Modeling of the net ecosystem exchange, gross primary production and ecosystem respiration for peatland ecosystems of West Siberia

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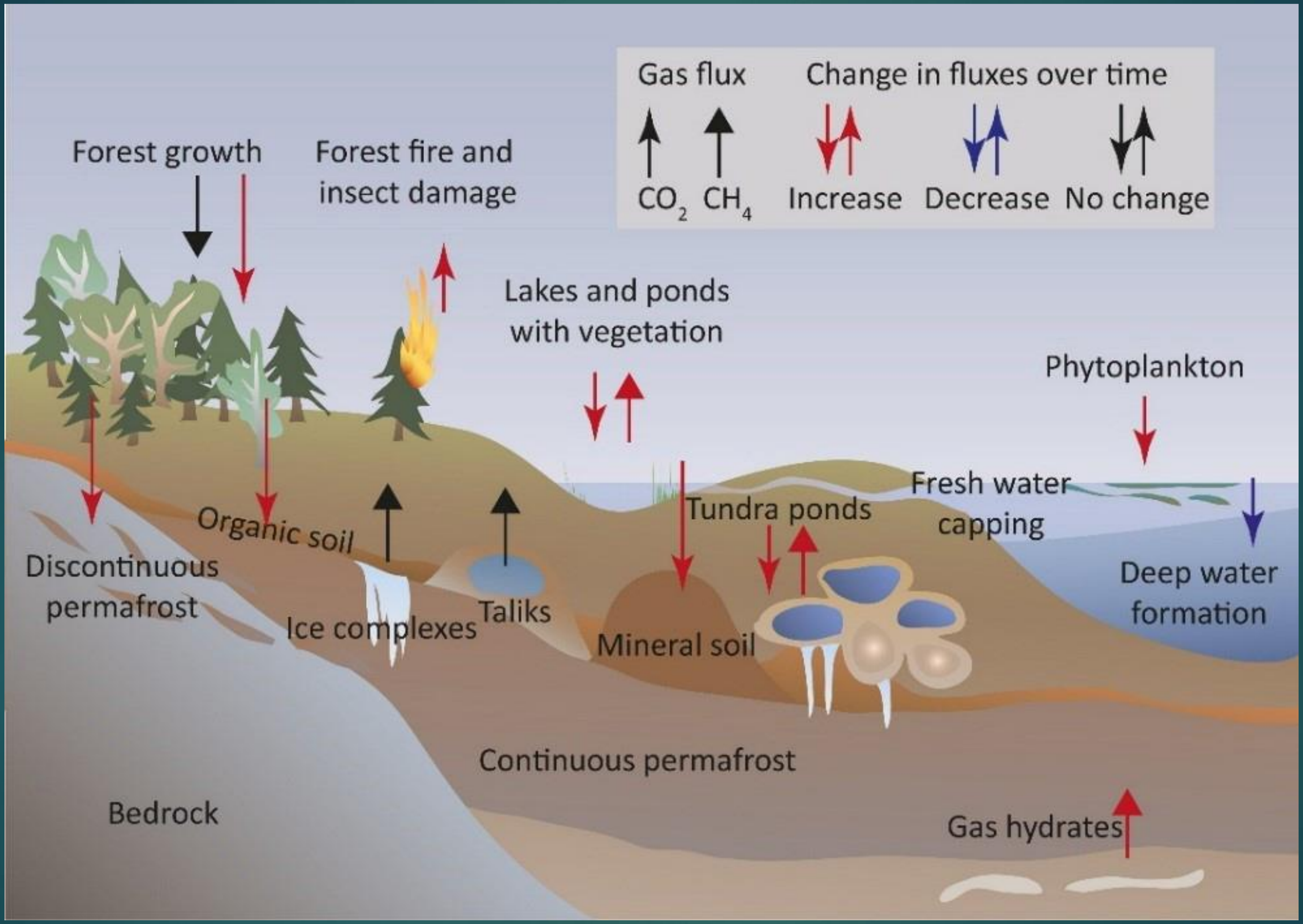
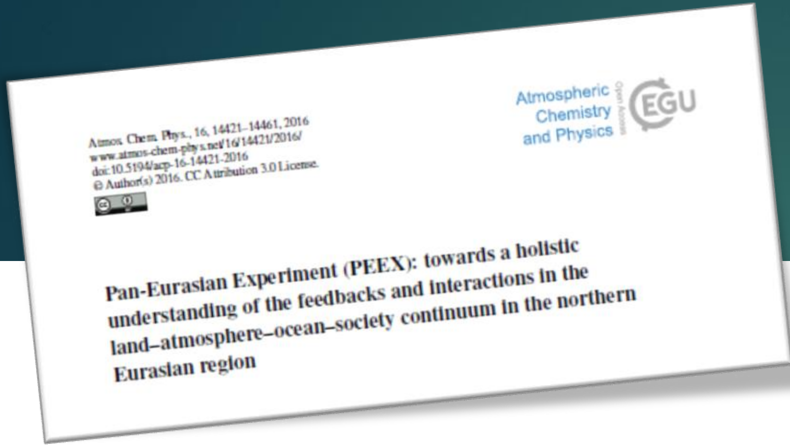


Carbon cycling in the Arctic will change as the climate warms.
Figure after ACIA, 2004 (Arctic Climate Impact Assessment, 2004).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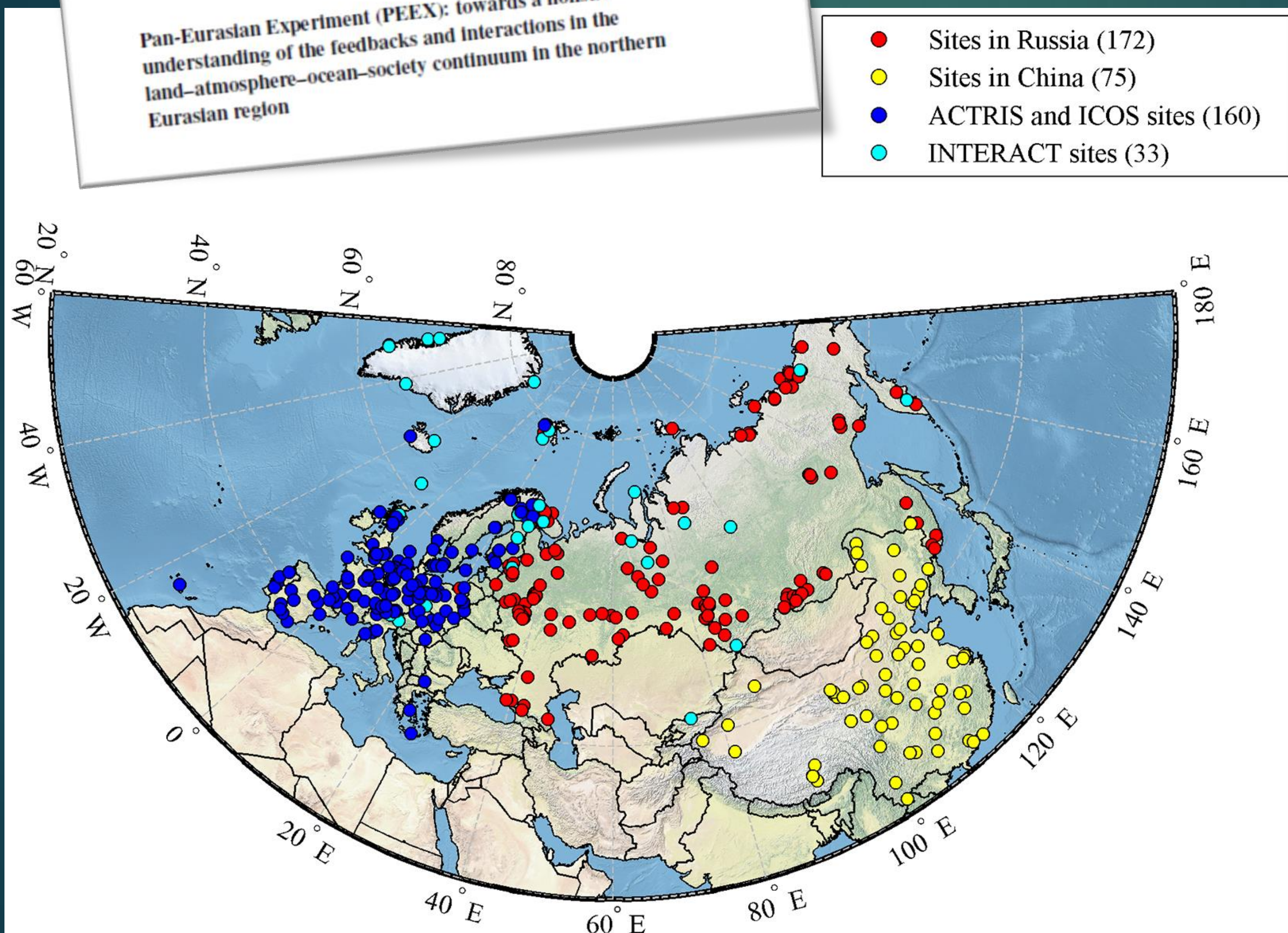
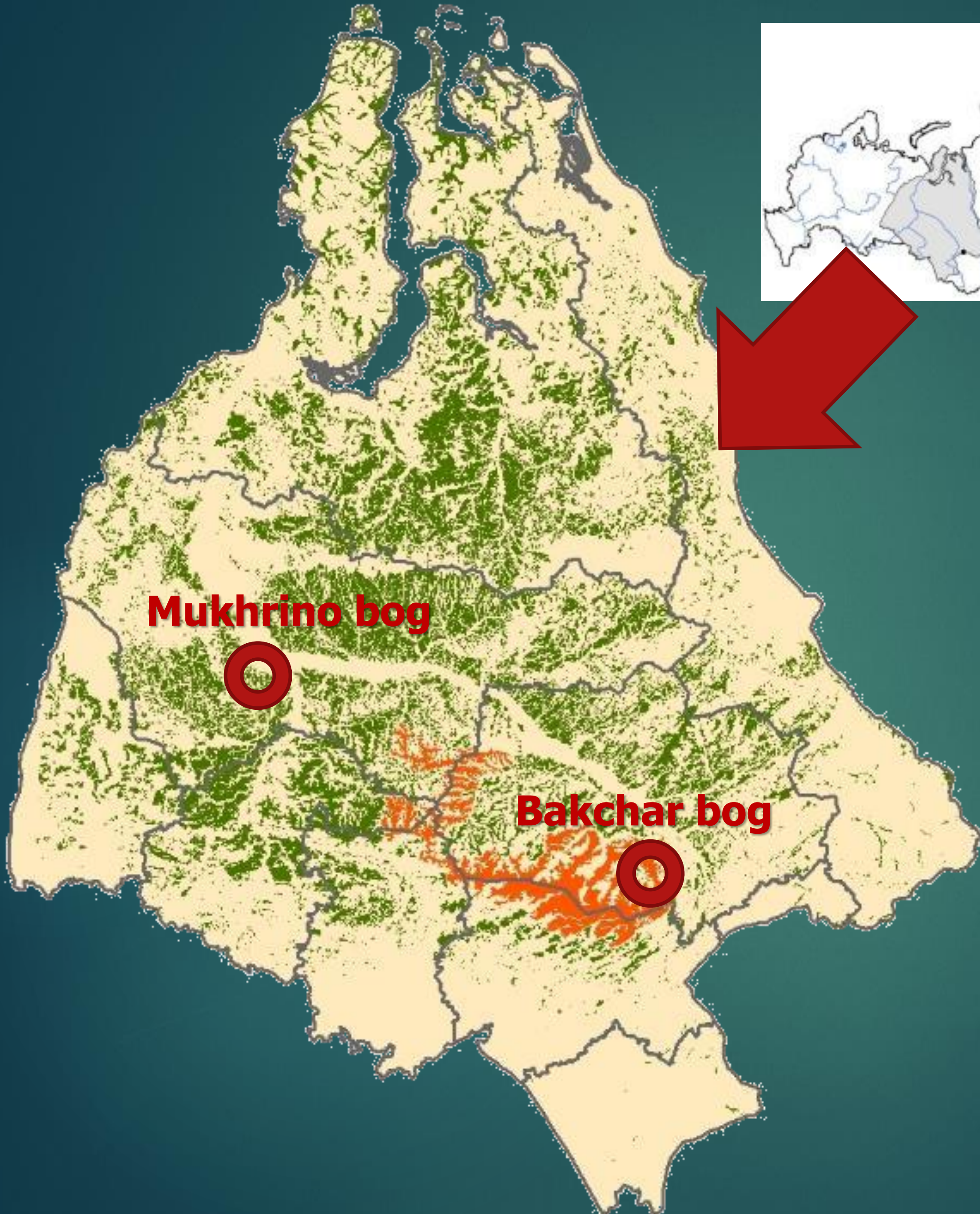
Pan-Eurasian Experiment (PEEX): towards a holistic understanding of the feedbacks and interactions in the land–atmosphere–ocean–society continuum in the northern Eurasian region



