NOAA Space Weather Observational Programs Status

Dr. Thomas Burns

Deputy Assistant Administrator for Systems

National Environmental Satellite, Data, and Information Service

October 31, 2013

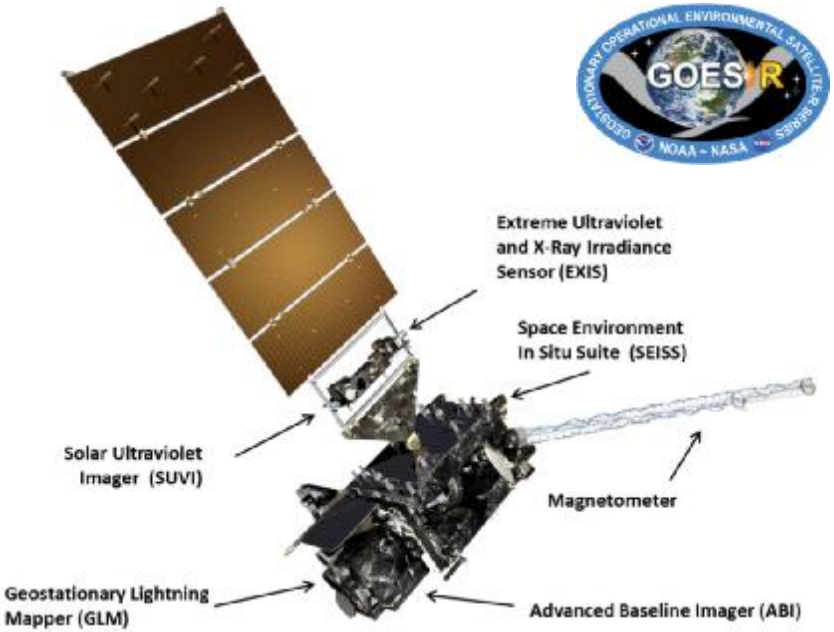
NOAA Space Weather Satellite Observing Capabilities

- **POES –** Space Environment Monitor (SEM-2), consisting of the Total Energy Detector (TED) and Medium Energy Proton and Electron Detector (MEPED)
- **GOES R** – the continuation of decades of backbone space weather observations of solar imagery (SUVI), x-ray and extreme ultraviolet (EUV) flux (EXIS), and energetic particles and magnetic fields (SEISS) at geostationary orbit
- **JPSS** - VIIRS night band observations of the auroral oval
- **COSMIC** – GPS radio occultation measurements for ionospheric scintillation and specification
- **DSCOVR** – the continuation of solar wind measurements after ACE
- **Future Technology** – NASA's Sunjammer – a test of advanced propulsion and its uses for, and effect on, solar wind measurements

GOES-R Series Overview

Benefits

- **Primarily atmospheric weather - Maintains continuity of weather observations and critical environmental data from geostationary orbit**
- **Provides improved warning of solar events to minimize impact to satellites, communications, manned space, navigation systems, and power grids**



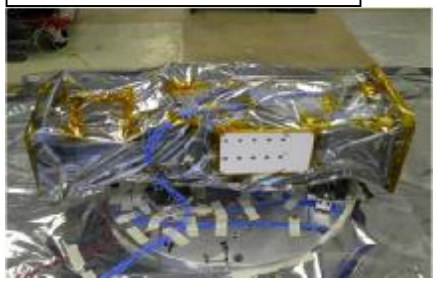
GOES-R Launch Readiness Date*	2QFY2016
Program Architecture	4 Satellites (GOES-R, S, T & U) 10 year operational design life for each spacecraft
Program Operational Life	FY 2017 – FY 2036
Program Life-cycle*	$10.860 billion

***Launch Readiness Date based on FY 2014 President's Budget Request**

Recent Events and Accomplishments

- **EXIS**
  - Ø FM-1 completed PSR.
  - Ø FM-2 in Environmental Testing
- **SEISS, SUVI**
  - Ø Completed Environmental Testing

