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GLOBAL CHANGE RESEARCH INSTITUTE
Czech Republic Academy of Sciences

QUO VADITIS AGRICULTURE, FORESTRY AND SOCIETY UNDER GLOBAL CHANGE

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PROBABLY OUR PLANET
IS WARMING AND MELTING

Global Change – basic definitions

Global change ***"wide spectrum of the biophysical, ecosystems and socio-economical changes, which are responsible for the observable changes of the planet Earth function"***
For example: climate changes, changes of biodiversity, air chemistry, landscape and ocean productivity"

Global Climate Change ***shows unique property - IS STRONGLY CONNECTED TO THE HUMAN ACTIVITY,*** mainly via remarkable releasing of the greenhouse gases into the atmosphere, the landscape changes, deforestation, intensive agriculture and transport.

Global change (GC) is under strong attention of the public and professional society. Unfortunately, GC ***IS NOT ONLY ECOLOGICAL BUT POLITICAL PHENOMENON***

SOURCES OF GLOBAL EMISSIONS OF GREEN-HOUSE GASES

Fossil fuel consumption:
36,8 Gt CO_2 (88%)

Deforestation and land-use changes:
4 Gt CO_2 (12%)

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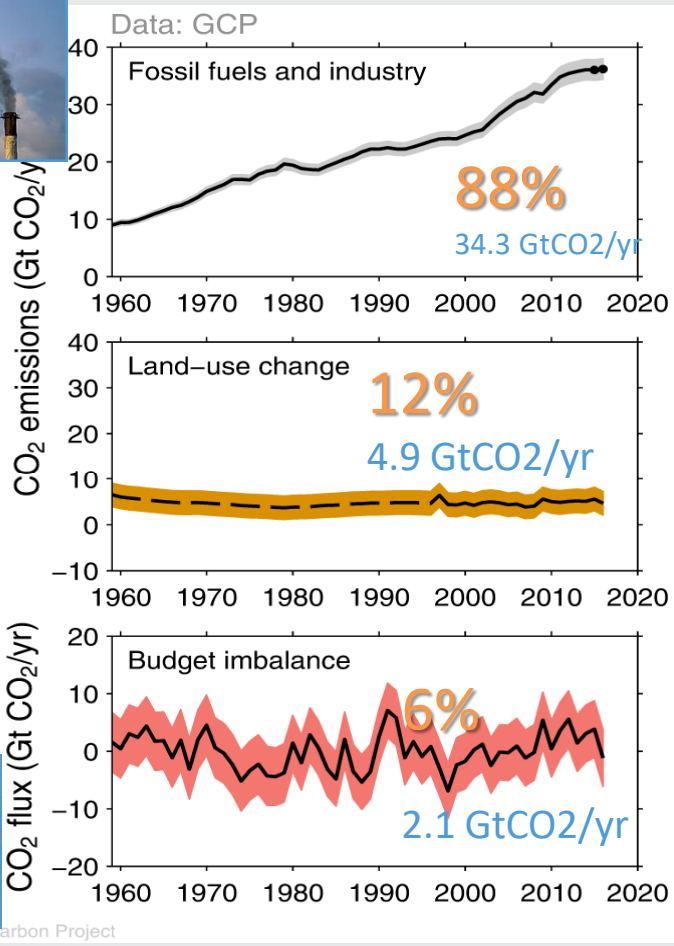
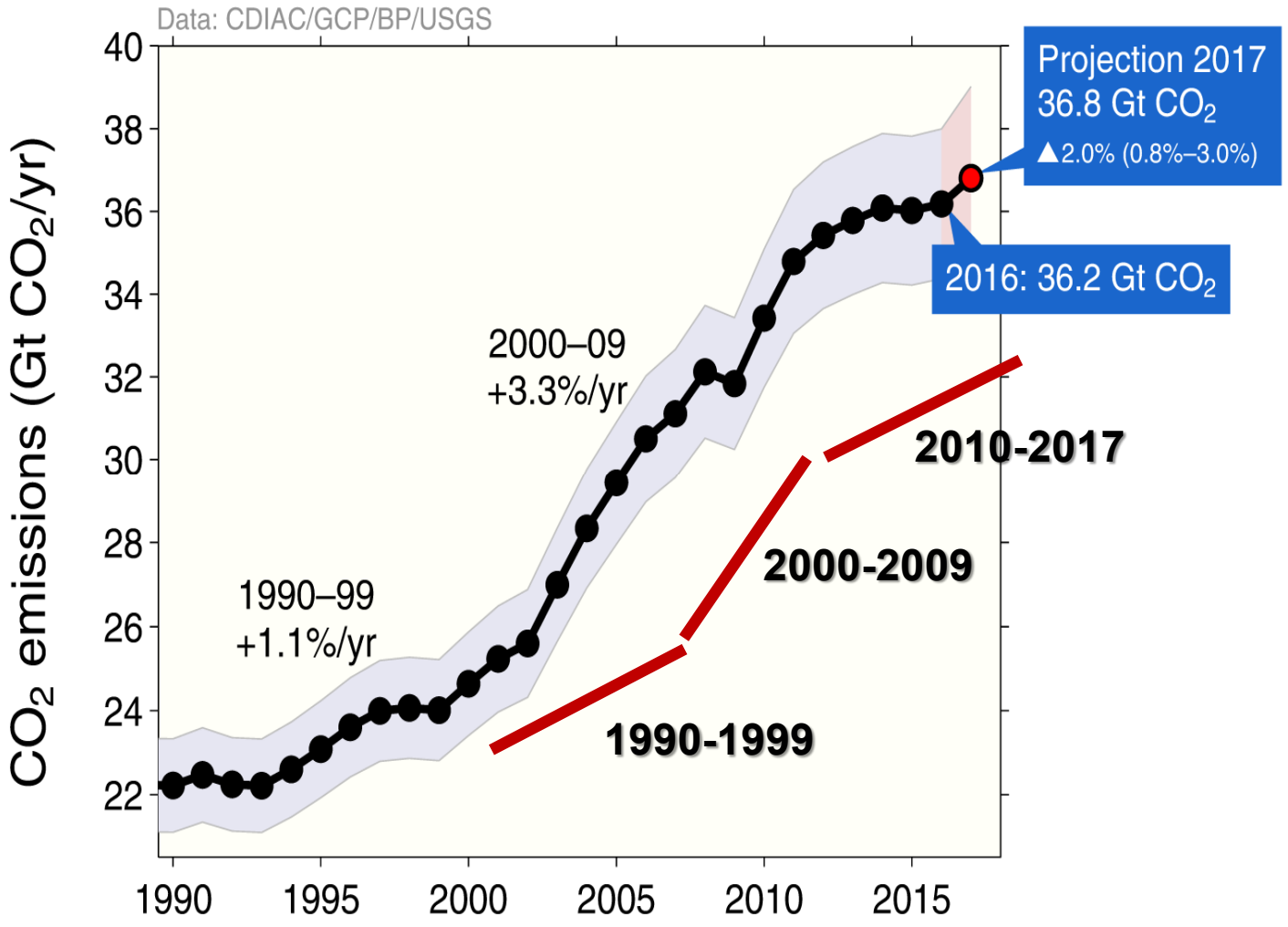
sources

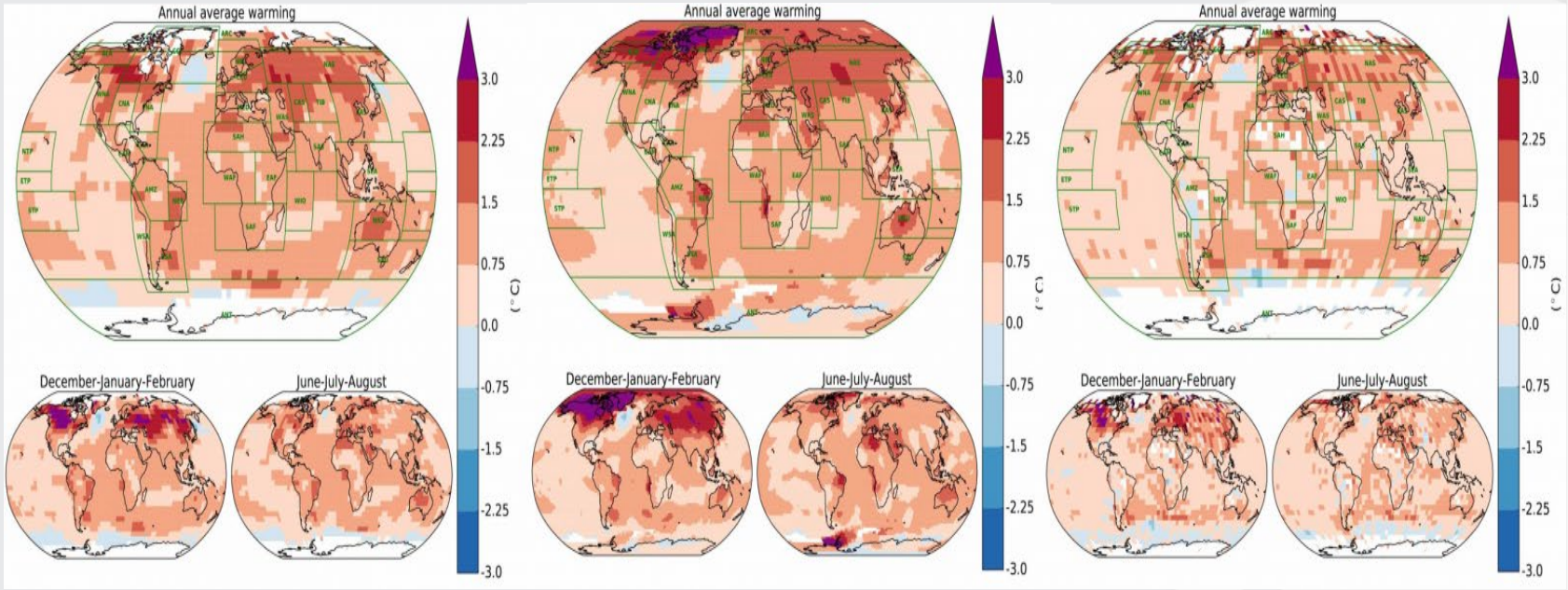
sinks



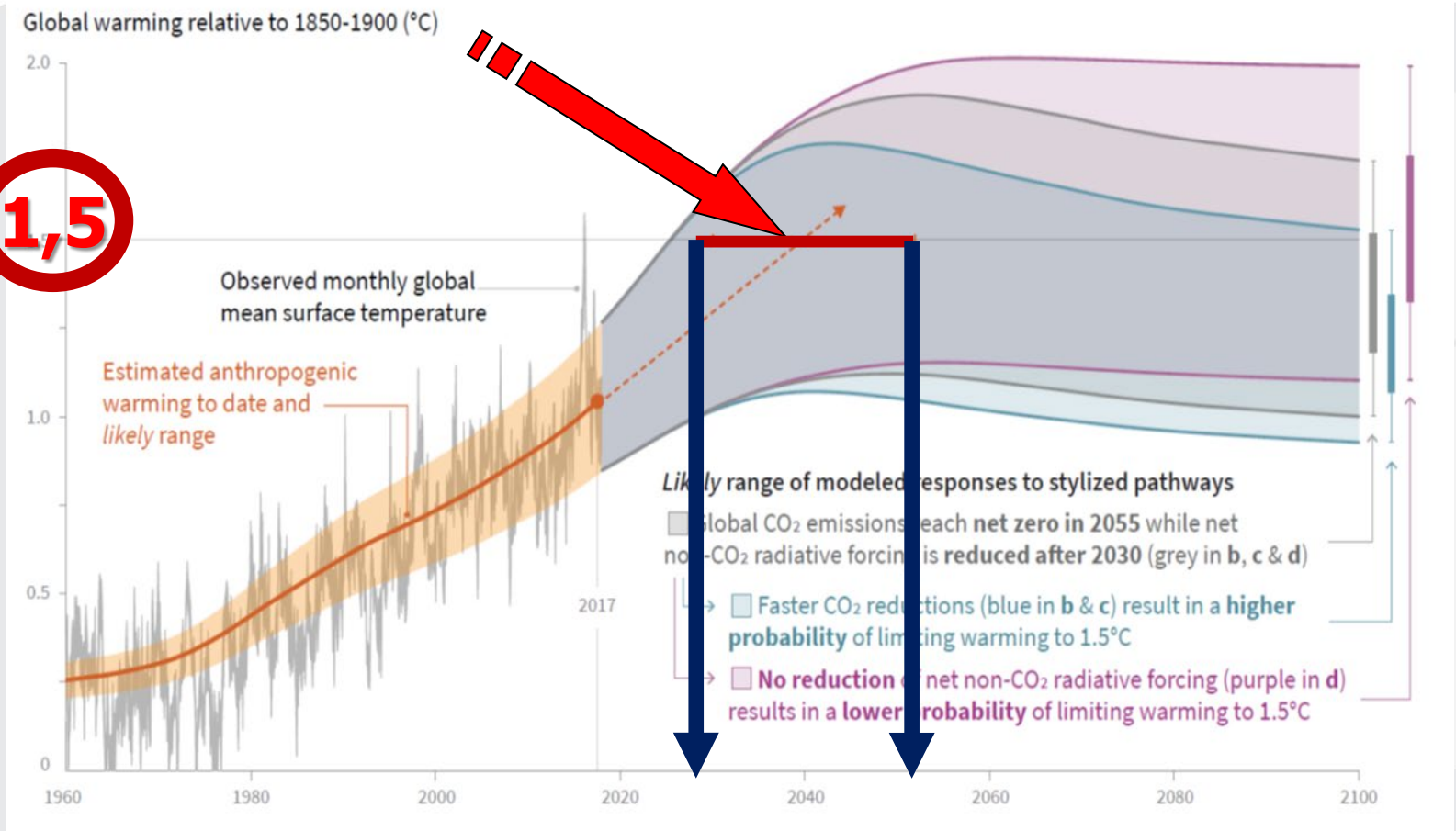
Budget imbalance – total emissions minus its increase in atmosphere, oceans and terrestrial systems

Current global CO_2 emission: + 63% in comparison to the year 1990





Measure of anthropogenic- determined temperature increase [°C] on the continent and ocean surface during the time section 2006 - 2015 compared to 1850-1900 according to three databases (left: NOAA, middle: NASA GISTEMP, right: HadCRUT4)



Development of global air temperature during time section 1960-2017 and model scenarios of global temperature stabilization BELOW or ON LEVEL of 1,5 ° C v in the year of 2040under current CO_2 emission regulation

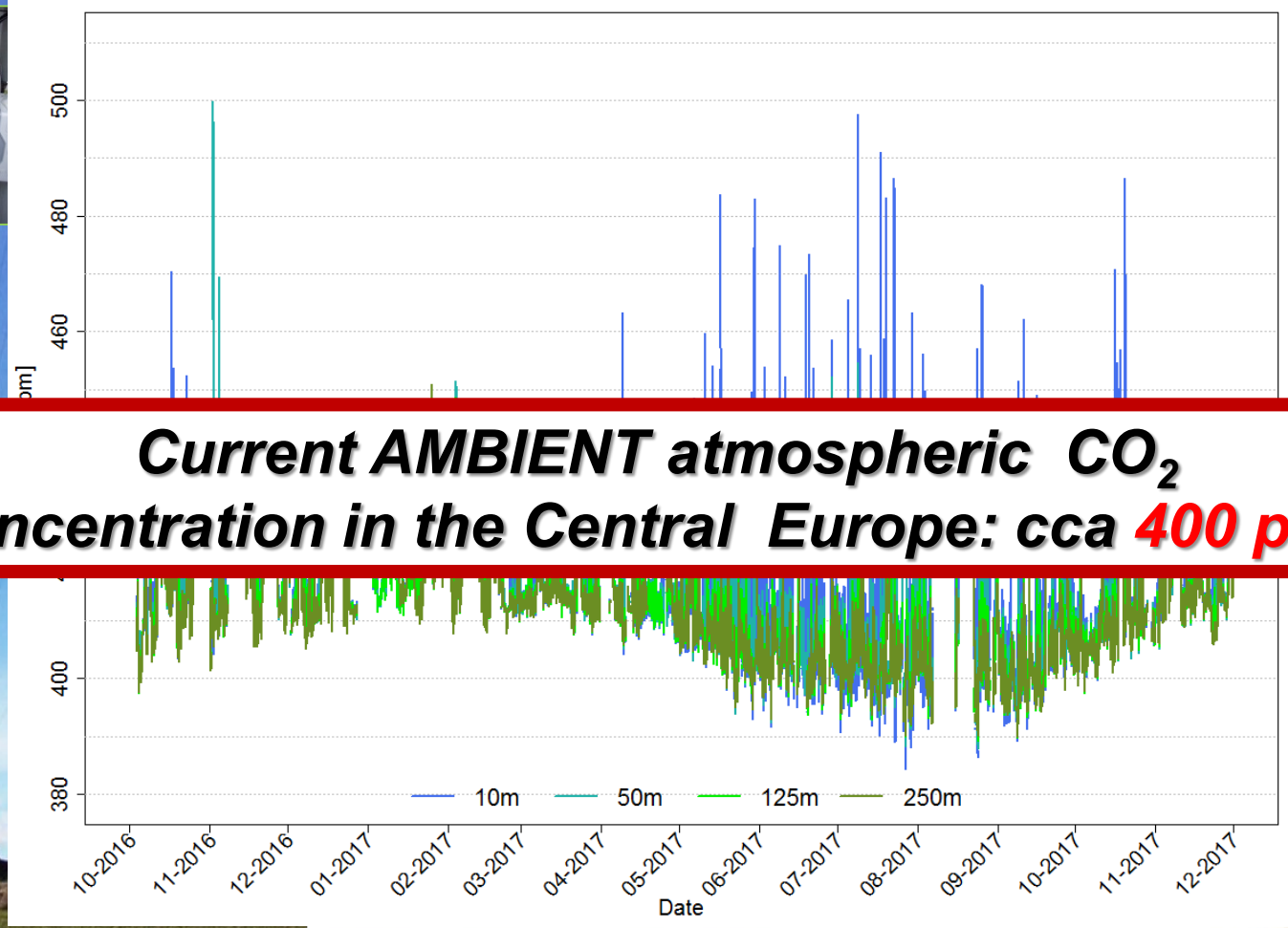
CARBON OXIDE a part of carbon cycle IS PLAYING VERY SPECIFIC AND IMPORTANT ROLE

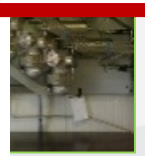
WHY ?

