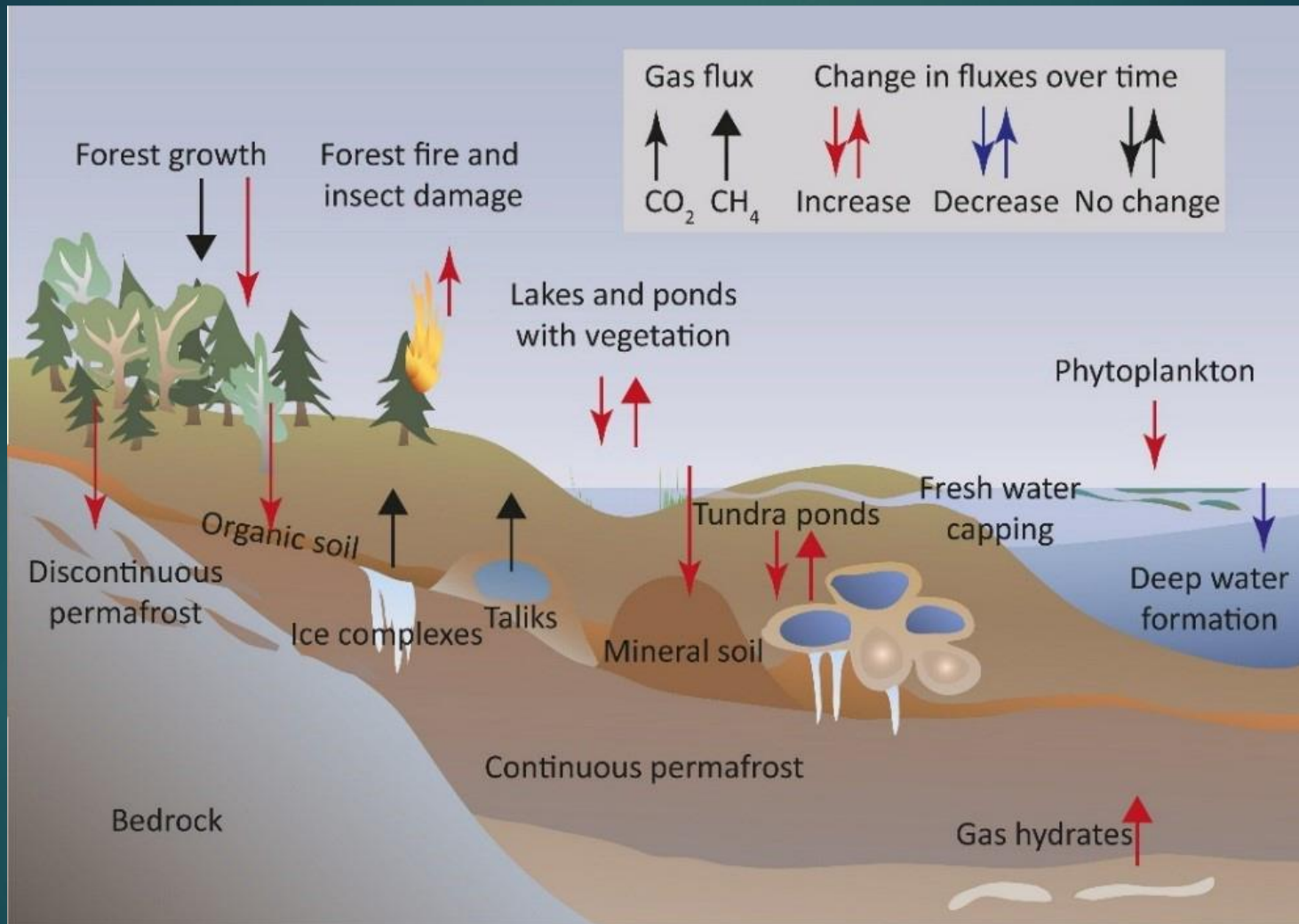




Modeling of the net ecosystem exchange, gross primary production and ecosystem respiration for peatland ecosystems of West Siberia

DYUKAREV E.A., LAPSHINA E.D., GOLOVATSKAYA E.A.,
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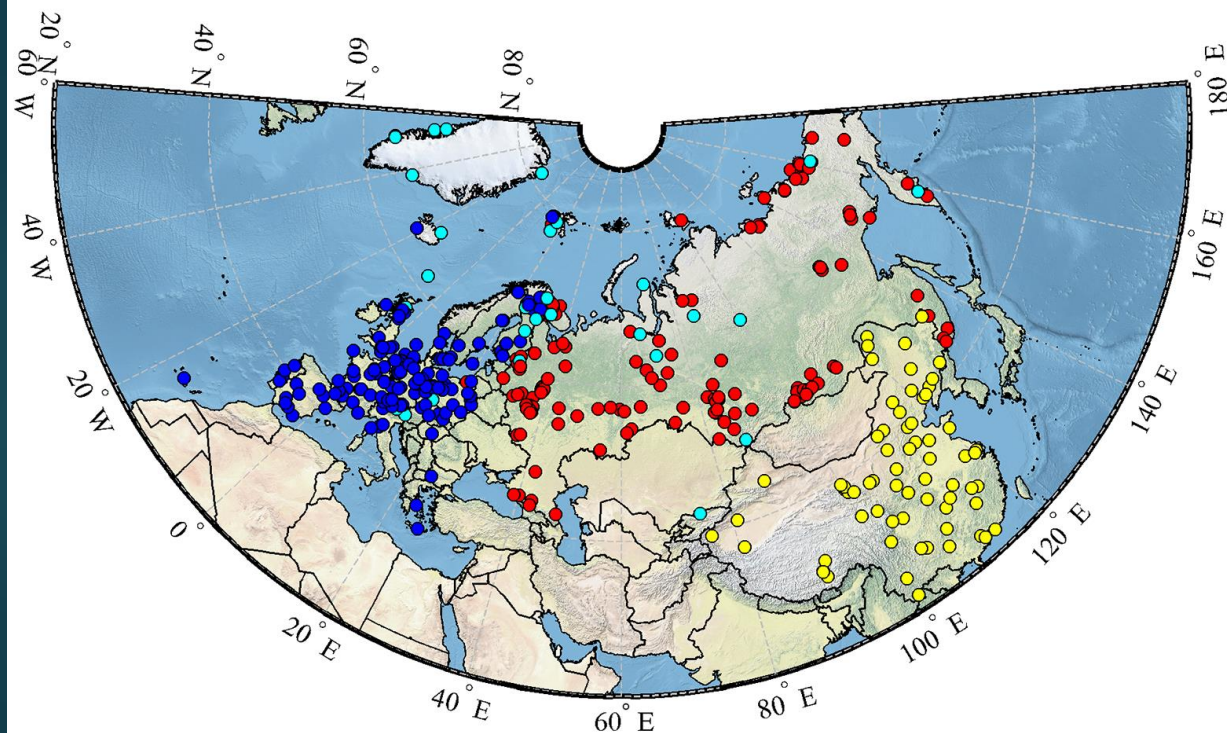
Carbon cycling in the Arctic will change as the climate warms. Figure after ACIA, 2004 (Arctic Climate Impact Assessment, 2004).

Atmos. Chem. Phys., 16, 14421–14461, 2016
www.atmos-chem-phys.net/16/14421/2016/
doi:10.5194/acp-16-14421-2016
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Atmospheric
Chemistry
and Physics
EGU

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

- Sites in Russia (172)
- Sites in China (75)
- ACTRIS and ICOS sites (160)
- INTERACT sites (33)



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)

