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METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

COST Action ES1404
1st Field campaign for comparison of instruments and exchange of methods

Erzurum, Turkey
1 – 3 March, 2016

FMI Image Processing Tool & Snow Cover Analysis of Webcam Images

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Background & Drivers
Life+ MONIMET Project

Climate Change Indicators and Vulnerability of Boreal Zone Applying Innovative Observation and Modeling Techniques

MONIMET

LIFE12 ENV/FI/000409

PROJECT LOCATION:

BUDGET INFO:

Total amount: 2,755,288 €

% EC Co-funding: 1,366,952 €

DURATION: Start: 02/09/13 - End: 01/09/17

PROJECT'S IMPLEMENTORS:

Coordinating Beneficiary: Ilmatieteen Laitos (FMI)

Associated Beneficiary(ies): Metsäntutkimuslaitos (METLA), Suomen Ympäristökeskus (SYKE), Helsingin Yliopisto (UHEL)

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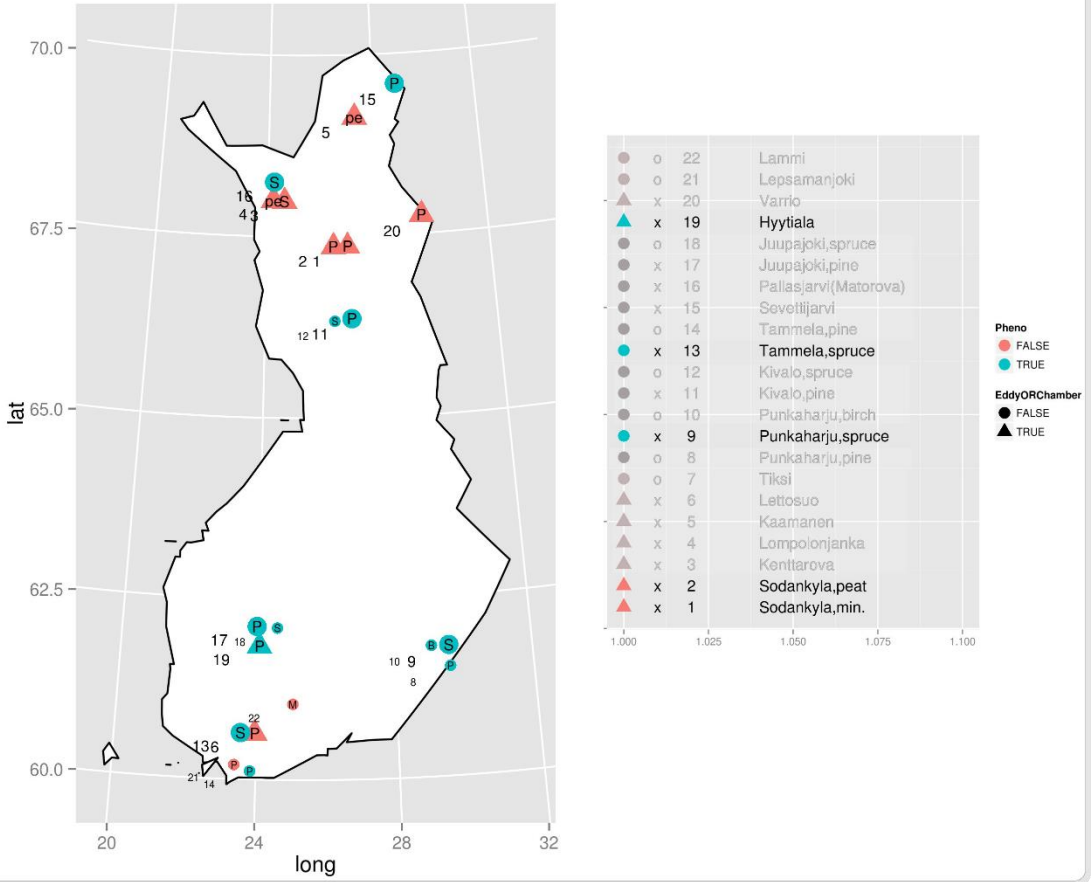
Background & Drivers
MONIMET Camera Network



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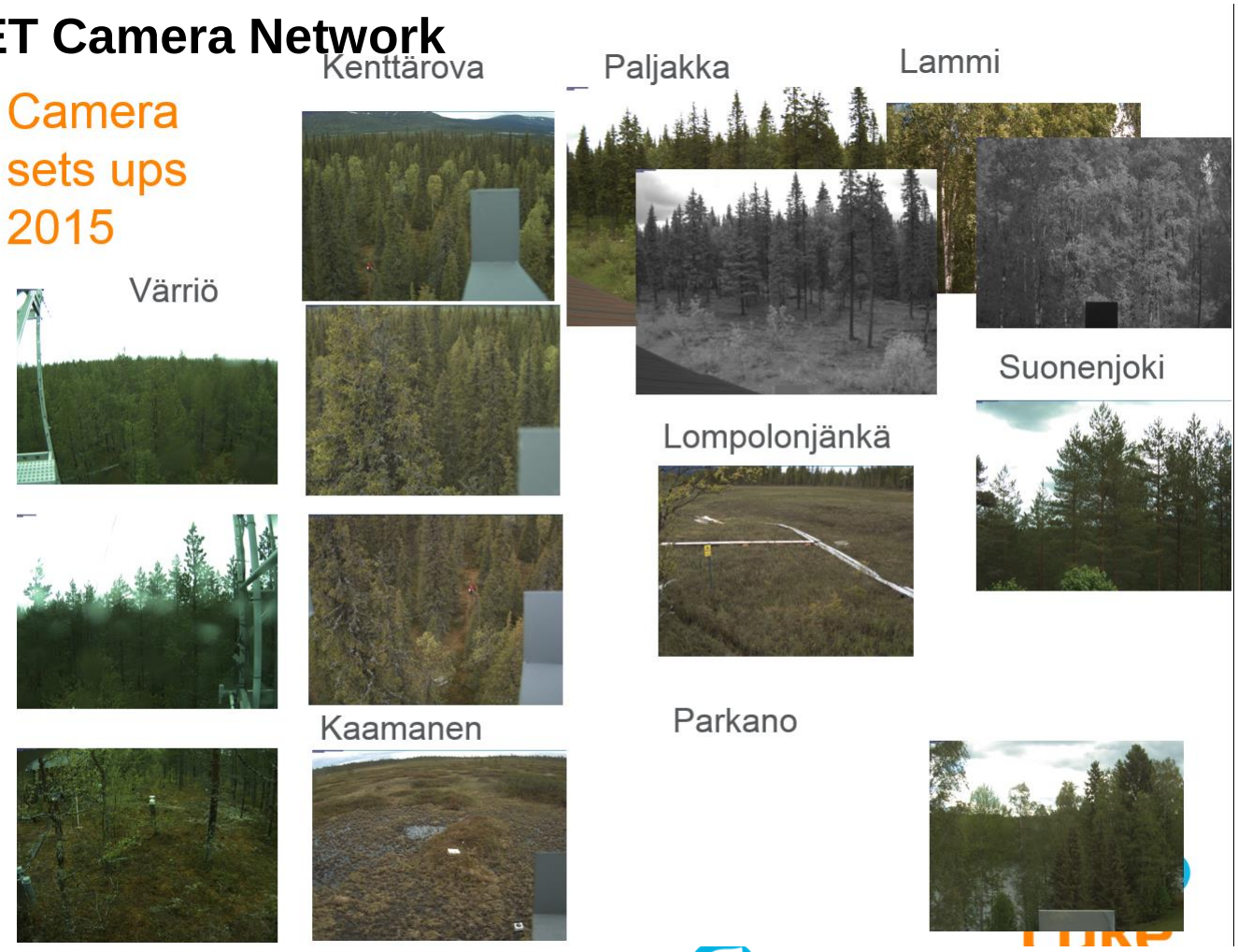
Background & Drivers
MONIMET Camera Network



