GOES-R and JPSS Proving Ground Demonstration Proposal:
Hazardous Weather Testbed – 2017 Spring Experiment

1. **Project Title:** 2017 Geostationary Operational Environmental Satellite R-series (GOES-R) and Joint Polar Satellite System (JPSS) Proving Ground – Hazardous Weather Testbed (HWT) Experimental Warning Program (EWP) Product Demonstrations

2. **Organization**: HWT/EWP, Norman, OK

3. **Products to be Demonstrated as a GOES-R and JPSS Proving Ground activity at the HWT in 2017:**
    - **a.** GOES-16 Advanced Baseline Imager (ABI) Imagery, Band Differences, RGB's, and Baseline Derived Products
    - **b.** GOES-16 Geostationary Lightning Mapper (GLM) Lightning Detection
    - **c.** ProbSevere Model (Risk Reduction)
    - **d.** NOAA Unique Combined Atmospheric Processing System (NUCAPS) Temperature and Moisture Profiles (JPSS)

4. **Demonstration Project Summary:**
    - **a. Overview:** As a GOES-R and JPSS Proving Ground (herein, Satellite Proving Ground) activity, GOES-16 and JPSS (via Suomi NPP) products and capabilities will be demonstrated in the HWT during the 2017 Spring Experiment. Satellite Proving Ground activities during the Spring Experiment will take place during the weeks of June 19, June 26, July 10, and July 17 2017 in the EWP. The EWP provides a conceptual framework and a physical space to foster collaboration between research and operations to test and evaluate new and emerging technologies and science to advance National Weather Service (NWS) warning operations. Products will be demonstrated within a simulated warning operations environment using a real-time AWIPS-II (D2D) framework within the HWT. NWS forecasters and broadcast meteorologists will be the primary evaluators. Various project scientists will also be in attendance throughout the experiment to provide project expertise and to communicate directly with the user community. The exposure to appropriate GOES-16 and JPSS products and capabilities during the height of the spring severe weather season will provide NWS forecasters, broadcast meteorologists, and scientists an opportunity to help determine best practices and operational applicability as well as critique and suggest improvements for algorithms in different stages of their development cycle. For the 2017 Spring Experiment, live GOES-16 imagery and products will be evaluated along with experimental GOES-R and JPSS algorithms.

    - **b. Plan, Purpose, and Scope:** The HWT provides the Satellite Proving Ground with an opportunity to demonstrate Baseline, Future Capabilities, and experimental products associated with the next-generation GOES-R geostationary and JPSS polar satellite systems that have the potential to improve short-range hazardous weather forecasting, nowcasting and warnings. The availability of GOES-16 products shortly after becoming available to NWS forecasters in operations will demonstrate the value of

such data in severe weather situations. It will also allow forecasters to test and develop best practices for using GOES-R data in convective situations, and will gauge the effectiveness of the GOES-R training. Given that GOES-16 Level 2 products are currently being validated and verified, this year's HWT will focus on assisting with these efforts. Therefore, on the GOES-R side, the focus will be on the baseline Level 2 products, and experimental products will likely make a return to the HWT in 2018. The structure of Satellite Proving Ground activities at the 2017 Spring Experiment in the HWT/EWP will be as follows:

There will be a total of 16 external participants spanning the four weeks, with four participants (three NWS forecasters and one broadcast meteorologist) in attendance each week. Forecasters will work in pairs participating in real-time simulated short-term forecast and warning operations in County Warning Areas (CWAs) across the CONUS determined based on SPC convective outlooks. Using the GOES-R HWT blog, participants will document their short-term experimental mesoscale forecast updates in real-time, highlighting the impact of the satellite-based imagery and products on those testbed forecasts. Additionally on the blog, they will record the reasoning behind experimental warnings, which will be issued using AWIPS-II/WarnGen, focusing on how the satellite information influenced those decisions. Participants will be encouraged to provide updates (verification) on the performance of previous experimental issuances using the blog as well.

