Thoughts on Some Space App Challenges

by

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and

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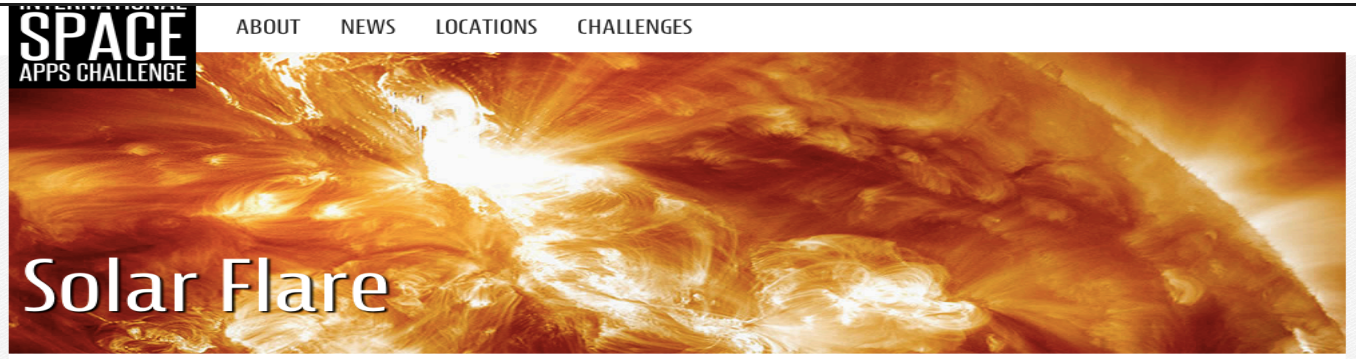
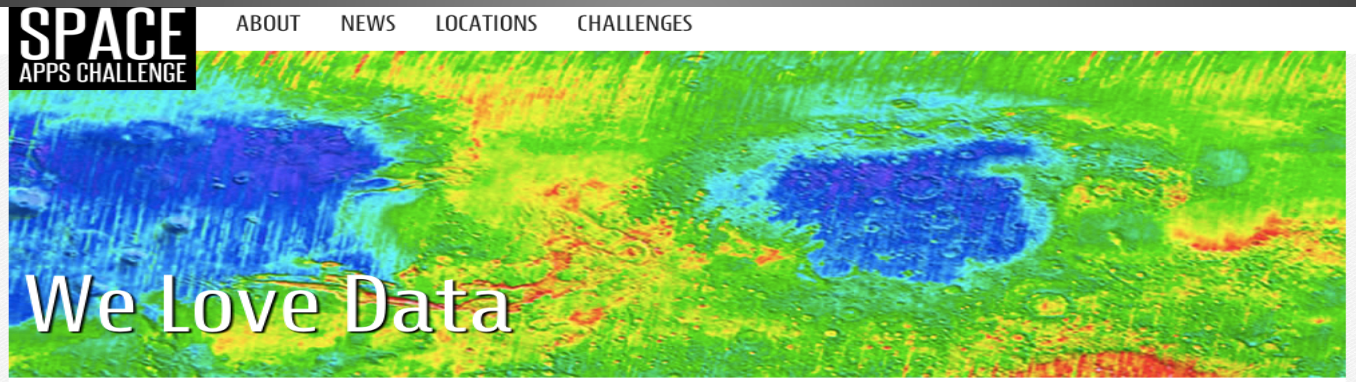


Episodic solar activity has a number of effects. Space weather can disrupt satellite operations, navigation, electric power, radio communications, geophysical exploration and much more.

CHALLENGE:

Create a physical or virtual representation of these invisible (to the human eye) phenomena that can affect so many vital terrestrial activities.



This open ideation challenge will create a large-scale virtual community dialogue to "think outside of the box" on ways we can engage and use spaceflight data - and local experiments on how to make that tangible.

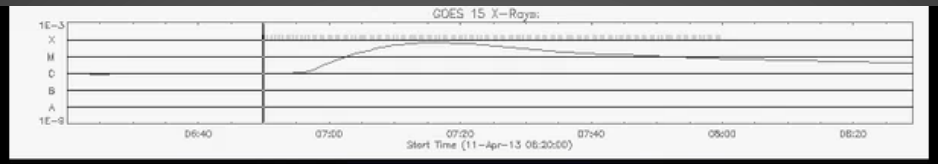
CHALLENGE:

How can we encourage people to interact with space data in new and meaningful ways to promote space enthusiasm, education, research? Can this be done on a global scale with universal appeal? Could this be applied to other fields?

The Challenges

- Big data:
  - Terrabytes/day of space physics data
  - How to share/analyze it in meaningful ways?
  - What does meaningful mean? Who would use it?
- Data Visualization?
  - How to connect/combine datasets?
    - NASA's SPICE library for solar system positions
    - Common visualization techniques for different missions?
    - SolarSoft (package for IDL – interactive data language)
    - AstroPy/SpacePy?
  - How to visualize multidimensional data in an easy way?
  - Interactive visualization = deeper insight for all

