Community Coordinated Modeling Center
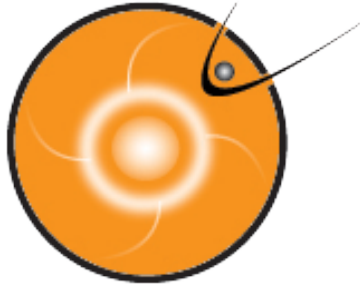
CCMC Overview

June 28 2016

Masha Kuznetsova & CCMC Team

MODELS • **DATA** • **TOOLS** • **DATABASES** • **SYSTEMS** • **SERVICES**
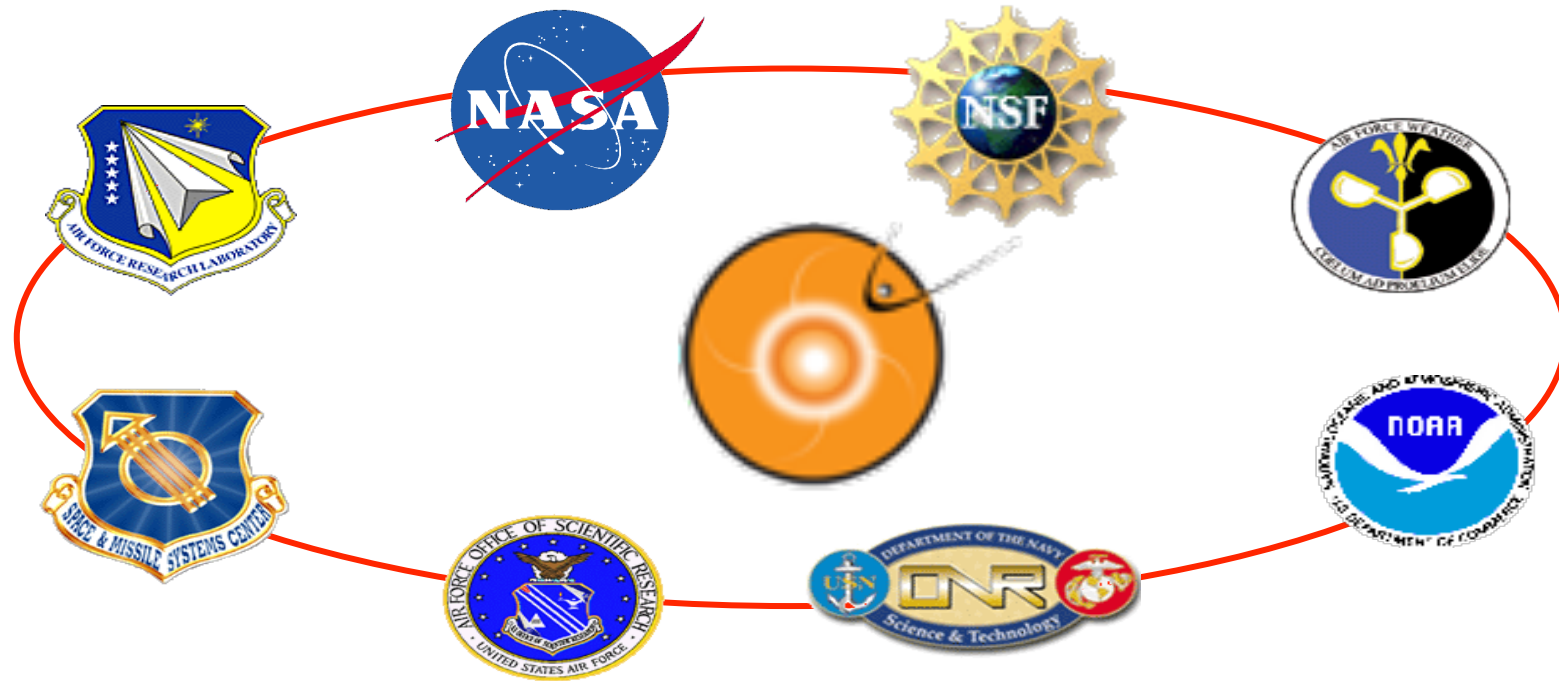
Outline

- Brief History

- Assets & Services

- Databases & Infrastructure

- Outlook

Community Coordinate Modeling Center
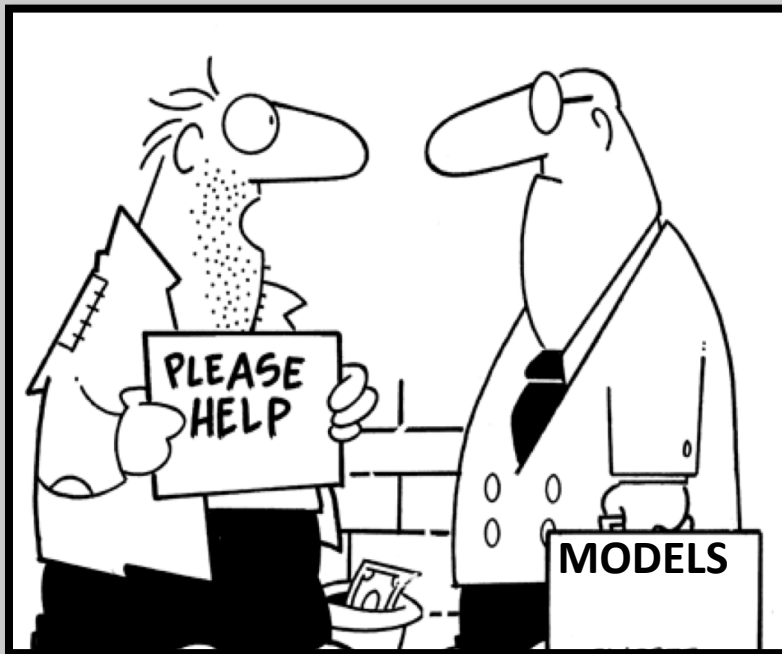

*Established in 2000 as an essential element
of the National Space Weather Program*

*to facilitate research & development for the
next generation of space environment modeling capability.*

Prior to CCMC

Models accessed and used by developers only.

"Valley of Death" between research and space weather applications

CCMC is a Game Changing Solution

http://ccmc.gsfc.nasa.gov
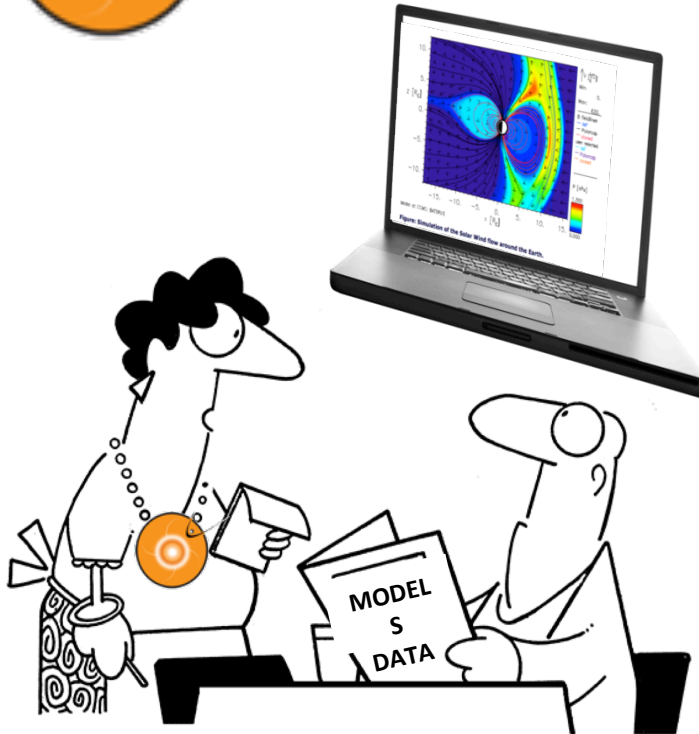
CCMC transformed the way how advanced models are utilized in research

Research

Robust Simulations
Assessment
Actionable Displays
Dissemination
Prototyping
Operations
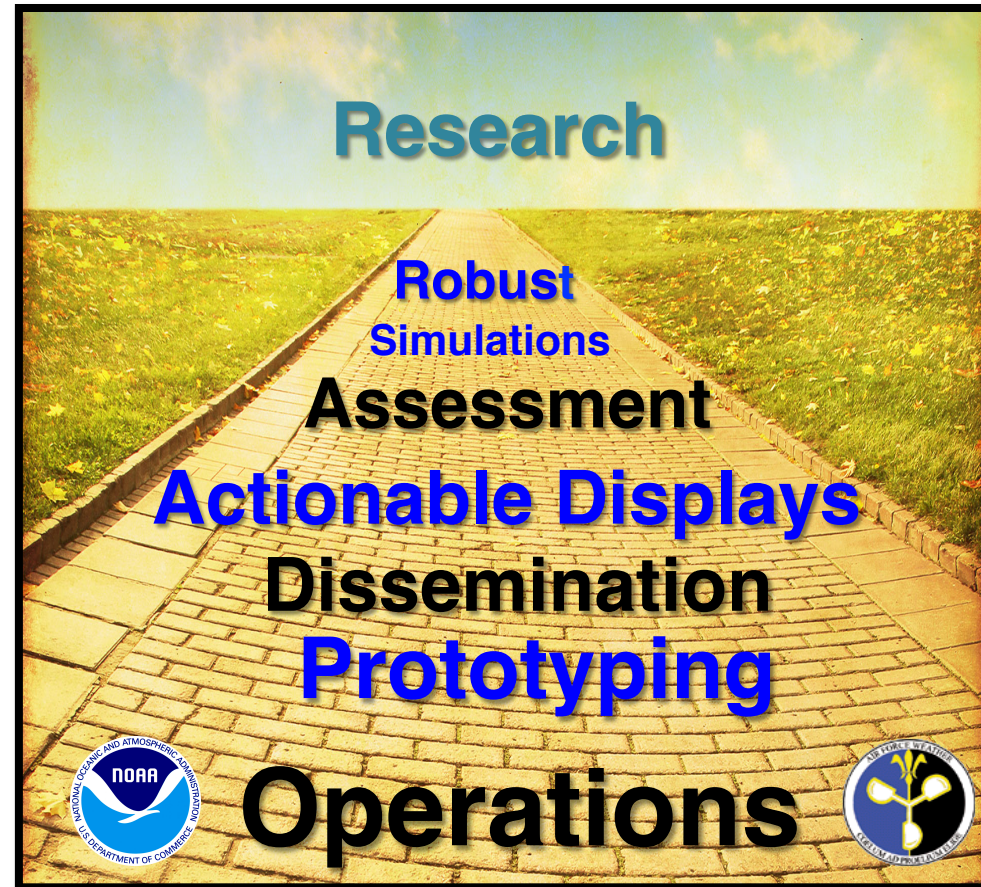
Pioneered the path from Research to Operations

