FINNISH METEOROLOGICAL INSTITUTE

Automatic digital image processing system for multiple camera networks: FMIPROT

Cemal Melih Tanis <cemal.melih.tanis (at) fmi.fi>
Ali Nadir Arslan <ali.nadir.arslan (at) fmi.fi>

EU Life+ MONIMET(LIFE12 ENV/FI/000409) Final Stakeholder Workshop,
02.11.2017, Helsinki, Finland

LifeMonimet
LIFE12 ENV/FI/000409

FINNISH METEOROLOGICAL INSTITUTE

Luke
LUONNONVARAKESKUS

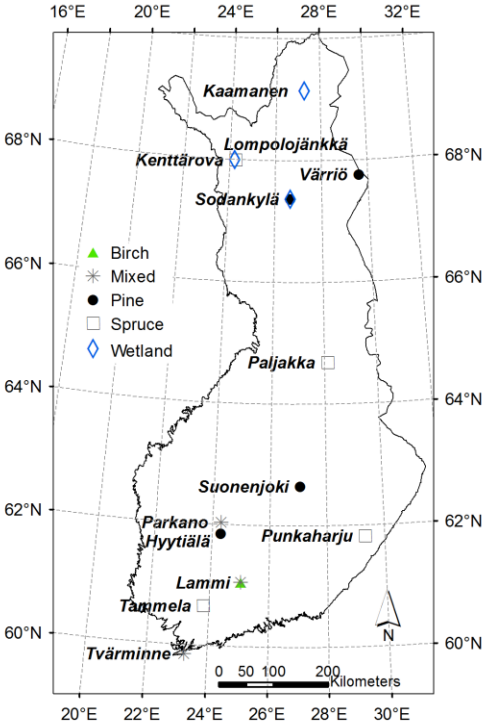
SYKE

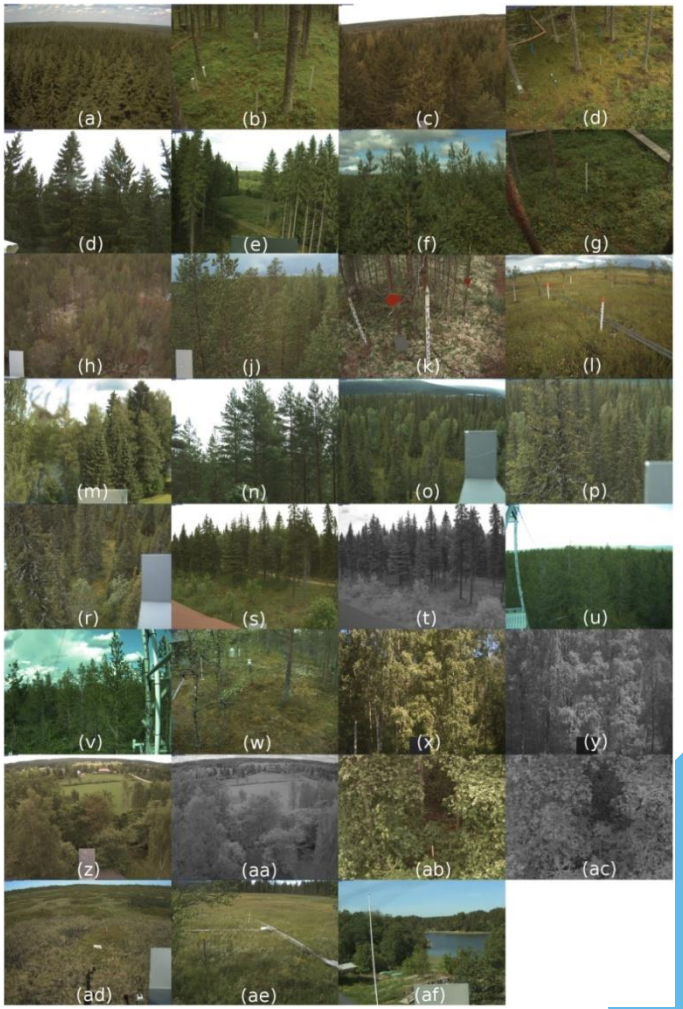
HELSINGIN YLIOPISTO
HELSINGFORS UNIVERSITET
UNIVERSITY OF HELSINKI

Life

FINNISH METEOROLOGICAL INSTITUTE

MONIMET Camera Network



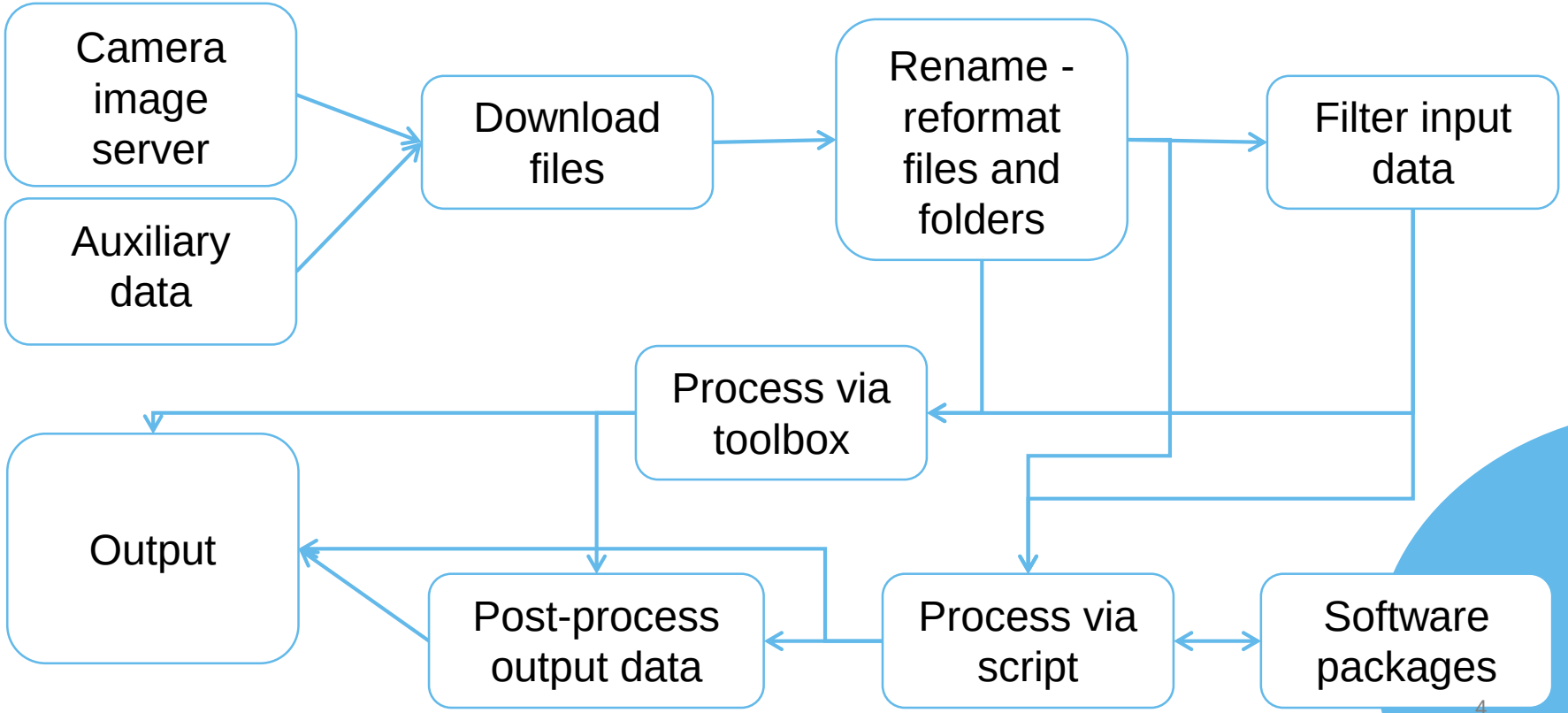


Peltoniemi, M., Aurela, M., Böttcher, K., Kolari, P., Loehr, J., Karhu, J., Linkosalmi, M., Tanis, C. M., Tuovinen, J.-P., and Arslan, A. N.: Webcam network and image database for studies of phenological changes of vegetation and snow cover in Finland, image time series from 2014–2016, Earth Syst. Sci. Data Discuss., https://doi.org/10.5194/essd-2017-62, in review, 2017.

