

PREPARATION AND OPERATIONS OF THE MISSION PERFORMANCE  
CENTRE (MPC) FOR THE COPERNICUS SENTINEL-3 MISSION

**S3-A MWR Cyclic Performance Report**

**Cycle No. 017**

**Start date: 21/04/2017**

**End date: 18/05/2017**



*Mission  
Performance  
Centre*



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#### Disclaimer

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## 1 Introduction

This document aims at providing a synthetic report on the behaviour of the radiometer in terms of instrumental characteristics and product performances as well as on the main events which occurred during cycle 17.

This document is split in the following sections:

- ❖ Section 2 gives an overview on the status of the current cycle
- ❖ Section 3 addresses the monitoring of the MWR of the current cycle. This section covers the short term monitoring of internal calibration, brightness temperatures and geophysical parameters.
- ❖ Section 4 addresses the long term monitoring from the beginning of the mission. It provides a view of the internal calibration monitoring as well as two subsections covering the monitoring of vicarious calibration targets and geophysical parameters.



## 2 Overview of Cycle 017

### 2.1 Status

The Table 1 gives a summary of the instrument behavior during this period.

Parameter	Status	Comments
Instrument	OK	Nominal
Internal Calibration	OK	Nominal
Geophysical products	OK	Nominal
Long-term monitoring	OK	Nominal for three analyses

Table 1 : General overview of the MWR quality assessment

#### Color legend:

	OK
	Warning
	NOK
	Not available



## 2.2 IPF processing chain status

### 2.2.1 IPF version

This section gives the version of the IPF processing chain used to process the data of the current cycle.

If a change of IPF version occurs during the cycle, the table gives the date of last processing with the first version and the date of first processing with the second version:

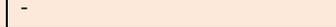
 : first date of processing

 : last date of processing

#### MWR L1B CAL

	NRT from Svalbard
06.03	
	

#### MWR L1B

IPF version	STC ( LN3)	NRT ( SVL)
06.03		
		

#### SRAL/MWR Level 2

	STC from Marine Center
06.07	
	

### 2.2.2 Auxiliary Data files

This section gives the version of the auxiliary data files used to process the data of the current cycle.

#### Side Lobe Correction file

Filename	Land processing center (LN3 center)
S3A_MW_1_SLC_AX_20000101T000000_20991231T235959_20160603T120000_____MPC_O_AL_002.SEN3	

#### MWR CCDB

Filename	Land processing center (LN3 center)
S3A_MW___CHDNAX_20160216T000000_20991231T235959_20161014T120000_____MPC_O_AL_002.SEN3	

#### Level2 Configuration file

Filename	Marine Center - STC
S3__SR_2_CON_AX_20160216T000000_20991231T235959_20170322T120000_____MPC_O_AL_008.SEN3	

### 3 MWR Monitoring over Cycle 017

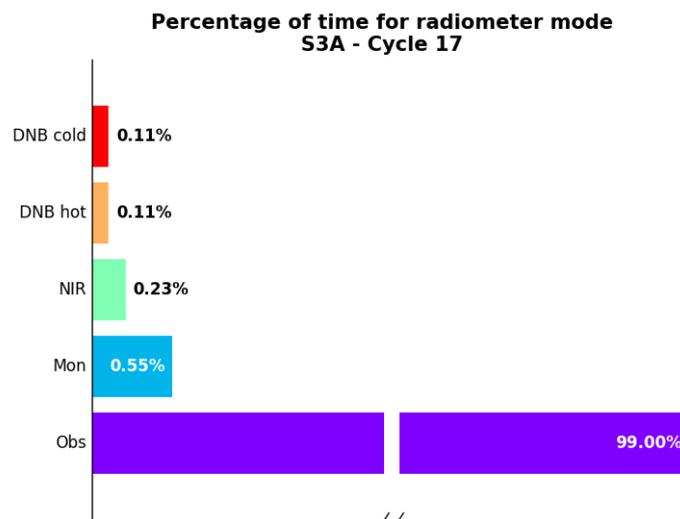
This section is dedicated to the functional verification of the MWR sensor behaviour during cycle 17 (21 April 2017 – 18 May 2017). The main relevant of the parameters, monitored daily by the MPC team, are presented here.

#### 3.1 Operating modes

The radiometer has several operating modes listed hereafter:

- ❖ Mode 0 : Intermonitoring (Earth observation)
- ❖ Mode 1 : Monitoring
- ❖ Mode 2 : Noise Injection calibration
- ❖ Mode 3 : Dicke Non-Balanced calibration (100% injection – hot point)
- ❖ Mode 4 : Dicke Non-Balanced calibration (50% injection – cold point)

Figure 1 gives the distribution of the different modes in the data.

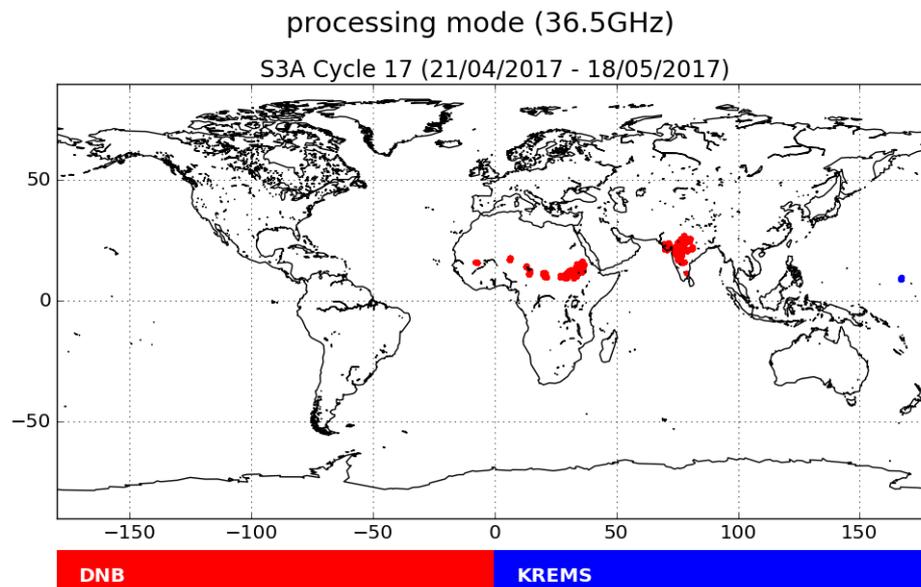


**Figure 1 : Distribution of operating mode**

For measurements in the Intermonitoring mode, two kind of processing can be used according to the measured brightness temperature. If this temperature is smaller than the reference load inside the instrument, the NIR processing is used; if the temperature is greater, the DNB processing is used. The transition from one processing to the other will occur more or less close to the coast depending on the

internal temperature of the MWR. The internal temperature of the MWR is such that only a small percentage of measurements required a DNB processing in this cycle as shown by Figure 2.

This figure shows also the passage over the US KREMS radar facility in the Kwajalein atoll (9°23'47" N - 167°28'50" E) in the Pacific. For safety reasons, the MWR is switched to a specific mode about 50 km before the facility location and back to nominal mode 50km after.



**Figure 2 : Map of measurements with DNB processing for 36.5GHz channel (red) and safety mode for both channels over KREMS (blue)**

## 3.2 Calibration parameters

To monitor the instrument behavior during its lifetime, the relevant parameters of the MWR internal in-flight calibration procedure are presented in the following subsections. These parameters are:

- ❖ the gain : this parameter is estimated using the two types of Dicke Non-Balanced calibration measurements (100% and 50% of injection). The DNB processing of the Earth measurements uses this parameter.
- ❖ the noise injection temperature : this parameter is measured during the Noise Injection calibration measurements. The NIR processing of the Earth measurements uses this parameter.

