Geostationary Operational Environmental Satellite (GOES) – R Series

ABI L2+ Derived Motion Winds Beta, Provisional and Full Validation Readiness, Implementation and Management Plan (RIMP)

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ABI L2+ Derived Motion Winds Beta, Provisional and Full Validation Readiness, Implementation and Management Plan (RIMP)

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Preface

The evolving calibration and validation (cal/val) maturity of Geostationary Operational Environmental Satellite R-Series (GOES-R) products throughout the beginning of the mission is described by three levels: Beta, Provisional, and Full validation. The Flight Project is responsible for producing the Level 1b (L1b) products according to the Level III requirement documents. Once Beta Maturity of the L1b products is achieved, the Level 2+ (L2+) will begin analysis towards Beta maturity. Further levels of maturity (Provisional and Full validation) require additional and often long-term activities. A detailed description of the three product maturity levels is given in Figure 1, but brief descriptions of the three maturity levels are:

Beta: the product is minimally validated and may still contain significant errors; based on product quick looks using the initial calibration parameters.
Provisional: product performance has been demonstrated through a large, but still (seasonally or otherwise) limited, number of independent measurements. The analysis is sufficient for limited qualitative determinations of product fitness-for-purpose, and the product is potentially ready for testing operational use.
Full: product performance has been demonstrated over a large and wide range of representative conditions, with comprehensive documentation of product performance, including known anomalies and their remediation strategies. Products are ready for operational use.

Assessment and declaration of maturity levels is performed during Peer Stakeholder–Product Validation Reviews (PS-PVRs). At each PS-PVR, the status of products will be presented by members of the cal/val science teams. For L2+ products, Beta maturity PS-PVRs are held in close proximity with and prior to Operations Handover. The review panel at the PS-PVRs will include the GOES-R Operational Readiness Working Group (GORWG), GOES-R Program System Engineering (PSE), NOAA Office of Satellite and Product Operations (OSPO), and GOES-R Product Readiness and Operations (PRO). The Readiness, Implementation, and Management Plans (RIMPs) have been created to document the analysis techniques, methodology, duration, tools, data, resources, staffing, and schedule of the Post-Launch Product Tests (PLPTs) to be used by the cal/val science teams to demonstrate the different levels of product maturity. The primary purpose of the RIMPs is to act as a planning resource for the cal/val teams as they prepare for Launch. Additionally, the RIMPs can be used by other members of the GOES-R Program to prepare for cal/val activities, to assess the suitability of the cal/val test plans, and to understand the data and resource requirements the science teams have. Cal/val testing is likely to reveal necessary algorithm changes to evolve the product quality through the maturity levels. The Algorithm Change Management Plan (ACMP) will be used to track and implement these algorithm changes.

The introspection necessary to create these RIMPs has led to extensive consultations between the cal/val teams and other groups within the GOES-R Program, including the Flight Project, the Ground Segment, and a team of experts from The Aerospace Corporation under contract from GOES-R PSE to help improve the cal/val mission. Figure 2 below describes the responsibilities and accountability of each of the main parties involved in the creation of the RIMPs. This delineation is required because GOES-R operations are to be handed over from the GOES-R Program to NOAA OSPO at the end of the PLT period, yet the process of validating product maturity will continue. This changing nature of accountability during the process must be acknowledged. Accountability of the RIMPs changes at Operations Handover from NASA to NOAA and is aligned with the level of each RIMPs' validation maturity objective. Accountability determines which organization owns documentation, process, and procedures. Responsibility determines which organization creates, executes, and maintains specific activities.

GOES-R Product (L1b and L2+) Maturity Levels

Beta Validation

Preparation Activities
- Initial calibration applied (L1b).
- Rapid changes in product input tables, and possibly product algorithms, can be expected.
- Product quick looks and initial comparisons with ground truth data (if any) are not adequate to determine product quality.
- Anomalies may be found in the product and the resolution strategy may not exist.

End state
- Products are made available to users to gain familiarity with data formats and parameters.
- Product has been minimally validated and may still contain significant errors.
- Product is not optimized for operational use.

Provisional Validation

Preparation Activities
- Validation and quality assurance (QA) activities are ongoing, and the general research community is now encouraged to participate.
- Severe algorithm anomalies are identified and under analysis. Solutions to anomalies are in development and testing.
- Incremental product improvements may still be occurring.
- Users are engaged in the Customer Forums (L2+ products only), and user feedback is assessed.

End state
- Product performance (L1b or L2+) has been demonstrated through analysis of a small number of independent measurements obtained from selected locations, periods, and associated ground-truth/field program efforts.
- Product analysis are sufficient to communicate product performance to users relative to expectations.
- Documentation of product performance exists that includes recommended remediation strategies for all anomalies and weaknesses. Any algorithm changes associated with severe anomalies have been documented, implemented, tested, and shared with the user community.
- Testing has been fully documented.
- Product ready for operational use and for use in comprehensive calibration/validation activities and product optimization.

Full Validation

Preparation Activities
- Validation, QA, and anomaly resolution activities are ongoing.
- Incremental product improvements may still be occurring.
- Users are engaged and user feedback is assessed.

End state
- Product performance for all products is defined and documented over a wide range of representative conditions via ongoing ground-truth and validation efforts.
- Products are operationally optimized, as necessary, considering mission parameters of cost, schedule, and technical competence as compared to user expectations.
- All known product anomalies are documented and shared with the user community.
- Product is operational.

Figure 1. GOES-R product maturity levels.

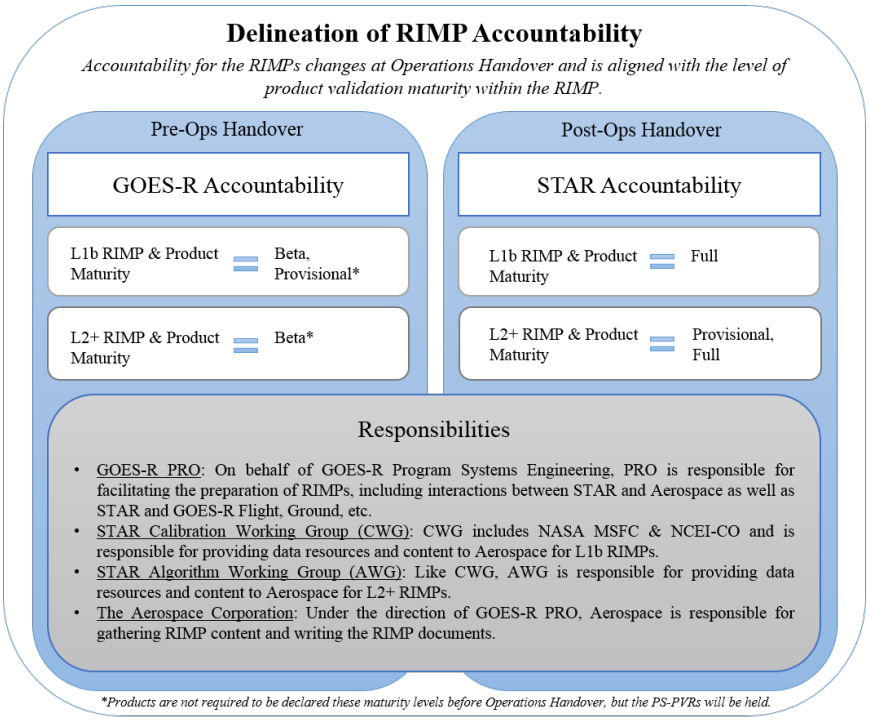

Figure 2. Delineation of accountability between GOES-R and STAR.

1. Derived Motion Winds Validation Overview

This Readiness, Implementation, and Management Plan (RIMP) covers all validation stages of the GOES-R Advanced Baseline Imager (ABI) Derived Motion Winds (DMW) L2+ product. There are three stages in the validation process, Beta, Provisional, and Full validation. Each stage is defined by Post-Launch Product Tests (PLPTs), which guide the overall validation process. This RIMP includes a summary of the methods and tools employed to prove DMW has met a given validation stage. Appendices are included that present more detail on each PLPT and detail on the different data sets employed in the validation of the DMW product.

The DMW product retrieves atmospheric winds by tracking features in satellite infrared and visible imagery. The Derived Motion Winds Algorithm (DMWA) employs a sequence of images to estimate atmospheric motion and assign this motion to a representative height in the atmosphere. Note the cadence addresses the frequency of the DMW product available to users, not the internal needs of the algorithm. The algorithm itself requires three consecutive scans of the same type to actually derive the necessary wind vectors. Hence, the first products would not be available until three consecutive scans existed over the same region.

The DMW team has identified 56 Post-Launch Product Test (PLPT) verification events with success criteria to achieve Beta maturity. There are 21 additional events defined to attain provisional maturity and another 21 to attain Full maturity with the appropriate pass/fail success criteria.

