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EGU General Assembly 2008

Monolithic field Lysimeter

a precise tool to close the gap between laboratory and field scaled investigations.

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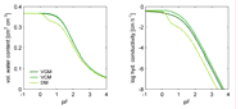
Are laboratory analyzes relevant at the field scale?



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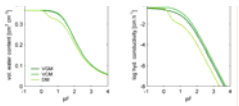

Durner, W. (2008)

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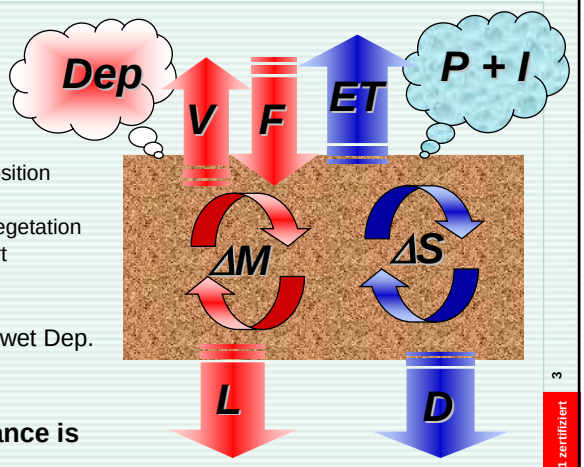
Water Balance – Solute Balance (plain homogeneous Areas)

- **Water Balance**
  - ➔ P + I – ET – D - ΔS = 0
- **Solute Balance**
  - ➔ Dep + F – V – L – ΔM = 0

    Dep = atmospheric Deposition
    F = Fertilization
    V = Losses through Vegetation and Gas Transport
    L = Leaching
    ΔM = Change of Mass
  - ➔ Dep = P * Pc + I * Ic + wet Dep.
    L = D * Dc
    ΔM = ΔS * Δc
- **A well known Water Balance is the Basis for any Solute Transport Investigation**



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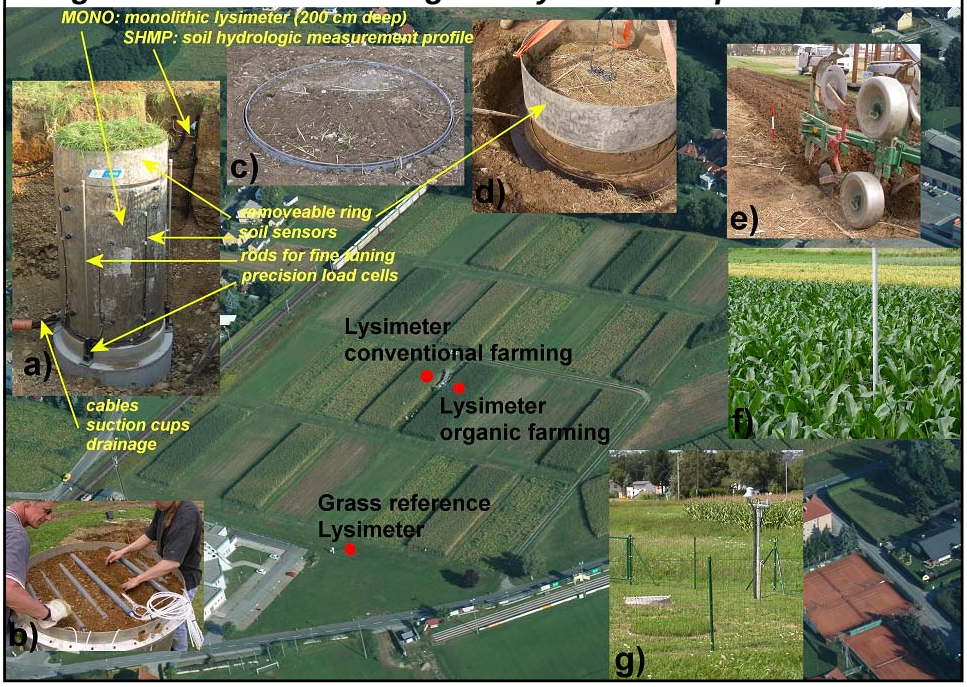
Agricultural test field Wagna – Lysimeter implementation



