NOAA / NESDIS / STAR

SATELLITE METEOROLGY AND CLIMATOLOGY DIVISION

2016 ANNUAL REPORT

Photo Credit: Geostationary Operational Environmental Satellite R-Series (GOES-R) Art (Lockheed Martin)

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1. MESSAGE FROM THE DIVISION CHIEF

In 2016, the Center for Satellite Applications and Research (STAR) Satellite Meteorology and Climatology Division (SMCD) supported Joint Polar Satellite System (JPSS) and Geostationary Operational Environmental Satellite R-Series (GOES-R) programs for mission-critical operations and scientific research. The division completed 14 major projects as part of the STAR Annual Operating Plan (AOP). The results from some of these projects are innovative and will have profound influences on satellite communities. Specifically, we:

Dr. Fuzhong Weng, Chief of STAR's Satellite Meteorology and Climatology Division

1) Completed and delivered a report of assessments of benefits and readiness to utilize a commercial small-sat constellation of microwave sounding mission.
2) Delivered the GOES EvapoTranspiration and Drought product system (GET-D) to NCEP for pre-operational assessment in land surface modeling and drought monitoring operations
3) Completed reprocessing of GOES-13 Atmospheric Motion Vectors (AMVs) using the GOES-16 winds algorithm over the lifetimes of seven historical hurricanes for use in NCEP GSI / HWRF assimilation experiments
4) Delivered the calibration coefficients for AMSU-A for MetOp-C launch readiness

The achievements made by the division federal employees and contractors were highly appreciated and recognized by NOAA, NESDIS, and STAR senior managements. Ken Pryor received the Department of Commerce Gold Medal Award for significant scientific advances made to the microburst windspeed potential product that enable more accurate and higher confidence levels in severe thunderstorm downburst predictions. His work to employ a comprehensive validation process involving a multi-sensor direct comparison approach resulted in the implementation of coefficients that improve the microburst windspeed potential algorithm, which will help save lives and property. He also ensured our stakeholders will access the new resulting data by his training and outreach efforts, and by developing a new phone application. Drs. Shobha Kondragunta and Istvan Lazslo received NOAA Bronze Medal for enhancing the accuracy of Suomi National Polar-Orbiting Partnership Visible Infrared Imaging Radiometer Suite aerosol products and ensuring that products reach the operational user community with reduced latency.

In FY16, SMCD published a total of 59 papers in American and international journals (e.g AMS, AGU, IEEE). These articles are peer-reviewed and cited extensively by the community.

For FY17, SMCD will continue to provide mission critical support in JPSS/GOES-R programs. The Division submitted 17 milestones in satellite algorithm developments and product generation as part of the STAR FY17 annual operating plan, listed below:

1) Resolve the VIIRS SDR anomaly and SST bias during blackbody temperature changes by developing and implementing an improved calibration algorithm
2) Validate OMPS Limb EDR products as created from NDE operational processing
3) Complete test the impact of reprocessed VIIRS SDRs on aerosol detection products
4) Reduce CrIS radiance spectrum ringing artifact with extended interferogram data points.
5) Complete GOES-16 ABI post-launch calibration for level 1b radiance provisional maturity review
6) Complete reprocessing OMPS-NP and OMPS-TC EDR products from Suomi NPP mission
7) Deliver improved VIIRS active fire algorithms for integration into NDE and CSPP
8) Provide an initial assessment of inter-satellite biases and their stability between ATMS and AMSU-A data
9) Implement Global Precipitation Measurement (GPM) Microwave Imager (GMI) rainfall rates to the operational Ensemble Tropical Rainfall Potential (eTRaP) product
10) Deliver enterprise land surface temperature algorithm package and documents to algorithm integration team for operational tests
11) Complete updates of Suomi NPP global surface type products
12) Complete documentations on GOES-R aerosol particle size parameter algorithm for the GOES-R NOAT products critical design review
13) Complete development and delivery of the SNPP VIIRS Vegetation Products System for NOAA operation
14) Release the NOAA/USGS Land Product Characterization System (LPCS) that includes seamless inventory and ordering of satellite products, including definition of output products, output subsets, and product transformations
15) Complete beta validation maturity reviews for GOES-16 L2 baseline products
16) Expand NPROVS system with advanced moisture radiosondes and better analysis tools
17) Develop a merged convective initiation (CI)–Downburst Potential product via GOES-R3 project and complete evaluation of the product accuracy."

Dr. Fuzhong Weng
Chief, Satellite Meteorology and Climatology Division
NOAA/NESDIS/Center for Satellite Applications and Research

2. WELCOME NEW SMCD STAFF

SMCD would like to warmly welcome the following staff to our team…

Melinda Lovins: Property Specialist (Contractor, IMSG, Inc.)

-Joined SMCD in March 2016

-Primary duties include property accountability and division action items

3. SMCD OVERVIEW

3.1 Satellite Meteorology and Climatology Division Mission Statement

SMCD conducts research and develops new satellite products to improve and expand the use of satellite data for monitoring global meteorological, environmental, and climatological conditions. The Division conducts an end-to-end program ranging from planning new satellite instruments to developing new satellite products and applications and transitioning these developments to operations in NOAA's weather, climate, and environmental monitoring and prediction systems.

SMCD's Science Priorities include the following:

- *Calibrate and intercalibrate all instruments to meet SI traceable standard*
- *Improve and enhance calibration and retrieval algorithms*
- *Develop the suite of products through common algorithms and blended techniques*
- *Strengthen climate studies using satellite instruments and products*
- *Improve uses of satellite data in numerical weather prediction (NWP) models*
- *Promote collaboration with international space agencies*

Satellite sensor data and products developed in SMCD fall in the following discipline areas:

- *Advanced Technology Microwave Sounder (ATMS) sensor data record*
- *Cross-Track Infrared Sounder (CrIS) sensor data record*
- *Visible Infrared Imaging Radiometer Suite (VIIRS) sensor data record*
- *Ozone Mapping and Profiler Suite (OMPS) sensor data record*
- *GOES imager/sounder products*
- *GOES-R Advanced Baseline Imager (ABI) level 1 and 2 products*
- *Advanced Microwave Sounding Unit level 1 and level 2 products*
- *Advanced Very High Resolution Radiometer (AVHRR) level 1 and 2 products*
- *Reference environmental (climate) data records from satellites (e.g., MSU/SSU and SBUV2)*

Satellite environmental data and products developed in SMCD fall in the following discipline areas:

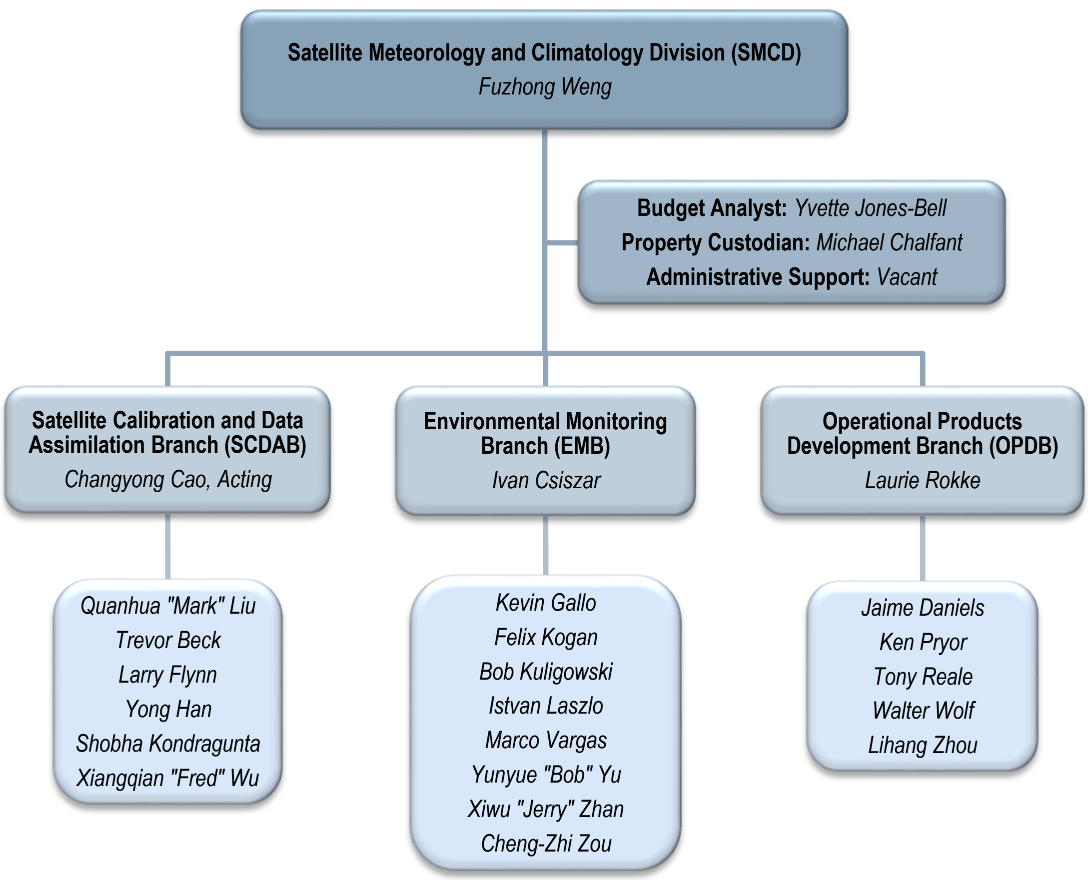
- *Atmospheric variables – temperature, humidity, winds*
- *Land surface variables – soil moisture, vegetation, surface temperature, surface albedo, surface type*

- *Hydrological variables – precipitation, cloud water, rain water, graupel, hail, snow, total water*
- *Environmental hazards – aviation hazards, air quality, fires, flash floods, drought*
- *Climate variables – ozone, Earth radiation budget, aerosols, greenhouse gases*

In addition to developing new and improved sensor and environmental products, SMCD also conducts the following crosscutting activities to support the broad NOAA missions:

- *Community Radiative Transfer Model (CRTM)*
- *Global Space-based Inter-Calibration System (GSICS)*
- *Integrated Calibration and Validation System (ICVS)*
- *Enterprise Algorithm for Satellite Common Ground System*

3.2 SMCD Organization Chart



3.3 SMCD Branches

Satellite Calibration and Data Assimilation Branch (SCDAB)

- SCDAB's mission is to:
    - Provide lifecycle instrument calibration/validation support to NOAA's operational environmental satellites in both polar-orbiting and geostationary orbits by:
        - Providing technical oversight on the development of future satellite instruments; supporting pre-launch testing of instrument performance; investigating instrument performance waivers as well as impacts on users, and developing mitigation strategies;
        - Leading satellite post-launch calibration/validation; maintaining and improving the radiometric and geolocation accuracy of operational satellite radiometer to ensure data quality for all applications;
        - Performing long-term monitoring of instrument performance and participating in anomaly resolution;
        - Supporting recalibration for climate studies.
    - Develop radiative transfer models for satellite data assimilation used in numerical weather predictions.
    - Foster international collaboration for mutual benefits through bilateral and multilateral agreements.

