Operations Plan

for the
GOES-R Proving Ground
portion of the
Hazardous Weather Testbed and
2011 Spring Experiment

Program overview by:
Chris Siewert (OU-CIMMS / SPC)
Bonnie Reed (NWS / GPO)
Kristin Kuhlman (OU-CIMMS / NSSL)
Travis Smith (NSSL)
Greg Stumpf (NSSL)
Steve Weiss (SPC)
Wayne Feltz (UW-CIMSS)
John Walker (UAH)
Kris Bedka (SSAI)
Jason Otkin (UW-CIMSS)
Justin Sieglaff (UW-CIMSS)
Geoffrey Stano (SPoRT)
Dan Lindsey (NESDIS/STAR/RAMMB)
Ralph Petersen (UW-CIMSS)
Bob Aune (UW-CIMSS)

Product developers contributed the material regarding their respective products.

Revision Date: April 29, 2011

Table of Contents

1 INTRODUCTION 3
1.1 Plan Purpose and Scope 3
1.2 Overview 3
2 GOALS OF PROVING GROUND PROJECT 3
3 GOES-R PRODUCTS TO BE DEMONSTRATED 4
3.1 Cloud and Moisture Imagery 4
3.2 Lightning Detection 5
3.3 Enhanced “V”/ Overshooting Top Detection 6
3.4 Convective Initiation 7
3.5 Nearcasting Model 7
3.6 WRF based lightning threat forecast 7
3.7 UWCI Convective Initiation 7
3.8 Statistical Hail Probability Product 8
4 PROVING GROUND PARTICIPANTS 8
4.1 CIMSS 8
4.1.1 Cloud and Moisture Imagery 8
4.1.2 Enhanced “V”/Overshooting Top Detection 9
4.1.3 Convective Initiation 9
4.1.4 Nearcasting Model 9
4.1.5 Weather Event Simulations (WES) Cases 10
4.2 UAH 10
4.2.1 Convective Initiation 10
4.3 SPoRT and NSSL 10
4.3.1 WRF based Lightning Threat Forecast 10
4.3.2 Lightning Detection 10
4.4 CIRA 10
4.4.1 Simulated Imagery 11
4.4.2 Statistical Hail Probability Product 11
4.5 National Severe Storms Laboratory - Experimental Warning Program 11
4.6 Storm Prediction Center – Experimental Forecast Program 11
5 RESPONSIBILITIES AND COORDINATION 12
5.1 Project Authorization 12
5.2 Project Management 12
5.3 Product Evaluation 12
5.4 Project Training 12
5.4.1 General Sources 12
5.4.2 Product Training References 12
6 PROJECT SCHEDULE 14
7 MILESTONES AND DELIVERABLES 14
7.1 Products from Providers 14
7.2 Training materials from Providers 14
7.3 Final report 14
8 RELATED ACTIVITIES AND METHODS FOR COLLABORATION 15
8.1 EFP 15
8.2 EWP 15
8.3 GOES-R Risk Reduction Products and Decision Aids 15
9 SUMMARY 15
10 REFERENCES 15

1 Introduction

1.1 Plan Purpose and Scope

The Spring Experiment activity at the National Oceanic and Atmospheric Administration's (NOAA's) Storm Prediction Center (SPC) and Hazardous Weather Testbed (HWT) in Norman, OK provides the GOES-R Program with a Proving Ground (PG) for demonstrating pre-operational data and algorithms associated with GOES-R. The main focus of the Experiment will be demonstrating the official GOES-R Baseline and Option-2 products; however, it will also include operational readiness trials of products transitioning from Risk Reduction. 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.

1.2 Overview

The SPC as well as the Experimental Forecast Program (EFP) and Experimental Warning Program (EWP) within the HWT will receive early exposure to GOES-R PG products during the 2011 Spring Experiment running from May through June. Pre-operational demonstrations of these GOES-R PG data will provide National Weather Service (NWS) operational forecasters at the SPC and HWT an opportunity to critique and improve the products relatively early in their development. In 2009, the first year SPC participated in the PG Program, foundational relationships were established and demonstration methodologies were developed leading to optimal testing of suites of products in subsequent years. In 2010, the second year of the GOES-R PG Spring Experiment activities, a more integrated effort between the GOES-R PG and the experimental programs within the HWT took place to increase exposure of the GOES-R PG activities to the operational community. This year, the Experiment will run from May 9th – June 10th, 2011 and the focus is to again demonstrate and test GOES-R Proving Ground products within an operational framework while collaborating with broader warning/forecast community within other Spring Experiment entities. Additionally, this year will include training and evaluations on Day-1 products as well as collaborations with developers on potential Day-2 products. Chris Siewert, the satellite champion at SPC, will be coordinating Proving Ground activities in Norman. He has coordinated the Spring Experiment activities at the SPC and HWT for the last several years and has since been building collaborative relationships within the local and broad operational community.

