GOES-R Proving Ground Demonstration Proposal and Operations Plan
2016 National Hurricane Center Demonstrations

1. **Project Title:** The 2016 Satellite Proving Ground at the National Hurricane Center

2. **Organization**: NOAA/NCEP/NHC

3. **Products to be Demonstrated in the NHC GOES-R Proving Ground:**

    1) Hurricane Intensity Estimate (Baseline)
    2) Super Rapid Scan imagery (Baseline)
    3) Tropical Overshooting Tops (Future Capability)
    4) GOES-R natural color imagery product (Future Capability)
    5) Red-Blue-Green (RGB) Air Mass product (Future Capability)
    6) RGB dust product, EUMETSAT version (Future Capability)
    7) RGB dust product, CIRA DEBRA-Dust version (Future Capability)
    8) Saharan Air Layer product (Future Capability)
    9) Pseudo natural color imagery product (Future Capability)
    10) RGB daytime microphysics product (Future Capability)
    11) RGB nighttime microphysics product (Future Capability)
    12) RGB convective storms product (Future Capability)
    13) Rapid Intensification Index (Risk Reduction)
    14) Lightning density product (Baseline)
    15) VIIRS Day/Night band (JPSS)
    16) Derived Motion Winds (Baseline)
    17) NUCAPS soundings (JPSS)
    18) AIRS, NUCAPS, and IASI Ozone Retrievals (JPSS)

4. **Demonstration Project Summary:**
    a. **Overview:** The NOAA Satellite Proving Ground at the National Hurricane Center (NHC) has been providing forecasters with early exposure to GOES-R products since it began in 2010. The PG runs during the height of the Atlantic and N. E. Pacific hurricane seasons, 1 August through 30 November. During this time pre-operational demonstrations of GOES-R and JPSS products provide NHC operational forecasters with an opportunity to gain experience with new capabilities in the pre-launch period and to critique and improve the products relatively early in their development.

    b. **Plan, Purpose, and Scope:** The purpose of the NOAA Satellite Proving Ground (PG) at the National Hurricane Center (NHC) is to provide NHC forecasters with an advance look at tropical cyclone-related satellite products for evaluation and feedback during the most active period of the Hurricane season (August 1 – November 30). A total of 18 products will be demonstrated during the 2016 NHC PG, including 15 GOES-R baseline products, future capabilities, and risk reduction products as well as 3 JPSS future capability products. Demonstration products and algorithms will be provided by NESDIS/STAR, CIRA, CIMSS, CIMAS, SPoRT, and OAR. The ABI products will be produced using proxy data from Meteosat, GOES, and MODIS. NUCAPS soundings will be produced using data from S-NPP sounders. The GLM

product will be produced from proxy ground-based World Wide Lightning Location Network (WWLLN) data. NHC also has access to the Vaisala GLD360 ground-based lightning data in real time on their NWS National center Advanced Weather Interactive Processing System (N-AWIPS) systems as another proxy for the GLM.

Feedback on the utility of the NHC PG products was gathered through a web based form, informal email exchanges between the NHC participants and product providers, and a mid-project review that will be held at NHC on in September 2016. Highlights of forecaster feedback will be submitted via a final report to the GOES-R/JPSS Proving Ground and, after review, will be posted to the GOES-R Proving Ground website (http://www.goes-r.gov/users/pg-activities-01.html). Supplemental information on PG products will also be provided by product developers via blogs, which are available from http://nasasport.wordpress.com and http://rammb.cira.colostate.edu/research/goes-r/proving_ground/blog.

The focus of this demonstration is on products for the Hurricane Specialist Unit (HSU) during the climatologically most active part of the Atlantic hurricane season. Some PG products are also being evaluated by the Tropical Analysis and Forecast Branch (TAFB), in coordination with the Ocean Prediction Center/Weather Prediction Center/Satellite Analysis Branch (OPC/WPC/SAB) PG. Some of those demonstrations extend beyond the hurricane season. This plan will only describe the activities associated with the 2016 HSU GOES-R PG activities and the TAFB demonstrations that overlap with those. Additional TAFB products under evaluation are described in the operations plan for OPC/HPC/SAB/TAFB being led by M. Folmer.

c. **Goals:** The main goals of the NHC Hurricane Season PG Experiment are to demonstrate identified GOES-R surrogate products in real-time at the NHC during the 2016 hurricane season so the NHC forecasters can use, get familiar with, and evaluate the products and provide valuable feedback to the product developers and GOES-R Program Office (GPO).

The NHC PG includes a large number of baseline, future capability, and risk reduction products for demonstration. To manage this large number of products and keep the NHC PG from overwhelming forecasters, demonstrations were divided into five categories, each with its own evaluation goals (Table 1). This evaluation strategy allows the Satellite Liaisons to focus training and evaluation efforts on a smaller subset of products with specific goals in mind while continuing to collect feedback on the more mature NHC PG products. This method proved successful in the last two years and will be continued for the 2016 NHC PG demonstration. Since this will be the last NHC PG Experiment prior to the launch of GOES-R, Baseline products will be emphasized in 2016.

Table 1. The 2016 NHC PG Evaluation Categories. GOES-R Baseline products (*) will be emphasized in the 2016 NHC PG in preparation for the launch of GOES-R.

