

CryoLand

Lake and River Ice

Services and Products



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CryoLand Dissemination Workshop, Innsbruck, Austria, 4 Dec. 2014

Lake and River Ice – Product overview



Variable	Provider	Resolution	Sensor type	Region	Status
Lake Ice Extent (Optical)	SYKE & FMI	0.0025 °	MODIS/Terra	Extended Baltic (Pan-European)	Operational service
Lake Ice Extent (SAR Data)	NORUT	10-100m	SAR [Radarsat-2, Sentinel-1]	Selected Areas	Pre-operational (by user requests)
River Ice Extent (SAR Data)	NORUT	1 - 50m	Multi-sensor/SAR [Radarsat-2, TSX, CSK, S-1] (LS8 & S2 also suitable)	Selected Areas	Pre-operational (by user requests)

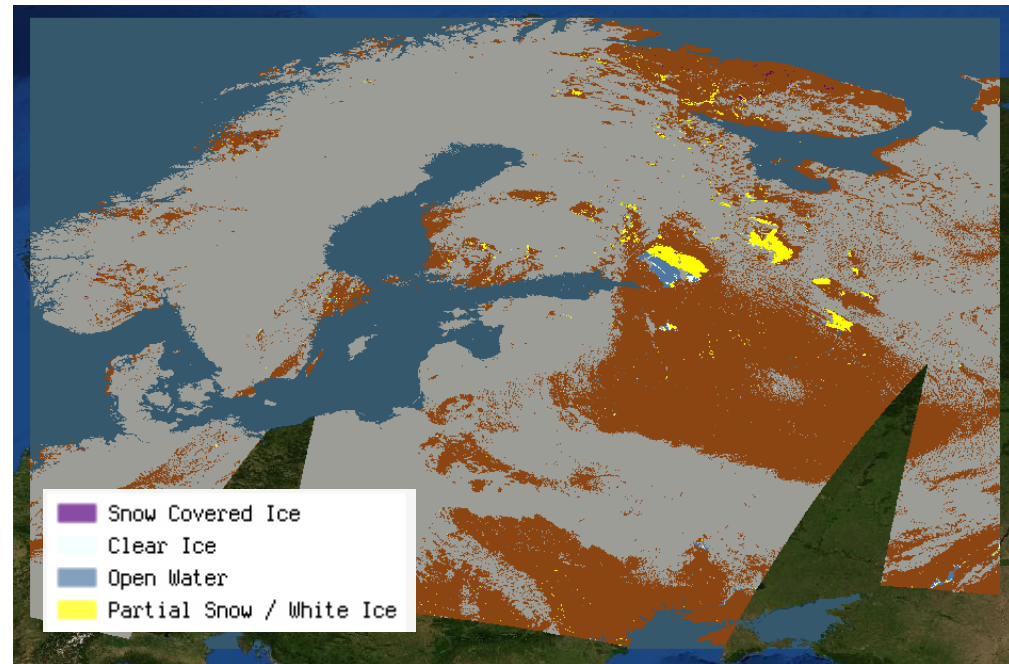
EO Data:

- Moderate resolution optical: Moderate resolution imaging spectrometers (MODIS/Terra)
- SAR and HR optical systems: Radarsat-2, Sentinel-1, TerraSAR-X, Cosmo-SkyMed, SPOT-4/5, Landsat-8)
- PMW systems: DMSP SSMI/S (applied for development efforts)

Optical Lake Ice Extent - SYKE/FMI

Status:

- NRT Data production & delivery begun late January 2014
 - Data packaging according to CryoLand specifications
 - Data available from: <http://neso.cryoland.enveo.at/cryoland/cryoclient/>
- Operations for winter 2014-2015 guaranteed



Baltic LIE Product : April 29 2013

Parameter	Specification
Thematic variable	Lake ice extent
Thematic accuracy	Mapping accuracy: 74% (overall classification accuracy against operator interpreted SPOT-4 imagery)
Spatial coverage	Extended Baltic Sea drainage basin (Pan-European)
Delivery time period	Spring (Feb-Jun) / Restricted by cloud cover and amount of day light
Temporal frequency	Daily 4-8 hours from image acquisition
Spatial resolution	0.0025 °
Sensor	MODIS/Terra
CryoLand status	Operational



