Using plot measurement data for the validation of an eco-hydrological river basin model

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River basin model - Requirements:

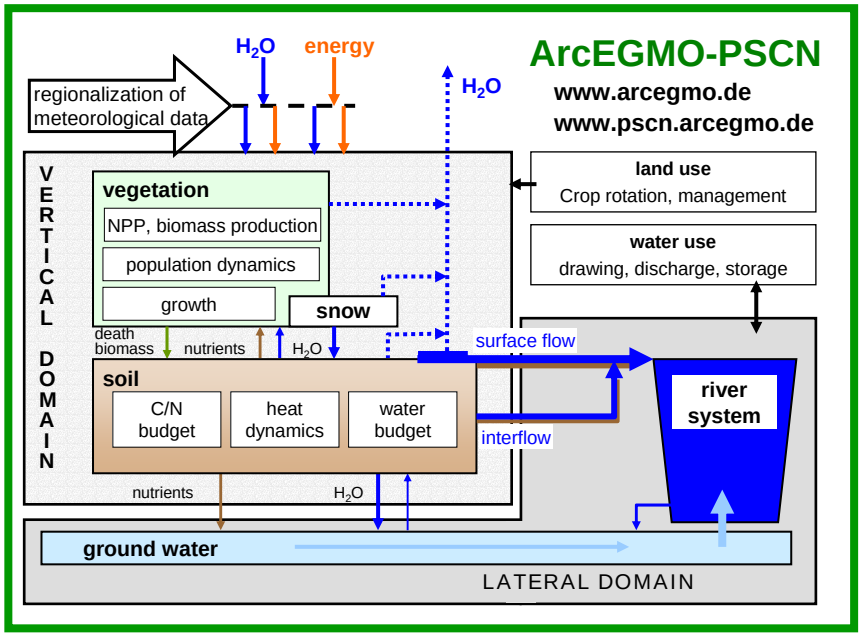
Describe the relationships between

- water budget (including surface and subsurface flows)
- vegetation dynamics
- carbon and nitrogen budget

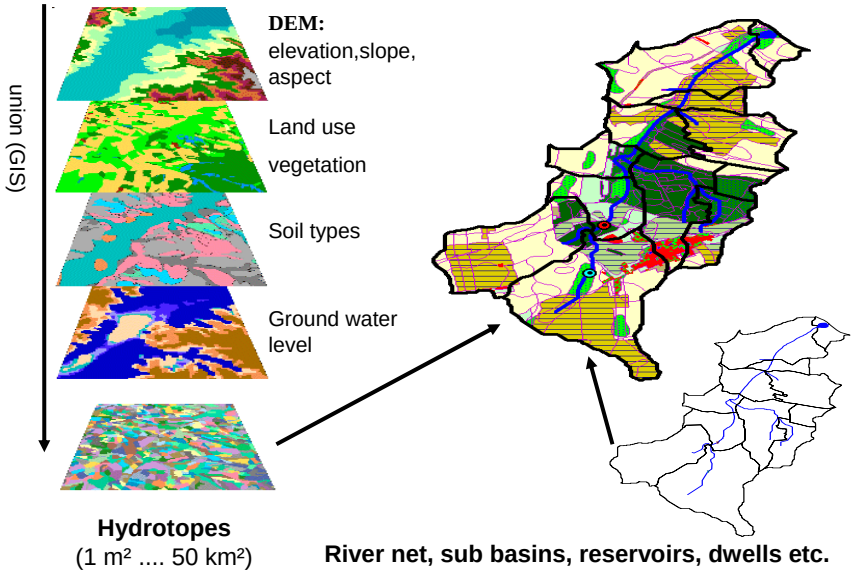
in its spatial and temporal variability in dependence of

- weather conditions
- management and disturbances

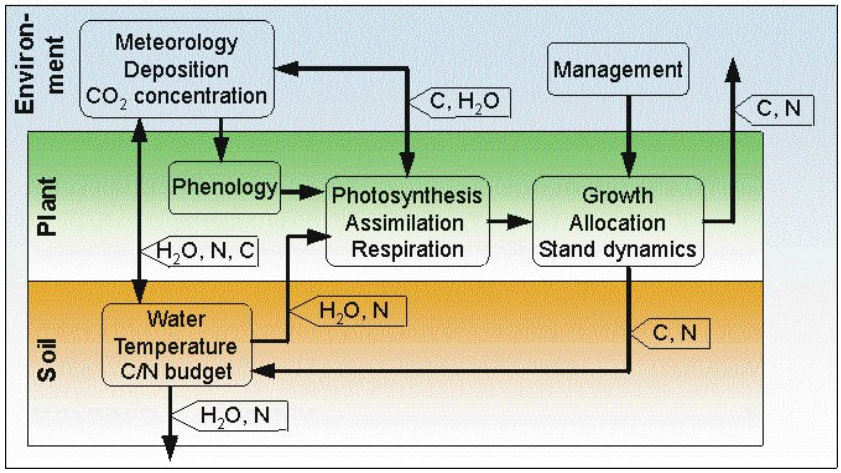
- **allows to simulate future conditions (scenarios)**
- **adaptable to specific aims**
- **GIS-coupled → easy handling**