### 3.2.1 Gain

Figure 3 shows the monitoring of the receiver gain for the current cycle. The mean value over the cycle is 4.757mV/K and 4.549mV/K for channel 23.8GHz and 36.5GHz respectively. These values are close to values estimated on-ground during characterization of the instrument (4.793mV/K and 4.665mV/K for



channels 23.8GHz and 36.5GHz respectively). The gain for both channels shows a slight increase. Nominal behavior is observed since only 1 cycle of data is considered in this section.

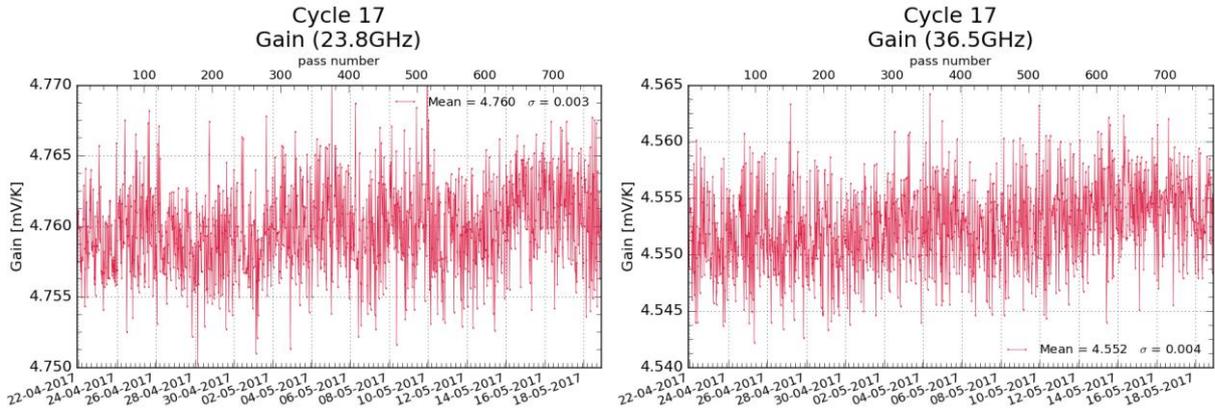


Figure 3 : monitoring of receiver gain for both channels :23.8GHz (left) and 36.5GHz (right)

### 3.2.2 Noise Injection Temperature

Figure 4 shows the monitoring of the noise injection temperature for the current cycle. The noise injection temperature for the 23.8GHz channel is constant over the cycle close to 314K. For the 36.5GHz channel, the diode shows a slow increase along the cycle of less than 0.2K. Nominal behavior is observed since only 1 cycle of data is considered in this section. The monitoring will be pursued and data checked for any impact.

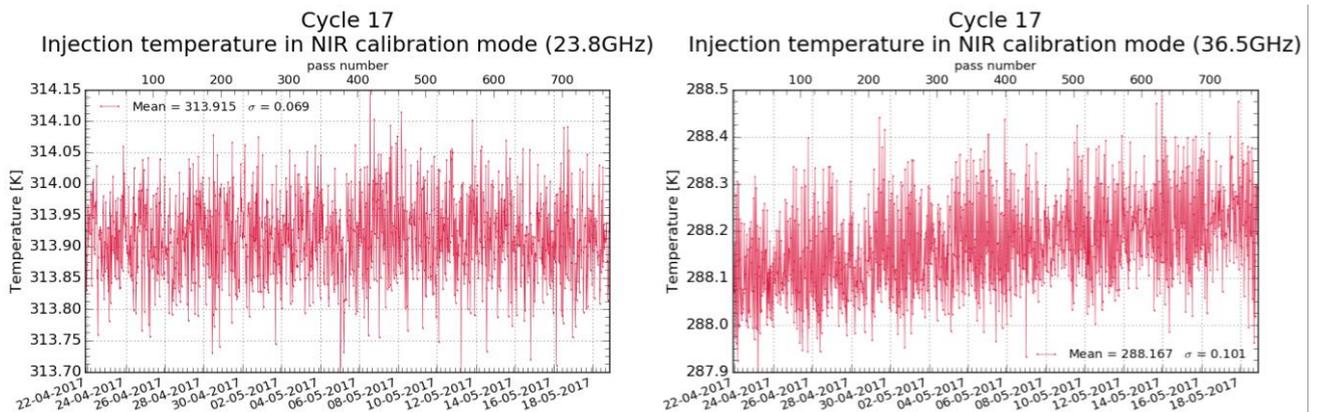


Figure 4 : Monitoring of Noise Injection temperature for both channels :23.8GHz (left) and 36.5GHz (right)

### 3.3 Brightness Temperatures

The two following figures show maps of brightness temperatures for both channels split by ascending (right part) and descending (left part) passes. Figure 5 and Figure 6 concern the channels 23.8GHz and



36.5GHz respectively. These maps show a good contrast between ocean and land for both channels. Not all products were received by MPC this cycle as highlighted by the missing passes in the figures below.

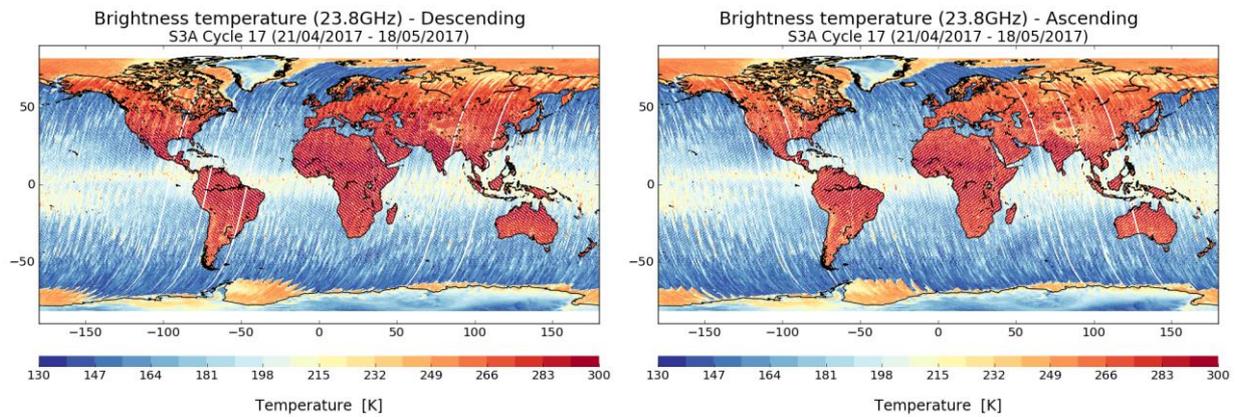


Figure 5 : Map of Brightness temperatures of channel 23.8GHz for ascending (right) and descending (left) passes