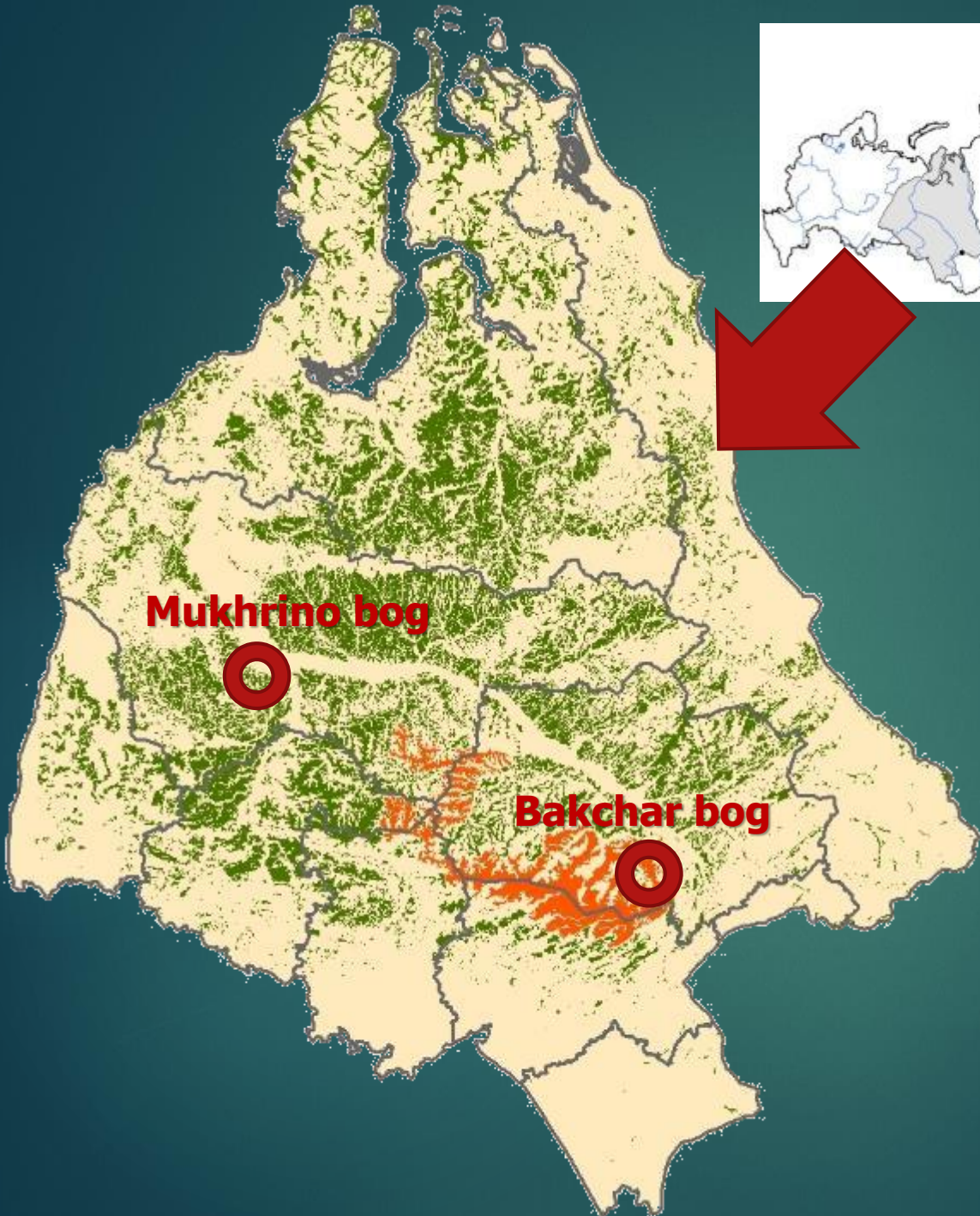


West Siberia peatlands

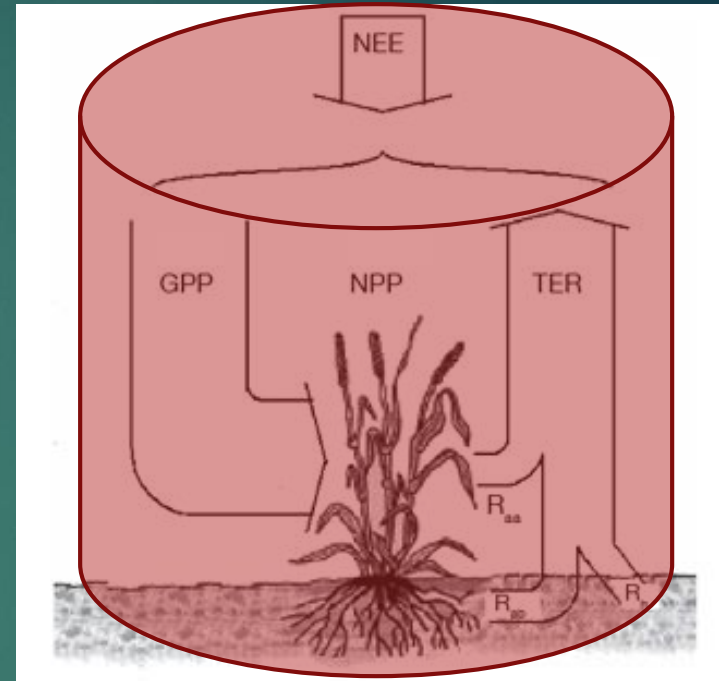
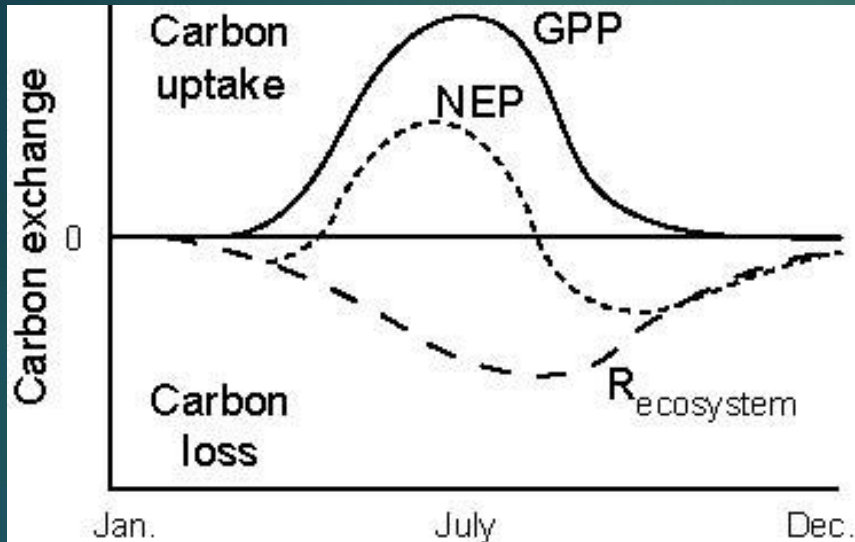
Total area
- 592 440 km²,

Peat storages
- 148 Pg

Carbon storages
- 70 pg C



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



$$\text{NEE} = \text{ER} - \text{GPP}$$

$$\text{ER} = \text{AR} + \text{HR}$$

$$\text{NPP} = \text{GPP} - \text{HR}$$

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 FIELD STATION RESEARCH SITE EQUIPMENT

Field station house
The research site is located in the ecosystem of a raised bog and covers different community types from a tree bog to open Sphagnum bogs and pools. The polygon is equipped with a 7.5 km long wooden boardwalk path, making access to the monitoring equipment convenient and not destructive. The system of alternative energy supply (solar panels and wind generator), located in the central part of the site and provides energy for research equipment, internet plate and the living house.

Hydrological point
Hydrological point (Piezometer) is used for monitoring of water level in the bog. Measurements are performed by hydrological equipment.

Air, soil temperature and snow depth logger
Automatic air, soil and snow depth logger is used for monitoring of air, soil and snow depth. Measurements are performed by automatic equipment.

Piezometer
Piezometer is used for monitoring of water level in the bog. Measurements are performed by piezometer.

Open Top Chambers site
The experiment is also for studying ecosystem response to climate change. The chambers are used for monitoring of CO₂ fluxes. Water table is raised and lowered by 10 cm. The chambers are used for monitoring of CO₂ fluxes.

Lysimeter
Lysimeter is used for monitoring of water fluxes in the soil. Measurements are performed by lysimeter.

Satellite Internet plate
A satellite internet plate is used for providing internet connection to the research site. The plate is used for providing internet connection to the research site.

Alternative energy complex
Alternative energy complex is used for providing alternative energy to the research site. The complex is used for providing alternative energy to the research site.

Manual and automatic rain gauges
Manual and automatic rain gauges are used for monitoring of precipitation. Measurements are performed by manual and automatic rain gauges.

Manual weather station
Manual weather station is used for monitoring of weather conditions. Measurements are performed by manual weather station.

Automatic chamber CO₂ emission
Automatic chamber CO₂ emission is used for monitoring of CO₂ emission. Measurements are performed by automatic chamber CO₂ emission.

Automatic weather station
Automatic weather station is used for monitoring of weather conditions. Measurements are performed by automatic weather station.

