proba-v

QUARTERLY IMAGE QUALITY REPORT

IQR#023

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1. Radiometric Image Quality

1.1. Summary

The equalization coefficients for the SWIR strips of the LEFT and RIGHT camera were updated in the ICP files on July 1 on the basis of the yaw maneuver data. This results in a clear improvement of the non-uniformities in the scene, both for low and high frequency variations.

The Libya-4 calibration results for **RED and NIR band of mainly the RIGHT camera show a clear positive trend over last 6 months** (much more pronounced as before). This in turns leads to a decreasing trend observed in the DCC calibration results for the BLUE band as the DCC results are expressed relatively to the RED band. On the basis of the Libya-4 results no decrease is observed over time in the RIGHT Blue band (therefore no degradation model is being applied for the RIGHT blued band), but both RED and NIR band show a positive trend which is more pronounced for the last 6 months. This might explain why in the DCC results which are expressed relatively to the RED band a clear decreasing trend is seen in the blue band while no trend is observed in the NIR band.

Currently the increasing trend for RED and NIR bands are not yet corrected for in the ICP files. Investigations are ongoing to see how this can be best accounted for in the ICP file and to understand the cause of this trend.

One new bad pixel was identified (i.e. CENTER SWIR2 Pixel ID 114 (0-based)).

1.2. Assessment of the radiometric accuracy

1.2.1. Absolute radiometric accuracy

The absolute radiometric calibration requirement for PROBA-V specifies a 5 % absolute accuracy. This requirement is assessed through vicarious calibration over Libya-4 desert site and Rayleigh calibration zones.

1.2.1.1. Libya-4 desert calibration

Methodology

The nominal approach for assessing the absolute radiometric accuracy relies on the comparison between cloud-free TOA reflectance as measured over the Libya-4 desert site by PROBA-V and the modelled TOA reflectance values, following the approach described in [LIT1]. Validation of the approach using various satellite data (i.e. AQUA-MODIS, MERIS, AATSR, PARASOL, SPOT-VGT) has shown that absolute calibration over the Libya-4 desert is achievable with this approach with an accuracy of 3% [LIT1, LIT2].

Results

In Figure1, Figure3 and Figure 5 the monthly averaged results ($avg(\rho_{TOA}^{k,ProbaV(Acom)}/\rho_{TOA}^{k,model})$) and its standard deviation are given for respectively LEFT, CENTER and RIGHT camera.
The individual area-averaged results are given in Figure2, Figure4 and Figure 6 with a 3 % error bar (as expected uncertainty for an individual result) for respectively VNIR and SWIR strips.

Results are obtained based on the **Collection 1** ICP files.

Since October 2018 a degradation model (see section 1.2.3) is no longer applied to the SWIR absolute calibration coefficients as the current linear model resulted in an overcorrection of the degradation in the SWIR.
The equalization coefficients for the SWIR strips of the LEFT and RIGHT camera were updated in the ICP files on July 1 on the basis of the yaw maneuver data. This results in a clear improvement of the non-uniformities in the scene, both for low and high frequency variations.

For all cameras the RED and NIR bands show a positive trend; for the RIGHT camera this trend is much more pronounced over the last 6 months. Even for the Blue band of the RIGHT camera a slight positive trend is being observed for the latest months.

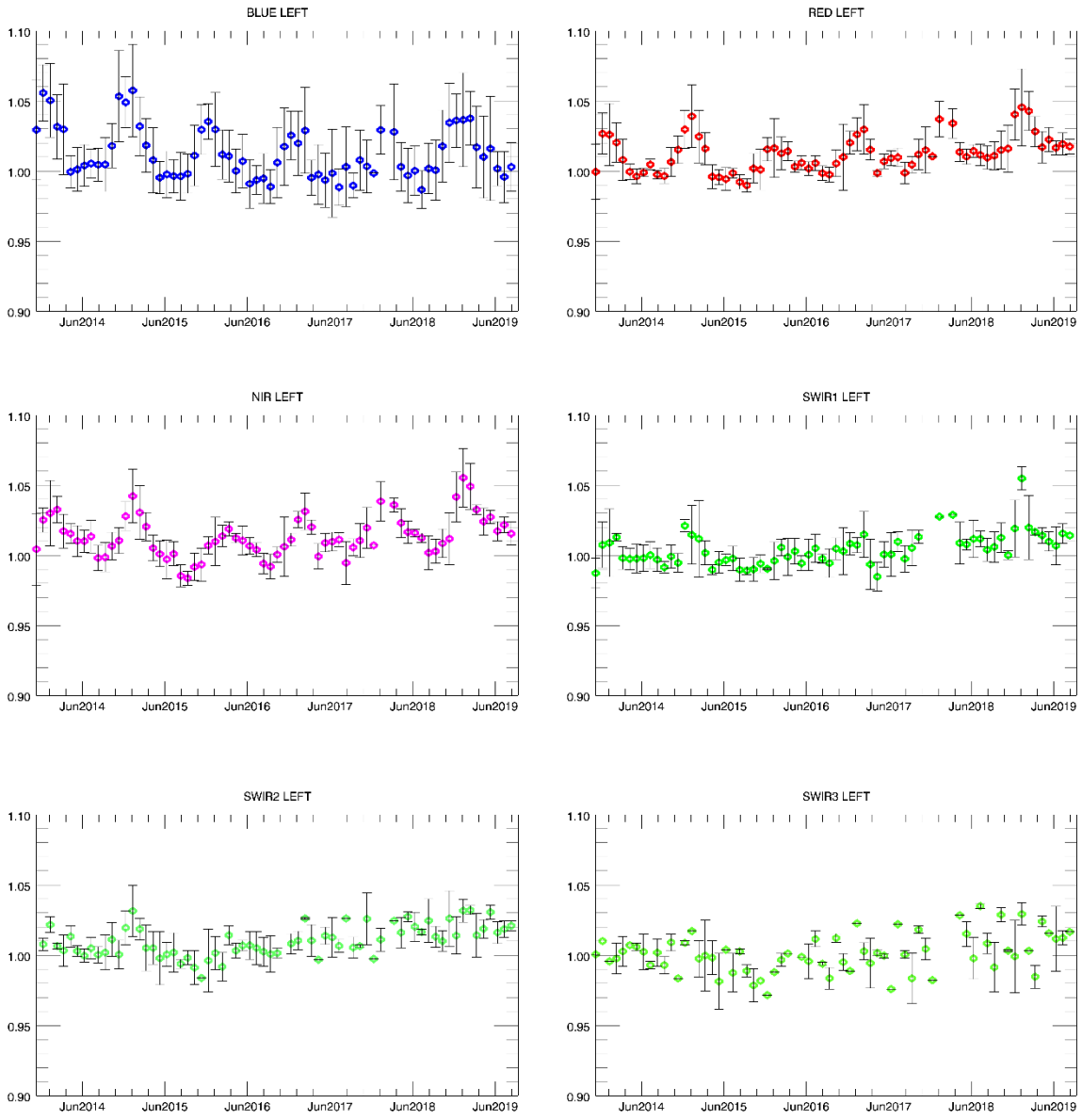


Figure 1. Libya-4 desert calibration results: LEFT monthly averaged results (Collection 1)

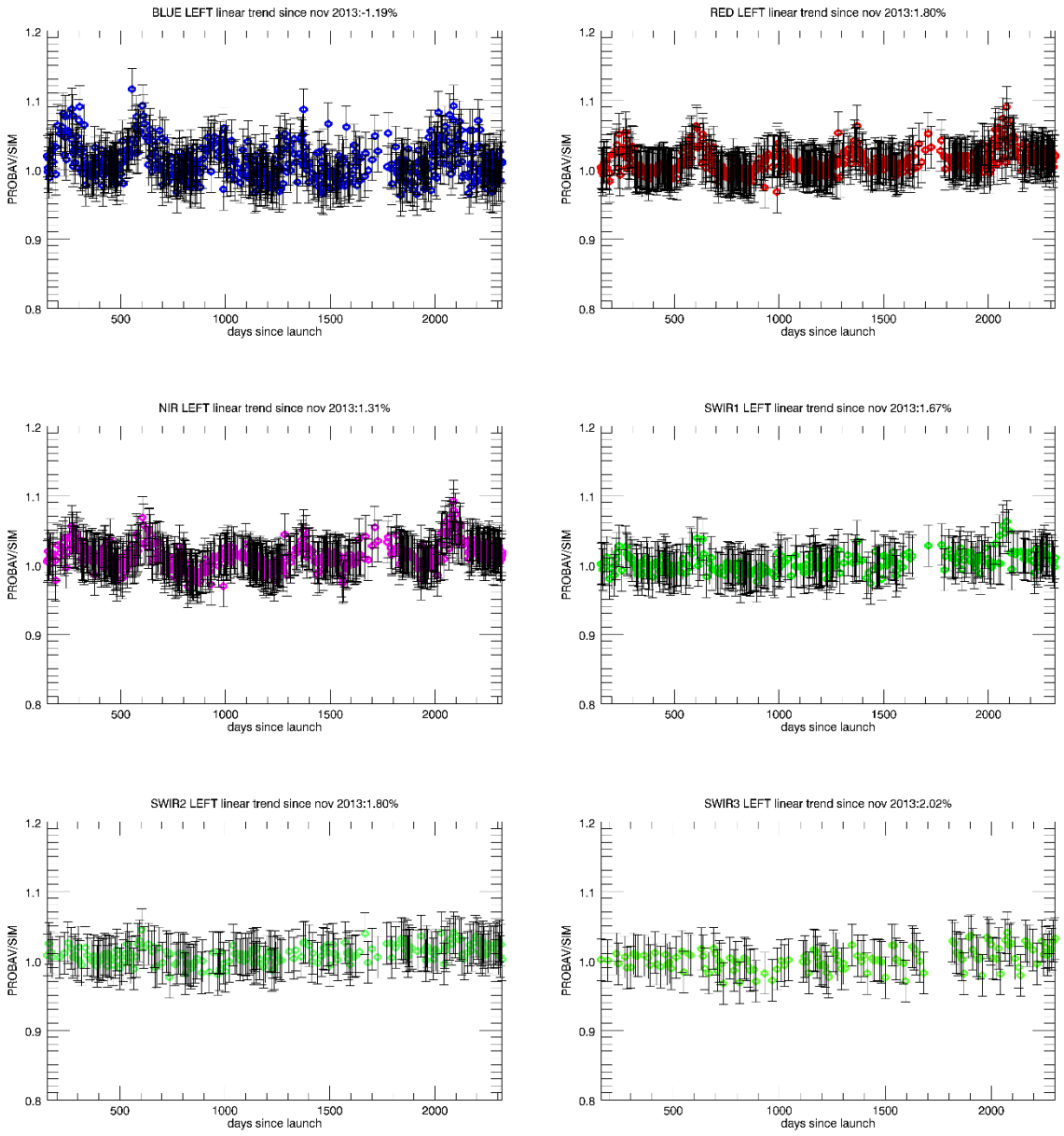


Figure 2. Libya-4 desert calibration results: LEFT individual results (Collection 1)

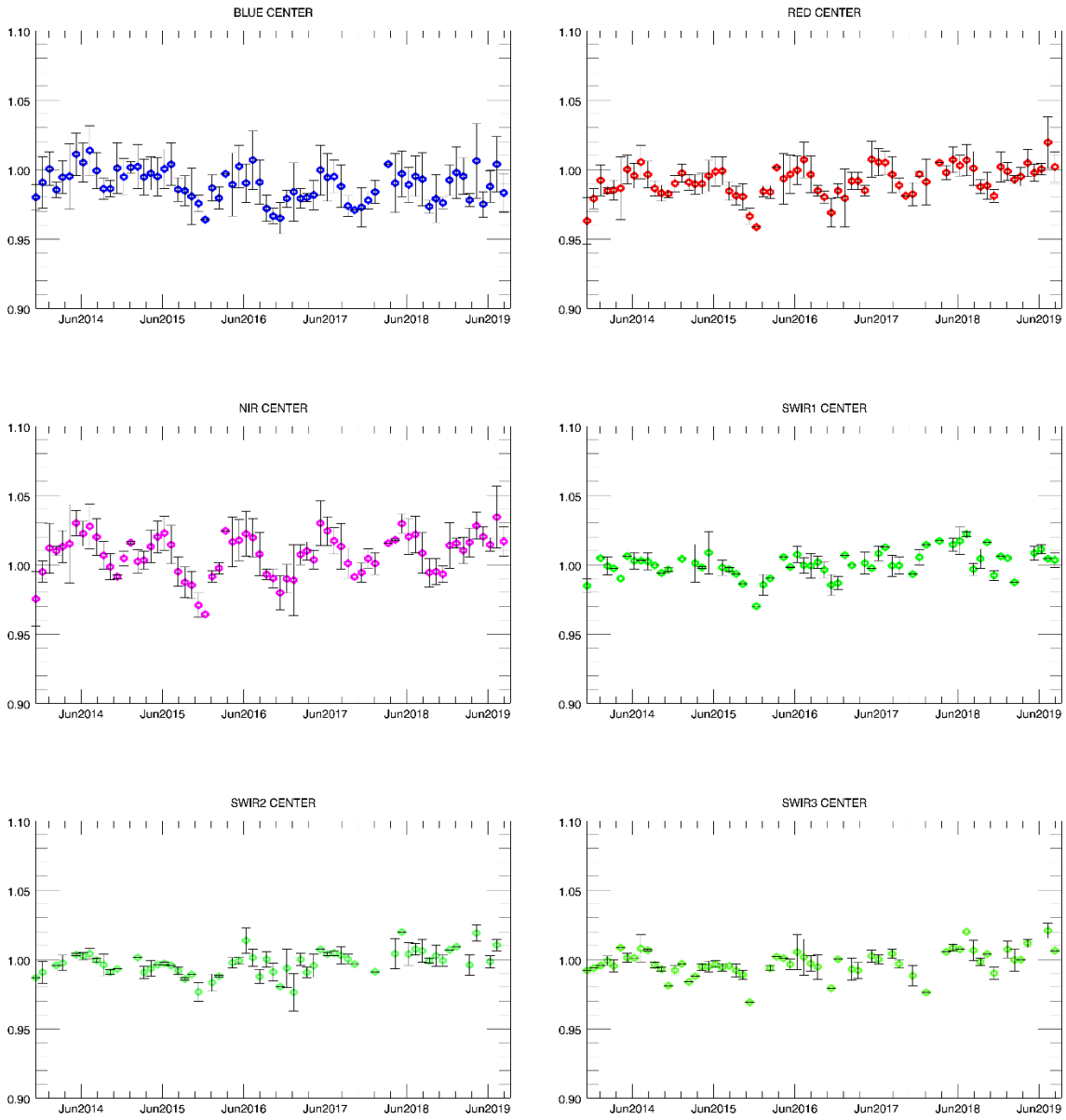


Figure 3. Libya-4 desert calibration results: CENTER monthly averaged results (Collection 1)

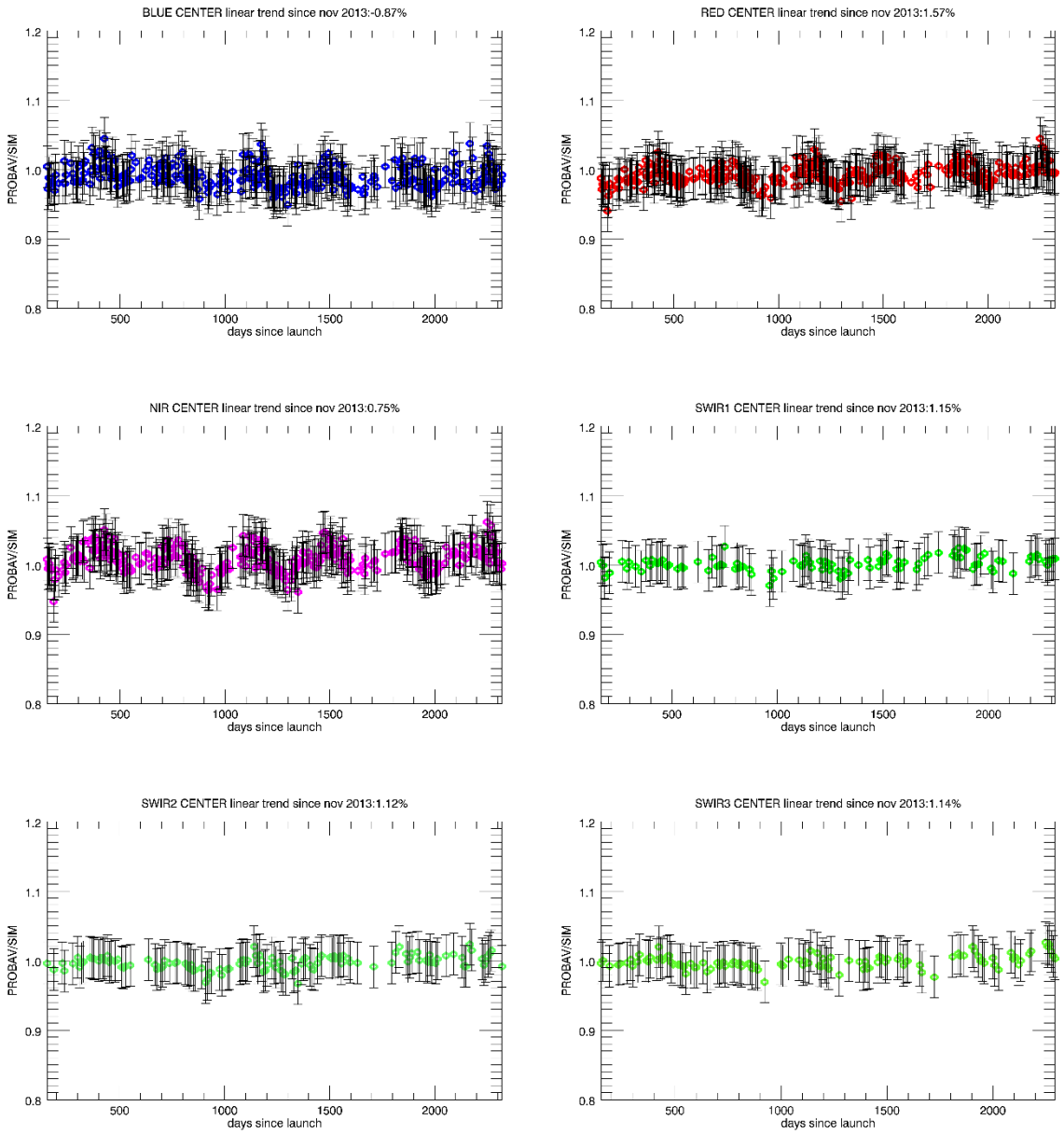


Figure 4. Libya-4 desert calibration results: CENTER individual results (Collection 1)

