Operations Plan

for the
GOES-R Proving Ground
2012 Aviation Weather Experiment

Program overview by:
Chad Gravelle (UW-CIMSS / NWSOPG)
Amanda Terborg (UW-CIMSS / AWC)
Bonnie Reed (NWS / GPO)
Bruce Entwistle (NWS / AWC)
David Bright (NWS / AWC)
Jason Levit (NWS / AWC)
Wayne Feltz (UW-CIMSS)
Bob Aune (UW-CIMSS)
Kris Bedka (SSAI)
Dan Lindsey (NESDIS / STAR / RAMMB)
Bill McCaul (NASA MSC / SPoRT / USRA)
Mike Pavolonis (NESDIS / UW-CIMSS)
Ralph Petersen (UW-CIMSS)
Justin Sieglaff (UW-CIMSS)
Bill Smith Jr. (NASA LaRC)
Geoffrey Stano (SPoRT)
John Walker (UAH)

Product developers contributed the material regarding their respective products.

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Table of Contents

1 INTRODUCTION ... 4
1.1 Plan and Purpose ... 4
1.2 Overview ... 4
2 GOALS OF THE PROVING GROUND PROJECT ... 4
3 GOES-R PRODUCTS TO BE DEMONSTRATED ... 4
3.1 Simulated Cloud and Moisture Imagery ... 5
3.2 WRF and HRRR Lightning Threat Forecast ... 6
3.3 UW Convective Initiation / Cloud-Top Cooling Rates ... 6
3.4 UAH Convective Initiation ... 7
3.5 Enhanced-V / Overshooting Top Detection ... 7
3.6 Pseudo Geostationary Lightning Mapper ... 8
3.7 NearCasting Model ... 8
3.8 Low Cloud and Fog Detection ... 9
3.9 Volcanic Ash Detection and Height ... 9
3.10 SO_2 Detection ... 9
3.11 Aircraft Icing Threat ... 10
4 PROVING GROUND PARTICIPANTS ... 10
4.1 CIMSS ... 11
4.1.1 Simulated Cloud and Moisture Imagery ... 11
4.1.2 UW Convective Initiation / Cloud-Top Cooling Rates ... 11
4.1.3 Enhanced-V / Overshooting Top Detection ... 11
4.1.4 NearCasting Model ... 12
4.1.5 Low Cloud and Fog Detection ... 12
4.1.6 Volcanic Ash Detection and Height ... 12
4.1.7 SO_2 Detection ... 12
4.2 CIRA ... 12
4.2.1 Simulated Cloud and Moisture Imagery ... 13
4.3 NASA SPoRT ... 13
4.3.1 WRF and HRRR Lightning Threat Forecast ... 13
4.3.2 Pseudo Geostationary Lightning Mapper ... 13
4.4 NASA LaRC ... 13
4.4.1 Aircraft Icing Threat ... 13
4.5 UAH ... 13
4.5.1 Convective Initiation ... 14
4.6 Aviation Weather Center Operations ... 14
4.7 Aviation Weather Testbed Summer Experiment ... 14
5 RESPONSIBILITIES AND COORDINATION ... 14
5.1 Project Authorization ... 14
5.2 Project Management ... 14
5.3 Project Evaluation ... 15
5.4 Project Training ... 15
5.4.1 General Sources ... 15
5.4.2 Product Training References ... 15
5.4.2.1 Simulated Cloud and Moisture Imagery ... 15
5.4.2.2 WRF and HRRR Lightning Threat Forecast ... 15
5.4.2.3 UW Convective Initiation ... 15
5.4.2.4 UAH Convective Initiation ... 15
5.4.2.5 Enhanced-V / Overshooting Top Detection ... 16
5.4.2.6 Pseudo-Geostationary Lightning Mapper ... 16
5.4.2.7 NearCasting Model ... 16

5.4.2.8 Low Cloud and Fog Detection 16
5.4.2.9 Volcanic Ash Detection and Height 16
5.4.2.10 SO_2 Detection 16
5.4.2.11 Aircraft Icing Threat 16
6 PROJECT SCHEDULE 16
7 MILESTONES AND DELIVERABLES 17
7.1 Products from Providers 17
7.2 Training Materials from Providers 17
7.3 Mid-term Evaluation Report 17
7.4 Final report 18
8 RELATED ACTIVITIES AND METHODS FOR COLLABORATION 18
8.1 GOES-R Risk Reduction Products and Decision Aids 18
9 SUMMARY 18
10 REFERENCES 18

1 INTRODUCTION

1.1 Plan Purpose and Scope

The National Oceanic and Atmospheric Administration (NOAA) Aviation Weather Center (AWC) and Aviation Weather Testbed Summer Experiment (hereafter together referred to as Aviation Weather Experiment) provide the GOES-R Proving Ground (PG) with a pre-operational environment in which to deploy and demonstrate algorithms associated with its next generation GOES-R geostationary satellite system. Providing GOES-R aviation-related products to the AWC will allow official GOES-R Baseline and derived products to be demonstrated in operations; however, operational readiness trials of products transitioning from Risk Reduction are also included. 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 high latitude data sources to emulate the satellite sensors.

1.2 Overview

The GOES-R PG will provide aviation-related products to the AWC and Aviation Weather Testbed Summer Experiment. The early exposure to GOES-R PG products will occur within AWC Operations from July 2012 through September 2013 and within the Aviation Weather Testbed Summer Experiment which will take place from 4-15 June 2012. Pre-operational demonstrations of the GOES-R PG products will provide the aviation forecasters the opportunity to critique and improve the products relatively early in their development. Chad Gravelle and Amanda Terborg, the GOES-R satellite liaisons at the National Weather Service Operations Proving Ground and AWC, will be coordinating the GOES-R desk within the Aviation Weather Testbed Summer Experiment.

