



American Commercial Space Weather Association

Space Weather Enterprise -- Commercial Sector Role

2019 Space Weather Enterprise Forum
Department of Interior, Washington DC
June 26, 2019

Conrad C Lautenbacher, Jr
CEO, GeoOptics, Inc



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Agenda

- Space Weather Enterprise
- Commercial Space Weather
 - ACSWA
- Space Weather Bill
- Organizational Efficiency
- Commercial Contributions
 - Specific capabilities
 - Impact



The Space Weather Enterprise

Products and Services

Maximizing Value



Analogy:
**“Weather
Enterprise”**

Government

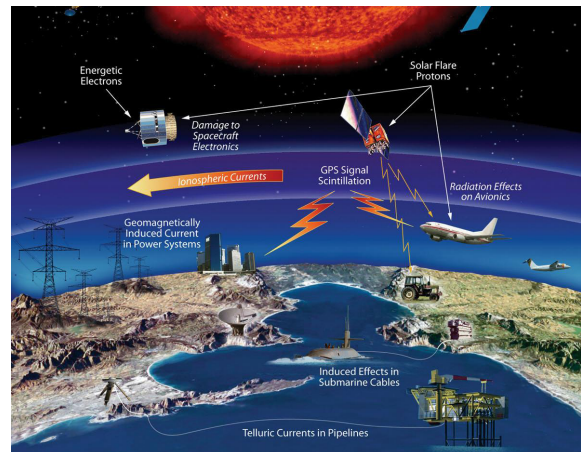
- **Public Safety**
- Economic Health
- National Defense
- **Regulation**

Academia

- Science
- **Research**

Commercial

- Services
- **Efficiency**
- Competition
- **Robust Economy**
- Communication
- **Research**



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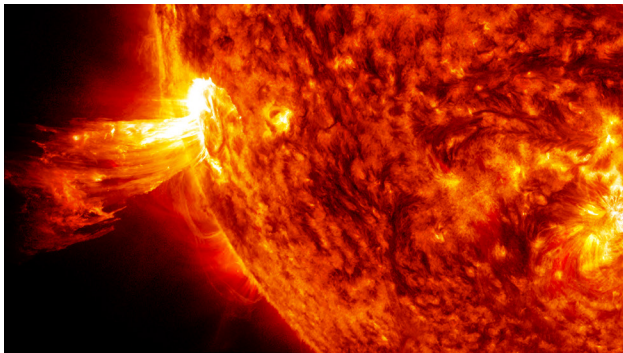
Commercial Space Weather Industry

Products and Services

Value Chain

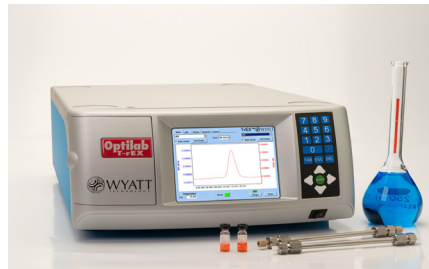
Upstream

- Research
- Observations
- Instrumentation
- Data



Mid-Stream

- Data Processing
- Computation
- Algorithms
- Models



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Downstream

- Forecasts
- Warnings
- Services
- Emergency Mgt



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- Formed in 2010, 5 Members;

- 2019, 19 Members:

AER, ASTRA, CPI, CRC, GO, NGF,
SP, PiQ, PRA, PSI, Q-up, SAC,
SEC, SET, SSI, SSH, SA, NGF



www.acswa.us

Executive Committee:

G. Crowley (ASTRA)

A. Engell (NGF)

J. Gannon (CPI)

J. Green (SHA)

D. Intriligator (CRC)

C. Lautenbacher (GO)

R. Robinson (SP)

R. Schunk (SEC)

K. Tobiska (SET)



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U.S. National Space Weather Strategy*

In Place

- “The Strategy and Action Plan aiming to foster a **collaborative environment** in which **government, industry,** and the **American people** can better understand and prepare for the effects of space weather.” *
- “The Nation must continue to **leverage existing public and private network of expertise and capabilities** ... to improve the ability to manage risks associated with space weather.” *

- That means: **including the commercial sector in planning and executing specific viable goals for services and products.**

*https://www.whitehouse.gov/sites/default/files/microsites/ostp/final_nationalspaceweatherstrategy_20151028.pdf



Space Weather Research & Forecasting Act

What Should be Included?

