Ground-based validation of satellite snow products

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WP-2170

IDEAS-QA4EO Workshop, 01.04.2022.

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Outline

- Environmental **camera networks** and the portal
- FMIPROT (**Image processing toolbox**)
- **NRT Processing** of snow cover
- Geolocation **metadata** in **webcam** derived data **IN PROGRESS**
- **API** for webcam derived data **download** **DONE**
- **NRT** Comparison of **webcam vs satellite** data **DONE**
- Airport and Phenocam Network cameras **DONE**
- **In-situ** data and satellite data **validation**
- **NRT** Comparison of **in-situ vs satellite** data **IN PROGRESS**
- **Visualization** options **PLANNED**
- **Machine learning** methods in **webcam** data processing **PLANNED**

FMIPROT & Camera Network Portal

FMIPROT
- Download
- Publications
- Tutorials

Camera Network Portal
- MONIMET
- UEF
- PHENOCAM
- EUROPHEN
- LUMIKE

Operational Monitoring
- MONIMET SD
- LUMIKE SD
- MONIMET FSC
- LUMIKE FSC
- Phenocam FSC M
- Phenocam FSC A
- MONIMET Vegetation
- UEF Vegetation
- LumiPilotti
- LumiPilotti All
- Download Data

Cal/Val Activities

Contact Information

FMI

Camera Network Portal

This portal aims to list existing camera networks and provide information and links on how to reach the data. All data belongs to their rightful owners as indicated in their webpages and/or publications.

If the communication protocols of the webcams are supported by FMIPROT, their CNIFs (camera network information file) are provided so the data can be used in FMIPROT. CNIFs also provide available metadata collected from publications and webpages to be used in this website for visualization purposes (e.g. marking on maps) and also for camera specification and geolocation dependent processing (e.g. georectification).

Map of the cameras

This map only shows the cameras where the geolocation metadata is available. Cameras in the same location may seen as one. Click and move to pan and scrool to zoom in/out. Camera view direction is also shown if the camera direction is available in metadata. Different colors of camera icons indicate different camera networks, where available, not their status.

https://fmiprot.fmi.fi/

FMIPROT & Camera Network Portal

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MONIMET Camera Network

MONIMET Camera network is a network of digital surveillance cameras for automated monitoring of phenological activity of vegetation and snow cover in the boreal ecosystems of Finland. Cameras were mounted at 14 sites, each site having 1-3 cameras. Detailed information for the camera network and the data can be found in Peltoniemi et al.

Data

Image datasets can be found under the Zenodo community 'Phenological time lapse images and data from Monimet EU Life+ project (LIFE12 ENV/FI/000409).' Datasets in Zenodo are updated every year. For access to the data by FMIPROT over direct FTP (only for operational monitoring), contact MONIMET project team with the information implying your purpose and duration of your study.

MONIMET imagery data downloaded from Zenodo repositories can be processed using FMIPROT. In the next section, there is the link to an offline camera network information file (CNIF), which can be loaded into FMIPROT to add the camera network.
Replace the path of the images in the CNIF (marked with {edit_here}) with the path that you have downloaded the images from Zenodo repositories, and FMIPROT will be able read and process images directly.

A tutorial for that is available here. It only takes a few minutes to add the cameras to FMIPROT and start processing.

Metadata & Status

Last updated at 2022-03-30 17:44:34. Refresh the page for the latest update.

FMIPROT Online CNIF Link (for operational use, to process near real time images): http://fmiprot.fmi.fi/camnet/cnifs/monimet.tsvx
FMIPROT Offline CNIF Link (For processing already downloaded images in your machine): http://fmiprot.fmi.fi/camnet/cnifs/monimet_local.tsvx

34 cameras are listed from metadata (some cameras may not be present or active). If the number of cameras is 0, then there may be a problem in the update of the metadata. >>Report such case

Show the list of the cameras and the metadata

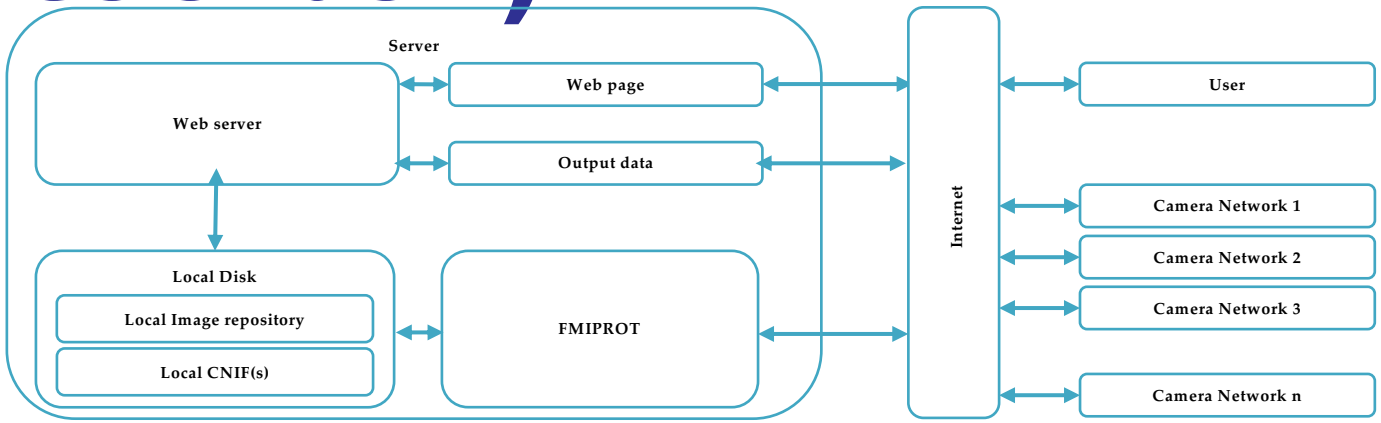
Latest camera images

Show latest images

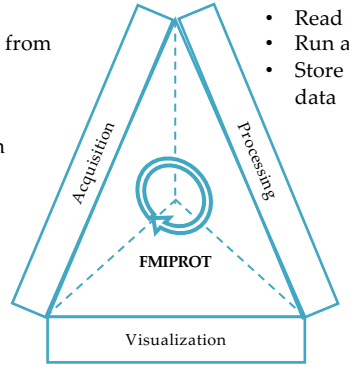
https://fmiprot.fmi.fi/

FMIPROT (Image processing toolbox)

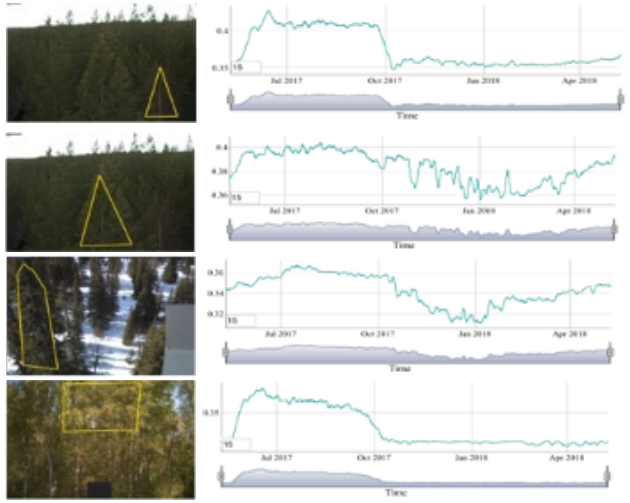
OPEN SOURCE

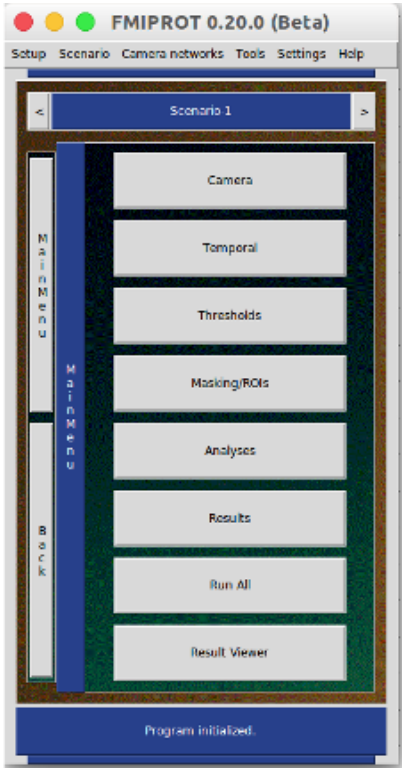


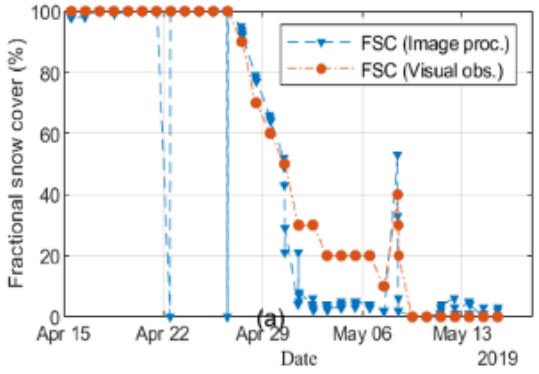
- Get camera information from CNIF(s)
- List and download images from repositories