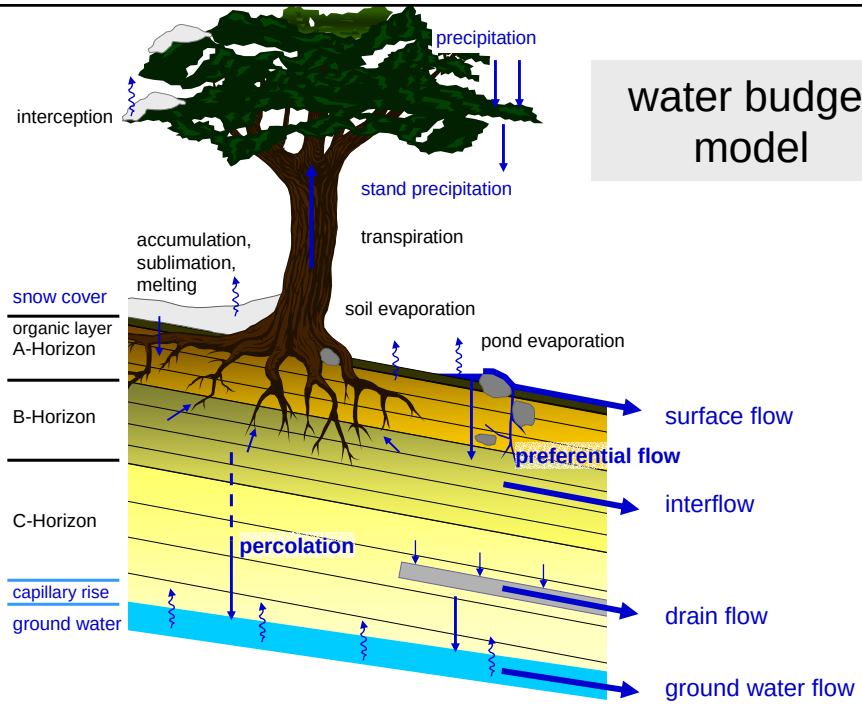


Spatial aggregation scheme



Environment – Vegetation – Soil





water budget model

Water budget model

Potential Evapotranspiration (PET)

- PENMAN or TURC-IVANOV model
- PET affects potential transpiration, soil and interception evaporation

Interception

- interception depends on LAI and precipitation
- *parameter:* maximum interception storage capacity per LAI
- interception storage is emptied according to PET
- interception evaporation reduces transpiration demand

Snow cover

- energy balance approach
- accumulation, melting, sublimation, condensation

Water budget model

Percolation

- capacity model coupled with interflow and preferential flow
- field capacity, wilting point, saturated water conductivity

Interflow

- water content exceeds the field capacity in inclined layers
- lower water conductivity of the following deeper soil layer

preferential flow

- empirical approach = f (land use)
- amount depends on clay, stone, and water content

Capillary rise

- Empirical approach following Ad-hoc-AG Soil Germany (KA5)

Land use models in PSCN

Static model

Dynamic model
Input: time functions (root depth, LAI)

independent from environmental conditions during simulation run

controlled

crop rotation scheme generator

Generic growth model (**EPIC$_{simpl}$**)

Simulation of
- phenology
- growth
- water budget
- C/N-budget

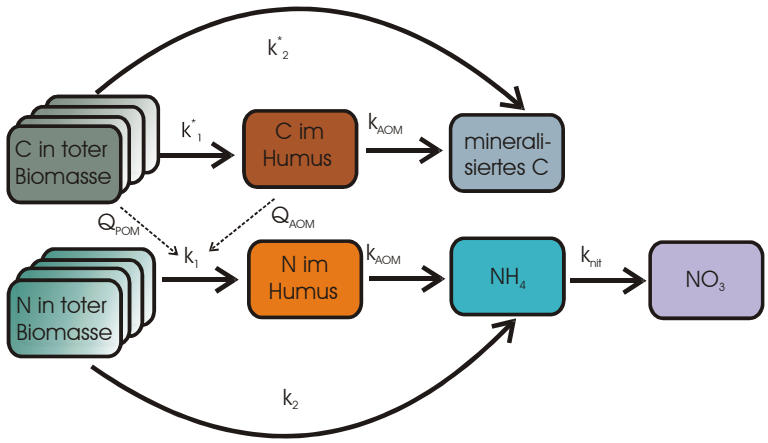
in dependence from the **environmental conditions** and **management**

