QUARTERLY IMAGE QUALITY REPORT

IQR#017

Reporting period from 16/12/2017 to 15/03/2018

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Document Control

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1. Radiometric Image Quality

1.1. Summary

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.

A slight increase is observed in the DCC interband calibration results for the NIR strip of all cameras. It is currently unclear what is causing this trend.

For the LEFT and CENTER blue strips calibration results are relatively stable over the recent months and therefore the applied degradation model is assumed to be still valid

During Q1 of 2018 one new bad pixel (i.e. Left SWIR1 PixelID 104)) 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 **<u>Collection 1</u>** ICP files.

As the calibration results for the SWIR strips of the RIGHT camera continues to show an overcorrection of the degradation, it was decided to no longer apply a degradation model for the RIGHT SWIR strips. Since 2018 a degradation model is no longer in use of for the right SWIR strips.

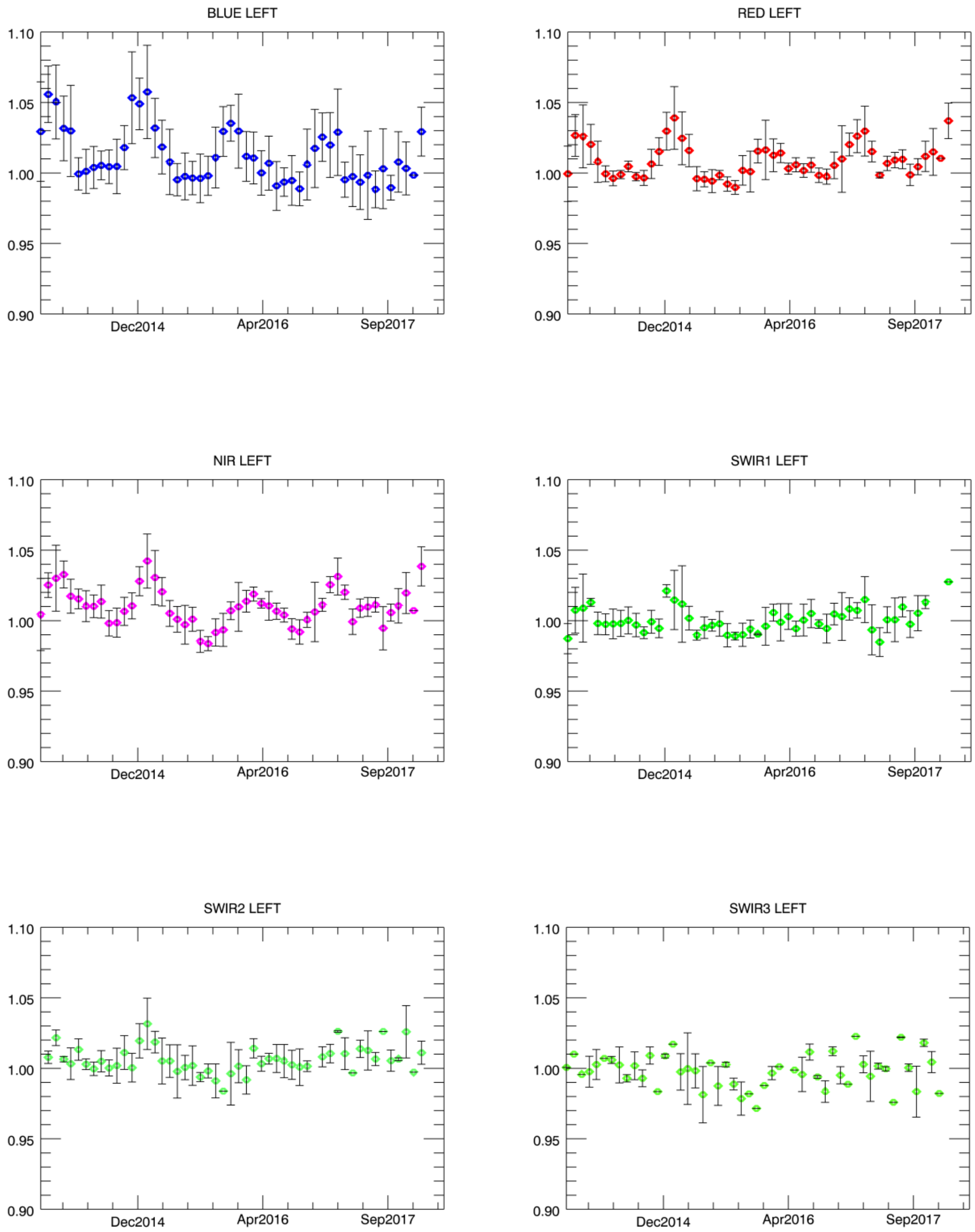


Figure 1. Libya-4 desert calibration results: LEFT monthly averaged results (Collection 1)

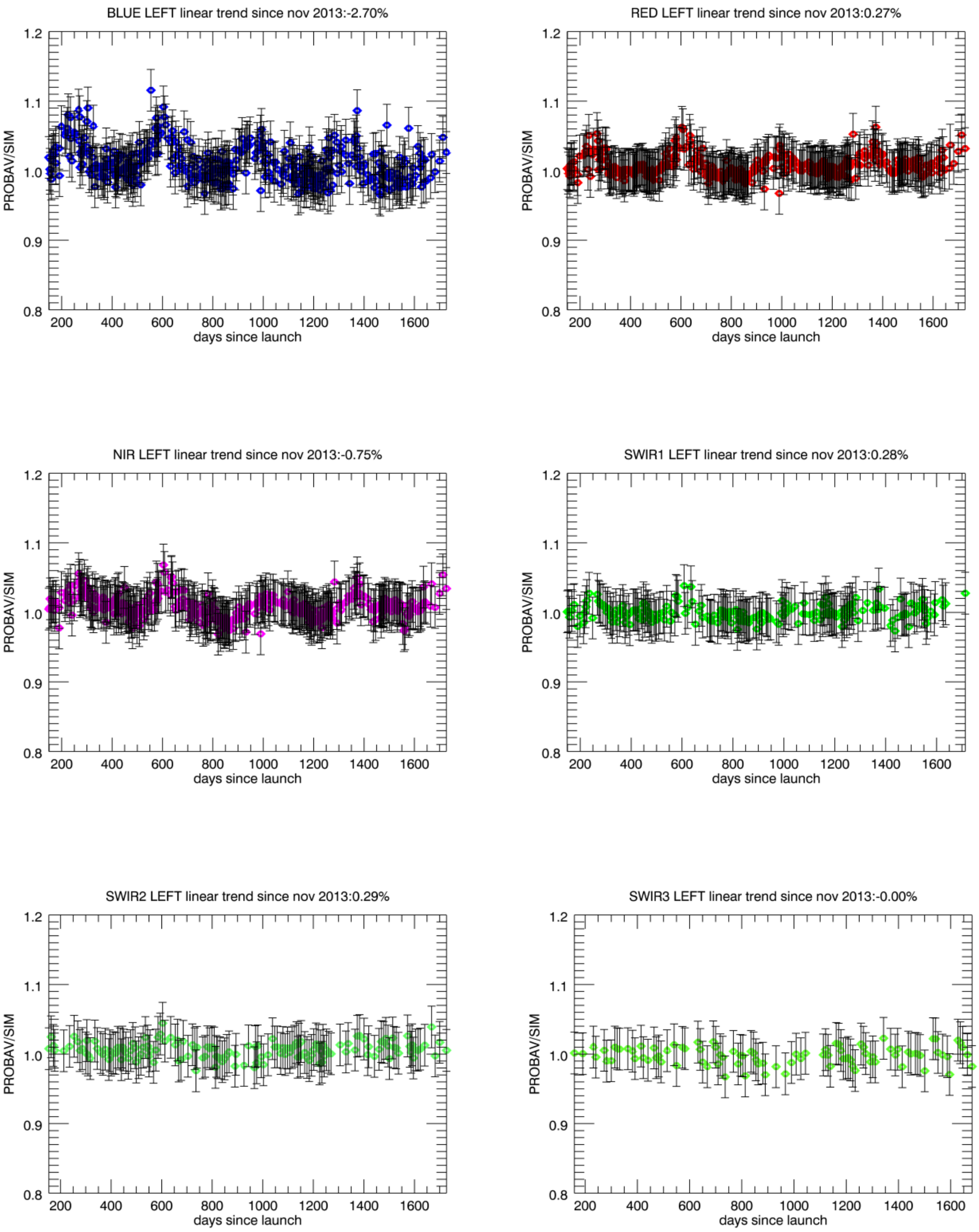


Figure 2. Libya-4 desert calibration results: LEFT individual results (Collection 1)

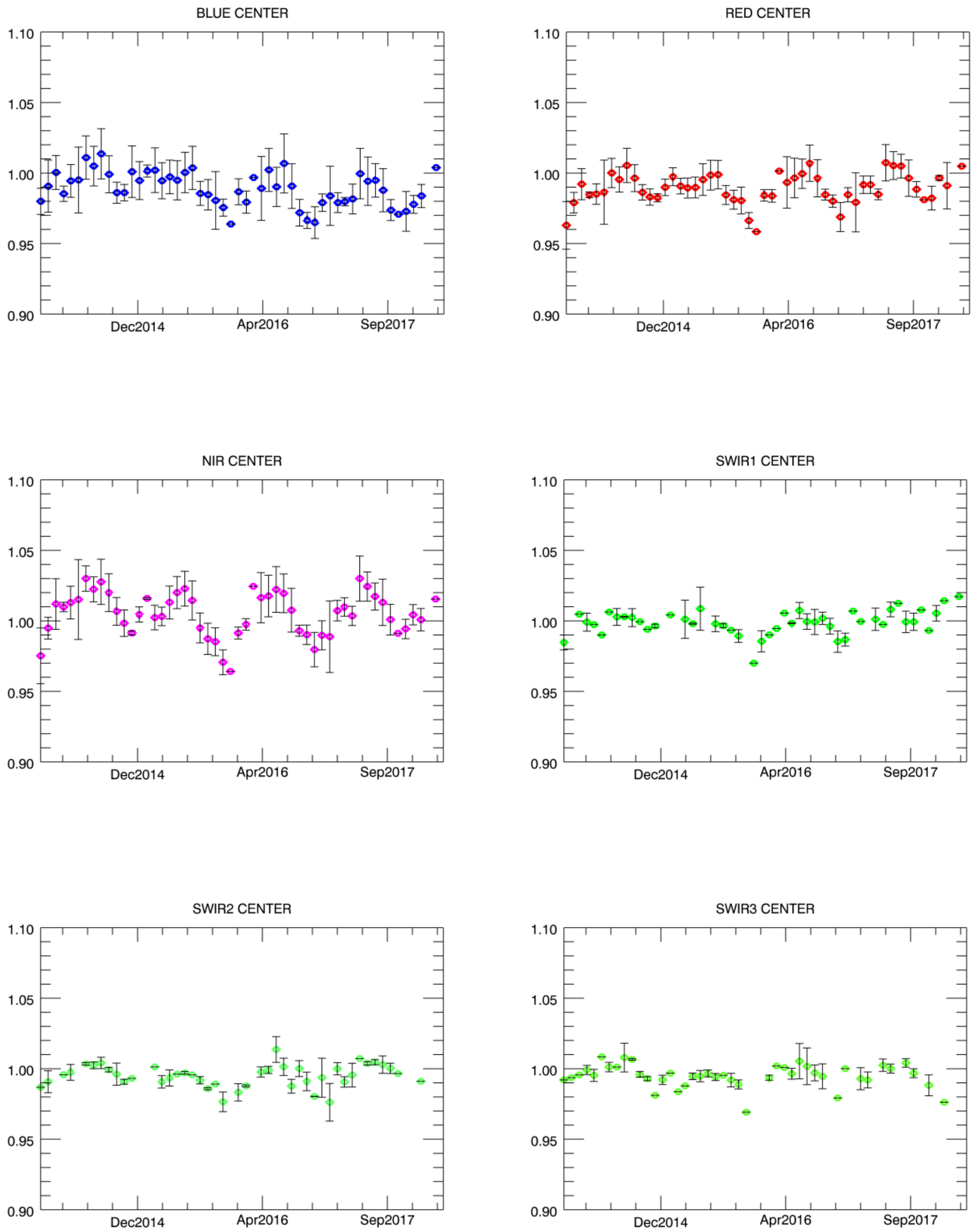


Figure 3. Libya-4 desert calibration results: CENTER monthly averaged results (Collection 1)

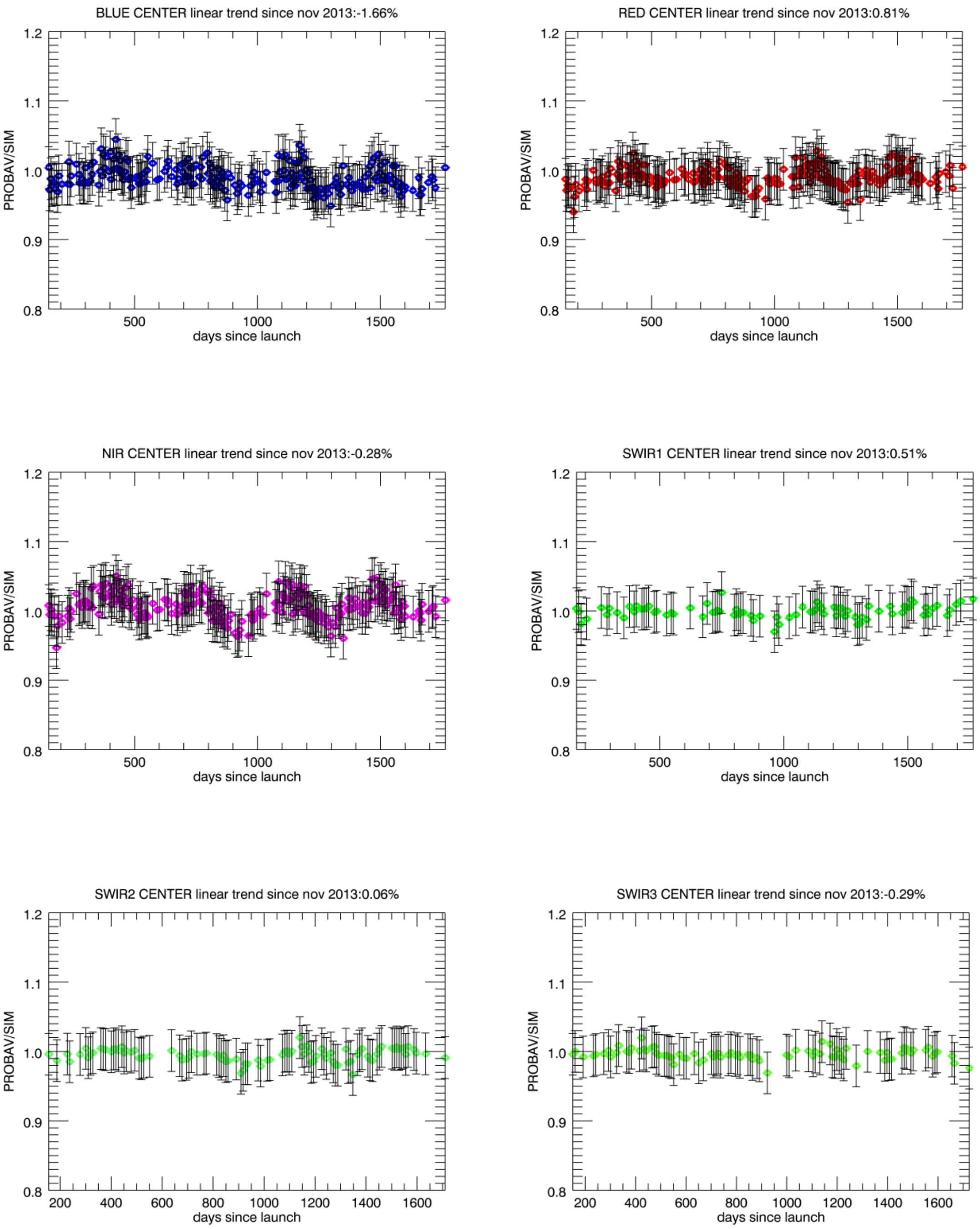


Figure 4. Libya-4 desert calibration results: CENTER individual results (Collection 1)

