S3-A Land and Sea Ice Cyclic Performance Report

Cycle No. 020

Start date: 11/07/2017
End date: 07/08/2017

Ref. S3MPC.UCL.PR.08-020
Issue: 1.0
Date: 16/10/2017
Contract: 4000111836/14/I-LG
<table>
<thead>
<tr>
<th>Customer:</th>
<th>ESA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contract No.:</td>
<td>4000111836/14/I-LG</td>
</tr>
<tr>
<td>Document Ref.:</td>
<td>S3MPC.UCL.PR.08-020</td>
</tr>
<tr>
<td>Date:</td>
<td>16/10/2017</td>
</tr>
<tr>
<td>Issue:</td>
<td>1.0</td>
</tr>
<tr>
<td>Project:</td>
<td>PREPARATION AND OPERATIONS OF THE MISSION PERFORMANCE CENTRE (MPC) FOR THE COPERNICUS SENTINEL-3 MISSION</td>
</tr>
<tr>
<td>Title:</td>
<td>S3-A Land and Sea Ice Cyclic Performance Report</td>
</tr>
<tr>
<td>Author(s):</td>
<td>Land and Sea Ice ESLs</td>
</tr>
<tr>
<td>Approved by:</td>
<td>G. Quartly, STM ESL Coordinator</td>
</tr>
<tr>
<td>Authorized by:</td>
<td>Sylvie Labroue, STM Technical Performance Manager</td>
</tr>
<tr>
<td>Distribution:</td>
<td>ESA, EUMETSAT, S3MPC consortium</td>
</tr>
<tr>
<td>Accepted by ESA</td>
<td>P. Féménias, MPC TO</td>
</tr>
<tr>
<td>Filename</td>
<td>S3MPC.UCL.PR-08-020 - i1r0 - LandSeaIce Cyclic Report 020.docx</td>
</tr>
</tbody>
</table>

**Disclaimer**

The work performed in the frame of this contract is carried out with funding by the European Union. The views expressed herein can in no way be taken to reflect the official opinion of either the European Union or the European Space Agency.
### Changes Log

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>16/10/2017</td>
<td>First Version</td>
</tr>
</tbody>
</table>

### List of Changes

<table>
<thead>
<tr>
<th>Version</th>
<th>Section</th>
<th>Answers to RID</th>
<th>Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table of content

1 INTRODUCTION ................................................................................................................................................. 1

2 CYCLE OVERVIEW ............................................................................................................................................... 2

3 PROCESSING BASELINES ................................................................................................................................. 3

4 DATA AVAILABILITY & INSTRUMENT MODES ................................................................................................. 4
  4.1 DATA AVAILABILITY ...................................................................................................................................... 4
  4.2 SRAL INSTRUMENT MODE ............................................................................................................................ 5

5 AVAILABILITY OF POLAR GEOPHYSICAL CORRECTIONS ............................................................................ 9
  5.1 AVAILABILITY OF GEOPHYSICAL CORRECTIONS OVER ICE SHEETS (NTC PRODUCTS) ..................... 9
  5.2 AVAILABILITY OF GEOPHYSICAL CORRECTIONS OVER ICE SHELVES (NTC PRODUCTS) ................. 10
  5.3 AVAILABILITY OF GEOPHYSICAL CORRECTIONS OVER SEA ICE .................................................... 12
  5.4 AVAILABILITY OF SNOW DENSITY, SNOW DEPTH AND SEA ICE CONCENTRATION OVER SEA ICE 14

6 GEOPHYSICAL PARAMETER MONITORING FOR LAND ICE ................................................................. 15
  6.1 20Hz Ku Band Elevation (elevation_ice_sheet_20_ku) .................................................................................. 15
  6.2 20Hz Ku Band Ice Sheet Range (range_ice_sheet_20_ku) .......................................................................... 18
  6.3 20Hz Ku Band Ice Sheet Sigma0 (sig0_ice_sheet_20_ku) ........................................................................... 20
  6.4 20Hz Ku Band OCOG (ICE-1) Range (range_ocog_20_ku) ......................................................................... 22
  6.5 20Hz Ku Band OCOG (ICE-1) Sigma0 (sig0_ocog_20_ku) ......................................................................... 23
  6.6 20Hz Ku Band PLRM Ice Range (range_ice_20_plrm_ku) .......................................................................... 26
  6.7 20Hz Ku Band PLRM Sigma0 (sig0_ice_20_plrm_ku) ............................................................................... 29
  6.8 20Hz Ku Band Surface Class (surf_class_20_ku) ...................................................................................... 31

