# NOAA-NESDIS Space Weather Observing Systems

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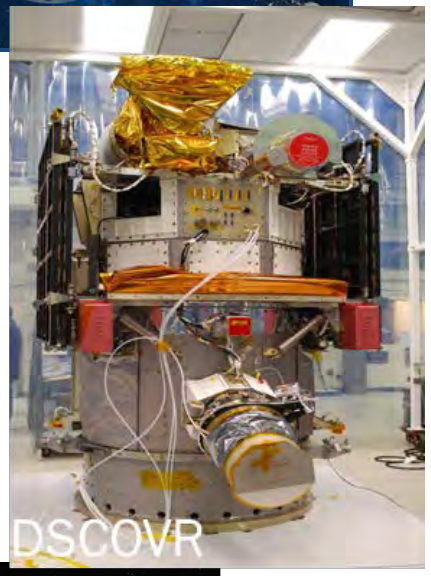
## Development: Satellite Programs in Support of SpWx Services

- **Deep Space Climate Observatory (DSCOVR) (Orbit insertion June 7-8, 2015):** Solar wind plasma and magnetic field from L1 Lagrangian point – Warnings of imminent solar storms
- **GOES-R Series (GOES-R planned Fall 2016 launch):** Solar imaging and x-ray/extreme ultraviolet irradiance, in-situ plasma, energetic particles, and magnetic field
- **COSMIC-2 (Launches in 2016 and 2018):** GNSS radio occultation for space weather and meteorology (in collaboration with Taiwan)
- **Space Weather Follow-on:** Provides continuity for solar wind data and adds coronagraph images – Alerts potential solar storm events, 1-4 days in advance



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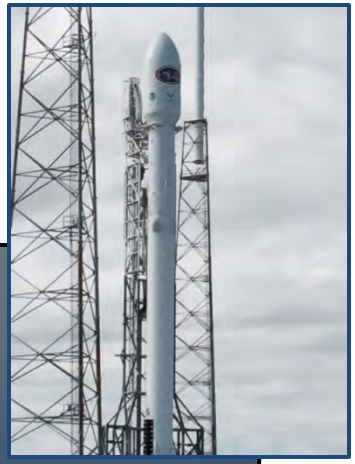
# DSCOVR Launch

DSCOVR launched February 11, 2015 on a Falcon 9 rocket



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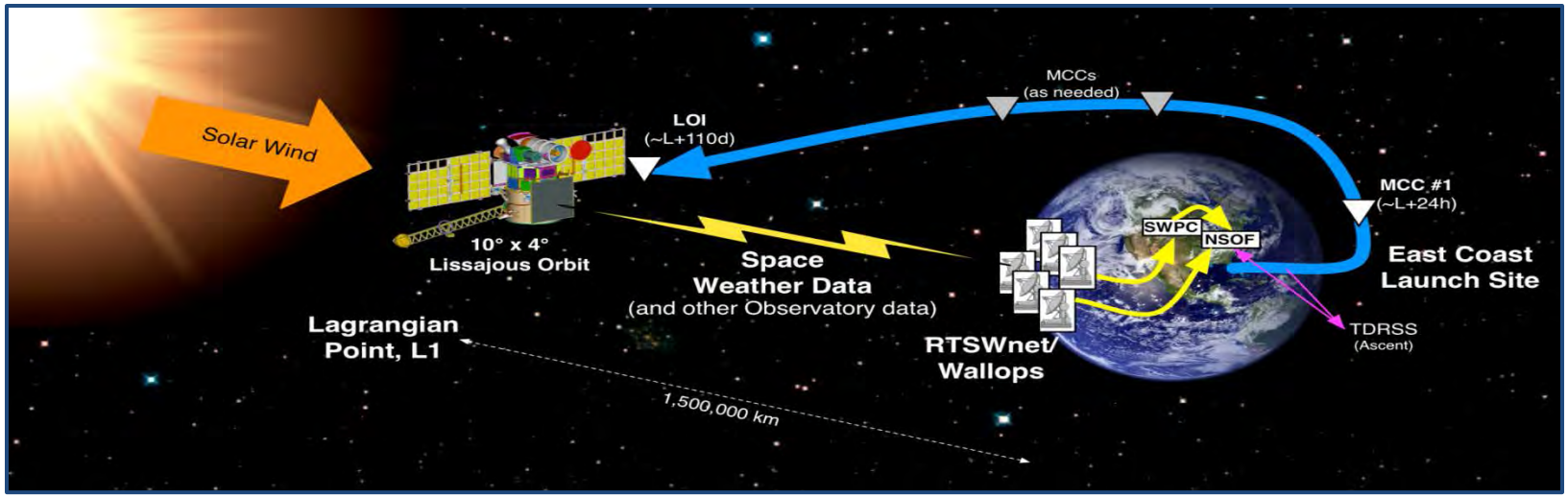
# DSCOVR Mission Overview