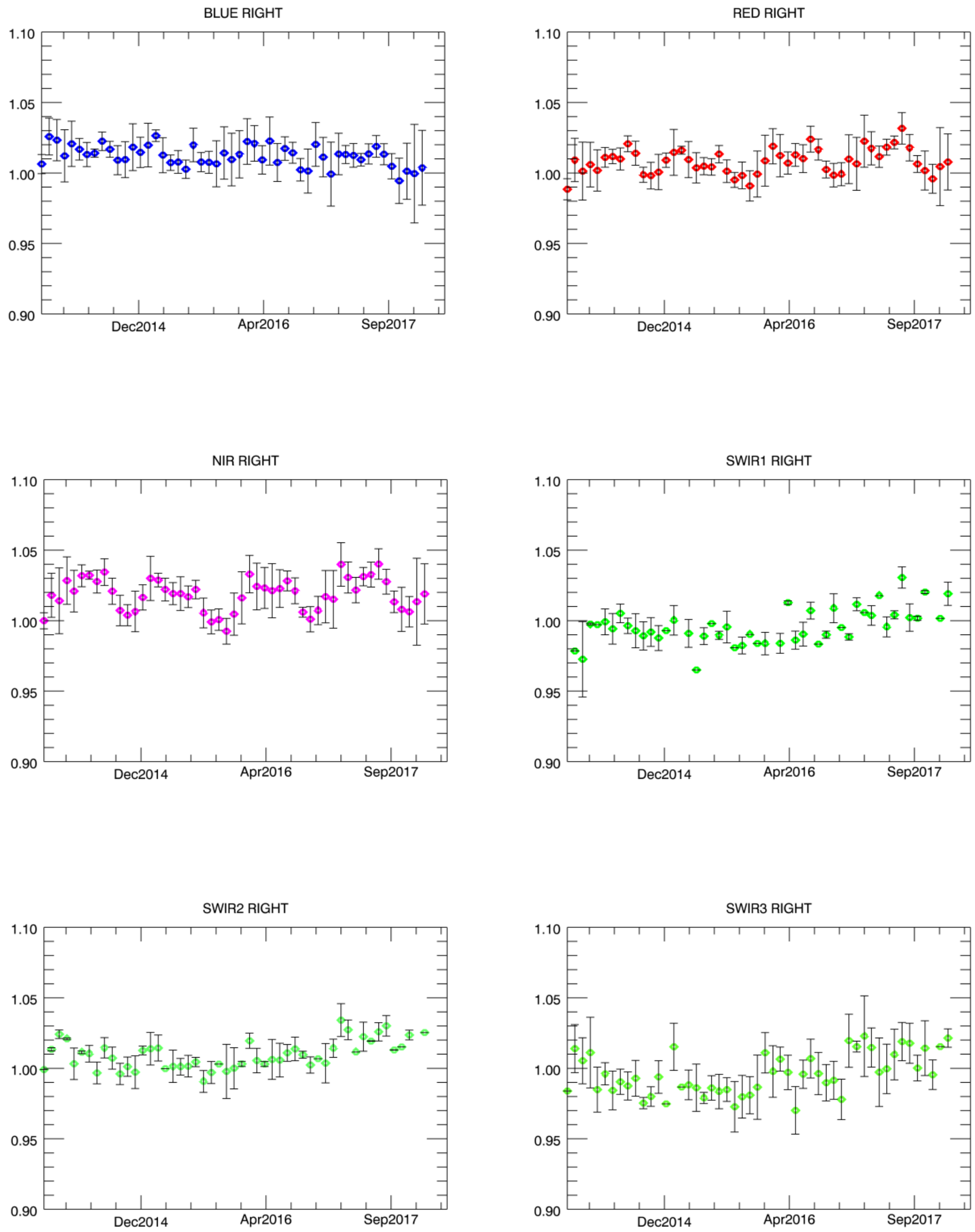


Figure 5. Libya-4 desert calibration results: RIGHT monthly averaged results (Collection 1)

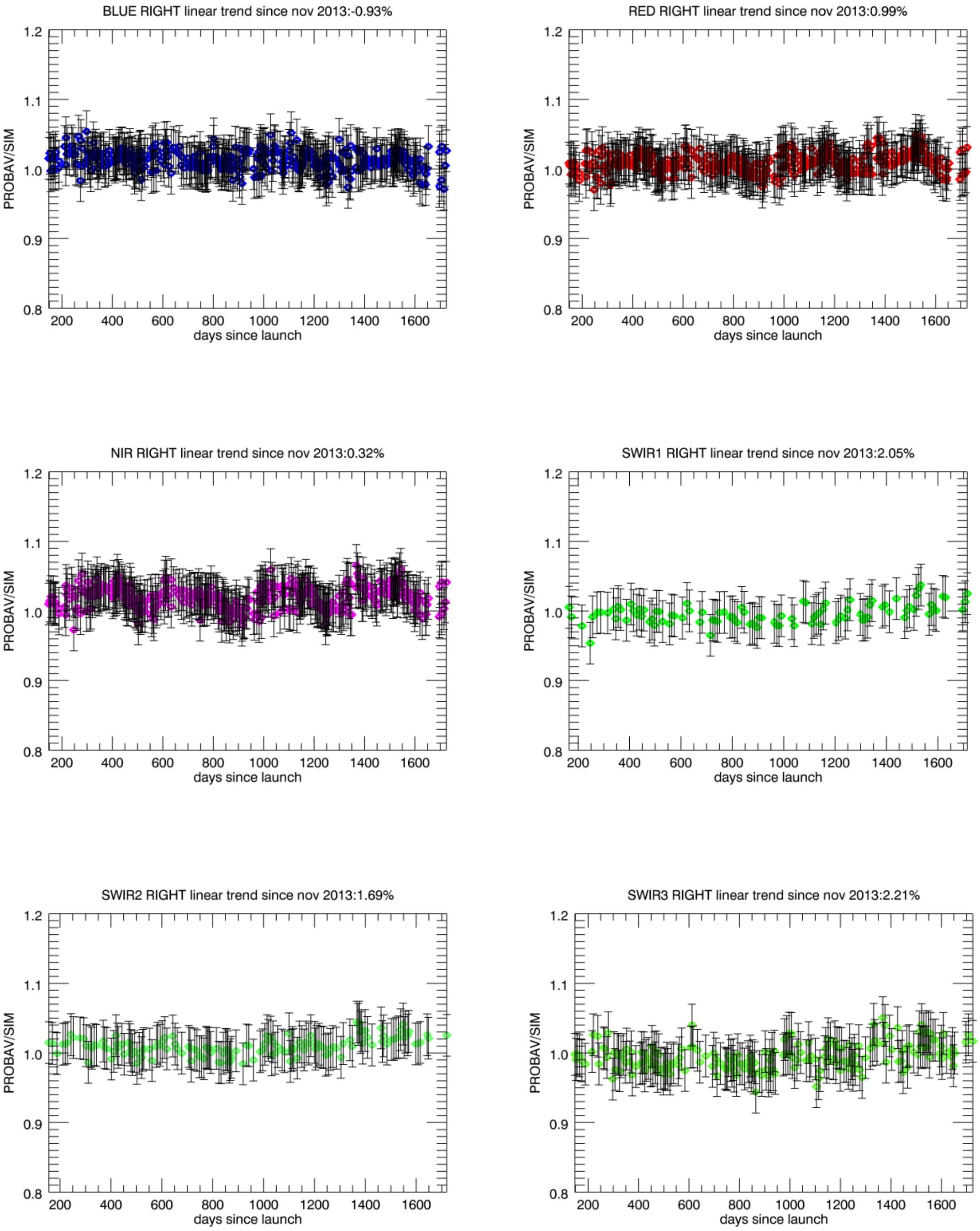


Figure 6. Libya-4 desert calibration results: RIGHT individual results (Collection 1)

1.2.1.2. Rayleigh calibration

Methodology

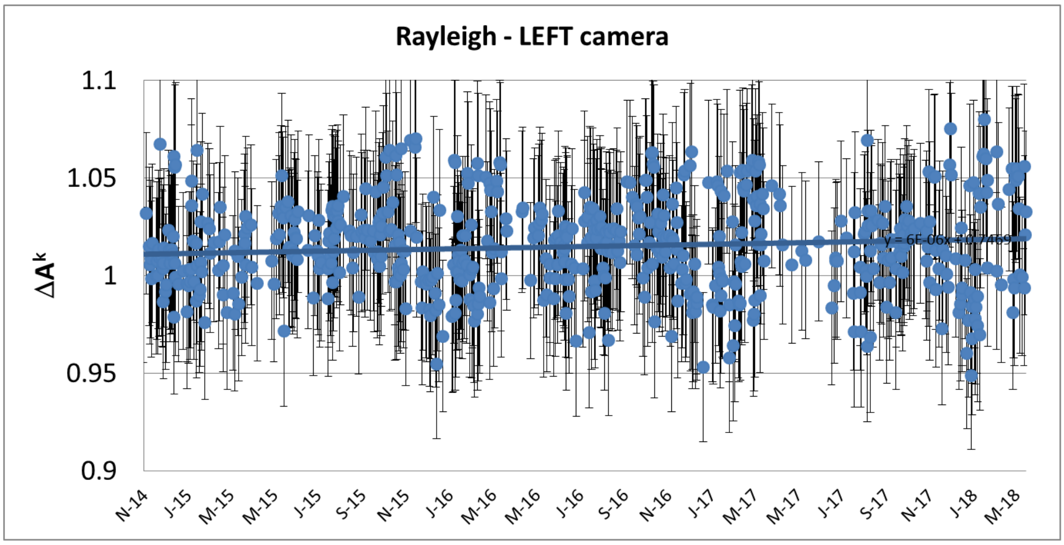
The Rayleigh calibration approach is an absolute calibration method for BLUE and RED bands. The primary assumption of the approach is that the ocean does not contribute to the Top-Of-Atmosphere (TOA) signal in the NIR. The contribution of aerosol scattering is derived from the ***NIR reference band*** 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.



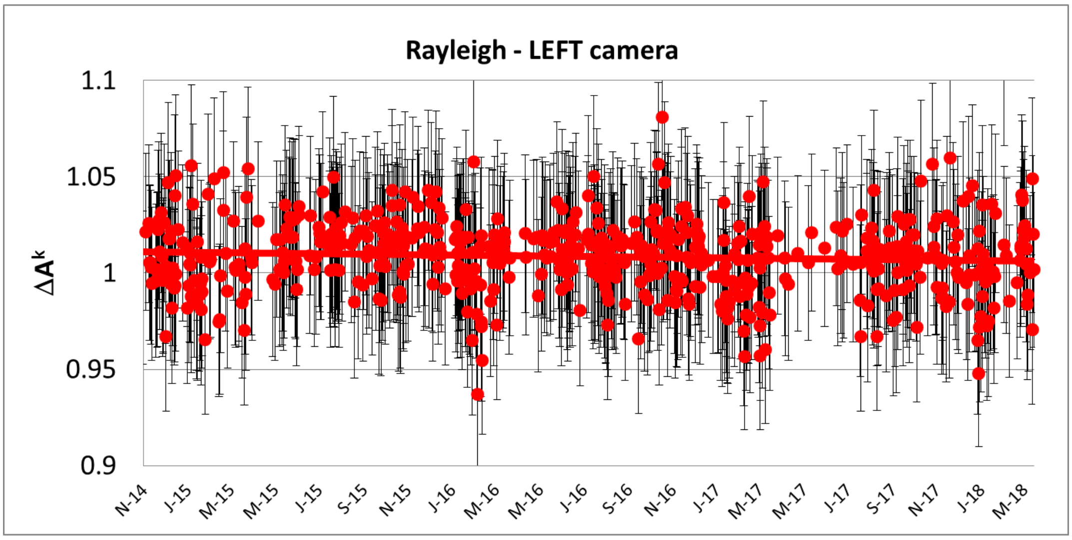
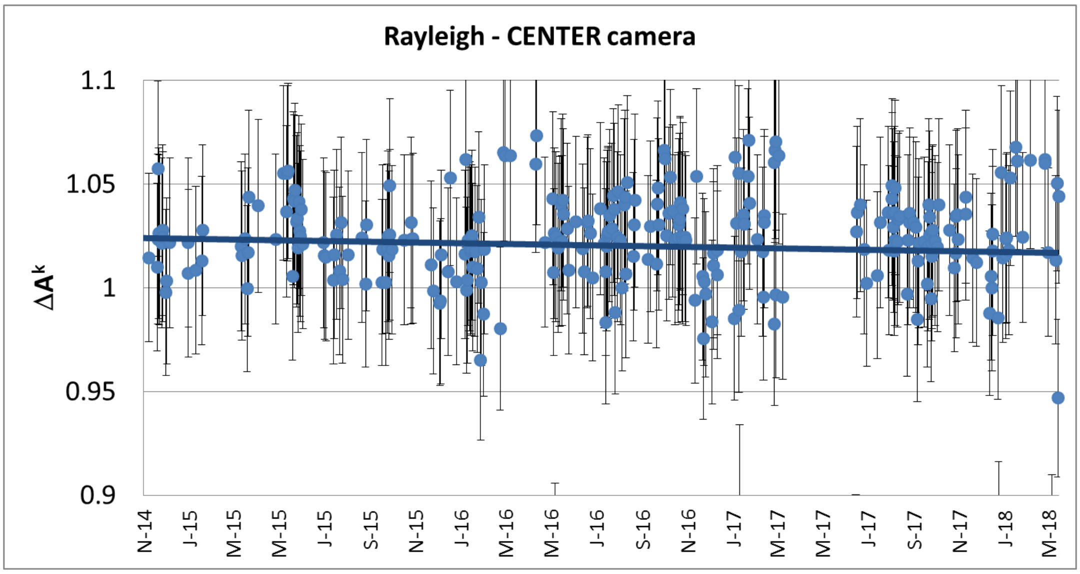


Figure 7. Rayleigh absolute calibration results: LEFT camera (Collection 1)



