2012 Biogeosciences REU Potential Projects

From Climate Change to Contamination: Stable Isotopic Composition of Water in Central Iowa

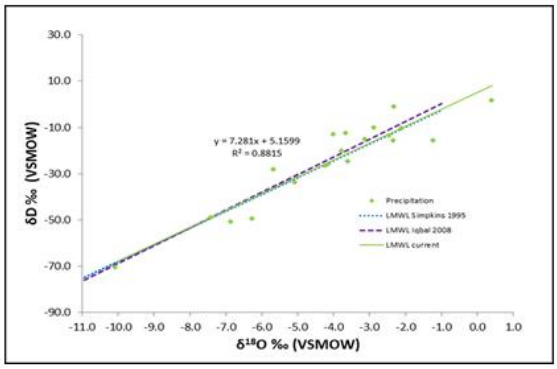
Mentors: Drs. Alan D. Wanamaker and William W. Simpkins, Department of Geological and Atmospheric Sciences

Stable isotopes of oxygen and hydrogen are useful environmental tracers and indicators of climate change in hydrologic systems. Students will discover the power of these isotopes by field sampling of rivers, lakes, precipitation, and groundwater in central Iowa. They will analyze the isotopic composition using a Picarro L1102-i Isotopic Liquid Water Analyzer and produce a local meteoric water line with the data. Results will be compared to previous data from the region to show sources and sinks of water and identify changes in isotopic composition due to climate change.

Picarro L1102-i Isotopic Liquid Water Analyzer located in the lab of the Stable Isotope Paleo-Environments Research Group (SIPERG)

REU participants install rainfall collector for isotopes at River Valley Park in Ames

REU field trip to install seepage meters on Deer Lake, Itasca County, Minnesota



2011 Meteoric Water Line for central Iowa produced during Summer 2011 REU

Satellite Remote Sensing of Water in Agricultural Ecosystems

Mentor: Dr. Brian Hornbuckle, Department of Agronomy

How will the water cycle change and what role will agriculture play? Our research group monitors the land surface water cycle at a unique NASA-funded and USDA- supported outdoor laboratory that we call the Iowa Validation Site. We use the data collected here to understand how satellite remote sensing can be used to monitor water over larger regions. Summer students would make field measurements and analyze data.

Sensors and sampling at the Iowa Validation Site

Integrating prairie vegetation within row-cropped agricultural landscapes

Mentor: Dr. Matt Helmers, Department of Agricultural & Biosystems Engineering

Restoration of native prairie systems within crop production systems is a promising strategy for erosion control and water quality improvement in agricultural landscapes. Twelve watersheds at the Neal Smith National Wildlife Refuge in Central Iowa are used to evaluate the environmental benefits of prairie strips. Students will participate in field sample collection, downloading data, site maintenance, and data analysis. The work will provide experience involving a long-term field experiment testing the effectiveness of prairie vegetation in reducing soil erosion and nutrient loss from agricultural landscapes. More information on this project can be found at http://www.nrem.iastate.edu/research/STRIPs/index.php

Neal Smith National Wildlife Refuge

Hickory Grove Water Quality Improvement Plan

Mentor: Dr. Michelle Soupir, Department of Agricultural & Biosystems Engineering

Hickory Grove Lake is experiencing event driven water quality problems. In general, the Hickory Grove watershed has few elevation changes and much of the agricultural land is under tile drainage management. Storm related surface runoff has led to gully erosion, debris and nitrogen spikes immediately after these events. We will develop a plan to improve water quality by monitoring event and current conditions and modeling with APEX, SWAT, and WASP models.

