RADIO ASTRONOMY

Journal of the Society of Amateur Radio Astronomers
November - December 2022

HAARP – High Frequency Active Auroral Research Program

Dr. Richard A. Russel
SARA President and Editor

Whitham D. Reeve
Contributing Editor

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It is the mission of the Society of Amateur Radio Astronomers (SARA) to: Facilitate the flow of information pertinent to the field of Radio Astronomy among our members; Promote members to mentor newcomers to our hobby and share the excitement of radio astronomy with other interested persons and organizations; Promote individual and multi station observing programs; Encourage programs that enhance the technical abilities of our members to monitor cosmic radio signals, as well as to share and analyze such signals; Encourage educational programs within SARA and educational outreach initiatives. Founded in 1981, the Society of Amateur Radio Astronomers, Inc. is a membership supported, non-profit [501(c) (3)], educational and scientific corporation.

Cover Photo: University of Alaska Fairbanks - Geophysical Institute

Contents

President's Page

I would like to start with a quote from Wolfgang …
"SARA was organized over 40 years ago to provide a resource and forum for amateur radio operators to expand their skills in the design of advanced antennas, receivers, and processing equipment. With advances of technology over time weaker and weaker source became accessible to amateurs. Observations are possible today which people back in the founding time of SARA could only dream of."

SARA Accomplishments in 2022

- SARA Grant Committee – Tom Crowley has organized several grants for qualifying organizations
- SARA Store – Lester Veenstra (Store Manager) has done an outstanding job with the Scope-in-a-Box radio telescope program.as well as James Pettingale – SuperSID program coordinator, and Dr. Chuck Higgins – Radio Jove Coordinator
- Chip Sufitchi – Outstanding support as the SARA Web administrator
- Special thanks to VP Jay Wilson, Treasurer Brian O'Rourke, Secretary Bruce Randall, Contributing Editor Whitham Reeve, and Past President Dennis Farr

Other Accomplishments:

- SARA Journal (Radio Astronomy) – published six times per year
- Fully indexed references to all journals, conference proceedings and video presentations – invaluable for doing research for your radio astronomy project.
- Monthly Zoom session – Drake's Lounge (forum to discuss technical challenges with leading experts)
- Monthly Zoon session – Radio Telescope Observation Party (forum to discuss how to observe astronomical sources)
- Monthly Zoom session – Australia Drake's Lounge (forum to discuss radio astronomy with Australia members)
- SARA – Listserve – real-time forum to provide 24/7 technical interchange between members.
- SARA YouTube Channel – provides presentations on all aspects of amateur radio astronomy. This includes tutorials and radio astronomy observations.
https://www.youtube.com/channel/UC-SzptAQZ-20c9CkRb9ZPxw/videos

- Two major conferences each year (East Coast and West Coast) in which the members meet and present results from the past year.

There has been a significant amount of volunteer activity this year! We appreciate everyone's involvement in making SARA a premier international amateur radio astronomy organization.

Thanks!

Rich
SARA President

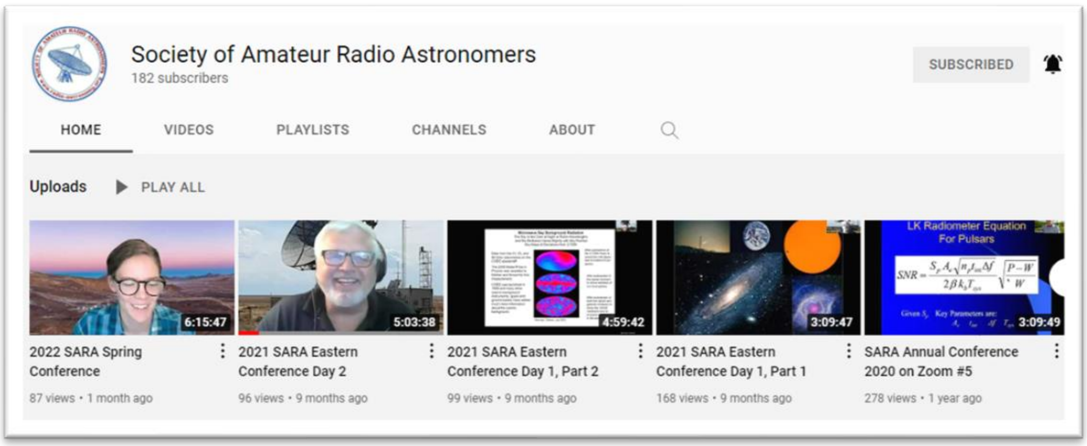
Editor's Notes

We are always looking for basic radio astronomy articles, radio astronomy tutorials, theoretical articles, application and construction articles, news pertinent to radio astronomy, profiles and interviews with amateur and professional radio astronomers, book reviews, puzzles (including word challenges, riddles, and crossword puzzles), anecdotes, expository on "bad astronomy," articles on radio astronomy observations, suggestions for reprint of articles from past journals, book reviews and other publications, and announcements of radio astronomy star parties, meetings, and outreach activities.

Subscribe to the SARA YouTube Channel

SARA has a YouTube channel at: https://www.youtube.com/channel/UC-SzptAQZ-20c9CkRb9ZPxw/videos

We are also looking to add content to the site. Anyone who wants to help produce a series of 5 - minute videos relating to radio astronomy technology or observations please contact me. (drrichrussel@netscape.net)



Observation Reports

We are now accepting 1-2 page observation reports. These reports should include the astronomical object's RA/DEC plus UTC of the observation. Also include the telescope configuration, process used to observe the object and results. Picture of the setup and plots of the observation are a plus to the report.

If you would like to write an article for Radio Astronomy, please follow **the newly updated Author's Guide** on the SARA web site:
http://www.radio-astronomy.org/publicat/RA-JSARA_Author's_Guide.pdf.

Let us know if you have questions; we are glad to assist authors with their articles and papers and will not hesitate to work with you. You may contact your editors any time via email here: edit@radio-astronomy.org.

The editor(s) will acknowledge that they have received your submission within two days. If they do not reply, assume they did not receive it and please try again.

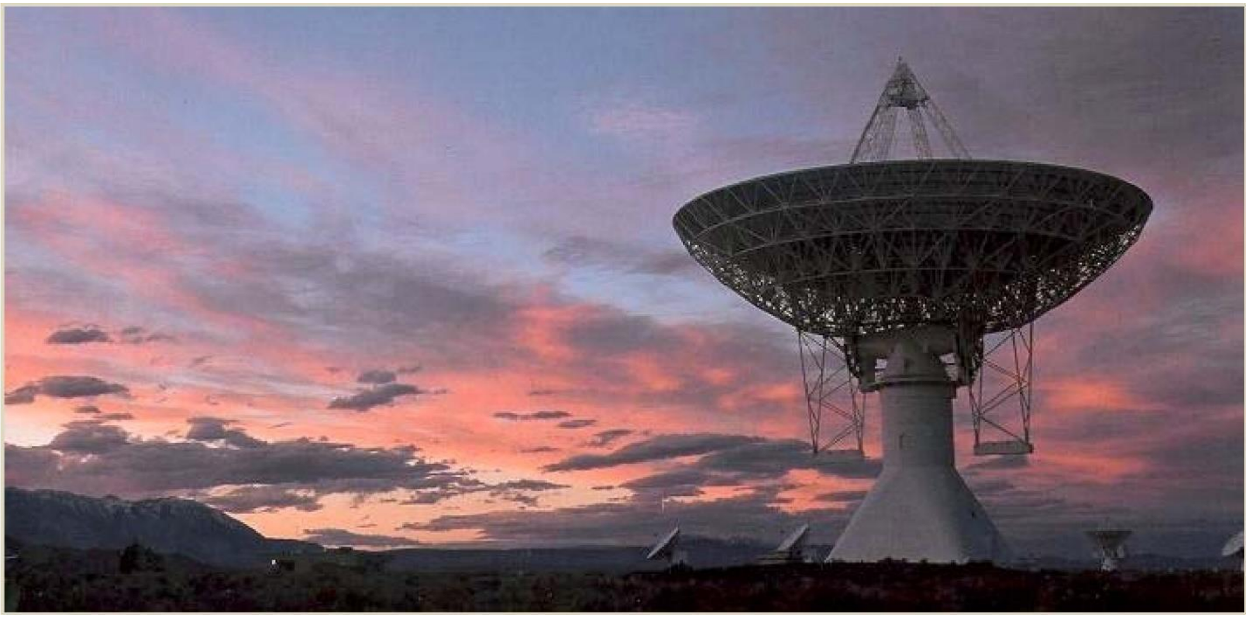
Please consider submitting your radio astronomy observations for publication: any object, any wavelength. Strip charts, spectrograms, magnetograms, meteor scatter records, space radar records, photographs; examples of radio frequency interference (RFI) are also welcome.
Guidelines for submitting observations may be found here: http://www.radio-astronomy.org/publicat/RA-JSARA_Observation_Submission_Guide.pdf

2023 SARA Western Conference

Bishop, California, USA on 17 and 18 March, 2023

The 2023 SARA Western Conference will be held at Bishop, California at the Owens Valley Radio Observatory on Friday and Saturday, 17 and 18 March 2023. OVRO is operated by California Institute of Technology and is located about 20 miles southeast of Bishop.

From the OVRO website (http://www.ovro.caltech.edu/): "*The Owens Valley Radio Observatory (OVRO) is one of the largest university-operated radio observatories in the world. Known by locals as 'The Big Ears', the observatory is located near Bishop, California, approximately 250 miles north of Los Angeles on the east side of the Sierra Nevada. For reference, its coordinates are 37:14:02N latitude, 118:16:56W longitude at 1222 meters above sea level. ...*" Image below from http://www.ovro.caltech.edu/



Call for papers: Papers are welcome on subjects directly related to radio astronomy including hardware, software, education and tutorials, research strategies, observations and data collection and philosophy. If you wish to present a paper please email a letter of intent, including a proposed title and abstract to the conference coordinator at westernconf@radio-astronomy.org no later than 20 December 2022.

Be sure to include your full name, affiliation, postal address, and email address, and indicate your willingness to attend the conference either in person or virtually to present your paper. Submitters will receive an email response, typically within one week. Final advance presentations should be submitted to the Western Conference coordinator for inclusion in the proceedings no later than March 1, 2023. Due to the work required to prepare the proceedings, this should be considered a hard deadline.

Presentations and proceedings: In addition to presentations by SARA members, we plan to have speakers from OVRO and we have arranged for an OVRO scientist to make a presentation (more details to follow). Papers and presentations on radio astronomy hardware, software, education, research strategies, philosophy, and observing efforts and methods are welcome. Formal proceedings will be published for this conference. If presenters want to submit a paper or a copy of their presentation, we will make them available to attendees on a flash drive.

Basic schedule: The conference will be entirely held at Owens Valley Radio Observatory with presentations by SARA members and supporters and OVRO staff followed by a tour of the OVRO facilities. Virtual attendance at the conference will be possible at a reduced rate for those who cannot attend in person.

Contact: Please contact conference coordinator David Westman if you have any questions or if you would like to help with the conference: westernconf@radioastronomy.org.

Getting there: Bishop and OVRO are located in a valley between the eastern Sierra Nevada and White Mountains. Because of the remote location we recommend conference participants make their travel plans and hotel and rental car reservations early. Possibilities are to fly into San Francisco (SFO) and connect to the regional airport at Eastern Sierra Airport (BIH), 2 miles from of Bishop. The airline traveling into Eastern Sierra is United Airlines, which has marketing agreements with a number of airlines including American Airlines.

Registration: Registration for in person attendance at the 2023 Western Conference is just US$55.00. The reduced rate to attend the conference on line is $15. You must be a SARA member to register for the conference. The in person conference rate will include lunch at the conference site on Friday and Saturday. Payment can be made through PayPal, www.paypal.com by sending payment to treas@radio-astronomy.org. If you need to send a check for registration, please send it to SARA Treasurer (c/o Brian O'Rourke), 337 Meadow Ridge Road Troy, VA 22974-3256. Please include in comments that the payment is for the **2023 Western Regional Conference**.

Hotel reservations: There are many hotels and motels in Bishop with reasonable rates.
The Bishop Inn offers rooms from $63 a night, and the El Rancho Motel rates start at $98 per night. The Best Western Bishop motel rates start at $135 per night, and others can be found in the same range.

Saturday night dinner: We will make a group dinner reservation at a local restaurant for Saturday night.

Additional Information: Additional details will be published online at www.radioastronomy.org and in the SARA journal, *Radio Astronomy*, as we get closer to the conference date.

SARA Student & Teacher Grant Program

All, SARA has a grant program that is, sad to say very underutilized. We will provide kits or money to students and teachers including college students to help them with a radio telescope project. SARA can supply any of the following kits:

[1] SuperSID
[2] Scope in a Box
[3] IBT (Itty Bitty Telescope)
[4] Radio Jove kit
[5] Inspire
[6] Sky Scan

We can also provide up to five hundred dollars ($500.00 USD) for an approved radio telescope project.

We have on occasion provided more money based on the merits of the project and the SARA Grant Committee approval.

More information on the grant program can be found at the URL below.
SARA Student and Teacher Project Grants | Society of Amateur Radio Astronomers (radio-astronomy.org)

All that is required is the SARA grant request form be filled out and sent in. If it needs more work for approval, we will work with the student to help ensure their success.

Please pass the word that SARA will fund any legitimate radio telescope project anywhere in the world.

If you have a question, contact me at crowleytj at hotmail dot com.

Tom Crowley
SARA Grant Program Administrator

NEW Drake's Lounge Australia

This new zoom forum is geared to the Melbourne, Australia time zone (UTC+10) in order to improve coordination with our Australia, New Zealand, and Japanese members. The next meeting is on December 24, 9 AM Melbourne time (2000 UTC December 23). A zoom announcement will be sent out to all SARA members before the meeting.

Radio Telescope Observation Party (RTOP)

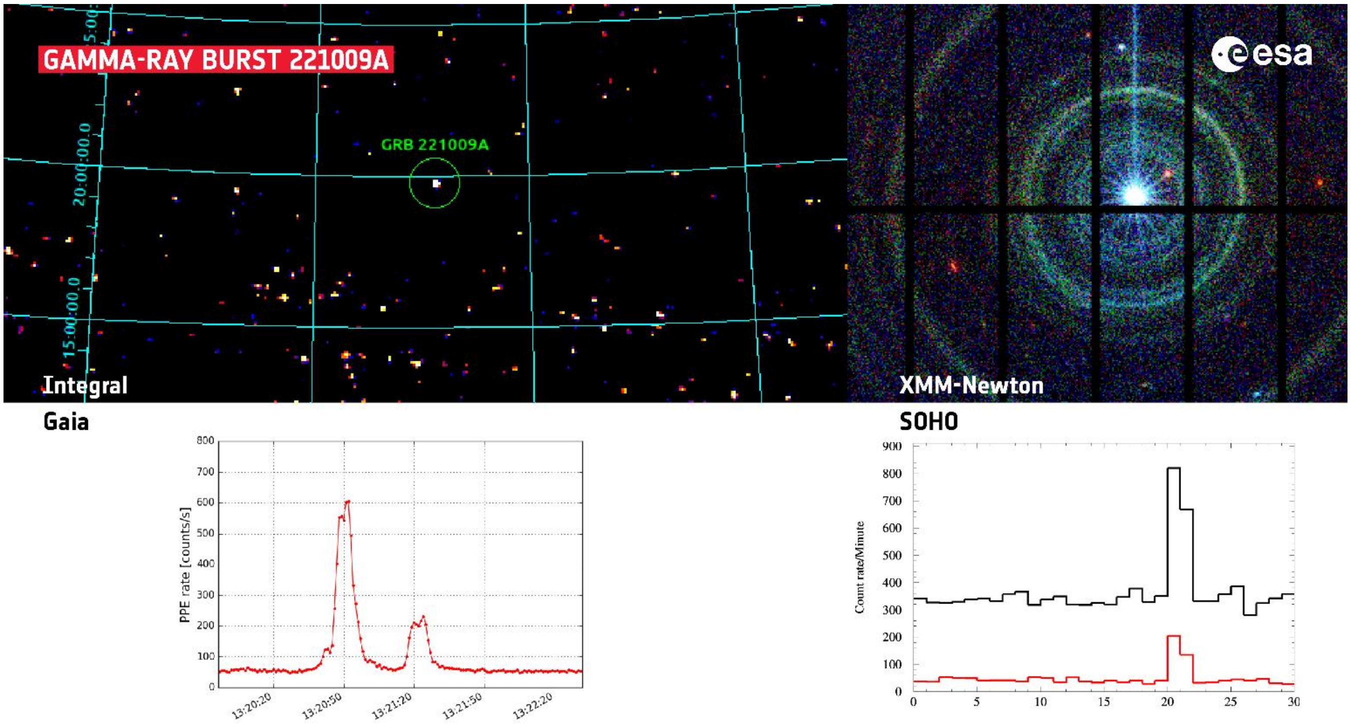
RTOP is designed to demonstrate how to take observations using various radio telescopes. It will also cover how to record and analyze data.
RTOP is every month on the 1st Sunday at 2 pm Eastern time (1800 UTC). ZOOM email notifications will be sent to all members.

Drake's Lounge

Join the SARA community as we discuss the latest astronomy and radio astronomy news. The lounge also provides a forum to share and get advice on your radio astronomy projects from very experienced amateur radio astronomers.

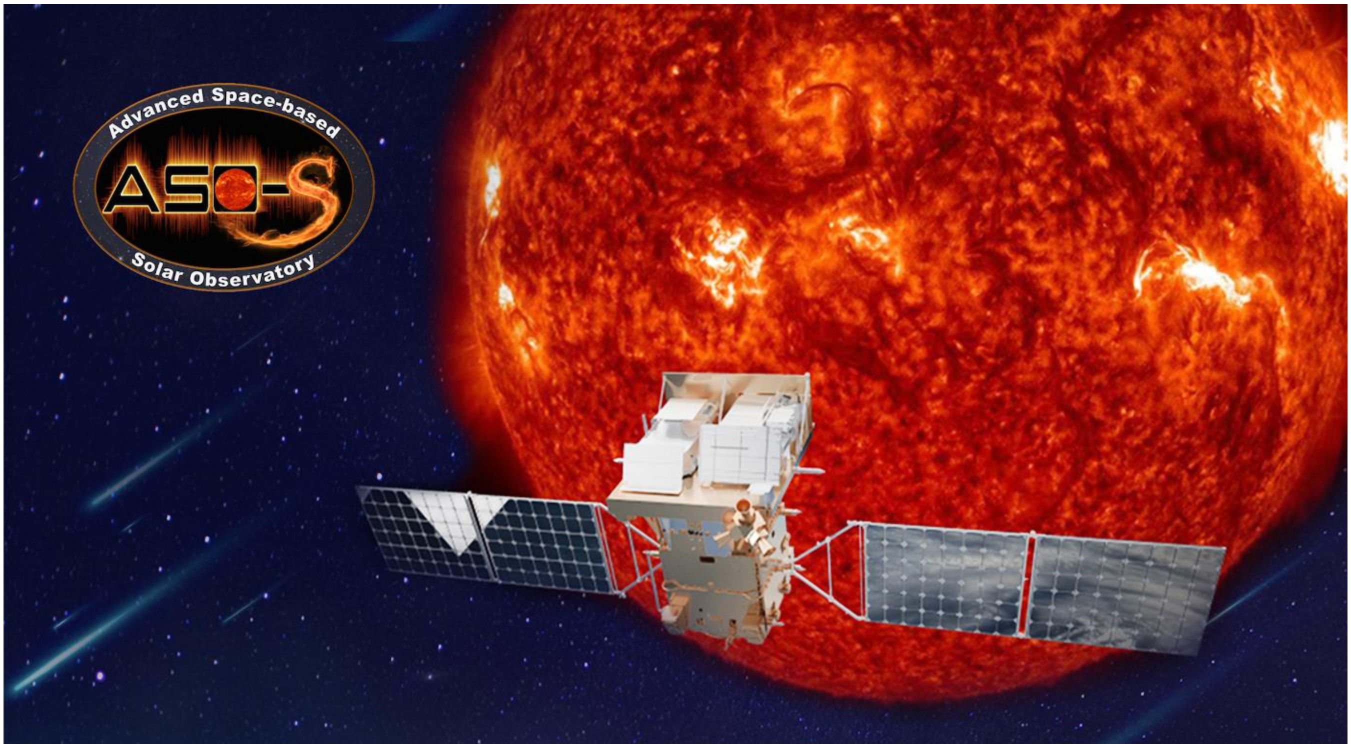
Drake's Lounge is every month on the 3rd Sunday at 2 pm Eastern time (1800 UTC). ZOOM email notifications will be sent to all members.

News: (November - December **2022)**

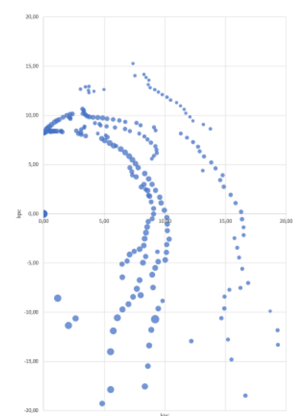


European Space Agency ~ *ESA spacecraft catch the brightest ever gamma-ray burst*: https://www.esa.int/ESA_Multimedia/Images/2022/10/ESA_spacecraft_catch_the_brightest_ever_gamma-ray_burst

Universe Today ~ Arecibo Won't Be Rebuilt: https://www.universetoday.com/158125/arecibo-wont-be-rebuilt/



ASO-S Successfully Launched on 9 October, 2022: The first comprehensive space solar observatory in China, Advanced Space-based Solar Observatory (ASO-S), was successfully launched from Jiuquan, Gansu Province, on 9 October at 07:43 am China Standard Time. ASO-S focuses on solar eruptions and their origins (https://www.nature.com/articles/s41550-021-01593-9). A special issue describing the whole mission can be found at http://www.raa-journal.org/issues/all/2019/v19n11/ . The ASO-S home page can be accessed via the following link http://aso-s.pmo.ac.cn/en_index.jsp , which is being updated continuously. ASO-S team will announce the training course on how to access the data in due time.



Radio2Space ~ *Study of the galactic hydrogen distribution with SPIDER 300A radio telescope*: https://www.radio2space.com/study-of-the-galactic-hydrogen-distribution-with-spider-300a-radio-telescope/

Spaceweather.com ~ *Powerful Gamma-Ray Burst Made Currents Flow in the Earth*: https://spaceweather.com/archive.php?view=1&day=18&month=10&year=2022

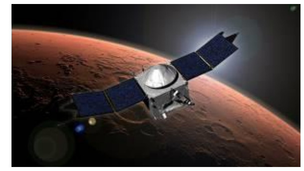
Research Notes of the AAS ~ *A Significant Sudden Ionospheric Disturbance Associated with Gamma-Ray Burst GRB 221009A*: https://iopscience.iop.org/article/10.3847/2515-5172/ac9d2f

MeteorNews ~ *New Nomenclature Rules for Meteor Showers Adopted*: https://www.meteornews.net/2022/11/03/news-from-the-meteor-library-new-nomenclature-rules-for-meteor-showers-adopted/

Universe Today ~ *Just Four Robots Could Deploy a Huge Radio Telescope on the Far Side of the Moon*: https://www.universetoday.com/158409/just-four-robots-could-deploy-a-huge-radio-telescope-on-the-far-side-of-the-moon/

Radio2Space ~ *SPIDER 300A radio telescope for radio astronomy installed near Prague in Czech Republic*: https://www.radio2space.com/portfolio/spider-300a-radio-telescope-for-radio-astronomy-installed-near-prague-in-czech-republic/

Universe Today ~ *NASA's MAVEN Witnessed Auroras as Multiple Solar Storms Crashed into Mars*: https://www.universetoday.com/158678/nasas-maven-witnessed-auroras-as-multiple-solar-storms-crashed-into-mars/



ArXiv ~ *The discovery and scientific potential of fast radio bursts*: https://arxiv.org/abs/2211.06048

NRF-SARAO ~ *Extraterrestrial signal search is underway using the southern hemisphere's biggest radio telescope*: https://www.sarao.ac.za/media-releases/extraterrestrial-signal-search-is-underway-using-the-southern-hemispheres-biggest-radio-telescope/

History of Geo- and Space Sciences ~ *History of the Potsdam, Seddin and Niemegk Geomagnetic Observatories – First Part: Potsdam*: https://hgss.copernicus.org/preprints/hgss-2022-14/

SKA Observatory ~ *SKA Observatory celebrates start of telescope construction in Australia and South Africa*: https://www.skao.int/en/news/441/ska-observatory-celebrates-start-telescope-construction-australia-and-south-africa

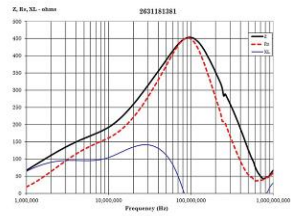
SARA Member Pablo Lewin, NASA Exoplanet Watch Community ~ *Member of the Month*: https://exoplanets.nasa.gov/exoplanet-watch/about-exoplanet-watch/community/

Universe Today ~ *One of the World's Biggest Radio Telescopes is Hunting for Signals From Extraterrestrial Civilizations*: https://www.universetoday.com/158966/one-of-the-worlds-biggest-radio-telescopes-is-hunting-for-signals-from-extraterrestrial-civilizations/

$$N = R^{*} \cdot f_{p} \cdot n_{e} \cdot f_{\ell} \cdot f_{i} \cdot f_{c} \cdot L$$

Universe Today ~ *Construction Begins on the Square Kilometer Array*: https://www.universetoday.com/159011/construction-begins-on-the-square-kilometer-array/

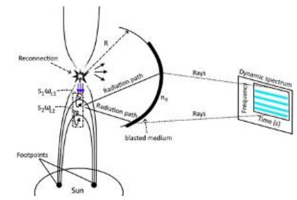
Technical Knowledge & Education (November – December 2022)



In Compliance ~ *Cable Antennas and Ferrite Cores*: https://incompliancemag.com/article/cable-antennas-and-ferrite-cores/

EDN ~ Capacitors

- Part 1: *Ceramic capacitors: How far can you trust them?*: https://www.edn.com/ceramic-capacitors-how-far-can-you-trust-them/
- Part 2: *Class 2 ceramic capacitors—can you trust them?*: https://www.edn.com/class-2-ceramic-capacitors-can-you-trust-them/
- Part 3: *Capacitors–the old decoupling standbys*: https://www.edn.com/capacitors-the-old-decoupling-standbys/



Community of European Solar Radio Astronomers (CESRA) ~ *Characteristics of stripes-pattern radio-emission sources*: https://www.astro.gla.ac.uk/users/eduard/cesra/?p=3386

All About Circuits ~ *Fourier Series Circuit Analysis—An Intro to Fourier Series Representation*: https://www.allaboutcircuits.com/technical-articles/fourier-series-circuit-analysis-an-introduction-to-fourier-series-representation/

TechOnline ~ *RF Demystified—What Is an RF Attenuator?*: https://www.techonline.com/tech-papers/what-is-an-rf-attenuator/

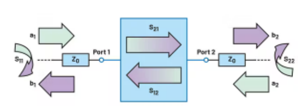
Rohde & Schwarz ~ *Output Power Measurement on Noise Sources*: https://www.rohde-schwarz.com/us/applications/output-power-measurement-on-noise-sources-application-note_56280-1224193.html

ArXiv ~ *The Possible Cause of the 40 SpaceX Starlink Satellite Losses in February 2022: Prompt Penetrating Electric Fields and the Dayside Equatorial and Midlatitude Ionospheric Convective Uplift*: https://arxiv.org/abs/2210.07902

ADS ~ *Overexpansion-dominated coronal mass ejection formation and induced radio bursts*: https://ui.adsabs.harvard.edu/abs/2022A%26A...666A.166W/abstract

YouTube video ~ *The Most Important Algorithm Of All Time*: https://www.youtube.com/watch?v=nmgFG7PUHfo

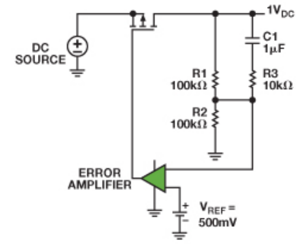
Coilcraft ~ *S-parameters for High-frequency Circuit Simulations*: https://www.coilcraft.com/getmedia/35dbfd16-8483-4ef7-bb07-9b28a04f6dcc/doc1721_When-to-Use-S-parameters.pdf



Electronic Design ~ *RF Demystified: The Different Types of Scattering Parameters*: https://www.electronicdesign.com/technologies/analog/article/21250652/analog-devices-rf-demystified-the-different-types-of-scattering-parameters

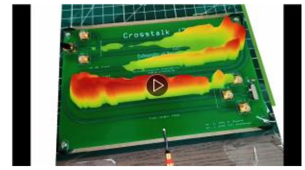
Center for Geospace Storms ~ *3rd CGS Workshop* (Conference presentations that concentrate on geospace modeling, and model-data comparisons, "at the edge of possibility"): https://cgs.jhuapl.edu/News-and-Events/Agenda/index.php?id=127

AGU Geophysical Research Letters ~ *Ganymede-Induced Decametric Radio Emission: In Situ Observations and Measurements by Juno*: https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2020GL090021



Analog Devices ~ *Noise-Reduction Network for Adjustable-Output Low-Dropout Regulators*: https://www.analog.com/en/analog-dialogue/articles/noise-reduction-network.html

Pasternack ~ *GPS & GNSS Antenna Configurations*: https://www.pasternack.com/images/pdf/2022/PE-GPS-Antenna.pdf



Andy Eadie's Post ~ *Capturing the propagation of electromagnetic waves at 5 billion samples per second*: https://www.linkedin.com/posts/andyeadie_emc-emctesting-emctroubleshooting-activity-6996739119255080960-e_aw

AR ~ *Posters*, including RF and EMC Formulas and Charts, Mathematical Tools of the Trade Poster, Radiated and Conducted Immunity Test Requirements & Solutions: https://arworld.us/poster/

Announcements (November - December 2022

National Science Foundation
WHERE DISCOVERIES BEGIN

NSF Funding for the Great American Solar Eclipses 2023 and 2024

The upcoming Great American Solar Eclipses, on October 14, 2023 and April 8, 2024, provide unique opportunities for science, education and outreach that various National Science Foundation (NSF) programs seek to support through this Dear Colleague Letter (DCL). The annular eclipse in 2023 will cover the western United States from Oregon to Texas while the total eclipse in 2024 will be visible from Texas to Maine with a partial solar eclipse viewable over most of the continental United States. The ease of observing these eclipses provides tremendous educational and outreach potential for the Americas. In addition, scientific advances enabled by observations of the eclipse include, understanding of the solar corona and magnetospheric, ionospheric, and atmospheric responses to changes in solar flux. The eclipses provide opportunity for ground-based observations of the solar corona to test new diagnostics enabled by instrumentation development.

