Auroral Radio Source Modelling for AERO-VISTA

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Outline of Content

1) AERO-VISTA Introduction
2) Auroral Zone Model Development
3) Emission Source Characterization
4) Synthetic Spectrograms
5) Conclusions and Future Work
AERO and VISTA's chief objective is to calculate direction of arrival information for the radio aurora.

We need auroral radio source simulation to answer the following questions:

1. When will we see the emissions?
2. What are we expected to see?
3. How can we represent this mathematically?
2) Auroral Modelling: Ovation Prime Data

Aurora at 1200 on 9/16/2012, Geographic Coordinates

Aurora at 1200 on 9/16/2012, Restriction: 0.800 ergs/cm^2/s (8%)
2) Auroral Modelling: Planar Modelling Method

Aurora on 9/16/2012, Planar Model

Restriction: 0.390 ergs/cm^2/s (20%)

Modelled Ellipses from 20% Restriction
2) Auroral Modelling: Actual vs Generated

Overlay of Auroral Restriction and Generated Model
0.39 erg/cm²/s Restriction
2) Model Application: Auroral Access Reports

In one day, AERO will spend approximately 3 hours in the north and south aurora (combined) or about 12 minutes per orbit.
3) Emission Parameters: Source Modes

The four main source modes are:
1. Auroral Hiss
2. Auroral Roar
3. Medium Frequency Burst (MFB)
4. Auroral Kilometric Radiation (AKR)

Each source mode has the following unique characteristics:
- Occurrence rate
- Occurrence length (time)
- Occurrence altitudes (km)
- Frequency range
- Frequency bandwidth
- Polarization characteristics
- Spectral intensities

From the Auroral Model
Time-dependent characteristics:
- Latitude
- Longitude

Semi-Gaussian Step Distribution

Normal Distribution

LaBelle, Dartmouth
3) Point Source Visualization

AERO Orbit on 1/1/2022
19 seconds after 1609516800 unix time

Northern Polar View  Southern Polar View  Equatorial View

Spectral Intensity [W/m^s/Hz]
- 5.882000e-16
- 5.882000e-15
- 5.882000e-14

Equator
Prime Meridian
4) Synthetic Spectrograms

Sample AERO Spectrogram on 1/1/2022

- Frequency [kHz] vs Time [s] since 1641052800 Unix Standard
- Color scale for Spectral Intensity [W/m^2/Hz]
- Legend: Blue = Prime Meridian, Magenta = Equator
4) Synthetic Spectrograms

Sample AERO Spectrogram on 1/1/2022

Frequency [kHz]

Time [s] since 1641052800 Unix Standard

Spectral Intensity [W/m^2/Hz]
4) Synthetic Spectrograms

Sample AERO Spectrogram on 1/1/2022

- Frequency [kHz]
- Time [s] since 1641052800 Unix Standard
- Spectral Intensity [W/m^2/Hz]
5) Future Work

Team Work:
- Culmination of five summer student projects: Kristen, Huda, Enriko, Anmol, and I
  - Two vector sensors

Personal Work:
- Plasma propagation and emission effects on source modes
- More accurate source mode polarizations and altitudes
- More accurate occurrence rates
- Specific south pole model – rather than symmetric
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Questions?

Thank you!
3) Emission Parameters: Statistical Considerations

- HEALPix convention of spherical data representation
- Kent Distribution of polarized sources
3) Point Source Visualization