Grape 1.0:

Early Data and Pilot Experiments

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19 March 2021

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Conference Context

Friday, March 19, 2021

Eastern Daylight Time	UTC	Title		
		Opening Remarks & Ora Personal Space Weather Station E ***Chair: Nathaniel Frisse*** *Zoom Moderators: Gareth Perry KD2SA*		
8:30 AM EDT	**1230z**	**Opening Remarks / Webinar Opens** • Dr. Nathaniel Frissell W2NAF • Dr. Jeff Gingerich (Provost) • Dr. Michelle Maldonado (Dean)		
8:45 AM EDT	1245z	**Overview of the Personal Space Weather Station and Project Upd**		
9:00 AM EDT	1300z	**TangerineSDR Data Engine and Overall Architecture**		
9:20 AM EDT	1320z	**TangerineSDR Clock Module Design**		
9:40 AM EDT	1340z	**Mid-latitude Irregularities in the Early Results from the Ionospheric Sounding Mode Using Chirp Ionosondes of Opportunity for the HamSCI Personal Space Weather Station**	Dev Joshi K	
10:00 AM EDT	1400z	**PSWS Grape Hardware: Version 1.0 and Pilot Experiments**	Kristina Collins KD8OXT	Case Western Reser University
10:20 AM EDT	1420z	**PSWS Grape Hardware: The Second Generation**	John Gibbons N8OBJ	Case Western Reserve University
10:40 AM EDT	1440z	**Estimation of Ionospheric Layer Height Changes From Doppler Frequency and Time of Flight Measurements on HF Skywave Signals**	Steve Cerwin WA5FRF	HamSCI Community
11:00 AM EDT	**1500z**	**Break** *(Moderators: Dev Joshi KC3PVE & David Kazdan AD8Y)*		
		Oral Session II		

10:30 AM EDT	**1430z**	**Break**	
10:45 AM EDT	1445z	Experiment Co-Design Session	**Experiment Co-Design Session** ***Chair: Kristina Collins KD8OXT*** *Zoom Moderators: Veronica Romanek KD2UHN & Shaaf Sarwar KC3PVF*
12:00 PM EDT	1600z	**Lunch Discussion (Open Meeting - Everyone Moves to New iPoster Zoom Meeting Link)** *Moderators: George Byrkit K9TRV, Dev Joshi KC3PVE, & Nathaniel Frissell W2NAF*	
			iPoster Session HamSCI Posters/Demos ***Chair: Nathaniel Frissell W2NAF*** *Zoom Moderator: Laurie McCoy*

