QUARTERLY IMAGE QUALITY REPORT

IQR#018

Reporting period from 16/03/2018 to 15/06/2018

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DOCUMENT CONTROL

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Change record

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1.0	20/06/2018	All	Initial version	

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1. Radiometric Image Quality

1.1. Summary

Although a degradation model for center and left BLUE strips is in place since May 2017 months, some decrease in the DCC inter-band calibration results is still observed for the blue band. This decrease might also be linked to increase in responsivity observed for the RED strips.

It should be noted that since 2018 a degradation model is no longer in use for the right SWIR strips. In some of the other SWIR strips we start to see a slight overcorrection of the degradation. Currently a degradation model is still in place for these SWIR strips. It will have to be evaluated if an adaptation of the degradation model parameters is required.

An investigation is currently ongoing to identify the causes of a slightly different degradation slope observed in the lunar center SWIR 2 calibration results (not shown) compared to the desert results.

During Q2 of 2018 one new bad pixel (i.e. Left SWIR1 PixelID 4) was identified.

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.

It should be noted that since 2018 a degradation model is no longer in use for the right SWIR strips. In some of the other SWIR strips we start to see a slight overcorrection of the degradation. Currently a degradation model is still in place for these SWIR strips. It will have to be evaluated if an adaptation of the degradation model parameters is required.

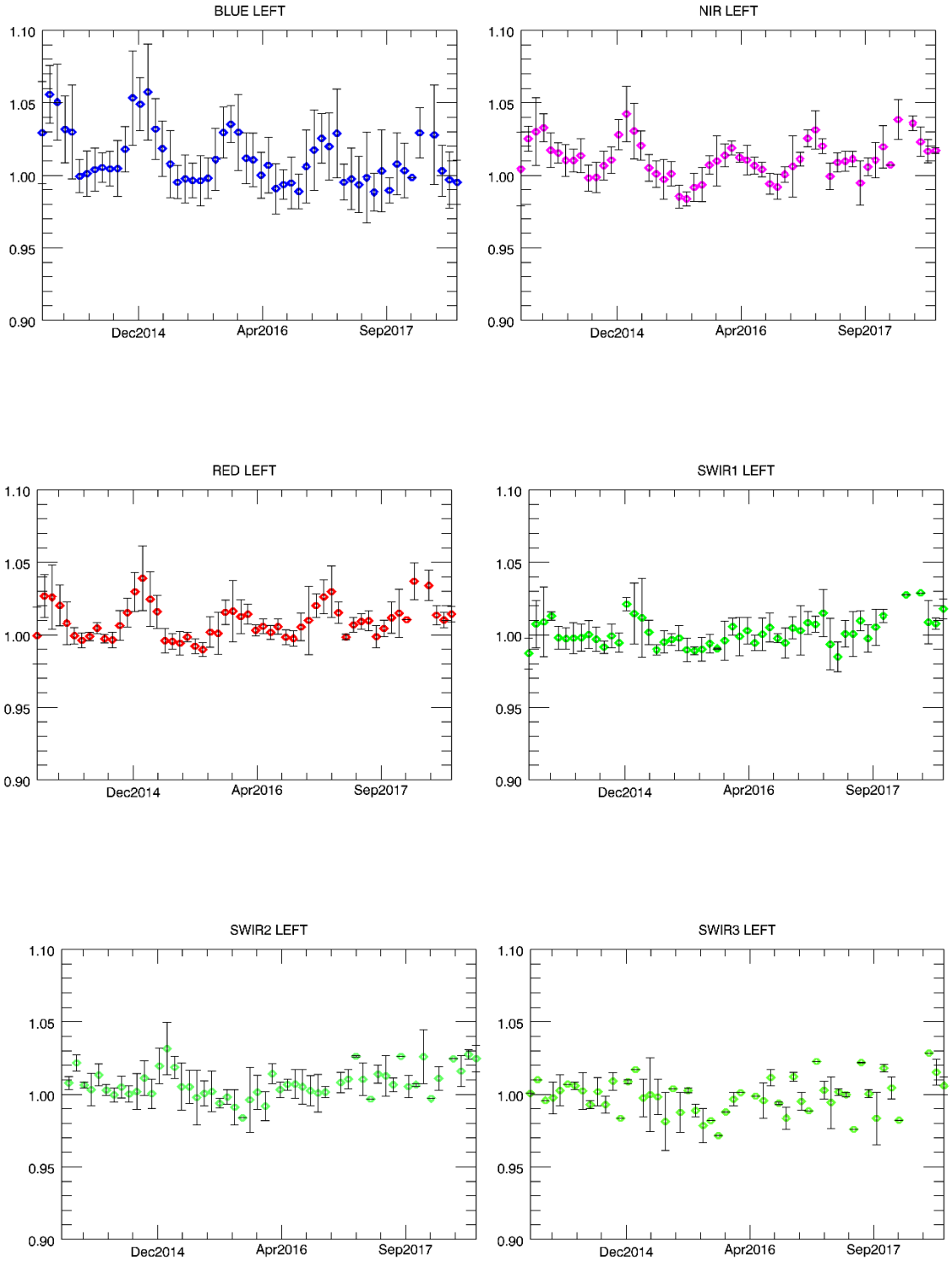


Figure 1. Libya-4 desert calibration results: LEFT monthly averaged results (Collection 1)

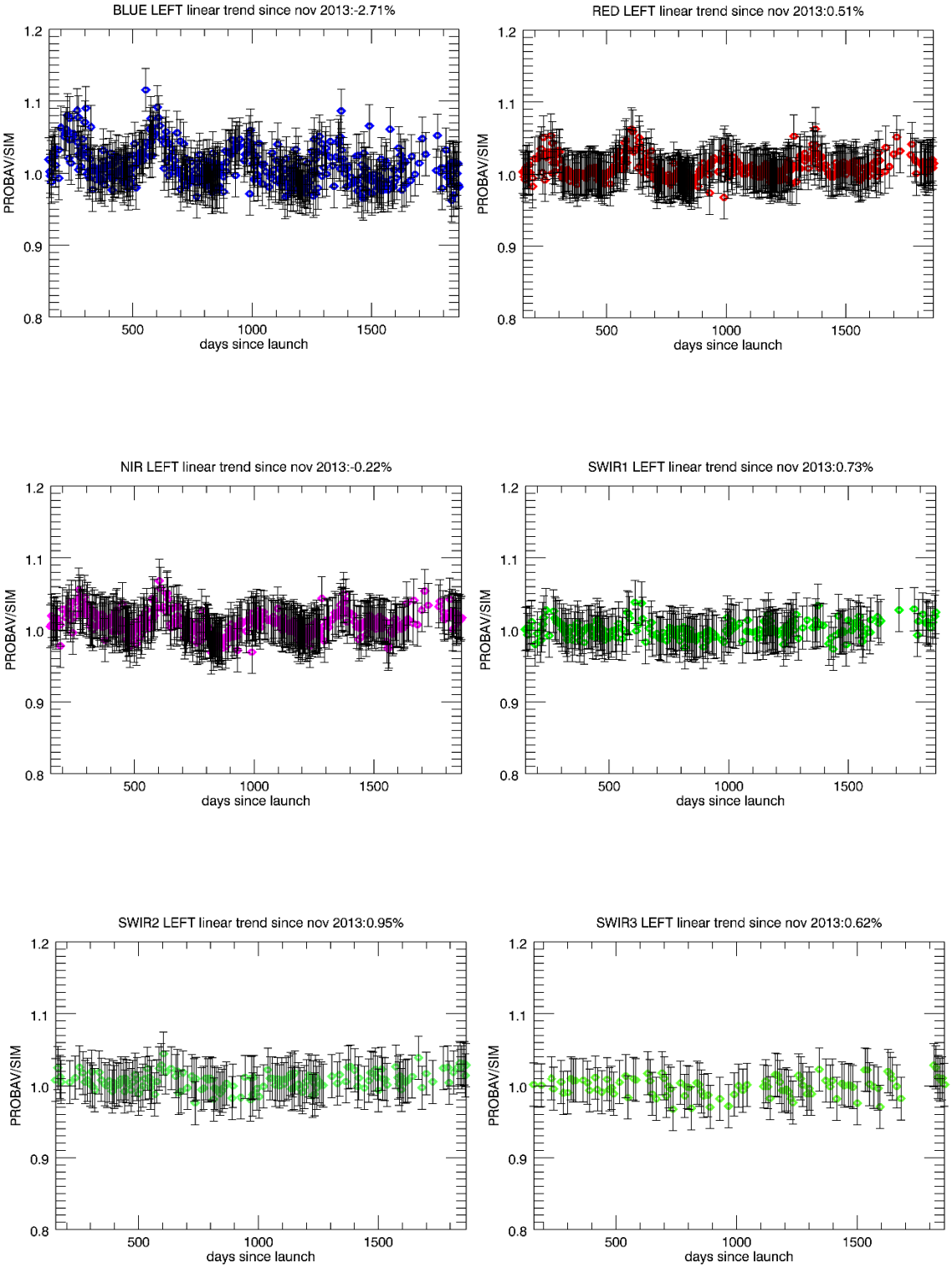


Figure 2. Libya-4 desert calibration results: LEFT individual results (Collection 1)

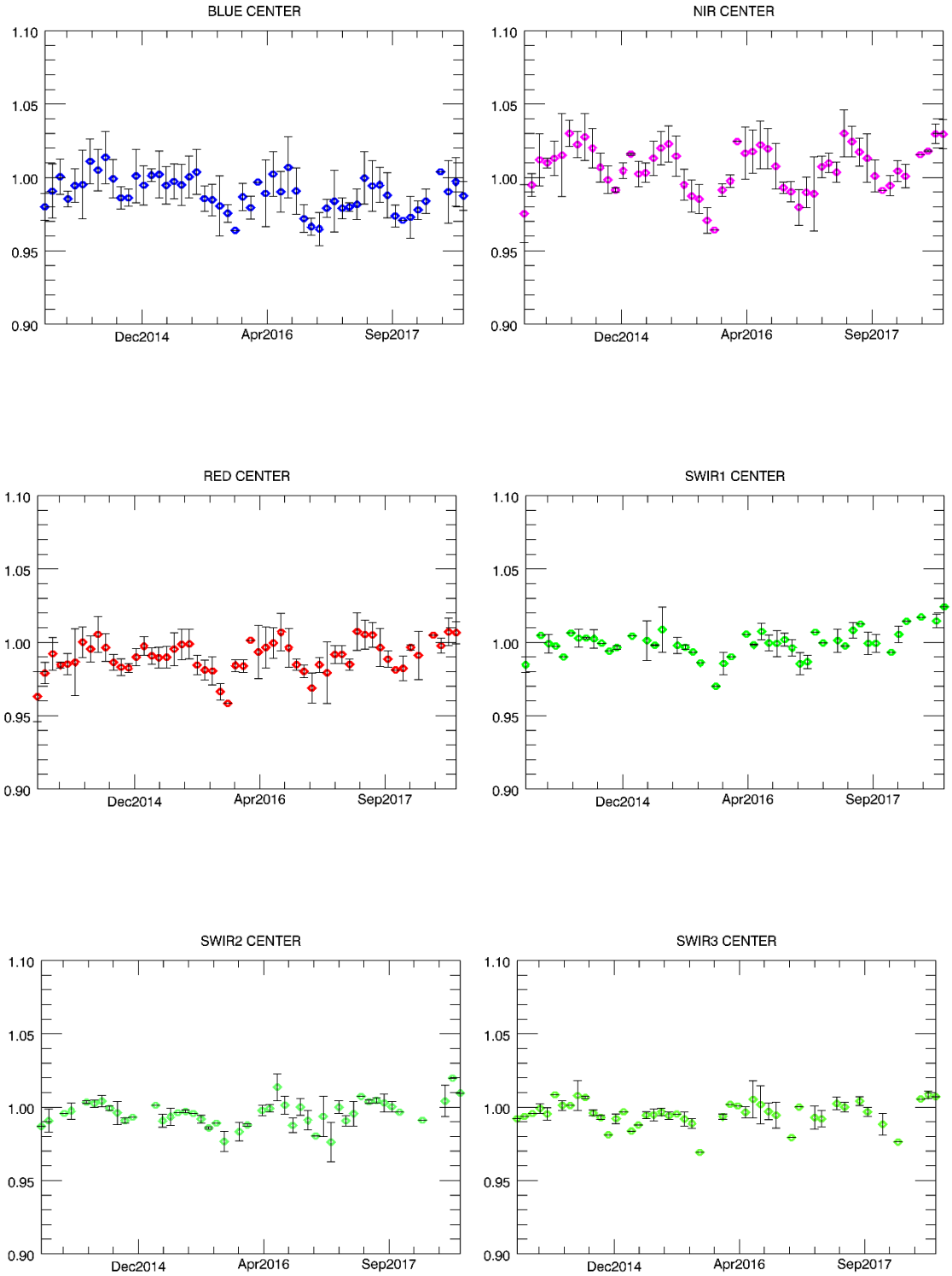


Figure 3. Libya-4 desert calibration results: CENTER monthly averaged results (Collection 1)

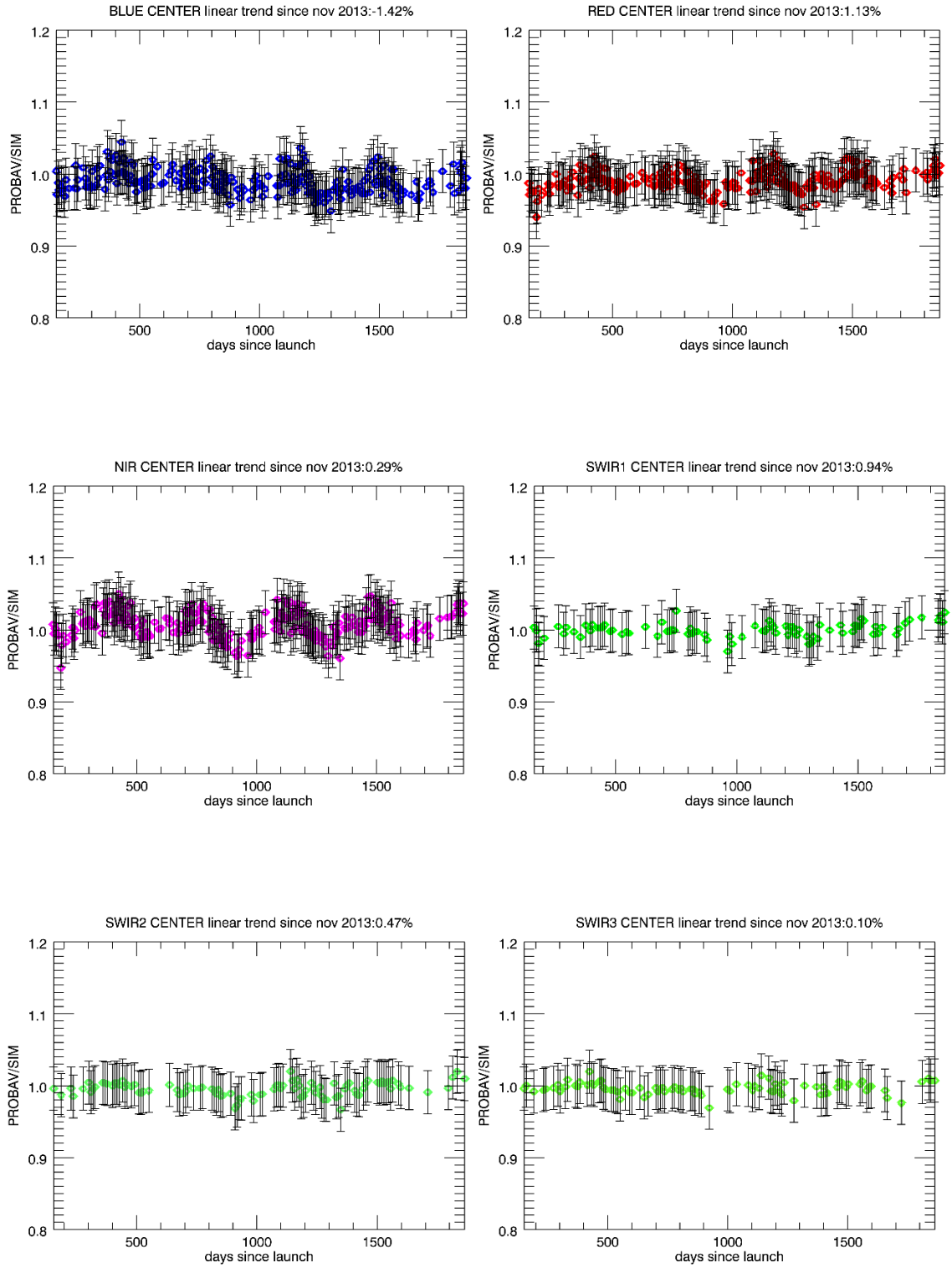


Figure 4. Libya-4 desert calibration results: CENTER individual results (Collection 1)

