National Aeronautics and Space Administration

SPoRT Quarterly
January – March 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

SPoRT Participation in ICE-POP

NASA SPoRT provided one of several numerical weather prediction (NWP) modeling solutions to South Korea for the 2018 PyeongChang Winter Olympic and Paralympic Games during February and March. Known as the International Collaborative Experiments for PyeongChang 2018 Olympic and Paralympic Winter Games (ICE-POP), the field campaign combined a suite of radar, satellite, and in situ observations, with numerical modeling assets and data assimilation experiments over the complex terrain of the Korean Peninsula. The SPoRT experimental configuration of the NASA Unified-Weather Research and Forecasting (NU-WRF) model was run in real time during the Olympic and Paralympic Games, and serves as a benchmark for future research to improve our understanding of snowfall in complex terrain, our ability to estimate snow using satellites, and for improving prediction models that parameterize these intricate processes.

For the real-time NWP solution, SPoRT has configured the NU-WRF modeling framework to generate 24-hour forecasts four times per day, with initialization times at 0000, 0600, 1200, and 1800 UTC. The model physics suite features the advanced 4-ice microphysics and short- and long-wave radiation parameterization schemes developed at NASA Goddard Space Flight Center. The NU-WRF grid setup consists of a triple-nested domain at 9-km, 3-km,

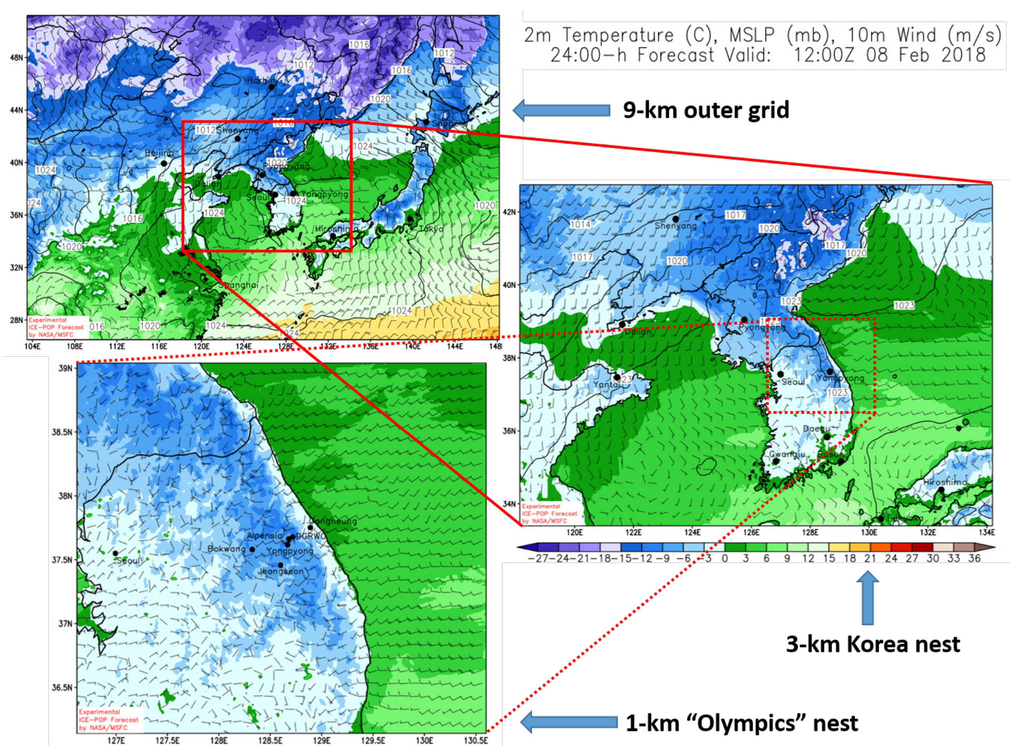


Figure 1. Depiction of the triple-nested grid configuration for the real-time NU-WRF forecast guidance, consisting of 9-km (upper-left), 3-km (right), and 1-km (lower-left) mesh grids.

and 1-km horizontal spacing, and 62 terrain-following vertical levels, covering regions spanning eastern Asia (9-km grid), the Korean peninsula and surrounding waters (3-km grid), and the eastern Korean peninsula centered on the Olympics venue (1-km grid; Fig. 1). Initial and (lower) boundary conditions are provided by the National Centers for Environmental Prediction (NCEP) Global Forecast System model and SPoRT's own 2-km resolution sea surface temperature composite product.

A few blog posts were published on the Wide World of SPoRT blog that highlighted a combination of SPoRT NU-WRF model simulations of high-impact winter storm events, passive microwave flux retrievals compared to model fluxes, and field campaign instrumentation supporting ICE-POP. Among the high-impact events included strong winds that postponed the Men's Downhill Alpine skiing on 11 February, strong winds and snowfall that again disrupted downhill skiing competition on 14 February, and several heavy snowstorms that occurred between the February Olympic and March Paralympic Games. Readers are encouraged to visit SPoRT's blog site for more details of simulation and observational examples during the Olympic and Paralympic Games. Here, we show a comparison between NU-WRF simulated and passive-microwave retrieved fluxes from 11 February, which shall form the basis for data assimilation research experiments in the coming months.

