

# How a Commercial Sector and CCMC Partnership Can Advance Space Weather Enterprise Over the Next 10 Years

## CCMC Workshop

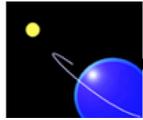
April 11, 2016

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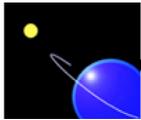
# What Must Motivate Our Enterprise?

## **BIG challenges of Energy and Fresh Water**

- ✓ Cannot be touched without governments, industries and individuals having better health, wealth, security, transportation, and communication infrastructures this decade
- ✓ White House and OSTP now recognize Space Weather as an active area of Infrastructure Risk Management at U.S. national and at international collaboration levels

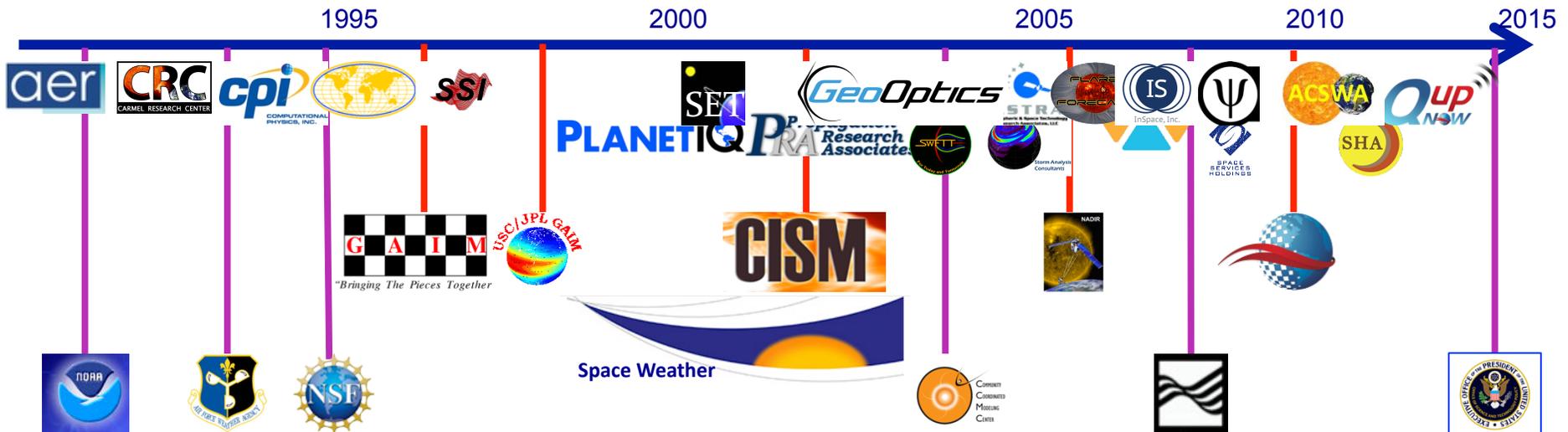
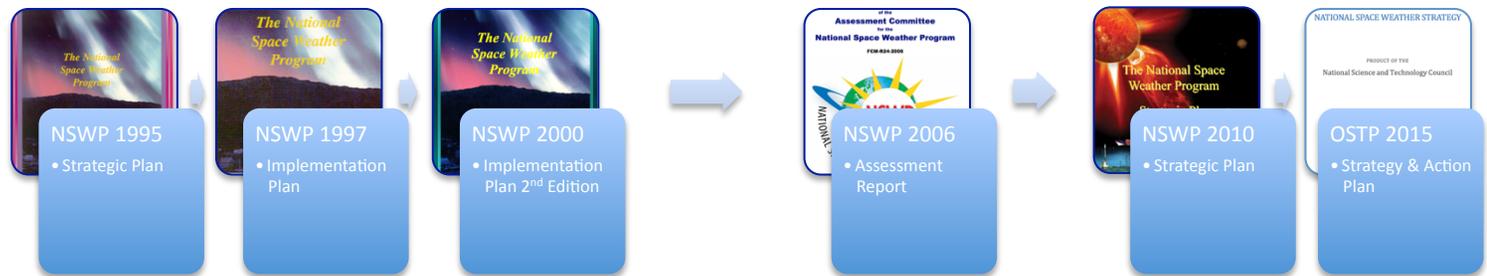
## **BIG promises 2016 – 2025**

