Modelling Water, Nitrogen and Carbon Fluxes during Decomposition of Crop Residues, Incorporated or left at the Soil Surface

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Introduction

- Global change:
  - carbon sequestration in agricultural land
- Reduced / no-tillage
  - change in crop residue localisation

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soil water dynamics
nutrient distribution
microbial activity

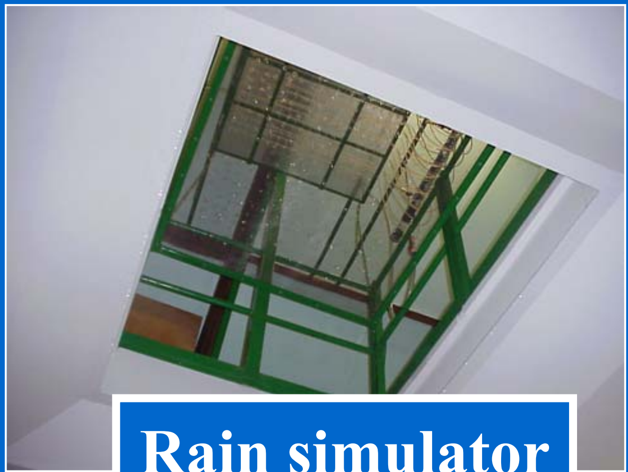
} **Residue decomposition**
Fate of C, N in soil

