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# Influence of different amount of precipitation on soil CO2 emission in the pine forests of boreal zone in Central Siberia

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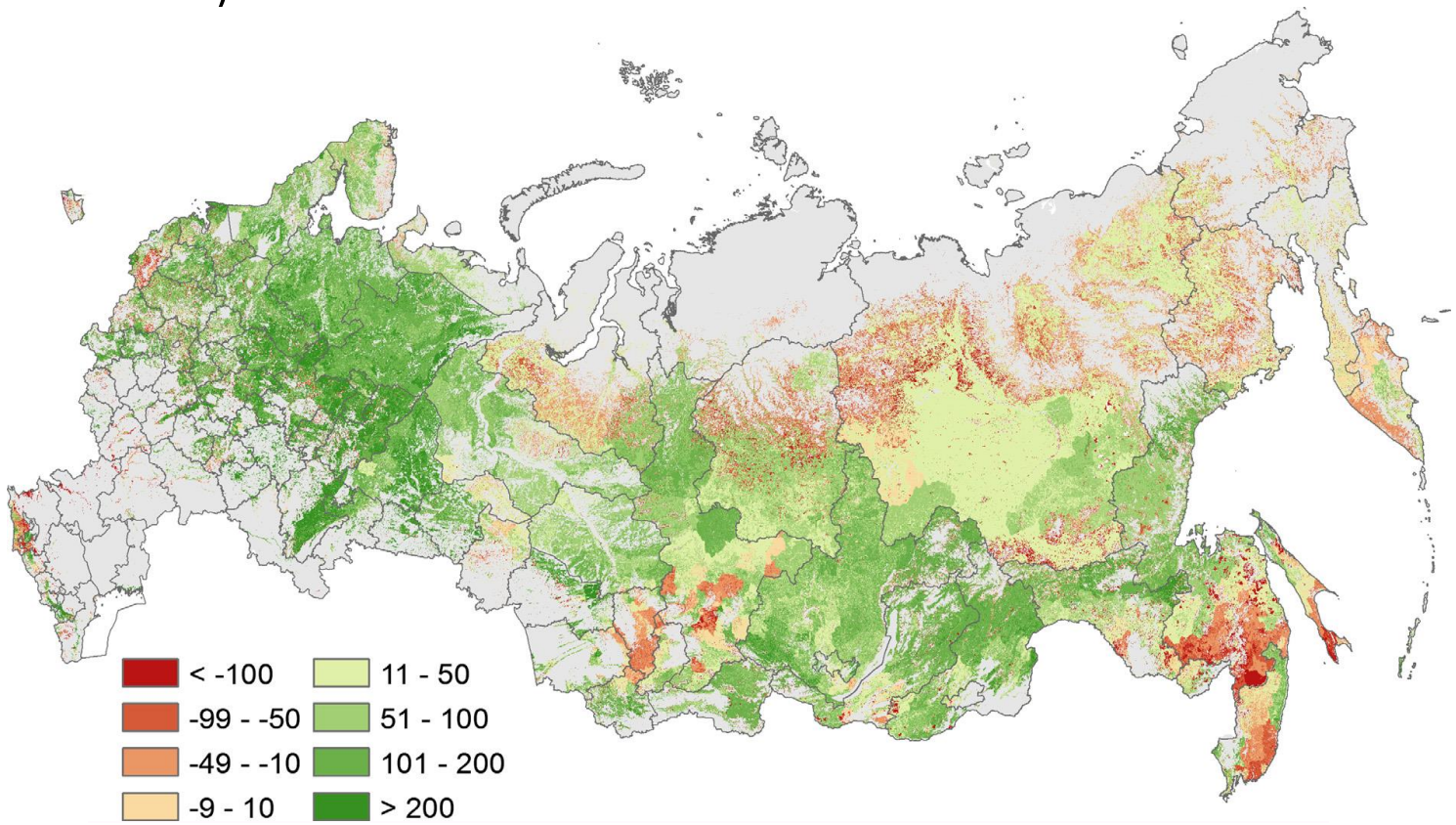
# Soil $CO_2$ sequestration in Russia: a significant role of boreal forests (lack of data for vegetation models)




- The forests of Russia make up about 23% of the entire forest area of the whole world. They contain about 43 Pg C in terrestrial vegetation, including 35 Pg C in living biomass (Shvidenko et al., 2009).
- International Institute for Applied Systems Analysis Russian territory acted as a source of $CO_2$ at a rate of 0.53 Gt C $g^{-1}$ (Nilsson et al., 2000). Institute of Physico-Chemical and Biological Problems of Soil Science, Russian Federation – the Russian territory is completely carbon sink in the amount of 0.81-1.10 Gt C $g^{-1}$ (Kurganova et al., 2008) + Dolman et al. (2012) obtained by the upscaling eddy covariance data that carbon sink is 0.63 PgC yr-1.

