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HAARP



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[An Electromagnetic Interference Study of Potential Transmitter Sites for the HF Active Auroral Research Program \(HAARP\)](#) Jul 19, 1993 41 pages

Authors: [Joseph A. Goldstein](#); [Edward J. Kennedy](#); [Adrian S. Eley](#); [Michael A. Rupar](#); [NAVAL RESEARCH LAB WASHINGTON DC](#)

... of the proposed High Frequency Active Auroral Research Program (**HAARP**) transmitter facility. The proposed **HAARP** facility will consist of a large planar array of antennas excited by phased high power transmitters ... a major factor in the site selection process for **HAARP**. The EMI investigations were conducted in two phases. ... locations using an airborne transmitter at thirteen potential **HAARP** sites. The results from the Phase I measurements were examined ... receiver locations that are representative of the impact area for the EMI from **HAARP**. The results for both the Phase I and Phase II ...

Full Text

[Upper Atmospheric Effects of the HF Active Auroral Research Program Ionospheric Research Instrument \(HAARP IRI\)](#) May 1993 19 pages

Authors: [V. Eccles](#); [R. Armstrong](#); [MISSION RESEARCH CORP NASHUA NH](#)

... ' of which nitric oxide (NO) is an example. Because the **HAARP** (HF Active Auroral Research Program) facility is ... and investigate certain natural processes, a study of possible effects of **HAARP** on the ozone layer was conducted. The study used a detailed model ... efficiently produced by auroras. Since the total energy emitted by **HAARP** in the year is some 200,000 times less than ... in the upper atmosphere by auroras, the study demonstrates that **HAARP** HF beam experiments will cause no measurable depletion ... Ozone, Ozone depletion, Ozone layer, Odd nitrogen, Nitric oxide, **HAARP** Emitter characteristics

Full Text

[Investigation of Plasma Phenomena in the Ionosphere Under Natural Conditions and Under Conditions Artificially Perturbed by HAARP](#) Aug 17, 2005 81 pages

Authors: [James A. Secan](#); [Edward J. Fremouw](#); [Andrew J. Mazzella Jr](#); [John Rasmussen](#); [A. L. Snyder](#); [NORTHWEST RESEARCH ASSOCIATES INC BELLEVUE WA](#)

... ionosphere perturbed by the High-frequency Active Auroral Research Program (**HAARP**) high-frequency heater. The research being conducted falls within Hanscom Technical ... NRL), and other research organizations in the application of diagnostic instrumentation to **HAARP**. Among the **HAARP** instruments that we are applying to ionospheric research are three NWRA ... are posting TEC from these instruments, and phase-scintillation records from the ITS10S receivers, on the **HAARP** Web site (www.haarp.alaska.edu) for telescience applications and for decision-making during active experiments, and we are also focusing ...

Full Text

[A Diagnostic System for Studying Energy Partitioning and Assessing the Response of the Ionosphere During HAARP Modification Experiments](#) May 15, 1996 55 pages

Authors: [Frank T. Djuth](#); [John H. Elder](#); [Kenneth L. Williams](#); [GEOSPACE RESEARCH INC EL SEGUNDO CA](#)

... key radio wave diagnostics in support of the HF Active Auroral Ionospheric Research Program (**HAARP**). Project activities led to the design, development, and fabrication of a variety of hardware units and to ... , a large amount of support instrumentation was developed to accommodate complex field experiments. Overall, the **HAARP** diagnostics are powerful tools for studying diverse ionospheric modification phenomena. They are also flexible enough to support a host of other missions beyond the scope of **HAARP**. Many new research programs have been initiated by applying the **HAARP** diagnostics to studies of ...