The first 35 of these events will verify that the product is generated for the Bands 2, 7, 8, 9, 10, and 14 for either Full Disk (FD) hourly, CONUS every 15 min, mesoscale every 5 min, and in Mode 3 and 4 for FD and CONUS. Additionally, the verification will include either some daytime for Band 2, or nighttime for Band 7 as well as cloudy and cloud-free conditions for Band 8. Bands 9 and 10 will be verified under cloud-free conditions and Band 14 under cloudy conditions. This verification will be carried out in parallel during the first week of PLPT and its success criteria include a verification that the retrievals fall within the expected measurement range. No specific type of mesoscale scene is necessary. However, emphasis would be placed upon a mesoscale event that occurred when radiosondes were taken over the CONUS. With all scan types, three consecutive scans are necessary to derive DMW. No North/South (N/S) scan data is needed or used for the validation of DMW.

The next 21 events that need to be completed to reach Beta maturity will assess the accuracy and precision of the DMW product for FD, CONUS, and mesoscale conditions for Bands 2, 7, 8, 9, 10, and 14 under similar conditions for the different bands as the first 35 events (cloudy, cloud-free, some daylight, some nightlight). These validation events will be carried out in parallel during 5 weeks after the first initial 35 are completed. Success is achieved for these events when the DMW products are quantitatively analyzed (accuracy and precision) with shortfalls documented over the limited time frame of these events.

There are 21 validation events that have been defined to obtain provisional maturity that focus on assessing and characterizing the performance of DMW products generated using ABI Bands 2, 7, 8, 9, 10, and 14 for FD, CONUS, and mesoscale sectors for cloudy, cloud-free, some daylight and nightlight conditions depending on the band. The criteria by which the GOES-R DMW will be evaluated to determine if provisional status has been met are:

- Assess the accuracy and precision of all DMW products over a wide range of representative conditions.
- Document feedback from the primary user (NWS). This feedback will be documented via the PS-PVR process.
- The following requirements must be met at provisional; horizontal resolution, vertical resolution, mapping accuracy, and measurement range.
- Accuracy and precision do not have to be met to attain provisional status, however, if they do not do so, the reasons behind not meeting these requirements must be documented, to include reporting of incidents/issues as an Algorithm Discrepancy Report (ADR) for discussion at the Algorithm Action Review Team (AART).
- Have remediation strategies in place for known issues.
- Product is ready for potential operational use (user decision) and for use in scientific publications.

The final 21 validation events that have been defined to obtain Full maturity status have the same focus as the 21 validation events defined to obtain provisional maturity, that is: they will be used to continue to assess the accuracy and precision of the Derived Motion Wind product but now generated over a full range of retrieval conditions, including a full seasonal cycle. The success criteria for the Full maturity events generated under these conditions is that they will satisfy the accuracy and precision specified in the Mission Requirements Document (MRD) and/or that in case the performance is not met, the product limitations, justifications for those limitations and/or potential remediation have been identified. While specifications do not have to be met for the product to reach Full maturity, the reason(s) must be documented along with further remediation strategies recommendations if they are not. Users must concur that the product has reached Full maturity. The PLPTs are planned to begin immediately after provisional maturity has been obtained and to last 36 weeks. It assumes that the clear-sky mask is working properly and/or it has been validated.

The Beta, Provisional, and Full maturity validation events for DMW make use of an independent verification data set collocated in space and time, visualization, statistical analysis and matching comparison tools. They are either routine or Deep-dive tools and all of them have been completed by December 2015. The product will be validated by comparison with a reference data set from radiosonde wind observations over land; aircraft wind observations [Aircraft Communications Addressing and Reporting System (ACARS), Aircraft Meteorological Data Relay (AMDAR)], Global Forecast System (GFS) analysis winds, and operational GOES-E/GOES-W Atmospheric Motion Vectors (AMVs).

Details of the validation processes and procedures, monitoring and analysis methods, tools, and expected output artifacts are described in the following sections. Due to the large number of events, the PLPT events that support the Beta, Provisional, and Full maturity for DMW are listed as well as their details given in Appendix A. The reference data sets are provided in Appendix B.

Each PLPT event that supports Beta maturity is listed below; details are in in Appendix A.

- **ABI-FD_DMW01/08/15**
- **ABI-FD_DMW02/09/16**
- **ABI-FD_DMW03/10/17**
- **ABI-FD_DMW04/11/18**
- **ABI-FD_DMW05/12/19**

- **ABI-FD_DMW06/13/20**
- **ABI-FD_DMW07/14/21**
- **ABI-FD_DMW22/29**
- **ABI-FD_DMW23/30**
- **ABI-FD_DMW24/31**
- **ABI-FD_DMW25/32**
- **ABI-FD_DMW26/33**
- **ABI-FD_DMW27/34**
- **ABI-FD_DMW28/35**
- **ABI-FD_DMW36/43/50**
- **ABI-FD_DMW37/44/51**
- **ABI-FD_DMW38/45/52**
- **ABI-FD_DMW39/46/53**
- **ABI-FD_DMW40/47/54**
- **ABI-FD_DMW41/48/55**
- **ABI-FD_DMW42/49/56**

The following Table identifies the frequency of each scan type for Modes 3 and 4. It includes the required cadence of the DMW product as defined by both the GOES-R Functional and Performance Specification (F&PS) and the Product User's Guide (PUG). The bottom line reflects, for each appropriate scan type, the frequency of that product used for verification purposes. Any validation that occurs will use the frequency of the operational output, as indicated in the Table.

** There is no CONUS scan type for Mode 4, but there are required products over the CONUS that are derived from the FD output*
#The DMW product is derived from three consecutive scans of the same scan type

Mode	Mode 3			Mode 4		
Scan Type	FD	CONUS	Mesoscale	FD	CONUS	Mesoscale
Scan Freq	15 min	5 min	30 sec	5 min	5 min*	N/A
F&PS#	60 min	15 min	5 min	15 min	15 min	N/A
PUG	60 min	15 min	5 min	15 min	15 min	N/A
Verif Freq	60 min	15 min	5 min	15 min	15 min	N/A

Table 1. DMW documented product cadence and verification approach.

Each PLPT event that supports Provisional maturity is listed below; details are in in Appendix A.

- **ABI-FD_DMW57/64/71**
- **ABI-FD_DMW58/65/72**
- **ABI-FD_DMW59/66/73**
- **ABI-FD_DMW60/67/74**
- **ABI-FD_DMW61/68/75**
- **ABI-FD_DMW62/69/76**
- **ABI-FD_DMW63/70/77**

Each PLPT event that supports Full maturity is listed below; details are in in Appendix A.

- **ABI-FD_DMW78/85/92**
- **ABI-FD_DMW79/86/93**
- **ABI-FD_DMW80/87/94**
- **ABI-FD_DMW81/88/95**

- **ABI-FD_DMW82/89/96**
- **ABI-FD_DMW83/90/97**
- **ABI-FD_DMW84/91/98**

2. Schedule of Events

The verification of events include

- Current – December 2015: Finish testing all DMW validation tools sufficient to support DOE 4 in the summer of 2016.
- Current – September 2016: Evaluate results using data from Data Operations Exercise (DOE)-3/4.
- Current – October 2016: Test and evaluate algorithm with Himawari-8 data.
- December 2016: Final version of the DMW tools ready for GOES-R Cal/Val (Working tools ready by December 2015 will be further tested and updated as needed with Himawari and DOE-4 data in 2016).
- L+44 days: Starts System Performance Operational Test (SPOT).
- L+155 days: PLPT starts – Beta maturity events start.
- L+195 days (PLPT start + 6 weeks) – Beta maturity ends - Handover to OSPO.
- L+197 days + 24 weeks (6 months): Provisional maturity verification ends – Full testing starts.
- L+197 days + 24 weeks + 36 weeks (9 months): Full maturity verification ends.

Derived Motion Wind (DMW) product Beta maturity validation effort will be divided in two stages. The first one is to qualitatively verify that with the sensor in either Mode 3 or Mode 4, the DMW FD product is generated every 60 minutes in Mode 3 and every 15 minutes in Mode 4, every 15 min for CONUS in either Mode 3 or 4 and every 5 min for mesoscale in Mode 3 and falls within expected ranges. This stage is planned to take 1 week, all the analyses are carried out in parallel and it will provide an early assessment of the product performance characteristics. The second stage is to more carefully quantify the accuracy and precision of the product and identify areas of degraded performance using a limited number of independent measurements, and it is planned to last 5 weeks. The product performance assessment will be conveyed to the user community.

The details of the GOES-R validation schedule are also shown in Figure 2.1. System Performance Operation Test (SPOT) begins when ABI L1b and the L2 Cloud and Moisture Imagery (CMI) Beta evaluation begins. The L1b and L2 CMI data should be declared Beta maturity by L+87 days. One day later, the GOES Rebroadcast (GRB) will be populated with that data. The L2+ products must reach Beta maturity by Handover at L+197 days, the same time that ABI L1b and CMI reach Provisional. Given that L2+ Beta tests require at least 6 weeks, L2+ Beta testing must get underway by L+155 days, but can begin as soon as the ABI L1b and CMI reach Beta (L+87 days).

