

## Measuring Results at the Wagna Research Field – a Complex Dataset for Model Preparation and Validation on the Lysimeter Scale



Messergebnisse am Forschungsfeld Wagna –  
ein komplexer Datensatz zur Modellerstellung und  
-validierung auf der Lysimeterskala

MMM Conference Graz  
January 2007

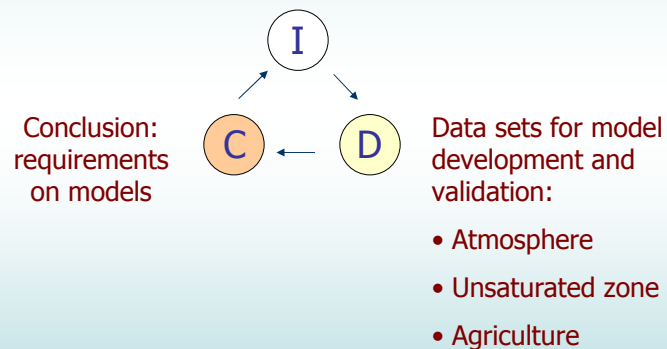


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## Outline

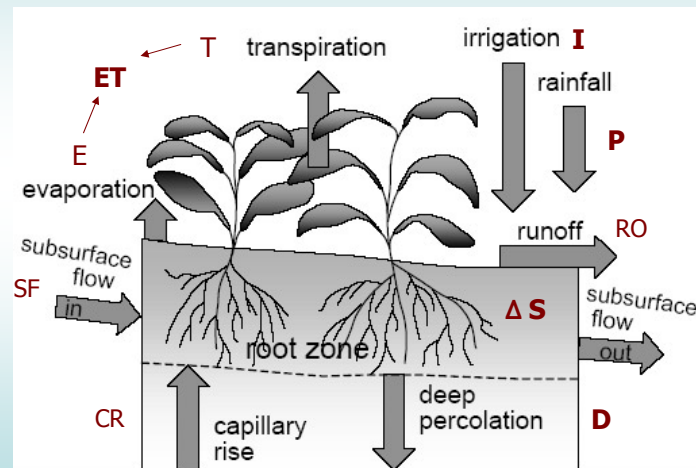
Soil water balance  
Solute transport equation



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## Model Basics – Soil Water Balance

$$P + I - ET - D - \Delta S = 0$$



Soil water balance of the root zone  
according to ALLEN et al. 1998, p. 12, modified

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## Solute Balance

$$Dep + F - V - L - \Delta M = 0$$

**Dep** = atmospheric deposition

$$Dep = P \cdot Pc + I \cdot Ic + \text{wet Dep}$$

**F** = fertilisation

**V** = losses through vegetation and gas transport

**L** = leaching

$$L = D \cdot Dc$$

**$\Delta M$**  = change of mass

$$\Delta M = \Delta S \cdot \Delta c$$

according to Fank 2006

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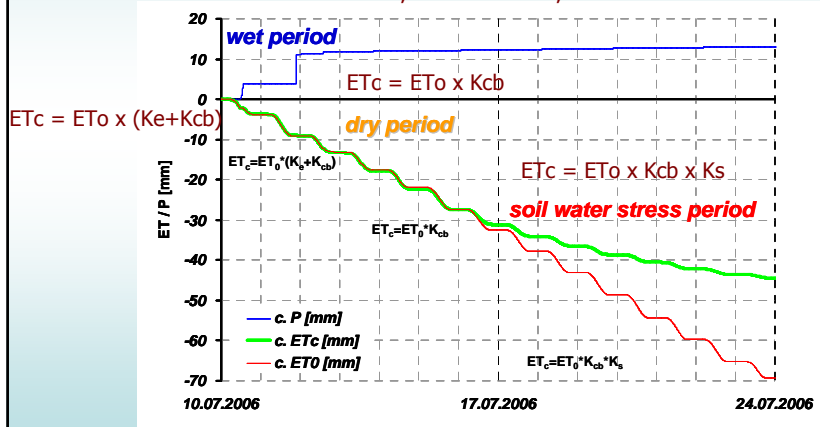
## Atmosphere