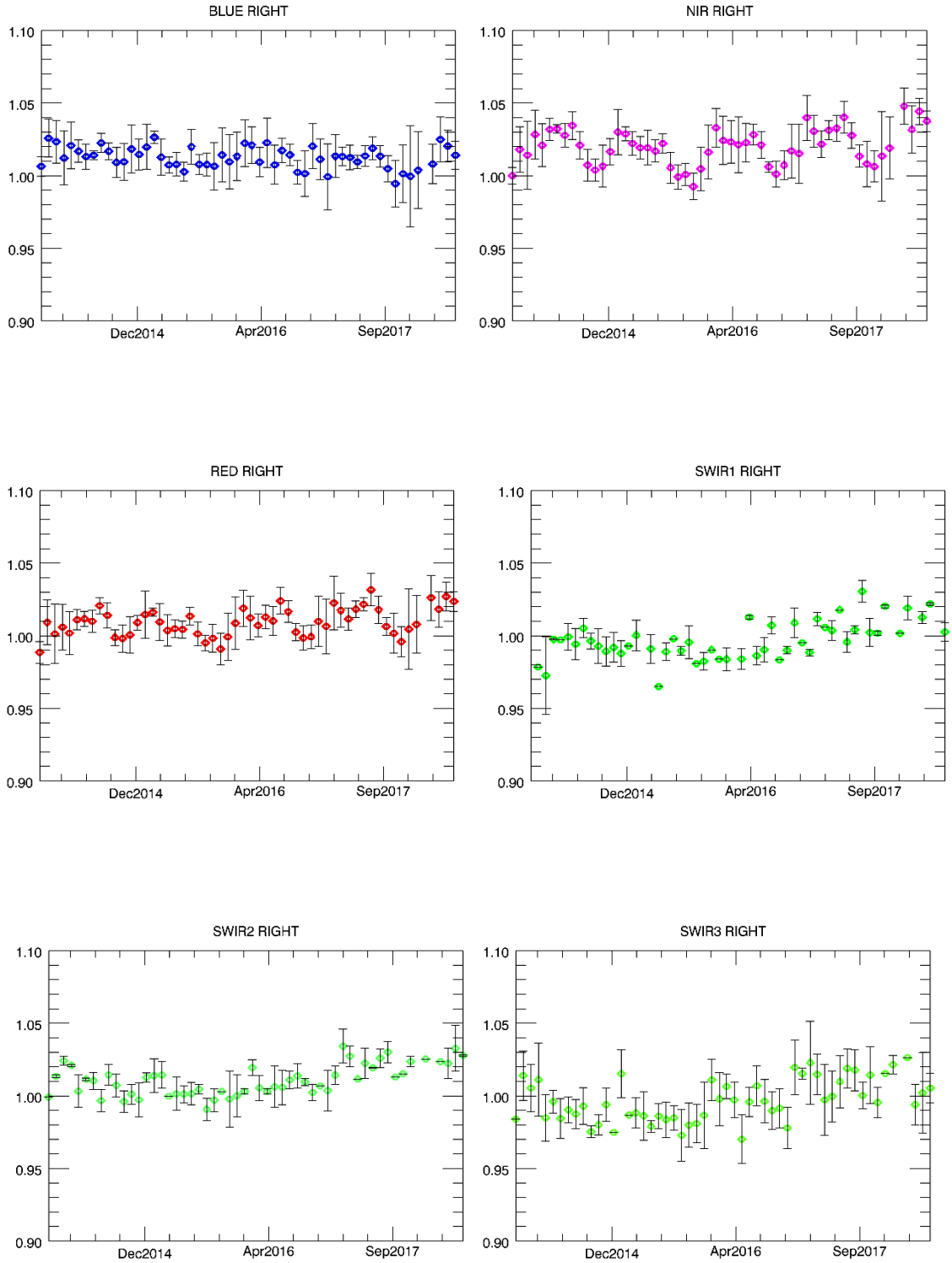


Figure 5. Libya-4 desert calibration results: RIGHT monthly averaged results (Collection 1)

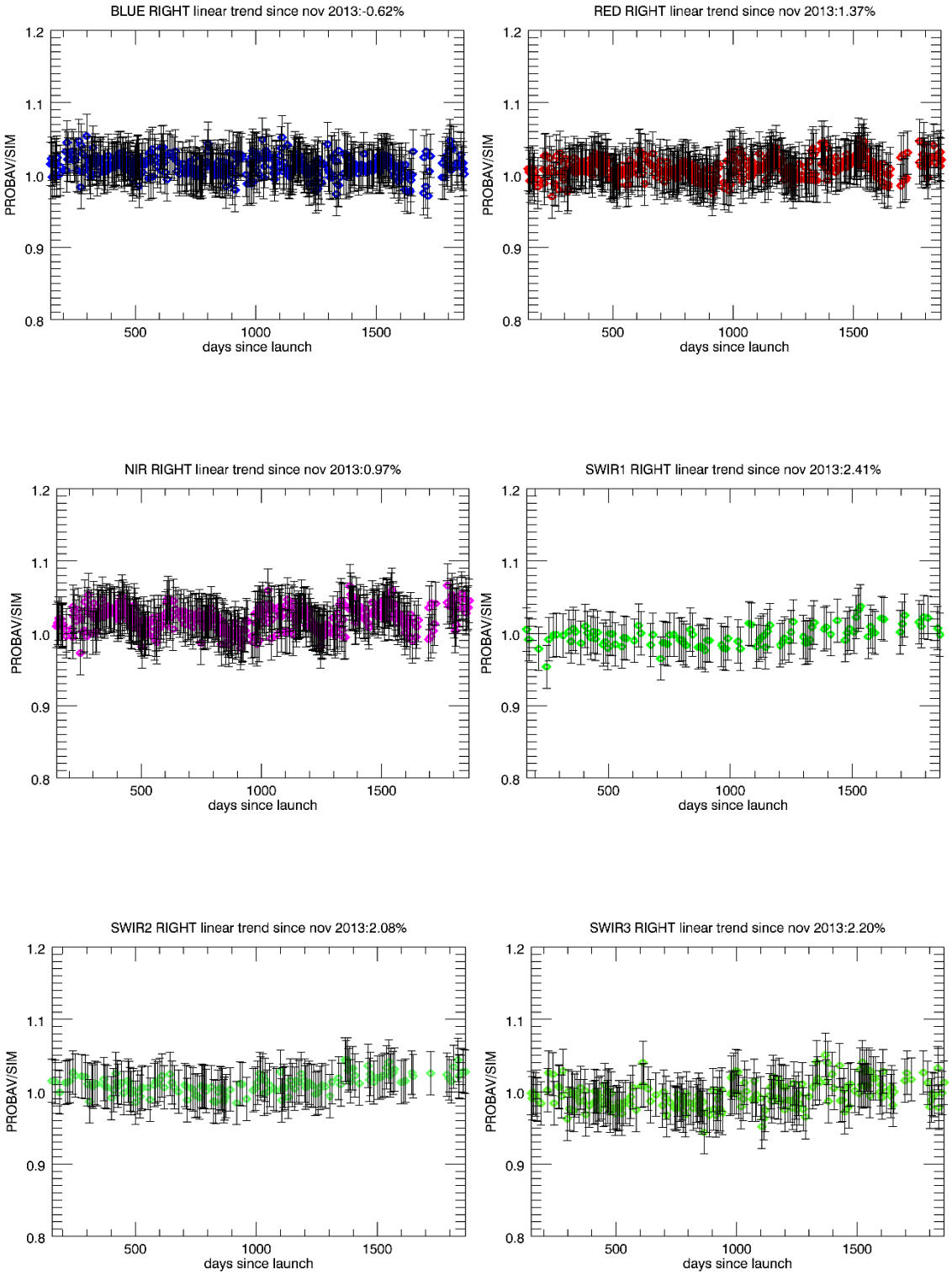


Figure 6. Libya-4 desert calibration results: RIGHT individual results (Collection 1)

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.

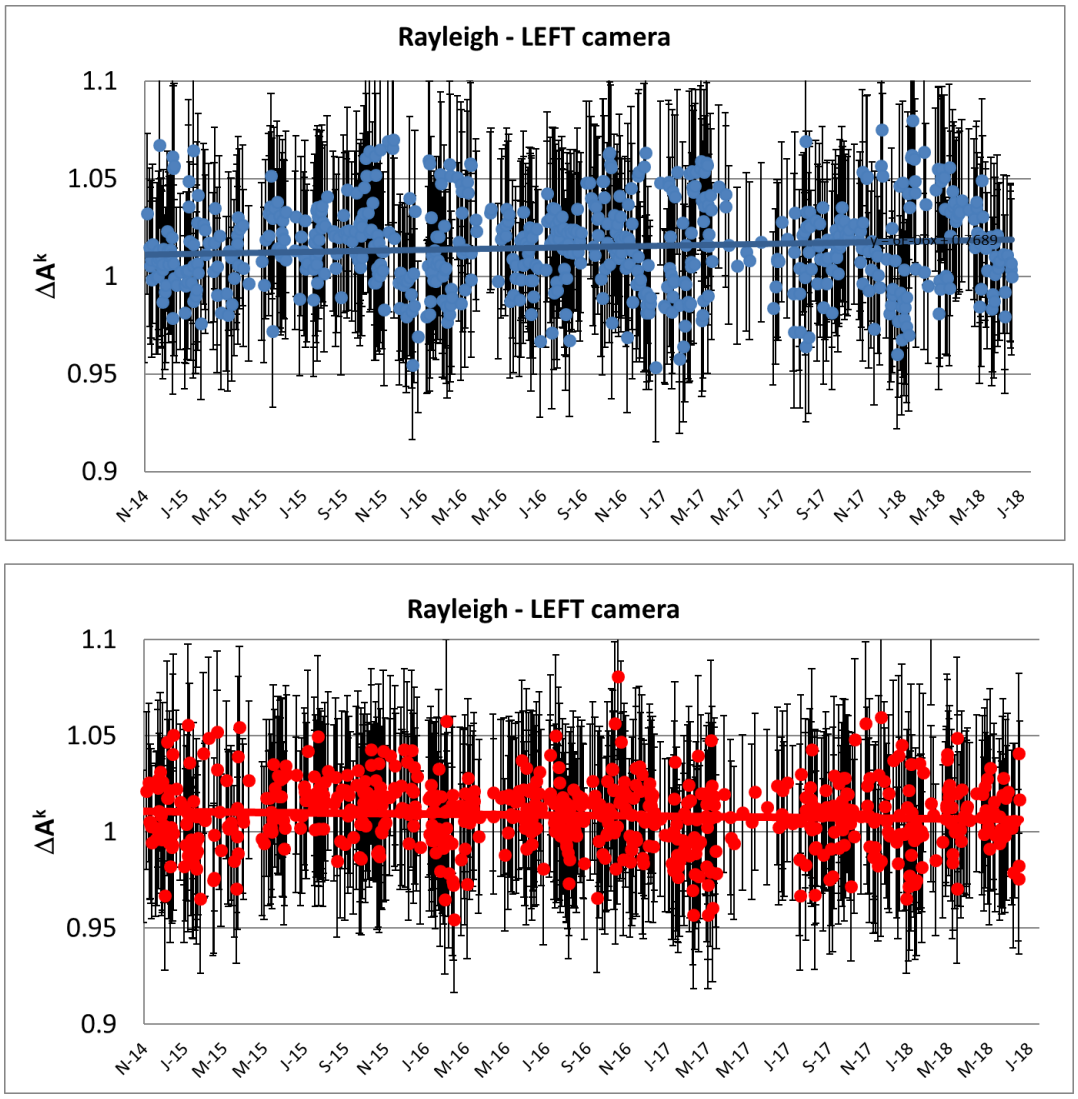


Figure 7. Rayleigh absolute calibration results: LEFT camera (Collection 1)

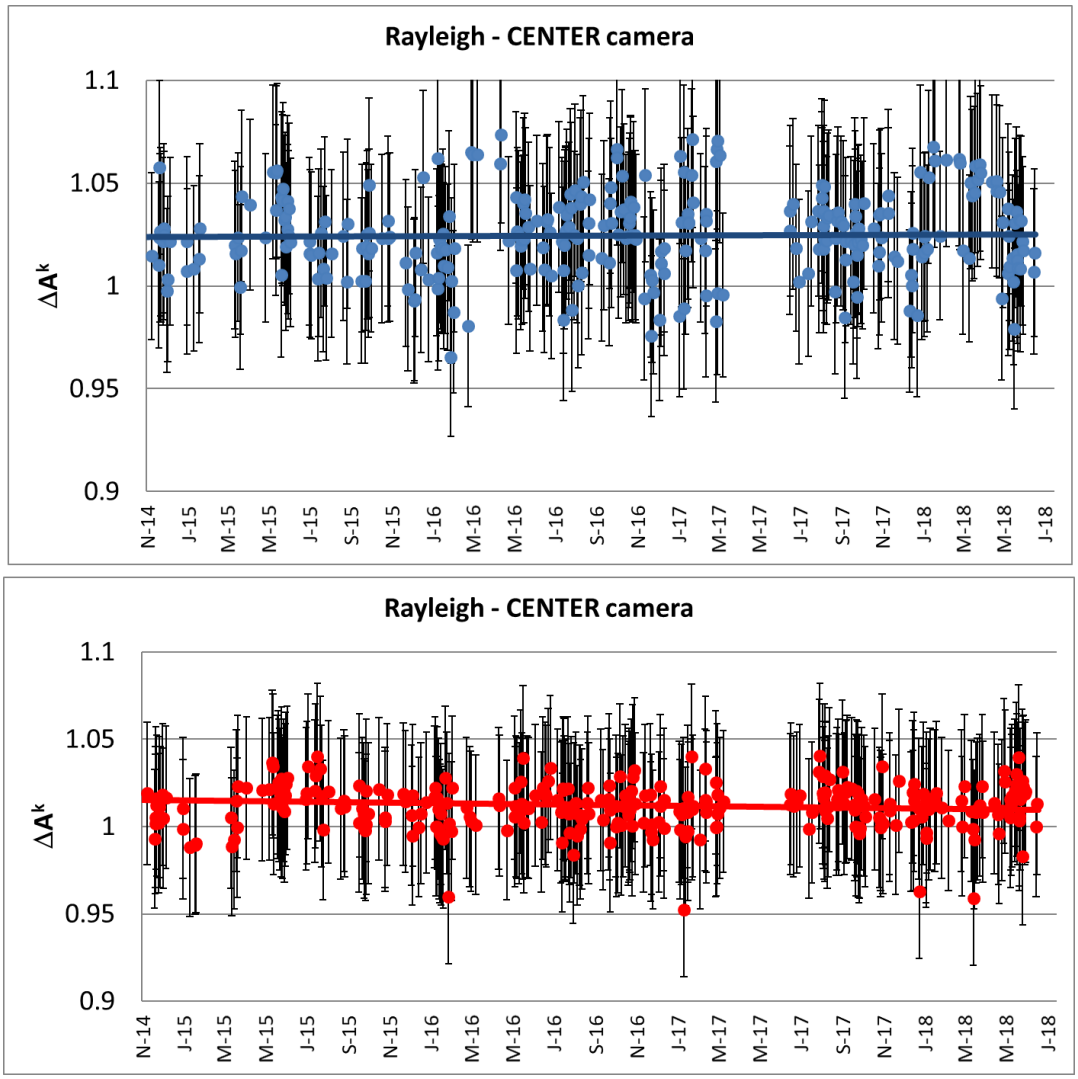
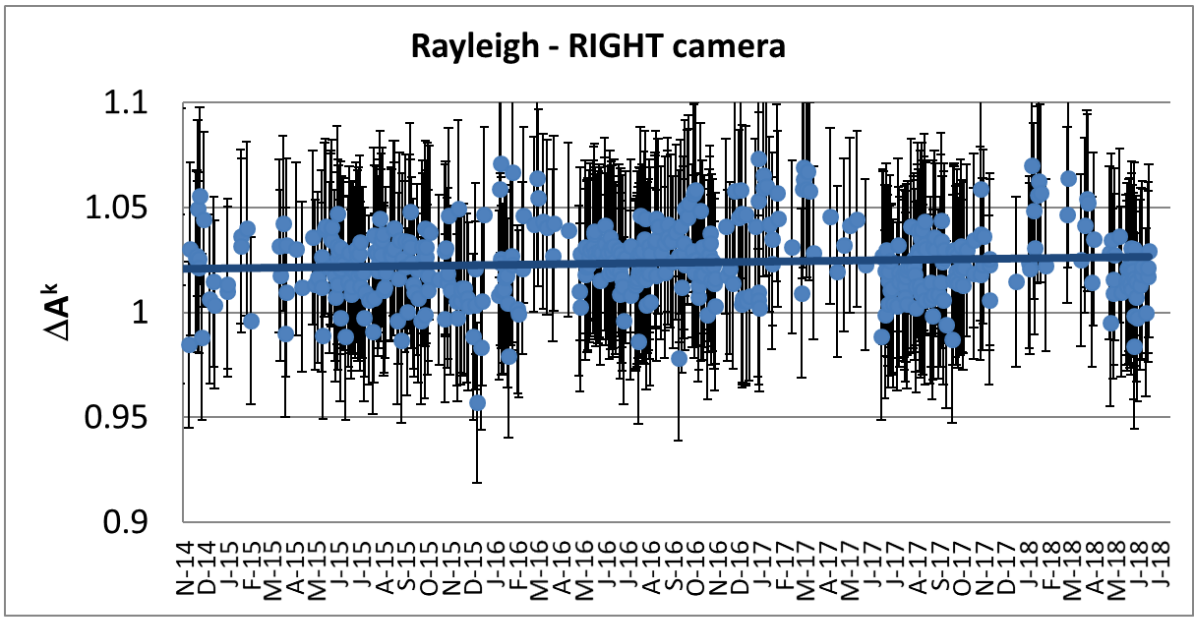


