National Aeronautics and Space Administration

The SPoRT REPORT

SPoRT Quarterly
January – March 2009

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The Wide World of SPoRT here:
http://www.nsstc.uah.edu/sportblog

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-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 Weather Forecast Offices (WFOs) in the Southern Region, the research leading to the transitional activities benefits the broader scientific community.

Quarterly Highlights

MODIS SSTs Transitioned Into Version 3 of the WRF Environmental Modeling System

SPoRT has developed a version of the Moderate Resolution Imaging Spectroradiometer (MODIS) sea surface temperature (SST) composite that has been implemented in the most recent version of the National Weather Service (NWS) Weather Research and Forecasting (WRF) Environmental Modeling System (EMS). The WRF EMS is a complete, full-physics numerical weather prediction package that incorporates dynamical cores from both the National Center for Atmospheric Research Advanced Research WRF (ARW) and the National Center for Environmental Prediction (NCEP) Non-hydrostatic Mesoscale Model (NMM). The installation, configuration, and execution of either the ARW model or NMM is greatly simplified by the WRF EMS to encourage its use by the NWS WFOs and the university community. The WRF EMS is easy to run on most Linux workstations and clusters without the need for compilers. Version 3 of the WRF EMS (currently a beta version) contains the most recent public release of the WRF NMM and ARW modeling system (the WRF Pre-processing System (WPS) utilities, and the WRF Post-Processing (WPP) program. The system is developed and maintained by the NWS National Science Operations Officer (SOO) Science and Training Resource Coordinator, Dr. Robert Rozumalski.

In order to initialize the WRF EMS with high-resolution MODIS SSTs, SPoRT developed a version of the composite product consisting of MODIS SSTs over oceans and large lakes with the NCEP Real-Time Global (RTG) product filling data over land points. Filling the land points is required due to minor inconsistencies between the WRF land-sea mask and that used to generate the MODIS SST composites. This methodology ensures a continuous field that adequately initializes all appropriate arrays in WRF. Composites covering the Gulf of Mexico, western Atlantic Ocean, and northern portions of the Caribbean are generated daily at 0400, 0700, 1600, and 1900 UTC (geographical coverage shown in Fig. 1). The MODIS SST product is output in gridded binary-1 (GRIB-1) data format for a seamless incorporation into WRF via the WPS utilities. The full-resolution, 1-km MODIS product is subsampled to 2-km grid spacing due to limitations in handling very large dimensions in the GRIB-1 data format. The GRIB-1 files are posted online at <ftp://ftp.nsstc.org/sstcomp/WRF/>, which can be directly accessed by the

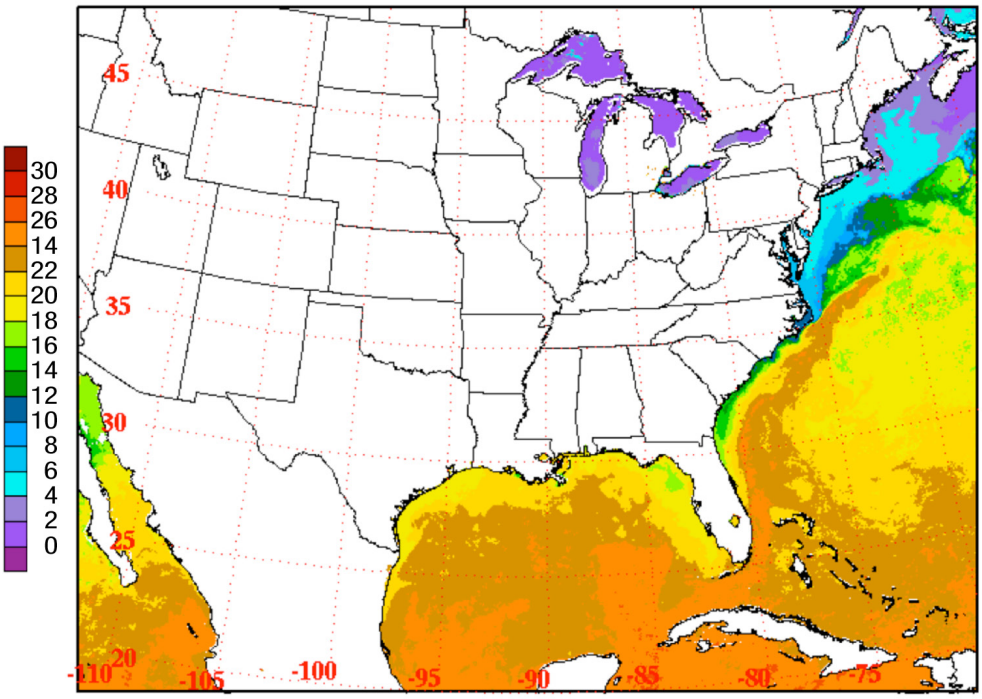

Figure 1. Depiction of the geographical extent of the real-time SPoRT MODIS SST composites for use in numerical modeling applications.