7 SLOPE CORRECTION ASSESSMENT .................................................................................................................. 33

8 GEOPHYSICAL PARAMETER MONITORING FOR SEA ICE ........................................................................ 35
  8.1 20Hz Ku Band Altimeter Derived Surface Type (surf_type_class_20_ku) ................................................... 35
  8.2 20Hz Ku Band Freeboard (freeboard_20_ku) .............................................................................................. 37
  8.3 20Hz Ku Band Interpolated Sea Surface Height Anomaly (int_sea_icsshha_20_ku) ............................... 38
  8.4 Sea Surface Height Anomaly (sea_ice_sshha_20_ku) .................................................................................. 38
  8.5 20Hz Ku Band Sea Ice Concentration (sea_ice_concentration_20_ku) ..................................................... 39

9 CROSSOVER ANALYSIS ...................................................................................................................................... 41

10 REPEAT TRACK ANALYSIS ............................................................................................................................. 42

11 LONG TERM MONITORING ............................................................................................................................ 43

12 EVENTS ............................................................................................................................................................... 44

13 CONCLUSIONS ..................................................................................................................................................... 45

14 APPENDIX A ......................................................................................................................................................... 46
List of Figures

Figure 1: SR_2_LAN IPF Versions and Availability during cycle 20----------------------------------------------3
Figure 2: SR_2_WAT IPF Versions and Availability during cycle 20-----------------------------------------------3
Figure 3: Map of SRAL mode over Antarctic ice sheet and ice shelves for cycle 20 NTC--------------------------5
Figure 4: Map of SRAL mode over Greenland ice sheet for cycle 20 NTC-----------------------------------------6
Figure 5: Map of SRAL mode over the Antarctic sea ice for cycle 20 NTC----------------------------------------7
Figure 6: Map of SRAL mode over the Arctic sea ice for cycle 20 NTC------------------------------------------8
Figure 7: Percentage of Geophysical Correction Non-availability over Antarctic Ice Sheets---------------------10
Figure 8: Percentage of Geophysical Correction Non-availability over the Greenland Ice Sheet------------------10
Figure 9: Availability of Geophysical Corrections over Antarctic Ice Shelves ----------------------------------11
Figure 10: Map of Ocean Tide Correction (sol. 2) over Antarctic ice shelves in cycle 20 NTC------------------12
Figure 11: Map of Ocean Tide Correction (sol. 2) Failure Locations over Arctic in cycle 20 NTC----------------14
Figure 12: Map of 20Hz Ku band Ice Sheet Elevation over Antarctica and Greenland for cycle 20--------------17
Figure 13: Maps of 20Hz Ku Band Ice Sheet Range (range_ice_sheet_20_ku)-------------------------------------19
Figure 14: Maps of 20Hz Ku Band Ice Sheet Sigma0 (sig0_ice_sheet_20_ku)--------------------------------------21
Figure 15: Maps of 20Hz Ku Band OCOG (Ice-1) Range (range_ocog_20_ku)--------------------------------------23
Figure 16: Maps of 20Hz Ku Band OCOG (Ice-1) Sigma0 (sig0_ocog_20_ku)---------------------------------------25
Figure 17: Maps of 20Hz Ku Band PLRM Ice Range (range_ice_20_plrm_ku)--------------------------------------27
Figure 18: Plot of 20Hz Altitude - PLRM range over Antarctic Ice Sheets---------------------------------------28
Figure 19: Maps of 20Hz Ku Band PLRM Sigma0 (sig0_ice_20_plrm_ku)-------------------------------------------30
Figure 20: Maps of 20Hz Ku Band Surface Class (surf_class_20_ku)-------------------------------------------32
Figure 21: Maps of Slope Correction Failure Locations--------------------------------------------------------34
Figure 22: Maps of 20Hz Ku Band Altimeter Derived Surface Type (surf_type_class_20_ku)----------------------36
Figure 23: Maps of 20Hz Ku band Freeboard (freeboard_20_ku)-----------------------------------------------38
Figure 24: Maps of 20Hz Ku band Sea Ice Concentration (sea_ice_concentration_20_ku)------------------------40
List of Tables

