

CryoLand Snow Services and Products

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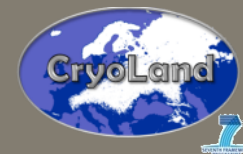


Snow Products Specifications

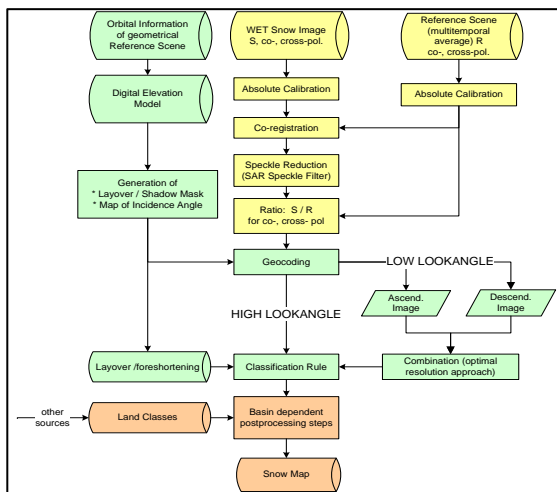


Product Type	Spatial Resolution	Temporal Coverage	Coverage	Latency Time	Implementation Priority	EO Sensors	Product Availability
Snow extent, Pan-European	500	Daily, full year	35N – 72N 11W – 50E	<1 day	1	MODIS, Sentinel S3	Operational, in near real time
Snow extent, regional	250 m – 500 m	Daily, full year	Alps, Nordic, Baltic Sea area	<1 day	1	MODIS Sentinel S1, S3	Operational, in near real time
Snow extent, local	25 – 50 m	monthly, full year	Alpine valleys, small AOIs (on request)	<1 day	1	Sentinel 2, (Landsat)	Pre-operational, in near real time
Snow Water Equivalent (Low res) Pan-European	10 – 25 km	Daily, dry snow season	35N – 72N 11W – 50E	<2 days	1	SSM/I/S, AMSR2	Operational, in near real time
Melting snow area	100 m	Daily, Spring/Summer/Fall/Winter	Regional, local	<1 day	2	ASAR (archived), Radarsat-2 Sentinel S1	Operational, in near real time (Scandinavia)
Statistical snow Information	HRU / basin	Daily	Local	<1 day	2	--	Operational for predefined hydrological basins, in near real time
Snow Surface Wetness	1000 m	Daily	Regional	<1 day	3	MODIS, Sentinel S3	Pre-operational, in near real time
Snow Surface Temperature	1000 m	Daily	Regional, local	<1 day	3	MODIS, Sentinel S3	Pre-operational, in near real time

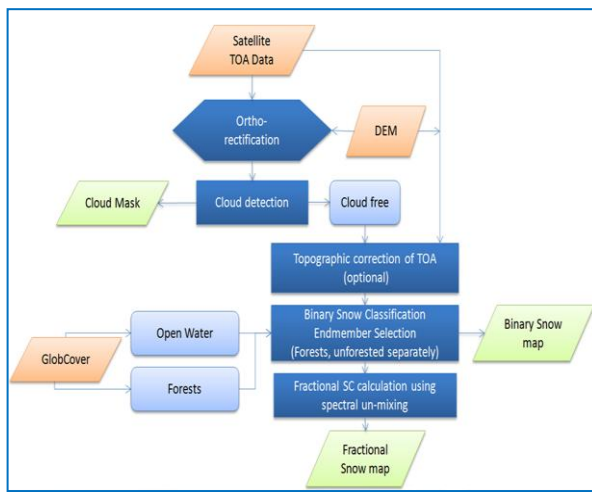
Processing chains – general remarks



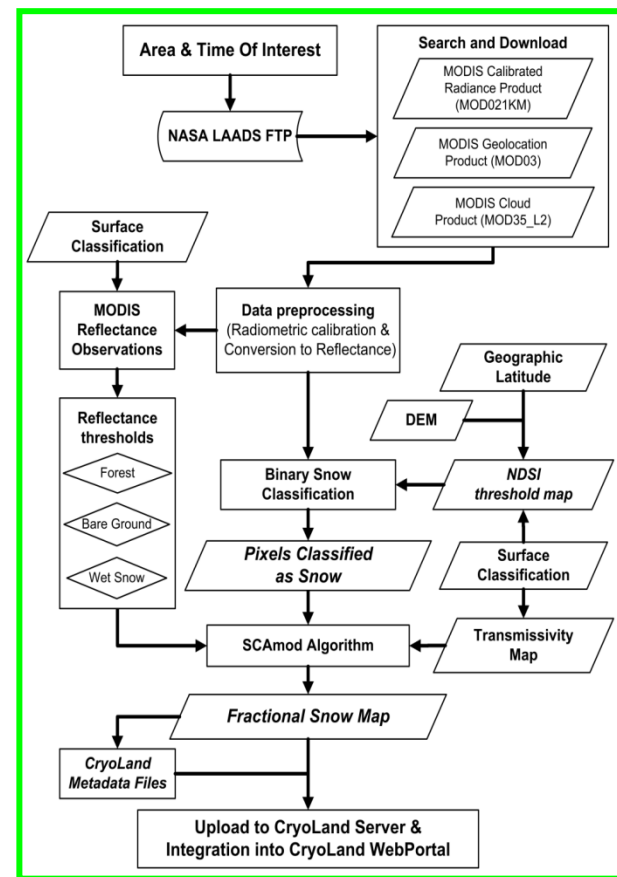
- CryoLand includes a network of product processing hosts
- Processing chains have been upgraded during the project lifetime and made more robust
- Processing chains for operational products are fully automated
- Processing chains are verified with respect to performance, robustness, etc.



