Tracking Sporadic E with the LWA Radio Telescopes

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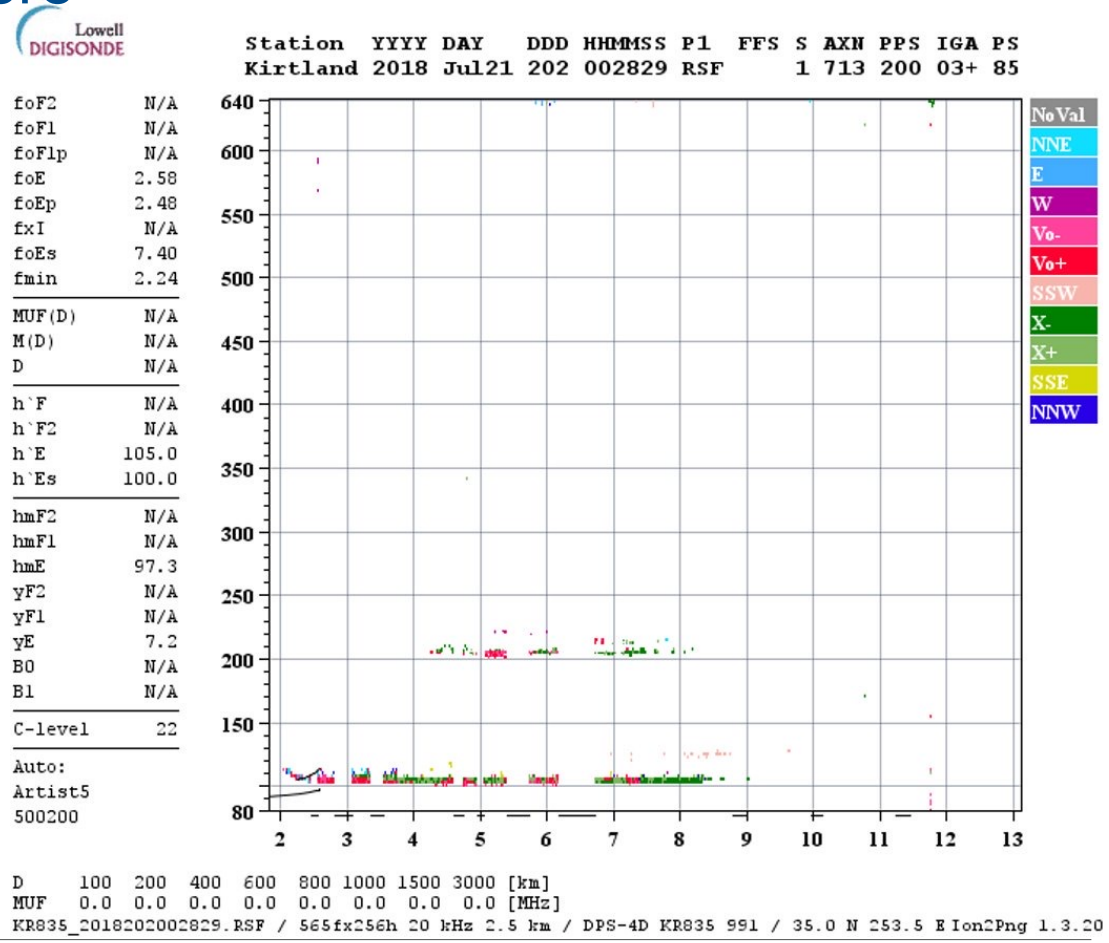
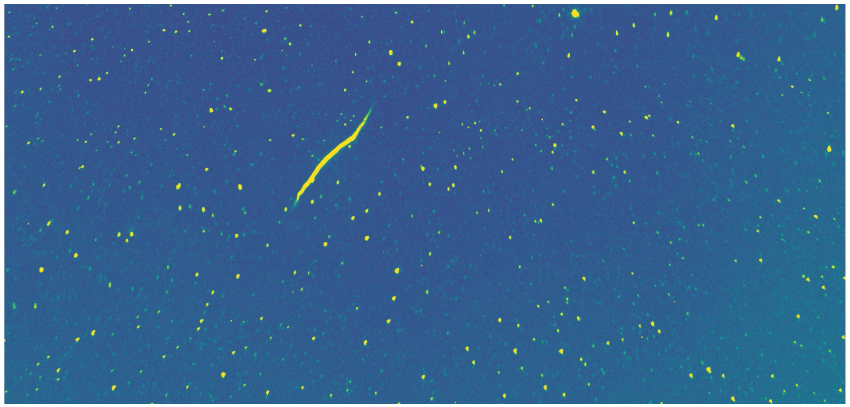
The Bottom Side Ionosphere

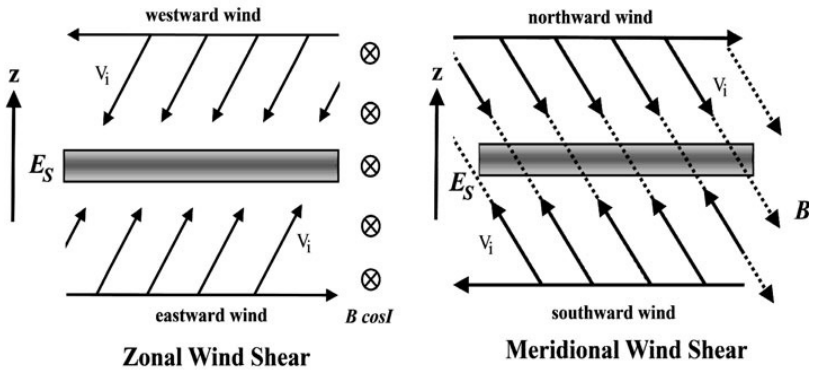
- Bottom side ionosphere is somewhat predictable
- The electron density profile is monitored for both scientific and space weather situational awareness
- Can display highly dynamic behavior on a range of size/time scales
- One type of disturbance is sporadic E
  - E region of ionosphere (90 – 130 km)
  - Ions interact with wind and geomagnetic field to produce extremely dense, thin structures
  - Structures are highly reflective at HF and VHF frequencies having a severe impact on radio propagation



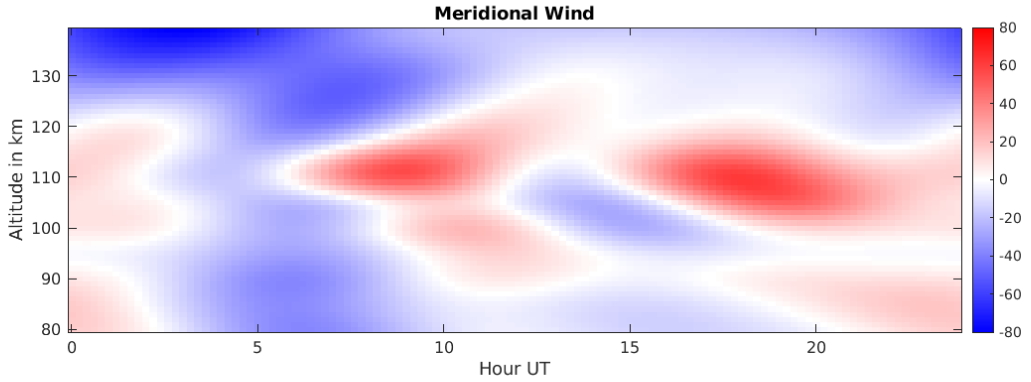
Sporadic E Formation

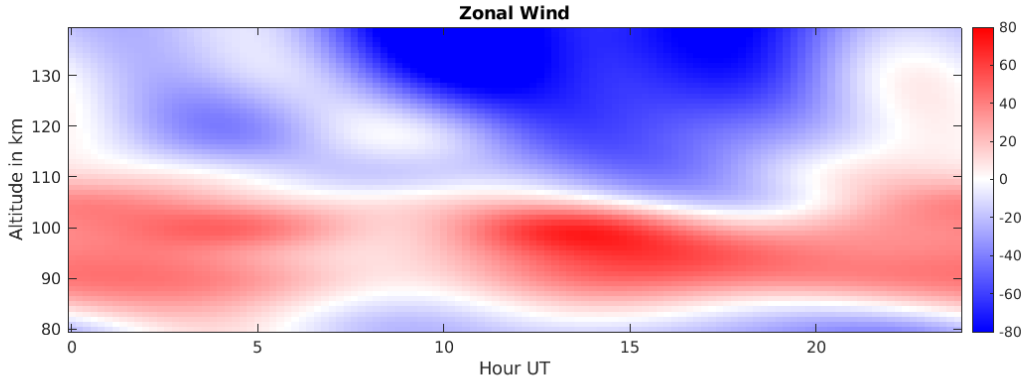


Windshear mechanisms of Sporadic E layer formation

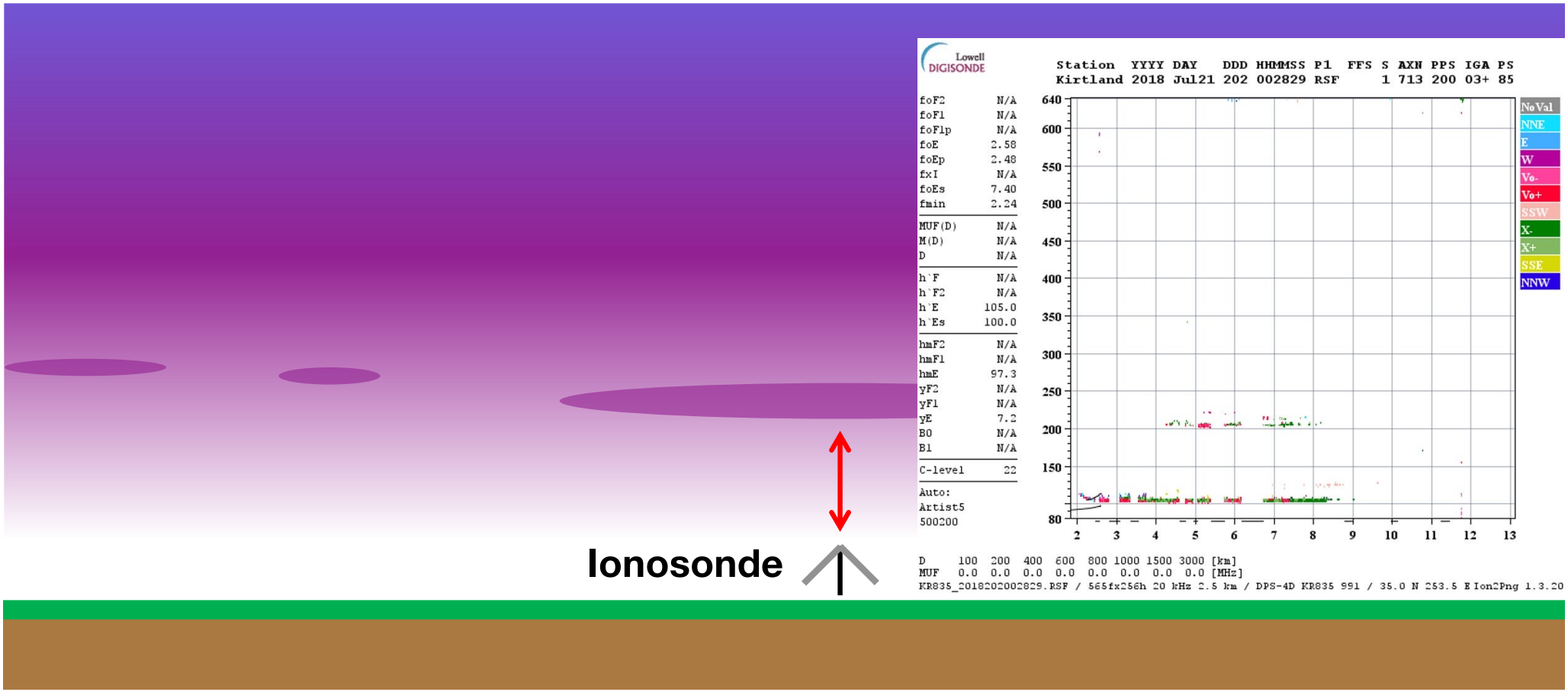


(a) Haldoupis, C. (2012) (b)



