10 YEARS CzechGlobe

GLOBAL CHANGE
RESEARCH INSTITUTE CAS

DendroNetwork

Real-time biomonitoring of forest ecosystems

Jan Krejza
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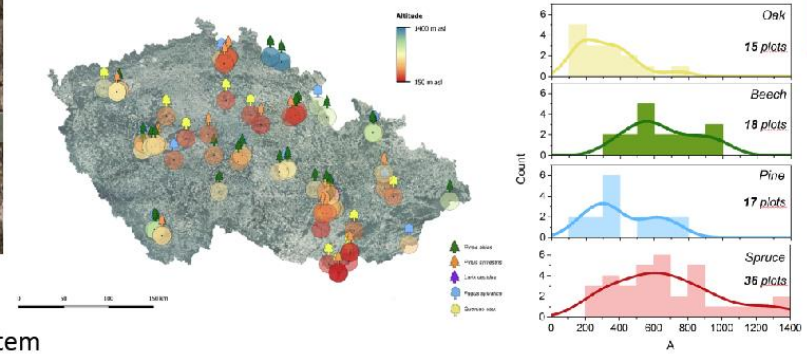
Welcome to **DendroNetwork**

bio-monitoring the state of forest ecosystems in the Czech Republic providing information in real-time.

Field site records

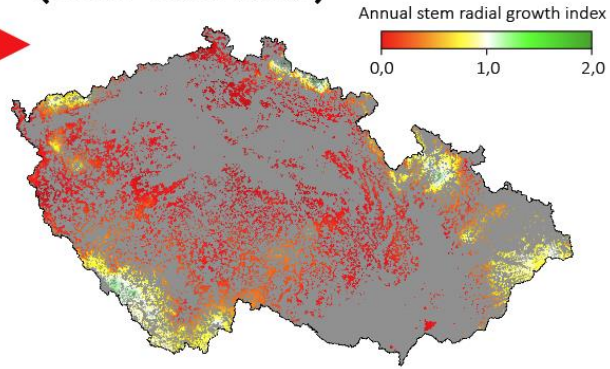
Dendrometer measures variations of the stem diameter (SDV) with high spatial (micrometre) and temporal frequency (hours). The pattern of SDV is based on (1) irreversible stem growth dynamic and (2) tree water regime.

Distribution of DendroNet plots



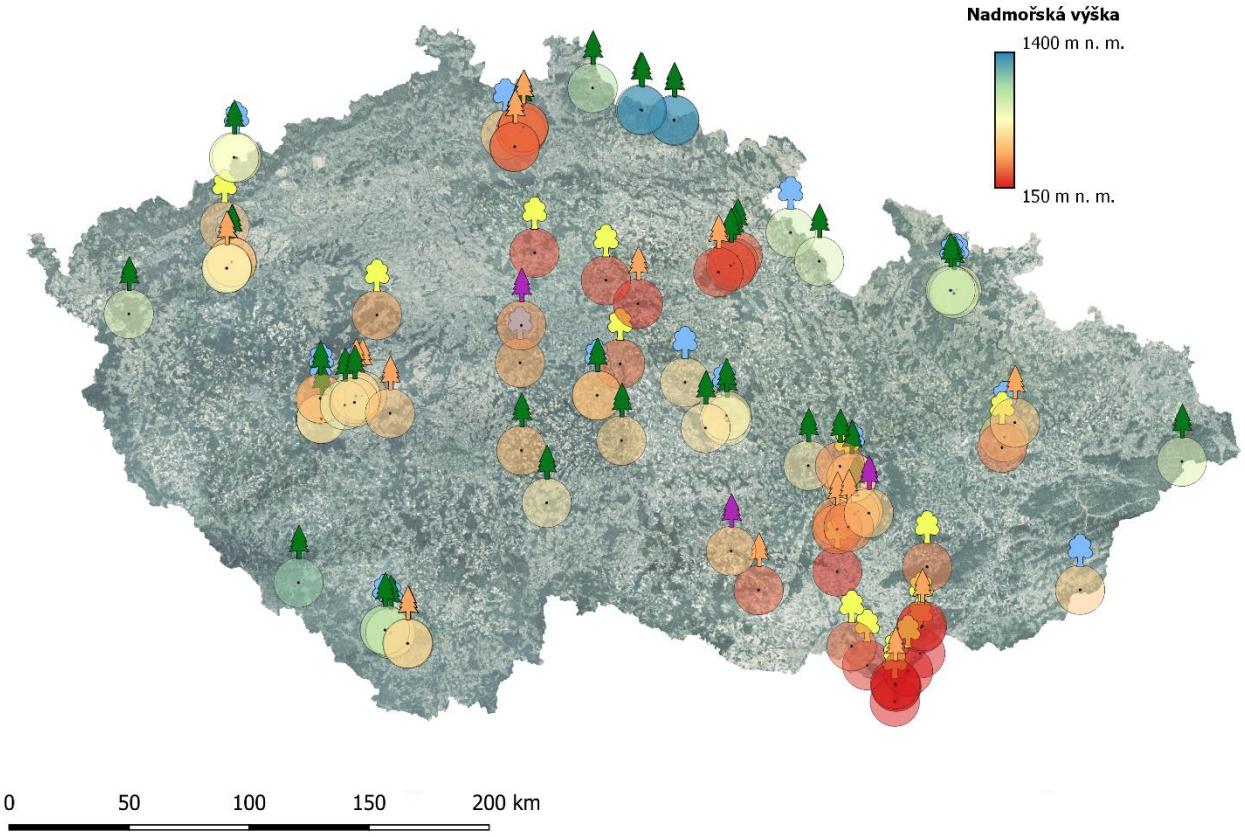
Distribution of the plots in a vertical gradient of the Czech Republic (A). (B) Spatial distribution of the research and monitoring plots within the Czech Republic