The GOES-R Operations phase begins after Handover marking the start of a 12 month Extended Validation period for ABI L1b and CMI, which is coincident with the start of the 6 month L2+ Provisional validation, followed by another nine months period for L2+ products to reach Full maturity, 15 months after Handover. There will be a set of pre-launch preparation activities that include the generation and test of tools and models with L1b data sets, L2+ product data sets and diagnostic data sets as indicated in Section 7.

The DMW product Provisional maturity validation effort will characterize the accuracy and precision of the product and identify areas of degraded performance for an extended but still not seasonally representative (larger than the one used for Beta) number of independent measurements. At the completion of this part of the effort the product will be conveyed to the user as ready for operational assessment and user feedback will be requested. By the end of the Full maturity validation effort, the product accuracy and

precision will have been characterized over the full range of retrieval conditions, and the product declared fully operational after user review and feedback. Please see Section 6.

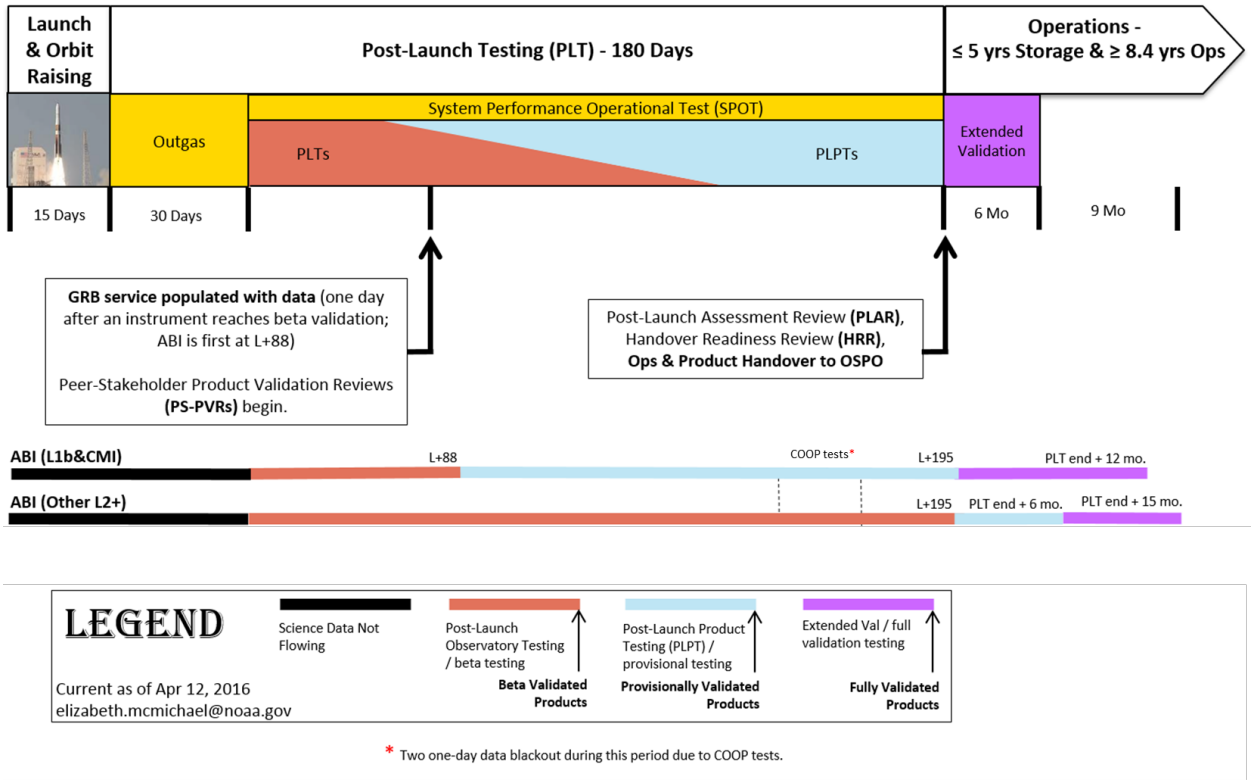

Figure 3. Schedule of events.

3. Roles and Responsibilities

3.1 Primary Point of Contact

The primary point of contact (POC) for leading the DMW validation effort is Jamie Daniels.

3.2 GOES-R Point of Contact

The primary POC at GOES-R for the DMW validation effort is Wayne MacKenzie.

3.3 Test Analyst/Engineer

The support lead for all events will be Jaime Daniels and the analyst support team will be composed of Wayne Bresky, Andy Bailey, Americo Allegrino and Steve Wanzong.

3.4 GOES-R Feedback

Formal feedback to the GOES-R Program regarding the DMW validation will be provided by Jaime Daniels.

3.5 Level of Effort

AWG Lead: Jaime Daniels (0.40 FTE)
Support Scientist: Wayne Bresky (0.80 FTE)
Support Scientist: Andy Bailey (0.80 FTE)
Support Scientist: Americo Allegrino (0.50 FTE)
Support Scientist: Chris Velden (0.10 FTE)
Support Scientist: Steve Wanzong (0.50 FTE)

4. Tools

The DMW validation methodology includes a set of collocation and analysis tools. The collocation tools collocate the DMW products with wind observations from other observing platforms or numerical weather prediction analysis fields. These tools are typically executed in an automated way. The analysis tools enable visualization of the DMW products and/or the reference data and statistical comparisons to be done. Most of the same set of tools is used for Beta and Provisional. For some tools (those that are 100% complete) testing will be performed pre-launch using DOE-4 data. It is possible that after testing a small amount of effort might be needed to alter those tools slightly.

Appendix C contains a detailed description of the tools used for DMW validation.

5. Analysis Methods

Radiosonde from the National Centers for Environmental Prediction (NCEP) will be used. Comparison of the ABI DMW against other independent satellite-based DMWs (i.e., operational GOES winds) will further test the consistency of the ABI DMW product over both land and oceanic areas.

A long chain of uncertainties arising from sensor radiance response, image registration, estimation of surface properties (e.g., emissivity, reflectance), retrieval of cloud properties, feature tracking, and height assignment can impact the DMW products. The main objective of the analysis is to determine the DMW product accuracy and provide a better understanding and quantification of the impacts of these uncertainties on the product performance.

5.1 Method 1

Visualization of any and all initial, intermediate, and final data at varying spatial scales. Use of a specific visualization tool to allow qualitative analysis of the data through the processing chain can help identify anomalies, verify underlying assumptions, and guide algorithm adjustments.

5.2 Method 2

Examination of the DMW algorithm performance in situations that stress the algorithm and its underlying assumptions. Examples of such stressing situations include: 1) tracking and height assignment of targets containing thin cirrus; 2) cloud targets where significant cloud evolution is occurring; 3) target scenes that may contain multi-cloud layers; and 4) tracking of cloud features in the vicinity of the jet stream or hurricanes. This range of conditions may not be fully represented during PLPT, so validation will need to continue after PLPT.

Provisional maturity success criteria specifics:

- Characterize product accuracy and precision and convey to the user community.
- Accuracy and precision (MRD specifications as indicated below) do not have to be met to attain provisional status, however, if they do not do so, the reasons behind not meeting these requirements must be documented (see at the end of A.2.21 for requirements).
- Document impacts from challenges with upstream dependencies.
- Document feedback from the primary user (NWS).
- Have remediation strategies in place for known issues.
- Product is ready for potential operational use (user decision) and for use in scientific publications.

Full maturity success criteria specifics:

- Characterize product accuracy and precision over a full range conditions, including seasonal and convey to the user community.
- Accuracy and precision (MRD specifications as indicated below) do not have to be met to attain provisional maturity, however, if they do not do so, the reasons behind not meeting these requirements must be documented and potential remediation(s) identified.
- Document impacts from challenges with upstream dependencies.
- Document feedback from the primary user (NWS).
- Have remediation strategies in place for known issues.
- Product is fully operational (after user review, feedback and approval).

