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Towards a model-based inventory of soil organic carbon in agricultural soils for the Swiss greenhouse gas reporting

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The Swiss inventory submission under the United Nations Framework Convention on Climate Change (UNFCCC) reports on changes in soil organic carbon stocks under different land-uses and land-use changes. The approach currently employed for cropland and grassland soils combines Tier 1 and Tier 2 methods and is considered overly simplistic. As the UNFCC encourages countries to develop Tier 3 methods for national greenhouse gas reporting, we aim to build up a model-based inventory of soil organic carbon in agricultural soils in Switzerland.

We conducted a literature research on currently employed higher-tier methods using process-based models in four countries: Denmark, Sweden, Finland and the USA. The applied models stem from two major groups differing in complexity – those belonging to the group of general ecosystem models that include a plant-growth submodel, e.g. Century, and those that simulate soil organic matter turnover but not plant-growth, e.g. ICBM. For the latter group, carbon inputs to the soil from plant residues and roots have to be determined separately.

We will present some aspects of the development of a model-based inventory of soil organic carbon in agricultural soils in Switzerland. Criteria for model evaluation are, among others, modeled land-use classes and land-use changes, spatial and temporal resolution, and coverage of relevant processes. For model parameterization and model evaluation at the field scale, data from several long-term agricultural experiments and monitoring sites in Switzerland is available. A subsequent regional application of a model requires the preparation of regional input data for the whole country – among others spatio-temporal meteorological data, agricultural and soil data. Following the evaluation of possible models and of available data, preference for application in the Swiss inventory will be given to simpler model structures, i.e. models without a plant-growth module. Thus, we compared different allometric relations for the estimation of plant carbon inputs to the soil from yield data that are usually provided with the models. Calculated above- and below-ground carbon inputs vary substantially between methods and exhibit different sensitivities to yield data. As a benchmark, inputs to the soil from above- and below-ground crop residues are calculated with the IPCC default method. Furthermore, the suitability of these estimation methods for Swiss conditions is tested.