A strong northwest flow of very cold air prevailed across the Korean Peninsula and surrounding waters on 11 February. The 10-m wind speeds plus sensible and latent heat fluxes at 0600 UTC 11 February are shown in Figure 2, comparing the 9-km model grid simulation with the satellite flux retrievals. The retrievals are hourly-averaged composites that were produced in near real-time for the ICE-POP campaign, derived from swaths of the constellation of passive microwave satellites. As the bitter cold Siberian air mass flows over the warmer open waters of the Sea of Japan, Yellow Sea, and western Pacific Ocean, substantial heat and moisture fluxes are directed from the sea surface to the atmosphere. The 10-m model and retrieved wind speeds both depict a similar broad pattern of high wind speeds up to and exceeding 15 m s-1 across favored corridors downwind of the Korean Peninsula, China, and Russia (Figs. 2a and b). The model sensible heat flux on the 9-km grid (Fig. 2c) has a broad pattern similar to the retrieval composite (Fig. 2d), but with an axis exceeding 500 W m-2 from the east coast of the Korean Peninsula to central Japan, and a broader amplitude between ~200-400 W m-2, generally higher than the retrieval values The model latent heat flux (Fig. 2e) shows a similar pattern, except for a larger coverage of values exceeding 500 W m-2 between the Korean Peninsula and Japan, and offshore of central and southern Japan. The maxima offshore of Japan show good agreement between the model and retrieval patterns (Fig. 2f). The NU-WRF flux amplitudes for this case were generally higher than that of the retrieval, likely due to several factors such as the retrieval being an hourly-averaged composite compared to instantaneous model fluxes, differences in product resolution, input sea surface temperatures, and model errors in simulated wind speed, and near-surface temperatures and moisture. Additional research activities as part of ICE-POP are being conducted to examine the benefits of assimilating the surface meteorology retrievals into the model for improving the predictions of oceanic heat and moisture transport into the atmosphere and their attendant impacts on air-mass modification.