Background & Drivers
The idea of FMIPROT

The idea of FMIPROT has first come out when MONIMET project team has started to use ``PhenoCam GUI´´ of PhenoCam project. [1] PhenoCam GUI is an image processing tool to get phenological data from the images of PhenoCam network. But PhenoCam GUI,

- **Only covers phenological analysis,**
- **Requires certain filename convention**
- Requires to download images manually

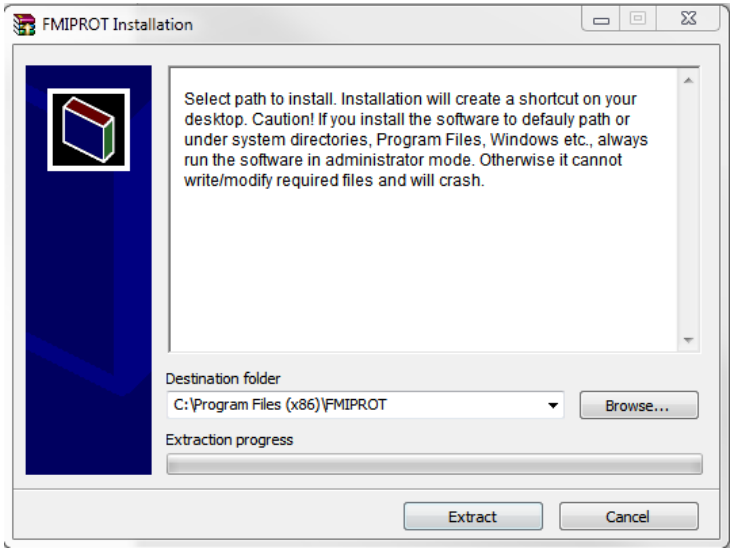
It was also known that MONIMET will cover many types of analysis on webcam images. Thus, a more suitable and expandable tool is planned to be created. That software would;

- Download and handle images automatically,
- **Be designed in a way that more types of analysis will be added in time,**
- **External users can add their own algorithms**
- **Be designed in a way to be used with many camera networks in the future**
- Be open source
- Be standalone

FMIPROT

Software

- The language used in FMIPROT is **Python**.
- For GUI, **TkInter** module is used.
- Main module used for image processing is **Mahotas**.
- Software is now available only to project partners with distrubitions for
  - **Windows**
  - **Linux**
- **Installation is straightforward** for both distrubitions and does not require any auxilary installation; the code is compiled beforehand.
- Detailed **user manual** is included.



