National Aeronautics and
Space Administration

NASA's SPoRT Center

Progress in Extending Terrestrial Weather R2O/O2R to Space Weather

Dr. Ghee Fry
Marshall Space Flight Center
Mail Code ST13
Huntsville AL 35812

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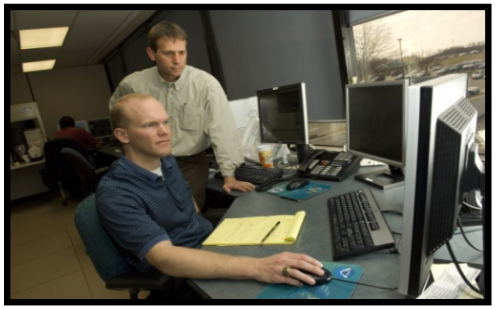
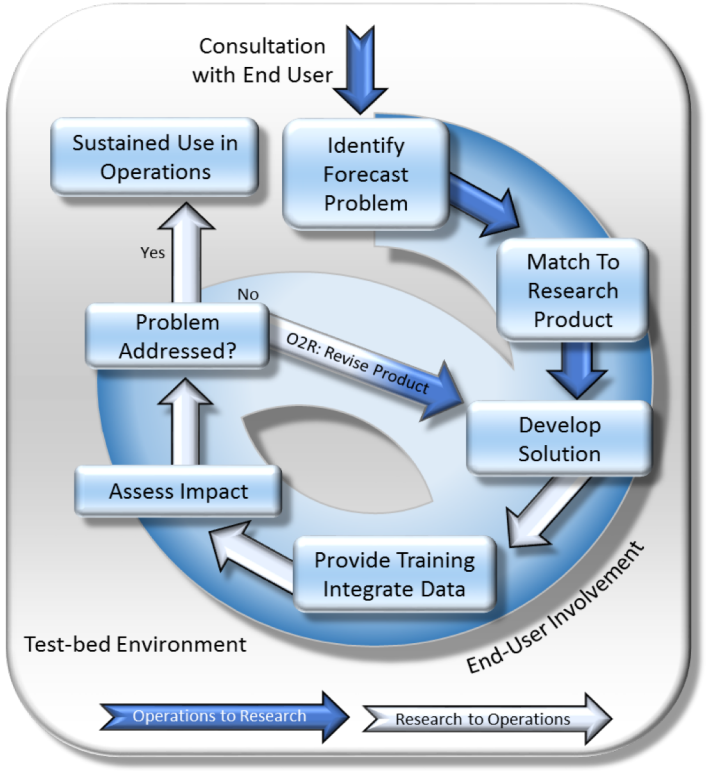
SPoRT Mission and History



- **Mission:**
  - **Transition unique NASA and NOAA observations and research capabilities to the operational weather community to improve short-term weather forecasts on a regional and local scale.**
  - Established in 2002 through an unsolicited proposal from then-MSFC scientists Bill Lapenta, Steve Goodman, and Gary Jedlovec
  - Supported by NASA's Research and Analysis Program and the Weather Focus Area (Tsengdar Lee) and supplemented by NASA, NOAA, and other proposal areas to build upon core capabilities and partnerships.
  - Significant support from NOAA received through Satellite Proving Grounds (GOES-R 2009+ / JPSS 2011+) and Risk Reduction activities, and NOAA's Modeling, Analysis, Predictions, and Projections starting 2017

SPoRT R2O/O2R Paradigm

- Bridge the "Valley of Death" through interactive partnership with end users
  - Maintain interactive partnerships with help of specific advocates
  - Integrate into user decision support tools
  - Create product training
  - Perform targeted product assessments
- Concept has been used to successfully transition more than 40 satellite datasets to operational users for nearly 15 years
- SPoRT-like approach candidate to take space weather transition "the last mile"



