Global trends of soil organic carbon based on soil moisture and ensemble learning

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The response of SOC spatial variability to different soil moisture conditions has not been explored at the global scale in part due to the lack of continuous information of these variables across large areas of the world. Analyzing this relationship could be useful to reduce the current uncertainty around SOC distribution and change. Large scale models and SOC mapping efforts contrast with country specific SOC maps, and large uncertainties on SOC magnitudes and patterns remain across large areas of the world. Our main objective was to explore SOC trends using soil moisture values as prediction factors. Using SOC point data from the World Soil Information Service (WoSIS, n=87002 point data between the years 1991 and 2015) we applied a cross validation-based ensemble learning approach to generate continuous SOC maps in a quinquennial basis (limited to 0-30 cm depth). The cross validated root mean squared error (RMSE) of our ensemble for the period 1991 -1995 varied from 32 to 33 g/kg while the correlation between modeled and observed data varied from r=0.45 to r=0.55. The accuracy of SOC estimates increased for the period 2011-2015 (r=0.75 to r=0.81 and RMSE= 20 to 23 g/kg). However the lower RMSE (16 to 17 gr/kg) was found for the years 2001-2005 (r=52 to r=58). Trend detection analysis applied to SOC predictions reveal areas showing significant (p-value < 0.05) positive trends across ~2.7 million km2 at the global scale ranging from 0.3 to 29 g/kg. Significant negative trends of SOC were found across ~3.6 million km2 at the global scale ranging from -22.2 to -0.3 g/kg. Main SOC losses were found across North America, Europe, central Africa, and Siberia. Our results quantifying the response of soils to changing soil moisture conditions contribute with new insights that are useful for the development of soil carbon monitoring systems.