NSF's Division of Atmospheric and Geospace Sciences and Division of Astronomical Sciences welcome proposals and supplements to fund science and outreach surrounding the 2023 and 2024 Solar Eclipses. Details are available here:
https://www.nsf.gov/pubs/2023/nsf23014/nsf23014.jsp?WT.mc_ev=click&WT.mc_id=&utm_medium=email&utm_source=govdelivery

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Dear SCOSTEP Colleagues,

It is our great pleasure to announce that ***Symposium on the Future of Heliospheric Science: From Geotail and Beyond*** will be held at Koshiba-Hall, University of Tokyo, between 28 -31 March 2023.

The Geotail satellite, launched in July 1992 from Florida, U. S. A., as a joint project between ISAS (now JAXA) and NASA, has been studying the structure and dynamics of the magnetotail and other key regions of the magnetosphere. It has achieved epoch-making results, including numerous discoveries in magnetospheric physics. After more than three decades in operation, a failure of the onboard data recorder that occurred at the end of June has considerably reduced the amount of data that can be received, while data from some onboard instruments are no longer available. Therefore, we have now decided to end Geotail’s operation. The shutdown is scheduled to take place by the end of December of this year.

The purpose of this symposium is to link the tremendous results of Geotail to the future by reviewing the achievements of Geotail to date and looking forward to the exploration of the inner heliosphere system that consists of several sub-systems, Geospace, planetary system, interplanetary space, and the Sun in the late 2020s. The exploration will further expand its area to the whole heliosphere beyond that time frame. The future exploration will also contribute to the space weather research/forecast that supports human activities in Geospace, Moon and other planets.

The symposium will be held in a hybrid format. In addition to invited talks, we plan to call for contributed talks and posters. The call for contributed papers is scheduled to open around December.

Place: Koshiba Hall, Hongo Campus, The University of Tokyo: https://www.s.u-tokyo.ac.jp/en/map/map01.html
Date: March 28(Tuesday) to 31(Friday) 2023

Yoshifumi Saito, Geotail Project Manager, ISAS/JAXA

Space Weather Workshop April 17-21, 2023 (In-person with a Virtual Component)

Hotel, registration, student program, and additional information will be announced in early 2023 at the UCAR Website (https://cpaess.ucar.edu/meetings/space-weather-workshop-2023).

The 2023 Space Weather Workshop will be held in-person, with a virtual component, April 17-21, 2023. Space Weather Workshop is an annual conference that brings industry, academia, and government agencies together in a lively dialog about space weather. What began in 1996 as a conference for the space weather user community, Space Weather Workshop has evolved into the Nation's leading conference on all issues relating to space weather.

The conference addresses the remarkably diverse impacts of space weather on today's technology. The program highlights space weather impacts in several areas including communications, navigation, spacecraft operations, human space exploration, aviation, space traffic coordination, and electric power. The workshop will also focus on the highest priority needs for operational services that can guide future research and new high-value capabilities that can be transitioned into operations. The conference fosters communication among researchers, space weather service providers, and users of space weather services.

Space Weather Workshop is organized by the University Corporation for Atmospheric Research (UCAR) Cooperative Programs for the Advancement of Earth System Science (CPAESS), along with a community-based organizing committee and co-sponsored by the NOAA Space Weather Prediction Center, the NSF Division of Atmospheric and Geospace Sciences, and the NASA Heliophysics Division.

NASA's Small Business Innovation Research (SBIR) 2023 Phase I Solicitation, January 2023
(Space Weather R202R)

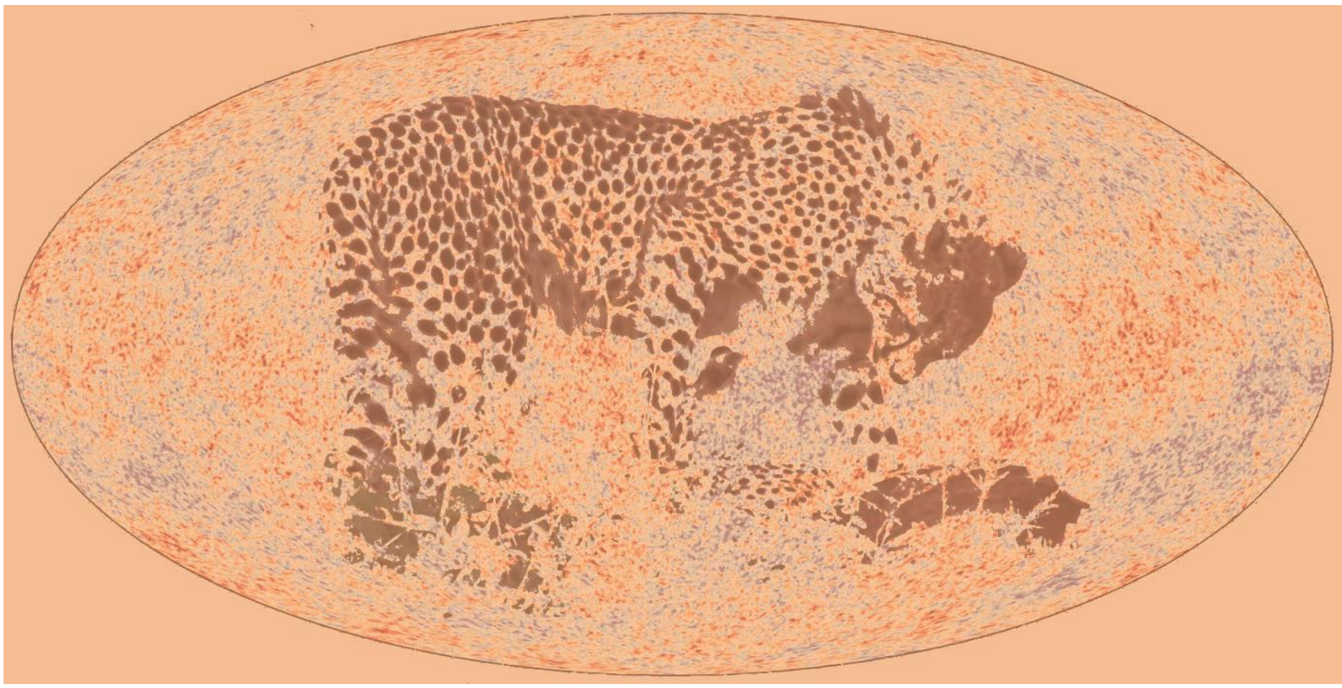
Get ready for NASA's Small Business Innovation Research (SBIR) program, which will be soliciting proposals in January 2023. The SBIR program seeks to transform scientific discovery into products and services through innovations that have the potential for infusion into NASA programs and missions, the potential for commercialization into NASA relevant commercial markets, and that have a societal benefit.

Specifically, the Space Weather Research to Operations to Research Technology Development and Commercial Applications subtopic (S14.01) will broaden NASA's impact in this area by nurturing small businesses that are forming a national space-weather applications, commercial-business sector as part of NASA's response to the National Space Weather Strategy and Action Plan. Continued work under this subtopic is important to assure the protection of human and technological assets in space and on the ground, and to ensure that NASA's exploration activities continue unabated, to improve life on Earth. Successful space-weather projects will aim to improve one or more of the following priority focus areas:

- Forecasting technologies,
- Techniques and applications,
- Commercial and decision-making applications,
- Advanced data-driven discovery techniques, and
- Instrumentation.

There will be additional 2023 SBIR subtopics of interest to the Heliophysics community that will include enabling technologies for In Situ Particles and Fields and Remote-Sensing instruments (S16.3); these include more specifically: in-situ instruments such as ion and neutral mass spectrometers, wind and drift meters, thermal plasma, energetic particles, DC and wave electric and magnetic fields. Remote sensing instruments include solar and geospace FUV/EUV and X-ray imagers and radio-wave electromagnetic sounders of ionospheric and magnetospheric plasmas. These technologies must be capable of withstanding space radiation levels, survival and operational temperatures, and launch stresses.

The SBIR program has several phases with various levels of support. Phase I awards up to $125,000 are for six months. Phase II awards up to $750,000 for prototype development are for 24 months. Phase III, intended for infusion and commercialization of the product, must seek non-SBIR funding, which could include NASA/SMD. Direct questions to Jim Spann (james.f.spann at nasa.gov), Mitzi Adams (mitzi.adams at nasa.gov), or Anthony DeStefano (anthony.m.destefano at nasa.gov) or see https://sbir.nasa.gov/ .



Cosmology on Safari 2023, 6 – 10 March 2023, Hluhluwe, KwaZulu-Natal, South Africa

We are pleased to announce that registration is now open for Cosmology on Safari 2023 at https://cosmosafari.co.za . This will be the 4th Cosmology on Safari conference, and again we will bring together experts in the field to discuss the interplay between cosmological models and data, with an emphasis on the challenges that remain in cosmology. The topics covered will span a wide range of theoretical issues and observational probes; details and a preliminary list of invited speakers are available on the website.

Cosmology on Safari 2023 will take place during March 5-11 2023, at Anew Hluhluwe Hotel & Safaris, in KwaZulu-Natal, South Africa (https://anewhotels.com/hotels/hluhluwe-safaris/). The Hotel is a 15 minute drive from the Memorial Gate of the Hluhluwe-Imfolozi game reserve, in which you can find all of the "Big 5" (lion, leopard, elephant, rhino, water buffalo) and many more wild creatures in their natural habitat. There are many other activities and nature reserves to explore in the area, including the nearby iSimangaliso (St Lucia) Wetland Park, a UNESCO World Heritage Site.

Registration and abstract submission close on 15 January, 2023. The registration fee is 5000 ZAR - please see the website for details. There is some funding available to partially support South African students, and interested parties should contact the conference organisers.

Important Dates:

- 4 Nov 2023: Registration opens
- 15 Jan 2023: Abstract submission deadline (presenters will be notified by 30 Jan 2023)
- 15 Feb 2023: Final payment deadline (unpaid bookings will be cancelled on this date)
- 5–11 Mar 2023: Conference

Please feel free to forward this message to others who might be interested, and apologies if you receive this announcement more than once. We hope to see you in South Africa in 2023!

Organising Committee:

- Hsin Cynthia Chiang, Matt Hilton, Yin-Zhe Ma, Kavilan Moodley, Jonathan
- Sievers, Kenda Knowles, Edwin Retana, Sinenhlanhla Sikhosana, Mugundhan
- Vijayaraghavan, Anthony Walters

Email: help_at_cosmosafari.co.za

The next URSI General Assembly & Symposium is scheduled for August 19-26, 2023 at Saporo, Japan.

Commission G encourages you to submit your contributions particularly focused on "ionospheric physics" that may fall within the broad theme of the Joint Session organized by Commissions E, J and G (described below.

Session: EJG

Title: Machine learning & signal processing to analyze & mitigate EMI

Description: Contemporary techniques for characterizing and mitigating EM interference primarily use signal processing as their basis with machine learning now starting to appear in experimental systems. These tools have found use in the modeling and mitigating interference of different kinds, in a variety of systems. This session would cover the latest developments in the areas of machine learning, deep learning and signal processing for interference characterization, classification, and mitigation. The session also seeks papers on challenging applications where the use or the potential use of these techniques could significantly reduce the effects of interference. The paper submission deadline is January 25, 2023. You can find all the information on the website: https://www.ursi-gass2023.jp/

If you need any complementary information, please do not hesitate to contact us.
Hariharan Krishnan, Convener (Commission G)

Frontend Research at Low Radio Frequency Radio Astronomy: Science and Technical Challenges

PROGRAM:

- Low frequency radio astronomy and the LOFAR telescope, Lecturer: R. Vermeulen - International LOFAR Telescope (ILT)
- LOFAR surveys: a new window of observation of the Universe, Lecturer: R. van Weeren - Leiden University, The Netherlands
- LOFAR LBA: Sky Survey and Practical Use, Lecturer: F. de Gasperin - INAF- Istituto di Radioastronomia, Italy
- Ionosphere Calibration, Lecturer: M. Mevius - ASTRON, The Netherlands;
- Very Long Baseline Interferometry with LOFAR, Lecturer: L. Morabito - Durham University, United Kingdom
- Polarization at low radio frequencies and cosmic magnetism, Lecturer: A. Bonafede - DIFA University of Bologna, Italy

- Computational challenges in low frequency radio astronomy, Lecturer: G. Taffoni - INAF- Osservatorio Astronomico di Trieste, Italy
- Solar radio astronomy and space weather, Lecturer: P. Zucca - ASTRON, The Netherlands
- Pulsars at low radio frequencies, Lecturer: C. Tiburzi - INAF- Osservatorio Astronomico di Cagliari, Italy
- Transients at low radio frequencies, Lecturer: A. Rowlinson - University of Amsterdam and ASTRON, The Netherlands
- Cosmic rays and magnetic fields in nearby galaxies, Lecturer: V. Heesen - Hamburg University, Germany
- Radio Galaxies at low radio frequencies, Lecturer: R. Morganti - ASTRON and University of Groningen, The Netherlands
- Non-thermal phenomena in galaxy clusters and large-scale-structure, Lecturer: G. Brunetti - INAF- Istituto di Radioastronomia, Italy
- The impact of low frequency observations in Cosmology, Lecturer: S. Camera - Physics Dept. University of Torino, Italy

Website for application: https://www.cifs-isss.org/Program042023.aspx

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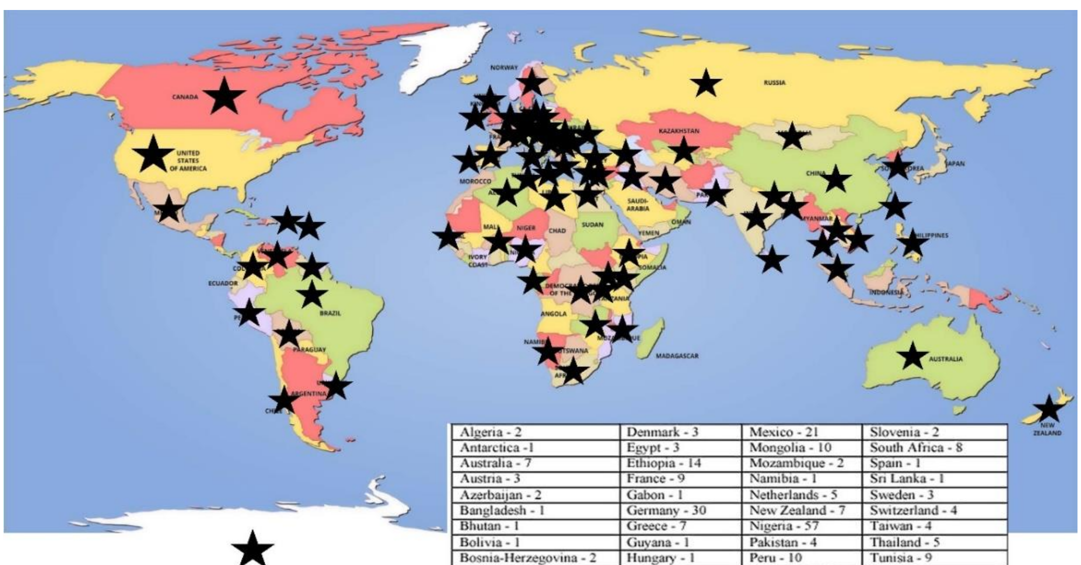
International Union of Radio Science: General Assembly & Scientific Symposium (URSI-GASS) 2023

Host: Japan National Committee of URSI (JNC-URSI)
Sponsors:
The Institute of Electronics, Information and Communication Engineers (IEICE),
Science Council of Japan (SCJ)(under process),
International Union of Radio Science (URSI)
General Chair: Prof. Kazuya Kobayashi, Chuo University, Tokyo, Japan
Conference Secretariat: Convention Linkage, Inc., Sapporo, Japan
Website: https://www.ursi-gass2023.jp/

SuperSID

Collaboration of Society of Amateur Radio Astronomers and Stanford Solar Center

- Stanford provides data hosting, database programming, and maintains the SuperSID website
- Society of Amateur Radio Astronomers (SARA) sells the SuperSID monitors for 48 USD to amateur radio astronomers and the funds are then used to support free distribution to students all over the world (image below as of Fall 2017)
-
- Jonathan Pettingale at SARA is responsible for building and shipping the SuperSID monitor kits: SuperSID@radio-astronomy.org
- SuperSID kits may be ordered through the SARA SuperSID webpage: http://radio-astronomy.org/node/210
- Questions about the SuperSID project may be directed to Steve Berl at Stanford: steveberl@gmail.com
- Jaap Akkerhuis at Stanford is responsible for the SuperSID software and SARA has provided financial support for his efforts
- SuperSID website hosted by Stanford: http://solar-center.stanford.edu/SID/sidmonitor/
- SuperSID database: http://sid.stanford.edu/database-browser/
- The data is searchable by time, station, date, and multiple plots may be placed on the same graph for comparison.



Algeria - 2	Denmark - 3	Mexico - 21	Slovenia - 2
Antarctica -1	Egypt - 3	Mongolia - 10	South Africa - 8
Australia - 7	Ethiopia - 14	Mozambique - 2	Spain - 1
Austria - 3	France - 9	Namibia - 1	Sri Lanka - 1
Azerbaijan - 2	Gabon - 1	Netherlands - 5	Sweden - 3
Bangladesh - 1	Germany - 30	New Zealand - 7	Switzerland - 4
Bhutan - 1	Greece - 7	Nigeria - 57	Taiwan - 4
Bolivia - 1	Guyana - 1	Pakistan - 4	Thailand - 5
Bosnia-Herzegovina - 2	Hungary - 1	Peru - 10	Tunisia - 9
Brazil - 11	India - 33	Philippines - 3	Turkey - 2
British Virgin Islands - 1	Indonesia - 2	Poland - 2	Uganda - 5
Bulgaria - 2	Iran - 4	Portugal - 3	UK - 32
Burkino Faso - 1	Iraq - 1	Rep of Congo - 3	Uruguay - 9
Canada - 33	Ireland - 9	Romania - 4	US Virgin Islands - 2
Chile - 1	Italy - 42	Russia - 3	USA - 491
China - 38	Kenya - 23	Rwanda - 1	Uzbekistan - 2
Columbia - 9	Korea (South) - 2	S Africa - 4	Venezuela - 2
Croatia - 7	Lebanon - 11	Senegal - 1	Vietnam - 1
Cypress - 1	Libya - 1	Serbia - 1	Zambia - 2
Czech Republic - 1	Malaysia - 19	Singapore - 3	
D Rep of Congo - 4	Malta - 1	Slovak Repub - 2	

SID Monitor Distribution
1078 instruments
82 countries
7 continents

For official use only
Monitor assigned: __________
Site name: _______________
Country: _________________

SuperSID Space Weather Monitor

Request Form

	Your information here		
Name of site/school *(if an institution)*:			
Choose a site name: *(3-6 characters) No Spaces*			
Primary contact person:			
Email:			
Phone(s):			
Primary Address:	Name School or Business Street Street City State/Province Country Postal Code		
Shipping address, if different:	Name School or Business Street Street City State/Province Country Postal Code		
Shipping phone number:			
Latitude & longitude of site:	Latitude: ___________________________ Longitude: __________________________		

I understand that neither Stanford nor the Society of Amateur Radio Astronomers is responsible for accidents or injuries related to monitor use. I will assure that a surge protector and other lightning protection devices are installed if necessary.

Signature: ____ **Date: ___________________________**

I will need:

What	*Cost*	*How many?*
SuperSID distribution USB Power	$48 (assembled)	
USB Sound card 96 kHz sample rate *(or provide this yourself)*	$40 *(optional)*	
Antenna wire (120 meters) *(or you can provide this yourself)*	$23 *(optional) with connectors attached and tested*	
RG 58 Coax Cable (9 meters) *(or provide this yourself)*	$14 *(optional) with connectors attached and tested*	
Shipping	US $12 Canada & Mexico $40 all other $60	
	TOTAL	$

____ **I have included a $____________ check** (payable to SARA)

____ **I will make payment thru** www.paypal.com to treas@radio-astronomy.org

or

____ If you are a Minority-serving institution, in a Developing or economically deprived nation, and/or you are using the monitor with students for educational purposes, you may qualify for obtaining a monitor at reduced or no cost. Check here if you wish to apply for this designation. Then tell us how you want to use the SuperSID monitor. Include type of site, number of students involved, whether public or private school, grade levels, etc. and describe your program. The goal of the SuperSID project is to provide as many students with systems as possible. If you are able to pay for a system, even if you qualify for a free one, please do so and help support our goal.

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For more details on the Space Weather Monitor project, see: **http://sid.stanford.edu**

To set up a SuperSID monitor you will need:

1 Access to power and an antenna location that is relatively free of electric interference (could be indoors or out)

2 A **PC**** with the following minimal specifications:

   a. A sound card that can record (sample) up to 96 kHz, or a USB port to connect such a sound card (for North and South America)
      i. All other countries can use AC97 sound card with 48 kHz record (sample) rate. Most computers made after 1997 will have AC97.
   b. Windows 2000 or more recent operating system
   c. 1 GHz Processer with 128 mb RAM
   d. Ethernet connection & internet browser (desirable, but not required)
   e. Standard keyboard, mouse, monitor, etc.

3 An inexpensive antenna that you build yourself. You'll need about 120 meters (400 feet) of **insulated** wire. Solid wire is easier to wind than stranded. Magnet wire will work but be more fragile. You can use anything from #18 to #26 size wire. The antenna frame can be made of wood, PVC pipe, or similar materials. We'll provide instructions. You can purchase the wire from us or obtain your own.

4 RG58 coax cable with a BNC connector at one end to run from the antenna to the SuperSID receiver. 9 meters is recommended, but the length will depend on where you place the antenna. You can purchase the coax from us or obtain your own.

5 Surge protector and other protection against a lightning strike

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Return this form to: SuperSID@radio-astronomy.org

or mail to: SARA
Brian O'Rourke, SARA Treasurer
337 Meadow Ridge Rd,
Troy, VA 22974-3256

Announcing Radio JOVE 2.0

The Radio JOVE Team

Radio JOVE students and amateur scientists from around the world observe and analyze natural radio emissions of Jupiter, the Sun, and our galaxy using their own easy to construct radio telescopes.

Our Project announces Radio JOVE 2.0, where participants assemble a 16-24 MHz radio spectrograph to observe solar, Jupiter, Galactic, and Earth-based natural radio emissions and share their observations with fellow participants.

In the Beginning

Radio JOVE started as a NASA sponsored educational outreach project in 1999. We developed a radio telescope kit suitable for receiving signals from Jupiter, the Sun, the Galaxy, and Earth-based radio emissions. The original kit comprised a radio receiver (RJ1.1) and a dual dipole antenna for 20.1 MHz. An important goal was to teach electronic principles including how to build, solder, and assemble the radio receiver and antenna.

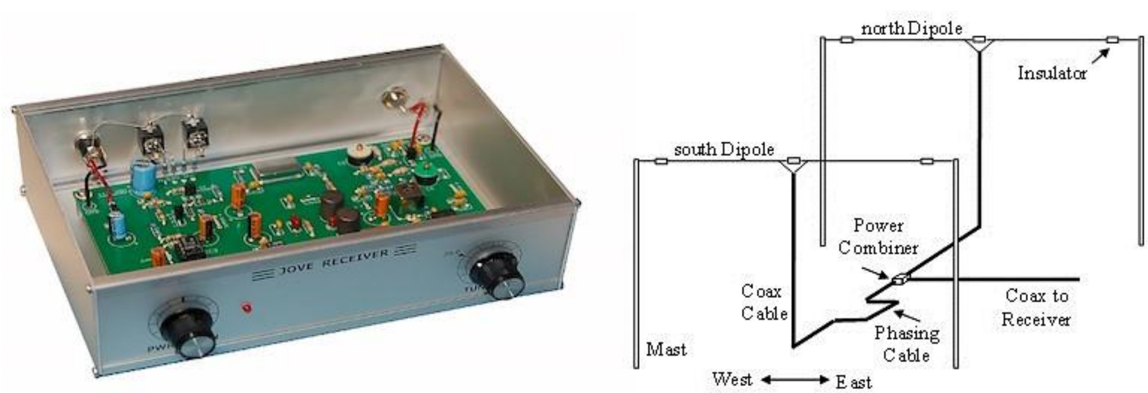

Figure 1. A Radio JOVE RJ1.1 receiver and a schematic of the dual-dipole antenna.

In addition to the hardware, three software packages were developed. These were Radio Jupiter Pro (Jupiter emission prediction program), Radio-SkyPipe (strip chart program) and Radio Sky Spectrograph (control and display of radio spectrograph data).