Each week will begin with an 11 am - 7 pm orientation/forecast shift on Monday, while the Tuesday through Thursday eight hour forecast shifts will begin between 9 am and 3 pm, depending on when the primary convective activity is likely to start. The goal will be to begin Tuesday through Thursday one to two hours before the onset of deep convective development so data can be tested in the pre-convective environment as well as post-convective initiation. Each Mon-Thurs forecast shift will begin with a brief discussion regarding the anticipated convective threat (location/timing/mode/severe type) for the day. At the end of the day on Thursday, in collaboration with the NWS Warning Decision Training Division (WDTD), participants will develop presentations sharing their experiences in the Spring Experiment, highlighting appropriate cases and satellite products. These will be presented virtually Friday morning as part of the “Tales from the Testbed” webinar, in which scientists and NWS entities outside of Norman are encouraged to participate.

Participants will have completed the required GOES-R training (SATFC-G) prior to arrival in Norman. SATFC-G will prepare participants to use the imagery from GOES-16. Additional Articulate Power Point modules will also be completed for the non-operational and JPSS products being demonstrated, along with supplemental GLM training. Broadcast participants are strongly encouraged to visit their local NWS Forecast Office for AWIPS-II hands-on familiarization prior to the experiment. Feedback will be gathered throughout the experiment in the form of: 1) surveys to be completed at the end of each day and week, 2) real-time blogging, 3) real-time discussions, 4) daily debriefs during the start of each day, and 5) weekly debriefs

Friday morning. Notes from the daily and weekly debriefs will also be posted to the GOES-R HWT blog (http://goesrhwt.blogspot.com/).

c. **Goals:** The main objective of the Satellite Proving Ground demonstrations within the HWT is to demonstrate and evaluate Baseline, Future Capability and experimental products that have the potential to improve short-term forecasts, nowcasts and warnings of hazardous weather across the CONUS. Highlights of forecaster feedback will be organized in a final report which will be submitted to the Satellite Proving Ground and provided to product developers so that recommended changes and improvements to products can be addressed. The one-on-one interactions between the project scientists, NWS forecasters, and broadcast meteorologists allow for valuable discussions during real-time hazardous weather events, maximizing research-to-operations-to-research (R2O2R) feedback, a key goal of the Proving Ground. Additionally, the real-time demonstration of experimental and baseline products ensures the algorithms work properly in AWIPS-II. Finally, exposing NWS forecasters and broadcast meteorologists to GOES-16 baseline products and capabilities shortly after availability allows for the development of best practices for using the data in severe weather operations.

5. **Participants Involved:**
   a. **Providers:**
      i. GOES-16 Advanced Baseline Imager (ABI) Imagery, Band Differences, RGB's, and Baseline Derived Products (Line – NWS, Bowlan – CIMMS/SPC)
      ii. GOES-16 Geostationary Lightning Mapper (GLM) Lightning Detection (Calhoun – CIMMS/NSSL, Stano – NASA/SPoRT)
      iii. ProbSevere Model (Pavolonis – NESDIS)
      iv. NOAA Unique Combined Atmospheric Processing System (NUCAPS) Temperature and Moisture Profiles (Barnet – STC; Dostalek - CIRA)
   b. **Consumers:**
      i. Hazardous Weather Testbed

6. **Project Schedule/Duration (some dates are preliminary and subject to change):**
   a. Products tested in HWT AWIPS-II system: 15 May 2017
   b. Training sent to participants: 15 May 2017
   c. Product demonstrations begin: 18 June 2017
   d. Product demonstrations end: 22 July 2017

7. **Project Decision Points and Deliverables:**
   a. Proving Ground Operations Plan – First Draft: 17 April 2017
   b. Proving Ground Final Report: 25 Aug 2017

8. **Responsibilities and Coordination:**
   a. Michael Bowlan, OU/CIMMS and NOAA/SPC – Co-Principal Investigator for Satellite Proving Ground activities taking place in the HWT in 2017
   b. Kristin Calhoun, OU/CIMMS and NSSL – Co-Principal Investigator for Satellite Proving Ground activities taking place in the HWT in 2017

c. William Line, NOAA/NWS – Co-Principal Investigator for Satellite Proving Ground activities taking place in the HWT in 2017

d. Gabriel Garfield, OU/CIMMS and NOAA/OUN – EWP Coordinator

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

Product Name: GOES-16 Advanced Baseline Imager (ABI) Imagery, Band Differences, RGB's, and Baseline Derived Products

Primary Investigator: William Line (NOAA/NWS) and Michael Bowlan (CIMMS/SPC)

Hazardous Weather Testbed, Experimental Warning Program Relevance:

- GOES-16 ABI imagery and products provide information about the pre-convective environment, convective initiation, and the evolution of mature convection.
- Evaluation of GOES-16 ABI imagery and products in the HWT shortly after availability in AWIPS allows for the development of best practices for use in convective situations.