Big problem for scientists as well!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1E-3
X
M
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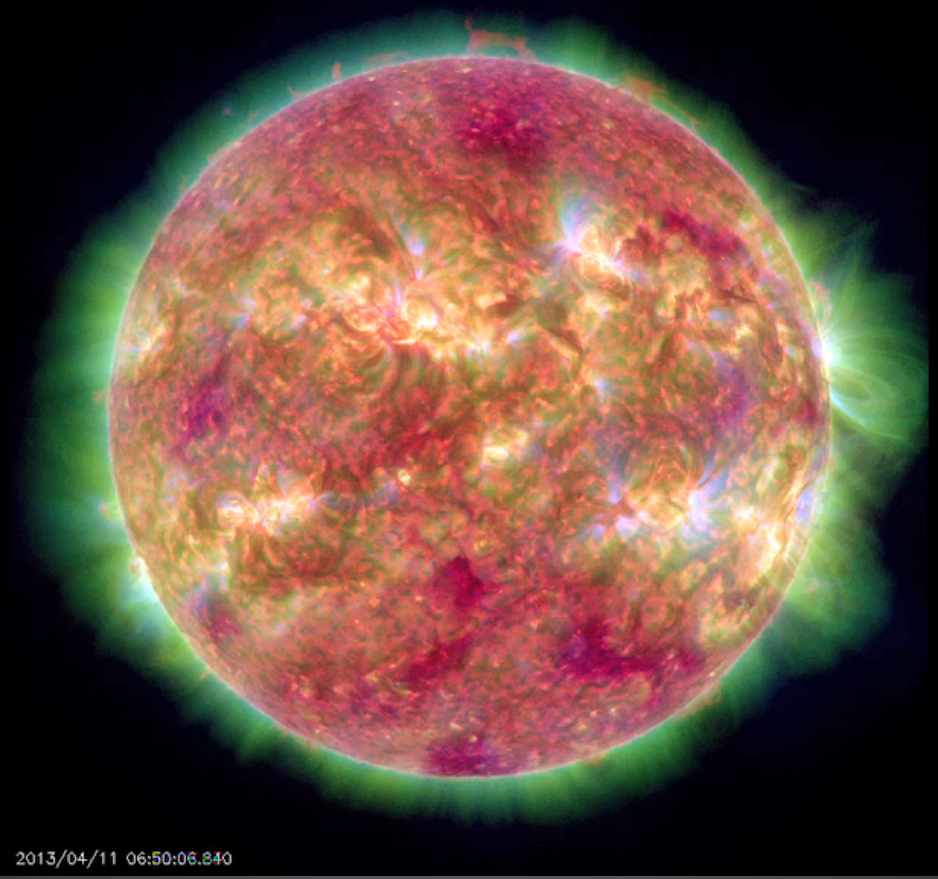
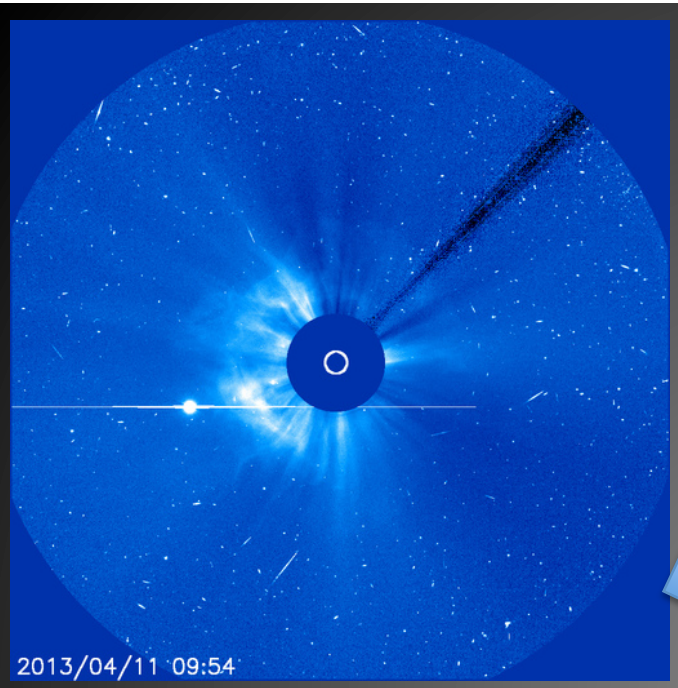
Start Time (11-Apr-13 06:20:00)