Windows installation dialog

FMIPROT

Interface

Active Menu controls

Camera preview / Mask selection / Plotting pane

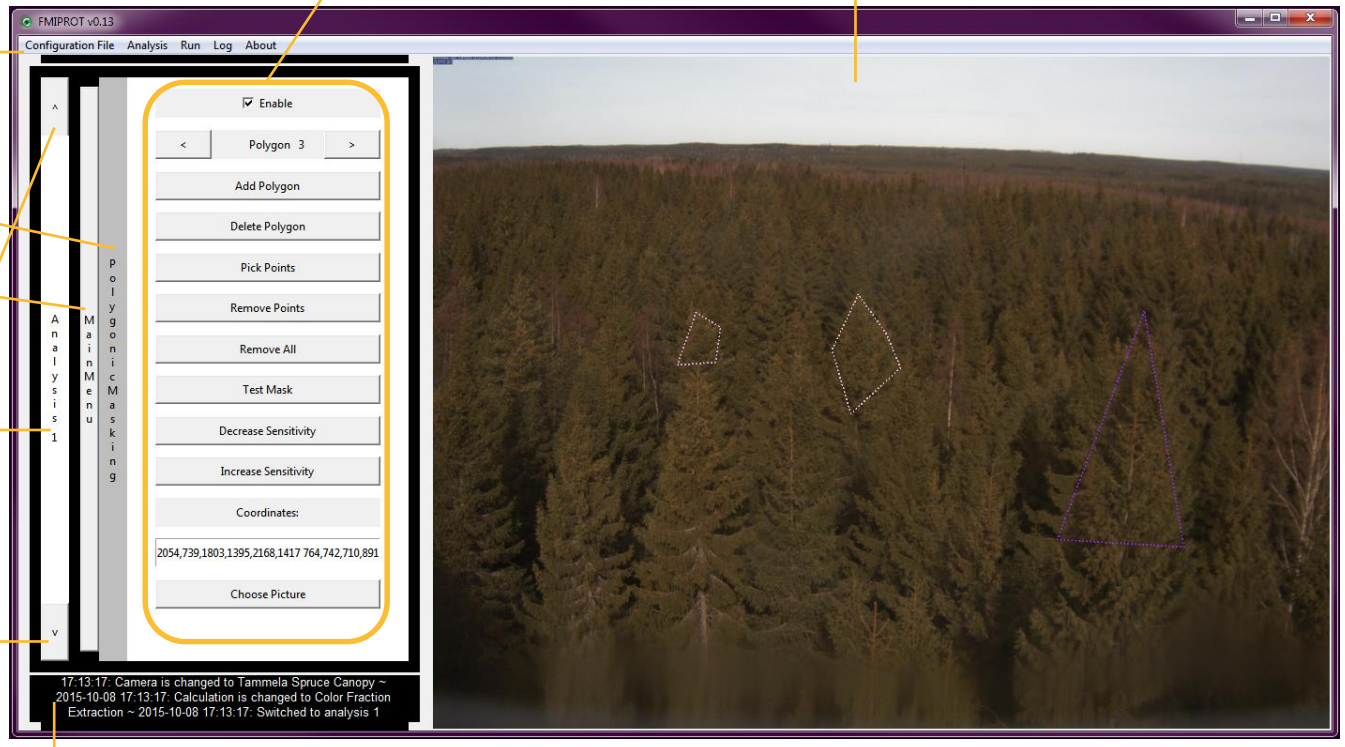
Menubar

Active Menu Title

Previous Menu Button

Active Analysis Number

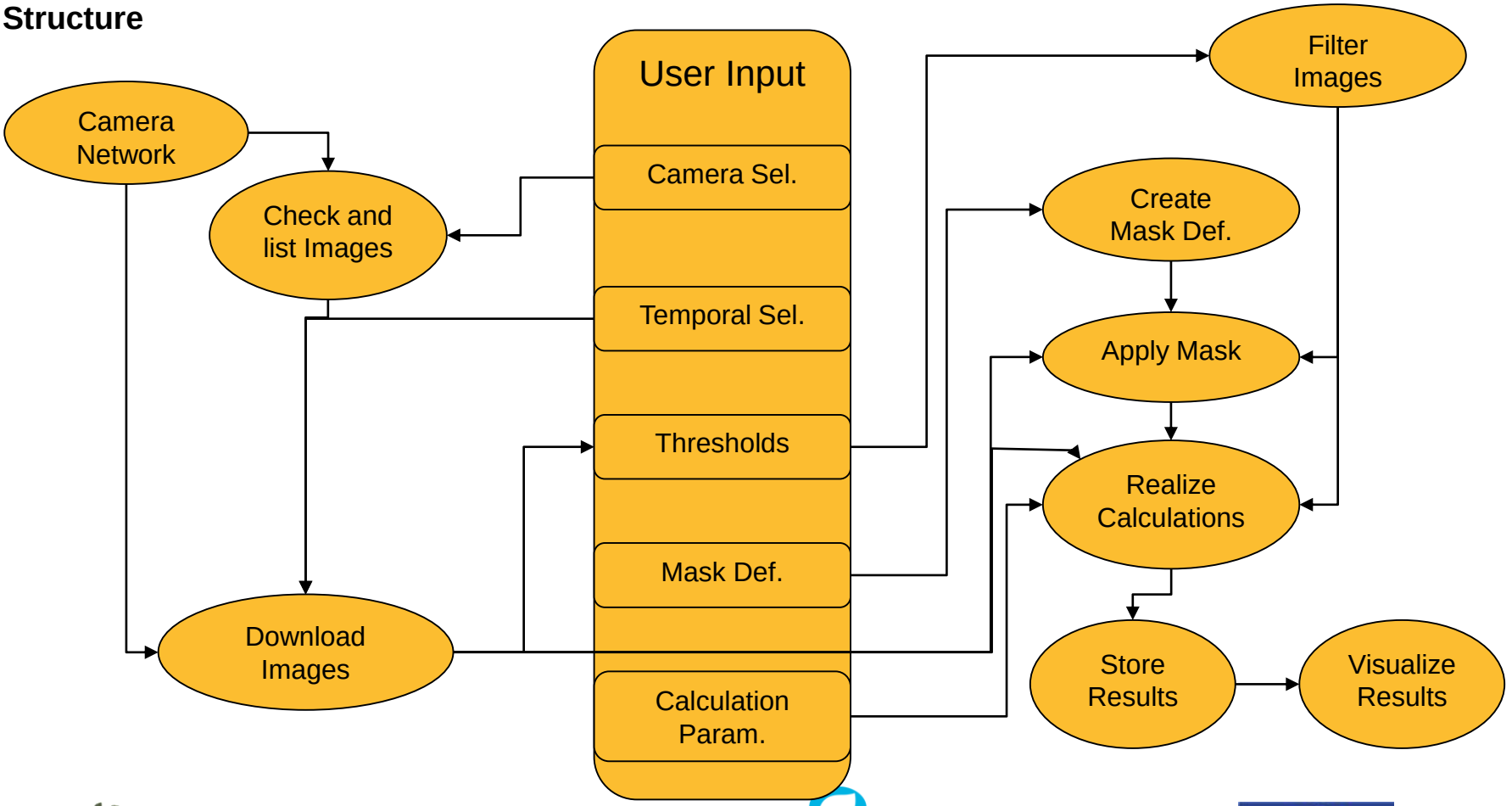
Navigation buttons to change active analysis



Recent entries of log file

FMIPROT

Structure



FMIPROT

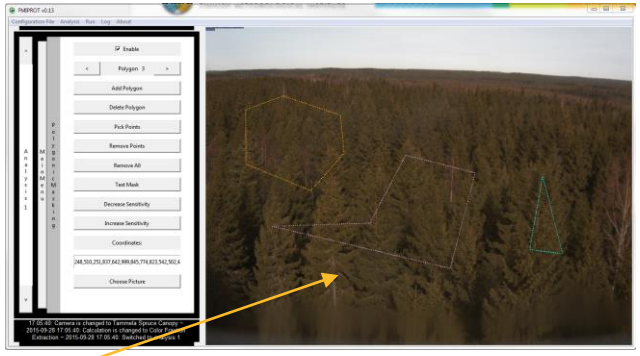
Configuration Files

Configuration files **store the input parameters of analyses**, to be loaded into FMIPROT later to modify/repeat analyses.

Configuration files provide possibility to,

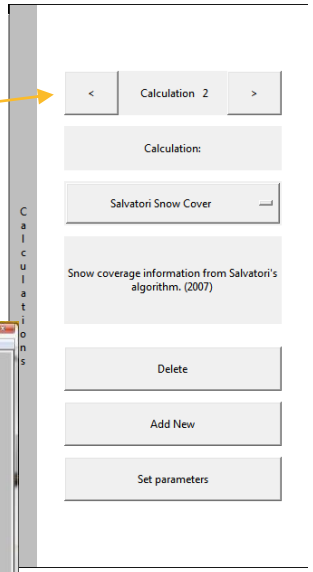
- Make different types of **analyses at once** or same type of analyses with different input parameters **for comparative use.**
- Distribute the analyses parameters easily to **work with it in a group**
- Repeat anaylses in case of failure, software crash etc.

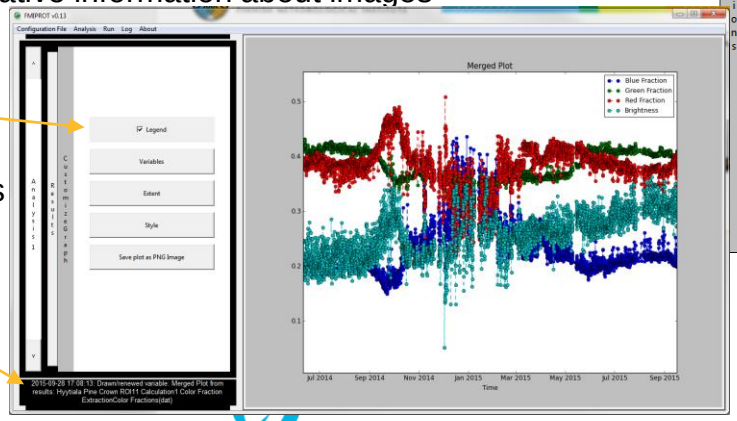
FMIPROT



Features

- Connection to MONIMET Camera Network
- Temporal selection for images; seperately for date and time.
- Threshold selection for brightness and color index fractions of images
- Polygonic masking; **multiple polygons for one region of interest**
- Storing downloaded images for future analyses
- Possibility to use only downloaded images, independent of the network
- **Multiple calculations in one analyses**
- Report generation in HTML format for analysis configurations
- Check the image archive and report for quantitative information about images
- Plotting results for 1D and 2D data
- **Customizable plots**
- **Detailed logging**
- Possibility to run only one or all of the analyses





FMIPROT

Algorithms

Current

- Color index ratios
- Snow Detection
- Snow Cover
  - Geo-rectified
  - Non-rectified