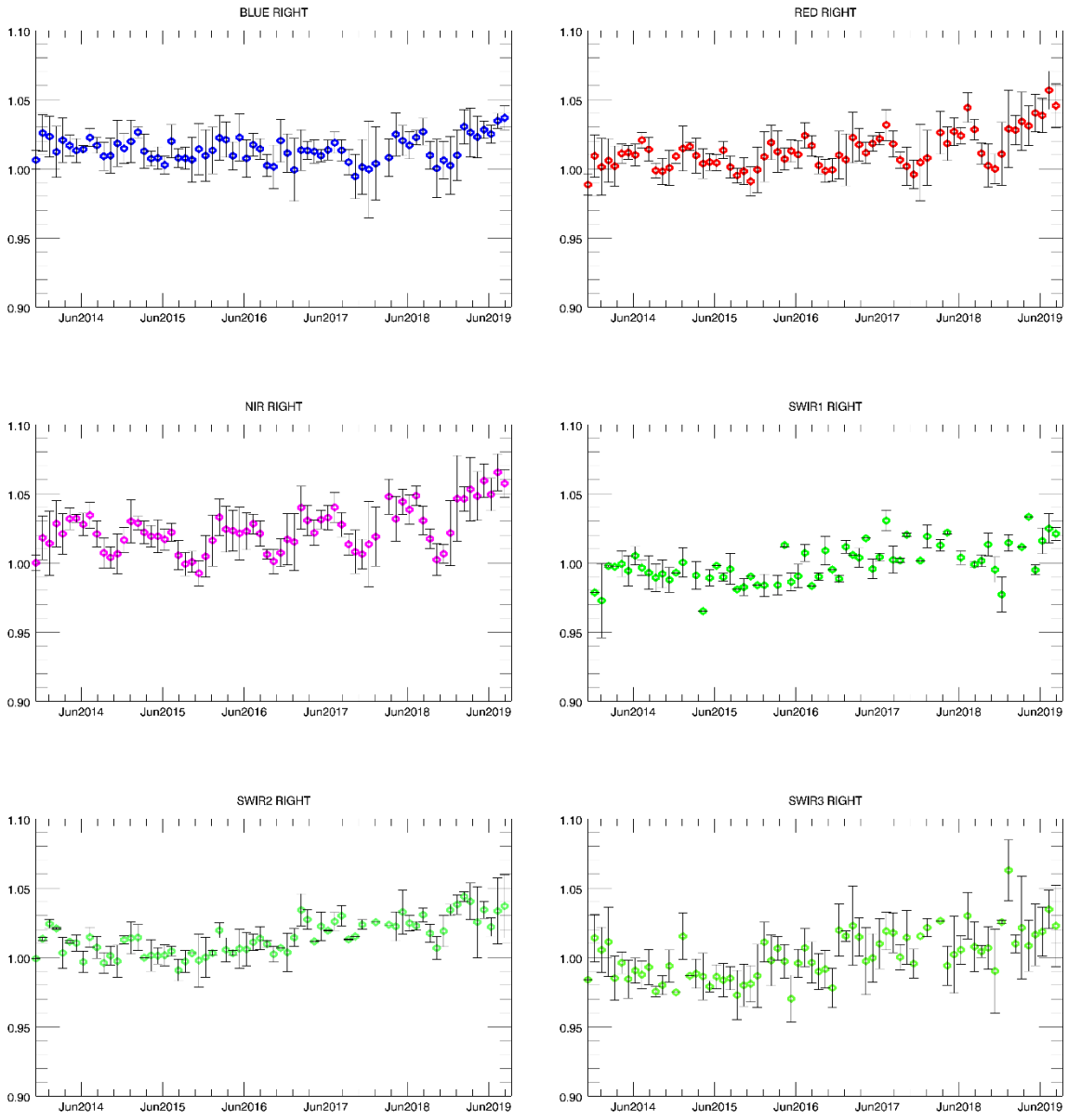


Figure 5. Libya-4 desert calibration results: RIGHT monthly averaged results (Collection 1)

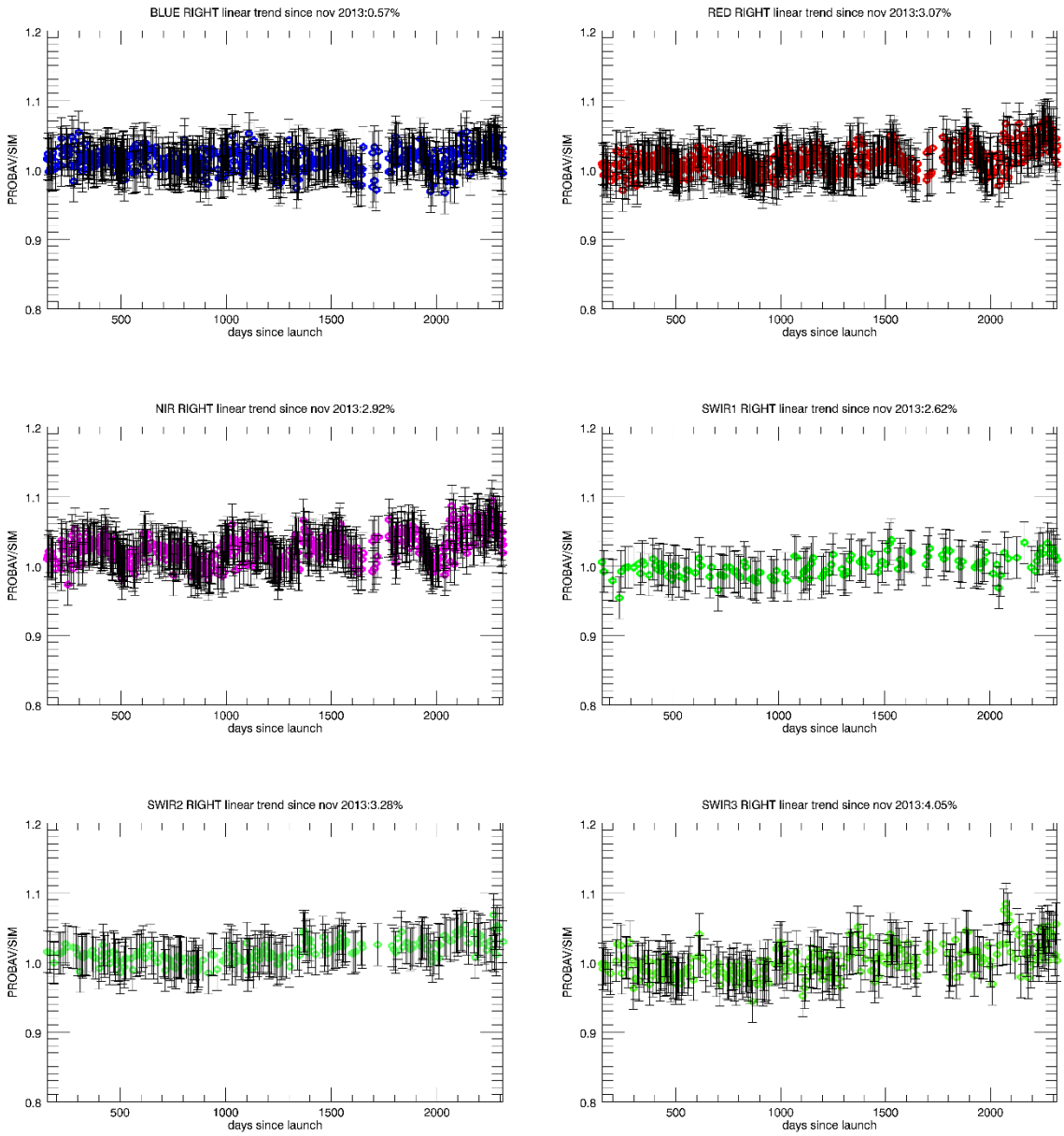


Figure 6. Libya-4 desert calibration results: RIGHT individual results (Collection 1)

1.2.1.2. Rayleigh calibration

Methodology

The Rayleigh calibration approach is an absolute calibration method for BLUE and RED bands. The primary assumption of the approach is that the ocean does not contribute to the Top-Of-Atmosphere (TOA) signal in the NIR. The contribution of aerosol scattering is derived from the ***NIR reference band*** where molecular scattering is negligible. The aerosol content estimated from the NIR band is then transferred to the BLUE and RED band to model the TOA radiance with a radiative transfer code. The simulated radiance values are then compared with the measured values.

Results

The scene averaged Rayleigh results ($(\rho_{TOA}^{k,ProbaV(Acom)}/\rho_{TOA}^{k,model})$) (with a 4 % error bar as rough indication of uncertainty of one individual result) obtained since January 2014 for LEFT, CENTER and RIGHT camera are given in respectively Figure 7, Figure 8 and Figure 9.

Results are obtained using the **Collection 1 ICP** files.

No significant trend is visible in the Rayleigh calibration results.

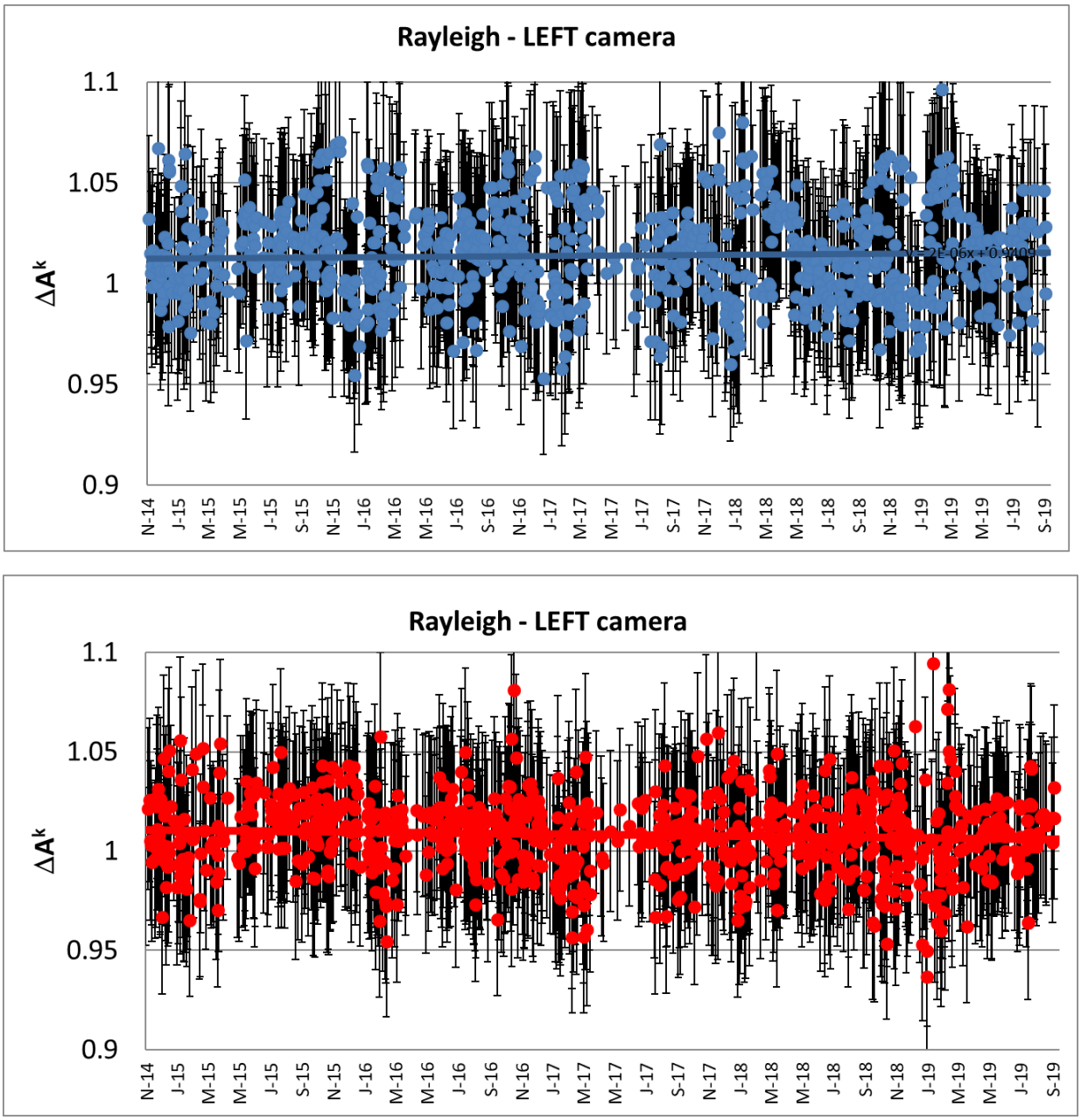
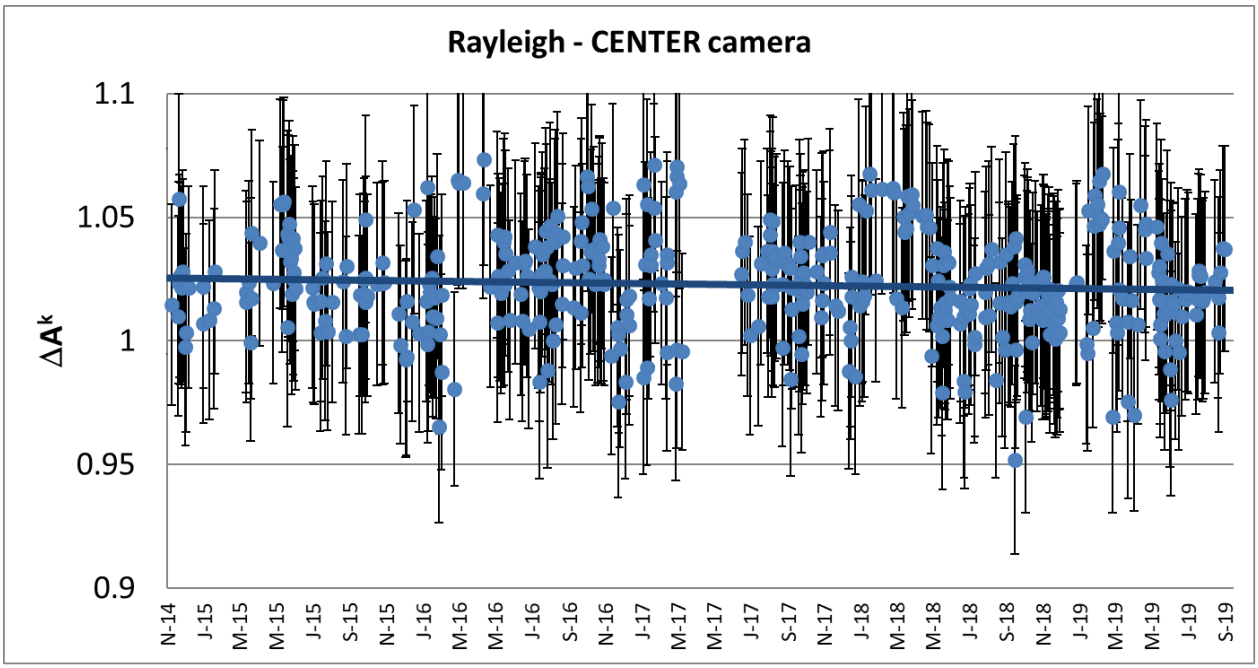


Figure 7. Rayleigh absolute calibration results: LEFT camera (Collection 1)