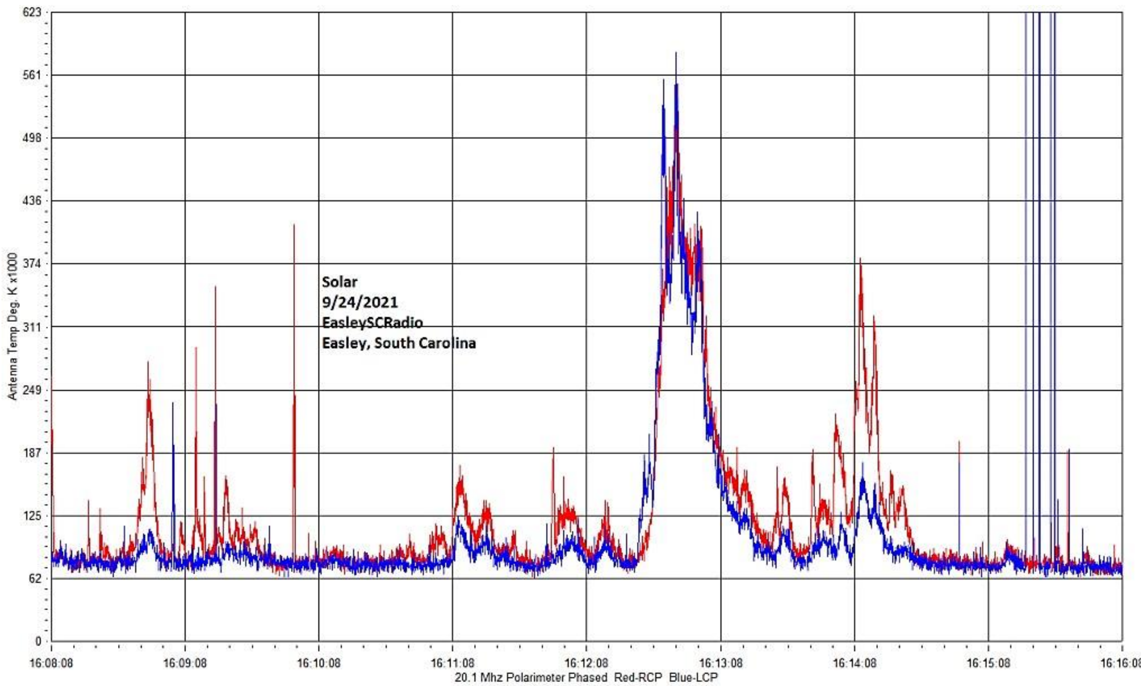

Figure 2. A SkyPipe strip chart showing multiple solar bursts using a JOVE receiver. John Cox, SC.

The Growth of Radio JOVE

As of Autumn 2021, over 2,500 kits have been sold at cost to schools and individuals around the world. Thousands of data submissions from observers have been made to the Radio JOVE data archive.

The Radio JOVE web site has always provided a wealth of information describing observation methods and various educational materials intended to teach radio astronomy techniques and scientific methods. Biannual newsletters are produced and several telephone help sessions are held each year.

A sub-group of experienced observers known as the Spectrograph Users Group (SUG) evolved from the core JOVE group. These observers developed data collection and analysis techniques using more advanced equipment and techniques. SUG members have contributed to articles published in peer-reviewed scientific journals. This group remains active under the Radio JOVE listserv at https://groups.io/g/radio-jove/.

Moving Forward with New Technology

In the past, Radio JOVE provided the hands-on experience of building a radio kit. We have many RJ1.1 receivers in operation successfully contributing scientifically valuable data. It has, however, become increasingly difficult to obtain parts for the RJ1.1 receiver kits and we therefore decided to replace the RJ1.1 receiver with a new SDR-based design for the receiver portion of our radio telescope kits. While we continue to support the hardware and software for the original RJ1.1 receivers, the only kits now available for purchase from Radio JOVE contain this newly designed system.

In recent years, new technologies have made software defined radios (SDRs) ever more affordable. These radios can operate on a single frequency like the original JOVE receiver but can also generate spectrograms which depict radio activity as a function of both time and frequency. Such displays offer new insights into our studies of the Sun, Jupiter, the Galaxy, and both natural and artificial Earth-based radio emissions.

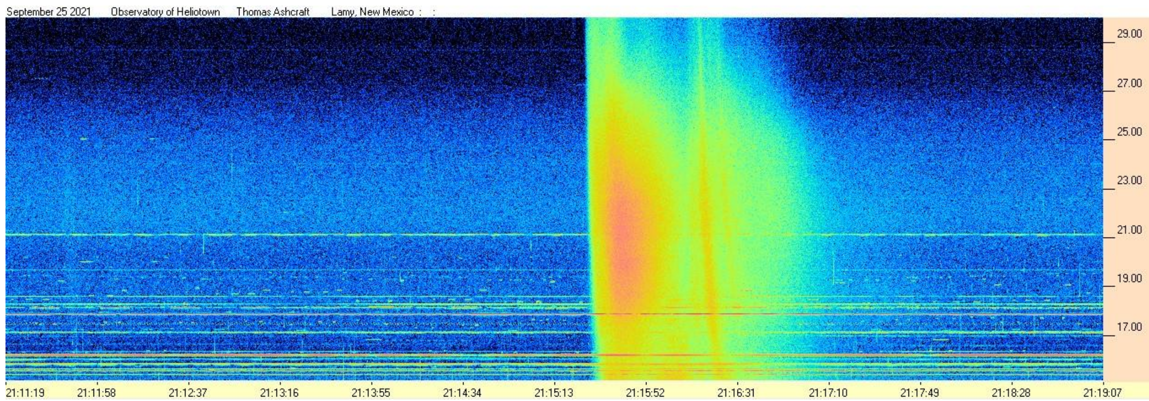

Figure 3. Radio spectrogram showing multiple solar bursts received by Tom Ashcraft in New Mexico. Horizontal scale is time and the vertical scale is frequency. Amplitude is displayed using different colors corresponding to the strength of signals.

Radio JOVE continues to sell radio telescope packages including an antenna, receiver, and software; however, the receiver is now a commercially built SDR.

Figure 4. The JOVE team has had considerable success with the SDRPlay RSP1A unit and will provide support for using this instrument for our radio astronomy program. Not all SDR types can be supported, but it is our intent to provide support for some other SDRs as they become available during this period of rapid SDR development.

It continues to be our goal to introduce new observers to the scientific method and help them experience the thrill of receiving cosmic radio signals. Through a series of educational training modules and observing and analysis projects we aim to guide new observers to levels where they can contribute to Citizen Science projects.

We continue to support our large user base that uses JOVE RJ1.1 receivers – both in terms of technical support for the receivers but also with new and exciting observing projects for both RJ1.1 and SDR users.

We welcome both new and experienced observers to the JOVE 2.0 program as we share the excitement of receiving, studying, and understanding radio signals from our corner of the galaxy.

Please see the Radio JOVE web site at https://radiojove.gsfc.nasa.gov for more information.

RADIO JOVE 2.0 RADIO TELESCOPE KIT ORDER FORM

Order Online using PayPal™

* * * Please allow 2 to 3 weeks for delivery. * * *

IMPORTANT: Before you order the Jove receiver kit and/or the antenna kit, we suggest that you read the on-line manuals. You will need to provide additional materials and tools to complete the antenna. The cost of additional materials for the antenna support structure (masts, etc.) may be in the range of US$75 to US$100. Also note that the optimal antenna height can be up to 20ft, depending upon your latitude.

Item # RJK2u – Complete 2.0 Kit: Receiver + Unbuilt Antenna Kit + Software This kit includes an SDRplay RSP1A, USB Cable, SMA/BNC cable, F-adapter, unbuilt Antenna Kit (RJA), printed assembly manuals, and Radio-Sky Spectrograph (RSS) software. Note: Kit does not include antenna support structure. **Price: $215 + Shipping (See reverse for shipping)**	**Item # RJK2p** – Complete 2.0 Kit: Receiver + Professionally Built Antenna Kit + Software This kit includes an SDRplay RSP1A, USB Cable, SMA/BNC cable, F-adapter, Professionally Built Antenna Kit (RJA2), printed assembly manuals, and Radio-Sky Spectrograph (RSS) software. Note: Kit does not include antenna support structure. **Price: $384 + Shipping (See reverse for shipping)**
Item # RJA – Unbuilt Antenna Kit The RJA Radio JOVE Antenna Kit includes a printed construction manual, stranded copper easy-to-solder antenna wire, ceramic insulators, RG-59 easy-to-solder coax cable, screw-on Fconnectors, and a power combiner. Note: Kit does not include antenna support structure. Assembly requires a soldering gun and other tools. **Price: $90 + Shipping (See reverse for shipping)**	**Item # RJA2** – Professionally Built Antenna Kit The RJA2 Radio JOVE Antenna Kit includes a printed installation manual, two professionally assembled dipole antennas constructed of #14 Copperweld wire with Budwig center insulators and center support rope attachment points, high quality RG-6 coax with pre-installed commercial grade connectors, and a power combiner. Note: Kit does not include antenna support structure. **Price: $249 + Shipping (See reverse for shipping)**
Item # LTJ2 – Listening to Jupiter, 2nd Ed. by R. S. Flagg PDF download of Richard Flagg's book "Listening to Jupiter, 2nd Ed., 2005". The file is downloaded from a secure website. **Price: $10 + $0 shipping (PDF file download)**	**Item # RJR2** – Radio JOVE 2.0 Receiver-Only Kit This kit includes one SDRplay RSP1A SDR receiver, USB Cable, SMA/BNC cable, and F-adapter, printed assembly manuals, and Radio-Sky Spectrograph (RSS) software. **Price: $135 + Shipping (See reverse for shipping)**

RADIO JOVE 2.0 RADIO TELESCOPE KIT ORDER FORM (continued)

Order Online at https://radiojove.net/kit/order_form.html OR
Complete this form and mail with payment

Payment may be made by Credit Card via PayPal™, U.S. Check, U.S. Money Order, International Money Order in U.S. funds drawn on a U.S. bank, or Western Union Money Transfer made payable to **The Radio JOVE Project**. No bank-to-bank wire transfers are accepted. Purchase Orders are accepted from U.S. Institutions.

Send to: The Radio JOVE Project
1301 East Main St
MTSU Box 412
Murfreesboro, TN 37132, USA
email: chiggins@mtsu.edu
FEIN: 20-5239863

Item	Description	Quantity	Item Price	Shipping (see below)	Subtotal
RJK2u	Complete Radio JOVE 2.0 Kit Receiver + unbuilt Antenna		$215		
RJK2p	Complete Radio JOVE 2.0 Kit Receiver + Professionally Built Antenna		$384		
RJA2	Professionally Built Antenna-Only Kit		$249		
RJA	Unbuilt Antenna-Only Kit		$90		
RJR2	Receiver-Only Kit		$135		
LTJ2	Listening to Jupiter, 2nd Ed., by R.S. Flagg (PDF download)		$10	$0	
				Total:	

Shipping Fees for Radio JOVE: We ship all packages using USPS Priority Mail flat rate boxes.
U.S.A.: $17.00
Canada: $57.00
All Other International Shipping: $85.00

Ship to: (Please print clearly)

Name: ____

Address: ____

City, State, Postal Code: ____

Province, Country: ____

Email: ____

Visit the Radio JOVE web site and fill out the team application form at https://radiojove.net/sign_up_form.php even if you are just an interested individual so that you can receive important information about kit updates, online services, and activities within the project as they occur!

The British Astronomical Association
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Telephone: 020 7734 4145 Fax No.: 020 7439 4629
Email: office@britastro.org Website: www.britastro.org

Please send all reports and observations to John Cook: jacook@jacook.plus.com

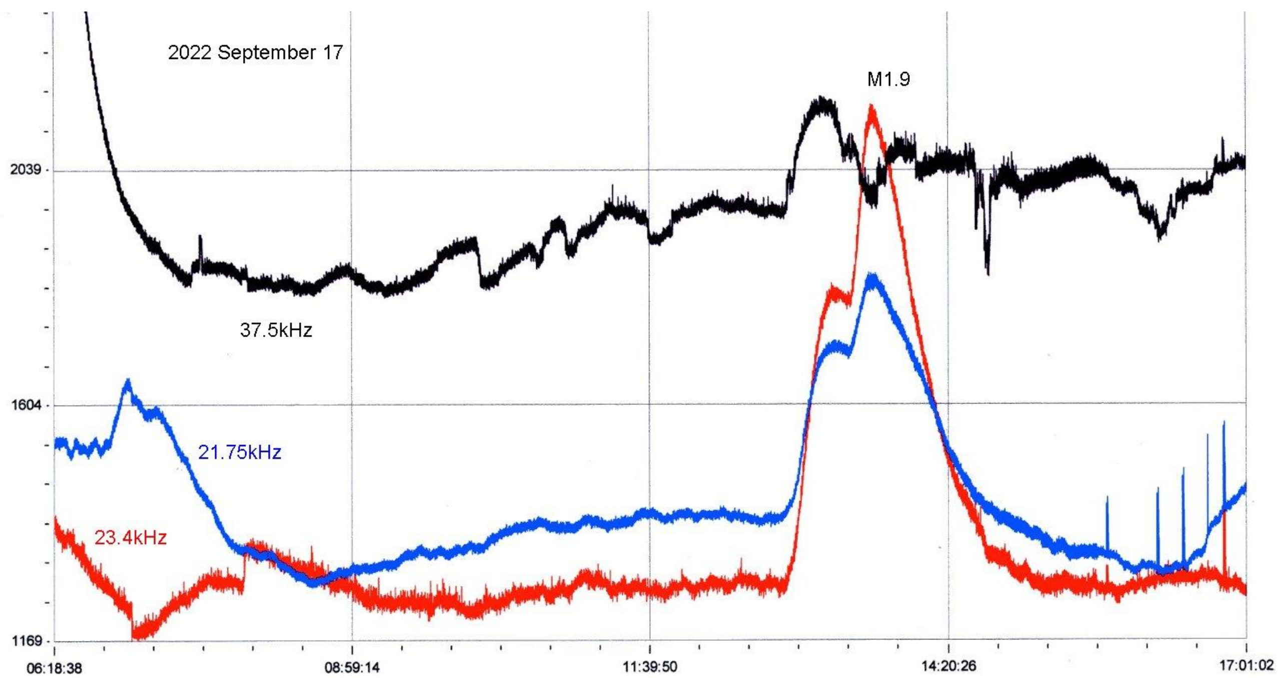
John Cook's VLF Report

BAA Radio Astronomy Section, Director: Paul Hearn

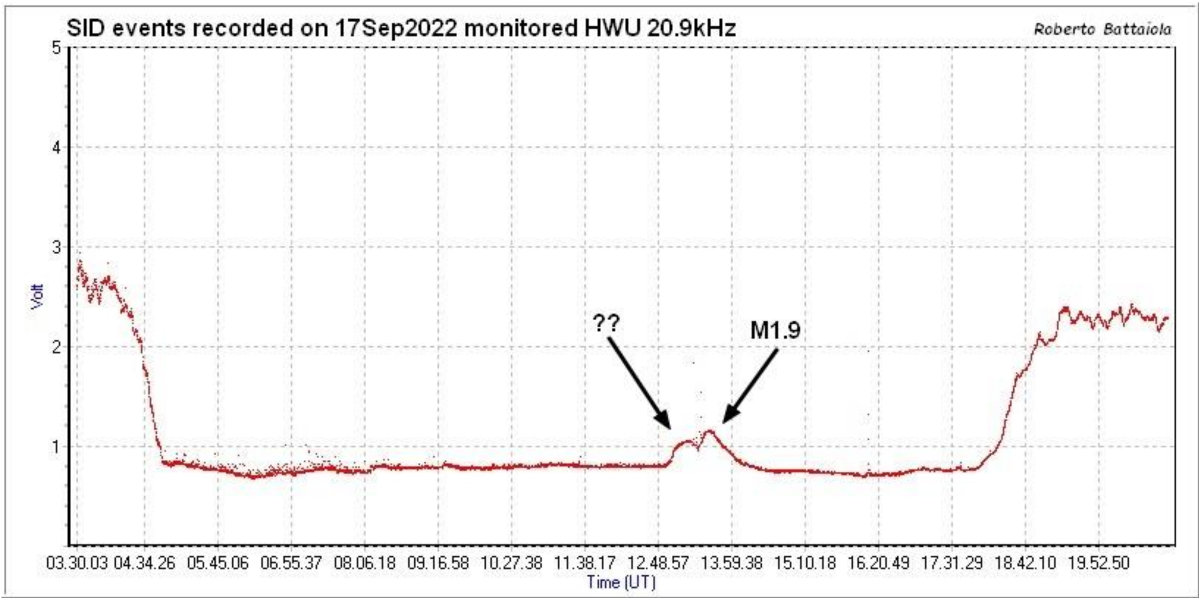
RADIO SKY NEWS **2022 September**

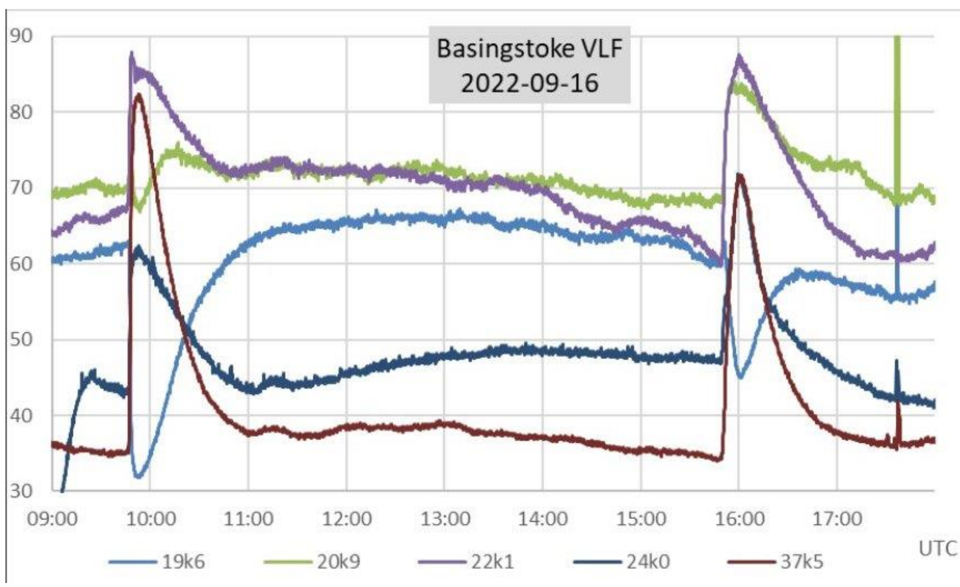
VLF SID OBSERVATIONS

The high level of solar activity continued into September, with 101 SWPC listed flares recorded as SIDs. Many of these were again multiple peaked, making a total of 134 events recorded. There were also plenty of overlapping flares, making them difficult to separate. This recording by Colin Clements shows the M1.9 flare peaking at 13:37UT on the 17th, overlapping the earlier unlisted flare:

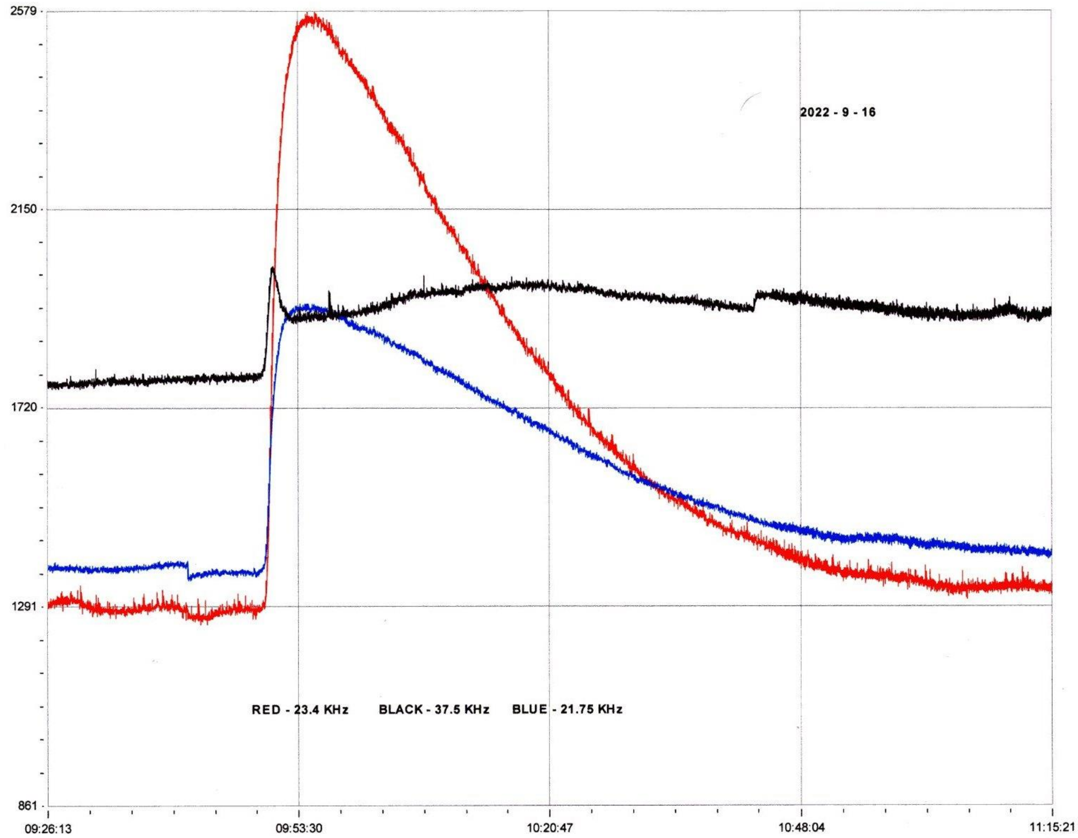


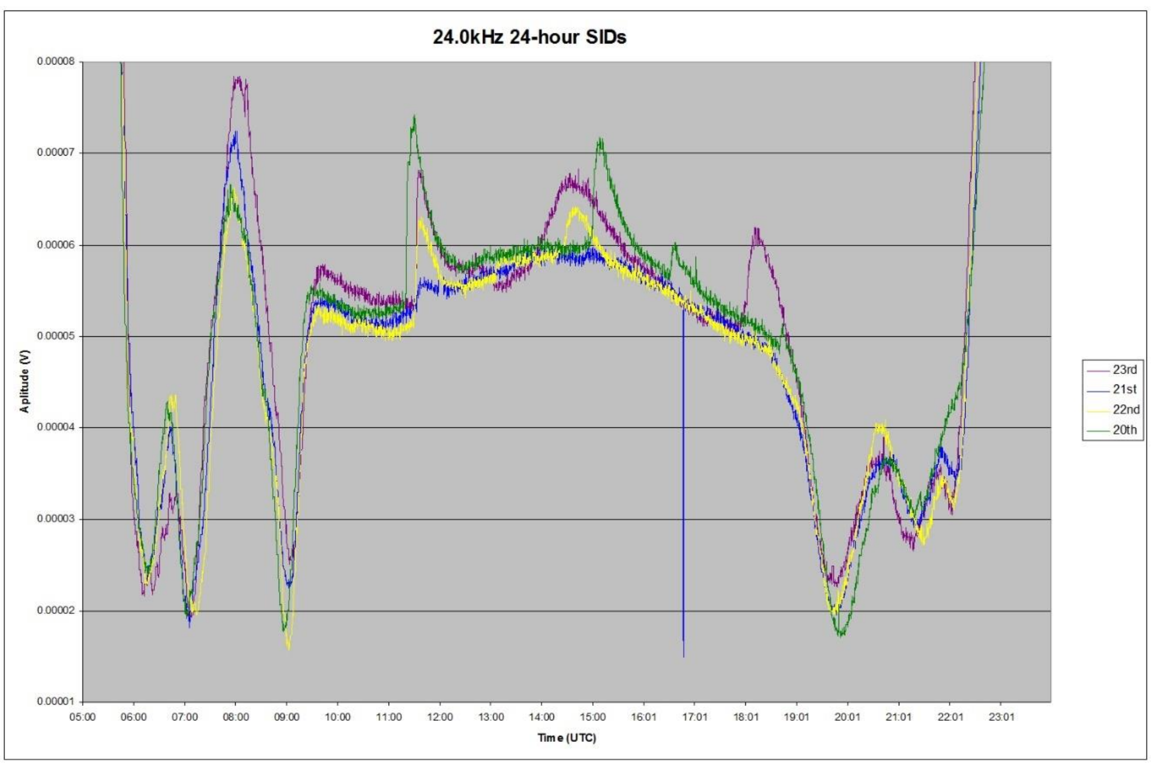
The 37.5kHz signal is tricky to interpret, but appears to show a peak matching the first peak at 21.75 and 23.4kHz, followed by a dip at the M1.9 peak. SIDs on other days do show a rise in signal strength from the 37.5kHz signal. The recording by Roberto Battaiola also shows a very similar SID response:



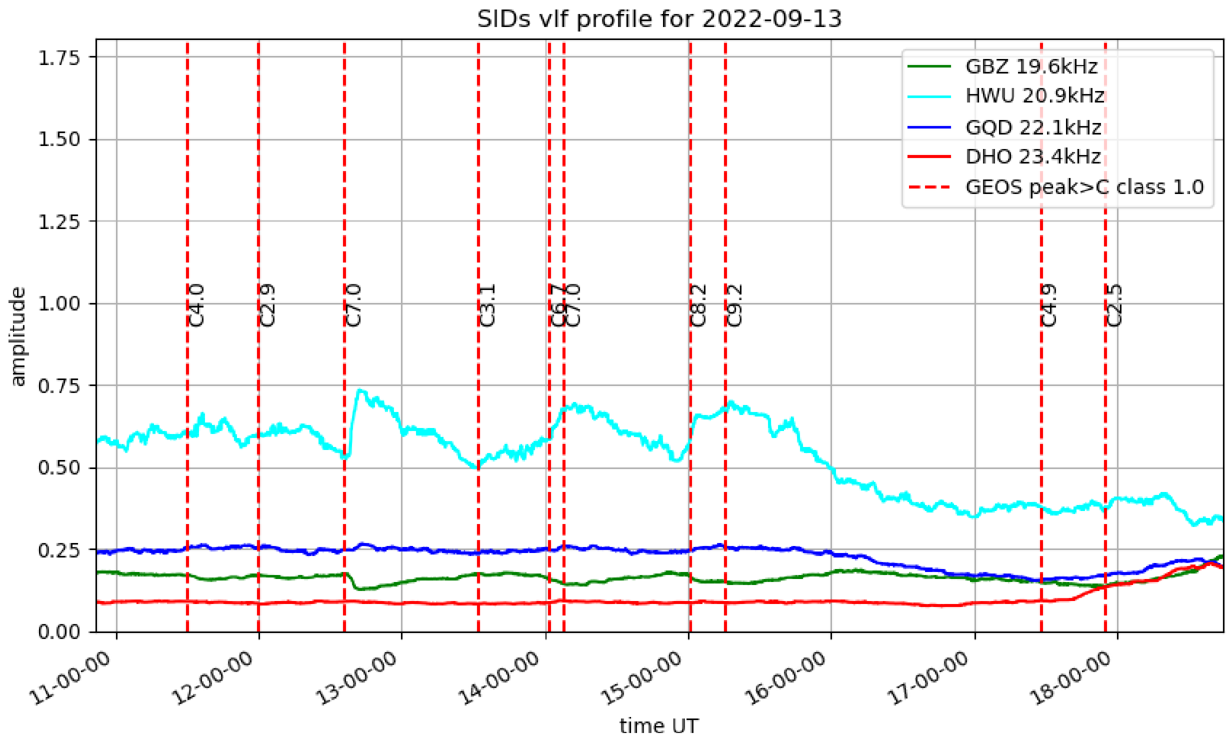


The two strongest flares in September are shown here by Paul Hyde, the M7.9 flare peaking at 09:54, and the M6.2 peaking at 16:04, both well timed in an otherwise very quiet day. They are mostly simple 'shark fin' SIDs, although 22.1kHz shows a hint of a 'spike and wave' SID for the first flare, and 19.6kHz is similar for the second flare. Colin Clements noted a very odd response to the M7.9 flare; 23.4kHz and 21.75kHz both show ordinary 'shark fin' SIDs, while 37.5kH shows a very narrow spike followed by a small dip and then a very small rise over the next hour. It appears to be a 'spike and wave' SID, but very different to those normally recorded.