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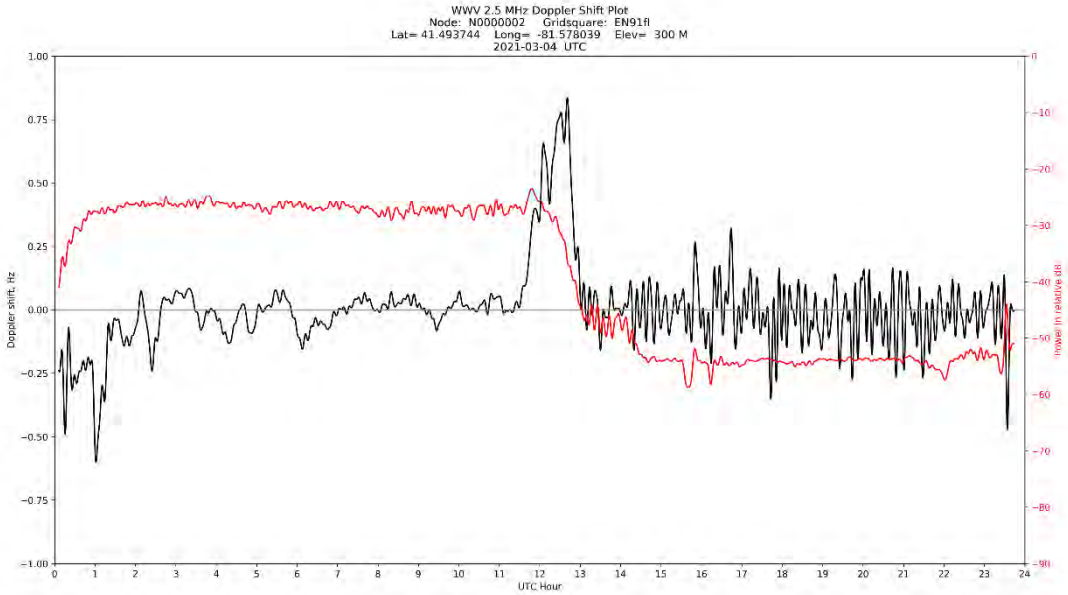
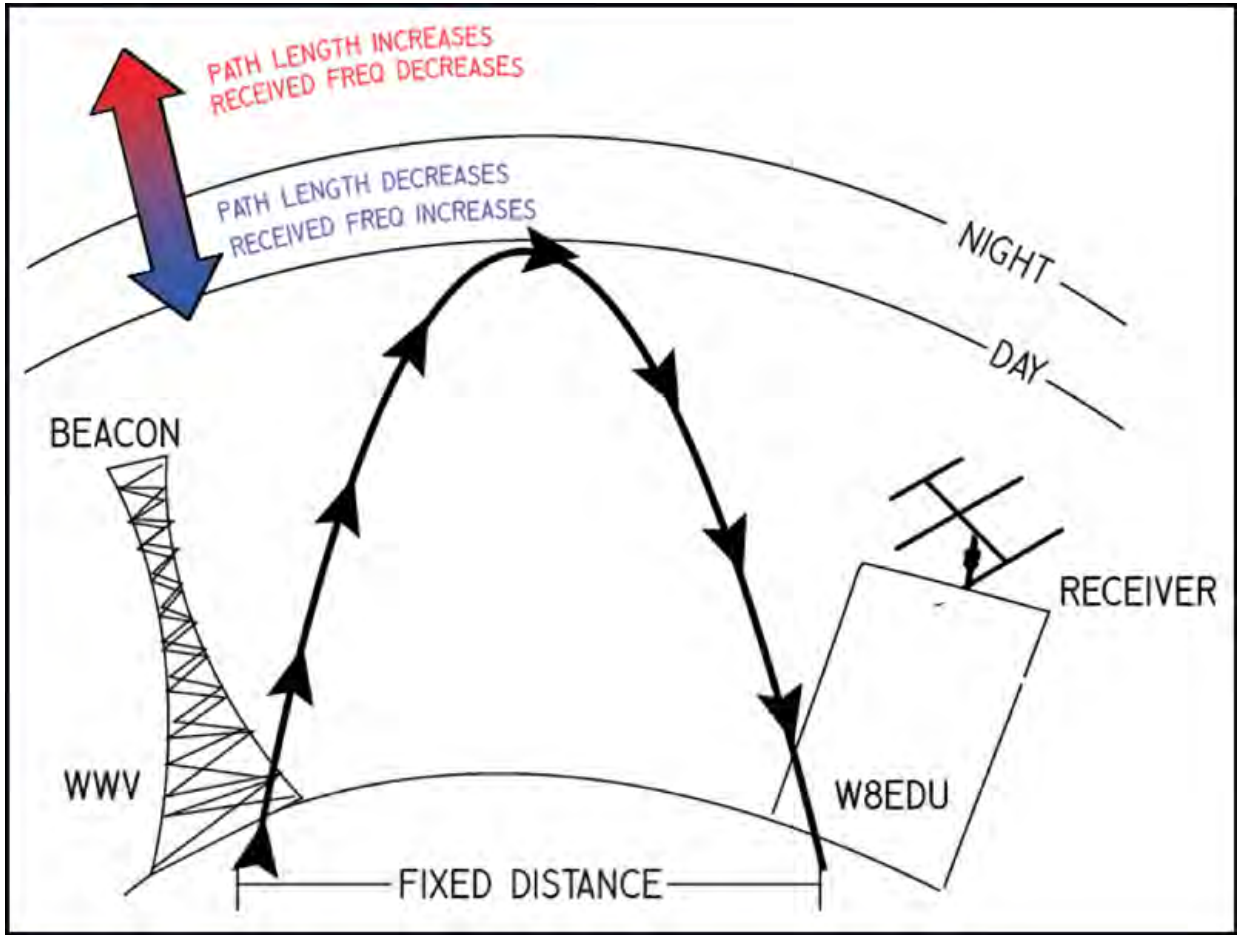
Theory of Operation





https://eos.org/features/ham-radio-forms-a-planet-sized-space-weather-sensor-network

https://ieeexplore.ieee.org/document/9377452

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Experiments

Data we've collected so far:

- Long-Term Pilot Experiments using Grape 1.0 hardware:
  - Individuals: AD8Y, N8OBJ, AB4EJ
  - College clubs: W6BHZ, W3USR, K2MFF
  - Control station: W3LLA
- Pilot Campaigns Using Various Hardware:
  - WWV Centennial Festival of Frequency Measurement (October 2019)
  - June 2020 and December 2020 Eclipse Festivals

Our next experiment is the **Grape Circle Path**, a set of stations along an approximate shared bearing from WWV.

