



Gnuradio, Citizen Science, and Red Pitaya

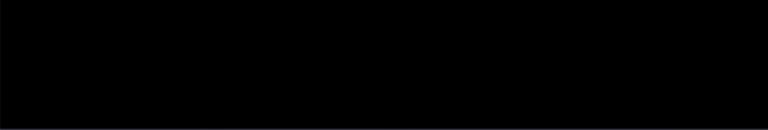
Robert W McGwier, PhD

11/14/2017

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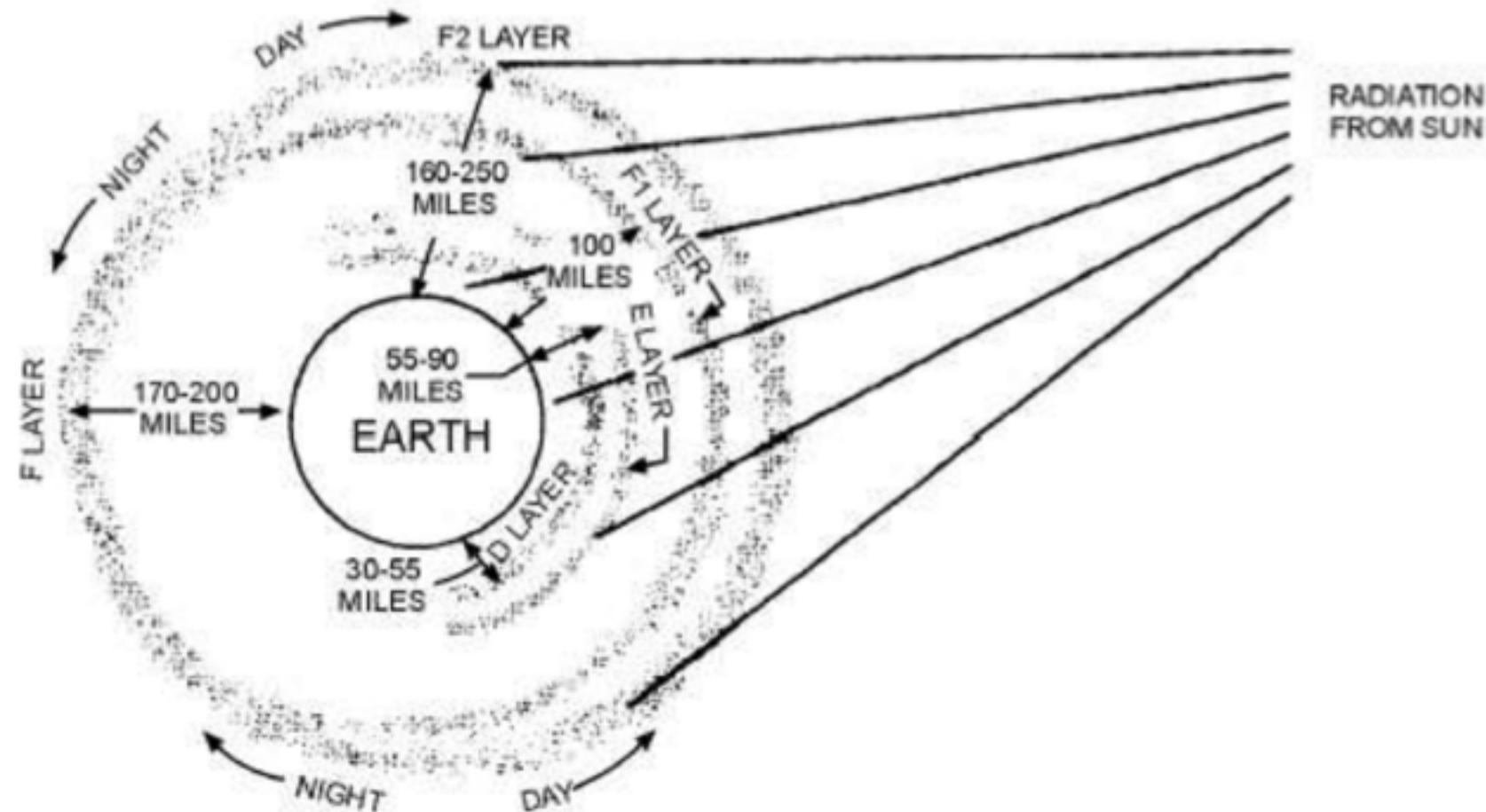
Ted and Karyn
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HF Propagation