The CCMC as a Hub for Collaborative Advancing of Space Weather Predictive Capability System
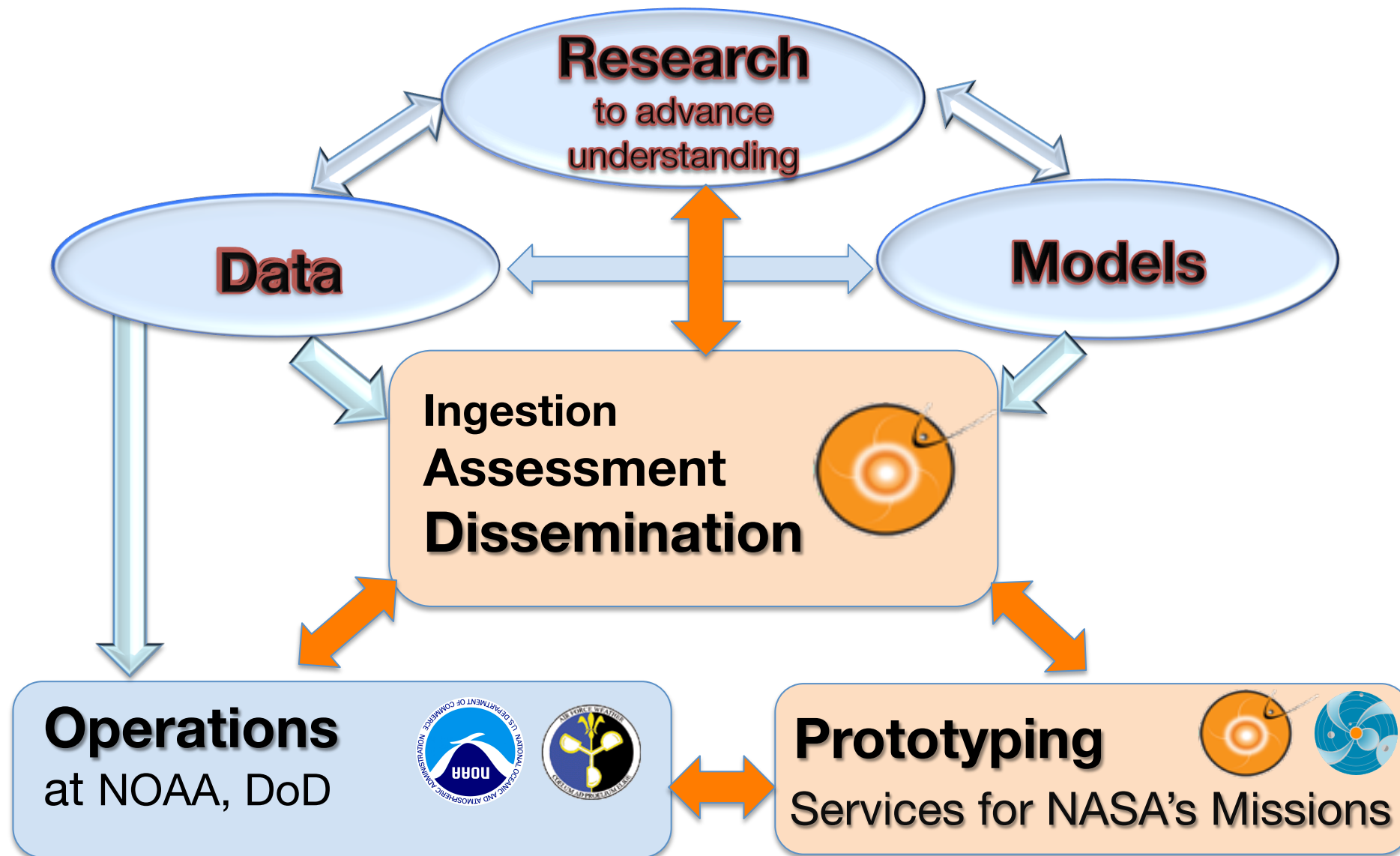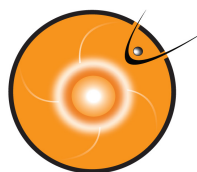
CCMC Assets & Services

Models
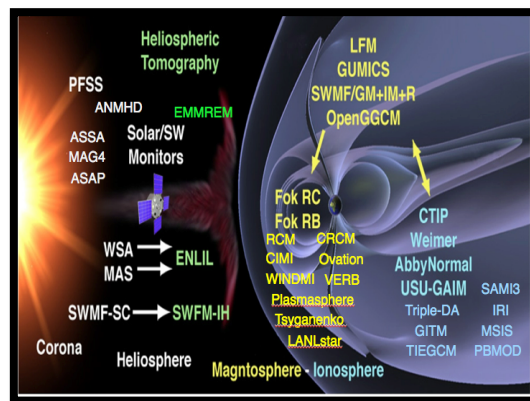
(expanding collection: > 80)

Simulation Services

(> 16,000 runs)

Assessment

Skill Score
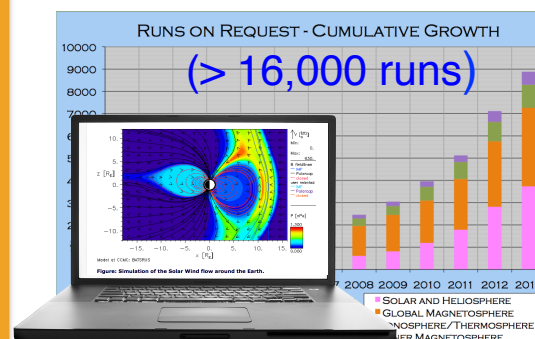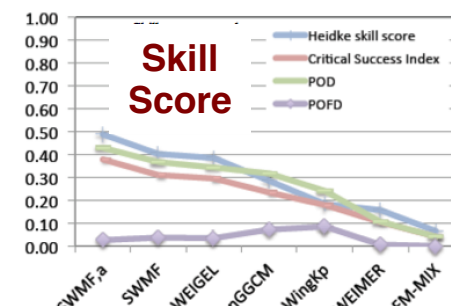
Scoreboard

Dissemination

Flexible Infrastructure Tools, Databases Actionable Displays

Space Weather Services

for NASA's missions
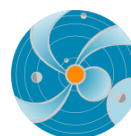
Space **W**eather **R**esearch **C**enter

Hands-on Education

Expanding Collection Of Models at CCMC: > 80

Corona:
SWMF.SC+EEGGL+CME
AWSoM · EEGGL
PFSS.Petrie
PFSS.Macneice
PFSS.Luhmann · ANMHD
MAG4 · UMASEP
ASAP · ASSA · AMOS
WSA · NLFFF · SRPM
MAGIC · SNB3GEO
GCR · BON · NOVICE
NAIRAS · CARI-7

Heliosphere:
WSA-ENLIL
WSA-ENLIL+Cone
WSA-ENLIL+EPREM
WSA-ENLIL+SEPMOD
REleASE
PREDICCS
EXO Solar Wind
EMMREM
CORHEL
Heltomo SMEI
Heltomo IPS
BRYNTRN
DBM
SWMF.SH
DIPS

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

Inner Magnetosphere:
RCM
Fok.CIMI
Fok.RBE
UPOS RB
AE-8/AP-8
AE-9/AP-9
VERB

Ionosphere/Thermosphere:
TIE-GCM · SAMI-3
GMAT · SAM
CTIPe · IDA4D
USU-GAIM
SWACI-TEC
ABBYNormal
NRLMSISE
GITM
PBMOD
TRIPL-DA
Weimer IE
Weimer-deltaB
IRI · JB2008
DTM
COSGROVE-PF
IMPACT

CCMC Web-Based Signature Services
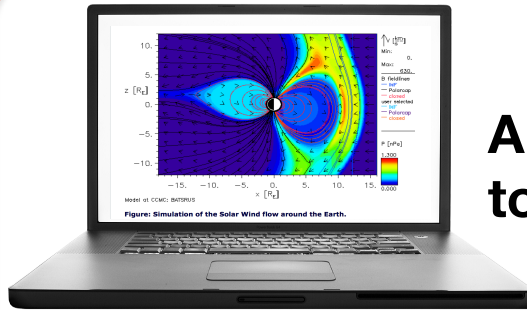
Runs-on-Request System

An interactive system to serve advanced models to the international research community

- **User-configurable input parameters and settings.**
- **Comprehensive on-line visualization & downloads**
- **Users advising and custom simulations.**

iSWA
- solar
- heliosphere
- magnetosphere
- ionosphere
- planetary

Integrated Space Weather Analysis System

A system for real-time space environment monitoring, event analysis, system science, and education.

- **Actionable Products extracted from real-time model runs and data, designed in partnership with NASA mission operators, NOAA, USAF**
- **Real-time and historic events**
- **User-configurable display, Web services, API**

Runs-on-Request
Valuable and highly utilized resource
Usage Summary (March 2016)

Runs on Request - Cumulative Growth

16,400 RUNS TOTAL   (> 1 PB Storage)

Total Publications: >200
Publications (2014-2016): 50
Publications (2012-2013): 43

Last 5 years	SH	GM	IT	IM	Total Runs
2011	1793	2277	735	1103	5908
2012	2826	2937	847	1818	8428
2013	3753	3513	1002	2259	10527
2014	5206	3987	1218	2553	12964
2015	6397	4472	1713	3247	15829
2016 (Jan-Mar)	6621	4557	1798	3362	16338

- SOLAR AND HELIOSPHERE
- GLOBAL MAGNETOSPHERE
- IONOSPHERE/THERMOSPHERE
- INNER MAGNETOSPHERE

Kameleon

Metadata, Standardization, Access, Interpolation

Goal: To facilitate access to space weather models hosted at the CCMC and enable scientific discovery and model coupling

Raw Model Output

Kameleon Converters:
Converter (C)
KameleonJ (Java)

CDF/HDF5
+metadata

Embedded python
reader/interpolator

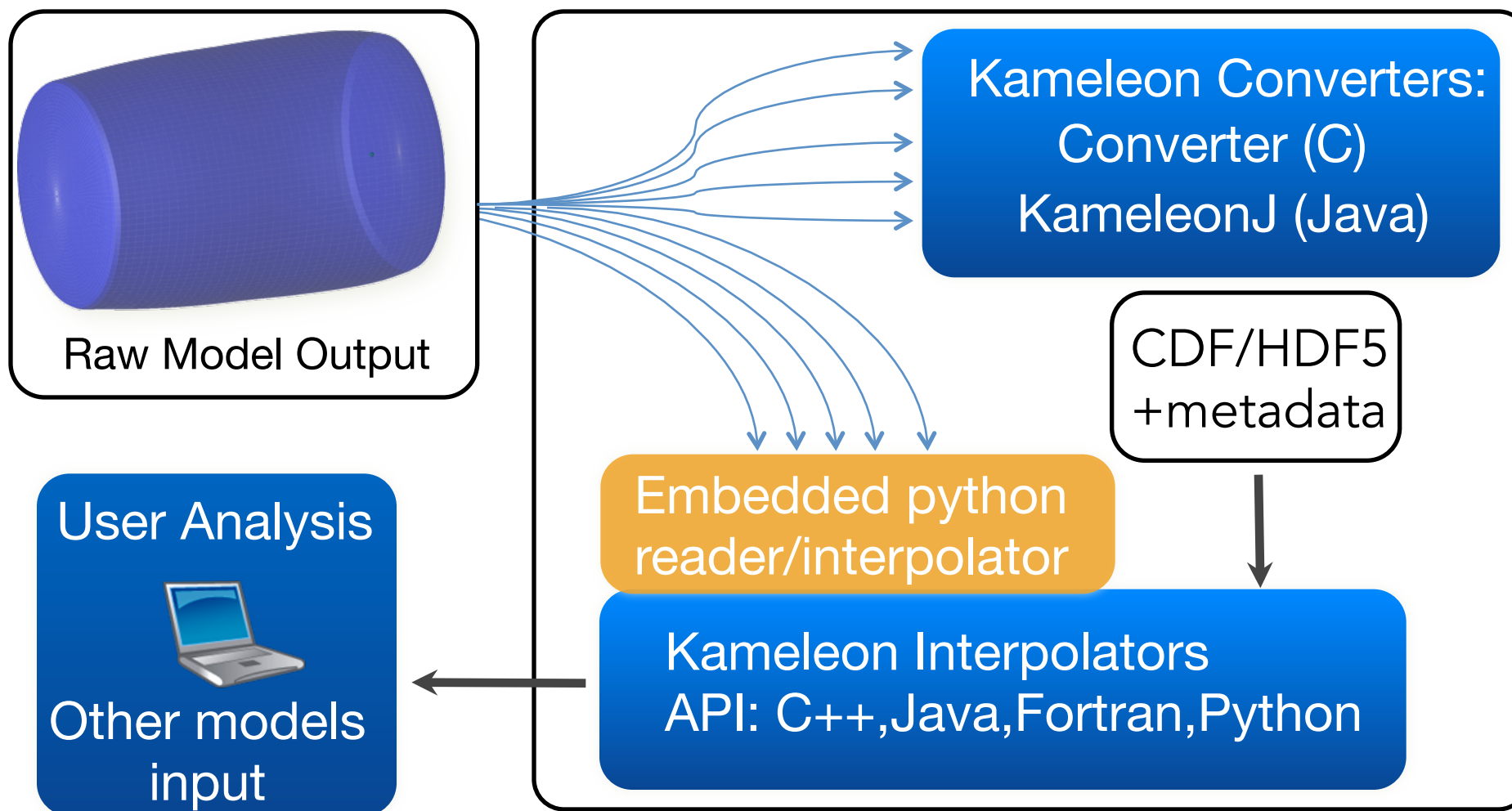Kameleon Interpolators
API: C++,Java,Fortran,Python

User Analysis

Other models
input
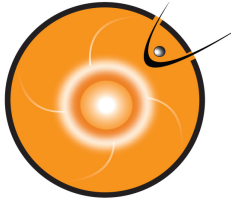
Kameleon-plus 6.0.1 documentation

http://ccmc.gsfc.nasa.gov/downloads/Kameleon/Overview.htm

- Tutorials
- Documentation
- Developer tools

Quick installer for different platforms:

- Gets users up in running in minutes
- Precompiled libraries
- Example scripts in Python, C++, C, and FORTRAN
- Matplotlib Visualization scripts

SEARCH

Enter search terms or a module, class or function name.

