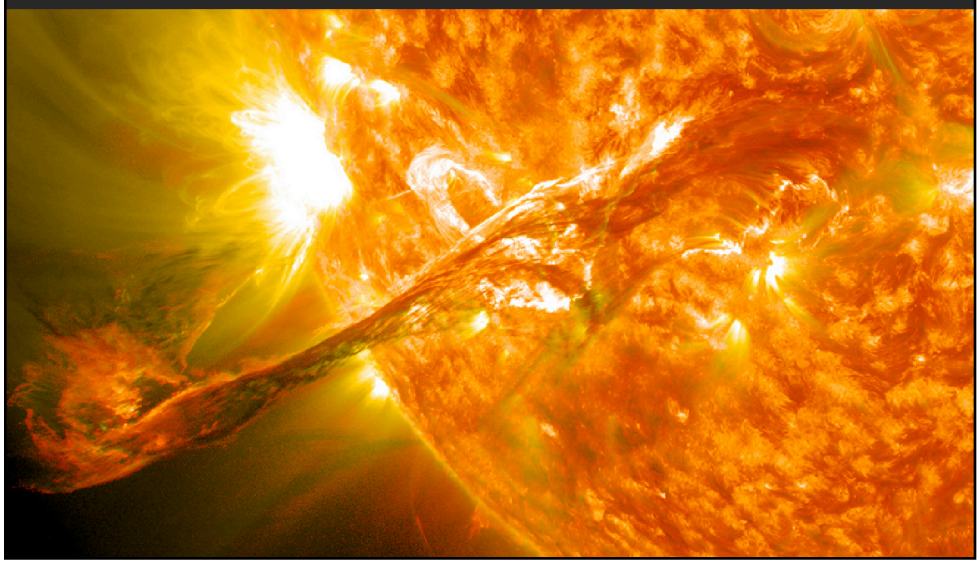
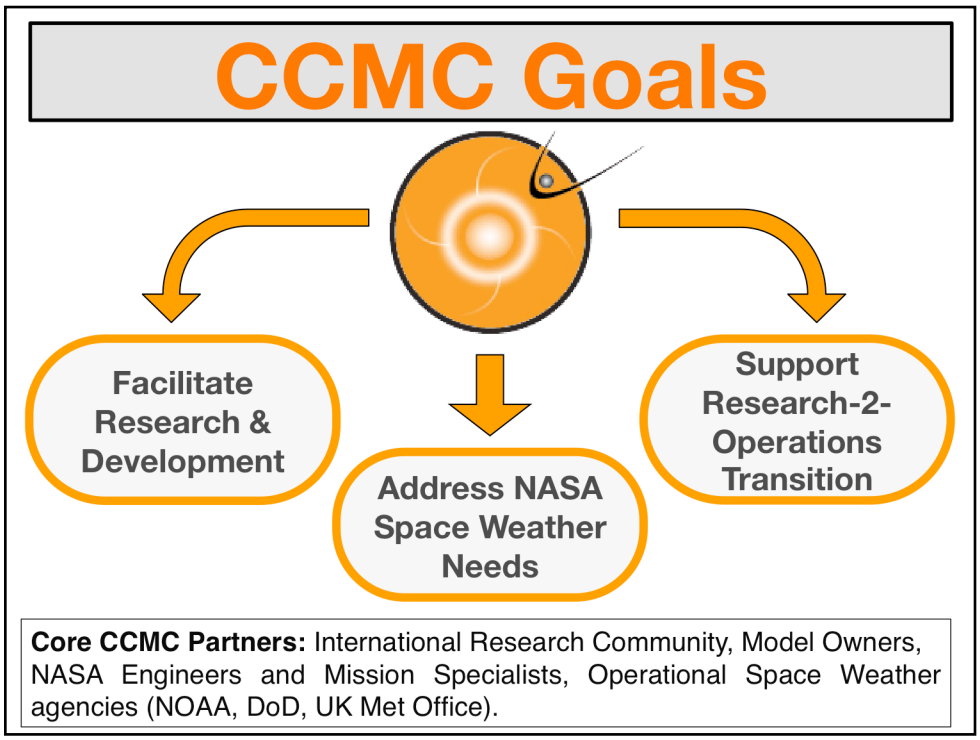
National Aeronautics and Space Administration
NASA
The Integrated Space Weather Analysis System
Yaireska Collado-Vega
Aknowledgement: Marlo Maddox
Space Weather Training
Kennedy Space Center
http://ccmc.gsfc.nasa.gov
HSD
Space Weather Lab
www.nasa.gov