2013/04/11 06:50:06.840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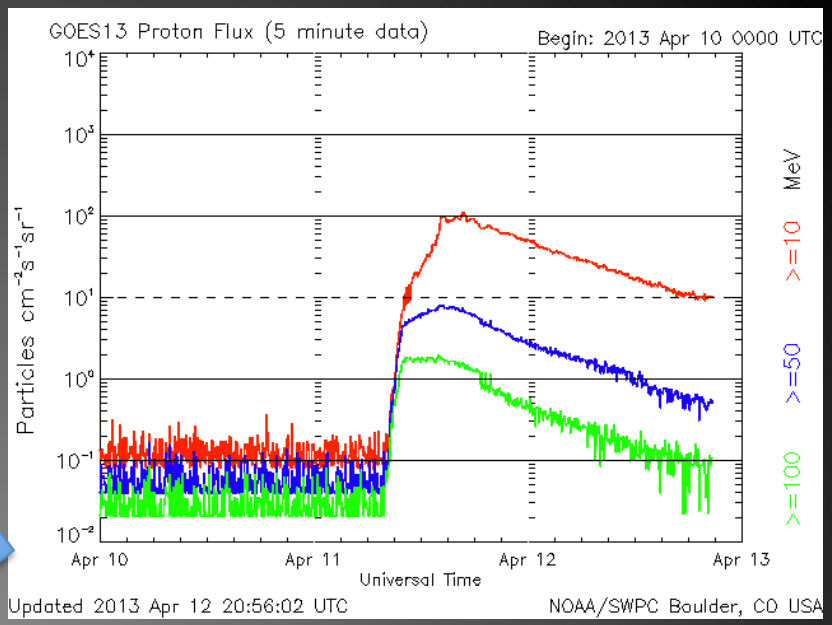