Forest model **4C**
(FORESEE - Forest Ecosystems in a Changing Environment)
including competition

complexity

feedback model

Carbon and nitrogen turnover



Model Input: time series

Meteorology (Δt <= 1 day)

- precipitation
- humidity
- air temperature
- wind velocity
- radiation

Water use

- Drawing and discharge
- Storage management

Land use

- In dependence from the vegetation model

Ground water tables

discharges

- for calibration (ground water storage parameters) and validation

Model Input: spatial data

Location of the meteorological stations

Soil map

- with standard profile information (soil physical and chemical parameters)

Land use map

- specific parameters accordingly the used vegetation model

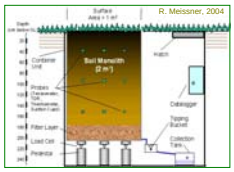
Digital Elevation Model (DEM)

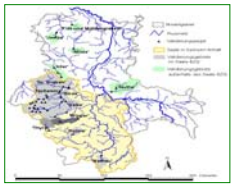
River net

Hydrological catchments and sub-basins

Reservoirs, dwells etc.

Model application

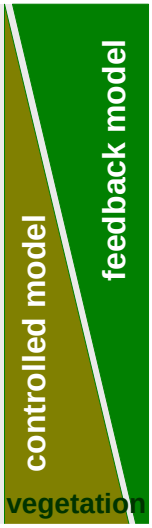




patch:
lysimeter, field
1m² - 1 ha (one hydrotope)

microscale:
catchment, farm
1 ha – 50 km²

meso- und macroscale:
river basin, district, country
(50 – 100 000 km²)



Model validation and development

River basins

- Development and validation of aggregation and regionalization schemes
- Validation of the catchment model by comparison of the simulated and the measured discharges (river and ground water)

Small measurement catchments

- Development, parameterisation and validation of sub-models (lateral domain)
- Validating the interaction of all sub-models

Measurement plots (e.g. lysimeters, forest stand)

- Development, parameterisation and validation of sub-models (vertical domain)
- Validating the interaction of the sub-models (vertical domain)

Lysimeterstation Buttelstedt (Thuringia)

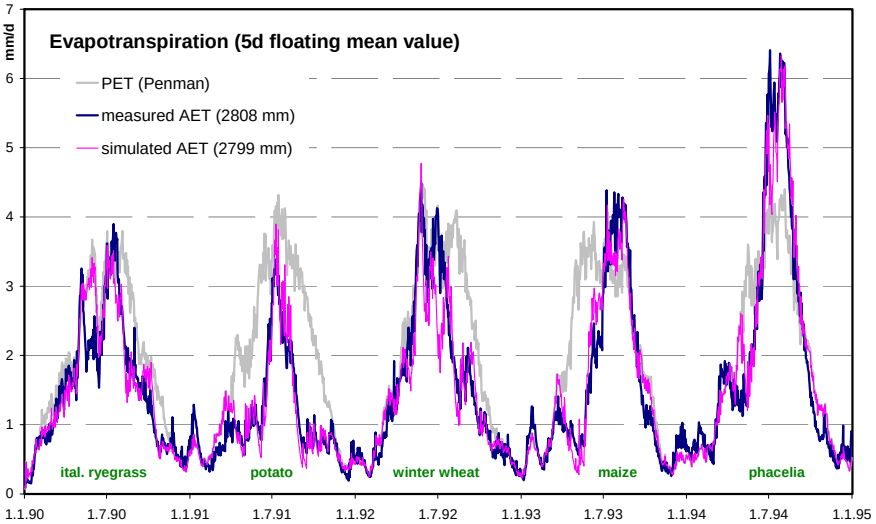
- Central German dry region (8.2°C; 550 mm)
- Haplic Phaeozem soils with silty-loamy texture developed from loess

- depth: 2.5 m
- surface area: 2 m²
- monolithically filled and installed in an agricultural field to avoid oasis effects
- 1983 -1994: field plants
- 1995 - 2004: vegetable plants