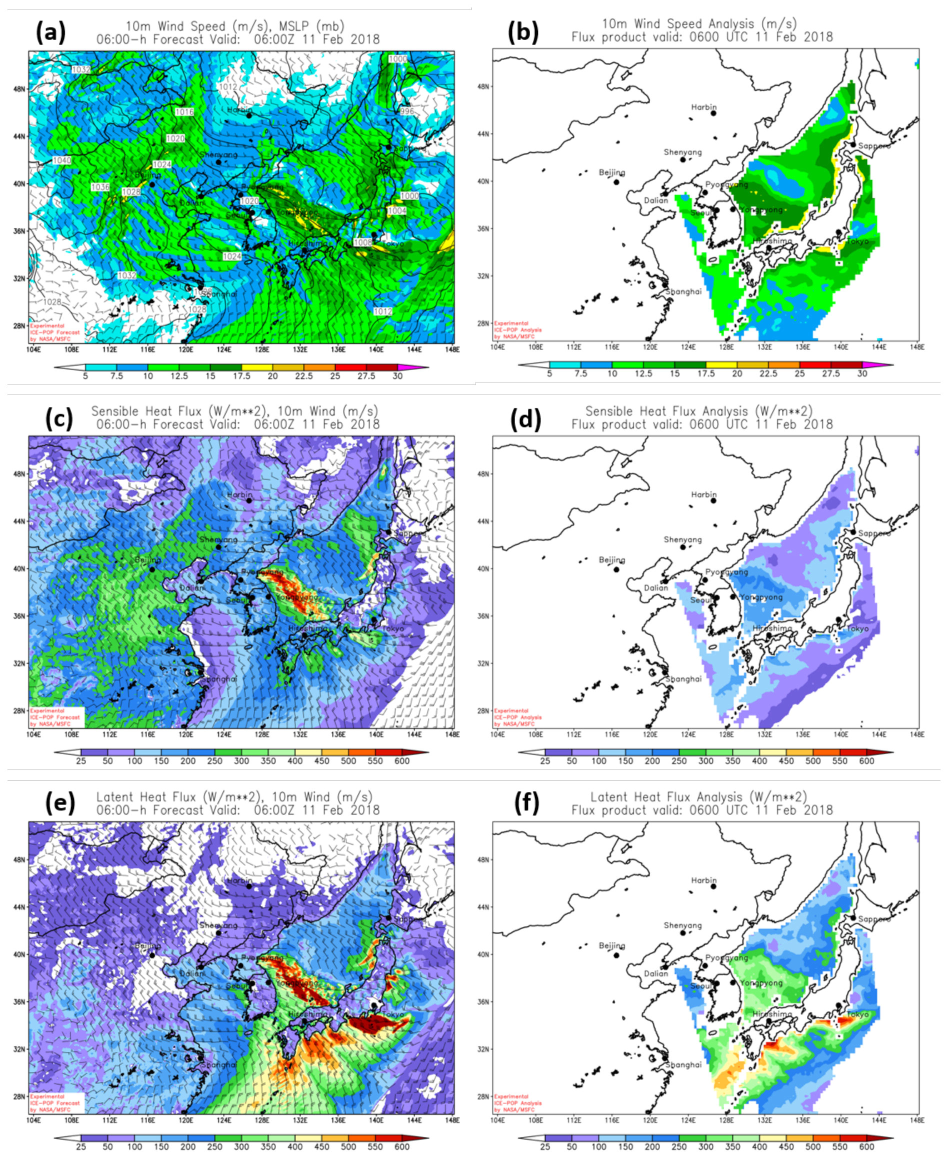


Figure 2. Comparison between NU-WRF modeled and passive-microwave hourly-averaged composite retrievals of 10-m wind speed (m s-1), sensible, and latent heat flux (W m-2) valid 0600 UTC 11 February 2018. (a) NU-WRF interval 10-m wind speed, (b) 10-m wind speed retrieval, (c) NU-WRF sensible heat flux, (d) sensible heat flux retrieval, (e) NU-WRF latent heat flux, and (f) latent heat flux retrieval.

Recent Accomplishments

New GOES-17 receiving station (left) adjacent to the existing GOES-16 receiving station (right) outside the Activities Building at MSFC.

Installation of Additional Ground Station to Support GOES-S/West

A new Geostationary Operational Environmental Satellite–R Series (GOES-R) receiving station was installed at MSFC in March 2018. This joins a previous station that was installed in early 2017 that currently receives GOES Rebroadcast data from GOES-16, which is assigned to the East position. The new station will receive data from GOES-17 (-West) when the satellite becomes operational later this year. Data from all 6 spacecraft instruments are received and processed—including the Advanced Baseline Imager, Geostationary Lightning Mapper, and Solar Ultraviolet Imager—and will be used to support research activities including multi-spectral Red-Green-Blue products and using lightning detections as a precursor to the formation of severe weather.

Soil Moisture Assimilation in the Land Information System

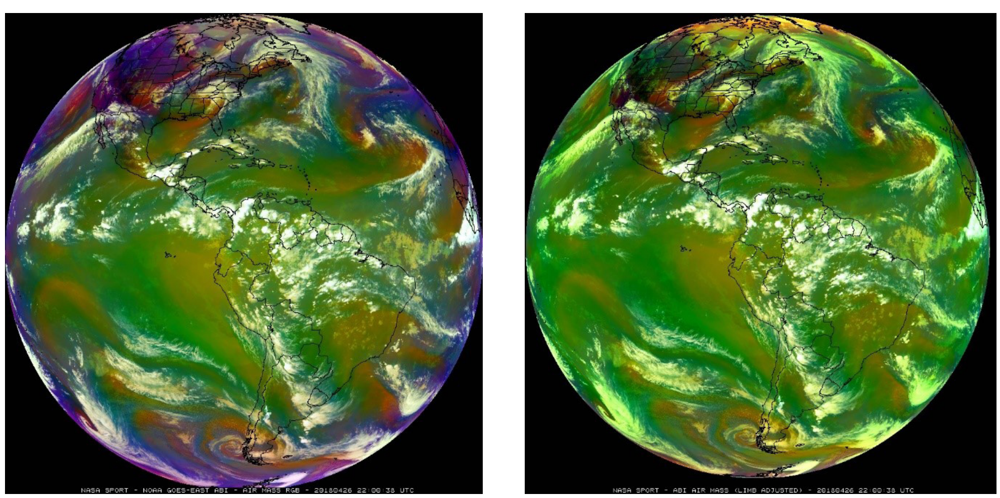
SPoRT is assimilating retrievals of soil moisture from the NASA Soil Moisture Active-Passive (SMAP) satellite mission. SMAP is a microwave radiometer which can detect changes in near-surface (up to 5 cm depth) soil moisture. SMAP retrievals are assimilated into an experimental version of Land Information System (LIS) known as the “SMAP LIS” with the goal of improving soil moisture and surface fluxes of water and energy. We have seen qualitative improvements in soil moisture distributions over known problem areas such as the eastern US-Canada border. Soil moisture products from this model run are available on our web page under Real-Time Data (Land Information System).

Our current research focuses on the impact of the soil moisture changes on numerical weather prediction. We have performed modeling experiments with WRF using LIS runs (with and without SMAP assimilation) for soil moisture initial/boundary conditions. The changes in water availability for evapotranspiration affect the partition between latent and sensible heating, leading to changes in boundary layer development and convective initiation.

Two initial case studies have shown promising results by improving the position and timing of convective development. A comprehensive quantitative assessment of the NWP impacts is in progress, focusing on the summers of 2015 and 2016.

