

Several dozen hams and space scientists sat down together earlier this year in New Jersey to compare notes on findings from last year's solar eclipse and explore ways in which each group could help the other, now and in the future.

A “Virtuous Cycle”

Hams and Scientists Helping Each Other

BY RICH MOSESON,* W2VU



Photo A. Approximately 60 hams, scientists, and ham/scientists attended the HamSci workshop this past February at the New Jersey Institute of Technology. Attendees came from as far away as England and Arizona. (W2VU photos)

One of the reasons amateur radio exists, according to the FCC, is for “(c)ontinuation and extension of the amateur’s proven ability to contribute to the advancement of the radio art” [FCC rules, §97.1(b)]. As a group, we have been doing this consistently for the past hundred years and, despite popular opinion to the contrary, we are still doing it today.

Some of amateur radio’s latest contributions to advancing “the radio art” were on display recently at the Ham Radio Science Citizen Investigation (HamSci) workshop, where the focus was on how hams and professional space scientists could best work together for everyone’s benefit.

About 60 hams and scientists (many were in both camps) gathered in late February at the New Jersey Institute of Technology (Photo A) for a two-day conference focusing on data collected during last summer’s total solar eclipse and on helping gather more data in the future through a network of personal “space weather stations.” Conference organizer and HamSci coordinator Nathaniel Frissell, W2NAF (Photo B), said he hopes that such information exchanges will lead to a “virtuous cycle” of hams and scientists learning from each other.

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This reporter’s main takeaway was that hams can provide space scientists something they frequently lack — a large and geographically-diverse network of data collection points — while the scientists can then use that additional data to improve their analysis and provide hams (among many others) with a better understanding of the processes at work in our ionosphere that allow us to communicate over great distances. As solar physicist and banquet speaker Phil Erickson, W1PJE, of MIT’s Haystack Observatory noted in his keynote address, “there is much left to discover,” pointing out that “one hundred years after beginning to research space weather, we still don’t understand why the ionosphere stays ionized at night.”

The Eclipse — Mostly as Predicted, But With Some Surprises

Most of the presentations on the first day of the conference were focused on propagation data collected during last summer’s solar eclipse, using a variety of collection methods, including logs from the HamSci-sponsored Solar Eclipse QSO Party, spots on the Reverse Beacon Network (RBN), WSPR (Weak Signal Propagation Reporter) and the PSK Reporter networks (Photo C), and monitoring signal levels of consistent transmitters, such as AM broadcast stations and WWVB (Photo D). In addition, the professionals conducted such



Photo B. HamSci Coordinator and conference organizer Nathaniel Frissell, W2NAF.

experiments as measuring total electron content (TEC) in the ionosphere and making "on the ground" observations, such as noting that four out of five cows in a field being used for radio experiments returned to their barn during the eclipse and that 40 turtles came out of a nearby pond during totality, all thinking it was time for bed!

The results were remarkably consistent with each other, and most of the

measurements and observations were as expected, with the ionosphere behaving like it was sunset — a considerable dropoff in distances covered on 20 meters and analogous increases in contact distances on 40, 80, and 160 meters (Photo E). What surprised everyone, though, was the speed and strength with which signal levels returned to normal after the eclipse. Changes were gradual before totality, but bounced back sharply and quickly afterward. Some ham presenters speculated that it was due to a higher population concentration (and thus more ham activity) east of the eclipse path, but measurements of total electron count in the ionosphere showed the same patterns.

Of course, finding unexplained phenomena like this is one of the reasons that scientists conduct these types of experiments. The scientists were also able to visualize Traveling Ionospheric Disturbances (TIDs) during the eclipse and, for the first time ever, were able to record a TID "bow wave," which is similar to the shock wave produced by supersonic aircraft.