2 Goals of Proving Ground Project

There are many products competing for the attention of the SPC and Weather Forecast Office (WFO) forecasters. This year will focus on demonstrating the GOES-R baseline and Option-2 products selected for this year's activities and identified in Table 1. This strategy has the best chance of maximizing the Operations-to-Research feedback that is one of the PG goals. The most important aspect of the interactions this spring will be to build relationships between each key product development team and the diverse user groups within both the HWT and the broader weather community. Thus, we envision that each visitor will participate in each of the existing HWT programs' experimental activities and discussions (in particular regarding satellite-based products) to improve integration of GOES-R PG effort in these HWT activities in future years.

3 GOES-R products to be demonstrated

There are four GOES-R Baseline and Option-2 products identified to be demonstrated during the Spring Experiment at SPC. Additionally, the Spring Experiment will also demonstrate GOES-R Risk Reduction (R3) and GOES I/M Product Assurance Plan (GIMPAP) products. These products are listed in Table 1 and described further in the following subsections.

Table 1. Products to be demonstrated during Experiment

<table>
<tr><th>Demonstrated Product</th><th>Category</th></tr>
<tr><td>Cloud and Moisture Imagery</td><td>Baseline</td></tr>
<tr><td>Lightning Detection</td><td>Baseline</td></tr>
<tr><td>Enhanced “V”/Overshooting Top Detection</td><td>Option 2</td></tr>
<tr><td>Convective Initiation</td><td>Option 2</td></tr>
<tr><td>Nearcasting Model</td><td>GOES-R Risk Reduction</td></tr>
<tr><td>Weather Research and Forecasting (WRF) based lightning threat forecast</td><td>GOES-R Risk Reduction</td></tr>
<tr><td>Convective Initiation (University of Wisconsin)</td><td>GIMPAP</td></tr>
<tr><td>Statistical Hail Probability (Cooperative Institute for Research in the Atmosphere)</td><td>GIMPAP</td></tr>
<tr><td colspan="2">Category Definitions:
Baseline Products - GOES-R products that are funded for operational implementation as part of the ground segment base contract.
Option 2 Products - New capability made possible by ABI as option in the ground segment contract. Option 1 in the ground segment contract will provide reduced product latency.
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</td></tr>
</table>

3.1 Cloud and Moisture Imagery

Simulated cloud and moisture imagery from the Advanced Baseline Imager (ABI) will be provided to the SPC for use in the Spring Experiment. This effort provides the GOES-R Proving Ground with direct collaborations within the modeling community, as synthetically produced satellite imagery can provide insight into model performance. Additionally, band differences between select GOES-R IR channels will also be provided to further analyze microphysical performance within the model, as well as simulate the capabilities of GOES-R IR channels to provide additional information to the forecasting community. The specific band differences will be determined by the product developers.

For UW-CIMSS, 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 Seeman 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.

The CIRA procedure for creating the synthetic ABI data is similar to that described above for CIMSS. A version of the CRTM is used for the gaseous absorption, with specialized procedures for the cloudy atmosphere. The CIRA procedure reads numerical model output from either WRF-ARW, Coupled Ocean/Atmosphere Mesoscale Prediction system (COAMPS) (developed at the Naval Research Laboratory, Monterey, California), or Regional Atmospheric Modeling System (RAMS), and then calculates synthetic brightness temperatures from several of the GOES-R ABI bands. For the SPC Proving Ground the emphasis is on the WRF-ARW, and the imagery is restricted to IR channels. Work is underway to utilize recent advances in the CRTM so that standard code can be used for the clear and cloudy atmospheres, but this will not be ready for the 2011 experiment.

An automated system is currently being developed by a team of collaborators from CIRA, NASA, National Severe Storms Laboratory (NSSL), and SPC, and the simulated GOES-R output produced by the system will be delivered to SPC during the 2011 Spring Experiment. CIRA's observational operator will read the netcdf output from the WRF model that is run at SPC. As described above, the CRTM is used to compute gaseous optical depths, and the delta-Eddington formulation is to compute brightness temperatures for the clear and cloudy areas. Five simulated bands from GOES-R's Advanced Baseline Imager will then be produced from each hourly output file from the WRF simulation. Three band differences from these channels will also be produced and provided to the SPC. CIRA has elected to simulate a subset of the full ABI band spectrum in order to be able to deliver the output to the SPC in a timely manner. The 12- to 36-hour forecasts from the first IR and Water Vapor bands are available by 09 UTC each morning, in time for use by the operational forecasters.

3.2 Lightning Detection

A proxy for the GOES-R Geostationary Lightning Mapper (GLM) will be demonstrated during the Spring Experiment at the SPC. This product takes the raw total lightning observations, or sources, from any of the ground-based Lightning Mapping Array (LMA) networks available to the EWP 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.

