Do spatial patterns of water and matter fluxes below the main rooting zone depend on canopy processes?

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Canopy influences water *and* element input patterns

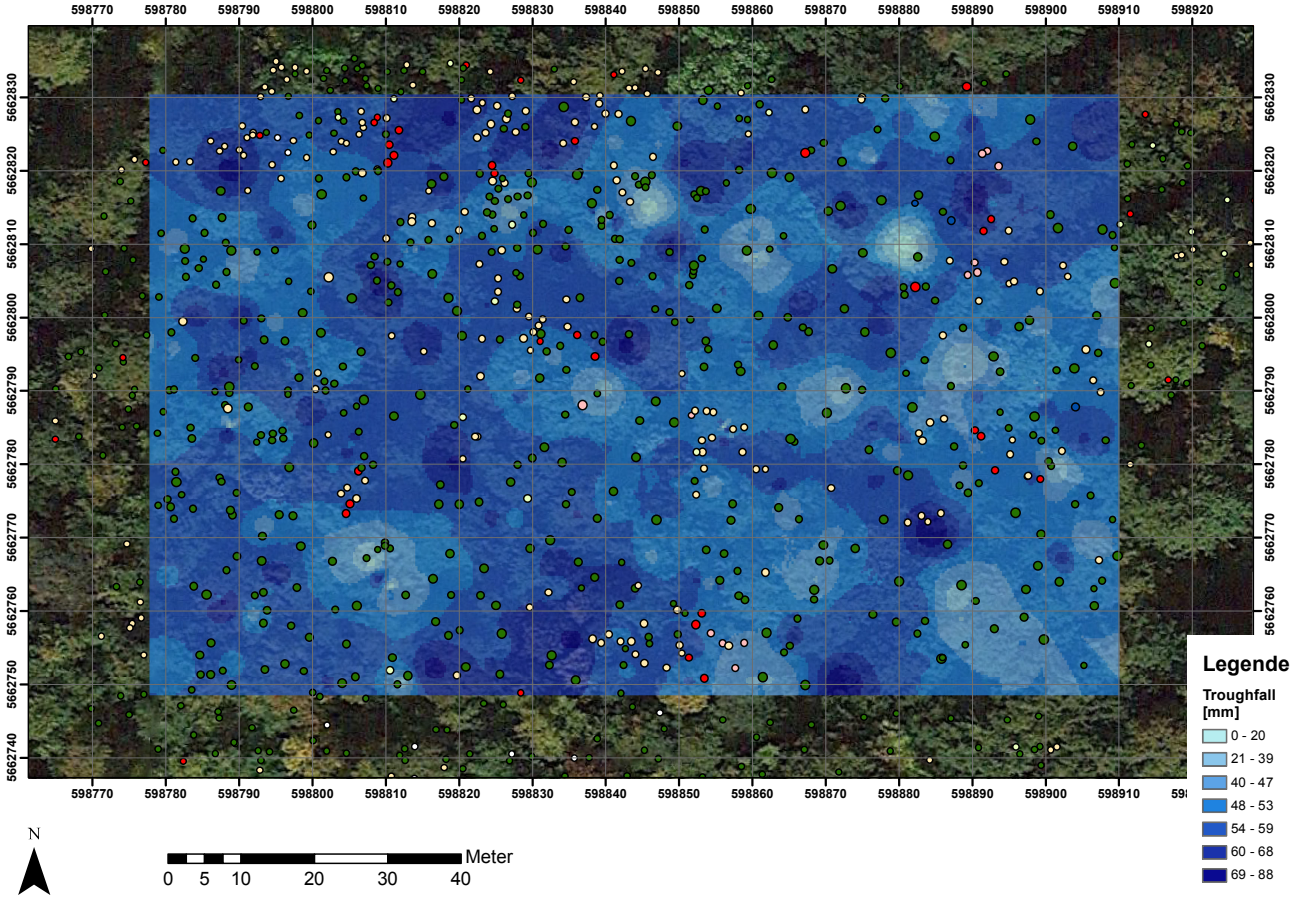
Both net precipitation and input of elements, like nitrogen, depend on canopy processes

- Redistribution of precipitation by canopies
- Dry deposition by turbulent fluxes
- Canopy exchange
- Wet deposition

Below-canopy water fluxes are heterogeneous and relatively stable in time. Here we ask

Are spatial patterns of below canopy nitrogen deposition also stable in time?