SCAW processing chain for the Alps



FSC processing chain for the Alps



FSC processing chain for the Pan-European region

Pan-European Fractional Snow Cover Product

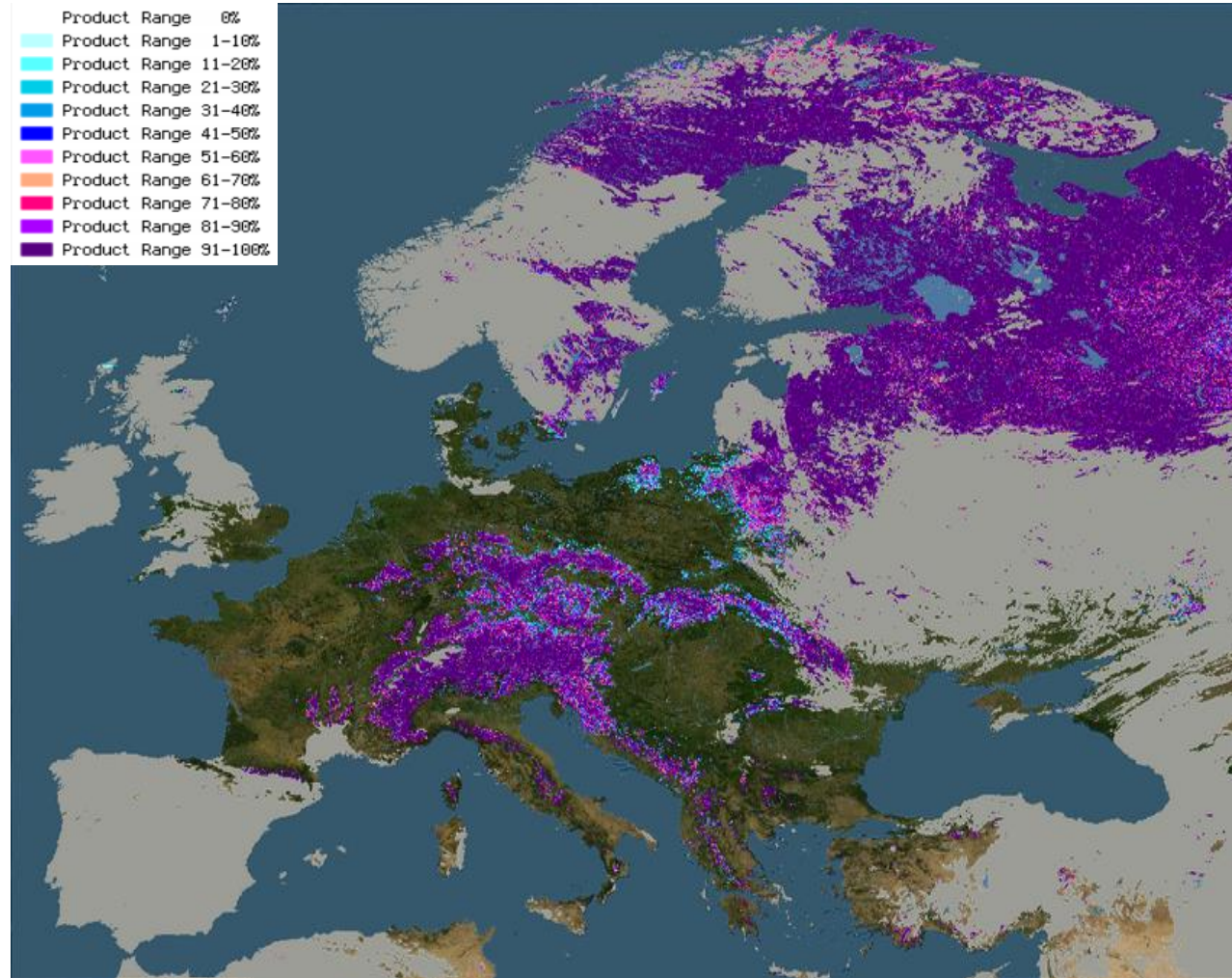


Product Specifications:

- Domain:
72°N 11°W – 35°N 50°E
- Projection: LatLon/WGS84
- Pixel size: 0.005° (ca 500 m)
- Latency: < 1 day

Status:

- Sensor: MODIS
(Backup VIIRS, Sentinel-3)
- Uncertainty map (unbiased RMSE) provided for each daily product
- Archive of Daily Snow product from 2000-Today
- Fully Operational NRT for Winter 2013/14

