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Long-term soil organic carbon changes in cereal and ley rotations: model testing

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Reliable modeling of soil organic carbon (SOC) dynamics in agroecosystems is crucial to define mitigation strategies related to crop management on the farm scale as well as the regional scale. International climate agreements and national political decisions rely to a large extent on the National Greenhouse gas Inventory Reports that are submitted annually to the UNFCCC. However, lower tier methods are used to estimate SOC changes on cropland in most country reports. The application of mechanistic models in national greenhouse gas inventory estimation requires proper model testing against measurements in order to verify the estimated emissions. Few long-term field experiments measuring SOC stock changes have been conducted in Norway. We evaluate the performance of the Introductory Carbon Balance Model (ICBM) in simulating SOC changes over 60 years in a field experiment conducted in Ås from 1953-2013. The site is located in south-eastern Norway, on the boarder of the boreal and temperate climate zone, where the majority of the country's grain production occurs. The field trial consisted of four rotations: I) continuous cereal, II) cereal + row crops, III) 2 years of ley + 4 years of cereal, IV) 4 years of ley + 2 years of cereal, and four treatments per rotation: a) low NPK, b) high NPK, c) low NPK + FYM, and d) straw (on rotations I and II) or high NPK + FYM (on rotations III and IV). The annual external modifying factor of the decomposition rate was calculated based on daily minimum and maximum temperature, precipitation, relative humidity, wind speed, and net radiation, and adjusted for soil type and crop management according to default ICBM calibration. We present results of simulated C changes for the long term plots and explore options to improve parameter calibration. Finally, we provide suggestions for how problems regarding model verification can be handled with when applying the model on a national scale for inventory reporting.