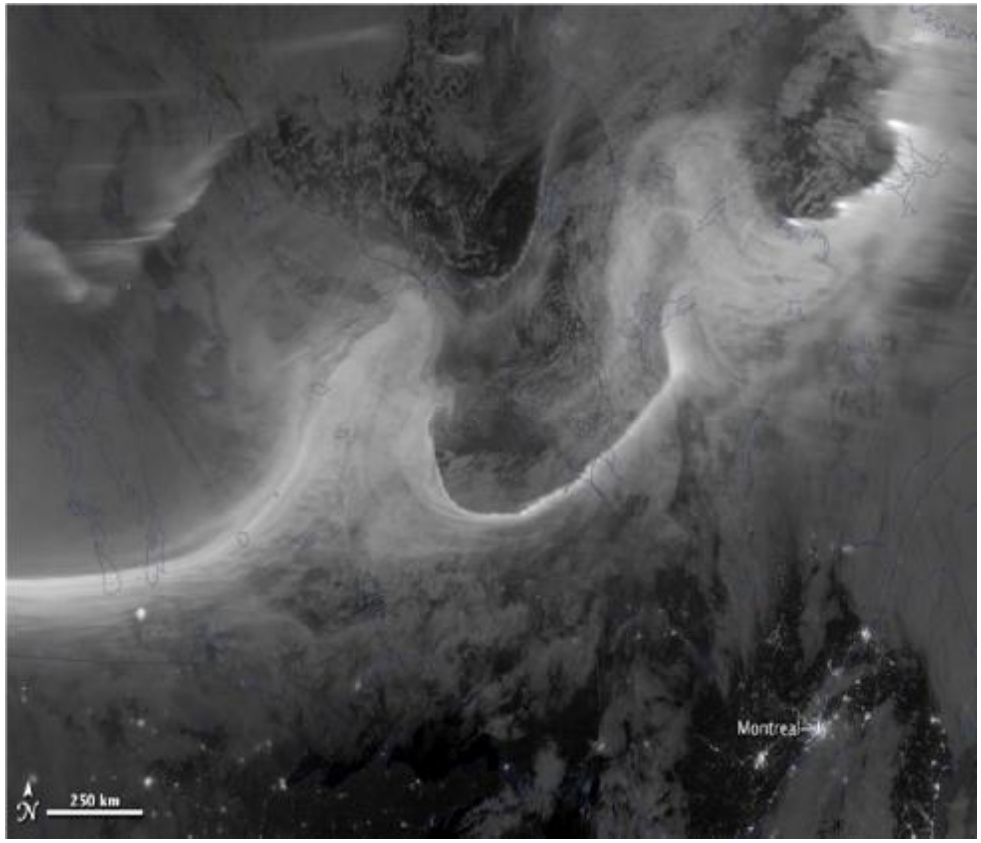
EXI FM2 on Vibration Table



SUVI FM1 Thermal Vacuum Chamber entry

SEISS FM1 Thermal Vacuum Chamber entry

Joint Polar Satellite System (JPSS)



S-NPP VIIRS Day Night Band Aurora Over Canada

5

COSMIC 2

- Follow-on to current COSMIC satellite constellation
- Design concept meets L1RD requirements
  - System will provide 8000+ worldwide soundings per day
  - All weather, uniform coverage over oceans and land
- 12 Satellite Constellation is planned
- Planned 2 launches in different inclinations
  - First launch will carry 6 satellites to 24 degree orbit, FY 2016
  - Second launch will carry 6 satellites to 72 degrees orbit, FY 2018

GPS RO Roles

- **NOAA activities (if funded):**
  - Manage all US activities as Lead US agency
  - Provide ground system
  - Provide payload data processing and archiving capability

- **Taiwan activities:**
  - Provide 12 spacecraft + 1 optional spare
  - Provide integration of payloads onto spacecraft
  - Provide mission operations center
  - Provide command & control station
  - Provide limited data recovery and processing

