Mechanistic treatment of plant N use, root-microbe competition, and microbial processes improves high-latitude and global ecosystem carbon budget predictions

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The current versions of the Community Land Model perform poorly when compared to carbon, hydrological, and energy budget observations in high latitude systems. Among the several modeling goals for NGEE-Arctic is the improvement of these processes in CLM so that realistic predictions of the C-climate feedbacks can be integrated in an Earth System Model (CESM or ACME). We report here on modeling progress in CLM that the Berkeley Lab group has recently made to improve representation of (1) nutrient controls on photosynthesis; (2) competition between roots and microbes for nutrients; (3) a microbial model of nitrogen fixation; and (4) interactions between microbes, enzymes, and mineral surfaces. We also present a meta-analysis approach using results from dozens of high-latitude temperature and nutrient addition experiments to evaluate CLM responses to these perturbations. We show that the current method of representing nutrient controls on photosynthesis results in unrealistic nitrogen perturbation responses and diurnal cycles of GPP. Our approach that prognoses leaf nitrogen and its impact on photosynthesis and more realistically represents the below- and above-ground competitive environment dramatically improves site-level and global-scale comparisons with observationally derived metrics.