National Aeronautics and Space Administration

SPoRT Quarterly
April – June 2018

The SPoRT REPORT

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Short-term Prediction Research and Transition (SPoRT) Center
NASA Marshall Space Flight Center (MSFC), Huntsville, AL
http://weather.msfc.nasa.gov/sport/

The SPoRT Center is a NASA- and NOAA-funded project to transition unique observations and research capabilities to the operational community to improve short-term weather forecasts on a regional scale. While the direct beneficiaries of these activities are selected NOAA Weather Forecast Offices (WFOs) and National Centers, the research leading to the transitional activities benefits the broader scientific community.

Quarterly Highlights

The Geostationary Lightning Mapper Makes Its Operational Debut

2018 has been an exciting year for the Geostationary Lightning Mapper (GLM). In January, the instrument reached its provisional status; full operational status is expected to be announced later this fall. The overall project has been a multi-agency effort as the GLM implementation team has focused on GLM product algorithms and application-based training. NASA SPoRT's primary contribution has been the development of GLM applications-based training. These efforts paved the way for the initial products to be more formally established and to provide clarity on what training needs to be addressed for the GLM. This past May, the GLM was evaluated by operational forecasters and broadcast meteorologists at the Hazardous Weather Testbed (HWT) in Norman, Oklahoma. At HWT, SPoRT personnel, along with other members of the GLM implementation team, served as GLM subject matter experts for several weeks. This allowed for one-on-one

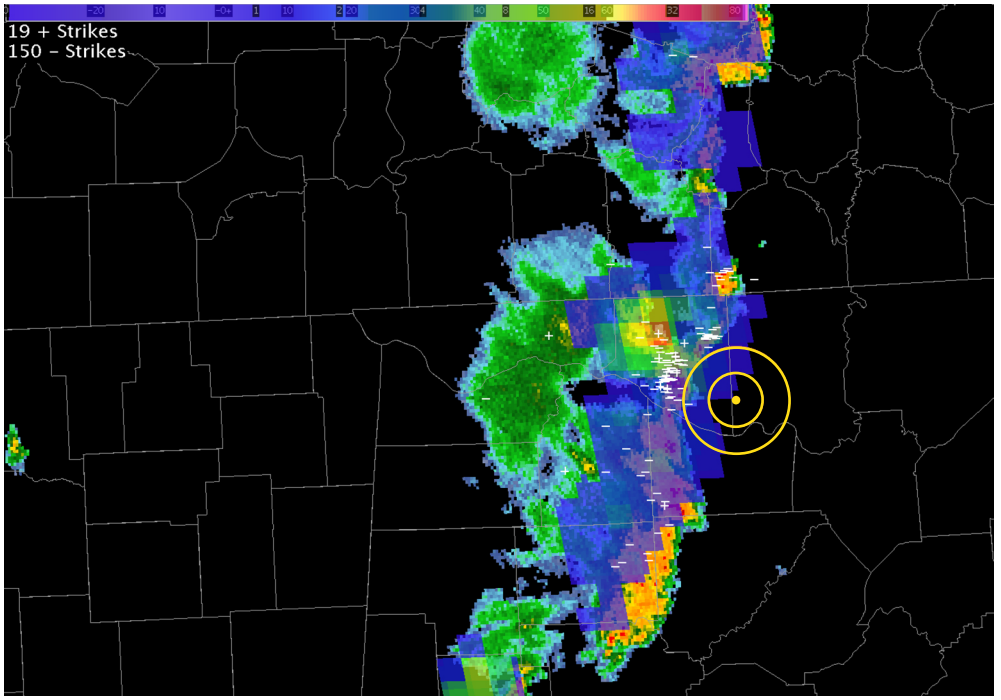

Figure 1. The GLM 5 minute flash extent density overlaid on the Multi-radar Multi-Sensor reflectivity at lowest altitude with the National Lightning Detection Network cloud-to-ground flashes (white) at 2321 UTC. This shows storms approaching the Huntsville International Airport surrounded by the yellow rings of 5 and 10 nm. Initially, the legacy cloud-to-ground observations were sufficient to issue the airport weather warning. Figure courtesy of Brian Carcione NWS Huntsville, captured 5-30-18.

interactions between operational end users, GLM scientists, and algorithm developers to discuss what the GLM provides in operations and to select cases for subsequent training. This was a unique opportunity for members of the multi-agency GLM implementation team to interact with forecasters as they explored operational applications of GLM, many of the forecasters using the data for the first time.

Building on the foundation provided by the HWT, the GLM implementation team's focus shifted to a preliminary test and evaluation (PT&E) of the GLM products at nine select National Weather Service (NWS) forecast offices and center weather service units. The NWS Operations Proving Ground led this evaluation to test the technical issues for the GLM products, such as the data latency and functionality of the Advanced Weather Interactive Processing System (AWIPS) plug-in. With a successful test, the focus shifted to the pre-operational assessment of the GLM starting in late June. Unlike the PT&E, this assessment focused specifically on how forecasters have used the GLM data in real-time operations. This has been jointly led by the NWS Operations Proving Ground and Geoffrey Stano.

