NESDIS SATELLITE PRODUCTS FROM RESEARCH TO OPERATIONS

Stacy L. Bunin*[1], Tom Schott[2], Kevin Berberich[2]

[1] Noblis, Falls Church, Virginia
[2] NOAA/NESDIS, Suitland, Maryland

Presented at the Second Conference on Transition of Research to Operations: Successes, Plans, and Challenges in New Orleans, Louisiana, January 2012

1. INTRODUCTION

The National Oceanic and Atmospheric Administration's (NOAA) National Environmental Satellite, Data, and Information Service (NESDIS) provides timely access to satellite data for a variety of domestic and international users. Over the last decade, NESDIS has successfully transitioned key capabilities from research to operations through utilization of the Satellite Products and Services Review Board (SPSRB) process in addition to established geostationary and polar-orbiting satellite acquisition programs.

This paper focuses on the examples of product development efforts that have successfully transitioned from research to operations and will highlight some products that are currently in the transition process.

2. OVERVIEW OF THE SPSRB PROCESS

The SPSRB is a structured process providing operational users of satellite data a means to satisfy data requirements. The SPSRB is responsible for the oversight and guidance necessary to effectively manage the product life cycle process from product development, transition into operations, enhancements, and retirement.

The SPSRB process allows for a couple of avenues for products to be transitioned from research to operations. A user can identify the need for a new or improved satellite observation or product by submitting a user request. User requests are currently restricted to.gov or .mil web domains. Other users can submit requests through a NESDIS sponsor.

Scientific agencies can also identify maturing satellite product development or algorithms that improve current shortfalls and may provide significant user benefits.

Product development begins after a user requirement is validated and resources are identified. Product development efforts that transition to operations include continuity products for replacement satellites, new and enhanced capabilities from existing satellite systems, and new products from new satellite systems.

3. NESDIS PRODUCT DEVELOPMENT EFFORTS

3.1 *Successful Development Efforts*

Over the last several years there have been many successful development efforts that have utilized the SPSRB process and transitioned capabilities from research to operations benefiting the end user and helping to satisfy requirements. A few of these efforts are highlighted below.

ASCAT High Resolution Winds and Ice Imagery

The Advanced Scatterometer (ASCAT) instrument aboard the Metop satellite has provided the opportunity to generate a variety of new products. Products from ASCAT became particularly important for continuity after the failure of the National Aeronautics and Space Administration (NASA) QuikSCAT satellite. Product development for ASCAT derived products started in 2006. New 25-km and 50-km ocean surface wind products were successfully transitioned to operations a couple of years later, however, product development for

* *Corresponding author address*: Stacy L. Bunin, Noblis, Falls Church, VA; e-mail: sbunin@noblis.org.

additional products continued. Recently two new ASCAT products were transitioned from research to operations. A high spatial resolution ocean surface wind product with a resolution of 3-5 km was declared operational. This product is generated over specific tropical storms to help scientists understand the additional storm structure not shown in standard wind products. A sample of the new high resolution ocean surface wind product is shown in Figure 1.

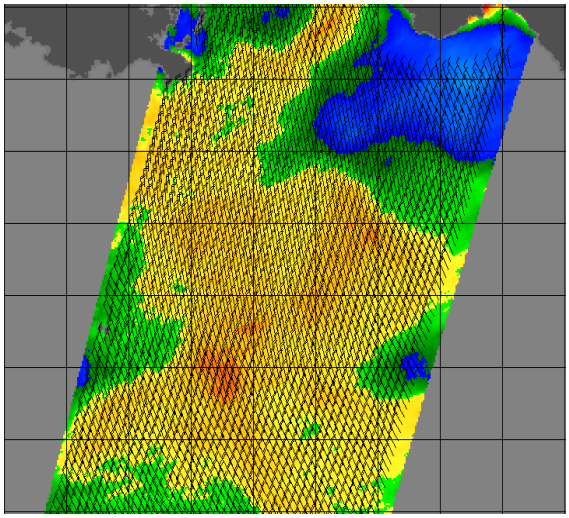

Figure 1. ASCAT high spatial resolution wind product.

