System Verification Report (SVR) Phase 2 Year 3

glaciers cci

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Document status sheet

Version	Date	Changes	Approval
0.4	01. 02. 2017	Skeleton established	
	28. 03. 2017	GAMMA Ice Velocity Processor	
	25. 04. 2017	GIUZ Glacier Outline Processor	

The work described in this report was done under ESA contract 4000109873/14/I-NB. Responsibility for the contents resides with the authors that prepared it.

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1. Introduction

1.1 Purpose and Scope

The system verification report (Deliverable 3.2, SVR) should confirm that the system as outlined in the SPD [AD 3] and described in more detail in the DPM [RD 5] and IODD [RD 4] is properly working when executed in other hardware and/or software environments. According to the SoW, the SVR "gives a complete report of all activities executed and the results achieved form a technical assessment of the end-to-end prototype system with all its subcomponents to verify that the prototype is compliant to the requirements outlined in the Product Specifications Document (PSD, [RD 6]) and technical specifications (IODD, DPM) and that it fulfils its intended purpose and replicates the results of the algorithms selected through the round-robin."

Specifically, the SVR should include for each of the generated products:

- a description of the objectives and scope of the processor
- a list of all elements and components of the prototype that have been tested including a description of the platform, the network, and the interfaces with other systems
- a description of all test activities carried out and of the criteria on how the prototype was tested to ensure that the requirements are fulfilled and that the system performs as specified
- a summary description of all test cases, test procedures, and test data used
- a record of all test results
- a description of all acceptable and stated limitations in the prototype system and the steps taken to workaround anomalous, inappropriate, or undesired operating conditions.

Due to the required interaction with an analyst or operator for many of the products, the tests have been performed at the level of modules (e.g. glacier area, velocity, DEM differencing) by the Systems Engineers and EO team. It was ensured that the test operator was not involved in the development or implementation of the tested module.

For all modules the objectives of the processor and the components tested, the performed test activities and the achieved results are documented in this report. The tests are completed by conclusions relevant for the system engineers towards system development and sustainability.

Results from the first system verification reported within the Phase 1 and the Phase 2 year 1 and year 2 System Verification and reported in previous versions of the SVR [RD 7] will not be replicated here.

1.2 Applicable and Reference Documents

ID	Title	Issue	Date
[AD 1]	ESA Climate Change Initiative Statement of Work RFQ/3-13904/13/I-NB	1.0	17.05.2013
[AD 2]	Glaciers_cci proposal	revised	2.09. 2013
[AD 3]	Glaciers_cci SPD	0.7	22.08. 2013

Table 1: List of Applicable Documents

ID	Title	Issue	Date
[RD 1]	ESA CCI Project Guidelines, EOP-DTEX-EOPS-TN-10-0002	1.0	5.11. 2010
[RD 2]	Glaciers_cci-D1.4_DARD-Ph2Yr2	0.8	29.11. 2015
[RD 3]	Glaciers_cci_ph2-D2.1_ATBDv2.4	2.4	25.01. 2016
[RD 4]	Glaciers_cci IODDv1	0.5	21.11. 2012
[RD 5]	Glaciers_cci DPMv1	0.5	8.11. 2012
[RD 6]	Glaciers_cci-D1.2_PSD-Ph2Yr2	0.8	12.12. 2016
[RD 7]	Glaciers_cci_D3.2_SVR-Ph2Yr2	0.3	10.06. 2016

Table 2: List of Referenced Documents

1.3 Document Structure

This document is organised as follows:

- Section 1 gives an introduction on the deliverable, purpose, applicable and reference documents, its structure and release information.
- Section 2 discusses the verification methodology background.
- Sections 3 – 7 present the results of the module tests.

1.4 Update for year 3 of Phase 2

Within year 3 of Phase 2 verification was performed of the Glacier Area (GIUZ) and Ice Velocity (GAMMA) modules. The process and results are reported in this SVR.

Development is ongoing for several PS modules and upgrades will be tested after phase 2 within other project frameworks.

2. Verification methodology

The system needs to be verified to ensure system integrity after software updates or installation on a new platform. It is not the purpose of the system verification process to validate the product scientifically but to ensure reproducibility of a defined process, processing system.
The verification processes should distinguish between testing after a system upgrade and the installation on a new platform. While after a software upgrade the results may differ if e.g. a classification algorithm was changed, no or minor differences are to be expected if the PS is installed on a new system. In any case deviations have to be understood and rectified.

In general a benchmark test scenario is defined for the system verification. Such a test scenario covers:

- Hardware requirements
- Software (availability) requirements
- Input Data
- Benchmark Data
- Scenario Process
- Other Resources

The Scenario Process description describes the processing steps and pass/fail tests to be conducted. The processing steps, if based on multiple executables, are best complemented by a script that conducts the different processing steps in an automated fashion to minimize operator errors.

All data (input, intermediate, output, benchmark) must be checked for integrity and consistency. Tests to be done are:

- Availability
- Integrity
- Format
- Content

The use of hash values derived from a hash function is the preferred method to check the data. If the data are consistent the hash value is identical. The preferred hash function is based on the Message-Digest Algorithm 5 (MD5) a widely used and implemented cryptographic algorithm. It computes a 128-bit hash value of any dataset. For some products where deviations on the byte level have to be expected (e.g. meta data holding processing dates), special tools may be necessary to only compare or hash the data part that is not affected by dynamic content. Fall-back strategies are value thresholds and visual inspection. The latter might be the only useful method after software upgrades affecting the product algorithm.

Other tests in the scenario address the processing environment. Tests need to cover the expected processing/production time, disk space as well as memory space usage. The results are OS and hardware dependent and will usually be checked against a threshold.

3. Glacier area

3.1 Objectives of the processor

Two models have been developed in ArcGIS 10.2 that aim to: a) calculate glacier topographical parameters according to GLIMS standards, and b) calculate drainage divides with additional removal of sliver polygons. Whereas a) includes the functionality of GAM4 (Topo module) in the DPM (RD-5), b) is a combination of GAM3 (Divides module) with GUI3 (Basin editing) that aims at reducing the workload for manual editing as far as possible. The basic idea is to increase the degree of automatic calculations using a standardized workflow and prepare the processing line for a conversion to free software (Python). The tests have been performed using the same input dataset and thresholds on five different computers, with differing Microsoft Windows operating systems.