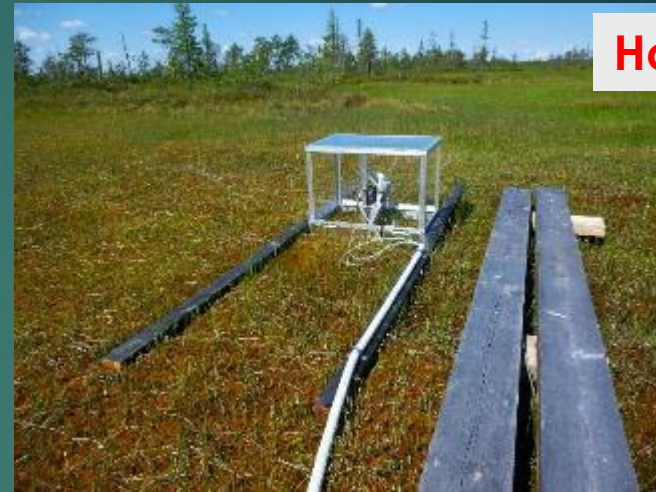
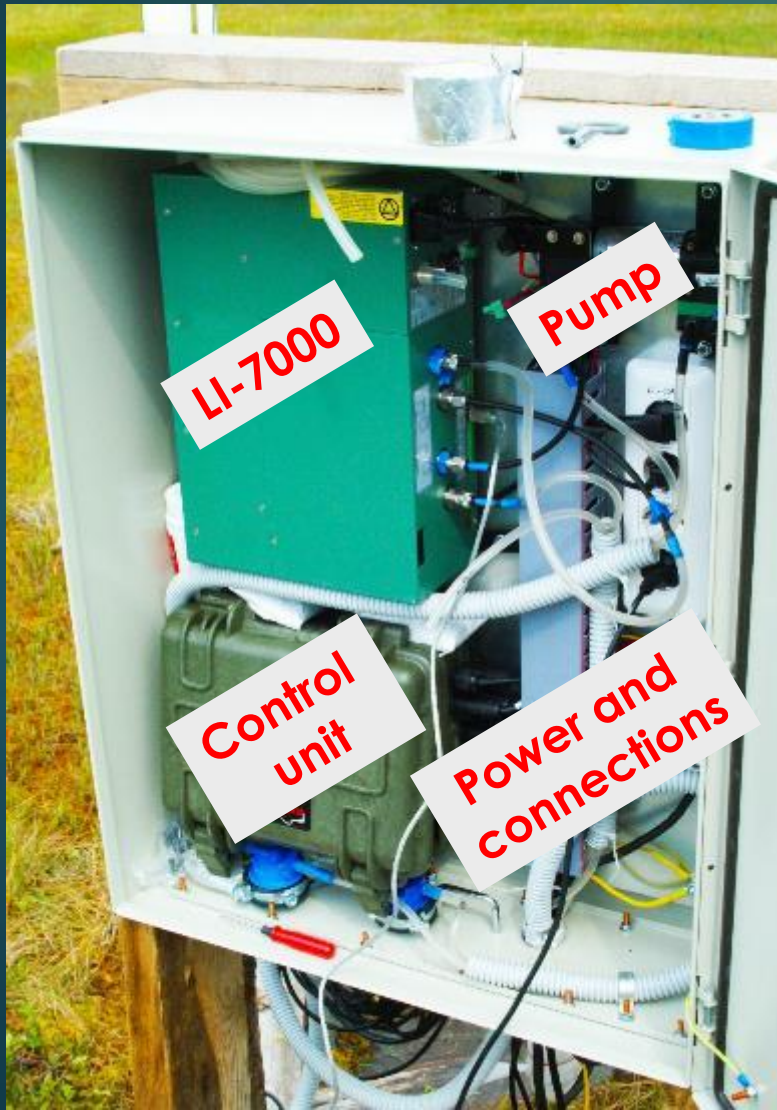
Eddy covariance tower
Eddy covariance tower is used for monitoring of eddy covariance. Measurements are performed by eddy covariance tower.

Research site equipment
The research site is equipped with various equipment for monitoring of environmental parameters. Measurements are performed by research site equipment.

