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The presenters will respond after your question. Feel free to continue the conversation! Just type your name before each of your comments so we can keep track of who's saying what.

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Friday, March 20, 2020

Oral Session I

Talk 1, 1345z: Nathaniel Frissell

Overview of the Personal Space Weather Station and Project Update

Enter questions and answers

1. Dr. MacDonald: How much data is already on the various servers?
   Answer: One answer was > 5 TB. Looking into moving this (or a copy) to MIT Haystack's Madrigal data system (NSF supported) for user download through APIs and subsequent analysis.
2. Ben Witvliet: I am mainly interested in using the Orange SDR for similar science, when will the Orange be available? And is the interfacing open for such alternative uses?
   Scotty: the Ethernet protocol will be open, as will all of the hardware interfaces.
3. Vladimir Papitashvili: How an ordinary ham radio operator can participate in the PSWS effort using his/her standard equipment (transceiver, etc.)? Answer (From Nathaniel W2NAF): One possibility is to run WSPRNet modes, which will automatically send data back to WSPRNet.org. I often use these observations in my studies. Another possibility is making measurements of WWV Doppler Shift. This can be done with the instructions available here: https://hamsci.org/wwv-centennial-festival-frequency-measurements#Procedure.or https://hamsci.org/spectrum-lab-solar-eclipse-instructions-page. Stability can be greatly improved using a GPSDO.

Talk 2, 1400z: Scotty Cowling

TangerineSDR Data Engine and Overall Architecture

Enter questions and answers

1. Ben Witvliet: When will Orange SDR become available? I'm interested in the receiver and GPSDO. Use case e.g. cheap NVIS channel sounding and a low-cost ionosonde for equatorial Africa. Scotty: longest case is DCC in September. Keep an eye out on TangerineSDR.com for progress over the summer.

2. Dr. MacDonald: where are PSWS data stored? on your own PSWS, in the cloud, somewhere else?
   Answer: Will be covered in a later talk Bill Engelke is handling the data storage architecture and will address data questions in the last talk of this session. It's a combination of local storage and moving it into the main data repository.

3. Ben Witvliet: Will the 2 receiver channels be synchronous? Very important for me because of polarization measurement.
   Answer: The two channels will be synced and the way the clock is being done, one can also sync multiple receivers so can do 6 or more sync channels if wanted.

4. Bob Gerzoff: Bill Liles said the ADALM Pluto (from Analog Devices: https://www.analog.com/en/design-center/evaluation-hardware-and-software/evaluation-boards-kits/adalm-pluto.html) does not cover the frequency range we are interested in. I was wondering what range that was? Scotty: the ADALM Pluto covers 325MHz to 3.8GHz. The TangerineSDR covers 100kHz to 60MHz.

5. Sean Elvidge: On one of your slides you mentioned the use of a LEA-M8F for the GPSDO. This doesn't (I don't think) support raw data output which would be needed to calculate the total electron content which for the PSWS would be a nice extra feature. Would you consider switching this out for a similarly priced raw-data module (e.g. the NEO/LEA-M8T)? Further might there be an option to use a "low cost" dual frequency receiver (e.g. ZED-F9P)? Scotty: You are correct, we need a dual-frequency GPS for TEC measurements. That is what we would like to use if we can find a cost effective unit.

   N8UR: I've been testing 7 different uBlox models and we will make a performance/cost tradeoff. The dual frequency units (ZED-F9P and ZED-F9T) have much lower second-to-second jitter (spec'd at 4ns) than the single frequency ones. But they have a ~$100 price premium. However the NEO-M8F has some interesting characteristics and might be an alternative; need to do more investigation on that. There is also an interesting question about whether the RTK capabilities of some of the modules might

allow a better result by measuring the offset of a timepulse input to the receiver. Much, much more investigation to do on that.

N8UR: re the M8F vs M8T -- yes, we will look at the raw data output capability of whatever module we use.

6. Nicolas de Poulpiquet: What frequencies will the tangerinesdr will focus on? Scotty: Initial TangerineSDR version will cover 100kHz - 60MHz. We will see about including WWVB at 60kHz, that would be a good idea.

7. Dr. MacDonald, I heard the cost for the 2 systems is roughly $500/$1000, is there more modularity possible? can you get the single board computer for collecting data from another instrument without the SDR ham radio part for instance? Scotty: Yes, you can acquire the pieces individually, since they are all off-the-shelf parts. If you wanted to connect sensors directly to the LH computer and report their data to the Central Server, that should be possible, even without the SDR receiver portion of the TangerineSDR.

8. Anton Kashcheyev, UNB: I know that RPi3b+ shares the USB2 bus for GB ethernet, that seems as a bottleneck for 2ch 122MS ADC. Would you consider switching to RPi4, which has a full capacity GB ethernet? Also a more powerful processor at a very similar cost. Scotty: That is why we have been using the Odroid N2, which is a more powerful SBC than the RPI3 or RPi4. The GbE does not connect through the USB bus on the Odroid, so you get much better throughput. It is possible that the RPi4 would work also.

Talk 3, 1420z: Tom McDermott

TangerineSDR Dual-Receiver RF Module Design

1. Ben Witvliet: We need to calibrate phase difference between the input. They are generally synchronous, but not coherent. How can that be done? Can the noise source be fed simultaneous into both ports?

    Tom: The inputs of both receiver channels are processed by one FPGA. In the case of two receiver modules, then all 4 receivers are processed by the same one FPGA. What is necessary is for one NCO (per virtual RF channel) to be used for all the physical receivers, so that both (or all 4 if there are two dual-channel receivers) remain coherent. The noise source is likely of too low amplitude to be used reliably for phase correlation between receivers. One noise source is

shared (via resistive splitter and separate transformers) between the two receivers.

2. Ben Witvliet: Common clock does not ensure the ports are phase coherent. See ANAN-200D and other SDR's. Phase difference is a random word due to FPGA processing. So you need a way to measure and correct for the startup phase difference. How is that planned?

   Tom: For one Data Engine, see answer to #1 above. The difficulty comes when there are distributed receivers at different locations. Then the NCOs for the different units do not necessarily start at the same time. Whether they can be left in a phase-offset state, or somehow started at the same Pulse-Per-Second time has not been studied. This depends on the Clock Module / GPS system to a large extent.

3. Ben Witvliet: Question for Tom N5EG: we need to calibrate phase difference between the input. They are generally synchronous, but not coherent. How can that be done? Can the noise source be fed simultaneous into both ports?
   So even if both ADC's are sampling synchronous using the same clock, how do we ensure that the baseband streams are phase coherent (which is one step further than synchronous).

   Scotty: The noise source can be fed simultaneously to both inputs. If we synchronously reset the FPGA virtual receivers, we should be able to maintain phase coherency.

   Tom: I am not sure the noise source will have sufficient amplitude to reliably correlate phase between channels. This could be characterized. For three receivers, the method described in the last page of my presentation ("Phase Closure") is commonly used to calibrate phase offsets. My view is that channels within a single FPGA can be reasonably assured of phase coherence, provided we correctly implement the FPGA NCO sharing. Then it should not be necessary to rely on an external signal to verify coherence. Between different sites, there will not be a signal source usable for cross-site calibration. There are other considerations, such as feedline calibration, antenna amplifier calibration, etc.

4. Ben Witvliet: The HPSDR group was not able to solve coherence in the FPGA software. Were you able to solve that for the Orange SDR?

   Tom: I cannot speak to how others implemented their solutions as compared to Tangerine SDR. Right now we have a concept but no actual hardware. My understanding is that some other projects have used a separate NCO per physical receiver, in which case the starting phase of the different NCOs is probably not the same.

5. Anton Kashcheyev: How good is the reliability of relay-switches, in particular temperature range? Thinking about the possibility to use this equipment up north (in much below zero temperatures)?

   Tom: there are temperature sensitivities and this hasn't been tested much yet. There are other components that also have temperature sensitivities (such as

electrolytic capacitors have poor low temperature performance). The design has not been implemented with wide-temperature-range components, so active heating might be required for severely cold environments. Typical components are specified 0-50 C.

6. Marco Neri: Will it be possible to implement a TdoA application on it?
   Answer: Interferometry is one of the intended applications. Success in that should imply the ability to support TDoA applications (although the software/firmware would likely have differences).
7. Aidan Montare: Clarification: The noise source is only for verifying if things are working, right? I.e., would you use this in actual data collection?
   Answer: The noise source is for calibration of amplitude (5 dB ENR).
8. Aidan Montare: This is all really excellent. Does TAPR have any resources on how they approach the design of this and other projects in general?