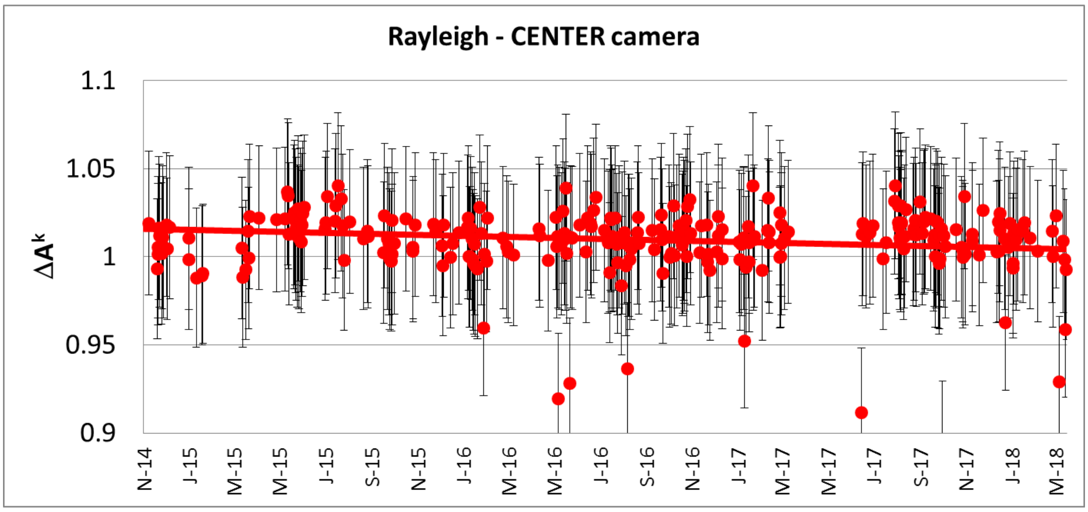
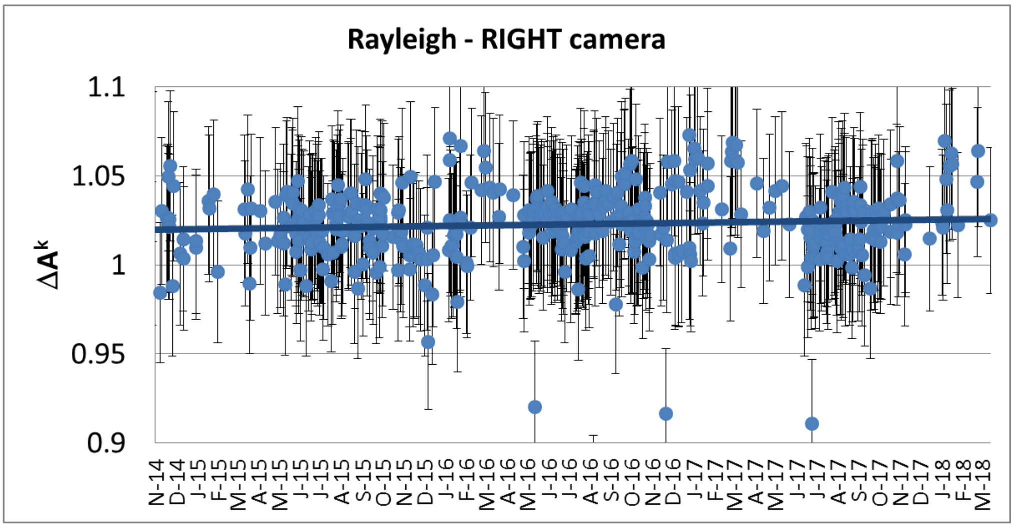


Figure 8. Rayleigh absolute calibration results: CENTER camera (Collection 1)



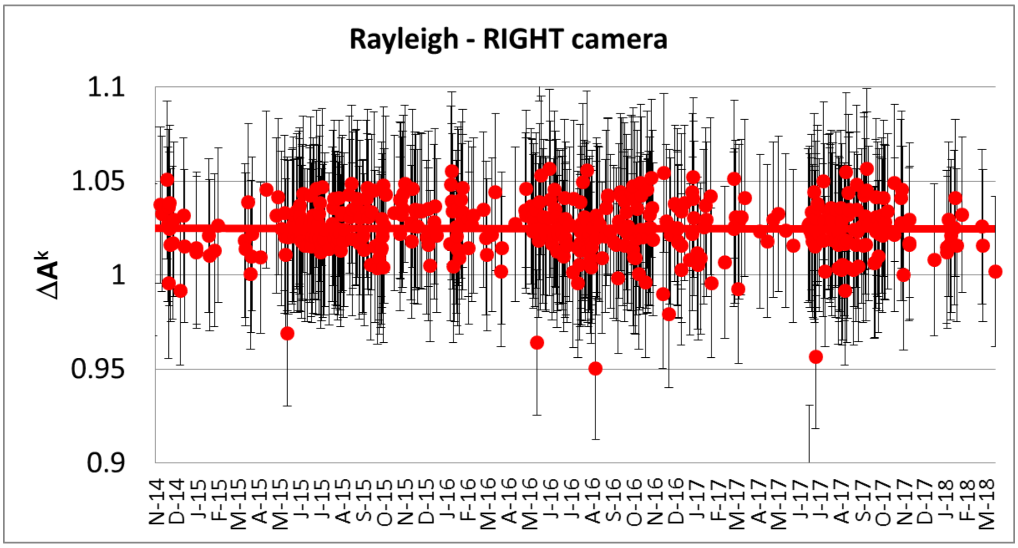


Figure 9. Rayleigh absolute calibration results: RIGHT camera (Collection 1)

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

The LEFT and CENTER BLUE calibration result seems to be more stable since the application of the new degradation model (active since September 2017).
A slight increase is observed in the DCC interband calibration results for the NIR strip of all cameras. It is currently unclear what is causing this trend.

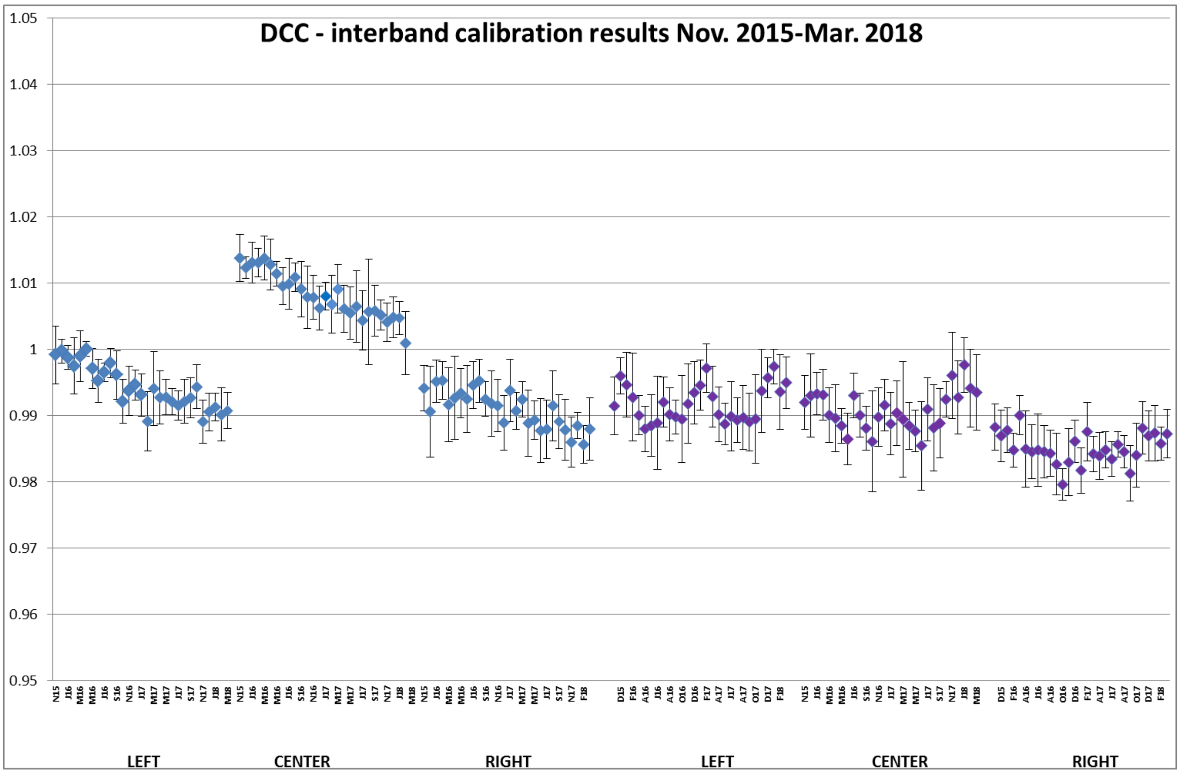


Figure 10. DCC inter-band calibration results: LEFT, CENTER and RIGHT camera

1.2.3. PROBA-V Multi-temporal radiometric accuracy

1.2.3.1. Degradation model

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		
	until 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. For the SWIR center 2 strip, the processing is still under investigation. Therefore no results are given for the CENTER SWIR2 strip.

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.

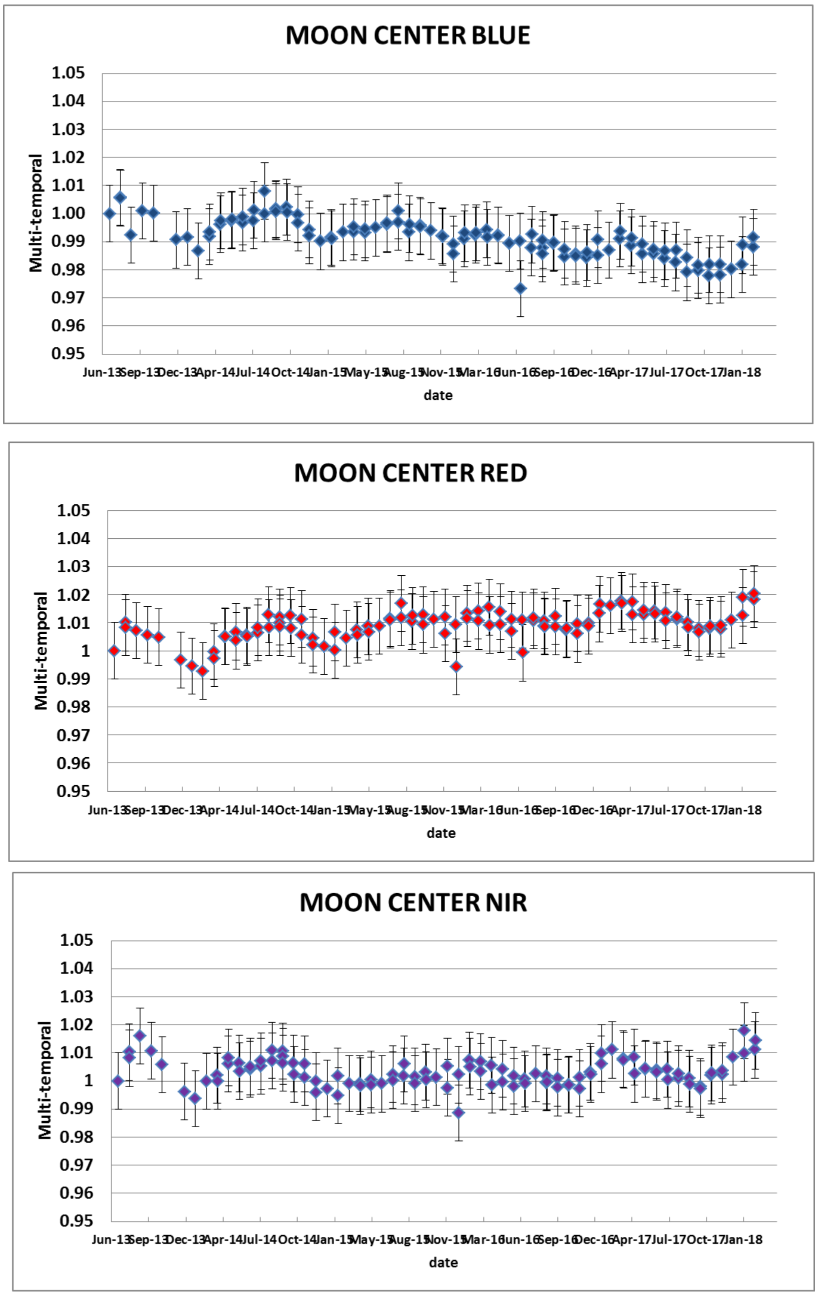


Figure 11. Lunar Calibration results CENTER camera normalised to June 2013 (collection 1 ICP files)

1.3. 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 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.

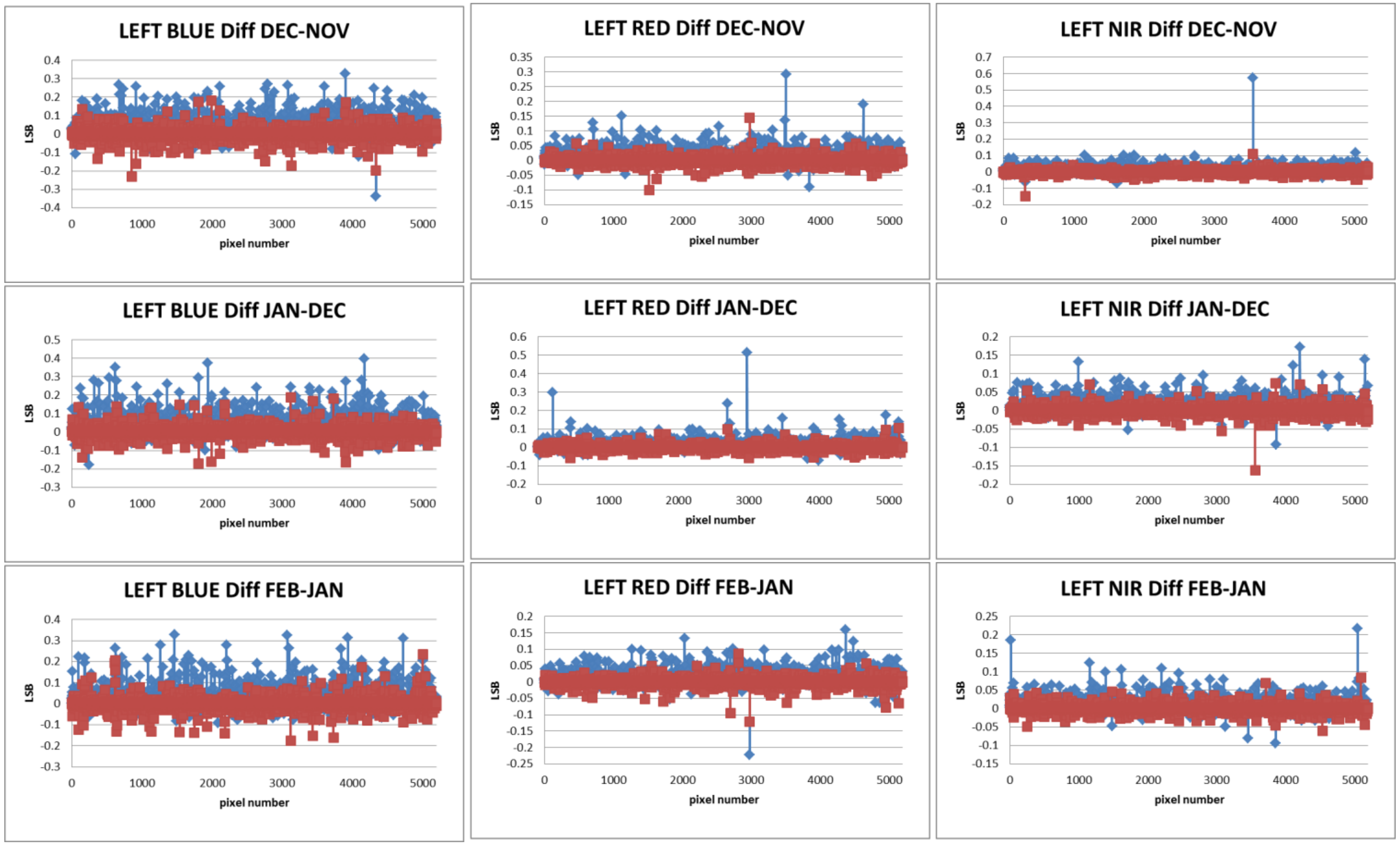


Figure 12. LEFT camera VNIR: Monthly difference (Nov 2017-FEB 2018) in dark current (Blue) and standard deviation (Red) of the monthly averaged results.