Camera Networks

- Environmental Monitoring
  - Research Institutes
  - Environment Institutes
  - Universities
- Traffic
  - Traffic Agencies
- Safety
  - Ski resorts
  - Traffic Agencies
  - Police
- Tourism
  - Ski Resorts
  - Municipalities

“Traditional” Processing



Challenges

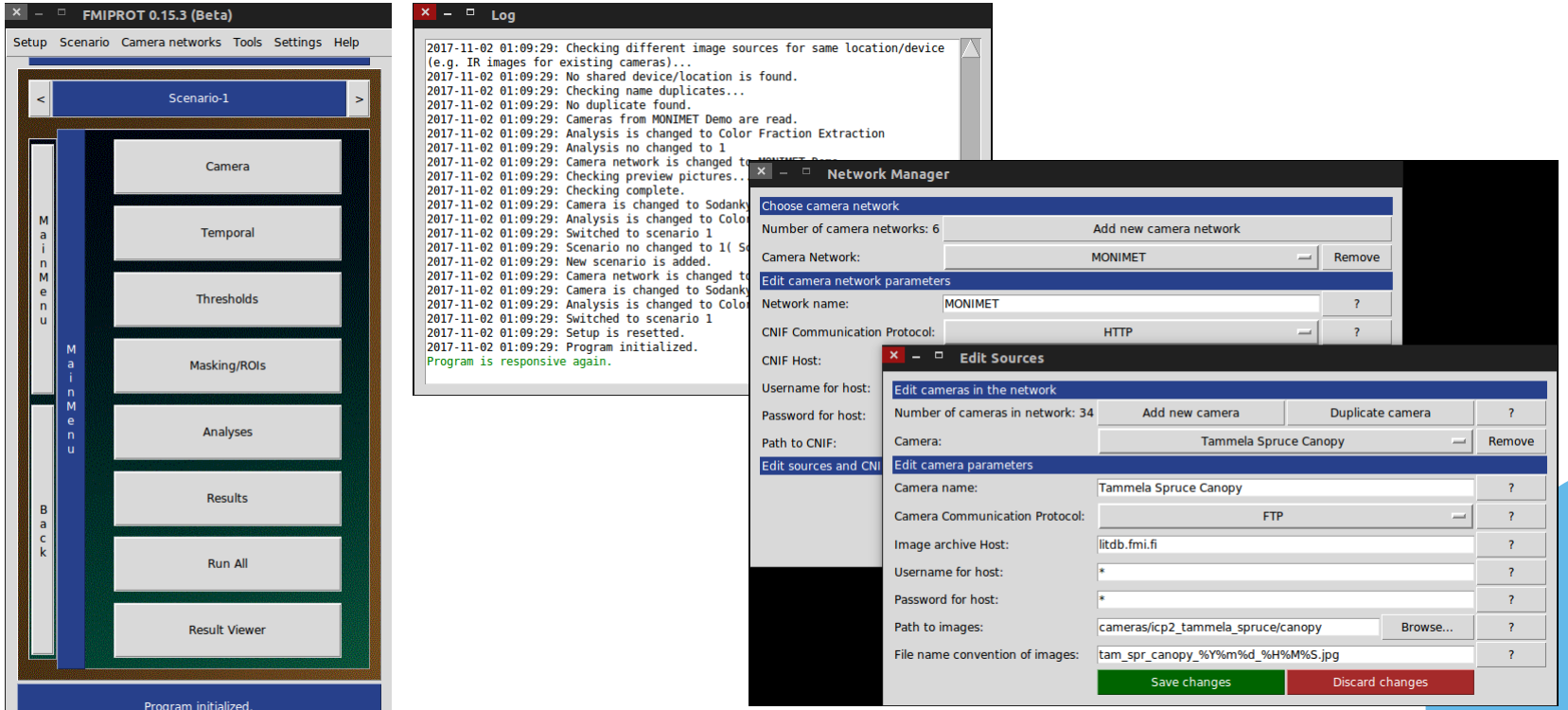
- Obtaining images
  - Different protocols (e.g. HTTP, FTP, authentication)
  - Different filename and path formats
  - Different file formats (e.g. .jpg, .png, .raw, .zip, .tar)
- Processing chains
  - Filenames or scripts are needed to be edited for different cameras/networks
  - Might require different environment/connection settings
- Processing tools and software packages
  - Software dependency
  - Complicated installations and setups
  - Requiring scripting/coding skills
  - Lack of GUI