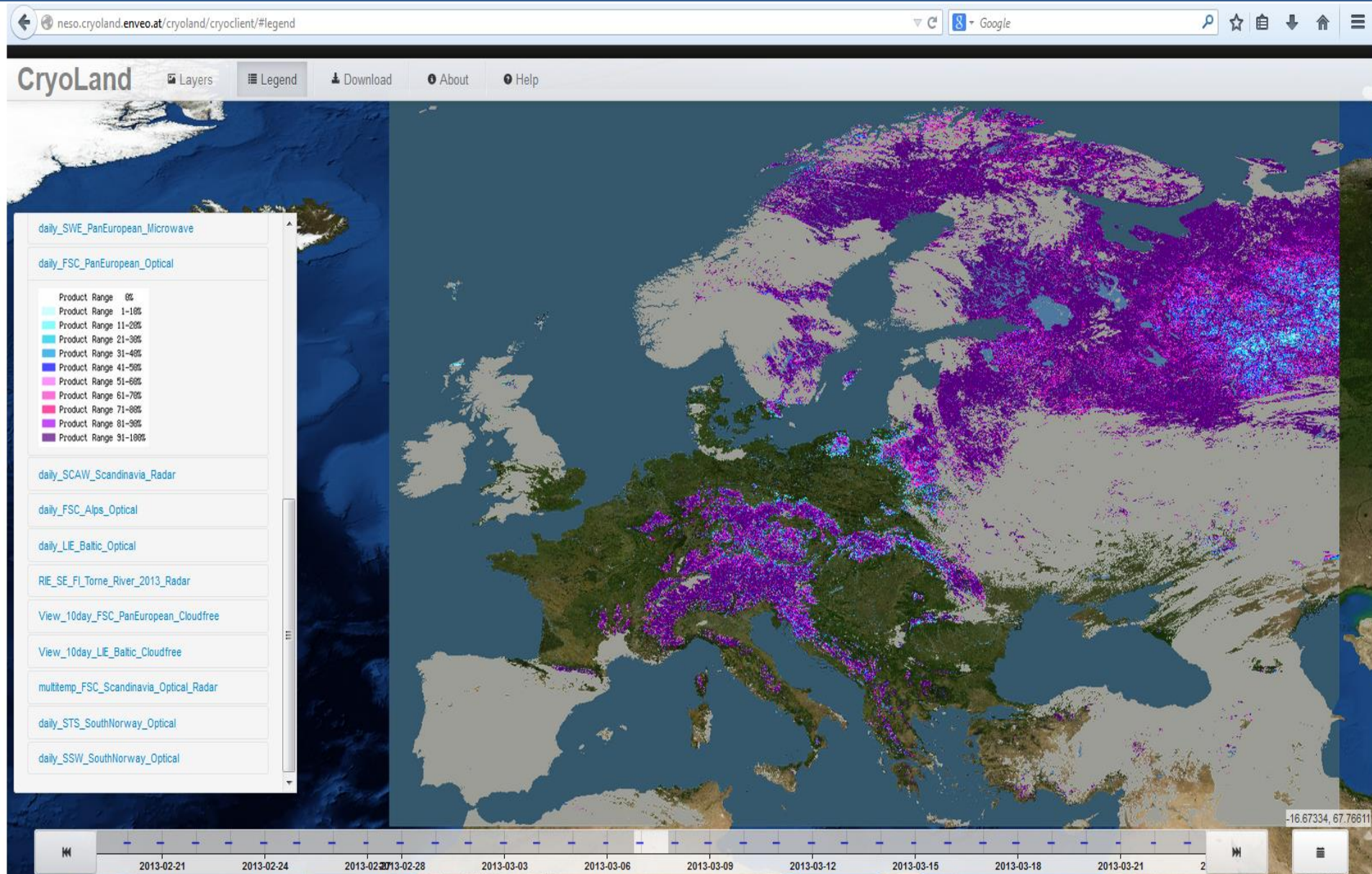


CryoLand pan-European FSC product, 4/3/2013

Planned for the next seasons – proposed as Core Service to Copernicus Office



Uncertainty Map for Pan-European Fractional Snow Cover Product



Uncertainty Map for Pan-European Fractional Snow Cover Product



neso.cryoland.enveo.at/cryoland/cryoclient/#legend/8.41943359375,53.13232421875,5

Google



CryoLand

Layers

Legend

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About

Help

daily_FSC_PanEuropean_Optical_Uncertainty

- RMSE per Pixel 0-4%
- RMSE per Pixel 5-8%
- RMSE per Pixel 9-12%
- RMSE per Pixel 13-16%
- RMSE per Pixel 17-20%
- RMSE per Pixel 21-24%
- RMSE per Pixel 25-28%
- RMSE per Pixel 29-32%
- RMSE per Pixel 33-36%
- RMSE per Pixel 37-40%
- RMSE per Pixel 41-100%

