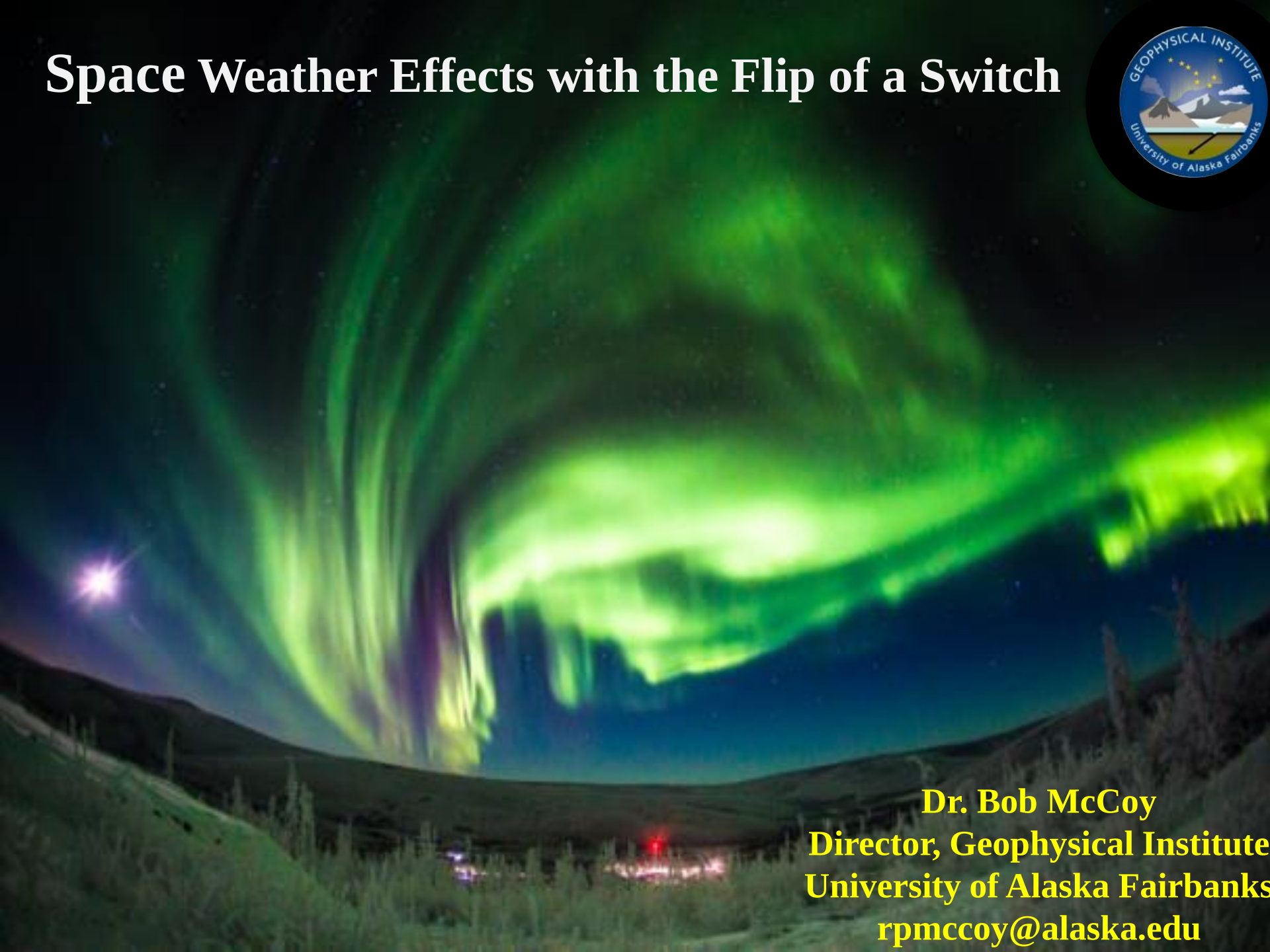
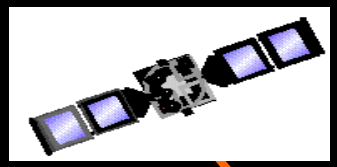
Space Weather Effects with the Flip of a Switch



Dr. Bob McCoy
Director, Geophysical Institute
University of Alaska Fairbanks
rpmccoy@alaska.edu