3.2 Components tested

In Year 3 the Glacier Topo Parameter Tool (GTPT) used to perform the GAM4 calculations was improved and tested.

The output of model 1 (GTPT) is a set topographical parameters (area, minimum elevation, maximum elevation, range, mean elevation, median elevation, mean slope, latitude and longitude per glacier and mean aspect and sector per glacier) displayed in the attribute table of the respective shape file.

Algorithm(s) tested:

- Glacier Topo Parameter Tool (GTPT)

Input datasets for the test:

- Alaska Interferometric SAR (IfSAR) DEM (ifsar.gina.alaska.edu).
- Glacier outlines: RGI v4.0, Alaska

3.3 Description of prototype and test environment

Current prototype production environment (desktop computer):
Hardware: Intel(R) Core(TM) i7-4790K CPU @ 4.00 GHz 4.00 GHz, 32 GB RAM, 64-bit Operation System, x64-based processor
Operating System: Microsoft Windows 8.1 Enterprise
Software: ArcMap 10.2

2nd Prototype test environment (University of Zurich):
Hardware: Intel(R) Xeon(R) CPU E5-2680 @ 2,70 GHz 2.70 GHz (2 processors) 256 GB RAM, 64-bit Operation System, x64-based processor
Operating System: Microsoft Windows Server 2012 R2 Datacenter
Software: ArcMap 10.2

3rd Prototype test environment (at EURAC in Bozen):
Hardware: Intel(R) Xeon(R) CPU E5-2680 @ 2,70 GHz 2.70 GHz (2 processors) 8.00 GB RAM, 64-bit Operation System, x64-based processor
Operating System: Microsoft Windows Server 2012

Software: ArcMap 10.2

4th Prototype test environment (personal laptop computer):
Hardware: Intel(R) Core(TM) i3 CPU M330 @ 2.13 Ghz 2.13 GHz, 4 GB RAM, 64-bit Operation System
Operating System: Microsoft Windows 10
Software: ArcMap 9.3.1

5th Prototype test environment (at GUIO in Oslo):
Hardware: 20 x Intel (R) Xeon (R) CPU ES-2698 v4 @ 2.20 GHz, 195 GB RAM, 64-bit operating system, x64-based processors
Operating System: MS Windows Windows Server 2012 R2 Standard
Software: ArcMap 10.3.0

Network, Interfaces:
Scene selection and download has to be performed manually.

3.4 Requirements for successful testing

- Compliance of output products with specifications in PSD:
  - Completeness: The tested prototype can produce datasets as specified in the PSD. For individual modules results need to be in shapefile format:
    - glacier outlines (vector) in shapefile format.

- Reproducibility:
  - The output products can be reproduced (using the test procedure defined below) on a different computer by a different operator. Two levels are distinguished:
    - Product compliance: the output products from the prototype installation and the test installation are within the specified accuracy requirements (outlines for bare ice should agree within a ±1 pixel buffer to the reference data) and have the same geometry (i.e. no location shifts).
    - Conclusions compliance: The interactive GUIs are required to derive a high-quality product.

- Test condition:
  - Correct reproduction of glacier outlines using ENVI that is installed on a different computer and run by another operator.

3.5 Test procedure

ArcMap 10.3, ArcMap 10.2 and ArcMap 9.3.1 software packages were applied to create the product. The performed steps of the GTPT test procedure are:

1. Calculate zonal statistics of the respective glacier polygon based on the ASTER GDEM2, the slope and the aspect grid.

The performed steps of the DSPRT test procedure are:

1. Calculate drainage divides based on watershed algorithm.
2. Calculate pour points to merge small unrealistic basins, based on a buffer of 250 m.
3. Conversion of polygon outlines to line features to derive a polygon ID left and right of the line. Based on a size threshold of 0.04 km2 only polygons are selected and merged which have the same polygon ID.

Test operator: Philipp Rastner (GIUZ) and Robert McNabb (GUIO).

3.6 Results of the test

Table 2.1 lists for both methods and the three environments the results of the classification after thresholding with the indicated value. The counting refers to the number of pixels being classified as glaciers (1) and other terrain (2). As expected, the tests provided a perfect agreement of results for all three environments (Table 3). Figure 3 shows the test site and a visualization of the script. The calculated parameters were identical for the current and first prototype and a subset is shown in Figure 4..

Dataset	Method	Current version	2nd prototype	3rd prototype	4th prototype	5th prototype
Alaska Interferometric SAR (IfSAR) DEM	GTPT	378 polygons with topographical parameters				Passed Same statistics were calculated

Table 3: Classification results achieved for the two methods and latest version.

