Space Weather @ NASA

Community Coordinated Modeling Center (CCMC)
&
Space Weather Research Center (SWRC)

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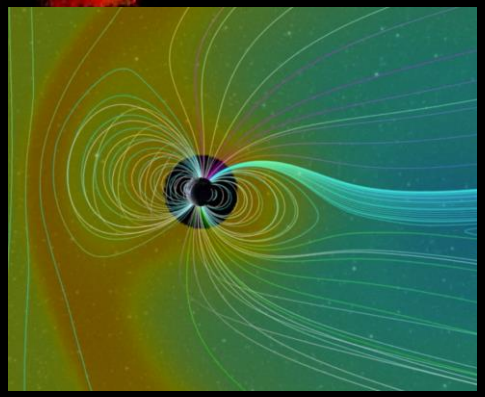


2016, 4th AOSWA, Jeju, Republic of Korea

Space Weather: NASA's Role

NASA formulates and implements a national research program for understanding the Sun and its interactions with the Earth and the Solar System and how these phenomena impact life and society.

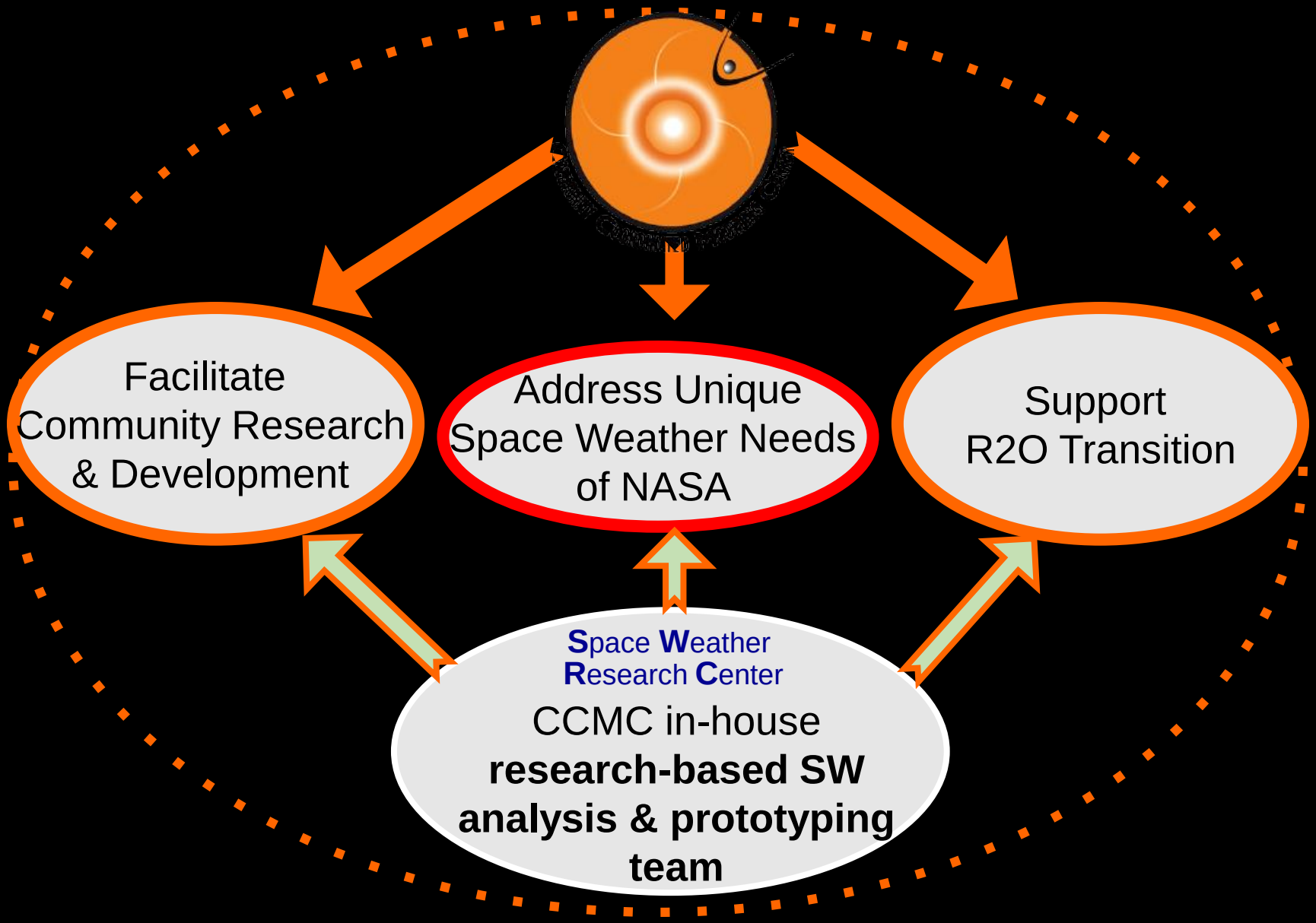
Space Weather: NASA's Role

NASA researches and prototypes new mission and instrument capabilities, providing new physics-based algorithms to advance the state of heliophysics and space weather modeling.

