

Direction Finding of Auroral Radio Emissions

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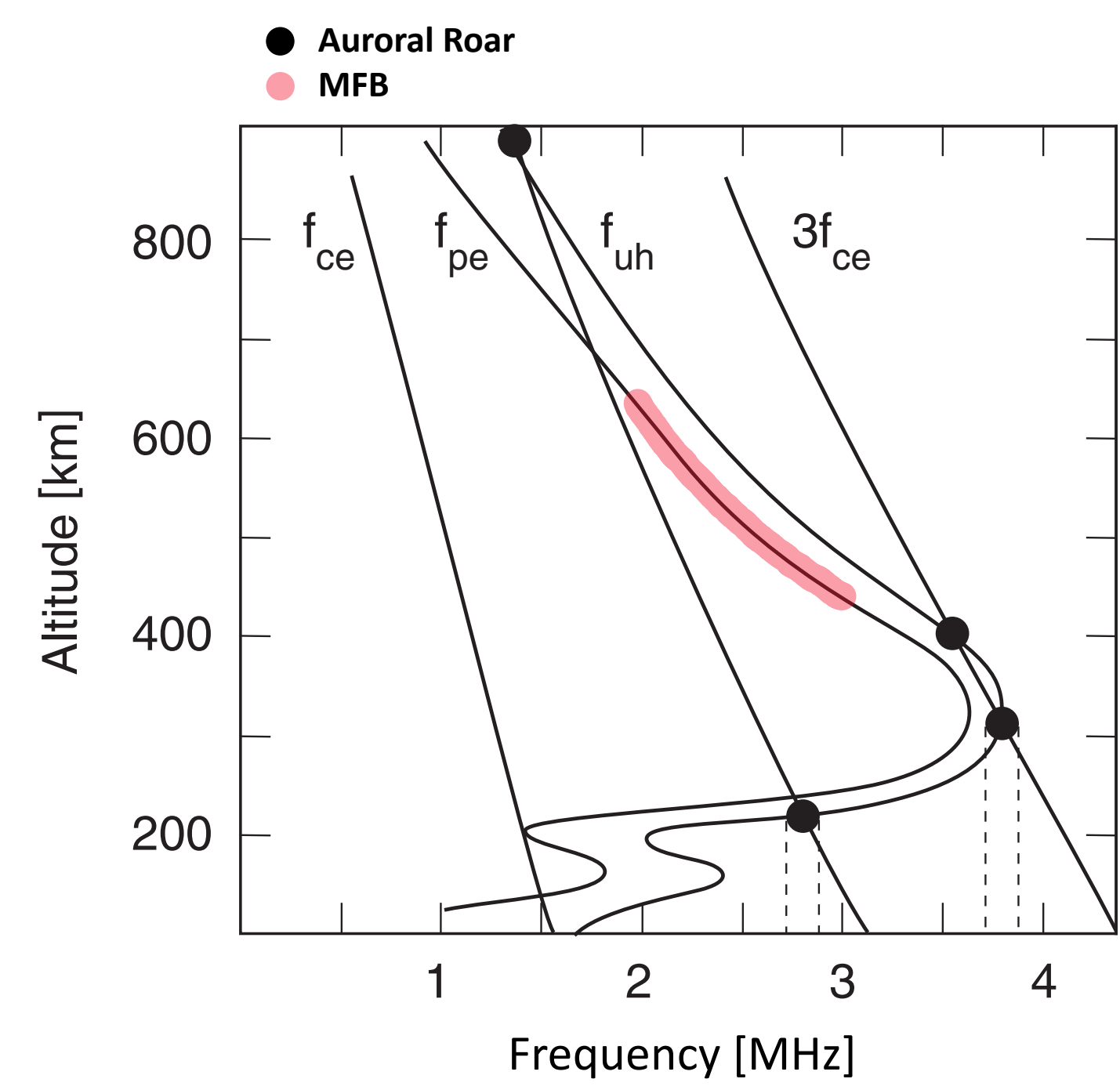