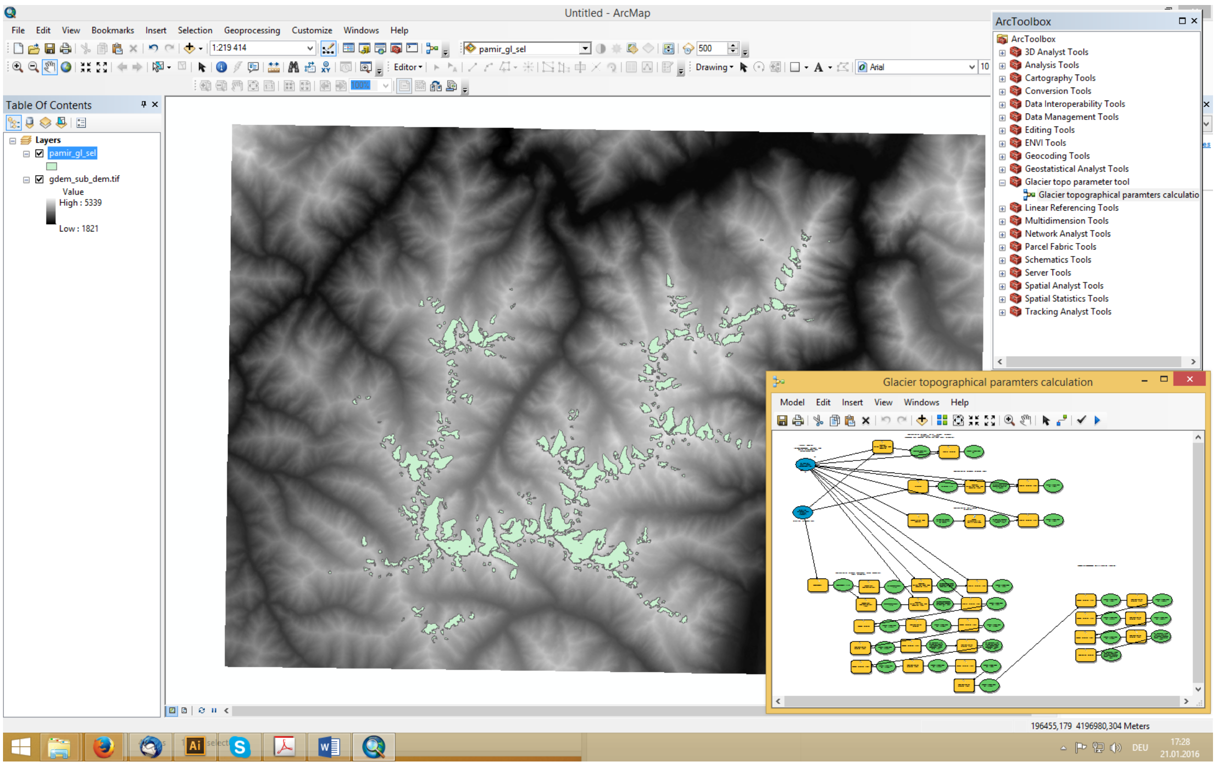
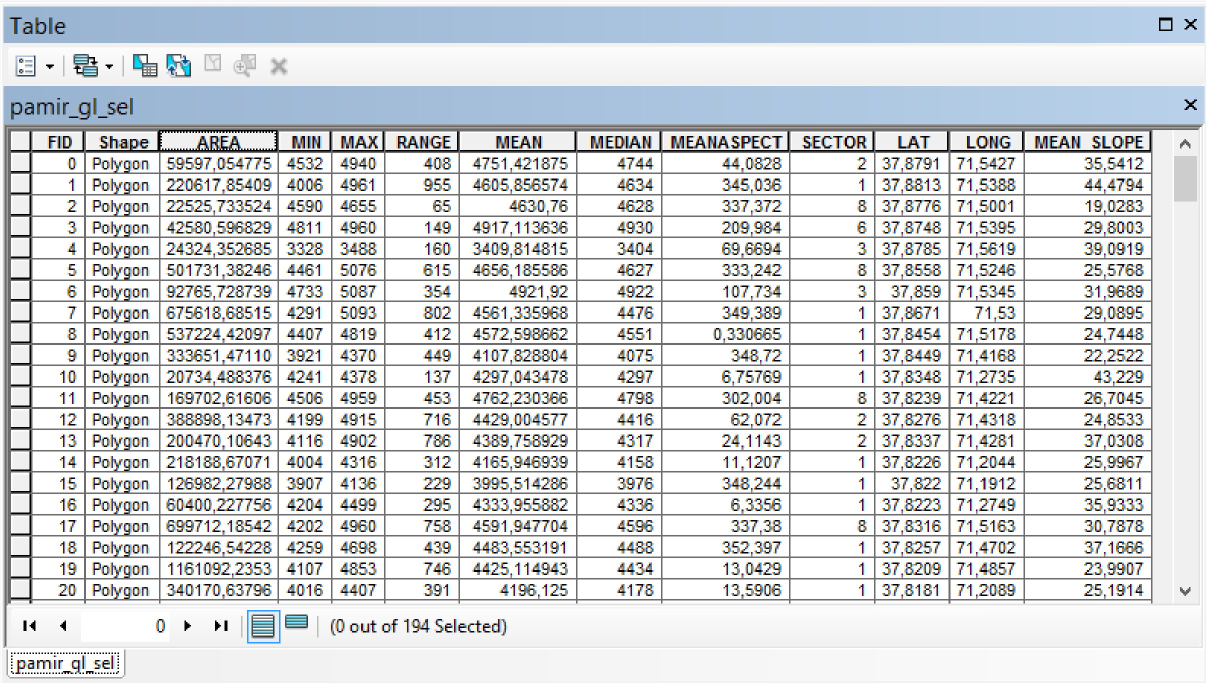


Figure 1: Glacier outlines of the test site (shaded green) and a visualization of the script.



Table

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FID	Shape	AREA	MIN	MAX	RANGE	MEAN	MEDIAN	MEANASPECT	SECTOR	LAT	LONG	MEAN_SLOPE
0	Polygon	59597,054775	4532	4940	408	4751,421875	4744	44,0828	2	37,8791	71,5427	35,5412
1	Polygon	220617,85409	4006	4961	955	4605,856574	4634	345,036	1	37,8813	71,5388	44,4794
2	Polygon	22525,733524	4590	4655	65	4630,76	4628	337,372	8	37,8776	71,5001	19,0283
3	Polygon	42580,596829	4811	4960	149	4917,113636	4930	209,984	6	37,8748	71,5395	29,8003
4	Polygon	24324,352685	3328	3488	160	3409,814815	3404	69,6694	3	37,8785	71,5619	39,0919
5	Polygon	501731,38246	4461	5076	615	4656,185586	4627	333,242	8	37,8558	71,5246	25,5768
6	Polygon	92765,728739	4733	5087	354	4921,92	4922	107,734	3	37,859	71,5345	31,9689
7	Polygon	675618,68515	4291	5093	802	4561,335968	4476	349,389	1	37,8671	71,53	29,0895
8	Polygon	537224,42097	4407	4819	412	4572,598662	4551	0,330665	1	37,8454	71,5178	24,7448
9	Polygon	333651,47110	3921	4370	449	4107,828804	4075	348,72	1	37,8449	71,4168	22,2522
10	Polygon	20734,488376	4241	4378	137	4297,043478	4297	6,75769	1	37,8348	71,2735	43,229
11	Polygon	169702,61606	4506	4959	453	4762,230366	4798	302,004	8	37,8239	71,4221	26,7045
12	Polygon	388898,13473	4199	4915	716	4429,004577	4416	62,072	2	37,8276	71,4318	24,8533
13	Polygon	200470,10643	4116	4902	786	4389,758929	4317	24,1143	2	37,8337	71,4281	37,0308
14	Polygon	218188,67071	4004	4316	312	4165,946939	4158	11,1207	1	37,8226	71,2044	25,9967
15	Polygon	126982,27988	3907	4136	229	3995,514286	3976	348,244	1	37,822	71,1912	25,6811
16	Polygon	60400,227756	4204	4499	295	4333,955882	4336	6,3356	1	37,8223	71,2749	35,9333
17	Polygon	699712,18542	4202	4960	758	4591,947704	4596	337,38	8	37,8316	71,5163	30,7878
18	Polygon	122246,54228	4259	4698	439	4483,553191	4488	352,397	1	37,8257	71,4702	37,1666
19	Polygon	1161092,2353	4107	4853	746	4425,114943	4434	13,0429	1	37,8209	71,4857	23,9907
20	Polygon	340170,63796	4016	4407	391	4196,125	4178	13,5906	1	37,8181	71,2089	25,1914