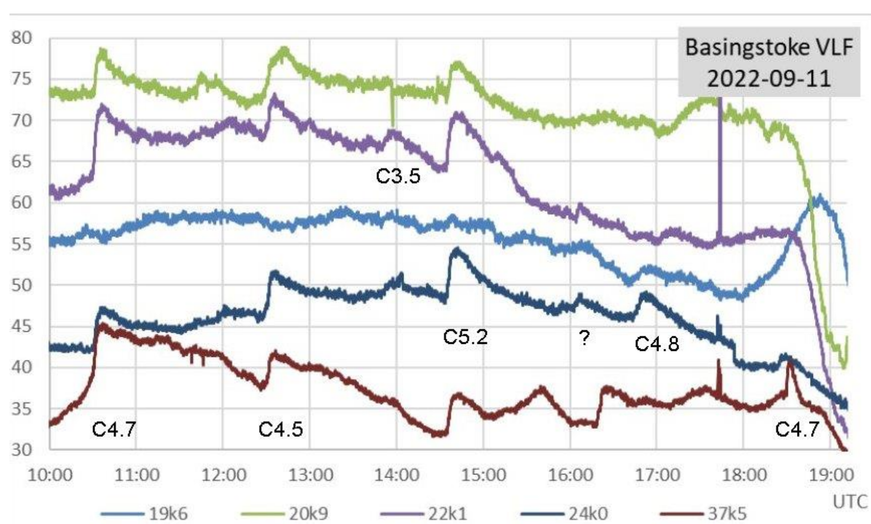

2579
2150
1720
1291
861
2022 - 9 - 16
RED - 23.4 KHz
BLACK - 37.5 KHz
BLUE - 21.75 KHz
09:26:13
09:53:30
10:20:47
10:48:04
11:15:21


24.0kHz 24-hour SIDs
Aplitude (V)
0.00008
0.00007
0.00006
0.00005
0.00004
0.00003
0.00002
0.00001
05:00
06:00
07:00
08:00
09:00
10:00
11:00
12:00
13:00
14:00
15:00
16:01
17:01
18:01
19:01
20:01
21:01
22:01
23:01
Time (UTC)
23rd
21st
22nd
20th

Mark Edwards noticed an apparent 24 hour repetition of flares on the 21st, 22nd and 23rd. His recording shows the three days superimposed, all showing a SID within a few minutes of 11:36, and the 20th just 5 minutes earlier. Just pure chance I suspect!

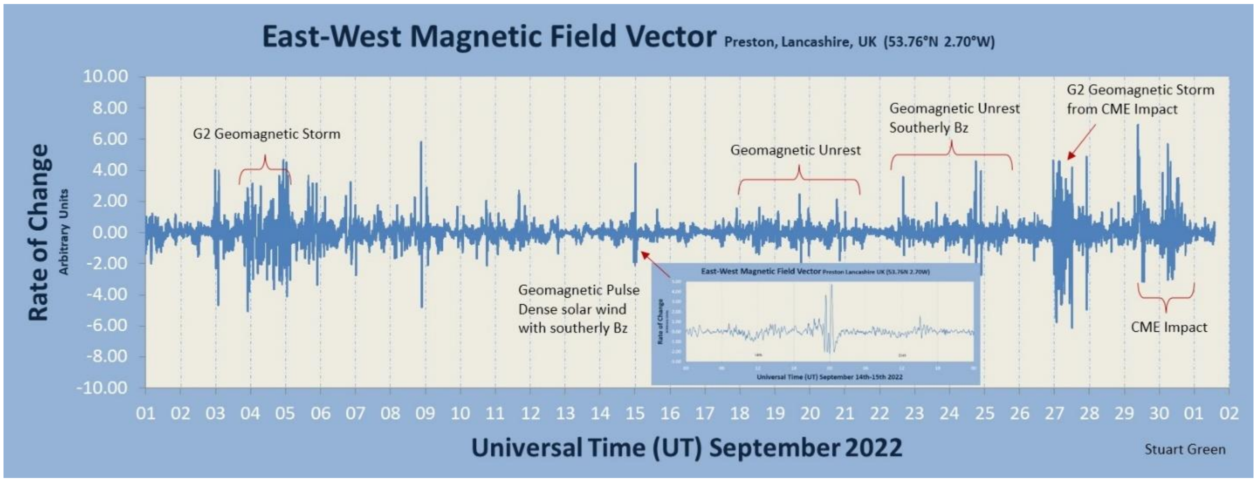


This recording by Mark Prescott on the 13th shows how the many overlapping flares have made analysis very difficult. The C7.0 flare at 12:40 produced a very clear SID, while those through the afternoon have become much less clear.

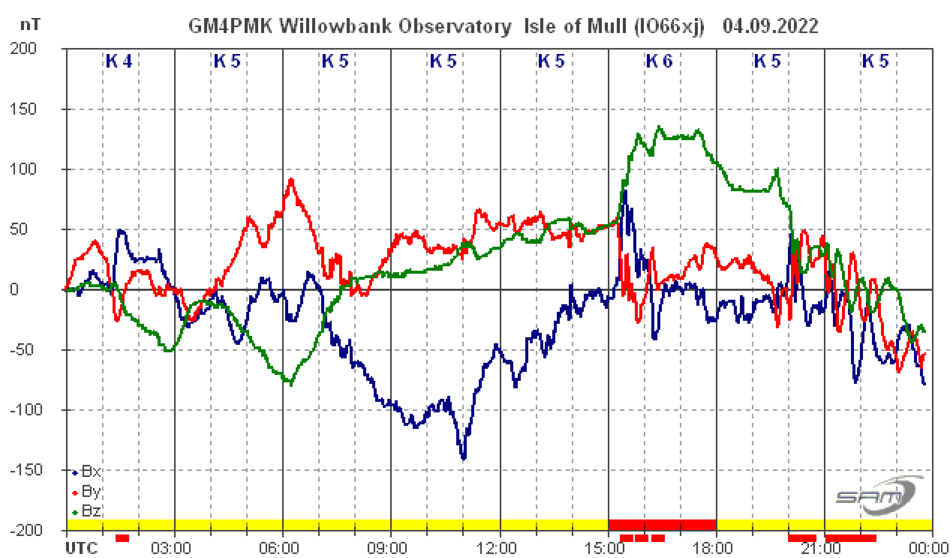


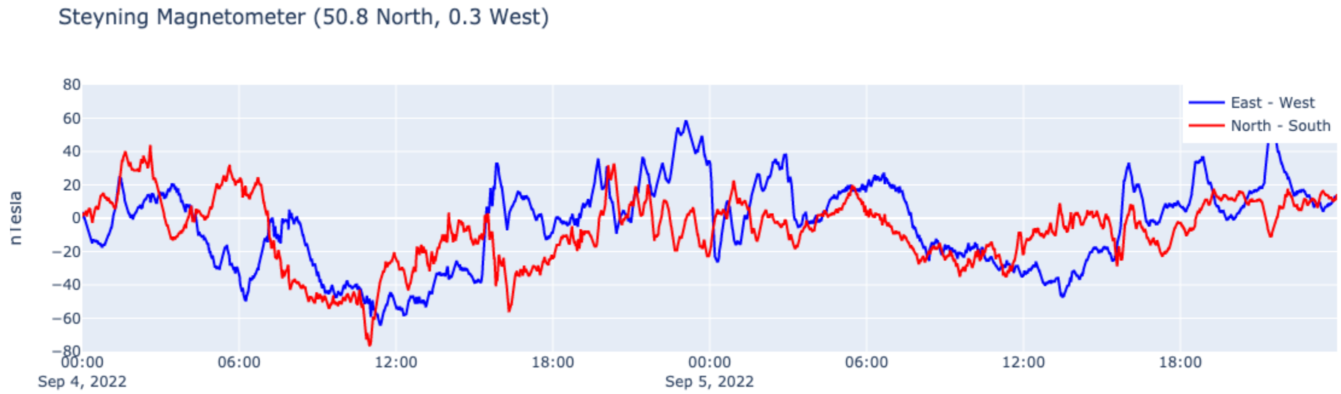
Paul Hyde's recording from the 11th shows a better spaced series of flares, although with some noise present. The spikes seen around 17:50 are from an induction hob, and so easy to eliminate. They can also be seen in the recording from the 16th shown previously.

MAGNETIC OBSERVATIONS

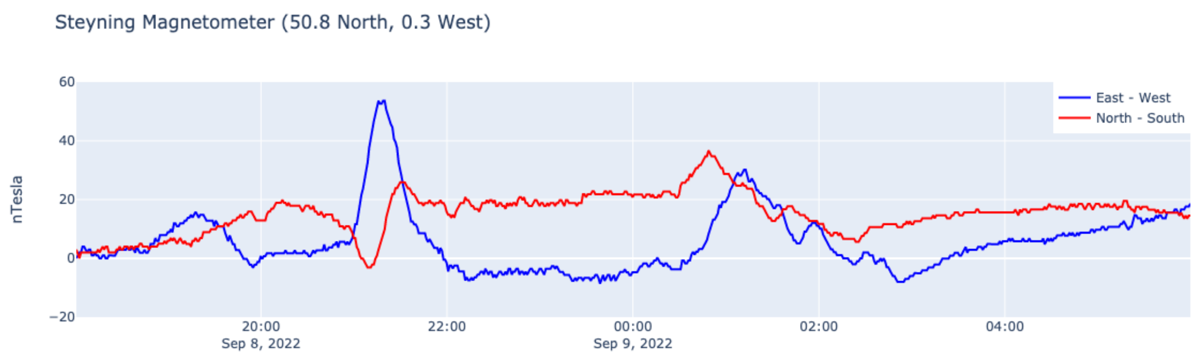


Stuart Green's summary of September's magnetic activity shows a mostly quiet period, with stronger storms to start and end the month. Despite the number of strong flares recorded, there were very few CMEs directed towards Earth. The most active period was the 4th and 5th, due to a mixture of a general high speed solar wind and some glancing blows from CMEs in late August. Roger Blackwell's chart shows the 4th:



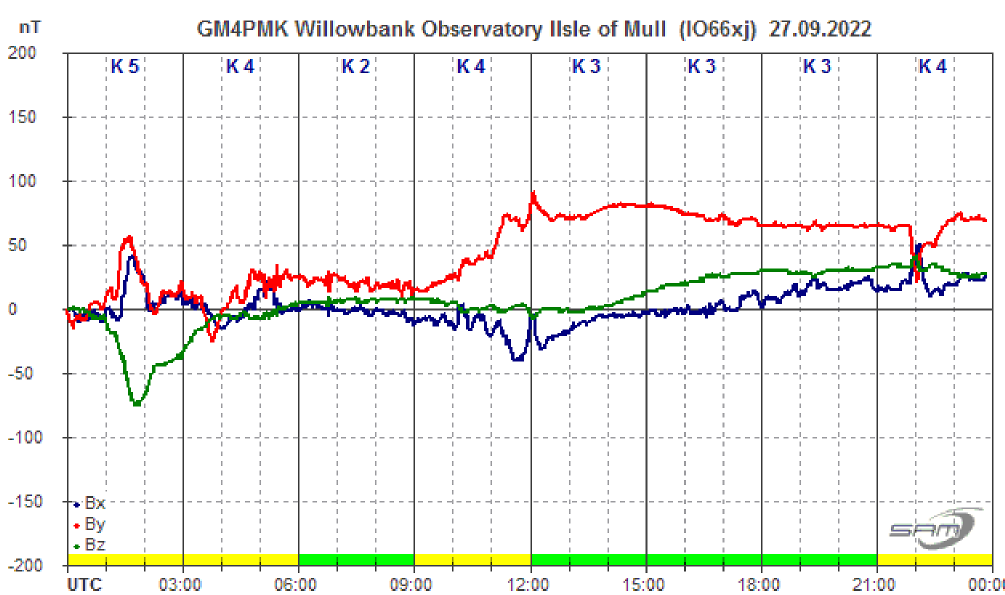


Nick Quinn's chart shows the 4th and 5th, activity decaying slowly through the 5th. Disturbed conditions continued through to the 8th, with a strong pulse about 21:20 shown in his recording:



The source of this sudden pulse does not seem to be CME related.

A large trans-equatorial coronal hole was active towards the end of September, along with some minor CMEs. Magnetic activity started around 23:00UT on the 26th, and continued through the 27th.

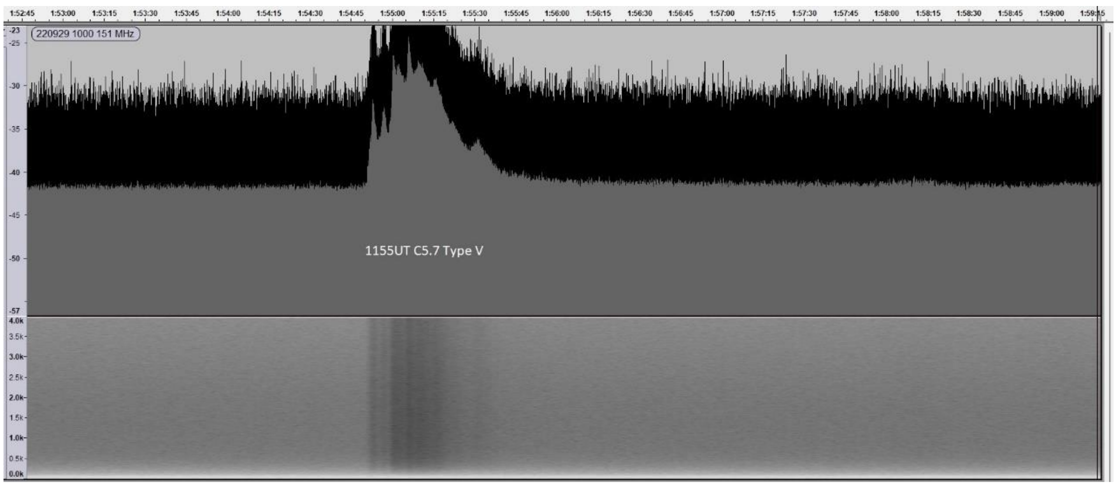


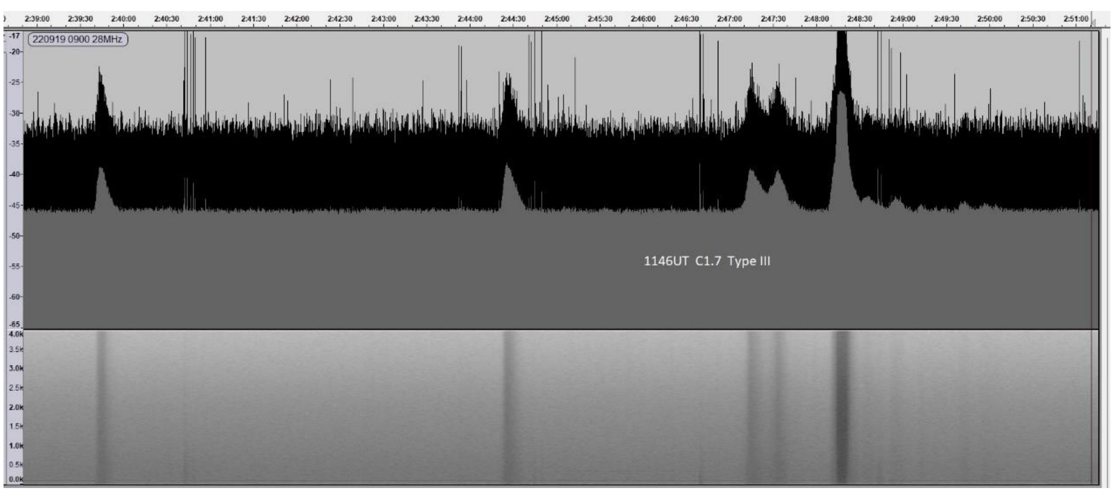
Roger Blackwell’s chart shows some very rapid oscillations during the morning. This faded a little in the afternoon, before becoming more disturbed again at the end of the month and into October.

Magnetic observations received from Roger Blackwell, Colin Clements, Stuart Green, Nick Quinn and John Cook.

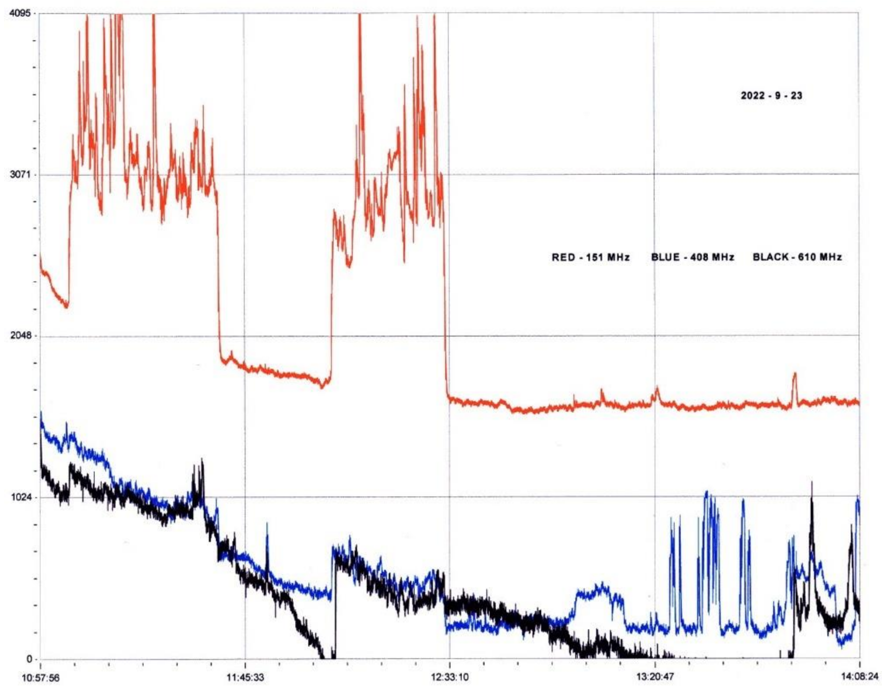
SOLAR EMISSIONS

The sun is now very low in the sky for VHF /UHF monitoring of solar emissions. Colin Clements and Colin Briden did mange to catch some signals, but most of the flares did not appear to have any VHF / UHF activity. Colin Briden’s recording of a type V emission at 151MHz matches the C5.7 Flare at 11:55 on the 29th. The signal rises about 17dB above the background, and lasts for just one minute.





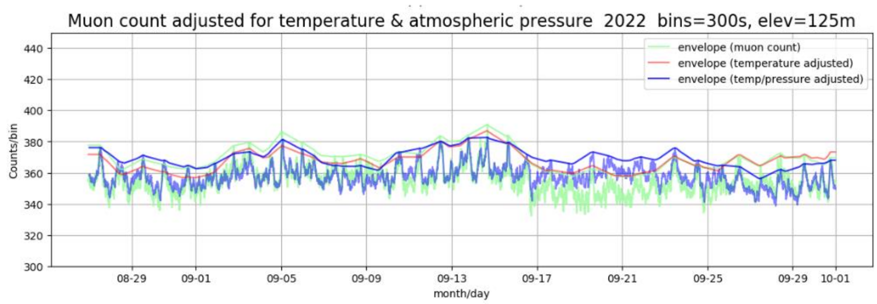
This 28MHz type III signal is from the 19th, peaking about 20dB above the background at 11:46 on the 19th. Its timing matches a C1.7 flare, although we did not record a SID from it.

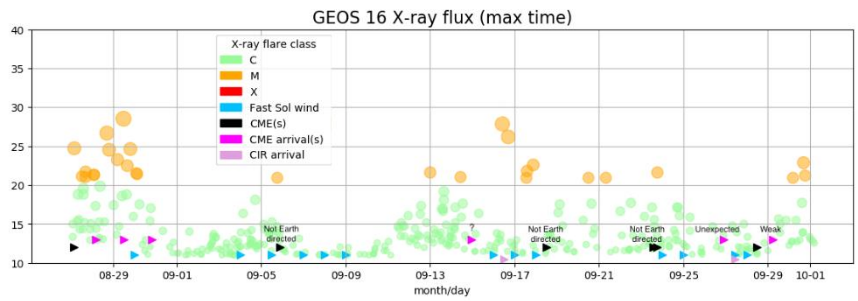


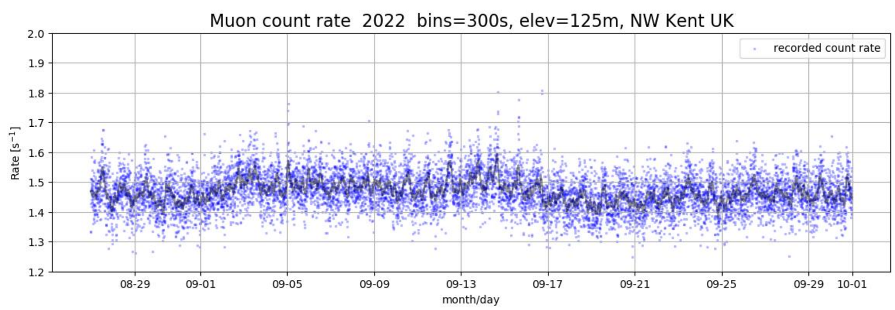
Colin Clements' recording from the 23rd shows two strong signals at 151MHz (red), the second of which matches the C7.2 flare. There is also a small rise at 408MHz (blue) and 610MHz (black). The source of the first signal is not clear, as it starts well after the earlier C2.7 flare. The increase in 408MHz activity after 13:20 may be related to the unclassified flare recorded at 13:24. The SWPC flare list shows quite a number of unclassified flares during the afternoon of the 23rd. Colin Also noted noise bursts on the 16th, 22nd and 24th.

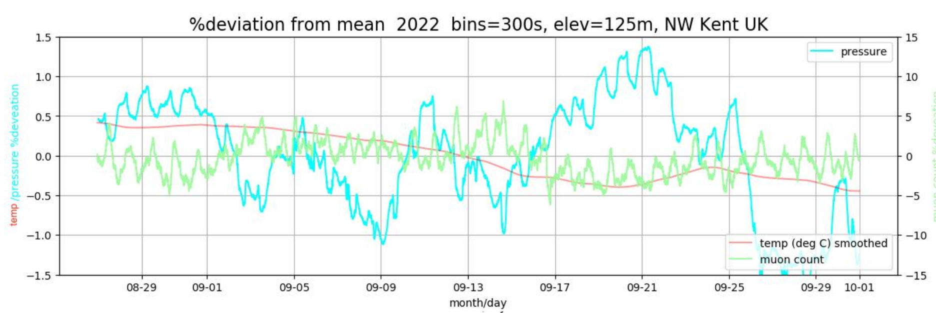
MUON OBSERVATIONS

Mark Prescott has made further muon counts shown in these charts:

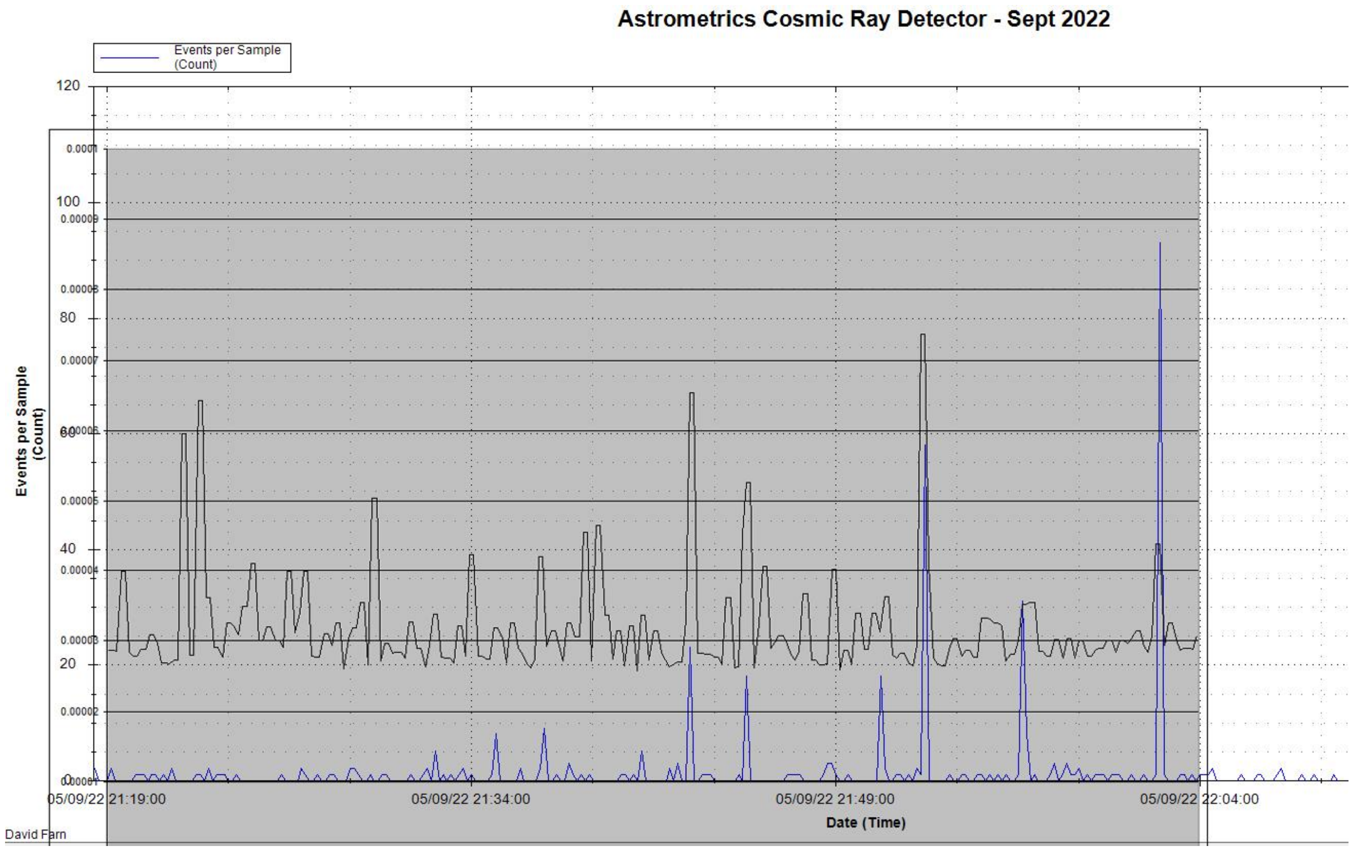








The data has been adjusted for temperature and atmospheric pressure as explained in the August edition. Muon counts can be seen to fall slightly following the stronger solar events as the solar wind speed and density increases.