Do spatial patterns of below canopy water and nitrogen fluxes propagate through the soil?



Example: Canopy drip interpolated from 360 throughfall samplers. Dots indicate the location of tree stems on the ground, different colors refer to different species

Methods: Above and below-ground flux measured across net precipitation gradient

Site: Old growth unmanaged beech-dominated forest (Hainich National Park, Central Germany)
Soil: Shallow Cambisols and Luvisols on Loess loam on calcareous bedrock
Measurements: Throughfall (funnels) and percolation (lysimeters without walls, stemflow and preferential flow can enter laterally). Arranged in a factorial design (6 locations, see table) covering a throughfall gradient and near and far positions from tree stems
Maximum distance between locations is 40 meters
Sampling: Water flux, nitrogen concentration, bi-weekly over two years
For statistical analysis pooled into eight periods of three months each.

Throughfall amount	Distance to tree stem: close	Distance to tree stem: far
low	A	D
medium	B	E
high	C	F

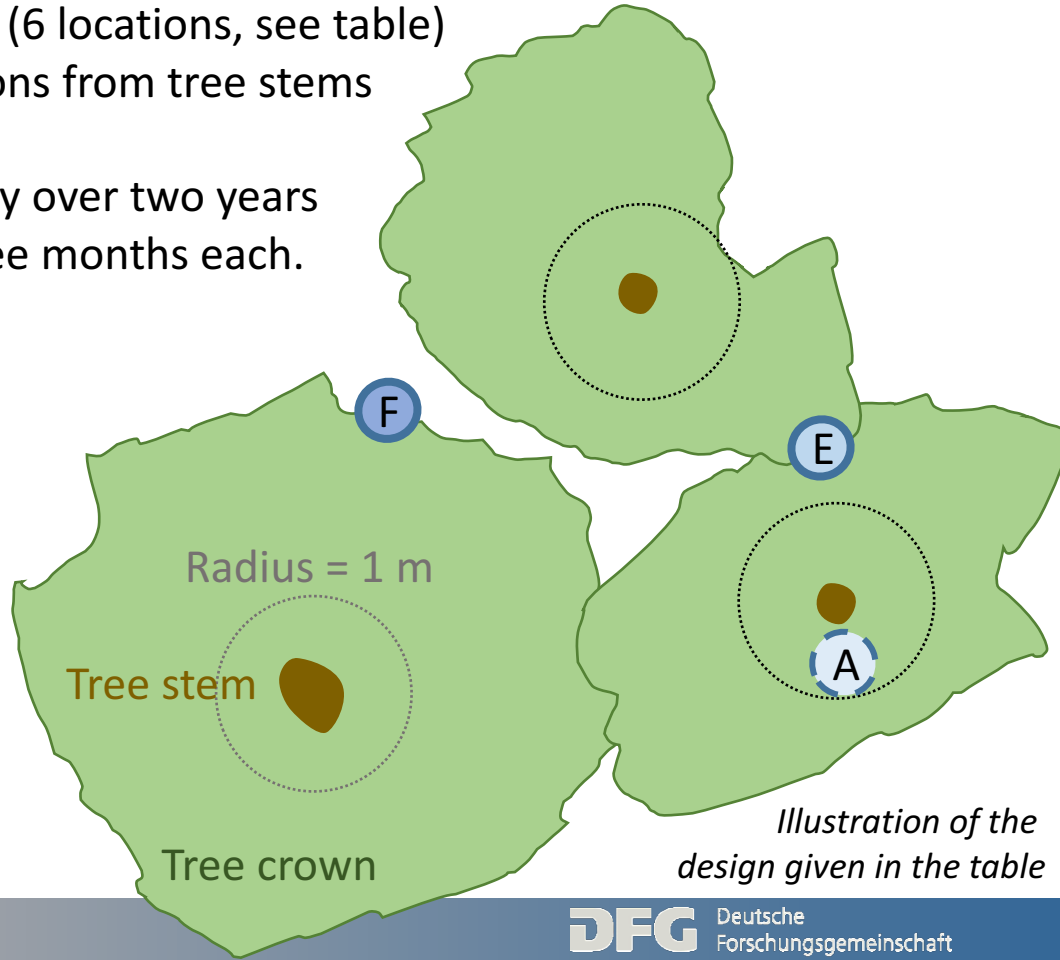
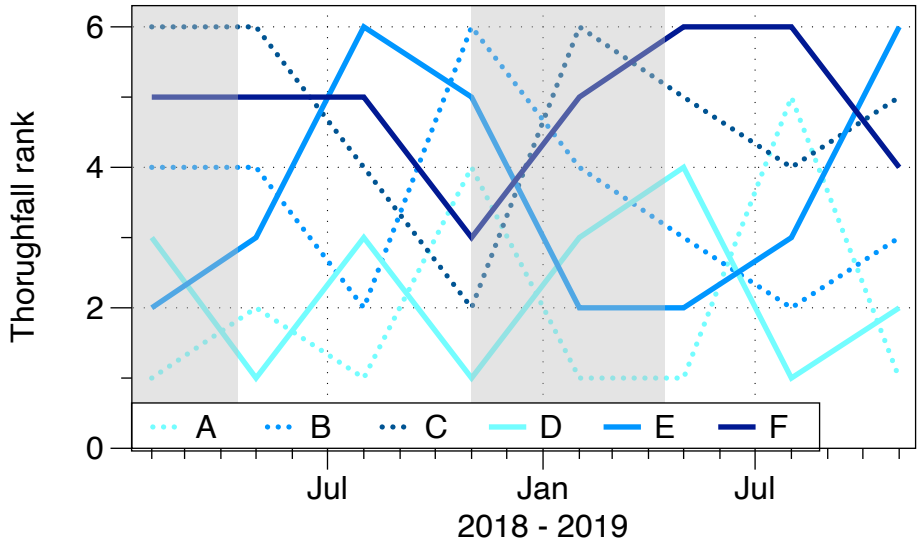
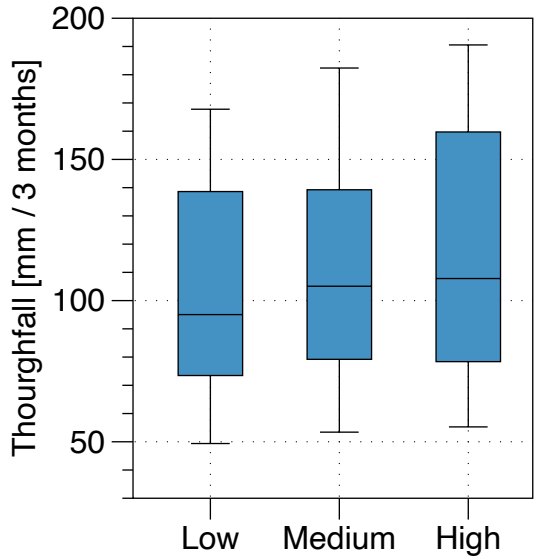
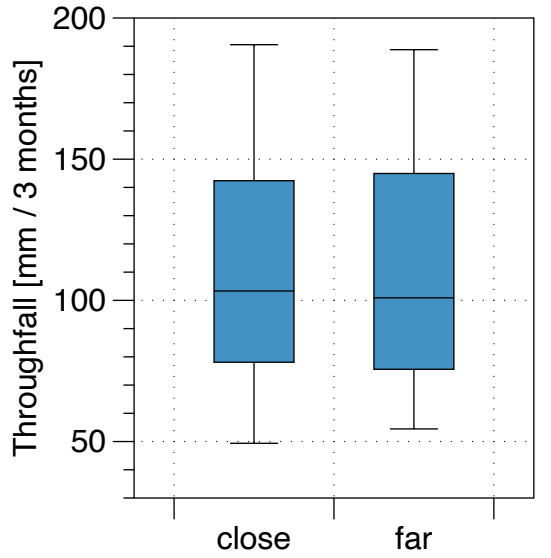


