CryoLand

GMES Snow and Land Ice Service 2011-2015

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CryoLand is a Collaborative Project (2011-2015) funded by EU under FP7´.
Theme SPA.2010.1.1-01– Stimulating the development of downstream GMES services.

Overall Project Objective

Develop, implement and validate
an operational sustainable service for
monitoring Snow and Land Ice
as a Downstream Service
within GMES.

The project prepares the basis for a future cryospheric component of the GMES Land Monitoring Service.

Project Sub-Objectives

- Develop and validate a pan-European satellite-based snow and land ice service delivering highly needed products to the user society.
- Integrate and operationalise existing snow and land ice services
- Prepare the tools for offering snow and ice services world-wide
- Develop tools to utilize data from the GMES Sentinel Satellite Series for snow and ice applications
- Perform full verification and real time demonstration of the services
- Prepare the basis for the Cryosphere Component of a GMES Global Land Monitoring Service
- Products conform to INSPIRE/GEOSS standards
- Make products available via state-of-the-art online services
- Issue guidelines for stakeholders and for service deployment operations

CryoLand Project Partners

10 Partners from Austria, Finnland, Norway, Romania, Sweden and Switzerland

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Partners:

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Kongsberg Satellite Services
Tromsø, Norway
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Northern Research Institute
Tromsø, Norway
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Norwegian Computing Center
Oslo, Norway
http://www.nr.no

National Meteorological Administration
Bucharest, Romania
http://www.meteoromania.ro

GAMMA Remote Sensing
Gümlingen. Switzerland
http://www.gamma-rs.ch

Swedish Meteorological & Hydrological Institute
Norrköping, Sweden
http://www.smhi.se

Users of CryoLand Services

CryoLand User Group includes >60 Organisations from 14 Countries

Application Fields

- Hydropower companies
- Energy traders
- Road, Railway and River Authorities
- Geotechnical and Construction companies
- Avalanche warning centres
- Ecologists
- Hydrological services
- Meteorological services
- Climate monitoring institutions
- Reindeer herders
- Environmental agencies

CryoLand User group contributes to:

- Product and service Requirements
- Requirements for service interfaces

4 User WS held in 2011

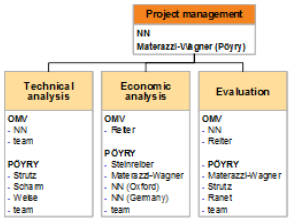
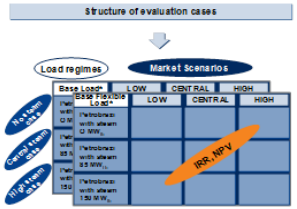
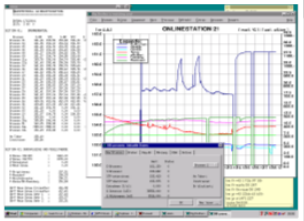
- Consolidation of Product and Service Specification **WS 5/2012**
- Testing and Evaluation of services and products **(ongoing)**

Pöyry Water Resources

Pöyry is a global consulting and engineering company

- 7000 experts in about 50 countries, project experience in more than 100 countries, 17000 projects annually

Pöyry Hydropower / Pöyry Water Resources offers services within the hole life cycle of water resources development projects

MASTER PLAN RECONN. STUDY	(PRE)-FEASIBILITY STUDY	TENDER / FINAL DESIGN	PROJECT CONSTRUCTION	OPERATION REHABILITATION
				
• Development of River stretches • Hydrological Investigations • Critical Review of HP Plants • Understand technical solution and options • Check on alternatives • Understand legal and institutional framework • Evaluate environmental impacts	• Draft design • Feasibility Design • Technical Report • Hydrological optimization • Geological Investigations • Topographical Invest. • Development of Alternatives • Economic analysis • Risk Assessment • Alignment with Power strategy	• Tender Design • Technical Specifications • General Specifications • Technical documents • Commercial documents • Tendering • Tender evaluation • Contract negotiation support	• Detail design Civil Works • Detail Design EM Works • Project Management / Coordination • Site Management • Site Supervision • Contract Management • Design within EPC contractor or • Design within Owner's engineer	• Detail design Civil Works • Detail Design EM Works • Project Management • Design within EPC contractor or • Design within Owner's engineer • Operation concept • Training • Maintenance concepts

Needs for Snow Information

Hydropower Design (Masterplans, Feasibility Studies)

- Verification of hydrological data of flood events (runoff contribution of snowmelt)
- PMF Studies (Probable Maximum Flood, Rain-on-Snow events)
- Glaciers (Spatial extent of glaciers and potential for Glacial Lake Outburst Floods GLOF)

Hydropower Operation

- Inflow Forecasting (daily, weekly, seasonal forecasts; snow model calibration and updating)
- Reservoir Optimization Studies (seasonal glacier and snow melt inflow)

Water Resources Management

- Flood Forecasting (Precipitation Runoff Modelling; snow model calibration and updating)
- Climate Change Impact Studies (Water Balance Modelling; historic changes in snow cover extent and glacier extent)

Needs for Glacier Information

Estimation of glacial melt contribution to summer runoff / inflow to reservoirs

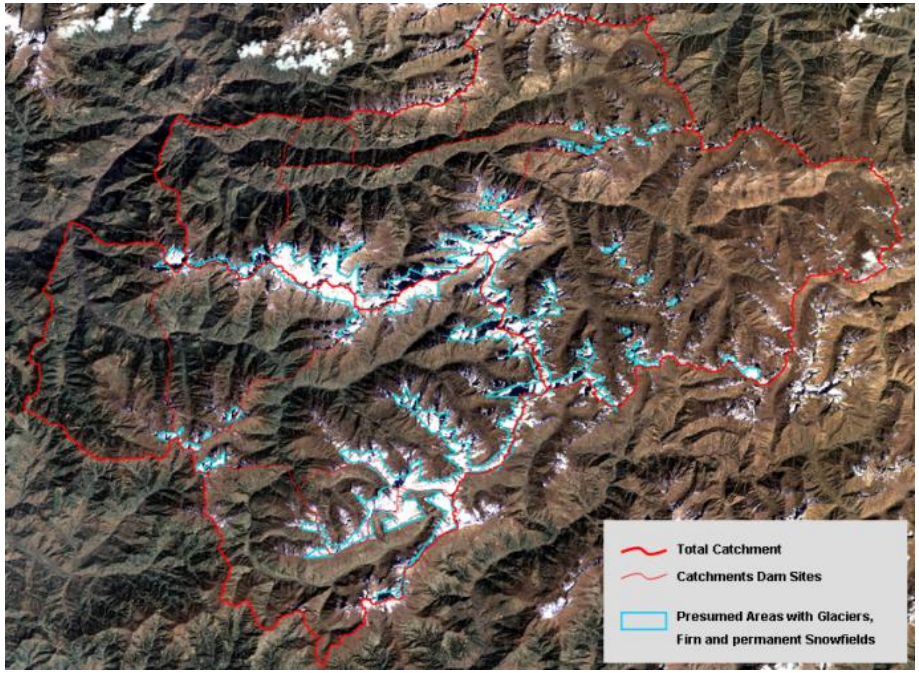
- Time series of maps of ice and snow on glaciers
- Mapping of debris covered glaciers