WRF EMS. The MODIS SST composites are also downloaded to the SOO/Science and Training Resource Center (STRC) data server, which is directly accessible by the WRF EMS and NWS WFOs.

A sample comparison between the MODIS SST and the RTG SST over southern Florida in a WRF EMS model initialization is shown in Figure 2. The SPoRT MODIS SST composite provides the model with superior detail of the ocean gradients around Florida and surrounding waters. The operational RTG SST from March 1, 2007, (Fig. 2(a)) depicts a relatively smooth field while the SPoRT MODIS product (Fig. 2(b)) shows exquisite details of the warm Gulf Stream, and cooler shelf waters near the Bahamas and the west coast of Florida. Differences of 2–3 °C are common, leading to enhanced SST gradients on either side of the Gulf Stream and along the edges of the cooler shelf waters (Fig. 2(c)).

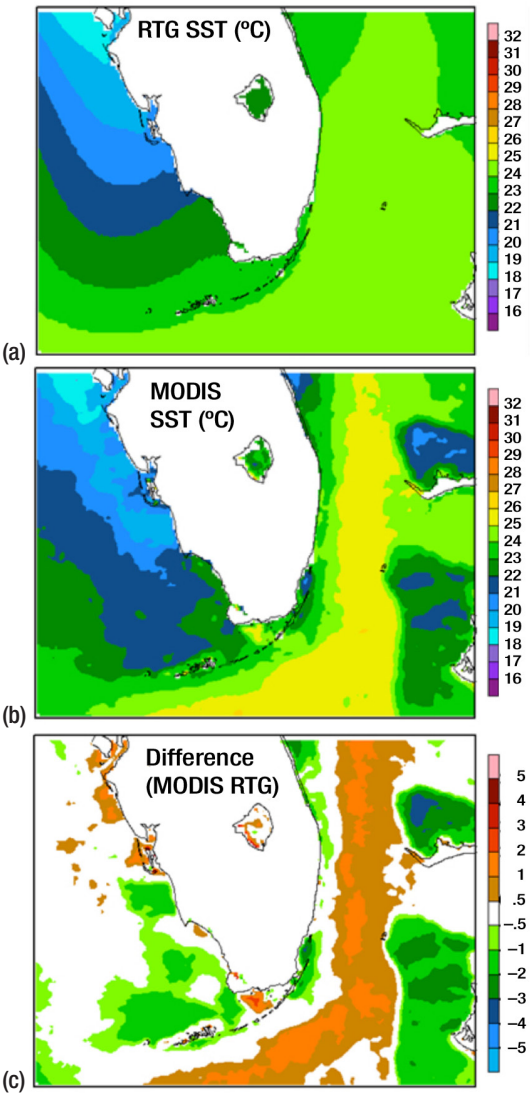

Figure 2. A sample comparison of WRF model initialized SSTs (°C) over southern Florida using the NCEP RTG SST (panel (a)) and SPoRT MODIS SSTs (panel (b)) from March 1, 2007. The differences field (MODIS RTG) is given in panel (c).

Project Updates

AIRS Profile Assimilation

A month-long series of 48-hr forecasts using updated background error and boundary conditions has been completed. The impact of the Atmospheric Infrared Sounder (AIRS) profiles on WRF forecasts is conducted by comparing parallel runs of WRF: one with AIRS and a control run without AIRS. Results indicate that AIRS profiles produce an analysis closer to in situ observations than the background field, which should lead to improved initial conditions and better forecasts when used to initialize a model forecast. For forecast impact, WRF forecasts were verified against North American Mesoscale Model Forecast Meteograms analyses, and statistics were compiled every 6 hr for the daily 48-hr forecasts from January 17–February 22, 2007. Results show that by including AIRS thermodynamic profiles, temperature bias improved at all pressure levels. AIRS profiles also improved geopotential height bias except in the boundary layer. For precipitation, verification is done by comparing the model outputs to the 4-km NCEP Stage IV precipitation data. The 6-hr cumulative precipitation data are mapped to the WRF model domain for direct grid comparison. Results showed overall improvements in bias score and equitable threat score at all precipitation thresholds.

