PERSONAL SPACE WEATHER STATION NETWORK RESEARCH & DEVELOPMENT UPDATE

HAMSCI WORKSHOP, MARCH 2026

TRAVIS ATKISON, UNIVERSITY OF ALABAMA

CHRISTIAN HIRSCHEY, UNIVERSITY OF ALABAMA

GAVIN WARD, UNIVERSITY OF ALABAMA

WILLIAM ENGELKE (BILL), UNIVERSITY OF ALABAMA, AB4EJ

TODAY'S TOPICS

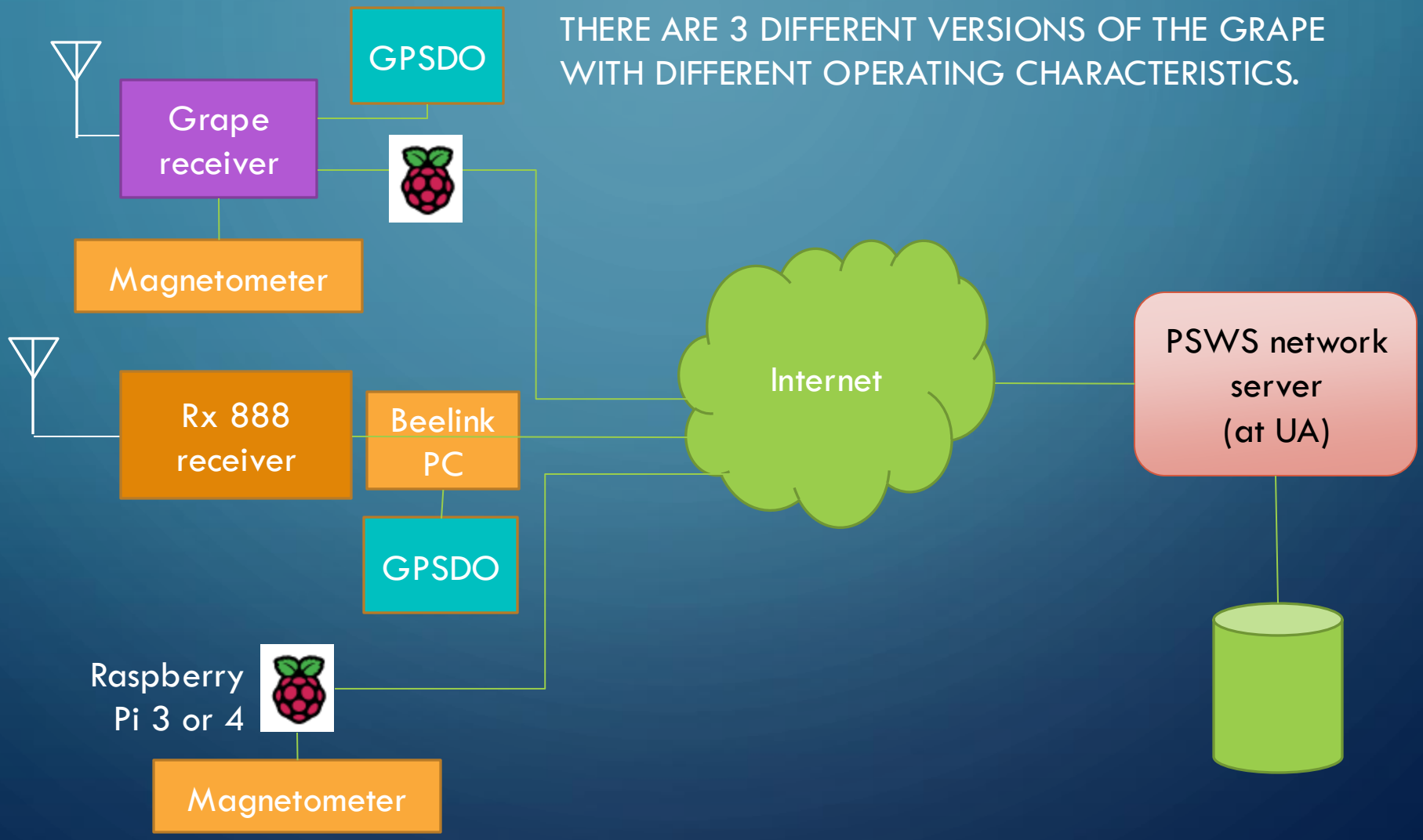
- About the Personal Space Weather Station Network
  - Objective: to use Amateur Radio for serious science;
  - For example, what are all the causes of waves in the ionosphere? Can we forecast signal fading (QSB)? Can we improve propagation forecasting? How far in advance can we forecast impacts of solar flares & coronal mass ejections? How do these phenomena affect GPS accuracy and communication with aircraft outside VHF range?
- How we collect data
- How we are organizing and analyzing this data
- Overview of new ideas being considered (charette results)