NHC PG Experiment, 1 Aug - 30 Nov 2015			
Category	**Description**	**Evaluation Goal(s)**	
Mature	Products that have been included in NHC PG for several years, have received positive feedback, and proven useful for tropical applications. Less training needed.	Continue to make these products available so additional forecaster feedback can be obtained, time permitting.	Natural Color RGB Air Mass RGB Dust Saharan Air Layer Pseudo Natural Color SRSO* VIIRS DNB
Quantitative	Products that provide objective, quantitative guidance.	Perform a quantitative verification in the post-season and provide feedback to product developers, and to help gain forecaster confidence for eventual operational transition.	HIE* Lightning-based RII
Introductory	Forecasters have received little exposure and limited feedback received.	Emphasize these products and obtain feedback on possible tropical applications.	RGB Daytime Micro RGB Nighttime Micro RGB Conv Storms Derived Motion Winds* NUCAPS soundings ET products
Comparison	Products similar to other NHC PG products. As the GOES-R launch approaches, decisions will need to be made regarding the product sets to be routinely included on NHC AWIPS systems.	Encourage forecasters to display the comparison products along with the originals to provide feedback on the strengths and weaknesses of each.	DEBRA-Dust Lightning density*
Underutilized	Products included in the NHC PG for several years yet HSU applications still not clear	Work with HSU to determine if these products should continue to be included in their current form, be modified, or given less emphasis in NHC's eventual operational AWIPS configuration.	TOTs

5. Participants Involved:

a. **Providers:**
   1) Hurricane Intensity Estimate (HIE and CIMSS)
   2) Super Rapid Scan imagery (CIRA and CIMSS)
   3) Tropical Overshooting Tops (CIMSS)
   4) GOES-R natural color imagery product (CIRA)
   5) Red-Blue-Green (RGB) air mass product (CIRA and SPoRT)
   6) RGB dust product (EUMETSAT version) (SPoRT)
   7) RGB Enhanced dust product (DEBRA-Dust) (CIRA)
   8) Saharan Air Layer (SAL) product (CIMAS, CIMSS and SPoRT)
   9) Pseudo natural color imagery product (CIRA)
   10) RGB daytime microphysics product (SPoRT)
   11) RGB nighttime microphysics product (SPoRT)
   12) RGB convective storms product (SPoRT and CIRA)
   13) Rapid Intensification Index (RII) (CIRA)
   14) Lightning density product (CICS)
   15) VIIRS Day/Night band (S-NPP product) (CIMSS, SPoRT, and CIRA)
   16) Derived Motion Winds (NOAA/NESDIS/STAR)
   17) NUCAPS soundings (NOAA/NESDIS/STAR and SPoRT)
   18) AIRS, NUCAPS, and IASI Ozone Retrievals (NOAA/NESDIS/STAR and SPoRT)

b. **Consumers:**
   1) NHC Hurricane Specialist Unit (HSU)
   2) NHC Tropical Analysis and Forecast Branch (TAFB)

6. **Project Schedule:**

   i. 01 Jun 2016 – Begin product checkout at NHC
   ii. 01 Aug 2016 – Product demonstrations begins
   iii. Sep 2016 – Mid-project review at NHC
   iv. 30 Nov 2016 – Product demonstrations end
   v. Jan/Feb 2017 - Conference call with all project participants
   vi. Mar 2017 – Final evaluation report completed

7. **Project Decision Points and Deliverables:**
   a. Proving Ground Demonstration Plan – First Draft: 24 July 2016
   b. Proving Ground Operations Plan – Final: 31 July 2016
   c. Proving Ground Final Report: 31 March 2017

8. **Responsibilities and Coordination:**

   a. **Project Authorization**
   - Richard Knabb, Director, NHC
   - Steve Goodman; GOES-R Chief Scientist and PG Program Manager

   b. **Project Management**
   - Mark DeMaria, NOAA/NCEP/NHC
   - Andrea Schumacher, CIRA/Colorado State University (CSU)
   - Michael Brennan, NOAA/NCEP/NHC

- Jack Beven, NOAA/NCEP/NHC
- Renate Brummer, CIRA/Colorado State University (CSU)
- Erin Dagg, CIRA/Colorado State University (CSU)

c. Technical Support at NHC
- M. DeMaria, Technology and Science Branch Chief, NHC
    - Implementation of all product delivery mechanisms at NHC will be coordinated with the TSB Chief

d. Additional POCs
- Jack Beven – NHC focal point
    - Coordinate with other hurricane specialists as well as forecasters from the NHC Tropical Analysis and forecast Branch.
- Michael Brennan – Alternate focal point at NHC
    - Assist Jack in planning, preparation, and execution
- Hugh Cobb and Nelsie Ramos – NHC focal points for the Tropical Analysis and Forecast Branch (TAFB)
- Mark DeMaria (NOAA/NCEP/NHC)
    - Overall NHC PG project management
    - Lightning-based rapid intensification index
- John Knaff (NOAA/NESDIS/STAR/RAMMB)
    - MSG product generation
    - POC for Super Rapid Scan Imagery
- Don Hillger (NOAA/NESDIS/STAR/RAMMB)
    - GOES-R true color algorithm
- Debra Molenar (NOAA/NESDIS/STAR/RAMMB)
    - Technical support for CIRA products
- Kevin Micke (CIRA/CSU)
    - Technical support for CIRA products
- Steve Miller (CIRA/CSU)
    - Specialized version of the RGB dust product
- Jason Dunion (U. of Miami, CIMAS-NOAA/Hurricane Research Division)
    - Coordinate with CIMSS and CIRA on demonstrating RGB aerosol/dust product
    - Saharan air layer product
    - Pseudo natural color imagery product
- Chris Velden (U. Wisconsin, CIMSS)
    - POC for HIE and overshooting tops product
- Gary Jedlovec and Kevin Fuell (SPoRT)
    - Provision of RGB and other image products in N-AWIPS format and related training
- Michael Folmer (CICS/UM)
    - Coordination with OPC/HPC/SAB/TAFB PG and demonstration of GOES-R tropical cyclone products to NASA during the HS3 field experiment
- Emily Berndt and Bradley Zavodsky (SPoRT)
    - POCs for AIRS, NUCAPS, and IASI Ozone Retrievals

9. **Budget and Resource Estimate:** Funded through the GOES-R Science Office as part of the Omnibus Proving Ground funding to CIRA, CIMSS, NASA/SPoRT.

