Lysimeters for Global Change Research:

Biological Processes and the Environmental Fate of Pollutants

Testing Fringe Effects for Bromide Transport in High Precision Weighable Field Lysimeters

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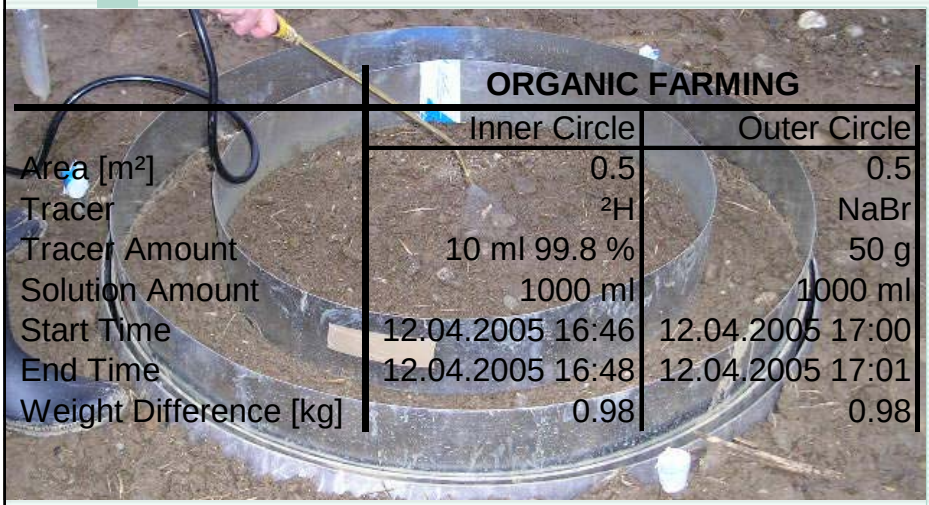
Field Lysimeter excavation

Minimize Lysimeter Measurement Errors

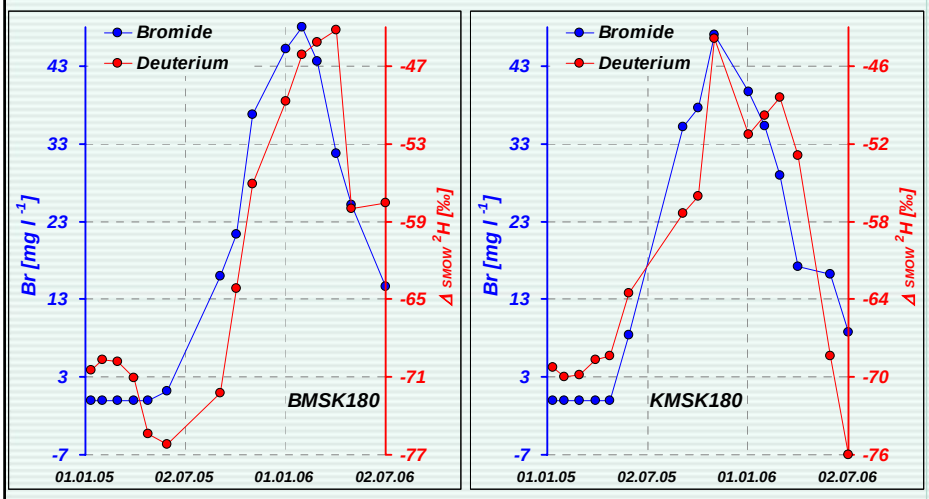
- Mechanized cultivation
- Prevent Oasis/Island effects
- The best lysimeter is the one you don‘t see

Double Tracer Experiment to detect Macroporous Flow and Transport Parameters in the Lysimeter