DSCOVR Mission: Joint NOAA, NASA, and DoD Program for continuing critical space weather observations




## Mission Objectives

- DSCOVR Mission Primary Operations Objective: To provide solar wind thermal plasma and magnetic field measurements to enable space weather forecasting by NOAA
- Secondary Science Objectives: 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

- Launched: February 11, 2015
- Launch Vehicle: Falcon-9
- Small Explorer Spacecraft Bus
- Design life of 2 years (goal of 5 years)
- L1 Orbit, ~1.5 million kilometers from earth

## Instrument Suite

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

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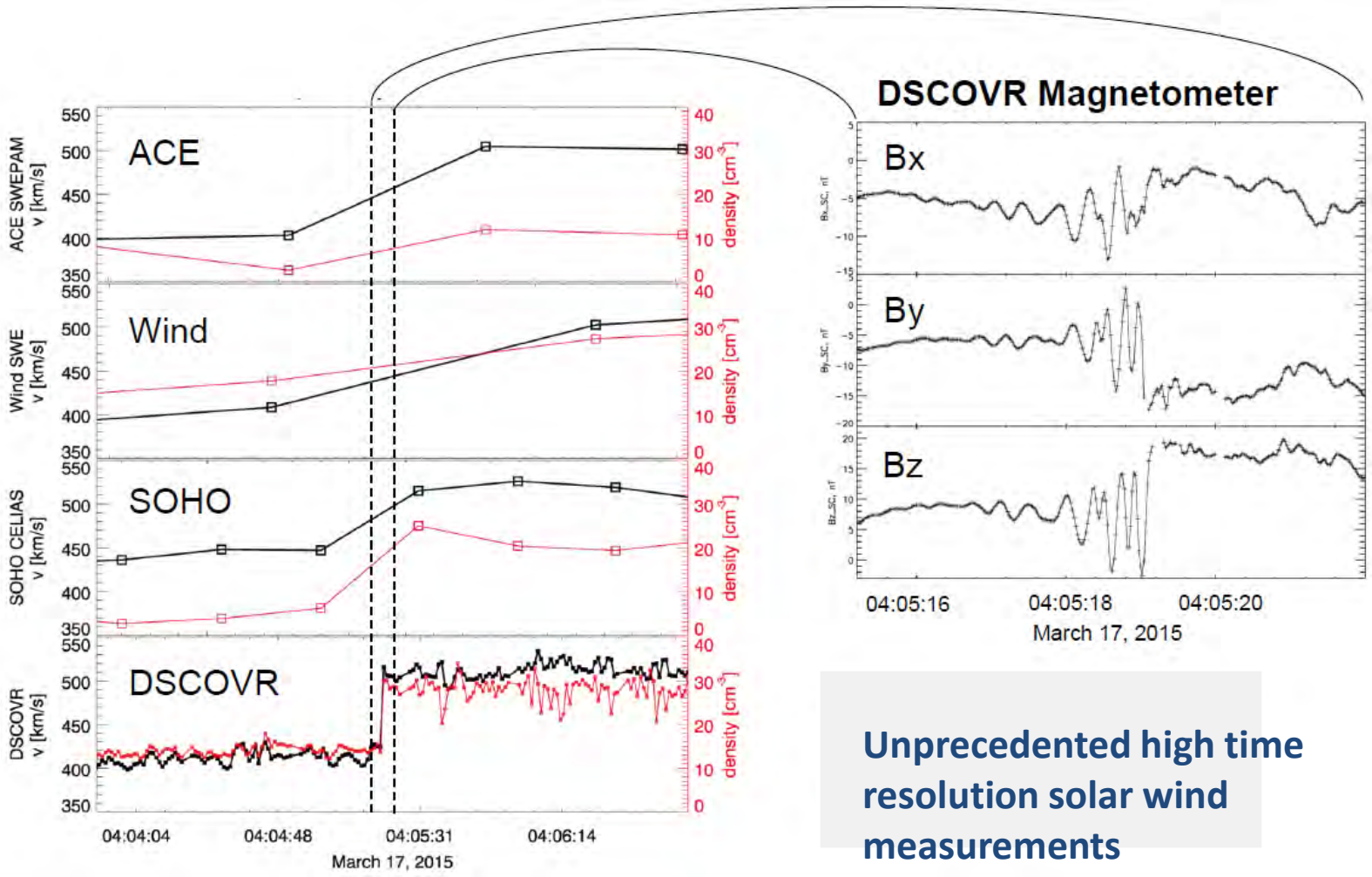
## DSCOVR Event Timeline and Space Weather Instrument Status