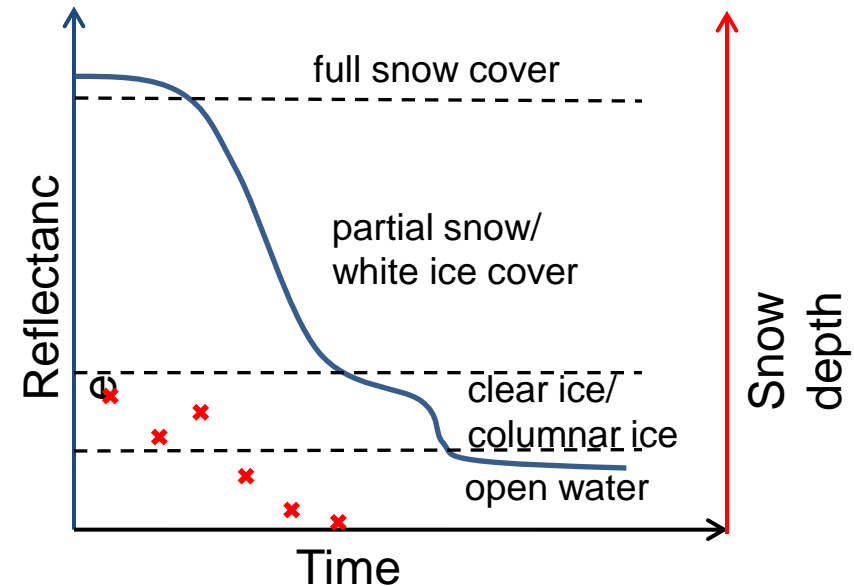
S Y K E



Optical Lake Ice Extent - SYKE/FMI

- **Specification:**

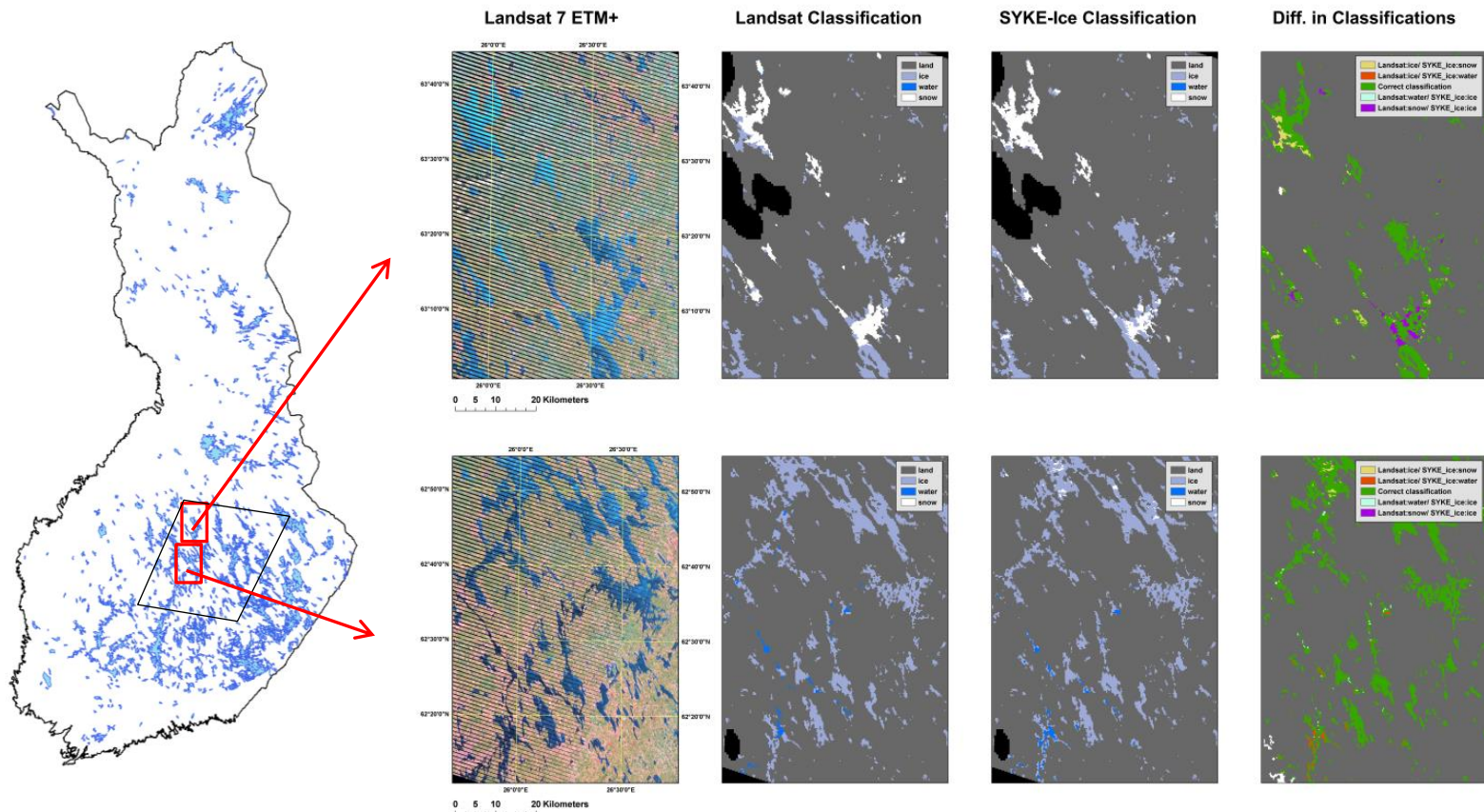
- Algorithm: Reflectance thresholds
 - Threshold reflectances derived by **comparing snow-depth on ice in-situ observations and MODIS- reflectance time-series and compared to corresponding values from literature.**
- The interpretation reduced to four class classification:
 - 1) Full snow cover
 - 2) Partial snow / white ice cover
 - 3) Clear ice
 - 4) Open water
- Spatial resolution 250m
 - Using MODIS Band-1 (620-670 nm)
 - Thresholds can be determined for other instruments as well (e.g. VIIRS & Sentinel-3).
- Daily product for melting season
- Covering Extended Baltic Sea drainage basin (Pan-Europe)
- Restricted by
 - cloud cover and season (i.e. amount of day light)
→ only spring season observed



