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Mid infrared spectral properties of northern soils across a latitudinal transect in Alaska

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We investigated the influence of site characteristics and soil properties on the chemical composition of organic matter in soils collected from a latitudinal transect across Alaska through analysis of diffuse reflectance infrared Fourier transform mid infrared (MidIR) spectra of bulk soils. The study included 119 soils collected from 28 sites including forest, tundra and grassland ecosystems. Organic, mineral, and cryoturbated soil layers from a variety of depths in the active layer and upper permafrost were included in the study. We found that organic matter chemistry as well as site and soil properties exerted a strong influence on the MidIR spectra. The spectra were very sensitive to the decomposition state of soil organic matter (SOM) as shown by MidIR differences among Oi, Oe and Oa organic layers. We found differences in peak intensity and area for several spectral bands when comparing Oi and Oa layers. The Oi layers had peaks at 3406, 2923-5, 2852-4, 1159-60 and 1052-60 cm^{-1} that were greater than Oa layers, suggesting that Oi layers contained greater abundance of labile residues and phenolic-OH compounds, aliphatic compounds (waxes, lipids and fats), and carbohydrates. In contrast, Oa layers had a greater presence of amide groups (possibly from microbial cells), aromatics, C=C bonds, carboxylates and carboxylic acids. Another significant factor differentiating the layers was the incorporation of clays and silicates into the decomposing organic matter of Oa layers. In addition, we found that MidIR spectra were related to many site/soil attributes including land cover type, parent material, and related factors, such as permafrost presence/absence, water permeability, soil depth, bulk density, cation exchange capacity, and pH. We identified specific bands that might be used in future studies to quickly estimate, from a single analysis, the total organic carbon (TOC), inorganic carbon, total nitrogen (TN), and TOC:TN of organic and mineral soils from Arctic and sub-Arctic regions. Our results show that the information contained in MidIR spectra

of bulk soil integrates SOM chemical composition with site environmental and soil conditions that influence SOM degradation state. The observed relationships also highlight the potential of linking information derived from MidIR to soil forming factors, which can facilitate geospatial extrapolations of SOM degradation state across the region.