

National Aeronautics and Space Administration



# The Integrated Space Weather Analysis System

*Marlo Maddox*

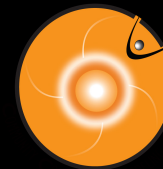
*Space Weather Training For Mission Operators*

*January 28<sup>th</sup>, 2014*

*NASA Goddard Space Flight Center*

*Greenbelt, MD*

<http://ccmc.gsfc.nasa.gov>



www.nasa.gov

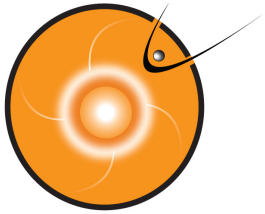
# How Do You Quickly Determine Past, Present, & Expected Space Weather Impacts?



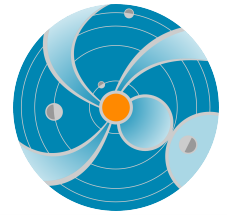


With so many NASA assets throughout the Heliosphere, the agency identified a critical need for the

# Integrated Space Weather Analysis System



# iSWA Project Overview



## **OCE Technical Excellence Initiative Project**

- Partnership between NASA HQ OCE, SWL, CCMC, & AETD
- Address technical challenges in acquiring space weather environment information
- Began March 2008
- Version 1.0 deployed November 2009

## **Fundamental Challenges To Be Addressed**

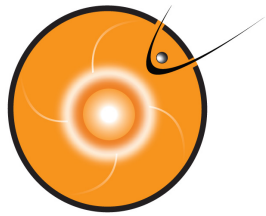
- Existing space weather resources are diverse and scattered
- Data accessibility
- Accurate real time now-casting & forecasting of the space environment
- Historical space weather impact analysis

## **Initial Requirements Gathering**

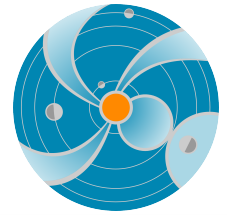
- GSFC SSMO, JSFC SRAG

## **Refined Requirements**

- Space Weather Workshops for NASA Robotic Missions

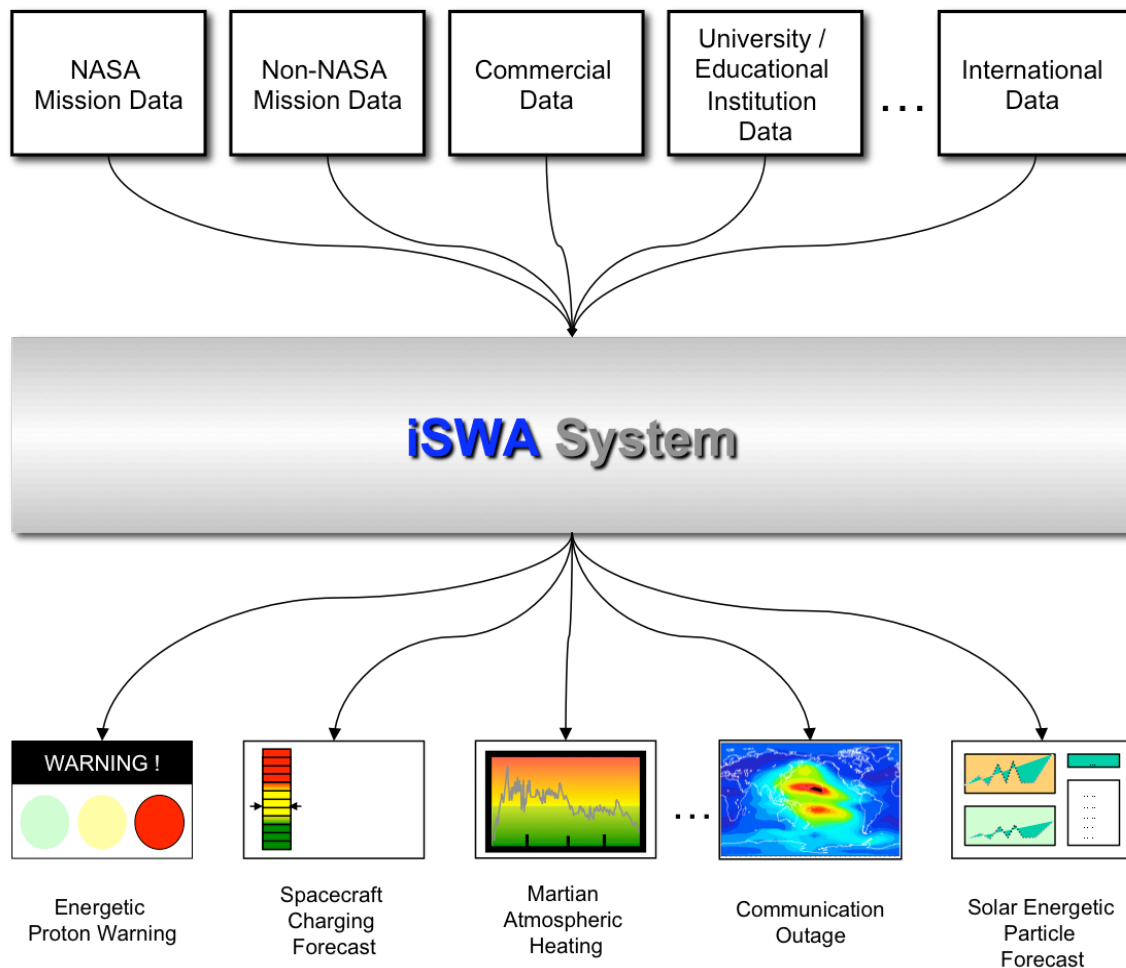


# iSWA Solution & Deliverables



1. Acquire, ingest, and produce NASA relevant space weather information
2. Utilize both observational and simulation/model data
3. Produce and provide real-time data streams
4. Categorize and archive data for historical impact analysis
5. Provide customizable and highly configurable displays
6. Disseminate through the most widely deployed and accessible interface – the web

