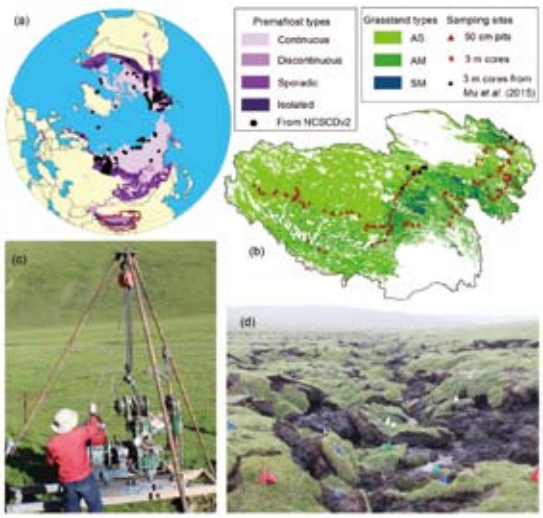
Understanding Permafrost Carbon Budget

Permafrost is ice-containing soil, rock or sediment that is frozen for more than two consecutive years. Most permafrost is distributed in cold regions (high latitudes or high altitudes) across the Northern Hemisphere. During the last few decades, permafrost regions have experienced significant climate warming with widespread occurrence of permafrost thawing such as active layer deepening and thermal erosion. These thawing processes could result in the release of frozen carbon stock into the atmosphere, triggering positive carbon-climate feedback. Reliable evaluation of the permafrost carbon stock is the scientific basis for better understanding the direction and strength of the permafrost carbon-climate feedback. However, due to the lack of systematic field observations and appropriate upscaling methodologies, substantial uncertainties exist in the permafrost carbon budget, which limits our understanding on the fate of frozen carbon in a warming world.

Focusing on the study of Tibetan permafrost, Dr. YANG Yuanhe's group at the CAS Institute of Botany conducted a two-year field sampling campaign during 2013-2014, and obtained sediment samples from 342 3m-deep cores and 177 50cm-deep soil pits across 173 sampling sites. By combining a high-resolution satellite dataset with interpolated meteorological and edaphic datasets, they evaluated the pool size and spatial variations of permafrost carbon stock to 3m depth using a support vector machine (SVM) model. The results revealed that Tibetan permafrost stored a large amount of organic carbon in the top 3m, with the median pool size being 15.31 Pg C. Of them, 44% occurred in deep layers (100-300 cm). The organic carbon density exhibited a decreasing trend from the southeastern to the northwestern plateau. The large carbon pool size, together with significant permafrost thawing implies a risk of carbon emissions and positive climate feedback across the alpine permafrost region.



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This study contributed a new valuable permafrost carbon database, which can be used for benchmarking and parameterization of Earth System Models to produce reliable projections on permafrost carbon dynamics under continuing warming scenario. It also developed a comprehensive methodology which could be used to obtain spatially explicit estimations of carbon stocks with quantitative uncertainty analysis.

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