GEUS

Are detailed sorption characteristics regarding soil domains imperative for estimation of glyphosate leaching through fractured clayey till?

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GEUS – Geological Survey of Denmark and Greenland

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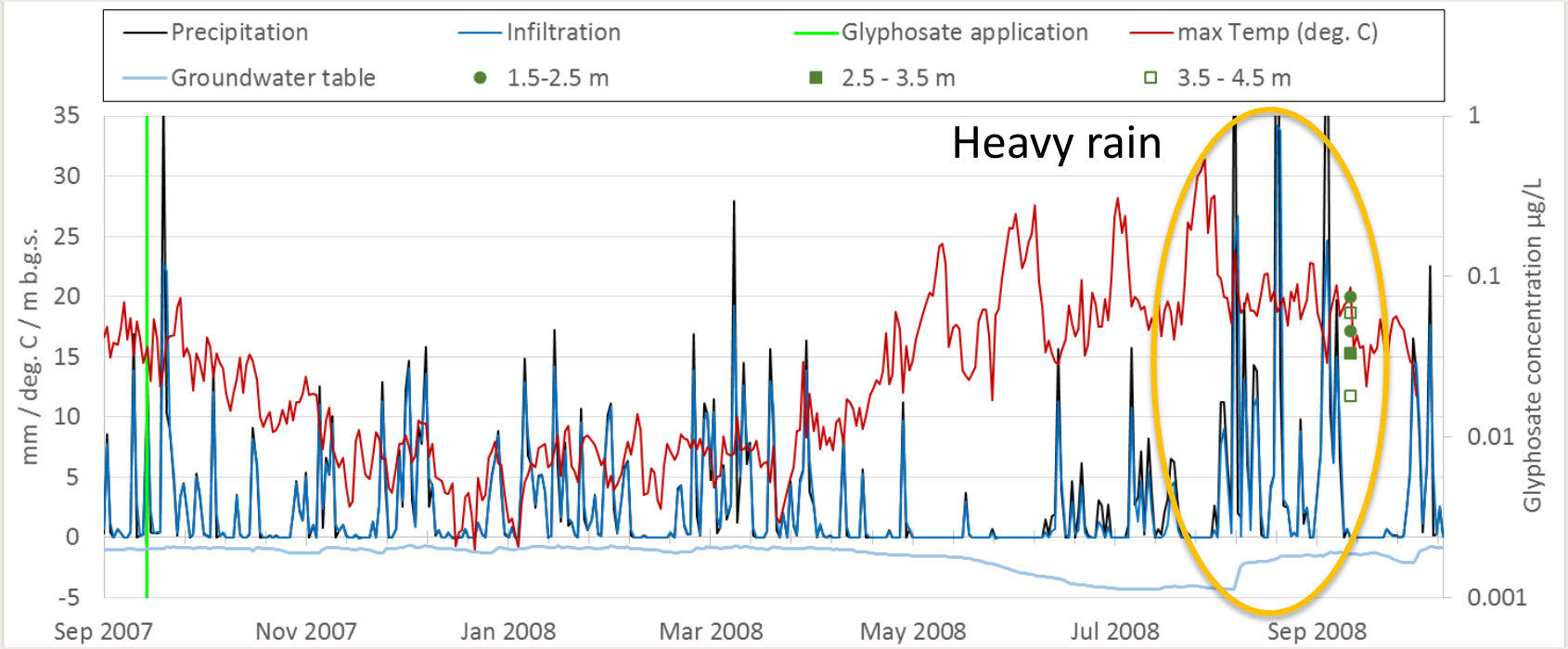
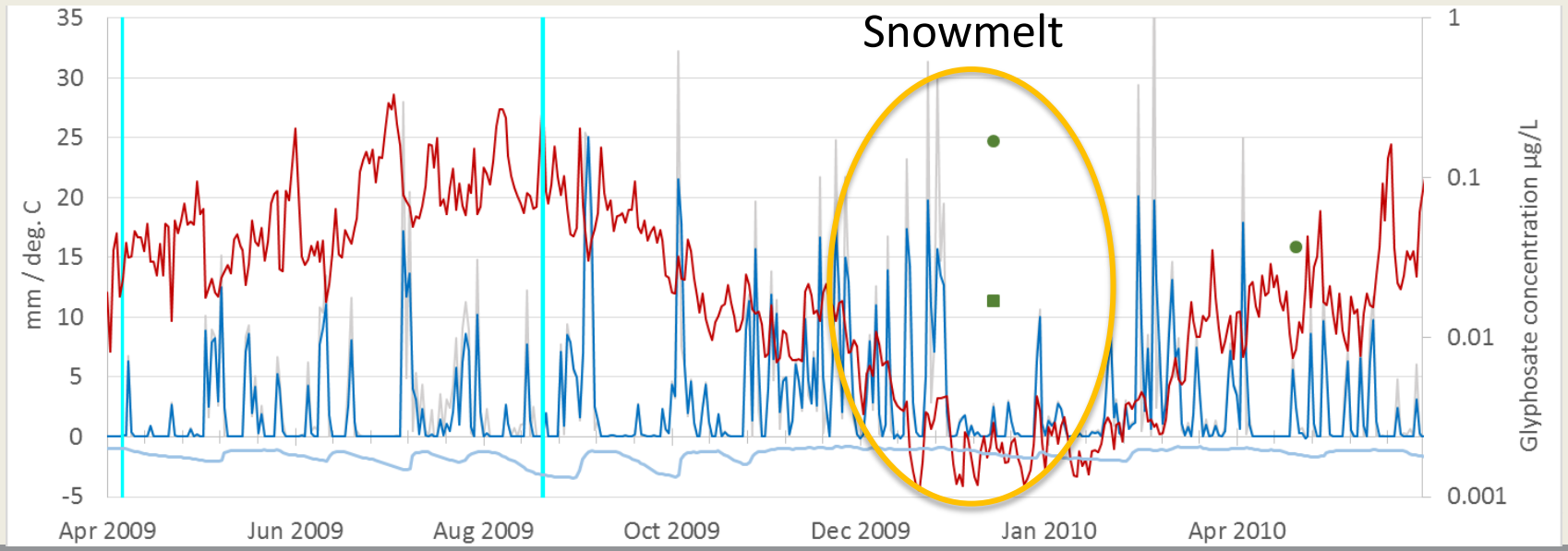
Observations