1. Product Name: Hurricane Intensity Estimate (HIE)

Primary Investigator: Chris Velden, UW/CIMSS

NHC/TAFB Relevance: Infrared-based estimates of tropical cyclone (TC) intensity from subjective interpretation of imagery have been the cornerstone of operational tropical cyclone forecast agencies for several decades. The HIE is the next generation version of the objective Automated Dvorak Technique (ADT) for GOES-R.

Product Overview:
- The HIE GOES-R algorithm will estimate hurricane intensity (mean sea level pressure (MSLP) and max surface wind) from ABI IR-window channel imagery.
- Product will be demonstrated in pre-launch using 15 min GOES-East CONUS (MSG) IR imagery for those systems west (east) of 60ºW
- The code for the product was derived from the current operational ADT (v8.2.1).

Product Methodology:
- Product will be run in real-time at UW/CIMSS in Madison, WI, during Atlantic tropical cyclone events and made available via dedicated web site.
- It will be automatically activated upon NHC declaring any Atlantic system a Tropical Depression or greater strength.

Hurricane Intensity Estimate Products:
- Estimates of TC maximum sustained surface wind, minimum sea-level pressure

Recent Product Modifications:
- June 2014, HIE now run using modified ADT version 8.2.1 (CIMSS and SAB operational version)

Concept for Pre-Operational Demonstration:
- The HIE products will be generated at CIMSS in real time and provided using the mechanisms as the current Advanced Dvorak Technique (ADT)

Concept for Operations:
- The HIE is a baseline GOES-R product and will be provided as part of the operational processing system

2. Product Name: Super Rapid Scan Imagery

Primary Investigator: T. Schmit, NESDIS/ASPB, J. Knaff, NESDIS/RAMMB

NHC/TAFB Relevance:
- GOES-R will provide routine 5-min imagery and better capabilities for providing 1 min imagery than the current GOES satellites. The 1-min imagery are not routinely utilized by NHC for tropical cyclone applications, so special datasets are being collected to provide experience the higher time resolution imagery.
- Will provide super rapid scan operations (SRSO) data during hurricane events to better document convective evolution, and provide research datasets for improving atmospheric motion vectors

Product Overview:
- The 1-min imagery will be provided from current GOES satellites. This will include Super Rapid Scan Operations (SRSO) data from the operational GOES-east and –west when possible and SRSO-Research (SRSO-R) from GOES-14.

Product Methodology:
- Short periods of SRSO data may be collected for land-falling cases, although this ability is constrained by the operational RSO scanning mode that is triggered when tropical storm operations are in place. Typically RSO is called for GOES-east, so SRSO will be called for GOES-west if the storm is far enough west.
- The GOES-14 satellite will be available during the main part of the 2013 Hurricane Season (Aug-Oct) and will be centered at 105ºW. Extended periods of 1 minute imagery will be available (SRSO-R), and will be called for cases of interest. With SRSO-R, 26 images can be collected every ½ hour.

Super Rapid Scan Imagery Products:
- Full resolution 1 minute visible imagery

Recent Product Modifications:
- None

Concept for Pre-Operational Demonstration:
- The current satellite systems at NHC are not set up to ingest the 1 min imagery, so these will be ingested at CIMSS and CIRA and made available via web pages.

Concept for Operations:
- SRSO data will be available via direct readout systems or NESDIS servers and displaced on AWIPS2 systems at NHC when GOES-R becomes operational.

3. Product Name: Tropical Overshooting Tops (TOTs)

Primary Investigators: Sarah Monette and Chris Velden

NHC/TAFB Relevance:
- The product can help to identify vortical hot towers, which are related to tropical cyclone formation and rapid intensification. For TAFB applications, the TOT product has the potential to help identify the most active areas of convection for their marine products.
- NHC forecasters will provide feedback on the utility of the TOT product in the preparation of their operational forecasts.

Product Overview:
- Real-time TOT activity over the tropical and subtropical Atlantic east (west) of 55°W based on 15-min Meteosat (GOES-East) imagery.

Product Methodology:
- Uses infrared window channel imagery to identify protrusions above cumulonimbus anvils associated with very strong updrafts.

Tropical Overshooting Tops Products: Lat/Lon and strength of TOTs updated every 15 min.

Recent Product Modifications:
- July 2013 – ADT used to identify TC CDO pattern, TOT threshold reduced from 9K to 5K in cold CDO region as defined by IR brightness temperatures.

Concept for Pre-Operational Demonstration:
- The TOT product is generated at CIMSS and displays made available through a web page (http://cimss.ssec.wisc.edu/goes_r/proving-ground/nhc/ot/). TOT files are also distributed to NHC and made available for N-AWIPS format.

Concept for Operations:
- The TOT product is a variation of the GOES-R Overshooting Tops algorithm. The TOT product could be generated on a central system at NESDIS and distributed along with the OT product.

4. Product Name: GOES-R Natural Color Imagery

Primary Investigator: Don Hillger, NESDIS/STAR/RAMMB

NHC/TAFB Relevance:
- GOES-R will provide natural color products with high time resolution. Although GOES-R will not have a green channel so that a true color image cannot be generated, a very close approximation is possible by predicting the green channel from neighboring visible and near-IR channels. This approximation to a true color imagery (called natural color) hold great potential for public outreach. The product also can be used for analysis similar to what the current single channel visible imagery is used for. This includes identification of cloud features and structure, aerosols, etc. Tropical specific applications are described in Appendix 2.

Product Overview:
- Natural color imagery will be generated from MODIS imagery and made available in real time via a web page. Since MODIS has a green band, the true color image can also be generated for comparison with the natural color version to evaluate the GOES-R algorithm.

