Constraining climatic controls on soil iron content

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Iron is an essential redox-sensitive nutrient whose concentration in the critical zone impacts life's ability to flourish. Constraining which climatic and environmental factors most strongly control soils' Fe content will improve our understanding of the distribution of soil Fe, its bioavailability, and how this distribution may change with climate change. B horizons of modern soils from the contiguous United States were collected, representing multiple climate regimes with a mean annual precipitation (MAP) range of 113 to 4592 mm yr^{-1} and a mean annual temperature range of 4.1 to 22.9°C. Soils' bulk geochemistry, C content, and Fe-bearing minerals were analysed; sequential Fe extraction was used to measure four Fe "pools." Geochemical data were correlated to climatic and environmental variables using Principal Components Analysis. Soils' Fe content and dominant climate variables depended strongly on climate regime. MAP, range in precipitation, solar radiation, and soil energy influx strongly predict reduced iron minerals and lower pH, particularly for soils with a Mediterranean climate regime; this suggests that seasonality in precipitation can be an important control on soil iron content depending on climate regime. For soils in temperate climate regimes, the mean range in temperature exerted the most control. For soils in arid climate regimes, pH was the strongest predictor of soil behavior. Therefore, climatic controls on soil Fe content vary across climate regimes, elucidating some mechanisms behind the distribution of this essential nutrient. Additionally, soil Fe content may be a useful indicator of climate regime through space and time.