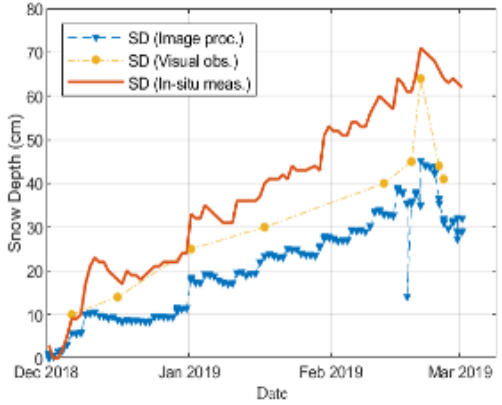


- Read images
- Run algorithms
- Store results as raw data
- Generate report with visualized results









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Tanis, 2020
Arslan et. al., 2017

Operational Monitoring (NRT Processing)

Status of setups

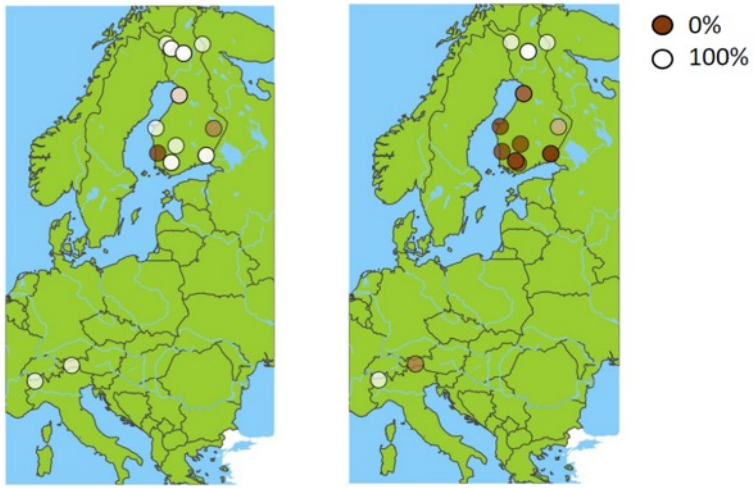
Name	Setups	Analyses	Clock	Intervals	Last run time	Link to the results
Snow depth monitoring with MONIMET Camera Network	4	4	5 - 20	30 mins.	Start: 2022-03-30 19:36:01 EEST Finish: 2022-03-30 19:36:54 EEST	
Snow depth monitoring with LUMIKE Cameras in Sodankylä	1	4	5 - 20	60 mins.	Start: 2022-03-30 19:07:01 EEST Finish: 2022-03-30 19:07:03 EEST	
Fractional snow cover monitoring with MONIMET Camera Network	7	7	5 - 20	30 mins.	Start: 2022-03-30 19:37:01 EEST Finish: 2022-03-30 19:38:22 EEST	
Fractional snow cover monitoring with LUMIKE Cameras in Sodankylä	1	2	5 - 20	60 mins.	Start: 2022-03-30 19:11:02 EEST Finish: 2022-03-30 19:11:04 EEST	
Fractional snow cover monthly monitoring with Phenocam Cameras	2	2	5 - 20	60 mins.	Start: 2022-03-30 19:11:04 EEST Finish: 2022-03-30 19:12:39 EEST	
Fractional snow cover annual monitoring with Phenocam Cameras	3	3	5 - 20	24000 mins.	Start: 2022-03-21 05:02:02 EET Finish: 2022-03-21 05:26:39 EET	
Vegetation monitoring with MONIMET Camera Network	15	35	5 - 20	30 mins.	Start: 2022-03-30 19:36:54 EEST Finish: Running now	
Vegetation monitoring with UEF Cameras	2	2	5 - 20	30 mins.	Start: 2022-03-30 19:42:01 EEST Finish: 2022-03-30 19:42:58 EEST	
Snow cover monitoring pilot with FMI HAV Cameras (Latest one month)	8	25	5 - 21	10 mins.	Start: 2022-03-04 07:07:03 EET Finish: Running now	
Snow cover monitoring pilot with FMI HAV Cameras (All dates available)	11	56	1 - 2	43200 mins.	Start: 2022-02-11 03:07:02 EET Finish: 2022-02-11 07:08:07 EET	

Last run is on time | Running now | Next run is late

Data

140 analyses in 54 setups are producing output data for **16 parameters**, using input data from **49 cameras** in **5 camera networks**.

The data can be downloaded in **Download Data** page.



Webcam derived FSC
Latest values at
2021-03-16T16:00:00

Webcam derived FSC
Latest values at
2021-03-31T16:00:00

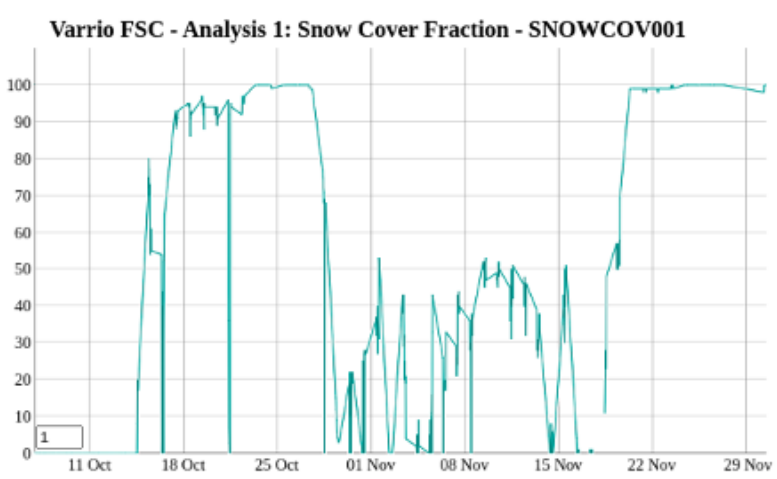
Fractional snow cover monitoring with MONIMET Camera Network

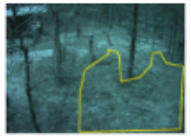
Results

7 setups are defined for operational monitoring.