(Anyone here in Des Moines, IA?)

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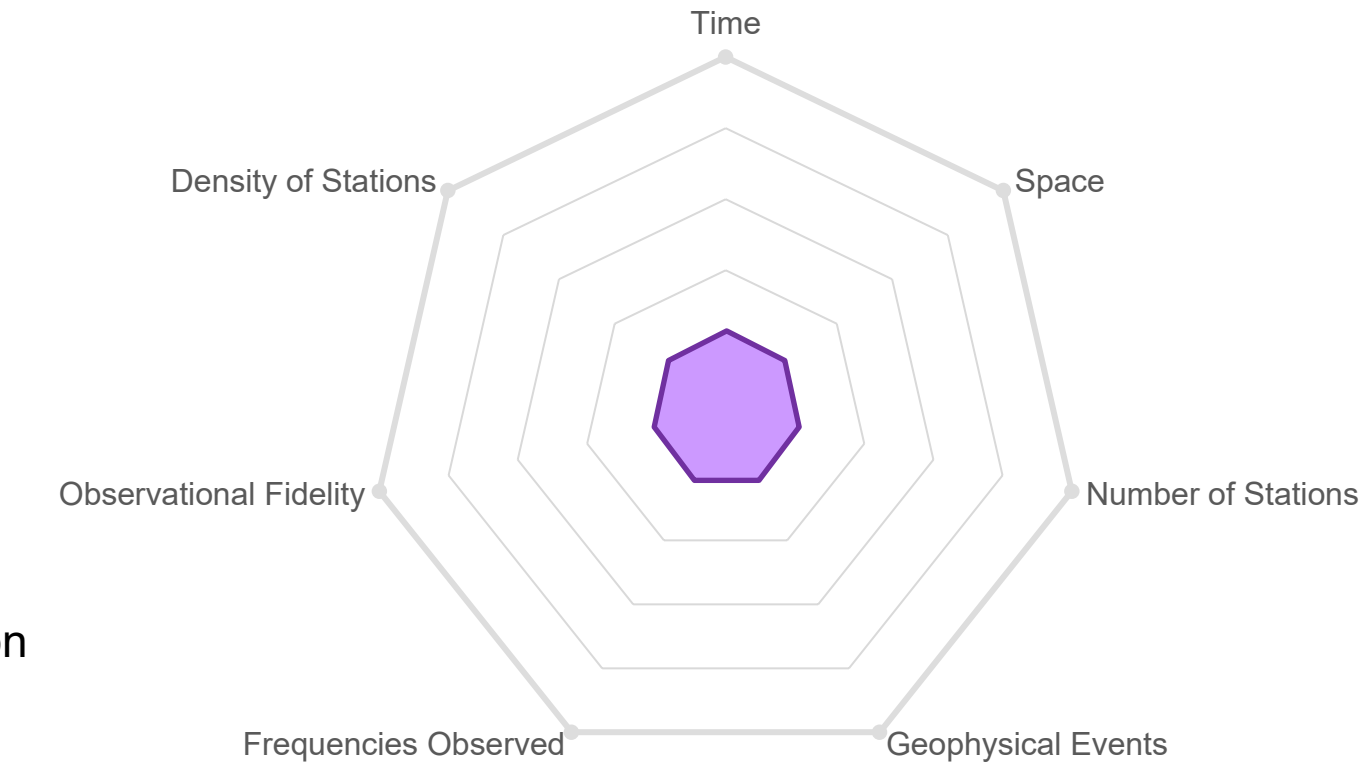
Comparing Datasets

Pilot experiments differ in terms of **scale, focus** and **fidelity.**

- Scale
  - Time
  - Space
  - Number of stations
- Focus
  - Geophysical events of interest
  - Frequencies observed
- Fidelity
  - Observational fidelity – bandwidth, precision
  - Density of stations

Each category is rated 1-10.

(*Disclaimer:* These visualizations are neither quantitative nor authoritative, but can help to highlight distinctions between experimental approaches.)



