DEVELOPMENT OF LEVEL 2 CALIBRATION AND VALIDATION PLANS FOR GOES-R; WHAT IS A RIMP?

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ABSTRACT

Calibration and Validation (Cal/Val) plans for Geostationary Operational Environmental Satellite version R (GOES-R) Level 2 (L2) products were documented via Resource, Implementation, and Management Plans (RIMPs) for all of the official L2 products required from the GOES-R Advanced Baseline Imager (ABI). In 2015 the GOES-R program decided to replace the typical Cal/Val plans with RIMPs that covered, for a given L2 product, what was required from that product, how it would be validated, and what tools would be used to do so. Similar to Level 1b products, the intent was to cover the full spectrum of planning required for the Cal/Val of L2 ABI products. Instead of focusing on step-by-step procedures, the RIMPs concentrated on the criteria for each stage of the validation process (Beta, Provisional, and Full Validation) and the many elements required to prove when each stage was reached.

Index Terms— Calibration, Validation, GOES-R, Cloud Mask

1. INTRODUCTION

The creation of the L2 RIMPs was a complex and dynamic process. The suite of L2 products required 18 separate L2 RIMPs guided by 4 lead authors who interacted with 12 different science leads from Satellite Applications and Research (STAR) along with GOES-R program personnel. Each L2 RIMP had to accommodate a fixed GOES-R validation schedule and GOES-R requirements. Furthermore there were conflicting documents on exactly what the standards were for validation, and hundreds of pre-existing Post Launch Product Tests (PLPTs) that also were to be addressed within the RIMPs. The L2 RIMPs were standardized to insure critical content such as the appropriate criteria for each stage, tools, schedule, processes, and the description of pre-existing Validation Events (VEs) were handled in a consistent manner.

Initial efforts determined the scope of the documents, and afterwards organized, coordinated, and developed the L2 RIMPs. Discrepancies were identified between the Functional and Performance Specification (F&PS) and the Product User's Guide (PUG), and measures to be used to validate each product were successfully established. Risks were identified throughout the development of the RIMPs and passed forward to the appropriate review boards. Interactions between the L2 products Cal/Val efforts had to be accounted for, especially in the case of the Clear Sky Mask (CSM), which is a necessary input to many L2 products. The CSM coordination and development is discussed in section 3.

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2. CLOUD AND MOISTURE IMAGERY (CMI)

Cloud and Moisture Imagery (CMI) was a special case, and followed the L1b schedule. Anticipation for GOES-R Imagery is high, and numerous pre-launch efforts have focused on being able to exploit this Imagery as soon as it becomes available (e.g. Greenwald et al [1]). For CMI, the only L2 Key Performance Parameter (KPP), a key challenge was the predominance of non-quantitative criteria. While certain aspects of CMI are quantitative, such as properly mapping the radiances from L1b, the primary purpose of CMI is the human identification of critical phenomena from sand storms to hurricanes to snow cover. Different users will search for different atmospheric and ground features depending on their location and event of interest, and the CMI products must accommodate them all. Hence the CMI RIMP described an extensive set of display tools that covered the breadth of interests across the user community. The CMI RIMP also had to accommodate the overarching schedule of when data would first be made available to users, since they could only contribute after such access occurred. This coordination was accomplished as part of the CMI RIMP development.

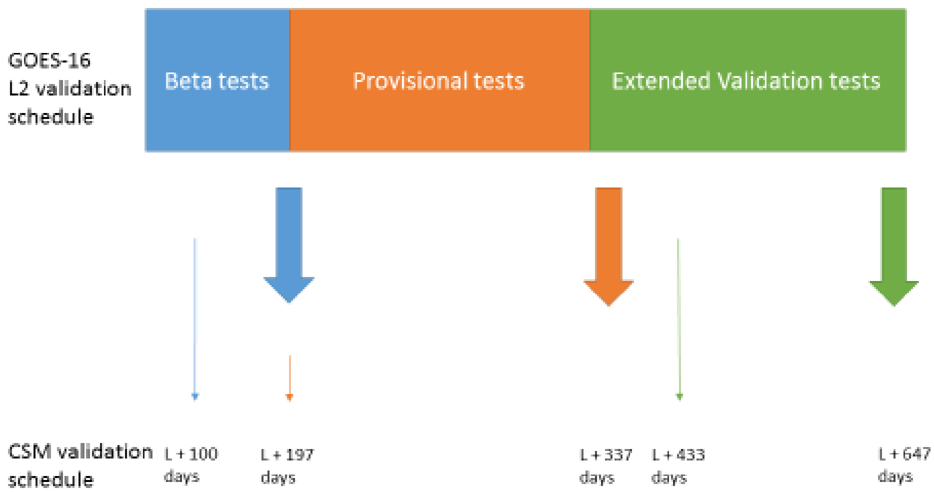

Figure 1: Schedule of the Clear Sky Mask (CSM) validation compared to the overarching schedule of L2 product validation. Large arrows represent the L2 schedule, thinner arrows are for the CSM. The CSM completes the provisional stage when the other L2 products complete beta.

