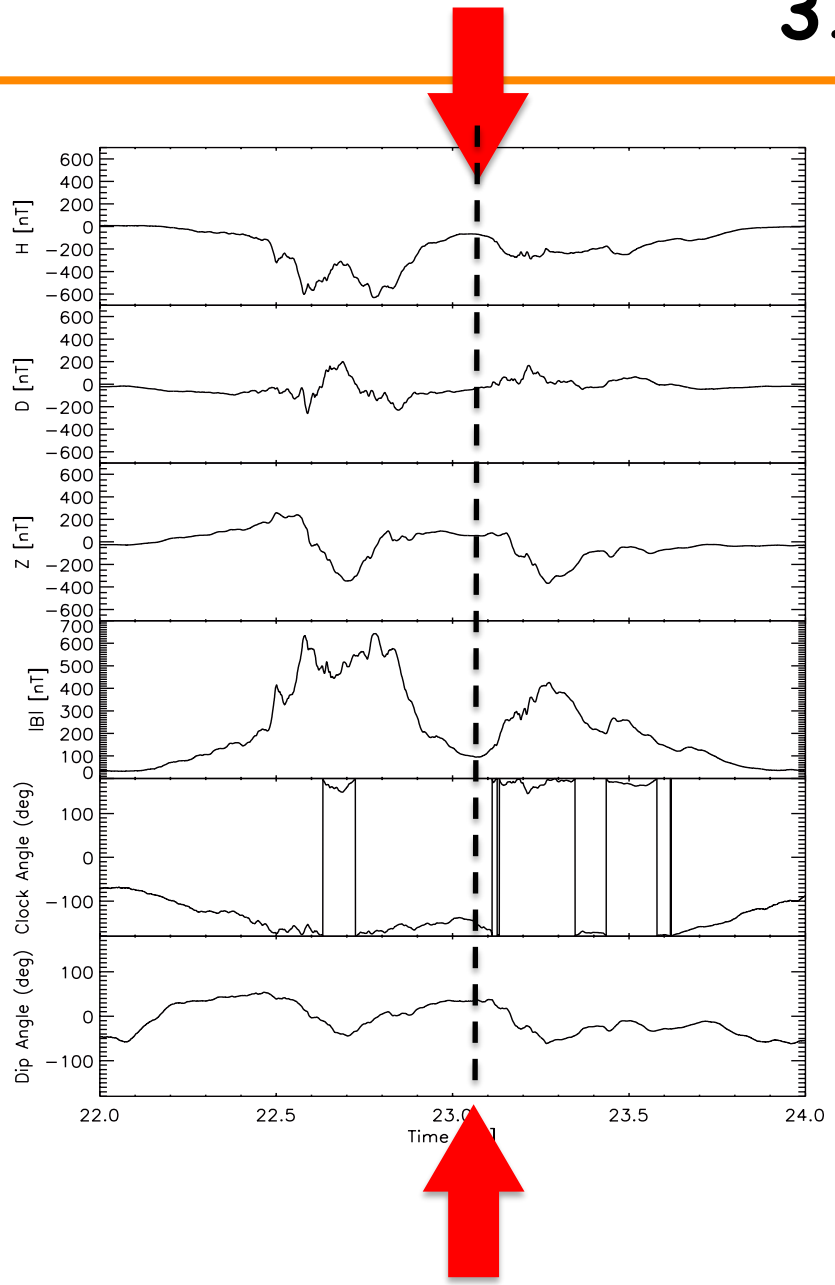

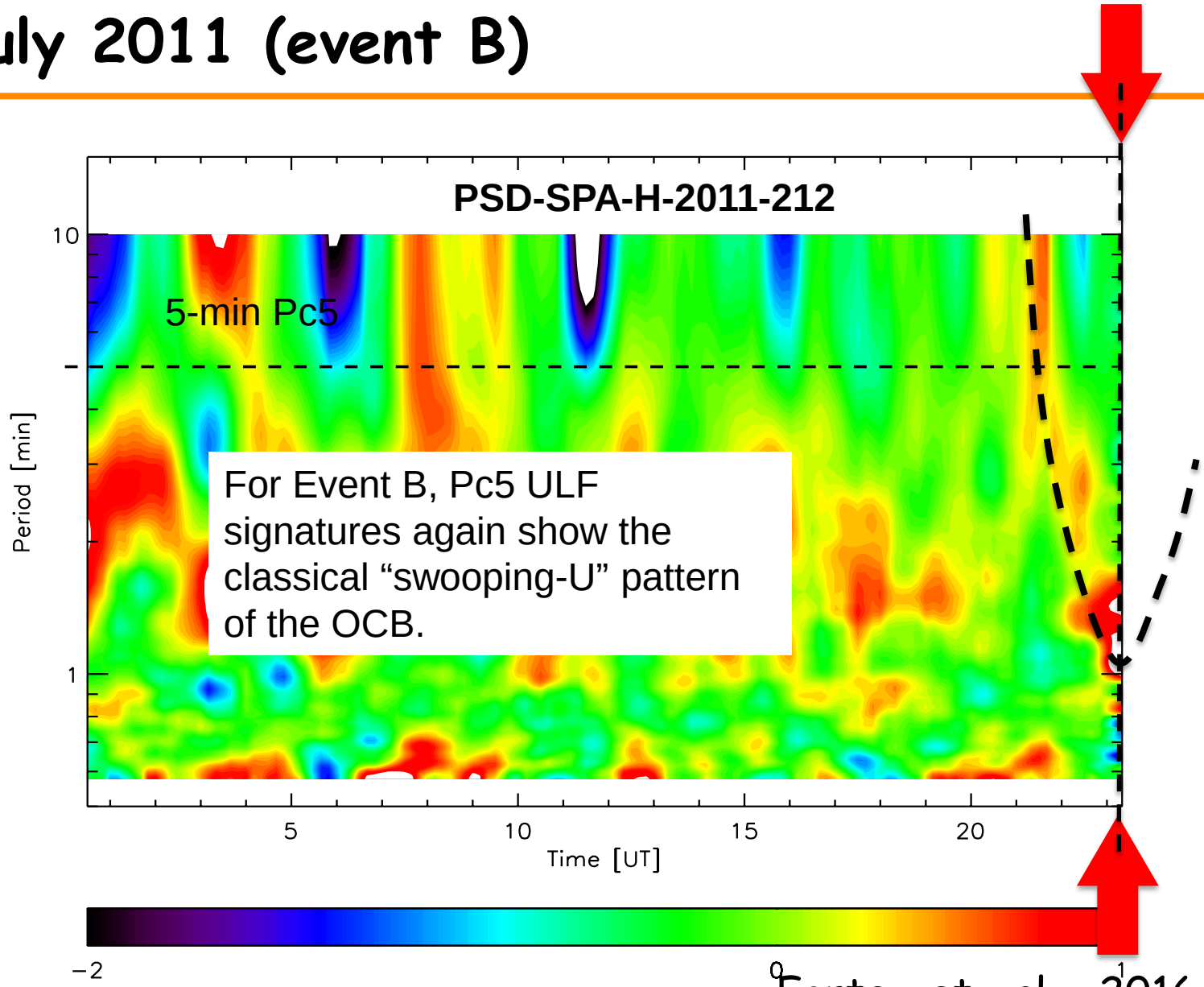

For Event B, Pc5 ULF signatures again show the classical “swooping-U” pattern of the OCB.

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Magnetic Analysis

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1. For both Event A and B, there was marked reconfiguration of the magnetospheric OCB, as indicated by ground-based fluxgate magnetometers.