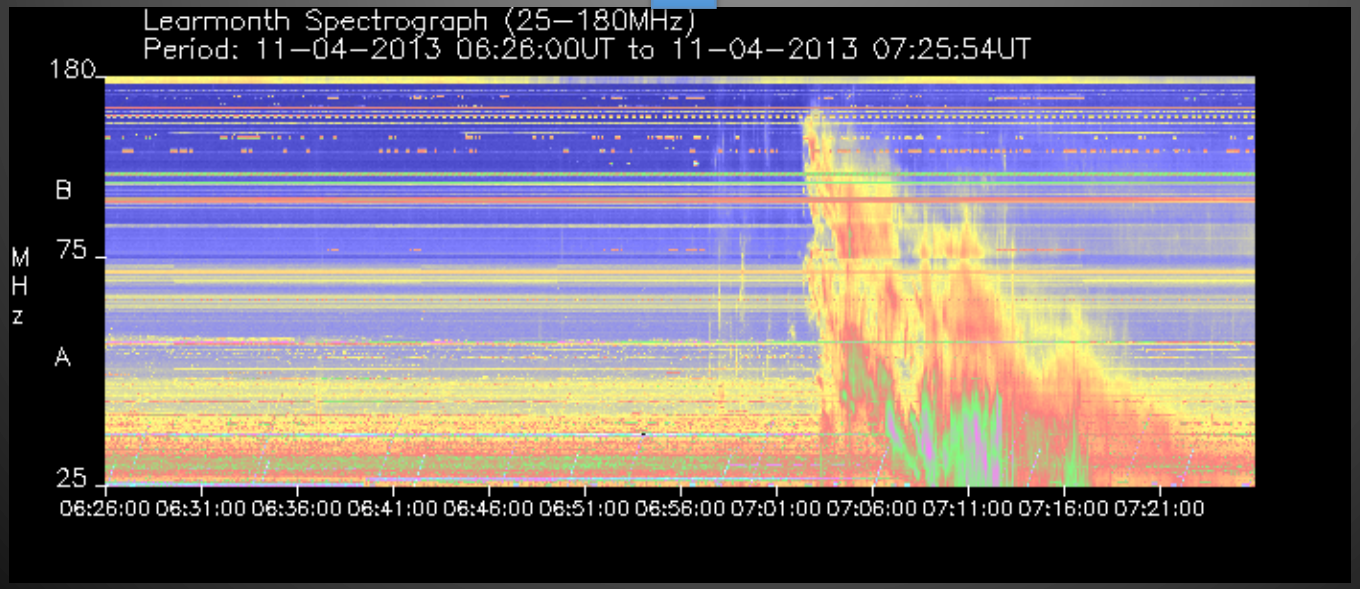
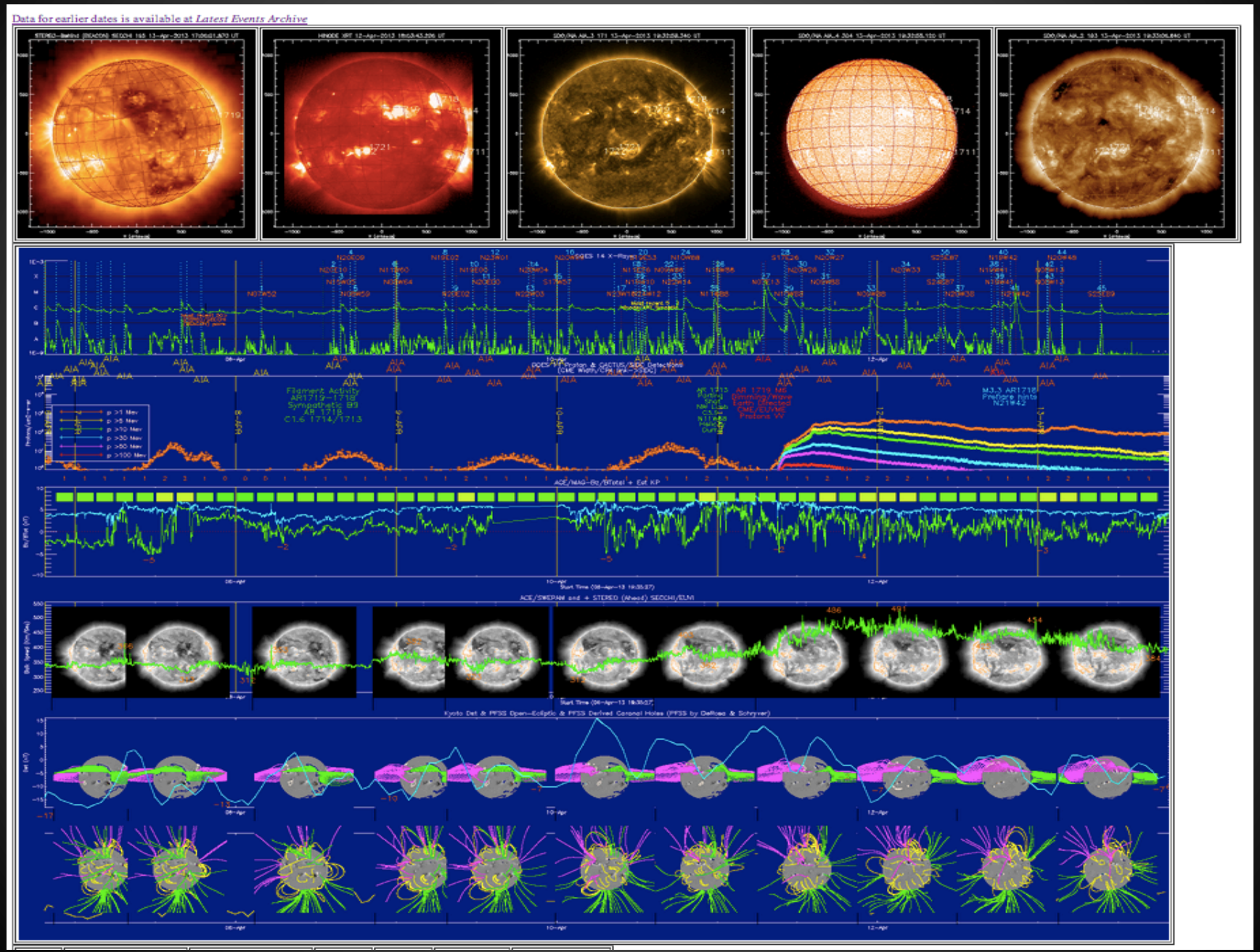
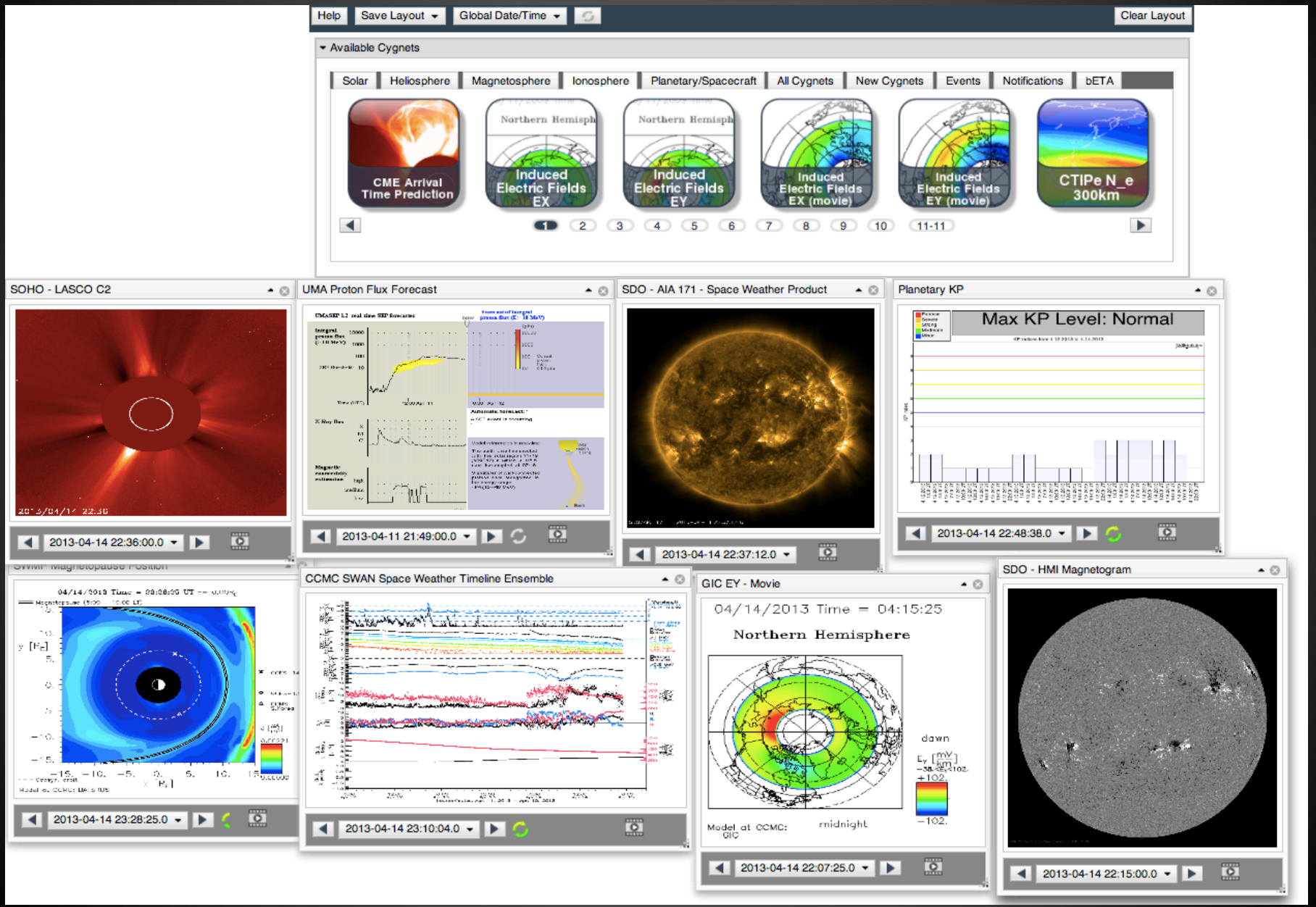