Figure 8. Rayleigh absolute calibration results: CENTER camera (Collection 1)



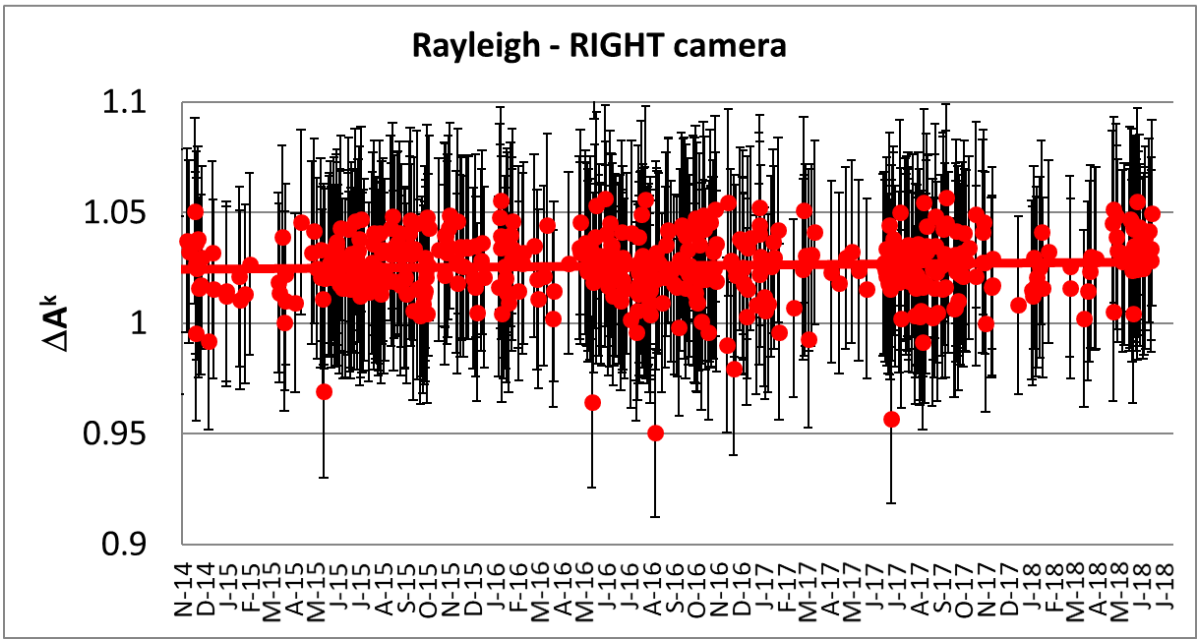


Figure 9. Rayleigh absolute calibration results: RIGHT camera (Collection 1)

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 June 2018) is given in Figure 10 for all cameras using the **collection 1 ICP files**.

Although a degradation model for center and left BLUE strips is in place since about 13 months, some decrease in the DCC inter-band calibration results is still observed for the blue band. This might also be linked to increase in responsivity observed for the RED strips.

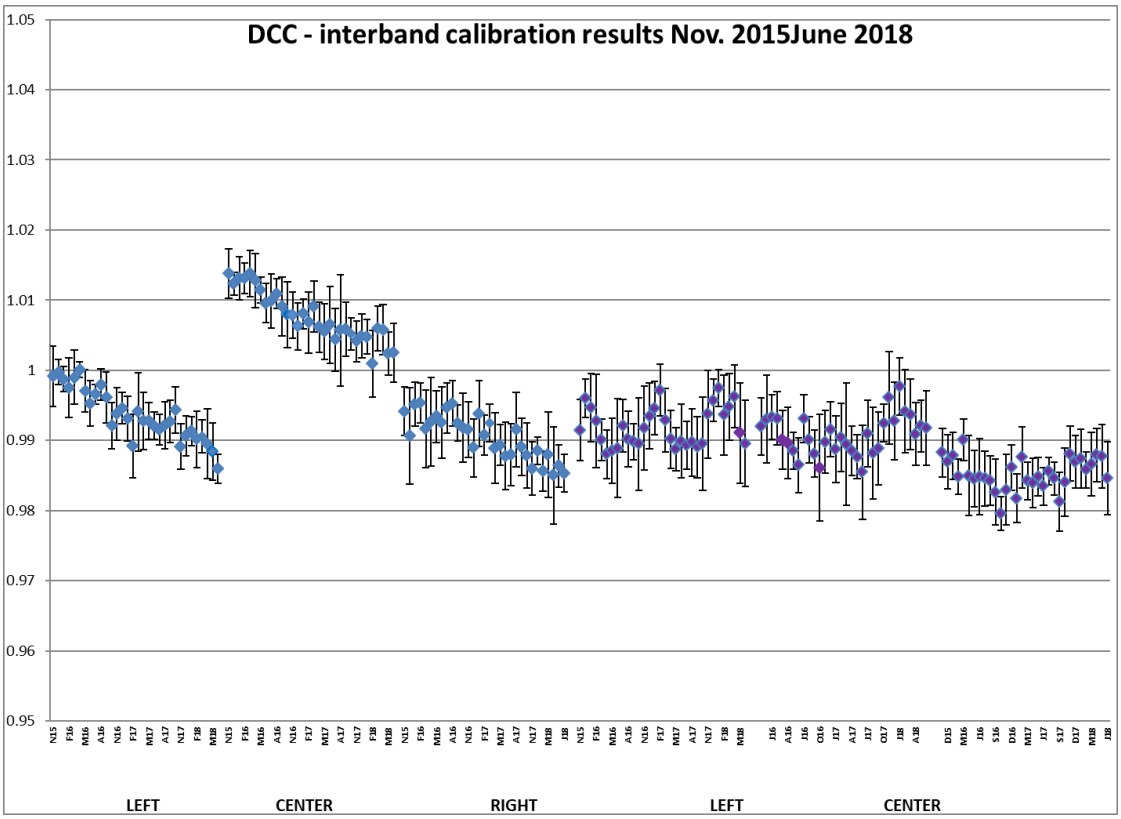


Figure 10. DCC inter-band calibration results: LEFT, CENTER and RIGHT camera

1.2.3. PROBA-V Multi-temporal radiometric accuracy

1.2.3.1. Degradation model

No changes have been made to the degradation models in this reporting period.

As the calibration results for the SWIR strips of the RIGHT camera continues to show an overcorrection of the degradation, a degradation model is since 2018 no longer applied to the SWIR strips of the right camera.

In Table 1 the applied degradation model correction is given. This linear degration 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.

Table 1 SWIR degradation model: applied linear trend/month

	degradation model ICP		
	untill aug 2017	since sept 2017	Since Jan 2018
SWIR1 LEFT	-0.087	-0.087	-0.087
SWIR2 LEFT	-0.104	-0.104	-0.104
SWIR3 LEFT	-0.097	-0.097	-0.097
SWIR1 CENTER	-0.093	-0.093	-0.093
SWIR2 CENTER	-0.092	-0.092	-0.092
SWIR3 CENTER	-0.086	-0.086	-0.086
SWIR1 RIGHT	-0.106	-0.077	NA
SWIR2 RIGHT	-0.143	-0.122	NA
SWIR3 RIGHT	-0.122	-0.078	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 RIGHT	-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.

Similarly as in the Libya-4 CENTER RED results an increase in responsivity is observed in the lunar CENTER RED results and a degradation in the BLUE calibration results, whereas the results of the NIR strip seems to stable over time.

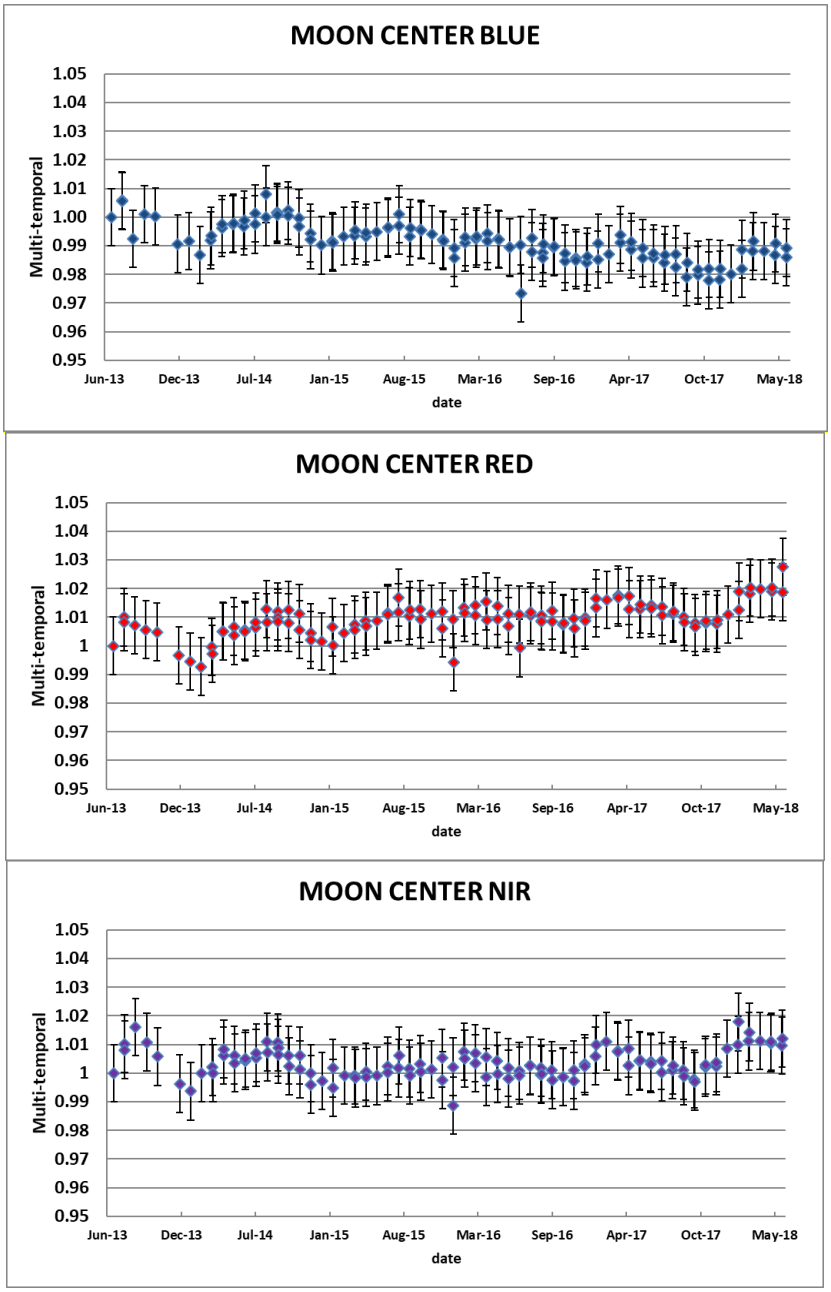


Figure 11. Lunar Calibration results CENTER camera normalised to June 2013 (collection 1 ICP files)

1.2.3.3. Libya-4 VS Moon

An investigation is currently ongoing to identify the causes of different degradation slope (Figure 12) observed in the lunar center SWIR 2 calibration results compared to the desert results.

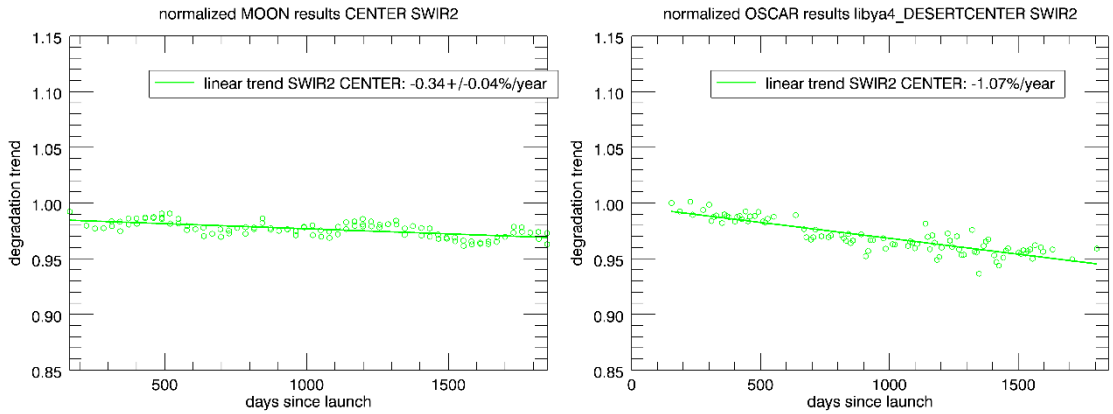


Figure 12. Comparison of degradation monitoring of CENTER SWIR2 strip on the basis of the lunar and Libya-4 calibration results

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 in Figure 13, Figure 14 and Figure 15 for respectively LEFT, CENTER and RIGHT camera.

Dark current differences for the VNIR bands are well below 1 DN.

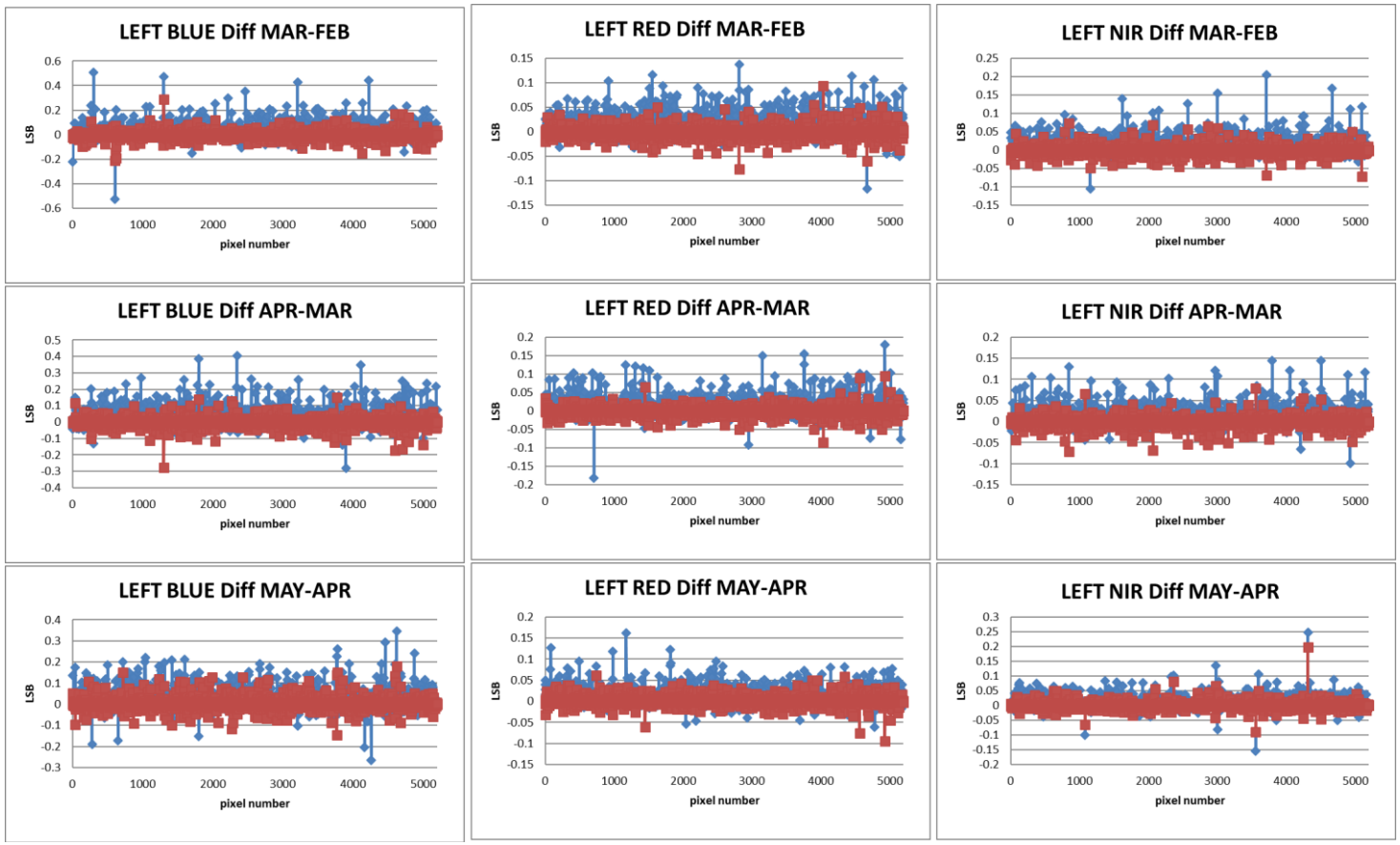


Figure 13. LEFT camera VNIR: Monthly difference (FEB-MAY 2018) in dark current (Blue) and standard deviation (Red) of the monthly averaged results.