Space weather at NASA

- Due to its unique needs, NASA provides space weather services for its own missions.
- Two individual and closely collaborating NASA activities responsible for the services:
  - Johnson Space Center SRAG (Space Radiation Analysis Group).
  - Goddard Space Flight Center CCMC/SWRC.

Community Coordinated Modeling Center



CCMC Assets & Services:
Comprehensive Collection Of Space Weather Models

Corona

SWMF.SC
PFSS.Petrie
PFSS.Macneice
PFSS.Luhmann
ANMHD
UMASEP
SRPM
MAG 4
ASAP
WSA
MAGIC
ASSA
SNB3GEO
NLFFF.Wiegelmann

Heliosphere

ENLIL
Posner SEP
PREDICCS
EXO Solar Wind
EMMREM
CORHEL
Heltomo SMEI
ENLIL+Cone
Heltomo IPS
BRYNTRN
SWMF.SH

Magnetosphere

LFM-TING
GUMICS
LFM-MIX
GIC
OpenGGCM
SWMF+RCM+deltaB
SWMF+RCM
SWMF+RCM+RBE
SWMF+RCM+CRCM
LFM-MIX-TIEGCM
WINDMI
LANLstar
IGRF
Tsyganenko
Fok RBE
Weigel-deltaB
PS VP
Apex
AACGM
Ovation Prime

Inner Magnetosphere

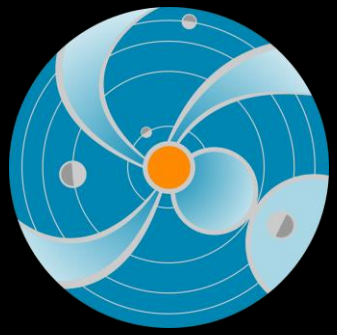
RCM
Fok.CIMI
Fok.RC
UPOS RB
AE-8/AP-8
AE-9/AP-9
VERB

Ionosphere/Thermosphere

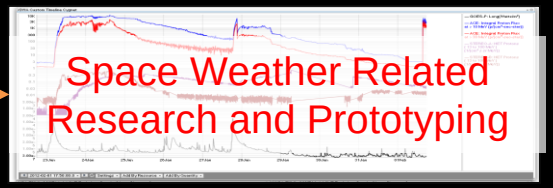
SAMI-2
SAMI-3
TIE-GCM
CTIPe
IRI
USU-GAIM
SWACI-TEC
ABBYNormal
MSIS
GITM
PBMOD
TRIPL-DA
Weimer IE
Weimer-deltaB
JB2008
COSGROVE-PF