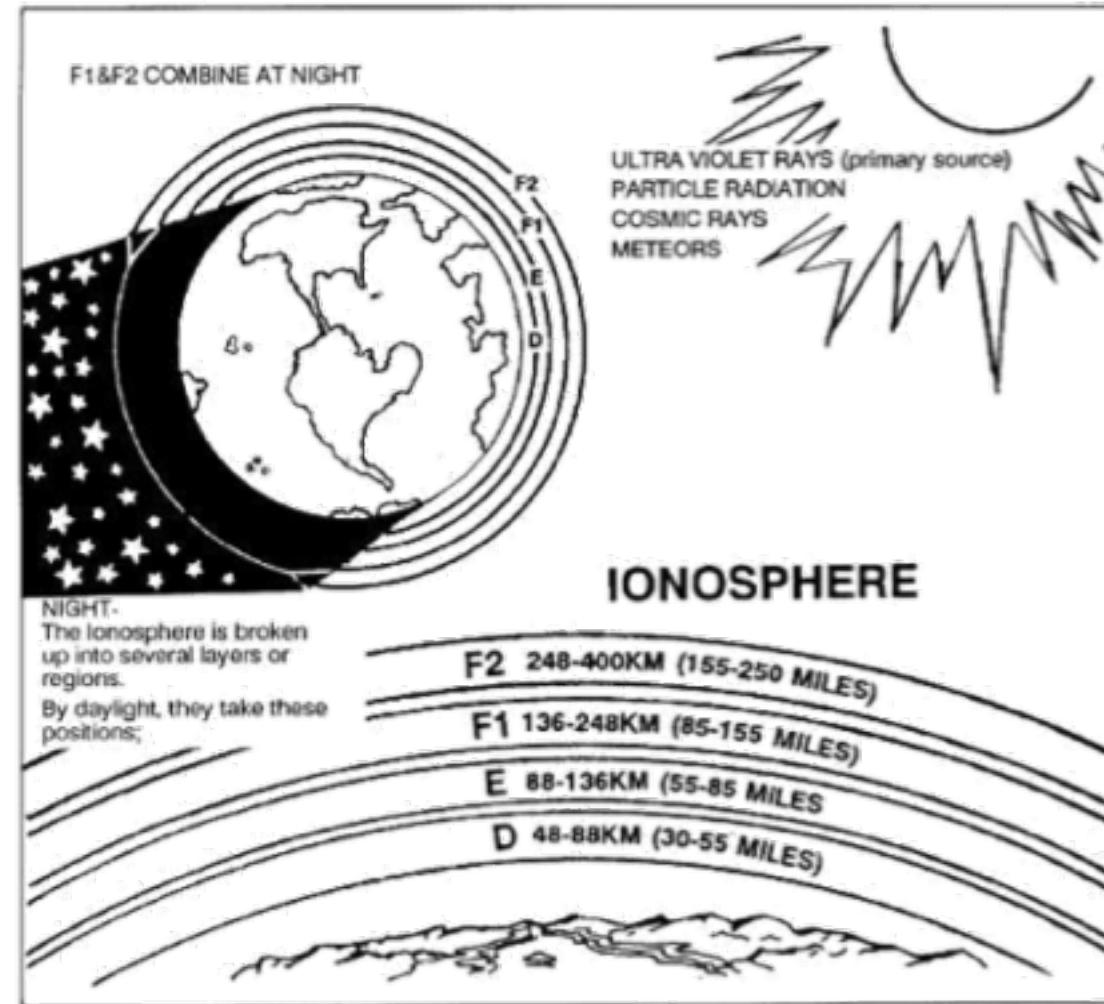
A quick look at how it all works

Simple model of the ionosphere (Carl, K9LA)

- http://k9la.us/The_Structure_of_the_Ionosphere.pdf

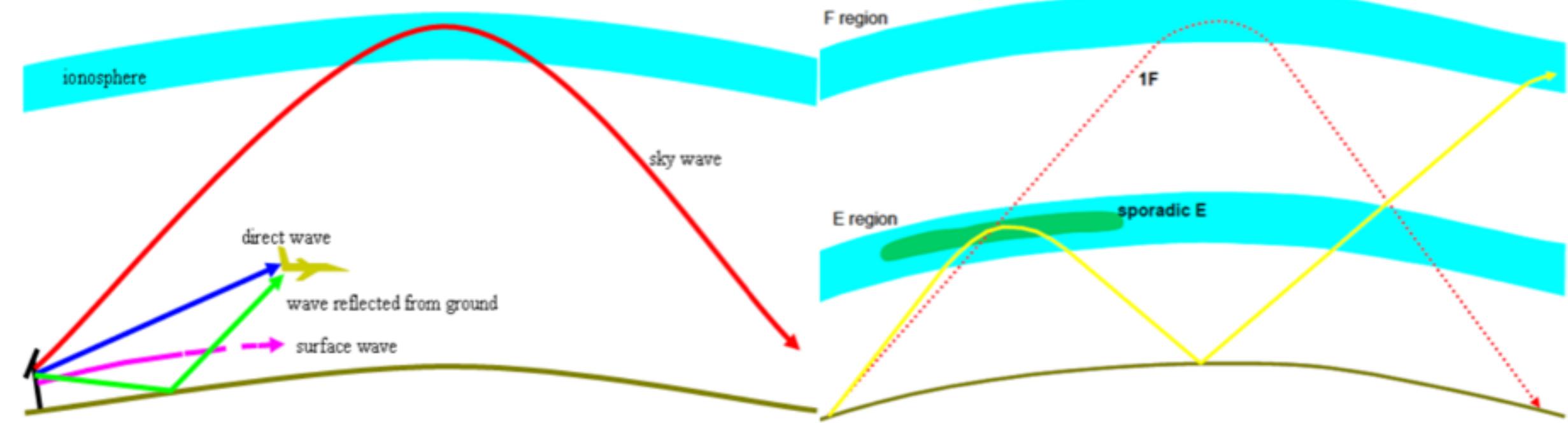


Ionosphere, another view



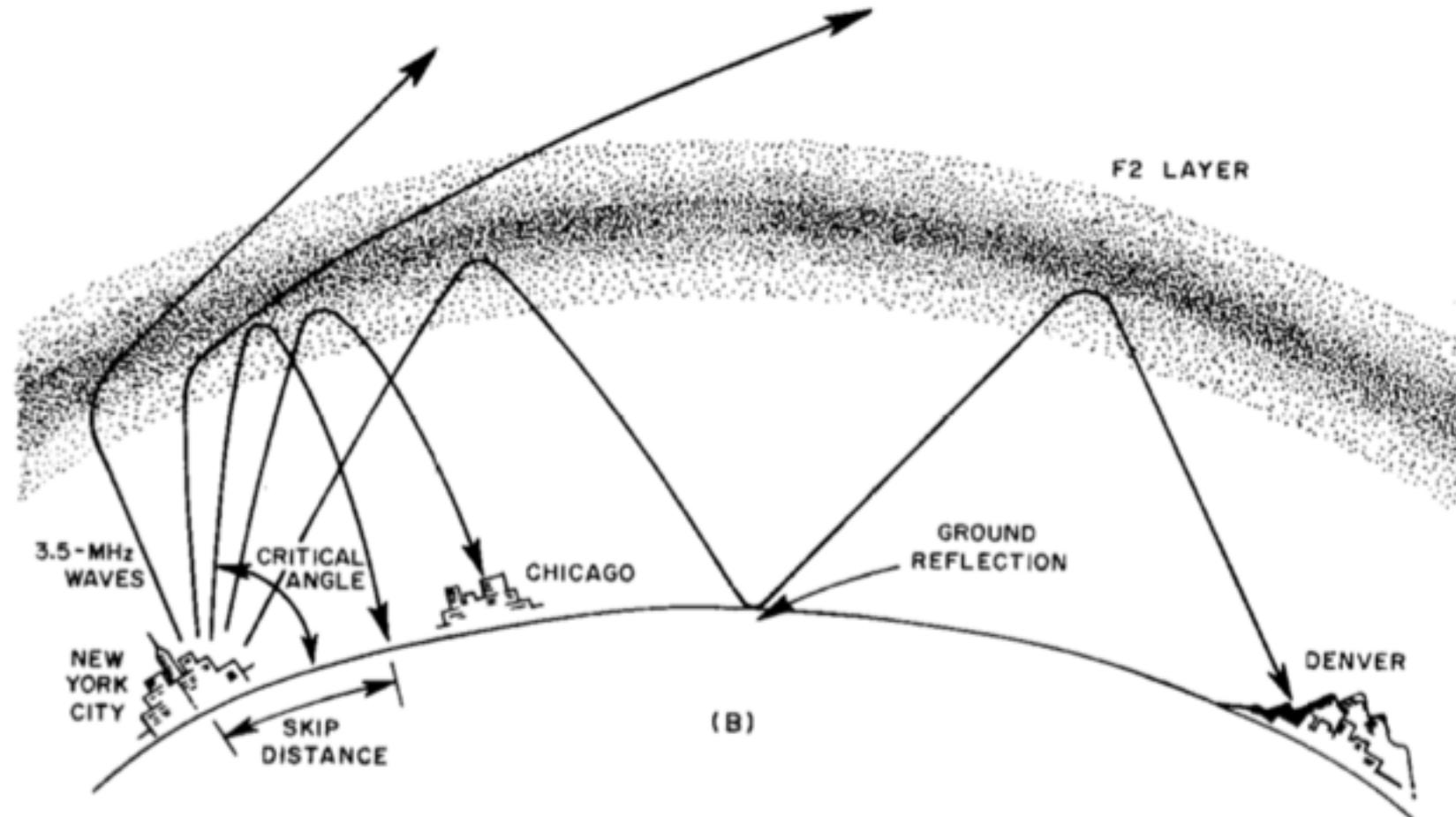
Graphic: Nathaniel Frissell, NJIT

Radio Propagation via Ionosphere (Aus. Gov.)