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



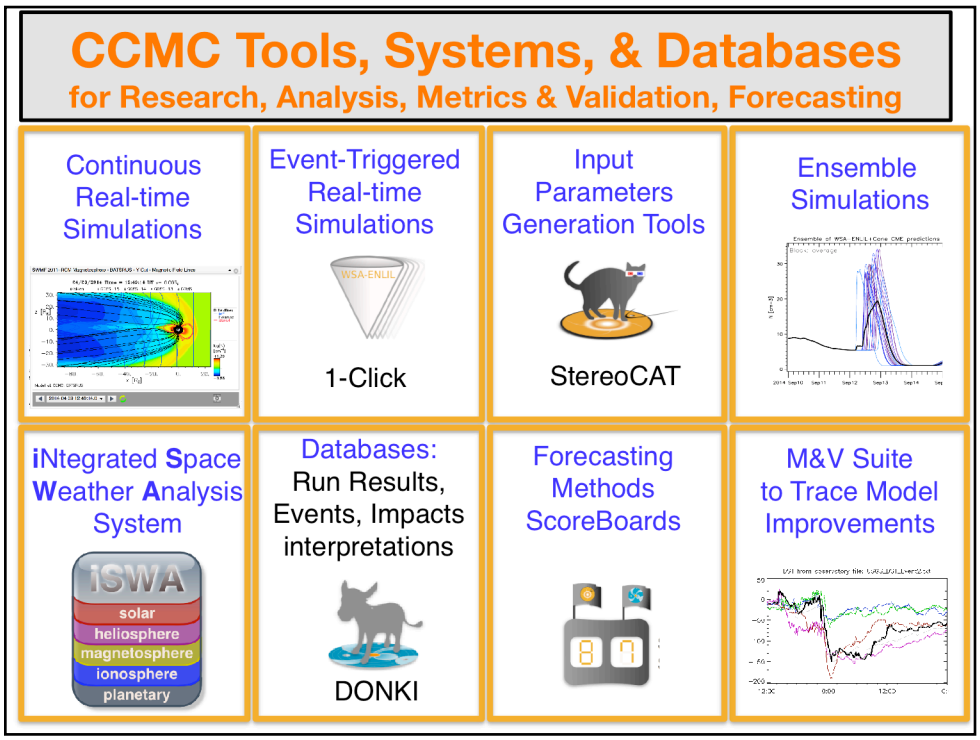


The CCMC Now is pursuing the following goals:

Facilitate research, education and development of next generation Space weather models and tools.

Support research models and advanced forecasting techniques transition to operations.

Address unique space weather needs of NASA user.



Examples of Tools, Systems & Databases for Research Analysis, M&V, Forecasting

(AVAILABLE ONLINE, ACCESSIBLE WORLD-WIDE)

CONTINOUS REAL-TIME SIMULATIONS

Models continuously running in real-time (with real-time drivers).

Data flow monitoring and controlling systems

EVENT-TRIGGERED REAL-TIME SIMULATIONS

1-Click system to submit event-triggered forecasting simulations (e.g., Enlil Cone Model).

Enables any interested person to generate forecasts.