Select setup to switch to: varrio

varrio





>Setup report page
>Download/Open data file
Plot:
Snow Cover Fraction
Reset plot
Toggle help

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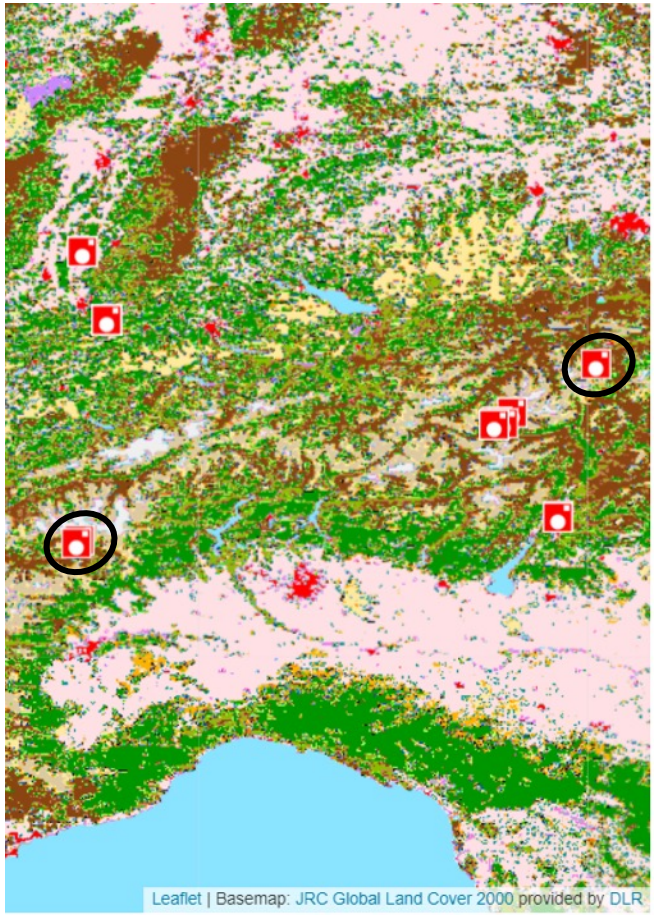
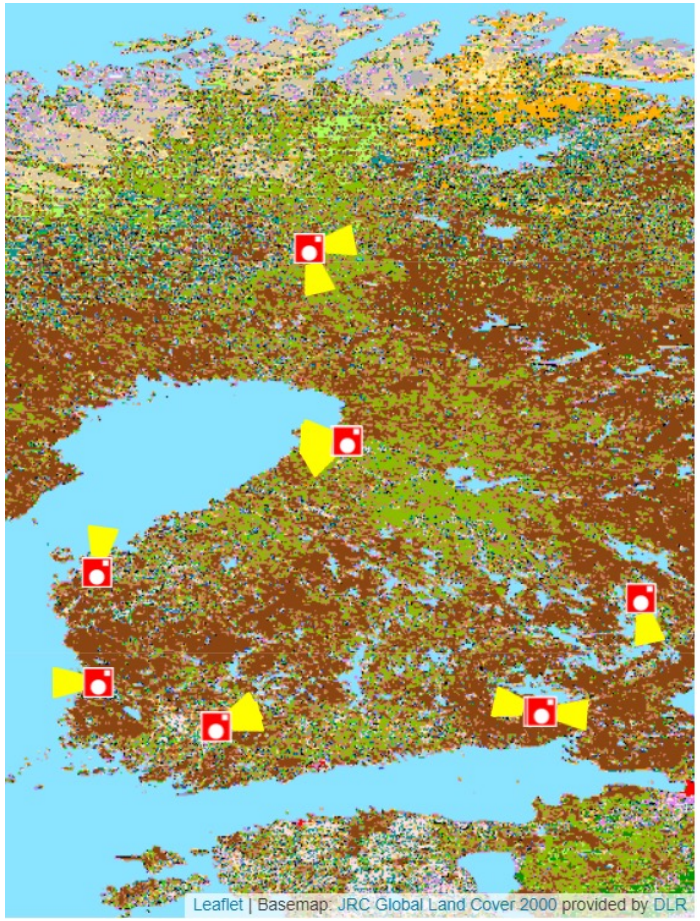
Airport Cameras in Finland and Phenocam Cameras in The Alps





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API for webcam derived data download

Parameters:

- All
- Green Fraction
- Red Fraction
- Snow Cover Fraction
- Snow Depth

Networks:

- All
- LUMIKE
- MONIMET
- UEF

Cameras:

- All
- Hyytiala Pine Crown
- Hyytiala Pine Ground
- Jokioinen Agriculture Landscape
- Kaamanen Wetland Ground
- Kenttarova Spruce Canopy
- Kenttarova Spruce Crown
- Kenttarova Spruce Ground
- LUMIKE-6032OverAll
- LUMIKE-6032R1
- LUMIKE-6032R2
- LUMIKE-6032R3

Start date (ISO):	2020-11-23T00:00:00
End date (ISO):	2020-11-30T23:59:59
Latitude (degrees):	0.00
Longitude (degrees):	0.00
Distance (degrees):	201.25
Bounding box (degrees):	-180.00,-90.00,180.00,90.00
Special filters:	None
Format:	Download as CSV File

Submit

HTTP Request:
https://fmiprot.fmi.fi/operational/getdata.php?**parameters**=Snow+Cover+Fraction&**network**=MONIMET&**startdate**=2020-11-23T00%3A00%3A00&**enddate**=2020-11-30T23%3A59%3A59&**format**=csv

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Comparison with satellite data

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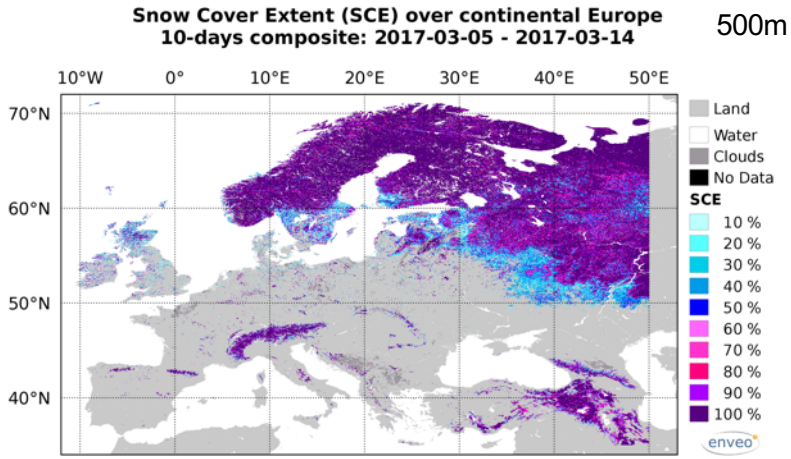
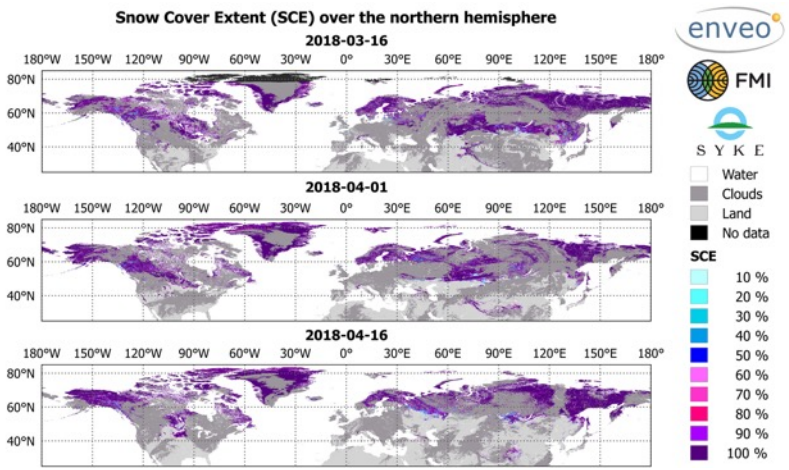
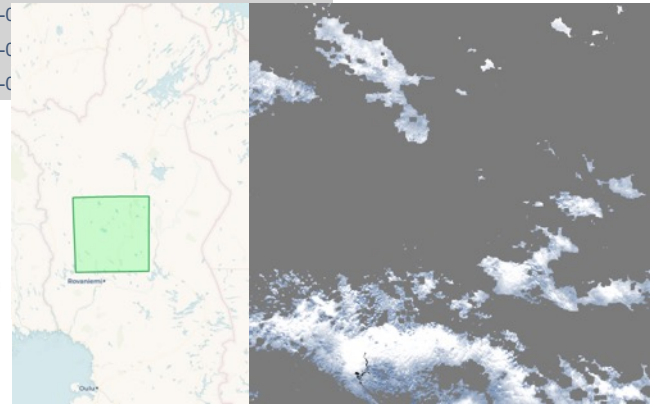
Network	Camera	Latitude	Longitude	Elevation	Timezone	Time	Snow Cover Fraction
MONIMET	Hyytiala Pine Ground	61.84769	24.29496		+01:00	2022-03-29T11:01:35	1.0
MONIMET	Hyytiala Pine Ground	61.84769	24.29496		+01:00	2022-03-29T11:31:35	1.0
MONIMET	Hyytiala Pine Ground	61.84769	24.29496		+01:00	2022-03-29T12:01:38	nan
MONIMET	Hyytiala Pine Ground	61.84769	24.29496		+01:00	2022-03-29T12:31:38	1.0
MONIMET	Lompolojankka Wetland Ground	67.99725	24.2091		+00:00	2022-03-29T11:00:00	97.0
MONIMET	Lompolojankka Wetland Ground	67.99725	24.2091		+00:00	2022-03-29T12:00:00	98.0
MONIMET	Sodankyla Pine Ground	67.36201	26.63751		+02:00	2022-03-29T11:01:35	99.0
MONIMET	Sodankyla Pine Ground	67.36201	26.63751		+02:00	2022-03-29T11:31:36	100.0
MONIMET	Sodankyla Pine Ground	67.36201	26.63751		+02:00	2022-03-29T12:01:38	100.0
MONIMET	Sodankyla Pine Ground	67.36201	26.63751		+02:00	2022-03-29T12:31:38	100.0
MONIMET	Sodankyla Pine Peatland	67.36849	26.65442		+02:00	2022-03-29T11:01:34	100.0
MONIMET	Sodankyla Pine Peatland	67.36849	26.65442		+02:00	2022-03-29T11:31:34	100.0
MONIMET	Sodankyla Pine Peatland	67.36849	26.65442		+02:00	2022-03-29T12:01:36	100.0
MONIMET	Sodankyla Pine Peatland	67.36849	26.65442		+02:00	2022-03-29T12:31:36	100.0
MONIMET	Tammela Spruce Ground	60.64598306	23.80650111		+02:00	2022-03-29T11:31:35	85.0
MONIMET	Tammela Spruce Ground	60.64598306	23.80650111		+02:00	2022-03-29T12:01:38	0.0
MONIMET	Tammela Spruce Ground	60.64598306	23.80650111		+02:00	2022-03-29T12:31:38	0.0
MONIMET	Varrio Pine Ground	67.75488	29.60989		+00:00	2022-03-29T11:13:39	100.0
MONIMET	Varrio Pine Ground	67.75488	29.60989		+00:00	2022-0	
MONIMET	Varrio Pine Ground	67.75488	29.60989		+00:00	2022-0	
MONIMET	Varrio Pine Ground	67.75488	29.60989		+00:00	2022-0	