GOES13 Proton Flux (5 minute data)
Begin: 2013 Apr 10 0000 UTC
Particles cm⁻²s⁻¹sr⁻¹
Apr 10
Apr 11
Apr 12
Apr 13
Universal Time
>=10 MeV
>=50
>=100
Updated 2013 Apr 12 20:56:02 UTC
NOAA/SWPC Boulder, CO USA


Learmonth Spectrograph (25–180MHz)
Period: 11–04–2013 06:26:00UT to 11–04–2013 07:25:54UT
180
B
75
MHz
A
25
06:26:00 06:31:00 06:36:00 06:41:00 06:46:00 06:51:00 06:56:00 07:01:00 07:06:00 07:11:00 07:16:00 07:21:00

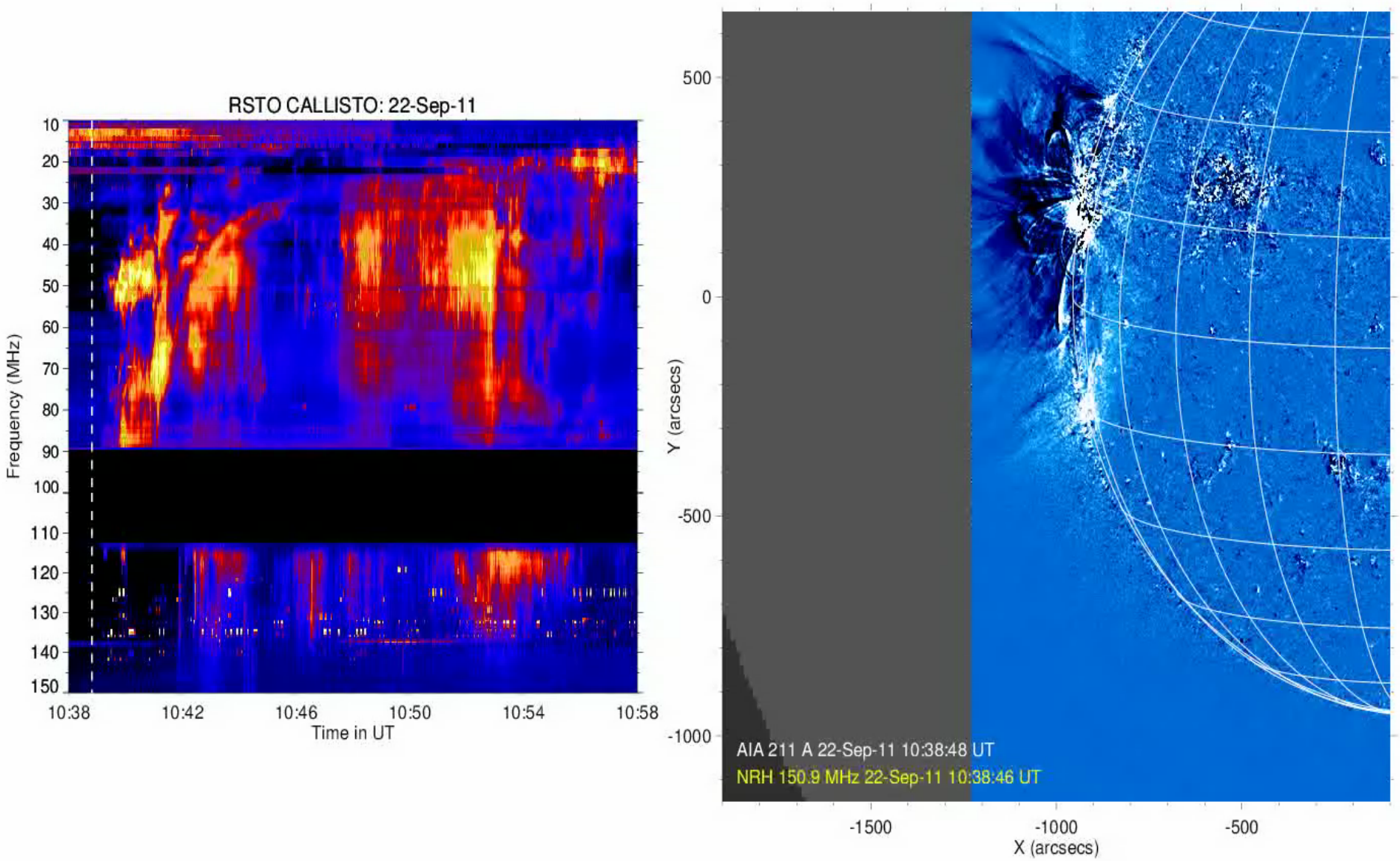
http://www.lmsal.com/solarsoft/latest_events/