- National Science and Technology Council (NSTC)
 - Establish a Space Weather Working Group (SWWG) patterned after NAS Fair Weather Report re terrestrial weather activities cooperation with **Commercial Sector**
 - Install OSTP as Coordinator of federal government and **Commercial Sector** to improve national space weather monitoring and survival capability
- National Policy should Include:
 - Sustain baseline capability for space weather observations
- OSTP with NOAA, NASA, NSF, DOD, **Commercial**
 - Develop and sustain integrated strategy for solar and solar wind observations



Space Weather Research & Forecasting Act

Sample Instructions to U.S. Agencies

- OSTP in Coordination with:
 - NOAA, NASA, NSF, DOD, USAF, USN, **Commercial**
 - Develop contingency plan for continuous space weather forecasting including instruments
- NOAA, USAF, USN, with **Commercial**
 - Conduct a survey of future needs and make publicly available
- NSF, NASA, DOD, **Commercial**
 - Conduct basic multidisciplinary research activities and Include Decadal Surveys by NAS
- SWWG
 - Develop preliminary benchmarks for measuring solar disturbances
 - Brief Congress on progress at regular intervals



Enterprise Efficiency

Which system architecture is the most efficient?

Swim Lanes?

Making full use of
Academia, Government
and Commercial Sectors



Or an inefficient

Free for All?

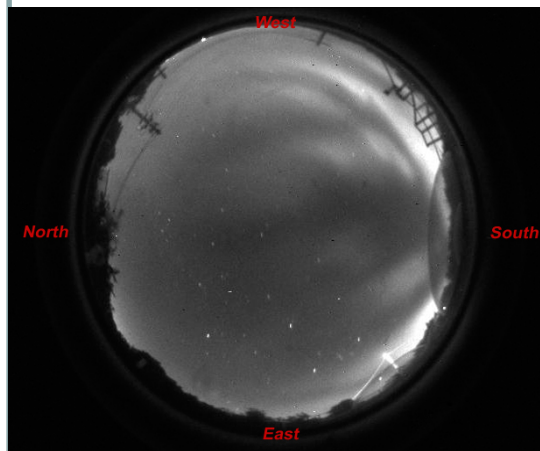
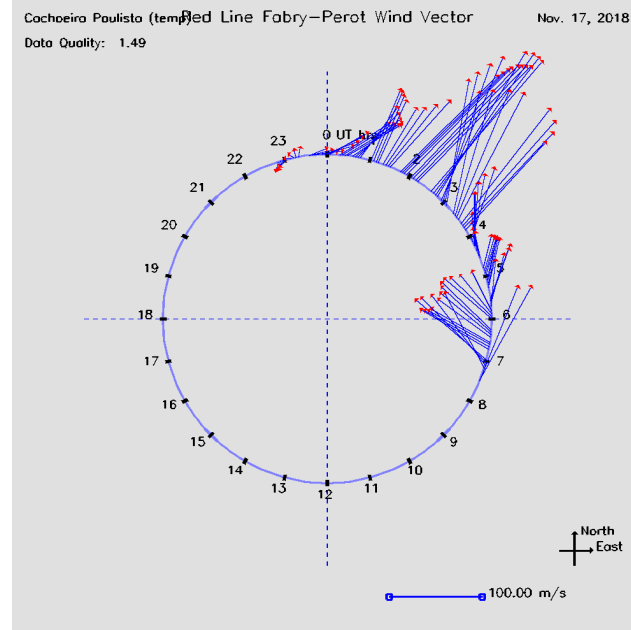
Spectral Sensing products

CPI develops **sensor technology** for monitoring the near-earth space environment from the ground and space.

- Small form factor high luminosity **optics** for space based remote sensing.
- Ground based neutral atmosphere sensors, including **imagers, spectrographs and Doppler imagers.**
- Remote, autonomous **ground based sensing stations** that monitor the ionosphere and neutral thermosphere.