# INTEGRATED SPACE WEATHER ANALYSIS SYSTEM

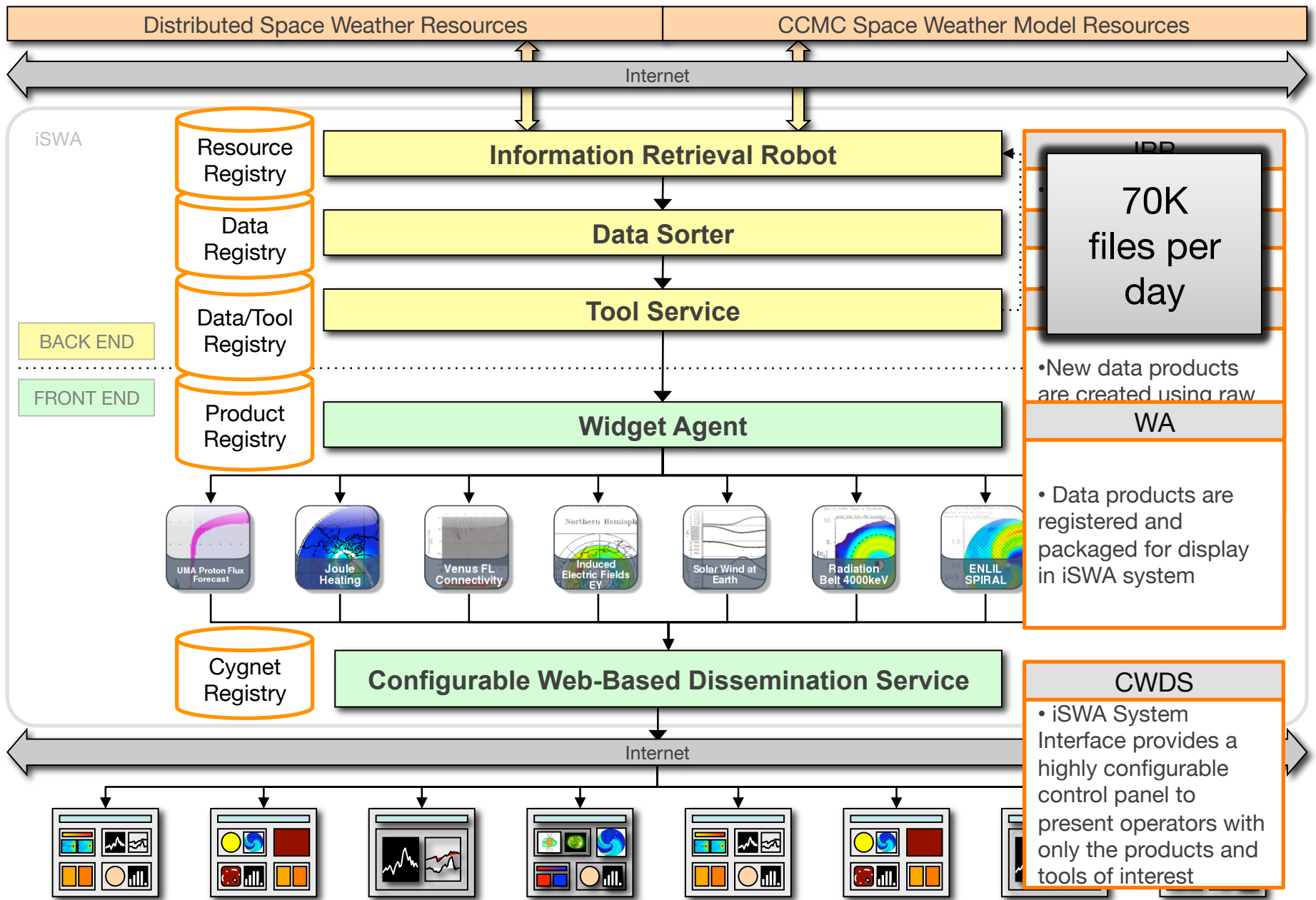


Highly diverse and distributed space weather data consisting of the latest observational data along with the most advanced space weather model simulation output.

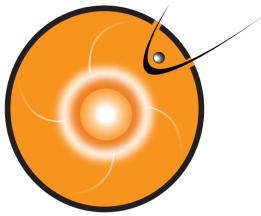
iSWA system collects data from a large and evolving list of sources. Data is sorted, characterized, and processed into 'mission decision supporting' products in response to individual user queries.

iSWA generates and provides a user-configurable display panel that can be accessed from a standard web browser. The end user can then customize their display to focus on specific products of interest.

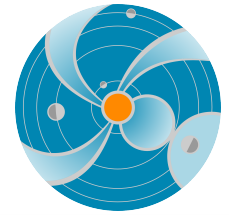
# INTEGRATED SPACE WEATHER ANALYSIS SYSTEM



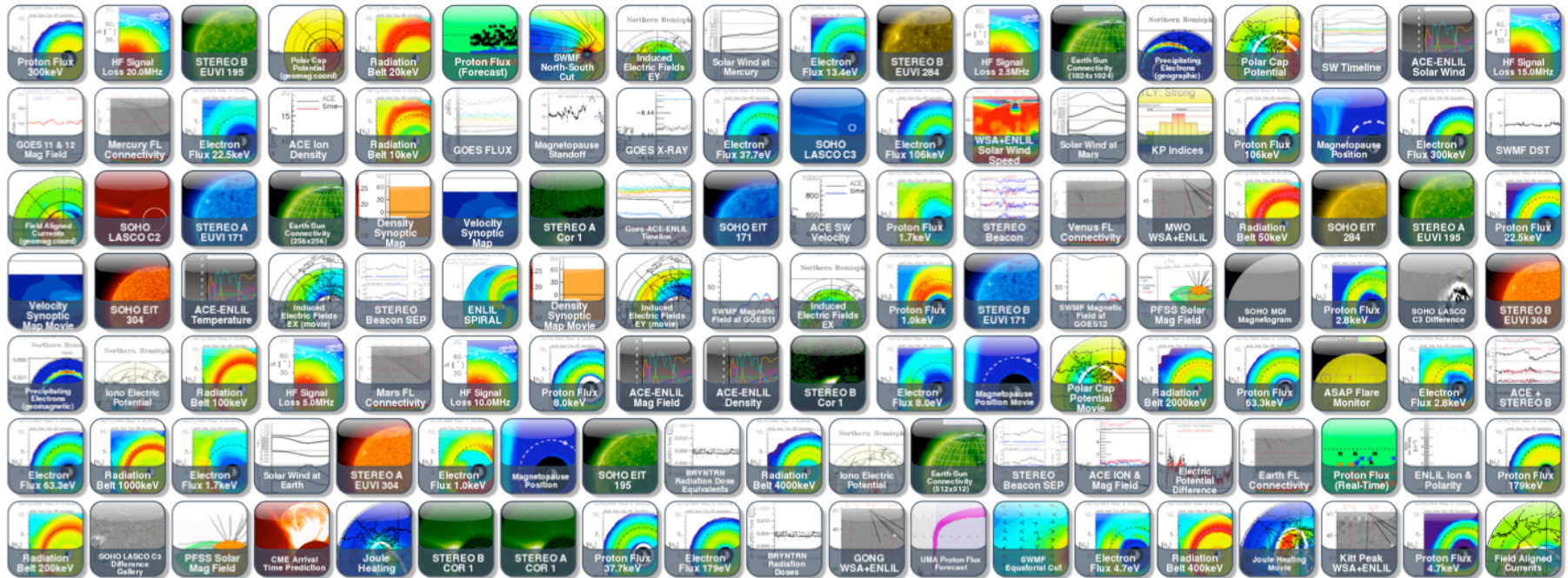
• **493** Unique Data Feeds, **57** Million Files Registered and Archived, **359** Consumable Display Products currently managed in iSWA Cygnet Catalog



# Innovative Dissemination



ISWA has ~300 products including modeling results and comprehensive sets of observational data.