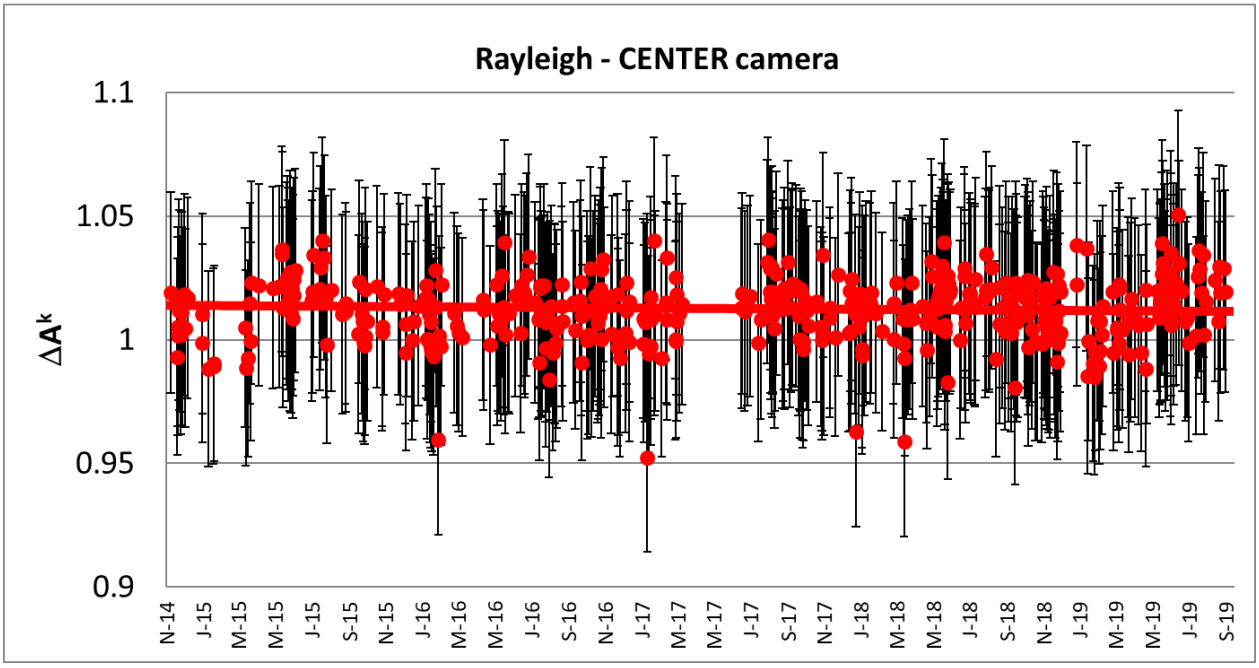


Figure 8. Rayleigh absolute calibration results: CENTER camera (Collection 1)

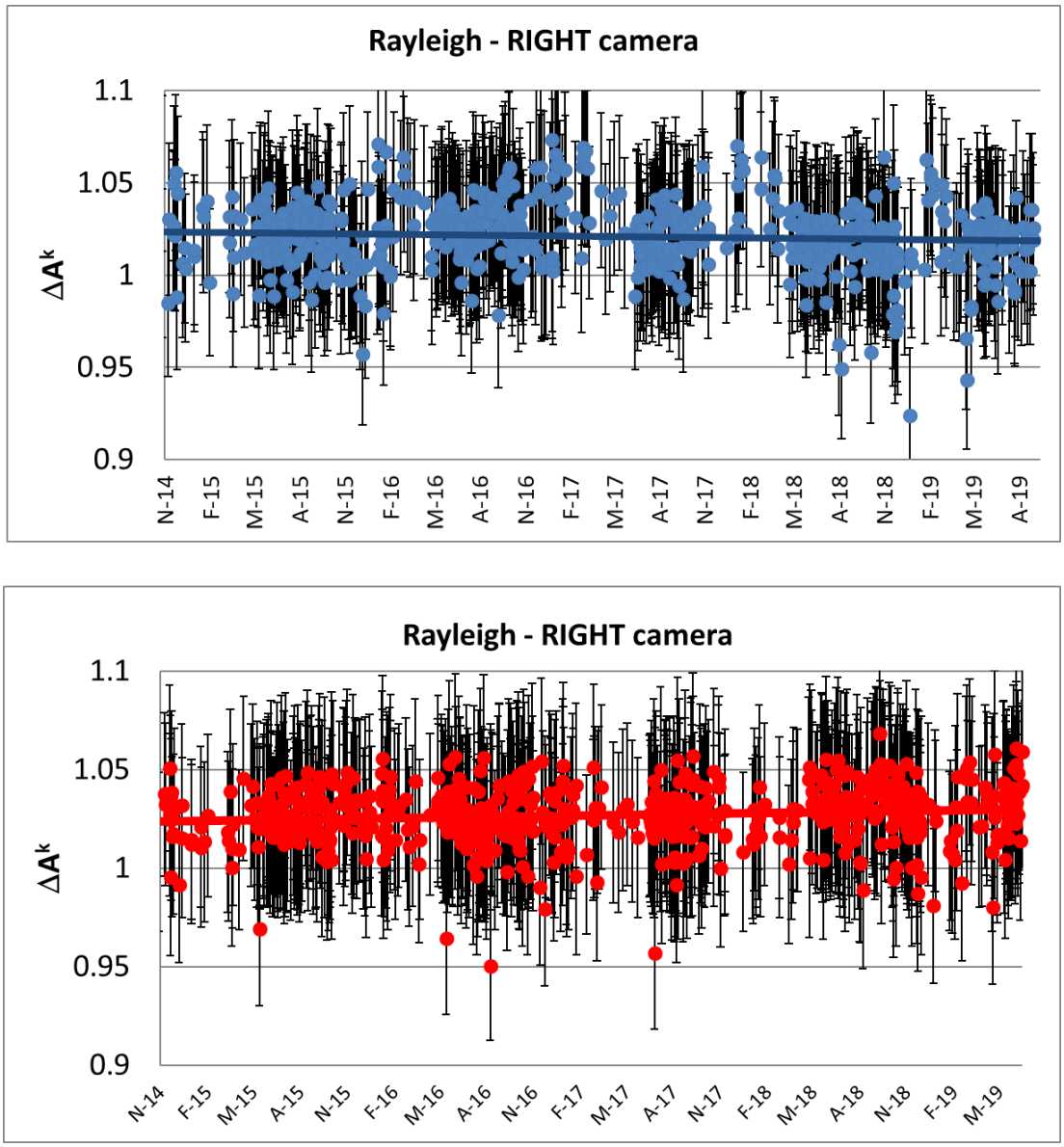


Figure 9. Rayleigh absolute calibration results: RIGHT camera (Collection 1)

1.2.2. Inter-band radiometric accuracy

The inter-band radiometric calibration requirement for PROBA-V specifies a 3 % inter-band accuracy. This requirement is assessed through vicarious calibration over deep convective clouds.

1.2.2.1. Calibration over deep convective clouds (DCC)

Methodology

The DCC approach is an inter-band calibration method. It makes use of bright, thick, high altitude, convective clouds over oceanic sites. Their reflective properties are spectrally flat in visible and near-infrared and the only contributions to the observed signal are from the cloud reflectance, molecular scattering and ozone absorption which can be modelled with a radiative transfer code.
The cloud reflectance in the non-absorbing VNIR bands is mainly sensitive to the cloud optical thickness. The DCC method uses the TOA reflectance in the 'reference' RED band to estimate cloud optical thickness assuming a fixed ice particle model. The derived cloud optical thickness is then used to model using a radiative transfer code the TOA reflectance for the BLUE and NIR band.

The method is not suited for the SWIR band as clouds are no longer spectrally uniform in this spectral region.

Results

The DCC inter-band calibration is defined by reference to the used RED reference band. The average DCC inter-band calibration result per month (from March 2015 to September 2019) is given in Figure 10 for all cameras using the **collection 1 ICP files**.

The DCC calibration results show a decrease in responsivity of the BLUE bands of all cameras, even after May 2017 when the degradation model for BLUE LEFT/CENTER strips was implemented (see 1.2.3.1). Please note that for BLUE RIGHT strip no degradation model is applied as no degradation is observed on the basis of the OSCAR Libya-4 results (see 1.2.1.1). A possible explanation for the trend observed in the DCC BLUE band results, is the increase of responsivity in the RED band as observed in the Libya-4 results for all cameras as well as in the moon calibration results for the CENTER camera. As the BLUE band DCC results, are inter-band calibration results, expressed relatively to the RED band, an increase in responsivity of the RED band (and not for the BLUE band) will result in a decrease of the BLUE band DCC inter-band calibration results.

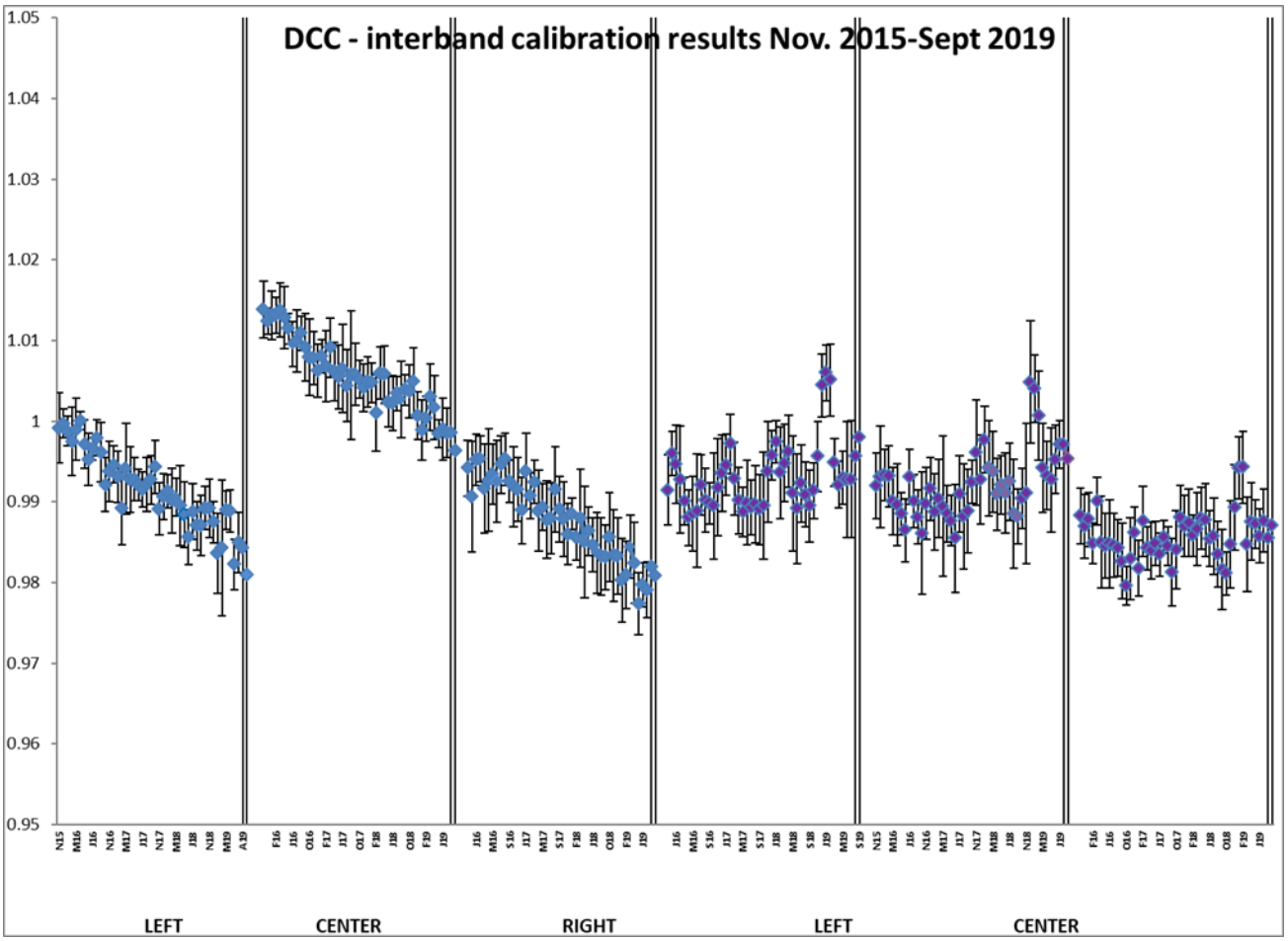


Figure 10. DCC inter-band calibration results: LEFT, CENTER and RIGHT camera

1.2.3. PROBA-V Multi-temporal radiometric accuracy

1.2.3.1. Degradation model

Since October 2018 a degradation model is no longer applied to the SWIR absolute calibration coefficients as the current linear model resulted in an overcorrection of the degradation in the SWIR. Once ICP files are updated for the non-uniformities as quantified on the basis of the yaw maneuver, the Libya-4 desert results will be reprocessed in order to better quantify the degradation for the various SWIR strips and to re-evaluate the degradation model for the SWIR strips to be used in the reprocessing (collection 2).

In Table 1 the applied degradation model correction is given. This linear degradation model is being applied for collection 1 since start of the operational phase (i.e. October 2013). A re-evaluation of the coefficients of the SWIR degradation model was performed in summer 2017. Since Jan 2018 a degradation model is no longer applied to the RIGHT SWIR strips. From October 2018 onwards, absolute calibration coefficients for the SWIR strips are not updated.

Table 1 SWIR degradation model: applied linear trend/month

	Degradation model ICP			
	Start- aug 2017	Sept 2017-Dec 2018	Jan 2018-Sept 2018	Oct 2018-..
SWIR1 LEFT	-0.087	-0.087	-0.087	NA
SWIR2 LEFT	-0.104	-0.104	-0.104	NA
SWIR3 LEFT	-0.097	-0.097	-0.097	NA
SWIR1 CENTER	-0.093	-0.093	-0.093	NA
SWIR2 CENTER	-0.092	-0.092	-0.092	NA
SWIR3 CENTER	-0.086	-0.086	-0.086	NA
SWIR1 RIGHT	-0.106	-0.077	NA	NA
SWIR2 RIGHT	-0.143	-0.122	NA	NA
SWIR3 RIGHT	-0.122	-0.078	NA	NA

A degradation model is used to update the absolute calibration coefficients of the LEFT and RIGHT BLUE since May 2017. A re-evaluation of the coefficients of the degradation model was performed in summer 2017. Since then no changes have been made to the model. In
Table 2 the coefficients are given.

Table 2 Degradation model BLUE LEFT and CENTER camera: applied linear trend/month

	Linear trend/month (%)	
	Degradation model ICP	Degradation model ICP
STRIP	May 2017-aug 2017	since sept 2017
BLUE LEFT	-0.028	-0.036
BLUE CENTER	-0.011	-0.034

1.2.3.2. Lunar calibration

The Lunar calibration results for the VNIR CENTER camera bands, normalised to June 2013, are given in Figure 11. The results are given based on the **collection 1 ICP** files.

Over the entire mission the BLUE band lunar calibration results show a decreasing trend which is more pronounced in the first years when the BLUE band degradation model was not yet in place (implemented since May 2017).

The DCC the RED and NIR lunar calibration results show a slightly increasing trend similar as observed over the Libya-4 desert site.

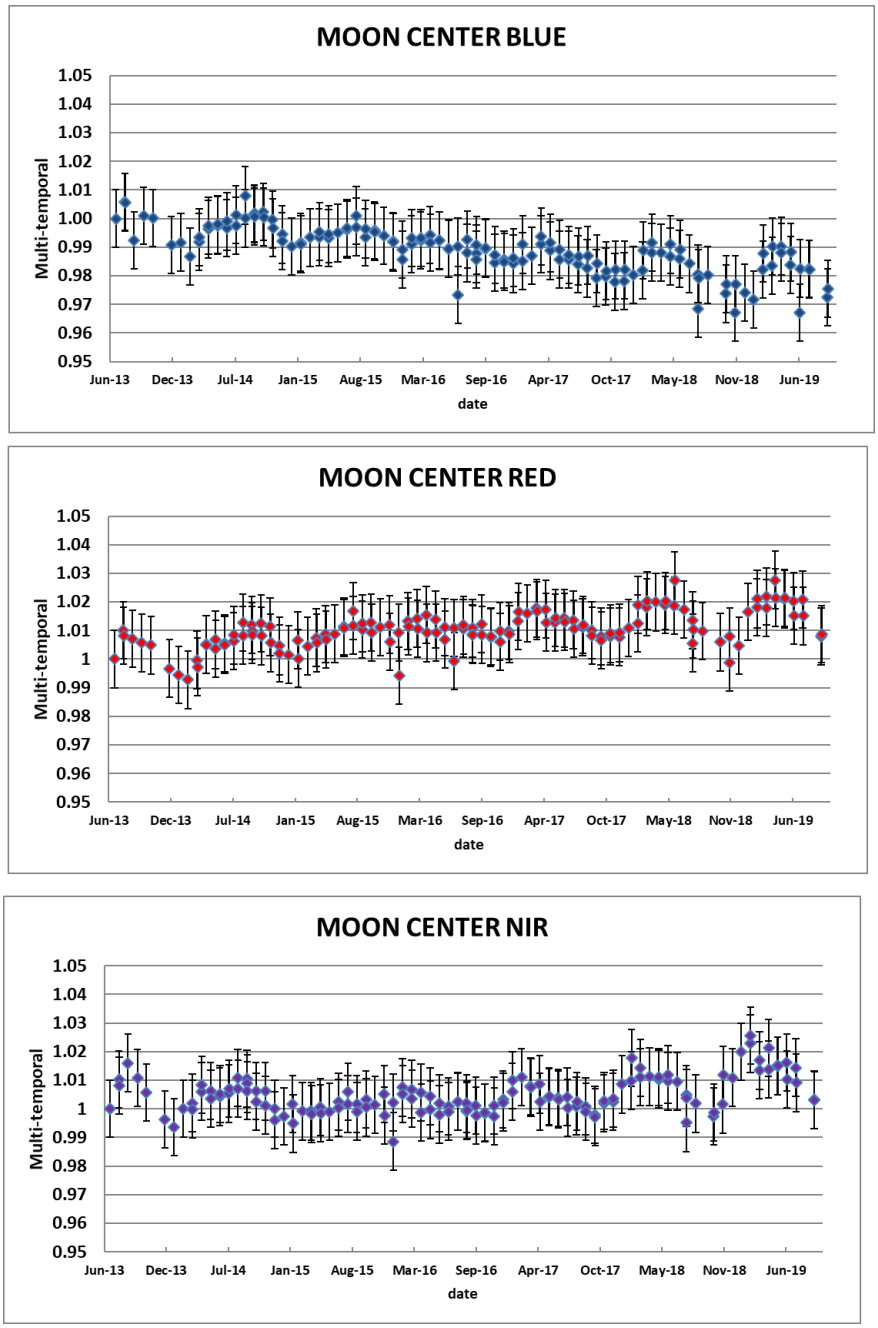


Figure 11. Lunar Calibration results CENTER camera normalised to June 2013 (collection 1 ICP files)

1.3. Dark current

1.3.1. Methodology

- Monthly difference plots:
  - All dark current results obtained during a period of one month for observations performed with a long integration time are averaged per pixel. This gives for each pixel the monthly averaged dark current, expressed **in LSB/s**, and its standard deviation.
  - The dark current results and its standard deviation expressed in LSB/s are converted to **LSB** using a maximum Integration Time for nominal acquisitions. For VNIR strips **0.006s** is used. For SWIR strips **0.02s.**
  - The differences between months (i.e. Month3-Month2, Month2-Month1) are calculated. This is done for both the dark current and the stdev. Differences are visualized in plots in blue the dark current difference in LSB is plotted, in red the standard deviation difference. This latter is an indicator of changes in the dark current noise between months.