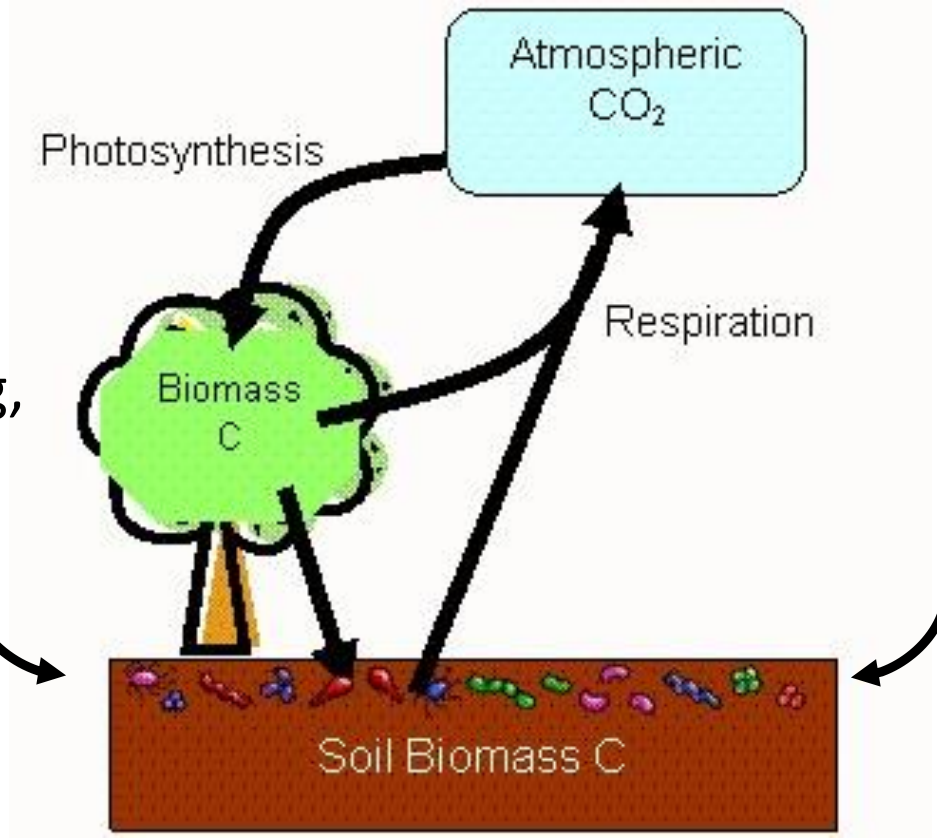
Net ecosystem carbon budget (gC m2); negative values indicate a carbon source, positive values a carbon sink (Shvidenko and Schepaschenko, 2014)
http://tsmithrussia.weebly.com/population-and-settlement.html

# Soil Respiration

- As an important component of the carbon cycle, soil respiration includes the total $CO_2$ released by the respiration of plant roots, soil microorganisms and mycorrhizae

Anthropogenic impact:

- clear cutting and logging,
- pollution,
- fossil fuel burning




Natural external factors:

- temperature,
- precipitation,
- nutrient supply

# *Main goal*

- to consider the reaction of soil $CO_2$ emission to the different amounts of precipitation in pine forests of Central Siberia.

***Study objectives:***

(1)to characterize temporary changes in soil $CO_2$ emissions in pine forests of Central Siberia in areas with a differentiated amount of precipitation;

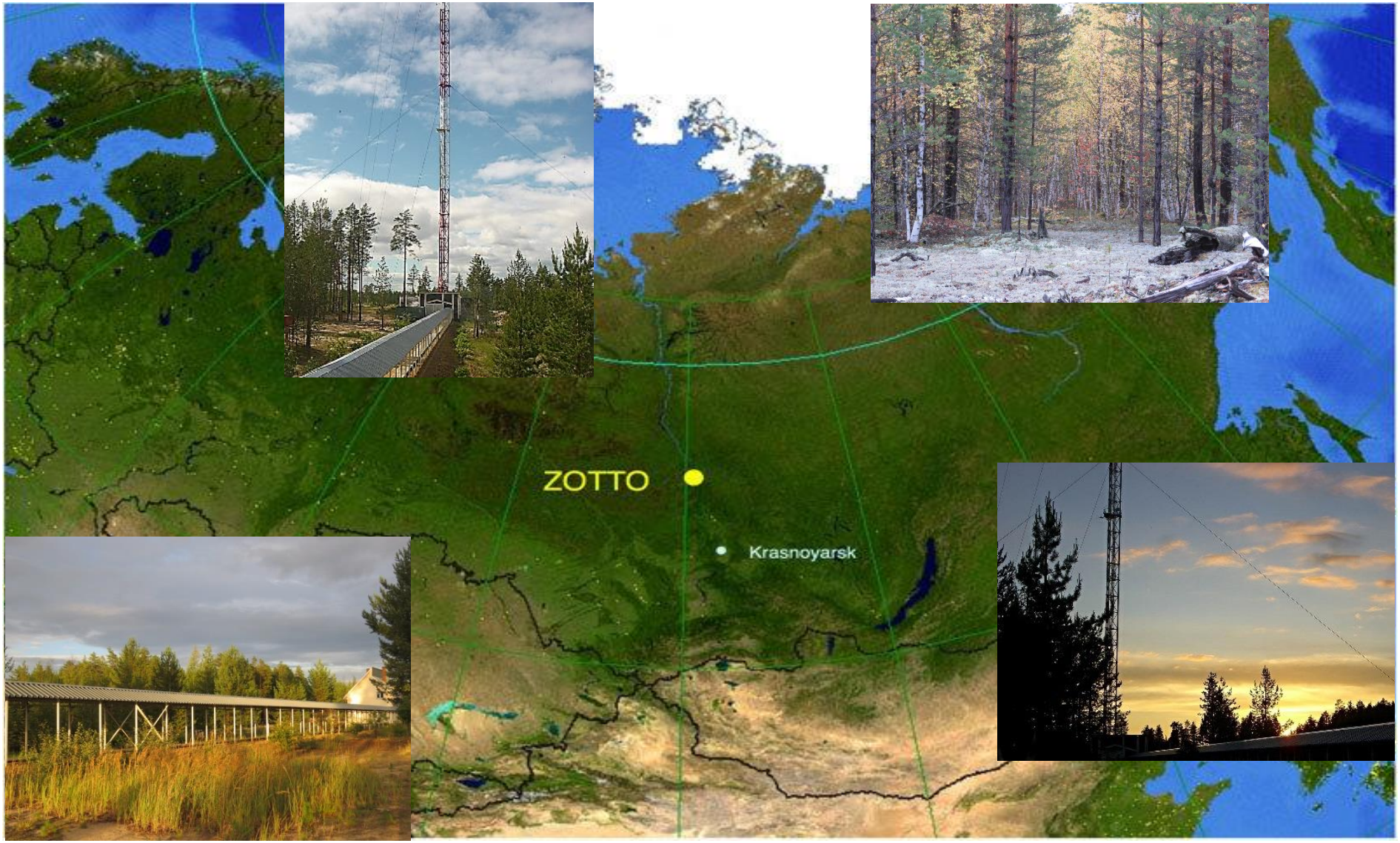
(2)to study the influence of the hydrothermal conditions of a particular season on the formation of a flow of $CO_2$;

