Effective Date: Date of Last Signature

Responsible Organization: GOES-R/Code 417



# Geostationary Operational Environmental Satellite (GOES-R) PROVING GROUND PROGRAM PLAN
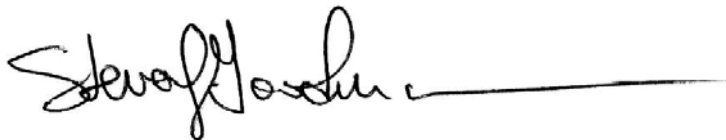
## March 2010



**U.S. Department of Commerce (DOC)**
**National Oceanic and Atmospheric Administration (NOAA)**
**NOAA Satellite and Information Service (NESDIS)**

## Foreword

This plan documents the NOAA plan for organizing and conducting "proving ground" activities to demonstrate early operational integration of future GOES capabilities.  This program consists of a broad set of field demonstration activities structured to gain early NWS (and others) field experience utilizing the NOAA Test Beds. Due to the importance of these new capabilities and the length of time required for planning, development, and acquisition of satellites, NOAA has undertaken early planning and demonstration activities to ensure timely and cost-effective integration of the future GOES capabilities. The GOES-R Proving Ground program will enable transition from  research-to-operations with the principal focus being on the forecaster/AWIPS-II environment; to prepare for the GOES-R information, and to get real-world experience and product feedback by leveraging existing resources, and to evaluate product tailoring and decision aids.  In addition, by leveraging current research and other satellite assets, NWS and others can produce improved guidance. The Proving Ground activities close the loop from Algorithm Working Group development of legacy and new product algorithms and decision aids, through real-world forecaster experience with those products, to feedback to the developers.


This document serves as the top-level plan for the proving ground demonstration program. This plan is not intended to provide definitive requirements or technical specifications; nor does it represent a commitment, except as all or parts are approved and funded. The plan does, however, provide the vision and basis for collaborative NWS and NESDIS demonstration activities supporting the GOES-R implementation.


Steven J. Goodman
GOES-R Program Scientist

# PROVING GROUND PROGRAM PLAN

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# 1—Introduction

## 1.1    Plan Purpose and Scope

This plan provides the framework and guiding principles for the Proving Ground program to provide early use of GOES-R capabilities in National Weather Service (NWS), Environmental Protection Agency (EPA), Department of Defense (DoD), and other operational environments. The purposes of this plan are to:

- Document the vision and objectives of the Proving Ground program and concept

- Provide the top-level plan for describing the overall scope and management approach for the program

- Identify key decision points and checkpoints for effective management control.

The scope of this document is limited to those functions necessary to pre-operationally demonstrate selected capabilities of the next generation GOES satellites.  The demonstration proving ground will be the broad agency test bed that will feed other activity planning. Other User Readiness functions such as technical, programmatic and budgetary planning and coordination of GOES-R and NWS systems and NWS-wide training, staffing, and forecast procedure development will be addressed in the higher level User Readiness Plan being developed.  This Proving Ground Program Plan will become a component of the overall User Readiness Plan.

As substantive changes occur in program direction or scope, this plan will be updated and reissued. Section 1 presents an overview of the concept and approach for the Proving Ground, its objectives and scope. Section 2 provides a description of the demonstration and operational concepts. Section 3 provides the implementation approach, including program phases, general schedule, and key decision points, and Section 4 describes the overall program management approach.

