Developing a Solar Eclipse Simulation for Greater Good:
The Next Iteration

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Introduction

- HamSCI held the Solar Eclipse QSO Party (SEQP) during the August 21, 2017 total solar eclipse.

- We developed an SEQP simulation program in MATLAB using the PHaRLAP ionospheric ray tracing package and the SAMI3 ionospheric model.

- Initially we focused on simulating user-submitted QSOs and RBN spots when the eclipse was over the US.

- US-US propagation changes were just one of many effects from the eclipse.

- We were filtering out a lot of the US-Europe data.

US-Europe RBN spots during SEQP
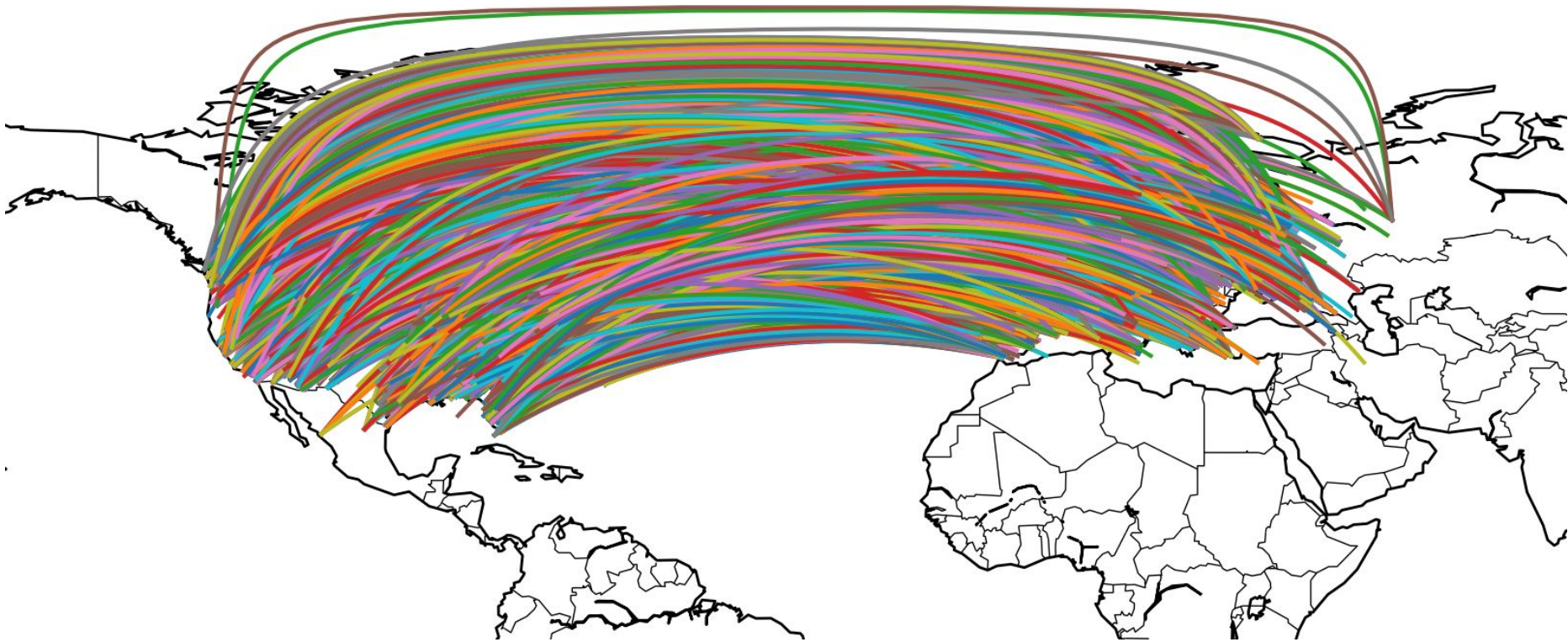
Say Hello to Simulation 2.0

A number of improvements have been made to the simulation:

- Increased simulation distance from 2,500 km to 10,000 km.
- Maximum number of "hops" increased from 3 to 10.
- The "best" ray is now highlighted.
- More verbose output results to allow for further processing.
- Can now simulate across oceans.