Real-time Geostationary Limb-Correction to improve the Air Mass RGB interpretation

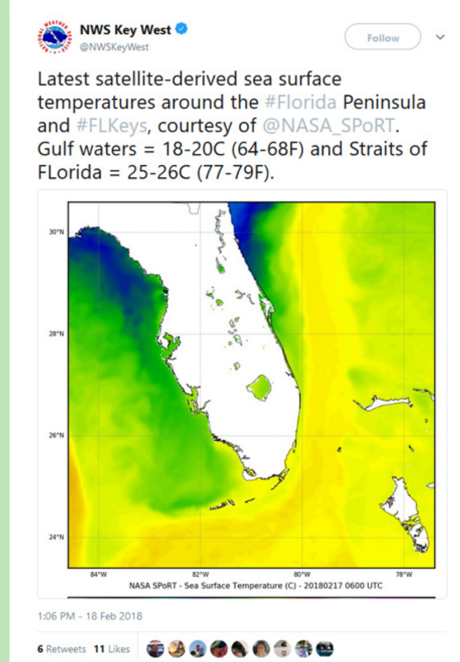
SPoRT began producing a real-time version of the limb-corrected Air Mass RGB following the technique of Elmer et al. 2016 to improve usability and interpretation of the Air Mass RGB. The full-disk limb-corrected Air Mass RGB is available real-time for both GOES-16 ABI and Himawari-8 AHI on the SPoRT web page. The limb-correction removes the false blue/purple coloring at high viewing angles. As the outgoing radiation travels through a greater column of the atmosphere at high viewing angles more radiation is absorbed by water vapor and ozone. This absorption results in cooler brightness temperatures in the water vapor and ozone channels used to derived the Air Mass RGB and manifests as false blue/purple coloring. The false coloring can make it difficult to effectively interpret air masses at high viewing angles. At high viewing angles cold, polar air is difficult to distinguish due to similar color produced by limb effects and warm, moist tropical air typically green may appear blueish.



Example of GOES-16 ABI Air Mass RGB (right) and limb-corrected Air Mass RGB (left).

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).



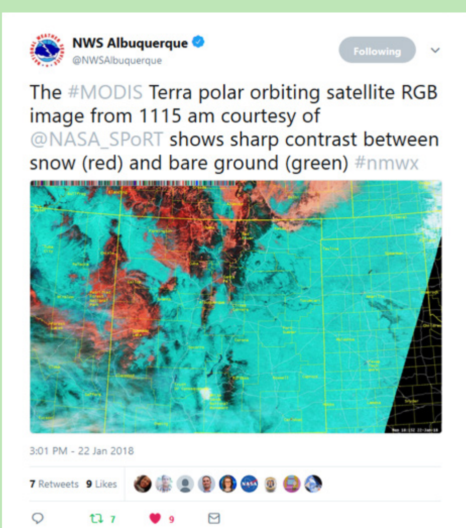
Wide World of SPoRT Blog

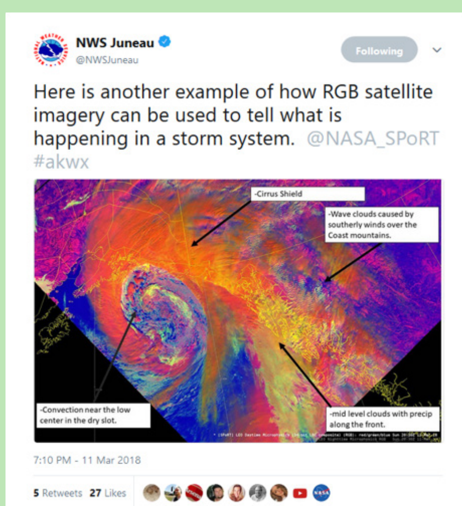
The first quarter of 2018 had 4 posts on the Wide World of SPoRT blog. These 4 posts focused on activities surrounding SPoRT's participation in the NASA field Campaign, ICE-POP. Mr. Jonathan Case used these blog posts to highlight how SPoRT supported the campaign by providing real-time Global Precipitation Mission data via a specialized web site and producing real-time numerical model output to enable science investigations related to high-terrain winter precipitation.

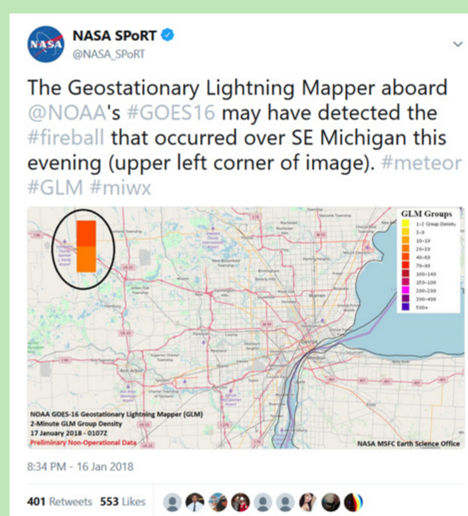
- https://nasasport.wordpress.com/2018/02/07/nasa-sport-providing-real-time-numerical-weather-prediction-guidance-for-2018-winter-olympics/
- https://nasasport.wordpress.com/2018/02/15/high-winds-impacting-olympic-events-captured-by-nasa-sport-model-and-satellite-products/
- https://nasasport.wordpress.com/2018/02/23/shallow-snow-and-high-wind-event-of-14-february-during-the-pyeongchang2018-winter-olympics/
- https://nasasport.wordpress.com/2018/03/08/plenty-of-fresh-powder-for-paralympic-winter-games-in-pyeongchang-three-snowstorms-in-eight-days/