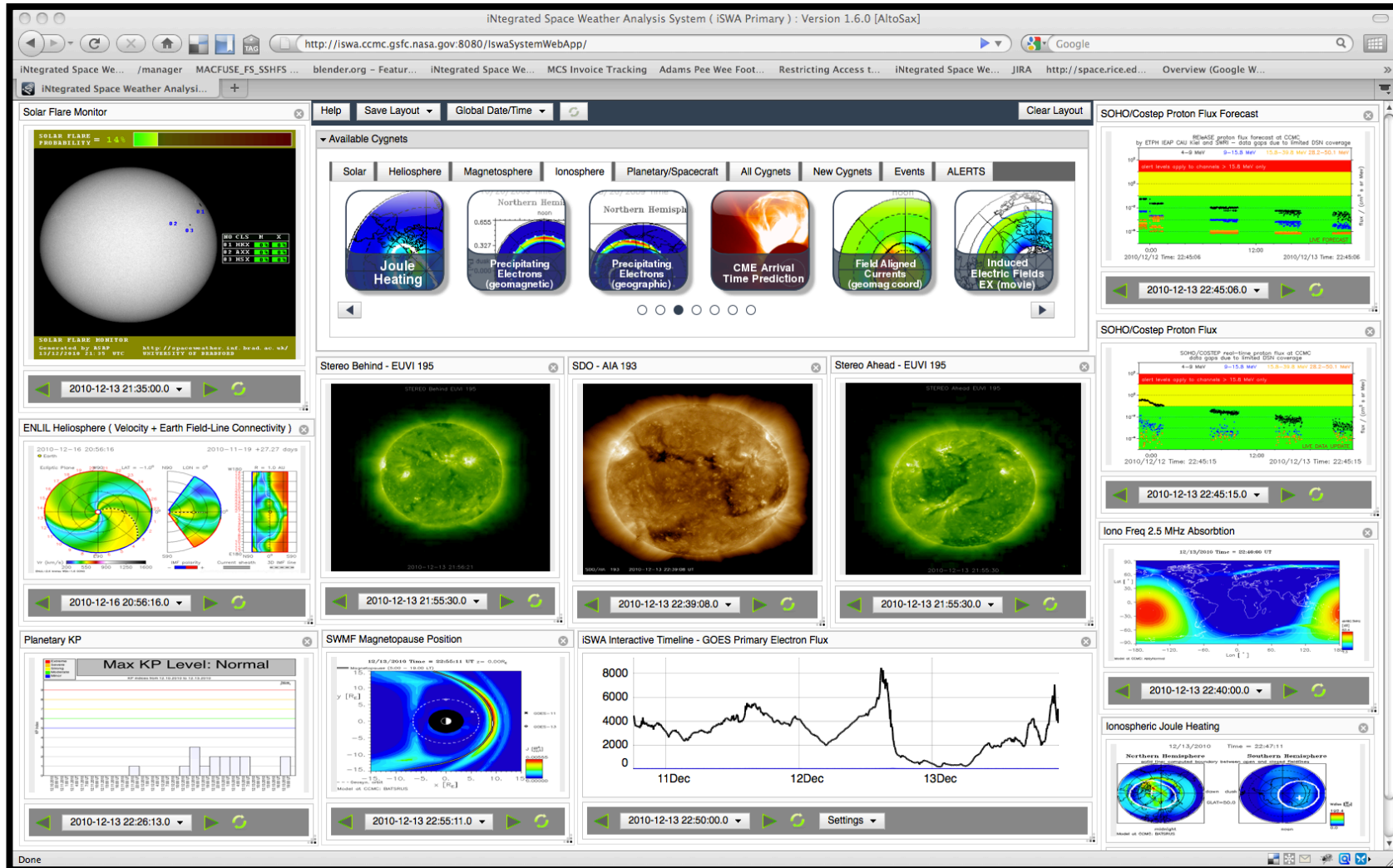


Web-based. User configurable. Available world-wide.  
One-stop shop for state-of-the-art information!  
<http://iswa.gsfc.nasa.gov>





# Unprecedented Access to Space Weather Information



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

Help Save Layout Global Date/Time Clear Layout

**Layout & Global Controls**

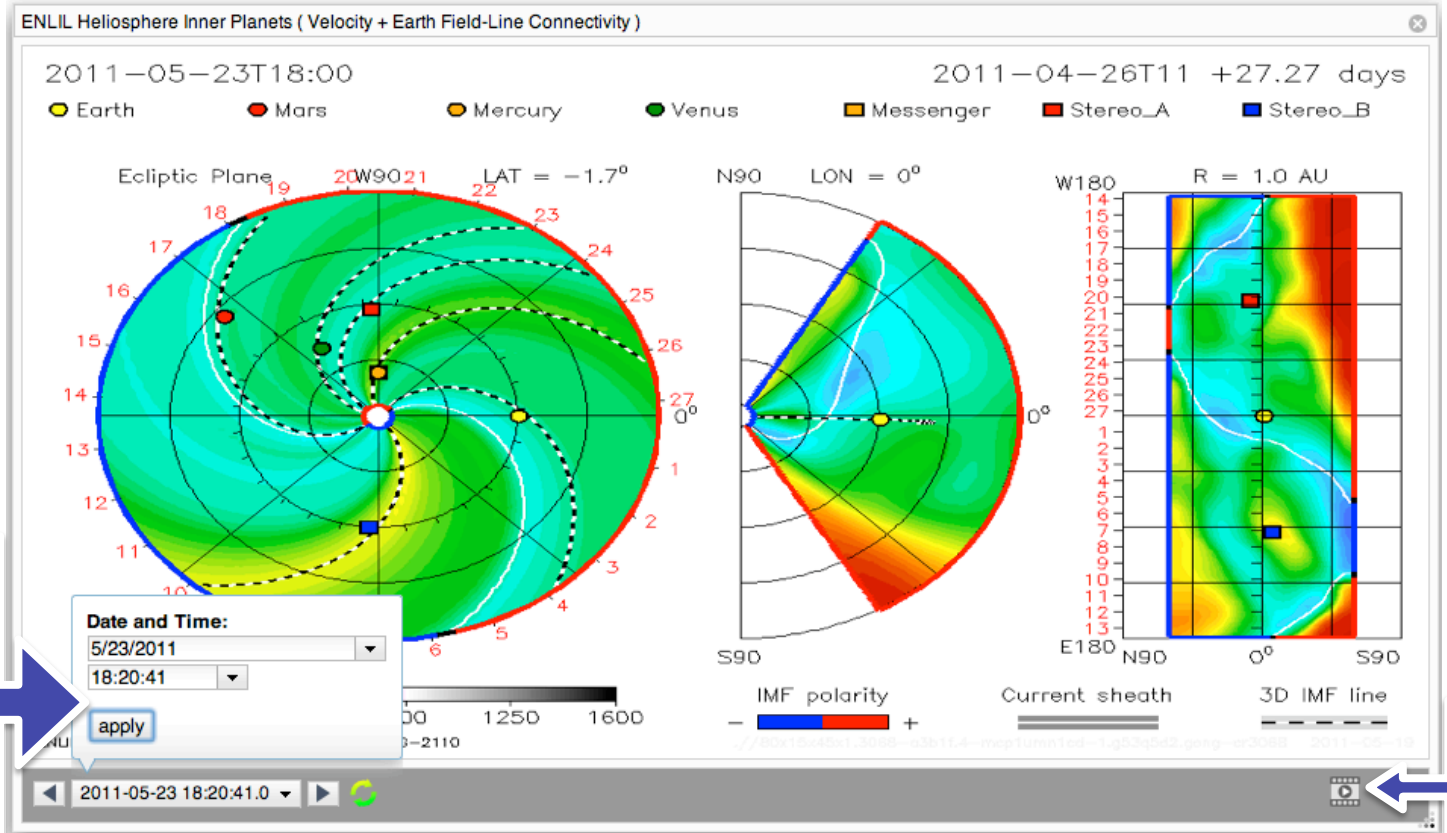
Available Cygnets

Solar Heliosphere Magnetosphere Ionosphere Planetary/Spacecraft All Cygnets New Cygnets Events ALERTS bETA

CME Arrival Time Prediction ASAP Flare Monitor UMA Proton Flux Forecast SOHO EIT 171 SOHO EIT 171 (NRL) SOHO EIT 195