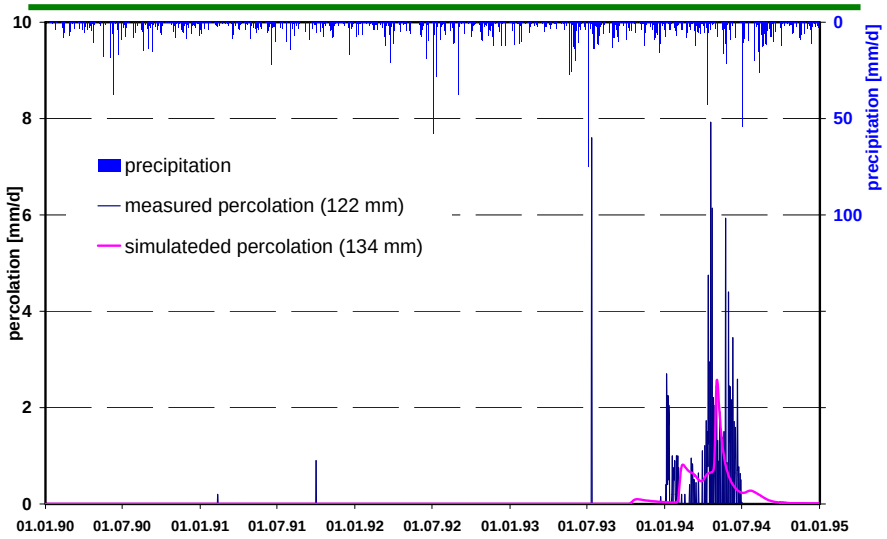
They are weighed continuously with an accuracy of 0.05 mm.

The percolating water is collected by ceramic suction cups (0.03 MPa) at a depth of 230 cm.

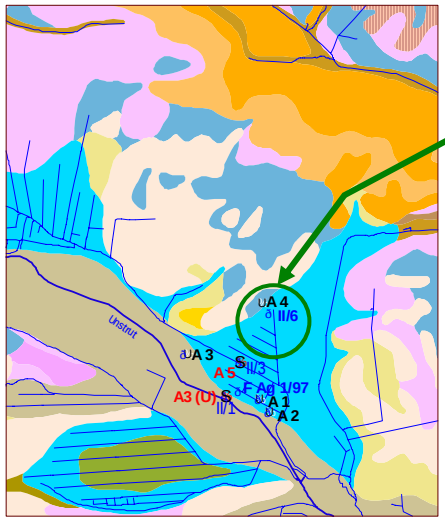
Lysimeter Buttelstedt



Lysimeter Buttelstedt



Lysimeterstation Altengotternsches Ried



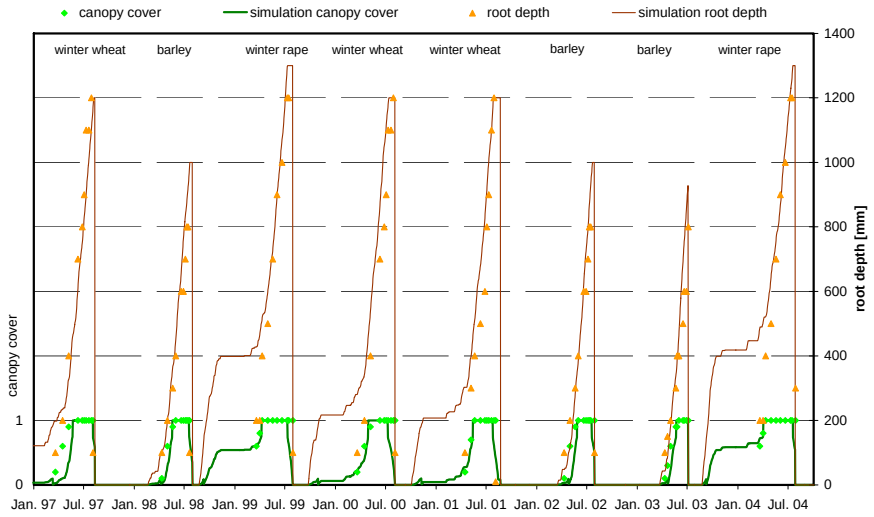
N

ð II/1 GW-Messstelle
S II/1 GW-Sammler
% A 5 Sickerwasser-Messstelle
U A 3 Lysimeter
Fließgewässer

