Ecosystem ecologists and biogeochemists have sought to use nitrogen isotope ratios ($\delta^{15}N$) as integrative metrics of ecosystem N cycling yet have been hampered by the possibility of multiple simultaneous effects that may be realistic proxies for future growth conditions under increased deposition, mineralization, or disturbance events. Furthermore, it remains to be seen if fertilization alters plant $\delta^{15}N$ values in predictable ways that may be realistic proxies for future growth conditions under increased deposition, mineralization, or disturbance events.

Panama Results

Methods

Alaska: Fertilization of 16 plots began in 2002, sampled in 2007. Single doses of pelleted NH$_4$NO$_3$ (N), ortho-P$_2$O$_5$ (P), both (N+P), or none (C), annually at a level of 200, in year 1, or 100 kg ha$^{-1}$ yr$^{-1}$ in subsequent years, per nutrient. Picea mariana was sampled in triplicate from each plot at the height of needle expansion.

Panama: Fertilization of 16 40-400m plots began in 1998, sampled in 2011. Four doses of coated urea as (NH$_4$)$_2$CO, 125 kg N ha$^{-1}$ yr$^{-1}$, phosphorus as triple superphosphate (CaH$_2$PO$_4$)$_2$, 75 kg P ha$^{-1}$ yr$^{-1}$, both, or none. Canopy heights are to 40 and the forest is possibly >200 years old. Alnus blakiana, Heisteria concinna, Oenocarpus mapora, and Tetragastris panamensis canopy leaves were shot in triplicate in all plots where possible.

Sampling: $\delta^{15}N$ values were measured using persulfate oxidation coupled to the denitrifier method. $\delta^{15}N$ values of total dissolved N were measured from five 15+4.2 cm cores extracted with 2M KCl the day of sampling at the height of the growing season (Panama) or beginning of the rainy season (Panama). NH$_4$ and NO$_3$ $\delta^{15}N$ values measured from ion exchange resin bags incubated for 4 (Panama) to 8 (Alaska) weeks.

Main Questions

Can plant $\delta^{15}N$ values be reliably used as a N-cycle integrator, like C:N:P ratios, to predict changes in soil fertility or plant productivity?

How do ecosystem $\delta^{15}N$ values from fertilization experiments compare to patterns from natural boreal and tropical forests?

How do we separate sources from pathways of N-cycling in order to understand plant $\delta^{15}N$ values?

Conclusions

Fertilization experiments exhibit biospecific effects on plant $\delta^{15}N$ values. In the tropics plants simply trace sources and in boreal forest they reflect the waning influence of ectomycorrhizal fungi. Fertilization produces an excess of labile NO$_3$ regardless of soil type or climate, and this causes significant enrichment of the remaining NO$_3$. If this metric is to be regarded as a useful integrator of increasing N availability these artifacts must be seen to occur in natural ecosystems that have undergone environmental changes or increased N deposition as well.

What is surprising is that it was P in boreal and N in tropical forests that triggered these effects. This runs counter to established theory. Echoing other recent assessments, the idea that N is in excess of plant demands in the tropics and boreal forests are strictly N limited is not supported.

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