Social Media

A total of 46 updates were posted to Twitter and Facebook. Specific to Twitter, these posts accumulated over 3 million impressions and 8,600 likes. Here are a few highlights:



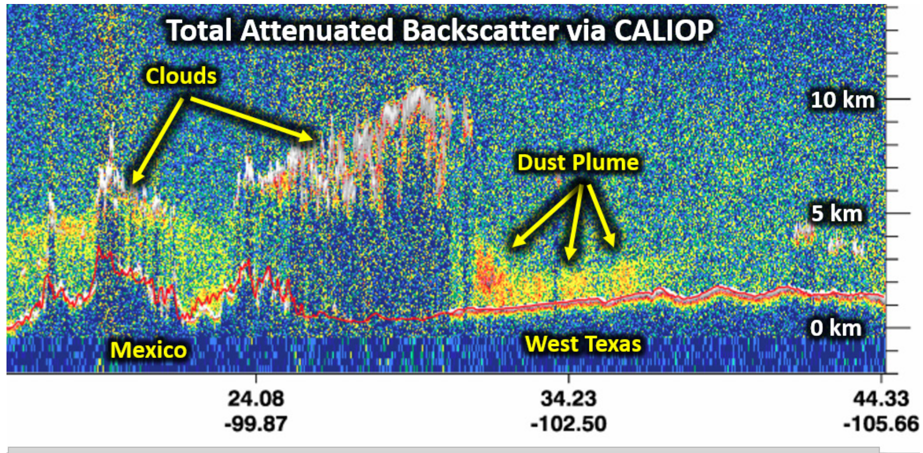


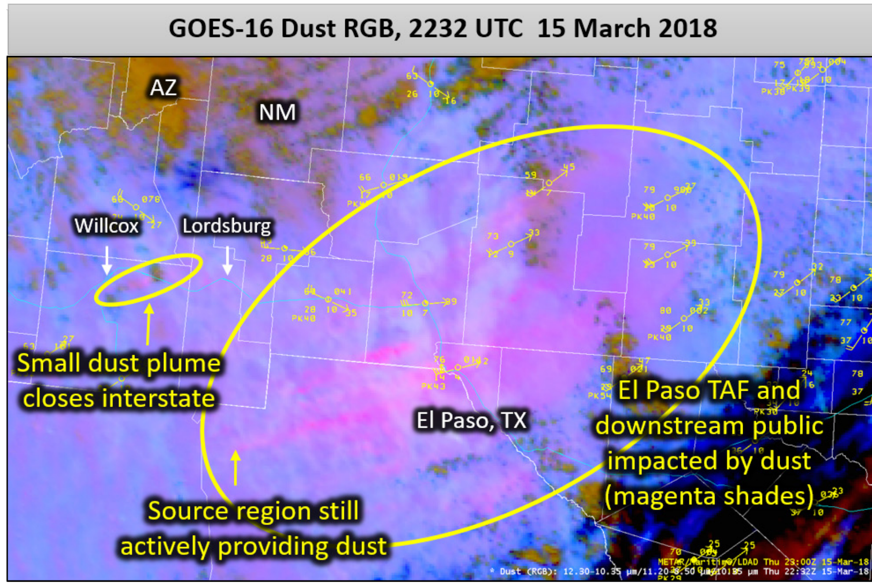


Transitions and Assessments

Assessment of Dust RGB with NASA CALIOP Verification

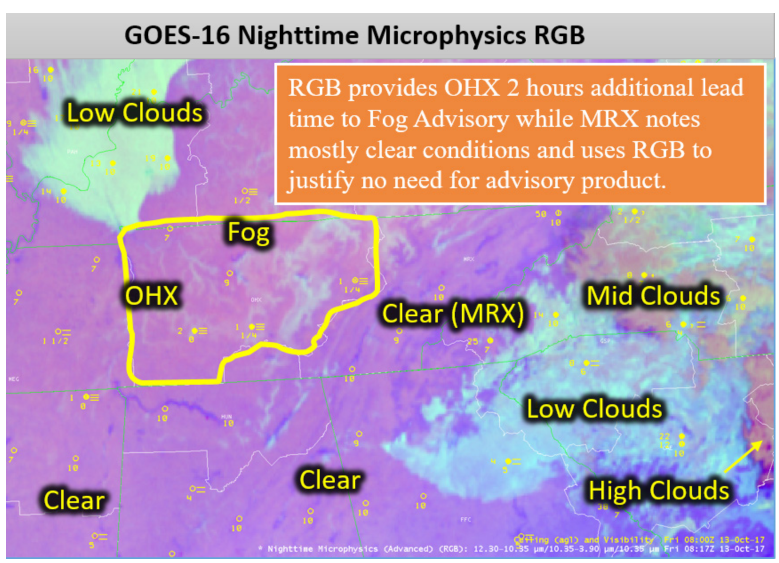
Since 2012 the NASA Moderate Resolution Imaging Spectroradiometer (MODIS) has been used to prepare NWS operational forecasters for the capabilities expected in the new GOES-R era. The Dust RGB from MODIS and Visible Infrared Imaging Radiometer Suite (VIIRS) had impacts in the U.S. Southwest as published in the National Weather Association (NWA) Journal of Operational Meteorology (Fuell et al. 2016). Currently, SPoRT is "completing the loop" of transition by assessing the Dust RGB from GOES-16 with select Southwest Weather Forecast Offices (WFOs). The objective of this assessment is to evaluate what similar and/or new value the Dust RGB via GOES-16 provides from the previous Proving Ground era as well as develop "best practices" and training cases to recommend to the wider operational community. Starting in March 2018 forecaster feedback has indicated large impact of the Dust RGB for public and aviation forecasts, both at the local WFO level, as well as aviation centers with larger areas of responsibility. On March 15 the Dust RGB (bottom) was applied to analyze a dust plume originating from data-sparse, northern Mexico to anticipate impacts to aviation in west Texas and southern New Mexico. In addition, a highway closure in Arizona occurred due to low visibility from blowing dust. The LIDAR backscatter (top) from NASA's Cloud-Aerosol Lidar and Infrared Pathfinder (CALIOP) is being examined to provide quantitative information about the dust plume related to height and thickness, which is not available in the Dust RGB. CALIOP allows verification of the signature seen in the qualitative Dust RGB to aid forecaster understanding and interpretation of GOES-16 imagery. See the SPoRT Blog for details on an additional Dust RGB and CALIOP example.