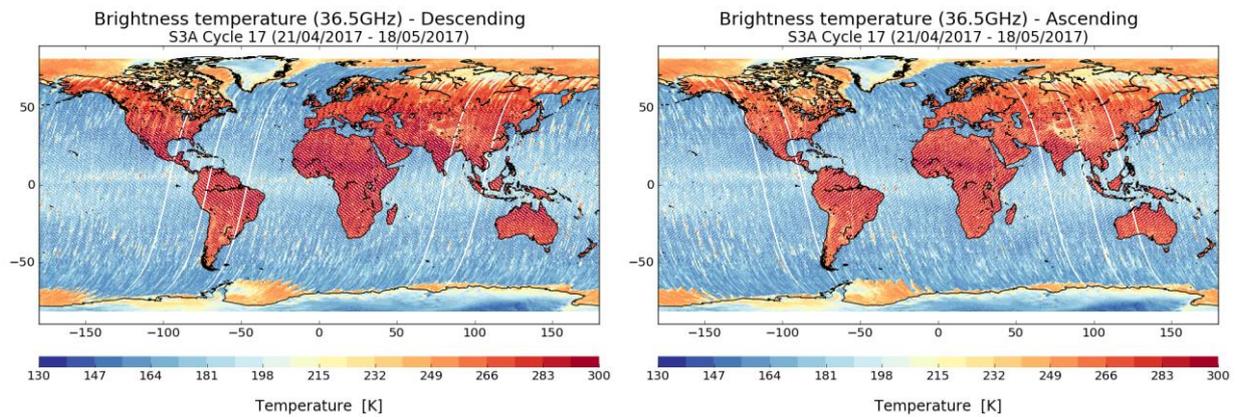


Figure 6 : Map of Brightness temperatures of channel 36.5GHz for ascending (right) and descending (left) passes

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## 3.4 Geophysical products monitoring

The inversion algorithms allow to retrieve the geophysical products from the measurements of the radiometer (brightness temperatures measured at two different frequencies) and the altimeter (backscattering coefficient ie  $\sigma_0$ ). Four geophysical products are issued from the retrieval algorithms: the wet tropospheric correction, the atmospheric attenuation of the  $\Sigma_0$ , the water vapor content, the cloud liquid water content. This section provides an assessment of two of these retrievals used by the SRAL/MWR L2 processing: the wet tropospheric correction and the atmospheric attenuation of the  $\Sigma_0$ . The wet tropospheric correction is analysed through the MWR-ECMWF difference of this correction.

### 3.4.1 Wet Tropospheric Correction

Figure 7 presents the histograms of the MWR-ECMWF differences of wet tropospheric correction ( $\Delta WTC$ ) for cycle 17. In this figure, Sentinel-3A/MWR correction is compared to the correction retrieved by Jason2/AMR (IGDR) and SARAL/MWR (IGDR) over the same period.

The standard deviation of the difference MWR-ECMWF corrections for S-3A is around 1.38cm for both SAR and PLRM corrections while it is 1.54cm for SARAL and 1.12cm for Jason-2. First Jason-2 benefits from its three channels radiometer (18.7GHz, 23.8GHz, 34GHz), providing a correction with a smaller deviation with respect to the model. SARAL/MWR is closer to S-3A/MWR in this context with its two channels (23.8GHZ and 37GHZ for SARAL, 23.8 and 36.5GHz for S-3A). Then the standard deviation for SARAL is the closest reference, even though the  $\Sigma_0$  in Ka band raises some questions. With the use of STC products for S-3A, the  $\Delta WTC$  for the three instruments are directly comparable since all use ECMWF analyses for the computation of the model correction. The standard deviation of  $\Delta WTC$  for S-3A is smaller than for SARAL meaning that we have a better estimation of the correction for S-3A according to these metrics. Jason-2 gives the best performances with the smallest deviation. Moreover, one can notice that both SAR and PLMR corrections have very similar performances: mean(std) of  $\Delta WTC$  being close to -0.005cm(1.39cm) and 0.014cm(1.38cm) for SAR and PLRM respectively.

Figure 8 presents a map of the  $\Delta WTC$  for Sentinel-3A only for SAR correction on the left and PLRM correction on the right. For this cycle, the maps show geographical patterns expected for this parameter. Note that the color scale is centered to the mean value. The comparison with Jason2 map of  $\Delta WTC$  (Figure 9) shows similarities although Sentinel-3A  $\Delta WTC$  is larger than Jason2 because of their different instrument configuration.

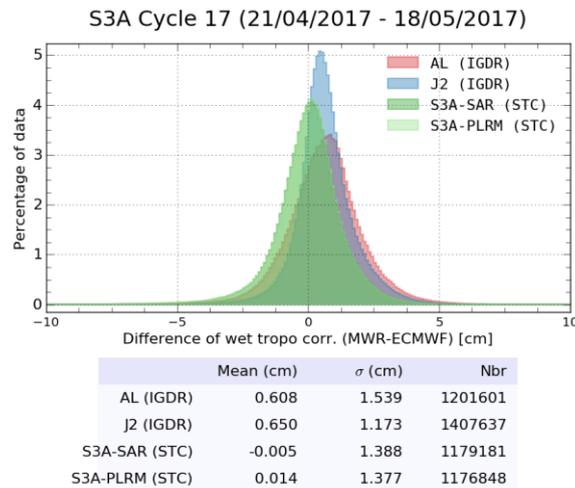


Figure 7: Histograms of MWR-ECMWF difference of wet tropospheric correction for SARAL/MWR, Jason2/AMR and Sentinel-3A/MWR SAR and PLRM

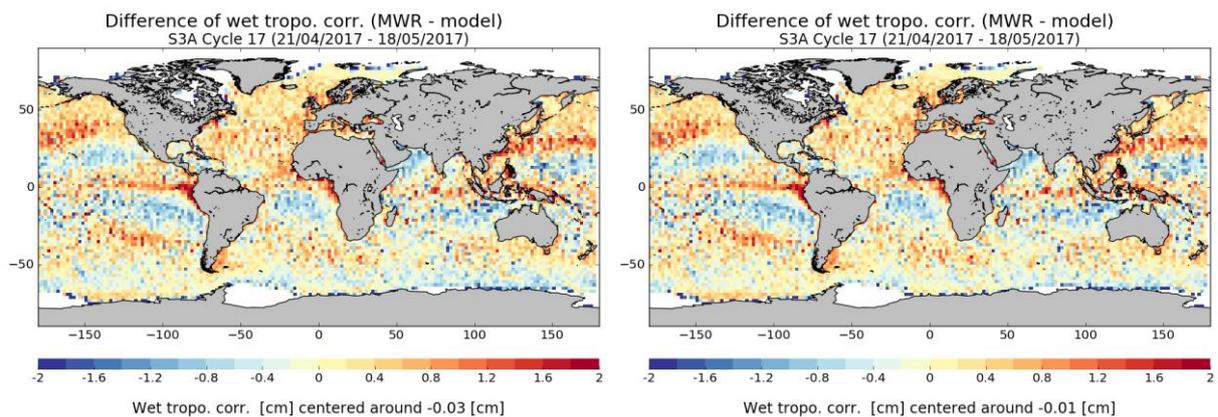


Figure 8 : MWR-ECMWF difference of wet tropospheric correction : using SAR (left) and PLRM altimeter backscatter (right)

