

National Aeronautics and
Space Administration



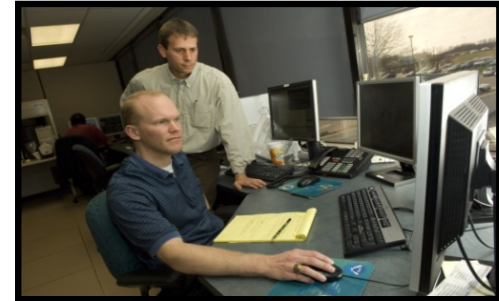
NASA's SPoRT Center

Progress in Extending Terrestrial Weather R20/O2R to Space Weather

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SPoRT Mission and History



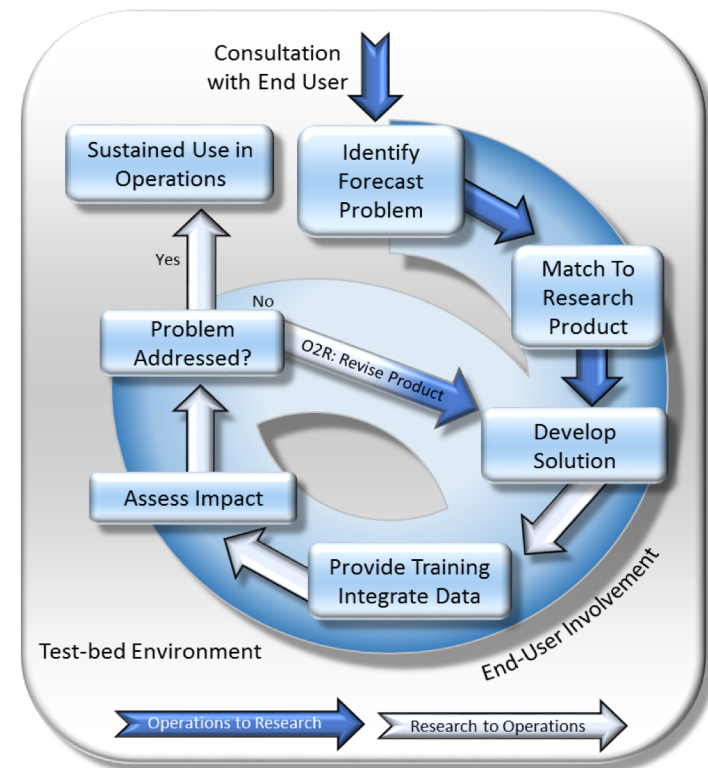
- **Mission:**
 - **Transition unique NASA and NOAA observations and research capabilities to the operational weather community to improve short-term weather forecasts on a regional and local scale.**
 - Established in 2002 through an unsolicited proposal from then-MSFC scientists Bill Lapenta, Steve 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

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”



SPoRT

Current Partnerships



Over 30 NWS WFOs
and All Regional
Headquarters



National Centers
for Environmental Prediction

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



NOAA Cooperative Institutes
as Data and Product Partners



Team Focus Areas

Remote Sensing

Land and Atmospheric Modeling

Lightning

Data Dissemination and Integration

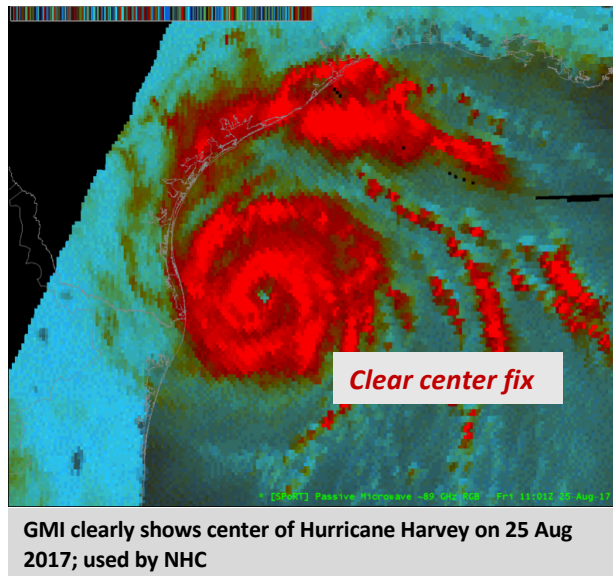
End User Outreach

Space Weather Applications

- 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)