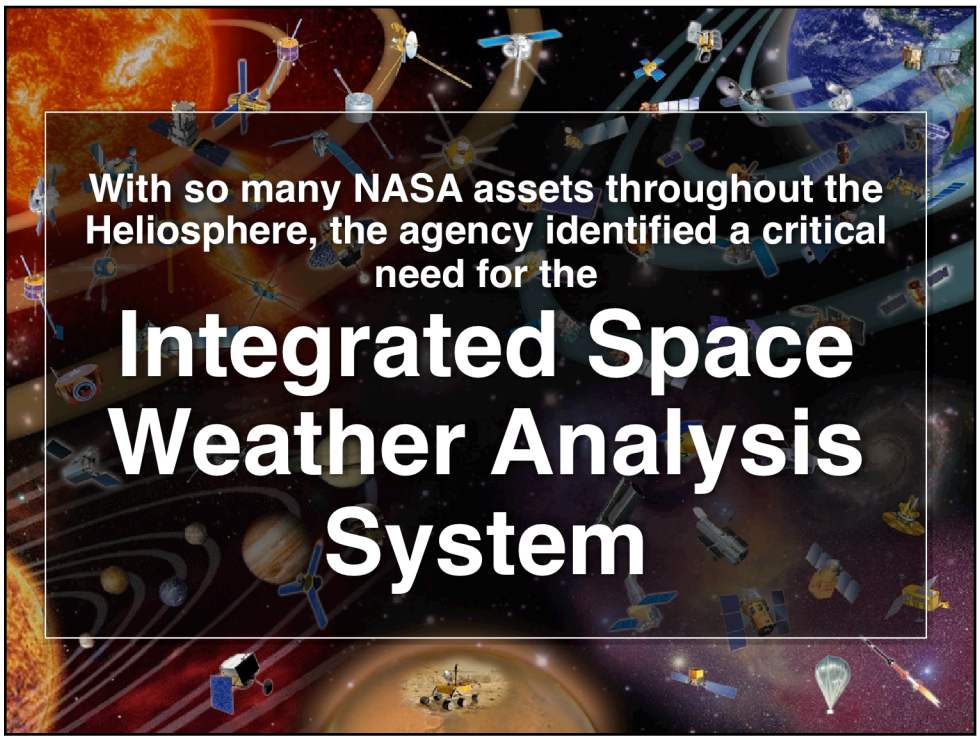
INPUT PARAMETERS GENERATION TOOLS

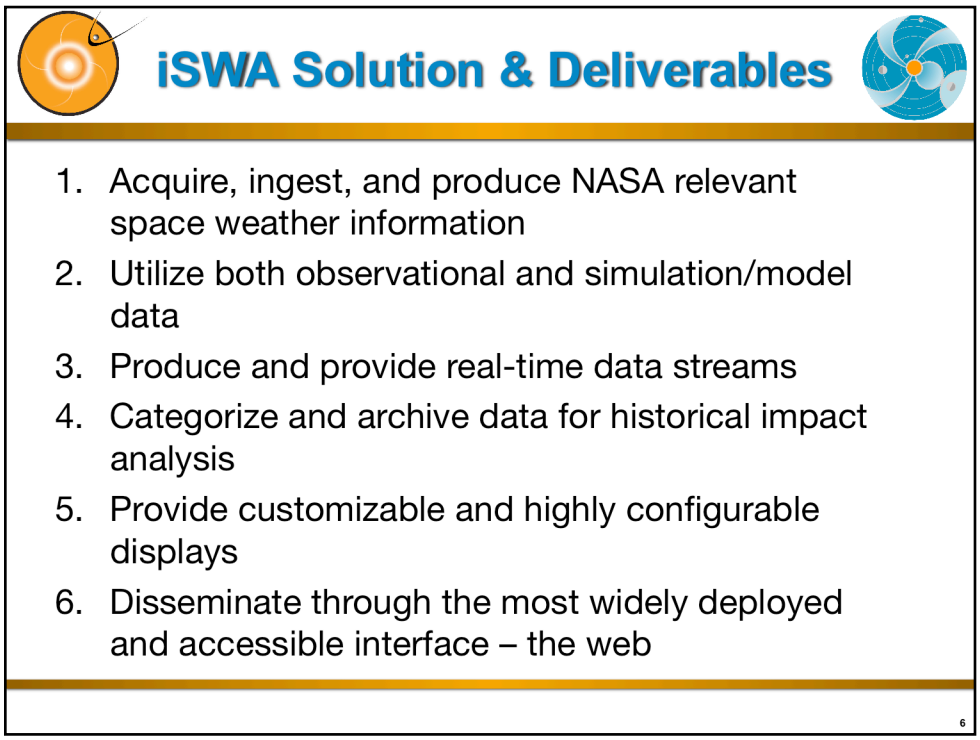
Stereo Coronal Mass Ejection Analysis Tool (StereoCAT) is a component of the CCMC's on-line Input Parameters Generation Suite that enables RoR users and space weather forecasters to quickly calculate the kinematic properties of Coronal Mass Ejections (CMEs). With a few mouse clicks, StereoCAT uses triangulation of SOHO and STEREO coronagraph images to determine CME speed, direction, and opening angle. The derived CME parameters can be utilized as input for a broad range of CME propagation models (including real-time Enlil-Cone model of CME propagation).