Finnish Meteorological Institute image PROcessing Toolbox

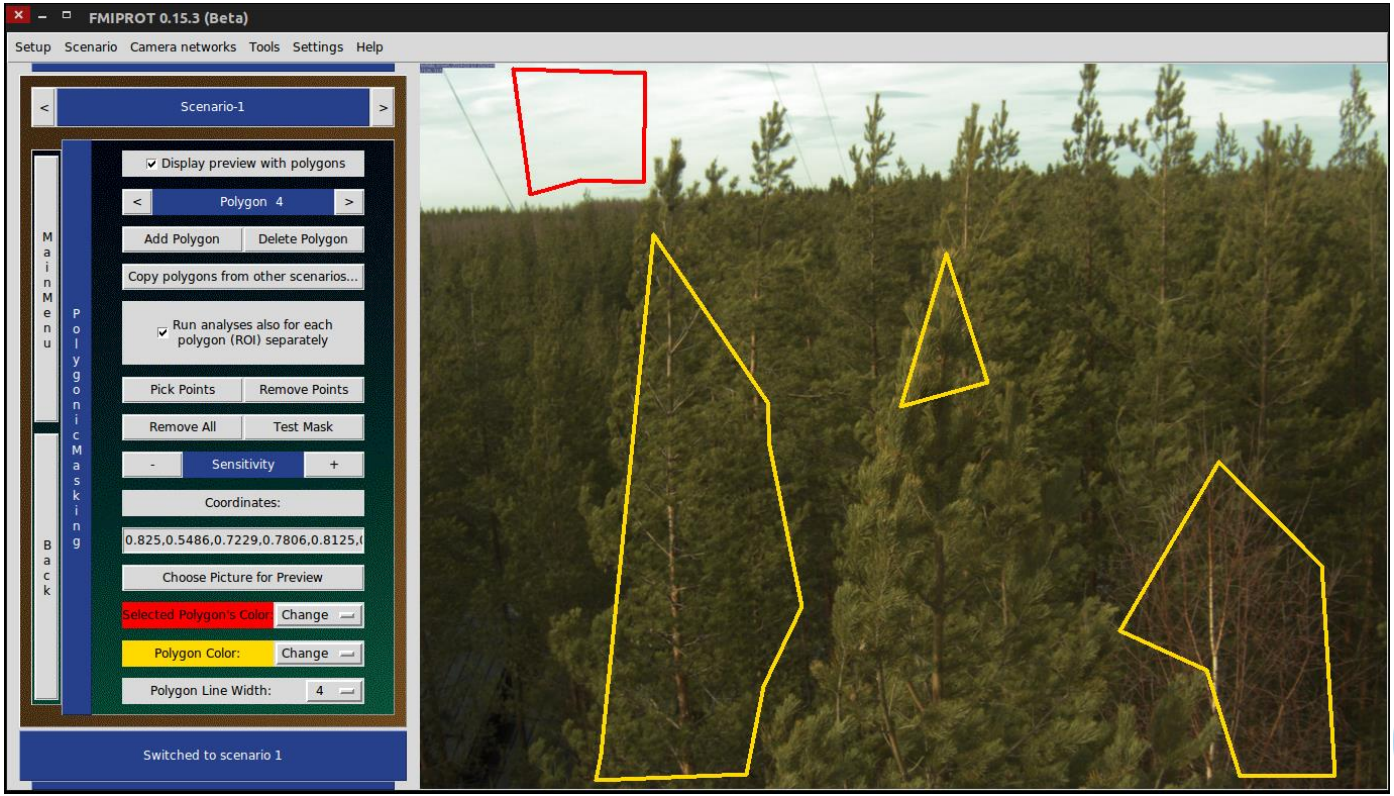
- 100% Graphical User Interface
- Multiple camera networks
- Automated file download
- Automated file handling
- Plugin system
- Save/load analysis options
- Data filtering
- Visualization of output data
- Post-analysis reports
- Time-series animations with analysis results*
- Satellite data support as auxiliary/ reference data*
- Validation tool*
- Image analyis from videos**
- Post-processing**
- Script generation and scheduled analyses**

