Energy deposition of a Pc5 ULF wave in the polar ionosphere measured by EISCAT

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Ultra Low Frequency (ULF) Waves

- Pc5 range (2 – 7 mHz; 2 – 10 minute period)
- Heating of electrons due to ULF waves:
  - Thermal electron population ($E < 10$ eV):

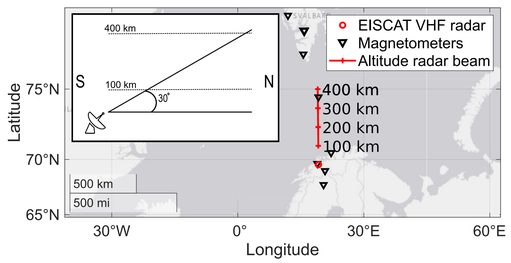
$$\phi_e = \lambda_e \frac{dT_e}{dz} \sin^2(I) \text{ [W/m}^2\text{]}$$

  - Energetic particle precipitation ($E > 70$ eV):

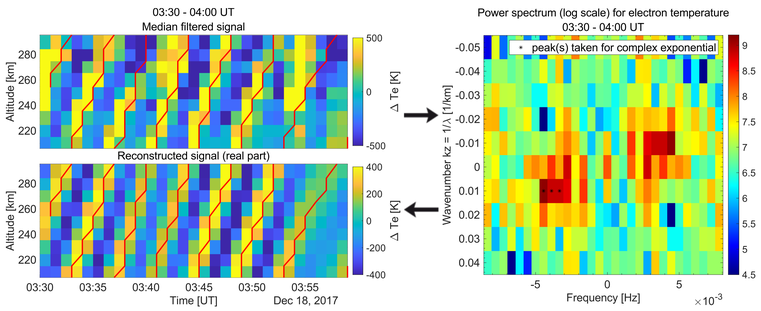
$$Q_p = W_{ion} \alpha_{eff} N_e^2 \text{ [W/m}^3\text{]}$$

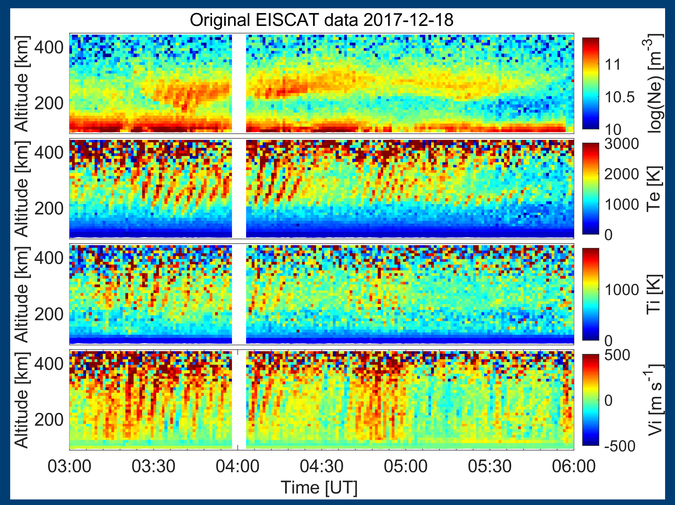
λ_e: thermal conductivity
T_e: electron temperature
I: magnetic inclination
W_{ion}: average energy per ion-electron pair produced
α_{eff}: effective recombination coefficient
N_e: electron density

