D6.9 Technical material and hand-outs for user training

Deliverable D6.9

Issue 1.0

Due date of deliverable: 01 June 2016
Actual submission date: 02 June 2016

SEN3APP

Processing Lines And Operational Services Combining Sentinel And In-Situ Data For Terrestrial Cryosphere And Boreal Forest Zone

FP7 Grant agreement No 607052

Document History

Date	Update	Contributor	Organization
01/05/2016	Draft	Mwaba Hiltunen	FMI
05/05/2016	Product description template	Ali Nadir Aslan	FMI
10/05/2016	ENVEO products	Gabriele Bippus	ENVEO
20/05/2016	GAMMA product update	Tazio Strozzi	GAMMA
25/05/2016	FSC product description	Sari Metsämäki	SYKE
27/05/2016	SYKE product updates	Olli Pekka Mattila	SYKE
30/05/2016	Update chapter 3 and 4	Mwaba Hiltunen	FMI
02/05/2016		Ali Nadir Aslan	FMI

Document Release Sheet

Book captain:	Name (ORG)	Sign Date
Approval (lead contractor for WPX)	Name (ORG)	Sign Date
Endorsement:	Name, Title, (ORG)	Sign Date

Dissemination level	
Public	**x**
Restricted to a group (including the Commission Services) specified by the consortium	
Confidential, only for members of the consortium and for the Commission Services	

Table of Contents

Acronyms:

C-SAR: C Band Synthetic Apareture Radar

DFSC: Daily Fractional Snow Cover

DMSP: Defense Meteorological Satellite Program

ETM+:   Enhanced Thematic Mapper

EU: European Union

FMI: Finnish Meteorological Institute

FMIARC: Arctic Research Centre of Finnish Meteorological Institute

FP7 :   Seventh Framework Programme for Research and Technological Development

FSC: Fractional Snow Cover

FTP :   File Transfer Protocol

GLO: Glacier Outlines

GLS: Snow and Ice Areas on Glacier

GLV: Glacier Velocity

HR: High Resolution

HTTP: Hypertext Transfer Protocol

IMS: Ice Mapping System

INSPIRE: Infrastructure for Spatial Information in the European Community

IW: Interferometric Wide Swath

LIE: Lake Ice Extent

MODIS: Moderate Resolution Imaging Spectroradiometer

MSI: MultiSpectral Instrument

NH: Northern Hemisphere

NPP: National Polar-orbiting Partnership

OLCI :   Ocean Land Colour Instrument

OLI: Operational Land Imager

SCAW:	Wet Covered Snow Area
SE:	Snow Extent
SLC:	Single Look Complex
SLSTR:	Sea and Land Surface Temperature Radiometer
SSMI/S:	Special Sensor Microwave Imager/Sounder
SWE:	Snow Water Equivalent
SYKE:	Suomen Ympäristökeskus (Finnish Environment Institute)
TM:	Thematic Mapper
WCS:	Web Coverage Service
WMS:	Web Map Service
VHR:	Very High Resolution
VIIRS:	Visible Infrared Imaging Radiometer Suite

1. Introduction

In this document, the products generated within the EU FP7 project SEN3APP are described and information on how to access the products is provided. SEN3APP products can be downloaded via the FMIARC GeoPortal (http://saana.nsdc.fmi.fi/fmiarc-geoportal) and the CryoLand GeoPortal (http://neso1.cryoland.enveo.at/cryoclient/). For more information about the FMIARC geoportal and the CryoLand GeoPortal contact Mwaba.Hiltunen@fmi.fi and gabriele.bippus@enveo.at, respectively.

Methods of downloading data:

- WebClient: FMIARC- GeoPortal and CryoLand GeoPortal

- FTP services

- Web Coverage Service (WCS)

- Web Map Service (WMS)

- Drop box

- Http

SEN3APP products are grouped into four categories; Land cover and phenology, Snow, Glacier and Lake ice products.
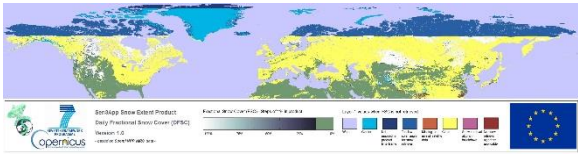
The following section provides details about the products and method to access each product.

2. Products Descriptions

2.1 Snow Products

2.1.1 Fractional Snow Cover Extent for Northern Hemisphere from Optical Data (FMI & SYKE)

Table 2.1.1.: Fractional Snow Cover Extent for Northern Hemisphere from Optical Data (FMI & SYKE) Specifications
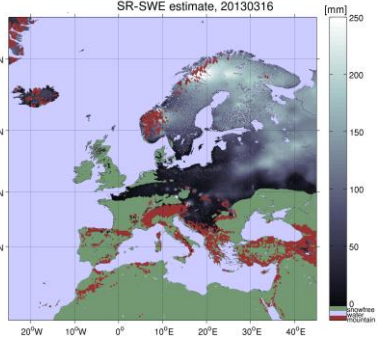
Product Code & Name	*Fractional Snow Cover Extent*	
		Product example: *FSC northern hemisphere 20160225*

Contact	Dr. Kari Luojus, Finnish Meteorological Institute Email: kari.luojus@fmi.fi Dr. Sari Metsämäki, Finnish Environment Institute Email: sari.metsamaki@ymparisto.fi
Overview	The Daily Fractional Snow Cover (DFSC) product provides the fractional snow cover (FSC) in percentage (%) per grid cell for all satellite overpasses of a given day. The product represents the best estimate of today's snow cover. If there are multiple snow observations (only far north within a day), the satellite observations applied are those giving best solar illumination (highest solar elevation). The product is generated for each day based on a 24 hours' time window limited by sunlight. The product is produced and made available for each day in near real time.
Validation Status	The VIIRS based product has not been validated, but the algorithm behind it (applied to nearly corresponding sensors) has undergone extensive validation. We refer here to the description of GlobSnow SE product (Metsämäki et al., 2015) where some validation is presented and to the actual the validation report from GlobSnow product (available on request from Kari Luojus, FMI). Metsämäki, S., Pulliainen, J., Salminen, M., Luojus, K., Wiesmann, A., Solberg, R., Böttcher, K., Hiltunen, M. and Ripper, E., "Introduction to GlobSnow Snow Extent products with considerations for accuracy assessment", Remote Sensing of Environment, Vol. 156, January 2015, pp. 96-108, doi: 10.1016/j.rse.2014.09.018. Bippus, G., Nagler, T., Ripper, E., Hüsler, F., Wunderle, S., Metsämäki, S., Böttcher, K., Foppa, N., Fontana, F., Schöner, W., Unger, R., Malnes, E., Hindberg, H., Solberg, R., Due Trier, O., Luojus, K., Hiltunen, M., Pulliainen, J. and Pinnock, S. (2014): Full Snow Extent Validation and Intercomparison Report. ESA DUE GlobSnow-2, Del. 21. Publication in preparation.
User Guide	The description of the NH FSC product is in preparation. The description to the legacy FSC product, which is applicable for most parts is available here: http://www.globsnow.info/se/GlobSnow2_SE_SWE_Product_User_Guide_v1_r1.pdf
Algorithm Theoretical Basis Document	The algorithm is described in: Metsämäki, S., Pulliainen, J., Salminen, M., Luojus, K., Wiesmann, A., Solberg, R., Böttcher, K., Hiltunen, M. and Ripper, E., "Introduction to GlobSnow Snow Extent products with considerations for accuracy assessment", Remote Sensing of Environment, Vol. 156, January 2015, pp. 96-108, doi: 10.1016/j.rse.2014.09.018. Additional information regarding the algorithm can also be found in the User Guide.

