Model approaches for Soil hydraulics and nitrogen balances on the Lysimeter scale with “CoupModel”

Ansätze zur Modellierung der Wasserhaushaltskomponenten und der Stickstoffbilanz in Lysimetern mit dem Modellpaket „CoupModel“

1. Introduction
2. Model concept
3. Model use
4. Results
5. Conclusion
1. Introduction

- CoupModel is a software for analysing the soil-plant-atmosphere system
- Coupling of the older models SOIL and SOIL-N
- Aim of this work was to test the applicability of the model on the lysimeter scale

2. Model concept

**General information**

- One-dimensional transient-flow model for unsaturated zone
- CoupModel includes:
  - soil hydraulics
  - plant growth and development
  - Nitrogen and Carbon balances
  - sorption, transformation and reduction of material
- Detailed model input (e.g. climatic data, plant attributes)
- Simulation of nearly every ecosystem possible
2. Model concept

General information

- Soil profile column
- Water transport by RICHARDS-Equaion
- Driving force: climate
- Driving force: dynamic psi
- Model output: e.g., percolated water, leached nitrogen
- Plant management: fertilization, irrigation, ploughing

Nitrogen Transport

- Nitrogen balances are simulated by biotic processes
- Nitrogen amounts represented by different pools
- Plant e.g., roots, stem, leafes
- Soil e.g., litter, humus, feaces
2. Model concept

Nitrogen Transport

- Soil e.g.
  - Litter
  - Humus
  - Faeces
  - NO$_3^-$
  - NH$_4^+$
- Different Ways of N-Input:
  - Atm. deposition
  - Manure (org.& min.)
  - Mycorrhiza

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3. Model use

Object of investigation

- Biological farmed lysimeter in Wagna
- Weighable field lysimeter
- Undisturbed profile of local soil
- Profile divided in 7 horizons
- Vegetation: oil pumpkin (*Cucurbita peto*), two plants

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### Driving forces

1. Climatic data in ten-minute-interval
   - Precipitation
   - Air temperature
   - Relative humidity
   - Wind speed
   - Net radiation

2. Dynamic psi:
   Applied pressure at suction-cups in daily mean values

### Spatial scale

3. Soil data
   - Horizon thickness
   - Water retention curves,
   - Water tension & -content
   - Soil temperature
3. Model use

**Time scale**
- Simulation time from April to September 2005

**Initial conditions**
- Water contents and soil temperatures for each Profile
- Nitrate and Ammonium concentrations

**Verification parameter**
- Hydraulic attributes of soil horizons
- Process of plant development

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4. Results

**4. Results – soil hydraulics**
- Good temporal agreement of simulated and observed seepage hydrograph
4. Results – soil hydraulics

- Cumulated hydrograph shows discrepancies in seepage quantity

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4. Results – soil hydraulics

- Discrepancies in hydraulic model because of
  - Incorrect plant development:
    - calculated evapotranspiration is too low
  - Inexact soil attributes
    - Unrealistic unsaturated conductivity
    - Undervaluation of soil storage capacity

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4. Results

4. Results – nitrogen transport

- No data for verifying soil nitrate/ammonium concentrations available

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5. Conclusion

5. Conclusion

- CoupModel allows to create realistic simulations of water- and massbalances on the microscale (~1m²)

- the complexity of the Model requires very detailed information of soil physics and plant development

- driving forces may be measured climatic data series or generated statistical values

- if detailed data series are available, CoupModel is suitable for Models on the Lysimeter scale

- use as virtual lysimeter possible

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Thank you for your attention

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