0 (0 out of 194 Selected)

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Figure 2: Extract of the derived topographic glacier parameters with the GTPT module using glacier outlines and the ASTER GDEM2 as input.

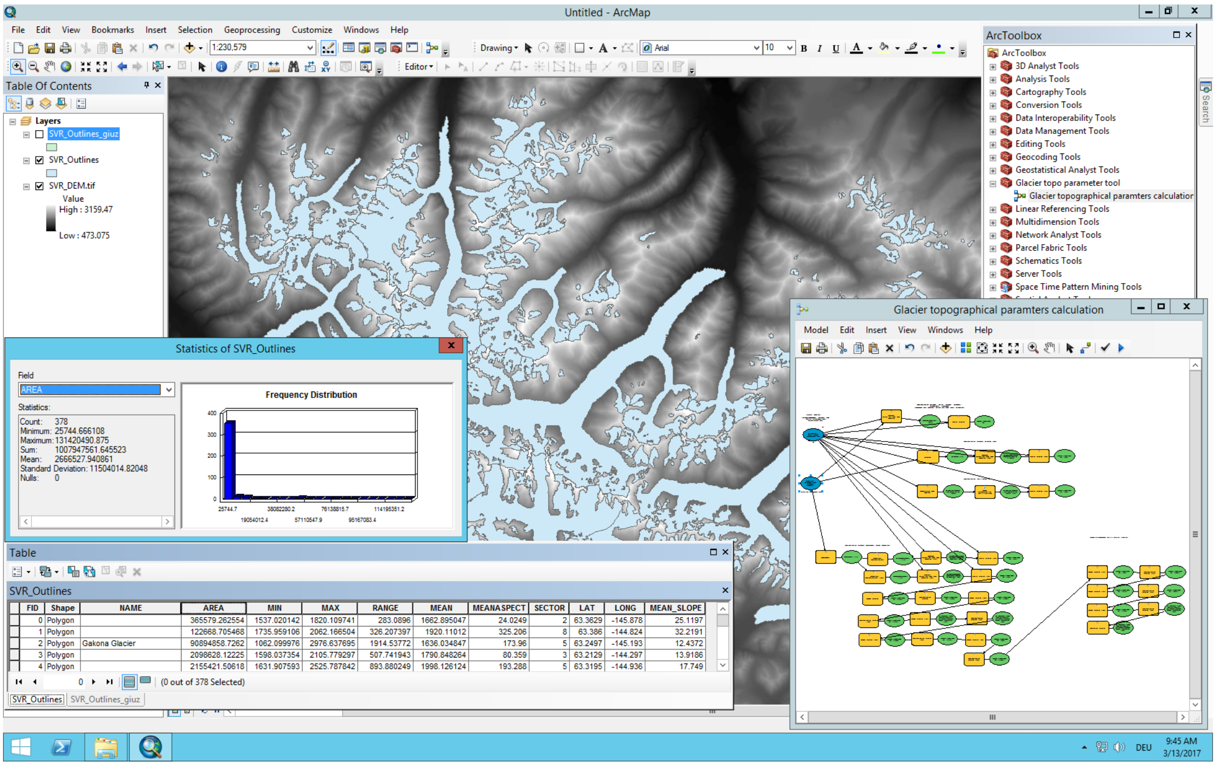

Figure 3: Extract of the derived topographic glacier parameters with the GTPT module using glacier outlines and the Alaska Interferometric SAR (IfSAR) DEM as input (OSLO results).