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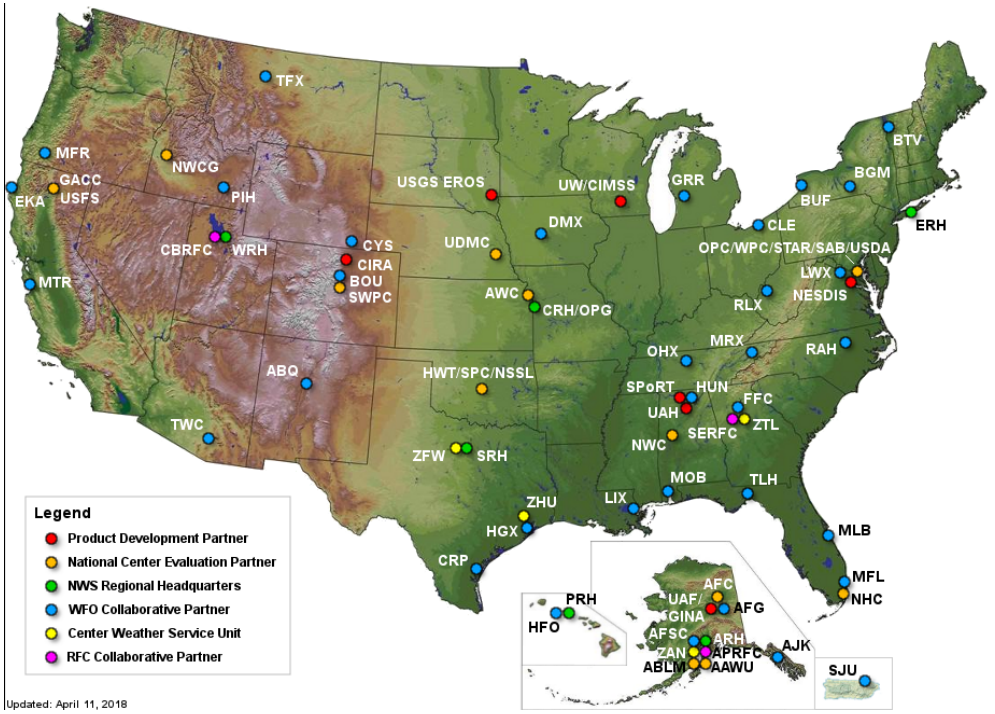
Current Partnerships

National Centers
for Environmental Prediction

- Environmental Modeling Center
- National Hurricane Center
- Weather Prediction Center
- Ocean Prediction Center
- Aviation Weather Center
- Storm Prediction Center

Over 30 NWS WFOs
and All Regional
Headquarters

NOAA Cooperative Institutes
as Data and Product Partners



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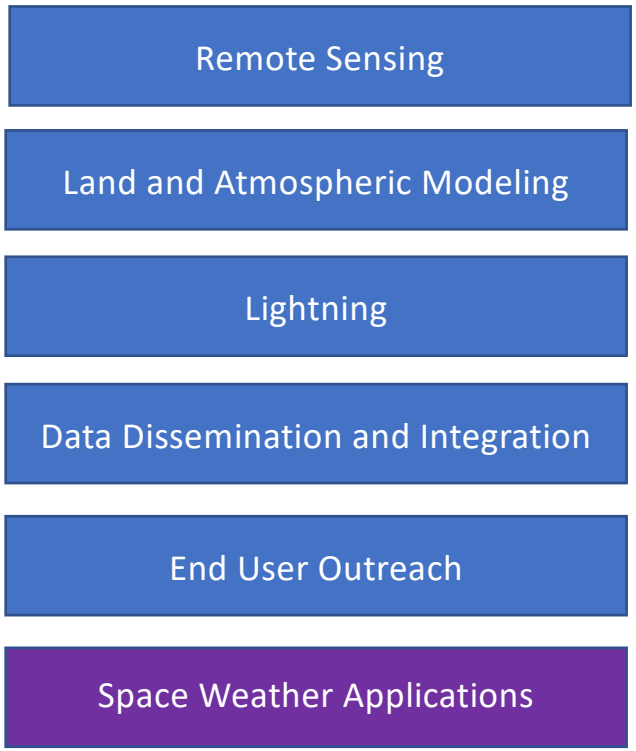
Team Focus Areas



- Perform targeted research activities to exploit unique capabilities of NASA satellites and technologies to solve specific weather forecasting challenges
- Support for product dissemination to AWIPS, AWIPS II, N-AWIPS, WMS, etc.
- Apply unique R2O/O2R paradigm for transitioning data and obtaining valuable feedback from NWS forecasters
- Demonstrate SPoRT paradigm to Space Weather Applications, leveraging new NASA products (MAG4 transition)