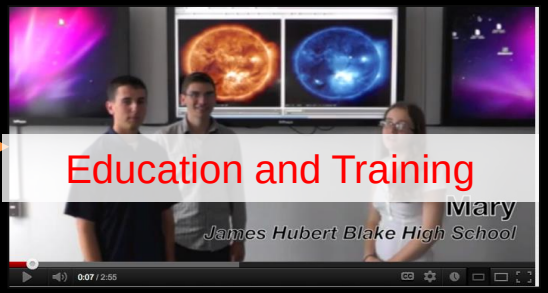
SWRC Concept of Operations

Space Weather Research Center



Partnering with the US and international organizations





SWRC Concept of Operations

World-leading Modeling

Space weather tools

Data streams from NASA and other sources

Protecting NASA's missions

Space weather related research and Prototyping

Reporting and workshops

Building space weather knowledge bases

Education and training

Partnering with US and international organizations

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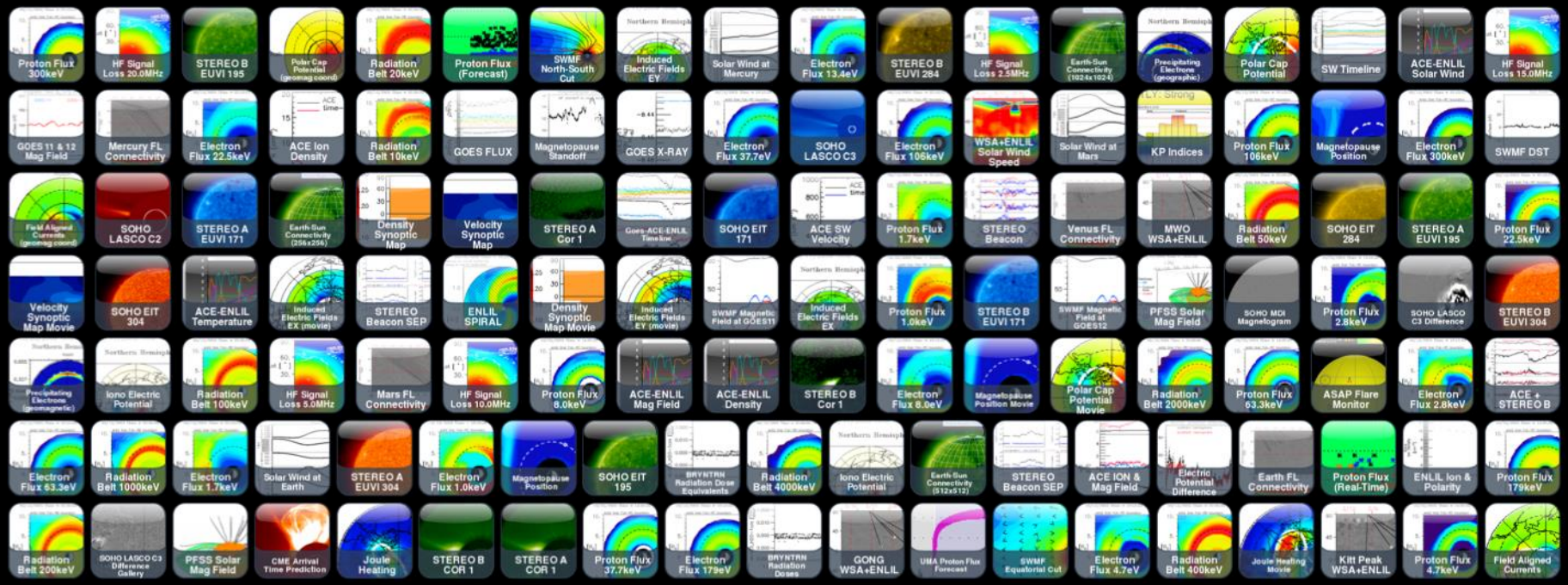
Innovative Dissemination: iSWA

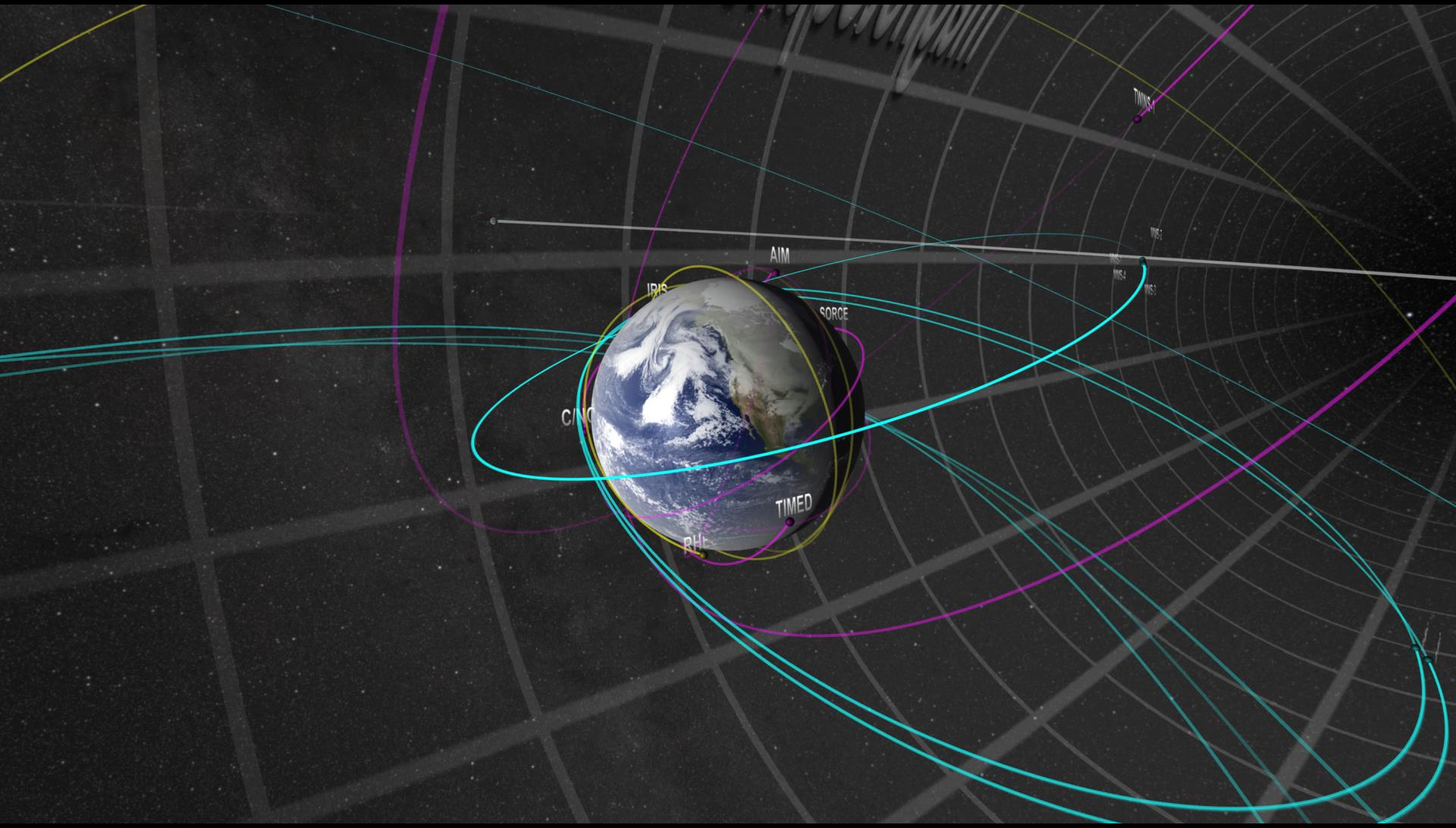
ISWA has >300 products including modeling results and comprehensive sets of observational data.