## 1.2    Proving Ground Mission

The GOES-R Proving Ground program is being initiated to facilitate research-to-operations with the principal focus being on the forecaster/AWIPS-II environment; to prepare for the GOES-R information, to get real-world experience by leveraging existing resources, and to evaluate product tailoring.  The GOES-R Proving Ground engages NWS, EPA, DoD, and other operational environments in pre-operational demonstrations of selected capabilities of next generation GOES with the objective to bridge the gap between research and operations by:

- Utilizing current systems (satellite, terrestrial, or model/synthetic) to emulate future GOES-R capabilities
- Infusing GOES-R-like products and techniques into NWS operations with emphasis on AWIPS and transitioning to AWIPS-II
- Engaging in a dialogue to provide feedback between developers and users

The Proving Ground accomplishes its mission through:

- Sustained interaction between developers and end users for training, product evaluation, and solicitation of user feedback.
- Close coordination with GOES-R Algorithm Working Group (AWG) and Risk Reduction activities as sources of demonstration products, promoting a smooth transition to operations.

The intended outcomes of the Proving Ground Program are to enable "Day-One" readiness (operational use at the time the satellite is declared operational) and maximum utilization for both the developers and users of GOES-R products, enabling an effective transition to future operations.

## 1.3    Background

The GOES-R Proving Ground engages the NWS forecast and warning community as well as the EPA and DoD in pre-operational demonstrations of select capabilities with GOES-R attributes (enhanced spectral, spatial, and temporal resolution). This venture facilitates the examination and validation of new ideas, technologies, and products primarily through the Advanced Weather Information Processing System (AWIPS). Emphasis is placed on the transition from AWIPS-I (AWIPS Legacy) to AWIPS-II (AWIPS Migration), the next-generation decision support system for forecasters. Pre-operational analysis will prepare users for the new types of satellite imagery and tools that will become available with GOES-R.

This project joins National Environmental Satellite, Data, and Information Service (NESDIS), NOAA's cooperative institutes, and its affiliated partners (including NWS forecast offices) to participate in the demonstration of GOES-R products. The Proving Ground provides simulated/proxy GOES-R products for operational assessment. Testing methodology includes the combination of current GOES instruments with other satellite channels, utilization of other proxy imagers such as the Moderate Resolution Imaging Spectro radiometer (MODIS) and the Spinning Enhanced Visible Infrared Imager (SEVIRI) channels, and the use of synthetic, model generated Imagery to replicate GOES-R products.  Field proving of early satellite products has been evolving for many years. Developmental and/or demonstration prototyping of current satellite products and or test activities is currently being conducted at many locations.   For example, as of 2009, over 70 offices were served with up to 40 various products.  Although most were not AWG-demonstrated GOES-R products, they did provide early experience for the forecaster in using both legacy and new products at higher spatial resolution.

## 1.4    Program Purpose and Scope

The purpose of the GOES-R Proving Ground Program is to connect the NWS and other agencies at an early stage so that the GOES-R Program can be a success from day-one. To achieve this, we must ensure our baseline products are ready for use by the operational community when the satellite is declared operational and that we create realistic expectations of product availability and any known limitations.

The GOES-R AWG is responsible for the development and validation of Level-2 product algorithms for the future GOES-R earth viewing Advanced Baseline Imager (ABI) and Geostationary Lightning Mapper (GLM) instruments.  The scope of the PG Program is to demonstrate the products developed from the AWG algorithms in an operational environment so the forecasters can become familiar with and provide valuable feedback about the planned products. During the pre-launch phase of GOES-R the AWG-developed algorithms cannot be fully demonstrated due to the use of simulated and proxy data for the ABI and GLM.  It is expected, however, that the PG program demonstrate the products developed from the AWG as closely as possible, and note deviations from the official products.  After AWG-demonstrated algorithms have been demonstrated, risk reduction products, integrated products, and decision aids may be demonstrated.

The Satellite PG will be a recipient of and a resource for User Education and Training. PG participants (developers, managers and users) will need to be educated on the characteristics of and applications of the satellite products to be demonstrated and integrated into operations of the NWS forecast offices and national centers and other NOAA offices (NESDIS, NOS, NMFS, etc). The proxy and simulated GOES-R products used in the PG will be integrated along with other remote sensing data into training modules by COMET and VISIT and included in SHyMet courses and Weather Event Simulator (WES) cases.  Decision aids, new display systems and modifications to NOAA's operations provided by PG participants, will be addressed in user education, training and WES cases.