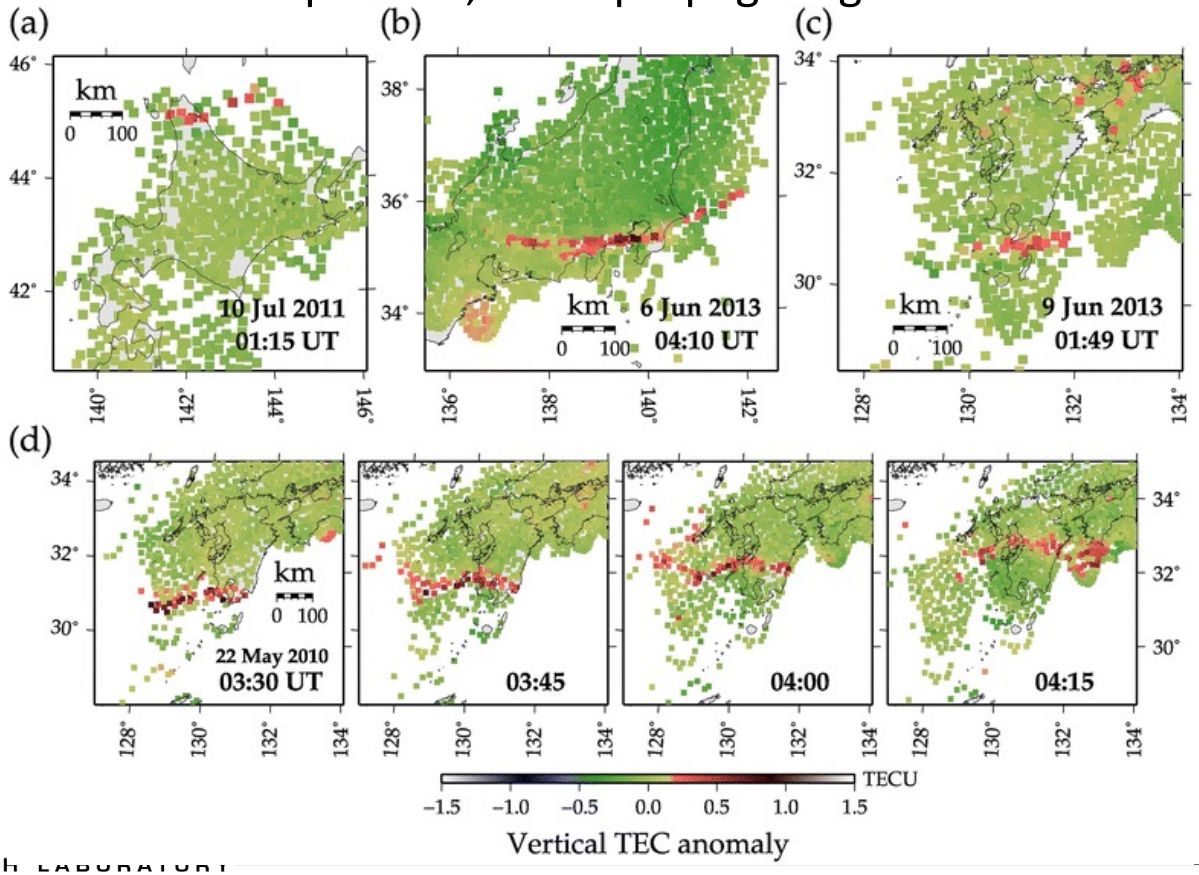


Ionosondes are used for vertical observations, miss structure entirely



Horizontal Structure

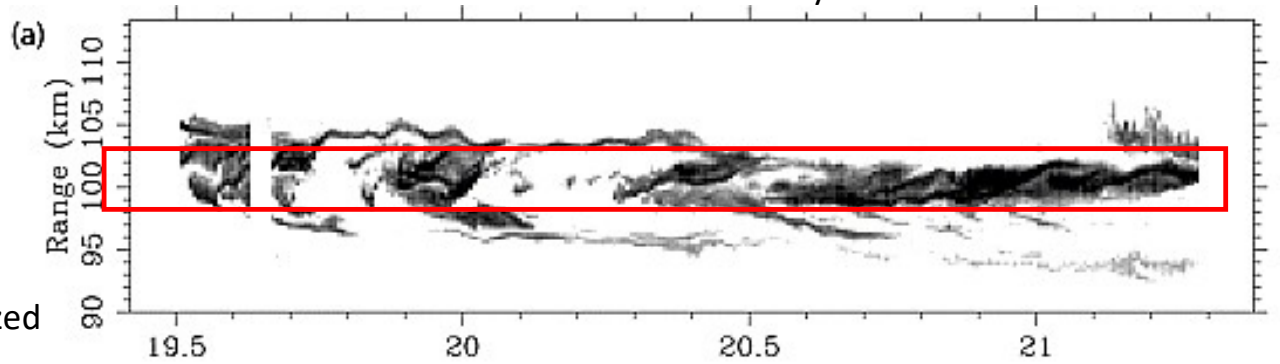
Sporadic E forms in discrete patches, often propagating fronts.



Maeda and Heki 2015

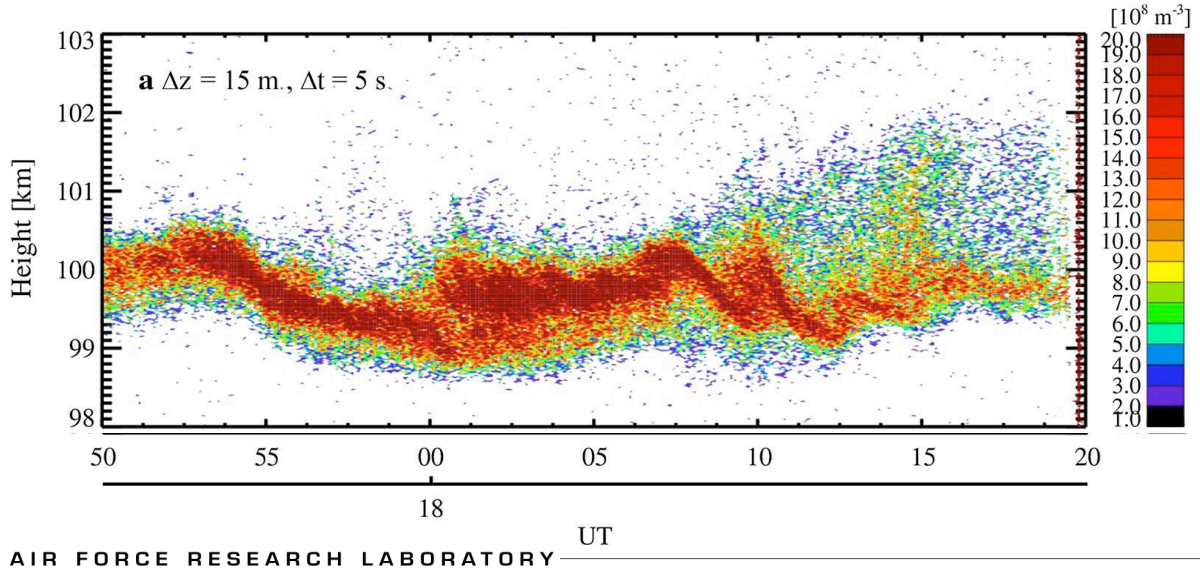
Vertical Structure

In coherent scatter radar over Puerto Rico - Hysell et al. 2009



Not all irregularities are field aligned!