*To be available in the next version
**Planned for future

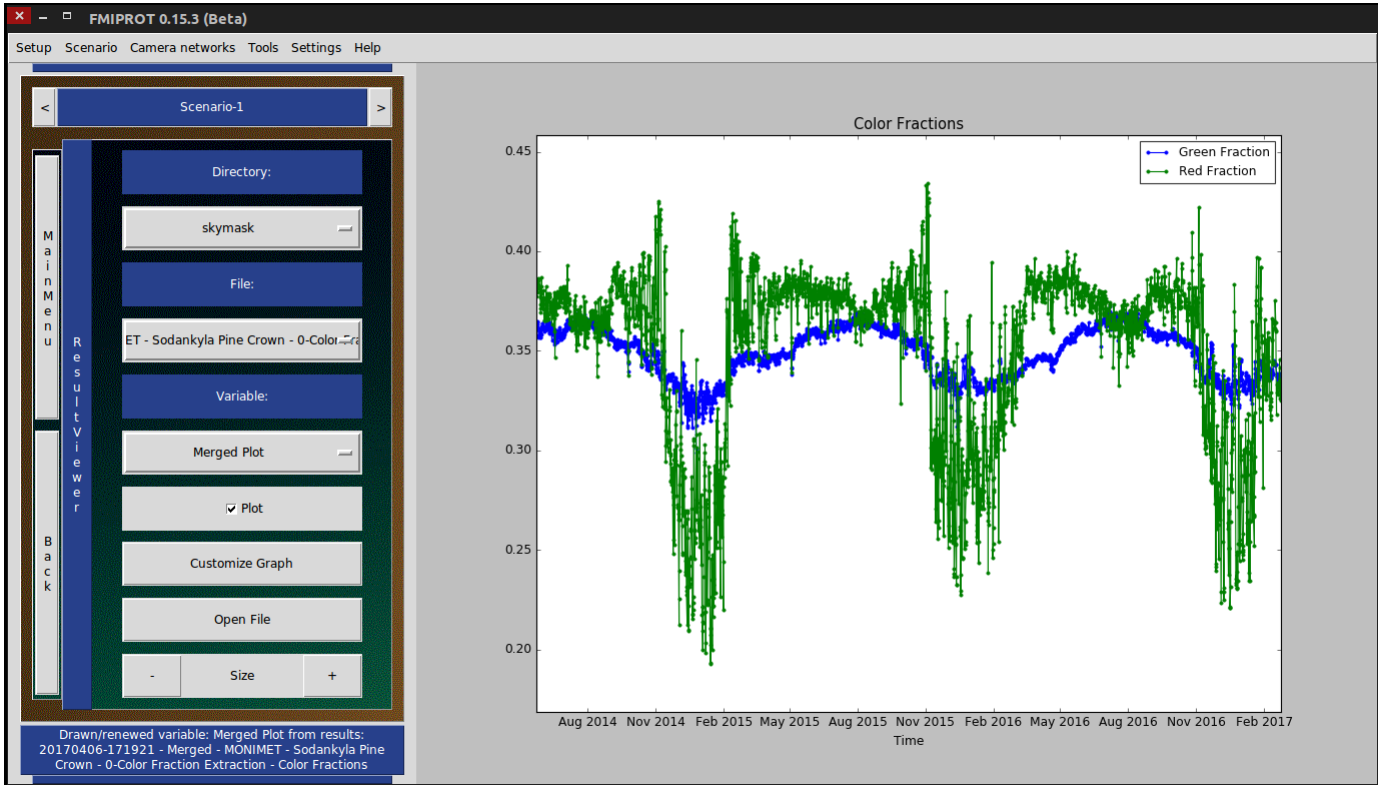
Main menu, log, network manager



Masking (ROIs)



Results viewer



Post-analysis reports

FMIPROT Setup Report

Go to: Scenario-1

Scenario-1

Camera Selection

Camera Network	Camera Name
MONIMET-LOCAL	Hyytiala Pine Crown

Temporal Selection

Date and time intervals

	Start	End
Date	2014-03-01	2014-07-30
Time	11:15:00	11:45:00

Masking/ROIs

Run analyses also for each polygon (ROI) separately: False

Polygon	Coordinates
1	0.8115,0.5417,0.7375,0.7375,0.75,0.8264,0.8135,0.8083,0.8469,0.9667,0.9292,0.9653,0.8938,0.6931

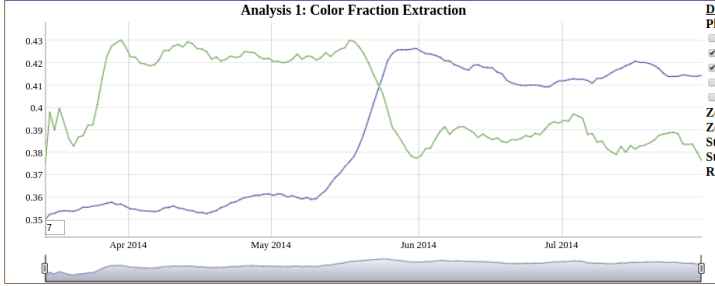
Thresholds

Type	Value	Minimum	Maximum
Image Threshold	Brightness	0.0	1.0
Image Threshold	Luminance	0.0	1.0
ROI Threshold	Red Fraction	0.0	1.0
ROI Threshold	Green Fraction	0.0	1.0
ROI Threshold	Blue Fraction	0.0	1.0
Pixel Threshold	Red Channel	0	255
Pixel Threshold	Green Channel	0	255
Pixel Threshold	Blue Channel	0	255

Analyses

Analysis No	Analysis Name	Analysis Parameters	
		Parameter	Value
1	Color Fraction Extraction	Green Fraction	Selected
		Red Fraction	Selected
		Blue Fraction	Selected
		Brightness	Selected
		Luminance	Selected
		Exclude burned pixels	Selected
		Red channel statistics	Not Selected
		Green channel statistics	Not Selected
		Blue channel statistics	Not Selected