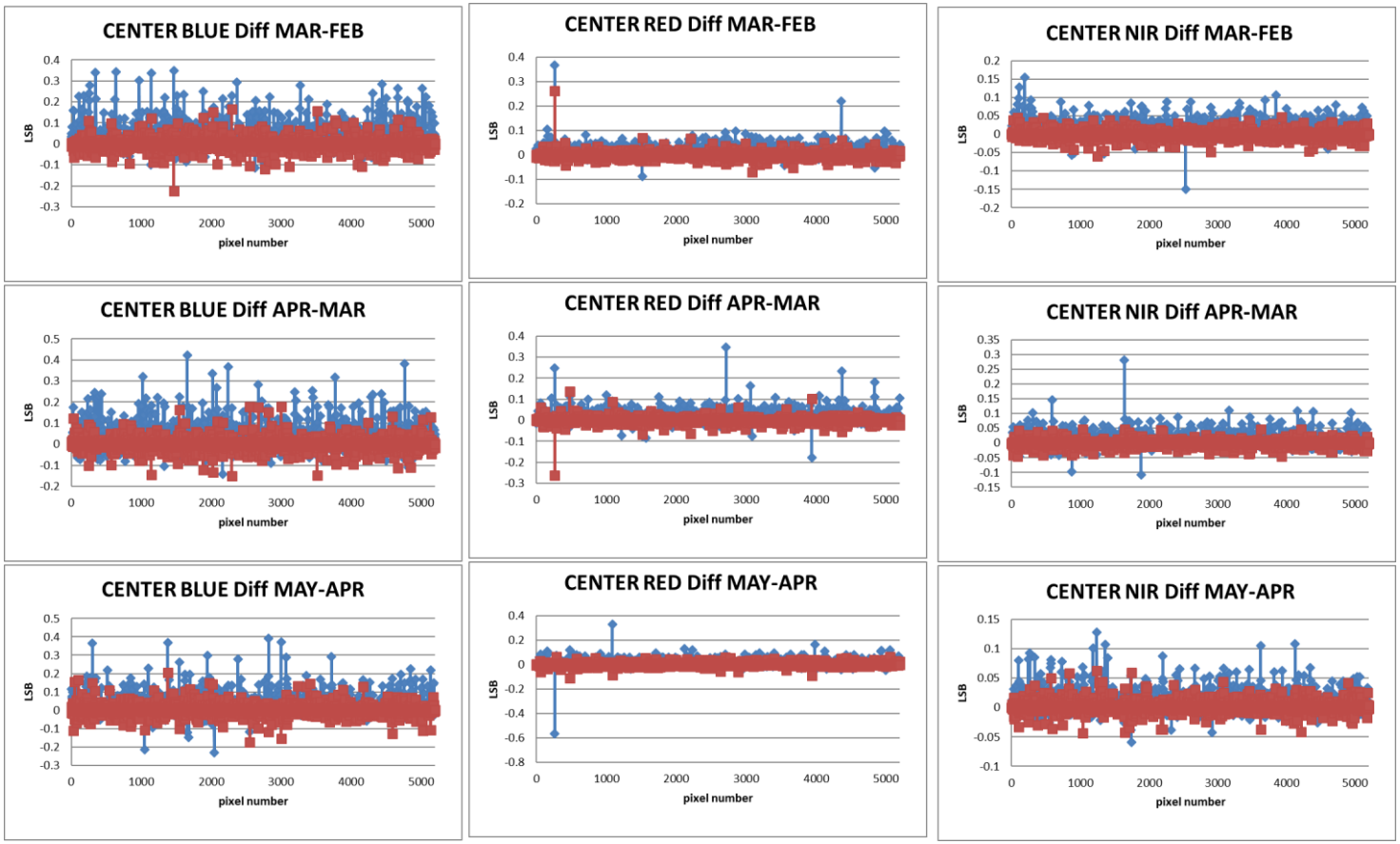


*Figure 14. CENTER camera VNIR: Monthly difference (*FEB-MAY 2018*) in dark current (Blue) and standard deviation (Red) of the monthly averaged results.*

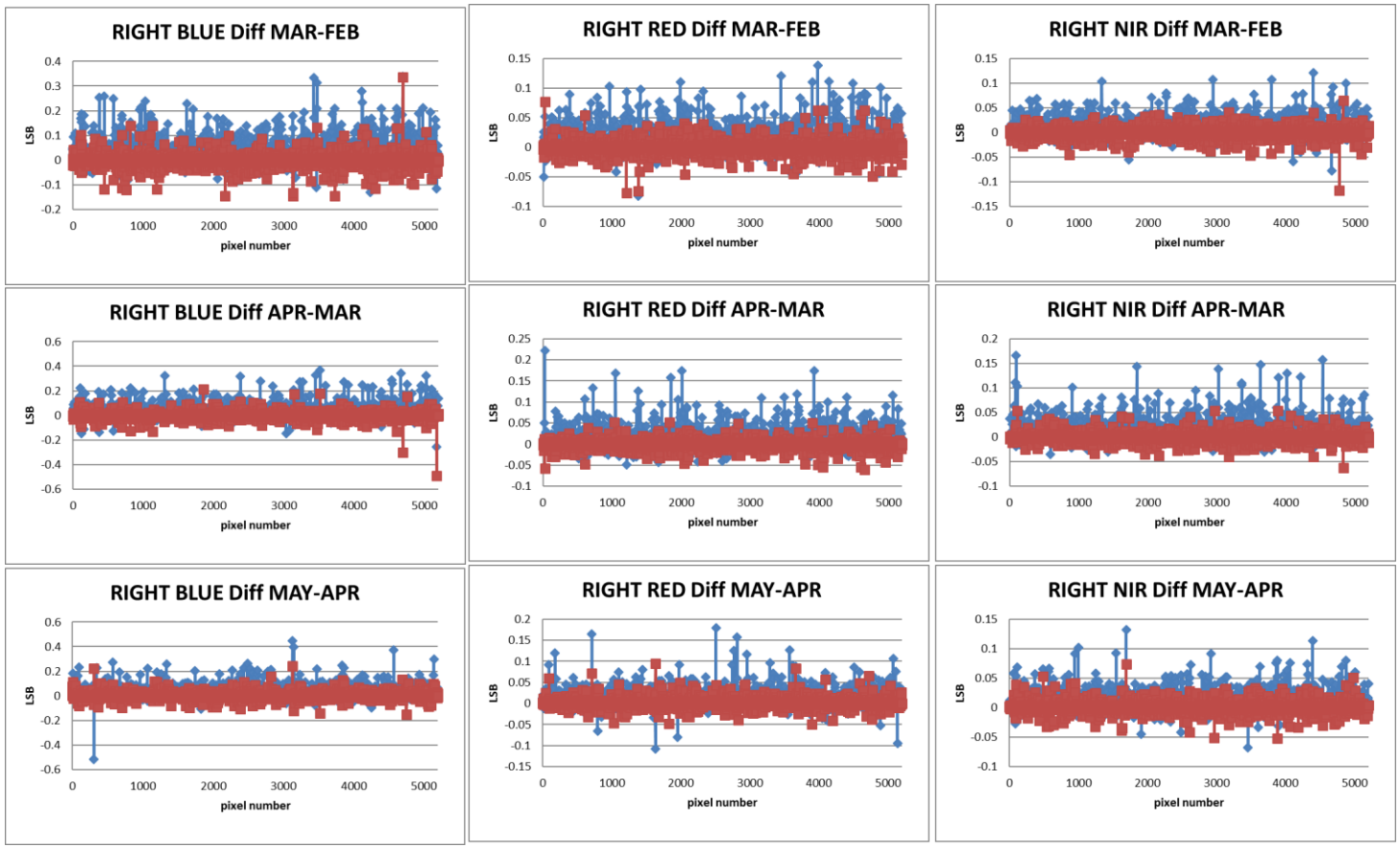


*Figure 15. RIGHT camera VNIR: Monthly difference (*FEB-MAY2018*) in dark current (Blue) and standard deviation (Red) of the monthly averaged results.*

1.3.3. SWIR results

Monthly difference plots for SWIR dark currents are given in Figure 16, Figure 17 and Figure 18 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, Table *4* and *Table 5* the resulting SWIR dark current status during the last 3 months is reported for respectively LEFT, CENTER and RIGHT camera.

Similarly as in previous reporting periods jumps in the dark current values of a few SWIR pixels is observed, requiring regular updates of ICP dark current values.

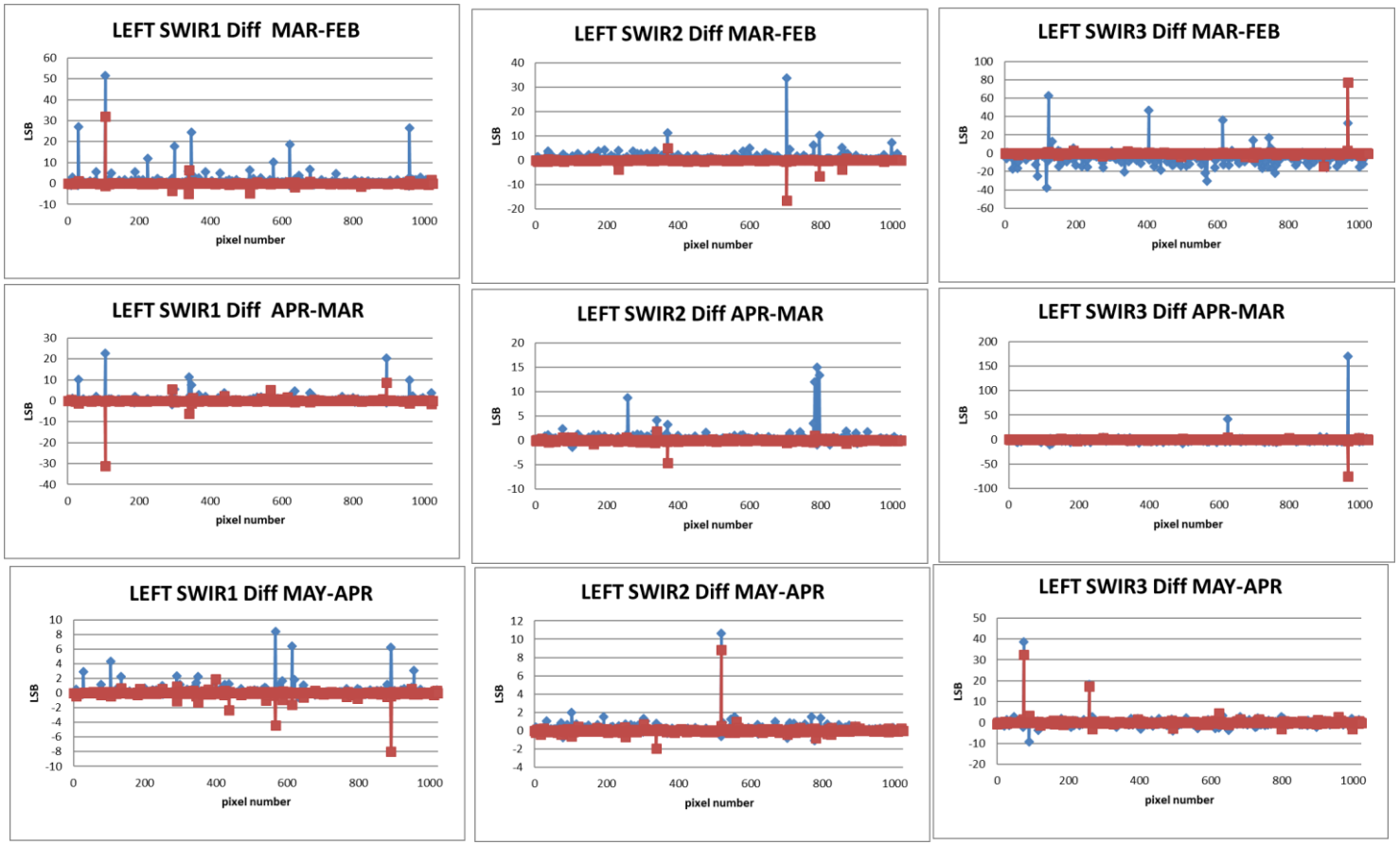


Figure 16. LEFT camera SWIR: Monthly difference (FEB - MAY 2018) in dark current (Blue) and standard deviation (Red) of the monthly averaged results.

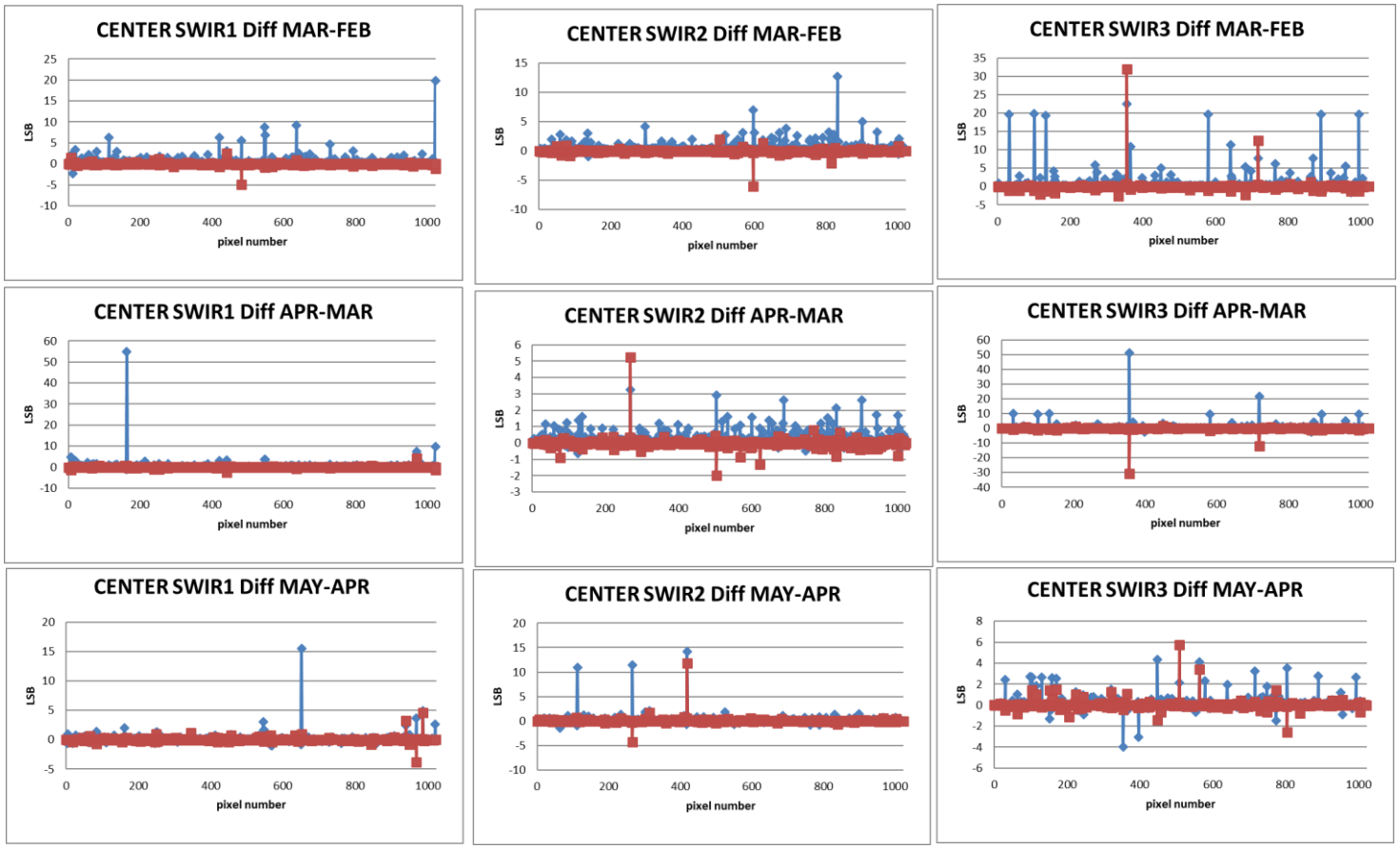


Figure 17. CENTER camera SWIR: Monthly difference (FEB - MAY 2018) in dark current (Blue) and standard deviation (Red) of the monthly averaged results.