Map showing the existing ACTRIS (aerosols, clouds, and trace gases research infrastructure network) and ICOS (Integrated Carbon Observations System) stations

The Fonovaya station, Tomsk (Institute of Atmospheric Optics SB RAS)

ZOTTO station (Max Planck Institute for Biogeochemistry / I. V. Sukachev Institute of Forest, SB RAS)



West Siberia peatlands

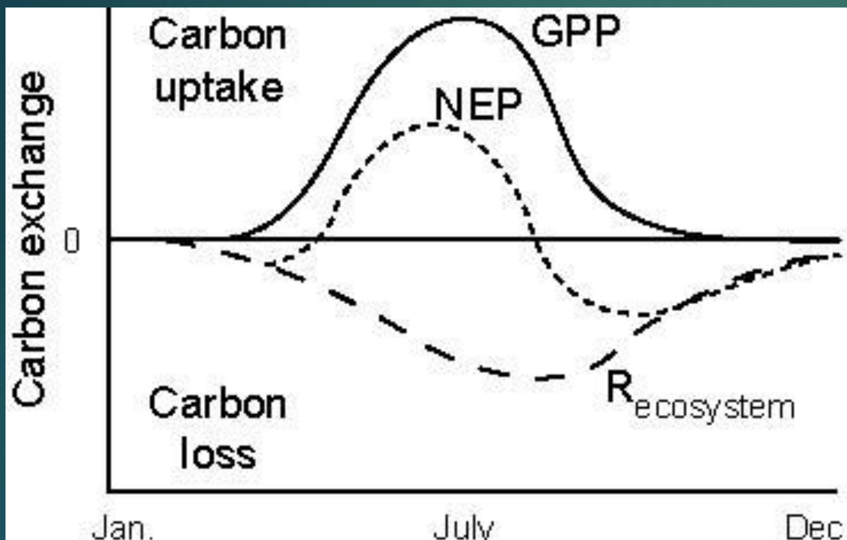
Total area - 592 440 km^2,

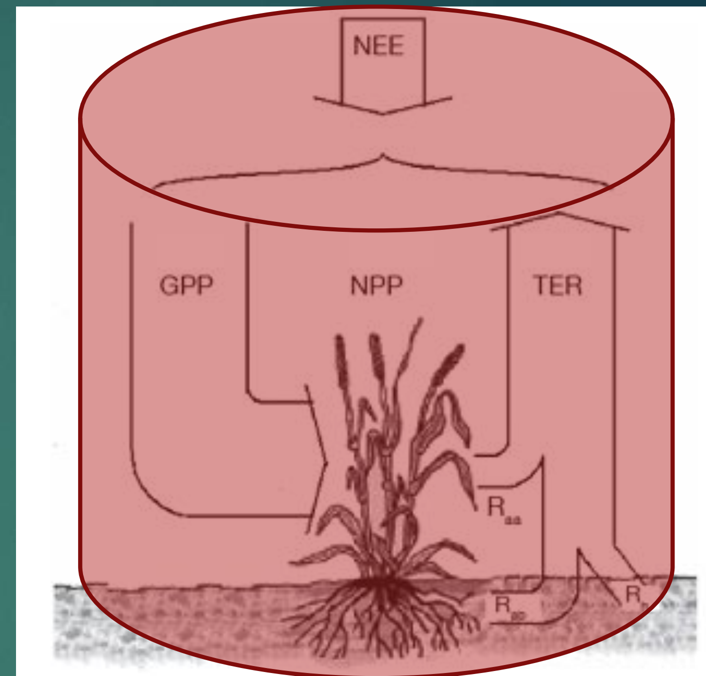
Peat storages - 148 Pg

Carbon storages - 70 pg C

Sheng et al., GBC 2004

NEE is the balance between two large fluxes: photosynthesis and ecosystem respiration