The threshold reflectances determined from time series of MODIS reflectance observations from the surroundings of in-situ measurements for snow cover thickness on ice.

Optical Lake Ice Extent - validation

- Comparison against visually interpreted Landsat- images
 - Qualitatively: The general pattern of snow covered areas and open water areas are identified. Differences due to method of classification and resolution.
 - Overall mapping accuracy: 74% (overall classification accuracy against operator interpreted SPOT-4 imagery)
 - A test case from 30th April 2010 using Landsat 7 ETM+ image shown below



SAR Lake Ice Extent (LIE) product - Norut

Status:

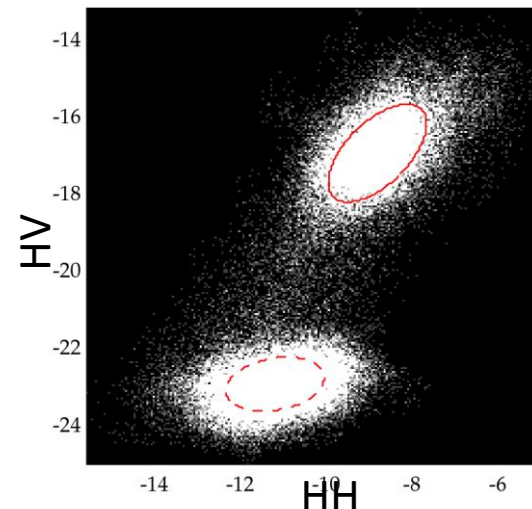
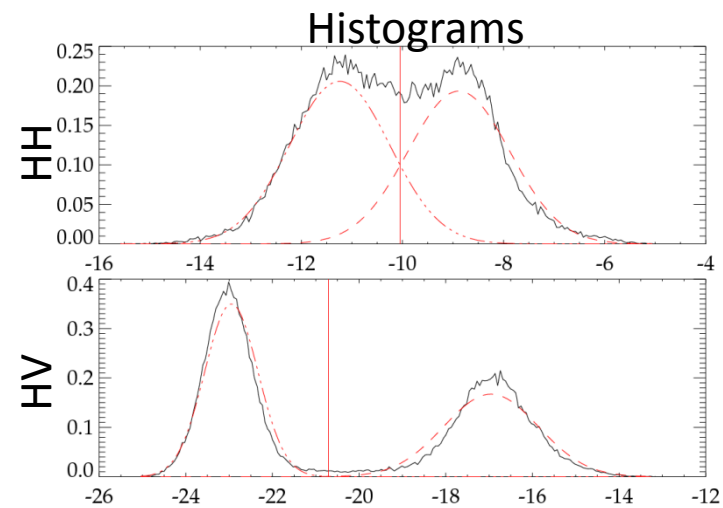