Results



Setups, Scenarios, Analyses

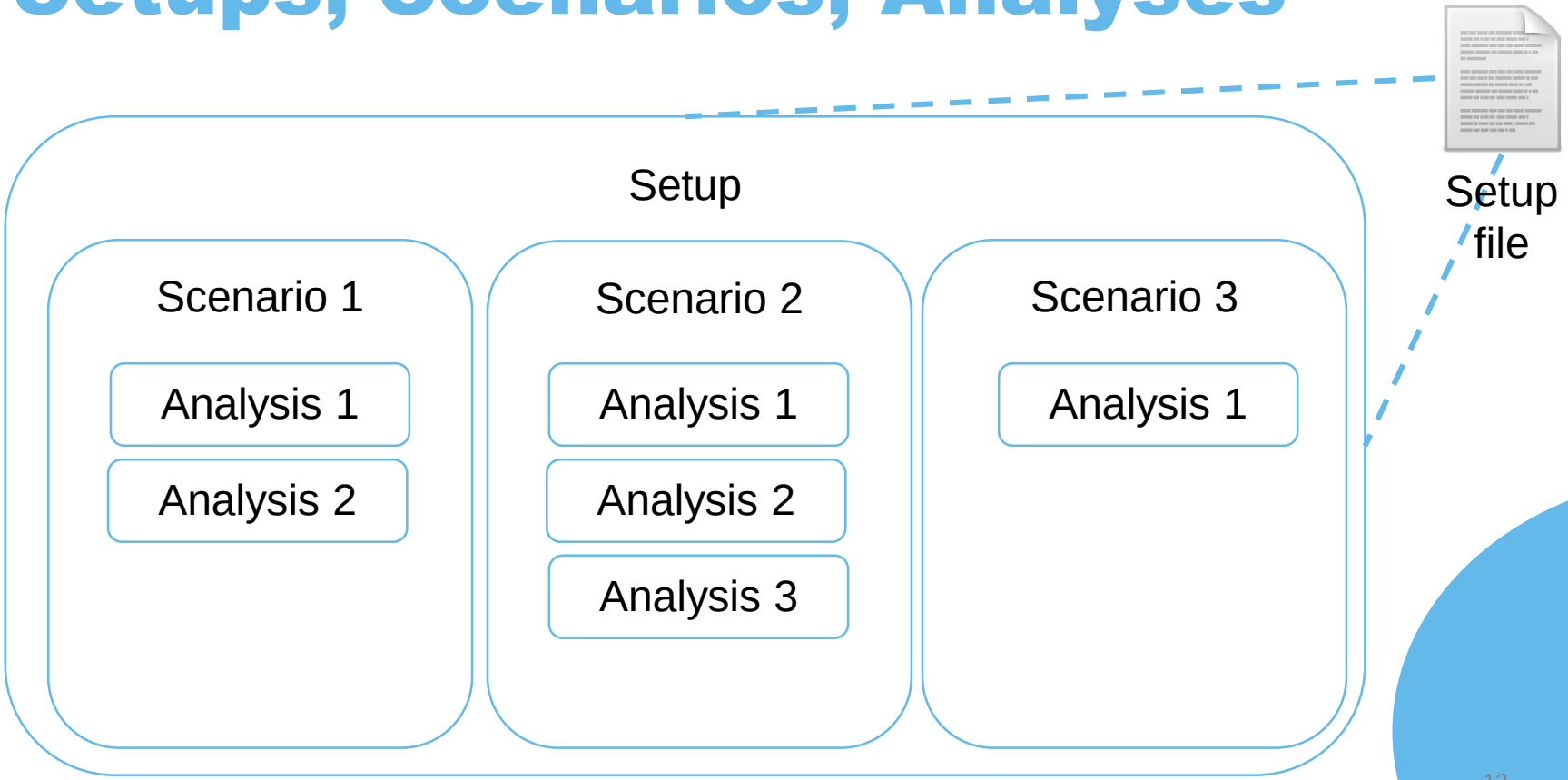
Scenario

- Camera network
- Camera
- Temporal filtering
  - Date
  - Time of day
- Masking (ROI Selection)
- Thresholds
  - Pixel value (R, G, B)
  - Color fraction index (R, G, B)
  - Brightness
  - Luminance

Analysis

- Parameter 1
- Parameter 2
- Parameter 3
- …

Setups, Scenarios, Analyses



Algorithms

- Green color fraction (Green chromatic coordinate)
- Red color fraction (Red chromatic coordinate)
- Blue color fraction (Blue chromatic coordinate)
- Green-Red Vegetation Index
- Green Excess Index
- Custom color index
- Orthorectified RGB True color image (Incoming version)
- Snow extent (Incoming version)
- Snow cover fraction (Incoming version)
- Time series animation (Incoming version)

Extraction of vegetation indices for same species in different locations

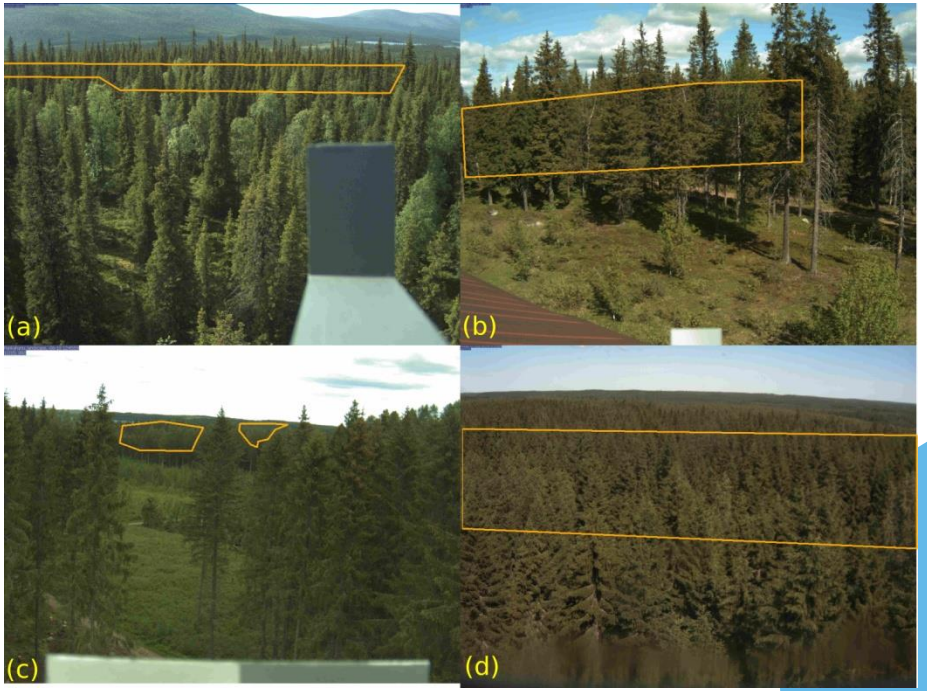
Camera FOVs and ROIs of the analyses for the comparison of vegetation indices: (a) Kenttärova canopy camera, (b) Paljakka landscape camera, (c) Punkaharju landscape camera, (d) Tammela canopy camera
Vegetation indices: Green fraction, red fraction, green-red vegetation index, green excess index.