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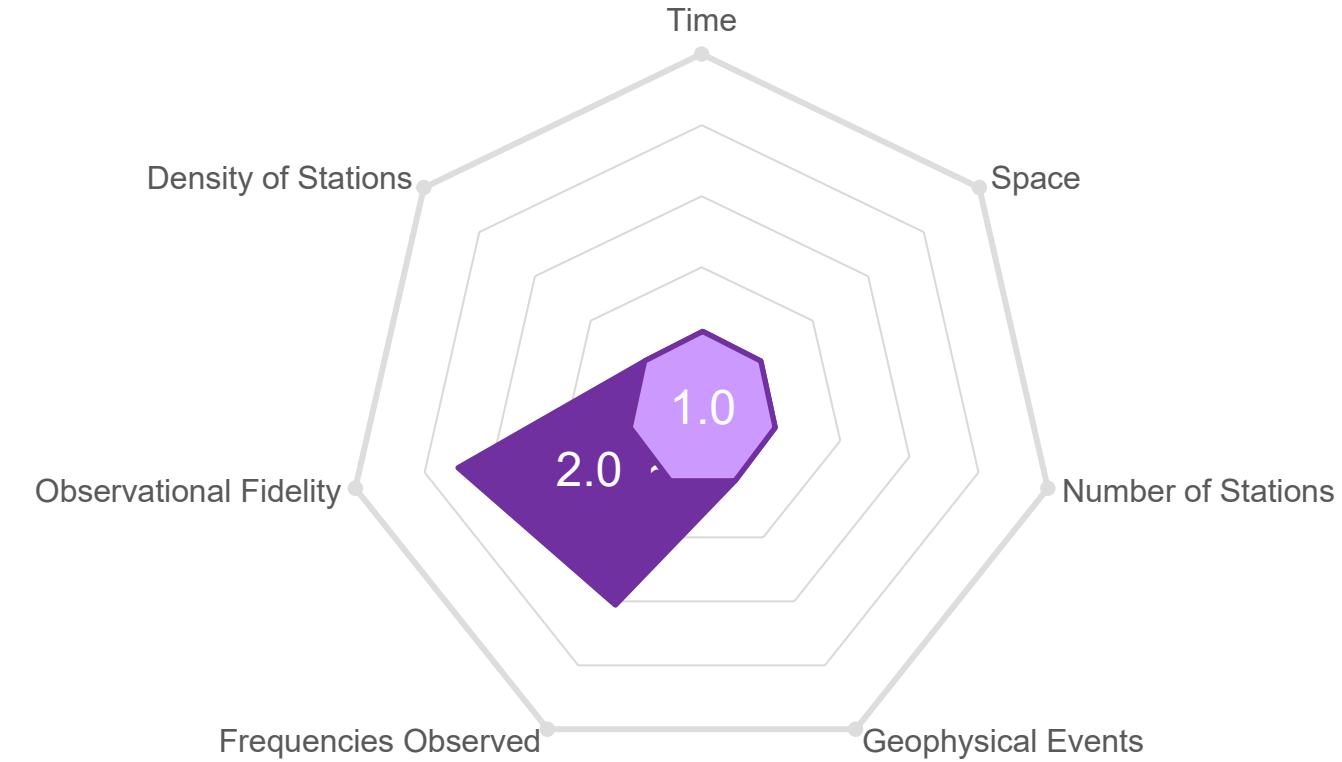
Grape 1.0 versus Grape 2.0

Grape 1.0 has **one channel**, whereas Grape 2.0 will have a full complement of **4**.

Grape 1.0 measures a **derived data product** (estimated frequency shift of the carrier). On Grape 2.0, the audio stream will be sampled at 8 kHz with a 16 bit A/D, recovering the upper **sideband** as well as the carrier on each channel and enabling us to monitor frequency splitting. All channels will sample simultaneously.