Another new operational product is a daily sea ice product generated for Alaska, Antarctic, Arctic, Ross Ice Shelf, and Weddell Sea. Users for these products include the National Ice Center and the National Weather Service Alaska region. Figure 2 shows an operational daily ice composite image.

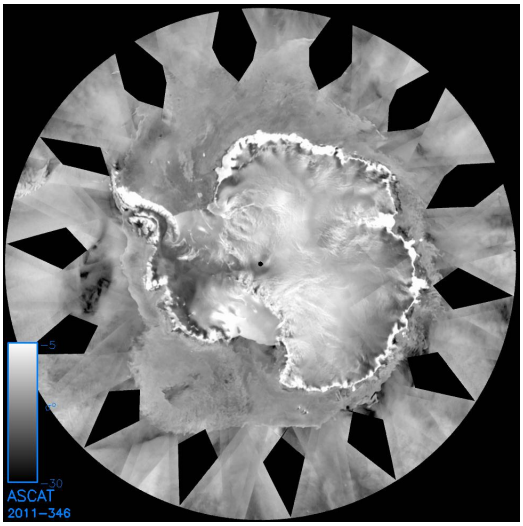

Figure 2. ASCAT daily ice composite imagery over the Antarctic.

Blended Total Precipitable Water (bTPW)

In 2009 a new operational blended TPW product became available to users. The product blended data from microwave instruments on polar-orbiting satellites, as well as data from GOES and GPS into one unified product. The blended TPW product is used by satellite analysts and weather forecasters to help analyze and forecast heavy rain and flooding events. By blending the individual TPWs into one product, a forecaster can get a more complete observation of the movement of moisture in the atmosphere. However, this product was generally only available over oceans, leaving gaps over the land.

A new enhancement was recently declared operational that uses the output from the Microwave Integrated Retrieval System (MIRS), which has the capability of retrieving TPW over land and oceans in all weather conditions. In addition, the enhanced product added TPW data from the Defense Military Satellite Program (DMSP) for increased temporal sampling. Figure 3 shows the original blended TPW product along with the new enhanced product that fill in the gaps over land regions.

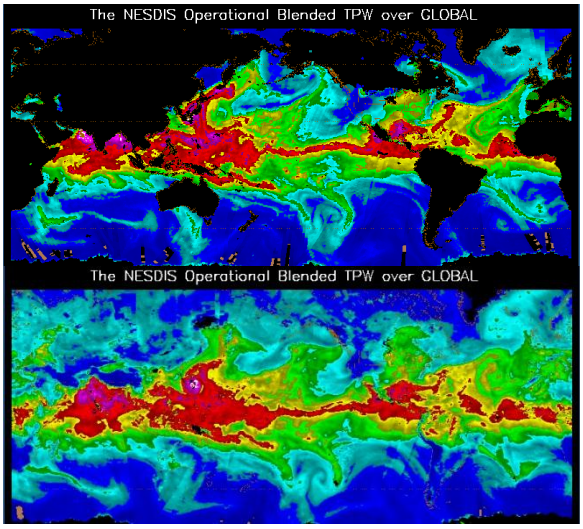

Figure 3. The original blended TPW product (top) with the enhanced product (bottom).

Ensemble Tropical Rainfall Potential

The Ensemble Tropical Rainfall Potential (eTRaP) project's purpose is to generate estimates of 24-hour rainfall associated with land-falling tropical cyclones. The algorithm uses rain rates from microwave sensors from several polar-orbiting satellites to supplement rainfall estimates from model forecasts and to increase precipitation forecast lead times. Validation showed that the combination of several TRaPs versus using single sensor forecasts reduces overall random error and allows for more accurate location of the rainfall maximum.

The eTRaP products have been operational since 2009 and are in the process of being upgraded to include probability of precipitation calibrations. Figure 4 shows an example of an ensemble tropical rainfall potential product that was generated for Hurricane Irene.

