Soil organic matter characteristics in moist acidic tundra and its relationship with vegetation,
soil bacteria, environment, and microtopography

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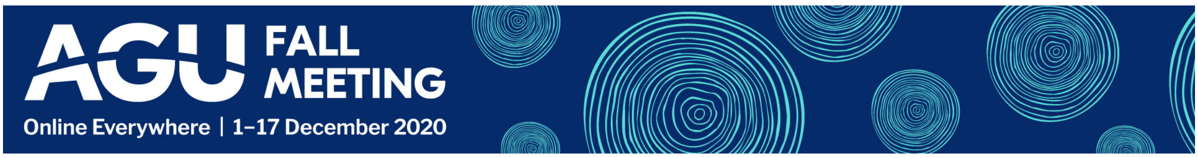

INTRODUCTION

- Arctic permafrost soil carbon stock 1460-1600 Pg, vulnerable to climate change.
- To understand the C dynamics in permafrost soil, we need to understand the composition of SOM as well as C quantity
- The composition of SOM is determined by the chemistry of plant inputs, as a major source material and by microbial decomposition and synthesis
- Therefore, we investigated the molecular compositions of SOM in a moist acidic tussock tundra
- In addition, relationships among SOM chemistry, vegetation and microbial structure, and soil properties were examined

MATERIALS AND METHODS

- Study site: Council (64.51°N, 163.39°W), northeast of Nome on the Seward Peninsula in Alaska
- Main vegetation: moss (*Sphagnum* spp.), cotton grass (*Eriophorum vaginatum*), and bog blueberry (*Vaccinium uliginosum*)
- Soil type: Typic Histoturbels
- A total of 70 soil samples (0-10, 10-20 cm depth) over an area of about 300 m × 50 m
- SOM composition: Pyrolysis-gas chromatography/mass spectrometry (py-GC/MS): pyrolysis temp (590 °C), peak identification througy NIST08 mass library, 167 compounds identified
- Microbial composition: pyrosequencing of 16S rRNA gene
- Soil physico-chemical properties: moisture content (MC), total carbon (TC) and nitrogen (TN) content, soil pH, inorganic nitrogen content, dissolved organic carbon (DOC)

