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# MOLECULAR-LEVEL CHANGES TO SOIL ORGANIC MATTER WITH INCREASING SOIL TEMPERATURE

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Global warming may change soil organic matter (SOM) quality and the potential for soil to change from a carbon sink to a source are major concerns and a source of uncertainty in climate change models (Knorr *et al.*, 2005). Current soil warming experiments have focused on bulk SOM characteristics which may conceal important changes in the composition of SOM. In this study, biomarker Gas Chromatography/Mass Spectrometry (GC/MS) and Nuclear Magnetic Resonance (NMR) spectroscopy methods were applied to investigate the molecular composition of SOM in a mixed forest in southern Ontario, and to examine the degradation of various litter and SOM fractions in a 14-month field warming experiment.

The soil warming experiment consisted of a control, a middle-site, and a warming block in a moist mixed forest with a homogeneous topography and evenly-distributed vegetation. The temperature differences between the control and warming blocks ranged from 3.5-6°C. After the 14-month warming treatment, the soil organic carbon content was greatly enriched in the warmed block (6.49%) as compared with that of the control (3.88%; Figure 1), suggesting that the increase in carbon input was higher than the increase in carbon degradation with soil warming. For individual SOM components, the impact of soil warming was also related to the chemical recalcitrance of the compounds and other physical properties (such as physical protection by clay minerals). For instance, carbohydrates, which are considered to be among the most labile fraction of SOM (Gleixner *et al.*, 2001), were easily degraded in the warmed block despite a higher carbon input (Figure 1). Conversely, steroids and terpenoids, which were less labile, increased in the solvent-extractable soil lipid fraction with warming, probably due to a higher input (Figure 1). Similarly, cutin-derived compounds, which are considered to be a more “stable” SOM fraction, increased in the warmed soil likely due to the enhanced degradation and input of leaf litter with increasing temperature, while suberin-derived compounds, another component of the bound lipids, remained similar with soil warming (Figure 1). Interestingly, lignin compounds, which are usually considered to be refractory due to their aromaticity (Gleixner *et al.*, 2001), decreased in the warmed soil

(Figure 1). Lignin degradation parameters (ratios of acid to aldehyde) of both litter and soil samples also confirmed the enhanced degradation of lignin with soil warming. Increased fungal biomass in the warmed soil, as represented by phospholipid fatty acid biomarkers, may be responsible for the elevated lignin degradation because fungi are considered the primary decomposer of lignin in the soil environment. This study shows that there is great potential for lignin transformation with soil warming, which may have large impact on the climate change models and SOM composition with global warming.

Finally, the warmed and control soils were further examined with NMR spectroscopy to investigate the composition of SOM that was not “amenable” by the GC/MS biomarker analyses. The preliminary results from our NMR analyses showed that microbial biomass might account for the increased carbon content in the warmed soil.

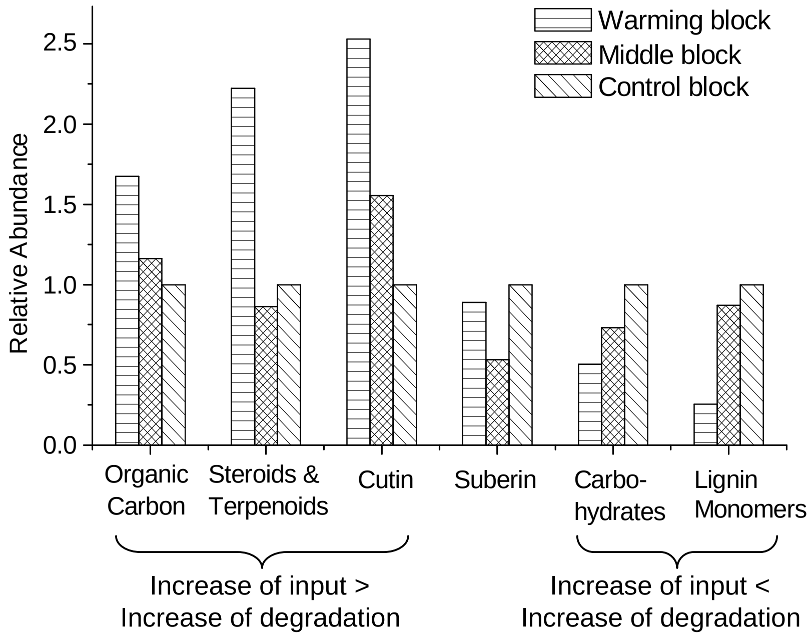


Figure 1. Relative abundance of organic carbon and various soil chemical fractions from the soil warming experiment. Relative abundance = concentration in the warming or middle-block soil/ that in the control soil.

## REFERENCES

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