STUDYING IONOSPHERIC ACTIVITY USING DOPPLER SHIFT (NSF SPONSORED)

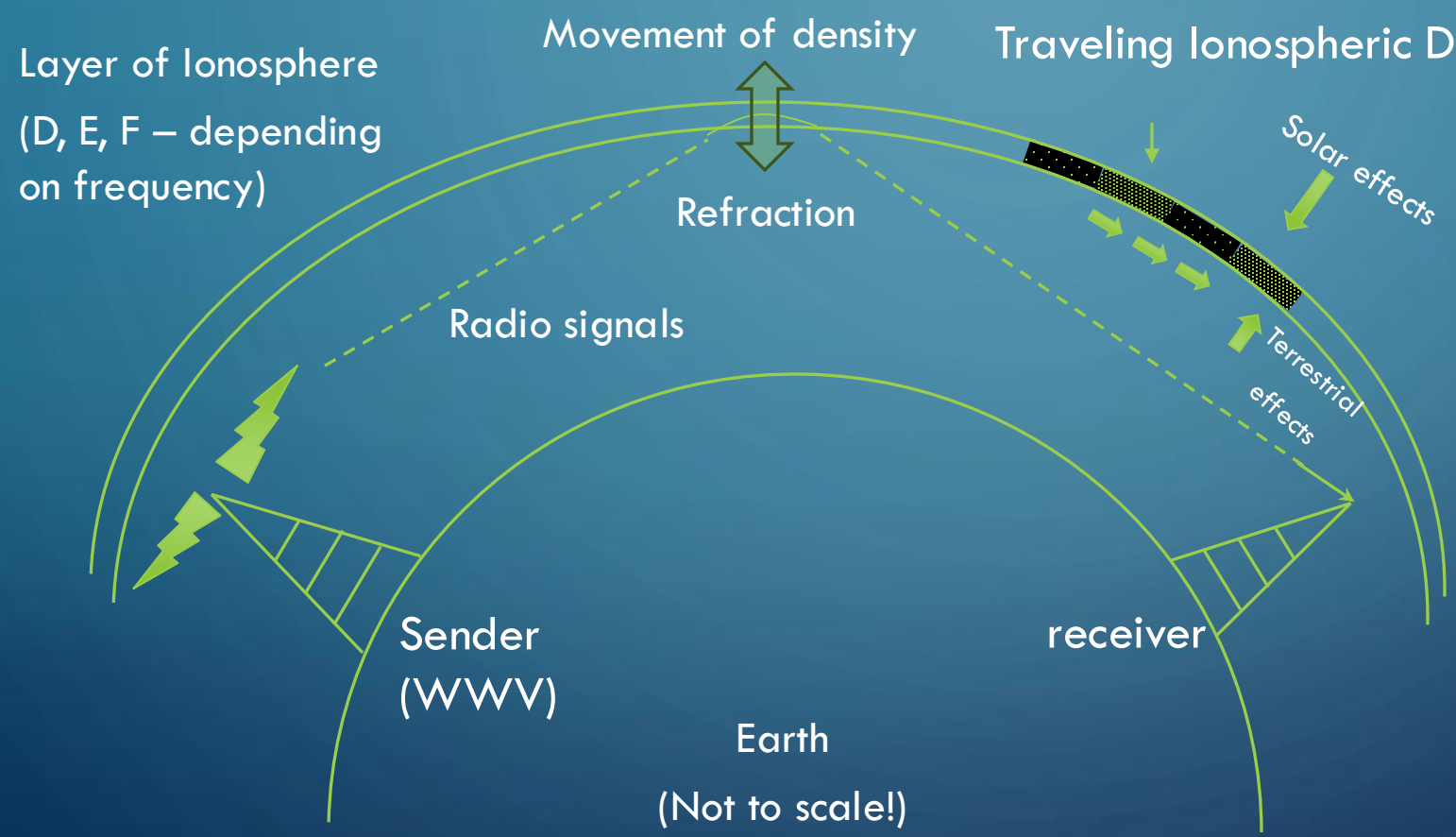
- WWV – located in Boulder, Colorado - transmits highly stable carriers on 2.5, 5, 10, 15, 20 and 25 MHz
- By using GPS-disciplined clock we can see tiny frequency variations caused by movement in ionosphere
- Can study in combination with magnetometer output, satellite data, etc.
- Can triangulate directions of Traveling Ionospheric Disturbances (that is, plasma density waves) using multiple stations

HAMSCI/PSWS DATA COLLECTION NETWORK

THERE ARE 3 DIFFERENT VERSIONS OF THE GRAPE WITH DIFFERENT OPERATING CHARACTERISTICS.



