GOES-R Proving Ground Demonstration Proposal:
Storm Prediction Center – 2013-2014 Demonstrations

1. **Project Title:** 2013-2014 GOES-R Proving Ground – SPC Product Demonstrations

2. **Organization**: SPC, Norman, OK

3. **Products to be Demonstrated as a GOES-R Proving Ground activity in the SPC:**
   - **a.** Cloud-Top Cooling (GIMPAP)
   - **b.** Overshooting Top Detection (Future Capability)
   - **c.** NearCast Model (Risk Reduction)
   - **d.** GOES-R Convective Initiation (Future Capability)
   - **e.** GOES-R Fog and Low Stratus (Future Capability)
   - **f.** Total Lightning Detection (PGLM) (Baseline)
   - **g.** Lighting Threat Forecast (Future Capability)
   - **h.** GOES-14 Super Rapid Scan Operations for GOES-R (SRSOR) (Baseline)

4. **Demonstration Project Summary:**
   - **a. Overview:** The SPC will receive early exposure to GOES-R Proving Ground (PG) products throughout the remainder of 2013 into 2014 through activities led by SPC's GOES-R PG Liaison, William Line. The Liaison will begin by spending several weeks in SPC operations shadowing forecasters. The goal of the shadow shifts will be to: become familiar with SPC operations and the responsibilities of each forecast desk; learn the forecast processes of each individual forecaster and the tools they use; identify challenges the SPC forecasters face.

     The liaison will look for opportunities and situations in which GOES-R PG products may fit into the forecast process and provide unique and complementary beneficial information to SPC operations. Over time, he will introduce such products to forecasters and train them how to properly interpret the information the products provide. The Liaison will interact further with forecasters by monitoring and demonstrating the products at a desk on the operations floor in real-time. The gradual exposure to appropriate pre-operational GOES-R products during multiple seasons and over different weather regimes will provide SPC forecasters an opportunity to help determine operational applicability as well as critique and suggest improvements for products relatively early in their development cycle.

   - **b. Plan, Purpose, and Scope:** The NOAA/NWS/NCEP Storm Prediction Center (SPC) provides the GOES-R Proving Ground with an opportunity to demonstrate products associated with the next generation GOES-R geostationary satellite system. This activity will demonstrate the GOES-R baseline and future capabilities products as well as provide operational readiness trials of products transitioning from the GOES-R Risk Reduction (R3) program. The availability of GOES-R products will demonstrate, pre-launch, a portion of the full observing capability of the GOES-R system, subject to the constraints of existing data sources to emulate the satellite sensors.

c. **Goals:** The main objective of the GOES-R product demonstrations described therein is to integrate applicable products into SPC operations and have forecasters evaluate and provide feedback through verbal communication, surveys, and/or email correspondence. This feedback will be included in a mid-term and a final report which will be submitted to the GOES-R PG, and eventually provided to product developers so that necessary changes and improvements to products can be made. The one-on-one interactions between the SPC GOES-R PG Liaison and SPC forecasters allow for valuable discussions during real-time hazardous weather events, maximizing operations-to-research feedback, a GOES-R PG goal. In addition, training SPC forecasters to use GOES-R products pre-launch increases day-1 readiness in the SPC, another goal of the PG. Finally, incorporation of new products into SPC operations will help to fulfill the SPC mission of issuing timely and accurate watch and forecast products for high-impact mesoscale weather events.

5. **Participants Involved:**
   a. **Providers:**
      i. Cloud-Top Cooling (Feltz/Sieglaff – CIMSS)
      ii. Overshooting Top Detection (Bedka/Cronce – CIMSS)
      iii. NearCast Model (Petersen – CIMSS)
      iv. GOES-R Convective Initiation (Mecikalski – UAH/SPoRT)
      v. GOES-R Fog and Low Stratus (Pavolonis – CIMSS)
      vi. Total Lightning Detection (PGLM) (Stano/Calhoun – SPoRT/NSSL)
      vii. Lightning Threat Forecast (McCaul, Chronis, Alexander – USRA, UAH, ESRL - GSD)
      viii. GOES-14 Super Rapid Scan Operations for GOES-R (SRSOR) (Schmit/Knaff – ASPB /RAMMB)
   b. **Consumers:**
      i. Storm Prediction Center

6. **Project Schedule/Duration (some dates are preliminary and subject to change):**
   a. Shadow shifts in SPC operations: 11 Jun 2013
   b. Identify products for demonstration: 11 Jun 2013
   c. Make products available in N-AWIPS systems: 22 Jul 2013
   d. Stress-test N-AWIPS systems: 22 Jul 2013
   e. Develop product training material: 19 Aug 2013
   f. Provide initial product training: 09 Sep 2013
   g. Product demonstrations begin: 16 Sep 2013
   h. Product demonstrations mid-term report: 21 Apr 2014
   i. Product demonstrations end: 22 Aug 2014
   j. Final evaluation report: 26 Sep 2014

