2016 STAR JPSS Annual Science Team Meeting Report

Executive Summary

The third Center for Satellite Applications and Research (STAR) Joint Polar Satellite System (JPSS) Annual Science Team Meeting was held August 8-12, 2016 at the National Oceanic and Atmospheric Administration (NOAA) Center for Weather and Climate Prediction in College Park, MD. The meeting gathered more than 300 members from many disciplines across JPSS programs and the user community and featured nearly 200 presentations and 40 posters. This meeting also hosted a one day Global Space-based Inter-Calibration System (GSICS) User's Workshop that was attended by over 50 researchers.

The primary goals of the meeting were as follows: 1) provide briefings on the Program level and National Environmental Satellite, Data, and Information Service (NESDIS) level priorities, 2) review science teams' readiness for the JPSS-1 (J1) launch in regards to Sensor Data Record (SDR) and Environmental Data Record (EDR) algorithm development, improvements, and pre-launch to post-launch preparedness, 3) review science teams' continued support for the Suomi National Polar-orbiting Partnership (NPP) Mission and for the mechanisms planned for adaptation into the J1 mission to meet NOAA's operational missions and priorities, 4) facilitate face-to-face meetings between all participating members (e.g. science teams, universities, cooperative institutes, government agencies, industry) to improve upon the current JPSS products and generate useful innovative products for a variety of end users and advanced applications, 5) evaluate the status of the enterprise algorithms and implementation for Suomi NPP as well as the path forward for J1 data processing, and 6) review progress on Suomi NPP data reprocessing schemes to generate mission-long high quality science data products. This report provides overview summaries of the JPSS and STAR Program management outlook,

SDR/EDR team achievements, Integrated Calibration/Validation System (ICVS)/Long-Term Monitoring (LTM) upgrades, algorithm management and transition of J1 algorithms, operational processing systems status in maintaining Suomi NPP products and readiness towards J1 launch, and continuation of climate data records with the J1 data products. The new additions to the annual meeting this year - the GSICS User Workshop, and presentations on JPSS socioeconomics and educational outreach - are also summarized in this report.

1. JPSS and STAR Program Management

Leaders from NOAA and the JPSS Program started the meeting with a plenary session summarizing the overall status of the program. Two Program level achievements were announced: 1) the approval of the JPSS-3 and -4 follow-on missions in the fiscal year 2016 budget, and 2) a long-term agreement with the European Center for the Exploitation of Meteorological Satellites (EUMETSAT) for continued support. With these two agreements, the JPSS program envisions continuity of high quality critical observations through the year 2030. The program also noted the need for high quality polar satellite observations with a higher frequency than what is available today. With upcoming polar satellite missions from Russia and China, the JPSS program anticipates a total of six satellite constellations available to reach the desired observation frequency. The program called for international collaboration and cooperation in achieving this objective.

The program also discussed other key investments such as moving towards enterprise algorithms, requirements traceability, and instrument health monitoring tools to help preserve instrument capabilities for many years to come. The speakers stressed the need for mission-long reprocessing and archival of products generated using the most mature algorithms, in order to (a) achieve long-term consistency of data product quality and reliable interpretation of trends observed with data products, (b) setup a baseline for further advancement of observational records, and (c) enable users to utilize the high-quality products retrospectively to evaluate impacts on user applications and prepare the necessary infrastructure to use the near-real time products.

The program went on to describe the need for continued efforts towards 1) the development of a robust baseline of accurate observations through user consultations; 2) algorithm enhancements and improvements based on user needs and product use for a wide variety of user applications; 3) providing user training on product utility; 4) mapping capabilities of various data products from Suomi NPP/J1 and other satellite platforms (e.g. Geostationary Operational Environmental Satellite [GOES]-R) to derive blended products and fused in-situ data sets to address data needs across NOAA line offices (e.g. National Weather Service (NWS), National Marine Fisheries Service (NMFS), Oceanic and Atmospheric Research (OAR)) and a wide variety of users who are gateways to the public and public safety; and 5) evaluate NESDIS operationally produced products and use of the products for operational applications across NOAA line offices (e.g. The NESDIS operationally producted fire products use in numerical weather prediction (NWP) models to forecast trajectories of smoke).