CCMC: A. Pembroke
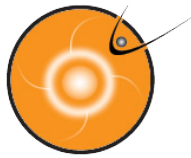
Mag-Iono-Coupling Patch-Panel

High-Latitude Electric Potential Models

- empirical
- data assimilation
- global MHD

empirical:
Heelis
Weimer
Foster
Heppner & Maynard
Ridley

data assimilation:
AMIE
SuperDARN

global MHD:
SWMF
OpenGGCM
LFM

Particle Precipitation Models

- empirical analyticl
- global MHD

empirical analyticl:
Fuller-Rowell & Evans
Hardy et al.
Ovation Prime
Hardy et al.
Ovation Prime
Roble & Ridley

global MHD:
SWMF
OpenGGCM
LFM

Penetration Electric Field Models

- inner magnetosphere

Driven by SWMF:
- FRC
- CRCM
- RCM
Driven by Tsyganenko:
- RCM

All drivers are converted to a common format.
The tool is called as a KAMELEON subroutine to provide values on the grid;
call kameleon (model, time, mlts, mlats, variables, values_output)

Ionosphere/Thermosphere Models:
CTIPe/TIE-GCM/GITM

Towards coupled heliosphere and SEP models

SEP MODELS

| SEPMOD | EPREM | SWMF: FLAMPA | SWMF: Kota SEP |

AMBIENT SOLAR WIND

SHOCK ACCELERATED PARTICLES

SHOCK FRONT

COMPRESSED SOLAR WIND

EJECTA

SOLAR ERUPTION

SUN

SOLAR-HELIOSPHERE MHD MODELS

| **WSA-ENLIL+Cone** | **CORHEL** | **SWMF: AWSoM-R** |

Hydrodynamic CME   *Flux Rope CME (Titov-Demoulin, Gibson-Low)*

Modelers: N. Arge, D. Odstrcil, J. Luhmann, J. Linker, N.Schwadron, M. Gorby, I.Sokolov
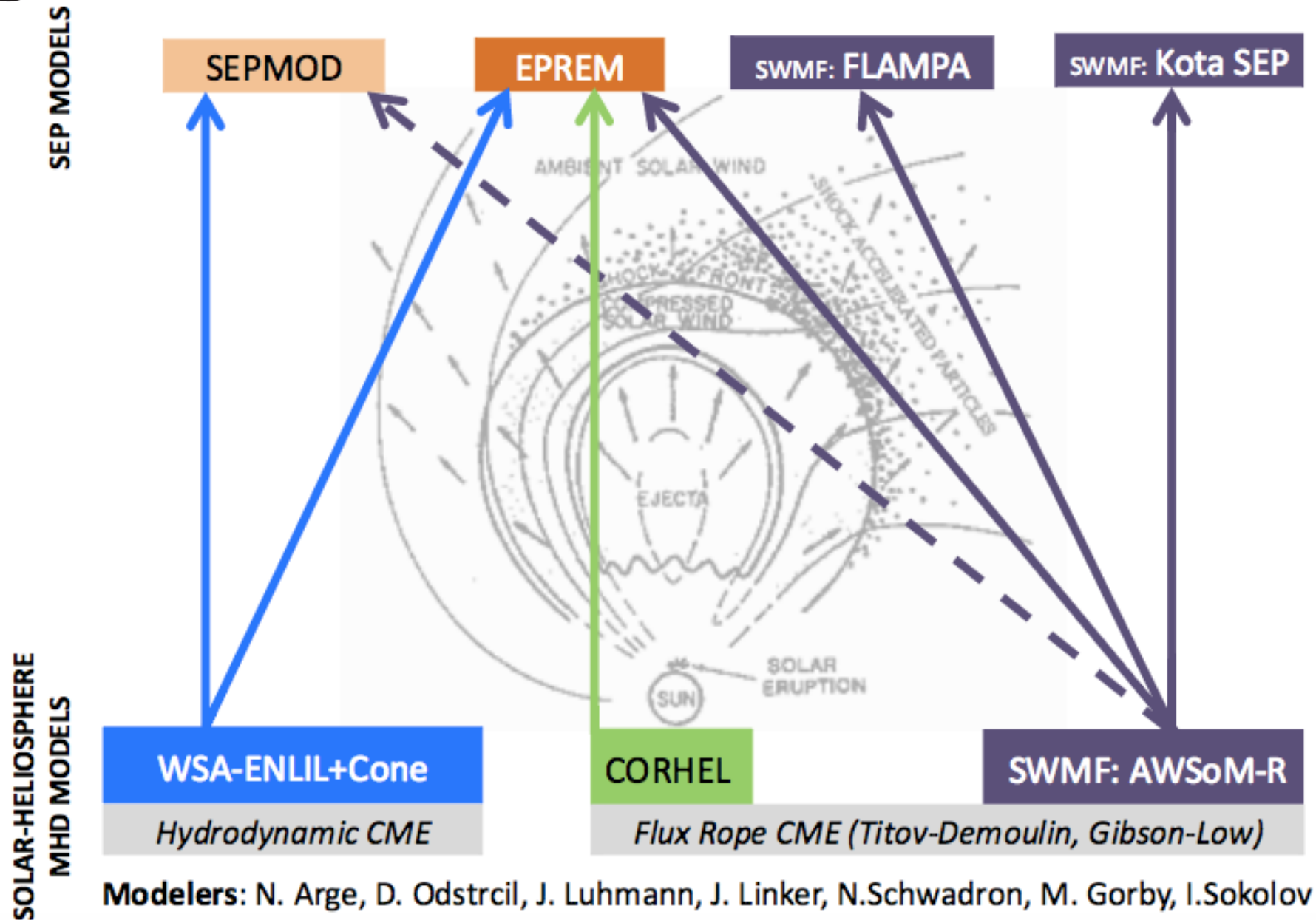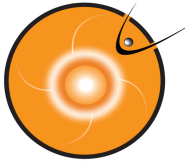
Results for a set of PIC simulations are available for on-line visualization

- Fields, Plasma Parameters, Pressure Tensors (scalars, vectors, field lines)

- Quick-look set of Distribution Functions (DF)

- DF generation on request in a region-of-Interest specified by user.

- Opportunity to modify simulation settings through Runs-on-request.

- Particle data (2D runs) for 1 time step **~ 4TB**

Emerging need to expand
kinetic simulation services at the CCMC

Integrated Space Weather Analysis System

http://iSWA.ccmc.gsfc.nasa.gov
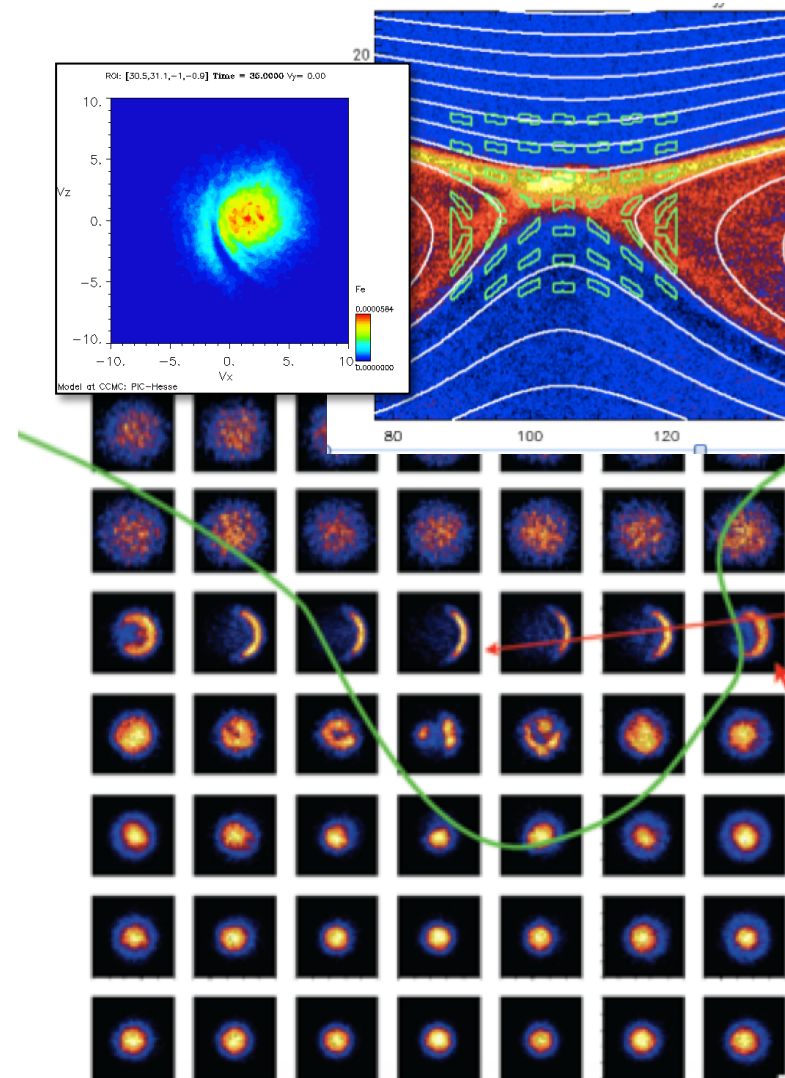
Mobile Access Powered by iSWA

Android Front-End to iSWA

- History Mode
- Movie Mode
- >120k Downloads
- Available in Google Play Store
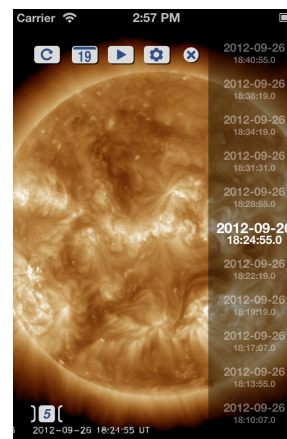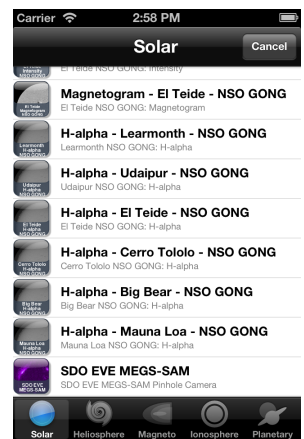
IOS Front-End to iSWA