- IMPORTANT greenhouse gas

- SUBSTRATE for photosynthetic carbon assimilation

Continental observation of atmospheric green-gasses concentration ICOS-ATMO network





Current AMBIENT atmospheric CO_2 cconcentration in the Central Europe: cca 400 ppm!!!

two basic approaches for the global change impact mitigation are currently available

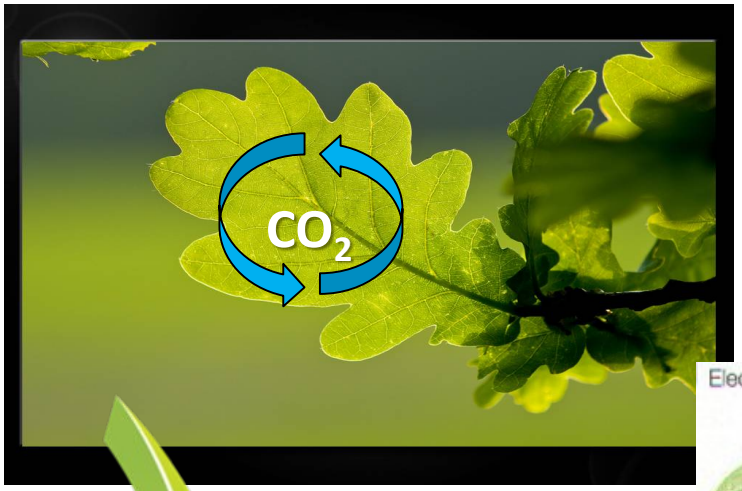
Technology – „FOSSIL ZERRO - decarbonisation"

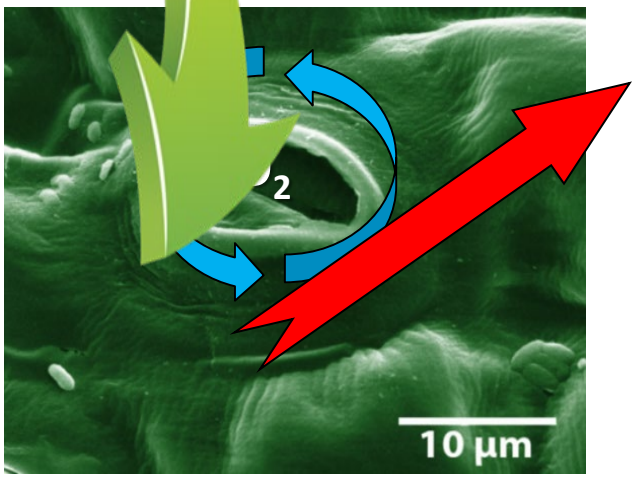
Biological mitigation – photosynthetic assimilation

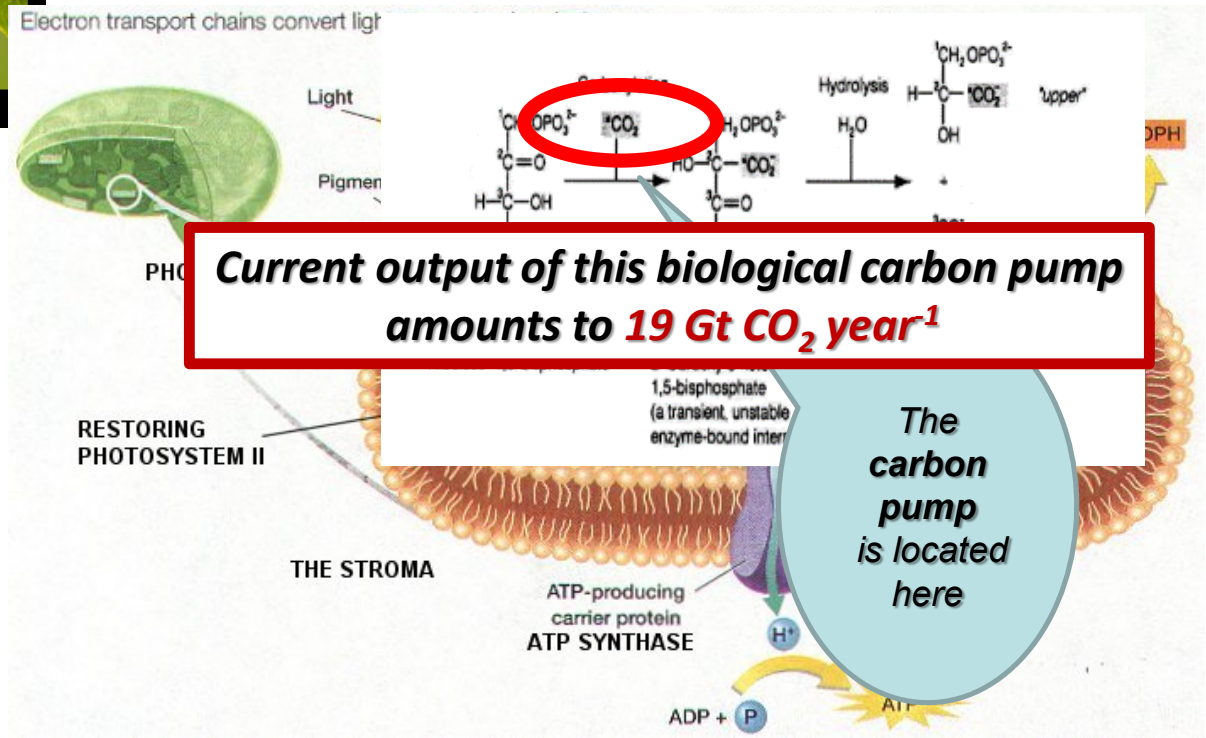
Biological carbon assimilation

IS THE MOST MASSIVE TOOL FOR GC MITIGATION

THESE PROCESSES ARE SO MASSIVE THAT ARE NAMED AS BIOLOGICAL PHOTOSYNTHETIC CARBON PUMP !!!

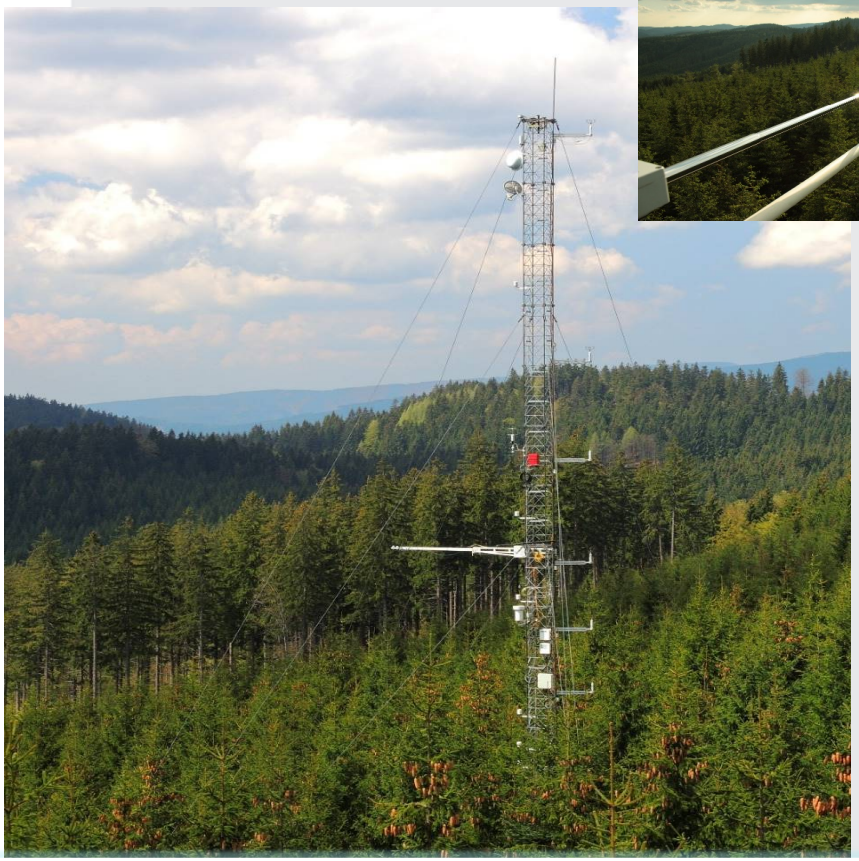






Current output of this biological carbon pump amounts to 19 Gt CO_2 $year^{-1}$

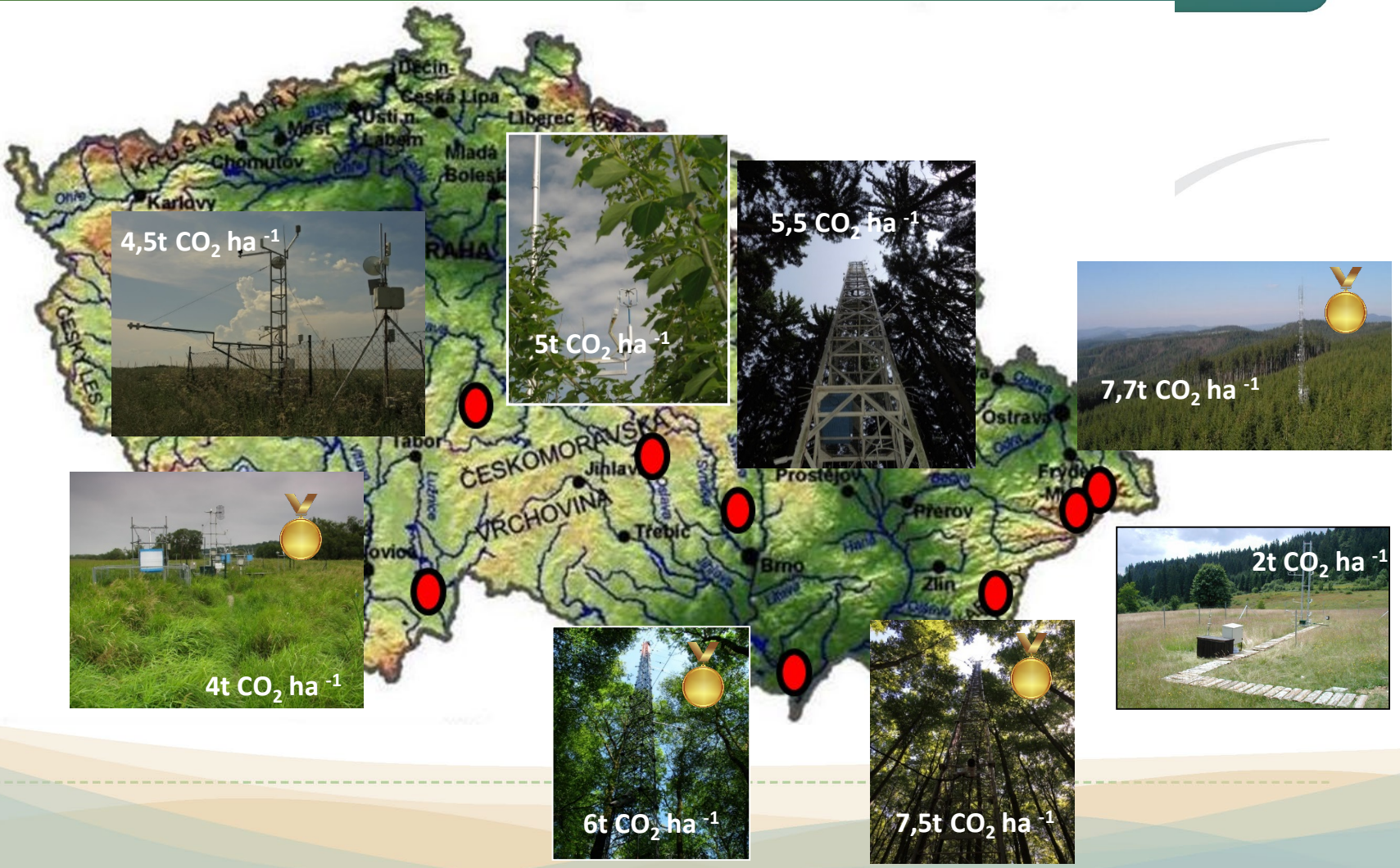
Are we able to evaluate the carbon pump???



EDDY-COVARIANCE technique:

Measurement of carbon, water vapour, latent and sensible heat exchange between a plant stand and atmosphere

CzechGlobe „eddy“ station network used for carbon storage estimation in different ecosystem types– European infrastructure ICOS-ECO



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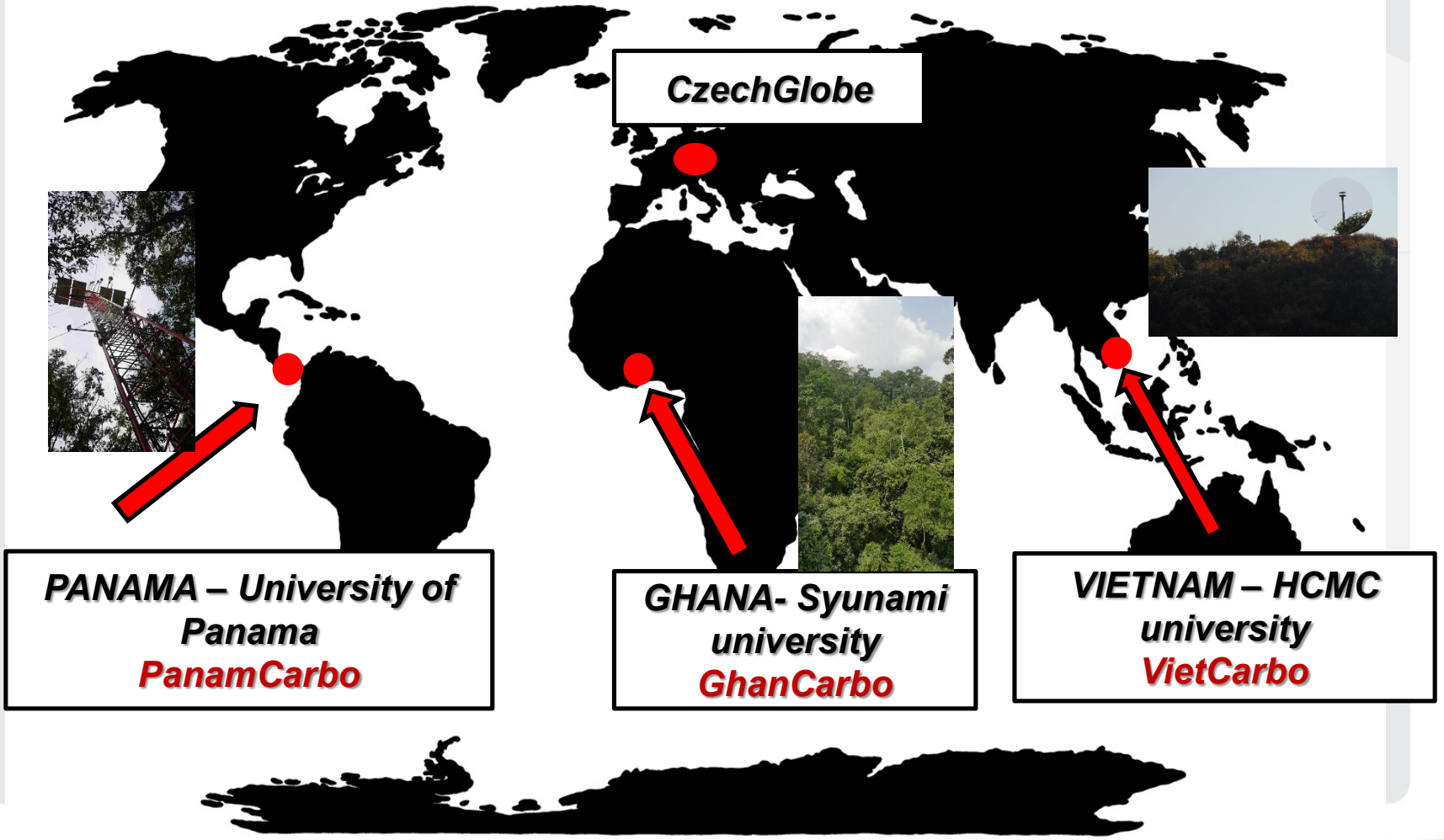
CzechGlobe international network of „eddy“ station TropCarboNet



