

Proba – V 12th Quality Working Group (QWG): Summary Report

The 12th Proba-V QWG took place via WebEx on 27th - 28th Oct 2020

Participants:			
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Objectives of the meeting

The main discussion points for the QWG meeting #12 are recalled:

1. **Mission Status:** the operational phase was discontinued on 30 June 2020 to limit the impact of the orbital drift and the new experimental phase started on 1st July 2020 with focus on acquiring data over Africa and Europe together with ad-hoc acquisition campaigns. Flight and Ground Segment overall performances are excellent with no sign of degradation. During the meeting, the results of recent experimental campaigns such as Moon acquisitions and Super Resolution experiments will be reviewed. In terms of data quality, the radiometric and geometric accuracy are largely within the mission goals requirements also looking at the independent assessment over Libya-4 performed by Rayference that demonstrated an excellent accuracy within the 3%.
2. **Mission Experimental phase:** we are working to move towards the operations and exploitations of the Proba-V Companion Cubesat (PV-CC) to progressively complement and expand Proba-V observation capabilities addressing new application domains and exploring the constellation concept. The initial schedule has drifted due to shift in launch date of 1st PV-CC (VNIR), currently set during Aug-Nov 2021. The exploitation plan will be re-discussed in view of different overpasses and extreme SZA conditions at the PV-CC launch. The Cal Val plan will take into account the methods and tools already developed at VITO for Proba-V.
3. **Algorithm baseline for C2:** the development and validation of the NN cloud screening are completed, the results are clearly showing a significant improvement with respect to C1, the relevant module is ready for processing. The development of the new AC scheme is on-going with the prototype and TDS provided to VITO and successfully integrated in the PDGS. The assessment of the best AOD climatology will be the key discussion of the meeting to define the remaining validation activities in order to reach conclusive results and freeze the final baseline. The provisional timeline for the C2 reprocessing will be presented by VITO and discussed within the QWG together with the potential evolution of the C3 baseline.
4. **Continuity:** the transition from Proba-V to S3 at CGLS, originally planned on 1st July 2020, was delayed due to issues in the operational processing chain, it is currently on-going starting from NDVI at 300m. The status of planned upgrade on SYN-VGT branch will be reviewed and the results on consistency assessment of S3 SYN-VGT against Proba-V will be presented by VITO during the meeting.

Flight and Ground Segment Status

The overall performances of the platform and sensor are excellent and very stable with platform availability between 98,1% and 99.9% for the last 9 months. All performance parameters are well within the requirements, the system is very stable with no sign of degradation.

The Flight Segment status is reviewed, here below the main indicators:

- **LTDN predictions:** 09:11 AM are reached in October 2020, as expected
- **Platform Status:** during this period, the platform was very stable. No on-board failure, both primary and redundant chains available

The main activities on the platform are summarized here below:

- **Transition to Proba-V Experimental Phase:** the activity started in July 2020, the new LSM was uploaded on 30 June 2020 to perform the acquisition over Africa and Europe. On 13 July 2020, an updated LSM was uploaded to remove the acquisition over the poles to solve a mass memory overwriting issue.

- *On-request acquisitions*: until the launch of PV-CC, planned for August 2021, the focus will be on systematic acquisitions with emphasis on 100m over Africa and Europe and on-request acquisitions for Cal/Val and Science purposes. The first Moon-Imaging campaign is on-going and will cover the period from 23 Oct to 03 Nov, some improvement is required on the SW to automate the planning of moon calibrations above 30 degree after full moon. The first Super Resolution experiment was performed on 22 October over Amazonia, the next acquisition should be planned in agreement with REDU and QINETIQ
- *AOCS*: pointing performance is far better than the requirements
- *Power Budget*: largely positive and stable
- *Thermal performances*: the optical bench thermal variation is $\sim 1.50\text{C}$ per day, confirming the excellent thermal performances of radiator and optical bench
- *Decompression errors*: the number of decompression errors is currently low. VITO has performed a better classification of the error events that contains a split between the impact of geometric and decompression errors on the daily products. The catalogue should be updated to consider the experimental phase with reduced LSM.
- *Ground segment status*: the satellite and ground segment operations are running nominally.

Radiometric and Geometric calibration

The **absolute location accuracy** is presented for the year 2020 and shows an average ALE of ~ 70 m. The long-term analysis of the inter-band accuracy is very good and within the requirements. The inter-band errors per spectral bands are always below 70m for the three cameras. The **multitemporal accuracy** for the period from 1st July 2020 until the present is well within the specifications with about 85% of compliance to the requirement for the VNIR bands and 94% for the SWIR, despite of the low multitemporal statistic. Finally, it is demonstrated the excellent Proba-V multitemporal stability, by showing in a temporal sequence the same tile for some selected regions.

The **long-term radiometric accuracy and multi-temporal stability** analysed by Rayference Libya-4 Cal/Val site, showed a very accurate Proba-V calibration except for the BLUE band and left camera, where deviations are in the order of 4-5%. In addition, the polar plots showed a dependency on azimuthal configuration that may point to potential polarization sensitivity. VITO investigated these results and presented in detail the outcomes from this analysis together with the study on the potential impact of polarization sensitivity in this band. An assessment of a possible resulting upgrade in the ICP file for C2 is also introduced. In detail, the BLUE TOA reflectance is found to be about 1,2% lower than MODIS AQUA band 9 TOA reflectance probably due to the absolute bias and the degradation of BLUE response not fully corrected in C1.