## 1.5    Proving Ground Program and the NWS Strategic Goal

The GOES-R Proving Ground supports the NWS Strategic Goal to "Develop a fully integrated observation system (e.g., satellite, radar, upper air, etc), along with analysis tools to fully exploit data and enable strategic warn-on-forecast stretch goals."  The PG also supports several of the high impact weather NOAA mission goals. As the next generation of observing systems, e.g., GOES-R, NPP, and JPSS come on line, the forecasters will have less and less time to analyze this growing amount of observational and model data.  The system will need to assimilate observations from multiple platforms into products that directly address forecast and warning requirements (e.g., convective initiation giving specific convective threat, icing threat, flood potential, etc).  An end-state objective is to automatically analyze the data and determine when the forecaster needs to react.  The proving ground will support this objective through demonstration of decision aids during the risk-reduction phase of the program.

# 2—Proving Ground Description

## 2.1    Critical Timeline

During the pre-launch period it is anticipated that selected forecast offices and national centers will be asked to participate in evaluation of selected GOES-R data and products.  In order to do

so, these forecasters will need to be trained and that in turn requires development of specific training modules. The proving ground is expected to be a major aid to producing those training modules. The first phase of the proving ground is to demonstrate baseline products so that training modules can be developed in time to train those forecasters who will be asked to participate in post-launch checkout of GOES-R. This sequence is shown in the Figure 2.1 timeline below.

Some GOES-R training has already begun. For example, a VISITview lesson on the ABI was developed in 2005, MODIS data started to flow to several forecast offices in 2006 and more recently, a COMET module on GOES-R was released. In addition, a Weather Event Simulation for the ABI is under-development.
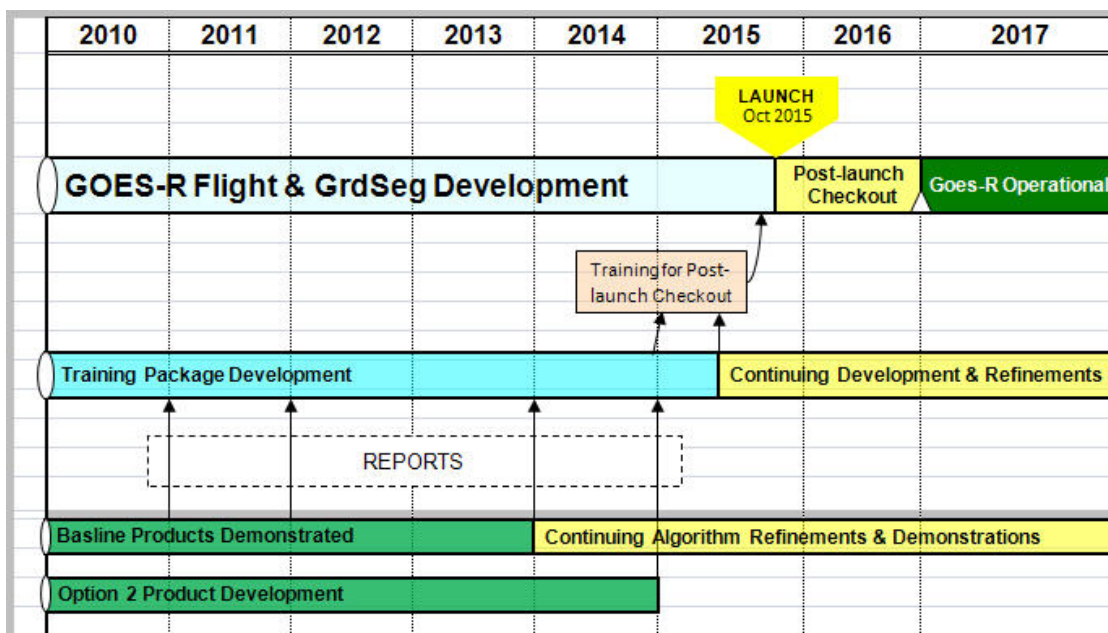


**Figure 2.1 Overall GOES-R and Proving Ground Timeline**

Appendix 1 lists the Required GOES-R Product Set and Appendix 2 lists Warning Related Products of a priority nature.

