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Climatic Control of Sulphur Biogeochemistry in Soils at the Continental Scale

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As an essential macronutrient, sulphur (S) is usually not limiting in soils due to widespread and significant deposition from polluted atmosphere. However, the worldwide air pollution control has substantially reduced atmospheric S deposition on land, making S increasingly limiting in soils. Soil S exists mainly in organic forms, but inorganic sulphate is the only form available to root uptake. Thus, decomposition of organic S to form sulphate is becoming an increasingly important pathway to supply nutrient S to plants, considering the declining atmospheric S deposition. Climate largely controls biogeochemical cycles, but how it affects the degree of decomposition of soil organic S remains unclear. Moreover, soil organic S can be stored in both mineral-associated organic matter (MAOM) and particulate organic matter (POM). As MAOM is more stable against microbial decomposition than POM due to mineral protection, organic S in them may also differ in the stability against decomposition. Thus, it is necessary to determine whether and how the decomposition degree of organic S in these two fractions differ in their dependence on climate. Here, we use S K-edge XANES spectroscopy to determine the decomposition degrees of organic S in both MAOM and POM in soils collected across a climate gradient at the continental scale. Preliminarily results showed that the decomposition degree of organic S in MAOM was higher than that in POM, and both increased similarly with increasing mean annual temperature. The decomposition degree of organic S in MAOM substantially decreased with increasing effective soil moisture defined as the difference between mean annual precipitation and potential evapotranspiration, but the degree in POM did not depend on the moisture at all. Ongoing data analyses will reveal the contributions of other environmental factors (vegetation and edaphic variables) to the S decomposition degree at the continental scale. Our preliminary findings suggest that climate plays a major role in S biogeochemical cycling, but the sensitivity of the cycling in response to climate change depends on whether S is stored in MAOM or POM.