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Stabilization of polar soils organic matter: insights from 13-C NMR and ESR spectroscopy

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Polar soils play a key role in the global carbon balance, as they contain maximum stocks of soil organic matter (SOM) within the whole pedosphere. Low temperature and severe conditions provides the accumulation of large amounts of organic matter in permafrost soils over thousands of years. The quality and composition of organic matter of polar soils is underestimated. In order to better understand the implication of permafrost SOM to greenhouse gas emissions, an accurate knowledge of its spatial distribution, both in terms of quantity and quality (i.e. biodegradability, chemical composition and humification degree) is needed. The chemical composition of SOM determines its decomposability and, therefore, it determines the rate at which carbon may be transferred from soils to the atmosphere under warming conditions. Biodegradability of SOM has been related to humification degree, as more advanced stages in the humification process imply a depletion of the labile molecules, as well as an increase in the bulk aromaticity, which provides a higher stability of the SOM. Soils from Antarctic and different sectors of Arctic biome were investigated by 13-C NMR and electron spin resonance spectroscopy. It was shown, that the characteristic feature of polar soils humic acids is the dominance of aliphatic compounds on the aromatic one. This is related to the humification precursors component composition, namely to dominance of the remnants of lower plants, especially in Antarctic and low period of biological activity, which regulates the humification rate. Humic acids of Antarctic and various Arctic soils show the portion of aromatic components not more than 30 %. ESR spectroscopy shown that the concentration of free radicals is proportional to the humic acids stabilization degree. Less humified organic materials show the highest portion of free radical content, while the most developed soils and buried organic layers show decreased contents of free radicals. The database on soil organic matter composition of polar soil should be created with aim to evaluate current state of the humosphere and to provide the prognostic scenarios of possible mineralisation of humus.