1. This is validated by ASI images of auroral structures.

2. Data from other Antarctic sites (not shown), support this magnetospheric reconfiguration.

1. **The rapid magnetic reconfiguration is associated with the observed scintillation.**

L-Band spectral modifications

09 August 2010 (event A)

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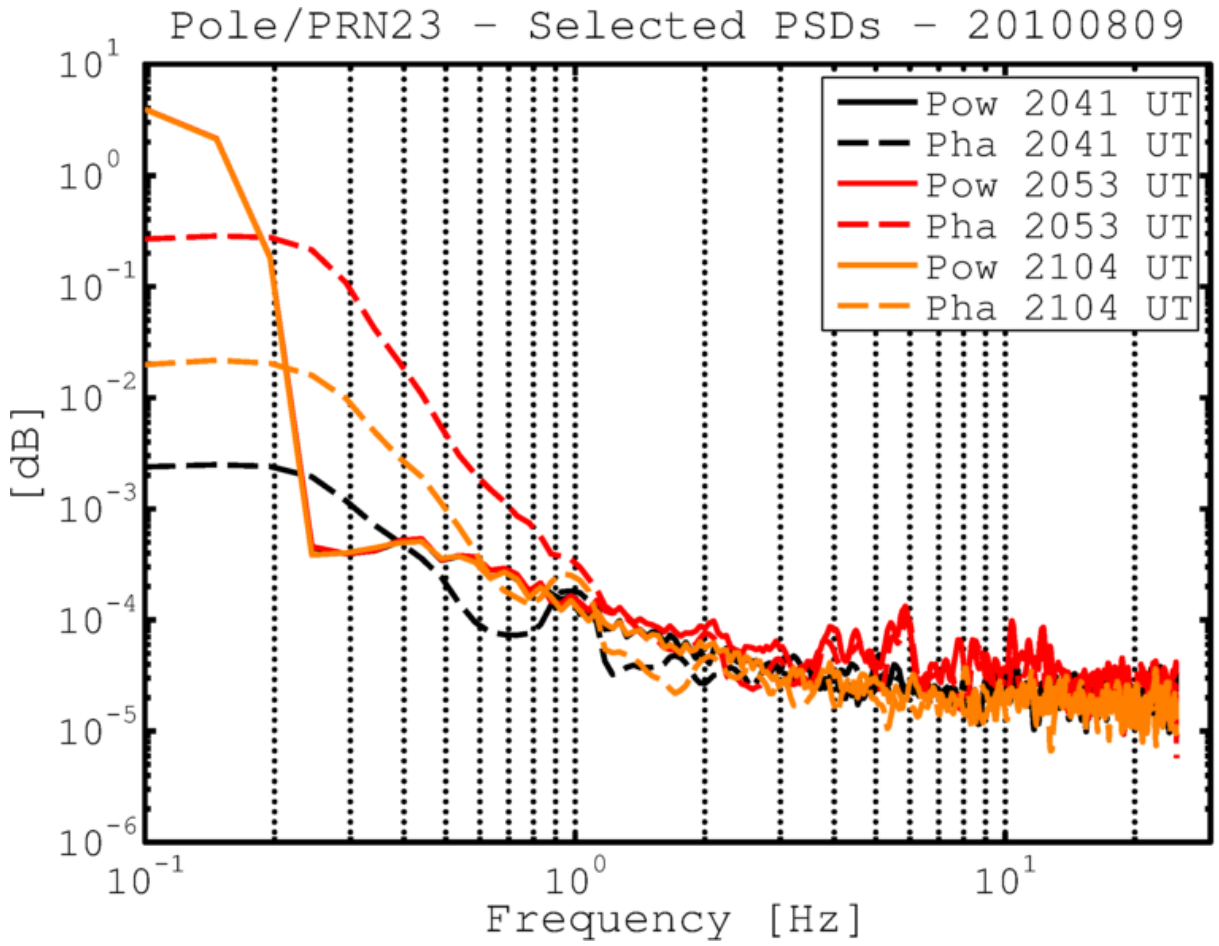