Full Text

[Characterization of the Auroral Electrojet and the Ambient and Modified D Region for HAARP Using Long-Path VLF Diagnostics](#) Mar 15, 2001 127 pages

Authors: [Timothy F. Bell](#); [STANFORD UNIV CA SPACE TELECOMMUNICATIONS AND RADIO SCIENCE LAB](#)

... electrojet and the ambient and modified D-region directly above and near the **HAARP** (High Frequency Active Auroral Research Program) facility in Alaska. To ... D-region diagnostic systems were constructed and deployed in five High Schools near the **HAARP** facility and along the west coast of Alaska. In addition in order ... of D-region diagnostic systems was acquired during a number of Fall and Spring **HAARP** campaigns during the period of performance. This data was then used to determine the state of the D- region above **HAARP** during the campaigns and to provide information on the location of the auroral ...

Full Text

[Electromagnetic Spectrum Occupancy Study of a Potential Transmitter Site for the HF Active Auroral Research Program \(HAARP\)](#) Sep 30, 1994 50 pages

Authors: [Joseph A. Goldstein](#); [Edward J. Kennedy](#); [Monroe Y. McGown](#); [NAVAL RESEARCH LAB WASHINGTON DC](#)

... frequency occupancy in the immediate vicinity of the proposed High Frequency Active Auroral Research Program (**HAARP**) facility to be constructed in the Gakona, Alaska area. The **HAARP** facility will consist of a large planar array of antennas excited by phased high power transmitters operating in the lower portion of the HF band ... of Gakona was measured in order to assess the potential for electromagnetic interference problems arising from the **HAARP** facility. The measurements covered the frequency spectrum from 2 MHz to 1000 MHz. Data was collected ...

Full Text

[HAARP Imaging Riometer Diagnostic](#)

Jul 16, 1997 20 pages

Authors: [Ted J. Rosenberg](#); [ADVANCED POWER TECHNOLOGIES INC WASHINGTON DC](#)

... prototype 16-beam, 38.6 MHz riometer system developed by APTI and the University of Maryland for the **HAARP** program. The prototype system is the forerunner for a full-scale imaging riometer diagnostic instrument for characterizing the ionospheric volume perturbed by controlled RF heating experiments. The prototype system, installed at the **HAARP** site near Gakona, AK, consists of a 1 x 16 antenna array ... absorption spikes accompanied by only weak magnetic signatures. The proximity of the prototype system to the **HAARP** RF heater can result in significant interference to the riometer signal, making ...

Full Text

[HAARP, Research and Applications](#)

1990 19 pages

Authors: [Dennis Papadopoulos](#); [Paul A. Bernhardt](#); [Herbert C. Carlson Jr.](#); [William E. Gordon](#); [Alexander V. Gurevich](#); [NAVAL RESEARCH LAB WASHINGTON DC](#)

... wide range of applications created by the HF Active Auroral Research Program (**HAARP**). The report is based on the deliberations of a scientific committee sponsored by the Air Force Research Laboratory ... Naval Research and convened by the East-West Space Science Center of the University of Maryland. The **HAARP** represents a technological advancement with capabilities that allow for new and unique dual-use research and ... , supplemented with the generation of FAS and with the use of the transmitter as a radar, makes the **HAARP** transmitter a unique source for remote sensing and communication uses.

Full Text

[Telescopic Imaging of Heater-Induced Airglow at HAARP](#)

Jan 2007 6 pages

Authors: [Michael C. Kelley](#); [CORNELL UNIV ITHACA NY OFFICE OF SPONSORED PROGRAMS](#)

... of its behavior, lower ionospheric structure must be known. Under this grant, we conducted telescopic imaging of heater-induced airglow at **HAARP** to optically measure fine structure in the ionosphere and to study airglow sources. In the presence of aurora and a strong blanketing E layer, **HAARP** was modulated at intervals of several seconds. For several cycles, small bright airglow spots were observed whenever **HAARP** was on. These spots are elongated horizontally, indicating drift motion, and are the same order of brightness as the aurora. ...

Full Text

[HAARP Diagnostic Instruments; High Frequency Active Auroral Research Program](#)

Dec 2002 71 pages

Authors: [Paul A. Kossey](#); [James C. Battis](#); [AIR FORCE RESEARCH LAB HANSCOM AFB MA SPACE VEHICLES DIRECTORATE](#)

... in Gakona, Alaska. This site is being developed as part of the High Frequency Active Auroral Research Program (**HAARP**). A key objective of the program is the identification and characterization of the physical processes initiated in the ionosphere and space via interactions with high ... unwanted ones, are also research areas of increasing interest. To provide the experimental capabilities required to meet its objectives, the **HAARP** Gakona facility includes a powerful, phased-array, high-frequency (HF) transmitter and an extensive complement of radio-frequency and optical diagnostic instruments.