ET<sub>0</sub> (reference evapotranspiration): according to Penman-Monteith

ET<sub>c</sub> (crop ET under standard conditions) = ET<sub>0</sub> × K<sub>c</sub> (crop coefficient)

$$K_c = K_{cb} + K_e$$

$$T = ET_0 \times K_{cb}, E = ET_0 \times K_e; K_e = K_c - K_{cb}$$

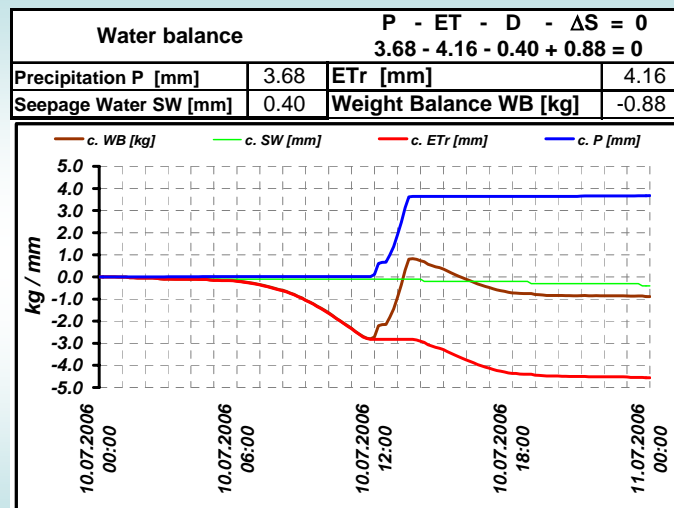


Evaluation of crop factors and soil water stress factors from lysimeter measurement and short term evaluation of grass-reference evapotranspiration (WALTER *et al.*, 2005)

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## Unsaturated Zone – Water Balance

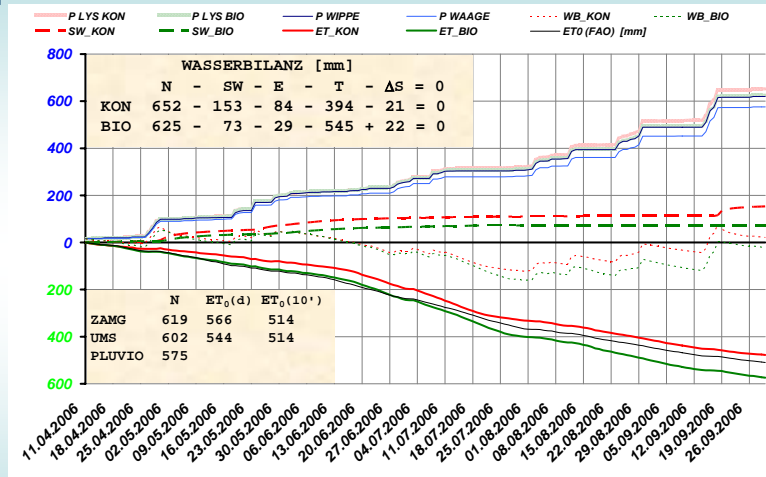


Daily water balance elaborated from lysimeter measurement

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## Unsaturated Zone – Water Balance

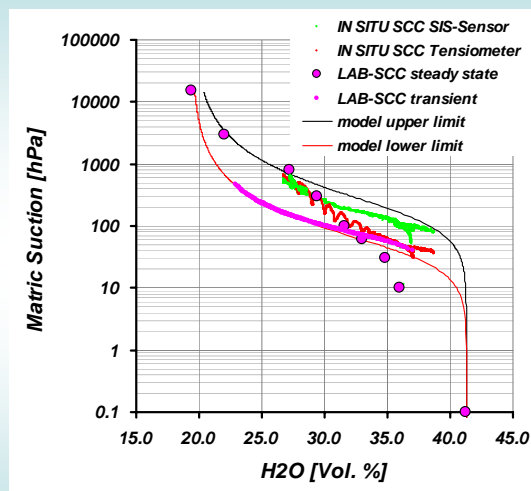


Water balance for a vegetation period; comparison between two different cropping systems (KON = maize, conventional farming, BIO = clover/grass, organic farming)