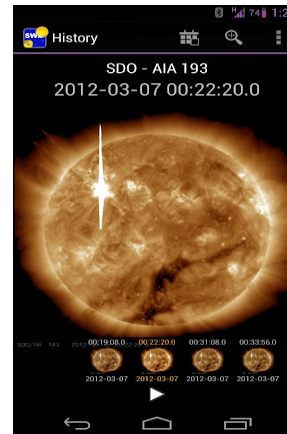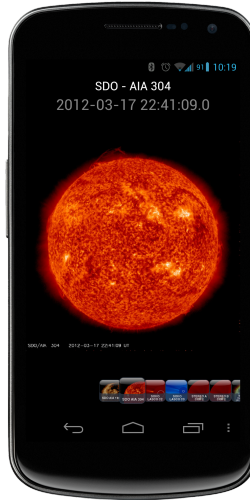- >110k Downloads
- Available in App Store

Distributed Space Weather Resources

CCMC Space Weather Model Resources

Internet

iSWA

Resource Registry

Data Registry

Data/Tool Registry

BACK END

FRONT END

Product Registry

Information Retrieval Robot

Data Sorter

Tool Service

Widget Agent

IRR

• Routinely ingest and

DS

• Data is registered in

TS

• New data products are created using raw

WA

• Data products are registered and packaged for display in iSWA system

UMA Proton Flux Forecast

Joule Heating

Venus FL Connectivity

Induced Electric Fields EY

Solar Wind at Earth

Radiation Belt 4000keV

ENLIL SPIRAL

Cygnet Registry

Configurable Web-Based Dissemination Service

CWDS

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

Internet

User Configurable Displays

Integrated Space Weather Analysis System
iSWA In Numbers

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

- **22,000 users in 2015,**
- **2.6 Millions** iSWA Cygnet Requests Per Month
- **282k** Mobile Space Weather Apps Downloaded
- **600** iSWA Display Products (Cygnets)
- **1000** Data Streams (vs 500 in 2014)
- **>100K** files per day
- ~ **90 Millions** Files Registered and Archived

Assessment, Metrics & Validation

Testing predictive capability **before the event onset**

CME Scoreboard

Flare Scoreboard

SEP Scoreboard

Event-based M&V to trace model improvement

A list of **events**.
High quality **data**.
A library of **metrics**.

Simulate the same set of events over and over…

Examples:
TEC, foF2, Ne
Neutral density,
Auroral boundaries,
Ground magnetic
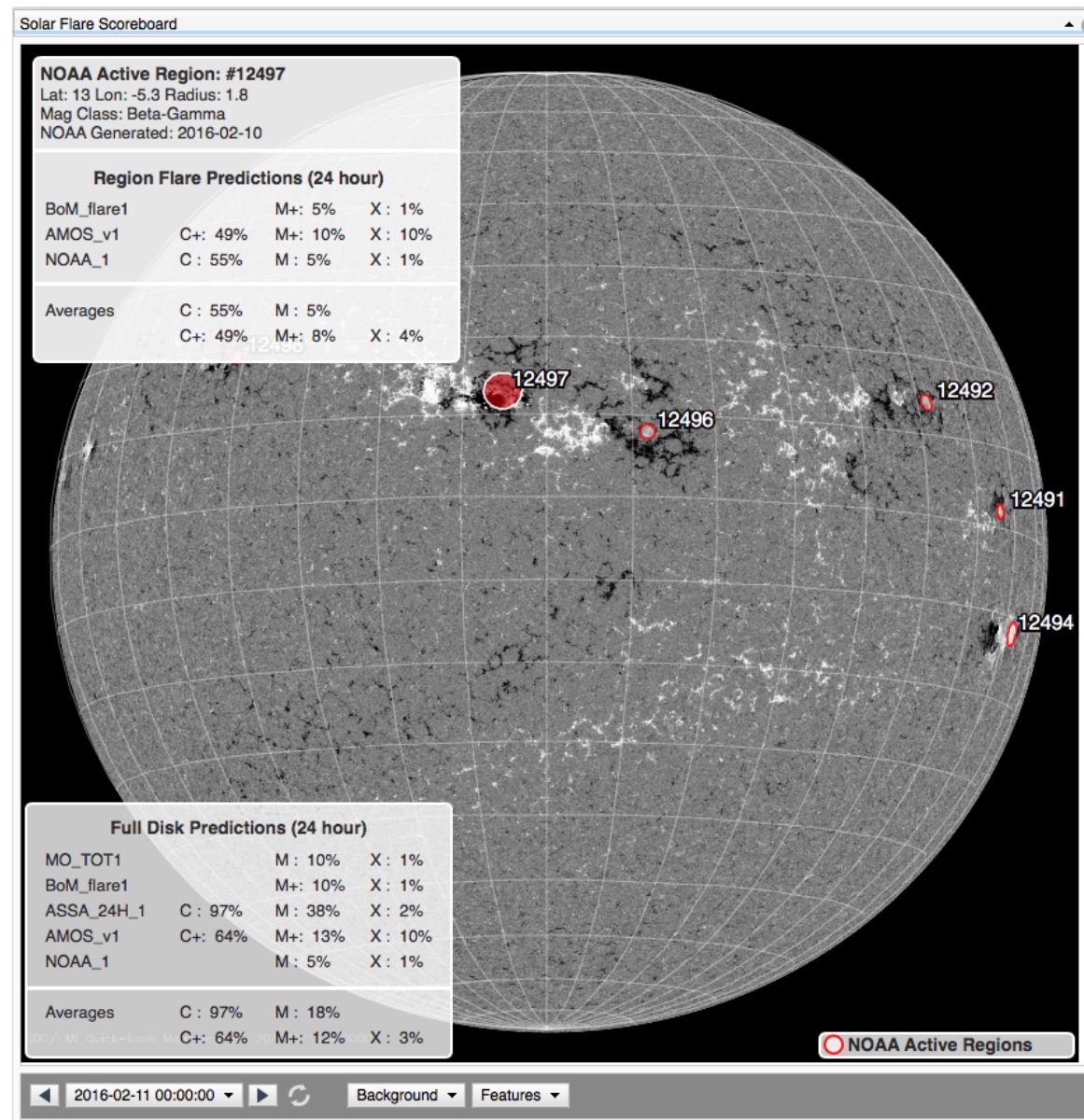perturbations

Sanity check Toolkit for real-time runs

Sensitivity analysis to external drivers and internal assumptions

Performance evaluation for extreme conditions

Correlate forecasts with impacts

Flare Scoreboard:
Ensemble Solar Flare Forecasts

Solar Flare Scoreboard

NOAA Active Region: #12497
Lat: 13 Lon: -5.3 Radius: 1.8
Mag Class: Beta-Gamma
NOAA Generated: 2016-02-10

Region Flare Predictions (24 hour)

BoM_flare1			M+: 5%	X : 1%
AMOS_v1	C+: 49%		M+: 10%	X : 10%
NOAA_1	C : 55%		M : 5%	X : 1%
Averages	C : 55%		M : 5%	
	C+: 49%		M+: 8%	X : 4%

12497 12496 12492 12491 12494

Full Disk Predictions (24 hour)

MO_TOT1		M : 10%	X : 1%
BoM_flare1		M+: 10%	X : 1%
ASSA_24H_1	C : 97%	M : 38%	X : 2%
AMOS_v1	C+: 64%	M+: 13%	X : 10%
NOAA_1		M : 5%	X : 1%
Averages	C : 97%	M : 18%	
	C+: 64%	M+: 12%	X : 3%

○ NOAA Active Regions

◀ 2016-02-11 00:00:00 ▾ ▶ ↻   Background ▾   Features ▾

Multipurpose Tools, Systems, Databases, Interfaces

Data Management, Metadata, Standardization, Access

KAMELEON
CONVERSION ● ACCESS ● INTERPOLATION

- Science Data Formats, Metadata
- Data Conversion
- Access & Interpolation Library
- Reusable Data Model/Framework

FlexDIT — Flexible Data Ingestion Tool

- Designed to facilitate ingestion of disparate time series data from a variety of sources into CCMC's existing infrastructure
- Describe input data via XML for efficient dataset imports
- Generalized parser works with a variety of formats

Integrated Space Weather Analysis System

iSWA
solar
heliosphere
magnetosphere
ionosphere
planetary

- Web-Based Space Weather Dissemination System
- User Configurable, Interactive Products
- Web Services
- Real-Time & Historical Model + Observational Data

StereoCAT CME Analysis Tool

- Determine CME kinematic parameters
- Create CME height-time measurements
- Create an ensemble of CME measurements
- Save and share measurement sessions

Database Of Notifications, Knowledge, Information

- Catalog of space weather phenomena
- Knowledgebase of interpretations, simulation results, and forecasting analysis
- Online tool for dissemination of forecasts, notifications, & archiving event-focused information

EEGGL Eruption Event Generator (Gibson & Low)

- Use observations defining the CME source region (location and flux rope orientation,
- Generate Gibson-Low flux rope parameters for the flux rope emergence models.

Space Weather Scoreboard

- Research-based forecasting methods validation
- Scientific community submits forecasts in real-time
- View and Compare all forecasting methods

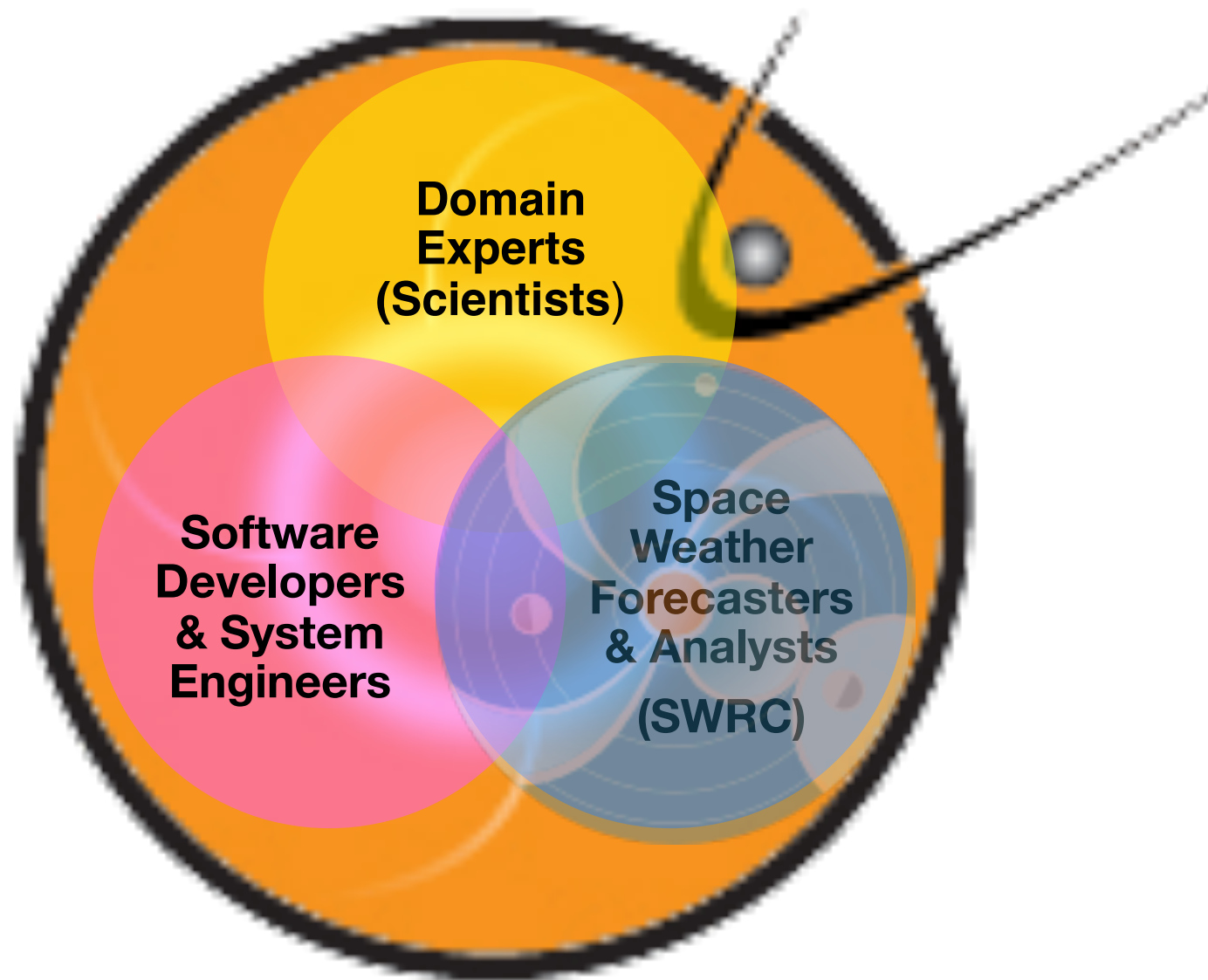## Space Environment Automated Alerts, Anomaly Analysis Assistant (SEA[5])