Spatial Coverage & Resolution	Northern Hemisphere Spatial resolution: 1000m, (in future 500m)
Temporal Coverage & Resolution	Daily product, Weekly and Monthly aggregate products
Platform(s)	Suomi NPP
Sensor(s)	VIIRS
Data Format (s)	NetCDF, GeoTIFF
Version	V1.0
Producers	FMI and SYKE
Data Policy	Data are provided free of charge during the project period for non-commercial usage
Access	Products will be provided through the FMIARC GeoPortal. http://saana.nsdc.fmi.fi/fmiarc-geoportal/ Available via http, wms and wcs.

2.1.2 High Resolution (5km) Pan-European SWE Product (Augmented Using Optical FSC Data) (FMI)

Table 2.1.2.: High Resolution (5km) Pan-European SWE Product (Augmented Using Optical FSC Data) (FMI) Specifications
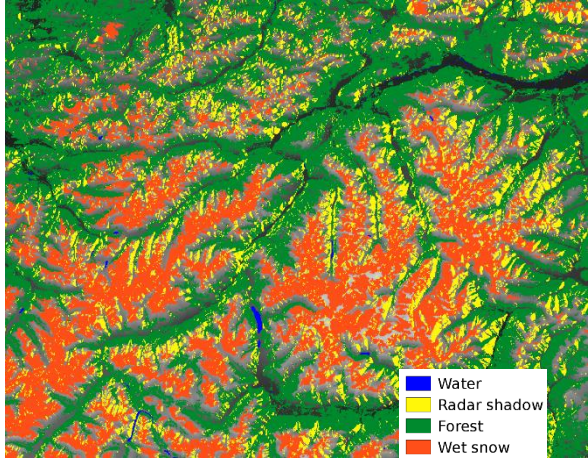
Product Code & Name	*Pan-European Snow Water Equivalent*	
		 Product example: *Pan-European SWE*

Contact	Matias Takala, Finnish Meteorological Institute Email: Matias.Takala@fmi.fi
Overview	The product estimates Snow Water Equivalent (SWE) in millimeters for Pan European grid in 0.05 degrees spatial resolution. Ground without snow, mountains and water bodies are masked out. Snow line is masked using combination of IMS and VIIRS data.
Validation Status	Validation is performed one season. Details are in manuscript: Takala, M., Ikonen, J., Luojus, K., Lemmetyinen, J., Metsämäki, S., Cohen, J., Arslan, A. N. and Pulliainen, J., "New Snow Water Equivalent processing system with improved resolution over Europe and its applications in hydrology". *to be submitted*
User Guide	In preparation
Algorithm Theoretical Basis Document	Algorithm is described in manuscript: Takala, M., Ikonen, J., Luojus, K., Lemmetyinen, J., Metsämäki, S., Cohen, J., Arslan, A. N. and Pulliainen, J., "New Snow Water Equivalent processing system with improved resolution over Europe and its applications in hydrology". *to be submitted*
Spatial Coverage & Resolution	Pan European grid, 0.05 degrees pixel
Temporal Coverage & Resolution	Daily product
Platform(s)	DMSP F-series
Sensor(s)	SSMI/S
Data Format (s)	GeoTIFF
Version	V1.0
Producers	SYKE and FMI
Data Policy	Data are provided free of charge during the project period for non-commercial usage.

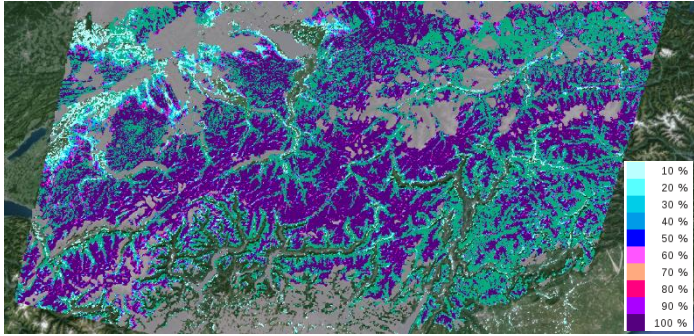| Access	Products will be provided through the FMIARC GeoPortal. (http://saana.nsdc.fmi.fi/fmiarc-geoportal/)
	Available via http, wms and wcs.

Table 2.1.3: Regional Wet Snow Cover from Sentinel-1 Data (ENVEO) Specifications

Product Code & Name	*SCAW – Wet Snow Covered Area*	**Product example:** *Wet snow covered area from Sentinel-1 (subset of track 168) of 09 May 2015 in the Alps.*
Contact	Dr. Gabriele Bippus, ENVEO IT GmbH, Austria gabriele.bippus@enveo.at	
Overview	The wet snow cover product provides binary information on melting snow for non-forested areas. The product is generated for the European Alps. Water bodies, forested areas, as well as areas affected by radar shadow or fore-shortening are masked. Bare ground and dry snow are identified as one class. Products are provided including metadata meeting INSPIRE standards.	
Validation Status	For a preliminary quality assessment, the product was intercompared with snow maps from Landsat 7 ETM+ and Landsat 8 OLI data. Further validation is on-going in the SEN3APP – project (2014-2016).	
User Guide	The description of the wet snow cover product over the Alps is in preparation. As soon as products are provided through the CryoLand GeoPortal the product description will be included in the CryoLand User Guide, available at http://cryoland.enveo.at/downloads/CryoLand4Newbies/CryoLand4Newbies.pdf	

Algorithm Theoretical Basis Document	Nagler, T., Rott, H., Ripper, E., Bippus, G., Hetzenecker, M. (2016): Advancements for Snowmelt Monitoring by means of Sentinel-1 SAR. Remote Sensing. Submitted.
Spatial Coverage & Resolution	Coverage of Sentinel-1 tracks over the Alpine area. 4 Sentinel-1A tracks are needed to cover the full alpine area. 100 m pixel size
Temporal Coverage & Resolution	Melting season, 2015 – present. 12 days repeat time per track. With Sentinel-1B improvement to 6 days repeat time.
Platform(s)	Sentinel-1
Sensor(s)	C-SAR (Level 1 SLC IW)
Data Format (s)	GeoTIFF, optionally NetCDF
Version	V2.1.0
Producers	ENVEO IT GmbH
Data Policy	Data are provided free of charge during the project period for non-commercial usage
Access	Products will be provided through the CryoLand GeoPortal (http://nes01.cryoland.enveo.at/cryoclient/)

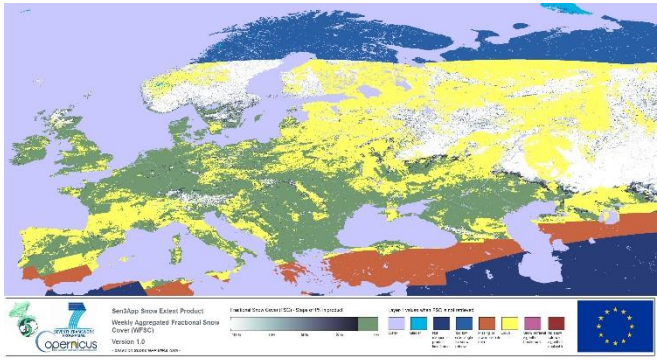### 2.1.4   Regional and Pan-European Fractional Snow Cover Product from Synergistic Sentinel-3 SLSTR/OLCI Data (ENVEO)

Table 2.1.4.: Regional and Pan-European Fractional Snow Cover Product from Synergistic Sentinel-3 SLSTR/OLCI Data (ENVEO) Specifications

Product Code & Name	*FSC – Fractional Snow Cover for the Pan-European and the Alpine area*	**Product example:** *Fractional snow cover retrieved from synergistic usage of MERIS and AATSR data of 25 October 2003 over alpine area. Semi-transparent grey areas indicate cloud cover. Snow in forest is classified binary.*
Contact	Dr. Gabriele Bippus, ENVEO IT GmbH, Austria gabriele.bippus@enveo.at	
Overview	The daily fractional snow cover products for the Pan-European [72°N/11°W – 35°N/50°E] and Alpine [49.57°N/4.66°E – 43.62°N/17.77°E] area are currently based on Terra MODIS data. The product provides information on fractional snow extent per pixel in percent. Water bodies, cloud covered areas, pixels affected by polar night and invalid input pixels are masked. As soon as Sentinel-3 SLSTR and OLCI data will be continuously available, the service will use these data as input. Products are provided including metadata meeting INSPIRE standards.	
Validation Status	Pan-European FSC: daily uncertainty layer providing RMSE per pixel. Additionally, snow maps from multiple VHR and HR optical satellite data were used to validate the product. The product participates also in the ESA project SnowPEx – The Satellite Snow Product Intercomparison and Evaluation Exercise. Validation activities are continuously ongoing. Alpine FSC: the product is evaluated with snow maps from multiple VHR and HR optical satellite data, as well as with in-situ data (snow depth) available for Austria. Validation activities are continuously ongoing.	
User Guide	Products are described in the CryoLand User Guide, available at http://cryoland.enveo.at/downloads/CryoLand4Newbies/CryoLand4Newbies.pdf	
Algorithm Theoretical Basis Document	EU-FP7-CryoLand project documentation (Deliverable D4-2: Snow products – Algorithms, Processing Lines and Service Description).	