The assessment included the original nine PT&E sites and expanded to nearly two dozen NWS offices representing many of the participants at the HWT in May. At the time of this writing, the assessment has been very successful. Forecasters have provided overall positive feedback on the utility of the GLM data in operations. Furthermore, they have raised unique issues, such as observance of possible clear air discharges that have directly led to training modifications to address what forecasters are observing. Also, several cases have been submitted by forecasters that SPoRT is turning into two-three minute "Applications Library" examples to quickly highlight ways to use the GLM. Figures 1 and 2 show the first example of the Huntsville, Alabama, National Weather Service office using the GLM for an airport weather warning. As of this writing, nearly 80 National Weather Service offices are now ingesting GLM data ahead of the formal, operational declaration by NOAA to occur later this fall.

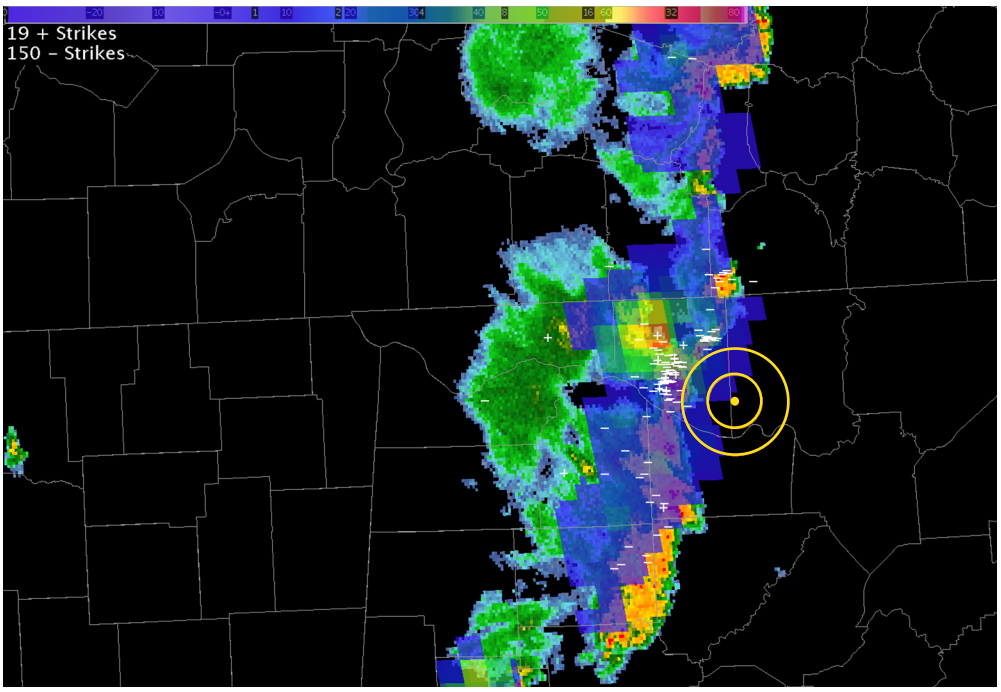

Figure 2. Same as the previous figure but for 0059 UTC. Here, the main line has pushed east of the Huntsville International Airport and is weakening. However, the GLM was critical in identifying long flashes in the trailing stratiform region. The GLM showed continuing lightning over the airport and illustrated the continued weather threat simply and effectively. Figure courtesy of Brian Carcione NWS Huntsville, captured 5-31-18.

Recent Accomplishments

SPoRT Participates in the 2018 Fire Continuum Conference

SPoRT Applications Integration Meteorologist and NWS Huntsville forecaster Kris White, participated in the Fire Continuum Conference, held at the University of Montana from Monday, May 21 through Thursday, May 24. The Fire Continuum Conference features a number of U.S. and international speakers from various operational and research agencies, academia, and the private sector. Kris White gave a presentation entitled, "Using NASA's Remote Sensing Datasets and Land Information System to Characterize Lightning Initiated Wildfires" which highlighted recent work demonstrating that land surface and sub-surface properties are the primary drivers of lightning initiated wildfires and that lightning plays a secondary but important role in ignition. The presentation focused on analyzing antecedent conditions leading up to lightning initiated wildfire events over the United States using various NASA remote sensing assets and SPoRT's Land Information System (SPoRT-LIS). Examples of variables of interest may include LIS 0-10 cm soil moisture, the Atmospheric Land EXchange Inverse (ALEXI) model Evaporative Stress Index, LIS total column relative soil moisture and MODIS/VIIRS green vegetation fraction (GVF), which represent moisture and vegetation coverage in the areas which fires do and do not initiate. An initial subset of more than 900 cases was utilized to perform analysis on all selected parameters at the location of fire starts and locations of other lightning events that do not start fires between 2012 and 2015.