Operational Products Development Branch (OPDB)

- OPDB's mission is to:
    - Develop and transition products into NOAA Operations, with its primary goal to reduce the time to transition products into operations.
    - Conduct applied research on the use of geostationary and polar-orbiting satellite data for the analysis of significant meteorological and surface-based phenomena; work in tandem with NESDIS operations to implement scientific techniques developed within NESDIS and elsewhere to produce quantitative, derived products, such as subjective pattern recognition techniques as well as long-term science maintenance of operational products.
    - Help improve short-range warnings and forecasts in support of NOAA's mission, the highest priority of OPDB's research and development activity. As a result, the principal customer is the National Weather Service. Other important users are the U.S. Department of Defense, the Department of Agriculture, and international agencies such as the World Meteorological Organization and foreign weather services.
    - Provide support in training NWS and Department of Defense (DoD) forecasters through the development of in-residence and distance learning courses at the

Cooperative Program for Meteorological Education and Training (COMET) in Boulder, Colorado.
    - Lead the strategic objective of the STAR enterprise approach to enable cost-effective development of interoperable multi-sensor and multiplatform algorithms, pre- and post-launch instrument calibration and validation, long-term science maintenance, user outreach, and value-added applications.
    - Provide project management for algorithm science and related activities that include support for both the GOES-R and JPSS satellite programs.
    - Through OPDB satellite project managers working across the STAR divisions, organize, lead, and integrate the science teams, resources, and tools to collaborate effectively to provide reliable deliveries and algorithm stewardship in support of NOAA goals. For further information go to www.star.nesdis.noaa.gov/jpss/index.php (JPSS Project) and www.star.nesdis.noaa.gov/goesr/ (GOES-R AWG Project).

Environmental Monitoring Branch (EMB)

- EMB's mission is to:
    - Develop, evaluate, and transition to operation satellite-based products that quantify geophysical environmental variables that characterize the state of the solid surface and the atmosphere of the Earth and its radiant energy budget.
    - Conduct an end-to-end program that includes:
        - Development, enhancement, and maintenance of products from current operational environmental satellite systems;
        - Studies supporting the planning of new satellite instruments for developing new satellite products and applications for current and next generation instruments;
        - Transition of these developments to operations in NOAA's weather, climate, and environmental monitoring and prediction systems.
    - Conduct research and development falling in the following discipline areas:
        - Atmospheric variables – aerosols, deep-layer temperatures, cloud properties;
        - Land surface variables – vegetation, snow, and ice cover;
        - Hydrological and Energy Cycle variables – precipitation, Earth radiation budget;
        - Environmental hazards – fires, heavy rainfall and flash floods, drought.

4. ACCOMPLISHMENT SUMMARIES

4.1 Potential Applications of Small Satellite Microwave Observations for Monitoring and Predicting Global Fast Evolving Weathers

POC: Fuzhong Weng

Remote sensing observations from space-borne microwave instruments on board polar-orbiting operational environmental satellites (POES) have proved to be invaluable to numerical weather prediction (NWP) because of their all-weather sounding capability. However, the temporal resolution of POES microwave sounders from the current operational NOAA and METOP satellites is not high enough to fully capture fast-evolving weather systems. Although geostationary operational environmental satellite (GOES) imagers and sounders offer higher temporal resolutions of visible and infrared observations, but these observations cannot observe the vertical structures within and below storms and clouds except for optically thin cirrus.

A smallsat including spacecraft and payloads weighs less than 500 kg, and requires a short development cycle. A launch failure results in a lower impact than a traditional POES system. A smallsat constellation with each smallsat carrying a microwave sensor onboard can be used to understand, monitor and predict fast-evolving weather systems over the entire globe. Besides payloads and drags, which are common engineering issues for smallsats, proper calibration, quick data processing, and stable data management remain challenging for the development of any microwave small satellite constellation. Since the calibration, antenna and receiver subsystems of small satellite instruments are quite different from the NOAA legacy instruments, applications of small satellite data in weather forecasts require a new forward radiative transfer model, a new bias estimate and cross-calibration among smallsats and effective data thinning with overlapping swaths. This study presents some preliminary results on the orbital simulations of a few smallsat constellations using the Advanced Technology Microwave Sounder (ATMS) scan geometry as a demonstration. A constellation comprising of 14 small satellites with microwave instruments onboard is capable of covering the entire globe at an hourly interval. For a designated microwave small satellite constellation, the brightness temperature distribution in space and time is simulated using the operational forecast fields as inputs to the Community Radiative Transfer Model (CRTM). It is demonstrated that the structural change of fast-evolving weather systems such as a middle latitude cyclone can be well captured from small satellite brightness temperatures (see Figure 1). Small satellite constellation with microwave sounders on board acts equally well as the geostationary microwave sounder but their costs are much lower, compared to geo-mission.

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[1] X. Zou, Z. Qin and Y. Zheng, "Improved tropical storm forecasts with GOES-13/15 imager radiance assimilation and asymmetric vortex initialization in HWRF," in *Mon. Wea. Rev*., vol. 143, pp. 2485-2505, July 2015

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environmental monitoring: The MicroMAS project," in *Geoscience and Remote Sensing Symposium (IGARSS), 2012 IEEE International*, pp.206-209, 22-27 July 2012

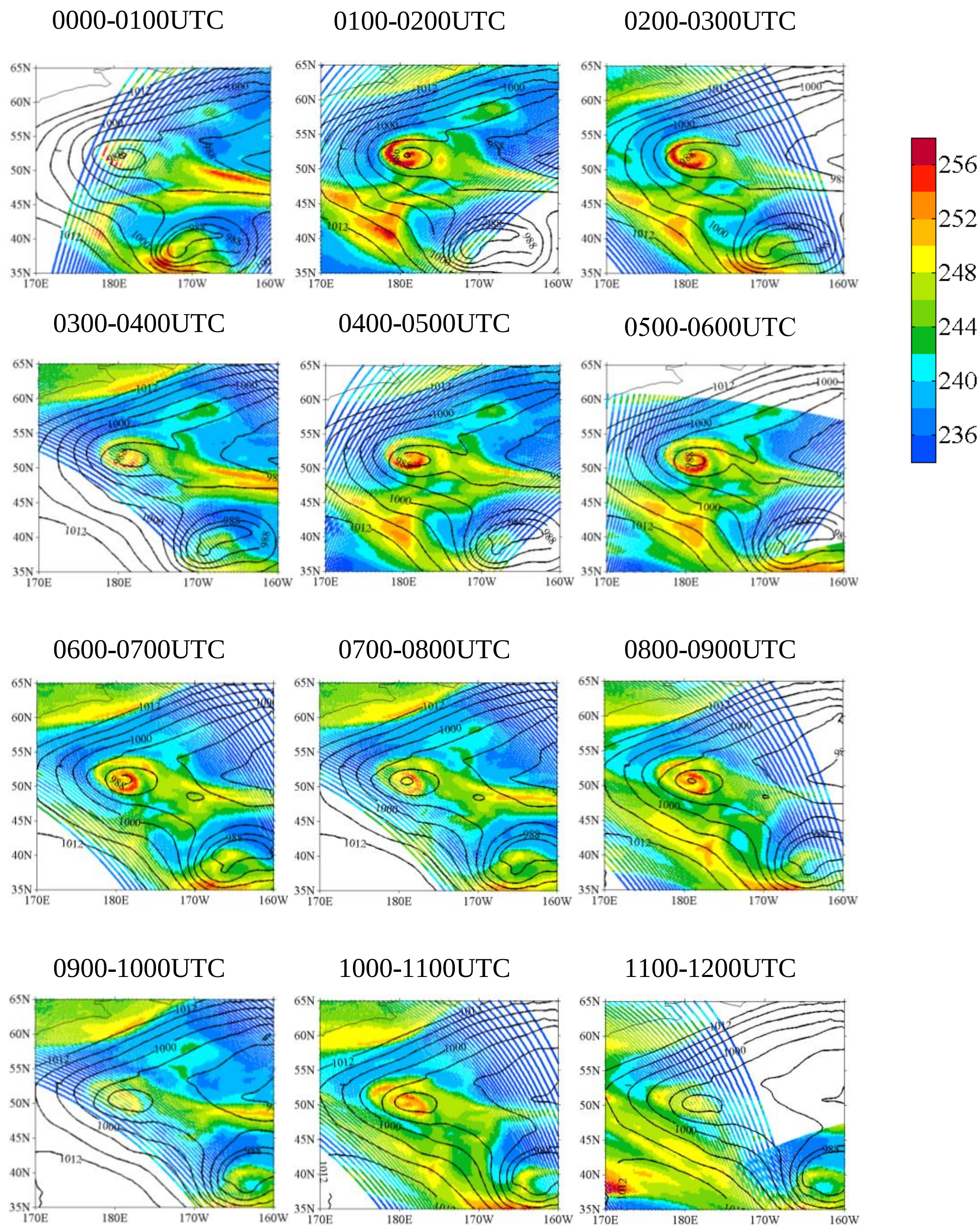


Figure 1. Evolution of a mid-latitude cyclone on January 19, 2016 by the microwave smallsat constellation. Brightness temperatures at ATMS channel 22 (reflecting mid-troposphere water vapor) are shaded and mean sea level pressure are indicated by contours.

4.2 Incorporating Global Change Observation Mission-Water (GCOM-W) Advanced Microwave Scanning Radiometer-2 (AMSR2) Rain Rates into the Operational Ensemble Tropical Rainfall Potential (eTRaP) Product

POC: Bob Kuligowski

Tropical Rainfall Potential (TRaP) is a gridded forecast of rainfall from a tropical cyclone during the next 24 hours; it has been produced operationally at Office of Satellite and Product Operations (OSPO) for every tropical system worldwide for more than a decade. A TRaP is produced by taking a gridded estimate of rainfall from satellite data and moving it along the official predicted storm track (e.g., from the National Hurricane Center) for 24 hours and accumulating the rainfall (assuming the rainfall pattern around the storm does not change with time) to get a predicted total. More recently, an enhancement called Ensemble Tropical Rainfall Potential (eTRaP) was put into operations at OSPO. In the ensemble, all of the TRaPs in 6-hour segments (i.e., lead times of 0-6, 6-12, 12-18, and 18-24 hours) are organized by time period (e.g., all of the TRaP segments covering 12 to 18 UTC on a particular date) and combined into a weighted ensemble. The weights are based on the satellite instrument used to produce the rain rates (since the accuracy varies from one instrument to the next) and on the lead time of the TRaP segment—for instance, a TRaP that represents an 18-24 hour forecast will receive less weight than one that represents a 0-6 hour forecast. The TRaPs from each instrument are also adjusted so that there are no significant differences in bias from one instrument to the next. The weighted ensemble is used to produce total accumulations for 0-24 hours and the four 6-hour segments, plus probabilities that the rainfall accumulation at each pixel will exceed a given amount.

