



# Future of the HAARP Facility

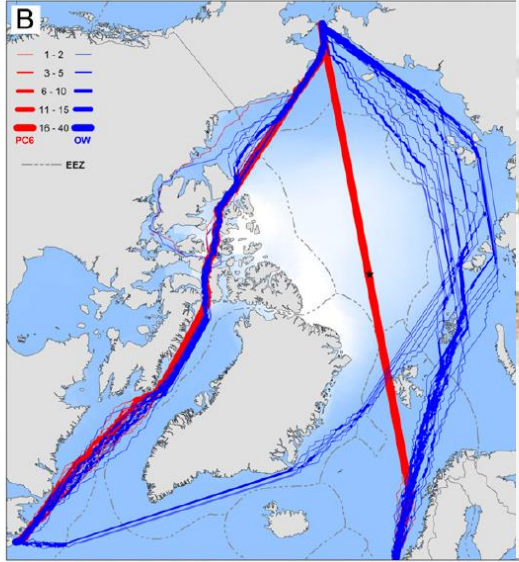
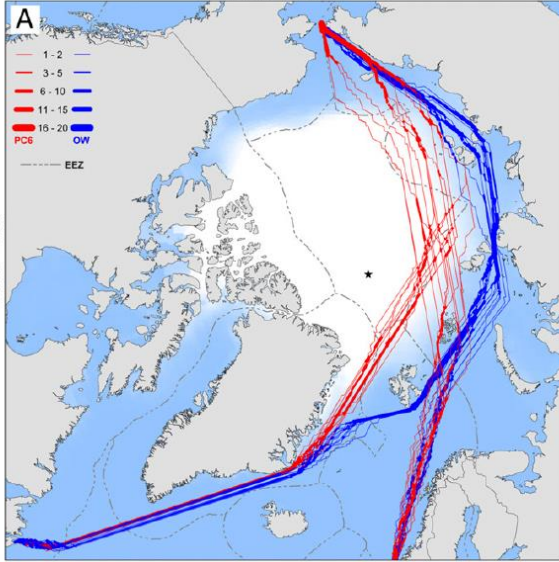
**Bob McCoy**  
**Director, Geophysical Institute**  
**University of Alaska Fairbanks**  
**[rpmccoy@alaska.edu](mailto:rpmccoy@alaska.edu)**



2006 - 2015

2040 - 2059

RCP 4.5



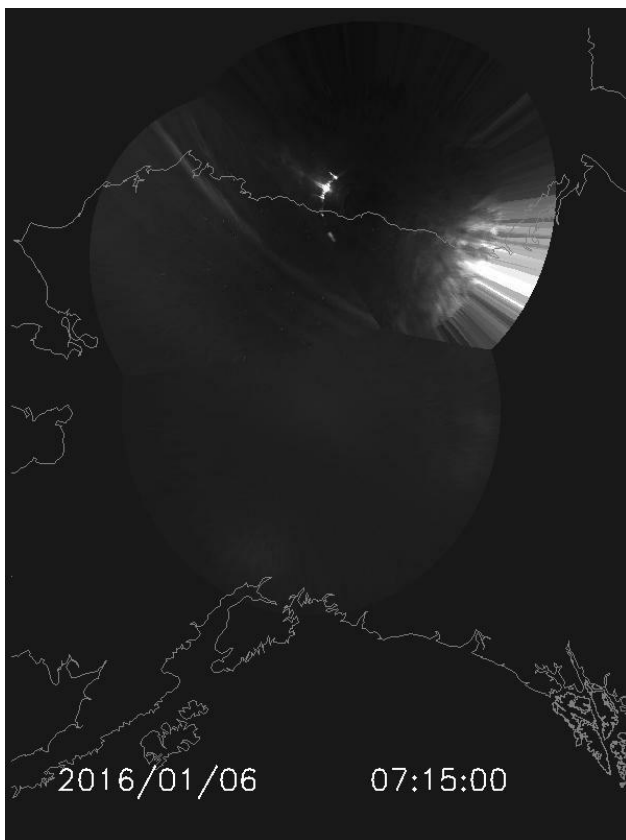
**US Chairmanship  
2015-2017**



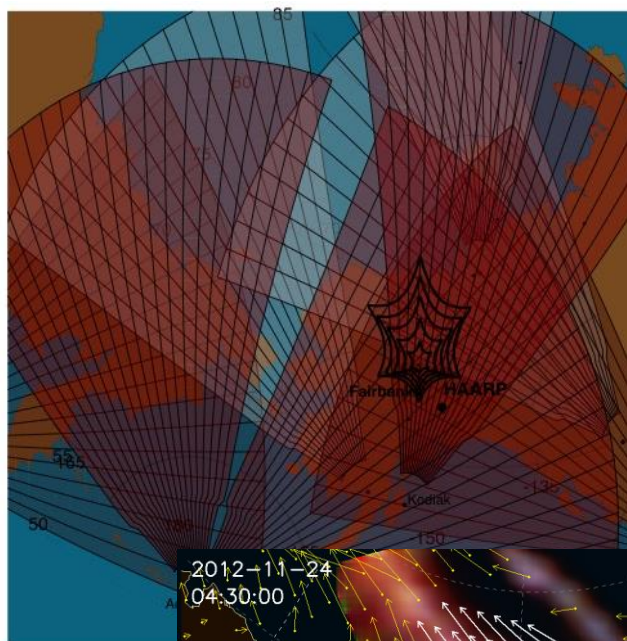
# Future Space Research in Alaska:

Integrated networks of high-latitude instruments to provide observations for Space Weather research