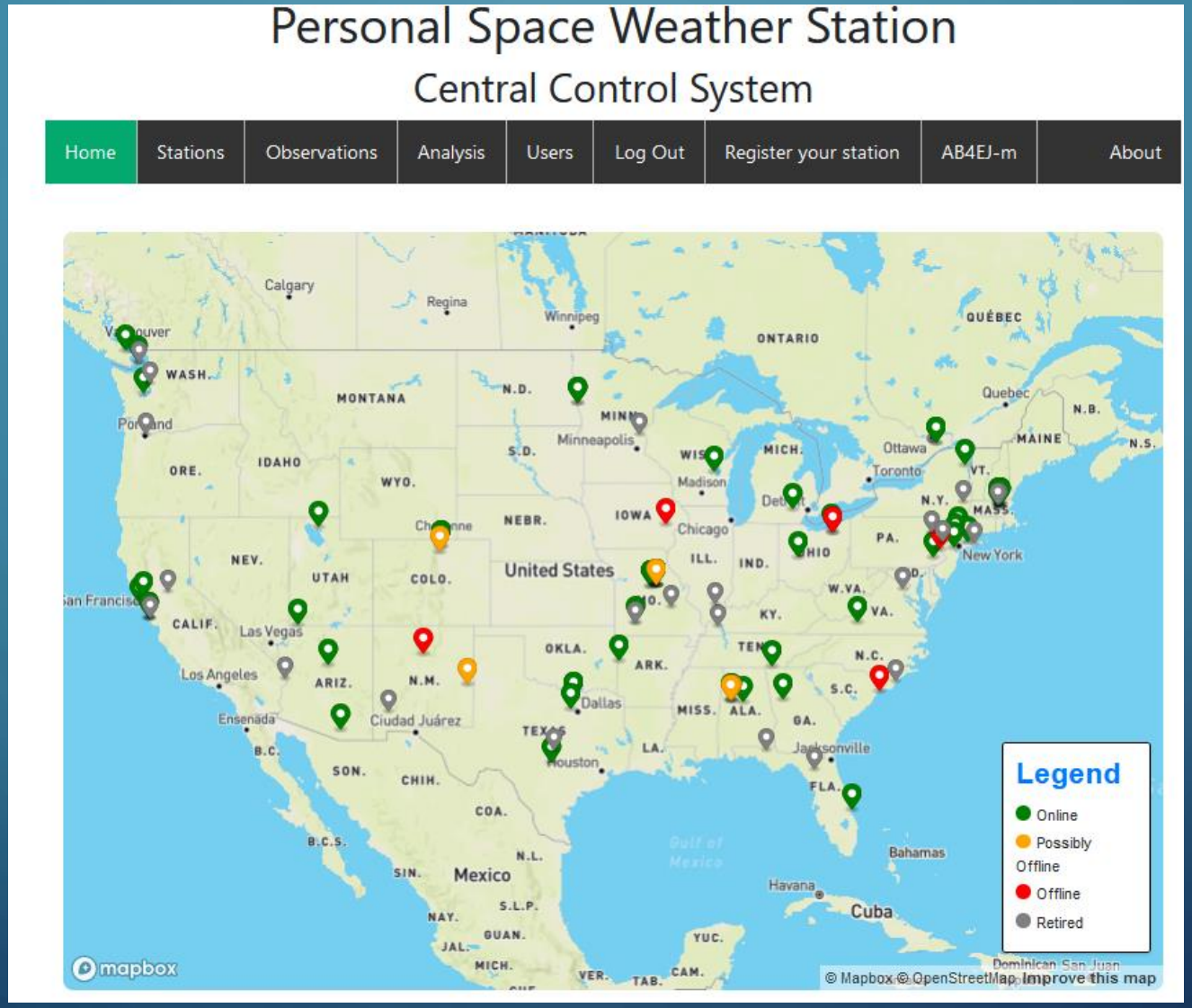
HOW THESE SYSTEMS WORK



Refraction varies according to plasma density, which moves by solar effects (EUV), polar vortex, solar storms, thunder storms, geomagnetic effects and other phenomena; all of which vary by RF frequency

Image credit: Kristina Collins, KD8OXT, Case Western Reserve University

Current stations include North America, Alaska, New Zealand, Northern Canada, Antarctica, Europe. Looking for more locations.



https://pswsnetwork.eng.ua.edu

WORKINGS OF THE NETWORK

- All the active stations daily upload an observation (24 hours of spectrum data), on one to nine bands
- The PSWS server catalogs and cross-references each observation, and also creates a “waterfall” plot for visualization
- Some stations also have a magnetometer to observe geomagnetic variations; these are also catalogued and plotted.