Spatial Coverage & Resolution	Pan-European FSC: 72°N/11°W – 35°N/50°E Pixel size: ca 500 m (will be improved to about 300 m with Sentinel-3) Alpine FSC: 49.57°N/4.66°E – 43.62°N/17.77°E Pixel size: ca 250 m
Temporal Coverage & Resolution	Pan-European FSC: 2000 – present, daily Alpine FSC: 2010 – present, daily
Platform(s)	Terra, in future Sentinel-3
Sensor(s)	MODIS, in future synergistic usage of SLSTR / OLCI
Data Format(s)	GeoTIFF, optionally NetCDF
Version	V2.1.0
Producers	ENVEO IT GmbH
Data Policy	Data are provided free of charge during the project period for non-commercial usage
Access	Products are provided through the CryoLand GeoPortal (http://nes01.cryoland.enveo.at/cryoclient/)

2.1.5 Extended Baltic Sea Drainage Basin Direct Broadcast FSC Based on NPP VIIRS/Sentinel-3 SLSTR (SYKE & FMI)

Table 2.1.5.: Extended Baltic Sea Drainage Basin Direct Broadcast FSC Based on NPP VIIRS/Sentinel-3 SLSTR (SYKE & FMI) Specifications
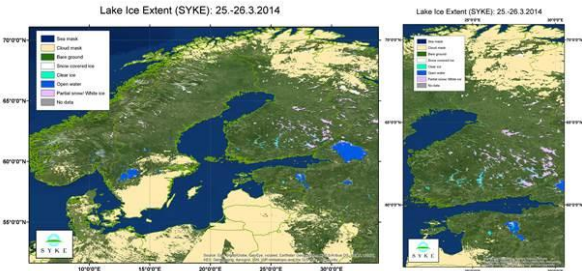
Product Code & Name	*FSC-Fractional Snow Cover Extent*
	 Product Example: *Weekly FSC aggregate 20160228*
Contact	Dr. Sari Metsämäki, Finnish Environment Institute Email: sari.metsamaki@ymparisto.fi Dr. Kari Luojus, Finnish Meteorological Institute Email: kari.luojus@fmi.fi
Overview	The Daily Fractional Snow Cover (DFSC) product for extended Baltic region provides the fractional snow cover (FSC) in percentage (%) per grid cell for all satellite overpasses of a given day (for the Pan-European domain). The product represents the best estimate of today's snow cover. If there are multiple snow observations (only far north within a day), the satellite observations applied are those giving best solar illumination (highest solar elevation). The product is generated for each day based on a 24 hours' time window limited by sunlight. The product is produced and made available for each day in near real time.
Validation Status	The VIIRS-based product, being rather new, has not been extensively validated, but the algorithm behind it (applied to the nearly corresponding sensors: Terra/MODIS and Envisat/AATSR) has been validated. The algorithms have been applied in Northern Hemisphere SE production in GlobSnow) and in European-scale SE production in CryoLand-project (Solberg et al., 2013). The validation results reported in these projects are valid and representative so far, until VIIRS (or preferably S-3) based validation is carried out. The existing validations relevant to the Extended Baltic Sea Fractional Snow Cover Extent product are presented in: Solberg, R., Metsämäki, S., Malnes, E., Hindberg, H., Bippus, G., Nagler, T., Luojus, K., Ryyppö, T., Hiltunen, M., and Pulliainen, J. (2013): Implementation of Upgraded Snow Services – V1.0. EU FP7 CryoLand, Internal Deliverable ID4.6, 86 pp. Publication in preparation. Metsämäki, S., Mattila, O.-P., Pulliainen, J., Niemi, K., Luojus, K., Böttcher, K. (2012). An optical reflectance model-based method for fractional snow cover mapping applicable to continental scale. *Remote Sensing of Environment, 123, 508-521.*

	Metsämäki, S., Pulliainen, J., Salminen, M., Luojus, K., Wiesmann, A., Solberg, R., Böttcher, K., Hiltunen, M. and Ripper, E., "Introduction to GlobSnow Snow Extent products with considerations for accuracy assessment", Remote Sensing of Environment, Vol. 156, January 2015, pp. 96-108, doi: 10.1016/j.rse.2014.09.018.
User Guide	The description of the Extended Baltic Sea FSC product is in preparation. The description to the legacy FSC product, which is for most parts applicable, is available here: http://www.globsnow.info/se/GlobSnow2_SE_SWE_Product_User_Guide_v1_r1.pdf
Algorithm Theoretical Basis Document	The algorithm is described in: Metsämäki, S., Pulliainen, J., Salminen, M., Luojus, K., Wiesmann, A., Solberg, R., Böttcher, K., Hiltunen, M. and Ripper, E., "Introduction to GlobSnow Snow Extent products with considerations for accuracy assessment", Remote Sensing of Environment, Vol. 156, January 2015, pp. 96-108, doi: 10.1016/j.rse.2014.09.018. Metsämäki, S., Mattila, O.-P., Pulliainen, J., Niemi, K., Luojus, K., Böttcher, K. (2012). An optical reflectance model-based method for fractional snow cover mapping applicable to continental scale. *Remote Sensing of Environment, 123, 508-521.* Additional information regarding the algorithm can also be found in the User Guide.
Spatial Coverage & Resolution	Limited Pan-European domain Spatial resolution: 1000m, (in future 500m)
Temporal Coverage & Resolution	Daily product Weekly and Monthly aggregate products
Platform(s)	Suomi NPP
Sensor(s)	VIIRS
Data Format (s)	NetCDF, GeoTIFF
Version	V1.0
Producers	SYKE and FMI
Data Policy	Data are provided free of charge during the project period for non-commercial usage
Access	Products will be provided through the FMIARC geoportal. WMS, WCS

2.2 Lake Ice Product

2.2.1 Lake Ice Extent (SYKE)
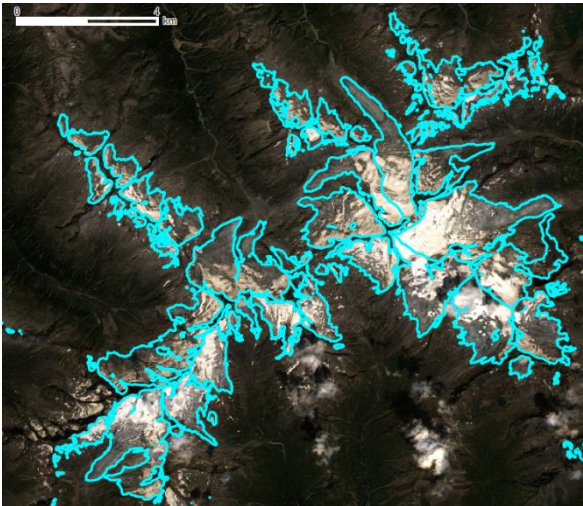
Table 2.2.1.: Lake Ice Extent (SYKE) Specifications

Product Code & Name	*LIE – Lake Ice Extent*	***Product example:*** *Lake Ice Extent*
Contact	Olli-Pekka Mattila, Finnish Environment Institute Olli-pekka.mattila@ymparisto.fi	

