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The effects of seasonal variability of precipitation and vegetation cycle on enhanced weathering for carbon sequestration

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Enhanced weathering (EW) is one of the most promising technologies for sequestering atmospheric carbon. It consists on accelerating the chemical weathering fluxes naturally occurring in soils, by means of the addition of silicate minerals (i.e., *forsterite*), used as amendments, to the soil. If crushed into micrometer-sized particles, these minerals are characterized by high dissolution rates, that may be further improved under high soil water content and low pH conditions. Before actually applying EW technique at the global scale for carbon sequestration, an in-depth characterization of weathering and carbon sequestration rates, under different environmental conditions, is needed, also looking at correlated beneficial/detrimental effects. In this context, modeling approaches may play a pivotal role, since they allow to achieve this goal without affording costs required by laboratory and field experiments. The present study describes the application of a dynamic mass balance model connecting ecohydrological, biogeochemical and olivine dissolution dynamics. The model is composed of four connected components and is solved through an explicit system of eight mass balance total differential equations and an implicit one having 22 algebraic equations.

In this study, the model is applied to two sites in Italy (i.e., Sicily, in the south and the Padan plain, in the north) and two in the USA (i.e., California, in the south-west and Iowa, in the north-central area). The most common crops for the case studies, i.e., wheat for Sicily and California and corn for the Padan plain and Iowa are here considered, along with the most frequent soil types, namely the clay loam for Sicily and California and the silty clay loam for the Padan plain and Iowa. Maps of lithological composition of bedrocks and spatial distributions of soil pH have been also used to calibrate the background weathering flux, responsible of the H^+ consume from all the minerals naturally present in the soil. Apart from deriving the most suitable locations, among those presented, providing the highest weathering and carbon sequestration rates, these simulations allow to assess the role of different climate, crop and soil types on EW dynamics, in perspective to find the combination that maximizes the CO_2 sequestration.