The Integrated Space Weather Analysis System

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http://ccmc.gsfc.nasa.gov
How Do You Quickly Determine Past, Present, & Expected Space Weather Impacts?
Objectives: provide the latest space weather information to NASA's robotic mission operators, as well as DoD partners.

With so many NASA assets throughout the Heliosphere, the agency identified a critical need for the Integrated Space Weather Analysis System.
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
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
iSWA 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.
- The diagram illustrates the flow of data and resources within the iSWA (Internet Space Weather Application) system.

**BACK END**

- **Resource Registry**
- **Data Registry**
- **Data/Tool Registry**
- **Product Registry**

**FRONT END**

- **Information Retrieval Robot**
- **Data Sorter**
- **Tool Service**
- **Widget Agent**

**CMMC Space Weather Model Resources**

**Internet**

**Distributed Space Weather Resources**

**iSWA System Interface** provides a highly configurable control panel to present operators with only the products and tools of interest.

**IRR**

- Routinely ingest and receive external data streams.
- Automatically configures/re-configures via a resource registry database.

**DS**

- Data is registered in database, time-tagged, sorted, categorized, and archived in a data tree.

**TS**

- New data products are created using raw data and combinations of existing data products.

**WA**

- Data products are registered and packaged for display in iSWA system.

**CWDS**

- iSWA System Interface provides a highly configurable control panel to present operators with only the products and tools of interest.

**Numerical Data**

- 493 Unique Data Feeds,
- 57 Million Files Registered and Archived,
- 359 Consumable Display Products currently managed in iSWA Cygnet Catalog.
ISWA has ~300 products including modeling results and comprehensive sets of observational data.


http://iswa.gsfc.nasa.gov
Unprecedented Access to Space Weather Information

http://iSWA.ccmc.gsfc.nasa.gov
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
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
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.
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
New Systems/Extensions Powered by iSWA

- Project specific implementations
- Full iSWA feature set, infrastructure
- Customized cygnet/product catalog
- Integrated Solar Energetic Proton Event Alert Warning System – Advanced Radiation Project (OCT Game Changing Office)

Expanded Numerical Database - FlexDIT

- 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 – Linking to DONKI

- Building catalog of space weather event, forecaster-logs, alerts, etc.
- Establishing linkages, relationships, cause-and-effects between activities
http://iSWA.ccmc.gsfc.nasa.gov
• 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
Supplemental Sides/Details
Specific Examples...
Jan 23 flare (M8.7)/CME ($v=2210\text{km/s}$)
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)

CME arrival

Max KP Level: Minor

Kp=5 /minor geomagnetic storm
An iSWA layout for the 23 Jan 2012 event


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