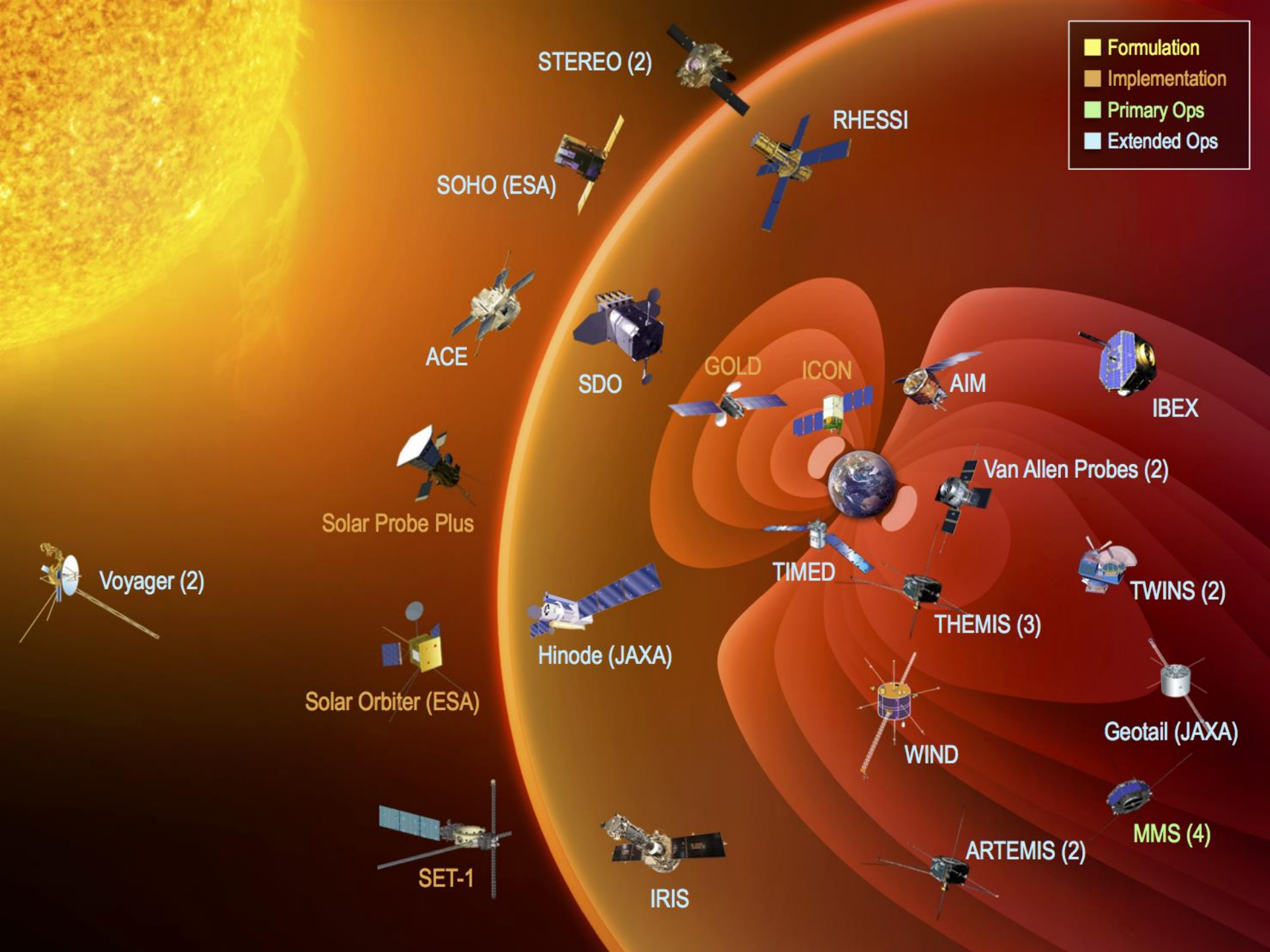


Web-based. User configurable. Available world-wide.
One-stop shop for state-of-the-art information!
http://iswa.gsfc.nasa.gov

iphone

Android


AIM
IRIS
SORCE
TIMED


Formulation
Implementation
Primary Ops
Extended Ops
STEREO (2)
RHESSI
SOHO (ESA)
ACE
SDO
GOLD
ICON
AIM
IBEX