Exploring the use of Machine Learning to Develop a Predictive Model for Future Fire Seasons

During the last few months a project on exploring the use of machine learning to produce predictive estimates of important fire season variables such as start, severity and length has been spun up. The end goal is to provide this beneficial information to fire management officials. A database is being built consisting of a multitude of remotely sensed and model datasets. The location, time, size and cause of each fire over the 2000-2015 time period is retrieved from the United States Department of Agriculture (USDA) Forest Service Fire database (Short 2015). While this database has fires dating back to 1992, the available model and remotely sensed data has a start date of 2000. The project looks to take advantage of a variety of remotely sensed assets produced by SPoRT. Specifically, this project will use MODIS leaf area index (LAI) and Green Vegetation Fraction (GVF), the Evaporative Stress Index (ESI) with 2-, 4-, 8-, and 12-week composite images to characterize the surface moisture, and the SPoRT-LIS model volumetric soil moisture (VSM) and soil moisture percentiles (SMP) of surface layer depths ranging up to 100 cm. In addition, gridded surface data consisting of temperature, precipitation, relative humidity, dead fuel moisture, wind direction and speed will be used. A database has been produced that combines all of this data at the location of each recorded fire. From the newly created database, queries can be made to explore the data and the land surface and atmospheric conditions at the time of the fire. Preliminary statistical trends have been explored to determine the start (5th percentile), peak (50th percentile) and end (95th percentile) of the fire season by the National Geographic Area Coordination Center (GACC) regions. These results are shown in Figure 3. From this, we observe distinct trends in the fire seasons. In densely populated areas in the East and South, fire season starts early and ends late (units in Julian Day). Most likely attributed to human ignition of the fires extending the natural fire season as indicated in Balch 2017. Moving west, more seasonal type trends appear in the data with the peak in the dry seasons. This data will be explored more and additional datasets will be added to the fire database as the work continues with the overall goal of using machine learning to produce a predictive model.

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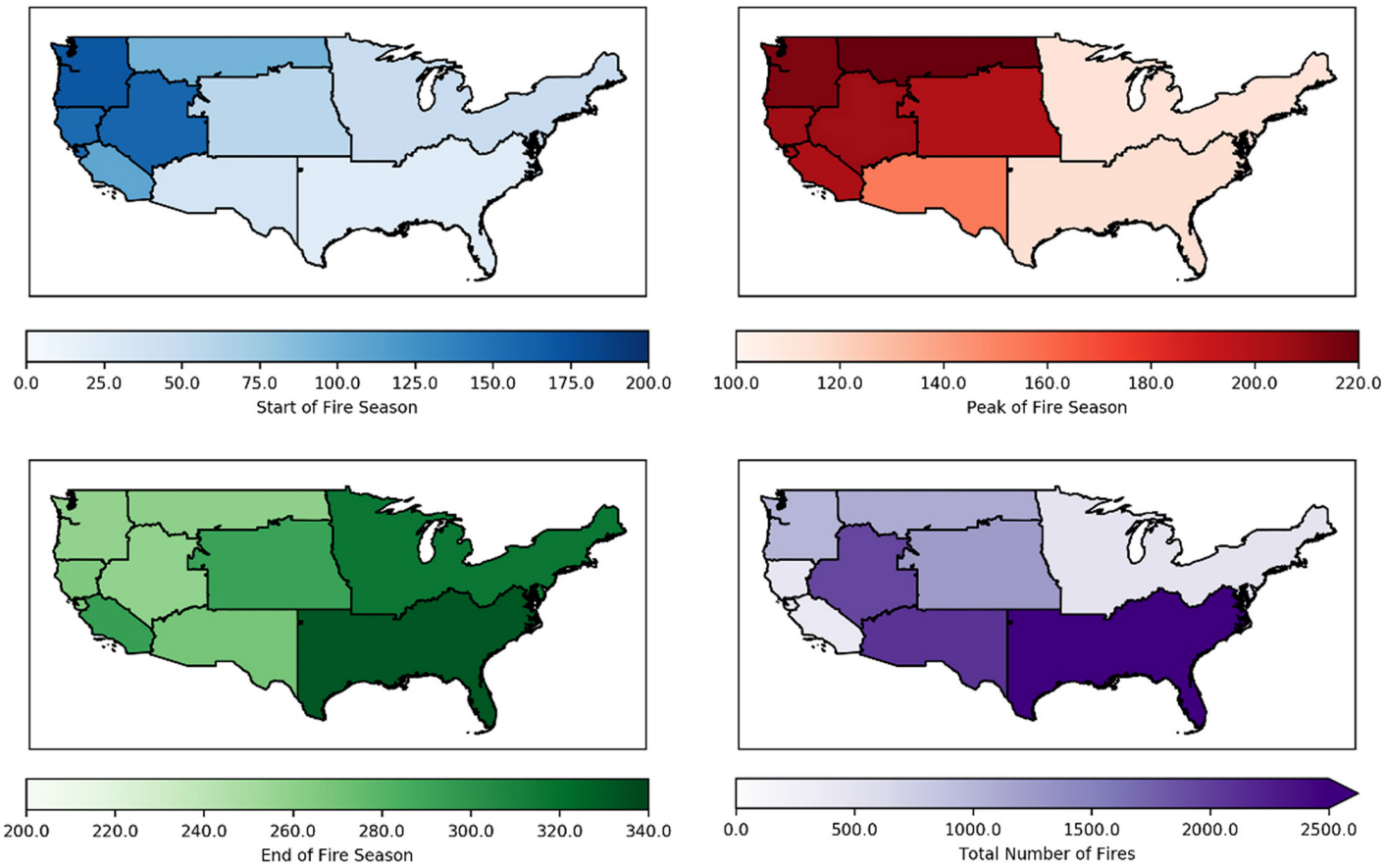


Figure 3: Statistical start (5th percentile), peak (50th percentile) and end (95th percentile) of fire seasons (units in Julian Day) by GACC regions for fires larger than 500 acres over the 2000-2015 fire seasons. Bottom right is the total number of fires (> 500 acres) by region.