Table 1: Data Availability for NTC--------------------------------------------------------------- 4
Table 2: % Non Availability of Geophysical Corrections over Sea Ice (NTC)-----------------------13
Table 3: % Availability of Snow Density, Snow Depth, Sea Ice Concentration over Sea Ice ----------14
1 Introduction

This document provides a report of the performance and data quality of the Sentinel-3A SRAL Level 2 data products over land ice (polar ice sheets, ice shelves, and ice caps) and sea ice surfaces.

For land ice the SR_2_LAN Level 2 NTC (Non Time Critical) products which contain the final orbit and geophysical corrections are assessed. These are produced by the S3 Instrument Processing Facility (IPF) at CNES.

For sea ice, we assess the SR_2_WAT Marine Level 2 NTC (Non Time Critical) products, produced by the S3 Marine Centre.

The objectives of this document are:

- To provide a data quality assessment.
- To report on any changes likely to impact data quality at any level, from instrument status to software configuration.
- To present the major useful results for cycle 20, from 11 July 2017 to 07 August 2017.
2 Cycle Overview

This is 27-day cycle 20 (11-July-2017 to 07-Aug-2017), the seventh cycle since Sentinel-3A entered its routine operational phase following commissioning. Sentinel-3A was launched on 16-February-2016.

During this cycle, Sentinel-3A SRAL operated in SAR mode over land ice and sea ice surfaces.
3 Processing Baselines

During this cycle there was no Instrument Processing Facility (IPF) software version change for SR_2_LAN NTC products.

One version of the IPF was used to compute the altimeter parameters for the L2 Land (SR_2-LAN) NTC dataset during this cycle. This was IPF-SM-2, version 06.07.

![Figure 1: SR_2_LAN IPF Versions and Availability during cycle 20](image1)

The version of the S3-MPC software used to compute the altimeter parameters for the L2 Marine (SR_2-WAT) NTC dataset is the IPF-SM-2, version 06.07.

![Figure 2: SR_2_WAT IPF Versions and Availability during cycle 20](image2)
4 Data Availability & Instrument Modes

4.1 Data Availability

The percentage of L2 product orbits received during this 27 day cycle by the MPC and contributing to this report were:

<table>
<thead>
<tr>
<th>Product Type</th>
<th>Latency</th>
<th>% Orbits Received</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR_2_LAN</td>
<td>NTC</td>
<td>99.5</td>
</tr>
<tr>
<td>SR_2_WAT</td>
<td>NTC</td>
<td>100%</td>
</tr>
</tbody>
</table>

*Table 1: Data Availability for NTC*

Note that these are percentages of products received by the Mission Performance Centre at the time of report issue, and may be lower than the final data availability if there have been processing centre delays.
4.2 SRAL Instrument Mode

Over land ice surfaces the SRAL instrument operated in SAR closed loop during this cycle. Closed-loop is the autonomous form of surface tracking typically used for altimetry missions, as compared with open-loop which depends on a pre-computed DEM stored onboard.

Flag: instr_op_mode_20_ku
Mode: all
Cycle: 20 NTC  SR_2_LAN

Rel. Orbits: 1 to 385
First Time: 2017-07-11T22:22
Last Time: 2017-08-07T21:32
IFF Version: IFF-SM-2 D8.07

Figure 3: Map of SRAL mode over Antarctic ice sheet and ice shelves for cycle 20 NTC
For sea ice and ocean surfaces the SRAL instrument operated in SAR open loop mode during this cycle. Note that the mode mask is fixed and does not dynamically change from cycle to cycle. In open loop the range window is positioned using a 1-D along track DEM with a-priori knowledge of the surface height.
Figure 5: Map of SRAL mode over the Antarctic sea ice for cycle 20 NTC
Figure 6: Map of SRAL mode over the Arctic sea ice for cycle 20 NTC
5 Availability of Polar Geophysical Corrections

In this section the availability of geophysical corrections to altimeter range contained in the L2 products over ice sheets, ice shelves and sea ice are analysed for this cycle. Missing or invalid geophysical corrections can cause errors in the final L2 elevation parameters, and erroneous steps in derived time series of ice sheet surface elevation change or sea ice freeboard.