Glacier Lake Outburst Floods

- GLOF potential very important for dam design and dam safety

Climate Change impact studies

- Information on historic glacier extent and glacier retreat
- Supports calibration of snow and glacier model components in water balance modelling



Palas Valley and Spat Gah Catchment, NWFP Pakistan


CryoLand
Snow
Glaciers
Lake / River Ice
Products from Satellite Data and In-situ Measurements

CryoLand Products

Specifications of products are done according to user needs which were assessed in 4 workshops held in Vienna, Oslo, Saariselka, Bucharest in 2011 and consolidated in the user meeting in Stockholm in 2012.
Products are conform to INSPIRE/GEOSS standards

Snow Service - Main Products:
- Snow Cover Area (fractional, binary, hemispheric/continental; regional)
- Snow Water Equivalent (Coarse)
- Wet snow (Melting) area
- Surface Albedo

Main EO Data:
- Optical Satellite (MODIS, Sentinel S3)
- SAR (ERS, ENVISAT, Sentinel S1)
- Passive MW data (AMSR)

Glacier Service - Main Products:
- Glacier area / outlines
- Maps of snow / ice area
- Ice motion maps
- Glacier dammed lakes

Main EO Data:
- High Resolution MS Optical (SPOT)
- High Resolution SAR (TerraSAR-X, ERS, ENVISAT, S1)

Lake / River Ice - Main Products:
- Lake Ice and River Ice extent
- Temporal changes of ice extent
- Snow extent

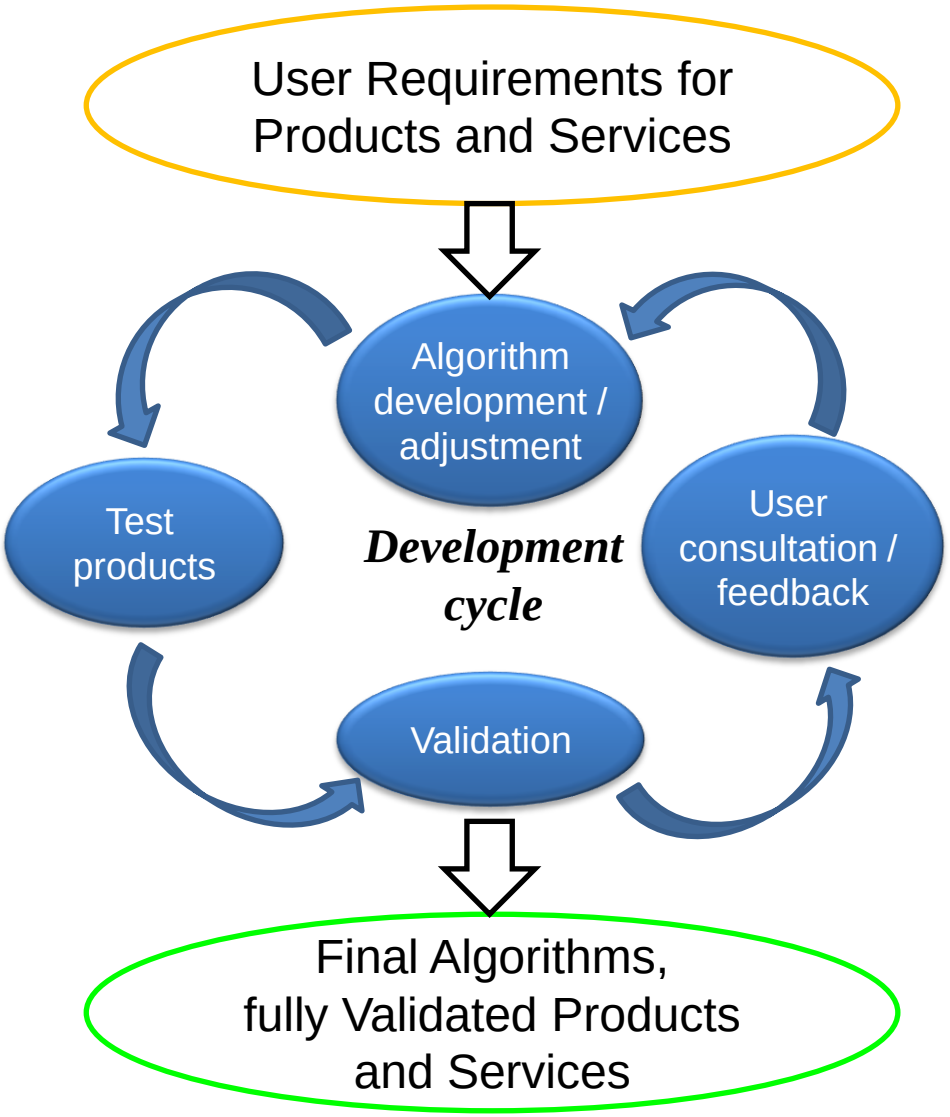
Main EO data:
- SAR (ENVISAT, RadarSAT, TSX, S1)
- Optical Satellite data (SPOT, Landsat, S2)

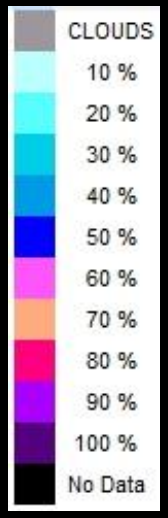
Approach for product and service improvement towards user needs