MAIN FEATURES OF CZECH AGRICULTURE AND ITS VULNERABILITY TO GLOBAL CHANGE IMPACT

- **LARGE AREA OF AGRICULTURE USED FIELDS**
  - ✓ ***positive*** from the used technics and phytotechnics point of view
  - ✓ ***negative*** from landscape stability, carbon storage and water cycle point of view
  - ✓ ***negative*** from the biodiversity point of view

- **BIG PORTION OF LAND-OWNERS WHICH ARE NOT FARMERS PROPERTY**
  - ✓ agriculture soil ***is rented*** **-** not big interest for the long-term soil cultivation and sustainable development

- **EU AGRICULTURE POLICY, MARKET FARMING**
  - ✓ ***preferential orientation*** on „market attractive crops – rape in biofuels with ***negative*** impact on soil fertility and erosion protection
  - ✓ ***decrease of cattle number*** with all consequences (for example: deficiency of organic compounds in the soil
  - ✓ ***increased sensitivity*** of agrosystem to extreme events (drought, floods)

RECENT DROUGHT EVENTS IN THE CZECH REPUBLIC

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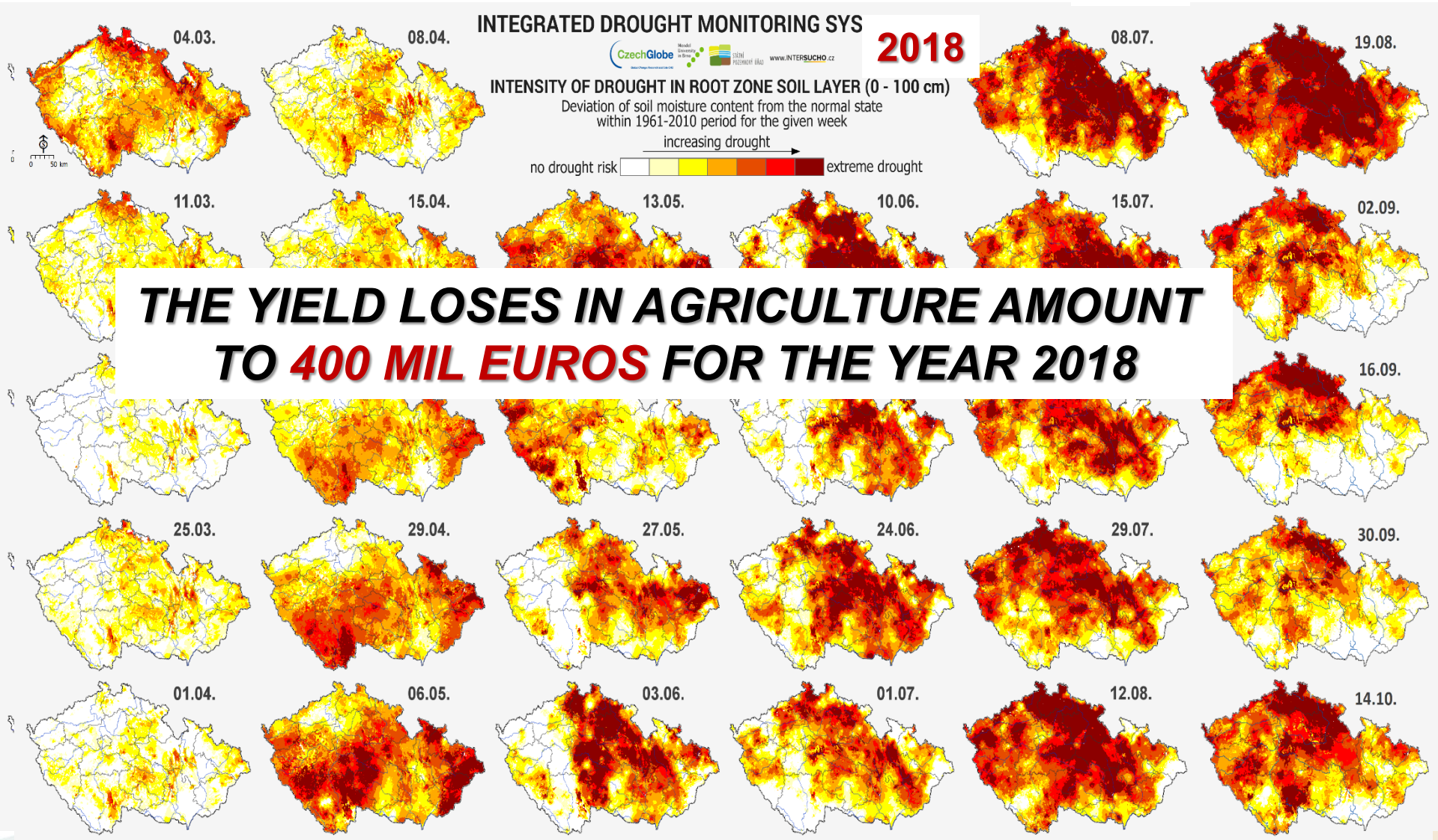
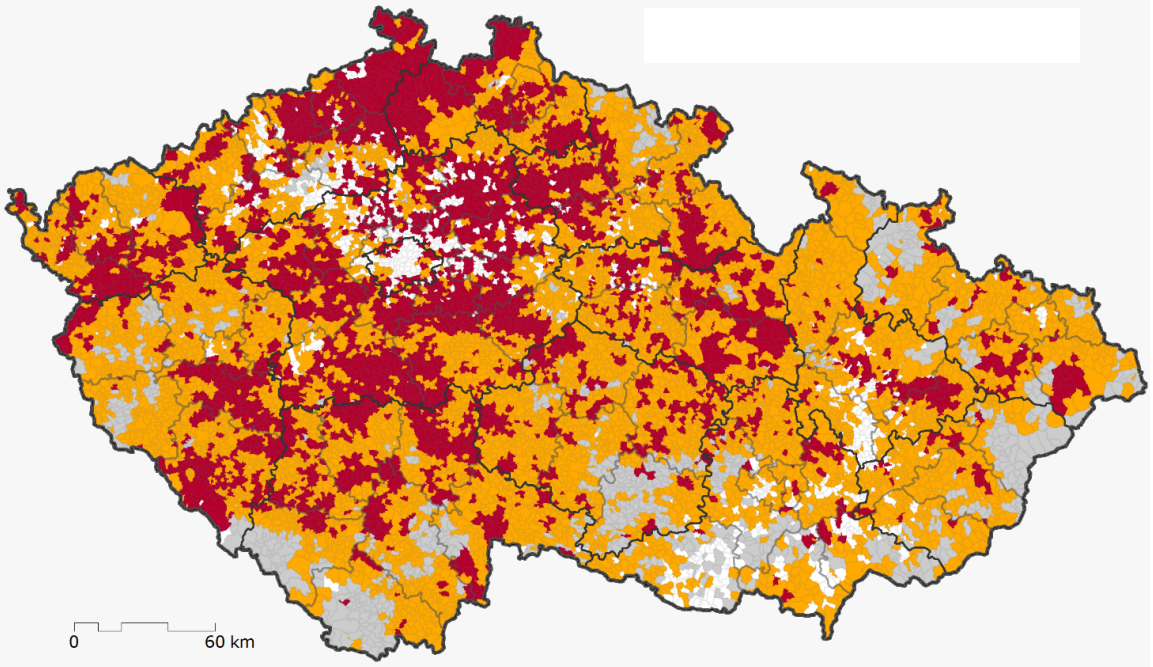


THE YIELD LOSES IN AGRICULTURE AMOUNT TO 400 MIL EUROS FOR THE YEAR 2018

Deviation of the permanent grass stands yield because the drought 2018



Areas with yield decrease

- o 30 - 50 %
- o 50 % a více

Poskytovatel dat:
AGRÁRNÍ KOMORA České republiky
Zemědělský svaz České republiky

INTERSUCHO

Zpracoval:
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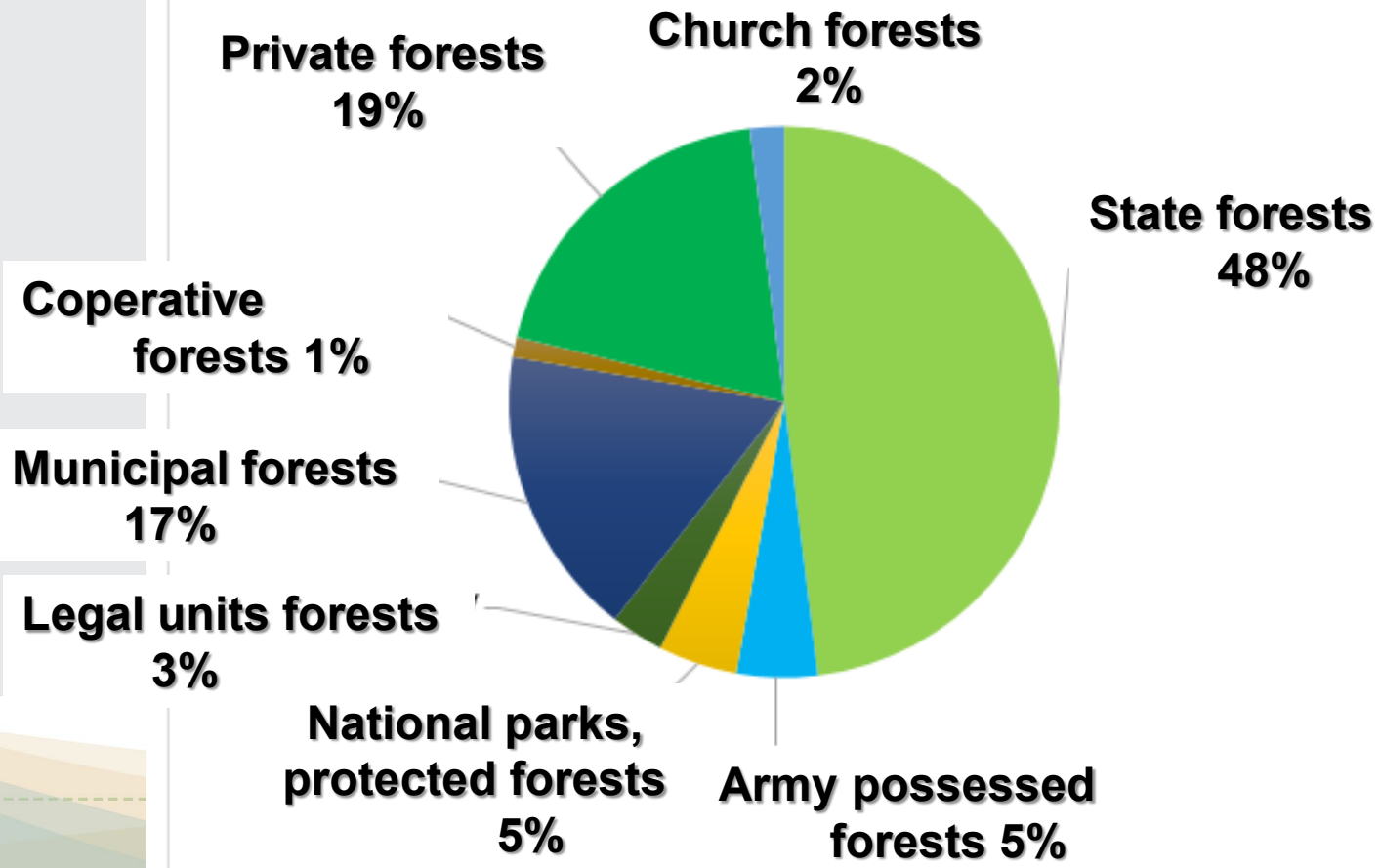
MAIN FEATURES OF CZECH FORESTRY AND ITS VULNERABILITY TO GLOBAL CHANGE IMPACT

Forests ownership in the Czech Republic

FORESTS AREA IN THE CZECH REPUBLIC AMOUNTS TO 32%



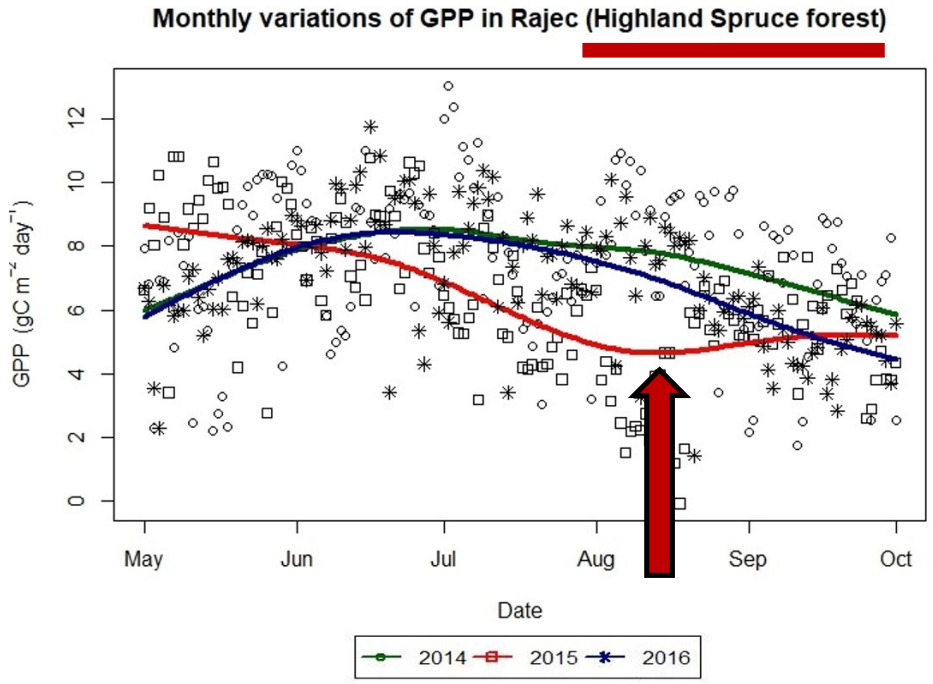
- **SYSTEM OF THE SATE FORESTS MANAGEMENT**
  - ✓ ***system of „tender***s“
  - ✓ ***cancelation of regional Forest enterprises*** (58 units)