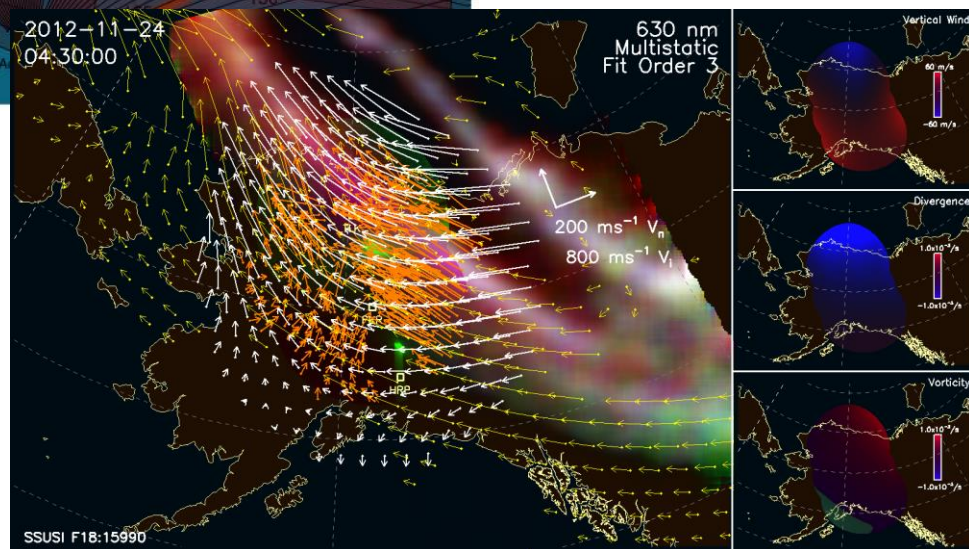
## Auroral Cameras



## Radars



## Wind Imagers



NATIONAL SPACE WEATHER STRATEGY

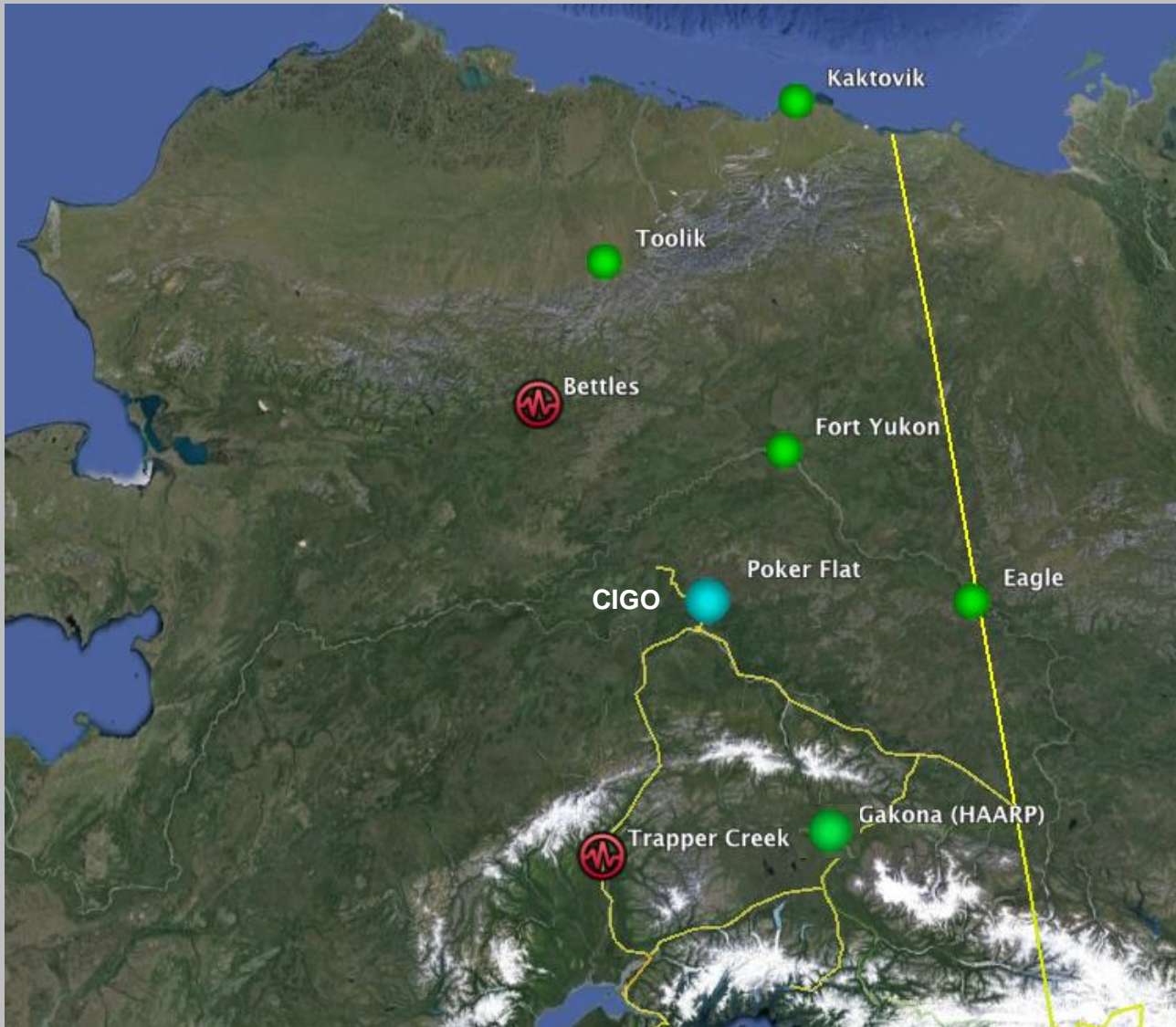
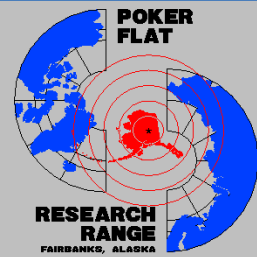
PRODUCT OF THE  
National Science and Technology Council



October 2015



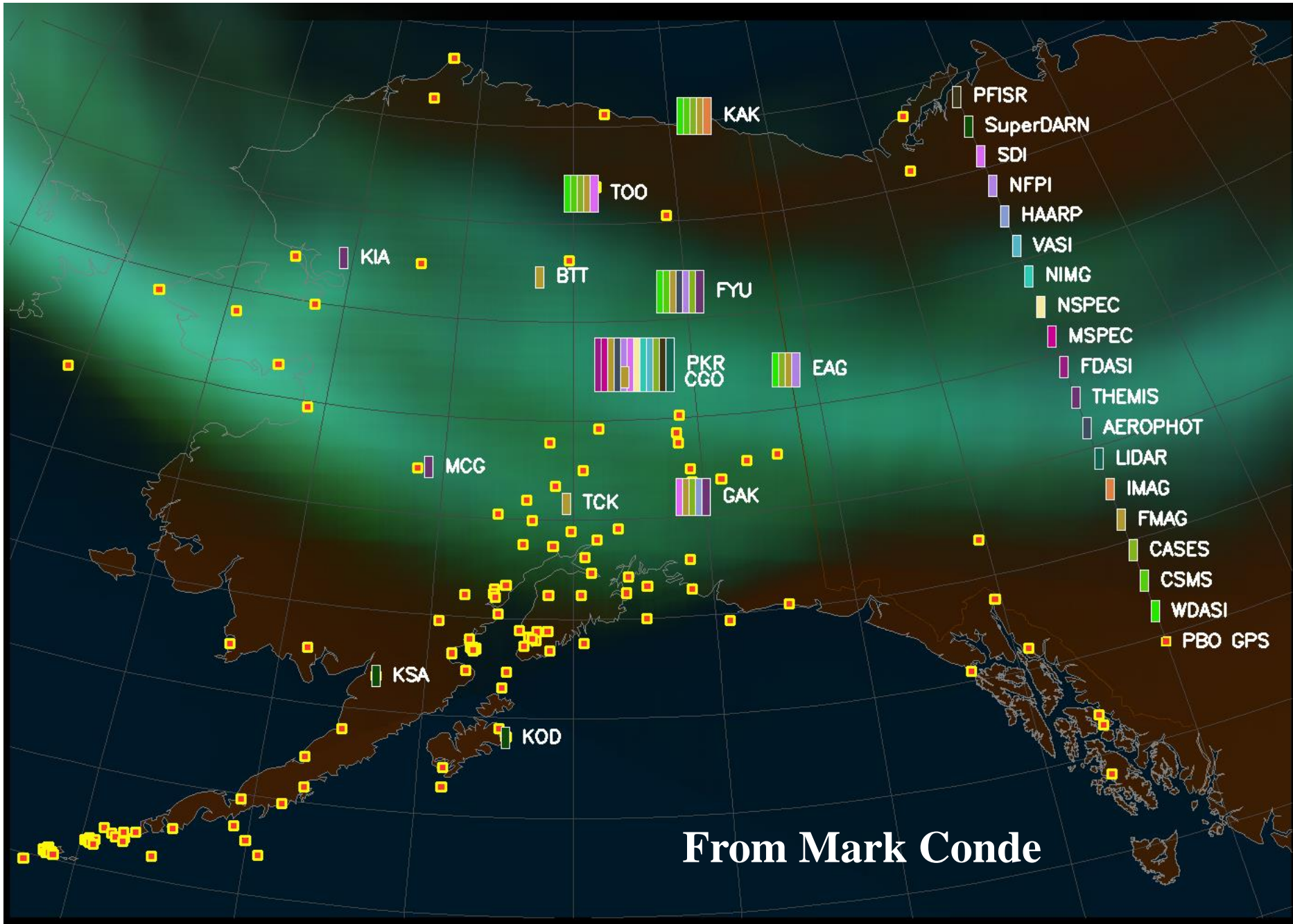
# Station Locations



 Mag Only

 Mag  
+  
Optics

**From Don Hampton**



From Mark Conde

# High frequency Active Auroral Research Program (HAARP)



- Gakona AK - 62.39 deg, 145.15 deg (West)
- 33 acre phased HF transmitter array;
- 2.8 to 10 MHz;
- Multiple beams & transmission to 30 elevation angle
- 5 x 3600 hp diesel engines; 3.6 MW;
- \$290M (half Congressional earmarks + half AFRL, ONR & DARPA)





