EU Life+ MONIMET Project

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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.

- While climate change is a problem in need of global action, its effects are localized and affect regions in very different ways. Equally, certain areas exert a greater influence on the global climate and carbon balance than others, and it is this dynamic relationship that makes tackling climate change so complex.

- Over the next century, scientists predict a mean annual temperature increase of 2-6 °C. This change will be particularly important in the boreal forest biome, which is distributed in a band around the northern sub-polar regions of Earth.

- 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.

Objectives

- To collect information, data and expertise that is currently spread over several institutes, in order to build a comprehensive platform for analyzing climate change effects on seasonal dynamics of various phenomena
- To create links and add value to existing monitoring mechanisms such as ICOS and EO systems (COPERNICUS) and make use of data acquired in previous EU Life+ funded, and other projects related to ecosystem monitoring
- 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

Achievements

MONIMET CAMERA 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/

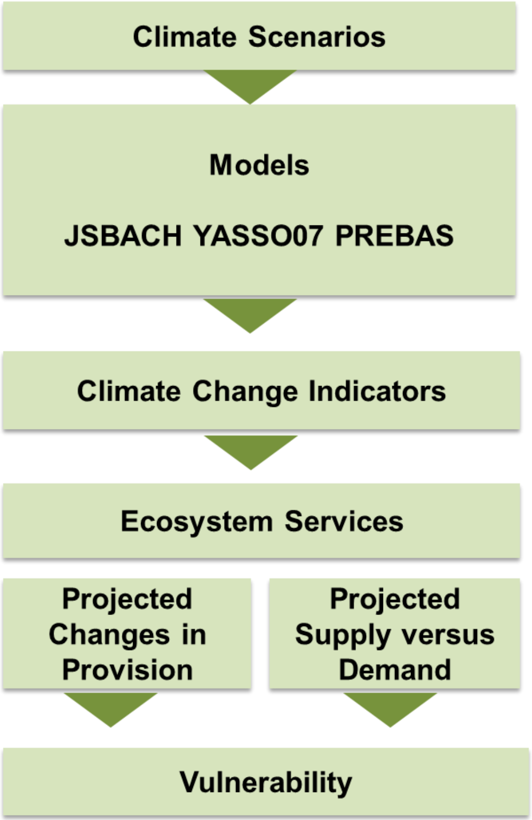
Achievements

FMIPROT TOOLBOX

Finnish Meteorological Institute Image Processing Toolbox (FMIPROT) was designed to analyze digital images from webcams for phenological and meterological purposes in an automated and user-friendly way.

Achievements

MONIMET MODELING SYSTEM



Achievements

DEMONSTRATION ON ECOSYSTEM SERVICES AND VULNERABILITY

Impacts of a warming climate on the provision of ecosystem services of boreal forests.

Key climate change indicators published in Climateguide.fi

Achievements

PUBLICATIONS (4 in review and 16 published/accepted)

