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# Historical changes in air temperature are evident in temperature fluxes measured in the sub-soil.

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Warming trends in soil temperature have implications for a plethora of soil processes, including exacerbated climate change through the net release of greenhouse gases. Whereas long-term datasets of air temperature changes are abundant, a search of scientific literature reveals a lack of information on soil temperature changes and their specific consequences. We analysed five long-term data series collected in the UK (Dundee and Armagh) and Canada (Charlottetown, Ottawa and Swift Current). They show that the temperatures of soils at 5 – 20 cm depth, and sub-soils at 30 – 150 cm depth, increased in line with air temperature changes over the period 1958 – 2003. Differences were found, however, between soil and air temperatures when data were sub-divided into seasons. In spring, soil temperature warming ranged from 0.19°C at 30 cm in Armagh to 4.30°C at 50 cm in Charlottetown. In summer, however, the difference was smaller and ranged from 0.21°C at 10 cm in Ottawa to 3.70°C at 50 cm in Charlottetown. Winter temperatures were warmer in soil and ranged from 0.45°C at 5 cm in Charlottetown to 3.76°C at 150 cm in Charlottetown. There were significant trends in changes to soil temperature over time, whereas air temperature trends tended only to be significant in winter (changes range from 1.27°C in Armagh to 3.35°C in Swift Current). Differences in the seasonal warming patterns between air and soil temperatures have potential implications for the parameterization of models of biogeochemical cycling.