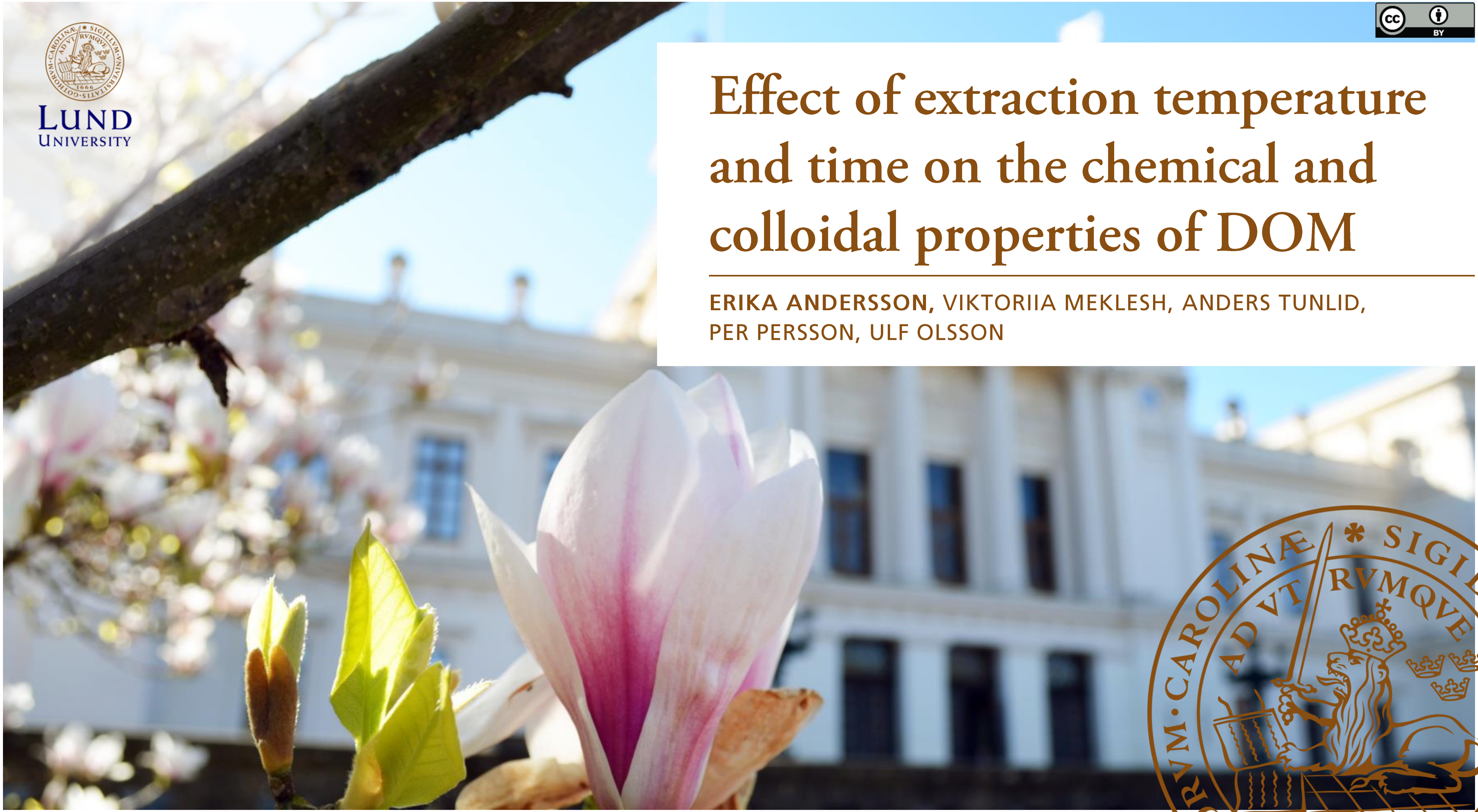

Effect of extraction temperature and time on the chemical and colloidal properties of DOM