avg_10day_SSPI_PanEuropean_Microwave

avg_30day_SSPI_PanEuropean_Microwave

daily_MODIS_RGB651_PanEuropean

daily_FSC_Baltic_Optical

multitemp_FSC_Scandinavia_Optical

daily_SWE_PanEuropean_Microwave

daily_FSC_PanEuropean_Optical

daily_SCAW_Scandinavia_Radar

daily_FSC_Alps_Optical

daily_LF_Baltic_Optical



2013-02-21

2013-02-24

2013-02-28

2013-03-03

2013-03-06

2013-03-09

2013-03-12

2013-03-15

2013-03-18

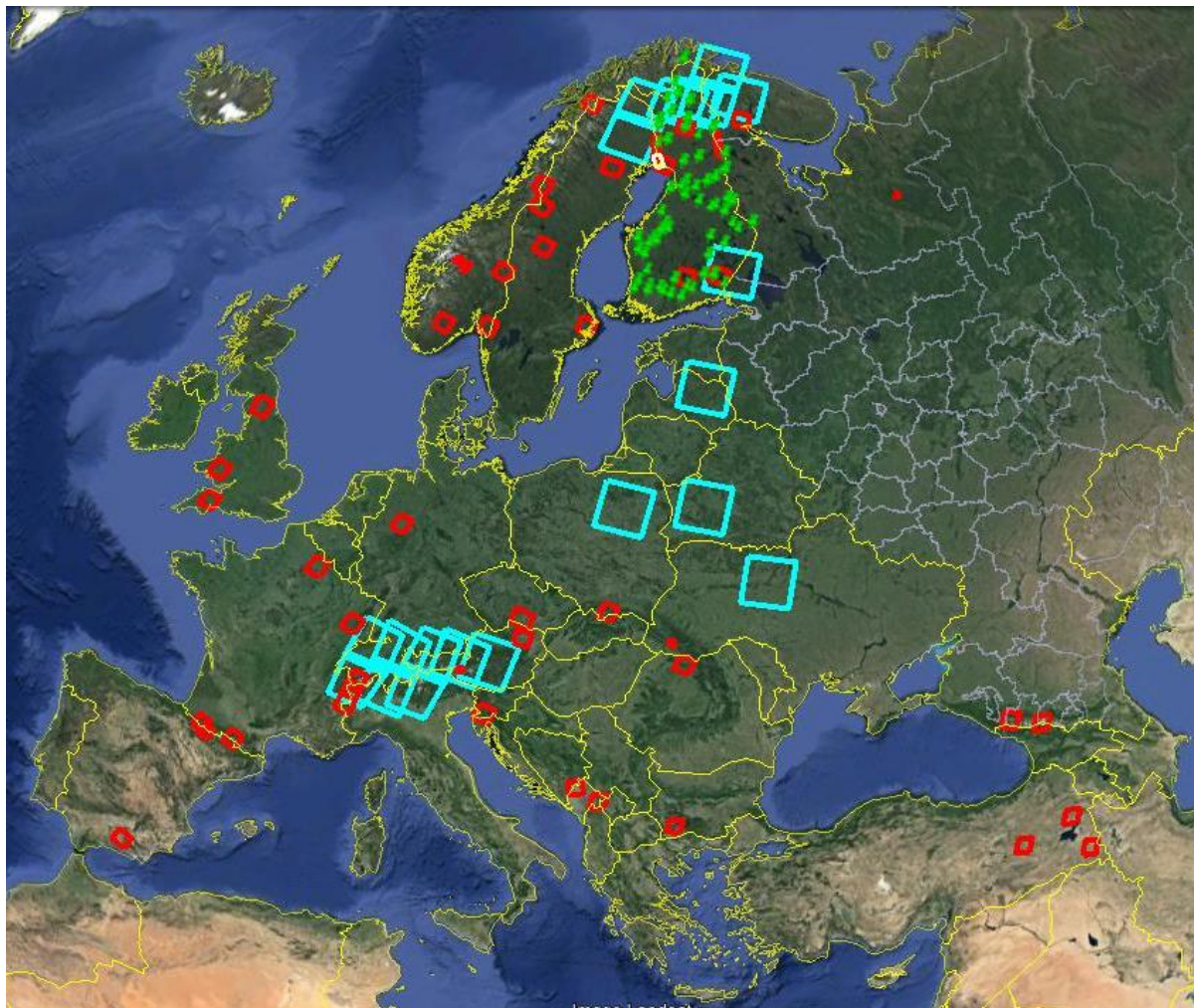
2013-03-21

2



-18.12354, 32.17041

Snow Extent Product Quality Assessment



Quality Assessment of Snow Extent Products is performed in different environments:

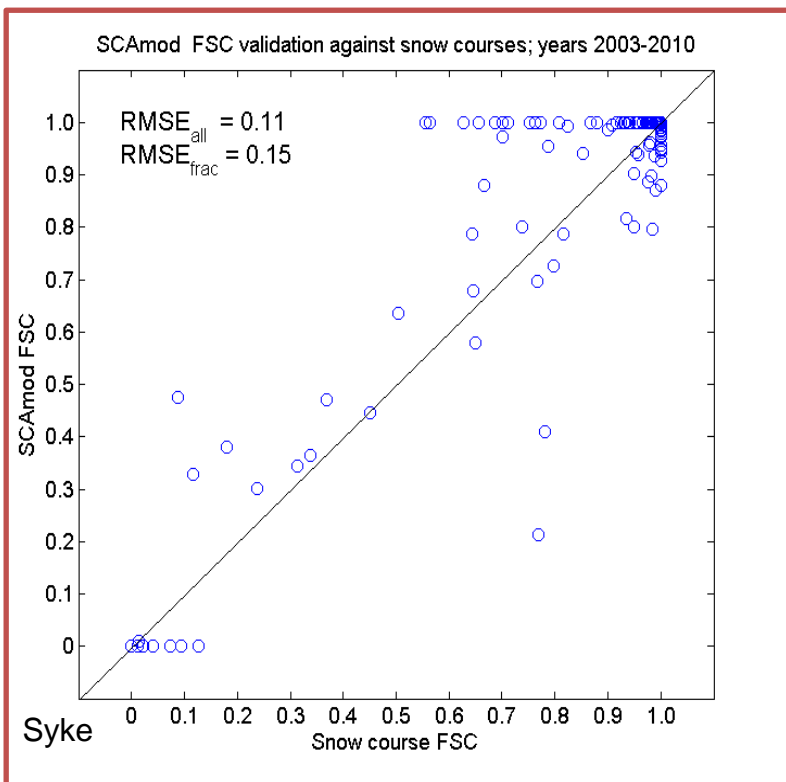
- Fractional SE products from high resolution optical images:
 - Very High resolution images (IKONOS, SPOT5, Quickbird, WorldView-1/-2)
 - Landsat TM/ETM+
- In-situ snow transects measured operationally by SYKE in Finland

VHR Optical Images - **Landsat TM/ETM+** -
In-situ snow transects

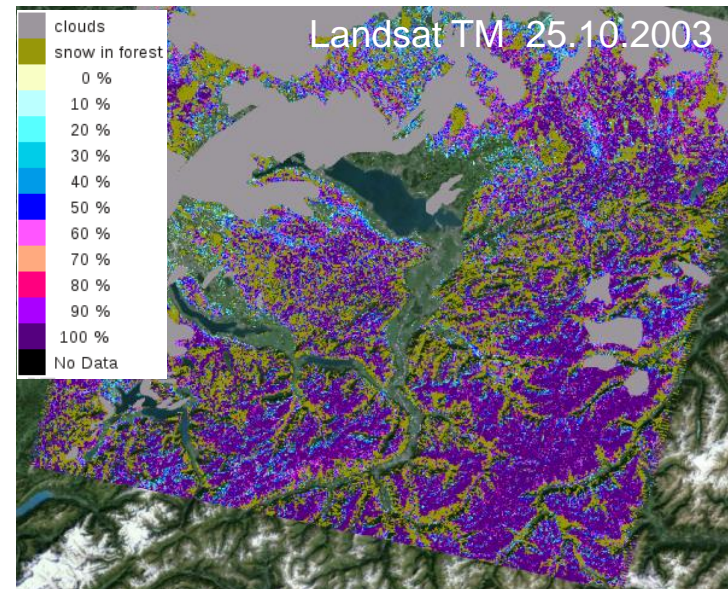
Accuracy Assessment of SE Products



Pan-European FSC versus In-situ Snow transects Finland



High and Very High resolution Images provide detailed snow information in mountains and forests (sparse->dense) and enable the quality assessment of CryoLand SE products in these areas.



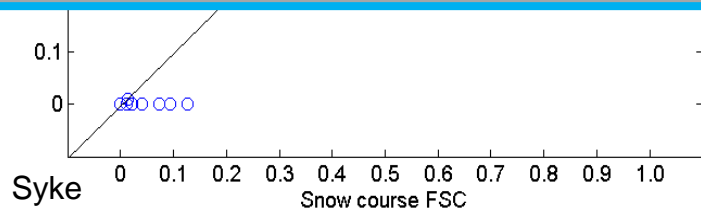
Pixel (unforested)	RMSD	BIAS	R
106714	17.3	-3.93	0.89

Pan-European FSC

versus In situ Snow

High and Very High resolution Images
provide detailed snow information in

The CryoLand Pan-European Snow Product
participates in the ESA funded project
**SNOWPEX – THE SATELLITE SNOW PRODUCTS
INTERCOMPARISON AND EVALUATION
EXERCISE**
contributing to WMO Global Cryosphere Watch and
WCRP CLiC