1. Y. Gao, T. Markkanen, M. Aurela, I. Mammarella, T. Thum, A. Tsuruta, H. Yang, and T. Aalto. Response of water use efficiency to summer drought in boreal Scots pine forests in Finland. Biogeosciences, 14, 4409-4422, 2017
2. Raivonen, M., Smolander, S., Backman, L., Susiluoto, J., Aalto, T., Markkanen, T., Mäkelä, J., Rinne, J., Peltola, O., Aurela, M., Tomasic, M., Li, X., Larmola, T., Juutinen, S., Tuittila, E.-S., Heimann, M., Sevanto, S., Kleinen, T., Brovkin, V., and Vesala, T.: HIMMELI v1.0: HelsinkI Model of MEthane buiLd-up and emIssion for peatlands, Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2017-52, **in review**, 2017.
3. Susiluoto, J., Raivonen, M., Backman, L., Laine, M., Mäkelä, J., Peltola, O., Vesala, T., and Aalto, T.: Calibrating a wetland methane emission model with hierarchical modeling and adaptive MCMC, Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2017-66**, in review**, 2017.
4. Thum, T., Zaehle, S., Köhler, P., Aalto, T., Aurela, M., Guanter, L., Kolari, P., Laurila, T., Lohila, A., Magnani, F., Van Der Tol, C., and Markkanen, T., 2017. Modelling sun-induced fluorescence and photosynthesis with a land surface model at local and regional scales in northern Europe, Biogeosciences, 14, 1969-1987, doi:10.5194/bg-14-1969-2017.
5. Ruosteenoja, K., Markkanen, T., Venäläinen, A., Räisänen, P. and Peltola, H., 2017. Seasonal soil moisture and drought occurrence in Europe in CMIP5 projections for the 21st century, Climate Dynamics, doi:10.1007/s00382-017-3671-4.
6. Gao Y., Markkanen T., Thum T., Aurela M., Lohila A., Mammarella I., Hagemann S., Aalto T. Assessing various drought indicators in representing drought in boreal forests in Finland. Hydrol. Earth Syst. Sci. 20, 175–191, 2016.
7. Linkosalmi M., M. Aurela, J.-P. Tuovinen, M. Peltoniemi, C. M. Tanis, A. N. Arslan, P. Kolari, T. Aalto, J. Rainne, and T. Laurila. Digital photography for assessing vegetation phenology in two contrasting northern ecosystems. Geosci. Instrum. Method. Data Syst., 5, 417–426, 2016, doi:10.5194/gi-5-417-2016
8. Böttcher K., T. Markkanen, T. Thum, T. Aalto, M. Aurela, C. H. Reick, P. Kolari, A. N. Arslan, and Jouni Pulliainen. Evaluating Biosphere Model Estimates of the Start of the Vegetation Active Season in Boreal Forests by Satellite Observations. Remote Sens. 2016, 8(7), 580; 2016, doi:10.3390/rs8070580