Microphysical Adjustments to WRF Forecasts

Progress continues in the realm of single-moment microphysics as applied to cold season snowfall events, with adjustments currently guided by aircraft observations obtained during the Canadian CloudSat/CALIPSO (Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation) Verification Project in 2007. Current work focuses on incorporating a parameterization of the distribution slope parameter as a function of column integrated, excess vapor path with respect to ice. Saturation with respect to ice is relevant to the development of particular crystal habits,

especially dendrites, which are likely to be large in diameter and aggregate near cloud base to even larger crystal sizes. Profiles of radar reflectivity, from both the ground-based King City precipitation radar and the orbiting NASA CloudSat radars are being compared to radar reflectivity simulated by hydrometeor profiles within WRF model forecasts. In addition to parameterization of the slope parameter, the bulk density of snow is also allowed to change as a function of slope parameter, so that the properties of precipitating ice transition smoothly from a high-density, small crystal at cloud top to a lower density, dendrite or aggregate-like crystal at cloud base. Forecast simulations are being completed on the National Severe Storms Laboratory (NSSL) experimental, 4-km resolution domain and configuration, as well as nested simulations at 9, 3, and 1 km to coincide with earlier simulations performed by NASA Goddard Space Flight Center (GSFC) to support scientists and forecasters during the Canadian CloudSat/CALIPSO Validation Project (C3VP) campaign.

WRF Lightning Forecasts

Work has also begun on a project to apply the WRF lightning threat algorithm to an ensemble of Center for Analysis and Prediction of Storms (CAPS) WRF simulations for a prototype day from the spring 2008 storm season. Software has been built and tested, and appears to be ready for "production runs" on all the ensemble members. Because the CAPS WRF runs were typically done using a 4-km mesh, as opposed to the 2-km mesh for which the McCaul et al. lightning algorithm was developed, caution will be necessary in applying the nominal calibration constants to the ensembles, and recalibration against lightning mapping array (LMA) data for the prototype CAPS case may be necessary. However, preliminary evidence suggests that only the graupel flux threat component is very sensitive to grid mesh spacing, with the vertically integrated ice component being relatively insensitive.

WRF Studies With the Land Information System

Mr. Case developed a script to run Land Information System (LIS) in real time on the SPoRT Linux cluster using atmospheric forcing from Global Data Assimilation System and Stage IV precipitation analyses. The script was designed to perform daily history restarts

New Collaborative Blog Unveiled: *The Wide World of SPoRT*

SPoRT has developed and recently unveiled a new, public weblog (or "blog") in order to improve the visibility of SPoRT projects relevant to operational forecasters, and to encourage discussion among WFOs within the Southern Region. Titled "The Wide World of SPoRT," the goal of the blog is to "foster interaction between product developers and end users," and was designed by Web design team member Erik Reimers. Administrative duties for the site are being handled by Andrew Molthan, a UAH (The University of Alabama in Huntsville) graduate student working with SPoRT through the NASA MSFC Cooperative Education Program. The blog provides SPoRT team members the ability to write short articles highlighting the utility of products developed within their focus areas, often related to ongoing weather events. This allows operational meteorologists to be aware of the value of unique NASA data sets to forecast problems on a casual level that invites feedback and discussion through the ability to post and respond to comments. Currently, access is available to SPoRT WFO partners within the Southern Region of the NWS. Recent articles have discussed the utility of MODIS false color products in the discrimination of snow and cloud cover following recent blizzards in the Midwest, the release of new training products related to the North Alabama LMA, and the success of experimental high-resolution WRF model forecasts in the prediction of two severe weather outbreaks across the southeastern United States. SPoRT invites you to regularly view "The Wide World of SPoRT" by visiting the link on the title page of this SPoRT Quarterly Report, or by linking through the main SPoRT Web page.

of an LIS run that already underwent a long, multiyear spinup to obtain a soil equilibrium state. A goal of running LIS in real time is to provide land surface initialization data to the CAPS for inclusion into a subset of their WRF ensemble runs that will be generated during the upcoming 2009 NSSL/SPC (Storm Prediction Center) Spring Experiment. Also, high-resolution, daily LIS output could be used in future diagnostic type of experiments in assessing gradients in soil moisture that may impact differential heating and ultimately convective initiation during the summer months.