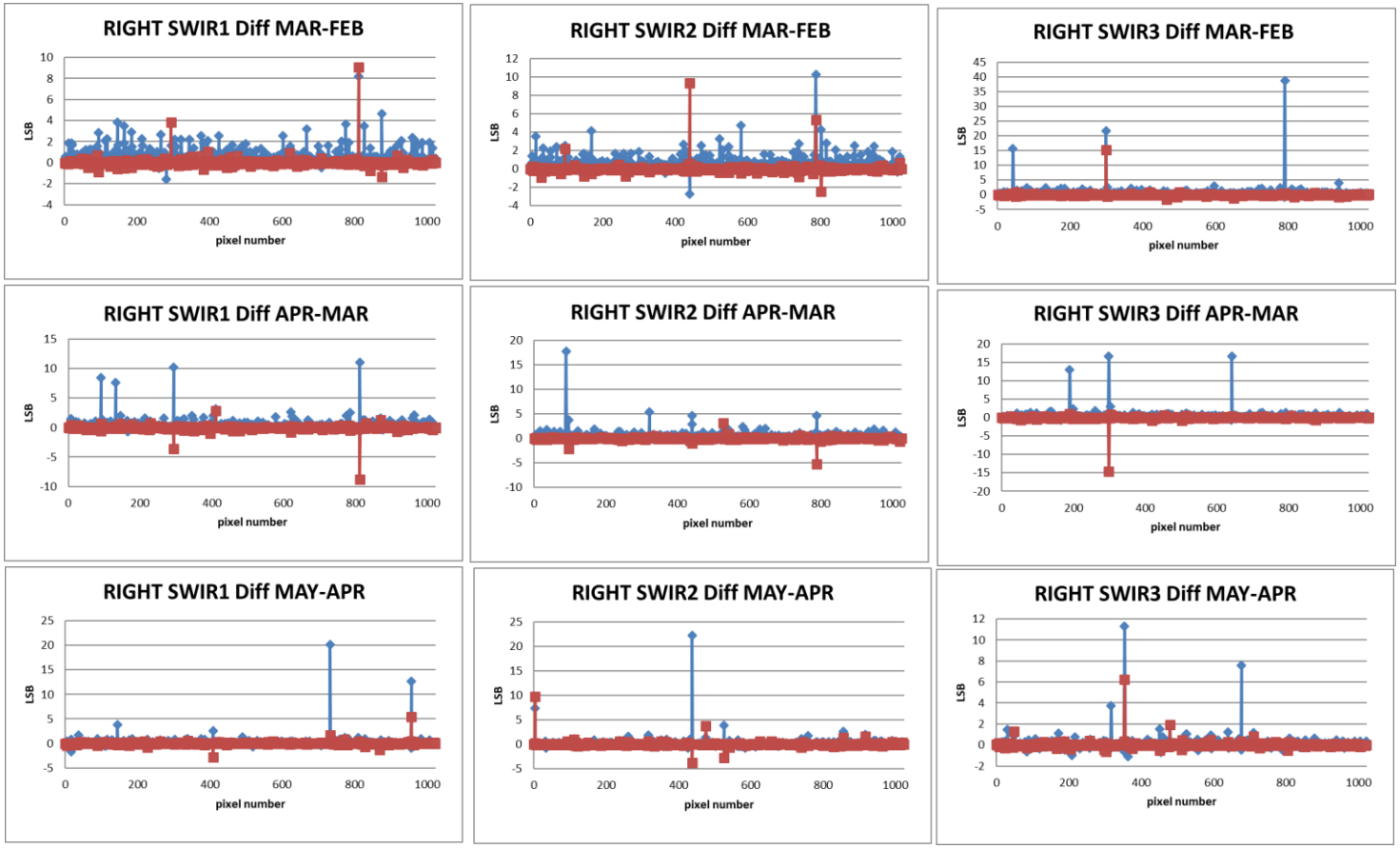


Figure 18. RIGHT camera SWIR: Monthly difference (FEB - MAY 2018) in dark current (Blue) and standard deviation (Red) of the monthly averaged results.

LEFT SWIR																	
Jan-Feb-Mar						Feb-Mar-Apr						Feb-Mar-Apr					
SWIR1		SWIR2		SWIR3		SWIR1		SWIR2		SWIR3		SWIR1		SWIR2		SWIR3	
28	H DC BAD	702	H DC BAD	20	H DC BAD	28	H DC BAD	794	H DC BAD	20	H DC BAD	104	H DC BAD	257	H DC NOK	90	H DC BAD
298	H DC BAD	368	H DC NOK	34	H DC BAD	104	H DC BAD	192	H DC NOK	23	H DC BAD	567	H DC BAD	338	H DC NOK	20	H DC NOK
345	H DC BAD	794	H DC NOK	35	H DC BAD	298	H DC BAD	231	H DC NOK	34	H DC BAD	892	H DC BAD	519	H DC NOK	23	H DC NOK
575	H DC BAD	858	H DC NOK	85	H DC BAD	338	H DC BAD	257	H DC NOK	90	H DC BAD	28	H DC NOK	781	H DC NOK	34	H DC NOK
956	H DC NOK	996	H DC NOK	90	H DC BAD	345	H DC NOK	338	H DC NOK	115	H DC BAD	298	H DC NOK	788	H DC NOK	75	H DC NOK
104	H DC NOK	270pixels	H DC OK	115	H DC BAD	956	H DC NOK	368	H DC NOK	119	H DC BAD	338	H DC NOK	794	H DC NOK	115	H DC NOK
222	H DC NOK			121	H DC BAD	78	H DC NOK	599	H DC NOK	121	H DC BAD	345	H DC NOK	298pixels	H DC OK	119	H DC NOK
290	H DC NOK			150	H DC BAD	120	H DC NOK	702	H DC NOK	173	H DC BAD	614	H DC NOK			121	H DC NOK
336	H DC NOK			159	H DC BAD	187	H DC NOK	711	H DC NOK	216	H DC BAD	635	H DC NOK			173	H DC NOK
338	H DC NOK			216	H DC BAD	222	H DC NOK	778	H DC NOK	231	H DC BAD	956	H DC NOK			216	H DC NOK
508	H DC NOK			231	H DC BAD	336	H DC NOK	781	H DC NOK	336	H DC BAD	198pixels	H DC OK			231	H DC NOK
621	H DC NOK			276	H DC BAD	385	H DC NOK	788	H DC NOK	370	H DC BAD					259	H DC NOK
678	H DC NOK			370	H DC BAD	425	H DC NOK	858	H DC NOK	404	H DC BAD					336	H DC NOK
179pixels	H DC OK			404	H DC BAD	508	H DC NOK	996	H DC NOK	419	H DC BAD					370	H DC NOK
				438	H DC BAD	567	H DC NOK	283pixels	H DC OK	438	H DC BAD					404	H DC NOK
				471	H DC BAD	575	H DC NOK			494	H DC BAD					419	H DC NOK
				495	H DC BAD	621	H DC NOK			510	H DC BAD					438	H DC NOK
				510	H DC BAD	635	H DC NOK			564	H DC BAD					494	H DC NOK
				564	H DC BAD	678	H DC NOK			568	H DC BAD					510	H DC NOK
				568	H DC BAD	750	H DC NOK			591	H DC BAD					564	H DC NOK
				591	H DC BAD	892	H DC NOK			615	H DC BAD					568	H DC NOK
				615	H DC BAD	181pixels	H DC OK			630	H DC BAD					591	H DC NOK
				725	H DC BAD					660	H DC BAD					615	H DC NOK
				729	H DC BAD					729	H DC BAD					623	H DC NOK
				740	H DC BAD					740	H DC BAD					630	H DC NOK
				744	H DC BAD					753	H DC BAD					660	H DC NOK
				753	H DC BAD					761	H DC BAD					729	H DC NOK
				761	H DC BAD					818	H DC BAD					740	H DC NOK
				856	H DC BAD					856	H DC BAD					753	H DC NOK
				906	H DC BAD					906	H DC BAD					761	H DC NOK
				935	H DC BAD					948	H DC BAD					818	H DC NOK
				67pixels	H DC NOK					966	H DC BAD					856	H DC NOK
				826pixels	H DC OK					998	H DC BAD					886	H DC NOK
										100 pixels	H DC NOK					906	H DC NOK
										799pixels	H DC OK					804pixels	H DC OK

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

JAN-FEB-MAR						FEB-MAR-APR						MAR-APR-MAY					
SWIR1		SWIR2		SWIR3		SWIR1		SWIR2		SWIR3		SWIR1		SWIR2		SWIR3	
481	H DC BAD	596	H DC BAD	30	H DC BAD	1021	H DC BAD	295	H DC BAD	30	H DC BAD	5	H DC NOK	112	H DC NOK	30	H DC NOK
545	H DC BAD	831	H DC BAD	99	H DC BAD	5	H DC NOK	596	H DC BAD	99	H DC BAD	161	H DC NOK	266	H DC NOK	99	H DC NOK
728	H DC BAD	295	H DC NOK	131	H DC BAD	111	H DC NOK	831	H DC NOK	131	H DC BAD	651	H DC NOK	419	H DC NOK	131	H DC NOK
1021	H DC BAD	533	H DC NOK	364	H DC BAD	161	H DC NOK	900	H DC NOK	354	H DC BAD	969	H DC NOK	256pixels	H DC OK	354	H DC NOK
111	H DC NOK	900	H DC NOK	579	H DC BAD	419	H DC NOK	242pixels	H DC OK	364	H DC BAD	987	H DC NOK			364	H DC NOK
419	H DC NOK	239pixels	H DC OK	640	H DC BAD	481	H DC NOK			579	H DC BAD	1021	H DC NOK			448	H DC NOK
547	H DC NOK			682	H DC BAD	545	H DC NOK			716	H DC BAD	217pixels	H DC OK			564	H DC NOK
634	H DC NOK			890	H DC BAD	547	H DC NOK			868	H DC BAD					579	H DC NOK
654	H DC NOK			994	H DC BAD	634	H DC NOK			890	H DC BAD					716	H DC NOK
199pixels	H DC OK			152	H DC NOK	728	H DC NOK			957	H DC BAD					868	H DC NOK
				266	H DC NOK	969	H DC NOK			994	H DC BAD					890	H DC NOK
				354	H DC NOK	201pixels	H DC OK			152	H DC NOK					957	H DC NOK
				448	H DC NOK					266	H DC NOK					994	H DC NOK
				697	H DC NOK					448	H DC NOK					135pixels	H DC OK
				716	H DC NOK					640	H DC NOK						
				763	H DC NOK					682	H DC NOK						
				868	H DC NOK					697	H DC NOK						
				957	H DC NOK					763	H DC NOK						
				112pixels	H DC OK					123pixels	H DC OK						

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

RIGHT																	
JAN-FEB-MAR						FEB-MAR_APR						MAR-APR-MAY					
873	H DC BAD	167	H DC NOK	40	H DC NOK	810	H DC BAD	786	H DC BAD	297	H DC BAD	89	H DC NOK	438	H DC BAD	188	H DC NOK
446	H DC NOK	580	H DC NOK	163	H DC NOK	89	H DC NOK	87	H DC NOK	40	H DC NOK	130	H DC NOK	4	H DC NOK	297	H DC NOK
810	H DC NOK	786	H DC NOK	297	H DC NOK	130	H DC NOK	167	H DC NOK	188	H DC NOK	292	H DC NOK	87	H DC NOK	354	H DC NOK
904	H DC NOK	801	H DC NOK	790	H DC NOK	292	H DC NOK	320	H DC NOK	640	H DC NOK	732	H DC NOK	320	H DC NOK	640	H DC NOK
335pixels	H DC OK	377pixels	H DC OK	939	H DC NOK	873	H DC NOK	438	H DC NOK	790	H DC NOK	810	H DC NOK	786	H DC NOK	677	H DC NOK
				275pixels	H DC OK	354pixels	H DC OK	580	H DC NOK	939	H DC NOK	957	H DC NOK	395pixels	H DC OK	314pixels	H DC OK
								801	H DC NOK	302pixels	H DC OK	363pixels	H DC OK				
								399pixels	H DC OK								

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

1.4. High Frequency Equalisation/Striping

Methodology

The high frequency interpixel variation or equalization differences are estimated on radiometrically corrected images i.e. the radiometric model is applied including the equalization coefficients (gi). If they are correct, they remove all the pixel to pixel non-uniformity. In principle the multi-angular method then detects no non-uniformities, only noise if systematic non-uniformities are detected, they can be viewed as corrections to the existing equalization coefficients ($\Delta gi, high$). Working like this is in fact an advantage as it focuses entirely on the changes from the existing coefficients. The coefficients can be updated by multiplying the new estimates ("correction coefficients") with the old ones:

$$gi, new = gi\ x \Delta gi, high$$

The $\Delta gi, high$ are estimated as follows:

- An input image is taken, containing as little variation in the scene as possible. Image containing uniform snow areas over Antarctica or Greenland during local summer are ideal for VNIR bands. For SWIR bands images over homogeneous desert sites (e.g. Libya4) are used.
- Low pass image: is obtained by calculating an averaging filter in the along track direction.
- HFRR (high frequency relative response) image is the ratio between the original and the low pass image. It contains only the high frequency information.
- In the HFRR image, the trimmed mean is calculated in the along track direction (using all pixel values of a column).
- The average and standard deviation over the considered time period is calculated.

Results

No multi-angular calibration acquisitions have been performed for the VNIR strips over Antarctica.

High Frequency/striping analyses for the SWIR strips over desert sites has been performed mid-June 2018. Please note that no HF equalisation updates have been done during the reporting period. The SWIR High Frequency/striping results for LEFT, CENTER and RIGHT camera are given in respectively Figure 19,Figure 20, *Figure 21*.
Observed stripes in the equalisation profiles might be linked to a sudden significant jump in the DC values of that pixel. It is therefore expected that the vertical strips will strongly be reduced with the foreseen update of the ICP dark current values