At 100 km electrons are not fully magnetized

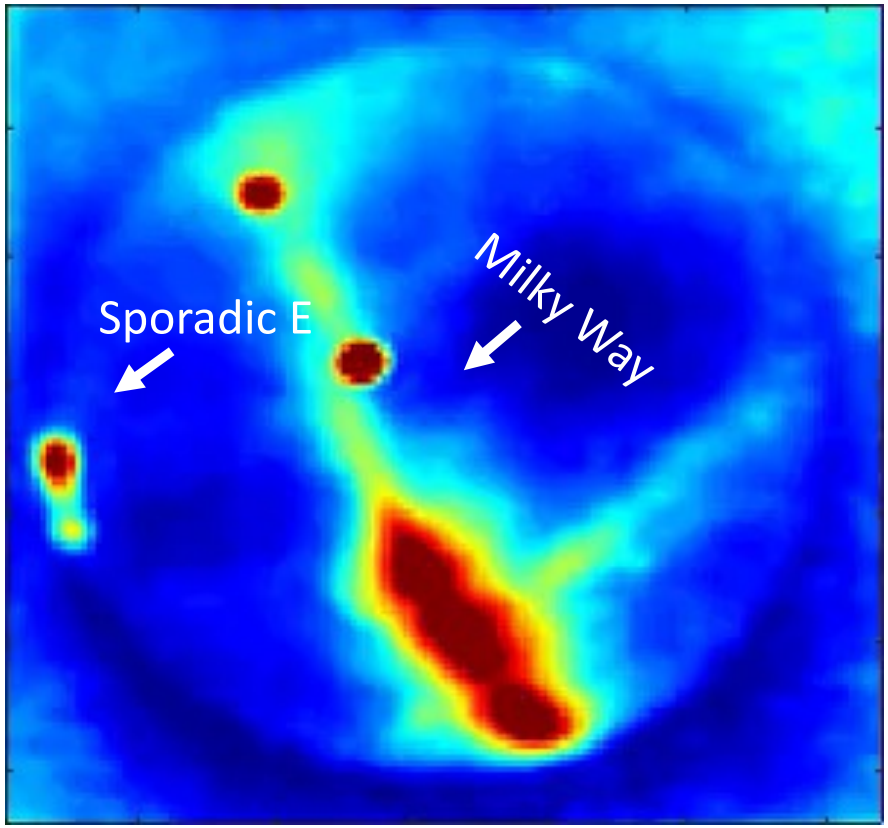


Ca^+ Lidar measurements over Tachikawa - Ejiri et al. 2019

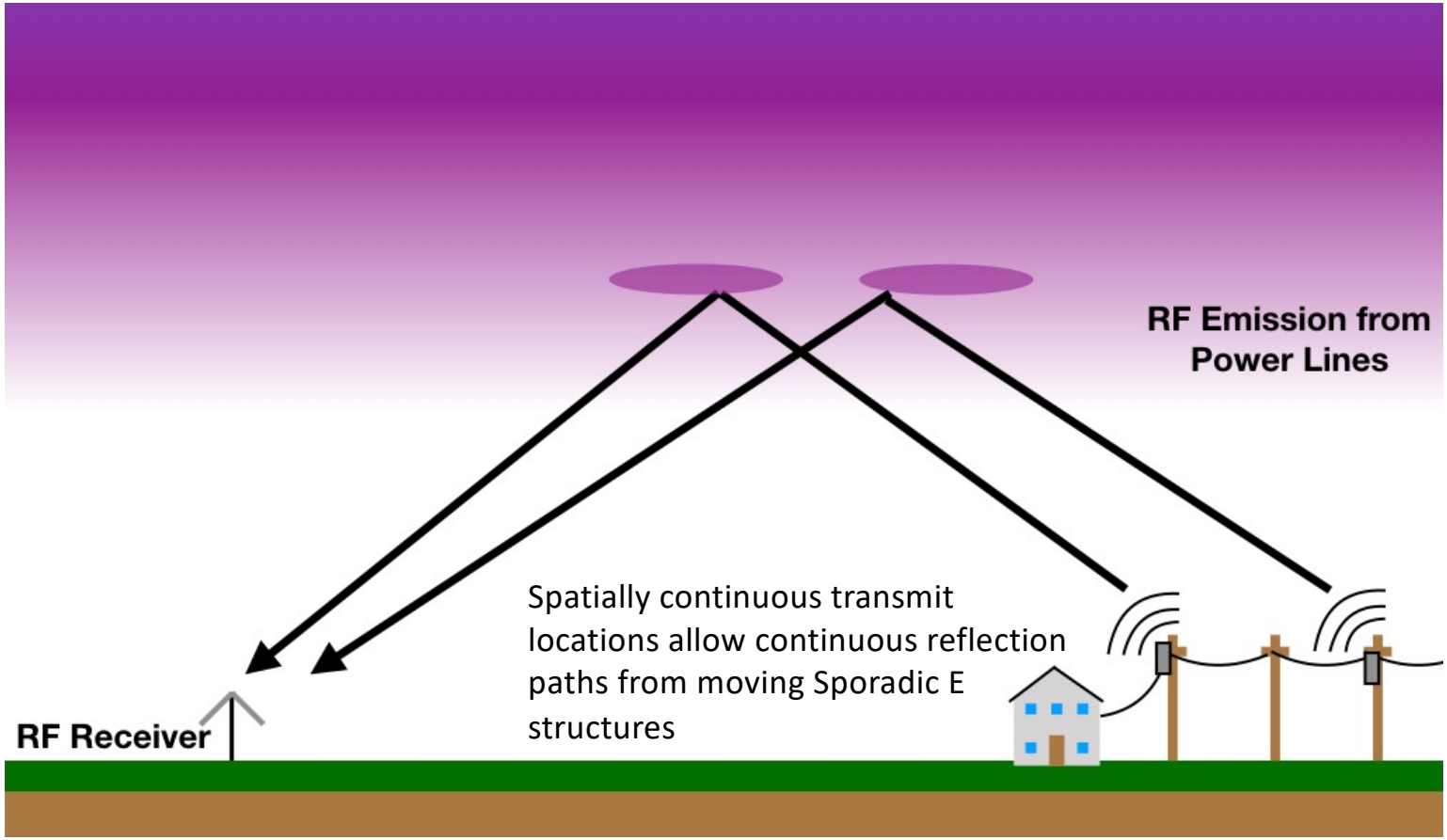
LWA Sporadic E Tracking

LWA-SV Station at Sevilleta National Wildlife Refuge

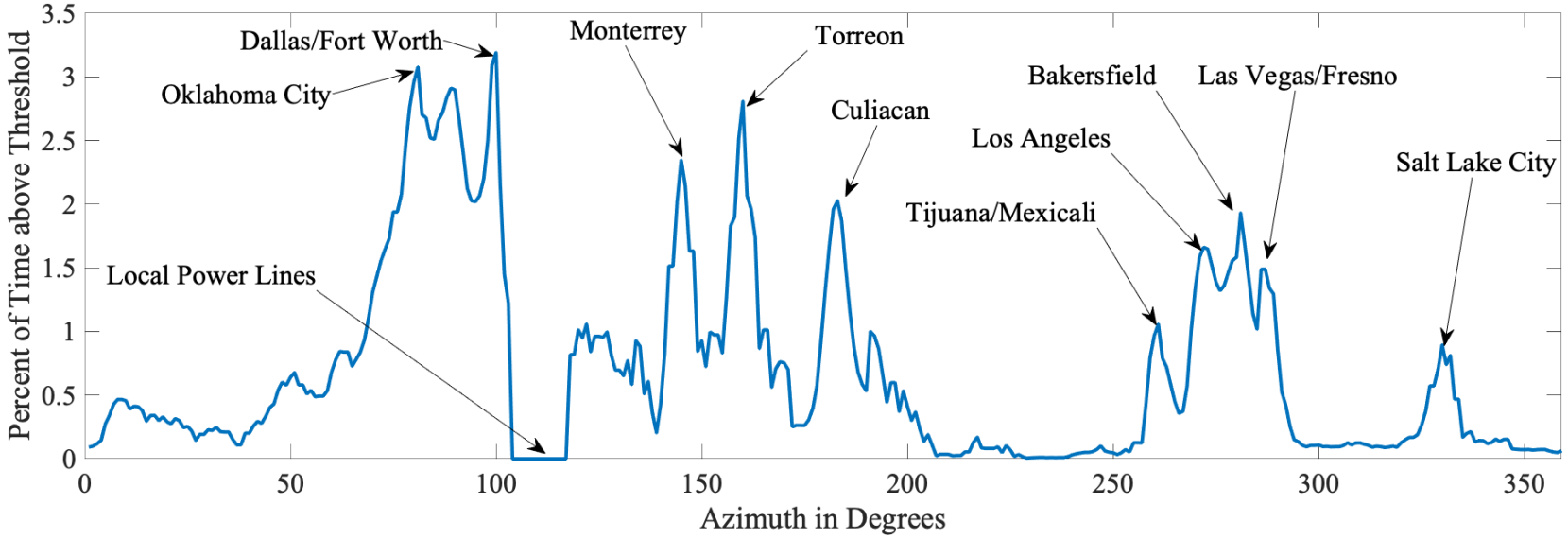
LWA All-Sky Image at 38 MHz



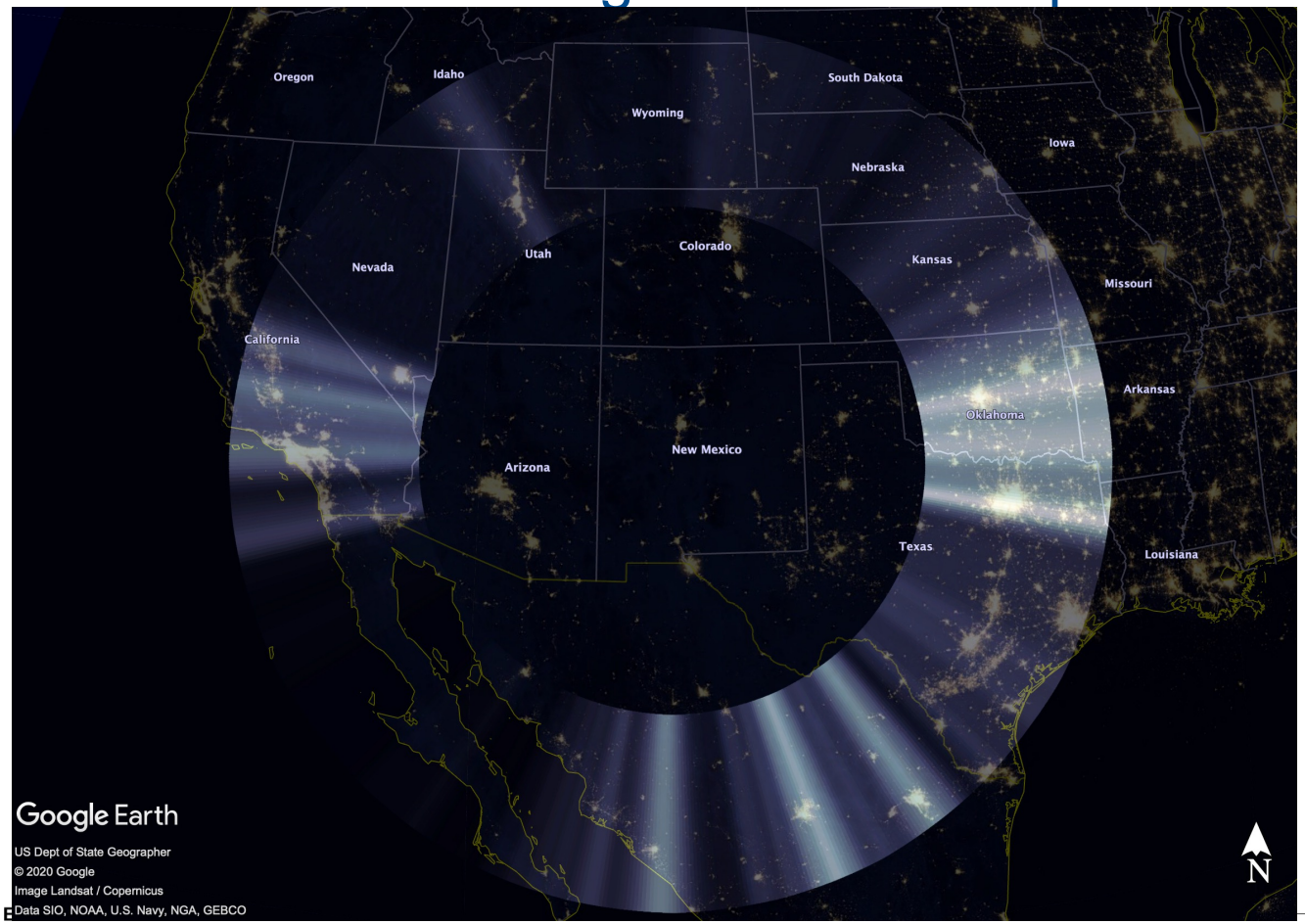
Forward scatter of HF/VHF Noise?



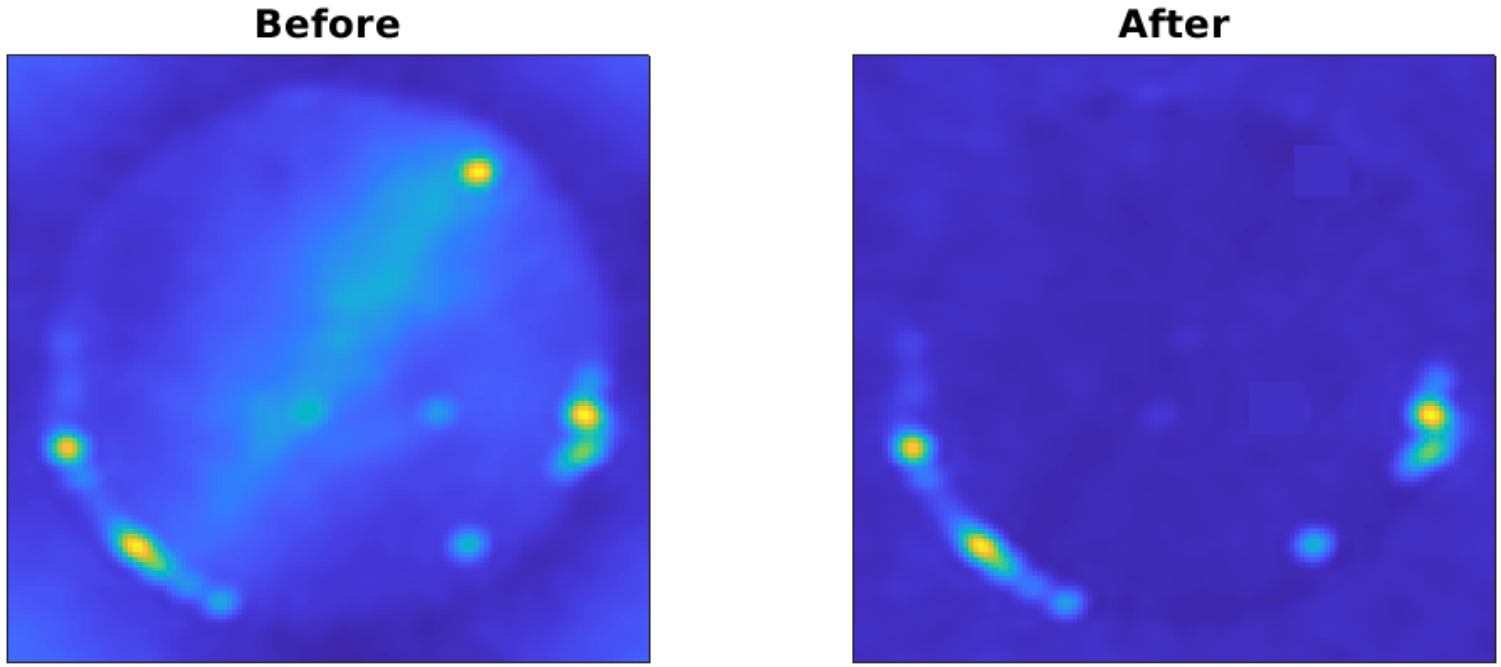
Azimuthal Brightness Distribution Points towards cities



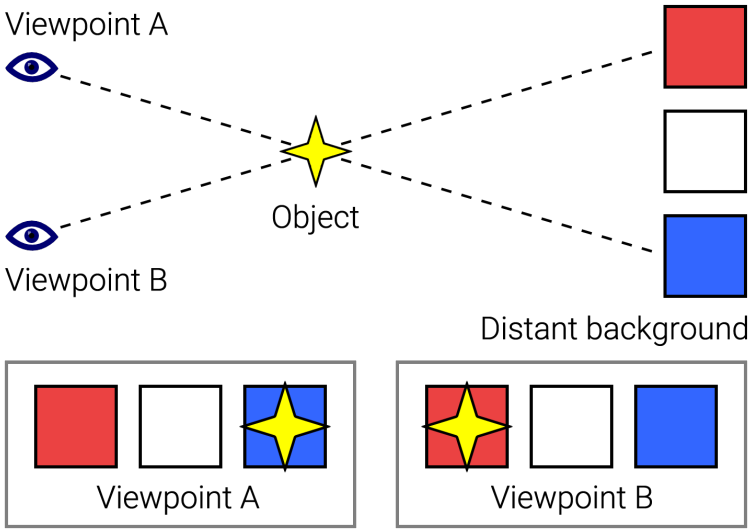
Azimuthal Distribution on Light Pollution Map