1. User requirements / dialogue for improved product requirements and specification

2. Algorithm development / adjustment to match user needs
3. Generation of test products and validation for different regions and periods
4. User consultation and feedback on product and services

5. Final algorithms, fully validated products and services





01-02-2011

CRYOLAND PAN EUROPEAN
FRACTIONAL SNOW EXTENT

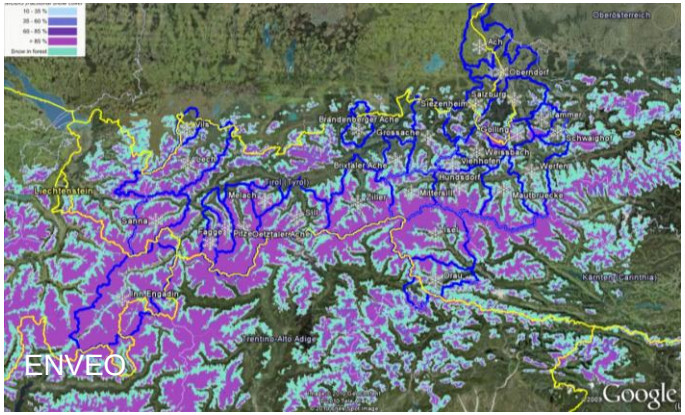
FSC Product Specs:

Daily
1 km Pixel
(500 m: 2013/14)
Latency: <12 h
MODIS
(Sentinel-3)

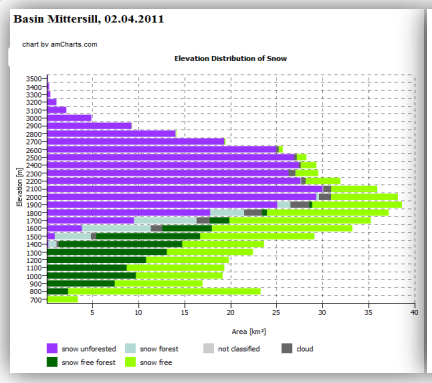
Pre-Operational:
www.cryoland.eu

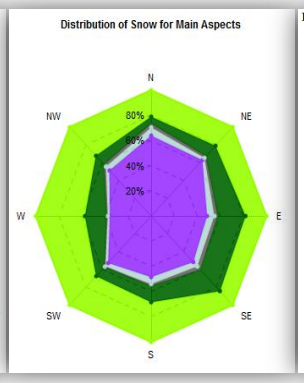
Regional Snow Cover Products

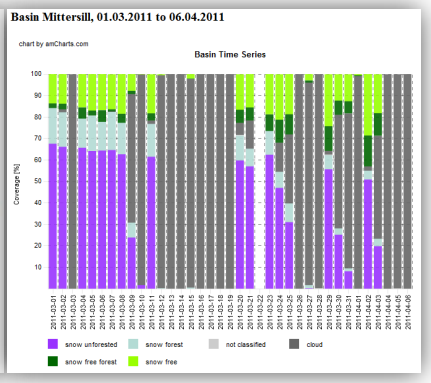
Alpine Areas 250 m (MS Unmixing)



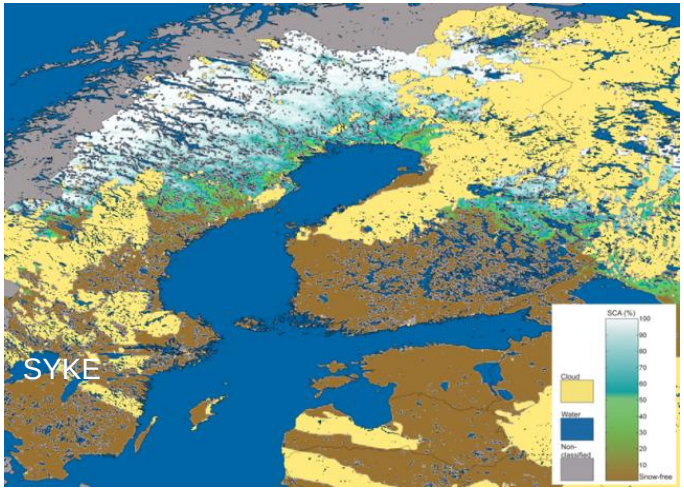
Generated for User Specified Basins



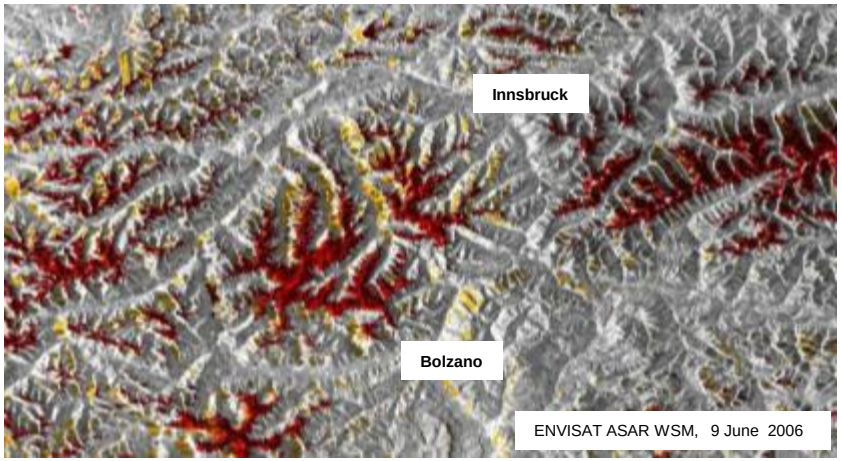




Boreal Forests 500 m (ScaMod)