Answer: “take a look at the specifications on the TangerineSDR.com web site. That will give you some idea of how we approach the design tasks.”--Scotty

Aidan again: Is/will there be some sort of public way to track all the features/additional modules that are being suggested? It might be nice to give people a way to 1) see which features are being worked on, 2) give the project maintainers a way to compare which requirements are most worth working on 3) start sketching out how they might extend the TangerineSDR to their particular application, even if the boards this requires aren’t finished/existent yet.

Scotty: Ideally we will write a specification before designing a board. The idea is to provide enough information that anyone can design an RF board or Clock module. A public clearing house is a good idea to keep track of all of the proposed and/or already built modules. We hope that people designing the boards will let us know what they are doing so we can put their information up on the TangerineSDR web page.

Aidan: Encouraging them to share their design sketches for the website would be awesome! My hope is that if people know someone else is interested in, and they can see what ideas have been generated so far, they’ll have a jumping off point.

Talk 4, 1440z: John Ackermann

TangerineSDR Clock Module Design

1. Ben Witvliet PE5B: John, you asked what sort of the clock we would like to have. I would like to see the ordinary and extraordinary wave of the F-layer separately. And measure time-of-flight. See it as an ionosonde or oblique sounder. I would like the receiver and transmitter to have a clock for that. So mainly short-term stability and low phase noise. Can you do that? ;-)

N8UR ANSWER:
Hi Ben -- well, how much do you want to spend? :-)
We really need the science folks to help us convert their requirements into these accuracy/stability/noise parameters. In any case, the clock module will have the ability to take external 10 MHz and PPS inputs if you want to use a better reference than we supply.
Anton Kashcheyev: As it was mentioned earlier today, and shown in some of the presentations discussing TIDs, to study TIDs we need < 0.1 Hz frequency resolution, that in HF frequencies will require 1e-8 - 1e-9 short/medium term stability. TID periods are of an order of ~10 to 60 minutes. The absolute number is not that important. From our experience, we always used 'low-cost' 10 MHz OCXO, but if modern technology can allow using VTXCO with this stability at a lower price, it would be just fantastic.
For other applications, I agree, there might be different requirements. We should seek advice from other scientific groups too.

ANSWER N8UR:
Thanks, Anton. Getting into that range for stability should be doable at low cost. Combined with GPS that's an order of magnitude better than those of a decade ago, we have several ways we could do that. 10 MHz TCXO is probably good enough. It would be nice if we could skip the 10 MHz step (for cost) and directly discipline 122.88 VCXO but I don't know yet if we can find one that's good enough. Trying to get info from XO manufacturers but it's surprisingly hard when you're not buying 100K units…

We've seen some folks talking about long baseline interferometry, but that's a much tougher nut to crack.

2. David Themens: What capacity will you have to listen to ionosondes? Track accurate group range? Phase-coherent measurements for polarization? Would be amazing to have a network of passive HF receivers listening to global ionosonde networks. We're talking about effectively getting oblique ionograms from N_receivers*N_ionosondes worth of propagation paths. That would be an unprecedented amount of ionospheric data that can be fairly easily assimilated into ionospheric models (especially useful over remote or ocean areas). Even if it could only do a few frequencies, it would still be a huge amount of relevant data. Ionosondes are a very valuable signal of opportunity here.

   N8UR ANSWER:
   Hi David -- lots of great ideas! Not sure there's much I can do to answer them, though. TangerineSDR will be able to tune to any frequency in the 100 kHz to ~55 MHz range (with the first RF module), so anything in that range is fair game.

3. Mike Kennedy: John: I am curious, which equipment did you use to collect the Allen deviation data? Which equipment do you have or access to for the phase noise

measurement? Thanks. (VA3TEC)

N8UR ANSWER:
Hi Mike -- for short-term stability and phase noise measurements I use either a Timing Solutions TSC-5120A or a Miles TimePod (both cover 1 to ~30 MHz). References include several OCXOs, an HP 5065A rubidium, and several Cesiums, including an HP 5071A with high perf tube.

For PPS measurements, I use the TICC timestamping counter I designed a few years ago, in a "multi-TICC" configuration of four boards that allow 8 input channels, so I can measure 8 GPSs simultaneously with ~60ps resolution. The multi-TICC is fresh off the workbench and I'll be posting some info about it to the time-nuts list in the next couple of weeks.

Talk 5, 1500z: William Engelke

TangerineSDR Database and Control System Architecture

1. Aidan M: Any thoughts on using a repository like OSF?
   A: there are many options here (every time I give this presentation, someone suggests to me another possibility that I had not heard of before… which is *good*). We are going to evaluate many of these options as we get closer to deployment.
2. Aidan M: Is the progress on this part of the project shared somewhere? How can people get involved?
   A: see http://tangerineSDR.com . There is a weekly telco every monday night using Teamspeak. You can join or listen to recordings of the sessions.
3. Anton Kashcheyev, UNB: Canada has a wonderful facility, precise time and frequency HF station (CHU) in Ottawa transmitting at ~3.33MHz 7 and 14MHz. Why would you limit your measurements only to WWV?
   A: WWV is just a place to start. For aggregating data to observe for Traveling Ionospheric Disturbances, I believe we have to have a lot of people observing the same station. We can certainly include CHU as an option.
   Aidan Montare: TangerineSDR should support CHU and other standards stations. Our low-cost version from CWRU is focused on just WWV at the moment, but we're interested in doing both WWV and WWVH
   AB4EJ: in TangerineSDR you can select any carrier frequency you want for a channel; so as long as you know the frequency of CHU (or Radio Moscow, for that matter), you can collect data on it. The question then becomes: for what analysis is the data useful? I guess we will need to have "campaigns" - where we specify a carrier to watch.
4. TSDR antenna?
   A: could you please re-phrase this as a question?

5. Stephen Hamilton: iIs there a plan to use Grafana for data analysis like SatNOGS does?
   A: we have not yet looked into what data analysis software to use; but we can certainly consider it
6. Alan, KB3LTT Are there any plans to port the software to interface and run on desktop pc's?
   A: there is no plan to port the Local Host to run under Windows, if that is the question. If the desktop is running Ubuntu, the software should work out of the box.

Good presentation. Question wrt FT8 & WSPR -- isn't this information already stored in the Princeton computers and can be accessed? Also, have you considered RBN for existing, stored data? Or is granularity or something not sufficient ? de K3ZJ
A: You can see FT8 and WSPR data related to your station on the respective web sites if you are running a FT8 or WSPR receiver (with spot uploading enabled). TangerineSDR will support that so that you don't need to tie up your main transceiver observing the data if you don't want to (moreover, most rigs can't watch 8 to 16 bands at once for decoding). The local analytics is just a nicety, and you can see this whether you are uploading spots to PSKReporter/WSPRNet or not. (At least that is the plan!)

7. Gwyn Griffiths G3ZIL: Having given up on Influx timeseries DB because of cardinality issues I'm now testing out (with Rob, AI6VN) Timescale DB for WSPR spots and related data. Would your approach of Maria DB have advantages? We're using Grafana as a user interactive display.
   A: MariaDB is being used only for functions that a relational database is good for, e.g., keeping track of participants and providing a cross-reference to collected data (which is being stored as (HDF5) files in a Linux directory structure).
   One of the things about the data we're collecting is that a lot of it is raw spectrum or FFTs. Standard analytics is oriented toward counting the number of things (like spots, or the number of users or whatever). Software for working with this is like Tableau and Grafana (I think based on their web site). We need something different for working with spectrum data - at least a front end to decode it and maybe a second "big data" step to collect and do analytics.
   Thank you for these comments.

Talk 6, 1520z: David Witten et al.

Magnetometer Support for the Personal Space Weather Station and Related Projects

1. David Themens: Are you measuring just magnitude or directional components as well? (Answered: 3-component capability). What science limitations does the 10nT sensitivity cause? I'm used to talking about magnetometers in terms of sub nT or a few tens of pT sensitivity.
2. Dr. MacDonald: $20 is a great price point. Any examples of use of this mag already? E.g. on a website or project page
   KD0EAG: non yet, in the works.
3. James W8ISS: Did i hear correctly that they are considering a 'grove' style connector?
   Answer: KD0EAG: The 'grove' connector is an option to support alternative SBC users. It can also accommodate a JST-PH 4pin connector or just soldered wires.
4. Terry Bullett W0ASP: Most magnetometers I have seen are buried. This one will be above ground? Why?
   KD0EAG: Important question, yet to be determined.
5. Jim Secan: I would be concerned about interference. If someone runs their lawnmower alongside the magnetometer that could generate a huge false signal. Siting would be important.
6. Terry Bullett: Never mind a kW of transmitted HF nearby.