500m



1km





CLMS High Resolution Snow and Ice 20m FSC

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RMSE Maps and Plots

Copernicus Snow Cover Pan European 500m Resolution

FSC values for each available webcam location are extracted and directly compared with daily averaged values of webcam derived data. 7 Days RMSE Map shows the RMSE values of value pairs for latest 7 days of available satellite product and corresponding webcam derived data for each location. RMSE from 0 to 100 is colored from green to red. 7 Days Scatter Plot shows value pairs for latest 7 days of available satellite product and corresponding webcam derived data for each location. Different locations are colored differently. 1 Year Scatter Plot shows value pairs for satellite products from latest June 18 to previous June 17 before that year (latest summer-to-summer) and corresponding webcam derived data for each location. Different locations are colored differently.

Maps and plots will only be visible if there is any valid data in comparison. For example, there may be no valid data in winter days due to the camera data corresponds to the low sun zenith angle (polar night) pixels.

21 Days RMSE Map

21 Days Scatter Plot

1 Year RMSE Map

1 Year Scatter Plot

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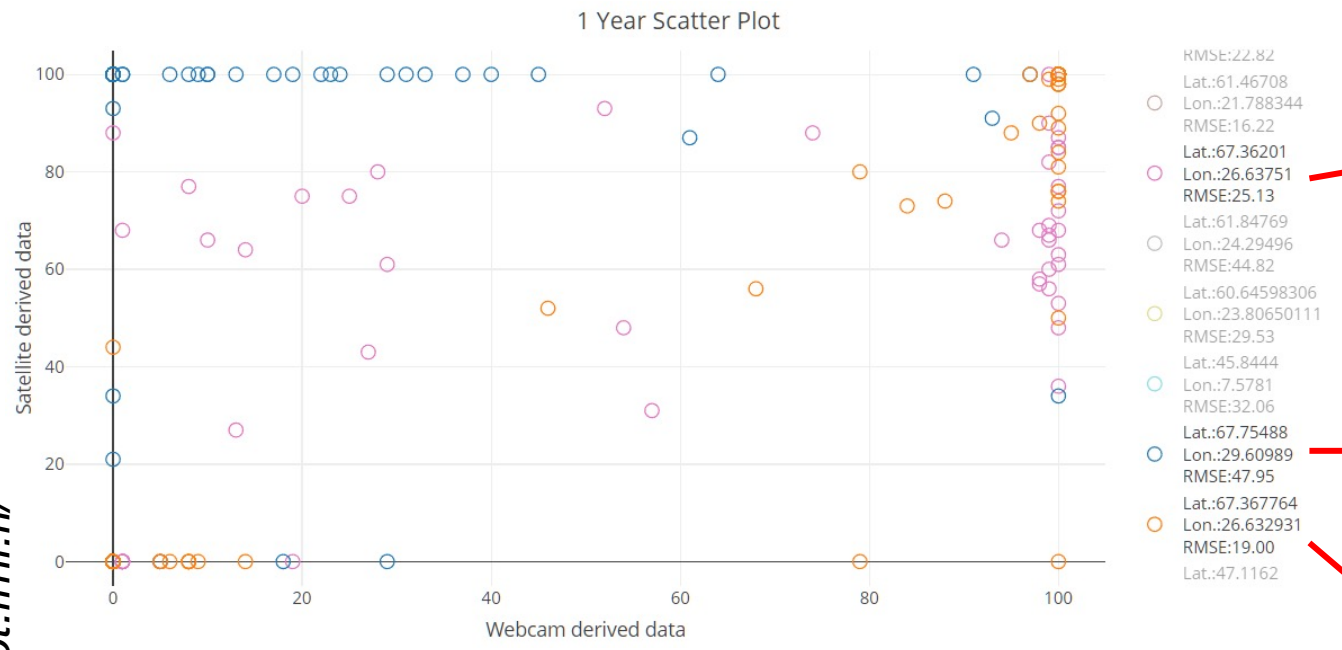
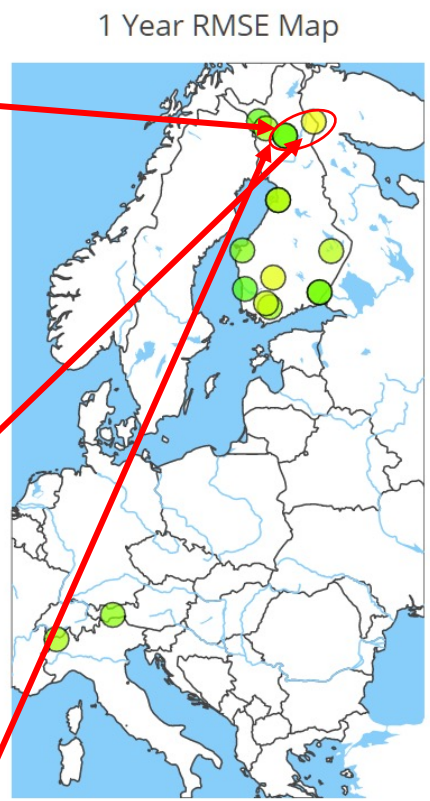
RMSE Maps and Plots





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NRT Comparisons

Cal/Val Activities

Multiple sets of comparisons are running in FMIPROT server regularly, triggered by a job scheduler, producing near real time results for comparison of satellite products with webcam derived data.

Cal/Val activities are in development. Comparison options, the data and the availability may change without notice.

4 sets of comparisons are defined for operational monitoring. Results are visualized in this page.