Melting Snow Areas



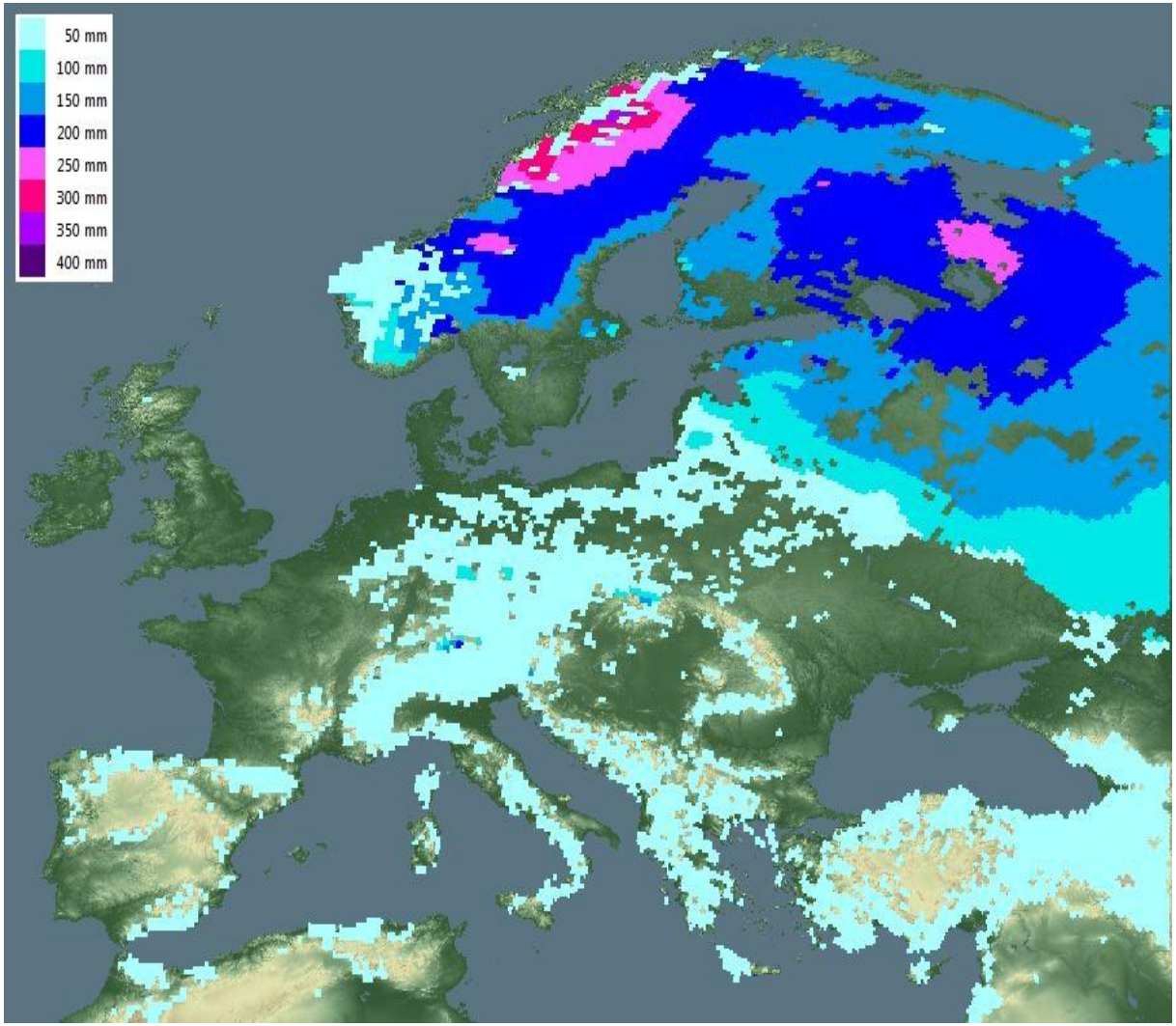
Pan European SWE Product

Draft requirements and specification:

- Projection: LatLon / WGS84
- Pixel size: 0.1 deg; ca 10 km
- Temporal resolution: Daily
- Latency: < 1 day

• Product status:

- Algorithm based on H-Saf and GlobSnow, new post-processing and data delivery
- Based on passive microwave observations and ECMWF weather station data



CryoLand SWE product, 15/2/2011

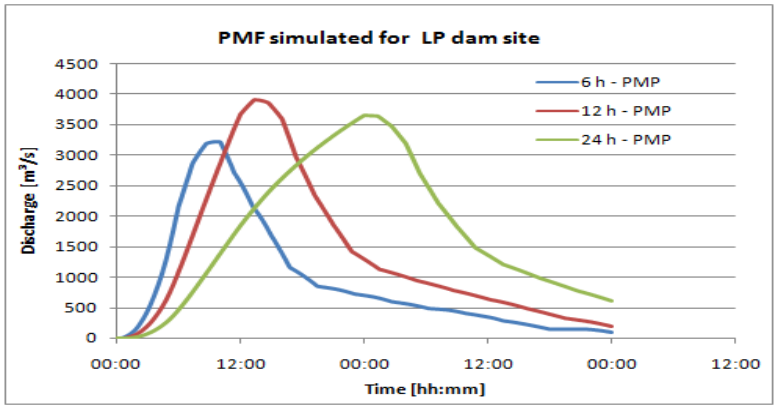
Snowmelt contributions to runoff

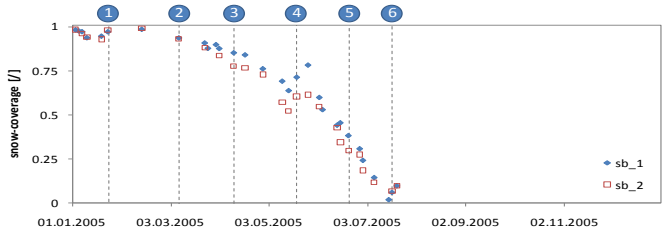
Verification of hydrological data of flood records

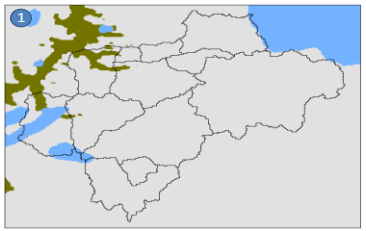
- Can snowmelt contributions have increased runoff up to the recorded levels ?