Product Overview:

- GOES-16 ABI single-band imagery and band differences are already available to NWS forecasters in AWIPS-II.
- RGB imagery and baseline derived products will be available to NWS forecasters in AWIPS-II just prior to experiment.
- Imagery and products idenitified as potentially benifiting forecasters in convective warning situations will be the focus of this evaluation.
- 30-sec and 1-min imagery will be evaluated when available, in addition to the 5-min CONUS imagery

GOES-16 ABI Products:

- ABI single-band imagery (16 channels)
- ABI band difference imagery
    - 10.3-12.3 μm (Split Window), 1.6 – 0.64 (Split Snow), 6.2 - 7.3 μm (Split Water Vapor), 9.6 - 10.3 μm (Split Ozone)
- ABI RGB imagery
    - Simple: Day Land Cloud Convection, Day Cloud Phase, Day Land Cloud
    - Advanced: Day Convection, Air Mass, Differential Water Vapor
- ABI baseline derived products
    - Derived Motion Winds, Derived Stability Indices, Total Precipitable Water, and others as time allows.

Concept for Operational Demonstration:

- GOES-16 ABI imagery and products will be delivered to the HWT via the Satellite Broadcast Network (SBN) and displayed in AWIPS-II.

Concept for Operations:

- GOES-16 ABI imagery and products are centrally produced at OSPO/ESPC and delivered by SBN and PDA.

Product Name: Geostationary Lightning Mapper (GLM) and derived lightning detection products

Primary Investigator: Kristin Calhoun (OU/CIMMS & NOAA/NSSL) and Geoffrey Stano (NASA/SPoRT)

Hazardous Weather Testbed, Experimental Warning Program Relevance:

- Identify developing deep convection and areal coverage by observing optical detections of both cloud-to-ground and intra-cloud lightning.
- Evaluate trends from GLM in relationship to storm evolution, storm coverage, severe weather, and flooding potential along with relationships to other fields available at HWT.
- Identify product types, visualization techniques, and tools for future GLM observations.
- Identify best practices for GLM products and integration into forecaster storm interrogation methodology.

Product Overview:

- GLM beta release level 2 products (groups, events and flashes) with individual time, locations, and radiances will be available 12 June 2017 and visualized within AWIPS-II with the baseline GLM plug-in.
- A Lightning Cluster Filter Algorithm (LCFA) identifies the clustering of optical events into groups and groups into flashes.
- Time period of display will be evaluated as part of the experiment, but nominally will be 1-min density plots of events, groups, and flashes.

GOES-16 GLM Products:

- Events – single pixel optical detection exceeding the background threshold for detection.
- Groups – optical events such as individual return strokes or high current discharges (i.e., K-change). May consist of one or more events (pixel) occurring within a single integration time, including all adjacent pixels, and weighted by the optical intensity of the associated Events.
- Flash Centroids – One or more groups occurring within 330 ms and 16.5 km. The flash is given as a single, centroid point weighted by the optical intensity of the associated Groups.

Concept for Operational Demonstration:

- GLM data will be delivered to the HWT via the SBN and displayed in AWIPS-II.
- In case of release date delays, GLM data may also be delivered via the LDM from NASA/SPoRT to the HWT if the GOES Rebroadcast feed is active.

Concept for Operations:

- GLM data and products are expected to be centrally produced at OSPO/ESPC and delivered by SBN or PDA following 9 June 2017.

Product Name: NOAA/CIMSS ProbSevere Model (ProbSevere) and associated NOAA/CIMSS ProbTornado Model (ProbTor)

Primary Investigator: Mike Pavolonis (NESDIS)

Hazardous Weather Testbed, Experimental Warning Program Relevance:

- Assists forecasters in severe weather situations by highlighting storms that are more or less likely to become severe/tornadic in the near future.
- Products will be evaluated on their ability to increase forecaster confidence and skillfully extend lead-time to severe hazards for NWS warnings during potential severe weather situations.