As old satellites are retired, rain rates from new satellites must be brought into the ensemble to replace them; otherwise, there will not be enough TRaPs to form the basis for an ensemble forecast. This became an acute problem in the Atlantic Basin several years ago; at one point eTRaPs were available only 50% of the time because of a lack of TRaPs. To solve this problem, several new rain rate estimates have been added to the ensemble in recent years, most recently the AMSR2 onboard the GCOM-W satellite, using rain rates from the GCOM-W1 AMSR2 Algorithm Software Processor (GAASP). Before a TRaP from a new satellite can be added to the ensemble, its accuracy relative to the other TRaPs needs to be evaluated so that it can be weighted appropriately in the ensemble. This was done by comparing the accuracy of TRaPs from AMSR2 data to TRaPs produced by other satellites. Three tropical systems that made landfall over the CONUS during 2012-2013 were evaluated for 7 different time periods and it was found that the skill of the AMSR2 TRaPS was very similar to that of the TRaPs from other microwave instruments (the Tropical Rainfall Measuring Mission and the Advanced Microwave Sounding Unit/Microwave Humidity Sounder), so the weight of the AMSR2 TRaPs in the ensemble was set at 1; in addition, it was found that no bias adjustment was needed. The resulting AMSR2 TRaPS were then incorporated into eTRaP, and the results showed minimal impact on skill, which was acceptable since the objective was to improve the reliability of the product and not necessarily its accuracy. This new version of eTRaP became operational at NESDIS in early May 2016

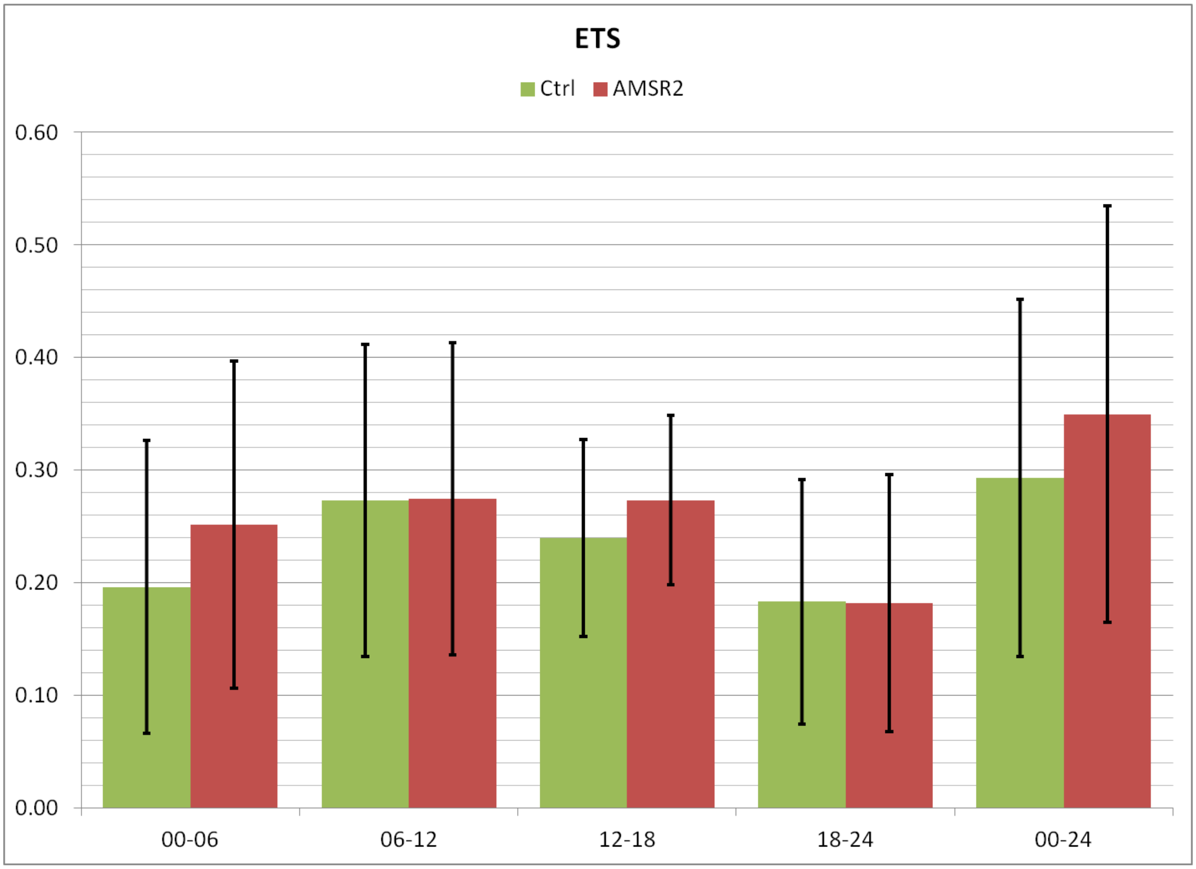


Figure 2. Equitable Threat Score (0=no skill relative to chance, 1=perfect skill) for eTRaP without ("Ctrl") and with ("AMSR2") AMSR2 TRaPs included for 7 different predictions during the 2012-2013 Atlantic hurricane seasons, with forecast lead times indicated by the x-axis. The bars indicate the 95% confidence interval

4.3 Complete Development of Version 1 JPSS Risk Reduction Aerosol Optical Depth (AOD) and Particle Size Parameter Algorithm and Deliver Algorithm Theoretical Basis Document (ATBD) for Operational Readiness Review to NDE

POC: Istvan Laszlo

The concept of an Enterprise Processing System (EPS) requires the development of algorithms that use the same method (science solution and assumptions) for the retrieval problem and its realization (software) regardless of the source of satellite inputs, whether they are from instruments onboard polar or geostationary platforms. To build an efficient EPS algorithm is not a trivial task. For the retrieval of aerosol optical depth (AOD) the challenge is the identification of routines common to algorithms developed for the Advanced Baseline Imager (ABI) onboard the geostationary satellite GOES-R (now GOES-16) and for the Visible Infrared Imaging Radiometer Suite (VIIRS) onboard the Suomi National Polar-orbiting Partnership (Suomi NPP) and the future Joint Polar Satellite System (JPSS) satellites. From the common routines of the ABI and VIIRS AOD algorithms a “core engine” was built, which then became the “backbone” of Version 1 of the JPSS Risk Reduction AOD and Particle Size Parameter Algorithm. This algorithm is an “EPS-class” algorithm; it was delivered together with a significantly updated Algorithm Theoretical Basis Document for the Algorithm Readiness Review in December 2015 and for subsequent Operational Readiness Review and implementation in NDE2.0

In the course of building the EPS AOD algorithm several additional challenges were also addressed. One of these was implementing an approach to improve estimates of high AOD values. This was needed because evaluation of the initial AOD product with ground-based retrievals of aerosol from the Aerosol Robotic Network (AERONET) indicated an underestimation of high AERONET AOD values. The approach implemented to reduce this underestimation uses the near-infrared (2250-nm) band to estimate the blue (488-nm) surface reflectance required to retrieve AOD instead of the red (672-nm) band when the AOD is large. The reasoning behind this approach is the moderate influence of aerosol on the near-infrared band even for high AOD values. This leads to a less uncertain estimate of the surface in the blue band compared to the uncertainty incurred when the blue-band surface reflectance is estimated from the red band that is strongly affected by aerosols. A related challenge was to detect when the near-infrared band should be used instead of the red band. In the current implementation this is done by checking for unphysical surface reflectance obtained from the red band and checking if the difference between the blue surface reflectances estimated from the red and near-infrared bands is larger than a threshold. This is a somewhat ad hoc solution; future work will explore if a more objective method could be applied instead. The EPS AOD algorithm makes retrievals at the nominal 0.75-km horizontal resolution. This poses yet another challenge since the accuracy and precision requirements the product should meet were established for a 6-km resolution. This challenge was addressed by updating quality controls and implementing new internal tests that screen out pixels/conditions that violate the assumptions assumed to be present for a successful AOD retrieval. Finally, version

1 of the EPS algorithm implements a "deep-blue-like" approach to retrieve AOD over bright snow-free land surfaces. (Note: Version 1 of the bright-surface retrieval, which uses global surface reflectances derived for bands below 470 nm, has been replaced in version 2 by another method that uses ratios instead of the absolute values of the "deep-blue" reflectances.)

The work, which was supported by the JPSS Risk Reduction Program, supports the NOAA mission goal "Serve society's needs for weather and water information" by improving accuracy for high AOD events, by extending the AOD range (Figure 1), and by performing retrievals over bright surface that make the product more useful for stakeholders (NWS Weather Forecast Offices, NWS global aerosol prediction system, Naval Research Laboratory (NRL) - aerosol assimilation, operational air quality forecasters) and to downstream products. Timely delivery of the EPS AOD algorithm and ATBD helps meet the planned operational date of EPS.

a) IDPS

b) EPS

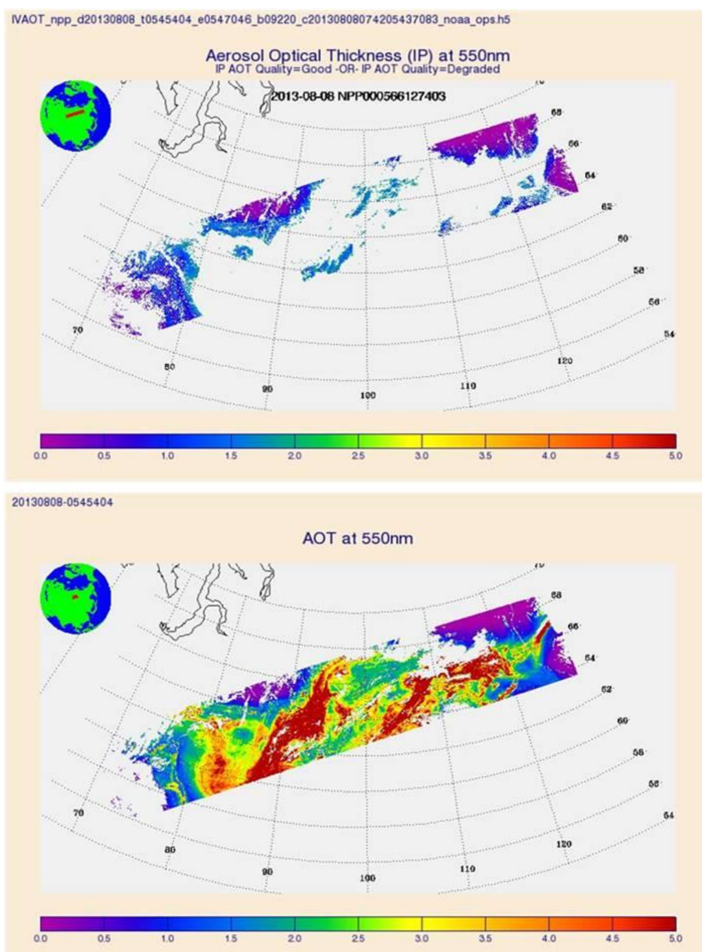


Figure 3. Illustration of impact of extended AOD range: (a) The AOD product from the operational Interface Data Processing Segment (IDPS) misses the smoke plume from Siberian fires (08/08/2013). (b) More retrievals and extended AOD range in EPS algorithm allow capturing the full extent of smoke.