Overview	The Lake Ice Extent product describes the general lake ice state from optical satellite images. Lake pixels, not obscured by clouds and where polar night is not hindering observations, are classified to three classes:
	
	    1) ice with full snow cover
	
	    2) ice with variable snow/white ice cover
	
	    3) open water	

Validation Status	The product has undergone validation with relatively limited data. Further validation is on-going in SEN3APP –project (2014-2016).	
User Guide	http://cryoland.enveo.at/news-and-events/40-updated-cryoland-4-newbies-online, the guide is for accessing data via the CryoLand GeoPortal, but also describes the data products included.	
Algorithm Theoretical Basis Document	EU-FP7-CryoLand project documentation (Deliverable D5-2: Glacier and Lake/ River lce products - algorithms, processing line and service description). Available on request.	
Spatial Coverage & Resolution	Northern Europe (Baltic Sea drainage basin) [45 - 71ºN, 5 - 45ºE] Spatial resolution: Current: 250m; after shift to Sentinels 2/3: 20m and 300m	

Temporal Coverage & Resolution	2011-2015, historical data will be produced along with more extensive validation Temporal resolution: Daily
Platform(s)	Current: Terra Main: Sentinel-2, Sentinel-3 Auxiliary: Landsat-8, NPP Suomi
Sensor(s)	Current: MODIS Main: MSI (S2), OLCI & SLSTR (S3) Auxiliary: OLI (L8), VIIRS (NPP Suomi)
Data Format (s)	GeoTIFF
Version	V1.0
Producers	Finnish Environment Institute
Data Policy	Creative Commons 4.0-BY
Access	Currently distributed through CryoLand GeoPortal: http://neso1.cryoland.enveo.at/cryoclient/

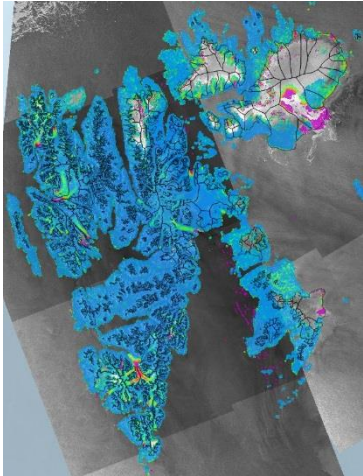## 2.3   Glacier Products

2.3.1   Glacier Outlines (ENVEO)

Table 2.3.1.: Glacier Outlines (ENVEO) Specifications

Product Code & Name	GLO – Glacier outlines	
		Product example: Glacier outlines from Sentinel-2 subset (R022) from 13 August 2015, Venedigergruppe, Austria.
Contact	Dr. Gabriele Bippus, ENVEO IT GmbH, Austria gabriele.bippus@enveo.at	
Overview	Glacier outlines are mapped from very high resolution (VHR) or high resolution (HR) optical satellite data, acquired ideally in late summer, at time of maximum ablation. Glaciers affected fully or partly by clouds or cloud shadows are excluded from the product generation. Glacier outlines and internal rocks on glaciers are mapped as closed polygons, and defined by associated entries in the attribute table. Each glacier has a unique ID following the GLIMS standards, which is also used for all other features associated to the glacier (e.g. internal rock, pre-glacial lake, etc.). The product is generated only on demand for selected regions. Products are prepared following the internationally accepted standards of GLIMS (Global Land Ice Measurements from Space) and the INSPIRE standards.	
Validation Status	Limited validation with orthophotos for selected glaciers available, validation activities are ongoing.	
User Guide	The product is described in the CryoLand User Guide, available at http://cryoland.enveo.at/downloads/CryoLand4Newbies/CryoLand4Newbies.pdf	
Algorithm Theoretical Basis Document	EU-FP7-CryoLand project documentation (Deliverable D5-2: Glacier and Lake/ River Ice products - Algorithms, Processing Line and Service Description). An updated ATBD is in preparation.	

Spatial Coverage & Resolution	Selected glaciers. ≤ 10 m – 30 m pixel size (depends on available satellite data)
Temporal Coverage & Resolution	Single date. Temporal resolution depends on availability of usable satellite data.
Platform(s)	Sentinel-2, Landsat 5/7/8, other satellites with VHR or HR optical sensors
Sensor(s)	MSI, TM / ETM+ / OLI, other VHR or HR optical sensors
Data Format (s)	Shapefiles (vector) meeting the internationally accepted standards of GLIMS (Global Land Ice Measurements from Space).
Version	V1.0
Producers	ENVEO IT GmbH
Data Policy	Data are provided free of charge during the project period for non-commercial usage.
Access	Products are provided only on demand via FTP or e-Mail.

2.3.2   Ice Velocity (GAMMA)
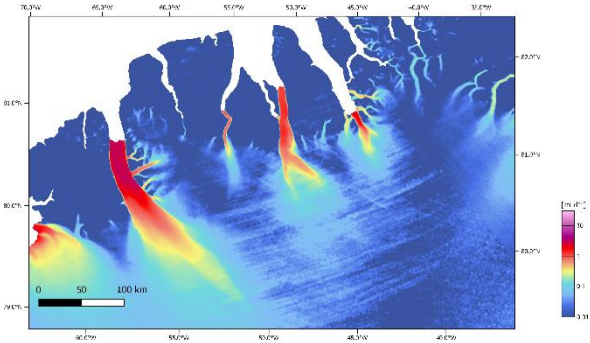
Table 2.3.2.: Ice Velocity (GAMMA) Specifications

Product Code & Name	**Ice Velocity**	

	$0 \quad m/year \quad 300$ **Product example:** Ice surface velocity map of glaciers in the Svalbard Archipelago from Sentinel-1 SLC data acquired between September 30 and October 13, 2015.
Contact	Tazio Strozzi, Gamma Remote Sensing, Worbstrasse 225, 3073 Gümligen (BE), SWITZERLAND, strozzi@gamma-rs.ch
Overview	Knowledge on glacier ice velocity provides a better understanding of a wide range of processes related to glacier dynamics, for example glacier mass flux, flow modes and flow instabilities (e.g. surges), sub-glacial processes (e.g. erosion), and the development of glacier lakes and associated hazards. In addition, the comparison of the spatio-temporal variations of glacier velocities both within and between regions will improve understanding of climate change impacts. Satellite SAR missions make it possible to operationally map and monitor glacier flow on a nearly global scale using offset-tracking methods. With Sentinel-1 Level 1 SLC data, downloaded from the Scientific Data Hub, the retrieval of ice surface velocity maps over the Svalbard Archipelago is possible since August 2014 every 12 or 24 days. Horizontal surface velocity data in m/day are provided together with a quality measure, a header file describing the input data and validation, and a quick-look image of the product in GeoTIFF format.
Validation Status	Processor qualified and operational. Verification of selected glaciers.
User Guide	Product User Guide (PUG), ESA Glacier_CCI Project, Version 1.4 22.02.2016, http://www.esa-glaciers-cci.org/index.php?q=documents#
Algorithm Theoretical Basis Document	Algorithm Theoretical Basis Document Phase 2 (ATBD), ESA Glacier_CCI Project, Version 2.1 25.11.2014, http://www.esa-glaciers-cci.org/index.php?q=documents#
	F. Paul, T. Bolch, A. Kääb, T. Nagler, C. Nuth, K. Scharrer, A. Shepherd, T. Strozzi, F. Ticconi, R. Bhambri, E. Berthier, S. Bevan, N. Gourmelen, T. Heid, S. Jeong, M. Kunz, T.R. Laukues, A. Luckman, J. Merryman, G. Moholdt, A. Muir, J. Neelmeijer, M. Rankl, J. Van Looy and T. Van Niel, The glaciers climate change initiative: Methods for creating glacier area, elevation change and velocity products, Remote Sensing of Environment, 162: 408–426, doi: 10.1016/j.rse.2013.07.043, 2015.
	Strozzi T., A. Kouraev, A. Wiesmann, U. Wegmüller, A. Sharov and C. Werner, Estimation of Arctic glacier motion with satellite L-band SAR data,

	Remote Sensing of Environment, 112:636-645, doi:10.1016/j.rse.2007.06.2007, 2008. Strozzi T., A. Luckman, T. Murray, U. Wegmüller, and C. Werner, Glacier motion estimation using SAR offset-tracking procedures, IEEE Transactions on Geoscience and Remote Sensing, Vol. 40, No. 11, pp. 2384-2391, November 2002.
Spatial Coverage & Resolution	Svalbard Archipelago (Norway) at 100 m posting
Temporal Coverage & Resolution	From 2015.08.02 onwards every 12 or 24 days
Platform(s)	Sentinel-1
Sensor(s)	C-SAR
Data Format (s)	ASCII file (csv format) with header file description (xml format) and quick-look image (GeoTIFF format)
Version	Version 04
Producers	Gamma Remote Sensing
Data Policy	Open
Access	Products are provided on demand. Access via unique http link.