Monitoring Hickory Grove Lake

Resuspension of E. coli in sediment laden streams

Mentor: Dr. Michelle Soupir, Department of Agricultural & Biosystems Engineering

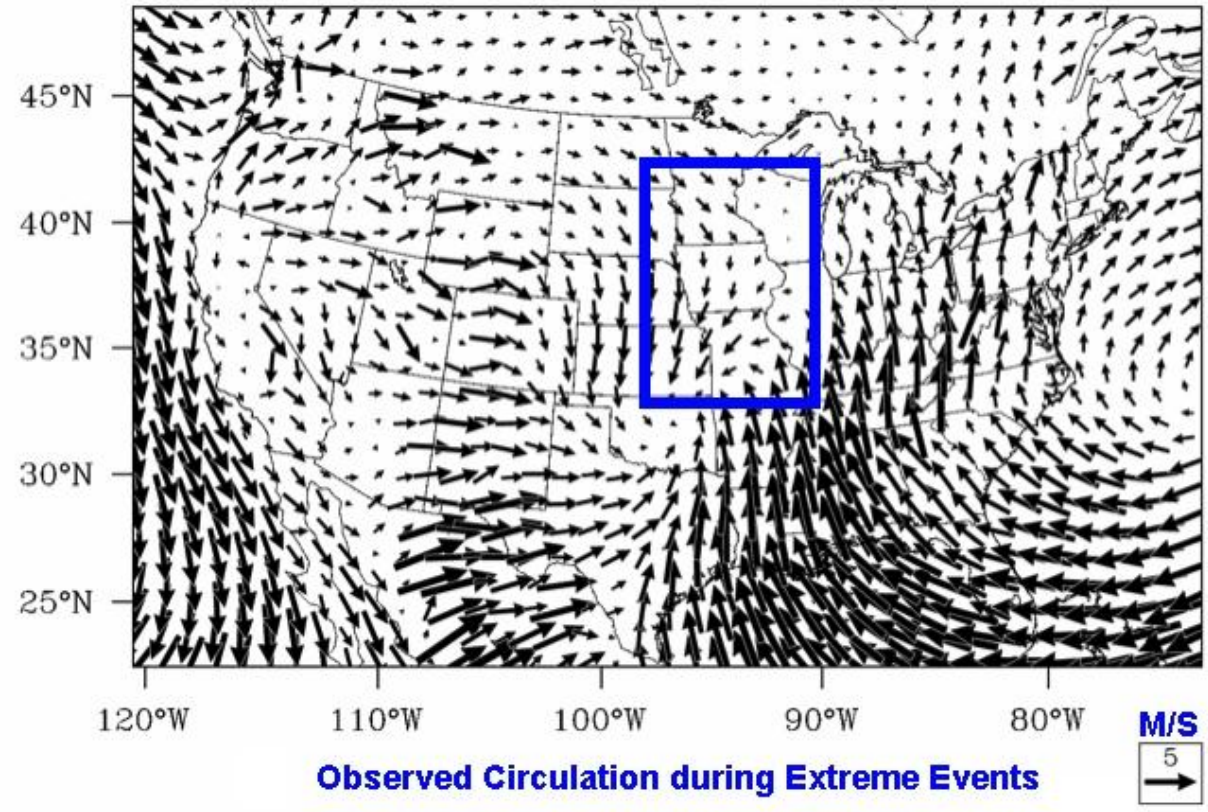
In the United States, harmful microorganisms are the leading cause of impairments in the 300,000 miles of rivers and shorelines and 5 million acres of lakes that do not meet U.S. water quality standards. This project involves field experiments to measure resuspension of E. coli in Squaw Creek, located in Ames, Iowa. We will collect samples during storm events to compare bacteria concentrations before, during, and after high flows and use the results to improve models of the fate and transport of E. coli in streams. This will improve predictions of conditions where a risk to human health is likely and the implementation of land management practices to reduce bacterial pollution in the nation's water bodies.

Stream sampling

Changes in Weather and Precipitation Extremes in Future Climate

Mentor: Dr. Bill Gutowski, Department of Geology and Atmospheric Science

This work will entail analyzing results from recent simulations of climate change that cover the central U.S. The student will look at simulated future changes in extreme precipitation and what causes the changes. The student may also have opportunity to examine how severe weather changes in the future simulations. The work will provide experience with using output from climate models and thus insight into how these models function.