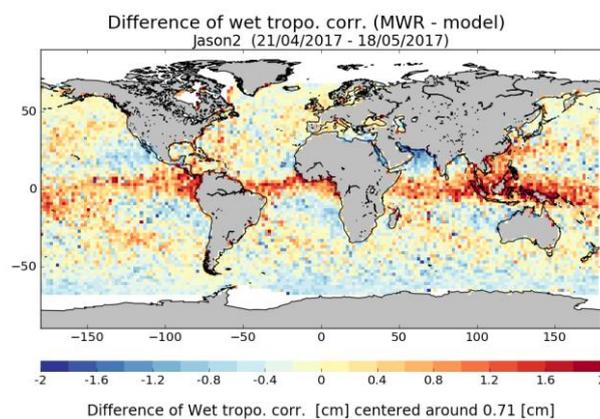
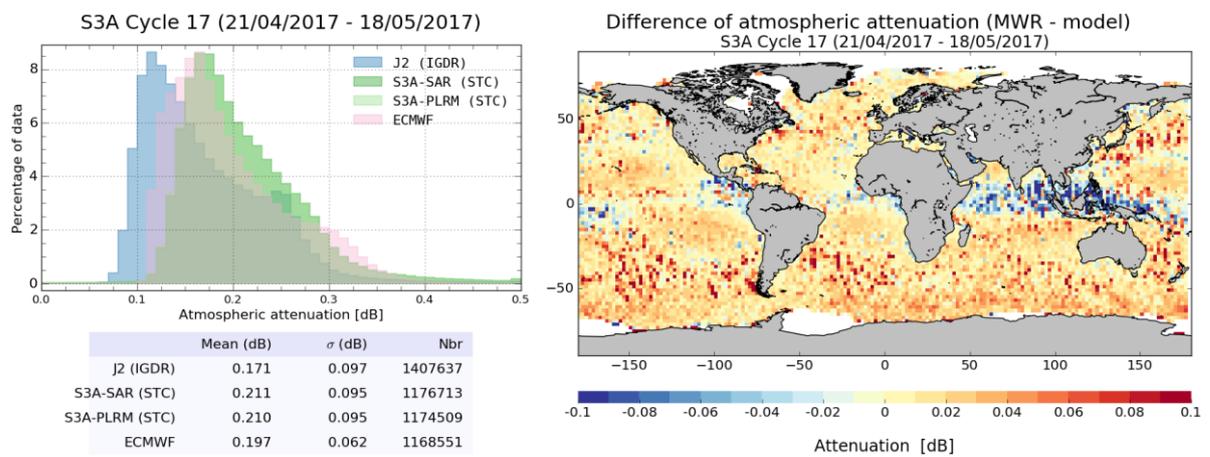


Figure 9 : Jason2/AMR MWR-ECMWF difference of wet tropospheric correction (IGDR product)



### 3.4.2 Atmospheric Attenuation

The left part of Figure 10 presents the histograms of the Ku band atmospheric attenuation of the Sigma0. In this figure, Sentinel-3A attenuation is compared to the attenuation retrieved for Jason2/AMR. The results of S-3A are very similar to Jason-2 results with an average attenuation close to 0.21dB for S-3A and 0.17dB for Jason2. Mean value for Jason2 has slightly changed since last cycle (0.2dB for cycle 15 of S-3A). The right part of Figure 10 shows a map of the difference of MWR attenuation and model attenuation computed from ECMWF analyses for Sentinel-3A. Globally a bias of 0.02 dB between MWR and model attenuation can be estimated from this plot.



**Figure 10 : Ku band Atmospheric attenuation of the Sigma0**  
**Left : Histograms for Sentinel-3A/MWR, Jason2/AMR, Model attenuation; Right: Map of difference of MWR-model atmospheric attenuation for Sentinel-3A**



## 4 Long-term monitoring

In this section, a long-term monitoring of the MWR behaviour is presented.

### 4.1 Internal Calibration parameters

This section presents a long term monitoring of internal calibration parameters. Data used for the diagnosis presented here are:

- ❖ Reprocessed data (using IPF v6.5) from cycle 1 to cycle 9
- ❖ MWR L1B data generated by PDGS at Svalbard core ground station are used from 26/10/2016

#### 4.1.1 Gain

Figure 11 shows the daily mean of the receiver gain for both channels. This calibration parameter is used in the DNB processing of the measurements. As seen previously in section 3.1, only a small part of the measurements are processed in DNB mode. The first part of the monitoring of the calibration parameters is performed using NTC product generated during the first reprocessing (IPF v6.5), the second part using NRT products from the day of the IPF update on the Svalbard ground station forward. The gap between the two datasets comes from the delay between the end of the reprocessed period and the implementation of the IPF on the station. This gap will be covered by a future reprocessing.

From the two panels of Figure 11, one can see that the receiver gain has a different behaviour for each channel. The gain for the 23.8GHz is slowly increasing since the beginning of the mission showing two slopes and an inflexion point during cycle 7. The gain has increased of +0.03mv/K since the beginning of the mission. For the 36.5GHz channel, the gain is increasing from cycle 1 and then starts to decrease at the beginning of cycle 4. Since cycle 15, it started to increase again. Due to the small number of data processed using this parameter, it will be difficult to assess if this decrease has an impact on data quality. The monitoring will be pursued and data checked for any impact.

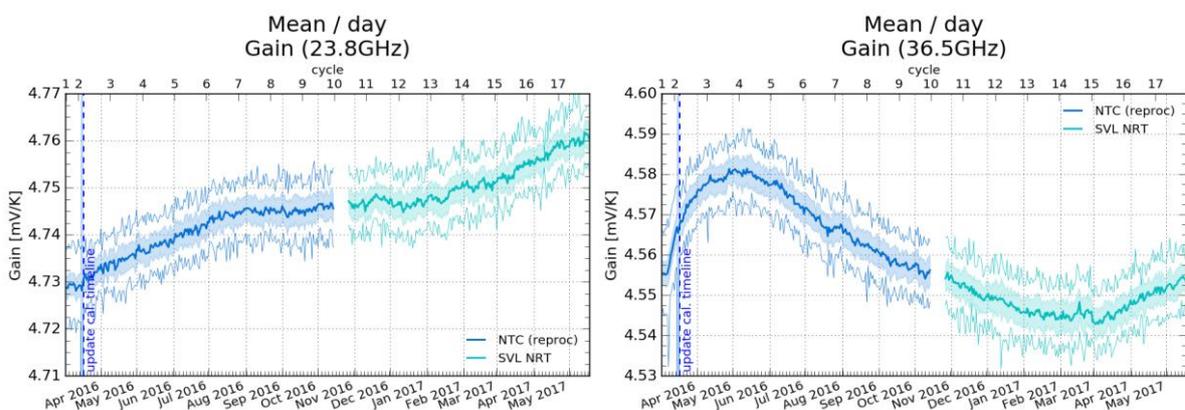


Figure 11 : Daily mean of the gain for both channels : 23.8GHz (left) and 36.5GHz (right)