Full Text

[Electromagnetic Interference Impact of the Proposed Emitters for the High Frequency Active Auroral Research Program \(HAARP\)](#)

May 14, 1993 134 pages

Authors: [G. A. Robertshaw](#); [A. L. Snyder](#); [M. M. Weiner](#); [MITRE CORP BEDFORD MA](#)

The proposed **HAARP** emitters at the Gakona (Alaska) preferred site and at the Clear AFS (Alaska) alternative site are the Ionospheric Research Instrument (IRI), the Incoherent Scatter Radar (ISR), and the Vertical Incidence Sounder (VIS). The electromagnetic interference (EMI) impact of those emitters on receiving systems in the vicinity of the sites is estimated in this study. The results are intended for use as an input to the Air Force Environmental Impact Statement as part of the Environmental Impact Analysis Process.

Full Text

[Imaging of Underground Structure Using HAARP](#)

Feb 1999 48 pages

Authors: [Randall L. Mackie](#); [GSY-USA INC SAN FRANCISCO CA](#)

... are at a depth to diameter ratio of approximately 3:1 or less. Detection of tunnels in actual field conditions is more difficult because of the low signal levels in the AMT frequency range and geologic noise. This was evident in all data sets analyzed under this contract. The **HAARP** transmitter has the potential to be a valuable exploration tool in that it could generate EM fields that appeared locally as plane waves and could overcome the problems with low AMT signal levels and geologic noise. Our modifications to robust processing algorithms for AMT data and for controlled source data have ...

Full Text

[Geophysical Electromagnetic Sounding Using HAARP](#)

Mar 2002 14 pages

Authors: [Eugene M. Wescott](#); [Davis D. Sentman](#); [ALASKA UNIV FAIRBANKS GEOPHYSICAL INST](#)

... by several methods. One, which has proven useful, is the controlled source magnetotelluric method (CSAMT). Current over a wide range of frequencies is introduced into the earth through a grounded dipole. Then the resulting electric and magnetic fields are measured at a distance greater than several skin depths. The apparent resistivity is then calculated by: $\rho = 1/5f E/B(\exp 2)$ The apparent resistivity vs. frequency can be converted into true resistivity vs. depth. This grant involved an investigation into the **HAARP** virtual antenna pattern out to 200 km, and its use as a CSAMT transmitter.

Full Text

[On the Onset of HF-Induced Airglow at HAARP](#)

Feb 13, 2004 11 pages

Authors: [E. V. Mishin](#); [W. J. Burke](#); [T. Pedersen](#); [BOSTON COLL CHESTNUT HILL MA INST FOR SCIENTIFIC RESEARCH](#)

Observations of airglow at 630 nm (red line) and 557.7 nm (green line) during the February 2002 campaign at the High Frequency Active Auroral Research Program (HAARP) heating facility are analyzed. We find that during injections toward magnetic zenith (MZ) the green and red lines gain ~ 5 R within ~ 1 s and ~ 20 R within ~ 10 s, respectively. We term this period the onset of the HF-induced airglow. A model of the onset at magnetic zenith is developed. It accounts for background photoelectrons and dissociative recombination of $O(^+2)$. It is shown that heating and acceleration of background electrons ...

[Full Text](#)[SATSIN System Manual](#)

Jan 1995 66 pages

Authors: [Robert C. Livingston](#); [SRI INTERNATIONAL MENLO PARK CA](#)

This report outlines the design, functions and operation of the HAARP Diagnostic Satellite Scintillation (SATSIN) system that will be used to characterize ... propagation path from satellite radio beacons passes through the heated volume created by HAARP. The signal, altered in phase and amplitude by the irregularities, is received by ... this information, the strength, shape and motion of the in situ irregularities generated by HAARP can be implied. The hardware and software components of the system are reviewed, and the installation and operation in conjunction with the HAARP network are outlined.