1. MOLECULAR COMPOSITION OF SOM AND VEGETATION STRUCTURE

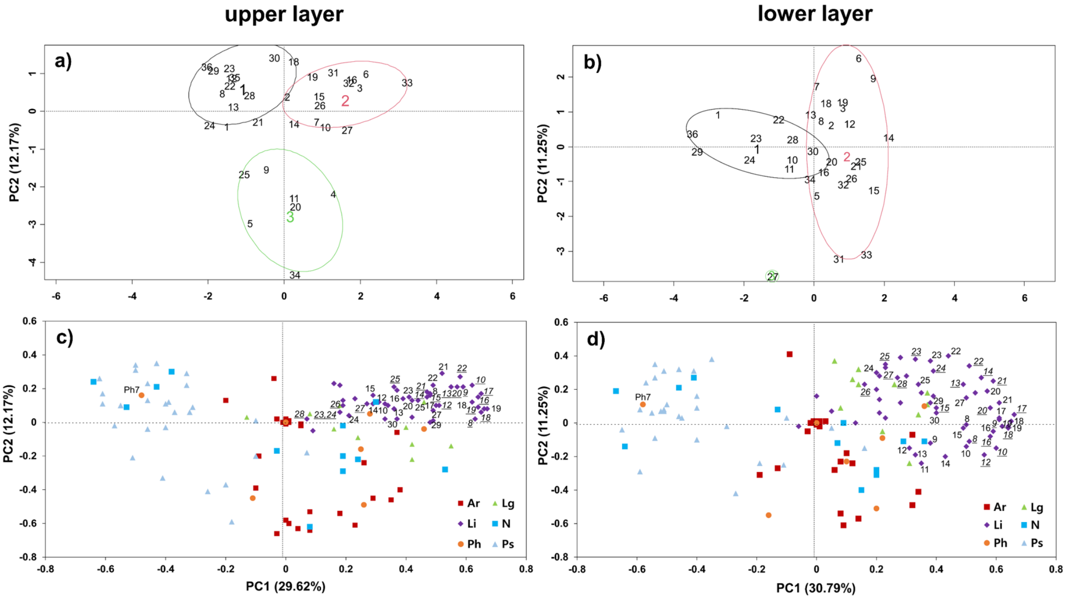

Fig. 1. Principal component analysis (PCA) results using the relative abundances of pyrolysis products in the upper (a, c) and lower soil layers (b, d). The numbers of score plots are the sampling points. Ps: polysaccharides; N: N-containing compounds; Lg: lignins; Ph: phenols; Ar: aromatics; Li: lipids

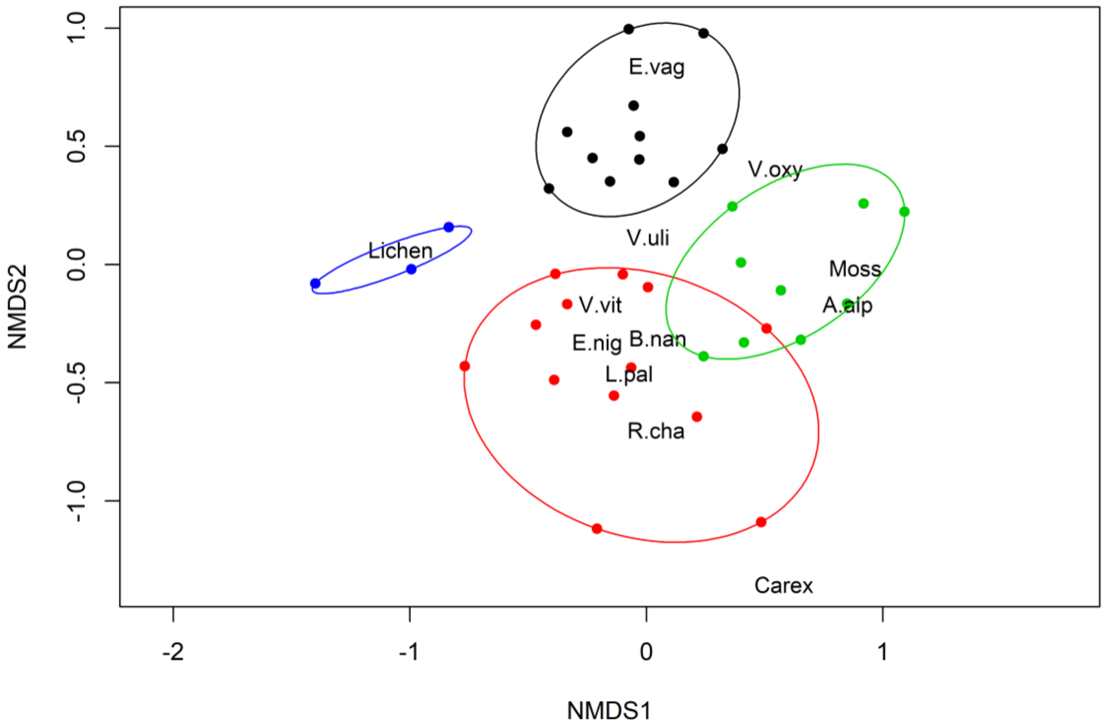

Fig. 2. Non metric multidimensional scaling (NMDS) of the vegetation compositional data for the Council, AK site. The color sd-ellipses represent each of the vegetation groups described. The species characteristics of these groups are Eriophorum vaginatum (E.vag) for G1 (black), lichen for G2 (blue), mosses (Sphagnum spp.) for G3 (green), and Betula nana (B.nan), Rubus chamaemorus (R.cha), Carex spp. for G4 (red).