- Mission/Location Specific Space Environment Tool
- Automated/Custom Alerts & Notifications
- Assimilate & Display Anomaly Information

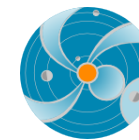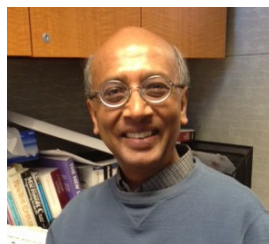CCMC Talent
represents the entire space weather community

Domain Experts (Scientists)

Software Developers & System Engineers

Space Weather Forecasters & Analysts (SWRC)
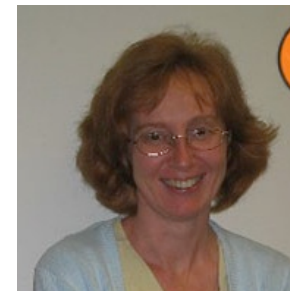
CCMC Staff

NASA+NSF ~ 13 FTEs

S. Bakshi

Kiran Patel

M.Kuznetsova (**Director**)

Leila Mays (**Acting Deputy**)

Anna Chulaki

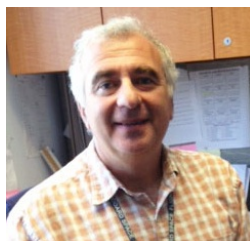M. Mendoza

P. Macneice
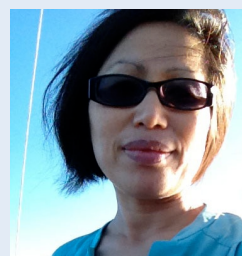
L. Rastaetter
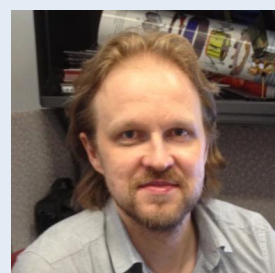
Ja Soon Shim
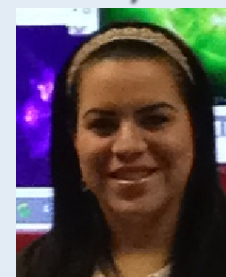
A. Pembroke

Chiu Wiegand

R.Mullinix

A. Taktakishvili

SWRC Team (GSFC ~ 1.5 FTEs)

B. Thompson

Yihua Zheng

A. Pulkkinen (**Lead**)

Y. Collado-Vega
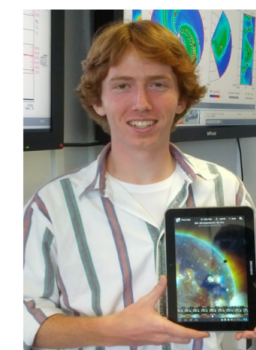
J. Boblitt

+ post-docs
+students

CCMC Community

CCMC staff is a part of an expanding CCMC Community

CCMC Affiliates at GSFC

CCMC Advisory Group Chair: R. Walker.

ADVISORS and SUPPORTERS

Dr. Ray Walker*	Dr. Dan Fry*	Dr. Alex Glocer*	Dr. Joe Minow*	Dr. Robert Robinson*	Dr. David Sibeck*	Dr. Howard Singer*	Dr. Delores Knipp	Dr. Janet Luhmann
Dr. George Siscoe	Dr. Jan Sojka*	Dr. Alex Pevtsov*	Dr. Marc DeRosa*	Dr. Mark Linton*	Dr. Angelos Vourlidas	Dr. Kent Tobiska*	Dr. Joe Borovsky*	Dr. Nick Arge*

* denotes Advisory Group 2016-2018 members

CCMC ADVISORY GROUP 2016-2018

MODEL PROVIDERS

CCMC Interns

CCMC Visitors

Advisory Group suggestions include:
Improve visualization.
Better management of the archive
of simulations.

CCMC Partners
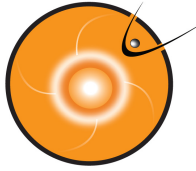
Connections to the Community
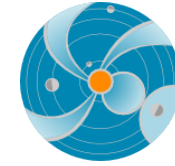
- **Biennial Community Workshops for updates, feedback, guidance (latest in spring 2016).**

- **Annual NASA Robotic Mission Operations Workshops (organized by SWRC team, next Sept 29-30, 2016).**

- Sessions at CEDAR-GEM-SHINE workshops, NOAA Space Weather Workshop, European SW week,…

- Regular tag-ups with Ops agencies (NOAA, NASA/SRAG, AFWA, Met Office, …)

- Participation is LWS Steering Committee & TIM Workshops

- Regular tag-ups with funding agencies.

CCMC Databases Re-Architecture Models, Simulations and Beyond

Objectives:

- Address a need for a hub for the community to easily search and obtain simulations data for their own research
- Enable easy model-data comparisons
- Enable easy linkage between different CCMC databases
- Enable community to build a wide range of tools and front-end applications utilizing simulation data from CCMC

Status:

- Database design based on SPASE and IMPEx
- Web interface allowing to enter model information
- Web service interface allowing applications to obtain model information (JSON format)

Dedicated Computational Infrastructure

Super Computing Clusters **(2200 CPU's)**	**Dedicated Servers, Workstations & Virtual Machines** **(1800 CPU's)**
1.2 Peta-Byte of Data Storage	**1-10 GB network SEN Support**

CCMC

Failover Architecture

Rack Footprint

8 in B32
16 in B21
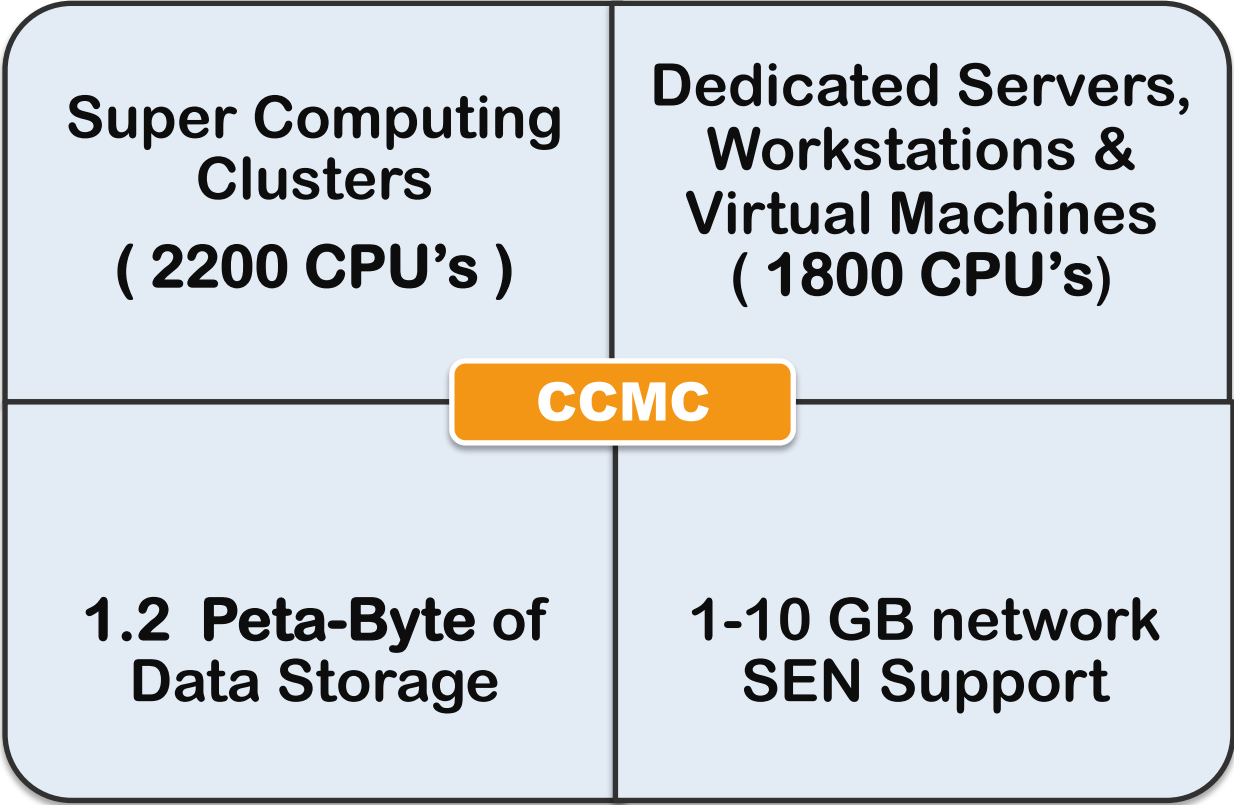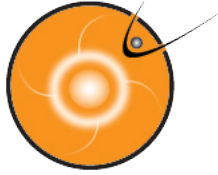
Outlook

- CCMC is:

  - Asset of international space weather community,

  - Fast response unit to emerging community needs,

  - Assess point to state-of-the-art capabilities, a venue for dissemination of research results,

  Actual + virtual repository of models, simulations results, space weather products, +

  - Playground for scientists,

  - Hub for collaborative research & development,

  - Resource for hands-on education.

Supplementary material

Key Elements of Space Weather Forecasting and Analysis Capability
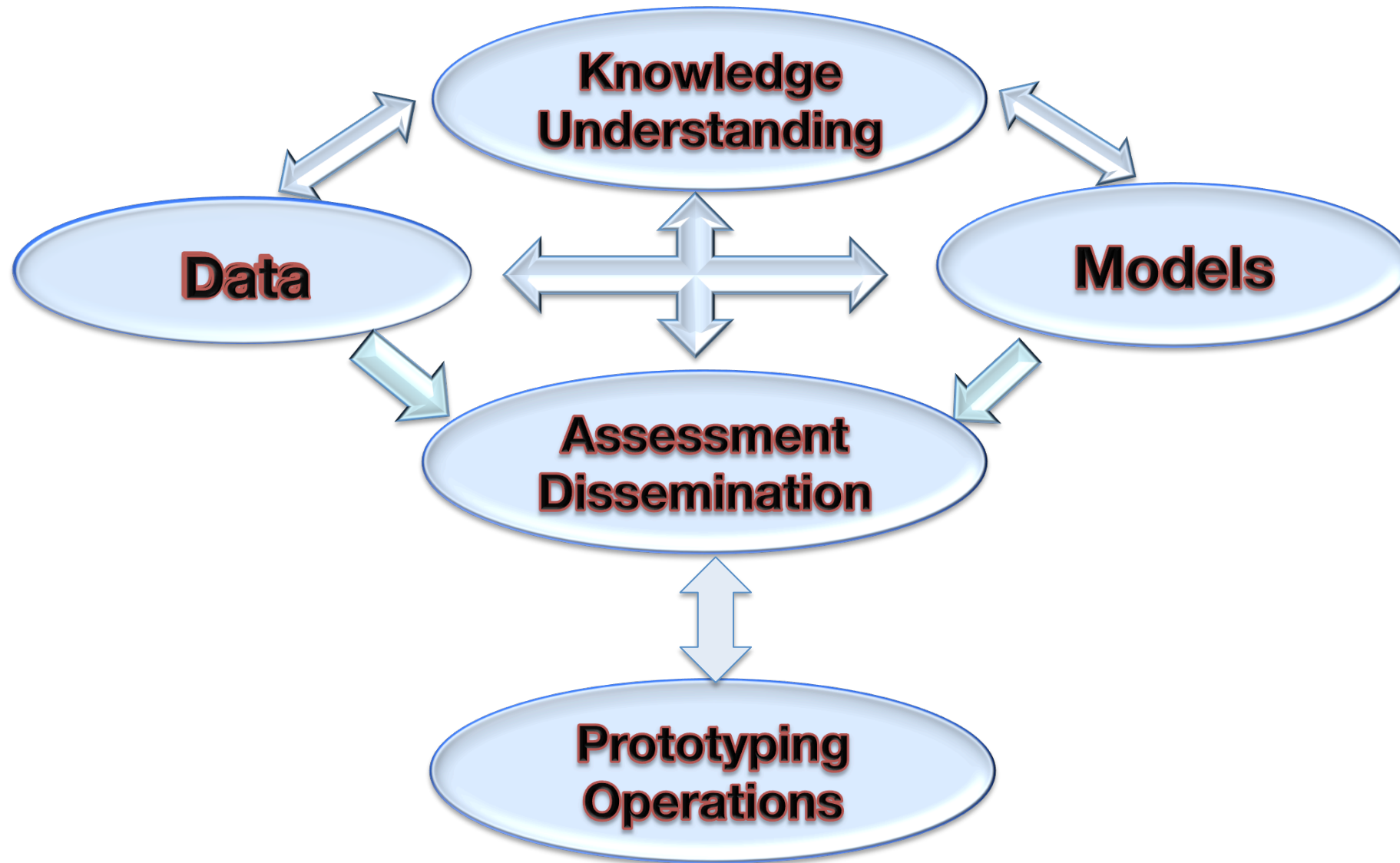
Expanding Collection Of Models at CCMC: > 80
New + Upgrades 2014-2016