Nighttime Microphysics RGB

SPoRT's GOES-R Proving Ground work included the use of proxy data from MODIS (Aqua, Terra), VIIRS (S-NPP), as well as AVHRR imagers to create the Nighttime Microphysics (NtMicro) RGB composite imagery to demonstrate ABI capabilities. This past Fall 2017 and Winter 2018 SPoRT engaged with partner NWS WFOs to evaluate the impact of the NtMicro RGB from GOES-16 on analyzing and monitoring aviation hazards of low ceilings and visibilities. A total of 68 forecaster feedback entries occurred online and in 35% of the events the NtMicro RGB was said to have large to very large impacts on the lead time of issuing or amending a hazard product/forecast. In the GOES-16 NtMicro RGB example presented here, the Nashville (OHX) office had roughly 2-hours additional lead time over standard imagery products for a Fog Advisory product while the Morristown/Knoxville (MRX) office was able to see relatively clear skies over its area and decided to not issue a hazard product. As with other RGB products from GOES, the NASA CALIPSO mission is being used to examine fog and cloud features to add quantitative information regarding cloud height, thickness, and type.



Training for New NASA and NOAA Products

Development of application-based training as contributions to NOAA's GOES-16 Satellite Training Advisory Team (STAT) library continues for RGB composite imagery from ABI. All "Quick Guides" were completed this quarter as well as several shorter, learning objects ("Quick Briefs"). These Quick Briefs (see graphic), created by SPoRT in collaboration with experienced users and scientists, are browser-based items with audio, graphics, animations, and bullet points. The Quick Briefs are 5-7 minutes in length with instructional design aspects to help the learner retain the most important information. The Ash and Fire Temperature RGBs are brand new products for U.S. forecasters. The Quick Briefs demonstrate how the Ash RGB provides a consistent product both night and day to monitor ash plumes and the value of the Fire Temperature RGB product to both detect fire hotspots and also qualify their intensity. Similar Quick Guide and Quick Brief items are in development for the Geostationary Lightning Mapper (GLM). In addition, SPoRT continues to provide training on NASA missions such as Global Precipitation Measurement (GPM) for the JPSS STAT. A training module on the GPM mission and precipitation-related products was developed to support the use of passive microwave data in operations.

Publications

Berndt, E. B., N. J. Elmer, A. L. Molthan, and **L. A. Schultz**, 2018: A Methodology to Determine Recipe Adjustments for Multispectral Composites Derived from Next-Generation Advanced Satellite Imagers. *J. Atmos. Oceanic Technol 35, 643-664.* https://doi.org/10.1175/JTECH-D-17-0047.1

Berndt, E. and M. Folmer, 2018: Utility of CrIS/ATMS profiles to diagnose extra-tropical transition. Results in Physics 8, 184-185. https://doi.org/10.1016/j.rinp.2017.12.006

Blankenship, C., J. L. Case, W. Crosson, and **B. T. Zavodsky**, 2017: Correction of Forcing-Related Spatial Artifacts in a Land Surface Model by Satellite Soil Moisture Data Assimilation. *IEEE Geosci. Remote Sens. Lett., 15(4), 498-502.* https://doi.org/10.1109/LGRS.2018.2805259

Case, J. L. and **B. T. Zavodsky**, 2018: Evolution of 2016 Drought in the Southeastern United States from a Land Surface Modeling Perspective. *Results in Physics 8, 654-655.* https://doi.org/10.1016/j.rinp.2017.12.029

Naeger, A. R., Impact of dust aerosols on precipitation associated with atmospheric rivers using WRF-Chem simulations. *Results in Physics* (in press). https://doi.org/10.1016/j.rinp.2018.05.027