Product Methodology:
- ABI will have blue and red bands, but no green band. Thus, it will not be possible to provide a true color image.
- The AWG imagery team has developed a method to accurately estimate the green band using look up tables, where the green band is estimated from the blue, red and near-IR bands.
- The simulated green band is combined with the blue and red bands to generate the natural color imagery.
- This algorithm will be tested using MODIS data to create storm-centered natural color images.

GOES-R Natural Color Imagery Products:
- Natural color imagery (and true color imagery for verification) will be generated routinely using MODIS.

Recent Product Modifications:
- None

Concept for Pre-Operational Demonstration:
- Imagery centered on features of interest (e.g., tropical cyclones) will be generated and made available via a web page. For tropical cyclone applications, these are available from http://rammb.cira.colostate.edu/products/tc_realtime/. These products will also be generated in AWIPS2 format as those systems become available at National Centers.

Concept for Operations:
- The natural color imagery could be generated at an operational location in NESDIS and distributed along with the GOES-R ABI. A local application could also be developed for AWIPS2 systems, to reduce the bandwidth required to send the extra natural color images.

5. Product Name: MSG RGB Air Mass

Primary Investigators: Kevin Fuell (SPoRT) and John Knaff (NESDIS/STAR/RAMMB)

NHC/TAFB Relevance and Product Overview:
- Product allows for a three-dimensional assessment of the best state of the atmosphere.

- Allows for a more accurate analysis of where rapid cyclogenesis, jet streaks, and PV anomalies occur.

Product Methodology:
- Product is generated from Meteosat Second Generation SEVIRI channels 12 (WV6.51), 10 (WV7.43), 9 (IR9.71), and 8 (IR11.03).

- Highlights differences between dry, tropical and cold air masses and is accomplished by:
  - Differencing the two water vapor channels (i.e., at 6.51 µm and 7.41 µm) (Red)
  - Differencing the ozone channels (i.e., 9.71 µm and 11.03 µm). (Green)
  - Uses the 6.51 µm channel to indicate gross air mass temperature differences. (Blue)

MSG Air Mass Products:
- MSG-based RGB Air Mass imagery will be generated every 15 minutes.

Recent Product Modifications:
- None

Concept for Pre-Operational Demonstration:
- Product is generated at SPoRT and then provided to NWS Regional HQ via the SPoRT LDM and on to local NWS Weather Service Offices where they are converted to a format suitable for display in AWIPS. For National Centers they are converted to a format suitable for N-AWIPS at SPoRT and provided via an ftp server or the LDM.

Concept for Operations:
- It is anticipated that by the time GOES-R is operational, the AWIPS2 deployment will be completed, so that this RGB product can be locally generated from the individual ABI bands.

6. Product Name: RGB Dust (EUMETSAT Version)

Primary Investigator: Kevin Fuell (SPoRT) and John Knaff (NESDIS/STAR/RAMMB)

NHC/TAFB Relevance:
- The dust product will allow for the monitoring of dust storms over the African continent and tracking of dust plumes into the tropical Atlantic waters where easterly waves move and sometimes develop into tropical cyclones. This will be of value to NWS National Centers that have marine forecast responsibilities.

Product Overview:
- Product designed to monitor the evolution of dust storms during both day and night.

Product Methodology:
- The dust product is an RGB composite based upon infrared channel data from the Meteosat Second Generation satellite. The resulting product depicts dust in magenta and purple colors over land during day and night, respectively. Over the ocean the dust also shows up as magenta, although with a little less contrast than over the land.
- Product is generated from Meteosat Second Generation SEVIRI channels 7 (IR8.7), 9 (IR10.8), and 10 (IR12.0).

- Highlights dusty regions, which is accomplished by:
  • Differencing two IR channels related to optical thickness (i.e., at 12.0 µm and 10.8 µm) (Red)
  • Differencing two IR channels related to particle phase (i.e., 9.71 µm and 11.03 µm). (Green)
  • Uses the IR window channel (10.8 µm) to indicate surface temperature. (Blue)

MSG Dust Products:
- MSG-based RGB Dust imagery will be generated every 15 minutes.

Recent Product Modifications:
- None

Concept for Pre-Operational Demonstration:
- Product is generated at SPoRT, converted to a format suitable for N-AWIPS and provided via an ftp server or the LDM.

Concept Operations:
- It is anticipated that by the time GOES-R is operational, the AWIPS2 deployment will be completed, so that this RGB product can be locally generated from the individual ABI bands.

7. Product Name: RGB Dust (CIRA DEBRA-Dust)

Primary Investigator: Steve Miller (CSU/CIRA)

NHC/TAFB Relevance:
- The Dynamic Enhancement Background Reduction Algorithm (DEBRA) is designed to monitor the onset of lofted mineral dust events over the African interior and track plumes across the eastern/central Atlantic Ocean (to the extent of Meteosat Second Generation SEVIRI spatial coverage). DEBRA-Dust complements the EUMETSAT RGB Dust product, attempting to refine/simplify identification of the salient features of interest.

Product Overview:
- Desert surfaces are notorious for producing false alarms in traditional dust enhancement techniques. DEBRA-Dust employs dynamic land surface emissivity and temperature background information to estimate the clear-sky signal of common dust-detection tests, and uses these values as a baseline for determining the presence of lofted dust. The result is a confidence factor (0=no dust, 1=confident dust) which, when presented as color-enhanced Red/Green/Blue imagery, provides a visually intuitive way of isolating dust from other elements of the complex scene, while suppressing land-surface artifacts.

Product Methodology:
- The DEBRA-Dust product is based on Meteosat Second Generation SEVIRI data. Although it is foremost a quantitative product (meaning that it can be thresholded on confidence factor value to isolate dust regions), it is presented in imagery form for this demonstration. Here, the areas of high dust confidence appear in yellow hue, with saturation values tied to the confidence factor strength (brightest yellow = highest confidence). To first order higher confidence factors correlate with optically thicker dust, but this is not a hard/fast rule and the foremost purpose of this product is a mask.