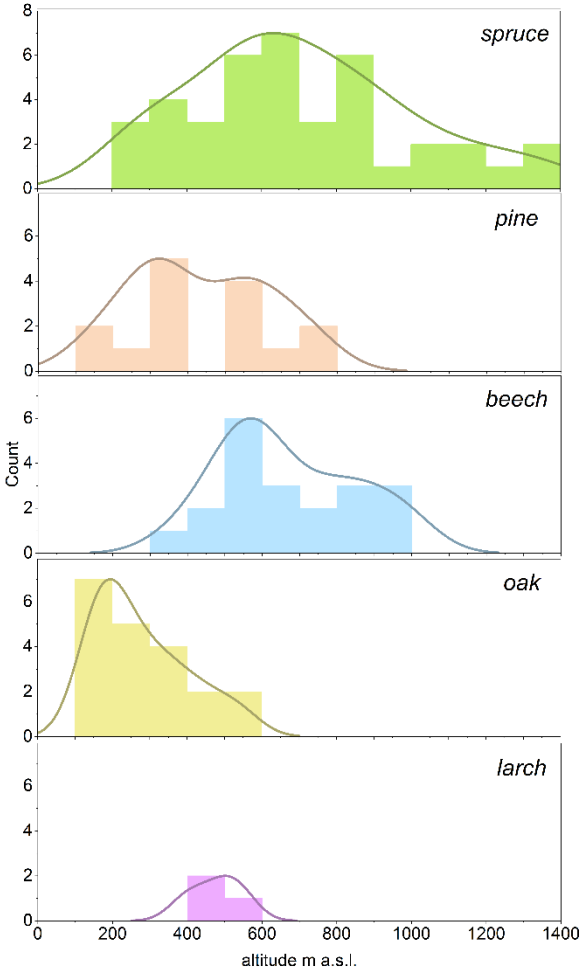
Processed data visualization (near real-time)

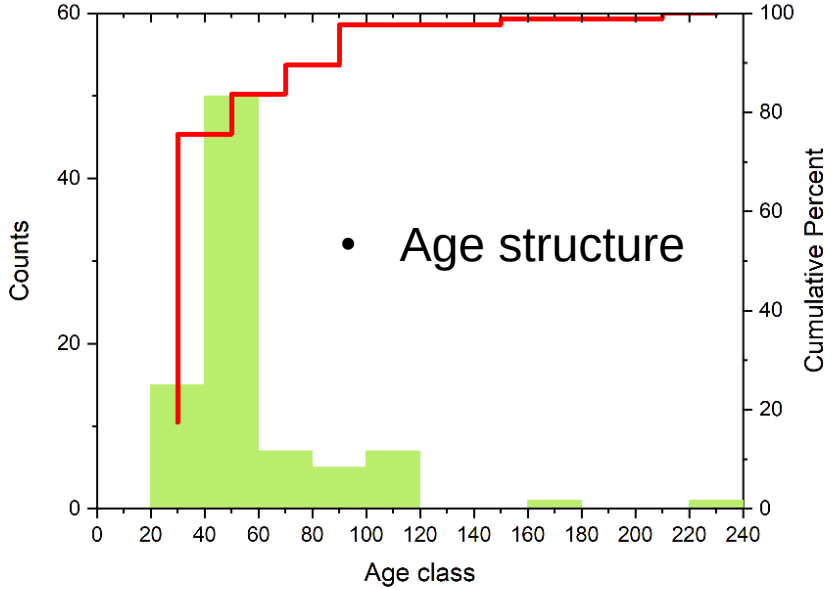


Effect of a climatic factor on stem increment of Norway spruce in the Czech Republic based on upscaling procedure

DendroNetwork







Spatial and vertical gradient of conditions

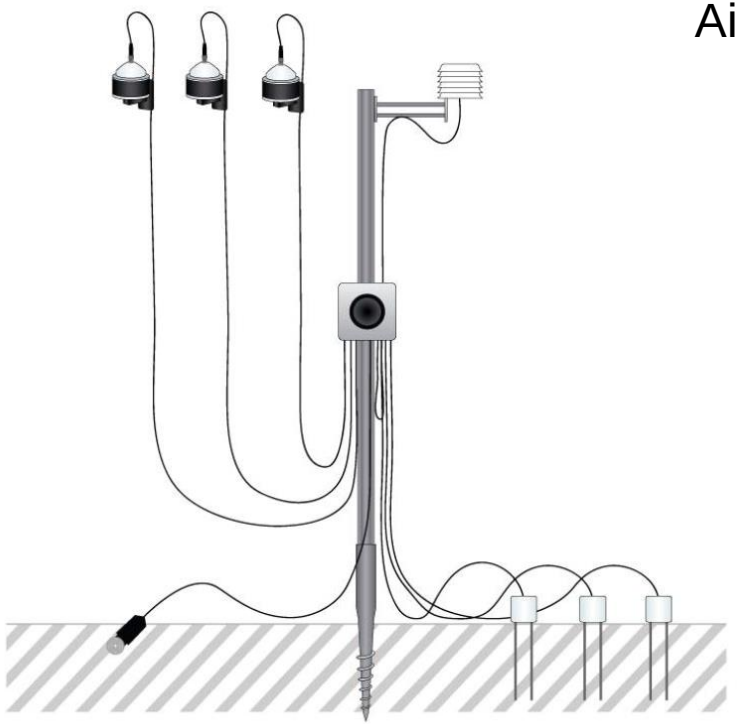
- Large forest complex
  - Monoculture
    - **DendroNetwork plot** (30 x 30 m)
      - Dominant trees

- Ownership structure

State forests	**LČR s.p.**	24	**28%**
	VLS s.p.	33	**38%**
	others	14	**16%**
Municipal forests		2	**2%**
Private forests		13	**15%**
Total		86	**100%**

DendroNetwork

- On-line station (72 plots)
- Off-line stations (26 plots)