Name	Sets of calc.	Clock	Intervals	Last run time
Copernicus High Resolution Snow Cover Pan European 20m Resolution	2	1 - 4	1400 mins.	Start: 2022-03-30 01:11:02 EEST Finish: 2022-03-30 01:17:00 EEST
Copernicus High Resolution Snow Cover Pan European 100m Resolution	2	1 - 4	1400 mins.	Start: 2022-03-30 01:12:02 EEST Finish: 2022-03-30 01:18:03 EEST
Copernicus Snow Cover Extent Northern Hemisphere 1km Resolution	2	1 - 4	1400 mins.	Start: 2022-03-30 01:13:02 EEST Finish: 2022-03-30 01:13:24 EEST
Copernicus Snow Cover Pan European 500m Resolution	2	1 - 4	1400 mins.	Start: 2022-03-30 01:13:25 EEST Finish: 2022-03-30 01:13:37 EEST

Last run is on time | Running now | Next run is late

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ESA Living Planet Symposium - poster

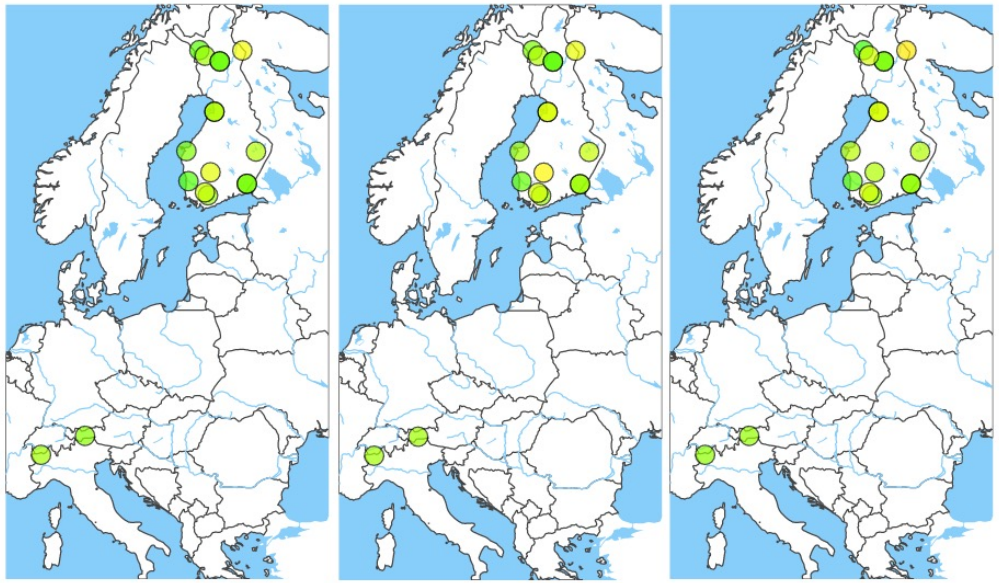
Tue 24.5.2022 (session: A9.07), Bonn, Germany

Near real-time intercomparison of satellite and webcam derived snow cover

Cemal Melih Tanis, Ali Nadir Arslan, Anna Frey, Elisa Lindgren, Burak Simsek, Mwaba Hiltunen, Lasse Latva and Kari Luojus

name.surname@fmi.fi, Finnish Meteorological Institute, Erik Palménin Aukio 1, 00560, Helsinki, Finland

Session: A9.07 Advancements in Remote Sensing of Seasonal Snow



RMSE values from the intercomparison of webcam and satellite derived fractional snowcover for last 1 year of data. Left: Copernicus Snow Cover Pan European 500m Resolution Middle: Copernicus Snow Cover Extent Northern Hemisphere 1km Resolution Right: Copernicus High Resolution Snow Cover Pan European 20m Resolution (Green: 0%, Red: 100%)

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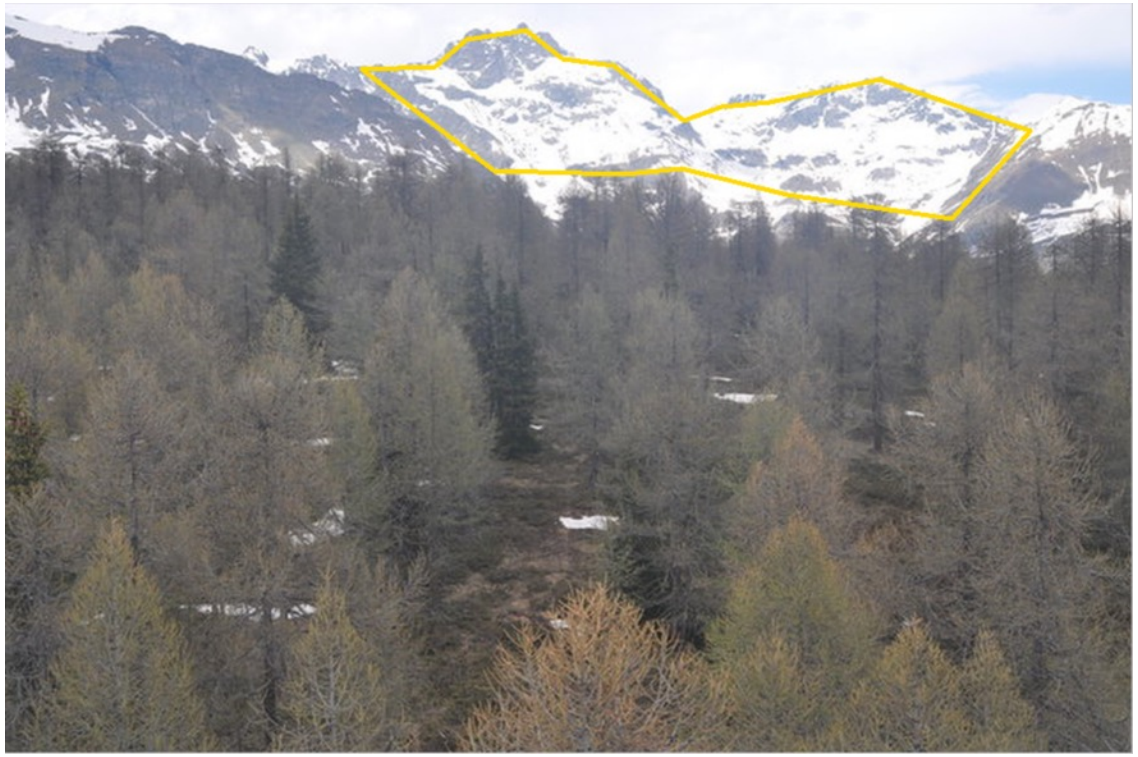
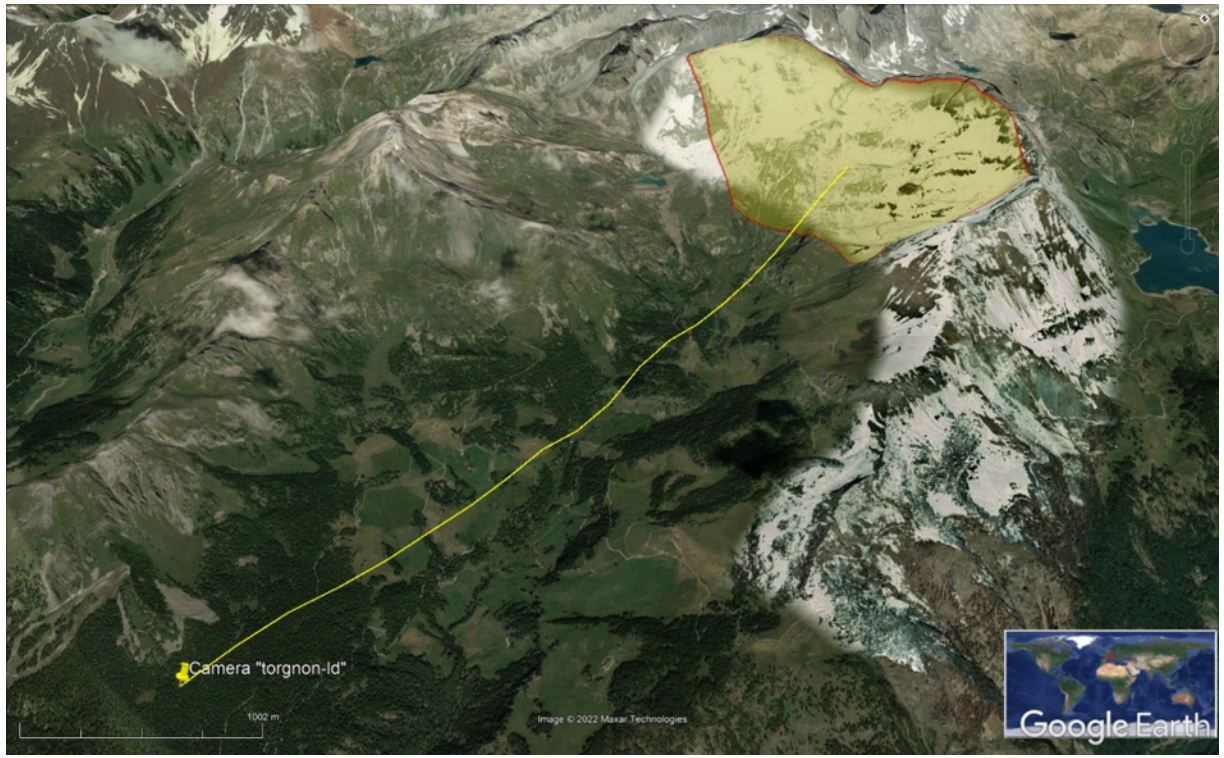
ROI information in FSC data