WSA-ENLIL

WSA-ENLIL+Cone

LFM-TING   GUMICS

TIE-GCM   SAMI-3

WSA-ENLIL+EPREM   LFM-MIX   GIC

GMAT   SAM

WSA-ENLIL+SEPMOD   OpenGGCM+CTIM

CTIPe   IDA4D

SWMF.SC+EEGGL+CME   SWMF+RCM+deltaB   RCM   USU-GAIM

AWSoM   EEGGL   REleASE   SWMF+RCM   Fok.CIMI   SWACI-TEC

PFSS.Petrie   PREDICCS   SWMF+RCM+RBE   Fok.RBE   ABBYNormal

PFSS.Macneice

PFSS.Luhmann   ANMHD   EXO Solar Wind   SWMF+RCM+CRCM   UPOS RB   NRLMSISE

EMMREM   LFM-MIX-TIEGCM   AE-8/AP-8   GITM

MAG4   UMASEP   CORHEL   WINDMI   LANLstar   AE-9/AP-9   PBMOD

ASAP   ASSA   AMOS   Heltomo SMEI   IGRF   Tsyganenko   VERB   TRIPL-DA

Weigel-deltaB   Weimer IE

WSA   NLFFF   SRPM   Heltomo IPS   PS VP   Apex   Weimer-deltaB

MAGIC   SNB3GEO   BRYNTRN   AACGM   Ovation Prime   IRI   JB2008

DBM   IMPACT   DTM

GCR BON   NOVICE   SWMF.SH   AMPS

NAIRAS   CARI-7   DIPS   COSGROVE-PF

Corona   **Heliosphere**   **Magnetosphere**   **Inner Magnetosphere**   **Ionosphere/ Thermosphere**

Interactive On-Line Visualization & Analysis

- ✓ Basic model output and derived quantities.
- ✓ User-ordered custom variables (*email the formula to Lutz and it will be tested & added*).
- ✓ Automated movie & time series generation.
- ✓ Time series plotter & analyzer.
- ✓ 2D slices, Line plots, 3D flow lines, ASCII lists
- ✓ Magnetic mapping.
- ✓ Interfaces with Virtual Observatories.
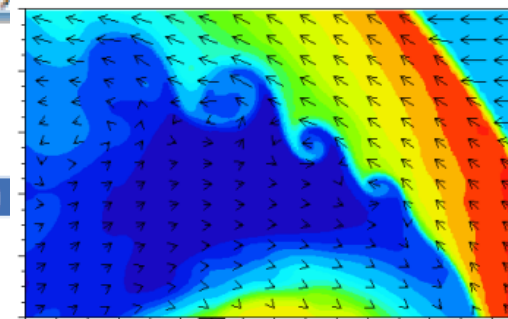- ✓ Change-Log on CCMC web page.
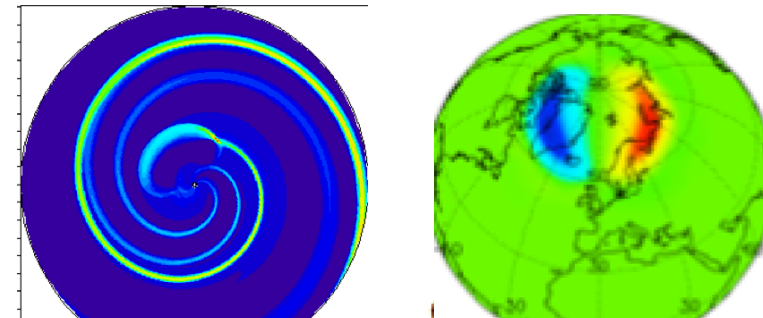
Choose Quantities:

Q 1: J

Choose Plot Mode:

ColorContour (2D)

3D-Surface
Line (1D)
Contour (2D)
Vector (2D)
ColorContour (2D)
Color+Vector
Contour+Vector
Color+Contour
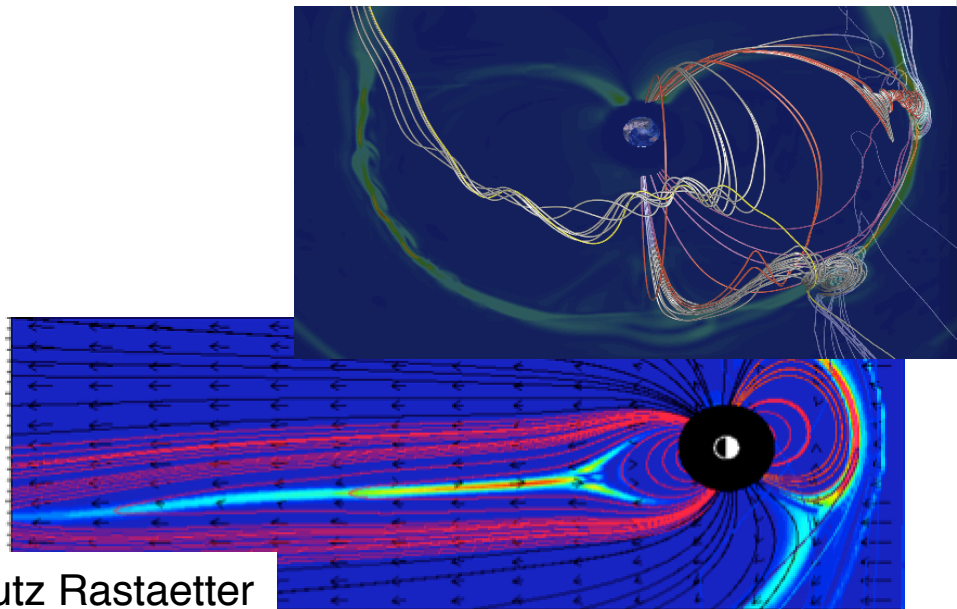Color+Vector+Contour
Color+Vector+Flowlines
3D Flowlines

B1_y
B1_z
En.
J_x
J_y
J_z
B
beta
V
J
B1

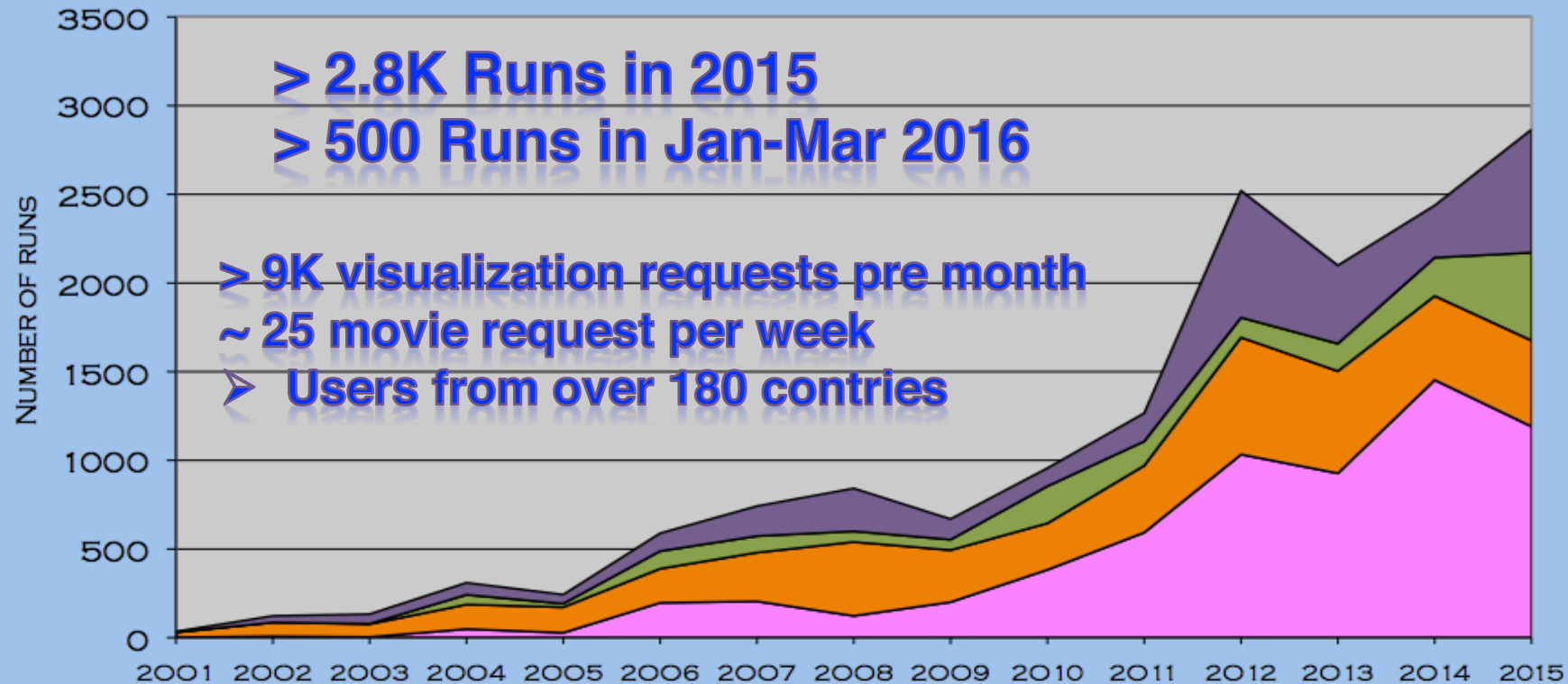Color Contour, (Vertical) Li

Color table: Rainbow
☐ Reverse Colortable
Number of levels: 32

Lutz Rastaetter

CCMC Statistics: SIMULATION SERVICES

RUNS ON REQUEST - EXECUTED PER YEAR

> 2.8K Runs in 2015
> 500 Runs in Jan-Mar 2016

> 9K visualization requests pre month
~ 25 movie request per week
➢ Users from over 180 contries

NUMBER OF RUNS

Last 5 years	SH	GM	IT	IM	Total Runs
2011	593	377	137	159	1266
2012	1033	660	112	715	2520
2013	927	576	155	441	2099
2014	1453	474	216	294	2437
2015	1191	485	495	694	2865
2016 (Jan-Mar)	224	85	85	115	509