[Full Text](#)[Diagnostics and Modeling of the Auroral Ionosphere Under the Influence of the Gakona HF Transmitter](#)

Aug 2001 39 pages

Authors: [Davis D. Sentman](#); [Eugene M. Wescott](#); [John V. Olson](#); [Antonius Otto](#); [William A. Bristow](#); [ALASKA UNIV FAIRBANKS GEOPHYSICAL INST](#)

... separate elements that address science and education objectives of the HAARP program. These elements are: (1) To establish the characteristics of the ionospheric ... responsible for the ELF/VLF waves generated by modulation of HAARP HF emissions, and to measure the ELF radiation pattern. ... attempt to stimulate hydromagnetic waves in the ionospheric waveguide using the HAARP heater. (3) To develop a simulation model for the plasma physical and electromagnetic ... of Stimulated Electromagnetic missions. (5) To provide scientific education about HAARP and physical science in general to members of the local ...

[Full Text](#)[Investigations of the Nature and Behavior of Plasma-Density Disturbances That May Impact GPS and Other Transionospheric Systems](#)

Oct 31, 2002 33 pages

Authors: [Angela M. Andreason](#); [Elizabeth A. Holland](#); [Edward J. Fremouw](#); [Andrew J. Mazzella Jr.](#); [G. S. Rao](#); [NORTHWEST RESEARCH ASSOCIATES INC BELLEVUE WA](#)

... being accomplished. An array of diagnostic instruments is being maintained and enhanced in association with the High-frequency Active Auroral Research Program (HAARP). In addition to a classic riometer and a GPS Total Electron Content (TEC) sensor previously operating at the HAARP site, NWRRA also operates a set of Transit receivers for measurements of TEC and scintillation at VHF and UHF, supplementing the receiver at HAARP with a receiver north of the site and an additional receiver installed south of the HAARP site.

[Full Text](#)[Investigations of the Nature and Behavior of Plasma Density Disturbances That May Impact GPS and Other Transionospheric Systems](#)

Nov 26, 2001 30 pages

Authors: [Edward J. Fremouw](#); [Andrew J. Mazzella Jr.](#); [Guan-Shu Rao](#); [NORTHWEST RESEARCH ASSOCIATES INC BELLEVUE WA](#)

... being accomplished. An array of diagnostic instruments is being maintained and enhanced in association with the High-frequency Active Auroral Research Program (HAARP). In addition to a classic riometer and a GPS Total Electron Content (TEC) sensor previously operating at the HAARP site, NWRRA also operates a set of Transit receivers for measurements of TEC and scintillation at VHF and UHF, supplementing the receiver at HAARP with a receiver north of the site and an additional receiver installed south of the HAARP site.

[Full Text](#)[Environmental Impact Statement. Volume 1. Proposed High Frequency Active Auroral Research Program](#)

Jul 1993 401 pages

Authors: [PHILLIPS LAB HANSCOM AFB MA](#)

... constructing and operating a proposed ionospheric research facility in interior Alaska. The system is referred to as HAARP (High-frequency Active Auroral Research Program), and would be used primarily for conducting ... to develop methods for enhanced communications for both civilian and defense applications. The HAARP system consists of a powerful high frequency radio transmitter, referred to as the ... gathering (diagnostic) instruments. This document addresses three alternatives associated with the construction of the HAARP facility; namely construction at either Clear or Gakona, and the no action ...

[Full Text](#)[Summer 2000 Student/Faculty Science Campaign. July 31-August 8, 2000](#)

Oct 1, 2000 57 pages

Authors: [Arnold L. Snyder Jr](#); [NORTHWEST RESEARCH ASSOCIATES INC BELLEVUE WA](#)

... Campaign was to provide competitively selected university faculty and students with opportunities for upper atmospheric and space physics research involving the HAARP high frequency transmitter and associated diagnostic instrumentation located near Gakona, Alaska. This report documents the technical program and participants ... of the Student I Faculty experiment summaries in areas ionospheric generation of ULF/ELF/VLF radiowaves, D-Region diagnostics, SuperDARN observations of HAARP induced ionospheric irregularities, and potential for telescopic assessments of HAARP induced ionospheric airglow.