## 2.2    Field Operational Projects

The GOES-R Proving Ground is organized in two ways: by test bed and by GOES-R algorithm product demonstrated. An algorithm team lead may provide specific products for selected WFOs to address, while NOAA test beds will demonstrate products of particular interest to that test bed. One or more cooperative institutes may support products demonstrated in one of these NWS specialized test beds. For example, at an early Hazardous Weather Test Bed demonstration, two NOAA cooperative institutes and one NASA center participated:

- CIMSS supporting Convective initiation,

- CIRA supporting Statistical Hail Prediction, and

- SPoRT supporting Lightning Data

The Storm Prediction Center (SPC) provided the independent evaluation in the operational setting.  In all cases, the proving ground operations plans for a specific year will provide detail on the products to be demonstrated and the roles and responsibilities of supporting organizations and those providing an independent assessment of the products demonstrated.  The emphasis is placed on conducting an independent evaluation in an operational environment.

The intent is that Proving Ground activities be conducted at many and varied field sites including NOAA Test Beds and numerous Weather Forecast Offices (WFOs) in all NWS Regions. The NOAA Test Beds include:

- Hazardous Weather Test bed
- Hydrometeorological Test bed
- Satellite Algorithm Test Bed
- Aviation Weather Test bed
- Joint Hurricane Test bed
- Joint Center for Satellite Data Assimilation

The PGEB and the National Weather Service have jointly identified a set of GOES-R Products as "Warning Related" products - those that directly contribute to NWS Warning Mission (Save Lives & Property) and can be evaluated operationally in near real time.  The GOES-R PG activities should focus on the AWG version of these algorithms/products for demonstration due to their critical importance in day-to-day high impact weather.  These products are identified below:

Baseline Products:
- Volcanic Ash: detection & Height
- Cloud and Moisture Imagery
- Hurricane Intensity
- Lightning Detection:  Events, Groups & Flashes
- Rainfall Rate / QPE
- Total Precipitable Water
- Fire/Hot Spot Characterization

Option 2 Products:
- Aircraft Icing Threat
- Convective Initiation
- Enhanced "V" / Overshooting Top Detection
- Low Cloud and Fog
- $SO_2$ Detection

# 3—Implementation Approach

## 3.1    General Project Readiness Process

To conduct a successful product demonstration and evaluation, the following steps must be accomplished:

1) First a specific cooperative institute or center, under the direction of an AWG Applications Team (listed in Appendix 2) codes the product algorithm for either AWIPS or McIDAS implementation.  The code may be intended for on-site implementation (at the CI), or at a central facility such as one of the test beds and/or a WFO.
2) Documentation and training packages are prepared in accordance by the CI or AWG.
3) Code is then installed and checked out at either the central facility and displayed on-site, or installed and displayed at the site and staff at the demonstration site is trained.
4) The AWG team lead takes on an active support role while the site conducts the demonstration.
5) The primary test bed prepares an evaluation report with support from the AWG team lead involved and input from participating WFOs and provides it to the GOES-R Program Office (GPO).

