Proba – V 15th Quality Working Group (QWG): Summary Report

The 16th Proba-V QWG took place as hybrid event at VITO (Mol) and via Microsoft Teams on 22th - 23th March 2023

Partecipants:			
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Objectives of the meeting

The main topics of the meeting are recalled with the main discussion points:

- *Mission Status and Calibration:* since end of Proba-V Experimental Phase (October 2021) the vegetation instrument was switched to standby mode and limited maintenance calibration segments are acquired with the aim of monitoring the temporal stability of the sensor and the instruments' health status. The number of planned calibrations is limited by the downlink constraints although few X-band passes per month were added since summer 2022 to acquire over Gobabeb site. Currently following acquisitions are planned for monitoring purposes: a) acquisitions over the two RadCalNet sites (Railroad Valley Playa - USA and Gobabeb - Namibia) to assess the radiometric absolute calibration and the geometric performances as well as the temporal stability; b) Dark Current monitoring to monitor temperature increase in the optical bench mainly due to the instrument ageing and orbital drift effects; c) Lunar acquisitions on a monthly basis to gather valuable data in support of the validation of ESA Lunar Irradiance Model (LIME). During the meeting these calibrations activities will be reviewed also considering the current platform status presented by REDU and its impacts on the acquisitions results.

- *Collection 2 and Collection 3*: the full Proba-V C2 reprocessing is now completed, and a detailed Validation Report has been provided by VITO to the QWG. The C2 TOC products were certified as CEOS-ARD compliant and endorsed by CEOS-Land Surface Imaging Virtual Constellation and CEOS Working Group on Calibration & Validation. The overall accuracy has largely improved with respect to C1, namely: C2 shows more clear observations than in C1 at all resolutions and the C1 issues related to the dependency of cloud masking on the latitude are solved. The differences between C1 and C2 at TOA level are small whereas larger bias is observed at TOC level in the BLUE and RED bands over densely vegetated areas where the observed C2 NDVI is lower. Finally high correspondence between SPOT-VGT and Proba-V is observed for both collections as well as a strong correspondence of C2 NDVI with MetOp/AVHRR (EUMETSAT Satellite Application Facility on Land Surface Analysis/LSA-SAF) ENDVI10 and MODIS MOD13A3 NDVI time series. First feedback on C2 will be provided by UCL as first user of the collection and analyzed within the QWG. During the meeting the endorsement of the release of C2 data to the users will be discussed as well as the preparation of the future C3 baseline. The C3 reprocessing activity will be conducted as part of the FDR4VGT project with the main objective to ensure a consistent and harmonized LTDR of TOA L1C products from VGT1/VGT2/PV 20+ years archive.

- *Continuity*: several progresses were made during 2022 to enhance the consistency of Proba-V and S3 SYN-VGT, although some quality issues and large discrepancies in the historical mission data for the 2020-2022 period remain and require a full reprocessing of the archive to obtain a consistency in the VGT-PV-S3 LTDR. The CGLS biophysical products processing chain switched to S3 and the analysis on S3-Proba-V derived products shown a good quality and overall temporal and spatial consistency.

- *Proba-V Companion Cubesat:* the PV-CC launch was delayed due to Vega-C failure, the current launch schedule is set for end of summer 2023 and the commission phase is planned to last three months. The first objective of this IOD is to verify that the in-orbit performances of such small Cubesat are comparable to those of bigger platforms, this IOD will be key to set the ground of future potential constellation for increasing the revisit time. The PV-CC Cal/Val plan is well consolidated and widely discussed within the QWG, the focus will be on the reuse of Proba-V know-how and its infrastructure and on RadCalNet and S2-cross-over as benchmark for radiometry and geometry. During the meeting the proposal on a synergistic exploitation in combination with Sentinel-2 will be discussed and the PV-CC revisit time and global coverage analysed for data exploitation purposes.

Flight and Ground Segment Status

The vegetation instrument was switched to standby mode on 31 October 2021 and a minimum amount of calibration activities were planned during this phase to monitor the instrument performances stability.

The nominal planning currently includes: the lunar acquisitions since November 2021 to provide reference data for the validation of ESA LIME model and the Energetic Particle Telescope (EPT) measurements that will continue at least for the next 3 years to complete the current solar cycle.

The overall platform status is nominal, the power budget is positive and very stable, the thermal status showed an increase in overall temperature from mid-December 2022 due to increasing illumination of the spacecraft. The current Proba-V orbit is in fact close to a down/dusk orbit with no eclipse. To mitigate this effect and maintain a good thermal stability a strategy based on a new spacecraft attitude profile was implemented. This new scenario, implemented at REDU since Dec 2022 was successful in decreasing the temperature, although the drop in temperature is larger than expected and the payload is now experiencing very cold thermal environment. This new condition seems to impact the radiometric and geometric performances of the VGT sensor and could have an effect on the EPT sensor as well.