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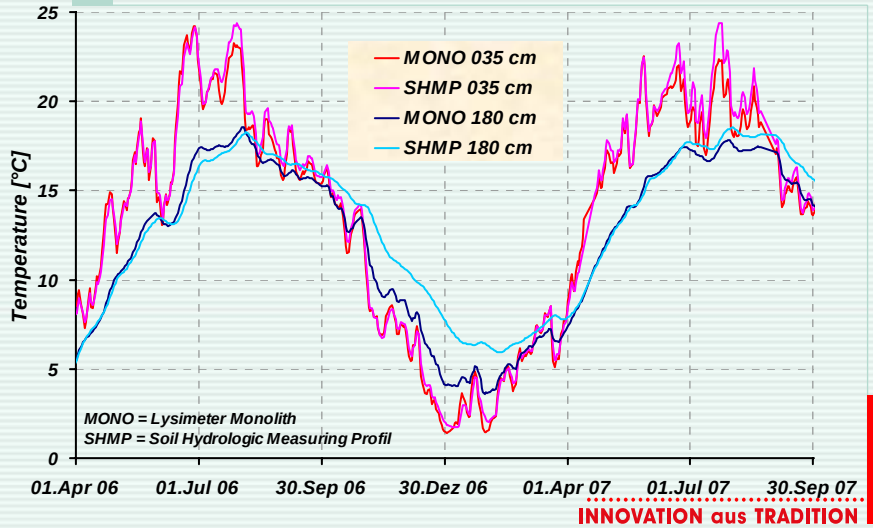
Soil temperature (daily values)
comparison of monlith and profile



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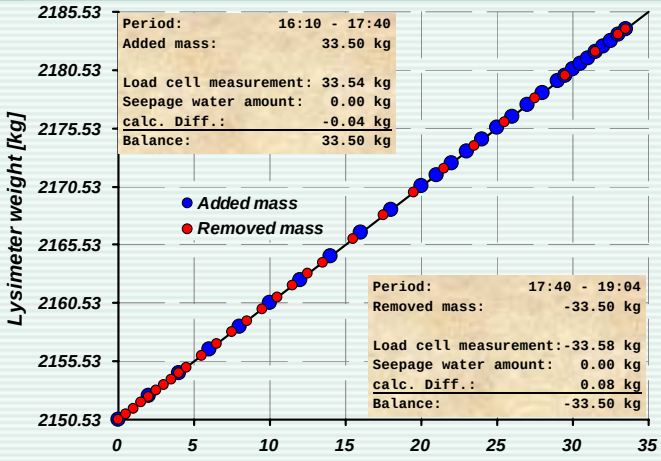
Pecision of Load cells
HYDROLYS (10. Oct. 2007)