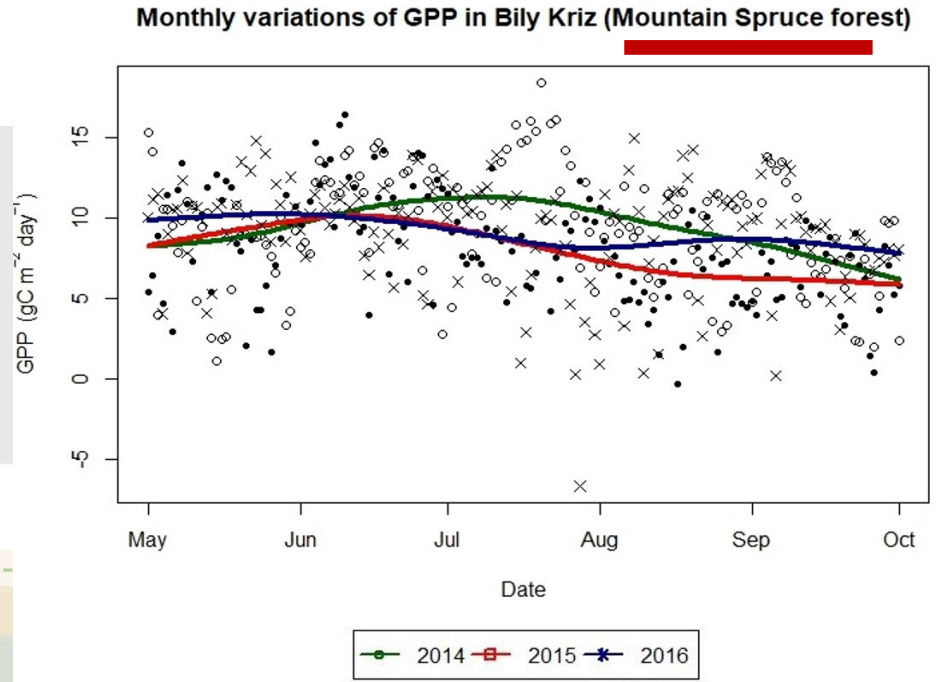
- **VERTICAL ZONALITY OF FORESTS (9 zones)**
  - ✓ ***from lowland up to alpine zone***
  - ✓ ***decrease of*** the biodiversity

- **BIG PORTION OF NORWAY SPRUCE STANDS - up to 65%**
  - ✓ consequences of large monoculture established on the not-correct sites

- **DECREASE OF FORESTS STAND VITALITY/TABILITY BECAUSE OF CC**
  - ✓ ***drought effect*** – on all tree species types
  - ✓ ***bark- beetle attack***
  - ✓ ***large area dieback of especially spruce stand in Sudetes***

Recent DROUGHT EVENTS effects on the forest stands carbon storage


Monthly variations of GPP in Rajec (Highland Spruce forest)
GPP (gC m⁻² day⁻¹)
0
2
4
6
8
10
12
May
Jun
Jul
Aug
Sep
Oct
Date
2014
2015
2016


Monthly variations of GPP in Bily Kriz (Mountain Spruce forest)
GPP (gC m⁻² day⁻¹)
-5
0
5
10
15
May
Jun
Jul
Aug
Sep
Oct
Date
2014
2015
2016

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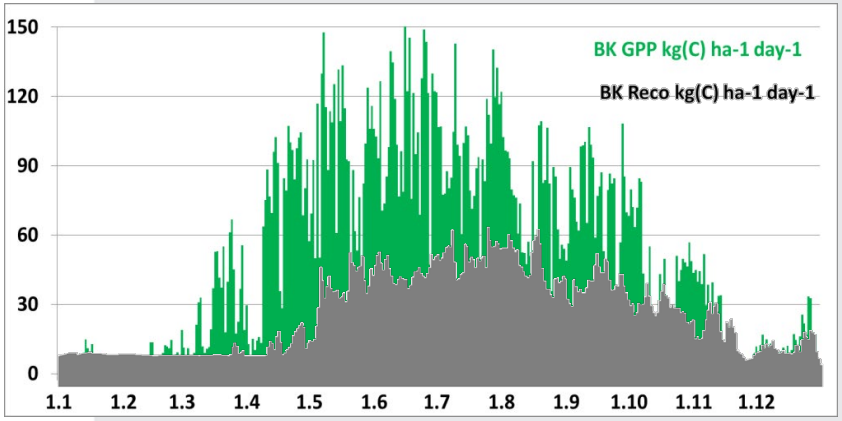
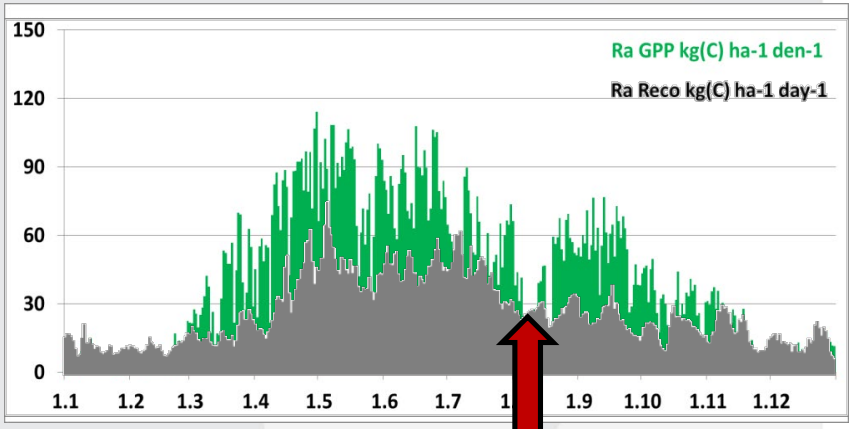
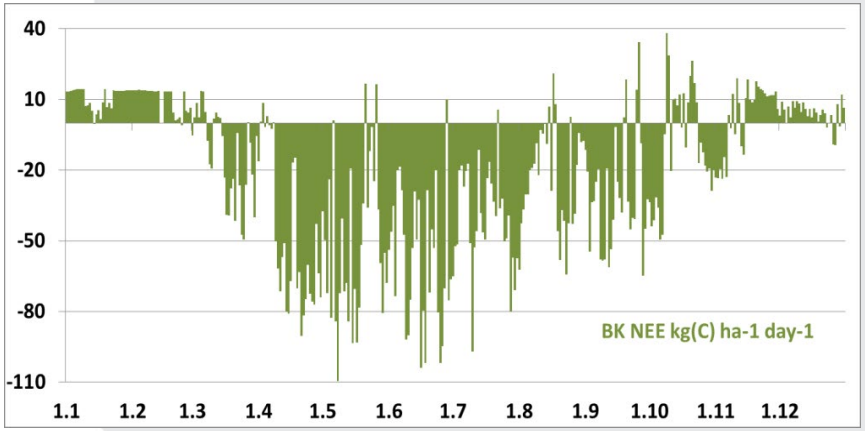
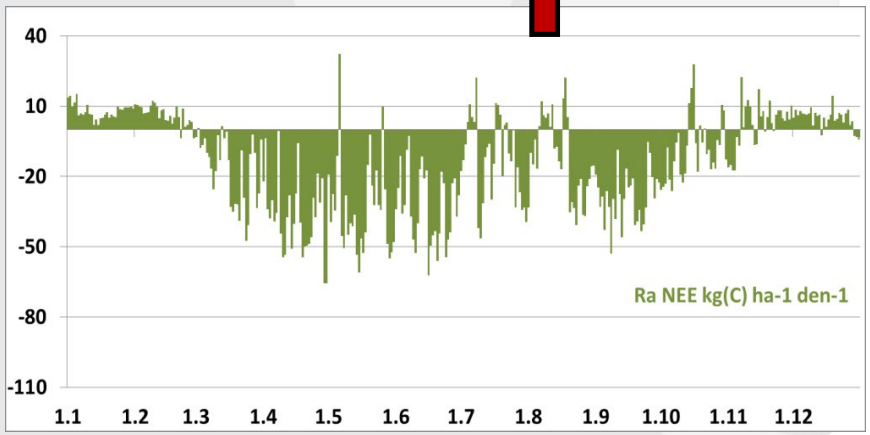
Mountain area – up to 1000 m a.s.l. — 2015 — Highland – up to 550 m a.s.l.







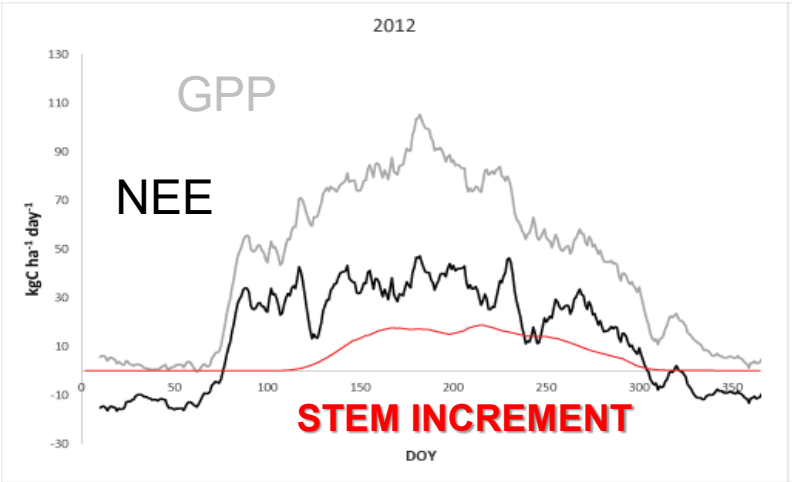


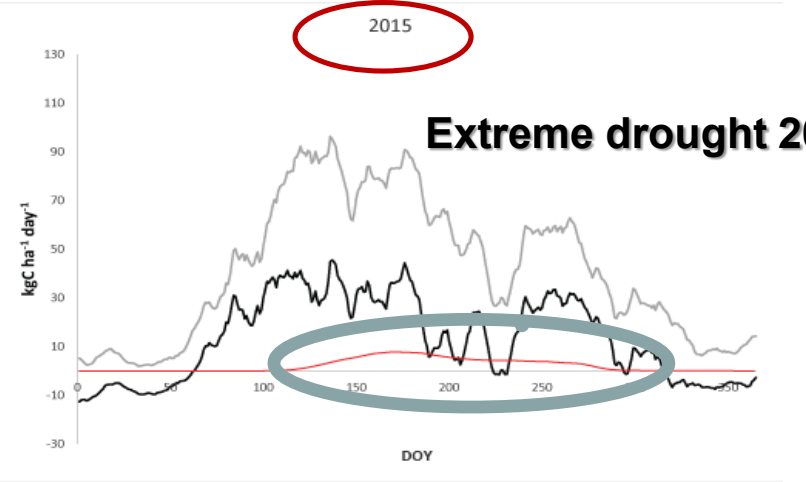
Tons of C ha^{-1} $year^{-1}$: **8,4** **4,9**

SUMMARY OF „CARBON STORAGE LOSSES“ BECAUSE THE DROUGHT EFEFCT IN SPRUCE STANDS LOCATED AT DIFFERENT ALTITUDES

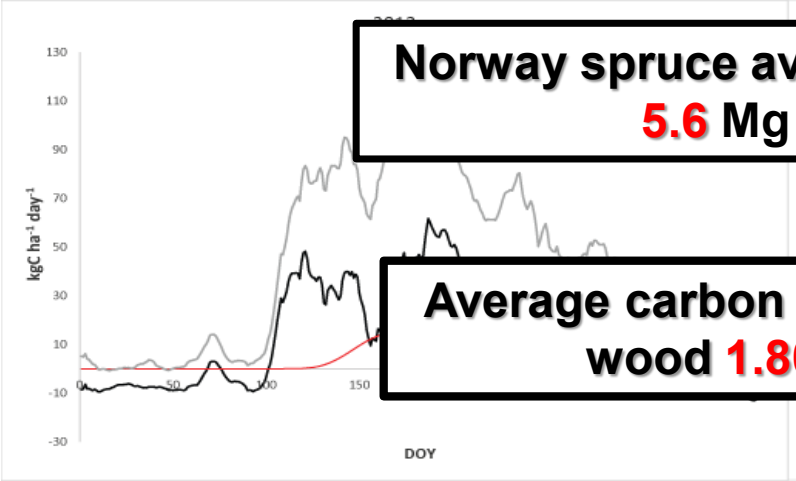
Carbon losses (%) compared to 10-years average

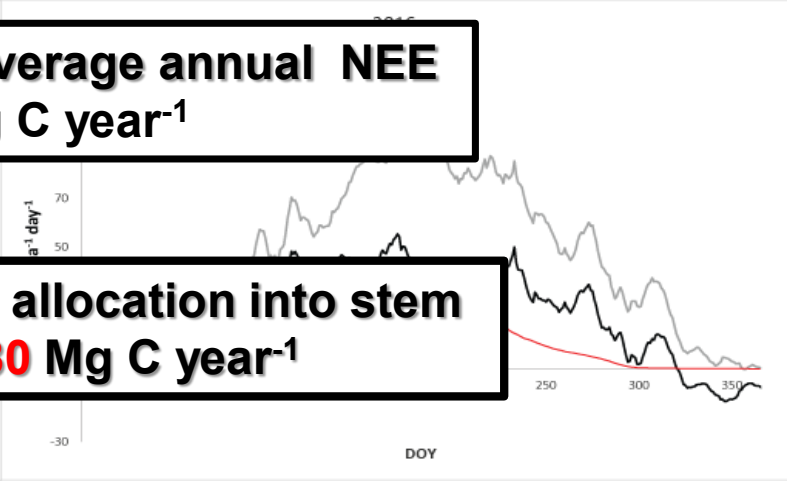
	2014	2015	2016
MOUNTAIN SPRUCE STAND (1000m a.s.l.)	102	94	105
HIGHLAND SPRUCE STAND (550m a.s.l.)	106	86	99



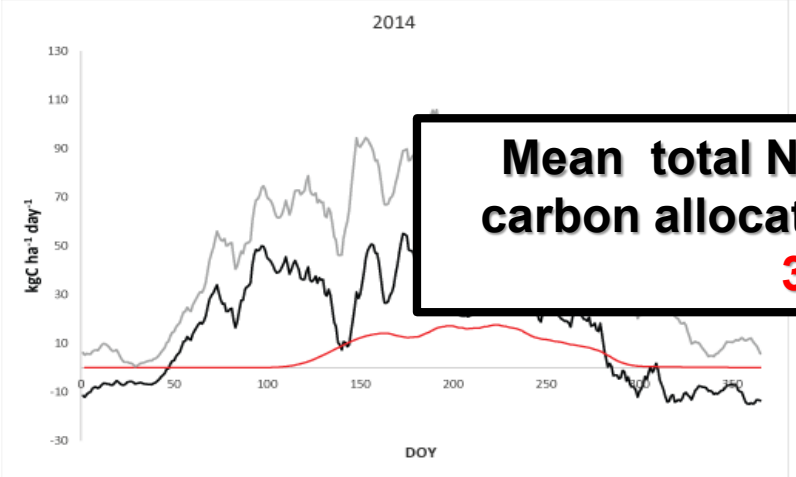


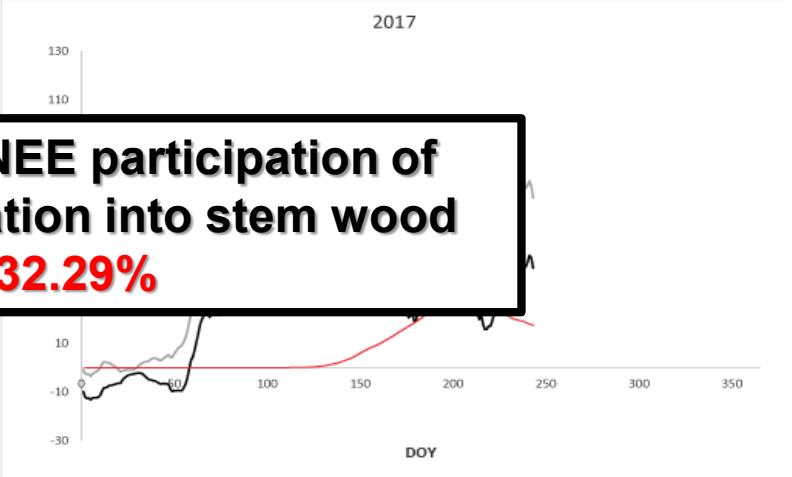
Norway spruce average annual NEE
5.6 Mg C year^{-1}





Average carbon allocation into stem wood 1.80 Mg C year^{-1}





Mean total NEE participation of carbon allocation into stem wood
32.29%

Comparison of broad-leaf and conifer trees response to the summer drought

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SPRUCE FOREST

Bílý Kříž 35 years old 16 m height

BEECH FOREST

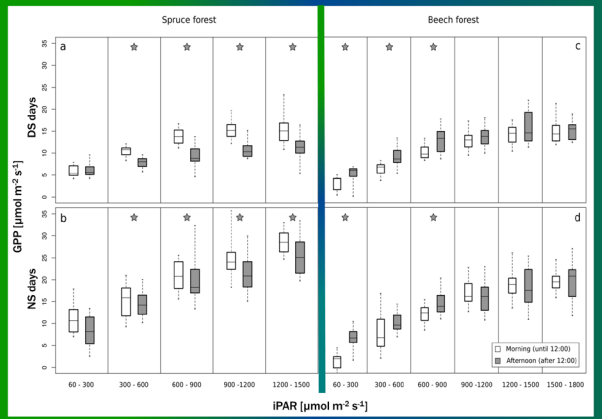
Štítná 112 years old 31 m height

clear days

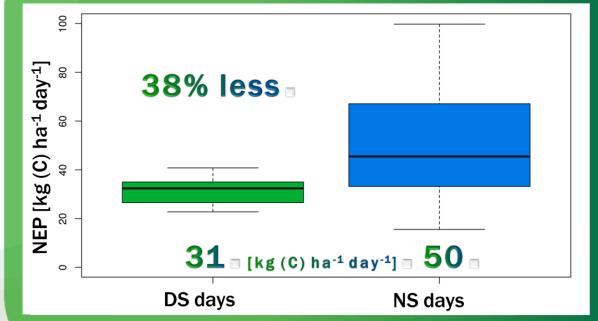
DROUGHT STRESS DAYS — DS
- no rain
- VPD >1000 Pa
- AWR > 50%