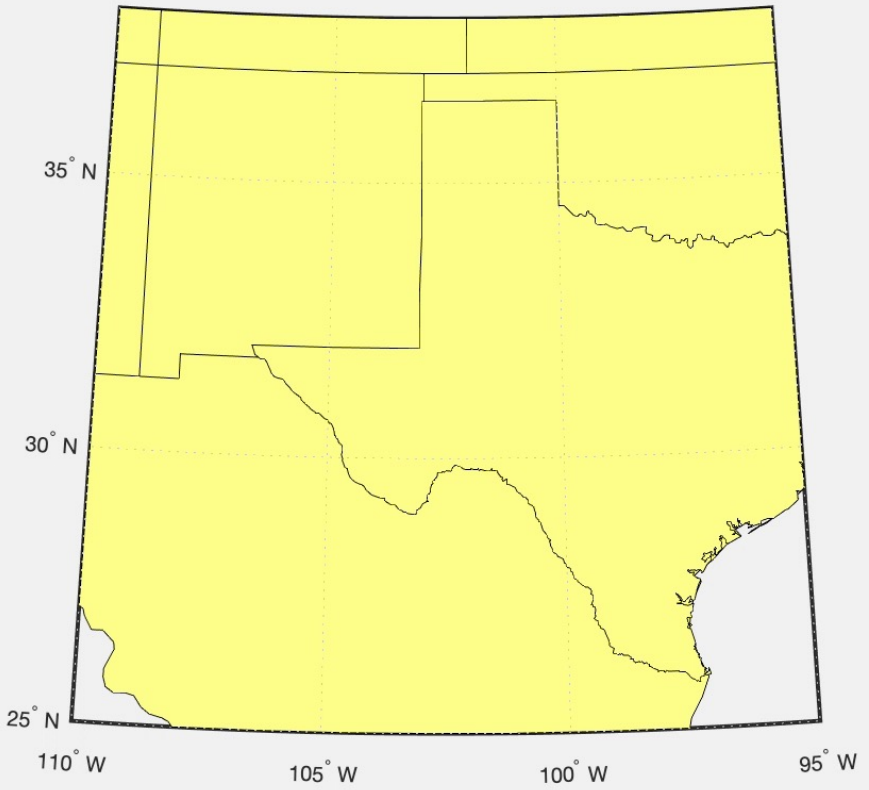


LST Subtraction for Automatic Es Detection with LWA



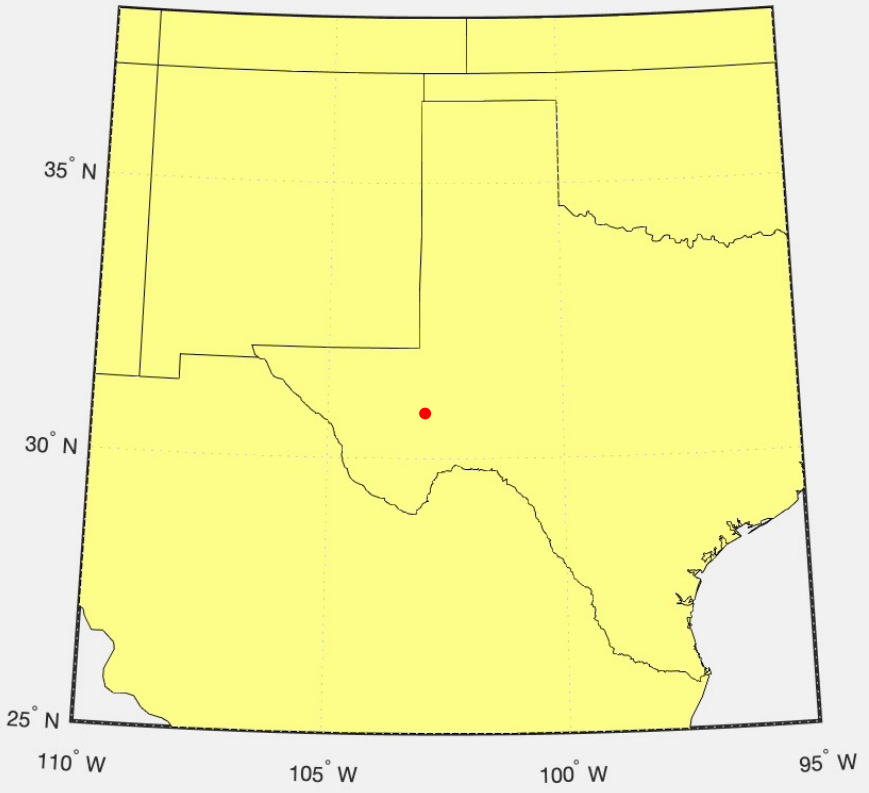
Mapping and Tracking Structures



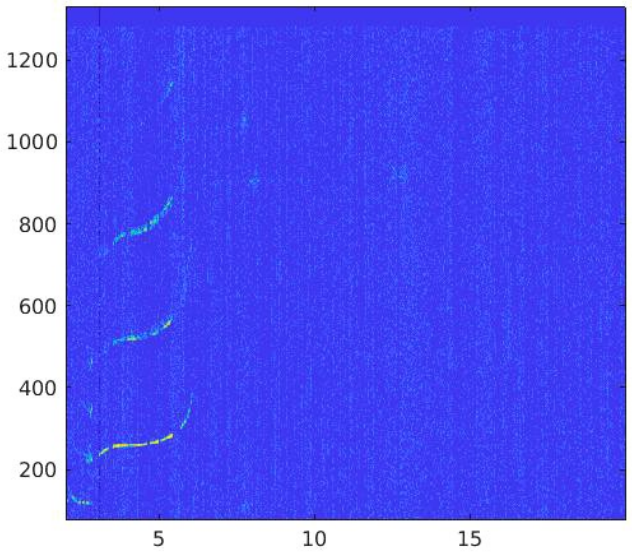


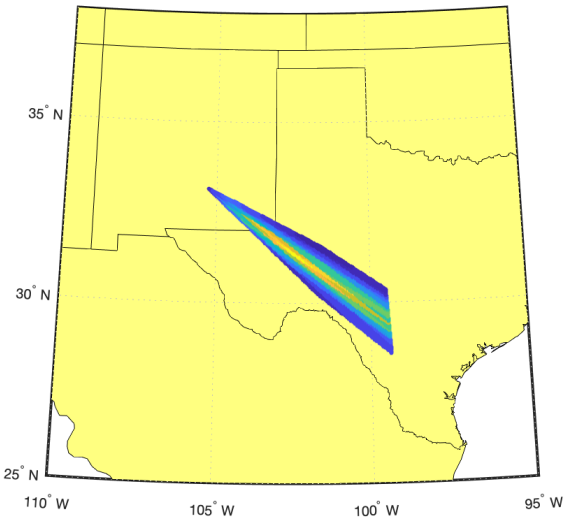
Summer 2022 Digisonde deployment to F.t Stockton TX

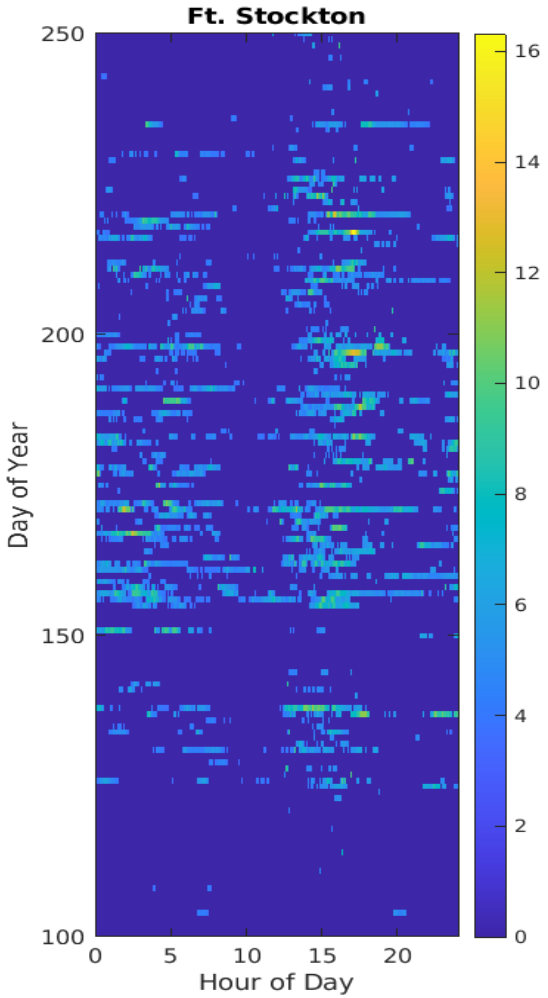
Digisonde Tower in Ft. Stockton TX
Photo by Jeff Holmes



LWA-SV success rate







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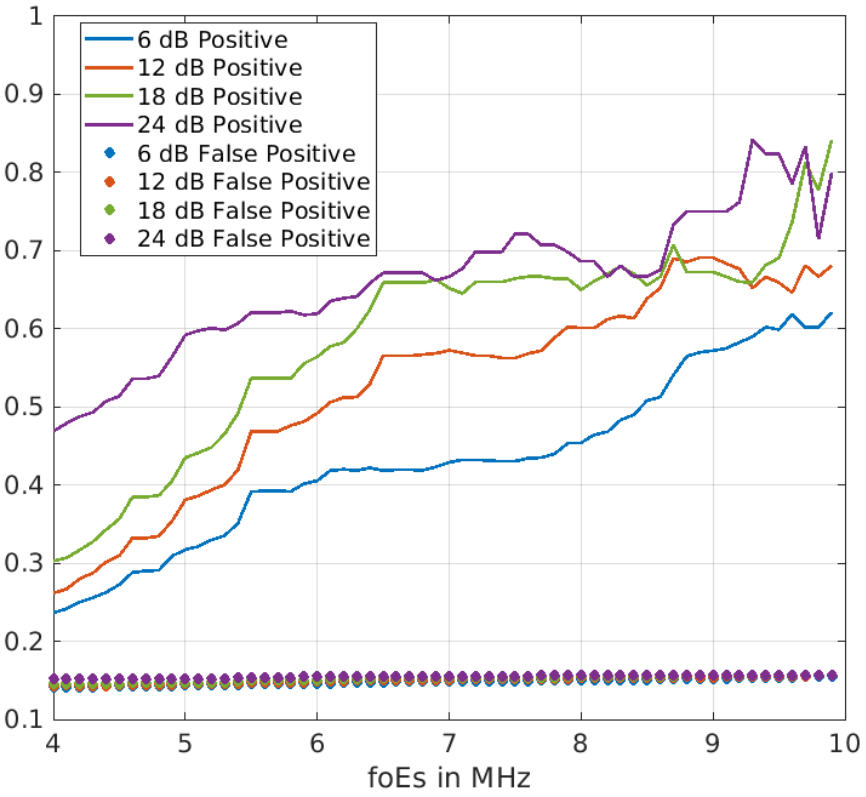
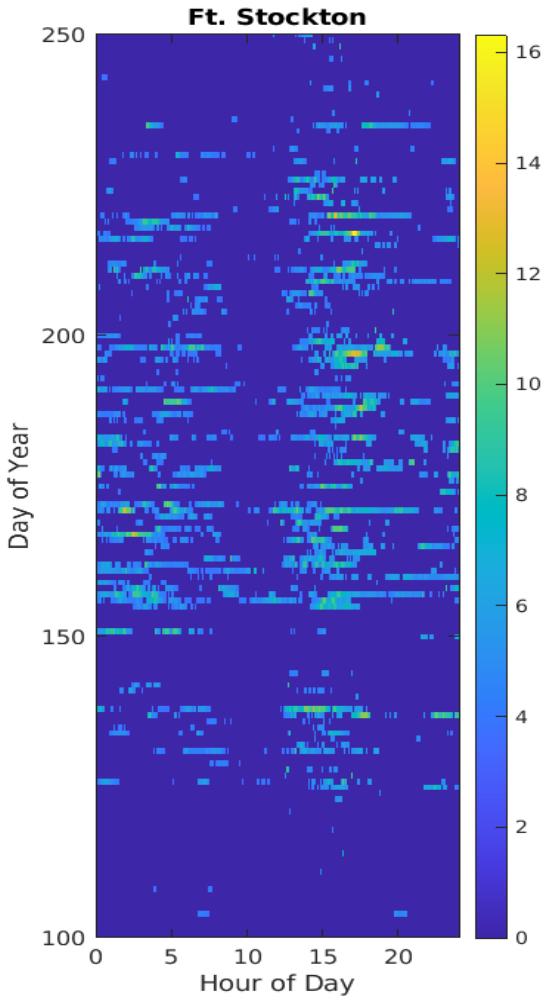
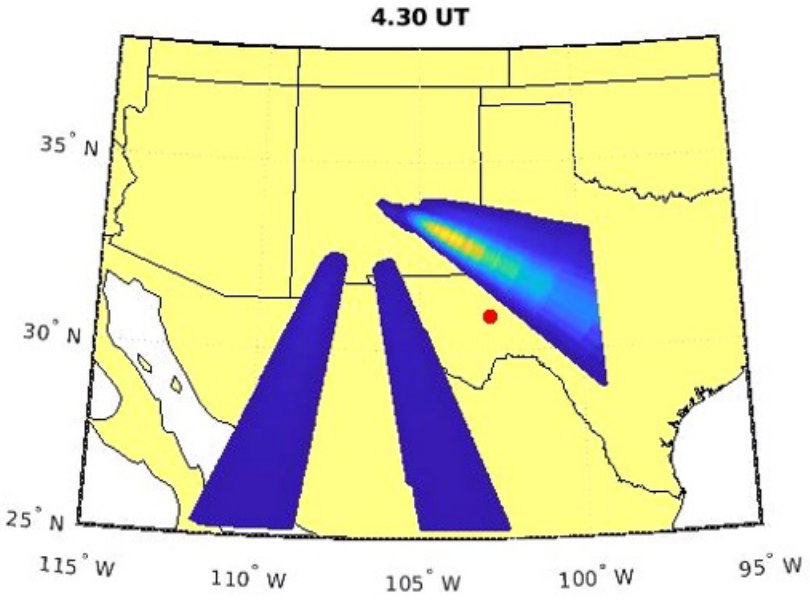
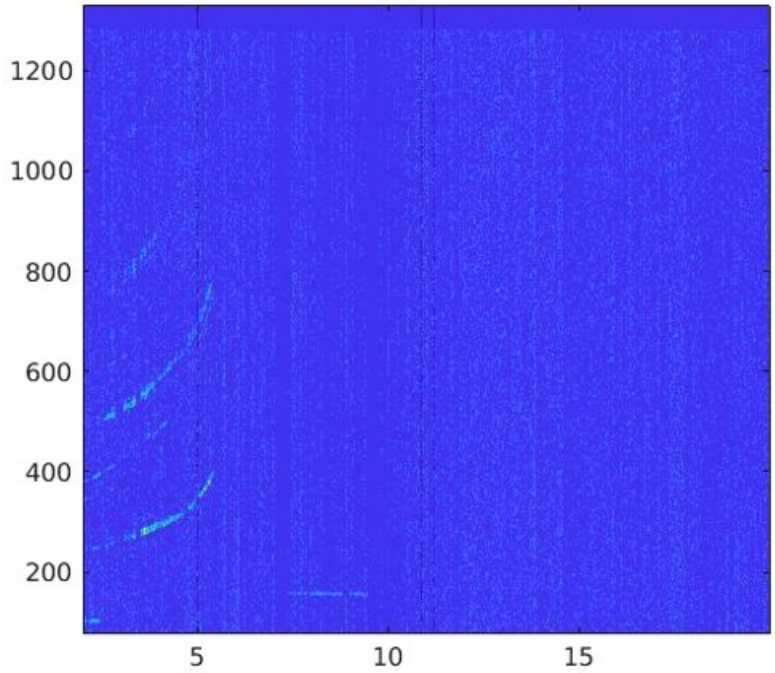