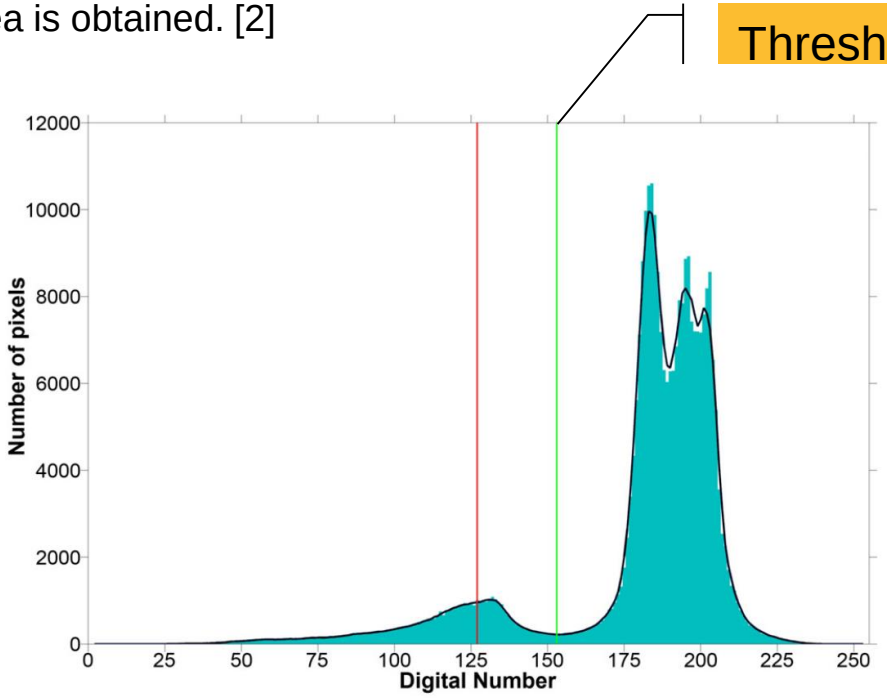
Planned

- Snow Depth
- Geo-rectified color index ratios
- Red-Green Vegetation Index
- Leaf Area Index

Snow Cover Analysis

Snow Detection & Snow Cover Analysis

Webcam images are also usable to extract snow cover information. An algorithm based on defining a threshold value according to the histogram of an image to classify a pixel as covered by snow or not is studied by Salvatori et. al. Using the algorithm with georectification of the images, snow coverage information of the visible area is obtained. [2]

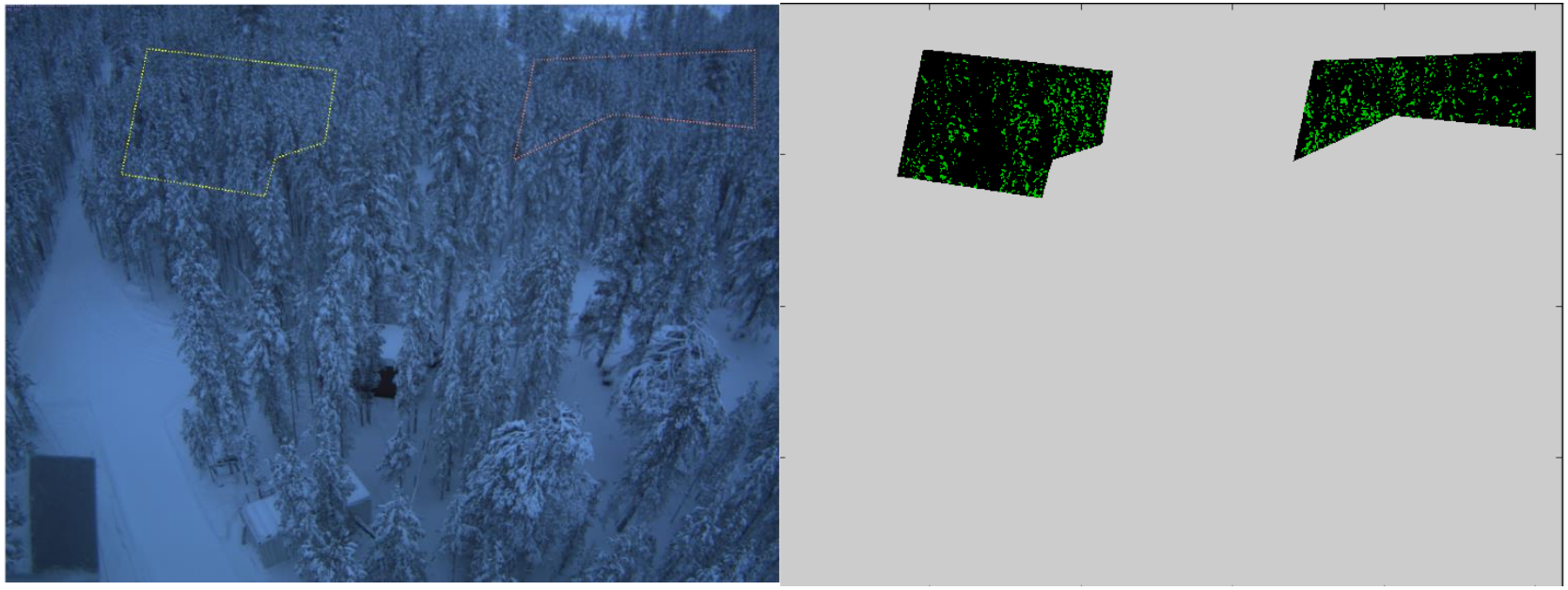


Selection of the threshold [3]