- History of Events
  - Launch: February 11, 2015
  - Transit to L1 Orbit:  February 11 – June 7, 2015
  - L1 Orbit Insertion (LOI): June 7-8, 2015
  - All instruments were activated and commenced check-out efforts during transit to L1
  - Transition to NOAA Operations: Planned for October 2015
- Space Weather Instrument Status
  - Magnetometer checked out with excellent results
  - Faraday Cup commissioning activities are underway
  - Electron Electrostatic Analyzer successfully commissioned

# DSCOVR Magnetometer Data Inter-comparison

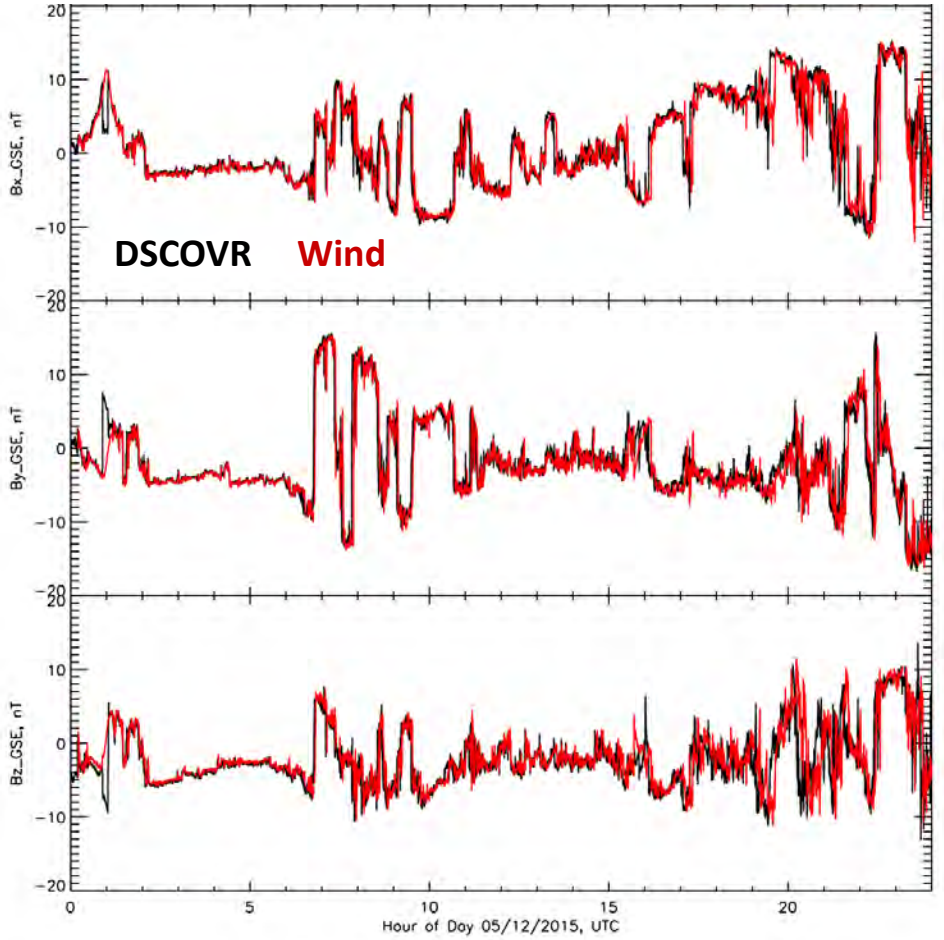



**Unprecedented high time resolution solar wind measurements**

*Graphic courtesy of Dr. Adam Szabo, NASA DSCOVR Project Scientist*

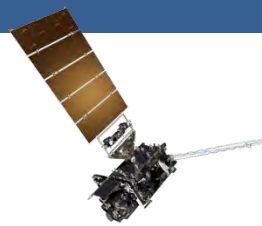
## Wind-DSCOVR Inter-comparison (At high voltage levels evaluated so far)

- Faraday Cup data negative bias was corrected
- Faraday Cup remaining commissioning activities:
  - Increase to 8kV to meet operational requirement
  - Optimize operations for low density (< 4cc) plasma measurements