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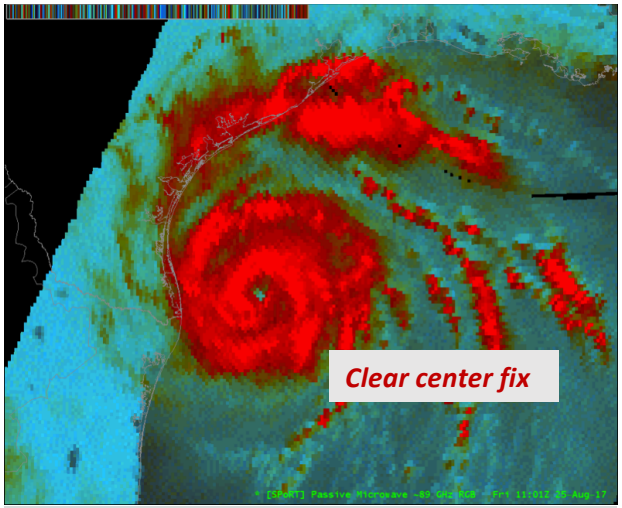
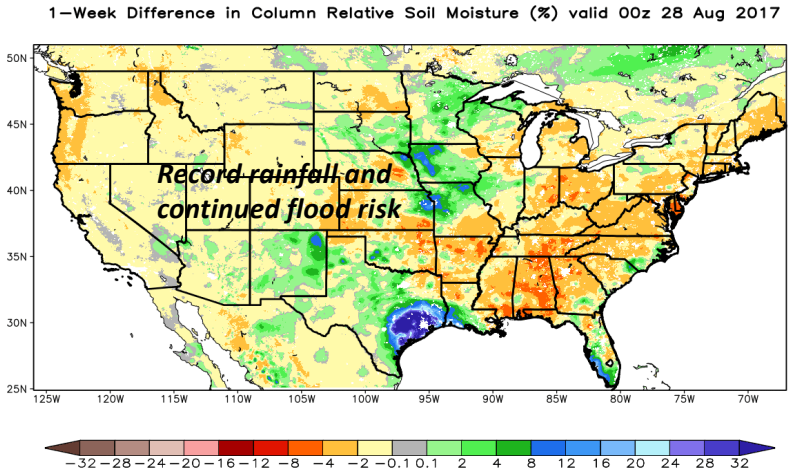
Remote Sensing / Land Atmosphere Modeling



GMI clearly shows center of Hurricane Harvey on 25 Aug 2017; used by NHC

NASA GPM Data:

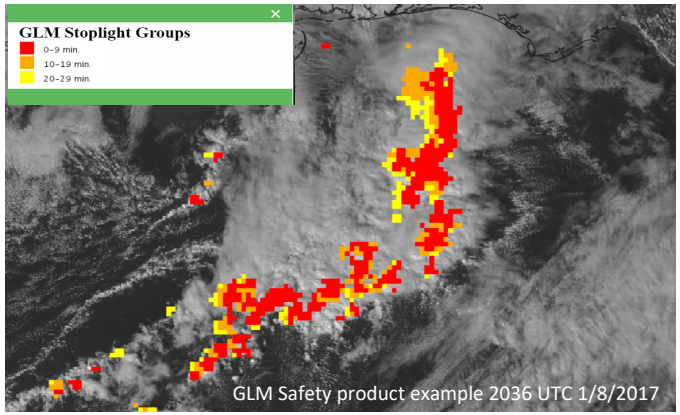
- False color composites for improved TC diagnosis
- IMERG rainfall estimates gap-fill radar/data-void areas