Questions!

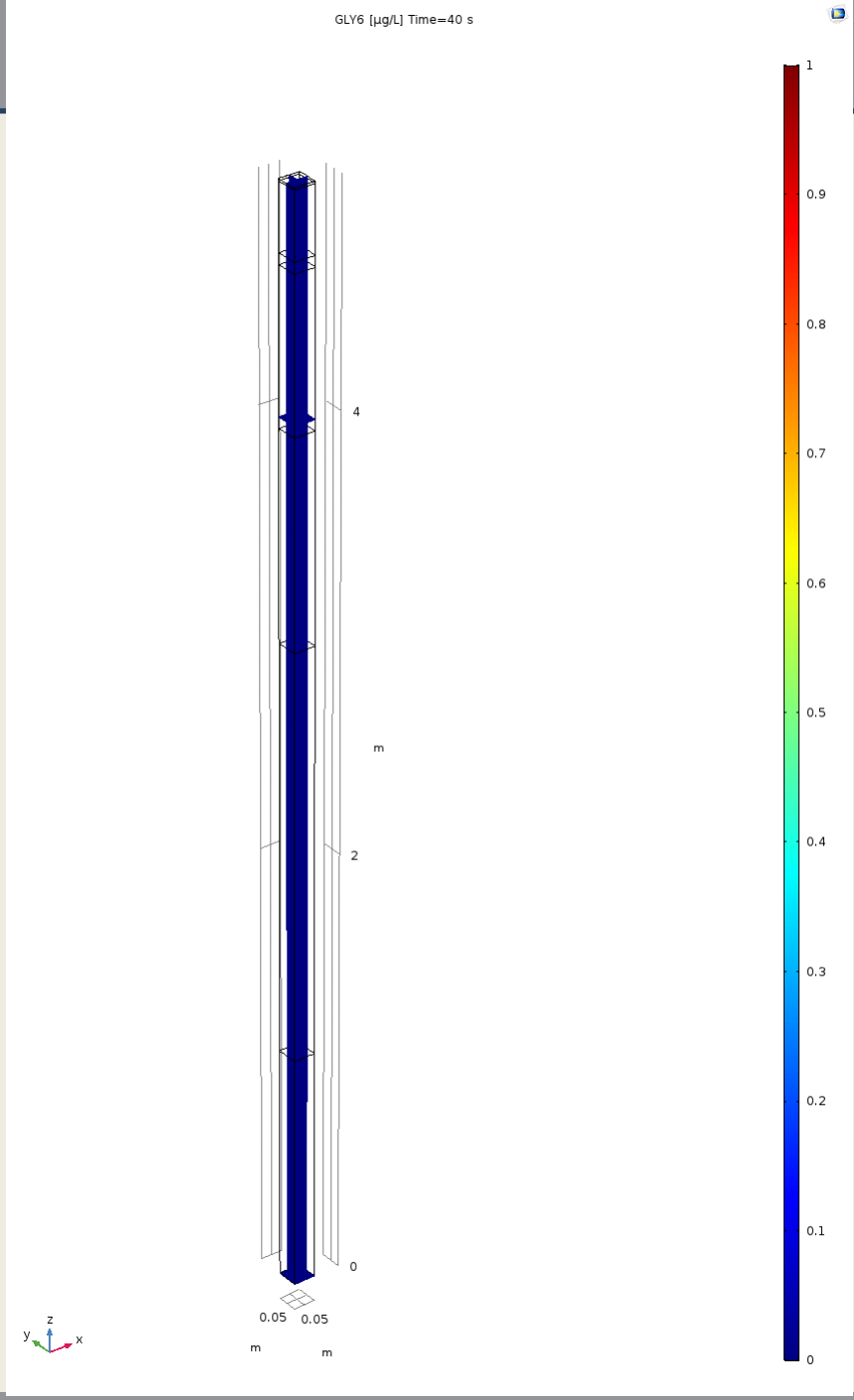
Why is glyphosate detected in high concentrations in groundwater beneath fractured clayey soils after heavy rain or snowmelt events?