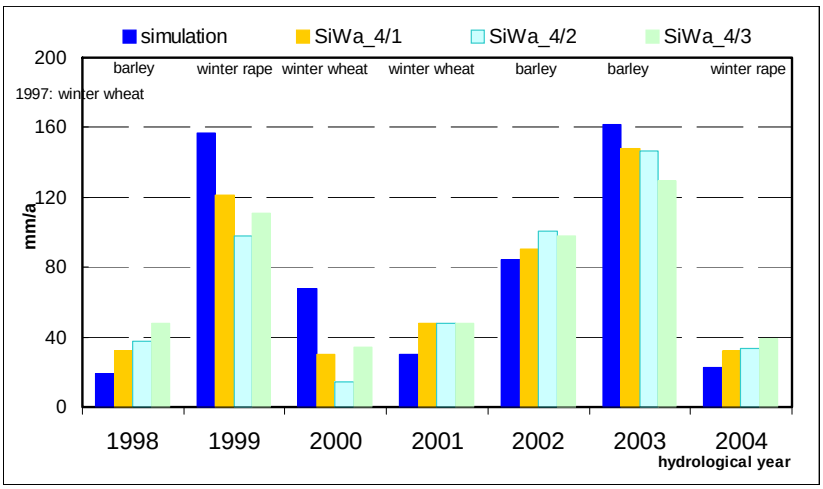
Boden:
Lehm, tonig (Gley)
Lehm-Vega (Vega)
Lehm, steinig (Tonmergelrendzina)
Löss (Tschernosem)