ENSEMBLE SIMULATIONS

to address uncertainties in input parameters

M&V SUITE TO TRACE MODEL IMPROVMENETS


With so many NASA assets throughout the Heliosphere, the agency identified a critical need for the
Integrated Space Weather Analysis System

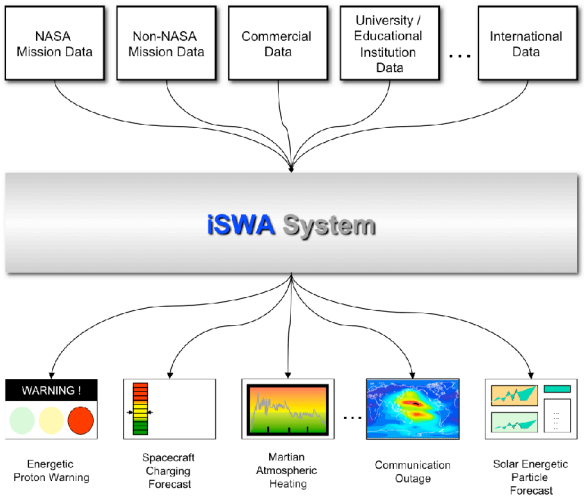


Observational data tells you what is happening now.

Model & Simulation data provides forecasts of expected/predicted space weather activity.

Customization allows users to select regions and phenomenon of interest.

iNTEGRATED SPACE WEATHER ANALYSIS SYSTEM

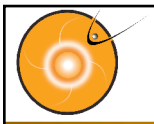


Highly diverse and distributed space weather data consisting of the latest observational data along with the most advanced space weather model simulation output.

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



Data Management Challenges

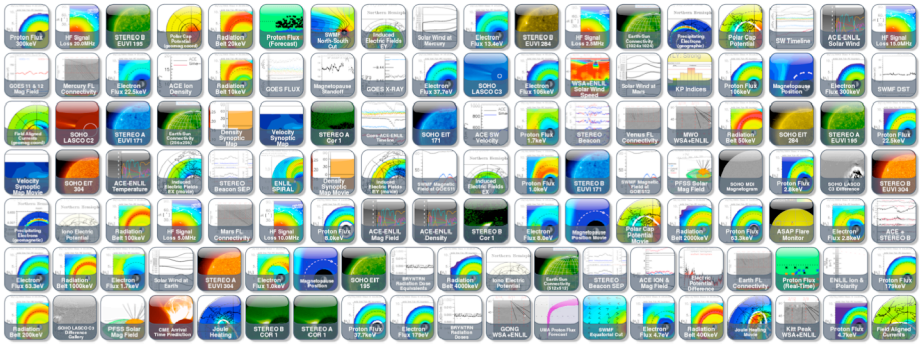
- Ingesting data streams from a variety of sources with varying:
  - Transfer Methods (push and pull)
  - Levels of availability
  - Access Protocols (http, ftp, scp, mv)
  - Naming Conventions
  - Update Intervals (efficient polling for new data)
  - Date & Time Stamp Formats i.e.

  [`2011-01-01_212500`] or [`2011-1-1_212500`] or [`20100101_212500`] or [`2011_001_212500`] or [`2010_Jan_01_212500`] or [`latest`] or...
- Sorting, Archiving, and Management
  - Persistent storage (file system or database)
  - Cataloging, How to keep track of what is where
  - Scalability, Additional storage
- Changes (urls, names, formats, extensions, etc.)