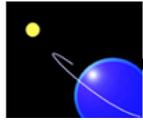
- ✓ Tesla to Toyota, Apple to Android – fully electric, self-driving cars
- ✓ Nvidia's virtual reality chips embedded in all mobile communications
- ✓ Bigelow's first commercial space tourist will sleep for a night in orbit
- ✓ GOOGLE global WiFi from any spot on the planet, anytime
- ✓ And underneath it all? Active **space weather risk management**
  - ◆ Personal radiation dosimetry – will be part of our health records
  - ◆ Scintillation disruptions to GPS and communications – will be gone
  - ◆ And yes – “Heliophysics” will have changed its name to ... ???



## National Space Weather Enterprise

- **National Space Weather Program** (1995, 1997, 2000, 2006, 2010)
- **Agencies** (OSTP, NOAA SWPC, AFWA, NSF, NASA CCMC, USGS)
- **Academia** (GAIM MURI, CISM, NADIR MURI, USU SWC)
- **Industry** (19 U.S. companies in ACSWA as of January 1, 2016)





## What are the Origins of Commercial Space Weather?

### **Vendors association concept**

- Inquiries in 1980s, led by T. Gray (consultant)
- Discussions in 1990s, led by V. Raben (Raben Systems, Inc.)
- Formed in 1995, led by T. Tascione (Sterling Software)

### **Space Weather Vendors Association (SWVA)**

- Re-formed in April 1999, led by A. Foster, L. Plumber (AIAA)
- 27 individuals from government, FFRDCs, commercial, academia

### **Commercial Space Weather Services Association (CSWSA)**

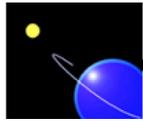
- Evolved in February 2000, led by J. Kappenman (Metatech)
- 35 individuals from government, commercial, academia

### **Commercial Space Weather Services Interest Group (CSWSIG)**

- Further evolved in 2001, led by J. Kappenman (Metatech); shortened to CSWIG in 2002
- 20 individuals from commercial organizations

### **American Commercial Space Weather Association (ACSWA)**

- Created in 2010, Executive Committee currently is D. Intriligator, G. Crowley, B. Schunk, K. Tobiska, B. Robinson, C. Lautenbacher, and A. Engell
- Growth to 19 U.S. companies in 2016



## What have we accomplished?

### **1977-1994 (seed): was there a role for the commercial sector?**

- ✓ What role for space environment information services can commercial entities provide?

### **1995-2000 (startup): where is the “line-in-sand?”**

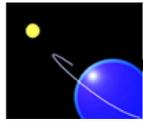
- ✓ 1995: Space Weather defined by National Space Weather Program
- ✓ 1995-2000: NOAA SEC sets up 3 CRADAs (**CIRES** (labor), **Sterling Software** (MSM), **Space Environment Technologies** (S2K)) and the “line-in-the-sand” discussion is born

### **2001-2010 (growth): a healthy industry emerges**

- ✓ 2001: NOAA SEC establishes a “Space Weather Providers Yellow Pages”
- ✓ 2002: Irish Space Weather initiative excites the imagination for commercial space weather
- ✓ 2004: AMS Fair Weather Report recognizes the commercial Space Weather sector
- ✓ 2008: ESWDS becomes operationally used by commercial Space Weather service providers
- ✓ 2009: Utah ARRA Stimulus funds USU Space Weather Center to commercialize ionospheric products
- ✓ 1990-2010: commercial product examples (AURIC, STK-SEET, LCPF, SIP, ESIR, CORHEL, CAPS/ES4D, smartphone apps, CASES, Q-upNow)

### **2011-2015 (expansion): commercial space weather’s ties to other industries**

- ✓ 2011: ASTRA launches DICES satellites to measure Space Weather SEDs (GPS/transportation)
- ✓ 2012: Q-up as a USU SWC spin-off (ionosphere ray trace/HF radio communications)
- ✓ 2013: SET provides solar and geomagnetic operational forecasts to USAF JSpOC (NORAD catalog)
- ✓ 2015: GeoOptics initiates build of CICERO Satellites (RO/Weather and Space Weather Data)
- ✓ 2015: PlanetIQ announces contract with India (Weather and Space Weather services)