Probable maximum flood studies

- PMF required for spillway design of dams, design value with strong impact on costs
- Rain-on-snow events can be crucial for PMF
- It is important to know the maximum extent of snow cover during flood season (e.g. snow cover at beginning of monsun season)
- Input for PMF simulations







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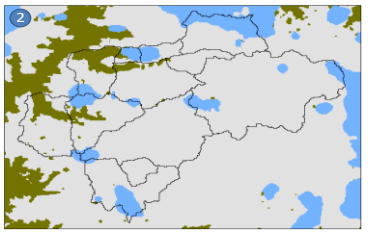

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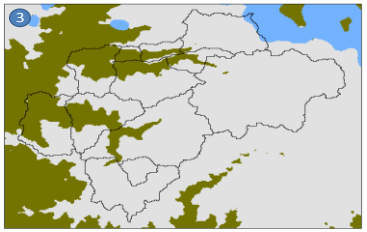

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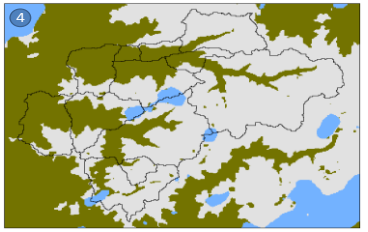

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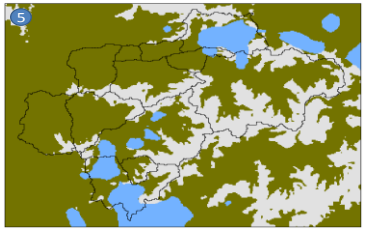


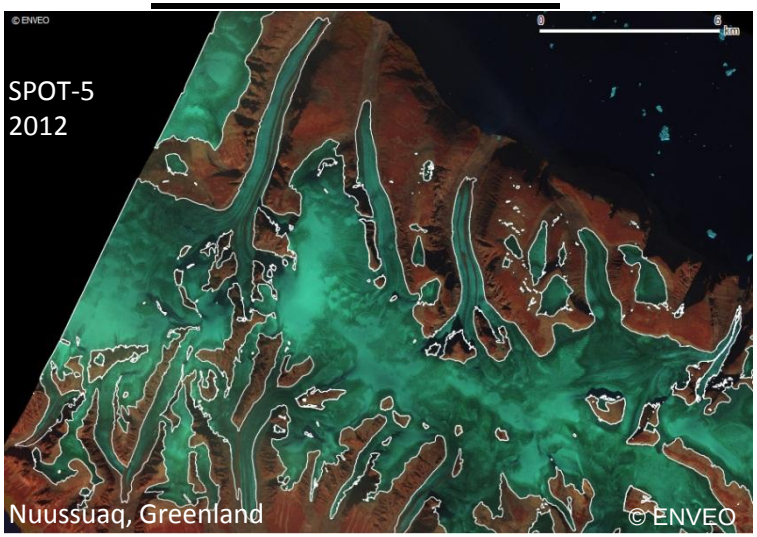
2005-06-21

2005-07-18

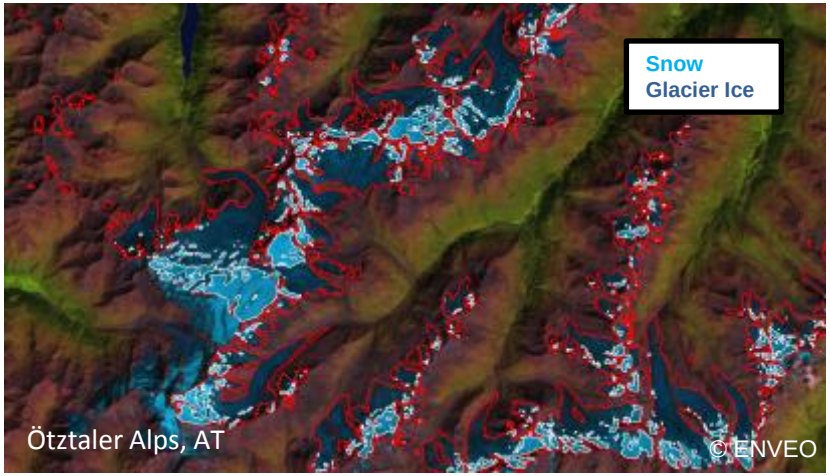
Applications in Pakistan, Turkey, West Balkan