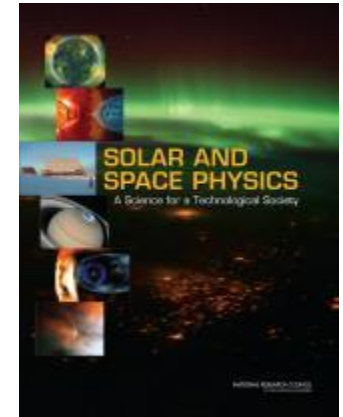




# 2013: Two National Research Council Studies Involving HAARP

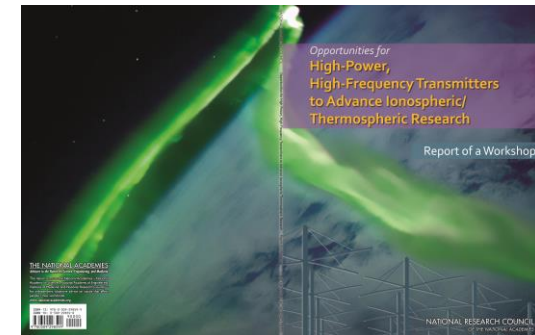
- **2013 Decadal Survey in Solar and Space Physics**

- Priority - Fully realize the potential of ionospheric modification techniques through **collocation of modern heating facilities** with a full complement of **diagnostic instruments including incoherent scatter radars**. This effort requires coordination between NSF and DOD agencies in planning and operation of existing and future ionospheric modification facilities.



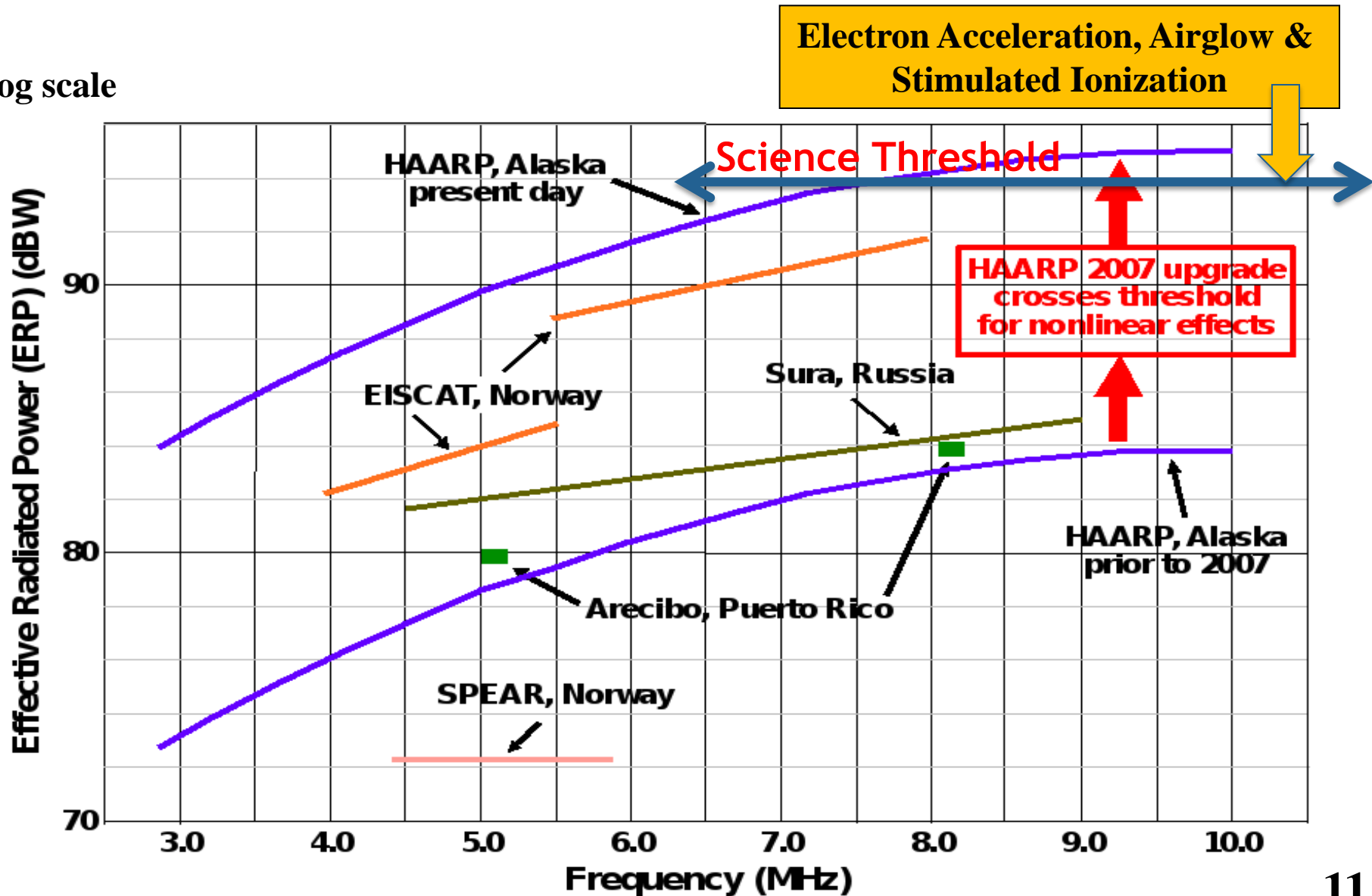
- **Mar 2013 - Workshop: Opportunities for High-Power, High-Frequency Transmitters to Advance Ionospheric/Thermospheric Research**

- NRC Workshops do not provide recommendations but report contains 72 pages of HAARP science
- Themes: Geospace and space weather; Stimulated emission and radiation belts; radio science, communications, and radar
- Strong recommendation to **co-locate incoherent scatter radar**