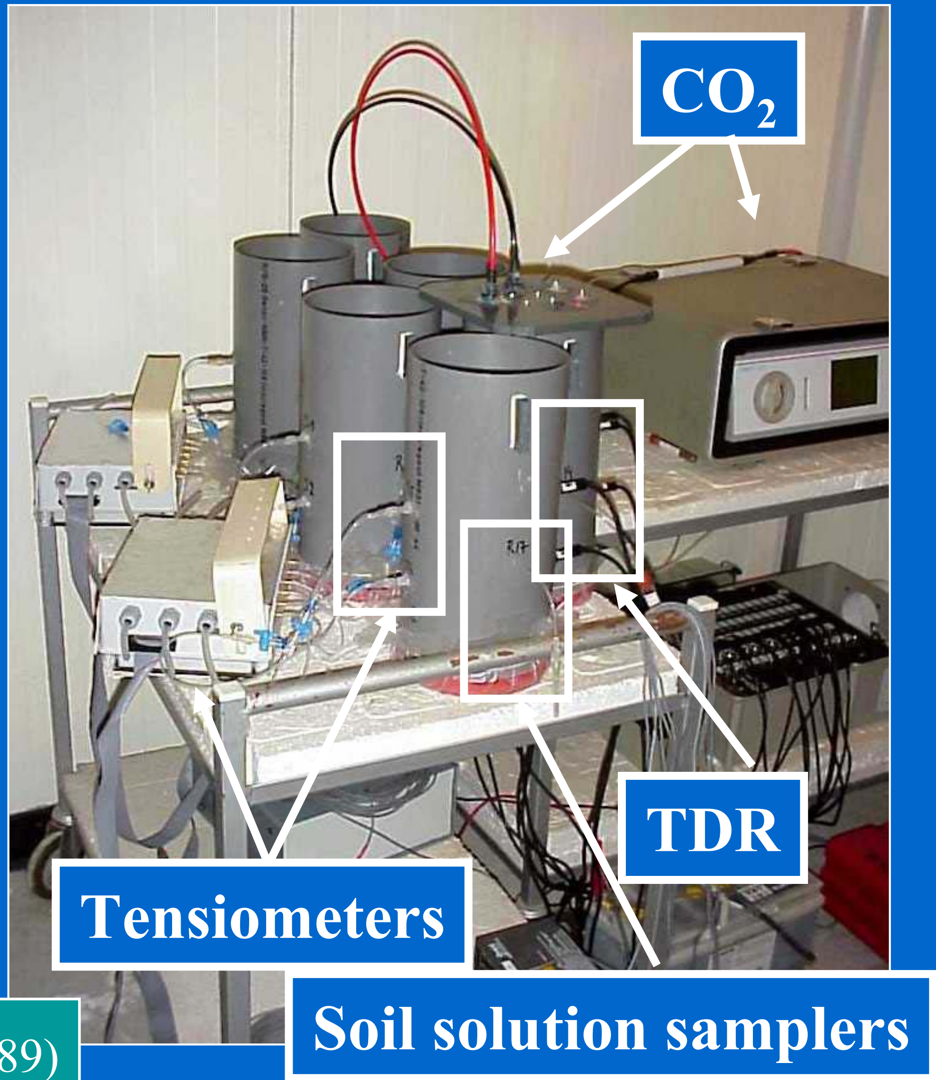
- Soil column experiment
- Modelling

Experimental setup

- Soil columns:
  - Silt loam soil
    - sieved at 2 mm
    - compacted in columns (1.3 g/cm^3 ; 25 cm, ∅ 15 cm)
  - Oilseed rape residue
    - labelled ^{13}C and ^{15}N
    - particle size of 1 cm
    - incorporated (0-10 cm) or mulch
    - 14 g DM/column (equivalent 7.4 t/ha)
- Incubation during 9 weeks at 20°C
  - 3 dry-wet cycles
  - Rain applied with rain simulator: 2.5 h at 12 mm/h

Experimental setup



