Soil CO_2 emission response to the main limiting factors changes during the snow-free period in Central Siberia

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Abstract

The study of the reaction of soil emissions in the middle taiga forests of Central Siberia to changing environmental factors, and in this case, limiting factors (conditions of moisture and the amount of nitrogen in the soil) revealed a number of differences between the mechanisms of adaptation to them. Moisture conditions, as a natural environmental factor, have a limiting effect on the CO_2 flux observed throughout the growing season. In this case, we can speak of a long-term and stable adaptation to the deficit and excess rainfall during the growing season. The reaction to the simultaneous introduction of nitrogen triggered a number of stress mechanisms to increase the nitrogen concentration, which reached a peak of development by the middle of the season, which caused a decrease in the emission rate at a high concentration of N.

Key words: soil efflux, boreal forest, climate change, carbon cycle, soil moisture, nitrogen, pulse response

Objectives

(1) estimate CO_2 fluxes from the soil surface during the growing season in two experimental sites: with different amounts of precipitation and nitrogen;

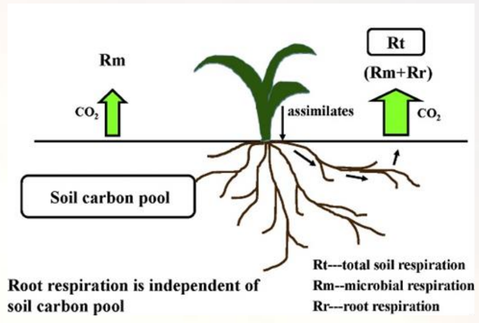
(2) determine of the limits of stability of the middle taiga forests of Siberia to the effects of external factors;

(3) compare the effects of limiting factors of various origins.

Soil emission and Limiting factors

Water (H_2O)

Nutrient supply Nitrogen (NH_4NO_3)



Lia et al., 2018

Conclusions

- Max efflux – 30% SWC (permanent soil moisture). Except for the 2015 season – the max efflux was observed for the site with 0% of precipitation due to the over precipitated conditions during the season.
- Temperature sensitivity at the 30% SWC site is higher in 4 times compared to other water treatments.
- Nitrogen addition enhances soil emission up to concentration in 100 kg N per ha (middle of the season). N-effect reviles at the end of the season when climate factors (temperature, moisture) are decline.
- Water factor characterized by the long-term adaptation mechanisms, nitrogen – has a strong impulse impact on emission rates.

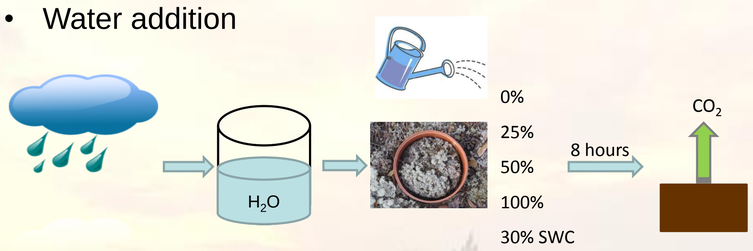
Research area

Boreal region of Central Siberia, Russia – Turukhansk district of Krasnoyarsk Region (60°N, 90°E).

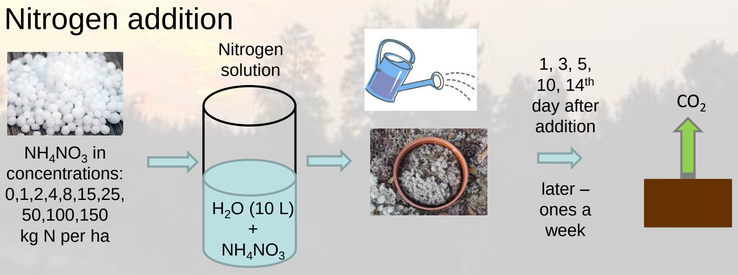
http://zottoproject.org/index.php/Main/Home