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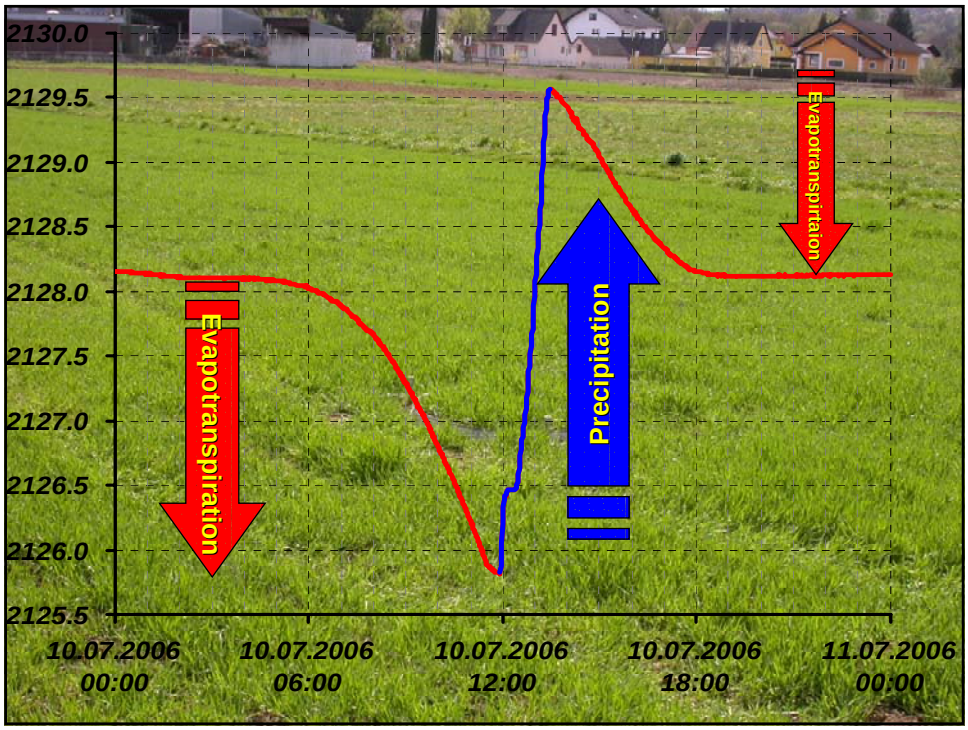
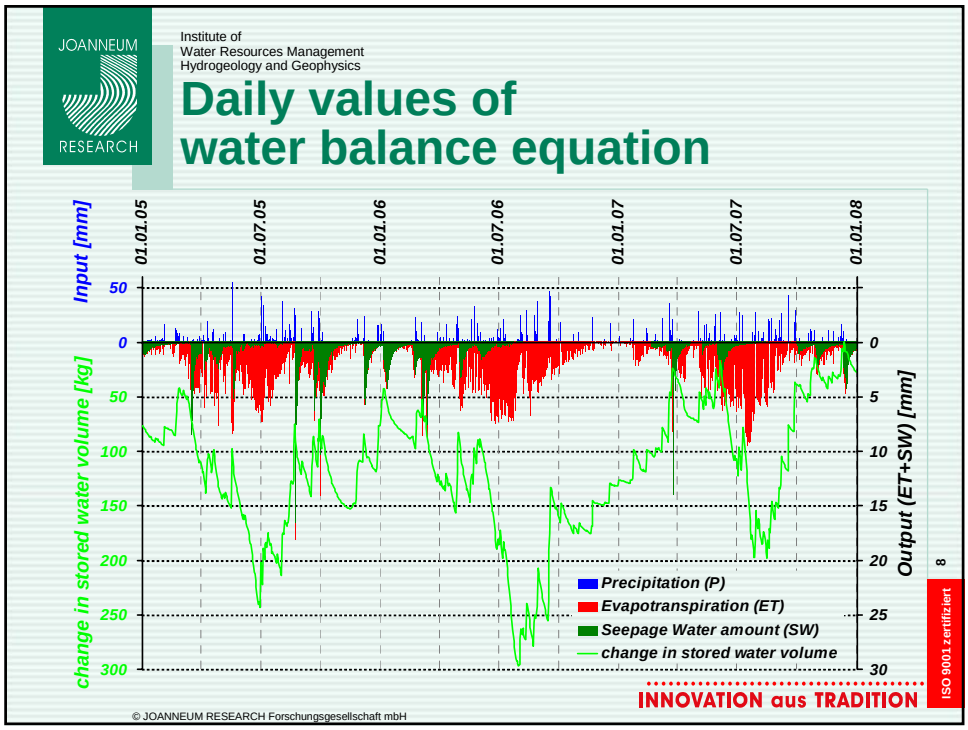

