

## EU Life + MONIMET: Climate change indicators and vulnerability of boreal zone applying innovative observation and modeling techniques

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The increased temperature in the boreal region has extended the growing season. Especially the spring recovery of photosynthesis has the potential to start earlier, which increases the net uptake of CO<sub>2</sub>. In the autumn, on the other hand, higher temperatures increase soil respiration (CO<sub>2</sub> emission). This has been shown to be significant during the warm late autumns, when low light levels cannot anymore maintain high photosynthesis levels. During the summer, the changing climate may increase the carbon uptake due to enhanced gross primary production (GPP). However, net uptake may also be reduced as a result of increased respiration or if excess heat and droughts reduce GPP. The drier and warmer conditions are also suggested to increase the frequency of forest fires. In addition to meteorological factors, carbon sinks are enhanced by the direct influence of higher CO<sub>2</sub> levels (CO<sub>2</sub> fertilization) and increasing nitrogen availability (atmospheric deposition and mineralization in the soil).

In MONIMET project, flux measurements by Eddy Covariance (EC) technique at six Finnish forest sites with the longest time series spanning over 15 years are used. In order to study the influence of climate change, these results are up-scaled in time and space. For this, modelling techniques are implemented at various scales (process models, land surface/biosphere models, global transport models), as well as the inversion technique based on tall-tower measurements of background concentrations. The use of web cameras are also investigated in upscaling and monitoring ecosystem processes. Image colour information provides a useful and cost-efficient way to monitor leaf onset and snow cover from broad areas, and they can be used as proxies and indicators of spring timing, for example. In addition, ecosystem behaviour can be monitored with earth observation satellites, which provide global data on various environmental variables.

Moreover, in MONIMET, an extensive network of web-cam phenological observation sites in Finland is implemented. The data is used to assess the indicators produced with the models. Finally, the models are run with climate scenario data, and consequently the impact of the climate change on land surface can be observed in terms of climate change indicators.

The main results of the project are to estimate vulnerability of boreal forest ecosystems to climate change impacts in the future, and to assess uncertainties due to measurements, climate models and ecosystem models. Results we aim to achieve can be listed as below

1. A harmonized webcam network for monitoring the seasonal cycle in boreal ecosystem carbon exchange
2. Demonstration of the mapping of climate indicators in boreal forest zone
3. Demonstration of vulnerability assessment for Finnish municipalities to climate change effects in boreal forest
4. Calibrated soil-vegetation-atmosphere model parametrisations for the boreal zone
5. Estimates of the uncertainty of the results

**In this paper we will present achievements on the objectives listed above.**

Keywords: Climate change, Camera network, Vulnerability