Snow Cover Analysis

Snow Detection & Snow Cover Analysis

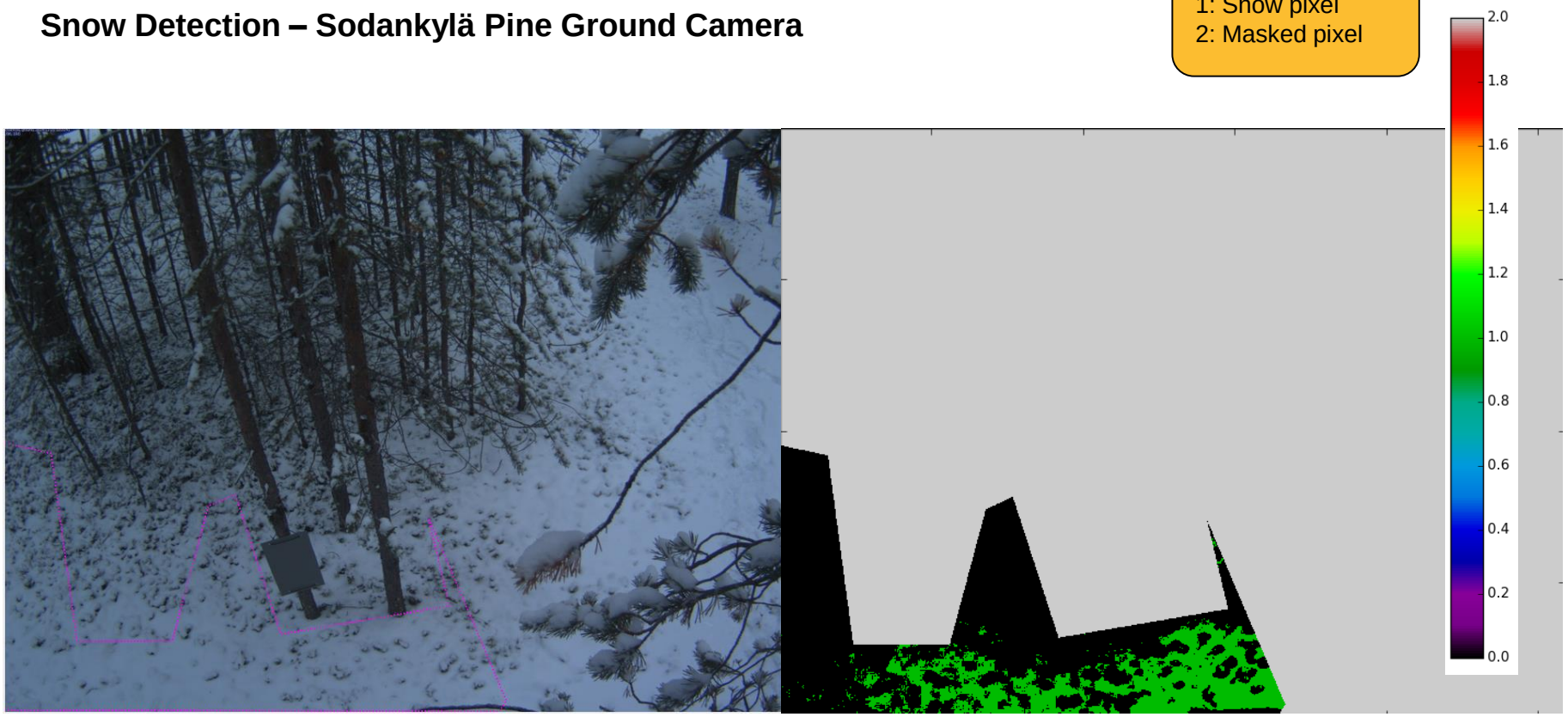
The algorithm is added to FMIPROT to study **how it works on the boreal region, both for the snow on the ground and the snow on the trees.** Below is an example for detecting snow on trees.



Snow Cover Analysis

Snow Detection – Sodankylä Pine Ground Camera

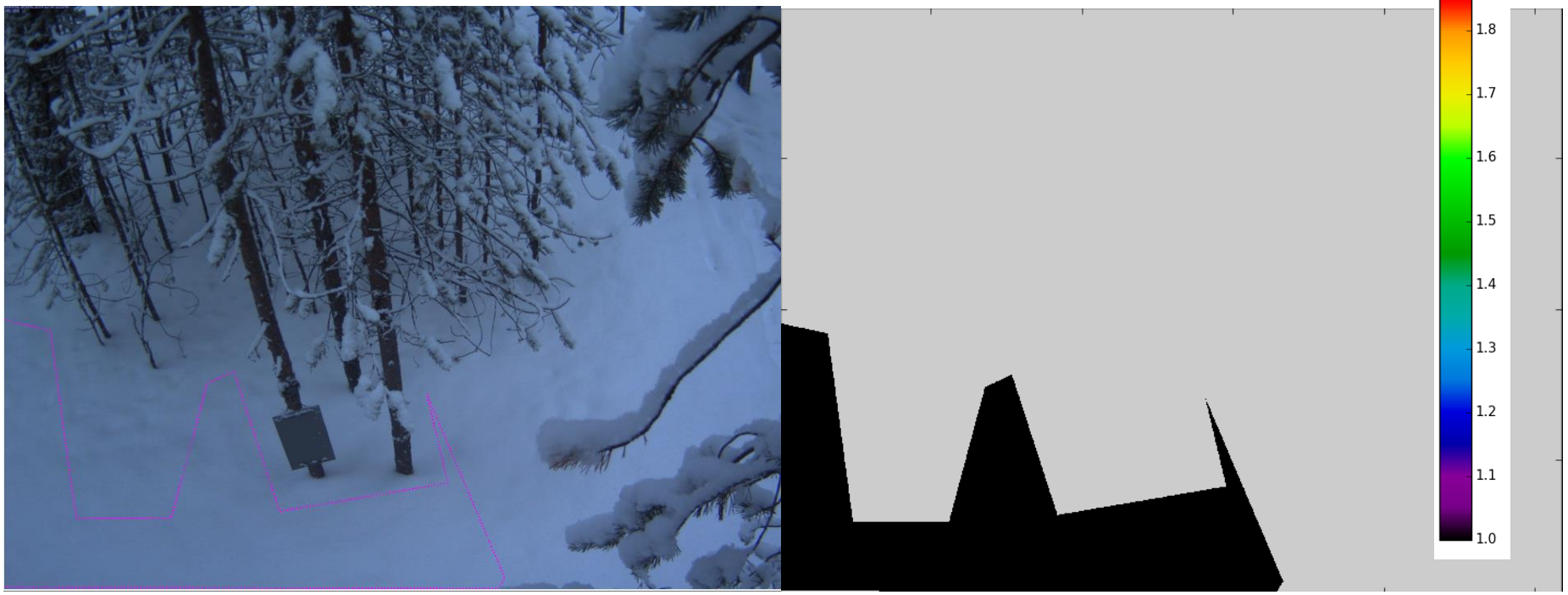
0: No-snow pixel
1: Snow pixel
2: Masked pixel