Recommend: <http://www.sws.bom.gov.au/Educational/5/2/2>

Oblique Propagation (Skip)





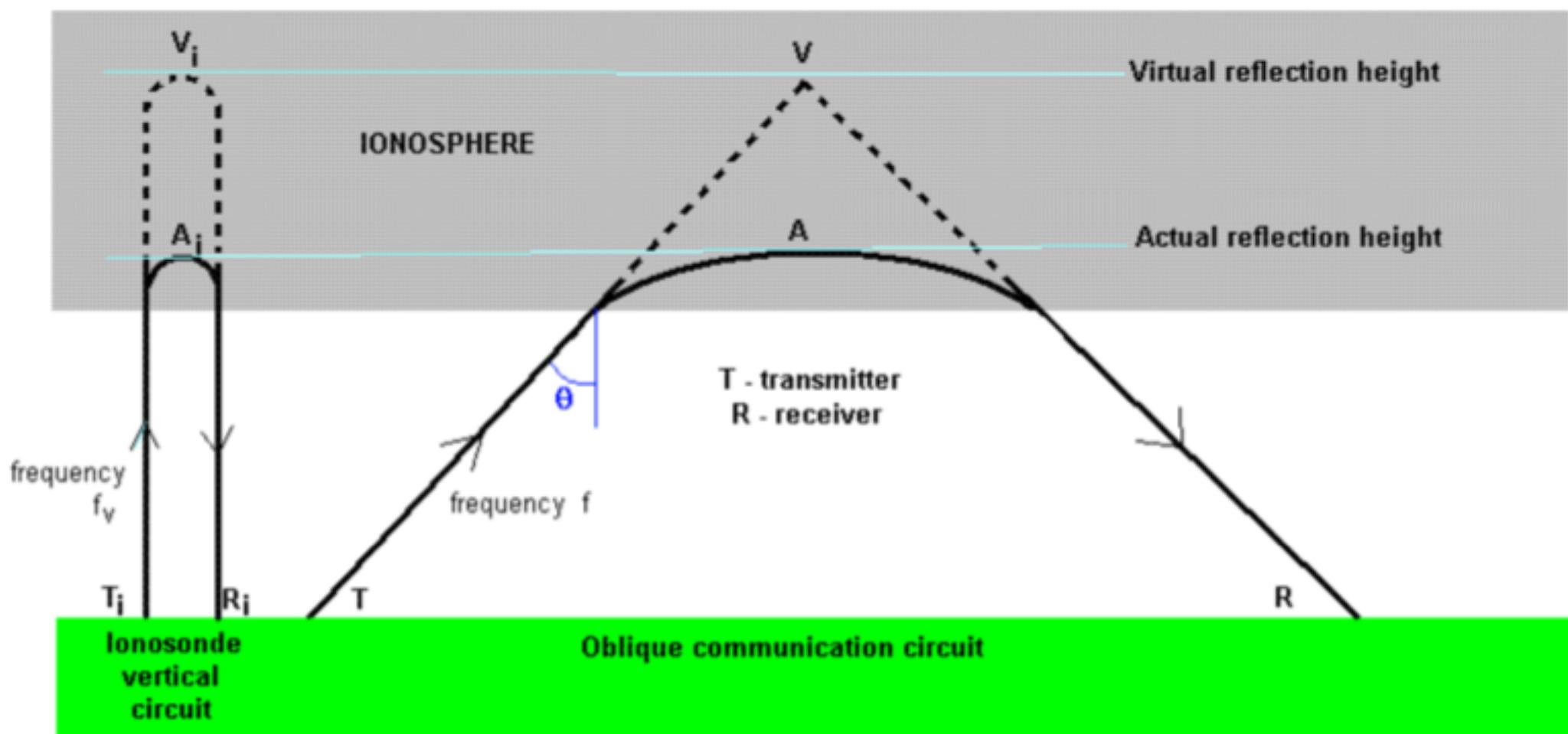
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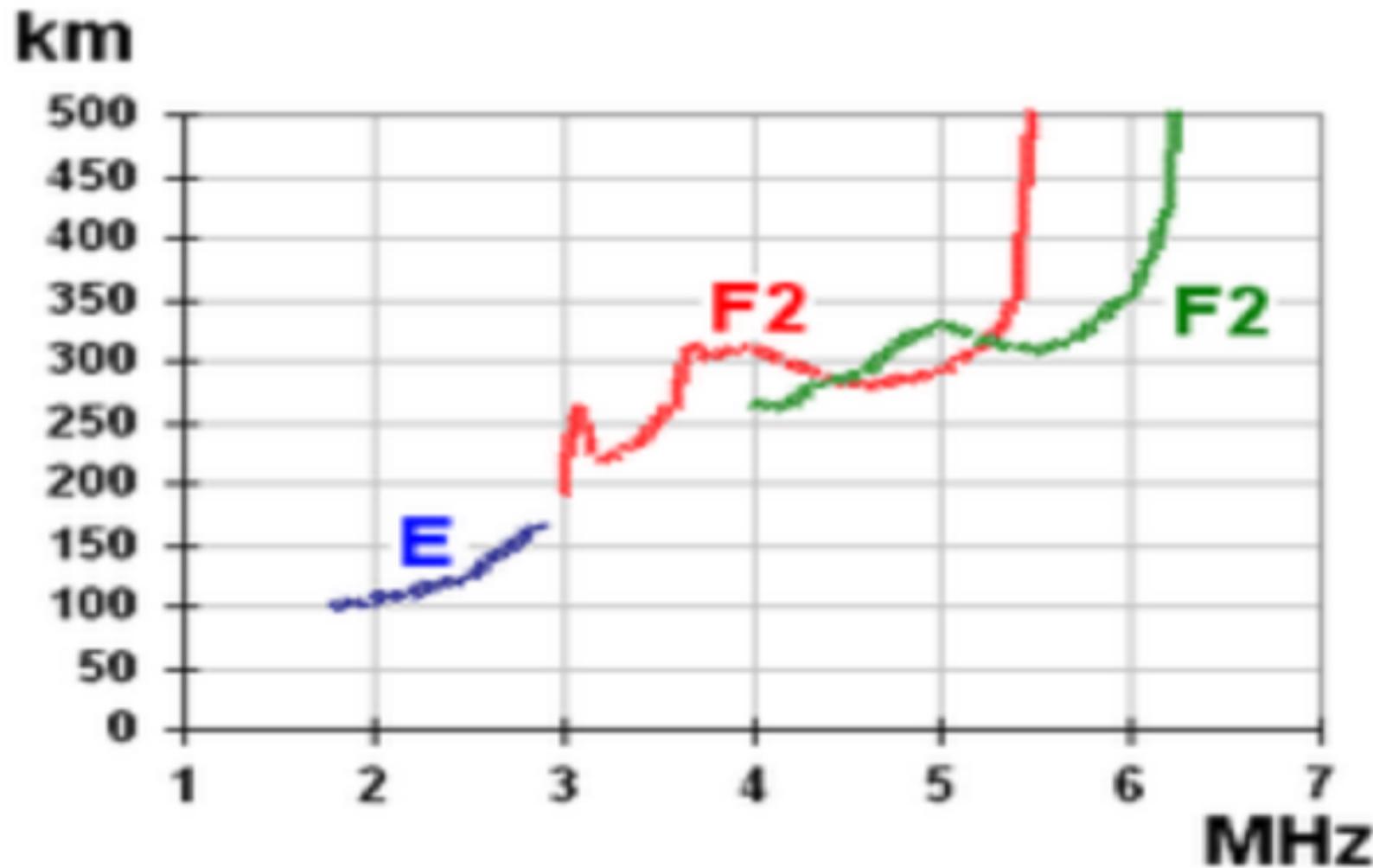
Ionosonde