## Where are we going?

### Industry growth in the next 10 years will continue

- ✓ Space weather risk management provided by commercial providers is expanding in –
  - ❖ Aviation (radiation monitoring, GPS-assisted landing, HF communications)
  - ❖ Transportation (GPS-assisted snowplowing)
  - ❖ Weather services (GNSS-RO measurements for H<sub>2</sub>O and TEC)
  - ❖ Defense (solar/geomagnetic forecasting for satellites orbit monitoring; missile BERs)
  - ❖ GEO satellites (charging conditions during storms)
  - ❖ Space habitation and long-duration travel (radiation monitoring)
  - ❖ Communications (spacecraft and high-altitude aircraft SEEs)
  - ❖ Power (GIC maps for regional grids)

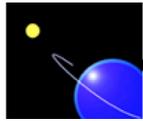
### AMS Enterprise Panels promote expanded partnerships

- ✓ ACSWA went to AMS for help in organizing a discussion with U.S. Government agencies to move beyond “line in the sand” topic and evolve a partnership of agencies, academia, and industry
- ✓ In response, AMS held 4 successful Enterprise Panels (2013, 2014, 2015, 2016) leading to new ideas

### IDEA 1: NOAA Weather Ready Nation (WRN) can help grow the enterprise

- ✓ Can identify roles and capabilities commercial and academic organizations provide
- ✓ Can highlight industry and academic efforts of educating the public about space weather

**IDEA 2: Expanded partnerships need an economic boost – we ask for agency groups (e.g., CCMC) to support, through partnerships, a **Space Weather Innovation Zone** to expand commercial and academic sector growth in SpWx Risk Management**



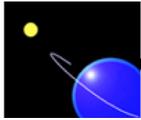
# How can a Commercial and CCMC Partnership Improve Infrastructure Risk Management?

## Commercial contributions

- ✓ Unique data sources, models, software, and hardware
- ✓ Direct links to industries and individual consumers through products and services
- ✓ Ultimate litmus test of societal benefit through business success or failure – **the market determines the value of our collective enterprise**

## CCMC contributions

- ✓ Testbed for integrating new systems, services, and products (ensemble modeling and data assimilation)
- ✓ Service of independent validation and verification
- ✓ Forum for developing a common, internationally collaborative, framework with a direct pathway to agency (e.g., FAA, NOAA NWS) R2O and O2R

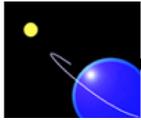


## How could these partnerships work?

### Example: SET's real-time aviation radiation monitoring system for business jets – ARMAS FM5

- **FM5 contains a micro dosimeter, data logger, GPS receiver, Iridium transceiver, battery, and Bluetooth in the size of a large smart phone**
- Measures ALL radiation in all altitude ranges with NASA technology
- **Reports personal dose exposure from anywhere in the world** providing REAL-TIME situational awareness onboard or on ground
- **Provides radiation region avoidance during events (like volcanic ash clouds)**
- FM5 is FAA compliant with its own power and no attachment to plane





