Satellite Proving Ground Demonstration Plan:
Alaska Aviation Weather Unit Proving Ground – 2016 Demonstrations

1. **Project Title:** 2016 Satellite Proving Ground – Alaska Aviation Weather Unit

2. **Organization:**
   - **a.** Alaska Aviation Weather Unit – Anchorage, AK

3. **Products to be Demonstrated as a GOES-R/JPSS Proving Ground activity at the AAWU**
   - **a.** Icing (VIIRS/MODIS)
     - **i.** Flight Icing Threat index
     - **ii.** Icing cloud tops
     - **iii.** Icing cloud bases
   - **b.** Ceiling/Cloud and Visibility (VIIRS/AVHRR/MODIS/GOES)
     - **i.** VIIRS Day/Night band
     - **ii.** Nighttime/24-hour Microphysics
     - **iii.** Fog and Low Stratus
     - **iv.** Natural Color and Snow/Cloud RGBs

4. **Demonstration Project Summary**

   a. **Overview**: The Satellite PG has provided aviation-related products to the Alaska Aviation Weather Unit. Pre-operational demonstrations of these products, which will provide aviation forecasters in Alaska the opportunity to critique and improve the products relatively early in their development, will occur throughout the coming year. Amanda Terborg, the Satellite Liaison at the Aviation Weather Center, and Eric Stevens, the Satellite Liaison in the High Latitude Proving Ground, will be handling all logistics and coordination of the new satellite datasets within the demonstration period.

   b. Plan, Purpose, and Scope: The AAWU 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 one long-term evaluation occurring through the year. Products will be evaluated based on the needs of the AAWU.

   c. Goals: The activities within the Satellite Proving Ground at the AAWU will focus on demonstrating and evaluating the baseline and future capabilities products as identified below, and more extensively on integrating them within AAWU operations. The 2016 demonstrations will include forecasters from the AAWU and likely the Anchorage CWSU, and will not only provide a valuable source of feedback, but will also aid in building relationships within the very unique aviation user community in Alaska. Both of these things will be vital parts in furthering the GOES-R/JPSS PG Research to Operations effort within the AAWU.

5. **Participants Involved:**
   - **a. Providers:**
     - **i.** Aircraft Flight Icing Threat (Smith Jr./Heidinger – NASA LaRC/CIMSS)
     - **ii.** VIIRS Day/Night band (Fuell/Strabala/Miller – SPoRT/CIMSS/CIRA)
     - **iii.** Nighttime/24-hour Microphysics (Fuell/Knaff – SpoRT/NESDIS STAR)
     - **iv.** Fog and Low Stratus (Pavolonis/Calvert – CIMSS)

v. Natural Color and Snow/Cloud RGBs (GINA)

b. Consumers:

i. Alaska Aviation Weather Unit

6. Project Schedule/Duration (timeline):

a. 2016 AAWU goals:

i. Ceiling/Cloud and Visibility

1. VIIRS Day/Night band

2. Nighttime and 24-hour Microphysics

3. Fog and Low Stratus

4. Natural Color and Snow/Cloud RGBs

ii. Aircraft Flight Icing Threat

1. Flight Icing Threat Index

2. Icing cloud bases

3. Icing cloud tops

b. First Products into the AAWU: Winter 2016

c. Deadline for all product availability: March 2016

d. Training Period: Winter 2016

e. Center Responsibilities: AAWU Operations is responsible for delivering accurate, consistent, and timely weather information for safe and efficient flight across the Alaskan airspace system. Main met-watch responsibilities are unique and widely varied, ranging from cargo and commercial carriers surrounding the three larger terminals (Anchorage, Fairbanks, and Juneau) to a plethora of general aviation operations; helicopters, floatplanes, and other small aircraft included. 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 AAWU will be evaluated on their usefulness in forecasting the various aviation hazards.

f. Final Evaluation Report: 31 December 2016

GOES-R/JPSS Proving Ground Product	Category	Acquisition into the AAWU	Training	Formal Evaluation
Aircraft Flight Icing Threat product suite	Future Capability	Winter 2016?	Winter 2016?	1 January – 31 December 2016
VIIRS Day/Night Band	Baseline	Already Acquired	Winter 2016	1 January – 31 December 2016
Nighttime/24-hour Microphysics	Future Capability	Already Acquired	Winter 2016	1 January – 31 December 2016
Fog and Low Stratus	Future Capability/NOAT priority (2)	Already Acquired	Winter 2016	1 January – 31 December 2016
Natural Color and Snow/Cloud RGB	Future Capability	Winter 2016	Winter 2016	1 January – 31 December 2016