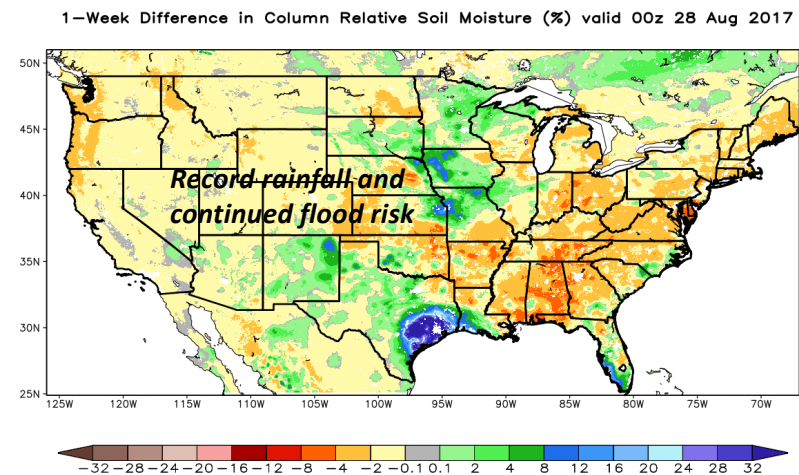
SPoRT

Remote Sensing / Land Atmosphere Modeling



NASA GPM Data:

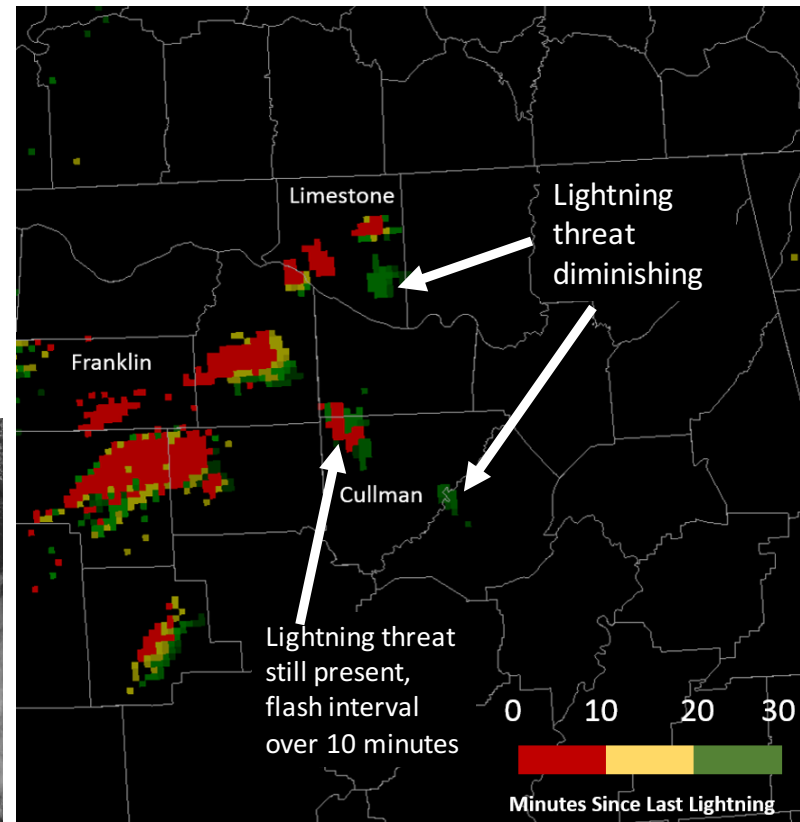
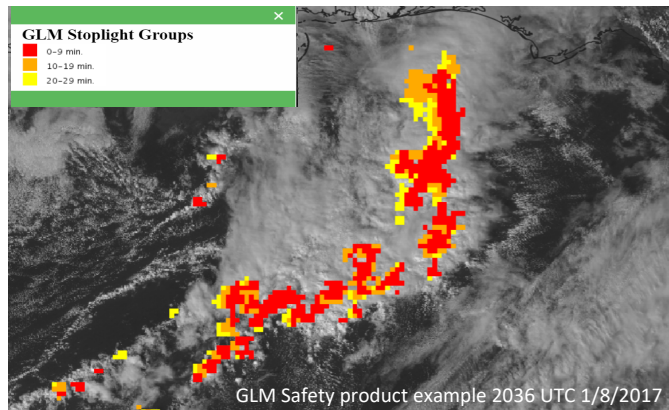
- False color composites for improved TC diagnosis
- IMERG rainfall estimates gap-fill radar/data-void areas



- 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



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

Night-time Microphysics RGB

- Utilizes MODIS & VIIRS channels/channel differences:
 - 12.0µm-10.8µm (optical depth)
 - Thicker = more red

Site Visits to WFOs

Day Convection RGB Quick Guide

Why is the Day Convection RGB Imagery Important?