New NASA Mission Activities

SPoRT's Remote Sensing Team is beginning to investigate applications of new NASA missions such as IceSat-2, TEMPO, TROPICS, and CYGNSS. IceSat-2 (Ice, Cloud, and Land, Elevation Satellite-2) is an upcoming mission of interest with a launch this fall. The ATLAS instrument onboard is a photon-counting laser altimeter capable of measuring the elevation of ice sheets, glaciers, sea ice, vegetation, and land. As an official Early Adopter of IceSat-2, SPoRT will have access to early release mission data to explore use of the data for forecasting challenges related to sea ice thickness and melt of relevance to our NWS Alaska Region partners. In addition to IceSat-2, SPoRT has recently focused on Early Adopter activities related to the TEMPO mission, Tropospheric Emissions Monitoring of Pollution. TEMPO will launch in the early 2020s and the instrument will provide the first geostationary observations of major air pollutants. This quarter, SPoRT team members attended the Western U.S. TEMPO Early Adopters Workshop and the TEMPO Science Team meeting to engage with end users and mission scientists to develop a plan to prepare end users for the unprecedented observations that will be valuable from TEMPO. Two other NASA missions of interest to SPoRT have a focus on tropical cyclone forecasting and analysis, TROPICS (Time-Resolved Observations of Precipitation structure and storm Intensity with a Constellation of Smallsats) and CYGNSS (Cyclone Global Navigation Satellite System). CYGNSS, a constellation of eight small satellites, was launched in December 2016 and provides accurate measurements of ocean surface winds with the goal of improving hurricane intensity forecasts. TROPICS is another constellation of CubeSats which will provide microwave measurements over the tropics to analyze the thermodynamic environment and precipitation structure of tropical cyclones with potential launch in fiscal year 2019. This quarter, SPoRT became an official Early Adopter of TROPICS to begin exploring how proxy mission data can be used to enhance operational hurricane forecasting.

The Geostationary Lightning Mapper (GLM) 30 Minute Hazard ("stoplight") Product

SPoRT has been collaborating with local emergency managers on lightning safety for several years. This work has centered on using the local North Alabama Lightning Mapping Array as a proxy in preparation for the GLM. In the course of this work, emergency managers have asked for three things to support their lightning safety efforts; 1) identify when and 2) where lightning is occurring, and 3) create a visualization that can be used on mobile devices. Last year, SPoRT created the GLM 30 minute hazard, or "stoplight", product highlighting hazards with the three color (red, yellow, and green) scheme, see Fig. 4. Work has been ongoing to prepare for an assessment this summer. The basic display shows the spatial extent of lightning, thanks to the GLM observations, and is color coded based on the age of the lightning observation. The original design is coded such that red is 0-9 minutes old, yellow is 10-19 minutes, and green is 20-29 minutes. The product covers 30 minutes of data, but updates every minute. Initial feedback has suggested that green should not be used as it could convey that conditions are safe and SPoRT is addressing this feedback to improve the product for the end users. The image (Fig. 4) shows an example of the GLM stoplight product in conjunction with the more traditional 1-minute density observations. A key advantage with the stoplight product is that it shows where lightning has been for the past 30 minutes, indicating the areas of most likely threat versus a single 1 minute snapshot. Also, even a still image can provide a general sense of storm motion.

The GLM stoplight product uses 30 minutes of data, which was deliberately chosen to match with the 30 minute lightning safety rule; stay indoors for 30 minutes after lightning is seen or thunder is heard. An upcoming journal article will discuss the product in further detail. Some early results using 80 hours of GLM data from 2017 provide valuable feedback for safety. Almost 709 thousand likely flash pairs over the entire GLM field of view were observed where the time between each pair was 10-45 minutes. Of that, 37% of the cases were between 20-45 minutes. When looking at time differences between 30-45 minutes, 15% (107,018 occurrences) fell within this time span. This small analysis shows that the 30 minute guidance is reasonable, but that a non-zero chance of lightning occurring outside this window exists.