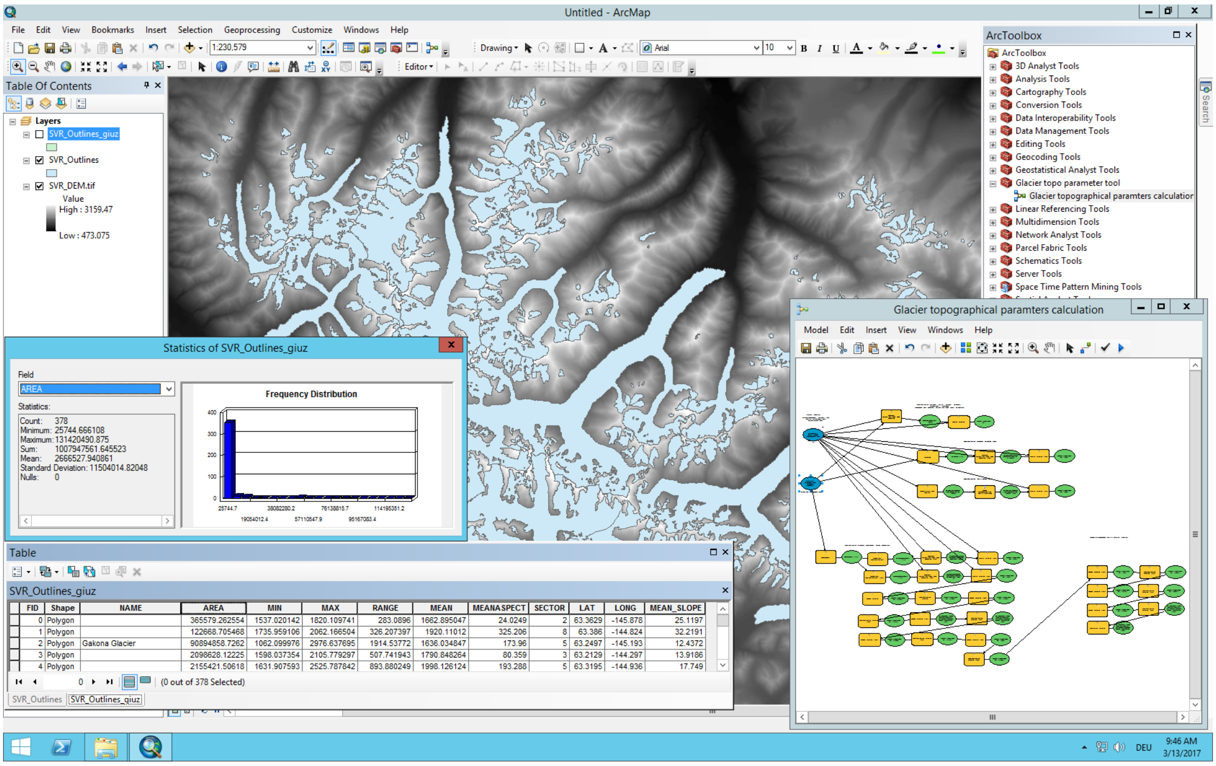

Figure 4: Extract of the derived topographic glacier parameters with the GTPT module using glacier outlines and the Alaska Interferometric SAR (IfSAR) DEM as input (GIUZ results).

This test gives the following performances:

- Compliance of output products with specifications in PSD:
  - Completeness:
    - The tested classification procedures reproduced all required datasets and confirmed the need for GUI2.

→ Test passed

Reproducibility:

- The output products were successfully reproduced. Two levels are distinguished:
  - Product compliance:
    - the product generated by the test installation is within the specified accuracy requirements (see Figure 3). Differences for clean ice were only found at the pixel level.

→ Test passed.

3.7 Relevant issues for system engineering

The prototype was developed using commercial software. This limits the current applicability. Besides that, we experienced also limitation in using older versions of ARCMap.

4. Surface Elevation Change

4.1 Objectives of the processor

The processor for the surface elevation change (SEC) product produces estimates of the rate of change of surface elevation in each cell of a geographical grid covering a glaciated area. The test has been performed on three different computers, with differing Unix/Linux operating systems to prove portability and independence of 32/64 bit systems.

4.2 Components tested

No software upgrade since last verification reported in SVR Phase 2 Year 2.

5. Elevation change: DEM Differencing

5.1 Objectives of the processor

The DEM differencing module should provide elevation difference from two multi-temporal DEMs. The definition is reproduced from Section 5.3.2 of the IODDv1. Tests were performed by Luc Girod (GUIO) and Tobias Bolch (GIUZ). It has to be stated that the Excel tool tested here is not the «official» Glaciers_cci DEM differencing prototype module and the test is included for completeness.

5.2 Components tested

No software upgrade since last verification reported in SVR Phase 2 Year 2.

6. Ice Velocity (ENVEO)

6.1 Objectives and scope of the processor

The ENVEO SAR Software Package (ESP) Version 2.1 is used to generate the ice velocity maps in Glacier CCI. ESP participated in the RR robin experiment for glacier CCI related to ERS ENVISAT and TerraSAR_X data. ESP is also used in the Greenland Icesheet CCI project, where it was also inter-compared and validated within Round Robin Exercises with several other software packages including IPP software from DTU, SUSI / GEUS, DLR, University of California / Irvine and in situ GPS data (See results of Round Robin Experiments, Icesheet CCI project). ESP includes modules for Sentinel-1 IWS, which was evaluated in the Rapid Round Robin exercise carried out in the Antarctic Icesheet CCI project together with IPP DTU processor and DLR Ice Velocity processor. ESP was also used for generating the first Greenland Icesheet Ice velocity map from Sentinel-1 IWS data (Nagler et al., 2015).

6.2 Components Tested

No software upgrade since last verification reported in SVR Phase 2 Year 2.

7. Ice Velocity (GAMMA)

In this section, the GAMMA offset tracking software for ice-velocity from Sentinel-1 (S1) data is verified. The microwave velocity module, as it is currently available, is essentially identical to the algorithm used in the round robin exercises. Therefore, the algorithm implementation did not change and do not require additional verification. The emphasis of the system verification is laid on testing the following aspects:

1. Compliance of the output products with the Input/Output Data Definition (IODDv1) and the latest Product Specification Document (PSD), respectively.
2. Reproducibility of the output products within the test environment.

The test operator was Andreas Wiesmann (GAMMA).

7.1 Objectives and scope of the processor

The ice-velocity from microwave module should deliver displacement information and meta-data from 2 repeat-pass SAR data acquisitions as shown below. This test confirms the implementation of the latest version of the processor that includes improved offset tracking algorithms, performance improvements and the processing of mosaicked Sentinel-1A/B frames.

The core of the GAMMA S1 ice velocity module is a shell script that runs standard GAMMA-software commands. It is described in more detail in the System Prototype Description (SPD) document. It is a standalone solution, therefore the tests do not include automated data access, feedback, and the dissemination of data products.

7.2 Components Tested

Algorithm(s) tested:

1. SAR offset-tracking with S1 (end-to end) based on multi frame S1 SLC data.

Input test data sets:

1. 2 S1 TOPS single-look complex (SLC) data sets (Location: Svalbard) from the Sentinel-1 Science Hub
2. DEM: DLR TanDEM-X IDEM at 90 m posting (https://tandemx-science.dlr.de).
3. Water Mask: Water mask derived from IDEM.
4. Ice Mask: generated from the Randolph Glacier Inventory 5.0 (http://www.glims.org/RGI/).

