GOES-R Proving Ground Demonstration Proposal and Operations Plan
2014 National Hurricane Center Demonstrations

1. **Project Title:** 2014 GOES-R 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 (HIE)
    2) Super Rapid Scan imagery
    3) Tropical Overshooting Tops
    4) GOES-R natural color imagery product
    5) Red-Blue-Green (RGB) Air Mass product
    6) RGB dust product (EUMETSAT version)
    7) RGB dust product (CIRA DEBRA-Dust version)
    8) Saharan Air Layer (SAL) product
    9) Pseudo natural color imagery product
    10) RGB daytime microphysics product
    11) RGB nighttime microphysics product
    12) RGB convective storms product
    13) Rapid Intensification Index (RII)
    14) Lightning density product
    15) VIIRS Day/Night band (S-NPP product)

4. **Demonstration Project Summary:**
    a. **Overview:** The NHC will continue to receive early exposure to GOES-R products during the 2014 Hurricane Season Experiment running from August through the end of November. Pre-operational demonstrations of these GOES-R products will provide NHC operational forecasters with an opportunity to critique and improve the products relatively early in their development. This activity will build on the GOES-R PG activities that began during the 2010 Hurricane Season. One JPSS product will continue to be demonstrated in 2014.

    b. **Plan, Purpose, and Scope:** The purpose of this plan is to identify the goals of the National Hurricane Center (NHC) Hurricane Season Proving Ground (PG) Experiment, provide an overview of the products being demonstrated, describe the activities necessary to conduct the experiment, identify the participants and their responsibilities, establish a project timeline/schedule with milestones and deliverables, and identify related activities at the NHC. The focus of this plan is on products for the Hurricane Specialist Unit (HSU) during the climatologically most active part of the Atlantic hurricane season (Aug-Nov). 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 2014 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.

The 15 products to be evaluated are summarized in Table 1 and the Appendices. Three of these products are new to 2014, including a CIRA version of the Dust Product (7), the Nighttime Microphysics (11) and a lightning density product (14).

c. **Goals:** The goals of the NHC Hurricane Season PG Experiment are to demonstrate identified GOES-R surrogate products in real-time at the NHC during the 2014 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). Feedback will be provided using the same form as in 2012 set up by M. Brennan. The new JPSS/GOES-R Proving Ground feedback web page will also be introduced in 2014.

Feedback from 2013 indicated that there may be too many products included in the NHC demonstration. To address this concern and ensure that useful feedback is obtained, the emphasis in 2014 will be product-dependent and specific goals will be more clearly elucidated. To facilitate this new approach, the 2014 demonstration will be divided into five categories, each with its own evaluation goals (see below). Even though three new products were added to the 2014 NHC PG demonstration, this new approach allowed Liaisons to focus current training and evaluation efforts on a smaller subset of products with specific goals in mind.

A. Mature Products (5) – GOES-R Natural Color, RGB Air Mass, RGB Dust (EUMETSAT Version), SAL, Pseudo Natural Color

These products have been included in the PG for several years, and forecasters already have familiarity with these. Based on previous feedback, these products have proven useful for tropical applications. Less training is needed for these products.

Evaluation Goal: Continue to make these products available so additional forecaster feedback can be obtained, time permitting.

B. Quantitative Products (2) – HIE, RII

These two products provide objective guidance on the initial intensity estimates and intensity changes. These will continue to be made available to forecasters in real time for evaluation, time permitting.

Evaluation Goal: Perform a quantitative verification in the post-season and provide feedback to product developers, and to help gain forecaster confidence for eventual operational transition.

C. Introductory Products (4) – RGB daytime and nighttime microphysics, RGB convective storms, VIIRS Day-Night Band

These products were introduced late in the 2013 demonstration and forecasters received little exposure to them. Only limited forecaster feedback has been obtained.

Evaluation Goal: Emphasize these products and obtain feedback on possible tropical applications.

D. Comparison Products (2) – RGB Dust (CIRA DEBRA-Dust version), Lightning density

As the GOES-R launch approaches, decisions will need to be made regarding the product sets to be routinely included on NHC AWIPS systems. The standard EUMETSAT Dust product has been demonstrated for several years, and has proven its utility for several HSU and TAFB applications. A more sophisticated product has been developed by CIRA, which shows promise. However, the new product is somewhat more difficult to implement. A decision needs to be made as to whether the enhancements are worth the additional complications. Similarly, a fairly standard product has been utilized at NHC for qualitative use of lightning data, which shows lightning locations composited over a few hours, color-coded by age. An alternative is to calculate lightning density based on lightning strikes over a specified time interval.

Evaluation Goal: Encourage forecasters to display the comparison products along with the originals to provide feedback on the strengths and weaknesses of each.

E. Underutilized Products (2) – SRSO, TOTs

Both the SRSO and TOT products have been included in the NHC demonstration for several years. Although these products have shown some utility for TAFB, the application to the HSU is not as clear.

Evaluation Goal: 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. For example, previous HSU feedback on the SRSO indicates that the 1 minute sampling is designed for convective time scales, but is not optimal for monitoring the longer time scales associated with the vortex evolution. Feedback on an optimal routine scanning interval will be obtained.