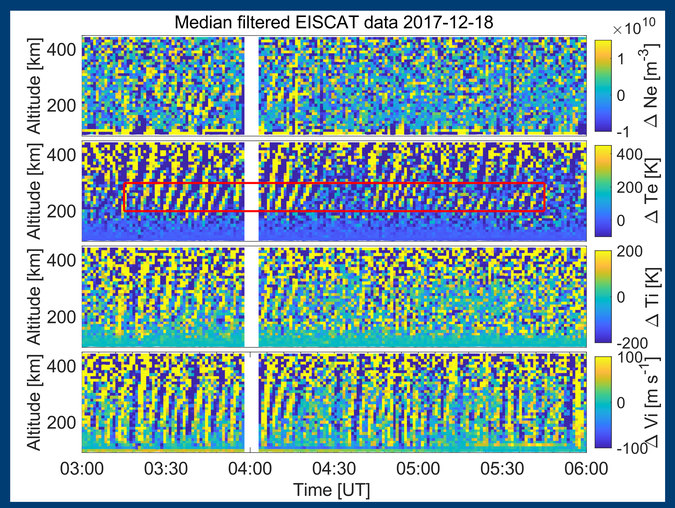
Detection mechanism – 2D FFT

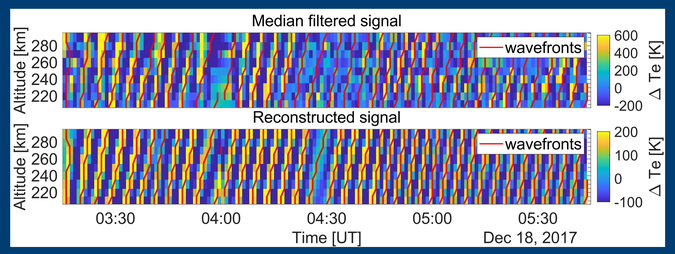


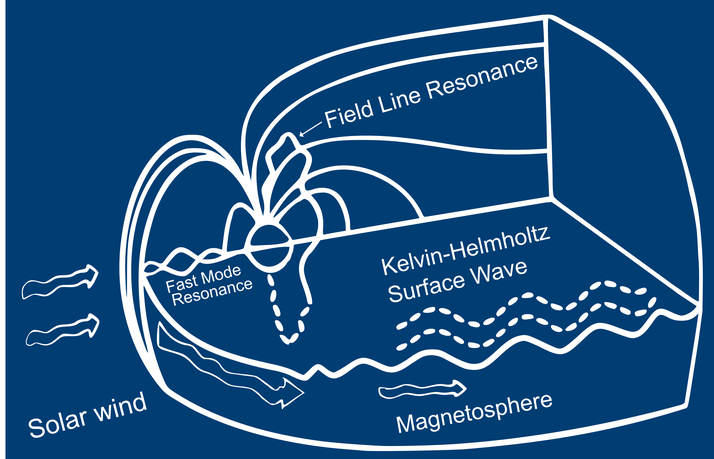
- Detect in electron temperature (median filtered 10 min x 30 km)
- 2D FFT (30 min running window; 15 min overlap). Linear interpolation data gaps.
- Reconstruct complex wave function from peak(s) in power spectrum: $\sum A_j * exp(i\phi) * exp(i(\omega_j t - k_{zj} z))$ and trace wavefronts





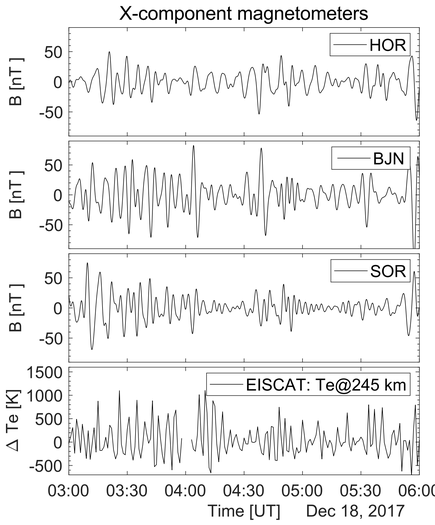


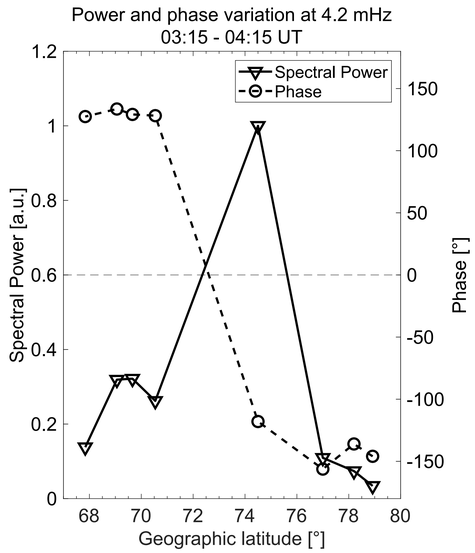




Case study: 18 December 2017

- Frequency: ~ 4.2 mHz
- Time period ULF waves: 03:15 – 05:45 UT (peak: 03:15 – 04:15 UT)
- Latitudinal extend:
  - ~69.5°–71.5° (EISCAT)
  - ~70°–76° (magnetometers)

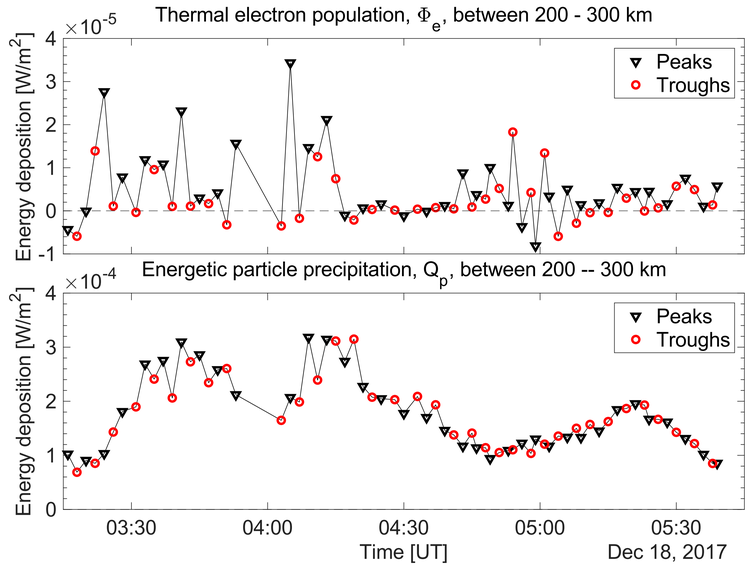




- ULF wave (field line resonance) observed on dawnside (06 - 09 MLT); most probable generation mechanism: Kelvin-Helmholtz instability on dawn flank of magnetopause.

Thermal heating

- More thermal heating along peaks than troughs



Conclusions and future work

- New detection mechanism developed and tested on case study
- Next: Distribution dissipated Poynting flux energy ($\nabla \cdot \vec{S}$) over Joule, frictional and thermal heating during ULF wave activity

Abstract Poster

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