MSG Dust Products:
- MSG-based DEBRA-Dust products are generated every 15 minutes.

Recent Product Modifications:
- A special version of DEBRA has been developed for this provisional demonstration which provides a more aggressive enhancement over water backgrounds.

Concept for Pre-Operational Demonstration:
- DEBRA-Dust is generated at CIRA and hosted online. If DEBRA becomes a formal demonstration product in the future then it will be further refined and converted into a format suitable for N-AWIPS and provided via ftp server or LDM.

Concept for Operations:
- The algorithm can be applied to GOES-R ABI bands. Plans are currently in place to develop a version applicable to the Advanced Himawari Imager (AHI) on Himawari-8.

8. Product Name: Saharan Air Layer (SAL)

Primary Investigator: Jason Dunion (UM/CIMAS and NOAA/OAR/HRD)

NHC/TAFB Relevance:
- The SAL is associated with dusty and stable air that can traverse the Atlantic Ocean from east to west and can reach as far west as the western Caribbean, Florida, and Gulf of Mexico during the summer. There is evidence that they can negatively impact tropical cyclone activity in the North Atlantic.

Product Overview:
- This product can be used to track the SAL's dust laden low- to mid-level dry air. It can also be used to monitor relatively dust-free low to mid-level dry air originating from the mid-latitudes.

Product Methodology:
- The SAL product uses a split window (10.8 and 12.0) algorithm to identify and track dry, dusty air (e.g., Saharan dust outbreaks) in the lower to middle levels of the atmosphere. The product is a simple two channel difference product (12.0 μm - 10.8 μm) with a color table chosen to highlight the features of interest.
- Dry (and possibly dusty) air is indicated by yellow to red shading in the SAL product.

Saharan Air Layer Products:
- The SAL imagery is generated from MSG every 15 minutes

Recent Product Modifications:
- None

Concept for Pre-Operational Demonstration:
- The product will be created at CIMSS and sent to NHC in N-AWIPS format via a SPoRT ftp server.

Concept for Operations:
- It is anticipated that by the time GOES-R is operational, the AWIPS2 deployment will be completed, so that multi-spectral imagery products can be locally generated from the individual ABI bands.

9. Product Name: Pseudo Natural Color Imagery

Primary Investigator: Jason Dunion (UM/CIMAS, NOAA/OAR/HRD)

NHC/TAFB Relevance:
- The GOES-R ABI will include a number of bands that can be combined to create color imagery products that highlight specific features of interest, such as cloud features, land-sea contrasts, surface features, etc. This particular product provides experience with image combinations designed to highlight cloud and other features in the main development region of the tropical Atlantic.

Product Overview:
- Although not a quantitative algorithm like the MODIS-based natural color products, four SEVIRI bands are combined and special enhancement tables are applied to highlight ocean, land, aerosol, and cloud features in colors that are qualitatively similar to those in true color imagery.

Product Methodology:
- The product combines MSG SEVIRI 0.6, 0.8, 1.6 and 3.9 μm channels to highlight the cloud and other features described above. The product colors are chosen to somewhat resemble a true color image.

- Daytime:
  - 1.6 μm (Red)
  - 0.8 μm (Green)
  - 0.6 μm (Blue)

- Nighttime
  - 3.9 μm with a gray scale chosen to highlight high clouds in lighter shades and low clouds and surface features in darker shades

Pseudo Natural Color Imagery Products:
- The product imagery files will be generated every 15 min in N-AWIPS format

Recent Product Modifications:
- None

Concept for Pre-Operational Demonstration:
- The product will be created at CIMSS and sent to NHC in N-AWIPS format via a SPoRT ftp server.

Concept for Operations:
- It is anticipated that by the time GOES-R is operational, the AWIPS2 deployment will be completed, so that multi-spectral imagery products can be locally generated from the individual ABI bands.

10. Product Name: RGB Daytime Microphysics Imagery

Primary Investigators: Kevin Fuell (UAH at NASA/SPoRT) and John Knaff (NESDIS/STAR/RAMMB)

NHC/TAFB Relevance and Product Overview:
- Cloud top microphysics are related to cloud properties such as precipitation type, updraft strength, hail product, and cloud thickness. These have implications for a number of NWS forecast applications. This RGB combines information about the cloud thickness, cloud particle phase and size, and cloud top temperature in order to analyze convective clouds as well as other cloud and surface features. The cloud particle phase and size can be qualitatively determined to estimate if strong updrafts (e.g. small ice particles at cloud top) are associated with the convection or if warm rain processes are active.

Product Methodology:
- Product is generated from Meteosat Second Generation SEVIRI channels VIS0.8, IR3.9, IR10.8 and was developed by Dr. Daniel Rosenfeld (The Hebrew University of Jerusalem, Israel)
- Highlights differences in cloud thickness, particle size and phase, and height by
    - Using VIS0.8 in Red for cloud top brightness and hence proxy to thickness
    - Using VIS3.9 (i.e. solar component only) in Green for particle size and phase
    - Using IR10.8. in Blue to for cloud top temperature as proxy to height

RGB Daytime Microphysics Imagery Products:
- MSG-based imagery will be generated every 15 minutes.

Recent Product Modifications:
- None

Concept for Pre-Operational Demonstration:
- Product is generated at SPoRT, converted to a format suitable for N-AWIPS, and provided via an ftp server or the LDM.

Concept for Operations:
- It is anticipated that by the time GOES-R is operational, the AWIPS2 deployment will be completed, so that this RGB product can be locally generated from the individual ABI bands.