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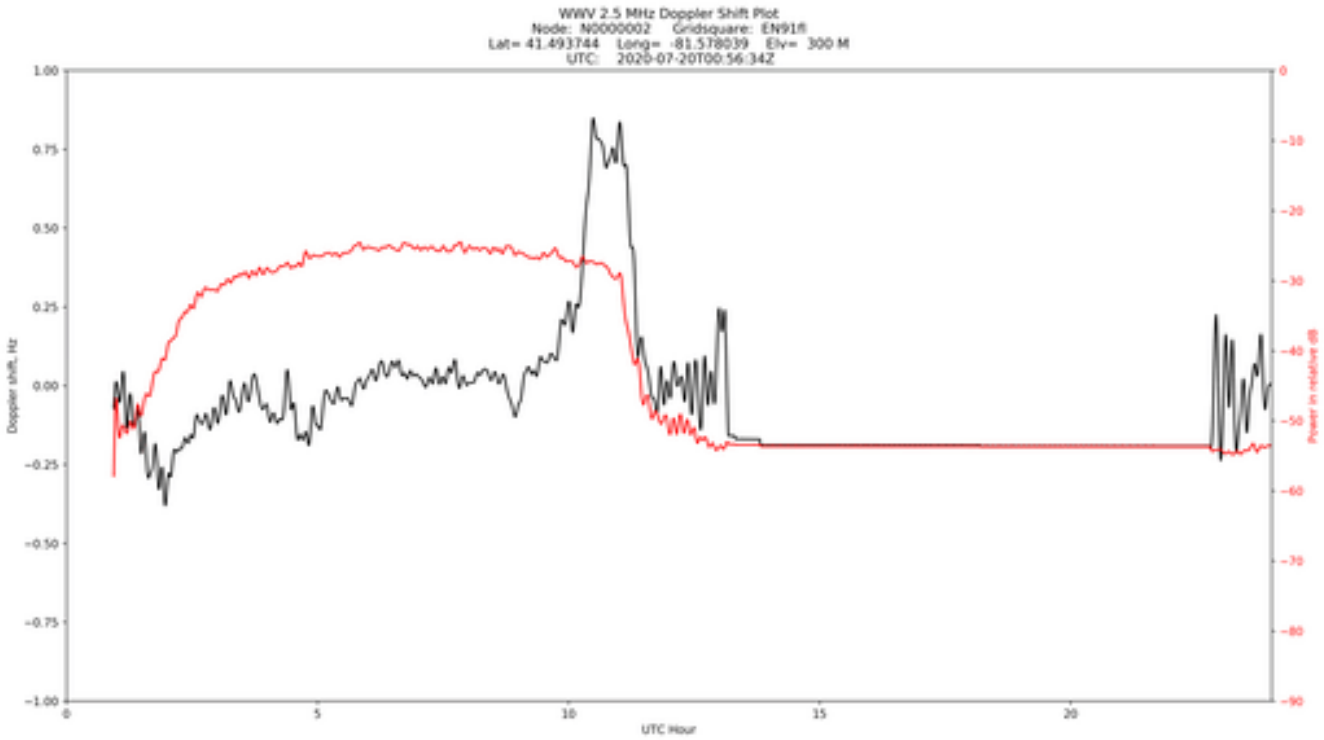
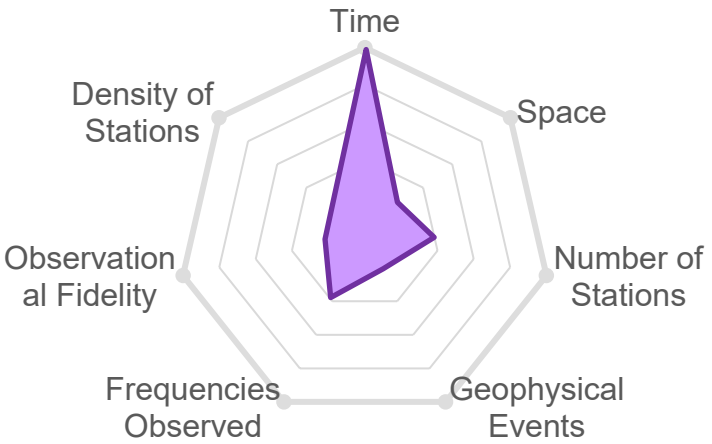
Time

Grape data from the past year is beginning to ferment.





https://www.youtube.com/watch?v=DvS7aWR4DC8

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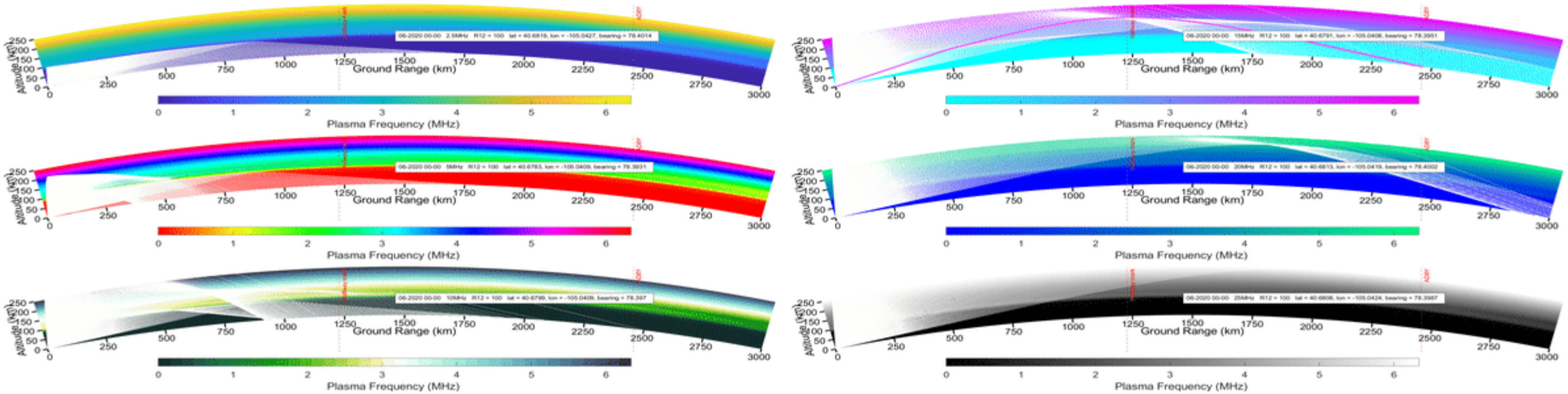
Multiple Frequencies