5.1 Availability of Geophysical Corrections over Ice Sheets (NTC Products)

For polar ice sheets, the primary geophysical corrections applied to the range are model dry tropospheric, model wet tropospheric, GIM ionospheric, solid earth tide, pole tide and ocean loading tide. We would normally expect 100% availability of all corrections except the altimeter derived ionospheric corrections (iono_cor_alt_01_ku, iono_cor_alt_20_ku).

For cycle 20 NTC the percentage of non-available geophysical corrections over Antarctic ice sheets was:
Figure 7: Percentage of Geophysical Correction Non-availability over Antarctic Ice Sheets

For cycle 20 NTC the percentage of non-available geophysical corrections over the Greenland ice sheet was:

![Graph showing percentage of geophysical correction non-availability over Greenland ice sheet]

Figure 8: Percentage of Geophysical Correction Non-availability over the Greenland Ice Sheet

5.2 Availability of Geophysical Corrections over Ice Shelves (NTC Products)

For polar ice shelves, the primary geophysical corrections applied to the range are as for ice sheets plus ocean tide and inverse barometric corrections.

For cycle 20 NTC the percentage availability of geophysical corrections over Antarctic ice shelves was:
Figure 9: Availability of Geophysical Corrections over Antarctic Ice Shelves

For ice shelf studies it is recommended that users replace the ocean tide correction (Ocean Tide Solution 2 in cycle 20) where it is valid in the L2 NTC products over Antarctic ice shelves with a more accurate high resolution circumpolar ocean tide model correction such as the Circum Antarctic Tidal Simulation (CATS 2008a), Padman et al (2008).

Note that the % non availability of ocean tide fields shown appear to be predominantly due to use of a different glacier grounding line (GLL) mask in the S3A processing as compared to the reports test mask which uses the Rignot 2016 GLL.
5.3 Availability of Geophysical Corrections over Sea Ice

Over sea ice the model dry tropospheric, model wet tropospheric, ionospheric, solid earth tide, pole tide and ocean tide and inverse barometric corrections are applied in the STC L2 Marine product.

For cycle 19 NTC the percentage availability of geophysical corrections over sea ice was:
Table 2: % Non Availability of Geophysical Corrections over Sea Ice (NTC)

The Ocean Tide solutions over the Arctic show missing values only very close to the coast:
5.4 Availability of Snow Density, Snow Depth and Sea Ice Concentration over Sea Ice

<table>
<thead>
<tr>
<th>Correction</th>
<th>% Availability Arctic Sea Ice</th>
<th>% Availability Antarctic Sea Ice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sea Ice Concentration(^1)</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Snow Density(^2)</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Snow Depth</td>
<td>100</td>
<td>(^{100})^{2}</td>
</tr>
</tbody>
</table>

\(^1\)Snow Density is set to a single value of 400 Kg/m\(^3\) as expected.

\(^2\)Snow depth over Antarctic sea ice is set to zero as expected.

\(^3\)Sea Ice Concentration is derived from a dynamic 3 day average of sea ice concentration calculated from SSM/I daily brightness temperature data.
6 Geophysical Parameter Monitoring for Land Ice

This section shows results and analysis of the primary L2 NTC parameters relating to land ice in cycle 20.

6.1 20Hz Ku Band Elevation (elevation_ice_sheet_20_ku)

20Hz Ku band surface elevation is the primary output of the land ice products over continental ice sheets and ice shelves.

Analysis of this parameter shows that the map of elevation is as expected but there is an unexpectedly high rate of parameter failure over the whole ice area in both Antarctica (32%) and Greenland (43%). This is currently under investigation by the MPC and ESA but it is believed to be due to two main reasons:

1. An issue with the L1 SAR processing over areas of sloping terrain. This affects the stability of the waveform positioning within the range window, particularly in the continental margins. This results in waveforms being located towards the edge of the range window or being truncated.

2. A SAR ice margin retracker tuning issue over areas of low slope.

Additionally, tests indicate that an error in the slope correction is present in this version of the IPF processing which will cause a resulting error in the elevation (of 30cm to several meters, dependent on slope) and to the location of the echo.

A small number of anomalous large negative values are also present. This is under investigation by the MPC.

