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METEOROLOGISKA INSTITUTET  
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# EU Life+ MONIMET

LIFE12 ENV/FI/000409

Stakeholder Workshop

## FMIPROT

## FMI Image Processing Tool

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## Background & Drivers

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





# Applications

## Color index ratios

Ratios of color indices in an image are usable to get information about especially phenological events. Using green and red fractions in an image, one can get results for the change in seasons of a vegetation. [2]

Ratio of a color index is the ratio of the sum (or mean) of the indices of that color in a selected area to the sum (or mean) of all color indices in that area in an image.

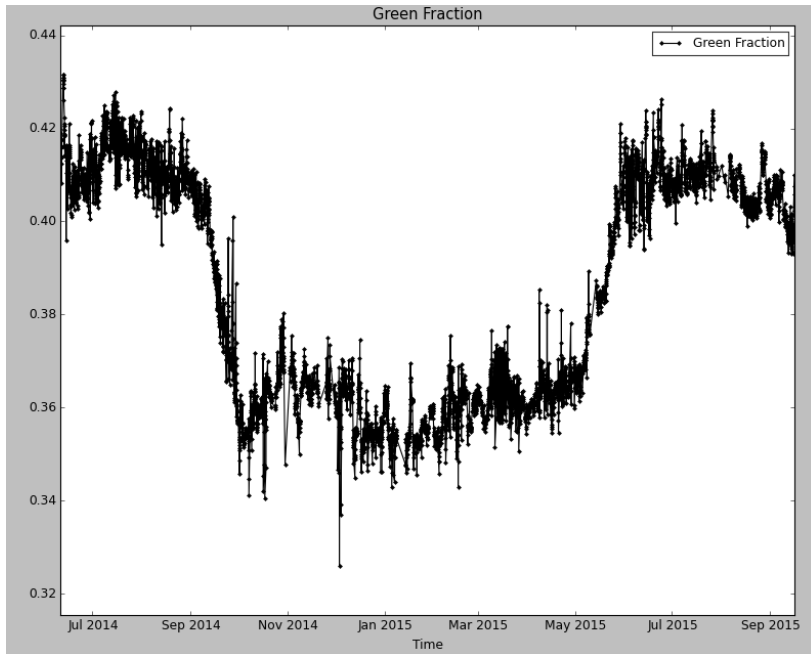
$$GF = \frac{G}{R + G + B} \quad RF = \frac{R}{R + G + B} \quad BF = \frac{B}{R + G + B}$$



# Applications

## Color index ratios

In FMIPROT, fractions for red, green and blue channel and the brightness of a selected area of an image can be calculated at the same time in one analysis. In the example below, **green fraction** of the area shown in picture from **Hyttiälä Canopy Camera** is plotted for June 2014 – September 2015.



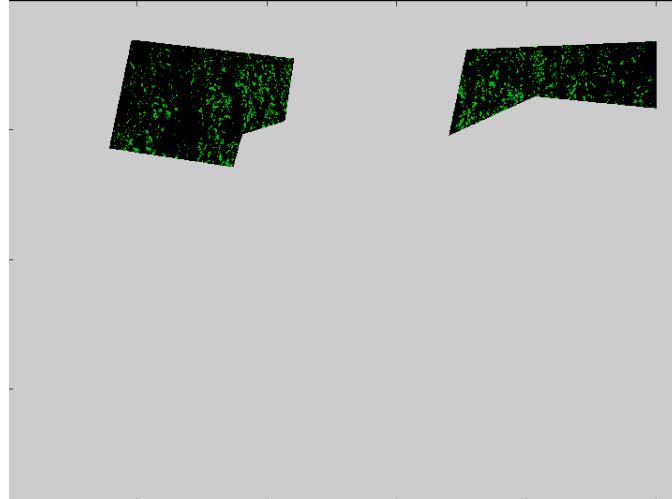


# Applications

## 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. [3]

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.





# Applications

## Snow Depth

MONIMET Camera Network also includes snow sticks on the ground visible by ground cameras. Although this study is not started yet, **using image segmentation and pattern recognition, it is planned to detect snow depth from the snow sticks by FMIPROT.** Snow sticks visible by Sodankylä Ground Camera is shown below.