- Is this behaviour captured by the regulatory model concept?
- Can the detailed information regarding flow and sorption be incorporated into a numerical model, thereby helping us better understand the leaching pattern through fractured clayey soils?

Regulatory model concept

- Homogeneous layers
- Piston flow
- Sorption values from plough layer in entire model
- DT50 distribution with depth as used in FOCUS

Note:
Fluctuating groundwater table



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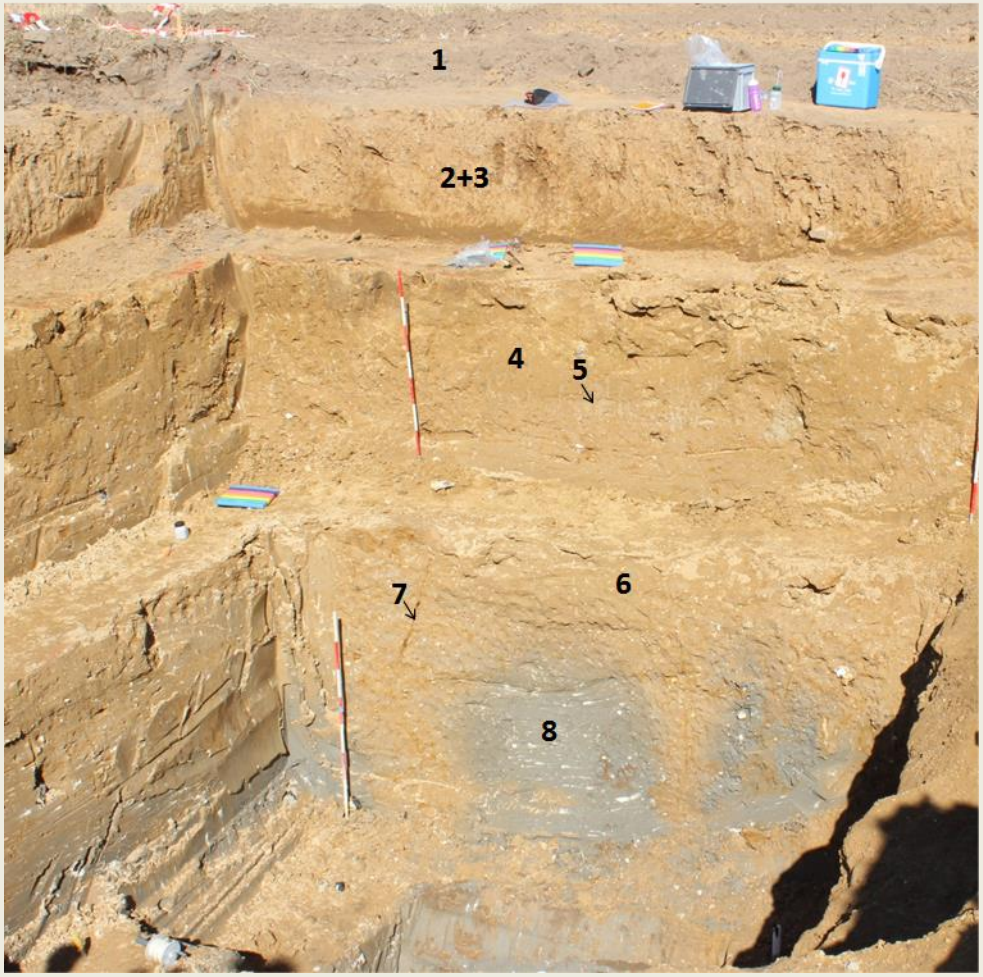
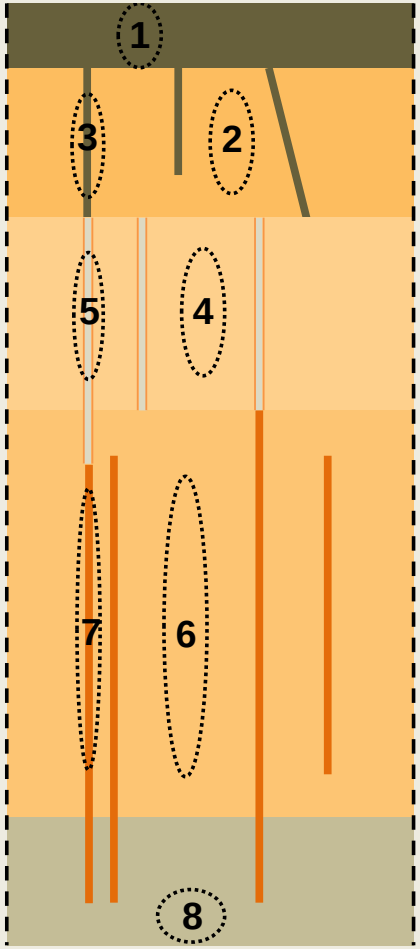