Data transmission 0:00; 12:00

Air temperature and humidity

EMS33S

Dendrometers 3x

DR26P

Soil water potential 1x

TEROS 21

Soil water content 3x

CS616

Present

Remote sensing data

Climate

Tree Ring Data

Dendrometer records

Forest inventory

Phenology

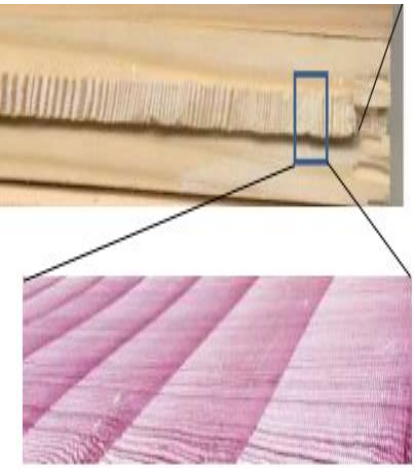
Data collection

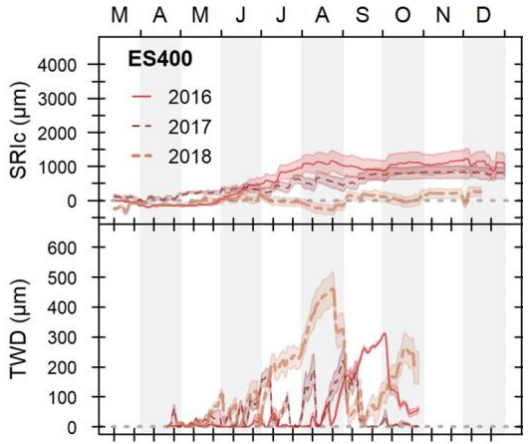
Future

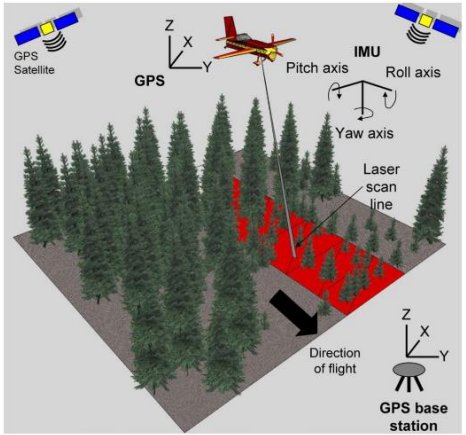
Climate scenarios

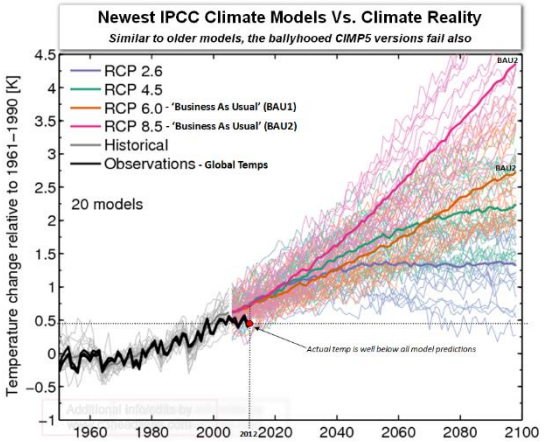
DendroNetwork

Near-real time products

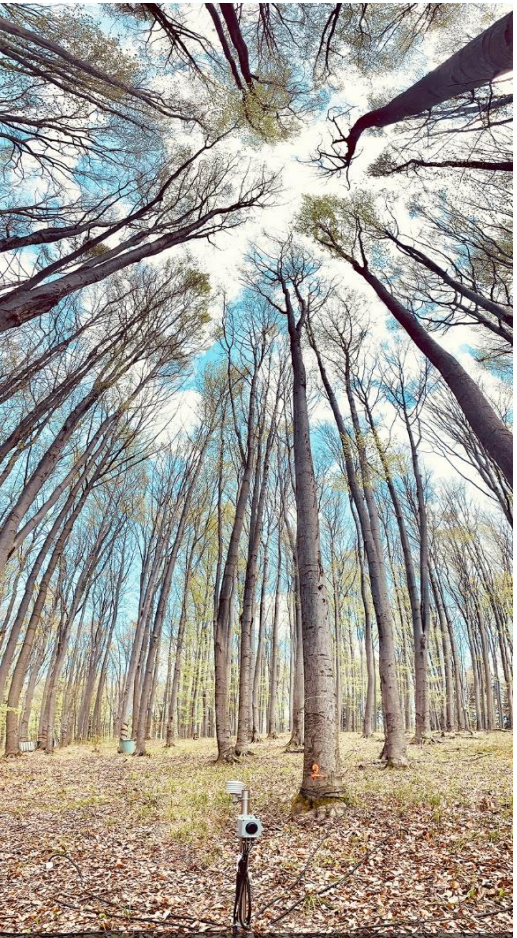








Dendrometer records



Near-real time products

DendroNetwork data flow diagram

Upscaling to country level

Forest productivity

Carbon sequestration

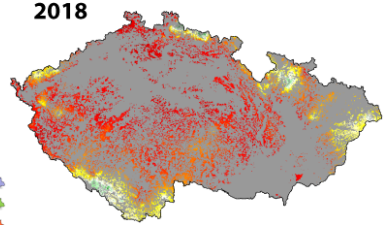
Water regime

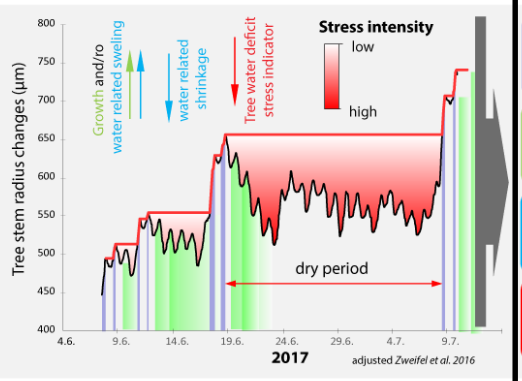
Drought stress indicators

dendronet.cz

Data visualization (near real-time)

2018





Forest productivity

Carbon sequestration

Water regime

Drought stress indicators

Phenology

Raw data monitoring

EMS data server

Field site records

- -stem diameter variation (dendrometer)
- -Relative humidity
- -Air temperature
- -Soil temperature
- -Soil water potential
- -Soil water content