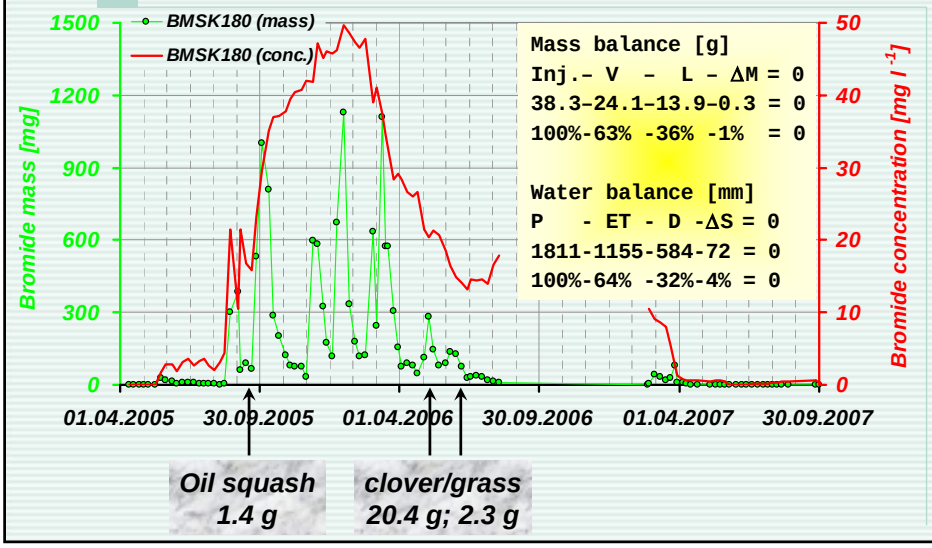


	ORGANIC FARMING	
	Inner Circle	Outer Circle
Area [m²]	0.5	0.5
Tracer	^{2}H	NaBr
Tracer Amount	10 ml 99.8 %	50 g
Solution Amount	1000 ml	1000 ml
Start Time	12.04.2005 16:46	12.04.2005 17:00
End Time	12.04.2005 16:48	12.04.2005 17:01
Weight Difference [kg]	0.98	0.98