Poker 2015 Campaign MIST
& MTeX

Ionospheric Effects

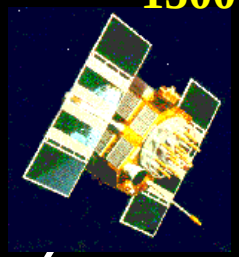


SATCOM

250 MHz

Refraction
Time Delays
Phase Shifts
Faraday Rotation
Dispersion

1500 MHz



GPS

Altimetry

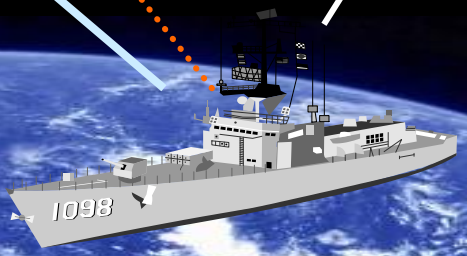
10,000 MHz

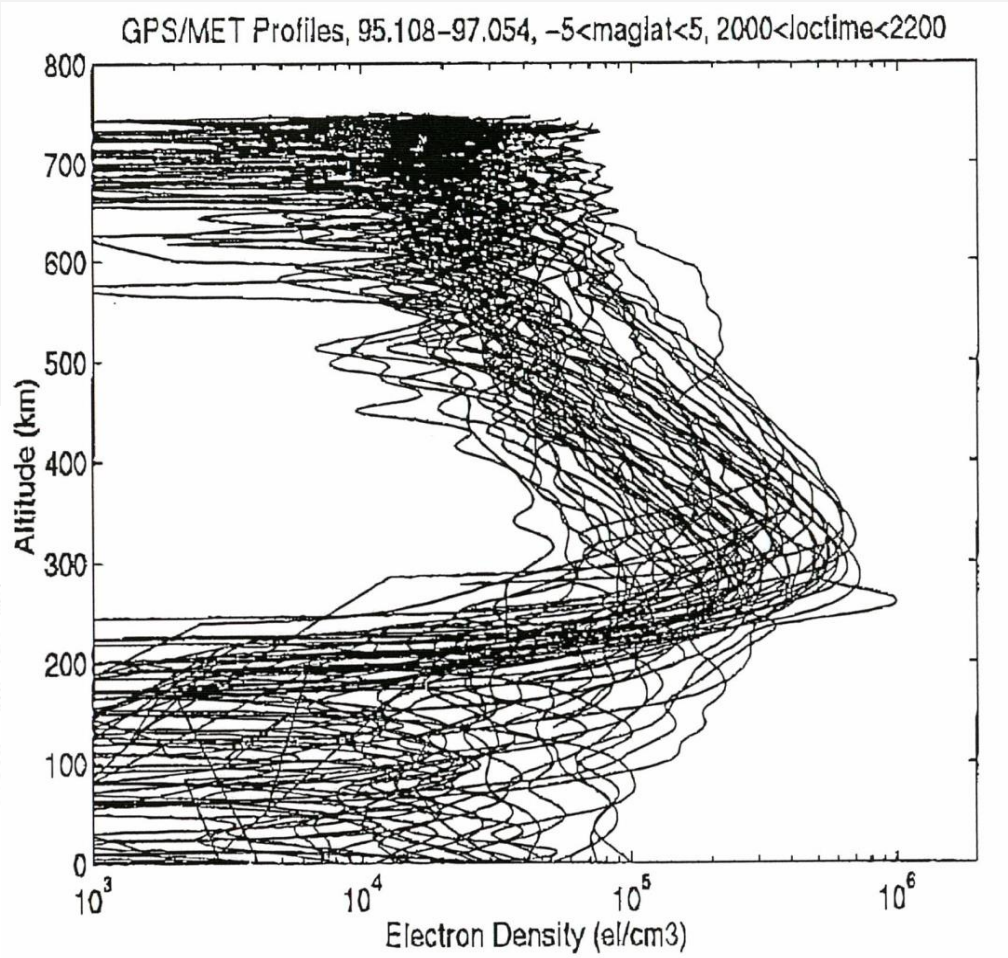
Scintillation

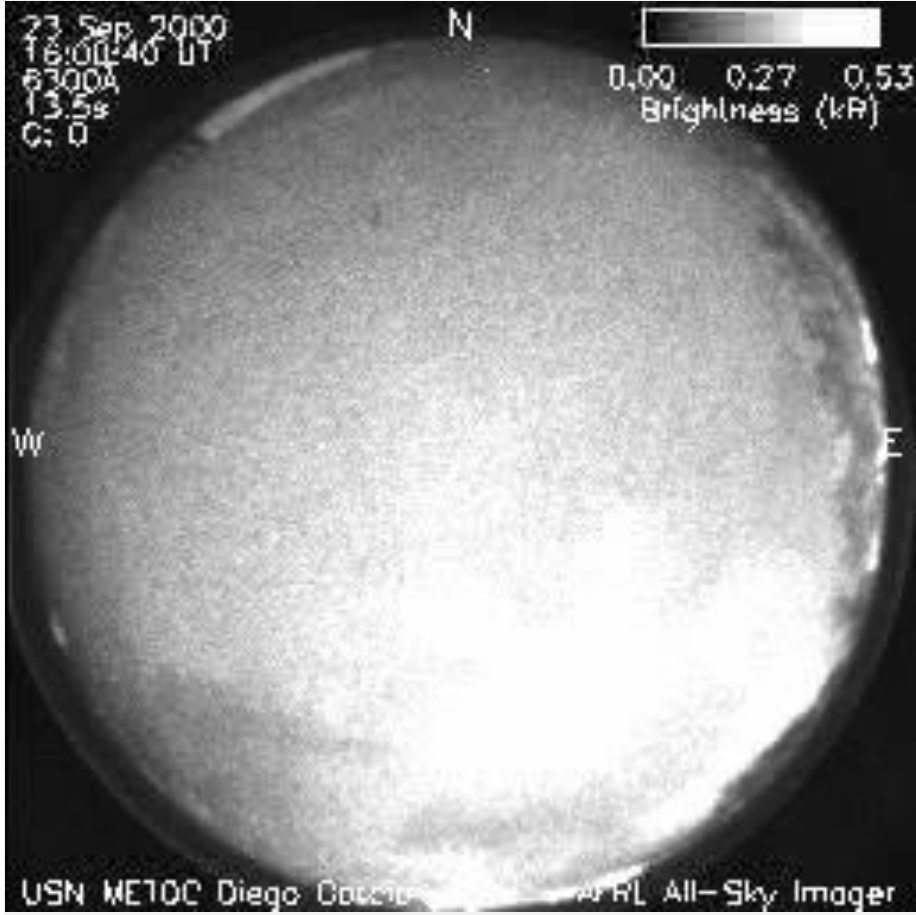
Reflection

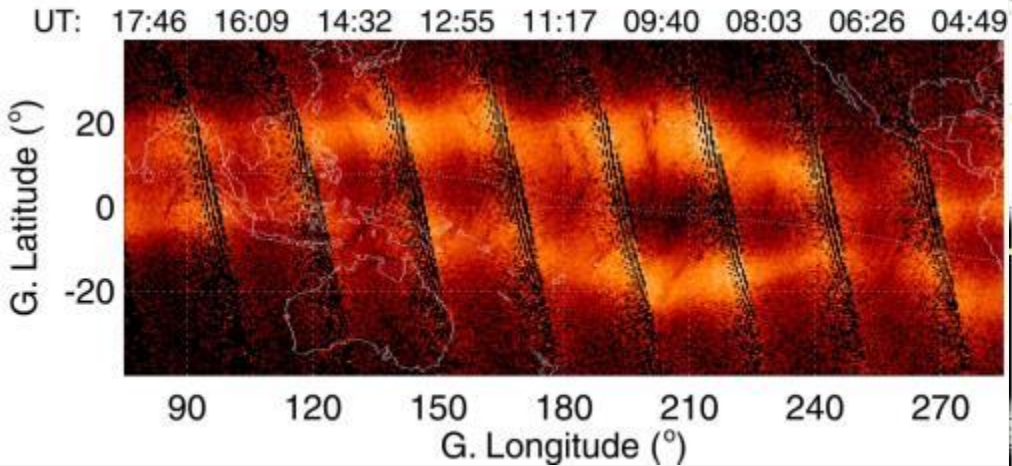
HF Comm.
OTH Radar

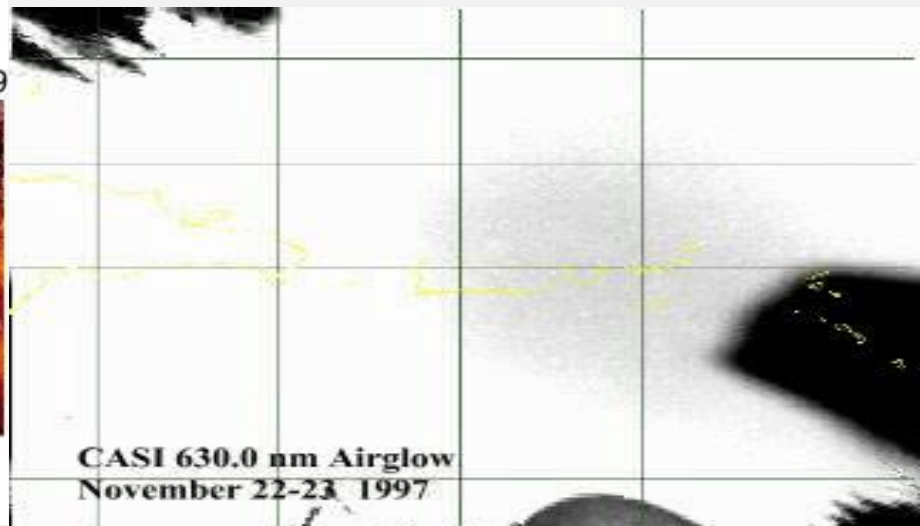
1-20 MHz



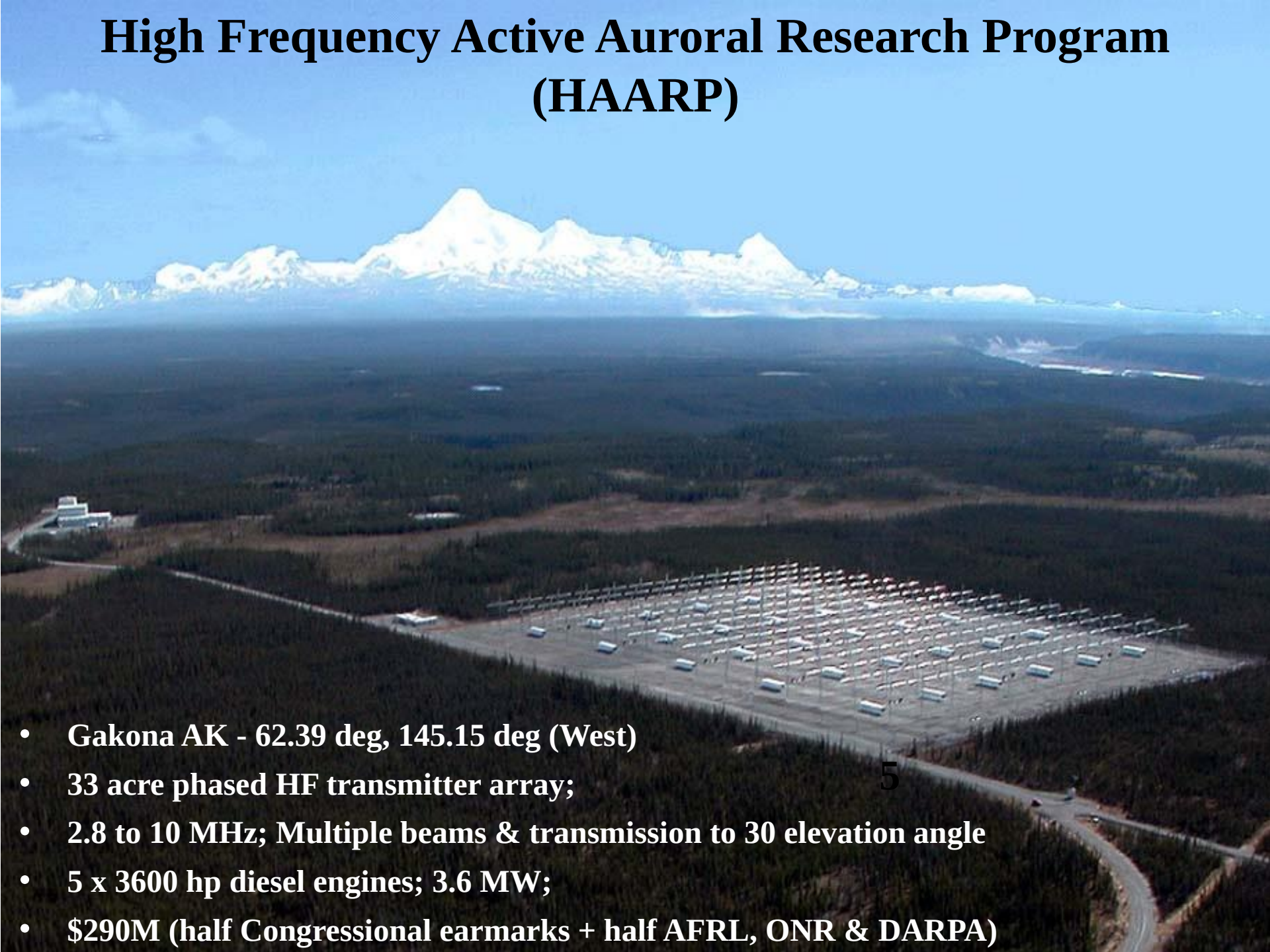

GPS/MET Profiles, 95.108-97.054, -5<maglat<5, 2000<loctime<2200
Altitude (km)
800
700
600
500
400
300
200
100
0
10^3
10^4
10^5
10^6
Electron Density (el/cm3)


23 Sep 2000
16:00:40 UT
6300Å
13.5s
C: 0
N
W
E
0.00 0.27 0.53
Brightness (kR)
USN METOC Diego Cocos
AFRL All-Sky Imager


UT: 17:46 16:09 14:32 12:55 11:17 09:40 08:03 06:26 04:49
G. Latitude (°)
20
0
-20
90 120 150 180 210 240 270
G. Longitude (°)


CASI 630.0 nm Airglow
November 22-23 1997

High Frequency Active Auroral Research Program (HAARP)

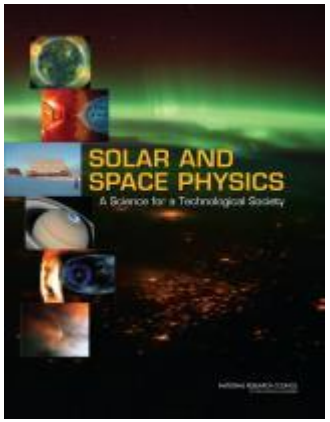


- Gakona AK - 62.39 deg, 145.15 deg (West)
- 33 acre phased HF transmitter array;
- 2.8 to 10 MHz; Multiple beams & transmission to 30 elevation angle
- 5 x 3600 hp diesel engines; 3.6 MW;
- $290M (half Congressional earmarks + half AFRL, ONR & DARPA)

2013: Two National Research Council Studies Involving HAARP

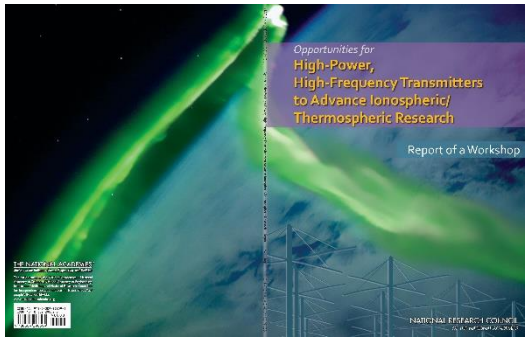
- **2013 Decadal Survey in Solar and Space Physics**

  - 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.



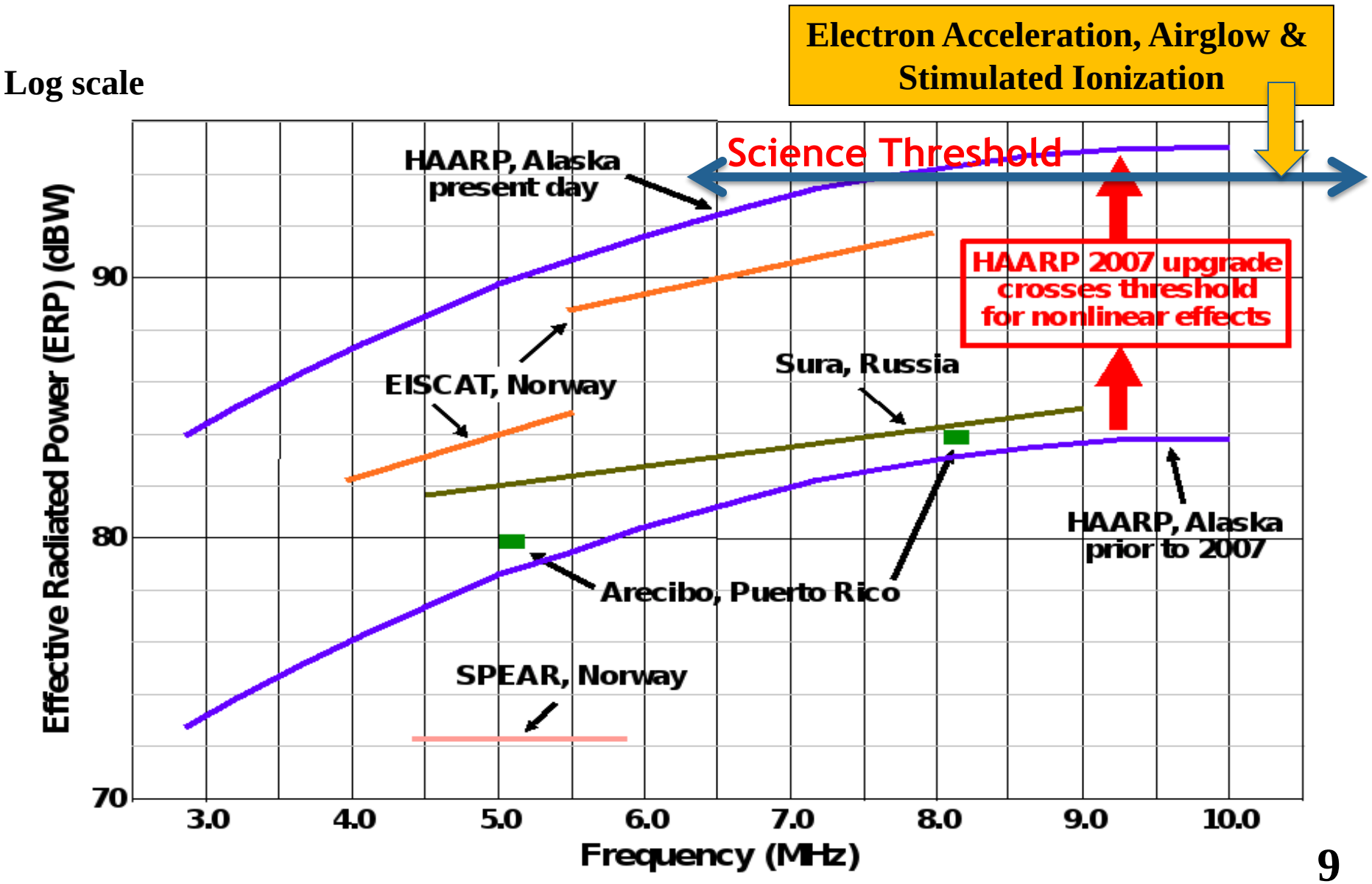
- **Mar 2013 - Workshop: Opportunities for High-Power, High-Frequency Transmitters to Advance Ionospheric/Thermospheric Research**