(3)determine optimal moisture conditions for maximum soil $CO_2$ emissions in a particular region.

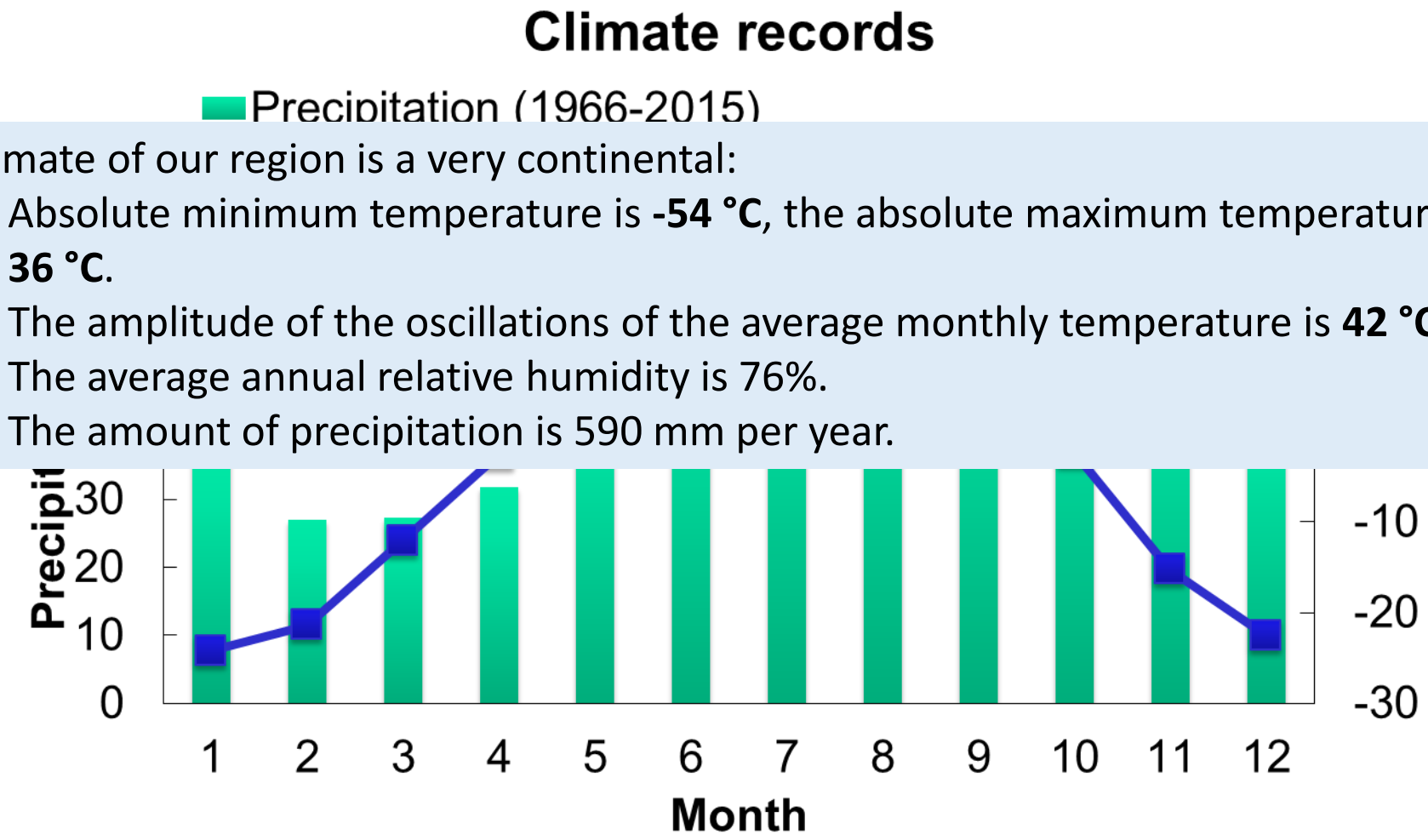
# Research Region


http://rareearth.ru/ru/pub/20151125/01827.html

# Research Station
# «Zotino Tall Tower Observation Facility ZOTTO»



# Meteorological Conditions




Climate of our region is a very continental:

- Absolute minimum temperature is **-54 °C**, the absolute maximum temperature is **36 °C**.
- The amplitude of the oscillations of the average monthly temperature is **42 °C**.
- The average annual relative humidity is 76%.
- The amount of precipitation is 590 mm per year.