7. Project Deliverables

a. Proving Ground Operations Plan – First Draft: 1 December 2015

b. Proving Ground Operations Plan – Final Draft: 14 March 2016

c. Proving Ground 2015 Demonstration Final Report: 31 December 2016

8. Responsibilities and Coordination:

a. Amanda Terborg, UW-CIMSS/AWC – Satellite Liaison
b. Eric Stevens, UAF-GINA – Satellite Liaison
c. Donald Moore, NOAA/NWS AAWU – MIC
d. Doug Wesley, NOAA/NWS AAWU – SOO
e. David Barber, NOAA/NWS AAWU – Satellite POC

Budget and Resources Estimate: Funded through the GOES-R Science Office as part of the Omnibus Proving Ground funding to CIRA, CIMSS, LaRC, UAH, and NASA/SPoRT. Funding also provided through GINA's work with the JPSS and GOES-R Proving Grounds and Program Offices.

Product Name: Aircraft 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 Aircraft Flight Icing Threat integrates various cloud properties from the GOES-R baseline 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 top priority 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 AAWU

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.
- The FIT algorithm will be run on MODIS and VIIRS for Alaska Region

GOES-R Flight Icing Threat Products (VIIRS/MODIS):

- Flight Icing Threat
- Icing cloud tops
- Icing cloud bases
- Supercooled Liquid Droplet detection

Concept for Pre-Operational Demonstration:

- The Flight Icing Threat product will be delivered to the Anchorage WFO and RFC AWIPS-2 systems via LDM from GINA/LaRC in a format suitable for display in D2D

Concept for Operations:

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

Product Name: VIIRS Day-Night Band Reflectance

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 capabilities that has numerous NWS applications. It has particular use in Alaska, where nighttime conditions dominate during the winter season, and can be utilized for a variety of aviation applications including low clouds, snow/ice discrimination, etc.

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 GINA and disseminated to Alaska Region AWIPS-2 systems for display in D2D. 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 are part of the operational satellite data stream for the NWS, displayed in AWIPS-2 via the SBN. It is hoped that the Reflectance product will be a part of this in the future.

Product Name: RGB Night-Time Microphysics

Category: Future Capability

Primary Investigator: Kevin Fuell, Andrew Molthan and Kevin McGrath (NASA SPoRT)

National Center/WFO Relevance:

- Provides situational awareness in the generation of the Area Forecasts and issuance of graphical AIRMETs for low ceilings at the AAWU

Product Overview:

- Takes advantage of multiple IR channels with the RGB concept to distinguish between various types of cloud physical, microphysical, and thermal characteristics. It was specifically designed to more efficiently highlight cloud types and the additional channels allow one to better distinguish between fog and low clouds at night compared to the standard "fog" imagery product.

Product Methodology:

- The Night-Time Microphysics is an RGB composite based on infrared data from the VIIRS and Terra/Aqua MODIS imagers. The resulting product depicts fog and low clouds as light blue areas in warm climates and light green in colder climates. The shades of the blues and greens will vary depending on the thickness of the fog and low clouds, and associated green and red contributions
- The product is generated using the 12.0, 10.8, and 3.9 micron IR channels
- Highlights fog and low clouds by the following:
  - Differencing two IR channels related to optical thickness (i.e., at 12.0 µm and 10.8µm) (Red)
  - Differencing two IR channels related to particle phase (i.e., 10.8 µm and 3.9 µm).
  - (Green)
  - Uses the IR window channel (10.8 µm) to indicate surface temperature. (Blue)

RGB Night-Time Microphysics Products:

- VIIRS Night-Time Microphysics
- Aqua and Terra MODIS Night-Time Microphysics
- AVHRR Night-Time Microphysics

Concept for Operational Demonstration:

- The Night-Time Microphysics products have been disseminated to the Anchorage WFO and RFC AWIPS-2 systems via LDM from NASA SPoRT

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 a decision aid

Product Name: Fog and Low Stratus

Category: Future Capability/NOAT Priority (2)

Primary Investigator: Mike Pavolonis (NOAA/NESDIS/STAR)

NWS Center/Office Relevance:

- Provides decision support and tactical decision aids for AAWU forecasters when identifying the presence and location of fog and low stratus throughout Alaskan airspace.
- Products can be used during the day and night, and when high cirrus or ice clouds are present.
- Comparisons to surface observations indicate the IFR probability product outperforms (almost twice as much skill) the traditional 3.9–11 μm brightness temperature difference.
- Fused product that incorporates GOES satellite observations and Rapid Refresh model output.
- Addresses one of the top future-capability priorities of the NOAT.