DAYS WITHOUT DROUGHT STRESS — NS
- shortly after rain
- VPD < 1000 Pa
- AWR < 50%

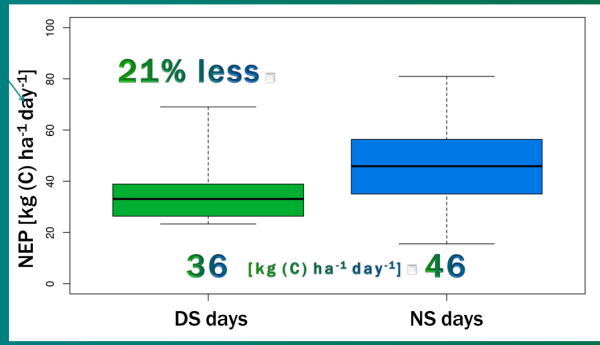
light response curves
before-noon and after-noon



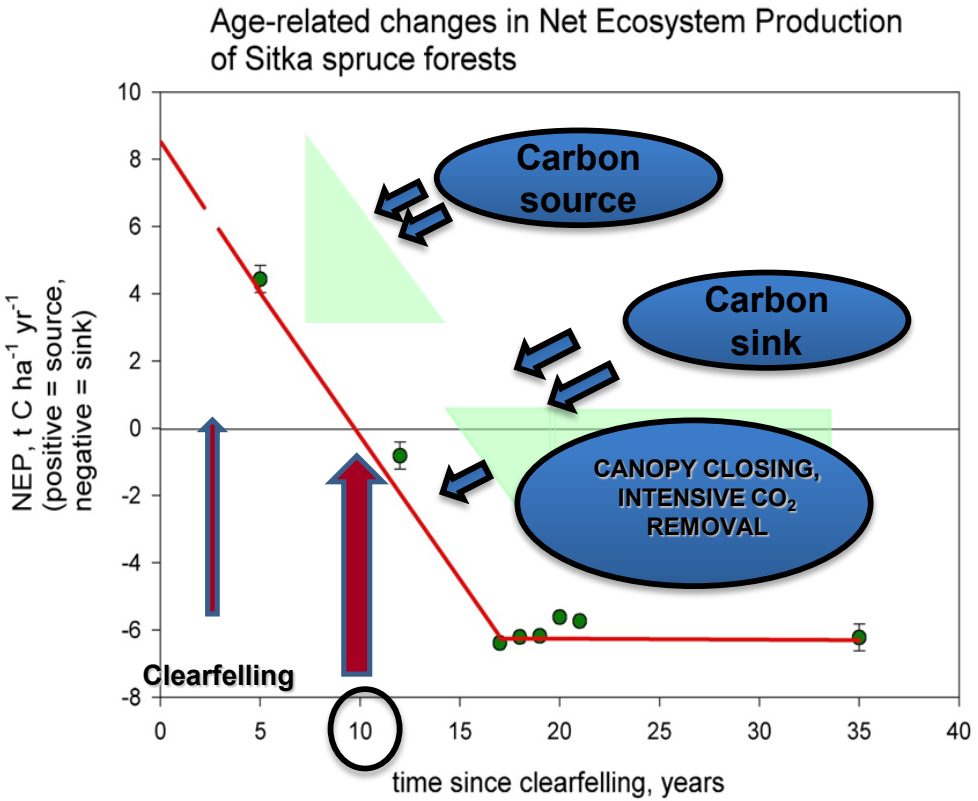
NEP



NEP

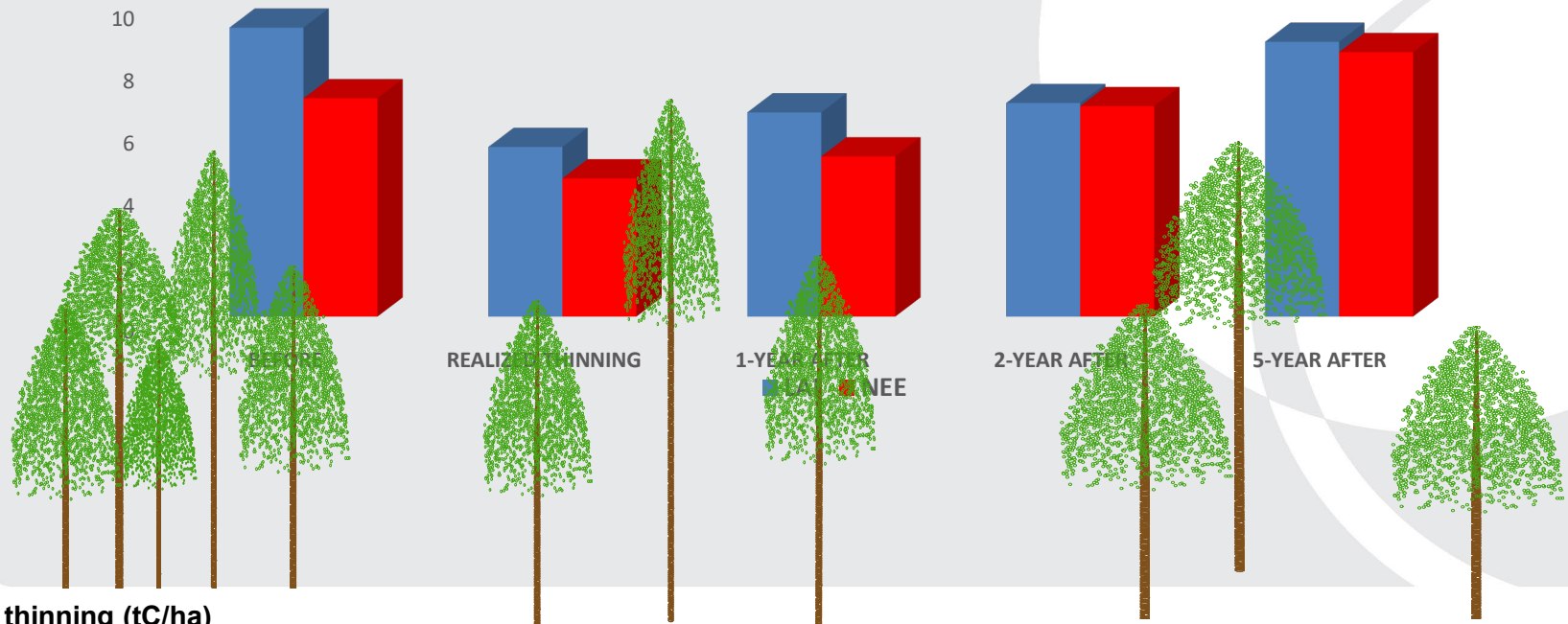


Carbon storage related to the sylviculture cycle - clearfelling, planting and carbon storage restoration



THINNING – CRUCIAL forester's tool for affecting carbon deposit capacity of forest stand

Changes of the carbon fluxes and leaf amount after thinning



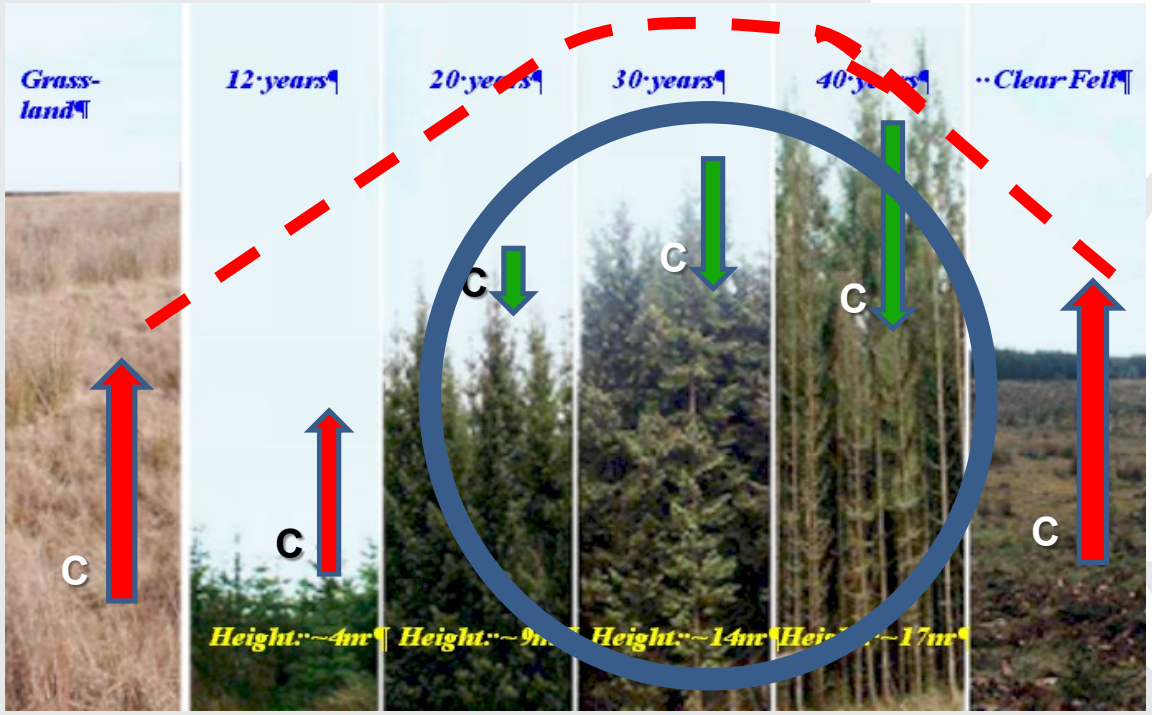
Before thinning (tC/ha)

- above ground 21
- below ground 7.5
- **Total 28.5**

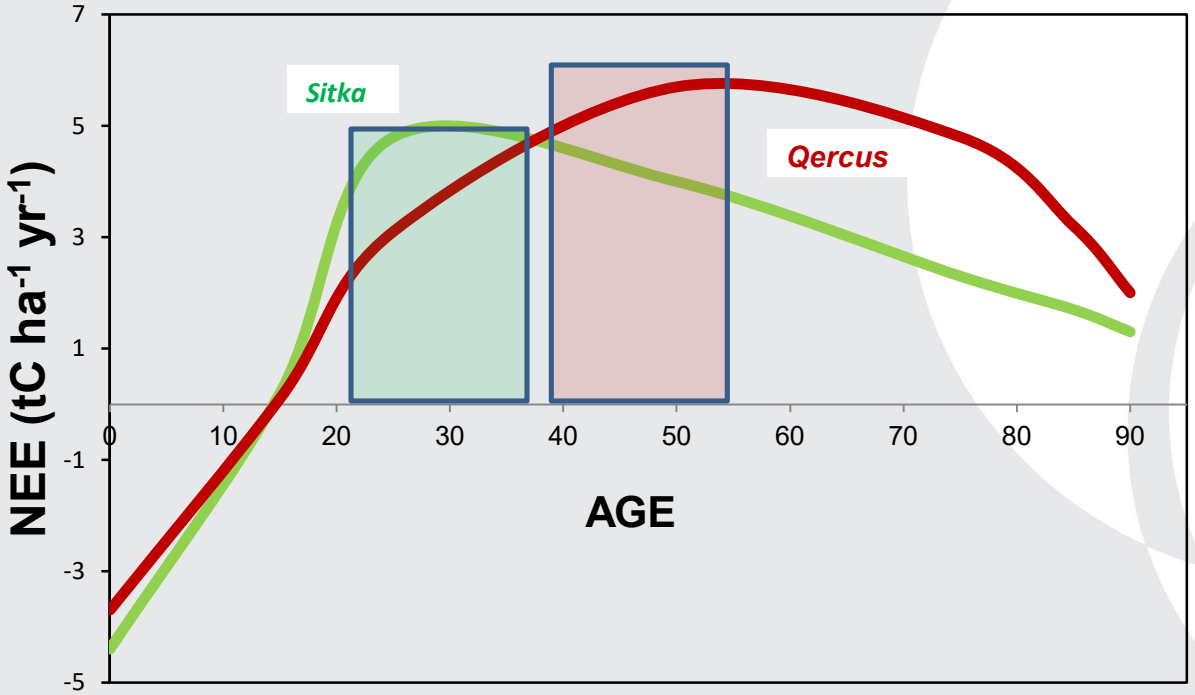
After thinning (tC/ha

- above ground 12
- below ground 4
- **Total 16**

Chronosequence of the carbon flux (NEE) during the development of Norway *spruce*



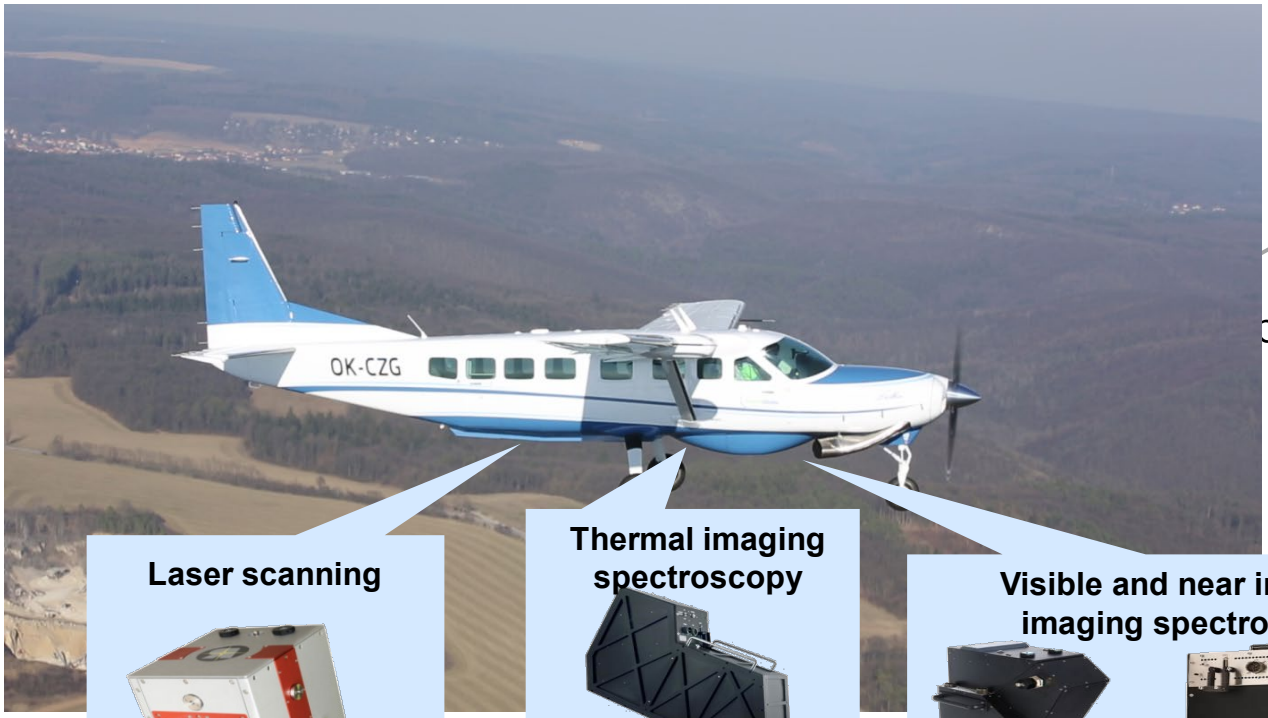
Chronosequence of the carbon flux (NEE) during the development of *Sitka spruce* and *Qercus cerris*



MAIN FEATURES OF CZECH SOCIETY AND ITS VULNERABILITY TO GLOBAL CHANGE IMPACT

- **SOCIAL SUBCONSCIOUS ABOUT THE GC IMPACT**
  - ✓ ***different according to the societal and economic status*** (farmers, foresters, urban inhabitant, businessman)
  - ✓ ***GC – „politicum“ -*** objective of the political orientation
  - ✓ ***General politic of the state*** – National Action plan for GC mitigation and adaptation
  - ✓ Technological measure – new technology (electrocars)
  - ✓ ***Fossil zero***
  - ✓ ***Smart approaches*** - smart city, carbon smart agriculture, forestry and landscaping
  - ✓ ***Importance of the society-education*** – environmental feeling – part of the general moral status –SaintExupery „Small prince“