Personal Space Weather Station

Central Control System

Observations

Home | Stations | Observations | Analysis | Users | Log In | Register your sta | About

☰ Open Filter | To download observation data, click on File/Observation link. Please be pati may take a whil p a large observation.

Data rate	Center Frequency	Station	Instrument	Size (MB)	File/Observation	Plot	Start (UTC)	End (UTC)
1	—	KV0S	Mag_rev_E	0.8334	OBS2024-03-12T00:00.zip		2024-03-12 00:00:00	2024-03-12 18:57:00
1	—	AB4EJ-FlexRadio	Magnetometer2	0.2994	OBS2024-03-12T00:00.zip		2024-03-12 00:00:00	2024-03-12 17:15:00
10	10.000 MHz	N6RFM/5	Grape v1.12	5.3423	OBS2024-03-12T00-00		2024-03-12 00:00:00	2024-03-12 14:27:00
10	15.000 MHz	ve3gtc	receiver1	17.1915	OBS2024-03-12T00-00		2024-03-12 00:00:00	2024-03-12 12:03:00
10	10.000 MHz	AA6BD	AA6BDGrape1	34.1748	OBS2024-03-11T00-00		2024-03-11 00:00:00	2024-03-12 00:00:00
10	10.000 MHz	W0ECC	W0ECC-GrapeA	34.1744	OBS2024-03-11T00-00		2024-03-11 00:00:00	2024-03-12 00:00:00
10	10.000 MHz	N6RFM/5	Grape v1.12	34.1752	OBS2024-03-11T00-00		2024-03-11 00:00:00	2024-03-12 00:00:00
10	10.000 MHz	WPHAM	Grape1 PSWS	34.1750	OBS2024-03-11T00-00		2024-03-11 00:00:00	2024-03-12 00:00:00

1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | ... | 1010 | next »

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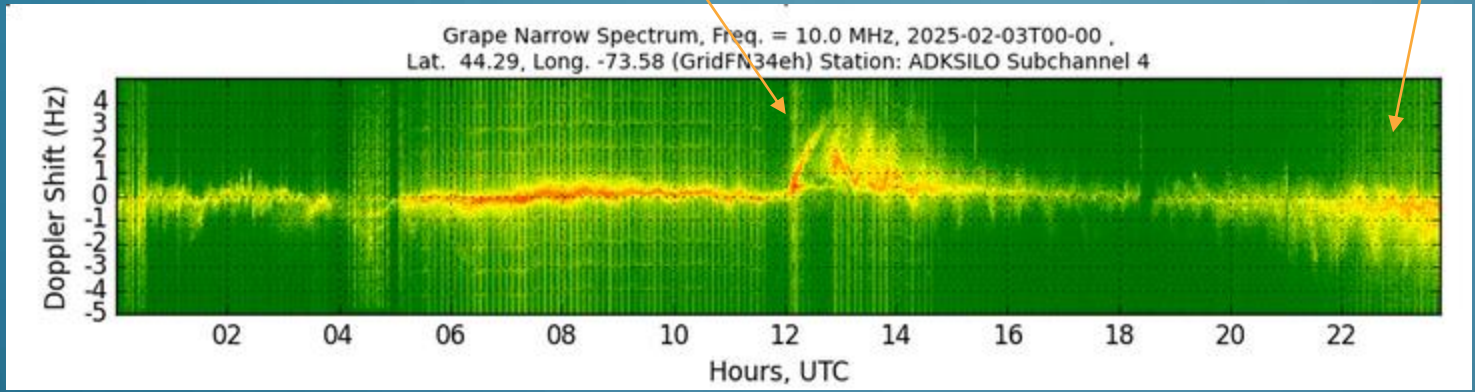
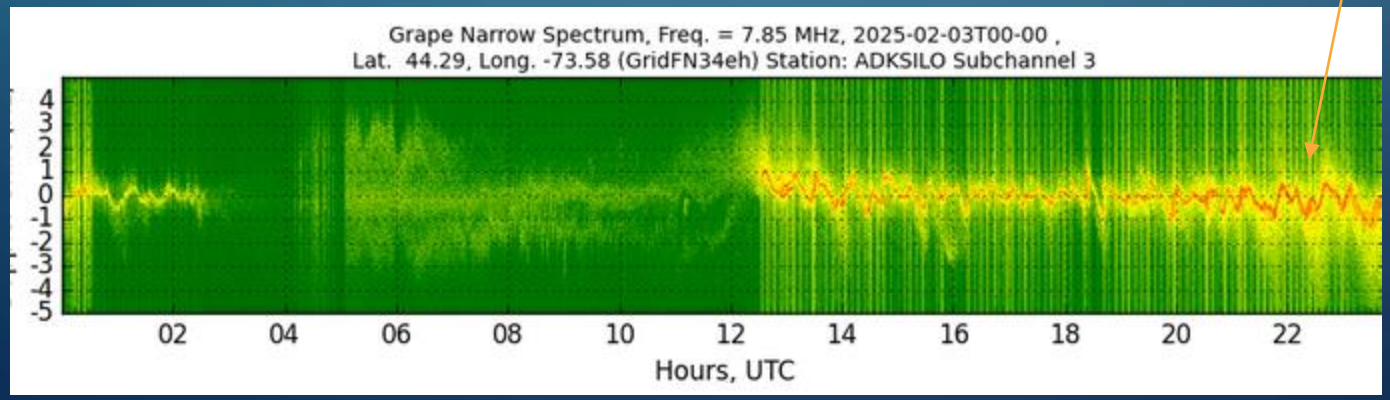
SUNRISE