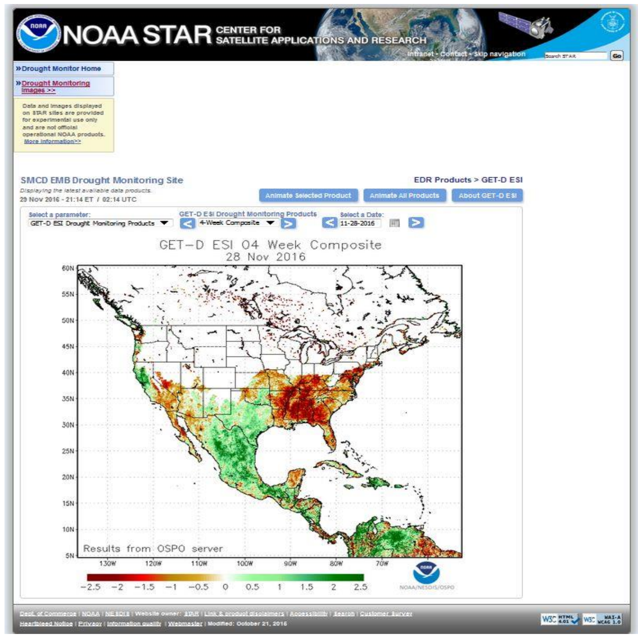
4.4 GOES Evapotranspiration and Drought Product System (GET-D) made operational and GET-D data are posted through both NESDIS OSPO and STAR websites

POC: Xiwu Zhan

Evapotranspiration (ET) is one of the main outputs of various land surface models (LSM) that connect numerical weather prediction models to the land surface. Most land surface models, such as the operational Noah model of NWS NCEP, use the water balance equation to estimate ET from precipitation and runoff. The uncertainties of the precipitation and runoff will result in errors in ET estimates for the numerical weather predictions (NWP). The Atmosphere-Land Exchange Inversion (ALEXI) model using GOES thermal infrared (TIR) based land surface temperature observations to retrieve ET and can provide independent information to validate or improve Noah LSM ET estimates. Based on the advantages of the TIR remote sensing of ET, NWS NCEP requested to generate GOES-based ET data for improving their NWP operations.

The ratio of the daily ET from ALEXI model to potential ET, which is computed from meteorological forcing data, is called Evaporative Stress Index (ESI). ESI has been proven to be a reliable soil moisture proxy. The negative anomaly of ESI from multi-year climatology has been well documented as one of the best indicators of drought. Therefore, NWS NCEP also requested to generate GOES-based EST data product for their drought monitoring operations. The US National Integrated Drought Information System (NIDIS) has also been using ESI as one of their main drought indices to provide drought information to the communities.

With supports from the NESDIS PSDI program and the NASA Applied Science Program, NESDIS has developed a GOES Evapotranspiration and Drought product system (GET-D) to meet the user needs, and has made the GET-D system operational since June 2016. Daily updated ESI data products have been posted at both NESDIS STAR and NESDIS OSPO websites, as shown in Figure 4.



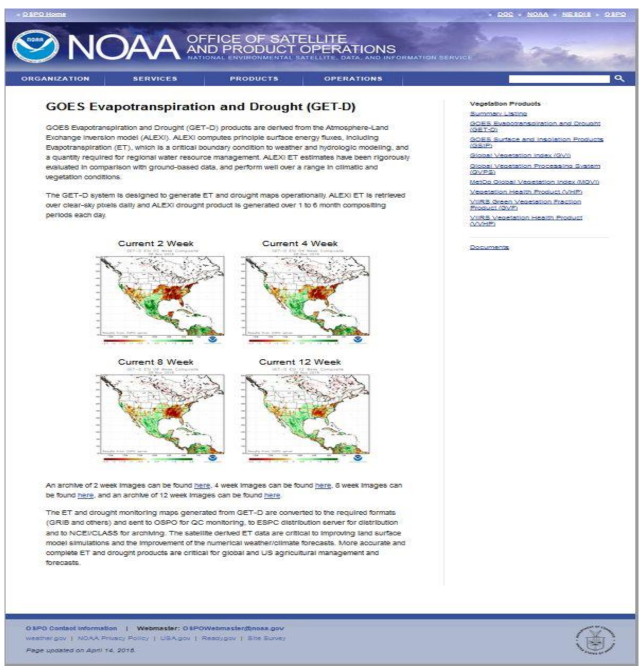


Figure 4. Screenshots of NESDIS STAR (left) and NESDIS OSPO (right) web pages of GOES Evapotranspiration and Drought Product System (GET-D)

https://www.star.nesdis.noaa.gov/smcd/emb/droughtMon/products_droughtMon.php
http://www.ospo.noaa.gov/Products/land/getd/

4.5 Calibration of AMSU-A on MetOp-C for Launch Preparation

POC: Cheng-Zhi Zou

MetOp is a series of polar orbiting meteorological satellites developed by the European Space Agency (ESA) and operated by the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT). The MetOp series includes MetOp-A, -B, and –C satellites. Following successful operations of MetOp-A and -B for nearly a decade, MetOp-C is scheduled to be launched on October 2018. MetOp-C will continue the observation of the Earth and atmosphere to provide critical data for numerical weather prediction and climate change monitoring. Among the instruments to be flying on MetOp-C, the Advanced Microwave Sounding Unit-A (AMSU-A) will provide the atmospheric temperature sounding data from the surface to the upper stratosphere. AMSU-A was built by US Northrop Grumman. For the previous MetOp-A and MetOp-B satellites, NOAA/STAR had provided AMSU-A pre-launch calibration to support operational L1B processing at NOAA. This work is also required at STAR for MetOp-C.

Pre-launch calibration of AMSU-A requires determination of the calibration coefficients for Platinum Resistance Thermometers (PRT), correction coefficients for in-light warm target, calibration accuracy, calibration nonlinearity, and noise equivalent temperature differences (NEdT), etc. These calibration coefficients are needed for generating accurate earth scene radiances using the instrument transfer equation. AMSU-A includes two modules: A1 and A2; each module consists of different channels. There are a total of 15 channels in the two modules. Pre-launch calibration is required for each channel and it is conducted separately for A1 and A2 modules. In addition, there are more than sixty PRTs on AMSU-A to monitor temperature changes of various instrument parts. One set of polynomial coefficients is required for each PRT, which convert the raw PRT reading in counts to temperature through a polynomial equation.

In FY2016, STAR scientists have developed calibration software and obtained calibration coefficients for all the parameters as mentioned above using thermal vacuum test dataset provided by Northrop Grumman. These coefficients have been delivered to partners at NESDIS/OSPO for input to the MetOp-C CPIDS (Calibration Parameter Input Dataset). The CPIDS is a database containing necessary calibration coefficients for satellite L1B processing. Once CPIDS is built, NOAA will conduct a ground system compatibility tests for MetOp-C. During the testing, STAR and OSPO will work together to evaluate the simulated data generated from the calibration coefficients. Once the test is completed, the obtained calibration coefficients will be used to generate operational L1B data for MetOp-C AMSU-A after its launched.

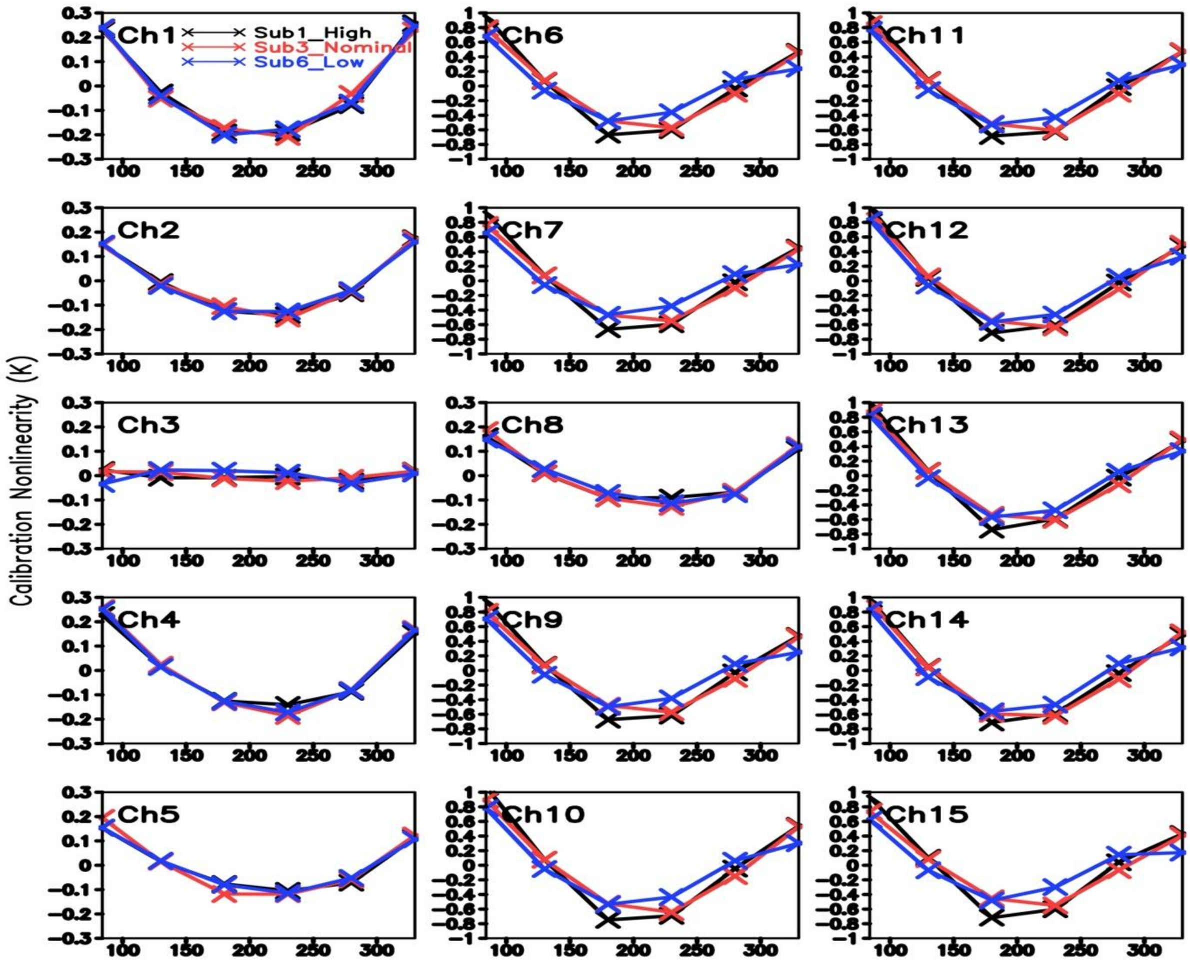


Figure 5. Calibration nonlinearity for all 15 AMSU-A channels at three Radio Frequency (RF) temperatures (blue: low temperature; red: medium temperature; black: high temperature). The RF temperatures for the AMSU-A A1 and A2 modules are different.