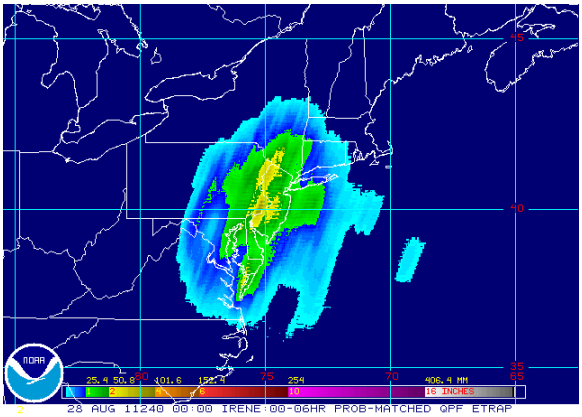

Figure 4. Tropical rainfall potential for Hurricane Irene in August 2011.

Multiplatform Tropical Cyclone Surface Wind Analysis

The multiplatform tropical cyclone surface wind analysis provides an estimation of the surface wind field around active tropical cyclones. The product is generated at 6-hour intervals for the analysis of 34-kt, 50-kt, 64-kt, and maximum wind radii.

The tropical cyclone surface wind analysis combines GOES-derived near core winds, cloud and feature winds from GOES and other geostationary satellites, ocean wind vectors from the ASCAT instrument aboard the Metop satellite, and low-level winds from the AMSU instrument on the POES, Metop, and Aqua satellites.

Images for each time period generated for tropical storms include the surface wind analysis on a storm scale, the surface wind analysis on the scale of the inner core of the storm, a time series of maximum winds and minimum sea level pressure, an infrared image of the tropical cyclone at analysis time, and the following data that is used in the analysis: AMSU data, cloud drift winds and water vapor wind data, infrared flight level proxy winds, and ASCAT data.

Figure 5 shows a wind analysis associated with Hurricane Katia. Figure 6 shows the time series of maximum winds and minimum sea level pressure during the same time frame.

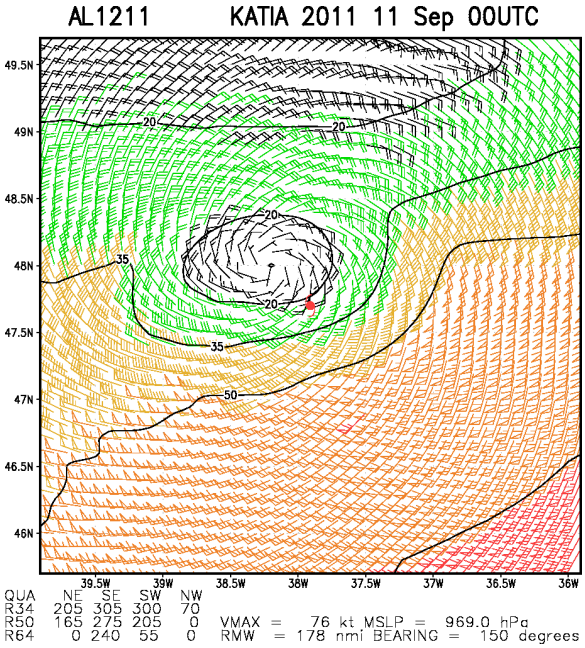

Figure 5. The multiplatform wind analysis from Hurricane Katia in September 2011.

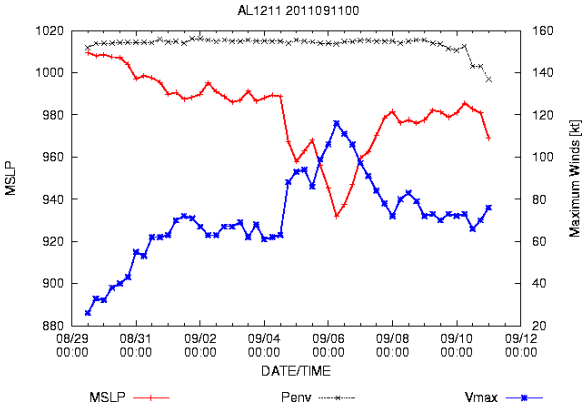

Figure 6. A time series of maximum winds and minimum sea level pressure during Hurricane Katia.

