Geophysical Research Abstracts
Vol. 15, EGU2013-6639-1, 2013
EGU General Assembly 2013

The ensemble simulations of soil carbon trends over U.S. Midwest under changing climate

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The North American ecosystem is a significant carbon sink and plays a disproportionate role in the global carbon budget. The 42 million ha of corn and soybeans planted yearly in the Midwest constitute 35% of all U.S. cultivated cropland. While Midwest agriculture represents a larger portion of the $200 billion annual U.S. agricultural production, the relative contribution that Midwest agriculture makes to the global carbon budget still remains uncertain, especially under changing climate and changing agrotechnologies that may feedback on climate. In this study, the DayCENT biogeochemical model was applied in the Midwest to evaluate soil organic carbon (SOC) trends in the mid-21st century under climate change scenarios in an effort to better quantify the contribution that Midwest agriculture makes to the global carbon budget.
The DayCENT model was driven by a 6-member ensemble of future climate projections generated by two general circulation models (Canadian GCM and French GCM) under three emission scenarios (B1, A1B, A2). The warm/dry Canadian GCM (CaGCM) predicted a growing-season (May-September) warming of 0.6 oC from the late 20th century to the mid-21st century, much smaller than 2.8oC warming predicted by the cold French GCM (FrGCM). The trends in growing-season precipitation vary from 9 mm (2.6%) in CaGCM to 8 mm (1.3%) in the FrGCM, although both are small compared to 6% increase over the whole U.S. during the course of the 20th century. Driven by this ensemble, DayCENT shows that SOC in the Midwest as a whole is expected to decline by 2-5% from the late 20th to the mid-21st century. However, the magnitudes of the trends and their signs highly depend on precise geographical regions, the climate model used to generate the ensemble, and the emission scenarios. The projected decrease in SOC occurs despite the fact that future net primary production (NPP) increases faster than respiration because grain and stack harvests remove a large portion of NPP.