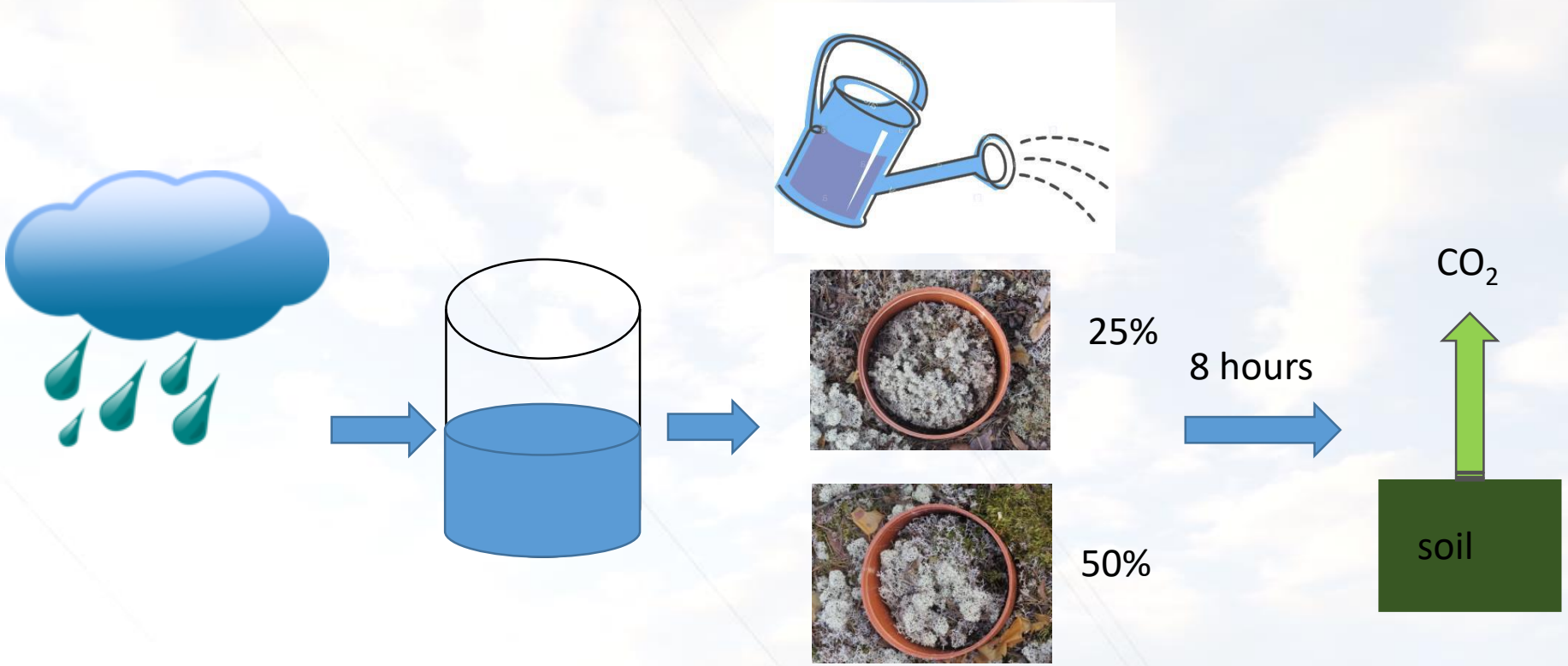
# Study Site


Lichen pine forest (10P)
Forest age: 75 years
N 60° 47’ 57”, E 089° 21’ 23”

# Experimental design

Water treatments:
0%, 25%, 50% and 100% from the precipitation events (rain)

# Experimental design




- After each rain during the observation period (June-September)
- Duration: 2 years

# Research Methods

- Soil efflux - $CO_2$ flux system based on the infrared gas analyzer – LI-8100 (Li-Cor Biogeosciences Inc., USA).
- Soil temperature - Soil Temperature Probe Type E (Omega, USA) in three depths – 5, 10, 15 cm.
- Volumetric soil moisture - Theta Probe Model ML2 (Delta T Devices Ltd., UK).