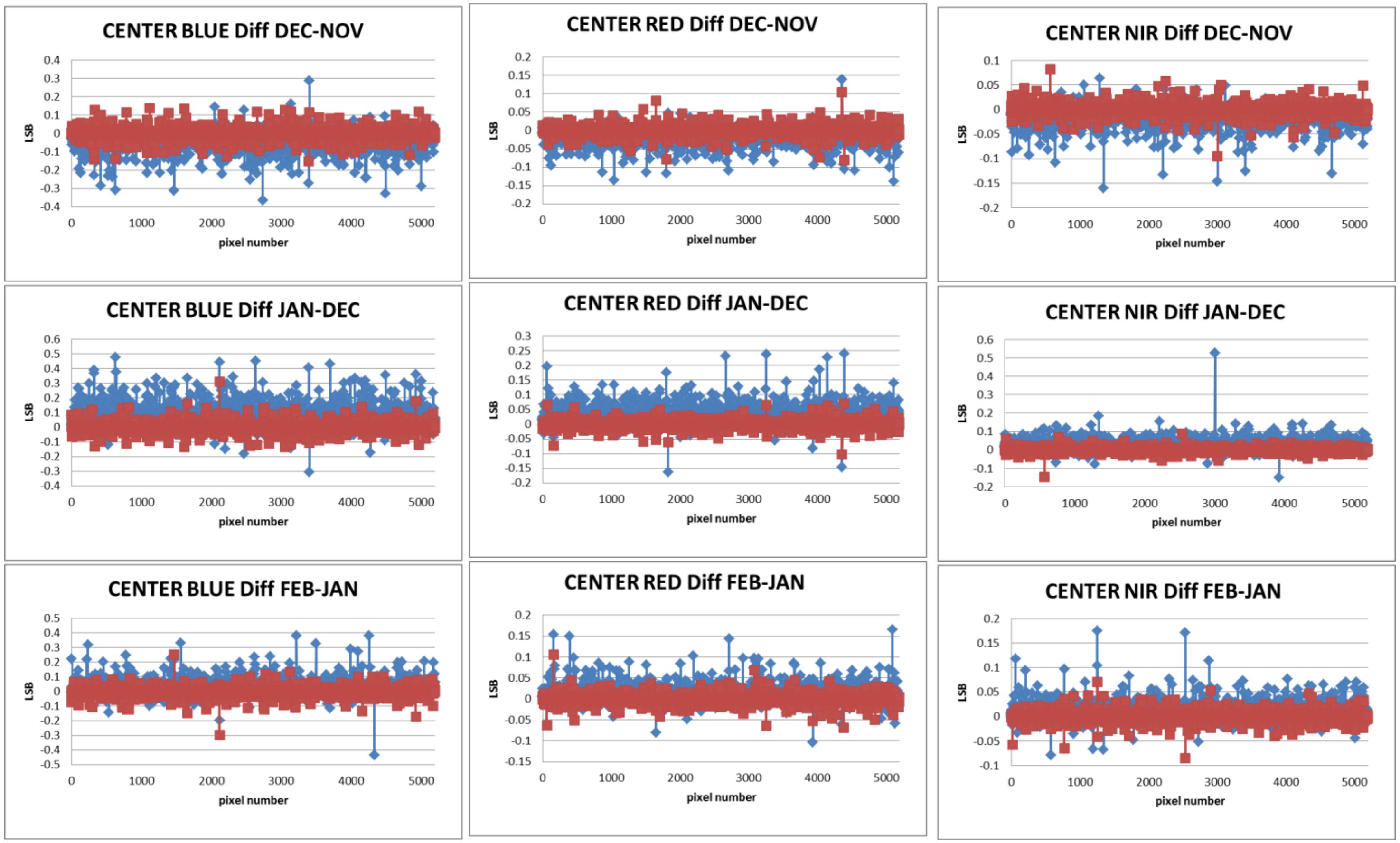


*Figure 13. CENTER camera VNIR: Monthly difference (*Nov 2017-FEB 2018*) in dark current (Blue) and standard deviation (Red) of the monthly averaged results.*

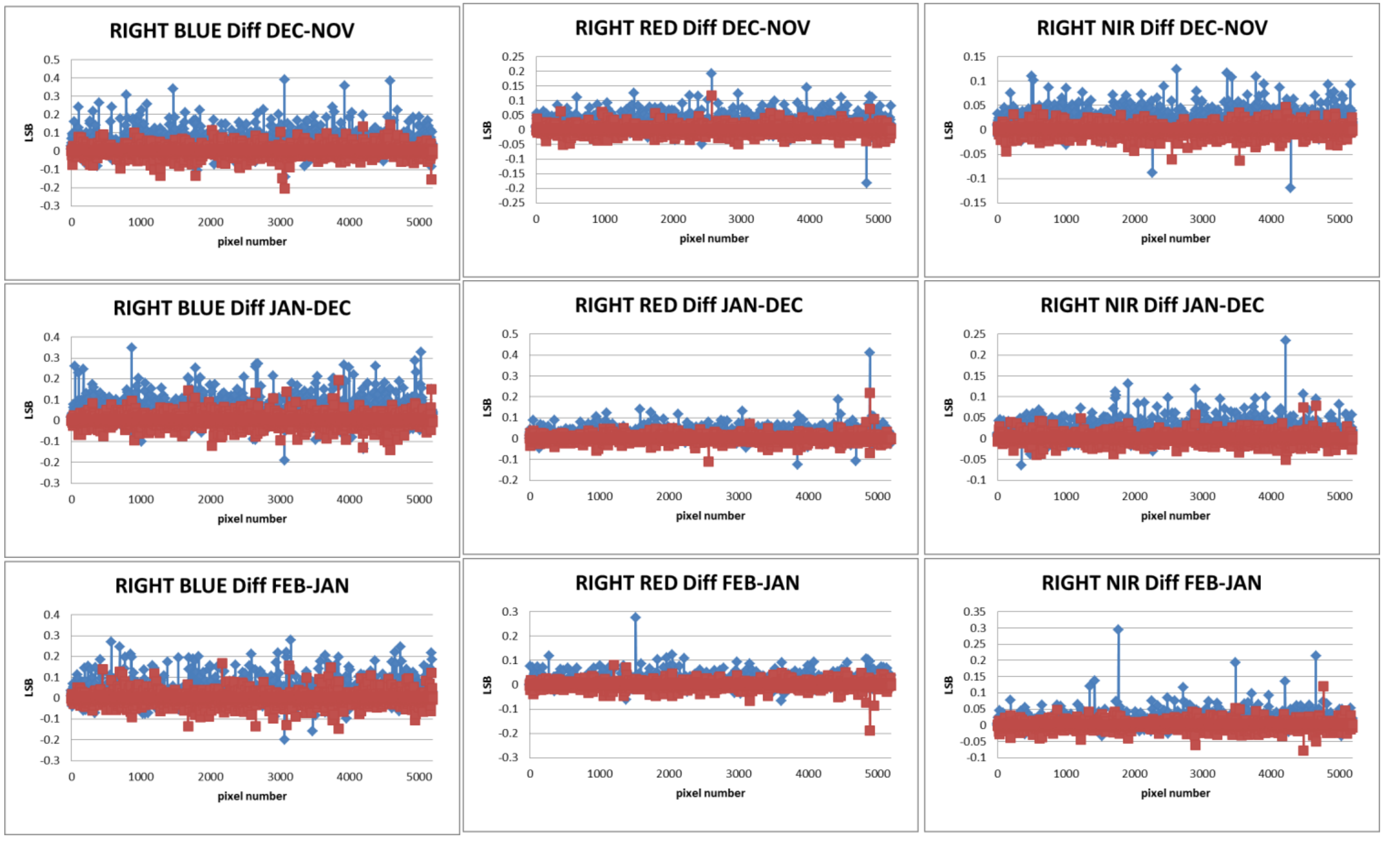


*Figure 14. RIGHT camera VNIR: Monthly difference (*Nov 2017-FEB 2018*) in dark current (Blue) and standard deviation (Red) of the monthly averaged results.*

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, Table 4 and

RIGHT SWIR																			
OCT-NOV-DEC							NOV-DEC-JAN							DEC-JAN-FEB					
144	H DC NOK	544	H DC BAD	252 pixels	H DC OK		294	H DC BAD	438	H DC NOK	752	H DC NOK		300	H DC BAD	333pixels	H DC OK	163	H DC NOK
622	H DC NOK	815	H DC BAD				172	H DC BAD	334pixels	H DC OK	241 pixels	H DC OK		144	H DC NOK			752	H DC NOK
894	H DC NOK	438	H DC BAD				904	H DC NOK						446	H DC NOK			244pixels	H DC OK
307pixels	H DC OK	354pixels	H DC OK				294pixels	H DC OK						622	H DC NOK				
														873	H DC NOK				
														296pixels	H DC OK				

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. In the previous reporting period a significant increase (i.e. monthly differences > 4 LSB)) in the dark current values of the LEFT SWIR3 was observed. This seems to be a bit more stabilised now.

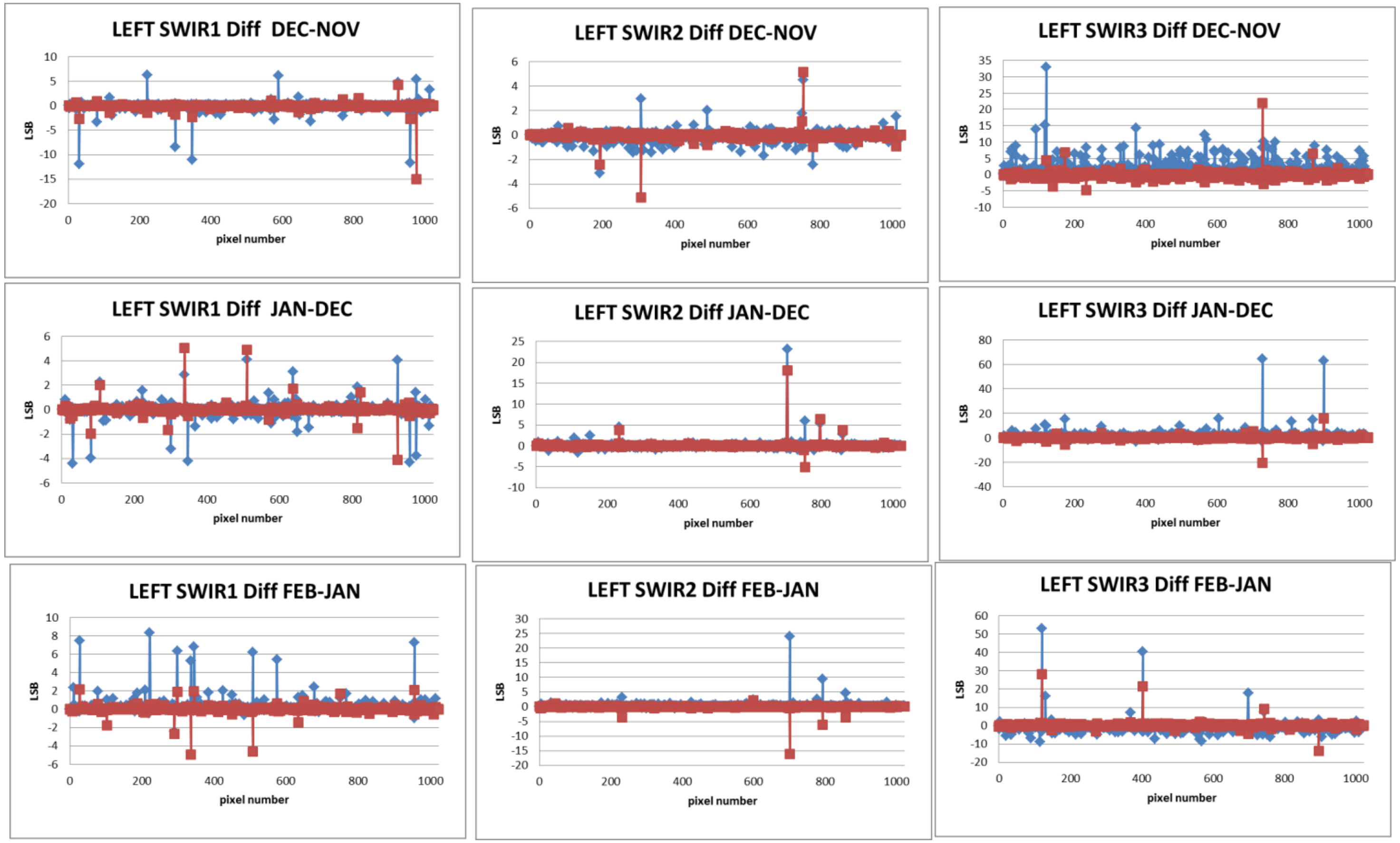


*Figure 15. LEFT camera SWIR: Monthly difference (*Nov 2017-FEB 2018*) in dark current (Blue) and standard deviation (Red) of the monthly averaged results.*

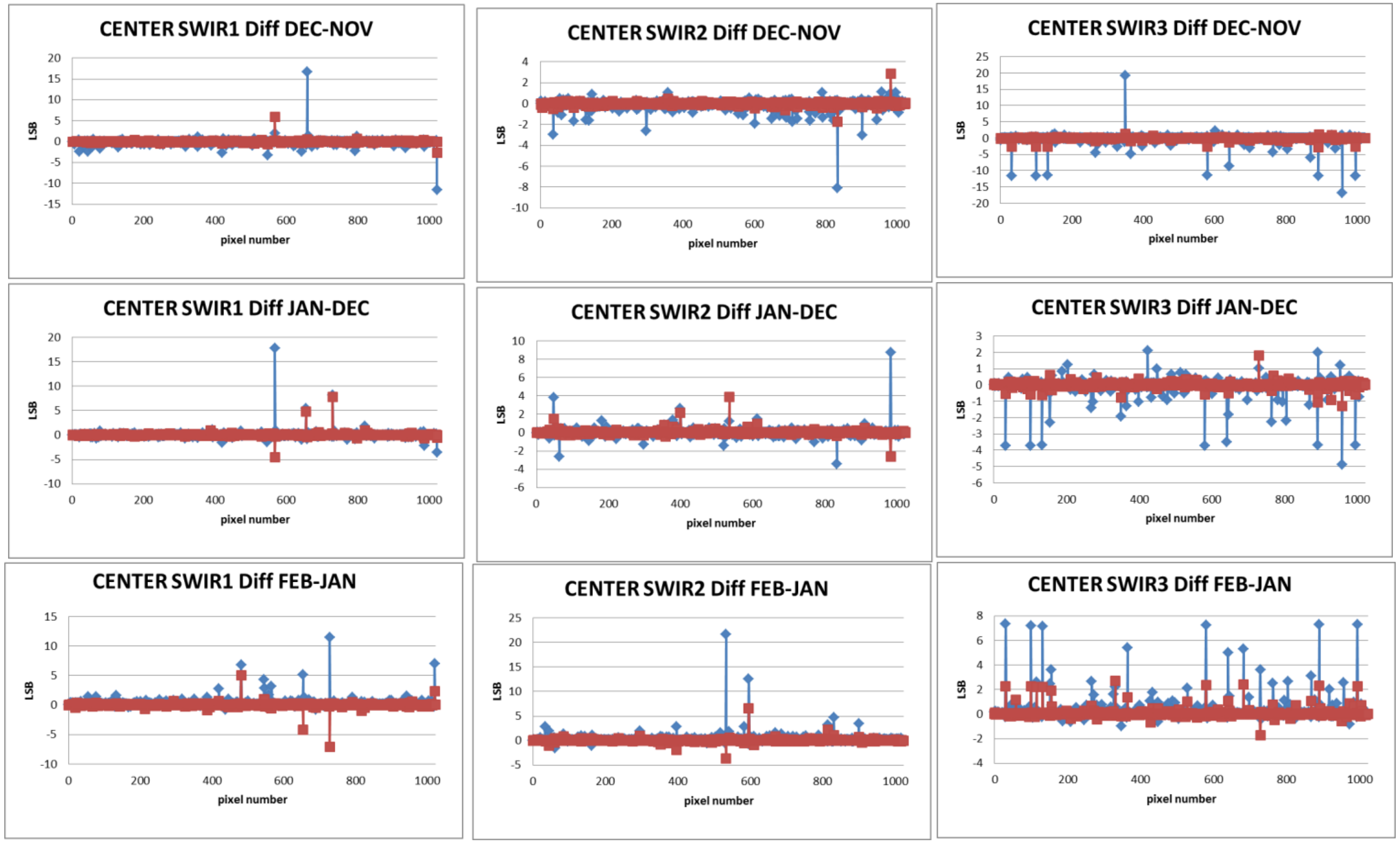


Figure 16. CENTER camera SWIR: Monthly difference (Nov 2017-FEB 2018) in dark current (Blue) and standard deviation (Red) of the monthly averaged results.