Reference input data (benchmark data) sets with md5 hash:

```
af8db68635c56339248b4238c57a3da3
S1A_IW_SLC__1SSH_20160210T154421_20160210T154451_009886_00E7DA_341E.zip
d21c5bd8416896b07e18627836a3c339
S1A_IW_SLC__1SSH_20160210T154449_20160210T154517_009886_00E7DA_BFF9.zip
cda35aea5697dafd85811cb278b72f3a
S1A_IW_SLC__1SSH_20160210T154515_20160210T154542_009886_00E7DA_E9D8.zip
024fa86ed2fa8acae7ff270367650729
S1A_IW_SLC__1SSH_20160210T154539_20160210T154557_009886_00E7DA_FB81.zip
dbf7ce227f4e04870a0e3f23fe9e3218
S1A_IW_SLC__1SSH_20160222T154421_20160222T154451_010061_00ED0B_7F90.zip
bf72cadfc0eecb06f485798c417ff203
S1A_IW_SLC__1SSH_20160222T154449_20160222T154517_010061_00ED0B_7A28.zip
88b957e0aa7324504cee77faa2068512
S1A_IW_SLC__1SSH_20160222T154515_20160222T154542_010061_00ED0B_0D28.zip
bbd41c6650bb04f039f33caeeba67af9
S1A_IW_SLC__1SSH_20160222T154540_20160222T154558_010061_00ED0B_B513.zip
```

```
fc2ff0e9631f71e44e6df1b9a2c547af  ../DEM/Svalbard.dem
e5b6d7601fbbcec2d477840a51641bf5  ../DEM/Svalbard.dem_par
edcde81aa248731e5406cabb130daf74  ../DEM/Svalbard.icemask.ras
91ab2dba35b82e0f8554fc9f2a498c6b  ../DEM/Svalbard.seamask.ras
```

Reference intermediate data (benchmark data) sets with md5 hash:

```
15473be4e69b8707855d9058e9acc994  20160210T154421_20160222T154421.bperp
6c8952a340bda23c887fa050fdd9c7ce  20160210T154421_20160222T154421.mli1
1958e0eb281ca28668a15e2f36cb687e  20160210T154421_20160222T154421.mli2
```

Reference output data (benchmark data) sets with md5 hash:

```
51c48ff8faaba4ce350396e7c2d8fa4e  IV_7_S1_20160210T154421_20160222T154421.300.tif
a387511dffb68c96769472c15f3eee5f  IV_7_S1_20160210T154421_20160222T154421.csv
49030deaff02646f7f16c288dea8d68a  IV_7_S1_20160210T154421_20160222T154421.xml
```

Processing time on development system: 10:28:34

7.3 Description of prototype and test environment

Development environment (reference system):
Hardware: Xeon(R) CPU E5-2660 @2.20GHz (16 cores 32 threads), RAM: 132GB
Operating System: Ubuntu Linux 14.04 LTS (x86_64), Kernel: 3.13.0-34-generic
Software: All required software packages installed as described in SPD (GAMMA software v20170301, gdal 2.1.0)

Production environment (production system):
Hardware: Xeon(R) CPU E5-2630 v2 @ 2.60GHz (6 cores, 12 threads), RAM: 64GB
Operating System: Ubuntu Linux 14.04.2 LTS (x86_64), Kernel: 3.16.0-77-generic
Software: All required software packages installed as described in SPD (GAMMA v20170301 software, gdal 2.1.0)

Network, Interfaces:
S1 data was retrieved from the local GAMMA S1 archive cluster.

7.4 Requirements for successful testing

- Compliance of output products with IODDv1/PSD:
    - Completeness: The tested prototype can produce all the output data sets as specified in the product specification document. The required output products are
        1. Displacement vectors in CSV format
        2. Meta information in XML format
        3. Quicklook in GeoTIFF format

- Reproducibility:
    - The output products can be reproduced (using the test procedure are defined below) on a different computer, by a different operator with similar resources and production time. Two levels are distinguished:
        1. Exact compliance of the data sets on a byte level (using md5hash or difference tools). This is not a strict requirement.
        2. Approximate compliance: the output products from both, the current prototype installation and the test installation, are within the specified accuracy requirements, and have the same geometry.

- Test condition:

- Correct reproduction of sample output data set using a test installation of the prototype that is installed on a different computer and that is operated by a different operator.

7.5 Test procedure

1. Run the S1 SLC based IV processing with the production script S1_SLC_tracking_full.sh (version 20170309) using the input data described above
2. Tests according to Section 7.4, Requirements for successful test.
3. Test operator: Andreas Wiesmann, GAMMA, 20 March 2017.

7.6 Test Results

Compliance of output products with IODDv1/PSD:

- Completeness:

  The test installation of the prototype reproduced all required data sets:

```
51c48ff8faaba4ce350396e7c2d8fa4e  IV_7_S1_20160210T154421_20160222T154421.300.tif
a387511dffb68c96769472c15f3eee5f  IV_7_S1_20160210T154421_20160222T154421.csv
49030deaff02646f7f16c288dea8d68a  IV_7_S1_20160210T154421_20160222T154421.xml
```

→ Test passed.

- Accuracy:
  1. Visual inspection of the velocity image shows no difference.
  2. Comparison of the velocity values in the CSV file show differences below 0.001%

→ Test passed.