Remote sensing - based process imaging on the different spatial level



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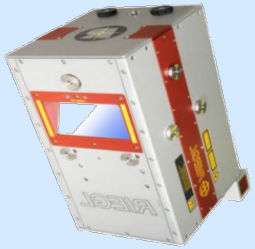
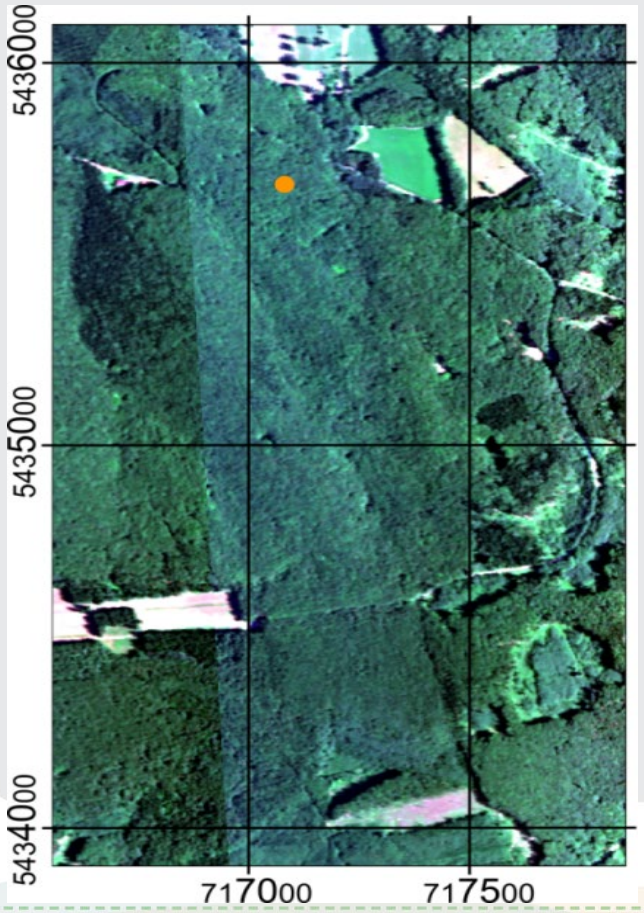
Laser scanning



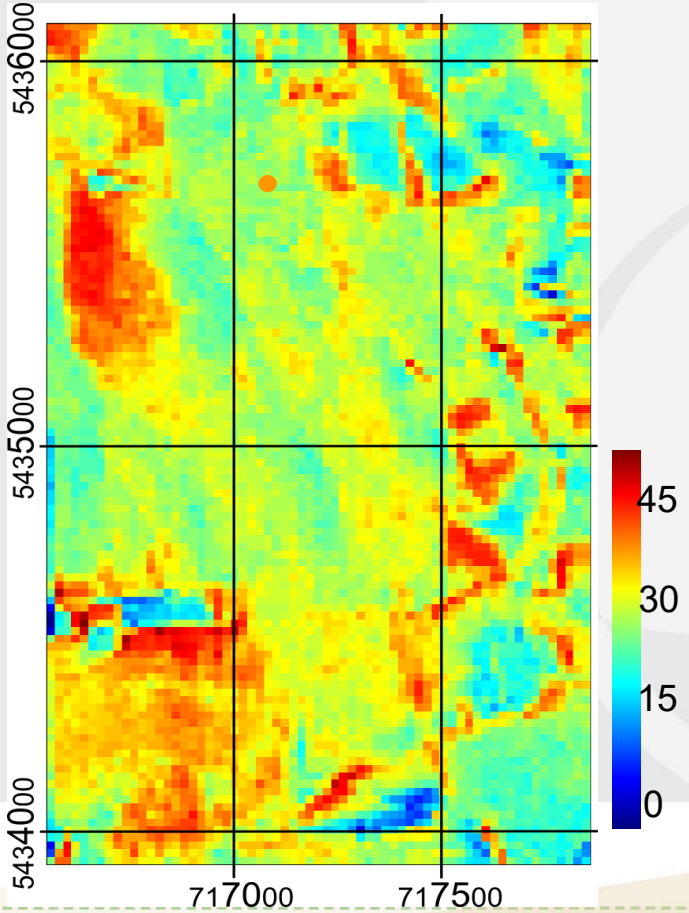
Thermal imaging spectroscopy

Visible and near infra-red imaging spectroscopy

Chlorophyll fluorescence signal distribution on the surface of Spruce canopy – indicator of photosynthetic assimilation

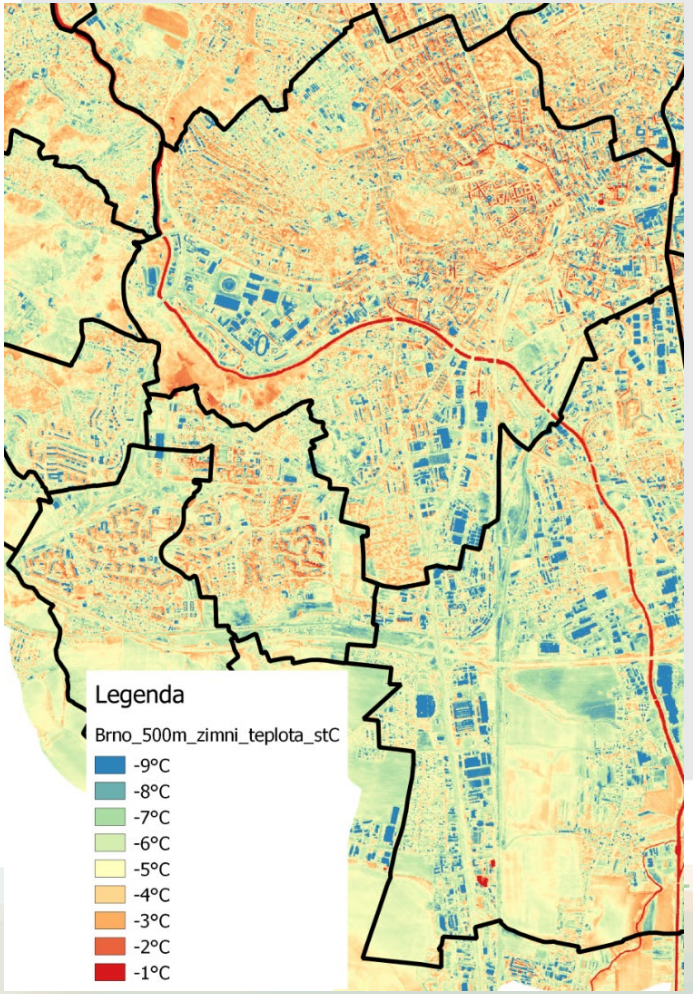


Airborne image (2.5m)

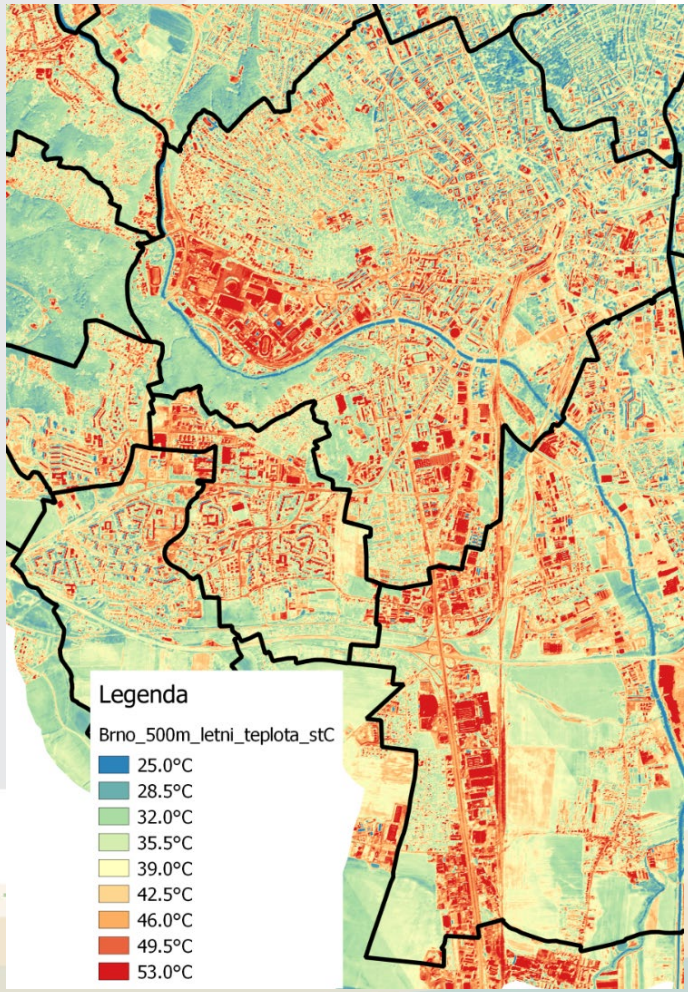


Thermal imaging of urban areas

Airborne thermal image (winter)

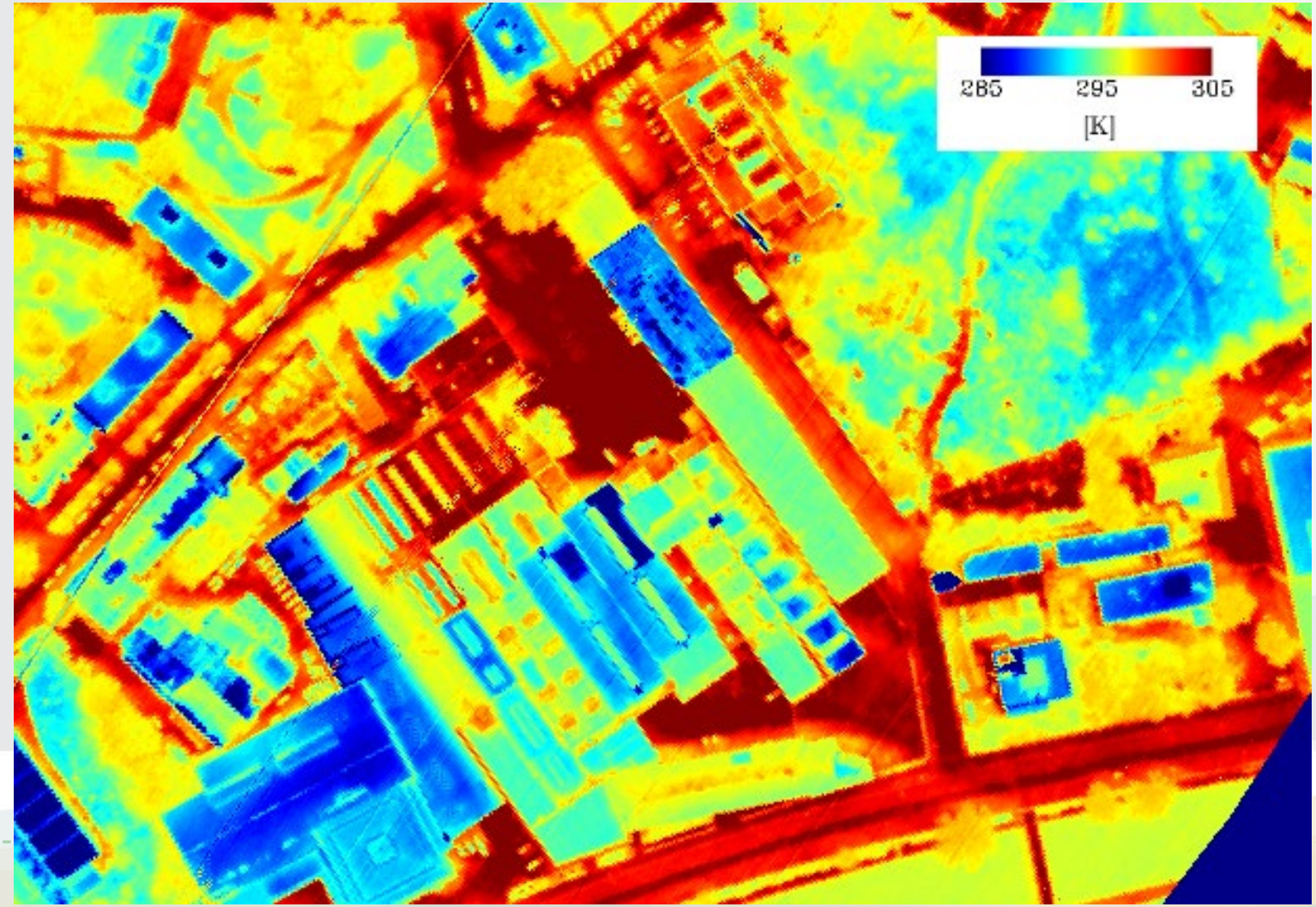


Airborne thermal image (summer)



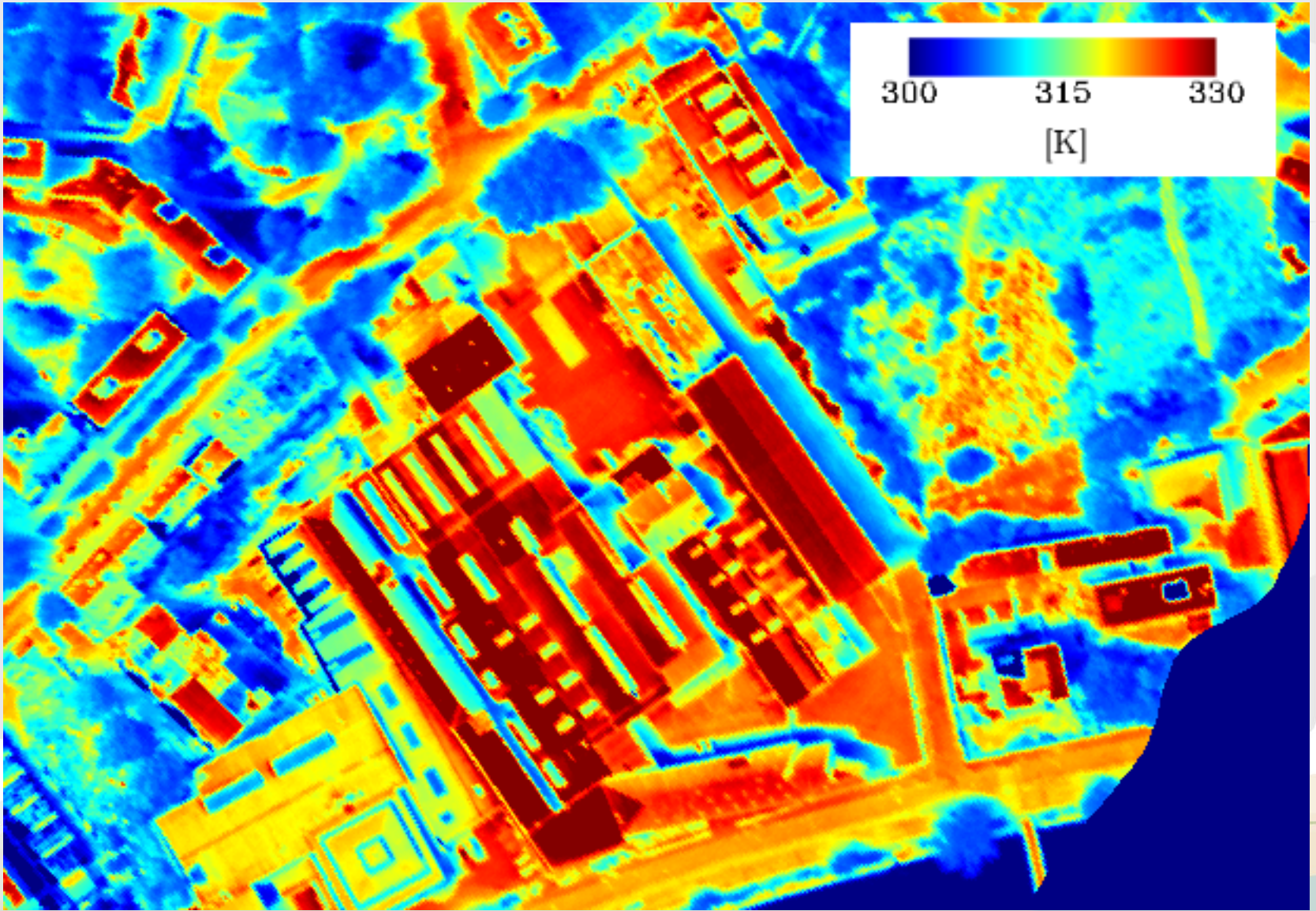
Temperature distribution in the Brno city

(summer night)

