Belowground carbon dioxide efflux in the contrast ecosystems of the north West Siberia: partitioning into different sources

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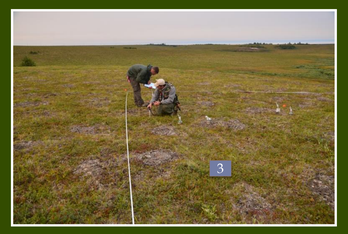
THE MAIN QUESTION

Climate change caused by the growth of greenhouse gas concentrations in the atmosphere focused the attention of researchers on the estimation of carbon budgets of various types of ecosystems, including the Arctic. Partitioning soil carbon dioxide efflux into individual components is necessary, as differential responses of these components to environmental change have profound implications for the soil and ecosystem carbon balance. The main objective of the study was to evaluate the contribution of autotrophic and heterotrophic components to CO_2 emission by soils of north ecosystems using field, laboratory and calculation methods

RESEARCH AREA AND RESEARCH SITES

North of West Siberia (Russia) in discontinuous and continuous permafrost zone



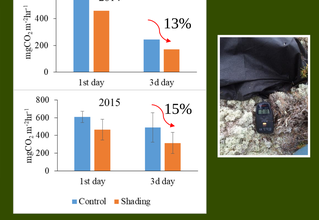
3. Tundra frost-boil ecosystem («spotted» tundra)

1. Permafrost peatlands (palsa)
2. Forest ecosystems (lichen and green moss pine forest)

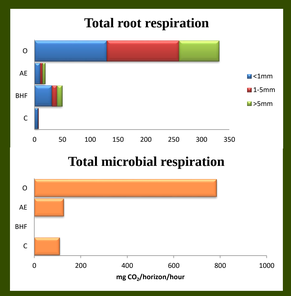
METHODS

- **Shading** — Method are base on stopping leaf photosynthesis and thus excluding new assimilate transport to the roots
- **Component integration** — Method is based on the physical separation of C pools and measuring the specific rates of CO_2 efflux from each component part
- **Root exclusion** — Comparison of planted and unplanted soil
- **Root mass regression** — Method is based on the assumed linear relationship between root biomass and the amount of CO_2 respired by roots

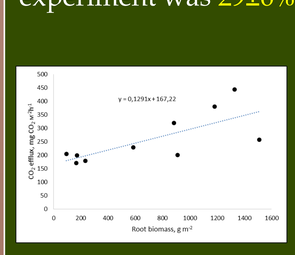
FOREST ECOSYSTEMS



The contribution of root respiration by SHADING experiment was more than 14% (only shrubby and grassy vegetation without trees)

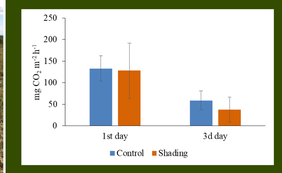


The contribution of root respiration by COMPONENT INTEGRATION experiment was 29±6%

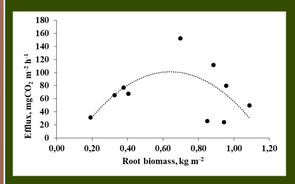


The contribution of root respiration by ROOT MASS REGRESSION experiment was from 16 to 60% depending on the vegetation projective cover

TUNDRA FROST-BOIL ECOSYSTEMS

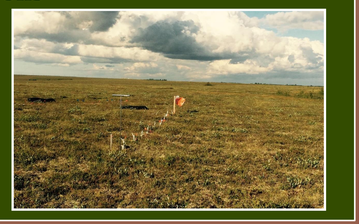


By SHADING experiment the contribution of root respiration was more than 34%

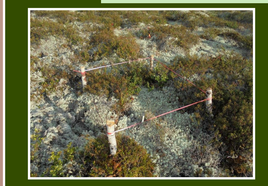


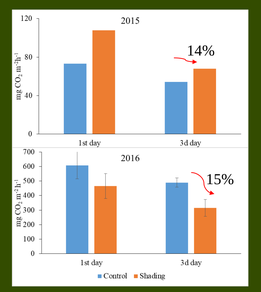
ROOT MASS REGRESSION method is not acceptable on frost boil tundra ecosystems because of the high heterogeneity of the physical, chemical and microbiological properties of soils

By COMPONENT INTEGRATION the contribution of root respiration was from 15 to 60% along the transect, covering the all elements of the landscape (boils, inter-boils)



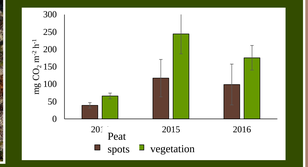
PERMAFROST PEATLANDS

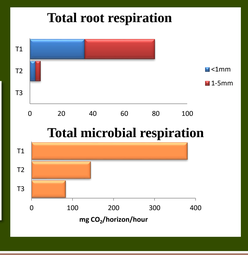




The contribution of root respiration by SHADING experiment was from 14 to 26%

The contribution of root respiration by COMPARISON OF PLANTED AND UNPLANTED SOIL was about 50%. In this approach, it is possible to underestimate the differences in microbial respiration.





By COMPONENT INTEGRATION the contribution of root respiration was 14±3%

CONCLUSION

- Belowground carbon dioxide efflux including the autotrophic and heterotrophic component, varies considerably in the ecosystems of the north West Siberia. In the middle of the growing season, it averages from 80 mg CO_2 m^{-2} h^{-1} in tundra and permafrost peatland ecosystems to 600 mg CO_2 m^{-2} h^{-1} in forests. High values of CO_2 production by forest soils are due to both high values of total microbial respiration and high root biomass (3-10 times more in comparison to peatland and tundra).
- The contribution of root respiration, calculated based on a complex of methods, varies significantly in all ecosystems. The minimum contribution was found for peatlands – from 14 to 26%, in forest and frost-boil tundra – from 15 to 60%.
- High variability of data is due both to the great heterogeneity of the environmental conditions of permafrost-affected ecosystems and to the methodological aspects. The use of a complex of methods makes it possible to reduce the methodological uncertainty of the results.

ACKNOWLEDGMENT

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