YEAR

☐ SOLAR AND HELIOSPHERE
☐ GLOBAL MAGNETOSPHERE
☐ IONOSPHERE/THERMOSPHERE
☐ INNER MAGNETOSPHERE

Actionable Tools & Displays Examples

Magnetopause position
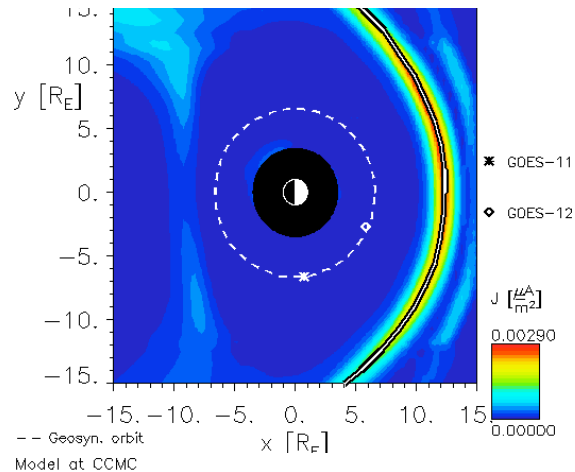
Auroral region location
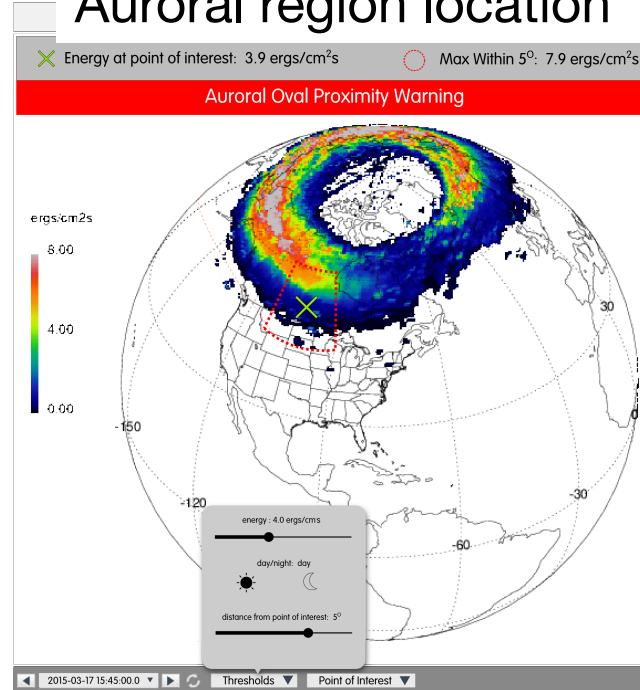
- Make complex models operationally useful.

- Ready to be used by forecasters.

- Products tailored for specific application/mission's needs.

- Large number of tools from one model.

- Certain products combine outputs from several models + data.

- **Examples**: images, plots, notifications, red-green-yellow

iNTEGRATED SPACE WEATHER ANALYSIS SYSTEM

NASA Mission Data

Non-NASA Mission Data

Commercial Data

University / Educational Institution Data

. . .

International Data

iSWA System

WARNING !

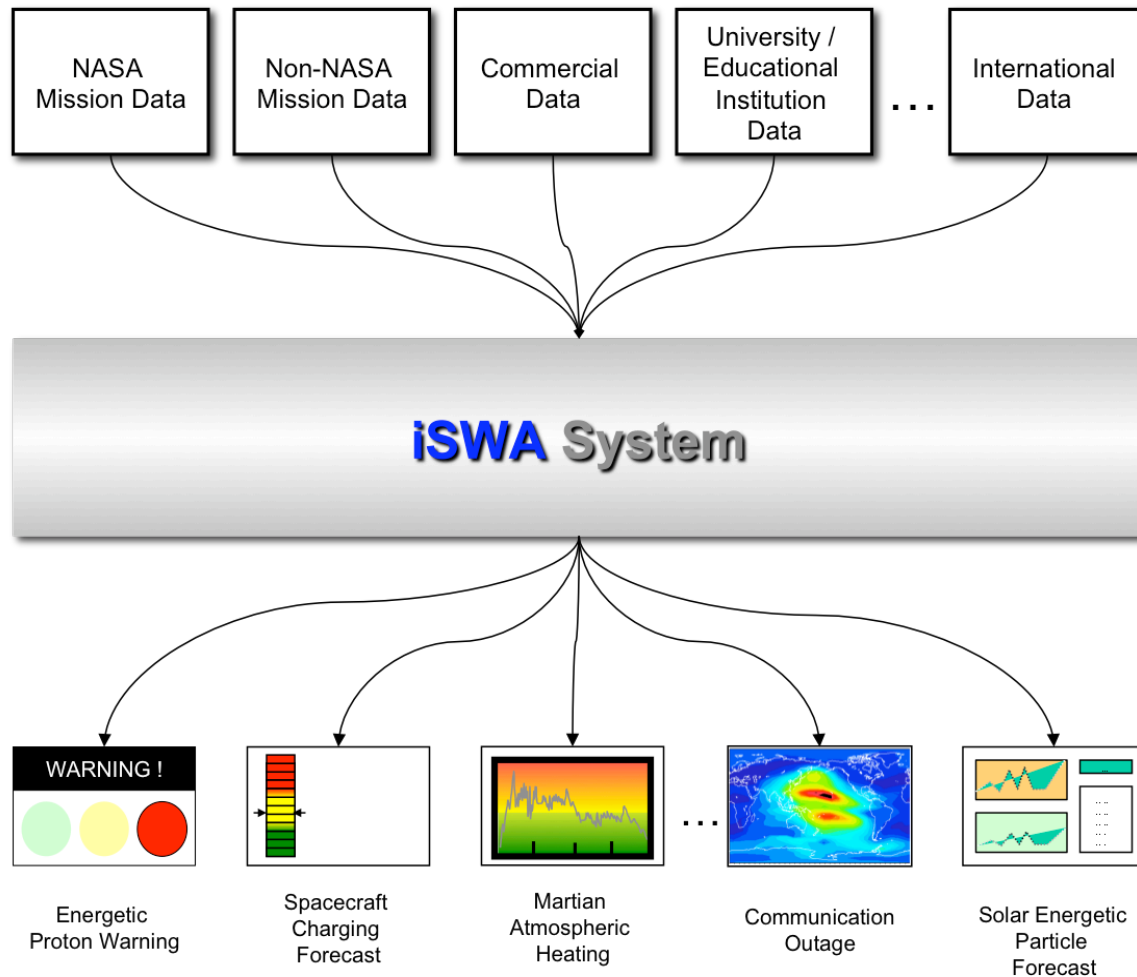Energetic Proton Warning

Spacecraft Charging Forecast

Martian Atmospheric Heating

. . .

Communication Outage

Solar Energetic Particle Forecast

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.

iSWA Design Highlights

BACK END

- **Comprehensive data model that drives the system**
  - Minimizes need for actual code modifications
  - Allows rapid additions and modifications to data feeds and display products
- **Every granule of data is registered, cataloged, and archived**
  - Access data products for any available time period
  - Generate new tools and functionality using multiple existing data products

FRONT END

- **Consistent Interface with uniquely identifiable product icons**
- **Customizable layout**
  - automatically saved on browser exit
  - can be bookmarked and shared
- **Auto updating products and tools**
- **Individual and global date search functionality for historical impact analysis**

- ~~**Detailed descriptions for data products**~~

Evolution of iSWA

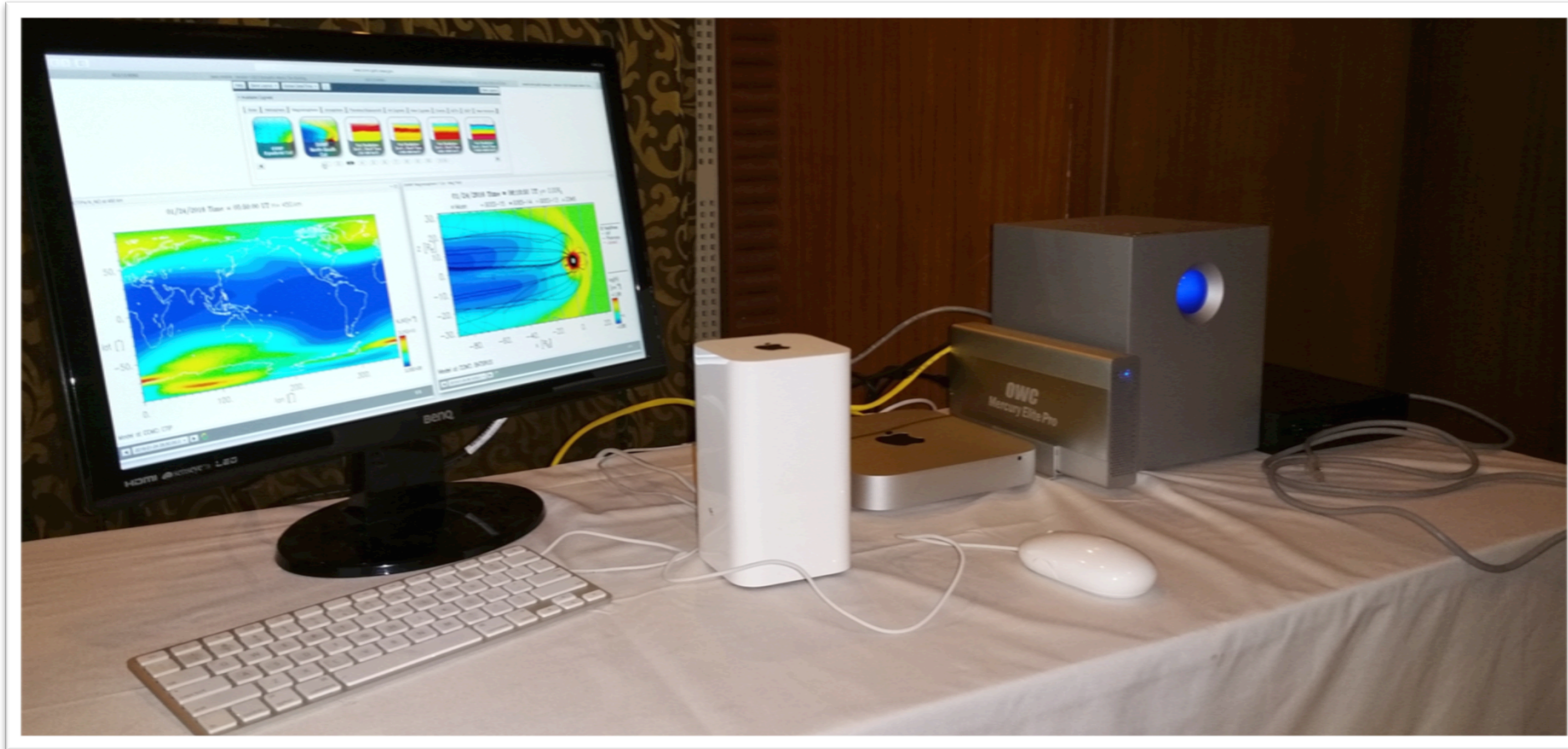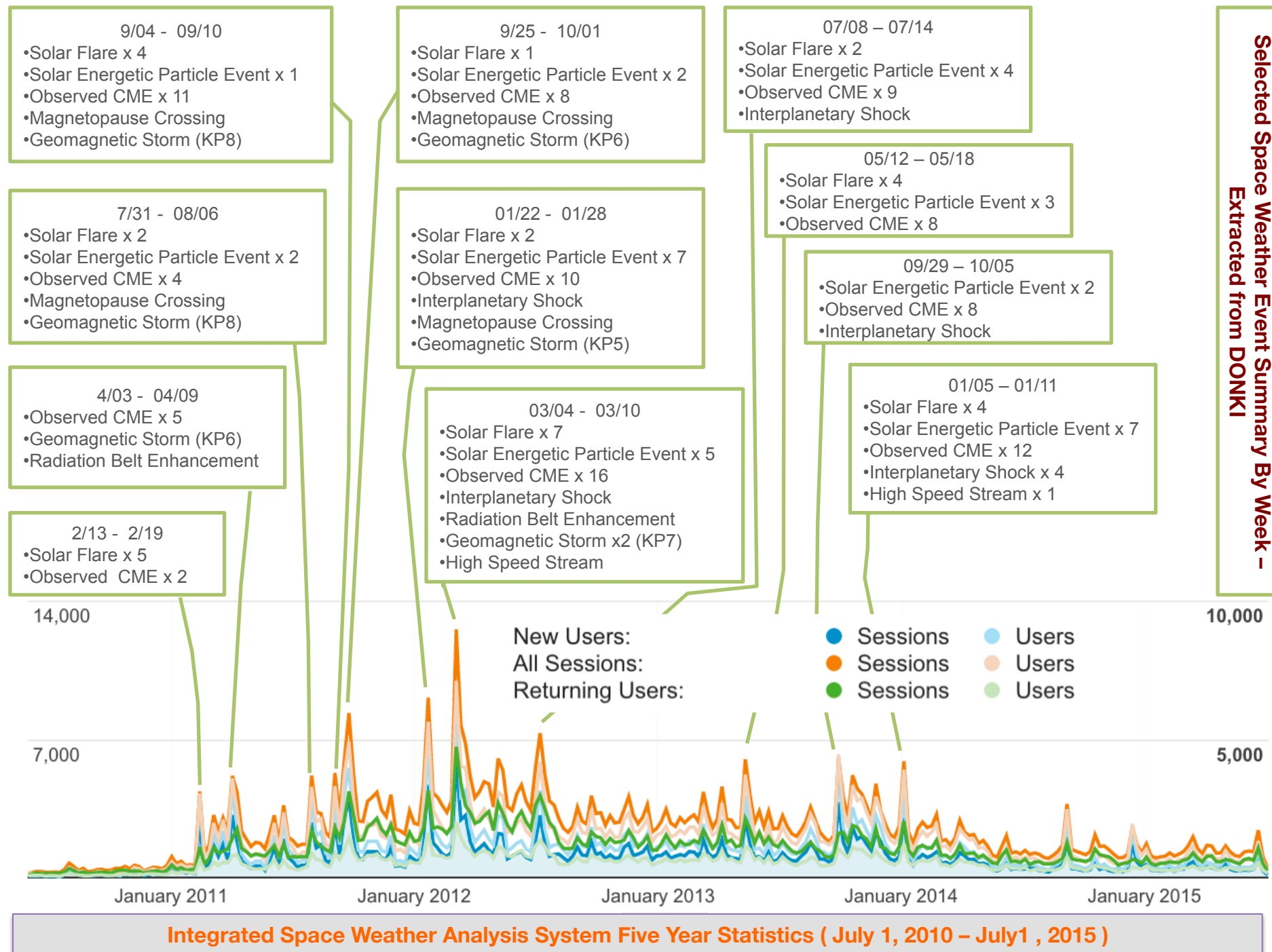Development System
~2008