1 2 3 4 5 6 7 8 9 10 11-15

Cygnets Control Panel



Cygnets Date Controls Options

Movie Mode Control

# Dynamically Generated & Interactive Products: Solarscape



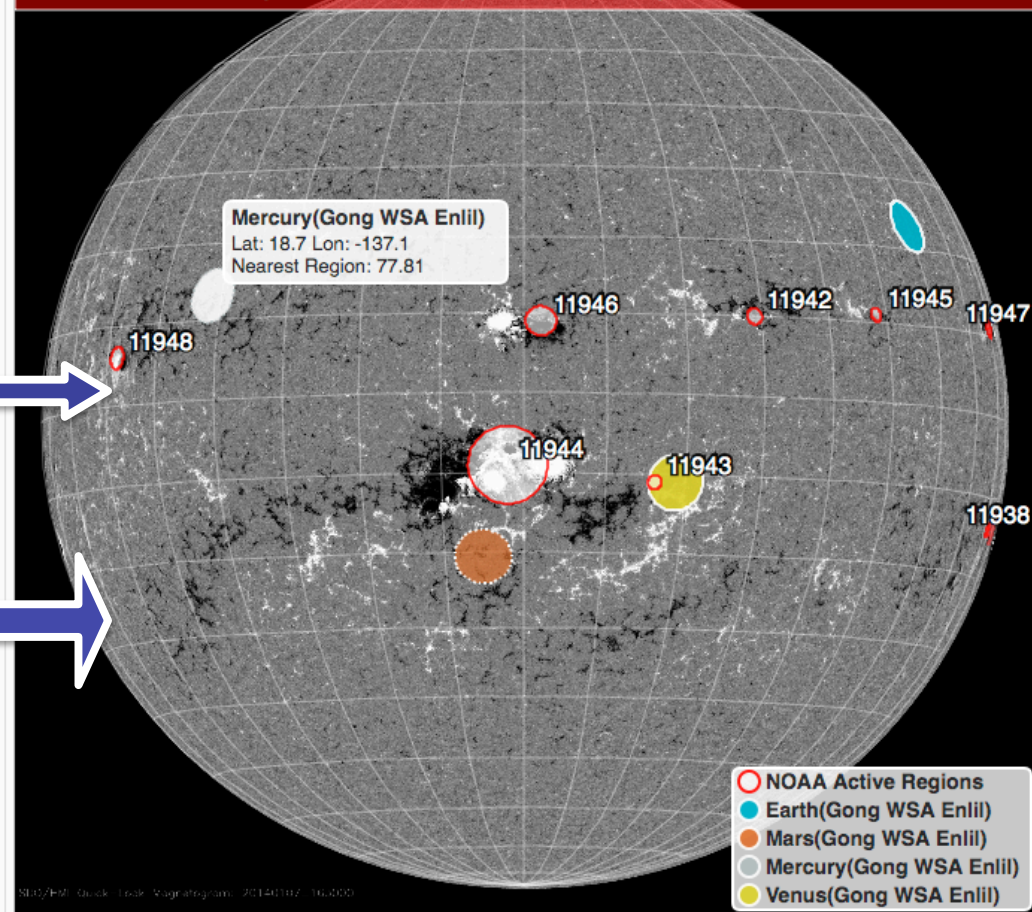
Alerts/  
Notifications

Magnetic Connectivity Solarscape Viewer

Notification: Earth(Gong WSA Enlil): 16.6 degrees from active region.  
Notification: Venus(Gong WSA Enlil): 2.6 degrees from active region.

User Selectable Features  
( MAG4, NOAA Active Regions,  
CCMC Magnetic Connectivity )

User Selectable Background  
( SDO , Generic Grid )



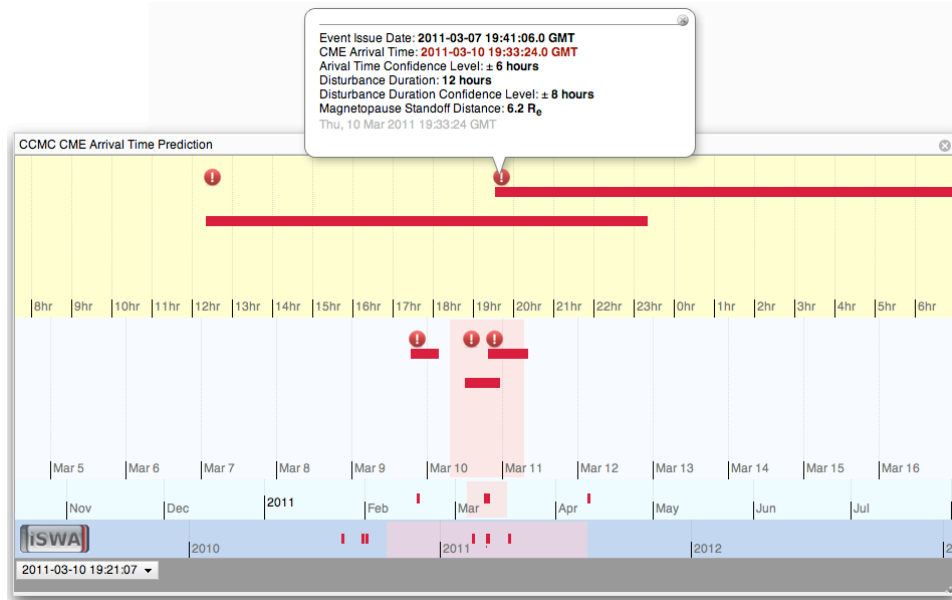
5127PM Quick Look Magnetogram 20140107 16:000

2014-01-07 16:30:00 Background Features

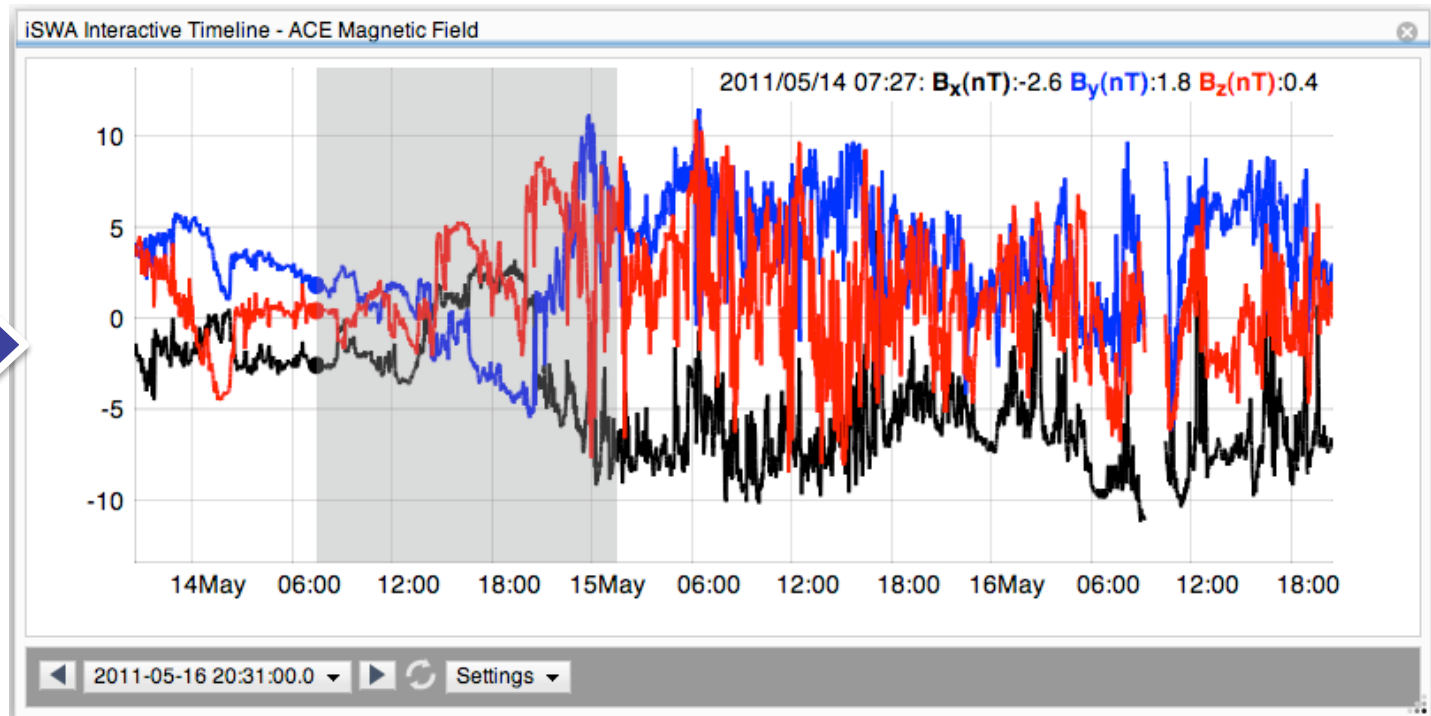
Dynamic Product with User Selectable Features From Several Sources