SUNSET



Sunrise moves plasma density down (closer to Earth): positive Doppler shift. During sunset, plasma density moves away from Earth, creating negative Doppler shift.

TIDs



We can see short and medium scale TIDs (waves in the plasma density) – this is what causes rapid signal fading (QSB)

PSWS DOWNLOAD API (V1.0)

- Endpoint: GET https://pswsnetwork.eng.ua.edu/observations/downloadapi/
- Required: start_date + end_date (YYYY-MM-DD) + location filter
- Location Filters: station_id (ex. S000028) or lat_min/max, lon_min/max
- Optional: instrument_id, frequency (MHz)
- Example Usage: curl/wget "https://pswsnetwork.eng.ua.edu/downloadapi/?station_id=S000028&instrument_id=31&start_date=2024-01-01&end_date=2024-01-01"
- More Documentation Available at https://pswsnetwork.eng.ua.edu/about/
- Usage will change when the Heliophysics API (HAPI) is deployed

UPGRADES TO REPOSITORY (PSWS)

- Heliophysics API (HAPI) for improved data downloading (#8, 21,27) * SEE POSTER ABOUT THIS
- VLF subsystem (#24) – Jonathan Rizzo KC3EEY
- Data Quality & Database Query Systems(#4,5,6,9)
- Improved System Registration/key management(#15)*
- Map filtering(#16)* + UI enhancements
- Watchdog enhancements/Grape 2 data (#32)*

SUBPROJECTS WITH ASTERISK (*) ARE IN PROGRESS

IDEAS FOR NEW WAYS OF ANALYSIS

- GNU-radio source block to pull PSWS data into flowgraph(#12)
- Python API for Doppler, level & Freq. spread(#19)
  - Related to HAPI
- WWV/WWVH disambiguation(#25) *
- Sensor integration: can use magnetometer, Doppler shift, and spot data together (#31)
- Field strength estimation/calibration(#11)

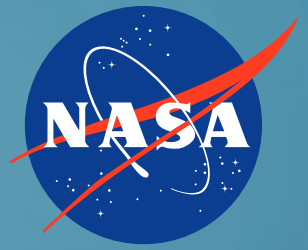
NEW VISUALIZATION IDEAS

- Sonification: another way to understand data(#22)
- Real-time spectrograms of SDRs in network(#20)
- Feature Annotation for use with plots(#10)
- Accessibility(#26)

COORDINATION/LOGISTICS

- Helpdesk/ticketing system(#14)*
- Organize top-level info about HamSCI(#13)*
- HamSCI in Romania + Europe & elsewhere(#17,18)

Q & A



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- Thanks to George Mason University and Johns Hopkins Applied Physics Lab for support in HAPI development.

- W. Engelke – bengelke@cs.ua.edu