8

Innovative Dissemination

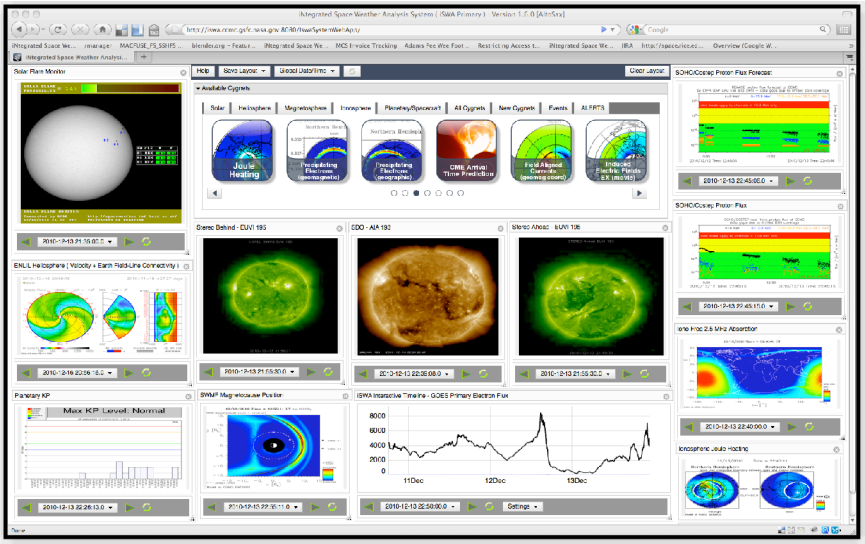
ISWA has ~300 products including modeling results and comprehensive sets of observational data.



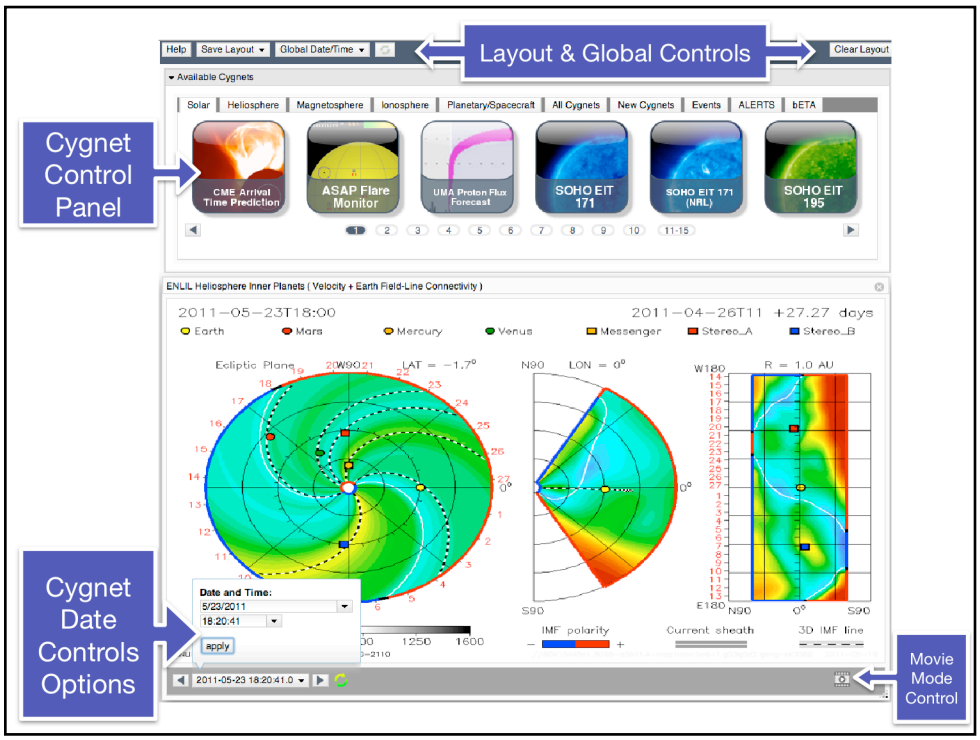
Web-based. User configurable. Available world-wide.
One-stop shop for state-of-the-art information!
http://iswa.gsfc.nasa.gov