Oral Session II

Talk 7, 1600z: Kristina Collins & David Kazdan

Update on the Low-Cost Personal Space Weather Station
w8edu.wordpress.com
5 MHz data: https://www.youtube.com/watch?v=2aHq1Q2bh54
2.5 MHz data: https://www.youtube.com/watch?v=VaizszcY8lE
FFM and Doppler instructions:
https://hamsci.org/wwv-centennial-festival-frequency-measurements
FFM Data: https://zenodo.org/record/3707210
FAIR Data Principles: https://www.go-fair.org/fair-principles
Frequency Analysis Network Interest Survey: https://forms.gle/ucRDZbU8ZgsaE2cX8

1. Why was there a delay between sunrise and the solar noise? Why did the sun appear in 5Mhz, then disappear, then reappear? Declan Mulhall
2. Terry Bullett WOASP: When foF2> 5 MHz, the ionosphere will block all solar noise below this frequency. I am dubious about this being blackbody radiation from the sun at 2.5 or 5 MHz. Phil W1PJE: agree - the daytime data is most likely noise misinterpreted as carrier Doppler. Should be carefully examined. The ionosphere should block the vast majority of solar emissions at these long wavelengths, if not all. David AD8Y: Yes,

those are noise and should be color-coded. The received signal strength (red) curve tells that tale.

3. Declan Mulhall Just looking at Steve Cerwin (slide 3) , these Pederson waves at dawn are probably key. Sorry for the naive questions, I'm new to this
4. AB4EJ: Kristina, et al - are you planning to post your slides on the Google drive? I would like to be able to refer to that, if possible… https://drive.google.com/open?id=1lK-j-UhmYCVPWJamVxirG89F3AKjb8-t

Talk 8, 1620z: Skip Crilly

Synchronized Multiple Radio Telescope Microwave SETI

1. [Phil Erickson W1PJE] How do you reject pulses that do not come in through the main lobe but are misidentified as being down the boresight of the antenna? Related: for telescopes closer together than the radio horizon (e.g. 1300 km), coincidence rejection of RFI by correlating multiple telescopes might not work as the human signal source might be in both telescopes.

ANSWER from Skip Crilly K7ETI:
Phil's question addresses a very important hypothesis that must be addressed in inferring and comparing causes of unusual pulses. I mentioned, when verbally answering the question at the end of my presentation, that my experience measuring RFI on radiotelescope sidelobes, using multiple feeds on one telescope, and simultaneous RFI on multiple telescopes, informs me that large variability of SNR usually exists in measured SNR of sidelobe signals, measured in narrow bandwidths (e.g. 4 Hz). This is due to Rician, approaching Rayleigh, amplitude statistics, of a tone in noise, and the highly variable aspect of antenna sidelobes, together convolving to create large SNR fluctuations. I do not observe these variations in the unusual pulses..

However, this is not, by itself, a sufficient argument to support or refute the existence of RFI in one and multiple antenna sidelobes, for four reasons: 1. Differential propagation path loss variations from an RFI source to multiple feeds and multiple telescopes may be low, and changing slowly, compared to capture time, and given sidelobe beamwidths, 2. RFI may be below the SNR threshold, affecting only the tail of the otherwise noise-caused Rayleigh distribution, 3. In multiple wide-spaced telescope systems, RFI to both telescopes may exist with precisely the same, or close, differential Doppler shift between telescope sites, compared to that due to Earth rotation only, and 4. My anecdotal experience is not quantified.

I have been interested, for a very long time, in building a radiotelescope that measures off-beam signals, synchronized with feed captures, for RFi amelioration. Thanks to Phil's question, I plan to assemble the system I need to implement a three polarization low antenna gain, antenna receiver system, capturing off axis signals, as three orthogonal samples on the Poincare Sphere. The system can be used in post processing, together with feed signals,to determine the

statistical significance of off-axis sidelobe signals in modeling explanations for the unusual pulses.

Talk 9, 1640z: Steve Cerwin

WWV Time Tick Arrival Time Study to Investigate Multiple Modes During Daily Dawn and Dusk Transitions

1. Terry Bullett W0ASP: Steve, great work. Are you aware there are ionosondes in both Boulder and Autin measuring the virtual height of the ionosphere as well as O/X mode time delay difference?

The plot in the slide is from Austin. In future analyses I will be sure to include the Boulder data as well. Thanks for the link to O/X mode data.

Steve, check out Figure 6 and paragraph at bottom of p 9 in chilcote et al., “Detection of TIDs by MF doppler sounding using AM transmissions” Radio Sci vol 50 doi 10.1002/2014RS005617 (2015). It shows an example of the effect you’re analyzing (though just notes it, does no analysis)

I found it! Excellent paper and very relevant. Thank you very much for this.
Steve

Steve, in case you’re still seeing this: great that you got the figire. I’d be very interested in hearing about future work you do on this. We have a system running which should get more data on it.

Till later
Jim

Talk 10, 1700z: David McGaw

Traveling Ionospheric Disturbances Observed Using Doppler Measurements of Clear-Channel AM Broadcast Transmitters

1. Steve Stearns K6OIK: How do you distinguish between doppler and apparent doppler due to interference from other cochannel signals at night?
2. Steve Stearns K6OIK: AM station frequency is controlled by crystal ovens that cycle on and off. Hence there can be apparent periodic jumps in carrier frequency due to oven control. Periods would be on the order of 10s of seconds to minutes but not milliseconds.
3. David McGaw N1HAC: Yes, indeed. The one I pointed out is particularly bad. I expect they are just ovening the crystal with an on/off heater rather than proportional.

Talk 11, 1720z: Phil Erickson

Amateur digital mode based remote sensing: FT8 use as a radar signal of opportunity for ionospheric characterization

1. Phil, can you give a forward look into how you envision using the aggregate group of detectable FT8 signals to make useful measurements? Is there a need to use the grid square info as part of the analysis? I'm thinking about the bias in the geographical mix of signals and how it is changing over a listening period, and how it will change stats as perceived at the listening location. (Jim Idelson)

   Phil: I referred to “super-resolution” techniques, where you oversample the code sequence in time and then try to synthesize range resolution that is better than the bandwidth (the one that works out to 0.5 Earth Radii unfortunately). Think about finding an edge - the faster you sample, the more you might be able to localize where the edge is. If we can get the range uncertainty down to 100-200 km, for example (factor of 10 better), then we could begin to do things like differentiate between different propagation paths, etc.
   For grid square info, the easiest is to focus first on messages with the grid square, but in a statistical sense, of course, any message (including “RR73”) could be important when looking at collective signals. Both are valuable. But remember that call signs do not tell you where people are necessarily from FCC databases - they could be /M (mobile).

Oral Session III

Talk 12, 1850z: Gareth Perry

Update on the Golden Ears Project

1. Were you to add a plot of s/c magnetic latitude versus time, you might find that the s/c has entered the auroral current system at the end of the time period when a broadband

of noise is seen. That isn't a determination, just a thought. Field aligned currents are commonly accompanied by broadband radio noise. (from Dennis Gallagher)
Indeed - that's the plan of attack I will likely take. There is another spectrogram I didn't show that shows the CW band "wash out" for a few degrees of latitude and the come back in.

2. How do we get involved? (from Scotty Cowling WA2DFI)
   Stay tuned! I need to develop a more organized (and centralized) way of distributing data and receiving feedback. I think the best way to do this is with a website.
3. Tim Duffy and/or Ward Silver can line up many super "Golden Ears" for you. (from Steven London)
   Excellent!
4. from Aidan Montare KB3UMD: Thanks Gareth! When you're considering getting more people involved, perhaps think of ways the average ham might do this kind of analysis on individual signals they record. [I] think that could be a neat way to get people used to "ham exploring" into more "ham sciencing" (as I call it)
   That's a very good suggestion - thanks. I'm less than average - I don't know CW, so I'm my own guinea pig in that respect.

