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Inverse coupling of DOC and nitrate export from soils and streams

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Over the last two decades, nitrate concentrations in surface waters have decreased across the Northeastern United States and parts of northern Europe. Many hypotheses have been proposed to explain this decrease, but the cause remains unclear. One control may be associated with increasing abundance of dissolved organic carbon (DOC), which in turn may be a result of soil recovery from acidification. Compared across catchments, surface water NO_3- decreases sharply with increasing DOC concentration. Here, we used measurements of soil and solution nitrate, DOC, and their isotopic composition (13C-DOC, 15N- and 18O-NO_3) to test several related hypotheses that changing acidification affects the release of DOC and bio-available DOC (bDOC) from soil, and that variation in stocks of soil C and release of bDOC partly control NO_3- export from forested catchments in New York State, USA. We examined whether DOC and NO_3- are both driven by soil C processes that produce inverse coupling at the scale of soil cores as well as across catchments, through comparison of soil and surface water chemistry across nine catchments selected from long-term monitoring networks in the Catskill and Adirondack Mountains. In addition, we conducted a series of soil core leaching experiments to examine the role of acidification and recovery in driving the net production of DOC and NO_3- from soils. Over 8 months, soil cores were leached biweekly with simulated rainfall solutions of varying pH (3.6 to 7.0) from additions of H2SO4, $CaCO_3$ and NaOH. These experiments did not yield a pH-induced change in DOC quantity, but did show a change in DOC quality, in that acidified cores released more bio-available DOC with less depleted 13C-DOC than cores with experimentally increased pH. All cores leached substantial amounts of nitrate. Together, these lab- and field comparisons are being used to identify the role of soil production and consumption processes in driving cross-watershed differences in DOC and NO_3-loss, or whether other factors (e.g., riparian, in-stream or hydrologic processes) likely explain this relationship.