2 GOALS OF THE PROVING GROUND PROJECT

The GOES-R products planned for demonstration in AWC Operations and the Aviation Weather Testbed Summer Experiment are listed in Table 1. The focus is on GOES-R Baseline and Future Capabilities; however two Risk Reduction products will also be evaluated during the Aviation Weather Testbed Summer Experiment, the NearCasting Model and the WRF and HRRR Lightning Threat Forecast. Four GOES-R products will be evaluated long-term (6 months or more) within AWC Operations, while demonstrations of seven products will occur over a two-week period during the Aviation Weather Testbed Summer Experiment. Although these approaches are different, they both will provide the opportunity to achieve the GOES-R PG goals. For example, AWC forecasters and Testbed participants will participate in training, discussions, and provide feedback on the GOES-R products, which are all essential in maximizing the Operations-to-Research process. The resultant interactions build relationships between the product development teams and the forecasters within the aviation community.

3 GOES-R PRODUCTS TO BE DEMONSTRATED

The products chosen to be demonstrated within AWC Operations are identified in Table 1. These products were chosen based on AWC needs and applicability time of year. During the Aviation Weather Testbed Summer Experiment, four GOES-R Baseline and Future Capabilities products will be demonstrated: (1) Simulated Cloud and Moisture Imagery, (2) Enhanced-V/Overshooting Top Detection, (3) Pseudo-Geostationary Lightning Mapper (GLM), and (4) Low Cloud and Fog. In addition, demonstrations of three GOES-R Risk Reduction and GOES I/M Product Assurance Plan (GIMPAP) products will occur within the Testbed Summer Experiment: (1) WRF and HRRR Lightning Threat Forecast, (2) University of Wisconsin Convective Initiation (UW CI), and (3) NearCasting Model. The seven GOES-R products will supplement the Testbed Summer Experiment's primary goal of developing and issuing Aviation Weather Statements that are focused on convective and low-cloud impacts to air-traffic. All ten products are listed in Table 1 and described further in the following subsections.

Table 1. Products to be demonstrated during Aviation Weather Experiment

Demonstrated GOES-R Product	Category
Simulated Cloud and Moisture Imagery*	Baseline
WRF and HRRR Lightning Threat Forecast*	Risk Reduction
UW Convective Initiation / Cloud-Top Cooling Rates*	GIMPAP
UAH Convective Initiation*	Future Capability
Enhanced-V/Overshooting Top Detection*	Future Capability
Pseudo-GLM*	Baseline
NearCasting Model*	Risk Reduction
Low Cloud and Fog*#	Future Capability
Volcanic Ash Detection and Height#	Baseline
SO_2 Detection#	Future Capability
Aircraft Icing Threat#	Future Capability
Category Definitions: **Baseline Products** - GOES-R products that are funded for operational implementation as part of the ground segment base contract. **Future Capability** - New capability made possible by ABI that requires additional funding to support. **GOES-R Risk Reduction** - The purpose of Risk Reduction research initiatives is to develop new or enhanced GOES-R applications and to explore possibilities for improving the AWG products. These products may use the individual GOES-R sensors alone, or combine data from other in-situ and satellite observing systems or models with GOES-R. **GIMPAP** - The GOES Improved Measurement and Product Assurance Plan provides for new or improved products utilizing the current GOES imager and sounder.	

#: Aviation Weather Center Operations

*: Aviation Weather Testbed 2012 Summer Experiment

3.1 Simulated Cloud and Moisture Imagery

Simulated cloud and moisture imagery from the Advanced Baseline Imager (ABI) will be provided to the Aviation Weather Testbed for use in the Spring Experiment by the Cooperative Institute for Meteorological Satellite Studies (CIMSS). This effort provides direct collaborations between the GOES-R Proving Ground and the modeling community, as synthetically produced satellite imagery can provide insight into model performance.

The radiance calculation for each ABI infrared channel involves several steps within the forward modeling system. First, CompactOPTRAN, which is part of the NOAA Community Radiative Transfer Model (CRTM), is used to compute gas optical depths for each model layer from the WRF-simulated temperature and water vapor mixing ratio profiles and climatological ozone data. Ice cloud absorption and scattering properties, such as extinction efficiency, single-scatter albedo, and full scattering phase function, obtained from Baum et al. (2006) are subsequently applied to each frozen hydrometeor species (i.e., ice, snow, and graupel) predicted by the microphysics parameterization scheme. A lookup table based on Lorenz-Mie calculations is used to assign the properties for the cloud water and rain water species.

Visible cloud optical depths are calculated separately for the liquid and frozen hydrometeor species following the work of Han et al. (1995) and Heymsfield et al. (2003), respectively, and then converted into infrared cloud optical depths by scaling the visible optical depths by the ratio of the corresponding extinction efficiencies. The longer path length for zenith angles > 0 is accounted for by scaling the optical depth by the inverse of the cosine of the zenith angle. The surface emissivity over land was obtained from the Seemann et al. (2008) global emissivity data set, whereas the water surface emissivity was computed using the CRTM Infrared Sea Surface Emissivity Model. Finally, the simulated skin temperature and atmospheric temperature profiles along with the layer gas optical depths and cloud scattering properties were input into the Successive Order of Interaction (SOI) forward radiative transfer model (Heidinger et al. 2006) to generate simulated TOA radiances for each ABI infrared band. The cloud and moisture imager is then derived from the TOA radiances.

Additionally, band differences between select GOES-R infrared channels will also be provided by the Cooperative Institute for Research in the Atmosphere (CIRA) to further analyze microphysical performance within the model, as well as simulate the capabilities of GOES-R infrared channels to provide additional information to the forecasting community. The CIRA procedure for creating the synthetic ABI data is similar to that described above for CIMSS. Numerical model output from the WRF-ARW is read and then synthetic brightness temperatures for several of the GOES-R ABI bands are processed.