CONTACT INFORMATION

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ESF plume over the Arecibo Observatory. Image taken 20 Nov 2014 at 10:30 PM local time, with a 4 minute exposure at 630.0 nm. ESF plumes started at about 8:20 PM. Top image is the corresponding 6300 FPI wind data

Texas Magnetometer Network



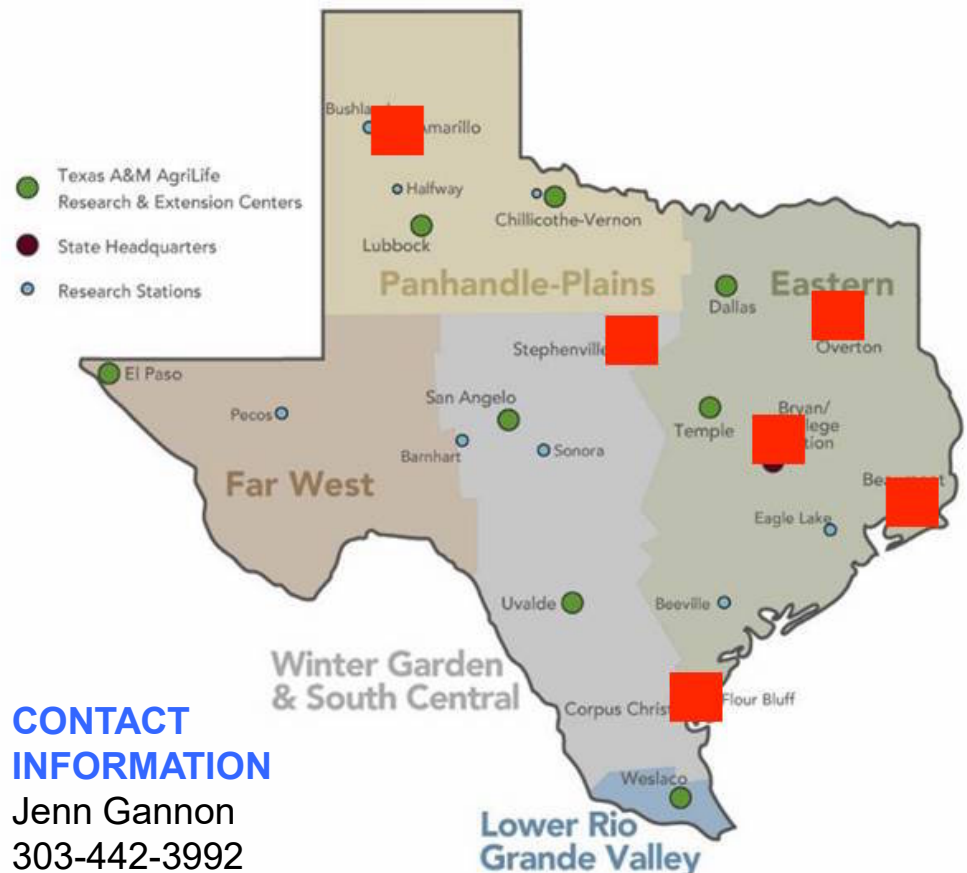
Commercial GIC products Magnetometers

- Industry-ready custom **magnetometer installations** – multiple installations across the US with academic and power utility partners.
- Subscription-based **commercial magnetometer network** supporting GIC mitigation, complementing federal observatory locations.

Real-time and predictive geoelectric field

- **Real-time, local geoelectric field** specifications using CPI's AVERT model.
- **Predictive indices** of GIC hazard.

CPI wins commercial bid to build magnetometer network for Texas A&M



CONTACT INFORMATION

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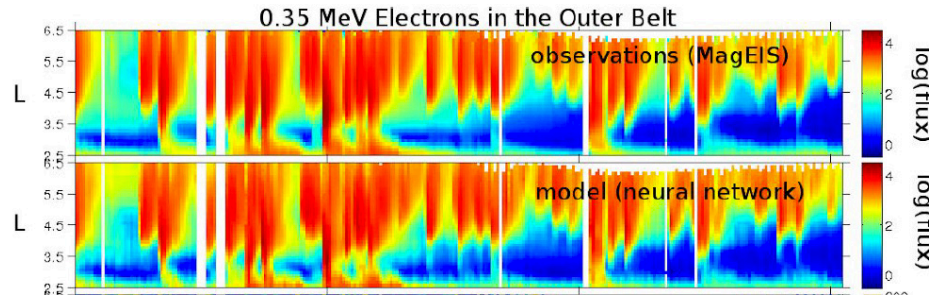


Protecting Space Assets



Space Hazards Applications, LLC

Developing tools for understanding space weather impacts to satellites, <https://spacehaz.com>



SatCAT:

An online configurable tool that allows users to generate and view internal charging levels tailored for their satellite orbit, shielding thickness, materials and mission duration.