  - 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



http://www.nap.edu/booksearch.php?booksearch=1&term=sale&record_id=18620

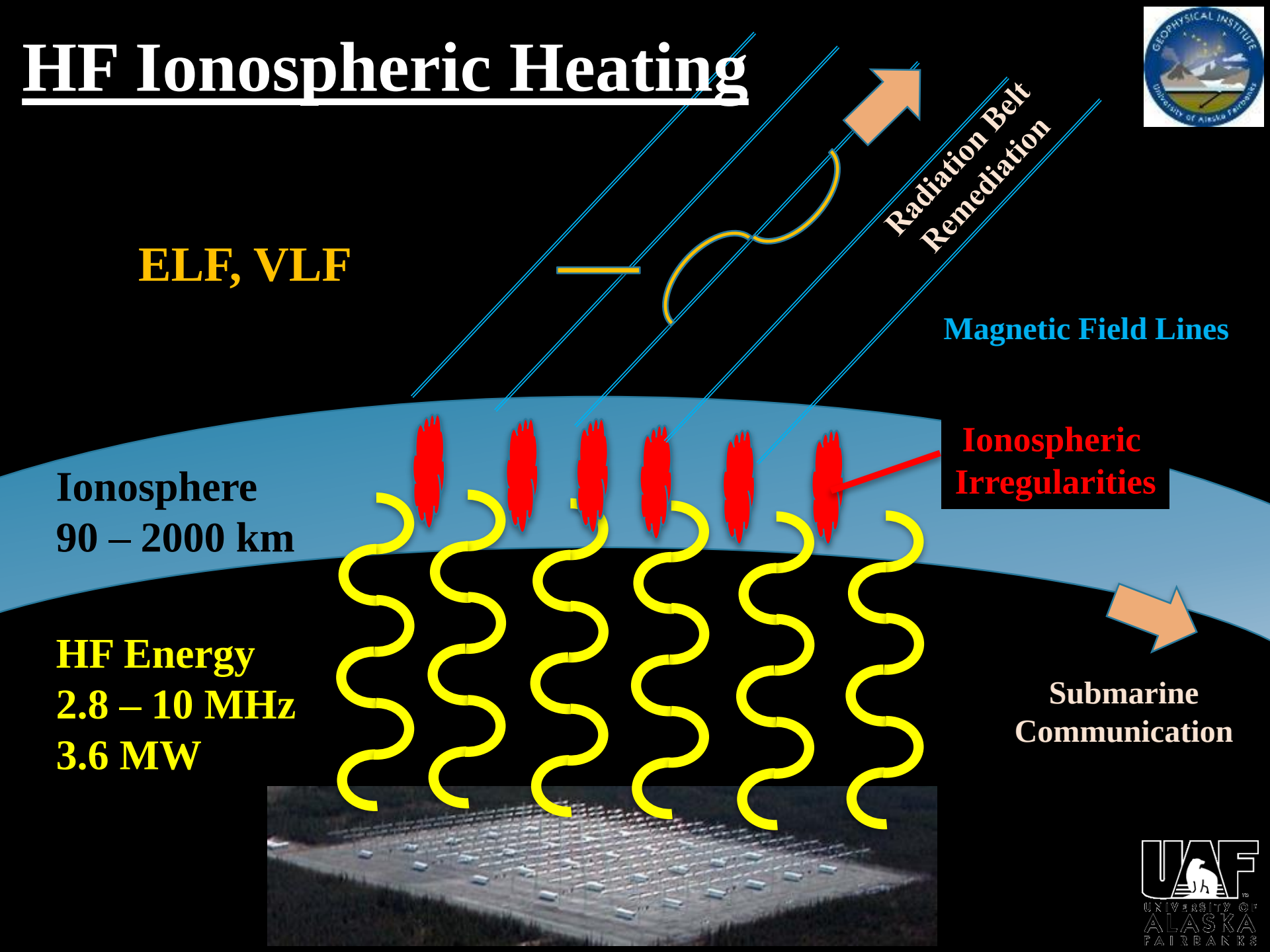
HAARP Compared to EISCAT, Sura & Arecibo