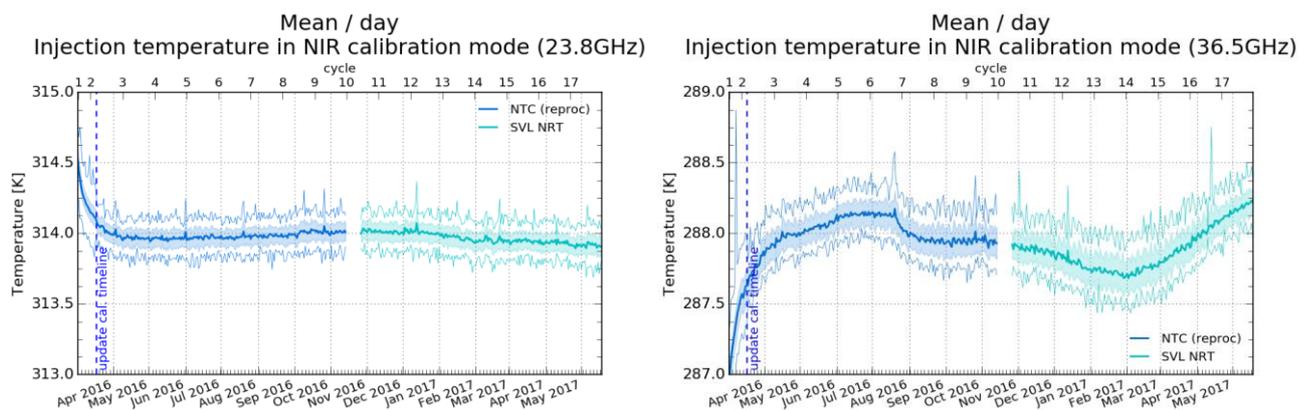


### 4.1.2 Noise Injection temperature

Figure 12 shows the daily mean of the noise injection temperature for both channels. This calibration parameter is used in the NIR processing of the measurements. As seen previously in section 3.1, the main part of the measurements are processed in NIR mode. Moreover the first part of the monitoring of the calibration parameters is performed using NTC product generated during the first reprocessing (IPF v6.5), the second part using NRT products from the day of the IPF update on the ground station. The gap between the two datasets comes from the delay between the end of the reprocessed period and the implementation of the IPF on the station. This gap will be covered by a future reprocessing.

From the two panels of Figure 12, one can see that the noise injection parameter has a different behaviour for each channel. For the 23.8GHz channel, the noise injection temperature has decreased of 0.5K during the first 2 cycles, after what there has been no significant change of behaviour until cycle 13. During this cycle, the noise injection temperature seems to start a slow decrease. For the channel 36.5GHz, one can see that the diode is not stabilized : the injection temperature has increased from cycle 1 to 5 followed by a stabilization period from beginning of June (cycle 5) to mid-July (end of cycle 6) when the noise injection temperature for the 36.5GHz channel starts to decrease, then increase during cycle 14. The monitoring will be pursued and data checked for any impact.

Some peak values are noticeable at the end of cycle 4 (mainly channel 23.8GHz), at the end of cycle 6, during cycle 9, 10, 12 and 16. Some of these peaks concerns both channels at the same time, while a small part of them only one of them. The investigations performed in the cycle 6 report has shown that these measurements are localized around a band of latitude that may change along the time series. The source is not yet clearly identified but a intrusion of the Moon in the sky horn is suspected.



**Figure 12 : Daily statistics of the noise injection temperature for channel 23.8GHz (left) and 36.5GHz (right): mean (bold line), min/max (thin line), standard deviation (shade)**

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## 4.2 Vicarious calibration

The assessment of the brightness temperatures quality and stability is performed by the use of vicarious calibrations. Two specific areas are selected. Sentinel-3A data used in this section are:

- ❖ coldest ocean temperature analysis uses Level 2 data
  - data from the recent processing (using IPF v6.5) (STC) from 06 April to 06 May,
  - data from the recent processing (using IPF v6.5) (NTC) from 15 June to 30 September.
  - STC data since December 2016
- ❖ Amazon forest analysis uses Level 1B data:
  - data from the recent processing using IPF v6.5 ( L1B NTC data from mid-March to October).
  - STC data from LN3 processing center

### 4.2.1 Coldest ocean temperatures

The first area is the ocean and more precisely the coldest temperature over ocean. Following the method proposed by Ruf [RD 1], updated by Eymar [RD 3] and implemented in [RD 7], the coldest ocean temperatures is computed by a statistic selection. Ruf has demonstrated how a statistical selection of the coldest BT over ocean allows detecting and monitoring drifts. It is also commonly used for long-term monitoring or cross-calibration [RD 4] [RD 5] [RD 6].

The Figure 13 presents the coldest ocean temperature computed following method previously described at 23.8GHz channel for Sentinel-3A/WMR and three other microwave radiometers: AltiKa/MWR, Jason2/AMR and Metop-A/AMSU-A. For AMSU-A, the two pixels of smallest incidence (closest to nadir) are averaged. The Figure 14 presents the same results for the liquid water channel of the same four instruments: 36.5GHz for Sentinel-3A, 37GHz for AltiKa , 34GHz for Jason2 and 31.4GHz for Metop-A.

Concerning the 23.8GHz channel presented on Figure 12, one can see the impact of the calibration of the MWR with the increase of the coldest ocean brightness temperature: around 135K before and 140K after the update of the characterisation file and LTM files for the STC on the fly products (green line). The temperature of the coldest ocean points is now closer to the other sun-synchronous missions (Metop-A, SARAL/AltiKa). The orange and brown lines are for the reprocessed data, respectively in STC and NTC timeliness.



The analysis for the liquid water channel (Figure 14) is more complicated due to the different frequency used by these instruments for this channel: 36.5GHz for Sentinel-3A, 37GHz for AltiKa, 34GHz for Jason2 and 31.4GHz for AMSU-A. But the coldest temperature can be used relatively one with another. For instance, one can see that the difference between AltiKa and Jason-2 is about 6K which is in line with the theoretical value estimated by Brown between the channel 34 GHz of JMR and the channel 37 GHz of TMR (-5.61 K ± 0.23 K) [RD 8]. Then we can expect that Sentinel3 should be closer to AltiKa than Jason2 due to the measurement frequency. The STC and NTC products reprocessed using the new MWR characterisation file (light green curves) show hottest temperatures similar to AltiKa. For the on-the-fly STC products, a jump in the temperatures occurs with the update of MWR characterisation file.

The period is too short to allow a drift analysis but it is reassuring to see that Sentinel-3A/MWR has the same behaviour than the other radiometer.

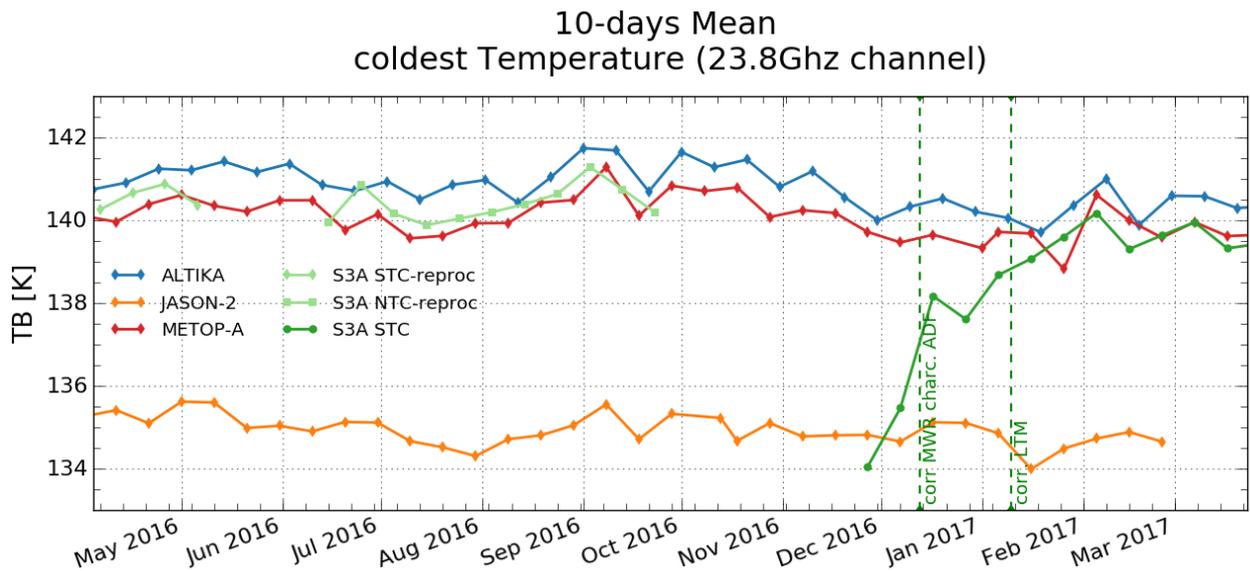


Figure 13 : Coldest temperature over ocean at 23.8GHz for Sentinel-3A, SARAL/AltiKa, Jason2, and Metop-A/AMSU-A