Product Overview:

- Fog and Low Stratus detection products are designed to quantitatively (expressed as a probability) identify clouds that produce MVFR, IFR, and LIFR conditions.
- Physical thickness of water cloud layers is estimated in the Water Cloud Thickness product.
- Primary limitation is that some discontinuity will be associated with the transition from sunlit to non-sunlit conditions and vice-versa.

Product Methodology:

- Satellite and NWP model data are used as predictors and ceilometer based surface observations of cloud ceiling are used to train the algorithm.
- During the day, the 0.65, 3.9, and 11 μm channels (in various ways) along with boundary layer relative humidity information from the NWP model are used as predictors (similar approach is utilized at night without the 0.65 μm channel).

GOES-R Fog and Low Stratus Products:

- MVFR, IFR, and LIFR Probabilities
- Water Cloud Thickness (Fog Depth)
- The products are available using GOES-13, GOES-15, MODIS, and VIIRS data.

Concept for Pre-Operational Demonstration:

- The Fog and Low Stratus products were delivered to the Anchorage WFO and RFC AWIPS-2 systems via the University of Wisconsin LDM and are displayable in D2D.

Concept for Operations:

- The Fog and Low Stratus Products are currently scheduled to be operationalized on OSPO ESPC systems and will be delivered to NWS users via SBN, NCO backbone, Direct Broadcast, and possibly AWIPS DDS as alternative.

Product Name: Natural Color Imagery

Category: Future Capability

Primary Investigator: Don Hillger, NESDIS/STAR/RAMMB

NWS Center/Office Relevance:

- AVHRR, MODIS, and VIIRS have the capability to produce natural color imagery, though at lower latency than geostationary satellites.
- GOES-R will also provide natural color products, but 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.
- The product provides a useful method in which to better discriminate between features such as low clouds, ice, etc.

Product Overview:

- Natural color imagery will be generated from AVHRR, MODIS, and VIIRS imagery is made available in real time via GINA's feeder site and also in the Alaska Region AWIPS-2 systems.

Product Methodology:

- The Natural Color RGB utilizes the 0.64 μm visible channels as the red component, the 0.86 μm visible channel as the green component, and the 1.61 μm near IR channel as the blue component.
- Land appears in varying shades of green due to the 0.86 μm sensitivity to vegetation, while snow appears more turquoise in color given the contribution of the 1.61 μm snow/ice channel. Higher clouds with ice crystals also appear with a lighter blue tinge, again because of the contribution from the snow/ice channel.

Natural Color Imagery Products:

- Natural color imagery is generated routinely at GINA using MODIS, AVHRR, and VIIRS data

Recent Product Modifications:

- None

Concept for Pre-Operational Demonstration:

- These products are currently available in the Alaska Region AWIPS2 systems and will be further trained upon at the AAWU.

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.

Product Name: Snow/Cloud RGB Imagery

Category: Future Capability

Primary Investigator: GINA

NWS Center/Office Relevance:

- AVHRR, MODIS, and VIIRS have the capability to produce snow/cloud RGB imagery, though at lower latency than geostationary satellites.
- Snow/cloud imagery will provide situational awareness for fog and low stratus forecasting over Alaskan airspace

Product Overview:

- Snow/Cloud RGB imagery was designed to help differentiate clouds from snow and ice and is generated from AVHRR, MODIS, and VIIRS imagery. It is displayed via GINA's feeder site and also in the Alaska Region AWIPS-2 systems.

Product Methodology:

- The Snow/Cloud RGB utilizes the 0.64 µm visible channel as the red component, the 1.16 µm near IR channel as the green component, and the 11.45 µm longwave IR channel as the blue component.
- In the resulting RGB, cirrus is a pink/violet shade due to the heavier contributions of the red and blue channels.
- Mid-level clouds are more of a balance of the three and are white, with equal contributions from all three.
- Surface ice and snow are red colored, as they have the greatest contribution of red.
- Low clouds appear with a yellowish tinge due to higher red and green contributions

Snow/Cloud RGB Imagery Products:

- Snow/Cloud RGB imagery is generated routinely at GINA using MODIS, AVHRR, and VIIRS data

Recent Product Modifications:

- None

Concept for Pre-Operational Demonstration:

- These products are currently available in the Alaska Region AWIPS2 systems and will be further trained upon at the AAWU.

Concept for Operations:

- The Snow/Cloud 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 Snow/Cloud images.