9

Unprecedented Access to Space Weather Information



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

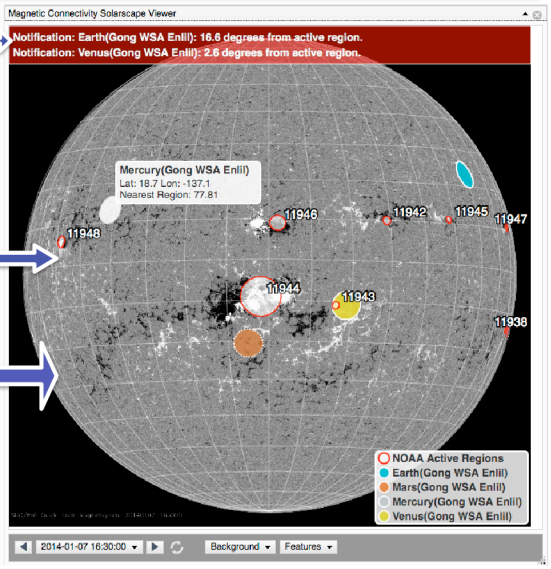

Layout & Global Controls
Help
Save Layout
Global Date/Time
Clear Layout
Available Cygnets
Solar
Heliosphere
Magnetosphere
Ionosphere
Planetary/Spacecraft
All Cygnets
New Cygnets
Events
ALERTS
bETA
Cygnet Control Panel
CME Arrival Time Prediction
ASAP Flare Monitor
UMA Proton Flux Forecast
SOHO EIT 171
SOHO EIT 171 (NRL)
SOHO EIT 195
ENLIL Heliosphere Inner Planets (Velocity + Earth Field-Line Connectivity)
2011-05-23T18:00
2011-04-26T11 +27.27 days
Earth
Mars
Mercury
Venus
Messenger
Stereo_A
Stereo_B
Ecliptic Plane
LAT = -1.7°
N90
LON = 0°
W180
R = 1.0 AU
S90
E180
IMF polarity
Current sheath
3D IMF line
Cygnet Date Controls Options
Date and Time:
5/23/2011
18:20:41
apply
2011-05-23 18:20:41.0
Movie Mode Control

Dynamically Generated & Interactive Products: Solarscape

Alerts/
Notifications

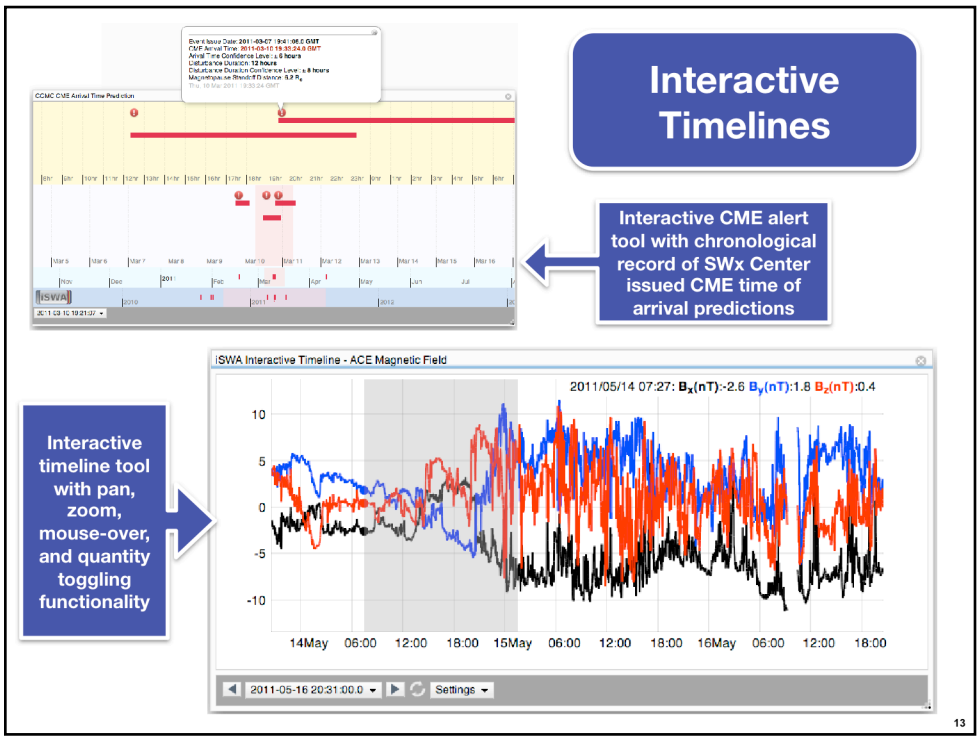
User Selectable Features
(MAG4, NOAA Active Regions,
CCMC Magnetic Connectivity)

User Selectable Background
(SDO , Generic Grid)