Long-term series

DENDROMETERS

Tree reaction in the past

Dendrochronology

PRODUCTS

Forest productivity

Carbon sequestration

Water regime

Drought stress indicators

Phenology

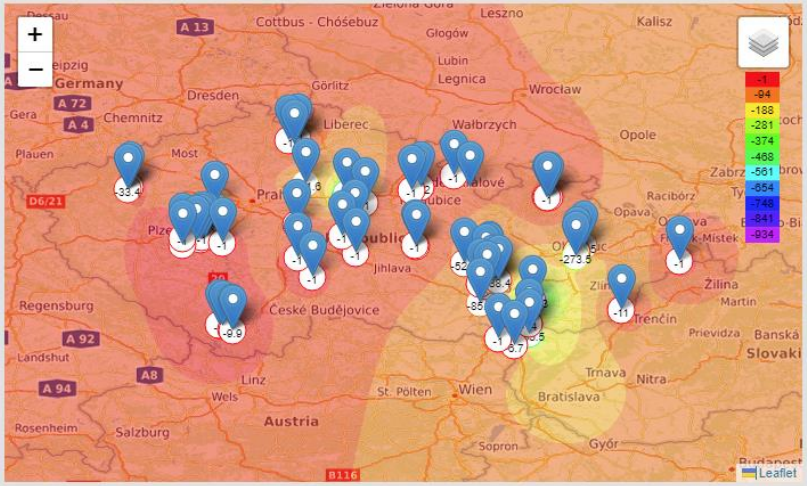
Dendrometer records

DendroNETWORK

- DendroNETWORK
- 02_SM_Ledce
- 08_SM_Rájec
- 09_SM_Bedřichov
- 11_SM_Osikový vrch
- 12_SM_Bílý Kříž
- 13_SM_Křtiny
- 14_SM_U dvou louček
- 20_BK_Štítná n. Vláří
- 22_BO_Kanice
- 23_BK_Vrbno p. P.
- 24_BK_Osikový Vrch
- 25_BK_Rájec
- 27_BK_Ledeč n. S
- 28_BK_Křtiny
- 29_SM_Žákova Hora
- 30_BK_Žákova Hora
- 31_BK_Kantorova
- 32_BO_Lanžhot
- 44_BO_Obecnice_Horní

Map | Recent Values | Daily Values | Chart | Quick Overview | Archive | About

Soil Water Potential [kPa]



Include extreme values | (displayed period) | DCV | Save to file ...

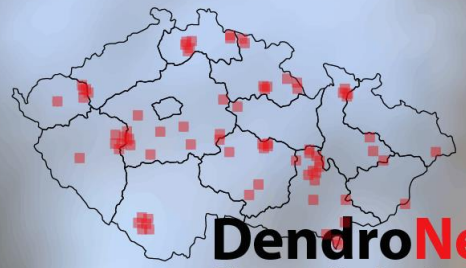
Air Humidity [%]
Soil Water Potential [kPa]

Air & Surface Temperature [°C]

http://dendronet.cz

Iceland Liechtenstein Norway grants

T A C R



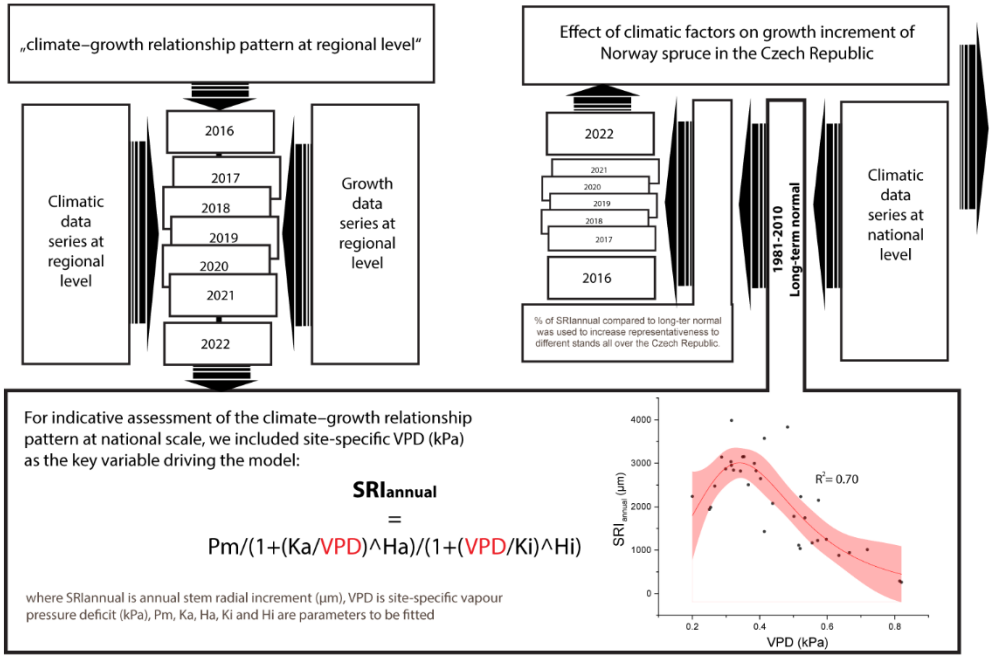
DendroNetwork

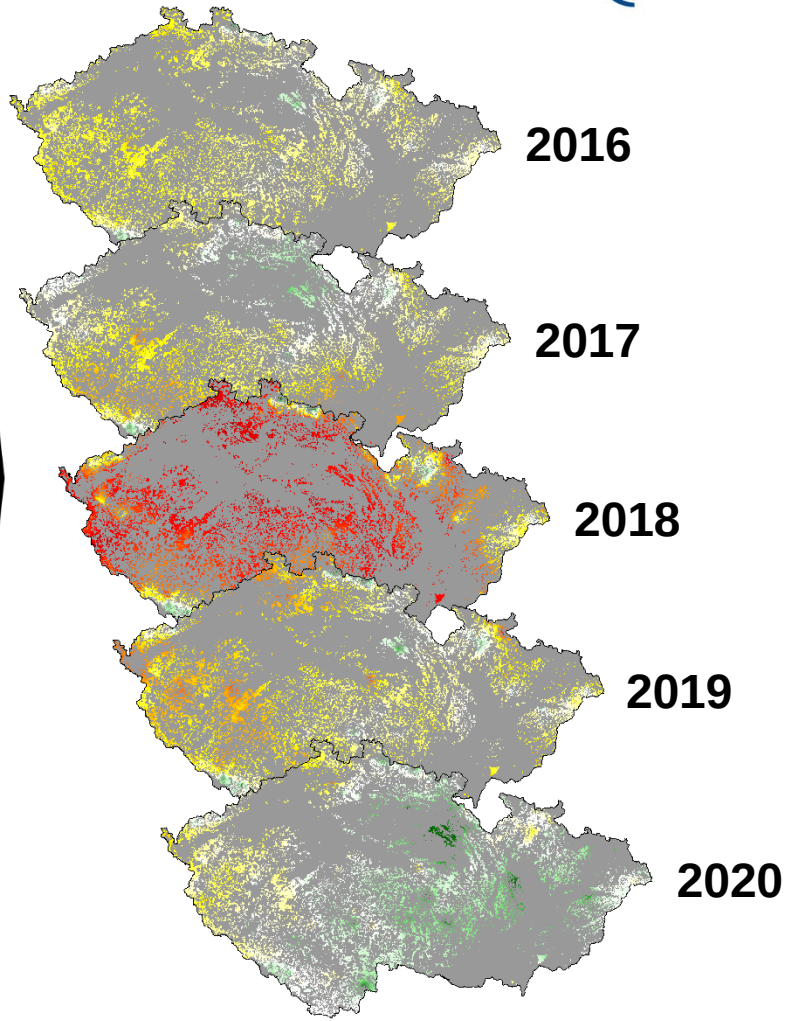
Bio-monitoring the state of forest ecosystems providing information in real-time