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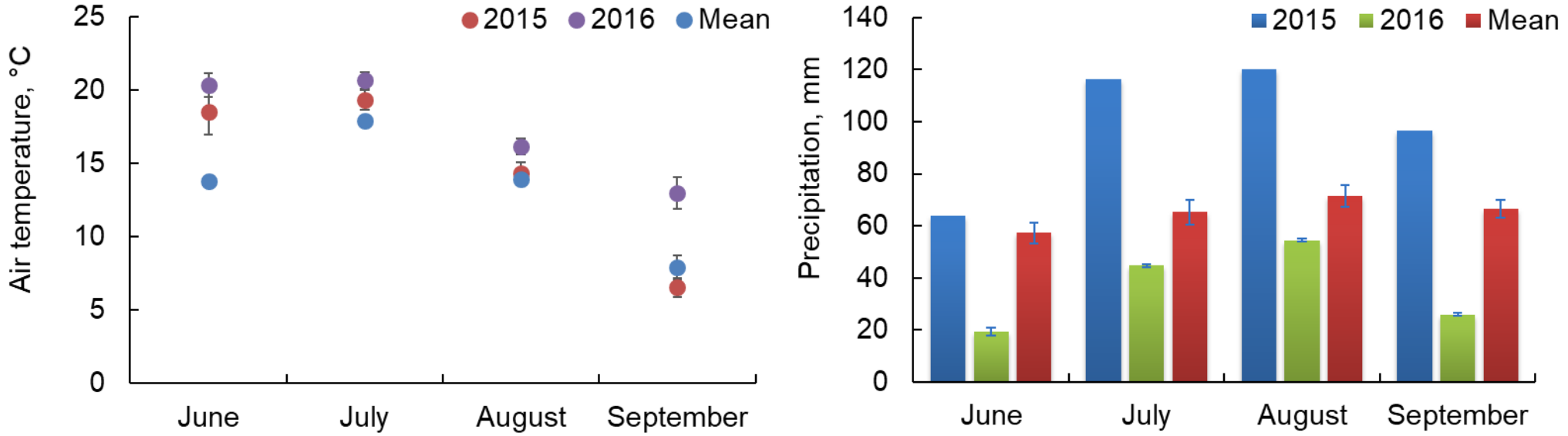
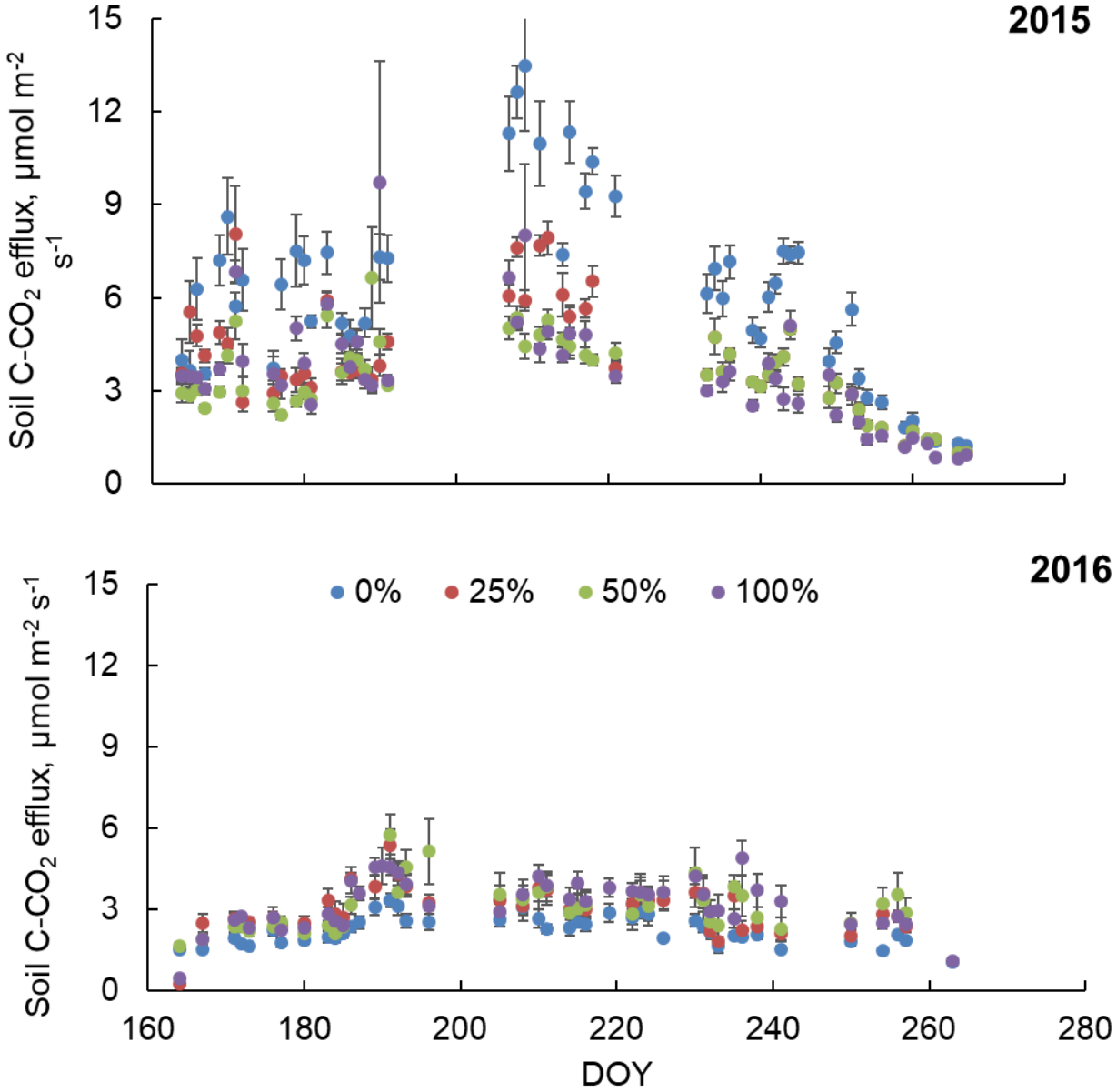
# Meteorological characteristics of the observation period




- Air temperature: mean seasonal temperature of 2016 was in 30 % higher comparing to the mean value; 2015 – was quite close to the mean but in June was warmer in 35 %.
- Precipitation: amount of precipitation in 2016 in the mid of season was in 25 %, at the start and end of it – in 60 % smaller than mean values; 2015 – in the mid of season in 75%, at the start and end of it – in 15 and 45 % respectively higher than mean values. Main differences in 2015 – in the mid of season, 2016 – at the start and end of season.