$$GF = \frac{Green}{Red + Green + Blue}$$

$$RF = \frac{Red}{Red + Green + Blue}$$

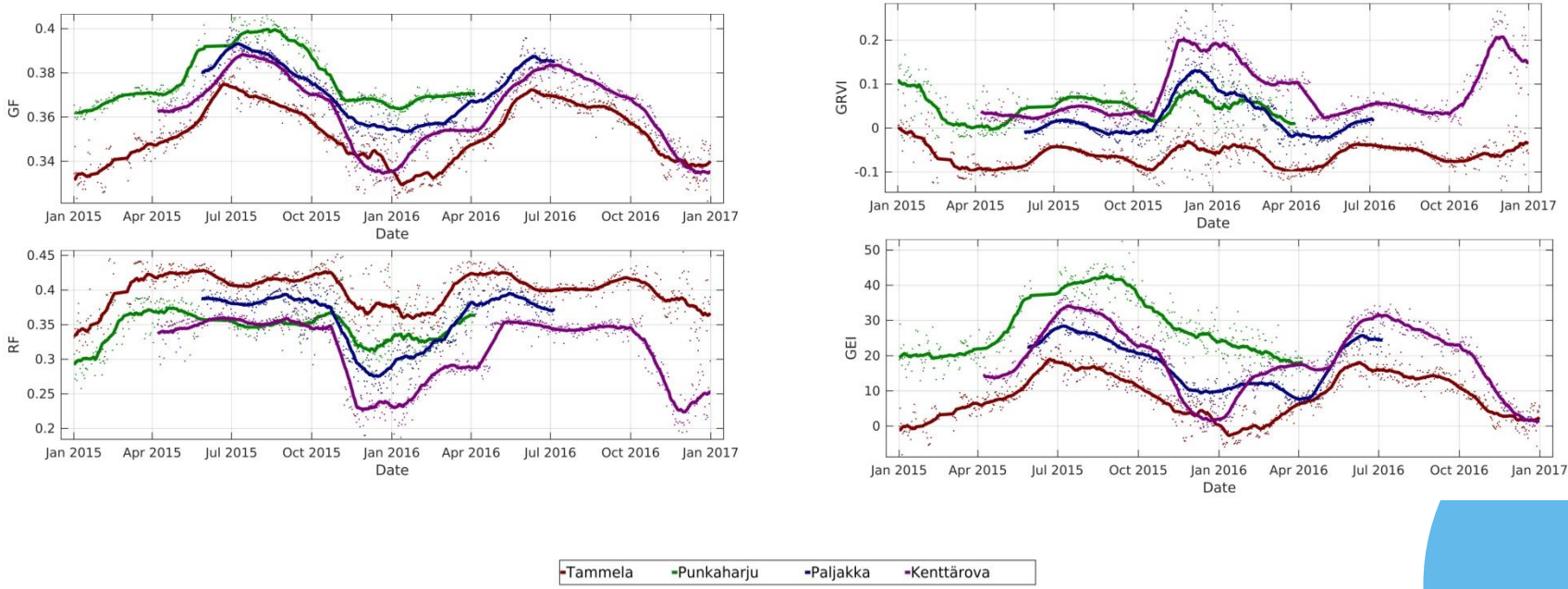
$$GRVI = \frac{Green - Red}{Red + Green}$$

$$GEI = 2\,Green - Red - Blue$$



Tanis, C.M., Arslan A.N., Peltoniemi, M., Linkosalmi, M., Aurela, M., Böttcher, K., Manninen, T., Kolari, P., Metsämäki, S., Laurila, T., Vesala, T., Pulliainen, J. Multiple Camera Networks and Automated Processing of Image Time Series, submitted.

Extraction of vegetation indices for same species in different locations

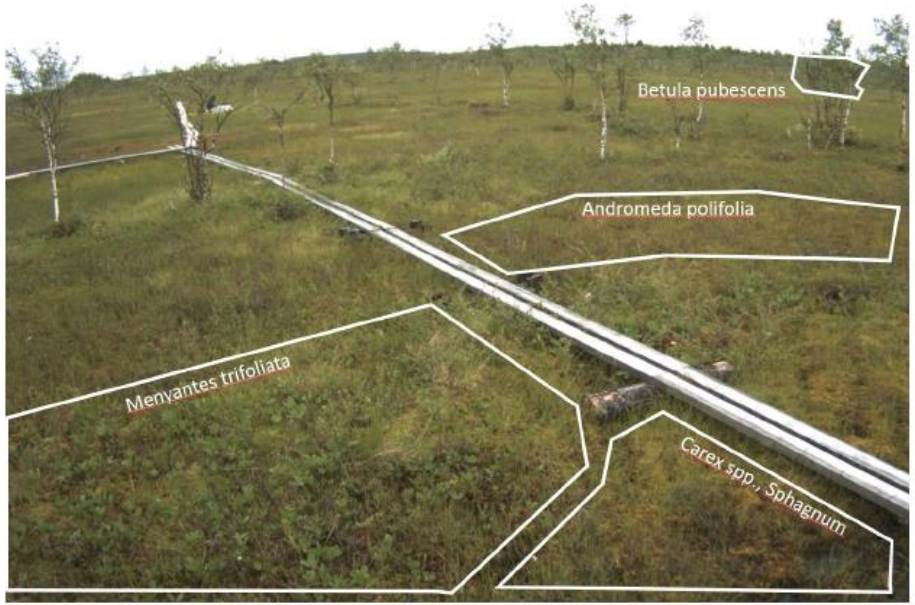


Tanis, C.M., Arslan A.N., Peltoniemi, M., Linkosalmi, M., Aurela, M., Böttcher, K., Manninen, T., Kolari, P., Metsämäki, S., Laurila, T., Vesala, T., Pulliainen, J. Multiple Camera Networks and Automated Processing of Image Time Series, submitted.

GCC changes by vegetation patch in Sodankylä wetland

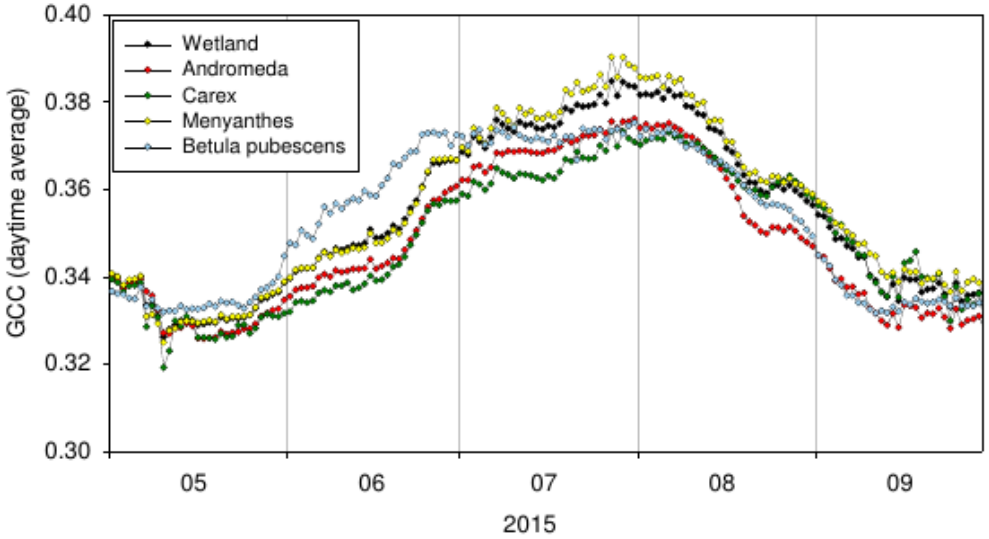
Regions of interests within a view of a camera used for the phenology analyses
in a heterogeneous wetland ecosystem by calculating green chromatic coordinate:

$$GCC = \frac{Green}{Red + Green + Blue}$$



Linkosalmi, M., Aurela, M., Tuovinen, J.-P., Peltoniemi, M., Tanis, C. M., Arslan, A. N., Kolari, P., Böttcher, K., Aalto, T., Rainne, J., Hatakka, J., and Laurila, T.: Digital photography for assessing the link between vegetation phenology and CO2 exchange in two contrasting northern ecosystems, Geosci. Instrum. Method. Data Syst., 5, 417-426, https://doi.org/10.5194/gi-5-417-2016, 2016.