3.3 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. 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. 2009). In addition to OTs, the University of Wisconsin - Cooperative Institute for Meteorological Satellite Studies (UW-CIMSS) has developed an objective enhanced-V detection product which will also be included for evaluation within the 2011 SPC Spring 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. Turbulence and cloud-to-ground (CG) 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 help better detect areas of potential turbulence, giving pilots ample warning of potentially dangerous flying conditions, as well as potential severe weather and lightning.

3.4 Convective Initiation

The University of Alabama in Huntsville (UAH) is developing a proxy product similar to 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 GOES-R Aviation AWG Critical Design Review), based on an overlap methodology that will exploit the high temporal resolution from GOES-R. Since current GOES does not have the temporal resolution of GOES-R, the GOES-R CI algorithm cannot operate optimally with current GOES 15-min refresh rate. However, the current SATCAST system is currently under going a transition to object based tracking to provide a more accurate representation of the GOES-R ABI CI algorithm within the current GOES framework. In order to provide 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 temporal resolution. The advantages of the object based SATCAST is that it can monitor object sizes down to 1 pixel, and track objects over the entire storm lifecycle if needed for easy validation purposes. The new system will be deployed at the HWT Spring Experiment.

The SATCAST algorithm uses a daytime statistically-based convective cloud mask, performs multiple spectral differencing of IR fields (so-called "interest fields"), and applies pixel-based 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 help remove spurious false alarms in SATCAST, which are in part caused by mesoscale AMV pixel tracking errors, view-angle related problems that affect interest field thresholds, and the inherent difficulties associated with tracking pixel scale growing cumulus in 4 km Infrared (IR) data. John Mecikalski and John Walker are showing other potential uses in various research areas with good success, specifically within the NOAA High Resolution Rapid Refresh model.

3.5 Nearcasting Model

A nearcasting model that assimilates full resolution information from the current 18-channel GOES sounder and generates 1-9 hour nearcasts of atmospheric stability indices will be included in the SPC Spring Experiment. Products generated by the nearcast model have shown skill at identifying rapidly developing, convective destabilization up to 6 hours in advance. The system fills the 1-9 hour information gap which exists between radar nowcasts and longer-range numerical forecasts. Nearcasting systems 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 uses a Lagrangian approach to optimize the impact and retention of information provided by GOES sounder. It also uses hourly, full resolution (10-12 km) multi-layer retrieved parameters from the GOES sounder. Results from the model enhance 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 IR satellite observations become cloud contaminated.

3.6 WRF based lightning threat forecast

The WRF based 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 Model conducted daily during the 2011 Spring Experiment. The algorithm uses two separate proxy fields to assess lightning flash rate density and areal coverage, based on storms simulated by the WRF model. One field, based on the flux of large precipitating ice (graupel) in the mixed phase layer near -15C, 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 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. A composite threat is created by blending the two aforementioned threat fields, after making adjustments to account for the differing sensitivities of the two basic threats to the specific configuration of the WRF model used in the forecast simulations.

3.7 UWCI Convective Initiation

The UWCI product has been delivered to the SPC as acting GOES-R CI proxy during SPC HWT testbed exercise for iterative feedback from operational forecasters. This input and feedback from operations is critical for improving this experimental product and preparing forecasters for GOES-R CI decision support information.

The UWCI algorithm is an experimental satellite based product used to diagnose and nowcast convective initiation (Sieglaff et al, 2010). The UWCI algorithm uses GOES-East 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. Currently the algorithm is designed to diagnose/nowcast developing convection. Scenes having a large amount of cirrus (ice) cloud are omitted, these scenes are hoped to be included in future versions of the algorithm.

3.8 Statistical Hail Probability Product

Developers at STAR/RAMMB and CIRA continue to work on an experimental hail probability product which will also be evaluated as part of the GOES-R PG Spring Experiment at SPC. The product is based on a statistical model built by using observed severe hail reports over several years, along with the corresponding (in space and time) GOES observations and analyses and forecasts from the SPC's surface mesoanlaysis and the Rapid Update Cycle (RUC) model. In addition to GOES data, inputs include MLCAPE, MLCIN, MLLI, surface dewpoint, surface-to-6-km shear, the height of the melting level and severe hail climatology. Additionally, information on the location of overshooting tops from the CIMSS/Bedka overshooting tops algorithm serves as an input to the model in order to better locate storms producing hail among those that have already formed. Output from the real-time product provides the probability of severe hail within the 0-3-hour time window on a 0.5x0.5 degree latitude/longitude grid across the eastern 2/3 of the U.S., roughly within the GOES-13 domain. The product was designed to provide additional guidance to SPC forecasters who generate hail probability forecasts several times per day as part of their convective outlooks. It may also assist in the issuance of mesoscale discussions and severe thunderstorm watches. Unique aspects provided by the hail probability product include: 1) it is fully automated and objective, requiring no forecaster input, 2) it updates with each new GOES scan, 3) it uses data from the SPC's surface mesoanalysis, which is the best available estimate of real-time parameters such as surface moisture and instability. Developers at CIRA will use the feedback provided by Spring Experiment participants to further improve future versions of the product.