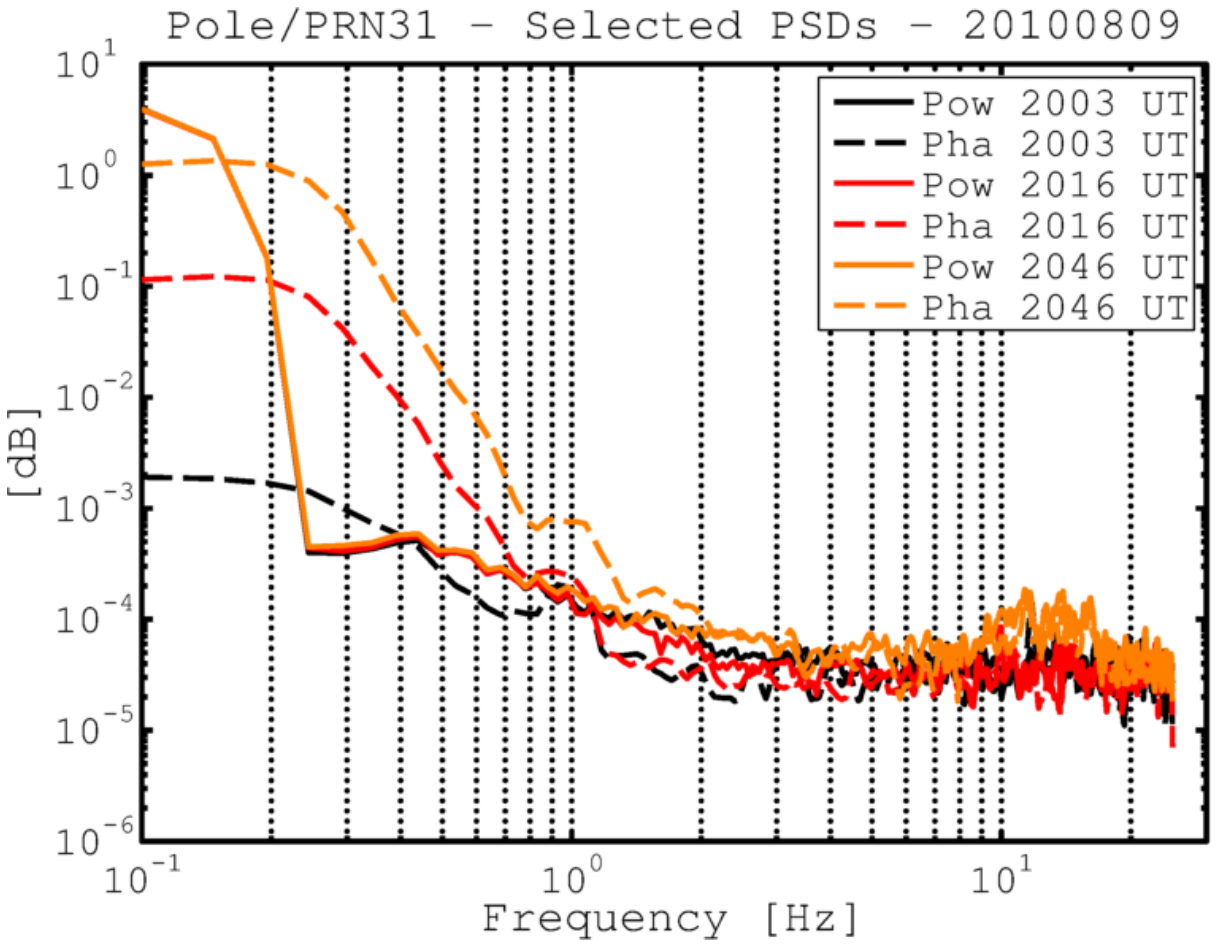

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