- Reproducibility:

  Processing time: 10:07:01

  Exact compliance of the data sets on a byte level:

  Comparison of reference and test data sets on a byte level using md5 hashes. This is only possible for intermediate products before the reprojection step. In the re-projection ambiguous results can be obtained on pixel level resulting in differing products on byte level. Comparison of hashes of intermediate and input data proves data integrity:

```
af8db68635c56339248b4238c57a3da3
S1A_IW_SLC__1SSH_20160210T154421_20160210T154451_009886_00E7DA_341E.zip
d21c5bd8416896b07e18627836a3c339
S1A_IW_SLC__1SSH_20160210T154449_20160210T154517_009886_00E7DA_BFF9.zip
cda35aea5697dafd85811cb278b72f3a
S1A_IW_SLC__1SSH_20160210T154515_20160210T154542_009886_00E7DA_E9D8.zip
024fa86ed2fa8acae7ff270367650729
S1A_IW_SLC__1SSH_20160210T154539_20160210T154557_009886_00E7DA_FB81.zip
dbf7ce227f4e04870a0e3f23fe9e3218
S1A_IW_SLC__1SSH_20160222T154421_20160222T154451_010061_00ED0B_7F90.zip
bf72cadfc0eecb06f485798c417ff203
S1A_IW_SLC__1SSH_20160222T154449_20160222T154517_010061_00ED0B_7A28.zip
88b957e0aa7324504cee77faa2068512
S1A_IW_SLC__1SSH_20160222T154515_20160222T154542_010061_00ED0B_0D28.zip
bbd41c6650bb04f039f33caeeba67af9
S1A_IW_SLC__1SSH_20160222T154540_20160222T154558_010061_00ED0B_B513.zip

fc2ff0e9631f71e44e6df1b9a2c547af  ../DEM/Svalbard.dem
e5b6d7601fbbcec2d477840a51641bf5  ../DEM/Svalbard.dem_par
edcde81aa248731e5406cabb130daf74  ../DEM/Svalbard.icemask.ras
91ab2dba35b82e0f8554fc9f2a498c6b  ../DEM/Svalbard.seamask.ras
15473be4e69b8707855d9058e9acc994  20160210T154421_20160222T154421.bperp
6c8952a340bda23c887fa050fdd9c7ce  20160210T154421_20160222T154421.mli1
```

```
1958e0eb281ca28668a15e2f36cb687e  20160210T154421_20160222T154421.mli2
```

→ Test passed.

- Approximate compliance:
  Approximate compliance of the output products with benchmark is shown by visual comparison. See Figure 5 to Figure 8.

→ Test passed.

- Test conditions:
  - Correct reproduction of the benchmark data set was obtained by performing a standard processing on the production system by an operator not involved in the service development.

→ Test passed.

Overall Test condition:

- The Velocity Module (microwave) was successfully qualified on the production system with S1 benchmark data.

→ Test passed.

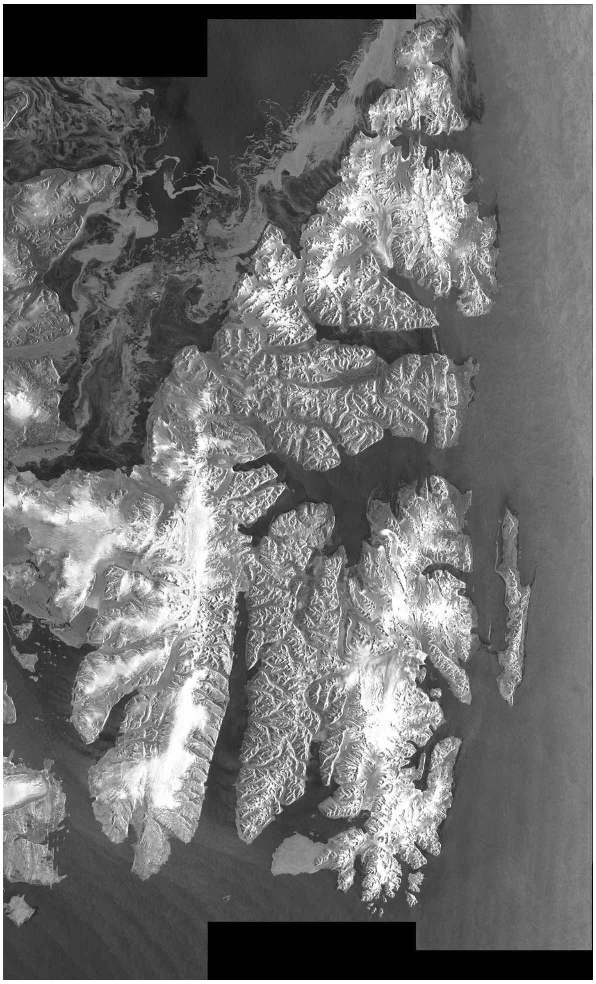

Figure 5: Benchmark image of the averaged backscatter intensity of the S1 image pair 20160210T154421_20160222T154421.pwr. Map is in SAR geometry.

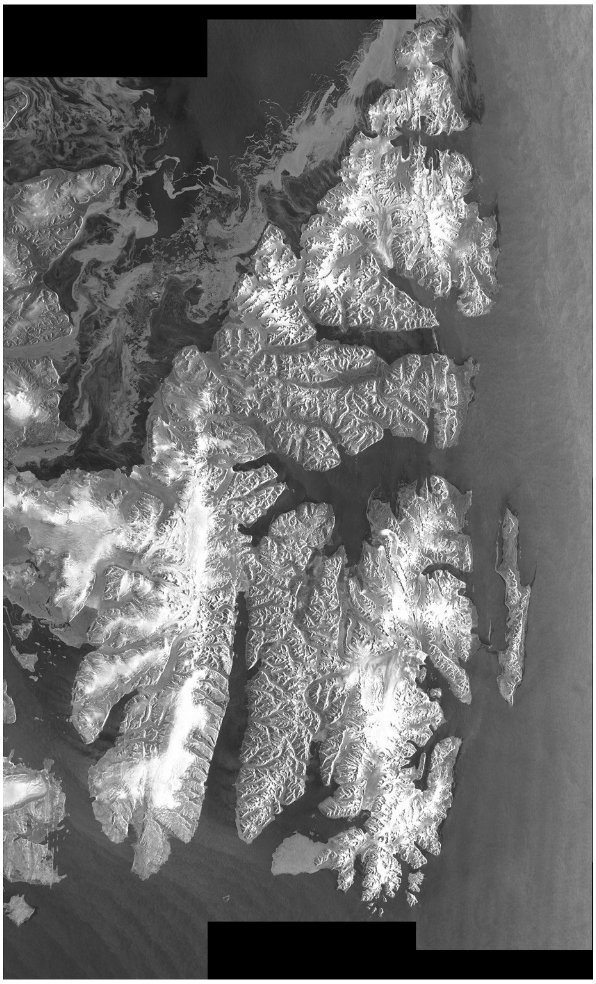

Figure 6: Test image of the averaged backscatter intensity of the S1 image pair 20160210T154421_20160222T154421.pwr. Map is in SAR geometry.