- **NASA/JPL activities:**
  - Non Recurring Engineering (NRE) for new sensor design

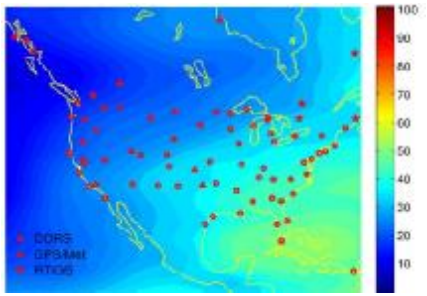
- **Air Force activities:**
  - Provide 6 primary payloads for the first launch
  - Provide launch services for the first launch
  - Provide 6 primary payloads for the second launch
  - Provide launch services for the second launch
  - Provide up to 12 secondary payloads for the first launch

COSMIC-2
Space Weather Contributions

Ionospheric Specification

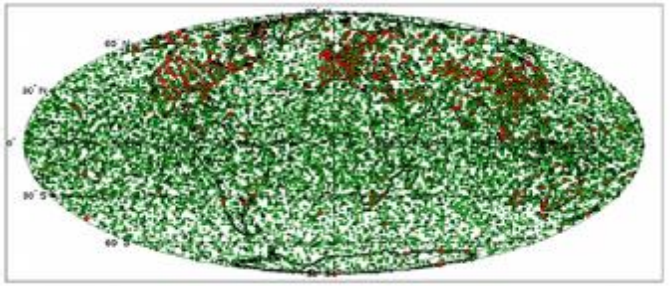
Enable a global deployment of the NOAA US-TEC model @ NWS/SWPC

- Reduce inaccuracies associated with the largest GNSS source of error
- Improved geo-positioning for surveying, farming, deep-sea oil extraction, ...
- Uniform global distribution of occultations avoids model biasing for land masses



Regional US-TEC model

Transition to Global Model

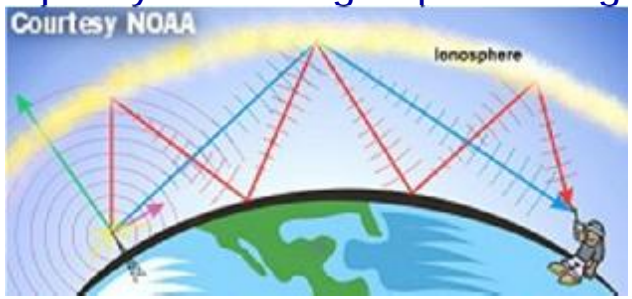


Model Input: > 8,000 occultations per day

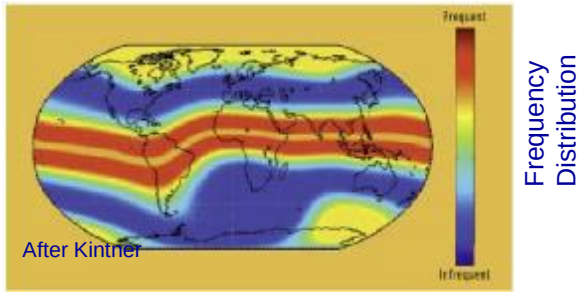
Ionospheric Scintillation

Contribute to assured radiowave connectivity and precise geo-positioning

- Locate regions of ionospheric scintillation that affect communications
- Specify errors in geo-positioning due to selective loss of GNSS links (GDOP)