Product geographic coverage/conditions: **CONUS**. Product vertical resolution: cloud motion vector winds: at cloud tops; clear-sky water vapor winds: 200 mb. Product horizontal resolution: 38 km. Product mapping accuracy: 5 km. Product measurement range: Speed: 5.83-300 kts (3-155 m/s). Direction: 0-360 deg. Product measurement accuracy: mean vector difference: 7.5 m/s. Product measurement precision: mean vector difference: 4.2 m/s. Temporal coverage qualifier: day and night. Product extent qualifier: quantitative out to at least 62 deg Local Zenith Angle (LZA) and qualitative at larger LZA. Cloud cover conditions qualifier: clear conditions associated with threshold accuracy.
Product geographic coverage/conditions: **Full Disk** - Hemispheric. Product vertical resolution: Cloud motion vector winds: at cloud tops. Clear-sky water vapor winds: 200 mb. Product horizontal resolution: 38 km. Product mapping accuracy: 5 km. Product measurement range: Speed: 5.83-300 kts (3-155 m/s). Direction: 0 to 360 deg. Product measurement accuracy: mean vector difference: 7.5 m/s. Product measurement precision: mean vector difference: 4.2 m/s. Temporal coverage qualifier: day and night. Product extent qualifier: quantitative out to at least 62 deg LZA and qualitative at larger LZA. Cloud cover conditions qualifier: clear conditions associated with threshold accuracy.
Product geographic coverage/conditions: **Mesoscale**. Product vertical resolution: Cloud motion vector winds: at cloud tops Clear-sky water vapor winds: 200 mb. Product horizontal resolution: 38 km. Product mapping accuracy: 5 km. Product measurement range: Speed: 5.83-300 kts (3-155 m/s). Direction: 0-360 deg. Product measurement accuracy: mean vector difference: 7.5 m/s. Product measurement precision: mean vector difference: 4.2 m/s (CCR 01892). Temporal coverage qualifier: day and night. Product extent qualifier: quantitative out to at least 62 deg LZA and qualitative at larger LZA. Cloud cover conditions qualifier: clear conditions associated with threshold accuracy.

Table 2. MRD specifications.

6. Output Artifacts

The performance statistics of "retrieved - reference DMW" will be stratified by retrieval conditions. The validation tools enable performance monitoring of the product. Stratification of comparison metrics will include: AMV type (i.e., band), AMV height, latitude, satellite zenith angle, AMV quality flags, and time of day (to the extent possible). Quantitative comparison metrics will be compiled on a daily and cumulative (i.e., multiple days) basis. Performance assessment and product issues will be documented at the conclusion of each maturity assessment phase.

6.1 Beta Maturity Artifacts

At the completion of the Beta analysis, a report will be prepared containing an initial quantitative assessment, based on a limited data set, of accuracy and precision of the DMW product as a function of: characteristic parameters (e.g., solar zenith angle, cloud mask, cloud type, and cloud top pressure conditions, Band 14 radiance or Bands 2, 7, 8, 9, and 10 reflectance, temperature, and wind data, etc.) The report will also discuss issues identified with the product. The criteria for declaring Beta maturity are described in section 5.2.

6.1.1 All tests are priority 1 and must pass. Each test described in sections 1 and 5 are critical and are therefore priority 1.

6.2 Provisional Maturity Artifacts

At the conclusion of the Provisional validation stage, results for the product performance will be presented at a Peer Stakeholder - Product Validation Review (PS-PVR) for the performance metrics results based on a longer period and larger range of representative conditions. The product limitations, areas where it does not satisfy the MRD specifications and the remediation strategies will be documented. The feedback from the primary user (NWS) will be requested and documented if available. NWS centers will be also provided test data and results of validation and asked to comment. The Provisional presentation will include a summary of user feedback received during the validation period. Provisional maturity can be assigned even if this product evaluation by the user is not available. The criteria for declaring Provisional maturity are described in section 5.2.

6.2.1 All tests are priority 1 and must pass. Each test described in sections 1 and 5 are critical and are therefore priority 1.

6.3 Full Maturity Artifacts

At the conclusion of the Full validation stage, results for the product performance will be presented at a PS-PVR for the performance metrics results based on a longer period and larger range of representative conditions. In particular, the Full stage will include the results over a seasonal representative set all the required modes (see condition and modes as used for validation events indicated in Appendix A), and as a function of characteristic parameters similar to those reported for Beta. The product limitations, areas where it does not satisfy the MRD specifications and the remediation strategies will be documented. The feedback from the primary user (NWS) will be requested and documented if available. NWS centers will be also provided test data and results of validation and asked to comment. The Full validation presentations will include a summary of user feedback received during the validation period. The criteria for declaring Full maturity are described in section 5.2.

6.3.1 All tests are priority 1 and must pass. Each test described in sections 1 and 5 are critical and are therefore priority 1.

6.4 Key artifacts

Key artifacts for the DMW validation effort will be the power point presentations tied to each validation phase, and the associated statistical accuracy as stratified by the criteria noted above.

Additionally, there will be output artifacts associated with product issues (and potential resolutions):

- Nonexistence of product file: contact L1b POC
- Visualization tests fail: look for errors in processing (cloud heights, etc.) as well as missing channel data.
- If channel data is missing, we will notify the L1b POC.
- If there are problems with the cloud information we will contact cloud team lead.
- Comparison metric criteria not met: the collocation process will be examined.
- Product anomalies: use appropriate deep dive tools to investigate.

6.5 Delivery schedule

The delivery schedule of artifacts for the DMW validation effort is tied to the schedule for completing beta, provisional, and full validation as given in section 5. All statistical analysis necessary to prove a given validation stage will be included in a power point presentation in time for the appropriate PS-PVR.

7. Pre-launch

The following have been completed during pre-launch:

- Ensured availability of resources (compute servers, local storage).
- Completion and testing of collocation and visualization tools.
- Verified access to all L1b data sets, L2+ product data sets and L2+ diagnostic data sets necessary for validating DMW.
- Simulated ABI imagery (FD, CONUS, and mesoscale).
- Performed validation of reference data.
- Used DOE-1, DOE-2 and DOE-4 data sets and GSIT2 system level sets.
- Participated in dry runs during DOE-3 (October 5 – November 11, 2015).

8. References

[1] PLPT_VE_List_L2_v1_0_20141022.xlsx
[2] CalValPlan_Vol2_L2_v1-1-draft-redlines_inc-ERB_comments_v2a - Clean - BobEdits.docx
[3] GOES-R Functional and Performance Specification
[4] GOES-R AWG Product Validation Tool Development: DMW
[5] GOES-R Series Ground Segment Project Algorithm Change Management Plan
[6] GOESR-CVCT-PLPT_BriefingToNOAA-IAC_2015-02-03_FINAL.pptx
[7] Derived Motion Winds_Validation_Table_v2_rico2.docx
[8] GOES-R_ABI_ATBD_Validation_Tools_/DMW_Ver1.0.docx

A. Appendix A: Validation Events

A.1 PLPT Events that Support Beta Maturity

The support lead for all events will be Jaime Daniels and the analyst support team will be composed of Wayne Bresky, Andy Bailey, Americo Allegrino and Steve Wanzong.

A.1.1 Event Name: ABI-FD_DMW01/08/15

Objective: validate that product is generated with correct Image Triplet (with image interval every 15 min) and distributed using Band 2 every hour/15 min/5 min of the day for every FD/CONUS/mesoscale containing some daylight.
Start Time: start of PLPT.
Duration: 1 week.
ABI Mode: Mode 3.
GOES-R Data Type(s): FD/CONUS/mesoscale at the cadence as shown in Table 1.
Beta Success Criteria: correct Image Triplet used and product generated in cloudy areas and falls within expected measurement range.
Dependencies: availability and quality of an ABI Band 2 Image Triplet (FD/CONUS/mesoscale) that contains some daylight; availability and quality of cloud mask, cloud type, and cloud top pressure.
Monitoring and Analysis Method: product inspection using Band 2 – Use of collocation tools and statistical analysis.

A.1.2 Event Name: ABI-FD_DMW02/09/16

Same as ABI-FD_DMW01 except for:
Objective: validate that product is generated with correct Image Triplet (with image interval every 15 min) using Band 7 every hour/15 min/5 min of the day for every FD/CONUS/mesoscale containing some nighttime.
GOES-R Data Type(s): FD/CONUS/mesoscale at the cadence as shown in Table 1.
Dependencies: availability and quality of an ABI Band 7 Image Triplet (FD/CONUS/mesoscale) that contain some nighttime; availability and quality of cloud mask, cloud type, and cloud top pressure.
Monitoring and Analysis Method: product inspection using Band 7 – Use of collocation tools and statistical analysis.

A.1.3 Event Name: ABI-FD_DMW03/10/17

Same as ABI-FD_DMW01 except for:
Objective: validate that product is generated with correct Image Triplet (with image interval every 15 min) in cloudy areas using Band 8 every hour/15 min/5 min of the day for every FD/CONUS/mesoscale.
GOES-R Data Type(s): FD/CONUS/mesoscale at the cadence as shown in Table 1.
Dependencies: availability and quality of an ABI Band 8 Image Triplet (FD/CONUS/mesoscale); availability and quality of cloud mask, cloud type, and cloud top pressure.
Monitoring and Analysis Method: Inspection of DMW product using Band 8 - Use of collocation tools and statistical analysis.