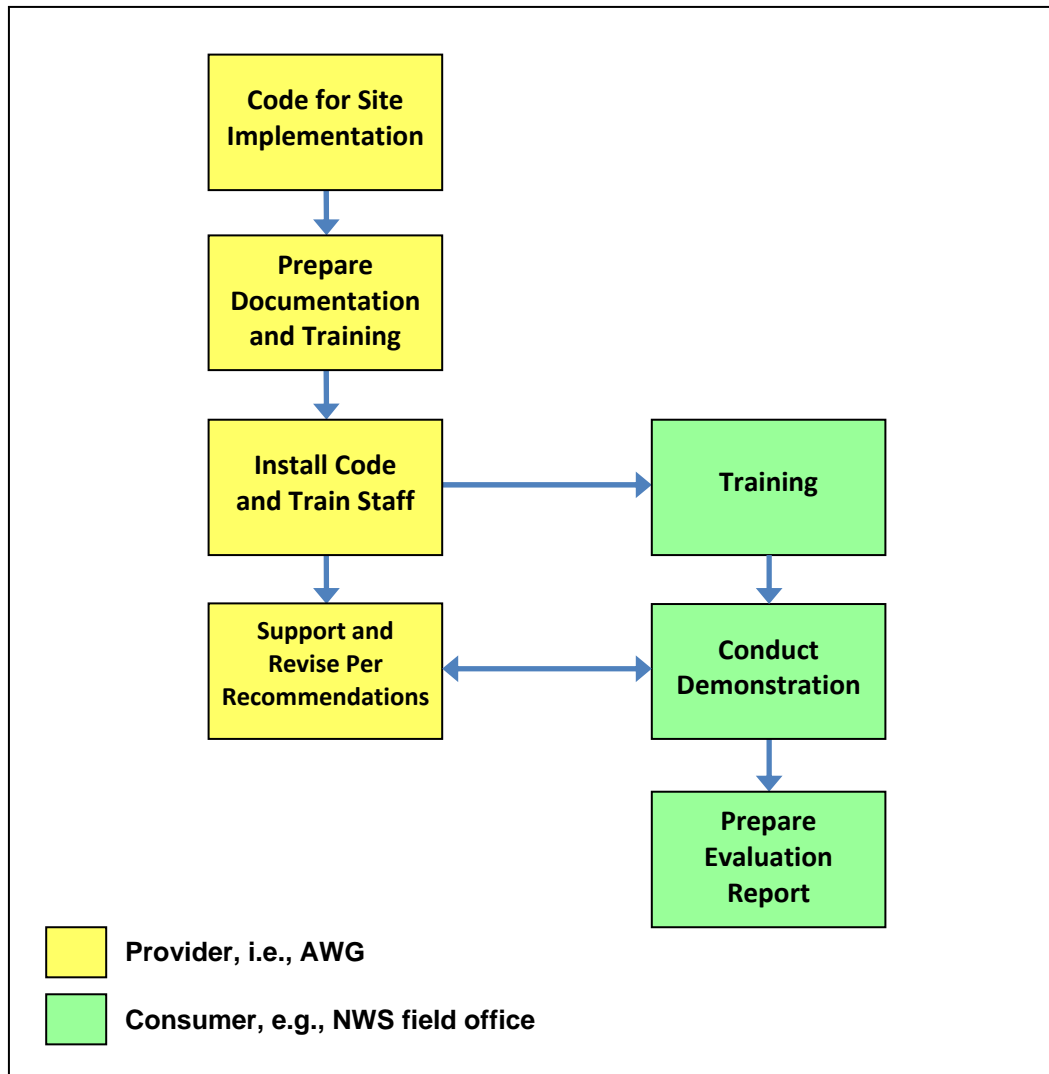See Figure 3.1 for a general flow chart of this activity.

**Figure 3.1 General Proving Ground Project Activities at Both Developer and Field Site**

## 3.2    Guidelines for Project Planning, Approval, Execution and Evaluation

Since the Proving Ground purpose is to *demonstrate*, to the extent possible, future products rather than to serve as a test bed for product *development*, in all cases it is important that projects demonstrate, as closely as possible, the "official" GOES-R algorithms.  If product development is part of the activity it will, once approved, be handled as a Risk Reduction activity.  This policy is to avoid misleading forecasters about the expected future GOES-R products.