Collaboration With NSSL on WRF Forecasts

SPoRT collaborated with NSSL and the Air Force Weather Agency (AFWA) on possible modeling efforts during the 2009 Spring Experiment, to be held from May 1 to June 5. Based on conversations this past quarter, it appears that the best possible scenario is to have AFWA generate daily LIS/WRF-coupled forecasts on NSSL's Continental U.S. (CONUS) WRF domain during the Spring Experiment to serve as a separate deterministic model for forecasters to examine. Mr. Dembek of SPoRT could provide AFWA with the source code to produce the unique postprocessed output products that are currently available in the operational NSSL WRF. In addition, there may be an opportunity for NSSL to run a second CONUS WRF run using the SPoRT MODIS SSTs during the Spring Experiment, in order to determine the robustness and reliability of their WRF runs incorporating MODIS SSTs in real time. A favorable reliability during the Spring Experiment test period would result in the transition of the MODIS SST composites into daily operations of the WRF model runs at NSSL.

WRF Sea Surface Temperature Forecast Impacts

Based on analysis of the MODIS composites during the 2007 Miami, FL, modeling studies, results indicated that large diurnal variations in surface water temperature can occur over Lake Okeechobee, up to 8 °C in magnitude. Therefore, our collaborators at Florida Institute of Technology (FIT) continued efforts to test an "anchor and drift" approach for creating hourly surface temperatures over Lake Okeechobee, FL, using a combination of MODIS and in situ data sets. These high time-resolution, MODIS SST composites were designed for incorporation into short-term WRF model runs using time-varying SSTs over Lake Okeechobee in order to capture the evolution of SSTs in the model's lower boundary condition and measure the impact on short-term numerical forecasts. FIT scientists evaluated nonuniform changes in MODIS-derived lake surface temperatures as a check on the "anchor and drift" approach to develop hourly lake SSTs.

SPoRT Evaluation of Fog Products

A second intensive study period was conducted from January 5–25, 2009, regarding the operational use of MODIS and Geostationary Operational Environmental Satellite (GOES) fog and low cloud products. The first period was held in the fall of 2008 with SPoRT's NWS partners at inland offices located in the Tennessee Valley region. This second period focused mostly on coastal locations in the southern United States. User participation was especially high from the forecast offices in Corpus Christi, Houston/Galveston, and Albuquerque.

The SOOs from these offices (Alex Tardy, Lance Wood, and Deirdre Kann, respectively) and their staffs made extra efforts to collaborate with SPoRT in the evaluation of these products, making the study period a success. Several examples were captured describing the use of the products to aid decisions related to aviation forecasts, resulting in advanced warning to NWS customers. While the GOES fog depth and low cloud base products were useful at times, limitations were realized regarding the difficulty in detecting shallow or sparse, subgrid scale fog. The MODIS fog product was seen as superior to GOES and had success with showing fog at 1-km resolution, but the temporal resolution was a limitation as noted by forecasters. However, the Albuquerque forecast office collaborated with SPoRT on a case that showed the value of MODIS 1-km data. The MODIS image (Fig. 3(a)) showed an area of fog west of Albuquerque, NM, (lower left on image) that would later impact a nearby airport in Gallup, NM. Meanwhile, this same area was very difficult to discern in the GOES imagery (Fig. 3(b)).