# Soil $CO_2$ dynamics for two seasons of experiment



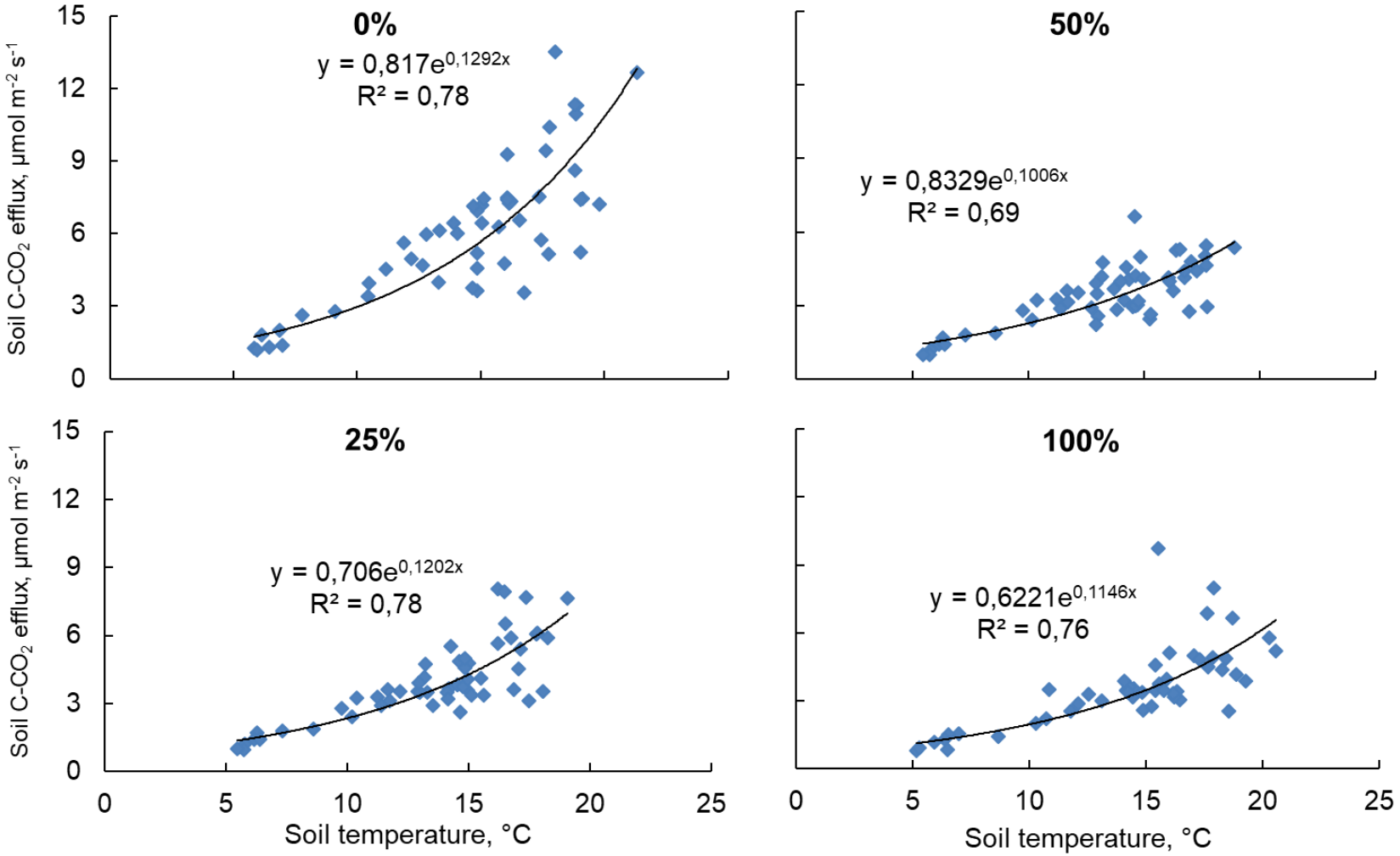

2015:

- max flux occurred at the middle of growing season;
- max flux – site with 0% precipitation;
- factor of flux inhibition – overmoistened.

2016:

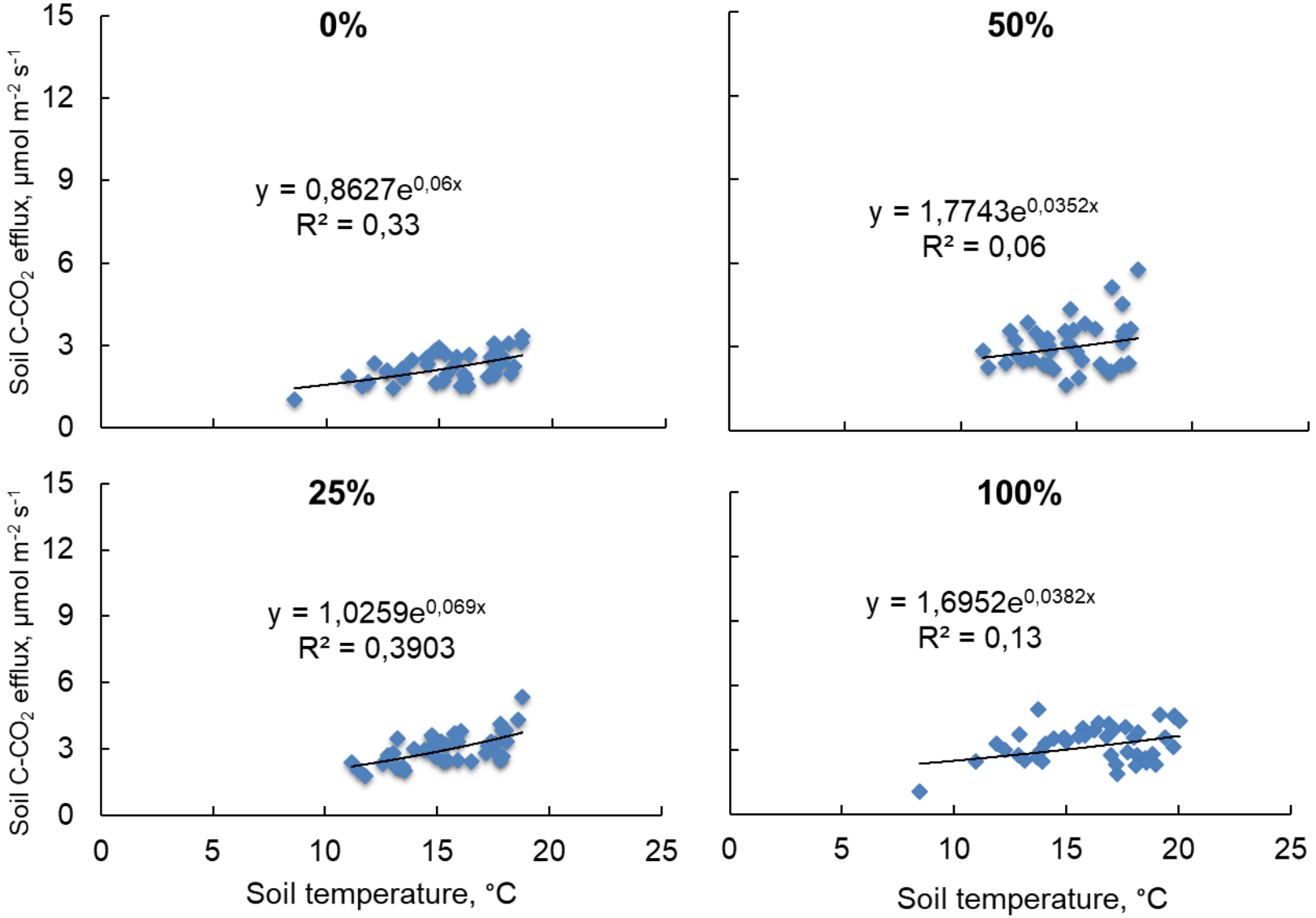
- max flux presented in the second half of June-start of July,
- max flux – site with 100% precipitation;
- factor of flux inhibition – lack of moisture/drought.

