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An approach to assess NEE and C-costs associated with an energy-crop production at different erosion-induced transient states in a typical Northeastern Germany landscape using process-based agroecosystem modeling

D. Chatskikh (1,2), C. Nendel (2), U. Hagemann (3), X. Specka (2), J. Augustin (3), M. Sommer (4), and K. Van Oost (1)

(1) George Lemaitre centre for Earth and Climate Research, Earth and Life Institute, Catholic University of Louvain, Place Louis Pasteur 3, B-1348 Louvain-la-Neuve, Belgium, (2) Institute of Landscape Systems Analysis, Leiniz-Centre for Agricultural Landscape Research (ZALF) e.V., Eberswalder Straße 84, D-15374 Müncheberg, Germany, (3) Institute of Landscape Matter Dynamics, Leiniz-Centre for Agricultural Landscape Research (ZALF) e.V., Eberswalder Straße 84, D-15374 Müncheberg, Germany, (4) Institute of Soil Landscape Research, Leiniz-Centre for Agricultural Landscape Research (ZALF) e.V., Eberswalder Straße 84, D-15374 Müncheberg, Germany

Net Ecosystem Exchange (NEE) and C-costs associated with energy-crop production systems which are outside of NEE must be determined to suggest optimal mitigation options. In theory, NEE can be positive, if SOC is building up, neutral or balanced, with no change in SOC, or negative, if SOC is lost as a result of a soil degradation processes. Unclearness in complex multiscale interactions between different processes in the landscape in combination with a well-known wide range of uncertainties around NEE estimations makes these estimations for landscape scale scarce. In this study we used a process-based modeling to assess C-costs associated with soil erosion, assessing NEE at different erosion-induced transient states in the experiment settled Northeastern Germany (near Dedelow) in a representative section of younger landscape of hummocky ground moraine (CarboZALF-D). We used Monica, a soil-crop-atmosphere model, which is well-validated for various crops and soil in Germany. In the model, NEE (=-NEP) refer to NPP minus C losses in heterotrophic respiration, while NBE (=-NBP) refers to the change in SOC stocks after C losses due to regular (e.g. soil erosion) or occasional (e.g. harvest) disturbances. In this study we applied Monica to analyze relationships between past geomorphic processes, landscape position, crop growth and NEE. In this study we were interested in general trends and associated agroecosystem properties, rather than on magnitude of the fluxes. The results showed that past soil redistribution affected NEE at both positions, while the Monica-based scenarios in combination with data-based interpolations helped to interpret the NEE budgets. The model captured the magnitude of differences in the daily NEE values, but also the differences in an accumulated NEE fluxes between different erosion-induced transient states. Thus for both eroded and deposited positions NEE was negative. However absolute values of NEE were smaller for the deposited site compare to the eroded one, and NBE was only slightly different from zero for both landscape positions. The approach might be applied for a long-term analysis of an agroecosystem evolution at the landscape scale. But in this case inclusion of the budgets requires validation against additional long-term SOC and NEE data is needed to increase credibility of this modeling. Moreover, the results of the modeling presented in this study were satisfactory only when landscape hydrology has been considered (based on measured precipitation and water contents at different landscape positions).