Previous presentation

Christian Albers: *"Pesticide sorption in fractured clayey tills varies substantially depending on soil domain and manure addition."*





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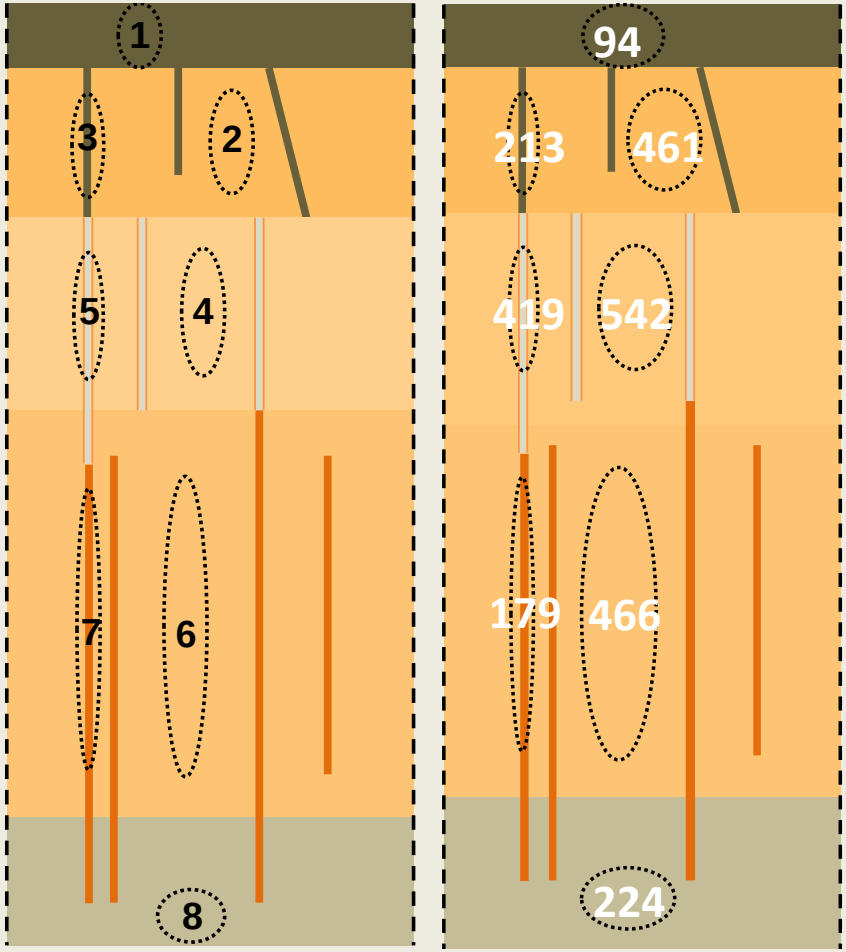
- Clayey till soils can contain wormholes and fractures that extend to great depths.
- Glyphosate shows varying sorption characteristics in the different soil domains.
- Sorption varies between domains at the same depths (matrix vs. fractures)
- Sorption data from the *plough layer* are **not** representative of the entire soil column.