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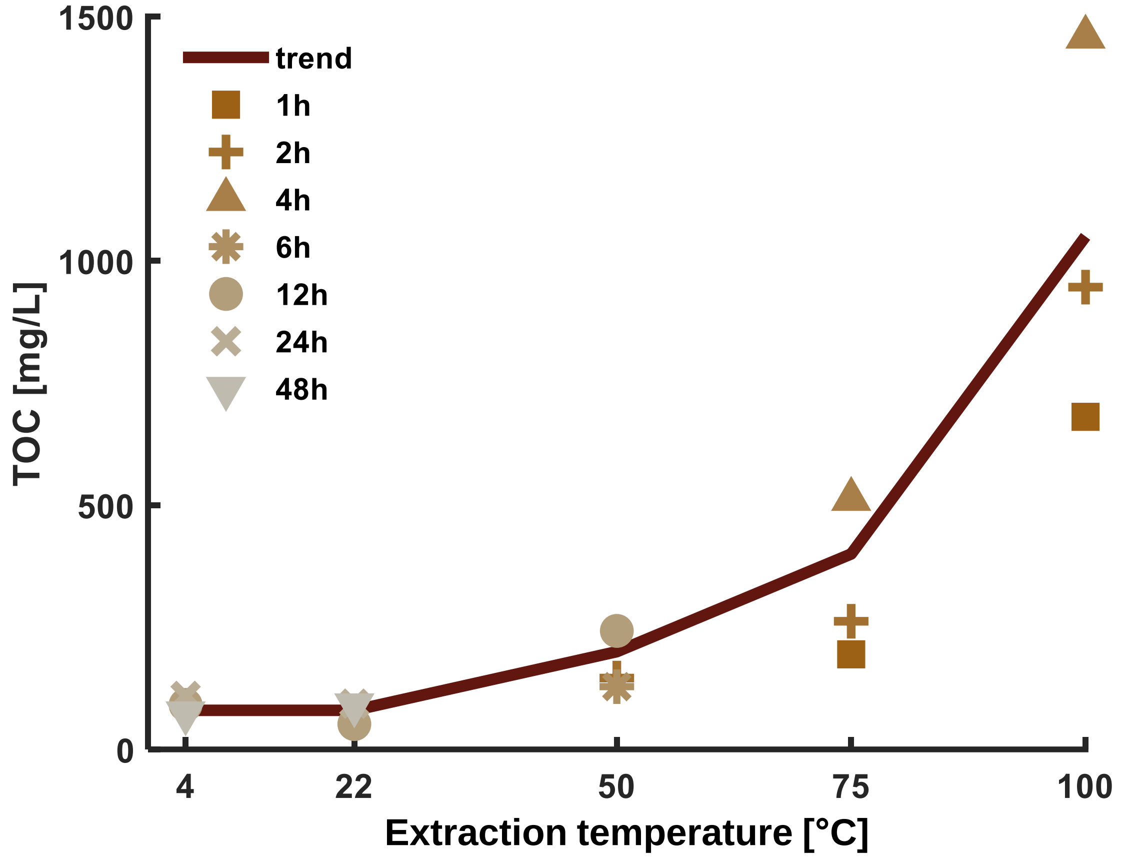
1. Introduction

The effect of extraction procedure on the properties of dissolved organic matter (DOM) is an ongoing discussion. The traditional approach is to use alkaline solvents to extract DOM from soil although it is getting more common to use water, either cold or boiling. We argue that DOM should be extracted in a way closely resembling the natural process to obtain a representative material for further studies of biogeochemical processes such as microbial decomposition.

Here we present a systematic study of the effects of extraction temperature and time on the chemical and colloidal properties of DOM extracted with water (filtered down to 0.2 µm) from a boreal forest soil collected in southern Sweden. Extractions were performed at 4°C and 22 °C for 12, 24 and 48 hours, at 50°C for 2, 6 and 12h and at 75°C and 100°C for 1, 2 and 4h. A combination of techniques were used for analysis and differences between the extracts are observed. This shows the importance of extraction procedure when studying processes involving DOM.