11. Product Name: RGB Nighttime Microphysics Imagery

Primary Investigators: Kevin Fuell (UAH at NASA/SPoRT)

NHC/TAFB Relevance and Product Overview:
- Cloud top microphysics are related to properties such as phase, temperature, and thickness. Hence, color variations within the composite image can be used to more efficiently analyze cloud type and structure than viewing individual channels or channel differences. This has implications for a number of NWS forecast applications, in particular, the differentiation of low clouds from fog. Tropical applications are described in Appendix 2.

Product Methodology:
- RGB imagery is generated from Meteosat Second Generation SEVIRI channels IR3.9, IR10.8, and IR12.0 using EUMETSAT " RGB Best Practices" recipe
- Highlights differences in cloud physical, particle phase, and thermal characteristics
  - Using IR12.0 - IR10.8 in Red, physically related to cloud optical depth
  - Using IR10.8 - IR3.9 in Green, physically related to particle phase and size
  - Using IR10.8. in Blue, physically related to temperature of surface and cloud tops

RGB Nighttime Microphysics Imagery Product:
- MSG-based imagery will be generated every 15 minutes.

Recent Product Modifications:
- EUMETSAT recipes have been applied to MODIS and VIIRS for additional, high-resolution imagery closer to the CONUS region

Concept for Pre-Operational Demonstration:
- Product is generated at SPoRT, converted to a format suitable for N-AWIPS, and provided via an ftp server or the LDM.

Concept Operations:
- It is anticipated that by the time GOES-R is operational, the AWIPS2 deployment will be completed, so that this RGB product can be locally generated from the individual ABI bands.

12. Product Name: MSG RGB Daytime Convective Storms

Primary Investigators: Kevin Fuell (SPoRT) and John Knaff (NESDIS/STAR/RAMMB)

NHC/TAFB Relevance and Product Overview:
- Convective storms are important for many NWS forecast applications. Tropical applications are described in Appendix 2.
- This product provides information about cloud top particle size (related to updraft strength), cloud top phase, and precipitation.

Product Methodology:
- Product is generated from Meteosat Second Generation SEVIRI channels WV6.2, WV7.3, IR3.9, IR10.8, NIR1.6 and VIS0.6.
- Highlights differences between dry, tropical and cold air masses and is accomplished by:
  • Differencing the two water vapor channels (6.2 µm and 7.3 µm) (Red)
  • Differencing the two IR channels (3.9 µm and 10.8 µm). (Green)
  • Differencing the Near IR and Vis channels (1.6 µm and 0.6 µm) (Blue)

MSG Air Mass Products:
- MSG-based RGB Air Mass imagery will be generated every 15 minutes.

Recent Product Modifications:
- None

Concept for Pre-Operational Demonstration:
- Product is generated at SPoRT, converted to a format suitable for N-AWIPS, and provided via an ftp server or the LDM.

Concept Operations:
- It is anticipated that by the time GOES-R is operational, the AWIPS2 deployment will be completed, so that this RGB product can be locally generated from the individual ABI bands.

Document last updated: 31 July 2013

13. Product Name: Tropical Cyclone Rapid Intensification Index (RII)

Primary Investigator: M. DeMaria, NWS/NCEP/NHC

NHC/TAFB Relevance:
- The comparison of operational and experimental RII products will provide an estimate of the utility of lightning data for rapid intensity prediction. The operational product run by NHC does not include lightning input.

Product Overview:
- A prototype rapid intensification index (RII) will be run in real time to demonstrate a decision aid using proxy GLM Lightning Detection data in combination with global model forecast fields, GOES imagery, SST and oceanic heat content analyses

Product Methodology:
- The various data sources are combined in a discriminant analysis algorithm that provides optimal weights of the independent variables to provide a classification of whether or not a tropical cyclone will rapidly intensify (max wind increase of 30 kt or greater) in the next 24 hours.

Rapid Intensification Index Products:
- The RII produces a text product, which provides a quantitative estimate of the RI probability, and time series of the lightning density information that is the input to the algorithm.

Recent Product Modifications:
- Aug 2013 – 3-class version (rapid weakening, average intensity change, rapid intensification) reduced to 2-class (rapid weakening eliminated) due to degradation of performance of RI detection, based on 2011-2012 tests. 2014 Algorithm redeveloped with 2013 cases added.

Concept for Pre-Operational Demonstration:
- The experimental version of the RII will be run at CIRA and made available to NHC via an ftp server (ftp://rammftp.cira.colostate.edu/demaria/NHCPG)

Concept for Operations:
- If the lightning input adds value to the RII probability, the operational version of the RII, which runs on the NCEP supercomputer, would be modified to routinely include the lightning input from GLM total lightning.

Document Last Updated: 1 July 2014

14. Product Name: GLD-360 Lightning Density

Primary Investigator: Scott Rudlosky (NESDIS/STAR), Joseph Sienkiewicz (OPC), Geoffrey Stano (SPoRT)

NHC/TAFB Relevance:
- Can be used to identify convection that may contain a significant amount of mainly cloud-to-ground (CG) lightning strikes.
- Will prepare forecasters to receive data from the GLM, baseline GOES-R instrumentation designed to measure total lightning.

Product Overview:
- Provides an 8x8 km boxed average estimation of CG lightning activity within the Vaisala GLD-360 network.
- Designed to give forecasters the opportunity to use and critique a demonstration of GLM type data to help improve future visualizations of these data.
- Serves as reference for comparison with full GLM proxies and derived products.

Product Methodology:
- Takes the raw lightning observations, or sources, from the Vaisala GLD-360 network and recombines them into a flash extent gridded field.
- These data are then mapped to a GLM resolution of 8 km and are available at 2, 5, 15, and 30-minute refresh rate.
- With the flash data, when a flash enters a grid box, the flash count will be increased by one and no flash is counted more than once for a give grid box.