Glacier Products

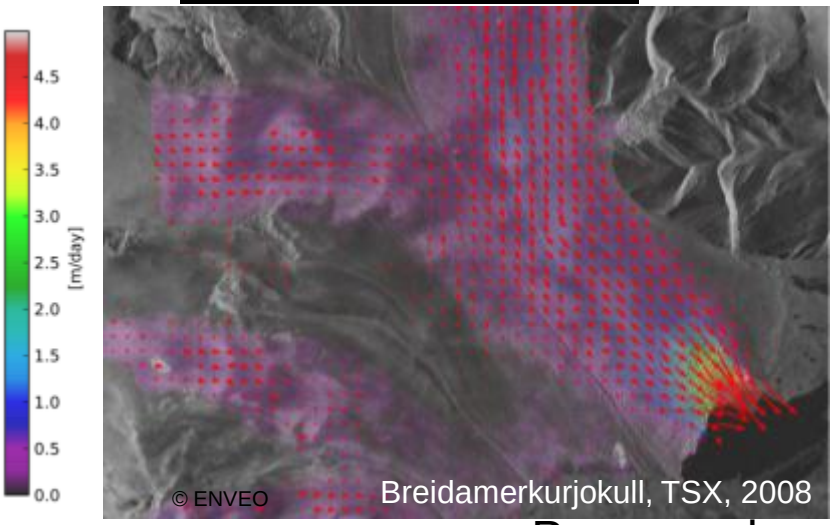
Glacier Outlines



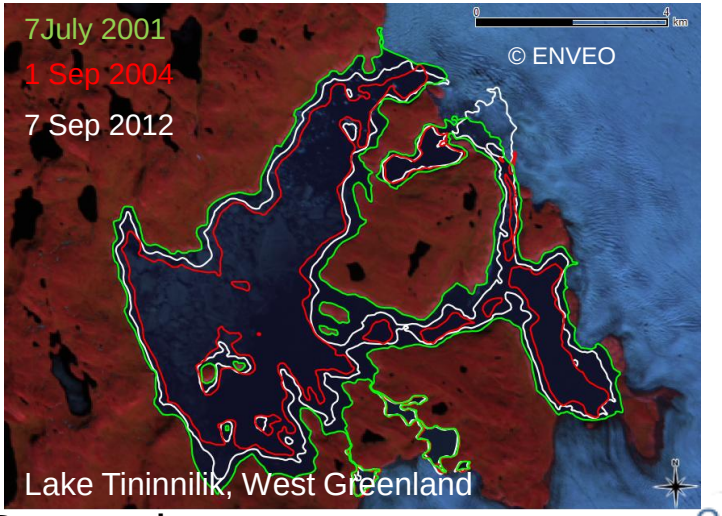
Snow and Glacier Ice areas



Ice Velocity Fields



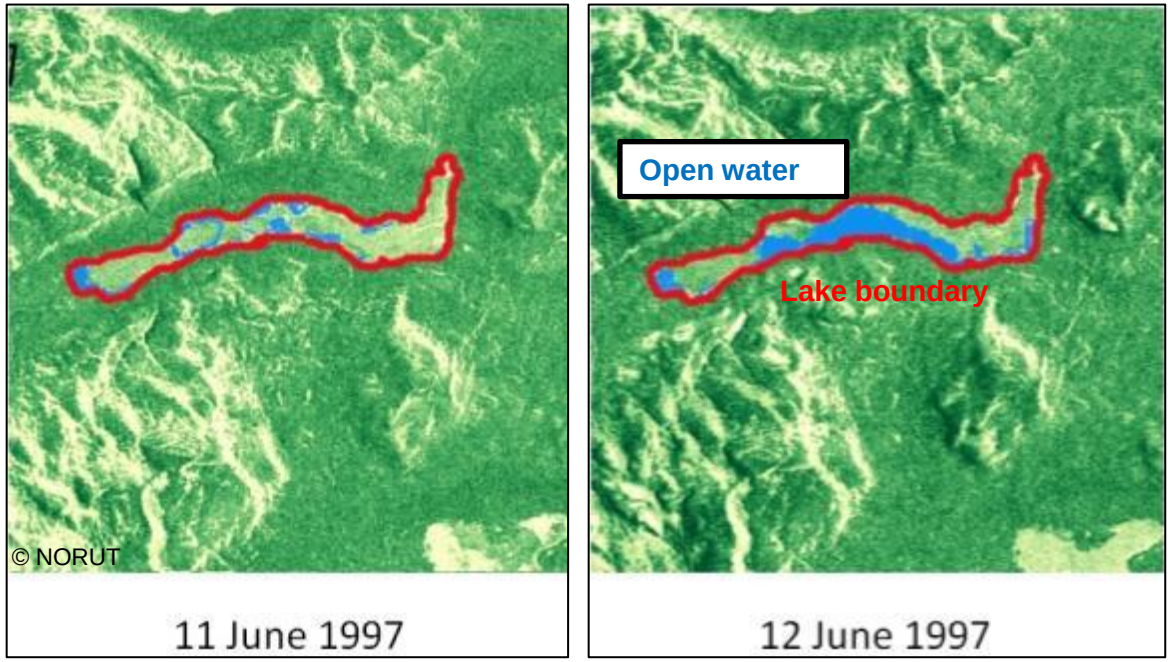
Extent of Glacier Lakes



Processed on Users Demand

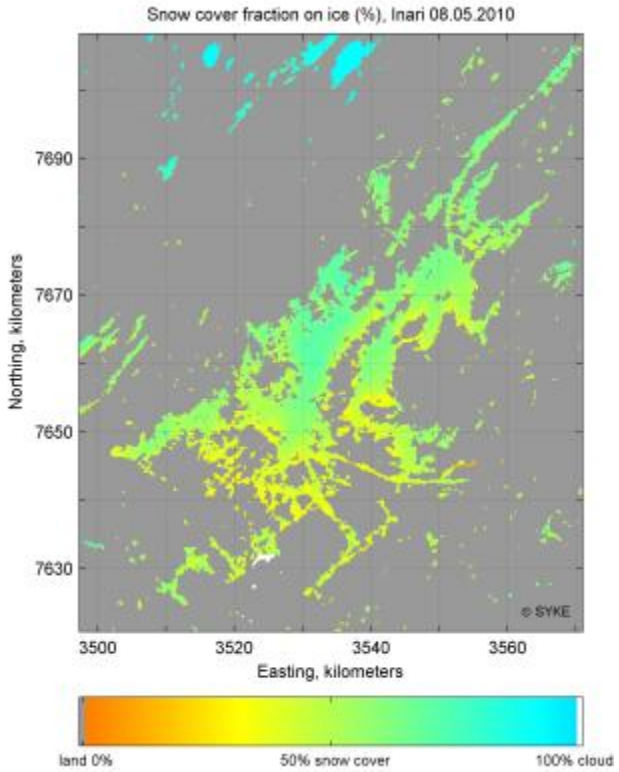
Lake / River Ice Prototype Products

Fresh Water Ice Extent and Temporal Changes



Break up of lake ice at the lake Nedre Heimdalsvatn, Norway: red - lake boundaries; blue – open water; green – lake ice.