4.6 Reprocessing of GOES Atmospheric Motion Vectors (AMVs) using the GOES-R Winds Algorithm for Use in Hurricane Weather Research and Forecasting (HWRF) Assimilation Experiments

POC: Jaime Daniels

Satellite-derived AMVs are an important component of the Global Observing System (GOS) that provide vital tropospheric wind information over expansive regions of the earth that are devoid of in-situ wind observations that include oceans, polar regions, and Southern Hemisphere land masses. These data are used in operational Numerical Weather Prediction (NWP) data assimilation systems where they have been demonstrated to improve the accuracy of global NWP forecasts. With the coming of GOES-R, it will be possible to generate higher spatial and temporal resolution AMVs that can capture atmospheric circulation features in and around the vicinity of tropical cyclones. Assimilation of these AMVs into the National Center for Environmental Prediction (NCEP's) Gridpoint Statistical Interpolation (GSI)/HWRF System has the potential to improve hurricane track and intensity forecasts.

The GOES-R Winds Team at STAR has utilized a number of satellite sensors (GOES-N/O/P, Himawari-8/AHI, Meteosat SEVERI, Terra/Aqua MODIS, NOAA/AVHRR, METOP/AVHRR, and NPP/VIIRS imagery) for the development and validation of not only the GOES-R winds algorithm, but also for other GOES-R Level-2 algorithms (e.g., Clear sky mask, cloud type/phase, cloud top temperature/pressure) whose output the winds algorithm depends on. Over the past year, the STAR GOES-R Winds Team has collaborated closely with its colleagues from the Cooperative Institute for Meteorological Satellite Studies (CIMSS) and NCEP in an effort that is part of a National Weather Service (NWS) Research to Operations (R2O) Initiative. This R2O iniative aims to expand and accelerate critical weather forecasting research-to-operations in order to address growing service demands and increase the accuracy of weather forecasts at global and regional scales, and for high weather impact weather events that include hurricanes. To this end, the GOES-R Winds Team has focused its efforts on optimizing/configuring the GOES-R AMV algorithm to take full advantage of the spatial and temporal resolution of available imagery in order to generate AMVs with the best possible geographic coverage and to improve wind analyses and NWP forecasts associated with tropical cyclones. The optimized GOES-R winds algorithm/configuration was used to reprocess GOES AMVs for the entire lifetime of seven tropical cyclones deemed high priority by NCEP, and include Atlantic Storms: Florence, Ernesto, Humberto, Karen, and Sandy, and the East Pacific Storms: Miriam and Hector. Figure 1 provides an illustration of GOES AMVs centered over Tropical Cyclones Florence, Ernesto, Miriam, and Sandy. With these AMV datasets in hand, our CIMSS colleagues performed a number of experiments with the NCEP operational HWRF to assess the impact of assimilating GOES AMVs on HWRF track and intensity forecasts. The track and intensity forecast results for the HWRF experiment involving Hurricane Sandy are shown in Figure 2. Assimilating GOES AMVs show modest positive impacts on HWRF track forecasts of Sandy (left figure) out to about 72 hrs when compared to the control run. A more positive result for HWRF intensity forecasts for Sandy is shown (right figure) where notable reductions in forecast errors in the 24-96 hr lead time range were obtained. These are very promising results and provide good lessons learned when attempts are made to assimilate high spatial and temporal resolution GOES-R AMVs into the HWRF.

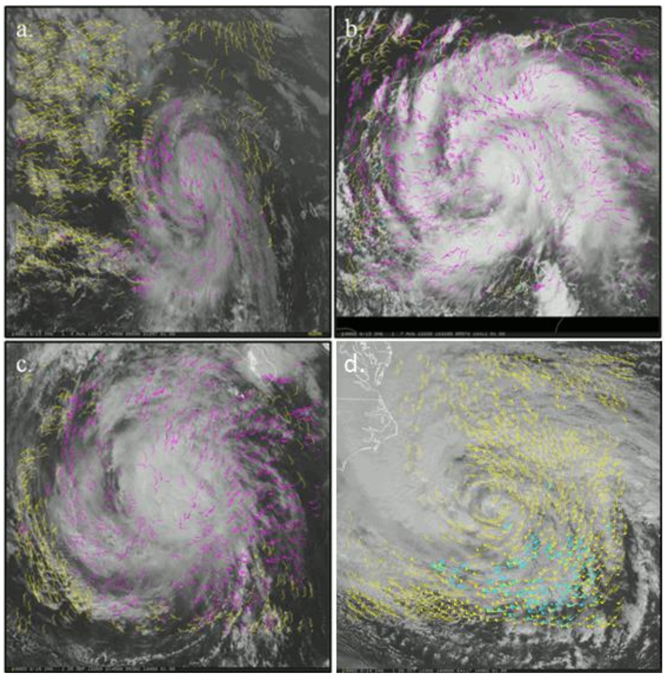


Figure 6. AMVs centered over Tropical Storms Florence (a), Ernesto (b), and Miriam (c). Upper level (100-400hPa) AMVs are show in magenta, Mid-Level (100-400 hPa) AMVs in cyan, and Lower Level (> 700 hPa) are shown in yellow. (d) AMVs centered over Hurricane Sandy. AMVs plotted in cyan have speeds exceeding hurricane force (> 75 mph).

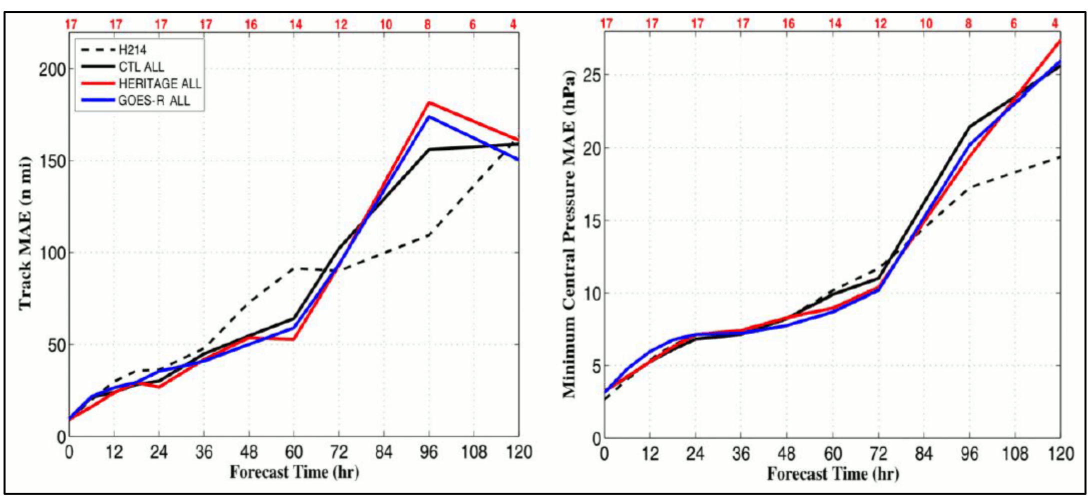


Figure 7. Mean absolute error (MAE) of HWRF forecast track (left) and forecast minimum Sea Level Pressure (right) for Hurricane Sandy. Results shown for Operational HWRF run (black dashed), Experimental Control (solid black), Experiment with GOES AMVs generated with NESDIS heritage AMV algorithm (red), and Experiment with GOES-R AMV algorithm (blue).

4.7 NOAA Environmental Data Record: SNPP CrIS Outgoing Longwave Radiation (OLR)

POC: Quanhua (Mark) Liu

Outgoing long-wave radiation (OLR) at the top of the atmosphere reflects emitted energy from Earth-atmosphere to space. Together with absorbed solar radiation, it determines energy gain or loss of our Earth-atmosphere system. Since OLR depends strongly on atmospheric temperatures and clouds, it is operationally used in the verification of precipitation and in the diagnostic for El Nino-Southern Oscillation (ENSO) and Madden-Julian Oscillation (MJO).

Starting from TIROS-N in 1978, AVHRR data has been used for the calculation of OLR. However, OLR data derived from hyper-spectral measurements has demonstrated much improved capacity in operational verification of precipitation and climate analysis compared to the AVHRR OLR. At NOAA/NESDIS/STAR, an algorithm has been developed and validated to derive OLR from infrared hyper-spectral sensors SNPP CrIS and Metop IASI.

Latency requirement (2 hours), accuracy requirement, and consistency with historical and other OLR products are the challenges. Therefore, a regression algorithm for SNPP CrIS OLR has been developed to meet the requirements for latency and accuracy as well as the algorithm consistency. The state-of-art data from Clouds and the Earth's Radiant Energy System (CERES) is used as an absolute reference to ensure consistency. The CrIS OLR environmental data record (EDR) achieves the objective goal. The bias is 1.1 Wm^{-2}, better than 3 Wm^{-2} for objective requirement. The standard deviation is 4.9 Wm^{-2}, better than 6 Wm^{-2} for objective requirement. Detailed validations are referred to in the paper by Zhang et al., 2016.