# Interactive Timelines

Interactive CME alert tool with chronological record of SWx Center issued CME time of arrival predictions

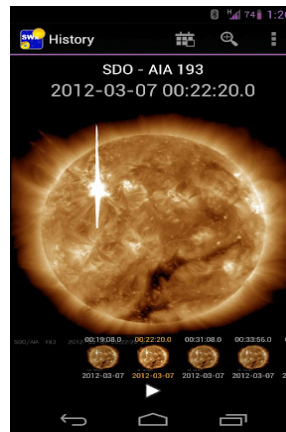
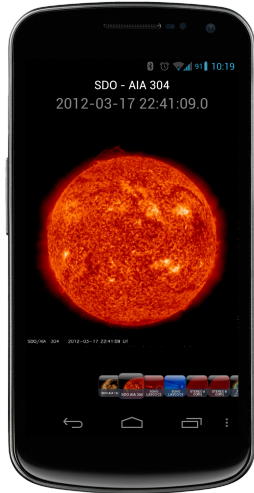


Interactive timeline tool with pan, zoom, mouse-over, and quantity toggling functionality



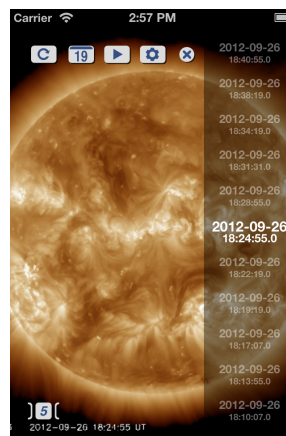
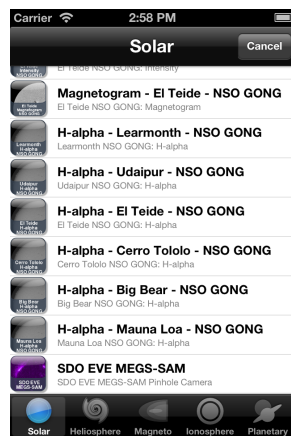


# Mobile Access Powered by iSWA



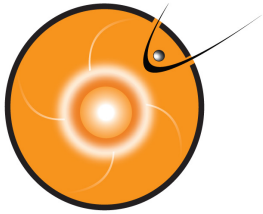
## Android Front-End to iSWA

- History Mode
- Movie Mode
- >50k Downloads
- Available in Google Play Store

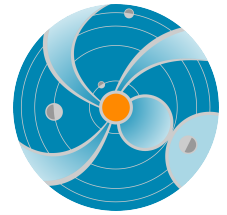


## iOS Front-End to iSWA

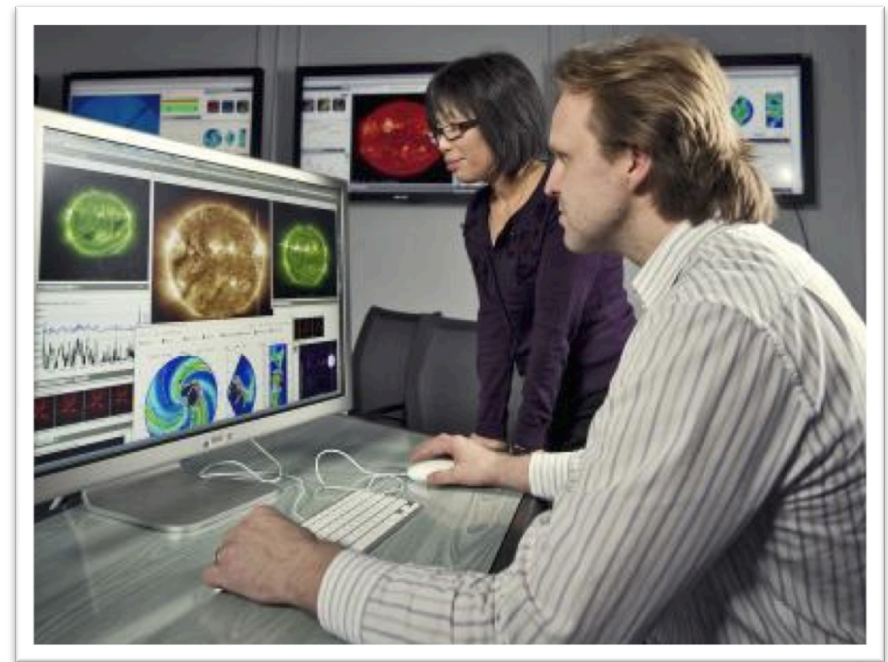
- >100k Downloads
- Available in App Store

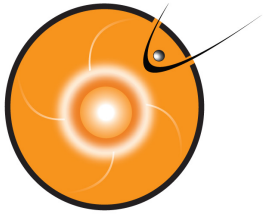


# Services for NASA Robotic Missions Powered by iSWA

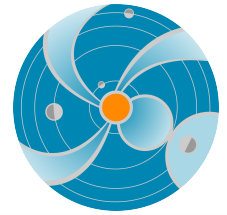


1. Providing assistance in spacecraft anomaly resolution by assessing whether space weather has any role in causing the observed anomaly/ anomalies.
2. Sending out weekly space weather reports/ summaries to NASA mission operators, NASA officials and involved personnel.



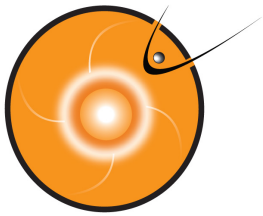


# Services for NASA Robotic Missions Powered by iSWA

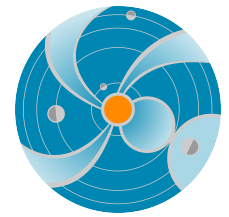


3. Sending out timely space weather info/forecasts regarding adverse conditions throughout the solar system, such as significant CME events, elevated radiation levels, etc.
4. Providing general space weather support for NASA customers.