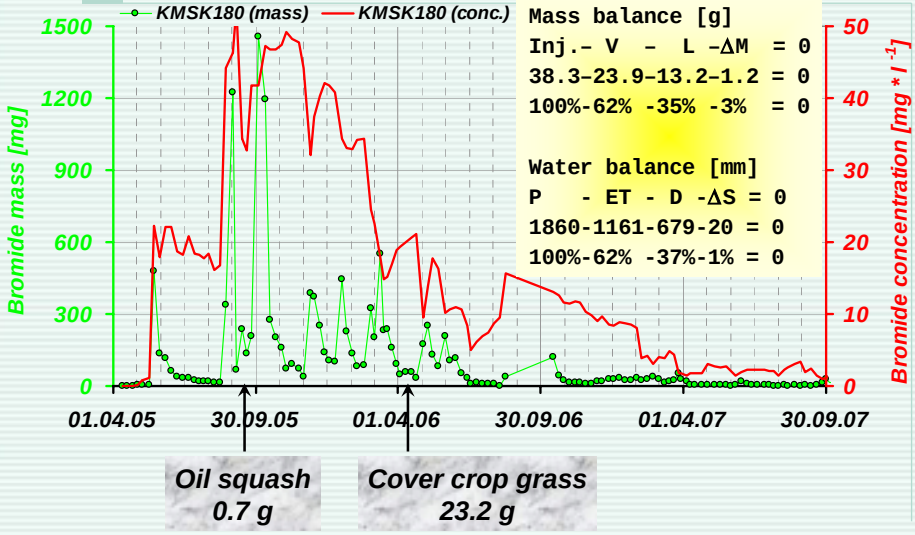
Comparison Bromide : Deuterium



Mass balance of the tracing experiment based on the water balance



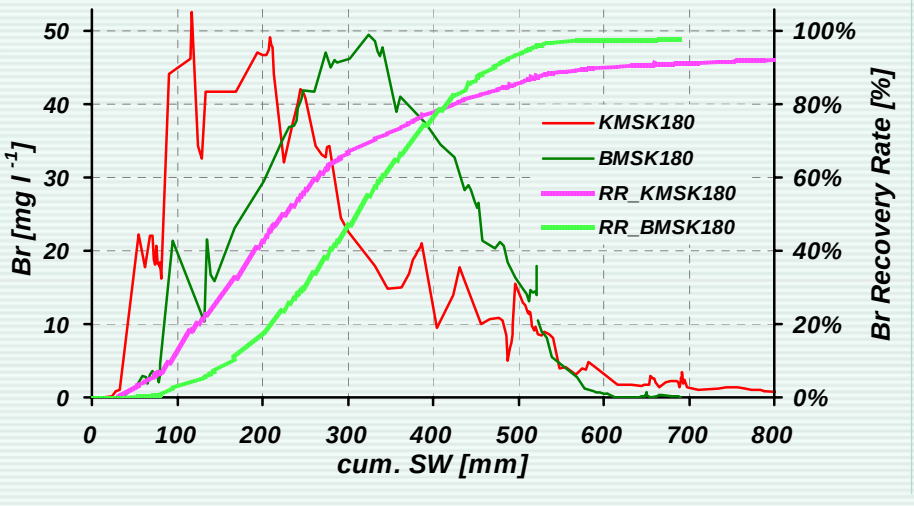
Mass balance of the tracing experiment based on the water balance



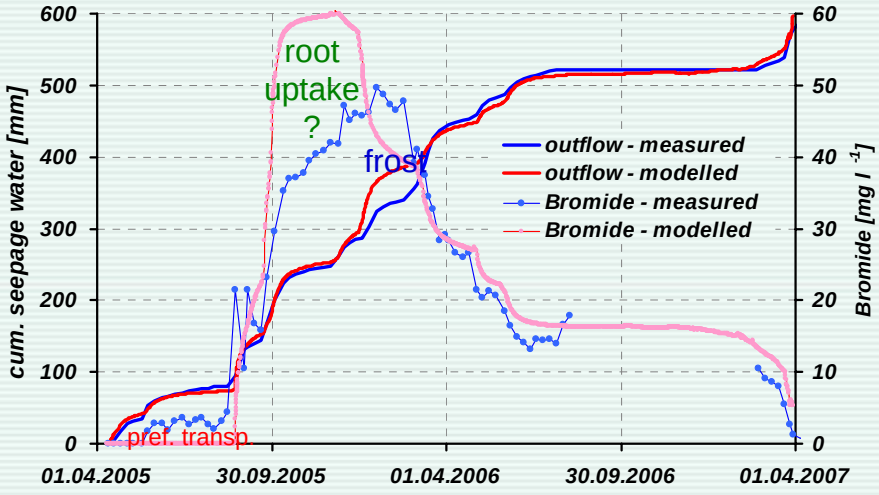
Mass balance [g]
Inj.- V - L -ΔM = 0
38.3-23.9-13.2-1.2 = 0
100%-62% -35% -3% = 0