# HAARP Compared to EISCAT, Sura & Arecibo

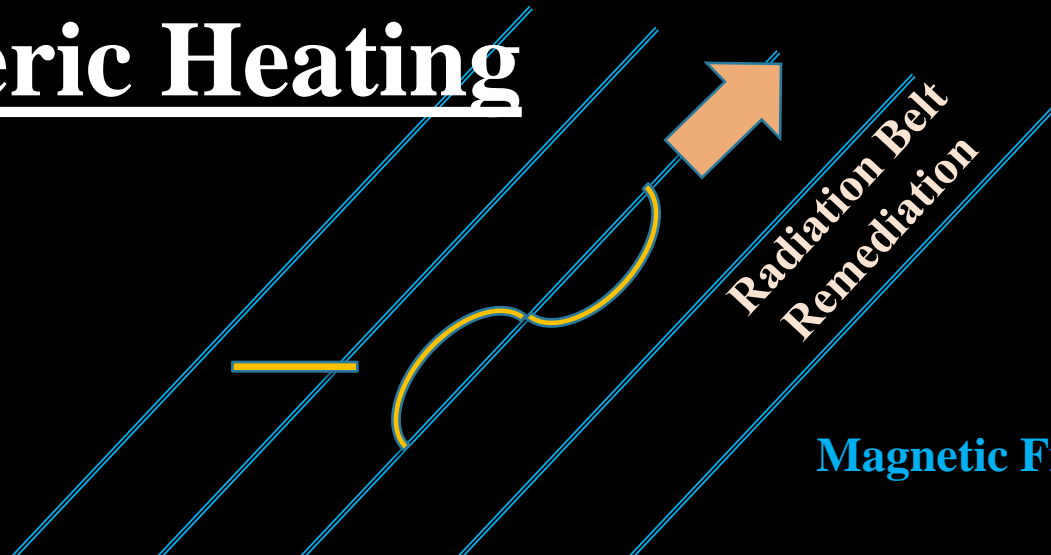
Log scale



# HF Ionospheric Heating



**ELF, VLF**

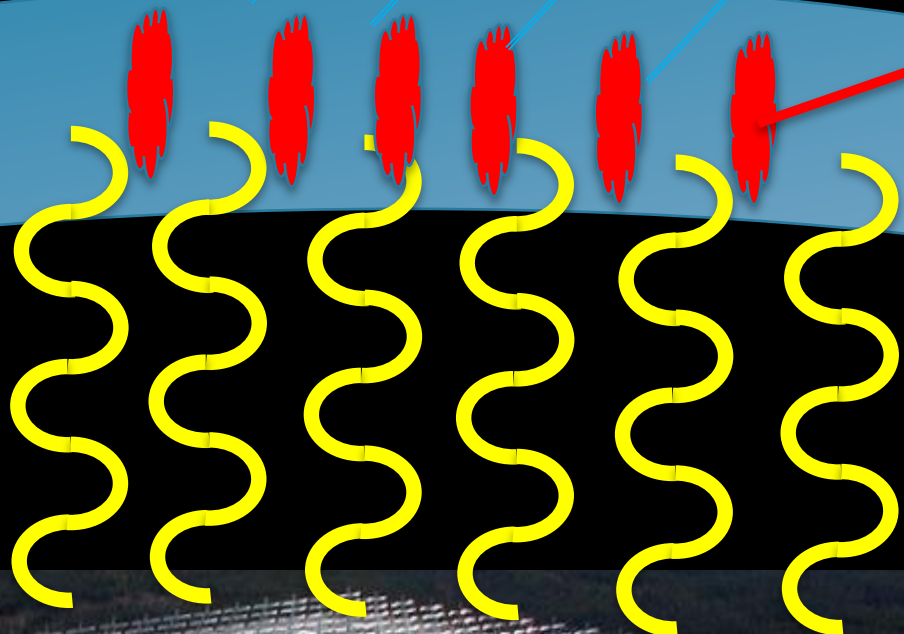


**Magnetic Field Lines**

**Ionosphere**  
90 – 2000 km

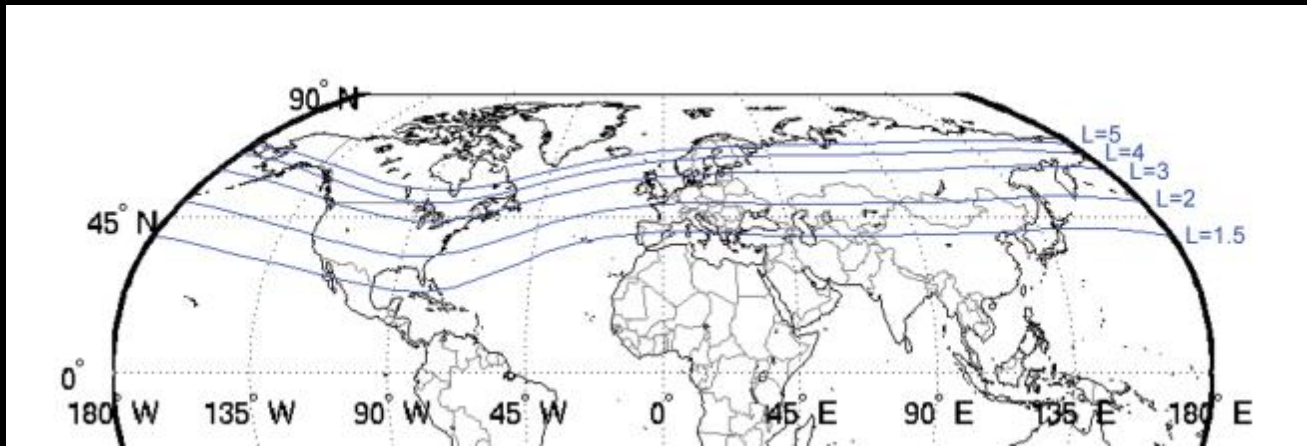
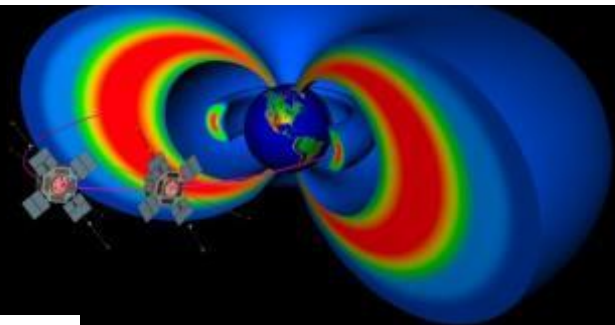
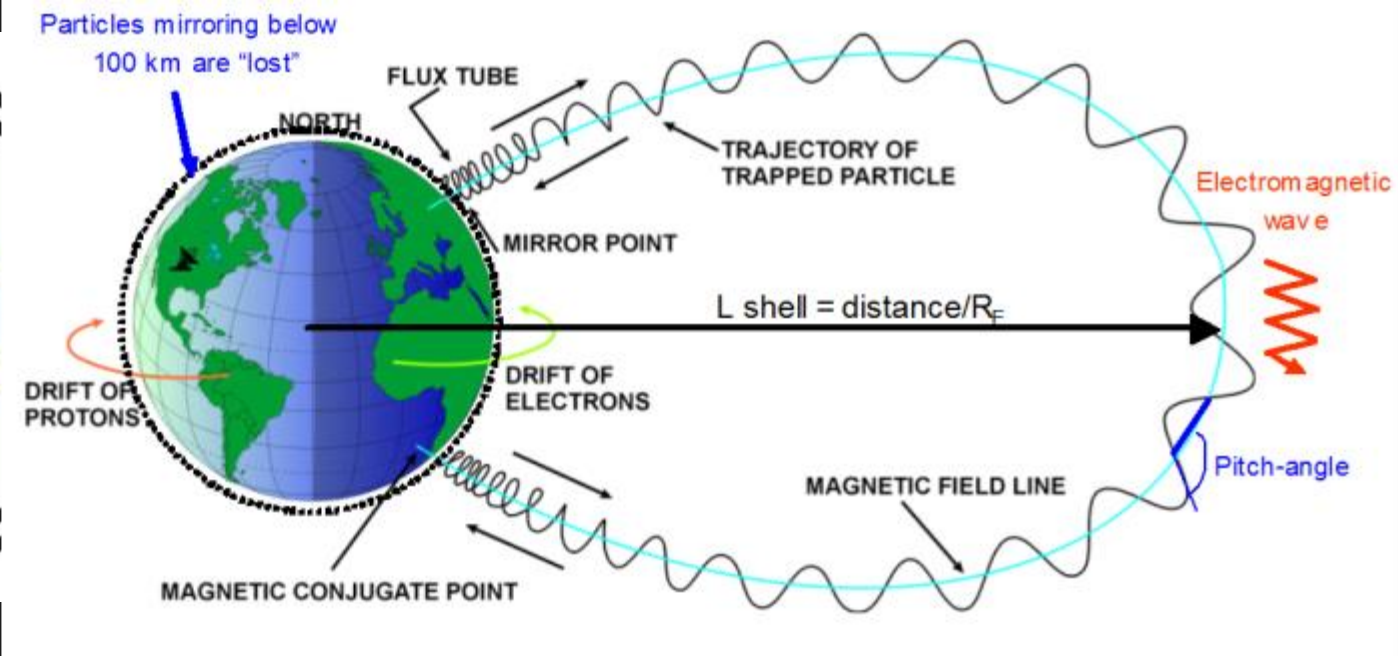
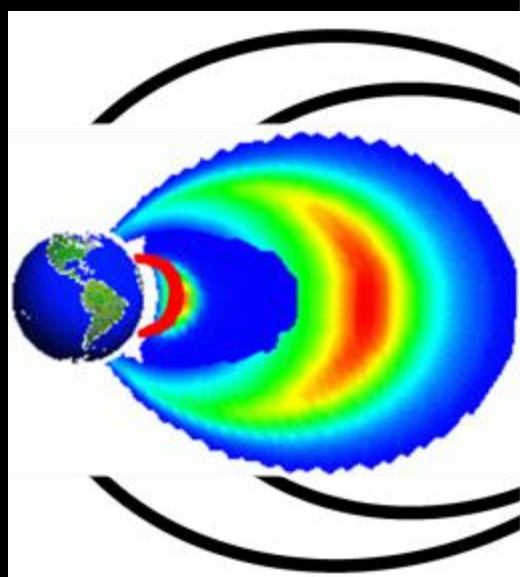
**Ionospheric Irregularities**

