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HIGH FREQUENCY ACTIVE AURORAL RESEARCH PROGRAM

University of Alaska Fairbanks
GEOPHYSICAL INSTITUTE

Date: May 2, 2024
To: Amateur Radio & Radio Astronomy Communities
From: HAARP Program Office
Subject: Notice of Transmission

The High-frequency Active Auroral Research Program (HAARP) will be conducting a research campaign May 8-10 UTC, with operating times specified in the table below. Operating frequencies will vary, but all HAARP transmissions will be between 2.8 MHz and 10 MHz. Actual transmit days and times are highly variable based on real-time ionospheric and/or geomagnetic conditions. All information is subject to change.

This campaign is being conducted in support of research proposals from the University of Alaska Fairbanks, and is studying mechanisms for the detection of orbiting space debris. Space debris poses a major risk to all space operations, including manned spacecraft and communications satellites. The experiments being performed at HAARP will help identify ways to improve collision detection on satellites. For more information on space debris, see the NASA Orbital Debris Program Office's FAQ at https://orbitaldebris.jsc.nasa.gov/faq/. For more information on research at HAARP, see the online HAARP FAQ at https://haarp.gi.alaska.edu/faq.

Note that these experiments will operate at frequencies based on the f_0F2 frequency from the Gakona ionograms. In general, transmissions will be very close to the f_0F2 frequency. There are no specific data collection requests from funded investigators, but reception reports are appreciated and may be submitted to uaf-gi-haarp@alaska.edu or to: HAARP, PO Box 271, Gakona, AK 99586

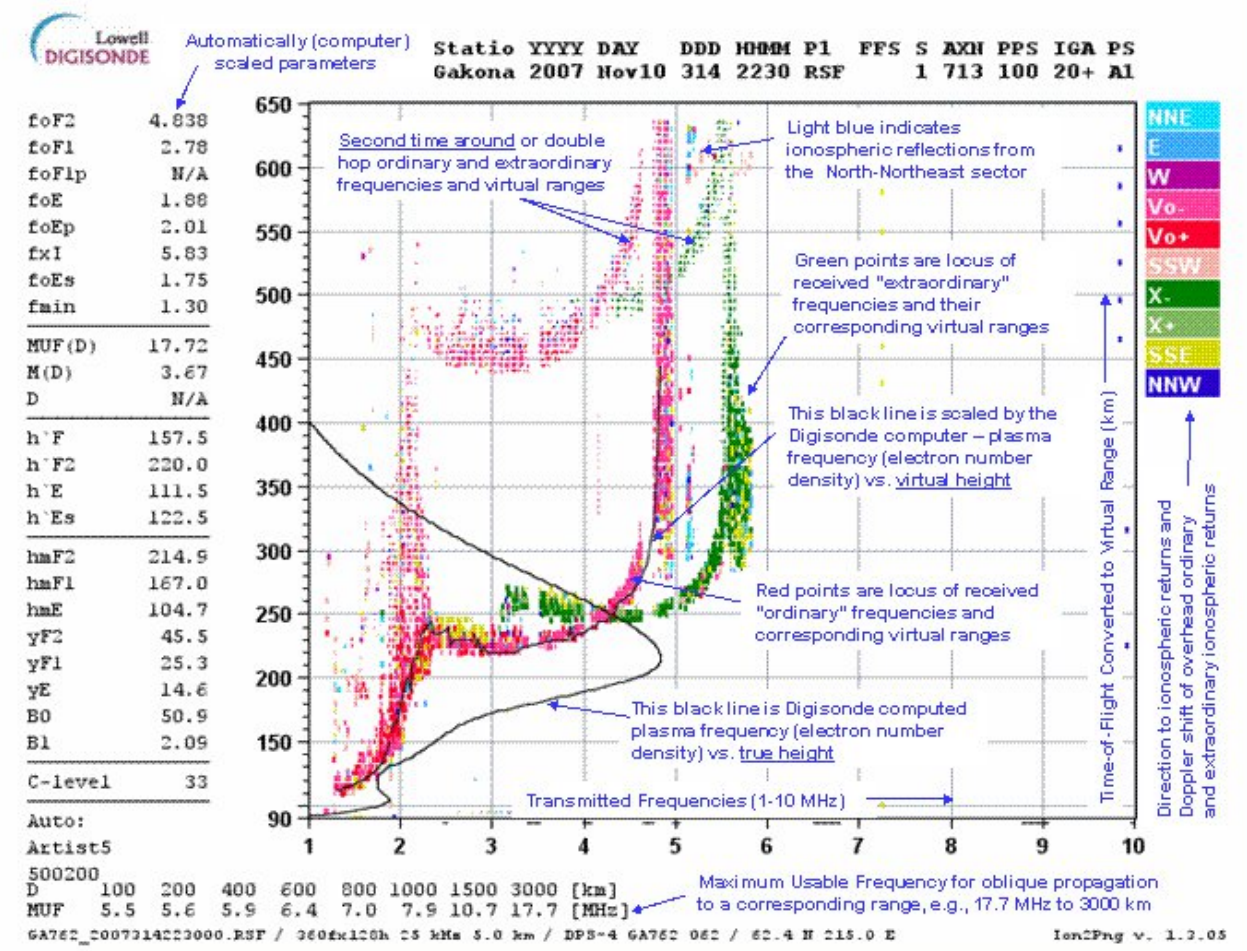
Date (UTC)	May 8	May 9	May 10
Time (UTC)	2000-0200	2000-0200	2000-0230
Frequencies (MHz)	3.25, f_0F2	3.25, f_0F2	3.25, f_0F2
Notes	See Gakona ionograms for f_0F2, from HAARP Diagnostic Suite	See Gakona ionograms for f_0F2, from HAARP Diagnostic Suite	See Gakona ionograms for f_0F2, from HAARP Diagnostic Suite