As mentioned in the previous quarterly report (IQR#005) the integration time used for the SWIR dark current acquisitions has been decreased from 3s to 0.2 s since 2015.

1.3.2. VNIR results

Monthly difference plots for VNIR dark currents are given

Figure 12, *Figure 13* and *Figure 14*
for respectively LEFT, CENTER and RIGHT camera.

Dark current differences for the VNIR bands are well below 1 DN, except for a very few outliers.

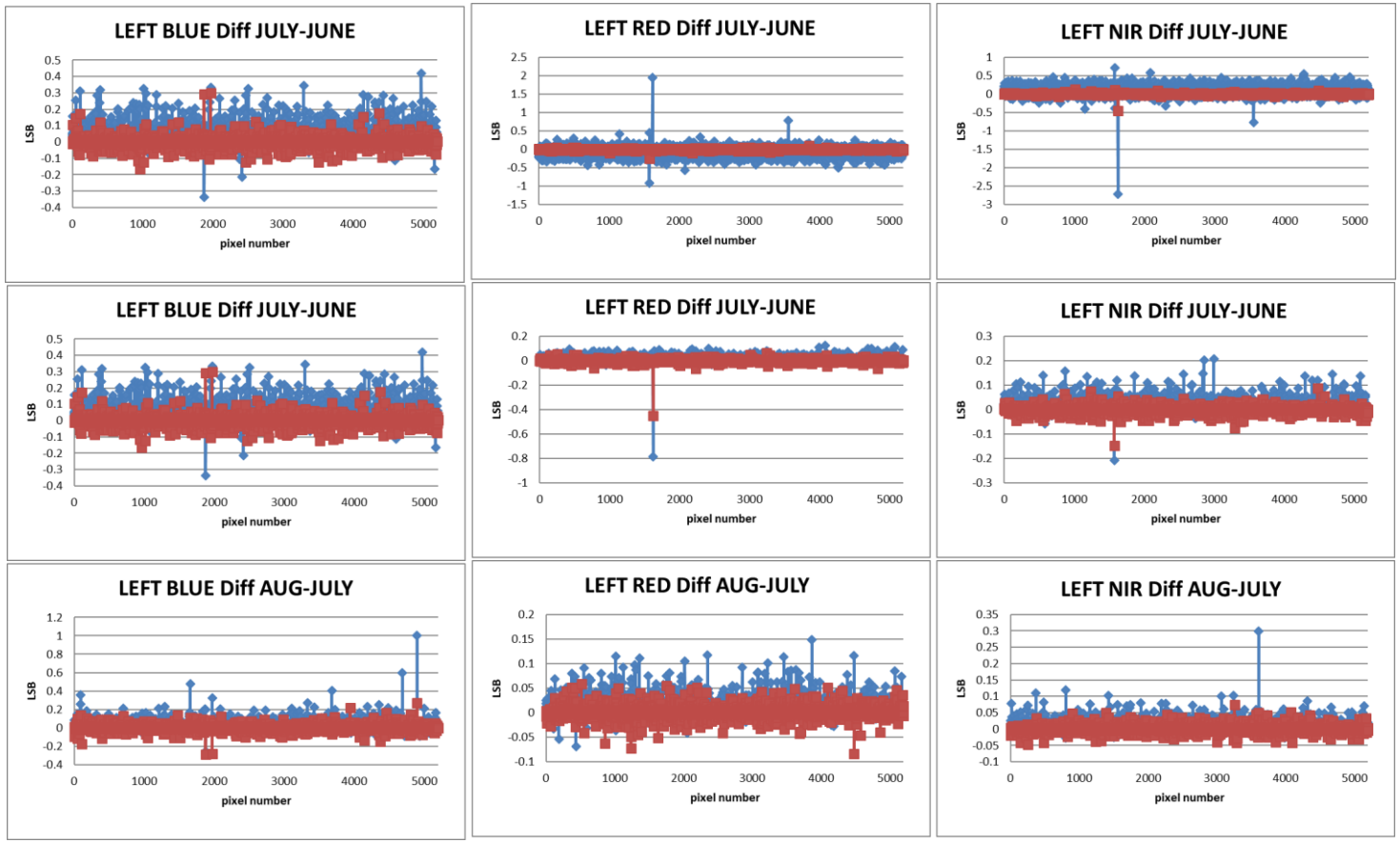


Figure 12. LEFT camera VNIR: Monthly difference (MAY-AUG2019) in dark current (Blue) and standard deviation (Red) of the monthly averaged

results.

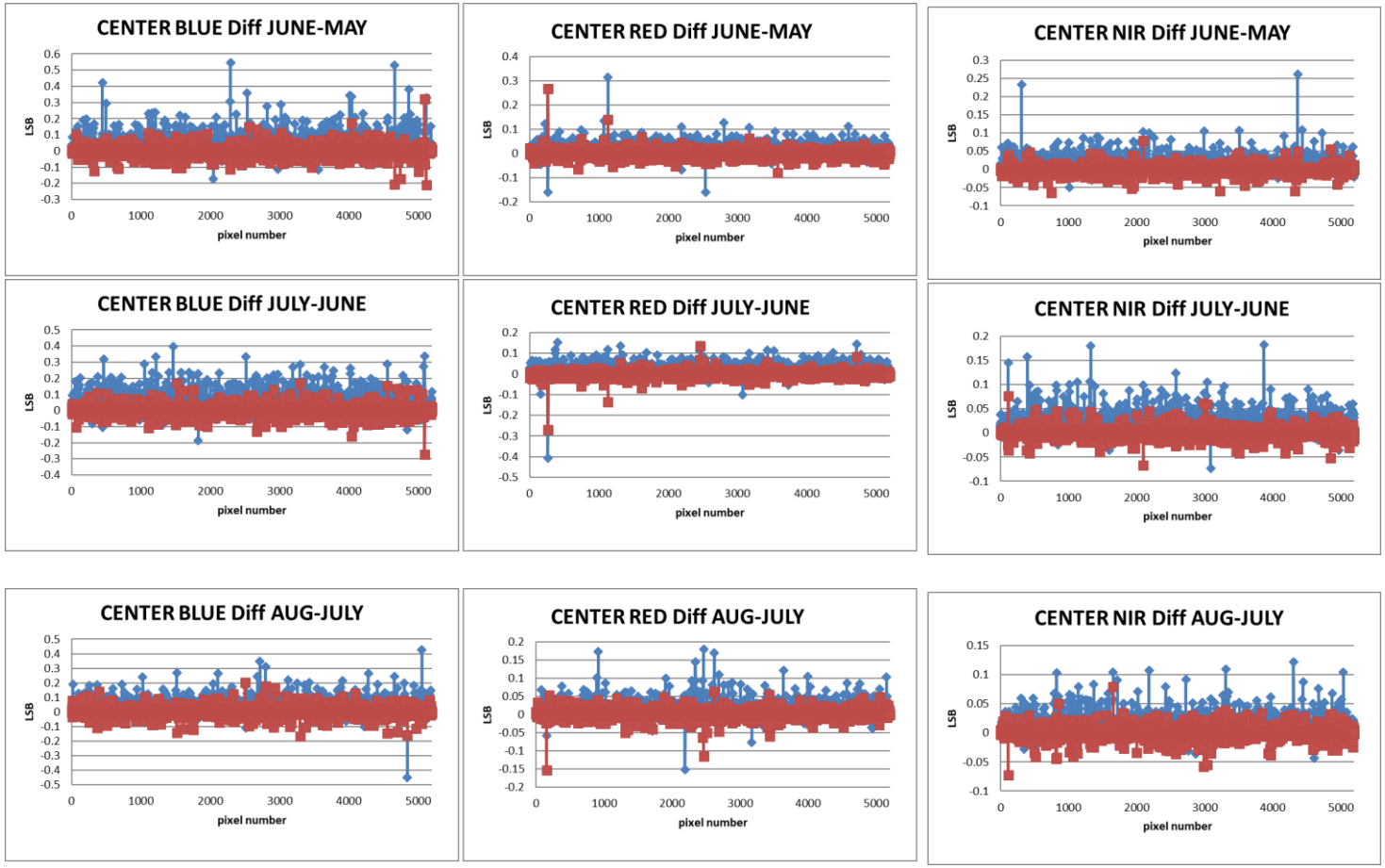


*Figure 13. CENTER camera VNIR: Monthly difference (*MAY-AUG2019*) in dark current (Blue) and standard deviation (Red) of the monthly averaged results.*

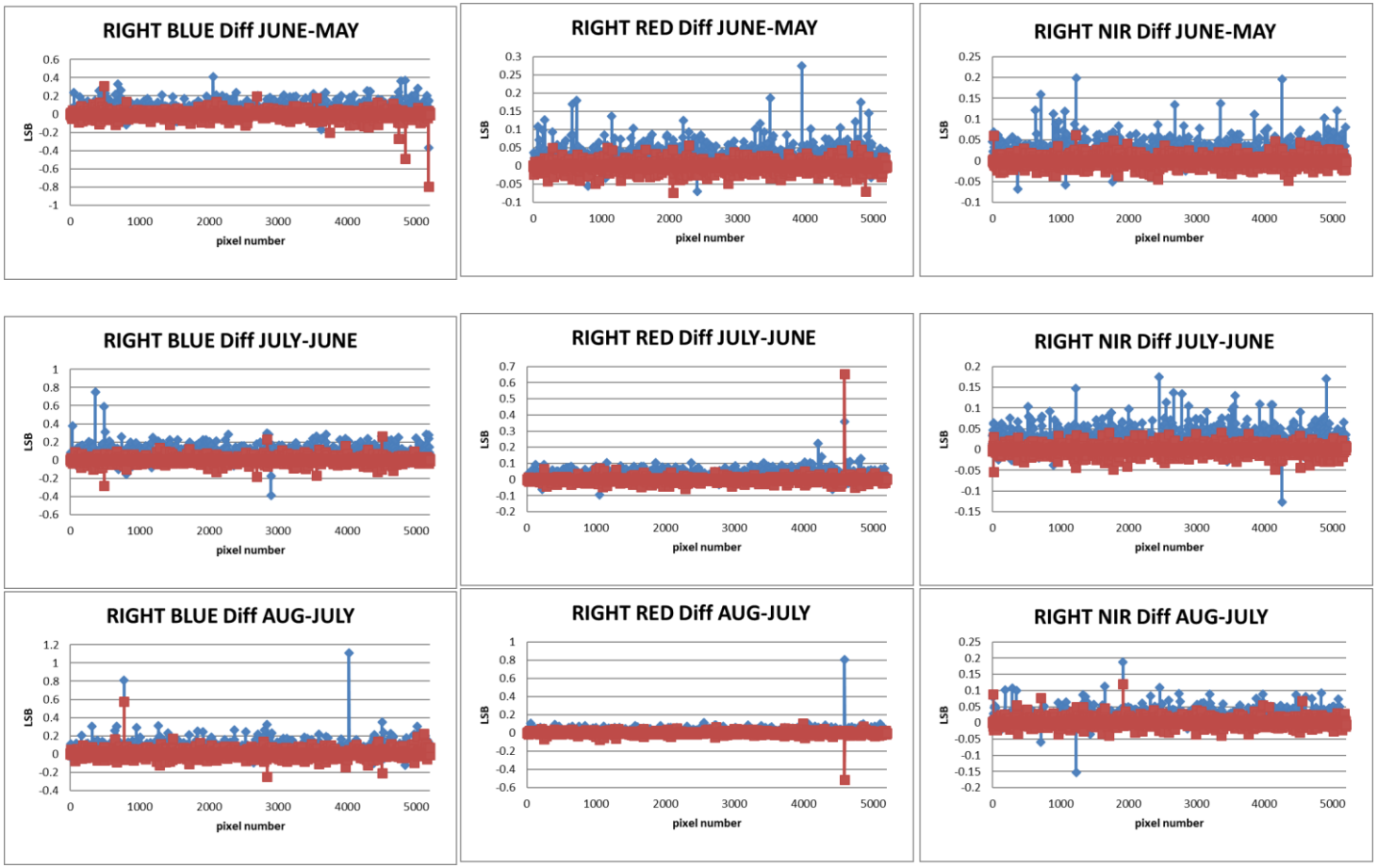


*Figure 14. RIGHT camera VNIR: Monthly difference (*MAY-AUG2019*) in dark current (Blue) and standard deviation (Red) of the monthly averaged results.*

1.3.3. SWIR results

Monthly difference plots for SWIR dark currents are given in

Figure 15, Figure 16 and Figure 17 for respectively LEFT, CENTER and RIGHT camera.

A dark current outlier analysis is performed for pixels having for at least one month a dark current expressed in LSB larger than the DC THRESHOLD. This DC THRESHOLD is set to 4 LSB. For those pixels the following dark current pixel statuses are given:

- Both monthly differences > 4 LSB ? **Quality is "H DC BAD"**
- One monthly difference > 4 LSB ? **Quality is "H DC NOK"**.
- Both monthly differences < 4 LSB ? **Quality is "H DC OK"**

In *Table 3*

LEFT																	
APR-MAY-JUNE						MAY-JUNE-JULY						JUNE-JULY-AUG					
SWIR1		SWIR2		SWIR3		SWIR1		SWIR2		SWIR3		SWIR1		SWIR2		SWIR3	
290	H DC BAD	717	H DC BAD	76	H DC BAD	362	H DC BAD	95	H DC BAD	82	H DC BAD	362	H DC NOK	95	H DC NOK	39	H DC BAD
323	H DC BAD	967	H DC BAD	82	H DC BAD	290	H DC NOK	175	H DC NOK	4	H DC NOK	275 pixels	H DC OK	296	H DC NOK	458	H DC BAD
951	H DC BAD	95	H DC NOK	370	H DC BAD	323	H DC NOK	296	H DC NOK	34	H DC NOK			422	H DC NOK	34	H DC NOK
39	H DC NOK	175	H DC NOK	824	H DC BAD	475	H DC NOK	422	H DC NOK	39	H DC NOK			622	H DC NOK	35	H DC NOK
362	H DC NOK	489	H DC NOK	4	H DC BAD	951	H DC NOK	489	H DC NOK	76	H DC NOK			414 pixels	H DC OK	82	H DC NOK
475	H DC NOK	665	H DC NOK	105	H DC NOK	267 pixels	H DC OK	665	H DC NOK	115	H DC NOK					115	H DC NOK
261 pixels	H DC OK	839	H DC NOK	167	H DC NOK			717	H DC NOK	167	H DC NOK					121	H DC NOK
		398 pixels	H DC OK	225	H DC NOK			967	H DC NOK	215	H DC NOK					215	H DC NOK
				281	H DC NOK			407 pixels	H DC OK	225	H DC NOK					336	H DC NOK
				400	H DC NOK					281	H DC NOK					348	H DC NOK
				415	H DC NOK					348	H DC NOK					354	H DC NOK
				513	H DC NOK					354	H DC NOK					355	H DC NOK
				548	H DC NOK					355	H DC NOK					370	H DC NOK
				901	H DC NOK					370	H DC NOK					384	H DC NOK
				966	H DC NOK					415	H DC NOK					438	H DC NOK
				932pixels	H DC OK					458	H DC NOK					510	H DC NOK
										510	H DC NOK					563	H DC NOK
										563	H DC NOK					564	H DC NOK
										809	H DC NOK					647	H DC NOK
										812	H DC NOK					678	H DC NOK
										824	H DC NOK					687	H DC NOK
										841	H DC NOK					768	H DC NOK
										901	H DC NOK					809	H DC NOK
										1011	H DC NOK					812	H DC NOK
										930 pixels	H DC OK					841	H DC NOK
																871	H DC NOK
																941	H DC NOK
																1011	H DC NOK
																937 pixels	H DC OK

Table 3. LEFT SWIR dark current pixel outliers (ID L1A).