NEE = ER - GPP

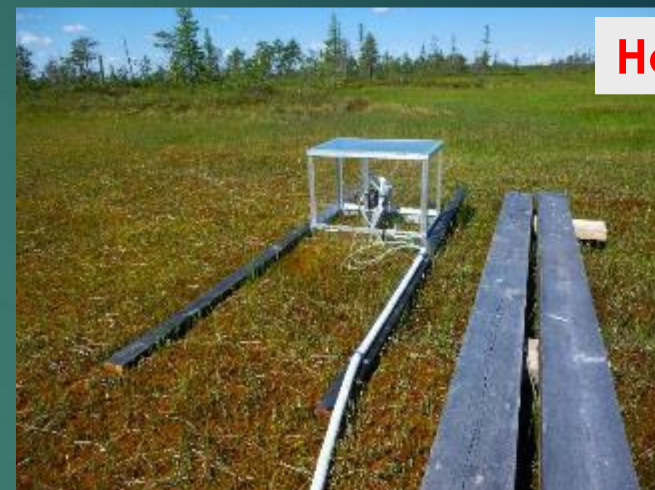
ER = AR + HR

NPP = GPP - HR

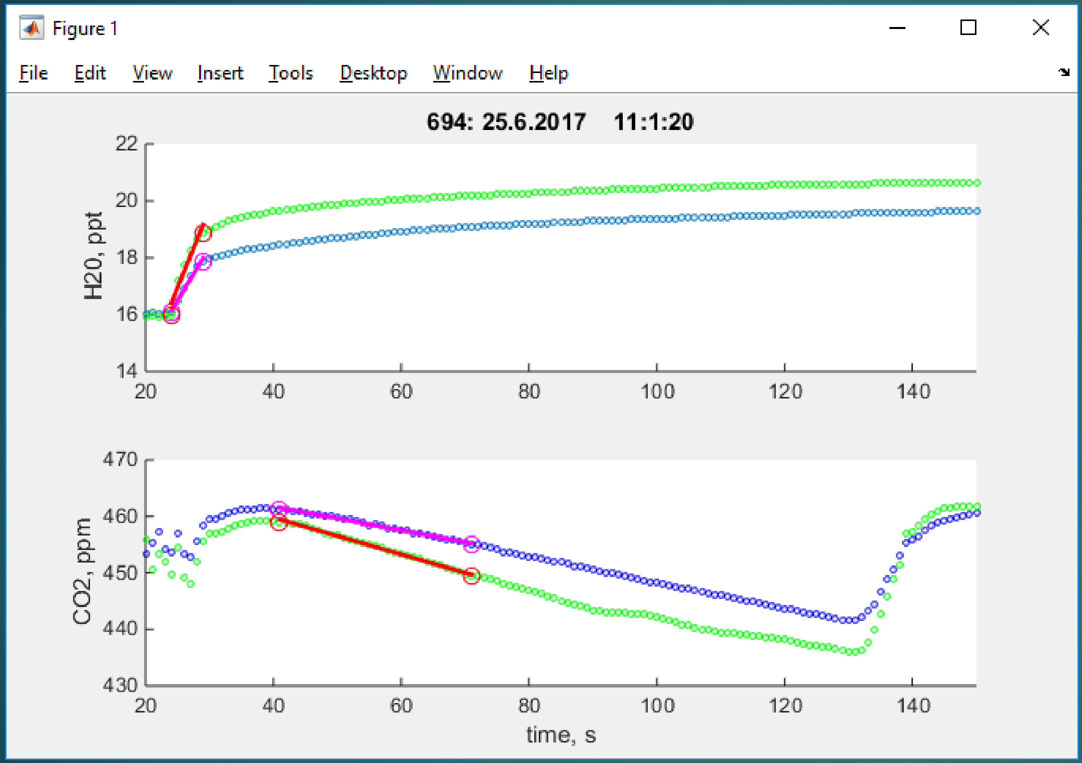
Mukhrino bog

Mukhrino Field Station is located in the central part of West Siberia, 30 km to the south-west from Khanty-Mansiysk, on the left Irtysh River bank near the wetland “Mukhrino”. Mukhrino Field Station was established as a part of the UNESCO chair “Environmental dynamics and global climate change” of Yugra State University in 2009. It is equipped with modern facilities allowing conducting year-round long-term scientific research, scientific excursions, summer schools, workshops.