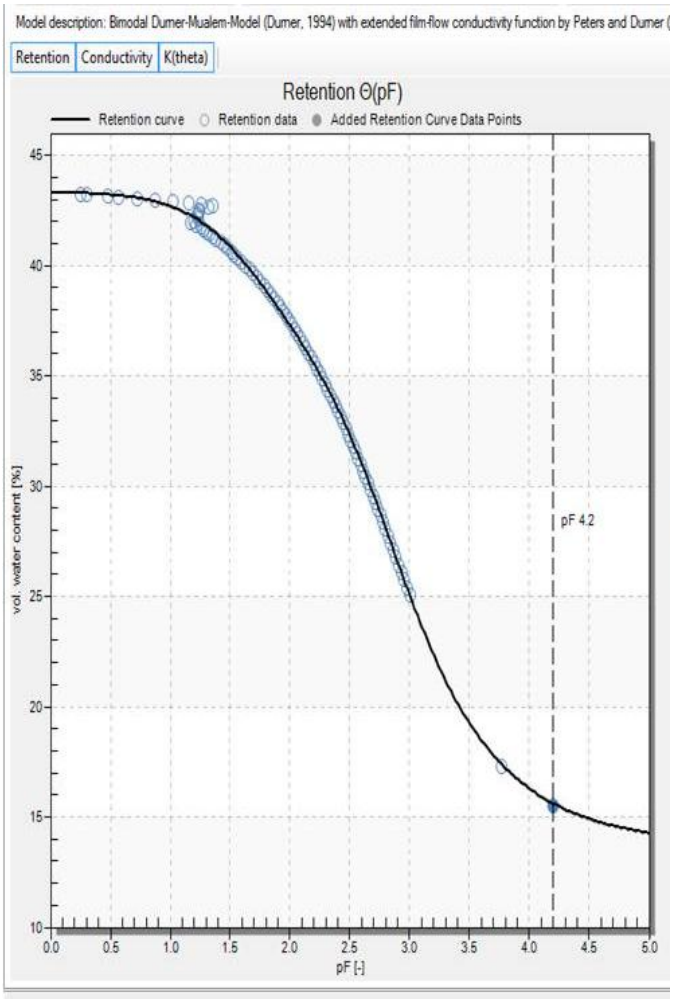


An example of the atmospheric circulation and implied moisture transport (indicated by the arrows) showing how extreme precipitation events in the Midwest can develop and be sustained.

Does Having More Organic Matter Make Soils Drought-Resistant?

Mentor: Dr. Tom Sauer, National Laboratory for Agriculture and the Environment (USDA ARS)

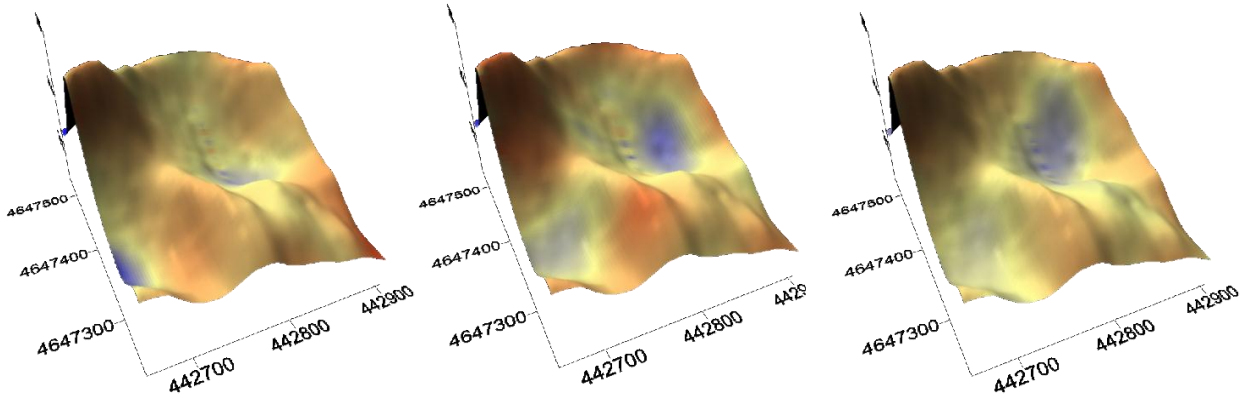
One of the observed impacts of climate change has been an increase in extreme events. Agriculture in rain-fed regions like the Midwest is vulnerable to both too much and too little precipitation (floods and droughts). Techniques to improve soil quality are under investigation for their ability to mitigate climate change effects. New, advanced instrumentation (called the HYPROP system) enables highly accurate measurement of plant-available-water (PAW) in soils. The proposed project would utilize this new technique to quantify PAW content in soils with varying organic matter content but otherwise similar physical and chemical properties.



