Satellite Proving Ground Demonstration Plan:
Aviation Weather Center Proving Ground – 2016 Demonstrations

Project Title: 2016 Satellite Proving Ground – Aviation Weather Testbed

1. **Organization:**
   - **a.** Aviation Weather Center Proving Ground, Kansas City, MO
   - **b.** Air Traffic Control Systems Command Center, Warrenton, VA
   - **c.** Center Weather Service Units

2. **Products to be Demonstrated as a GOES-R Proving Ground activity at the AWT**
   - **a.** Satellite Derived Motion Winds
   - **b.** Synthetic Cloud and Moisture Imagery
   - **c.** Flight Icing Threat
   - **d.** ACHA Cloud Top Altitudes
   - **e.** GLM Lightning Detection
   - **f.** JPSS AIRS Ozone Retrievals
   - **g.** VIIRS Imagery
     - **i.** Day/Night band
     - **ii.** VIIRS/MODIS Cloud Layers & Snow Cover Discriminator
   - **h.** GOES-14 SRSOR 1-minute imagery

3. **Demonstration Project Summary**

a. **Overview**: The Satellite PG has provided aviation-related products to the Aviation Weather Center (AWC) and Aviation Weather Testbed (AWT). Pre-operational demonstrations of these products, which will provide aviation forecasters the opportunity to critique and improve the products relatively early in their development, will occur throughout the coming year. Amanda Terborg, the GOES-R liaison at the AWC, will be handling all logistics and coordination of the new satellite datasets within the demonstration period.

b. Plan, Purpose, and Scope: The AWC 2016 demonstrations will provide the Satellite Proving Ground (PG) with a pre-operational environment in which to deploy and demonstrate algorithms associated with weather-related aviation hazards while in addition familiarizing end users with its next generation geostationary and polar satellite systems. The demonstration will consist of two ongoing long-term evaluations as well as two two-week long, intensive experiment periods in late winter and late summer. Products will be evaluated based on the operational desk structure of the AWC.

c. Goals: The activities within the Satellite Proving Ground at the AWT will focus on demonstrating and evaluating the baseline and future capabilities products as identified below, and more extensively on integrating them within AWC operations. The 2016 demonstrations will include forecasters from each desk within AWC operations, and this will not only provide a wide variety of feedback, but will also aid in building relationships within a very diverse aviation user community. Both of these things will be vital part in furthering the GOES-R/JPSS PG Research to Operations effort within the AWT.

4. **Participants Involved:**
   - **a. Providers:**
     - **i.** Satellite Derived Motion Winds (Daniels – NESDIS STAR)

ii. Synthetic Cloud and Moisture Imagery (Sieglaff/Lindesy – CIMSS/CIRA)
iii. Flight Icing Threat (Smith Jr./Heidinger – NASA LaRC/CIMSS)
iv. ACHA Cloud Height Algorithms (Heidinger/Wanzong – CIMSS)
v. Geostationary Lightning Mapper accumulated product (Stano – SPoRT)
vi. JPSS AIRS Ozone Retrievals (Berndt/Zavodsky – SPoRT)
vii. VIIRS Day/Night band (Fuell/Strabala/Miller – SPoRT/CIMSS/CIRA)
viii. MODIS/VIIRS Cloud Layers & Snow Discriminator (Miller – CIRA)
ix. GOES-14 SRSOR 1-minute imagery (Schmit/Lindsey - CIMSS)

b. Consumers:
i. Aviation Weather Center forecast operations
ii. AWC Air Traffic Control Systems Command Center forecast operations
iii. Center Weather Service Units

5. Project Schedule/Duration (timeline):

a. AWC Testbed Schedule:
i. Long-term evaluation (6 January – 30 April 2016) and the 2016 Winter Experiment (8 – 12 February and 22 – 26 February)
1. ACHA Cloud Altitudes
2. Synthetic Cloud and Moisture imagery
3. VIIRS/MODIS Imagery
4. Flight Icing Threat
5. Satellite Derived Motion Winds
6. JPSS Airs Ozone Retrievals
ii. Evaluation Period II (1 May – 1 September 2016) and the 2016 AWT Summer Experiment (10-22 August 2015)
1. ACHA Cloud Altitudes
2. Synthetic Cloud and Moisture imagery
3. Geostationary Lightning Mapper accumulated product
4. GOES-14 SRSOR 1-minute imagery
5. Airs Ozone Retrievals

b. First Products in AWC Testbed: May 2012
c. Deadline for all product availability: 6 January 2016
d. Training Period: 13 January – 30 September 2016
e. Center Responsibilities: AWC Operations is responsible for delivering accurate, consistent, and timely weather information for safe and efficient flight across the world airspace system. The main met-watch responsibilities range from small areas of the CONUS (West, Central, East) out to large portions of both the Pacific and Atlantic Oceans. In addition, they are also responsible for a smaller number of global aviation products. Satellite is used within operations to determine areal extent and intensity trends of in-flight weather hazards along aviator's routes of flight. The products demonstrated within the AWC will be evaluated on their usefulness in forecasting the various aviation hazards.
f. Mid-term Evaluation Report: 29 May 2016
g. Final Evaluation Report: 1 October 2016

