# Tracing of ^{15}N in a mountain spruce forest: comparison of experimental data with the TRACE model

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## Aims

(1)  Adaptation and calibration of the biogeochemical model TRACE to the Alptal experimental site
(2)  Validation of the model using a new time series of field ^{15}N tracer recoveries in soil and vegetation pools
(3)  Evaluation of the impact of elevated atmospheric N deposition on ecosystem N-status in the longer-term

## Experimental site Alptal

- Subalpine Norway spruce forest (*Picea abies*)
- Precipitation 2300 mm/a (30% as snow)
- Mean air temperature: 6°C
- Soil/parent rock: Gelysol/Flysch

*The experimental site is located at Alptal (SZ)*

## Long-term low-dose N addition

- since April 1995 N addition with sprinklers during rain events
- Two small catchments (each 1500m²):

    Catchment 1: control, rainwater only (12 kg/ha/a N)
    Catchment 2: NH4NO3 addition (+20-25 kg/ha/a N)

## [15]N tracer experiment

- Catchment 1: application of tracer by backpack sprayer

    1st dose: K[15]NO$_3$ from Juli 2000 – June 2001 (0.17 mmol/m²; 99 atom%)
    2nd dose: [15]NH$_4$Cl from Juli 2002 – June 2003 (0.7mmol/m²; 99 atom%)
- Catchment 2: application of tracer by sprinklers

    [15]NH$_4$[15]NO$_3$ from April 1995- March 1996 (219mmol/m²; 0.88 atom%)

*Experimental setup at Alptal*
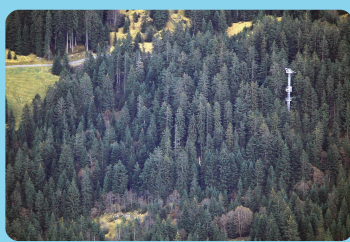
*Aerial view on the Alptal site*

## The TRACE model

- Biogeochemical process model of C, N and water fluxes in forest ecosystems
- Simulates [15]N:[14]N ratios of individual N pools by incorporating principles of pool dilution and mass balance
- TRACE was initially developed for a relatively closed red pine stand. Soils are Inceptisols on stony till with sandy-loam textures without ground vegetation
- Modeled ^{15}N tracer redistributions are directly comparable against field data
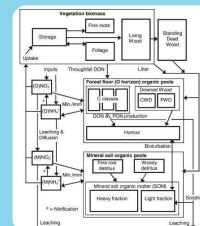
*Pools and fluxes of N in TRACE*

## Model adaptation

- Ammonium accumulation problem in mineral soil was fixed
- Nitrate concentration in preferential water flow was added by a new model formulation

## Parameterisation and calibration

- TRACE is based on more than hundred parameters and initial conditions for state variables which need to be defined
- Climate and N-deposition scenario was defined
- The model was calibrated against field data of whole-system C and N cycling independently of ^{15}N tracer recoveries
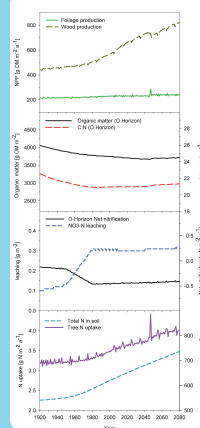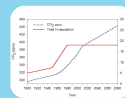
*Calibration results for key variables*

## Results

- Model to field comparisons of ^{15}N tracer allows us to specify whether fine-scale processes are described accuratly to get whole C and N cycling right
- Model prediction correctly shows that soil pools are the major sink for N deposition on both catchments
- However, the model shows some weakness by simulating quantitative ^{15}N recoveries
- Under-prediction of ^{15}N tracer in organic soil horizon and over-prediction in mineral soil horizon
- [15]N recoveries in wood, fine roots and also the NO$_3$ leaching flux are captured satisfactorily
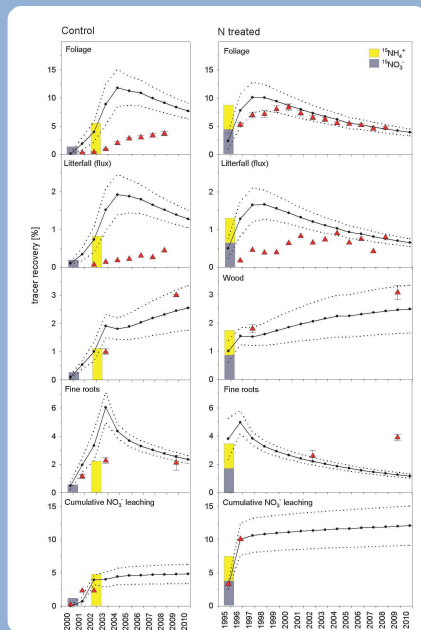- For foliage and litterfall fluxes ^{15}N recoveries are over-predicted by the model

*Model to field comparison of ^{15}N tracer recoveries in soil pools*
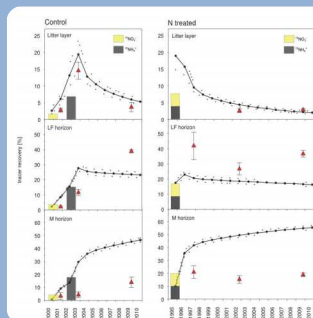
*Model to field comparison of ^{15}N tracer recoveries in different ecosystem N pools, the litterfall and the NO$_3$ leaching fluxes.*

## Conclusions

- Model to field comparison of ^{15}N recoveries form a large ^{15}N tracer experiment show that adaptation and calibration of the model to the Alptal site was successful
- TRACE should be improved by incorporating a ground vegetation layer taking up some of the atmospherically deposited inorganic N
- More foliage cohorts would need to be considered to improve the simulation of high recoveries in foliage and litterfall flux under control
- Because of different infiltration rates of the tracer into the soil the different application methods should be considered
- Model results show that the soil is able to retain most of the deposited N

## Outlook

- As a next step, we will use the model to simulate the effect of different climate and N-deposition scenarios on ecosystem C sequestration in this regionally representative mountain Norway spruce forest

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