Mapping Soil Moisture Content

Mentor: Dr. Amy Kaleita, Department of Agricultural & Biosystems Engineering

Soil moisture is a key factor in agricultural production and hydrologic performance of a field or watershed. Soil moisture varies in both space and time, because of interactions with the atmosphere and variations in topography and soil properties. But identifying and understanding the impact of within-field soil moisture patterns is currently limited by the time and resources required to do sufficient monitoring (sampling soil moisture using ground-based contact methods is prohibitively tedious). The launch of the Europeans Space Agency's SMOS (Soil Moisture Ocean Salinity) and the upcoming launch of the NASA's SMAP (Soil Moisture Active Passive) satellite will efficiently produce large amounts of soil moisture data, but the resolution is too coarse to be of immediate value at a farm scale. The aim of this study is to develop techniques to downscale low-resolution soil moisture estimates to generate high-resolution data using computational intelligence methods and sophisticated mapping algorithms.



Visualizations of soil moisture data from a nearby field on three example dates. Blue represents wetter soil, and red represents drier soil.

Biogeochemistry of alternative biomass cropping systems

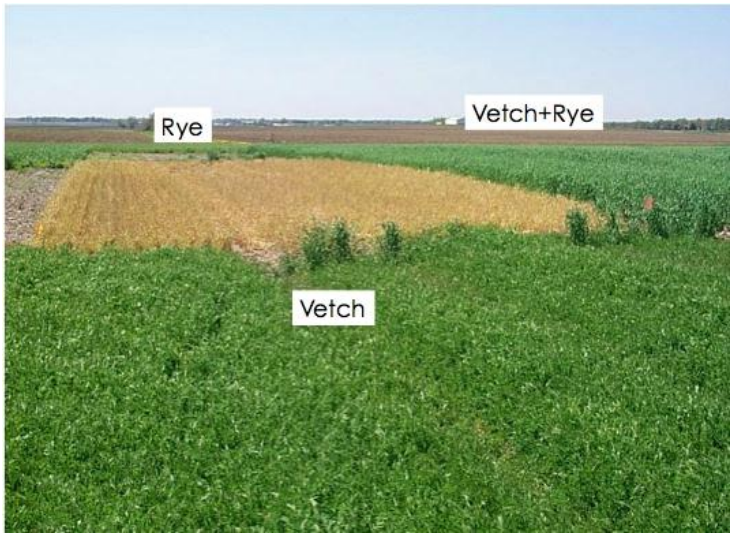
Mentor: Dr. Kirsten Hofmockel, Department of Evolutionary Ecology & Organismal Biology

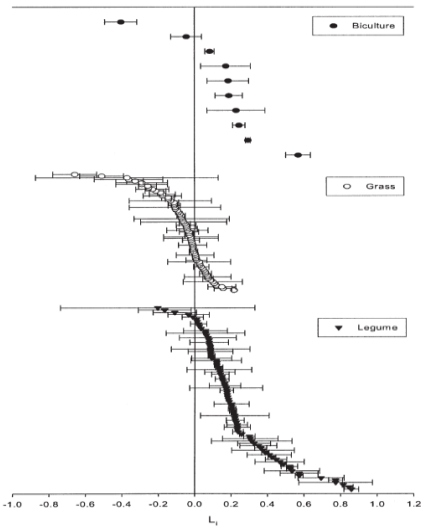
The Hofmockel Lab group investigates the value of several alternative biomass cropping systems based on their potential to support basic microbial pathways regulating C sequestration and greenhouse gas emissions. Our goal is to provide an explicit understanding of belowground mechanisms that regulate C and N cycling in agricultural soils. REU students would have an opportunity to participate in fieldwork, and conduct various laboratory assays, including molecular, biogeochemical and physiological techniques. The overarching goal of this research is to identify specific links between microbial functional guilds and ecosystem processes.