Production System
~2011

2nd Gen System
(Under Construction)
~2016

Evolution of iSWA

Iswa Portable Prototype
Deployed at Science for Space Weather Workshop January 2016, GOA, India

9/04 - 09/10
- Solar Flare x 4
- Solar Energetic Particle Event x 1
- Observed CME x 11
- Magnetopause Crossing
- Geomagnetic Storm (KP8)

9/25 - 10/01
- Solar Flare x 1
- Solar Energetic Particle Event x 2
- Observed CME x 8
- Magnetopause Crossing
- Geomagnetic Storm (KP6)

07/08 – 07/14
- Solar Flare x 2
- Solar Energetic Particle Event x 4
- Observed CME x 9
- Interplanetary Shock

7/31 - 08/06
- Solar Flare x 2
- Solar Energetic Particle Event x 2
- Observed CME x 4
- Magnetopause Crossing
- Geomagnetic Storm (KP8)

01/22 - 01/28
- Solar Flare x 2
- Solar Energetic Particle Event x 7
- Observed CME x 10
- Interplanetary Shock
- Magnetopause Crossing
- Geomagnetic Storm (KP5)

05/12 – 05/18
- Solar Flare x 4
- Solar Energetic Particle Event x 3
- Observed CME x 8

09/29 – 10/05
- Solar Energetic Particle Event x 2
- Observed CME x 8
- Interplanetary Shock

4/03 - 04/09
- Observed CME x 5
- Geomagnetic Storm (KP6)
- Radiation Belt Enhancement

03/04 - 03/10
- Solar Flare x 7
- Solar Energetic Particle Event x 5
- Observed CME x 16
- Interplanetary Shock
- Radiation Belt Enhancement
- Geomagnetic Storm x2 (KP7)
- High Speed Stream

01/05 – 01/11
- Solar Flare x 4
- Solar Energetic Particle Event x 7
- Observed CME x 12
- Interplanetary Shock x 4
- High Speed Stream x 1

2/13 - 2/19
- Solar Flare x 5
- Observed CME x 2

Selected Space Weather Event Summary By Week – Extracted from DONKI

New Users:
All Sessions:
Returning Users:

Sessions — Users
Sessions — Users
Sessions — Users

14,000

7,000

10,000

5,000

January 2011   January 2012   January 2013   January 2014   January 2015

Integrated Space Weather Analysis System Five Year Statistics (July 1, 2010 – July1 , 2015)

CME Arrival Prediction Scoreboard

- Initiated in 2013
- There are currently **19 registered methods** predicting CME arrival time, including entries from the CCMC, NOAA/SWPC, UK MetOffice, KSWC, SIDC
- Total CMEs in ScoreBoard: **108**

2016: 8   2015: 32   2014: 46   2013 (march start): 22

CME: 2015-06-21T02:48:00-CME-001

Actual Shock Arrival Time: 2015-06-22T17:59Z

Observed Geomagnetic Storm Parameters:
Max Kp: 8.0
Dst min. in nT: -195
Dst min. time: 2015-06-23T05:00Z
CME Note: From near disk center, AR 12371. Associated with M-class flares.

| Predicted Shock Arrival Time	Difference (hrs)	Confidence (%)	Submitted On	Lead Time (hrs)	Predicted Geomagnetic Storm Parameter(s)	Method
2015-06-22T17:00Z (-12.0h, +12.0h)	-0.98	90.0	2015-06-21T10:26Z	31.55	Max Kp Range: 4.0 - 8.0	Other (SIDC)
2015-06-22T21:00Z	3.02	----	2015-06-22T01:00Z	16.98	Max Kp Range: 5.0 - 8.0	WSA-ENLIL + Cone (Met Office)
2015-06-22T21:43Z (-7.0h, +7.0h)	3.73	100.0	2015-06-22T03:25Z	14.57	Max Kp Range: 6.0 - 8.0	WSA-ENLIL + Cone (GSFC SWRC)
2015-06-22T19:03Z (-5.15h, +3.33h)	1.07	100.0	2015-06-22T03:32Z	14.45	Max Kp Range: 7.0 - 8.0	Ensemble WSA-ENLIL + Cone (GSFC SWRC)
2015-06-22T23:00Z (+7.0h)	5.02	100.0	2015-06-22T06:28Z	11.52	----	DBM
2015-06-22T22:50Z (-5.0h, +8.0h)	4.85	----	2015-06-22T09:20Z	8.65	----	ElEvo
2015-06-22T14:00Z	-3.98	----	2015-06-22T15:23Z	2.60	Max Kp Range: -- - 7.0	WSA-ENLIL + Cone (NOAA/SWPC)
2015-06-22T19:48Z	1.82	97.5	---	---	Max Kp Range: 5.5 - 7.8	Average of all Methods
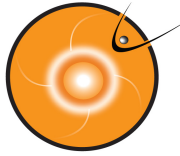
SWMF CME Modeling from Low Corona

- A new SWMF coronal model incorporates Semi-analytical **Threaded-Field-Line model** for the low solar corona (1 – 1.1 Rs)

- Speed up SWMF coronal simulations on factor of 100

- Uses a closed magnetic flux rope linearly superimposed on the background to initiate CME.
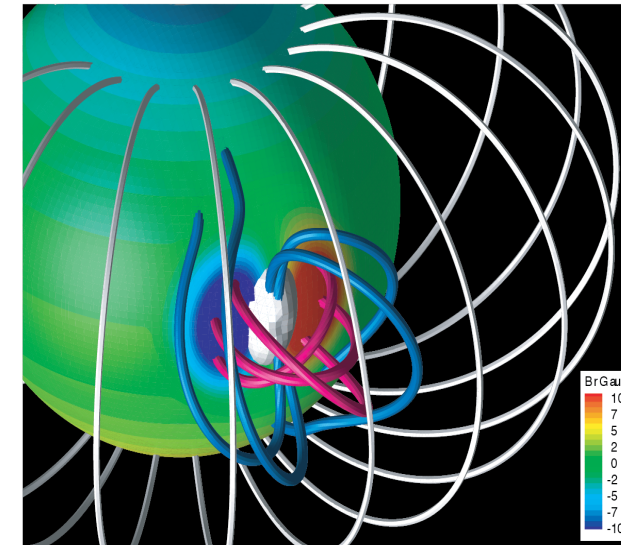
EEGGL Eruption Event Generator (Gibson & Low)

Use synoptic magnetograms to define location and orientation of CME flux rope.
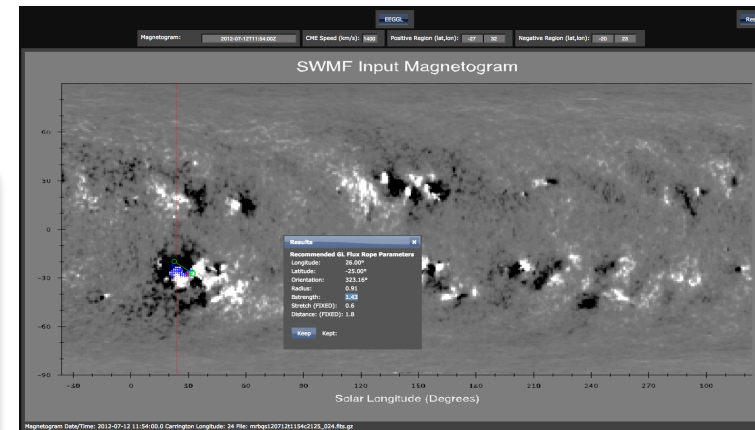
Modeler: I. Sokolov, U. of Michigan

CCMC: A.Taktakishvili, R. Mullinix

Model Type: Heliosphere
Model & Version: ENLIL 2.8f
Boundary Condition Type: Time-Dependent Sequence of Daily Update Maps (dt)
Inner Boundary Condition: from_WSA_V2.2_model
Run Objective: ambient_Solar_Wind
Observatory: GONGB (Standard QuickReduce Magnetogram Synoptic Map - mrbqs)
Carrington Rotation Start: 2055   **Carrington Longitude Start:** 008°
Start computation date (rundate_cal): 2007-04-27T00
Coronal observations date (obsdate_cal): null
Time unit = 86400. seconds   **Relaxation start time relative to rundate (tstart):** -14. time units
Simulation stop time (tstop): 191 time units   **Full 3D output cadence (tstep):** 14 time units
Outer Boundary: 2.1 AU (Mars inclusive; **radial span:** 2.0 AU, **region** 2 AU)
Simulation Grid: 1536x140x360 (0.1 to 2.1 AU radius; ±70° latitude, 20° to 160° co-latitude; 0° to 360° longitude)
Geometry: Spherical and Uniform   **Coordinate System:** HEEQ+180°
Resolution: high   **Number of Simulation blocks (nblk):** 1
Ambient wind conditions setting: a6b1mod   **ratio of specific heats (gamma):** 1.6666667   **runpar**=g53q5
  (**vfast**=700., **vslow**=200., **vrfast**=25., **vrslow**=100, **bfast**=300, **bscl**=2, **dfast**=200, **tfast**=2, **xalpha**=0.03, **nbrad**=1)
Rotation of the inner boundary: synodic