Mukhrino Bog
LICOR 7000-ACC2



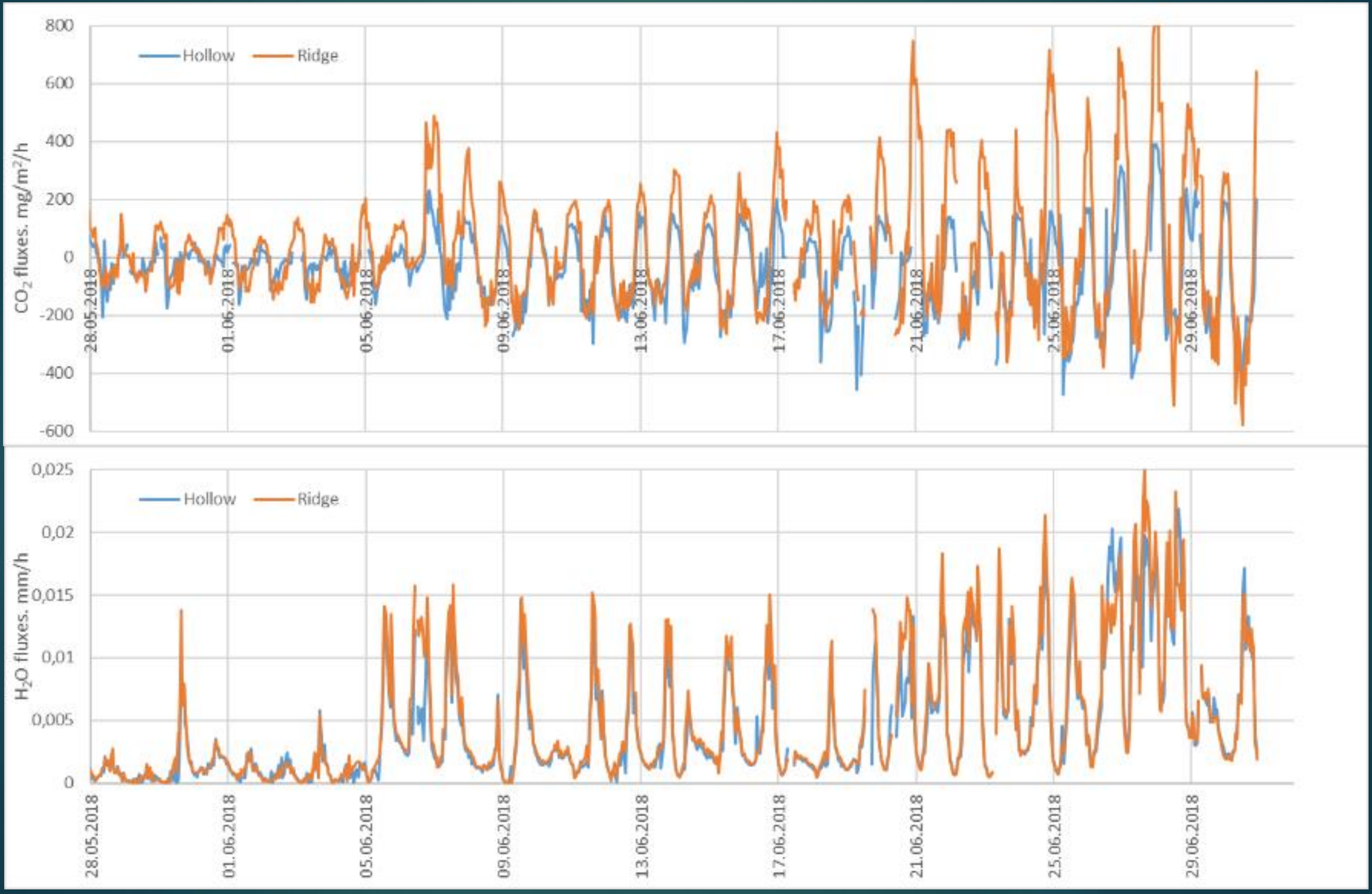
Flux estimation



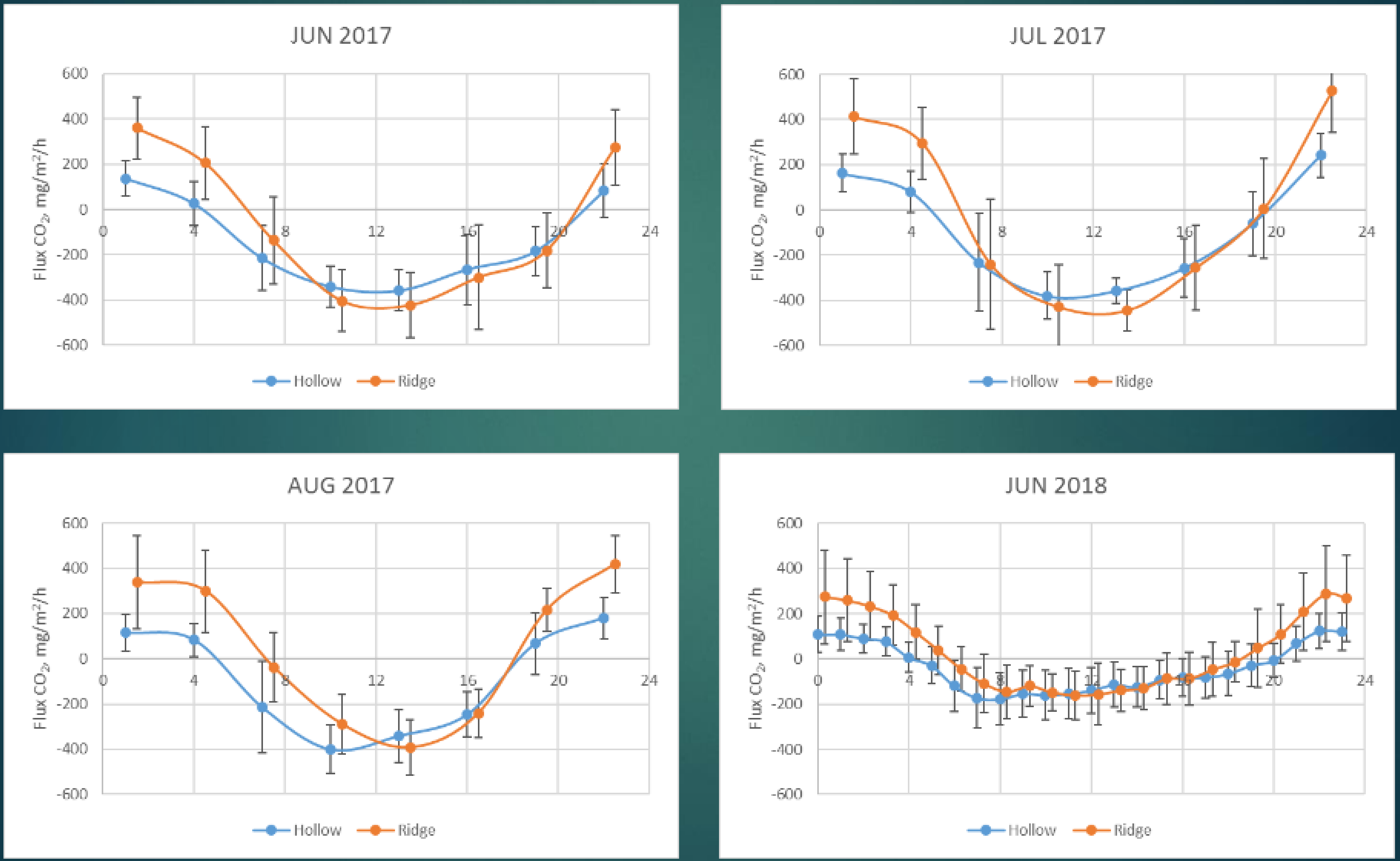
5 minutes exposition
1 hr repeat

- CO2 contents
- H2O contents
- Air temperature
- Relative humidity
- Surface temperature
- Photosynthetic active radiation
- Atmospheric pressure
- Wind speed
- Wind direction

CO_2 and H_2O fluxes (2018)



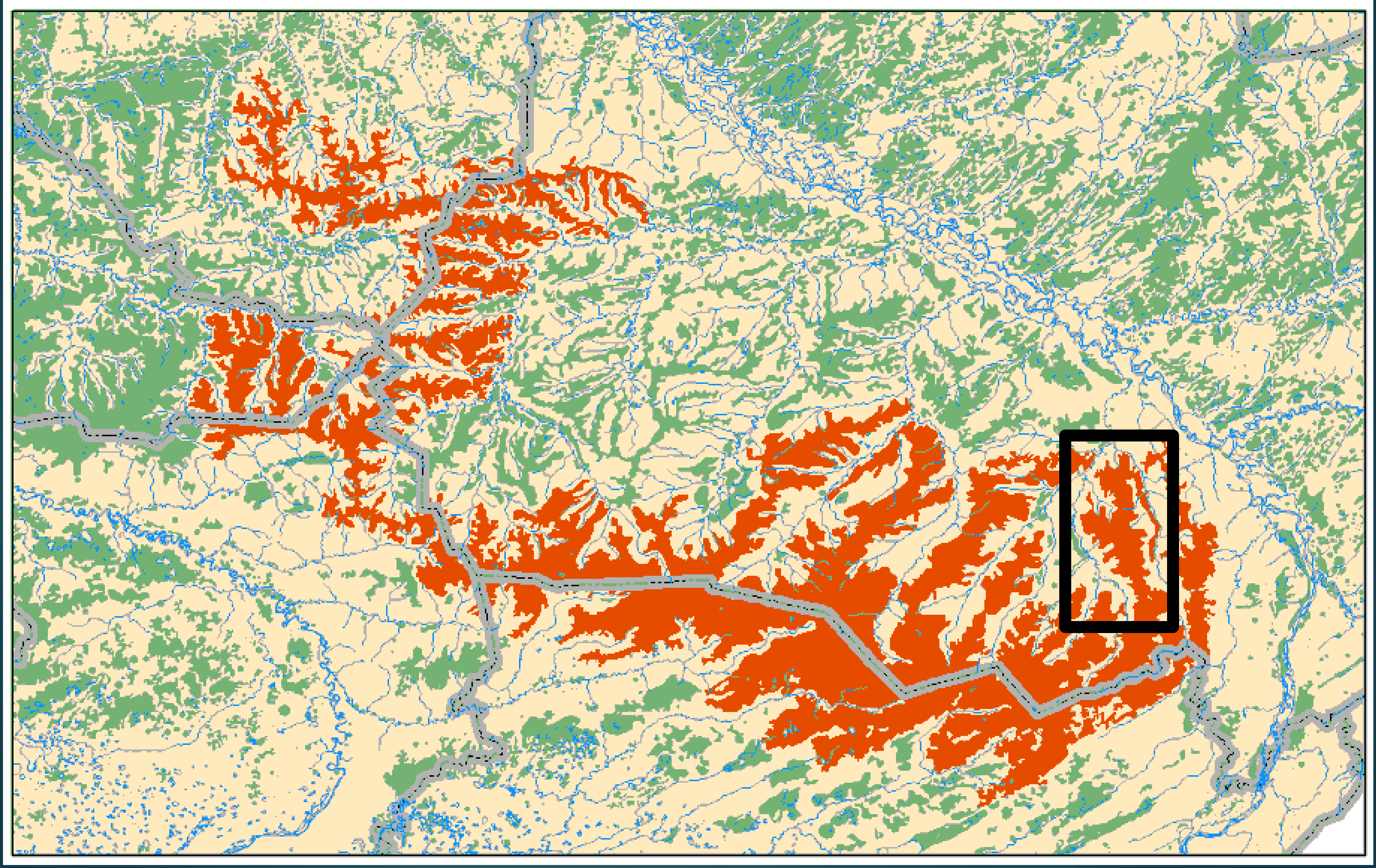
Diurnal flux variations

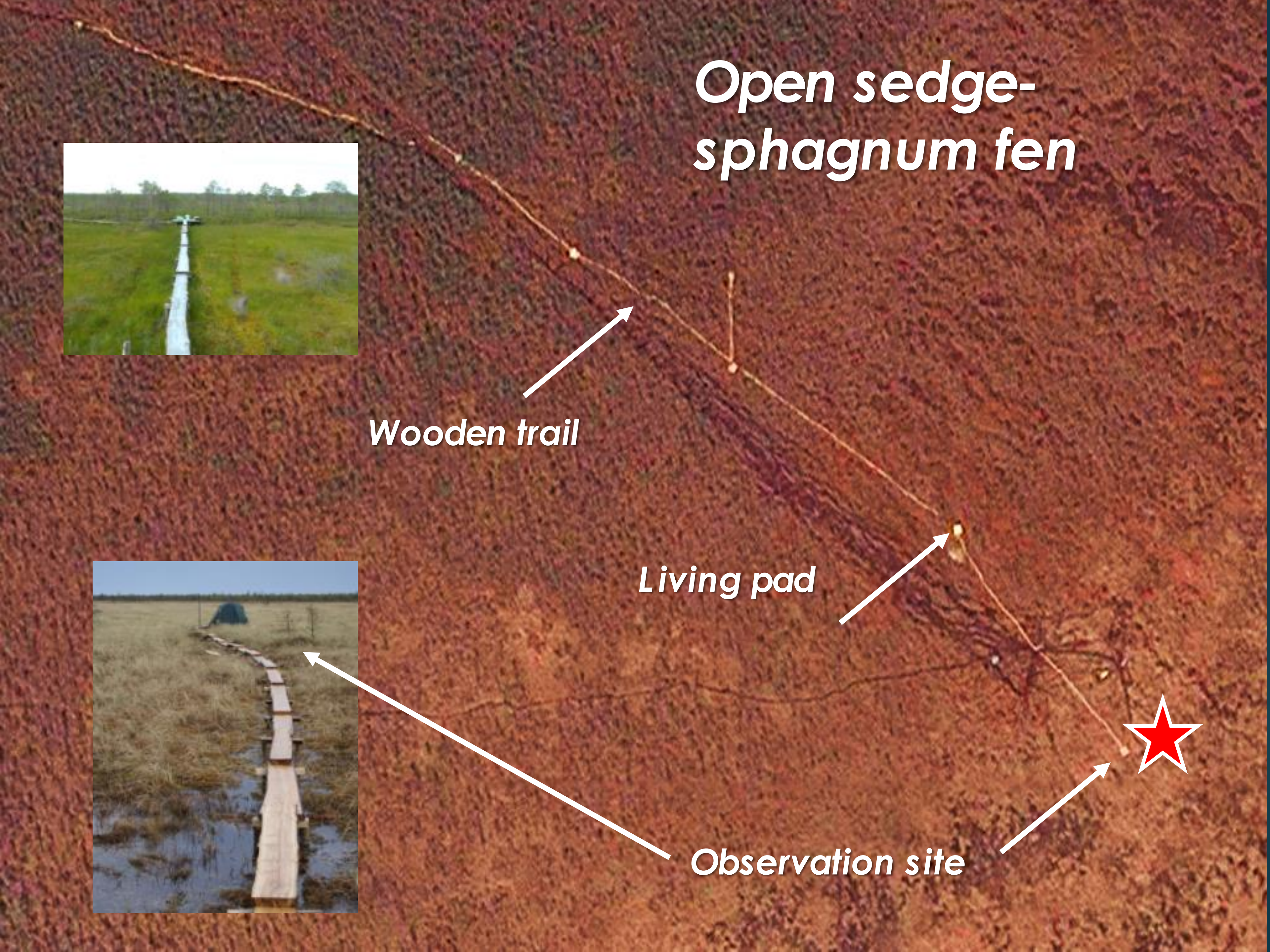


Monthly averaged fluxes

	CO_2 flux, gC/m^2		H_2O flux, mm	
	Hollow	**Ridge**	**Hollow**	**Ridge**
JUN 2017	-27,5	-14,9	9,6	10,2
JUL 2017	-19,8	-3,3	17,0	19,1
AUG 2017	-18,6	7,7	12,3	13,3
JUN 2018	-8,2	5,4	6,4	7,0