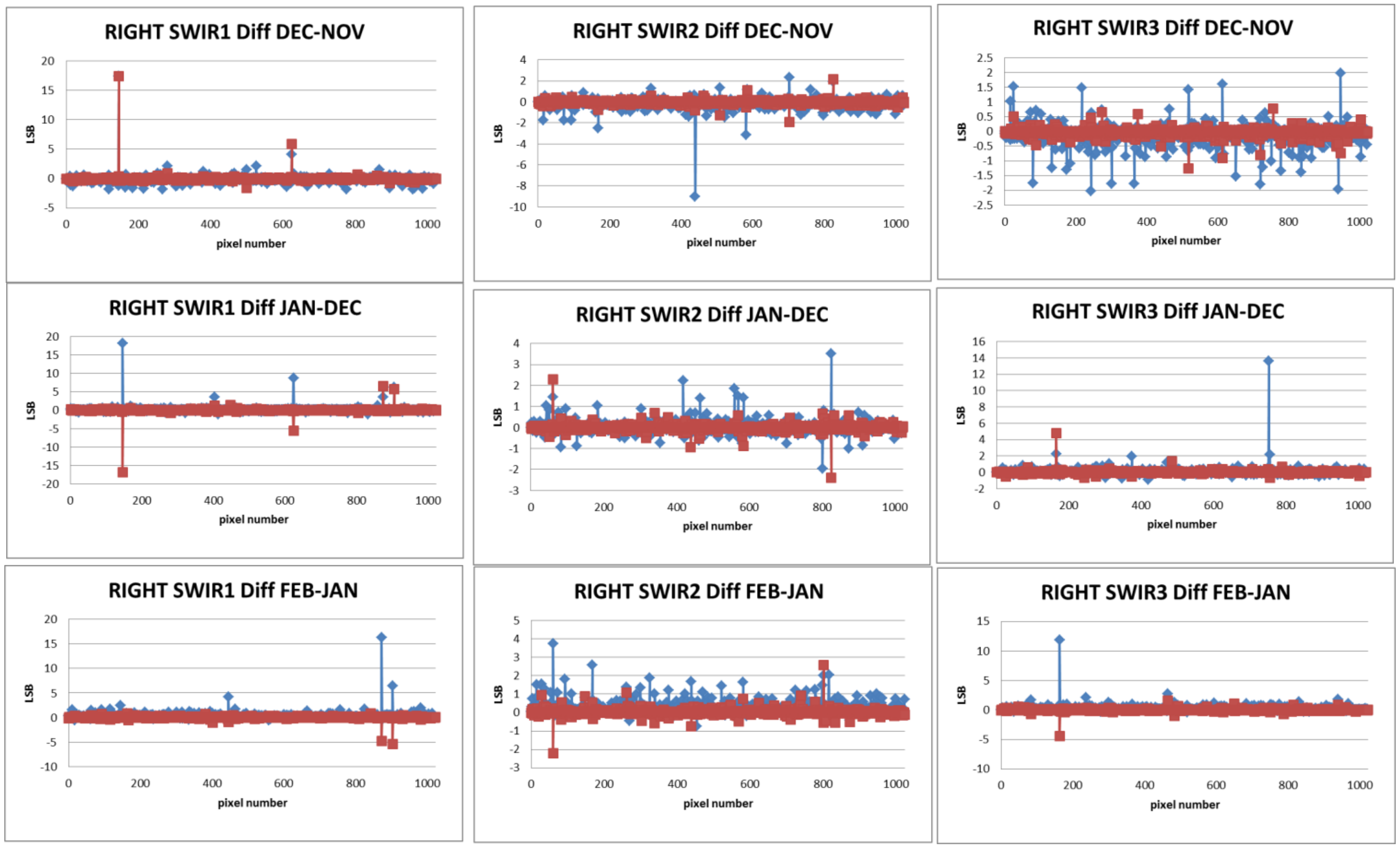


Figure 17. RIGHT camera SWIR: Monthly difference (Nov 2017-FEB 2018) in dark current (Blue) and standard deviation (Red) of the monthly averaged results.

LEFT SWIR

Oct-Nov-Dec					
SWIR1		SWIR2		SWIR3	
28	H DC BAD	192	H DC NOK	20	H DC BAD
298	H DC BAD	305	H DC NOK	23	H DC BAD
345	H DC BAD	351	H DC NOK	34	H DC BAD
956	H DC BAD	752	H DC NOK	90	H DC BAD
974	H DC BAD	753	H DC NOK	115	H DC BAD
219	H DC NOK	249pixels	H DC OK	138	H DC BAD
290	H DC NOK			150	H DC BAD
587	H DC NOK			159	H DC BAD
678	H DC NOK			172	H DC BAD
923	H DC NOK			173	H DC BAD
162pixels	H DC OK			198	H DC BAD
				216	H DC BAD
				231	H DC BAD
				273	H DC BAD
				276	H DC BAD
				327	H DC BAD
				336	H DC BAD
				370	H DC BAD
				381	H DC BAD
				406	H DC BAD
				419	H DC BAD
				423	H DC BAD
				438	H DC BAD
				471	H DC BAD
				493	H DC BAD
				494	H DC BAD
				495	H DC BAD
				510	H DC BAD
				518	H DC BAD
				553	H DC BAD
				564	H DC BAD
				568	H DC BAD
				591	H DC BAD
				592	H DC BAD
				615	H DC BAD
				617	H DC BAD
				630	H DC BAD
				658	H DC BAD
				660	H DC BAD
				675	H DC BAD
				695	H DC BAD
				704	H DC BAD
				707	H DC BAD
				721	H DC BAD
				729	H DC BAD
				740	H DC BAD
				753	H DC BAD
				761	H DC BAD
				764	H DC BAD
				769	H DC BAD
				818	H DC BAD
				824	H DC BAD
				849	H DC BAD
				856	H DC BAD
				871	H DC BAD
				906	H DC BAD
				907	H DC BAD
				935	H DC BAD
				948	H DC BAD
				998	H DC BAD
				1007	H DC BAD
				1009	H DC BAD
				35	H DC NOK
				58	H DC NOK
				85	H DC NOK
				119	H DC NOK
				164	H DC NOK
				171	H DC NOK
				188	H DC NOK
				226	H DC NOK
				230	H DC NOK
				455	H DC NOK
				475	H DC NOK
				486	H DC NOK
				545	H DC NOK
				563	H DC NOK
				725	H DC NOK
				734	H DC NOK
				754	H DC NOK
				759	H DC NOK
				772	H DC NOK
				866	H DC NOK
				957	H DC NOK
				999	H DC NOK
				813pixels	H DC OK

Nov-Dec-jan					
SWIR1		SWIR2		SWIR3	
28	H DC BAD	752	H DC BAD	23	H DC BAD
345	H DC BAD	231	H DC NOK	34	H DC BAD
923	H DC BAD	702	H DC NOK	90	H DC BAD
956	H DC BAD	794	H DC NOK	115	H DC BAD
974	H DC BAD	238pixels	H DC OK	119	H DC BAD
219	H DC NOK			171	H DC BAD
298	H DC NOK			273	H DC BAD
508	H DC NOK			438	H DC BAD
587	H DC NOK			494	H DC BAD
974	H DC NOK			564	H DC BAD
165pixels	H DC OK			568	H DC BAD
				725	H DC BAD
				729	H DC BAD
				764	H DC BAD
				866	H DC BAD
				20	H DC NOK
				35	H DC NOK
				58	H DC NOK
				138	H DC NOK
				150	H DC NOK
				159	H DC NOK
				164	H DC NOK
				172	H DC NOK
				173	H DC NOK
				198	H DC NOK
				216	H DC NOK
				230	H DC NOK
				231	H DC NOK
				276	H DC NOK
				327	H DC NOK
				336	H DC NOK
				370	H DC NOK
				381	H DC NOK
				406	H DC NOK
				419	H DC NOK
				423	H DC NOK
				471	H DC NOK
				475	H DC NOK
				493	H DC NOK
				495	H DC NOK
				510	H DC NOK
				518	H DC NOK
				545	H DC NOK
				553	H DC NOK
				563	H DC NOK
				591	H DC NOK
				592	H DC NOK
				603	H DC NOK
				615	H DC NOK
				617	H DC NOK
				630	H DC NOK
				658	H DC NOK
				660	H DC NOK
				675	H DC NOK
				677	H DC NOK
				695	H DC NOK
				704	H DC NOK
				707	H DC NOK
				721	H DC NOK
				740	H DC NOK
				753	H DC NOK
				761	H DC NOK
				769	H DC NOK
				807	H DC NOK
				818	H DC NOK
				824	H DC NOK
				849	H DC NOK
				856	H DC NOK
				871	H DC NOK
				897	H DC NOK
				906	H DC NOK
				907	H DC NOK
				935	H DC NOK
				936	H DC NOK
				948	H DC NOK
				998	H DC NOK
				1007	H DC NOK
				1009	H DC NOK
				844pixels	H DC OK

Dec-Jan-Feb					
SWIR1		SWIR2		SWIR3	
28	H DC BAD	702	H DC BAD	34	H DC BAD
345	H DC BAD	794	H DC BAD	90	H DC BAD
508	H DC BAD	231	H DC NOK	115	H DC BAD
956	H DC BAD	752	H DC NOK	438	H DC BAD
222	H DC NOK	858	H DC NOK	564	H DC BAD
298	H DC NOK	239pixels	H DC OK	568	H DC BAD
336	H DC NOK			725	H DC BAD
575	H DC NOK			729	H DC BAD
923	H DC NOK			20	H DC NOK
168pixels	H DC OK			23	H DC NOK
				35	H DC NOK
				85	H DC NOK
				119	H DC NOK
				121	H DC NOK
				131	H DC NOK
				150	H DC NOK
				159	H DC NOK
				171	H DC NOK
				216	H DC NOK
				231	H DC NOK
				273	H DC NOK
				276	H DC NOK
				370	H DC NOK
				404	H DC NOK
				471	H DC NOK
				494	H DC NOK
				495	H DC NOK
				510	H DC NOK
				563	H DC NOK
				591	H DC NOK
				603	H DC NOK
				615	H DC NOK
				677	H DC NOK
				699	H DC NOK
				740	H DC NOK
				744	H DC NOK
				753	H DC NOK
				761	H DC NOK
				764	H DC NOK
				807	H DC NOK
				856	H DC NOK
				866	H DC NOK
				897	H DC NOK
				906	H DC NOK
				935	H DC NOK
				936	H DC NOK
				943	H DC NOK
				879pixels	H DC OK

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

CENTER SWIR																	
OCT-NOV-DEC						NOV-DEC-JAN						DEC-JAN-FEB					
SWIR1		SWIR2		SWIR3		SWIR1		SWIR2		SWIR3		SWIR1		SWIR2		SWIR3	
1021	H DC BAD	831	H DC BAD	30	H DC BAD	566	H DC NOK	831	H DC NOK	957	H DC BAD	654	H DC BAD	533	H DC NOK	30	H DC NOK
419	H DC NOK	704	H DC NOK	99	H DC BAD	654	H DC NOK	980	H DC NOK	30	H DC NOK	728	H DC NOK	596	H DC NOK	99	H DC NOK
545	H DC NOK	900	H DC NOK	131	H DC BAD	657	H DC NOK	203pixels	H DC OK	99	H DC NOK	481	H DC NOK	831	H DC NOK	131	H DC NOK
547	H DC NOK	217pixels	H DC OK	266	H DC BAD	728	H DC NOK			131	H DC NOK	545	H DC NOK	980	H DC NOK	364	H DC NOK
657	H DC NOK			364	H DC BAD	1021	H DC NOK			266	H DC NOK	566	H DC NOK	205pixels	H DC OK	579	H DC NOK
671	H DC NOK			579	H DC BAD	171pixels	H DC OK			348	H DC NOK	1021	H DC NOK			640	H DC NOK
180pixels	H DC OK			640	H DC BAD					364	H DC NOK	175pixels	H DC OK			682	H DC NOK
				763	H DC BAD					579	H DC NOK					890	H DC NOK
				868	H DC BAD					640	H DC NOK					957	H DC NOK
				890	H DC BAD					763	H DC NOK					994	H DC NOK
				957	H DC BAD					868	H DC NOK					118pixels	H DC OK
				994	H DC BAD					890	H DC NOK						
				152	H DC NOK					994	H DC NOK						
				348	H DC NOK					114pixels	H DC OK						
				397	H DC NOK												
				597	H DC NOK												
				697	H DC NOK												
				804	H DC NOK												
				1016	H DC NOK												
				110pixels	H DC OK												

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

RIGHT SWIR																	
OCT-NOV-DEC						NOV-DEC-JAN						DEC-JAN-FEB					
144	H DC NOK	544	H DC BAD	252 pixels	H DC OK	294	H DC BAD	438	H DC NOK	752	H DC NOK	300	H DC BAD	333pixels	H DC OK	163	H DC NOK
622	H DC NOK	815	H DC BAD			172	H DC BAD	334pixels	H DC OK	241 pixels	H DC OK	144	H DC NOK			752	H DC NOK
894	H DC NOK	438	H DC BAD			904	H DC NOK					446	H DC NOK			244pixels	H DC OK
307pixels	H DC OK	354pixels	H DC OK			294pixels	H DC OK					622	H DC NOK				
												873	H DC NOK				
												296pixels	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

Multi-angular calibration acquisitions have been performed for the VNIR strips over Antarctica. The VNIR High Frequency/striping results for LEFT, CENTER and RIGHT camera are given in respectively Figure 22,Figure 23 and Figure 24.
The graphs at the top show the high frequency profile values ($\Delta gi,high$) per pixel in red, and the values plus and minus 1 standard deviation (estimated using the robust MAD statistic) in light blue. The graphs at the bottom show scattergrams which reveal the relation between the estimated $\Delta gi,high$ values and their stdevs. The scattergrams allow inspecting in a convenient way which pixels can be considered as outliers. The $\Delta gi,high$ VNIR values are low.