3.2 *Development Efforts in Transition*

The successful launch of the Suomi National Polar-orbiting Partnership (NPP) in October 2011 brought NESDIS one step closer to providing new operational products. Development efforts for some of these products began in 2006 through NOAA's NPP Data Exploitation (NDE) Project. NDE is the critical link between the NPP ground segment and the civilian operational user community. During the next year several new NDE products are expected to be transitioned to operations. The NDE products will be generated from the new instruments aboard NPP: Cross-track Infrared Sounder (CrIS), Advanced Technology Microwave Sounder (ATMS), Visible/Infrared Imager/Radiometer Suite (VIIRS), and Ozone Mapping and Profiler Suite (OMPS). The following section describes NDE products as well as products from other satellites that expected to transition into operations in 2012.

NDE: MIRS

The Microwave Integrated Retrieval System (MIRS) generates products over all-weather conditions for different surface types using data from microwave sensors. MIRS products have historically been generated from the AMSU-A and MHS instruments on the POES and Metop satellites and the SSM/I instruments on DMSP satellites. New MIRS products will be generated from NPP's ATMS instrument and will include: ice water path, rain water path, snow water equivalent, snow cover, sea ice concentration, cloud liquid water, temperature and moisture profiles, land surface temperature, land surface emissivity, total precipitable water, and rainfall rate.

Figure 7 shows one of NDE's first ATMS products following the launch of NPP. Figure 8 shows the full global total precipitable water product that will be transitioned to operations. The full suite of MIRS products is expected to be declared operational in late 2012.

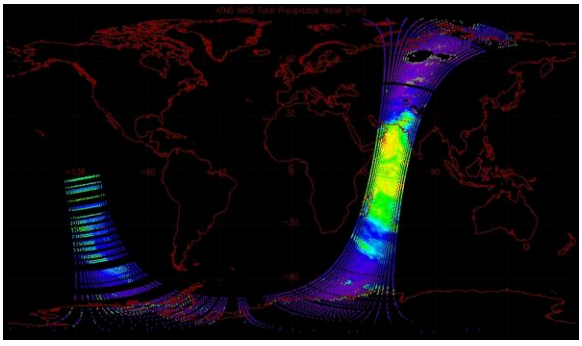

Figure 7. Total precipitable water from NPP data.

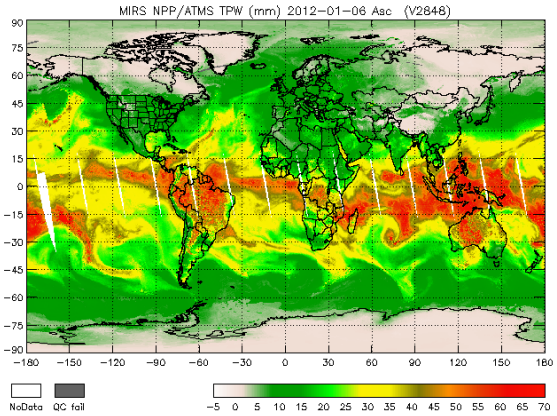

Figure 8. Global Total Precipitable Water from NPP data.

NDE: CrIS/ATMS

Hyperspectral sounding products are assimilated into numerical weather prediction models and are used within climate applications. Products have been generated from the AIRS instrument on the Aqua satellite and the IASI instrument on Metop. To provide for continuity, new products will be generated from CrIS and ATMS data from NPP. The first CrIS/ATMS product to transition to operations will be the principal components, which will compress 1305 channel radiances into approximately 85 independent values.

NDE: Green Vegetation Fraction

The green vegetation fraction (GVF) product is used to give a better characterization of the surface in land surface models compared to using climatology. GVF has been generated from the AVHRR instrument on the POES satellites and will also be generated from the VIIRS instrument on NPP.