7. **Project Decision Points and Deliverables:**
   a. Proving Ground Operations Plan – First Draft: 27 Sep 2013
   b. Proving Ground Operations Plan – Final Draft: 18 Oct 2013
   c. Proving Ground Mid-Term Report: 21 Apr 2014
   d. Proving Ground Final Report: 26 Sep 2014

8. **Responsibilities and Coordination:**
    - **a.** William Line, OU-CIMMS/SPC – Satellite Liaison
    - **b.** Steven Weiss, NOAA/SPC – Chief, Science Support Branch
    - **c.** Kathryn Miretzky, AS&D for GOES-R Program Office – PG Coordinator

9. **Budget and Resource 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: Cloud-Top Cooling

Primary Investigator: Wayne Feltz and Justin Sieglaff (UW-CIMSS)

Storm Prediction Center Relevance:

- Product helps forecasters to identify where convection is growing rapidly, quantifying the rate of growth.
- This product can be especially useful to SPC forecasters in identifying rapid convective growth where radar coverage is limited and at night when it is more difficult to see initial convective growth using IR imagery.

Product Overview:

- Product can be used to objectively determine where convective clouds are growing and how fast the growth is.
- Strong CTC rates correspond to more intense future precipitation cores (composite reflectivity, REF_{-10}, MESH, VIL) when compared to moderate and weak CTC rates.
- Cloud-top cooling is a satellite indicator used in the GOES-R Convective Initiation product and is considered a compliment and tactical decision aid for convective initiation.
- Product offers a consistent day/night CTC detection capability
- This product is available everywhere over CONUS, including areas where lightning and radar data are either insufficient or unavailable.

Product Methodology:

- Algorithm uses GOES imager data to identify immature convective clouds that are growing vertically and hence cooling in infrared satellite imagery (i.e., cloud-top cooling rate).
- Cloud phase information is utilized to deduce whether the cooling clouds are immature water clouds, mixed phase clouds, or ice-topped (glaciating) clouds.
- Final result is a prognostic value of a satellite-based measure of vertical cloud growth rate.

Cloud-Top Cooling Products:

- Instantaneous box-averaged cloud-top cooling rate (K $(15\ min)^{-1}$)

Concept for Operational Demonstration:

- Cloud-Top Cooling product is delivered to the SPC via the LDM and has been formatted for display in N-AWIPS.

Concept for Operations:

- The CONOPs for possible implementation into operations need further development (this assumes approval to proceed/ prioritization from NOAT). To date, possible paths to operations include:
    - Centrally produced at NESDIS/ESPC most likely as part of a convective toolbox.
    - Discuss with NCEP/NCO possibility of running at NCO most likely as part of a convective toolbox and deliver to NCO users via NCO-backbone and to non-NCEP users via future AWIPS DDS capability
    - Run as AWIPS-2 application and/or procedure.

Product Name: Overshooting Top Detection

Primary Investigator: Kristopher Bedka (NASA) and Wayne Feltz (UW-CIMSS)

Storm Prediction Center Relevance:

- Product has been shown to assist in the diagnosis and nowcasting of hazardous convective weather because there are strong overshooting top relationships with hazardous convective weather (i.e., severe weather, total lightning).
- Presence of a persistent overshooting top feature can signify an especially strong and long-lived storm and early recognition of an overshooting top can raise situational awareness of impending hazardous weather. Similarly, decreasing trends in overshooting top detection's may indicate that the cell is weakening.
- This product can be especially useful to SPC forecasters in monitoring mature convective trends where radar coverage is limited and at night when it is more difficult to see overshooting tops in the IR.

Product Overview:

- Overshooting convective cloud tops are domelike bulges atop an anvil cloud that indicate a strong updraft within a convective storm system that has vertically penetrated the tropopause.
- Convection with overshooting top signatures often produces hazardous weather conditions such as frequent lightning, heavy rainfall, and severe weather.
- Product offers a consistent day/night overshooting top detection capability.
- Product is available everywhere over CONUS, including areas where lightning and radar data are either insufficient or unavailable.

Product Methodology:

- Overshooting top product identifies clusters of 10.7 μm IR pixels significantly colder (>6 K) than the surrounding anvil cloud with a diameter consistent with commonly observed overshooting tops.
- Provides a detection accuracy that exceeds that of an existing overshooting top detection technique based on the water vapor minus infrared window brightness temperature difference.