Illustration of the design given in the table

Observed water flux



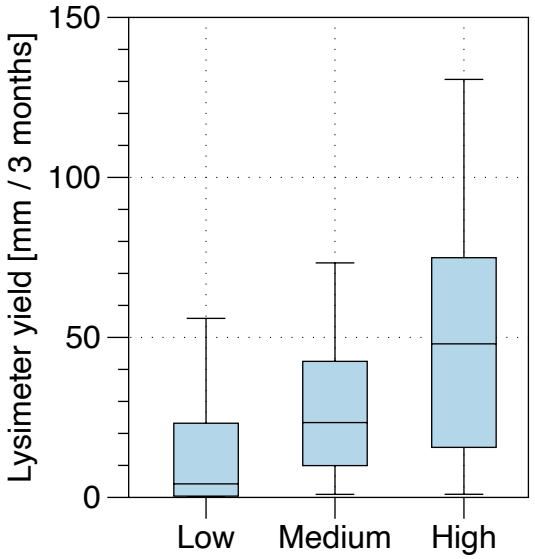


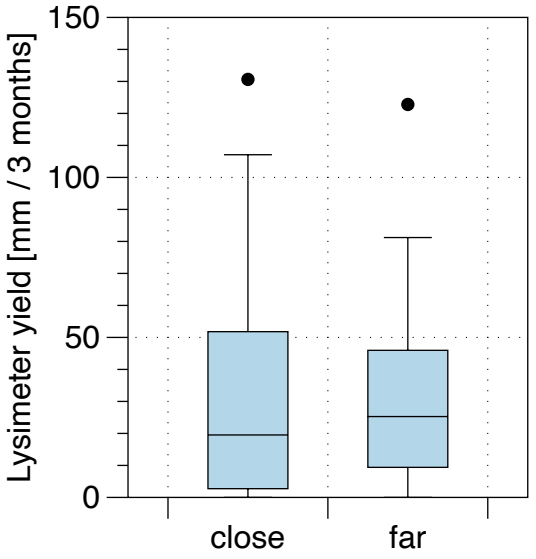


Throughfall – below canopy

Throughfall ranks of the measurement locations shuffled repeatedly over the measurement period, but overall the intended throughfall gradient was maintained over the two year period.

Throughfall treatment (as factor) came out as the single significant effect identified to explain lysimeter flow in a mixed effects model selection.