**HF Energy**  
2.8 – 10 MHz  
3.6 MW

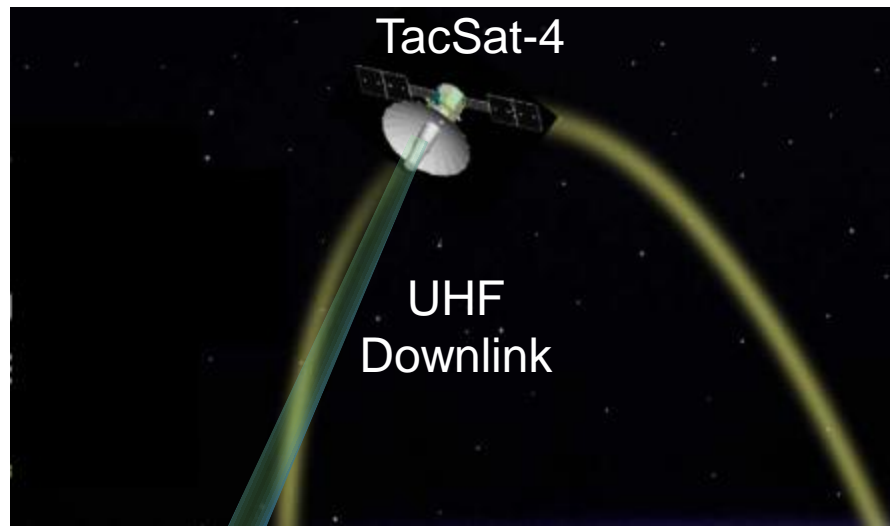


**Submarine Communication**





# COMMX Working with HAARP

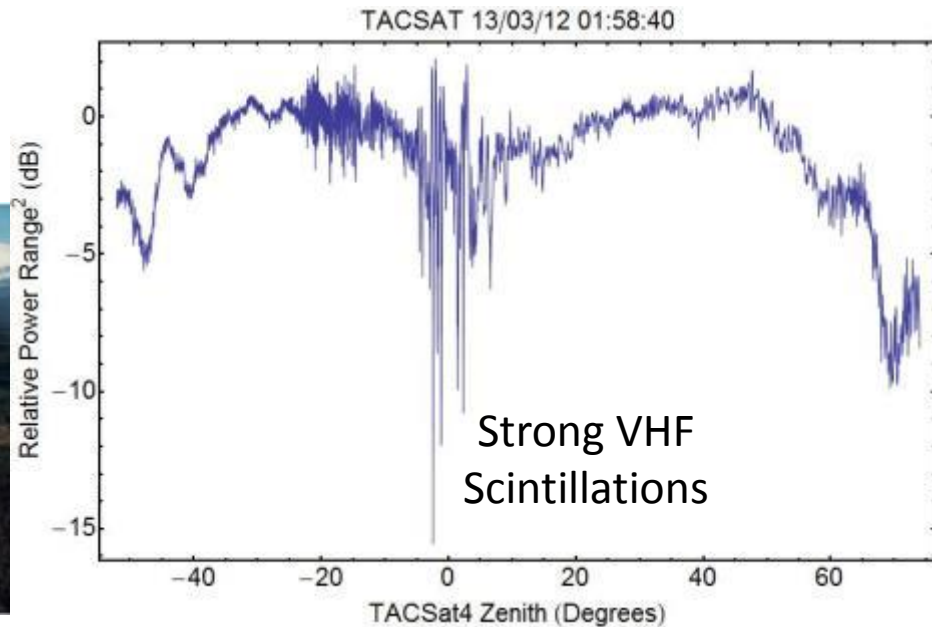


TACSat4  
Actively  
Pointed to  
Ground  
Receiver

Modified  
Region

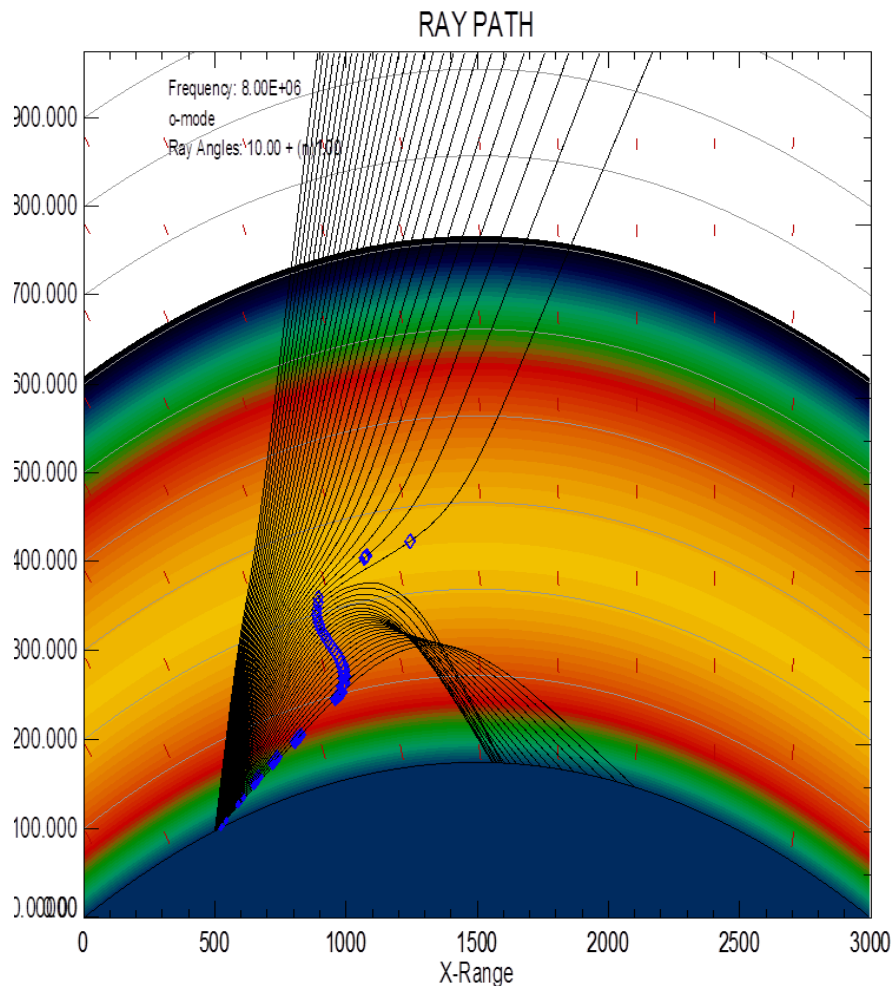
F-Layer Ionosphere

Courtesy Paul Bernhardt  
NRL

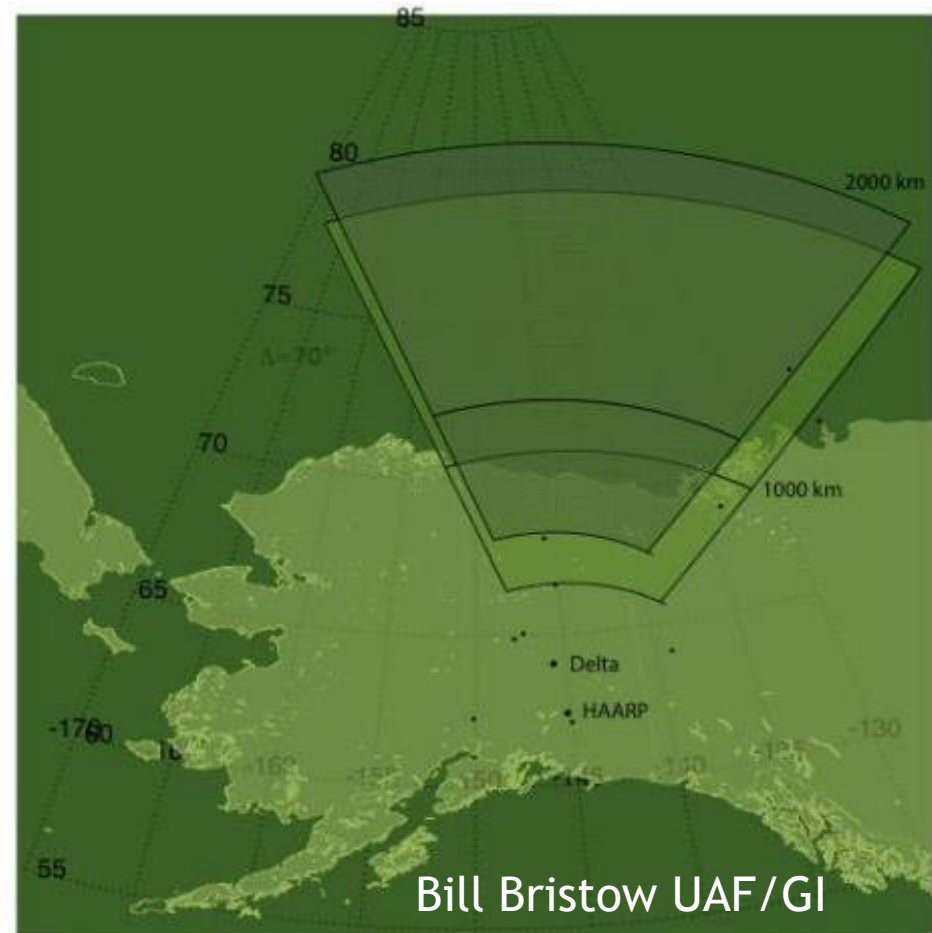