Overshooting Top Detection Products:

- Overshooting Top Detection

Concept for Operational Demonstration:

- Overshooting top product is delivered to the SPC via the LDM and has been formatted for display in N-AWIPS.

Concept for Operations:

- The CONOPs for possible implementation into operations need further development (this assumes approval to proceed/ prioritization from NOAT). To date, possible paths to operations include:
    - Centrally produced at NESDIS/ESPC most likely as part of a convective toolbox.

- Discuss with NCEP/NCO possibility of running at NCO most likely as part of a convective toolbox and deliver to NCO users via NCO-backbone and to non-NCEP users via future AWIPS DDS capability
- Run as AWIPS-2 application and/or procedure.

Product Name: NearCast Model

Primary Investigator: Ralph Petersen (UW-CIMSS)

Storm Prediction Center Relevance:

- Provides SPC forecasters with a highly observation-based decision support and situational awareness tool, particularly for the development and intensification (or weakening) of convection.
- Helps to fill in the information gap that exists in observational atmospheric sounding data by providing forecasters with vertical moisture and stability information at relatively high temporal (at least hourly) and spatial (10 km) resolution. Extends the use of these observations into short-term forecasts of the thermodynamic environment.

Product Overview:

- It provides forecasters with various atmospheric stability and moisture indices that can be used to aid in identifying when and where convection may be more (and less) likely to occur in the near (1-9 hour) future, and to assess whether the downstream environment will support persistence or further growth of existing convective storms.
- The hourly NearCast Model analysis output can be used to monitor the recent evolution of the observed NearCast fields in conjunction with other observed fields (satellite and radar imagery, lightning, etc.) or model data.
- Helps to fill the data gap that exists between observation-based nowcasts and longer-range (beyond 12 hours) NWP guidance.

Product Methodology:

- This Lagrangian model uses RAP model wind and height fields to dynamically project GOES temperature and moisture retrieval data forward in time. This results in detailed, hourly-updated information about the vertical structure of moisture and stability in the pre- and near-convective environment up to nine hours in advance.
- NearCast model output increases the areal coverage of single-time GOES data and retains details (maxima, minima, and extreme gradients) important to the development of convection several hours in advance, even after subsequent infrared satellite observations become cloud contaminated.

NearCasting Model Products:

- Vertical theta-e difference
- 500-mb mean-layer theta-e
- 780-mb mean-layer theta-e
- Vertical precipitable water difference
- 500-mb mean-layer precipitable water
- 780-mb mean-layer precipitable water

Concept for Operational Demonstration:

- NearCast Model products are delivered to the SPC via the LDM and have been formatted for display in N-AWIPS.

Concept for Operations:

- Expected to be centrally produced and delivered by NCO. The CONOPs for possible implementation into operations need further development (this assumes approval to proceed/ prioritization from NOAT). To date, possible paths to operations include:
    - Centrally produced at NESDIS/ESPC most likely as part of a convective toolbox.
    - Discuss with NCEP/NCO possibility of running at NCO most likely as part of a convective toolbox and deliver to NCO users via NCO-backbone and to non-NCEP users via future AWIPS DDS capability
    - Run as AWIPS-2 application and/or procedure.

Product Name: GOES-R Convective Initiation

Primary Investigator: John Mecikalski (UAH/SPoRT)

Storm Prediction Center Relevance:

- Provides 0-2 h probabilistic forecasts that highlight where convective initiation is likely, an SPC forecast challenge.

Product Overview:

- NWP-satellite fused probabilistic product that serves as a strategic aid for convective initiation.
- True probabilistic product (unlike previous versions of the convective initiation algorithm) because the algorithm incorporates information about the local atmospheric environment.

Product Methodology:

- Convective initiation probabilistic product is produced using a logistic regression framework.
- Convective cloud properties and 20 fields from the Rapid Refresh model are used to create 0-2 h probabilistic forecasts.
- Early verification statistics have much improved skill scores compared to the satellite-only CI product when the NWP environmental data are included.

GOES-R Convective Initiation Products:

- 0-2 h Probabilistic Forecasts of Convective Initiation

Concept for Operational Demonstration:

- GOES-R Convective Initiation product is delivered to the SPC via the LDM and has been formatted for display in N-AWIPS.

Concept for Operations:

- The CONOPs for possible implementation into operations need further development (this assumes approval to proceed/ prioritization from NOAT). To date, possible paths to operations include:
    - Centrally produced at NESDIS/ESPC most likely as part of a convective toolbox.
    - Discuss with NCEP/NCO possibility of running at NCO most likely as part of a convective toolbox and deliver to NCO users via NCO-backbone and to non-NCEP users via future AWIPS DDS capability
    - Run as AWIPS-2 application and/or procedure.

