PROPAGATION OF BIOGEOCHEMICAL SIGNALS FROM ARCTIC SOILS TO STREAMS

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NITROGEN RELEASE FROM WARMED TUNDRA

INORGANIC NITROGEN FLUX INCREASING IN KUPARUK RIVER

Kendrick et al. 2019
PROPAGATION OF CLIMATE WARMING SIGNALS
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- Transport
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- Transport
- Reaction
Upper Kuparuk River Basin, Alaska

WATER TRACKS
• 0.013-0.089 km²
• Up to 1/3 catchment area (McNamara et al. 1997)
WATER TRACKS CONVEY THE MAJORITY OF STORMFLOW

Cumulative Rainfall: 185.8 mm

Rushlow & Godsey 2017
NUTRIENT SPIRALING
NUTRIENT SPIRALING

Wagener et al. 1998
NUTRIENT UPTAKE
- NH₄⁺ or PO₄³⁻ pulse addition
NUTRIENT UPTAKE

- NH$_4^+$ or PO$_4^{3-}$ pulse addition
- Mass balance
NUTRIENT UPTAKE

- NH$_4^+$ or PO$_4^{3-}$ pulse addition
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- First-order kinetics
NUTRIENT UPTAKE

- NH$_4^+$ or PO$_4^{3-}$ pulse addition
- Mass balance
- First-order kinetics
- Duration: 2-8 h
HILLSLOPES PROPAGATE NH$_4^+$

Harms, Cook, Wlostowski, Godsey, Gooseff, in press, *Ecosystems*
HILLSLOPES ATTENUATE PO$_4^{3-}$

Harms, Cook, Wlostowski, Godsey, Gooseff, in press, Ecosystems
DRIVERS OF NUTRIENT RETENTION

Harms, Cook, Wlostowski, Godsey, Gooseff, in press, Ecosystems
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**Figure a**

NH$_4^+$ uptake (µg N m$^{-2}$ min$^{-1}$) vs. water temperature (°C)

- $r = 0.42$ (0.06, 0.76)

**Figure b**

PO$_4^{3-}$ uptake (µg P m$^{-2}$ min$^{-1}$) vs. Péclet number

- $r = 0.71$ (0.34, 0.93)

**Figure c**

PO$_4^{3-}$ uptake (µg P m$^{-2}$ min$^{-1}$) vs. Thaw depth (cm)

- $r = -0.78$ (-0.99, -0.12)

Year: 2012, 2013, 2014

Site: WT1, WT5
WATER TRACKS TRANSPORT NH$_4^+$
AND RETAIN PO$_4^{3-}$
Transient storage dominated downslope flux at lower flows
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- Transient storage unrelated to thaw depth or nutrient uptake
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Phosphorus retention weakly related to thaw depth
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- Greater abiotic and/or biotic retention capacity in upper, organic soil horizons
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- Greater abiotic and/or biotic retention capacity in upper, organic soil horizons
- Deepening flows through thawed mineral soils might bypass zones of active retention
N release
N/P-limited

N release
N/P-limited

N release

P-limited
N/P-limited

N release

P-limited
N/P-limited

N release

P-limited

P-limited

P-limited
UNFROZEN SOILS IN WINTER

Top: Snow Depth
- WT inferred snow depth
- HS inferred snow depth

Bottom: Ground Thermal Conditions
- Missing data
- WT thawed, HS partially frozen
- WT thawed, HS frozen
- WT partially frozen, HS frozen
- Both thawed
- Both partially frozen
- Both frozen
- HS thawed, WT partially frozen
- HS thawed, WT frozen
- HS partially frozen, WT frozen

Rushlow, Godsey, & Harms, in prep
FUTURE PROSPECTS

• Integration among arctic ecosystems
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- Integration among arctic ecosystems
  - Regional-scale phenomena
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  - Connectivity
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  - Formalize collaborations among Arctic study sites
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- Winter processes
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• Integration among arctic ecosystems
  ▶ Regional-scale phenomena
  ▶ Connectivity
  ▶ Formalize collaborations among Arctic study sites
• Winter processes
  ▶ Establish baselines & track change
FUTURE PROSPECTS

- Integration among arctic ecosystems
  - Regional-scale phenomena
  - Connectivity
  - Formalize collaborations among Arctic study sites
- Winter processes
  - Establish baselines & track change
  - Logistics challenges