The following maps show the 20Hz Ku band Elevation parameter plotted for the complete cycle.
S3A L2 Parameter:
elevation_ice_sheet_20_ku (m)

Mode: all
Cycle: 20 HTC SR_3 LAN
Rev. Orbits: 1 to 385
First Time: 2017-07-11T22:22
Last Time: 2017-08-07T21:32
IPF Version: IPF-SM-2.0.07

Histogram of Full Parameter Range

Histogram of Map Display Range

Location of full parameter set

Tracks within Antartica Ice Sheet

elevation_ice_sheet_20_ku vs Latitude

elevation_ice_sheet_20_ku (m)
Figure 12: Map of 20Hz Ku band Ice Sheet Elevation over Antarctica and Greenland for cycle 20
6.2 20Hz Ku Band Ice Sheet Range (range_ice_sheet_20_ku)

The ice sheet range is retracked using the SAR ice margin retracker and is the primary range used to calculate elevation in the L2 product.

There are higher than expected rates of failure in this parameter over all ice areas. An explanation of this is given in the preceding section on ice sheet elevation.
Figure 13: Maps of 20Hz Ku Band Ice Sheet Range (range_ice_sheet_20_ku)
6.3 20Hz Ku Band Ice Sheet Sigma0 (sig0_ice_sheet_20_ku)

The Ku band ice sheet sigma0 backscatter parameter is derived from the SAR ice margin retracker. The map of sigma0 over the ice sheets shows similar patterns of backscatter values to previous missions. Backscatter values are controlled by surface roughness characteristics, surface slope and differences in surface and volume echo. Over the ice sheet margins backscatter is low due to high surface slope, and over the East Antarctic ice sheet it is also low due to strong winds causing high surface roughness. Over the West Antarctic ice sheet and areas of Dronning Maud land there are high backscatter returns due to very smooth surfaces. In Greenland the ice sheet surface is smoother due to lower winds and regular melt events causing higher backscatter values.

There are higher than expected rates of failure in this parameter over all ice areas. An explanation of this is given in the preceding section on ice sheet elevation.
S3A L2 Parameter:
sig0_ice_sheet_20_ku (dB)

Model of:
Cycle: 20 NTC SR_3_LAN
RaI. Orbits: 1 to 385
First Time: 2017-07-11T23:13
Last Time: 2017-08-07T22:22
IPF Version: IPF-SM-2.05.07

Figure 14: Maps of 20Hz Ku Band Ice Sheet Sigma0 (sig0_ice_sheet_20_ku)
6.4 20Hz Ku Band OCOG (Ice-1) Range (range_ocog_20_ku)

This parameter is the range derived from the OCOG (Ice-1) retracker. Note that there are much lower failure rates (~2%) than for the SAR ice margin retracker (32%). This is because the OCOG centre of gravity retracking algorithm will retrack a wider range of waveform shapes and leading edge positions than the model fit approach used by the SAR ice margin retracker. This results in greater measurement density, but in some areas lower accuracy.
The Ku band OCOG sigma0 backscatter parameter is derived from the OCOG (Ice-1) retracker. The map of sigma0 over the ice sheets shows similar patterns of backscatter values to previous missions. Backscatter values are controlled by surface roughness characteristics, surface slope and differences in surface and volume echo. Over the ice sheet margins backscatter is low due to high surface slope, and over the East Antarctic ice sheet it is also low due to strong winds causing high surface roughness. Over the West Antarctic ice sheet and areas of Dronning Maud land there are high backscatter returns due to very smooth surfaces. In Greenland the ice sheet surface is smoother due to lower winds and regular melt events causing higher backscatter values.

There are higher than expected rates of failure in this parameter over the margins, West Antarctica and the Antarctic Peninsula, but much lower failure rates than for the SAR ice margin retracker. This is because the OCOG centre of gravity retracking algorithm will retrack a wider range of waveform shapes than the model fit approach used by the SAR ice margin retracker. This results in greater measurement density, but in some areas lower accuracy.
S3A L2 Parameter: \( \text{sig}_0 \_oocog \_20 \_ku \text{ (dB)} \)