Pixel (unforested)	RMSD	BIAS	R
106714	17.3	-3.93	0.89

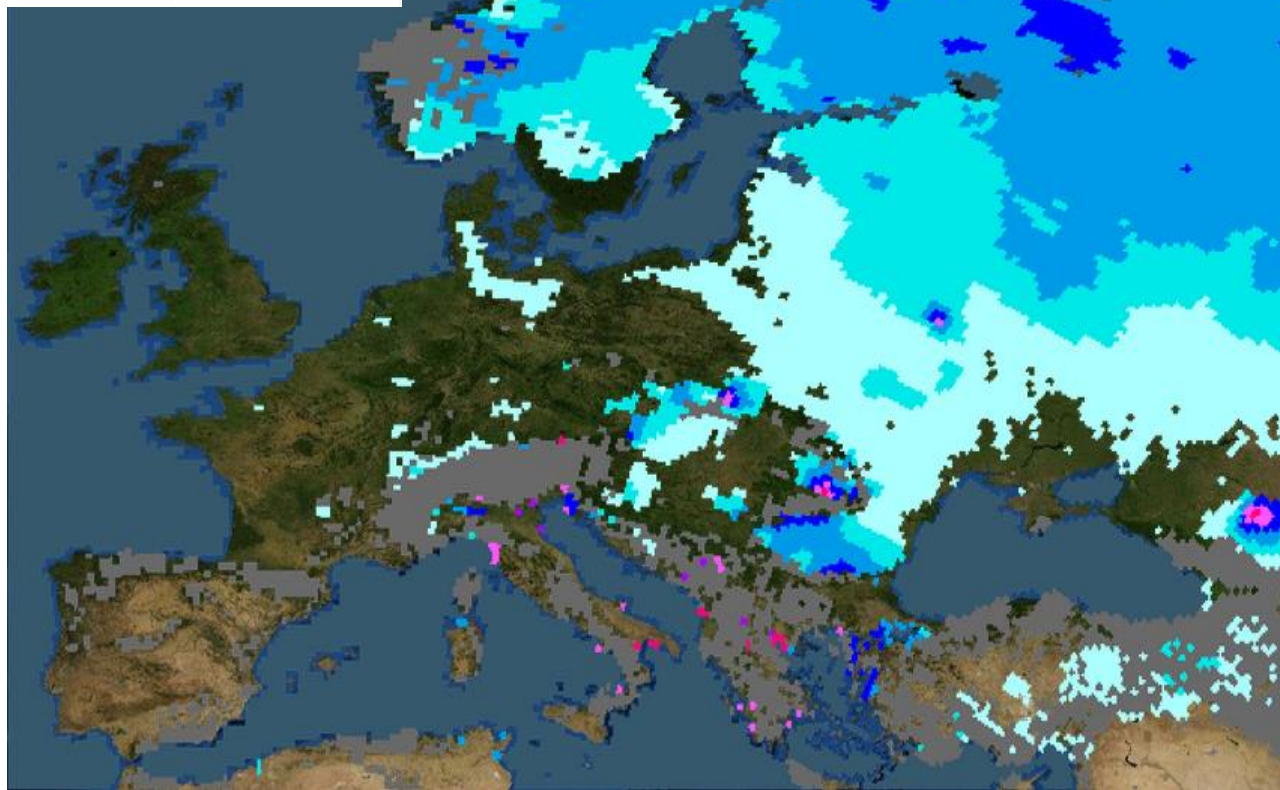
Pan-European SWE Product



Product Specifications:

- Domain:
72°N 11°W – 35°N 50°E
- Projection: LatLon / WGS84
- Pixel size: 0.1deg; ca 10 km
- Temporal resolution: Daily
- Latency: < 2 days

Snow Water Equivalent	0	mm w.e.
Snow Water Equivalent	1-50	mm w.e.
Snow Water Equivalent	51-100	mm w.e.
Snow Water Equivalent	101-150	mm w.e.
Snow Water Equivalent	151-200	mm w.e.
Snow Water Equivalent	201-250	mm w.e.
Snow Water Equivalent	251-300	mm w.e.
Snow Water Equivalent	301-350	mm w.e.
Snow Water Equivalent	351-400	mm w.e.



CryoLand pan-European SWE product, 4/3/2013

Status:

- SWE products from previous periods have still a smaller extent, but will be updated gradually
- Algorithm based on H-SAF and GlobSnow, new processing and data delivery
- Based on passive microwave observations and ECMWF weather station data