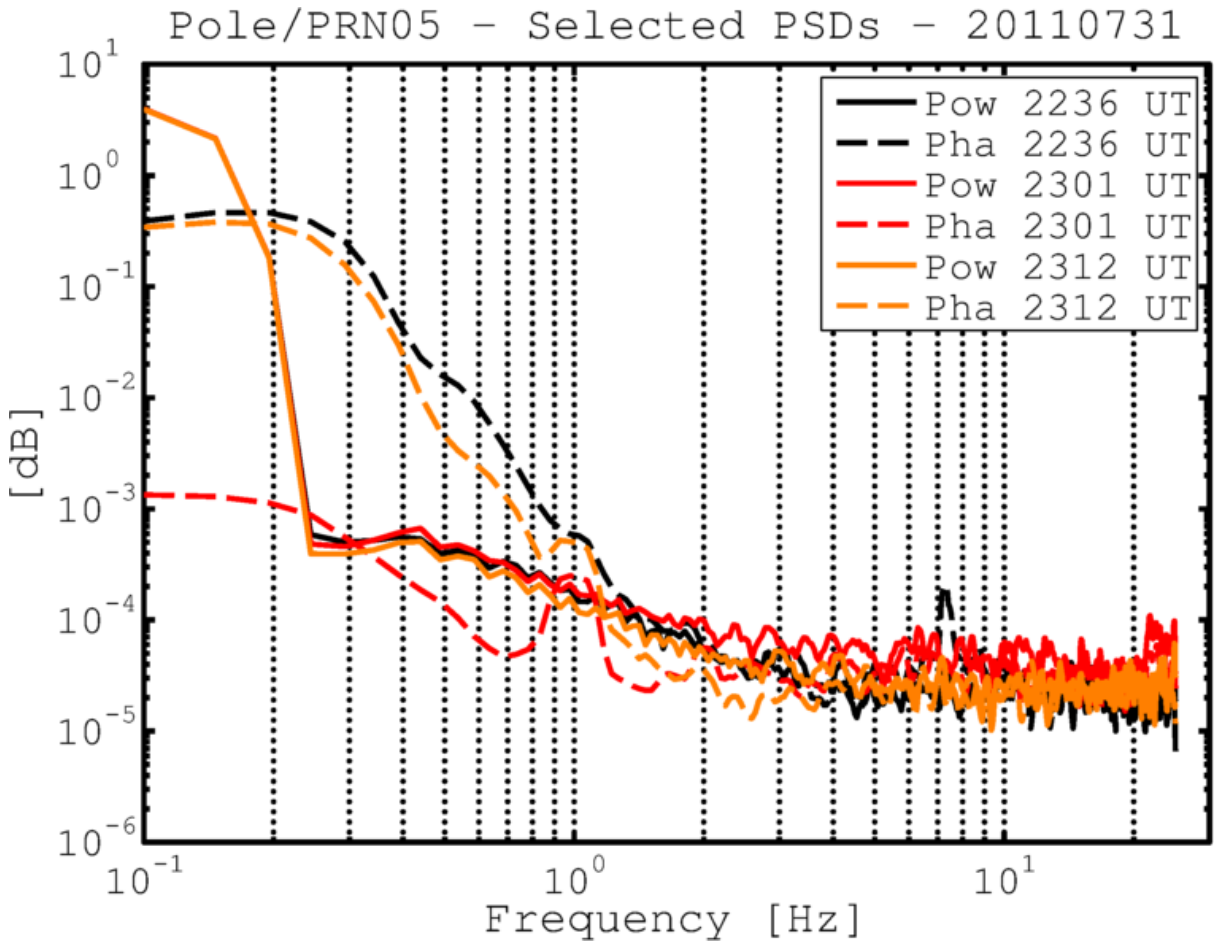