VITO in collaboration with REDU will investigate how to refine the new attitude approach to limit any side effects in the payloads. On the other hand, the impact of such strong thermal gradients on the VGT performances is interesting in preparation to PV-CC, which is expected to be subject to strong thermal instability.

Radiometric and Geometric calibration

The analysis of the calibration measurements acquired over RadCalNet sites in the last months has shown the strong impact of the orbital drift. Specifically, there is now a large temporal mismatch between Proba-V and RadCalNet measurements, since the current Proba-V overpass is around 7:30AM, while RadCalNet data are acquired starting from 9:00 AM. This temporal mismatch, together with the very poor illumination conditions of Proba-V acquisitions, strongly limit the usability of these measurements for radiometric calibration purposes. After internal discussion, it was agreed to further perform some calibration tests over Gobabeb site, using the eastward camera, which is looking towards the sun direction at later overpass time (the gain in overpass time is expected to be in the range of 20 min. In general, calibration acquisitions, in particular the lunar ones, shall be continued until the end of the PV-CC commissioning phase, since they can be of value for assessing the radiometric quality of PV-CC.

Collection 2 and Collection 3

The full Proba-V C2 reprocessing is completed, and a detailed Validation Report has been provided by VITO to the QWG. The C2 TOC products were certified as CEOS-ARD compliant and endorsed by CEOS-LSI-VC and CEOS-WGCV level.

The overall accuracy has largely improved as compared to C1, in particular in terms of cloud screening. The C2 shows much larger number of "good" clear pixels, which will benefit the downstream applications. Small differences are observed between C2 and C1 at TOA level due to the updates of ICP files, whereas big differences are observed at TOC level due to the different AC algorithm. Lower NDVI values have been found in C2, this effect is mostly evident in case of dense vegetation cover. Overall, the C2 shows a very good agreement with the considered benchmark datasets, including SPOT-VGT, AVHRR and MODIS data. Feedback on C2 were provided from UCL that reported an overall great improvement on the TOC data quality, although some artefacts were identified in few products. A quick check during the meeting has confirmed that these artefacts are induced by high AOD values in the input MERRA-2 data. The list of affected products will be provided to the users in a disclaimer associated to the C2 data release and actions will be taken to reprocess the affected segments.

The preparation of the future C3 baseline was extensively discussed. The reprocessing activity will be carried out in the frame of the FDR4VGT project with the main objective to ensure a consistent and harmonised LTDR of TOA L1C products from VGT1/VGT2/PV 20+ years archive. The first phase (2023-2025) of the project, expected to start in Q2/Q3 2023, will foresee the development of the prototype SW together with the assessment of inter-sensors biases and the estimation of the uncertainties at pixel. In phase 2 (2025-2027), the algorithm will be integrated in the processing infrastructure at VITO for the full reprocessing and a validation at global scale over the full archive will be performed.

Proba-V Companion Cubesat (PV-CC)

The PV-CC launch was delayed due to Vega-C failure, the schedule is set for the end of summer 2023 and the commissioning phase will last 3 months. At the time of IOCR the infrastructure will be successfully installed at REDU premises to be ready for operational phase (E2 operations REDU/ASL).

The PV-CC orbit is fixed by the launcher and the foreseen altitude of 564 Km will guarantee a revisit time over selected locations of few days and a global full coverage in about 40 days. This could be a limitation and some mitigation solutions are presented, in particular the use of the aerobraking manoeuvre to lower progressively the orbit. The adoption of this

manoeuvre was discussed and the QWG discourages this approach, since the associated risks are not fully known, and the added value is still to be demonstrated.

VITO presented the PV-CC PDGS status with related timeline and the outcomes of the SVT-3. The Cal Val plan is well consolidated and will largely relies on the lessons learnt and tools developed for Proba-V, additionally using cross-over with S2 to assess the radiometric and geometric accuracy and the systematic use of RadCalNet. The University of Valencia is contributing significantly to the PV-CC data exploitation by suggesting opportunities to implement a cloud masking and atmospheric correction approach for PV-CC based on AI. These methods will be tested during the commissioning phase and could provide an alternative algorithm baseline for the L2 processing algorithm for PV-CC.

Continuity and Consistency

Several progresses were made during 2022 to enhance the consistency of Proba-V and S3 SYN-VGT, although some quality issues remain and the discontinuity in the series of NDVI is very clear at the onset of the S3 mission. Consistency improved only with the last version of the IPF deployed in 2022 and it is expected to further improve with the upcoming version of the algorithm, to be implemented in summer 2023. Nevertheless, the strong discontinuity with the VGT/PV series is currently preventing the use of the SYN-VGT products for long-term analysis and it could be corrected only with a full mission reprocessing of the S3 archive, since the launch of S3B. The possibility to support this reprocessing was discussed during the meeting and a parallel discussion is already on-going in the frame of OPT-MPC and at ESA and EC level. In order to strengthen the argument for the reprocessing, we need to demonstrate the value of the SYN-VGT products as continuity to the VGT and PV 20+ years archive. This includes finding some strong use cases that further show how the SYN-VGT products can be used in combination with the Vegetation archive.