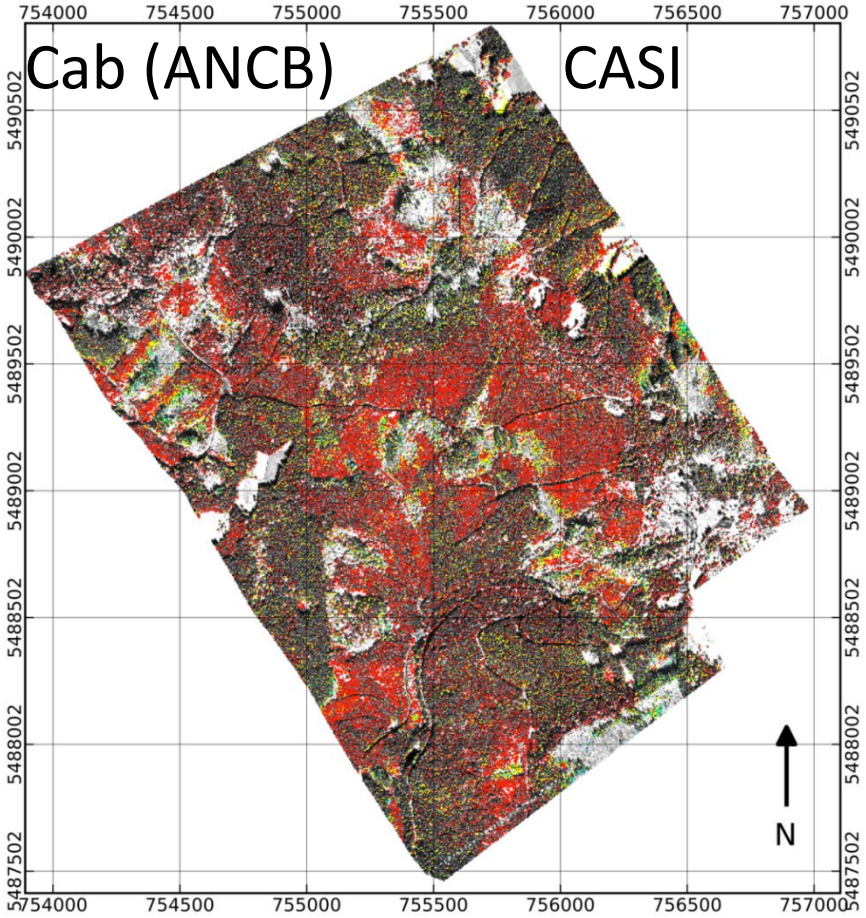


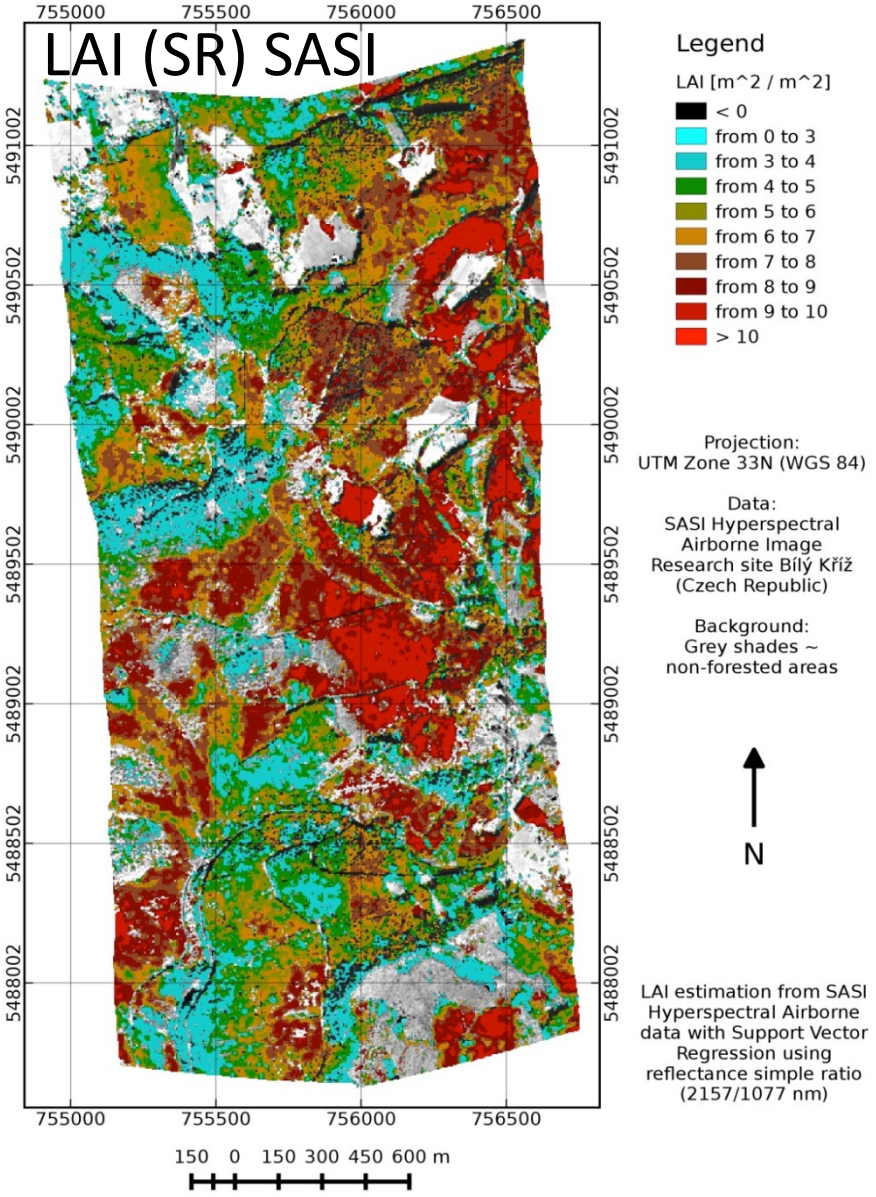
Temperature distribution in the Brno city

(hot summer afternoon)



Map of chlorophyll (Cab) and Leaf Area Index (LAI) using airborne hyperspectral data



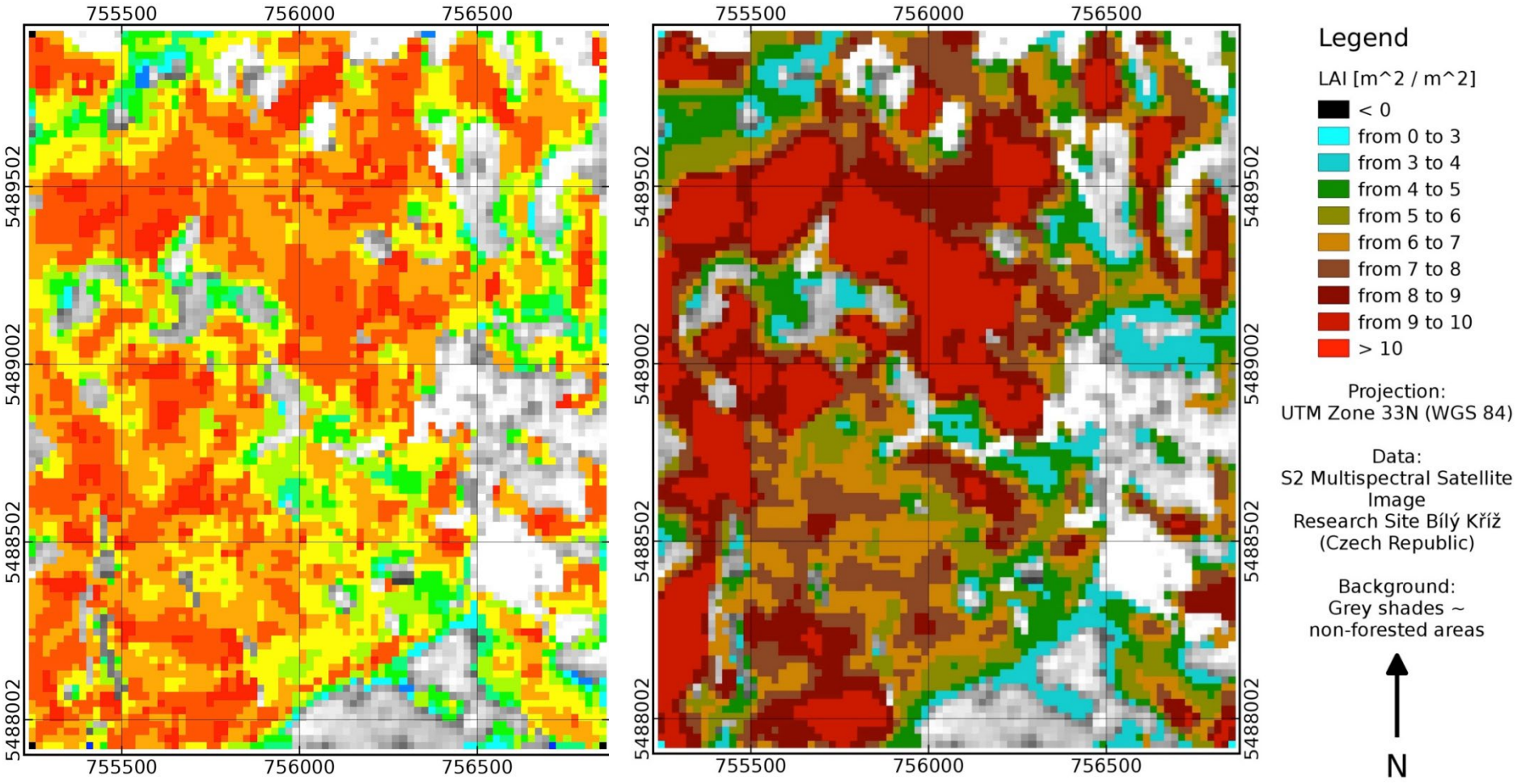


Homolová, L., Janoutová, R., Malenovský, Z. 2016. Evaluation of Various Spectral Inputs for Estimation of Forest Biochemical and Structural Properties from Airborne Imaging Spectroscopy Data. ISPRS - International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XLI-B7, pp.961-966.

Estimation of spruce stand quantitative traits using Copernicus Sentinel-2 satellite imagery (Bílý Kříž, Czech Republic, August 2016)

Chlorophyll content (Cab)

Leaf area index (LAI)



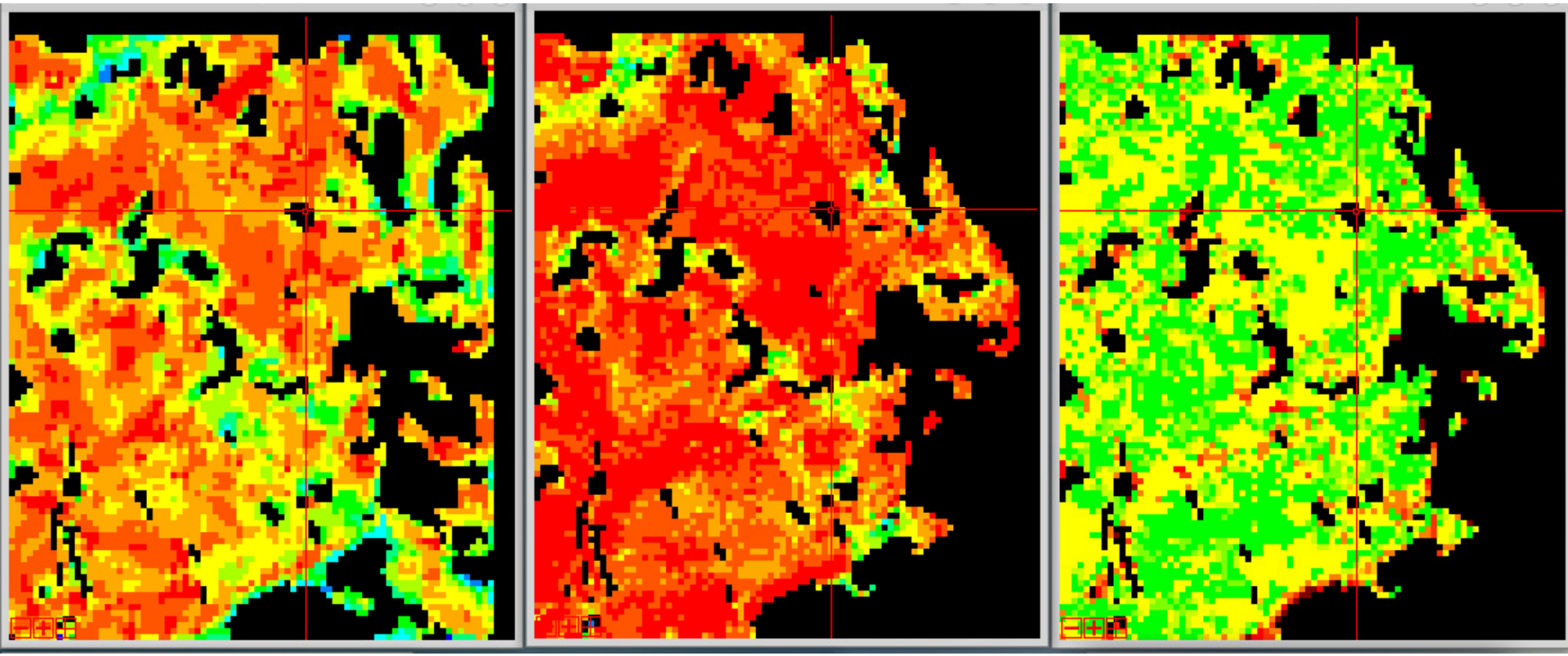
Malenovský, Z., Homolová, L., Janoutová, R., .. Huck, A. (2016). Potential of the Sentinel-2 Red Edge Spectral Bands for Estimation of Eco-Physiological Plant Parameters. Proceedings LivingPlanetSymposium, 9-13 May, Prague, Czech Republic. Edited by L. Ouwehand. ESA-SP Volume 740, ISBN: 978-92-9221-305-3.

Comparison of leaf chlorophyll content maps generated from satellite Sentinel-2 and airborne hyperspectral (CASI) images (Bílý Kříž, Czech Republic, August 2016)

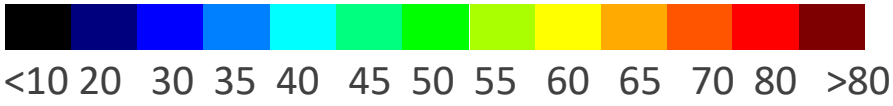
Sentinel-2 map

Airborne CASI map

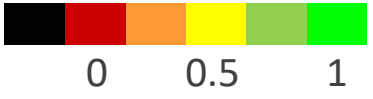
Similarity (69.8%)



Cab

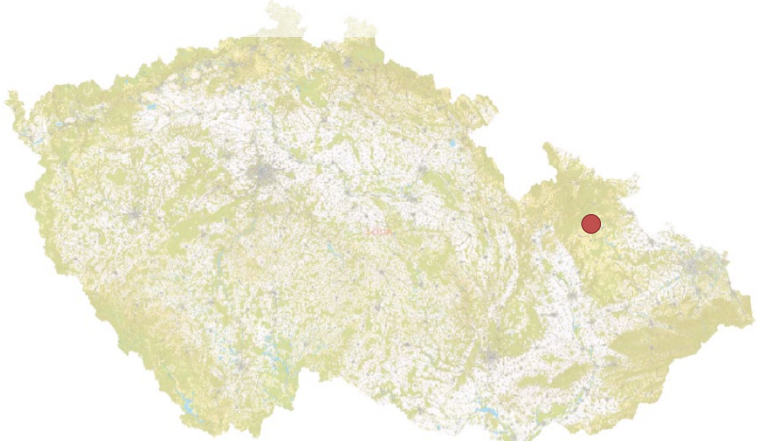


Similarity

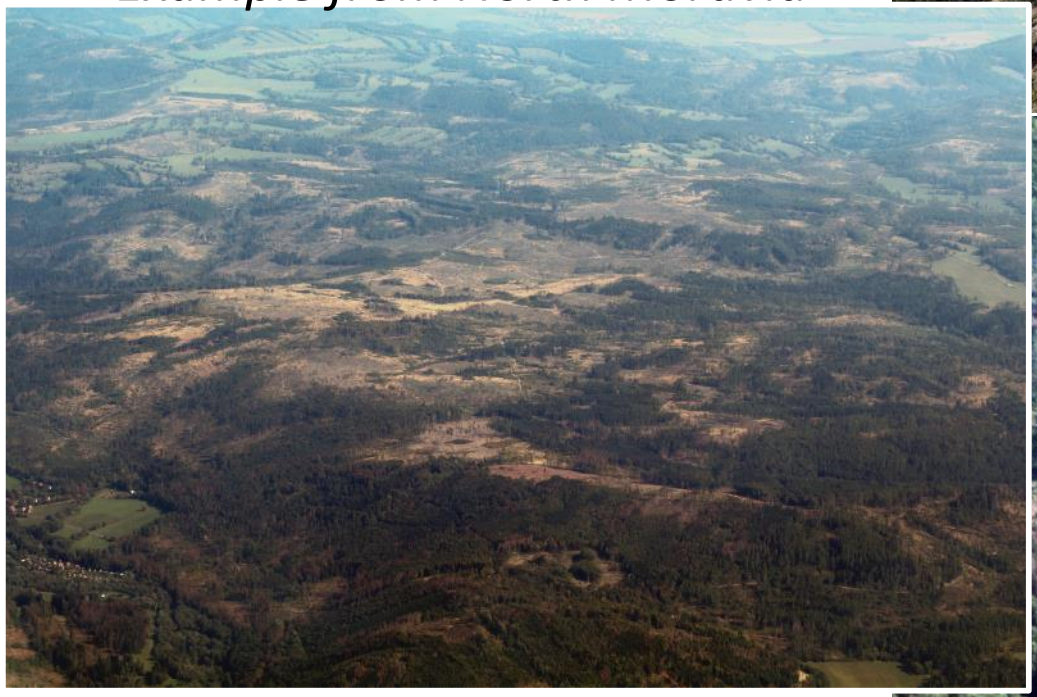


Malenovský, Z., Homolová, L., Janoutová, R., .. Huck, A. (2016). Potential of the Sentinel-2 Red Edge Spectral Bands for Estimation of Eco-Physiological Plant Parameters. Proceedings LivingPlanetSymposium, 9-13 May, Prague, Czech Republic. Edited by L. Ouwehand. ESA-SP Volume 740, ISBN: 978-92-9221-305-3.