Recous et al., this conference (n° 389)

Modelling

- Why modelling?
  - Interaction water dynamics ~ residue decomposition
  - Gross fluxes N-mineralization/immobilization
  - Scenario analysis
    - different rain applications
    - other crop residue quality
- Which model?
  - Link soil physical - biological processes
  - surface residue decomposition
  - simulation of ^{13}C, ^{15}N

Modelling: PASTIS model

- PASTIS : 1-dimentional, mechanistic model

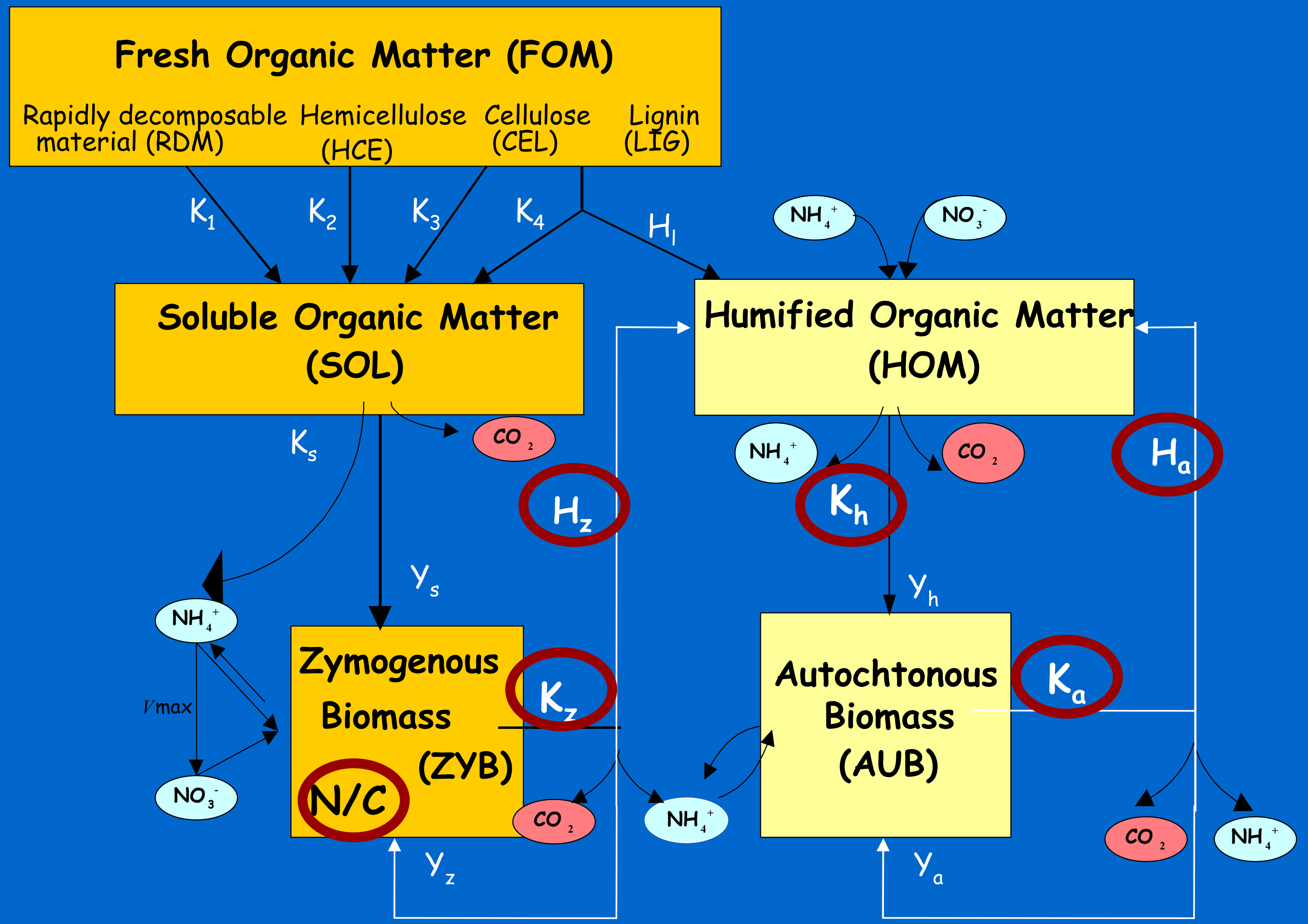
(Garnier et al., 2003)