1000 0 1000 2000 Meter

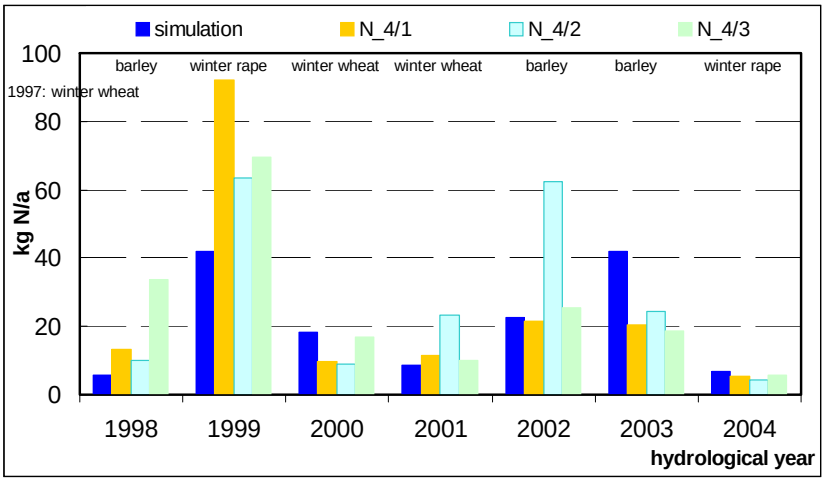
Altengottern A4: Crop development



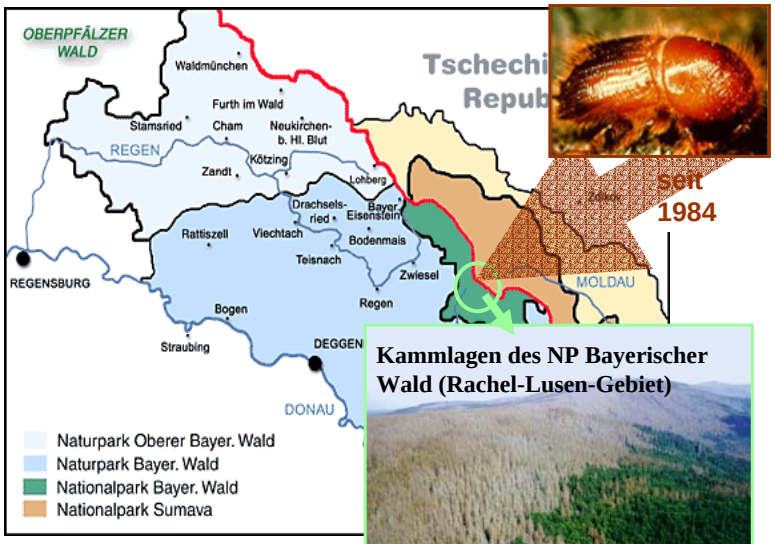
Altengottern A4: Percolation



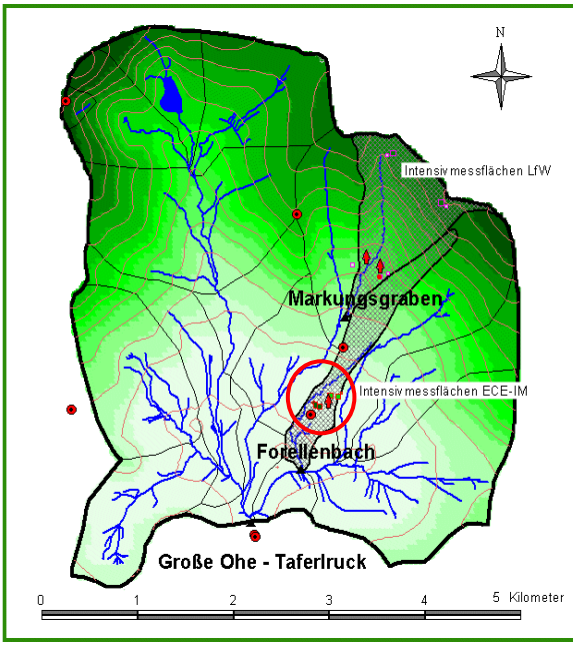
A4: Nitrogen leaching (NO_3 + NH_4)



Bavarian Forest - Große Ohe Catchment



Nationalpark Bayerischer Wald



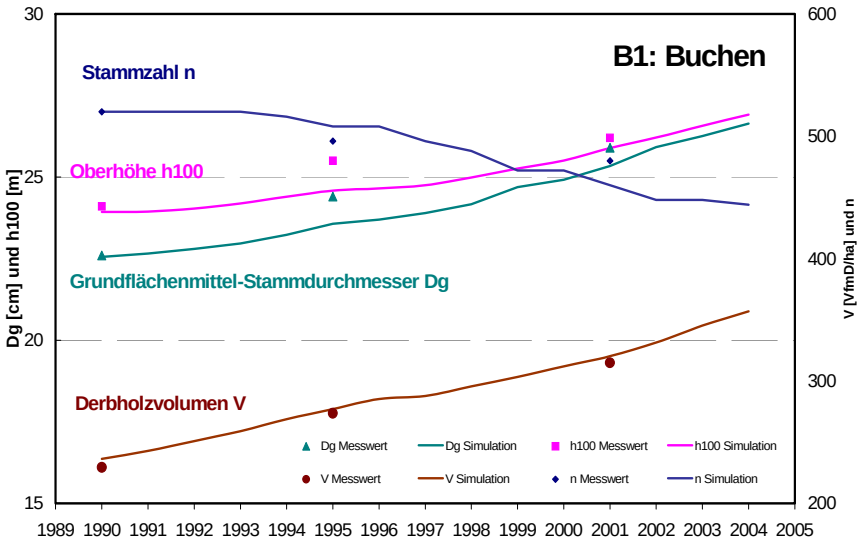
Intensivmessflächen ECE-IM Forellenbach

- **precipitation* (stand, cross)**
- **Stand dynamics**
- **Humus dynamic**
- **Soil moisture (TDR)**
- **Soil temperature**
- **Soil solution***
- **Ground water***

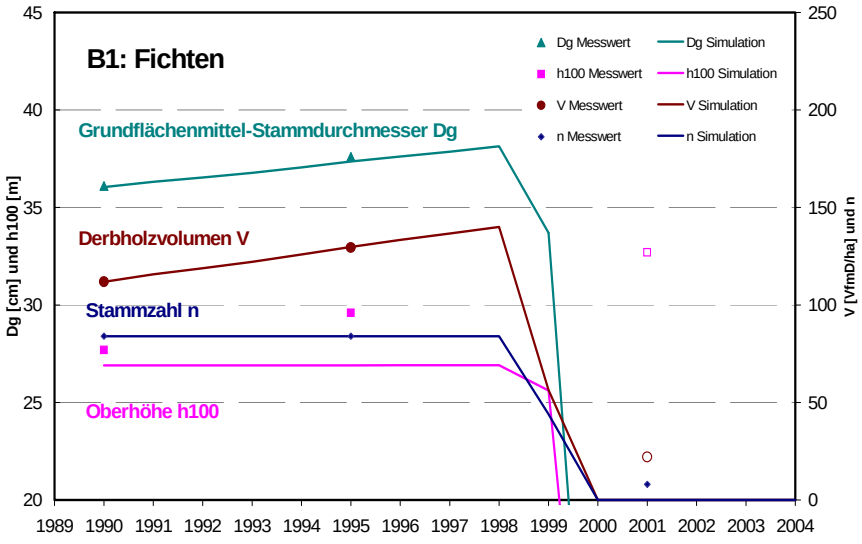
*quantity + quality

Beech stand B1 (820 m a.s.l., 1600 mm/a)