[Full Text](#)[Ionospheric Sensor Developments for the Year-2000 Solar Maximum](#)

Oct 23, 2000 45 pages

Authors: [E. J. Fremouw](#); [A. J. Mazzella Jr.](#); [G. S. Rao](#); [NORTHWEST RESEARCH ASSOCIATES INC BELLEVUE WA](#)

... , work during the year enhanced and exploited several diagnostic instruments deployed for the High frequency Active Aurora Research Program (**HAARP**). Under **HAARP**, measurements employing both GPS and coherent VHF-UHF signals transmitted from satellites in low-earth polar orbit resulted in time histories and latitudinal scans of absolute TEC over Alaska, and enhanced operation of the **HAARP** classic riometer resulted in essentially continuous observations of 30-MHz radiowave absorption over south-central Alaska. Analysis of a thermal instability expected to ...

[Full Text](#)

[Environmental Impact Analysis Process. Final Environmental Impact Statement. Part 2.](#)

Jul 1993 422 pages

[Proposed High Frequency Active Auroral Research Program](#)

Authors: [AIR FORCE MATERIEL COMMAND WRIGHT-PATTERSON AFB OH](#)

The FEIS describes the potential environmental impacts of constructing and operating a proposed ionospheric research facility in interior Alaska. The system is referred to as **HAARP** (High-frequency Active Auroral Research Program), and would be used primarily for conducting pioneering studies of ionospheric properties. This ... of the ionosphere and enable researchers to develop methods for enhanced communications for both civilian and defense applications. The **HAARP** system consists of a powerful high frequency radio transmitter, referred to as the ionospheric research instrument, and a number of ...

[Full Text](#)

[Excitation of Earth-Ionosphere Waveguide in the ELF and Lower VLF Bands by Modulated Ionospheric Current](#)

May 21, 1993 33 pages

Authors: [E. C. Field](#); [R. M. Bloom](#); [PACIFIC-SIERRA RESEARCH CORP SANTA MONICA CA](#)

... Hz with HF heaters. Our results show the dependence on source orientation, altitude, and dimension and therefore pertain to experiments using the HIPAS or **HAARP** ionospheric heaters. In the end-fire mode, the waveguide excitation efficiency of an ELF HED in the ionosphere is up to 20 dB greater than for a ... ERP of the HF heater, the optimum altitude increasing with increasing ERP. For HIPAS the best modulation altitude is around 70 km, whereas for **HAARP** there might be marginal value in modulating at attitudes as high as 100 Km. Ionospheric modification, Ionospheric currents, Ionospheric heating.

[Full Text](#)

[The WIND-HAARP Experiment: Initial Results of High Power Radiowave Interactions with Space Plasmas](#)

Nov 10, 1997 18 pages

Authors: [P. Rodriguez](#); [E. Kennedy](#); [M. Keskinen](#); [C. Sieftring](#); [S. Basu](#); [NAVAL RESEARCH LAB WASHINGTON DC PLASMA PHYSICS DIV](#)

Results from the first science experiment with the new HF Active Auroral Research Program (**HAARP**) facility in Alaska are reported. The initial experiments involved transmission of high frequency waves from **HAARP** to the NASA/WIND satellite. The objective was to investigate the effects of space plasmas on high power (approx. 300 kW) radiowave transmission from the ground to high altitudes in the magnetosphere. The data acquired suggest that ...