For updates on ionospheric conditions in Gakona, please consult ionograms from the HAARP Diagnostic Suite: https://haarp.gi.alaska.edu/diagnostic-suite

Additional Resources for Reading Ionograms

Understanding HF Propagation and Reading Ionograms from Bootstrap Workbench:
https://www.youtube.com/watch?v=oTFKNCo3CI8

Reading Your Ionogram-Keeping It Simple from John (VE6EY):
https://play.fallows.ca/wp/radio/shortwave-radio/reading-your-ionogram-keeping-it-simple/



The image above is an annotated ionogram from HAARP that describes features that may be of interest. Note that f_0F2 is calculated at the top left.

f_0F2 is the critical frequency of the F2 layer of the Earth's ionosphere. This is the frequency at which radio signals stop refracting off the ionosphere and begin passing through to outer space. For certain HAARP experiments that deal with interactions in the ionosphere, transmission frequencies below f_0F2 are desirable, while for other experiments (such as those involving high-altitude satellites), staying above f_0F2 is required.

Supplement to HAARP Notice of Transmission

General Information for HAARP Radio Enthusiasts:

1) The HAARP Ionospheric Research Instrument (IRI) transmits only in the frequency range 2.695 to 9.995 MHz, with certain frequencies blocked out as specified in the FCC license for call sign WI2XFX. The emission bandwidth may be up to 46 kHz wide, the actual value depending on the frequency and experiment;
2) The lower frequency transmissions many times are based on a harmonic of the local ionosphere's gyro frequency, the actual frequency depending on the experiment. The fundamental gyro frequency above HAARP varies from roughly 1.5 MHz at lower altitudes to 1.2 MHz at higher altitudes.
3) Higher frequency transmissions many times are based on the critical plasma frequency for the F2 region (foF2), which is determined by the Gakona ionosonde. These higher transmission frequencies may be above, below or at the critical frequency depending on the experiment. Mid-range frequencies often are used for artificial airglow experiments. The critical plasma frequency in the vicinity of HAARP varies widely depending on, among other things, time of day, season and sunspot cycle;
4) One or two carriers are transmitted and one or both of the carriers are modulated. The types of modulation varies with the experiment requirements. Modulation may be AM, FM, LFM or a complex waveform or a time sequence of different modulations;
5) Most experiments depend on ionospheric and geomagnetic conditions that are mostly unpredictable. The transmission frequencies for a given experiment may change to track changes in those conditions with little or no notice;
6) A scheduled experiment that depends on certain ionospheric or geomagnetic conditions may be rescheduled or cancelled if the required conditions do not occur;
7) To request a HAARP QSL card, send reception reports to: HAARP, P.O. Box 271, Gakona, Alaska 99586 USA;
8) Additional information can be found on the HAARP webpage at: https://haarp.gi.alaska.edu/ .

Monitoring HAARP IRI transmissions with a Software Defined Radio Receiver:

1) Listeners with an SDR receiver capable of 8 MHz bandwidth can monitor the entire frequency band noted above;
2) Transmissions most often are programmed to *Start* at top of the minute, ie, HH:MM:00 but some start at 30 seconds, ie, HH:MM:30. Transmissions usually *Stop* on the 30 second mark, ie, HH:MM:30 to allow time to retune the transmitter/antenna for the next experiment. There may be exceptions to the Start and Stop times;
3) When a carrier is seen to pop up on the SDR's displayed spectra, the listener can identify the center frequency using the SDR software and then reduce the bandwidth to further monitor, demodulate or analyze the signal;
4) If two SDRs are available, one can be used in a wideband mode to locate the signals and the other can be used in a narrowband mode to analyze, demodulate or monitor the specific signals;

5) Since the maximum emission bandwidth is 46 kHz (±23 kHz), SDRs with a 50 kHz bandwidth setting are able to monitor the entire modulated signal after it is located. However, the center frequency may be stepped through a range of frequencies or may change according to experiment requirements to another, far removed frequency;

6) Not all experiments use the full 46 kHz bandwidth, some use only a pure carrier and some use single sideband;

7) Some experiments require a transmitter On – transmitter Off cycle. The cycle times and On-Off ratios typically vary from experiment to experiment but Off times typically are minutes or fractions of a minute. Transmission On times can last from a couple minutes to a couple hours;

8) Radio propagation conditions and the IRI beam direction will affect the reception of the IRI transmissions or cause a fadeout at the receiving antenna location. Propagation conditions and beam directions can change significantly and rapidly during an experiment;

9) Some experiments require the IRI beam to be pointed along or near the local magnetic zenith. This means the beam is pointed parallel or nearly parallel to the local magnetic field lines. The magnetic zenith at the HAARP facility is approximately 75° elevation and 16° east of north;

10) Although the HAARP IRI transmits only in the HF range (see above), the transmissions can and some experiments are designed to generate ELF, SLF, ULF, and VLF emissions in the D/E-regions of the ionosphere. Other experiments may not be designed to generate these low frequency emissions but the emissions are generated as a side effect. Modulated heating of the D/E-region electrons by the HF transmissions in turn modulates the plasma conductivity, which generates a *virtual antenna* at altitudes between 70 and 85 km. Emissions up to 20 kHz have been demonstrated but most are below a few kilohertz. These low frequency emissions can propagate in the Earth-Ionosphere Waveguide or by other mechanisms, depending on frequency, and conceivably can travel great distances.

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Operated by the Geophysical Institute at the University of Alaska Fairbanks