



## Introduction

EU Life+ MONIMET is an ambitious project spearheaded by scientists in Finland to increase turnover of climate data by implementing a network of webcams in Finland's boreal forest and wetland environments. Boreal forest represents the world's largest terrestrial biome and exerts a pronounced effect on global climate and weather systems. In Finland, the boreal zone is blended with wetland environments that account for one-third of the country's territory. They are important for boreal greenhouse gas balances due to methane emissions. The project aims to:

- To create new webcam monitoring system in order to facilitate Earth Observation systems by providing time-series of field observation for calibration and validation, as well as to improve the assessment of forest ecosystem services,
- To synthesize modeling and observation approaches to identify climate change indicators,
- To establish link between the climate change indicators and their effects in order to create vulnerability maps of boreal zone in connection to climate change scenarios.

## Webcam Network

We established a network of cameras that are observing phenological changes in boreal ecosystems of Finland. Presently, 14 sites take images at 30 min intervals. Sites have 1-3 cameras positioned above canopies, crown level, and/or at ground level.

Image material has been used in phenological analyses of birches along a latitudinal gradient across Finland, snow cover analyses and compared to greenhouse gas fluxes on Scots pine and wetland ecosystems.

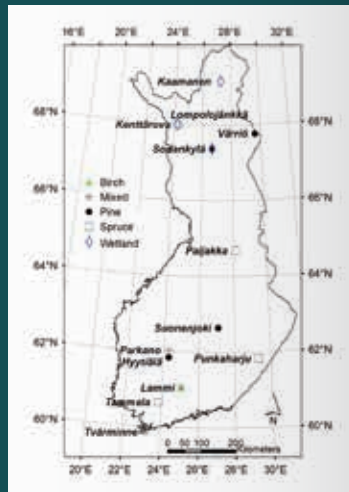


Image material is openly published in [https://www.zenodo.org/communities/phenology\\_camera/](https://www.zenodo.org/communities/phenology_camera/).

## In-situ and Satellite data

MONIMET provides time series of vegetation phenology, leaf area index, snow cover and soil freeze in Finland, based on both satellites and in-situ measurements. In addition, carbon, water and energy exchanges between the atmosphere and different ecosystems were measured at six sites. The MONIMET data were used for calibrating and validating land surface models, and for estimating trends in environmental phenomena such as the timing of snow melt in spring.

Maps of the start of the vegetation active period are presented in a web map application (<http://syke.maps.arcgis.com>) and are available for download from SYKE's Open Data Portal

## FMIPROT Toolbox

Finnish Meteorological Institute Image Processing Toolbox (FMIPROT) is designed to analyze digital images from webcams for phenological and meteorological purposes in an automated and user-friendly way. Multiple camera networks can be connected to FMIPROT and various options for analyses can be set up using graphical user interface. Automated downloading, handling and analyzing images from camera networks, generating reports and charts, user developed plugins are a few of various features. It can calculate different color indices used in vegetation phenology. The toolbox and more information can be found in MONIMET webpage.



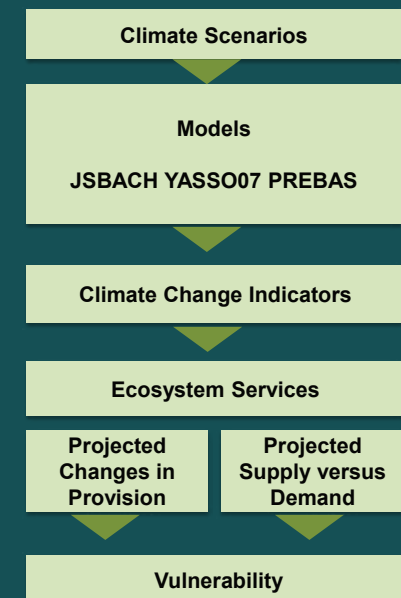
Screenshot: FMIPROT Toolbox

## MONIMET Modelling System

The carbon cycle of natural terrestrial ecosystems were estimated with two models – Land ecosystem model JSBACH and semi-empirical stand flux model PREBAS. Both of these models estimate photosynthesis and evapotranspiration of land ecosystems. The models differ in how they describe photosynthesis, vegetation phenology and account for land ecosystem types and land area.

While JSBACH returns the matter and energy balances of the whole landscape, PREBAS estimates the canopy values from stand properties. PREBAS is a stand growth model based on carbon acquisition and allocation in trees. Both JSBACH and PREBAS have been combined with the Finnish soil carbon model YASSO07.

Land ecosystem models were calibrated using in situ, earth observation and webcam data. The calibrated models were run with climate data adopted from 15 scenarios of the CMIP5 project including representative concentration pathway rcp2.6, rcp4.5 and rcp8.5 simulations. The timeseries and trends of selected climate change indicators were retrieved from the model results.



MONIMET: From Climate Scenarios to Vulnerability