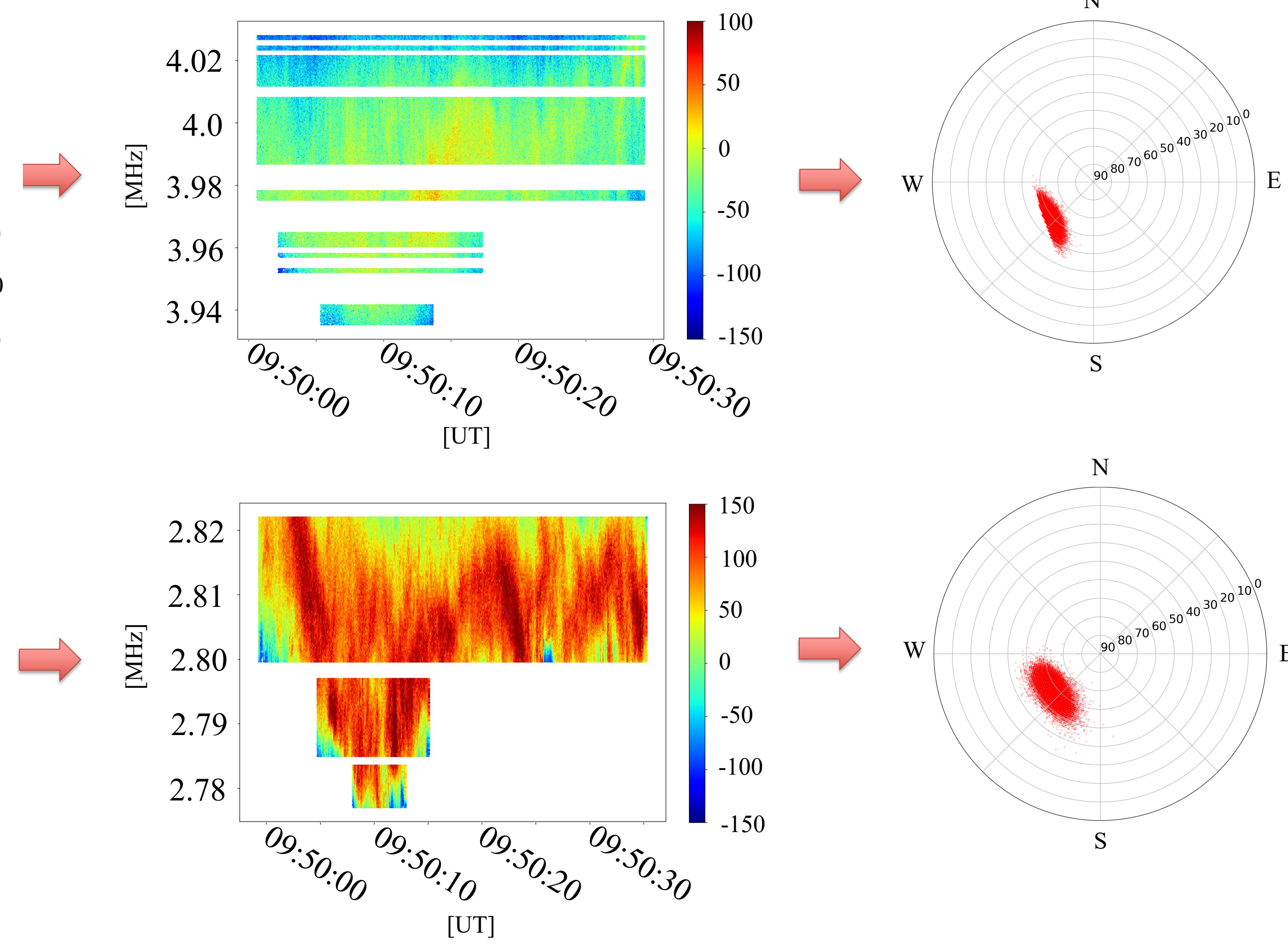