- Operational use by SWPC will take place after successful commissioning and product evaluation phases have been completed




*Graphic courtesy of Dr. Adam Szabo, NASA DSCOVR Project Scientist*

## GOES-R Series




- GOES-R Program: A collaborative development and acquisition effort between NOAA and NASA to develop, deploy and operate the next generation of geostationary operational environmental satellites (GOES-R-U)
- Mission Objective: Provide continuous imagery and atmospheric measurements of Earth's Western Hemisphere and space weather monitoring
- GOES-R satellite scheduled for launch in Fall 2016


### Instrument Suite

- Advanced Baseline Imager (ABI)
- ***Extreme Ultra Violet/X-Ray Irradiance Sensor (EXIS)**
- Geostationary Lightning Mapper (GLM)
- ***Magnetometer (MAG)**
- ***Space Environmental In-Situ Suite (SEISS)**
- ***Solar Ultra Violet Imager (SUVI)**

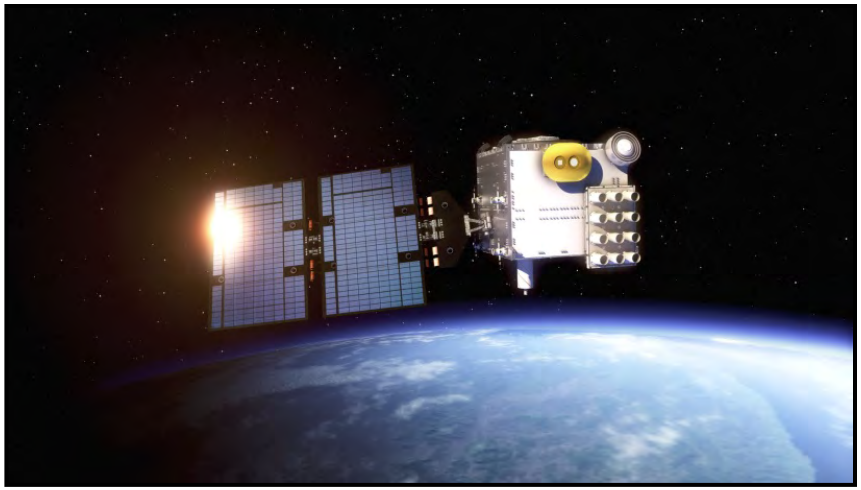


*** Space Weather Payloads**

- All GOES-R instruments integrated on spacecraft
- GOES-S/T/U instruments under development