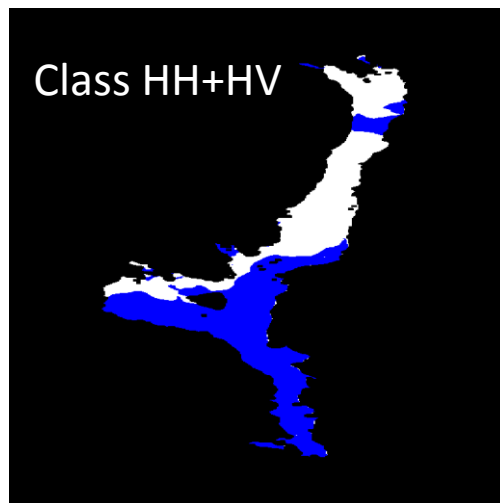
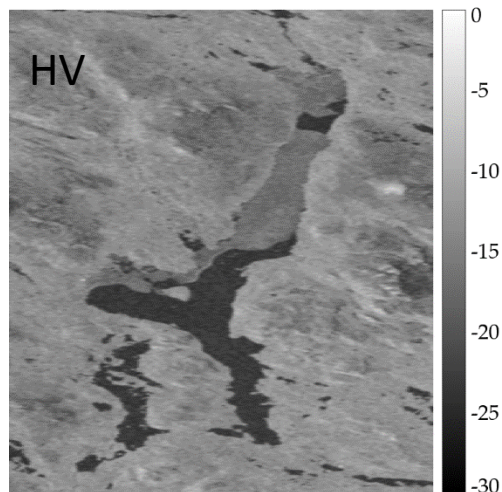
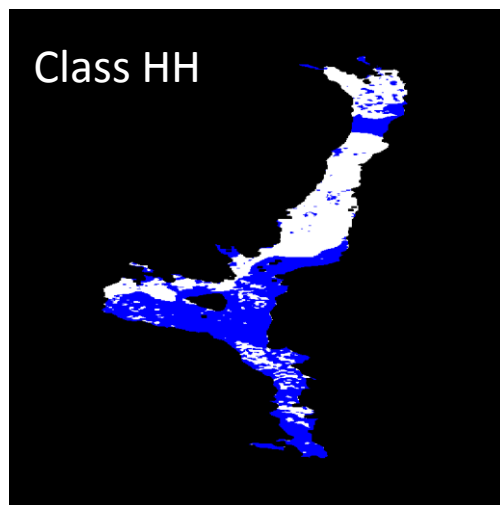
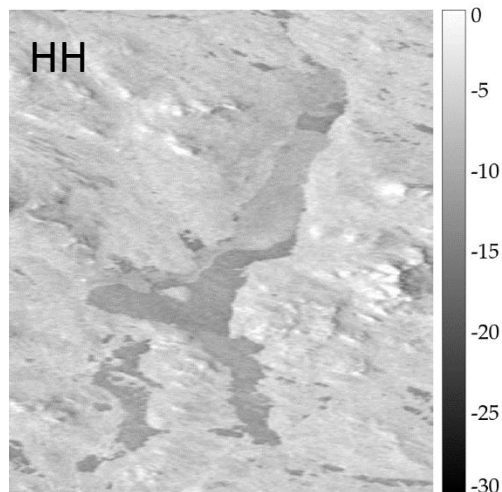
- Algorithms developed for dual-pol RS2 data
- Automatic processing, NRT
- Requires manual pre-selection of suitable scenes
- Not operational in Cryoland
- Will continue demonstrating lake ice detection in Norway using Radarsat-2 data



LIE products on Tyn, Norway, for 31 december 2013 (left) and 14 Januar 2014 (right)

Parameter	Specification
Thematic variable	Lake ice extent
Thematic accuracy	Validation is on-going
Spatial coverage	Norway
Delivery time period	Winter/spring
Temporal frequency	When data is available
Spatial resolution	0.0007°
Sensor	Radarsat-2
CryoLand status	Not operational

