Detecting the spatial variation of soil nitrification and denitrification: a multi-scale approach

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Project description:

- **What is soil nitrification and denitrification?**
  Soil nitrification is a microbial process that converts ammonium (NH_4^+) to nitrite (NO_2^-) by ammonia oxidizing bacteria (AOB) and archaea (AOA). NO_2^- is subsequently oxidized into nitrate (NO_3^-) by nitrite oxidizing bacteria (NOB). Nitrous oxide (N_2O), as a byproduct, will be emitted from soil during nitrification. In contrast, soil denitrification is a microbial process that reduces NO_3^- and NO_2^- to N_2O or nitrogen gas (N_2). Soil nitrification happens in aerobic conditions whereas denitrification is an anaerobic process, which happens where oxygen is low or absent.

- **Why should we care about soil nitrification and denitrification?**
  As soil nitrification happens very fast in situ, much of the NH_4^+-containing fertilizer in agricultural soils will be quickly converted to NO_3^-. Because NO_3^- is much more mobile than NH_4^+, soil NO_3^- can be easily leached away by precipitation. This will cause financial loss for farmers and affect water quality adversely. In addition, both soil nitrification and denitrification will generate N_2O, which is a potent greenhouse gas with a global warming potential 298 times higher than CO_2. Soil denitrification also produces nitric oxide (NO) and N_2. While N_2 is considered harmless to environment, NO is highly reactive and can contribute to acid rain. In short, both soil nitrification and denitrification are closely related to climate change and human health.

- **What can we do?**
  Although soil nitrification and denitrification and their environmental consequences have been known for many years, humans have had limited success in controlling either of the process. One important reason is both soil nitrification and denitrification vary vastly across small spatial scales. Because both biotic (such as soil microbes) and abiotic (such as soil moisture and temperature) factors regulate these processes, it is important to study them with a holistic method. In this project, we will try to tackle the problem of spatial variation of soil nitrification and denitrification at plot and ecosystem scales. We will try to answer the questions of what are the controlling factors that explain most of the variation in soil nitrification and denitrification across scales. We will use interdisciplinary approaches.

Other information:
Student and mentor will work together from May 23 – August 5 (11 weeks), 2016, at the W.K. Kellogg Biological Station (KBS) of Michigan State University. This project involves both field work and lab work for about 40 hours per week. The student will learn experimental design, data analysis and interdisciplinary skills including but not limited to microbial ecology, soil science and spatial ecology. Feel free to drop an email to Di Liang (liangdi@msu.edu) for questions this opportunity!