   Aidan: Haven't learned CW myself. Hopefully someday!
5. Steve, try to get Chip, K7JA, since he beat texting on Johnny Carson with CW some years ago!!! (from Dr. Jim WA3FET)
6. From Steve G3ZPS. FOC (Morse First Class Operators Club), has hundreds of top morse code Ops around the world.
   ` Good to know!
7. Gareth, it's interesting but in audio 'golden ears' is a somewhat derogatory term, denotation being that they claim to hear things (phenonmenon, distortion) that cannot be measured by precision test equipment. Kind of like the 'uni-directional' claim of some loudspeaker cable…) But in this context, it is highly complimentary of their CW skills. (From George Byrkit K9TRV)
   Phew - I'm glad I'm not insulting too many people.
8. Having been a synthesizer designer, our "golden Ears" were well respected musicians that could hear things other[s] couldn't and keep us honest. Having good hearing myself, they were right. (From David McGaw N1HAC)
   I was a drummer - too busy to listen to what everyone else was doing. ;)

Talk 13, 1910z: Magdalina Moses

Observations and Modeling Studies of the Effects of the 2017 Solar Eclipse on SuperDARN HF Propagation

1. What does the term camping [spelling?] mean? Why do you call it that?

2. What is the time scale of these “plasma irregularities”? Minutes, hours, days…? (from Robert Melville) (From Jim Secan) There is a full range of plasma structures in the ionosphere with time scales ranging from sub-seconds to days and greater. Each segment of this spectrum, both temporal and spatial, are filled with different phenomenology. Ionospheric scintillation, for example, covers spatial scales from meters to a few kilometers. SuperDARN structures are spatial scales of meters and times scales from seconds to minutes.
3. I’m interested whether we could follow the same steps of fusing PHaRLAP with different models for the data we’ve been collecting with doppler shift/multipath (from Aidan Montare KB3UMD)
   Probably. Do you have PHaRLAP already? If not, contact Manuel Cervera at manuel.cervera@dsto.defence.gov.au. It’s very helpful for generating simulated data from model ionospheres. (from Magda Moses, KM4EGE)
   Aidan: Thanks! I do not, but I’ll get a copy as soon as I get the chance.

Talk 14, 1930z: William Liles

EclipseMob: Initial Planning for 2024

1. Fascinating History. Would love to read an article synopsis Bill also highlights the importance of FAIR data principles. (From Dr. Elizabeth MacDonald) ANS: We have a paper in preparation that gives that synopsis. We will announce to HamSCI when and where it is published. And yes, FAIR data principles are very important.
2. You’re only discussing 2024. Do you have opportunity to use the 2020 Chile/Argentina eclipse as a smaller trial run? (From Chris Hamilton AE5IT)
   a. We talked about that, but we’re still testing the system.
   b. For colalboration the Viarrica Radio Club did some 2019 eclipse events and is in the path of totality for 2020, they may be a contact. (AE5IT)
3. First order, what is the difference between EclipseMob and PSWS? Could they be compatible? (Dr. MacDonald) Sorry I know this is a very naive question just not understanding the technical jargon. Are they different frequencies?
   ANS: (Liles) I would like to included using the VLF and LF transmitters for study of space weather. Currently the TAPR SDR only goes down to 100 kHz and I would like it to go

   down to 20 kHz
   N8UR: I strongly suspect the TangerineSDR will be able to go down to that frequency range. It’s only the front end components that might be a limitation, and I don’t think they have much of a high-pass characteristic. (On further thought, the coupling transformers might be the limiting factor. We need to verify the specs on those; sensitivity might go down at the bottom of their range, but given atmospheric noise down there, that might not be a limiting factor.)

4. Kristina Collins - Would like to try to collect data in advance of 2024 and planning for 2024. Dr. David Kazdan -

5. FYI, there is a just released NASA call for interdisciplinary eclipse science for 2020: https://science.nasa.gov/researchers/sara/grant-solicitations/roses-2020/amendment-5-new-opportunity-interdisciplinary-science-eclipse-added-roses-2020
6. How much difference between an annular eclipse versus a total eclipse? (from Nathan Frissell)
    a. Path of visual obstruction, not ionosphere; would be rather similar from an ionosphere perspective
7. Dave New, N8SBE: I was sending out WSPR during the 2017 eclipse on 80m. I thought some science came from that, so 2017 in my view was not a complete wash. What became of that science? Yes the WSPR data at 80 meters and other bands was important and used, I believe, in a paper by Nathaniel.
8. From Dr. Laura Lukes KK4FYT: The signal data may not have worked out, but we did get some interesting data about crowdsourced science--Most people (who completed survey) built/tested/ran experiment with other people rather than alone. Only about 30% ran the experiment locally--so that map shown represents where the kits were mailed, rather than where the data was collected. Because the signal data wasn't usable, we didn't create the comparative map of data collection locations, but that could be interesting.
9. From Kristina KD8OXT: Take a look at the map of upcoming solar eclipses: https://www.timeanddate.com/eclipse/list.html I'm working on mapping relevant stations and data collection points from now to 2024; for those who have interest and well-placed stations, please drop me an email at kd8oxt@case.edu.
10.

Talk 15, 1950z: Aaron Farnham, Anton Kashcheyev

A new CHAIN site in New Brunswick: low-cost HF and GNSS instruments for Solar Eclipse 2024

1. Walter Bordett: What is a TID? N2IK
    a. A TID is a traveling ionospheric disturbance (from Dr. Nathaniel Frissell)
2. Scotty Cowling: But is 100W optimum, or would more power be desirable?
    a. Phil W1PJE: 100 W is sufficient to do ionosondes.
    b. Anton: Ionosondes can be done even with less power transmitted. A good example would be works by Juha Vierinen, for example. All depends on what is the time resolution, whether it is oblique or vertical sounding and code used.
3. Robert Melville: How much do they cost?
    a. Anton: USRP N200 we use to build an ionosonde is 2.5k CAD.That is ~2k USD. https://www.ettus.com/all-products/un200-kit
    b. Nathaniel W2NAF: One of the reasons the TangerineSDR is being developed because low-cost options like the HackRFOne didn't have the scientific capabilities needed. The Ettus USRPs could do it, but they are expensive.

    c. Anton: USRP is indeed can not be considered a low -cost anymore, especially after NI took over Ettus… But taking into account cost of scientific-grade ionosondes, that is nothing.
    d. Nathaniel W2NAF: Right... CHAIN's definition of "inexpensive" might be different from that of a radio amateur...
    e. Anton: Anyway, my main message was to convince ham community to have dual-frequency GNSS receiver as a part of the Personal Space Weather Station
4. Aidan: Are basic HF sounded experiments something an amateur can do?
    a. Response from Ward Silver: Swept emissions are not authorized to amateurs, as far as I know. We can do critical frequency measurements but only in the amateur bands and all identification requirements must be followed.
    b. Response from Phil W1PJE: Problem: ionosondes need to go across most of the low HF band (below 15 MHz) due to the nature of ionospheric reflections, and it's hard to get licensed across those many bands. I.e. can't sweep across full frequency range with small ham frequency windows.
    c. Anton: We, as a scientific group, have a number of HF licenses to transmit in 1 to 30MHz. We would be interested in sharing the details of the signals we are transmitting for interested parties.
    d. Terry W0ASP: Such ionosonde HF transmit licences are very hard to obtain and highly coveted by those of us who have them. The big problem with cheap ionosondes is emission bandwidth and harmonic control. Using an all-band license requires being courteous to other users in the spectrum when you step on them.
    e. Anton: Most of our sites are in up north, far from the US border, but the new site in New Brunswick is very well located for tests. We are open to collaborate with the community to receive the signals we are transmitting, sharing the schedule and details.
5. John Armstrong: What are the specs desired in the Low cost sounders and receivers?
   Anton: the specs are the receiver/transmitter bandwidth, transmitted power and, of course, antenna system. It's a bit of a general question. I can try to elaborate if you provide more details.
6. Kristina KD8OXT: Possible data collection for eclipses before 2024?
   https://www.timeanddate.com/eclipse/list.html
7. Phil W1PJE: it should be possible to do a statistical comparison between the reference and USRP based sounder at the ionogram level (i.e. frequency vs. virtual height), before it gets fit to determine e.g. NmF2, etc. Your comparison ionograms show this. Have you done the large scale calibration/validation work yet?
   Anton: The ionosonde in Anatrctica (Ak Vernadksy station) has been operating for more than 2 years (side by side with IPS-42 ionosonde). The statistical comparison I presented was for 1 month of data. However, the group in charge of operating the ionosonde (RIAN, Kharkiv) has analyzed at least 1 year of manually scaled ionograms in terms of foF2, h'mF2, h'oE etc. They are sounding one after another with 2-3 minutes intervals, some of the discrepancies can be explained by that.

8. John Armstrong: Rather than sweep - would you consider a DSSS solution that would work from 1M to 10MHz?
    a. Anton: For oblique sounding we can do spread spectrum and are open for discussion/joint experiments.
9. Newbie MD Maktoomi: @ Anton, why do you think a dual-frequency receiver is more useful , why not a wideband receiver?