Lysimeter – below main root zone

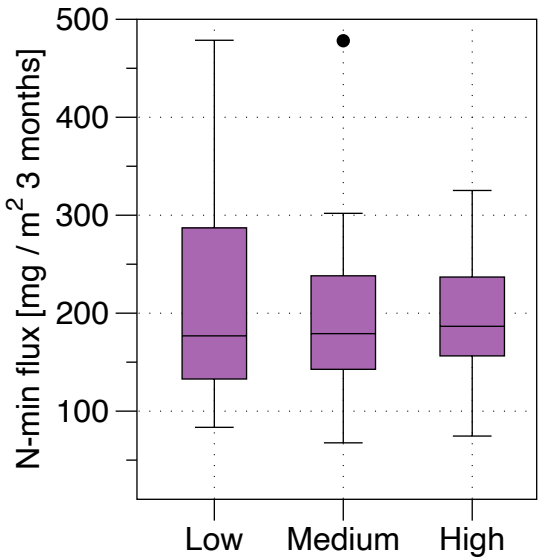
Observed N-min flux

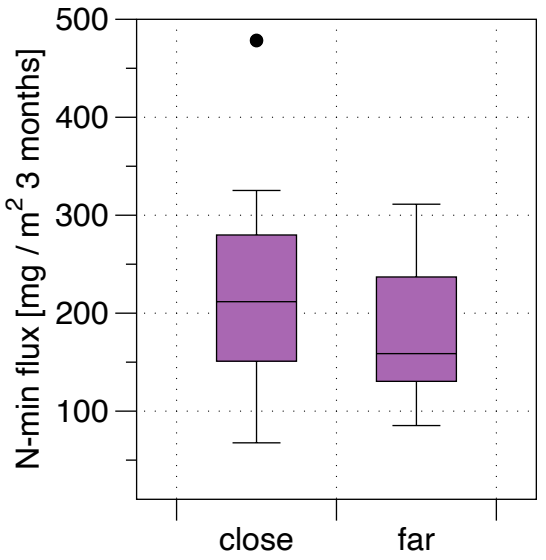
Below canopy deposition of mineral nitrogen was slightly elevated near tree stems, due to increased concentration loads there.

For nitrogen transport in soil water, throughfall treatment (as factor) was again the single significant variable related to nitrogen export below the main rooting zone. There, both concentration and water flux increased along the throughfall gradient.

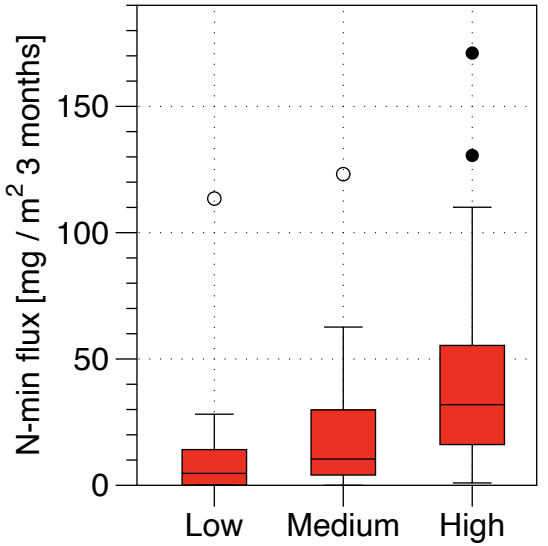
This research is only based on a small number of locations, due to the effort of installing lysimeters.

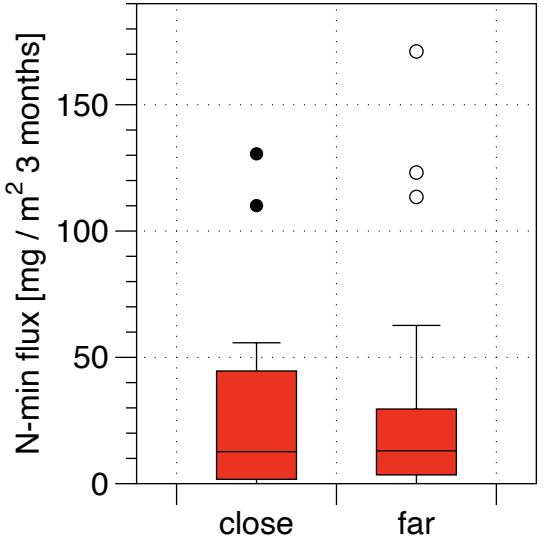
But it strongly indicates that spatial flux patterns generated by canopy processes are transmitted through to the soil and affect element transport below the main rooting zone.





Throughfall – below canopy





Lysimeter – below main root zone

Thank you! Suggestions? Questions?

We would like to thank technicians and students who helped with installation, data collection, organization and lab analyses.

More information of the field site and first results on the spatial patterns of water fluxes can be found here:

- Metzger et al., 2017. Vegetation impacts soil water content patterns by shaping canopy water fluxes and soil properties, Hydrological Processes -> https://onlinelibrary.wiley.com/doi/abs/10.1002/hyp.11274
- Metzger et al., 2019. Neighborhood and stand structure affect stemflow generation in a heterogeneous deciduous temperate forest, HESS -> https://www.hydrol-earth-syst-sci.net/23/4433/2019/

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