CENTER																	
APR-MAY-JUNE						MAY-JUNE-JULY						JUNE-JULY-AUG					
SWIR1		SWIR2		SWIR3		SWIR1		SWIR2		SWIR3		SWIR1		SWIR2		SWIR3	
448	H DC BAD	671	H DC BAD	536	H DC NOK	448	H DC BAD	114	H DC NOK	694	H DC NOK	234	H DC BAD	12	H DC NOK	216	H DC NOK
277	H DC NOK	265	H DC NOK	632	H DC NOK	663	H DC BAD	173	H DC NOK	830	H DC NOK	140	H DC NOK	114	H DC NOK	464	H DC NOK
497	H DC NOK	606	H DC NOK	830	H DC NOK	140	H DC NOK	180	H DC NOK	187pixels	H DC OK	150	H DC NOK	173	H DC NOK	694	H DC NOK
545	H DC NOK	345pixels	H DC OK	832	H DC NOK	234	H DC NOK	246	H DC NOK			448	H DC NOK	180	H DC NOK	190 pixels	H DC OK
663	H DC NOK			180pixels	H DC OK	497	H DC NOK	265	H DC NOK			545	H DC NOK	246	H DC NOK		
678	H DC NOK					905	H DC NOK	513	H DC NOK			663	H DC NOK	475	H DC NOK		
685	H DC NOK					286pixels	H DC OK	606	H DC NOK			290 pixels	H DC OK	513	H DC NOK		
905	H DC NOK							671	H DC NOK					355pixels	H DC OK		
274pixels	H DC OK							360pixels	H DC OK								

, *Table 4*,*Table 5* the resulting SWIR dark current status during the last 3 months is reported for respectively LEFT, CENTER and RIGHT camera.

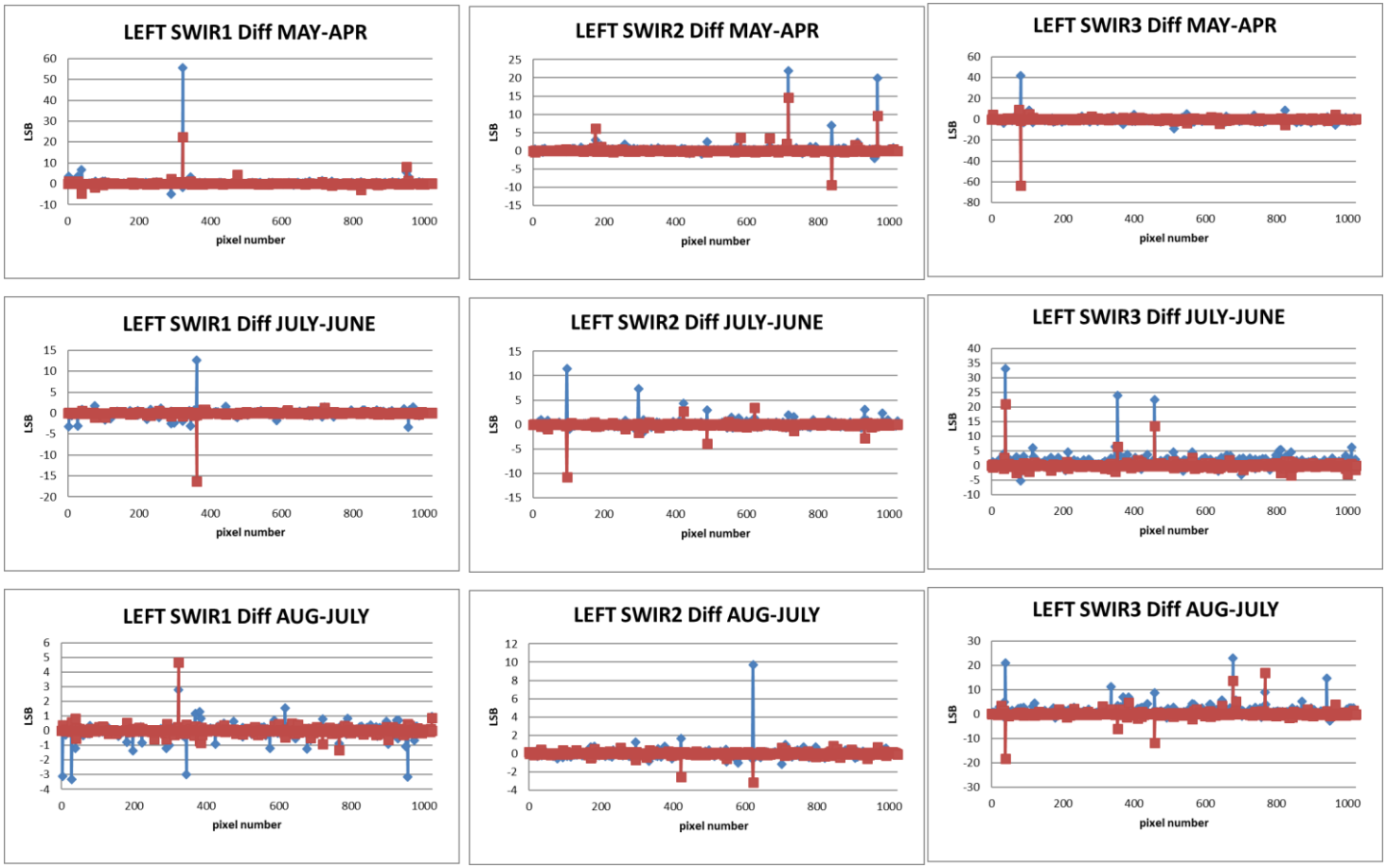


Figure 15. LEFT camera SWIR: Monthly difference (MAY-AUG2019) in dark current (Blue) and standard deviation (Red) of the monthly averaged results.

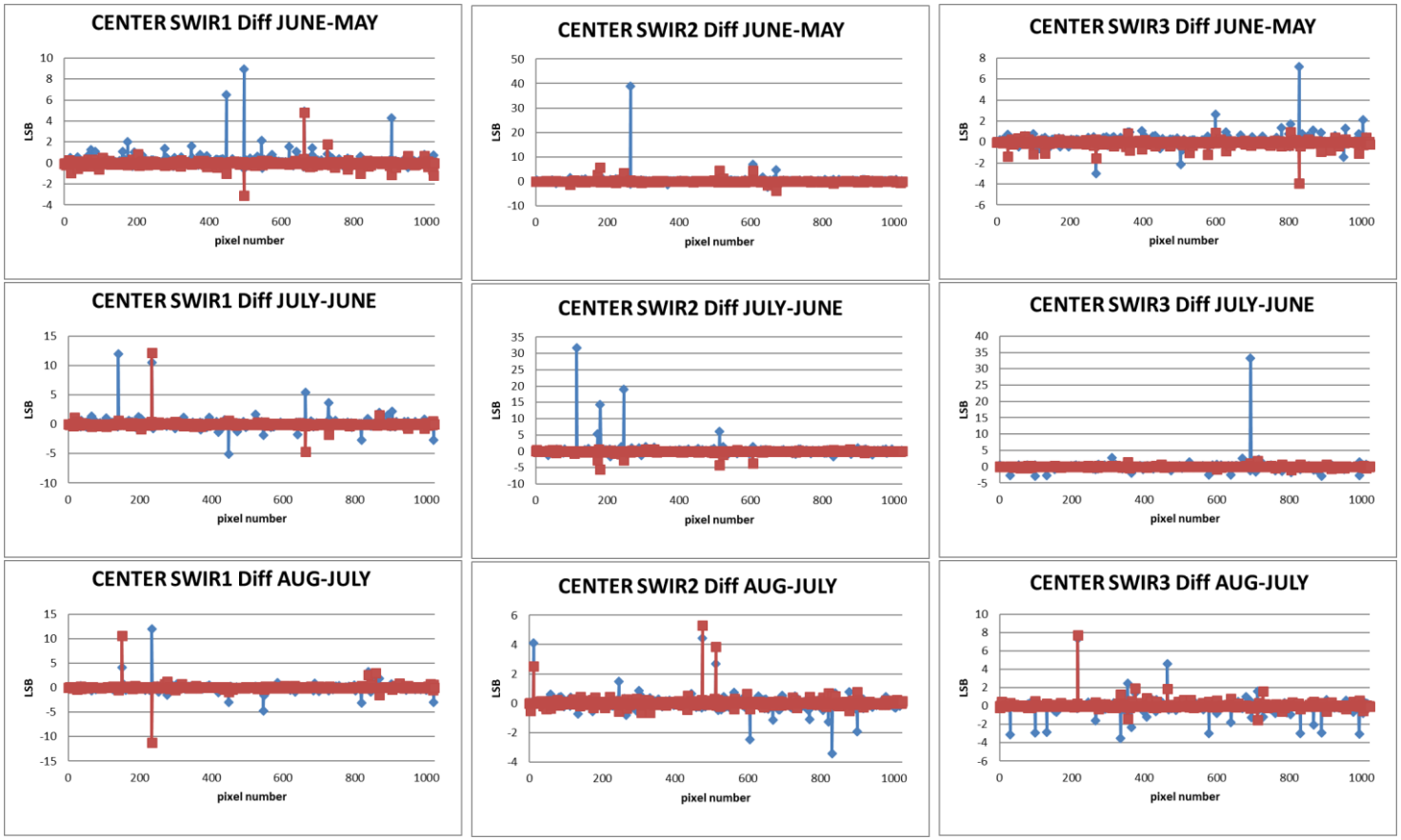


Figure 16. CENTER camera SWIR: Monthly difference (MAY-AUG2019) in dark current (Blue) and standard deviation (Red) of the monthly averaged results.

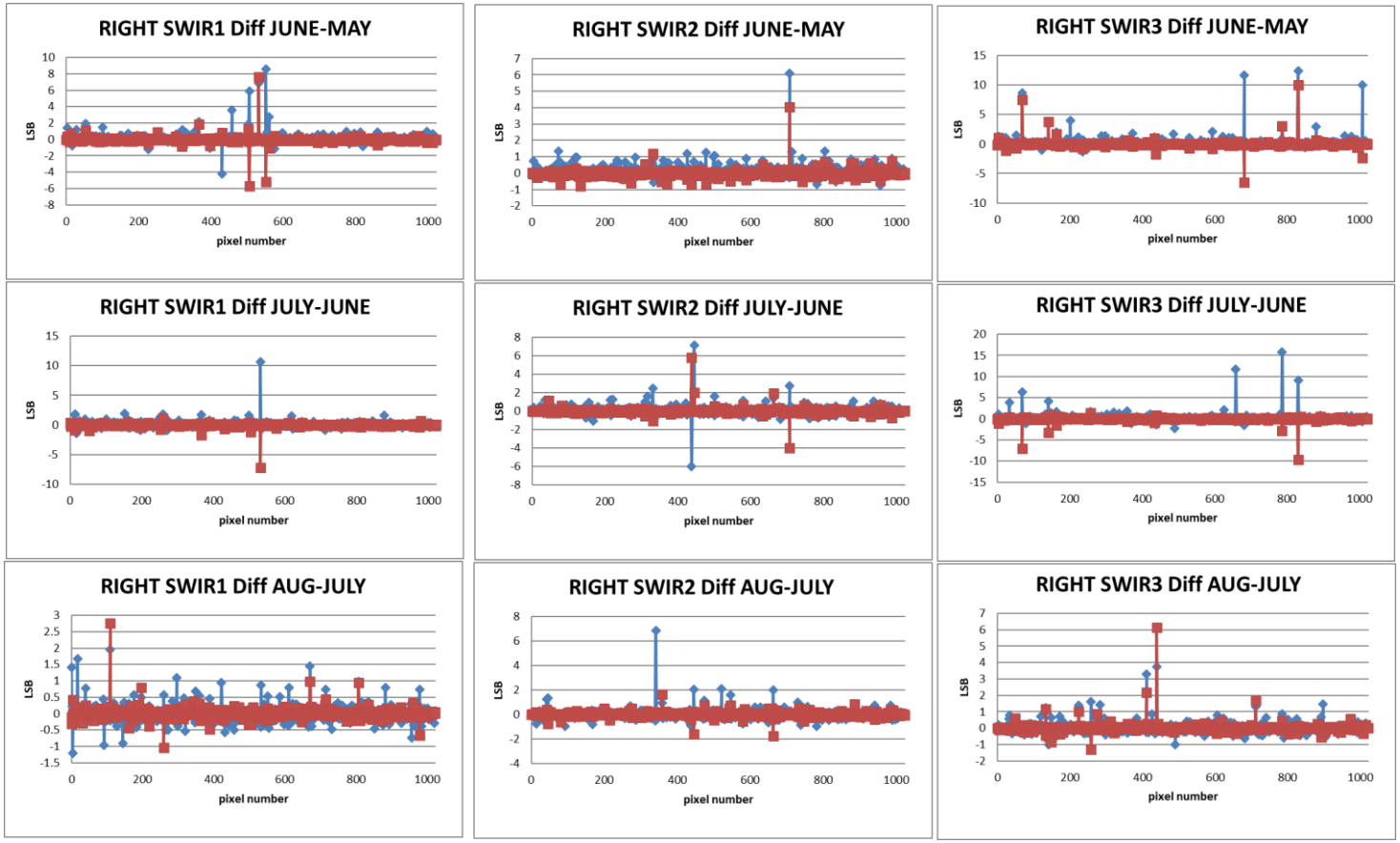


Figure 17. RIGHT camera SWIR: Monthly difference (MAY-AUG2019) in dark current (Blue) and standard deviation (Red) of the monthly averaged results.

LEFT																		
APR-MAY-JUNE						MAY-JUNE-JULY						JUNE-JULY-AUG						
SWIR1		SWIR2		SWIR3		SWIR1		SWIR2		SWIR3		SWIR1		SWIR2		SWIR3		
290	H DC BAD	717	H DC BAD	76	H DC BAD	362	H DC BAD	95	H DC BAD	82	H DC BAD	362	H DC NOK	95	H DC NOK	39	H DC BAD	
323	H DC BAD	967	H DC BAD	82	H DC BAD	290	H DC NOK	175	H DC NOK	4	H DC NOK	275 pixels	H DC OK	296	H DC NOK	458	H DC BAD	
951	H DC BAD	95	H DC NOK	370	H DC BAD	323	H DC NOK	296	H DC NOK	34	H DC NOK			422	H DC NOK	34	H DC NOK	
39	H DC NOK	175	H DC NOK	824	H DC BAD	475	H DC NOK	422	H DC NOK	39	H DC NOK			622	H DC NOK	35	H DC NOK	
362	H DC NOK	489	H DC NOK	4	H DC BAD	951	H DC NOK	489	H DC NOK	76	H DC NOK			414 pixels	H DC OK	82	H DC NOK	
475	H DC NOK	665	H DC NOK	105	H DC NOK	267 pixels	H DC OK	665	H DC NOK	115	H DC NOK					115	H DC NOK	
261 pixels	H DC OK	839	H DC NOK	167	H DC NOK			717	H DC NOK	167	H DC NOK					121	H DC NOK	
		398 pixels	H DC OK	225	H DC NOK			967	H DC NOK	215	H DC NOK					215	H DC NOK	
				281	H DC NOK			407 pixels	H DC OK	225	H DC NOK					336	H DC NOK	
				400	H DC NOK					281	H DC NOK					348	H DC NOK	
				415	H DC NOK					348	H DC NOK					354	H DC NOK	
				513	H DC NOK					354	H DC NOK					355	H DC NOK	
				548	H DC NOK					355	H DC NOK					370	H DC NOK	
				901	H DC NOK					370	H DC NOK					384	H DC NOK	
				966	H DC NOK					415	H DC NOK					438	H DC NOK	
				932pixels	H DC OK					458	H DC NOK					510	H DC NOK	
										510	H DC NOK					563	H DC NOK	
										563	H DC NOK					564	H DC NOK	
										809	H DC NOK					647	H DC NOK	
										812	H DC NOK					678	H DC NOK	
										824	H DC NOK					687	H DC NOK	
										841	H DC NOK					768	H DC NOK	
										901	H DC NOK					809	H DC NOK	
										1011	H DC NOK					812	H DC NOK	
										930 pixels	H DC OK					841	H DC NOK	
																871	H DC NOK	
																941	H DC NOK	
																1011	H DC NOK	
																937 pixels	H DC OK	

Table 3. LEFT SWIR dark current pixel outliers (ID L1A).