# SPACE ENVIRONMENT

Space Research Space Operatio

ARMAS measured enhanced dose protons along L 2.5-2.75 during th

NAIRAS dose rate climatology on Dec. 1 at all flight lo

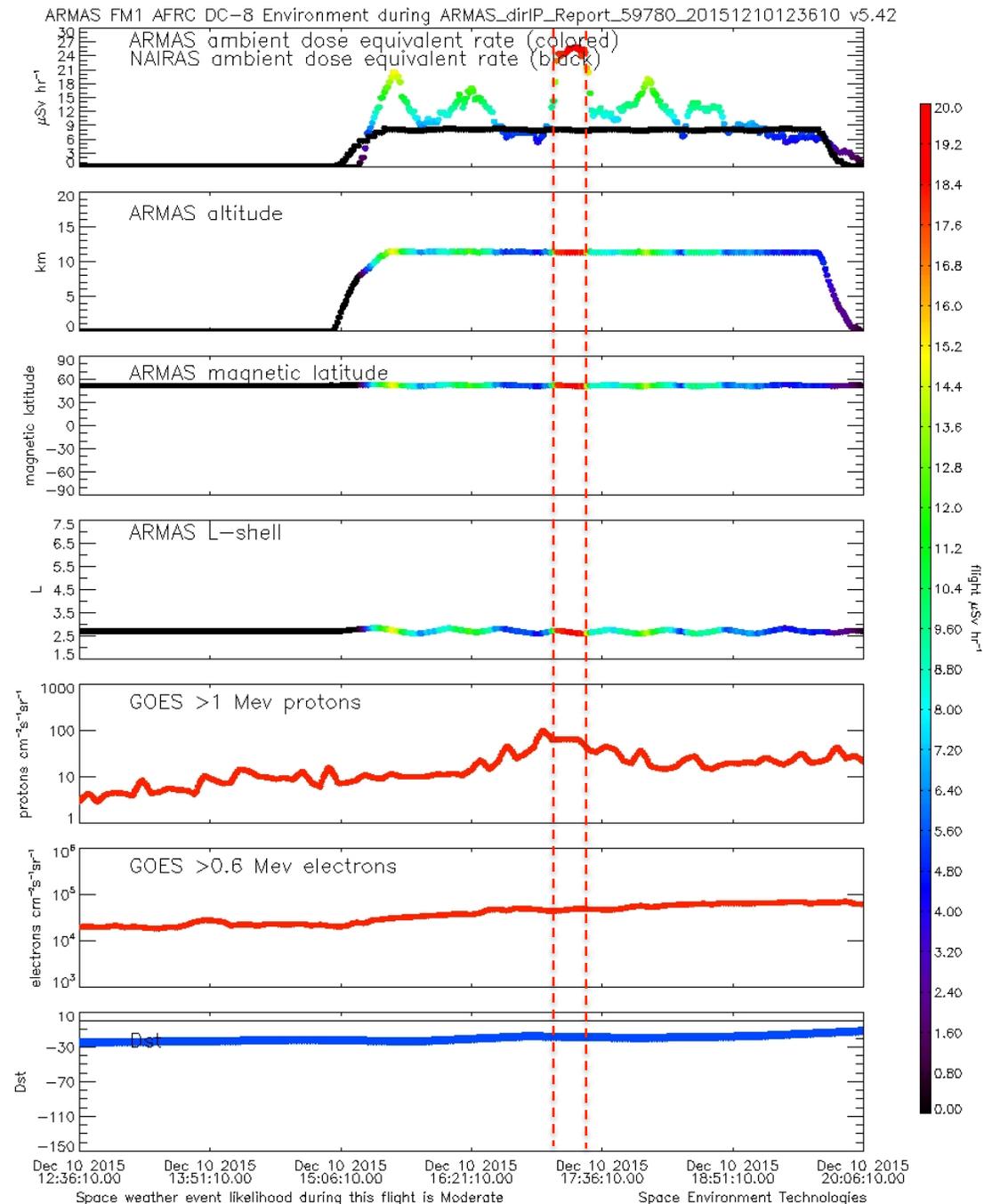
## First real-time radiation weather measured by ARMAS FM1

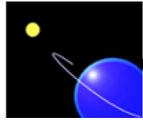
December 10, 2015 (during AGU) near Seattle, WA on the AFRC DC-8

Radiation “weather” increased by a factor of 2–3 above NAIRAS climatology during a 5 hour flight

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## One Example of Possible Partnerships

### SET contributions

- ✓ **Data:** ARMAS real-time data stream
- ✓ **Funding:** Direct sales to commercial aviation and individual crew/frequent flyers of dosimetry products and services – broad, new data collection capacity
- ✓ **Litmus test:** market will determine aviation radiation management value

### CCMC contributions

- ✓ **Testbed:** integrate ARMAS data with NAIRAS to build data assimilation capability; “test-drive” (not sell or distribute free) products that meet user needs; evolve ensemble models with NAIRAS, CARI, etc. for uncertainties
- ✓ **R2O TRL bridge:** perform independent validation and verification of exposure risk monitoring system to move from low to high TRL
- ✓ **Forums:** help promote common, internationally collaborative standards and best practices along with S. Korea, Europe, FAA, and NOAA NWS for O2R – use workshops and iSWA facilities