Proba – V 10th Quality Working Group (QWG): Summary Report

The 10th Proba-V QWG took place in Antwerp on 23th - 24th Oct, 2019

Partecipants:			
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Objectives of the meeting

The main discussion points for the QWG meeting #10 are recalled:

1. *Mission Status:* the FS and GS status after more than 6 years in space is excellent and all initial mission requirements were successfully met and largely exceeded. During the meeting the review of current mission performances will focus on calibration and on the assessment of impact of the special acquisitions performed during summer 2019 in order to prepare the experimental scenarios for the mission extension.
2. *Mission extension*: the extension strategy agreed at the previous QWG Meetings and approved at PB-EO will be recalled. The main focus of discussion will be to refine and prepare extension scenario, discussing on exploitation and calibration approaches and brainstorming on additional special acquisition campaigns for Science and Cal/Val purposes.
3. *Algorithms Baseline for C2*: the development, implementation and validation of the new NN cloud screening and AC scheme for C2 is on-going following the agreed schedule. During the meeting, the status of the development will be reviewed and the planning refined
4. *Continuity*: development and validation activities for the transition to Sentinel-3 are currently on going, the MPC is supporting CGLS during the transition; the status of these activities will be reviewed during the meeting and the consistency with Proba-V data discussed.

Flight and Ground Segment Status

The overall performances of the platform and sensor are excellent and very stable with platform availability between 99.2% and 99.9% max for the last 6 months. All performance parameters are well within the requirements, the system is very stable with no sign of degradation.
The Flight Segment status is detailed:
• *LTDN predictions:* 09:45 AM are reached in October 2019 as expected, 09:40 AM in Dec 2019 and 09:25 in June 2020;
• *Platform Status*: during this period the platform status was very nominal. Several key activities were performed on the platform during this period:
  - MVA acquisition over Barrax Cal/Val site in Spain on 22 August 2019 with the 2 pitch angles of +55 and -55 degrees;
  - 2 yaw manoeuvres over Mauretania2 and Sudan1 calibration regions using the nadir camera on 26 August and 28 August 2019 respectively;
  - Night-time acquisitions on 26 and 27 of June 2019 with RoI the so-called "Liverpool-Milan Axis" which is the most urbanized region of Europe;
• *AOCS performances:* performance is far better than requirement, the overall status is nominal;
• *Power Budget:* decrease of power probably due to the orbital drift but still within requirements. The power situation is very stable, showing no apparent degradation of the solar arrays, battery nor power distribution system.
• *Thermal performances:* excellent thermal performances of the radiator and optical bench; expected increasing of the temperature due to the orbital drift which leads to different light conditions. The anomalous increase of temperature of the optical bench associated to the last Antarctica acquisition is mentioned and will be a point of discussion for the planning of future Antarctica acquisitions.
• *Decompression errors:* the errors history since July 2017 is summarized until the last yaw manoeuvre on 26 August 2019 when the amount of decompression errors dropped significantly. A better decompression errors classification is suggested with the purpose to identify the root cause, if linked to a bad RF signal causing TM frame/packet drops or to some issues on board.
• *Ground segment status:* the satellite and ground segment operations are running nominally. ESA/Redu centre supports all planned passes, the data downlink is shared between Kiruna, Alaska and Inuvik stations with 10 X-band passes per day.

Radiometric and Geometric calibration

The DCC and moon calibration shows a jump in gain factor during last winter notably in the NIR band, and as already reported in the previous QWG, this can be correlated with increased temperature linked to disabling of the sunbathing mode implemented. The reason of temperature impact on the NIR band seems related to induced changes in SRF, which vary as a function of temperature, as demonstrated during prelaunch characterisation of the sensor. This effect could also explain the apparent increase of detector sensitivity observed in Red and NIR bands. Though, the trends are camera-dependent, which could point to some effects linked to geometry of observation. The investigation will be completed at the end of the Proba-V operational global mission, based on the full mission data, long-term trends derived from this ensemble of data will be estimated and used for the C2 re-calibration activity. The current inter-calibration status of the VGT1/VGT2/PV multi-sensor series was reviewed and the results on cross-calibration coefficients estimated over PICS were recalled, the results were extracted from published peer-reviewed literature and ad-hoc investigation, such as those performed within CEOS-IVO and C3S. The inter-comparison with S3 is for now limited to the analysis of TOA reflectance performed by VITO, which shows S3 slightly brighter than PV, around 1% in the VNIR bands; this analysis also confirmed the known 10% bias in the S3 SWIR band, due to the SLSTR SWIR calibration issue. In conclusion, there is not yet a consensus on per-band inter-calibration factors between VGT1/VGT2/PV/S3. This topic should be reconsidered in the coming months also taking into account the results of the SPAR@MEP project and the latest updates from the PV/S3 TOA reflectance inter-comparison.
The long-term ALE analysis shows a slight trend of geometric errors, though the mean value remains well within the requirements, demonstrating the excellent and stable performance. Per-band monthly averages of ALE for the full mission were computed and could be a valuable input for users to estimate geometric accuracy and its variation over time
Inter-band geometric accuracy trends are also presented. The suggestion, proposed at the previous QWG, on the possibility to implement different geometric error thresholds for different spatial resolutions, was recalled; this change will have a significant impact on the geometric processing chain, which is currently a single chain for all spatial resolution, furthermore this will also introduce an inconsistency in the geometric accuracy between the different resolution. à It was agreed to stick with the current single threshold for detection of geometric error for all spatial resolution products.