Forecasters can use the derived synthetic satellite data to key in on ABI water vapor or infrared window band features of interest, such as convective development and location, rather than using NWP derived fields.

3.2 WRF and HRRR Lightning Threat Forecast

The Weather Research and Forecasting (WRF) and High-Resolution Rapid Refresh (HRRR) Lightning Threat Forecast is a model-based method for making quantitative forecasts of fields of lightning threat. The algorithm uses microphysical and dynamical output from high-resolution, explicit convection runs of the WRF and HRRR Models. The algorithm uses two separate proxy fields to assess lightning flash rate density and areal coverage, based on storms simulated by WRF models. One lighting threat field is based on the flux of large precipitating ice (graupel) in the mixed phase layer near -15C and has been found to be proportional to lightning flash peak rate densities while accurately representing the temporal variability of flash rates during updraft pulses. The second lightning threat field, based on vertically integrated ice hydrometeor content in the simulated storms, has been found to be proportional to peak flash rate densities while also providing information on the spatial coverage of the lightning threat, including lightning in storm anvils. Finally, a composite threat is created by blending the two aforementioned lightning threat fields after adjustments are made to account for the differing sensitivities of the two basic threats to the specific configuration of the WRF and HRRR models.

Participants in the Aviation Weather Testbed will be exposed to the ability to incorporate short-term predictions of potential lightning activity into their forecasts. The lightning threat forecasts may assist forecasters in identifying the initial occurrence of convective initiation and deterministically analyze the severity of convection in the model output.

3.3 UW Convective Initiation / Cloud-Top Cooling Rates

The University of Wisconsin Convection Initiation / Cloud-Top Cooling Rate (UWCI; UW-CTC) algorithm is an experimental satellite-based product used to diagnose and nowcast convective initiation and convective cloud-top cooling rate (Sieglaff et al. 2011). The UWCI-CTC algorithm uses GOES imager data to determine immature convective clouds that are growing vertically and hence cooling in infrared satellite imagery. Additionally, cloud phase information is utilized to deduce whether the cooling clouds are immature water clouds, mixed phase clouds, or ice-topped (glaciating) clouds.

Based on previous experiment forecaster feedback, the UWCI-CTC algorithm has been improved to operate in areas of thin cirrus clouds during daytime hours by including GOES cloud optical depth retrievals. The focus for the 2012 Summer Experiment will be to use the UW-CTC rates as a prognostic tool for future NEXRAD observations. The NEXRAD fields of focus will be composite reflectivity, 18 and 30 dBZ echo top height, and Maximum Expected Hail Size (MESH) based on a UW-CTC rate vs.

NEXRAD study by Hartung et al. (2012). The goal of the demonstration is to determine how aviation forecasters can use the relationships from Hartung et al. (2012) in aviation convective forecasting responsibilities and how UW- CTC rate products and/or validation studies be improved.

3.4 UAH Convective Initiation

The University of Alabama in Huntsville (UAH) is developing a proxy product similar to the one they produced for the GOES-R Algorithm Working Group (AWG) official algorithm called SATellite Convection Analysis and Tracking (SATCAST). Beginning in late 2008 through 2009, UAH developed an object tracking methodology (Alternative 1 from the GOES-R Aviation AWG Critical Design Review), based on an overlap methodology that will exploit the high temporal resolution data from GOES-R. Since the current GOES does not have the temporal resolution of GOES-R, the GOES-R CI algorithm cannot operate optimally with the current GOES instrument’s 15-min refresh rate. In order to provide more accurate object tracking, a combination of overlap and mesoscale atmospheric motion vectors (Zinner et al. 2008) methodologies have been employed with great success. The addition of the Zinner et al. methodology allows for accurate object tracking with up to a 15-minute and, sometimes, 30-minute temporal resolution. The advantages of the object based SATCAST is that it can monitor object sizes down to 1 pixel, and easily track cloud objects between consecutive satellite scans for validation purposes.

Additionally, the previous versions of SATCAST produced “binary” yes/no output regarding the potential of CI for tracked cloud objects. However, as a result of forecaster user feedback, the algorithm is currently undergoing an enhancement that will provide forecasters with a “Strength of Signal” (SS) output. This method applies a linear regression approach to combine information from all available GOES IR channels into a single numerical value on a scale from 0 to 100, giving a sense for how strong the satellite-retrieved signal is for the development of cloud objects between the previous two GOES satellite scans.

The SATCAST algorithm uses a daytime statistically-based convective cloud mask, performs multiple spectral differencing tests of IR fields (so-called “interest fields”), and applies atmospheric motion vector (AMV) cloud tracking. SATCAST output has shown success when implemented in well-established algorithms supported by the Federal Aviation Administration, specifically the Corridor Integrated Weather System as part of the Consolidated Storm Prediction for Aviation (CoSPA). CoSPA integrates radar observations, Numerical Weather Prediction (NWP) winds and stability fields, and other data to assist in developing convective initiation nowcasts. NWP data helps remove spurious false alarms in SATCAST, which are in part caused by mesoscale AMV tracking errors, contamination from thin cirrus clouds, and the inherent difficulties associated with tracking pixel scale growing cumulus in 4 km Infrared (IR) data.