Programme **Kappa**

Forest productivity annual scale

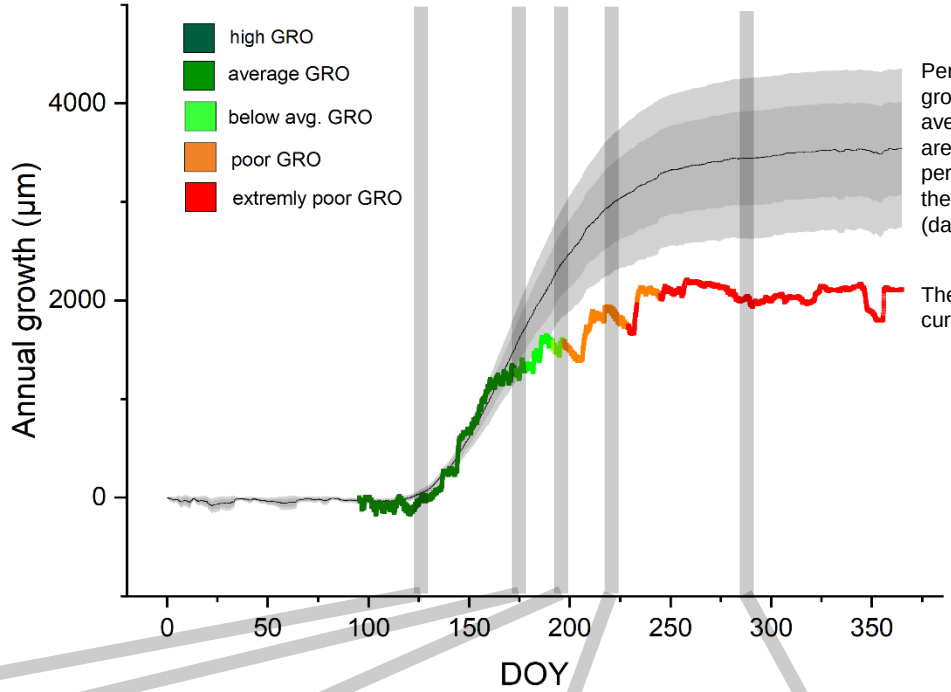
Map of fulfilment of production function of spruce ecosystems in individual years (2016-2020). A value of 1 indicates the same amount of production that was achieved in the reference period (1981-2010; white). Values > 1 indicate sites with higher than average production (green colour), on the contrary, values <1 indicate a decrease in production (yellow to red colour). Gray colour refers to land without coniferous forests.





Near Real-time Forest Monitoring

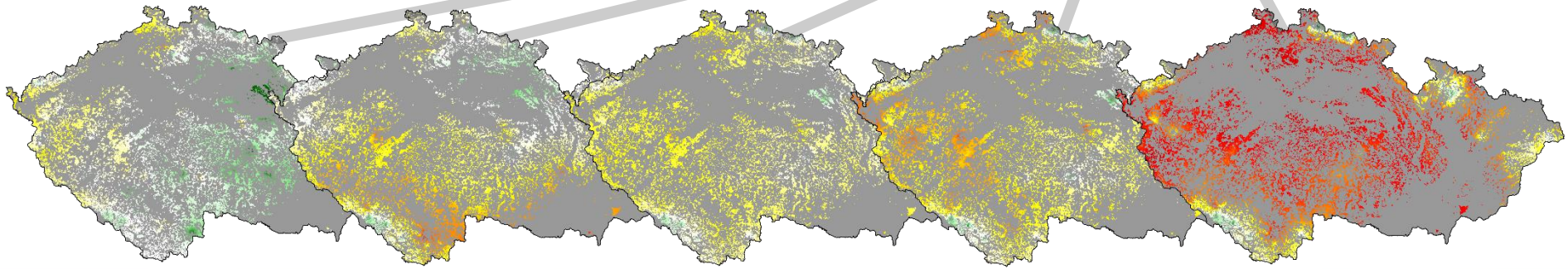
High spatial and temporal resolution of tree growth



Performance of a spruce tree growth at the site - Long-term average. The grey coloured areas indicate the 5–95% percentile range (light grey) and the 25–75% percentile range (dark grey) in last 20 years.