Product Name: GOES-R Fog and Low Stratus

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

Storm Prediction Center Relevance:

- Provides decision support and tactical decision aids for forecasters when identifying the presence and location of fog and low stratus. Several forecasters in the SPC have requested a product that improves upon current fog and low cloud detection capabilities at night.
- The presence of fog and low stratus clouds often influence the future development (or lack thereof) of convection. Additionally, estimations of fog dissipation can be helpful in predicting the timing of later convective development.
- Products can be used during the day and night and when high cirrus or ice clouds are present.

Product Overview:

- GOES-R 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.
- 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.

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, and MODIS data.

Concept for Operational Demonstration:

- Fog and Low Stratus products are delivered to the SPC via the LDM and have been formatted for display in N-AWIPS.

Concept for Operations:

- The Fog and Low Stratus Products are under consideration 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: Total Lightning Detection (PGLM)

Primary Investigator: Geoffrey Stano (SPoRT)

Storm Prediction Center Relevance:

- Can be used to identify convection that may contain significant lightning, both cloud-to-ground and intra-cloud lightning, which can be related to storm intensity.
- Will prepare forecasters to receive data from the Geostationary Lightning Mapper (GLM), baseline GOES-R instrumentation designed to measure total lightning.

Product Overview:

- Provides an 8km boxed average estimation of total lightning activity within the Lightning Mapping Array (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 1 to 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 given grid box.

GOES-R PGLM Products:

- Current LMA networks: Oklahoma (OKLMA), Northern Alabama (NALMA), D.C. LMA (DCLMA), Colorado (COLMA), Houston (HGLMA), West Texas (WTLMA) and New Mexico (NMLMA).

Concept for Operational Demonstration:

- The PGLM data are delivered to the SPC via the LDM and have been formatted for display 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.

Product Name: Lightning Threat Forecast

Primary Investigators: McCaul, Chronis, and Alexander (USRA, UAH, ESRL-GSD)

Storm Prediction Center Relevance:

- May have utility in the preparation of SPC Thunderstorm Outlook and Day 1 and 2 convective outlook products.
- May have utility at the SPC Fire Weather Forecast Desk by providing additional guidance to the occurrence of dry thunder.

Product Overview:

- Differentiates areas of convection in the modeled environment that are predicted to produce lightning from those that are not.
- Output displayed as lightning flash-rate density, or flashes $(5\ \text{min})^{-1}\ \text{km}^{-2}$

Product Methodology:

- A calibrated graupel flux at -15°C term, or Lightning Threat 1, captures the temporal variability of the lightning threat well.
- A calibrated vertically integrated ice content term, or Lightning Threat 2, captures the spatial coverage of the lightning threat well.
- Lightning Threat's 1 and 2 are blended together in a weighted average to produce the Flash Rate Density product, or Lightning Threat 3.

GOES-R Lightning Threat Forecast Products:

- Lightning Threat's 1, 2 and 3 from the WRF-NSSL model.
- Lightning Threats 3 from the HRRR model.

Concept for Operational Demonstration:

- The Lightning Threat Forecast products have been formatted for display in N-AWIPS.

Concept for Operations:

- This topic is still to be discussed.

Product Name: Super Rapid Scan Imagery (SRSOR)

Primary Investigator: Tim Schmit (NESDIS/ASPB) and John Knaff (NESDIS/RAMMB)

Storm Prediction Center Relevance:

- Will prepare SPC forecasters for the 1-minute imagery that will be routinely available with the GOES-R Advanced Baseline Imagery (ABI).
- Will help SPC forecasters in monitoring for convective initiation by providing imagery at a much higher refresh rate.
- Will serve as a "stress test" for the N-AWIPS system at the SPC.

Product Overview:

- GOES-R will provide routine imagery at a 30 sec – 1 min mesoscale refresh rate with the ABI. To prepare forecasters for this new capability, GOES-14, at 105^{o}W, will provide 1-minute imagery during select periods while it is out of storage.

Super Rapid Scan Imagery Products:

- Full resolution 1-minute visible imagery

Concept for Pre-Operational Demonstration:

- SRSOR imagery for SPC is pulled from the CIRA ftp server for display in N-AWIPS.

Concept for Operations:

- Super rapid scan is being used as proxy to develop GOES-R imagery use at time scales of 1 minute or less. It is hoped that AWIPS-2 tactical decision aids and use cases can be developed through these demonstrations.