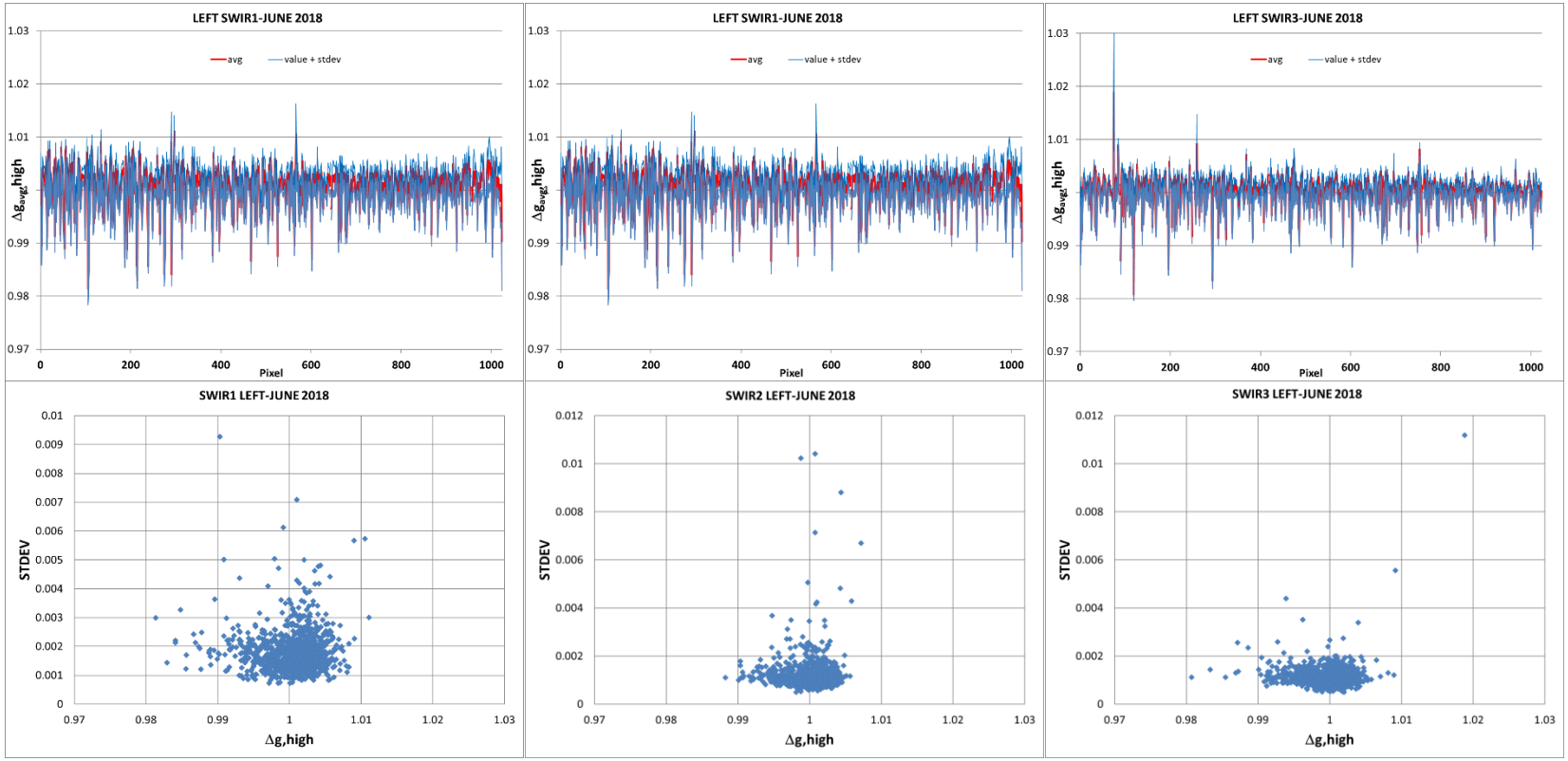


Figure 19. HF SWIR equalisation results LEFT June 2018

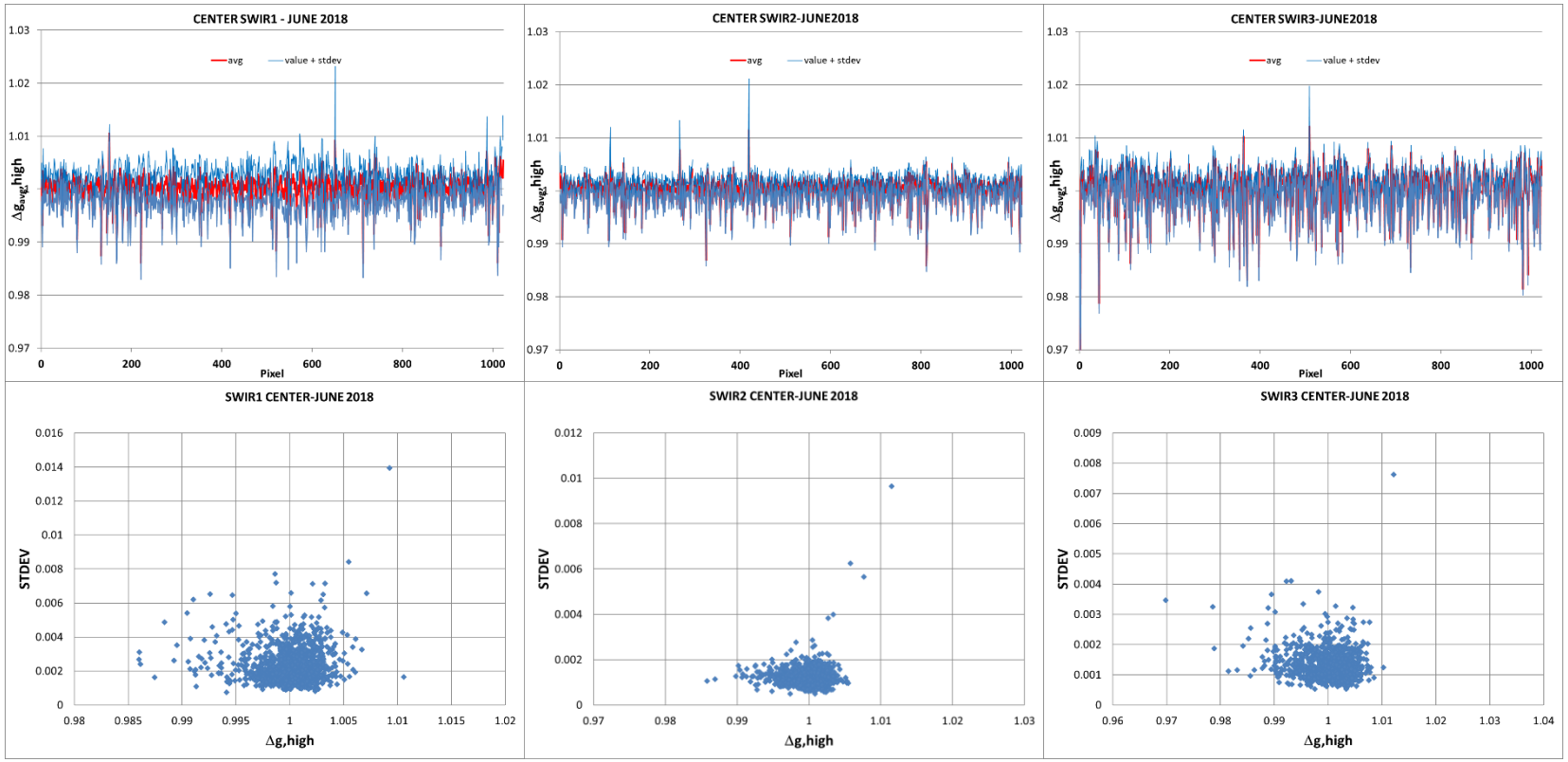


Figure 20. HF equalisation results SWIR CENTER: JUNE 2018

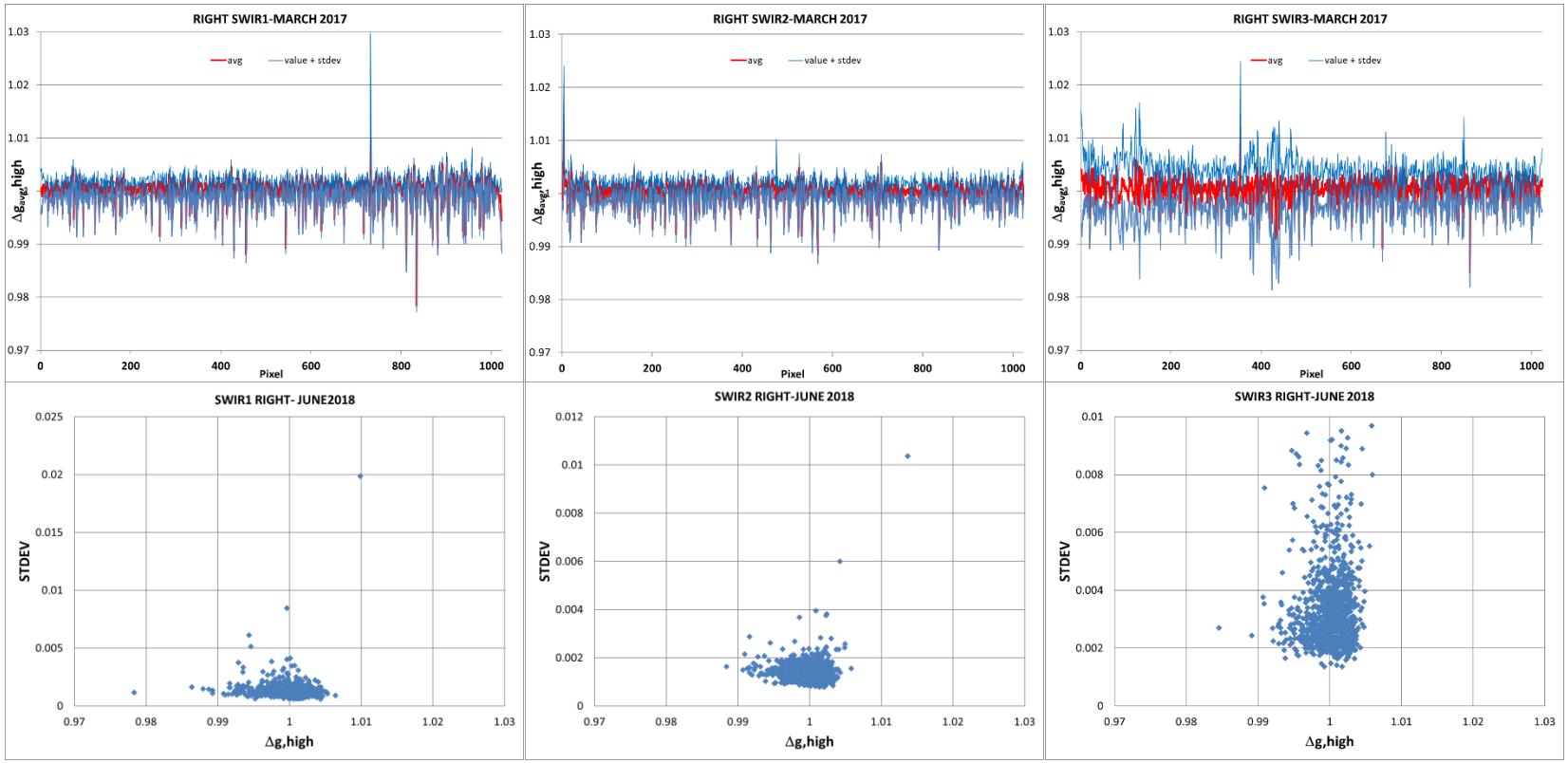


Figure 21. HF equalisation results SWIR RIGHT: JUNE 2018

1.5. Bad pixels

One new bad pixel was identified in this reporting period. In fact the pixel turned BAD just after the reporting period (i.e. on 17 June 2018).

Reporting period Mid-Dec 2017- Mid-March 2018																	
CAMERA	STRIP	pixel numbers (ID L1 A)															
		NEW BAD	BAD (from previous periods)														
left	swir1	4	28	104	298	345	352	644	956								
left	swir2		711	863													
left	swir3		90	172	250	370	419	438	568	759	761						
center	swir1		1021														
center	swir2		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

1.6. 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_1_R_000_201806XX_01.xml	LEFT SWIR1 Pixel 4 assigned status bad

Table 7: Radiometric ICP-file updates Collection 1

2. Geometric Image Quality

2.1. Summary

The quarterly average location error (ALE) over the period 16/3/2018 – 15/6/2018 was 68 m (1σ = 82 m) for all spectral bands (combined cameras). Compared to the previous reporting period the ALE has decreased by 11%.

The total number of chips per day and per spectral band used for the geometric accuracy analysis increased by 38% on average compared to the previous reporting period.

The daily average location error compliance (ALE < 300m) was 99.12%, which is 0.03% lower than in the previous reporting period. The inter-band geometric accuracy was 32 m – 54 m (σ = 7 – 17 m), which is 0.09 – 0.16 of a pixel (333 m), a result that is slightly better than in the previous reporting period.

The multi-temporal geometric accuracy was 83.82% (4.99% higher compared to previous quarter) for the VNIR and 94.98% (0.91% higher compared to previous quarter) for the combined VNIR/SWIR. The multi-temporal accuracies over the last full year are 82.55% and 94.86% 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	**16/3/2018 - 15/4/2018**	**16/4/2018 - 15/5/2018**	**16/5/2018 - 15/6/2018**
BLUE	54.34, σ = 31.49	52.77, σ = 30.57	55.16, σ = 31.97
RED	55.35, σ = 32.68	54.25, σ = 32.29	56.49, σ = 33.48
NIR	57.26, σ = 34.05	54.99, σ = 32.76	55.56, σ = 32.03
SWIR1	83.80, σ = 52.88	78.39, σ = 49.02	79.72, σ = 50.47
SWIR2	58.70, σ = 32.31	55.32, σ = 29.73	57.64, σ = 31.35
SWIR3	54.91, σ = 30.46	51.94, σ = 28.12	57.24, σ = 31.23

Table 8: Mean absolute location error for camera 1.

CAMERA 2 Mean and standard deviation ALE [m]			
Strip\Period	**16/3/2018 - 15/4/2018**	**16/4/2018 - 15/5/2018**	**16/5/2018 - 15/6/2018**
BLUE	67.36, σ = 36.99	64.65, σ = 33.51	76.65, σ = 37.86
RED	69.03, σ = 37.60	67.92, σ = 35.37	78.79, σ = 38.17
NIR	66.21, σ = 36.86	64.75, σ = 34.13	75.13, σ = 37.05
SWIR1	70.78, σ = 40.01	67.73, σ = 36.47	75.88, σ = 38.01
SWIR2	71.56, σ = 40.86	69.01, σ = 37.27	77.24, σ = 39.05
SWIR3	71.39, σ = 41.21	68.04, σ = 36.80	76.57, σ = 39.94

Table 9: Mean absolute location error for camera 2.

CAMERA 3 Mean and standard deviation ALE [m]			
Strip\Period	**16/3/2018 - 15/4/2018**	**16/4/2018 - 15/5/2018**	**16/5/2018 - 15/6/2018**
BLUE	64.20, σ = 36.00	61.43, σ = 35.63	56.86, σ = 32.08
RED	66.81, σ = 38.74	63.86, σ = 38.83	56.63, σ = 33.59
NIR	64.67, σ = 39.38	59.75, σ = 37.57	54.37, σ = 32.01
SWIR1	60.40, σ = 34.44	55.22, σ = 33.94	52.47, σ = 29.85
SWIR2	67.43, σ = 38.72	61.02, σ = 36.59	57.69, σ = 32.67
SWIR3	88.60, σ = 54.91	80.62, σ = 50.42	75.36, σ = 45.69

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 64.8 m, which is 4.6 m (6.6%) 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 16/3/2018 – 15/4/2018
- from 16/4/2018 – 15/5/2018
- from 16/5/2018 – 15/6/2018

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
16/03/2018	99.11	99.47	99.46	99.79	32120	71.16	84.06	36079	64.62	70.89	35340	62.54	73.55	33345	67.11	77.43
17/03/2018	98.99	99.30	99.46	99.77	29693	69.59	95.52	33479	62.28	73.73	33014	58.84	66.21	32413	63.53	73.63
18/03/2018	99.14	99.41	99.48	99.72	29173	67.98	93.03	33236	63.09	81.20	33285	60.25	74.54	32416	64.10	76.49
19/03/2018	98.79	99.31	99.34	99.71	33955	71.36	100.87	36775	64.73	83.73	36426	63.28	77.38	34993	66.31	78.60
20/03/2018	98.97	99.41	99.38	99.71	39526	65.29	86.73	43527	59.56	79.44	42642	57.57	76.28	39689	62.03	73.69
21/03/2018	99.28	99.48	99.48	99.72	33672	63.46	81.16	38465	58.60	67.10	38503	58.03	68.04	35774	62.32	72.60
22/03/2018	99.12	99.48	99.42	99.73	32004	68.35	87.46	36682	62.48	72.51	36584	61.31	79.83	35398	64.52	78.61
23/03/2018	98.81	99.30	99.28	99.69	32817	69.08	94.31	36742	63.75	76.25	36710	62.93	76.11	36008	65.13	78.33
24/03/2018	98.83	99.32	99.26	99.67	30202	75.55	91.84	33931	69.08	79.10	33792	66.19	76.87	32286	69.34	78.28
25/03/2018	98.94	99.25	99.30	99.73	29204	72.98	87.46	34017	67.93	76.43	32738	65.11	83.24	32367	67.58	78.96
26/03/2018	98.96	99.26	99.34	99.73	28483	79.20	88.16	33102	74.35	75.38	32375	71.49	73.26	31644	74.04	82.43
27/03/2018	98.89	99.11	99.14	99.76	29873	77.46	90.32	34236	73.80	82.21	34233	71.51	87.60	34047	72.92	74.37
28/03/2018	98.83	99.39	99.36	99.70	30368	69.70	97.24	34206	63.72	76.33	32680	63.70	82.38	33882	65.02	79.56
29/03/2018	98.73	99.20	99.15	99.70	31572	68.47	91.51	35879	63.68	74.75	33438	62.76	70.78	33376	64.88	79.90
30/03/2018	99.03	99.33	99.27	99.73	31682	65.14	86.57	36193	59.74	73.18	35274	60.21	73.15	33121	62.65	78.48
31/03/2018	98.92	99.30	99.25	99.68	29762	67.95	91.76	33234	62.37	83.23	33106	63.59	84.91	31423	65.49	80.72
01/04/2018	98.76	99.37	99.25	99.66	26257	69.82	97.15	30447	62.94	78.76	30156	63.43	87.24	29503	65.93	80.19
02/04/2018	98.75	99.22	99.22	99.65	27852	74.24	93.55	31231	68.71	79.00	29884	67.95	91.02	29093	69.66	87.89
03/04/2018	98.67	98.95	98.95	99.72	32006	78.90	95.77	36187	75.34	84.58	34688	73.57	77.19	34085	73.78	81.28
04/04/2018	98.72	98.99	99.10	99.75	30157	82.76	101.46	34144	78.29	82.65	33308	74.13	75.32	33033	74.54	73.37
05/04/2018	98.40	98.86	98.78	99.77	27867	97.80	104.08	31898	93.29	90.98	32322	89.20	85.74	32110	87.36	72.57
06/04/2018	98.01	98.64	98.61	99.60	30341	101.44	102.37	34156	96.37	92.07	35510	92.42	95.16	34397	90.29	86.27
07/04/2018	98.11	98.59	98.71	99.62	30189	98.20	106.52	33558	94.20	90.64	32949	89.47	83.52	32340	89.13	88.44
08/04/2018	98.68	99.01	99.01	99.75	35101	80.28	90.85	38830	75.85	86.23	37529	72.76	84.46	37351	72.76	74.39
09/04/2018	99.05	99.40	99.35	99.70	35089	65.53	87.60	39108	59.25	78.74	37381	57.66	77.47	38779	60.32	77.61
10/04/2018	98.82	99.38	99.29	99.71	29694	65.39	97.66	34649	58.43	81.88	33809	58.89	83.09	34304	62.93	83.06
11/04/2018	98.79	99.36	99.35	99.63	32306	65.13	95.76	35274	57.95	77.56	34324	58.67	78.07	32486	62.74	89.75
12/04/2018	98.75	99.24	99.27	99.66	30436	67.63	100.13	34555	59.70	78.80	33245	60.30	72.35	31594	64.45	82.11
13/04/2018	98.78	99.26	99.30	99.69	32099	66.15	94.31	36725	59.22	80.82	35560	60.43	74.82	35690	63.16	84.99
14/04/2018	98.98	99.46	99.46	99.73	37964	63.03	81.63	43764	58.47	79.33	42258	60.15	72.23	44539	62.95	79.25
15/04/2018	98.97	99.40	99.31	99.70	34880	64.10	93.16	38900	58.22	76.29	37877	60.35	86.89	38787	61.27	81.30
Averages	**98.82**	**99.23**	**99.23**	**99.71**	**30339**	**73.31**	**93.40**	**34274**	**67.71**	**79.52**	**33595**	**66.27**	**78.96**	**32879**	**68.53**	**79.46**

Table 11: Daily achieved compliance and the daily average location error (in m) for all spectral bands in the period 16/3/2018 to 15/4/2018.