The OLR is one of the JPSS EDRs. The SNPP CrIS OLR EDR has been operational since November 30, 2015, and the data are available from NOAA CLASS (http://www.class.ngdc.noaa.gov/saa/products/search?sub_id=0&datatype_family=NDE_L2&submit.x=12&submit.y=12). Figure?? shows the OLR for SNPP ascending orbits on September 19, 2016. Low OLR values are found over the Antarctic because of dry and cold atmospheric temperature. Low OLR values are also found over convective clouds where cloud top temperature is low. Very high OLR values are observed over the hot Sahara Desert during the daytime. Future work will focus on the OLR algorithm extension for CriS data of a full spectral resolution, as the spectral resolution of the CrIS data increase by a factor of 2 and 4 for mid-wave and short-wave bands respectively.

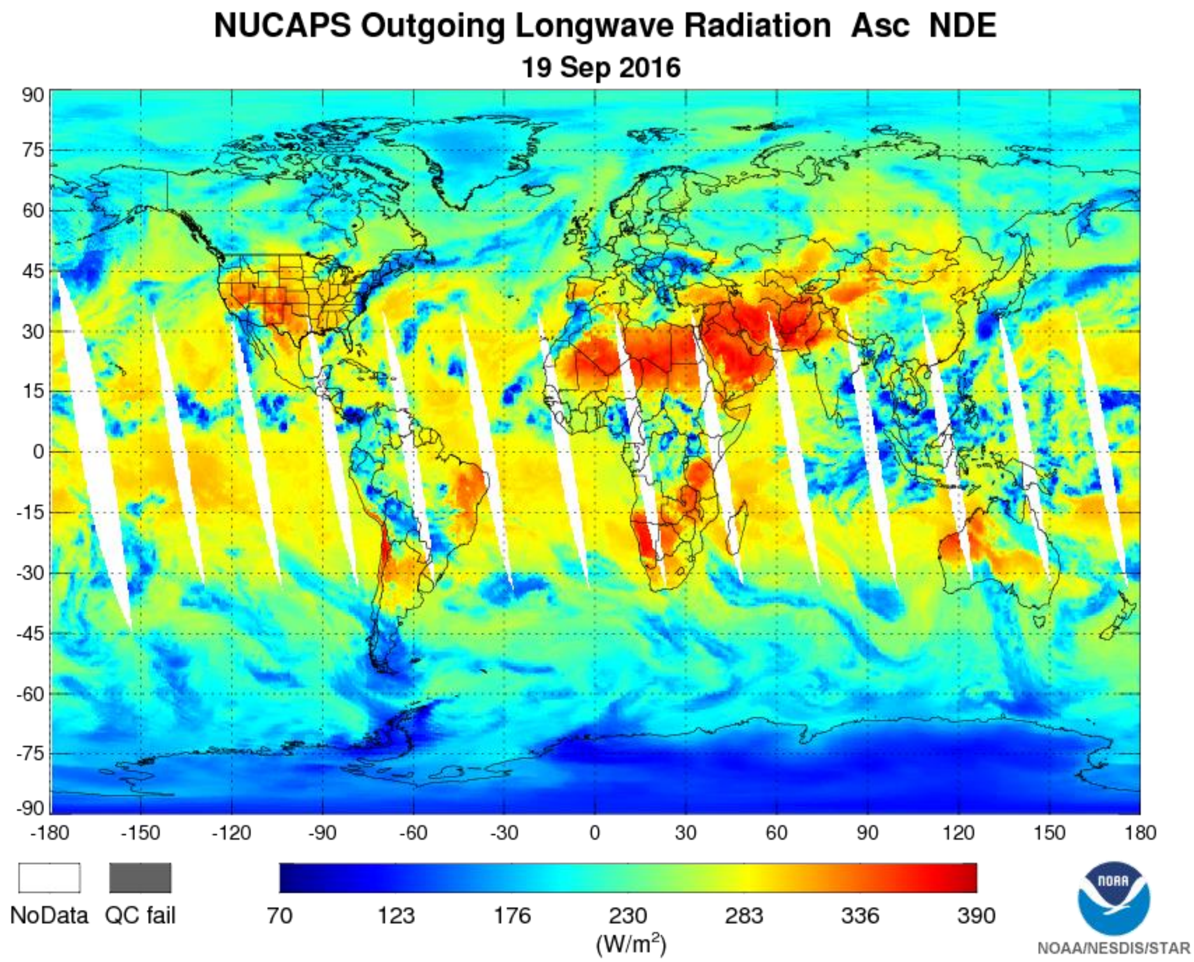


Figure 8. Outgoing longwave radiation derived from Suomi NPP CrIS

4.8 Analysis to Establish the Relationship between the Operational VIIRS and AVHRR GVF Datasets for NCEP Applications

POC: Marco Vargas

The SNPP VIIRS Green Vegetation Fraction (GVF) products are generated operationally and distributed to operational users including NOAA NCEP EMC Land Hydrology Team and NOAA ESRL. The SNPP VIIRS GVF operational product reached validated maturity and is ready for operational use. There is a need to start using the new SNPP VIIRS GVF to improve the representation of vegetation in weather forecasting models over existing climatological GVF to better simulate land-atmosphere energy exchanges during anomalous weather/climate regimes, temperature, moisture, and precipitation features, especially during warm seasons.

The goals of this milestone were first to compare the new near-real-time SNPP VIIRS GVF with both the current AVHRR operational GVF product and the AVHRR derived GVF climatology, and second to demonstrate that using the new near-real-time VIIRS GVF instead of the operationally used AVHRR derived GVF climatology in NCEP NWP models would improve the performance of NOAA's operational environmental prediction suite. The current AVHRR GVF operational product contains data gaps, and therefore cannot be used by NCEP EMC to initialize their Land Surface Models (LSM). Instead, the GVF dataset currently used in operational NCEP NWP LSM is a monthly climatology derived from the Normalized Difference Vegetation Index (NDVI) from AVHRR. The AVHRR GVF climatology was produced at 16 km resolution using 5 years of AVHRR NDVI data between April 1985 and March 1991.

We faced several difficulties in achieving our goals. The first challenge was the significant differences between the VIIRS and AVHRR GVF products: these two GVF products are generated from different sensors, with VIIRS being more advanced than AVHRR. In addition, the VIIRS GVF 4km spatial resolution is higher than the 16km AVHRR GVF. Also, the VIIRS GVF is derived from the Top of the Canopy Enhanced Vegetation Index (TOC EVI), whereas the AVHRR GVF is derived from the Top of the Atmosphere Normalized Difference Vegetation Index (TOA NDVI). Finally, different smoothing techniques are used by both VIIIRS and AVHRR GVF production systems. The second challenge is that during the comparison of the VIIRS and AVHRR GVF time series, it was discovered that the smoothing technique used by the VIIRS GVF production system was introducing a time shift in the annual cycle. An improved smoothing algorithm was implemented in the VIIRS GVF system that we run experimentally at the STAR Development Environment, which solved the time shift problem.

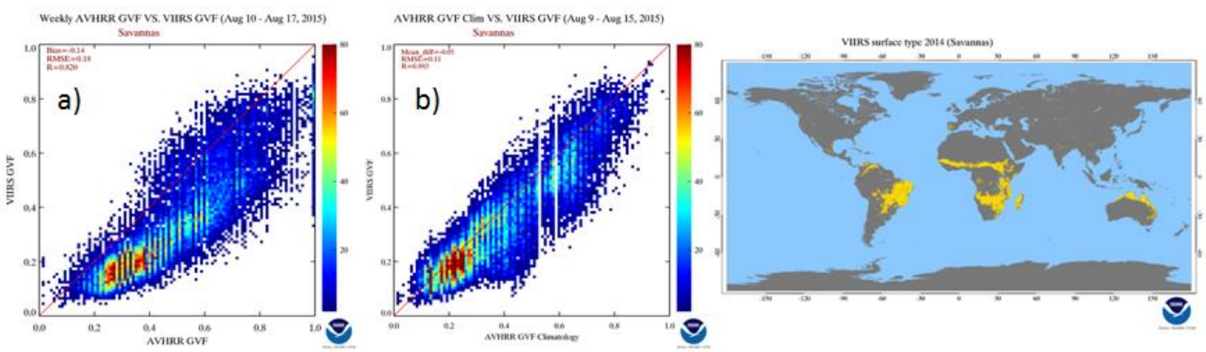


Figure 9. GVF Scatter plots for the savanna surface type: a) Scatter plot VIIRS vs. AVHRR GVF operational product, b) Scatter plot VIIRS vs. AVHRR GVF climatology

Time series and correlative analysis were used in the comparison of the VIIRS GVF and AVHRR GVF (operational product and climatology) products. The comparison was performed globally and regionally for all land pixels, and also globally and regionally by surface type. The temporal profile comparison and scatter plots among the different GVF datasets revealed that the amplitude of the AVHRR GVF is greater than the VIIRS GVF, the length of the AVHRR GVF growing season is greater than VIIRS GVF, and the AVHRR GVF climatology is closer to the VIIRS GVF than the AVHRR GVF operational product.

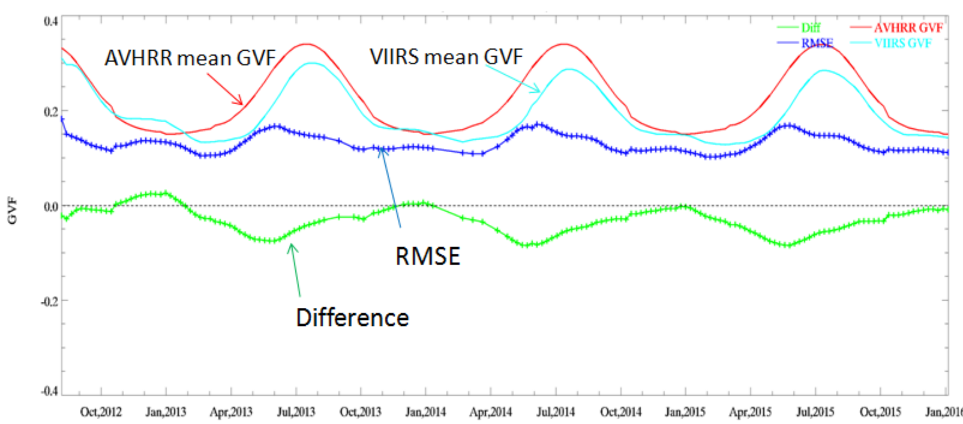


Figure 10. Global VIIRS vs. AVHRR GVF time series comparison (Oct 2012 to Jan 2016). VIIRS GVF (cyan), AVHRR GVF (red), VIIRS minus AVHRR GVF (blue), and RMSE (green).

A series of NCEP GFS model offline experiments were conducted to compare the impacts of using the climatological AVHRR GVF versus the near-real-time SNPP VIIRS GVF at different seasons during the year 2014. The results showed a positive impact on reduction in errors of surface temperature and surface humidity, and slight improvement of precipitation scores.