# Introduction to FMIPROT

## Software

- The language used in FMIPROT is **Python**.
- For GUI, **TkInter** module is used.
- Main module used for image processing is **Mahotas**.
- Software version is now **0.12 Beta**, available only to project partners with distributions for
  - **Windows**
  - **Linux**
- **Installation is straightforward** for both distributions and does not require any auxiliary installation; the code is compiled beforehand.
- Detailed **user manual** is included.

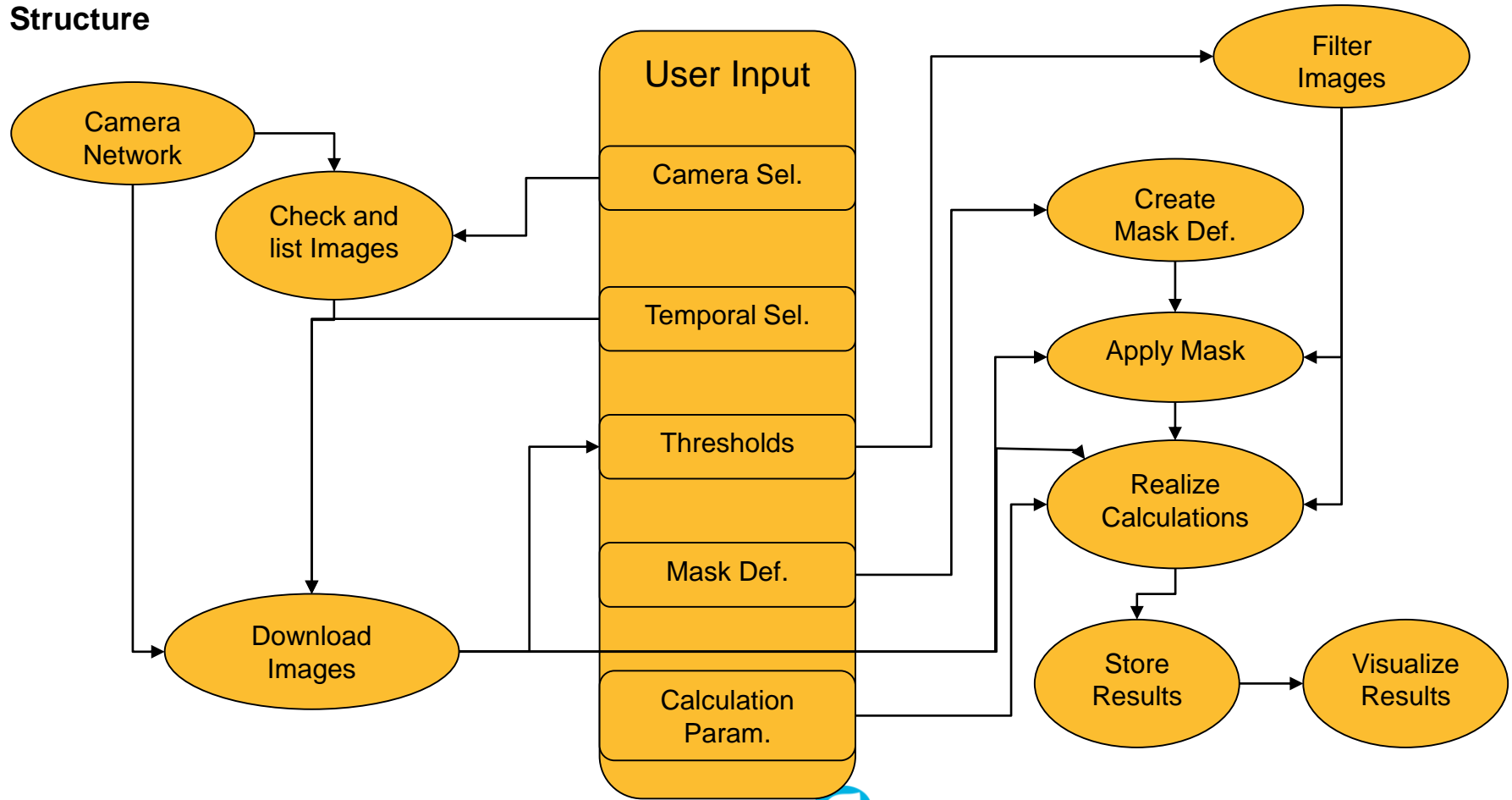






# Introduction to FMIPROT

## Structure





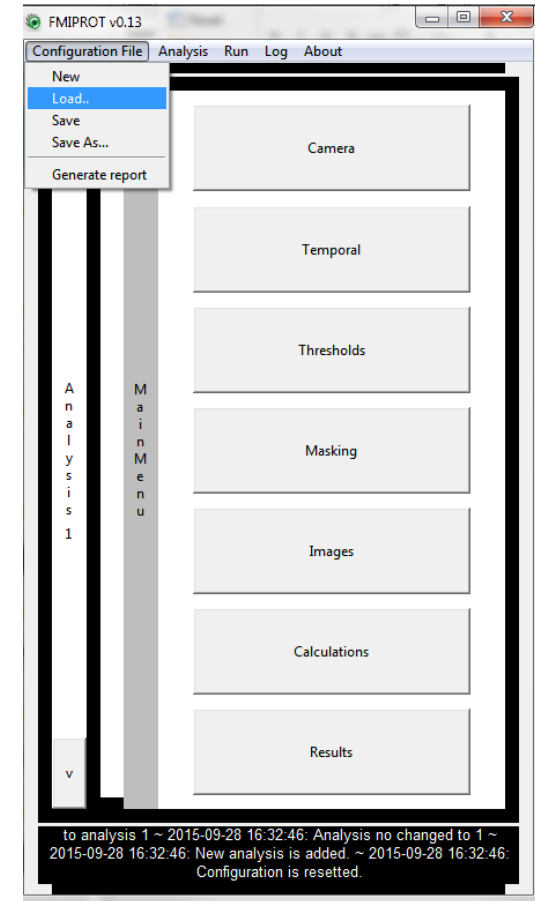
# Introduction to FMIPROT

## 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 analyses in case of failure, software crash etc.





# Introduction to FMIPROT

## Data Format of Results

Results from the analyses are saved as either **text files** with the extension ``.dat`` or **HDF5** files with the extension ``.h5``, depending on the dimensions of the output data.

**For one dimensional output, text files are used** and each output array is recorded to a column, as time of the image/event is in the first column. First row is the header and contains the names of the arrays. Data types are dependent on the output that the analyses gives, but converted to strings to record to the text file. Below is an example for the result file content for color fraction analysis.

**For the output data with more than one dimension, HDF5 files are used.** HDF5 files can store different datatypes with different dimensions in the same file so it is quite convenient to use in that sense.