Concept for Pre-Operational Demonstration:
- The GLD-360 lightning feed is used to create the 8x8 density grids at OPC. These grids are then made available to WPC, OPC, and SAB through the NCEP network for use in N-AWIPS.

Concept for Operations:
- This topic is still to be discussed, but it is more likely that the lightning density will be generated and displayed via plug-in in AWIPS-II.

15. Product Name: VIIRS Day-Night Band Reflectance

Primary Investigators: Kevin Fuell (NASA/SPoRT), Kathy Strabala (UW/SSEC), Steve Miller (CIRA/CSU)

NHC/TAFB Relevance:
- The VIIRS Day-Night Band (DNB) on S-NPP is a new low light sensing capabilities that has numerous NWS applications, including nighttime tropical cyclone center fixing, and cloud, fog and smoke detection. The DNB can also be used in conjunction with the ABI to give high resolution snapshot to complement the high time resolution from the ABI.

Product Overview:
- The DNB senses reflected moonlight at night. It can be used in similar ways to the visible channel during the day.

Product Methodology:
- The DNB measures reflected moonlight and emitted light from surface sources such as city lights and fires. To provide a more uniform image as the moon phase changes, a reflectance product is generated using the moonlight algorithm from CIRA.

VIIRS DNB Products:
- The reflectance product is available twice per day from the ascending and descending passes of S-NPP

Recent Product Modifications:
- None

Concept for Pre-Operational Demonstration:
- The DNB is obtained from servers at CIMSS and provided via a SPoRT ftp server. The CIRA moonlight code is applied at SPoRT to create the reflectance product before the data is posted for distribution. TC-centered DNB imagery is also being made available by CIRA on the TC Realtime page (http://rammb.cira.colostate.edu/products/tc_realtime/).

Concept for Operations:
- The DNB and other VIIRS channels will be part of the operational satellite data stream for the NWS.

Document last updated: 31 July 2013

16. Product Name: Derived Motion Winds

Primary Investigator: Jaime Daniels (NESDIS/STAR)

NHC/TAFB Relevance:
- Allows the forecasters to overlay satellite derived winds on satellite imagery to better diagnose and analyze atmospheric features such as jet streaks, shortwave troughs, etc.
- Can be used to assess model initialization accuracy of jet streaks, shortwave troughs, tropical cyclones, etc.

Product Overview:
- The algorithm uses ABI visible and infrared observations to extract atmospheric motion. The choice of spectral band will determine the intended target (cloud or moisture gradient) to be traced, its height in the atmosphere, as well as the scale of its motion.

Product Methodology:
- The mid- to upper tropospheric levels (100-600 hPa) use the mid-wave (6.7um – 7.3um) water vapor channels and longwave (10.7um) infrared channel for deriving vectors.
- The lower levels (600-950 hPa) are provided by combining the visible and infrared channels, depending on the time of day. Prior to GOES-R, the algorithm uses current Legacy GOES channels to derive the motion vectors.
- During daylight imaging periods, the visible channel usually provides superior low-level tracer detection than the longwave infrared channel due to its finer spatial resolution and decreased susceptibility to attenuation by low-level moisture.
- During the nighttime imaging period, the shortwave (3.9um) infrared channel compliments the longwave infrared channel to derive the motion vectors.

Products:
- The product is currently available for GOES-E and GOES-W at 15-minute increments.
- The product is displayed as wind barbs that can be overlaid on satellite imagery.

Concept for Pre-Operational Demonstration:
- The product is created in ASCII format and it converted to a GEMPAK readable upper-air observation file using an adapted Perl script developed at the NHC and OPC. These files will be used by N-AWIPS and AWIPS II NCP.

Concept for Operations:
- The AMVs product is a baseline GOES-R product and will be provided as part of the operational processing system.

Document last updated: 13 December 2014

17. Product Name: NOAA Unique CrIS ATMS Processing System (NUCAPS) Soundings

Primary Investigator: Barnett (NESDIS/STAR) and Berndt (SPoRT)

NHC/TAFB Relevance:
- This product provides forecasters with JPSS observation-based temperature and moisture profiles to aid in heavy rainfall and severe marine convection analysis.
- Helps to fill the spatial/temporal gap that exists in observed vertical temperature/moisture information.
- This evaluation seeks to use NUCAPs soundings to quantify the qualitative information provided by RGBs in regions of strong moisture gradients (e.g., tropical cyclone / SAL boundaries)

Product Overview:
- Utilization of satellite-derived temperature and moisture profiles in AWIPS2/D2D and possibly N-AWIPS.
- During experimental operations, NUCAPS will augment existing data/observations.

Product Methodology:
- Product uses a regression-based physical retrieval algorithm to combine CrIS and ATMS sounding to produce unique temperature and moisture profiles.
- Profiles are displayed in NSHARP Severe Weather Sounding Analysis tool in AWIPS II.
- Satellite-observed vertical temperature and moisture data profiles are presented in clear and cloudy Fields of Regard (FOR).

Products:
- NUCAPS Profile Availability (Time/Location)
- NUCAPS Vertical Temperature and Moisture Profiles

Concept for Pre-Operational Demonstration:
- NUCAPS is produced at NESDIS/NDE, delivered over the AWIPS Satellite Broadcast Network (SBN) and has been formatted for display in AWIPS II.

Concept for Operations:
- Ultimately, NUCAPS soundings would be displayed in NSHARP with Quality Control Flags that provide information from the microwave and IR instruments.
- Final AWIPS II display and product integration (with radar/satellite/RAOBs/Surface Observations) will depend on feedback from various demonstrations.

18. Product Name: AIRS, NUCAPS, and IASI Ozone Retrievals (JPSS)

Primary Investigators: Emily Berndt and Bradley Zavodsky (SPoRT)

MPS Relevance and Product Overview:
- Product(s) allows identification of potential stratospheric air intrusions into the troposphere by highlighting anomalous ozone levels, which also identifies regions of increased potential vorticity indicative of tropical cyclones going through extratropical transition.
- Allows for a more accurate analysis of where PV anomalies will occur and assists in the interpretation of the Air Mass RGB product.