A.1.4 Event Name: ABI-FD_DMW04/11/18

Same as ABI-FD_DMW01 except for:

Objective: validate that product is generated with correct Image Triplet (with image interval every 30 min) in cloud-free areas using Band 8 every hour/15 min/5 min of the day for every FD/CONUS/mesoscale.
GOES-R Data Type(s): FD/CONUS/mesoscale at the cadence as shown in Table 1.
Beta Success Criteria: correct Image Triplet used and product generated in cloud-free areas and falls within expected measurement range.
Dependencies: availability and quality of an ABI Band 8 Image Triplet (FD/CONUS/mesoscale); availability and quality of cloud mask, cloud type, and cloud top pressure.
Monitoring and Analysis Method: ABI Band 8 Image Triplet (FD) every hour – Use of collocation tools and statistical analysis.

A.1.5 Event Name: ABI-FD_DMW05/12/19

Same as ABI-FD_DMW04 except for:
Objective: validate that product is generated with correct Image Triplet (with image interval every 30 min) in cloud-free areas using Band 9 every hour/15 min/5 min of the day for every FD/CONUS/mesoscale.
GOES-R Data Type(s): FD/CONUS/mesoscale at the cadence as shown in Table 1.
Dependencies: availability and quality of an ABI Band 9 Image Triplet (FD/CONUS/mesoscale); availability and quality of cloud mask, cloud type, and cloud top pressure.
Monitoring and Analysis Method: inspection of DMW product using Band 9 – Use of collocation tools and statistical analysis.

A.1.6 Event Name: ABI-FD_DMW06/13/20

Same as ABI-FD_DMW04 except for:
Objective: validate that product is generated with correct Image Triplet (with image interval every 30 min) in cloud-free areas using Band 10 every hour/15 min/5 min of the day for every FD/CONUS/mesoscale.
GOES-R Data Type(s): FD/CONUS/mesoscale at the cadence as shown in Table 1.
Dependencies: availability and quality of an ABI Band 10 Image Triplet (FD/CONUS/mesoscale); availability and quality of cloud mask, cloud type, and cloud top pressure.
Monitoring and Analysis Method: inspection of DMW product using Band 10 – Use of collocation tools and statistical analysis.

A.1.7 Event Name: ABI-FD_DMW07/14/21

Same as ABI-FD_DMW04 except for:
Objective: validate that product is generated with correct Image Triplet (with image interval every 15 min), in cloudy areas using Band 14 every hour/15 min/5 min of the day for every FD/CONUS/mesoscale.
GOES-R Data Type(s): FD/CONUS/mesoscale at the cadence as shown in Table 1.
Beta Success Criteria: correct Image Triplet used and product generated in cloudy areas and falls within expected measurement range.
Dependencies: availability and quality of an ABI Band 14 Image Triplet (FD/CONUS/mesoscale); availability and quality of cloud mask, cloud type, and cloud top pressure.
Monitoring and Analysis Method: inspection of DMW product using Band 14 – Use of collocation tools and statistical analysis.

A.1.8 Event Name: ABI-FD_DMW22/29

Same as ABI-FD_DMW01 except for:
Objective: validate that product is generated with correct Image Triplet (with image interval every 5 min), using Band 2 every 15 min of the day for every FD/CONUS containing some daylight.

ABI Mode: Mode 4.
Beta Success Criteria: correct Image Triplet used and product generated and falls within expected measurement range for both cloudy and cloud-free.
Dependencies: availability and quality of an ABI Band 2 Image Triplet (FD/CONUS) every 15 minutes that contains some daylight; availability and quality of cloud mask, cloud type, and cloud top pressure.
Monitoring and Analysis Method: product inspection using Band 2 – Use of collocation tools and statistical analysis.

A.1.9 Event Name: ABI-FD_DMW23/30

Same as ABI-FD_DMW01 except for:
Objective: validate that product is generated with correct Image Triplet (with image interval every 5 min), using Band 7 every 15 min of the day for every FD/CONUS containing some nighttime.
ABI Mode: Mode 4.
Beta Success Criteria: correct Image Triplet used and product generated and falls within expected measurement range for both cloudy and cloud-free.
Dependencies: availability and quality of an ABI Band 7 Image Triplet (FD/CONUS) every 15 minutes that contains some nighttime; availability and quality of cloud mask, cloud type, and cloud top pressure.
Monitoring and Analysis Method: product inspection using Band 7 – Use of collocation tools and statistical analysis.

A.1.10 Event Name: ABI-FD_DMW24/31

Same as ABI-FD_DMW01 except for:
Objective: validate that product is generated with correct Image Triplet (with image interval every 5 min), in cloudy areas using Band 8 every 15 min of the day for every FD/CONUS.
ABI Mode: Mode 4.
Dependencies: availability and quality of an ABI Band 8 Image Triplet (FD/CONUS) every 15 minutes; availability and quality of cloud mask, cloud type, and cloud top pressure.
Monitoring and Analysis Method: product inspection using Band 8 – Use of collocation tools and statistical analysis.

A.1.11 Event Name: ABI-FD_DMW25/32

Same as ABI-FD_DMW04 except for:
Objective: validate that product is generated with correct Image Triplet (with image interval every 30 min), in cloud-free areas using Band 8 every 15 min of the day for every FD/CONUS.
ABI Mode: Mode 4.
Beta Success Criteria: correct Image Triplet used and product generated and falls within expected measurement range for cloud-free areas.
Dependencies: availability and quality of an ABI Band 8 Image Triplet (FD/CONUS) every 15 minutes; availability and quality of cloud mask, cloud type, and cloud top pressure.
Monitoring and Analysis Method: product inspection using Band 8 – Use of collocation tools and statistical analysis.

A.1.12 Event Name: ABI-FD_DMW26/33

Same as ABI-FD_DMW04 except for:
Objective: validate that product is generated with correct Image Triplet (with image interval every 30 min), in cloud-free areas using Band 9 every 15 min of the day for every FD/CONUS.
ABI Mode: Mode 4.

Dependencies: availability and quality of an ABI Band 9 Image Triplet (FD/CONUS) every 15 minutes; availability and quality of cloud mask, cloud type, and cloud top pressure.
Monitoring and Analysis Method: product inspection using Band 9 – Use of collocation tools and statistical analysis.

A.1.13 Event Name: ABI-FD_DMW27/34

Same as ABI-FD_DMW04 except for:
Objective: validate that product is generated with correct Image Triplet (with image interval every 30 min), in cloud-free areas using Band 10 every 15 min of the day for every FD/CONUS.
ABI Mode: Mode 4.
Dependencies: availability and quality of an ABI Band 10 Image Triplet (FD/CONUS) every 15 minutes; availability and quality of cloud mask, cloud type, and cloud top pressure.
Monitoring and Analysis Method: product inspection using Band 10 – Use of collocation tools and statistical analysis.

A.1.14 Event Name: ABI-FD_DMW28/35

Same as ABI-FD_DMW04 except for:
Objective: validate that product is generated with correct Image Triplet (with image interval every 5 min), in cloudy areas using Band 14 every 15 min of the day for every FD/CONUS.
ABI Mode: Mode 4.
Dependencies: availability and quality of an ABI Band 14 Image Triplet (FD/CONUS) every 15 minutes; availability and quality of cloud mask, cloud type, and cloud top pressure.
Monitoring and Analysis Method: product inspection using Band 14 – Use of collocation tools and statistical analysis.

A.1.15 Event Name: ABI-FD_DMW36/43/50

Objective: assess accuracy and precision of DMW product generated using Band 2.
Duration: 5 weeks.
ABI Mode: Mode 3.
GOES-R Data Type(s): FD/CONUS/mesoscale every hour/15 min/5 min containing some daylight.
Beta Success Criteria: correct Image Triplet used and product meets MRD specifications for a limited (i.e., not seasonally representative) number of independent measurements. Product is ready for operational use.
Dependencies: availability and quality of an ABI Band 2 Image Triplet (FD/CONUS/mesoscale) every hour that contains some daylight; availability and quality of cloud mask, cloud type, and cloud top pressure.
Monitoring and Analysis Method: Use collocation tools and statistical analysis as described in section 5 to verify quantitatively the beta criteria have been met for band 2.

A.1.16 Event Name: ABI-FD_DMW37/44/51

Same as ABI-FD_DMW36 except for:
Objective: assess accuracy and precision of DMW product generated using Band 7.
GOES-R Data Type(s): FD/CONUS/mesoscale every hour/15 min/5 min containing some nighttime.
Dependencies: availability and quality of a correct ABI Band 7 Image Triplet used (FD/CONUS/mesoscale) every hour that contain some nighttime; Radiosonde winds, aircraft winds, NCEP GFS analysis winds; availability and quality of cloud mask, cloud type, and cloud top pressure.

Monitoring and Analysis Method: Use collocation tools and statistical analysis as described in section 5 to verify quantitatively the beta criteria have been met for band 7.