Bakchar Bog
IMCES field station – 2005-2011




Open sedge-
sphagnum fen
Wooden trail
Living pad
Observation site

Vegetation and peat surveys

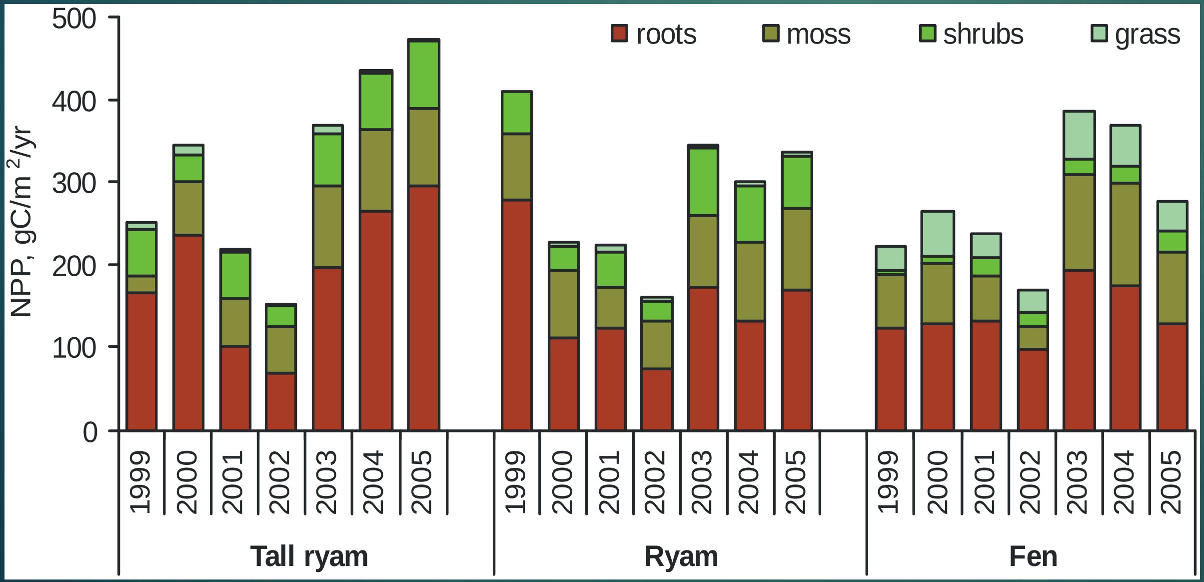
Vegetation productivity

Aboveground biomass (Moss, herbs, shrubs, trees)

Belowground biomass (roots)

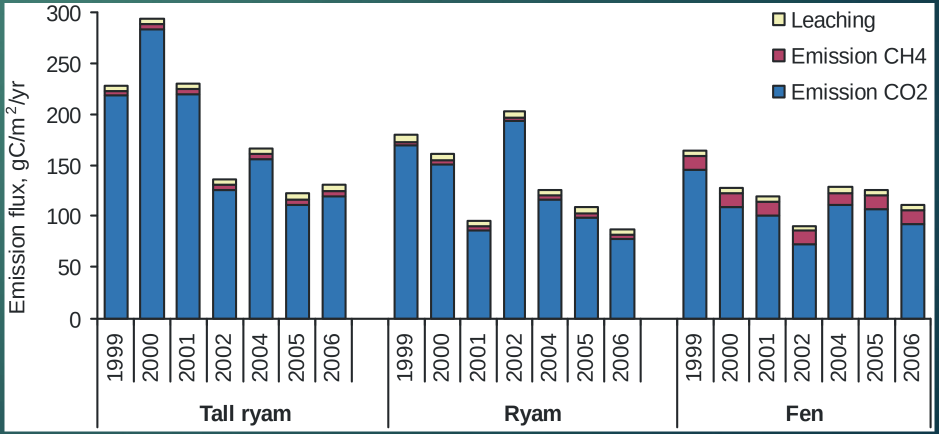
Net primary production (NPP)

Net primary productivity (NPP)



Golovatskaya, Plant and Soil, 2009

Manual dark chamber measurements



Golovatskaya, Plant and Soil, 2009

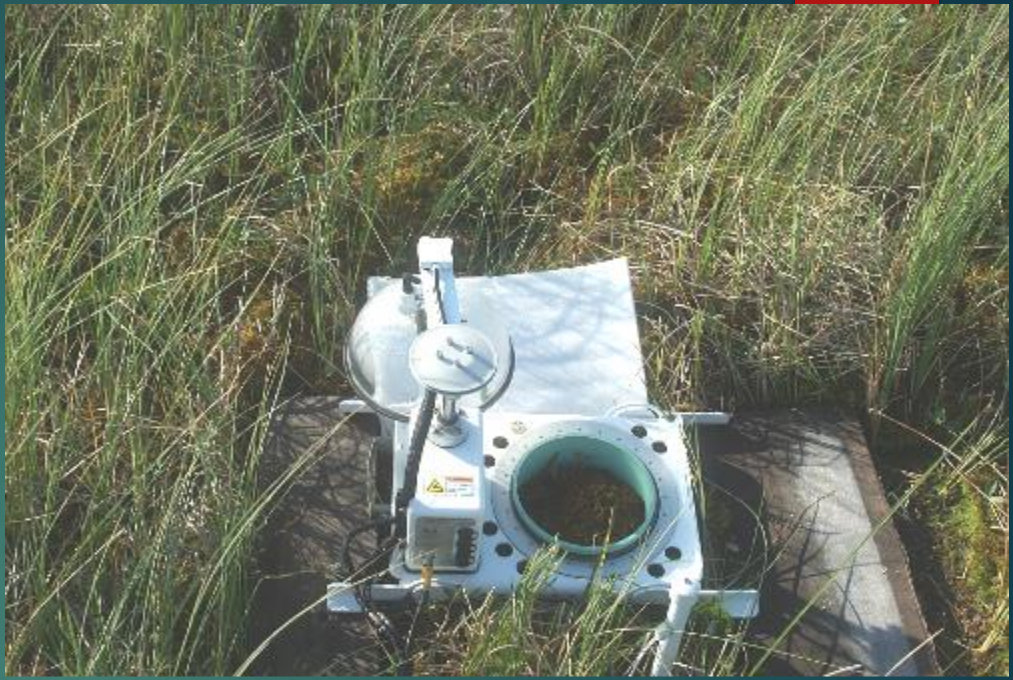
Studied ecosystems

Ridge-hollow complex

Open sedge-sphagnum fen

CO_2 flux measurements

Intense field campaigns
3-5 days per season



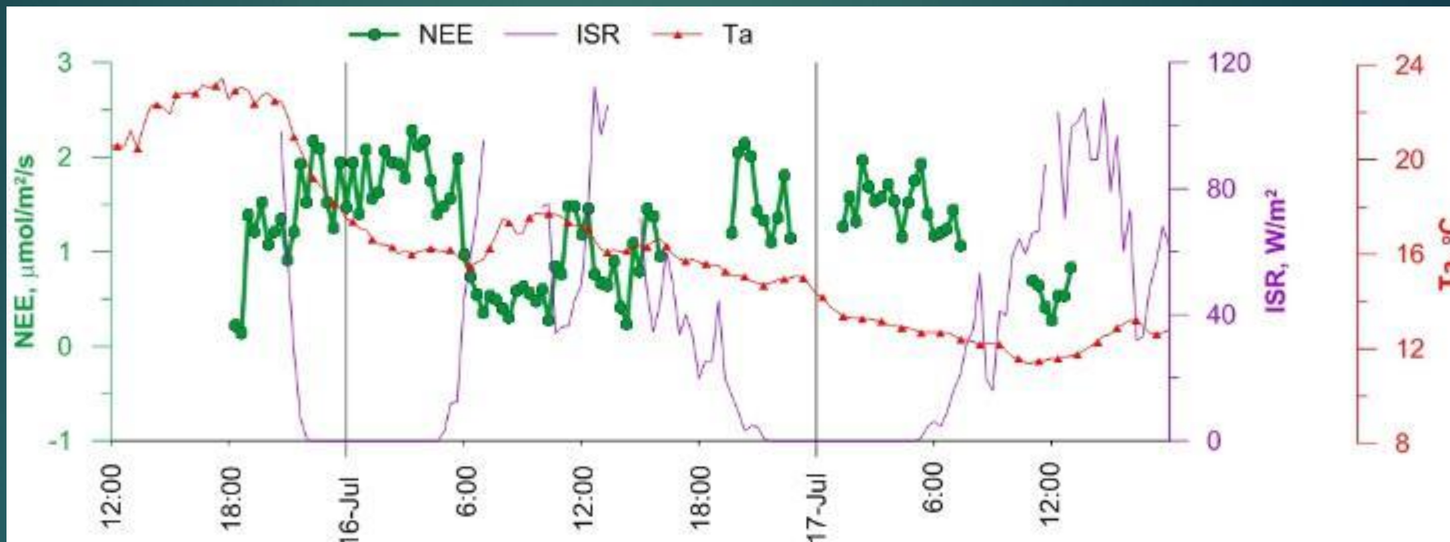
5 minutes exposition
20 minutes repeat

- CO_2 flux
- Air/surface/soil temperature
- Photosynthetic active radiation
- precipitation
- water level