The Day Convection RGB was designed for identification of convection with strong updrafts and small ice particles indicative of severe storms. The RGB helps increase recognition capabilities of severe storms by identifying the early stage of strong convection. Knowing the microphysical characteristics of convection clouds helps determine when they get the steps to improve recognition and have been forecast. Bright colors in the RGB indicate strong updrafts prior to the mature storm stage.

Color	Band / Band Diff. (nm)	Physically Related To:	Small contribution to total radiance:	Large contribution to total radiance:
Red	6.2 - 7.3	Cloud height	Low clouds	High clouds
Green	3.9 - 10.3	Particle size	Large ice or water particles, weak updrafts	Small ice or water particles, strong updrafts
Blue	1.6 - 0.64	Cloud phase	Ice clouds	Water clouds

Impact on Operations

Primary Application: Convection and Severe Weather: identify intense updrafts that indicate strong convection. Strong convection is bright yellow; smaller particles are more reflective; the 3.9µm value is large for small particles. Visible strong convection particles do not have enough time to grow. Strong convection quickly matures in the red and green colors, resulting in yellow. Differentiate heavy and anvil convection: mature or dissipating convection is orange or red depending on the amount of large ice particles and warmer cloud tops.

Limitations

Daytime only application: the RGB relies on solar reflection from visible, near-IR, and microwave channels. Pixel color impacted by sun/satellite viewing angles: yellow can be falsely increased due to sun glint in the 3.9 channel. Pixel color false during dawn/dusk when the sun angle is low. Yellow colors may not always indicate strong convection: very cold cloud tops with only moderate 3.9µm reflectance can result in yellow, but the updrafts are average strength. Yellow can also occur in non-severe clouds or "polluted" air. Dust carried aloft can lead to long lived, small ice particles.

Resources: METEOROLOGICAL SATELLITE TRAINING ADVISORY TEAM (SAT-TAT) <http://www.weather.msc.nasa.gov/sport> <http://www.noaa.gov> <http://www.nasa.gov>

Contributor: Dr. Emily Bernich Emily.Bernich@noaa.gov <https://www.weather.msc.nasa.gov/sport/>

"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



Message: NESDS-SFR_ProductEvaluation030415.pptx (3 MB)

Brad,

I am behind on these SFR assessments, but here is one for an event on March 4. The biggest problem I have noted with the assessments is receiving a SFR product when it is snowing, and continuing to receive them to get an idea of whether or not the trend is being captured by the product. It seems like we may receive three or four products, then we'll go 8 hours without a product. That was certainly the case for an event I archived in February (but have yet to blog or compile in ppt). I think it was the case for this March event too, but I can't be sure because my notes are not clear and the SPoRT archive ends on the 6th.

At any rate, I am attaching a powerpoint. I left the images fairly large so that you can take them out of ppt and look at the details. I hope it is helpful.

Dee

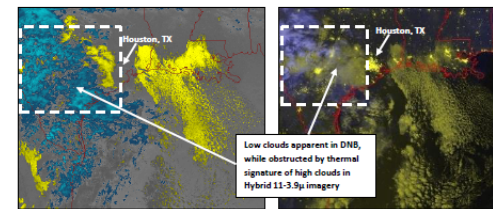


Figure 7. The SPoRT Hybrid GEO/LEO 11-3.5µ with VIIRS inserted (left) and the VIIRS Day-Night Band Radiance RGB Imagery

to all forecasters at each
n. The chat room was created to
in an open forum setting. In addition,
nation about specific products and
via email with users to acknowledge
or clarification. These conversations
that can then be shared with other

from 8 different WFOs stretching
were submitted during the two
In addition, a variety of blog posts and
sidered here from users. Overall, the
ferred product and 2/3rd of the users
s (Figure 8).