Van Allen Probes (2)
Solar Probe Plus
Voyager (2)
TIMED
TWINS (2)
THEMIS (3)
Hinode (JAXA)
Solar Orbiter (ESA)
Geotail (JAXA)
WIND
MMS (4)
ARTEMIS (2)
SET-1
IRIS

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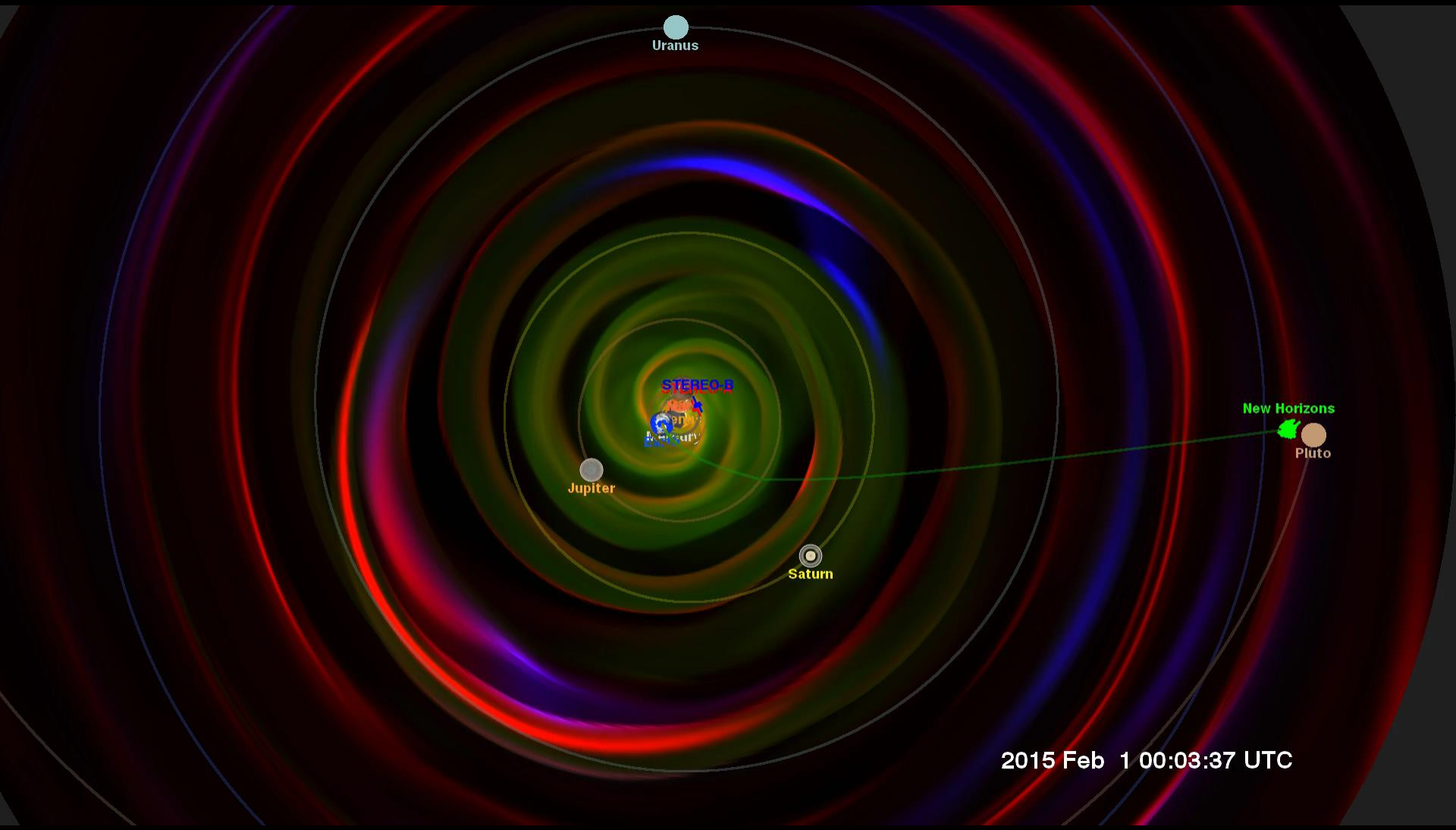
Uranus
STEREO-B
Jupiter
Saturn
New Horizons
Pluto
2015 Feb 1 00:03:37 UTC