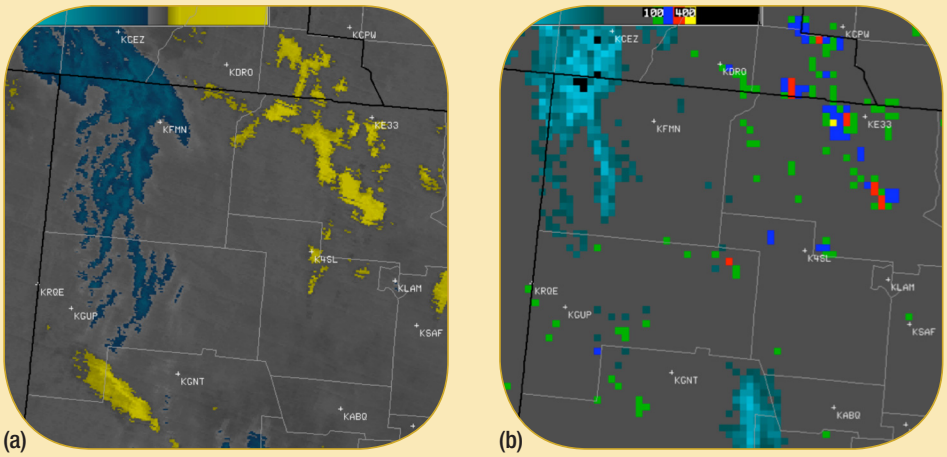

Figure 3. Depiction of the MODIS fog product (11–3.9 µm, panel (a) over northwest New Mexico. Note the area of MODIS fog (yellow in panel (a)) west of Albuquerque and southeast of Gallup is difficult to discern in the GOES image (panel (b)).

Related Activities

Dr. Will McCarty Leaves the SPoRT Team

Will McCarty, a graduate student working with SPoRT, received his Ph.D. from UAH on December 12, 2008. SPoRT supported Dr. McCarty when he began his graduate work 5 years ago and was also funded for several years by the NASA Earth and Space Science Fellowship (NESSF) program through the peer review selection process. Dr. McCarty's dissertation on "Assimilation of AIRS Cloud-free Radiances for Improved Short-term Weather Forecasts" helped SPoRT demonstrate the utility of AIRS data to improve short-term weather forecasts on a regional scale. Dr. McCarty's research and academic advisor was SPoRT's Principal Investigator and Adjunct Professor, Dr. Gary Jedlovec. Dr. McCarty now works as a research scientist at the Global Modeling and Assimilation Office at GSFC.

Jackie Shafer Joins the SPoRT Team

SPoRT welcomes Ms. Jackie Shafer to the team. Jackie received her M.S. degree in meteorology from FIT in August 2008 and joined SPoRT in December. While at FIT, Jackie focused on the analysis of tropical weather systems. At SPoRT, Jackie will be assisting with the production of satellite products from MODIS and Advanced Microwave Scanning Radiometer-Earth Observing System (AMSR-E) and in demonstrating the use of those products in the tropical environment.

GOES-R Proving Ground Proposal Accepted

A proposal submitted by SPoRT entitled "GOES-R Proving Ground Activities" has been accepted for funding by the NOAA GOES-R Program Office. The 3-year activity will extend the SPoRT transition to operations paradigm to GOES-R Advanced Baseline Imager (ABI) proxy data sets provided by the specific Algorithm Working Groups (AWGs) and the GOES-R Proving Ground team with emphasis on forecast problems of the Southern Region WFOs. One of the more significant outcomes of this work will be the transition into operations of total lightning data from additional ground-based networks as a proxy for GOES-R Geostationary Lightning Mapper (GLM) data. NASA SPoRT in collaboration with the GOES-R GLM AWG and other local lightning experts are looking to improve the use of total lightning data in the next generation of Advanced Weather Interactive Processing System (AWIPS) software (AWIPS II) and to assist in risk reduction efforts by transitioning and evaluating the use of GLM proxy data sets in the operational weather environment.

Dr. Gary Jedlovec (left) congratulates Dr. Will McCarty (right) on being awarded the Doctor of Philosophy degree in Atmospheric Science from UAH.

Recent Publications

Accepted for Publication

McCaul, E.W., Jr. , S.J. Goodman, K.M. LaCasse, and D.J. Cecil, 2008: Forecasting lightning threat using cloud-resolving model simulations. Accepted for publication in *Weather and Forecasting*.

Submitted for Review

McCarty, W.R., G.J. Jedlovec, and T.L. Miller, 2009: The Impact of the Assimilation of AIRS Radiance Measurements on Short-term Weather Forecasts. Under review by *J. Geophys. Res.*

Darden, C., D. Nadler, B. Carcione, D. Buechler, and G. Stano, 2009: Utilizing Total Lightning to Diagnose Convective Trends. Under review by the *Bulletin of the American Meteorological Society* (Map Room).