# Education And Training Powered by iSWA



Arranged by NASA IV&V Educator Resource Center  
High school teachers from West Virginia

Y. Zheng



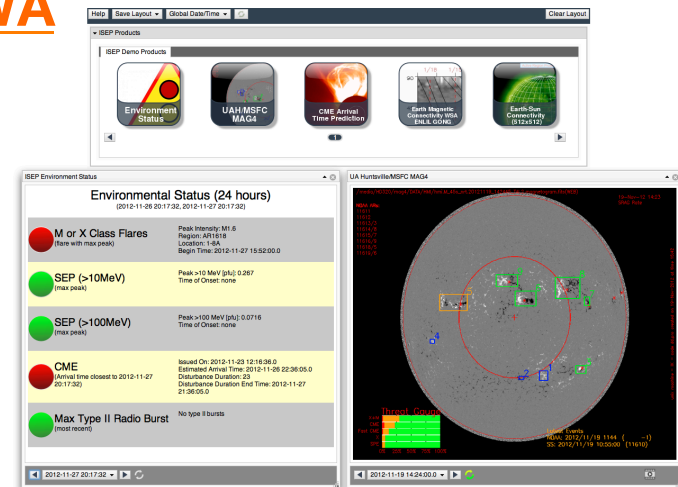


# iSWA Updates/Activities



## New Systems/Extensions Powered by iSWA

- Project specific implementations
- Full iSWA feature set, infrastructure
- customized cygnet/product catalog
- **I**ntegrated **S**olar **E**nergetic **P**roton Event Alert Warning System – Advanced Radiation Project (OCT Game Changing Office)



## Expanded Numerical Database

- New parameters
- Custom alerts
- Dynamically generated products
- Data streaming for external applications

## Web Services

- Building web-based interfaces for machine-to-machine interaction
- Enabling external systems to query, access, and link to iSWA data

## Space Weather Event Catalog and Event Linking

- Building catalog of space weather event, forecaster-logs, alerts, etc.
- Establishing linkages, relationships, cause-and-effects between activities

iNtegrated Space Weather Analysis System ( iSWA Primary ) : Version 1.6.0 [AltoSax]

http://iswa.ccmc.gsfc.nasa.gov:8080/IswaSystemWebApp/

iNtegrated Space Weather Analysis System ( iSWA Primary ) : Version 1.6.0 [AltoSax]

Help Save Layout Global Date/Time Clear Layout

Solar Flare Monitor

SOLAR FLARE PROBABILITY = 1.4

Available Cygnets

Solar Heliosphere Magnetosphere Ionosphere Planetary/Spacecraft All Cygnets New Cygnets Events ALERTS

Joule Heating Precipitating Electrons (geomagnetic) Precipitating Electrons (geographic) CME Arrival Time Prediction Field Aligned Currents (geomag coord) Induced Electric Fields EX (movie)

SOHO/Costep Proton Flux Forecast

Real-time proton flux forecast of CCMC by ETHP (EAP CAJ Kiel and SWRI - data gaps due to limited DSN coverage)

SOHO/Costep Proton Flux

SOHO/COSTEP real-time proton flux at CCMC data gaps due to limited DSN coverage

ENLIL Heliosphere ( Velocity + Earth-Field-Line Connectivity )

Planetary KP

Max KP Level: Normal

SWMF Magnetopause Position

iSWA Interactive Timeline - GOES Primary Electron Flux

Ionospheric Joule Heating

Done

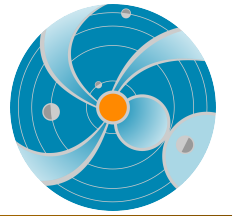
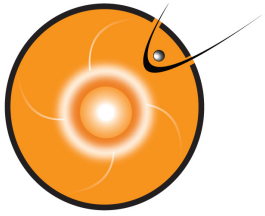
<http://iswa.ccmc.gsfc.nasa.gov>

# BOOKMARK DEMO

- Space Weather Event 04/11/2013 - <http://go.nasa.gov/13oVkrB>
- Venus Transit - <http://go.nasa.gov/13oR2k1>
- St. Patricks Day Storm 03/15/2013 - <http://go.nasa.gov/YGUeiO>
- Filament Eruption 02/27/2013 - <http://go.nasa.gov/XcgWDi>
- Space Weather Event 09/28/2012 - <http://go.nasa.gov/XGW0Eu>
- Space Weather Event 10/5/2012 - <http://go.nasa.gov/XtGsmH>
- Current 8-Day Timeline - <http://go.nasa.gov/16TediU>

<http://iSWA.ccmc.gsfc.nasa.gov>

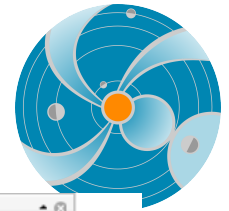
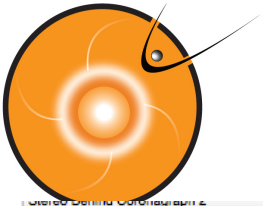
# **Supplemental Sides/Details**



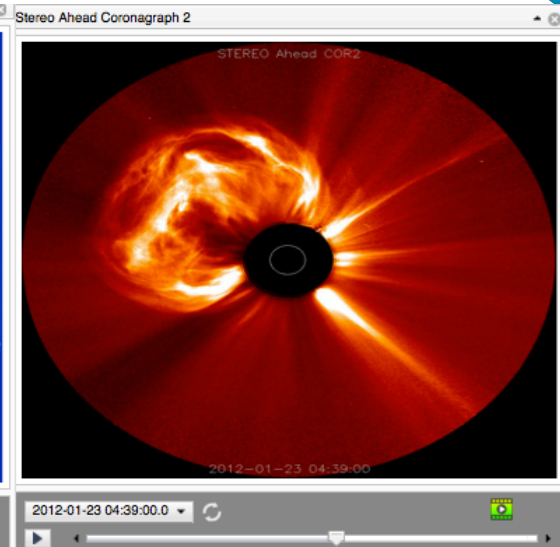
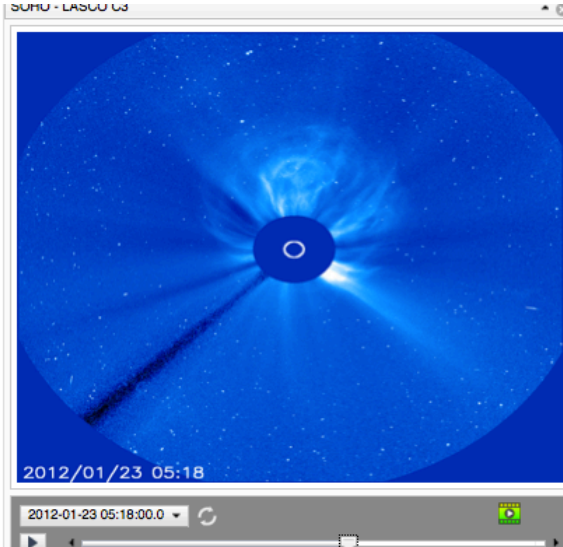
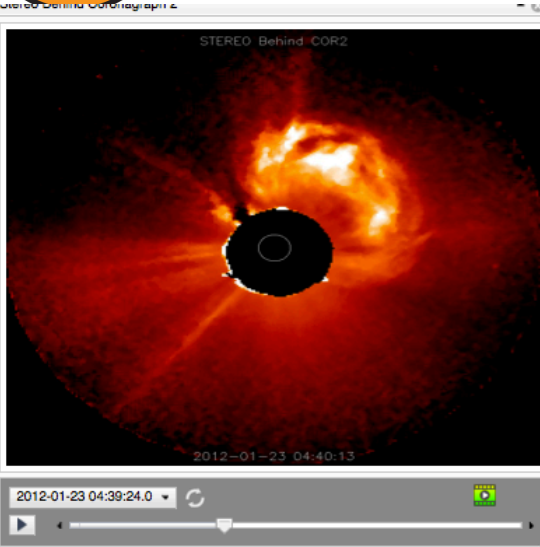
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# Specific Examples...