– module biotransformations C + N
  - residue-C decomposition $$\frac{dC}{dt} = -K_i C_i f_T f_W f_N f_B$$

(Lafolie, 1991)

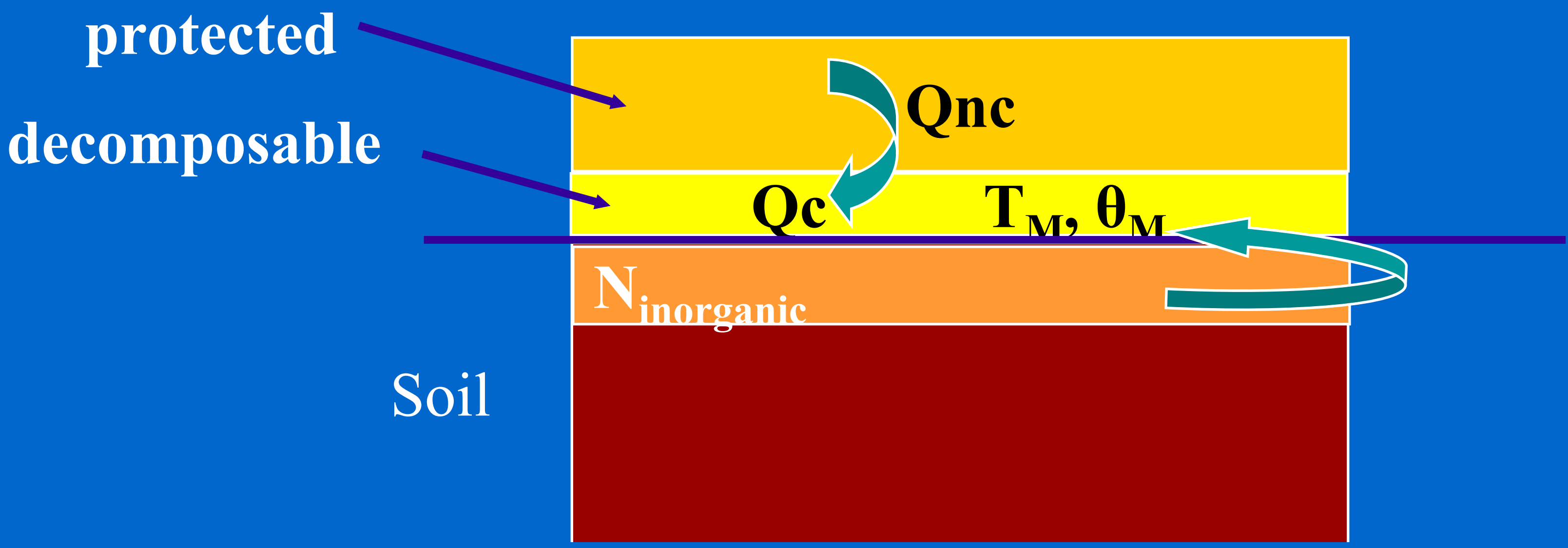
– module transport
  - water transfer **$\theta(t,z) \Rightarrow f_\theta(t,z)$**
  - heat transfer **$T(t,z) \Rightarrow f_T(t,z)$**
  - solute transport **$[NO_3](t,z) \Rightarrow f_{[NO3]}(t,z)$**