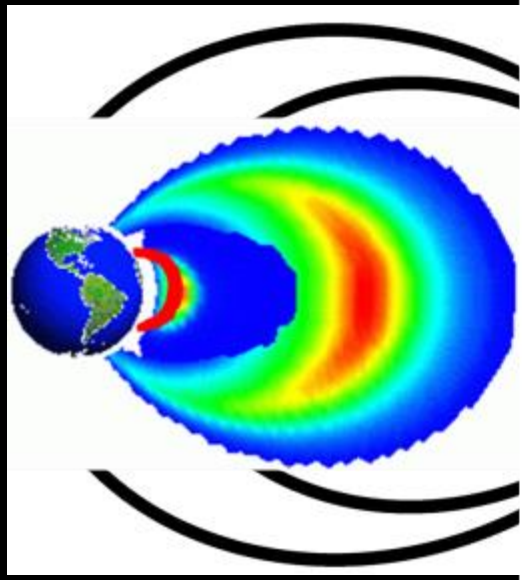


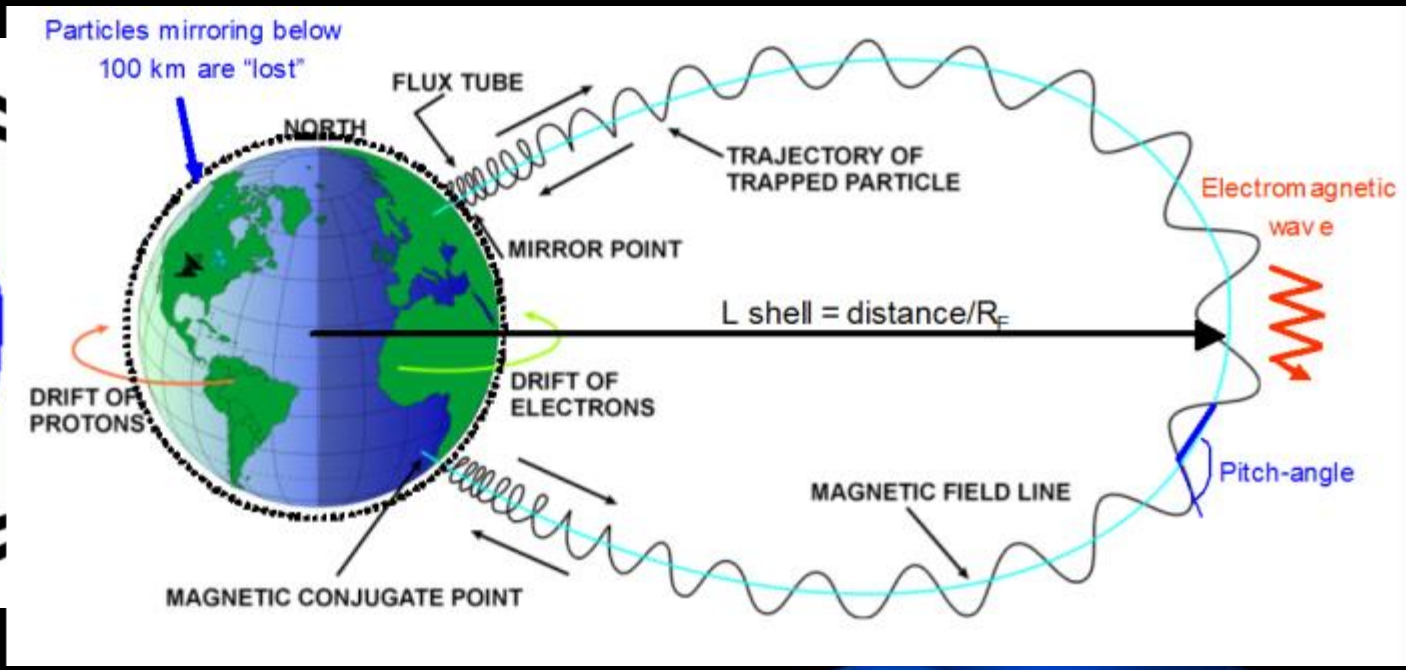

HAARP


PROJECT HAARP
HAARP
CIA
Mind Control
borneo

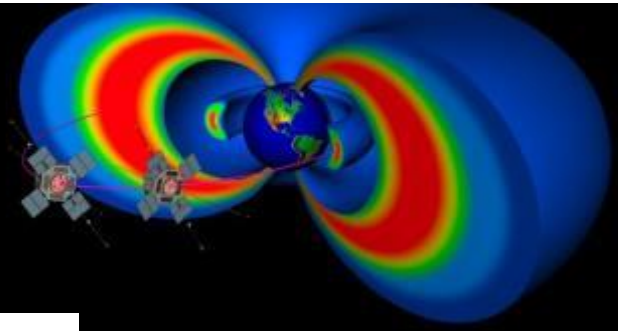
HF Ionospheric Heating

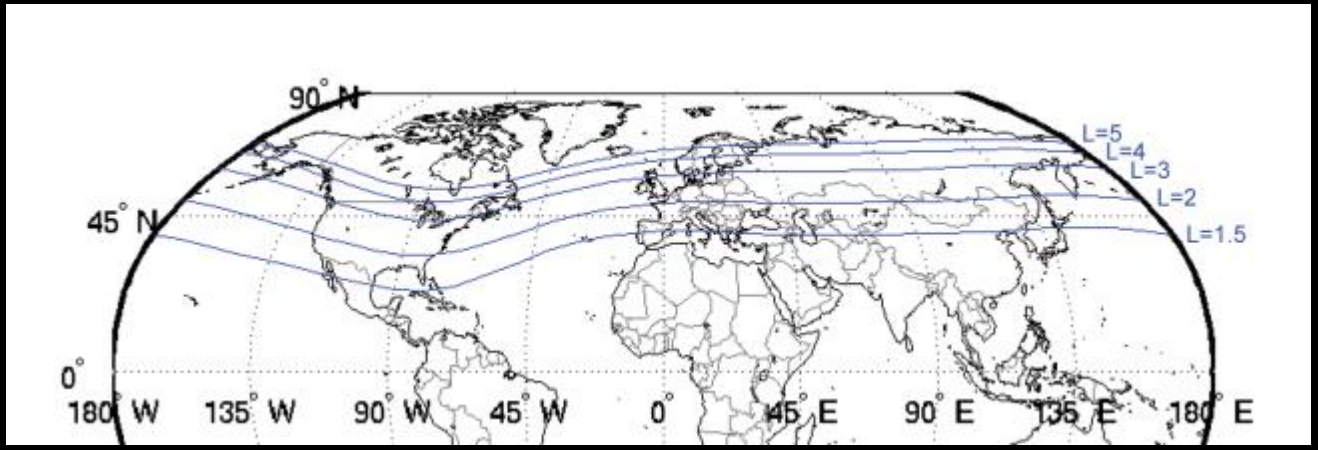




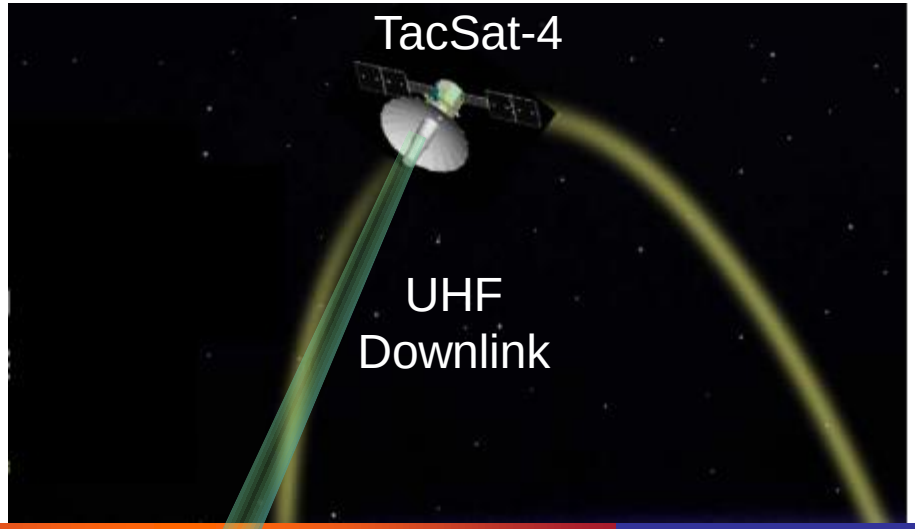


Van Allen Radiation Belts
L-Shells
NASA Van Allen Probes





COMMX Working with HAARP

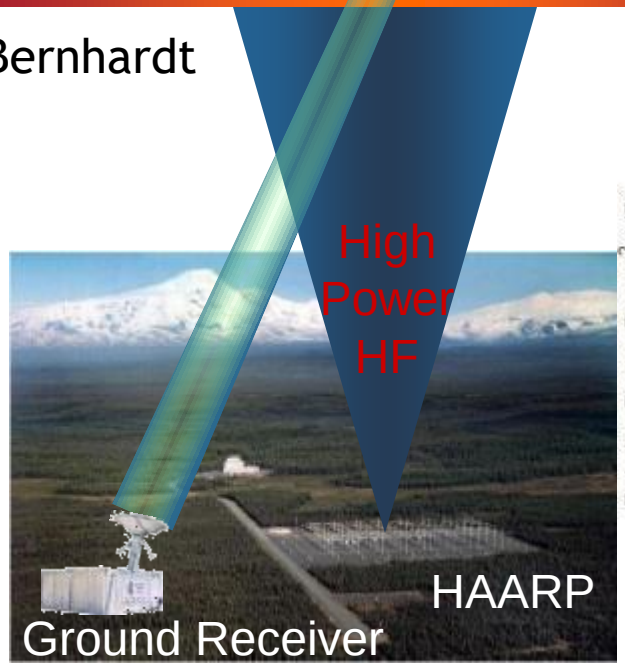


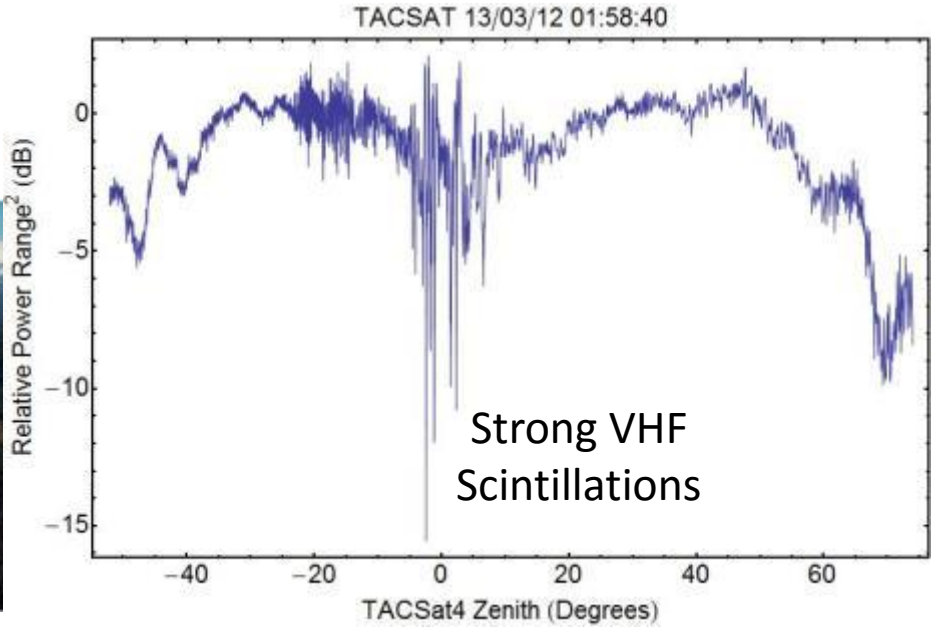
TACSat4 Actively Pointed to Ground Receiver