# Dependence $CO_2$ emission from the soil temperature



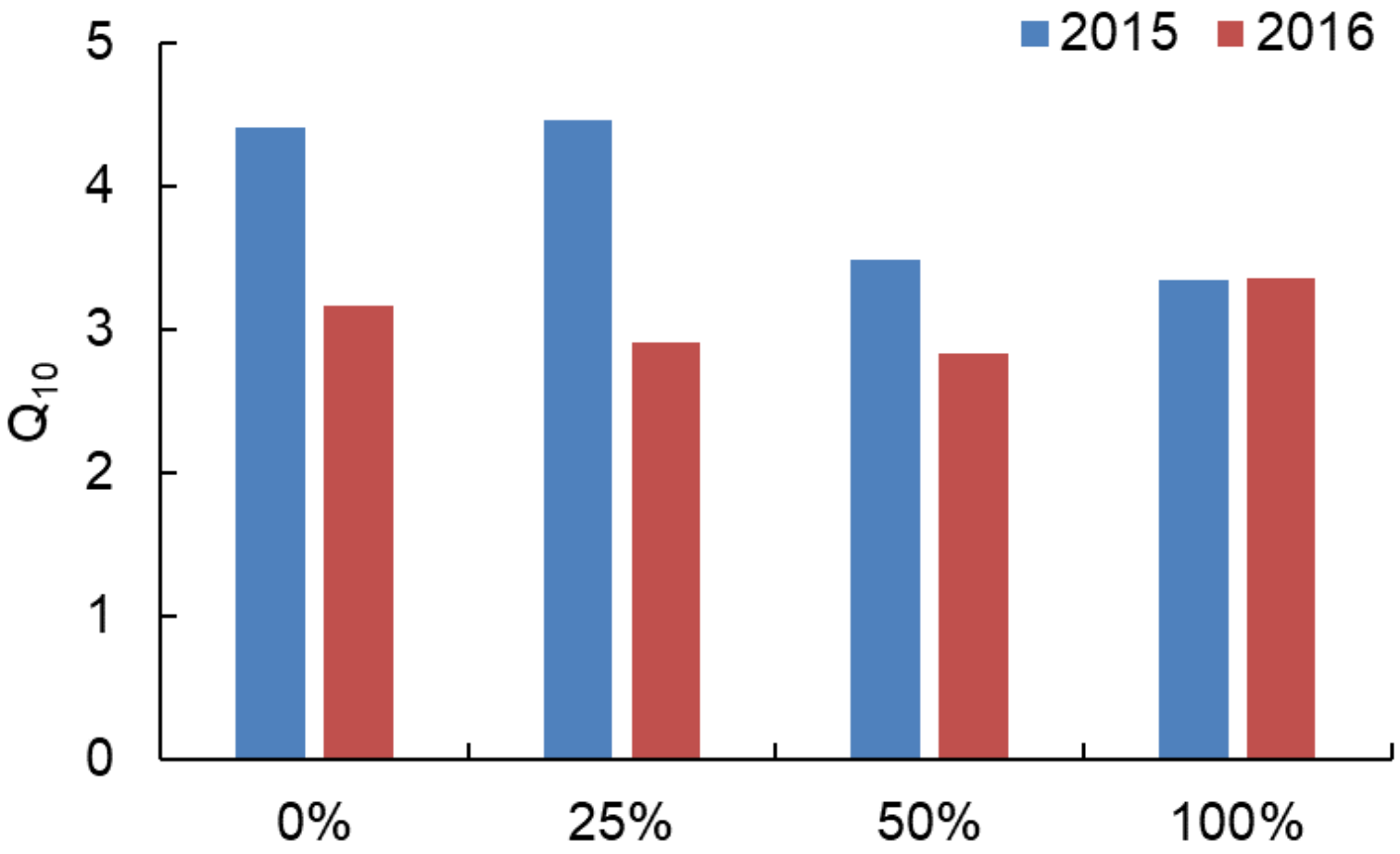

- 2015

# Dependence $CO_2$ emission from the soil temperature




- 2016

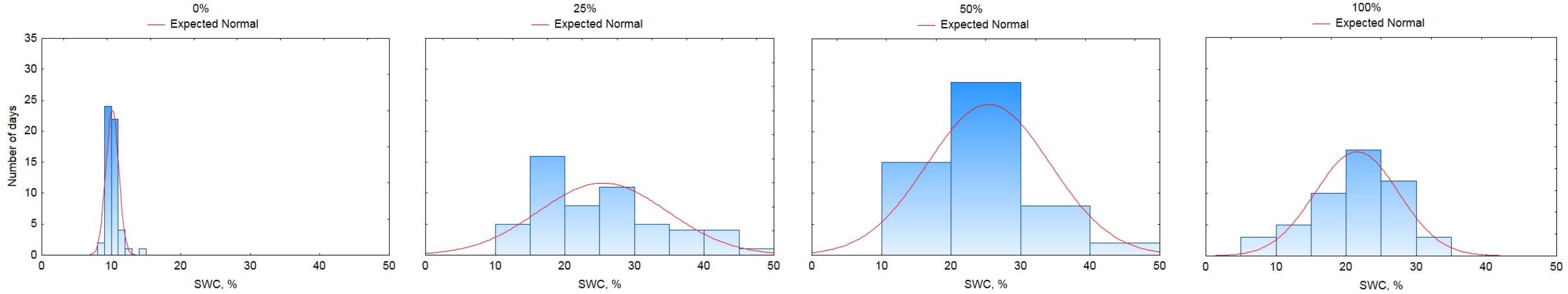
# $Q_{10}$ Coefficient



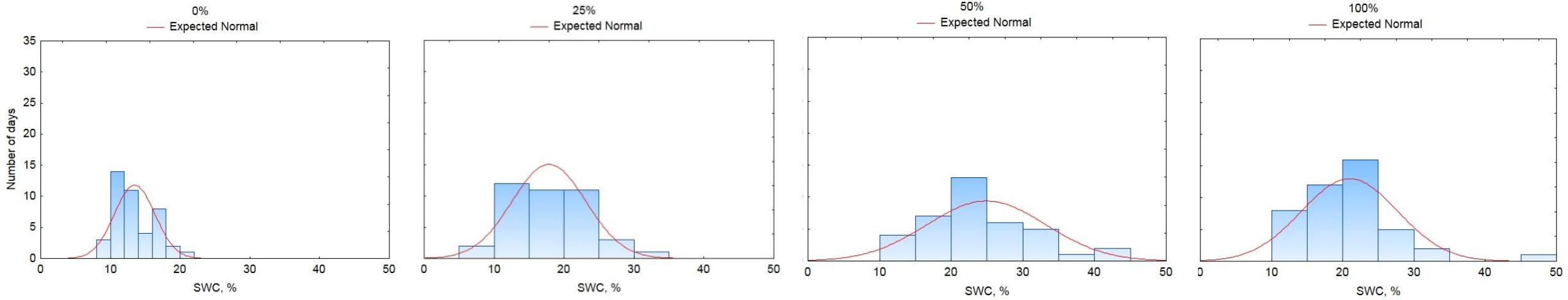

- Natural conditions (100%): the same response
- 50%: the increase in 20 % in more precipitated year
- 0 and 25%: the increase in 40 and 50 % respectively in more precipitated year

# Distribution of all measurements of soil $CO_2$ emission by the soil moisture

## 2015




## 2016



# SUMMARY

1. Changes in the amount of precipitation can inhibit (drought and overmoistened conditions) or intensify (optimal moistening conditions) the soil $CO_2$ emission.
2. The optimum moisture content of the soil is 20-30%: there is no restriction on the moisture factor.
3. The temperature exponential dependence is maximal at optimum soil moisture.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