GOES-R/JPSS Proving Ground Product	Category	Acquisition into Testbed	Training	Formal Evaluation
ACHA Cloud Height Algorithms	Baseline	Already Acquired	Spring 2014	6 January – 30 April 2016

Aircraft Flight Icing Threat	Future Capability/ NOAT Priority (3)	Already Acquired	Spring 2014	6 January – 30 April 2015
Satellite Derived Motion Winds	Baseline	Winter 2016	Winter 2016	6 January – 30 April 2016
VIIRS Day/Night Band	Baseline	Already Acquired	Spring 2014	6 January – 30 April 2016
VIIRS/MODIS Cloud Layers and Snow Discriminator	Future Capability	Winter 2016	Winter 2015	6 January – 30 April 2016
JPSS AIRS Ozone Retrievals	Future Capability	Winter 2015	Winter 2015	6 January – 1 September 2016
Geostationary Lightning Mapper Lightning Detection	Baseline	Already Acquired	October 2013	1 May – 1 September 2016
Synthetic Cloud and Moisture Imagery	Baseline	Already Acquired	May 2013	6 January – 1 September 2016
GOES SRSOR 1-minute Imagery	Baseline	Already Acquired	Winter 2013	When available in operations

6. Project Deliverables

- **a.** Proving Ground Operations Plan – First Draft: 7 November 2015
- **b.** Proving Ground Operations Plan – Final Draft: 14 March 2016
- **c.** Proving Ground 2015 Demonstration Mid-term Report: 29 May 2016
- **d.** Proving Ground 2015 Demonstration Final Report: 1 October 2016

7. Responsibilities and Coordination:

- **a.** Amanda Terborg, UW-CIMSS/AWC – Satellite Liaison
- **b.** Joshua Scheck, NOAA/NCEP AWC – ASB Chief
- **c.** Bruce Entwistle, NOAA/NCEP AWC - SOO
- **d.** Ashton Armstrong, AS&D for GOES-R Program Office – PG Coordinator

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

Product Name: GOES-R Flight Icing Threat

Category: Future Capability/NOAT Priority (3)

Primary Investigator: Bill Smith Jr. (NASA LaRC), Andy Heidinger (CIMSS)

National Center/WFO Relevance:

- The GOES-R Flight Icing Threat integrates various cloud properties from the GOES-R baseline DCOMP algorithm to generate a probability and intensity of icing and provides a forecasting tool for aviation operations.
- This product attempts to address one of the future-capabilities of the NOAT and will aid in further guidance regarding a more integrated, NWP-like approach in the future.
- Provides situational awareness for the issuance of icing AIRMETs at the AWC

Product Overview:

- Utilizes various satellite-derived cloud properties and provides information on icing conditions.
- Composed of three components including (1) an icing mask available day and night, which discriminates regions of possible icing, (2) an icing probability, estimated during the daytime only, and (3) a two-category intensity index which is also derived during the daytime only.
- The skill of the algorithm in detecting icing conditions (POD) reported by pilots (via PIREPs) is better than 90%

Product Methodology:

- The icing mask is developed using GOES-R derived cloud thermodynamic phase, cloud top temperature, and cloud optical thickness products to identify which cloudy pixels are most likely to contain significant super-cooled liquid water.
- During the daytime, the probability (low, medium, or high) of encountering icing and the intensity category [light (LGT), or moderate or greater (MOG)] are determined using the liquid water path and effective droplet size products.
- The GOES-R Flight Icing Threat product will assist in resolving small-scale areas of intense icing often missed in other products.

GOES-R Flight Icing Threat Products:

- Flight Icing Threat

Concept for Pre-Operational Demonstration:

- The Flight Icing Threat product was delivered to the Aviation Weather Testbed in February 2013 via the University of Wisconsin LDM and converted to a format suitable for display in N-AWIPS.

Concept for Operations:

- The expectation is that the FIT will be centrally produced at OSPO and delivered via SBN or PDA.