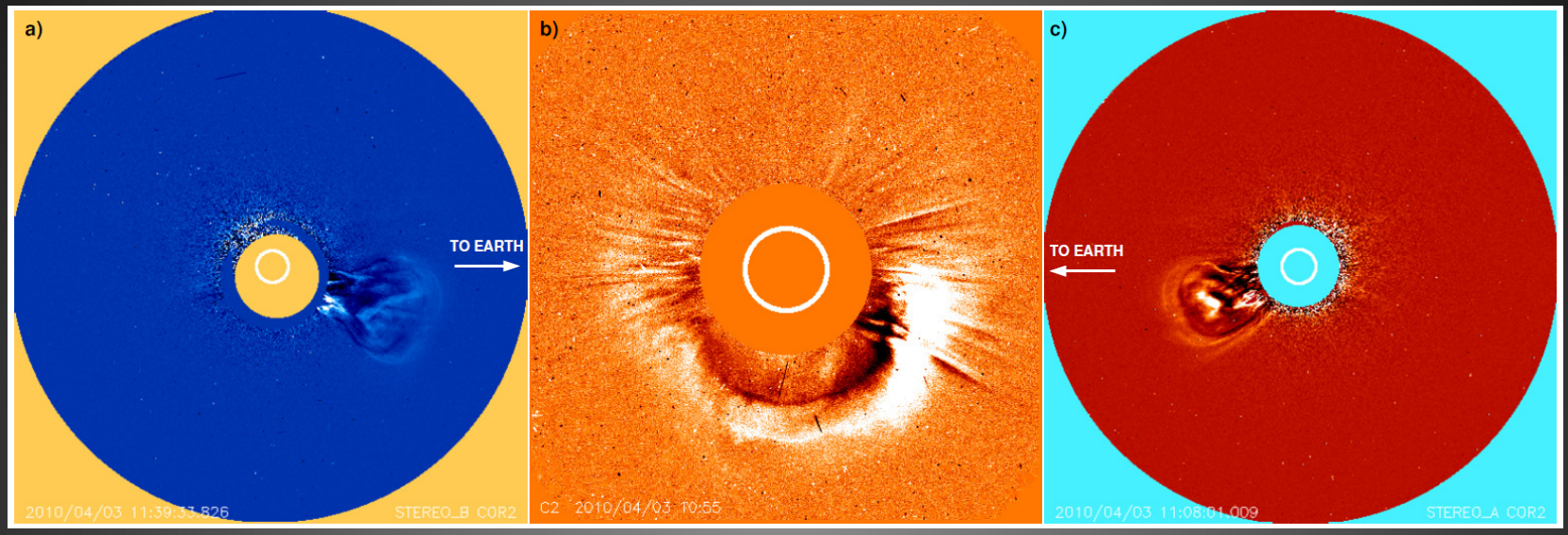
http://iswa.ccmc.gsfc.nasa.gov/

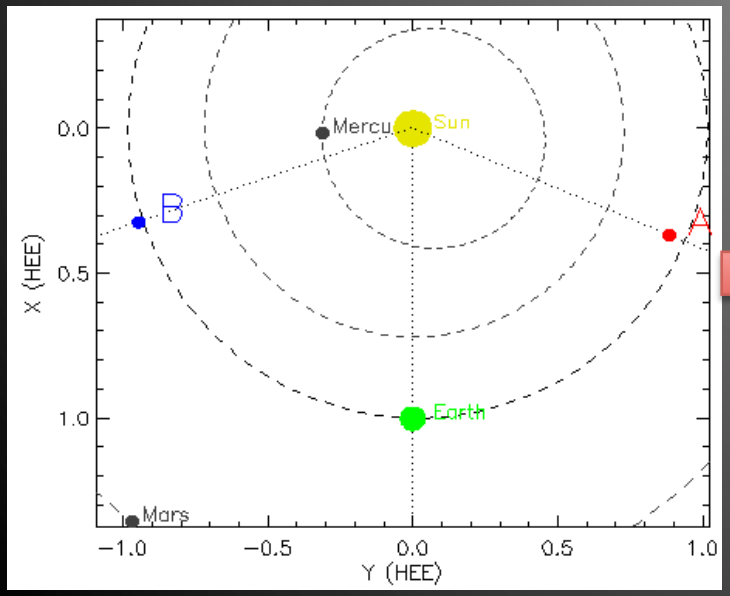


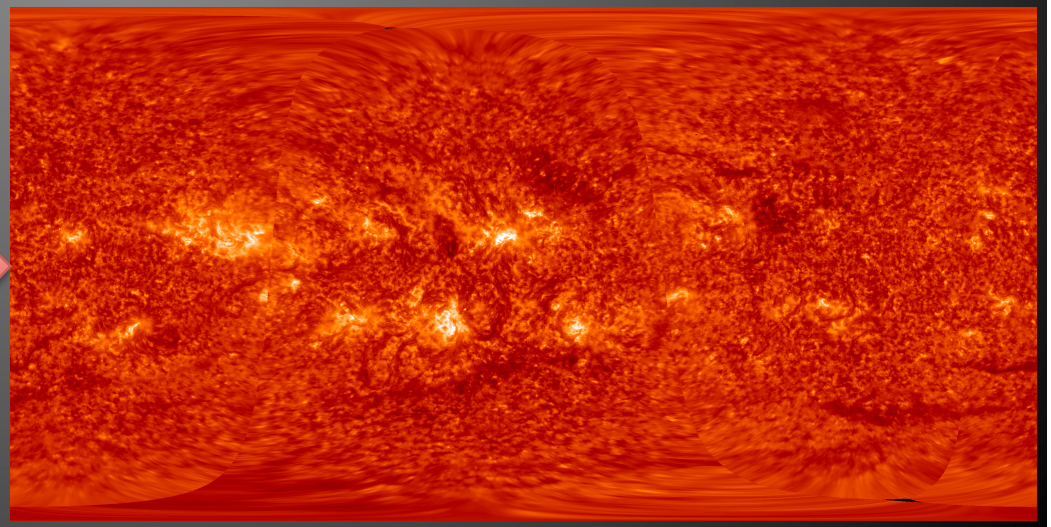
Combining Datasets for Analysis



Multi-viewpoint solar imaging!