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## Unsaturated Zone – Soil Physics

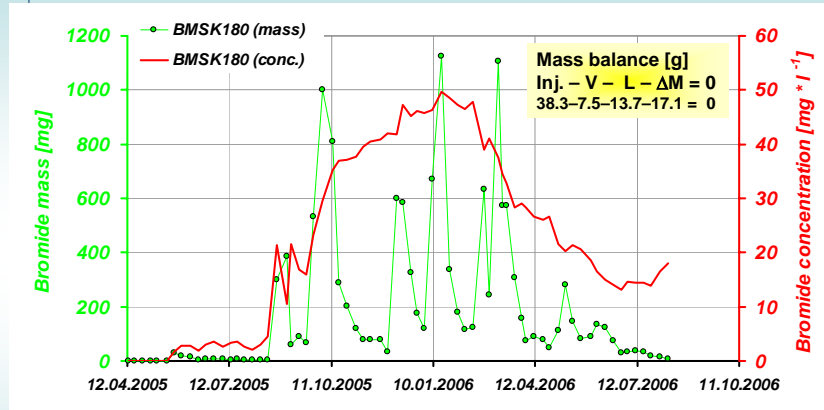


Soil physics (water content, matric suction):  
comparison of different data bases

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## Unsaturated Zone – Tracer Balance



Tracing experiment: tracer mass balance

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## Agriculture – Crop Development



02.06.2005, 06.07.2005, 03.08.2005,  
25.08.2005, 13.09.2005, 24.09.2005

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# Agriculture – Plant and Yield Data