There are two ways that a specific proving ground project can be initiated.  A producing organization, (referred to later in this document as "provider") e.g. a member of the Algorithm Working Group (AWG) may develop a Proving Ground Demonstration Proposal, a 1-page white paper describing what products will be evaluated, the time frame for development/documentation, the proposed location(s), and the proposed time frame for evaluation.  Alternatively, a consumer organization, (referred to later in this document as "consumer") e.g., one or more WFOs, one or more NOAA Test Beds, and/or a Regional

Headquarters, may provide a Proving Ground Demonstration Proposal in concert with one or more producing organizations.  In either case, the proposal is reviewed by the Proving Ground Executive Board, and, if acceptable, is then approved by the GOES-R Program Scientist. Any budget for the demonstration is allocated on a fiscal year basis at the same time.  A template for the Proving Ground Demonstration Proposal is contained in Appendix 3**.**

Once the GOES-R Program Senior Scientist accepts the proposal, a Proving Ground Operations Plan is jointly developed by the provider and consumer based on the proposal they submitted. The Operations Plan describes in more detail the goals of Proving Ground Project, the GOES-R product(s) to be demonstrated, identifies the Proving Ground Participants and their responsibilities, outlines the project schedule, and identifies milestones and deliverables.  A template for the Proving Ground Operations Plan is contained in Appendix 4.  The Proving Grounds Operations Plan is reviewed by the stakeholders (PG Partners involved, NWS POC(s), and the PGEB) and revised accordingly. After the GOES-R Program Senior Scientist approves it, the project commences.

As part of the approved Operations Plan, specific monitoring and quarterly reporting will be required. A key element is project progress alignment with the overall GOES-R launch readiness schedule to ensure low risk readiness for, ultimately, transition to the future GOES capabilities. Periodic progress reviews will be established by the PGEB to ensure timely progress and to meet changing conditions that may occur. As projects are established and executed, status will be maintained on the Proving Ground web site.

At the conclusion of the demonstration, a Proving Ground Final Report will be required which will follow the template in Appendix 5.  This report will include a description of the demonstration, describe the participants involved along with the activities that took place, and most importantly it will include an evaluation for each product demonstrated during the PG activity.  Input for the Final Report is expected from all of the Providers and Consumers involved in the activity.  Product recommendations for both current and future operations will be captured in the Final Report and any recommendations related to current operations will be delivered to responsible parties for consideration. The appropriate GOES-R/ AWG group will also be notified.  Additionally, NWS HQ will coordinate with WFOs to provide an annual report describing the PG activities in which they were involved including any recommendations to the GPO.

## 3.3    Project Implementation

### 3.3.1        *AWIPS II Compatibility*

Primarily, the Proving Ground program will be demonstrating GOES-R products within an operational environment using AWIPS II.  Therefore, it is important that the products be compatible with AWIPS II software standards.  The AWIPS II software coding standards can be found in TBD document.

### *3.3.2 Configuration Control Guidelines*

Once a Proving Ground Operations Plan is approved, it should not be modified without the consent of the Proving Ground Executive Board and all stakeholders involved in that project.

# 4—Management Approach

## 4.1 Management Approach

The overall program management responsibility is by the GOES-R Program Office, working in concert with NWS management. The GOES-R Program Office will provide policy level direction and coordination while NWS management insures that an appropriate evaluation is conducted and its results are promulgated throughout NWS. The individual demonstration projects will have their own management and coordination approach specified in the individual operations plan.