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 and provide the product assessments (e.g., testbed operators and forecasters). For the Spring Experiment at the SPC, there are four providers, CIMSS, UAH, CIRA and NASA’s Short-term Prediction Research and Transition (SPoRT) Center, and there are two consumers, NSSL-EWP and SPC-EFP. Invited visiting scientists funded by GOES-R Proving Ground, Risk Reduction or Visiting Scientist funding include Ralph Petersen, Bob Aune and Jordan Gerth (Nearcasting); Jason Otkin, Dan Lindsey and Dan Bikos (Synthetic Cloud and Moisture Imagery); John Mecikalski, John Walker, Justin Sieglaff, Lee Cronce, Chris Jewett and Lori Schultz (Convective Initiation); Wayne Feltz and Jason Brunner (Enhanced-V/Overshooting-top); Geoffrey Stano and Scott Rudlosky (pseudo-GLM); and Bill McCaul (WRF-based lightning threat forecast). The visiting scientists and the NWS forecasters round out the experiment team and their participation are described in the following paragraphs.

4.1 CIMSS

CIMSS will provide three products for demonstration in the Spring Experiment and they are described below.

4.1.1 Cloud and Moisture Imagery

00 UTC initialized NSSL WRF ARW NWP model generated ABI synthetic infrared radiances will be prototyped and available via internet quicklook site and McIDAS area format for evaluation. Forecasters can use the derived synthetic satellite data to key in on ABI water vapor

or IR window band features of interest such as convective development and location rather then using NWP derived fields. Quicklooks of simulated WRF ABI radiances are available at: http://cimss.ssec.wisc.edu/goes_r/proving-ground/nssl_abi/nssl_abi_rt.html

4.1.2 Enhanced "V"/Overshooting Top Detection

The overshoot top decision support products will be delivered in GRIB2 format for NAWIPS or AWIPS-II ingest, and will include a statistical relationship of OT location and chance for turbulence, severe weather and cloud-to-ground lightning. The GRIB2 will be delivered via a Local Data Manager (LDM) server at the University of Wisconsin.

SPC HWT PG participants will conduct an evaluation of the OT location derived turbulence, severe and CG lightning probability products. The main goal will be to make sure the optimal display is established to see if the products offer additional forecaster information where lightning or radar coverage is lacking in the case of CG probability (over Gulf of Mexico).

4.1.3 Convective Initiation

The UWCI products are being delivered in GRIB2 format via the University of Wisconsin LDM to the SPC and transferred to a format suitable for display in the NCEP Advanced Weather Interactive Processing System (NAWIPS) and Warning Decision Support System - Integrated Information (WDSS-II), as well as AWIPS-II. Forecasters will evaluate improved UWCI products (based on feedback from last year's SPC HWT 2010 participation) to see if the products offer additional lead time in warning process and provide information for SPC watch determination in marginal convective weather situations.

Outputs to be displayed within N-AWIPS/AWIPS/AWIPS II:

- Instantaneous box-averaged cooling rate
- Instantaneous cooling rate for each CI pixel within domain. Data range: -4K to -60K
- Instantaneous convective initiation 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
- 60-minute accumulated CI signal
- 60-minute accumulated box-averaged cooling rate

UWCI is also available in McIDAS AREA formats.

4.1.4 Nearcasting Model

The nearcasting products will be delivered to SPC and within the Spring Experiment in GRIB2 format via the University of Wisconsin LDM for display within the EFP N-AWIPS and EWP AWIPS/AWIPS II systems. Forecasters will evaluate the nearcasting model to see if it offers improved spatial and temporal convective initiation forecasts as well as additional watch/warning lead time during severe weather situations.

4.1.5 Weather Event Simulations (WES) Cases

Additionally, CIMSS will be working with NSSL and the Cooperative Institute for Mesoscale Meteorological Studies (CIMMS) to identify a WES training case and provide associated data sets to include Convective Initiation, Overshooting top/Enhanced-V, and GLM. Cases will be identified from 2010 Spring SPC HWT experiment and recent events.

4.2 UAH

University of Alabama at Huntsville will provide the GOES-R AWG CI product for demonstration in the Spring Experiment.