Historical Ham Radio-Science Links

Friday night's banquet speaker, Phil Erickson, W1PJE, focused his remarks on the long and continuing history of

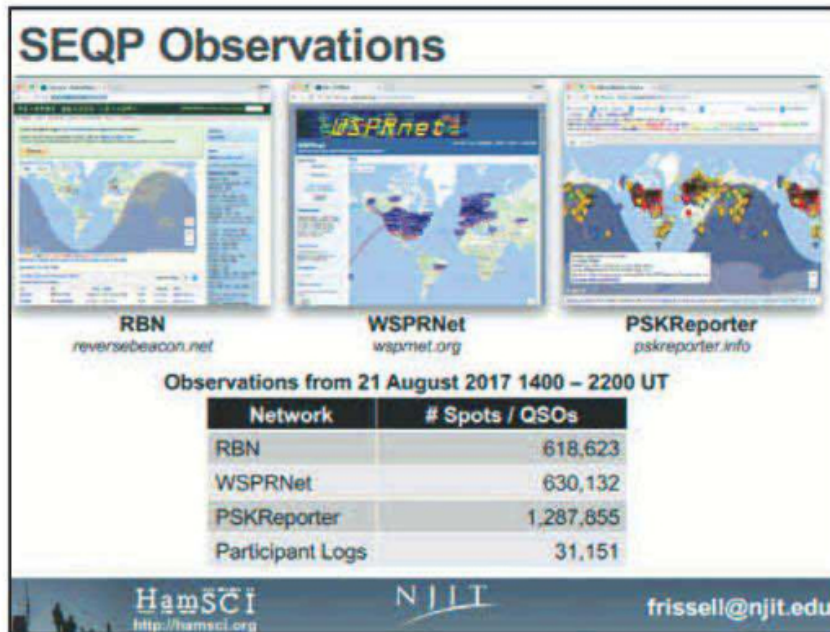


Photo C. Summary of observations during last summer's total solar eclipse of data collected from the Solar Eclipse QSO Party, the Reverse Beacon Network, the Weak Signal Propagation Reporter network, and the PSK Reporter network.

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cooperation between hams and scientists, starting with the ARRL-sponsored "Transatlantics" in the 1920s and CQ's Radio Amateur Scientific Observations program from 1949 to 1952 (Photo F), during which some 500 hams collected data on 50-MHz propagation and sent it to CQ, which relayed it to U.S. Air Force researchers.

Erickson presented a long list of hams who were also scientific pioneers (largely based on the CQ Amateur Radio Hall of Fame) and brought it up to the current day, when he said hams are "building disruptive hardware" with "high reliability and low cost" and are "blurring the line

between hardware and software." He said the greatest value to science that hams as a group can provide today is collection of wide-ranging propagation data to help scientists better understand space physics phenomena, such as the effects of the Earth's magnetic field on ionospheric propagation.

Future Cooperation

Day two of the conference focused on continuing to build cooperative relationships between scientists and hams, starting with a presentation on "Space Physics for Radio Amateurs and Ham Radio for Space Scientists."

A major topic was "Ideas for a Personal Space Weather Station," which workshop organizer W2NAF, describes as "a device that a ham could install at (his/her) station to make measurements such as ionospheric absorption, geomagnetic field variation, lightning detection, HF propagation and phase measurements." Five separate presentations focused on this subject for future cooperation between the ham radio and scientific communities.

Other subjects covered included NVIS (Near Vertical Incidence Skywave) research; lightning detection techniques; a low-cost software defined radio platform for receiving AM broadcast stations for ionospheric research; and "Wideband Recording Tools, VHF Beacon Net, and Pitaya Frequency Stability." There were also presentations on interactions between the solar wind and Earth's magnetosphere, the growth of DMR (digital mobile radio) in amateur radio and the new FT8 image mode.