IN PROGRESS





- ROI image coordinates in *FMIPROT setup*
- ROI geo-coordinates in *FMIPROT setup* if cannot be calculated automatically

- ROI geo-coordinates in results metadata
- ROI geo-coordinates in API response
  - Use in comparisons

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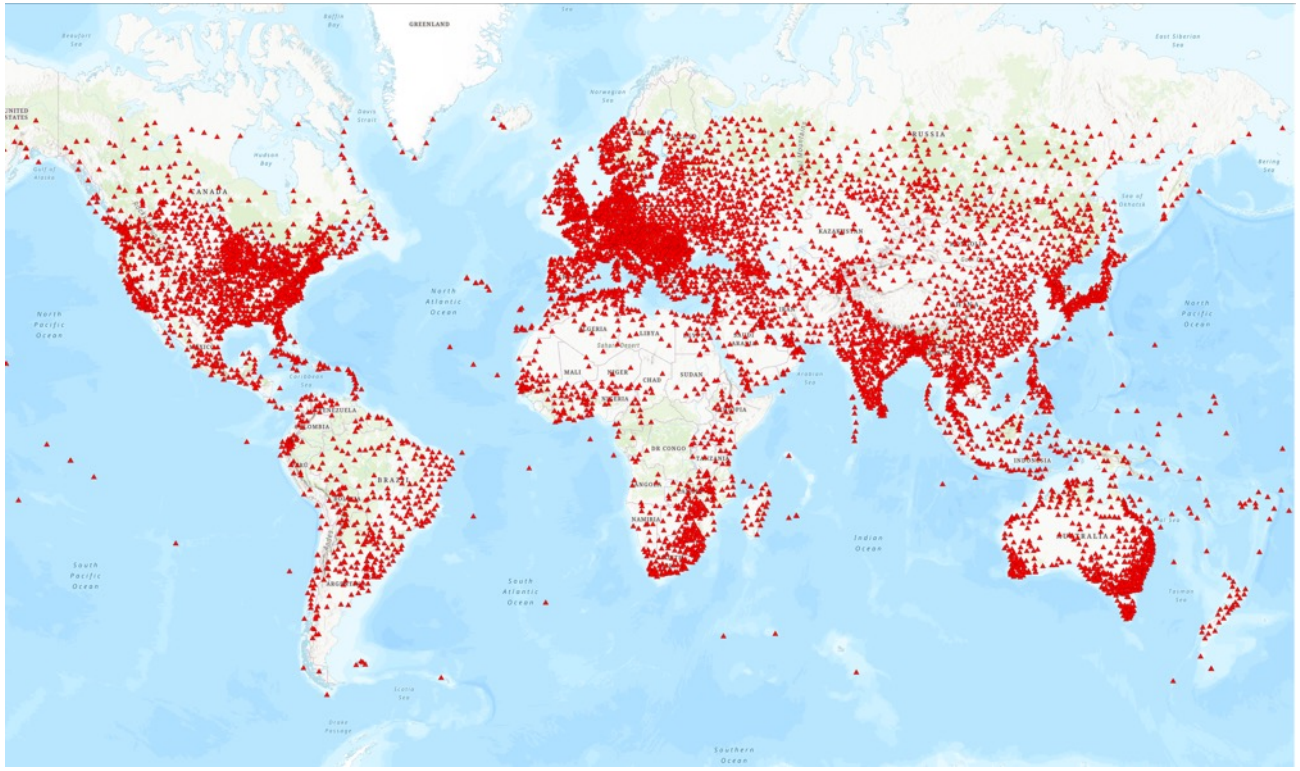
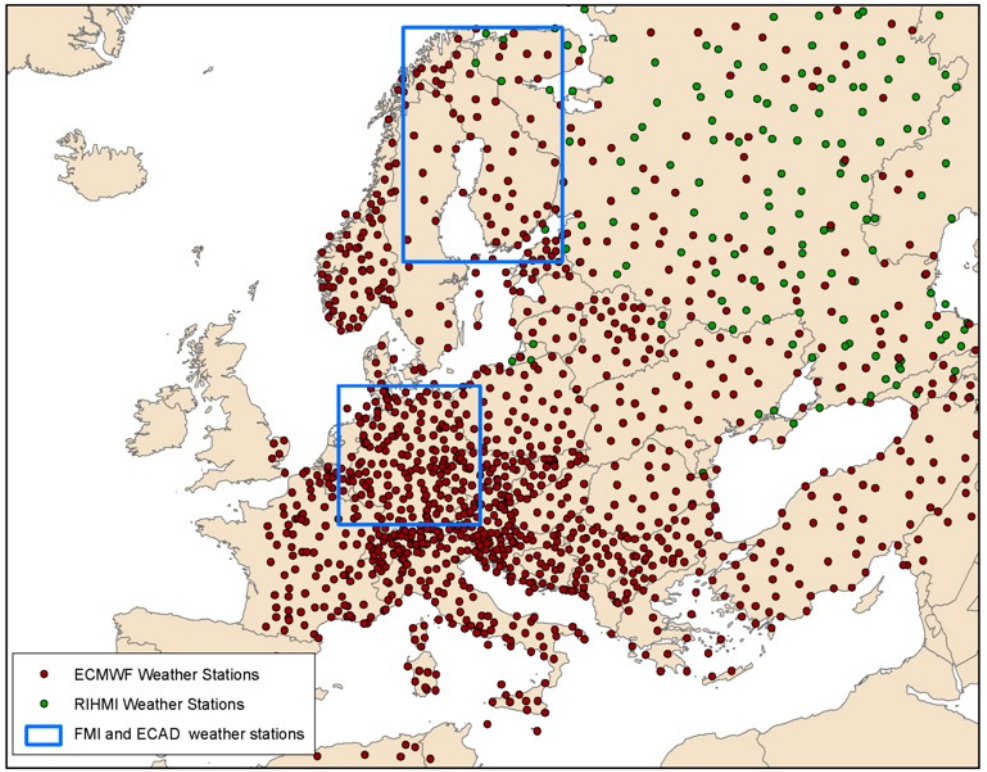
In-situ data



WMO Weather stations

Esri, USGS | Esri, FAO, NOAA | World Meteorological Organization (WMO)



Map of locations of in-situ snow depth data used in the validation of SEN3APP VIIRS based FSC product. The blue boxes outline the national weather station networks of Finland and Germany. (2016)