A.1.17 Event Name: ABI-FD_DMW38/45/52

Same as ABI-FD_DMW36 except for:
Objective: assess accuracy and precision of cloudy DMW product generated using Band 8.
GOES-R Data Type(s): FD/CONUS/mesoscale every hour/15 min/5 min.
Dependencies: availability and quality of a correct ABI Band 8 Image Triplet used (FD, CONUS, and mesoscale); availability and quality of cloud mask, cloud type, and cloud top pressure; availability of radiosonde winds, aircraft winds, and NCEP GFS analysis winds.
Monitoring and Analysis Method: Use collocation tools and statistical analysis as described in section 5 to verify quantitatively the beta criteria have been met for the cloudy DMW product using band 8.

A.1.18 Event Name: ABI-FD_DMW39/46/53

Same as ABI-FD_DMW36 except for:
Objective: assess accuracy and precision of clear-sky DMW product generated using Band 8.
GOES-R Data Type(s): FD/CONUS/mesoscale every hour/15 min/5 min.
Dependencies: availability and quality of correct ABI Band 8 Image Triplet used (FD, CONUS, and mesoscale); availability and quality of cloud mask, cloud type, and cloud top pressure; availability of radiosonde winds, aircraft winds, and NCEP GFS analysis winds.
Monitoring and Analysis Method: Use collocation tools and statistical analysis as described in section 5 to verify quantitatively the beta criteria have been met for the clear-sky DMW product using band 8.

A.1.19 Event Name: ABI-FD_DMW40/47/54

Same as ABI-FD_DMW36 except for:
Objective: assess accuracy and precision of clear-sky DMW product generated using Band 9.
GOES-R Data Type(s): FD/CONUS/mesoscale every hour/15 min/5 min.
Dependencies: availability and quality of a correct ABI Band 9 Image Triplet used (FD, CONUS, and mesoscale); availability and quality of cloud mask, cloud type, and cloud top pressure; availability of radiosonde winds, aircraft winds, and NCEP GFS analysis winds.
Monitoring and Analysis Method: Use collocation tools and statistical analysis as described in section 5 to verify quantitatively the beta criteria have been met for band 9.

A.1.20 Event Name: ABI-FD_DMW41/48/55

Same as ABI-FD_DMW36 except for:
Objective: assess accuracy and precision of clear-sky DMW product generated using Band 10.
GOES-R Data Type(s): FD/CONUS/mesoscale every hour/15 min/5 min.
Dependencies: correct ABI Band 10 Image Triplet used (FD, CONUS, and mesoscale); Radiosonde winds, aircraft winds, NCEP GFS analysis winds.
Monitoring and Analysis Method: Use collocation tools and statistical analysis as described in section 5 to verify quantitatively the beta criteria have been met for band 10.

A.1.21 Event Name: ABI-FD_DMW42/49/56

Same as ABI-FD_DMW36 except for:
Objective: assess accuracy and precision of DMW product generated using Band 14.
GOES-R Data Type(s): FD/CONUS/mesoscale every hour/15 min/5 min.

Dependencies: availability and quality of a correct ABI Band 14 Image Triplet used (FD, CONUS, and mesoscale); availability and quality of cloud mask, cloud type, and cloud top pressure; availability of radiosonde winds, aircraft winds, and NCEP GFS analysis winds.
Monitoring and Analysis Method: Use collocation tools and statistical analysis as described in section 5 to verify quantitatively the beta criteria have been met for band 14.

A.2 PLPT Events that Support Provisional Maturity

The support lead for all events will be Jaime Daniels and the analyst support team will be composed of Wayne Bresky, Andy Bailey, Americo Allegrino and Steve Wanzong.

A.2.1 Event Name: ABI-FD_DMW57/64/71

Objective: assess accuracy and precision of DMW product generated using Band 2.
Start Time: PLPT + 6 weeks, provisional will start immediately after PLT ends
Duration: 24 weeks.
ABI Mode: Mode 3.
GOES-R Data Type(s): FD/CONUS/mesoscale every hour/15 min/5 min containing some daylight.
Provisional Success Criteria: product meets MRD specifications over a large and wide but limited range of representative (except seasonally representative) conditions for the required mode as indicated below after A.2.21.
Dependencies: availability and quality of an ABI Band 2 Image Triplet (FD, CONUS, and mesoscale); availability and quality of cloud mask, cloud type, and cloud top pressure; availability of radiosonde winds, aircraft winds, and NCEP GFS analysis winds.
Monitoring and Analysis Method: Use collocation tools and statistical analysis as described in section 5 to verify quantitatively the provisional criteria have been met for band 2.

A.2.2 Event Name: ABI-FD_DMW58/65/72

Same as ABI-FD_DMW57 except for:
Objective: assess accuracy and precision of DMW product generated using Band 7.
GOES-R Data Type(s): FD/CONUS/mesoscale every hour/15 min/5 min containing some nighttime.
Dependencies: availability and quality of an ABI Band 7 Image Triplet (FD, CONUS, and mesoscale); availability and quality of cloud mask, cloud type, and cloud top pressure; availability of radiosonde winds, aircraft winds, and NCEP GFS analysis winds.
Monitoring and Analysis Method: Use collocation tools and statistical analysis as described in section 5 to verify quantitatively the provisional criteria have been met for band 7.

A.2.3 Event Name: ABI-FD_DMW59/66/73

Same as ABI-FD_DMW57 except for:
Objective: assess accuracy and precision of cloudy DMW product generated using Band 8.
GOES-R Data Type(s): FD/CONUS/mesoscale every hour/15 min/5 min.
Dependencies: availability and quality of an ABI Band 8 Image Triplet (FD, CONUS, and mesoscale); availability and quality of cloud mask, cloud type, and cloud top pressure; availability of radiosonde winds, aircraft winds, and NCEP GFS analysis winds.
Monitoring and Analysis Method: Use collocation tools and statistical analysis as described in section 5 to verify quantitatively the provisional criteria have been met the cloudy DMW product using band 8.

A.2.4 Event Name: ABI-FD_DMW60/67/74

Same as ABI-FD_DMW57 except for:
Objective: assess accuracy and precision of clear-sky DMW product generated using Band 8.
GOES-R Data Type(s): FD/CONUS/mesoscale every hour/15 min/5 min.
Dependencies: availability and quality of an ABI Band 8 Image Triplet (FD, CONUS, and mesoscale); availability and quality of cloud mask, cloud type, and cloud top pressure; availability of radiosonde winds, aircraft winds, and NCEP GFS analysis winds.
Monitoring and Analysis Method: Use collocation tools and statistical analysis as described in section 5 to verify quantitatively the provisional criteria have been met for the clear-sky DMW product using band 8.

A.2.5 Event Name: ABI-FD_DMW61/68/75

Same as ABI-FD_DMW57 except for:
Objective: assess accuracy and precision of clear-sky DMW product generated using Band 9.
GOES-R Data Type(s): FD/CONUS/mesoscale every hour/15 min/5 min.
Dependencies: availability and quality of an ABI Band 8 Image Triplet (FD, CONUS, and mesoscale); availability and quality of cloud mask, cloud type, and cloud top pressure; availability of radiosonde winds, aircraft winds, and NCEP GFS analysis winds.
Monitoring and Analysis Method: Use collocation tools and statistical analysis as described in section 5 to verify quantitatively the provisional criteria have been met for band 9.

A.2.6 Event Name: ABI-FD_DMW62/69/76

Same as ABI-FD_DMW57 except for:
Objective: assess accuracy and precision of clear-sky DMW product generated using Band 10.
GOES-R Data Type(s): FD/CONUS/mesoscale every hour/15 min/5 min.
Dependencies: availability and quality of an ABI Band 10 Image Triplet (FD, CONUS, and mesoscale); availability and quality of cloud mask, cloud type, and cloud top pressure; availability of radiosonde winds, aircraft winds, and NCEP GFS analysis winds.
Monitoring and Analysis Method: Use collocation tools and statistical analysis as described in section 5 to verify quantitatively the provisional criteria have been met for band 10.

A.2.7 Event Name: ABI-FD_DMW63/70/77

Same as ABI-FD_DMW57 except for:
Objective: assess accuracy and precision of DMW product generated using Band 14.
GOES-R Data Type(s): FD/CONUS/mesoscale every hour/15 min/5 min.
Dependencies: availability and quality of an ABI Band 14 Image Triplet (FD, CONUS, and mesoscale); availability and quality of cloud mask, cloud type, and cloud top pressure; availability of radiosonde winds, aircraft winds, and NCEP GFS analysis winds.
Monitoring and Analysis Method: Use collocation tools and statistical analysis as described in section 5 to verify quantitatively the provisional criteria have been met for band 14.

A.3 PLPT Events that Support Full Maturity

The support lead for all events will be Jaime Daniels and the analyst support team will be composed of Wayne Bresky, Andy Bailey, Americo Allegrino and Steve Wanzong.