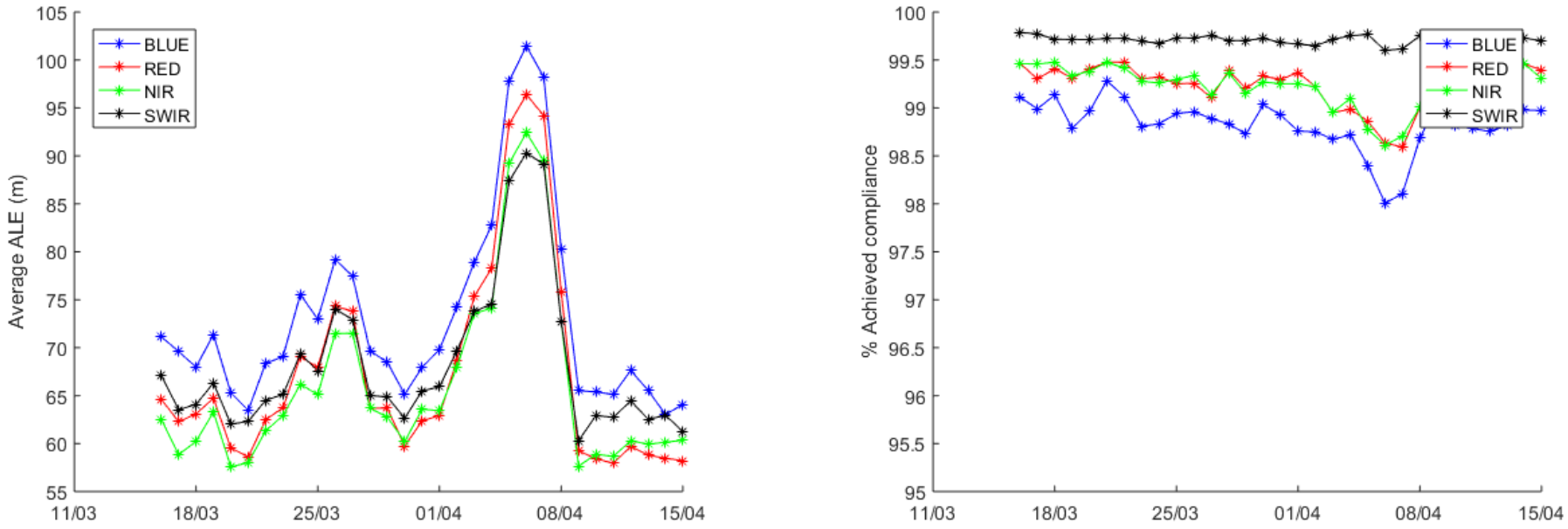
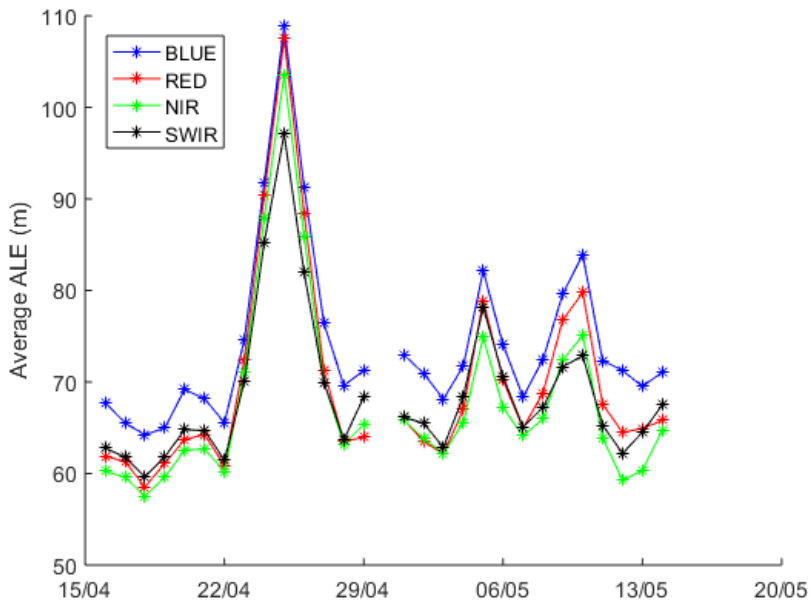


Figure 22: Daily average location error in the period from 16/3/2018 – 15/4/2018 (left) and the average daily compliance of the spectral bands (right).

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
16/04/2018	98.83	99.27	99.25	99.65	35548	67.77	101.44	39571	61.90	83.35	37511	60.27	82.39	36713	62.80	83.00
17/04/2018	98.93	99.08	99.16	99.70	37814	65.54	85.97	42586	61.31	83.61	39898	59.61	72.83	39547	61.79	81.34
18/04/2018	99.07	99.39	99.41	99.77	37433	64.23	90.82	41576	58.54	76.56	39894	57.54	73.56	40394	59.63	70.81
19/04/2018	98.88	99.17	99.25	99.70	33291	64.96	96.17	37817	61.11	77.52	37643	59.59	78.23	37619	61.81	77.70
20/04/2018	98.58	99.14	99.18	99.66	34856	69.18	99.05	38891	63.72	83.93	38026	62.59	88.99	38330	64.79	82.59
21/04/2018	98.86	99.18	99.23	99.73	37942	68.16	88.24	43058	64.27	81.25	41041	62.65	74.49	42366	64.71	72.51
22/04/2018	98.92	99.27	99.19	99.76	35319	65.57	89.35	40929	60.84	71.53	38757	60.22	74.05	40773	61.45	72.19
23/04/2018	98.89	99.03	99.02	99.72	35368	74.58	93.54	40839	72.49	81.38	39165	71.07	82.43	43196	70.03	75.87
24/04/2018	98.16	98.46	98.47	99.62	31057	91.84	103.87	36273	90.50	86.74	34424	87.95	89.35	37175	85.28	87.88
25/04/2018	97.37	97.33	97.25	99.56	33322	108.90	113.83	38343	107.48	104.16	35004	103.55	105.45	36379	97.06	94.79
26/04/2018	98.15	98.16	97.83	99.71	35543	91.30	92.75	41688	88.48	89.82	38132	85.90	86.29	40558	81.97	78.71
27/04/2018	98.90	99.07	98.99	99.69	35016	76.40	98.25	41868	71.21	83.58	39098	69.98	82.70	41363	69.94	88.10
28/04/2018	98.79	99.23	99.29	99.78	33035	69.61	91.88	38675	63.51	81.41	36534	63.20	77.00	39496	63.69	73.25
29/04/2018	98.58	99.16	99.19	99.59	31457	71.26	103.23	34721	63.96	87.29	32710	65.39	89.69	31987	68.37	95.29
30/04/2018	NaN	NaN	NaN	NaN	0	NaN	NaN	0	NaN	NaN	0	NaN	NaN	0	NaN	NaN
01/05/2018	98.82	99.21	99.30	99.71	32211	72.99	99.39	40073	65.95	85.51	37166	65.93	76.63	40056	66.18	77.43
02/05/2018	98.77	99.36	99.30	99.68	33246	70.95	95.18	40076	63.48	78.70	38319	63.79	79.56	39909	65.49	82.57
03/05/2018	98.73	99.17	99.23	99.63	33437	68.14	91.97	39236	62.16	80.49	37940	62.22	84.26	40614	62.87	86.74
04/05/2018	98.80	99.18	99.26	99.64	37491	71.75	93.96	41868	66.98	78.57	40046	65.59	73.85	40880	68.39	86.44
05/05/2018	98.71	98.91	99.06	99.68	40192	82.14	84.17	45489	78.86	82.81	44864	74.89	77.90	45763	78.17	84.50
06/05/2018	98.88	99.12	99.22	99.80	38002	74.05	88.59	43183	70.17	77.99	43748	67.16	70.53	45719	70.56	72.64
07/05/2018	98.87	99.07	99.08	99.75	35596	68.37	86.62	41142	64.97	78.87	44240	64.12	82.90	45537	65.08	72.42
08/05/2018	98.74	99.08	99.12	99.67	38790	72.45	95.80	44397	68.81	83.39	45545	65.98	77.95	47333	67.21	81.00
09/05/2018	98.70	98.97	99.12	99.67	33255	79.63	94.20	40504	76.79	81.36	41486	72.44	82.11	40538	71.68	76.25

10/05/2018	98.54	98.85	98.84	99.75	28263	83.90	99.45	34847	79.76	86.02	36584	75.08	80.39	37651	72.86	79.88
11/05/2018	98.84	99.26	99.29	99.71	34092	72.34	93.53	40704	67.58	80.93	42710	63.88	75.87	44383	65.27	75.78
12/05/2018	98.43	99.22	99.33	99.76	27814	71.26	101.16	31240	64.48	80.05	34987	59.25	68.96	35441	62.21	75.61
13/05/2018	98.69	99.09	99.23	99.68	29878	69.51	97.53	33150	64.94	87.92	31516	60.37	76.82	25198	64.49	76.64
14/05/2018	99.35	99.45	99.10	99.54	1849	71.09	59.35	2177	65.80	61.06	2336	64.72	65.11	2607	67.51	91.35
15/05/2018	NaN	NaN	NaN	NaN	0	NaN	NaN	0	NaN	NaN	0	NaN	NaN	0	NaN	NaN
Averages	98.71	99.03	99.04	99.69	31037	74.21	93.90	35831	69.64	81.99	34977	67.68	79.65	35918	68.62	80.47

Table 12: Daily achieved compliance and the daily average location error (in m) for all spectral bands in the period 16/4/2018 – 15/5/2018.



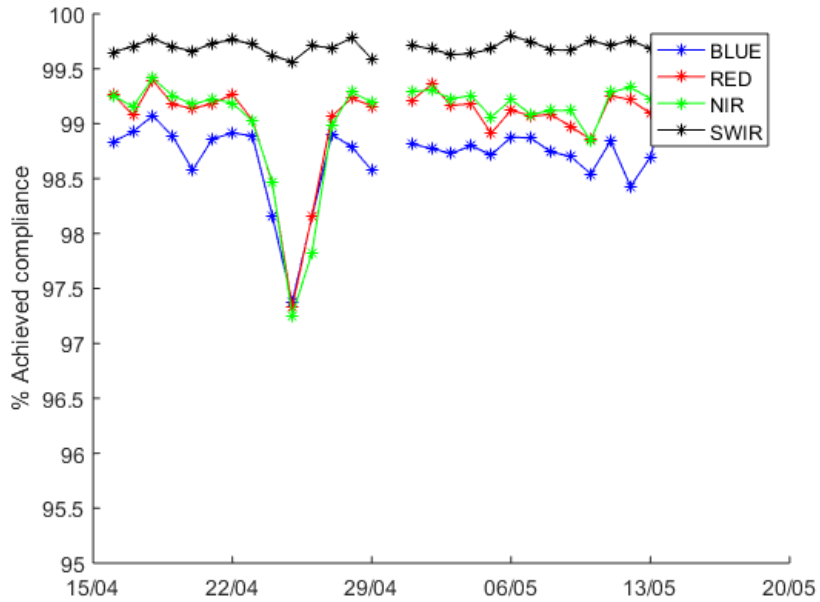


Figure 23: Daily average location error in the period from 16/4/2018 – 15/5/2018 (left) and the average daily compliance of all spectral bands (right).

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
16/05/2018	98.96	99.35	99.43	99.74	38597	64.39	94.31	45018	58.22	80.45	46230	56.56	74.87	48582	58.99	70.14
17/05/2018	98.88	99.40	99.40	99.68	39708	69.35	89.68	46357	62.29	79.19	46935	61.92	75.07	48462	65.74	81.25
18/05/2018	98.74	99.13	99.19	99.64	39471	72.50	98.30	46332	65.84	85.88	46562	64.39	76.80	47205	69.40	85.35
19/05/2018	98.84	99.20	99.33	99.78	40363	70.85	98.60	48058	63.43	78.28	50188	61.38	68.24	50589	64.93	67.98
20/05/2018	99.09	99.49	99.51	99.77	40280	65.14	89.74	48964	57.19	71.15	53167	56.05	73.43	52060	60.17	71.93
21/05/2018	99.02	99.41	99.47	99.70	40990	65.50	92.59	49035	59.02	75.32	54107	56.58	69.49	53516	60.44	77.09
22/05/2018	98.96	99.30	99.37	99.72	44145	69.77	95.46	53174	64.88	83.67	55451	61.84	69.87	55259	64.68	77.56
23/05/2018	98.97	99.25	99.35	99.78	45368	69.06	86.74	56231	63.83	74.00	59116	60.73	75.26	59307	63.26	72.53
24/05/2018	99.01	99.37	99.45	99.76	41087	65.63	96.82	50669	59.36	75.80	51647	57.75	69.82	52699	60.69	71.34

25/05/2018	98.96	99.39	99.35	99.73	40093	64.71	96.13	48623	59.02	78.46	48565	58.75	74.88	50898	61.36	79.83
26/05/2018	98.84	99.26	99.31	99.69	38406	67.56	92.21	47797	62.19	82.18	47150	61.55	73.08	50567	64.79	78.81
27/05/2018	98.79	99.22	99.32	99.71	39165	73.24	91.98	49500	69.05	84.33	49785	67.45	76.38	52975	69.08	82.29
28/05/2018	98.83	99.22	99.31	99.75	39831	75.79	91.14	50227	70.80	86.42	50857	71.55	78.49	54340	70.74	74.31
29/05/2018	98.94	99.32	99.39	99.76	41706	73.20	91.53	51450	67.95	74.35	54137	67.91	75.15	57247	69.09	77.10
30/05/2018	98.90	99.37	99.42	99.72	36918	69.96	97.46	44874	63.70	80.97	46544	62.02	77.24	50090	64.28	77.91
31/05/2018	98.98	99.52	99.41	99.78	9422	72.94	94.96	12220	64.22	68.45	11059	67.02	80.73	14697	64.46	63.77
01/06/2018	98.82	99.13	99.24	99.75	41274	77.95	88.32	49796	72.85	76.22	50653	68.79	72.84	52345	69.43	71.87
02/06/2018	98.93	99.23	99.38	99.78	44906	74.30	92.25	54247	68.92	78.40	55979	64.96	63.83	57312	65.62	71.91
03/06/2018	99.11	99.43	99.45	99.79	43646	63.88	96.41	51504	57.04	79.89	53533	55.21	72.16	54648	58.62	71.24
04/06/2018	98.71	99.06	99.11	99.66	41475	71.51	99.23	48680	65.62	82.48	47275	64.04	82.84	48349	68.04	81.93
05/06/2018	98.75	99.23	99.28	99.71	43159	73.22	99.84	52286	66.99	71.99	49467	65.21	73.01	51520	67.83	79.37
06/06/2018	98.66	99.04	99.19	99.78	41441	80.74	97.67	51797	75.13	82.14	49967	71.18	78.58	54769	69.20	72.79
07/06/2018	98.97	99.34	99.38	99.75	42529	73.04	91.55	52780	66.74	74.22	53612	63.70	72.10	56645	65.01	78.48
08/06/2018	98.80	99.23	99.24	99.73	40914	70.19	89.26	51204	64.60	77.39	53544	60.81	74.97	54042	63.70	78.39
09/06/2018	98.71	99.12	99.24	99.68	40970	74.73	93.66	51628	67.74	78.09	52742	63.05	76.11	52836	67.37	81.27
10/06/2018	98.83	99.22	99.32	99.74	40288	71.91	97.36	51363	65.32	79.57	54031	61.54	72.26	53065	64.27	76.13
11/06/2018	98.99	99.32	99.37	99.76	45922	64.54	87.63	56746	58.35	71.85	59659	57.31	67.95	59661	60.28	68.89
12/06/2018	98.96	99.28	99.27	99.74	42460	66.24	85.92	52071	61.83	72.01	53425	59.88	72.21	54895	61.40	73.48
13/06/2018	98.84	99.27	99.36	99.75	39315	68.10	91.61	48527	61.24	75.59	49112	60.64	71.42	49143	62.43	79.33
14/06/2018	98.75	99.21	99.39	99.69	39739	69.16	98.93	50089	61.76	81.33	54365	59.16	70.49	51135	62.64	82.11
15/06/2018	98.96	99.32	99.43	99.76	41381	63.79	93.95	51842	57.19	70.10	56492	56.79	68.78	53590	59.69	69.19
Averages	**99.73**	**99.28**	**98.89**	**99.34**	**40160**	**70.09**	**93.59**	**49132**	**63.95**	**77.75**	**50495**	**62.12**	**73.50**	**51692**	**64.44**	**75.66**

Table 13: Daily achieved compliance and the daily average location error (in m) for all spectral bands in the period 16/5/2018 – 15/6/2018.