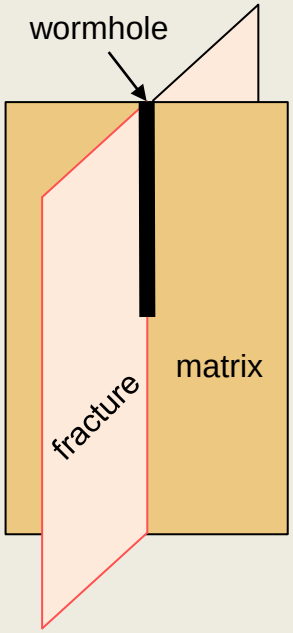
Choice of modelling software

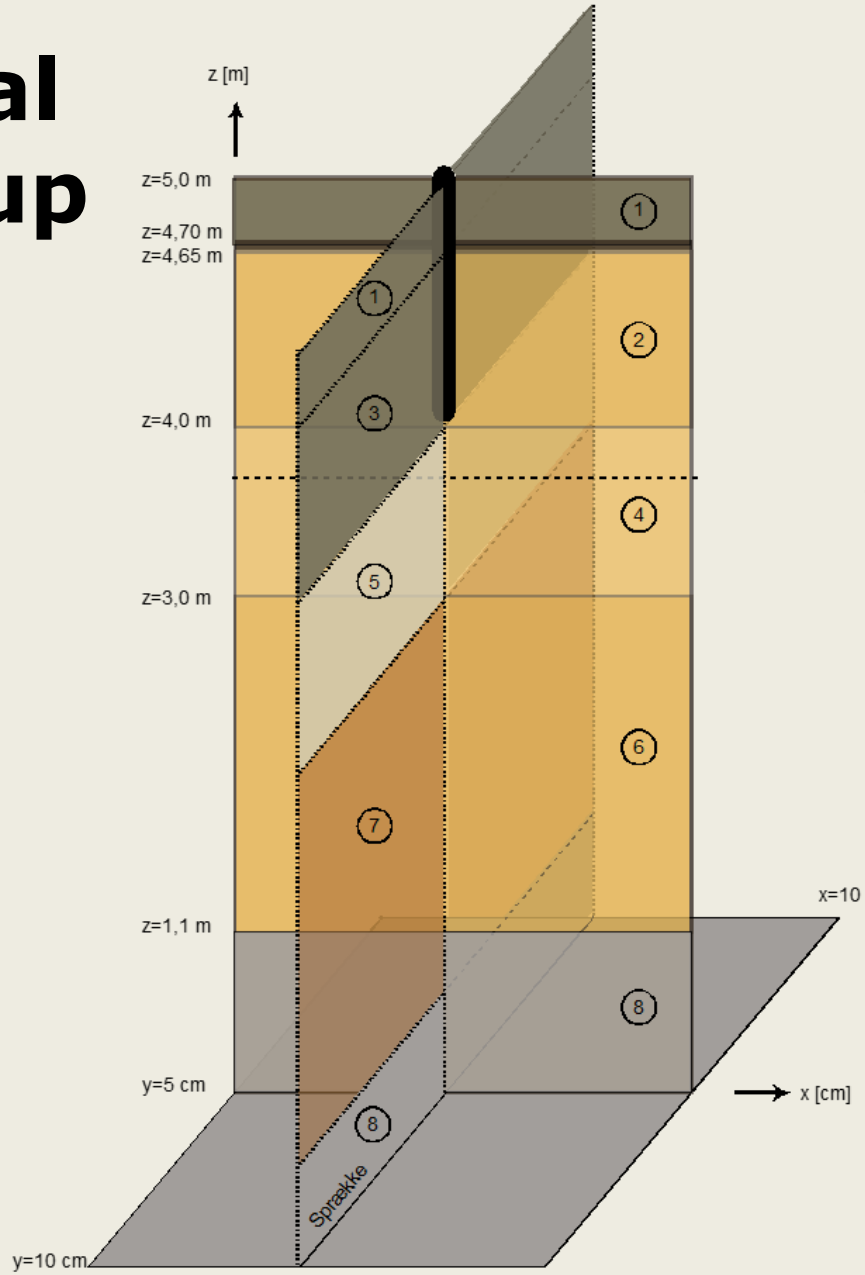
- ✓ 3D water and solute transport in variably-saturated zone
  - Water flow: Richard's equation
  - Glyphosate transport: Dispersion-advection equation