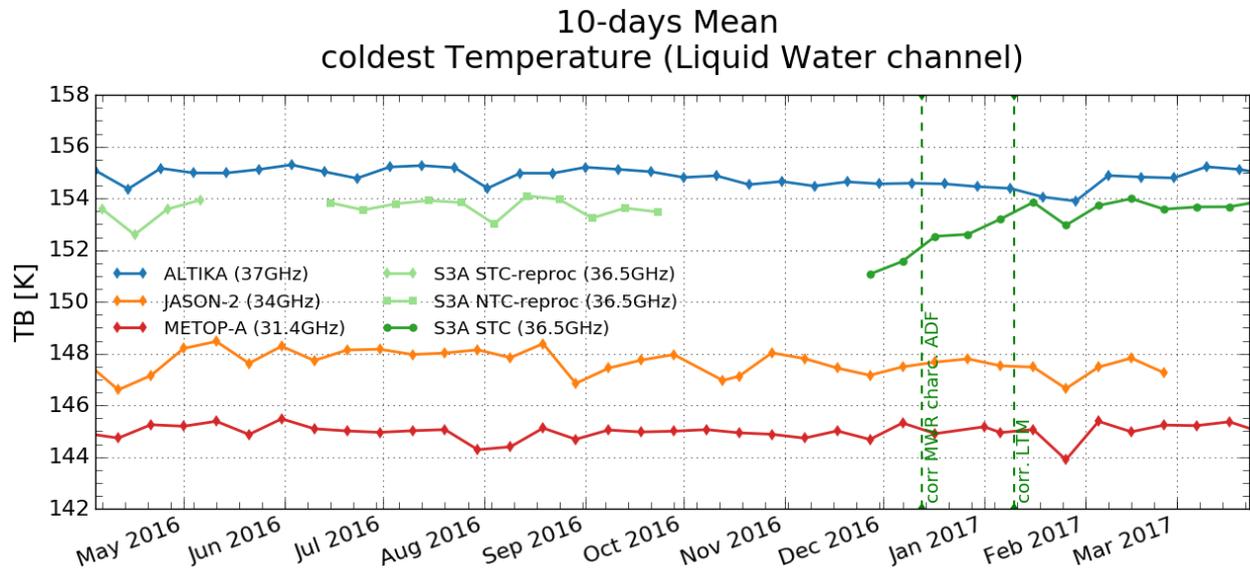


Figure 14 : Coldest temperature over ocean for the liquid water channel Sentinel-3A, SARAL/AltiKa, Jason2, and Metop-A/AMSU-A

#### 4.2.2 Amazon forest

The second area is the Amazon forest which is the natural body the closest to a black body for microwave radiometry. Thus it is commonly used to assess the calibration of microwave radiometers [RD 2][ RD 3]. The method proposed in these papers have been used as a baseline to propose a new method implemented in [RD 7]. In this new approach, a mask is derived from the evergreen forest class of GlobCover classification over Amazon. The average temperature is computed here over a period of 10 days except for Jason2 for which a period of one month is required. Due to the orbit of Jason2, a longer period is required to reach a significant number of measurements falling within the mask.

The averaged temperature over the Amazon forest is shown on Figure 15 and Figure 16 for water vapor channel (23.8GHz) and liquid water channel respectively. These two figures show the very good consistency of Sentinel-3A with the three other radiometers on the hottest temperatures: around 286K for the first channel, and 284K for the second channel. The mean value as well as the annual cycle is well respected. These results show the correct calibration for the hottest temperatures and the small impact of the MWR calibration for the hottest temperatures when comparing the NTC (updated calibration) and the NRT . As for the coldest ocean temperatures, the period is too short to allow a drift analysis.



Mean of Brightness Temperature (23.8GHz) over Amazon forest

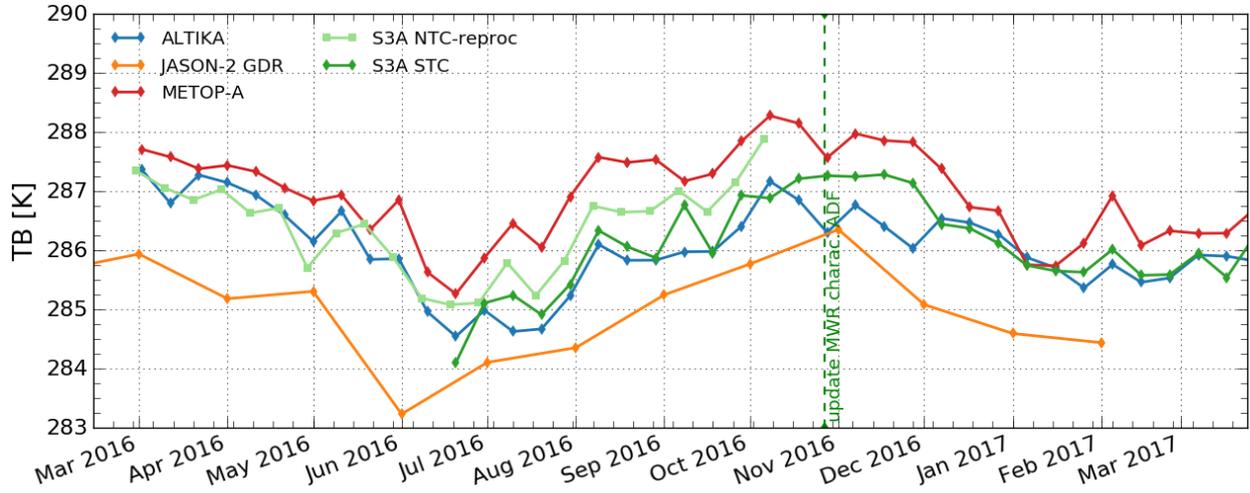


Figure 15 : Average temperature over Amazon forest at 23.8GHz channel for Sentinel-3A, SARAL/AltiKa, Jason2, and Metop-A/AMSU-A