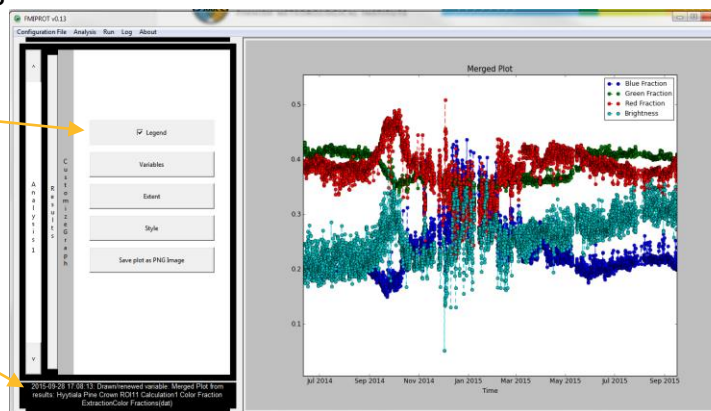
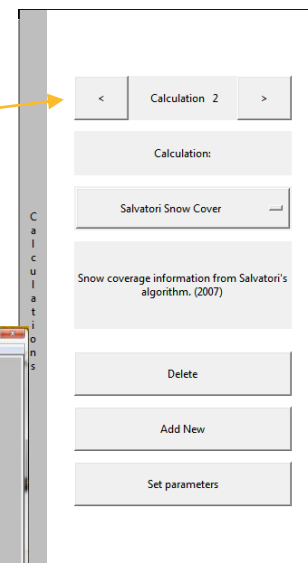
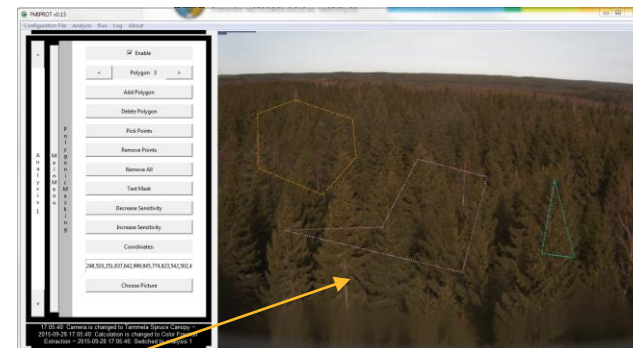
!Time	Blue Fraction	Green Fraction	Red Fraction	Brightness
2014-06-10_15:01:36	0.201534672656	0.419101416083	0.379363911261	0.221846544172
2014-06-11_10:01:35	0.193225028607	0.413768522727	0.393006448666	0.201502348727
2014-06-11_10:31:35	0.200048274019	0.412351012631	0.38760071335	0.210366631397
2014-06-11_11:01:35	0.190593235249	0.417636975312	0.391769789439	0.208757227443
2014-06-11_11:31:35	0.191850426232	0.417561216471	0.390588357297	0.215187387855
2014-06-11_12:01:37	0.192847409264	0.416182331703	0.390970259033	0.218922309308
2014-06-11_12:31:37	0.190220621901	0.416207212018	0.393572166081	0.225288752206
2014-06-11_13:01:38	0.193666456294	0.408274378219	0.398059165487	0.2464528901
2014-06-11_13:31:38	0.191274862779	0.415922234753	0.392802902469	0.219384240144
2014-06-11_14:01:38	0.188447545963	0.415934245851	0.395618208185	0.220065944836
2014-06-11_14:31:38	0.193560123697	0.414066584418	0.392373291886	0.217155547272
2014-06-11_15:01:38	0.191731485752	0.413774761427	0.394493752821	0.245630733007
2014-06-12_10:01:35	0.182602791227	0.430860449725	0.386536759048	0.187466373015



# Introduction to FMIPROT

## Features

- Connection to MONIMET Camera Network
- Temporal selection for images; separately 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
- Possibility to run only one or all of the analyses
- Plotting results for 1D and 2D data
- **Customizable plots**
- **Detailed logging**