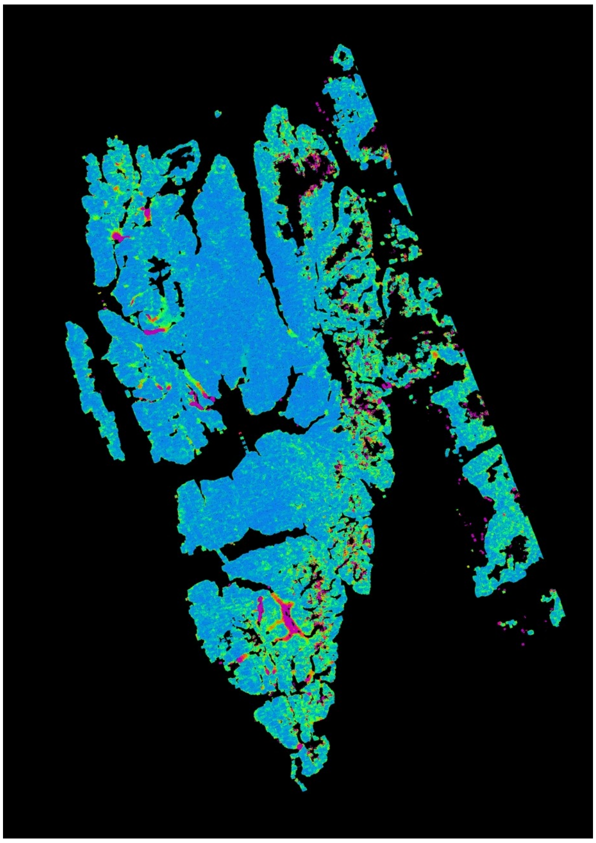

Figure 7: Benchmark image of the ice velocity map of the S1 image pair IV_RGI07_S1_20160210T154421_20160222T154421.300. Map is in WGS 84 / UTM zone 33N projection.

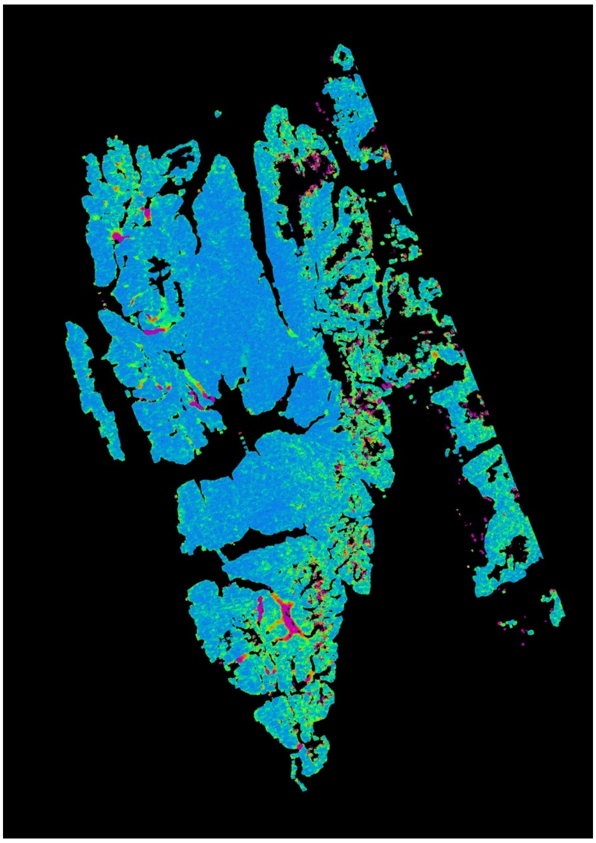

Figure 8: Test image of the ice velocity map of the S1 image pair IV_RGI07_S1_20160210T154421_20160222T154421.300. Map is in WGS 84 / UTM zone 33N projection.

7.7 Relevant issues for system engineering

The processing line is based on GAMMA software executables. Source code is written in ANSI-C and available and can be adapted if necessary.

8. Velocity from optical sensors

8.1 Objectives of the processor

The velocity from optical images module should provide the displacement from two multi-temporal optical images. The definition is reproduced from Section 6.3.2 of the IODDv1.

8.2 Components tested

No software upgrade since last verification reported in SVR Phase 2 Year 2.

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Abbreviations

ALOS	Advanced Land Observing Satellite
ASAR	Advanced Synthetic Aperture Radar
ASTER	Advanced Spaceborne Thermal Emission and Reflection radiometer
CC	Correlation Coefficient
CCI	Climate Change Initiative
CPU	Central Processing Unit
CSV	Comma Separated Values
DEM	Digital Elevation Model
DS-RT-RepAltDEM	Subtracting Repeat Track Repeat Altimetry
ERS	European Remote Sensing Satellite
ESA	European Space Agency
ETM+	Enhanced Thematic Mapper plus
GeoTIFF	TIFF files with georeferencing data embedded as tags within the TIFF file
GIS	Geographic Information System
GLIMS	Global Land Ice Measurements from Space
ICESat	Ice, Cloud, and Elevation Satellite
JERS:	Japanese Earth Resources Satellite
NDSI	Normalized Difference Snow Index
PALSAR	Phased Array type L-band SAR
PRISM	Panchromatic Remote-sensing Instrument for Stereo Mapping
PSD	Product Specifications Document
RR	Round Robin
SAR	Synthetic Aperture Radar
SNR	Signal to Noise Ratio
SoW	Statement of Work
SPOT	System Pour l'Observation de la Terre
SRTM	Shuttle Radar Topography Mission
SWIR	Short Wave InfraRed
TIFF	Tagged Image File Format
TM	Thematic Mapper
UTM	Universal Transverse Mercator
XML	Extensible Markup Language