Modified Region

F-Layer Ionosphere

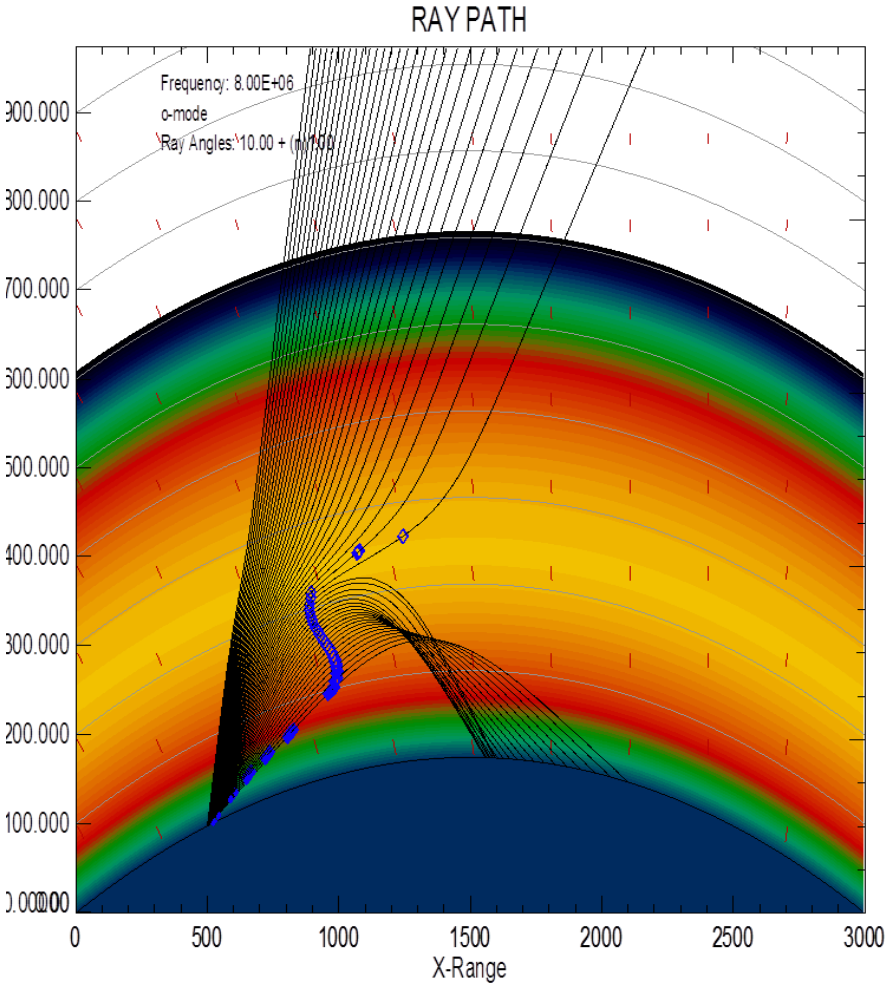
Courtesy Paul Bernhardt
NRL



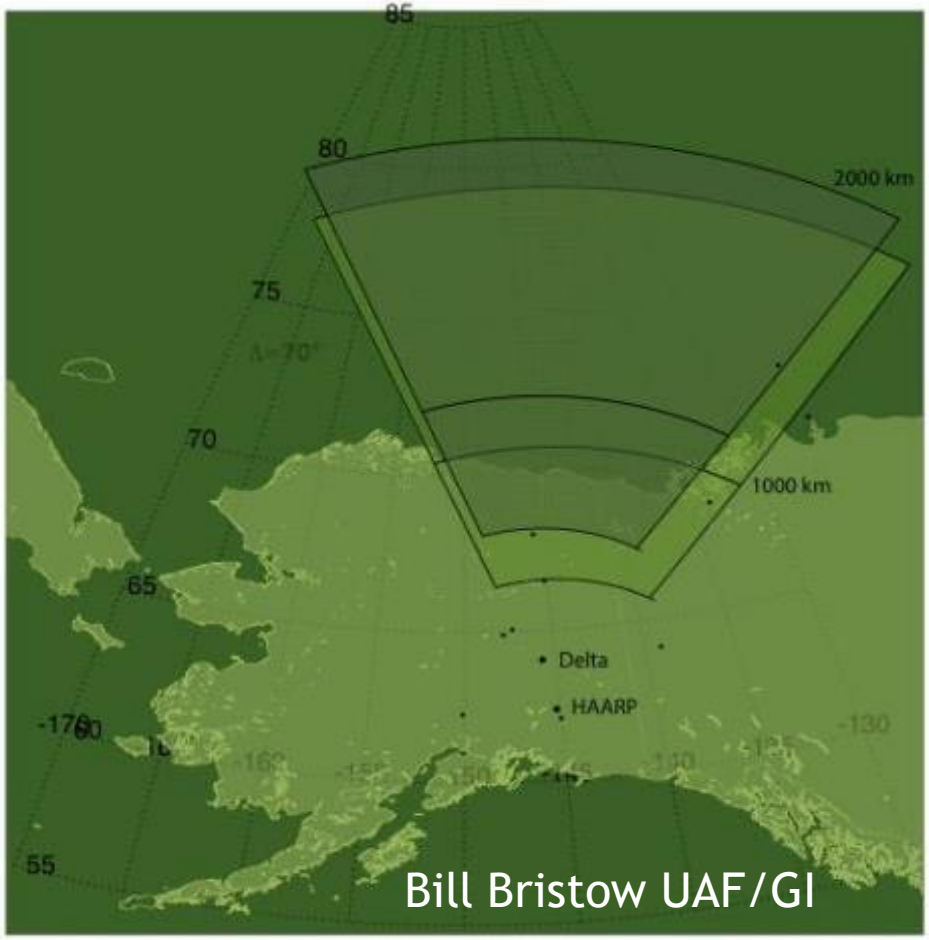


Over the Horizon Radar Experiments

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

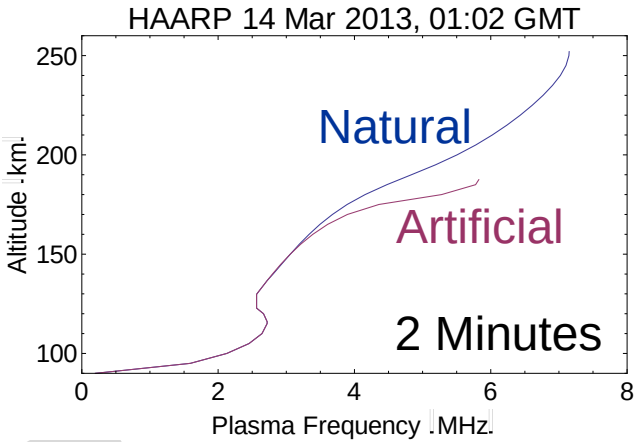


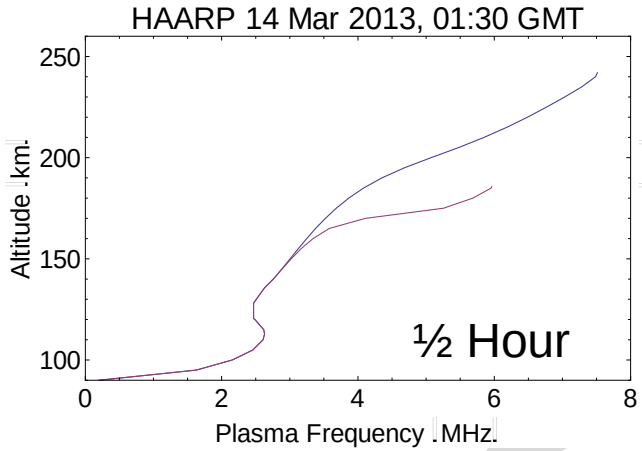
Offset of transmitter and receiver location; 2000 km range translates to about 80° latitude

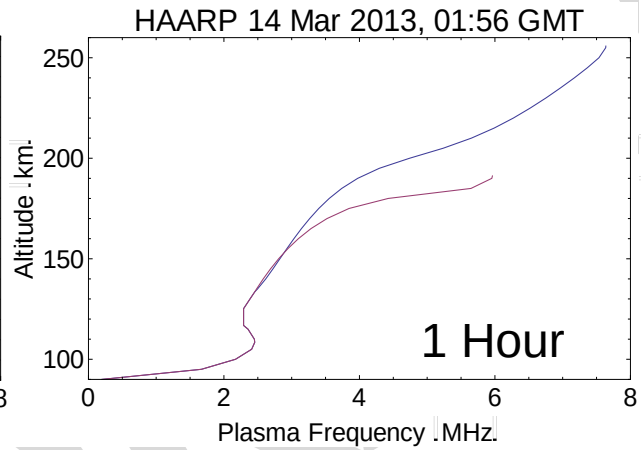


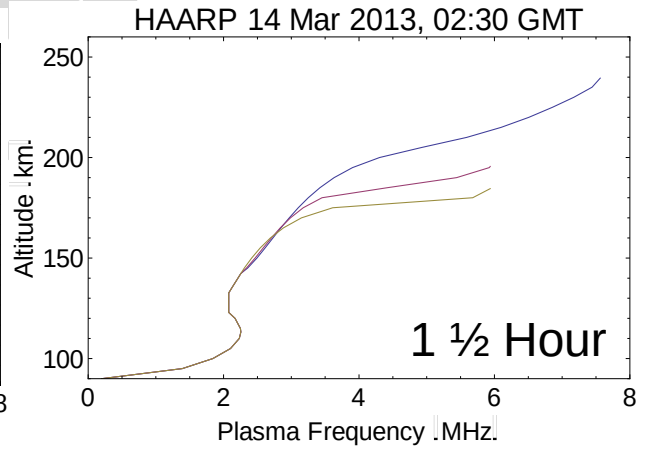
14 March 2013 01:30 to 04:00 GMT
Extended Artificial Ionization
with 5.8 MHz Twisted Beam