5. **Participants Involved:**
   a. **Providers:**
      1) Hurricane Intensity Estimate (HIE) (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 and SPoRT)

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

6. Project Schedule:

    i. Jun 1, 2014 – Begin product checkout at NHC
    ii. Aug 1, 2014 – PG begins
    iii. Sep 17, 2014 – Mid-project review at NHC
    iv. Nov 30, 2014 – Evaluation period ends
    v. Jan 2015, conference call with all project participants
    vi. Mar 2015 – Project final report completed

Table 1. The products to be evaluated in the 2014 NHC Proving Ground (Details provided in the Appendices)

Proving Ground Product	Category	Acquisition into NHC	Training	Formal Evaluation
1. Hurricane Intensity Estimate (HIE)	Baseline	June 1, 2014	July 24, 2014	Jan 2015
2. Super Rapid Scan imagery	Baseline	June 1, 2014	July 24, 2014	Jan 2015
3. Tropical Overshooting Tops	Future Capabilities	June 1, 2014	July 24, 2014	Jan 2015
4. GOES-R natural color imagery product	Decision Aid	June 1, 2014	July 24, 2014	Jan 2015
5. Red-Blue-Green (RGB) air mass product	Decision Aid	June 1, 2014	July 24, 2014	Jan 2015
6. RGB dust product (EUMETSAT)	Decision Aid	June 1, 2014	July 24, 2014	Jan 2015
7. RGB dust product (CIRA DEBRA)	Decision Aid	Aug 1, 2014	July 24, 2014	Jan 2015
8. Saharan Air Layer (SAL) product	Decision Aid	June 1, 2014	July 24, 2014	Jan 2015
9. Pseudo natural color imagery product	Decision Aid	June 1, 2014	July 24, 2014	Jan 2015
10.RGB daytime	Decision Aid	June 1, 2014	July 24, 2014	Jan 2015

microphysics				
11. RGB nighttime microphysics	Decision Aid	June 1, 2014	July 24, 2014	Jan 2015
12. RGB convective storms	Decision Aid	June 1, 2014	July 24, 2014	Jan 2015
13. Rapid Intensification Index (RII)	Future Capabilities	June 1, 2014	July 24, 2014	Jan 2015
14. Lightning density	Baseline	June 1, 2014	July 24, 2014	Jan 2015
15. S-NPP Day/Night Band	NPP Baseline	June 1, 2014	July 24, 2014	Jan 2015

7. Project Decision Points and Deliverables:
   a. Proving Ground Demonstration Plan – First Draft: 15 July 2014
   b. Proving Ground Operations Plan – Final: 31 July 2014
   c. Proving Ground Final Report: 31 March 2015

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)

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

   d. Additional POCs
   - Jack Beven – NHC focal point
     o Coordinate with other hurricane specialists as well as forecasters from the NHC Tropical Analysis and forecast Branch.
   - Michael Brennan – Alternate focal point at NHC
     o Assist Jack in planning, preparation, and execution
   - Hugh Cobb and Jessica Schauer – NHC focal points for the Tropical Analysis and Forecast Branch (TAFB)
   - Mark DeMaria (NOAA/NCEP/NHC)
     o Overall NHC PG project management
     o Lightning-based rapid intensification index
   - John Knaff (NOAA/NESDIS/STAR/RAMMB)
     o MSG product generation
     o 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 proving ground and demonstration of GOES-R tropical cyclone products to NASA during the HS3 field experiment

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

NWS Center/Office 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 60°W
- 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

NWS Center/Office 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 105°W. 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

NWS Center/Office 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

NWS Center/Office 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.

5a. Product Name: MSG RGB Air Mass

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

NWS Center/Office 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.

5b. Product Name: GOES Sounder RGB Air Mass

Primary Investigator: John Knaff (CIRA) and Kevin Fuell (SPoRT)

NWS Center/Office 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 was developed for Meteosat Second Generation SEVIRI channels 12 (WV6.51), 10 (WV7.43), 9 (IR9.71), and 8 (IR11.03) and applied here to the GOES sounder data. Sounder version uses WV6.2 and WV7.3, IR9.7 and IR10.8 in place of the SEVIRI channels mentioned above. Sounder version is 10 km spatial resolution and is updated once per hour.

- Highlights differences between dry, tropical and cold air masses and is accomplished by:
  - Differencing the two water vapor channels (i.e., at 6.2 µm and 7.3 µm). (Red)
  - Differencing the ozone channels (i.e., 9.7 µm and 10.8 µm). (Green)
  - Uses the 6.2 µm channel to indicate gross air mass temperature differences. (Blue)

Sounder Air Mass Products:
- The combined GOES-east, GOES-west sounder-based RGB Air Mass imagery will be generated once per hour.

Recent Product Modifications:
- None

Concept for Pre-Operational Demonstration:
- GOES Sounder RGB Air Mass product is generated at CIRA and then provided to NWS Regional HQ via the SPoRT LDM and on to local NWS Weather Service Offices and National Centers 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 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)

NWS Center/Office 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)

NWS Center/Office 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)

NWS Center/Office 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)

NWS Center/Office 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)

NWS Center/Office 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)

NWS Center/Office 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)

NWS Center/Office 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

NWS Center/Office 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)

MPHWPG 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)

NWS Center/Office 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.

Pseudo Natural Color Imagery 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.

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

The 15 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.