The spruce tree growth in the current year

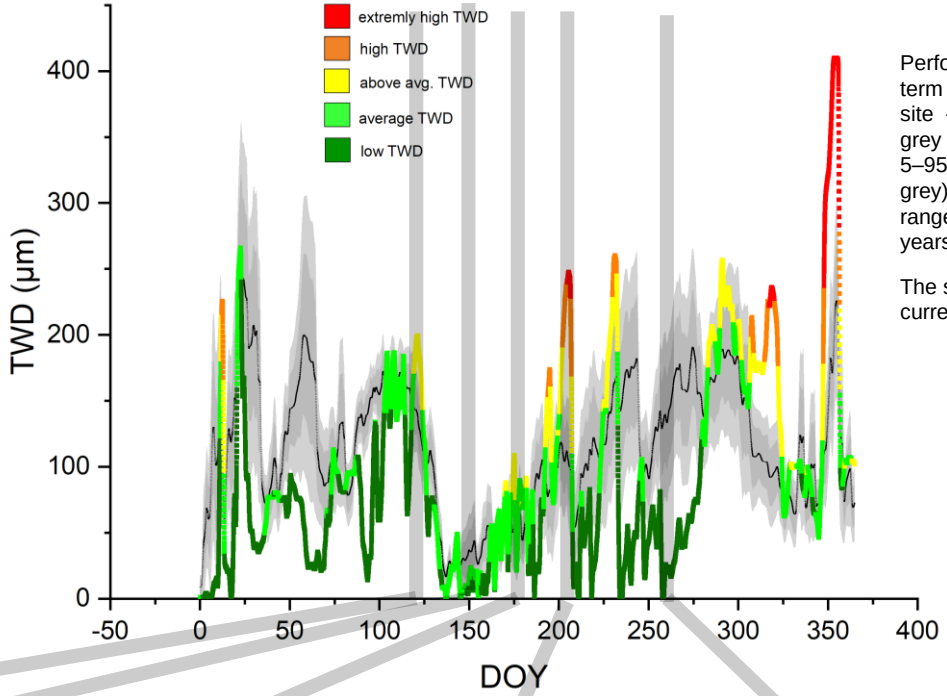
http://dendronet.cz



Near Real-time Forest Monitoring

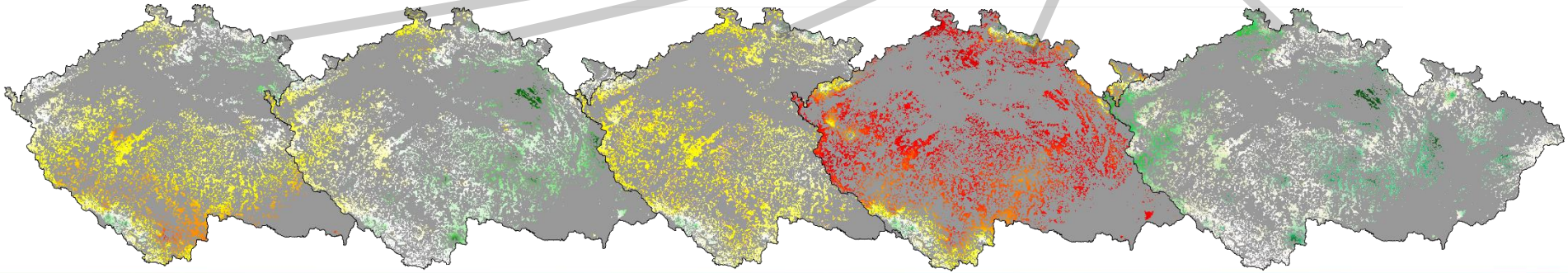
High spatial and temporal resolution of tree water deficit

http://dendronet.cz



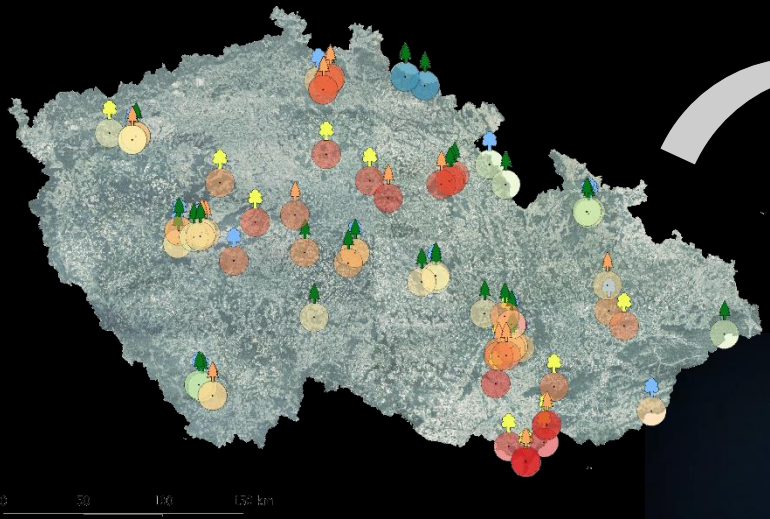
Performance of a spruce tree in term of tree water deficit at the site - Long-term average. The grey coloured areas indicate the 5–95% percentile range (light grey) and the 25–75% percentile range (dark grey) in last 20 years.

The spruce tree growth in the current year



Global Change Research Institute CAS

DendroNetwork



NEW set of sensors on the DendroNetwork stations.

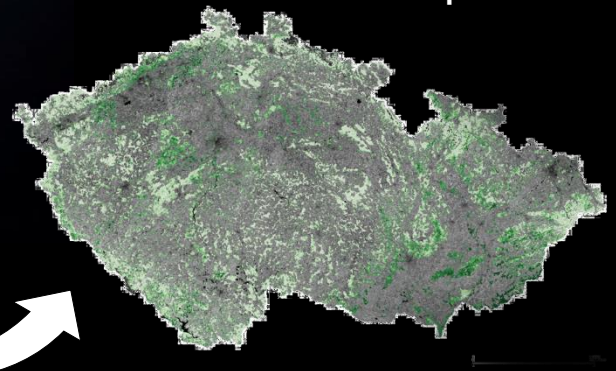
-unique
-fully automated
-precise

Remote sensing products

! New product !

DendroNetwork

Forest phenology



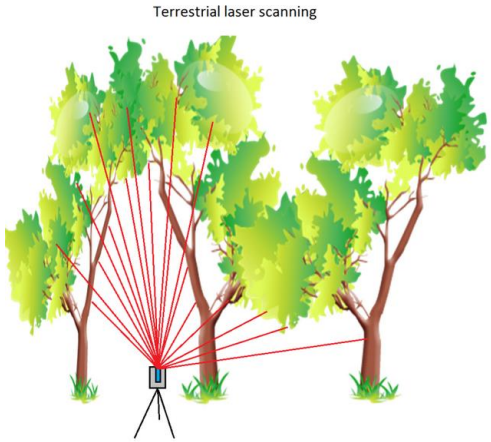
DendroNetwork & Remote sensing

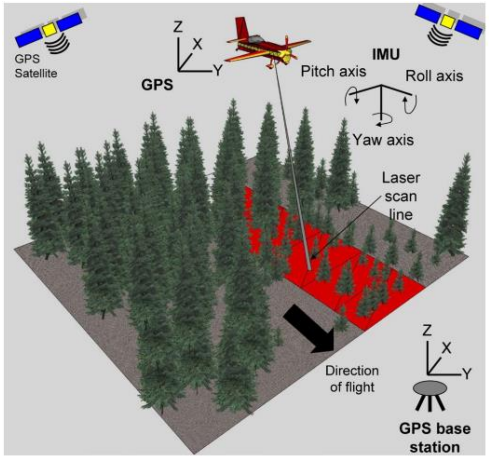
Satelite data – *GPP, NPP, stress indexes, LAI, NDVI…..*
Weekly – monthly - annually data

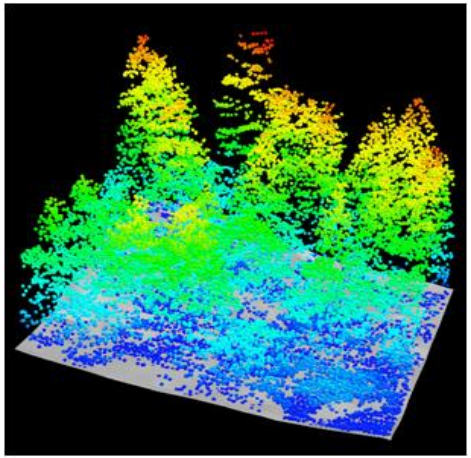
LiDAR – *forest structure, aboveground biomass, penetration indexes…*