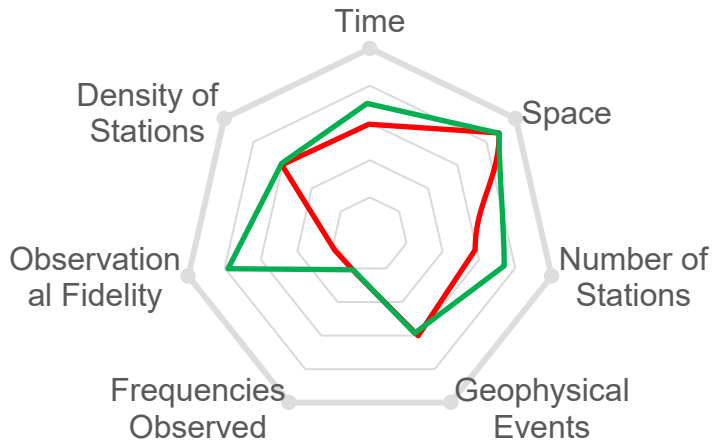
Different frequencies have different propagation characteristics:

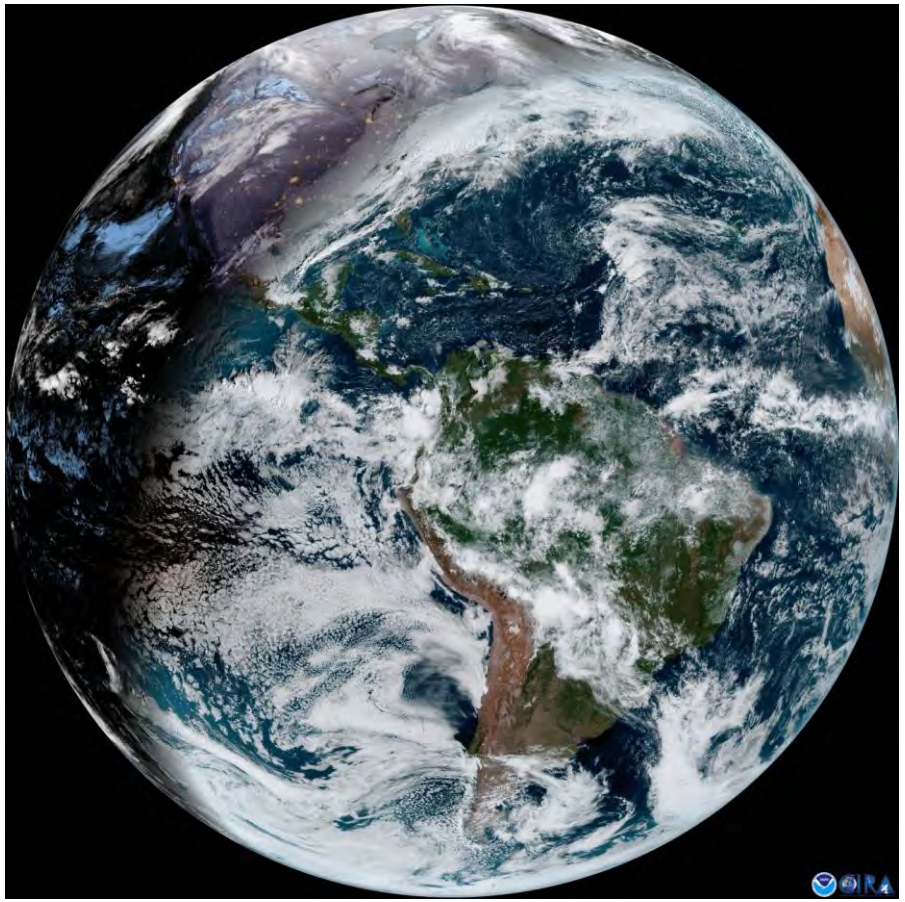


https://www.youtube.com/watch?v=b2qELLs7BRg

Improving Experiments

Thanks to all who participated in the June and December Eclipse Festivals. (3 days vs 8 days).