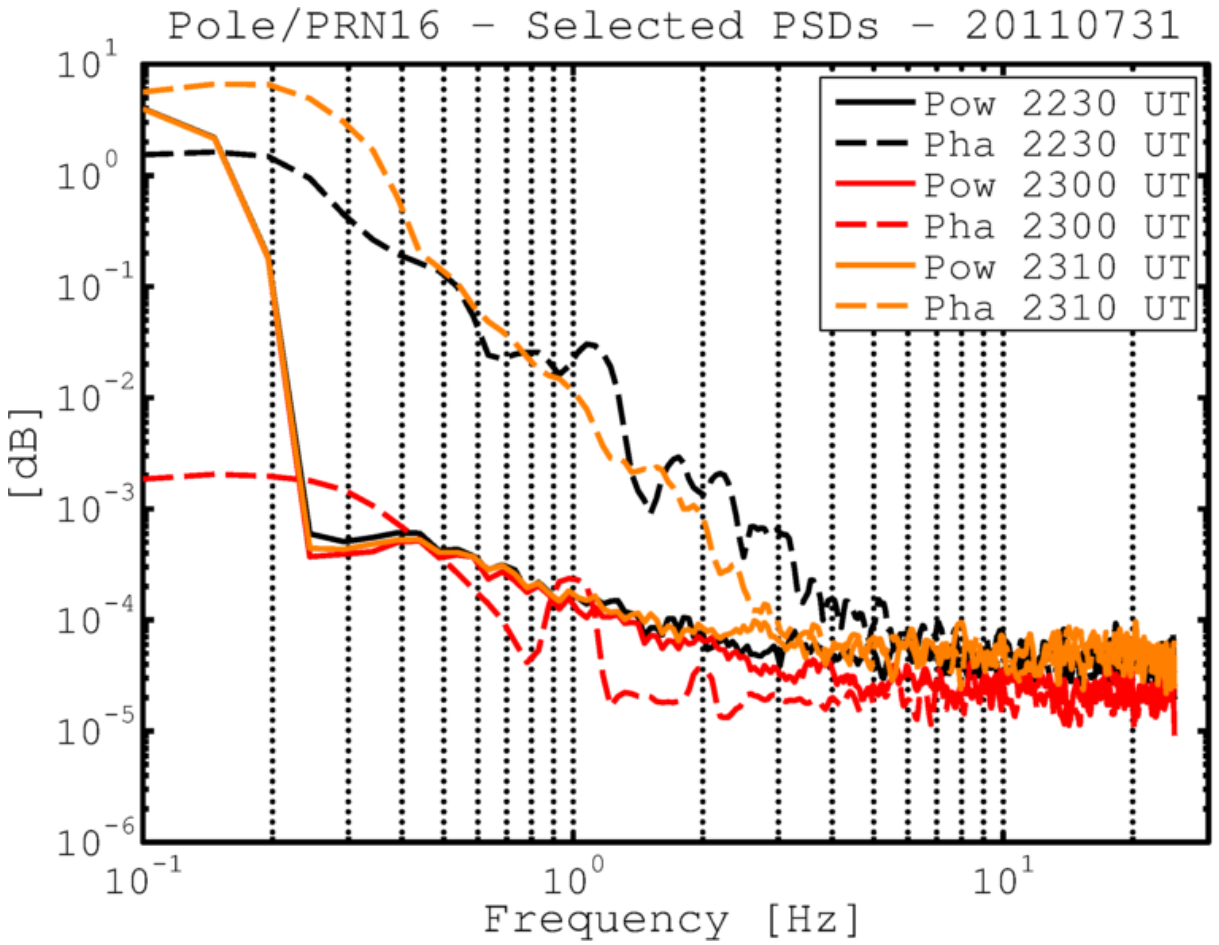
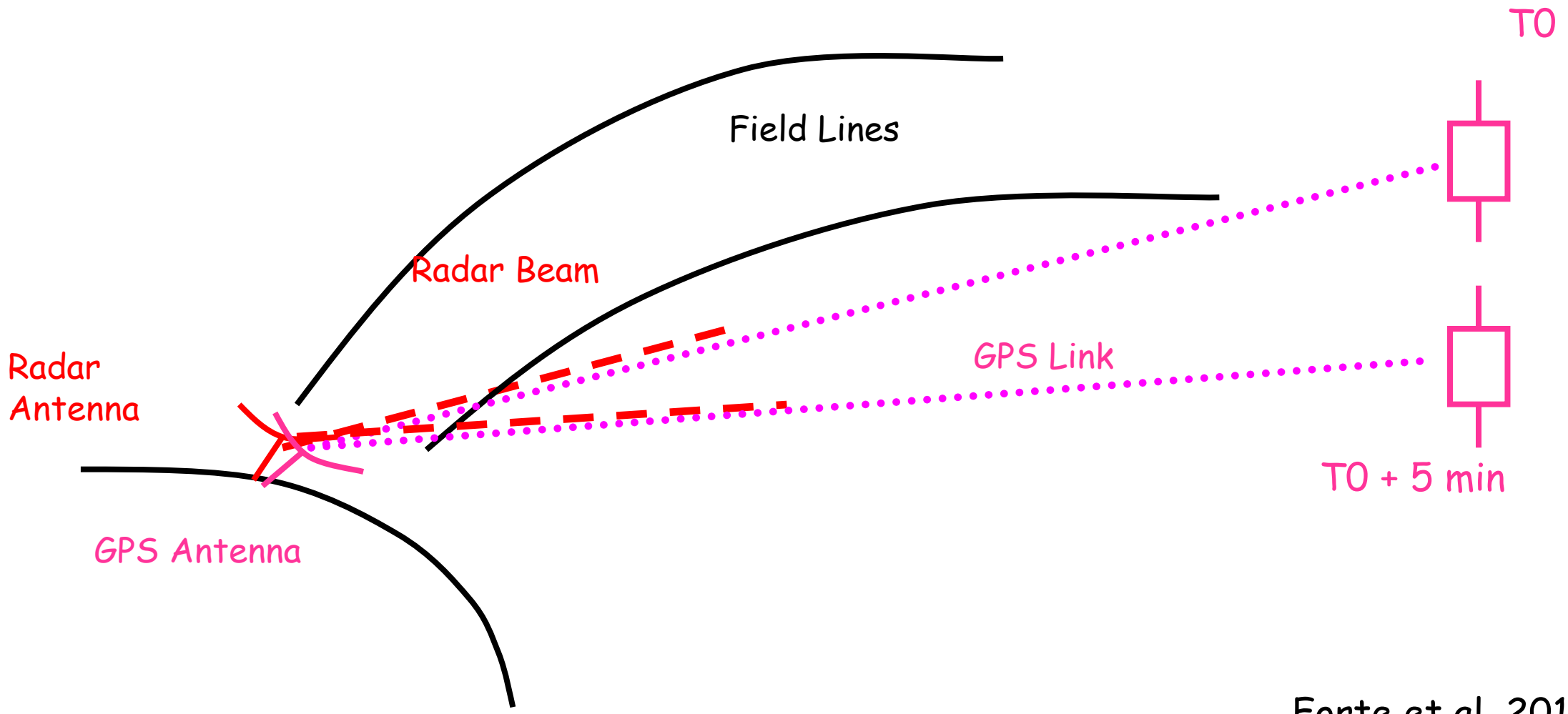