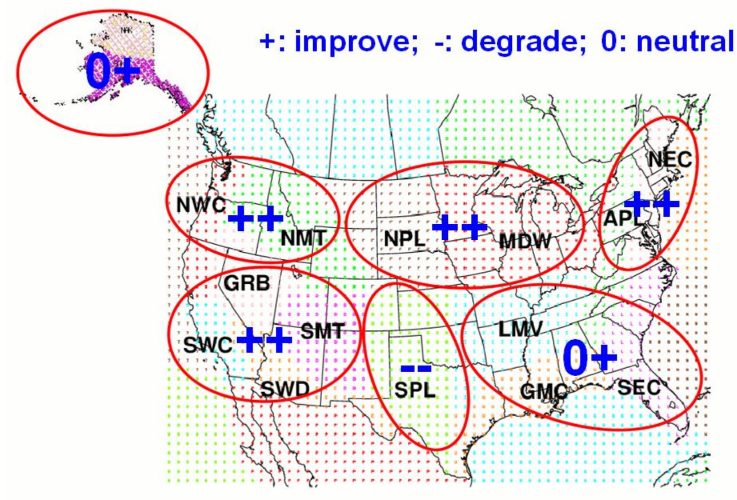


Figure 11. Forecast Verification Statistics (FVS) regions. The near-real-time VIIRS GVF shows a positive impact to reduce errors of 2-m air temperature in the GFS.

Our conclusion is that the new near-real-time SNPP VIIRS GVF operational product provides a better characterization of the surface in the Noah LSM compared to the current AVHRR GVF climatology (initial test results from NCEP/EMC demonstrate this). All operational NCEP models would benefit (e.g. better forecasts of near-surface winds, temperature, and humidity forecasts) by using the new near-real-time SNPP VIIRS GVF operational product.

4.9 Emissivity Product Development for JPSS/GOES-R Missions

POC: Yunyue Yu

Land Surface Emissivity (LSE) data is mostly required in retrieving land surface temperature (LST) from satellite infrared observations. It is also an important parameter in a variety of land processing models which are run by the Environmental Modeling Center (EMC) of the NOAA weather service. Currently, we are developing an enterprise LST algorithm for JPSS and GOES-R missions, in which LSE is required as one of the inputs.

The LSE data we produced covers the so-called split window infrared channels at 11 and 12 nm. It is derived from a two-component model. First, a bare soil surface emissivity is determined from historical and emissivity library datasets. Then, daily vegetation fraction and snow cover data are applied to compute the actual emissivity values of the surface which is covered partially by the vegetation and/or snow. Evaluation of the LSE data are conducted by in-situ emissivity data provided by international collaborators, by inter-comparison with the LSE data from EUMETSAT Land SAF group, and by LST validation in which the LSE data are used for the LST retrieval. Comparing to the existing LSE products (e.g. ASTER and MODIS emissivity), our LSE data is higher in spatial resolution (~ 1km) and less in uncertainty (~0.015). Currently, a daily global emissivity dataset is available upon request. Operational LSE data will be available by 2017.

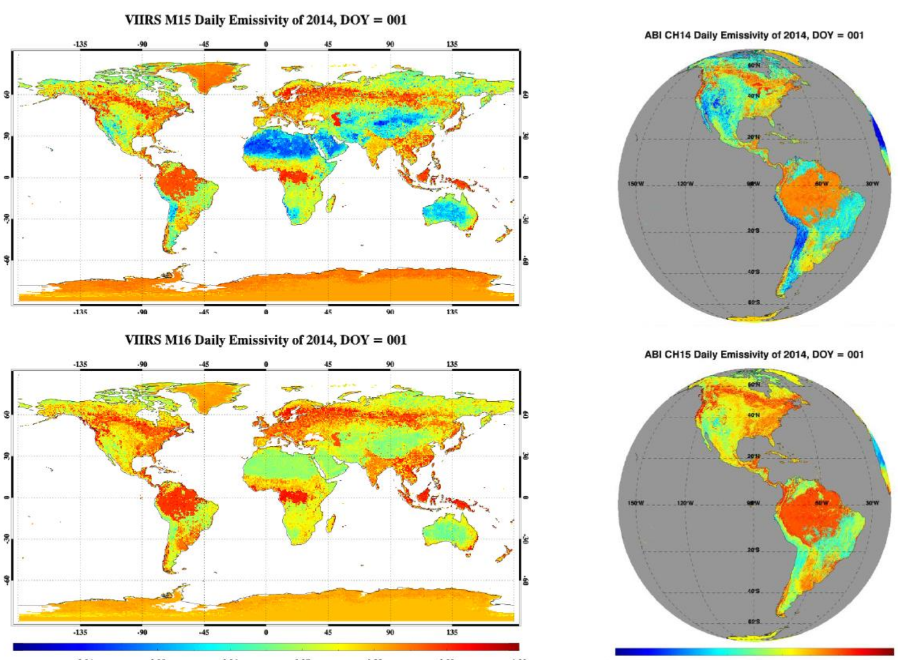


Figure 12. Daily global land surface emissivity data for the JPSS/VIIRS infrared channels (left), and the daily disk land surface emissivity data for the GOES-R/ABI infrared channels (right).

5. COMMUNITY IMPACT

5.1 STAR JPSS Annual Science Team Meeting 2016

POC: Lihang Zhou

On 12-15 August 2016 more than 300 scientists gathered in College Park, MD, for the third Center for Satellite Applications and Research (STAR) Joint Polar Satellite System (JPSS) Annual Science Team Meeting. Nearly 200 presentations and 40 posters were contributed by participants representing all aspects of the JPSS program and the polar satellite product user community including a new poster section dedicated to STAR summer interns.

JPSS is the latest generation of National Oceanic and Atmospheric Administration (NOAA) polar orbiting satellites, which provides daily global retrievals of various properties of Earth's surface and atmosphere. The initial satellite in the series, Suomi National Polar-orbiting Partnership (NPP), was launched in October 2011, and the next, JPSS-1, is due for launch in mid-2017. theme of the third annual meeting was "Impacts of JPSS" and the meeting focused on both the impacts of these improved satellite data on users such as weather forecasters and local emergency managers, as well as the broader impacts on society as a whole.

Throughout the meeting the presenters discussed the uses of Suomi NPP products by other NOAA agencies, international agencies, and other users. Progress on using Suomi NPP products in numerical weather prediction worldwide, in support of observing and predicting key weather phenomena (e.g. hurricanes, blizzards), and for event based applications (e.g. flash-floods, volcanic ash, wildfires etc.) were demonstrated to have shown remarkable success.

It was also noted that the critical issue for current and future satellite program success relies on working together with the users to understand how they use the products, which can help STAR JPSS to develop and understand product requirements going forward. Involving users, not just in designing product requirements, but also having satellite liaisons and programs to train the users was found to be the key to successfully expanding the reach of JPSS data.

Overall, the meeting participants reviewed and reaffirmed the main takeaways from last year's meeting, which called for continued efforts towards enterprise solutions (algorithms which can run on data from any of NOAA's polar or geostationary orbiting satellites) and towards greater reprocessing of the entire satellite record to take advantage of the latest algorithm developments. All of the science teams recognized the need for science quality data reprocessing and the archival of land, cryosphere, atmosphere, and ocean products maintaining high quality and consistency for satellite research and applications.

The meeting provided valuable time for face to face side meetings and informal discussions with external teams and users that helped to resolve many issues, ambiguities, and risk mitigation.

These meetings are rare because teams, which include STAR JPSS members, plus those in academia and industry, are often spread around the country and event internationally. Feedback from participants, team members, users and JPSS management was positive and indicated that the objectives envisioned for the meeting were satisfactorily fulfilled. The next STAR JPSS Annual Science Team Meeting will take place in October 2017.

Details and meeting presentations are available at
http://www.star.nesdis.noaa.gov/star/meeting_2016JPSSAnnual_agenda.php

Group photo of the 2016 JPSS Science Team Meeting Attendees.

5.2 2016 NOAA Workshop on JPSS Life-Cycle Data Reprocessing to Advance Weather and Climate Applications

POC: Fuzhong Weng

On May 17 and 18, 2016, the Center for Satellite Applications and Research (STAR) of the National Environmental Satellite, Data, and Information Service (NESDIS) held a workshop on Sensor Data Record (SDR) and Environmental Data Record (EDR) reprocessing in order to maximize Joint Polar Satellite System (JPSS) data applications. The JPSS preparatory mission Suomi National Polar-orbiting Partnership (SNPP), with the Visible Infrared Imaging Radiometer Suite (VIIRS), the Advanced Technology Microwave Sounder (ATMS), the Cross-track Infrared Sounder (CrIS), and the Ozone Mapper/Profiler Sensor (OMPS) on board, has been providing valuable data and lessons learned on anomalies and their resolution for algorithm improvement. Reprocessing using mature algorithms will ensure that all JPSS satellite data, starting with SNPP from the beginning of the time series through the JPSS life cycle, will be consistent on a common reference frame with known uncertainty. The workshop proceeding will be available for forward planning of algorithm upgrades for the 2017 JPSS-1 launch. Nearly 70 technical staff and associates connected with SNPP and JPSS at various branches of NOAA and NASA participated in the workshop. There were seven sessions, with presentations by invited speakers[1] and discussions. Various speakers addressed the importance of reprocessing of SNPP data during the course of the workshop. Following the opening session, SNPP on-orbit performance and sensor data anomalies were discussed in Session 2. SNPP data user experiences and recommendations for further improvements were discussed in Sessions 3 and 4. Improved and advanced calibration and validation algorithms for reprocessing applications were discussed in Session 5. Potential impacts of the reprocessed SNPP data on NOAA operations were discussed in Session 6. Session 7 included a final discussion on the issues, challenges, and next steps for baseline approaches, schedules, and plans for SDR and EDR reprocessing.

SNPP instruments are performing very well on orbit and the algorithms are very stable and nearing maturity. However, there has been quite a change in the data products—SDR and EDR—since the SNPP launch five years ago. The products were in various levels of maturity during these years as the data moved through beta, provisional, and then validated stages. The purpose of this workshop, therefore, was to discuss data reprocessing in an effort to bring all data in the time series to the fully validated level. Reprocessing, also referred to as “science reprocessing,” is the use of validated mature algorithms to regenerate the SDR time series of SNPP onwards for the JPSS life

[1] The individual presentations can be found on the NOAA Web site http://www.star.nesdis.noaa.gov/star/meeting_JPSS2016_LDRW.php.

cycle and thereby regenerate the EDR, again using mature algorithms, for weather and climate applications. The benefits of reprocessing are summarized as follows:

- Many user applications expect long-term consistency of data product quality for reliable interpretation of trends observed with data products (land, atmosphere, and ocean).
- Product maturity and validation schema from beta, provisional, and validated maturity progressively proves that each data product meets the product quality requirements.
- Consistent, long-term product quality metrics (e.g., Accuracy, Precision, and Uncertainty [APU], achieved through re-processing, are crucial to set up a baseline for further advancement of observational data records.
- Reprocessing will contribute to improved reanalysis schemes that merge data from many different observations through data assimilation to attain reliable global trends.
- Reprocessing using best science and most matured algorithms provides useful inputs for essential climate variables (ECVs) and critical CDRs.