2. RELATIONSHIPS BETWEEN SOM COMPOSITION AND SOIL VARIABLES/ BACTERIAL COMMUNITY

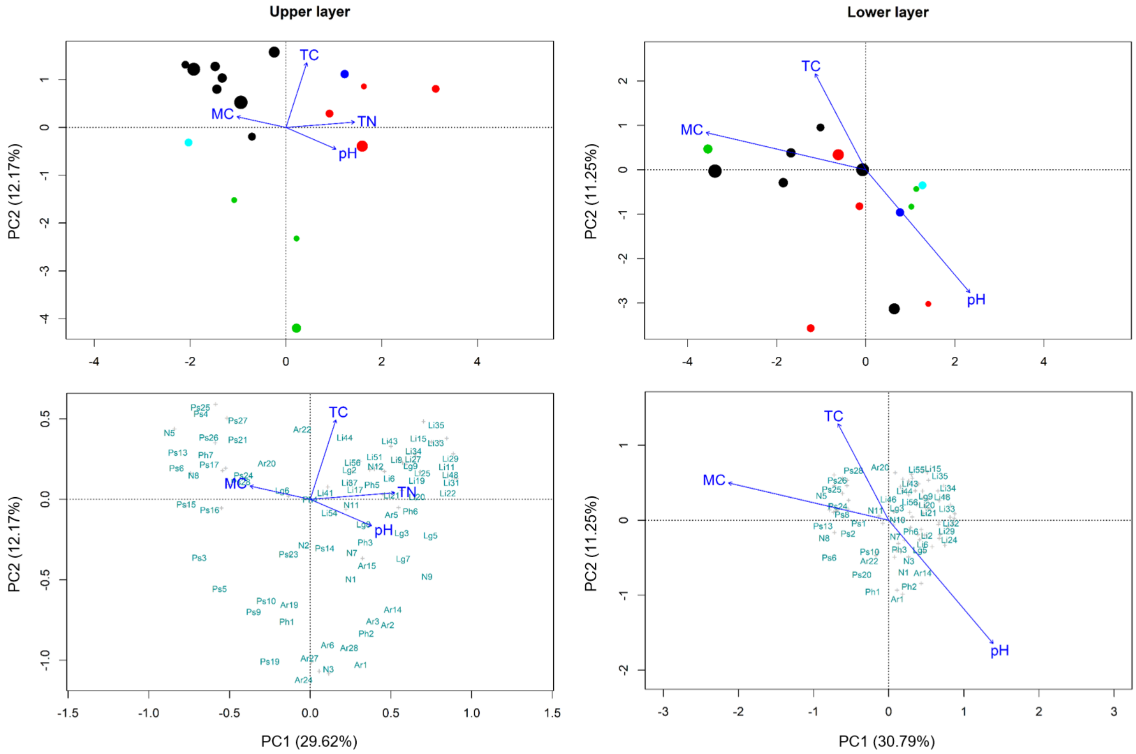

Fig. 3. Principal component analysis (PCA) biplots of the soil organic matter (SOM) compositional data for the Council, AK site. Both biplots showed the SOM composition, sampling sites, and main important soil variables: a) and c) in the upper soil layer and b) and d) in the lower soil layer. The significant soil physicochemical parameters are overfitted as arrows in the ordination (pH, MC, TC, TN).