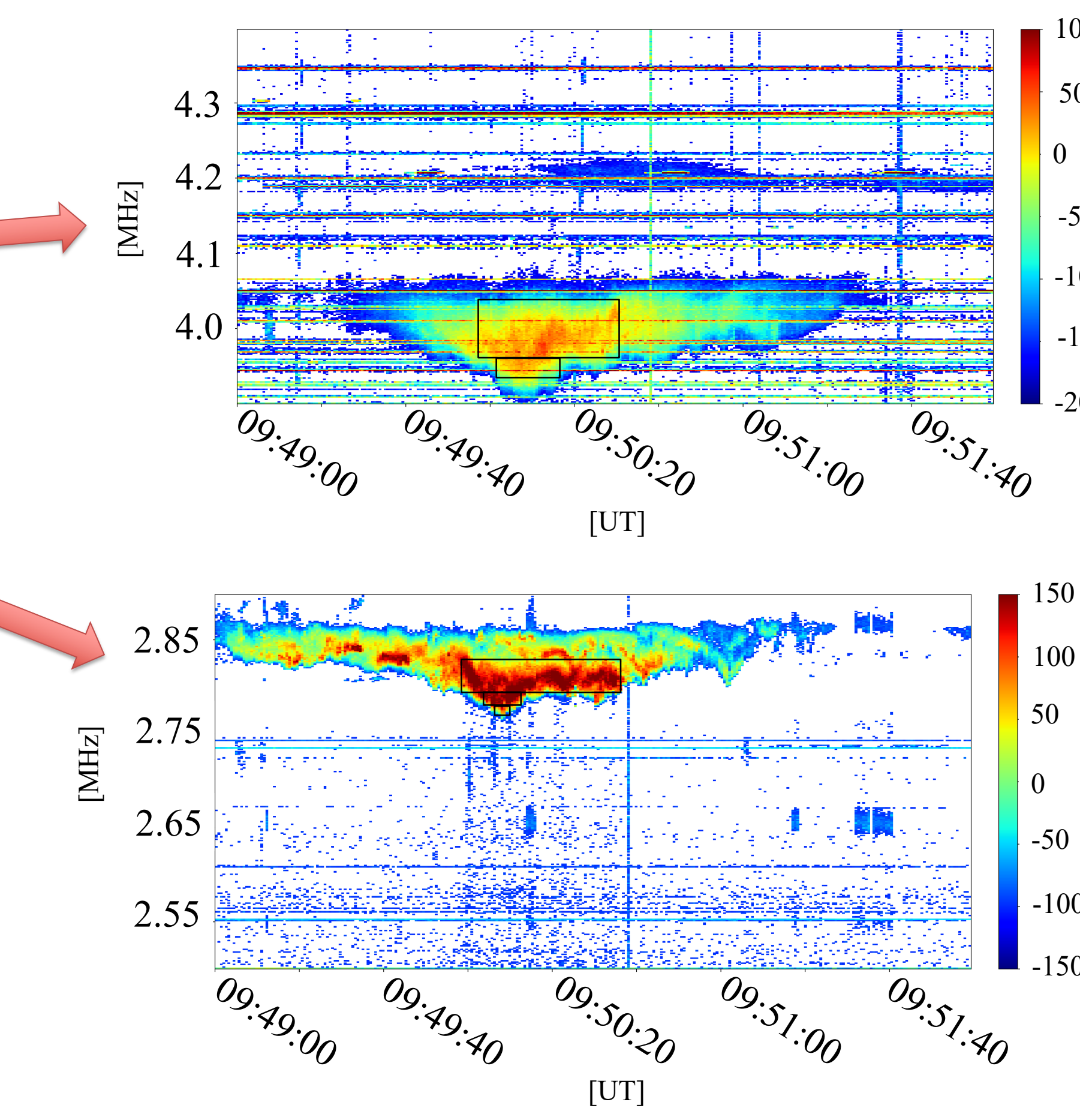
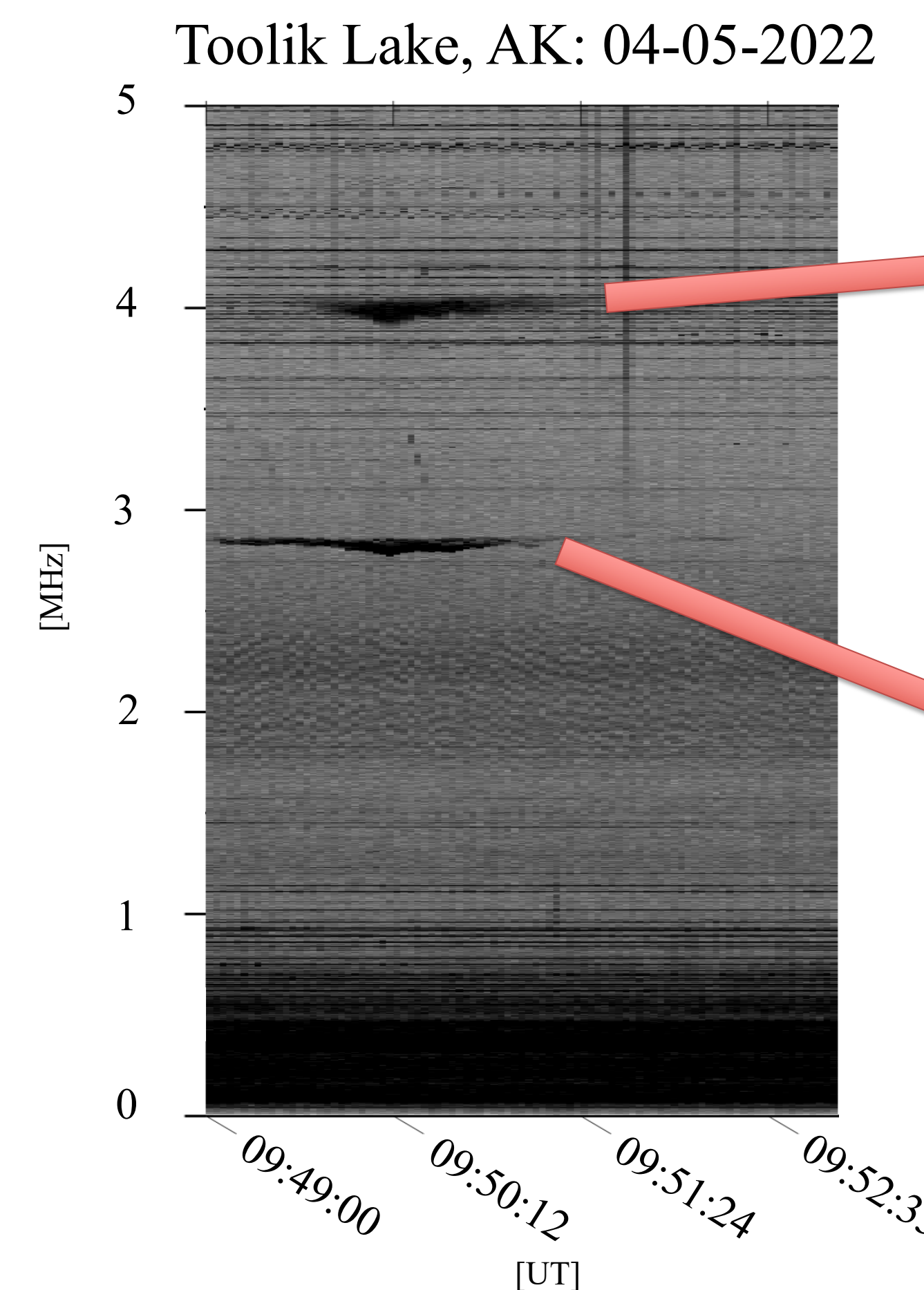