3.5 Enhanced-V/Overshooting Top Detection

Overshooting tops (OTs) are the product of deep convective storm updraft cores of sufficient strength to rise above the storms’ general equilibrium level near the tropopause region and penetrate into the lower stratosphere. Thunderstorms with OTs frequently produce hazardous weather at the Earth’s surface such as heavy rainfall, damaging winds, large hail, and tornadoes. Scientists at UW-CIMSS and NASA Langley Research Center have recently developed an objective satellite-based OT detection product (GOES-R Future Capability Product) that identifies clusters of pixels significantly colder than the surrounding anvil cloud with a diameter consistent with commonly observed OTs (Bedka et al. 2010). The product provides a detection accuracy that exceeds that of an existing OT detection technique based on the water vapor minus infrared window brightness temperature difference (Bedka et al. 2012). Turbulence and cloud-to-ground lightning are found to occur most frequently near the OT region, indicating that OTs represent significant hazards to ground-based and in-flight aviation operations. This algorithm will also improve the detection of areas with the potential of turbulence, giving pilots ample warning of potentially dangerous flying conditions, as well as potential severe weather and lightning.

Thunderstorms with an enhanced-V and strong anvil thermal couplet signature in infrared satellite imagery have been shown to be especially severe (Brunner et al. 2007). In addition to OTs, an objective enhanced-V detection product has been developed and will also be included for evaluation within the 2012 Aviation Weather Testbed Summer Experiment. McCann (1983) shows that the enhanced-V signature can appear 30 minutes before the onset of severe weather on the ground, thus providing a forecaster with crucial warning lead-time.

3.6 Pseudo-Geostationary Lightning Mapper

A GOES-R Geostationary Lightning Mapper (GLM) demonstration data set will be available during the Aviation Weather Testbed 2012 Summer Experiment. This product takes the raw total lightning observations, or sources, from any of the ground-based Lightning Mapping Array (LMA) networks available and recombines them into a flash extent gridded field. These data are mapped to a GLM resolution of 8 km and will be available at 1 or 2 min 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. Also, no flash is counted more than once for a given grid box. The pseudo GLM is not a true proxy data set for the GLM as it does not attempt to create a correlation between the VHF ground-based networks and the eventual optical-based GLM (individual events, groups, flashes at 20 second latency). However, the pseudo GLM product will give forecasters the opportunity to use and critique a demonstration of GLM type data to help improve future visualizations of these data. Additionally, experience gained using LMA-based 8-km products will serve as an idea farm and reference for comparison with full GLM proxies and derived products. Products expected to be produced include 8-km flash extent density, flash initiation density, and 30-minute flash extent density track.

3.7 NearCasting Model

A NearCasting model that assimilates full resolution moisture and temperature information from the current 18-channel GOES sounder and generates 1-9 hour forecasts of the future atmospheric moisture, equivalent potential temperature, and stability indices will be included in the Aviation Weather Testbed 2012 Summer Experiment. Products generated by the NearCast model have shown skill at identifying rapidly developing, convective destabilization up to 6-9 hours in advance. The system fills the 1-9 hour information gap which exists between radar nowcasts and longer-range numerical forecasts. Short-range numerical models must be able to detect and retain extreme variations in the atmosphere (especially moisture fields) and incorporate large volumes of high-resolution asynoptic data while remaining computationally efficient. The NearCasting system accomplishes this by using a Lagrangian approach to optimize the impact and retention of information provided by the GOES sounder. Its primary data source is hourly, full resolution (10-12 km) multi-layer retrieved parameters from the GOES sounder. Results from the NearCasting model increases the areal coverage of single-time GOES data and enhances current operational NWP forecasts by successfully capturing and retaining details (maxima, minima, and extreme gradients) critical to the development of convective instability several hours in advance, even after subsequent infrared satellite observations become cloud contaminated.

Aviation Weather Testbed participants will evaluate the NearCasting model with spatial and temporal forecasts of lower- and mid-level moisture transport patterns and the formation of convective instability. These products will assist forecasters in determining where and when convective initiation will (and will not) occur.

3.8 Low Cloud and Fog

The GOES-R fog/low cloud detection products are designed to quantitatively (expressed as a probability) identify clouds that produce Instrument Flight Rules (IFR) conditions (ceiling < 1000 ft and/or surface visibility < 1 mile). A naïve Bayesian classifier (e.g., Kossin and Sitowski 2008) is used to objectively determine the probability of IFR conditions. Both satellite and NWP model data are used as predictors and ceilometer based surface observations of cloud ceiling are used to train the classifier. 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. A similar approach is utilized at night without the 0.65 μm channel. Either global or regional NWP models can be used, depending on the availability (the Rapid Refresh model is used over CONUS). Comparisons to surface observations indicate that the GOES-R IFR probability product greatly outperforms the traditional 3.9 – 11 μm brightness temperature difference. In addition, the physical thickness of radiation fog layers is estimated. The primary limitation of the GOES-R approach is that some discontinuity will be associated with the transition from sunlit to non-sunlit conditions and vice-versa. The GOES-R low cloud base algorithm is described in detail in Calvert and Pavolonis (2011).

3.9 Volcanic Ash Detection and Height

The GOES-R volcanic ash products utilize infrared channels (7.3, 8.5, 11.0, 12.0, and 13.3 μm) to identify potential volcanic ash clouds (when the ash is the highest cloud layer) and to retrieve the ash cloud height, mass loading, and effective particle radius. These parameters are important for both nowcasting and forecasting purposes. The ash cloud height is needed to determine if ash is at flight level altitudes and to initialize the plume height in dispersion models. The GOES-R ash cloud height retrieval accounts for transmission of radiation through the ash cloud from below (e.g., the ash clouds are allowed to be semi-transparent to infrared radiation), so it produces high quality results even when applied to optically thin ash clouds. Validation efforts indicate that the GOES-R ash height retrieval can determine the ash cloud top height with accuracy (bias) of -1.35 km and a precision of 1.61 km, for tropospheric clouds.