Mukhrino Bog LICOR 7000-ACC2



7



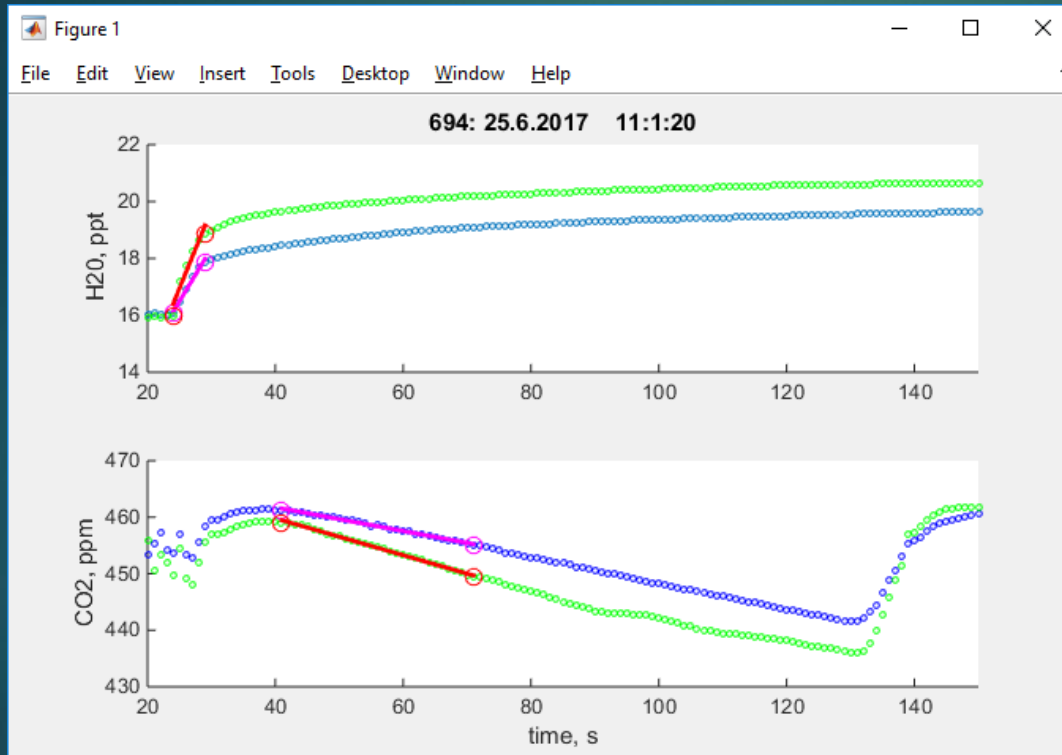
Hollow



Ridge

Flux estimation

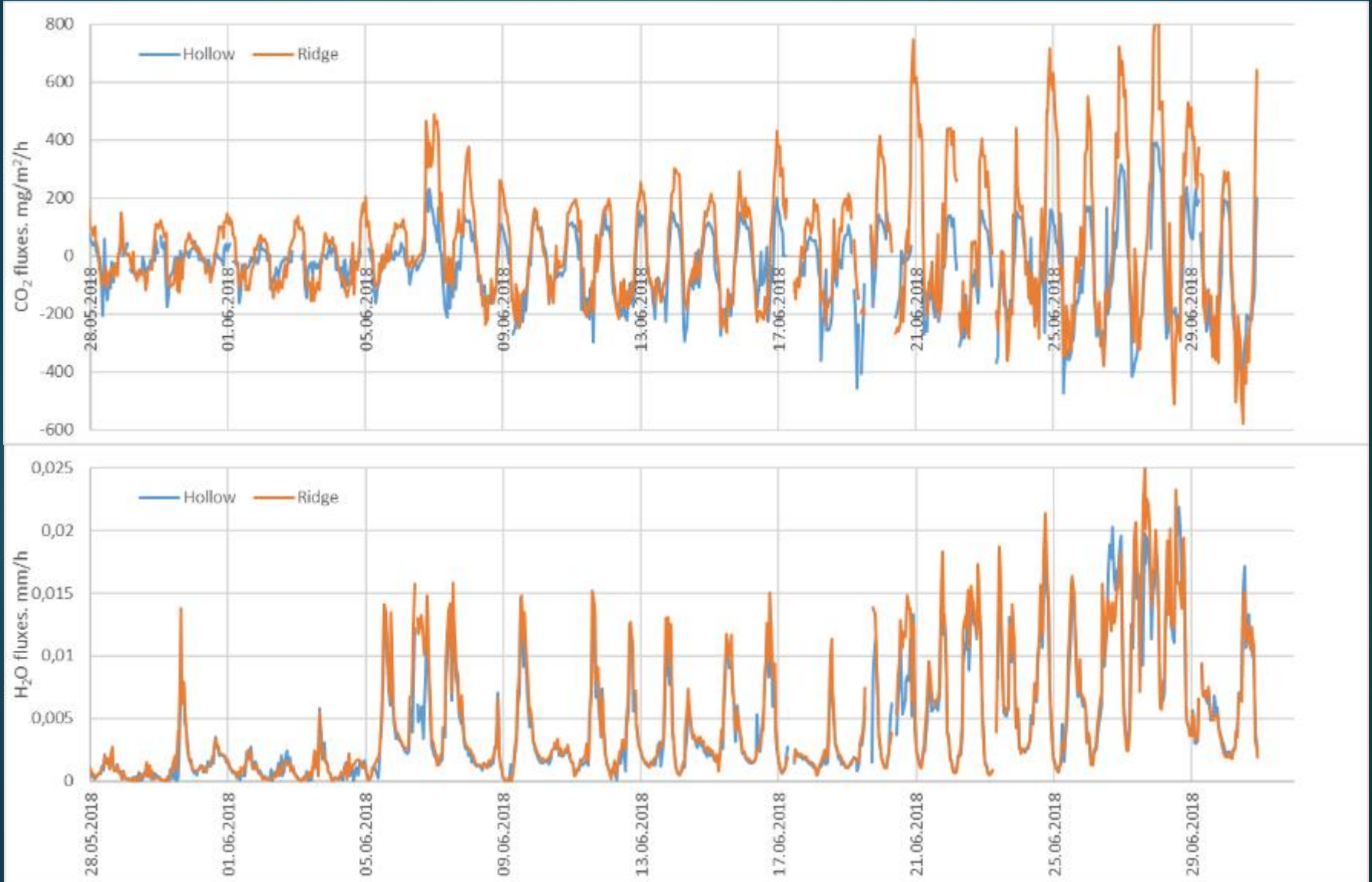
5 minutes exposition
1 hr repeat



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



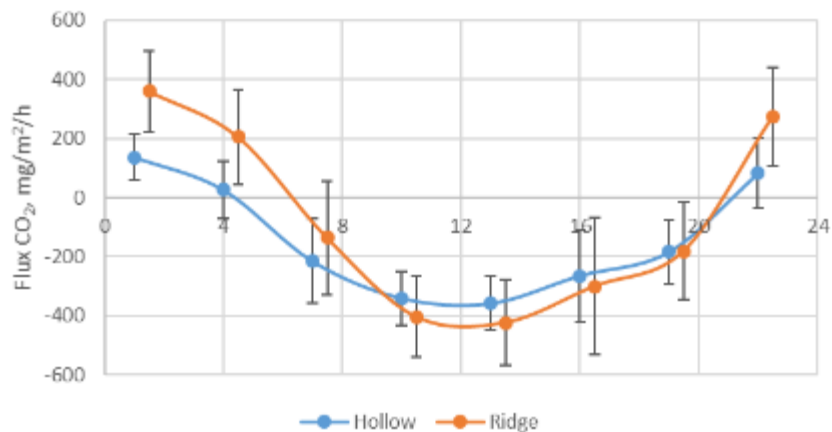
CO₂ and H₂O fluxes (2018)