Product Methodology:
- Products are generated from the Atmospheric Infrared Sounder (AIRS) aboard the Aqua polar-orbiting satellite. Both a total column ozone and ozone anomaly product are available. The products are available twice a day with a latency of approximately four hours.

- The products are then made available in VGF to overlay on current satellite imagery. The total column ozone concentration is mapped in a way to easily identify areas of interest with measurements made in Dobson units. Additionally the ozone anomaly product highlights regions where the ozone values significantly deviate from climatology and are representative of stratospheric air.

AIRS Ozone Products:
- Total Column Ozone and Ozone Anomalies in VGF format to be overlaid on satellite imagery (works best with the RGB Air Mass product).

Concept for Pre-Operational Demonstration:
- Products are generated at SPoRT and then provided to the Proving Ground in VGF format for use in N-AWIPS and provided via LDM.

Concept for Operations:
- It is anticipated that this product will be created using CrIS and/or OMPS on S-NPP satellite as part of the JPSS mission. The product would be generated by NESDIS and distributed to NWS WFOs and National Centers. If the product is not adopted by NESDIS, then SPoRT would provide an operational version of these products (if global data latencies are reduced over currently available data).

Document last updated: 6 May 2015

Appendix 2 – Tropical-Specific Aspects of the Products

The 18 product descriptions in Appendix 1 are the from the Proving Ground document folder. Some products are used in multiple demonstrations, and so do not always include specific details about tropical applications. Additional product details are provided here.

1)   Hurricane Intensity Estimate (HIE)

This is a hurricane-specific baseline product, so no further description is needed.

2)   Super Rapid Scan imagery

Tropical applications include improved tropical cyclone center fixing, especially near sunrise, and identification of active regions of convection for general marine forecasting. Another method to demonstrate ABI rapid scan capabilities is synthetic imagery. The HSU has not shown interest in this, but there may be opportunities in the future to utilize this general marine forecast application for TAFB.

3)   Tropical Overshooting Tops

This is a tropical-specific application, so no further description is needed. Possible HSU and TAFB applications were described in Appendix 1.

4)   GOES-R natural color imagery product

The natural color imagery is a general product, but will have a number of important tropical applications. It is useful to meteorologists for cloud, dust, aerosol and land/ocean surface feature identification. The product also has tremendous potential for illustrating the advances with GOES-R by showing natural color loops in media briefings.

5)   Red-Blue-Green (RGB) Air Mass product

This is useful for forecasting extratropical transition of tropical cyclones, interaction of tropical cyclones with upper level features for intensity prediction, and for genesis and intensity forecasting through the identification of moisture gradients. The product utility is enhanced when overlaid on model fields, which helps to provide a connection to quantitative applications, and providing insight into the accuracy of model initialization of air mass boundaries and other features.

6)   RGB dust product (EUMETSAT version)

Dust outbreaks are very common in the eastern Atlantic, and sometimes move all the way from Africa to North America. The proximity of tropical disturbances and TCs to dust boundaries is useful for genesis and intensity prediction.

7)   RGB Dust product (CIRA DEBRA version)

The tropical applications of this product are the same as for the EUMETSAT version. However, the DEBRA product is more sophisticated in that it utilizes background information and has colors tuned specifically for dust outbreaks over Africa and the east Atlantic.

8)   Saharan Air Layer (SAL) product

The SAL is associated with dry, stable air, which has implications for tropical cyclone genesis and intensity prediction. This product is used in conjunction with the RBG dust product, but keys more on thermodynamic properties such as dry mid-level air, rather than the aerosols.

9)   Pseudo natural color imagery product

This product complements the natural color imagery product by providing higher time resolution, but lower spectral resolution. Tropical applications are similar to those described for that product.

10)   RGB daytime microphysics product

Tropical applications include tropical cyclone intensity forecasting, since the particle size is related to updraft speed. Users can easily identify water-based vs ice-based clouds as well as an estimate of the cloud height category (i.e. low, middle, and high) via the thermal characteristics as a proxy, which has applications in the analysis of cloud type and structure for tropical cyclones as well as convective monitoring in the marine environment.

11)   RGB nighttime microphysics product

Tropical applications of this product are the same as for the daytime version of this product.

12)   RGB convective storms product

Tropical applications include cloud discrimination, (convective, stratiform), and genesis and intensity forecasting.

13)   Rapid Intensification Index (RII)

This is a hurricane-specific application as described in Appendix 1. The version being demonstrated includes lightning input, which has the potential to improve the accuracy of the operational RII.

14)   Lightning Density

This product complements the quantitative RII. The distribution of the lightning can help to illustrate the lightning radial distribution and asymmetries. It also highlights areas of active convection for TAFB applications.

15)   VIIRS Day/Night band (S-NPP product)

Tropical applications are the same as for visible imagery, including center location, storm structure identification (spiral bands, eye formation), and cloud monitoring.

16)   Derived Motion Winds

Tropical applications include assimilation of DMWs into dynamical models to improve numerical guidance and qualitative use in tropical wave and TC analyses and forecasts.

17)   NUCAPS soundings

This product complements the RGB Air Mass product in the identification of moisture gradients. Soundings capture the vertical extent of moist or dry layers and provide additional insight about the underlying environment not detected in the RGB. Tropical applications include diagnosing conditions conducive to TC formation and intensity change.

16)   AIRS, NUCAPS, and IASI Ozone Retrievals (JPSS)

Products allow for the identification of potential stratospheric air intrusions into the troposphere by highlighting anomalous ozone levels, and tropical applications relate to the diagnosis and prediction of extratropical transition.