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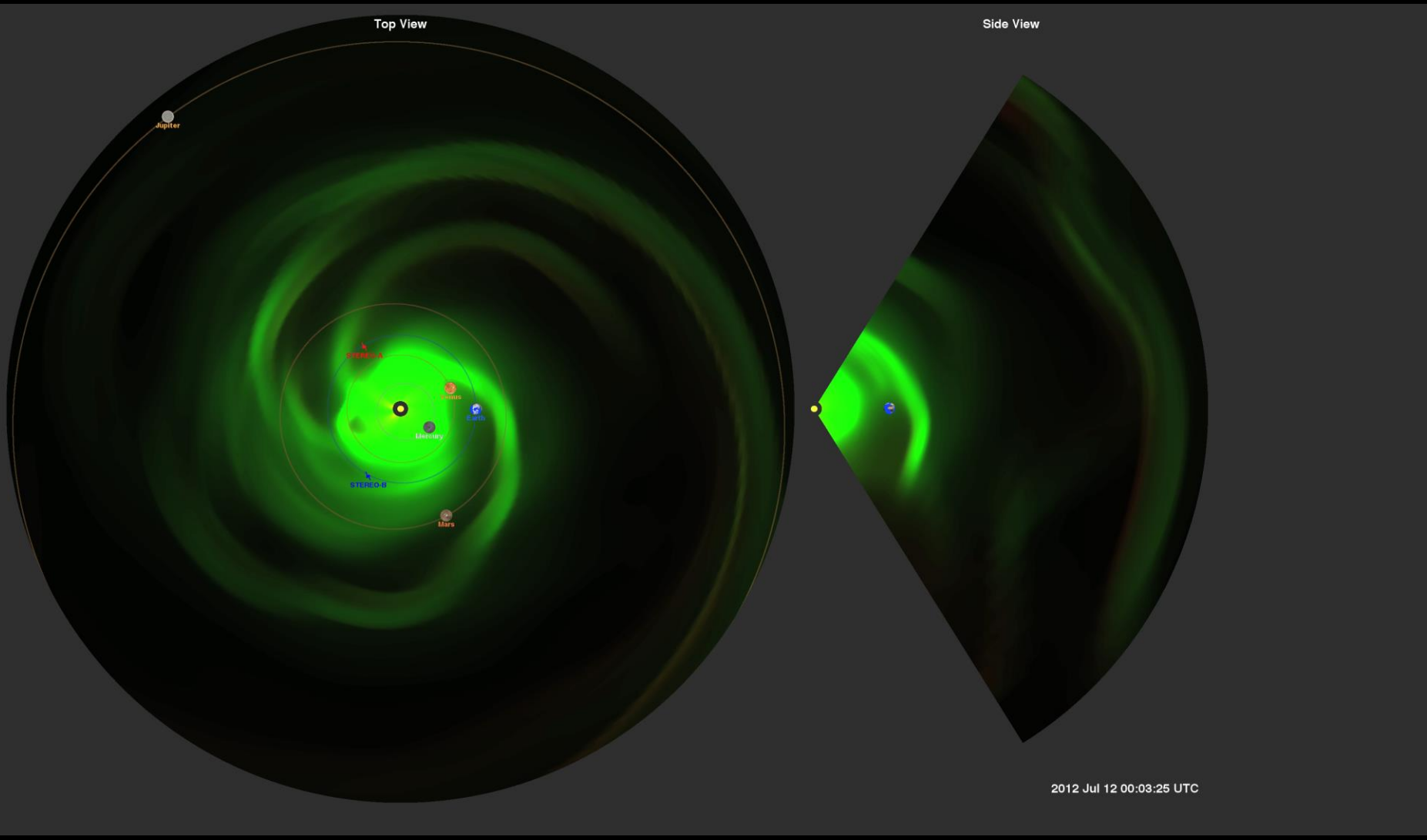
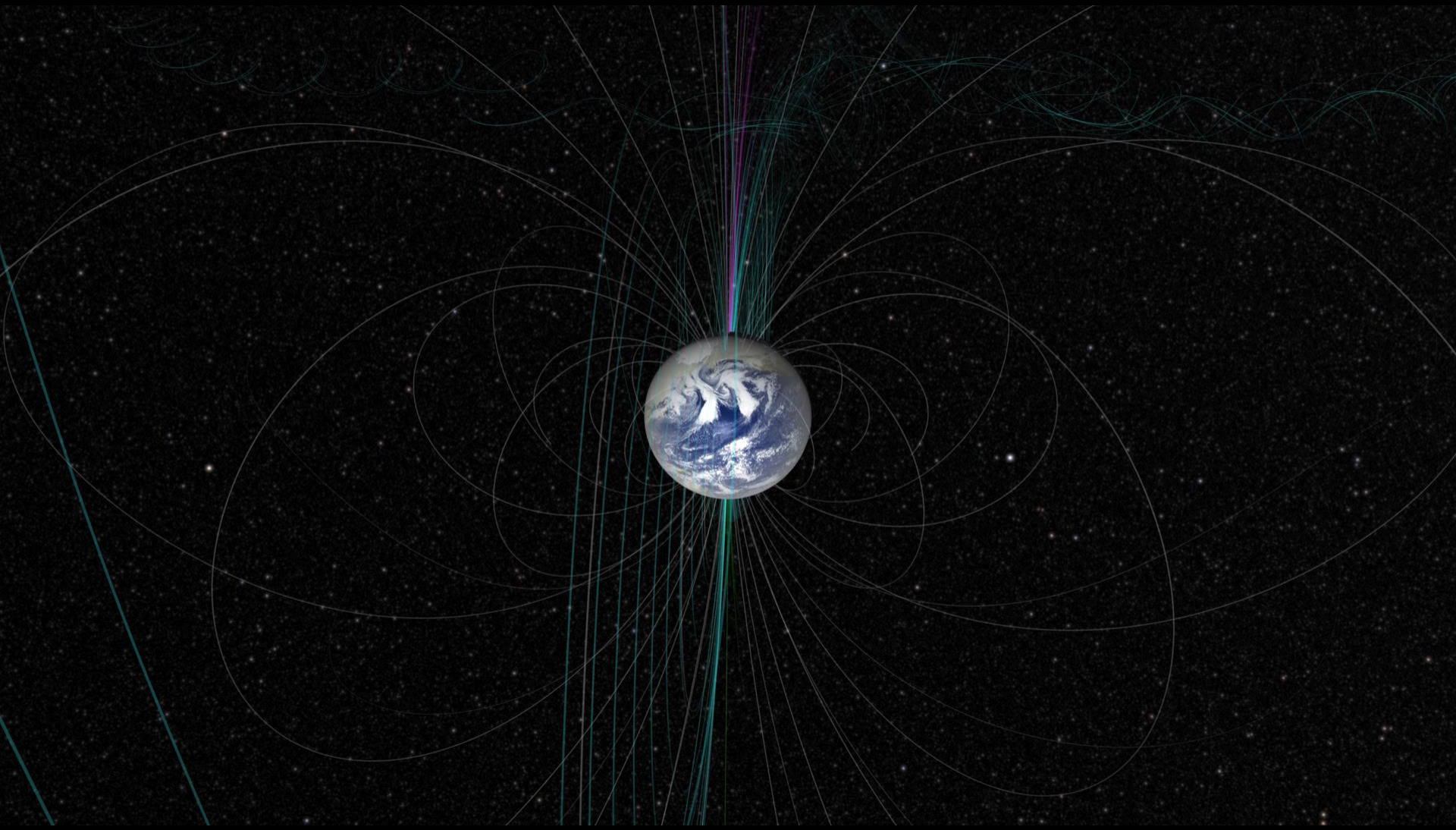