David Farn has been comparing his muon data with lightning strikes. Lightning is often recored on our VLF SID charts as interference, and so David has overlaid MarkEdwards' VLF data from the 5th onto the muon counts. Both observers are near Coventry. The chart shows data from 21:19 to 22:04, with VLF in black and muons in blue. A good match can be seen, particulalrly for the stronger lightning strikes. David has found an online paper that investigates how this occurs: https://www.science.org/content/article/cosmic-rays-could-reveal-secrets-lightning-earth

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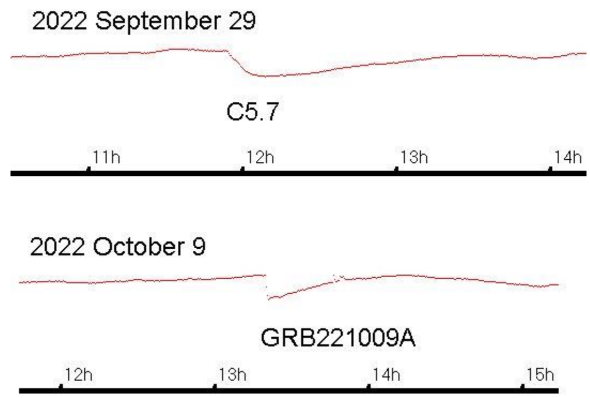
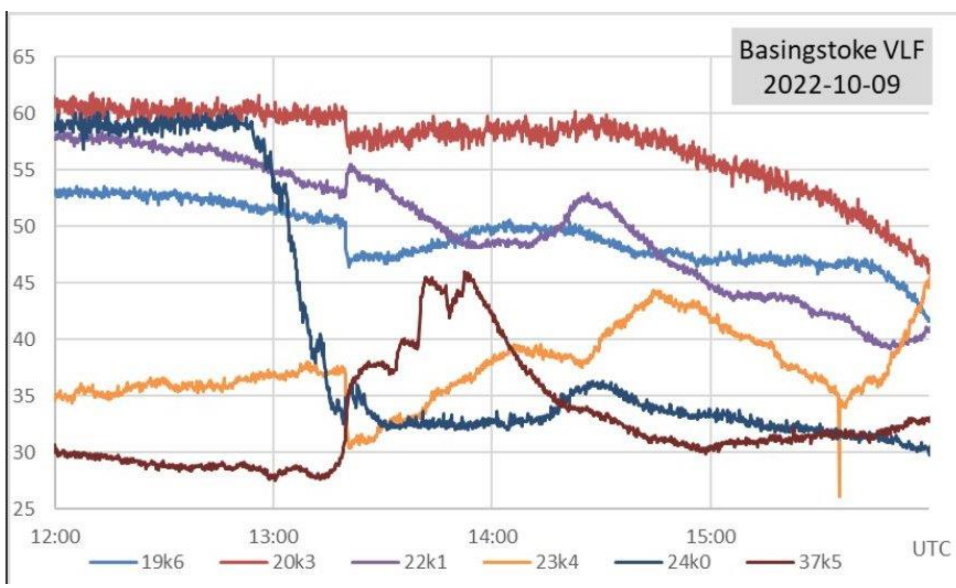
VLF SID OBSERVATIONS

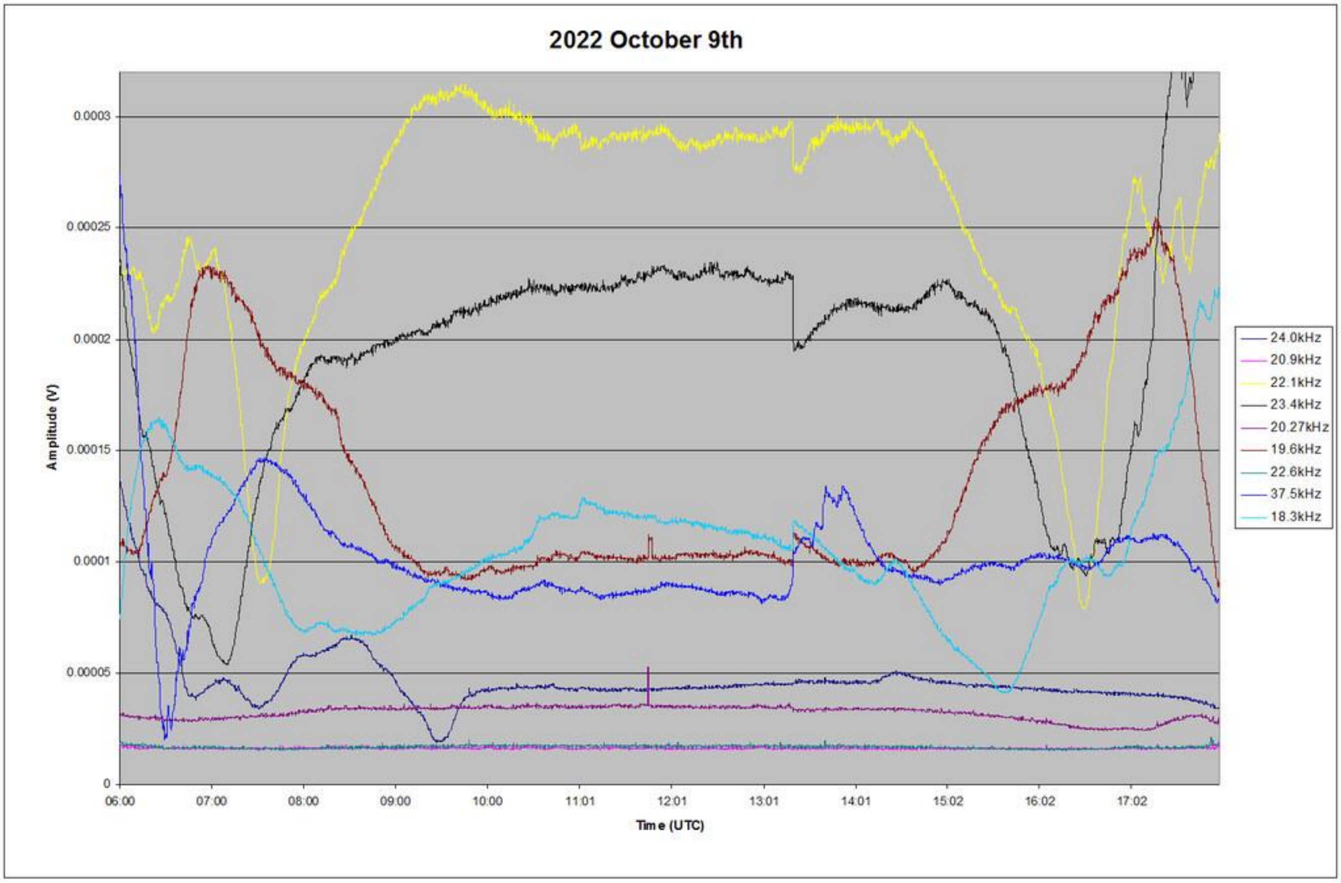
The number of SIDs recorded in October is much lower than in previous months, although many of them were from M-class flares (22% in October, 10% in September). Many of these flares overlapped so that SIDs were again often hard to separate. No X-class flares were recorded, with just a single X1.0 flare late on the 2nd appearing in the SWPC bulletin. The highlight of the month has to be the widely recorded Gamma Ray Burst (GRB) on the 9th. The Fermi and Swift Gamma ray satellites both detected an extremely strong Gamma ray burst at 13:16:59UT, while the STIX X-ray satellite recorded an X-ray signal just three minutes later. The sun was not flaring at this time, the GOES data showing a background flux at about a C1 level.

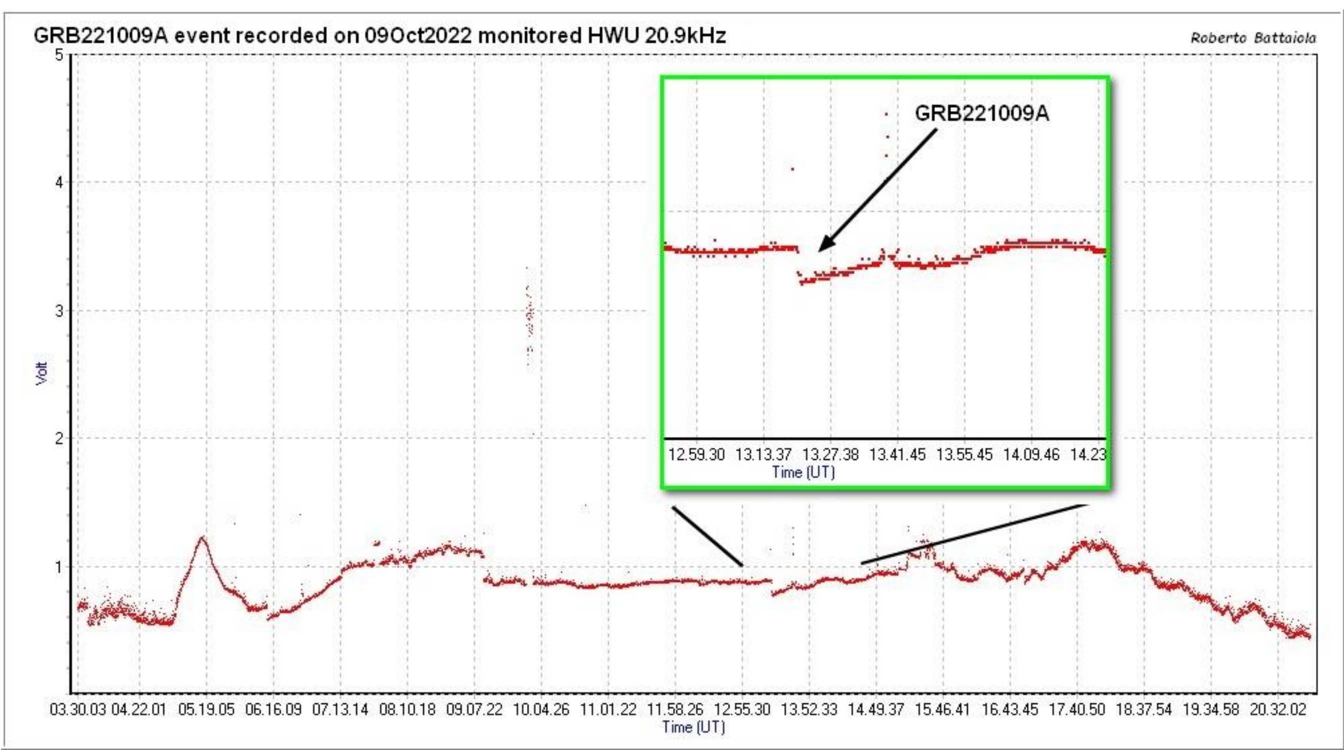


My own recording of the resulting SID compares in size to that of an ordinary C5.7 flare from last month, but has very sharp start and peak times. It looks more like a transmitter effect, but as it was also recorded on other signals then it must be from the GRB. There is a report on the qsl.net web site of a GRB detection on 2003 /03/29 using a 75kHz signal, although with a very short spike shaped SID.

Professional analysis located the source of the GRB to be in the constellation of Sagitta. This was at about 30 degrees altitude for the European VLF paths, but only about 3 degrees altitude for the trans-Atlantic paths. Recordings by Paul Hyde, Mark Edwards and Roberto Battaiola are shown on the next pages. Notice that 24kHz has hardly responded, and that 37.5kHz shows a very different SID.

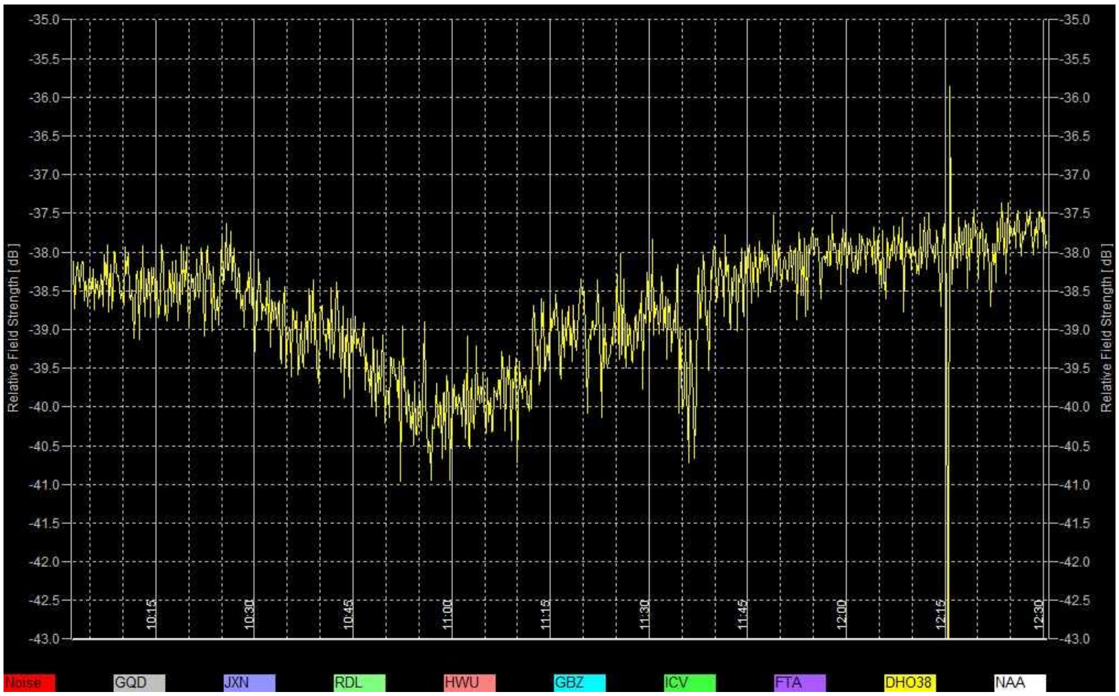



2022 October 9th
Amplitude (V)
Time (UTC)
24.0kHz
20.9kHz
22.1kHz
23.4kHz
20.27kHz
19.6kHz
22.6kHz
37.5kHz
18.3kHz


GRB221009A event recorded on 09Oct2022 monitored HWU 20.9kHz
Roberto Battaiola
Volt
Time (UT)
GRB221009A

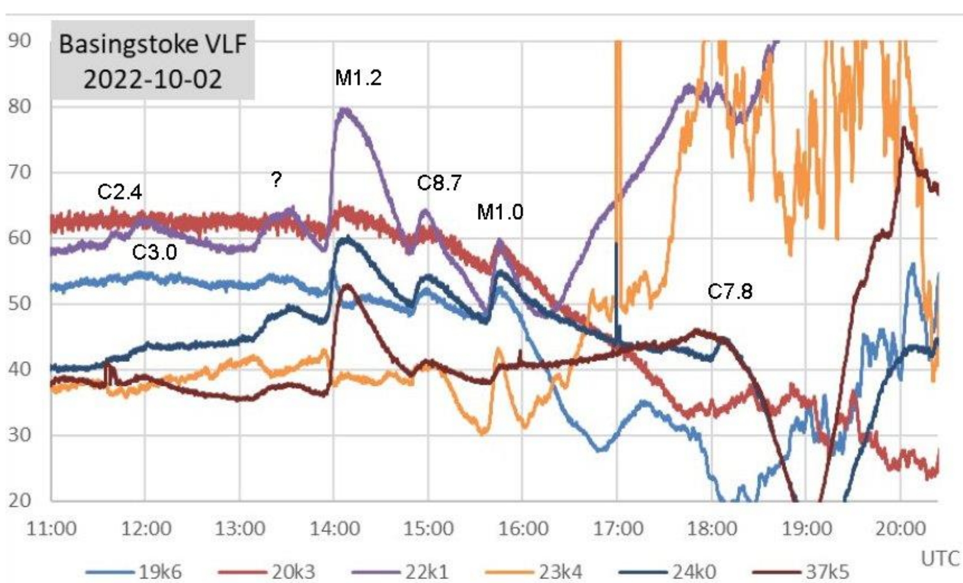
Mark Edwards provided a talk about the GRB detection for the zoom meeting on the 9th November, with a recording available from the section pages of the BAA web site.

There was a small partial solar eclipse on the 25th. It only reached about 15% here in the UK, but Chris Bailey did record a drop in signal level at 23.4kHz:

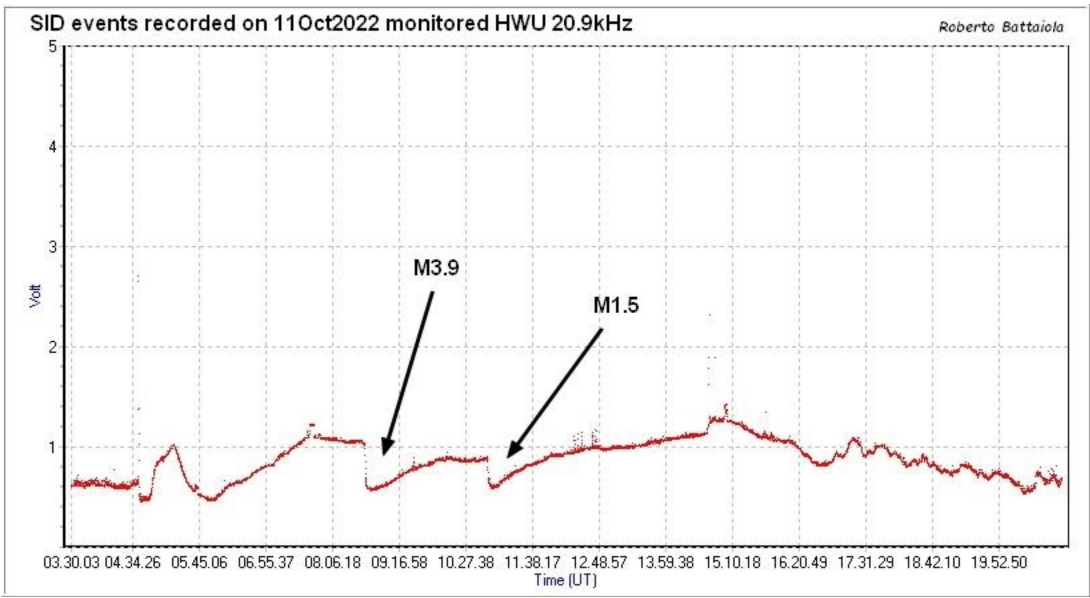


My own recording showed a small rise in 23.4kHz matching the eclipse.

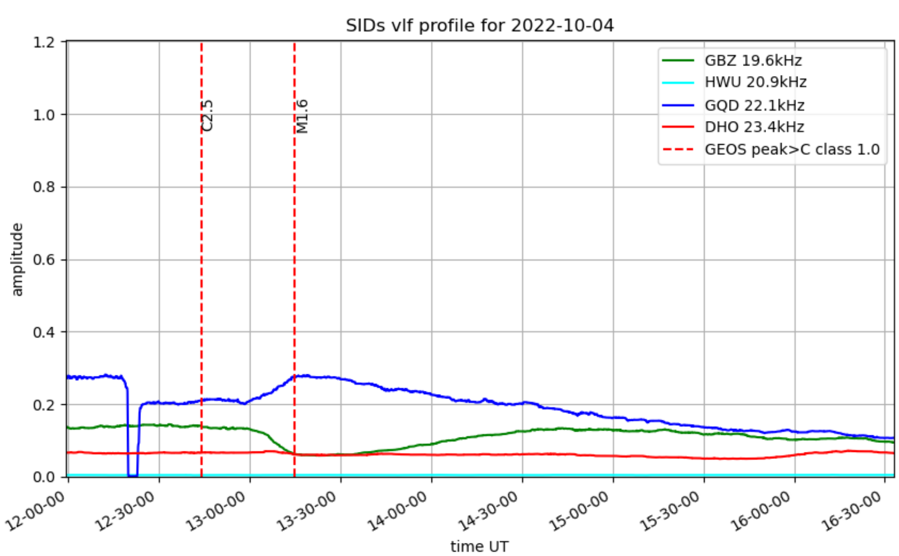
There was a good selection of stronger flares in October, the 2nd being particularly busy:



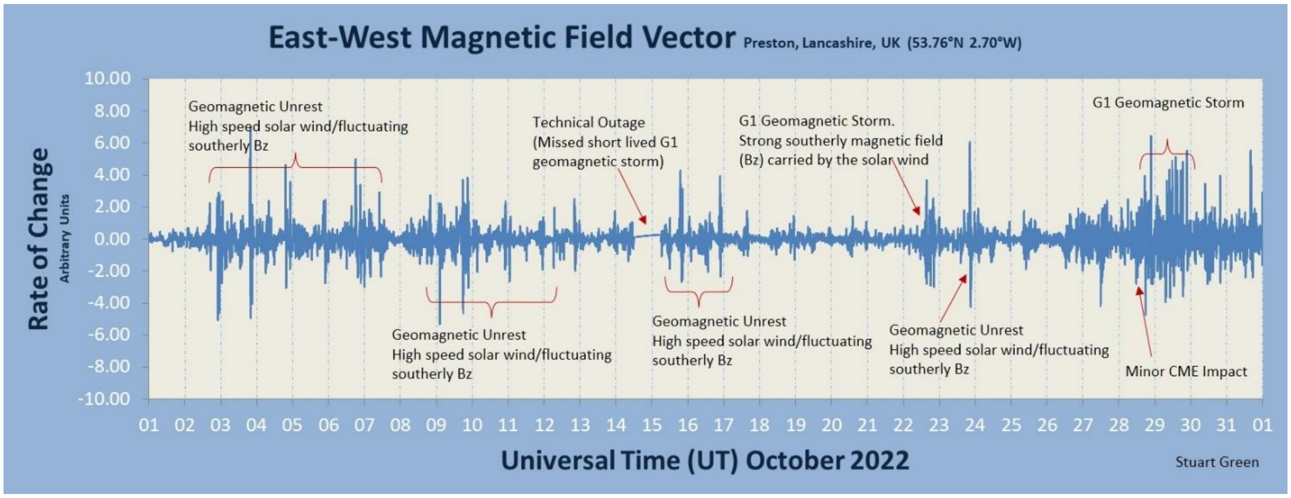
This recording by Paul Hyde shows the majority of the flares. 22.1kHz shows the three larger flares starting at 14:00 merging into one long SID, terminating as sunset takes over. 24kHz has a later sunset, and so also shows the C7.8 flare. A clear SID is also visible at 13:30, but is not classified in the SWPC lists. 23.4kHz is very difficult to interpret, being unstable all day. It also has the earliest sunset, with a very typical night-time signal after 17:30. There were two more M-flares on the 11th, shown by Roberto Battiaola:



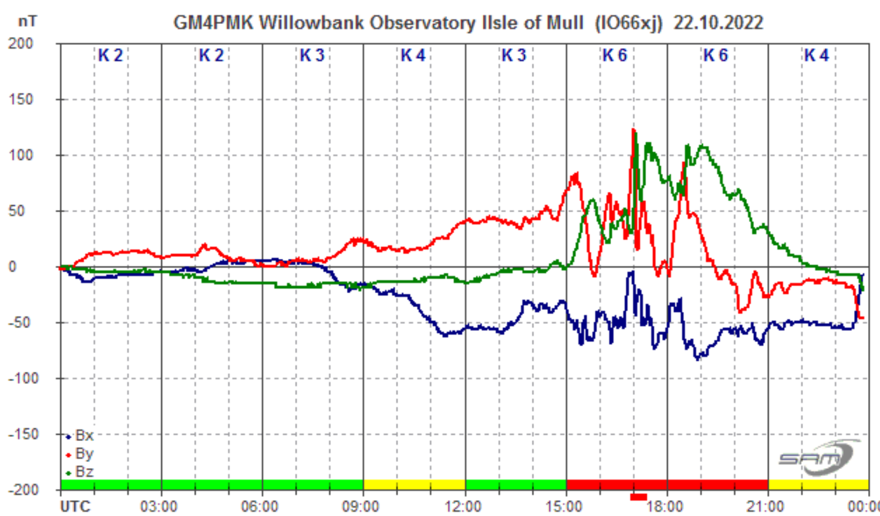
A very slow M1.6 flare was recorded in the afternoon of the 4th, shown in the recording by Mark Prescott. The rise time of the SID is about 15 minutes, with the decay lasting an hour.

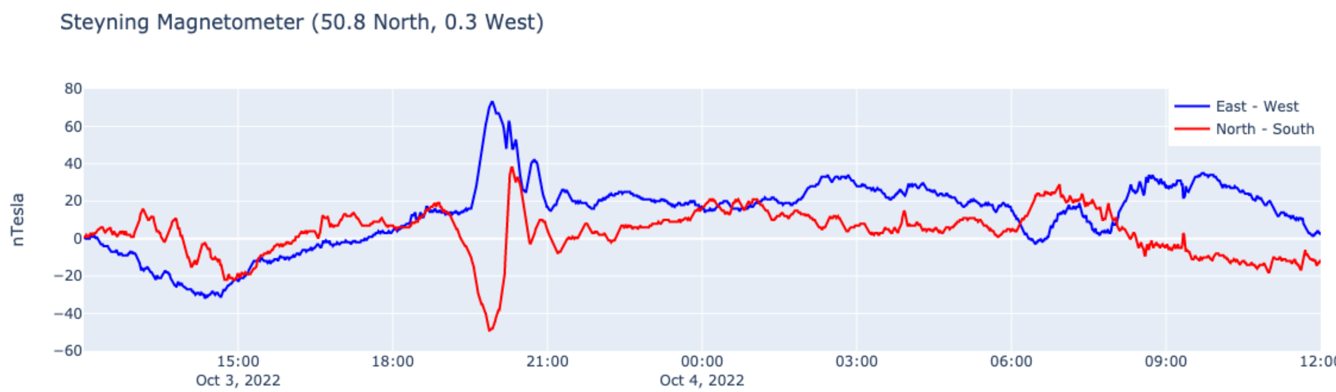


MAGNETIC OBSERVATIONS

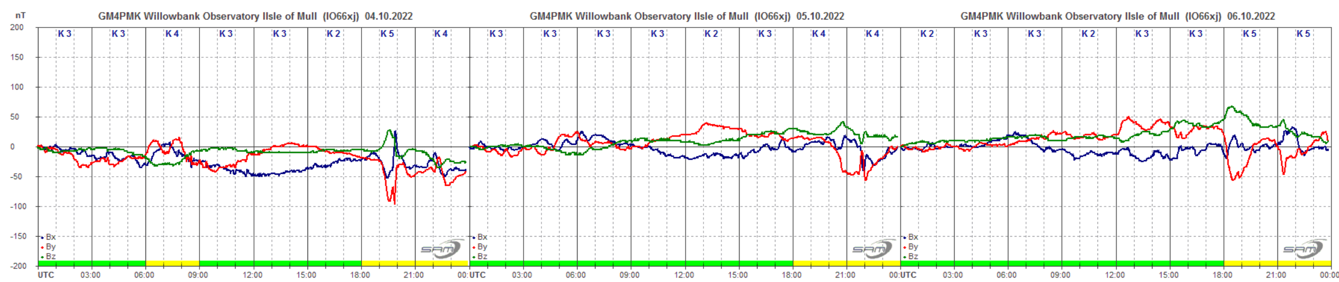


Stuart Green's monthly summary shows some moderate activity through most of October. Despite the number of M-class flares, no major CMEs were recorded. Most of the flares occurred close to the solar limb, and so CMEs were not directed towards Earth. There were some periods of very active magnetic disturbance from high speed winds, the 22nd shown here by Roger Blackwell:





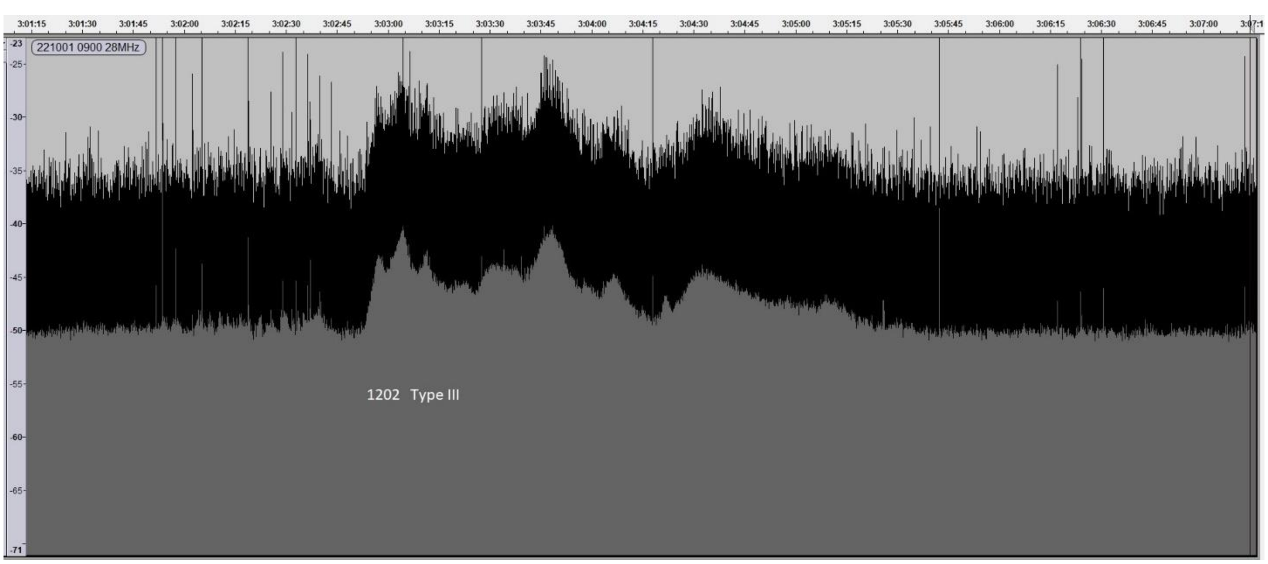
This recording from the 3rd and 4th by Nick Quinn shows a strong pulse around 20UT. It does not seem to be a CME impact, so is probably a shock in the solar wind. Recordings by Roger Blackwell show strong solar wind disturbances continuing on the 4th, 5th and 6th:



Magnetic observations received from Roger Blackwell, Colin Clements, Stuart Green, Nick Quinn and John Cook.