2.3.3   Ice Velocity (ENVEO)

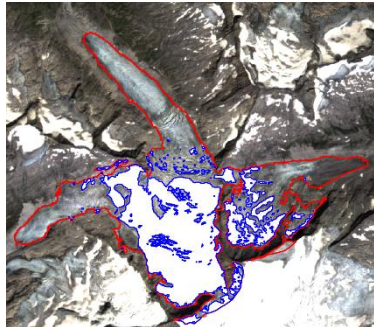*Table 2.1.1.: Fractional Snow Cover Extent for Northern Hemisphere from Optical Data (FMI & SYKE) Specifications*

Product Code & Name	*GLV – Glacier ice velocity*	

22

		Product example: *Ice surface velocity on outlet glaciers of Northern Greenland, mosaic from multiple Sentinel-1 IW data of 2015.*
Contact	Dr. Gabriele Bippus, ENVEO IT GmbH, Austria gabriele.bippus@enveo.at	
Overview	The product provides horizontal ice surface velocity on glaciers in m/day. Ice surface velocity products from Sentinel-1 Level-1 SLC IW, the standard mode of Sentinel-1 for land areas, are generated only for large glaciers with gently inclined surrounding terrain. For small glaciers or glaciers located in very complex terrain with steep surrounding slopes, satellite data with very high resolution are needed for the product generation. The product is generated on demand and can only be prepared if usable satellite imagery is available. Products are provided including metadata meeting INSPIRE standards.	
Validation Status	Intercomparisons of ice velocities from different satellite data for selected glaciers available, validation activities are ongoing.	
User Guide	The product is described in the CryoLand User Guide, available at http://cryoland.enveo.at/downloads/CryoLand4Newbies/CryoLand4Newbies.pdf	
Algorithm Theoretical Basis Document	EU-FP7-CryoLand project documentation (Deliverable D5-2: Glacier and Lake/ River Ice products - Algorithms, Processing Line and Service Description). Algorithm Theoretical Basis Document Phase 2 (ATBD), ESA Glacier_CCI Project, Version 2.1 25.11.2014, http://www.esa-glaciers-cci.org/index.php?q=documents# F. Paul, T. Bolch, A. Kääb, T. Nagler, C. Nuth, K. Scharrer, A. Shepherd, T. Strozzi, F. Ticconi, R. Bhambri, E. Berthier, S. Bevan, N. Gourmelen, T. Heid, S. Jeong, M. Kunz, T.R. Lauknes, A. Luckman, J. Merryman, G. Moholdt, A. Muir, J. Neelmeijer, M. Rankl, J. Van Looy and T. Van Niel (2015): The glaciers climate change initiative: Methods for creating glacier area, elevation change and velocity products, Remote Sensing of Environment, 162: 408–426, doi: 10.1016/j.rse.2013.07.043.	
Spatial Coverage & Resolution	Selected glaciers. Depends on available satellite data	

Temporal Coverage & Resolution	Temporal coverage and resolution depend on availability of satellite data.
Platform(s)	Sentinel-1, Sentinel-2
Sensor(s)	C-SAR (IW, SM), MSI
Data Format (s)	GeoTIFF, optionally NetCDF
Version	V1.0
Producers	ENVEO IT GmbH
Data Policy	Data are provided free of charge during the project period for non-commercial usage.
Access	Products are provided only on demand via FTP or e-Mail.

2.3.4   Snow / Ice Areas on Glaciers (ENVEO)

Table 2.3.4.: Snow / Ice Areas on Glaciers (ENVEO) Specifications

Product Code & Name	*GLS – Snow and ice areas on glaciers*	 **Product example:** *Snow areas (blue outlines) on selected glaciers (red outlines) in Austria from Sentinel-2 (R022) of 13 August 2015.*
Contact	Dr. Gabriele Bippus, ENVEO IT GmbH, Austria gabriele.bippus@enveo.at	
Overview	Snow and ice areas on glaciers are mapped from very high resolution (VHR) or high resolution (HR) optical satellite data, acquired in late summer, at time of	

	maximum ablation. Glaciers affected fully or partly by clouds or cloud shadows are excluded from the product generation. Snow areas on glaciers are mapped as closed polygons, and linked to the associated glacier with the unique GLIMS ID in the attribute table (cf. description of glacier outlines). The product is generated only on demand for selected glaciers.
	Products are prepared following the internationally accepted standards of GLIMS (Global Land Ice Measurements from Space) and the INSPIRE standards.
Validation Status	Limited validation with orthophotos for selected glaciers available, validation activities are ongoing.
User Guide	Not yet available
Algorithm Theoretical Basis Document	Bippus, G. (2011): Characteristics of summer snow areas on glaciers observed by means of Landsat data. PhD Thesis, University of Innsbruck: 231 pp. (http://acinn.uibk.ac.at/sites/default/files/PhD_Thesis_Bippus_August2011.pdf)
	EU-FP7-CryoLand project documentation (Deliverable D5-2: Glacier and Lake/ River Ice products - Algorithms, Processing Line and Service Description).
Spatial Coverage & Resolution	Selected glaciers.
	≤ 10 m – 30 m pixel size (depends on available satellite data)
Temporal Coverage & Resolution	Single date.
	Temporal resolution depends on availability of usable satellite data.
Platform(s)	Sentinel-2, Landsat 5/7/8, other satellites with VHR or HR optical sensors
Sensor(s)	MSI, TM / ETM+ / OLI, other VHR or HR optical sensors
Data Format (s)	Shapefiles (vector) meeting the internationally accepted standards of GLIMS (Global Land Ice Measurements from Space), optionally also provided as raster in GeoTIFF or NetCDF format.
Version	V1.0
Producers	ENVEO IT GmbH
Data Policy	Data are provided free of charge during the project period for non-commercial usage

Access	Products are provided only on demand via FTP or e-Mail.

