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Change in sulphur pools in forest ecosystems following the reduction of atmospheric sulphur dioxide

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Due to the reduction in sulphur (S) emissions, atmospheric sulphur dioxide (SO₂) concentrations and sulphur deposition in Europe decreased significantly in the last decades. Sulphur is an essential plant nutrient needed for the production of certain amino acids. Its compound sulphate is the principal anion in soil solution and a driver of base cation and aluminium leaching from soils. However, few studies have examined changes in sulphur pools in forest ecosystems as a response to reduction of S deposition. Within the monitoring framework of UNECE/ICP Forests (International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests) sulphur compounds in soil solution, biomass and deposition have been monitored for many years across Europe, allowing the evaluation of sulphur pools and dynamics in forest ecosystems. Here, we quantified the change in sulphur pools (soil solution, foliar and litterfall content) in the study period 2000 to 2014 across Europe, focusing on forest ecosystems dominated by European beech, Norway spruce and Scots pine. Our results show how the magnitude of decline in atmospheric SO₂ concentration and S deposition as well as climate and tree species moderate sulphur cycling in forest ecosystems, while the absolute effect can differ due to site-specific factors. This study increases our understanding regarding the long-term effects of elevated SO₂ concentration and S deposition and helps to evaluate the time scales and magnitude at which forest ecosystems react to changes in sulphur inputs. Eventually, consequences for forest ecosystems in countries with ongoing high atmospheric sulphur emissions and deposition may be predicted. On the other hand, the results may be used to improve predictions of forests likely to become deficient in S.