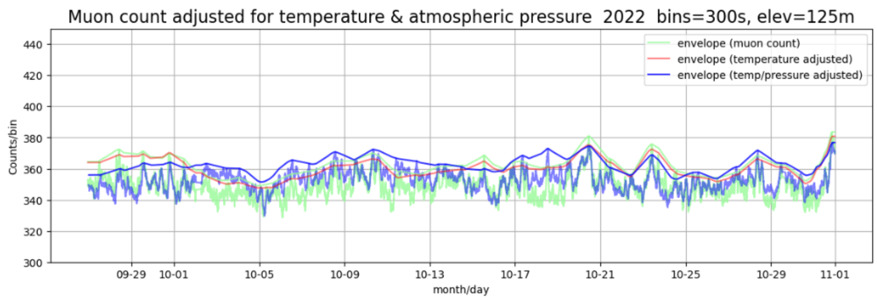
SOLAR EMISSIONS

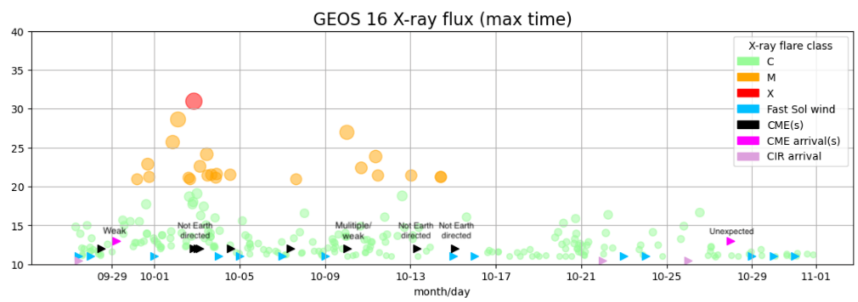
Colin Briden recorded a type III burst starting at 12:02UT on the 1st:



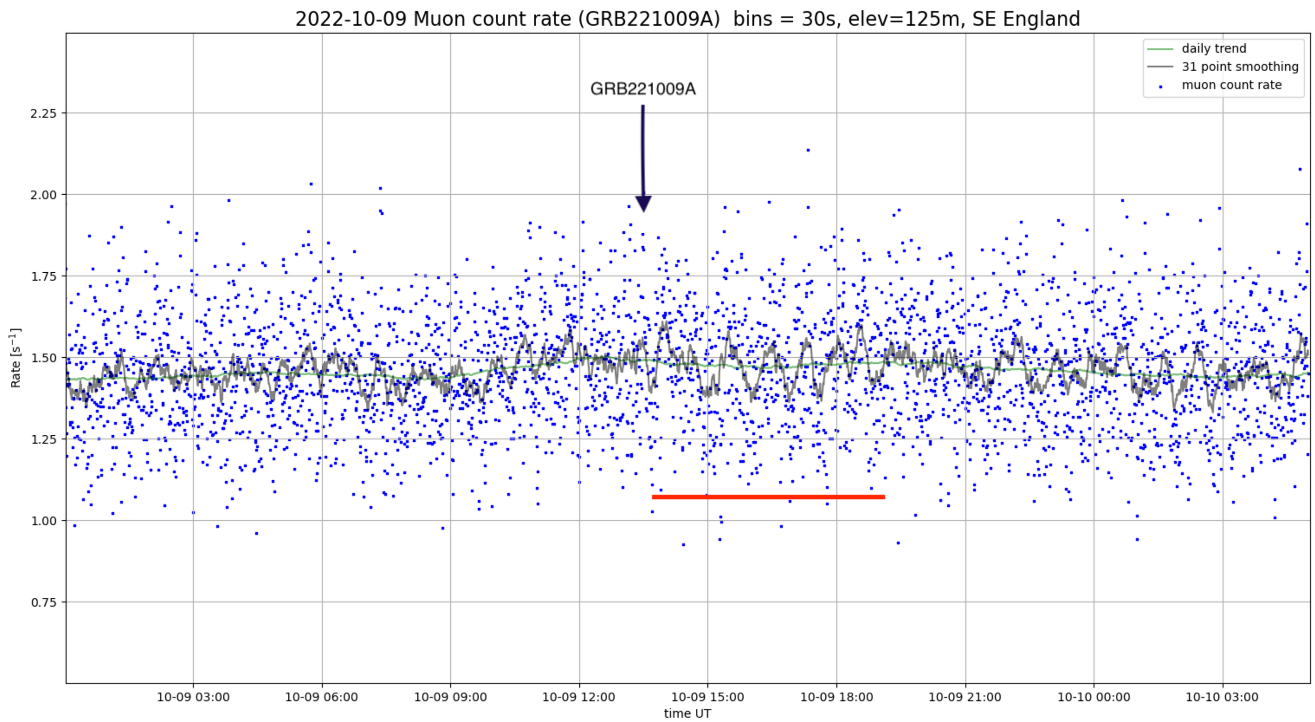
We did not record a SID at this time, but the SWPC bulletin does list a C3.5 flare starting at 11:00 with a peak at 13:00. Looking at the GOES X-ray data does show a smaller peak of about C2 at 12:00, confirming the link. It was a fairly weak burst of about 10db amplitude, lasting five minutes. The sun is now too low in the sky for Colin Clements to record VHF/UHF emissions.

MUON OBSERVATIONS





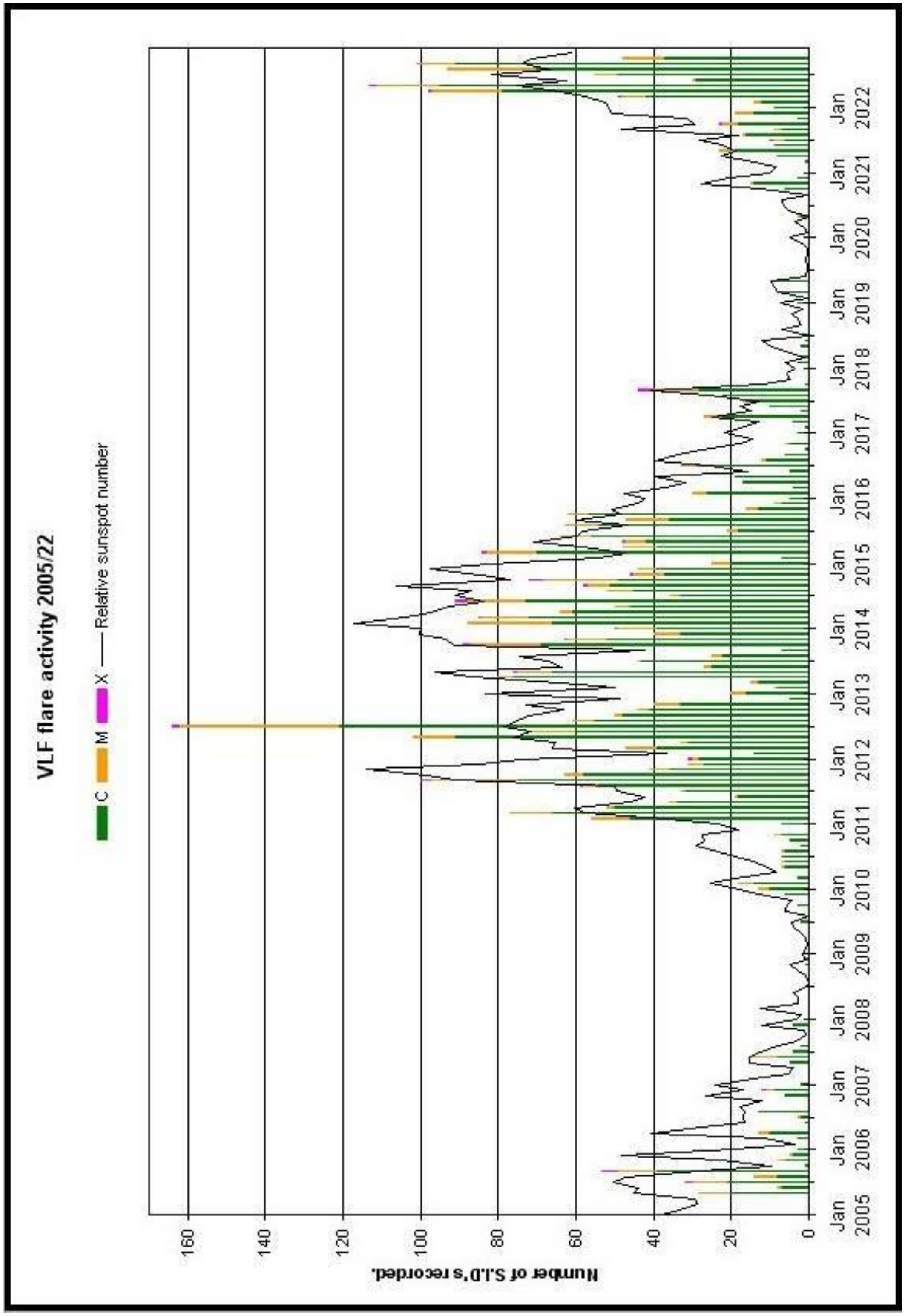
Mark Prescott's Muon counts do not show any significant features through October, although there was a small change in activity following the GRB.



Looking at the grey average trace, there does seem to be a more sinusoidal profile (marked by the red bar) compared to the periods before and afterwards. The connection with the GRB is not certain, but is interesting.

No meteor observations were received for October.

BARTELS CHART


VLF flare activity 2005/22
C
M
X
Relative sunspot number
Number of S.I.D's recorded.
0
20
40
60
80
100
120
140
160
Jan 2005
Jan 2006
Jan 2007
Jan 2008
Jan 2009
Jan 2010
Jan 2011
Jan 2012
Jan 2013
Jan 2014
Jan 2015
Jan 2016
Jan 2017
Jan 2018
Jan 2019
Jan 2020
Jan 2021
Jan 2022

British Astronomical Association
Supporting amateur astronomers since 1890
Radio Astronomy Section

BAA RA Section Winter programme 2023

Date	Presenter	Topic
Jan. 6th Friday 19:30 GMT (19:30 UTC)	**Whitham D. Reeve** Anchorage, Alaska USA	**HF Meteor Trail Reflections Observed at Anchorage, Alaska USA &** **UK observations using the new 6m beacon**
Jan. 21st Saturday 10:00 GMT (10:00 UTC)	**Dr Wolfgang Harman** Managing Director Astropeiler Stockert Observetery Germany	**An Introduction to Radio Astronomy** This will be a training presentation introducing the subject of Radio Astronomy. No previous understanding of the subject is required
Feb. 3rd Friday 19:30 GMT (19:30 UTC)	**Dr. Ziri Younsi** UKRI Stephen Hawking Fellow Mullard Space Science Laboratory University College London	**Imaging of black holes** with the Event Horizon Telescope
Mar. 3rd Friday 19:30 GMT (19:30 UTC)	**Dr. Chuck Higgins** Middle Tennessee State University Physics and Astronomy Dept.	**Citizen Science and Radio Jove** The Science and instrumentation for a Radio exploration of Jupiter
Mar. 31st Friday 19:30 GMT (18:30 UTC)	**Dr John Veitch** Senior Lecturer Institute for Gravitational Research School of Physics & Astronomy, University of Glasgow	**What gravitational waves can tell us about the universe**

If you have any suggestions for the winter 2023 term do let me know.
Our meetings are open to all. Once you are registered on the RA Section email list the Zoom link will be sent out to you before the meeting. If you are not on the email list, please request registration from Paul Hearn (paul@hearn.org.uk).

VINTAGE SARA

CHARLES OSBORNE, SARA HISTORIAN

The Cyclic Life of Big Dishes: Woodbury Georgia aka Woodbury Research Facility

This will be a story of the ups and downs of technology. In many ways applicable to so many large dish sagas we've been involved with. Woodbury is a small town 65 miles south of the Atlanta airport. A farming community of peach orchards, cotton fields, and pecan groves. A look at the pictures on Google Earth looks a lot like many small towns in the southeast, a few buildings renovated into antique shops and many overtaken by vines and neglect. Look southeast of town following Cove Road and you'll see a note about Woodbury Research Facility. Zoom in on that and bring up years of strange visitor pictures posted.

AT&T was searching for a remote location for a satellite downlink. Woodbury is an unusual topographic area in that a ring of hills surrounded and shielded an ideal flat area inside. They built what is called an " 'A' Station" meaning the largest of commercial dishes, 100 footers (30m). One dish to cover southeast, one dish to cover South, and a third wing which if needed could be built out for a westerly dish. A microwave link was built on the outside top of the surrounding ring of hills to beam microwave traffic in and out toward Atlanta minimizing interference to the dishes. The two sites about two miles apart were linked by underground lead cased multiconductor coaxial cable about 3.5" in diameter.

Even though the antennas were huge by most standards satellites were not very capable in the 70's and required multiple 3kw Klystron amplifiers to feed the 5.925-6.425 GHz C-Band signal uplink. On the downlink 3.7-4.2 GHz LNAs likewise were nothing like today. The AT&T dishes had 1:2 redundant helium cryocooled LNAs. That means a standby LNA is precooled and ready to backup a failed LNA on either polarization automatically. These cooling systems required several kw of AC power running compressors about the size of today's home heat pumps just to cool the LNAs down to 17 Kelvin physical temperature in a vacuum dewar much like Green Bank front ends. The compressors and outdated control systems remained when we got there in 1992. But the cryocooled LNAs were long gone.

The facility ran telephone and possibly television traffic for AT&T for perhaps ten years in the 70's and then technology and progress caught up with it. Instead of staffing and maintaining the huge dishes and facility, much smaller 7 to 11 meter dishes could be placed close to Atlanta to do the same job unmanned.

The facility was stripped of anything of value by AT&T and then sat empty and neglected for ten years. Pigeons had found the elevated equipment room as deluxe accommodations leaving inches of pigeon crap decaying the floors. The waveguide feed once carefully pressurized by dry air had long since succumbed to UV damage and the feed became a funnel for rain water. In winter it would freeze and expand splitting the aluminum waveguide.

At some point, possibly during divestiture, AT&T ownership of the site went to a local realtor, undoubtedly thinking he was about to make a quick profit. But he was mistaken, and unable to sell the site. Eventually he donated it to Georgia Tech for the tax write off. That's where the story gets interesting. Two electrical engineering professors: Dr.Paul Steffes W8ZI and Dr.Whit Smith KJ4SC envisioned turning it into a student project lab to rebuild the needed motor control circuits. GATech funded a small amount to cover the hiring of a caretaker at the site. He was a local living just down the street from the antennas all his life. He would keep the yard mowed, do pressure washing, painting, and in general keep an eye on the place to keep vandals out.

I got called in to come down on a tour and help explain what some of the remaining pieces were used for originally. I was working at Scientific Atlanta's Satellite Communications Division at the time. That's how I got to be involved as an advisor in the renovation project. Eventually I brought SARA in as helpers. We were allowed to use the dishes for drift scanning if we could get the feed system working again. I fabricated a new feed window and dry air system once we removed a lot of broken waveguide pieces and cleaned out what was left.

The site proved a useful hands-on project for several years of EE students. Gradually old wiring and damaged waveguide was removed. New motors were obtained and control circuits fabricated to move the dish again. I remember at one point the students had created a motor drive system using a stereo amplifier to provide variable speed control to the motors.

Large bundles of cables had been cut and there was no documentation. So limited safety circuits were fabricated. The dish was finally movable for the first time in perhaps fifteen years.

Lessons fortunately not learned the hard way that might prove useful to other sites in similar situations.

1.) Students think they are immortal. Never underestimate the risks they will take. I remember seeing pictures of students climbing the feed support arms without safety harnesses. At PARI similar issues were initially a problem. Even my wife Janis climbed to the top of the feed at PARI (125ft up) with a camera and tripod without telling anyone. At least she took a panorama and selfie at the top (amid a swarm of disturbed wasps) and successfully climbed down. Safety first. In the enthusiasm these sites engender in people, they will do the most ill-advised, and unexpected things.
2.) Arc Flash is a term I learned long after Woodbury. I recall working on and manually forcing large AC contactors to make a connection to test a circuit. There are often red fiberglass shields over some of these AC circuits. Turns out it's not just to reduce the risk of touching 208 VAC 3Φ circuits. If a high current is interrupted an arc can result which flashes copper into hot plasma which can blind or burn. The shields are there for a reason. Wear safety glasses and appropriate welding gloves. Learn about "arc flash" before you experience it by accident.
3.) Assume every circuit is live. Use a voltmeter repeatedly to be sure no voltage is present or has become present before working on mystery circuits. Not only can you end up with a large divot taken out of a good wire cutter. Lots worse things can happen if you are part of that connection. (I have several entertaining stories I could share.)
4.) The weights involved, and geared down power, of big motors on big dishes can do amazing things. Try to be ready with a safe way to stop motion before it turns into vast amounts of inertia. Ie make sure the brakes work. (Again several stories here.)
5.) Pair people up. Don't work alone with nobody knowing where you are. Expect the unexpected. Terms like "Lockout/Tag out" should be explained to everyone and why.
6.) Kill Switches. With big dishes come big chances of something going wrong where you need to instantly stop it. So do get the kill switches working. These are special switches you can push in to cut power to the motors. And you can pull out to also lockout all motion. They are all in series all over the antenna top to bottom and often lighted so you can find the closest one at night. If any switch is pulled out or pushed in nothing works, which is as it is intended. It's like a temporary lockout/tagout. It makes everyone be very sure that an area has been returned to active status after repairs.

Back to our Woodbury story.
Big satellite dishes often have limited ranges of motion and are not easily changed to widen that motion. Geosynchronous satellite dishes didn't have to move all the way down to the horizon. The dishes at Woodbury were made to cover specific sections of the sky. Yet for radio astronomy we really wanted to go down to galactic center or up above the satellite arc. Or even lower, to do hot / cold tests of noise temperature by pointing at trees or mountains.

Eventually they found that by slowly approaching the antenna stops you could almost get down to where we wanted to point. However sometimes the dish position was incorrect and the students would run the dish into the stop before realizing it. Even at Green Bank on the GBT they have microphones in strategic places to make sure they can hear any unexpected sounds all the way back to the control room. At

Woodbury the control room was about 75 ~100 feet from the motors and gears. At one point the gear train was actually driven into the stop and the pinion gear and rack gear it was driving against forced the metal support flooring down and the gears were unmeshed tip to tip. The only way they knew, was the big bang, when the gears remeshed. This happened several times over the years until finally a gear tooth was broken and parts had to be robbed from the other antenna to repair it. That reduced the chances that the second antenna could ever be used. Meanwhile high winds ripped two panels lose on that same antenna making it unlikely to ever be repaired. That focused all efforts on to the one antenna.

One lesson is that these parts are expensive. Making a new piece of any kind, but gears especially, is way beyond the capability of most small town machine shops. And inevitably these big dish projects seem to be undertaken by groups with no funding. So virtually any accident dooms the whole project. That's all the more reason to proceed very slowly and deliberately. Whatever safety circuits and procedures are envisioned double them and make them redundant. You'll thank me for it eventually.

SARA Involvement

For a number of years, myself, Jeff Lichtman, Tom Crowley, and others went down to Woodbury on days when the students were there and we could get access. Most of us were still working then and were limited to weekends. That was OK because the students also were mostly coming down on weekends only, due to class schedules.

We built up some C-Band receive capability and even tried to adapt the feed for L-Band experiments with predictable minimal success. For C-Band we of course had to stay well away from the satellite arc. C-Band 8 foot diameter backyard dishes were popular by then and the satellites were much more powerful than they had been when the big dishes were designed. Saturating the LNA was a definite possibility even with sidelobes.

One reason AT&T could no longer use the dishes was the feeds. The spacing on the satellites had become smaller and smaller as more satellites were added reaching 2°. On transmit a 100 foot dish could now potentially saturate the adjacent satellites if the transmit sidelobes were not controlled. The FCC mandated a much more restrictive radiation pattern on uplink and these rectangular feeds were too primitive to meet that mask. The feeds would have had to have been replaced. But by then a 7 to 11meter dish near Atlanta would be enough gain to make the link work. So the dishes were simply parked, stripped, and abandoned in the early 80s rather than upgraded to meet the new standards.
Around 1997 Jeff Lichtman and I were both in the midst of job changes and we had to scale back our time at Woodbury. But SETI-Institute's involvement would pre-empt us anyway.

At some point the money started to run out for Woodbury. A new source of funding was needed or the place would shut down. About this time the SETI Institute got interested in Woodbury as a potential FUD Site (Follow Up Detection Site). The 140 foot dish at Green Bank had been contracted and they wanted to use Woodbury to look at any target hits to see if they were Earth bound RFI or way out there. Woodbury isn't too far off the same Longitude but differs by many degrees of latitude. Enough to make it easy to not be looking at the same satellite in orbit or experiencing the same RFI on Earth.

The SETI Institute breathed some life into Woodbury for a year or so. They upgraded the motor and control system into something that could be remoted over the Internet so that an operator at Green Bank could bring the Woodbury dish online and move it to coordinates plus tune the receivers remotely and send that data back to Green Bank.

The feed on the Woodbury dish however had to be replaced to cover L-Band. Woodbury is a Cassegrain dish with a sub-reflector. That required a very long high gain corrigated feed. CSIRO/ATNF in Australia was contracted to design and build that 1-3 GHz feed. The SETI Institute also paid to have the old feed removed and the new installed. See the pictures. The old feed is the square horn. The new CSIRO/ATNF feed is a circular waveguide horn design. http://www.setileague.org/photos/woodbury/wrf05.jpg

A good set of pictures is on the SETI-League website showing Dr.Dave DeBoer (Georgia Tech), Jeff Lichtman, and John Glowacki (Australian Telescope National Facility) during the feed install. http://www.setileague.org/photos/woodbury/wrf03.jpg Dr.DeBoer would later become a key person at the SETI Institute's Allen Telescope Array for many years.

All this worked and Woodbury was online for about a year. I don't know the story as to what happened. But the SETI Institute left, deinstalled their electronics and test equipment, leaving GA Tech with a lot of holes in the system block diagram and no money to fill those holes.

At that point around 1998 I believe the site was sold to a metal sign manufacturer who just wanted the building because of its power and space in square feet. The dishes became something of a liability really. Today the buildings are empty and the site unused. And the expensive CSIRO feed is in much the same state of damage and disrepair as the previous feed. UV, wind, and weather has done its thing again and destroyed the mylar window over the feed letting water in for years. I found a recent YouTube drone flight someone did showing the circular feed in more recent times, with a tree growing out of it. https://www.youtube.com/watch?v=tI10XQh7y4I

Who is to say whether the site will be resurrected again, continue its slow deterioration, or just show up as some SciFi movie backdrop like it did in Walking Dead. It is listed as a potential movie set with the Georgia Film Office. --The End--

Featured Articles

HAARP Research Campaign ~ October 2022

Whitham D. Reeve

1. Introduction

The High-frequency Active Auroral Research Program, HAARP, operated by the Geophysical Institute at the University of Alaska Fairbanks, held a very successful 10-day research campaign on 19-28 October 2022 (figure 1). The campaign involved over 40 investigators, 13 experiments, and approximately 78 hours of transmitter/array time. All experiments except one were funded by the United States *National Science Foundation* (NSF). The one exception was funded by the *Canada Council for the Arts*.

Figure 1 ~ Graphic that was part of the press release by University of Alaska Geophysical Institute announcing the research campaign. The foreground shows the Ionospheric Research Instrument antenna array and transmitter enclosures. The Operations Center is the white building in the left near background. The mountains in the far background are part of the Wrangell Mountains with Mount Drum on the right, 40 km away, and Mount Sanford on the left, 50 km away. Image courtesy of UAF-GI.

This article briefly describes the campaign from my perspective both as an observer and participant. The Ionospheric Research Instrument (IRI), which is the transmitter and antenna array used to heat and alter the ionosphere above the facility with several gigawatts of radiated power, is the key instrument, but many diagnostic instruments were used including my own receiver and antenna systems. Readers interested in more detailed descriptions are referred to {Reeve16} and {Reeve17} for HAARP instrumentation and {Reeve22} for my own instrumentation. The official HAARP website also has many details including links to the diagnostics {HAARP}.

2. Overview

The October 2022 campaign was the most scientifically diverse campaign ever conducted at HAARP. It included a first-ever attempt to probe Jupiter's ionosphere using signals transmitted from Earth (*Jupiter Bounce* experiment), investigation of possible causes of the airglow phenomenon known as STEVE (Strong Thermal Emission Velocity Enhancement, *MIV experiment*), and an experiment to test the feasibility of using HF radio transmissions to measure the interiors of near-Earth asteroids (*Moon Bounce* experiment). These and other experiments are described in the following sections.

Coordination and discussions between the investigators and IRI operator are through an online collaboration and communication tool. This also is used to post spectrograms, ionograms and other data including occasional snapshots of some of the monitors in the HAARP Operations Center (figure 2) located about 1 km from the IRI. The IRI operator prepares scripts before the campaign that define details of each experiment such as frequencies, modulation, array configuration, transmitter power and transmission times. If needed, the scripts can be changed relatively quickly to accommodate ionospheric conditions as a given experiment progresses.

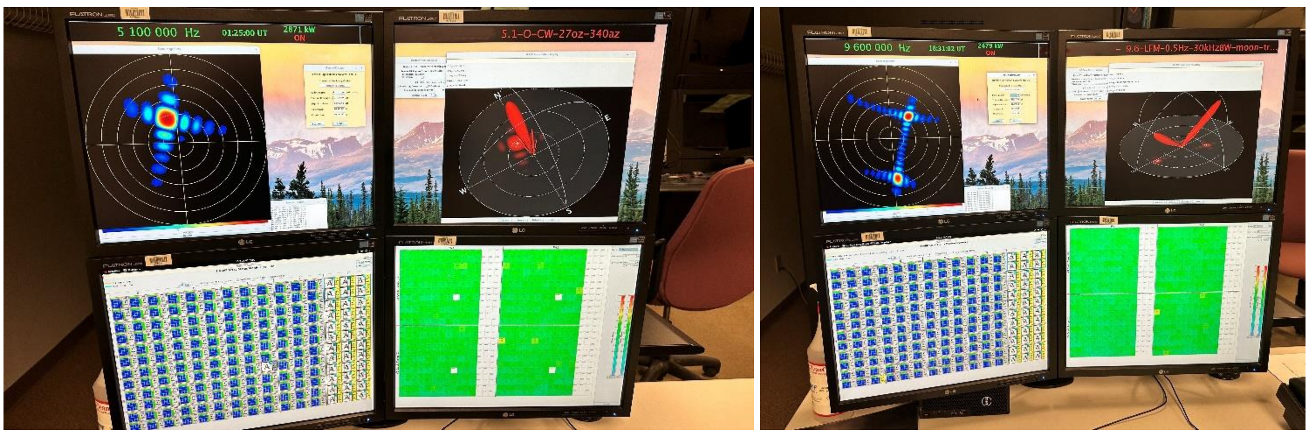


Figure 2 ~ Four of the many IRI monitors. Clockwise from top-left in each image is the IRI heat map (relative transmission power shown by color on a compass), 3-dimensional antenna pattern shown on a compass, array transmitter power amplifier cooling stack temperatures, and status of every transmitter in the array. All displays are real-time. Left: 5.1 MHz *PFISR* (Poker Flat Incoherent Scatter Radar) experiment at 0125 on 24 October with the array beam pointed 27° off-zenith elevation and 340° azimuth. Array gain was 26.5 dB; Right: 9.6 MHz Moon Bounce experiment at 1831 on 21 October with the array beam pointed 52.5° off-zenith elevation and 175.7° azimuth. Array gain was 27.0 dB. Images courtesy of UAF-GI.

