Space Weather and HAARP

CEDAR Student Workshop 2016

Bill Bristow
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Can HAARP Control Space Weather?

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The Military's Pandora's Box
by Dr. Nick Begich and Jeane Manning
HAARP: Weather Control

Is the HAARP Project a Weather Control Weapon?

"It isn't just conspiracy theorists who are concerned about HAARP. The European Union called the project a global concern and passed a resolution calling for more information on its health and environmental risks. Despite those concerns, officials at HAARP insist the project is nothing more sinister than a radio science research facility."
-- From documentary on HAARP project's weather control by Canada's CBC

HAARP: What is it?

HAARP (High Frequency Active Auroral Research Program) is a little-known, yet critically important U.S. military defense project which has generated quite a bit of controversy over its alleged weather control capabilities and much more.

Though denied by HAARP project officials, some respected researchers allege that secret electromagnetic warfare capabilities of the project are designed to forward the US military's stated goal of achieving full-spectrum dominance by the year 2020.

Others go so far as to claim that HAARP can and has been used for weather control, to cause earthquakes and tsunamis, to disrupt global communications systems, and more. They point to major aspects of the program which are kept secret for alleged reasons of "national security." The U.S. patent of a key developer of HAARP and other documentary evidence support these claims. And there is no doubt that electromagnetic weapons capable of being used in warfare do exist. The project's $300 million price tag also suggests more is going on than meets the eye.
High Frequency Active Auroral Research Program (HAARP)

Its Purpose?

SPACE WEATHER CONTROL!!

- 62.39 deg (North) lat; 145.15 deg (West) Gakona, AK
- Ionospheric Research Instrument (IRI) - phased array HF transmitter; 2.8 to 10 MHz; ~1000 acres; 5 x 3600 hp diesel engines; 3.6 MW; $290M
- Air Force Research Lab (RV) Kirtland AFB, NM
What is *Space Weather*?

- **Terrestrial Weather - Meteorology**
  The short-term state of the atmosphere, as distinguished from the long-term conditions of climate; this includes temperature, humidity, precipitation, wind, visibility, and other factors, chiefly considered in terms of their effects on life and human activity.

- Space weather is a relatively new field of science dedicated to the understanding of interactions between the Sun and Earth, and to the forecasting of solar flares, magnetic storms and other space-related phenomena.
Data assimilation of low-altitude magnetic perturbations into a global magnetosphere model

A snapshot of the baseline LFM-RCM simulation ($\Sigma = 10$ $S$) during the quasi-steady stage of the simulation (time indicated at the top). The Northern Hemisphere FACs including both R1 and R2 currents are shown. Upward current is positive. Solar magnetic coordinates are used such that the pole coincides with the Earth's magnetic axis, and noon is at the top. The distance between the constant latitude circles is $10^\circ$. The corresponding ionospheric potential is indicated by black contours (solid = positive and dashed = negative). The contours are spaced by roughly $10$ $kV$. Minimum/maximum
When space weather attacks!

By Brad Plumer  July 13, 2013

On a cool September night in 1859, campers out in Colorado were roused from sleep by a “light so bright that one could easily read common print,” as one newspaper described it. Some of them, confused, got up and began making breakfast.

Farther east, thousands of New Yorkers ran out onto their sidewalks to watch the sky glow, ribboned in yellow, white and crimson. Few people had ever seen an aurora that far south — and this one lit up the whole city.

At the time, it was a dazzling display of nature. Yet if the same thing happened today, it would be an utter catastrophe.
Space Weather Effects

Sunspots threatening utilities with blackouts

By TED SHERMAN

New Jersey's electric utilities are facing the threat of a major blackout from an unusual source—the sun. Sunspots, or solar flares, are entering a period of peak activity that officials say has the potential to knock out a number of high-voltage power transmission lines throughout the state. It is not a threat being taken lightly. Virtually the entire Canadian province of Quebec experienced a power failure last year after a gigantic solar flare induced tremendous magnetic disturbances across North America. The same event caused more than $2 billion in damage to transformers at two nuclear plants operated by Public Service Electric & Gas Co. (PSE&G) and generated wild voltage swings on transmission lines maintained by Jersey Central Power & Light Co. (JCP&L) and Atlantic Electric Co.