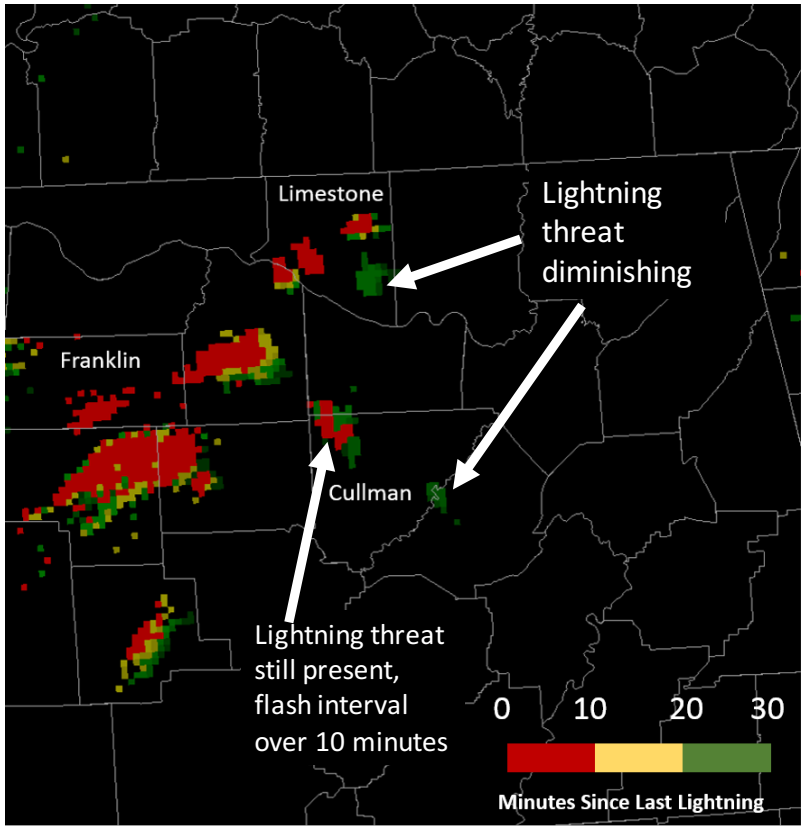
- Land surface **(LIS; SMAP)** to improve short-term weather and agricultural forecasts
- Use satellite-derived aerosols to improve satellite data assimilation and cloud microphysics in models

Lightning

- Extending interest in lightning safety research to explore displays to help advise on time since last observed lightning, and distance from recent threat
  - Schultz et al. 2017 in NWA JOM
- Adopting GIS tools and other displays to extend reach of GLM and other SPoRT generated data sets



GLM Safety product example 2036 UTC 1/8/2017



Training and Feedback

Training development implements educational design concepts, complimenting NOAA, in collaboration with the Satellite Training Advisory Team.

Diverse methods to meet a wide range of learning styles:

- Site visits by SPoRT / SMEs
- 1-minute videos, 3-5 minute videos, and 20+ case studies comprising the ***SPoRT Applications Library***
- User-based, operational modules
- Quick Guide format adopted for use in GOES-16 and JPSS products

Developed collaboratively with operational meteorologists to leverage their expertise.

Short, Narrated Modules

"Quick Guides"

Product quick references available online or in AWIPS

Assessments and Outreach

Targeted Assessments

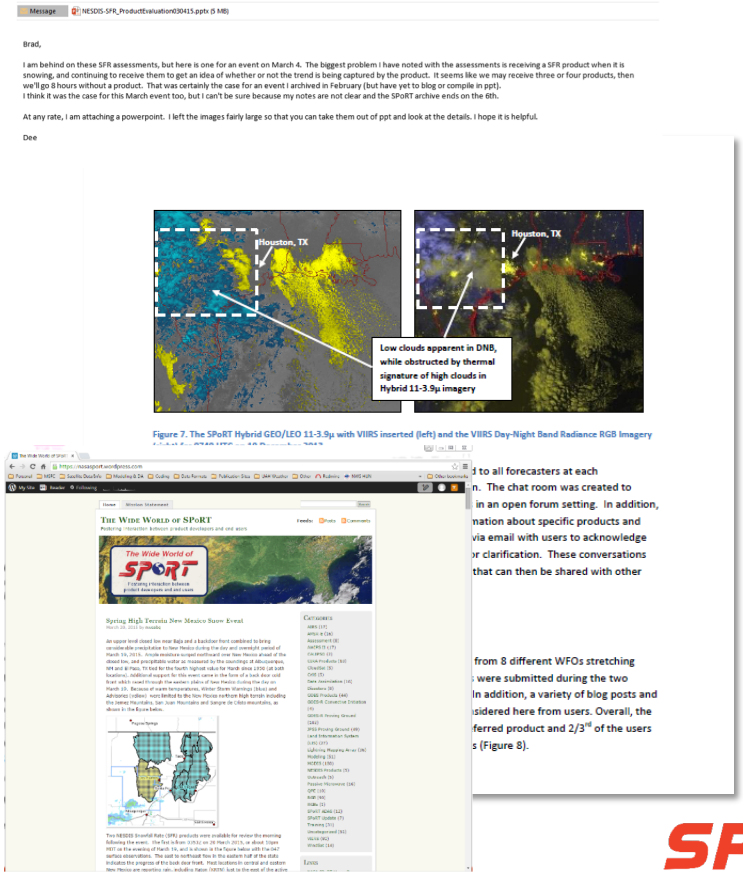
- Quantitative questions and qualitative feedback, soliciting open commentary on products and utility