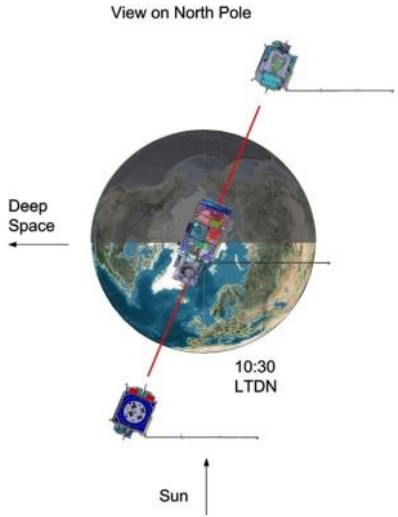
airbone LiDAR data- two perpendicular lines above each Dendro**Network** plot

Terrestrial laser scanning – new acquisition on DendroNetwork plots

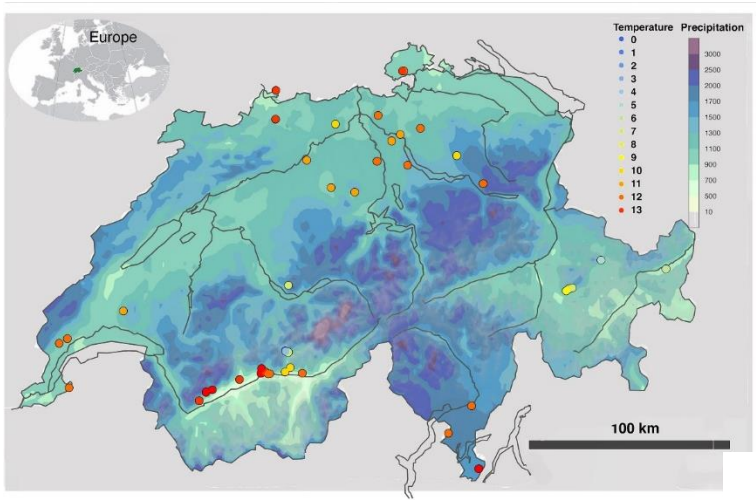








DendroNetwork & partnership



TreeNet

The biological drought and growth indicator network

https://treenet.info/

Swiss Federal Institute for Forest, Snow and Landscape Research WSL

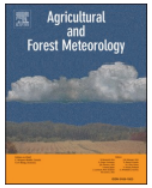
University of Idaho

Agricultural and Forest Meteorology 339 (2023) 109549

Contents lists available at ScienceDirect

Agricultural and Forest Meteorology

journal homepage: www.elsevier.com/locate/agrformet



Towards monitoring stem growth phenology from space with high resolution satellite data

Jan U.H. Eitel [a,b,*], David Basler [c,d], Sabine Braun [e], Nina Buchmann [f], Petra D'Odorico [c], Sophia Etzold [c], Arthur Gessler [g,f], Kevin L. Griffin [h,i,j], Jan Krejza [k,l], Yunpeng Luo [c], Andrew J. Maguire [m], Mukund P. Rao [h,n], Yann Vitasse [c], Lorenz Walthert [c], Roman Zweifel [c]

DendroNetwork & partnership

Norwegian University of Life Sciences

PRedicting the **I**mpacts of **D**rought **C**ombined with **T**emperature on **S**pruce Boreal Ecosystems in Norway

UNIVERSITY OF AGRICULTURE IN KRAKOW

New insights on the current dynamics of forest growth in changing climatic and environmental conditions using modern technologies

1919 CZECH GEOLOGICAL SURVEY

Forestry and Game Management Research Institute

Mendel University in Brno

Empa
Materials Science and Technology

WSL
Swiss Federal Institute for Forest, Snow and Landscape Research WSL

Effective forest vitality monitoring with semi-supervised learning (ForestSSL)

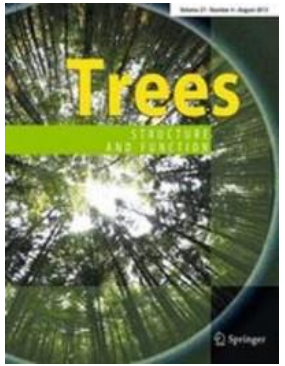
https://treenet.info/

Salomón, R.L., Peters, R.L., Zweifel, R., Sass-Klaassen, U.G.W., Stegehuis, A.I., Smiljanic, M., Poyatos, R., Babst, F., Cienciala, E., Fonti, P., Lerink, B.J.W., Lindner, M., Martinez-Vilalta, J., Mencuccini, M., Nabuurs, G.-J., van der Maaten, E., von Arx, G., Bär, A., Akhmetzyanov, L., Balanzategui, D., Bellan, M., Bendix, J., Berveiller, D., Blaženec, M., Čada, V., Carraro, V., Cecchini, S., Chan, T., Conedera, M., Delpierre, N., Delzon, S., Ditmarová, Ľ., Dolezal, J., Dufrêne, E., Edvardsson, J., Ehekircher, S., Forner, A., Frouz, J., Ganthaler, A., Gryc, V., Güney, A., Heinrich, I., Hentschel, R., Janda, P., Ježík, M., Kahle, H.-P., Knüsel, S., **Krejza, J.,** Kuberski, Ł., Kučera, J., Lebourgeois, F., Mikoláš, M., Matula, R., Mayr, S., Oberhuber, W., Obojes, N., Osborne, B., Paljakka, T., Plichta, R., Rabbel, I., Rathgeber, C.B.K., Salmon, Y., Saunders, M., Scharnweber, T., Sitková, Z., Stangler, D.F., Stereńczak, K., **Stojanović, M**., Střelcová, K., **Světlík, J.**, Svoboda, M., Tobin, B., Trotsiuk, V., Urban, J., Valladares, F., Vavrčík, H., Vejpustková, M., Walthert, L., Wilmking, M., Zin, E., Zou, J., Steppe, K., 2022. The 2018 European heatwave led to stem dehydration but not to consistent growth reductions in forests. Nat. Commun. 13, 28. https://doi.org/10.1038/s41467-021-27579-9