Mean of Brightness Temperature (Liquid Water channel) over Amazon forest

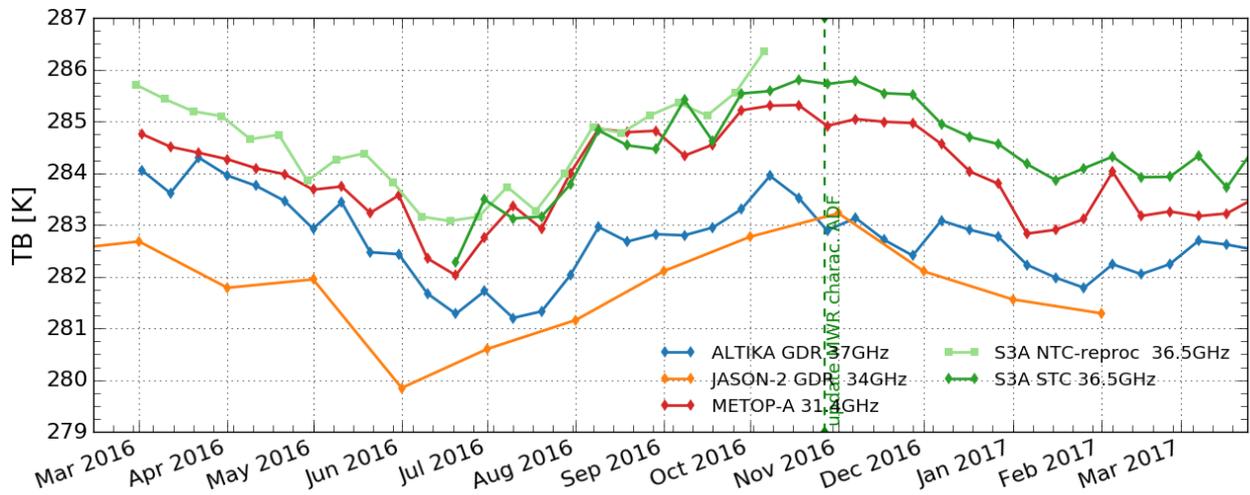


Figure 16 : Average temperature over Amazon forest at 36.5GHz channel for Sentinel-3A, SARAL/AltiKa, Jason2, and Metop-A/AMSU-A

4.2.3 References

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RD 2 S. Brown, C. Ruf, 2005: Determination of an Amazon Hot Reference Target for the on-orbit calibration of Microwave radiometers, *Journal of Atmos. Ocean. Techno.*, **22**, 1340-1352

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- RD 4** C. Ruf, 2002: Characterization and correction of a drift in calibration of the TOPEX microwave radiometer, **IEEE Trans. Geosci. Remote Sens.**, **40**, 209-511
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## 4.3 Geophysical products

### 4.3.1 Monitoring of geophysical products

In this section, comparisons of MWR-ECMWF fields are performed for several instruments. The selected instruments are Jason-2/AMR and SARAL/ALtiKa. For a long term monitoring perspective, GDR products are used to compute the difference with respect to ECMWF fields. GDR products for each mission have its own latency due to cycle curation and mission constraints such as the cold-sky calibration for Jason-2 mission. Indeed, ALtiKa GDR is available with delay of ~35 days, while for Jason2 this delay is up to 60 days.

#### 4.3.1.1 Wet tropospheric correction

Figure 17 shows the monitoring of the MWR-ECMWF differences of wet tropospheric correction ( $\Delta WTC$ ) using Level2 STC products from the Marine Center. Sentinel-3A correction is compared to Jason2/AMR and SARAL/MWR corrections. For SARAL (annoted AL in Figure 17) and Jason2 (J2), IGDR products were selected. The daily average of  $\Delta WTC$  for Sentinel-3A is close to 0cm since 10<sup>th</sup> of January while it is around 0.6cm for SARAL and Jason2. This difference is small and results partialy from the inversion algorithm.

The more relevant parameter to assess the performance of a correction is the standard deviation of  $\Delta WTC$ . First Jason-2 benefits from its three channels radiometer (18.7GHz, 23.8GHz, 34GHz), providing a correction with a smaller deviation with respect to the model. SARAL/MWR is closer to S-3A/MWR in this context with its two channels (23.8GHz, 37GHz). Then the standard deviation for SARAL is the closest reference, even though the Sigma0 in Ka band raises some questions. With the use of STC products for S-3A, the  $\Delta WTC$  for the three instruments are directly comparable since all missions use ECMWF analyses for the computation of the model correction. The standard deviation of  $\Delta WTC$  for S-3A is smaller than for SARAL meaning that we have a better estimation of the correction for S-3A according



to these metrics. Jason-2 gives the best performances with the smallest deviation. Moreover, one can notice that both SAR and PLMR corrections have very similar performances. The peak value in the standard deviation observed during cycle 14 for both SAR and PLRM  $\Delta$ WTC comes from the model correction provided by the products. During this day, one ECMWF analyse over the four required for a good estimation all along the day was missing.

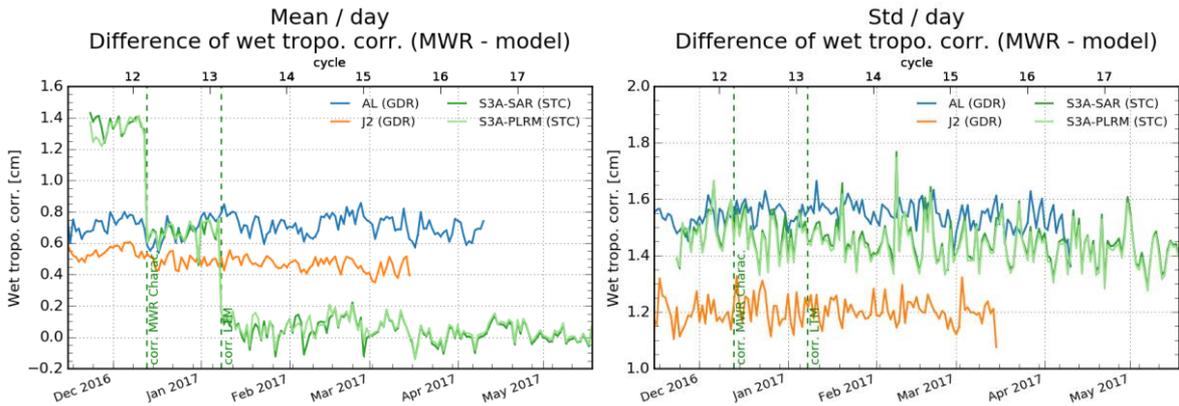


Figure 17 : Monitoring of difference MWR-ECMWF correction : daily average (left) and standard deviation (right)

#### 4.3.1.2 Atmospheric attenuation

Figure 18 shows the monitoring of the MWR-ECMWF differences of atmospheric attenuation ( $\Delta$ ATM\_ATT) using Level2 STC products from the Marine Center. Sentinel-3A correction in Ku band is compared to Jason2/AMR. SARAL/AltiKa is not shown here because the altimeter uses the Ka band. Figure 18 shows that the several evolutions affected mainly the average value of  $\Delta$ ATM\_ATT: the daily average show steps when the configuration of the IPF is updated, while the standard deviation is stable over the whole period. The mean of  $\Delta$ ATM\_ATT for Jason2 is around 0.005dB , a little larger for S-3A: around 0.015dB since mid-January, more stable around 0.01dB since mid-February. A finer tuning of the retrieval algorithm is expected to correct for this small difference.