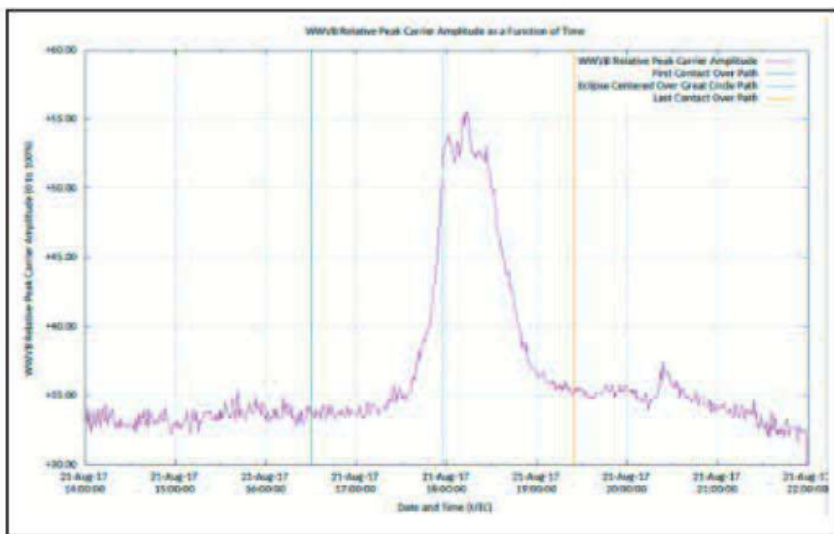


Photo D. KD2BD's monitoring of WWVB on 60 kHz showed a sharp increase in signal strength during the eclipse.

Participant Reactions

Attendees at the workshop were uniformly impressed, both in comments directly to CQ, and those posted on the HamSci reflector.

Participant Randy Smith, WU2S, who describes himself as a "non-scientist ham," said he was surprised that so many of the scientists were also hams, noting that only three of the 32 presenters did not hold ham licenses. "Another surprise," he noted, "was how being a ham, or knowing about sources of amateur radio data, contributes to a wide variety of scientific research ... The best aspect of the workshop was the opportunity to meet working scientists who share the same joy of building and operating ham radios that most of us have. David McGraw, N1HAC, a research engineer at Dartmouth College, showed us how to build and use a low-cost SDR for receiving AM broadcast stations for ionospheric research. Hyomin Kim, KD2MCR, a student at the NJIT Center for Solar-Terrestrial Research, made the case for building affordable ground magnetometers, which are a critical instrument for space weather research. He called his vision of an array of these devices as the 'ground version of CubeSats.'"

Smith concluded, "I left the workshop with a strong feeling that amateur radio can continue to play an important role in helping us understand the world

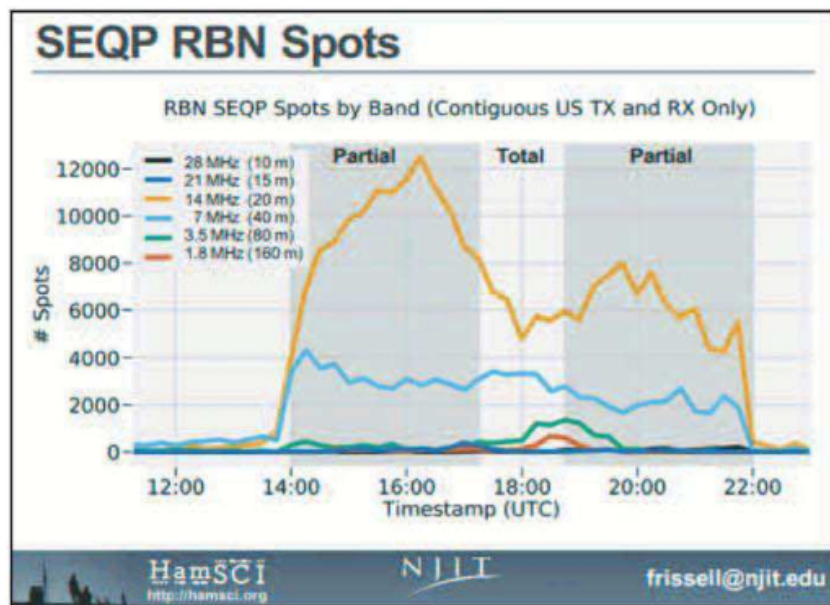


Photo E. Reverse Beacon Network spots during the Solar Eclipse QSO Party.