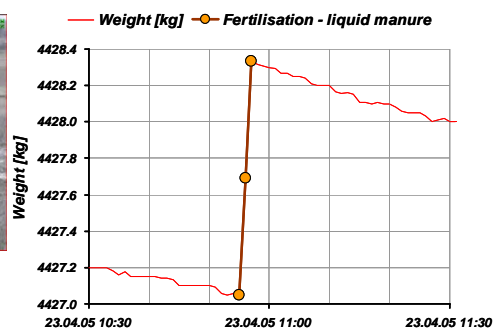
## Yield and plant content

Sample	organic farming				conventional farming				
	Tendrill	Pumpkin seeds	Pumpkin pulp	cum. sum	rotten pumpkin	Tendrill	Pumpkin seeds	Pumpkin pulp	cum. sum
Dry weight [kg/m <sup>2</sup> ]	0.030	0.141	0.366	0.537	0.053	0.036	0.091	0.139	0.319
Harvesting weight [kg/m <sup>2</sup> ]	0.033	0.233	6.544	6.810	0.097	0.042	0.147	1.847	2.133
Water content [kg/m <sup>2</sup> ]	0.003	0.092	6.178	6.273	0.044	0.006	0.056	1.708	1.814
<b>Nitrogen (Kjehldahl) [g/100g]</b>	1.560	5.890	1.965		4.890	1.500	5.580	1.595	
<b>[kg/ha]</b>	4.674	82.891	72.010	159.576	25.898	5.450	50.856	22.095	104.299
<b>Phosphorus [g/100g]</b>	0.180	1.000	0.185		1.050	0.300	1.140	0.290	
<b>[kg/ha]</b>	0.539	14.073	6.780	21.392	5.561	1.090	10.390	4.017	21.058
<b>Potassium [g/100g]</b>	0.740	0.520	3.815		1.700	0.930	0.660	4.620	
<b>[kg/ha]</b>	2.217	7.318	139.806	149.341	9.004	3.379	6.015	63.999	82.396
<b>Calcium [g/100g]</b>	4.420	0.050	0.655		0.820	3.590	0.060	0.350	
<b>[kg/ha]</b>	13.244	0.704	24.003	37.951	4.343	13.042	0.547	4.848	22.781
<b>Carbon [g/100g]</b>	61.200	95.300	83.750		86.100	64.000	94.700	82.400	
<b>[kg/ha]</b>	183.380	1341.176	3069.136	4593.692	456.003	232.512	863.096	1141.446	2693.057
<b>Magnesium [g/100g]</b>	0.280	0.390	0.205		0.450	0.260	0.460	0.140	
<b>[kg/ha]</b>	0.839	5.489	7.513	13.840	2.383	0.945	4.192	1.939	9.460
<b>Boron [mg/1000g]</b>	22.400	25.400	48.200		39.500	11.400	22.200	47.250	
<b>[kg/ha]</b>	0.007	0.036	0.177	0.219	0.021	0.004	0.020	0.065	0.111
<b>Manganese [mg/1000g]</b>	316.100	47.800	17.400		115.400	381.600	44.700	7.750	
<b>[kg/ha]</b>	0.095	0.067	0.064	0.226	0.061	0.139	0.041	0.011	0.251
<b>Sodium [mg/1000g]</b>	111.600	13.700	46.550		27.200	138.700	17.600	38.950	
<b>[kg/ha]</b>	0.033	0.019	0.171	0.223	0.014	0.050	0.016	0.054	0.135
<b>Copper [mg/1000g]</b>	12.220	12.250	8.380		15.660	10.350	10.110	7.615	
<b>[kg/ha]</b>	0.004	0.017	0.031	0.052	0.008	0.004	0.009	0.011	0.032
<b>Zinc [mg/1000g]</b>	53.600	98.000	33.850		92.700	51.600	118.800	29.350	
<b>[kg/ha]</b>	0.016	0.139	0.124	0.279	0.049	0.019	0.108	0.041	0.217
<b>Iron [mg/1000g]</b>	8774.000	102.600	288.900		1406.300	10673.900	118.800	120.300	
<b>[kg/ha]</b>	2.629	0.144	1.059	3.832	0.745	3.878	0.108	0.167	4.898

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# Agriculture – Fertilisation



10:55 – 10:57  
 $\Delta$  weight = 1.382 kg  
 $\sim 12.830 \text{ kg} \cdot \text{ha}^{-1}$

Video surveying system to check fertilisation (left) and lysimeter data to quantify the amount of fertilisation applied

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## Conclusion

When models are or will be applied to larger areas, they have to be ...

- ✓ validated on real data and
- ✓ calibrated regionally

as information of a single point (lysimeter) is used.

Numerical models have to be capable of simulating measured data of water and solute parameters of well known lysimeters before they are applied regionally (where less data is available).

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Site characterisation, technical description, results, photos ...:  
<http://www.lysimeter.com>

The screenshot shows the website interface. At the top, there is a navigation bar with 'Conference 2007', 'Home & Links', 'Lysimeter Station Wagner', and 'Contact & Credits'. A sidebar on the left contains 'Visit lysimeter Web sites' with logos for 'European Lyso', 'Austrian Lyso', and 'UM'. Below this is a map of Austria with a red dot indicating the location of the lysimeter station. The main content area is titled 'Installing a lysimeter in spring 2006' and features a photo of a person installing a lysimeter. Text next to the photo describes the installation process: 'The lysimeter cylinder filled with soil is then lifted from the hole, turned round and put on the ground near the pit with the upside down.' and 'The bottom plate and several centimeters of the natural soil are removed. 7 suction cups (of different sizes) for collecting seepage water are installed, see figure 3. Soil is replaced by different sizes of filter sand and gravel from top to bottom.' and 'The bottom of the lysimeter is covered with a fleece and a stainless steel bottom plate is mounted to the container. At the same time, soil samples of all horizons are taken to be analyzed for different parameters.' Below the photo is a caption: 'Figure 3: Installing suction cups'. At the bottom of the page, there is a footer with 'last update: July 25, 2006' and a logo.

Thank you for your attention!