4.2.1 Convective Initiation

UAH will provide the AWG version of the CI proxy tracking algorithm running on GOES to be included for real-time demonstration in the Spring Experiment within AWIPS/AWIPS-II and N-AWIPS systems. 0-1 hour yes/no nowcasts of CI over tracked cloud objects will be provided from the AWG CI proxy this year. The AWG CI will run along side the UWCI product and be interrogated by satellite data experts at the SPC for feedback and improvement.

4.3 SPoRT and NSSL

SPoRT and NSSL/CIMMS will provide lightning data for both the EFP and the EWP.

4.3.1 WRF based Lightning Threat Forecast

For the EFP, SPoRT will provide a WRF based lightning threat forecast based on the real-time NSSL forecasts. There will be three output fields based on graupel flux, vertically integrated ice, and a blended combination of the two. These model runs will expose forecasters to the ability to incorporate a short-term prediction of potential lightning activity into their forecasts and the results will be routinely displayed as hourly cumulative maximum gridpoint values, with units of flashes per square km per 5 min, on the NSSL WRF website, www.nssl.noaa.gov/wrf. An effort is also currently being explored to include the lightning threat within the WRF members of the CAPS ensemble. However, it is unclear whether this will be available at the beginning of the 2011 Spring Experiment. When available, the lightning threat forecast will be included within the CAPS ensemble output within the EFP on N-AWIPS workstations and evaluated alongside other ensemble output fields.

4.3.2 Lightning Detection

A pseudo GLM product created from very high frequency (VHF), ground-based total lightning network data from North Alabama, Oklahoma, Kennedy Space Center, and Washington DC will be provided to the EWP. The pseudo GLM is a direct outgrowth from discussions at the 2009 Spring Experiment expressing the need for a flash-based GLM demonstration product. SPoRT and NSSL/CIMMS have utilized a flash creation algorithm to combine the VHF total lightning data into flashes, and then created a flash extent product available at the GLM resolution. The overall emphasis of the pseudo GLM is to provide forecasters the opportunity to use real-time data that is representative of the future capabilities of the GOES-R Lightning Mapper and to provide feedback for visualization tools. In addition to these real-time products, archived data will be utilized by the EWP when real-time events are not available. SPoRT also will provide support in establishing the data flow from the total lightning networks outside Oklahoma to the Spring Experiment. This will be supported with product training and discussions with forecasters during the EWP. It is anticipated that a total lightning / GLM subject matter expert will participate in the EWP each week.

The LMA network data delivery will take place over an established LDM feed to NSSL every 2 minutes, with an average latency of 1 minute.

4.4 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 two products for demonstration within this year's Spring Experiment.

4.4.1 Simulated Imagery

An additional GOES-R Risk Reduction activity, the generation of simulated ABI imagery calculated from WRF radiances, will be included in the Spring Experiment. The simulated imagery will be converted to McIDAS AREA format and made available on the CIRA ADDE server, which can then be displayed with the N-AWIPS system during the SPC's Spring Experiment. Simulated satellite imagery calculated from model radiances will provide forecasters with a tool to evaluate model performance, as well as be able to examine the use of all GOES-R IR bands within an operational framework. Simulated band differences from the synthetic radiance data will also be provided by CIRA to demonstrate the capabilities of GOES-R in detecting atmospheric features using methods not available on the current suite of GOES satellites.

4.4.2 Statistical Hail Probability Product

A new experimental severe hail probability product which is a prototype for a decision aid that combines satellite information with model forecasts to produce a short-range forecast will be demonstrated during the Spring Experiment. The data will be provided via the CIRA LDM server for display within N-AWIPS during the Spring Experiment.

4.5 National Severe Storms Laboratory - Experimental Warning Program

The primary objective of the EWP is to evaluate the accuracy and the operational utility of new science, technology and products in a testbed setting in order to gain feedback for improvements prior to their potential implementation into National Weather Service (NWS) operations. The EWP brings together 16+ forecasters from NWS Warning Forecast Offices around the country (usually 1-2 from Norman WFO) to participate in the development and trial of new short-term and warning-focused forecast applications. Data (satellite, observational, and model) from new products provided within the EWP enable forecasters to examine a variety of real-time cases at the location(s) with the best opportunity for severe and near-severe weather. In addition, archive cases, or WES cases, are provided to the forecasters to assess applicability of lightning data to other events. Forecasters will be asked to evaluate products in terms of use for early diagnosis, warnings and other forecast applications.

4.6 Storm Prediction Center – Experimental Forecast Program

The EFP focuses on the regional forecast of severe weather from a few hours to a day in advance. For previous years, evaluation and discussion of high-resolution ensemble NWP drove creation of an initial forecast, with updates based on more recent NWP and observational data. Product developer-participants are asked to issue real-time, concrete forecasts of convective behavior. As a product developer becomes invested in the forecast issuance process, many subtleties are illuminated that research-minded scientists might not otherwise have in mind. An afternoon map discussion provides an opportunity for further group discussion about what worked and where forecast products had room for improvement. During this time, it is also expected that the EFP and EWP participants will collaborate on the day's forecasting issues. Because of the often-diverse perspectives in the room, map discussions facilitate detailed assessment of the soundness of the physical underpinnings of the techniques used in trial products.