There generally is no requirement that investigators be present at the HAARP facility during the campaigns unless they have on-site diagnostic instruments and need to locally control them. On the other hand, online presence is very important. Some diagnostic instruments are off-site and remotely controlled. I controlled my receiver systems at Anchorage Radio Observatory and Cohoe Radio Observatory from Anchorage, Alaska and was not present at HAARP during the campaign.

Many HAARP experiments benefit from amateur radio support or have citizen science applications, so a *Notice of Transmission* was distributed by the HAARP Program Office before the campaign to amateur radio astronomy and amateur radio groups. The transmission notice encouraged observers to submit their observations of the various experiments and provided an address for requesting a HAARP QSL card. The notice also included a brief description of the experiments and known frequencies and transmission times. Some experiments depended on knowing the ionosphere's plasma and gyro frequencies in real time. Because these naturally change, the transmission frequencies for some experiments sometimes changed with less than a minute's notice, adding to the challenges I and others had to record the received signals. Despite these challenges, I recorded over 550 gigabytes of digitized In-Phase and Quadrature-Phase (I-Q) data from three software defined radio receivers.

The campaign went very well with no major problems reported by the HAARP Program Director. On one occasion, the IRI had to be shut down for a few minutes due to an errant airplane flying toward the facility. An important step in HAARP campaign planning and execution is coordination with the Federal Aviation Administration, which issues a NOTAM before the campaign to announce temporary fight restrictions and warn pilots and dispatchers of the HAARP operation (*A NOTAM, or Notice to Air Missions, is a notice containing information essential to personnel concerned with flight operations* (for example, pilots) *but not known far enough in advance to be publicized by other means.*). The plane was detected by the on-site radar and Traffic Collision Avoidance System (TCAS), both of which were installed and are operated during research campaigns for this purpose. The pilot made no attempt to contact the facility on the air band VHF installed in the operations center.

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3. HAARP Ionosonde

Many HAARP experiments require heating of the ionosphere above the facility at natural frequencies. The IRI transmitter sometimes is called an *HF pump* because it pumps energy into the ionosphere, generally near the gyro or plasma frequencies or harmonics because those frequencies are the most efficient for heating. Thus, it is necessary to determine what those frequencies are immediately before and during an experiment. The on-site *DigiSonde* ionosonde is used for that purpose. The DigiSonde is an integral component of IRI operation, not only for experiments that produce artificial ionosphere layers or phenomena but also for experiments that involve propagation.

An ionosonde produces graphs, called ionograms, of the ionosphere's height plotted against frequency. The DigiSonde also has built-in computational capabilities and can provide plots of electron density against frequency and other information. These plots are analyzed by the array operator and investigators, and the frequency is chosen through collaboration in real-time. Sometimes, the IRI is setup to sweep through a range of frequencies in an effort to find the best frequency or frequencies for a particular experiment. Or, it may be run at a fixed frequency for several minutes to observe the effects.

The DigiSonde receiver antennas are only 0.8 km from the IRI array so interference is unavoidable when the IRI is transmitting unless specific measures are taken. In this case, the DigiSonde is switched to a *fast mode* and synchronized with the IRI to operate only during the IRI off periods. The tradeoff for the fast mode is lower signal-to-noise ratio and lower resolution ionograms, but a low-resolution ionogram can be produced in less than 10 seconds compared to slightly more than 4 minutes for a normal ionogram. The lower resolution is sufficient to spot artificial ionosphere layers, especially when a series of ionograms is viewed in succession as the artificial layer develops (figure 3).

Real-time ionograms produced by the HAARP DigiSonde at Gakona, Alaska may be viewed by visiting the HAARP Diagnostic Suite webpage {DIAGN}.

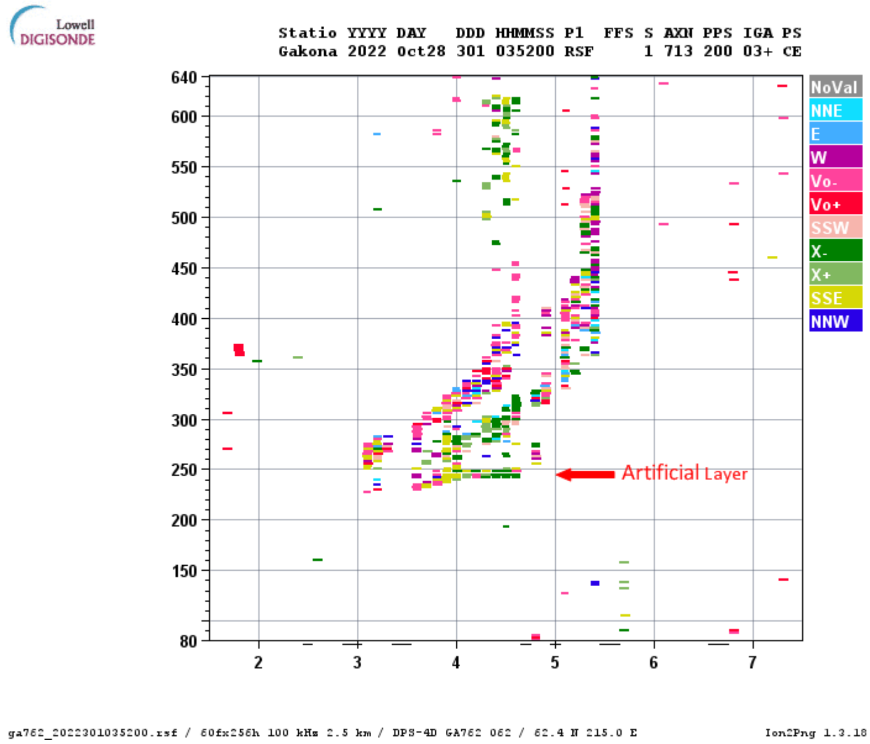

Figure 3 ~ One of a series of a low-resolution ionograms produced during a *Making the Invisible Visible* (MIV) experiment. Height above ground (km) is shown on the left vertical scale and frequency (MHz) on the lower horizontal scale. The pixel colors indicate various characteristics. The artificial ionosphere layer produced by the IRI at 240 km altitude is annotated by the red arrow. At the time shown, the IRI was transmitting a 4 minute linear slow sweep from 4.15 to 4.25 MHz. In fast mode, the DigiSonde sweeps only 60 frequencies by 256 height increments. A normal ionogram sweeps 392 frequencies by 512 height increments and integrates more pulses for each frequency to provide higher resolution and signal-to-noise ratio.

4. Experiments

The following are brief discussions of some of the experiments and the resulting signals I received at Anchorage. I simultaneously received and recorded the signals at Cohoe Radio Observatory but only show spectrograms from Anchorage. Anchorage is 286 km and Cohoe is 390 km from HAARP, and the received signals were very similar. The description of each experiment in italics is taken directly from the Notice of Transmission mentioned above.

My discussions include a screenshot of the *SpectraVue* receiver control software window. The window has three panels. The upper panel is the spectrogram with frequency shown on the horizontal scale along the top and received signal level in dBm on the left vertical scale. Received carrier waves are seen as spikes or humps and some include a marker that indicates the frequency and amplitude in a table in the upper-left corner. The displayed noise floor is the jagged line at the bottom of this panel. The middle panel is a waterfall that uses the same frequency scale as the spectrogram and shows the spectra over time from top to bottom. The waterfall spectra is time-stamped and the power is indicated by colors using a scale along the left edge of the waterfall. The bottom panel shows the center frequency, displayed frequency span and some display setup details such as the number of dB per division on the spectrogram vertical scale and displayed frequency resolution.

Making the Invisible Visible (MIV) – *Experiment using the HAARP IRI to test if hot electrons are capable of producing the continuum (white) emissions present in STEVE airglow. If successful, this experiment may provide new insights into the cause of the unique color of STEVE, a question that so far is unanswered.*

The anticipated results from the MIV experiment were optical effects similar to the STEVE airglow. The experiment also produced radio effects that I received at Anchorage. One such effect was *BUM*, or Broadband Upshifted Maximum in the stimulated electromagnetic emission spectra (figure 4). The BUM is a prominent feature produced when the HF pump frequency is close to a harmonic of the electron gyro frequency; in this case it was the 3rd harmonic at 4.27 to 4.28 MHz. I was surprised to receive the BUM because I expected it would be very weak and not detectable 286 km from HAARP at Anchorage.

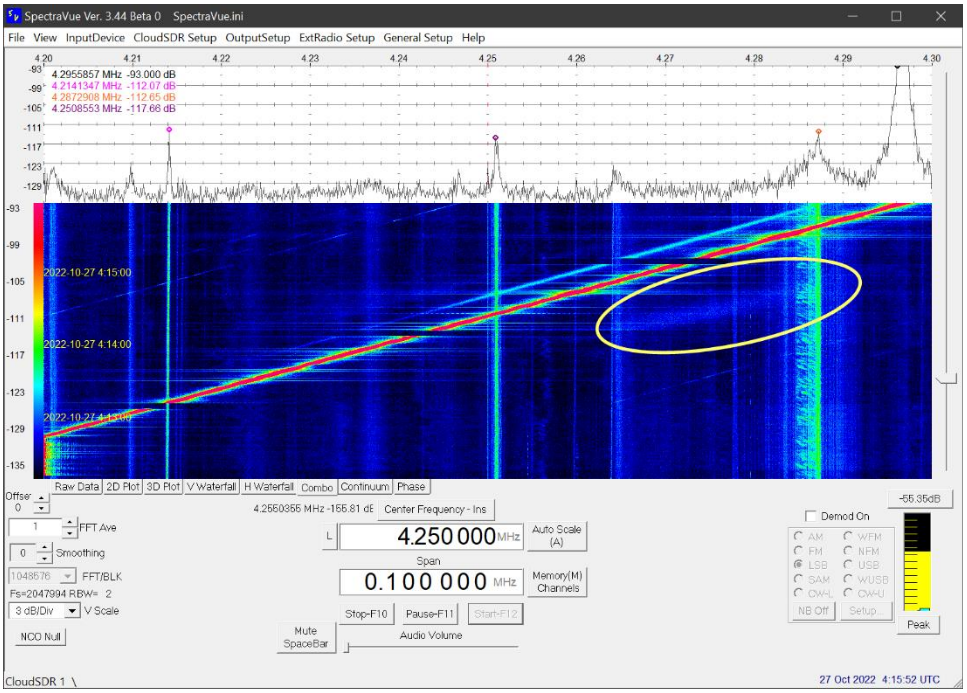

Figure 4 ~ Annotated spectra recorded at Anchorage for the MIV experiment at 0415 UTC on 27 October showing BUM - Broad Upshifted Maximum stimulated electromagnetic emissions (diffuse region circled in yellow) and considerable radio frequency interference (RFI) seen as vertical lines. The transmitted sweep is the bright, slanted line from lower-left to upper-right. The sweep required 4 minutes from 4.2 to 4.3 MHz. The BUM indicates the IRI transmissions are at an ionospheric resonant frequency and a good place for artificial plasma cloud generation. In this case, the BUM was produced when the HF pump frequency sweep was between 4.27 and 4.28. This screenshot was taken when the sweep frequency was 4.2955... MHz just before the sweep ended. Several spurious signals also are present with the three most prominent at 4.2141..., 4.2508... and 4.2872... MHz, the latter partially masking the BUM.

Moon Bounce – *A NASA Jet Propulsion Laboratory (JPL) project, in collaboration with Caltech's Owens Valley Radio Observatory (OVRO) and the University of New Mexico Long Wavelength Array (UNM-LWA), testing the potential use of HAARP/OVRO/UNM-LWA for interior sensing on near-Earth asteroids. This experiment will reflect HAARP transmissions off of the Moon, and the echo will be received by OVRO and UNM-LWA. Amateur radio enthusiasts are invited to listen to the transmissions/echos and submit reception reports to the HAARP facility at uaf-gi-haarp@alaska.edu, or by mailing a report to the address at the end of this document.*

For the Moon Bounce experiments, the HAARP IRI operated as the transmitter part of a bi-static radar with receivers dispersed at locations within view of the Moon including my observatories at Anchorage and Cohoe. The experiments were executed soon after local sunrise on 19, 20 and 21 October when the Moon was highest in the sky (about 43° elevation) and directly south of HAARP. A fixed frequency was used, 9.6 MHz. The modulation was a linear frequency sweep from 9.585 to 9.615 MHz (LFM with 30 kHz span) over a 2 second time period (0.5 Hz rate). The sweep modulated carrier was transmitted continuously during each session: 1.5 hours on 19 October and 1.0 hours on 20 and 21 October.

The Moon's distance from Earth was approximately 400 000 km and the signal's roundtrip propagation time from Earth to Moon and back was about 2.7 seconds, so any echoes fell between sweeps. The maximum radial velocity of the Moon with respect to Earth was only 67 m s^{-1} during the experiments, leading to a maximum echo Doppler frequency shift of only a couple Hz.

The HAARP outgoing transmissions were not particularly strong when received at Anchorage and Cohoe, and there was considerable unintentional foreign language shortwave broadcast station interference (figure 4). I believe the interfering stations were on the western side of the Pacific Ocean and that propagation toward Anchorage was enabled as the Sun rose above the Pacific Ocean. I did not see any obvious lunar echoes in real-time, but it is possible echoes are detectable in post-processing of the data files.

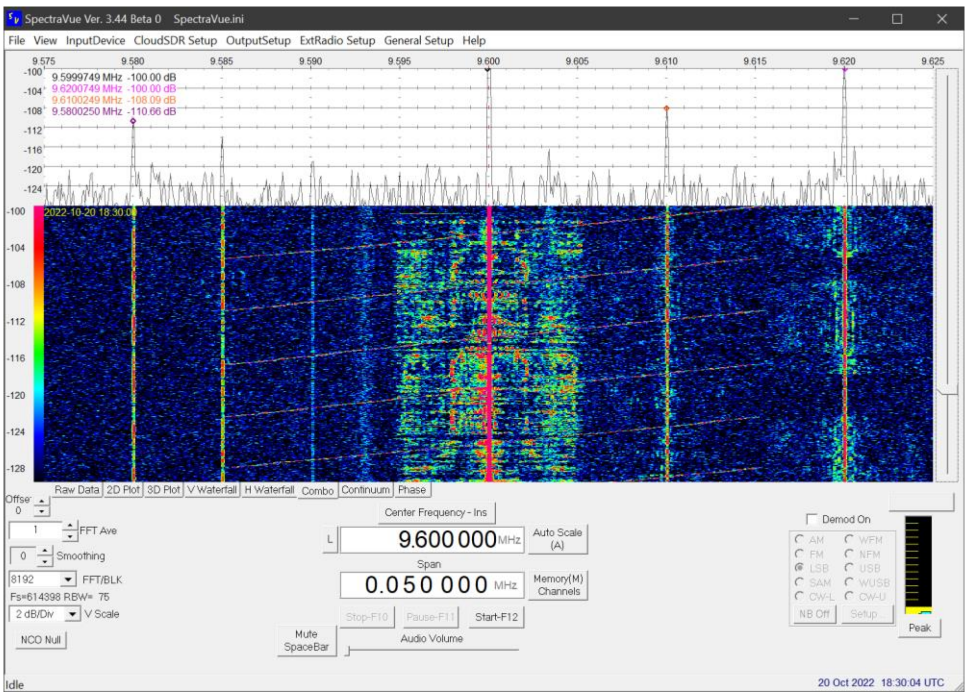

Figure 4 ~ Outgoing Moon Bounce spectra received at Anchorage at 1830 on 20 October in a 50 kHz span. The slanted lines are the sweeping IRI transmissions centered on 9.60 MHz. Shortwave broadcast stations are also received at 9.60, 9.610 and 9.620 MHz, the first two directly overlaying the experiment. Two other relatively strong non-voice transmissions are visible at 9.580 and 9.585 MHz. As the experiment progressed, various stations at 5 kHz intervals popped in and out of the monitored span, usually on the hour or half-hour.

Ghosts In The Airglow (GITAG) *– The second of a three part transmission art project, mixing audio and images at the boundary between Earth's atmosphere and outer space. Air glow and Luxembourg experiments will be paired with the AM modulation of Narrow Band Television (NBTV) video art, spoken word, and sound art created by Amanda Dawn Christie. As a citizen science experiment to learn more about propagation, shortwave listeners from around the world are invited to tune in and submit reception reports in exchange for QSL cards. Transmission frequencies will be listed on the project's new website www.ghostsintheairglow.space, and reception reports can be submitted using the online form which is also on the website. For those who do not have access to shortwave radio equipment, the project will also be streamed live on the home page of the project's website. There are frequently two frequencies transmitted simultaneously, and as such there are two videos embedded side by side (one for each frequency) that can be viewed simultaneously.*

Although the GITAG experiments were designed for artistic purposes and funded by the Canada Council for the Arts, they also had scientific characteristics useful to other investigators. The experiments required transmission of ten different frequencies, some of which changed after only 1 minute, and some transmissions used two simultaneous frequencies. For me, this made recording the experiment somewhat difficult. I had previously decided to record all experiments with the bandwidth of each receiver set to 100 kHz, so to accommodate GITAG I would have had to change recording schedules rather quickly to accommodate the frequency changes. As a result, I was able to record only a few sessions and one live screenshot from this experiment (figure 5).

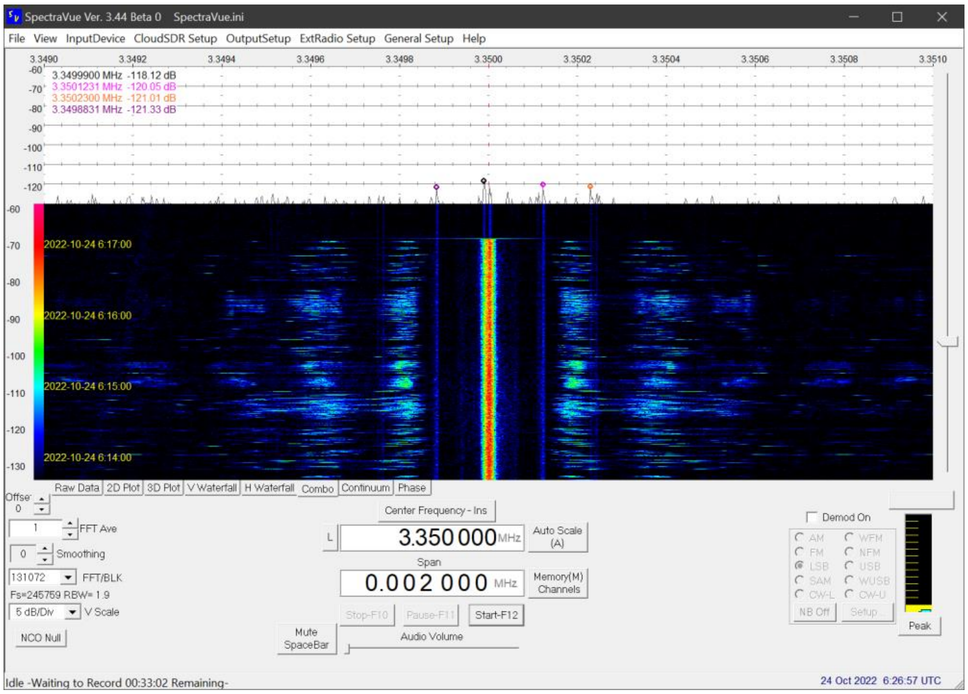

Figure 5 ~ Example GITAG spectra received at Anchorage shown in a 2 kHz span at 3.35 MHz on 24 October. This experiment consisted of simultaneous transmissions on 2.8 and 3.35 MHz, both using amplitude modulation (AM) and with transmissions directed along the magnetic zenith using O-mode (right circular polarization). These transmissions were programmed to end at 0617 as seen at the top of the waterfall. The resolution bandwidth seen in this image is 1.9 Hz.

The GITAG experiments included transmissions of voice, music and video recordings using amplitude modulation (AM). The transmissions took place both in the local mornings and late at night and some were directed east toward Canada while others were directed south of HAARP or along the magnetic zenith (MZ, the direction along the local magnetic field lines, which have an inclination of 75.5° from horizontal at HAARP). Such transmissions can cause magnetic *field-aligned irregularities* (FAI) and *field-aligned scattering* (FAS) and other phenomena in the ionosphere and are used in many HAARP experiments.

There was a possibility that some GITAG transmissions would cause the so-called *Luxembourg Effect* in which the audio that is modulating one frequency is superposed on another stronger signal frequency when the stronger signal modulates the ionosphere's electron density. This effect occurs only under the right conditions, and the superposed modulation is reported to be very weak. In the GITAG experiment, some sessions transmitted music on one frequency and voice on the other. If the Luxembourg Effect had occurred, both voice and music would be heard on one or both frequencies. I listened to both frequencies but the background noise prevented clear recognition of both voice and music so, for me, the results were inconclusive.

Interplanetary Ionosonde (Jupiter Bounce) – *Testing the use of HAARP (in conjunction with the University of New Mexico Long Wavelength Array) as an interplanetary ionosonde to measure the ionosphere of Jupiter. HF transmissions from HAARP will be directed at Jupiter, and UNM-LWA will listen for an echo off of the Jovian ionosphere. Ham radio operators note: please remain quiet! On Oct. 24, 0700-0800 UTC, we will attempt the largest active remote sensing operation in history. Due to the distances involved, it is very important that we keep the noise floor in the 2.7-10 MHz range as low as possible for the duration of the experiment.*

The Interplanetary Ionosonde, or Jupiter Bounce, experiment was another example of a bi-static radar application. Although many individual receivers were tuned to the transmissions, including my own, the only system likely to receive any echoes from the target Jupiter was the *Long Wavelength Arrays* in New Mexico.

The experiment was executed during a 1 hour period from 0700 to 0800 UTC (11 pm to 12 am local) on 23 October. During that time Jupiter was at its highest elevation, about 26° above the horizon, and south of HAARP. Nine frequencies were sequentially transmitted, starting at 2.8 MHz and ending at 9.6 MHz. The transmission cadence was 5.5 minutes ON, 0.5 minutes OFF for each frequency, and the IRI output power was 2.8 GW. The carriers were modulated with 10 kHz linear FM having a 2 second period (0.5 Hz waveform repetition rate). For example, the transmissions at 2.8 MHz swept from 2.795 to 2.805 MHz in 2 seconds (figure 6), repeated for 5.5 minutes followed by a 0.5 minute off period before the next frequency started. At the time of the transmissions, Jupiter was 4.0 astronomical units from Earth and the roundtrip propagation time was close to 66 minutes (1 AU is defined as 149.598... million km).

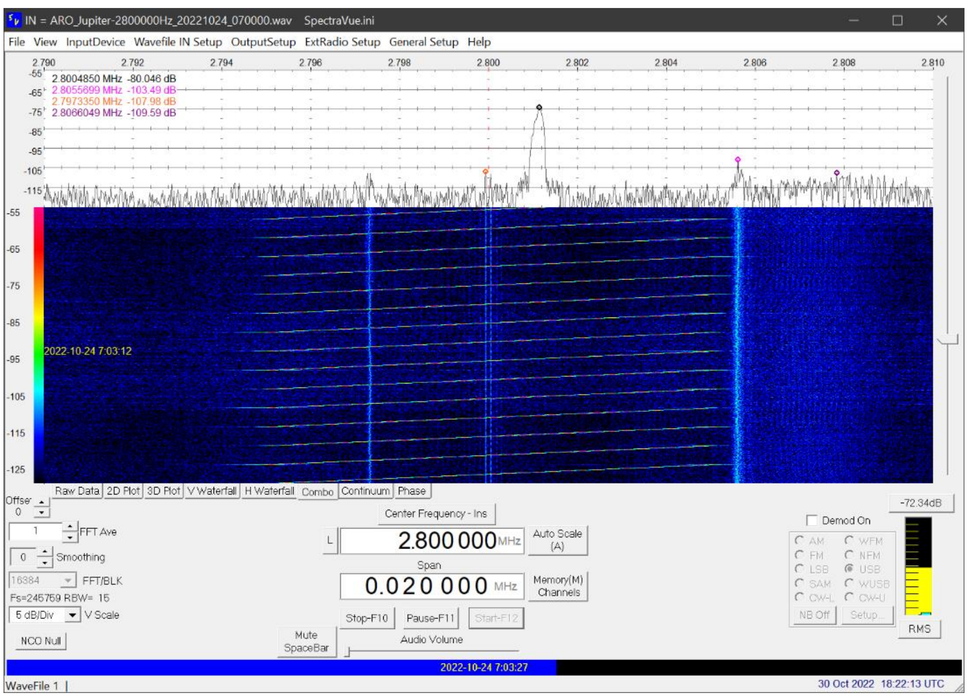

Figure 6 ~ Spectra at 0703 on 24 October for the outgoing Jupiter Bounce transmissions as received at Anchorage. The spectra is shown in a 20 kHz span and 2.80 MHz center frequency. The linear frequency sweeps are apparent in the waterfall, and the sweeping carrier was captured in the spectrogram at 2.8012 MHz just to the right of the center frequency. Return signals from these transmissions would not be received on Earth for over an hour. This image is from the playback of one of the recorded files.

A number of attempts were made in the 1960s to reflect signals from Jupiter in the UHF radio band. To my knowledge, no previous attempts have been made using HF. I did not expect to receive echoes at Anchorage or Cohoe because of the extremely low received signal levels characteristic of extreme distance propagation. In addition to the reduction of signal with distance, only a small (unknown) fraction of the signal incident on Jupiter would be reflected back to Earth. However, there was a possibility of the return signal being received by a very sensitive array such as the LWA in New Mexico. The LWA's received signals will be post-processed to see if any echoes are present, but I do not know when the results will be available.

Several other experiments were listed in the transmission notice, and I recorded signals from almost all of them. One of considerable interest to me was the *VLF Amplification* experiment. Here, *VLF* does not strictly refer to the familiar frequency band 3 to 30 kHz but to very low frequencies in general.

In the HAARP experiment, two HF frequencies are transmitted simultaneously, each using one-half of the IRI array. One frequency is modulated and is the *VLF generator*, and the other is a frequency designed to excite the ionosphere's plasma at or near its critical plasma frequency. Depending on ionospheric conditions, the transmissions can result in emissions in the approximate range 1 mHz to 30 or 40 kHz. These propagate along magnetic field lines into the radiation belts and also are received on the ground via propagation in the Earth-ionosphere waveguide. During the October experiments, the VLF generator frequency was modulated with a slow (6 second) ramp from 500 Hz to 3.5 kHz (figure 7).