SHELLS:

Will provide a neural network global specification of the high energy electron radiation belts that includes retrospective, real time, and forecast outputs.



Radiation Monitoring

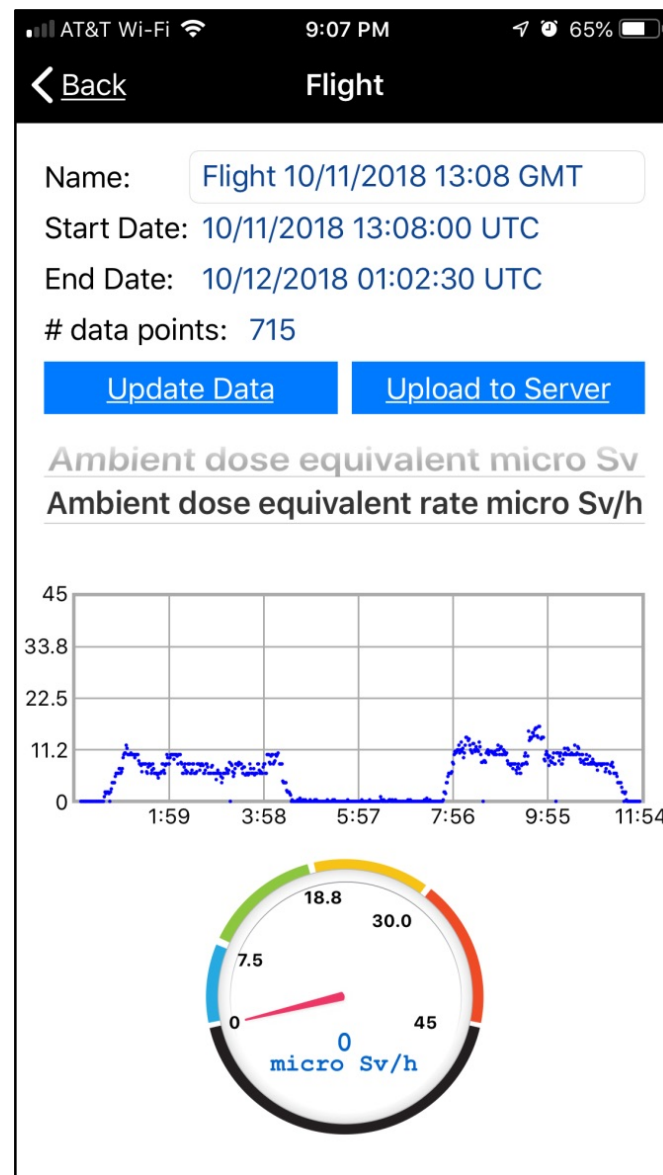


SPACE ENVIRONMENT TECHNOLOGIES

Space Weather Division

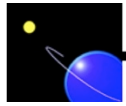
Compact Radiation Monitor plus app

State-of-the-art ARMAS Flight Module 7 (FM7) with Bluetooth



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Radiation Monitoring (2)



SPACE ENVIRONMENT TECHNOLOGIES

Space Weather Division

Compact Radiation Monitor plus app

Features:

- Measurement of absorbed dose in silicon
- Small size and mass
- Data retrieval via Bluetooth paired with smartphone or tablet app
 - Display current status on app
 - Use plane's WiFi to transmit to ground as needed
- Levels 2–3 real-time dose rates provided (absorbed, equivalent dose, & ambient dose equivalent rates)

Status:

- 4 units delivered 2018
- First production run for business jets complete in Q1 2019