    N8UR: Hi MD! This is referring to GPS receivers that pick up not only the L1 satellite broadcast at 1575 MHz, but also the L2 (1247 MHz) and/or L5 (1176 MHz) broadcasts as well. By using two frequencies separated like that, it's possible to determine the ionospheric impact on the signals, and reduce the uncertainty of the receiver's measurements. This improves the solution accuracy quite a lot. And a fall-out is that the processing also yields data that can be converted into TEC (Total Electron Content) data.

10. Do you think cell phones will have the dual frequency receiver by 2024? How could this be used by your project? (Dr. MacDonald) . Do you mean L5 only or L5 + L1?

    N8UR: cell phones will be using the L5 frequency starting Real Soon Now. But they use it mainly because it is a higher power signal that works better in urban canyons. My guess (and only that) is that the phones won't make available the raw carrier and code phase data that you need to take scientific advantage.

    The phones will use L1 + L5. I don't think they will use L2 because for their purposes it doesn't offer the same advantages because of lower power and different codes in the signal format. Don't quote me because I haven't double-checked, but L5 provides a C/A (coarse or carrier acquisition) code as well as P (precise) code. L2 doesn't have C/A.

    Anton: the main impediment to using dual frequency GNSS chips in cell phones is their intrinsic way of switching power off/on to save energy that leads to a reset in signal phase. It prevents from reconstructing TEC values. We had a project back to 2018-2019 to study such possibilities. It was not possible by that time. The latest Android OS (6?) allowed getting raw data from the cell phone receivers.

Talk 16, 2010z: Shing F. Fung

Propagation Teepee: A High Frequency (HF) Radio Spectral Feature Identified by Citizen Scientists

1. How often and when/where are tp's observed? I had thought it was observed during the eclipse, but now it seems more frequent. [Dr. MacDonald]

We haven't done a complete statistical study on TPs, but our impression is that TPs are more often seen in the late afternoon to evening hours (when thunderstorms are more prevalent), sometimes overnight. TPs are not related to eclipse.

2. Why would a lightning storm signature be stable for the several hours of the tp observation? [dr. macdonald]
   Thunderstorms are not typically stationary, but move at 10s of km/hr. Our explanation for TP is that they are signatures of moving thunderstorms, which can be followed for many hours.
3. Can you determine the location of lighting causing the teepees, and confirm that teepees are caused by them? Sorry about the confusion (I typed my question too quickly) [Lindsay Goodwin]
   If I understand your question correctly, maybe. We think that TPs are signatures of remote lightning, not the other way around. Using modeling and observations of TP apex frequencies, we could determine the range (distance) to their lightning source. That gives you a ring of possible locations to search for the possible responsible lightning. We're now working on finding and identifying the lightning storms that could be the sources of particular TP observations.
4. [W0ASP] Try http://en.blitzortung.org/live_lightning_maps.php
   Yes, thanks. We're also working with the WWLLN.
5. Couldn't any broadband source produce this type of feature? Maybe bleed over from one or multiple ionosondes could also produce a feature like this?
   Perhaps; but it is not obvious how the TP shape would always result. It is more difficult to explain the different TP groups that we also observe.
6. Ionosondes sweep frequency slowly and have well defined schedules [W0ASP]
   Are you asking if TPs could be produced by active sounding by ionosondes? I am stating that they can not be the source based on the time/frequency pattern of the source. [W0SAP]
Correct. I don't see how ionosondes could produce the TP signatures.

7. Steve G3ZPS...be interesting to know if the formation of the TEEPEES correlate with Sprites / blue Jets from energetic lighting strikes above thunder storms
   It would be hard to correlate TP and sprites observations in real time. Retrospective study is definitely possible, particularly if we could identify the lightning storm responsible for both the sprite and the TP observed.

Oral Session IV

Talk 17, 2050z: David Smith

Using amateur radio to validate model-based properties of earth's protective shield

1. If you can use existing networks (like WSPR) for this, can you pull the appropriate data for past known PCA events? An example would be nice. [Dr. MacDonald]
   Thanks for the questions. In theory, yes. The problem is that we don't see a great deal of propagation paths that would be close enough to the cutoff latitude that we could see

something. That being said, we became aware of WSPR not too long ago, so it could very well be that there is already data worth mining. ds

2. Tom Lauknes LA5VK: would a RBN/WSPR/etc. receiver and a space weather station at ~69N in northern Norway and 79N in Svalbard be interesting: David: definitely! Nathaniel W2NAF: Tom is a professional researcher in Norway so will make the connection.
3. AB4EJ: I thought i heard David say something about "negatively charged protons" - did I misunderstand, or is there such a thing? (outside of the Large Hadron Collider, I mean)... *Sorry I didn't make that clear. When using the "reverse engineering" technique to trace proton trajectories through a modeled magnetic field the method includes using an opposite charge on the energetic particle (proton in this case) and applying the Lorentz force law to move the proton through the magnetic field. Rather than starting the proton at some point outside the geomagnetic field and hoping it hits earth, we start with a "negative proton" and start it at the point in question near the earth (latitude, longitude, altitude) to see if the trajectory is allowed or forbidden. Smart & Shea did many, many studies using this method. Thanks for the opportunity to clarify!!*
4. [David N1HAC]: David, some yrs ago the Dartmouth group operated a chain of Rx's spanning 67-79 degrees in the Canadian sector. We saw variations of boundary of polar cap absorption over several days following major solar flares. Check out Figure 9 and associated discussion in LaBelle "High Latitude propagation studies using a meridional chain for receivers" Annales Geophysicae, volume 22, p 1705, 2004. Might make a kind of proof of concept for your idea.
   I'll check that out for sure!! Thanks.

5. [Gwyn Griffiths G3ZIL]: Dr. Smith - very much enjoyed your talk. As regards your slide "Amateur Radio Involvement", and you mentioned WSPR in your last slide. With AI6VN and N6GN we have a database of WSPR spots where we calculate the vertices of the great circle paths (an assumption, we know) and can output in Matlab format to end up with animations such as example across the Atlantic at 7MHz I've posted at https://www.dropbox.com/s/hzk6mijupjivtjg/G3ZIL_N_Atl_WSPR_GCpath_verticies.avi?dl=0
   Where the Kp index is also shown. Is this of help in reinforcing your message for the potential involvement of Amateur Radio?
   It very well could. I'll take a look. What I'm trying to do is get some propagation paths that are "close" to where we think the cutoff latitude would be, and over a period of weeks, months or whatever, see how the frequency cutoff changes. I'll check out your data, and again, thanks!! Dave, W6EY

Talk 18, 2110z: Rachel Frissell

Statistical Study of Open Closed Boundaries (OCB) using ULF Wave Observations from Antarctic AGOs, McMurdo Station, and South Pole Station

1. Can you clarify how you determine OCBs using the ULF power spectrum, again? [Xueling Shi]

Talk 19, 2130z: James Weygand

Temporal and Spatial Development of TEC Enhancements during Substorms

1.

Talk 20, 2150z: Diego Sanchez

Large Scale Traveling Ionospheric Disturbances Observed using HamSCI Amateur Radio, SuperDARN, and GNSS TEC

Diego, you are welcome for the use of the ionosonde data. [W0ASP]

1. What would be your ideal number of observers to quantify the LSTIDs? Do you need more? Or stronger events? What's on your wishlist? [Dr. MacDonald, great talk!]
   Answer: Need to increase coverage density globally but there are some curiosities and variations from event to event that make it difficult to say.

