Global patterns of nitrogen mineralization

Julia Maschler, J. Wan, D.S. Maynard, D. Routh, J. van den Hoogen, Z. Li, S. Niu, T. W. Crowther

1) Introduction

Soil inorganic nitrogen (N) is a main driver of plant productivity and soil respiration. Knowing how much nitrogen becomes plant-available through the process of N mineralization (N-min) can therefore aid projections of current and future carbon budgets of terrestrial ecosystems. Climate has previously been suggested to be an important driver of N-min, but we are lacking a quantitative and spatial understanding of the process. Here, we provide global, high-resolution maps of current potential net nitrogen mineralization, revealing global patterns in soil N availability.

2) Methods

Our dataset is made up of 571 data points from 4 published and unpublished datasets. All N-min measurements were obtained at or corrected to 25˚C (potential net N-min). After aggregating the points to pixels, we used the random forest algorithm to model global N-min patterns based on 87 geospatial layers (climate, vegetation, soil, human footprint). In 10-fold cross-validation, we obtained an R^2 of 0.18. While the model tends to overpredict small values and underpredict large values, it captures much of the variation in the training data (R^2 = 0.76).

Fig. 1 | Map of sampling sites

3) Results

N-min is highest in the tropics, but our high resolution map reveals considerable regional variation.

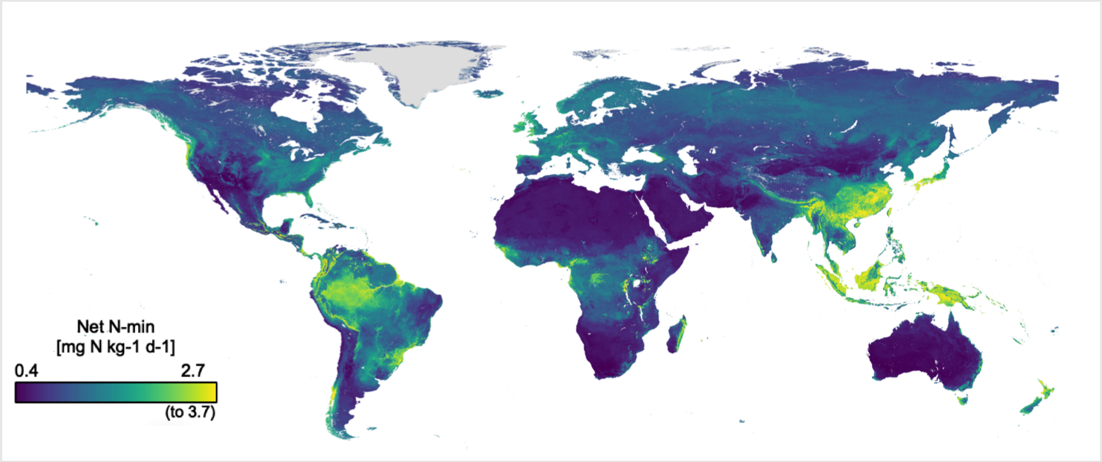

Fig. 2 | Map of current potential net N-min rates at the 1-km² pixel scale.

Warm, moist conditions with few extremes predict high N-min. Soil chemistry (pH, cation exchange capacity, organic carbon) is also a strong predictor. High N-min is associated with high plant productivity and a low proportion of N-fixing trees.

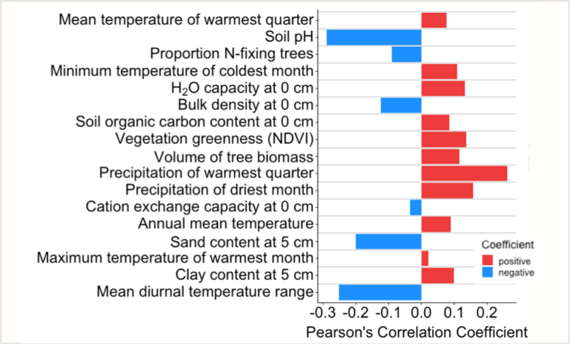

Fig. 3 | Correlation of N-min with most important model predictors (ranked by mean decrease in accuracy).

4) Discussion

Our spatially explicit map is an important step towards modeling plant growth constraints at a global scale. Our results strongly support the theory of a latitudinal gradient of N-min, probably because of the association of warm and moist climate with high N-min. Beyond this pattern, we identify finer variation associated with soil chemistry and plant community characteristics. As part of this project, we are modeling future N-min rates for the year 2050 under different RCP scenarios. As Earth system models incorporate more realistic nitrogen cycling, our results provide important insights into the patterns, quantities and possible drivers of a major component of this cycle.

Julia Maschler, Ph.D. student
Crowther Lab, ETH Zürich
julia.maschler@usys.ethz.ch