Compared to previous reporting there are some more pixels mainly in the RIGHT camera with $\Delta gi,high$ values larger than 1.005. This might be due to the fact that nominal scenes from Antarctica were used while for previous reporting period special calibration scenes focusing on specific homogeneous areas were used.

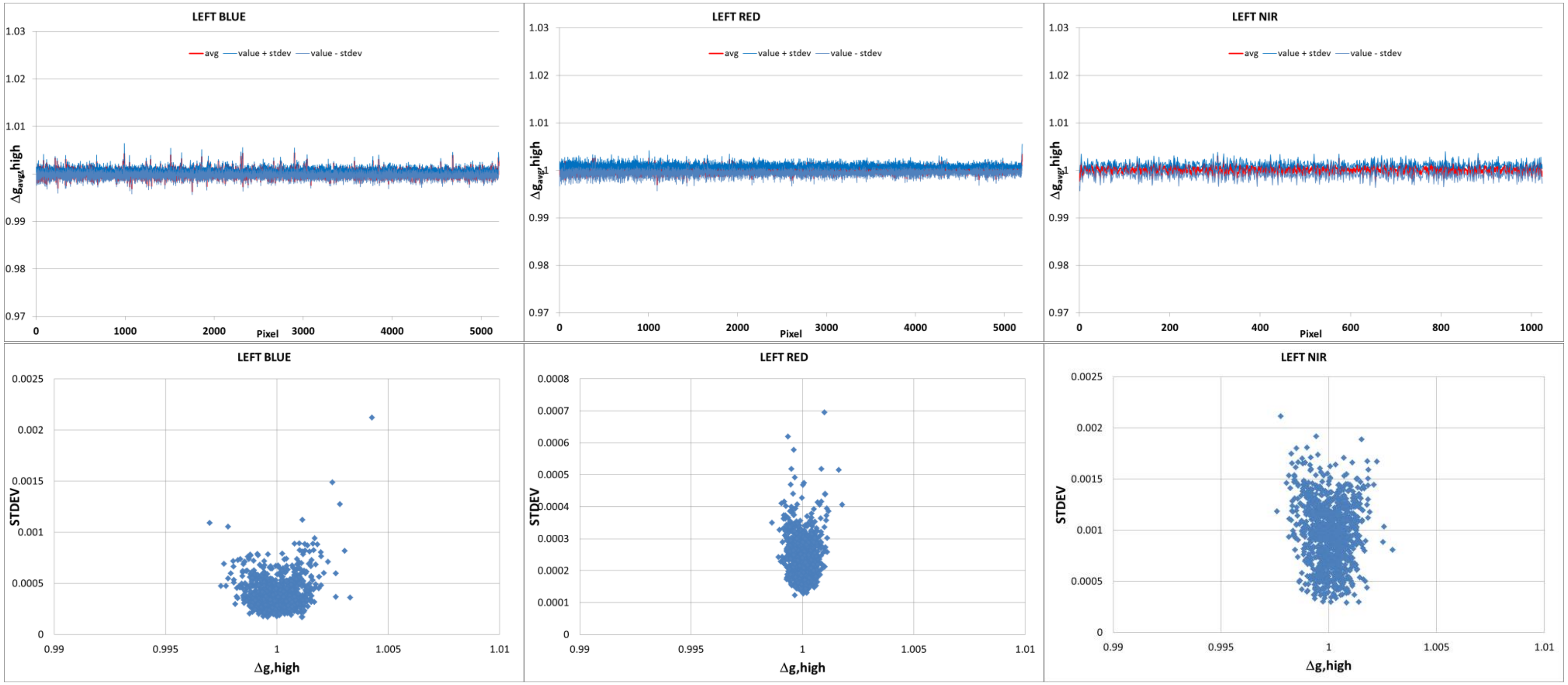


Figure 18. HF VNIR equalisation results VNIR LEFT Feb 2018

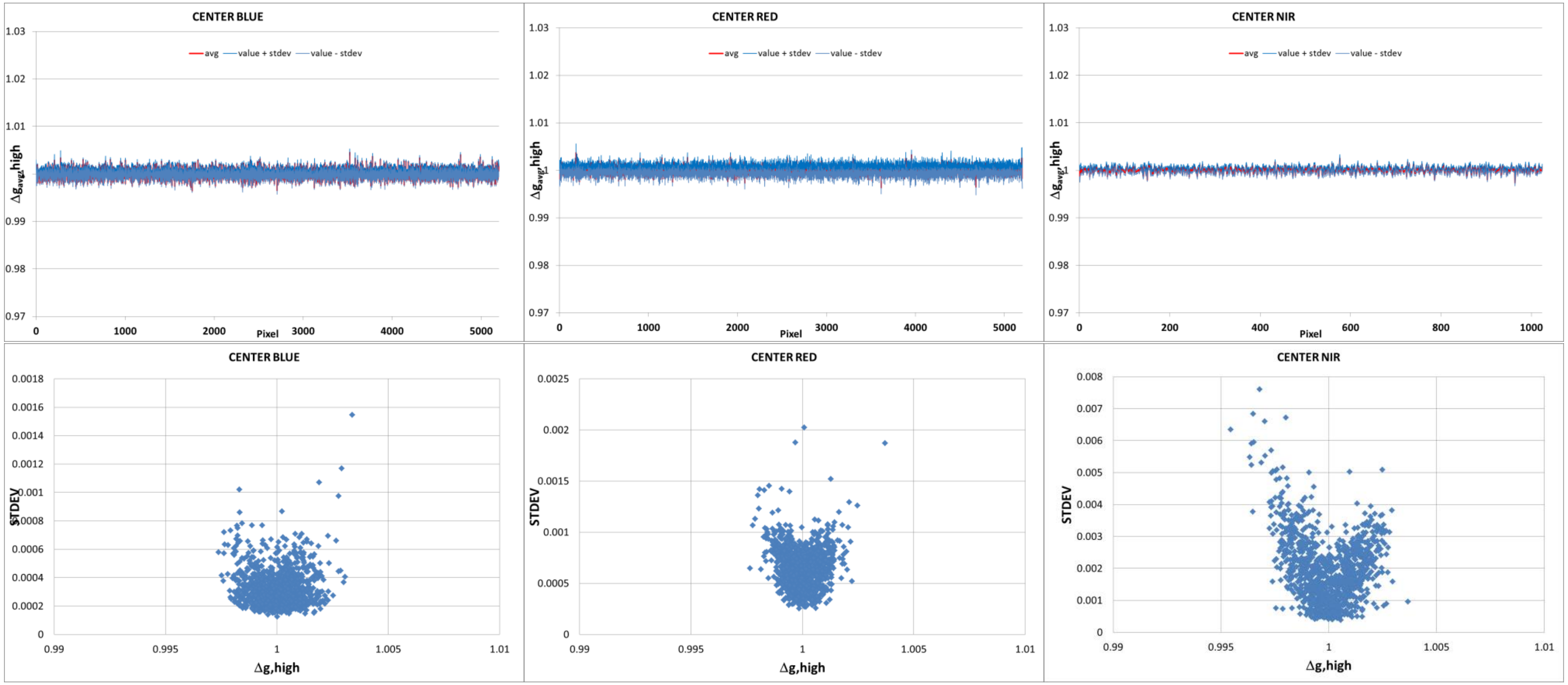


Figure 19. HF equalisation results VNIR CENTER: FEB 2018

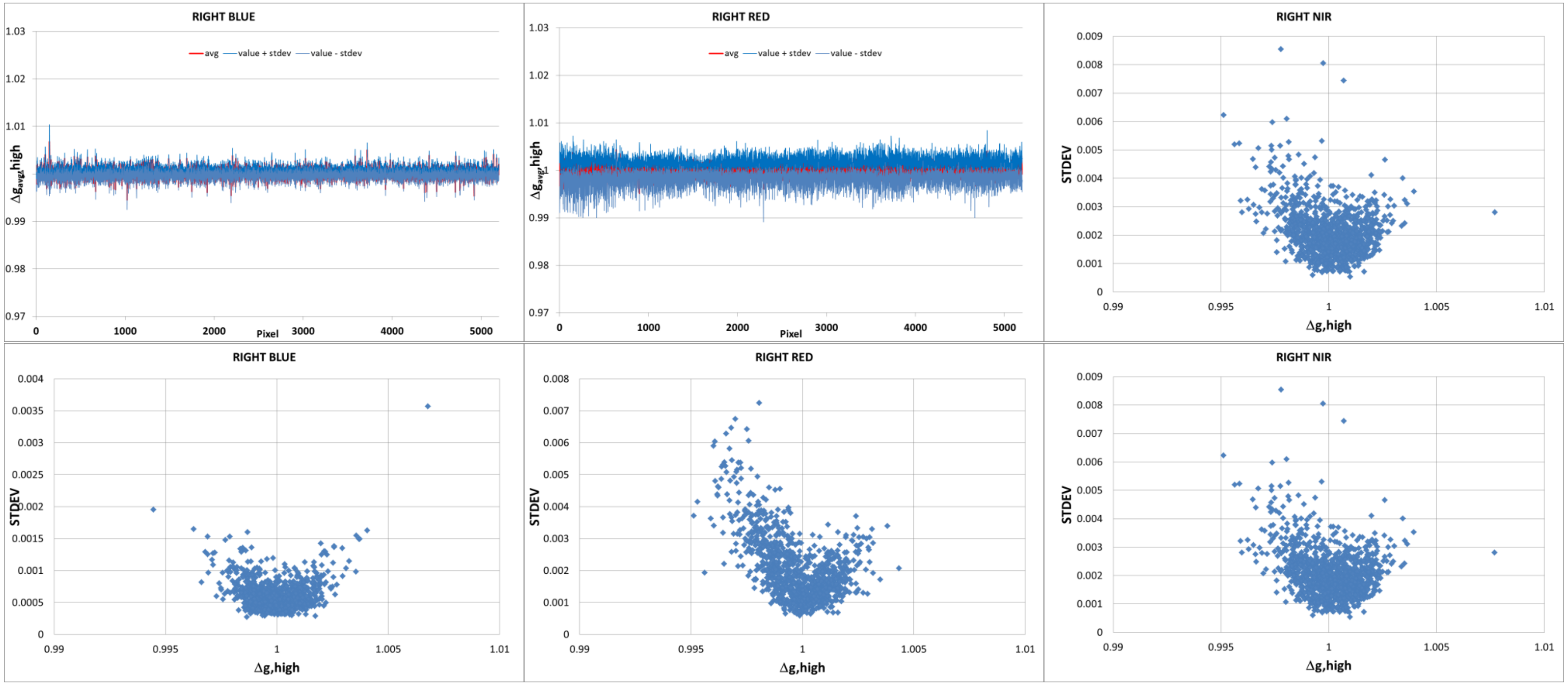


Figure 20. HF equalisation results VNIR RIGHT: FEB 20187

1.5. Bad pixels

One new bad pixel was identified in this reporting period.

Reporting period Mid-Dec 2017- Mid-March 2018																	
CAMERA	STRIP	pixel numbers (ID L1 A)															
		NEW BAD	BAD (from previous periods)														
left	swir1	104	28	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**

	****

* YEAR :2013-2016; MN:01-12; ** Applied Linear trend (in%)/month : SWIR1 LEFT: -0.087;SWIR2 LEFT:-0.104;SWIR3 LEFT:-0.097;SWIR1 CENTER:-0.093;SWIR2 CENTER:-0.092;SWIR3 CENTER:-0.086;SWIR1 RIGHT:-0.106;SWIR2 RIGHT:-0.143;SWIR3 RIGHT:-0.122. *** Applied linear trend (in %) /month: BLUE LEFT: -0.028, BLUE CENTER: -0.011, **** Applied linear trend (in %) /month: BLUE LEFT: -0.035, BLUE CENTER: -0.034, *****New coef for RIGHT SWIR strips: SWIR1 RIGHT:-0.077; SWIR2 RIGHT:-0.122; SWIR3 RIGHT:-0.078

Table 7: Radiometric ICP-file updates Collection 1

2. Geometric Image Quality

2.1. Summary

The quarterly average location error (ALE) over the period 16/12/2017 – 15/03/2018 was 76 m (1σ = 84 m) for all spectral bands (combined cameras). Compared to the previous reporting period the ALE has increased by 6%.

The total number of chips per day and per spectral band used for the geometric accuracy analysis decreased by 29% on average compared to the previous reporting period.

The daily average location error compliance (ALE < 300m) was 99.15%, which is 0.11% lower than in the previous reporting period. The inter-band geometric accuracy was 34 m – 58 m (σ = 9 – 22 m), which is 0.10 – 0.17 of a pixel (333 m), a result that is comparable to the previous reporting period.

The multi-temporal geometric accuracy was 78.83% (-6.85% compared to previous quarter) for the VNIR and 94.07% (-1.46% compared to previous quarter) for the combined VNIR/SWIR. The multi-temporal accuracies over the last full year are 82.37% and 94.94% 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	**16/12/2017 - 15/1/2018**	**16/1/2018 - 15/2/2018**	**16/2/2018 - 15/3/2018**
BLUE	57.72, σ = 34.41	58.62, σ = 34.64	51.98, σ = 30.61
RED	58.68, σ = 35.87	59.66, σ = 36.09	52.14, σ = 31.02
NIR	60.49, σ = 37.59	63.49, σ = 38.76	57.74, σ = 35.72
SWIR1	88.94, σ = 55.72	85.69, σ = 52.60	79.29, σ = 49.24
SWIR2	61.29, σ = 35.09	63.11, σ = 36.27	57.11, σ = 31.95
SWIR3	55.42, σ = 31.99	59.40, σ = 34.43	51.69, σ = 29.30

Table 8: Mean absolute location error for camera 1.

CAMERA 2 Mean and standard deviation ALE [m]			
Strip\Period	**16/12/2017 - 15/1/2018**	**16/1/2018 - 15/2/2018**	**16/2/2018 - 15/3/2018**
BLUE	70.59, σ = 39.20	63.39, σ = 36.50	50.82, σ = 29.55
RED	70.92, σ = 38.92	62.22, σ = 36.42	49.01, σ = 28.13
NIR	68.20, σ = 38.11	64.86, σ = 37.73	52.46, σ = 30.83
SWIR1	68.98, σ = 38.76	67.27, σ = 39.21	55.98, σ = 33.66
SWIR2	69.34, σ = 40.02	67.36, σ = 40.29	55.71, σ = 33.73
SWIR3	68.94, σ = 40.72	68.46, σ = 40.97	57.60, σ = 35.11

Table 9: Mean absolute location error for camera 2.