Schultz, C. J., T. J. Lang, E. C. Bruning, K. M. Calhoun, **S. Harkema**, and N. Curtis, 2018: Characteristics of Lightning Within Electrified Snowfall Events Using Lightning Mapping Arrays. *J. Geophys. Res. Atmospheres* 123(4), 2347-2367. https://doi.org/10.1002/2017JD027821

Presentations

Bell, J. R., L. A. Schultz, A. L. Molthan, D. B. Kirschbaum, M. Román, S. H. Yun, F. J. Meyer, K. A. Hogenson, R. Gens, H. M. Goodman, S. Owen, R. Amini, Y. Lou, M. Glasscoe, D. S. Green, J. J. Murray, J. C. Struve, J. Seepersad, and V. Thompson, 2018: NASA Earth Science Disasters Program Response Activities During Hurricanes Harvey, Irma, and Maria in 2017. *Major Weather Events and Impacts of 2017, 98th AMS Annual Meeting*, Austin, TX, 5.4.

Bell, J. R., L. A. Schultz, M. Jones, **A. L. Molthan**, S. A. Arko, K. A. Hogenson, and F. J. Meyer, 2018: Using Optical Remote Sensing and Synthetic Aperture Radar for Near-Real-Time Response to the Central U.S. Flooding in April-May 2017. *32nd Conference on Hydrology, 98th AMS Annual Meeting*, Austin, TX, 5.2.

Berndt, E. B., S. S. Harkema and M. J. Folmer, 2018: Anticipating Winter Weather with Next-Generation Satellite Sensors. *14th Annual Symposium on New Generation Operational Environmental Satellite Systems, 98th AMS Annual Meeting*, Austin, TX, 227.

Blankenship, C. B., J. L. Case, W. L. Crosson, **C. R. Hain**, and **B. T. Zavodsky**, 2018: Impacts of Assimilating SMAP Soil Moisture Retrievals in the SPoRT Land Information System, *22nd Conference on Integrated Observing and Assimilation Systems for the Atmosphere, Oceans, and Land Surface*, Austin, TX, 13.4

Cady, T., **A. Naeger, and A. L. Molthan**, 2018: Analysis of Orographically Enhanced Precipitation During an Atmospheric River Event for the OLYMPEX Field Campaign. *19th Symposium on Meteorological Observation and Instrumentation, 98th AMS Annual Meeting*, Austin, TX, 685.

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McGrath, K. M., E. Berndt, C. M. Gravelle, L. A. Byerle, **A. L. Molthan**, and **M. R. Smith**, 2018: AWIPS II Client-Side RGB Product Generation in the GOES-R Era. *34th Conference on Environmental Information Processing Systems, 98th AMS Annual Meeting*, Austin, TX, 8.3.

McGrath, K.M., P. J. Meyer, G.J. Jedlovec, and **E. B. Berndt**, 2018: NASA MSFC GOES-16 Receiving Station and Data Visualization. *34th Conference on Environmental Information Processing Technologies, 98th AMS Annual Meeting*, Austin, TX, TJ9.1.

McRoberts, D.B., S. M. Quiring, **B. T. Zavodsky**, C. D. Peters-Lidard, J. W. Nielsen-Gammon, **J. L. Case**, and D. M. Mocko, 2018: Improving the Drought Monitoring Capabilities of Land Surface Models by Integrating Bias-Corrected, Gridded Precipitation Estimates *32nd Conference on Hydrology, 98th AMS Annual Meeting*, Austin, TX, 66.

Molthan, A. L., D. Loftis, **J. R. Bell, J. Srikishen**, D. Sun, D. Bekaert, S. Cohen, J. J. Murray, and D. S. Green, 2018: Exploring Coastal Hazards in Virginia and North Carolina via Reanalysis of 2011 Hurricane Irene with Future Sea Level Rise. *16th Symposium on Coastal Environment, 98th AMS Annual Meeting*, Austin, TX, 3.4.

Molthan, A. L., M. Maskey, **C. Hain, P. Meyer**, U. Nair, C. Handyside, **K. D. White**, and M. Amin, 2018: Drought Information Supported by Citizen Scientists (DISCS), *34th Conference on Environmental Information Processing Technologies, 98th AMS Annual Meeting*, Austin, TX, 4A.1.

U. Nair, E. Rappin, E. Foshee, W. Smith, R. A. Pielke Sr., R. Mahmood, **J. L. Case, C. B. Blankenship**, J. M. Shepherd, J. A. Santanello, and D. Niyogi, 2018: Brown Ocean Effect on the Louisiana August 2016 Extreme Flooding Event, *32nd Conference on Hydrology, 98th AMS Annual Meeting*, Austin, TX, J30.4.

Schultz, L. A., J. R. Bell, J. B. Nicoll, R. Gens, **A. L. Molthan**, and F. J. Meyer, 2018: Investigating the Use and Integration of Synthetic Aperture Radar (SAR) Imagery in the Damage Survey Process within the NOAA/NWS Damage Assessment Toolkit (DAT). *34th Conference on Environmental Information Processing Technologies, 98th AMS Annual Meeting*, Austin, TX, 2A.2.