This year the EFP's focus will shift slightly to include a more convective initiation forecast strategy. Close collaborations with the OAR and the development of its Convective Initiation desk will drive this effort. While the detailed plan for how this will be accomplished has not yet been established, it is expected that there will be three forecast groups within the room with one each focusing on regional forecasts of severe weather, QPF and CI.

5 Responsibilities and Coordination

5.1 Project Authorization

Russ Schneider – SPC Director
Travis Smith – Program Director EWP
Steve Weiss – Program Director EFP
Steve Goodman – GOES-R Chief Scientist and PG Program Manager

5.2 Project Management

Chris Siewert – SPC Proving Ground Liaison

5.3 Product Evaluation

Chris Siewert – Lead, SPC
Kristin Kuhlman - EWP
Steve Weiss - EFP

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 the GOES-R Proving Ground Hazardous Weather Testbed Spring Experiment will be developed and provided through e-learning training modules, seminars, weather event simulations, and special case studies.

5.4.2 Product Training References

5.4.2.1 Lightning Detection

Prior to the start of the Spring Experiment, an online training module for the GLM products will be available at http://weather.msfc.nasa.gov/sport/training/. This includes background on the use of total lightning data on forecasters, how the pre-GLM products are created, and how to interpret the output. Forecasters will be able to review the module before arrival for the Spring

Experiment. Additionally, further in-person training and discussion on total lightning data will be provided to forecasters upon their arrival at the beginning of each shift week.

5.4.2.2 Cloud and Moisture Imagery

UW-CIMSS is providing real-time simulated ABI infrared band data from NSSL WRF ARW thermodynamic profile output.

(1) UW-CIMSS will provide a WES case (beta version). This includes not only simulated data, but a guide as well.
(2) CIRA has put together a VISIT training session titled "Synthetic Imaery for Forecasting Severe Weather." A few options for viewing the session are found here: http://rammb.cira.colostate.edu/training/visit/training_sessions/synthetic_imagery_in_forecasting_severe_weather/
(3) ABI VISITView from 2003 (somewhat dated) - http://www.ssec.wisc.edu/visit/briefings/abi03/viewbriefing.html
(4) GOES-R 101 VISITView - http://rammb.cira.colostate.edu/training/shymet/forecaster_GOESR101.asp
(5) GOES-R ABI VISITView “Classic” http://www.ssec.wisc.edu/visit/briefings/abi03/viewbriefing.html

5.4.2.3 Enhanced “V”/Overshooting Top Detection

This product consists of overshooting top location and objectively determined CG/turbulence relationships collocated with these locations for enhanced decision support. UW-CIMSS will provide in field training to EWP and EFP participants throughout experiment.

(1) General overviews of overshooting top and enhanced-V:
http://cimss.ssec.wisc.edu/snaap/overshootingtop/index.html
http://cimss.ssec.wisc.edu/snaap/enhanced-v/
http://convection.satreponline.org/doc_bedka.php
(2) Wiki and VISITView still in development
(3) Powerpoint training material has been developed by Kristopher Bedka and will be available to forecasters participating in the Spring Experiment.

5.4.2.4 Convective Initiation

UAH will provide a training session at the HWT and SPC PG Spring Experiment via a PowerPoint presentation. The training package will be available to the forecasters throughout the duration of the Experiment. The information provided for training within the HWT and SPC will help prepare participants for use prior to real-time forecasting exercises. Case examples and an algorithm overview will be the main focus points of the presentation.

5.4.2.5 Nearcasting Model

Real-time UW-CIMSS NearCasts can be viewed on the web at: http://cimss.ssec.wisc.edu/model/nrc/.

Web images are generated using the NWS/NCEP N-AWIPS software system. In addition to producing high quality graphics, these products can be directly included into operational workstations at AWC and SPC. Background and initial training materials can be accessed through the CIMSS NearCasting web page at: http://cimss.ssec.wisc.edu/model/nrc/. These materials will be referenced during the 2011 Spring Experiment.

5.4.2.6 Weather Research and Forecasting (WRF) based lightning threat forecast

SPC forecasters have had experience with the WRF based lightning threat forecast since the 2009 Spring Experiment within operations and are familiar with the product. While the EFP does not provide formal training to new participants as part of their operations plan, any training material will be made available on the EFP internal webpage for participants to view during the experiment Training modules will be developed by SPoRT based on forecaster feedback after the Spring Experiment.