Modelling: C + N



Modelling: mulch decomposition

(Findeling et al., 2004)



Physical parameters

- initial mass of mulch
- max. mass in contact with soil
- min./max. water content
- max. rain interception

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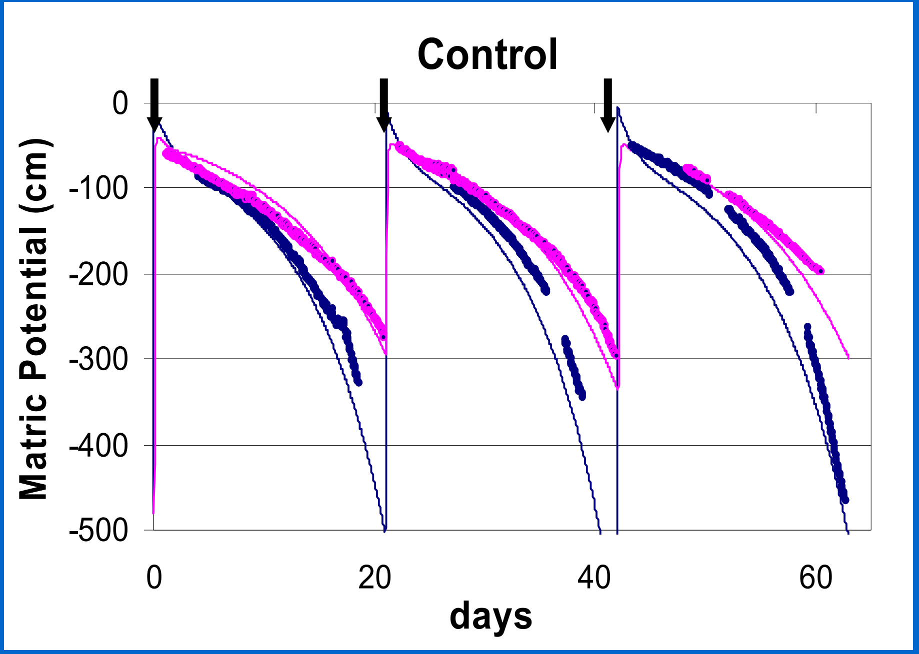
Biological parameters

- quality = incorporation
- specific functions for
  - Temperature
  - Water content
  - N availability