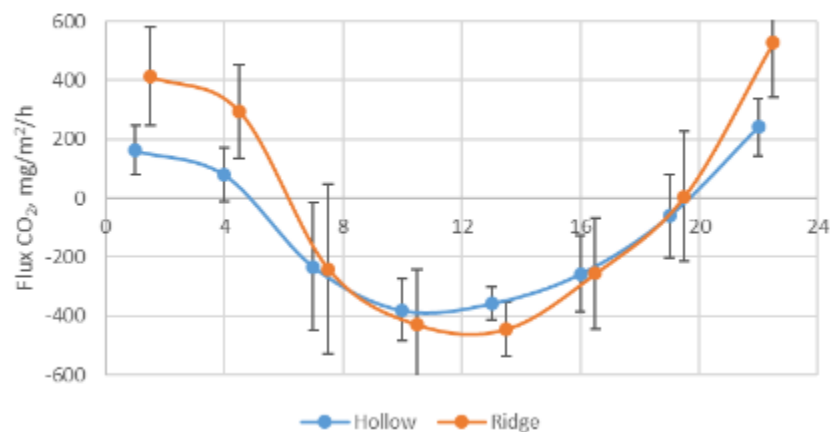
Diurnal flux variations

10

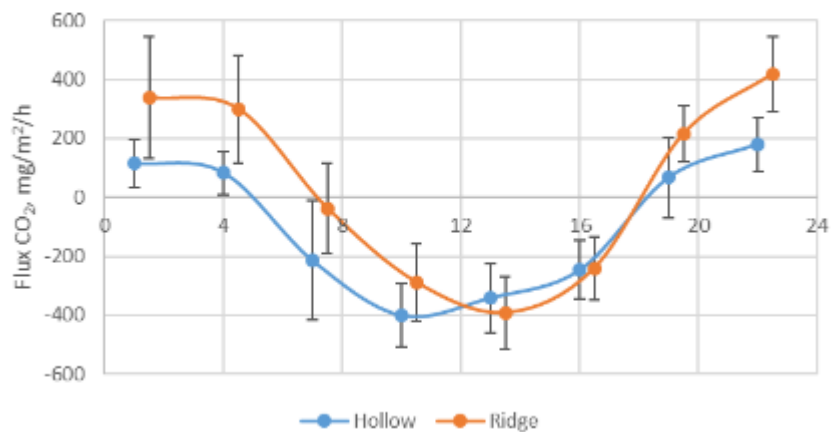
JUN 2017



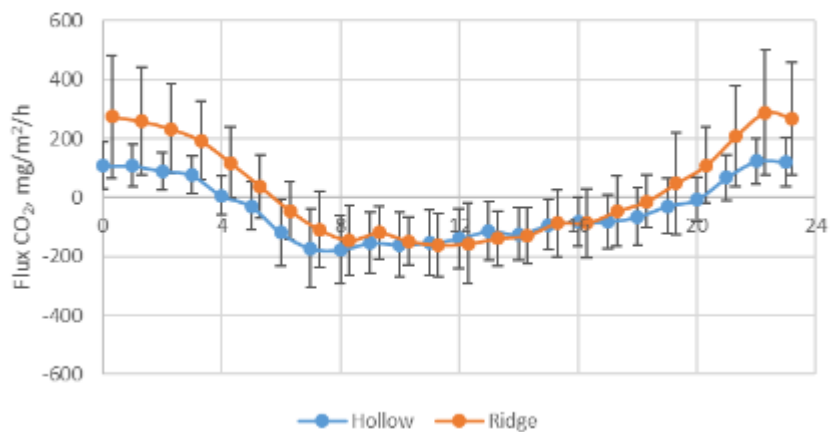
JUL 2017



AUG 2017



JUN 2018



Monthly averaged fluxes

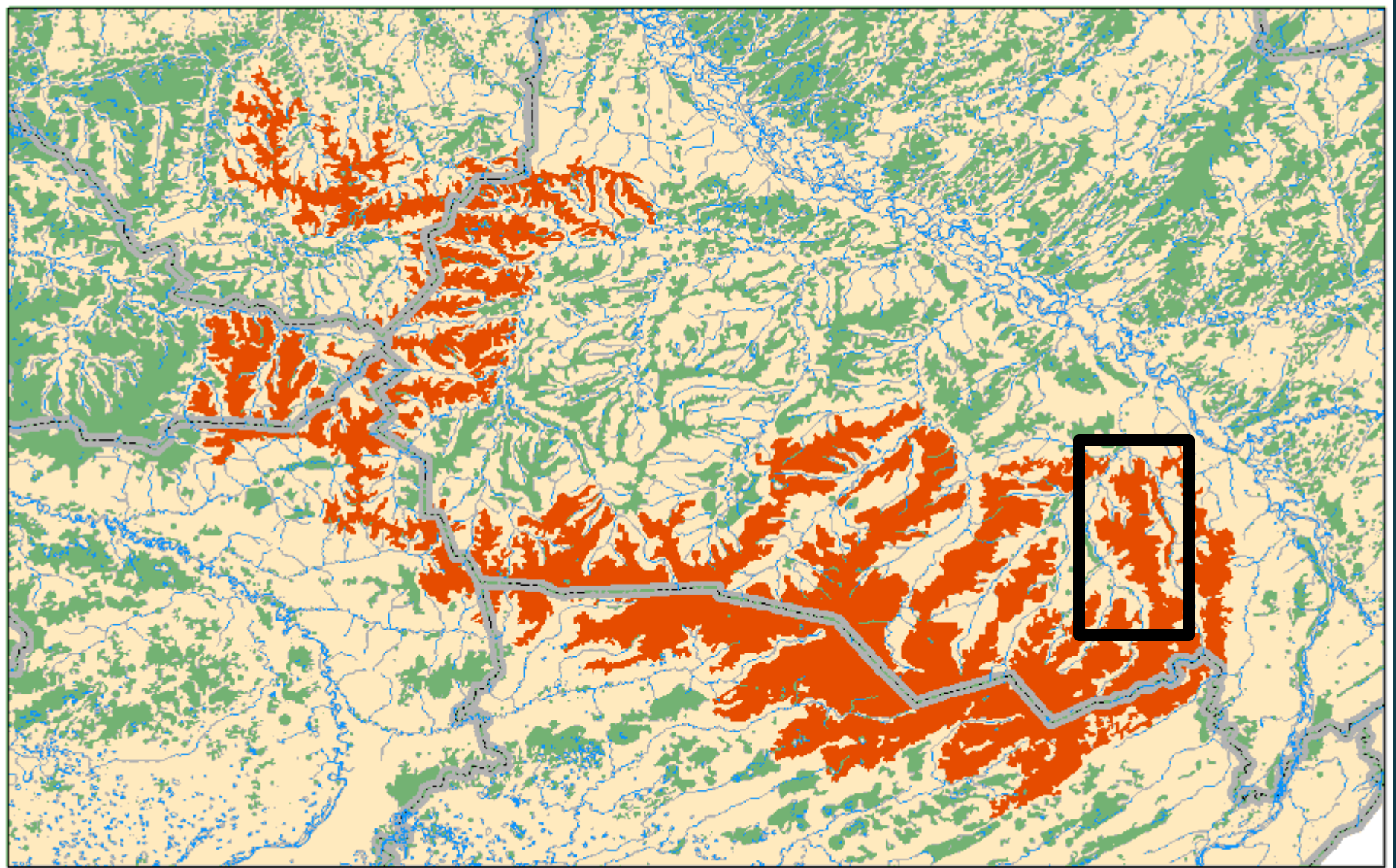
11

	CO ₂ flux, gC/m ²		H ₂ O 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

12



Open sedge-sphagnum fen



Wooden trail

Living pad



Observation site



Vegetation and peat surveys

Vegetation productivity

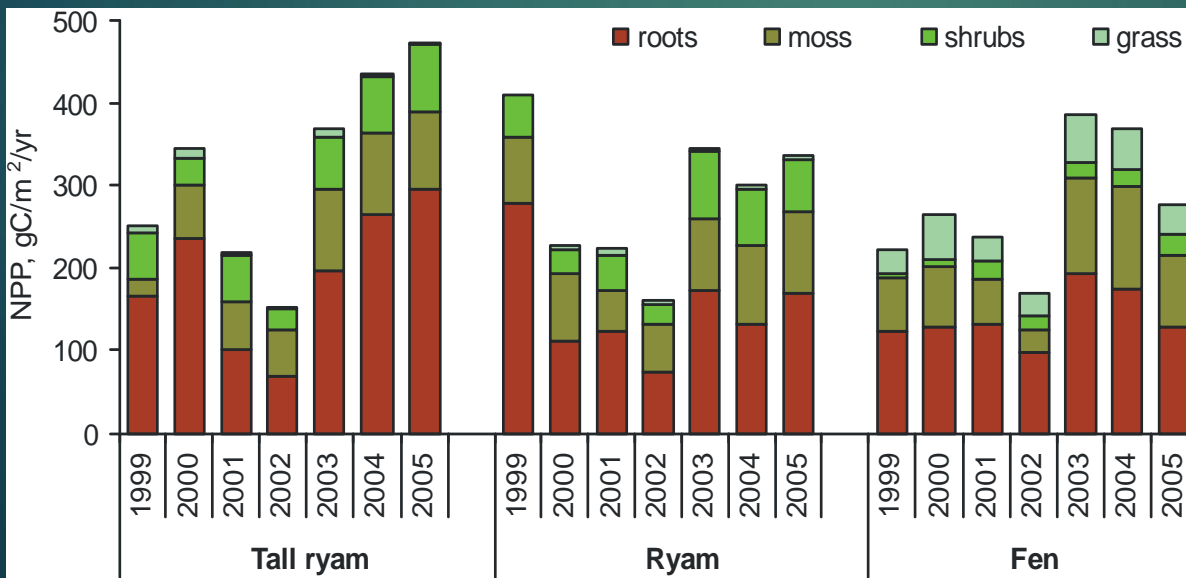
Aboveground biomass (Moss, herbs, shrubs, trees)

Belowground biomass (roots)

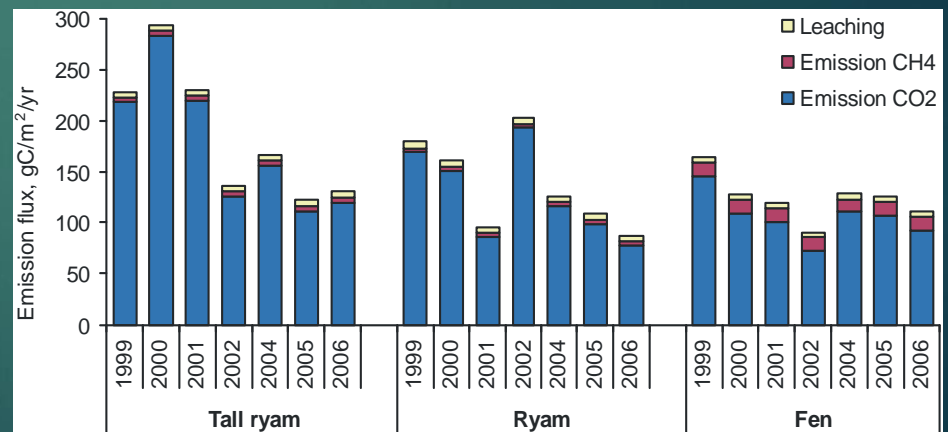
Net primary production (NPP)



Net primary productivity (NPP)



Manual dark chamber measurements



Studied ecosystems

Ridge-hollow complex



Open sedge-sphagnum fen

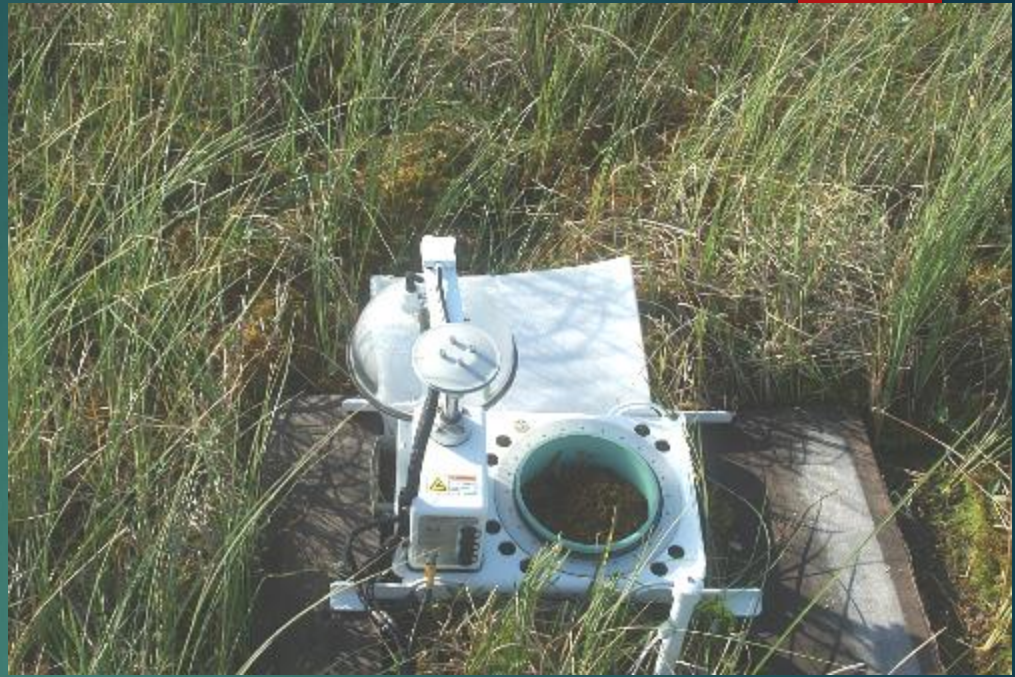


CO₂ flux measurements

Intense field campaigns
3-5 days per season

5 minutes exposition
20 minutes repeat

- CO₂ flux
- Air/surface/soil temperature
- Photosynthetic active radiation
- precipitation
- water level