Rsat-2: lake Femunden May 16th 2013



SAR/multi-sensor River Ice Extent product

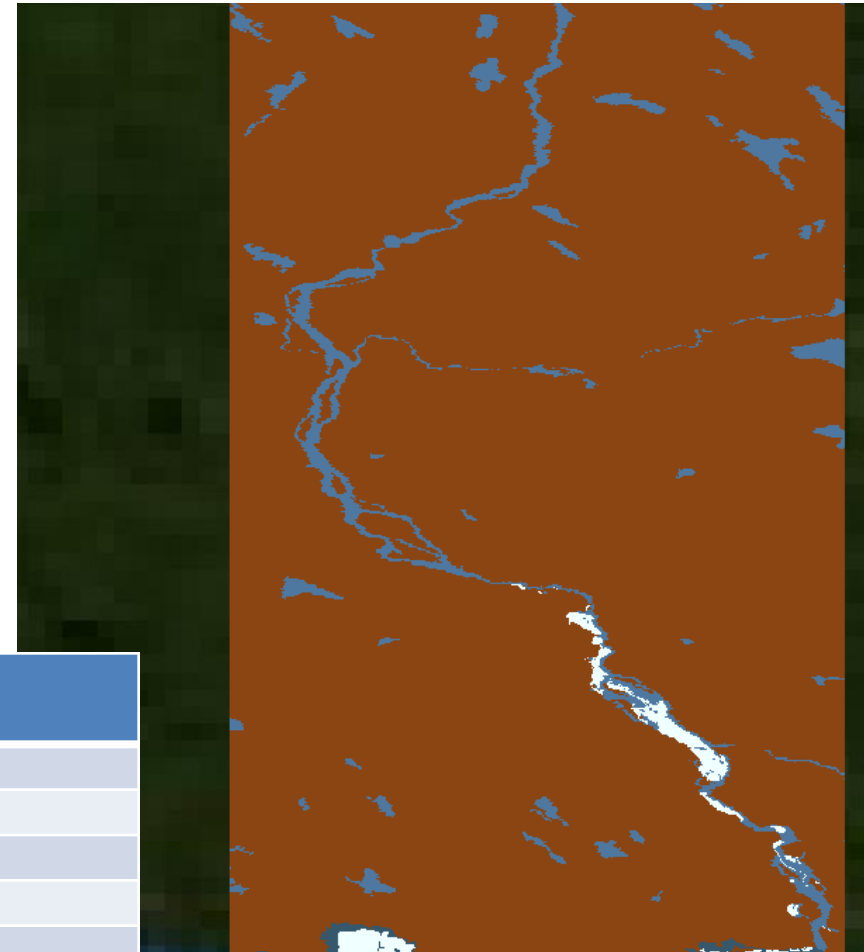
Norut



Status:

- Emergency service was demonstrated for Norway/Sweden/Finland for the spring of 2014
- Acquisitions in Torneriver + Tana river, prepared for emergency acquisitions if and when something occur
- Coordinated with NVE, SYKE and SMHI

Parameter	Specification
Thematic variable	River ice extent
Thematic accuracy	N/A
Spatial coverage	Norway, Sweden, Finland
Delivery time period	Winter/spring
Temporal frequency	When data is available
Spatial resolution	2-3 m
Sensor	Radarsat-2, TS-X, Cosmo-Skymed
CryoLand status	Not Operational



RIE Product Torne River 6 May 2013

Torneriver, time-series 2008 (Finland/Sweden)