2130.0
2129.5
2129.0
2128.5
2128.0
2127.5
2127.0
2126.5
2126.0
2125.5
Evapotranspiration
Precipitation
Evapotranspiration
10.07.2006 00:00
10.07.2006 06:00
10.07.2006 12:00
10.07.2006 18:00
11.07.2006 00:00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Daily values of
water balance equation
Input [mm]
01.01.05
01.07.05
01.01.06
01.07.06
01.01.07
01.07.07
01.01.08
50
0
change in stored water volume [kg]
50
100
150
200
250
300
0
5
10
15
20
25
30
Output (ET+SW) [mm]
Precipitation (P)
Evapotranspiration (ET)
Seepage Water amount (SW)
change in stored water volume
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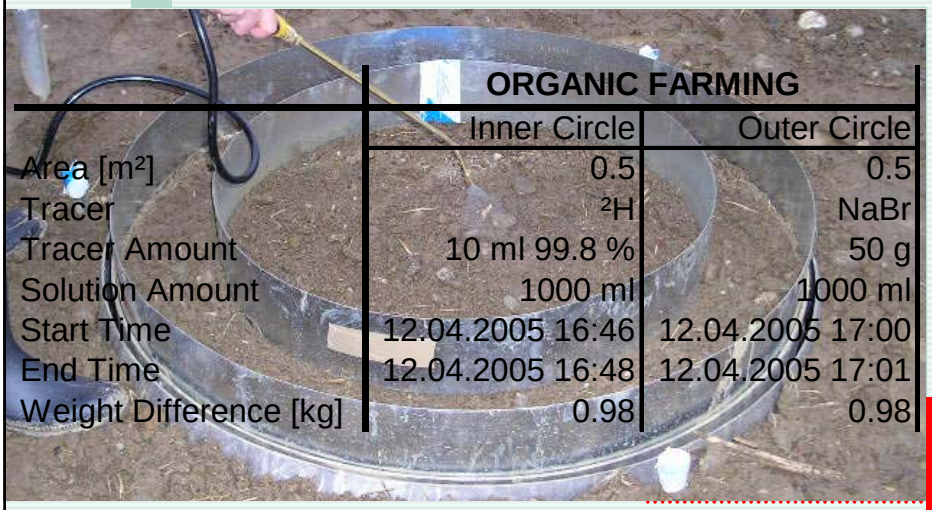
Double Tracer Experiment to detect Macroporous Flow and Transport Parameters in the Lysimeter



	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

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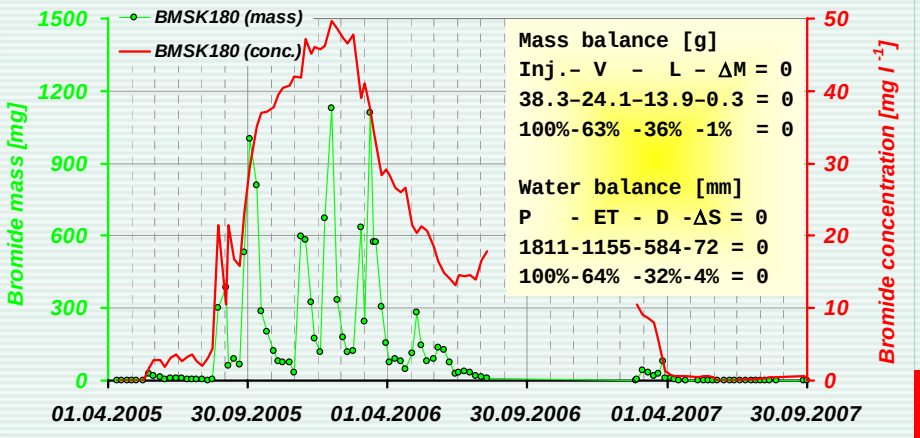
Mass balance of a tracing experiment based on the water balance



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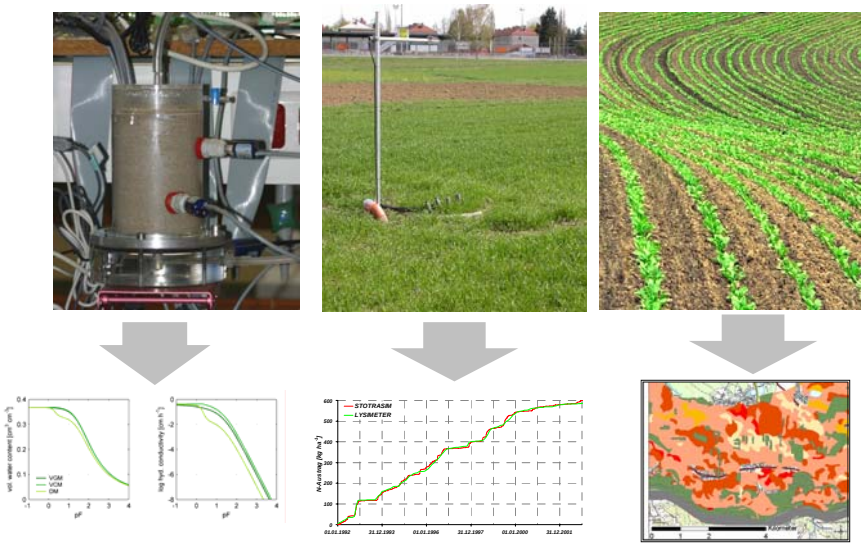
Summary and conclusions