[Full Text](#)

[Investigations of the Nature and Behavior of Plasma-Density Disturbances That May Impact GPS and Other Transionospheric Systems](#)

Oct 21, 1998 31 pages

Authors: [E. J. Fremouw](#); [E. A. Holland](#); [A. J. Mazzella Jr](#); [NORTHWEST RESEARCH ASSOCIATES INC BELLEVUE WA](#)

... observing such phenomena and others that may be produced artificially by means of high-frequency (HF) heating of the ionosphere in the HF Active Auroral Research Program (**HAARP**). The first-year efforts included collection and processing of TEC data from USAF's Ionospheric Measuring System (IMS); campaign operation of a portable ionospheric monitor for measurement of TEC and scintillation at Ascension Island; preliminary assessment of plasmaspheric contribution to TEC; and coordinating development of a variety of diagnostic instruments for **HAARP**.

[Full Text](#)

[Application of and Enhancement to Arctic Infrastructure for the Study of Long-Term Change in the Earth's Polar Mesosphere](#)

May 20, 2003 4 pages

Authors: [Michael C. Kelley](#); [CORNELL UNIV ITHACA NY SCHOOL OF ELECTRICAL AND COMPUTER ENGINEERING](#)

Our Summer 2000 preliminary study of HF-PMSE is published in Geophysical Research Letters. We carried out a full climatological study at HIPAS and a long campaign at **HAARP** in Summer 2001. Our work in 2002 included preliminary 139-MHz studies and collection of MF data from Poker Flat corresponding to the HIPAS observations. Our goal in 2003 is to complete the data collection for C. Ramos' thesis, hopefully with multiple radar observations at **HAARP**. Finally, we have submitted a paper dealing with new rocket observations in the Arecibo heater beam to the Journal of Geophysical Research.

[Full Text](#)

[Coherent HF Radar System for the Study of Natural and Heater Induced Ionospheric Irregularities](#)

Jun 1993 50 pages

Authors: [Bodo W. Reinisch](#); [James L. Scali](#); [D. M. Haines](#); [MASSACHUSETTS UNIV LOWELL CENTER FOR ATMOSPHERIC RESEARCH](#)

... of a highly stressed ionosphere. It is demonstrated that the DPS can characterize the behavior of the background ionosphere while simultaneously measuring the motion of irregular plasma structures. This capability can be applied to identify and track irregularities generated by high power HF transmitters as planned for **HAARP** (HF Active Auroral Research Program) experiments in Alaska. This report shows how the DPS identifies different plasma structures in a naturally stressed ionosphere within the field of view of the instrument which extends over several hundred kilometers in the ionosphere.

[Full Text](#)

[Establishing the National Polar Radio Science Consortium](#)

Apr 30, 1994 6 pages

Authors: [ALASKA UNIV FAIRBANKS GEOPHYSICAL INST](#)

The Geophysical Institute of the University of Alaska Fairbanks (GI- UAF) was designated as the Prime

[Full Text](#) Contractor to represent the NPRSC. Since the **HAARP** facility will be built in Alaska, the GI-UAF can provide various logistic support activities, in addition to playing the role of coordinating the scientific advisory and support functions for the NPRSC at the request of the ONR/AFPL

[Investigation of Ionospheric Disturbances and Associated Diagnostic Techniques](#)

Dec 12, 1995 21 pages

Authors: [L. M. Duncan](#); CLEMSON UNIV SC

[Full Text](#) ... high power rf transmitting facilities. A computer simulation of ionospheric response to ground launched acoustic pulses was constructed and results compared to observational data associated with HF and incoherent scatter radar measurements of ionospheric effects produced by earthquakes and ground level explosions. These results were then utilized to help define the design, construct and test for an HF Doppler radar system. In addition, an assessment was conducted of ionospheric diagnostic instruments proposed for the Air Force/ Navy High Frequency Active Auroral Research Program (**HAARP**).

[Further Investigations of Ionospheric Total Electron Content and Scintillation Effects on Transionospheric Radiowave Propagation](#)

Feb 12, 1998 41 pages

Authors: [C. C. Andreasen](#); [Edward J. Fremouw](#); [Andrew J. Mazzella](#); [G. S. Rao](#); [James A. Secan](#); NORTHWEST RESEARCH ASSOCIATES INC BELLEVUE WA

[Full Text](#) ... receivers to measure ionospheric total electron content (TEC), which introduces range errors on operational GPS links. Central tasks in this effort included utilization of receivers at four operational sites of the Ionospheric Measuring System (IMS), continued development and refinement of the IMS employing a fifth receiver located at Hanscom, and assessment and analysis of the resulting data. The newest of the efforts goes beyond passive observation of ionospheric effects on radiowave systems to preparation for active experiments in the High Frequency Active Auroral Research Program (**HAARP**).