Experimental design

- Water addition



- Nitrogen addition

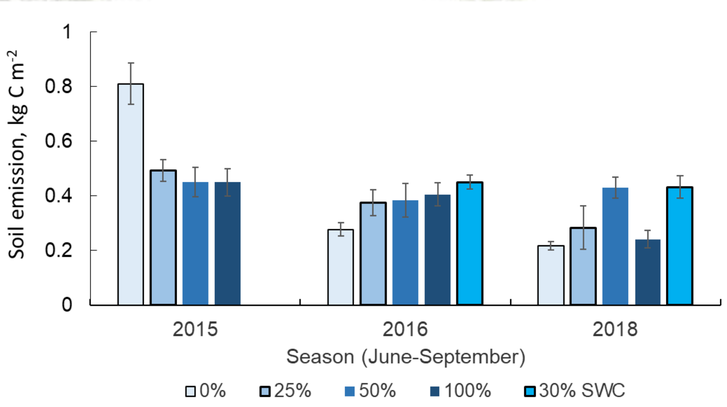


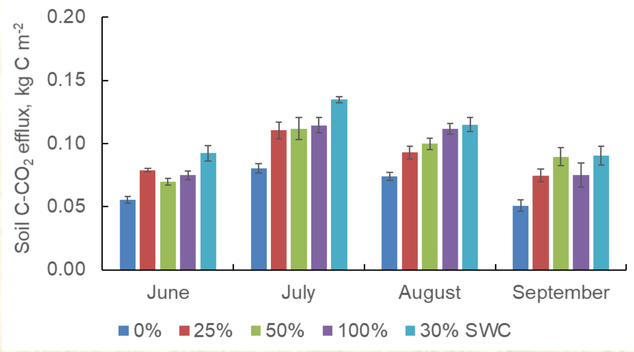
Instrumentation

- Soil efflux CO_2: LI-8100A (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), in 5 cm depth

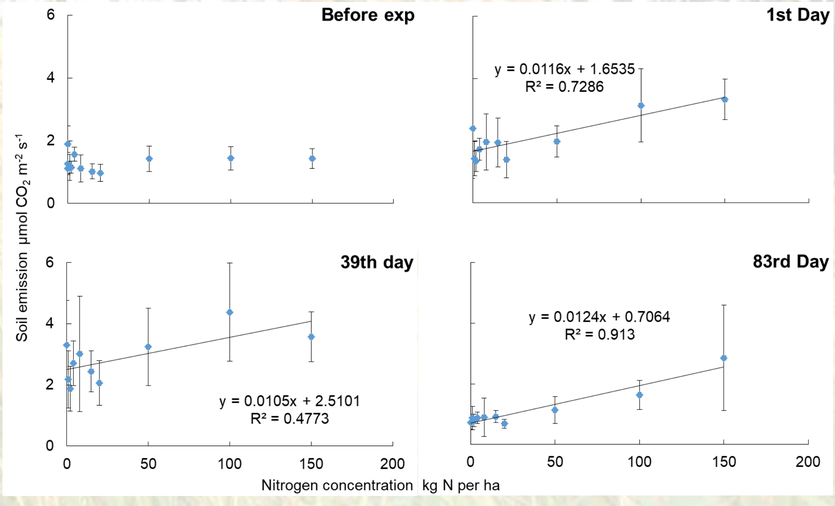
Results

- **Water addition experiment**



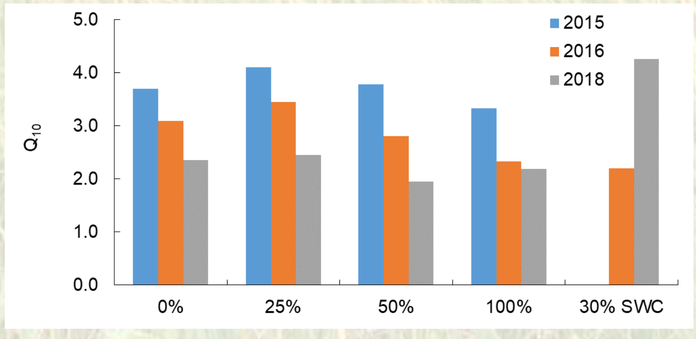


- **Nitrogen addition experiment**



- Temperature sensitivity of soil CO_2 fluxes – Q_{10} coefficient (Van't-Hoff equation,1989):

$$Q_{10} = \left(\frac{R_2}{R_1}\right)^{\left(\frac{10}{T_2 - T_1}\right)}$$



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