CO₂ fluxes

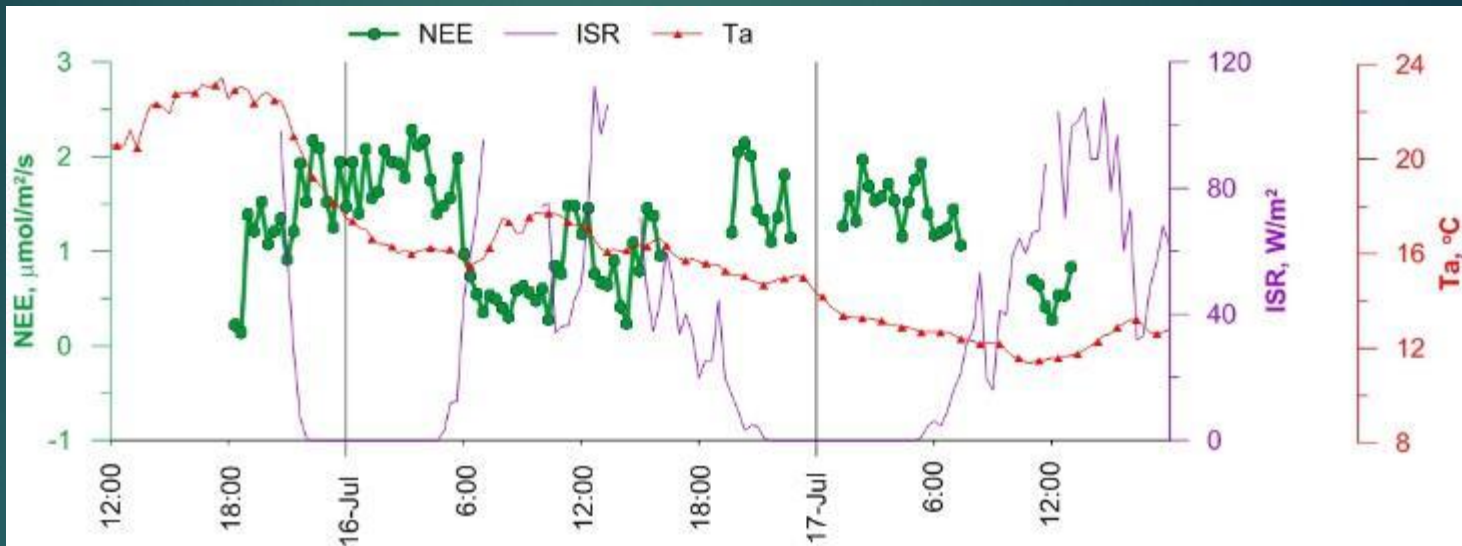
NEE – net ecosystem exchange

ISR – Incoming solar radiation

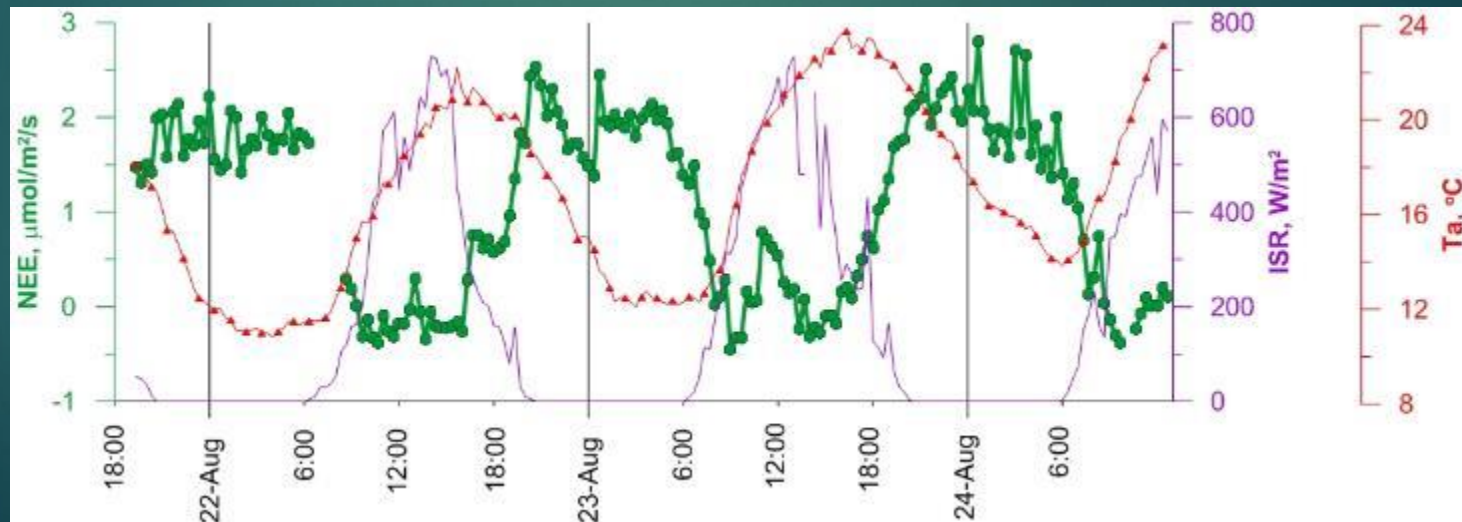
Ta – air temperature

18

July



August



Modelling

▶ $NEE = GPP - ER$

▶ $GPP = LAI \cdot \alpha \cdot PAR \cdot G_m / (\alpha \cdot PAR + G_m)$

▶ $ER = HR + AR$

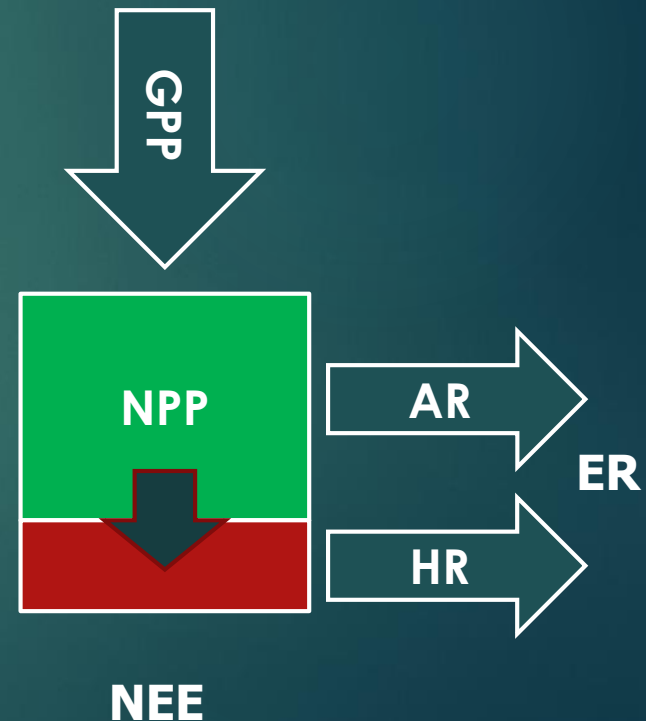
▶ $HR = E_{HR} \cdot \exp(k_R \cdot T_a)$

▶ $AR = LAI \cdot E_{AR} \cdot \exp(k_R \cdot T_a)$

▶ $ER = E_R \cdot \exp(k_R \cdot T_a)$

▶ $E_R = E_{HR} \cdot (1 + LAI \cdot f_{AR})$

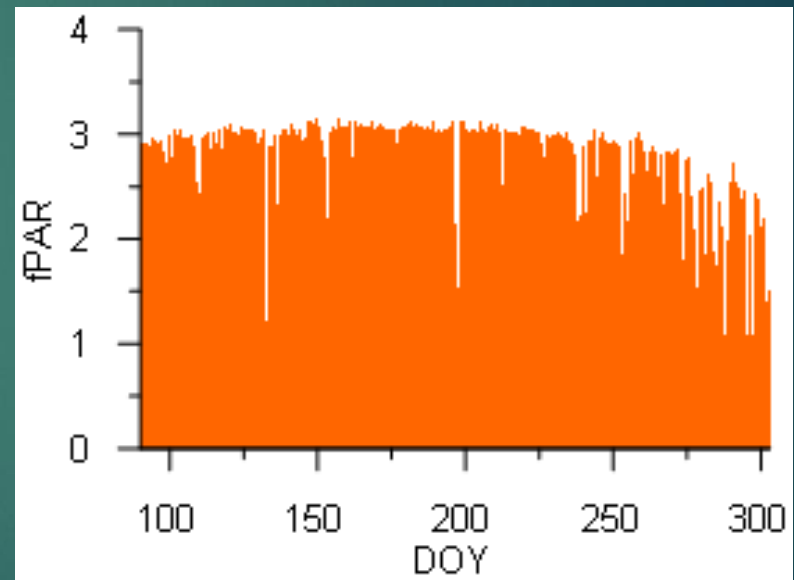
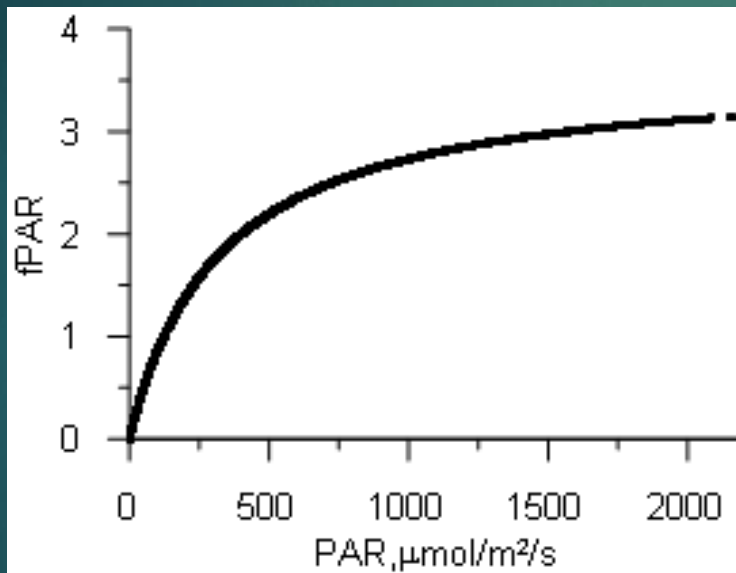
▶ $NPP = GPP - AR$



Gross primary production

20

$$GPP = LAI \cdot f_G(\text{PAR})$$
$$f_G(\text{PAR}) = \alpha \cdot \text{PAR} \cdot G_m / (\alpha \cdot \text{PAR} + G_m)$$