June 22, 2022





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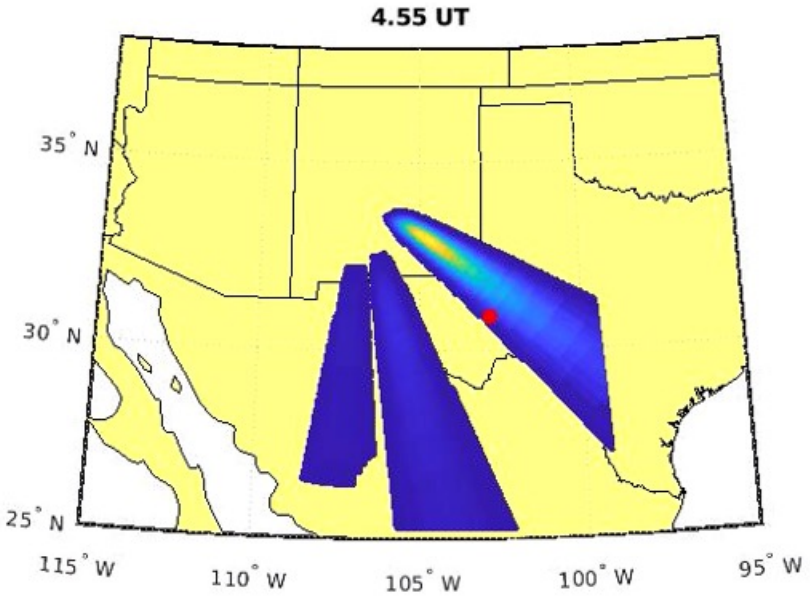

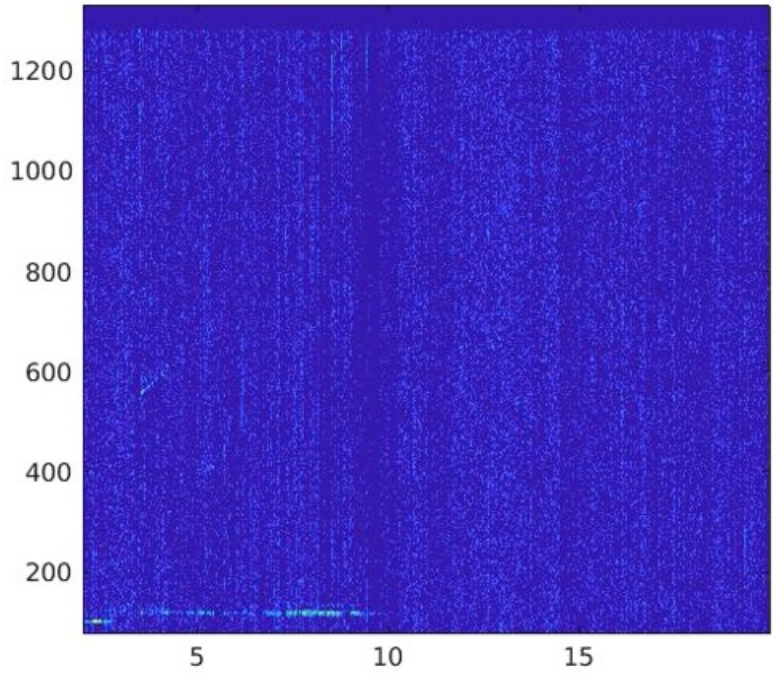

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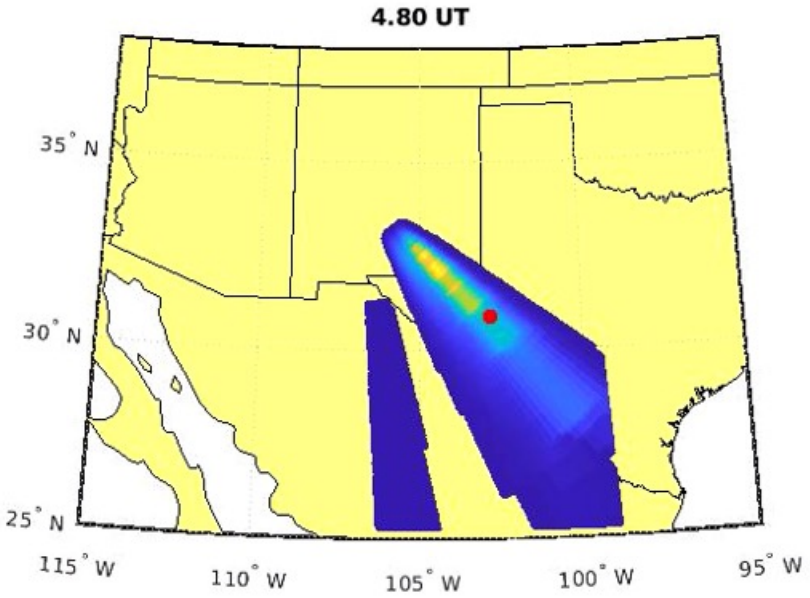

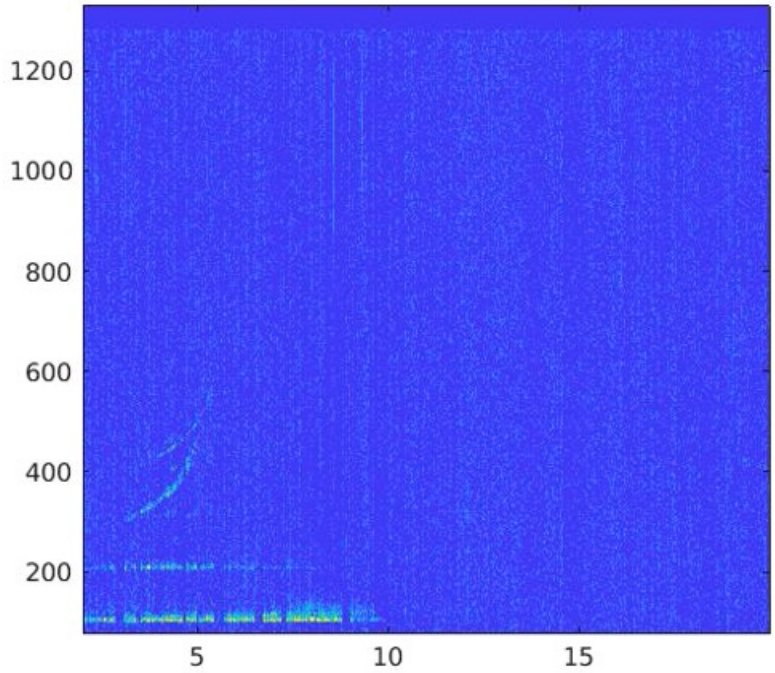

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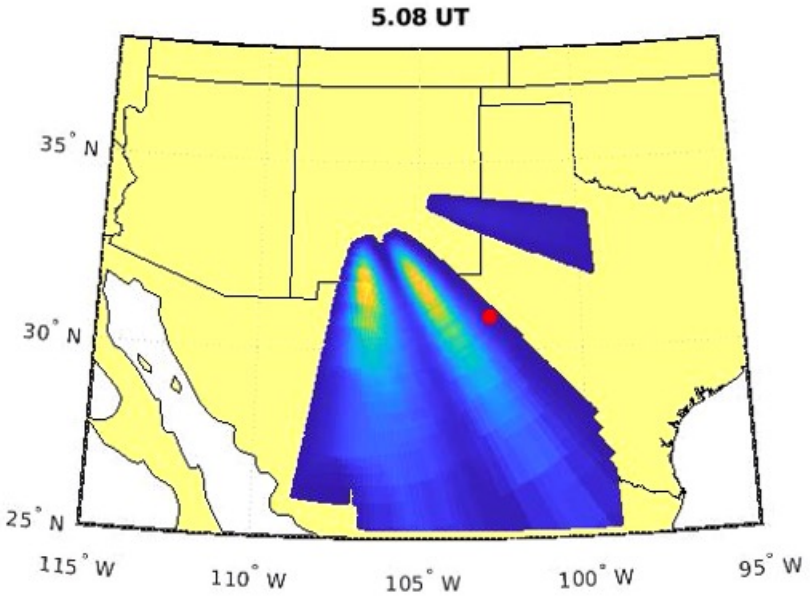

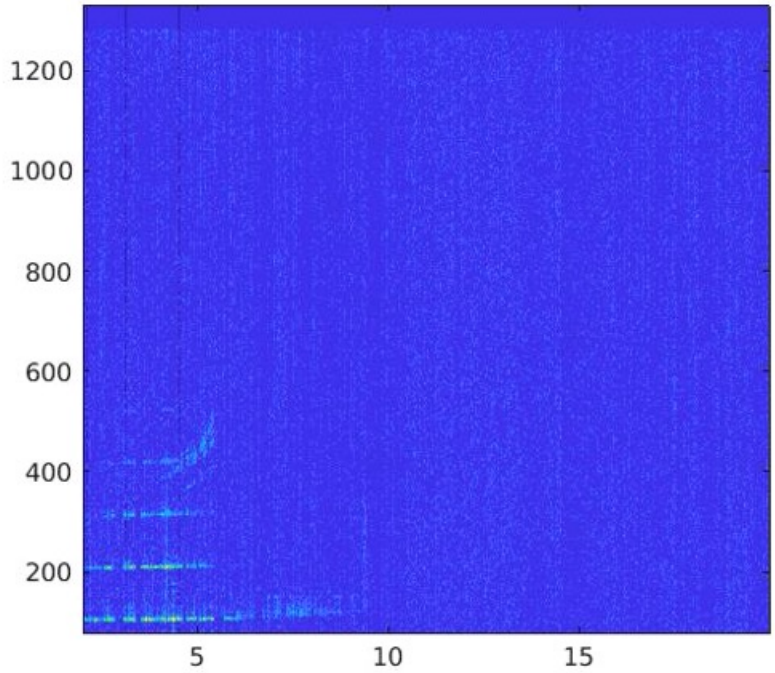

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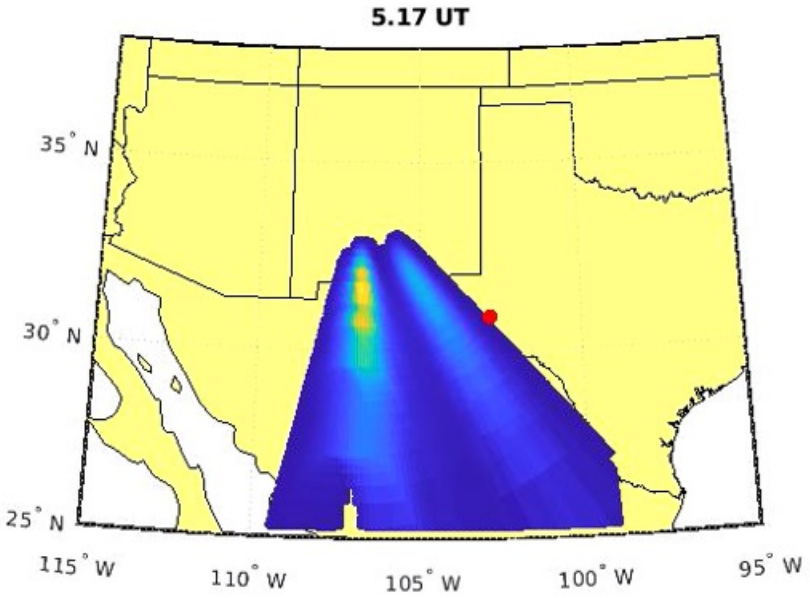
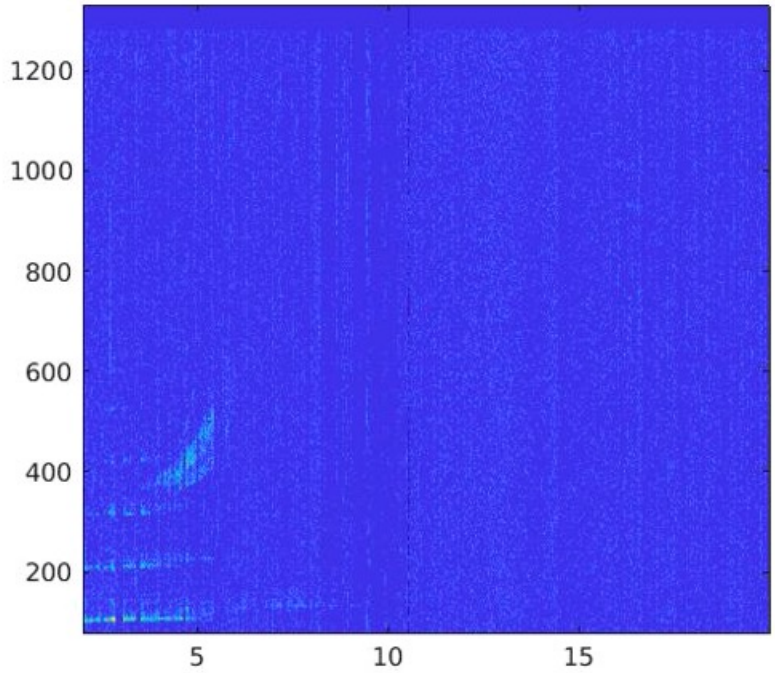
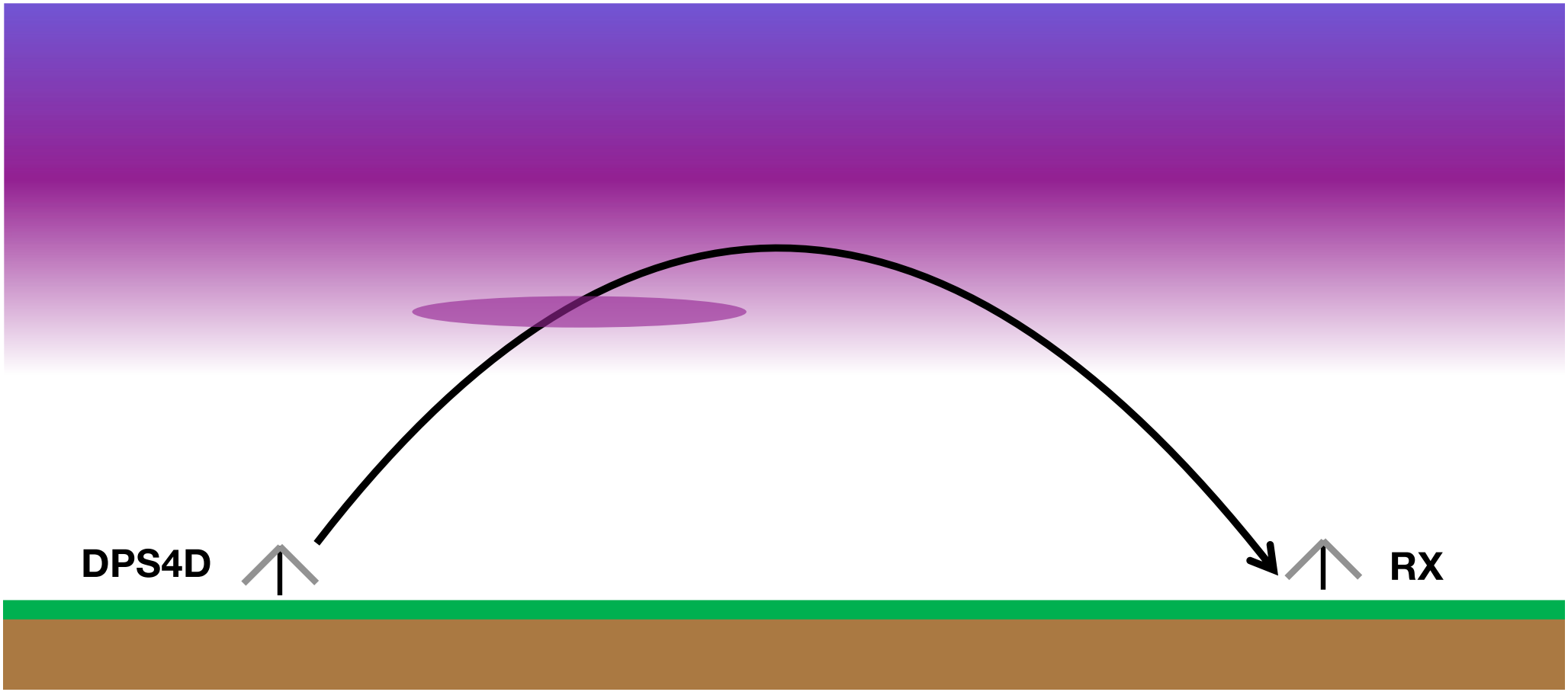