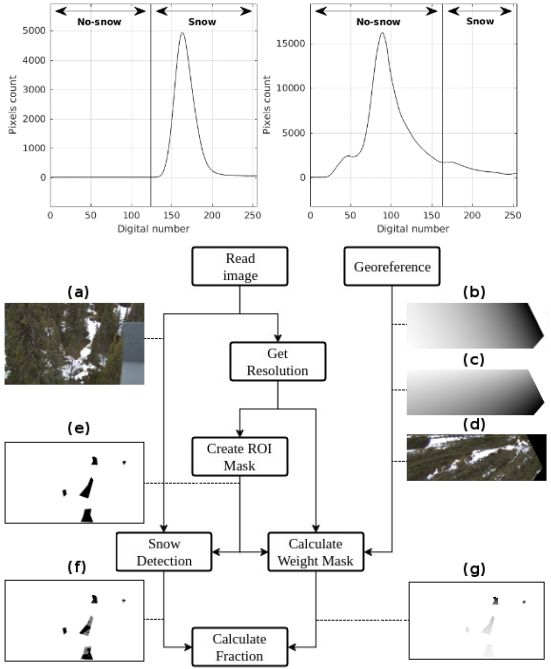
GCC changes by vegetation patch in Sodankylä wetland

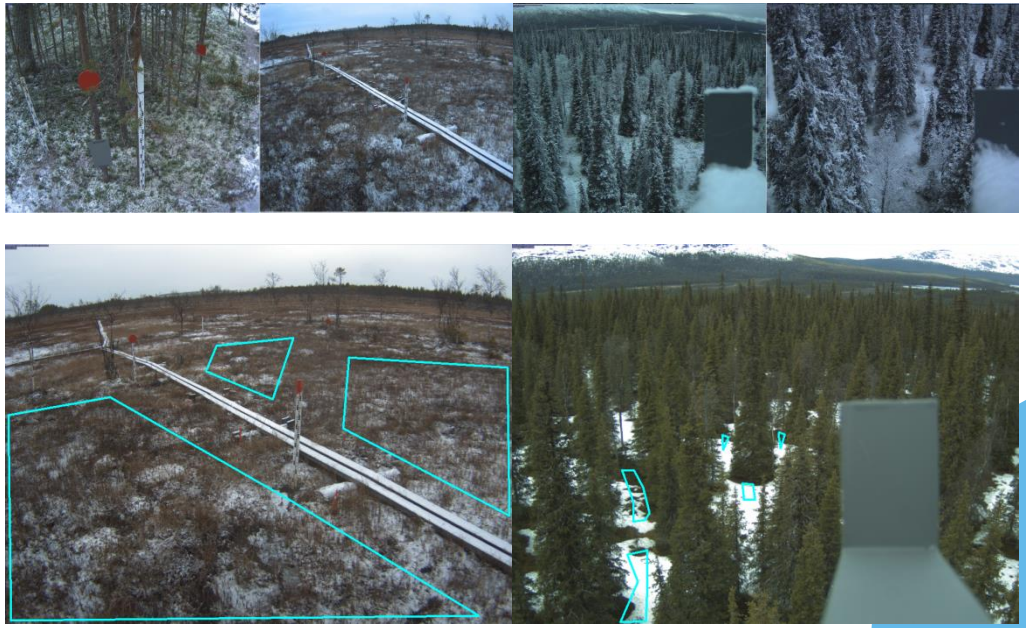


Mean daytime GCC of different Regions of Interests (vegetation types) during the period of May 2014 to October 2015 at a wetland in Sodankylä. Wetland refers to a combined ROI covering Andromeda, Carex and Menyanthes communities.

Linkosalmi, M., Aurela, M., Tuovinen, J.-P., Peltoniemi, M., Tanis, C. M., Arslan, A. N., Kolari, P., Böttcher, K., Aalto, T., Rainne, J., Hatakka, J., and Laurila, T.: Digital photography for assessing the link between vegetation phenology and CO2 exchange in two contrasting northern ecosystems, Geosci. Instrum. Method. Data Syst., 5, 417-426, https://doi.org/10.5194/gi-5-417-2016, 2016.

Snow cover fraction in Sodankylä and Kenttärova





Arslan, A.N.; Tanis, C.M.; Metsämäki, S.; Aurela, M.; Böttcher, K.; Linkosalmi, M.; Peltoniemi, M. Automated Webcam Monitoring of Fractional Snow Cover in Northern Boreal Conditions. Geosciences 2017, 7, 55.
Salvatori, R., Plini, P., Giusto, M., Valt, M., Salzano, R., Montagnoli, M., Cagnati, A., Crepaz, G., Sigismondi, D., 2011. Snow cover monitoring with images from digital camera systems. Italian Journal of Remote Sensing 137–145. doi:10.5721/ItJRS201143211

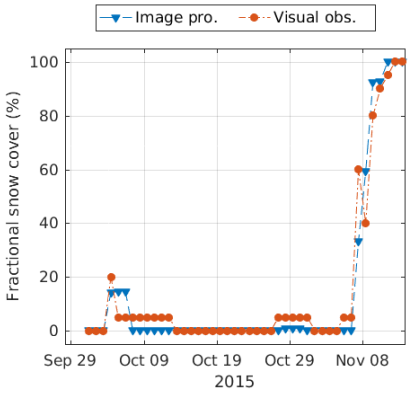
Snow cover fraction in Sodankylä and Kenttärova

