TERENO-SOILCan - Status, Network Activities and Research Projects


Agrosphere Institute, Forschungszentrum Jülch
TERENO Advisory Board Meeting, 16.-17. September 2013, Klink/Lake Müritz
SOILCan a Large Scale Climate Feedback Experiment

- **SOILCan lysimeter network**
- **Research topic**: influence of climate change on water and nutrient budget
- **Climate transect and transport of lysimeter** ("space for time approach") to measure water balance components under a real climate change
- **Lysimeters provides**: important data of soil temperature, \( \Theta, \psi \), soil water chemistry, precipitation, dew, evapotranspiration and reliable measurements of leachate and capillary uprise from new lysimeter approach (FANK 2009)
On-Going Activities, Topics and Problems

• New lysimeter technic secures a better estimation of lysimeter in- and outflow, managed by a pump device to transfer measured field conditions on the lower boundary;
• Investigation how soils react to climatic change with respect to matter cycling and water dynamics;
• Realistic identification of solute transport;
• Development of plant communities in terms of species traits (especially roots) and genetic structure in adaption to the local conditions;
• Changes of a dynamic towards a stable system;
• Discussion of the crop rotation (winter wheat, pea, winter rape, winter barley); discussion paper sent to AB with request for comments and recommendations; feedback of one AB member;
• Technical problems with pumps and pump control units (high attrition, to high pump frequencies), matric potential sensors;
• Working group for data processing;
Modelling Water Transport in SoilCan Lysimeters

M. Hannes, U. Wollschläger, H.-J. Vogel (UFZ)

- continuous datasets
- different soil types
- same soils under various atmospheric boundaries

Lysimeter measurements

Boundary conditions

Soil water-dynamics

Transport model

Parameterisation

Root-model

Improved understanding of

Hystereses

Global opt. algorithm

Data

Model adjustment

MUPHI

Optimization

- parameterization
- relevant processes
- limitations of Richards-equation

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Greenhouse Gas Measurements on Lysimeter Soils of Different Origin and Climate History

D. Weymann, N. Brüggemann, T. Pütz, and H. Vereecken (FZJ)

- Assessing greenhouse gas (GHG) fluxes from several lysimeter soils
- Investigation of dissolved greenhouse gas concentrations in soil solution, indirect fluxes of GHGs representing a source of substantial uncertainty in GHG balances and inventories.

Conclusions and Outlook

- Preliminary results underpin the importance of continuous measurements to detect short-term emission events
- Impact of induced climatic change cannot be detected so far
- Indirect GHG emissions might be particularly susceptible to climate-changing conditions
- GHG monitoring will be continued at a long-term scale

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Soil water content, soil temperature, CO$_2$-, N$_2$O-, and CH$_4$ - fluxes from grassland and arable soils (winter rape) at the Selhausen site.

Dissolved gas concentrations of N$_2$O and CO$_2$ in soil solution from arable, forest, and grassland lysimeters.
C- and N-Fluxes Influenced by Climatic Differences?

Intermediate Conclusions and Outlook

- Selhausen is warmer and dryer than Wüstebach and Rollesbroich
- Priming effect for nitrate, minor differences for nitrate induced by lysimeter translocation
- High nitrogen input via snow in Wüstebach
- But no priming effect for DOC, minor differences for DOC induced by lysimeter translocation
- Optimization of lower boundary condition is recommended
- On-going measurement/sampling program
Impact of Different Lower Boundary Conditions on Water Balance Components of the SOILCan-Lysimeter Network

J. Groh, T. Pütz & J. Vanderborght (FZJ)

Lower boundary condition

• Lower boundary control for lysimeters from the „space for time“ approach in Selhausen and Bad Lauchstädt (and Dedelow)
• Control by local field tensiometer measurements
• Seasonal matric potential development depends strongly on soil properties and meteorological conditions

Question:

• Correctness of actual lower boundary condition for transported lysimeter?
• Can we quantify the impact of different lower boundary approaches on water balance components for grass and crop lysimeters in Selhausen and Bad Lauchstädt
Lower Boundary Control of Lysimeters from Different Sites

**Hydrus 1-D**
- Virtual experiment
- Site specific soil and meteorological data
- Standard parameterization for grass and wheat

**Assumption:**
- Mix-model represents real field conditions
- Evaluate impact lower boundary control
Conceptual Approach for New Lower Boundary Control

Direct local Measurement
- P, T\text{aMax}, T\text{aMin}, R\text{N},
- W\text{s}, r\text{H}

Input Data

Hydrus 1-D soil profil modeling

Output Data

"Virtual field tensiometer" matric potential in 140cm depth

Adapted lower boundary control

UMS Pumping control

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Tracer Experiment within the SOILCan Network

J. Groh, T. Pütz, U. Wollschläger, M. Hannes & J. Vanderborght

Why:
- To define parameters for solute transport from the SOILCan lysimeters
- Edge-flow (wall effect) to proof excavation method or soil shrinkage effects

Aims:
- Quantification of the edge-flow effect in selected lysimeters
- Spatial variability of transport parameters in some monoliths
- Range of the climate change impact on soil chemistry and solute transport?
Double Tracer Application in Selected Lysimeters

**Focus:**
- Testing sidewall-flow with double tracer test (i.e. SAFFGINA et al. 1977, SAXENA et al. 1992, FANK 2009)

**Schedule:**
- KBr and NaCl
- KBr (nearly ideal water tracer (LEIBUNRGUT 2003, Anion exclusion can lead to a quicker flow than water)
- NaCl (still need to verify background concentration in soils)
Additional idea to detect side-flow

• Lysimeter from Gm with a high clay content
• Swelling and shrinkage in humid or dry periods lead to a significant crack between monolith and lysimeter wall (observed)

Single or double tracer application:

• Tracer application
• Extra irrigation (during rainfall events), for a quicker transit of tracer through the vadose zone (time limited experiment)
• BTC and soil core (every 5cm) analysis (center and wall) to receive tracer concentration over soil depth

CORWIN et al. 2000
Thank you for your attention!
Evaluating A Space For Time Approach For Soil Water Balances In Context Of Climate Change

Basic idea:
- Grass lysimeter in Rollesbroich and in Selhausen (from Rollesbroich)
- Sensitivity analysis (MC or DYNIA, WAGENER et al. 2002) parameter optimization (i.e. AMALGAM, VRUGT & ROBINSON 2009 or SCEM-UA, VRUGT et al. 2003) for both lysimeter sites

Challenge:
- Multi-objective model calibration of \( E_a, \psi, \theta, \) leachate (MERTENS et al. 2006, GROH et al. 2013)

Aims:
- How react model parameters under climate change conditions (stationary, non-stationary), important information for the transferability of model parameters in climate change studies (i.e. STEFFENS et al 2013, pesticide leaching, temperature, climate change)
- Climate change impact on the water balance components (\( E_a, S, \) leachate, and \( \psi, \theta \))