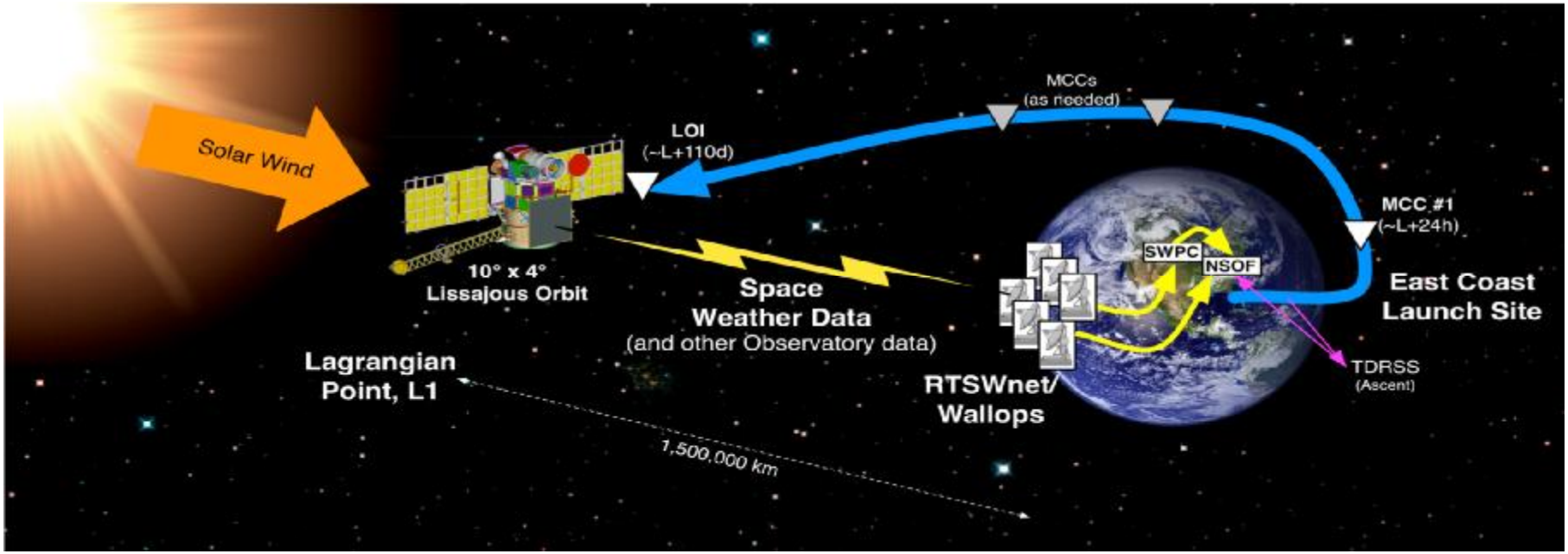


Assured Communications



Statistical distribution of scintillation

DSCOVR Mission Overview



Mission Objectives

- Primary operations objective of the DSCOVR mission is to provide solar wind thermal plasma and magnetic field measurements to enable space weather forecasting by NOAA
- Secondary science objectives are to image the Sun lit disk of Earth in 10 spectral bands with a spatial resolution of 12 km or better, to determine ozone, aerosol, cloud cover, cloud height, vegetation, and leaf area indices and to measure the Earth reflected irradiance in the wavelength range of 0.2 - 100 microns