Product Name: VIIRS Day-Night Band Reflectance/Radiance

Category: Baseline

Primary Investigators: Kevin Fuell (SPoRT), Kathy Strabala (CIMSS), Steve Miller (CIRA)

NWS Center/Office Relevance:

- The VIIRS Day-Night Band (DNB) on S-NPP is a new low light sensing capability that has numerous NWS applications. For aviation it can provide additional situational awareness for ceiling G-AIRMETs, Area Forecasts, TAF generation, and other cloud and visibility forecasts.

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.
- Generic DNB imagery is also available via LDM at SPoRT in AREA format for evaluation in N-AWIPS

Concept for Operations:

- The Near Constant Contrast DNB imagery and other VIIRS channels are a part of the operational satellite data stream via SBN for the NWS. It is hoped that the Reflectance product may also be included in this in the future.

Product Name: Synthetic Cloud and Moisture Imagery

Category: Baseline

Primary Investigator: Dan Lindsey (STAR/RAMMB), Justin Sieglaff (CIMSS), and Dan Bikos (CIRA)

National Center/WFO Relevance:

- Synthetic satellite cloud and moisture imagery forecasts allow forecasters to become familiar with the different bands associated with the GOES-R Advanced Baseline Imager (ABI).
- Realistic satellite bands using the model output allow forecasters to easily identify features that may be difficult to determine using standard and derived model output fields.
- Comparisons of synthetic satellite imagery with actual satellite imagery provide a method for NWP model performance evaluation.

Product Overview:

- Synthetic cloud and moisture imagery from the ABI replicates how atmospheric features will appear in the GOES-R ABI bands.

Product Methodology:

- After the NSSL runs their 0000 UTC 4-km WRF-ARW, several variables including temperature, water vapor, and other physical and microphysical parameters are obtained.
- When all variables have been received, a radiative transfer model (RTM) is run to generate the synthetic imagery bands.
- Hourly output of NSSL WRF data between 0900 UTC of Day 1 and 1200 UTC of Day 2 (F009-F036) is processed daily.
- Resolution of the output is 4-km to match the input resolution of the NSSL-WRF model; the GOES-R ABI IR bands will have 2-km resolution.

NSSL-WRF Synthetic Cloud and Moisture Imagery Products:

- ABI Bands 7-16, including wavelengths from 3.9 to 13.3 μm
- 10.35-3.9 μm Difference (to identify liquid water clouds)
- 10.35-12.3 μm Longwave Difference (to identify low-level moisture convergence)

Concept for Operational Demonstration:

- The NSSL-WRF product will be converted into AWIPS, AWIPS-II, and NAWIPS formats and sent to the National Centers and WFOs

Concept for Operations:

- The future of synthetic GOES-R imagery is unclear; however, GOES-R Cloud and Moisture Imagery is expected to be centrally produced at OSPO/ESPC and delivered by SBN or PDA.

Product Name: Geostationary Lightning Mapper accumulated product

Category: Baseline

Primary Investigator: Geoffrey Stano (SPoRT)

National Center/WFO Relevance:

- Can be used to identify convection that may contain significant lightning, both cloud-to-ground and intra-cloud lightning, that can affect enroute air traffic
- Will prepare forecasters to receive data from the GLM, baseline GOES-R instrumentation designed to measure total lightning.

Product Overview:

- A pseudo-GLM accumulated flash extent density product provides an 8 km, 2-min boxed average estimation of total lightning activity within the LMA networks.
- Designed to give forecasters the opportunity to use and critique a demonstration of GLM type data to help improve future visualizations of these data and its trends.
- Serves as reference for comparison with full GLM proxies and derived products.

Product Methodology:

- Takes the raw total lightning observations, or sources, from any of the ground-based LMA available 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 a 2-minute refresh rate, depending on the ground-based network being used.
- 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.

GOES-R PGLM Products:

- Current LMA networks: Oklahoma (OKLMA), Northern Alabama (NALMA), D.C. LMA (DCLMA), Colorado (COLMA), New Mexico (NMLMA), West Texas (WTLMA), and Houston (HGLMA)
- Expected LMA networks by summer 2014: Central Florida and Atlanta?
- GLD360 OCONUS proxy – limited NWS data feed from Vaisala

Concept for Pre-Operational Demonstration:

- The PGLM data, including the NALMA, OKLMA, and DCLMA networks, were delivered to the Aviation Weather Center in May 2012 and the COLMA and HGLMA in April 2013 via the SPoRT LDM. Additionally, the WTLMA, and NMLMA network data are expected in spring 2013. The files have been converted to a format suitable for display in N-AWIPS.

Concept for Operations:

- GLM data are expected to be centrally produced at OSPO/ESPC and delivered by SBN or PDA

Product Name: ACHA Cloud Height Algorithms

Category: Baseline

Primary Investigator: Andy Heidinger/Steve Wanzong (UW-CIMSS)

National Center/WFO Relevance:

- Provides additional information regarding cloud top properties that can be used for forecasting various aviation hazards, particularly in identifying cloud tops.
- Data is also generated on a global scale, providing additional data over data sparse areas (oceans, etc.) for the AWC's international operations branch.