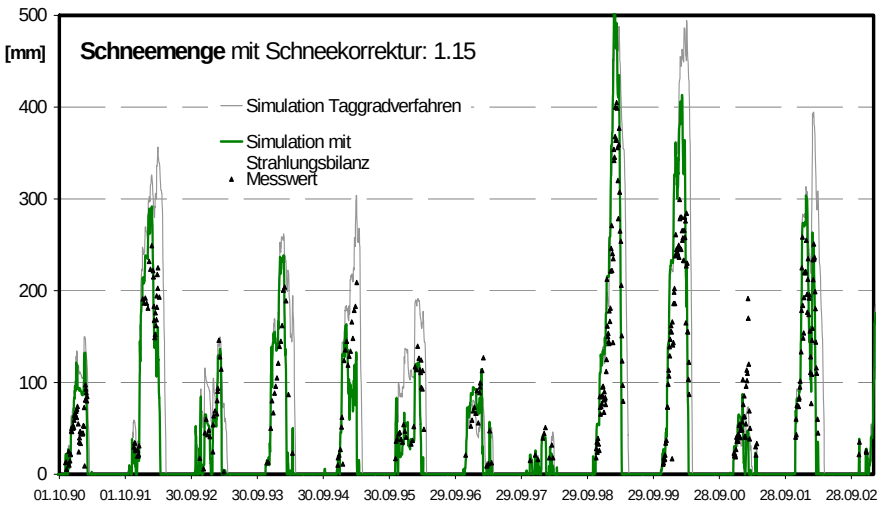
Stand development B1 - beech



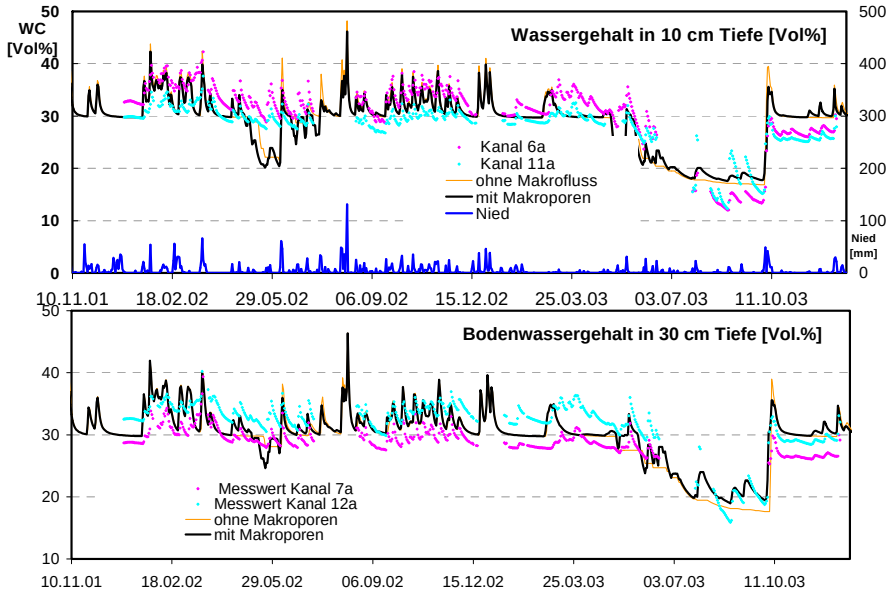
Stand development B1 - spruce



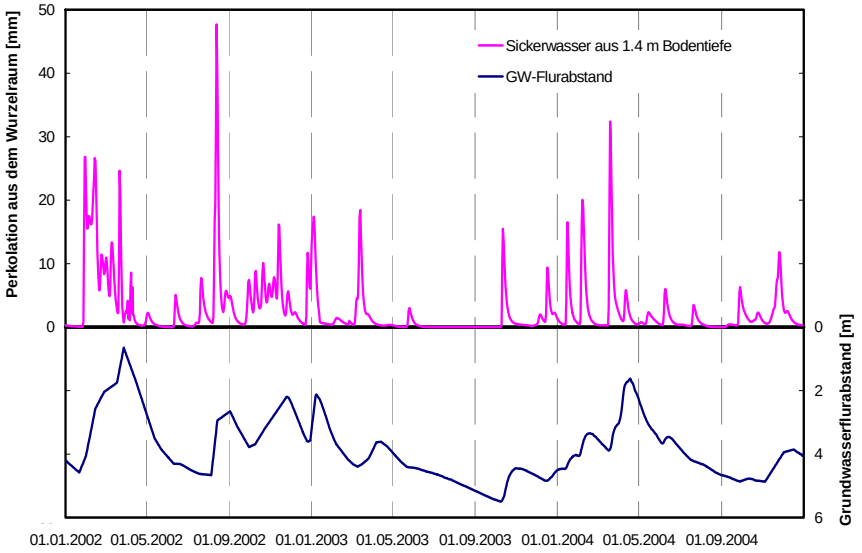
Validation snow model



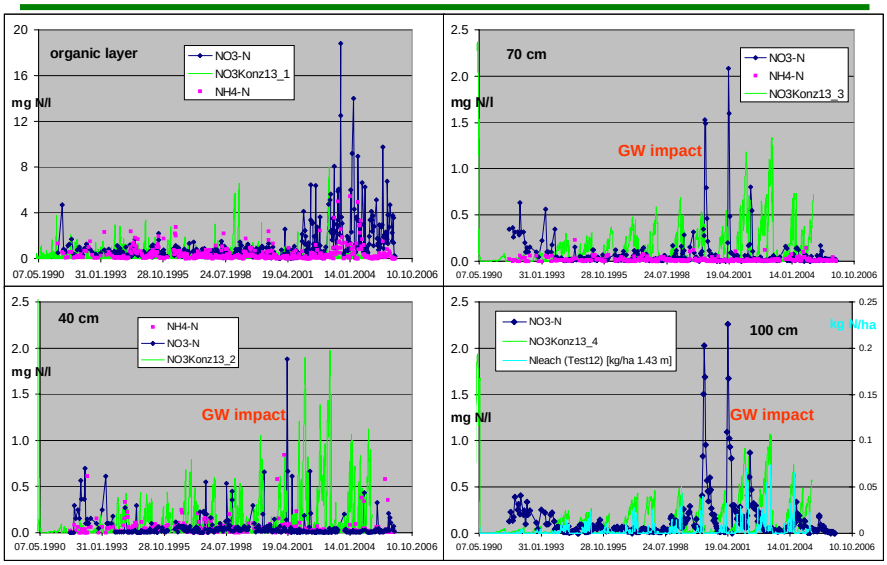
Soil water content



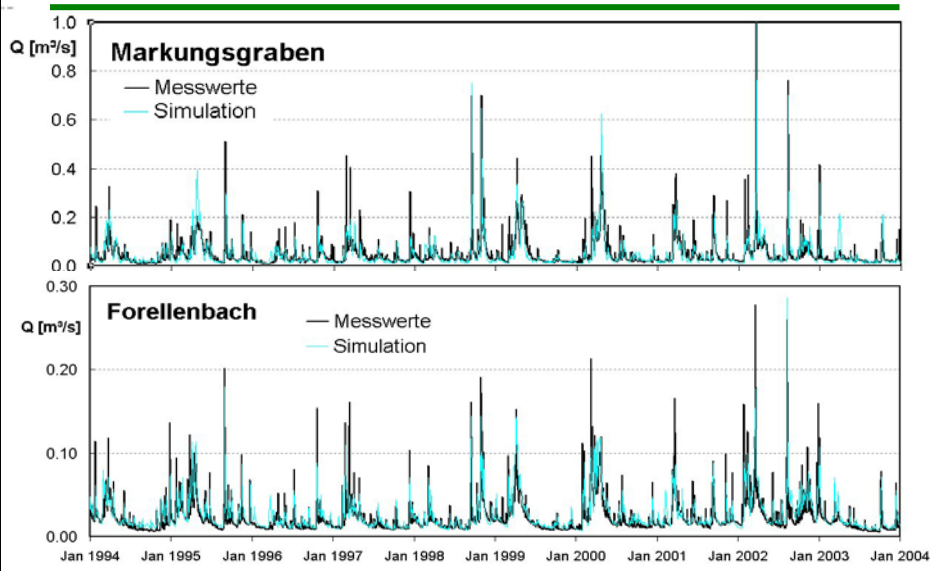
Percolation – ground water table



Validation - nitrogen model



Model validation - catchment discharges



Conclusions

Weighable lysimeters offer a solid data base for model development as well as for model validation.

Plot measurements are suitable for model validation in general, but ….

- Which system variables can and have to be observed?
- Frequency of data sampling
- Limitation (or quantification) of side effects

Co-operation between “modellers” and “field scientists” is very important!

Main problems in modelling:

- **water and nutrient uptake by plants (distribution profile, root development, …)**
- **C/N - balance**
- **preferential flow**

Co-operation between “modellers” and “field scientists” is very important!