2.4 Land Cover & Phenology Products

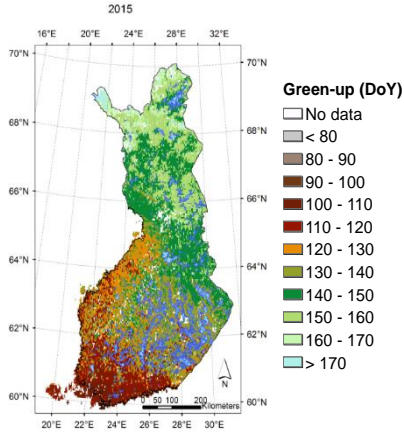### 2.4.1 Crop / Vegetation Classification (SYKE)

Table 2.4.1.: Crop / Vegetation Classification (SYKE) Specifications

Product Code & Name	*Agricultural monitoring*	*The data is delivered as table (e.g. .csv)*
Contact	Markus Törmä, Finnish Environment Institute Markus.torma@ymparisto.fi	
Overview	The products tailored for the Agency of Rural Affairs Finland (MAVI) for monitoring agricultural areas are simple classifications designed to target specific control requirements for agricultural subsidies. The requirements come both from EC as well as from national authorities. The products are still in development stage; summer 2016 will serve as demonstration phase for assessing the concept. Following test cases are used for demonstration in 2016: • Winter time vegetation • Summer time vegetation • Coarse un-supervised classification based on S1/S2 images	
Validation Status	Currently the validation dataset is used for product development. Validation is achieved during the use of the products. Some field control is unavoidable in the subsidies control process. These field visits will be used to also gather information on the performance of the satellite interpretations. Some dedicated field campaigns are foreseen.	
User Guide	Not available. Please, use the above contact.	
Algorithm Theoretical Basis Document	The product is still in development phase.	
Spatial Coverage & Resolution	Finland	

	Spatial resolution: 20m
Temporal Coverage & Resolution	The data products are delivered on specific dates, depending on the control requirement. Temporal resolution:
Platform(s)	Current: Landsat-8, Sentinel-1 Main: Sentinel-1, Sentinel-2 Auxiliary: Landsat-8
Sensor(s)	Current: OLI (L8), C-SAR (S1) Main: C-SAR (S1), MSI (S2) Auxiliary: OLI (L8)
Data Format (s)	Data tables (.csv, .xlsx)
Version	V0.8
Producers	Finnish Environment Institute
Data Policy	In the development stage the data is restricted to MAVI only.
Access	Demonstration phase: email Main: Machine readable web-interface

2.4.2   Phenology (SYKE)

Table 2.4.2.: Phenology (SYKE) Specifications

Product Code & Name	*Phenology product of Finnish Environment Institute*	*Product example:*
Contact	Kristin Böttcher, Finnish Environment Institute Kristin.bottcher@ymparisto.fi	
Overview	The product is derived from satellite data product time-series. The data products used are FSC (the same algorithm as for SYKE&FMI Extended Baltic Sea drainage basin direct broadcast FSC based on NPP VIIRS/Sentinel-3 SLSTR), NDVI and NDWI indices. Aim: The phenological product will contain four layers: 1) The date of the start of the vegetation active season in evergreen coniferous forest. This date corresponds to the start of photosynthetic activity in conifers. 2) The date of the greening-up of deciduous vegetation. This date corresponds to the time of bud break in deciduous trees. 3) The end of season date in evergreen coniferous forest. 4) The end of season date for deciduous vegetation. Currently, the product layers 3) and 4) are under development.	
Validation Status	Product layer 1) was calibrated against in situ observation of the start of season in evergreen coniferous forest from CO_2 flux measurements in Finland for the period 2001 to 2010. Validation will be carried out based on in situ observations from 2011 onwards for few sites in Finland.	

	Product layer 2) was validated based on in situ observations on the bud break of birch in Finland for the period from 2001 to 2008. The obtained root mean square error (RMSE) is 7 days. Validation will continue with in situ observations from 2009 to 2014.
User Guide	Not available. Please, use the above contact.
Algorithm Theoretical Basis Document	Böttcher, Kristin, et al. "MODIS time-series-derived indicators for the beginning of the growing season in boreal coniferous forest—A comparison with CO 2 flux measurements and phenological observations in Finland." Remote Sensing of Environment 140 (2014): 625-638.
	Delbart, N., Kergoat, L., Le Toan, T., L'Hermitte, J., Picard, G., 2005. Determination of phenological dates in boreal regions using normalized difference water index. Remote Sensing of Environment 97, 26-38.
Spatial Coverage & Resolution	Finland Spatial resolution: 0.05°
Temporal Coverage & Resolution	Coverage: 2001-2015 Temporal resolution: Annual maps
Platform(s)	Current: Terra Main: Sentinel-3
Sensor(s)	Current: MODIS (Terra) Main: SLSTR & OLCI (S3)
Data Format (s)	GeoTIFF
Version	V0.5
Producers	Finnish Environment Institute
Data Policy	Creative Commons 4.0-BY
Access	Currently: Upon request Aim: Web-access service (on-going)

3. FMIARC-GeoPortal

3.1 Key Features

- View maps from WMS services 1.1.1 and 1.3.0.
- View maps from WMTS service 1.0.0.
- Simultaneously display maps from different services, including the transparency adjustment for a single layer.
- Print map.
- Retrieve information from the catalog services (CSW 2.0.2 ISO AP 1.0).
- Query for services.
- Query for datasets and dataset series (compliant with INSPIRE requirements).
- Search for geographic names using the Gazetteer Service (WFSG).
- Display content of GeoRSS feeds.
- Provide intuitive mouse control for simple map navigation and better user experience.
- Perform queries against WFS services working both with WFS 1.1 and WFS 2.0 (ISO 19142).
- In addition to ISO 19142, ISO 19143 for filter encoding is also supported.
- Use WCTS and INSPIRE WPS-CT for online coordinate transformation.
- Create and Edit Personal Storage Service.
- Measure distances and areas with measuring functions within the map in both: 2D and 3D view mode.
- Save and restore current map context (OGC WMC).
- Show overview window.
- Monitor connected services with Quality Monitor Service.
- Process data from FMIARC Catalog with Geoprocessing and Clip-Zip-Ship functionality.
- Search and browse data (rasters, vectors, services, and business data) in FMIARC Catalog.
- Provides 2D and 3D map control supporting the display of a base map and rendering other supported data sources properly.
- Perform Shadow Analysis
- Extrude 2D vector features to build 3D cities in seconds
- Multilingual

3.2 Getting Started with the FMIARC GeoPortal

To start working with Geospatial Portal

- Open your Web browser and type http://saana.nsdc.fmi.fi/fmiarc-geoportal/ in the URL address field.
- The splash screen will be displayed and after a while Geospatial Portal will be run.

The FMIARC Geospatial Portal User Interface consists of the following elements; Banner, Side bar, toolbar, Map window, Data window and Search Result Panel. These can be seen in Figure 3.2-1 FMIARC Geospatial Portal.
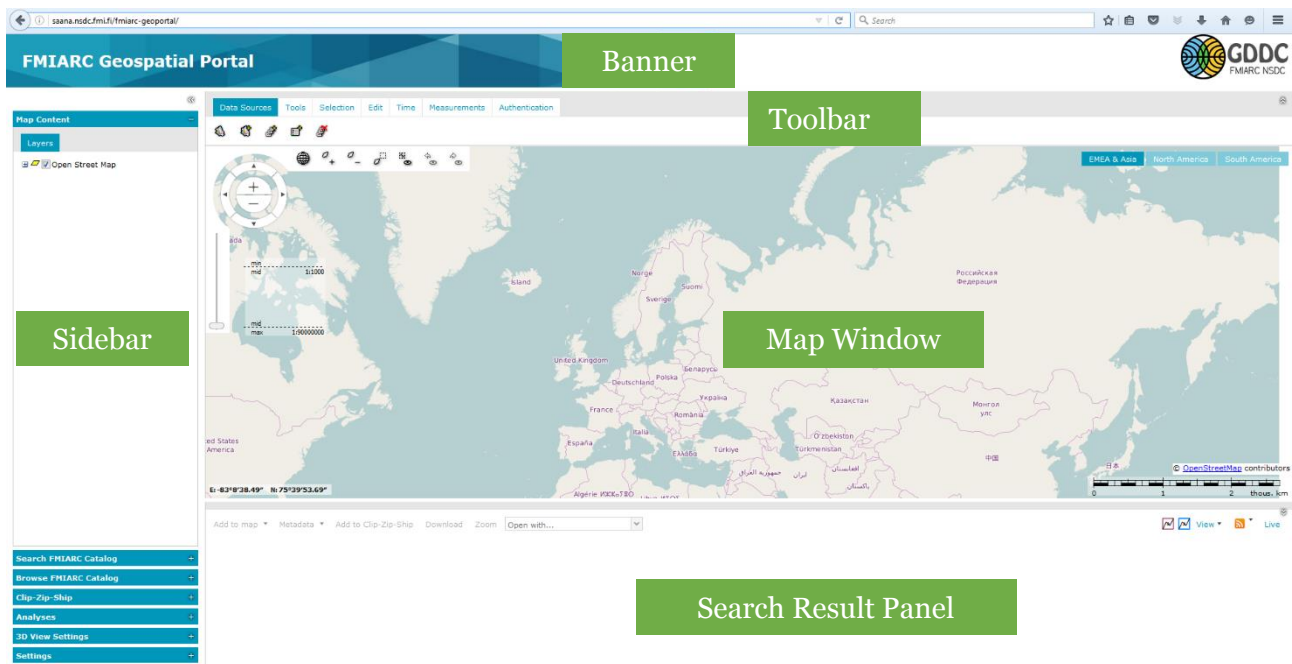