2. SDR/EDR Overview

The SDR and EDR overview presentations highlighted Suomi NPP product performance and major improvements towards J1 readiness accounting for J1 instrument changes, waivers, and associated algorithm mitigations. All of the Suomi NPP SDR products from the Visible Infrared Imaging Radiometer (VIIRS), Crosstrack Infrared Sounder (CrIS), Advanced Technology Microwave Sounder (ATMS), and the Ozone Mapping Profiler Suite (OMPS) met or exceeded the requirements, all J1 algorithm deliverables and schedules are met, and the post-launch cal/val plans and schedules for J1 Beta, Provisional and Validated Maturity are all in place. The presentations also detailed J1 pre-launch verification efforts with test data sets, as well as pre-operational science product verification support as part of ground system transition, preparedness, and operational readiness. Evaluation of the J1 products derived using the test data sets revealed expected performance. Regarding SDR utility, major application areas such as hurricane track and intensity evaluation, and assimilation of SDR products into NWP models for improving the forecast skill were highlighted. The status of reprocessing efforts, accomplishments, and computing needs for mission-long reprocessing of Suomi NPP SDRs were discussed.

The EDR portion of the meeting featured sessions dedicated to ozone, SST, ocean color, land and cryosphere, soundings, aerosols, clouds and imagery, and new this year – trace gases. The EDR overviews highlighted J1 readiness and EDR enterprise algorithm status where applicable. Applications utilizing the EDR products were highlighted, emphasizing end-to-end value from the data to the product, and on to environmental intelligence, and information for decision makers.

The teams also explained the need to redefine operational products as products that serve the purposes of the users. For example, NWP assimilations require near real time (NRT) products with short latency but less quality control while some applications for fisheries management could benefit from higher quality products at the expense of latency.

The teams also stressed the need for the generation of science quality products using the most matured algorithms to understand and improve upon challenges with the NRT data. In moving forward, all of the teams recommended that data product generation move away from mission based approach towards a measurement based approach to help ensure high quality and long term continuity for user applications. Some of the examples of measurement based data products, such as the sea surface temperature (SST) from an amalgamation of retrievals using the Advanced Clear-Sky Processor for Oceans (ACSPO) enterprise algorithm applied to both the polar and geostationary data sets were highlighted as a path finder for future mission agnostic or measurement based product generation.

The EDR teams also noted integration needs for data products from polar (morning, mid-morning, and afternoon satellites) and a constellation of data from different geostationary satellites from domestic and international agencies. Ultimately all of the EDR teams recommended finalizing enterprise algorithms and reprocessing plans, and the coordination of NOAA, the National Aeronautics and Space Administration (NASA), the Naval Research Laboratory (NRL), and any internal/external agencies for science algorithm consistency and validation of the products. The teams also emphasized user training of satellite derived products and their use by forecasting offices (e.g. use of the NOAA Unique CrIS/ATMS Processing

System [NUCAPS] sounder products in the Advanced Weather Interactive Processing System [AWIPS]), improved web resource development with easy visualization of data products, accessing data products for areas of interest fusing in situ measurements, and ease in getting the data. As expected, both the SDR and the EDR teams anticipate shorter timelines in reaching J1 SDR/EDR provisional and validated maturity.

3. ICVS/LTM Readiness

The STAR ICVS and the EDR LTM teams presented an overview of these systems and progress towards J1 readiness. The discussions included the capabilities of ICVS in monitoring both spacecraft and sensor health parameters through trending the instrument house-keeping and telemetry parameters. ICVS also highlighted the process of detecting anomaly events to trigger automated warning messages to NOAA satellite operations centers. Other new developments highlighted in the ICVS capabilities include the availability of NRT high resolution Suomi NPP VIIRS/GOES imagery products, and the satellite Data Application Demonstration system (DADs) for event based applications. The team has tested ICVS functionality with the J1 test data sets from the pre-operational testing events as part of J1 preparedness.