Mode: all

Cycle: 20 NTC SR_2_LAN

Ref. Orbits: 1 to 385

First Time: 2017-07-11T22:22

Last Time: 2017-08-07T21:32

IPF Version: IPF-SM-2 D6.07

Tracks within Antarctic Ice Sheet

\[ \text{sig}_0 \_oocog \_20 \_ku \text{ (dB)} \]

\[ 32 \quad 35 \quad 38 \quad 41 \quad 44 \quad 47 \quad 50 \quad 53 \quad 56 \]

\[
\text{sig}_0 \_oocog \_20 \_ku \text{ vs Latitude}
\]

\[
\text{sig}_0 \_oocog \_20 \_ku \text{ (dB)}
\]

\[ -85 \quad -80 \quad -75 \quad -70 \quad -65 \quad -60 \]

\[
\text{sig}_0 \_oocog \_20 \_ku \text{ (dB) (97.94085)/Full (2.099248)}
\]}
Figure 16: Maps of 20Hz Ku Band OCOG (Ice-1) Sigma0 (sig0_ocog_20_ku)
6.6 20Hz Ku Band PLRM Ice Range (range_ice_20_plrm_ku)

Range measurements derived from the PLRM waveforms and retracker show similar but slightly higher failure rates than for the SAR OCOG retracked range.

There is a strong orbit directional bias in the PLRM range over ice sheet surfaces. This is under investigation.
A plot of 20Hz altitude – PLRM range show a similar pattern of directional bias.
Figure 18: Plot of 20Hz Altitude - PLRM range over Antarctic Ice Sheets
6.7 20Hz Ku Band PLRM Sigma0 (sig0_ice_20_plrm_ku)

Backscatter sigma0 derived from the 20Hz Ku PLRM waveforms are shown below. There is a strong orbit directional bias over the ice sheets as discussed above in the section on PLRM range.
Figure 19: Maps of 20Hz Ku Band PLRM Sigma0 ($\text{sig0\_ice\_20\_plrm\_ku}$)
6.8 20Hz Ku Band Surface Class (surf_class_20_ku)

The 20Hz Ku surface classification parameter is derived from MODIS and GlobCover data. Users of the data requiring high resolution ice sheet glacier grounding line and calving front locations should consider applying their own surface type masks.

Flag: surf_class_20_ku
Mode: all
Cycle: 20 NTC SR_2_TLM

Rel. Orbits: 1 to 345
First Time: 2017-07-11T22:22
Last Time: 2017-08-07T31:32
IFF Version: IFF-SM-2 D8.07

![Antarctica including floating ice and ocean](image-url)
Flag: surf_class_20_ku
Model: all
Cycle: 20 NTC SR_2_LAN

First Time: 2017-07-11T22:22
Last Time: 2017-08-07T21:32
IPF Version: IPF-SM-2 05.07

Figure 20: Maps of 20Hz Ku Band Surface Class (surf_class_20_ku)
7 Slope Correction Assessment

A slope correction is applied to 20Hz Ku band elevation over ice sheets to relocate the SAR echo to the point of closest approach across track.

In cycle 20, due to the high failure rate of the SAR Ice Margin retracker, the slope correction is not performed on more than 30-42% of range measurements over the ice sheets.

Flag: slope_failure
Mode: all
Cycle: 20 NTC SR_2_LAN
Ref. Orbits: 1 to 385
First Time: 2017-07-11T22:22
Last Time: 2017-08-07T21:32
IPF Version: IPF-SM=2 08.07

Antarctica Ice Sheet + Floating Ice
Tests of the SAR mode slope correction (of measurements that are retracked) in this cycle indicate that there is an error in the echo direction calculation in the current IPF processing. This results in an erroneous relocation down slope of the nadir track. As a result a slope dependent error in the resulting elevation measurement of approximately 30cm to several meters is present. Users are advised to consider this additional error if using the 20Hz elevation parameter over land ice. This slope error should be fixed in the next IPF version.

A full assessment of the slope correction will be added to the report once the failure rate has been reduced.
8 Geophysical Parameter Monitoring for Sea Ice

This section shows results and analysis of the primary L2 NTC parameters relating to sea ice in cycle 20.