Snow Cover Analysis

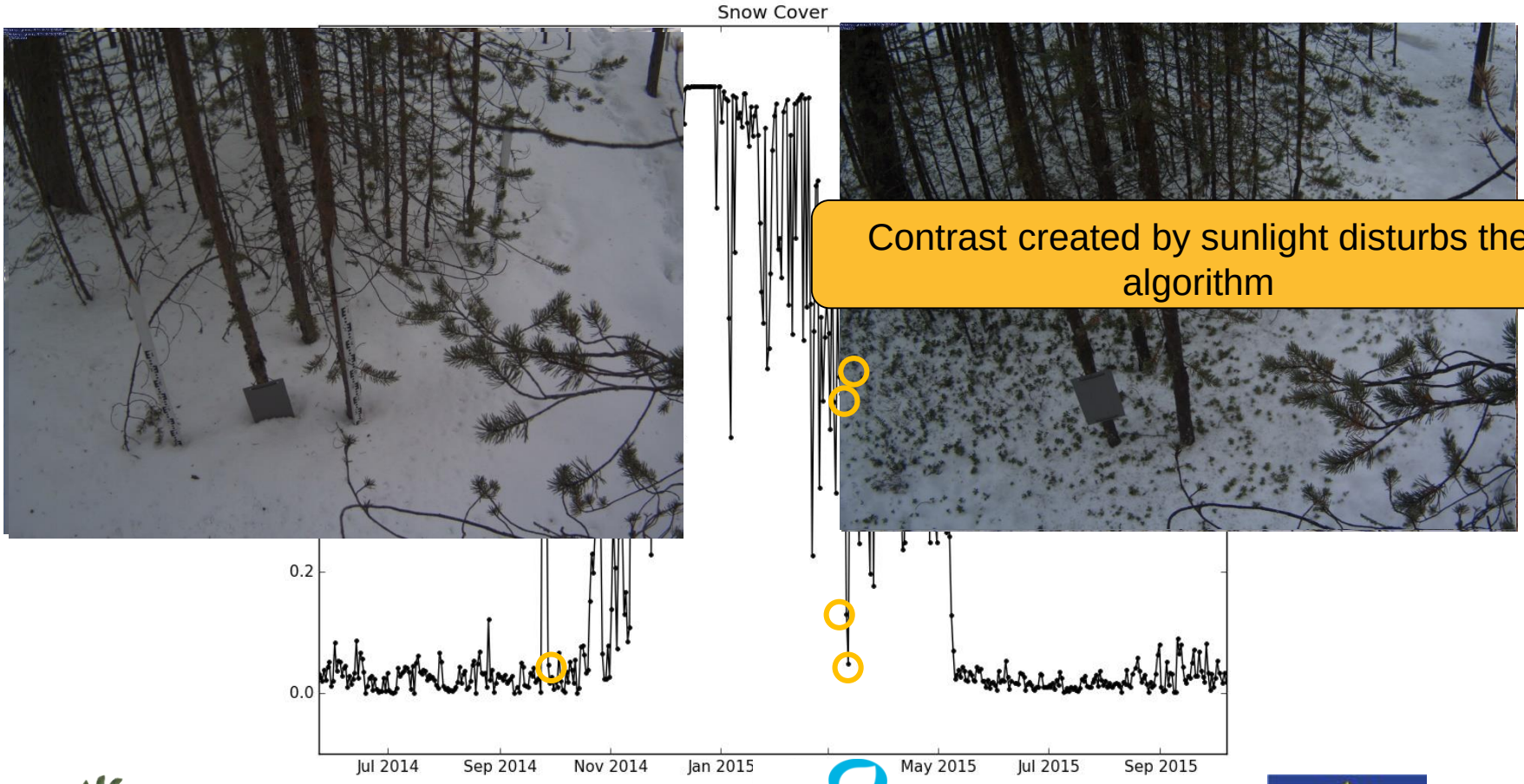
Snow Detection – Sodankylä Pine Ground Camera

0: No-snow pixel
1: Snow pixel
2: Masked pixel



Snow Cover Analysis

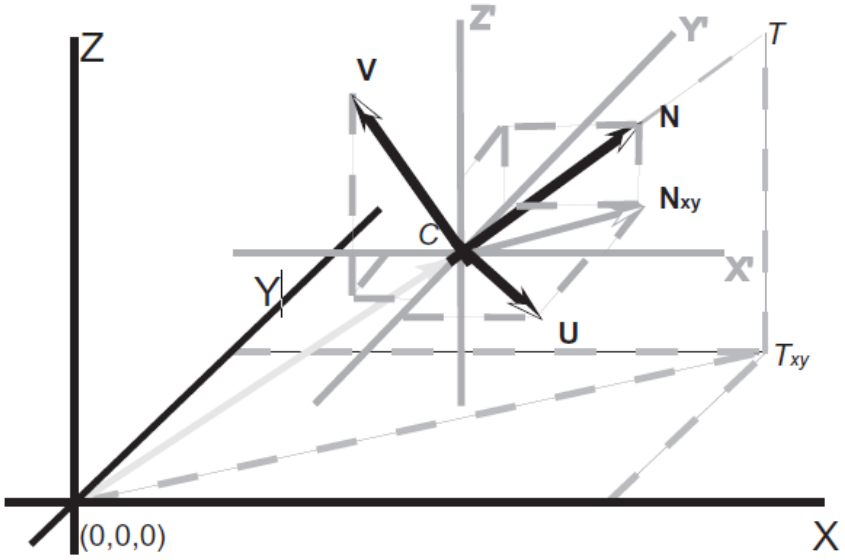
Snow Cover (No rectification) - Sodankylä Pine Ground Camera



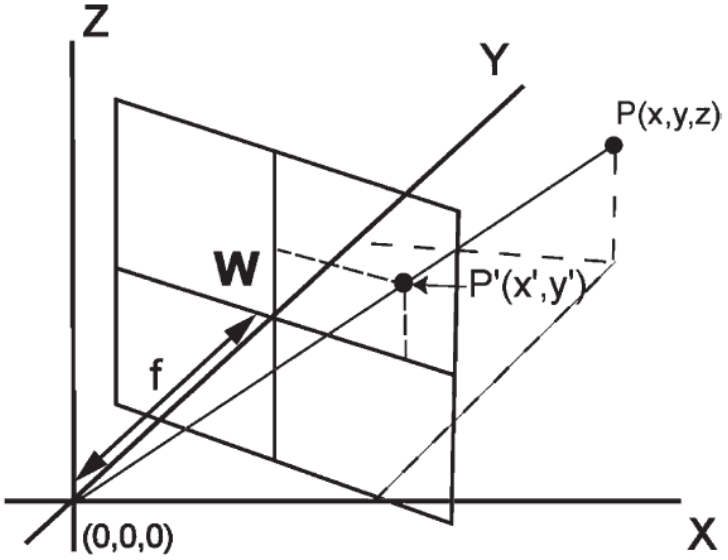
Contrast created by sunlight disturbs the algorithm

Snow Cover Analysis

Snow Cover (Rectification)



Change from world to camera coordinate system. [4]