5.4.2.7 UWCI Convective Initiation

Training documentation and VISITView training material is provided below. Visitiview training will be recorded to provide UWCI training was conducted before and since 2009 SPC HWT experiment. UW-CIMSS will provide in field training to EWP and EFP participants throughout experiment. Chris Siewert is already knowledgeable about UWCI products and has provided a Wiki web site with in field support.

(1) University of Wisconsin convective initiation strength and weaknesses fact sheet http://cimss.ssec.wisc.edu/goes_r/proving-ground/GOES_CINowcast.html
(2) UWCI training powerpoint
(3) VISITView training module (Scott Lindstrom)
    http://rammb.cira.colostate.edu/visit/uwci.html
(4) CIMSS Blog case study examples are available: http://cimss.ssec.wisc.edu/
(5) SPC UWCI WIKI webpage

6 Project Schedule

There are many activities that lead up to the successful execution of the Spring Experiment such as identifying participants, coordinating schedules, delivering and integrating algorithms, and developing training materials. These specific activities are identified in the chart below.

1. Identify and invite project leads – March 1, 2011
2. Identify forecasters for EWP/EFP participation – April 11, 2011
3. Stress-test EWP AWIPS-II systems – April 15, 2011
4. Deadline for all product availability – April 15, 2011
5. Deliver training materials – April 25, 2011
6. Develop WES for AWIPS-II – April 25, 2011
7. Verification of integration – April 25-29, 2011
8. Spring Experiment start – May 9, 2011
9. Spring Experiment end – June 10, 2011
10. Final evaluation report – August 5, 2011

7 Milestones and Deliverables

7.1 Products from Providers

Products to be demonstrated within this year's Spring Experiment should be delivered to the HWT by April 15 to ensure that product dataflow and display work correctly within the HWT programs. Delivered products to the SPC and within the EFP will be displayed within N-AWIPS and will be coordinated with Chris Siewert at the SPC. Products demonstrated within the EWP will be displayed within AWIPS/AWIPS-II and WDSS-II and will be coordinated with Greg Stumpf at NSSL.

7.2 Training materials from Providers

Each product delivered to the GOES-R PG Spring Experiment will be accompanied by related training materials. Forecasters and scientists participating in the Spring 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 on each of the products being demonstrated will occur on the first day of each experiment week. This will consist of a powerpoint presentation of no longer than 30 minutes in length and will be presented by a participating product expert. In addition, a short write-up explaining how the product works and its uses, including example images, will be provided for distribution amongst Spring Experiment participants for reference. If available, WES case events should be provided to Greg Stumpf at NSSL to be used within the EWP during days with no real-time weather situations. It is expected that the product developer provide the training material. Following each forecasting exercise, and at the end of each week, participants will be asked to provide feedback on the training they received. Participants will be asked if they felt prepared to use the products in a real-time forecasting situations and what material they would like to see in the future. This feedback will be invaluable in preparing formal training for future GOES-R products.

7.3 Final report

A final report detailing the GOES-R PG Spring Experiment activities during the entirety of the experiment shall be provided to the GOES-R Program Office at the date specified within the operations plan timeline. This report will discuss how each product was demonstrated within the various experiments. The report will also present feedback provided by participants of the Spring Experiment as well as suggestions for improvements to the GOES-R PG Spring Experiment activities for years to come. This feedback will be captured by Chris Siewert and Kristin Kuhlman during interactions with the participants throughout the Experiment timeframe.

8 Related activities and methods for collaboration

8.1 EFP

GOES-R Proving Ground products will be provided within the existing framework of the EFP as developed by Steve Weiss at SPC. The products will be used during two forecast periods throughout the day in regards to regional severe weather and convective initiation forecasting across the country as chosen by the EFP leader. Once per day the products will be discussed alongside other operational and experimental model-based products during an afternoon map briefing.

8.2 EWP

GOES-R Proving Ground products will be provided within the existing framework of the EWP as developed by Travis Smith, Greg Stumpf and Kristin Kuhlman at NSSL. The products will be used throughout the day during real-time regional severe weather events across the country as chosen by the EWP leader. Upon completion of the week, the participants will be asked to provide feedback via surveys and provided to the EWP leader.

8.3 GOES-R Risk Reduction Products and Decision Aids

GOES-R Risk Reduction products and decision aids will be demonstrated in addition to the Baseline and Option 2 products. The risk reduction products and decision aids demonstrated in the SPC Spring Experiment are described in Section 3.

9 Summary

This year's GOES-R PG Spring Experiment activities at the SPC and HWT will support the PG effort to demonstrate the defined GOES-R baseline products within an operational framework through various experimental programs. 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.

10 References

Baum, B. A., P. Yang, A. J. Heymsfield, S. Platnick, M. D. King, Y.-X. Hu, and S. T. Bedka, 2006: Bulk scattering properties for the remote sensing of ice clouds. Part II: Narrowband models. J. Appl. Meteor., 44, 1896-1911.

