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Modelling leaf litter and topsoil carbon stocks in Italian beech forests under a climate change scenario

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Climate change will likely affect both forest species distributions and organic carbon cycle, especially in the Mediterranean region. In Italy, beech forests are the most important ecosystem for their carbon stock, but are also highly threatened by climate change. Accordingly, a recent study showed a substantial reduction in beech range, especially in southern regions, along with a reduction in topsoil organic carbon between 64.5% and 98.8% under different IPCC scenarios. Such carbon stock in the first 5 cm of soil was shown to be significantly related to temperature seasonality and elevation. Following these results, we have conducted an elevational transect in 10 beech forests in Italy, sampling 3 stands at increasing elevation distance of 200 m from each other. In each of these 30 plots, we have collected leaf litter and topsoil (0-5 and 5-10 cm). A preliminary analysis of the relationship between organic carbon stocks and the two previous ecological predictors, i.e. temperature seasonality and elevation, showed a much stronger trend with the former, but the presence of spatial autocorrelation in the data. Accordingly, we have modeled carbon stock in the three layers using generalized least squares (GLS) to compensate for spatial autocorrelation, using non-correlated bioclimatic variables as predictors (including temperature seasonality and elevation). Our models were projected on current, potential and future (2070 RCP6) beech extent according to previous species distribution models. Considering the sum of leaf litter and topsoil, our results showed, on the one hand, a strong reduction of organic carbon stock, from 121 Tg under current beech extent to 225 Tg for 2070, taking into account a potential stock under current conditions of 410 Tg. On the other hand, organic carbon stock concentration was forecasted to increase, from 80 Mg/ha under current and potential conditions to 122 Mg/ha for 2070. Such increase will be much more evident in the Southern Apennines (up to 4 times) compared to the Alps (almost no change). These results are explainable in light of the change in temperature seasonality, a driving variable in all of our models, which is forecasted to increase from actual 6.2 to 6.9 °C for 2070 within beech extent.