Figure 3.2-1 FMIARC Geospatial Portal

3.3   How to download SEN3App data from the portal

From the side bar,

1. click on Browse FMIARC Catalog, this will change the side bar menu to look like Figure 3.3-1 Side Bar menu
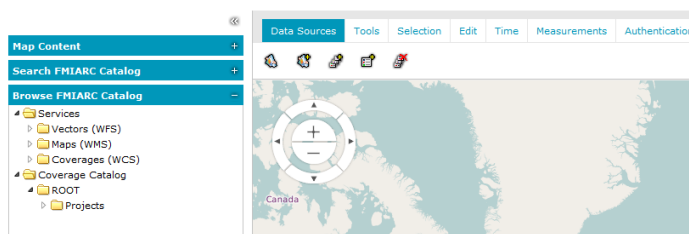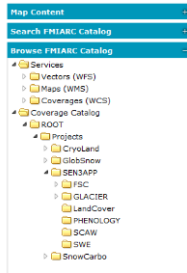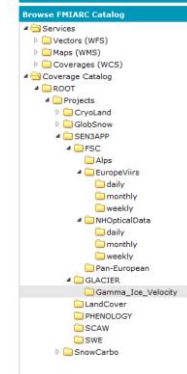

Figure 3.3-1 Side Bar menu

2. Click on Projects arrow and then select SEN3APP arrow, which will provide list of products available.

Selecting the arrows on the folder of interest provides more details on subfolders of what is contained.

For example: We want to download Snow Water Equivalent SWE, select the SWE folder and then in the search panel window, a list of all available SWE products are then listed. Select the product you are interested in and this will then be highlighted in red.
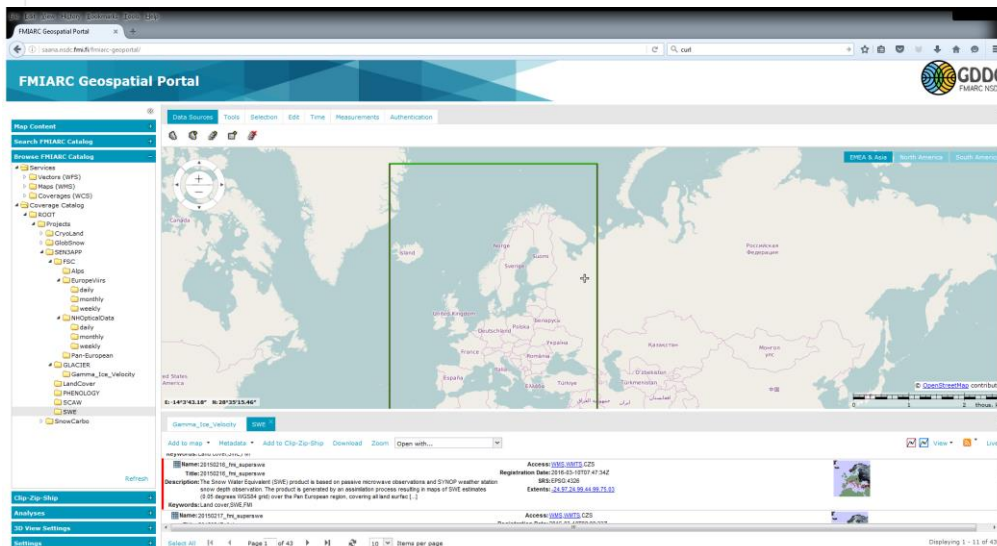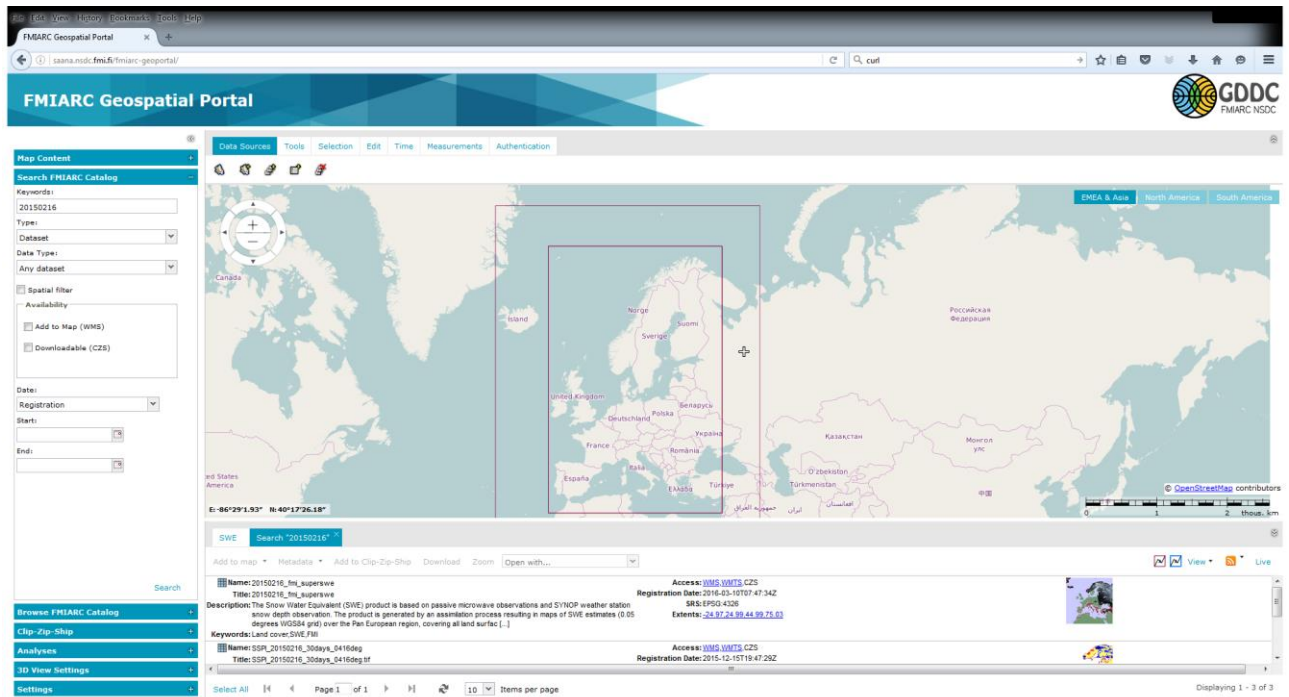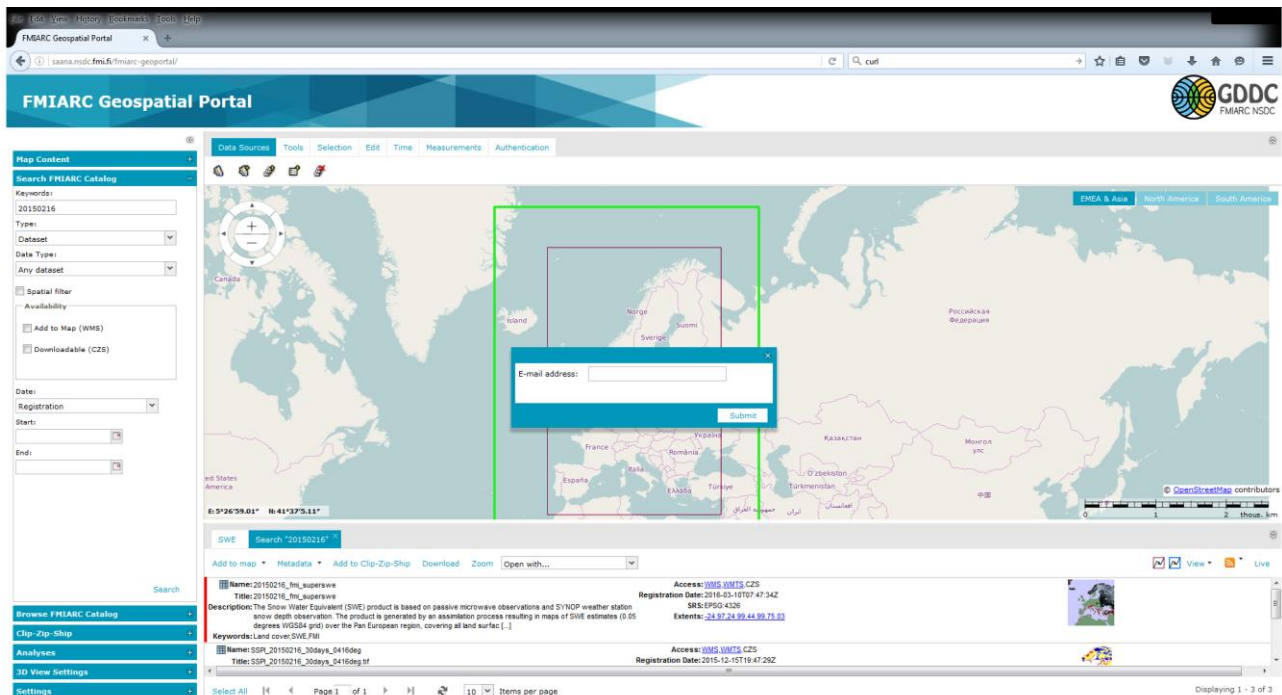