Why Simulation 2.0?

- Data collected from the RBN shows an SNR increase in the 5000-8000 km range.

- This rise in SNR has been attributed to cross-Atlantic contacts to Europe.

- Can we simulate this?

Figure from: *Ionospheric Response to the 2017 Great American Eclipse as Observed by Amateur Radio Activity*

Eclipse   **Control**

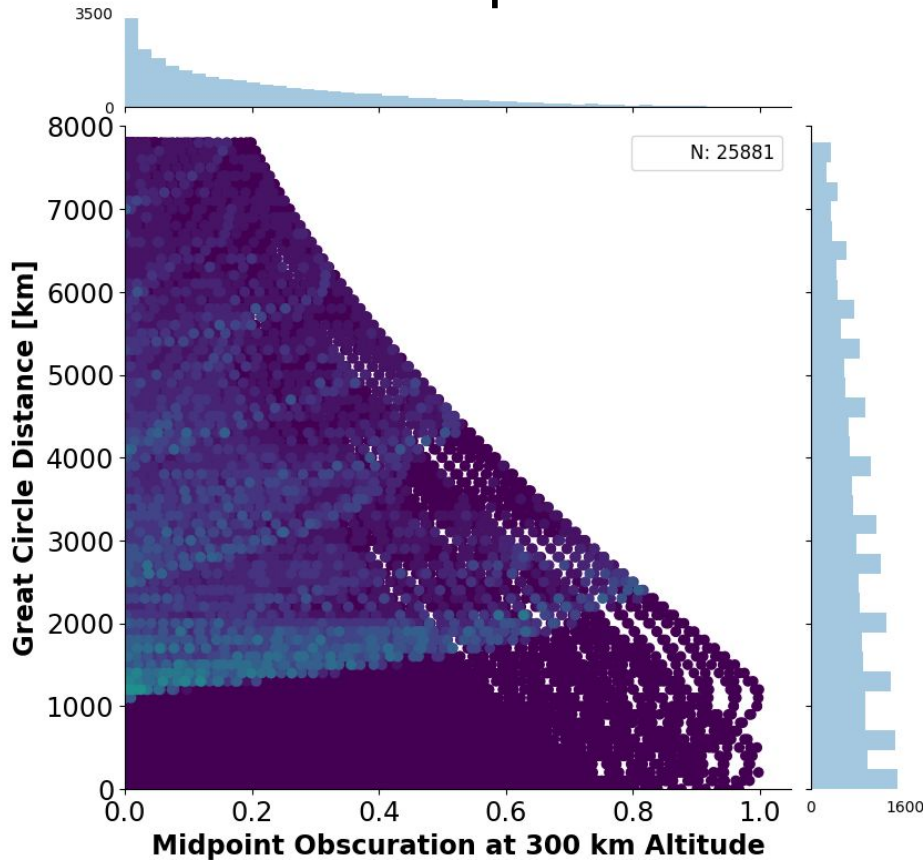jsv28@njit.edu

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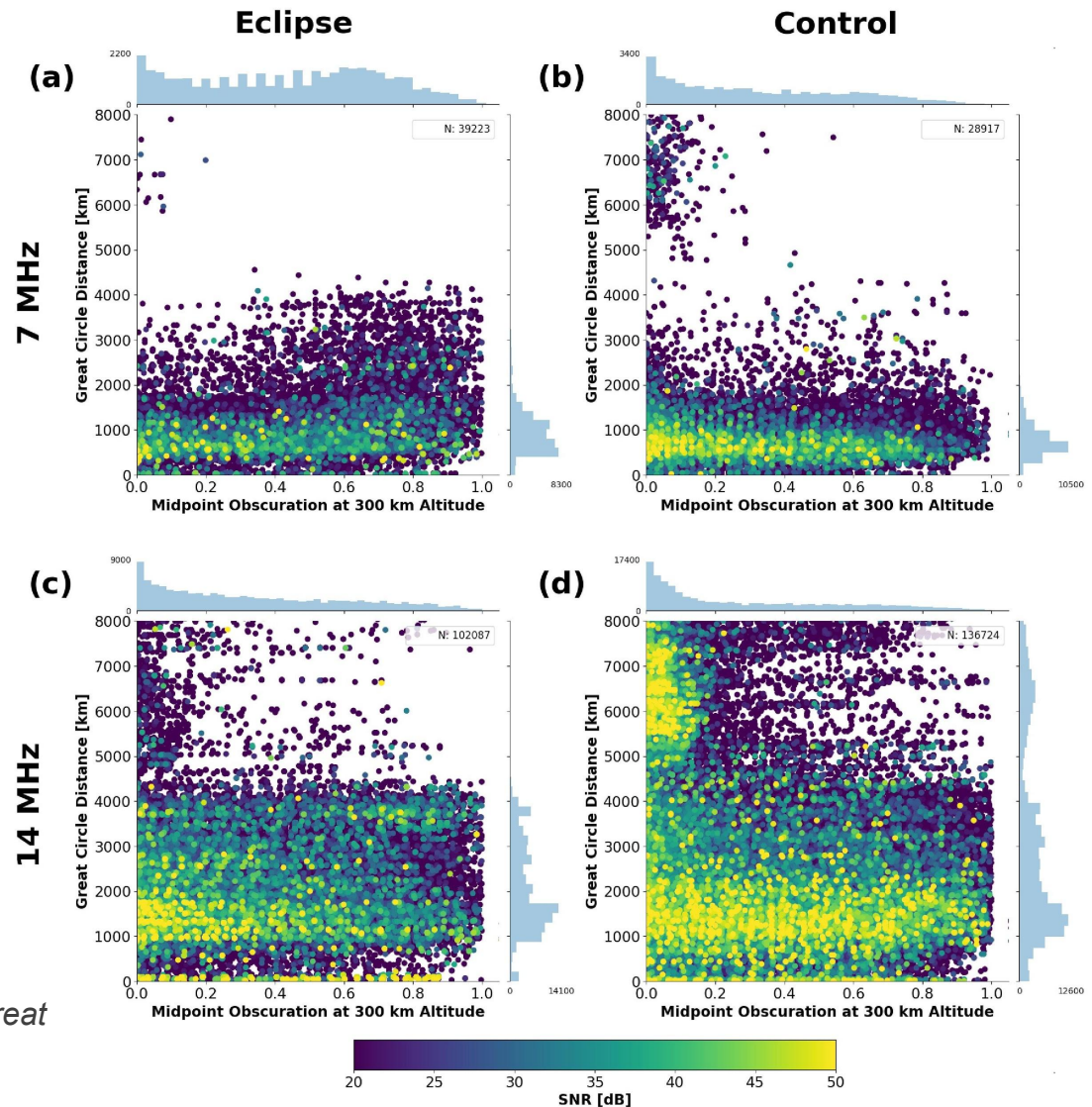
CONUS to EU - Simulation Parameters