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

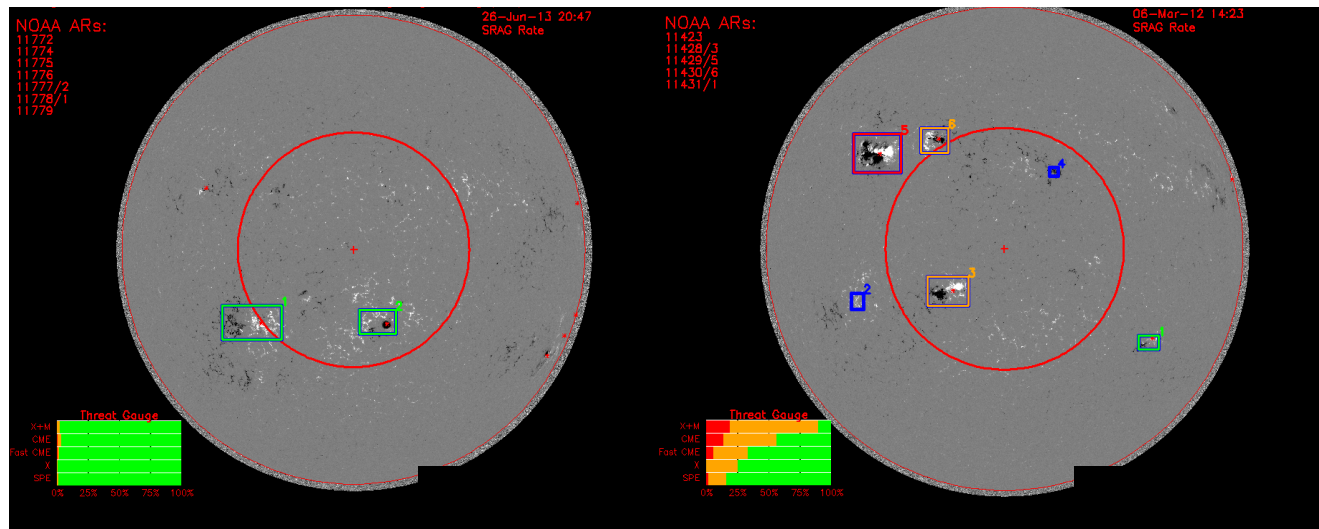


Overview of MAG4

- 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

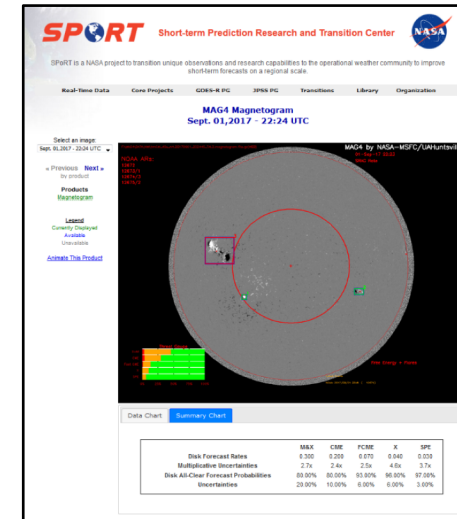


Transition Activities with SWPC

- 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



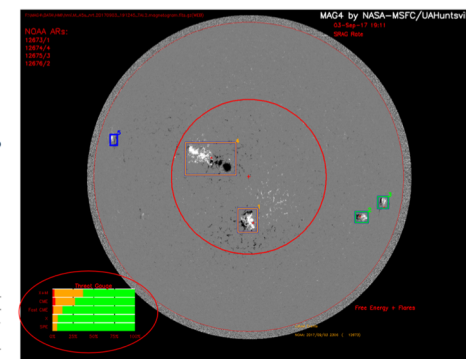
Slide from short training module for MAG4 developed at SPoRT