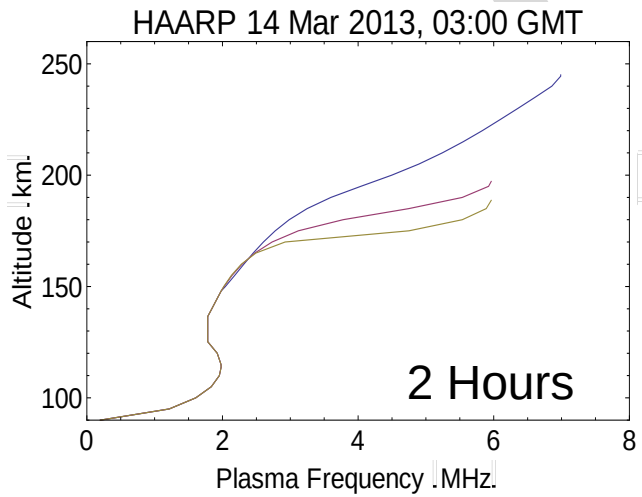
Courtesy Paul Bernhardt
NRL

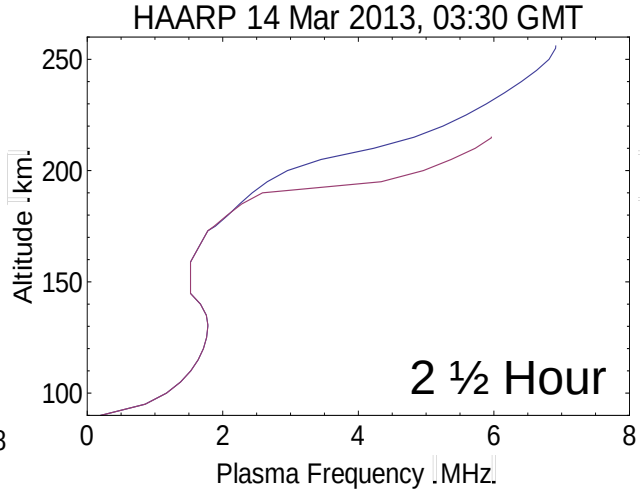


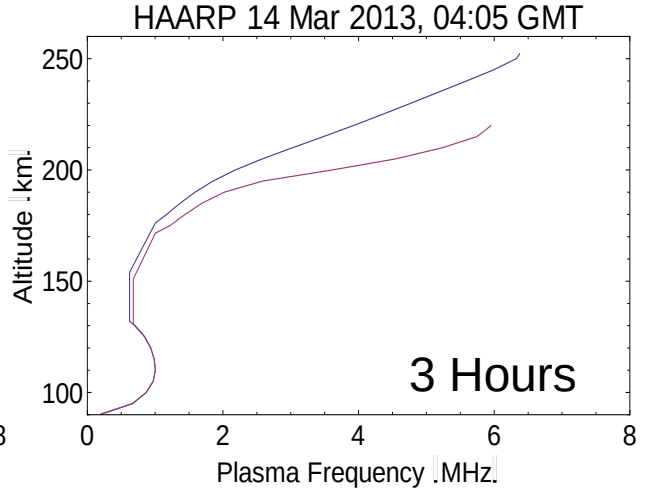




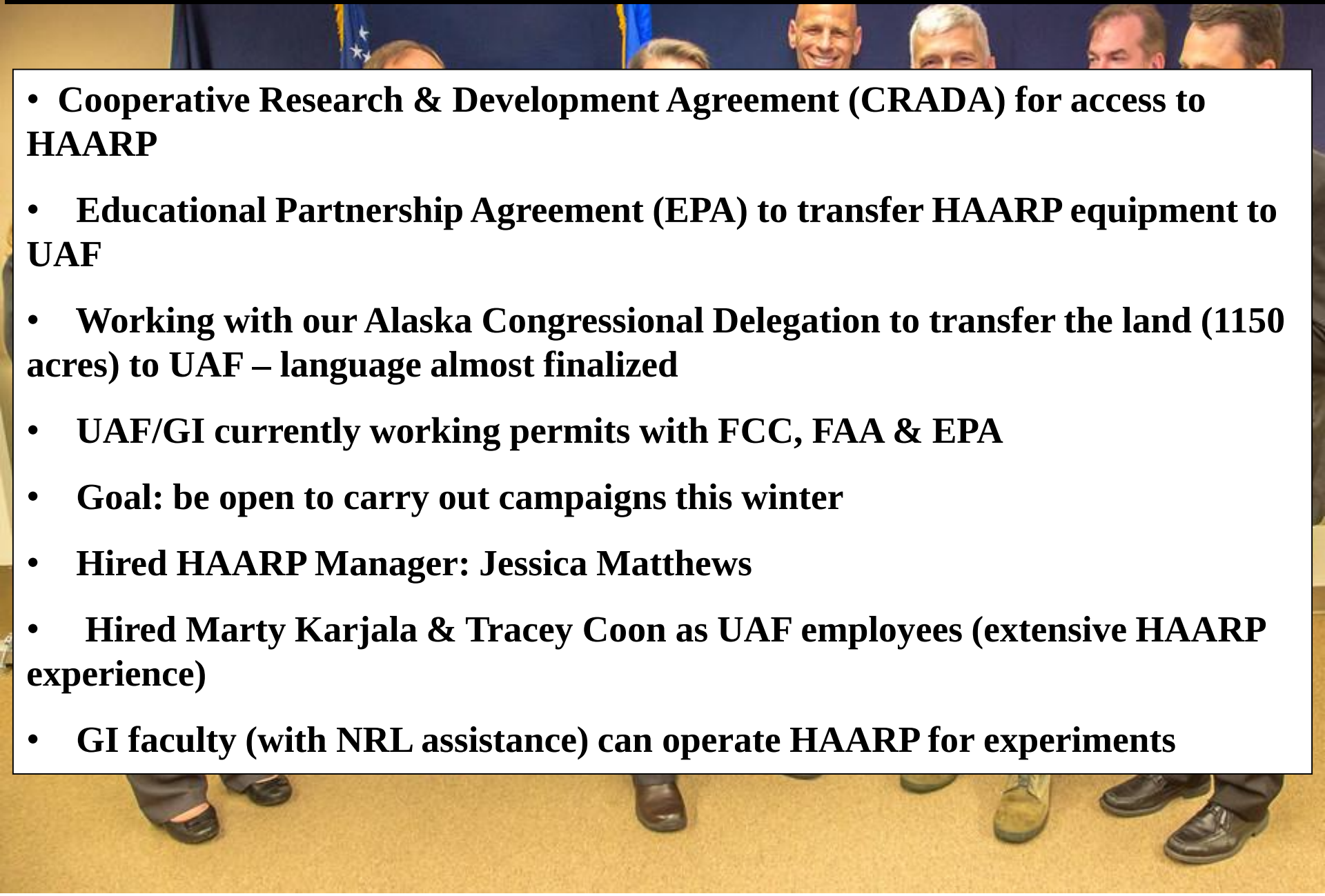






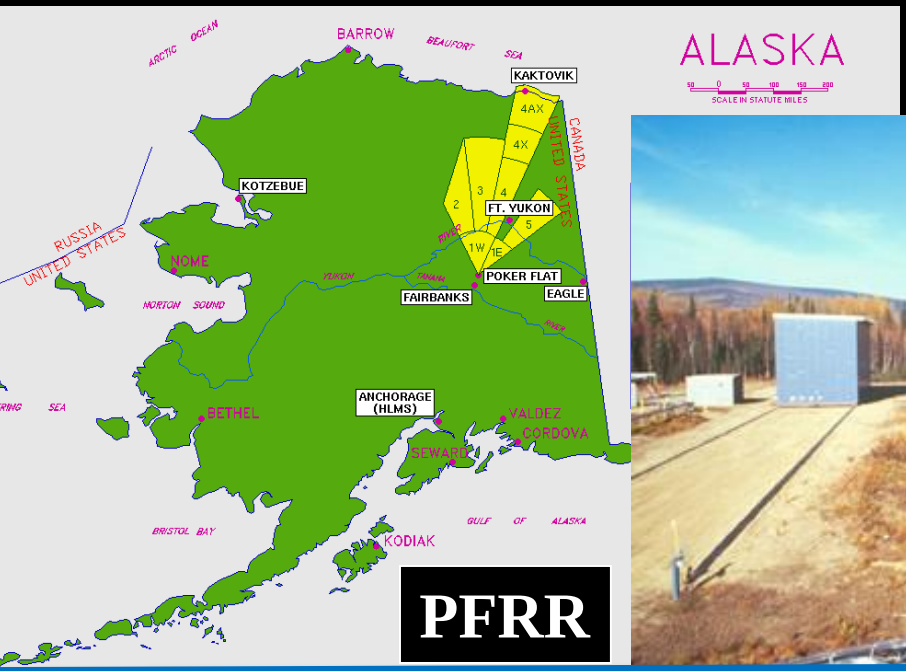


AFRL Maj Gen Masiello presented keys of HAARP to UAF Chancellor Rogers Aug 11, 2015



- **Cooperative Research & Development Agreement (CRADA) for access to HAARP**
- **Educational Partnership Agreement (EPA) to transfer HAARP equipment to UAF**
- **Working with our Alaska Congressional Delegation to transfer the land (1150 acres) to UAF – language almost finalized**
- **UAF/GI currently working permits with FCC, FAA & EPA**
- **Goal: be open to carry out campaigns this winter**
- **Hired HAARP Manager: Jessica Matthews**
- **Hired Marty Karjala & Tracey Coon as UAF employees (extensive HAARP experience)**
- **GI faculty (with NRL assistance) can operate HAARP for experiments**

Poker Flat Research Range + HAARP = Single Organization



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

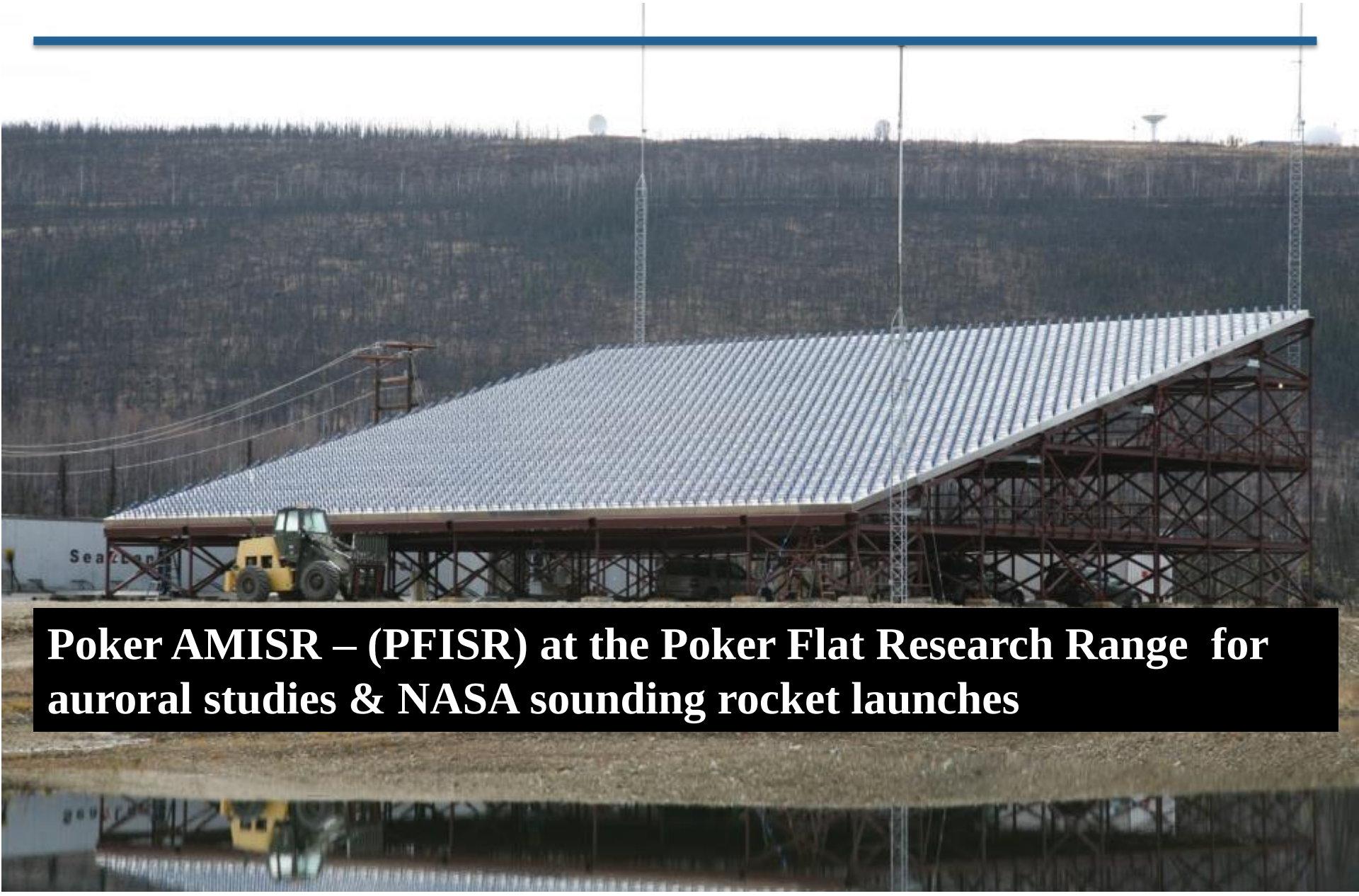
IN THE WORKS

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

AVAILABLE INFRASTRUCTURE

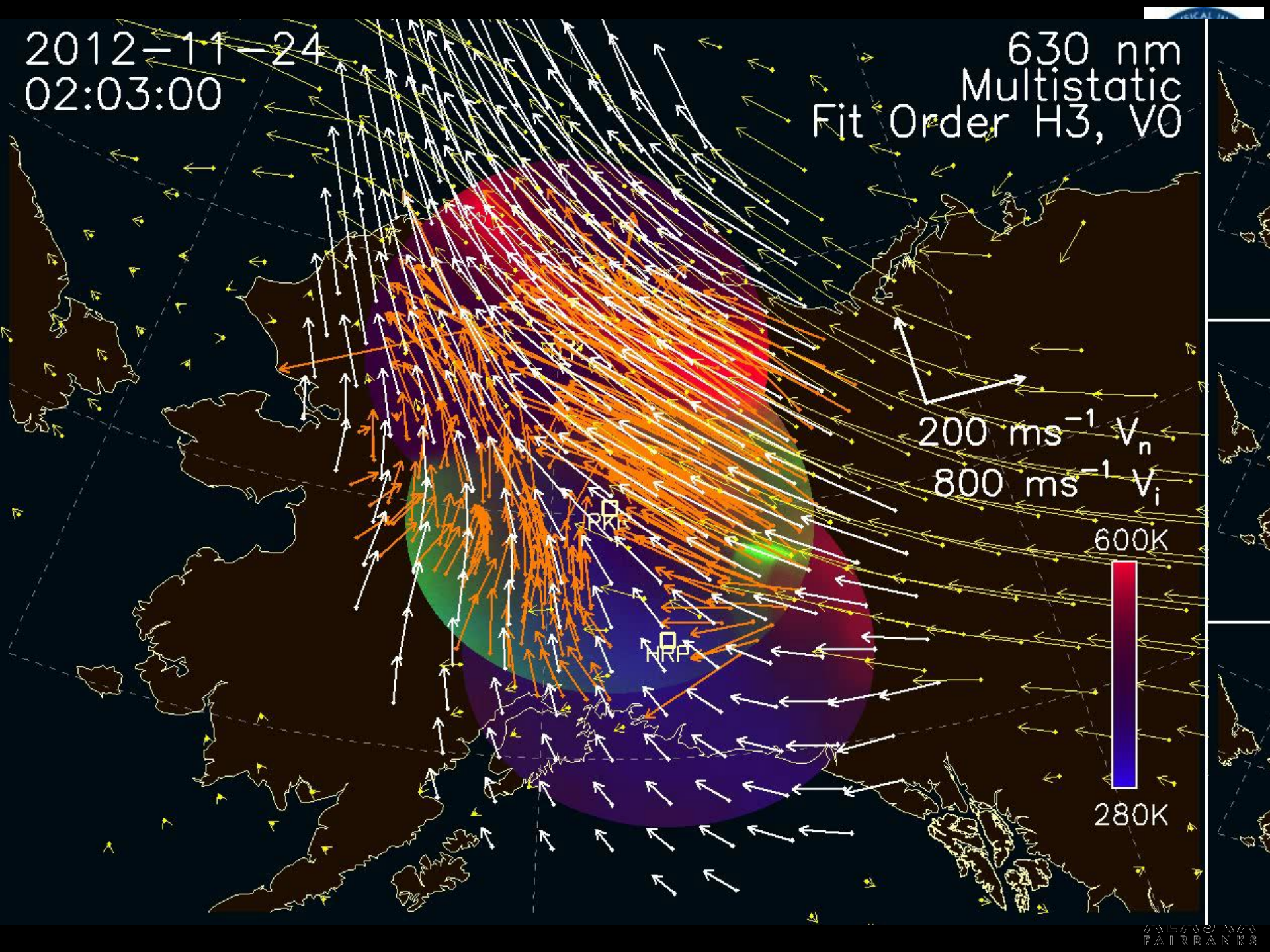
- Three Optical Shelters w/ two 5' domes, three 18" domes
- Seven remote shelters
- Heated project work spaces
- Fiber & power to all site locations