Figure 3.3-2 Search Panel product highlighted in red

3. Or Search FMIARC Catalog

In the keyword field enter the date 20150216 of the product we are looking for or keywords like SEN3APP, this will bring a list of all the related products. Click on the product in the search panel, this will then highlighted in red.

4. To download the product with the original input file click download. Then enter your email address and submit. You will then receive an email confirming your data request and then it will be followed by another email, with a link for you to download file.

4. HTTP Request and Batch Downloads

HTTP requests can be called from any clients that supports http protocol, for example using a browser (firefox) or curl.

4.1   WMS GetMap Request

Request Parameter	Required/Optional	Description
VERSION=version	Required	Request version.
REQUEST=GetMap	Required	Request name.
LAYERS=layer_list	Required	Comma-separated list of one or more map layers.
STYLES	Required	Comma-separated list of one rendering style per requested layer.
SRS=namespace:identifier	Required	Spatial reference system. (WMS 1.1.1 only)
CRS=namespace:identifier	Required	Coordinate reference system. (WMS 1.3.0 only)
BBOX=minx,miny,maxx,maxy	Required	Bounding box corners (lower left, upper right) in SRS units.
WIDTH=output_width	Required	Width in pixels of map picture.
HEIGHT=output_height	Required	Height in pixels of map picture.
FORMAT=output_format	Required	Output format of map.
TRANSPARENT=TRUE|FALSE	Optional	Background transparency of map (default=*FALSE*).
BGCOLOR=color_value	Optional	Hexadecimal red-green-blue color value for the background color (default=*0xFFFFFF*).
EXCEPTIONS=exception_format	Optional	The format in which exceptions are to be reported by the WMS (default=*SE_XML*).

Figure 4.1-1 WMS request parameters

4.1.1   Example how to download a map from your browser using http request

http://saana.nsdc.fmi.fi/erdas-apollo/coverage_public/EAIM?
VERSION=1.1.1&
SERVICE=WMS&
STYLES=default&
LAYERS=20150405_fmi_superswe&
Request=GetMap&WIDTH=500&
HEIGHT=1024&SRS=EPSG:3067&
BBOX=50199.481399999997,6582464.0357999997,761274.62470000004,
7795461.188468289&
FORMAT=image/png

4.2   WCS GetCoverage Request

Request Parameter	Required/ Optional	Description
REQUEST=GetCoverage	R	The name of the request. Must be "GetCoverage"
VERSION=1.0.0	R	The request protocol version
SERVICE=WCS	R	The service name. Must be "WCS"
COVERAGE=name	R	The name of an available coverage
CRS=crs_identifier	O	The coordinate reference system in which the request is expressed, or "Image".
RESPONSE_CRS= crs_identifier	O	Coordinate Reference System in which to express coverage responses. The default is the request CRS.
BBOX=minx, miny, maxx, maxy, minz, maxz	One of BBOX or TIME is required	Request a subset defined by the specified bounding box, with min/max coordinate pairs ordered according to the Coordinate
TIME= time1,time2,… or TIME= min/max/res, …	One of BBOX or TIME is required	Request a subset corresponding to the specified time instants or intervals, expressed in an extended ISO 8601 syntax. Optional if a default time (or fixed time, or no time) is defined for the selected layer. One of BBOX or TIME is required.

PARAMETER= val1,val2, …or PARAMETER= min/max/res	R	(Included only for range sets with compound values). Request a range subset defined by constraining parameter PARAMETER. The PARAMETER key is a variable string; it must match the name of a parameter listed in the range set
WIDTH = w (integer) HEIGHT = h (integer) [DEPTH =d (integer)]	R	Request a grid of the specified width (w), height (h), and [for 3D grids] depth (d) (integer number of gridpoints). Either these or RESX, RESY, [for 3D grids] RESZ are required.
FORMAT= format	R	Requested output format of coverage. Must be one of those listed under the description of the selected coverage.
INTERPOLATION=interpolation	O	Interpolation method used to resample the data. Must be one of those listed under the description of the selected coverage.
EXCEPTIONS= application/vnd.ogc.se_xml	O	The format in which exceptions are to be reported by the server.

Figure 4.2-1 WCS request parameters

4.2.1   Example how to download coverage data from your browser using http request

```
http://saana.nsdc.fmi.fi/erdas-apollo/coverage_public/EAIM?
REQUEST=GetCoverage
&SERVICE=WCS
&VERSION=1.0.0
&COVERAGE=20150405_fmi_superswe
&CRS=EPSG:4326
&RESPONSE_CRS=EPSG:4326
&BAND=band1
&BBOX=24.975,24.985786297872444,44.99000837992087,75.025
&WIDTH=500
&HEIGHT=500
&FORMAT=GeoTIFF
&INTERPOLATION=nearest neighbor
&EXCEPTIONS=application/vnd.ogc.se_xml
```

4.3   Batch Downloads

Batch or automated requests can be implemented through scripting using tools such as Curl , wget and Gdal. This can be done using for example python, bash or php scripts.

5. References

Algorithm Theoretical Basis Document Phase 2 (ATBD), ESA Glacier_CCI Project, Version 2.1 25.11.2014, http://www.esa-glaciers-cci.org/index.php?q=documents#

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Delbart, N., Kergoat, L., Le Toan, T., L'Hermitte, J., Picard, G., 2005. Determination of phenological dates in boreal regions using normalized difference water index. Remote Sensing of Environment 97, 26-38.

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F. Paul, T. Bolch, A. Kääb, T. Nagler, C. Nuth, K. Scharrer, A. Shepherd, T. Strozzi, F. Ticconi, R. Bhambri, E. Berthier, S. Bevan, N. Gourmelen, T. Heid, S. Jeong, M. Kunz, T.R. Lauknes, A. Luckman, J. Merryman, G. Moholdt, A. Muir, J. Neelmeijer, M. Rankl, J. Van Looy and T. Van Niel: The glaciers climate change initiative: Methods for creating glacier area, elevation change and velocity products, Remote Sensing of Environment, 162: 408–426, doi: 10.1016/j.rse.2013.07.043, 2015.

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