## 4.2 Executive Board

The policy-level Proving Ground Executive Board (PGEB) has been established to oversee the program. This Board is chaired by the GOES-R Program Senior Scientist and includes a NESDIS/STAR member each from the Advanced Satellite Products Branch (ASPB) and Regional and Mesoscale Meteorology Branch (RAMMB) (co-located with the Cooperative Institutes CIMSS and CIRA), an NWS/OCWWS and /OST member, and a member from the Algorithm Working Group. Current membership is provided in Appendix 6. The RAMMB member is also Risk Reduction Program manager, and the AWG member is Deputy Program manager for the AWG and lead for validation. The Board will review progress on a regular basis and determine readiness of the various projects and their checkpoints and major decision points.. The PGEB chair will approve operations plan proposals, operations plans, final decisions and policies as required and lead budget planning and evaluation of various initiatives. An Advisory Panel, drawn on an Ad Hoc basis from Cooperative Institutes, NOAA test beds, and NOAA Goal Teams supports the Board.

## 4.3 Proving Ground Database and Library

A relational database will be created and maintained by the PGEB chair's support staff, to serve as a management tool providing visibility into all aspects of the project. It will provide cross-referencing of all GOES-R products to:
- All users/test beds
- All cognizant supporting cooperative institutes,
- Timelines for preparation, conduct and evaluation report of a proving ground demonstration

Proving ground members will be able to query the database for selected matrix reports. In addition, all approved yearly operations plans will also be available online. All active (and past) proving ground activities are described and status maintained on the proving ground web site:

http://cimss.ssec.wisc.edu/goes_r/proving-ground.html.

## Appendix 1 – Required GOES-R Product Set

**Product list as of 2009**

| | | | | | |
|---|---|---|---|---|---|
| 1. Aerosol Detection (including Smoke and Dust) | | 33. Absorbed Shortwave Radiation: Surface | + |
| 2. Aerosol Particle Size | + | 34. Downward Longwave Radiation: Surface | + |
| 3. Aerosol Optical Depth | | 35. Downward Shortwave Radiation: Surface | |
| 4. Volcanic Ash: Detection and Height | | 36. Reflected Shortwave Radiation: TOA | |
| 5. Aircraft Icing Threat | + | 37. Upward Longwave Radiation: Surface | + |
| 6. Cloud Ice Water Path | + | 38. Upward Longwave Radiation: TOA | + |
| 7. Cloud Layers / Heights | + | 39. Ozone Total | + |
| 8. Cloud Liquid Water | + | 40. SO2 Detection | + |
| 9. Cloud & Moisture Imagery | | 41. Derived Motion Winds | |
| 10. Cloud Optical Depth | | 42. Fire / Hot Spot Characterization | |
| 11. Cloud Particle Size Distribution | | 43. Flood/Standing Water | + |
| 12. Cloud Top Phase | | 44. Ice Cover: Hemispheric | + |
| 13. Cloud Top Height | | 45. Land Surface (Skin) Temperature | |
| 14. Cloud Top Pressure | | 46. Snow Cover | |
| 15. Cloud Top Temperature | | 47. Snow Depth | + |
| 16. Cloud Type | + | 48. Surface Albedo | + |
| 17. Convective Initiation | + | 49. Surface Emissivity | + |
| 18. Enhanced "V" / Overshooting Top Detection | + | 50. Vegetation Fraction: Green | + |
| 19. Hurricane Intensity | | 51. Vegetation Index | + |
| 20. Lightning Detection: 1) Events 2) Groups and 3) Flashes | | 52. Currents | + |
| 21. Low Cloud and Fog | + | 53. Currents: Offshore | + |
| 22. Tropopause Folding Turbulence Prediction | + | 54. Sea & Lake Ice: Age | + |
| 23. Visibility | + | 55. Sea & Lake Ice: Concentration | + |
| 24. Probability of Rainfall | + | 56. Sea & Lake Ice: Motion | + |
| 25. Rainfall Potential | + | 57. Sea Surface Temperature (skin) | |
| 26. Rainfall Rate/QPE | | 58. Energetic Heavy Ions | |
| 27. Legacy Vertical Moisture Profile | | 59. Magnetospheric Electrons and Protons: Low Energy | |
| 28. Legacy Vertical Temperature Profile | | 60. Magnetospheric Electrons and Protons: Medium & High Energy | |
| 29. Derived Stability Indicies (5 indicies: CAPE, Lifted Index, K-index, Showalter Index, Total Totals) | | 61. Solar and Galactic Protons | |
| 30. Total Precipitable Water | | 62. Geomagnetic Field | |
| 31. Clear Sky Water | | 63. Solar Flux: EUV (GOES-O will produce) | |
| 32. Radiances | | 64. Solar Flux: X-Ray | |
| | | 65. Solar Imagery: X-Ray | |