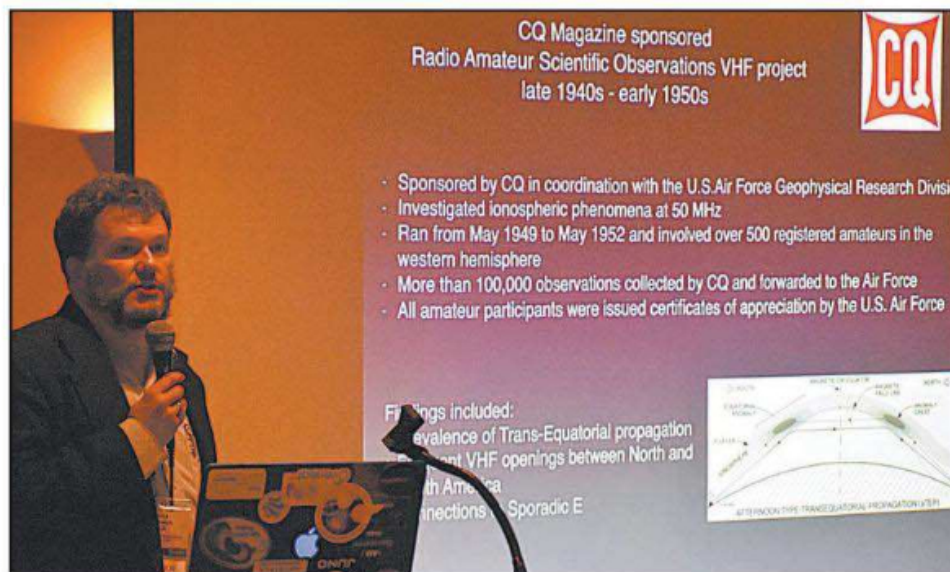


Photo F. Banquet speaker Phil Erickson, W1PJE, talks about CQ's Radio Amateur Scientific Observations program, conducted from 1949-1952 in conjunction with the U.S. Air Force.

around us. The radio contacts we make and the reporting systems we use can have a greater utility than just supporting bragging rights among fellow hams. As we find ways to work with researchers, and engage young people in the engineering and science (parts of our hobby), we will demonstrate the relevance of amateur radio to society as a whole."

Conference attendee and occasional CQ author Ed Efchak, WX2R, said "HAMSCI is a model for similar ongoing scientific cooperation in ... radio science. I think we need to explore other opportunities beyond the immediacy provided by the solar eclipse that can improve our collective understanding of key topics, be a catalyst of learning for hams and provide a conduit of data and information for the scientific community related to the technology surrounding amateur radio. It presents the opportunity for both clubs and individual hams to contribute to a collective whole ... I trust that this conference can continue into the future not only in its exploration of ionospheric science but in many of the areas of interest expressed in the February program."

Finally, keynote speaker Phil Erickson, W1PJE, said "(t)he HamSCI meeting at NJIT served a number of purposes for both amateur enthusiasts and scientists. Perhaps the greatest values for each: Amateurs received intense interest in the scientific possibilities of their activities and careful measurements, and this provides strong encouragement for the entire community by showing that there is a real and enduring interest in the results of using their very refined pow-

ers of observation, and that it all contains science.

"For scientists, they are deeply interested in expanding the reach and scope of ionospheric and atmospheric measurements through expansion of observing networks, and the workshop served to showcase the fact that amateur radio operators are technically savvy, good experimentalists, and excellent partners in using citizen science to advance knowledge of our planet's environment.

"In the future, I see nothing but positive days ahead as technology gets better, hams find out that there is a dual purpose to the activities they enjoy, and the community comes together to jointly use curiosity and careful methods in the pursuit of science for Earth's coupled atmosphere and near space regions.

"Personally, HamSCI activities are a highlight and a rare opportunity to

bridge my vocation — radio science and atmospheric studies — with my avocation — radio communications. It takes me back to the reasons I first embarked on a technical and scientific career: Intense curiosity, love for the subject, and a simple desire to learn as much as I can and transfer it to others. There is no higher purpose than these motivators."

For More Information...

A more specific summary of the presentations is on the HamSci website at <<https://bit.ly/2HSwgzt>>; and copies of many of the presentations may be viewed or downloaded by clicking on the session links on the conference agenda page at <<https://bit.ly/2pwZrJU>>. In addition, New Jersey's public television network aired a piece on the workshop, which is posted at <<https://bit.ly/2EWqx11>>.

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