The LTM system currently monitors Suomi NPP EDR products produced daily and accumulated over the life of the Suomi NPP satellite. The LTM system design embraces a content agnostic approach and facilitates easy expansion to house images, text, or data files from many different satellite instruments and products. The Phase 1 LTM system currently allows users to visualize satellite EDR products from the Suomi NPP and other domestic and international polar satellite constellations through a searchable interface to easily access data, products and plots by date, type, and other sorting parameters. Improvements planned for the Phase 2 LTM include maps of quality flags and inter-comparison of products from similar satellite instrument complements from an array of polar orbiting satellites. New additions to the LTM include a VIIRS high resolution SDR image page, weekly updated instrument anomaly history for the Suomi NPP and future J1 satellites to aid reprocessing.

4. Suomi NPP Products, J1 Cal/Val and Algorithm Transition

The STAR JPSS science teams are responsible for performing the calibration/validation for all of the Suomi NPP SDR and EDR products and conducting the planned product validation maturity reviews. Most of these products have been advanced to validated maturity, and are currently in the long-term monitoring and reactive maintenance phase. Suomi NPP CrIS and ATMS radiances have been operationally assimilated into the NWP Centers, and STAR CrIS SDR Full Spectral Resolution (FSR) radiances are routinely accessed by many NWP centers worldwide. Major accomplishments related to J1 readiness include scheduled deliveries of J1 Cal/Val plans, J1 SDR algorithm upgrades, and J1 launch ready processing coefficient tables (PCT)/look up tables (LUT) in association with both the JSTAR science teams and the STAR Algorithm Scientific Software Integration and System Transition Team (ASSISTT) team.

The STAR ASSISTT team detailed the overarching process of working with the scientists to transition algorithms to operations following standard sets of project reviews, requirements and risk tracking, documentation, and stakeholder interactions for the JPSS-Interface Data Processing System (IDPS), NPP Data Exploitation (NDE), and GOES-R programs. The current status of Suomi NPP/J1 SDR algorithms upgrades and deliveries to the Data Processing Engineering and System (DPES) in support of the IDPS build schedules, and deliveries for reactive maintenance of other EDRs remaining in the IDPS was presented. The presentation also discussed status related to (a) the EDRs currently in NDE operations, (b) deliveries for the EDRs migrating to NDE from IDPS (or replacement enterprise algorithms going to NDE), (c) the EDR algorithms expected to be in NDE operations, and (d) the NDE tailored products such as BUFR, GRIB, and other special data sets. The ASSISTT team reported J1 readiness and plans for early product distribution for pre-operational user readiness for NDE products, especially the enterprise products. The team also reported the progress on building the infrastructure for Suomi NPP/J1 near real time pre-operational product generation efforts in the STAR development environment to support software and product testing, validation, and user readiness.

On the algorithm reallocations and operationalization between the IDPS and the NDE/Office of Satellite and Product Operations (OSPO), the Algorithm Management Program (AMP) laid out a

transition plan consistent with the Program directives and in conformity to the Satellite Products and Services Review Board (SPSRB) process. All of the SDR and imagery EDR product generation will continue using the IDPS processing system, while the other JPSS EDR products are transitioned to operations through NDE/OSPO. Operationalization of these products in NDE/ESPC will follow after an evaluation of the current NDE processing loads and performance, and after an assessment of the current/future NDE operational processing capability needs. The AMP expects at least 6 months of transition time for users to switch from IDPS to NDE enterprise products after which IDPS products subscriptions to Comprehensive Large-Array Data Stewardship System (CLASS) will cease, but only after a realization of NDE products archival by the National Centers for Environmental Information (NCEI). Interdependencies associated with IDPS product generation may preclude decommissioning of the IDPS products generation, but may happen eventually. Back filling IDPS products with the NDE products for the entire Suomi NPP mission will be realized once NDE products are operationalized and funding appropriations are in place for retrospective processing. For a smooth transition and adaptation of NDE products in user applications, users will be provided with NDE test data products through an FTP site. Any fixes or suggested modifications to the NDE products from user agencies will be evaluated and accommodated in finalizing the NDE product generation for an eventual dissemination and archival of NDE products.