[Low Frequency Radio Research at Thule, Greenland](#)

Jan 1998 25 pages

Authors: [A. C. Fraser-Smith](#); [C. C. Teague](#); STANFORD UNIV CA SPACE TELECOMMUNICATIONS AND RADIOSCIENCE LAB

[Full Text](#) ... capability that would allow the amplitudes and frequency spectra of incoming low-frequency radio signals to be examined in real time either by experimenters on location at Thule or, with slightly less capability, at remote locations via telephone line. We report here the installation of the new computer with its new digital signal processing capability on a system essentially identical to the Thule system but located on the Stanford campus in California, where it was used for measurements during the first transmissions from **HAARP**, as well as transmissions from HIPAS, during early 1997.

[The WIND-HAARP-HIPAS Interferometer Experiment](#)

Apr 22, 1999 12 pages

Authors: [P. Rodriguez](#); [M. J. Keskinen](#); [E. J. Kennedy](#); [M. McCarrick](#); [J. Preston](#); NAVAL RESEARCH LAB WASHINGTON DC PLASMA PHYSICS DIV

[Full Text](#) We report on the first experiment using two high power, high frequency transmitting facilities in a bistatic, interferometer mode. The **HAARP** and HIPAS facilities in Alaska radiated at 4525 kHz with total combined power of about 700 kW, in the direction of the WIND spacecraft. The WAVES experiment aboard WIND received the transmissions at a distance of about 25 earth radii. The experimental setup thus resembled Young's two-slit experiment. The expected interference pattern was observed, and at the distance of WIND, the fringes sizes were about 30 km peak to peak.

[Detection of the 27 Aug 1998 Gamma Ray Flare, and Ionospheric Effects of Relativistic Electron Flux Enhancements](#)

May 1, 1999 26 pages

Authors: [Timothy F. Bell](#); STANFORD UNIV CA

[Full Text](#) Intense gamma ray flares and enhanced relativistic electron precipitation can have profound effects upon the characteristics of the nighttime D-region of the ionosphere. We examine recent examples of these phenomena and discuss their effects upon **HAARP** systems.

[Application of and Enhancement to Arctic Infrastructure for the Study of Long-Term Change in the Earth's Polar Mesosphere](#)

Apr 2001 6 pages

Authors: [Michael C. Kelley](#); CORNELL UNIV ITHACA NY SCHOOL OF ELECTRICAL AND COMPUTER ENGINEERING

[Full Text](#) Our Summer 2000 preliminary study of HF-PMSE is in review at GRL and the 2001 campaign is in full swing. We will have a full climatological study at HIPAS and a long campaign at **HAARP**. The latter will include 139 MHz studies as well.

[Experimental Demonstration of Underground Structure Characterization Using Sensitive Magnetic Sensors](#)

Nov 20, 2000 51 pages

Authors: [Suman Ganguly](#); CENTER FOR REMOTE SENSING INC FAIRFAX VA

[Full Text](#) Detection and characterization of various underground facilities using ELF/VLF signals generated by **HAARP** as well as from other sources are investigated. A novel 3-D E.M. code has been used for simulation using arbitrary shaped facilities and under arbitrary ground. Results of the simulation are extremely promising. Design of suitable sensors for E.M. detection has been performed. Plans for further development are made. For immediate applications a composite integrated with available sensors has been made available. They system allows detection and real-time analysis using sophisticated signal ...