- **Precise weighing monolithic field lysimeters avoid most of the known lysimeter shortcomings**
- **The water balance equation at the lysimeter scale can be solved for any timestep using measured data**
- **Precise lysimeter data are an essential basis**
  - ➔ For model development and model validation
  - ➔ For solute transport investigations and parameter definition
  - ➔ To reduce the gap between laboratory and field scaled investigations



development *validation* *application*

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Monolithic field Lysimeter – a precise tool to close the gap between laboratory and field scaled investigations

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The evaluation of lysimeter data allows a much more reliable calculation of the solute load carried towards the groundwater than any other method. If the lysimeters are weighable, precipitation and actual evapotranspiration can be deduced from changes of their weight. As previous research has shown precise measurement of dew, fog, and frost is possible using a high-precision weighable lysimeter. If drainage is measured separately all the parameters of the water balance equation are measured using one specific instrument. The main arguments against the use of lysimeters for monitoring water balance parameters and measuring solute transport parameters in the soil and unsaturated zone has been the discussion of some sources of error existing potentially in lysimeter measurements, such as the well known oasis effects, preferential flow paths at the walls of the lysimeter cylinders due to an insufficient fit of soil monoliths inside the lysimeters or the influence of the lower boundary conditions on the outflow rates.

In 2004 monolithic lysimeters have been implemented in the Wagna agricultural test field in southern Austria. The two scientific field lysimeters have a depth of 2 m and a surface of 1 m^2. In the different horizons of the loamy to sandy soil and the underlying gravel and sand water content using TDR-probes, the hydraulic potential using tensiometers and SIS-sensors and soil temperature are recorded in a time interval of 10 Minutes. The same data acquisition is done in the soil hydrologic measuring profile (SHMP). The precision load cells on the concrete fundament measure the lysimeters weight with a resolution of 50 g (0.05 mm water equivalent). The lower boundary condition of the lysimeter is realized as a suction cup rake. The soil water tension measured in 1.8 m below surface in the SHMP is transferred via an automatic controlled

vacuum pump to the suction cups. For tillage purposes the load cells are lowered to the fundament and the upper ring of the Lysimeter is removed. The field and the Lysimeter may be cultivated by machines. Afterwards the ring is remounted and the lysimeter is lifted on to the load cells. In April 2005, a tracer experiment was performed to test the solute transport regime for possible fringe effects due to the excavation technique. Data analysis shows a conservative behaviour of the bromide. Mass uptake by plants was proportional to the water uptake, and the total mass recovery of bromide was $>$95 %.

Due to the implementation of the lysimeter directly in the agricultural field there is no oasis effect cognizable. The lysimeter is cultivated in the same manner as the field. Based on the evaluation of the tracing experiments no fringe effects have been found; that indicates that the excavation technique causes no significant disturbance. The transfer of measured hydraulic potential in the SHMP onto the lower boundary of the lysimeter guaranties the same flow rates in the lysimeter as in the undisturbed soil. The comparison of measured soil water parameters between SHMP and the lysimeters monolith have shown that the difference are very small and reflect natural heterogeneity.

Based on this new type of field-lysimeters - high precision weighable monolithic lysimeters directly built in at the arable land - we get exactly measured water balance and solute transport parameters. Due to these characteristics, lysimeters are an excellent tool to validate the transferability of water and solute transport models which are mostly derived on the basis of laboratory experiments to an application on the field scale.Monolithic field lysimeters cover one scale of scientific or applied research working level, which is suited between laboratory scale and field scale. They combine the advantages of true field conditions and laboratory possibilities of varying parameters, handling and maintenance.