Bedka, K., J. Brunner, R. Dworak, W. Feltz, J. Otkin, and T. Greenwald, 2009: Objective Satellite-Based Overshooting Top Detection Using Infrared Window Channel Brightness Temperature Gradients Journal of Applied Meteorology and Climatology 2009 early AMS online release, posted September 2009

Deierling, W., W. A. Petersen, J. Latham, S. Ellis, and H. J. Christian, 2008: The relationship between lightning activity and ice fluxes in thunderstorms. J. Geophys. Res., 113.

Gatlin, P. and S. J. Goodman, 2010: A total lightning trending algorithm to identify severe thunderstorms. J. Atmos. Oceanic Tech., 27, 3-22.

Goodman, S. J. and Coauthors, 2005: The North Alabama Lightning Mapping Array: Recent severe storm observations and future prospects. Atmos. Res., 76, 423–437.

Han, Q., W. Rossow, R. Welch, A. White, and J. Chou (1995), Validation of satellite retrievals of cloud microphysics and liquid water path using observations from FIRE. J. Atmos. Sci., 52, 4183-4195.

Heymsfield, A. J., S. Matrosov, and B. Baum, 2003: Ice water path-optical depth relationships for cirrus and deep stratiform ice cloud layers. J. Appl. Meteor. Climatol., 45, 1388-1402.

Heidinger, A. K., C. O'Dell, R. Bennartz, and T. Greenwald, 2006: The successive-order-of-interaction radiative transfer model. Part I: Model development . J. Appl. Meteor. Clim., 45, 1388-1402.

Krehbiel, P. R., R. J. Thomas, W. Rison, T. Hamlin, J. Harlin, and M. Davis, 2000: GPS-based mapping system reveals lightning inside storms. Eos, Trans. Amer. Geophys. Union , 81, 21–32.

Kuhlman, K. M., C. L. Zielger, E. R. Mansell, D. R. MacGorman, and J. M. Straka, 2006: Numerically simulated electrification and lightning of the 29 June 2000 STEPS supercell storm. Mon. Wea. Rev., 134, 2734–2757.

McCaul, E.W., S.J. Goodman, K.M. LaCasse, and D.J. Cecil, 2009: Forecasting Lightning Threat Using Cloud-Resolving Model Simulations. Wea. Forecasting, 24, 709–729.

Otkin, Jason A. and Greenwald, Thomas J., 2008: Comparison of WRF model-simulated and MODIS-derived cloud data. Monthly Weather Review, Volume 136, Issue 6, pp.1957-1970. Call Number: Reprint # 5726

Schmit, T. J., M. M. Gunshor, W. Paul Menzel, Jun Li, Scott Bachmeier, James J. Gurka, 2005: Introducing the Next-generation Advanced Baseline Imager (ABI) on GOES-R, Bull. Amer. Meteor. Soc., Vol 8, August, pp. 1079-1096.

Schultz, C. J. W. A. Petersen, and L. D. Carey, 2009: Preliminary Development and Evaluation of Lightning Jump Algorithms for the Real-Time Detection of Severe Weather, Journal of Applied Meteorology and Climatology, Vol. 48, No. 12, pp. 2543-2563, (doi: 10.1175/2009JAMC2237.1)

Seeman, S. W., E. E. Borbas, R. O. Knuteson, G. R. Stephenson, and H.-L. Huang, 2008: Development of a global infrared land surface emissivity database for application to clear sky sounding retrievals from multispectral satellite radiance measurements. J. Appl. Meteor. and Climatol., 47, 108-123.

Sieglaff, J. M., L. M. Cronce, W. F. Feltz, K. M. Bedka, M. J. Pavolonis, and A. Heidinger, 2010: Nowcasting Convective Storm Initiation Using Satellite Based Box-Averaged Cloud Top Cooling and Microphysical Phase Trends, Submitted to Journal of Applied Meterology and Climatology, February 2010.

Steiger, S. M., R. E. Orville, and L. D. Carey, 2007: Total lightning signatures of thunderstorm intensity over North Texas. Part I: Supercells. Mon. Wea. Rev., 135, 3281–3302.

Wiens, K. C., S. A. Rutledge, and S. A. Tessendorf, 2005: The 29 June 2000 supercell observed during STEPS. Part 2: Lightning and charge structure. J. Atmos. Sci., 62, 4151–4177.

Zinner, T., H. Mannstein, and A. Tafferner, 2008: Cb-TRAM: Tracking and monitoring severe convection from onset over rapid development to mature phase using multi-channel Meteosat-8 SEVERI data, Meteorol. Atmos. Phys., DOI 10.1007/s00703-008-0290-y.