Ash concentration data are needed to determine if jet engine tolerances are exceeded (should accurate thresholds be made available by engine manufacturers). If a 1-km ash cloud thickness is assumed, the ash mass loading (ton/km^2) is numerically equivalent to ash concentration in mg/m^3. Ash loading data can also be used to initialize models. Comparisons to spaceborne lidar indicate that the GOES-R ash mass loading has an accuracy (bias) of 0.42 ton/km2 and a precision of 1.17 ton/km^2, subject to certain microphysical assumptions.

The ash effective particle radius is not an official GOES-R requirement, but it is automatically produced in the process of retrieving the ash height and mass loading. The ash effective particle radius can be used to determine if the ash cloud is dominated by small or large particles, which is important for predicting the atmospheric residence time (i.e., small particle remain suspended longer than large particles, all else being equal). This information can also be used to initialize models. Since it is not an official GOES-R product, the ash effective particle radius information will be retained in the quality flag output.

3.10 SO_2 Detection

When combined with water, SO_2 is corrosive and harmful to breathe and therefore a potential aviation hazard. Further, when injected into the stratosphere SO_2 is converted to sulfate droplets, which reflect incoming sunlight back to space, and can impact climate. The GOES-R SO_2 detection product utilizes infrared measurements (6.2, 7.3, 8.5, 11.0, and 12.0 μm) to identify pixels that contain 10 or more Dobson Units (DU) of Sulfur Dioxide (SO_2), when the SO_2cloud is the highest cloud layer. The SO_2 detection algorithm utilizes a unique blend of spectral and spatial information to detect SO_2. SO_2 loadings less than 10 DU are difficult to detect using the ABI, since the ABI cannot resolve individual SO_2 absorption lines. Validation efforts indicate that the SO_2 detection algorithm meets the GOES-R accuracy specification (70% correct detection) and the probability of detection is approximately 70% with a probability of false alarm of approximately 0%. The low false alarm rate makes this product ideal for use in an automated volcanic cloud alert system. In addition, while not required, SO_2 loading is also estimated using a simple regression relationship which will be stored in the quality flags.

3.11 Aircraft Icing Threat

The Aircraft Icing Threat is partially determined by the presence and density of super-cooled liquid water and the water droplet size distribution. The GOES-R Aircraft Icing Threat algorithm utilizes satellite-derived cloud properties that provide information on icing conditions. The product is available at the pixel level and composed of three components;

(1) an icing mask available day and night which discriminates regions of possible aircraft 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 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. Optically thick clouds composed of ice crystals at cloud top may obscure possible icing conditions from the satellite view and in such cases the icing threat is deemed to be unknown from the GOES-R data alone. 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. Larger droplets and liquid water paths are associated with a higher probability of severe icing. In the current algorithm, the MOG category always has a high probability of icing due to its strong dependence on liquid water path. However, the GOES-R Aircraft Icing Threat product will assist in resolving small-scale areas of intense icing often missed in other products.

There are many difficulties associated with validating the Aircraft Icing Product and feedback from the user community is sorely needed. Forecasters at the National Center for Atmospheric Research (NCAR) have successfully used the product to direct aircraft into intense areas of icing for basic research and for icing certification purposes. Icing pilot reports provide the most widely available in-situ aircraft icing information and these have been used extensively in developing and validating the GOES-R Aircraft Icing Threat product. The skill in detecting icing conditions reported by Pilot's (PODY) is better than 90% provided there are no high level clouds obscuring the satellite view. However, there is a lack of incentive to report 'no icing' conditions by pilots which makes accurately quantifying false alarms difficult to achieve.

4 PROVING GROUND PARTICIPANTS

The Proving Ground participants are broken into two categories, Providers and Consumers. Providers are those organizations that develop and deliver the demonstration product(s) and training materials to the consuming organization. The Consumers are those who work with the Providers to integrate the product(s) for demonstration into an operational setting for forecaster interaction while providing product assessments. For the Aviation Weather Experiment at the AWC there are four providers: the Cooperative Institute for Meteorological Satellite Studies (CIMSS), NASA's Short-term Prediction Research and Transition (SPoRT) Center, the NASA Langley Research Center (LaRC), the Cooperative Institute for Research in the Atmosphere (CIRA), and the University of Alabama - Huntsville (UAH). The Aviation Weather Center is the Consumer of the aviation-related products. This section lists which products each provider is providing and explains the delivery mechanism that will be used.

4.1 CIMSS

CIMSS will be providing seven products described below for demonstration in the Aviation Weather Experiment.

4.1.1 Simulated Cloud and Moisture Imagery

National Severe Storms Laboratory (NSSL) 4-km Advanced Research Weather Research Forecasting (WRF-ARW) numerical weather prediction model-generated advanced baseline imager (ABI) synthetic infrared radiances (Bands 8-16) initialized each day at 0000 UTC (F012-F036) will be demonstrated within the Aviation Weather Testbed Summer Experiment. This model output will be available for evaluation via the Local Data Manager (LDM) server at the University of Wisconsin in McIDAS AREA format.

Bands to be displayed within N-AWIPS:

- Band 8 (6.19 μm): Upper-level Tropospheric Water Vapor
- Band 9 (6.95 μm): Upper/Mid-level Tropospheric Water Vapor
- Band 10 (7.34 μm): Lower/Mid-level Tropospheric Water Vapor
- Band 11 (8.5 μm): Cloud-top Phase
- Band 12 (9.61 μm): Ozone
- Band 13 (10.35 μm): Clean Infrared Longwave
- Band 14 (11.2 μm): Infrared Longwave
- Band 15 (12.3 μm): Dirty Infrared Longwave
- Band 16 (13.3 μm): CO_2 Infrared Longwave

4.1.2 UW Convective Initiation / Cloud-Top Cooling Rates

The UWCI-CTC products will be delivered in General Regularly-distributed Information in Binary form 2 (GRIB2) format via the University of Wisconsin LDM to the AWC Testbed and converted to a format suitable for display in the NCEP Advanced Weather Interactive Processing System (N-AWIPS).