HF ionospheric radar

Two simple views of an ionosonde in action



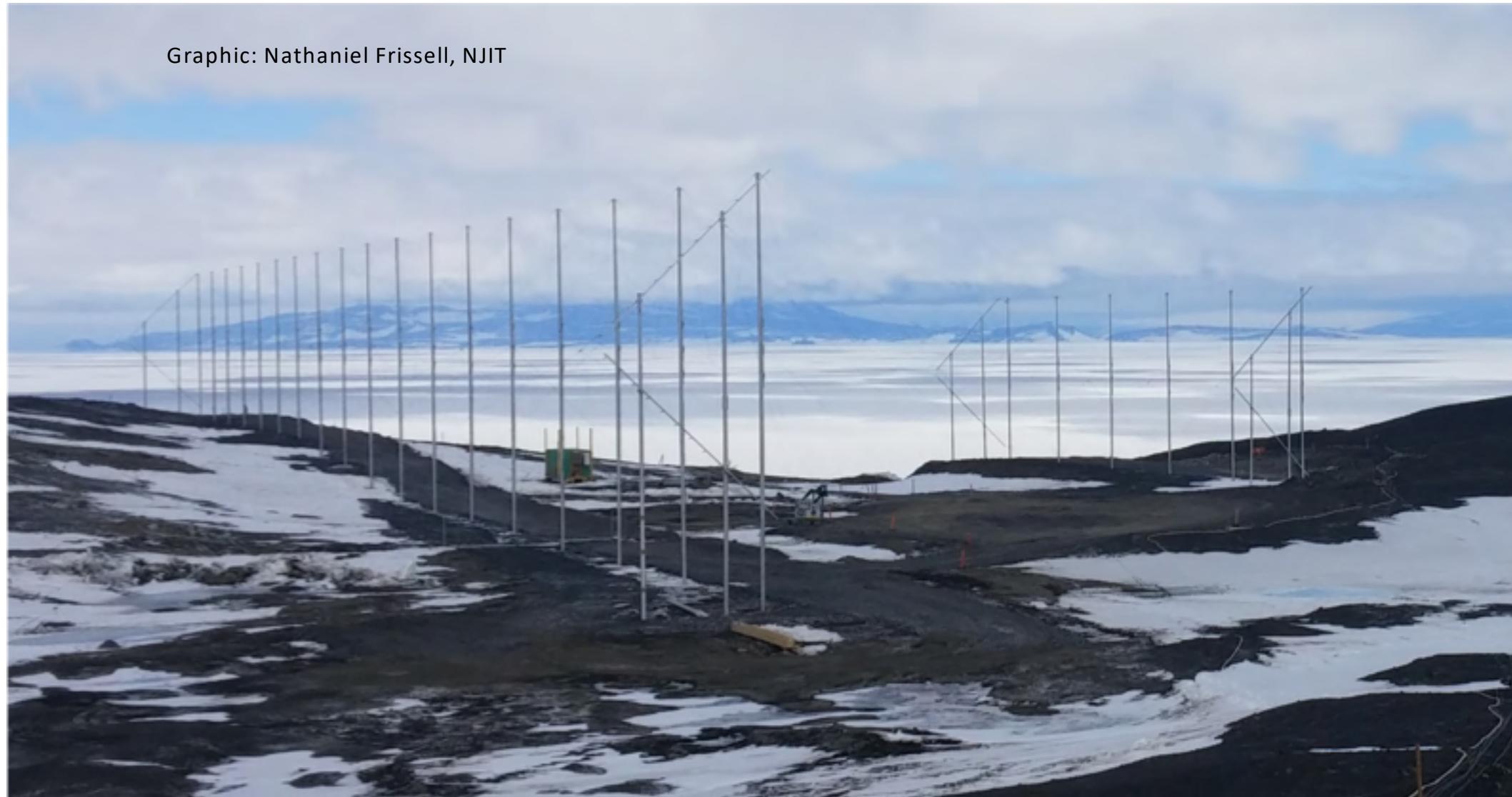
What kind of data do we get from ionosonde?