Talk 21, 2210z: Tim Duffy

Let's Push the Exploration of the Ionosphere to The Next Level (Invited)

1. Love the takeoff-angle scanning idea. With IQ capture on each antenna you could artificially scan all takeoff angles continually without physically switching phasing settings or interrupting ongoing operations/QSOs (AE5IT)

Here are the links Tim uses for assessing Space Weather prior to contests:

- http://swpc.noaa.gov
- ~~http://swpc.noaa.gov/products/wing-kp~~ From Rob Steenburgh AD0IU: SWPC no longer produces Wing-kp output. Short-term model Kp predictions can be found here.
- From Rob Steenburgh AD0IU: Rice University's Space Weather Status Page for Kp observations & predictions
- http://solen.info/solar/index.html
- http://swpc.noaa.gov/products/real-time
- http://swpc.noaa.gov/products/real-time-solar-wind
- http://hamqsl.com/solar.html

- https://dx.qsl.net/propagation/propagation.html

~ASSaturday, March 21, 2020

Invited Tutorials I

Talk 21, 1400z: Elizabeth MacDonald

Aurorasaurus: Citizen Science Observations of the Aurora

1. Do we only get info on large sunspots-Bill Hudzik,W2UDT
    a. From Nathaniel: We can get information on very small sunspots, too. There are systems that can do very detailed imaging of the solar surface.
    b. From Rob Steenburgh AD0IU: SWPC produces a daily solar region summary product you can find here.
2. From From James French W8ISS what are the chances of sending a bunch (10 or more) of "macro's" (suitcase size cubesats) with instrumentation to observe the sun on a constant basis? if the "macro's" were put into the L1 point, not much station keeping would be needed (correct?)
    a. From Nathaniel: James: correct, but there are chaotic/nonlinear processes that eventually make the satellite wander away unless periodic small stationkeeping is required. But L1 s/c last a very long time; ACE was launched in the mid 1990s and was the operational spc wx satellite at L1 until recently.
3. Scotty WA2DFI: What would be the optimum frequency bands for building an Aurora radio map?
    a. (from Liz) I am not totally sure, probably others can answer better. Some information here. http://www.g7rau.co.uk/soft/downloads/Tools_for_assisting_operation_during_Auroras.pdf
    Dave's talk!!
4. From Prof James P Sheerin:
    a. Is there a way to tag the photos uploaded with webcams in the area? (I catalog and rely on any and all known webcams in area to monitor for activity)
    (from Liz) That is something that's been on the todo list for awhile. One way is for the cams to tweet.

    b. Anything to note about CONNEX experiment (Delzanno, Reeves, LANL) (where Aurorasaurus is to play a key role) (Liz'll recall) I'm interested in Aurorasaurus for hi-lat HF experiments ?
        i. CONNEX is a proposal to create artificial aurora to map the footpoint of the magnetic field. We need to get it in the Decadal Survey (it wasn't proposed this round), and there will be a rocket soon (Reeves is PI). Citizen science can play a critical role in any of these missions
5. what's the hashtag for twitter?
   No hashtag, we just need you to use the word aurora and a location to make a report. @tweetaurora is the Aurorasaurus account
6. From Dr. David Kazdan AD8Y Our university club station has a 20 dB beam on 2-meters. It's idle 99+% of the time--anything to deploy it for here?
    a. (From Liz) I'm not sure, anyone?
7. From Vincent Ledvina (more as a comment): I am interested in more promotion of the Akasofu Epsilon parameter as it pertains to visual aurora. Maybe conducting a study on the multiple forms of aurora forecasting (using space weather plots vs. KP vs. DST vs. AE-index vs. Akasofu) would be helpful. Nothing is perfect but it would be helpful for aurora chasers to have one "go-to" dataset that they look at whenever they want to go out chasing.
    a. Bug me to send you the paper drafts on this. Would love to resubmit and work with different apps to promote the use.
    b. (From Jim Secan) An hourly-updated plot of many of the inputs to this parameter (from the DSCOVR satellite) and Kp can be found at https://spawx.nwra.com/spawx/kpsw.html
8. From Tai-Yin Huang to All panelists: can you determine the height where STEVE occurred?
9. From Jay Schwartz to All panelists and attendees: (10:44 AM) Dr. MacDonald: a REALLY GREAT presentation. Thank you. p.s. When are you going to get your HAM license?
10. De Alan KB3LTT:How strong of an aurora is needed to affect ground current measurements?
    a. Interesting question… I will have to look into this a bit more. I can say that normal, everyday aurora causes nT wiggles in magnetic field measurable by sensitive magnetometers on the ground… but not sure if that's your question.
11. From Ed Dunlop n3DJH: How about trying thermal imaging since STEVE has thermal properties. There is a clear transmission window in the atmosphere at about 10 microns. I am willing to help.
12. From Aidan Montare: Really interesting talk! Are there any effects in space weather in general, ideally ones that affect everyday life, that can be better understood by aurora? We don't usually get aurora where I live, so I'm interested to know how the aurora affects me (and I hope I do get to see one!)
    a. Well one is that the aurora causes increased radiation at high latitudes and can be a concern for aircraft personnel on polar flights. Also, has caused power grid

issues in the past that can start in auroral zone and cascade further south (as happened in 1989 in Quebec)
    b. Auroral absorption of HF radio is a potentially significant impact to aviation at high latitudes.
13. From James French W8ISS to All panelists and attendees: (10:48 AM) how much does that effect the ISS at 408km average height?
    a. Great question, ISS latitude doesn't go that high in latitude in its orbit (54° i want to say) so not so affected typicallybut for large events it can be in the aurora. Any metal object gets hit by plasma and charges, so that is monitored on the ISS.
14. From Dave New, N8SBE: Aurora concentrates on (understandably) visual (to us) phonomenon. What about infrared/ultraviolet?
    a. Great question… I'm not an expert on this, but there are infrared and UV emissions as well. For imaging from space, UV is the most visible.
15. From Sebastien Jean VE2GTZ Is it possible to download Aurorasaurus App for Canadian. It said is not available on the Canadian Apple Store? Thanks
    a. The apps should be listed worldwide in the next 1-2 months. In the meantime, use the desktop site, works fine on new modern bigscreen cell phones
16. Case Western Reserve University's W8EDU has 2-meter equipment and a quite directional, high-gain beam that mostly sits idle. Anything useful for it to be doing for autora work?
    a. Not sure??
17. Bill, AB4EJ: For building a 2M aurora station (for working QSOs) - do you need a preamp on antenna? (If so, it would have to automatically switch out when transmitting, right?) What is minimal useful power? I see that Q5Signal has a 150 W 2m transverter… Is there a 2m antenna size that would actually be *too* big (i.e., too directional to make for success)?
18.

Talk 22, 1445z: James LaBelle

Observing Radio Signals of Auroral Origin (Invited Tutorial)

1. From James Sheerin : Speaking of Summer : the consolation prize is PMSE .. Anybody speaking to PMSE in the ham scatter (yet)?
    a. From Dr. Phil Erickson W1PJE James: not quite yet, but we'll get there. For others: PMSE = Polar Mesospheric Summer Echoes; very bright scatter from probably charged ice particles in the mesosphere; VHF and up.
    b. HF interaction here (Free Access) (many more listed in scholar.google) https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2001GL013411
2. A note from David McGaw: Preamp design info is in "Receiving Antennas for the Radio Amateur", Nichols KL7AJ, ARRL, Appendix C.
3. From Aidan Montare KB3UMD: Picturing the spectrograms from the previous slide side-by-side with aurorasaurus photos. (Not a question just voicing interest.)
4. De ALan KB3LTT: Are these emissions similar to those from Jupiter?

5. From David McGaw N1HAC to All panelists and attendees: (11:12 AM) PMSE <> Noctilucent Clouds?
    a. From Dr. Phil Erickson W1PJE David: there are connections between PMSE and NLCs but as far as I know, the definitive word is still under construction. I'm not a PMSE active researcher, so that may be out of date.
6. From Jonathan Rizzo KC3EEY Does auroral hiss that Jim is describing include hiss emissions in the lower VLF and ULF band

The hiss I show at LF and lower MF is indeed the same phenomenon as some of the VLF hiss. First of all there are two broad types of VLF hiss, one is auroral, the other is not auroral at all but occurs at low/middle latitudes and is called "plasma spheric hiss". These two phenomena may often resemble each other, but they come from entirely different physical mechanisms acting in different places in the earth's space environment.
Focussing on the auroral hiss, there are at least two types of this: "continuous hiss" occurs mostly below 10 kHz and often for long time intervals , up to hours, during time s of auroral activity. "Imp "impulsive auroral hiss" extends from VLF up to higher frequencies and is concentrated within a few minutes (typically) of the substorm onset. The LF/MF signals I show are the upper extension of the impulsive VLF auroral hiss; sometimes the LF/MF part is observed without the VLF part.

7. From bill to All panelists and attendees: Why don't you see the fundamental roar freq?

I mentioned in my talk that for electrons perpendicular to the magnetic field, the "plasma frequency" resonance occurs at a somewhat higher frequency. this is called the upper hybrid frequency which is the square root of the sum of the squares of the plasma and gyro frequencies---hence the "upper hybrid frequency" must mathematically be higher than the gyro frequency. The "double resonance" involved in generation of auroral roar is actually when the gyro harmonic matches the upper hybrid, not the plasma frequency. (The reason is, the important physics involves motion of electrons perpendicular to mag field.)

the fundamental gyrofrequency can never match the upper hybrid frequency, so the first possible match is between the UH frequency and the second harmonic.

8. Prof James P Sheerin: also, on the slide of resonances: see the HF stimulation resonances causing ionization layers recent JGR https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2019JA027669
9. Aidan Montare: Anybody looked from satellites for the emissions that were predicted by the theory to be emitted away from earth?