Yellow = current GOES and GOES-R
Blue = GOES-R only
+ indicates Option 2 products

## Appendix 2 – AWG Applications Teams and Leads

Soundings – Chris Barnet, Tim Schmit
Winds – Jamie Daniels
Clouds – Andy Heidinger
Aviation – Ken Pryor, Wayne Feltz
Aerosols/Air Quality/Atmospheric Chemistry – Shoba Kondragunta
Hydrology – Robert Kuligowski
Land Surface – Bob Yu
SST and Ocean Dynamics – Alexander Ignatov
Cryosphere – Jeff Key
Radiation Budget – Istavan Lazslo
Lightning – Steve Goodman
Space Environment – Steven Hill

**Appendix 3 – Proving Ground Demonstration Proposal Template**

1) **Project Title:**

2) **Organization:**

3) **Products to be demonstrated Identify which GOES-R Products will be demonstrated (from Appendix 1 and 2):**
   a) <Product 1>
   b) <Product 2>

4) **Demonstration Project Summary:**
   a) Purpose:
   b) Scope:

5) **Participants (Centers) involved:**
   a) Providers
      i) <List CI or agency>
   b) Consumers
      i) <List consumers>

6) **Project schedule/duration (timeline):**
   a) Begin <date>
   b) End <date>

7) **Project decision points and deliverables**
   a) Proving Ground Operations Plan
   b) Proving Ground <demonstration> Final Report
   c) <Other>

8) **Responsibilities and Coordination**
   a) Provide how work is coordinated and who authorizes, manages, evaluates, trains, reports, etc.

9) **Budget and Resource Estimates**
   a) How many dollars (by FY), and what key resources are needed (e.g., people and things)
   b) If known, provide the Funding Source(s)

**Appendix 4 – Proving Ground Operations Plan Template**

1. **Introduction**
   a. Plan Purpose and Scope
   b. Overview
   c. Related Documents

2. **Goals of Proving Ground Project**

3. **GOES-R product(s) to be demonstrated**

4. **Proving Ground Participants**
   a. Providers
   b. Consumers

5. **Responsibilities and Coordination**
   a. Project Authorization
   b. Project Management
   c. Training
   d. Product Evaluation

6. **Project Schedule**

7. **Milestones and Deliverables**

8. **Related activities and methods for collaboration**

9. **Summary**

**Appendix 5 – Proving Ground Final Report Template**

1) **Project Title:**

2) **Organization:**

3) **Evaluator(s) {Consumer}:**

4) **Duration of Evaluation:**

5) **For each product:**
   a) **Product Evaluated:**

   b) **Recommendations (for current and future operations):**

6) **Conclusion**

**Appendix 6 – Executive Board Membership**

- Steve Goodman, GPO Senior Scientist, Chair
- Jaime Daniels, AWG Deputy Program Manager and Validation Lead
- Mark DeMaria, STAR/RAMMB@CIRA and Risk Reduction Program Manager
- Jim Gurka, GPO Ground Segment Project Scientist
- Mike W. Johnson, NWS/OST/Programs & Planning
- Tom Renkevens, NOAA/NESDIS/OSDPD Satellite Services Division
- Tim Schmit, STAR/ASPB@CIMSS
- Kevin Schrab, NWS/OCCWS

Note: Advisory members will be called upon for discussion of specific topics.