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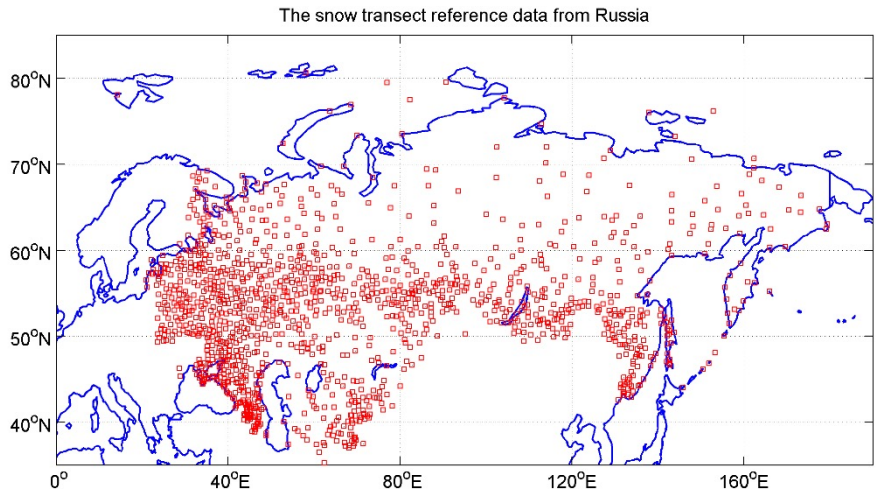
SEVENTH FRAMEWORK PROGRAMME

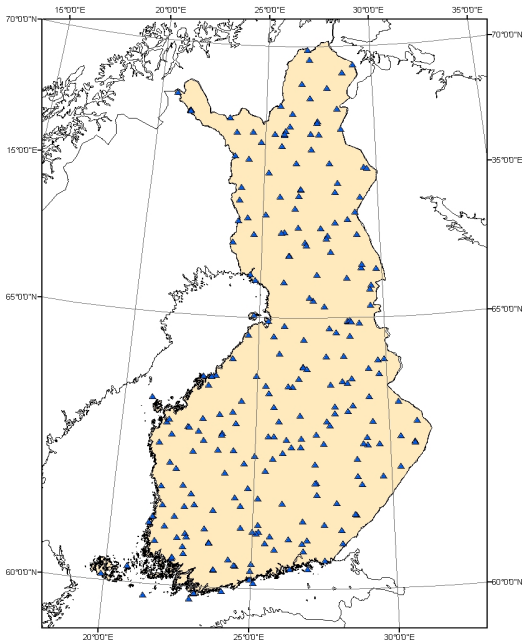
SYKE

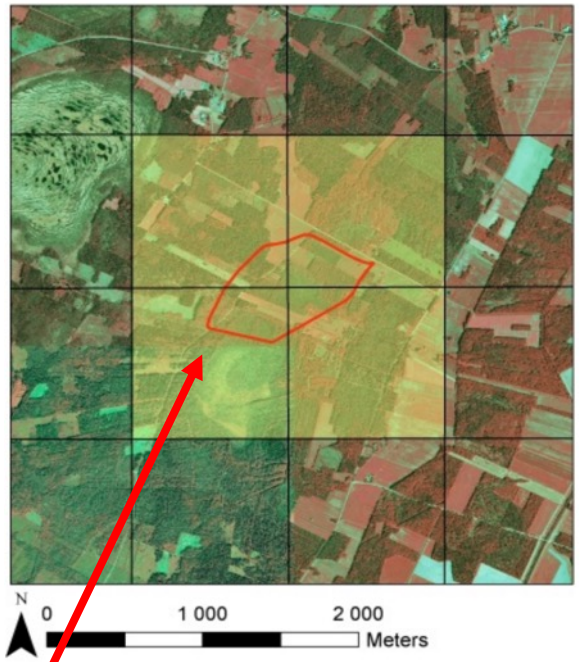
In-situ data
(snow transects = distributed, non-point data)

- Russia, a total of 1346 snow transects
- Vast geographical domain with diverse conditions



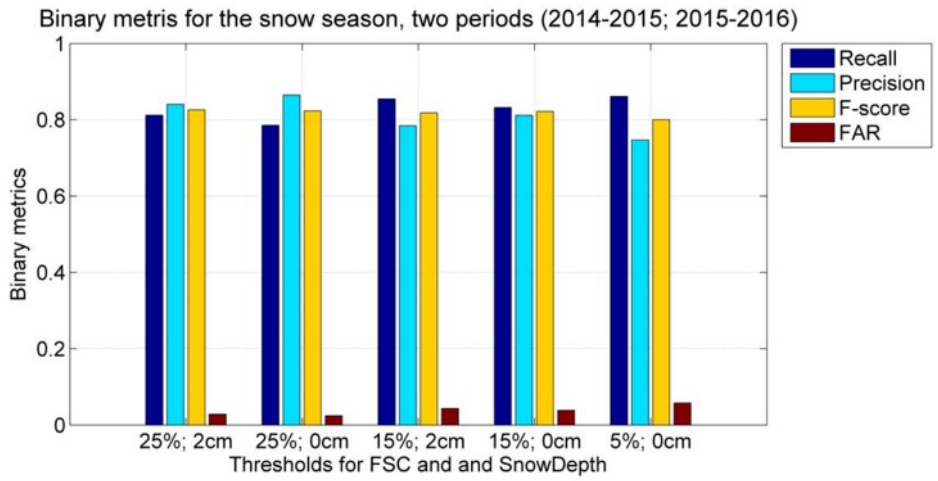
- Finland, 100+ national snow transects



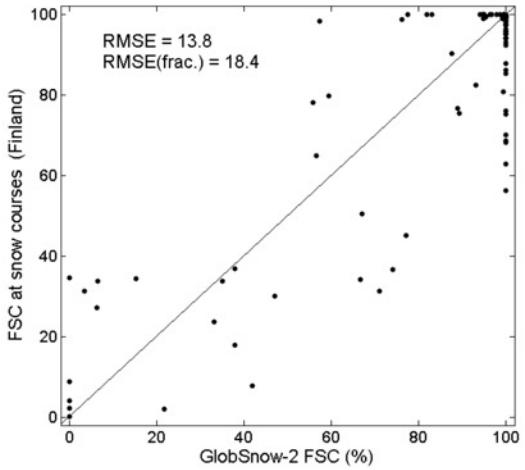


<u>Distributed snow transect data</u>
1 validation sample = 80 observations from a transect through varying landscape

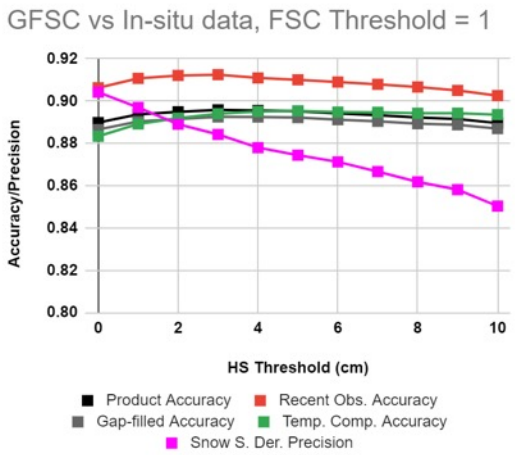
Satellite validation with in-situ data



SEN3APP VIIRS based FSC product vs in-situ data (snow depth from weather station)



Globsnow-2 FSC product vs in-situ data (snow cover from snow courses)



CLMS HRSI Gap-Filled FSC product vs in-situ data (snow depth from weather stations)