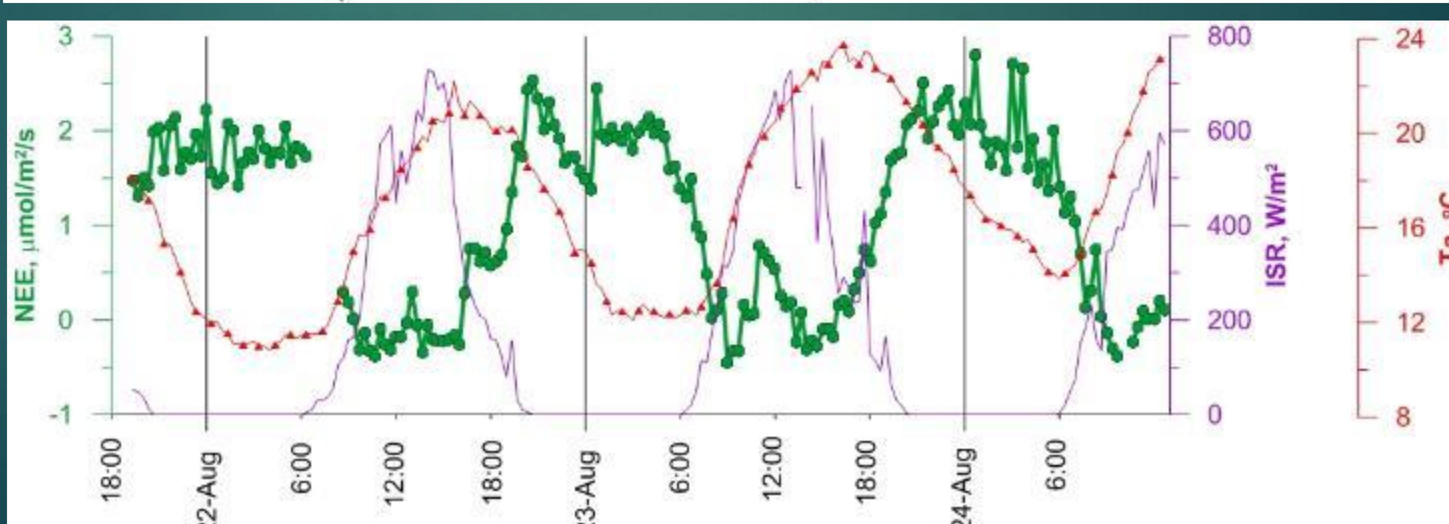
CO_2 fluxes

NEE – net ecosystem exchange
ISR – Incoming solar radiation
Ta – air temperature

July

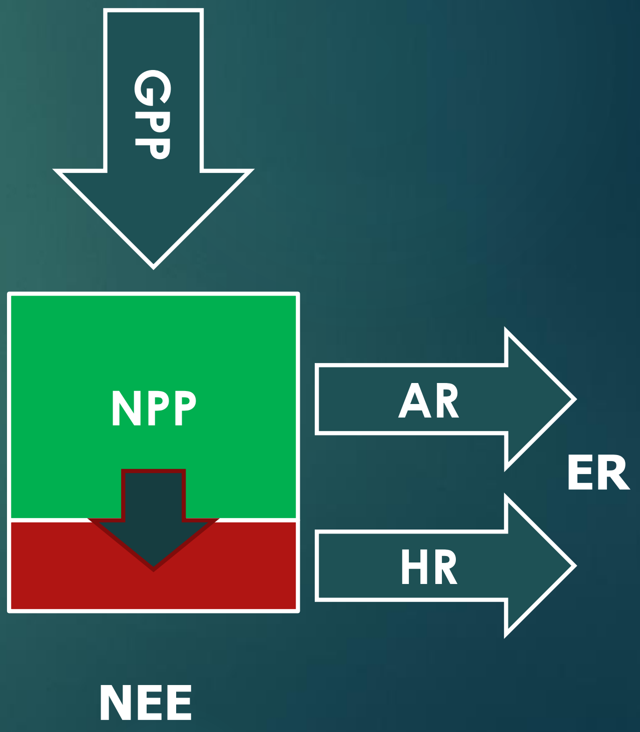


August



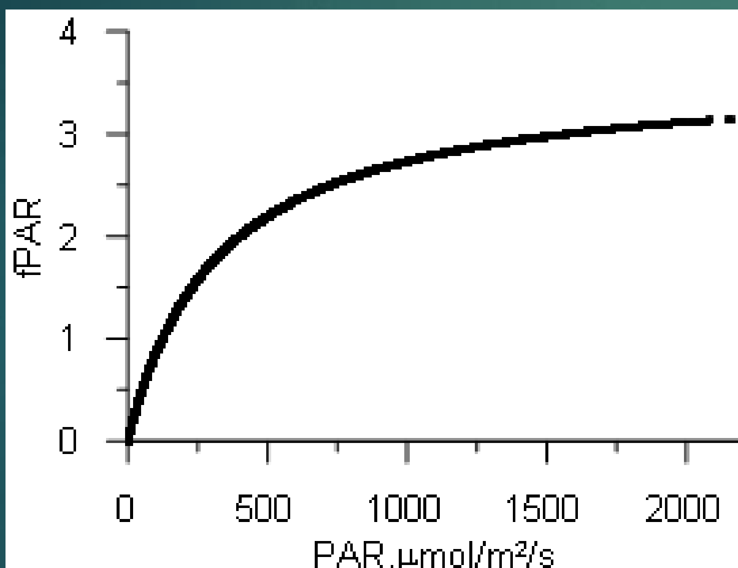
Modelling

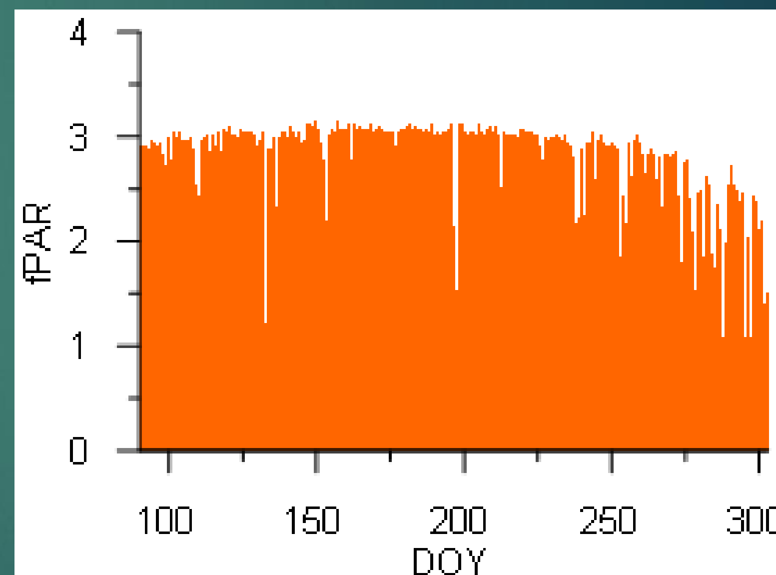
- $NEE = GPP - ER$
- $GPP = LAI \cdot a \cdot PAR \cdot G_m / (a \cdot PAR + G_m)$
- $ER = HR + AR$
  - $HR = E_{HR} \cdot \exp(k_R \cdot T_a)$
  - $AR = LAI \cdot E_{AR} \cdot \exp(k_R \cdot T_a)$
  - $ER = E_R \cdot \exp(k_R \cdot T_a)$
  - $E_R = E_{HR} \cdot (1 + LAI \cdot f_{AR})$
- $NPP = GPP - AR$



Gross primary production

$$GPP = LAI \cdot f_G(PAR)$$
$$f_G(PAR)=a \cdot PAR \cdot G_m / (a \cdot PAR + G_m)$$