- ✓ Allowing the incorporation of observed domains with user defined associated process understanding

→COMSOL Multiphysics
(www.comsol.com)

Conceptual model setup





Plough layer (1)

Oxidised matrix (2) with brown macropores and worm holes (3)

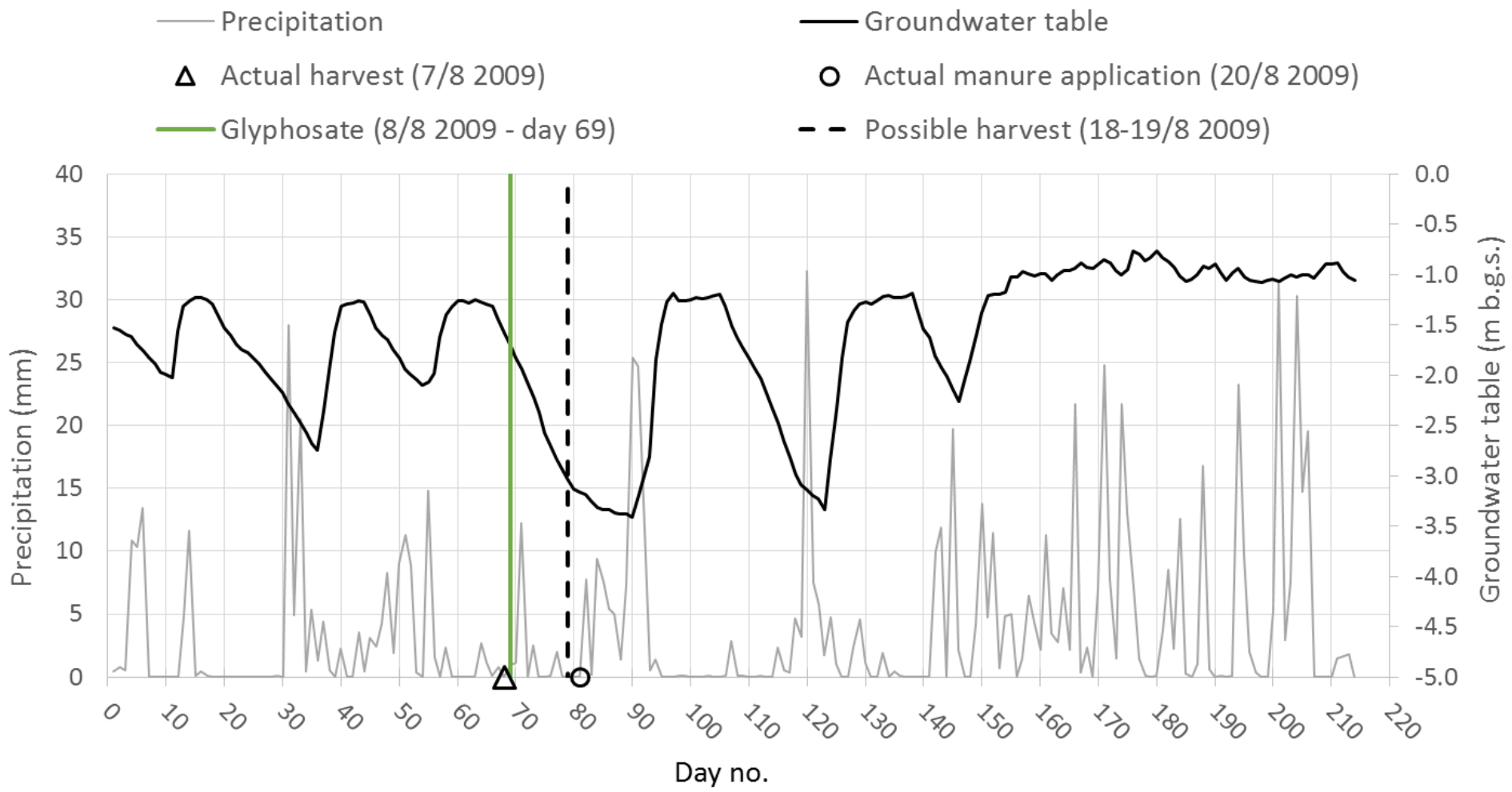
Oxidised matrix (4) with reduced macropores (5)