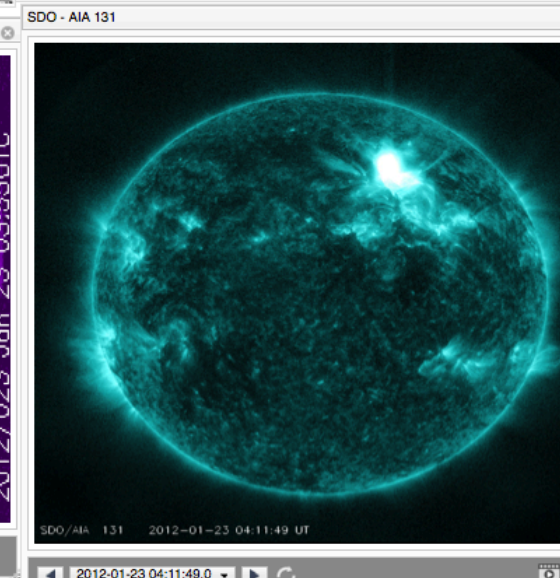
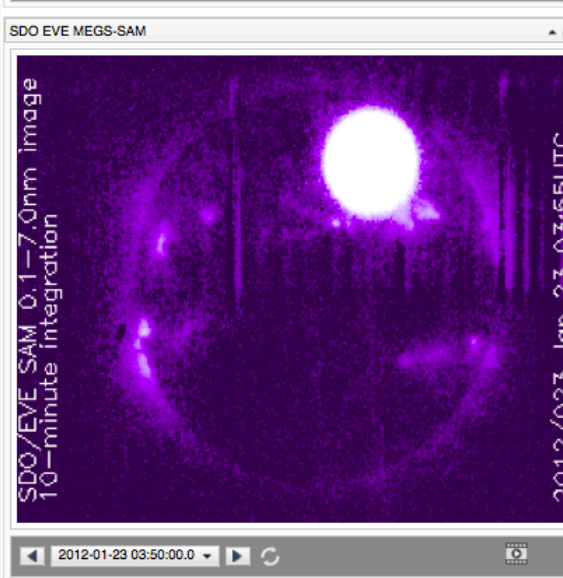
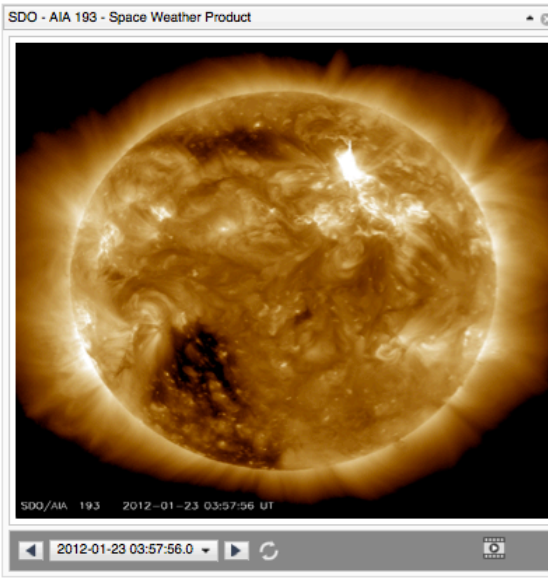
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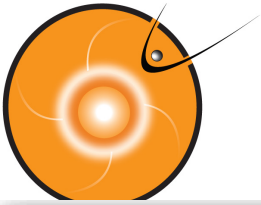
# Jan 23 flare (M8.7)/CME (v=2210km/s)



CME

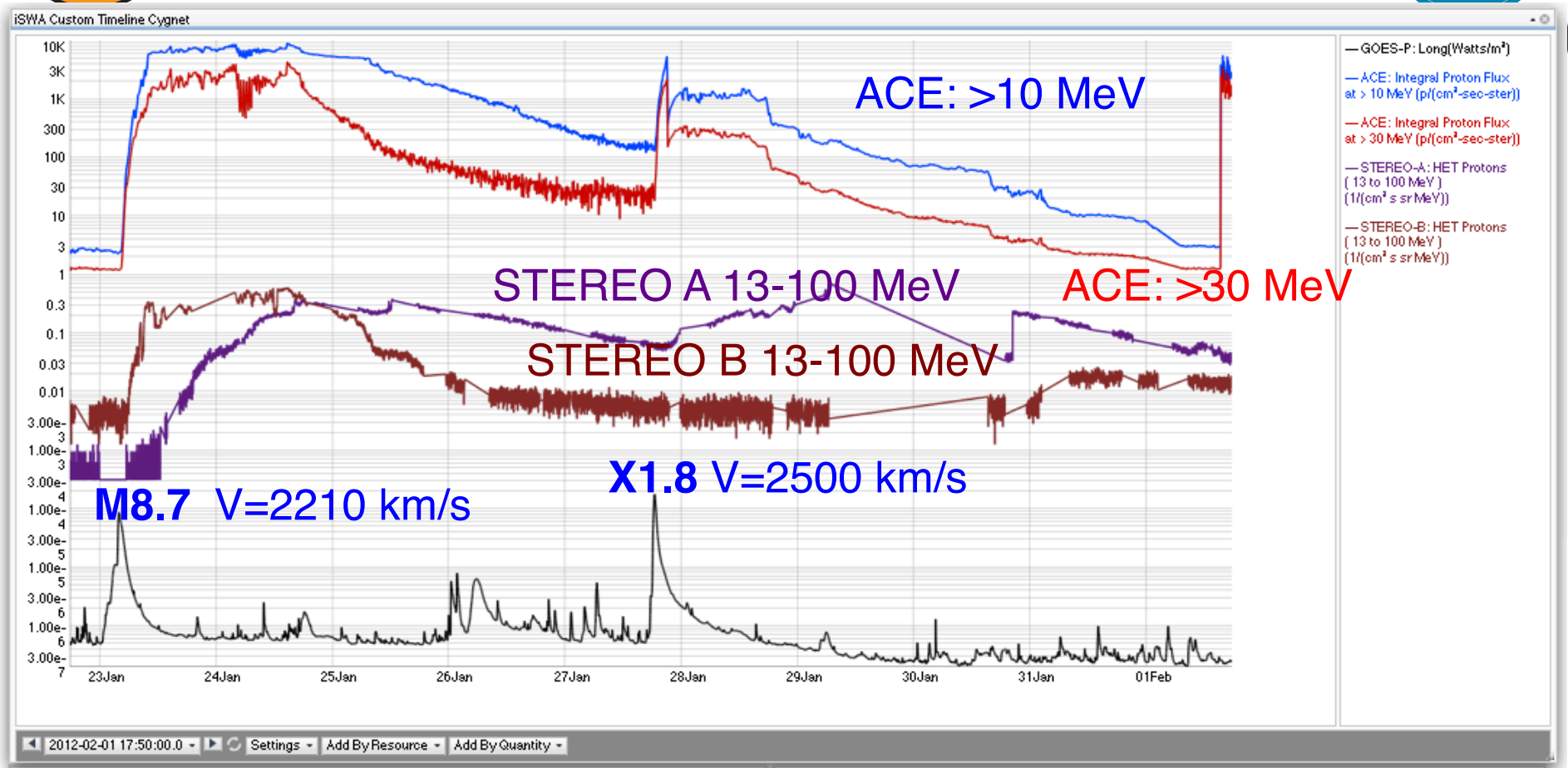
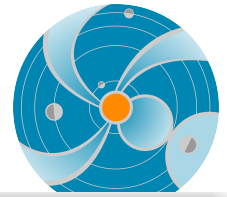