Sporadic E Scintillation and Backscatter



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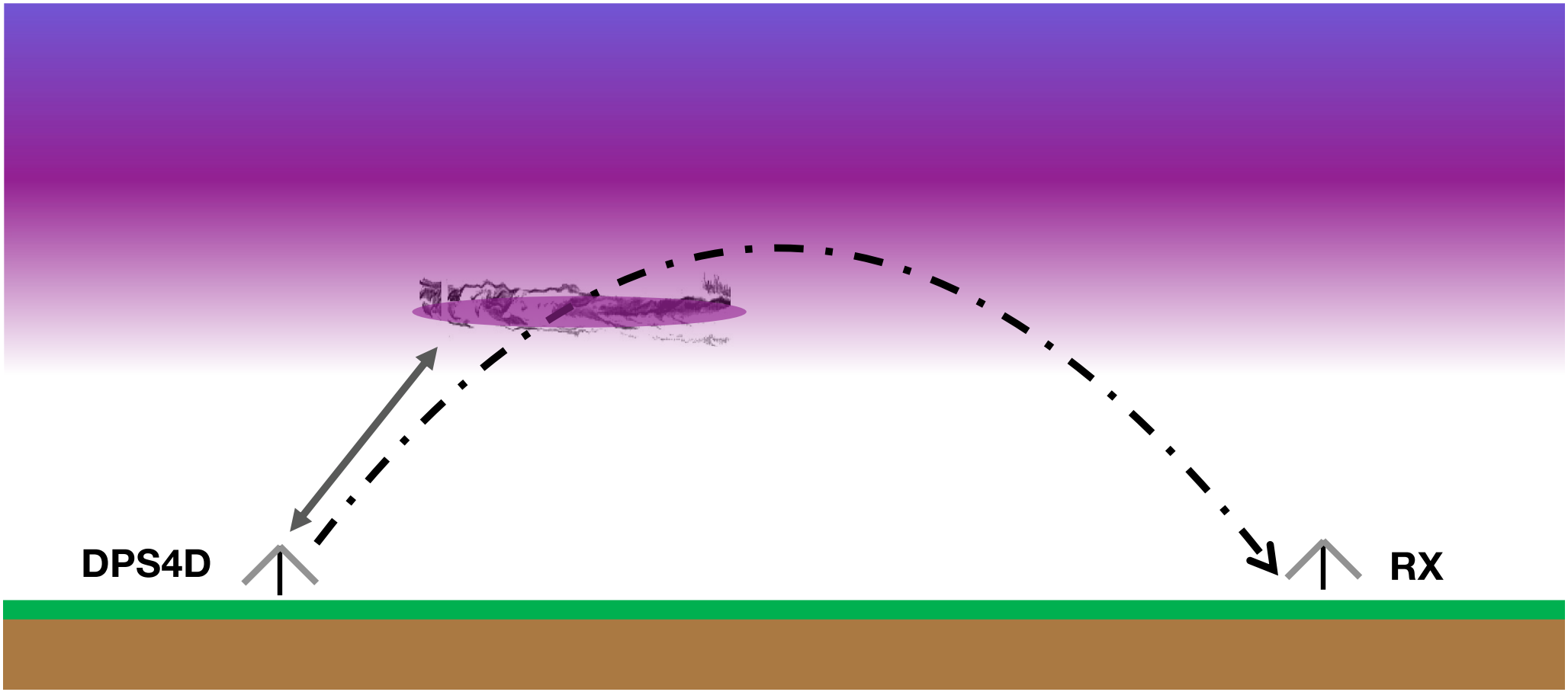
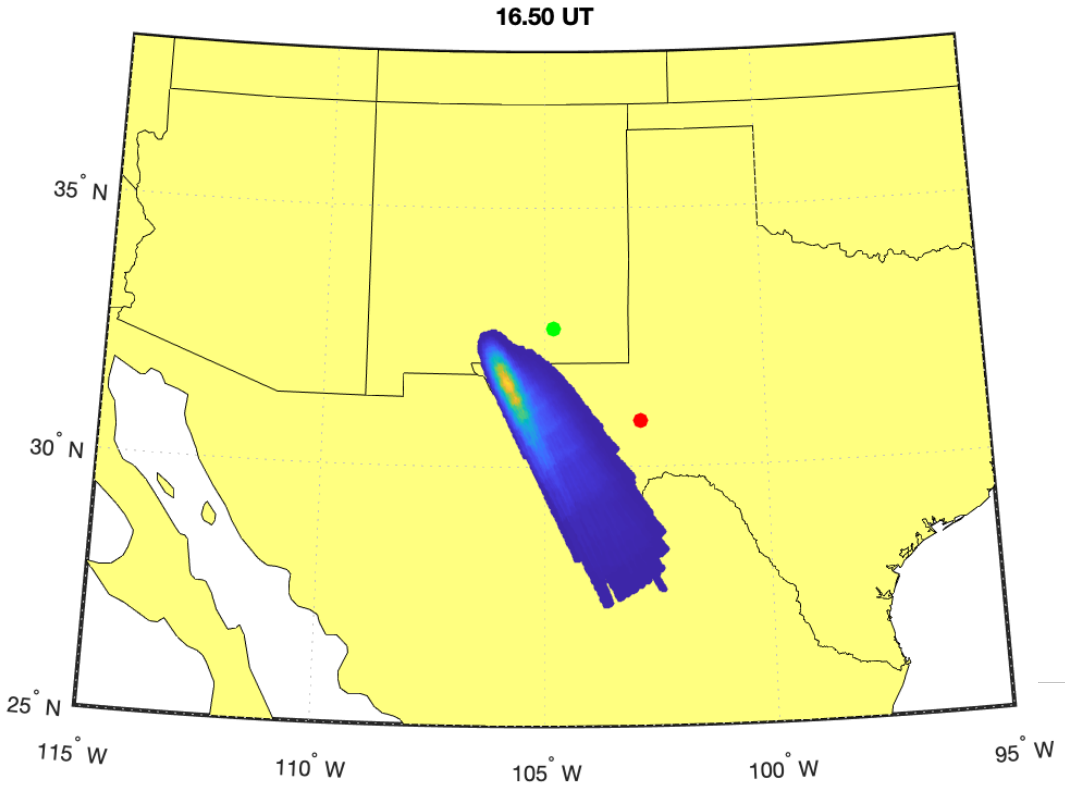
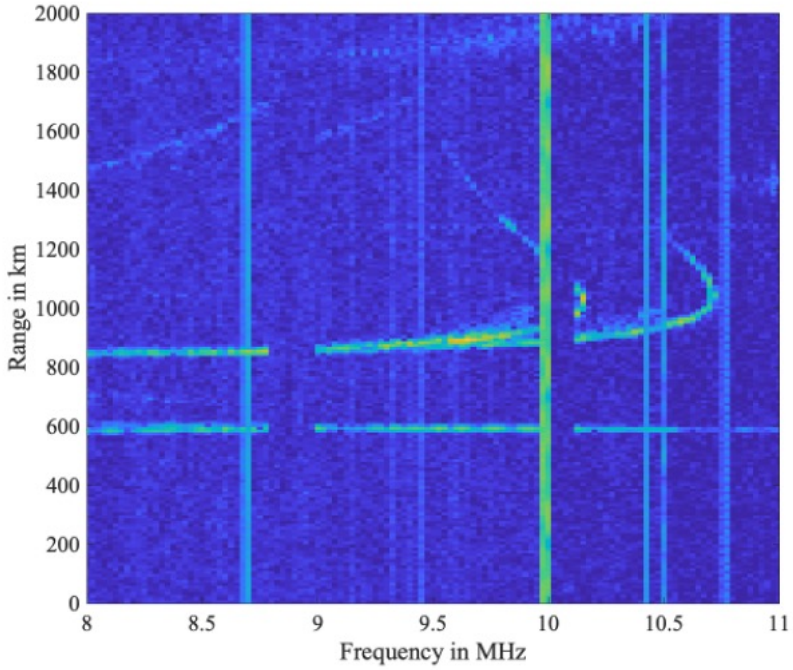


Es irregularities





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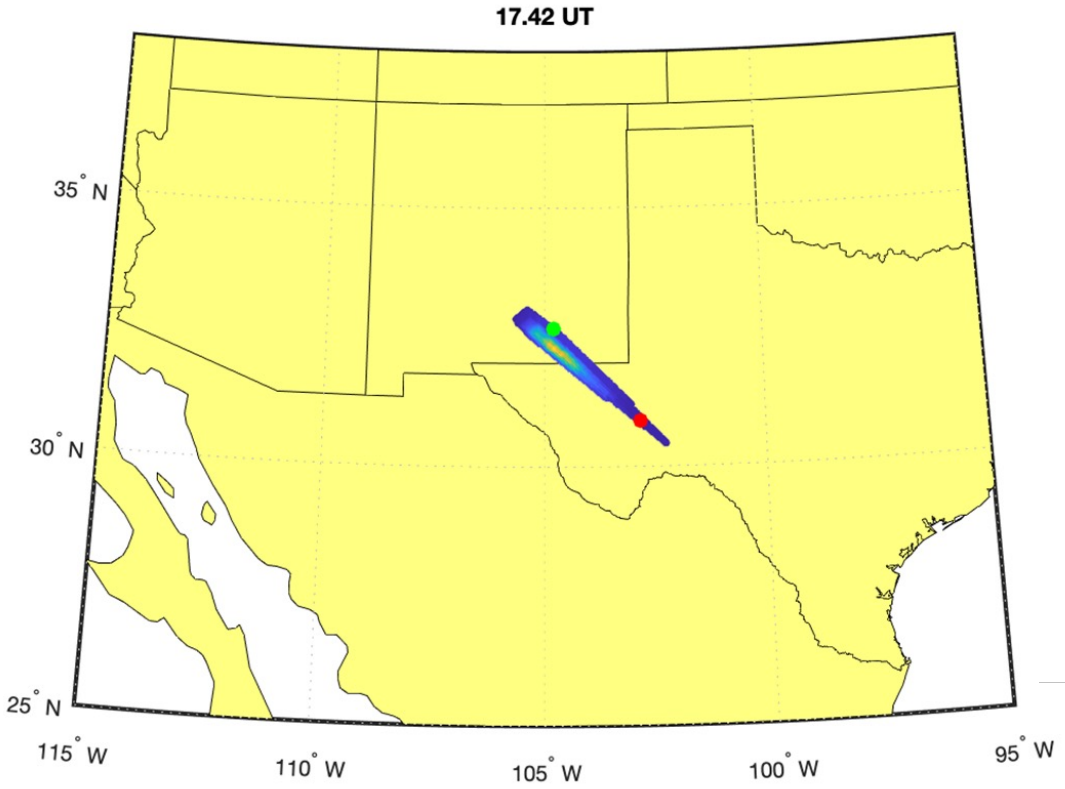