Planned for the next seasons – proposed as Core Service to Copernicus Office

Standardized SnowPack Indicator (SSPI) – derived from Pan-European SWE Product

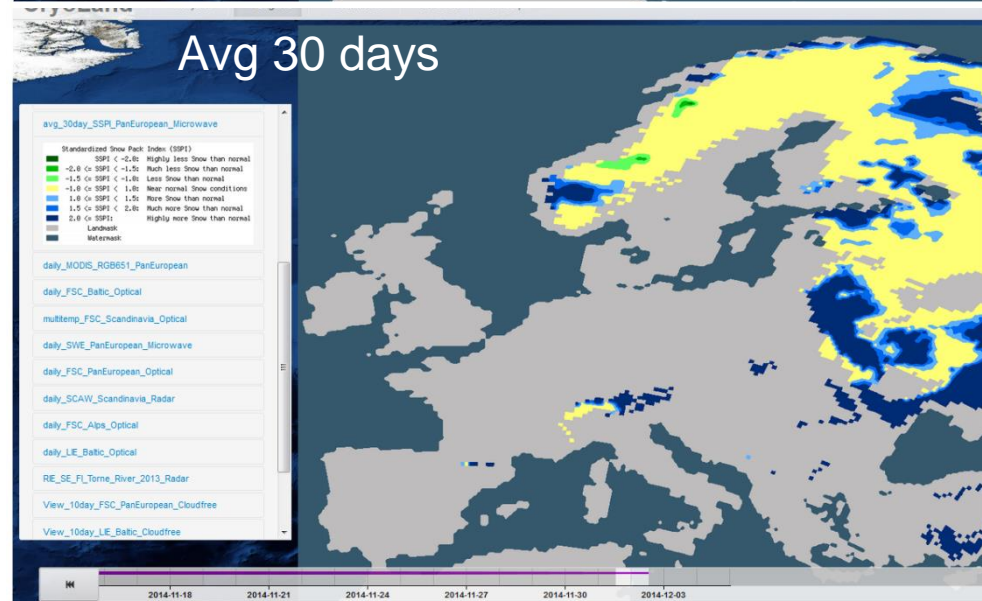
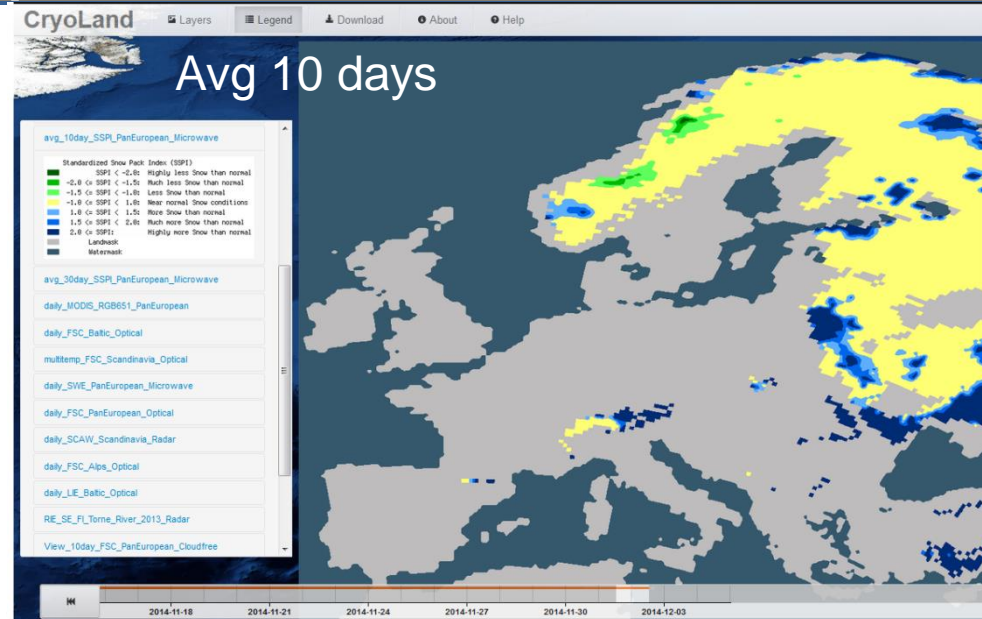


Product Specifications:

- Domain:
72°N 11°W – 35°N 35°E
- Projection: LatLon / WGS84
- Pixel size: 0.1deg; ca 10 km
- Temporal resolution: Daily
- Latency: < 2 days

Status:

- information on the relative volume of the snow pack on a 10 daily and 30 daily (monthly) basis compared to the reference period 1979 – 2010
- standardized values between -3 and 3 calculated from time series of daily snow water equivalent in mm of water (=kg/m² of snow)
- Product based on H-SAF and GlobSnow



Regional FSC product for the Alps

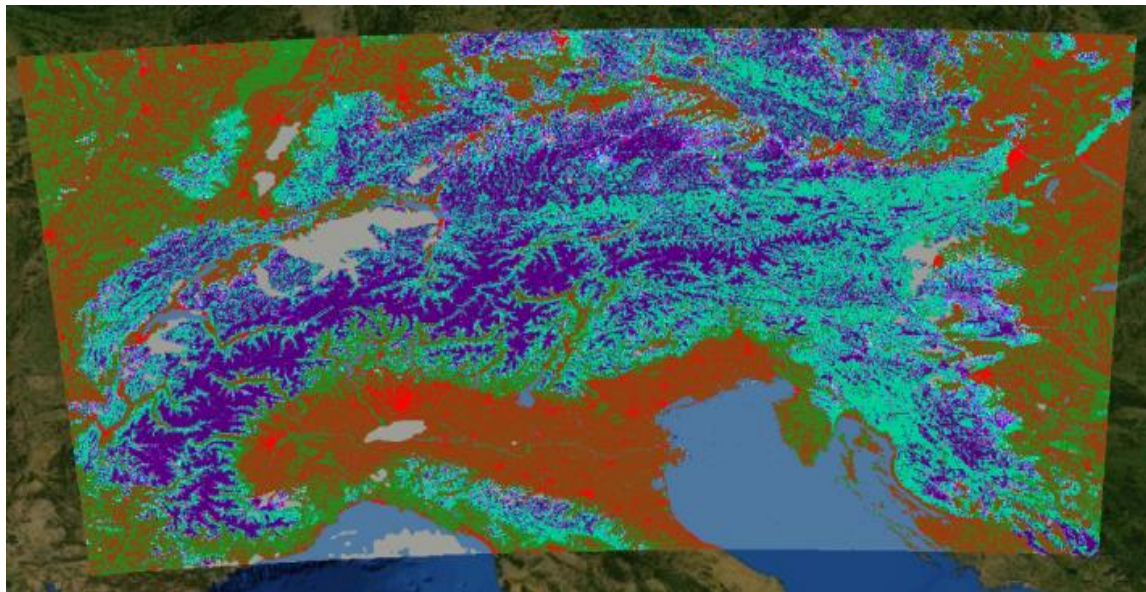


Product Specifications:

- Domain:
Full Alpine ridge and lowlands
- Projection: LatLon / WGS84,
or as requested by users
- Pixel size: 0.0025 deg; ca 250 m
- Temporal resolution: Daily
- Latency: < 1 day

Status:

- Sensor: MODIS
(Backup VIIRS, Sentinel-3)
- Archive of Daily Snow
product from 1 October 2012 -
Present
- Fully Operational NRT for Winter
2013/14



Operational version of the Alpine fractional snow cover map
from Terra MODIS data of 4 March 2013