Top View
Side View
Jupiter
STEREO-A
Venus
Earth
Mercury
STEREO-B
Mars
2012 Jul 12 00:03:25 UTC



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Engaging the whole community in forecasting CME arrival

Community Ensemble (from different CME models)

CME: 2014-01-07T18:24:00-CME-001

Actual Shock Arrival Time: 2014-01-09T19:32Z

Observed Geomagnetic Storm Parameters:
Max Kp: 3.0

Predicted Shock Arrival Time	Difference (hrs)	Submitted On	Lead Time (hrs)	Predicted Geomagnetic Storm Parameter(s)	Method	
2014-01-09T19:26Z (-10.0h, +10.0h)	-0.10	2014-01-07T21:00Z	46.53	----	STOA	L
2014-01-09T00:38Z (-7.0h, +7.0h)	-18.90	2014-01-08T00:41Z	42.85	Max Kp Range: 6.0 - 8.0	WSA-ENLIL + Cone (GSFC SWRC)	L
2014-01-09T08:00Z	-11.53	2014-01-08T01:31Z	42.02	Max Kp Range: 6.0 - 7.0	WSA-ENLIL + Cone (NOAA/SWPC)	L
2014-01-08T22:00Z	-21.53	2014-01-08T03:17Z	40.25	Dst min. in nT: -146 Dst min. time: 2014-01-09T11:00Z	Anemomilos	W S
2014-01-09T00:17Z (-6.9h, +9.2h)	-19.25	2014-01-08T04:11Z	39.35	Max Kp Range: 6.0 - 8.0	Ensemble WSA-ENLIL + Cone (GSFC SWRC)	L
2014-01-09T04:30Z (-2.5h, +2.5h)	-15.03	2014-01-08T05:02Z	38.50	Max Kp Range: 5.0 - 8.0	Other (SIDC)	L
2014-01-08T12:30						L
2014-01-09T12:00 +7.0h)	-7.33	2014-01-08T06:32Z	37.00	----	WSA-ENLIL + Cone	R
2014-01-09T04:00Z (-6.0h, +6.0h)	-15.53	2014-01-08T09:42Z	33.83	----	DBM	M (U
2014-01-10T04:04Z (-16.0h, +36.0h)	8.53	2014-01-08T14:56Z	28.60	Max Kp Range: 8.0 - 8.0 Dst min. in nT: -300	COMESEP	A
2014-01-09T08:02Z	-11.50	2014-01-08T16:37Z	26.92	----	Expansion Speed Prediction Model	A
2014-01-09T02:00Z	-17.53	2014-01-08T17:53Z	25.65	Max Kp Range: 8.0 - 9.0	BHV	V
2014-01-09T01:00Z	-18.53	2014-01-08T23:00Z	20.53	Dst min. in nT: -142 Dst min. time: 2014-01-09T12:00Z	Anemomilos	W S
2014-01-09T13:00Z (-7.0h, +7.0h)	-6.53	2014-01-08T23:17Z	20.25	Max Kp Range: 6.0 - 8.0	WSA-ENLIL + Cone	D
2014-01-09T11:22Z (-11.7h, +9.1h)	-8.17	2014-01-09T18:57Z	0.58	Max Kp Range: 3.0 - 5.0	Ensemble WSA-ENLIL + Cone (GSFC SWRC)	L
2014-01-09T06:35Z	-12.95	---	---	Max Kp Range: 6.0 - 7.625	Average of all Methods	A

Community-wide space weather forecasting validation activity

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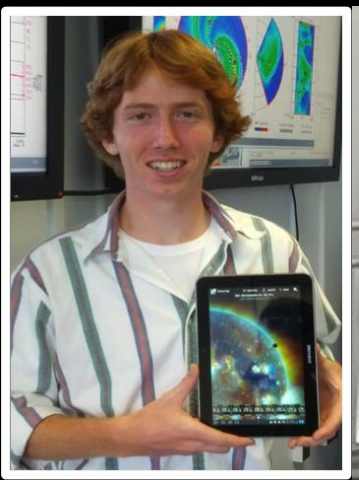
Education

- Engage high school and college interns in space weather forecasting, research and tool development
- Provide space weather training for young scientists to broaden their research scope
- Educating mission operators/engineers and the public (e.g., teachers) about space weather



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Partnership

- AFWA (Air Force Weather Agency)
  - space weather information exchange pipeline was established at the beginning of SWRC
  - space weather training
- NOAA + plus other government agencies
  - model and tool prototyping
- Universities + commercial space and international entities

NASA Goddard's Space Weather Research Center

- Proximity to state-of-the-art models and scientific expertise (~300 dedicated individuals in Heliophysics Division)
- Enable efficient (Research to Operations) R2O-O2R (Operations to Research).
- Quick and nimble (unconventional) forecasting procedures for the benefit of NOAA, NASA and other agencies
- Address NASA's unique space weather needs - space weather across the solar system
- Pioneering tools and methods

Thank You!

C. Alex Young
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