CAMERA 3 Mean and standard deviation ALE [m]			
Strip\Period	**16/12/2017 - 15/1/2018**	**16/1/2018 - 15/2/2018**	**16/2/2018 - 15/3/2018**
BLUE	65.03, σ = 38.25	79.59, σ = 48.42	84.43, σ = 43.94
RED	69.79, σ = 42.60	90.63, σ = 54.64	92.67, σ = 48.39
NIR	66.74, σ = 42.57	81.37, σ = 54.22	85.87, σ = 51.23
SWIR1	66.09, σ = 41.10	74.93, σ = 49.86	76.27, σ = 45.19
SWIR2	72.19, σ = 45.63	85.96, σ = 55.91	85.49, σ = 49.59
SWIR3	92.22, σ = 59.47	112.96, σ = 74.81	111.15, σ = 67.05

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 69.4 m, which is 4.8 m (7.4%) higher 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 16/12/2017 – 15/1/2018
- from 16/1/2018 – 15/2/2018
- from 16/2/2018 – 15/3/2018

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
16-12-17	98.94	99.49	99.54	99.75	24769	66.9	94.36	28592	58.49	75.28	27788	58.5	69.81	27508	62.48	80.21
17-12-17	98.75	99.43	99.49	99.74	23514	69.62	93.82	27279	60.52	83.88	26480	58.73	73.66	27361	62.84	80.83
18-12-17	98.66	99.5	99.39	99.75	23578	69.65	94.85	27388	59.11	70.01	26800	59.31	75.63	27415	61.3	74.58
19-12-17	98.71	99.35	99.42	99.69	27923	68.68	93.97	31666	59.5	71.83	31193	59.59	73.85	30879	63.65	82.55
20-12-17	98.9	99.32	99.44	99.77	29622	66.51	86.04	32638	58.02	68.09	31157	56.72	66.06	30975	61.45	73.2
21-12-17	98.98	99.56	99.46	99.74	25884	73.67	101.51	29022	62.56	64	27307	62.26	75.37	27679	66.67	78.65
22-12-17	98.86	99.32	99.36	99.68	19571	81.06	92.36	22852	73.14	75.34	22402	69.2	71.91	20869	74.11	81.76
23-12-17	98.58	99.33	99.26	99.73	23949	86.62	104.28	26692	77.41	66.37	25965	75.35	78.15	25236	78.69	75.84
24-12-17	98.47	99.33	99.36	99.71	23506	80.33	115.56	26269	69.12	80.85	24514	65.94	79.82	24760	69.43	78.25
25-12-17	98.76	99.13	99.25	99.68	20607	84.21	85.66	22879	75.89	71.52	21656	72.14	77.71	20455	79.45	87.93
26-12-17	98.51	99.24	99.32	99.7	21792	84.2	96.43	24795	74.85	83.45	23240	70.59	83.18	23763	77.17	92.29
27-12-17	98.68	99.17	99.13	99.64	22374	77.43	106.48	25907	68.99	74.71	23985	69.71	84.79	23967	73.04	84.74
28-12-17	98.76	99.25	99.22	99.61	23957	78.91	101.41	25793	71.1	69.72	24581	68.91	67.37	23349	75.46	89.7
29-12-17	98.82	99.34	99.37	99.75	26891	74.01	91.52	29180	66.55	75.52	28294	63.14	65.52	25859	70.68	77.65
30-12-17	98.99	99.53	99.62	99.75	26771	69.4	89.91	30609	61.67	68.78	29831	59.06	66.86	29083	65.36	82.64
31-12-17	99.05	99.55	99.52	99.7	25587	68.42	85.21	30064	61.71	71.01	28789	60.6	71.72	29755	64.85	73.89
01-01-18	99	99.42	99.23	99.7	26302	70.2	86.75	29645	63.18	69.32	27412	63.91	79.36	28279	66.06	79.17
02-01-18	99.02	99.34	99.28	99.69	32630	71.09	89.18	31919	64.23	74.81	30749	63.49	70.65	29178	68.28	87.26
03-01-18	98.89	99.33	99.31	99.74	27823	75.95	85.41	30818	70.24	74.58	30010	68.5	73.38	28923	72.33	80.64
04-01-18	99.14	99.54	99.49	99.75	27646	70.47	84.16	31750	65.16	73.14	30976	63.17	71.18	31149	67.39	78.06
05-01-18	99.15	99.48	99.43	99.75	27607	63.38	85.8	31481	57.76	69.67	30041	57.6	70.7	30952	60.48	73.1
06-01-18	98.97	99.44	99.33	99.78	18894	66.39	86.1	21319	59.9	72.52	21330	60.35	73.67	22124	62.02	73.68
07-01-18	98.96	99.4	99.4	99.74	28399	72.71	90.8	32526	65.22	66.23	31010	62.43	70.25	29811	69.25	74.89
08-01-18	98.73	99.17	99.26	99.73	23972	89.66	90.29	27072	82.91	84.82	25858	78.71	78.45	25987	83.61	89.71
09-01-18	97.44	98.19	98.47	99.68	23311	126.79	113.96	26191	117.47	95.96	26012	110.05	88.29	26163	111.57	91.3
10-01-18	98.34	98.77	98.88	99.68	27406	103.18	104.16	30106	93.71	84.99	29591	89.18	86.66	28791	92.33	88.34
11-01-18	98.1	98.77	98.78	99.66	29488	102.26	101.29	32502	94.35	82.86	31209	90.01	84.28	29894	94.41	84.09
12-01-18	98.84	99.2	99.39	99.77	30552	85.23	83.37	34209	78.79	75.01	32930	73.65	74.3	30798	82.61	72.42
13-01-18	99.26	99.61	99.53	99.8	31633	69.77	89.02	35507	63.01	67.3	33735	60.65	75.27	33916	67.19	69.17
14-01-18	98.86	99.44	99.39	99.73	28776	66.22	98.14	32758	59.97	79.27	32061	58.93	72.26	32388	61.79	83.68
15-01-18	98.85	99.43	99.44	99.71	30136	70.56	88.03	32550	62.6	76.2	30729	61.73	78.79	30541	65.42	78.1
Averages	**98.77**	**99.30**	**99.31**	**99.72**	**25964**	**77.53**	**93.87**	**29096**	**69.58**	**74.74**	**27988**	**67.49**	**75.13**	**27671**	**71.98**	**80.59**

Table 11: Daily achieved compliance and the daily average location error (in m) for all spectral bands in the period 16/12/2017 to 15/1/2018.

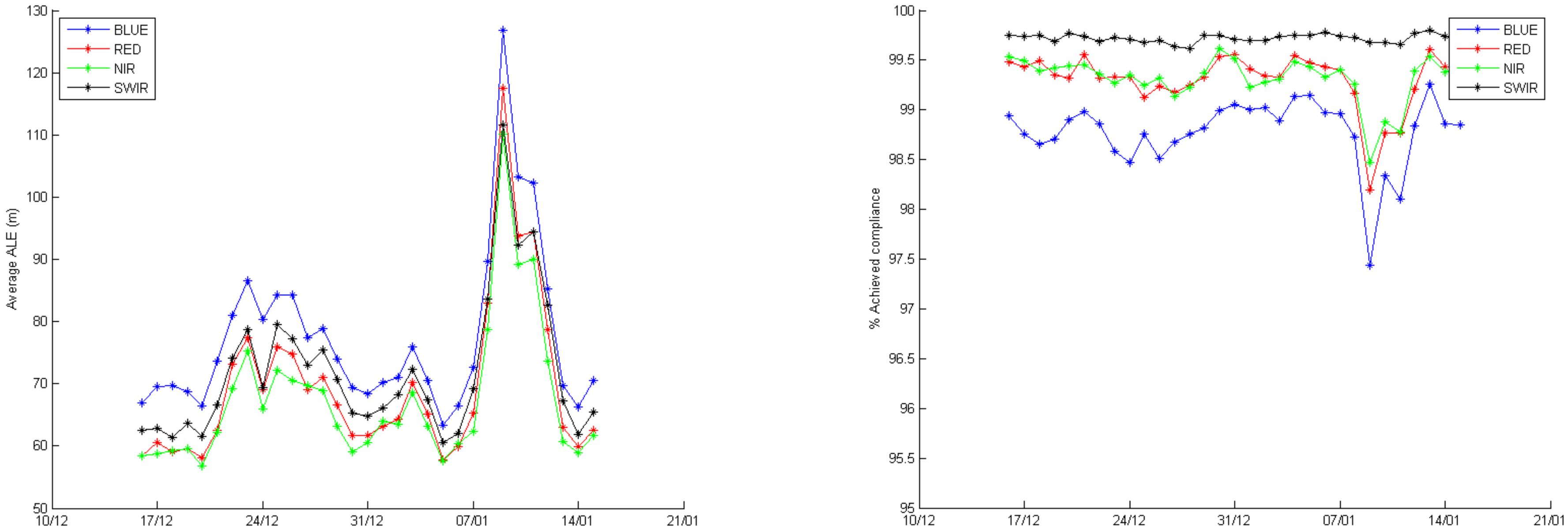
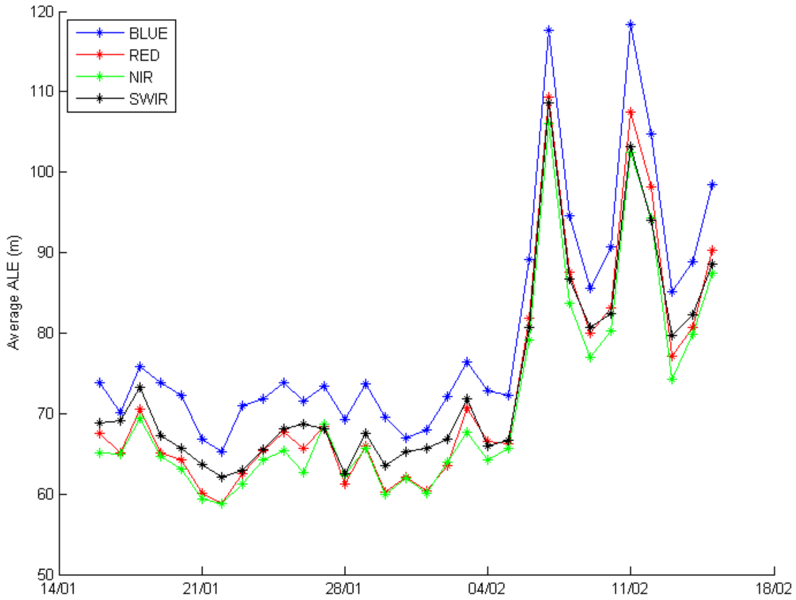


Figure 21: Daily average location error in the period from 16/12/2017 – 15/1/2018 (left) and the average daily compliance of the spectral bands (right).

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
16-01-18	98.74	99.3	99.28	99.78	30131	73.79	92.9	33487	67.52	75.21	31838	65.03	70.07	30443	68.86	80.28
17-01-18	99.23	99.55	99.47	99.82	30180	70.16	84.31	34090	65.14	66.52	32576	64.95	72.15	32370	69.06	71.55
18-01-18	98.94	99.38	99.42	99.74	28848	75.8	91.45	32324	70.55	80.25	31348	69.44	79.64	32549	73.33	78.59
19-01-18	98.68	99.27	99.29	99.66	26118	73.89	108.93	30428	65.15	85.97	28968	64.62	79.76	30230	67.23	84.17
20-01-18	98.83	99.44	99.38	99.74	29433	72.24	89.69	33747	64.2	74.91	31383	63.1	74.52	31454	65.72	75.1
21-01-18	99.1	99.49	99.49	99.75	29890	66.84	80.26	34420	60.14	68.47	32367	59.38	60.76	31313	63.62	74.53
22-01-18	99.18	99.57	99.53	99.75	26559	65.27	84.9	31761	58.82	73.63	30171	58.81	70.88	31393	62.16	81.18
23-01-18	98.73	99.47	99.45	99.71	28017	70.91	105.83	32435	62.55	77.13	31325	61.29	73.51	31999	62.91	76.17
24-01-18	98.89	99.28	99.33	99.68	31186	71.85	94.35	34043	65.41	76.98	32524	64.24	72.26	32581	65.53	79
25-01-18	98.64	99.28	99.27	99.71	27582	73.8	93.86	29933	67.62	76.89	29492	65.32	70.24	26968	68.07	83.09
26-01-18	99.09	99.53	99.56	99.75	24968	71.61	81.09	27640	65.67	73.87	26652	62.6	56.69	24876	68.72	84.16
27-01-18	98.65	99.28	99.28	99.77	22701	73.43	88.71	26823	68.36	75.03	25671	68.75	82.17	25822	68.06	75.33
28-01-18	98.86	99.45	99.37	99.76	23006	69.2	99.06	26336	61.17	71.26	25286	62.34	75.67	25767	62.54	75.96
29-01-18	98.65	99.33	99.34	99.69	21319	73.7	97.51	24301	65.9	80.08	23386	65.72	82.7	22908	67.54	85.22
30-01-18	98.88	99.51	99.41	99.77	23462	69.56	90.86	27506	60.23	65.32	26371	59.91	69.51	25787	63.55	75.26
31-01-18	99.01	99.43	99.46	99.74	20058	66.91	96.68	23806	62.15	85.49	23694	61.9	79.15	22737	65.28	79.99
01-02-18	98.99	99.44	99.36	99.68	23742	68	101.28	27621	60.43	86.05	26604	60.1	83.93	26690	65.61	81.54
02-02-18	98.81	99.34	99.3	99.69	24541	72.06	103.72	27430	63.55	74.37	26866	63.93	82.04	26390	66.76	76.78
03-02-18	99.06	99.38	99.46	99.74	23521	76.42	83.67	26894	70.67	74.42	26136	67.69	74.9	25916	71.88	78.22
04-02-18	99.14	99.48	99.5	99.84	26550	72.87	92.68	30453	66.54	74.26	29845	64.29	72.68	29844	65.92	63.15
05-02-18	98.77	99.38	99.4	99.72	25142	72.28	96.72	29154	66.21	79.77	28559	65.66	75.19	29648	66.65	75.74
06-02-18	98.49	98.97	98.96	99.67	22529	89.18	111.95	25120	81.81	86.93	24921	79.18	80.34	24949	80.74	87.62
07-02-18	97.41	97.96	97.97	99.64	22446	117.6	107.76	24019	109.35	88.37	24077	106.08	94.9	23116	108.68	93.51
08-02-18	98.5	98.88	98.89	99.74	23609	94.57	99.71	25760	87.52	82.59	25672	83.71	83.63	24698	86.7	86.4
09-02-18	98.73	99.22	99.17	99.77	21785	85.62	103.76	25315	80.03	80.92	25335	77.02	80.47	25098	80.69	79.18
10-02-18	98.24	98.97	98.82	99.73	21351	90.7	103.39	24285	83.13	87.1	24134	80.22	89.7	24517	82.39	80.97
11-02-18	96.84	97.92	98.08	99.55	20748	118.29	117.68	23013	107.5	95.79	23072	102.54	88.76	22729	103.23	99.49
12-02-18	97.66	98.38	98.51	99.64	25454	104.68	96.74	28532	98.17	86.83	28403	94.3	90.64	27405	94.09	91.9
13-02-18	98.64	99.08	99.23	99.66	21993	85.21	88.76	24967	77.12	78.13	24963	74.21	69.64	23451	79.71	86.73
14-02-18	98.41	99	98.88	99.65	18192	88.84	98.92	21719	80.73	92.25	21950	79.9	99.28	21130	82.31	85.54
15-02-18	97.61	98.72	98.54	99.6	20165	98.45	108.3	23900	90.36	93.35	24211	87.41	91.29	23700	88.52	92.18
Averages	**98.63**	**99.18**	**99.17**	**99.71**	**24685**	**79.80**	**96.63**	**28105**	**72.70**	**79.62**	**27348**	**71.09**	**78.29**	**27048**	**73.74**	**81.24**

Table 12: Daily achieved compliance and the daily average location error (in m) for all spectral bands in the period 16/1/2018 – 15/2/2018.



