

# Response of Soil Respiration to Rain

Xuhui Lee  
Yale University

## Abstract

**Objectives:** The primary objective of the project is to investigate biological and physical mechanisms that control soil respiration in rainstorms. Specifically, we wish to 1) quantify the magnitude of soil CO<sub>2</sub> flux pulse during and immediately after the rain event, 2) compare and contrast the flux pulse among different substrate and soil types such as conifer litter, deciduous litter, and crop residue, and 3) investigate how the flux pulse varies across elevation and soil drainage gradients.

**Locations and Research Activities:** The project consists of three main activities. In activity I, rain simulation experiments will be conducted at Harvard Forest in Massachusetts and three crop sites in Nebraska to discern the relevant biological and physical mechanisms that control the soil carbon flux in rainy weather. In activity II, laboratory incubation will be carried out with the forest floor material, crop residue and soil samples from the sites. In activity III, data from rain simulation and laboratory incubation will be combined with eddy covariance and other tower-based measurements at the sites to discern processes most relevant to the whole-ecosystem scale.

**Hypotheses:** It is hypothesized (1) that the O horizon of forest floor and the crop residue of farmland are more important than other layers in a soil profile in determining the response patterns of soil respiration in rainstorms, and (2) that soil CO<sub>2</sub> responds more strongly to wetting when soil water deficit is greater.

**Methods:** The methodology consists of in-situ observation, field manipulative experiment, and laboratory experiment. Each of the three approaches has its unique advantages and is also sensitive to different errors. It is important that they be used together to provide independent datasets for cross validation. The eddy covariance will provide in-situ observation of the ecosystem-scale CO<sub>2</sub> flux. Special attention will be given to data QA/QC in rainstorms. Rain simulation experiments will be conducted across elevation and soil moisture gradients at Great Mountain and Harvard Forest to discern the relevant biological and physical mechanisms that control the soil carbon flux in rainy weather. Rain simulation will also be carried out at three crop sites in Nebraska to determine how tillage alters the relationship between soil moisture and soil respiration. Laboratory incubation will be carried out with soil substrate collected from these sites. The incubation experiment will regulate and extend independent variables beyond what could be achieved economically with the EC and field manipulative experiments.

**Expected Results:** The project will make two original contributions to the science of terrestrial carbon cycle. First, current knowledge of the influence of soil moisture on soil respiration is based in large part on field research in fair weather. Because of the rapidly changing soil biophysical environment in rainstorms, processes that govern soil C flux may be quantitatively different from those in fine weather. Second, eddy covariance (EC), the Ameriflux core methodology, is more likely to malfunction in rainy weather than in dry weather, creating data gaps that must be filled in post-field data analysis. It is often assumed that the response function established in fine weather can be extended to rainy periods. The validity of this assumption is unknown given the difficulty of flux measurement in rain.