Climate change and Midwest corn cropping systems: evaluating the mitigation and adaptation aspects of cover crops

Mentor: Dr. Fernando Miguez, Department of Agronomy

There is increasing uncertainty about how long-term US climate trends are impacting corn-based cropping systems and threatening agricultural investments. In response, farmers are seeking new ways to ensure continued crop productivity while also minimizing environmental impact. Many varied agricultural management practices have both mitigation and adaption components, including the addition of cover crops to corn systems. A partnering student would contribute to a review evaluating the role that cover crops have on the greenhouse gas balance of Midwest cropping systems, mostly on the cover crop influence on nitrogen dynamics. A potential secondary goal would be to have students contribute to preliminary work aimed at understanding the influence that management practices have on flood response. More information on the overall project: http://sustainablecorn.org/.





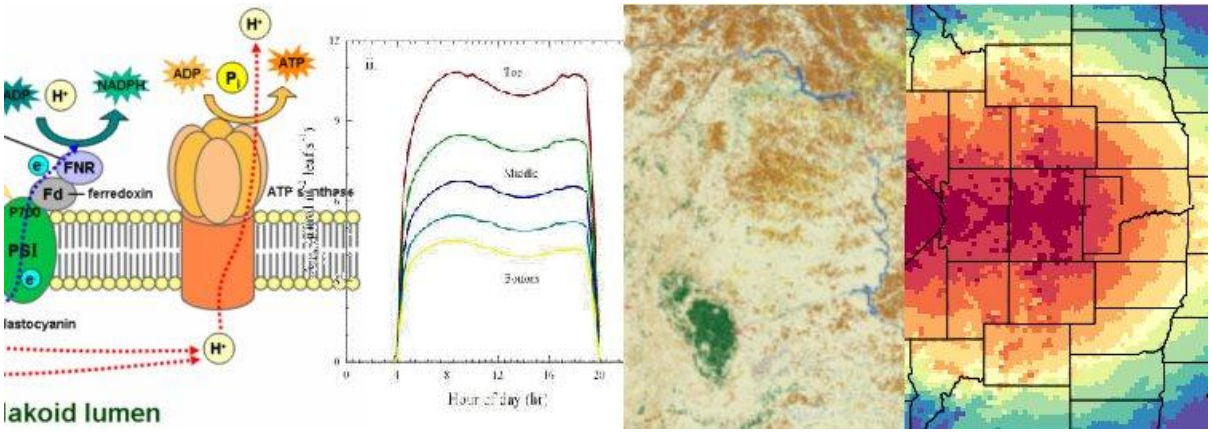
A field with typical cover crop varieties grown in the Midwest.

Using simulation models to predict and improve biomass production

Mentor: Dr. Fernando Miguez, Department of Agronomy

Within a continuous changing environment (climate change, water scarcity and soil degradation), simulation models are the best tools to explore sustainable near future land use systems including food/feed/fuel crops. The agro-ecosystem modeling group will be adapting the Agricultural Production Systems Simulator (APSIM; a platform of soil-plant-atmosphere models; www.apsim.info) to simulated yields and other important agronomic traits for US conditions. The objectives are to review and analyse literature information in order to parameterize, test and finally run simulations for specific US case studies.

APSIM
AGRICULTURAL PRODUCTION SYSTEMS SIMULATOR



Measurement, Monitoring, and Mechanisms of Agroecosystem Nitrous Oxide Flux

Mentor: Mike Castellano, Department of Agronomy

How can ecological principles be applied to mitigate and predict greenhouse gas emissions from high-intensity corn-based cropping systems? Our research evaluates the capacity of soil drainage and cover cropping strategies to reduce nitrous oxide emissions while investigating mechanisms that modulate the magnitude and timing of nitrous oxide fluxes. This research couples monitoring approaches in the field with experimental approaches in the lab. Students will experience both approaches and have the opportunity to collect and analyze data.