Yes, for example the auroral roar, there are "matching points" on the top of the ionosphere, and those generate auroral roar going upward. And indeed, satellites have observed this, actually going back as far as the 1960s. They called it "2- and 4-MHz radiation." One example reference Benson and Wong, J. Geophys Res, vol 92, p 1218, 1987

AKR emissions are primarily beamed outward and have been observed by many satellites since their discovery in 1974

Auroral hiss is also generated going upward and observed by many satellites

MF burst is thought to be also beamed upward, but observations by satellites are less certain. One possible observation was with the French DEMETER satellite, see Broughton et al., J Geophys Res vol 119, doi: 10.1002/2014JA020410 (2014)

Aidan M: Thanks! That's really cool to see.

10. From Jonathan Rizzo KC3EEY to All panelists: What is the mechanism of emission of auroral chorus in the VLF band?

VLF chorus is not related to aurora, but rather is generated by trapped charged particles in the Earth's magnetosphere at lower latitudes than aurora, and in fact near the equator. The detailed mechanism is not easy to explain. It basically involves a cyclotron resonance between the particles and the waves; that is a matching between the wave frequency and the electron gyrofrequency (the rate at which electrons revolve around the magnetic field). The gyrofrequency varies with magnetic field strength, ie. higher frequencies as you move off the equator (which is a minimum in magnetic field strength and hence gyrofrequency along a given field line) The chorus sources shift around in such a way as to produce the varying frequencies in the chorus. The details are subject of current research. there's a recent review paper by Tao et al. in "Science China" doi: 10.1007/s11430-019-9384-6 but be advised, not for the faint of heart!

11. From Scott Mecca: Some directive on what it takes to "tune up our gear" to listen for this would be great? Is there a *prefered mode* for listening?

    See discussion during meeting after tallk...

12. If local interference is an issue for detecting AKR from the ground, could it be done interferometrically? With a distributed, GPS-synchronized network?

Interference is a big issue for detecting ground level AKR. The signals tend to be weak, for one thing. Also they overlap with the lower part of the AM band and with beacon signals below 400 kHz. In Antarctica the man made signals are mostly absent, so almost all observations of ground level AKR come from there, and AKR is in fact pretty often observed, binterestingly is observed only in deep darkness (May-August at South Pole for example)

Interferometry has not yet been done on the ground level AKR signals. It would be very interesting to do so, because it would give some idea where (relative to aurora) the signals are coming down, also whether the AKR is coming down directly from the source or is "ducted" through narrow channels. So this is something that should be done.

Your note suggests the idea of using interferometry to discriminate the signals from the man made background. Possibly this could be effective, for example if akr comes primarily from overhead whereas the interfering AM and beacon signals come from low elevation angles, this could be effective. Might be a good strategy for observing AKR at northern hemisphere.

13. From Don WA9WWS to All panelists: Any advantage to doing this at higher altitude, like on top of mountain?

Hmmm, I'm a bit doubtful about advantages of this. Being in a remote place is an advantage for avoiding local interference . Being in a deep valley might also be helpful in that regard as long as your desired sources aren't at low elevation. ..anyone else have any thoughts on this?

14. From Tom Lauknes, LA5VK: To the HamSCI community; There could be an opportunity to set up a broadband HF receiver in a very radio silent area at 79N in Svalbard, with high speed internet access. Please contact me for discussions.

Interesting. I'm happy to lend a hand in any way, or at least keep aware of this. A Japanese group led by Yuka Sato have operated a receiver very similar to the ones I talked about in Svalbard, at the KHO outside Longyearbyen, and example paper showing some data from it is: Sato et al., J. Geophysical Research, vol 121, doi: 10.1002/2015JA022101 (2015). I am not sure of the current status of their receiver (it was an interferometer; it was there when I visited Svalbard back in 2014).

15.

Invited Tutorials II

Talk 23, 1545z: David Halliday

Operating Auroral Mode Ham Radio

1. From Aidan Montare: We operate from bright and sunny Cleveland, Ohio, U.S. Would it be feasible for us to do auroral contacts from our location? I'm learning today that aurora affect people way below the latitudes I usually associate with aurora, so I just wanted to clarify. Aidan- yes, I have a friend in Cleveland who makes Au contacts as often as I do.
2. From David AD8Y: On Hertz being a close approximation to cycles-per-second: http://p1k.arrl.org/pubs_archive/55597
3. Field aligned irregularity (FAI) contacts? For example, specular conditions on the path between the transmitter, scatter location, and receiver; spread/Doppler smear, etc. http://www.arrl.org/distance-records
4. From Chris Deacon, G4IFX: from my experience on 50 MHz we can regularly observe radio aurora significantly further south (south of London here) than we can visual aurora. Anyone got an explanation for that?
5. Skip Youngberg K1NKR: Is the important distance TX - aurora - RX, rather than just great circle TX - RX distance? That's the signal path.
6. Hams use the Maidenhead Grid Locator system to report the location of their stations. (Usually either 4 or 6 characters) See Wikipedia: https://en.wikipedia.org/wiki/Maidenhead_Locator_System

Talk 23, 1630z: Jim Breakall

Nikola Tesla – The Pioneer who Paved the Road to the World and Ham Radio as We Know It

1. Prof James P Sheerin to Jim Breakall: many thanks for your ***fantastic*** HF xtr at AO ..alas our HF campaign was cancelled by PR Governor decree to close AO ("non-essential")
2. From Kristina KD8OXT: For more musical tesla coil fun, check out this video from our friend Xyla KC1FSJ here at Case: https://www.youtube.com/watch?v=nH-3TdWI-yI This was with a group here called the Tesla Orchestra, which boasts an enormous set of musical tesla coils: https://www.youtube.com/watch?v=5vmQVxgAy90
3. Thanks James Sheerin and sorry the campaign was cancelled to use my HF antenna there. The HF Heating antenna was not damaged in Hurricane Maria, and that was very fortunate. Also, Kristina, that is fantastic at Case, my alma mater. My brother studied performance at the Cleveland Institute of Music with Principals of the Cleveland

Orchestra and was glad to hear about the Tesla Orchestra. Maybe my student could join you all….haha. David AD8Y: What's your brother's instrument?

4. He studied percussion with a performance degree and his teachers were Cloyd Duff (Principal Tympani) and Richard Wiener (Principal Percussionist). He is now at the University of Richmond and plays for the Williamsburg Symphony and Richmond Symphony and has a piano tuning business on the side too.
5. Thanks David. I hope to come and visit you all again sometime. AD8Y: We look forward to seeing you!
6. Thanks much
7. Back to the presentations now
8.

ePoster/eDemo Session I

Talk 24, 1800z: Laura Brandt

Into the Ionosphere: Real-Time Aurora Mapping Through Citizen Science

1. [KF6GG John Armstrong] - I posted a collection of Multipath graphs and an Excel sheet for generating them in a link to https://support.monsoonrf.com/Literature/Technical/Multipath/
    a. This relates to my question about the shape of your curve looking like a multipath attenuation as a function of range curve.

Talk 25, 1815z: Michael Hunnekuhl

An Aurorasaurus Citizen Science Database of Strong Thermal Emission Velocity Enhancement (STEVE) Observations

1.

Talk 26, 1830z: Michael McCormack

Live Aurora Network

1.

Talk 27, 1845z: Vincent Ledvina

Compact version of poster: https://i.imgur.com/n1SrIkK.jpg
Also here is a short compilation of real time aurora videos with the a7sii:
https://twitter.com/Vincent_Ledvina/status/1176716797300678657

Construction of an Aurora Camera in North Dakota to Aid in Citizen Science and Space Weather Applications

1. Is there any chance that the fripon.org meteor camera network may provide aurora images too?
    a. yes!

Talk 28, 1900z: Lindsay Goodwin

Novel methods for characterizing ionospheric irregularities in the high-latitude ionosphere

1. [Anton multiple questions] What model are you using? IRI & IGRF 2016. However, we are still playing with this, and are open to trying other models and techniques.[Lindsay]
2. GNSS We have not looked at GNSS yet, but we would love to [Lindsay]
3. From John Armstrong: The first two lobes of structure remind me of multipath intensity plots - any chance the dips are part of a multipath phenomena? Hi John, which figure were you referring to?[Lindsay --> https://hamsci.org/sites/default/files/pages/hamsci_workshop_2020/Posters/HamSCI_Goodwin.pdf]

ePoster/eDemo Session II

Talk 29, 1930z: Gwyn Griffiths

Patterns in Received Noise: Methods, Observations and Questions

1. RBN and FT8 give SNR. Would it be possible to give power in dBm which would be more meaningful for determining signal strength since local noise can always be variable with man made noise, etc.
2. We use my 'wsprdaemon' sw which is available at: https://github.com/rrobinett/wsprdaemon It runs on a Pi or other Debian server and currently gathers signals from a KiwiSDR or analog audo input. My current project it to make it compatible with a wide range of SDRs.
3. I've put a graph at https://www.dropbox.com/s/cvqoe4ac3uu2o6h/KJ6MKI%20Ground%20wave%20signal%20and%20SNR.jpg?dl=0
   To show KJ6MKI's SNR in blue, RH scale, and in red, LH scale his ground wave signbal at KPH after compensation for the varying noise level. So in this instance, the variation of nearly 10dB in the received SNR was virtually all changes in N, the signal was level to within +/- 0.3 dB or so.
4.