Conference Presentations

16th Conference on Satellite Meteorology and Oceanography

An Operational Assessment of the MODIS False Color Composite with the Great Falls, Montana, National Weather Service. Gina Loss, David Bernhardt, Kevin K. Fuell, and Geoffrey T. Stano

Combined MODIS and AMSR-E Composite SST Data for Regional Weather Applications. Gary Jedlovec, Jorge Vazquez, Edward Armstrong, and Stephanie Haines

Winter QPF Sensitivities to Snow Parameterizations and Comparisons to NASA CloudSat Observations. Andrew Molthan, John Haynes, Gary Jedlovec, and William Lapenta

Data Assimilation and Regional Weather Forecast Using Atmospheric InfraRed Sounder (AIRS) profiles. Shih-Hung Chou, Brad Zavodsky, Gary J. Jedlovec, and William Lapenta

13th Conference on Integrated Observing and Assimilation Systems for Atmosphere, Oceans, and Land Surface (IOAS-AOLS)

Impact of Lake Okeechobee Sea Surface Temperatures on Numerical Predictions of Summertime Convective Systems over South Florida. Jonathan L. Case, Michael E. Splitt, Kevin K. Fuell, Pablo Santos, Steven M. Lazarus, and Gary J. Jedlovec

Examining the Impacts of High-Resolution Land Surface Initialization on Local Model Predictions in the Southeastern U.S. Jonathan L. Case, Sujay V. Kumar, Pablo Santos, Jeffrey M. Medlin, and Gary J. Jedlovec

Fifth Annual Symposium on Future National Operational Environmental Satellite Systems-NPOESS and GOES-R

Sensitivity of short-term weather forecasts to assimilated AIRS data — Implications for NPOESS applications. Will McCarty, Brad Zavodsky, Shih-Hung Chou, and Gary Jedlovec

Transitioning NPOESS Data to Weather Offices: The SPoRT Paradigm with EOS Data. Gary Jedlovec

Fourth Conference on the Meteorological Applications of Lightning Data

An Operational Perspective of Total Lightning Information. David J. Nadler, NOAA/NWS, Huntsville, AL; Christopher B. Darden, Geoffrey Stano, and Dennis E. Buechler

Aviation, Range and Aerospace Meteorology Special Symposium on Weather-Air Traffic Management Integration

An enhanced convective forecast (ECF) for the New York TRACON. Jim Stobie, Mark Wheeler, Robert Gillen, Gary Jedlovec, and Danny Sims

Visitors

- January 28: Bill Bierbower, MSFC Chief Counsel, to learn about SPoRT
- March 11: Tom Auligne, NCAR, explore WRF data assimilation collaborations
- March 25: Bryan Baum, University of Wisconsin Cooperative Institute for Mesoscale Satellite Studies (CIMSS), to present a UAH seminar and learn about SPoRT

External Workshops and Meetings Attended

- 89th AMS Annual Meeting: Phoenix, AZ, January 11–15, 2009
- NCEP for AWIPS II collaboration discussions, Camp Springs, MD, February 19, 2009

Upcoming Events

- April 28–29: USWRP Testbed Workshop, Boulder, CO
- May–June: Hazardous Weather Testbed Spring Program, Norman, OK
  - Experimental Forecast Program: May 4–June 5
  - Experimental Warning Program (GOES-R Proving Ground): April 27–June 12
  - VORTEX-2: May 10–June 1
- May 12–13: JCSDA Science Workshop, UMBC
- May 12–14: NPOESS Training Development Workshop, Boulder, CO
- May 15: GOES-R Proving Ground Meeting, Boulder, CO
- May 20: JCSDA Presentation on Coupled WRF/LIS Case), Camp Springs, MD
- May 28–29: GHRSST Symposium, Santa Rosa, CA
- June–July: SPoRT Science Advisory Committee Meeting, Huntsville, AL
- June 17: JCSDA Presentation on MODIS/AMSR-E SST Composites (Jedlovec), Camp Springs, MD
- July 7–17: JCSDA Data Assimilation Workshop, Stevenson, WA

SPoRT Points of Contact

Principal Investigator: Gary Jedlovec: gary.jedlovec@nasa.gov
NASA Headquarters: Tsengdar Lee: tsengdar.lee@nasa.gov

National Aeronautics and Space Administration

George C. Marshall Space Flight Center
Huntsville, AL 35812
www.nasa.gov/marshall

www.nasa.gov

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