NDE: Polar Winds

Polar wind observations are provided over the polar regions where in-situ observations are lacking. Numerical weather prediction forecasts saw an improvement in accuracy when the first polar wind products were declared operational. Polar winds have been generated from the AVHRR on POES and Metop and the MODIS instrument on Aqua and Terra. Cloud-tracked atmospheric wind vectors will be generated from the VIIRS instrument on NPP. The VIIRS instrument has a better resolution towards the edges of the swath, which is expected to result in a better spatial coverage for the polar winds product, as well as more accurate wind information towards the edges of the swath.

Figure 9 shows a sample of the polar winds product from AVHRR data. A similar polar winds product will be generated from the VIIRS.

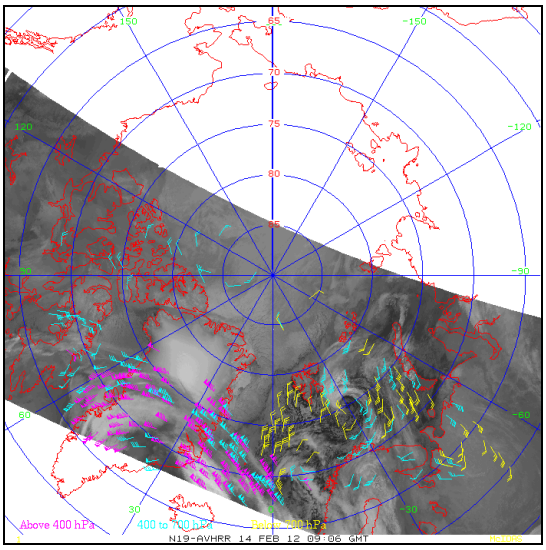

Figure 9. Polar Winds product.

NDE: NetCDF Reformatting Tool

NDE will provide most products in NetCDF4 format, but some users also require additional formats for specific products. For example, numerical weather prediction centers need radiances and other products in BUFR and GRIB2 formats. To avoid software redundancy of a different reformatting tool for each product system, a new tool is being developed that will be able to reformat required NDE products into BUFR and GRIB2.

The first products to be tailored using the NetCDF reformatting tool will be: CrIS radiances, ATMS antenna temperatures, VIIRS radiances, sea surface temperature, nadir profile ozone and OMPS radiances, aerosol optical depth, VIIRS polar winds, and VIIRS green vegetation fraction.

The reformatting tool will complete the ability to tailor these products during 2012 even though some of the products are still completing development prior to their transition to operations.

Table 1 shows the initial products that will have the capability of being reformatted into BUFR and GRIB2 formats.

Prioritized Product	BUFR	GRIB2
ATMS Radiances	X	
CrIS Radiances	X	
Nadir Profile Ozone (OMPS) and OMPS Radiances	X	
VIIRS Radiances	X	
Aerosol Optical Thickness	X	
Sea Surface Temperature	X	
VIIRS Polar Winds	X	
Green Vegetation Fraction		X

Table 1. Additional product formats from the NetCDF Reformatting tool.

Vegetation Health

Vegetation health products are used to predict areas of drought, forest fire risk, crop losses and production, and the start and end of growing season. Vegetation health products include vegetation health index (VHI), vegetation condition index (VCI), and temperature condition index (TCI). The VCI resolution will be improved, moving from 16-km to 4-km and the VHI and TCI products are new developments. All three of the vegetation health products are expected to be declared operational from the POES satellites using AVHRR data in the summer of 2012.

Synthetic Aperture Radar High Resolution Coastal Winds

High resolution coastal winds from SAR instruments are a useful input to forecasts in coastal regions with significant coastal topography. In these areas, dangerous high-spatially variable winds impact the safety of coastal transportation, fishing activities, search and rescue missions, and low-flying aircraft. Winds will be generated with a horizontal resolution of 1-km or less using SAR data from Radarsat and Envisat, initially for the Alaskan coastline, as well as the Washington and Oregon coasts.