Talk 30, 1945z: Sovit Khadka

Neutral Winds in the Equatorial Thermosphere as Measured With the SOFDI Instrument

1.

Talk 31, 2000z: Jonathan Rizzo

Using a PVC Pipe antenna and a Raspberry Pi to Detect VLF Natural Radio

Best locations to install ? Away from long wire fences ? The best locations for an E-Field receiver must be an open field, away from trees and vegetation as they attenuate the E-Field signal. Structures like buildings can also attenuate the signal as well.

For an H-Field loop, they can be installed under trees and vegetation, however, structures can provide some attenuation.

A wire fence should be much of a problem at all. With both antennas, it is important to install in a location with the lowest level of power line hum, if possible. A site survey with a portable VLF receiver is important, not only for determining the lowest hum level, but also for monitoring power line harmonics, as some harmonics might be stronger at certain times of the day at certain locations.

Talk 32, 2015z: Jarred Glickstein & Soumyajit Mandal

Electromechanical ELF Transmitters for Wireless Communications in Conductive Environments

1.

Talk 33, 2030z: Stephen Hamilton & Charles Suslowicz

Visualizing the Electromagnetic Spectrum in the Time Domain

1. Github for the software: https://github.com/sshamilton/iq-graphing
2. Great article that has a great explanation on IQ data and also a theory IQ visualization app: https://arachnoid.com/software_defined_radios/

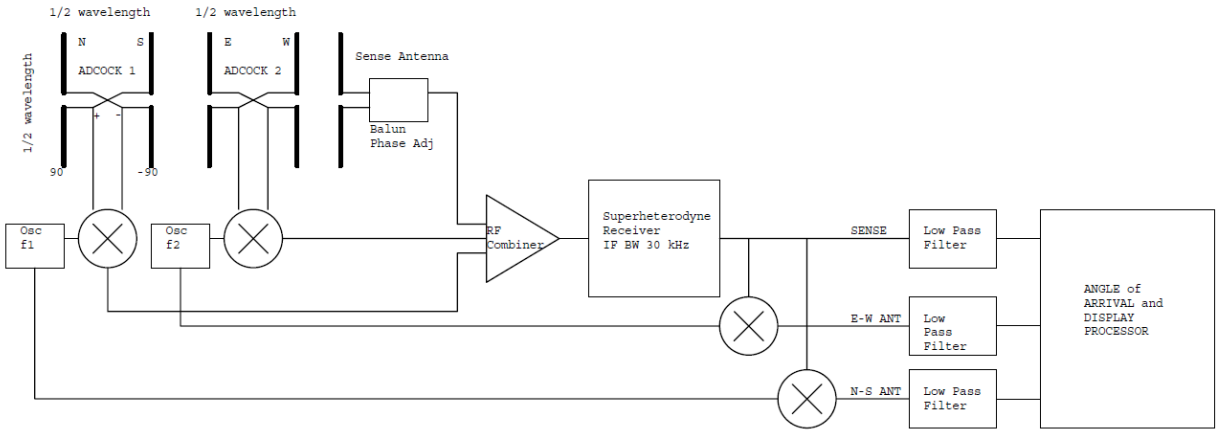
ePoster/eDemo Session III

Talk 34, 2100z: Nolan Pearce

Direction Finding: Analog and Digital Applications

1. [KF6GG - John T Armstrong] There is an Automatic Direction Finding design that I think would be particularly easy to implement with SDR and a few components. It was a commercial product of Ocean Applied Research (San Diego). It used a modulation - demodulation technique to combine the output from 3 antennas at RF so that the compbined signal could be passed through one receiver-IF chain and separated at baseband.

From Memory -



NOTES from KF6GG John T Armstrong:

1. This document was created for HAMSCI 2020 because no on-line patents or information could be found for the OAR (Ocean Applied Research)* ADF system. This is drawn from memory. If I can find my original manual, I will scan it and post it.
2. I don't recall the values of f1 and f2 from the original, but I think they were 10kHz and 30kHz.
3. In my opinion, f1 and f2 should not be harmonically related (In fact should be relatively prime, if they are close together).
4. fx max + / - RF modulation should fit in IF passband. Fx is either f1 or f2.
5. For modulation < 5kHz, f1 could be 13 kHz and f2 could be 23 kHz => IF BW >= 50 kHz
6. All dispersions and the delay caused by the receiver IF bandwidth filter design are applied to both signals.
7. In Analog processing, there is a need to adjust the phase delay of the Sense antenna and to ensure the LPF delays are the same.
8. This configuration should be easy to duplicate with an SDR. Note that only one SDR RF/IF path is required. The output 'detection, demodulation and filtering as well as the three LP filters could all be implemented in DSP. Of course if you have 2 identical SDR RF/IF paths (digital delays are deterministic ;)) then parallel the process and be done with it.
9. There is another procedure for separating the 3 signals and sending them through the same IF filter, which utilizes "Analog QFAST". To see a description, refer to the patent https://patents.google.com/patent/US5559828 “Transmitted reference spread spectrum communication using a single carrier with two mutually orthogonal modulated basis vectors”

* OCEAN APPLIED RESEARCH CORPORATION
USA California sCompany Number C0535947

Talk 35, 2115z: Jonathon Smith

Super Cheap Scintillation Console: Literate-Pancake

1. From Dave New, N8SBE: Do you need the USB HUB and HDMI cable for all units? I.e. you can use VNC, etc. to remotely administrate over wireless. Also, don't forget the price for a microSD card for each unit. Is the cost of the patch antenna included in the GPS receiver cost? The SD card of course, what a gaffe. Since the Pi has wifi and bluetooth it should be possible to use without the cables, however I don't have any experience installing the linux distro remotely. You can install locally, then admin remotely. Thus only one set of cables needed for initial install, but you don't need them for each unit. Latest versions of Pi-Star, which is used to create digital hotspots using a hardware radio 'hat' on a Pi-ZeroW, sets up a WiFi access point automatically if it doesn't find a configured access point to pair to. You then use your laptop WiFi finder function to find the Pi-ZeroW, and log in using the default ID and password. After logging in, you can then configure Pi-Star to attach to your household access point. Reboot, and viola, the Pi-ZeroW now connects to your local access point. Find the IP address assigned to it, and open a web browser on your laptop to that IP address. Log in, and you can then remote admin.
2. [KF6GG John Armstrong] For implementing a version of this without having to use a GPS receiver - try Peter MacDoran (Istac) solution. The basis of the design was worked out at JPL and spun out to ISTAC and was patented.
   https://patents.google.com/patent/US4797677A/en
   The patent describes scintillation as one of the components identified.

   The basic process is to convert the entire GPS signal to baseband and use the doppler offsets to identify the satellites using an externally provided ephemeris. This was a complicated analog system - but would be very easy to implement in an SDR. You would see the scintillation of all the satellites in one 'simple' SDR output. L1 is clocked at 1 Mega-Chip per second (2MHz BW), and band-limiting should not degrade the postprocessing, so a low cost SDR would likely work.
3.

Talk 36, 2130: Aidan Montare and John Gibbons

Visualizations of HF Doppler Observations

1. Excellent work for such a short time John and Aidat. Amazing you could accomplish so much in a short time and limited access during this crazy time. I really enjoyed the time compressed visualization. Steve WA5FRF

2.

Talk 37, 2145: David Vine

The Language of Amateur Radio

1. Excellent! Non-STEM, too: https://ieeexplore.ieee.org/document/7910230
2. At CWRU in Cleveland, we are running what we believe is the only non-STEM university course using amateur radio. --AD8Y for W8EDU

Talk 38, 2200: Nathaniel Frissell

Closing Discussion and Remarks

1.