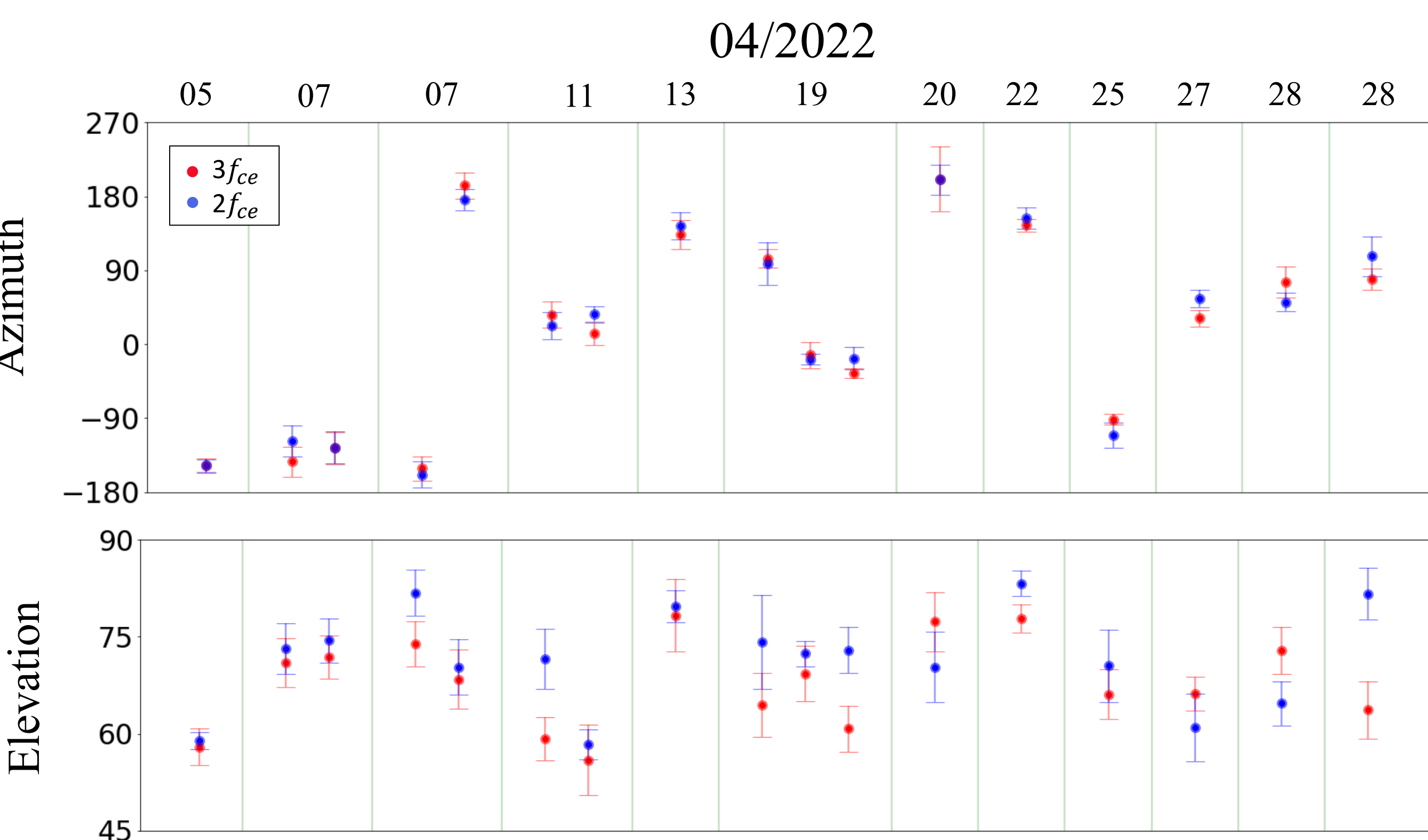
Figure 1: Profile of the ionosphere showing the points where the harmonics of the cyclotron electron frequency match the upper hybrid frequency profile [2]. The hypothesized MFB source profile is also shown [4].