- Transmitters along East Coast of US.
- Receivers throughout Europe.
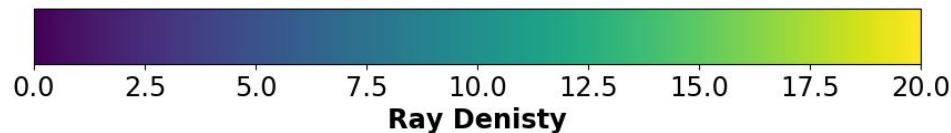- 9 station pairs in total.
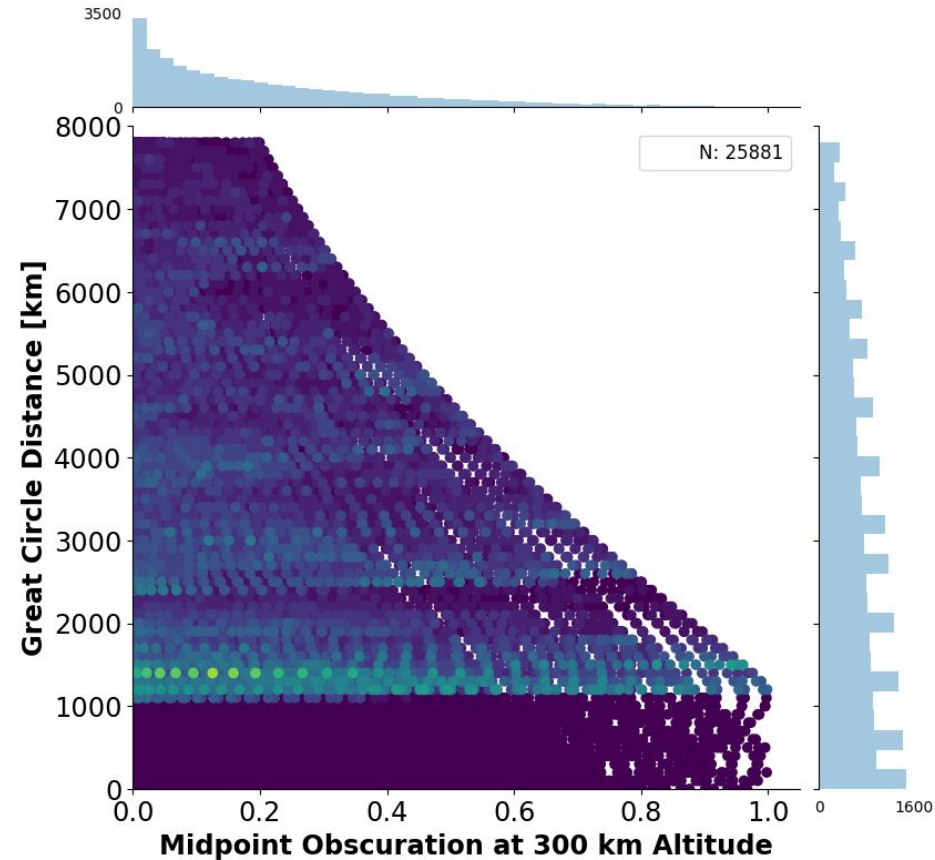- Raytraced at 7 MHz and 14 MHz.
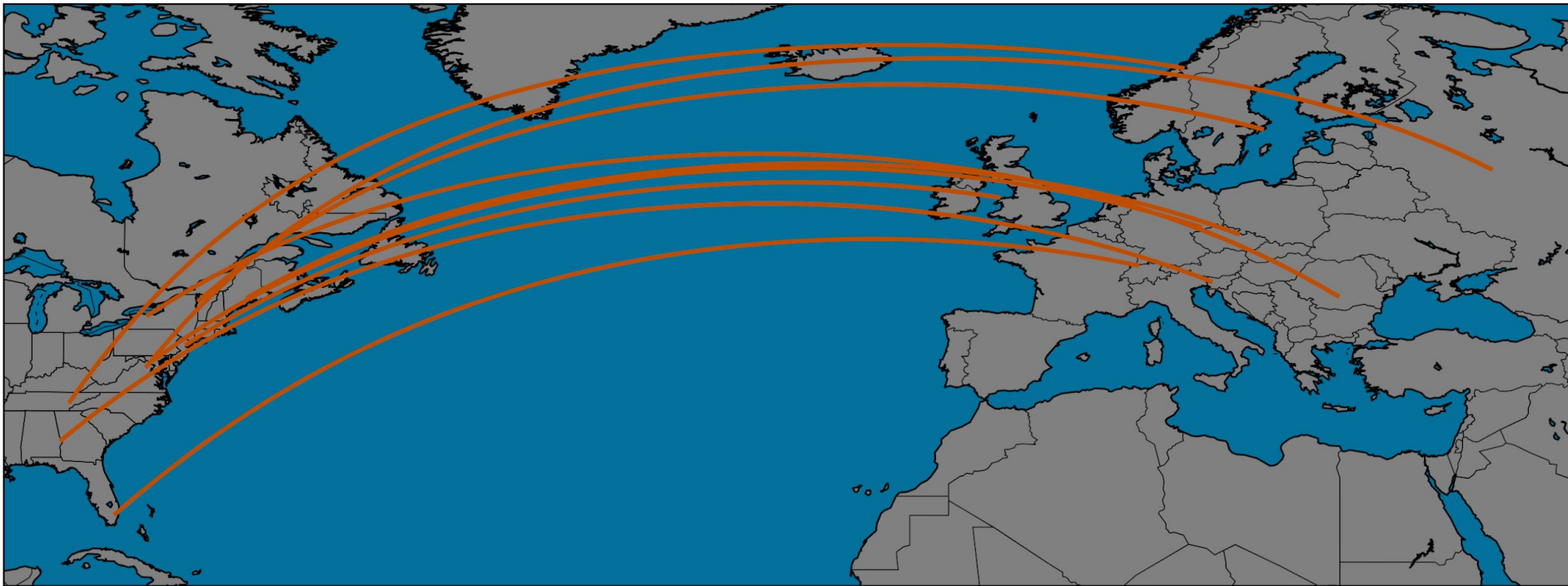