A time/space tradeoff exists.

Large experiments may be considered as containing small experiments within them – and vice versa.

https://hamsci.org/june-2020-eclipse-festival-frequency-measurement

https://hamsci.org/december-2020-eclipse-festival-frequency-measurement

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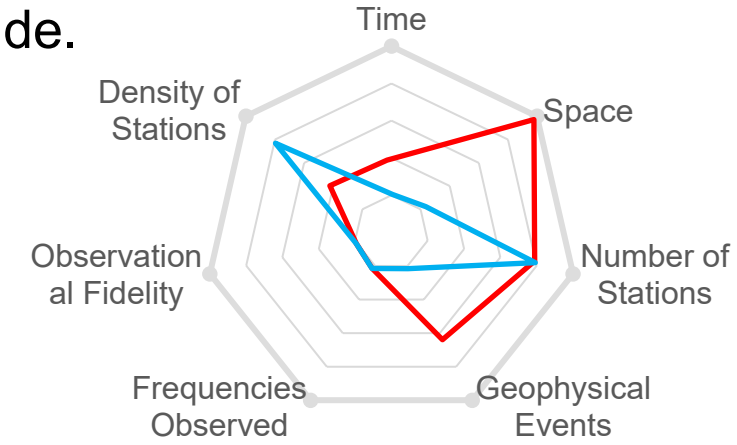
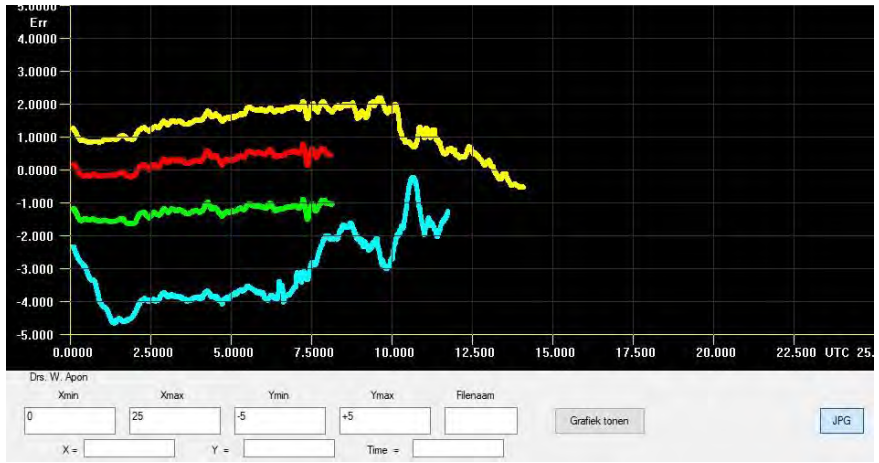
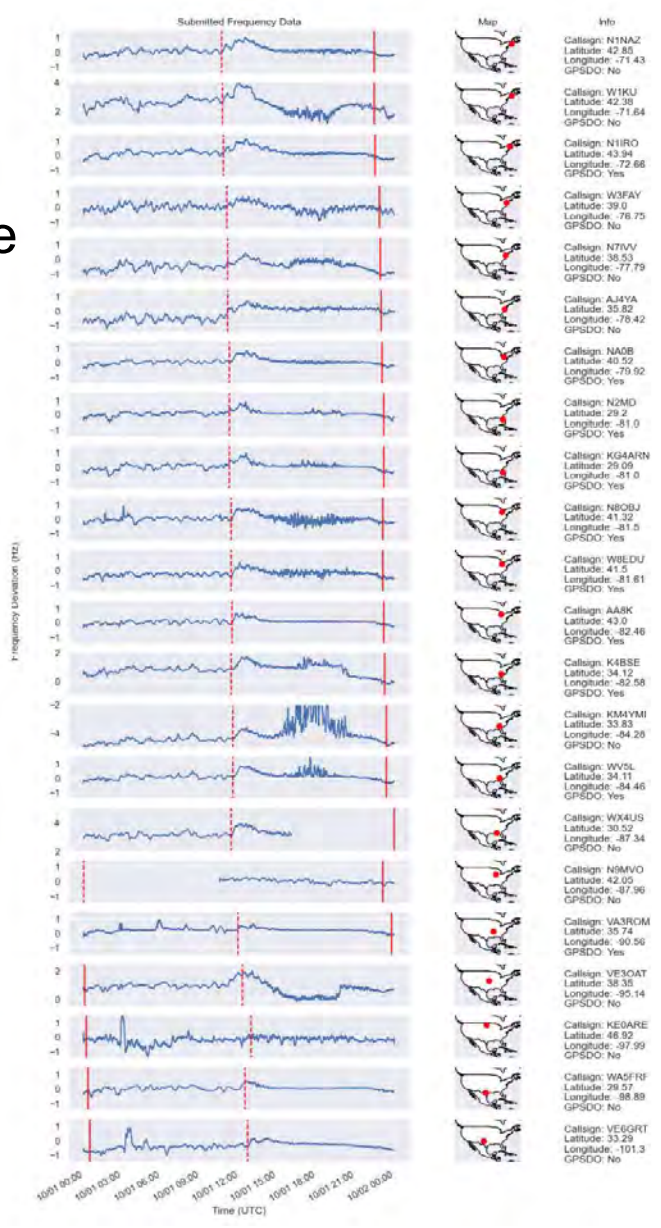
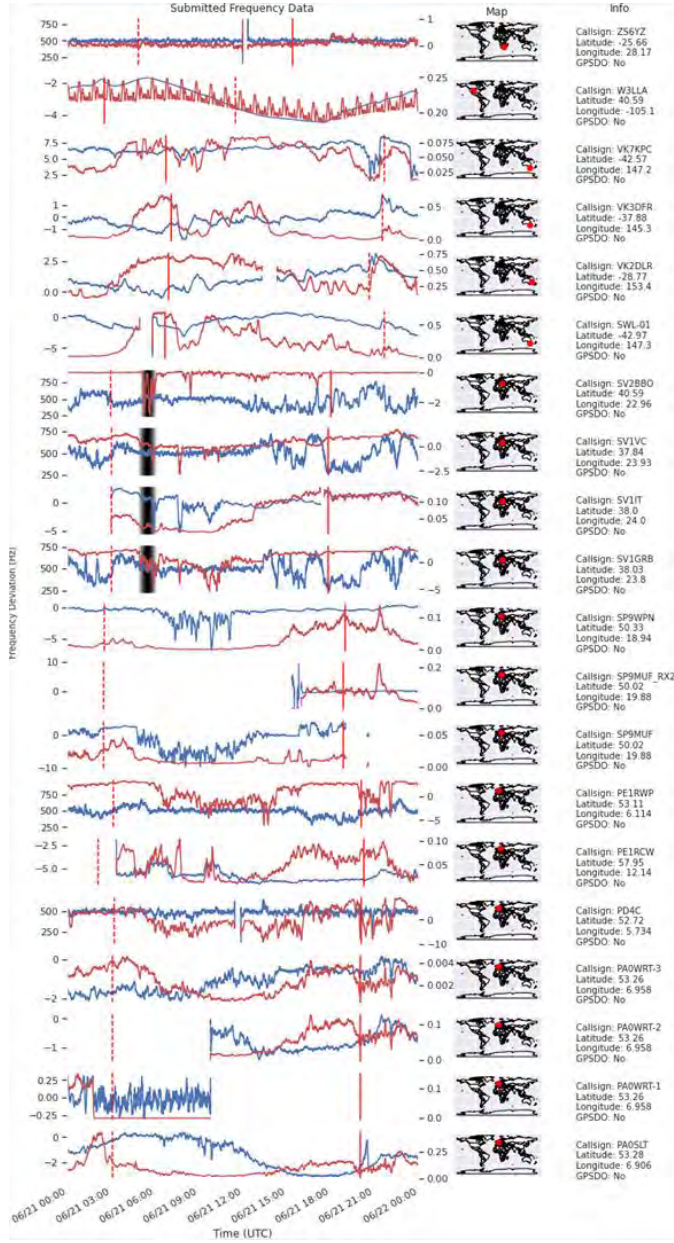
Density of Stations

The WWV FFM had 45 stations in CONUS; the June 2020 Eclipse Festival had 50 stations worldwide.









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Next Steps

- Moving to Grape 2.0 (see: N8OBJ)
- Continuing long-term data collection
- Connecting theory and observation (see: WA5FRF, etc)
- Creating more targeted long-term experiments (Grape Circle)
- Creating more dynamic citizen science experiments (see: Co-Design session)

….and now, N8OBJ.

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