5. J1 Operational Processing Systems – PLT Status

Both the IDPS and the OSPO product generation system representatives presented detailed milestones, build plans, algorithm updates and schedules for Operational Readiness Review (ORR) and Transition to Operations (TTO) plans for J1 processing system readiness. As part of pre-operational evaluation and operational readiness, the IDPS Block 1.2 and Block 2.0 systems were verified for science product integrity during the Operations-Based Site Acceptance Test (OBSAT) and Level-3, Ground Project/Segment Acceptance Test (LG2). Similar procedures are on the way for NDE 2.0 product verifications in sync with the Block 2.0 IDPS. The teams also discussed pathways of receiving Block 2.0 IDPS SDRs, Temperature Data Records (TDR), and EDR ingests to NDE 2.0 towards the generation of NESDIS Unique Products (NUPs), tailored

Global Change Observation Mission-Water (GCOM-W) Advanced Microwave Scanning Radiometer (AMSR)/2 Day1 and Day 2 products, the Product Distribution and Access (PDA) sub-system, and operational readiness for J1.

With regards to post-launch testing schedules, the NASA flight operations and instrument post-launch test lead provided updates on Post Launch Tests (PLT) plans and the Integrated Mission Timeline (IMT). The PLT starts shortly after launch and continues for the first 90 days until operations are handed over to OSPO. The PLT plans went through peer reviews with NOAA and NASA scientists' involvement. The PLT team is still open for any discussion related to adding any post-launch tests all the way up to launch and during launch. A majority of the instrument post-launch tests have been tested with the J1 satellite in Joint Compatibility Tests (JCT-2 and -3). The upcoming JCT-4 will ensure that all of the remaining PLTs get tested. A thorough review and rehearsals all the way to the door opening (9-52 days) have been accomplished. The PLT teams are still reviewing the day 53-90 schedules and require science inputs on certain issues.

6. Climate Data Records Continuation with JPSS Data Products

The NCEI presentation discussed the Climate Data Records (CDR) program that started with the traditional Polar Orbiting Environmental Satellite (POES) systems, and discussed the challenges associated in blending the Suomi NPP/JPSS advanced satellite products to continue the CDRs. Thematic and Fundamental CDRs so far have focused on POES observations due to the availability of reliable, consistent, long term POES records. About 35 bundles of CDRs (amounting to about 200 EDRs) from POES have been transitioned to operations so far, and the JPSS instrument complements allow for the extension of many of these CDRs, which aids in maintaining a continuous record of CDRs for the atmosphere, land, and oceans. Some of the challenges associated with using the JPSS data products for the continuation of CDRs stem from the difficulties in changing the design of the decision support systems that are tailored together with the traditional POES derived CDRs.

Some users are apt to embrace the latest instrument technology, additional channels and better spatial resolution offered by the JPSS suite of instruments and may adapt to the associated changes decision support systems, while some other uses prefer that the new product look like the POES product sacrificing additional benefits offered by the JPSS products. The presentation then discussed a couple of approaches to circumvent this issue: (a) designating a CDR JPSS steering team to work with the user community on a case-by-case basis to prioritize CDRs for JPSS-era continuity (e.g. reprocessed SDRs), (b) determine options for extending prioritized CDRs, and (c) negotiate among partners for execution and sustainment of CDRs.

