Title: Carbon cycle dynamics within Oregon's urban-suburban-forested-agricultural landscapes

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Our research team at Oregon State University launched a new project on the effects of land use and land cover on the exchanges of carbon, water and energy in current and future climate conditions across a gradient of urban-suburban agricultural and forested landscapes across Oregon. The region spans strong gradients from high population/high forest productivity/mesic climate in the west to low population/low productivity/arid climate in the east. Land use is changing to reduce GHG emissions.

The study is focused on the effects of (1) conversion of semi-arid sagebrush and Willamette Valley agricultural crops to bioenergy production; (2) afforestation of idle land and rangelands deemed suitable for forests or poplar crops under future climate conditions.

Policy-relevant questions are: How do current land uses and cover affect carbon dynamics, and carbon, water and energy exchanges, including cooling/warming effects? Given possible climate trajectories, what land-use strategies will reduce carbon dioxide emissions while optimizing sustainability of native vegetation and food crops?

Our approach integrates remote sensing land-use/land-cover and data from tall tower CO_2 observations and flux sites with comprehensive modeling approaches using the Community Land Model, CLM4.5. Artificial neural network analysis is used to examine current spatio-temporal patterns in carbon, water and energy exchange, and enhance CLM4.5 to improve its ability to predict these processes and carbon sequestration in the future.

In summer 2014, we installed flux towers in wheat and grass crops and a poplar plantation in the Willamette Valley to provide data for model parameters and testing. First results from the new flux sites indicate significant alterations in the carbon, water and energy exchange associated with land cover change in areas currently used for agriculture. For example, the wheat crop showed a change of the ratio of sensible to latent heat from 1 to 2 and 5 pre-senescence, post-senescence, and post-harvest, respectively. Annual NEP of the wheat crop is expected to be modest (e.g. ~170 g C m^{-2} yr^{-1}; Turner et al. 2007) compared with an average of 480 g C m^{-2} yr^{-1} (range 305-694) observed in highly productive Douglas-fir nearby (NECB and net emissions will be estimated in the future). The poplar plantation leaf-off is about 30 days prior to that of other poplar plantations in the Willamette Valley, so we will model the range of phenological transitions. Remote sensing, including phenocams, will identify timing of leaf emergence and physiological maturity and harvest in the major crop types and poplar plantations for model inputs.

We are using the new CLM4.5 model version that includes crop PFTs, and setting up the model to run at fine resolutions (4 km grid, 3-hourly). Our first analysis is to model current sources and sinks of atmospheric CO_2 in the western part of the region with high population/high forest productivity/high agricultural use. Then we will compare changes in modeled carbon, water and energy with conversion from the non-food crop lands to forest and/or poplar bioenergy crops under future climate conditions. Finally, we will assess the effects of land use changes expected in the whole domain, including sagebrush-steppe areas that are being converted to bioenergy crops in the semi-arid region. We will separate the future climate effects from management effects, and predict the interaction of the two.