The need for multiple instruments: adding co-located ISR

EISCAT measurement geometry – new experiment



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17 October 2013

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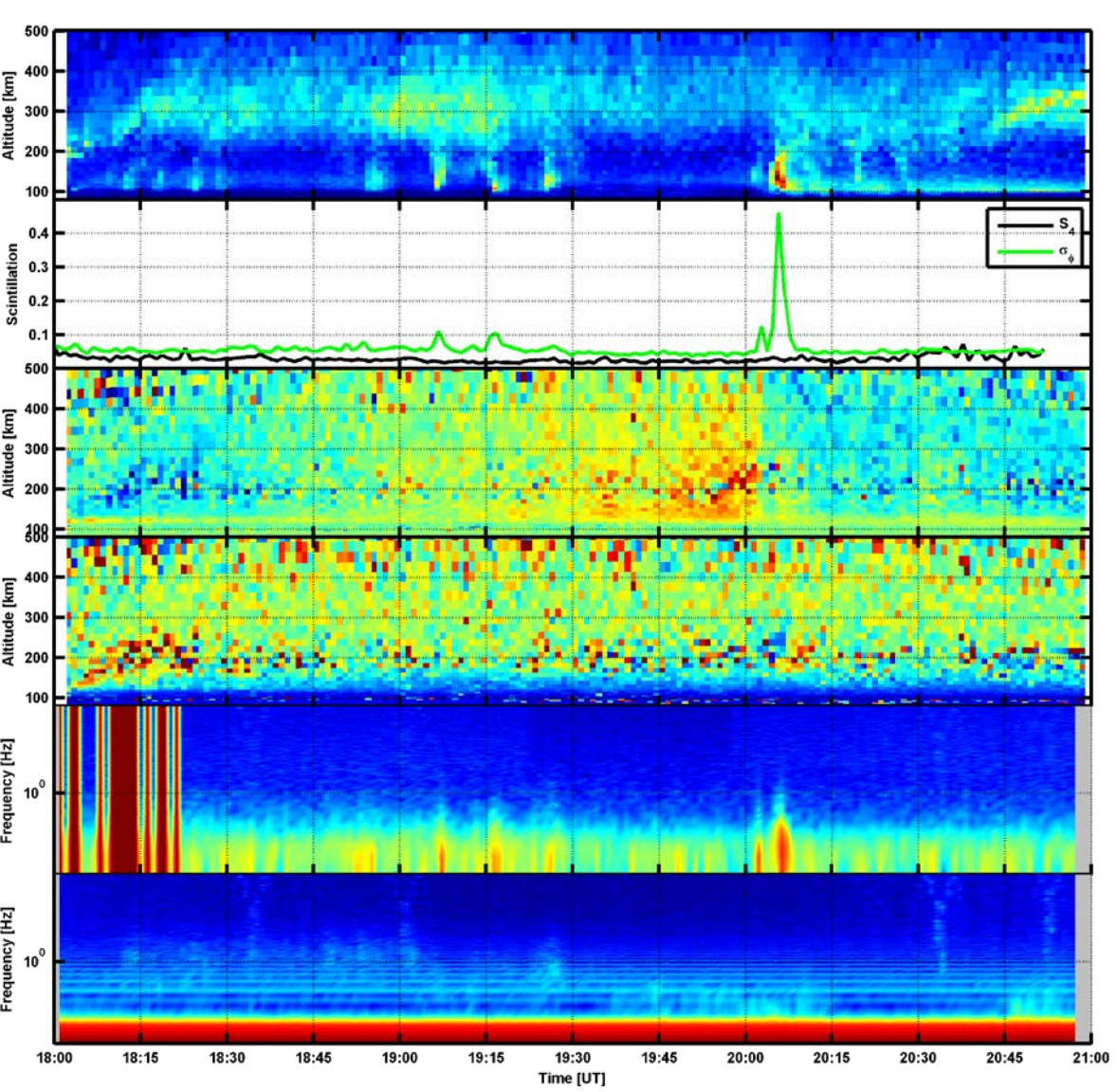
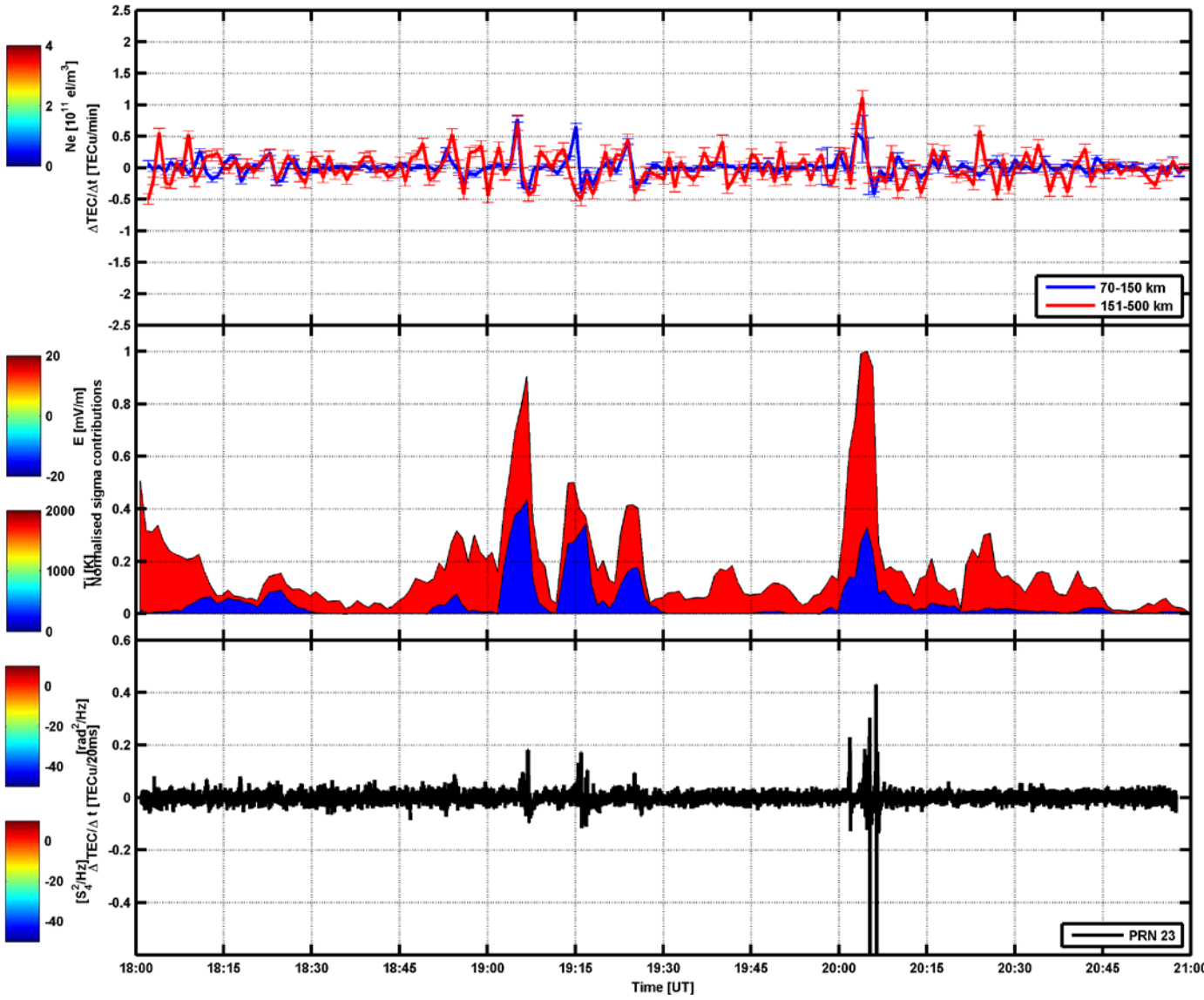
under final review