While sunspot activity approaching an 11-year peak, utility engineers are bracing for the possibility of even more severe power line disturbances.

"In some ways, the power system is very fragile," said Joseph Weibel, manager of system reliability for PSE&G, noting that the addition in recent years of more and more high-voltage transmission lines, and the need to operate at full load to meet increasing customer demand for electricity, have made the nation's electric grid even more sensitive and vulnerable to the effects of solar storms than ever before.

Last month, sunspot activity forced PSE&G for the second time in four months to reduce power at the Salem nuclear station in Lower Alloways Creek Township to avoid damage to the power plant's main transformers. Atlantic Electric has been installing monitoring equipment on all large transformers to track the effects of solar storms, and JCP&L has been upgrading some of its transformers, including those at the Oyster Creek nuclear plant in Lacey Township, in an effort to deal with the problem.

Image contributed by L. J. Lanzerotti, Bell Laboratories, Lucent Technologies, Inc.
Severe internal damage caused by the storm of 13 March, 1989
Space Weather Effects

P-ANIK!

High-tech chaos as satellites spin out of control

The New York Times

2 Canadian Space Satellites Are Knocked Out by Storm

OTTAWA, Jan. 22 (Reuters) — An electromagnetic storm knocked out Canada's two communications satellites Thursday, and one of them may be lost for ever, the operating company, Telesat Canada, said Friday.

Telesat executives said an unusual localized storm caused short-circuits on its Anik A-1 and E-1 satellites, disrupting telephone, television and transmission services.

Developing Service Promises Accurate Space Weather Forecasts in the Future

Science & Medicine

Weathering the storm in space

Sun gets blame for zapped Aniks

Telesat still trying to fix $300-million satellite, but chance of revival dim

Image Credit: L. J. Lanzerotti, Bell Laboratories, Lecent Technologies, Inc.
Anik-E1 and E2 satellite failures of January 1994 revisited

H.-L. Lam, D. H. Boteler, B. Burlton, and J. Evans

Received 11 May 2012; revised 10 September 2012; accepted 11 September 2012; published 10 October 2012.

The consecutive failures of the geosynchronous Anik-E1 communication satellite on January 20, 1994, and Anik-E2 about nine hours later on January 21 (both incidents occurred on January 20 local time) received considerable publicity because the malfunctions of the satellites disrupted television and computer data transmissions across Canada, as well as telephone services to remote northern communities for hours. This often-cited event is revisited here with materials not covered before. Using publicly available information, Anik-E failure details, media coverage, recovery effort and cost incurred are first presented. This is then followed by scrutiny of space weather conditions pertinent to the occurrences of the Anik-E upsets. We trace the space weather episode’s inception on the Sun, propagation through interplanetary medium, and manifestation in magnetic field variations as well as in energetic electron flux increases, and its eventual impact on the Anik-Es. The genesis of the energetic electron enhancements that have been blamed for the satellite malfunctions is thus traceable via high-speed solar wind stream with Alfven wave fluctuations to a longitudinally wide coronal hole on the Sun. Furthermore, strong magnetic pulsations preceding electron flux peaks indicate Pc5 ULF (Ultra Low Frequency) waves as a probable acceleration mechanism for the energetic electron flux enhancement that resulted in the internal charging of the Anik-Es. The magnetic fluctuations may even be possible triggers for the subsequent discharge that caused the satellites to malfunction. This incident illustrates that satellite operators should be on alert for elevated high-energy electron environment that is above established thresholds, as specifications in satellite design may not render a satellite immune from internal charging.