# Example analyses

## Sodankylä Pine Crown Camera Color Index Fraction Analysis





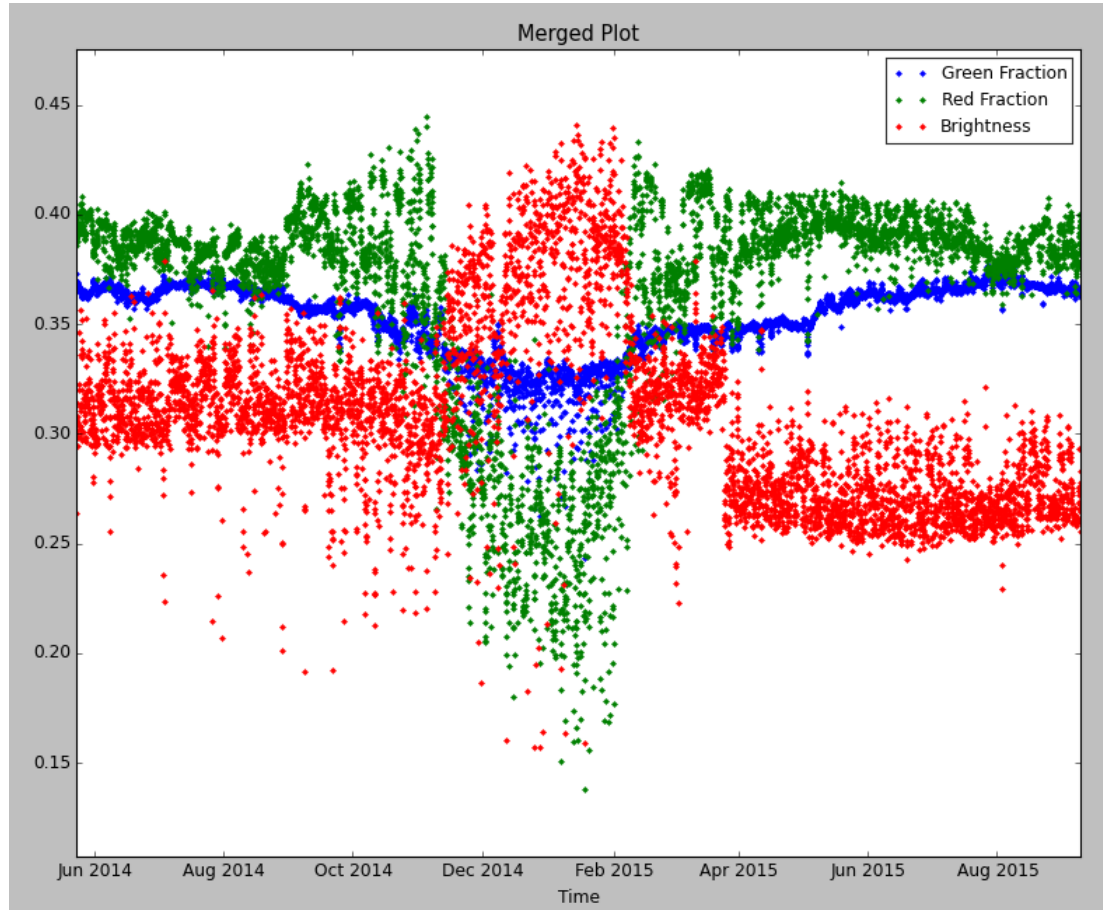
# Example analyses

## Sodankylä Pine Crown Camera Color Index Fraction Analysis

T i m e o f t h e d a y	Start:	Minimum:
	<input checked="" type="checkbox"/> Enable	<input checked="" type="checkbox"/> Enable
	09:45	0.15
	End:	Maximum:
	<input checked="" type="checkbox"/> Enable	<input type="checkbox"/> Enable
	15:15	1.00
S e t p a r a m e t e r s	<input checked="" type="checkbox"/> Green Fraction	
	<input checked="" type="checkbox"/> Red Fraction	
	<input type="checkbox"/> Blue Fraction	
	<input checked="" type="checkbox"/> Brightness	



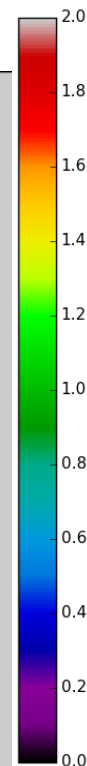
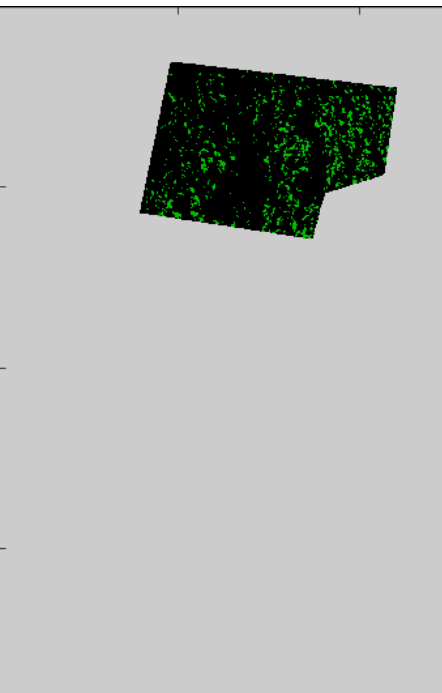
## Example analyses