NSF Advanced Modular Incoherent Scatter RADAR (AMSIR)



Poker AMISR – (PFISR) at the Poker Flat Research Range for auroral studies & NASA sounding rocket launches


Thank
You

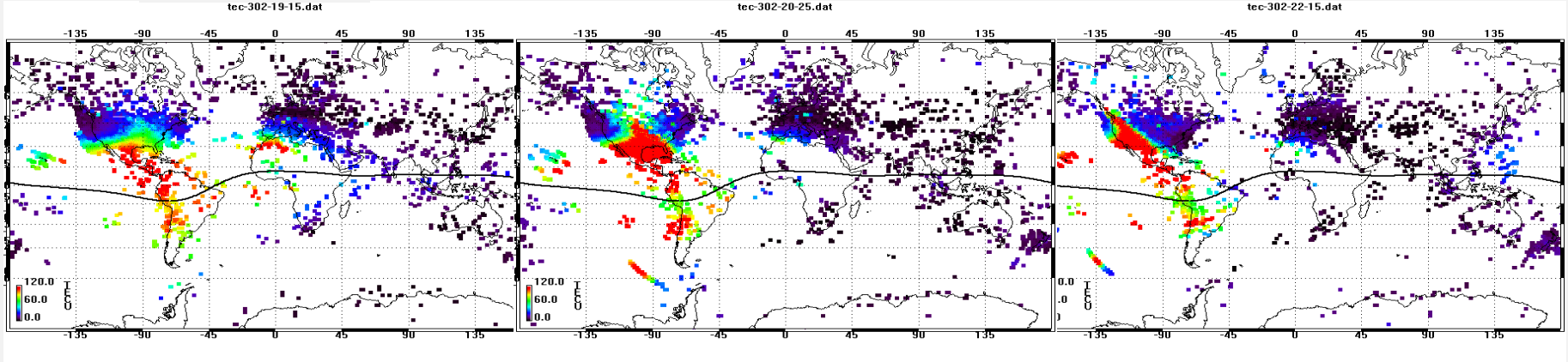

2012-11-24
02:03:00
630 nm
Multistatic
Fit Order H3, V0
200 ms^{-1} V_n
800 ms^{-1} V_i
600K
280K
RKR
KRP

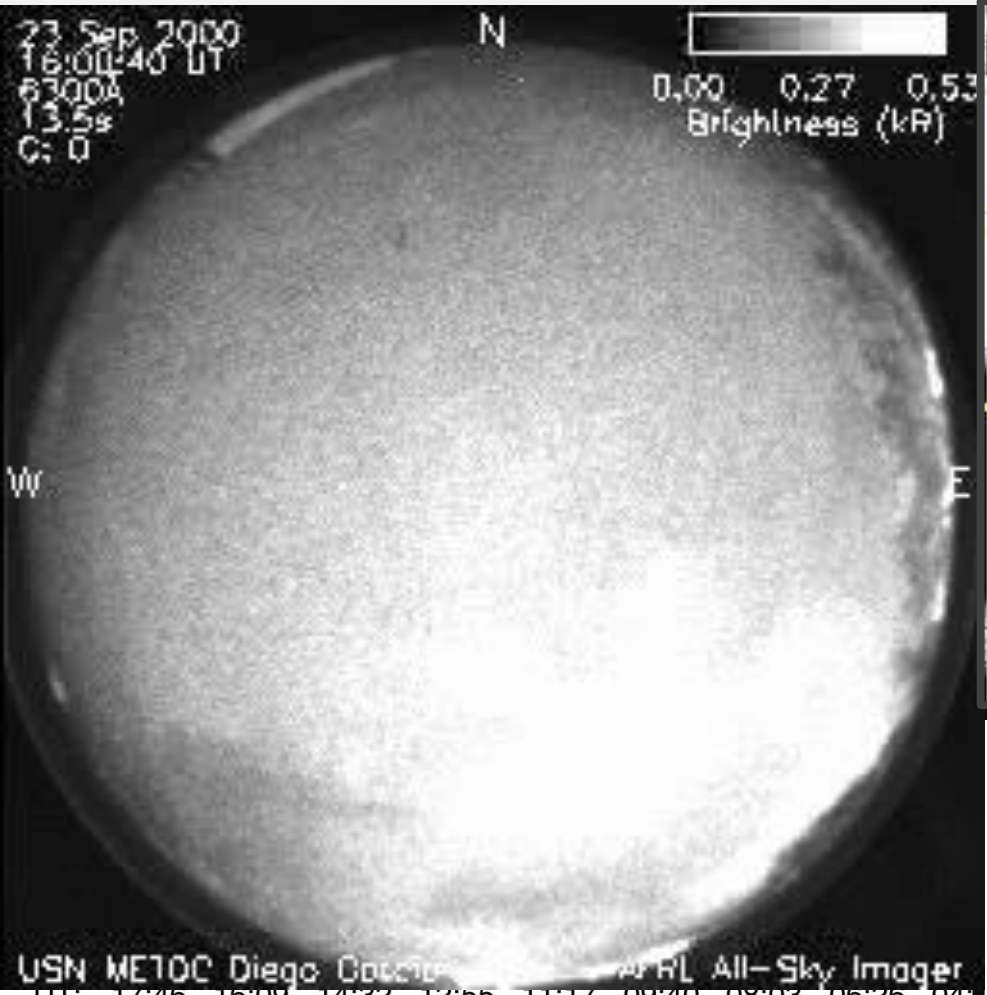
Storm-Enhanced Density (SED)
Oct 29, 2003 - "Halloween Storm"

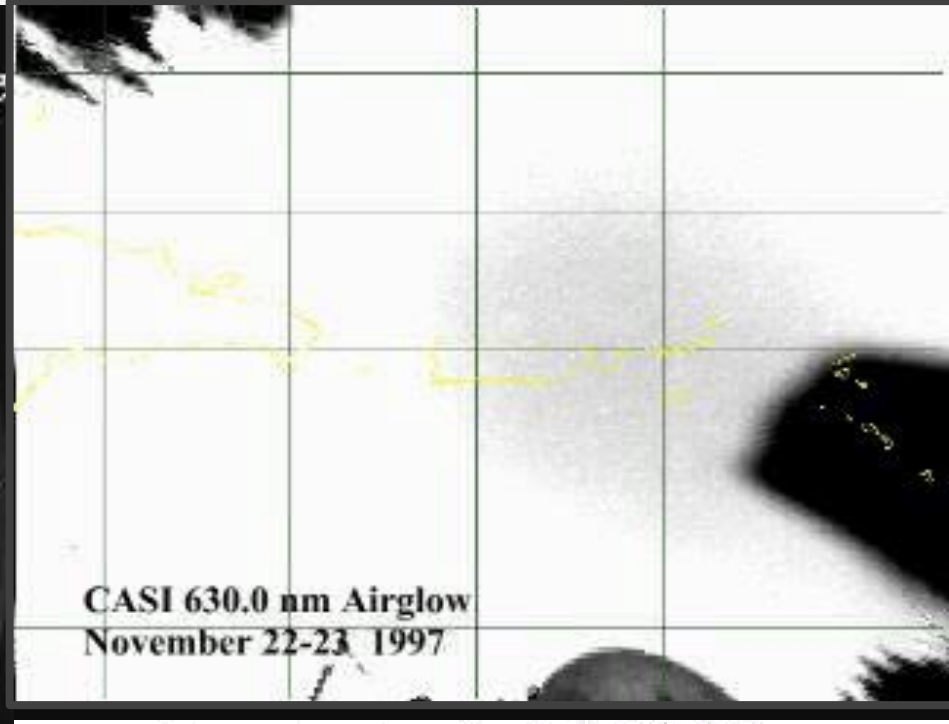
- **SED seen in total electron content (TEC) data collected by GPS**

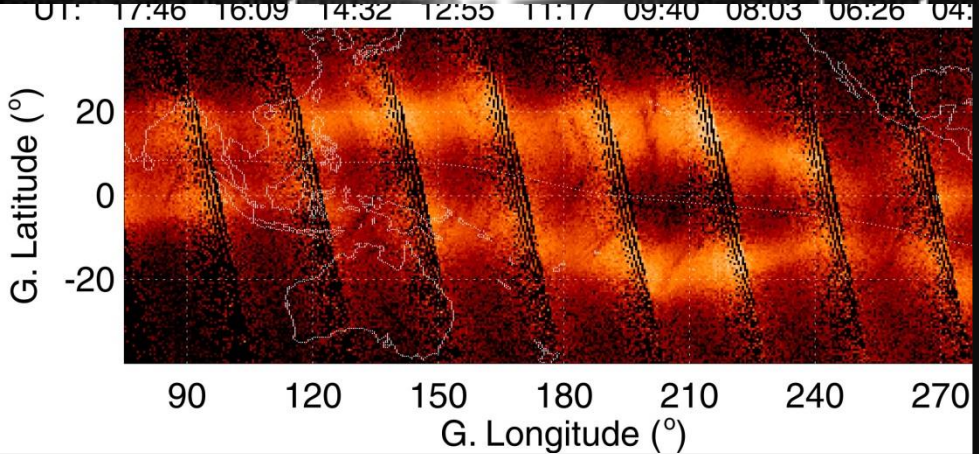
- **This event impacted the WAAS system in the US for many hours**