Space Weather Effects

Energetic particles cause damage to solar panels and can cause deep dielectric charging.
Space Weather Effects

Atmospheric drag leads to uncertainty in orbit calculations.
NATIONAL SPACE WEATHER STRATEGY

PRODUCT OF THE
National Science and Technology Council

October 2015
October 29, 2015

Dear Colleagues,

Space weather is a naturally occurring phenomenon that has the potential to cause substantial detrimental effects on the Nation’s economic and social well-being. Preparing for and predicting space-weather events and their potential effects on Earth is a significant challenge. Recent efforts led by the United States and its international partners have resulted in significant progress toward improving the understanding, monitoring, prediction, and mitigation of this hazard, but much more needs to be done.

Over the past 5 years, OSTP has coordinated interagency efforts to improve the Nation’s ability to prepare, avoid, mitigate, respond to, and recover from the potentially devastating impacts of space-weather events. These efforts included the establishment of the Interagency Space Weather Operations, Research, and Mitigation (SWORM) Task Force in November 2014. The goal of the SWORM Task Force was to unite the national- and homeland-security enterprise with the science and technology enterprise to formulate a cohesive vision to enhance national preparedness for space weather.

This National Space Weather Strategy and accompanying National Space Weather Action Plan are the result of the SWORM Task Force’s efforts. These documents transcend agency-mission and sector boundaries to describe how the Federal Government will coordinate its efforts on space weather and how the Federal Government plans to engage academia, the private and public sectors, and other governments on space weather. The Strategy and associated Action Plan aim to enhance the preparedness of the Nation by interweaving and building upon existing policy efforts to identify overarching goals that underpin and drive the activities necessary to improve the security and resilience of critical technologies and infrastructures.

These documents represent only a next step to improving national preparedness for space weather. The Strategy sets overall goals for Federal action, while the Action Plan establishes Federal actions and timelines for implementation. Many of these activities will require long time horizons, which will necessitate sustained engagement among government agencies and the private sector. This challenge requires the Nation to work together to continually improve understanding, prediction, and preparedness to enhance the Nation’s resilience against severe space-weather events.

Sincerely,

John P. Holdren
Assistant to the President for Science and Technology
Director, Office of Science and Technology Policy
S. 2817

To improve understanding and forecasting of space weather events, and for other purposes.

IN THE SENATE OF THE UNITED STATES
APRIL 19, 2016

Mr. PETERS introduced the following bill; which was read twice and referred to the Committee on Commerce, Science, and Transportation

A BILL

To improve understanding and forecasting of space weather events, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be cited as the “Space Weather Research and Forecasting Act”.

SEC. 2. SPACE WEATHER.

(a) In General.—Subtitle VI of title 51, United States Code, is amended by adding after chapter 605 the following:

“CHAPTER 607—SPACE WEATHER

“60701. Space weather.
“60702. Observations and forecasting.
“60703. Research and technology.
“60704. Space weather data.
“§ 60701. Space weather

“(a) FINDINGS.—Congress makes the following findings:

“(1) Space weather events pose a significant threat to humans working in the space environment and to modern technological systems.
This bill directs the Office of Science and Technology Policy to:

- improve the nation's ability to prepare, avoid, mitigate, respond to, and recover from potentially devastating impacts of space weather events;
- coordinate the activities of the National Space Weather Program Council members; and
- develop an integrated strategy for solar and solar wind observations beyond the lifetime of current assets.

The National Science and Technology Council shall establish an interagency working group on space weather.

The National Oceanic and Atmospheric Administration (NOAA) shall:

- secure reliable secondary capability for near real-time coronal mass ejection imagery; and
- develop requirements and a plan for follow-on space-based observations for operational purposes.

The National Science Foundation (NSF) and the Air Force shall each:

- maintain ground-based observations of the Sun; and
- provide space weather data by means of ground-based facilities, including solar observatories.

NOAA and the Air Force shall conduct a survey to prioritize the needs of space weather forecast users.

The NSF, NOAA, and the National Aeronautics and Space Administration (NASA) shall pursue multidisciplinary research in subjects regarding solar physics, space physics, and space weather.

NASA shall seek to implement missions meeting science objectives identified in National Academy of Sciences (NAS) Solar and Space Physics Decadal surveys.

NASA, the NSF, NOAA, and the Air Force shall:

- develop a mechanism to transition NASA and NSF research findings, models, and capabilities to NOAA and the Department of Defense space weather operational forecasting centers; and
- enhance coordination between research modeling centers and forecasting centers.