Product Overview:

- Provides information on cloud top properties (height, temperature, phase) not available via ground-based instruments.
- Provides better spatial and temporal coverage than radiosonde-collected observations.

Product Methodology:

- Multiple IR channels on the ABI are used to estimate cloud temperature, cloud emissivity, and particle size.
- Height and pressure are derived from the temperature and NWP profiles from the GFS
- Products are generated within minutes of receiving satellite data and are consistent through the terminator.

ACHA Cloud Height Products:

- Cloud Top Height
- Cloud Top Temperature

Concept for Pre-Operational Demonstration:

- The ACHA Cloud Height products were delivered to the Aviation Weather Testbed via the CIMSS LDM in May 2012 and have been formatted for display in N-AWIPS.

Concept for Operations:

- The ACHA cloud height algorithms are expected to be centrally produced at OSPO/ESPC and delivered by SBN or PDA, and will also provide input for other AWIPS decision aids.

Product Name: Super Rapid Scan Imagery

Category: Baseline

Primary Investigator: T. Schmit (NESDIS/ASPB), D. Lindsey, (NESDIS/RAMMB)

National Center/WFO Relevance:

- GOES-R will provide routine 5-min imagery and better capabilities for providing 30 sec and 1 min imagery than the current GOES satellites. 1-min imagery is routinely utilized at AWC when GOES-14 is out of storage.
- Will provide super rapid scan operations (SRSO) data during experimental periods and the summer demonstration to better forecast for high-impact aviation weather hazards and expose forecasters to GOES-R-like temporal resolution.

Product Overview:

- 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:

- SRSO-R 1-minute data will be collected February 1-25 and April 18-May 13, 2016
- During the, the GOES-14 satellite will be centered at 105 W and utilized for experimental and operational use at the AWC. With SRSO-R, 26 images can be collected every ½ hour.

Super Rapid Scan Imagery Products:

- Full resolution 1 minute visible imagery

Concept for Pre-Operational Demonstration:

- The SRSOR has been previously implement into the N-AWIPS workstations in AWC Operations and the AWT. This data will be available for demonstration during its experimental runs.

Concept for Operations:

- SRSO data will be available via direct readout systems and is also expected to be centrally produced at OSPO/ESPC and delivered via SBN or PDA for AWIPS-II or NESDIS servers and displayed on AWIPS2 systems at AWC when GOES-R becomes operational.

Product Name: AIRS Ozone Retrievals (JPSS)

Category: Baseline

Primary Investigators: Emily Berndt and Bradley Zavodsky (SPoRT)

National Center/WFO Relevance:

- 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.
- When used with the RGB Airmass, may allow for a more accurate analysis of where there may be increased areas of ozone due to intrusions, which may result in danger to aircraft and health risks for flight crews and passengers.

Product Overview and 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 HAZMAP 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 via NESDIS OSPO/ESPC. 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).

Product Name: VIIRS/MODIS Cloud/Snow Discriminator

Category: Future Capability

Primary Investigator: Steve Miller (CIRA)

National Center/WFO Relevance:

- May have utility in the generation of the Area Forecasts and issuance of graphical AIRMETs for low ceilings, as well as icing and turbulence. It would be of particular use in the western portion of the CONUS where complex terrain is dominant and remains snow covered for at least half of the year.
- May have utility in issuing FA forecasts over the tropics and Caribbean

Product Overview:

- Takes advantage of multiple IR and visible channels with the RGB concept to distinguish between cloud layers and snow cover during the day. It also demonstrates the type of imagery that will become available in the GOES-R at much higher temporal and spatial resolutions

Product Methodology:

- As snow cover and clouds are both highly reflective in the visible spectrum, and thus difficult to distinguish, the Cloud/Snow Discriminator takes advantages of infrared imagery and the thermal and longwave differences to better identify what is snow and what is cloud.
- The Cloud/Snow Discriminator combines information from multiple channels to create a single visual aid for distinguishing between snow and clouds, highlighting snow in white and clouds in yellow.
- The capability also exists to further distinguish specific cloud layers, highlighting both low and high clouds.

VIIRS/MODIS Cloud/Snow Products:

- VIIRS Cloud/Snow Discriminator
- MODIS Cloud/Snow Discriminator

Concept for Operational Demonstration:

- The Cloud/Snow Discriminator products will be formatted for display in N-AWIPS and pulled into the Aviation Weather Testbed via LDM from CIRA

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 and used as a decision aid.