Products to be displayed within N-AWIPS:

- Instantaneous box-averaged cloud-top cooling rate (K $(15\ \text{min})^{-1}$)
- Instantaneous CI signal
    - Value 0: No CI nowcast
    - Value 1: "Pre-CI Cloud Growth" associated with growing liquid water cloud
    - Value 2: "CI Likely" associated with growing supercooled water or mixed phase cloud
    - Value 3: "CI Occurring" associated with cloud that has recently transitioned to a thick ice cloud top
    - Value 4: "Ice Cloud Mask" associated with areas where cloud contamination will inhibit CI nowcasts

4.1.3 Enhanced-V/Overshooting Top Detection

The Enhanced-V (thermal couplet) and Overshooting Top (OT) Detection products will be delivered to the AWC Testbed in GRIB2 format via the LDM server at the University of Wisconsin and converted to display in N-AWIPS. Probabilistic products derived from the relationship between OT location and turbulence, severe weather, and cloud-to-ground lightning will also be included.

Products to be displayed within N-AWIPS:

- Enhanced-V (thermal couplet) detection
- Overshooting top detection
- Probability of turbulence
- Probability of cloud-to-ground lightning
- Probability of severe weather at surface

4.1.4 NearCasting Model

The NearCasting Model products will be delivered to the AWC Testbed for the 2012 Summer Experiment in GRIB2 format via the University of Wisconsin LDM for display within N-AWIPS.

Products to be displayed within N-AWIPS:
• 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
• Vertical precipitable water gradient difference
• 500-mb mean-layer precipitable water gradient
• 780-mb mean-layer precipitable water gradient
• Long-lived Convection Index

4.1.5 Low Cloud and Fog
The Low Cloud/Fog products will be delivered in netCDF format via the University of Wisconsin LDM to the AWC Testbed and converted to a format suitable for display in the NCEP Advanced Weather Interactive Processing System (N-AWIPS).

Products to be displayed within N-AWIPS:
• Probability of IFR conditions
• Cloud thickness
• Cloud-top phase
• Cloud-top height

4.1.6 Volcanic Ash Detection and Height
The MODerate-resolution Imaging Spectroradiometer (MODIS) Volcanic Ash Detection and Height products will be transmitted to AWC Operations in compressed netCDF format via the University of Wisconsin LDM for display within AWIPS.

Products to be displayed within AWIPS:
• MODIS Ash height
• MODIS Ash mass loading
• MODIS Ash particle effective radius

4.1.7 SO_2 Detection
The MODerate-resolution Imaging Spectroradiometer (MODIS) SO_2 Detection products will be transmitted to AWC Operations in compressed netCDF format via the University of Wisconsin LDM for display within AWIPS.

Products to be displayed within AWIPS:
• MODIS SO_2 detection
• MODIS SO_2 loading

4.2 CIRA
The CIRA and the National Environmental Satellite, Data, and Information Service (NESDIS) Center for Satellite Applications and Research (STAR) Regional and Mesoscale Meteorology Branch (RAMMB), located at Colorado State University in Ft. Collins, CO, will be providing one product for demonstration during the Aviation Weather Testbed 2012 Summer Experiment.

4.2.1 Simulated Cloud and Moisture Imagery
NSSL WRF-ARW ABI band differences initialized each day at 0000 UTC (F012-F036) will be demonstrated within the Aviation Weather Testbed Summer Experiment. The simulated imagery will be

converted to McIDAS AREA format and transferred via the CIRA McIDAS ADDE server, where it will be displayed within N-AWIPS. In addition, a backup source of imagery for the ABI synthetic infrared radiances (Bands 8-16) will be provided.

Products to be displayed within N-AWIPS:
• 10.35 minus 3.9 μm (low-level cloud and fog detection)
• 10.35 minus 12.3 μm (low-level water vapor convergence detection)

4.3 NASA SPoRT
NASA's SPoRT Center will be providing two products for demonstration during the Aviation Weather Testbed 2012 Summer Experiment.

4.3.1 WRF and HRRR Lightning Threat Forecast
SPoRT will provide NSSL-WRF and HRRR lightning threat forecasts to the Aviation Weather Testbed. The three output fields are based on graupel flux, vertically integrated ice, and a blended combination of each that predict the hourly maximum total lightning flash rate density.

Products to be displayed within N-AWIPS:
• Hourly Max Lightning Threat 1 (Graupel Flux at -15C)
• Hourly Max Lightning Threat 2 (Vertically Integrated Ice)
• Hourly Max Lightning Threat 3 (Combination of Lightning Threat 1 & 2)

4.3.2 Pseudo-Geostationary Lightning Mapper
A pseudo-GLM product created from very high frequency (VHF) ground-based total lightning network data from Northern Alabama, Oklahoma, Cape Canaveral FL, and Washington D.C. will be provided to the Aviation Weather Testbed Summer Experiment.

Products to be displayed within N-AWIPS:
• Total Lightning Flash Extent Density (km^2 min^{-1})

4.4 NASA LaRC
The NASA LaRC will be providing one product for demonstration to AWC Operations.

4.4.1 Aircraft Icing Threat
NASA LaRC will provide the Aircraft Icing Threat data to AWC Operations. The product is derived every 30 minutes from GOES-E and GOES-W over a domain that encompasses the CONUS, much of Canada, and Alaska. Data will be made available in McIDAS Area file format and transmitted via the University of Wisconsin LDM.