Modelling: concept

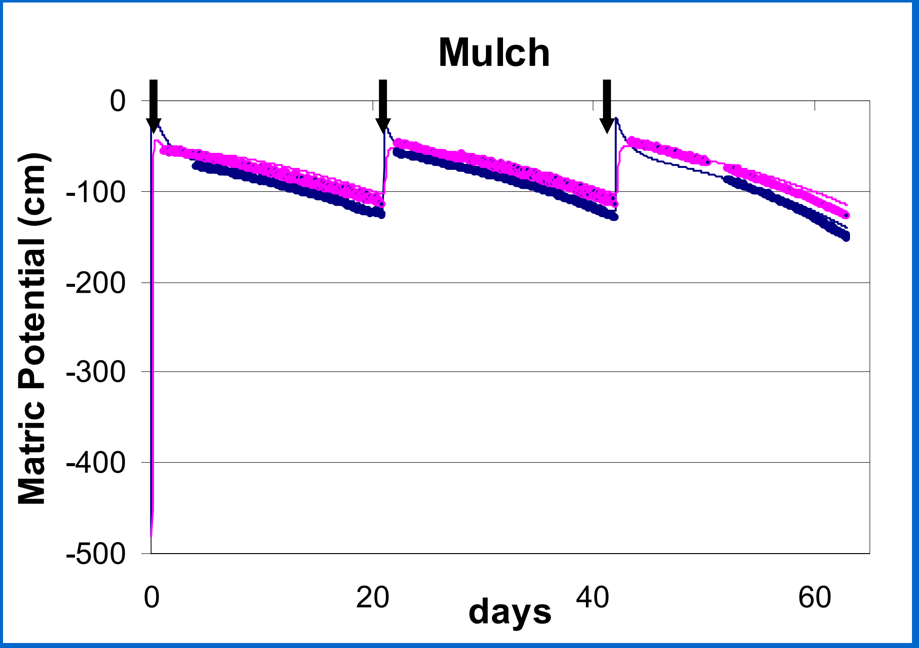
Input	Model	Output
Constant temperature Hydrodynamic parameters - column control soil Biological parameters - incubation experiment	Initial conditions Boundary conditions	Water potential CO_2-flux NO_3^--N residual ^{13}C