Mahnken, M., Cailleret, M., Collalti, A., Trotta, C., Biondo, C., D'Andrea, E., Dalmonech, D., Marano, G., Mäkelä, A., Minunno, F., Peltoniemi, M., Trotsiuk, V., Nadal-Sala, D., Sabaté, S., Vallet, P., Aussenac, R., Cameron, D.R., Bohn, F.J., Grote, R., Augustynczik, A.L.D., Yousefpour, R., Huber, N., Bugmann, H., Merganičová, K., Merganic, J., Valent, P., Lasch-Born, P., Hartig, F., Vega del Valle, I.D., Volkholz, J., Gutsch, M., Matteucci, G., **Krejza, J.,** Ibrom, A., Meesenburg, H., Rötzer, T., van der Maaten-Theunissen, M., van der Maaten, E., Reyer, C.P.O., 2022. Accuracy, realism and general applicability of European forest models. Glob. Chang. Biol. n/a. https://doi.org/https://doi.org/10.1111/gcb.16384

Krejza, J., Haeni, M., **Darenova, E., Foltýnová, L., Fajstavr, M., Světlík J., Nezval, O.,** Bednář, P., **Šigut, L., Horáček, P.,** Zweifel, R., 2022. Disentangling carbon uptake and allocation in the stems of a spruce forest. Environ. Exp. Bot. 104787. https://doi.org/10.1016/J.ENVEXPBOT.2022.104787

Krejza, J., Cienciala, E., **Světlík, J., Bellan, M., Noyer, E., Horáček, P.,** Štěpánek, P., **Marek, M. V,** 2021. Evidence of climate-induced stress of Norway spruce along elevation gradient preceding the current dieback in Central Europe. Trees 35, 103–119. https://doi.org/10.1007/s00468-020-02022-6



DendroNetwork & scientific outputs 2023

Eitel, J.U.H., Basler, D., Braun, S., Buchmann, N., D'Odorico, P., Etzold, S., Gessler, A., Griffin, K.L., **Krejza, J.,** Luo, Y., Maguire, A.J., Rao, M.P., Vitasse, Y., Walthert, L., Zweifel, R., 2023. Towards monitoring stem growth phenology from space with high resolution satellite data.

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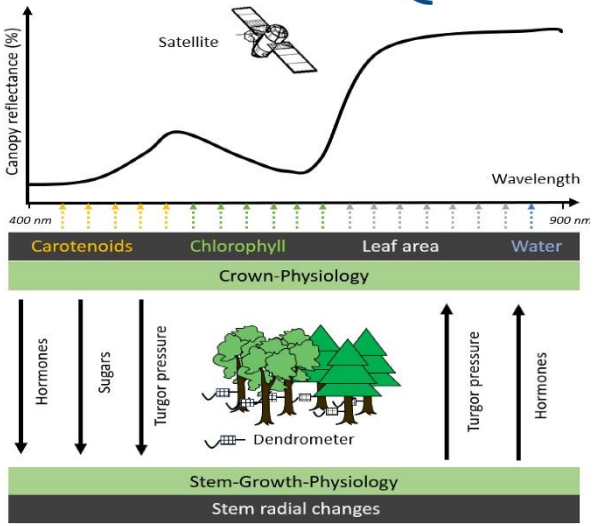
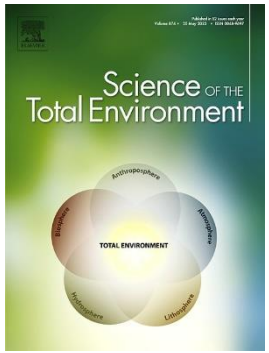
https://doi.org/https://doi.org/10.1016/j.agrformet.2023.109549



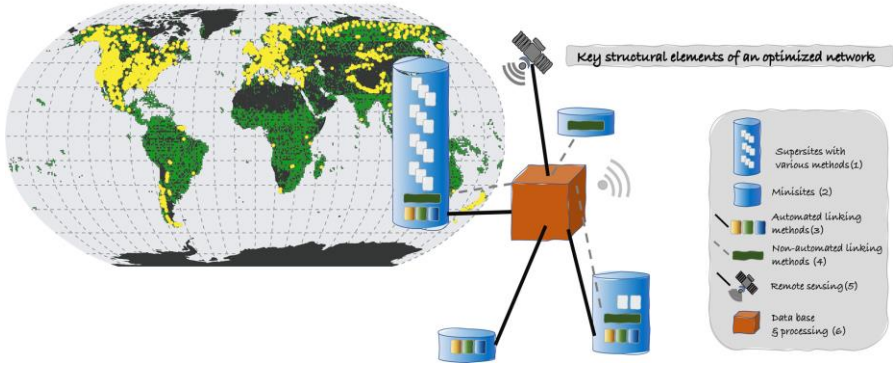


Zweifel, R., Pappas, C., Peters, R.L., Babst, F., Balanzategui, D., Basler, D., Bastos, A., Beloiu, M., Buchmann, N., Bose, A.K., Braun, S., Damm, A., D'Odorico, P., Eitel, J.U.H., Etzold, S., Fonti, P., Freund, E.R., Gessler, A., Haeni, M., Hoch, G., Kahmen, A., Körner, C., **Krejza, J.,** Krumm, F., Leuchner, M., Leuschner, C., Lukovic, M., Martínez-Vilalta, J., Matula, R., Meesenburg, H., Meir, P., Plichta, R., Poyatos, R., Rohner, B., Ruehr, N., Salomón, R.L., Scharnweber, T., Schaub, M., Steger, D.N., Steppe, K., Still, C., **Stojanović, M.,** Trotsiuk, V., Vitasse, Y., von Arx, G., Wilmking, M., Zahnd, C., Sterck, F., 2023.

Networking the forest infrastructure towards near real-time monitoring – A white paper.

Sci. Total Environ. 162167.
https://doi.org/https://doi.org/10.1016/j.scitotenv.2023.162167

From individual sites to a near real-time forest monitoring network



Global Change Research Institute CAS

CzechGlobe

Ústav výzkumu globální změny AV ČR, v. v. i.

DendroNetwork

Real-time biomonitoring of forest ecosystems

http://dendronet.cz

krejza.j@czechglobe.cz

Jan Krejza, Jan Světlík, Petr Horáček, Martin Benc, Sergei Mikhailov, Ondřej Nezval, Lucia Petrovičová, Marko Stojanovič, Lukáš Vlachovič, Roman Zweifel, Matthias Haeni, Eva Dařenová, Ladislav Šigut, Lucie Homolová, Marek Fajstavr, Janko Arsič, Michal Bellan, Jiří Kučera, Michal V. Marek