A.3.1 Event Name: ABI-FD_DMW78/85/92

Objective: assess accuracy and precision of DMW product generated using Band 2.
Start Time: end of Provisional.

Duration: 36 weeks.
ABI Mode: Mode 3.
GOES-R Data Type(s): FD/CONUS/mesoscale every hour/15 min/5 min containing some daylight.
Full Success Criteria: product meets MRD specifications over a full range of conditions, including seasonal for at least a year for the required modes as indicated above after A.3.21.
Dependencies: availability and quality of an ABI Band 2 Image Triplet (FD, CONUS, and mesoscale); availability and quality of cloud mask, cloud type, and cloud top pressure; availability of radiosonde winds, aircraft winds, and NCEP GFS analysis winds.
Monitoring and Analysis Method: Use collocation tools and statistical analysis as described in section 5 to verify quantitatively the full validation criteria have been met for band 2.

A.3.2 Event Name: ABI-FD_DMW79/86/93

Same as ABI-FD_DMW78 except for:
Objective: assess accuracy and precision of DMW product generated using Band 7.
GOES-R Data Type(s): FD/CONUS/mesoscale every hour/15 min/5 min containing some nighttime.
Dependencies: availability and quality of an ABI Band 7 Image Triplet (FD, CONUS, and mesoscale); availability and quality of cloud mask, cloud type, and cloud top pressure; availability of radiosonde winds, aircraft winds, and NCEP GFS analysis winds.
Monitoring and Analysis Method: Use collocation tools and statistical analysis as described in section 5 to verify quantitatively the full validation criteria have been met for band 7.

A.3.3 Event Name: ABI-FD_DMW80/87/94

Same as ABI-FD_DMW78 except for:
Objective: assess accuracy and precision of cloudy DMW product generated using Band 8.
GOES-R Data Type(s): FD/CONUS/mesoscale every hour/15 min/5 min.
Dependencies: availability and quality of an ABI Band 8 Image Triplet (FD, CONUS, and mesoscale); availability and quality of cloud mask, cloud type, and cloud top pressure; availability of radiosonde winds, aircraft winds, and NCEP GFS analysis winds.
Monitoring and Analysis Method: Use collocation tools and statistical analysis as described in section 5 to verify quantitatively the full validation criteria have been met for the cloudy DMW product using band 8.

A.3.4 Event Name: ABI-FD_DMW81/88/95

Same as ABI-FD_DMW78 except for:
Objective: assess accuracy and precision of clear-sky DMW product generated using Band 8.
GOES-R Data Type(s): FD/CONUS/mesoscale every hour/15 min/5 min.
Dependencies: availability and quality of an ABI Band 8 Image Triplet (FD, CONUS, and mesoscale); availability and quality of cloud mask, cloud type, and cloud top pressure; availability of radiosonde winds, aircraft winds, and NCEP GFS analysis winds.
Monitoring and Analysis Method: Use collocation tools and statistical analysis as described in section 5 to verify quantitatively the full validation criteria have been met for the clear-sky DMW product using band 8.

A.3.5 Event Name: ABI-FD_DMW82/89/96

Same as ABI-FD_DMW78 except for:
Objective: assess accuracy and precision of clear-sky DMW product generated using Band 9.
GOES-R Data Type(s): FD/CONUS/mesoscale every hour/15 min/5 min.

Dependencies: availability and quality of an ABI Band 8 Image Triplet (FD, CONUS, and mesoscale); availability and quality of cloud mask, cloud type, and cloud top pressure; availability of radiosonde winds, aircraft winds, and NCEP GFS analysis winds.
Monitoring and Analysis Method: Use collocation tools and statistical analysis as described in section 5 to verify quantitatively the full validation criteria have been met for band 9.

A.3.6 Event Name: ABI-FD_DMW83/90/97

Same as ABI-FD_DMW78 except for:
Objective: assess accuracy and precision of clear-sky DMW product generated using Band 10.
GOES-R Data Type(s): FD/CONUS/mesoscale every hour/15 min/5 min.
Dependencies: availability and quality of an ABI Band 10 Image Triplet (FD, CONUS, and mesoscale); availability and quality of cloud mask, cloud type, and cloud top pressure; availability of radiosonde winds, aircraft winds, and NCEP GFS analysis winds.
Monitoring and Analysis Method: Use collocation tools and statistical analysis as described in section 5 to verify quantitatively the full validation criteria have been met for band 10.

A.3.7 Event Name: ABI-FD_DMW84/91/98

Same as ABI-FD_DMW78 except for:
Objective: assess accuracy and precision of DMW product generated using Band 14.
GOES-R Data Type(s): FD/CONUS/mesoscale every hour/15 min/5 min.
Dependencies: availability and quality of an ABI Band 14 Image Triplet (FD, CONUS, and mesoscale); availability and quality of cloud mask, cloud type, and cloud top pressure; availability of radiosonde winds, aircraft winds, and NCEP GFS analysis winds.
Monitoring and Analysis Method: Use collocation tools and statistical analysis as described in section 5 to verify quantitatively the full validation criteria have been met for band 14.

B. Appendix B: GOES-R and Validation Reference Data

B.1 Data Set #1: Radiosondes

Description: Radiosondes from the National Weather Service (NWS) Upper-air Observations Program (00 and 12 UTC).
Source: Man-Computer Interactive Data Access System (McIDAS) Abstract Data Distribution Environment (ADDE) server and NCEP prep BUFR files (locally stored and preprocessed), the server which contains this data is run by OSPO, and hereafter will be referred to as the "OSPO McIDAS ADDE server.
Storage Location: In house.
Point of Contact: Americo Allegrino, Wayne Bresky, Frank Tilley, and Dennis Keyser (NCEP).
Access Process: Copy from source.
Spatial Coverage: CONUS.
Temporal Coverage: Every 12 hours.
Contingency: None.

B.2 Data Set #2: Aircraft winds

Description: Aircraft winds (ACARS, AMDAR) (continuous).
Source: NCEP prep BUFR files (s4.ssec.wisc.edu).
Storage Location: NCEP prep BUFR.
Point of Contact: Americo Allegrino and Jim Jung.
Access Process: FTP – download from s4.ssec.wisc.edu.
Spatial Coverage: Global.
Temporal Coverage: Continuous.
Contingency: None.

B.3 Data Set #3: GFS wind analyses

Description: GFS analyses (00, 06, 12, and 18 UTC).
Source: NCEP (ftp.ncep.noaa.gov).
Storage Location: NCEP.
Point of Contact: NCEP.
Access Process: Download from ftp.ncep.noaa.gov.
Spatial Coverage: Global.
Temporal Coverage: Every 6 hours.
Contingency: None.

B.4 Data Set #4: Operational GOES-E Derived Motion Winds

Description: GOES-E Derived Motion Winds (hourly)
Source: OSPO McIDAS ADDE server.
Storage Location: In house.
Point of Contact: Wayne Bresky and Andy Bailey.
Access Process: NESDIS OSPO servers.
Spatial Coverage: NHEM, SHEM, and CONUS.
Temporal Coverage: Hourly.
Contingency: None.

B.5 Data Set #5: Operational GOES-W Derived Motion Winds

Description: GOES-W Derived Motion Winds (hourly).
Source: OSPO McIDAS ADDE server.

Storage Location: In house.
Point of Contact: Wayne Bresky and Andy Bailey.
Access Process: NESDIS OSPO server.
Spatial Coverage: NHEM, SHEM, and CONUS.
Temporal Coverage: Hourly.
Contingency: None.

C. Appendix C: Tools

C.1 Tool #1: run_GOESwind_matchs_unified_raob_netcdf.scrpt

Location: Local computers.
Description: Performs collocation (time and space) of L2+ wind products with reference/ground truth data (NWS radiosondes).
Developer: Americo Allegrino.
Development Schedule: Done.
Data Sets: Network Common Data Form (NetCDF) DMW data and radiosonde.
Data Dependencies: Availability of DMW and radiosonde data.
Testing Accomplished or Planned: 100%.
POC: Americo Allegrino.[6, 7]

C.2 Tool #2: prepbufr_ftp_matchups_netcdf.scrpt

Location: Local computers.
Description: Performs collocation (time and space) of L2+ wind products with reference/ground truth data (ACARS Aircraft wind observations).
Developer: Americo Allegrino.
Development Schedule: Done.
Data Sets: Aircraft data and NetCDF DMW data.
Data Dependencies: Availability of NetCDF DMW data and aircraft data (which is dependent on Wisconsin machine and pre-processing of aircraft data).
Testing Accomplished or Planned: 100%.
POC: Americo Allegrino.[6, 7]