CENTER																		
APR-MAY-JUNE						MAY-JUNE-JULY						JUNE-JULY-AUG						
SWIR1		SWIR2		SWIR3		SWIR1		SWIR2		SWIR3		SWIR1		SWIR2		SWIR3		
448	H DC BAD	671	H DC BAD	536	H DC NOK	448	H DC BAD	114	H DC NOK	694	H DC NOK	234	H DC BAD	12	H DC NOK	216	H DC NOK	
277	H DC NOK	265	H DC NOK	632	H DC NOK	663	H DC BAD	173	H DC NOK	830	H DC NOK	140	H DC NOK	114	H DC NOK	464	H DC NOK	
497	H DC NOK	606	H DC NOK	830	H DC NOK	140	H DC NOK	180	H DC NOK	187pixels	H DC OK	150	H DC NOK	173	H DC NOK	694	H DC NOK	
545	H DC NOK	345pixels	H DC OK	832	H DC NOK	234	H DC NOK	246	H DC NOK			448	H DC NOK	180	H DC NOK	190 pixels	H DC OK	
663	H DC NOK			180pixels	H DC OK	497	H DC NOK	265	H DC NOK			545	H DC NOK	246	H DC NOK			
678	H DC NOK					905	H DC NOK	513	H DC NOK			663	H DC NOK	475	H DC NOK			
685	H DC NOK					286pixels	H DC OK	606	H DC NOK			290 pixels	H DC OK	513	H DC NOK			
905	H DC NOK							671	H DC NOK					355pixels	H DC OK			
274pixels	H DC OK							360pixels	H DC OK									

Table 4. CENTER SWIR dark current pixel outliers (ID L1A)

RIGHT																		
APR-MAY-JUNE						MAY-JUNE-JULY						JUNE-JULY-AUG						
506	H DC NOK	438	H DC BAD	682	H DC NOK	509	H DC NOK	438	H DC BAD	68	H DC NOK	532	H DC NOK	341	H DC BAD	68	H DC NOK	
552	H DC NOK	707	H DC BAD	68	H DC NOK	431	H DC NOK	445	H DC BAD	831	H DC NOK	517pixels	H DC OK	438	H DC BAD	141	H DC NOK	
431	H DC NOK	959	H DC BAD	201	H DC NOK	506	H DC NOK	707	H DC BAD	141	H DC NOK			445	H DC BAD	659	H DC NOK	
532	H DC NOK	584pixels	H DC OK	831	H DC NOK	552	H DC NOK	593pixels	H DC OK	201	H DC NOK			601pixels	H DC OK	787	H DC NOK	
504pixels	H DC OK			1009	H DC NOK	509pixels	H DC OK			659	H DC NOK					831	H DC NOK	
				432 pixels	H DC OK					682	H DC NOK					458 pixels	H DC OK	
										787	H DC NOK							
										1009	H DC NOK							
										447 pixels	H DC OK							

Table 5. RIGHT SWIR dark current pixel outliers (ID L1A)

1.4. Bad pixels

There are three new bad pixels identified in this reporting period.

Reporting period Mid-June 019 - Mid September 2019																	
CAMERA	STRIP	pixel numbers (ID L1 A)															
		NEW BAD	BAD (from previous periods)														
left	swir1		3	28	39	104	298	345	352	644	956						
left	swir2		711	717	863												
left	swir3		82	90	172	250	370	419	438	568	759	761					
center	swir1		448	819	1021												
center	swir2	**114**	57	295	769	831	900										
center	swir3		29	30	99	131	448	476	579	640	763	804	889	890	917	938	994
right	swir1																
right	swir2		14	438	470												
right	swir3																

Table 6: Overview Bad pixels

1.5. Radiometric ICP file

The updates to the radiometric ICP file used within the user segment for the processing of the nominal PROBA-V data by PF are listed in the Table 9 for collection 1.

PROBAV_X_R_000_YEARMN01_**101**.xml*	Update dark currents Update of SWIR absolute following linear degradation model**
PROBAV_X_R_000_20161201_01.xml	Update dark currents Update of SWIR absolute following linear degradation model**
PROBAV_X_R_000_20161201_01.xml	Update dark currents Update of SWIR absolute following linear degradation model**
PROBAV_X_R_000_20161201_01.xml	Update dark currents Update of SWIR absolute following linear degradation model**
PROBAV_X_R_000_20161201_01.xml	Update dark currents Update of SWIR absolute following linear degradation model**
PROBAV_X_R_000_20170101_01.xml	Update dark currents Update of SWIR absolute following linear degradation model**
PROBAV_X_R_000_20170120_01.xml	SWIR status map updated : 1 bad pixel added
PROBAV_X_R_000_20170201_01.xml	Update dark currents Update of SWIR absolute following linear degradation model**
PROBAV_X_R_000_20170220_01.xml	SWIR status map updated : 1 bad pixel added

PROBAV_X_R_000_20170301_01.xml	Update dark currents Update of SWIR absolute following linear degradation model**
PROBAV_X_R_000_20170401_01.xml	Update dark currents Update of SWIR absolute following linear degradation model** SWIR status map updated : 1 bad pixel added
PROBAV_X_R_000_2017051_01.xml	Update dark currents Update of SWIR absolute following linear degradation model** Update of LEFT BLUE and CENTER BLUE absolute calibration coefficients following linear degradation model***
PROBAV_X_R_000_20170601_01.xml	Update dark currents Update of SWIR absolute following linear degradation model** Update of LEFT BLUE and CENTER BLUE absolute calibration coefficients following linear degradation model***
PROBAV_X_R_000_20170701_01.xml	Update dark currents Update of SWIR absolute following linear degradation model** Update of LEFT BLUE and CENTER BLUE absolute calibration coefficients following linear degradation model*** SWIR status map updated : 1 bad pixel added
PROBAV_X_R_000_20170801_01.xml	Update dark currents Update of SWIR absolute following linear degradation model** Update of LEFT BLUE and CENTER BLUE absolute calibration coefficients following linear degradation model*** SWIR status map updated : 2 bad pixel added
PROBAV_X_R_000_20170901_01.xml	Update dark currents Update of SWIR absolute following linear degradation model***, new coef applied for RIGHT SWIR strips***** Update of LEFT BLUE and CENTER BLUE absolute calibration coefficients following linear degradation model **with new coef** **** SWIR status map updated : 2 bad pixel added

PROBAV_X_R_000_20171001_01.xml	Update dark currents Update of SWIR absolute following linear degradation model***, new coef applied for RIGHT SWIR strips***** Update of LEFT BLUE and CENTER BLUE absolute calibration coefficients following linear degradation model **with new coef** ****
PROBAV_X_R_000_20171101_01.xml	Update dark currents Update of SWIR absolute following linear degradation model***, new coef applied for RIGHT SWIR strips***** Update of LEFT BLUE and CENTER BLUE absolute calibration coefficients following linear degradation model **with new coef** ****
PROBAV_X_R_000_20171201_01.xml	Update dark currents Update of SWIR absolute following linear degradation model***, new coef applied for RIGHT SWIR strips***** Update of LEFT BLUE and CENTER BLUE absolute calibration coefficients following linear degradation model **with new coef** ****
PROBAV_X_R_000_20180101_01.xml	Update dark currents Update of LEFT and CENTER SWIR absolute following linear degradation model***; **No update of RIGHT SWIR absolute cal**.. Update of LEFT BLUE and CENTER BLUE absolute calibration coefficients following linear degradation model **with new coef** ****
PROBAV_X_R_000_20180201_01.xml	Update dark currents Update of LEFT and CENTER SWIR absolute following linear degradation model***; **No update of RIGHT SWIR absolute cal**.. Update of LEFT BLUE and CENTER BLUE absolute calibration coefficients following linear degradation model **with new coef** ****
PROBAV_X_R_000_20180301_01.xml	Update dark currents Update of LEFT and CENTER SWIR absolute following linear degradation model***; **No update of RIGHT SWIR absolute cal**.. Update of LEFT BLUE and CENTER BLUE absolute calibration coefficients

	following linear degradation model **with new coef** ****
PROBAV_X_R_000_20180401_01.xml	Update dark currents Update of LEFT and CENTER SWIR absolute following linear degradation model***; **No update of RIGHT SWIR absolute cal**.. Update of LEFT BLUE and CENTER BLUE absolute calibration coefficients following linear degradation model **with new coef** ****
PROBAV_X_R_000_20180501_01.xml	Update dark currents Update of LEFT and CENTER SWIR absolute following linear degradation model***; **No update of RIGHT SWIR absolute cal**.. Update of LEFT BLUE and CENTER BLUE absolute calibration coefficients following linear degradation model **with new coef** ****
PROBAV_X_R_000_20180601_01.xml	Update dark currents Update of LEFT and CENTER SWIR absolute following linear degradation model***; **No update of RIGHT SWIR absolute cal**.. Update of LEFT BLUE and CENTER BLUE absolute calibration coefficients following linear degradation model **with new coef** ****
PROBAV_X_R_000_20180701_01.xml	Update dark currents Update of LEFT and CENTER SWIR absolute following linear degradation model***; **No update of RIGHT SWIR absolute cal**.. Update of LEFT BLUE and CENTER BLUE absolute calibration coefficients following linear degradation model **with new coef** ****
PROBAV_X_R_000_20180801_01.xml	Update dark currents Update of LEFT and CENTER SWIR absolute following linear degradation model***; **No update of RIGHT SWIR absolute cal**.. Update of LEFT BLUE and CENTER BLUE absolute calibration coefficients following linear degradation model **with new coef** ****

PROBAV_X_R_000_20180821_01.xml	SWIR status map updated : 1 bad pixel added for SWIR2 center camera + correction for assignment of bad pixel status to wrong pixel ID
PROBAV_X_R_000_20180901_01.xml	Update dark currents Update of LEFT and CENTER SWIR absolute following linear degradation model***; **No update of RIGHT SWIR absolute cal**.. Update of LEFT BLUE and CENTER BLUE absolute calibration coefficients following linear degradation model **with new coef** ****
PROBAV_X_R_000_20181001_01.xml	Update dark currents. Update of LEFT BLUE and CENTER BLUE absolute calibration coefficients following linear degradation model **with new coef** ****
PROBAV_X_R_000_20181101_01.xml	Update dark currents. Update of LEFT BLUE and CENTER BLUE absolute calibration coefficients following linear degradation model **with new coef** ****
PROBAV_X_R_000_20181201_01.xml	Update dark currents. Update of LEFT BLUE and CENTER BLUE absolute calibration coefficients following linear degradation model **with new coef** ****
PROBAV_X_R_000_20190101_01.xml	Update dark currents. Update of LEFT BLUE and CENTER BLUE absolute calibration coefficients following linear degradation model **with new coef** ****
PROBAV_X_R_000_2010201_01.xml	Update dark currents. Update of LEFT BLUE and CENTER BLUE absolute calibration coefficients following linear degradation model **with new coef** ****

PROBAV_X_R_000_20190301_01.xml	Update dark currents. Update of LEFT BLUE and CENTER BLUE absolute calibration coefficients following linear degradation model **with new coef** ****
PROBAV_X_R_000_20190401_01.xml	Update dark currents. Update of LEFT BLUE and CENTER BLUE absolute calibration coefficients following linear degradation model **with new coef** ****
PROBAV_X_R_000_20190501_01.xml	Update dark currents. Update of LEFT BLUE and CENTER BLUE absolute calibration coefficients following linear degradation model **with new coef** **** One new bad pixel added : left SWIR3 PixelID 82 (0-based)
PROBAV_X_R_000_20190601_01.xml	Update dark currents. Update of LEFT BLUE and CENTER BLUE absolute calibration coefficients following linear degradation model **with new coef** **** Two new bad pixel added : left SWIR2 PixelID 717 (0-based) and CENTER SWIR1 PixelID 448
PROBAV_X_R_000_20190701_01.xml	Update dark currents. Update of LEFT BLUE and CENTER BLUE absolute calibration coefficients following linear degradation model **with new coef** **** Update equalization coefficients LEFT and RIGHT SWIR strips based on Yaw maneuver analyses.
PROBAV_X_R_000_20190801_01.xml	Update dark currents. Update of LEFT BLUE and CENTER BLUE absolute calibration coefficients following linear degradation model **with new coef** ****
PROBAV_X_R_000_20190901_01.xml	Update dark currents. Update of LEFT BLUE and CENTER BLUE absolute calibration coefficients following linear degradation model **with new coef** ****

Table 7: Radiometric ICP-file updates Collection 1

2. Geometric Image Quality

2.1. Summary

The quarterly Average Location Error (ALE) over the period 16/6/2018 – 15/9/2019 was 73 m (1σ = 80 m) for all spectral bands (combined cameras). Compared to the previous reporting period, the ALE has increased (deteriorated) by 9%. The total number of ground control points used was 533,018, which is 25% higher than in previous quarter.

The daily average location error compliance (ALE < 300m) was 99.20%, which is 0.04% lower than in previous quarter. The inter-band geometric accuracy range was 32 – 53 m (standard deviation range is 7 – 17 m), which is 0.10 – 0.16 of a pixel (333 m). The average inter-band RED-NIR registration accuracy was 34 m, which is 1 m higher than in previous reporting period.

The multi-temporal geometric accuracy was 81.34% (3.30% lower compared to previous quarter) for the VNIR and 95.08% (0.14% higher compared to previous quarter) for the combined VNIR/SWIR. The multi-temporal accuracies over the last full year are 66.90% and 84.31% for VNIR and VNIR/SWIR, respectively.

The geometric ICP file generated on 8/9/2016, valid from 1/9/2016 has remained valid throughout the reporting period.

2.2. Assessment of the geometric accuracy on L1C data

The absolute location error (ALE) and accompanying standard deviation of the Level1C data is presented in the tables below for each camera, spectral band/strip and reporting month.

CAMERA 1 Mean and standard deviation ALE [m]			
Strip\Period	**16/6/2019 - 15/7/2019**	**16/7/2019 - 15/8/2019**	**16/8/2019 - 15/9/2019**
BLUE	58.88, σ = 35.16	54.07, σ = 31.76	54.83, σ = 33.00
RED	60.45, σ = 36.87	54.82, σ = 32.78	56.64, σ = 34.95
NIR	59.77, σ = 35.14	55.49, σ = 32.16	56.37, σ = 33.87
SWIR1	86.55, σ = 53.62	79.16, σ = 49.09	81.21, σ = 51.37
SWIR2	60.31, σ = 33.57	55.62, σ = 30.78	56.94, σ = 31.92
SWIR3	57.23, σ = 32.54	50.07, σ = 28.24	52.39, σ = 30.31

Table 8: Mean absolute location error and standard deviation (σ) for camera 1.

CAMERA 2 Mean and standard deviation ALE [m]			
Strip\Period	**16/6/2019 - 15/7/2019**	**16/7/2019 - 15/8/2019**	**16/8/2019 - 15/9/2019**
BLUE	66.20, σ = 39.12	53.27, σ = 31.38	57.94, σ = 35.83
RED	67.83, σ = 39.50	54.03, σ = 31.60	59.60, σ = 36.79
NIR	64.37, σ = 37.47	51.11, σ = 30.16	57.11, σ = 35.29
SWIR1	66.13, σ = 38.60	53.33, σ = 31.11	59.35, σ = 35.15
SWIR2	65.65, σ = 39.06	52.43, σ = 31.03	58.47, σ = 36.30
SWIR3	65.20, σ = 38.91	51.69, σ = 30.73	57.76, σ = 36.09

Table 9: Mean absolute location error and standard deviation (σ) for camera 2.

CAMERA 3 Mean and standard deviation ALE [m]			
Strip\Period	**16/6/2019 - 15/7/2019**	**16/7/2019 - 15/8/2019**	**16/8/2019 - 15/9/2019**
BLUE	70.26, σ = 39.47	63.42, σ = 33.34	71.26, σ = 38.88
RED	71.24, σ = 41.69	67.18, σ = 37.25	75.81, σ = 43.30
NIR	64.42, σ = 37.78	57.94, σ = 32.74	66.42, σ = 38.67
SWIR1	64.56, σ = 36.83	55.92, σ = 30.81	60.58, σ = 33.86
SWIR2	68.42, σ = 39.15	60.76, σ = 33.82	67.28, σ = 38.37
SWIR3	88.71, σ = 51.89	82.92, σ = 47.81	90.56, σ = 53.67

Table 10: Mean absolute location error and standard deviation (σ) for camera 3.

In the reporting period the average location error of the Level 1C data was 63.1 m, which is 1.6 m (3%) lower than in the previous quarter.