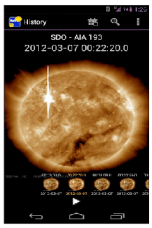


Dynamic Product with User Selectable Features From Several Sources

iSWA

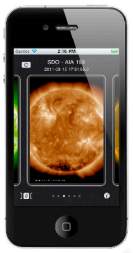

Interactive Timelines
Interactive CME alert tool with chronological record of SWx Center issued CME time of arrival predictions
Interactive timeline tool with pan, zoom, mouse-over, and quantity toggling functionality
iSWA Interactive Timeline - ACE Magnetic Field
2011/05/14 07:27: Bx(nT):-2.6 By(nT):1.8 Bz(nT):0.4
10
5
0
-5
-10
14May 06:00 12:00 18:00 15May 06:00 12:00 18:00 16May 06:00 12:00 18:00
2011-05-16 20:31:00.0
Settings
13

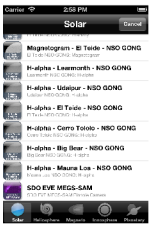
Mobile Access Powered by iSWA

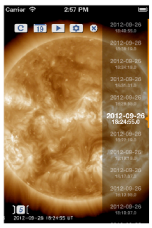


Android Front-End to iSWA

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







IOS Front-End to iSWA

- >100k Downloads
- Available in App Store

14

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.

15

Education And Training Powered by iSWA

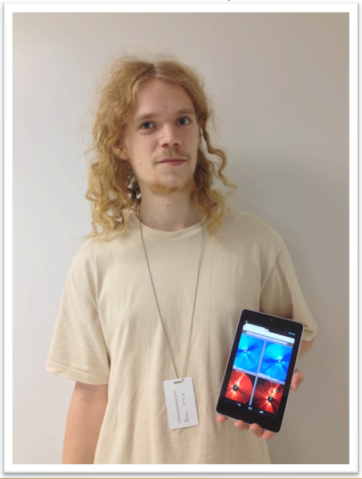
Arranged by NASA IV&V Educator Resource Center
High school teachers from West Virginia

Y. Zheng

16

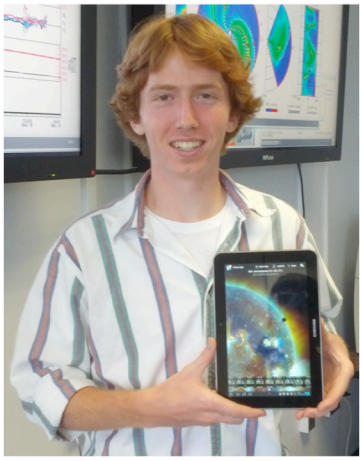
Undergraduate Computer Science Interns
SW Research Analysis Tool Development
Powered by iSWA

Jack LaSota
Web-based CME Analysis Tool



CME Tool Link Sample Analysis Link

Justin Boblitt
Android iSWA App



iTunes Link Android Link

17

iSWA Impact

NASA

- iSWA provides a new capability to quickly assess **past**, **present**, and **expected** space weather effects.
  - Mission operators have a resource to assist in both anomaly resolution as well as potential space weather impacts.
- iSWA has helped enable the Space Weather Laboratory to establish a new **Space Weather Center** service **providing alerts**, anomaly reports, and weekly space weather summaries based on iSWA tools and products.