User Engagement

- Following up on Q&A via email and responding to questions
- Sharing between SPoRT and forecasters via email, blogs, and social media
- Assessments finalized with report shared with product developers/contributors

Outreach

- Wide World of SPoRT blog
  - https://nasasport.wordpress.com
- @NASA_SPoRT, SPoRT Facebook Page



SPoRT Transition Activities with SWPC

- NOAA/NCEP and SWPC management encouraged establishing low-level of effort collaborations to test drive the SPoRT paradigm as a potential approach for Space Weather R2O/O2R
- Team of Heliophysics/MAG4 SMEs and SPoRT personnel were selected for internal MSFC funding to take the initial steps to transition MAG4 to SWPC forecasters as an experimental product
- Site visit to SWPC in summer 2017 to learn forecast process and challenges:
  - MAG4 was seen as an important experimental product that forecasters would like to use but was not available consistently enough for their needs
  - Cadence of available output was too low
  - Forecasters wanted more details about the outputs from the model rather than just a graphic that was available from the website or from other online portals
  - Forecasters currently use a series of different websites to obtain both operational and experimental datasets, so currently no true DSS for integration

SPoRT SWx: Alignment with National Space Weather Action Plan Goals

- SPoRT Space Weather Addresses National Priorities specified in National Space Weather Action Plan (SWAP)
- Alignment with SWAP Goal 5:
  - 5.4 Improve forecasting lead-time and accuracy
  - 5.5 Enhance fundamental understanding of space weather and its drivers to develop and continually improve predictive models
  - 5.6 Improve effectiveness and timeliness of the process that transitions research to operations

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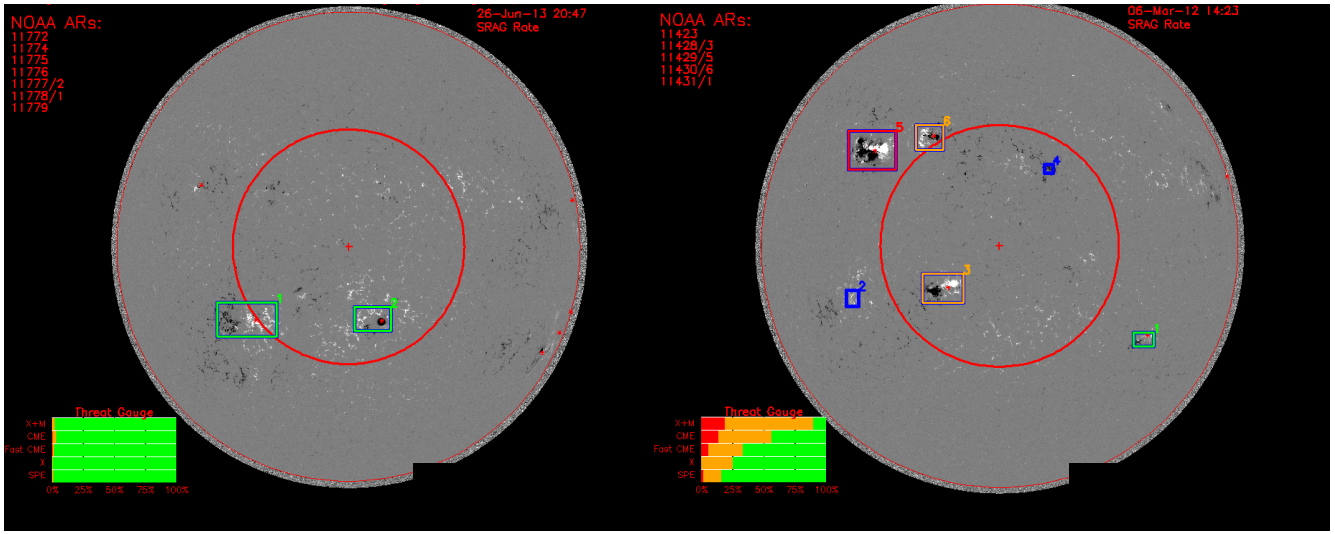
Overview of MAG4

