Global Patterns in the Carbon Cost of Nitrogen Acquisition

Project Leader: Adrien Finzi (Boston University), afinzi@bu.edu
Participants: Allison Gill (Boston University), agill@bu.edu
Andrew Richardson (Harvard Univ), arichardson@oeb.harvard.edu

Nitrogen (N) limitation of net primary production is distributed across the terrestrial biosphere. Plants access N in soil organic matter through the allocation of fixed carbon to roots and mycorrhizal symbionts. Total belowground carbon flux (TBCF) is one of the largest fluxes in terrestrial ecosystems and is therefore a major component of the global carbon cycle. Allocation of C belowground occurs at the expense of aboveground allocations (leaf area, wood production, maintenance respiration, etc), and thus the magnitude of TBCF implies a substantial cost for the acquisition of soil resources including nitrogen.

The goal of the proposed work is to estimate the C cost of N acquisition at the global scale. To do this we have compiled published information on TBCF (n=84) and the annual rate of net N mineralization (n=249) from sites spanning the tropics to the arctic. We use the annual rate of net N mineralization as a proxy for N uptake because (1) estimates of N uptake based on NPP multiplied by the %N of the component pools would conflate comparisons between TBCF and N uptake (i.e., correlated measurements) and (2) at the large spatial scales of this analysis it is possible to assume systems are in approximate steady state and hence net N mineralization should be very close to the annual rate of N uptake from the soil.

To characterize not only the C cost of N uptake but also the partitioning of gross primary production (GPP) above- vs. belowground, we will use annual GPP estimates derived from eddy covariance measurements of the net ecosystem exchange of CO_2 (NEE).

For this analysis, we propose to use flux data from the FLUXNET "La Thuile" database. We will endeavor to use data from sites spanning as wide a range of biome types as possible. These data will enable a comparison of site-specific rates of annual TBCF to annual GPP in order to compute the proportion of carbon allocated belowground relative to total C fixation. All sites meeting a set of criteria based on data quality flags and data availability will be included. For example, Richardson et al. (2010) retained only those years for which 75 per cent or more of the 30 min periods consisted of actual measurements or were gap-filled with 'high confidence' (Category A in Reichstein et al. 2005), and the fraction of missing daily NEE values did not exceed 5 per cent.

We will follow FLUXNET procedures (e.g. as defined in "Policy_LaThuile_Final.pdf") for keeping data providers informed as we make progress on this analysis, and for inviting data providers to make an intellectual contribution to the project. We will share preliminary results with site PIs whose data we use. Following initial manuscript review, we will invite all PIs who provide data and make a significant intellectual contribution to be coauthors on the subsequent draft and submission. All other data providers will be identified by name in the manuscript acknowledgements.

This analysis will provide fundamental insights into the coupling between the C and N cycles and also generate an important benchmark data set for regional and global scale models.