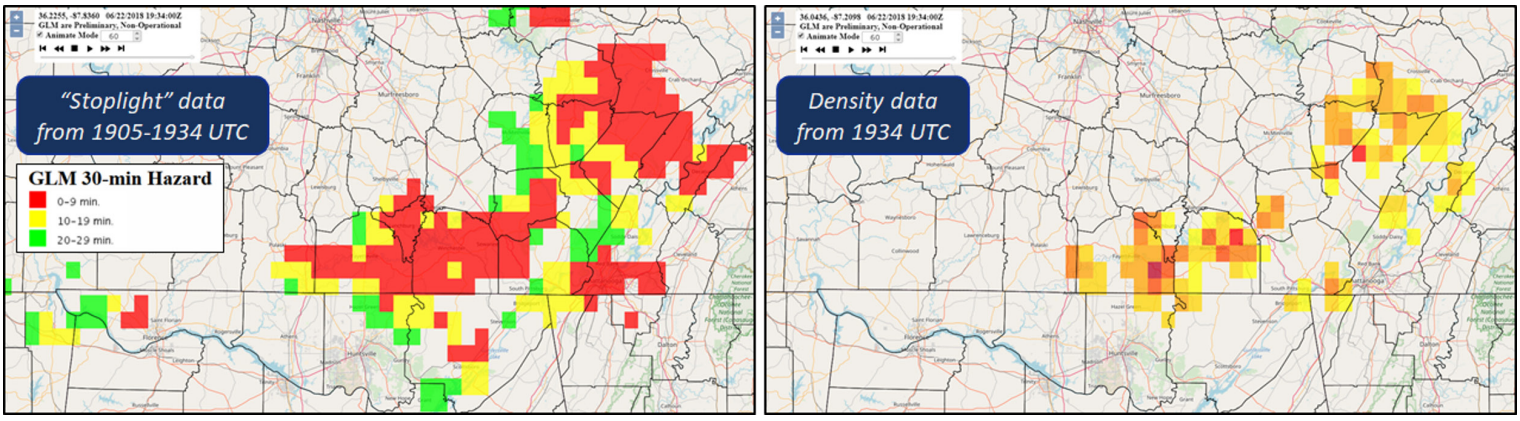


Figure 4: An example of the GLM 30 minute hazard, or stoplight, product (left) covering observations from 1905-1934 UTC versus the 1 minute GLM group density (right) for 1934 UTC.

Outreach Activities

SPoRT engages with our partners and the community in a number of ways, including through the use of social media and participation in outreach activities. You can follow us through Facebook (NASA SPoRT Center) and Twitter (@NASA_SPoRT). SPoRT also maintains the Wide World of SPoRT blog (http://nasasport.wordpress.com), where SPoRT scientists and our forecaster partners highlight interesting examples of product use. If you would like privileges to post on the SPoRT blog, please send an email to Kris White (kris.white@noaa.gov) or Jordan Bell (jordan.r.bell@nasa.gov).

Wide World of SPoRT Blog

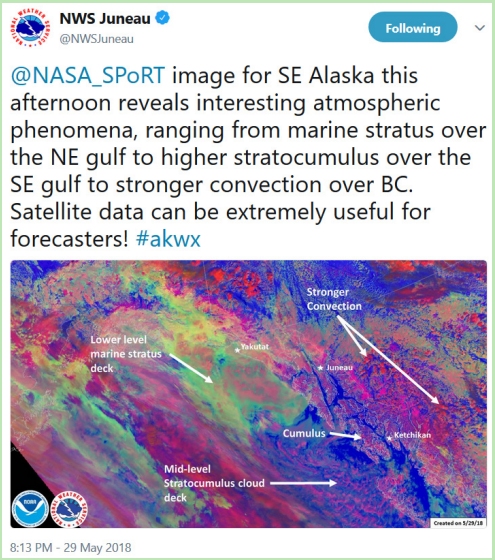
The NASA Wide World of SPoRT blog had eight blog posts during the 2nd quarter of 2018 covering a wide range of topics from NASA SMAP (Soil Moisture Active Passive) Retrievals to the use of the Geostationary Lightning Mapper (GLM) in operations. The first blog post of the quarter was written by Jon Case highlighting the integration of SMAP data into the SPoRT Land Information System (LIS) and showcasing the differences in the LIS with and without the SMAP data integrated. This blog post wraps up by highlighting a Mesoscale Convective System NWP simulation showing the differences between a run without the SMAP data assimilation and a run with the SMAP assimilated in the SPoRT LIS.

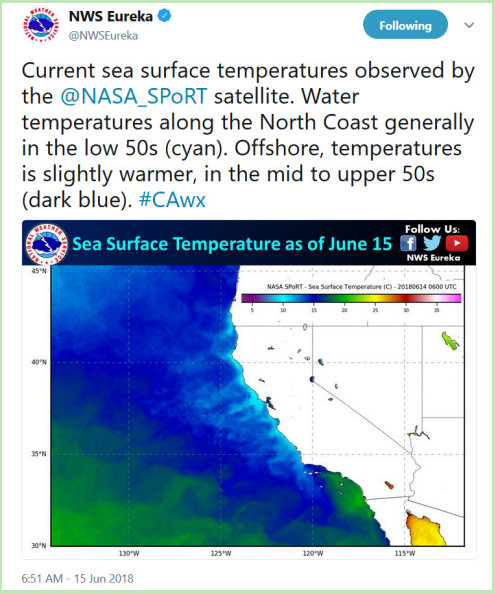
Another unique article on the blog this quarter was written by Kevin Fuell, showing NOAA's GOES-16's Dust RGB capturing a dust event on 12 April 2018 and comparing the dust signature to observations from NASA's Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP) instrument on the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO) payload. The post highlights how the GOES-16 Dust RGB product was able to help impact forecaster's decisions in extending advisories, while the CALIOP instrument was able to provide information such as plume height and thickness. This post is a great example of using multiple sensors for both operations and research.