- Uses empirical relationships between magnetic free energy and event rates to objectively categorize the current state of flare/CME risk on the Sun
- Probabilistic information on threat with quicker/easier analysis than current McIntosh approach for categorizing active regions
- Provides guidance on pre-flare/CME probability

All Clear Example: 26 June 2013 **High Threat Example: 7 March 2012**



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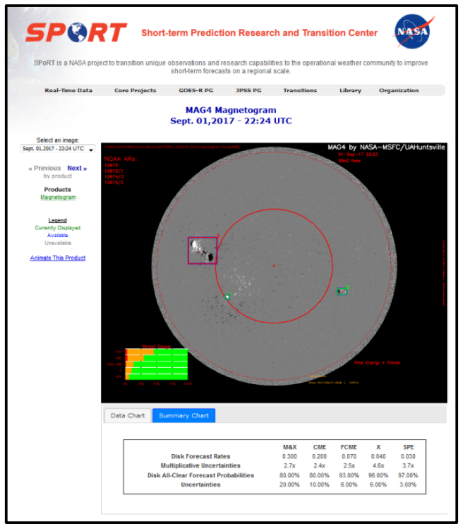
Transition Activities with SWPC

- Website (top right) where real-time MAG4 output flows into SPoRT processing; will allow animation and previous history
- Training slides (bottom right) on the use and interpretation of the product using instructional design techniques to reinforce learning concepts
- Testbed assessment for forecasters to evaluate product impacts alongside other operational forecasting tools; short 5-minute Likert scale survey to capture feedback and communicate success metrics

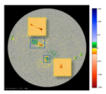


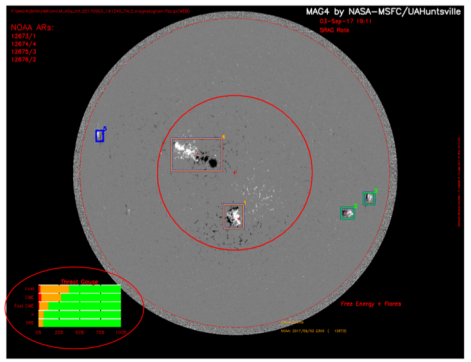
MAG4 Example on SPoRT website

Slide from short training module for MAG4 developed at SPoRT

Application Example

- Based on the observational data from the highlighted ARs, what can you say about the future threat of flares? CMEs? Other events? Rate and magnitude of these events?
- What is your prediction based on?
- With MAG4, threat predictions are calculated based on empirical relationships between magnetic free energy and event rates

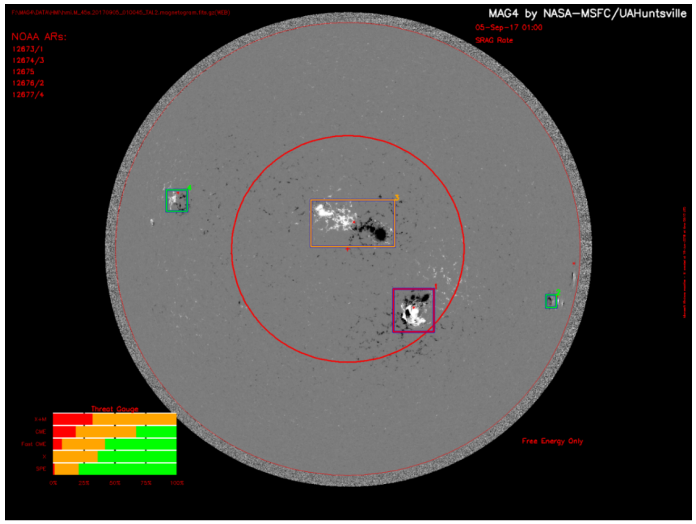




MAG4 Product Improvements

Results – Assessment and Forecaster Feedback

- September 2017 CME event processed and reproduced on archive website for demonstration due to low level of solar activity in summer 2018
- Testbed activity walked forecasters through their forecast process leveraging training to show ways products like MAG4 would add value to forecast process
- Quantitative probabilities defined objectively by MAG4 closely matched the more time-consuming subjective analysis performed by forecasters
- Forecasters foresee MAG4 as both a first-look, objective flare threat indicator and a source to enable higher confidence flare forecasts