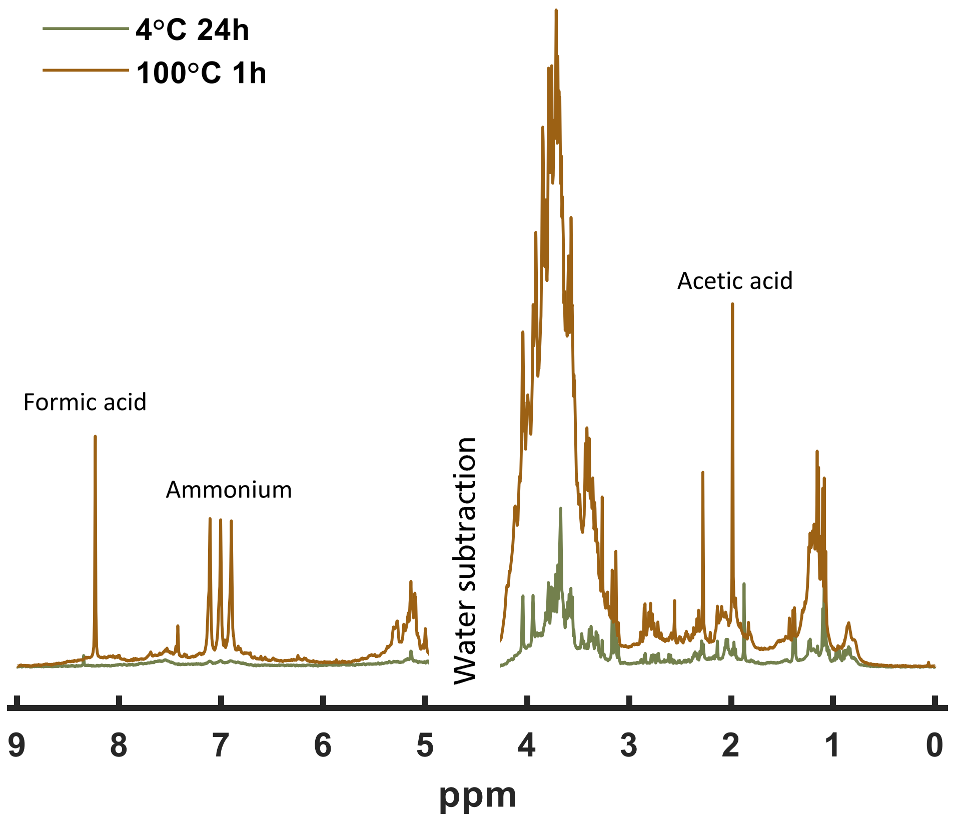
2. Concentration



Total organic carbon (TOC) was measured to estimate concentration differences between the extracts. The concentration of extracted organic carbon increase with increasing temperature, after room temperature is exceeded. However the increase is larger when above 75°C. No maximal extractable concentration is reached with longer extraction time at higher temperatures.

The trend line is constructed from the average concentration of the three extraction times at each extraction temperature.