We developed a tool to analyze auroral events from spectrograms. After selecting the events of interest, the tool allows users to select and remove interference lines. Power, frequency, and angular filtering was done to better select the event.

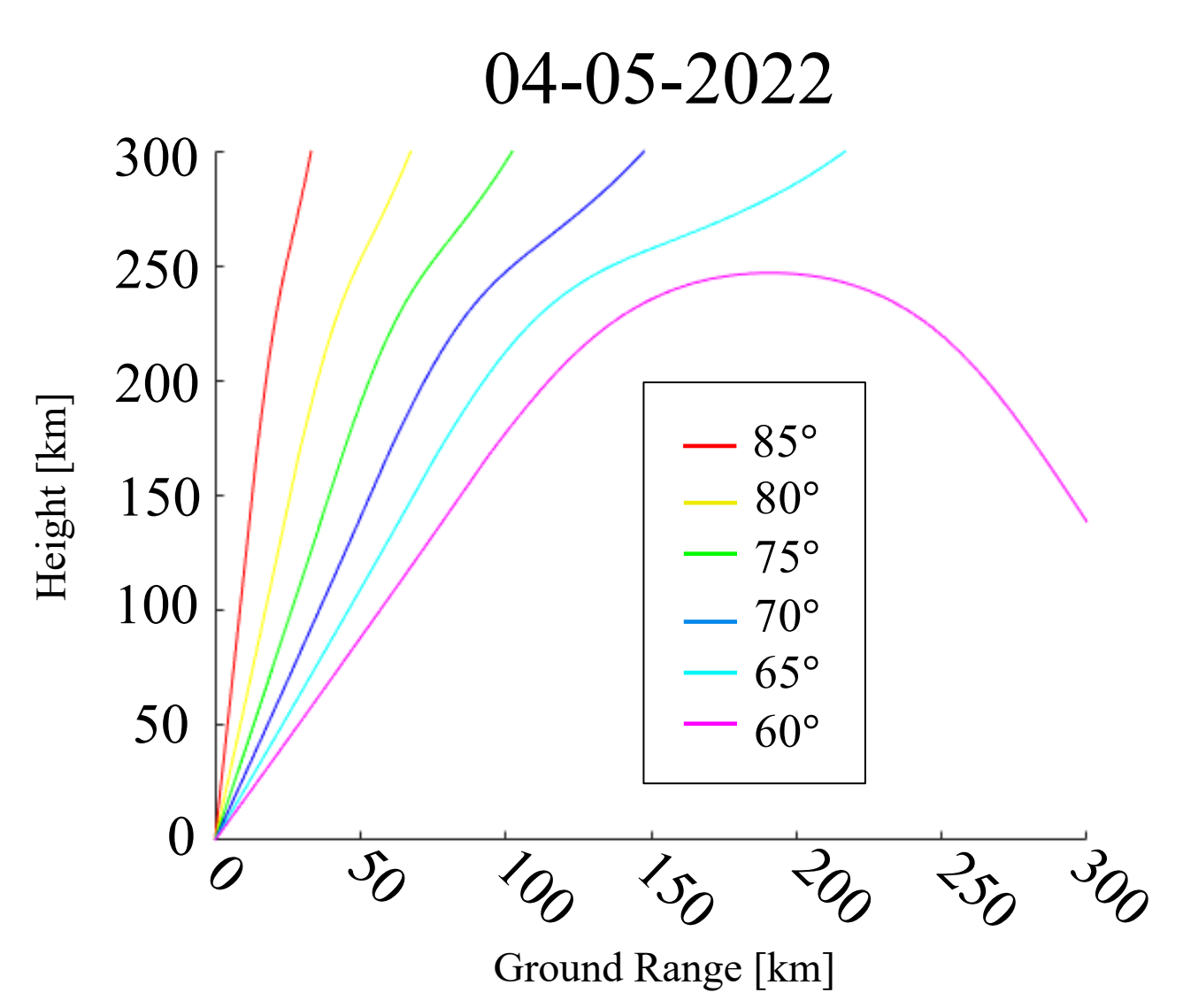
The main study compares $2f_{ce}$ and $3f_{ce}$ events occurring at the same time. A polar plot of the remaining points was then generated to show the angular distribution of the event. For these plots, the radial component is the median elevation, and the angular component is the median azimuth. This event shows a similar distribution for both frequencies. This suggests that in this case the emissions come from the same auroral arc.