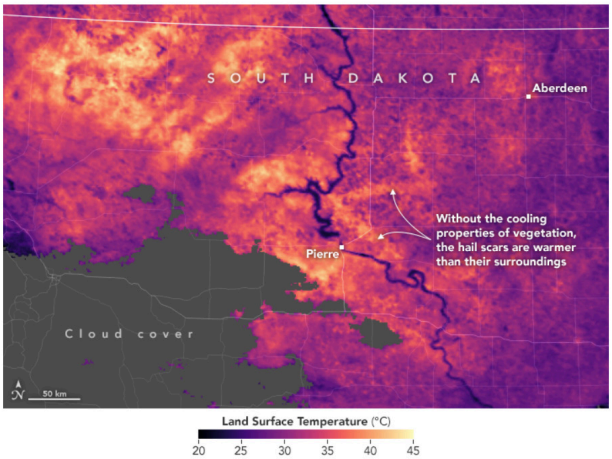
The final five blog posts of the quarter were all case studies on the use of GLM for various events. These blog posts were written by SPoRT personnel and colleagues at the NOAA/NWS Huntsville WFO. One blog post even described the lightning detected by GLM in the volcanic plume after the eruption of Mount Fuego in Guatemala. The Huntsville WFO had a nice blog post on how GLM helped their decision support for airport warnings.

Jordan Bell was recently featured providing insight in an Earth Observatory article discussing two hail damage swaths in South Dakota as a result of severe thunderstorms in late June. These two large damage swaths were observed by various NASA EO sensors and build off what Jordan's thesis work was when analyzing hail swaths and trying to develop an algorithm. Jordan, along with Andrew Molthan and Lori Schultz have continued work on using remote sensing to identify damage from both tornadoes and hail using not only optical remote sensing data but also synthetic aperture radar (SAR) imagery.

Tweets of the Quarter







The long lines of damage visible in these satellite images of South Dakota may look like a product of tornadoes. However, the width of the damage swath—well over 10 kilometers (6 miles) in many areas—is a clue that it was hail that pummeled these croplands. According to Jordan Bell, a research meteorologist with NASA's Short-term Prediction Research and Transition Center (SPoRT), tornado tracks rarely appear wider than a few kilometers.

Transitions and Assessments

Dust RGB Assessment for GOES-16 Advanced Baseline Imager

The availability of new IR channels from GOES-16 ABI has allowed the EUMETSAT-developed Dust RGB to be regularly created. SPoRT demonstrated this product via NASA's MODIS and VIIRS imagers as part of GOES-16 pre-launch user preparedness. Now, with GOES-16 ABI available, SPoRT conducted an assessment of this product with five NWS WFOs in the U.S. South/Southwest in March and April of 2018. The value of this new capability had large operational impacts to supporting the NWS mission of monitoring and forecasting blowing dust hazards. On April 12, 2018 a strong pressure gradient setup across the Southwest and associated winds resulted in several dust outbreaks, including a large plume across the Four Corners region (Fig. 5). The NWS forecast office in Albuquerque, NM, applied the Dust RGB for early detection of the dust plume in this region where in situ observations are sparse and radar coverage is poor. In addition, the RGB improved efficiency for monitoring the plume extent and movement over visible imagery where the dust blended into the desert background. The Dust RGB aided in the decision to upgrade a Wind Advisory to a High Wind Warning, and to issue a Special Weather Statement (SPS) for blowing dust impacts across northwest NM. Eventually, visibility dropped as low as 2.5 statute miles (i.e. instrument flight rules), and the cloud ceiling dropped to 2300 feet at an airport in extreme northwest NM. The El Paso, TX, forecast office also noted this event and the improvement through the use of the Dust RGB for detection and monitoring of dust plumes coming from the data-void region of Mexico. Additional monitoring into the nighttime was possible with the RGB given that visible imagery was no longer useful at that time. Overall feedback from forecasters during the assessment indicated the benefit of applying the RGB provided for increased lead time for issuing/amending forecast products for blowing dust. Interestingly, the Albuquerque, NM, office had a separate example where they were able to verify that blowing dust was not occurring during high wind conditions when dust plumes were anticipated.

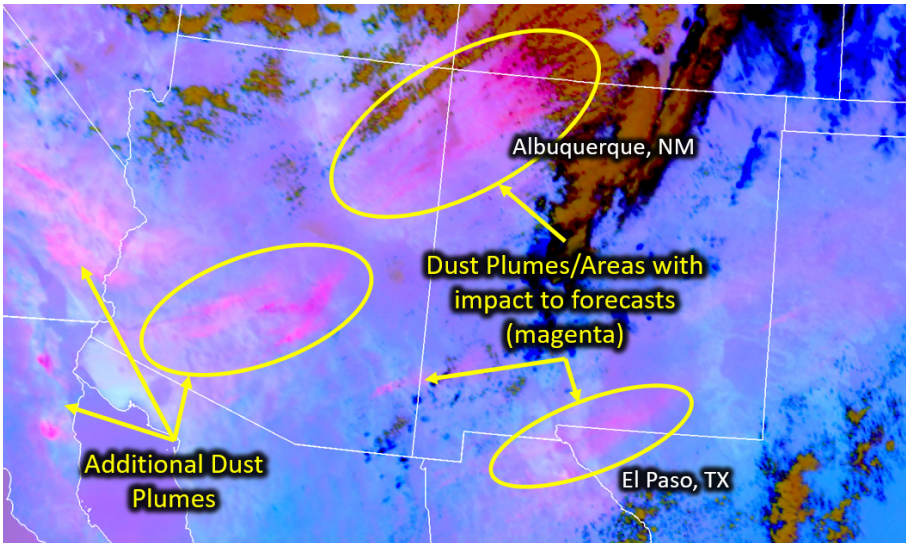


Figure 5. 12 April 2018 Dust RGB highlighting a dust outbreak in southwestern U.S.