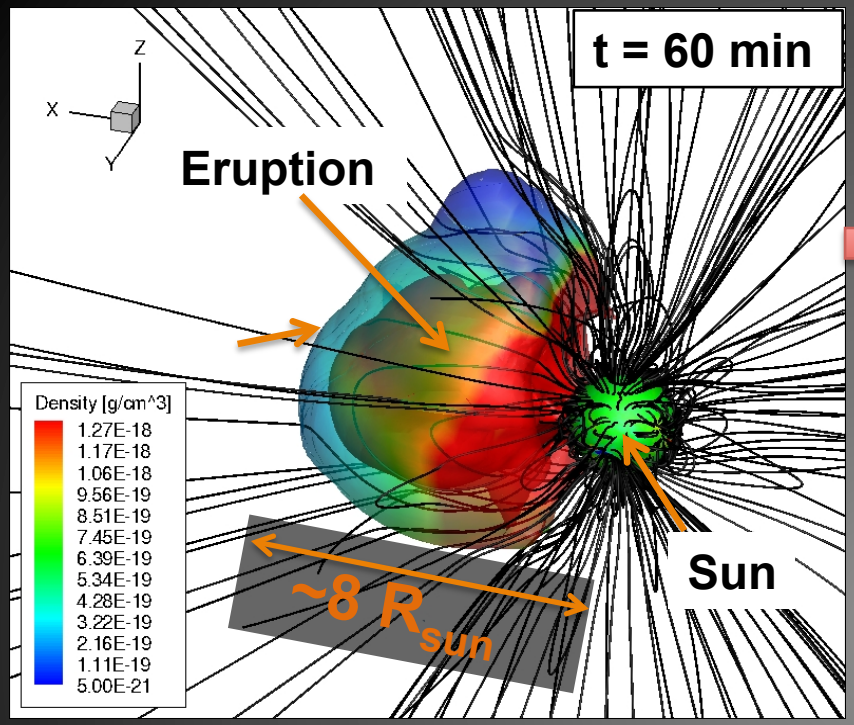


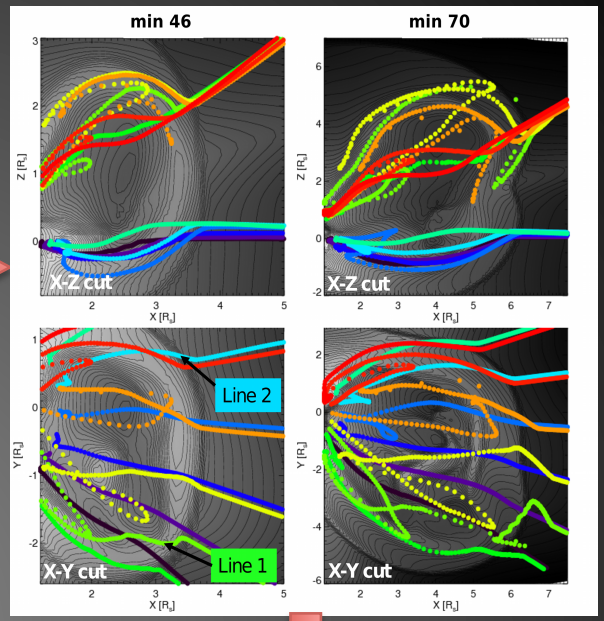


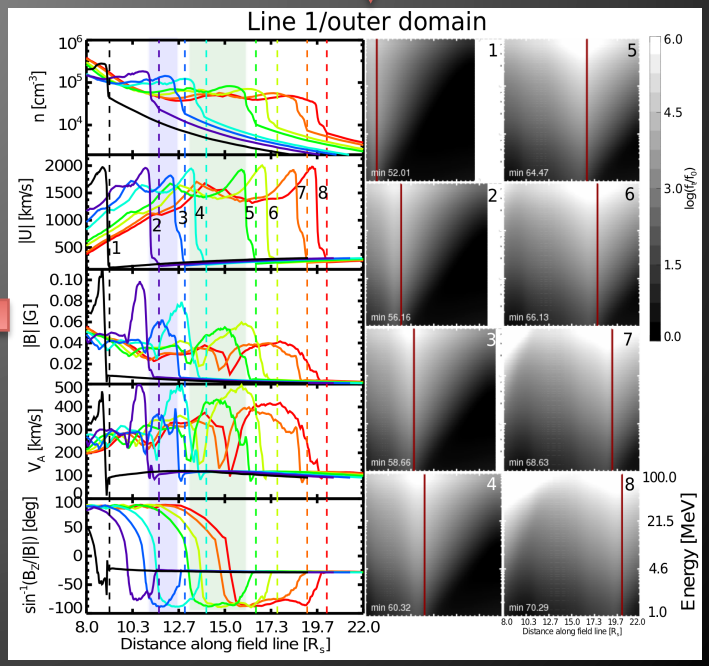


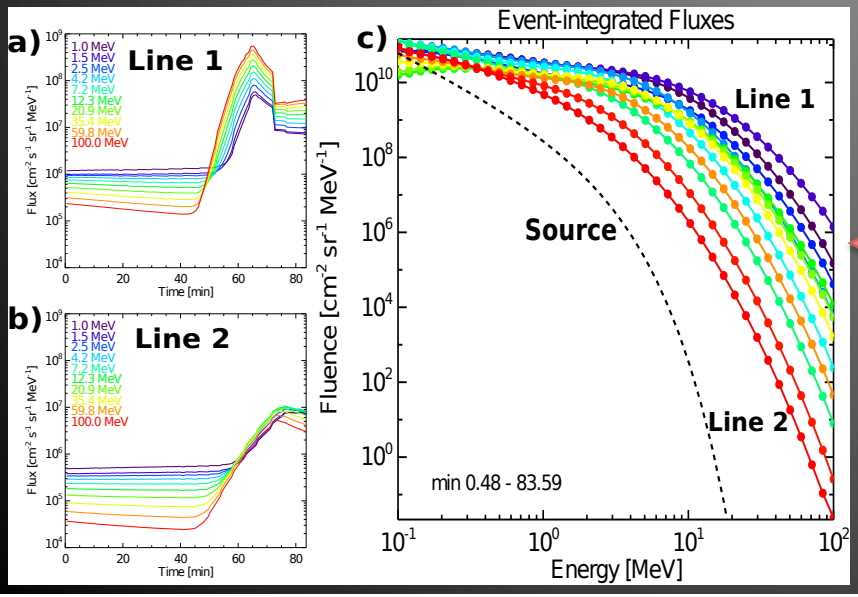
REAL-TIME 360-DEGREE MAP OF THE SUN!

Visualization of numerical simulations









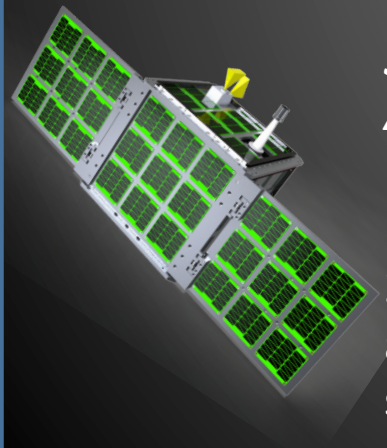
About Me:

Nate Darling
Staff Researcher at Boston University
BA Spanish Language
MS Mechanical Engineering
Interests: Small spaceflight projects (rockets, balloons, CubeSats), engineering STEM education and outreach, supporting research.

Projects:

The Venus Spectral Rocket (VeSpR)
Vacuum ultraviolet telescope payload deployed on sounding rocket, mission to understand water history of Venus.

ANDESITE
Ad-hoc networking demonstration using multiple magnetometer nodes to map the fine-scale structure of earth's magnetosphere.

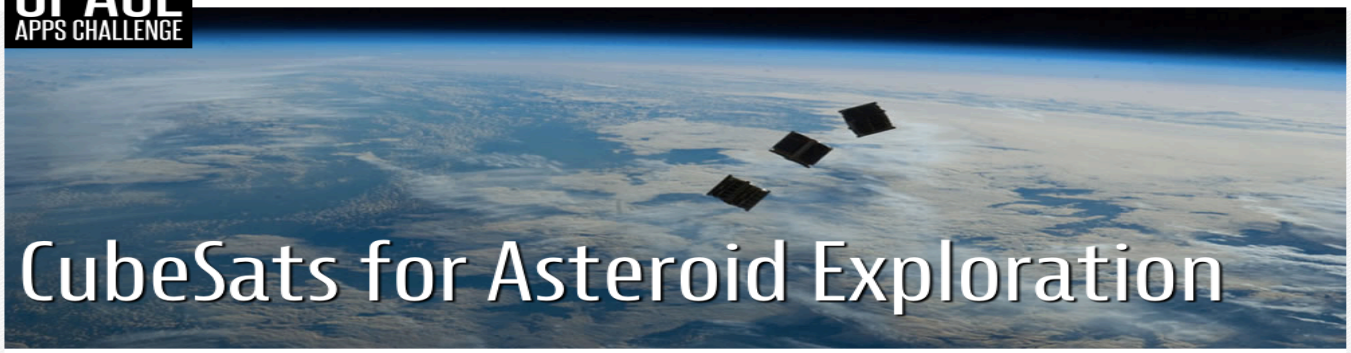


The Boston University Student satellite for Applications and Training (BUSAT
Modular, plug-and-play 27U CubeSat bus, auroral imager, electron spectrometer.