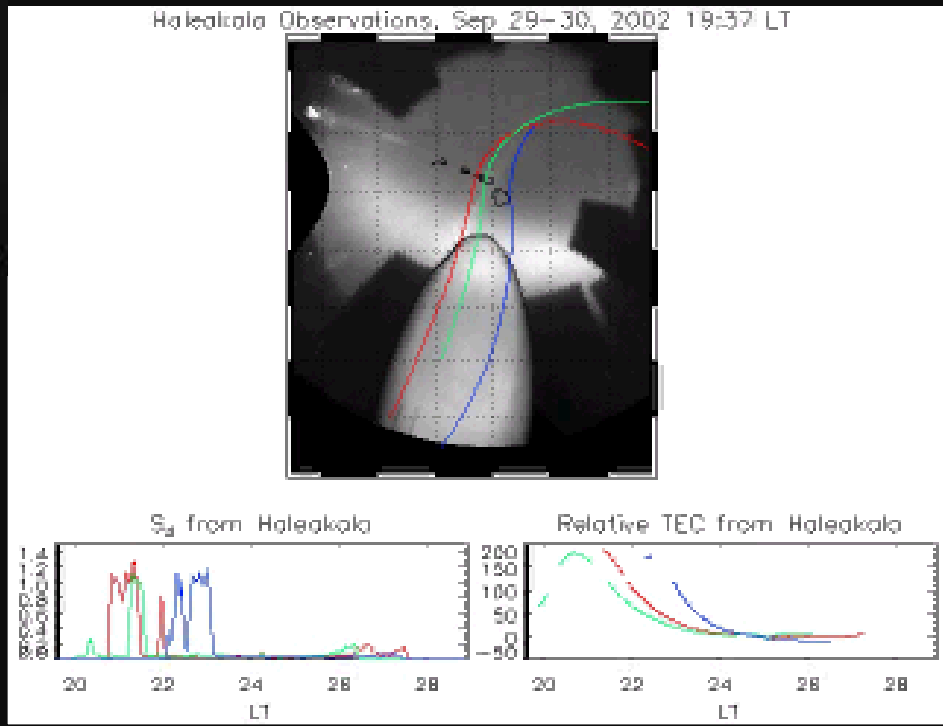
1915 UT **2025 UT** **2215 UT**

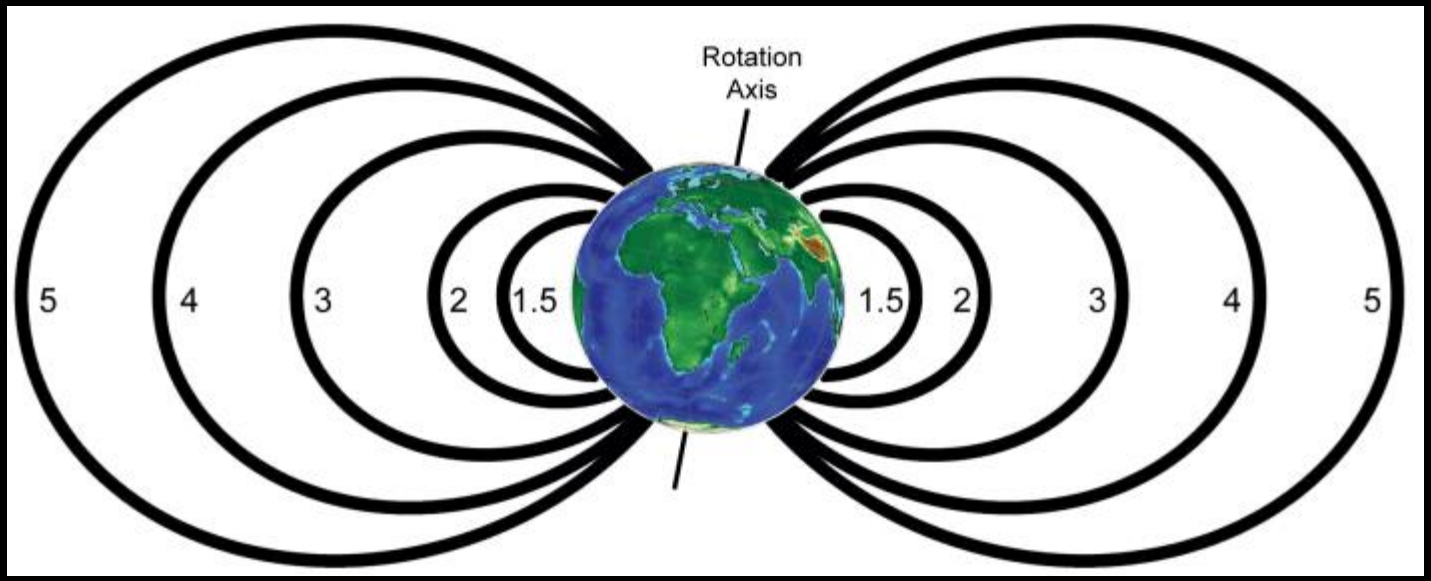



23 Sep 2000
16:00:46 UT
63004
13.5s
C: 0
N
W
E
0.00 0.27 0.53
Brightness (kR)
USN METOC Diego Garcia
RL All-Sky Imager

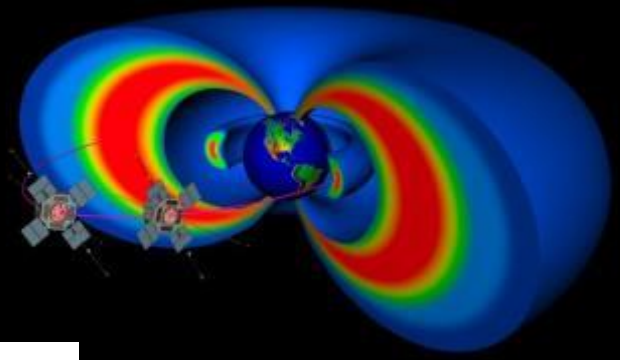

CASI 630.0 nm Airglow
November 22-23 1997

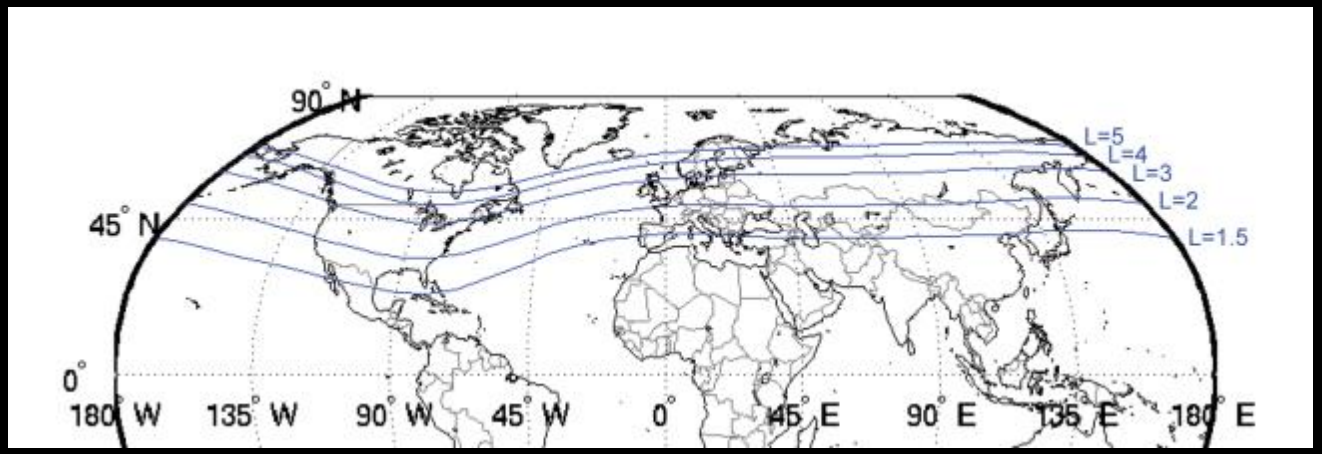

UT: 17:46 16:09 14:32 12:55 11:17 09:40 08:03 06:26
G. Latitude (°)
20
0
-20
90 120 150 180 210 240 270
G. Longitude (°)


Haleakala Observations, Sep 29–30, 2002 19:37 LT
S4 from Haleakala
Relative TEC from Haleakala
20 22 24 26 28
LT
20 22 24 26 28
LT



Van Allen Radiation Belts
L-Shells
NASA Van Allen Probes





Scintillation: Rayleigh-Taylor Instability in the Ionosphere

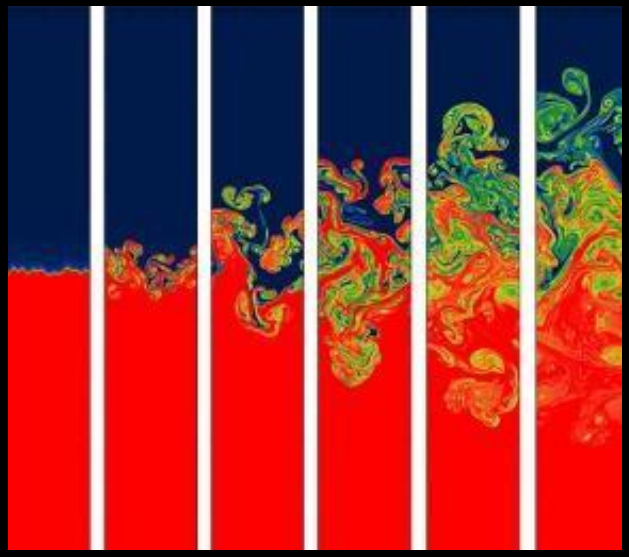
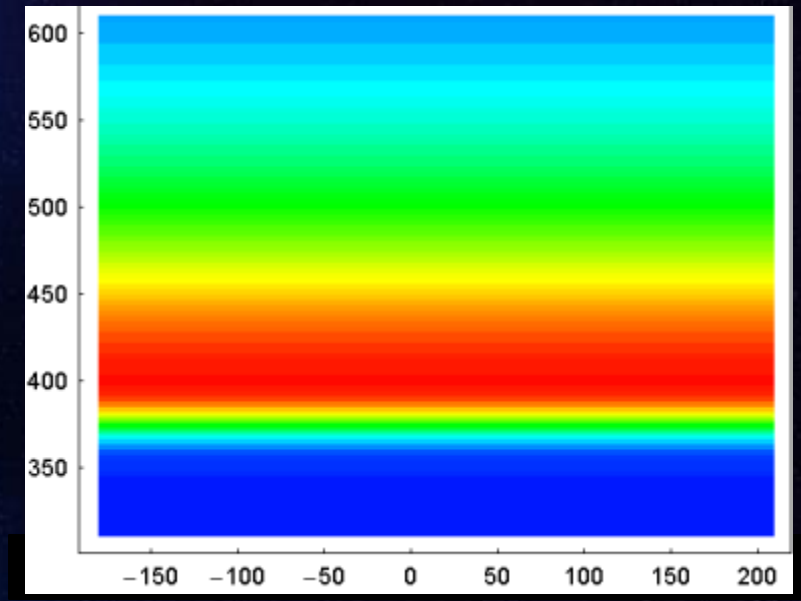


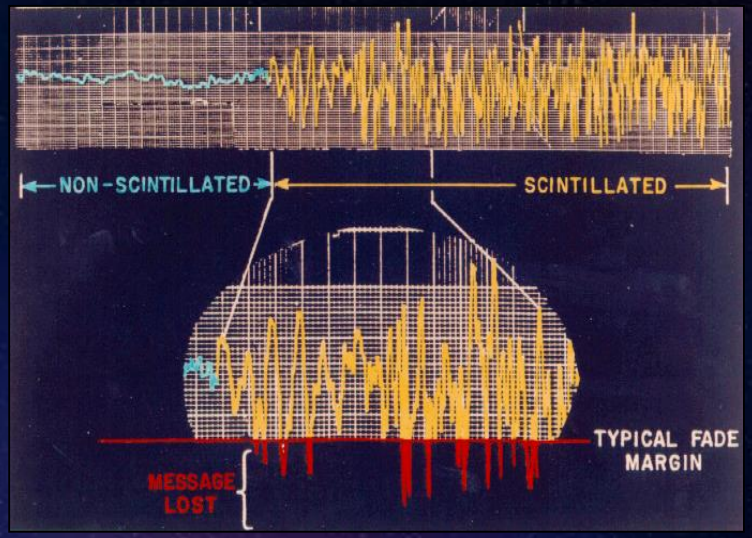
IMAGE ONR-506

Ionospheric Bubbles & Scintillation



Clear

Scintillated/Lost Data



UHF Comm

GPS Nav