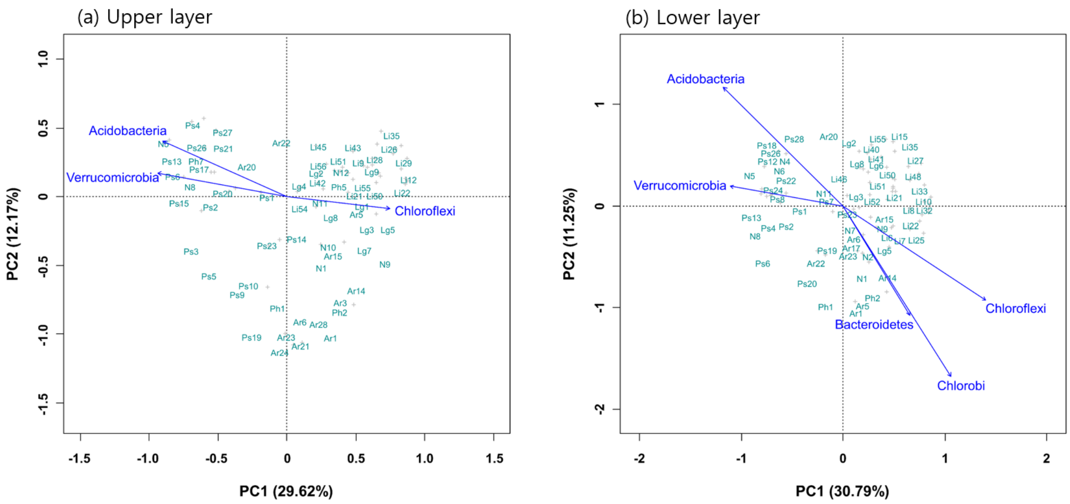

Fig. 4. Principal component analysis (PCA) biplots showing soil organic matter (SOM) composition and the main important bacterial variables in the Council, AK sites. The significant bacterial parameters are overfitted as arrows in the ordination. Names of the variables are Ps: polysaccharides; N: nitrogen-containing compounds; Lg: lignins; Ph: phenols; Ar: aromatics; Li: lipids

3. EXPLANATORY VARIABLES FOR SOM COMPOSITION

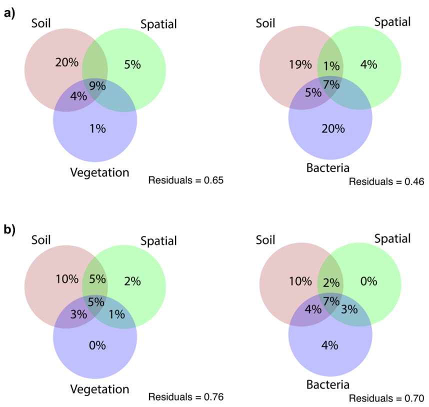

Fig. 5. Variance partitioning analyses for SOM composition including soil properties, spatial distance, and vegetation and bacterial composition in the (a) upper and (b) lower layers. Values show the fraction of variation explained by each component, as well as the shared contribution of each component.

SUMMARY

- Soil in this acidic moist tussock tundra was composed of polysaccharide-derived compounds, lipid-derived compounds, and aromatic compounds. These three groups of sites have different sources of SOM formation or different degradation status
- SOM composition had spatial structure which was partially related to elevation
- Current vegetation composition was not a main factor in explaining SOM compositional variation
- Soil properties and bacterial community were the main variables explaining SOM compositional variation at a local scale

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ABSTRACT

Soil organic matter (SOM) in the Arctic tundra region contains a huge amount of carbon (C) which is susceptible to climate change. Understanding the quality as well as the quantity of SOM is essential to predict the C dynamics in terrestrial ecosystem that is undergoing climate change. Therefore, we investigated the molecular compositions of SOM and the relationships between SOM chemistry with both plant and soil properties in a moist acidic tussock tundra found in Council, Alaska. A total of 70 soil samples was collected at two different depths with 10 cm intervals from 36 spots arranged with 25 m spaces over an area of about 300 m 50 m. Pyrolysis-gas chromatography/mass spectrometry (py-GC/MS) and pyrosequencing of 16S rRNA gene were used to identify the molecular composition of SOM and bacterial community, respectively. Soil physico-chemical properties were also measured. Our results showed that SOM composition was spatially structured and linked to microtopography however, vegetation, soil properties, and bacterial community composition did not show any spatial structure in overall. The composition of SOM was clearly descried by three different groups: *Sphagnum* moss-derived SOM, lipids and lignins rich materials, and aromatic rich materials. Simultaneously, soil properties and bacterial compositions were main responsible of variation for SOM composition, while vegetation composition had a residual effect. While *Sphagnum* moss-derived SOM was associated with higher soil MC and lower soil pH, aromatic rich materials were related to the lower TC content. Our study demonstrates that SOM composition in the moist acidic tundra was strongly related to soil properties and bacterial community composition rather than current vegetation structure.