Water balance [mm]
P - ET - D -ΔS = 0
1860-1161-679-20 = 0
100%-62% -37%-1% = 0

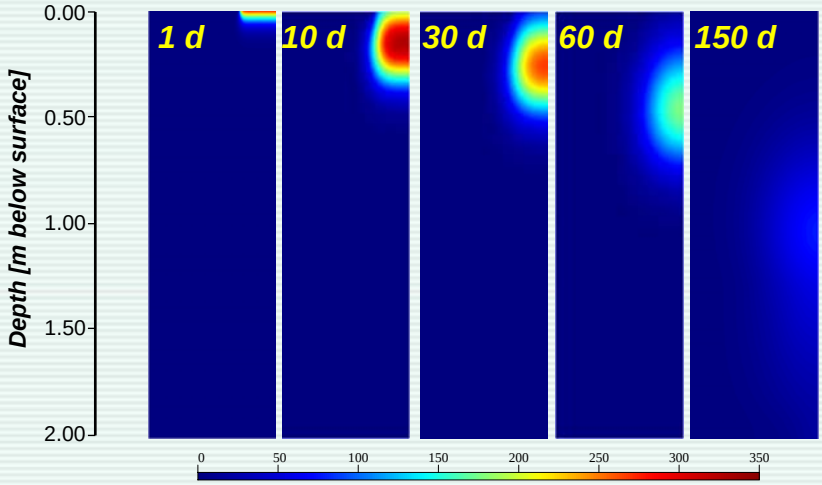
Comparison of the 2 Lysimeters



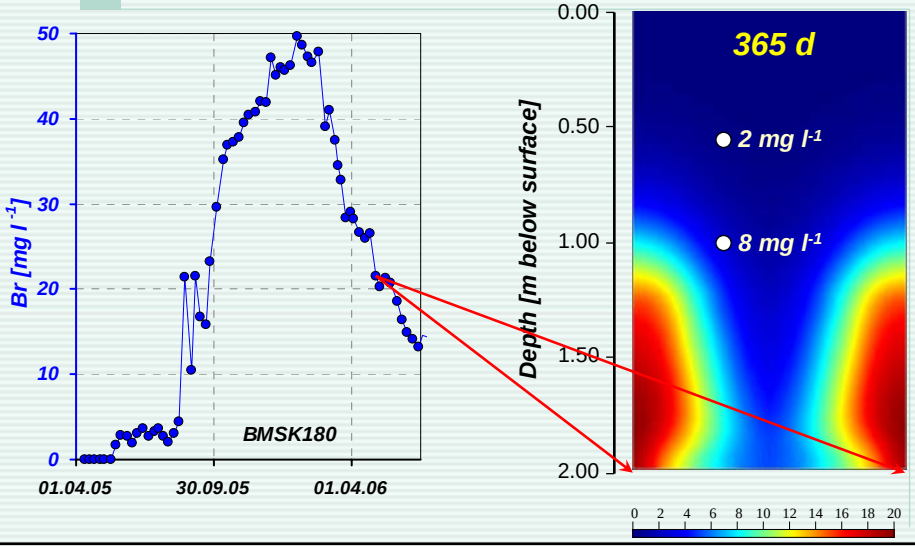
HYDRUS 1D
Modelling results



HYDRUS 2D –
Tracer distribution



Resident tracer distribution



Conclusions

- Precise field lysimeters reduce the known lysimeter shortcomings
- The evaluation of a double tracer experiment shows that there are no fringe effects due to the excavation technique
- Measurement of bromide content in the plants lead to a close mass balance, the tracer recovery rate exceeds 95 %.
- 3D breakthrough is almost equivalent to effective 1D breakthrough
- 3D data can be evaluated by assuming 1D transport

FANK, J. & W. DURNER: Testing Fringe Effects for Bromide Transport in High Precision Weighable Field Lysimeters

In August 2004, two weighable monolithic field lysimeters with a depth of 200 cm and a surface area of 1 m² have been installed at the agricultural test site Wagna (Styria, Austria). The lysimeters are equipped with a suction cup rake at the lower boundary to simulate natural hydraulic conditions for water flow and solute transport. At 35, 60, and 90 cm below surface additional suction cups allow the sampling of soil water. In April 2005, a tracer experiment was performed to test the solute transport regime for possible fringe effects due to the excavation technique. 50 g of NaBr dissolved in 1000 ml of water were applied near the outer fringe without any additional irrigation. For a period of two years, transport driven by natural atmospheric boundary conditions was observed, with regular sampling of bromide concentrations in the suction cups, bromide uptake by vegetation, lysimeter weight, soil water outflow, and bromide breakthrough.

The data evaluation was based on modeling the experiment with the Richards equation and the convection-dispersion equation, using an effective one-dimensional and a radial-symmetric three-dimensional simulation with the software tool HYDRUS-2D. The analysis shows a conservative behavior of the bromide. Mass uptake by plants was proportional to the water uptake, and the total mass recovery of bromide was >95 %. Transport took place with an effective dispersivity of 0.1 m, and a mean transport velocity of 2.4 m a^{-1}, reflecting a mean water content of about 17%. We found no fringe effects, which indicates that the excavation technique causes no significant disturbance. We conclude that high precision weighable lysimeters with controlled suction at the bottom are an excellent tool to reliably monitor water and solute transport in the vadose zone.