Concerning the inter-camera biases, the difference of mean reflectance in the desert overlap region between LEFT and CENTER cameras was estimated and no significant larger difference for the left camera was found. The polarization sensitivity is an interesting topic that needs to be further explored, no conclusive results were reached yet in the analysis, though the larger discrepancies observed with Rayference model were not confirmed.

The **degradation model** was applied in C1 since May 2017 and the biases were re-evaluated looking at the reprocessed scenes: the correction for overall bias should be $\sim 1\%$ with an extra correction of $\sim 0.7-1\%$ for LEFT BLUE to correct the inter-camera bias. The long-term vicarious calibration results from the previous QWG showed an increasing trend depending on temperature change, camera and band dependent that is not considered in the ICP files. The proposed solution on how to correct it in the C2 reprocessing is to apply a second-degree polynomial model. The preliminary results are showed for the CENTER camera: the RED and NIR trends are well corrected for by degradation model whereas the BLUE trend is corrected until ~ 1500 days since launch. More detailed analysis of the considered scenes, especially in terms of cloud contamination, for the BLUE degradation trending is then needed in order to consolidate the final ICP files for C2.

Algorithm Baseline Definition for C2

The final **NN cloud-screening algorithm** at 100m, 333m and 1Km is completed. The model was trained at University of Valencia, implemented at VITO and validated by Brockmann Consult. The final implemented prototype is a single global NN model that does not require ancillary data and multitemporal information. The C2 cloud detection results are far better than C1 and show a good consistency at all scales.

As next step is presented the idea to reuse the cloud detection trained on Proba-V data directly to PV-CC data. The **transfer learning approach** was already demonstrated successful starting from Landsat data and published in a paper. The main advantage of this method is that a cloud mask can be trained prior to mission actual operations, therefore allowing to be ready since the PV-CC launch with a reasonably accurate cloud mask trained from Proba-V mission. Moreover, the use of domain adaptation methods for assessing/validating radiometric consistency of two complementary sensors will be first tested for Proba-V and S3 SYN-VGT data.

The **AC** remains a critical part of the algorithm baseline considering its impact on the data quality. In the next months, the validation exercise will be further expanded finalizing the comparison exercise over all selected AERONET sites and including a much larger ensemble of aerosol mixtures and the CAMS dataset to derive the AOD climatology. The objective is to reach conclusive results to be compared with C1 and freeze the final baseline in view of C2 reprocessing.

The **reprocessing baseline** was presented and agreed, the campaign will start during Jan 2021 for 6 months duration, first delivery of 1-year data for CGLS will be granted already during Q1 2021, data will be disclosed to users in Sep 2021 after a full mission validation exercise. A potential list of upgrades to be considered in future C3 baseline is discussed and the possibility to harmonize the SPOT-VGT/PV/S3 LTDR is considered. To this end the LTDP project could be an interesting way forward as an alternative solution to the possible budget constraints. Other options were also gathered during the meeting and will be further consolidated during future QWG.

Mission Experimental Phase

During the meeting, several technical aspects related to the data quality assessment (radiometry, geometry and cross-calibration) were discussed with the purpose to define the **Cal/Val and Exploitation strategy for the Proba-V + PV-CC missions**. The development of PV-CC, in particular of the PDGS and calibration chain will be closely followed in the frame of dedicated coordination meetings between ESA/VITO/ASL. The first draft Cal/Val and Exploitation Plan will be issued by VITO in January 2021 and shared with the QWG for comments. The question on how to best exploit Proba-V beyond 2021 remains, considering the **evolution of the orbital drift** and the consequent increase of the SZA. The projected evolution of SZA shows that a time window with acceptable illumination conditions, especially for the eastward camera, will be present during the 2011 SH summertime and in 2012 NH summertime.

The feedback on the **special acquisitions** are reported:

Super resolution experiment: the acquisition was performed on 22 Oct 2020 over the Amazonian site turning the platform of 45o and reaching 75 m as effective resolution. The cloud coverage was good, and the data were processed up to L1A level. It is discussed on the possibility to change the test site to have more land features and select different rotation angles to obtain better spatial resolutions. In addition, the processing should be executed up to TOA products. The team from ESTEC should be involved in the loop of these next evolutions.

Lunar calibration acquisition: the acquisition is on-going from 23 Oct to 3 Nov, the first acquisition was performed with 90o phase angle, the next ones will have decreasing angles of 80o and 70o. The acquisition of the full cycle was limited by a constraint in the used SW, an action is already traced to QS in order to update the SW and complete the cycle in the range 30-85 degrees. The data will be used in order to validate the ESA Lunar model LIME, which is currently under finalization in the frame of another ESTEC project.

Continuity

From 1st July 2020 all NRT production of **biophysical variables** was expected to **switch to S3**, although the transition was delayed due to issues in the processing chain. Now the first set of biophysical variables, including NDVI, LAI, FAPAR, DMP, BA is ready and will be reprocessed starting from July 2020. This first set of products is still in demo mode with limited commitment on quality, in parallel a thorough assessment of their quality is on-going; as soon as it will be completed the data will be delivered as operational products. On VITO side, **consistency assessment of S3 SYN-VGT** data is on-going and some issues were presented and will be considered in the frame of S3 MPC. The current SYN-VGT quality doesn't ensure **continuity to the SPOT-VGT and Proba-V** data series yet, although upgrades are planned within the MPC to cure some of the remaining issues, in particular a bug in NDVI computation. The results will be further presented and discussed in the frame of S3VT Meeting.