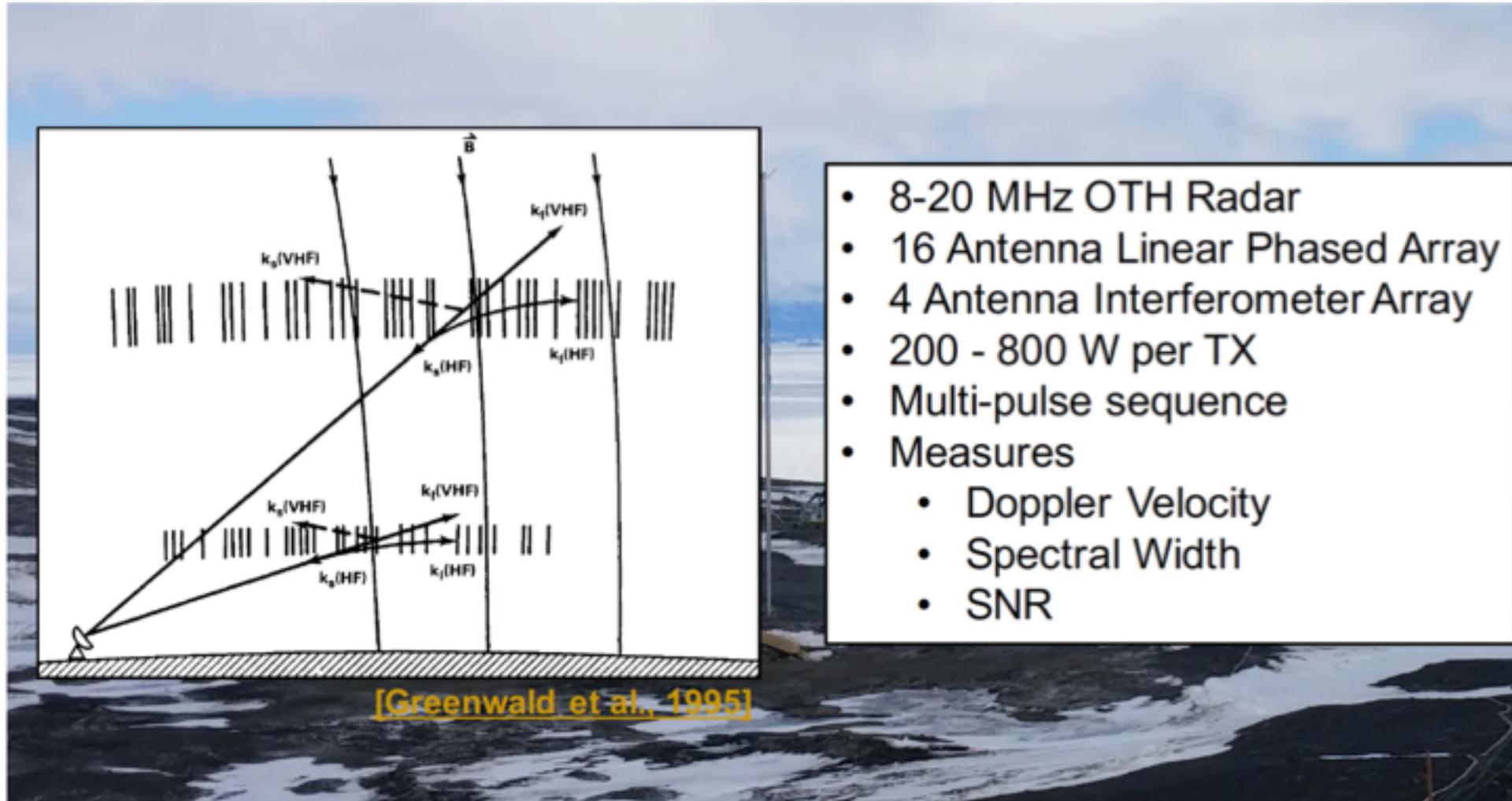
Super Dual Auroral Radar Network (SuperDarn)