Schultz, C. J., C. Hain, J. Case, and **K. White**, 2018: Understanding Changes in Modeled Land Surface Characteristics Prior to Lightning-Initiated Holdover Fire Breakout, *22nd Conference on Integrated Observing and Assimilation Systems for the Atmosphere, Oceans, and Land Surface, 98th AMS Annual Meeting*, Austin, TX, 1057.

Schultz, C. J., N. Curtis, L. Carey, P. Bitzer, and **A. LeRoy**, 2018: Understanding the Implications of Merging Existing Lightning Datasets with GLM for Severe Thunderstorm Monitoring, *14th Annual Symposium on New Generation Operational Environmental Satellite Systems, 98th AMS Annual Meeting*, Austin, TX, 704.

Smith, N., **K. D. White, E. Berndt, B. T. Zavodsky**, A. Wheeler, M. A. Bowlan, and C. D. Barnet, 2018: Nucaps in AWIPS: Rethinking Information Compression and Distribution for Fast Decision Making. *22nd Conference on Satellite Meteorology and Oceanography, 98th AMS Annual Meeting*, Austin, TX, 6A.6.

Stano, G. T., P. Meyer, K. M. McGrath, and **C. J. Schultz**, 2018: Early Assessment of Geostationary Lightning Mapper Observations. *14th Annual Symposium on New Generation Operational Environmental Satellite Systems, 98th AMS Annual Meeting*, Austin, TX, 12B.1.

Weaver, G. M., **B. T. Zavodsky**, N. Smith, J. F. Dostalek, **K. D. White, E. B. Berndt**, E. Stevens, D. Hoese, **L. A. Schultz**, C. M. Waterhouse, and C. M. Haisley, 2018: Results from an Operational Demonstration of a Gridded CrIS/ATMS Product for Cold Air Aloft. 22nd Conference on *Satellite Meteorology and Oceanography, 98th AMS Annual Meeting*, Austin, TX, 6A.4.

Weigel, A., R. Griffin, K. Knupp, T. Coleman, and **A. Molthan**, 2018: Using GIS to Investigate Land-Atmosphere Interactions Involved in Tornadogenesis, *34th Conference on Environmental Information Processing Technologies, 98th AMS Annual Meeting*, Austin, TX, 9.2.

White, K. D. and **E. Berndt**, 2018: From Polar Orbiters to GOES-16: The Evolution of Satellite Multispectral Composite Imagery and Applications at National Weather Service Forecast Offices. *14th Annual Symposium on New Generation Operational Environmental Satellite Systems, 98th AMS Annual Meeting*, Austin, TX, 231.

Zavodsky, B. T., and **A. L. Molthan**, 2018: NASA's Short-term Prediction Research and Transition (SPoRT) Center: A Paradigm for Transitioning Research to Operations, 8th *Conference on Transition of Research to Operations, 98th AMS Annual Meeting*, Austin, TX, 9.3.

Visits and Visitors

January 16: SPoRT team members met with **Bill Cooke** and **Danielle Moser** of MSFC Natural Environments Branch to discuss potential applications of the GOES-R Geostationary Lightning Mapper to the identification of meteoroid impacts in the Earth's atmosphere, which may be detectable using GLM information

January 24: **Dr. Wei-Kuo Tao** and **Dr. Toshi Matsui**, NASA Goddard Space Flight Center, visited to present work on modeling of mesoscale convective systems, and to discuss ongoing work on a NASA ROSES: Modeling, Analysis, and Prediction proposal examining simulation of lightning physics within the NASA-Unified WRF Model

January 31: **Dr. Elizabeth Page**, Director of COMET, visited SPoRT to discuss collaboration opportunities in the areas of training for satellite data applications in weather analysis and forecasting and disaster response areas of interest

March 28–29: Team members **Bruce Jakosky, Chris Pankratz, Thomas Sparn**, and **Edgar Johansson** from the Laboratory for Atmosphere and Space Physics at the University of Colorado visited to discuss potential collaborations in research to operations for space weather applications.

Community Participation

March 20–22: SPoRT team members participated in the **2018 Federal Esri GIS Conference** in Washington, D.C.,

Upcoming Calendar of Events

30 April to 25 May	Hazardous Weather Testbed, Norman, OK
1 May to 8 May	JPSS Summit, Alaska (virtual participation)
14 May to 18 May	Alaska Satellite Facility Users Working Group, Fairbanks, AK
	AMS Forest Weather/Agricultural Weather Biogeosciences, Boise, ID
21 May to 25 May	McIDAS Working Group, Madison, WI
	Fire Continuum Conference, Missoula, MT
28 May to 1 June	16th JCSDA Technical Review & Science Workshop, Boulder, CO
4 June to 8 June	MOISST Workshop, Lincoln, NE
	AMS WAF/NWP Conference, Denver, CO
	TEMPO Science Team Meeting, Boulder, CO
	15th Annual Meeting Asia Oceania Geosciences Society, Honolulu, HI
11 June to 15 June	Canadian Meteorological and Oceanographic Society 52nd Congress and Annual Meeting, Halifax, Nova Scotia, Canada

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