Envisat ASAR

SPOT

Envisat ASAR

28.04.2008

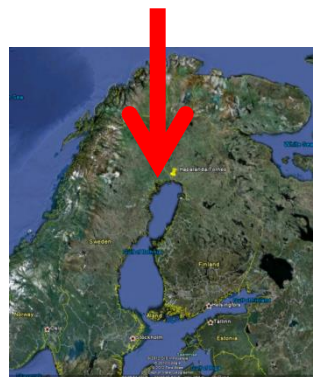
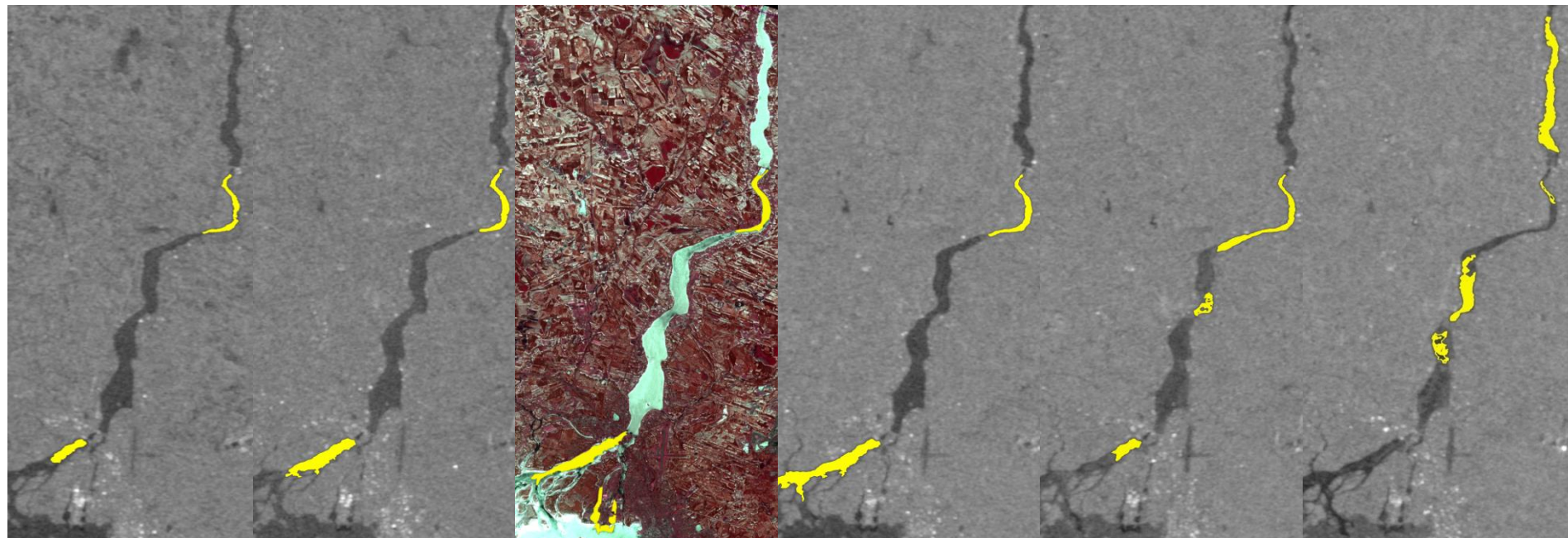
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30.04.2008