NASA Flight Opportunities
Microgravity test flight program for BUSAT's deployable solar panels.

SPACE APPS CHALLENGE

ABOUT NEWS LOCATIONS CHALLENGES



Description:

1. A website publicizing interplanetary destinations for CubeSats
2. Publicize available launch opportunities
3. Challenge public to find realistic trajectories
4. Foster collaborative discussion about interplanetary CubeSat mission design
5. Help to build an "interplanetary atlas" for such missions
6. Help discover what is possible for CubeSat exploration
7. Additional Challenge: Consider ways you could use a CubeSat to provide information about an asteroid

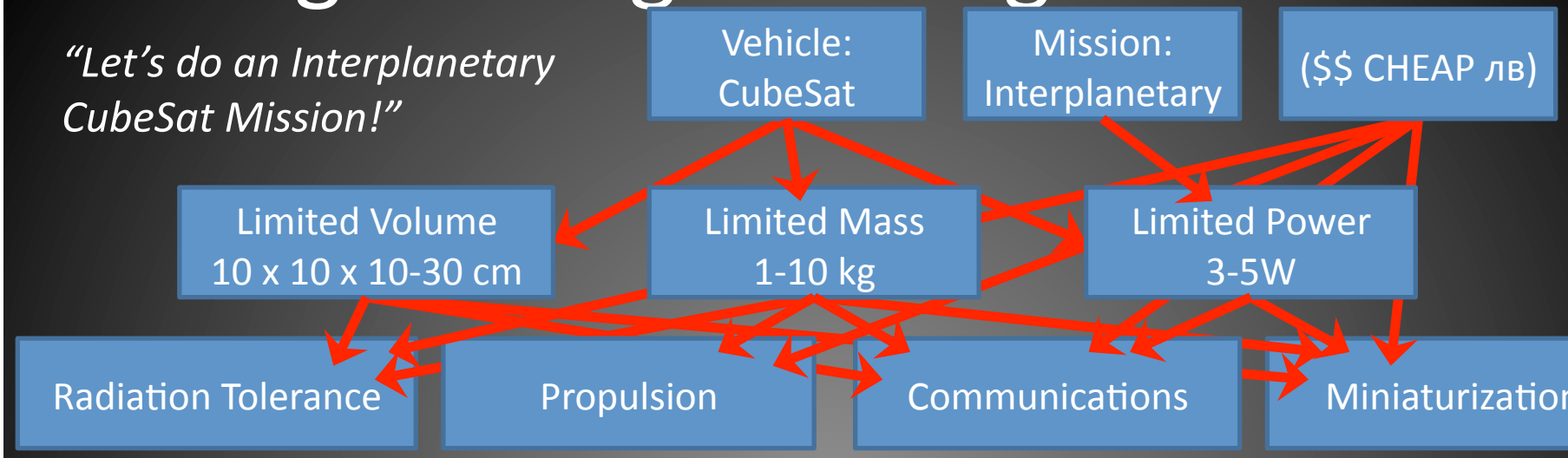
Items to consider:

1. Near-Earth asteroids
2. Interplanetary missions
3. 2015 launch date
4. Current propulsion technology
5. Standard CubeSat size
6. Reasonable power requirements
7. NASA's GMAT

Complicated…

The Engineering Challenge

"Let's do an Interplanetary CubeSat Mission!"



As vehicle volume and mass are limited, your ability to place shielding is also constrained. This means more money spent on radiation-hardened electronics, or higher risk of mission failure when a single-event upset or latchup occurs.

Low mass means you can't carry lots of propellant, which limits how much acceleration you afford on your mission for adjusting the attitude and changing your orbit. This is important for getting to your destination, but also affects communications.

Limited power generation ability (you don't have very much surface area to cover with solar panels) means that your communications system cannot consume very much power in getting the signals back to earth, and CubeSats can't have big antennas.

Often, missions are accomplished with remote sensing instrumentation developed for terrestrial or large format applications. Can the science be done with small form factor and power budget?

Space systems engineers tackle the complexity by creating a list of requirements – starting from the top with a mission statement.

Requirements Example

Mission Statement:
My CubeSat will go to the far side of the moon and record radio frequency noise to learn about the history of the universe.

The "Big Picture"

Exactly what you have to do in order to achieve the mission goals

Objectives:
Record radio frequency data from XXX MHz to XXX MHz within XX km of the dark side of the lunar surface between longitude XX.XXX and XX.XXX for at least XX minutes, transmit data to earth.

Exactly what each system has to do in order to support the mission

Structural requirements:
- Survive launch vibration
- Shield electronics from radiation environment

Propulsion requirements:
- Provide enough delta V to achieve lunar orbit

Power requirements:
- Provide enough power for communications system, propulsion system, thermal management system

Thermal requirements:
- Keep satellite electronics within operating temperature range

Your Job

Introduce the public to the realities of CubeSat space exploration by

1. characterizing the major players in a satellite's life. This could include:
   - ***Hardware*** (structure, solar panels, propulsion system, radio, antennas, shielding, heaters, coolers, cameras, sensors, single board computers)
   - ***Missions*** (planets, asteroids, science questions to be answered)
   - ***How to get there*** (Launch vehicles, the "interplanetary highway", secondary payload launch opportunities)
   - ***Ground-based systems*** (radio ground stations, telescopes)

2. introducing the public to the engineering constraints imposed when several of these components are chosen or combined:
   - Incorporate a feature that emulates requirements tracking ("so you want to go to the moon? … OK, you're going to need …").
   - Incorporate a feature that tracks interdependencies of the mission ("so you want a bigger propulsion unit? … OK, that's gonna cost you …").

ssion design video game?

Possible Missions

- Mineral surveys of asteroids
- Solar system escape
- Space weather monitoring
- Phobos sample return
- Earth-moon radio-quiet observatory
- Out-of-Ecliptic

(from Robert Staehle NASA/NIAC talk)

http://amsat-uk.org/2013/03/09/interplanetary-cubesats/#more-14592