# COSMIC-2 Mission

COSMIC-2 Mission: Joint NOAA, NASA, DoD and National Space Organization of Taiwan (NSPO) Program



## Mission Overview

- Launch Dates: C-2a: September 2016; C-2b: CY2018 (FY2019)
- Launch Vehicle: C-2a : Falcon Heavy [STP-2 Mission]; C-2b – TBD (rideshare or free-flyer)
- Design Life: 5 years
- Mission: 5 years (on orbit)
- Orbits: C-2a launch – equatorial, C-2b launch – polar inclination

## Mission Objectives

- Follow-on to current COSMIC-1 satellite constellation
- Design concept meets L1RD requirements
  - System will provide 10,000+ worldwide soundings per day
  - All weather, uniform coverage over oceans and land with 30 min average latency
- 12 Satellite Constellation, 2 launches in different inclinations
  - 6 satellites to 24 degree orbit – carries USAF secondary payloads
  - 6 satellites (+ 1 optional spare) to 72 degree orbit – carries Taiwan secondary payloads (planned)

## Instruments

- First Launch:
  - TriG GNSS-RO receiver (TGRS)
  - ***Ion Velocity Meter (IVM)**
  - ***RF Beacon Transmitter**
- Second Launch:
  - TGRS
  - Taiwan-procured Scientific Payloads for second launch are TBD

*** U.S. Air Force provided Space Weather Payloads**

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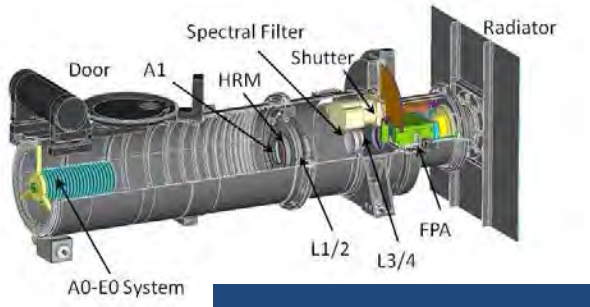
## Space Weather Follow-on (SpWx FO) Plans

- NOAA is exploring a Space Weather Follow-on Program to follow DSCOVR. Highlights of the mission are:
  - A more robust architecture
    - Multiple satellites for long-term continuity
    - Addition of a coronagraph
    - An Ion Sensor
    - Improved plasma measurements for meeting more stringent user requirements – high plasma velocity

## SpWx FO with Compact Coronagraph (CCOR)

- NOAA is collaborating with the U.S. Naval Research Laboratory on the design of an operational Compact Coronagraph (CCOR)
  - CCOR will provide solar coronagraph data continuity by replacing the aging SOHO/LASCA coronagraph capability
  - Data obtained from the CCOR will provide long lead-time forecasts of solar storms
  - The CCOR compact design reduces the sensor optical train by two thirds and mass by one half when compared to current coronagraphs




CCOR Conceptual Design

## Road Ahead

- NOAA will continue to collaborate with NASA on advanced sensor and propulsion technologies that benefit space weather

- NOAA will address assigned Space Weather Operations Research and Mitigation (SWORM) actions over the next several years

## Summary

- Upcoming launches by NOAA and its partners will provide capabilities to better prepare, mitigate, and respond to space weather events
- NOAA is pursuing a new initiative to develop and deploy an operational space weather satellite mission to the L1 Lagrangian point, which will include a solar coronagraph as one of its primary instruments

# Questions?