8.1 20Hz Ku Band Altimeter Derived Surface Type (surf_type_class_20_ku)

This parameter is the output of the sea ice echo discriminator. Whilst the maps of surface type looks reasonable, validation of the data has shown that the discriminator requires some further tuning (with too few leads identified) and that results from this parameter should not be used for this product version of cycle 20.
Figure 22: Maps of 20Hz Ku Band Altimeter Derived Surface Type (surf_type_class_20_ku)
8.2 20Hz Ku band Freeboard (freeboard_20_ku)

The histogram of freeboard results from this cycle show a greater proportion of negative freeboard values and a wider spread of freeboard than would be expected. Although negative freeboard is possible due to snow loading, this spread of values is likely to be erroneous. This is most likely due to incomplete tuning of the surface type discriminator algorithm causing incorrect classification of leads as floes and a possible unresolved sea ice lead and floe retracker bias.
8.3 20Hz Ku Band Interpolated Sea Surface Height Anomaly (int_sea_ice_ssha_20_ku)

Analysis of this parameter will be added in future cycles once the sea ice discrimination has been tuned.

8.4 Sea Surface Height Anomaly (sea_ice_ssha_20_ku)

Analysis of this parameter will be added in future cycles once the sea ice discrimination has been tuned.
8.5 20Hz Ku band Sea Ice Concentration (sea_ice_concentration_20_ku)

Sea ice concentration data is available in 100% of records in the STC product in cycle 20. Sea Ice Concentration is derived from a dynamic 3 day average of sea ice concentration calculated from SSM/I daily brightness temperature data and this map is consistent with external sea ice extent maps for this period.
Figure 24: Maps of 20Hz Ku band Sea Ice Concentration (sea_ice_concentration_20_ku)
9 Crossover Analysis

Measuring the elevation residual at orbit crossover points is a primary method of assessing the performance of the altimeter and the processing chain. Over time intervals where there is no expected change in the surface elevation, the elevation difference at a crossover provides a measure of altimeter and chain performance, height error and antenna polarity issues.

Due to the reported high failure rates with the 20Hz Ku band Elevation parameter in this cycle, the density of measurements is too low to produce meaningful crossover results that can be compared with previous missions. As soon as the failure rate is reduced to nominal levels then a crossover analysis result will be reported in this section for this cycle.
10 Repeat Track Analysis

Repeat track analysis is a method of processing several years of operational altimetry data to produce gridded maps of temporal change in the ice sheet’s surface elevation and mass balance since the start of mission. These can be validated against known ice sheet dynamics and other external sources of temporal change data.

Since cycle 20 is the 7th cycle since the start of the operational phase there is not a long enough time series of stable measurements to produce a repeat track analysis. This analysis will be added to reports from cycles in 2018 once at least a year of stable data is available.
11 Long Term Monitoring

In this section the long term performance statistics of Sentinel-3A parameters over land ice and sea ice will be analysed to indicate the stability of the instrument and ground processing. As cycle 20 is the 7th cycle in the routine operations phase, no long term statistics are available for this cycle.
12 Events

List of all events happened during the cycle affecting the Land and Sea Ice validation:

1. There were no changes in IPF versions which affect measurement density or quality for land ice or sea ice products in this cycle.
13 Conclusions

For Level-2 NTC Land products over polar ice sheets, maps of L2 ice sheet elevation and sigma0 backscatter show expected patterns of spatial variability over the ice sheet topography and surface types as compared to previous missions, but there are 32-42% higher than expected levels of retracker and tracker failure in the primary 20Hz Ku band ice sheet elevation and range parameters over all areas (ice sheet interior and margins) resulting in lower than expected measurement density. There is also an error in the slope correction in the current IPF affecting accuracy of the calculated elevation over sloping surfaces. This is currently under investigation by the MPC and ESA.

For Level-2 NTC Marine products, the sea ice freeboard and surface discrimination parameters requires further tuning and we recommend that they are not used in this cycle.
Other reports related to the STM mission are:

- S3-A SRAL Cyclic Performance Report, Cycle No. 020 (ref. S3MPC.ISR.PR.04-020)
- S3-A MWR Cyclic Performance Report, Cycle No. 020 (ref. S3MPC.CLS.PR.05-020)
- S3-A Ocean Validation Cyclic Performance Report, Cycle No. 020 (ref. S3MPC.CLS.PR.06-020)
- S3-A Land and Sea Ice Cyclic Performance Report, Cycle No. 020 (ref. S3MPC.UCL.PR.08-020)

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

End of document