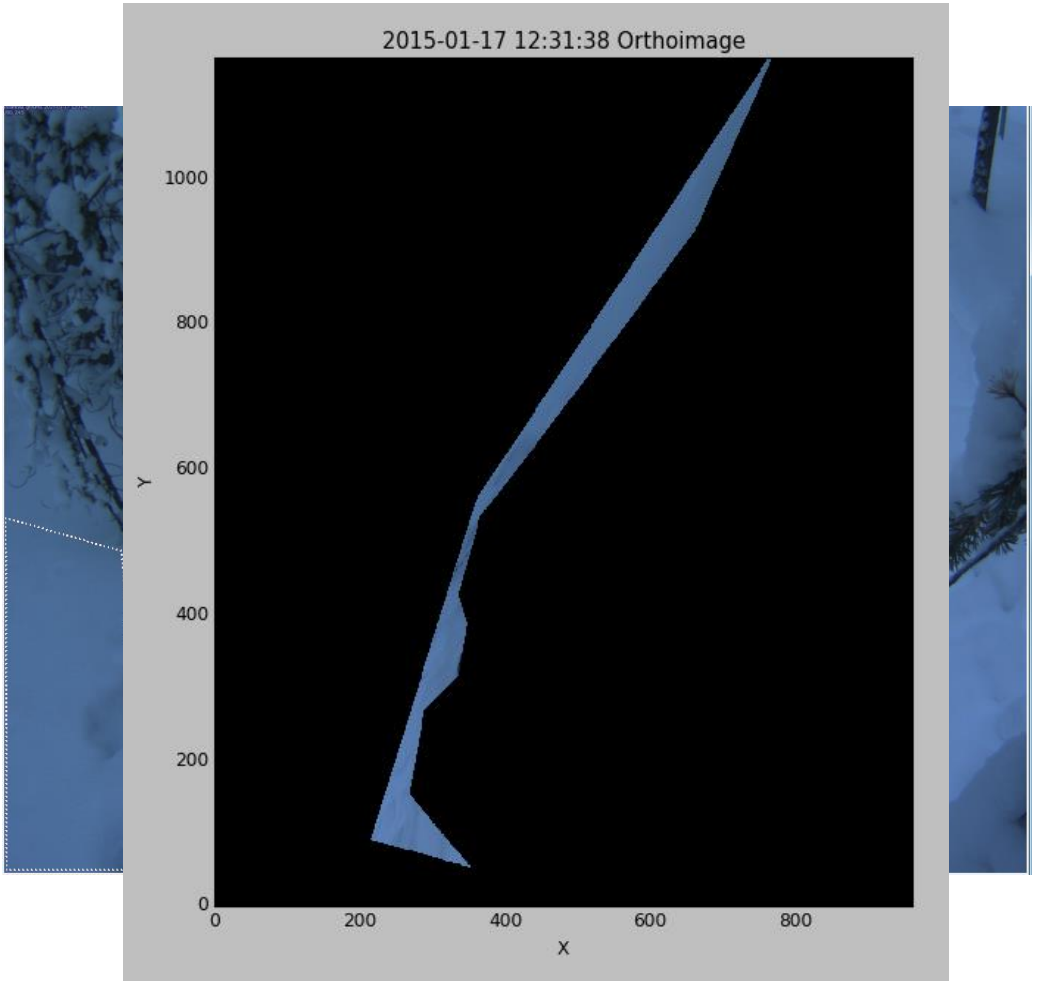
Simplified geometry of the perspective projection for one single point. [4]

Snow Cover Analysis - Snow Cover (Rectification)

Snow Cover Analysis

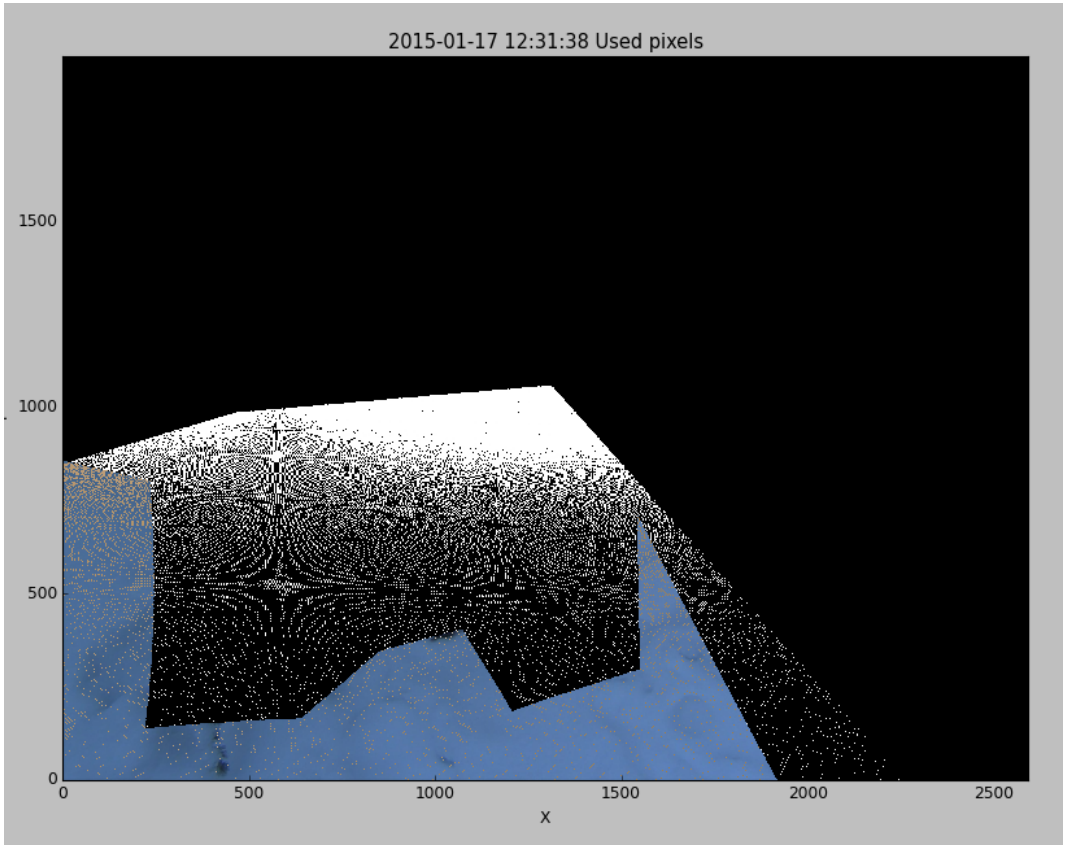
Snow Cover (Rectification) - Sodankylä Pine Ground Camera

- **Elevation is excluded since area is not wide enough to fit the coordinates obtained from 3m resolution device.**
- **Camera alignment parameters are used.**
- **Spatial extent covers only the masked area, to decrease calculation time.**
- **Image from 17.01.2015 12:31:38**