## Example analyses

### Snow Detection – Sodankylä Pine Canopy Camera

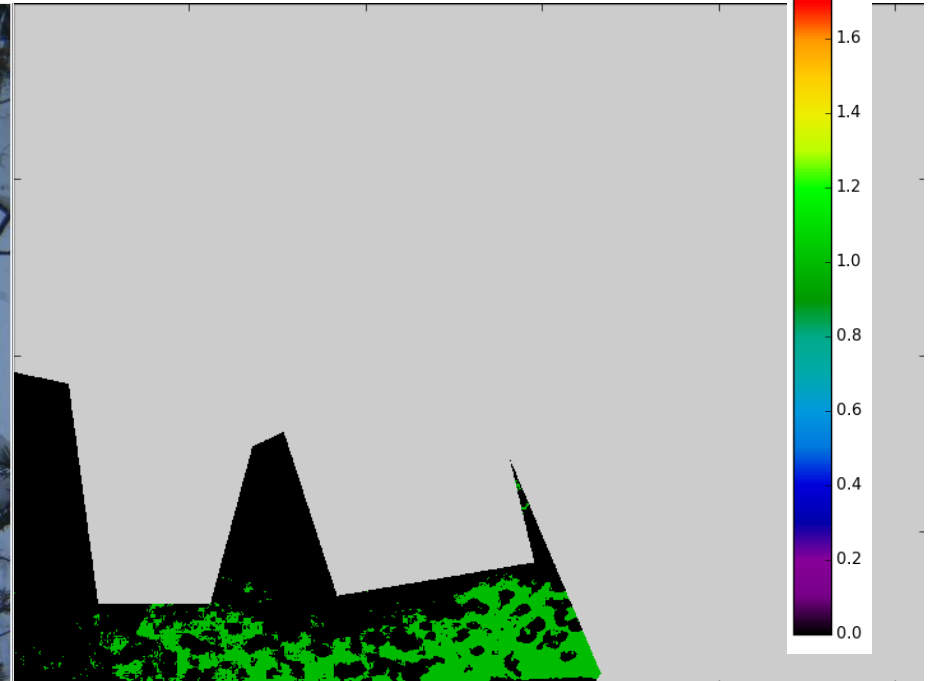






# Example analyses

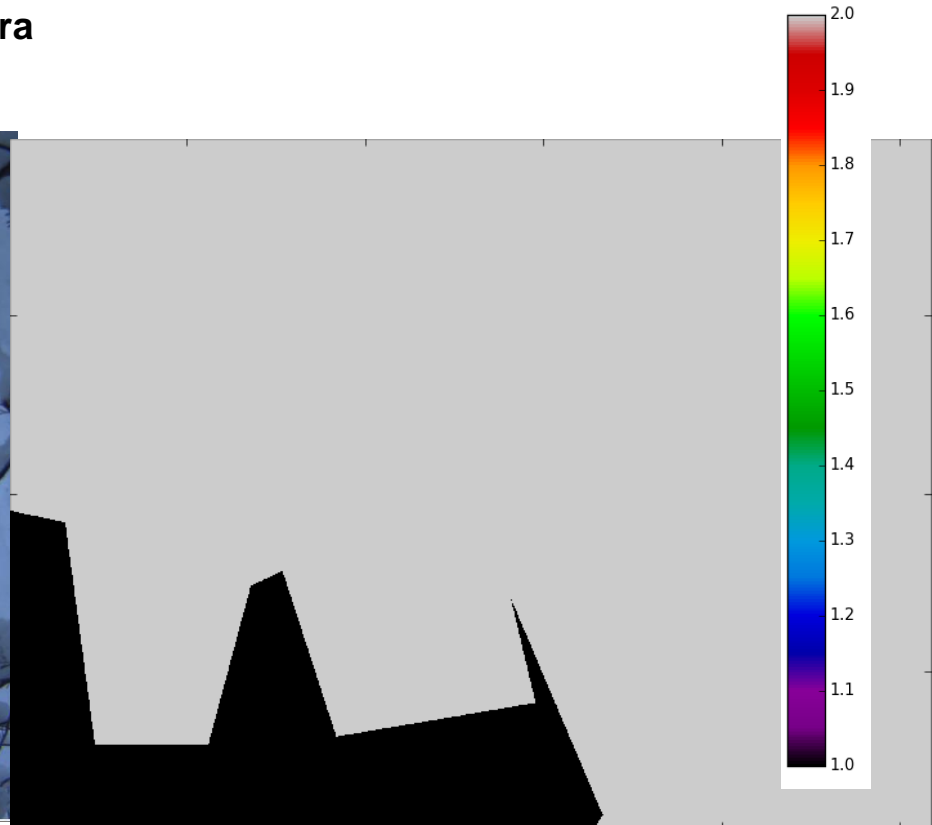
## Snow Detection – Sodankylä Pine Ground Camera