Figure 10 shows an example of the SAR coastal wind product.

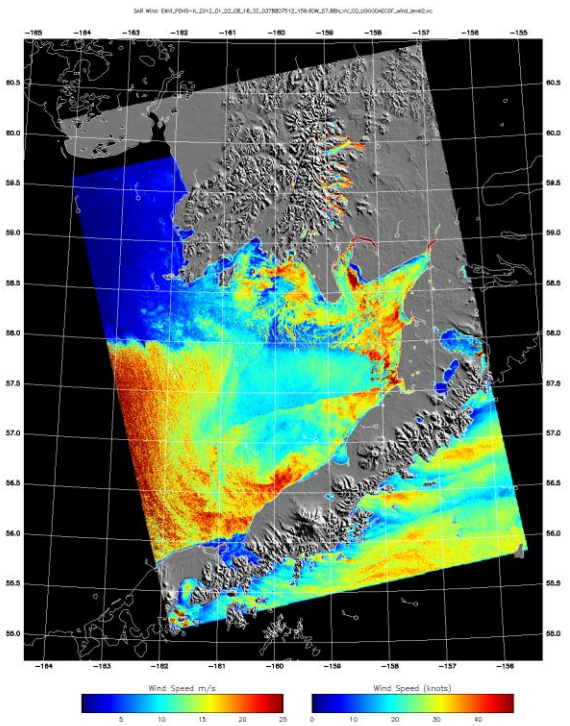

Figure 10. An example of the SAR high resolution coastal wind product.

Oceanic Heat Content

Oceanic heat content (OHC) is a measure of the integrated vertical temperature from the sea surface to the depth of 26°C. It will be used to monitor the temperature variations at depth to determine how the ocean conditions affect coral reefs, particularly at deeper reef sites. It will also be used to improve hurricane intensity forecasts.

OHC will initially be available for the North Atlantic and east Pacific basins. Products are generated using the sea surface height anomalies and the POES-GOES blended sea surface temperature analysis, as well as data from the altimeters aboard Jason-1, Jason-2, and Envisat.

4. CONCLUSION

The SPSRB holds monthly meetings to discuss user requests, determine strategies to address user requests and approve new products and services for operational use. The SPSRB process has proven to be successful at transitioning products from research into operations. It helps bridge the gap between requirements and the program execution processes. The SPSRB also helps to open the lines of communications between researchers, product generators, and users.

There are several new products that will be transitioning from research to operations in 2012 and beyond. Users can identify any additional requirements for new or enhanced capabilities by submitting a user request at https://requesttracker.osd.noaa.gov/admin_login.asp (currently limited to .gov and .mil domains). All user requests are considered by the SPSRB for product development.

5. REFERENCES

Advanced Scatterometer Data Products, http://manati.orbit.nesdis.noaa.gov/products/ASCAT.php

Blended Total Precipitable Water Products, http://www.osdpd.noaa.gov/bTPW/

CrIS/ATMS Product Information, http://www.star.nesdis.noaa.gov/smcd/spb/iosspdt/iosspdt.php

Ensemble Tropical Rainfall Potential Products, http://www.ssd.noaa.gov/PS/TROP/etrap.html

Microwave Integrated Retrieval System, http://www.osdpd.noaa.gov/ml/mirs/

Multiplatform Tropical Cyclone Surface Wind Analysis Products, http://www.ssd.noaa.gov/PS/TROP/mtcswa.html

Polar Wind Product Information, http://stratus.ssec.wisc.edu/projects/polarwinds/

Satellite Products and Services Review Board (SPSRB) Process Paper, V11.5, available from http://projects.osd.noaa.gov/spsrb/doc/SPSRB_Process_Paper_Ver11-5.doc

Synthetic Aperture Radar Products, http://www.star.nesdis.noaa.gov/sod/mecb/sar/sarproducts.html

Vegetation Health Products, http://www.star.nesdis.noaa.gov/smcd/emb/vci/VH/index.php