MAG4 Example on SPoRT website

Application Example

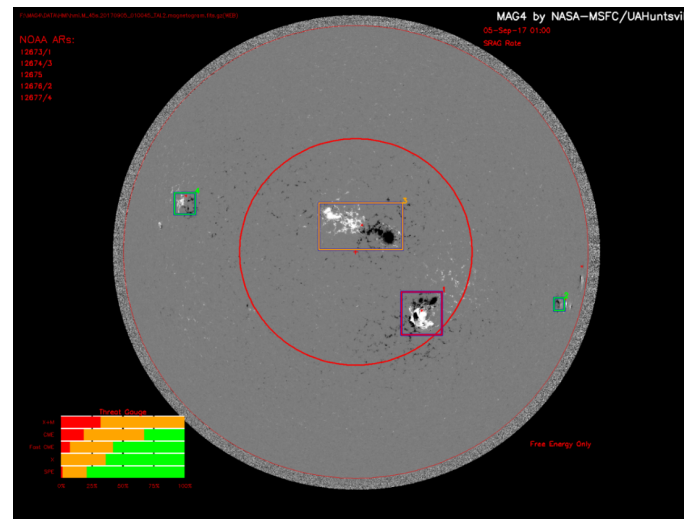
- Based on the observational data from the highlighted ARs, what can you say about the future threat of flares? CMEs? Other events? Rate and magnitude of these events?
- What is your prediction based on?
- With MAG4, threat predictions are calculated based on empirical relationships between magnetic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



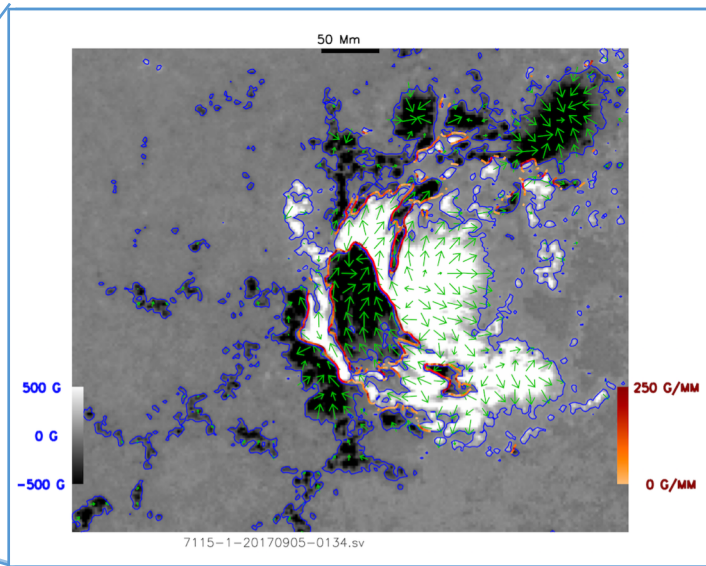
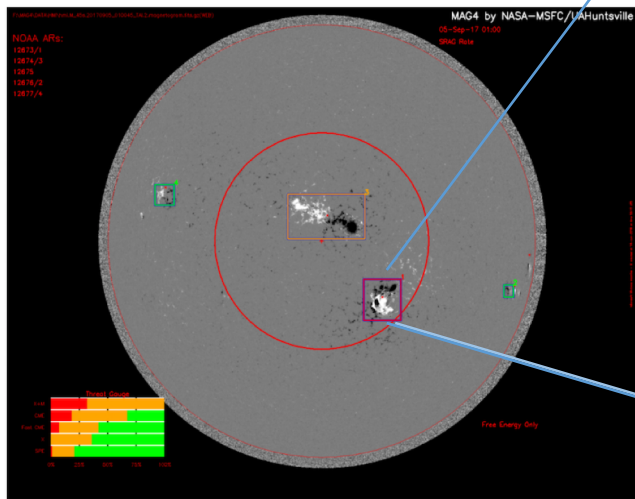
	M&X	CME	FCME	X	SPE
Disk All-Clear Forecast Probabilities	20%	40%	70%	70%	90%
Disk Probability of Event	80%	60%	30%	30%	10%
Uncertainties	30%	30%	30%	50%	20%
Risk Category	Expected	Likely	Chance	Chance	Slight Chance

AR#	#	Location	M&X	CME	FCME	X	SPE	Distance	W _{L,SG}
Units								Degrees	KG
12673	1	SW16	87%	55%	26%	26%	10%	17	109

Additional MAG4 Product Improvements

Assessing Space Weather Threat

AR 12673 Sep 5 2017 01:00 UT



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

AR#	#	Location	M&X	CME	FCME	X	SPE	Distance Degrees	VL ₄₀₀ kg
12673	1	S8W16	87%	55%	26%	26%	10%	17	100

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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