Products to be displayed within N-AWIPS:
• To Be Determined

4.5 UAH
UAH will be providing one product for demonstration during the Aviation Weather Testbed 2012 Summer Experiment.

4.5.1 UAH Convective Initiation
The UAH-CI product will be delivered in General Regularly-distributed Information in Binary form 2 (GRIB2) format via the University of Wisconsin LDM to the AWC Testbed and converted to a format suitable for display in the NCEP Advanced Weather Interactive Processing System (N-AWIPS).

Products to be displayed within N-AWIPS:
• Strength of Signal (0-100)

4.6 Aviation Weather Center Operations

AWC Operations delivers consistent, timely, and accurate weather information for safe and efficient flight across the world airspace system. They have a significant met-watch responsibility over the entire CONUS and large portions of the Atlantic and Pacific Oceans. AWC forecasters depend on satellite data to determine the areal extent and intensity trends of in-flight weather hazards along aviators' routes of flight. GOES-R products demonstrated within AWC Operations will be evaluated for how they assist forecasters

4.7 Aviation Weather Testbed Summer Experiment

The 2012 Aviation Weather Testbed Summer Experiment will create, test, and refine the next generation national aviation weather forecast: The Aviation Weather Statement. Working in teams, AWC forecasters and participants from the AWC's government, academic, and private partners will collaboratively develop this new forecast product within the Aviation Weather Testbed. To assist them, they will use and evaluate emerging weather data sets that focus on identifying high-impact atmospheric convection. The Aviation Weather Testbed participants will evaluate which GOES-R convective products are useful for input into the Aviation Weather Statement.

During each week, Testbed participants will rotate through two traffic flow management desks, one high-resolution model desk, and the GOES-R product demonstration desk. Although the demonstration products will be available at each desk, having a dedicated desk for GOES-R products will allow the participants to focus on them in greater detail. The GOES-R desk's responsibility will be to use demonstration products and imagery to monitor areas of convective initiation and high-impact convection that disrupts traffic flow and/or terminals and then coordinate that information with the traffic flow management desks.

Close interaction between participants (i.e., AWC forecasters, academia, and AWC partners) and the GOES-R liaisons will drive the feedback process that can be followed in real-time through blog posts each day (available here: http://goesrawt.blogspot.com/). At the end of each day, participants will complete survey questions related to their experiences which will be followed by a debriefing. The feedback gained from the real-time experiment will be compiled and distributed in the final report delivered in February 2013 by the AWC GOES-R liaison.

5 RESPONSIBILITIES AND COORDINATION

5.1 Project Authorization

Steve Goodman – GOES-R Chief Scientist and PG Program Manager
David Bright – NOAA/NCEP/AWC Chief, Aviation Support Branch
Bruce Entwistle – NOAA/NCEP/AWC Science and Operations Officer

5.2 Project Management

Chad Gravelle – NWS Operations Proving Ground GOES-R Liaison
Amanda Terborg – AWC GOES-R Liaison
Bonnie Reed – NOAA/NWS/OST

5.3 Product Evaluation Leads

Chad Gravelle – NWS Operations Proving Ground GOES-R Liaison

Amanda Terborg – AWC GOES-R Liaison
Bruce Entwistle – NOAA/NCEP/AWC Science and Operations Officer
Jason Levit – NOAA/NCEP/AWC Aviation Weather Testbed Project Director

5.4 Project Training

5.4.1 General Sources

GOES-R training is developed and provided by a number of different partners across the weather enterprise. NOAA, collaboratively through NESDIS and the NWS, partners with the COMET, VISIT, and SPoRT to develop and deliver training on the new features, operations, and capabilities of the GOES-R satellite. Training for products demonstrated within AWC Operations will be provided 2-3 weeks prior to the product evaluation period through seminars given by the product developer or GOES-R Liaison and through one-on-one training between the GOES-R Liaison and AWC forecasters. Training for products demonstrated within the Aviation Weather Testbed Summer Experiment will be provided through a "Training Manual". For each product, the training manual will contain an overview, strengths and weaknesses, links to e-learning training modules, and a case study illustrating how the products can be used within AWC operations. It will be the responsibility of the testbed participant to become familiar with the GOES-R products demonstrated within the Aviation Weather Testbed Summer Experiment. To compliment the training manual, the two GOES-R Liaisons will be present during the testbed experiment to direct the GOES-R desk and answer any questions the participants may have.

5.4.2 Product Training References

5.4.2.1 Simulated Cloud and Moisture Imagery

• Web-based Video: GOES-R 101
http://rammb.cira.colostate.edu/visit/video/goesr101/player.html

• Web-based Video: Utilizing Synthetic Imagery in Forecasting Severe Thunderstorms
http://rammb.cira.colostate.edu/training/visit/training_sessions/synthetic_imagery_in_forecasting_severe_weather/video/

5.4.2.2 WRF and HRRR Lightning Threat Forecast

• Presentation:
http://weather.msfc.nasa.gov/sport/training/lfa/LFAtraining_20111025.pdf

5.4.2.3 UW Convective Initiation

• Presentation:
ftp://ftp.ssec.wisc.edu/pub/ssec/justins/uwctc_2012_hwt_training.pptx

5.4.2.4 UW Convective Initiation

• Presentation: ftp://ftp.ssec.wisc.edu/pub/ssec/justins/uwctc_2012_hwt_training.pptx

5.4.2.5 Enhanced-V/Overshooting Top Detection

• Web-based Video:
http://rammb.cira.colostate.edu/training/visit/training_sessions/objective_overshooting_top_and_thermal_couplet_detection/video/

5.4.2.6 Pseudo-Geostationary Lightning Mapper

• Web-based Video:
http://weather.msfc.nasa.gov/sport/training/pseudo_GLM/launcher.html