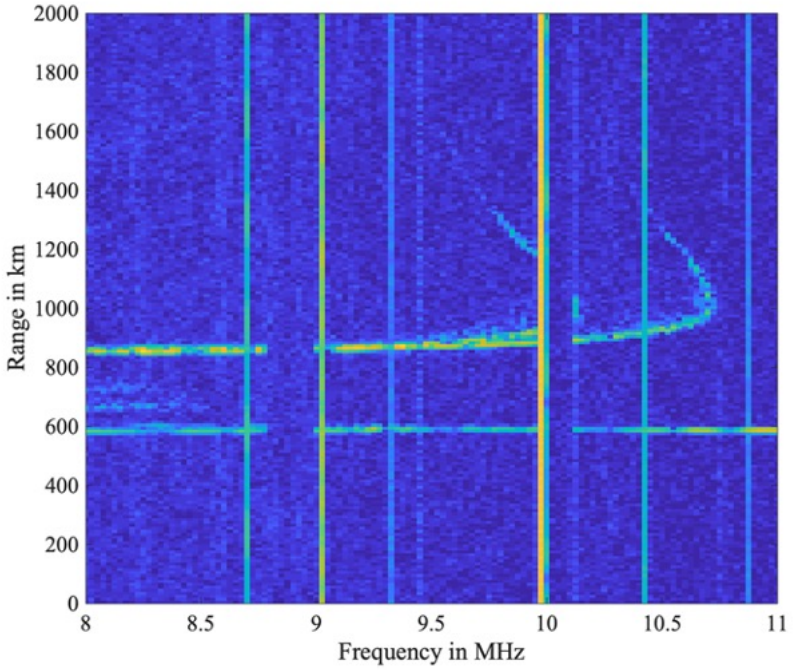

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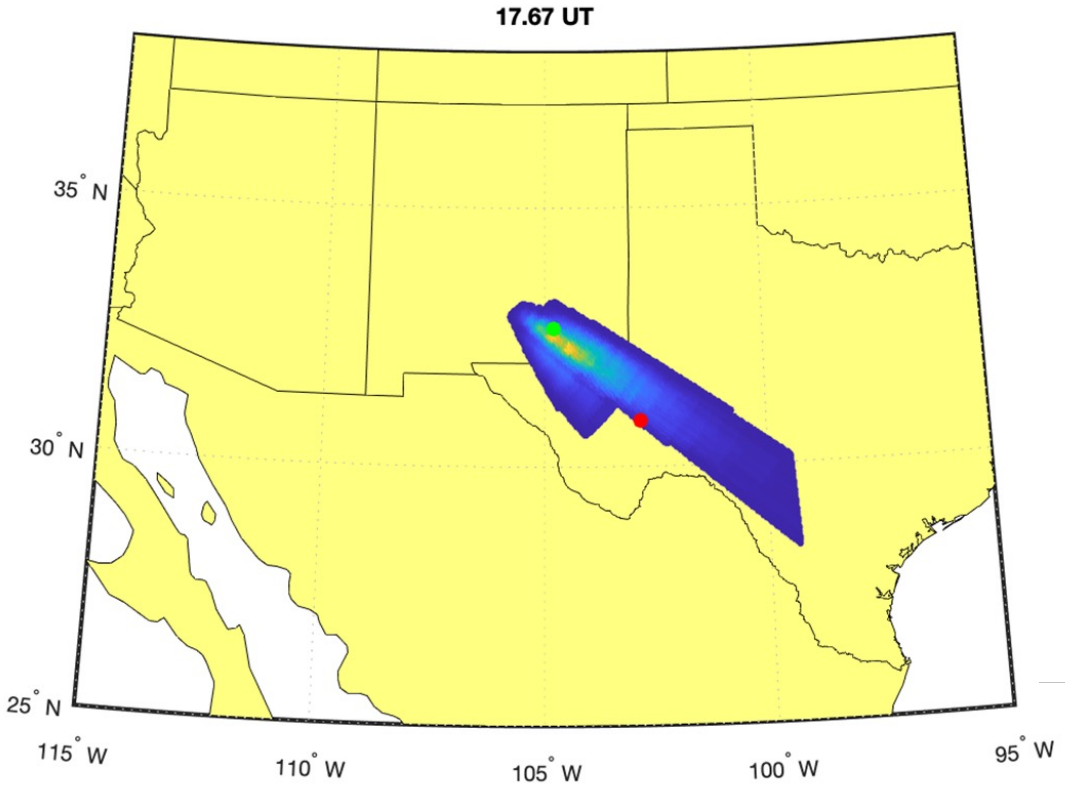

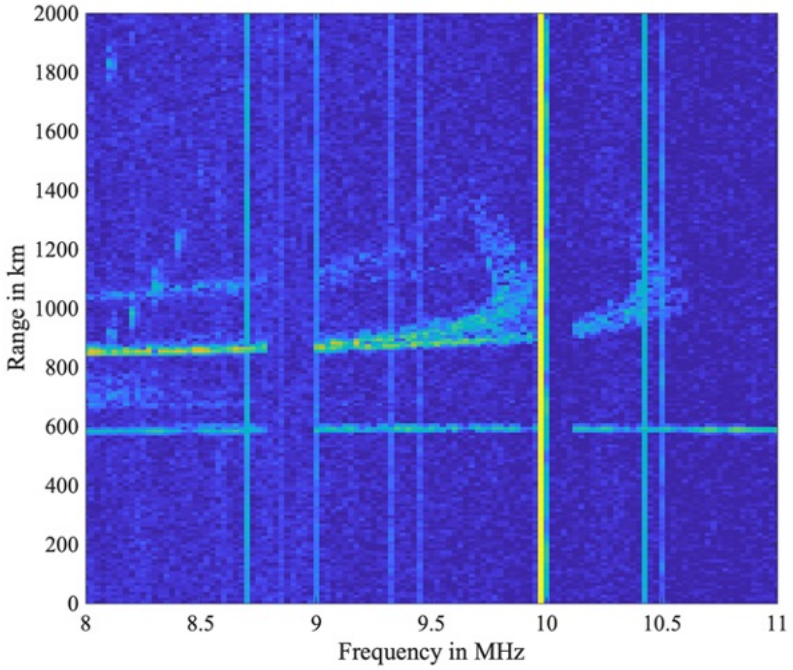

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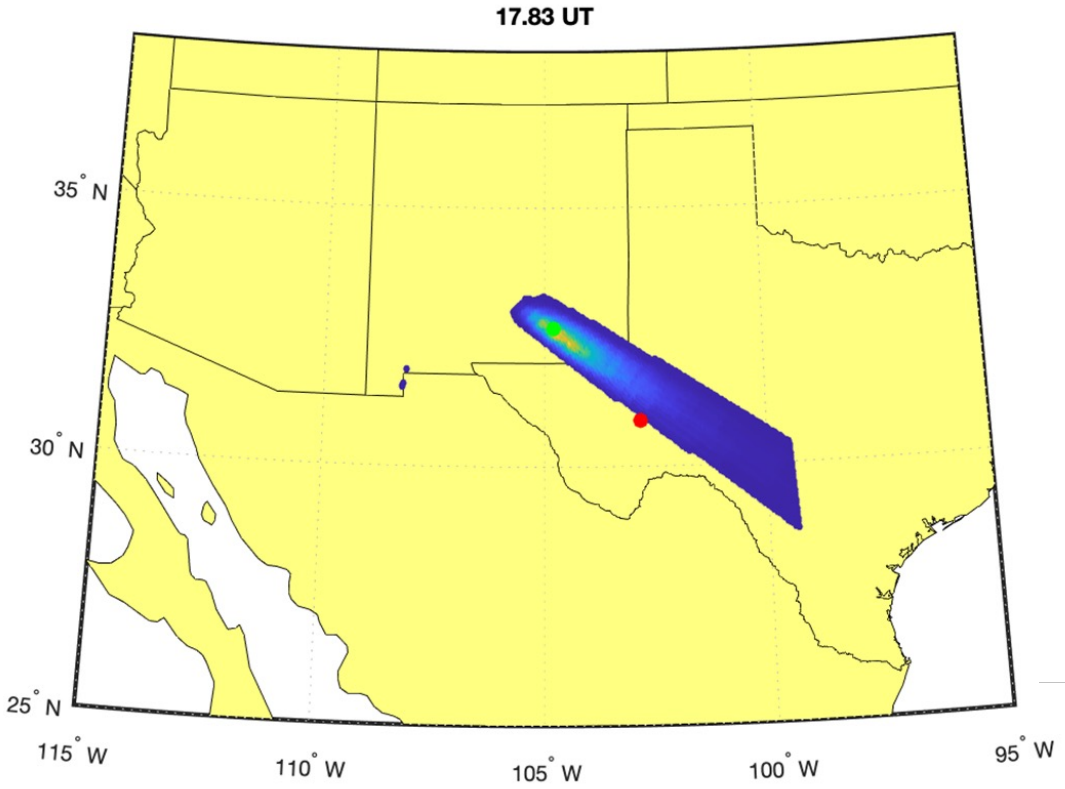