01.05.2008

02.05.2008

04.05.2008

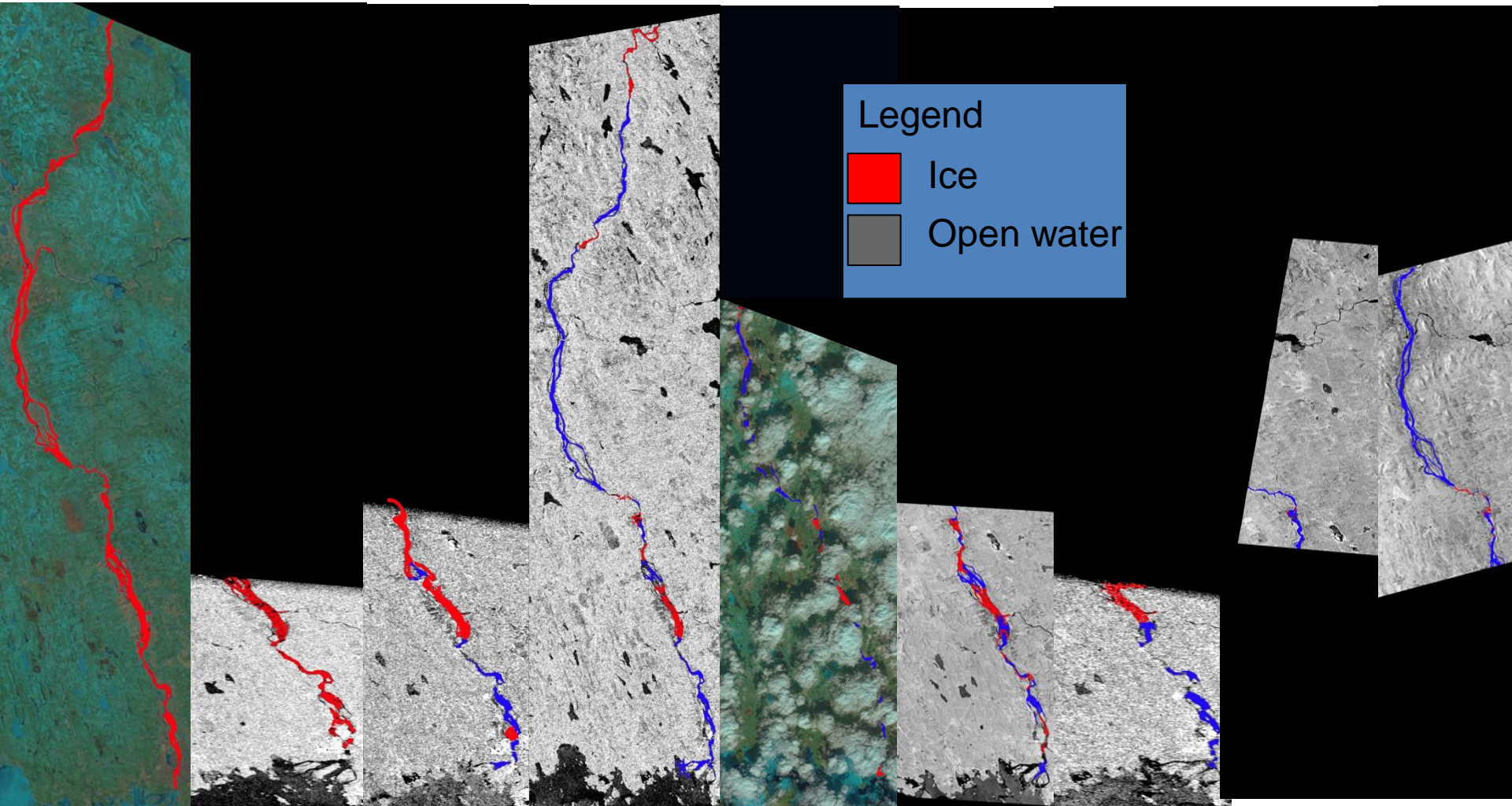


Open leads on Torneriver, supervised classification

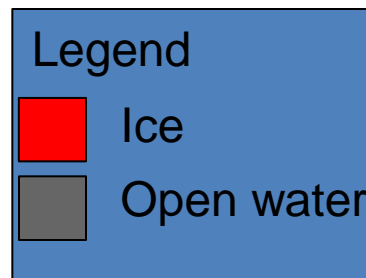
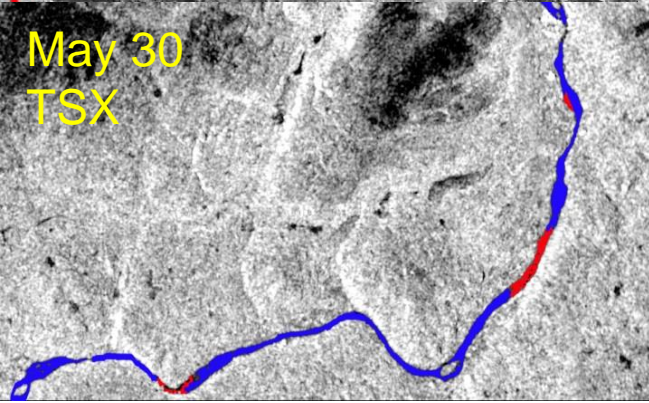
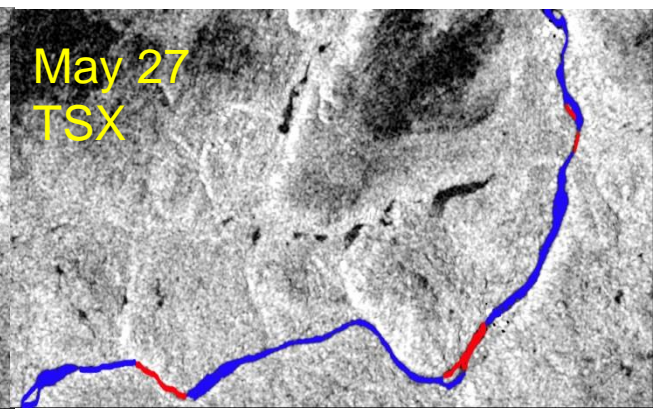
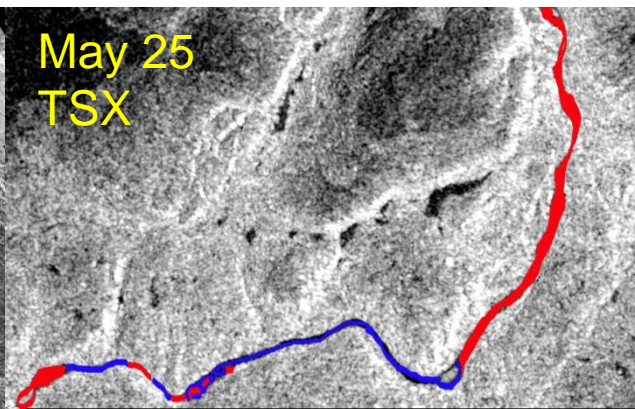
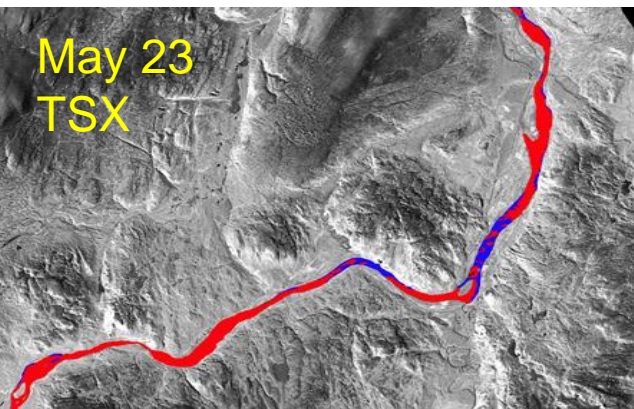
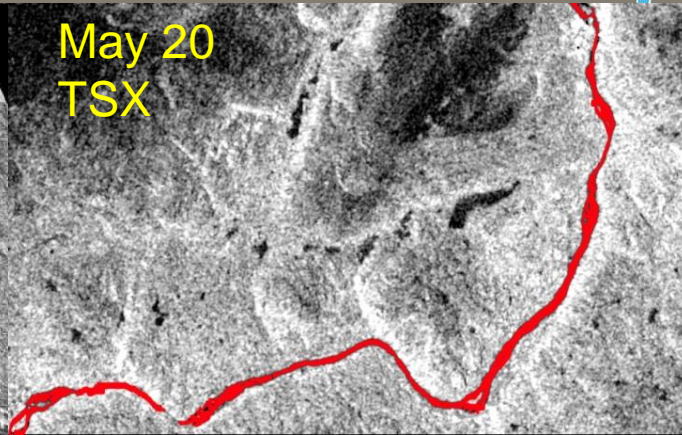
Torneriver, 2014: Ice breakup (multi-sensor)



LS-8	RS-2	CSK	RS-2	LS-8	CSK	RS-2	CSK	CSK
25.04	28.04	01.05	02.05	02.05	03.05	04.05	05.05	07.05



Tana River, 2014: –classified time series



Torneriver, Sentinel-1: 20 Sept. 2014



Pixel spacing
40x40 m

Sentinel-1 will allow high resolution (oper.) services for Lake and River Ice applications, although with certain limitations due to resolution and polarization specs

Lake and River Ice – Summary



- A new Optical Lake Ice Extent algorithm based on Terra/MODIS 250m reflectance data was developed and operationalized by SYKE
- Optical LIE products have been made available for users through the CryoLand GeoPortal by SYKE and FMI
- NORUT has continued improvement and testing of High Resolution Lake and River Ice Extent detection using multi-sensor data
 - Lake ice demonstrated for a few selected Norwegian and Finnish lakes
 - Lake ice: Potential shown, dual pol data are preferred, limited capabilities due to low temporal coverage during spring melt period (data limited)
 - River ice: Demonstrated in Torneo (2013 and 2014) and Tana (2014) rivers
- Both (Pre-operational, High Resolution) lake and river ice products can be operationalized if interest is expressed and funding can be secured

Thank You