# Example analyses

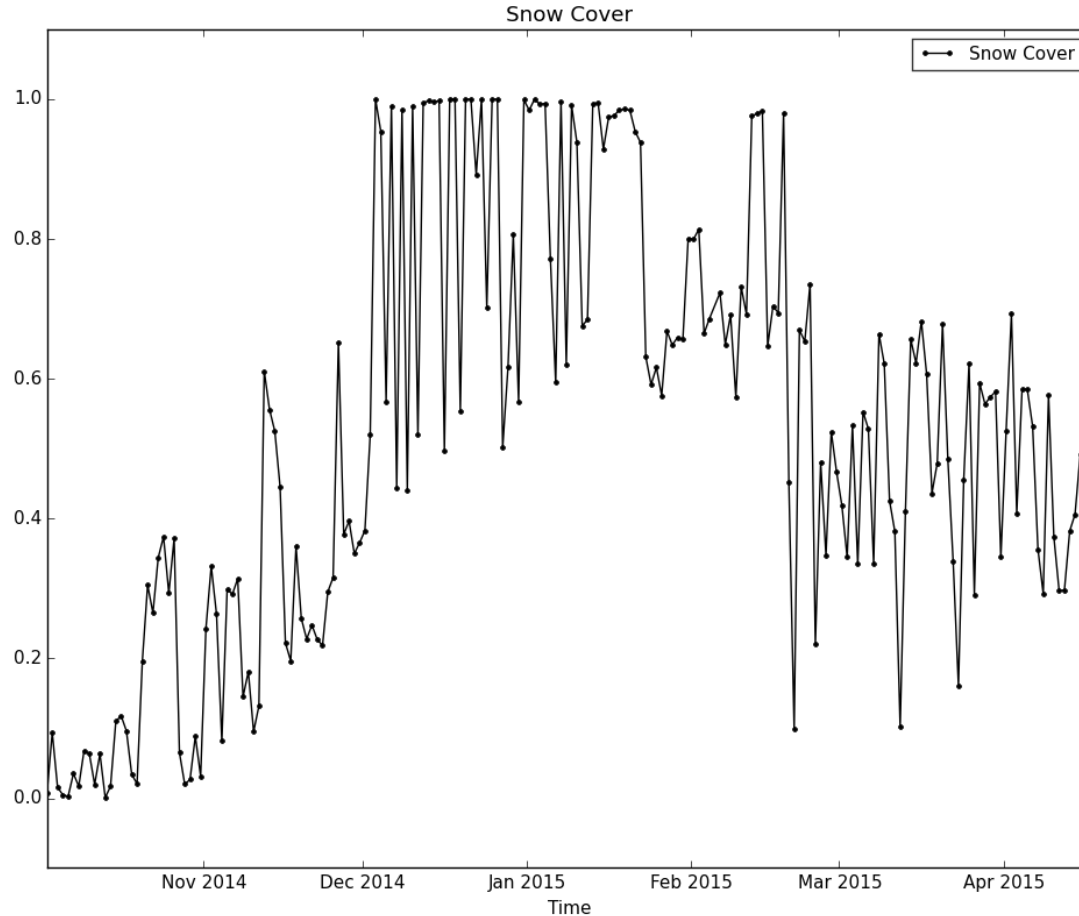
## Snow Detection – Sodankylä Pine Ground Camera





## Example analyses

### Snow Cover (No rectification) - Sodankylä Pine Ground Camera





## Future Work

- Georectification
- 3D Visualization
- Pseudo 4 Channel analyses ( Handling IR images with optical images)
- Exception control
- Statistical analyses on results
- GUI Visual Design (e.g. Textures)
- Multiple camera networks





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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] Junbin Zhao, Yiping Zhang, Zhenghong Tan, Qinghai Song, Naishen Liang, Lei Yu, Junfu Zhao, Using digital cameras for comparative phenological monitoring in an evergreen broad-leaved forest and a seasonal rain forest, *Ecological Informatics*, Volume 10, July 2012, Pages 65-72, ISSN 1574-9541, <http://dx.doi.org/10.1016/j.ecoinf.2012.03.001>.
- [3] 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.
- [4] Dizerens, C., Hüsler, F., & Wunderle, S. Webcam imagery rectification and classification: Potential for complementing satellite-derived snow maps over Switzerland.