Bark beetle outbreaks in Czechia



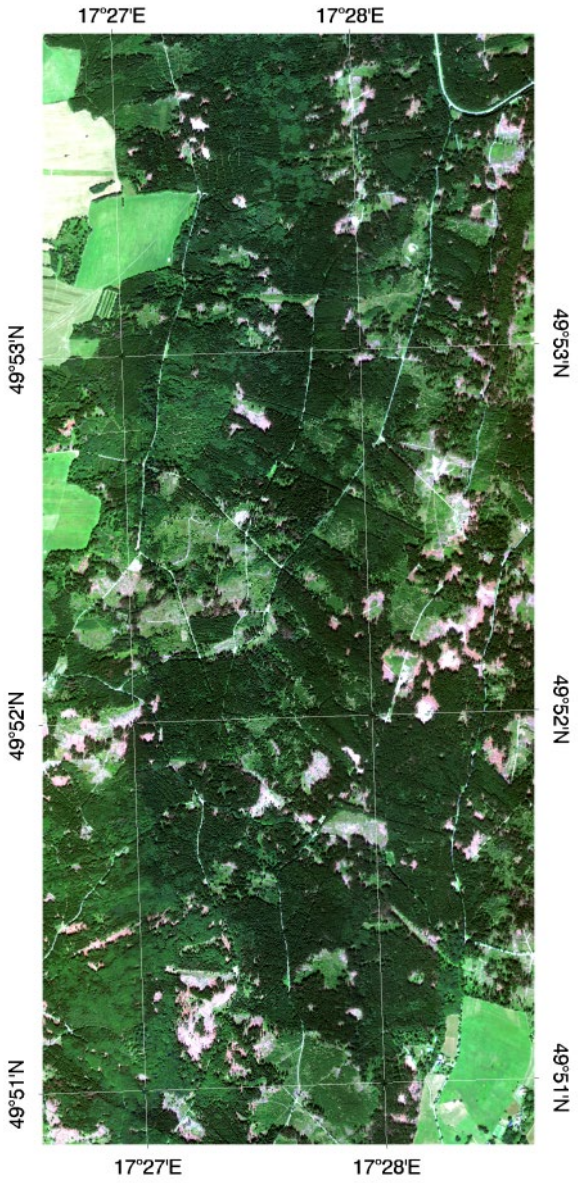
Example from North Moravia



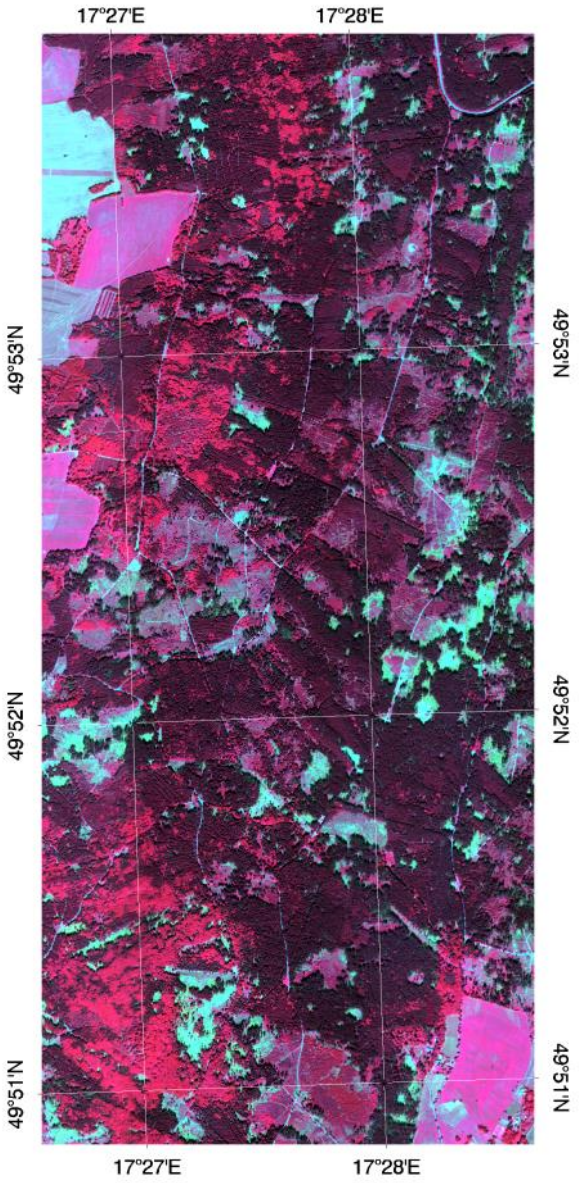
Photographs by Petr Lukeš

Region of Bruntál – August 2017

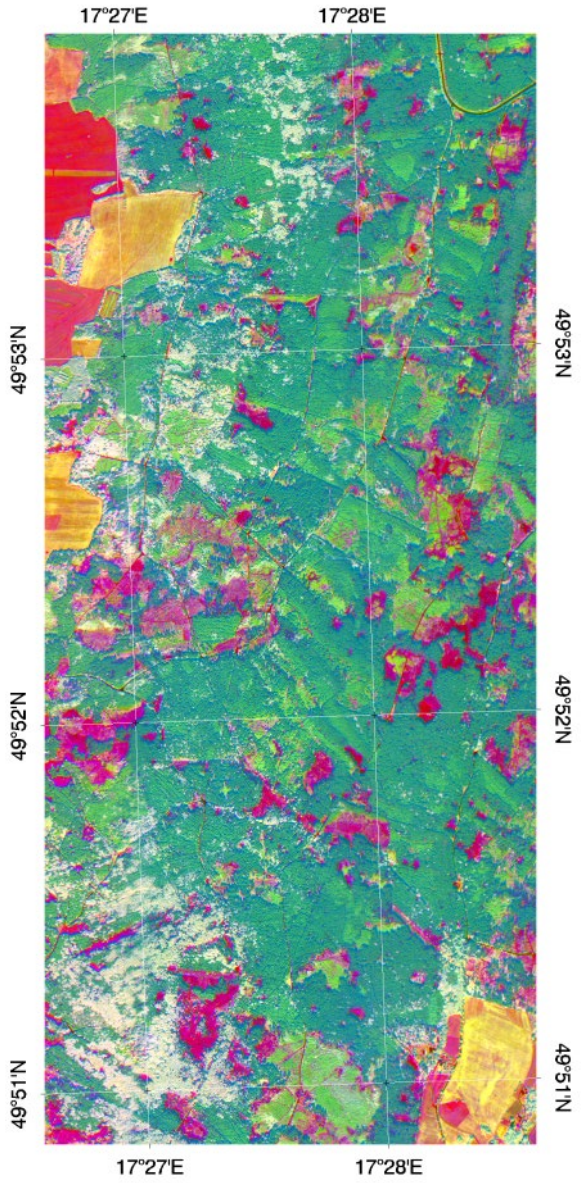
a) True color



b) False color (near infra-red)

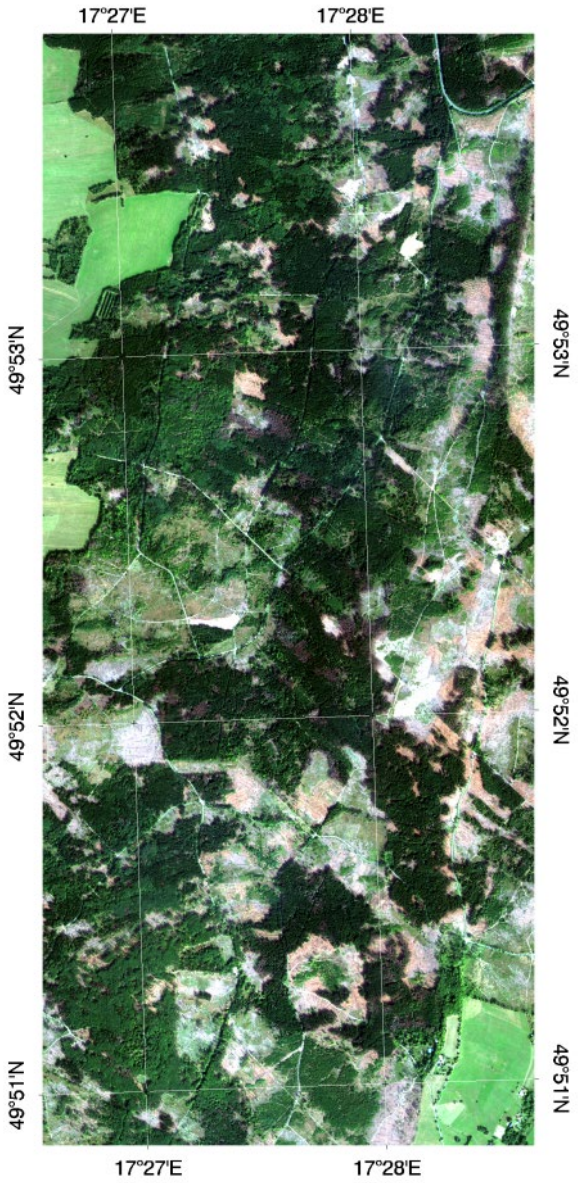


c) Principal components

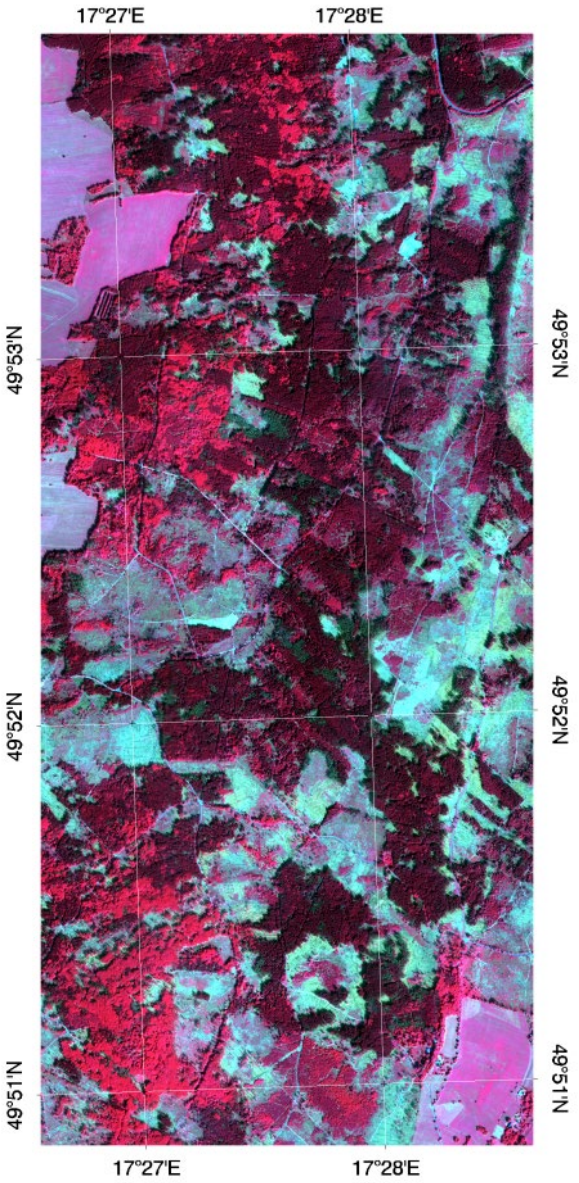


Region of Bruntál – August 2018

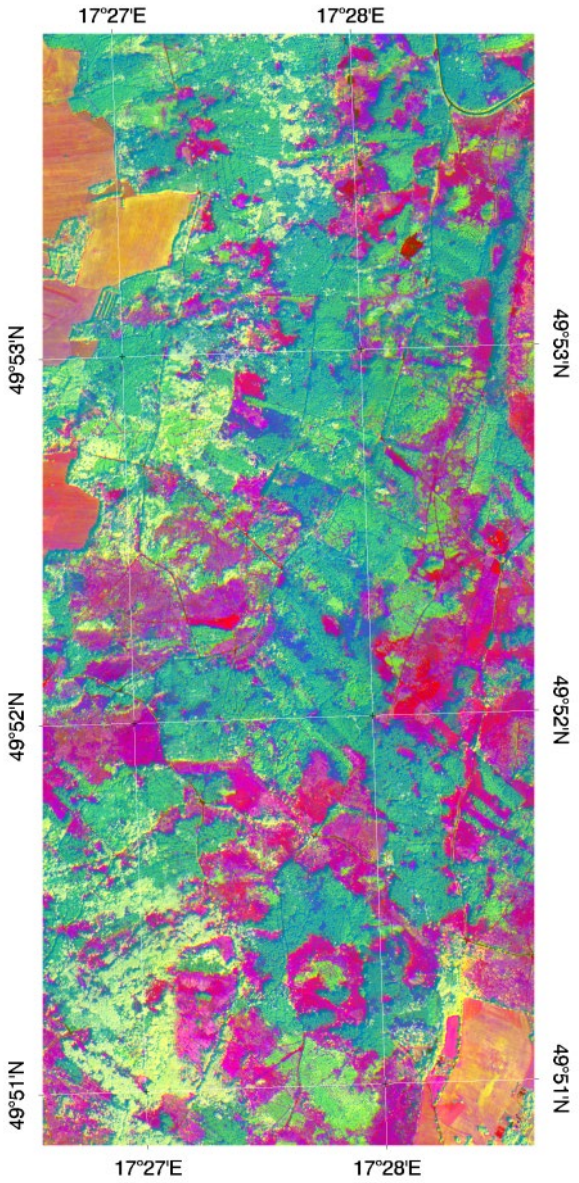
a) True color



b) False color (near infra-red)

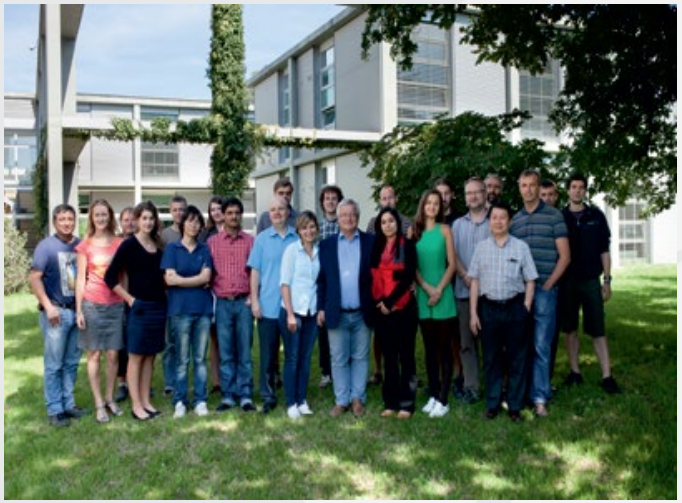


c) Principal components



Thank a lot for your attention

(without great work of my colleagues will be not possible to prepare this lecture)



CzechGlobe Global Change Research Institute AS CR

Národní referenční bod měření skleníkových plynů ICOS-ATM

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