2.3. Assessment of the geometric accuracy on L2 data

2.3.1. Absolute geometric accuracy

The daily summary of the L2 data absolute location error for all spectral bands is presented in the tables and figures below for the three reporting months:

- from 16/6/2019 – 15/7/2019
- from 16/7/2019 – 15/8/2019
- from 16/8/2019 – 15/9/2019

The tables list:

- The day of the measurement in format dd-mm-yy
- The daily achieved compliance (%B) for the BLUE band (% of GCP where ALE <=300m)
- The daily achieved compliance (%R) for the RED band (% of GCP where ALE <=300m)
- The daily achieved compliance (%N) for the NIR band (% of GCP where ALE <=300m)
- The daily achieved compliance (%S) for the SWIR band (% of GCP where ALE <=450m)

- The number of GCP per day (NB-B) used to derive the absolute location error ALE for the BLUE band
- The daily average ALE (in m) for the BLUE band (MU-B)
- The daily ALE standard deviation (in m) for the BLUE band (STD-B)

- The number of GCP per day (NB-R) used to derive the absolute location error ALE for the RED band
- The daily average ALE (in m) for the RED band (MU-R)
- The daily ALE standard deviation (in m) for the RED band (STD-R)

- The number of GCP per day (NB-N) used to derive the absolute location error ALE for the NIR band
- The daily average ALE (in m) for the NIR band (MU-N)
- The daily ALE standard deviation (in m) for the NIR band (STD-N)

- The number of GCP per day (NB-S) used to derive the absolute location error ALE for the SWIR band
- The daily average ALE (in m) for the SWIR band (MU-S)
- The daily ALE standard deviation (in m) for the SWIR band (STD-S)

Day	%B	%R	%N	%S	NB-B	MU-B	STD-B	NB-R	MU-R	STD-R	NB-N	MU-N	STD-N	NB-S	MU-S	STD-S
16/06/2019	98.77	99.26	99.43	99.75	40479	68.23	99.21	52361	60.93	79.12	57111	54.85	69.2	54309	61.15	75.75
17/06/2019	99.07	99.41	99.47	99.78	44600	63.22	89.4	55790	56.25	71.12	59507	53.39	66.44	59276	57.37	73.42
18/06/2019	99.13	99.47	99.58	99.81	43391	62.44	83.29	52890	56.96	69.63	59746	52.94	63.82	59592	56.03	66.55
19/06/2019	99	99.34	99.44	99.77	42266	68.12	93.36	51614	61.58	81.74	55584	57.62	73.79	55452	60.04	70.78
20/06/2019	99.14	99.36	99.43	99.76	41504	65.16	83.57	51073	59.44	73.83	54309	56.88	73.58	54375	59.22	72.43
21/06/2019	98.98	99.26	99.45	99.81	39492	65.87	92.12	49080	59.57	79.39	53661	56.45	66.62	54094	58.43	68.19
22/06/2019	98.92	99.45	99.51	99.81	38117	66.27	83.11	46721	59.33	74.31	52030	54.35	61.55	53120	58.16	62.91
23/06/2019	98.92	99.29	99.48	99.79	41275	68.98	89.95	49184	63.86	78.57	56390	56.88	69.66	55763	60.29	64.72
24/06/2019	98.6	99.1	99.31	99.76	40664	82.18	96.54	49568	76.51	83.72	54836	68.97	72.94	52868	71.6	73.46
25/06/2019	98.78	99.11	99.36	99.77	39256	73.82	83.2	49519	69.37	81.39	54973	62.05	74.13	53549	65.96	72.16
26/06/2019	98.79	99.06	99.29	99.74	39255	79.61	85.6	47368	75.38	81.63	53416	66.92	70.94	52464	70.43	75.75
27/06/2019	98.71	99.15	99.4	99.78	36935	82.34	89.73	44837	78.57	82.32	52431	70.83	72.99	51526	74.5	71.88
28/06/2019	98.42	98.85	99.15	99.7	36864	87.63	100.17	44398	83.47	82.77	51302	76.1	78.94	50067	79.54	80.09
29/06/2019	98.48	98.97	99.23	99.72	38772	87.71	90.91	47051	83.94	81.78	50829	78.54	76.89	50105	81.37	81.64
30/06/2019	98.76	99.1	99.19	99.63	31600	83.1	94.46	38267	79.11	82.74	39840	76.19	79.29	36209	77.07	86.07
01/07/2019	98.88	99.22	99.3	99.75	40189	84.42	87.4	49188	80.26	72.48	52243	75.89	70.54	53839	77.82	74.42
02/07/2019	98.76	99.09	99.3	99.76	39778	82.18	97.63	48484	78.35	83.7	52307	71.56	72.96	52088	75.11	72.32
03/07/2019	98.87	99.12	99.27	99.67	38564	75.64	94.94	46800	72.32	84.87	50096	65.71	76.9	47995	70.55	81.71
04/07/2019	98.85	99.18	99.37	99.74	39162	78.35	93.66	46912	74.52	83.17	51845	69.94	71.01	49724	72.54	74.87
05/07/2019	98.77	99.04	99.17	99.69	35966	83.88	89.72	42802	80.79	85.69	46282	76.77	79.31	46093	78.81	81.67
06/07/2019	98.54	98.81	99.02	99.77	33020	96.68	103.56	38789	92.93	84.01	42986	87.32	84.28	43749	88.41	77.66
07/07/2019	97.8	97.91	98.32	99.61	31333	107.95	107.33	37168	107.56	101.9	42386	98.57	93.59	41605	98.91	94.66
08/07/2019	98.07	98.26	98.25	99.65	35199	105.96	98.61	42193	103.9	92.97	44517	96.05	86.72	43906	94.69	91.14
09/07/2019	98.29	98.41	98.68	99.71	36655	101.98	93.27	44084	98.94	88.28	47924	91.42	85.79	48129	88.29	82.2
10/07/2019	98.98	99.23	99.42	99.77	39206	83.91	90.22	46512	79.12	76.46	51966	72.03	66.09	52802	74.53	72.32
11/07/2019	98.89	99.3	99.39	99.78	35854	70.93	86.9	43958	66.29	79.83	48084	60.31	76.72	49260	61.92	66.98
12/07/2019	98.93	99.2	99.33	99.71	37996	69.77	86.44	47442	64.83	76.38	49806	58.68	77.96	49744	63.21	75.32
13/07/2019	98.74	99.19	99.38	99.75	38070	69.2	95.08	46544	62.61	78.27	51404	56.75	66.99	50640	62.67	73.86
14/07/2019	99.09	99.29	99.41	99.76	42111	65.19	84.74	51013	61.05	77.86	55510	55.8	69.34	54564	62.54	75.5
15/07/2019	98.86	99.4	99.54	99.76	39183	66.76	90.69	45404	59.72	75.8	47448	54.96	69.6	44979	60.44	73.5
Averages	**98.76**	**99.09**	**99.26**	**99.74**	**38558**	**78.25**	**91.83**	**46900**	**73.58**	**80.86**	**51358**	**67.82**	**73.95**	**50729**	**70.72**	**75.46**

Table 11: Daily achieved compliance and the daily average location error (in m) for all spectral bands in the period 16/6/2019 – 15/7/2019.

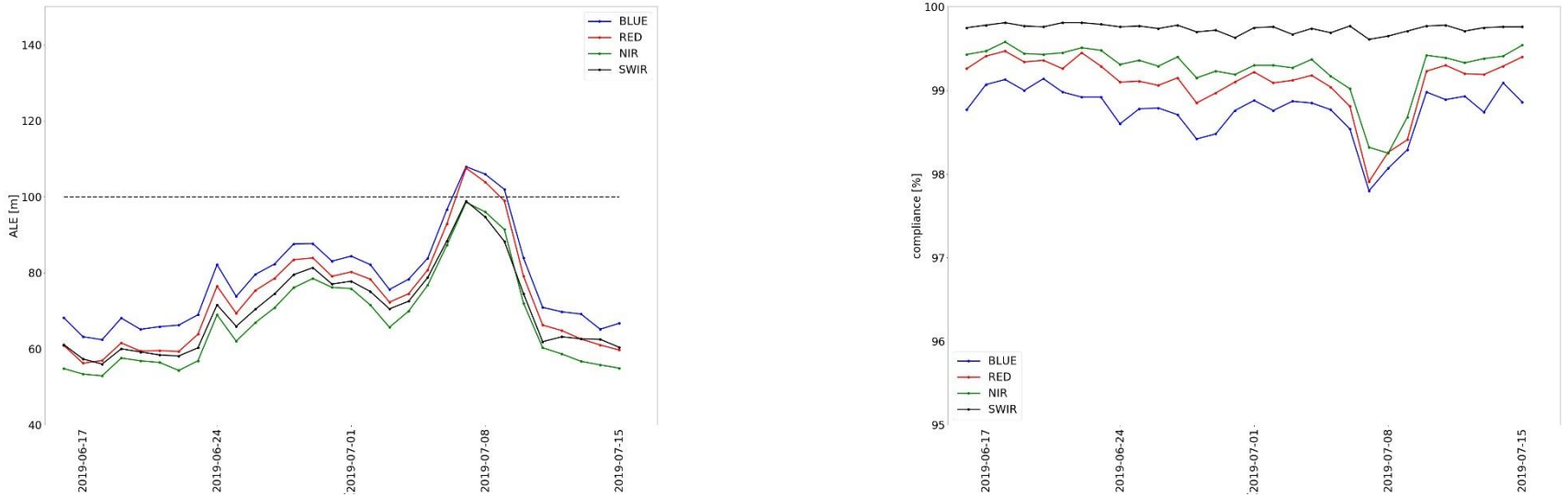


Figure 18: Daily average location error in the period from 16/6/2019 – 15/7/2019 (left) and the average daily compliance of the spectral bands (right).

Day	%B	%R	%N	%S	NB-B	MU-B	STD-B	NB-R	MU-R	STD-R	NB-N	MU-N	STD-N	NB-S	MU-S	STD-S
16/07/2019	98.85	99.29	99.4	99.71	34830	68.71	90.92	44492	61.93	78.61	49248	57.52	69.54	49296	62.18	71.81
17/07/2019	98.85	99.23	99.42	99.71	36144	69.43	94.6	45264	63.17	74.67	49386	58.37	71.44	49051	62.51	80.44
18/07/2019	98.91	99.24	99.4	99.72	38731	71.25	90.96	48734	67.4	77.92	53138	62.82	85.06	53654	64.48	83.31
19/07/2019	98.95	99.31	99.4	99.72	38114	79.76	98.04	47061	75.86	80.11	51584	69.73	66.35	52368	71.9	80.27
20/07/2019	98.81	99.19	99.33	99.78	33257	80.78	94.81	42111	76.64	84.31	47280	69.23	73.27	48157	70.94	67.84
21/07/2019	98.91	99.16	99.37	99.73	37663	71.9	85.73	48018	68.61	83.19	53475	60.72	66.98	52121	64.76	73.73
22/07/2019	98.8	99.14	99.33	99.72	37290	72.99	86.25	46980	69.97	73.63	53647	63.53	72.24	51420	67.37	72.16
23/07/2019	98.99	99.26	99.4	99.73	36093	73.09	90.16	45102	69.15	74.29	50340	62.82	70.36	50591	67.13	75.44
24/07/2019	98.96	99.42	99.58	99.76	29280	69.93	87.27	36745	64.11	77.22	42670	59.81	69.67	40580	64.29	73.76
25/07/2019	98.86	99.24	99.44	99.78	36790	72.29	93.64	46663	67.54	83.74	54605	61.21	67.09	52051	65.04	74.66
26/07/2019	98.88	99.28	99.47	99.75	35767	70.2	98.3	45415	64.1	77.19	51241	57.8	66.48	48590	63.01	76.15
27/07/2019	98.81	99.31	99.44	99.76	38451	67.87	87.37	47798	61.85	69.94	52339	58.66	69.73	51430	60.93	67.12
28/07/2019	99	99.5	99.56	99.81	39909	65.52	89.71	49358	57.88	64.58	53851	54.92	66.53	53852	57.76	69.1
29/07/2019	98.89	99.34	99.52	99.78	35283	66.93	104.22	44483	60.99	82.57	49923	56.63	66.98	50576	57.68	67.25
30/07/2019	98.87	99.28	99.45	99.74	38374	68.26	96.43	47708	62.75	74.57	51121	60.89	68.3	50603	63.43	80.08
31/07/2019	98.87	99.2	99.34	99.68	29264	69.06	90.9	36273	62.83	76.11	36835	59.16	66.06	30591	63.59	76.46
01/08/2019	99.16	99.45	99.58	99.77	38343	64.73	92.03	46775	59.53	71.68	53367	56.62	64.49	52113	59.36	67.59
02/08/2019	99.17	99.44	99.57	99.78	36514	65.4	84.67	44514	61.87	72.38	52549	58.55	63.96	52059	61.32	72.3
03/08/2019	98.98	99.38	99.42	99.73	31772	72.03	94.31	38389	66.19	76.35	42443	63.72	74.95	42573	66.13	74.44
04/08/2019	98.54	98.94	99	99.72	33649	92.54	99.17	41755	89.15	87.37	45395	83.22	78.79	44458	84.38	80.4
05/08/2019	96.86	97.09	97.36	99.63	30556	135.9	110.51	36716	130.89	97.24	39675	122.21	88.63	40226	118.59	85.59
06/08/2019	96.87	97.13	97.56	99.65	28922	136.21	108.7	34615	128.66	97.6	38278	118	89.68	39411	117.4	92.73
07/08/2019	97.19	97.92	98.28	99.7	26555	120.78	114.77	32739	113.01	98.89	38057	97.7	84	38329	100.53	84.99
08/08/2019	97.68	98.02	98.14	99.65	31467	109.18	102.01	38480	103.7	90.47	41920	91.13	86.05	43547	93.12	90.68
09/08/2019	98.31	98.77	98.99	99.7	34440	95.97	106.14	42458	90.04	82.34	43727	81.35	80.49	44910	83.97	79.98

10/08/2019	98.9	99.11	99.24	99.71	36289	85.63	88.59	43120	81.21	79.81	45561	73.66	74.66	45860	77.67	83.13
11/08/2019	98.83	99.25	99.41	99.75	32614	72.99	89.03	39713	67.38	80.21	43498	61.19	69.42	44021	64.67	73.32
12/08/2019	99.02	99.33	99.45	99.76	37582	70.82	88.86	45800	64.81	79.56	50435	58.4	72.6	51985	61.76	72.53
13/08/2019	98.76	99.13	99.27	99.72	40324	77.73	89.83	49440	71.68	74.09	52393	65.7	73.33	51801	68.6	78.92
14/08/2019	98.74	99.06	99.24	99.74	38548	77.84	93.35	47092	73.95	76.64	50810	69.23	75.73	50442	70.54	73.42
15/08/2019	99.04	99.33	99.44	99.73	37974	75.34	91.78	44684	70.8	75.69	48064	66.63	67.09	49402	69.74	73.74
Averages	**98.65**	**99.02**	**99.19**	**99.73**	**35186**	**80.36**	**94.61**	**43499**	**75.09**	**79.77**	**47963**	**69.07**	**72.9**	**47615**	**71.77**	**76.56**

Table 12: Daily achieved compliance and the daily average location error (in m) for all spectral bands in the period 16/7/2019 – 15/8/2019.

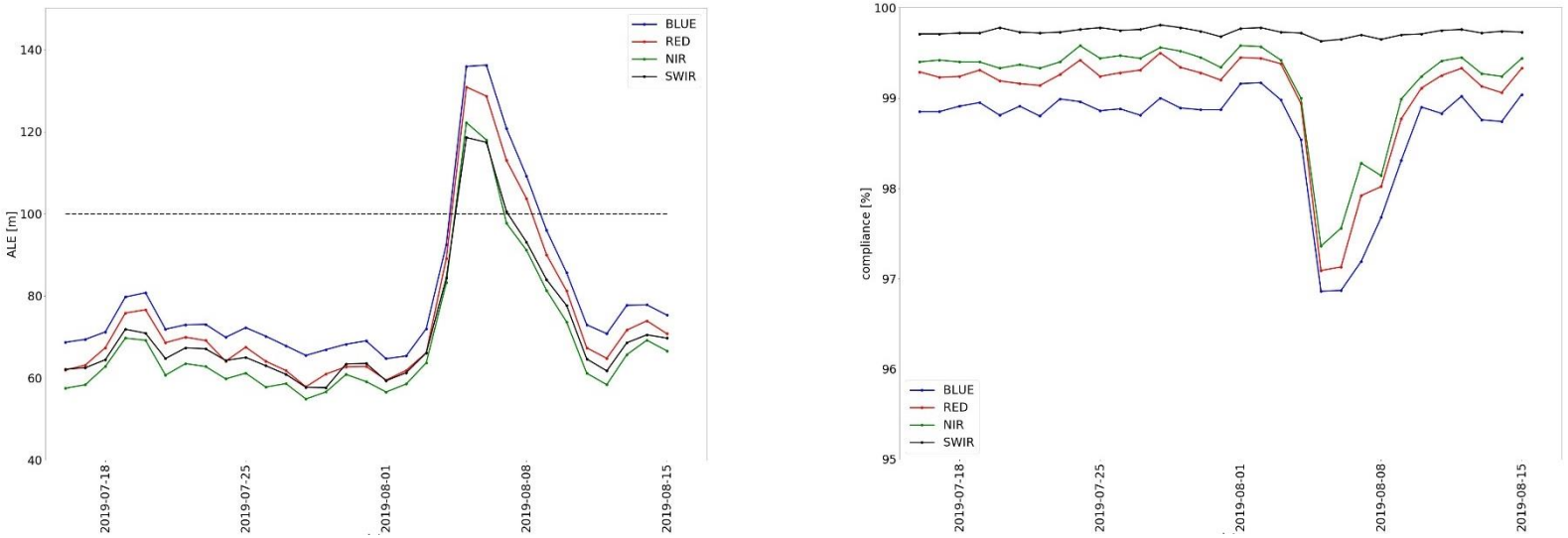


Figure 19: Daily average location error in the period from 16/7/2019 – 15/8/2019 (left) and the average daily compliance of all spectral bands (right).