# Over the Horizon Radar Experiments

8 MHz; Covers range of ~1100 km to ~1800 km from radar

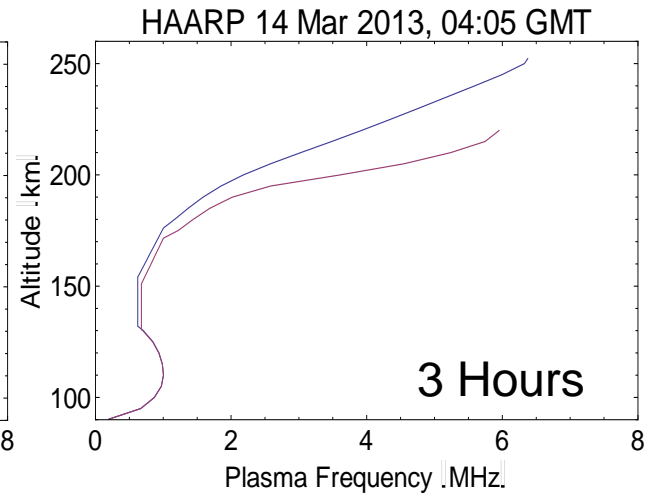
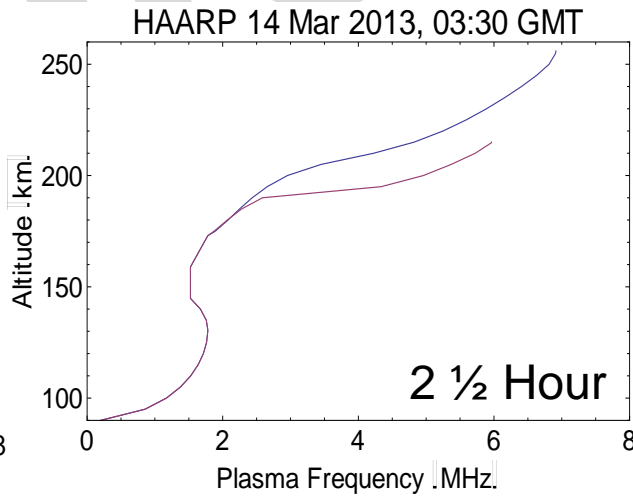
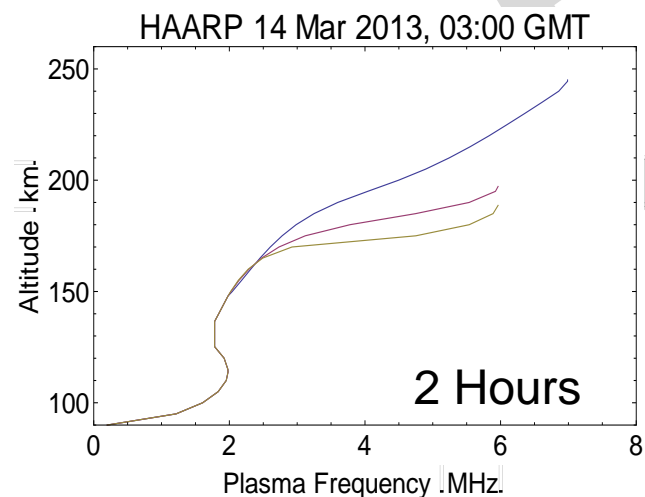
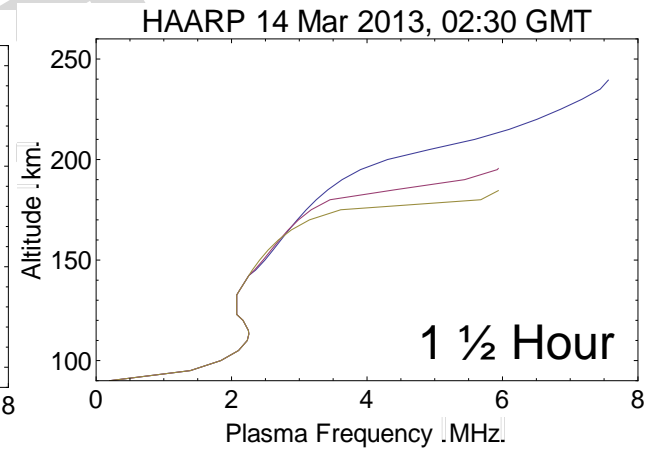
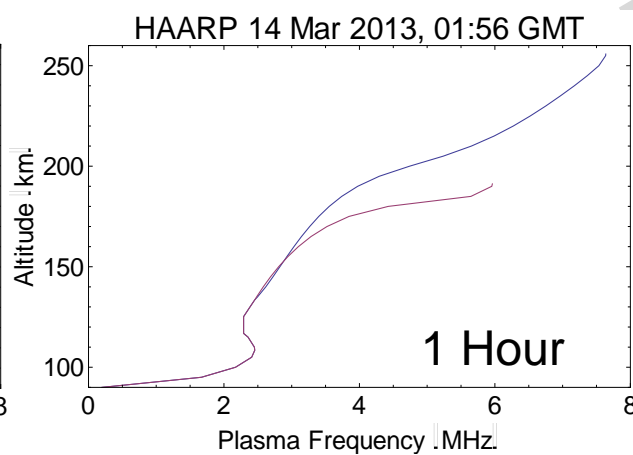
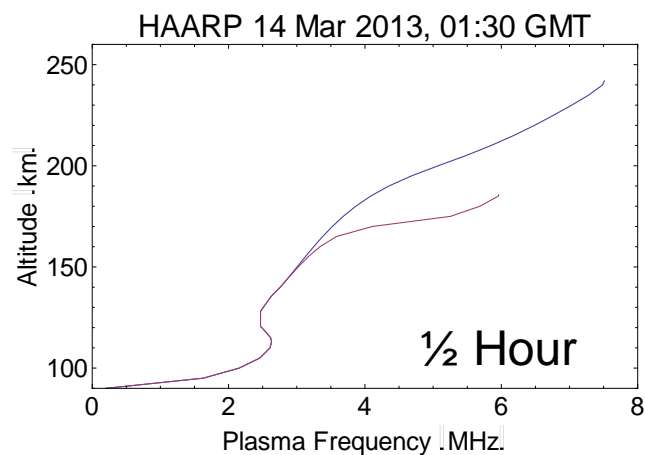
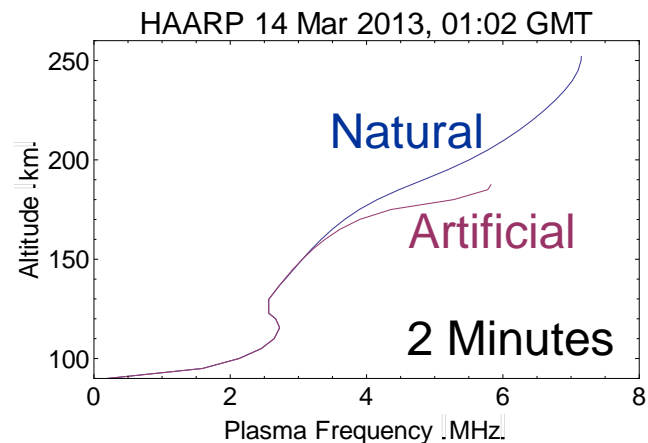