C.3 Tool #3: run_wind_raob_catchup_stats_nomcidas.pscrpt

Location: Local computers
Description: Creates daily statistics, for different regions, using the GOES/Radiosonde Observation (RAOB) collocation file for a given date range.
Developer: Americo Allegrino.
Development Schedule: Done.
Data Sets: Collocation file.
Data Dependencies: Availability of matchup file which depends on the availability of DMW and reference data.
Testing Accomplished or Planned: 100%.
POC: Americo Allegrino.[6, 7]

C.4 Tool #4: stat.sh

Location: Local computers.
Description: Creates daily statistics using the GOES AMV/Aircraft collocation file for a given date range, channel number and region.
Developer: Americo Allegrino.
Development Schedule: Done.
Data Sets: Collocation file.
Data Dependencies: Availability of matchup file which depends on the availability of DMW and reference data.
Testing Accomplished or Planned: 100%.
POC: Americo Allegrino.[6, 7]

C.5 Tool #5: plot_gnuplot_wind_raob_statsv3.pscrpt

Location: Local computers.
Description: Reads daily statistics file and creates a time series plot or scatter plot using GNUPLOT functions.
Developer: Americo Allegrino.
Development Schedule: Done.
Data Sets: Statistics file.
Data Dependencies: Valid statistics file.
Testing Accomplished or Planned: 100% data.
POC: Americo Allegrino.[6, 7]

C.6 Tool #6: plot_nomcidas_wind_raob_stats.pscrpt

Location: Local computers.
Description: Reads daily statistics file and creates a time series plot or scatter plot using PGPLOT functions.
Developer: Americo Allegrino.
Development Schedule: Done.
Data Sets: Statistics file.
Data Dependencies: Valid statistics file.
Testing Accomplished or Planned: 100%.
POC: Americo Allegrino.[6, 7]

C.7 Tool #7: wndstat

Location: Local computers.
Description: Program which plots time series of selected parameters.
Developer: Wayne Bresky.
Development Schedule: Done.
Data Sets: Statistics file.
Data Dependencies: Valid statistics file.
Testing Accomplished or Planned: 100% data.
POC: Wayne Bresky.[6, 7]

C.8 Tool #8: winst1lev4

Location: Local computers.
Description: Program which constructs profiles of Root Mean Square Error (RMSE) and bias for a specified pressure ranges.
Developer: Wayne Bresky.
Development Schedule: Done.
Data Sets: Collocation file.
Data Dependencies: Valid collocation file.
Testing Accomplished or Planned: 95% with the remaining 5% completed with DOE data.
POC: Wayne Bresky.[6, 7]

C.9 Tool #9: hgterrplotrms

Location: Local computers.
Description: Constructs histogram of height differences for a specified pressure given a collocation file.
Developer: Wayne Bresky.
Development Schedule: Done.
Data Sets: Valid collocation file.

Testing Accomplished or Planned: 95% with the remaining 5% completed with DOE data.
POC: Wayne Bresky.[6,7]

C.10 Tool #10: motion5x5

Location: Local computers.
Description: A program for running the GOES-R winds algorithm on a single target scene. Program displays a variety of intermediate output in multiple X-windows.
Developer: Wayne Bresky.
Development Schedule: Done.
Data Sets: Middle image time area file, 2: L1b tracking files (brightness temperature or reflectance in HDF-4 format) and a L2+ cloud file (cloud top pressure, cloud type, cloud phase products in HDF-4 format).
Data Dependencies: Bands 2, 7, 8, 9, 10, and 14 and the availability of tracking and cloud files.
Testing Accomplished or Planned: 100%.
POC: Wayne Bresky[6,7].

C.11 Tool #11: hist_simple

Location: Local computers.
Description: A program for generating a histogram and scatter plot of two variables from the 300 word/record collocation file.
Developer: Wayne Bresky.
Development Schedule: Done.
Data Sets: The two RAOB McIDAS MD files are obtained from the NOAA/NESDIS/OSPO McIDAS ADDE server and the 300 word/record collocation file is the output of the collocation process within NOAA/NESDIS/Center for Satellite Applications and Research (STAR).
Data Dependencies: Bands 2, 7, 8, 9, 10, and 14 and availability of radiosonde files.
Testing Accomplished or Planned: 95% with the remaining 5% completed with DOE data.
POC: Wayne Bresky.[6, 7]

C.12 Tool #12: combff

Location: Local computers.
Description: A program for combining two satellite wind/radiosonde match files which enables one-to-one comparisons to measure impacts of a change to the satellite winds algorithm.
Developer: Wayne Bresky.
Development Schedule: Done.
Data Sets: 300 word/record RAOB/AMV collocation files.
Data Dependencies: Bands 2, 7, 8, 9, 10, and 14 and availability of radiosonde data.
Testing Accomplished or Planned: 95% with the remaining 5% completed with DOE data.
POC: Wayne Bresky.[7]

C.13 Tool #13: McIDAS-V

Location: Local computers.
Description: Open source, visualization and data analysis software package from the University of Wisconsin - Madison, Space Science and Engineering Center (SSEC).
Developer: SSEC.
Development Schedule: External tool available at STAR and OSPO.
Data Sets: L2+ data products.
Data Dependencies: Bands 2, 7, 8, 9, 10, and 14 and Derived Motion Wind products.
Testing Accomplished or Planned: N/A. This is a SSEC milestone, not an AWG specific milestone.

POC: McIDAS Users Group.[6, 7]

C.14 Tool #14: McIDAS-X

Location: Local computers
Description: Open source, visualization and data analysis software package from the University of Wisconsin - Madison, SSEC.
Developer: SSEC.
Development Schedule: External tool available at STAR and OSPO
Data Sets: L2+ data products.
Data Dependencies: Bands 2, 7, 8, 9, 10, and 14 and Derived Motion Wind products.
Testing Accomplished or Planned: N/A. This is a SSEC milestone, not an AWG specific milestone.
POC: McIDAS Users Group.[6, 7]

C.15 Tool #15: nestgfs

Location: Local computers.
Description: Compare NetCDF AMV output to GFS analysis data, and write out an independent match NetCDF file.
Developer: Steve Wanzong.
Development Schedule: Classic NetCDF files are supported. Framework and GOES-R Ground system support still need to be added.
Data Sets: Classic NetCDF match files.
Data Dependencies: Bands 2, 7, 8, 9, 10, and 14 and availability of GFS Analysis data.
Testing Accomplished or Planned: 30% with the remaining 70% completed with Framework and DOE data.
POC: Steve Wanzong

D. Appendix D: Acronyms

Acronym	Definition
AART	Algorithm Action Review Team
ABI	Advanced Baseline Imager
ACARS	Aircraft Communications Addressing and Reporting System
ADDE	Abstract Data Distribution Environment
ADR	Algorithm Discrepancy Report
AMDAR	Aircraft Meteorological Data Relay
AMV	Atmospheric Motion Vectors
AWG	Algorithm Working Group
BUFR	Binary Universal Form for the Representation of meteorological data
Cal/Val	Calibration and Validation
CCR	Configuration Change Request
CMI	Cloud and Moisture Imagery
CONUS	Continental United States
CWG	Calibration Working Group
DMW	Derived Motion Winds
DMWA	DMW Algorithm
DOE	Data Operations Exercise
F&PS	Functional and Performance Specification
FD	Full Disk
GFS	Global Forecast System
GOES	Geostationary Operational Environmental Satellite
GOES-E	GOES-East
GOES-R	GOES R-Series
GOES-W	GOES-West
GORWG	GOES-R Series Operational Requirements Working Group
GRB	GOES Rebroadcast
HRR	Handover Readiness Review
L1b	Level 1b
L2+	Level 2+
LZA	Local Zenith Angle
McIDAS	Man-computer Interactive Data Access System
McIDAS ADDE	McIDAS Abstract Data Distribution Environment
McIDAS MD	McIDAS Meteorological Data
MOST	Mission Operations Support Team
MRD	Mission Requirements Document
MSFC	Marshall Space Flight Center
N/S	North/South

Acronym	Definition
NASA	National Aeronautics and Space Administration
NCEI	National Centers for Environmental Information
NCEI-CO	NCEI - Colorado
NCEP	National Centers for Environmental Prediction
NESDIS	National Environmental Satellite, Data, and Information Service
NetCDF	Network Common Data Form
NHEM	Northern Hemisphere
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service
OSPO	Office of Satellite and Product Operations
PLAR	Post-Launch Assessment Review
PLPT	Post-Launch Product Test
PLT	Post-Launch Test
POC	Point of Contact
PRO	Product Readiness and Operations
PSE	Program System Engineering
PS-PVR	Peer Stakeholder-Product Validation Review
PUG	Product User's Guide
QA	Quality Assurance
RAOB	Radiosonde Observation
RIMP	Readiness, Implementation and Management Plan
RMSE	Root Mean Square Error
SHEM	Southern Hemisphere
SPOT	System Performance Operational Test
SSEC	Space Science and Engineering Center
STAR	Center for Satellite Applications and Research
TBD	To Be Determined
UTC	Universal Time Coordinated