Day	%B	%R	%N	%S	NB-B	MU-B	STD-B	NB-R	MU-R	STD-R	NB-N	MU-N	STD-N	NB-S	MU-S	STD-S
16/08/2019	98.83	99.17	99.29	99.77	33068	78.18	95.06	40559	73.07	80.54	44737	67.24	70.58	45989	69.31	69.67
17/08/2019	98.69	99.16	99.24	99.71	34734	84.64	92.27	43159	78.38	75.66	46676	72.49	70.84	46054	75.08	80.99
18/08/2019	98.7	99.13	99.18	99.72	36494	85.8	93.7	44330	79.96	75.74	48044	73.08	76.97	47344	76.83	77.21
19/08/2019	98.81	99.2	99.36	99.76	38343	74.35	91.04	45934	68.17	71.4	50223	62.62	71.64	50447	65.35	74.54
20/08/2019	99.06	99.47	99.57	99.81	40814	73.21	89.11	49005	66.28	69.18	54856	60.52	65.32	57200	63.75	69.36
21/08/2019	98.94	99.27	99.43	99.74	36895	72.43	86.54	43821	66.74	73.25	47585	60.3	71.59	50864	62.55	71.2
22/08/2019	99.03	99.37	99.42	99.73	29812	80.88	89.34	36309	73.19	70.05	37942	68.04	78.71	40524	69.66	79.52
23/08/2019	98.94	99.27	99.34	99.69	37005	75.55	88.63	44025	69.6	70.79	46271	65.31	72.91	47994	65.39	73.68
24/08/2019	99.06	99.47	99.57	99.78	38310	67.02	78.86	46139	61.67	69.24	52377	57.77	64.37	53096	59.64	64
25/08/2019	98.95	99.34	99.44	99.8	34667	70.32	85.88	42562	65.17	71.11	49156	61.63	65.57	51214	62	65.65
26/08/2019	98.71	99.09	99.21	99.72	28755	88.37	102.12	33466	84.2	80.79	33714	78.86	76.05	35973	79.27	78.41
27/08/2019	98.61	98.96	99.16	99.7	35773	84.97	95.07	42095	80.47	79.51	47278	75.13	75.82	46675	75.55	82.37
28/08/2019	99.16	99.36	99.52	99.83	34619	66.76	83.28	42040	62.66	71.89	46825	58.87	57.48	49661	59.35	60.17
29/08/2019	99.07	99.48	99.57	99.79	36416	66.73	80.32	44949	61.51	67.88	49552	58.97	65.03	53844	59.79	67.02
30/08/2019	98.7	99.11	99.3	99.71	35278	79.33	92.34	42846	74.5	83.73	46889	70.14	79.54	49750	69.63	70.08
31/08/2019	98.61	99.04	99.27	99.78	34488	81.59	96.05	39876	75.82	86.68	39596	71.92	74.33	40809	71.37	80.14
01/09/2019	98.86	99.16	99.37	99.77	40730	73.14	85.46	48200	68.6	82.86	50872	63.39	66.49	53317	63.88	68.64
02/09/2019	99.14	99.42	99.54	99.78	38437	65.37	85.58	45531	60.28	71.35	48718	56.35	62.82	51705	58.35	69.94
03/09/2019	99.09	99.4	99.46	99.81	36146	67.82	86.99	43416	62.44	72.37	46378	59.37	73.79	50038	59.83	65.94
04/09/2019	98.84	99.14	99.36	99.67	36897	66.26	99.96	44786	59.56	79.88	47198	55.71	71.77	48440	58.2	79.03
05/09/2019	98.76	99.29	99.46	99.76	33793	64.92	89.96	41382	59.44	77.97	44318	56.33	68.13	44380	59.94	71.22
06/09/2019	99.06	99.4	99.53	99.76	36055	60.07	77.5	44510	55	66.04	47814	52.27	63.54	49418	56.61	68.18
07/09/2019	99.1	99.46	99.5	99.81	33127	61.77	89.87	40348	54.83	64.36	43518	52.17	64.11	46448	55.33	64.6
08/09/2019	99.02	99.43	99.43	99.72	30028	67.33	98.4	37496	59.89	82.52	39885	56.3	77.81	42531	60.03	73.58
09/09/2019	98.88	99.36	99.49	99.77	37699	67.71	90.81	45647	59.11	67.77	49648	54	64.66	51625	57.61	71.74
10/09/2019	99.07	99.38	99.46	99.78	38852	66.34	84.14	47005	59.83	71.98	51576	55.2	66.96	53891	57.66	70.25
11/09/2019	99.32	99.47	99.53	99.81	37739	67.54	85.34	43998	62	67.53	46736	57.73	64.34	50928	60.99	69.97
12/09/2019	98.92	99.24	99.29	99.79	35061	85.04	89.32	40520	80.52	82.96	43937	75.13	72.49	47732	78.01	73.48
13/09/2019	98.11	98.37	98.57	99.66	33961	109.09	104.54	38729	104.91	90.24	43304	96.51	83.38	44727	96.33	79.69
14/09/2019	97.61	97.77	97.77	99.64	30747	121.12	111.78	35630	118.81	96.11	38650	109.14	90.53	39401	107.41	89.96
15/09/2019	96.6	96.83	96.75	99.68	30376	130.56	106.54	35529	127.35	92.03	35662	121.19	98.56	36636	114.39	85.89
Averages	**98.78**	**99.13**	**99.24**	**99.75**	**35326**	**77.56**	**91.15**	**42382**	**72.06**	**76.24**	**45804**	**67.22**	**71.81**	**47698**	**68.68**	**73.1**

Table 13: Daily achieved compliance and the daily average location error (in m) for all spectral bands in the period 16/8/2019 – 15/9/2019.

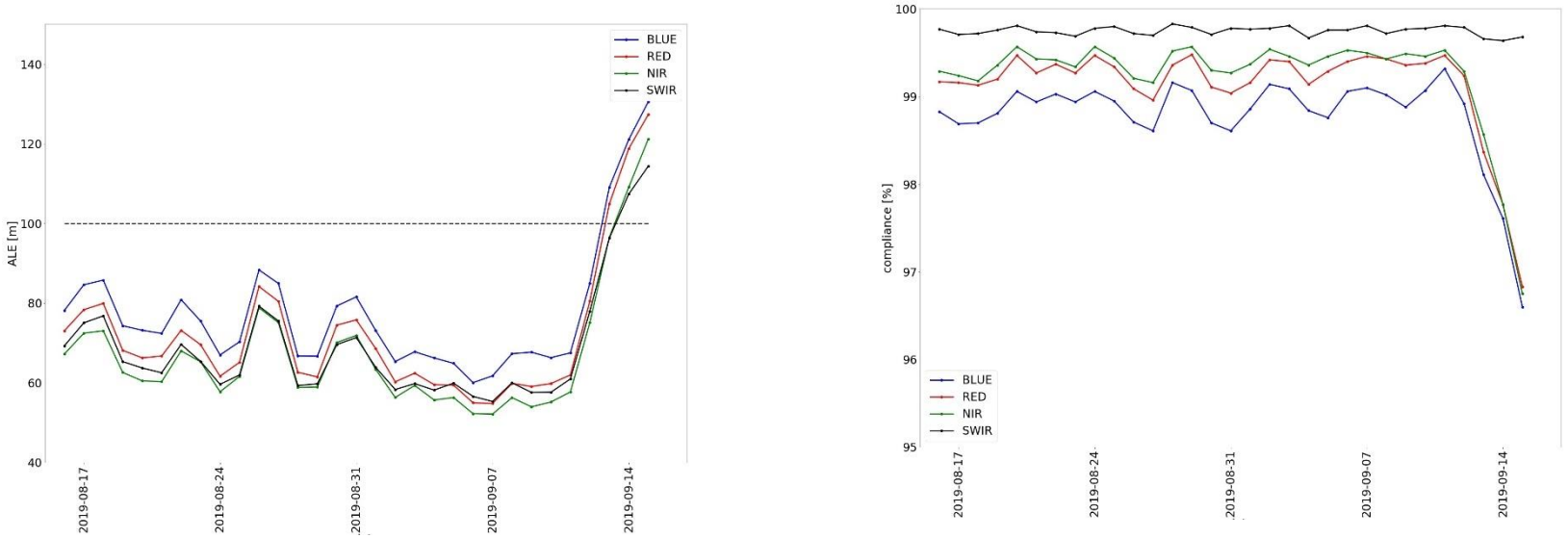


Figure 20: Daily average location error in the period from 16/8/2019 – 15/9/2019 (left) and the average daily compliance of all spectral bands (right).

2.3.2. Inter-band geometric accuracy

The monthly average inter-band geolocation error for all spectral band combinations was as follows:

Band pair	Inter-band error [m]
BLUE-RED	32.70, σ = 9.83
BLUE-NIR	50.22, σ = 16.95
BLUE-SWIR	52.74, σ = 15.49
RED-NIR	33.83, σ = 11.51
RED-SWIR	43.12, σ = 9.36
NIR-SWIR	41.43, σ = 7.90

Table 14: Inter-band geolocation accuracy and standard deviation for period 16/6/2018 – 15/7/2019 for the combined cameras, at 95% confidence level.

Band pair	Inter-band error [m]
BLUE-RED	32.51, σ = 9.64
BLUE-NIR	48.79, σ = 15.27
BLUE-SWIR	51.00, σ = 13.74
RED-NIR	33.78, σ = 11.90
RED-SWIR	42.77, σ = 9.60
NIR-SWIR	40.96, σ = 7.72

Table 15: Inter-band geolocation accuracy and standard deviation for period 16/7/2019 – 15/8/2019 for the combined cameras, at 95% confidence level.

Band pair	Inter-band error [m]
BLUE-RED	31.77, σ =9.31
BLUE-NIR	47.49, σ = 15.18
BLUE-SWIR	48.17, σ = 12.46
RED-NIR	33.26, σ = 12.82
RED-SWIR	40.20, σ = 8.74
NIR-SWIR	39.34, σ = 7.38

Table 16: Inter-band geolocation accuracy and standard deviation for period 16/8/2019 – 15/9/2019 for the combined cameras, at 95% confidence level.

For the combined cameras, the inter-band geometric accuracy range was 32 – 53 m (standard deviation range is 7 – 17 m), which is 0.10 – 0.16 of a pixel (333 m). The average inter-band RED-NIR registration accuracy was 34 m, which is 1 m higher than in previous reporting period.

2.3.3. Multi-temporal geometric accuracy

During this reporting period the multi-temporal compliance of the geometric accuracy was:

- 81.34% for the VNIR sensor (197,964 GCPs used),
- 95.08% for the VNIR/SWIR combined (219,219 GCPs used).

The compliance values are 3.30% lower and 0.14% higher than in the previous quarter for VNIR and VNIR/SWIR, respectively.
The multi-temporal accuracies over the last full year for VNIR and VNIR/SWIR are 66.90% and 84.31%.

For the VNIR the multi-temporal geometric accuracy is below the requirements. A map of regions with decreased multi-temporal geometric accuracy is presented in

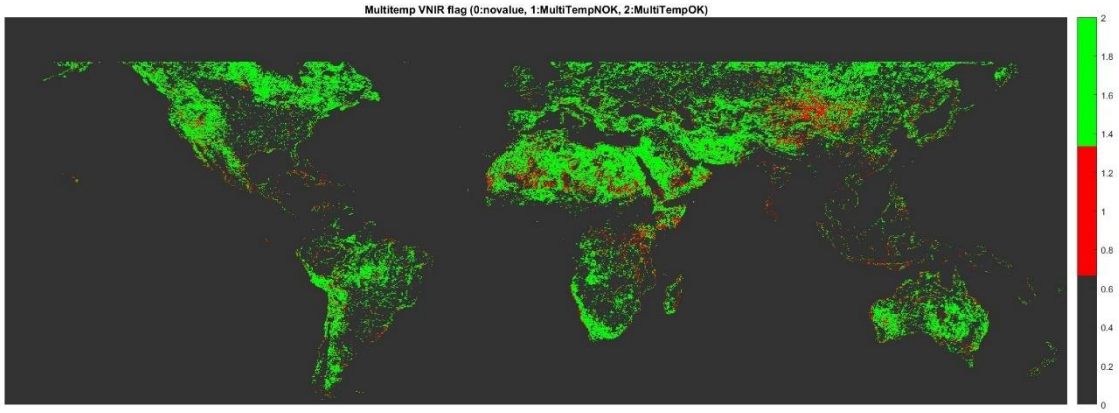


Figure 21.

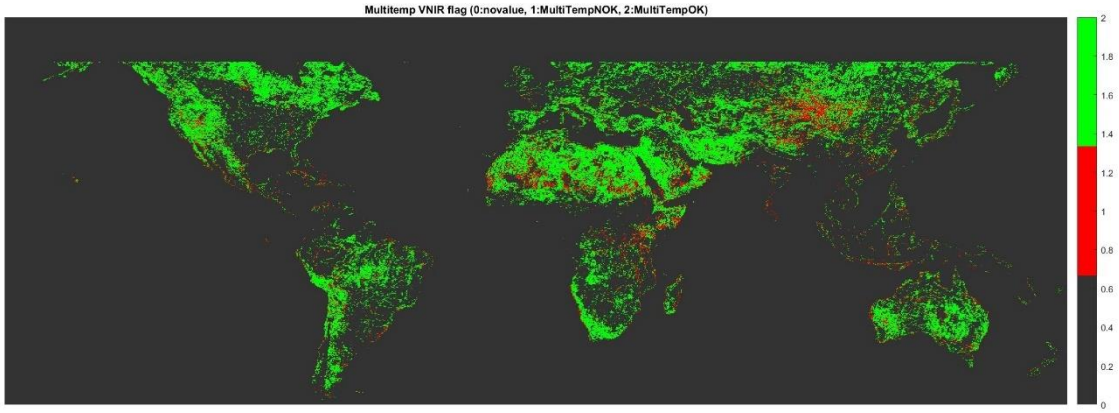


Figure 21: Multi-temporal geometric accuracy for the VNIR sensor for 16/6/2019 – 15/9/2019. Compliant areas are marked in green; areas with accuracy below 95% are marked in red. Grey areas represent no data.

For the combined VNIR/SWIR the multi-temporal geometric accuracy is compliant with the requirements. A map of regions with decreased multi-temporal geometric accuracy is presented in 22.

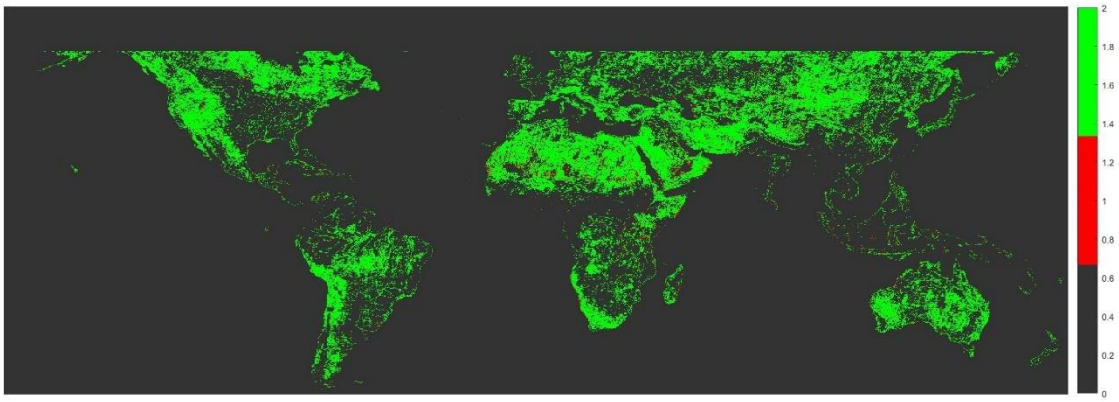


Figure 22: Multi-temporal geometric accuracy for the VNIR/SWIR combined for 16/6/2019 – 15/9/2019. Compliant areas are marked in green; areas with accuracy below 95% are marked in red. Grey areas represent no data.

2.4. Geometric ICP file

On 08.09.2016 a new file with validity date set to 01.09.2016 was created.

ICP filename	Description
PROBAV_ICP_GEOMETRIC#LEFT_20160901_V01 PROBAV_ICP_GEOMETRIC#CENTER_20160901_V01 PROBAV_ICP_GEOMETRIC#RIGHT_20160901_V01	Correction for the gradual degradation observed in the last week of August and first week of September 2016.

3. Reference documents

RD-1	PROBA-V Commissioning Report Annex 1-Radiometric Calibration Results [N77D7-PV02-US-20-CRPT-Annex1-RadiometricCalibartion-v1_3]
RD-2	PROBA-V Commissioning Report Annex 2-Geometric Calibration Results [N77D7-PV02-US-20-CRPT-Annex2-GeometricCalibartion-v1_3]
LIT1	Govaerts Y., Sterckx S. and Adriaensen S. (2013) "Use of simulated reflectances over bright desert target as an absolute calibration reference" Remote Sensing Letters, Vol. 4, Iss. 6, 2013.
LIT2	S. Adriaensen, K. Barker, L. Bourg , M. Bouvet, B. Fougnie, Y. Govaerts, P. Henry, C. Kent, D. Smith, S. Sterckx. "CEOS IVOS Working Group 4: Intercomparison of vicarious calibration methodologies and radiometric comparison methodologies over pseudo-invariant calibration sites A Report to the CEOS/IVOS Working Group", 2012
LIT3	Sterckx S., Adriaensen S., Livens, L., "Rayleigh, Deep Convective Clouds and Cross Sensor Desert vicarious calibration validation for the PROBA-V mission." IEEE Transactions on Geoscience and Remote Sensing. Inter-Calibration of Satellite Instruments Special Issue. Vol.51:3, 1437 – 1452.

Table 17: Reference Documents