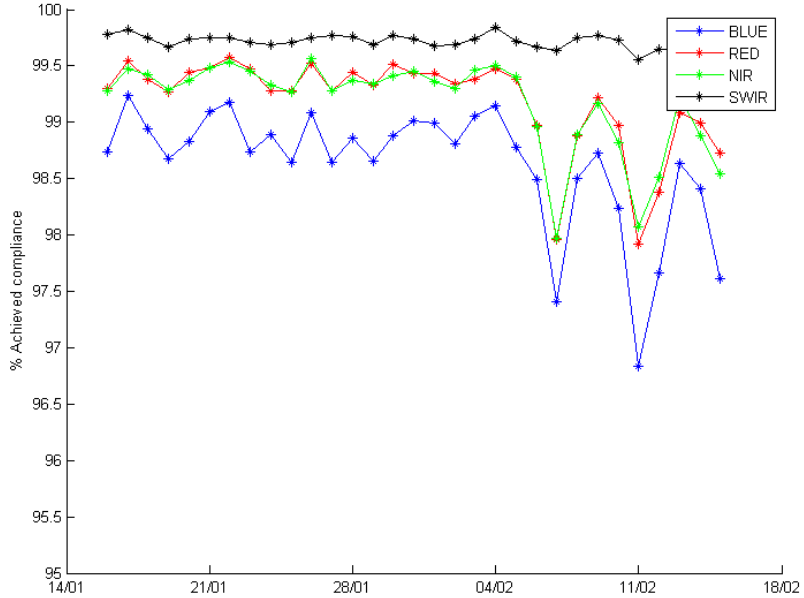
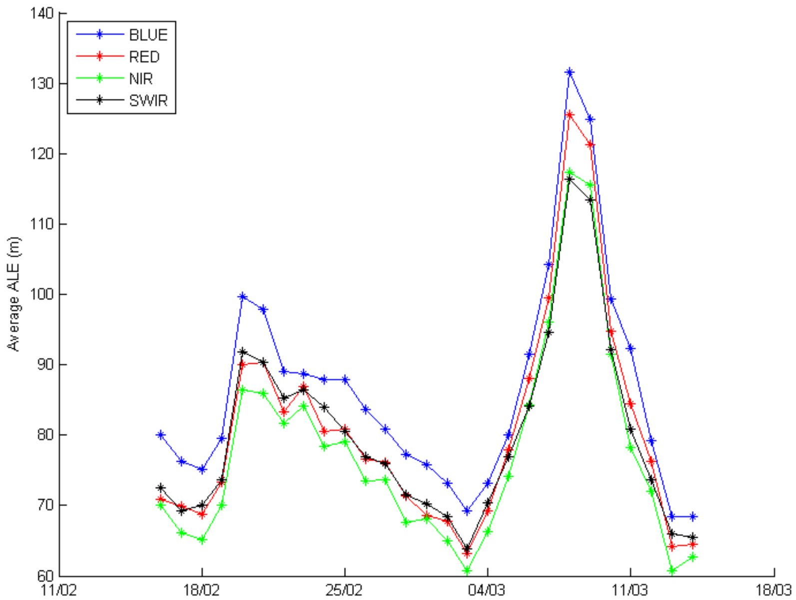


Figure 22: Daily average location error in the period from 16/1/2018 – 15/2/2018 (left) and the average daily compliance of all spectral bands (right).

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
16-02-18	98.61	99.3	99.11	99.64	23586	80.02	96.65	25479	70.94	71.75	24471	70.08	81.17	25122	72.46	90.57
17-02-18	98.79	99.23	99.27	99.72	24644	76.31	86.2	26498	69.88	73.57	25924	66.21	74.44	25583	69.29	78.72
18-02-18	98.93	99.38	99.46	99.74	23197	75.2	89.42	26817	68.68	74.65	26426	65.08	70.84	26301	70.01	81.23
19-02-18	98.56	99.18	99.13	99.78	19699	79.62	95.38	23290	73.35	82.89	23258	69.98	84.39	22345	73.73	67.83
20-02-18	97.93	98.9	98.94	99.6	21457	99.65	114.22	24006	90.07	91.74	24528	86.45	86.67	22811	91.77	89.69
21-02-18	98.4	99	98.97	99.65	22349	97.88	101.44	24517	90.31	90.44	24280	85.95	86.92	24006	90.39	92.83
22-02-18	98.93	99.22	99.24	99.79	21844	89.06	93.6	24897	83.29	86.76	24515	81.69	78.55	23923	85.25	80.37
23-02-18	98.7	98.96	99.03	99.65	21390	88.75	103.72	24934	86.84	95.81	24882	84.19	89.93	24311	86.37	88.24
24-02-18	98.58	99.09	99.13	99.59	20831	87.89	98.95	24193	80.61	89.52	24601	78.33	89.62	23743	83.9	91.88
25-02-18	98.22	98.95	98.95	99.61	23857	87.92	102.02	26759	80.79	83.87	25729	79.03	88.43	25701	80.55	86.5
26-02-18	98.7	99.08	99.24	99.69	27459	83.66	92.44	31006	76.66	79.73	30861	73.57	70.85	29353	76.89	84.83
27-02-18	99.09	99.37	99.39	99.76	29037	80.82	86.46	32922	76.1	81.61	33242	73.6	75.32	32155	75.88	81.61
28-02-18	98.82	99.33	99.32	99.7	25935	77.29	102.84	29221	71.41	85.96	28932	67.64	81.64	27872	71.46	83.77
01-03-18	98.85	99.34	99.22	99.69	25969	75.77	99.72	27896	68.65	81.27	26604	68.1	86	25104	70.22	76.98
02-03-18	98.86	99.34	99.34	99.77	29140	73.11	90.43	32339	67.69	76.41	31378	64.91	77.7	30460	68.34	71.33
03-03-18	98.97	99.31	99.42	99.75	32305	69.17	86.06	35700	63.27	73.35	34737	60.72	70.14	33261	63.82	74.3
04-03-18	99.02	99.41	99.49	99.72	31038	73.24	84.44	34204	69.3	82.54	35731	66.34	72.24	33291	70.34	84.5
05-03-18	98.64	99.05	99.05	99.67	29698	80.01	96.74	32807	77.96	89.24	33530	74.22	74.71	31321	76.92	79.27
06-03-18	98.3	98.55	98.45	99.67	30947	91.47	100.79	33558	88.01	93.84	33086	84.25	86.42	30551	84.11	81.86
07-03-18	97.54	97.81	97.62	99.64	30988	104.3	99.99	34409	99.59	87.82	34731	96.01	90.87	31829	94.63	89.21
08-03-18	96.78	97.09	97.22	99.61	28138	131.56	107.63	31516	125.58	99.49	32139	117.4	92.76	30388	116.33	93.83
09-03-18	96.66	96.91	97.03	99.65	31217	124.79	107.33	33893	121.26	99.52	34737	115.47	96.63	33339	113.48	95.81
10-03-18	98.15	98.63	98.76	99.67	34751	99.41	99.51	36790	94.81	80.23	36948	91.46	84.66	35410	92.12	90.02
11-03-18	98.11	98.72	98.83	99.77	17740	92.23	108.08	19662	84.5	80.5	19858	78.23	70.11	19951	80.93	73.36
12-03-18	98.89	99	99.23	99.81	34354	79.29	80.78	37631	76.2	79.63	37514	72.11	72.14	35494	73.62	80.75
13-03-18	99.2	99.41	99.45	99.71	35296	68.45	82.69	38828	64.1	80.33	39154	60.74	71.11	37270	65.99	84.54
14-03-18	98.93	99.33	99.29	99.72	32579	68.45	87.23	35925	64.55	79.79	36734	62.72	78.48	34420	65.41	78.76
15-03-18	98.68	99.25	99.21	99.71	35389	77.16	93.16	37724	70.36	77.67	37418	67.78	78.9	34125	71.2	75.58
Averages	**98.49**	**98.92**	**98.95**	**99.70**	**27016**	**86.49**	**96.10**	**29989**	**80.90**	**84.16**	**29946**	**77.57**	**80.84**	**28715**	**80.16**	**83.43**

Table 13: Daily achieved compliance and the daily average location error (in m) for all spectral bands in the period 16/2/2018 – 15/3/2018.



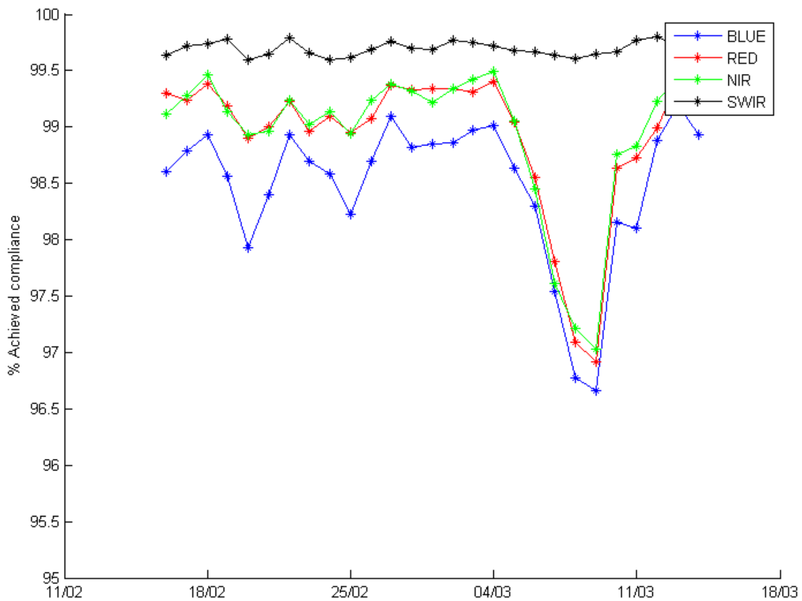


Figure 23: Daily average location error (left) for all spectral bands in the period from 16/2/2018 – 15/3/2018 and the average daily compliance (right).

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	35.63, σ = 9.45
BLUE-NIR	53.69, σ = 22.05
BLUE-SWIR	56.81, σ = 17.97
RED-NIR	33.93, σ = 16.44
RED-SWIR	45.38, σ = 11.37
NIR-SWIR	44.11, σ = 8.55

Table 14: Inter-band geolocation accuracy for period 16/12/2017 to 15/1/2018 for the combined cameras, at 95% confidence level.

Band pair	Inter-band error [m]
BLUE-RED	36.73, σ = 10.41
BLUE-NIR	52.11, σ = 16.98
BLUE-SWIR	57.26, σ = 15.48
RED-NIR	33.47, σ = 15.08
RED-SWIR	46.04, σ = 10.01
NIR-SWIR	46.02, σ = 8.69

Table 15: Inter-band geolocation accuracy for period 16/1/2018 to 15/2/2018 for the combined cameras, at 95% confidence level.

Band pair	Inter-band error [m]
BLUE-RED	37.62, σ = 10.28
BLUE-NIR	54.14, σ = 17.54
BLUE-SWIR	57.59, σ = 14.32
RED-NIR	34.78, σ = 15.71
RED-SWIR	46.48, σ = 10.89
NIR-SWIR	45.50, σ = 8.92

Table 16: Inter-band geolocation accuracy for period 16/2/2018 to 15/3/2018 for the combined cameras, at 95% confidence level.

For the combined cameras, the inter-band geometric accuracy ranged from 34 - 58 m (standard deviation range is 9 - 22 m), which is 0.10 – 0.17 of a pixel (333 m). This result is comparable to the previous reporting period. The average inter-band RED-NIR registration accuracy was 34 m, which is slightly higher (+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:

- 78.83% for the VNIR sensor (132,881 GCPs used),

- 94.07% for the VNIR/SWIR combined (146,373 GCPs used).

The multi-temporal sensor compliance has decreased by 6.85% and 1.46% for the VNIR and combined VNIR/SWIR, respectively, compared to the previous reporting period (in which values were 85.68% and 95.53%, 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 24.

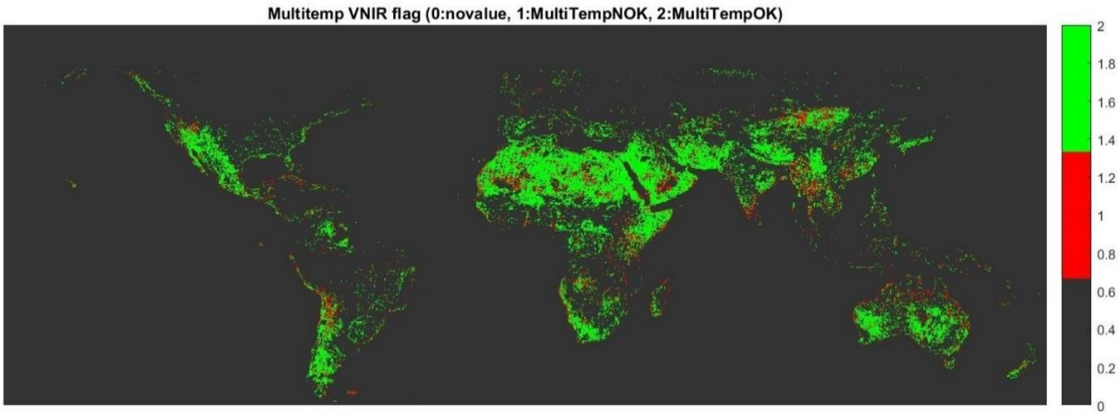


Figure 24: Multi-temporal geometric accuracy for the VNIR sensor. Compliant areas are marked in green; areas with accuracy below 95% are marked in red. Grey areas represent no data.

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 25.

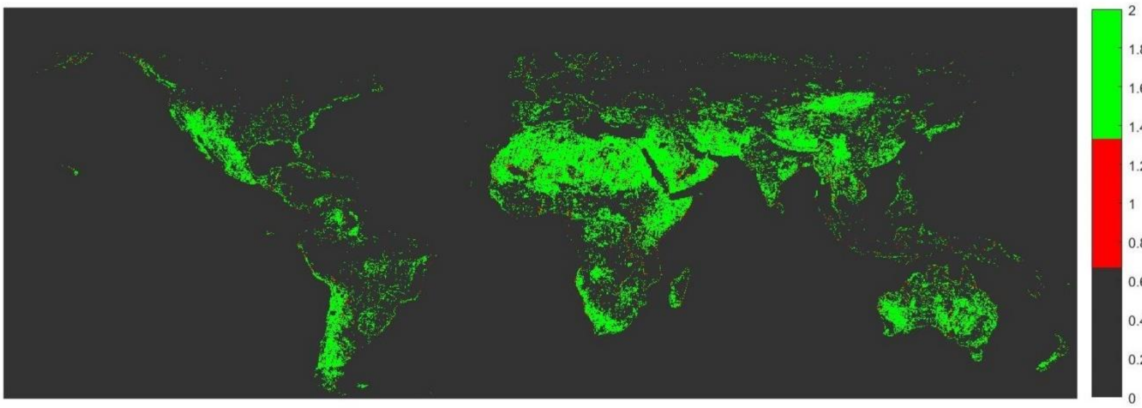


Figure 25: Multi-temporal geometric accuracy for the VNIR/SWIR combined. Compliant areas are marked in green; areas with accuracy below 95% are marked in red. Grey areas represent no data.

Over the last full year, the multi-temporal accuracy for VNIR and VNIR/SWIR is XX.XX% and Yy.YY%, 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