Offset of transmitter and receiver location; 2000 km range translates to about  $80^\circ$  latitude

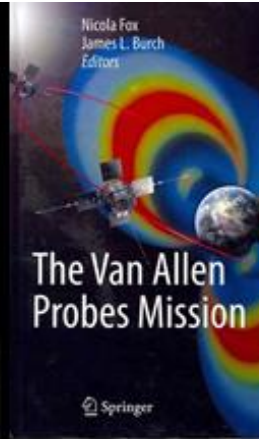
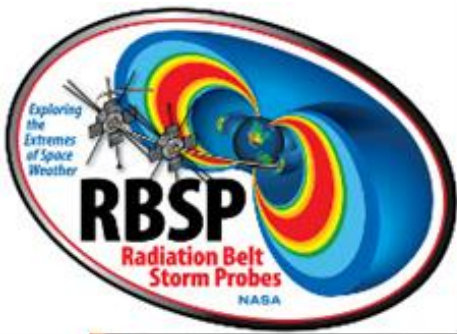


# 14 March 2013 01:30 to 04:00 GMT Extended Artificial Ionization with 5.8 MHz Twisted Beam

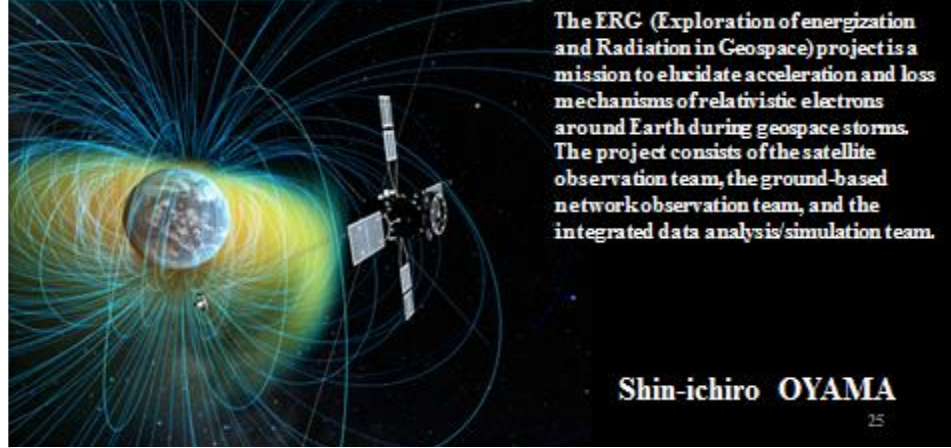
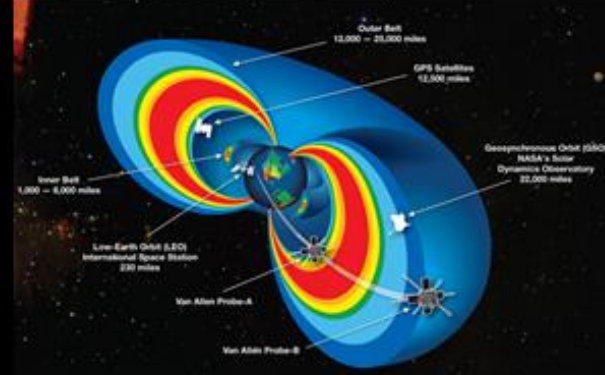
Courtesy Paul Bernhardt  
NRL





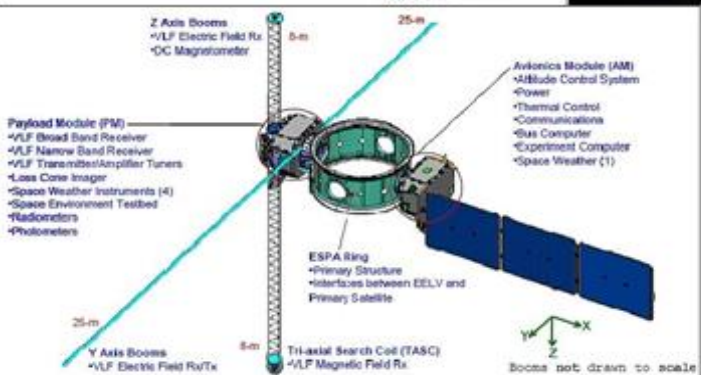
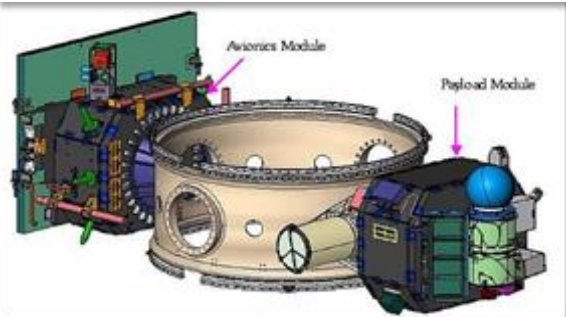


**ERG – A small-satellite mission to investigate the dynamics of the inner magnetosphere**



The ERG (Exploration of energization and Radiation in Geospace) project is a mission to elucidate acceleration and loss mechanisms of relativistic electrons around Earth during geospace storms. The project consists of the satellite observation team, the ground-based network observation team, and the integrated data analysis/simulation team.