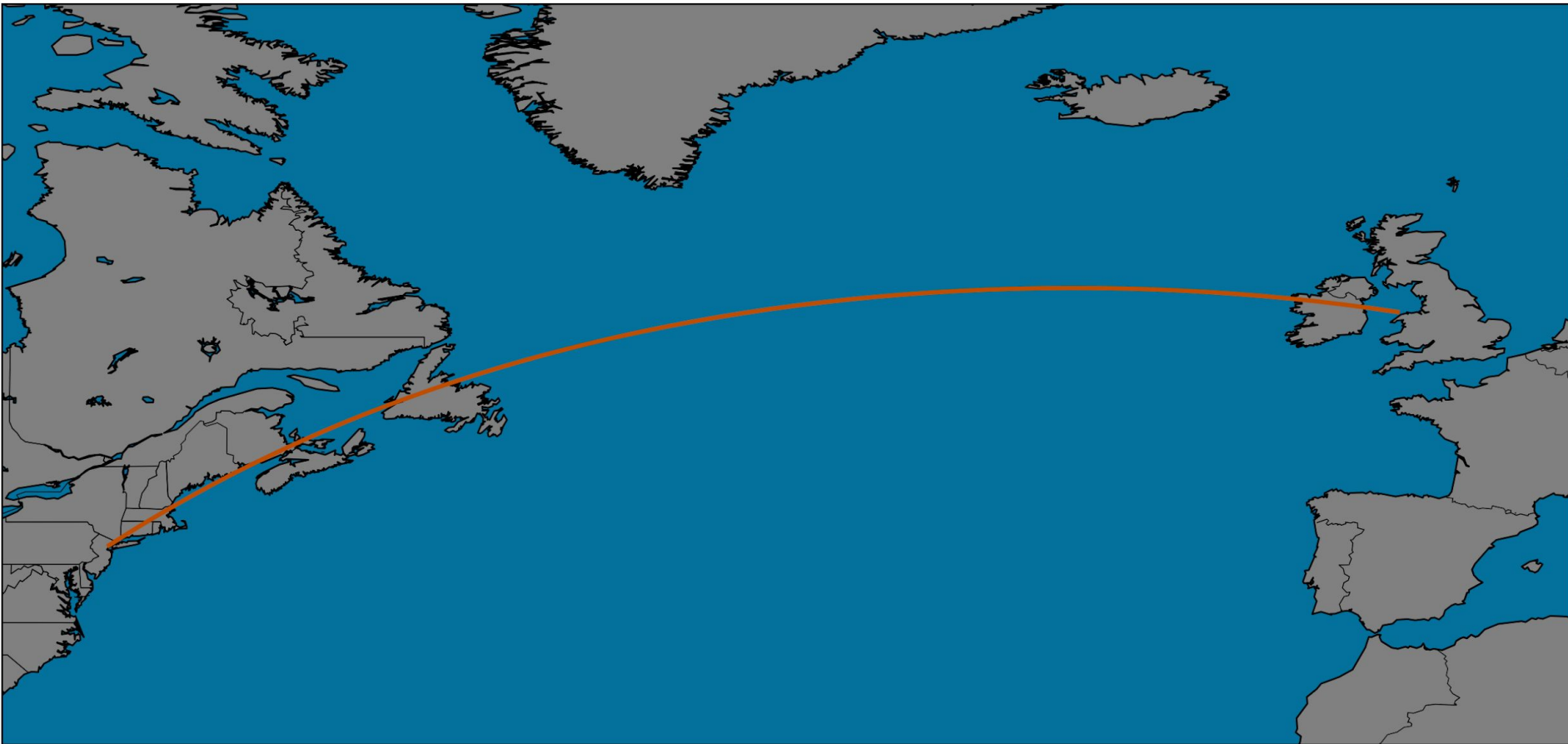
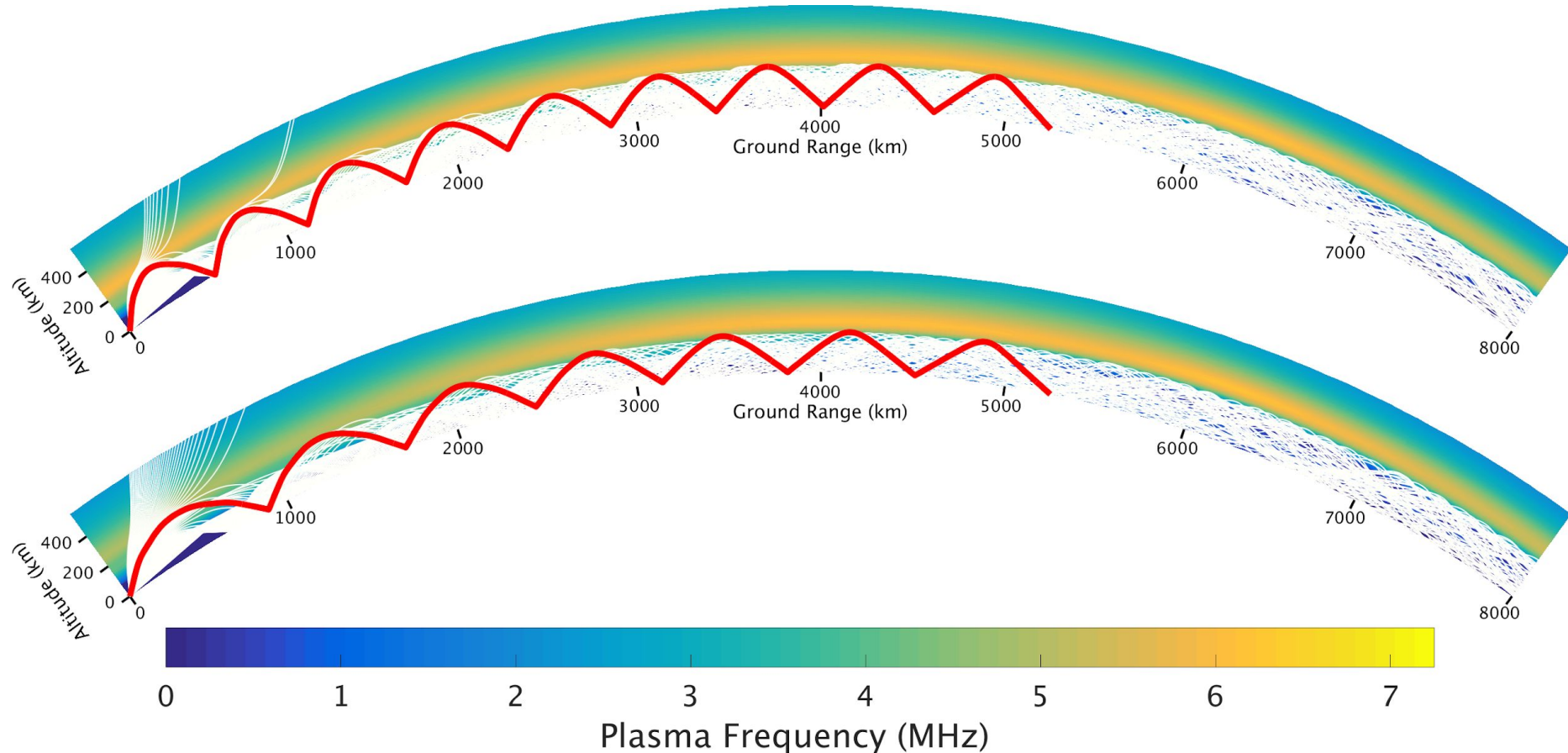# CONUS to EU - 14 MHz Ray Density