Preliminary Results

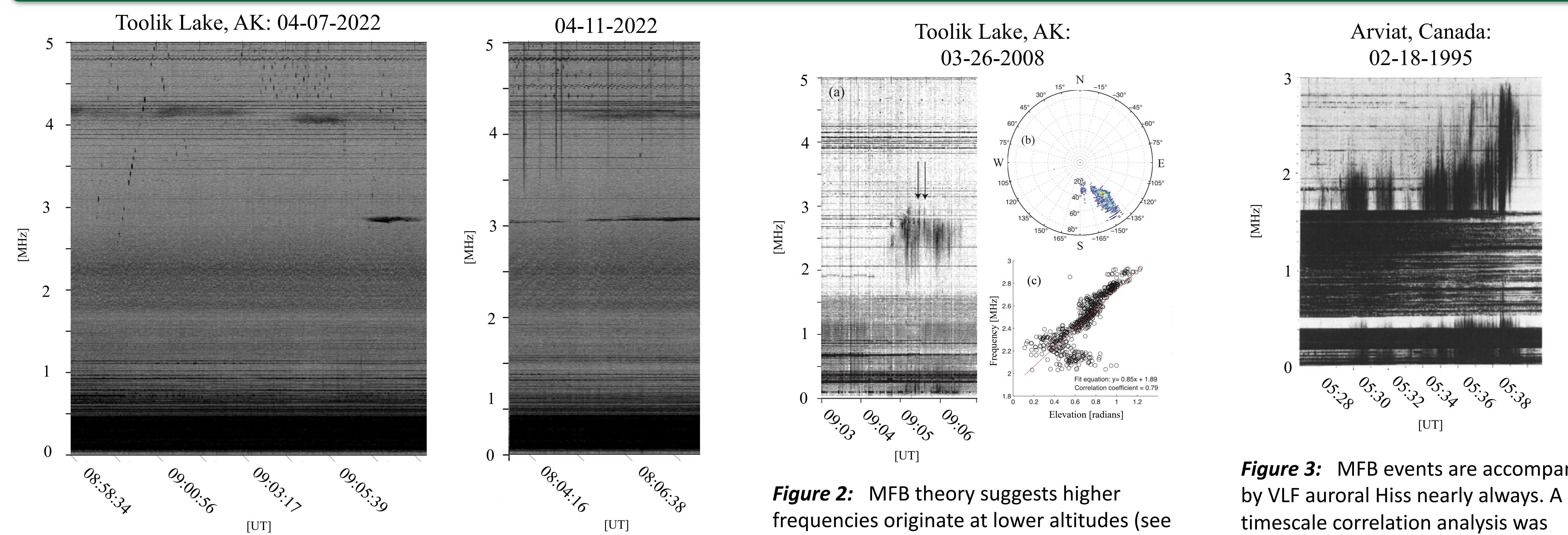


Analysis of one month of simultaneous harmonic roar events, where respective azimuths are within 15° . Theory suggests that $2f_{ce}$ events come from a higher elevation than $3f_{ce}$ when generated from the bottom side of the ionosphere. Most of these results are consistent with this hypothesis. Further analysis of the other events considering model density profiles and using ray tracing will tell whether they are consistent with generation in the top side of the ionosphere.

The PHaRLAP ray tracing toolbox was used to analyze sources of $2f_{ce}$ events. Various initial elevation angles for a bottom side source are shown. Placing the source in the ionosphere and launching normal to the magnetic field in future work will allow direct adjustment of the elevation angle. We will compare the simulation results with observed data. This will be extended to $3f_{ce}$ sources as well.



Other Applications



Observations suggest that the $3f_{ce}$ occurrences are often noticeably more diffuse than $2f_{ce}$. The mechanism behind this is unknown and can be studied further by first selecting many diffuse instances. These can then be analyzed to look for common properties and compared with theory for an explanation. Direction finding may provide an important clue.

Figure 2: MFB theory suggests higher frequencies originate at lower altitudes (see Figure 1). Previous results shown above indicate the opposite [1]. The tools we developed combined with ray tracing can be used to confirm and seek the cause of this discrepancy.

Figure 3: MFB events are accompanied by VLF auroral Hiss nearly always. A timescale correlation analysis was previously done [3]. Direction and timescale analysis of these events can be done in higher resolution using the technique we developed.

Conclusion

We have developed tools that can be applied to a range of outstanding problems to do with auroral radio emissions. A wider range of $2f_{ce}$ and $3f_{ce}$ direction data will be analyzed. The MFB and auroral Hiss event directions will also be studied.

References and Acknowledgments

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