Observation vs. Simulation



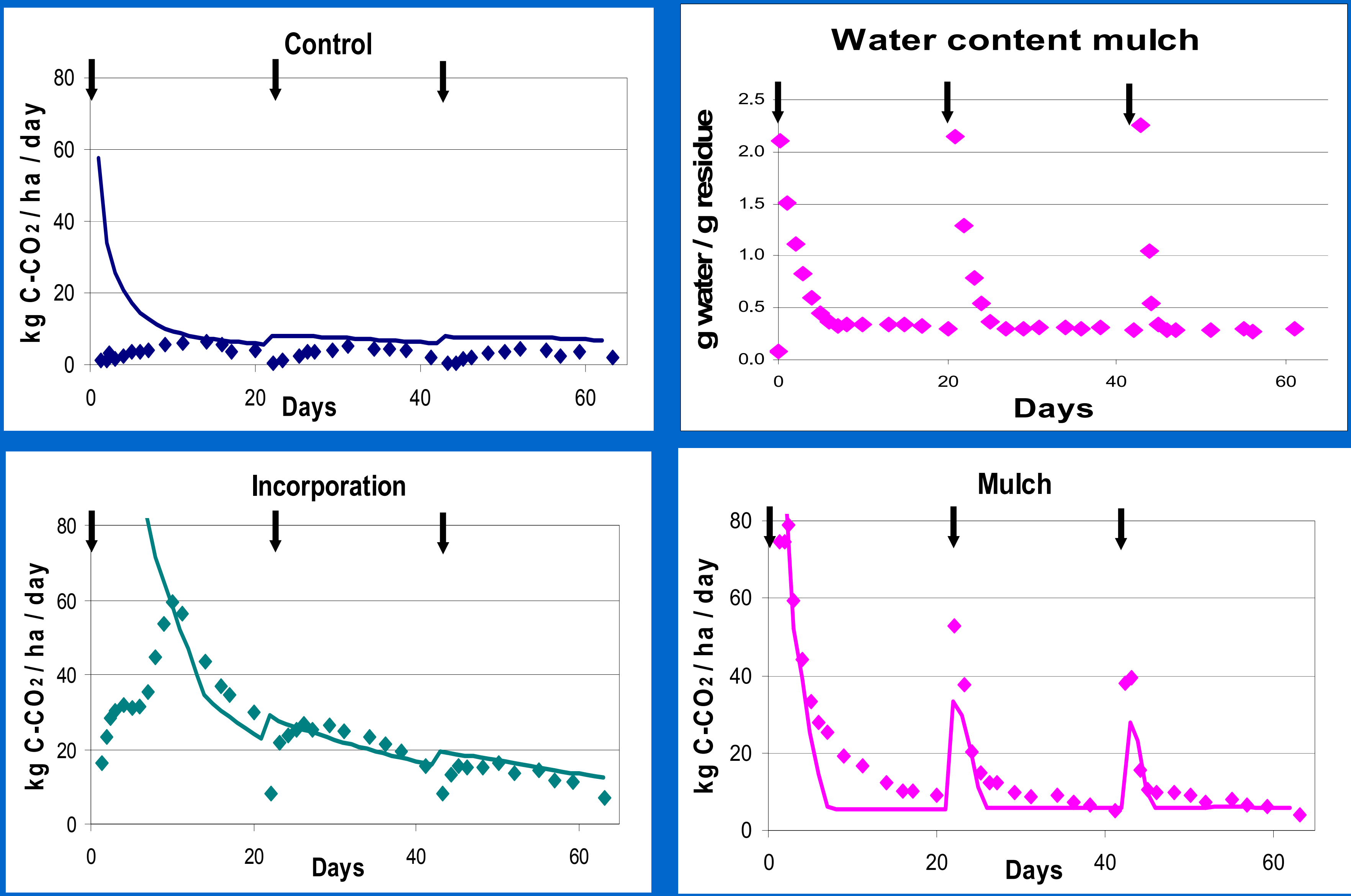
Soil water potential

Calibration: control columns
Same parameters for all treatments



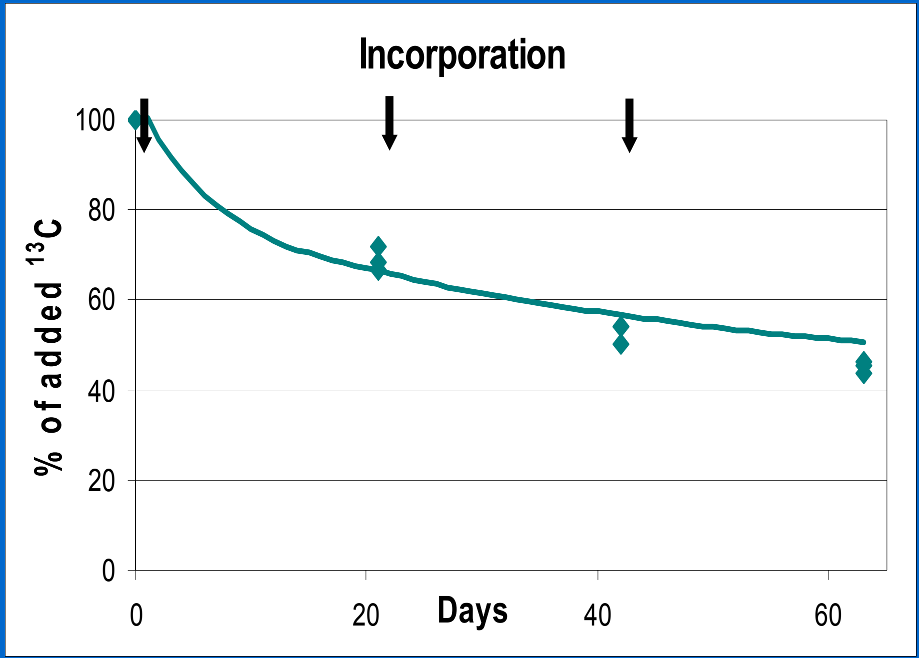
◆ Observation (-6 cm)
— Simulation (-6 cm)
◆ Observation (-14 cm)
— Simulation (-14 cm)