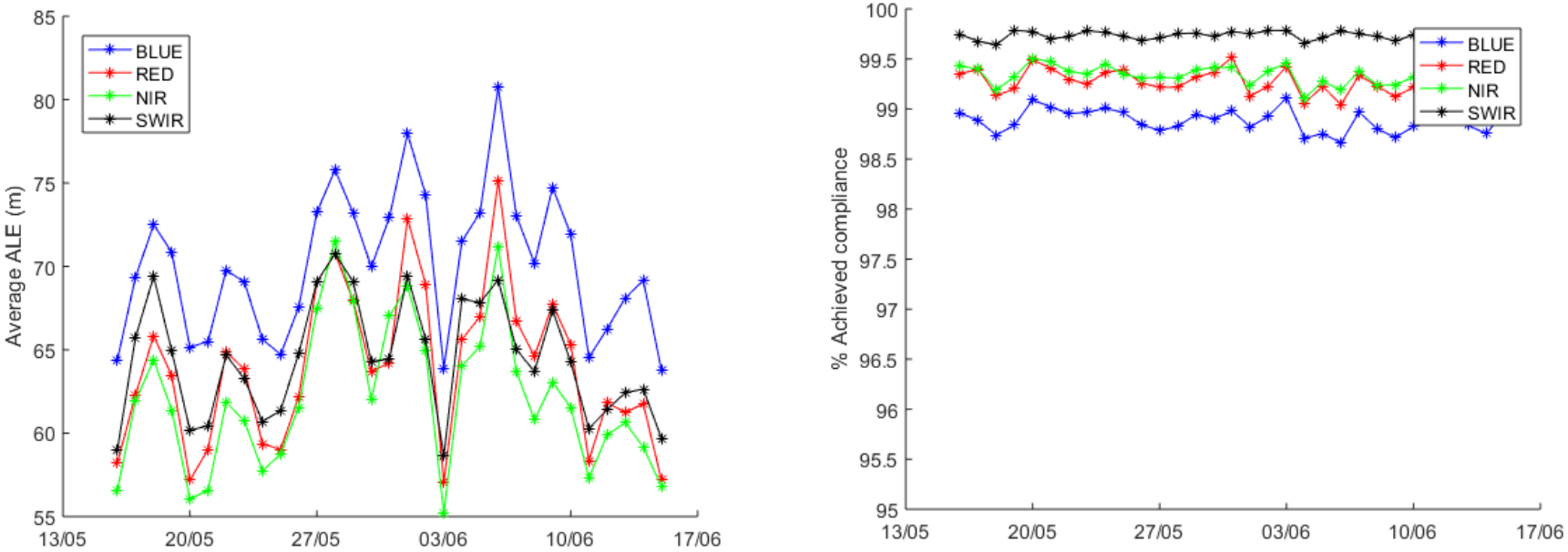


Figure 24: Daily average location error (left) for all spectral bands in the period from 16/5/2018 – 15/6/2018 and the average daily compliance (right).

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	35.01, σ = 9.76
BLUE-NIR	50.83, σ = 17.43
BLUE-SWIR	53.53, σ = 14.69
RED-NIR	33.72, σ = 16.10
RED-SWIR	42.09, σ = 9.89
NIR-SWIR	41.98, σ = 8.13

Table 14: Inter-band geolocation accuracy for period 16/3/2018 to 15/4/2018 for the combined cameras, at 95% confidence level.

Band pair	Inter-band error [m]
BLUE-RED	34.52, σ = 9.69
BLUE-NIR	50.09, σ = 14.98
BLUE-SWIR	51.16, σ = 12.95
RED-NIR	33.62, σ = 13.94
RED-SWIR	40.72, σ = 9.49
NIR-SWIR	40.20, σ = 7.37

Table 15: Inter-band geolocation accuracy for period 16/4/2018 to 15/5/2018 for the combined cameras, at 95% confidence level.

Band pair	Inter-band error [m]
BLUE-RED	32.23, σ = 9.52
BLUE-NIR	48.35, σ = 15.52
BLUE-SWIR	49.04, σ = 12.17
RED-NIR	32.92, σ = 11.97
RED-SWIR	40.54, σ = 8.38
NIR-SWIR	39.19, σ = 7.46

Table 16: Inter-band geolocation accuracy for period 16/5/2018 to 15/6/2018 for the combined cameras, at 95% confidence level.

For the combined cameras, the inter-band geometric accuracy ranged from 32 – 54 m (standard deviation range is 7 – 17 m), which is 0.09 – 0.16 of a pixel (333 m). This result is slightly better to the previous reporting period. The average inter-band RED-NIR registration accuracy was 33 m, which is slightly lower (-1 m) 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:

- 83.82% for the VNIR sensor (158,443 GCPs used),
- 94.98% for the VNIR/SWIR combined (201,556 GCPs used).

The multi-temporal sensor compliance has increased by 4.99% and 0.91% for the VNIR and combined VNIR/SWIR, respectively, compared to the previous reporting period (in which values were 78.83% and 94.07%, respectively).

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

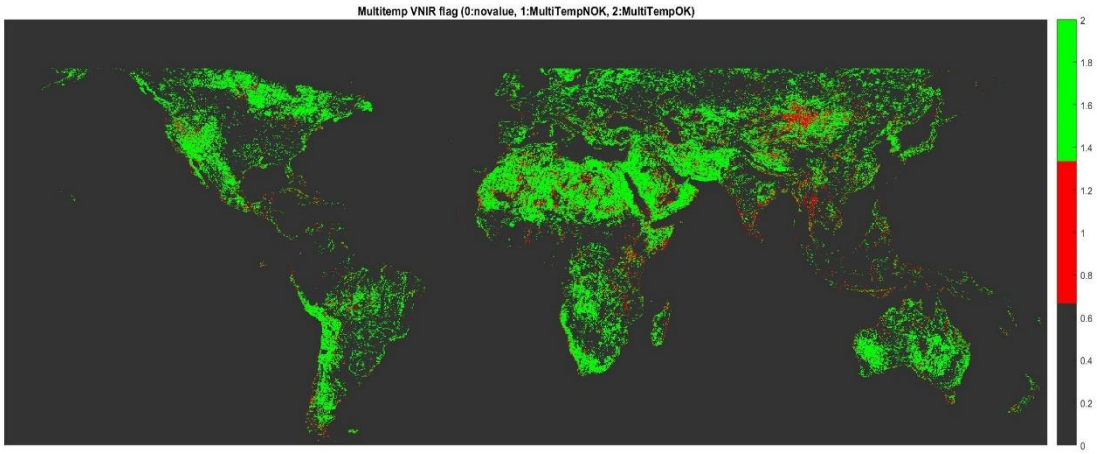
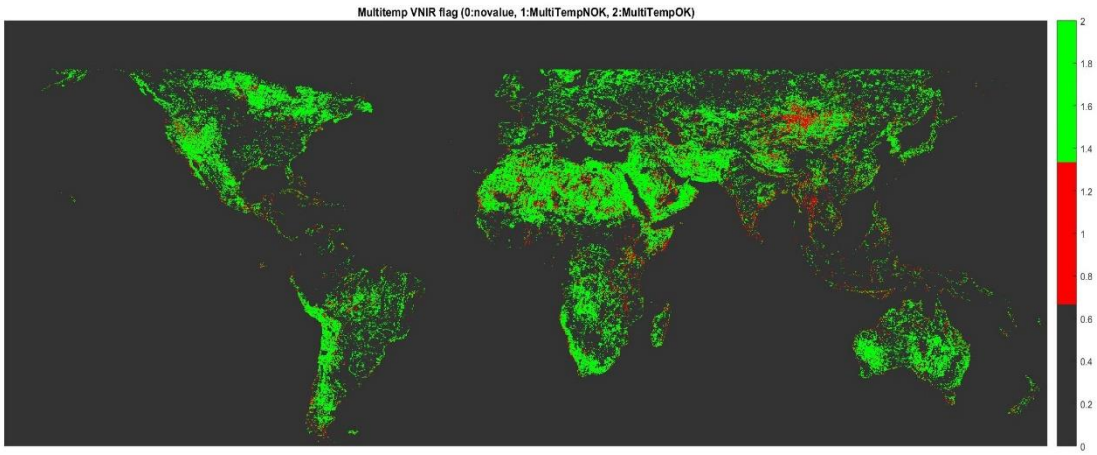


Figure 25.



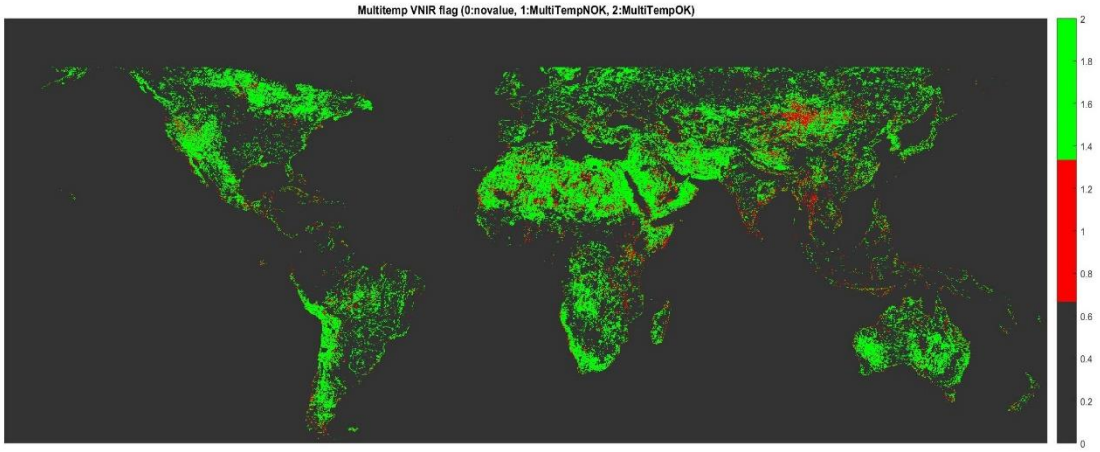
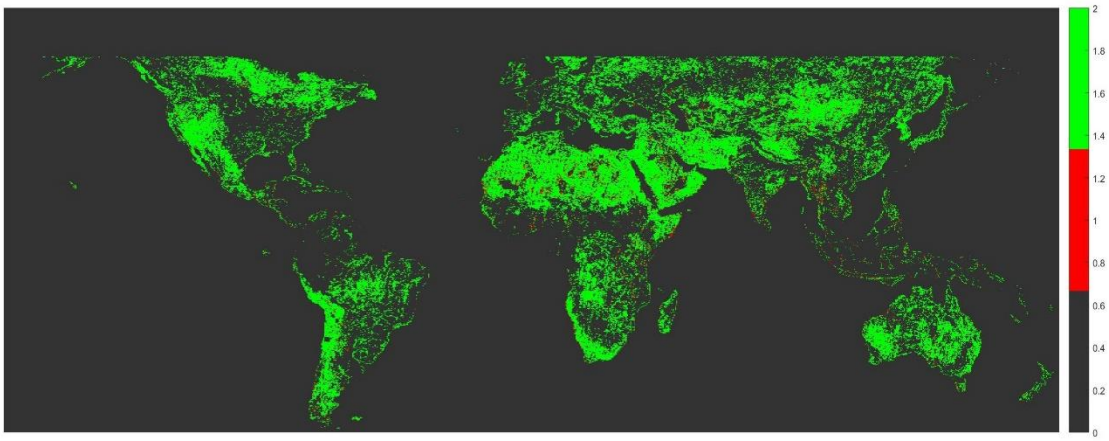


Figure 25: Multi-temporal geometric accuracy for the VNIR sensor. Compliant areas are marked in green; areas with accuracy below 95% are marked in red. Grey areas represent no data.

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



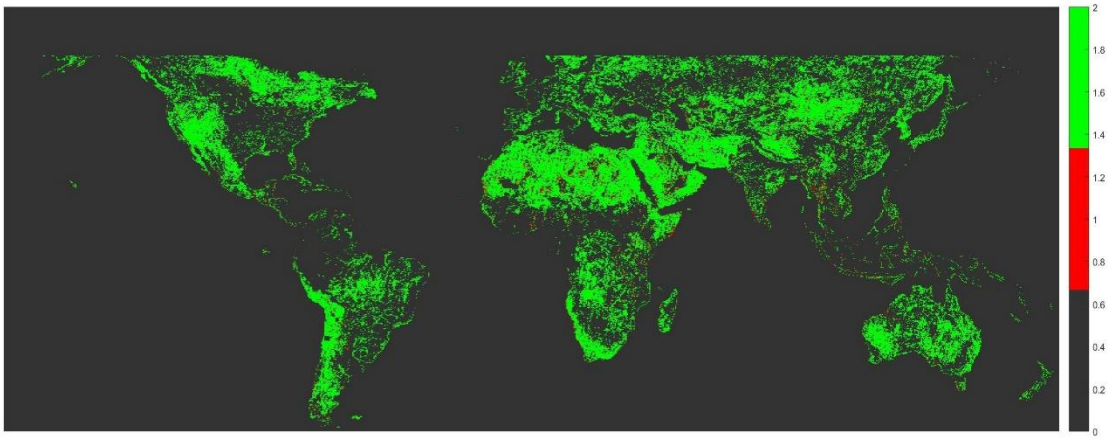


Figure 26.

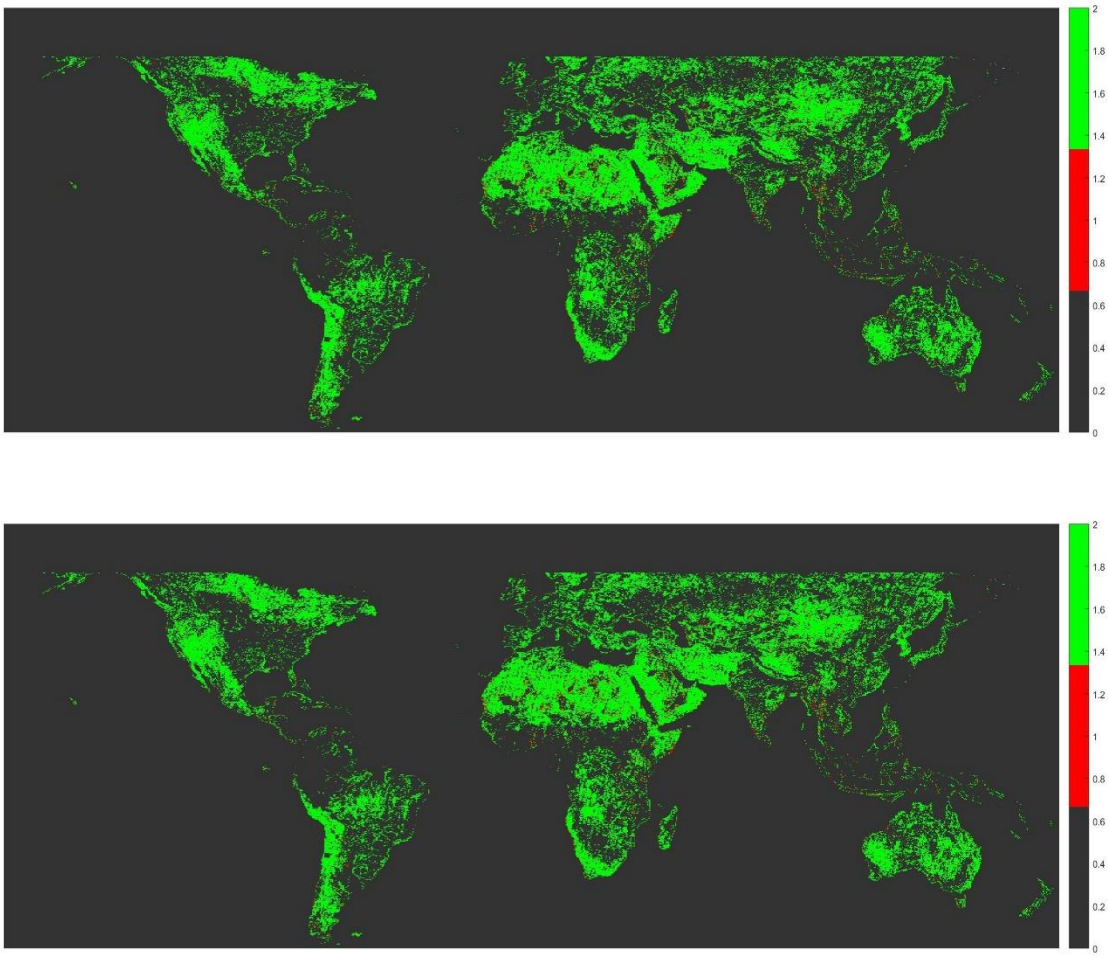


Figure 26: Multi-temporal geometric accuracy for the VNIR/SWIR combined. Compliant areas are marked in green; areas with accuracy below 95% are marked in red. Grey areas represent no data.

Over the last full year, the multi-temporal accuracy for VNIR and VNIR/SWIR is 82.55% and 94.86%, respectively.

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 18: Reference Documents