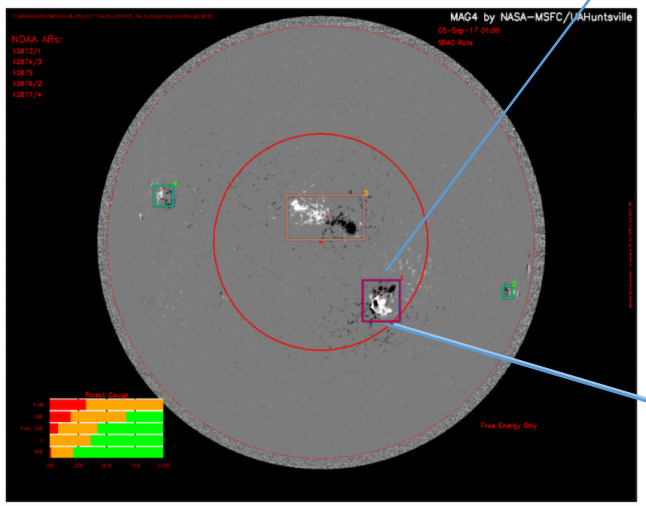
	M&X	CME	FCME	X	SPE
Disk All-Clear Forecast Probabilities	20%	40%	70%	70%	90%
Disk Probability of Event	80%	60%	30%	30%	10%
Uncertainties	30%	30%	30%	50%	20%
Risk Category	Expected	Likely	Chance	Chance	Slight Chance

AR#	#	Location	M&X	CME	FCME	X	SPE	Distance	WL_{SG}
Units								Degrees	kG
12673	1	S8W16	87%	55%	26%	26%	10%	17	109

Additional MAG4 Product Improvements

Assessing Space Weather Threat

AR 12673 Sep 5 2017 01:00 UT



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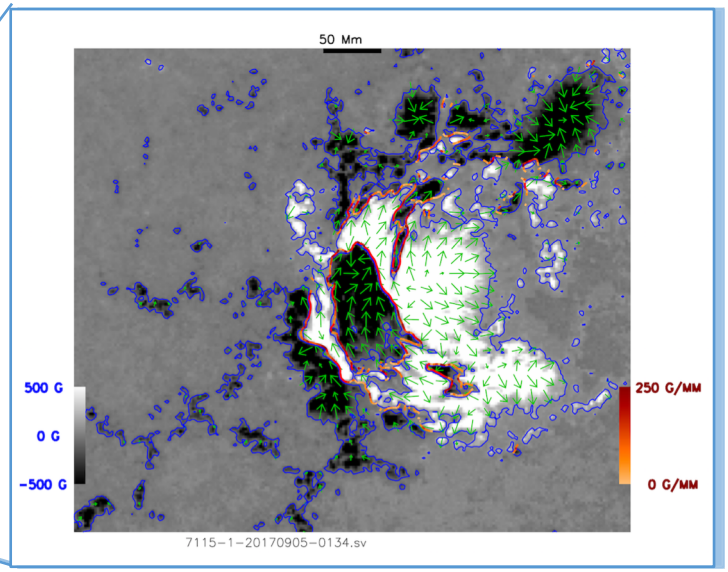

Active Region Zoom (with overlays)
Improves MAG4 Decision Support Tool Value

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Summary:
SPoRT Space Weather R2O/O2R

National Aeronautics and Space Administration

- SPoRT's R2O/O2R paradigm that has resulted in 16+ years of success for terrestrial weather
- SPoRT's seed-funded testbed activity demonstrates paradigm can be applied to space weather challenges
- Requires strong collaborations with NOAA National Weather Service partners
- SPoRT paradigm provides an opportunity to establish a bridge between research community and operational forecasters for terrestrial / space weather applications

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