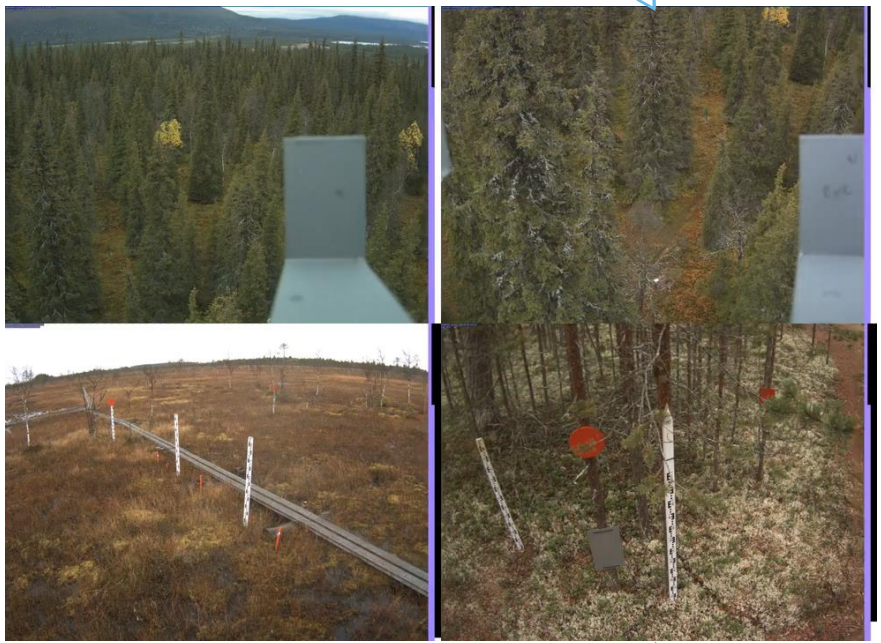
RMSE for each season (2015-2016 and 2015-2017)

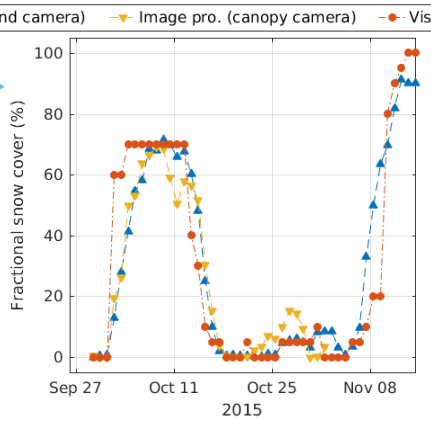
Season / Site	Kenttärova Canopy	Kenttärova Ground	Sodankylä Ground	Sodankylä Wetland
Early Season	16	17	18	16
Mid-winter	18	12	30	27
Melting Season	20	18	21	24
Summer	1.7	0.45	3.6	0.27
Overall	13	11	19	18

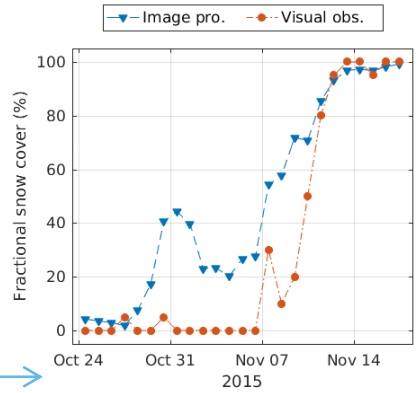
Arslan, A.N.; Tanis, C.M.; Metsämäki, S.; Aurela, M.; Böttcher, K.; Linkosalmi, M.; Peltoniemi, M. Automated Webcam Monitoring of Fractional Snow Cover in Northern Boreal Conditions. Geosciences 2017, 7, 55.

Snow cover fraction in Sodankylä and Kenttärova – 2015 – 2016 Early season results



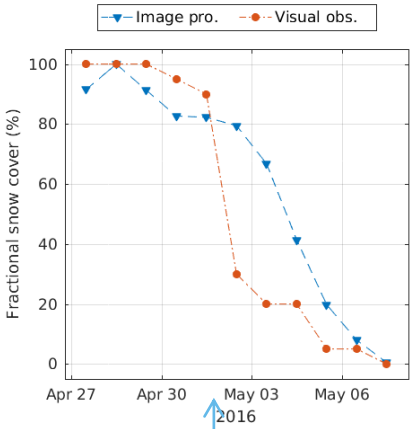


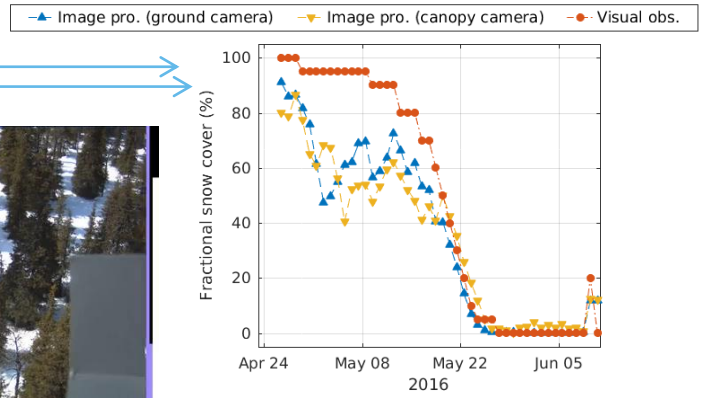


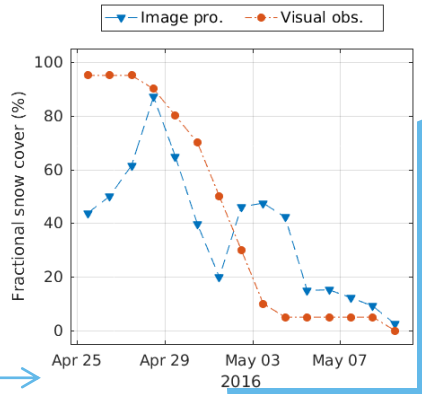


Arslan, A.N.; Tanis, C.M.; Metsämäki, S.; Aurela, M.; Böttcher, K.; Linkosalmi, M.; Peltoniemi, M. Automated Webcam Monitoring of Fractional Snow Cover in Northern Boreal Conditions. Geosciences 2017, 7, 55.

Snow cover fraction in Sodankylä and Kenttärova – 2015 – 2016 Melting season results







Arslan, A.N.; Tanis, C.M.; Metsämäki, S.; Aurela, M.; Böttcher, K.; Linkosalmi, M.; Peltoniemi, M. Automated Webcam Monitoring of Fractional Snow Cover in Northern Boreal Conditions. Geosciences 2017, 7, 55.

Questions?

FMIPROT is available at
http://monimet.fmi.fi/?page=FMIPROT

LifeMonimet
LIFE12 ENV/FI/000400