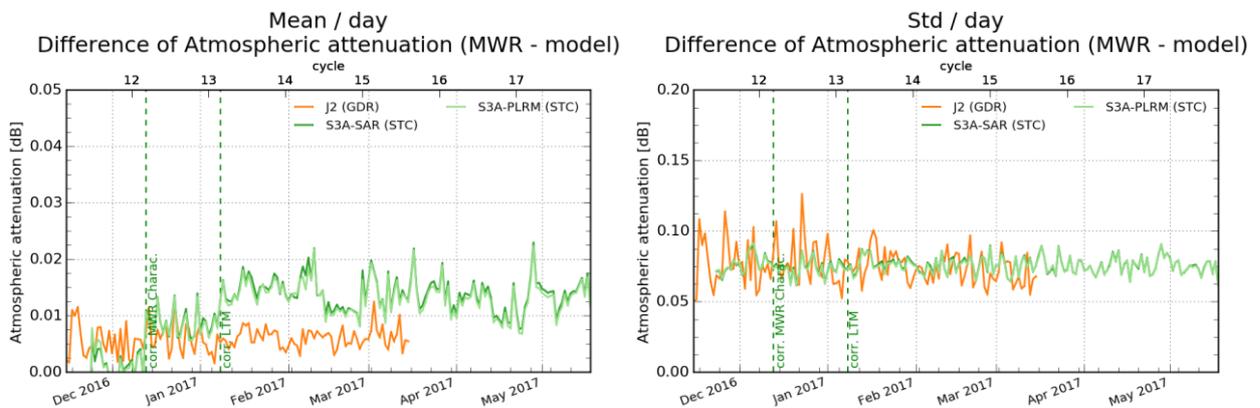
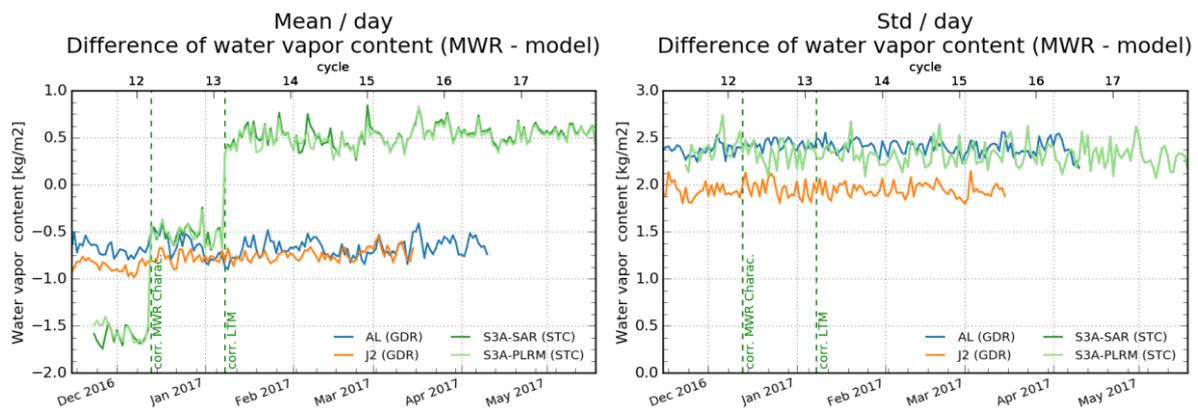


Figure 18 : Monitoring of difference MWR-ECMWF atmospheric attenuation : daily average (left) and standard deviation (right)



### 4.3.1.3 Water vapor content

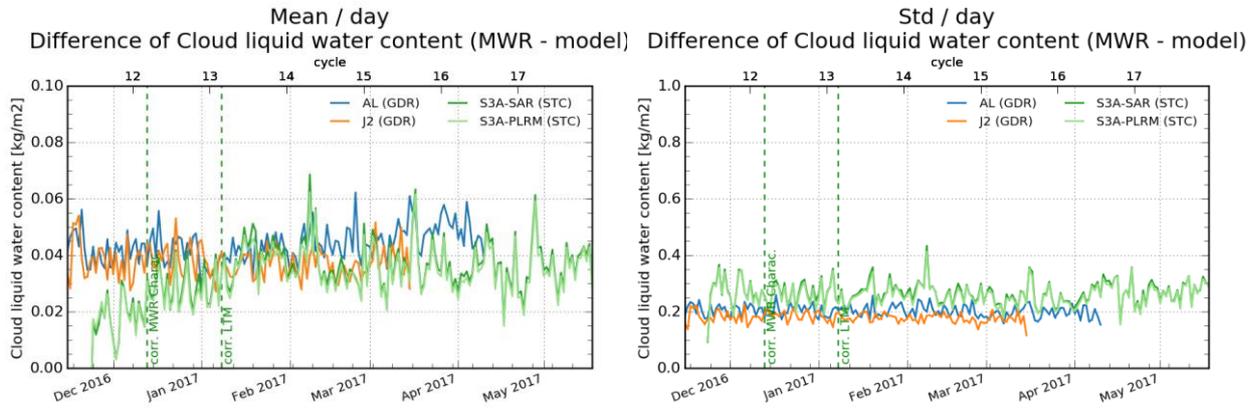
Figure 19 shows the monitoring of the MWR-ECMWF differences of atmospheric attenuation ( $\Delta WV$ ) using Level2 STC products from the Marine Center. Sentinel-3A correction in Ku band is compared to Jason2/AMR. SARAL/AltiKa is not shown here because the altimeter uses the Ka band. Figure 18 shows that the several evolutions affected mainly the average value of  $\Delta WV$ : the daily average show steps when the configuration of the IPF is updated, while the standard deviation is stable over the whole period. The mean of  $\Delta WV$  for Jason2 is between  $-1.0\text{kg/m}^2$  and  $-0.5\text{kg/m}^2$ , very close to AltiKa results of  $-0.5\text{kg/m}^2$ , and a little larger for Sentinel-3A: around  $0.5\text{kg/m}^2$  since mid-January. The standard deviation of  $\Delta WV$  is very similar between AltiKa and S-3A between 2 and  $2.5\text{kg/m}^2$ , and a little smaller for Jason2 around  $2\text{kg/m}^2$ . A finer tuning of the retrieval algorithm is expected to correct for the small difference of the daily average.



**Figure 19 : Monitoring of difference MWR-ECMWF water vapour content : daily average (left) and standard deviation (right)**

### 4.3.1.4 Cloud liquid water content

Figure 20 shows the monitoring of the MWR-ECMWF differences of cloud liquid water content ( $\Delta WC$ ) using Level2 STC products from the Marine Center. Sentinel-3A fields is compared to Jason2/AMR and SARAL/AltiKa. Figure 20 Figure 18 shows that the several evolutions affected mainly the average value of  $\Delta WC$ : the daily average show steps when the configuration of the IPF is updated but with a smaller effect than for the other geophysical parameters, while the standard deviation is stable over the whole period. The mean of  $\Delta WC$  is close to  $0.04\text{kg/m}^2$  for the three missions. The standard deviation of Sentinel-3A is little higher than for the two other missions:  $\sim 0.3\text{kg/m}^2$  for S-3A,  $0.2\text{ kg/m}^2$ . This point needs to be analyzed.



**Figure 20 : Monitoring of difference MWR-ECMWF cloud liquid water content : daily average (left) and standard deviation (right)**

### 4.3.2 Comparison to in situ measurements

The comparison of wet tropospheric correction to Radiosonde measurements will be addressed with 2 years of data.



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## 5 Specific investigations

None.



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## 6 Events

No event related to MWR instrument.

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## 7 Appendix A

Other reports related to the STM mission are:

- ❖ S3-A SRAL Cyclic Performance Report, Cycle No. 017 (ref. S3MPC.ISR.PR.04-017)
- ❖ S3-A Ocean Validation Cyclic Performance Report, Cycle No. 017 (ref. S3MPC.CLS.PR.06-017)
- ❖ S3-A Winds and Waves Cyclic Performance Report, Cycle No. 017 (ref. S3MPC.ECM.PR.07-017)
- ❖ S3-A Land and Sea Ice Cyclic Performance Report, Cycle No. 017 (ref. S3MPC.UCL.PR.08-017)

All Cyclic Performance Reports are available on MPC pages in Sentinel Online website, at:  
<https://sentinel.esa.int>

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