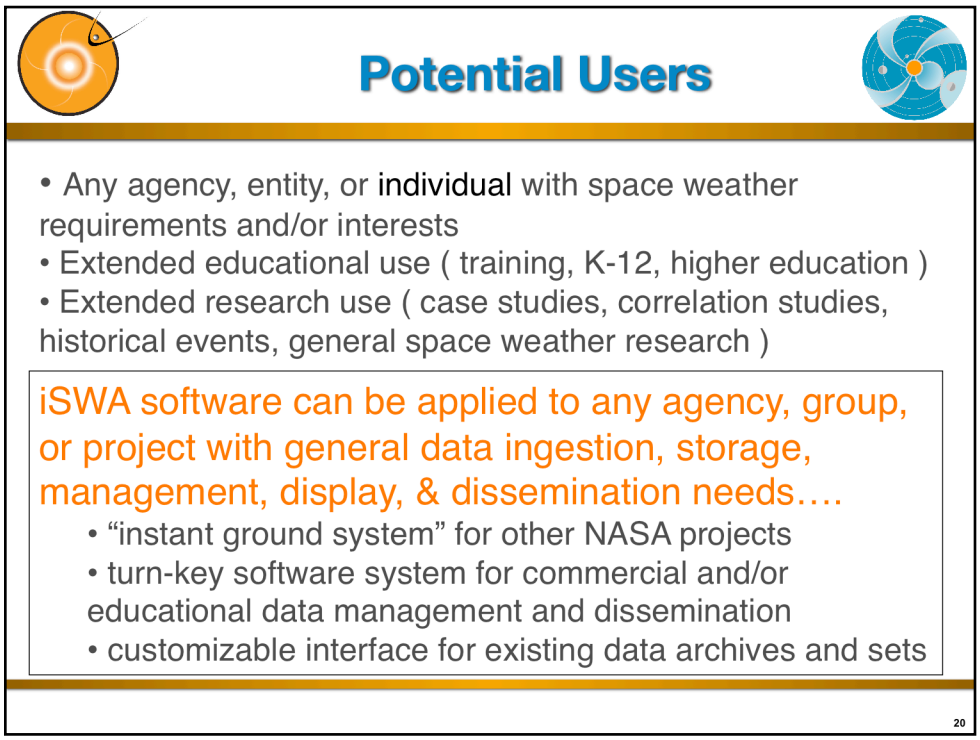
External Agencies

- Air Force Space Weather Agency can **monitor the iSWA system 24x7 for CME eruptions** and notify the CCMC as soon as an event is detected. A notification triggers a CME Cone Model calculation at CCMC that **estimates the CME arrival time, duration, and expected impact on earth**.
- iSWA has enabled numerous collaborations with data, model, and product developers/providers who want their tools to be available in iSWA.

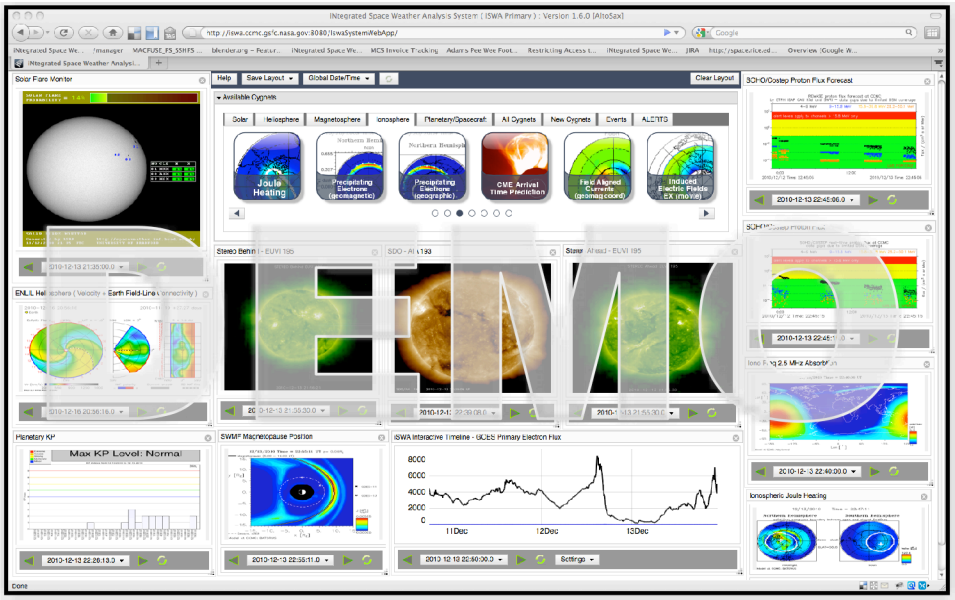
Science, Education, and Public Outreach

- Researchers, universities, and "citizen scientists" have access to a comprehensive suite of real-time and historical space environment data products.

Who Uses iSWA?
NASA
NOAA
NSF
Johnson Space Center
esa
SRI
Space Weather Lab
EMBRY-RIDDLE Aeronautical University
CSEM
NCAR
ASTRA
KASI
Predictive Science, Inc.
EPRI
University of Colorado Boulder
SPENVIS
UNIVERSITY of NEW HAMPSHIRE
KMA Korea Meteorological Administration
The Catholic University of America
CASS
IAGA International Association of Geomagnetism and Aeronomy
CISM
Met Office
ICARUS RESEARCH, INC.
JAXA
FINNISH METEOROLOGICAL INSTITUTE
NiCT
Dartmouth
APL The Johns Hopkins University Applied Physics Laboratory
STEL
BOSTON UNIVERSITY



Potential use…



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