Graphic: Nathaniel Frissell, NJIT



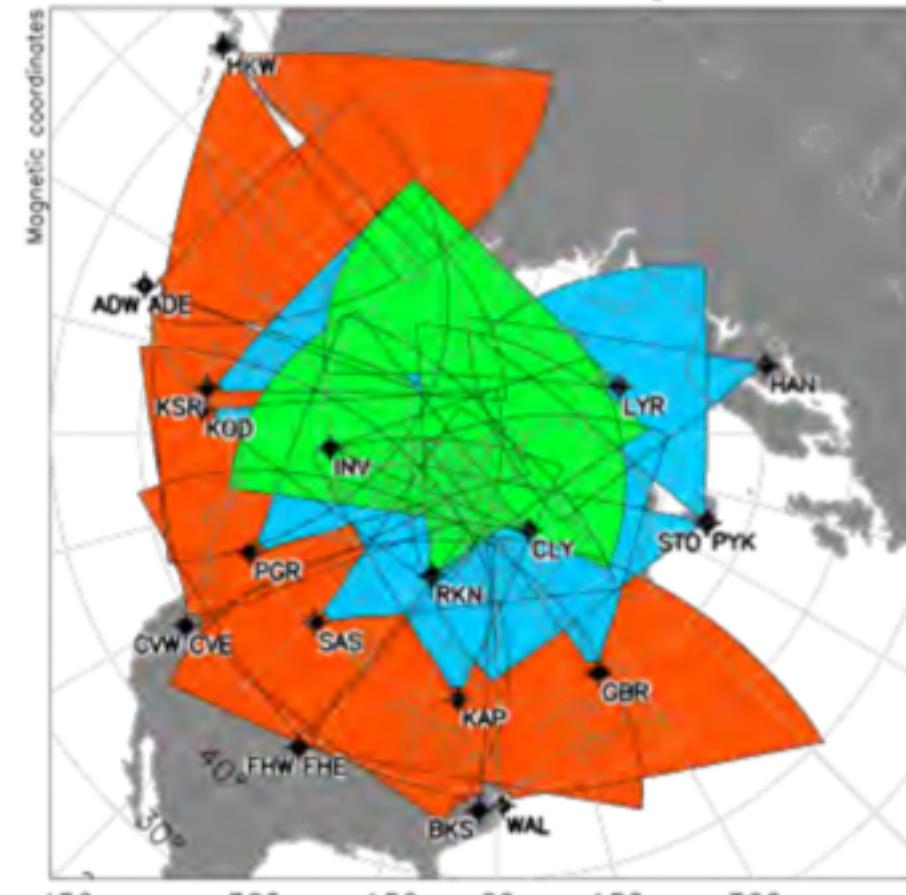
SuperDARN details



SuperDARN Radar, McMurdo Station Antarctica

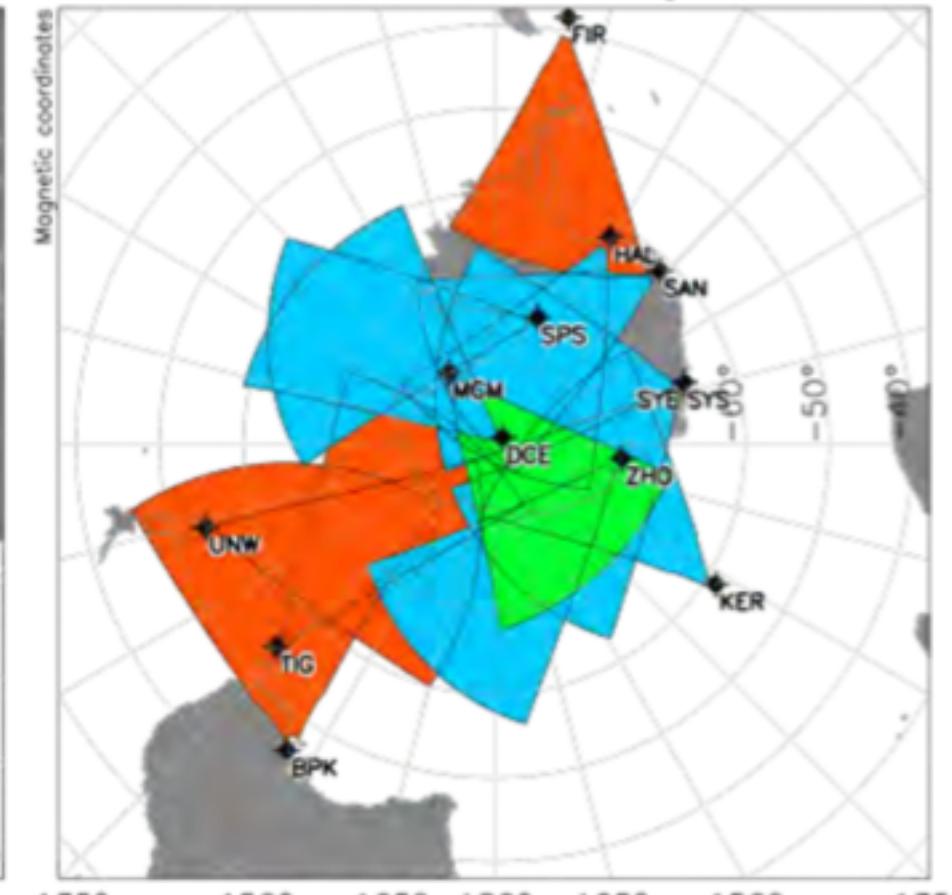
Photo N. Frissell, 2014

Northern Hemisphere



High-latitude

Southern Hemisphere



Mid-latitude

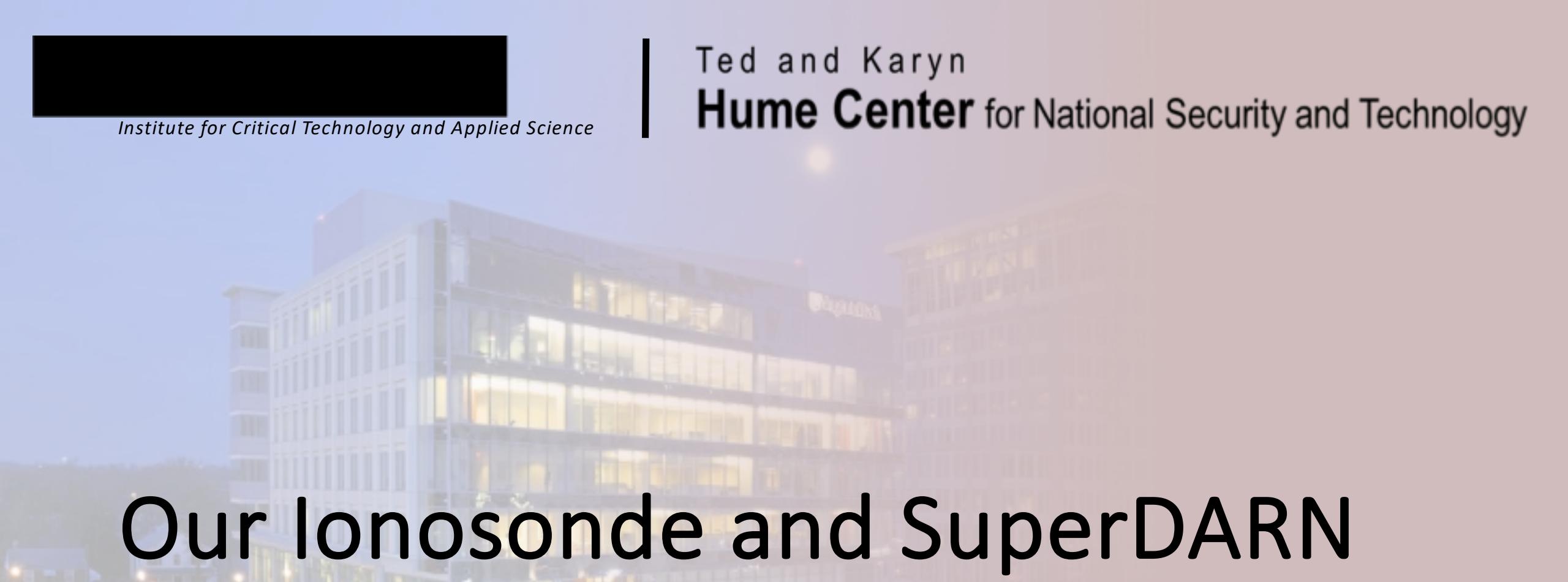
Polar cap

[<http://vt.superdarn.org>, 15 Sept 2018]