Oxidised matrix (6) with oxidised macropores (7)

Reduced matrix (8) with oxidised macropores (7)

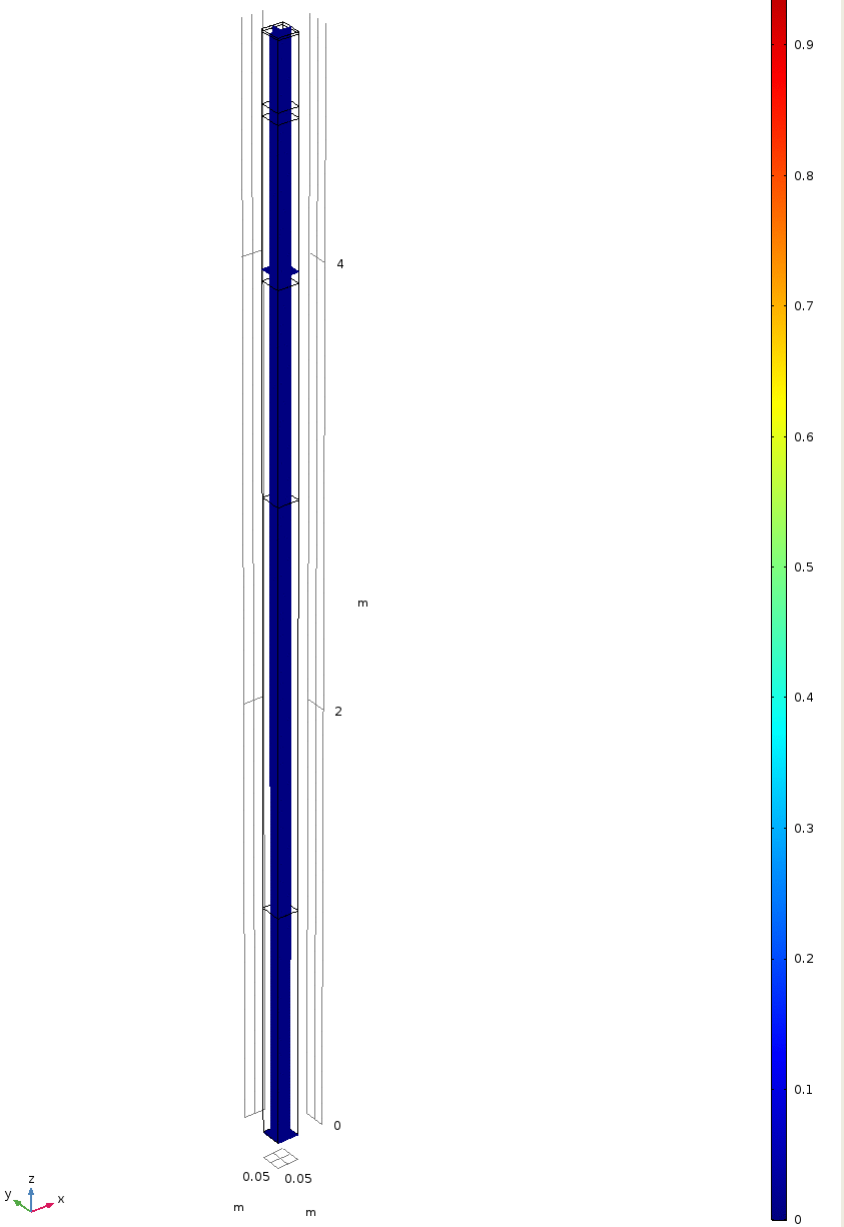
Reduced matrix (8)