5.4.2.7 NearCasting Model

• http://hwt.nssl.noaa.gov/Spring_2011/EUMETSAT_2010_Petersen_NearCasting_Text.pdf

5.4.2.8 Low Cloud and Fog

• Presentation:
http://cimss.ssec.wisc.edu/~mpav/GOES-R_FLS_training_06072012.pptx

5.4.2.9 Volcanic Ash Detection and Height

• Presentation:
http://cimss.ssec.wisc.edu/goes_r/proving-ground/training/ash_training_short_v4.pptx

5.4.2.10 SO_2 Detection

• Presentation:
http://cimss.ssec.wisc.edu/goes_r/proving-ground/training/ash_training_short_v4.pptx

5.4.2.11 Aircraft Icing Threat

• Available prior to October 2012

6 PROJECT SCHEDULE

• AWC Testbed Schedule: 4-15 June 2012
• Products into AWC Testbed: 1 May 2012
• AWC Forecast Operations Schedule: 15 July 2012 – 31 December 2012
• First products into AWC Forecast Operations: 15 July 2012
• Midterm Report: September 2012
• Final Evaluation Report: February 2013

Table 2. Product schedule for Aviation Weather Experiment

GOES-R Proving Ground Product	Acquisition into Testbed/Forecast Operations Due Date	Training	Initial Evaluation Campaign Dates
Simulated Cloud and Moisture Imagery*	4 May 2012	21-31 May 2012	4-15 June 2012
UW Convective Initiation / Cloud Cooling*	4 May 2012	21-31 May 2012	4-15 June 2012
UAH Convective Initiation*	4 May 2012	21-31 May 2012	4-15 June 2012
Low Cloud and Fog*#	4 May 2012	21-31 May 2012* 2-13 July 2012#	4-15 June 2012* 15 July - 31 December 2012#
Aircraft Icing Threat#	15 October 2012	17-31 October 2012	1 November - 31 March 2013

GOES-R Proving Ground Product	Acquisition into Testbed/Forecast Operations Due Date	Training	Initial Evaluation Campaign Dates
NearCasting Model*	4 May 2012	21-31 May 2012	4-15 June 2012
WRF and HRRR Lightning Threat Forecast*	4 May 2012	21-31 May 2012	4-15 June 2012
Pseudo-GLM*	4 May 2012	21-31 May 2012	4-15 June 2012
Enhanced V/Overshooting Top Detection*	4 May 2012	21-31 May 2012	4-15 June 2012
Volcanic Ash Detection/Height#	17 August 2012	20-31 August 2012	1 September 2012 - 1 September 2013
$S0_2$#	14 September 2012	17-28 September 2012	1 October 2012 - 1 October 2013

*****: Aviation Weather Testbed 2012 Summer Experiment
#: Aviation Weather Center Operations

7 MILESTONES AND DELIVERABLES

7.1 Products from Providers
Products to be demonstrated within this year's Aviation Weather Testbed Summer Experiment should be delivered to the AWC by 4 May 2012 and for AWC Operations according to Table 2. Early transfer of these products will ensure that product dataflow and display work correctly within the AWC programs. The demonstrated products for the Aviation Weather Experiment will be displayed within N-AWIPS / AWIPS and coordinated with Jason Levit at the AWC.

7.2 Training materials from providers
Each product delivered to the GOES-R PG Aviation Weather Experiment will be accompanied by related training materials. Forecasters and scientists participating in the Aviation Weather Experiment may not be familiar with the products; therefore, it is important that they receive training in order to properly evaluate product performance during real-time forecasting exercises. Training for products demonstrated within AWC Operations will be provided 2-3 weeks prior to the product evaluation period through seminars given by the product developer or GOES-R Liaison and through one-on-one training between the GOES-R Liaison and AWC forecasters.

For products demonstrated within the Aviation Weather Testbed Summer Experiment, training will be provided through a training manual discussed in Section 5.4.1. In addition, the GOES-R liaisons will spend the first 90 minutes of each morning familiarizing the GOES-R desk participants with the demonstration products. This will be done using a training PowerPoint and a case study that will highlight background information and the strengths and weaknesses for each demonstration product.

7.3 Mid-term evaluation report
A mid-term evaluation report will be provided to the project authorization team roughly halfway through the Aviation Weather Experiment timeframe (September 2012). This report will detail the current status and progress of the GOES-R PG Aviation Weather Experiment activities and suggest changes if needed.

7.4 Final report
A final report detailing the GOES-R PG Spring Experiment activities during the entirety of the experiment will be provided to the GOES-R Program Office in February 2013 by the AWC GOES-R Liaison. This report will discuss how each product was demonstrated within the Aviation Weather

Experiment, present feedback provided by participants, and suggest product and experiment improvements. The feedback will be gathered by the GOES-R Liaisons, Chad Gravelle and Amanda Terborg, and by the AWC Science and Operations Officer, Bruce Entwistle.

8 RELATED ACTIVITIES AND METHODS FOR COLLABORATION

8.1 GOES-R Risk Reduction Products and Decision Aids

In addition to the Baseline and Future Capability products, two GOES-R Risk Reduction products will be demonstrated within the Aviation Weather Experiment. The Risk Reduction products, NearCasting Model and WRF / HRRR Lighting Threat Forecast, are described in Section 3.

9 SUMMARY

This year's GOES-R PG Aviation Weather Experiment at the AWC will support the PG effort to demonstrate the defined GOES-R baseline products within an operational framework. Direct collaboration with the operational warning and forecasting communities through the EWP and EFP respectively are currently ongoing. Feedback gathered from these activities will aid in successful product training for forecasters as well as improvements in product performance by product developers.

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