Product Overview:

- Statistical models provide probabilistic guidance to forecasters on the likelihood of severe weather occurrence for convection in the near term [0-90 min].
- Algorithms incorporate multiple datasets from satellite, radar, total lightning, and NWP into easy-to-interpret products, helping to consolidate/reduce the "fire hose" of data during busy weather situations.
- Model output is CONUS-wide and day/night independent.

Product Methodology:

- Spatial and temporal features are extracted and computed from satellite and radar storm objects. Satellite trends are shared with overlapping radar objects.
- Trained statistical models compute the probability that a storm will produce severe weather in the near-term, using GOES-derived, NEXRAD-derived, Earth Networks Total Lightning Network™ (ENTLN)-derived, and Rapid Refresh (RAP)-derived data.
- ProbSevere and ProbTor update every 2 minutes.

ProbSevere Products

- ProbSevere Model: provides guidance on hail, wind, and tornado threats.
- ProbTor Model: provides guidance on tornado potential.
- Products are displayed as color contours of severe and tornado probabilities around storms on radar.
- Data readout is available by sampling the probability contour. This provides the exact probabilities of hazards and the detailed model predictor values.

Concept for Operational Demonstration:

- GeoJSON files (on the order of kilobytes) will be delivered to the HWT via the LDM and converted on-the-fly into a shapefile using AWIPS-II.

Concept for Operations:

- The CONOPs for possible implementation of ProbSevere and ProbTor needs further development and is pending Proving Ground evaluations, as well as formal approval by the NOAT.

Product Name: NOAA Unique Combined Atmospheric Processing System (NUCAPS)

Primary Investigator: Chris Barnet (Science and Technology Corporation, Columbia, MD)

Hazardous Weather Testbed, Experimental Warning Program Relevance:

- NUCAPS provides forecasters with largely observation-based temperature and moisture profiles and plan views to aid in severe weather analysis, filling a spatiotemporal gap.
- A new "automated-modification" NUCAPS algorthim will be tested for the first time.

Product Overview:

- NUCAPS profiles will be available over the CONUS from EUMETSAT/MetOp-B in the late morning and from JPSS/Suomi-NPP in the early afternoon.
- NUCAPS profile availability provides a plan view of available NUCAPS profiles within a swath and whether a profile has passed (green) or failed (yellow/red) quality control.
- After selecting a profile location, the NUCAPS temperature and moisture profile will load on a skew-T diagram in the AWIPS-II/NSHARP application.
- Multi-level, gridded plan views of NUCAPS thermodynamic info will be available.
- A post-processed version of the soundings attempts auto modification of the low-levels.

Product Methodology:

- Product uses an ensemble of microwave-only, regression-based and physical retrieval algorithms to combine infrared and microwave measurements to produce temperature, moisture, and trace-gas profiles globally – in both clear and cloudy scenes.
- Automated-modification algorithm uses RTMA data and GOES-16 Skin Temperature to modify the surface and boundary layer to be consistent with surface observations.

NUCAPS Products:

- NUCAPS Profile Availability (time/location) with quality control flags
- NUCAPS Vertical Temperature and Moisture Profiles
- NUCAPS Vertical Temperature and Moisture Profiles with RTMA modification
- NUCAPS gridded plan view

Concept for Operational Demonstration:

- NUCAPS from Suomi-NPP is produced at NESDIS/NDE and delivered over the AWIPS SBN. NUCAPS from MetOp-B is produced at NESDIS/OSPO and delivered to the HWT through NASA/SPoRT via LDM. Both are formatted for display in AWIPS-II.
- Gridded NUCAPS from Suomi-NPP is produced at NASA/SPoRT using data from UW DB/CSPP, provided via LDM, and has been formatted for display in AWIPS-II.
- Post-processed modified NUCAPS data will be provided via LDM from CIRA.

Concept for Operations:

- NUCAPS from NPP is produced at NESDIS/NDE and delivered operationally over the SBN. NUCAPS from MetOp-B is produced at NESDIS/OSPO and delivered via LDM. Gridded NUCAPS from NPP is produced at NASA/SPoRT and delivered via LDM.
- Future AWIPS-II display and integration will depend on feedback from evaluations.