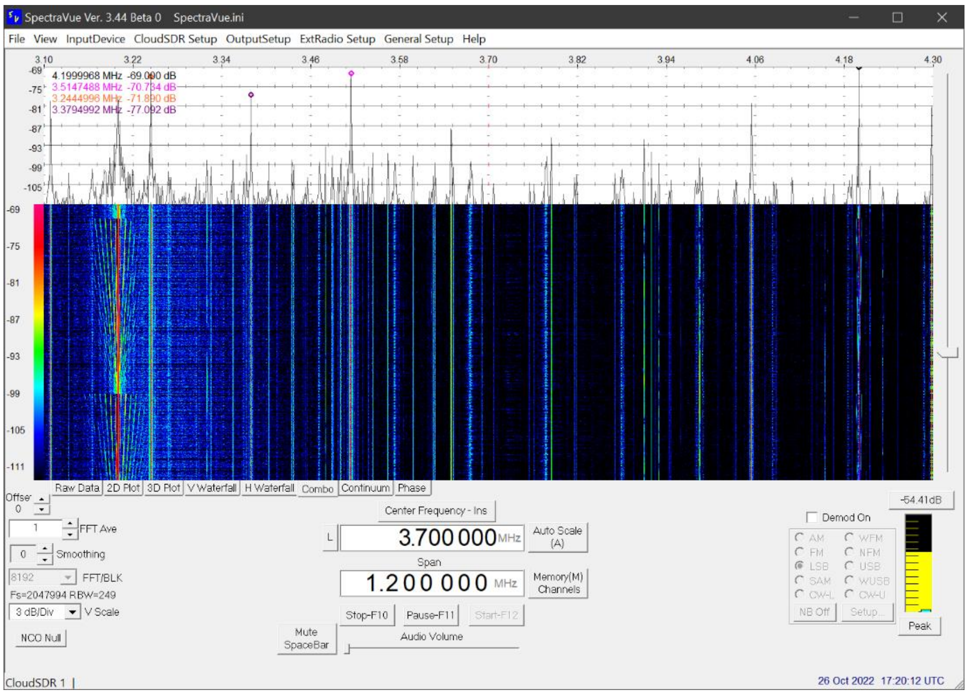

Figure 7 ~ VLF Amplification experiment received at Anchorage at 1720 on 26 October shown in a 1.2 MHz span. The displayed center frequency is 3.7 MHz, middle of the actual IRI transmit frequencies of 3.2 MHz and 4.2 MHz. The lower frequency, near the left side of the image, is modulated with a 0.5 to 3.5 kHz ramp with 6 second period and is seen as a fan-shaped waterfall. The higher frequency, near the right edge, is an unmodulated carrier wave. There are many other signals seen in the spectrum.

I am in the process of refurbishing two very large wire coils in wooden frames that I plan to use to detect the magnetic component of the emissions generated by future VLF Amplification experiments. I also am nearing the end of the construction stage of a search coil magnetometer consisting of 160 000 turns of very thin magnet wire with a design frequency range of a few mHz to a few hundred Hz, which I believe will be suitable for detecting the emissions from future VLF Amplification experiments.

Other HAARP experiments involved simple carrier wave transmissions at a fixed frequency or multiple modulated carriers but are not described here. The scientific results from all 13 experiments eventually will be published by the principal investigators but where and when is unknown at this time.

5. Campaign Weather

Investigators who traveled to HAARP for the October research campaign were met by winter weather including several inches of snow (figure 8), but they had a brief *warm* spell with blustery winds on 20 October (figure 9).

Figure 8 ~ View from a drone at about 13.8 m (50 ft) altitude of the Ionospheric Research Instrument – crossed-dipole antennas and transmitter enclosures – as the Sun was setting at the HAARP facility. Mount Drum, part of the Wrangell Mountains, is in the middle far background. This image was taken near the same location as the opening image in this article but at a lower altitude. Image courtesy of UAF-GI.

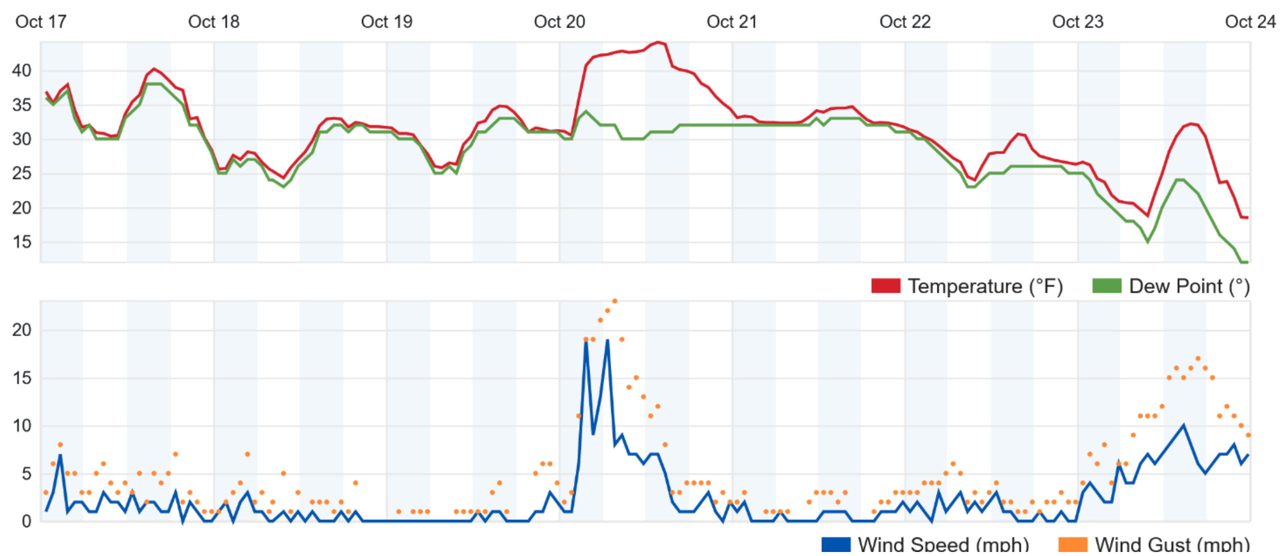

Figure 9 ~ Weather reported by the weather station at the HAARP facility. The research campaign started on 19 October with freezing temperatures and negligible winds. The temperature warmed above freezing the next day but then steadily fell, reaching –9° F on 25 October and remaining in the low twenties through the end of the campaign on 28 October. The weather station is located at the Modular UHF Incoherent Radar (MUIR) site about 400 m from the HAARP Operations Center. Source: WeatherUnderground for station KAKGAKON7 at https://www.wunderground.com/dashboard/pws/KAKGAKON7

6. Future Campaign Observation Strategies

The received signal levels at Anchorage and Cohoe for almost all experiments were generally very strong even at frequencies far below the design range of my antennas: HF Log Periodic Antenna at Anchorage and a single crossed-dipole LWA Antenna at Cohoe. During the MIV experiment on 23 October at a frequency of 4.2 MHz, the signal was so strong at Anchorage I had to set 30 dB of attenuation on the receiver input to control the displayed signal. Receiving strong signals has been the case for past campaigns as well, so no changes are envisioned for the antenna or receiver systems. However, one aspect that I intend to refine is the receiver recording bandwidths, especially for experiments that involve multiple frequencies. Since I use software defined radio receivers with wide bandwidths (RFSpace *CloudSD*R with up to 61 MHz bandwidth), this is easy to accommodate by making simple software setup changes.

My general strategy for past campaigns was to record wide bandwidths that encompassed the entire HAARP IRI frequency range 2.8 to 10 MHz. The full range, including a buffer on each end, is accommodated by a receiver bandwidth setting of 10 MHz and a center frequency of 6.4 MHz. These settings yielded aggregate file sizes of I-Q data for a given experiment that were quite large. During the October 2022 campaign, I started with this setup but then chose to limit the receiver bandwidth to 100 kHz and set the center frequency to that of the experiment. Two disadvantages soon arose: 1) Some experiments involved two frequencies but only one could be recorded at Anchorage; 2) Frequency changes, all unpredictable because of the ionosphere and some only a few minutes apart, were very difficult to follow. It is for these reasons that I intend to revert to an updated version of the previous strategy for future campaigns.

The revised strategy will use the 10 MHz bandwidth setting for all experiments except those with a single, predetermined, fixed frequency, in which case the bandwidth setting will be 100 kHz (for reference, the IRI's maximum emission bandwidth is 46 kHz). Since I often take screenshots of the dynamic spectra and waterfall, I still can narrow the displayed span and then set the displayed frequency resolution by adjusting the FFT frame size to focus on a particular signal.

There are some limitations to the foregoing setup. First, the 10 MHz bandwidth setting is limited to an FFT frame size of no more than 131 072 bits in the CloudSDR receivers. Since the receiver sampling rate for this bandwidth is 12 287 969 Hz, the highest displayed frequency resolution is 94 Hz. For comparison, the 1 MHz bandwidth setting has a 1 228 796 Hz sampling rate and the FFT frame size may be set from 2048 to 2 097 152; the highest resolution is 0.6 Hz.

The second limitation is the FFT frame size cannot be changed *on-the-fly* while recording because the receiver software requires that the recording be stopped to make the change and then restarted. This disrupts the recording schedule so it is necessary to have the displayed spectrum resolution setup beforehand. A third limitation is the SpectraVue waterfall rate is inversely related to the FFT frame size, so for higher displayed resolutions, the waterfall rate is slower. If a highly dynamic spectra is to be captured in a screenshot (for example, linear FM with 2 Hz rate), a faster waterfall rate is desirable and a lower resolution must be used.

A fourth possible limitation arises because of the wide receiver bandwidth. The radio traffic in the lower end of the HF band normally is very busy because of the relatively good propagation from distant transmitters. The lower end of the band also is very noisy with atmospheric noise and local interference sources. The cumulative effect is the possible overload of the receiver front end. The CloudSDR receivers and SpectraVue software are equipped with overload indicators, but I have never seen them lit even when the receiver is set for maximum bandwidth. Nevertheless, noise conditions and possible overload needs to be considered with each campaign.

Another modification to the recording strategy that I probably will use when two frequencies are transmitted is to setup two receivers, one for each frequency and a relatively narrow bandwidth setting. However, depending on the experiment, one or both frequencies likely will depend on the ionosphere's real-time characteristics, which can be very dynamic and thus limit the usefulness of this strategy. When a range of frequencies is to be transmitted, an alternative is to add more receivers and split the frequency band so that each receiver records part of the band. All of my installations use a receiver multicoupler or high quality RF power splitters, so adding receivers is simple.

The conclusions are: 1) The receiver setups will depend on the research campaign and the individual experiments; 2) The receiver setups can be planned only generally; and 3) A high level of flexibility is needed to accommodate the inevitable changes during research campaigns and also the radio band conditions.

As noted above, higher receiver bandwidth settings result in larger file sizes and, in turn, the need for more data storage space. This is easily handled during short campaigns by the existing 500 GB supplementary solid-state storage drive (SSD) already installed in the observatory PCs. At each observatory, the existing SSD shares space with system backups so, for long campaigns such as the one in October 2022, a larger drive would prevent data loss if a lot of the drive space is already used by backups. To improve the situation, I plan to upgrade to 1 TB supplementary SSDs; these use PCIe M.2 NVME technology and are inexpensive and easy to change.

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7. References

{DIAGN} HAARP Diagnostics: https://haarp.gi.alaska.edu/diagnostic-suite

{HAARP} HAARP website homepage: https://haarp.gi.alaska.edu/

{Reeve16} HAARP Antenna Array – Photographic Tour 2016: https://reeve.com/Documents/Articles%20Papers/Reeve_HAARP16.pdf

{Reeve17} HAARP Diagnostic Instruments – Photographic Tour 2017: https://reeve.com/Documents/Articles%20Papers/Reeve_HAARP17.pdf

{Reeve22} Solar Radio & Geomagnetic Activity Observed in Alaska During August 2022: https://reeve.com/Documents/Articles%20Papers/Reeve_Aug2022%20Radio-MagneticActiv_Alaska.pdf

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Non-USA members	
Each USB drive	$20.00 (airmail)
USB drive+ 1-year members extension	$35.00

*Already a member and want any or all these USB drives or DVD's? Buy any one for $15.00 or get any three for $35.00.

SARA Store (radio-astronomy.org/store.)

SARA offers the above USB drives, DVDs, printed Proceedings and Proceedings on USB drive and other items at the SARA Store: http://www.radio-astronomy.org/e-store. Proceeds from sales go to support the student grant program. Members receive an additional 10% discount on orders over $50 US. Payments can be made by sending payment by PayPal to treas@radio-astronomy.org or by mailing a check or money order to SARA, c/o Brian O'Rourke, 337 Meadow Ridge Rd, Troy, VA 22974-3256

SARA Online Discussion Group
SARA members participate in the online forum at http://groups.google.com/group/sara-list. This is an invaluable resource for any amateur radio astronomer.

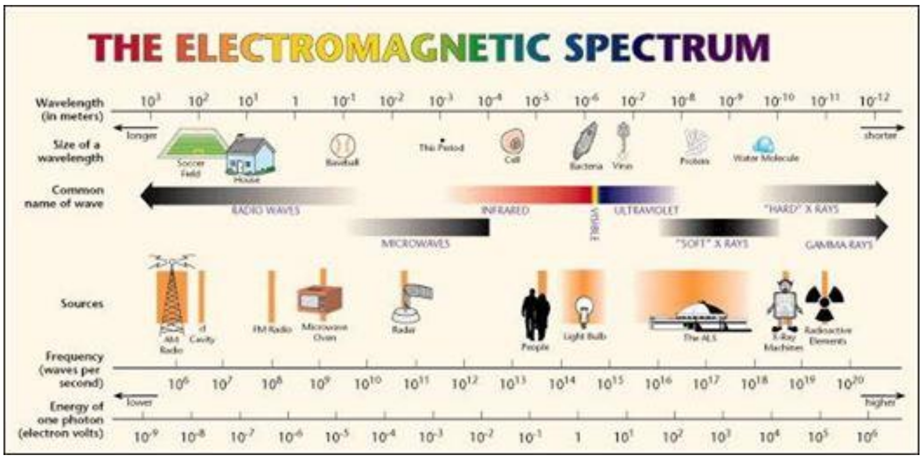
SARA Conferences
SARA organizes multiple conferences each year. Participants give talks, share ideas, attend seminars, and get hands-on experience. For more information, visit http://www.radio-astronomy.org/meetings.

Facebook
Like SARA on Facebook
http://www.facebook.com/pages/Society-of-Amateur-Radio-Astronomers/128085007262843

Twitter
Follow SARA on Twitter@RadioAstronomy1

What is Radio Astronomy?

This link is for a booklet explaining the basics of radio astronomy.
http://www.radio-astronomy.org/pdf/sara-beginner-booklet.pdf



Administrative

Officers, directors, and additional SARA contacts

The Society of Amateur Radio Astronomers is an all-volunteer organization. The best way to reach people on this page is by email with SARA in the subject line SARA Officers.

President: Dr. Rich Russel, AC0UB, https://www.radio-astronomy.org/contact/President
Vice President: Jay Wilson, https://www.radio-astronomy.org/contact/Vicepresident
Secretary: Bruce Randall, NT4RT, https://www.radio-astronomy.org/contact/Secretary
Treasurer: Brian O'Rourke, K4UL, https://www.radio-astronomy.org/contact/Treasurer
Past President: Dennis Farr,
Founder Emeritus and Director: Jeffrey M. Lichtman, KI4GIY, jeff@radioastronomysupplies.com

Board of Directors

Name	Term expires	Email
Ed Harfmann	2024	edharfmann@comcast.net
Dr. Wolfgang Herrmann	2023	messbetrieb@astropeiler.de
Tom Jacobs	2023	tdj0@bellsouth.net
Charles Osborne	2023	k4cso@twc.com
Bob Stricklin	2024	bstrick@n5brg.com
Steve Tzikas	2024	Tzikas@alum.rpi.edu
Jon Wallace	2023	wallacefj@comcast.net
David Westman	2024	david.westman@engineeringretirees.org

Other SARA Contacts

All Officers	http://www.radio-astronomy.org/contact-sara	
All Directors and Officers	http://www.radio-astronomy.org/contact/All-Directors-and-Officers	
Eastern Conference Coordinator	http://www.radio-astronomy.org/contact/Annual-Meeting	
All Radio Astronomy Editors	http://www.radio-astronomy.org/contact/Newsletter-Editor	
Radio Astronomy Editor	Dr. Richard A. Russel	drrichrussel@netscape.net
Contributing Editor	Whitham D. Reeve	whitreeve@gmail.com
Educational Outreach	http://www.radio-astronomy.org/contact/Educational-Outreach	
Grant Committee	Tom Crowley	grants@radio-astronomy.org
Membership Chair	http://www.radio-astronomy.org/contact/Membership-Chair	
Technical Queries (David Westman)	http://www.radio-astronomy.org/contact/Technical-Queries	
Webmaster	Ciprian (Chip) Sufitchi, N2YO	webmaster@radio-astronomy.org

Resources

Great Projects to Get Started in Radio Astronomy

Radio Observing Program

The Astronomical League (AL) is starting a radio astronomy observing program. If you observe one category, you get a Bronze certificate. Silver pin is two categories with one being personally built. Gold pin level is at least four categories. (Silver and Gold level require AL membership which many clubs have membership. For the bronze level, you need not be a member of AL.)

Categories include

1) SID
2) Sun (aka IBT)
3) Jupiter (aka Radio Jove)
4) Meteor back-scatter
5) Galactic radio sources

This program is a collaboration between NRAO and AL. Steve Boerner is the Lead Coordinator and a SARA member.

For more information:
Steve Boerner
2017 Lake Clay Drive
Chesterfield, MO 63017
Email: sboerner@charter.net
Phone: 636-537-2495
http://www.astroleague.org/programs/radio-astronomy-observing-program

Radio Jove

The Radio Jove Project monitors the storms of Jupiter, solar activity and the galactic background. The radio telescope can be purchased as a kit or you can order it assembled. They have a terrific user group you can join.
http://radiojove.gsfc.nasa.gov/

INSPIRE Program

The INSPIRE program uses build-it-yourself radio telescope kits to measure and record VLF emissions such as tweeks, whistlers, sferics, and chorus along with man-made emissions. This is a very portable unit that can be easily transported to remote sites for observations.
http://theinspireproject.org/default.asp?contentID=27

SARA/Stanford SuperSID

Stanford Solar Center and the Society of Amateur Radio Astronomers have teamed up to produce and distribute the SuperSID (Sudden Ionospheric Disturbance) monitor. The monitor utilizes a simple pre-amp to magnify the VLF radio signals which are then fed into a high definition sound card. This design allows the user to monitor and record multiple frequencies simultaneously. The unit uses a compact 1-meter loop antenna that can be used indoors or outside. This is an ideal project for the radio astronomer that has limited space. To request a unit, send an e-mail to supersid@radio-astronomy.org

Radio Astronomy Online Resources

SARA YouTube Videos: https://www.youtube.com/channel/UC-SzptAQZ-20c9CkRb9ZPxw/videos	
AJ4CO Observatory – Radio Astronomy Website: http://www.aj4co.org/	A New Radio Telescope for Mexico - ORION 2021 01 20. Dr. Stan Kurtz https://www.youtube.com/watch?v=Q9aBWr1aBVc
Radio Astronomy calculators https://www.aj4co.org/Calculators/Calculators.html	National Radio Astronomy Observatory http://www.nrao.edu
Introduction to Amateur Radio Astronomy (presentation) http://www.aj4co.org/Publications/Intro%20to%20Amateur%20Radio%20Astronomy,%20Typinski%20(AAC,%202016)%20v2.pdf	NRAO Essential Radio Astronomy Course http://www.cv.nrao.edu/course/astr534/ERA.shtml
RF Associates Richard Flagg, rf@hawaii.rr.com 1721-1 Young Street, Honolulu, HI 96826	Exotic Ions and Molecules in Interstellar Space -- ORION 2020 10 21. Dr. Bob Compton https://www.youtube.com/watch?v=r6cKhp23SUo&t=5s
RFSpace, Inc. http://www.rfspace.com	The Radio JOVE Project & NASA Citizen Science – ORION 2020.6.17. Dr. Chuck Higgins https://www.youtube.com/watch?v=s6eWAxJywp8&t=5s
CALLISTO Receiver & e-CALLISTO http://www.reeve.com/Solar/e-CALLISTO/e-callisto.htm	UK Radio Astronomy Association http://www.ukraa.com/
Deep Space Exploration Society http://DSES.science	CALLISTO software and data archive: www.e-callisto.org
Deep Space Object Astrophotography Part 1 -- ORION 2021 02 17. George Sradnov https://www.youtube.com/watch?v=Pm_Rs17KlyQ	Radio Jove Spectrograph Users Group http://www.radiojove.org/SUG/
European Radio Astronomy Club http://www.eracnet.org	Radio Sky Publishing http://radiosky.com
British Astronomical Association – Radio Astronomy Group http://www.britastro.org/baa/	The Arecibo Radio Telescope; It's History, Collapse, and Future - ORION 2020.12.16. Dr. Stan Kurtz, Dr. David Fields https://www.youtube.com/watch?v=rBZlPOLNX9E
Forum and Discussion Group http://groups.google.com/group/sara-list	Shirleys Bay Radio Astronomy Consortium marcus@propulsionpolymers.com
GNU Radio https://www.gnuradio.org/	SARA Twitter feed https://twitter.com/RadioAstronomy1
SETI League http://www.setileague.org	SARA Web Site http://radio-astronomy.org
NRAO Essential Radio Astronomy Course http://www.cv.nrao.edu/course/astr534/ERA.shtml	SARA Facebook page https://www.facebook.com/pages/Society-of-Amateur-Radio-Astronomers/128085007262843
NASA Radio JOVE Project http://radiojove.gsfc.nasa.gov Archive: http://radiojove.org/archive.html https://groups.io/g/radio-jove	Simple Aurora Monitor: Magnetometer http://www.reeve.com/SAMDescription.htm
National Radio Astronomy Observatory http://www.nrao.edu	Stanford Solar Center http://solar-center.stanford.edu/SID/

For Sale, Trade and Wanted

At the SARA online store: radio-astronomy.org/store.

SARA Polo Shirts

New SARA shirts have arrived.

We now have a good selection of X, XX, and XXX shirts available in all colors including white!

Shirts are $20 at the conference and $25 shipped.

Contact the treasurer at treas@radio-astronomy.org for availability and shipping.

Scope in a Box

radio-astronomy.org/store.

Kit of parts and software to build a working Radio Telescope to detect Hydrogen Line emissions. Available to USA addresses only at this time.

SuperSID Complete Kit ($112-$160 depending on options)
radio-astronomy.org/store.

SARA Publication, Journals and Conference Proceedings (various prices)
radio-astronomy.org/store.

SARA Journal USB Drive ($15-$35 depending on shipping option)
radio-astronomy.org/store.

The USB drive covers the society journal "Radio Astronomy" from the founding of the organization in 1981 thru 2020. Articles cover a wide range of topics including: cosmic radiation, pulsars, quasars, meteor detection, solar observing, Jupiter, Radio Jove, gamma ray bursts, the Itty Bitty Telescope (IBT), dark matter, black holes, the Jansky antenna, methanol masers, mapping at 408 MHz and more. This CD contains all of the above and more with over 4800 pages of articles on radio astronomy. Also included is a copy of Grote Reber's handwritten, 34 page document "Carriage and Mirror Detail" of his historic antenna now on display at the National Radio Astronomy Observatory (NRAO) in Greenbank, WV. You also get an electronic copy of the 109 page "Basics of Radio Astronomy" from JPL Goldstone-Apple Valley Radio Telescope. Also included is the NRAO 40-foot radio telescope "Operators Manual", which by the way, you get to operate if you attend the Eastern SARA conference in July.

SARA Advertisements

There is no charge to place an ad in Radio Astronomy; but you must be a current SARA member. Ads must be pertinent to radio astronomy and are subject to the editor's approval and alteration for brevity. Please send your "For Sale," "Trade," or "Wanted" ads to edit@radio-astronomy.org. Please include email and/or telephone contact information. Please keep your ad text to a reasonable length. Ads run for one bimonthly issue unless you request otherwise.

SARA Brochure

Membership Information

Annual SARA dues Individual $20, Classroom $20, Student $5 (US funds) anywhere in the world. Membership includes a subscription to Radio Astronomy, the bimonthly Journal of The Society of Amateur Radio Astronomers, delivered electronically (via a secure web link, emailed to you as each new issue is posted). We regret that printing and postage costs prevent SARA from providing hardcopy subscriptions to our Journal.

We would appreciate the following information included with your check or money order, made payable to SARA:

Name: ______________________

Email Address : ______________________
(required for electronic Journal delivery)

Ham call sign: ______________ (if applicable)

Address: ______________________

City: ______________________

State: ______________________

Zip: ______________________

Country: ______________________

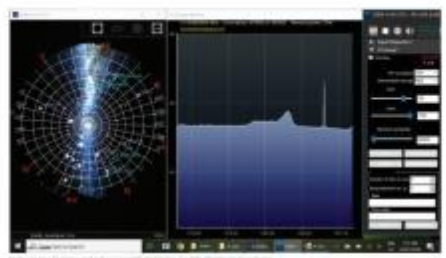
Phone: ______________________

Please include a note of your interests. Send your application for membership, along with your remittance, to our Treasurer.

For further information, see our website at:
http://radio-astronomy.org/membership

How to get started?

SARA has a made a kit of software and parts to detect the Hydrogen line signal from space. This is an excellent method to get started in radio astronomy. It teaches the principles of antenna design, signal detection, and signal processing. Read more about this and other projects on our web site.



Society of Amateur Radio Astronomers, Inc.
Founded 1981

Membership supported, nonprofit [501(c) (3)]
Educational and Radio Astronomy Organization

Knowledge through Common Research, Education and Mentoring

SARA members have been privileged to use this forty foot diameter drift-scan hydrogen line radio telescope every year at their annual meeting in Green Bank.

http://radio-astronomy.org

Why Radio Astronomy?

Because about sixty five percent of our current knowledge of the universe has stemmed from radio astronomy alone. The discovery of quasars, pulsars, black holes, the 3K background from the "Big Bang" and the discovery of biochemical hydrogen/carbon molecules are all the result of professional radio astronomy.

The Society of Amateur Radio Astronomers

SARA was founded in 1981, with the purpose of educating those interested in pursuing amateur radio astronomy.

The society is open to all, wishing to participate with others, worldwide.

SARA members have many interests, some are as follows:

SARA Areas of Study and Research:

- Solar Radio Astronomy
- Galactic Radio Astronomy
- Meteor Detection
- Jupiter
- SETI
- Gamma Ray/High Energy Pulse
- Detection
- Antennas
- Design of Hardware / Software

The members of the society offer a friendly mentor atmosphere. All questions and inquiries are answered in a constructive manner. No question is silly!

SARA offers its members an electronic bi-monthly journal entitled Radio Astronomy. Within the journal, members report on their research and observations. In addition, members receive updates on the professional radio astronomy community and, society news.

Once a year SARA meets for a three-day conference at the Green Bank Observatory in Green Bank West Va.

There is also a spring conference held at various cities in the Western USA. Previous meeting have been at the VLA in Socorro, NM and at Stanford University.

How do I get started?

Just as a long journey begins with the first step, the project you elect must start with a clear idea of your objectives. Do you wish to study the sun? Jupiter? Make meteor counts? Do you wish to engage in imaging radio astronomy? What you decide will not only determine the type of equipment you will need, but also the local radio spectrum.

How do amateurs do radio astronomy?

Radio astronomy by amateurs is conducted using antennas of various shapes and sizes, from smaller parabolic dishes to simple wire antennas. These antennas are connected to receivers and most of these receivers are software defined radios these days. Data from the receivers are collected by computers, and the received signals will be displayed as charts, graphs or maybe even sky maps. As diverse as the observed objects, so is are the instruments and tools used. SARA members will always be supportive to find good solutions for what one wishes to observe.

Is amateur radio astronomy instrumentation expensive?

Technical information freely circulated in our monthly journal helps amateurs to obtain good low noise equipment from off the shelf assemblies, or to build their own units. The actual cash investment in radio astronomy equipment need not exceed that of any other hobby.

What are amateurs actually looking for in the received data?

The aim of the radio amateur is to find something new and unusual. Just as an amateur optical observer hopes to notice a supernova or a new comet, so does an amateur radio observer hope to notice a new radio source, or one whose radiation has changed appreciably.

The Reber Telescope at NRAO. Constructed by Grote Reber in 1937 in his back yard in Wheaton, Illinois

SARA Members discussing the IBT (Itty Bitty Telescope)