3. CLEAR SKY MASK (CSM)

The CSM was an exceptional challenge since it impacted numerous other L2 products. Such challenges with cloud mask verification have occurred with other programs such as the Suomi National Polar-orbiting Partnership (SNPP) and described in Kopp et al [2]. Figure 1 shows the overall L2 validation schedule, and the completion dates set for the CSM. The CSM schedule had to account for all downstream dependencies, since all of the L2 products had to meet the schedule reflected in Figure 1. None of the dependent L2 products could finish validation without an acceptable CSM. Therefore the CSM completion date through Full Validation is a good 200 days before the end of formal validation activities. Each dependent product both influenced the CSM completion dates, and likewise were written to correspond with the expected availability, and accuracy, of the CSM. Therefore the resulting 18 L2 RIMPs are properly correlated with CSM progress and planning, with margin in case of unexpected events.

4. LOGISTICS FOR OTHER L2 RIMPS

Along with schedule coordination, synchronization between VEs and Post-Launch Product Tests (PLPTs) was accomplished for each of the L2 products. This was realized by breaking the 18 products into specific groups with common themes or dependencies. The most straightforward were the cloud products. These are created in a very specific chain of algorithms, as shown in Figure 2. The cloud product RIMPs were broken down based on this chain. Three cloud RIMPs cover nine different cloud products, which were grouped together based on their position in the chain and the similarity of the tools employed to prove validation. The exception is cloud phase, whose characteristics and validation techniques are more in line with those used for cloud optical parameters. The Cloud Optical Microphysical Properties (COMP) algorithms are significantly different for day and night, and they are treated as separate entities (DCOMP – Daytime, NCOMP – Nighttime) in the RIMPs. Figure 2 also shows the RIMPs that cover each cloud product.

Similar ideas were employed for land and aerosol products, though for these products each individual product retained its own RIMP. Since these algorithms did not run in a chain, it was appropriate to retain individual RIMPs. Volcanic ash was a more difficult case, since ash events vary widely over large time scales, and there is no guarantee of a significant ash event during the official Cal/Val period. The RIMP accounts for this possibility and the RIMP includes options to quantitatively show volcanic ash product performance even if no significant event occurs.

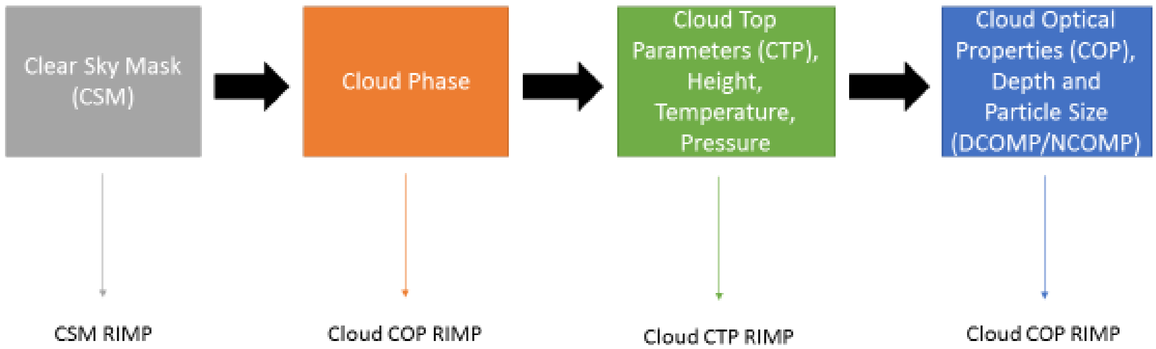

Figure 2: Simple schematic of the cloud product algorithm chain. The associated cloud RIMPs are below the algorithm/product, and the products are combined consistent with the algorithms that product them.

Although each L2 RIMP followed the same format, additional considerations were necessary for Derived Motion Winds (DMW) and Hurricane Intensity Estimation (HIE). In the case of DMW, it contained more than triple the number of PLPTs compared to any other L2 product. This proved unwieldly, and only after extensive discussion was a consolidation approach agreed to by all parties. The result retained all of the necessary and applicable PLPTs while avoiding an unduly lengthy and repetitive RIMP. For HIE the challenge was in describing correct quantitative criteria for what is an estimate by design. Nevertheless quantitative values were present in requirement documents and were incorporated into the HIE RIMP to provide an effective standard by which the various stages of validation may be met.

One item which consumed much discussion early in the L2 RIMP process was risks. Initial versions of each RIMP contained an explicit section for risk, which resulted in many duplicative descriptions of the same risk. Such risks included outdated algorithms, resource contention, the algorithm change process, and challenging schedules to attain the first validation stage (beta). Ultimately these risks were removed from the RIMPs and collected by the program to be adjudicated by the appropriate board(s). The end result was risks being removed from the L2 RIMPs, and any discovered during RIMP development were documented through another forum.

5. SUMMARY AND STATUS

GOES-R, now GOES-16, successfully launched on 19 November 2016. GOES-16 reached its testing position (e.g. GOES-Central) on 5 December and validation procedures are now underway, under the conditions described in the RIMPs.

The presentation will describe the overall structure of the L2 RIMPs, the details provided for each L2 RIMP, how different products and their internal and external dependencies were dealt with, and the issues overcome to complete the RIMPs before launch.

6. REFERENCES

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