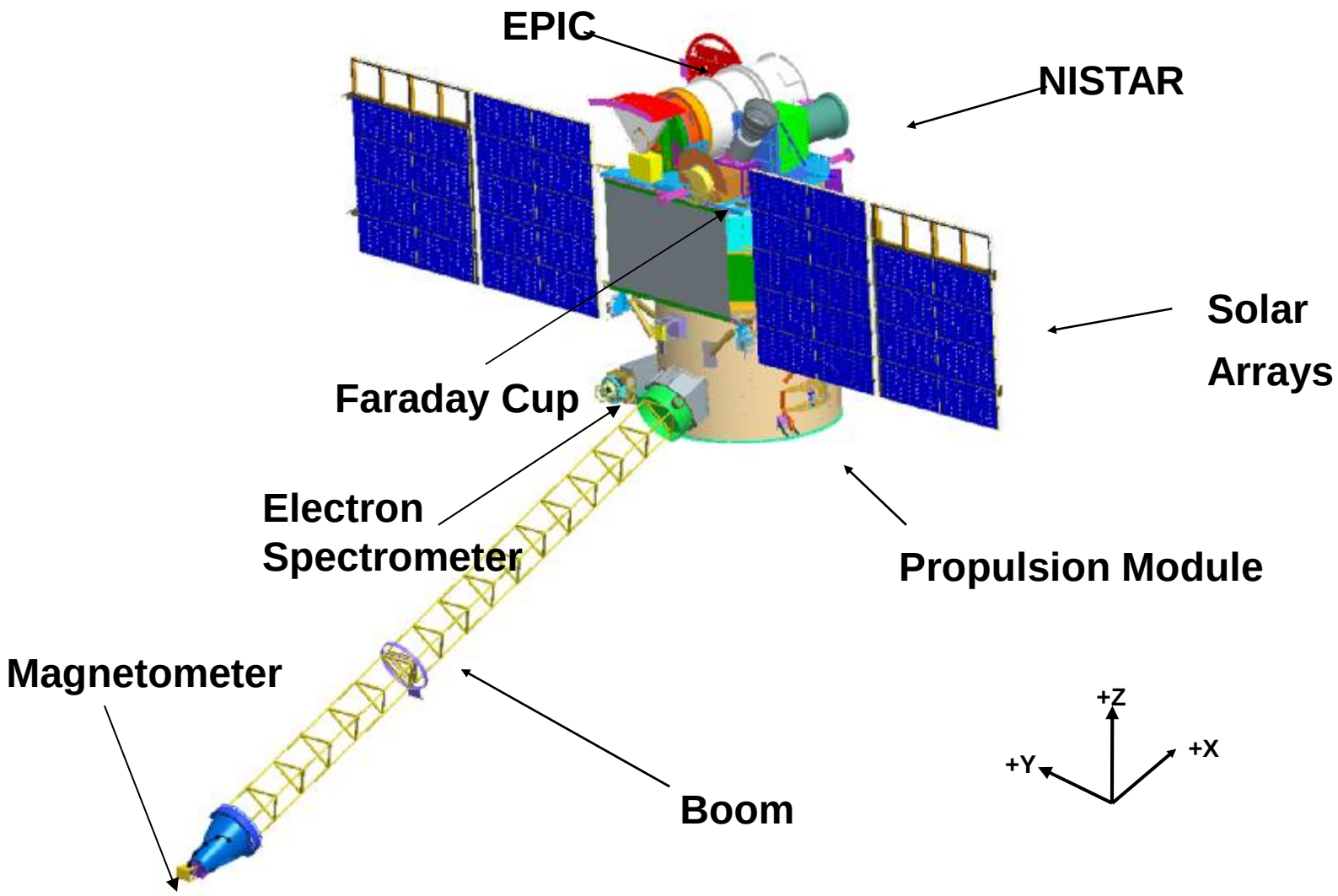
Mission Overview

- Launch Vehicle: Falcon-9
- Small Explorer Spacecraft Bus
- L1 Orbit

Instruments

- Plasma –Magnetometer (PlasMag): Magnetometer and Faraday Cup
- Electron Spectrometer
- Earth Polychromatic Imaging Camera (EPIC)
- NIST Advanced Radiometer (NISTAR)
- Pulse Height Analyzer (PHA)

Sun Side (-X)


EPIC
NISTAR
Solar
Arrays
Faraday Cup
Electron
Spectrometer
Propulsion Module
Magnetometer
Boom
+Z
+Y
+X

DSCOVR Status and Issues

FY 2013 Programmatic Changes:

- USAF awarded a task order contract to Space X for a Falcon 9 v1.1 November 2012