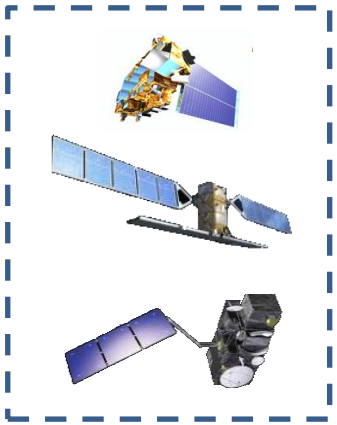
Snow Cover on Lake Ice



Snow covered (FSC) area on lake ice , 8 May 2010

Service Level Concept

Satellite EO



EO Data Providers

GMES Core Service Land

In-situ Data

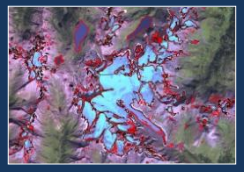
In-situ Data Providers

CryoLand

Product Providers

Snow

Glacier

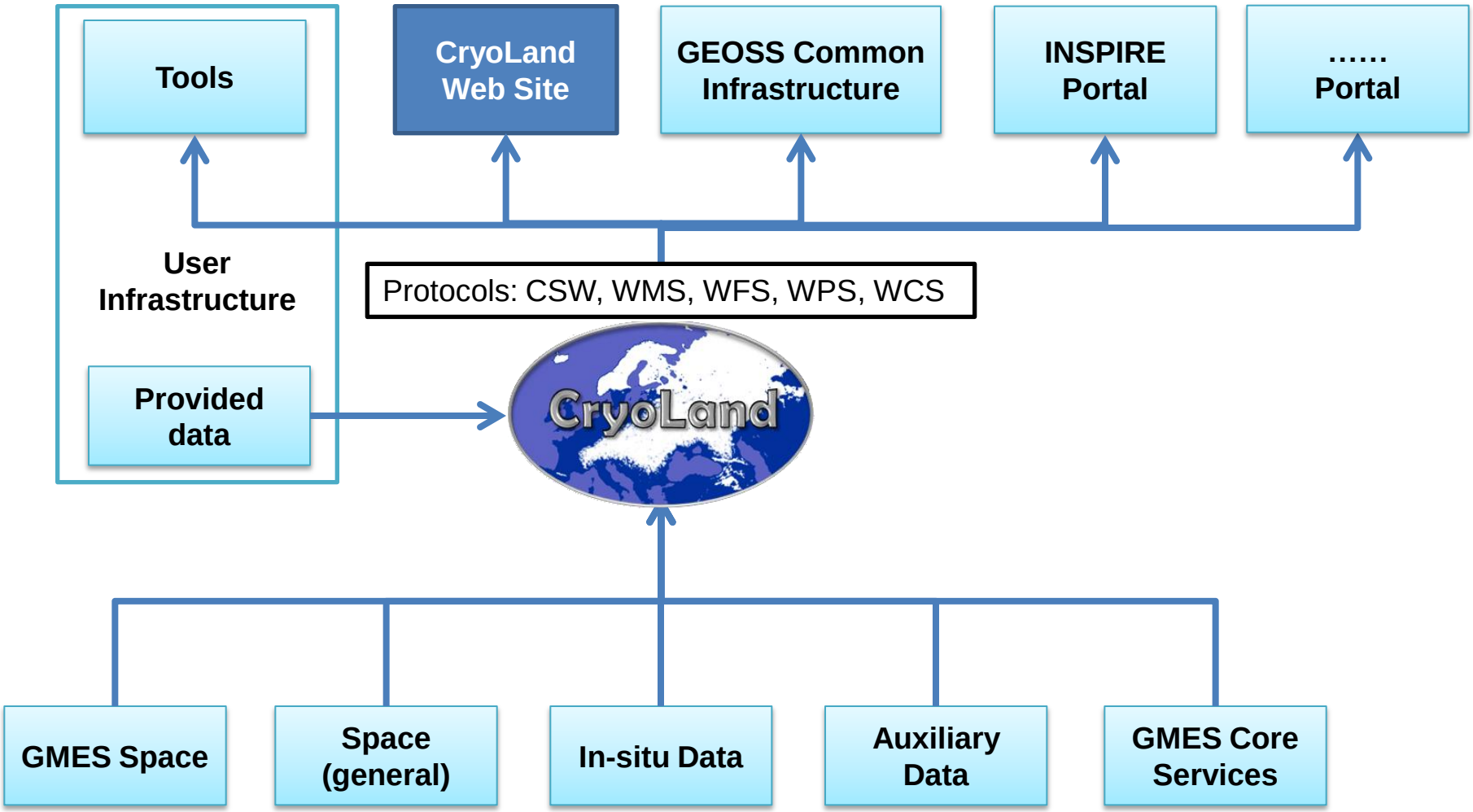


Lake /River Ice

User

Data provided by the user

Product and Information Exchange



CryoLand Snow – Ongoing Activities

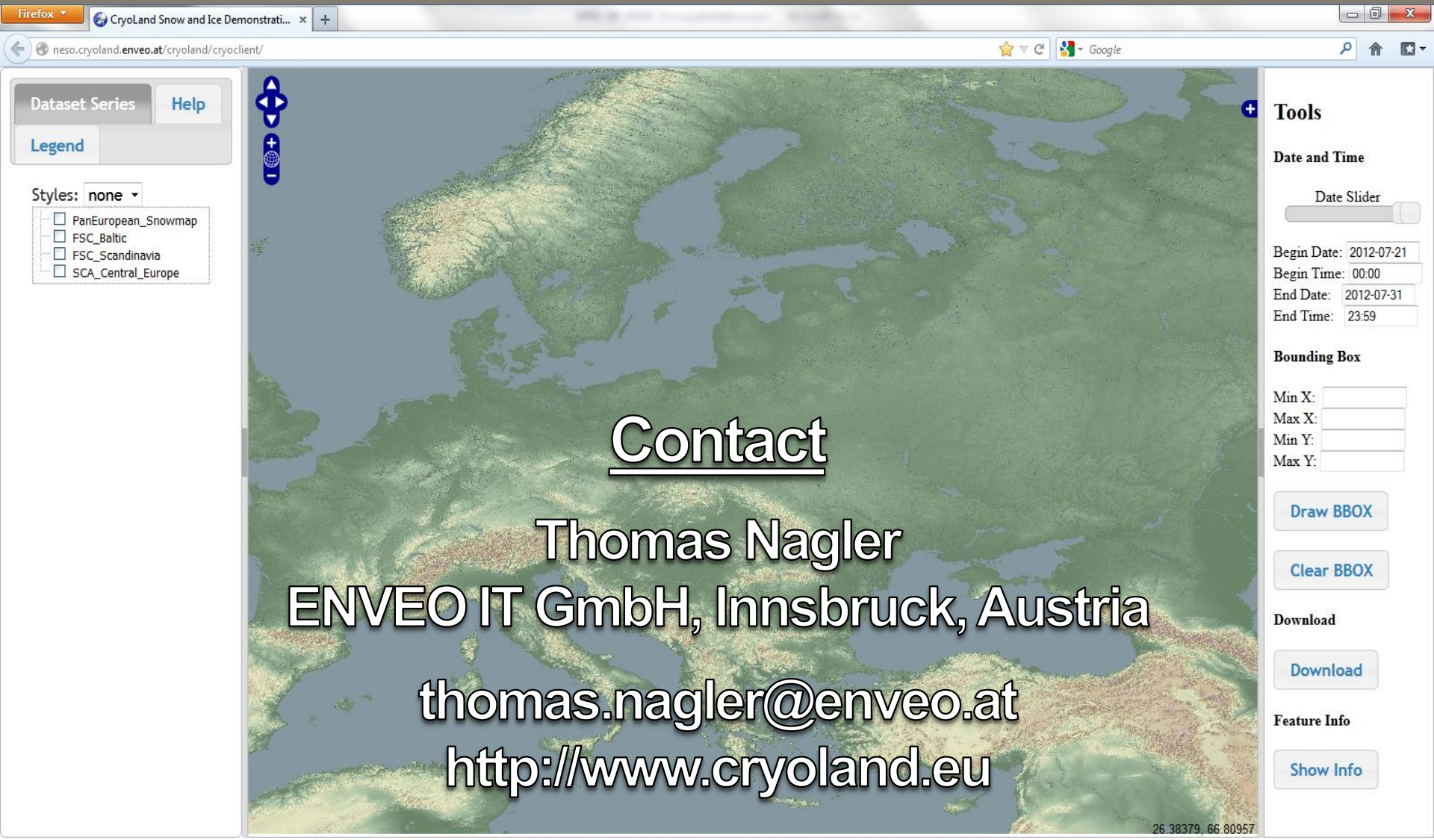
- NRT Time Pilot Service for Pan-European FSC and SWE winter 2012/2013. http://cryoland.eu
- Validation of SE products and products quality assessment
- User WS for evaluation of Pilot Services, planned for May 2013.
- Adaptation and implementation of algorithms to Sentinel Satellite Series.
- End-2-End testing and evaluating of CryoLand Services.
- CryoLand Demonstration of NRT Snow Services 2013/14, including pan-european and regional snow products, but also primary lake ice and glacier products.