3. Chemical composition

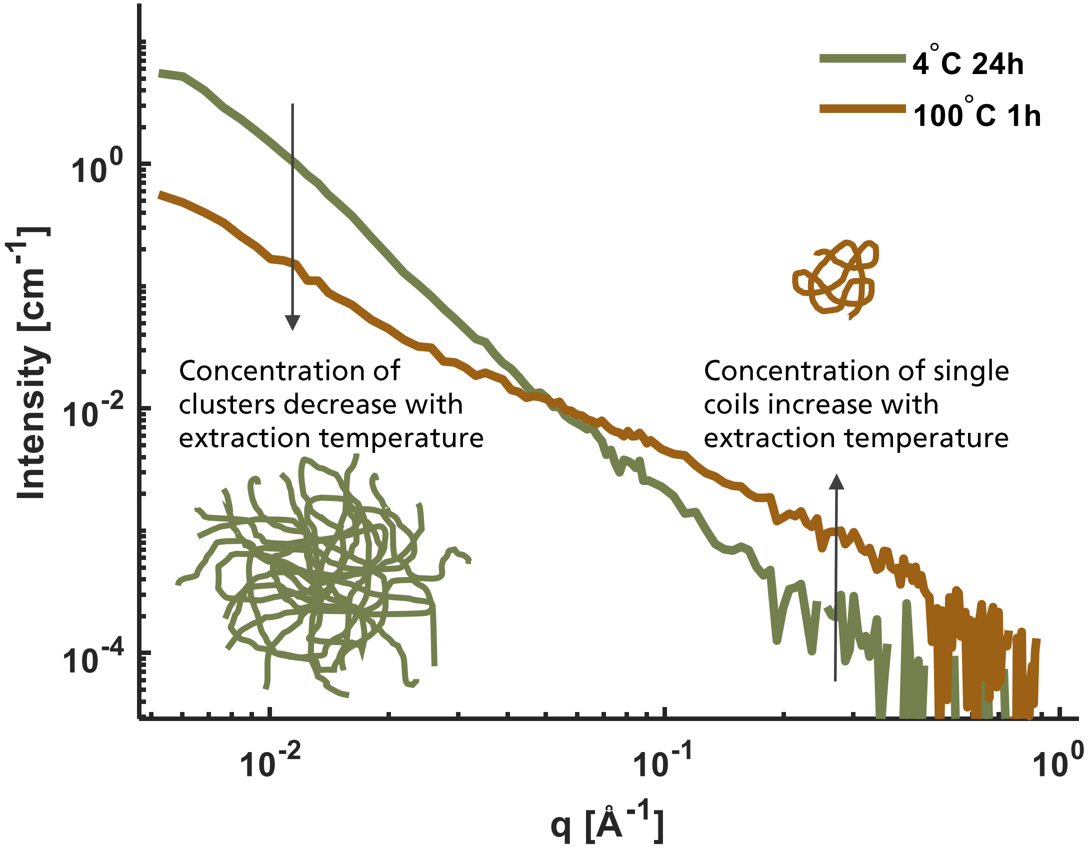


[1]H nuclear magnetic resonance (NMR) is a useful technique for analysing chemical composition in solution. Apart from the components assigned in the figure the region from about 0.6-1.6 ppm show resonances from aliphatic components, 3-4.3 ppm from carbohydrates and 6-9 ppm from aromatics. From our data we conclude that the major component of the DOM is a mixture of carbohydrates, regardless of extraction temperature. This has also been confirmed by ^{13}C solid state NMR (data not shown). Observe that almost no aromatic resonances are observed in contrast to what is commonly seen in humic acids[1].

The intensity of the signal is proportional to the concentration of material and we see, as in the TOC, that the concentration is higher at higher extraction temperature. This is true for all detected components.

[1] Water-resources investigations report 89-4196, Thorn et al, 1989

4. Colloidal structure



Small angle x-ray scattering (SAXS) can be used to study the particle structure of colloidal DOM on the length scale of around 1-100 nm. Based on our conclusion from NMR we have fitted our SAXS data with a model combining the scattering of single flexible polymer coils (carbohydrates) and large fractal clusters. At low extraction temperature the scattering is dominated by the large clusters while the scattering from coils increase with extraction temperature. We conclude that the DOM particles are large carbohydrate clusters which dissolve into free polymer coils when extracted using hot water.

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5. Summary

DOM extracted from a boreal forest soil using water was mainly composed of carbohydrates as concluded by NMR. SAXS showed that the DOM particles were arranged as large clusters which dissolved into single polymer coils at elevated extraction temperatures. This made it possible to extract a higher concentration of below 0.2 µm particles of DOM as seen by the TOC and NMR.

The structural difference of the DOM particles may affect biogeochemical processes such as interactions with mineral particles and decomposition. Therefore we argue that DOM preferably should be extracted using water of a temperature resembling the natural conditions studied.

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