  Launch scheduled for November – January fiscal 2015

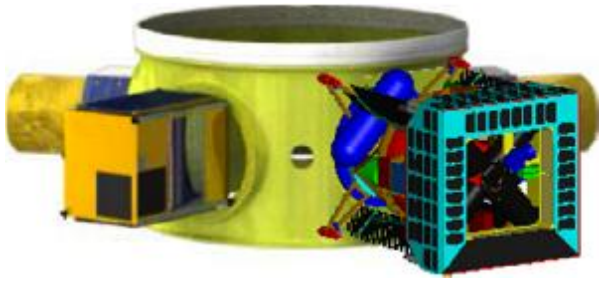
- NASA Earth Sciences Division reprogrammed FY2013 funds allowing the EPIC and NISTAR sensors to be re-integrated onto the satellite
- NOAA received a Sequestration reduction in funding to the program in FY2013 resulting the in new launch date

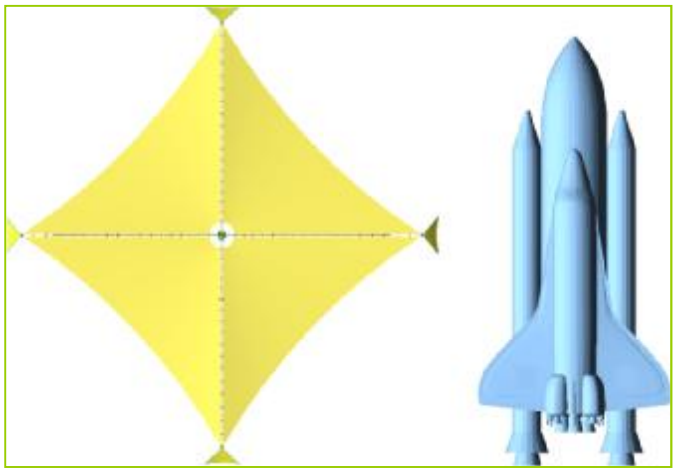
Project status:

- DSCOVR KDP-C successfully completed August 27, 2013
- Recalibration of solar wind sensors is complete
- Satellite integration is near completion
- Environmental testing scheduled for Dec 2013/Jan 2014
- Magnetic cleanliness testing has been successfully completed
- Impact of government shutdown on project is still being assessed

Sunjammer

- NASA Space Technologies Mission Directorate (STMD) is developing a solar sail for flight test in early 2015
- The Sunjammer mission is co-manifested on a Falcon 9 with DSCOVR
- Mission Characteristics
  - 1200 m^2 solar sail demonstration project – largest solar sail ever flown
  - Test will demonstrate sail deployment and navigation
  - Secondary objectives are to demonstrate orbit holding at double DSCOVR's distance from Earth
  - Mission will carry solar wind sensors





Sunjammer Quadrant Deployment
Test 9.30.2013

NOAA Interest in Sunjammer

- Sunjammer is a NASA Space Technology Mission Directorate (STMD) flight demonstration of solar sail propulsion
  - Mission primary objective is to deploy and navigate with solar sail propulsion in an earth escape orbit
  - Mission is carrying Plas/Mag sensors – critical to demonstrating non-interference on solar wind measurements from the sail's metalized surface
  - Secondary mission objectives are to demonstrate artificial LaGrange orbit station keeping at sub-L1 and out-of-ecliptic
  - Sunjammer is also an important test of the business case for commercial provision of solar wind data and CME imagery and has commercial partners
- NOAA will partner in the mission
  - We are developing an Agreement with NASA to acquire the mission data at Fairbanks
  - We will archive the science data and support its analysis and cross-calibration with DSCOVR and ACE
  - We are also interested in monitoring the earnings of the secondary commercial revenues of the mission's commercial partners

Future Planning

NOAA is engaged now in planning for continuity of critical space weather measurements in the future

We are conducting option studies and have re-started studies with Naval Research Laboratory on a Compact Coronagraph (CCOR)

We are coordinating very closely with NASA Heliophysics as we develop plans

We are studying the possible contributions of the commercial sector to our future missions