LaRC Convective Products

Collaboration with NASA Langley Research Center (LaRC) to transition a suite of convective products has been occurring through an assessment activity started in May with forecasters at NWS Center Weather Service Units (CWSU). Prior to the assessment forecasters were provided initial training via teleconference as well as an online feedback form. Several events in May had user feedback on the use of probability products for overshooting tops and high ice water content as well as a 'visibility text' product related to turbulence and convective intensity. On May 4 the Houston CWSU applied the high ice water content probability to note a large plume of likely super-cooled particles that could impact aircraft efficiency due to potential ice accumulations. As storms moved further east into the Texas Hill Country a pilot report confirmed the icing hazard and no other flights were directed to that region. With the assessment period ending in June, a summary report is being prepared to document assessment results.

Community Participation

Andrew Molthan represented SPoRT and MSFC Earth Science on May 3 in Baton Rouge, Louisiana to support NASA's involvement in Louisiana Legislative Day, briefing school tours, legislators, and their staff on SPoRT and MSFC Earth Science contributions to state interests.

Members of the SPoRT team participated in NASA Day in the Park on June 16th at Big Spring Park in downtown Huntsville to provide outreach about the project and related Earth Science activities to the Huntsville community

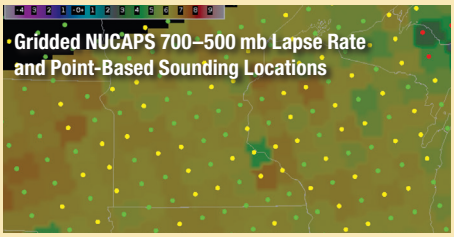
Anita Leroy gave a SPoRT overview presentation to Austin Peay State University students from the Governor's School for Computational Physics on 8 June as part of their visit to the National Space Science and Technology Center and NASA MSFC.

Chris Schultz was selected to one of ten slots on the Marshall Early Career Organization Council. The goal of the council is to develop skills among the early career workforce at MSFC to bridge the gap between interns and mid career management.

GOES-R and JPSS Proving Ground Activities

NUCAPS Products at the Hazardous Weather Testbed

SPoRT team members Kris White, Emily Berndt, and Sebastian Harkema traveled to the Hazardous Weather Testbed as subject matter experts for the NOAA Unique Combined Atmospheric Processing System (NUCAPS) Soundings and Gridded Products. As part of the JPSS Sounding Applications Initiative, scientists from multiple organizations including SPoRT, the Cooperative Institute for Research of the Atmosphere (CIRA), and Science and Technology Corporation (STC) had the opportunity to interact with forecasters regarding the operational utility of NUCAPS products for assessing the pre-convective environment. Prior to the start of HWT, SPoRT worked with JPSS, NESDIS, and SSEC to develop code and provide direct broadcast NUCAPS Soundings to HWT to address the latency of S-NPP NUCAPS Soundings in AWIPS. Forecasters were able to view NUCAPS Soundings with a latency of 40-60 minutes compared to the 90-240 minute latency of the operational NUCAPS Soundings. Forecasters provided feedback on the value of CIRA's modified NUCAPS Soundings, Improved Latency Soundings, and the Gridded NUCAPS. Much of the forecaster feedback from HWT will be conveyed to NUCAPS developers and operational data providers to improve the availability and display of the NUCAPS Soundings in AWIPS. Forecaster feedback from HWT has also provided additional insight on best practices and requirements to consider while SPoRT and STC work with Jason Burks of NWS/CIRA/Meteorological Development Lab to baseline the Gridded NUCAPS in AWIPS.



Training Updates

SPoRT team members worked to gather RGB application examples and expert content for the Air Mass and Differential Water Vapor RGBs to prepare forecasters for the analysis of synoptic-scale systems and their potential impacts during the upcoming Fall season. Both of these RGBs use new water vapor channels not previously available in operations from geostationary orbit, and NASA remote sensing instruments and expertise are aiding training development. In addition, other work for the NOAA Satellite Training Advisory Team (STAT) has included topics of Snowfall Rate and Quantitative Precipitation Estimate products. A significant focus of SPoRT's training efforts has been the development of materials for 'application basics' of the Geostationary Lightning Mapper (GLM) on GOES-16 as well as a lesson to educate forecasters on the difference between GLM and traditional ground-based lightning networks. Both of these efforts were created in two formats: a short, web-based 'micro-lesson' (5-8 minutes) and a 2-page Quick Guide for use during operations. To quickly prepare forecasters for a preliminary assessment of the GLM flash extent density product, these two training items were combined into one deliverable for participating offices. SPoRT's total lightning applications training topics include severe weather, but it also goes further to demonstrate GLM value for public and aviation safety as well as the use of total lightning in radar-void areas.

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Stano, G. T., 2018: An Operational Overview of the Geostationary Lightning Mapper GOES-R. Short Course at the *52nd Canadian Meteorological and Oceanographic Society Conference*, Halifax, Nova Scotia, 10-14 June.