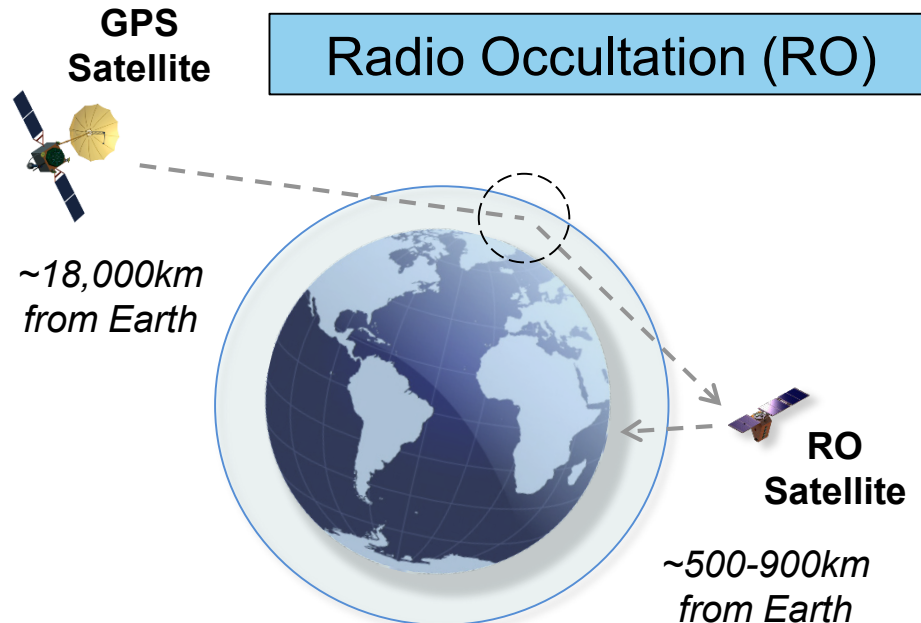
Ionospheric Data



“Community Initiative for Continuing
Earth Radio Occultation”

CICERO

- Nano Satellites
- 6 24 48 ?
- Cion Receiver
- Ground Command & Control
- Data Processing
- Products
 - High Resolution Atmospheric Profiles
 - Bending Angle
 - Refractivity
 - Density
 - Pressure
 - Temperature/Moisture
 - Absolute Measurement Heights
 - Ionospheric Electron Density
 - Global Temporal & Spatial avgs
 - Global pressure contours, gradients & geostrophic winds
- Replenishment & Updating



COSMIC

- Fully Successful RO Test
- Rapidly Reaching End of Life



Commercial Space Contributions

Examples

- Power Grid Outages*
 - Storm Severity Index “Dst”
 - Commercially developed for USAF
 - Now publically available and in use
- Radiation in Air Travel*
 - ARMAS** Program
 - Started by commercial company
 - Measures radiation dose
- Ionospheric Scintillation*
 - Event during Katrina wiped out HF radio
 - Companies w/Utah State -- free 24 hr global forecasts

*Courtesy of W. Kent Tobiska

**Automated Radiation Measurements for Aerospace Safety



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*Linking Scientific Understanding
with Operational Priorities*

The End



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Capabilities*

- Algorithm development
 - Automatic event detections (flares, solar energetic particles, geoeffective CMEs)
- Calibration/validation
- Data assimilation
- GPS modeling and services
- HF propagation
- Numerical modeling and simulation
 - Sun, interplanetary medium
 - magnetosphere, ionosphere
 - thermosphere, lower atmosphere
- Operational implementations / Research to Operations (R2O)
- Risk and threat analyses for infrastructure and space resources
- Satellite data analysis & data product development
- Sensor hardware & modeling
- Software tools
 - Application development (web-based and smart phone)
 - Data hosting / data product delivery
 - Data / model visualization
- Space Situational Awareness (SSA)
- Spacecraft anomaly prediction and assessment
- Space weather data product and service distribution
- Space weather now-casting/forecasting

*<http://www.acswa.us/capabilities.html>



Fair Weather Report*

- Eleven Recommendations

1. NWS defines processes for making decisions not products
2. NWS Establish independent advisory body
3. All three parties seek neutral host to discuss issues periodically
4. NWS maintain activities essential to mission
5. NWS Make data and products available in internet accessible formats
6. NWS Improve process for developing new products that meet new needs
7. NWS develop process to balance local new product creation with public-private partnership
8. NWS Adopt/improve processes for communicating information in probabilistic formats
9. NWS retain role as official source of instrumentation, data, and data collection standards
10. Private sector work with other sectors to develop processes to minimize friction
11. Academia use transparent processes to transfer technologies and avoid conflicts of interest



*Fair Weather: Effective Partnerships in Weather and Climate Services (2003) NRC Report

