Extending Terrestrial Weather R2O/O2R to Space Weather at NASA’s SPoRT Center

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SPoRT & Established R2O/O2R Paradigm

- SPoRT has transitioned terrestrial satellite observations or satellite-enhanced models to operational decision makers since 2002
- Partnerships with more than 60 operational decision making groups
- Proven paradigm for transitioning NASA research data across the “Valley of Death” (right) through collaborative interaction with decision makers to develop value-added solutions to operational forecasting challenges

Short-term Prediction Research and Transition (SPoRT) staff works collaboratively with decision makers to tailor experimental product solutions to meet their needs
Paradigm Demonstration at 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
- Site visit to SWPC in August 2017 to learn forecast process and challenges

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<thead>
<tr>
<th>R2O Challenge</th>
<th>R2O Solution</th>
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<tr>
<td>1. Subjective McIntosh approach is time-consuming and can be cumbersome, especially if there are multiple active regions at one time.</td>
<td>1. Forecaster pull for MSFC-developed, experimental MAG4 product as one solution to enable more objective forecasting approach.</td>
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<td>2. MAG4 not available consistently enough for forecaster needs—cadence too low; university-run website down too frequently.</td>
<td>2. Integrated model into operational SPoRT product data stream and created dynamic website to display output.</td>
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<td>3. More details about the model outputs needed beyond graphic available from current website or other online portals.</td>
<td>3. Created graphical interface that links magnetogram image to tabular display of model output.</td>
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<td>4. Questions about how to interpret the product.</td>
<td>4. Developed user-focused training.</td>
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R2O Solution #1: 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 flare
- Provides guidance on preflare/CME probabilities within 30 degrees (and some reduced reliability within 30-60 degrees) of solar center—foreshortening limitation suffered by any observational source

All Clear Example: 26 June 2013

High Threat Example: 7 March 2012
R2O Solution #2 and #3: Dynamic MAG4 Website

- MAG4 code successfully integrated onto SPoRT processing machines to produce real-time output; running stably
- Real-time (previous 48 hours) and archive (previous 28 days) websites created
  - Automatically links hourly (cadence requested by SWPC forecasters) MAG4 output to graphical site
  - Tabular output with event rates and probabilities
- Iterated with SWPC forecasters on website functionality and look via multiple telecons

Real-time link: https://weather.msfc.nasa.gov/cgi-bin/sportPublishMAG4.pl?dataset=mag4realtime
Archive link: https://weather.msfc.nasa.gov/cgi-bin/sportPublishMAG4.pl?dataset=mag4archive
R2O Solution #4: User-Focused Training

- Short, online training module produced using Articulate Rise
  - Relevant background for the space weather forecasting
  - Brief overview of MAG4 product
  - Example of how MAG4 can be used to supplement other operational products
  - Tutorial on how to interpret the imagery and use the new website
  - Follows instructional design guidelines for creating

- Follows instructional design guidelines for creating online learning items

- Hands-on training was delivered during a multi-day Science Sharing Session site visit at SWPC
Summer 2018 Testbed Activity

- 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
NASA’s SnAP Activity

• Representatives from NASA Centers with relevant space weather expertise and missions (GSFC, MSFC, JPL, JSC, LaRC) and operational decision making organizations (NOAA, Air Force) have had multiple meetings to develop a Space Weather Science Applications Project (SnAP) to enable more effective translation of NASA-funded space weather research into operations.

• See Terry Onsager’s invited presentation (IN42B-06) on Thursday morning at 11:35 A.M. for more details.
Summary

- SPoRT’s R2O/O2R paradigm that has resulted in 15+ years of success for terrestrial weather can be applied to space weather challenges
- Forecaster pull for MAG4 enabled opportunity to demonstrate proof of concept; transition focused on four specific forecast challenges collaboratively identified with SWPC
- Feedback from SWPC forecasters and management has been positive regarding the approach of forecaster engagement and implementation of R2O solutions
- Further expansion of work will be enabled through NASA’s SnAP activities, which aims to connect NASA with NOAA, DoD, NSF, universities, and the private sector community
Questions/Comments/Discussion

Website:  http://weather.msfc.nasa.gov/sport/
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Contact Brad Zavodsky (brad.zavodsky@nasa.gov) or Ghee Fry (ghee.fry@nasa.gov) for follow-on discussions/collaborative opportunities