Group photo of the JPSS Data Reprocessing Workshop Attendees - May 17, 2016.

5.3 The 7th Asia-Oceania Meteorological Satellite Users' Conference (AOMSUC-7)

POC: Fuzhong Weng

The 7th AOMSUC was held on October 23-27, 2016 in Songdo City, Incheon, Korea. It was well attended by 230 people from 80 Asia-Oceania countries. Since the AOMSUC inception in 2009, Fuzhong Weng and Mitch Goldberg have served as International Conference Steering Committee (ICSC) members, and work closely with the ICSC chair to make the conference successful. The Asia and Oceania regions are frequently affected by severe natural phenomena such as tropical cyclones, torrential monsoons, volcanic eruptions, yellow sand storms, floods, sea ice and wildfires. The importance of monitoring the climate and the environment from satellites is also increasing, which has prompted enhanced global interest in the field. In this area, meteorological and earth observation satellites provide frequent and extensive observational information for use in disaster prevention and climate monitoring/diagnostics, and are indispensable in today's world.

Today, Korea, China, Europe, India, Japan, the Russian Federation and the United States all launch operational meteorological satellites over Asia and Oceania, as part of the Global Observing System (GOS) promoted by the World Meteorological Organization (WMO), which contributes to the Global Earth Observation System of Systems (GEOSS) coordinated by the Group on Earth Observations (GEO).

The AOMSUC-7 conference objectives are to further enhance the exchanges on application techniques among satellite data users in Asia/Oceania as well as to advance satellite observation technologies and to promote synergetic development related to meteorological satellites in this region. Fuzhong Weng chaired the AOMSUC-7 session 7, "Application of Satellite Data to Data Assimilation and Numerical Weather Prediction (NWP)" with CMA/National Satellite Meteorological Center (NSMC) Deputy in-general, Dr. Datong Zhao. In this session, seven speakers reported the progress on satellite radiance assimilation. The data assimilation experiments are carried out in global, regional, and convective scale models. Significant advancements have been made in assimilating geostationary satellite imager thermal-channel radiances (COM, AHI and GOES) in both research and operational forecast models. Also, significant progresses have been made on assimilation of FY-3C data in CMA and ECMWF forecast models.

6. AWARDS

The following SMCD Staff were honored with awards during the 2016 calendar year, in recognition of their significant contributions and dedication to fulfilling NOAA's mission and vision. Congratulations to all!

Department of Commerce (DOC) Gold Medal Award

Scientific/Engineering Achievement

Recipient: Kenneth L. Pryor

This award, the highest honorary award given by the Department, is granted by the Secretary for distinguished performance characterized by extraordinary, notable, or prestigious contributions that impact the mission of the Department and/or one operating unit and that reflect favorably on the Department.

"Mr. Pryor is honored for significant scientific advances made to the Microburst Windspeed Potential product that enable more accurate and higher confidence levels in severe thunderstorm downburst predictions. His work to employ a comprehensive validation process involving a multi-sensor direct comparison approach resulted in the implementation of coefficients that improve the Microburst Windspeed Potential algorithm, which will help save lives and property. He also ensured our stakeholders will access new resulting data by his training and outreach efforts, and by developing a new phone app."

[Pictured: Ken Pryor (STAR)].

NOAA Bronze Medal Award

National Environmental Satellite Date and Information Service (NESDIS)

Recipients: Shobha Kondragunta and Istvan Laszlo

The NOAA Bronze Medal Award is the highest honor award granted by the Under Secretary of Commerce for Oceans and Atmosphere, the Bronze Medal recognizes superior performance by federal employees.

"Shobha Kondragunta and Istvan Laszlo are honored for enhancing the accuracy of Suomi National Polar-Orbiting Partnership Visible Infrared Imaging Radiometer Suite aerosol products and ensuring that products reach the operational user community with reduced latency."

STAR Award for Innovation
Individual

Recipient: Xi "Sean" Shao (UMD/CICS)

This award recognizes the accomplishments of individuals for development, proof or application of novel approaches, methods, or devices that solve technical or organizational challenges and realize gains previously not feasible. The potential applications and value of these approaches may be recognized, sought out and emulated by external organizations. Solutions are marked by originality and vision of pathways by which benefits can be realized.

"For innovative research and publication of the journal paper 'Spectral dependent degradation of the solar diffuser on Suomi-NPP VIIRS due to surface roughness-induced Rayleigh scattering'."

[Pictured, standing left to right: Stephen Volz (NESDIS), Xi "Sean" Shao (UMD/CICS), Mike Kalb (STAR), Hugo Berbery (UMD/CICS), and Fernando Miralles-Wilhelm (UMD/CICS)].

STAR Award for Technology
Individual

Recipient: Yong Chen (UMD/CICS)

This award recognizes the efforts of individuals who have made significant contributions to development, application and implementation of new technologies or technology-based systems that significantly increase NOAA's capacity to observe, measure, analyze, or use satellite derived scientific and technical information. The emphasis is on sensors, sensor systems and information systems technologies.

"For developing a state-of- the-art system for processing, calibrating and validating Cross-track Infrared Sounder (CrIS) full spectral resolution data for weather and climate applications."

[Pictured, standing left to right: Fuzhong Weng (STAR), Stephen Volz (NESDIS), Yong Chen (UMD/CICS), Mike Kalb (STAR), Hugo Berbery (UMD/CICS), and Fernando Miralles-Wilhelm (UMD/CICS)].

STAR Award for Technology
Team

Recipients: Sea Surface Temperature (SST) and Algorithm Scientific Software Integration and Transition (ASSIST) Team

[Prasanjit Dash (CIRA), **Meizhu Fan (IMSG)**, Irina Gladkova (GST), Alexander Ignatov (SOCD), **Veena Jose (IMSG)**, Yury Kihai (GST), Maxim Kramar (GST), **Aiwu Li (IMSG)**, Xingming Liang (CIRA), Boris Petrenko (GST), **Shanna Sampson (IMSG)**, John Sapper (OSPO), and **Walter Wolf (SMCD).**]

"Awarded for the development and implementation of the high quality SST product from Himawari-8."

This award recognizes a team who has made significant contributions to development, application and implementation of new technologies or technology-based systems that significantly increase NOAA's capacity to observe, measure, analyze, or use satellite derived scientific and technical information.

[Pictured, standing left to right, back row: Walter Wolf (STAR), Xingming Liang (CIRA), Mike Kalb (STAR), Murty Divakarla (IMSG); (Front row) Veena Jose (IMSG), Aiwu Li (IMSG), Meizhu Fan (IMSG), Stephen Volz (NESDIS), and Vance Hum (IMSG).]

STAR Award for Program/Project Management

Team

Recipients: STAR JPSS Management [**Tom Atkins (IMSG)**, **Murty Divakarla (IMSG)**, **Xingping Liu (IMSG)**, **Tess Valenzuela (IMSG)**, and **Lihang Zhou (STAR).**]

This award recognizes the efforts of a team who have made significant contributions by leading the planning, implementation or execution of "corporate" scientific, technical, or administrative programs, projects or initiatives.

"For managing a cost-effective JPSS STAR calibration and validation program and transitioning new JPSS products and algorithms critical for NOAA operations." *[Pictured, standing left to right, back row: Fuzhong Weng (STAR), Le Jiang (IMSG), Tom Atkins (IMSG), Murty Divakarla (IMSG), Mike Kalb (STAR), Vance Joy (IMSG); (Front row) Hui Xu (IMSG), Lihang Zhou (STAR), Xingpin Liu (IMSG), Tess Valenzuela (IMSG), Stephen Volz (NESDIS)]*

STAR Award for Service

Individual

Recipient: Kenneth Carey (ERT)

"Awarded for unmatched professionalism, commitment, and skill in facilitating across organization and community-wide venues that have greatly increased the span and quality of scientific engagement to the benefit of STAR, NESDIS, NOAA, and countless scientific colleagues."

This award recognizes significant technical, administrative and/or management contributions to provide exemplary service to STAR, NESDIS, NOAA and/or external partners that enable the success of one or more high-priority new initiatives.

[Pictured, left to right: Fuzhong Weng (STAR), Stephen Volz (NESDIS), Jingli Yang (ERT), and Mike Kalb (STAR).]

STAR Award for Service

Team

Recipients: Manik Bali (CICS), Lawrence Flynn (SMCD), Xiangqian Wu (SMCD), Yuanzheng Yao (ERT), Fangfang Yu (ERT)

"Awarded for outstanding service to WMO's Global Satellite Inter Calibration System (GSICS) community and Leadership of the NOAA GSICS Coordination Center"

This award recognizes significant technical, administrative and/or management contributions to provide exemplary service to STAR, NESDIS, NOAA and/or external partners that enable the success of one or more high-priority new initiatives.

[Pictured, left to right, back row: Fuzhong Weng (STAR), Xiangqian Wu (STAR), Stephen Volz (NESDIS), Mike Kalb (STAR), and Fernando Miralles-Wilhelm (UMD/CICS); (Front row): Manik Bali (ERT), Lawrence Flynn (STAR), Shubha Barriga (ERT), Jingli Yang (ERT), and Hugo Berbery (UMD/CICS)].

7. PUBLICATIONS

1. **Bali, M.**, **Mittaz, J. P., Maturi, E.,** & Goldberg, M. D. (2016). Comparisons of IASI-A and AATSR Measurements of Top-of-Atmosphere Radiance over an Extended Period. *Atmos. Meas. Tech.*, 9(7), 3325-3336. [10.5194/amt-9-3325-2016]

2. Bodeker, G. E., Bojinski, S., Cimini, D., Dirksen, R. J., Haeffelin, M., Hannigan, J. W., Hurst, D. F., Leblanc, T., Madonna, F., Maturilli, M., Mikalsen, A. C., Philipona, R., **Reale, T.**, Seidel, D. J., Tan, D. G. H., Thorne, P. W., Voemel, H., & Wang, J. (2016). Reference Upper-Air Observations for Climate: From Concept to Reality. *Bulletin of the American Meteorological Society*, 97(1), 123-135. [10.1175/BAMS-D-14-00072.1]

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