Warming effects on permafrost ecosystem carbon fluxes controlled by plant nutrients

With the support by the National Natural Science Foundation of China, a recent study by the research group led by Prof. Yang Yuanhe (**杨元合**) from the Institute of Botany, Chinese Academy of Sciences shows that plant nutrients control the response of permafrost ecosystem carbon fluxes to warming, which was published in *Ecology* (2017, 98(11): 2851−2859).

Permafrost ecosystems, mainly distributed in arctic and alpine regions, store tremendous amounts of soil organic carbon, and are the most vulnerable ecosystems to climate warming. Modeling studies demonstrate that large uncertainties exist in projecting the permafrost carbon-climate feedback. A key part of this uncertainty is related to an insufficient understanding of warming effects on nutrient availabilities (mainly nitrogen and phosphorous) and their subsequent influences on ecosystem CO_2 exchange.

By conducting a manipulative warming experiment in a Tibetan alpine swamp meadow underlain by permafrost, we found that experimental warming initially enhanced ecosystem CO_2 uptake, but the increased rate vanished after the period of peak plant growth, even though soil water was not limiting. Results also showed that the increased CO_2 uptake was attributed to the increase in soil temperature and leaf area index during the early growing season, while during the late growing season, there were no significant relationships between the warming-induced changes in CO_2 uptake and the above mentioned parameters, indicating that other factors may mediate the ecosystem CO_2 uptake response to warming. The authors observed that warming significantly reduced nitrogen and phosphorous concentrations in the leaves of dominant plant species, and the weakened warming effect on CO_2 assimilation was associated with the lowered leaf nutrient concentrations. Further analysis showed that the changes in the concentrations of leaf nitrogen and phosphorous likely resulted from accelerated plant senescence in the warmed plots.

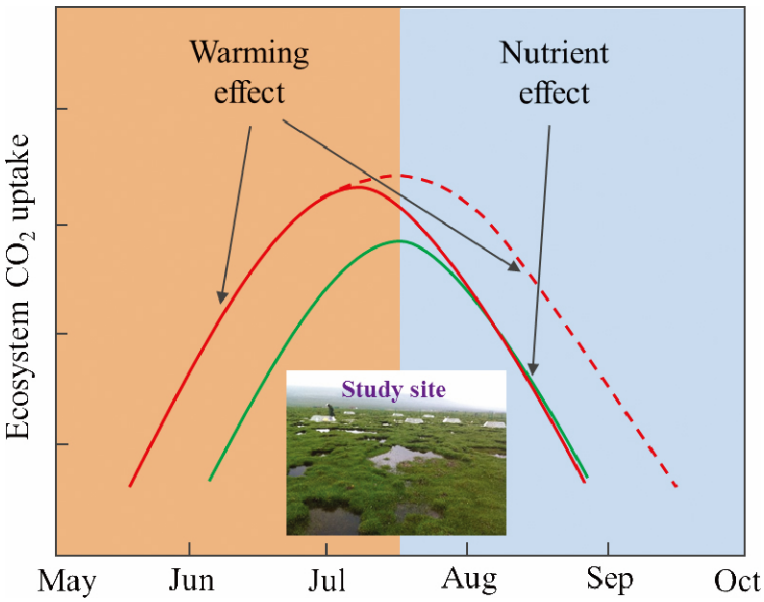

Figure Responses of ecosystem CO_2 uptake were mainly controlled by soil temperature during early growing season and plant nutrients during late growing season in a Tibetan alpine swamp meadow underlain by permafrost. Red and green curves indicate warming and control treatments, respectively.

Contrary to the traditional understanding that warming-induced increase in soil nutrient availability would benefit ecosystem CO_2 uptake in arctic permafrost regions, the authors found that in Tibetan permafrost areas, increasing temperature had no obvious impacts on soil nutrients but reduced plant nitrogen and phosphorous concentrations, thus limiting ecosystem carbon feedback to climate warming. These findings indicate that the responses of the carbon cycle in these warming-sensitive ecosystems to climate change are more complex than previously assumed.