9. Mäkelä, J., Susiluoto, J., Markkanen, T., Aurela, M., Järvinen, H., Mammarella, I., Hagemann, S., and Aalto, T., 2016. Constraining ecosystem model with adaptive Metropolis algorithm using boreal forest site eddy covariance measurements, Nonlin. Processes Geophys., 23, 447-465, doi:10.5194/npg-23-447-2016.
10. Goll, D. S., Brovkin, V., Liski, J., Raddatz, T., Thum, T., and Todd-Brown, K. E. O., 2015. Strong dependence of CO_2 emissions from anthropogenic land cover change on initial land cover and soil carbon parametrization. Global Biogeochemical Cycles, 29, 1511–1523, doi:10.1002/2014GB004988.
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12. Metsämäki, S.; Böttcher K.; Pulliainen, J.; Luojus, K., Cohen, J.; Takala, M.; Mattila, O.P.; Schwaizer, G.; Derksen, C. The accuracy of snow melt-off day derived from optical and microwave radiometer data and the relationship of snow water equivalent and fractional snow cover — a study for Europe, **in review**.
13. Holmberg, M., Akujärvi, A., Anttila, S., Arvola, L., Bergström, I., Böttcher, K., Feng, X., Forsius, M., Huttunen, I., Huttunen, M., Laine, Y., Lehtonen, H., Liski, J., Mononen, L., Rankinen, K., Repo, A., Piirainen, V., Vanhala, P., Vihervaara, P. 2015. ESLab application to a boreal watershed in southern Finland - preparing for a virtual research environment of ecosystem services. Landscape Ecology 30: 561-577 doi:10.1007/s10980-014-0122-z
14. Akujärvi, Anu, Aleksi Lehtonen, and Jari Liski. 2016. Ecosystem services of boreal forests-Carbon budget mapping at high resolution. Journal of Environmental Management 181: 498-514.
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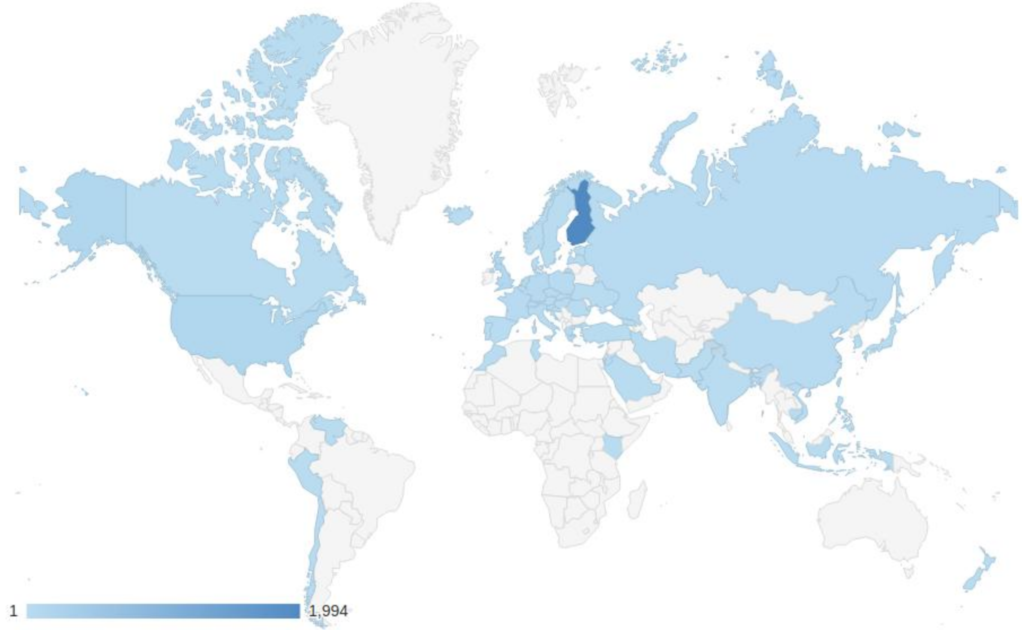
17. Arslan, A.N.; Tanis, C.M.; Metsämäki, S.; Aurela, M.; Böttcher, K.; Linkosalmi, M.; Peltoniemi, M. Automated Webcam Monitoring of Fractional Snow Cover in Northern Boreal Conditions. *Geosciences* **2017**, *7*, 55.
18. Mikko Peltoniemi, Mika Aurela, Kristin Böttcher, Pasi Kolari, John Loehr, Jouni Karhu, Maiju Linkosalmi, Cemal Melih Tanis, Juha-Pekka Tuovinen, and Ali Nadir Arslan, Webcam network and image database for studies of phenological changes of vegetation and snow cover in Finland, image time series from 2014-2016 **in review**.
19. Mikko Peltoniemi, et all, Networked web-cameras monitor congruent seasonal development of birches with phenological field observations, Agricultural and Forest Meteorology, accepted.
20. Cemal Melih Tanis, et all, FMIPROT **in review**.

Sessions per country



Data acquired between 16.06.2016 – 30.10.2017

Sessions from Top 10 countries

Country	Acquisition		
	Sessions	% New Sessions	New Users
	2,718 % of Total: 100.00% (2,718)	48.90% Avg for View: 48.90% (0.00%)	1,329 % of Total: 100.00% (1,329)
1. Finland	1,994 (73.36%)	42.53%	848 (63.81%)
2. United States	134 (4.93%)	92.54%	124 (9.33%)
3. Taiwan	96 (3.53%)	2.08%	2 (0.15%)
4. United Kingdom	87 (3.20%)	98.85%	86 (6.47%)
5. Germany	47 (1.73%)	76.60%	36 (2.71%)
6. Slovenia	31 (1.14%)	6.45%	2 (0.15%)
7. Italy	27 (0.99%)	55.56%	15 (1.13%)
8. Netherlands	26 (0.96%)	61.54%	16 (1.20%)
9. Belgium	23 (0.85%)	60.87%	14 (1.05%)
10. Latvia	22 (0.81%)	50.00%	11 (0.83%)

Data acquired between 16.06.2016 – 30.10.2017