Observation vs. Simulation

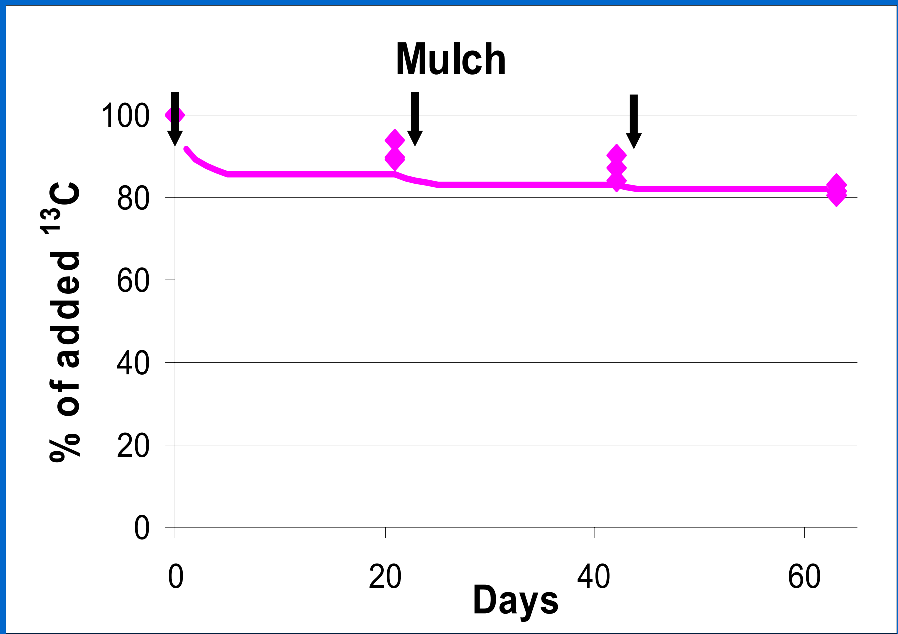


Observation vs. Simulation

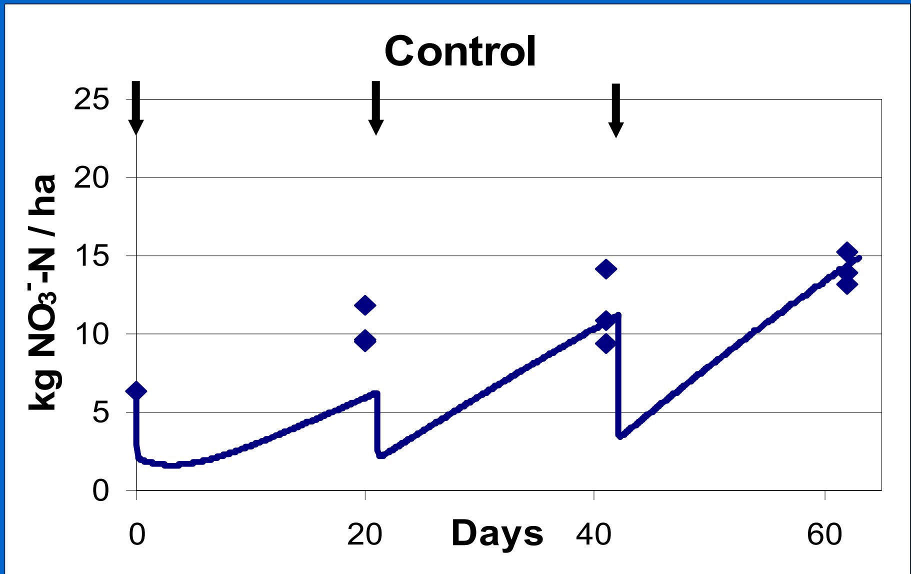
Residual oilseed rape-C



Incorp.: 55% C mineralized
Mulch: 18% C mineralized



Observation vs. Simulation

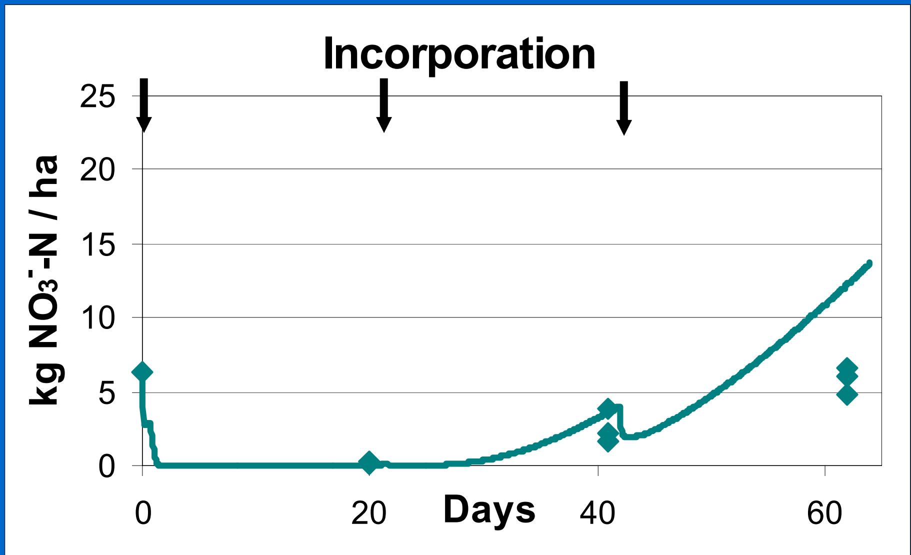


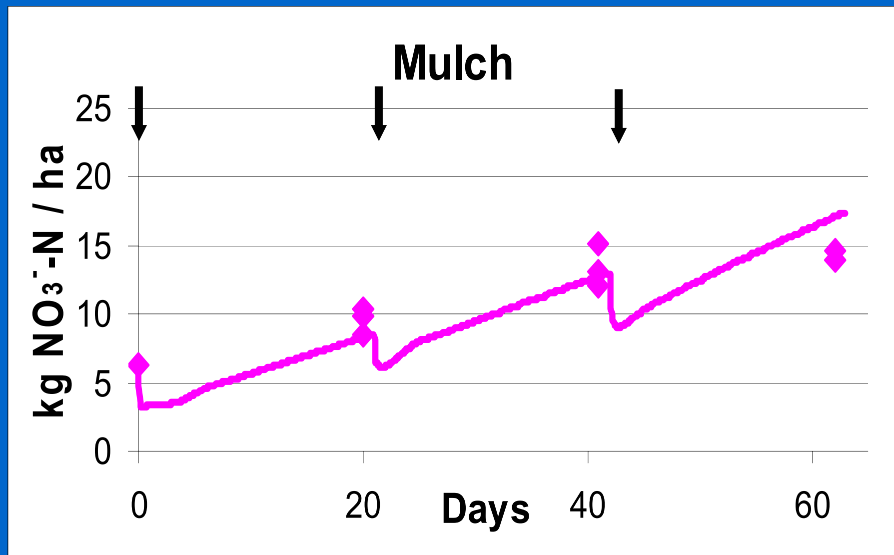
NO_3^--N (0-5 cm soil layer)

Incorp.: net N immobilization
Mulch: net N mineralization

Measured NO_3^--N:

mineralization-immobilization,
leaching + upward transport





Conclusion / Perspectives

- Model
  - interaction water / N-dynamics
- Improvements for
  - initial rate of C-mineralization
  - mulch decomposition
    - transport of nitrate, soluble C from mulch
- Perspectives
  - effect of residue quality
  - scenario analysis