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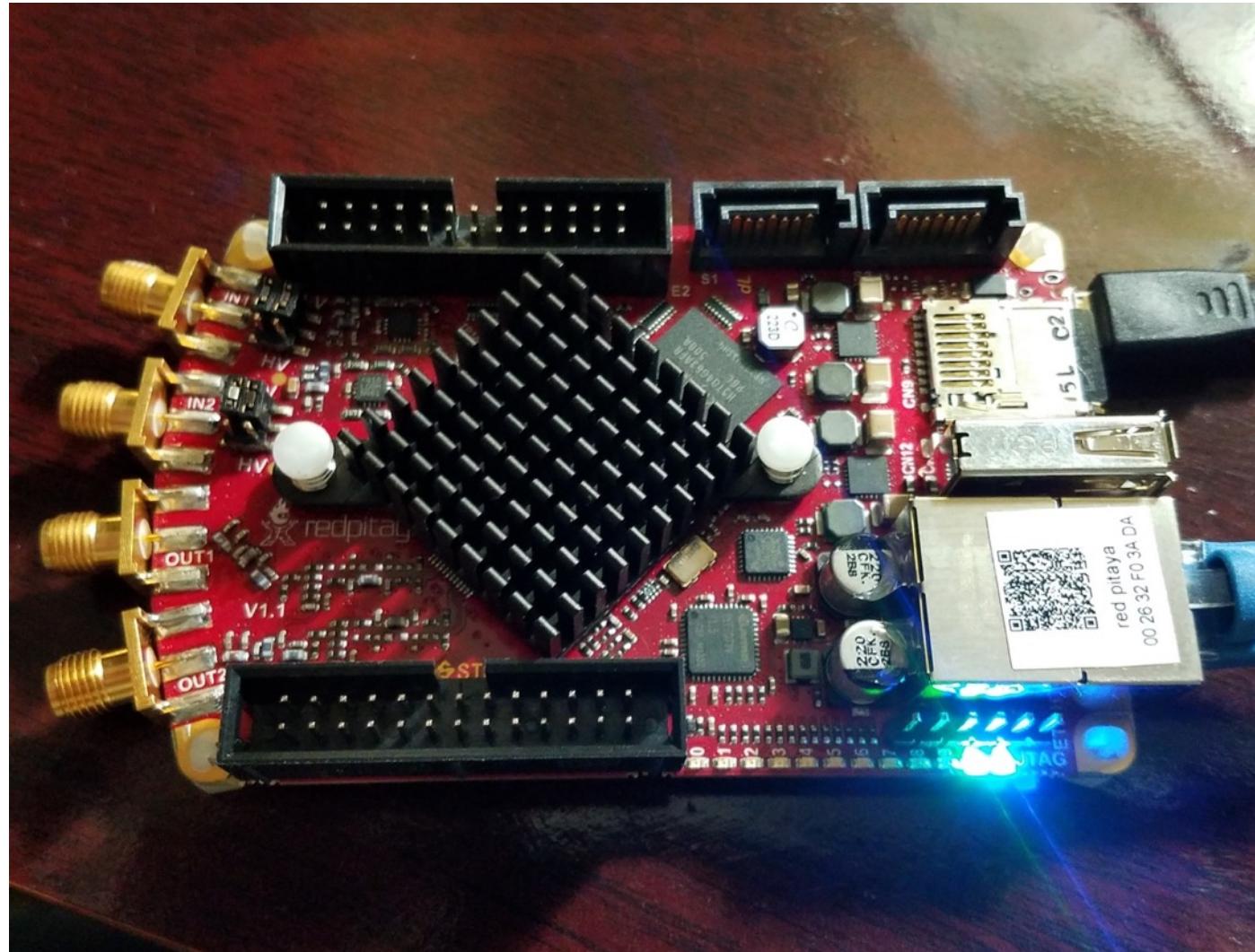
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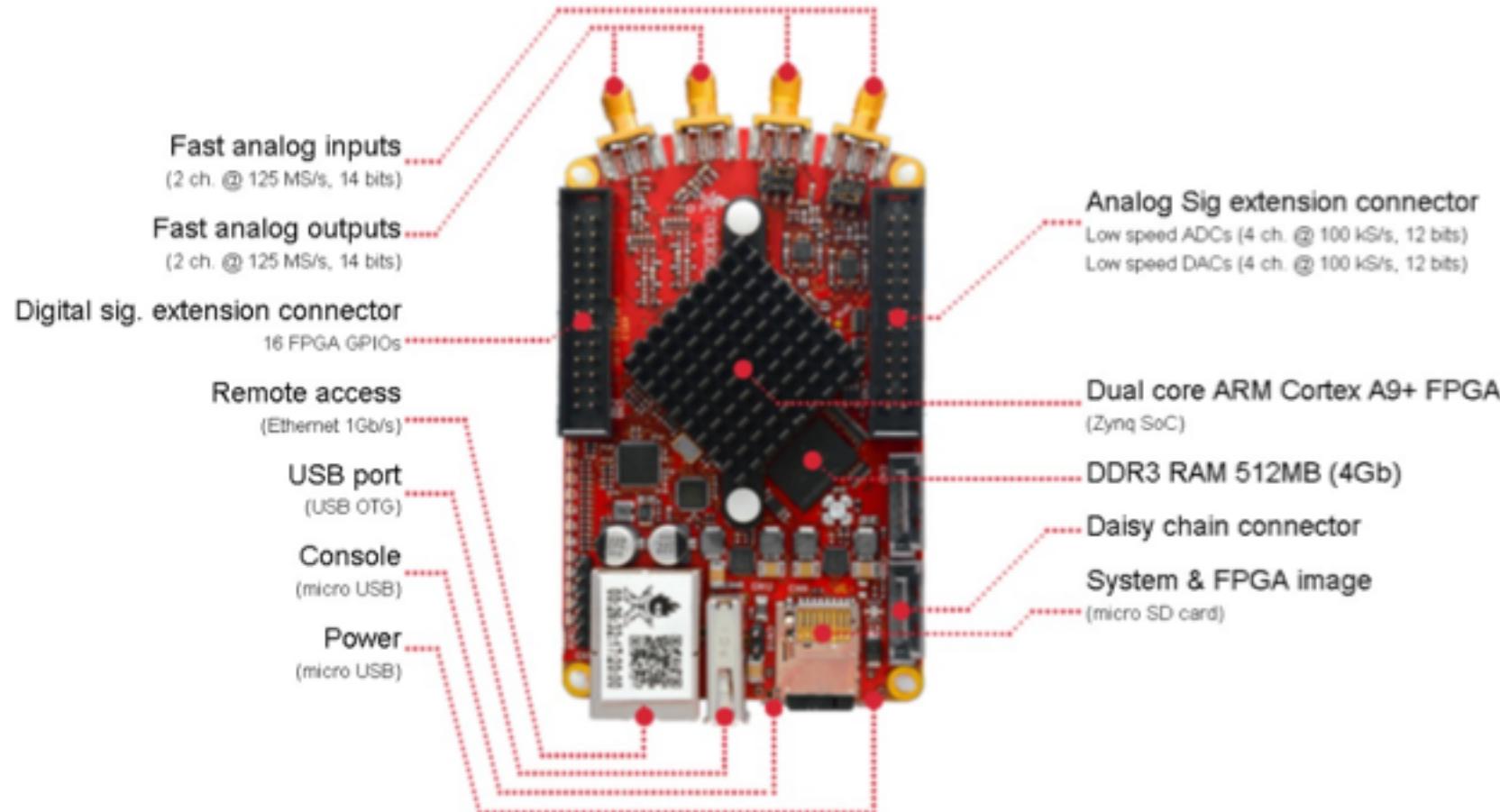
Our Ionosonde and SuperDARN

Current implementation details and plans going forward

Red Pitaya SDR



Hardware Overview

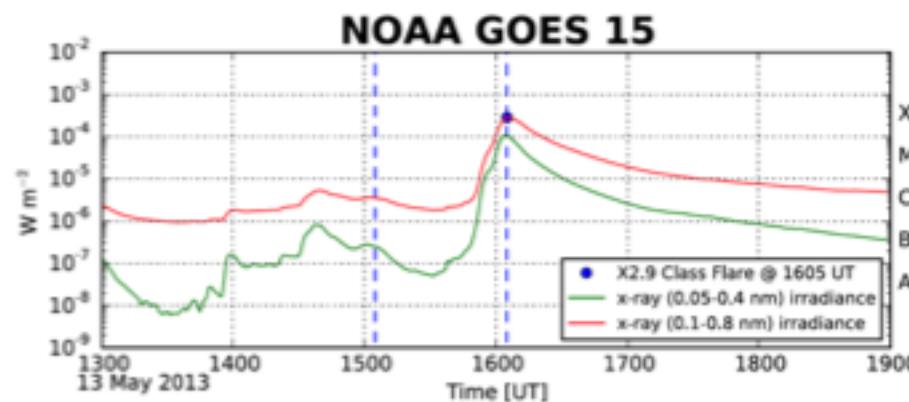


Red Pitaya measured specs (COTS)