[Global Ionospheric Structure, Dynamics, and System Effects](#)

Jun 24, 2002 18 pages

Authors: [Robert C. Livingston](#); [SRI INTERNATIONAL MENLO PARK CA](#)

... of ground-based scintillation receivers was established to provide real-time diagnostics and communication outage alerts and forecasts. Barium releases and resulting striation structures (or lack of) were observed with scintillation receivers and HF radar. Ionospheric corrections for GPS tracking of re-entry vehicles were performed for the equatorial ionosphere, and a number of auroral ionosphere experiments were carried out at Sondrestromfjord, Greenland. A scintillation diagnostic array was designed for the **HAARP** program. Various GPS sensor calibrations and signal analyses were performed.

[Full Text](#)

[Diagnostics and Modeling of the Auroral Ionosphere Under the Influence of the Gakona HF](#)

Feb 27, 2004 53 pages

[Transmitter](#)

Authors: [Davis D. Sentman](#); [Eugene M. Wescott](#); [John V. Olson](#); [Antonius Otto](#); [William A. Bristow](#); [ALASKA UNIV FAIRBANKS GEOPHYSICAL INST](#)

... the Gakona HF transmitter interacts with the ionospheric D- region, and by means of a number of experiments and theoretical models to characterize the resultant effects. A Public Outreach program was instituted to help educate the community in the Gakona area about the goals and research of the **HAARP** program. The work in the contract was divided into 5 subtasks, each under the direction of a separate UAF investigator: 1. ELF/VLF Wave Measurement and Interpretation Program (I). Sentman), 2. ULF Wave Measurement Program (J. Olson), 3. Simulation (A. Otto), 4. SuperDARN Operations (W. Bristow), ...

[Full Text](#)

[Ionospheric Measurements in the Wake of Solar Maximum](#)

Apr 30, 2004 145 pages

Authors: [Angela M. Andreassen](#); [John Begenesich](#); [Edward Fremouw](#); [Elizabeth Holland](#); [Andrew J. Mazzella Jr](#); [NORTHWEST RESEARCH ASSOCIATES INC BELLEVUE WA](#)

... System (AN/GMQ-35) and the NWRA ITS10S coherent radio receiving system. The primary measurements were of ionospheric total electron content (TEC) and radiowave scintillation, for describing the ionosphere and its plasma-density structures during this solar epoch and under the perturbing influence of **HAARP**. Records of TEC were inverted tomographically to produce two-dimensional (altitude vs. latitude) images of plasma density. By these and other means, ionospheric features such as the main F-layer trough and polar patches were characterized for application to Air Force environmental models.

[Full Text](#)

[Imaging and Forecasting of Ionospheric Structures and Their System Impacts](#)

Jan 27, 2005 76 pages

Authors: [Bodo Reinisch](#); [Gary Sales](#); [Paul Song](#); [MASSACHUSETTS UNIV LOWELL CENTER FOR ATMOSPHERIC RESEARCH](#)

... VLF station monitoring with the RPI/IMAGE instrument. We carried out RPI measurements using specifically designed operational modes with lower receiver gains. In the past year, several Radiation Belt Remediation (RBR) studies were done and many of them remain active. The results of two **HAARP** heating experiments with the digisonde at Gakona, Alaska are described. Additionally, we discuss work done in several areas. We introduced a new Java-based Drift software package for the digisonde drift data analysis and visualization. DISS Support for the Digisonde Network continued. The CAL/VAL, project ...

[Full Text](#)

[Artificial Ionospheric Turbulence and Radio Wave Propagation \(Sura - HAARP\)](#)

Nov 1, 2006 164 pages

Authors: [Vladimir L. Frolov](#); [RUSSIAN ACADEMY OF SCIENCES NIZHNY NOVGOROD RADIO PHYSICAL RESEARCH INST](#)

This report results from a contract tasking Radio Physical Research Institute (NIRFI) as follows: The objectives of the project were: (i) integrated experimental, theoretical and computer simulation studies of non-linear plasma phenomena, produced in the upper ionosphere by powerful HF radiation and giving rise to plasma density irregularities with a wide range of cross-field (relatively to geomagnetic field lines) scales from centimeters to tens of kilometers, (ii) investigation of an influence of these irregularities on characteristics of HF and VHF radio waves passed through the ionosphere ...

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