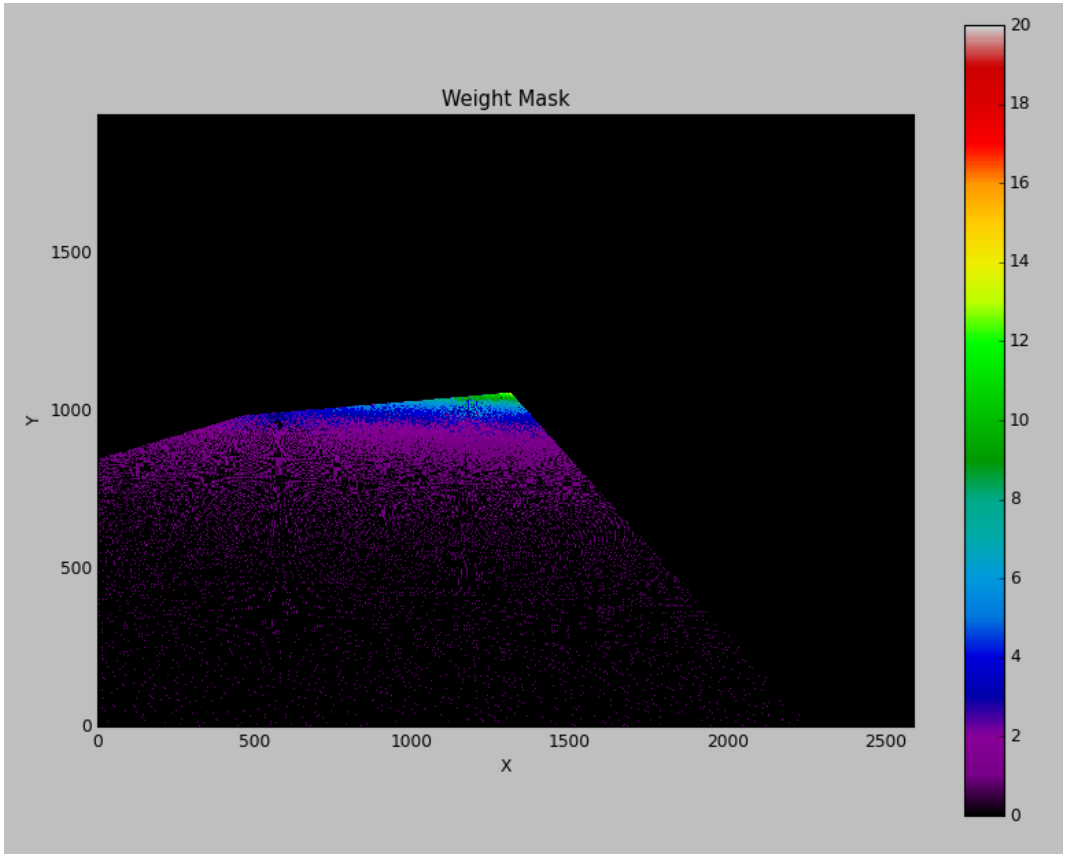
Snow Cover Analysis

Snow Cover (Rectification) - Sodankylä Pine Ground Camera



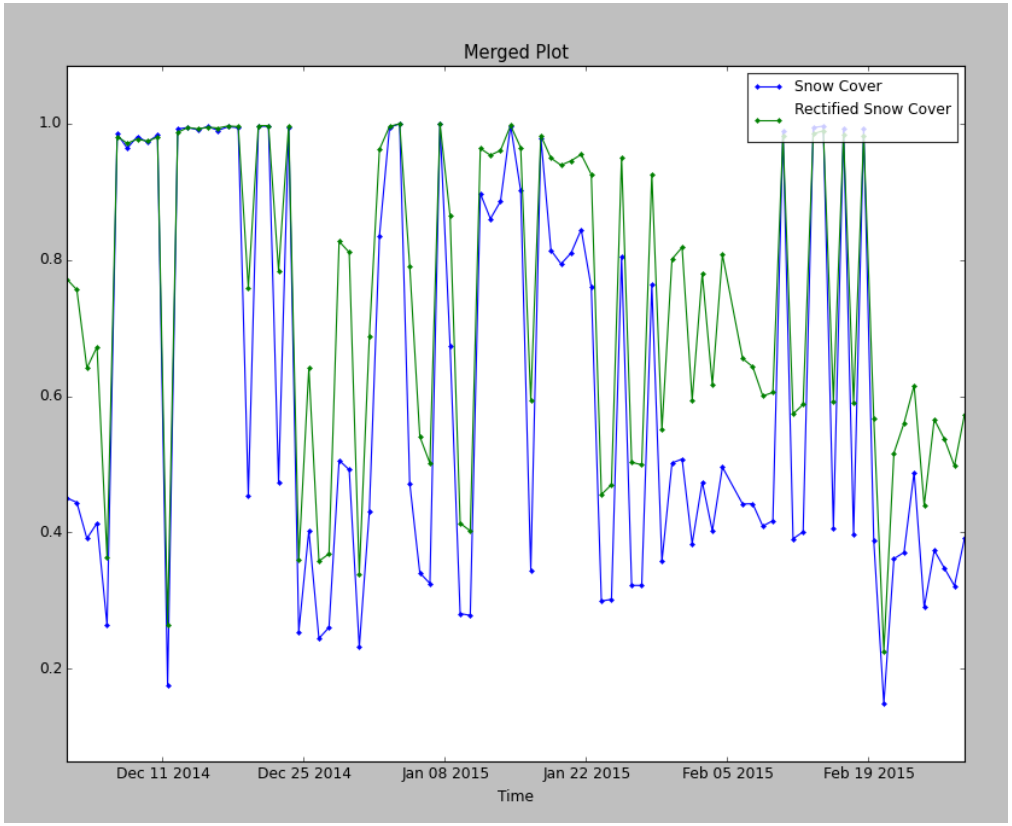
Snow Cover Analysis

Snow Cover (Rectification) - Sodankylä Pine Ground Camera



Snow Cover Analysis

Snow Cover (Rectification) - Sodankylä Pine Ground Camera



Future Work

- 3D Visualization
- Pseudo 4 Channel analyses (Handling IR images with optical images)
- Exception control
- Statistical analyses on results
- GUI Visual Design (e.g. Textures, layout redesign)
- Multiple camera networks
- Connection to MONIMET server for analysis request on supercomputer
- Processing for custom images on local disks

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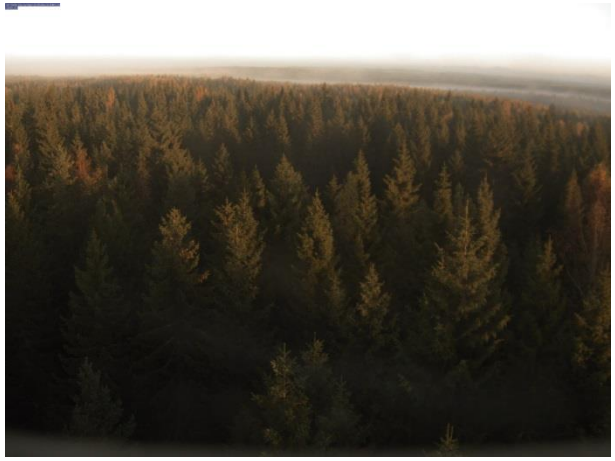
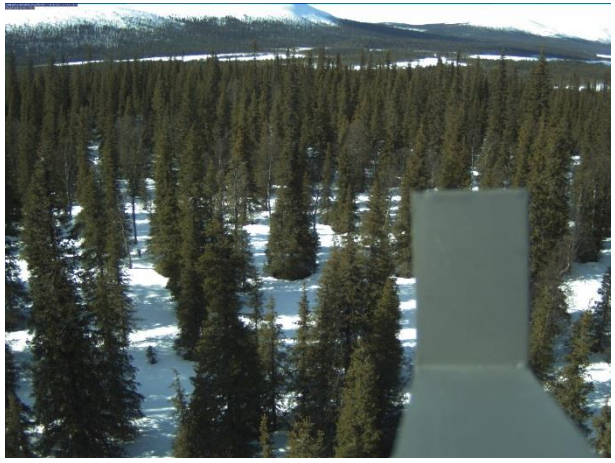
Thank you!





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References

[1] The University of Hampshire, PhenoCam Network – Software Tools, http://phenocam.sr.unh.edu/webcam/tools/

[2] Salvatori, R., Plini, P., Giusto, M., Valt, M., Salzano, R., Montagnoli, M., Cagnati, A., Crepaz, G., and Sigismondi, D. (2011) Snow cover monitoring with images from digital camera systems, Ital. J. Remote Sens., 43, 137–145.

[3] Dizerens, C., Hüsler, F., & Wunderle, S. Webcam imagery rectification and classification: Potential for complementing satellite-derived snow maps over Switzerland.

[4] Corripio, J., G., Snow surface albedo estimation using terrestrial photography, 2004, *International Journal of Remote Sensing,* VOL. 25, NO. 24, 5705–5729.