**Shin-ichiro OYAMA**



## Recent & future satellite missions with potential to use HAARP:

- Van Allen Probes
- DSX
- ERG
- e-POP on CASSIOPE
- Karina

# AFRL Maj Gen Masiello presented keys of HAARP to UAF Chancellor Rogers Aug 11, 2015



- **Cooperative Research & Development Agreement (CRADA) for access to HAARP**
- **Educational Partnership Agreement (EPA) to transfer HAARP equipment to UAF**
- **House & Senate have approved wording to transfer 1150 acres to UAF**
  - **Amending the National Defense Authorization Act (NDAA)**
- **UAF/GI currently working permits with FCC, FAA & EPA**
  - **Goal: First campaigns this winter (Feb 2017)**
- **Hired HAARP Manager: Jessica Matthews**
- **Hired Marty Karjala & Tracey Coon as UAF employees (prior HAARP employees)**
  - **Additional contract support as needed**
- **GI faculty (with NRL assistance) can operate HAARP for experiments**

# Current Status of HAARP Diagnostics

## OPERATIONAL

- Digisonde
- Cases GPS Receiver System
- ITS-30 Receiver System
- Fluxgate Magnetometer
- MUIR (16 Panel)
- TCI-540 Antenna w/ coaxial feed to pad

## IN THE WORKS

- GNSS GPS Receiver System
- THEMIS GBO
- Optical Equipment (Narrow and wideband w/ telescope )

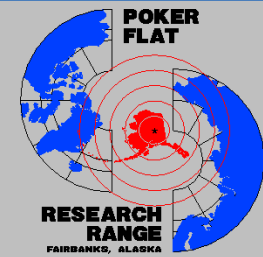
## AVAILABLE INFRASTRUCTURE

- Three Optical Shelters w/ two 5' domes, three 18" domes
- Seven remote shelters
- Heated project work spaces
- Fiber & power to all site locations





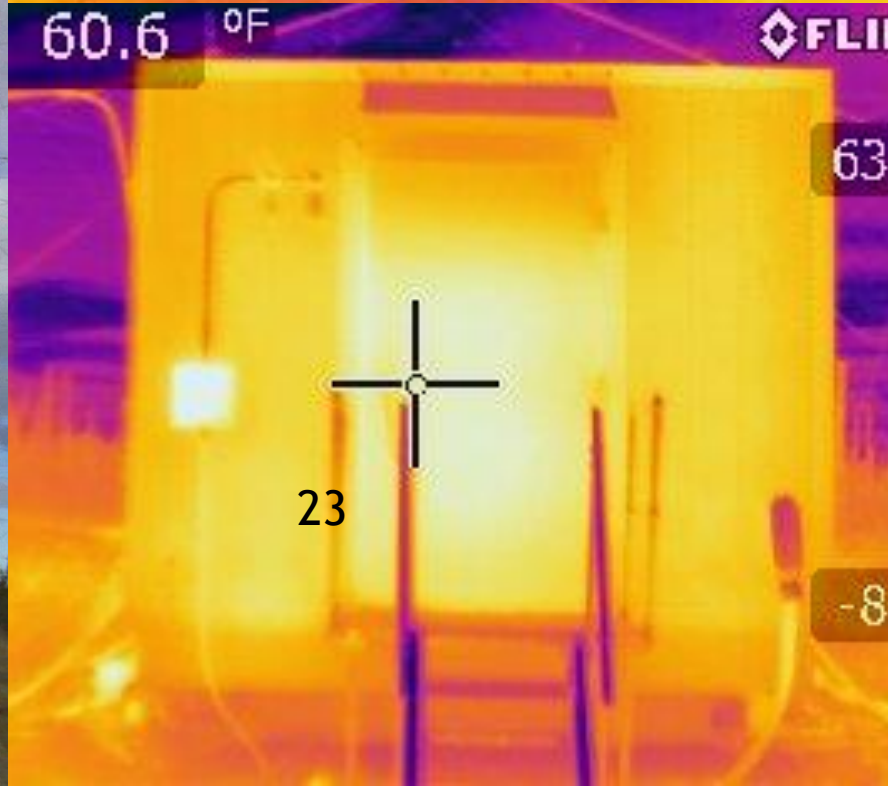
# Poker Flat Incoherent Scatter Radar



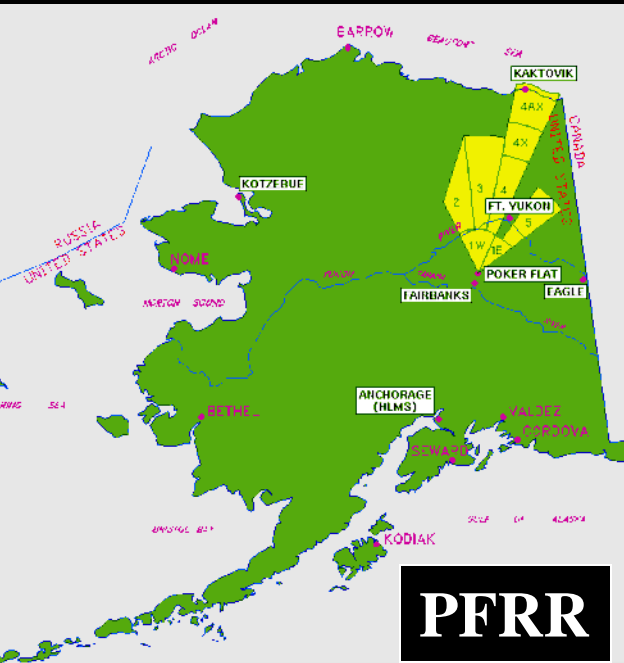
- The first of the Advanced Modular Incoherent Radar (AMISR) installations (NSF funded)
- 4096 individual radar elements in a phased array



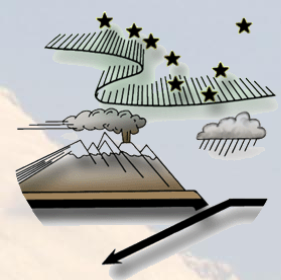




# Poker Flat Research Range + HAARP = Single Organization







GEOPHYSICAL INSTITUTE



## **Polar Aeronomy and Radio Science (PARS)**

**Previously funded by: AFRL, ONR and NSF**



**HAARP is a community facility. The community (you) saved it from demolition. We need your help to help sustain it.**

**Please help us to continue science at HAARP:**

**1. Think how HAARP could assist your science**

- **Bring diagnostic instruments to HAARP for collaborative studies**
- **Consider existing or new satellites (& cubesats)**

**2. Please write proposals to your favorite funding agency**

- **NSF, NASA, DOE, AFOSR, ONR, AFRL, DARPA, etc.**

**3. Please encourage these agencies to work together**

- **Combine efforts to create experiment campaigns**

**4. Encourage agencies to reinstate PARS**

**Thank  
You**