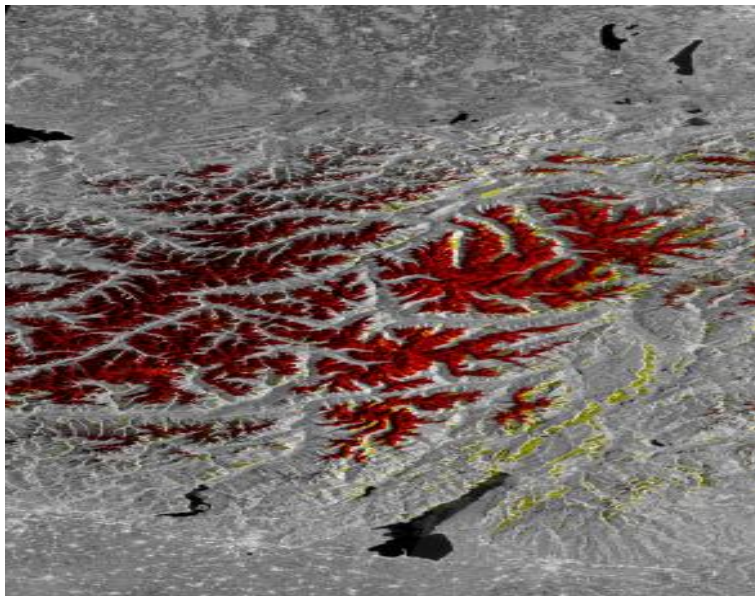
	Product Range	0%
	Product Range	1-10%
	Product Range	11-20%
	Product Range	21-30%
	Product Range	31-40%
	Product Range	41-50%
	Product Range	51-60%
	Product Range	61-70%
	Product Range	71-80%
	Product Range	81-90%
	Product Range	91-100%

Wet Snow Covered Area for the Alps



Product Specifications:

- Domain: Full Alpine ridge and lowlands
- Projection: LatLon / WGS84, or as requested by users
- Pixel size: 0.001 – 0.002 deg; ca 100 m – 200 m
- Temporal resolution: Weekly (could be improved to 2 – 3 times / week depending on Sentinel-1 data availability)
- Latency: < 1 day



Product example of wet snow extent in the Alps from Envisat ASAR data (red: wet snow; yellow: radar shadow)

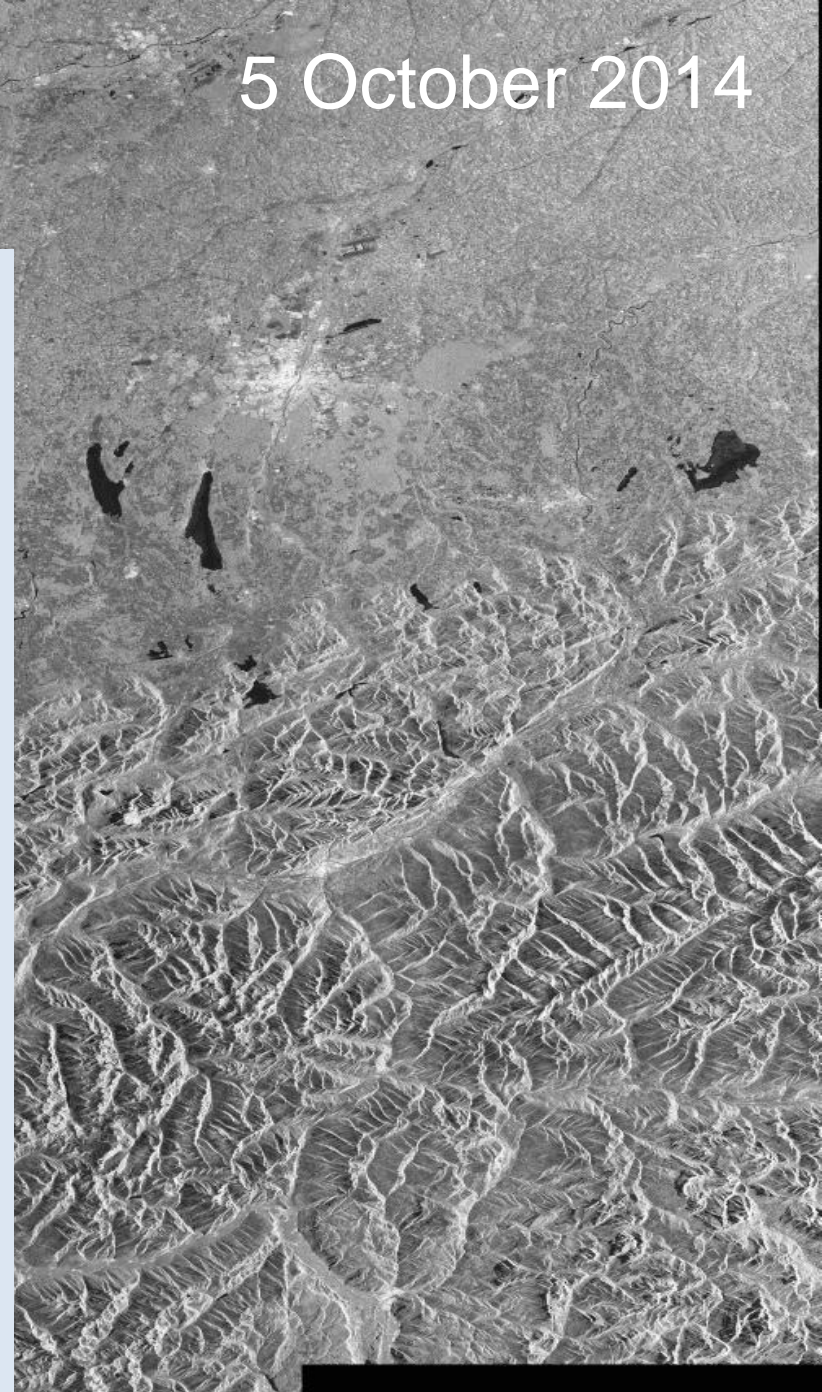
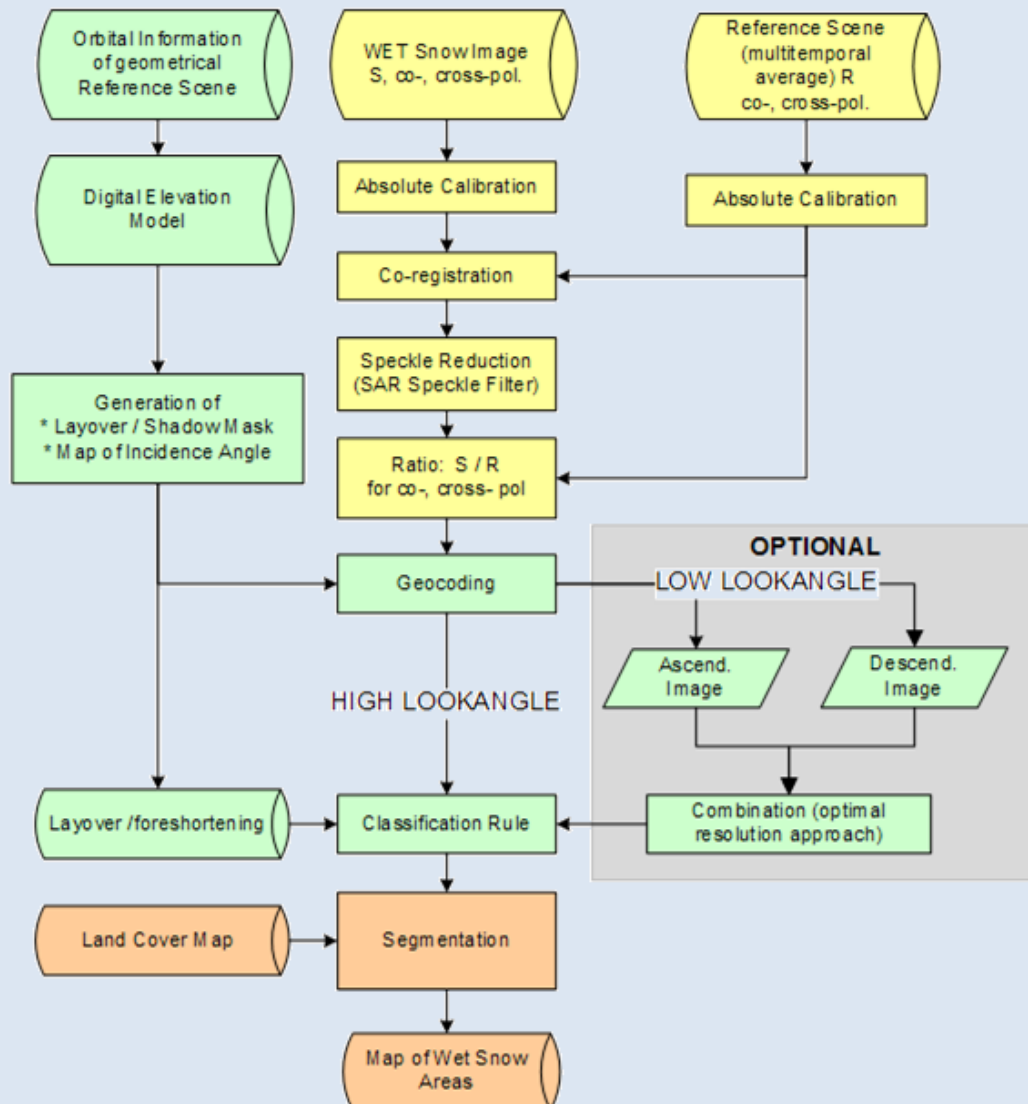
Status:

- Demonstration Snow products generated from archived Envisat ASAR data available
- Processing chain is fully implemented in ENVEO's in-house developed software
- Input data from Sentinel-1 needed to re-start operational product generation
- Start of operational wet snow service for Alpine area from Sentinel-1 data planned for melting season 2015

5 October 2014



Wet Snow Map Procedure

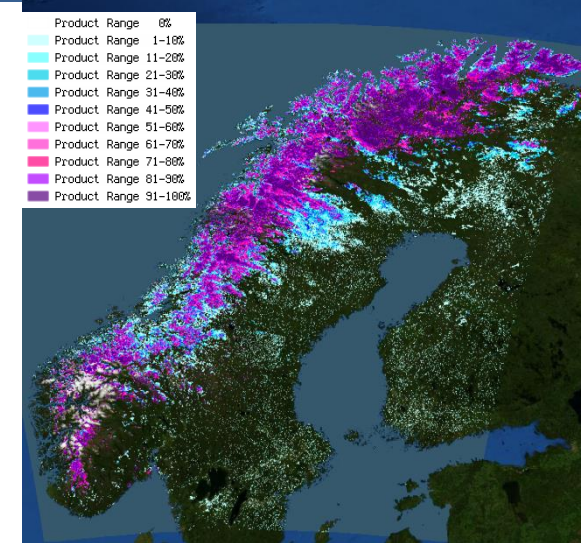


Snow Products for Baltic Sea Area and Scandinavia



Operational Snow Products:

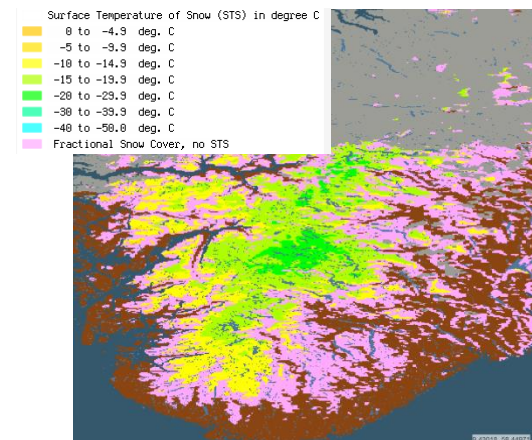
- Daily FSC product (500 m) from optical data (MODIS) for Baltic Sea Area (SYKE)
- Multi-sensor (MODIS & SAR) / multi-temporal FSC product for Scandinavia (NORUT / KSAT)
- Wet snow covered area from SAR data for Scandinavia (Norway) (NORUT)



Regional fractional snow cover map from MODIS and Radarsat-2 of 16/5/2013

Demonstration Snow Products:

- Snow Surface Temperature (1 km) from optical satellite data (MODIS) for southern Norway (NR)
- Snow Surface Wetness (1 km) from optical satellite data (MODIS) for southern Norway (NR)



STS for South Norway on 11/3/2013
enveo