BonaRes Thematic Workshop

Nitrogen Cycling in Agricultural Ecosystems

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May 12-14, 2020, Garmisch-Partenkirchen, Germany.

Including field trip to SUSALPS sites on May 14.

Abstract:

Use and cycling of reactive nitrogen in agricultural ecosystems is on the one hand of pivotal importance to sustain productivity and thus, food security. On the other hand the little efficient use of fertilizer nitrogen by plants results in detrimental effects on soil quality as well as in undesired reactive nitrogen losses along hydrological and gaseous pathways that compromise air, soil and water quality also in adjacent natural ecosystems. This workshop aims at bringing together experts from the BonaRes community in order to summarize the current state of knowledge on nitrogen cycling in agricultural soils and to identify most important knowledge gaps that are relevant to improve nitrogen management, i.e., mainly to improve nitrogen use efficiency and reduce nitrogen losses to the environment.

Furthermore, the workshop participants will discuss opportunities and approaches to synthesize the nitrogen research that is conducted in different BonaRes A projects with the primary goal to identify universal indicators of changes of nitrogen-related soil functions and to identify the key processes that should be considered in modeling N cycling and how they can be parametrized.

Workshop topics

1) The soil microbiome as driver of nitrogen cycling (*Michael Schloter, Michael Dannenmann*)
    a. The soil microbiome as a regulator for nitrogen retention and loss
    b. From DNA analysis to activity (RNA and proteins); operon structures
    c. Linking N, C, P and S cycling
    d. Linking genes and biogeochemical process measurements:
        i. How can we bridge the scales between molecular measurements and N turnover/flux measurements?
        ii. Which genes are indicators for what processes and functions?
        iii. Which molecular indicators are best suitable as early warning systems for changes of nitrogen-related soil functions?

2) Abiotic soil nitrogen cycling (*Nicolas Brüggemann, Michael Schloter*)
    a. Physical processes (e.g., physical nitrate stabilization in aggregates, adsorption)
    b. Chemical processes (e.g., chemodenitrification, reaction of hydroxylamine with nitrite, soil organic matter and the mineral soil matrix).
    c. Links between abiotic and biotic processes

3) Towards the quantification of full nitrogen balances in agricultural soils (*Michael Dannenmann, Ralf Kiese*).
    a. Nitrogen mass balances in different agricultural systems
        i. Is there nitrogen mining or accumulation?
        ii. What are the effects of climate and management changes on nitrogen balances?
    b. What are hardly quantified nitrogen input/output flows that prevent us from developing holistic N mass balances (e.g., dinitrogen emissions, biological nitrogen fixation)? How can we better quantify these processes?

4) Towards improved nitrogen management (*Ralf Kiese, Nicolas Brüggemann*)
    a. Importance of organic fertilization (also in combination with mineral N fertilization) for improvement of soil nitrogen availability, carbon sequestration and soil fertility.
    b. Effects of crop and soil management on nitrogen use efficiency and productivity.

5) How to synthesize nitrogen research of the BonaRes A projects? Can the BonaRes A project data be used to derive universal indicators of nitrogen-related soil functions? (*Hans-Jörg Vogel, Michael Dannenmann, Ralf Kiese, Michael Schloter, Nicolas Brüggemann*)
    Within subtopic 5, the participants – based on the outcome of the workshop - will discuss approaches for synthetic analyses of the work on nitrogen cycling conducted in various BonaRes A projects. A key goal is to identify generally applicable indicators of changes in nitrogen cycling and associated soil functions such as
    - decreasing/increasing productivity
    - soil filter function for nitrate
    - soil organic carbon and nitrogen storage
    - greenhouse gas balance

    For this purpose those parameters (including potential indicators) that are widely measured across the projects are planned to be collected after the workshop with the help of the BonaRes Center and subsequently analyzed for suitability of various indicators (e.g., microbial indicators such as gene abundance or microbial C:N:P:S stoichiometry) that predict changes in soil functions and thus can serve as early warning system.
    Another aspect that will be discussed is how measurements of nitrogen cycling parameters can be used to identify and quantify relevant processes as a prerequisite for modeling nitrogen cycling in response to management strategies.

Participation: Participants from the BoNaRes community, invited external experts. Participants should submit an abstract of max. 300 words, which fits the scope of at least one of the main workshop topics. Deadline for submission of abstracts: Jan 31, 2020.

Registration at: https://www.ufz.de/index.php?en=46684&nopagecache

There are three types of contributions

1) 10 min presentation
2) 3 min impulse presentation with few slides only
3) poster.

During submission of the abstract, the authors can indicate their preferential contribution type.

List of aspects that are of potential use for a synthetic analysis across BoNaRes A projects

Relevant processes:

- Plant N uptake of organic N, ammonium, nitrate.
- Nitrogen use efficiency as derived from dividing plant N exports by fertilizer N inputs
- Nitrogen use efficiency as derived from ^{15}N labeled fertilizer application and tracing in plant and soil
- Biological N fixation (symbiontic, free living) (method: acetylene or direct ^{15}N measurement or mass balance)
- Gross protein depolymerization
- Gross ammonification
- Gross nitrification
- Denitrification
- Microbial immobilization of a) monomeric N, b) ammonium, c) nitrate
- Dissimilatory nitrate reduction to ammonium.
- Abiotic N stabilization in soil organic matter (including stabilization of microbial residues)
- Soil emissions of NH_3.
- Fluxes of N_2O and NO and N_2.
- Leaching of nitrate, ammonium, DON (and DOC)
- Erosion N losses such as colluvial transport mechanisms
- Total N balances including all N mass balance relevant N inputs and outputs
- …..

Relevant boundary conditions:

- Fertilization: form, timing and N input rate
- Atmospheric N deposition
- ….

Measurable state variables

- SOC/TN stocks
- Stability of SOC/TN (physical soil fractions)
- DON, DOC
- Soil ammonium, nitrate and nitrite concentrations
- Soil microbial biomass C and N (fumigation extraction)
- Net ammonification
- Net nitrification
- Denitrification potential/enzyme activity (acetylene-based methods)
- Nitrogen in plant yield
- ….

Relevant information on soil and site

- Ecosystem type, management, history of management
- General soil characteristics
- Climate and weather
- ….

Potential indicators

- Genes and microbial community changes
- Microbial biodiversity
- Abundance and diversity of soil animals
- Microbial C:N ratio
- Soil C:N ratio
- DOC : (DON+DIN) ratio
- Microbial N retention (based on N turnover)
- Diagnostical soil C and N fractions (based on physical density separation)
- ……