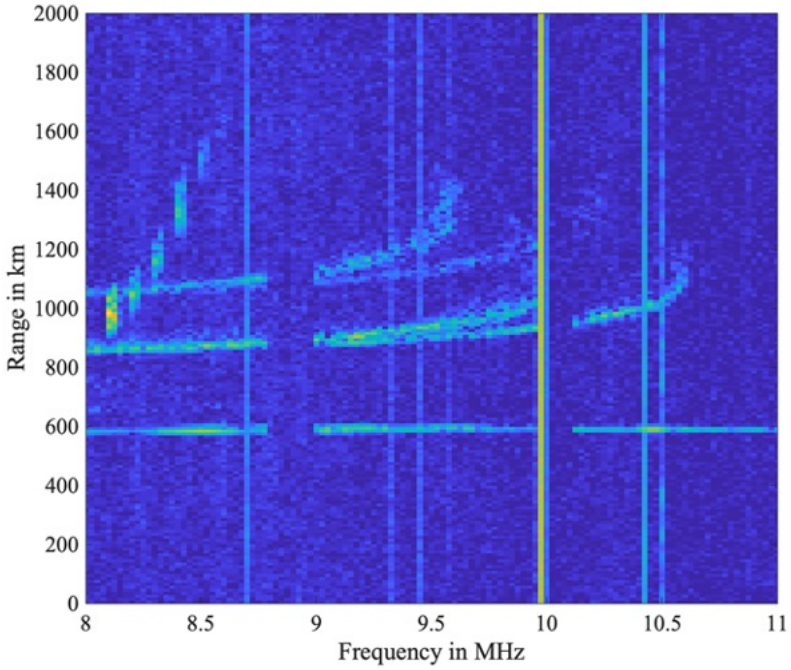

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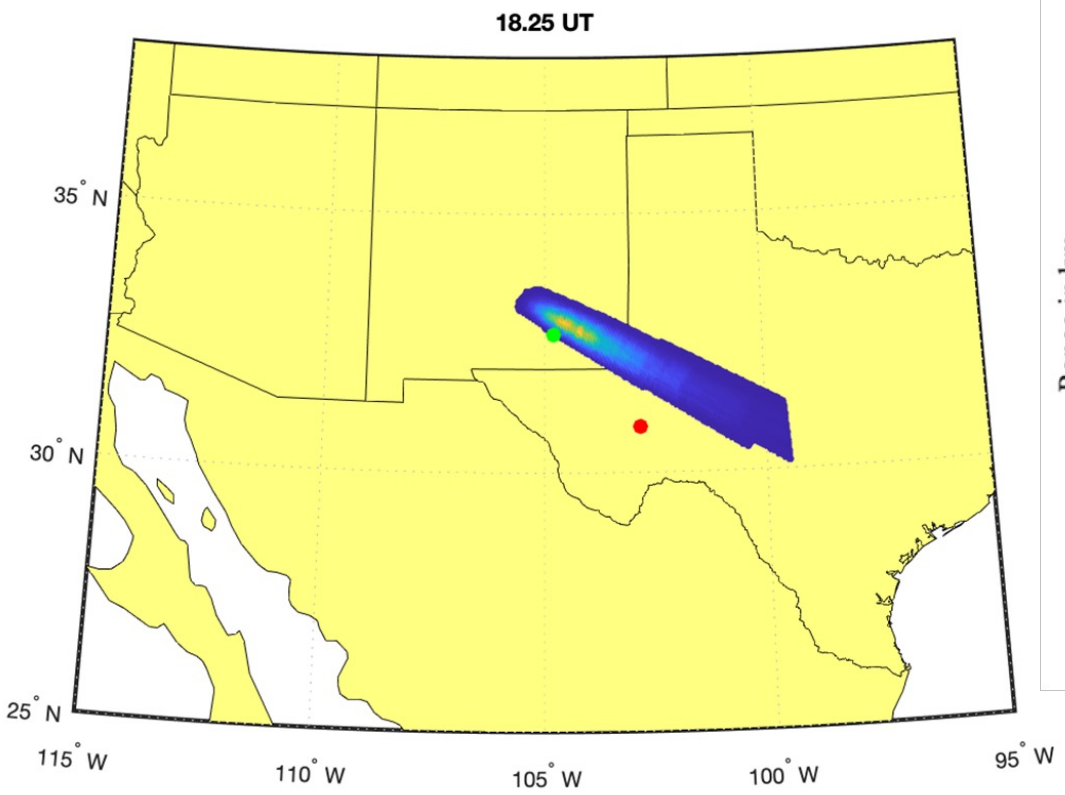
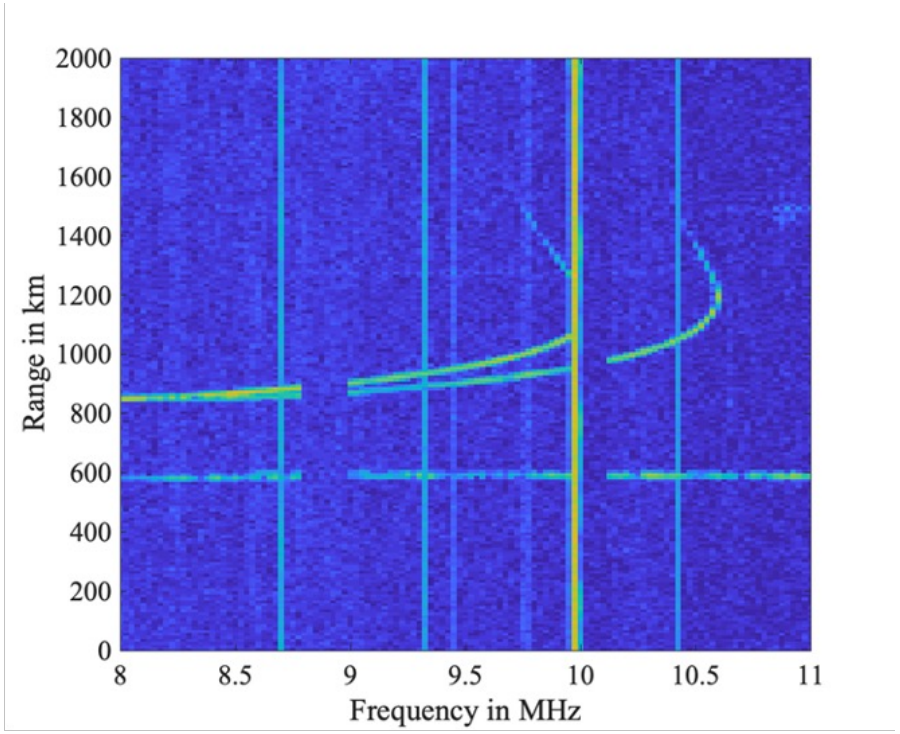
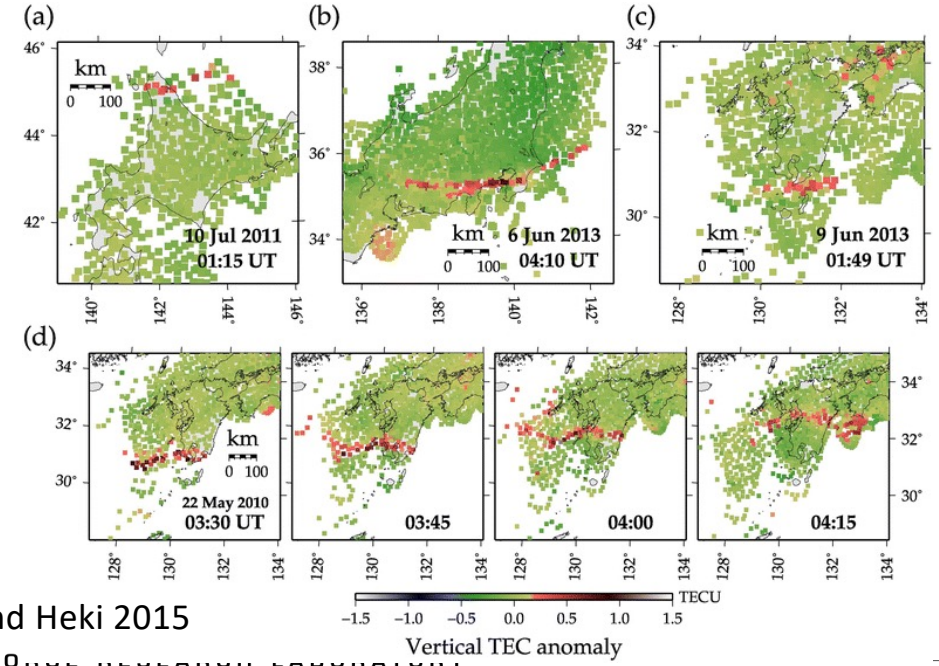


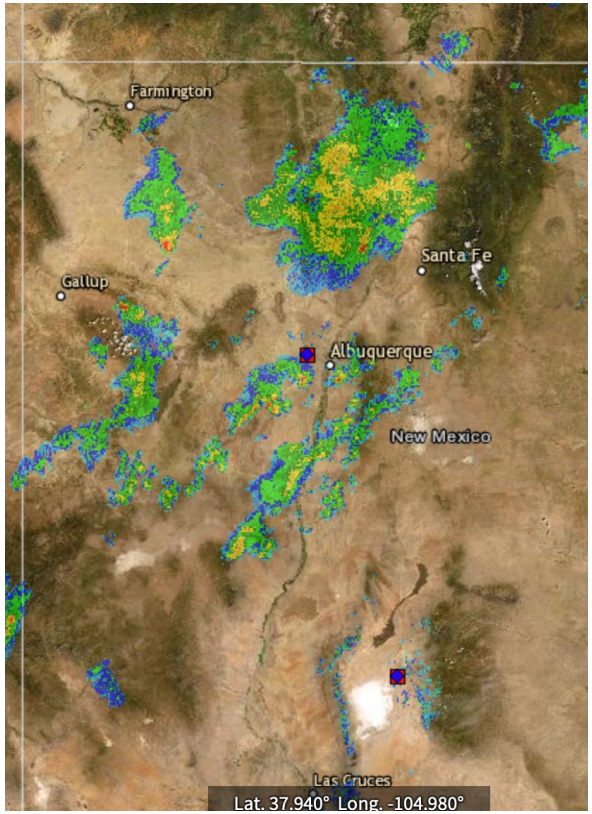


Sporadic E – Similar to thunderstorms

Similar to thunderstorms, Sporadic E forms in discrete patches, often propagating fronts. Impossible to predict exact location where it will occur.

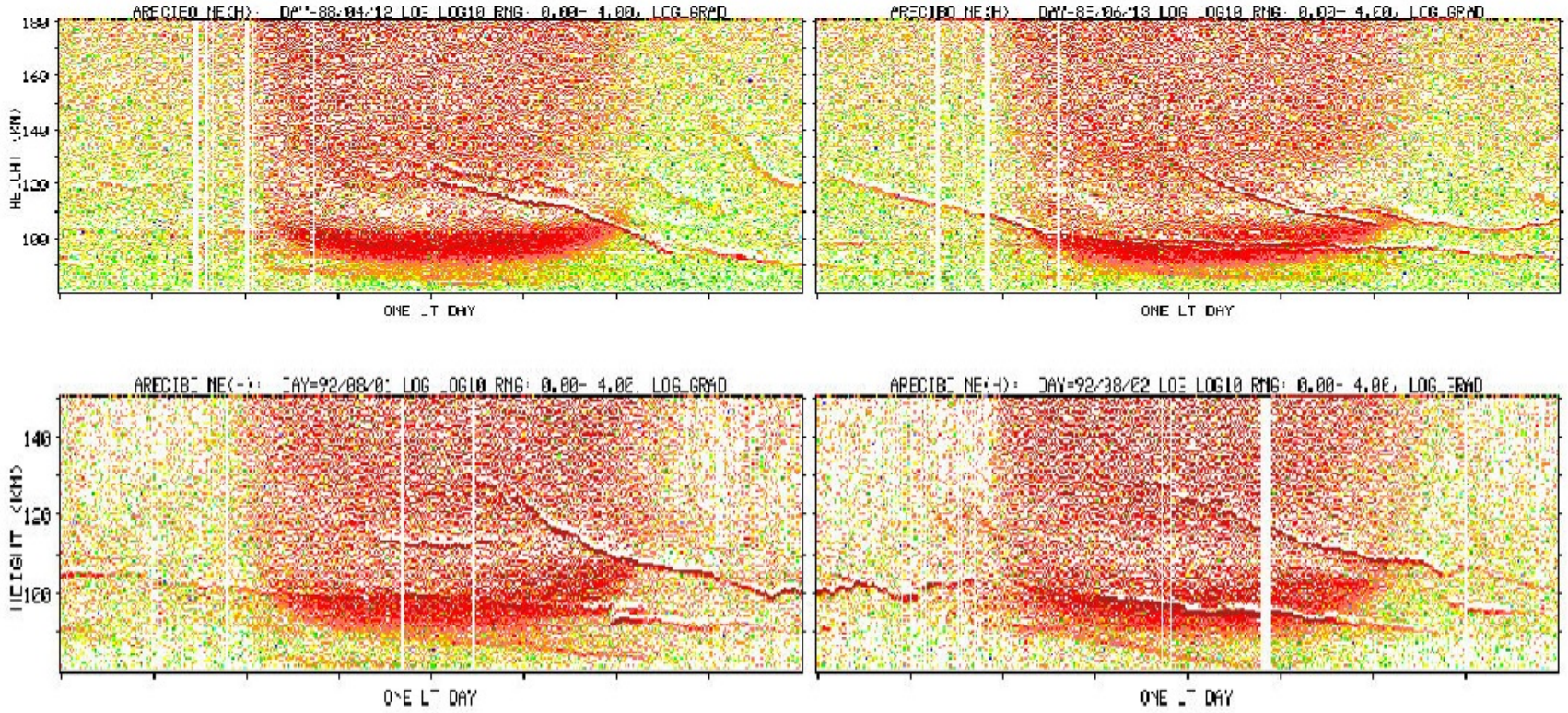


Maeda and Heki 2015

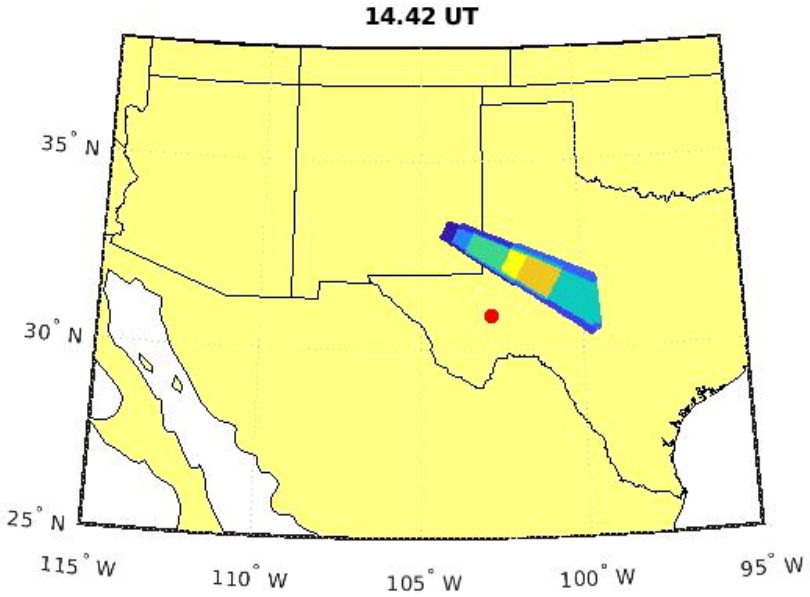


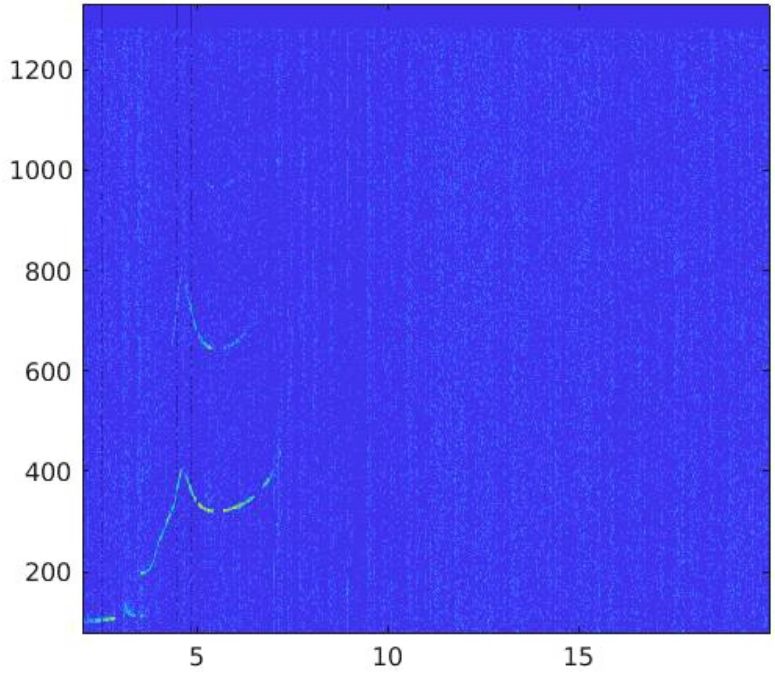
Sporadic E Formation

Descending Layers over Puerto Rico - Christakis et al. 2009



June 18, 2022





August 6, 2022