Stano, G. T., M. R. Smith, C. J. Schultz, P. J. Meyer, and K. M. McGrath, 2018: Early Operational Activities with the Geostationary Lightning Mapper. *52nd Canadian Meteorological and Oceanographic Society Congress, GOES-16: Activities and Applications Part 1,* Halifax, Nova Scotia, 10-14 June, 9967.

Visits and Visitors

May 8-10: Dr. Juan Crespo of the University of Michigan, now JPL, visited SPoRT on May 8-10 to highlight his work to develop flux products from CYGNSS observations for the purpose of diagnosing the development of extratropical cyclones.

June 18-22: Dr. Nadia Smith, Science and Technology Corporation visited SPoRT June 18-22 to collaborate with SPoRT and MDL on development related to baselining Gridded NUCAPS in AWIPS.

June 26-27: Dr. Katie Crandall Vigil from NOAA NWS Operations Proving Ground visited SPoRT June 26-27 to discuss her research and assessment activities related to multispectral imagery and color vision deficiency.

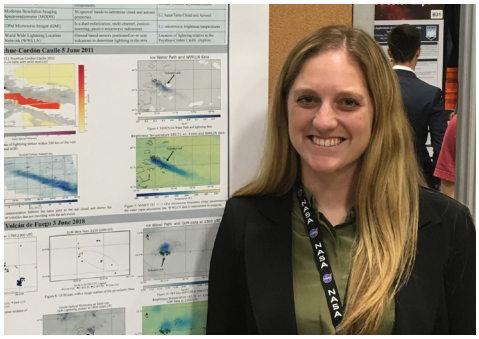
Congratulations and Awards

Andrew Molthan was invited to participate in the inaugural class of the AMS Early Career Leadership Academy, April 25-27, including two and a half days of presentations and collaborations focused on early career leadership development, strategic thinking, relationship-building, and follow-on small group mentoring activities.

Chris Schultz was given an award by the American Meteorological Society for outstanding service as the Chair of The Board of Early Career Professionals for his service to the society from 2016-2018.

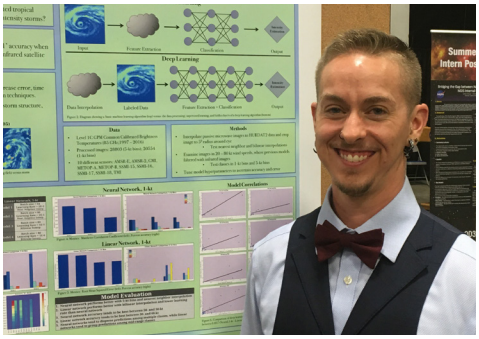
Summer Interns

Virginia Andrews



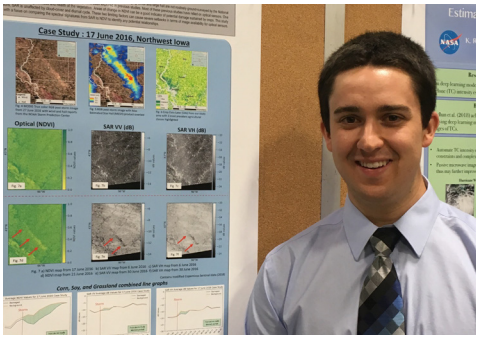
Virginia Andrews worked with Chris Schultz and Aaron Naeger throughout the summer using NASA satellite data obtained from, MODIS (Aqua and Terra), MISR, GMI, OMI, CALIPSO, and SSMIS in order to understand the transport and distribution of both volatiles and ash particles in a plume. The NOAA GOES-16 satellite data was also used, specifically the geostationary lightning mapper (GLM) data and advanced baseline imager (ABI) data to look at cloud and aerosol properties. Virginia is currently a second year PhD student at the University of Alabama. She completed her Master's and Bachelor's degree at Texas Christian University.

Ryder Fox



Ryder Fox collaborated with MSFC Earth Science Branch mentors Andrew Molthan and Manil Maskey to explore the use of deep learning techniques for improved estimation of weak tropical cyclones via passive microwave brightness temperatures and structures, seeking to improve upon local efforts using GOES infrared imagery. Ryder recently completed their Bachelor of Science in Atmospheric Physics at New Mexico Institute of Mining and Technology. They will be continuing their education in a doctoral program at the University of Miami's Rosenstiel School of Marine and Atmospheric Science.

Cole Payne



Cole Payne worked with Jordan Bell and Andrew Molthan this summer. Cole worked this summer on looking into the integration of synthetic aperture radar (SAR) with optical remote sensing analysis when looking at hail damage swaths in the central United States. Cole recently completed his Master's degree in Remote Sensing at the University of Alaska Fairbanks. He received his Bachelor's degree in Geology from the University of Missouri-Kansas City.

Upcoming Calendar of Events

9 July to 13 July	Esri User Services Conference, San Diego, CA
10 July to 11 July	Aviation Weather Research Program Research Review and Weather Satellite Integration Technical Exchange Meeting, Boulder, CO
16 July to 19 July	Friends and Partners in Aviation Weather, Washington, DC
27 Aug to 30 Aug	National Weather Association Annual Meeting, St. Louis, MO
11 Sep to 14 Sep	NOAA Satellite Training Advisory Team Meeting, Boulder, CO
11 Sep to 13 Sep	GLM Science Team Meeting, Huntsville, AL

National Aeronautics and Space Administration

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