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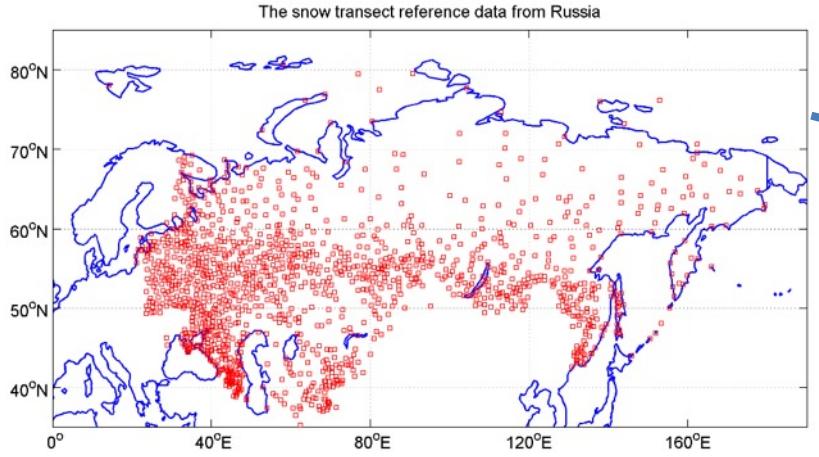
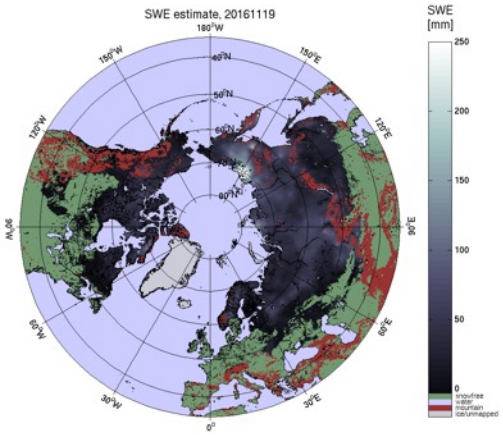
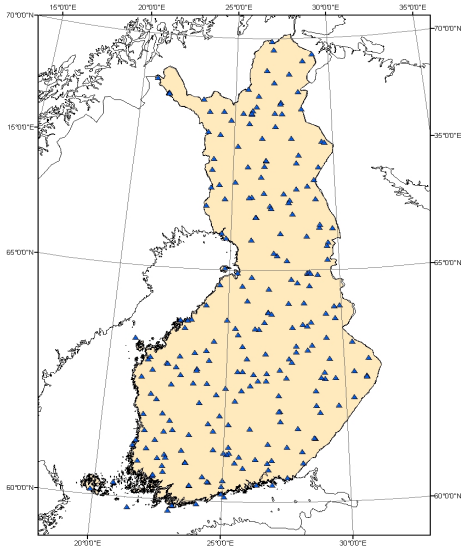
Satellite validation with in-situ

Russia: 1300+ snow transects from a vast geographical domain & diverse conditions

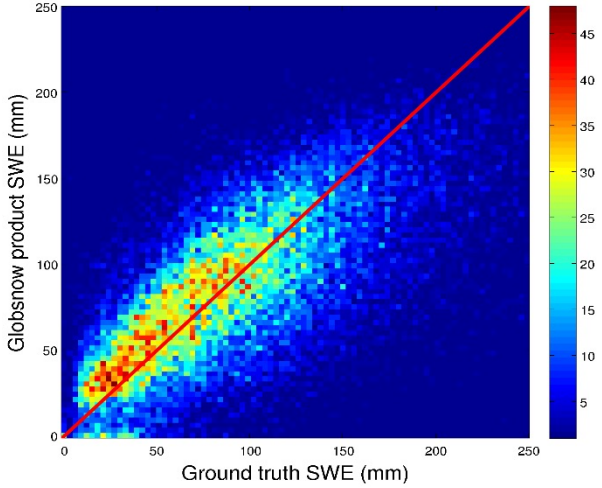




Finland: 100+ snow courses



Satellite-based SWE product accuracy determined from an independent & diverse multi-decadal reference dataset for NH



snowpex

esa

snow cci

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NRT Comparison chains

IN PROGRESS

Cal/Val Activities

Multiple sets of comparisons are running in FMIPROT server regularly, triggered by a job scheduler, producing near real time results for comparison of satellite products with webcam derived data.

Cal/Val activities are in development. Comparison options, the data and the availability may change without notice.

4 sets of comparisons are defined for operational monitoring. Results are visualized in this page.

and in-situ

Name	Sets of calc.	Clock	Intervals	Last run time
Copernicus High Resolution Snow Cover Pan European 20m Resolution	2	1 - 4	1400 mins.	Start: 2022-03-30 01:11:02 EEST Finish: 2022-03-30 01:17:00 EEST
Copernicus High Resolution Snow Cover Pan European 100m Resolution	2	1 - 4	1400 mins.	Start: 2022-03-30 01:12:02 EEST Finish: 2022-03-30 01:18:03 EEST
Copernicus Snow Cover Extent Northern Hemisphere 1km Resolution	2	1 - 4	1400 mins.	Start: 2022-03-30 01:13:02 EEST Finish: 2022-03-30 01:13:24 EEST
Copernicus Snow Cover Pan European 500m Resolution	2	1 - 4	1400 mins.	Start: 2022-03-30 01:13:25 EEST Finish: 2022-03-30 01:13:37 EEST

Last run is on time | Running now | Next run is late

- Collate daily data during the day
- Run comparisons whenever
  - satellite data is available
  - daily ref. data is complete

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Comparison / Visualization options

PLANNED

Satellite product
- CLMS SE 500m
- CLMS SE 1km
- CLMS HRSI FSC
- CLMS HRSI GFSC
- Globsnow FSC
- HSAF H34
- HSAF H35
- …

Reference data
- In-situ SD
  - WMO In-situ
  - FMI In-situ
  - ALPS Stations
- In-situ FSC
  - FMI Snow Course
- Webcam derived
  - FSC
    - MONIMET
    - Phenocam Alps
    - Phenocam North America
    - Europhen Pan-European

Resampling
- Nearest neighbour
- Average
- Median
- Majority (classified)
- Max distance: XX

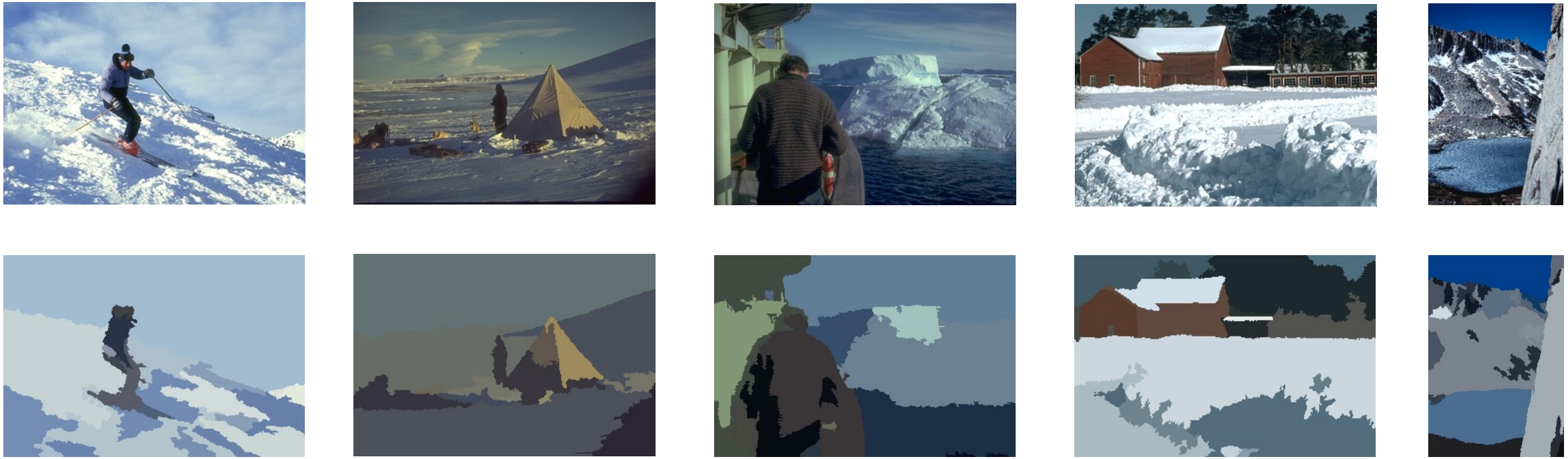
Thresholds
- FSC: XX
- SD: XX

Metrics
- Accuracy
- FAR
- POD
- Kappa
- RMSE

Plots
- Time series
- Scatter
- Trend lines
- Error bars
- …

ML for webcam derived snow cover

PLANNED



Prof. Georgios Tziritas

EXAMPLE METHOD

Image Segmentation based on Tree Equipartition, Bayesian Flooding and Region Merging

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Ground-based validation of satellite snow products

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