16 October 2013

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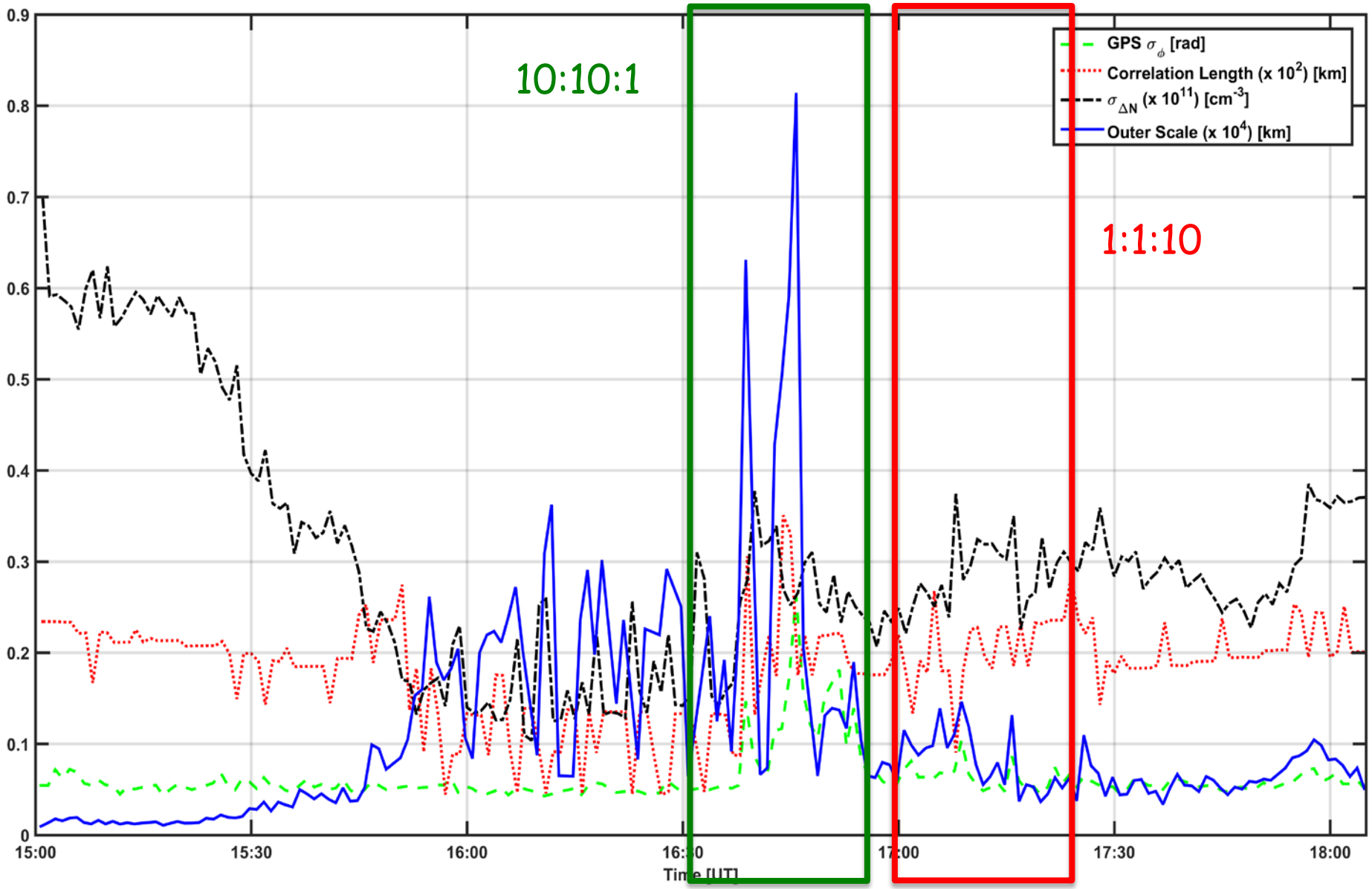
under final review



Conclusions

- Reconfiguration of the magnetospheric OCB -> particle precipitation -> ionisation in the ionosphere
- Spatially and temporally varying precipitation
- Phase and TEC fluctuations in GNSS signals caused by ionisation structures, formed in response to global magnetospheric system
- Low-frequency PSD enhancements associated with ionisation structures in the auroral ionosphere
- Future observations will include:
  - ✓ Co-located ISR measurements – energy cascade (EISCAT, Resolute Bay)
  - ✓ Multiple GPS receivers (Canada and Europe)
  - ✓ Multiple sensors: HF (SuperDARN, KAIRA), VHF (KAIRA), UHF (ISR), L-band (GNSS)

Thank you for the attention