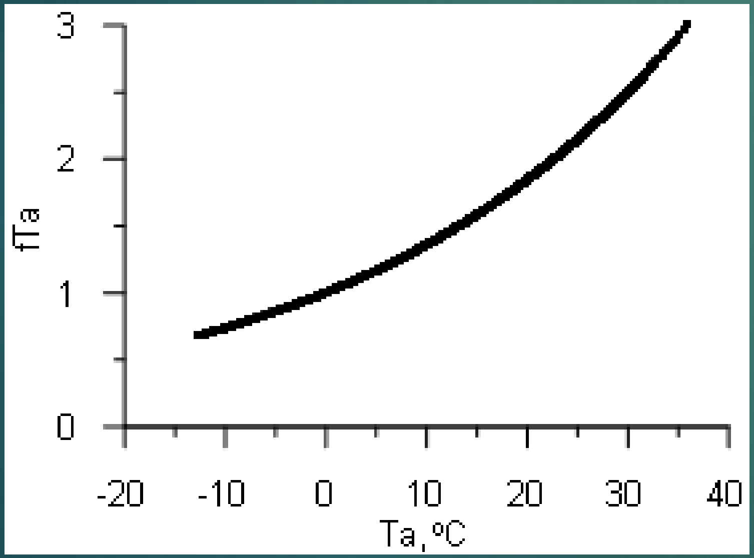


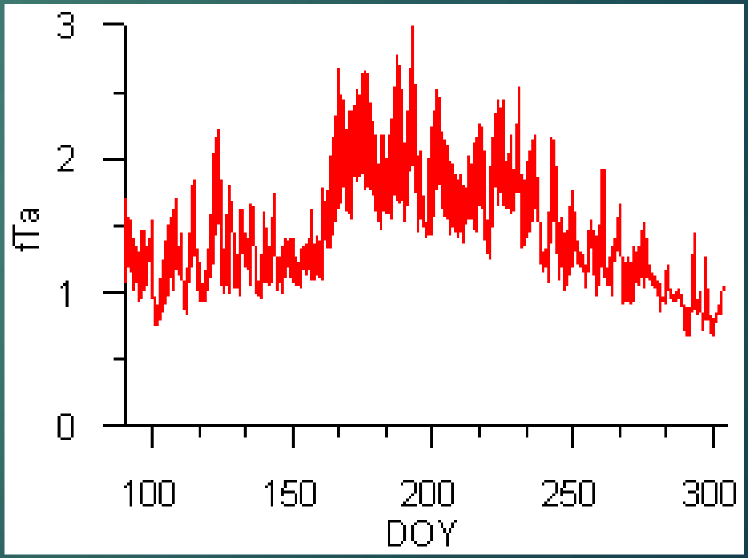
PAR [µмоль м$^{-2}$с$^{-1}$] = k ·ISR [W/m2]

Heterotrophic and autotrophic respiration

$$HR = E_H \cdot \exp(k_H \cdot T_a)$$

$$AR = LAI \cdot E_A \cdot \exp(k_A \cdot T_a)$$





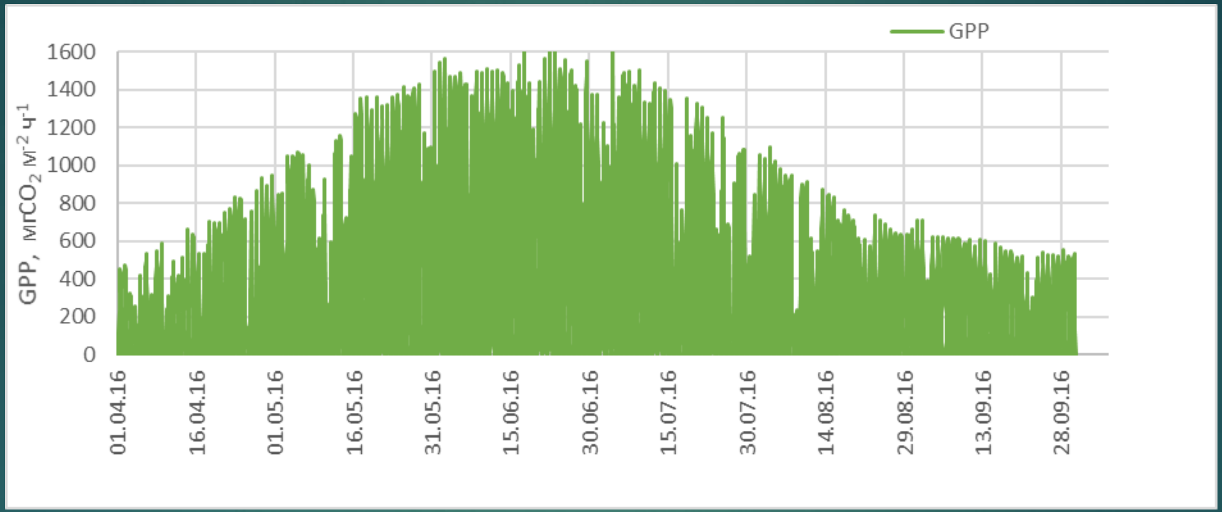
Model calibration

- $GPP = LAI \cdot a \cdot PAR \cdot G_m / (a \cdot PAR + G_m)$
- $ER = HR + AR = E_R \cdot \exp(k_R \cdot T_a)$

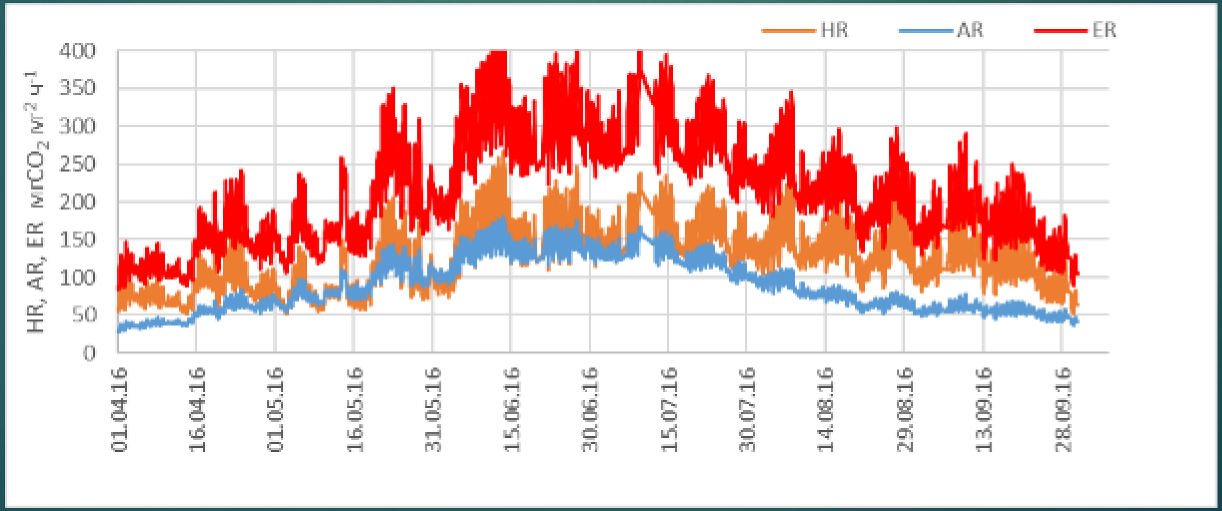
- a, k_R , f_{AR}– from automated chamber experiments
- G_m – from manual NPP vegetation surveys
- E_R – from manual dark chamber experiments