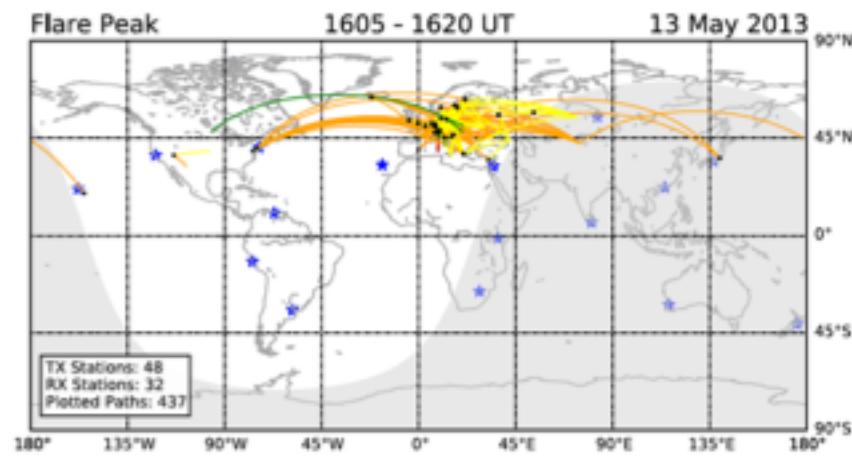
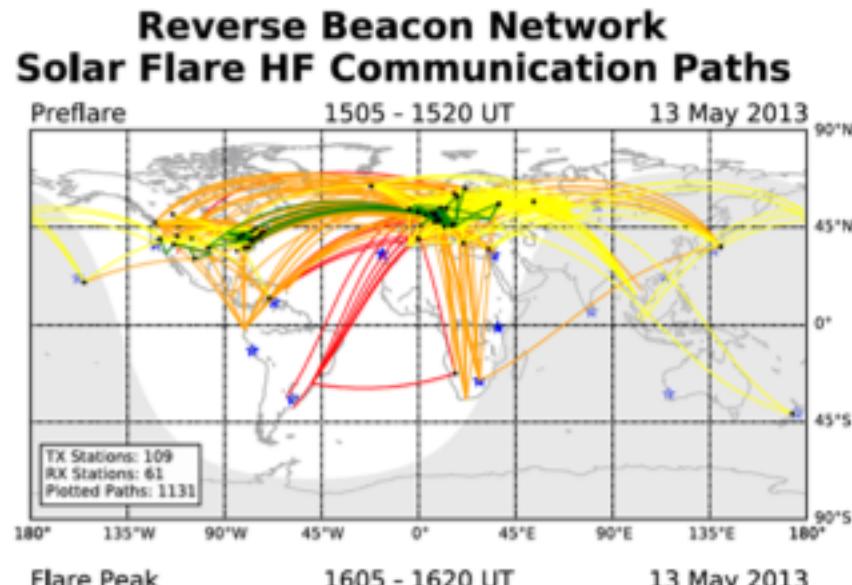


- Isolation between inputs: < 50 dB
- MDS in 500 Hz –120 dBm at 5, 10, 15, and 20 MHz on a single port with $50\ \Omega$ dummy load in the other port
- Alterations will improve these, not yet finished: remove horrid op amp acting as a buffer between SMA input connectors and ADC and replace with a transformer per channel
- Work being done by student at VT as part of his MSEE under my direction to replace older equipment in use by SuperDARN (described later)

Citizen Science Experiment HF passive



[Frissell et al., 2014, Space Weather]



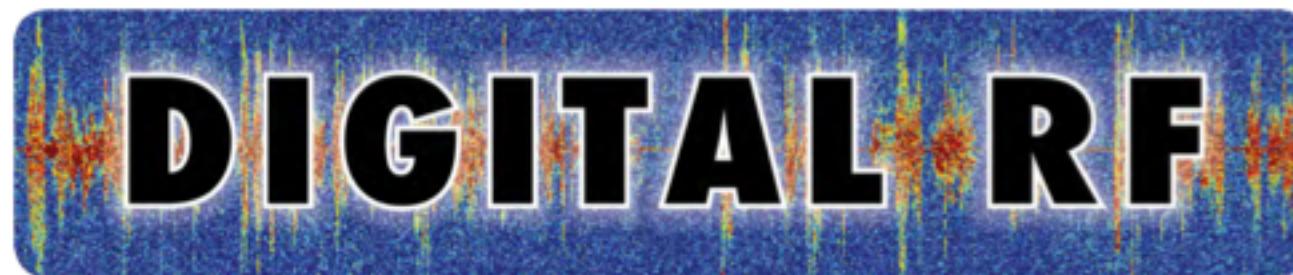
PSKReports
WSPR
RBN
FT8

Need Metadata and Signal Data

- RF Instrument Metadata
 - Center Frequency
 - Bandwidth
 - Impulse Response
 - Sampling Fidelity (e.g. # of bits)
 - Voltage to ADC Calibration Number
 - Timestamp (UTC Locked)
- Station Metadata
 - Station ID
 - Station Configuration
 - Geographic Location

- Provides a solution for storing all metadata with IQ data
- Uses standardized HDF5 data format
- GnuRadio Source and Sink Blocks
- Open Source

https://github.com/MITHaystack/digital_rf



Personal Space Weather Station

The Personal Space Weather Station project ultimately aims to create a small, multi-instrument system that can make ground-based measurements of the space environment. The observations from this project will not only be useful to the owner of the system, but also aggregated into a central database for space science and space weather research purposes. Initial work focuses on the development of a scientific-grade high frequency (HF) radio receiver, as well as the necessary software and network infrastructure. This project is led by the **New Jersey Institute of Technology Center for Solar Terrestrial Research (NJIT-CSTR)** in collaboration with the **Massachusetts Institute of Technology Haystack Observatory** and the **Tucson Amateur Packet Radio, Inc. (TAPR)**.

Articles

- **The Personal Space Weather Station** by Ward Silver, N0AX
 - QST, April 2018, Reprinted with Permission

Presentations

- **Personal Space Weather Station Overview** by Nathaniel Frissell, W2NAF
 - HamSCI Meeting, NJIT, Newark NJ, February 2018
- **TAPR Sunday Seminar** by Nathaniel Frissell, W2NAF
 - TAPR Digital Communications Conference, Albuquerque, NM, September 2018
 - **PDF of Slides**
 - YouTube Video (Coming Soon)

Get Involved

Want to be involved? Please request to join the [hamsci-swstation GoogleGroup](#) or contact **Nathaniel, W2NAF, at hamsci@hamsci.org.**

- [hamsci-swstation GoogleGroup](#)
- [HamSCI GitHub](#)



Questions, contact



- Questions?
- Contact: Dr. Bob McGwier, rwmcgwi@vt.edu



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