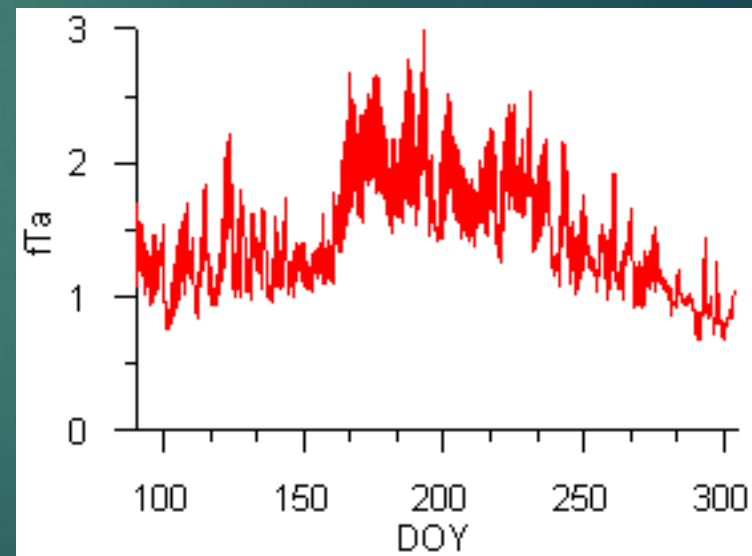
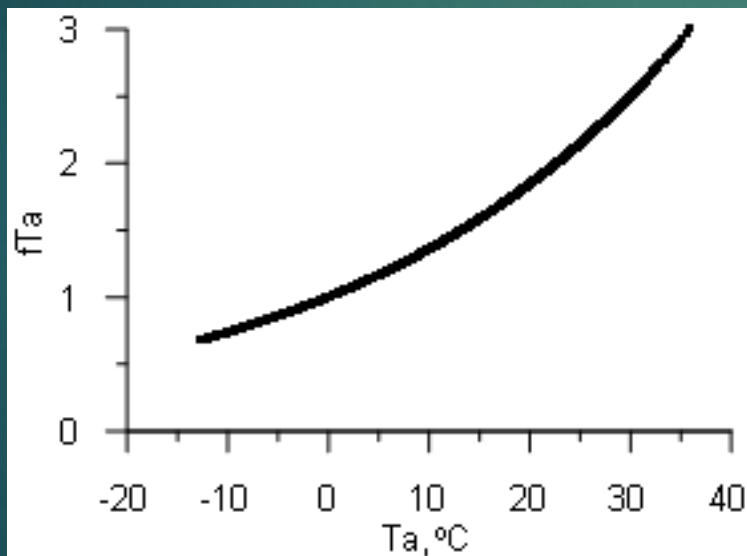
$$\text{PAR} [\mu\text{mol} \cdot \text{m}^{-2} \cdot \text{s}^{-1}] = k \cdot \text{ISR} [\text{W}/\text{m}^2]$$

Heterotrophic and autotrophic respiration

21

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

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



Model calibration

▶ $GPP = LAI \cdot \alpha \cdot PAR \cdot G_m / (\alpha \cdot PAR + G_m)$

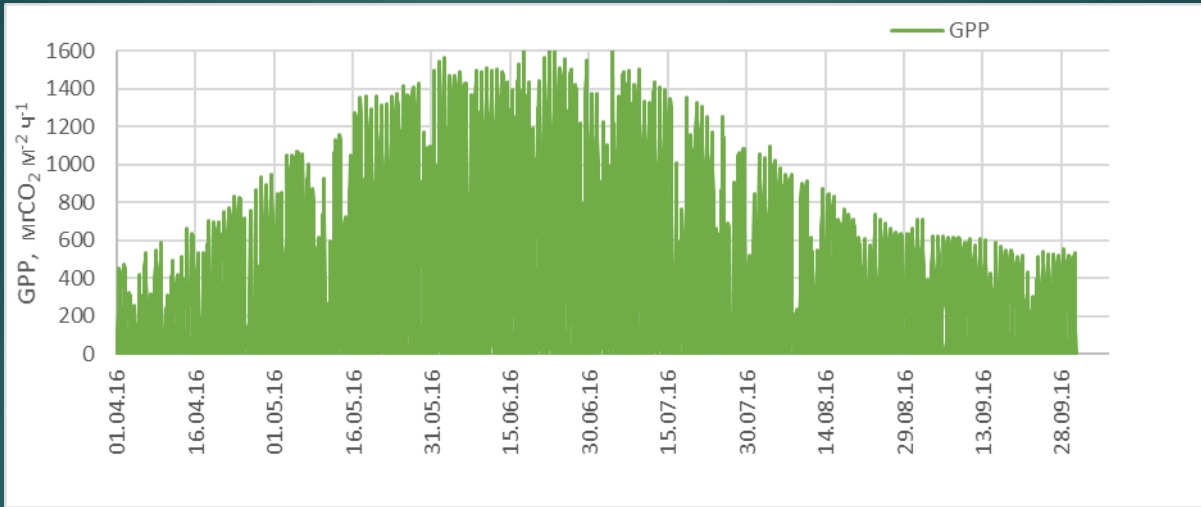
▶ $ER = HR + AR = E_R \cdot \exp(k_R \cdot T_a)$

