An Electromagnetic Interference Study of Potential Transmitter Sites for the HF Active Auroral Research Program (HAARP)

Jul 19, 1993 41 pages

Upper Atmospheric Effects of the HF Active Auroral Research Program Ionospheric Research Instrument (HAARP IRI)

May 1993 19 pages

Investigation of Plasma Phenomena in the Ionosphere Under Natural Conditions and Under Conditions Artificially Perturbed by HAARP

Aug 17, 2005 81 pages

A Diagnostic System for Studying Energy Partitioning and Assessing the Response of the Ionosphere During HAARP Modification Experiments

May 15, 1996 55 pages

Characterization of the Auroral Electrojet and the Ambient and Modified D Region for HAARP Using Long-Path VLF Diagnostics

Mar 15, 2001 127 pages

Electromagnetic Spectrum Occupancy Study of a Potential Transmitter Site for the HF Active Auroral Research Program (HAARP)

Sep 30, 1994 50 pages
HAARP Imaging Riometer Diagnostic
Authors: Ted J. Rosenberg; Advanced Power Technologies Inc Washington DC
Jul 16, 1997 20 pages

HAARP, Research and Applications
Authors: Dennis Papadopoulos; Paul A. Bernhardt; Herbert C. Carlson Jr.; William E. Gordon; Alexander V. Gurevich; Naval Research Laboratory Washington DC
1990 19 pages

Telescopic Imaging of Heater-Induced Airglow at HAARP
Authors: Michael C. Kelley; Cornell Univ Ithaca Ny Office of Sponsored Programs
Jan 2007 6 pages

HAARP, Diagnostic Instruments; High Frequency Active Auroral Research Program
Authors: Paul A. Kossey; James C. Battis; Air Force Research Lab Hanscomafb MA Space Vehicles Directorate
Dec 2002 71 pages

Electromagnetic Interference Impact of the Proposed Emitters for the High Frequency Active Auroral Research Program (HAARP)
Authors: G. A. Roberts; T. Z. Gurevich; MITRE Corp Bedford MA
May 14, 1993 134 pages

Imaging of Underground Structure Using HAARP
Authors: Randall L. Mackie; Gsy-Usa Inc San Francisco CA
Feb 1999 48 pages

Geophysical Electromagnetic Sounding Using HAARP
Authors: Eugene M. Wescott; Davis D. Sentman; Alaska Univ Fairbanks Geophysical Inst
Mar 2002 14 pages
On the Onset of HF-Induced Airglow at HAARP

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 dissipative recombination of O+(2). It is shown that heating and acceleration of background electrons ...

SATSIN System Manual

Authors: Robert C. Livingston; SRI INTERNATIONAL MENOLO 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.

Diagnostics and Modeling of the Auroral Ionosphere Under the Influence of the Gakona HF Transmitter

Authors: Davis D. Sentman; Eugene M. Wescott; John V. Olson; Antoninus 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 onospheric 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 ...

Investigations of the Nature and Behavior of Plasma-Density Disturbances That May Impact GPS and Other Transionospheric Systems

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, NWRA 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.

Investigations of the Nature and Behavior of Plasma Density Disturbances That May Impact GPS and Other Transionospheric Systems

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, NWRA 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.

Environmental Impact Statement, Volume 1. Proposed High Frequency Active Auroral Research Program

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 ...

Summer 2000 Student/Faculty Science Campaign, July 31-August 8, 2000

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.

Ionospheric Sensor Developments for the Year-2000 Solar Maximum

Authors: E. J. Fremouw; A. J. Mazzella Jr.; G. S. Rao; NORTHWEST RESEARCH ASSOCIATES INC BELLEVUE WA

...

**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 ...

Excitation of Earth-Ionosphere Waveguide in the ELF and Lower VLF Bands by Modulated Ionospheric Current

**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 altitudes as high as 100 Km. Ionospheric modification, Ionospheric currents, Ionospheric heating.

The WIND-HAARP Experiment: Initial Results of High Power Radiowave Interactions with Space Plasmas

**Authors:** P. Rodriguez; E. Kennedy; M. Keskinen; C. Siefring; 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 magnetoshere. The data acquired suggest that ...

Investigations of the Nature and Behavior of Plasma-Density Disturbances That May Impact GPS and Other Transionospheric Systems

**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.

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

**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.

Coherent HF Radar System for the Study of Natural and Heater Induced Ionospheric Irregularities

**Authors:** Bodo W. Reinisch; James L. Salli; 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.

Establishing the National Polar Radio Science Consortium

**Authors:** ALASKA UNIV FAIRBANKS GEOPHYSICAL INST

The Geophysical Institute of the University of Alaska Fairbanks (GI-UAF) was designated as the Prime
Investigation of Ionospheric Disturbances and Associated Diagnostic Techniques

Authors: L. M. Duncan; CLEMSON UNIV SC

Further Investigations of Ionospheric Total Electron Content and Scintillation Effects on Transionospheric Radiowave Propagation

Authors: C. C. Andreaesen; Edward J. Fremouw; Andrew J. Mazzella; G. S. Rao; James A. Secan; NORTHWEST RESEARCH ASSOCIATES INC BELLEVUE WA

Low Frequency Radio Research at Thule, Greenland

Authors: A. C. Fraser-Smith; C. C. Teague; STANFORD UNIV CA SPACE TELECOMMUNICATIONS AND RADIOSCIENCE LAB

The WIND-HAARP-HIPAS Interferometer Experiment

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

Detection of the 27 Aug 1998 Gamma Ray Flare, and Ionospheric Effects of Relativistic Electron Flux Enhancements

Authors: Timothy F. Bell; STANFORD UNIV CA

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

Authors: Michael C. Kelley; CORNELL UNIV ITHACA NY SCHOOL OF ELECTRICAL AND COMPUTER ENGINEERING

Experimental Demonstration of Underground Structure Characterization Using Sensitive Magnetic Sensors

Authors: Suman Ganguly; CENTER FOR REMOTE SENSING INC FAIRFAX VA

Global Ionospheric Structure, Dynamics, and System Effects
Diagnostics and Modeling of the Auroral Ionosphere Under the Influence of the Gakona HF Transmitter

Feb 27, 2004  53 pages

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 (D. Sentman), 2. ULF Wave Measurement Program (J. Olson), 3. Simulation (A. Otto), 4. SuperDARN Operations (W. Bristow), ...

Ionospheric Measurements in the Wake of Solar Maximum

Apr 30, 2004  145 pages

Authors:  Angela M. Andreasen; John Begenisich; 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.

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 ...

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 ...

Total Results: 40