NASA and the NSF shall support the development of technologies and instrumentation to improve space weather forecasting lead-time and accuracy.

NASA and the NSF shall:

- make space weather related data obtained for scientific research available to space weather forecasters and operations centers, and
- support model development and applications to space weather forecasting.

The Space Weather Interagency Group shall develop benchmarks for measuring solar disturbances.

NOAA shall inform the Department of Homeland Security about space weather hazards to protect national critical infrastructure from space weather events.

The National Security Council shall develop mechanisms to protect national security assets from space weather threats.

Space Weather Conditions on NOAA Scales

24-Hour Observed Maximums

R: none  S: none  G: none

Latest Observed

R: none  S: none  G: none

Predicted 2015-06-14 UTG

R1-R2: 1%  S1 or greater: 1%

Solar Wind Speed: 536 km/sec
Solar Wind Magnetic Fields: Bt 13 nT, Bz -2 nT

SWPC now on Twitter as of 2 May
published: Monday, May 23, 2016 17:10 UTC
The Space Weather Prediction Center began use of Twitter on May 2nd as another social media outreach tool.

National Space Weather Strategy and Action Plan Released
published: Thursday, October 29, 2015 21:58 UTC
Today, OSTP Director John Holdren announced the release of the

New Website Q&A
published: Wednesday, September 23, 2015 14:01 UTC
If you have questions about the new website, we likely answer them here.

What’s that bright spot in the Coronal Mass Ejections Image?
published: Monday, September 21, 2015 20:08 UTC
What are those bright spots that appear in the CME Image, people often ask.

http://www.swpc.noaa.gov
What do we need to know?

Space weather originates on the sun. So, we need to know:

• Has an event occurred on the sun?

• Was the event in a position to generate a *geoeffective* solar wind disturbance?

• What effects are expected?

• When will effects be felt on earth?
Watching the Sun

Ionospheric Effect of Flare
Solar Protons

PROTON FLUX

Relative Intensity (log scale)

DAYS

Image Credit: M. A. Shea, Geophysics Directorate, Philips Lab
Predicting Arrival
(the 93 million mile gap)
Solar Wind Monitoring
Ring Current Particles

Graph showing the Dst (nT) over time from 21 April 2001 00:00 UT, with phases marked as T1, T2, T3, T4, and T5.

Images depict changes in magnetic fields (B_sc-B_dip; Y/R_E) and solar wind pressure (P_1; nPa) at T = 24 hr, T = 32 hr, T = 39 hr, T = 42 hr, and T = 48 hr.
Fig. 1. Radial profile of electron flux measured by CRRES at energies from 153 keV to 1.58 MeV showing the two-zone structure of the radiation belts, and variability during geomagnetic storms (reproduced from Horne et al., 2003, Copyright 2003 American Geophys...
Why DARPA was interested in HAARP – Controlling Space Weather

- High-energy electrons and protons in the Van Allen radiation belts are a major hazard to spacecraft

- VLF electromagnetic waves can act to remove particles from Van Allen belts

- Ionospheric heating can inject VLF waves into space

- HAARP location suitable for experiments of this type
Experiment Setup

- Alaska: Chistochina receiver site (36 km from HAARP facility)
- Conjugate Point: ship-borne and buoy measurements
First Observation (2004)

- Original HAARP Facility (960 kW)
- Echoes observed for ~30 minutes
Different Methods of Generation

- AM
- Line Sweep
- Circle Sweep
- ‘Beam Paint’

- Stimulated emissions indicate removal of high-energy particles

Slide shamelessly stolen from Mark Golkowski
Space Weather Effects

Atmospheric drag leads to uncertainty in orbit calculations.

We should learn how to predict drag
Use HAARP to Learn about Space Weather

Formation and decay of FAI give estimates of diffusion

Ionospheric Composition from narrow band SEE

Neutral density and drifts and electron densities from API

Dust charging in polar mesospheric clouds
High Frequency Active Auroral Research Program (HAARP)

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