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

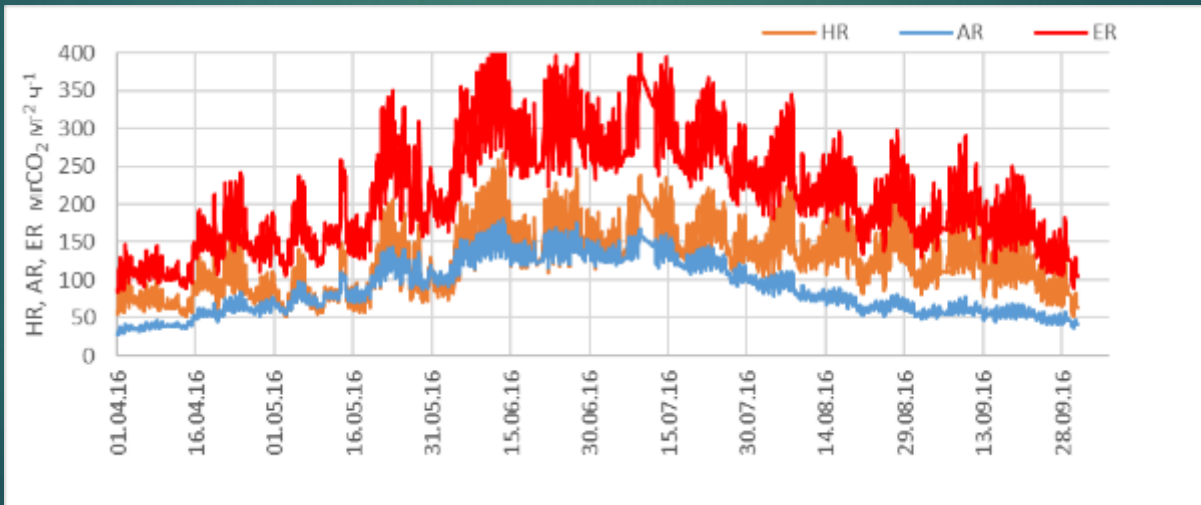
Simulation results - FEN - 2016

23

GPP



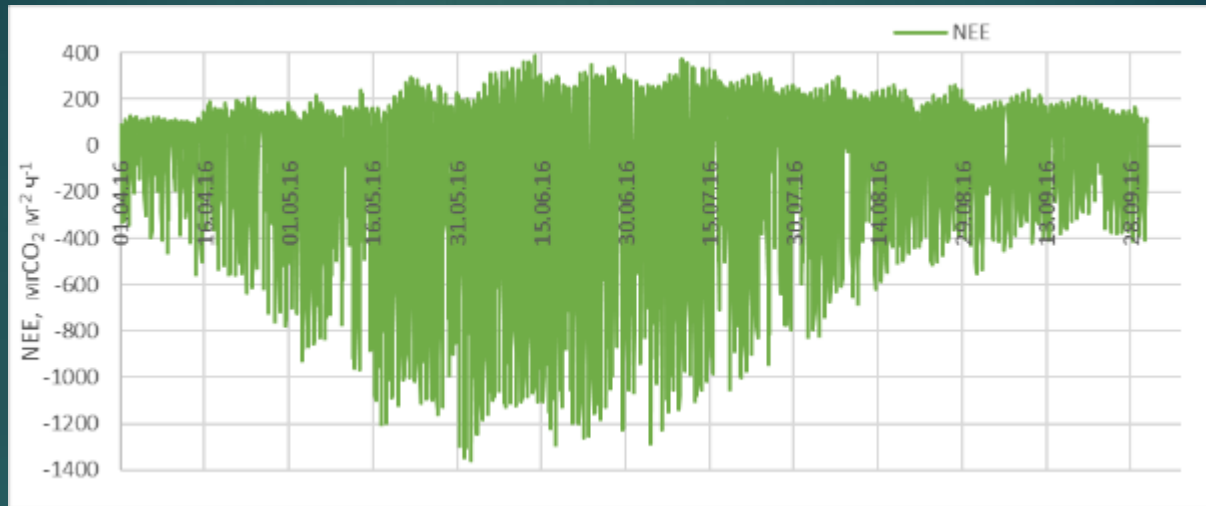
ER
HR
AR



Simulation results - FEN - 2016

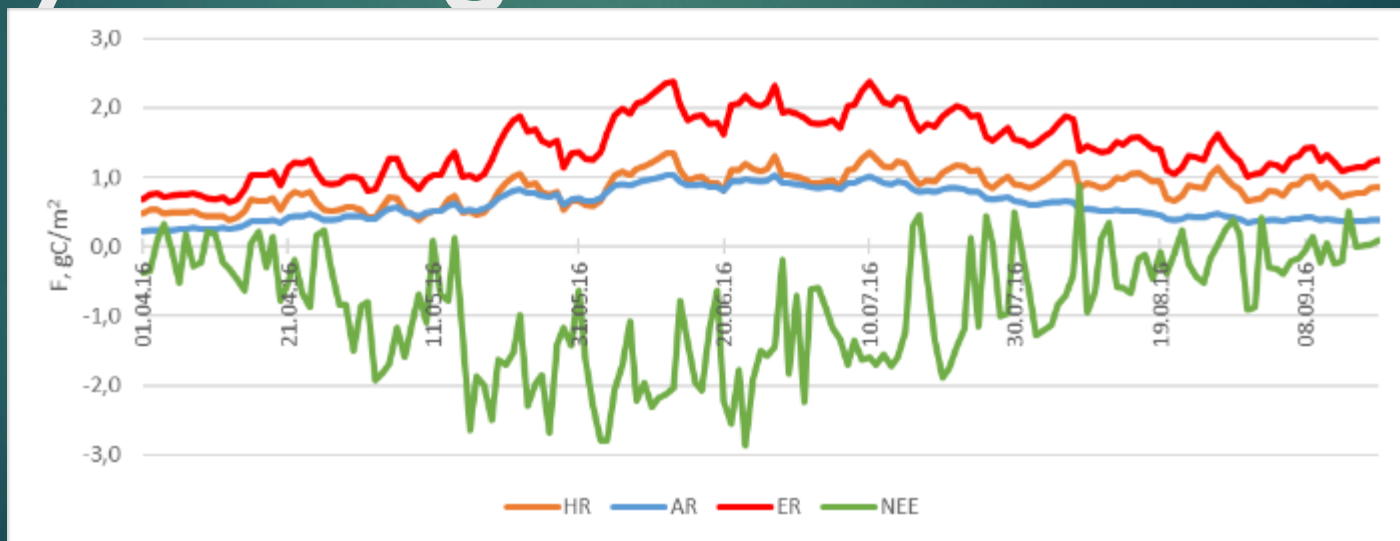
24

NEE

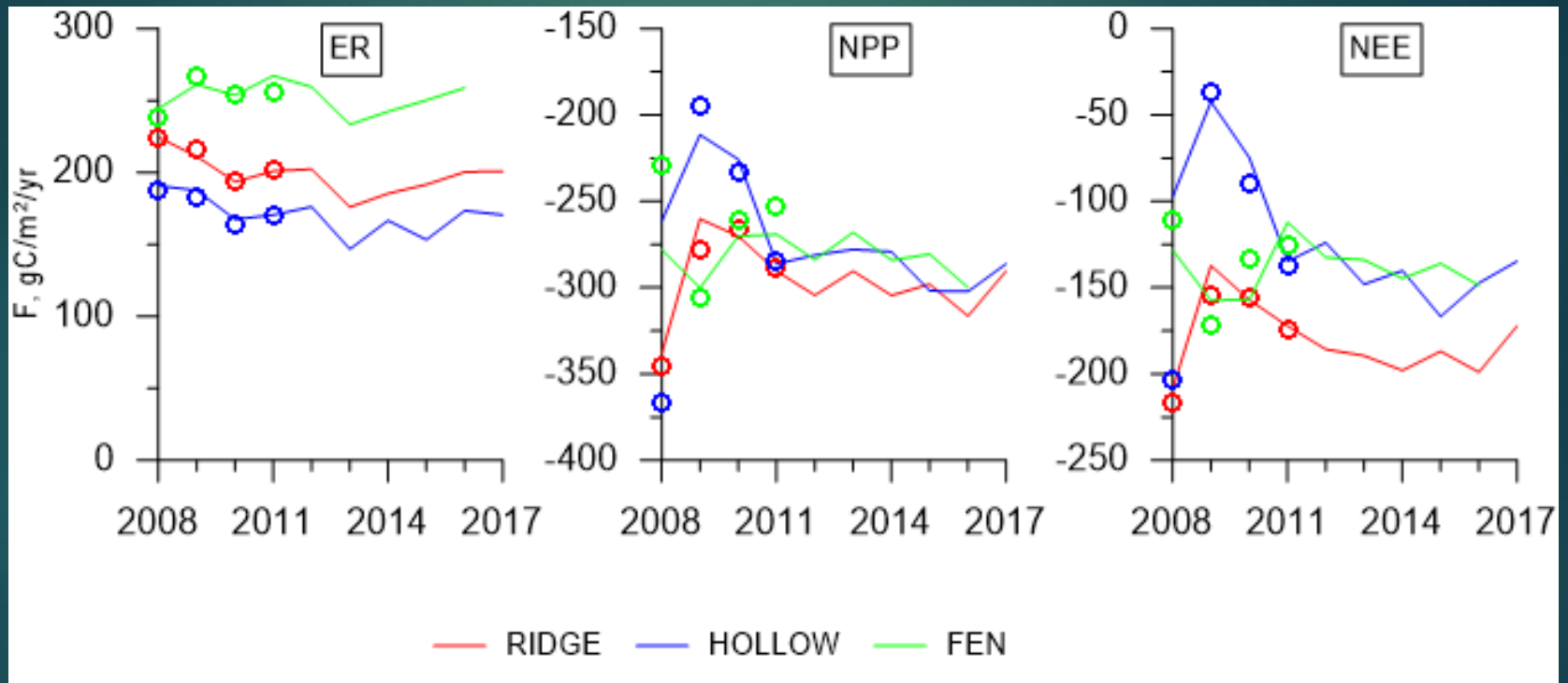


Daily average fluxes

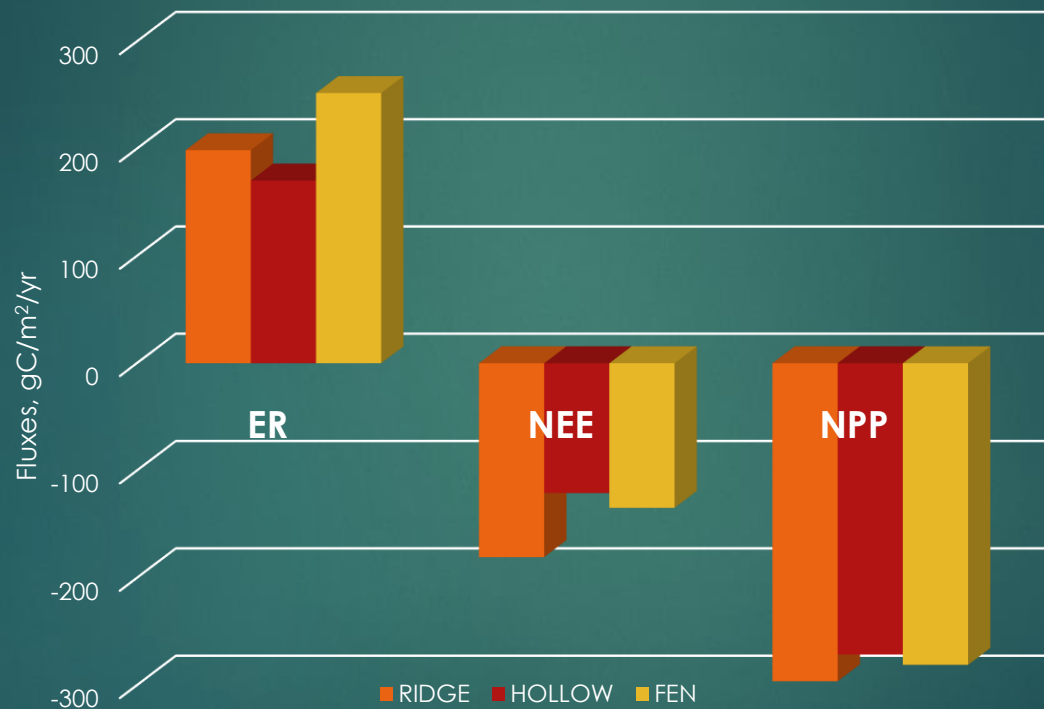
NEE
ER
HR
AR



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 под руководством ведущих ученых по приоритетным направлениям научных исследований ФГБОУ ВО «Югорский государственный университет»

«Исследование и моделирование отклика функционирования болотных экосистем Западной Сибири на современные изменения климата и антропогенное воздействие»