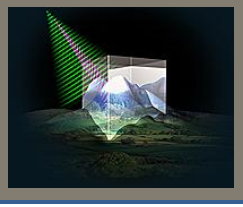
Sustainability of Services after the Project (1/2015)

- CryoLand is designed as a downstream service providing services and products matching user needs. As a downstream service it is planned to be a self-standing service.

- CryoLand has the technical capabilities for covering the cryospheric component of the GMES land core services. It can be expanded towards global snow and land ice monitoring and can contribute to the generation of ECVs of snow, glaciers and lake ice, but so far no mandate to do this as a regular service.

CryoLand Geo-Portal





CoReH$_2$O
A Satellite Mission for Cold Regions Hydrology

Earth Explorer Mission Candidate (EE7) – ausgewählt für Phase-A Studien in 2009

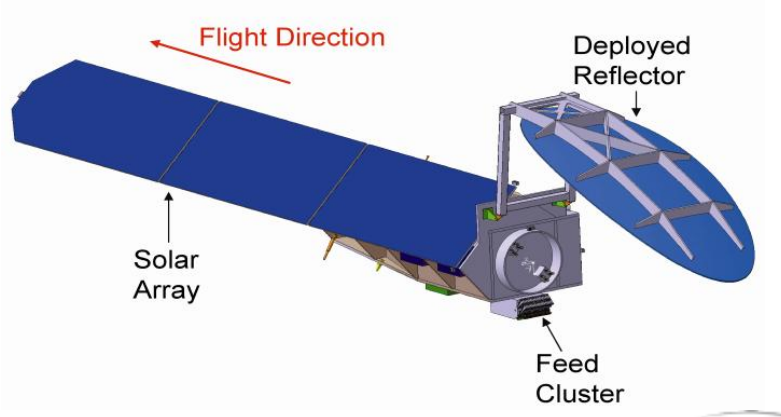
ZIELSETZUNG: Verbesserte Beobachtungen von Schnee und Eisparameter, im speziellen des Wasseräquivalents der Schneedecke und Winterakkumulation auf Gletschern.

für **Anwendungen in**

- Klimaforschung
- Hydrologie und Wasserwirtschaft
- Zur Beschreibung der Austauschprozesse zwischen der Erdoberfläche und Atmosphäre
- Gletscher-Massenbilanz und Wechselwirkung mit Klima
- Schneeschmelze und Gletscherabfluss (Süßwasser-Ressource)

Dauer der Mission	4 Jahre minimum, (Goal: 5 Jahre)
Orbit	dawn/dusk, near polar
Sensor	SAR, Ku-band und X-band, VV und VH Polarisation
Einfallswinkel und Streifenbreite	30 – 45 deg (range) Streifenbreite ≥ 100 km

Technisches Konzept:

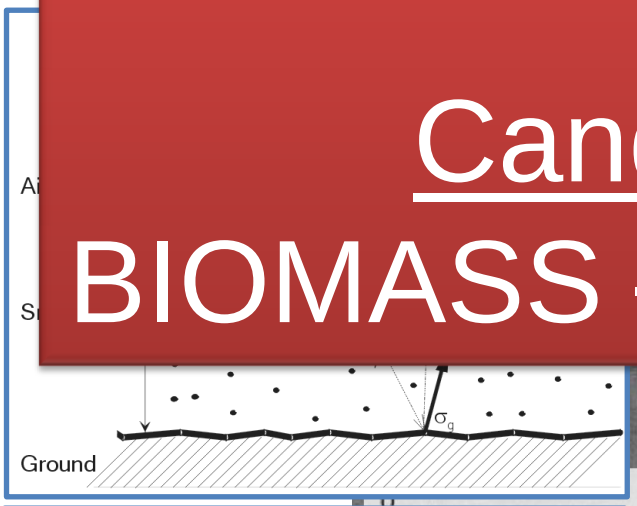


Kartierung der Schneeakkumulation mittels X- und Ku-Band Radar

Inset:
Ve
SW
Ra
in-
Me

Selection of Earth Explorer-7
5-6 March 2013 Graz

Candidate Missions:
BIOMASS – CoReH2O – Premier



Backscatter contributions:
Volume, surface, and interaction terms

$$\sigma^0 = \sigma^{as} + \sigma^{v} + \sigma^{gv} + \sigma^{g'}$$

Karte der Schneeakkumulation: Kuparuk River, Alaska, difference Feb. 2008 –Nov. 2007 von Ku-VV & VH (PolScat), X-VV & VH (TSX)