7. GSICS User Workshop

This year's GSICS User's Workshop was conducted as a one day session during the annual meeting. Over 50 researchers and users met to exchange information on advances, applications, and requirements for calibration products. The following were among the key take-away messages: (1) GSICS activities have matured to the point where they are providing the foundation for a truly Global System of infrared instrument measurements including polar and geostationary satellites, (2) methods for visible, microwave and ultraviolet instruments are progressing and are addressing differences in the reference measurements, sensor technologies and Earth signatures in their different spectral regions, and (3) the ICVS is an important asset in the NOAA participation in GSICS activities.

8. Socioeconomics and educational outreach

The NOAA Office of Performance, Risk, and Social Science (PRSS) highlighted the need for social science integration, value concept and economic evaluation of NOAA products to help decision makers achieve NOAA's mission. Their presentation outlined the vision and goals of NOAA's social science committee that has representatives from each of the NOAA line offices. They discussed the value of NOAA data (environmental intelligence) for the private and public sectors, improved economic decisions resulting from the direct use of environmental intelligence and perceived benefits to human behavior. The presentation detailed the use of evaluation tools such as the cost-benefit analysis among data and observing systems, the analysis of alternatives

to evaluate benefits of different scenarios of program/project implementation, and market and non-market evaluation methods. The presentation emphasized the importance of evaluations to justify government funding, the alignment of mission goals and operations to public value, and decision-making for both resource allocation and towards the prioritization of observing systems. The presentation also included specific examples of satellite valuation studies, associated benefits, and current PRSS initiatives on end-to-end value evaluations and socio-economic benefits.

As part of the JPSS educational outreach activities, IM Systems Group, in collaboration with the City University of New York (CUNY) and scientists at STAR, presented a summary of the JPSS training program for summer 2016 interns titled, "Students Professional and Academic Readiness with Knowledge in Satellites (JPSS-SPARKS)." The training program provided hands-on experience to six graduate interns on JPSS science product algorithm research and development, calibration/validation, the fundamentals of the research to operations process, programming languages, and standards used in the operational implementation of the JPSS science algorithms. Student evaluation metrics were presented on the training collected at the beginning and at the end of the training program. Future plans on the continuation of the JPSS educational outreach and program, expansion of this training program to accommodate students from many universities in succeeding years, and planned improvements were discussed to seek suggestions and comments from the educational communities, forums, academic and industry partners.

9. Conclusion

In conclusion, the third JPSS STAR Annual science meeting was a success with enough breadth to cover the large STAR JPSS program and in-depth presentations proving that the program is well prepared for the launch of J1. Throughout the meeting, an array of presentations discussed Suomi NPP product applications across NOAA line offices, domestic and international agencies and users. Progress on using Suomi NPP products in NWP assimilations 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.) have shown remarkable success.

A consensus on these indicated that the JPSS Program is well coordinated from the development of algorithms to product generation, cal/val, and user engagement through many proving ground initiatives. The ability to derive JPSS products through direct broadcast networks and using Community Satellite Processing Package (CSPP) has been found to be extremely fruitful for many regional applications. The meeting also noted that the critical issue for current and future satellite program success relies on working together with the users, developing requirements, understanding the requirements and the use of products by user communities, and meeting the requirements through the development of science quality products. The process of making new products, demonstrations of the product applications, operationalization, and having satellite liaisons and programs to train the users have been found to be the key success parameters.

Presentations made by distinguished NOAA leaders and the JPSS program office offered many recommendations for the future direction of the program. Overall, the science team panel has called for continued efforts towards enterprise solutions and moving away from mission based approach and towards measurement based approach. The panel also envisioned the globalization and unification of cal/val processes and product maturity definition derived from a variety of satellite platforms. All of the science teams recognized the need for science quality data reprocessing and archival of land, cryosphere, atmosphere, and ocean products maintaining high quality and consistency for satellite research and applications. The meeting provided 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. Feedback from participants, team members, users and JPSS management was positive and indicated that the objectives envisioned for the meeting were satisfactorily fulfilled.

Details and all the meeting presentations are available on the STAR JPSS webpage. http://www.star.nesdis.noaa.gov/star/meeting_2016JPSSAnnual_agenda.php