Simulation results - FEN - 2016

GPP

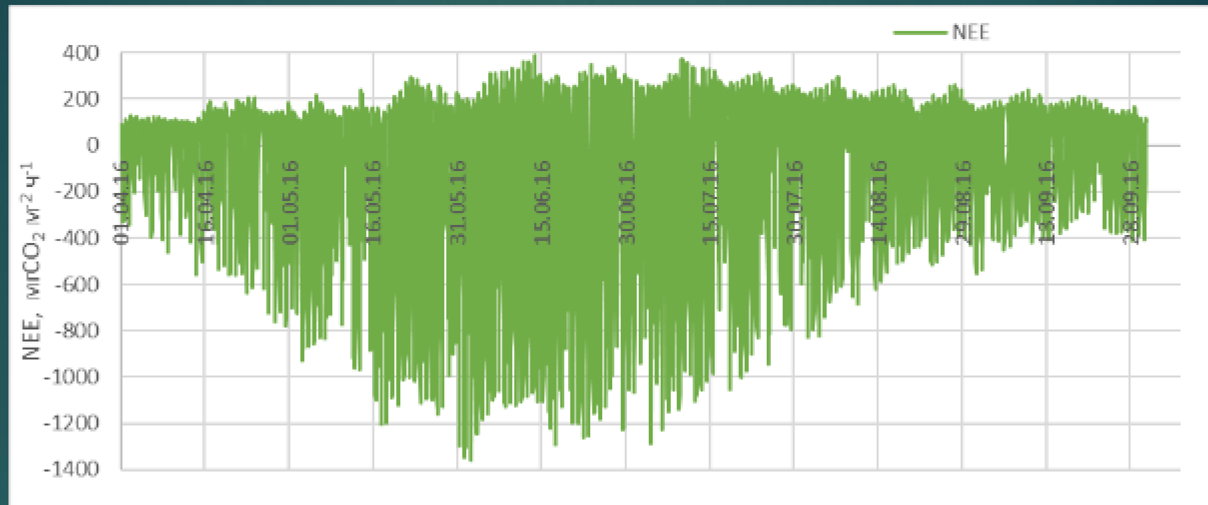


ER
HR
AR



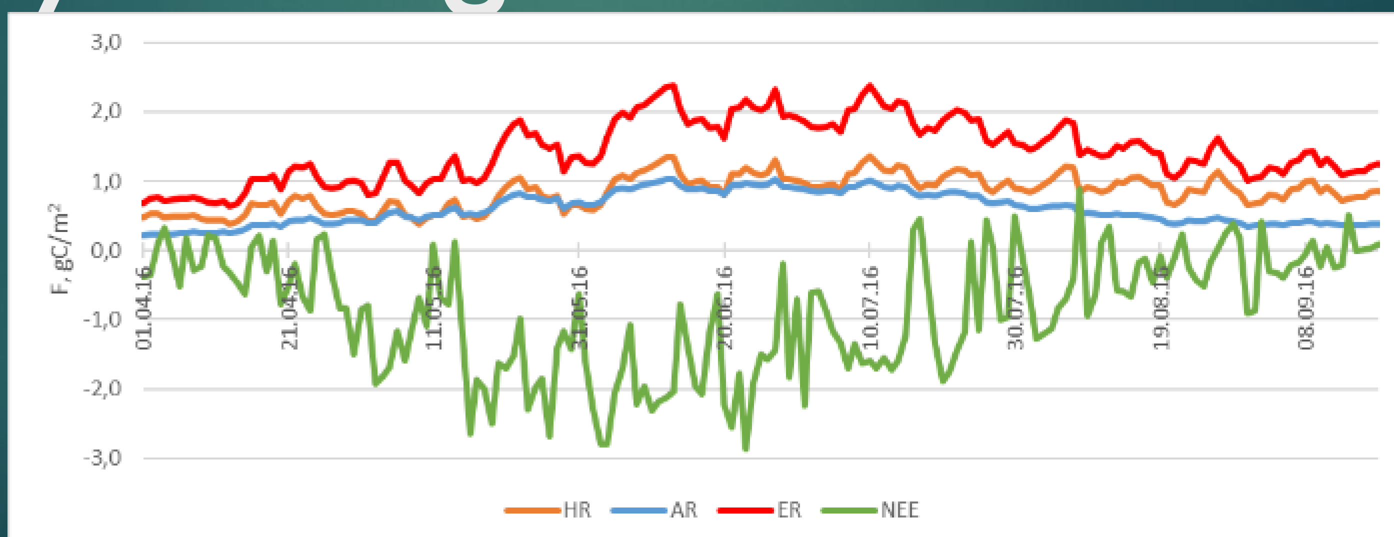
Simulation results - FEN - 2016

NEE

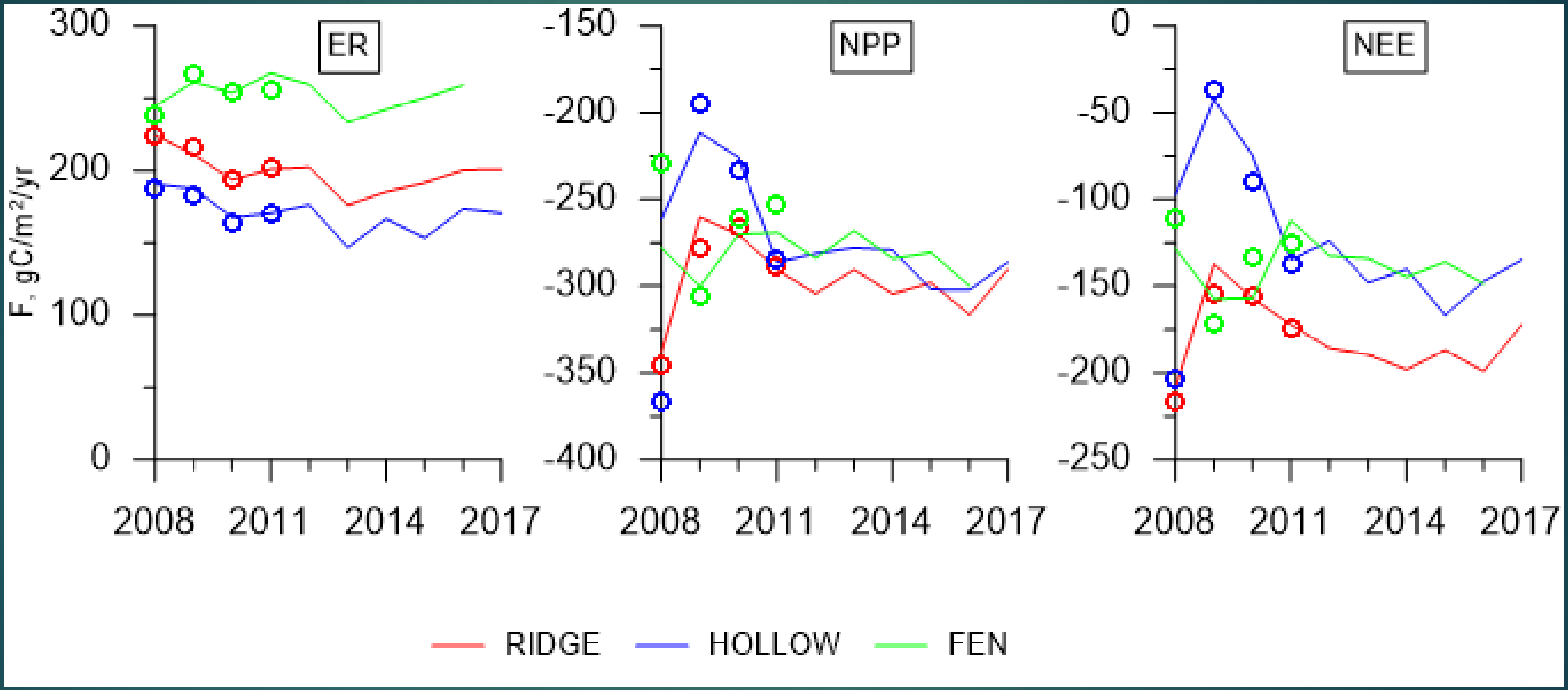


Daily average fluxes

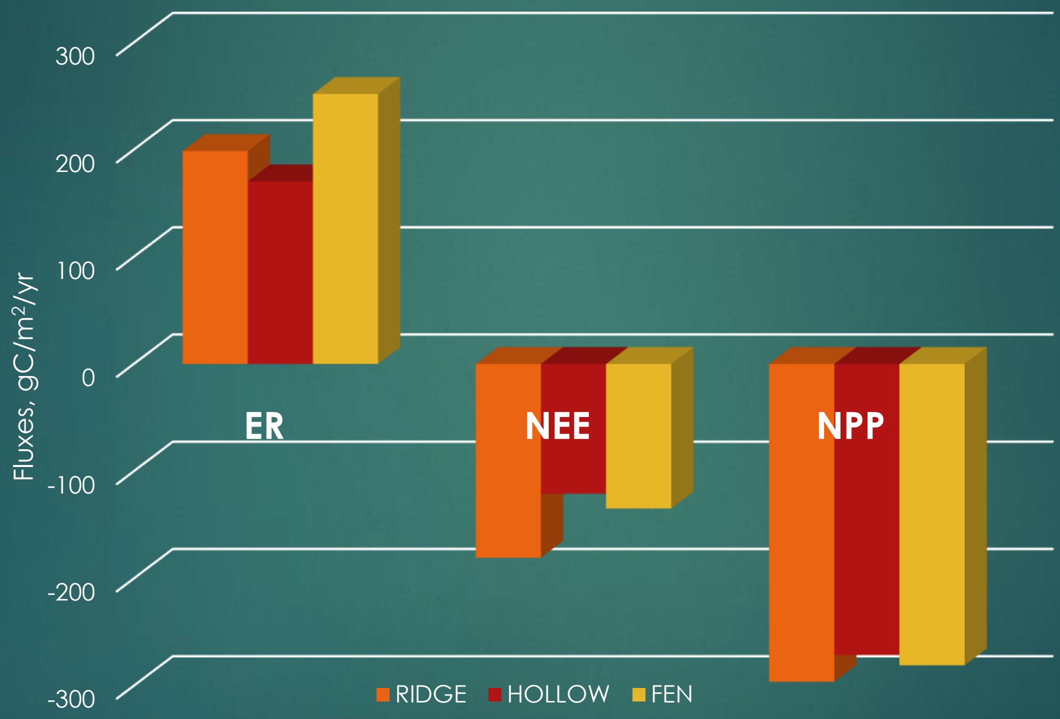
NEE
ER
HR
AR



Yearly variation of fluxes



Annual estimations 2008-2016 (gC m^{-2})



Compare

2017	Bakchar		Mukhrino	
	Hollow	Ridge	Hollow	Ridge
GPP	-373,3	-305,2		
AR	82,0	18,9		
HR	118,1	151,6		
ER	201,0	170,5		
NEE	-172,3	-134,7	-121,6	-86,4
NPP	-290,4	-286,3		

Thank you for your attention

**Исследование выполнено при поддержке средств гранта на создание ведущих научных школ
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