Flare



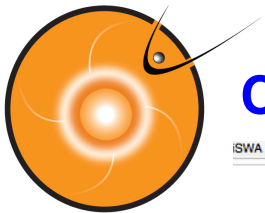
# SEP: proton radiation (flare and CME)

## iSWA SuperTimeline

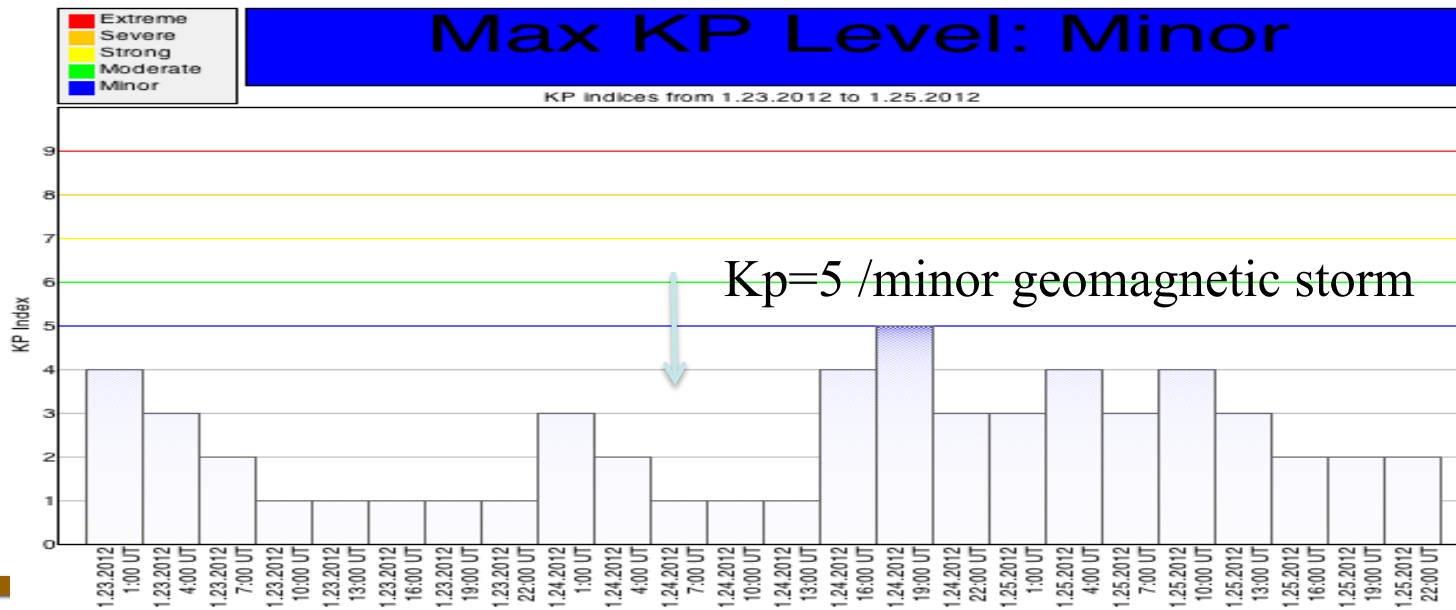
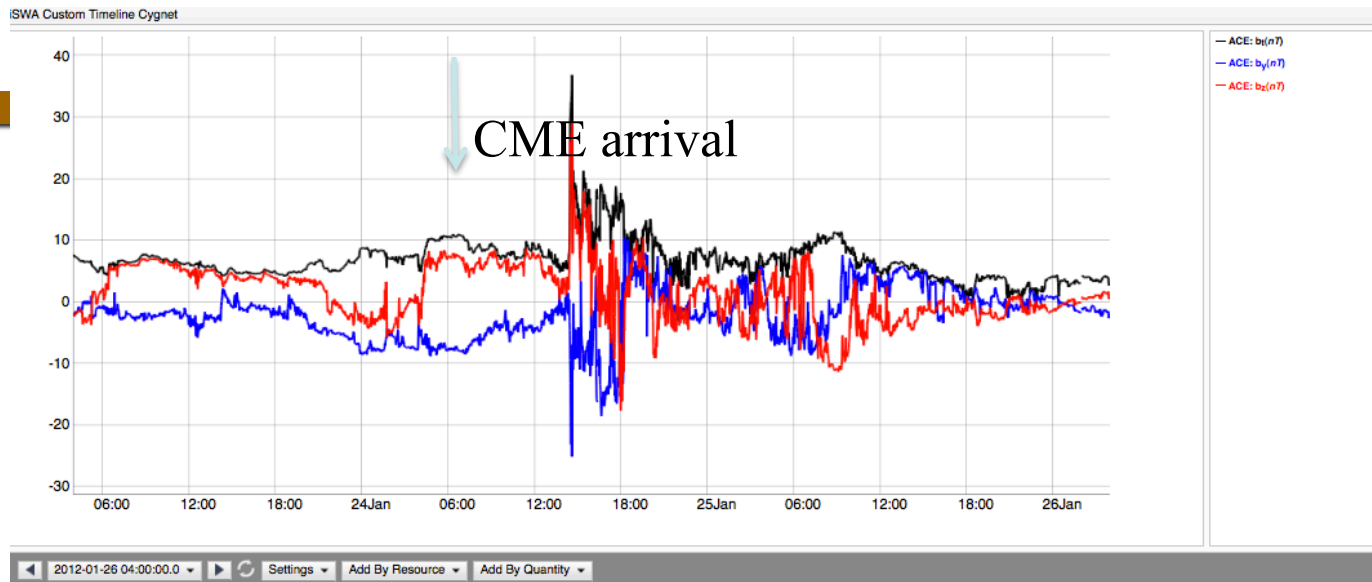
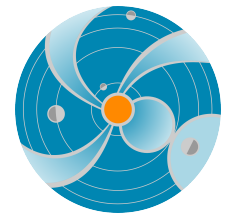


The Jan 23 and Jan 27 flare/CME pairs were associated with the same active region 1402. Both events created significantly enhanced ion radiation (SEP flux levels).

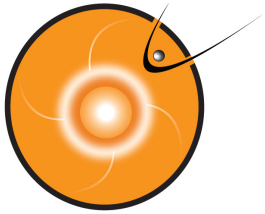
Several polar flights were rerouted due to the radiation



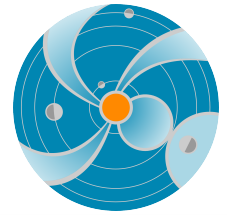
# CME impact at Earth (a minor geomagnetic storm only)







## An iSWA layout for the 23 Jan 2012 event



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[http://bit.ly/Jan23\\_27\\_2012\\_layout](http://bit.ly/Jan23_27_2012_layout)

Provide a dynamic view of the event with some key products

The Jan 23 event produced a very strong radiation storm  
- slightly less than that of **the March 7 2012 event**

*Peak flux (Jan 23): 6310 pfu at Jan 24 15:30 UT*

*Peak flux (Mar 7): 6530 pfu at Mar 8: 11:15 UT*

**Active Region 1429 activities during March 2012**

[Earthside Major Events](#)

[Backside major events](#)

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