Eclipse

Control

K2MFF to GW8IZR - 7 MHz

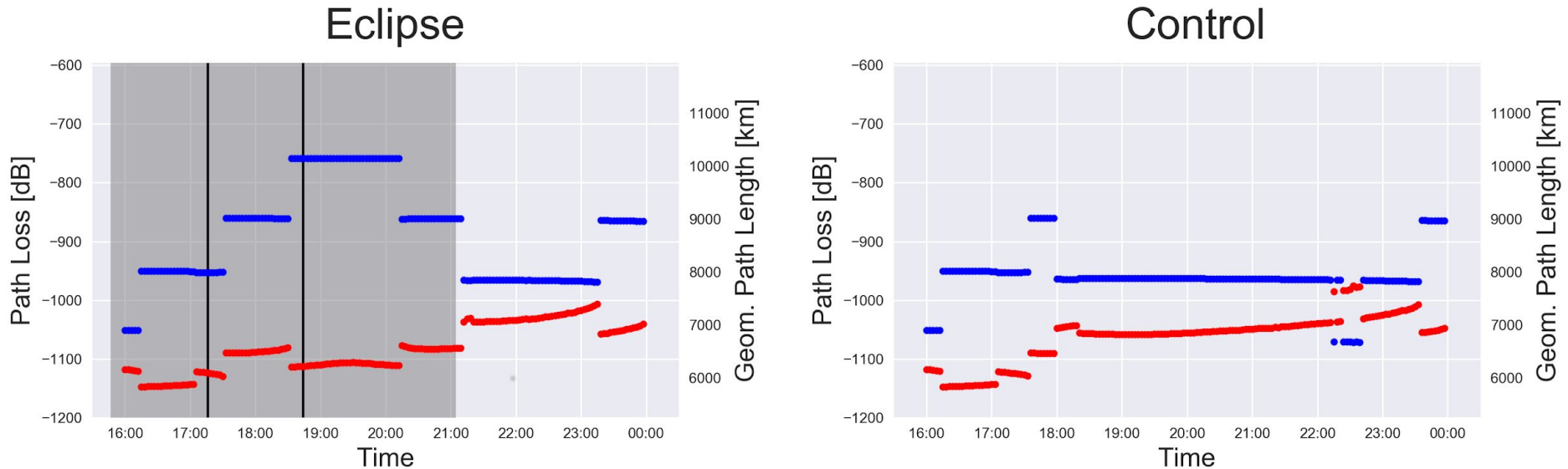## Newark, NJ to Manchester, UK

K2MFF to GW8IZR - 7 MHz Raytraces

Plasma Frequency (MHz)

Top: Control
Bottom: Eclipse

21 August, 2017 19:39:00 UTC

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K2MFF to GW8IZR - 7 MHz Path Loss

Blue: Path Loss [dB]
Red: Geometric Path Length [km]

$$\text{Path Loss} = 20 \log_{10}(d) + 20 \log_{10}(f) + 32.45$$

d is geometric path length in kilometers
f is frequency in megahertz

Conclusions & Future Work

- Our simulation can now simulate long-distance communications such as those demonstrated here.

- Our naive method of path loss calculation is designed for line-of-sight radio communications and not suitable for over-the-horizon use.

- We want to implement ionospheric absorption and imperfect ground reflections in order to improve power loss calculations.

- We have yet to replicate the results shown in the RBN eclipse and control data.

- We can use population density data as a method of masking out areas where there are no receivers.

References

- "The results published in this paper were obtained using the HF propagation toolbox, PHaRLAP, created by Dr Manuel Cervera, Defence Science and Technology Group, Australia (*manuel.cervera@dsto.defence.gov.au*). This toolbox is available by request from its author."

- Huba, J.D., D. Drob "SAMI3 prediction of the impact of the 21 August 2017 total solar eclipse on the ionosphere/ plasmasphere system" *Geophysical Research Letters* 44 (2017).

- Frissell, N.A., et. al. "Ionospheric Response to the 2017 Great American Eclipse as Observed by Amateur Radio Activity" *Geophysical Research Letters* (2018, submitted).

Thank You