Mission Extension

As agreed during the previous meetings, the operational global/daily mission will be discontinued by end of April 2020, to prevent that orbit drift will have impact on long-term trend analysis. Starting from this date, the mission will enter an Experimental Phase of 2/3 years during which new mission concepts will be verified for the sake of advances in Science and Applications. The extension strategy will consist in using complementary Cubesats (1 VNIR and 1 TIR sensor) to compensate and progressively expand Proba-V observations capabilities, which will be degraded by the orbital drift. In addition, special campaigns will be planned for Science and Cal/Val, the list of such special modes was gathered and collected during previous QWG meetings, it includes in particular: MVA, yaw, Moon, Antarctica and nighttime acquisitions. Several experiments were already performed with these new modes, demonstrating their technical feasibilities. Feedback from the QWG on the added value of such new observation modes will be provided in the coming months. The implementation schedule of the Extension Phase was recently impacted by the delay in the launch of the first Cubesat, which is now set during Q3 2020. Mitigation strategies were discussed during the meeting, including gathering new proposals for special Science and Cal/Val acquisitions.

Algorithm Baseline Definition for C2

The implementation of the NN cloud algorithm is on going in line with the proposed schedule. The development, implementation and validation of the 333 m chain were completed, showing extremely good overall accuracy and significant improvements with respect to the C1. The development of the 1km was also completed and implementation and validation are currently on going. The 100m chain is still to be fully developed, since the NN needs to be specifically tuned for this resolution, this is expected to be completed by end of Nov 2019. The new A/C chain will be implemented at VITO in close collaboration with HYGEOS. It will consist in an updated SMAC scheme with improved LUTs, using ancillary dataset for AOD. The main activity will be a global long-term inter-comparison exercise to identify the best AOD climatology. For this purpose, the same validation protocols and quality metrics, adopted within ACIX, will be reused. Implementation and validation of this new AC scheme will be completed by end of Q2 2020. The new BRDF correction module was finalized and made available in the MEP as Jupiter Notebook.

User Feedback and Continuity

The feedback from the Copernicus global Land Service on Proba-V data and an overview of the CGLS products portfolio are presented. The global land cover map at 100m was made available since May 2019. Some update on the work to complete the transition to S3 is presented: the V2 of SYN-L1C tool was received in May 2019 and some technical difficulties were encountered for the SW integration, all identified issues were solved thanks to the close and effective interaction with developers (Brockmann). There some critical verification activities planned during November 2019. This period will be crucial to evaluate the level of maturity of CGLS pre-processing and retrieval chains applied to S3 data and to assess its level of readiness to sustain NRT operations. Potential issues will need to be addressed with appropriate mitigation action, in order to ensure smooth transition to S3 when the Proba-V mission will terminate the global acquisitions (end Apr 2020).

The SPAR@MEP project updates are introduced: the algorithm is currently being further improved within the CIRCAS ESA-SEOM project to include the retrieval of cloud single scattering properties in a similar way as for the aerosol properties. This version of the algorithm might be used in the SPAR@MEP project to overcome possible issues with the reliability of the cloud mask. The radiometric accuracy and multi-temporal stability of the considered LTDR, which was acquired with 3 different radiometers (VGT1/VGT2/Proba-V), should be carefully assessed as a first step for the project. Furthermore, the processing performances should be significantly improved in order to sustain the mission reprocessing. To this end, the current plan is to exploit multi-cores CPU, or, alternatively, the GPU technology. Both parallel processing with CPU multi-cores and GPU are available on the MEP. VITO is willing to support such activities, as part of the nominal MEP user support, with the goal of fully exploiting all processing capabilities of the MEP environment. To this end, it was agreed to hold a dedicated meeting in VITO with Rayference, to discuss on technical details of the MEP implementation and optimization.

UCL presented the results of processing classification chain developed to generate the Proba-V Land Cover Mapping @100m product. The project uses the full C1 Proba-V 100 m archive for the generation of multiyears global land cover map at 100m. One of the objectives of the project is to improve current state-of-the-art 100m global land cover map at 100m, in particular with respect to cropland/grassland discrimination and forest sub-class classification.
Multi-years 100m composites are generated using the mean compositing, which aims at minimizing the cloud contamination and reducing variations in reflectance values due to image acquisition with varying geometries. The MC algorithm averages quality controlled reflectance values over the compositing period. It has proved to significantly reduce BRDF and atmospheric artefacts. Some issues with cloud and cloud shadow masks had impact on the pixel classification: not valid observations are found in the whole compositing period because of pixels systematically flagged as cloud such as it is observed over urban areas. All these issues are expected to be largely resolved in the C2.

In terms of S-3 SYN-VGT products consistency, significant progresses were recently made, in particular in the AOD retrieval, leading to more realistic AOD and surface reflectances products. A cross-comparison of SYN-VGT TOA reflectances with Proba-V shows overall good agreement for VNIR bands, while for the SWIR a clear bias is observed in the same order of magnitude of the SLSTR SWIR radiometric bias. Important upgrades and bug fixes were recently implemented in a latest version of S3-SYN algorithm; these upgrades will be available in the PDGS starting from Dec 2019.