Boundary conditions



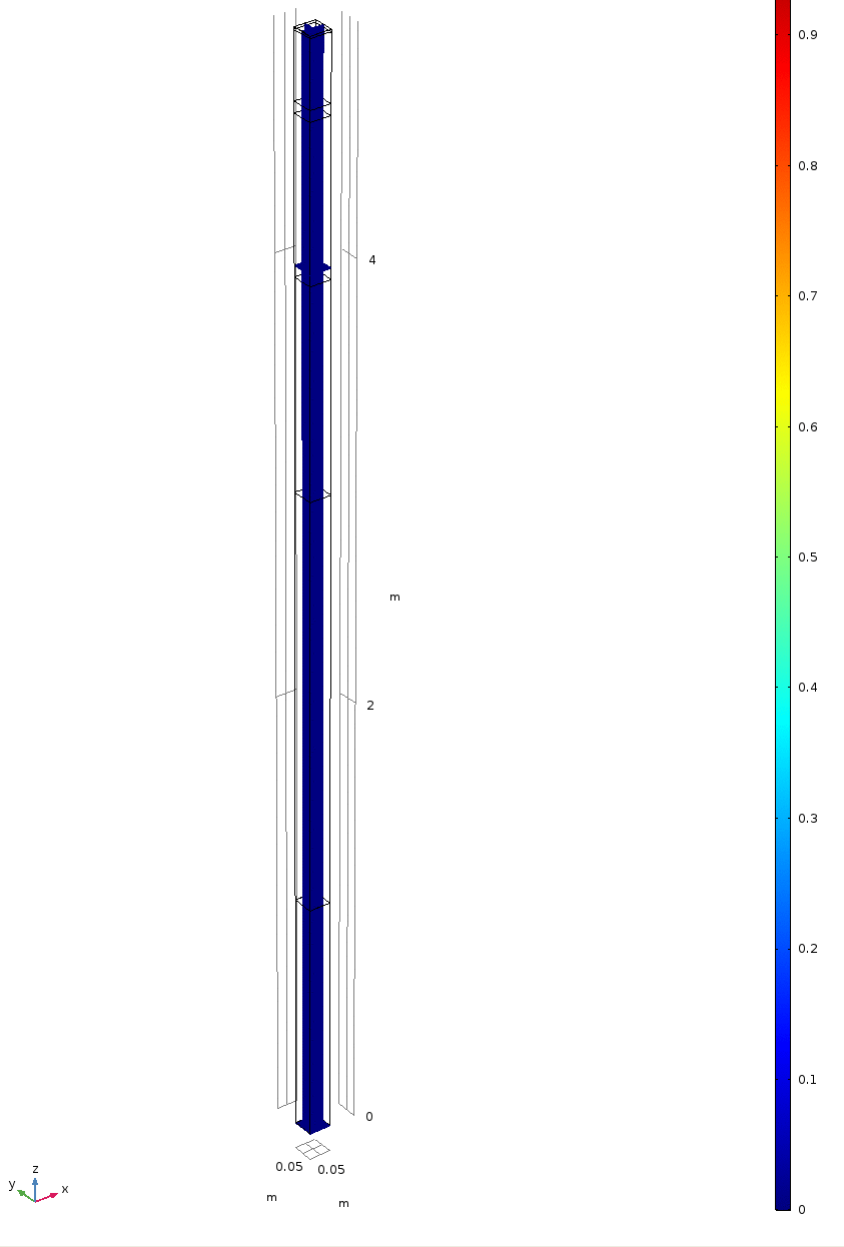
GLY6 [µg/L] Time=40 s

Piston flow/transport
Sorption and degradation – 1 domain



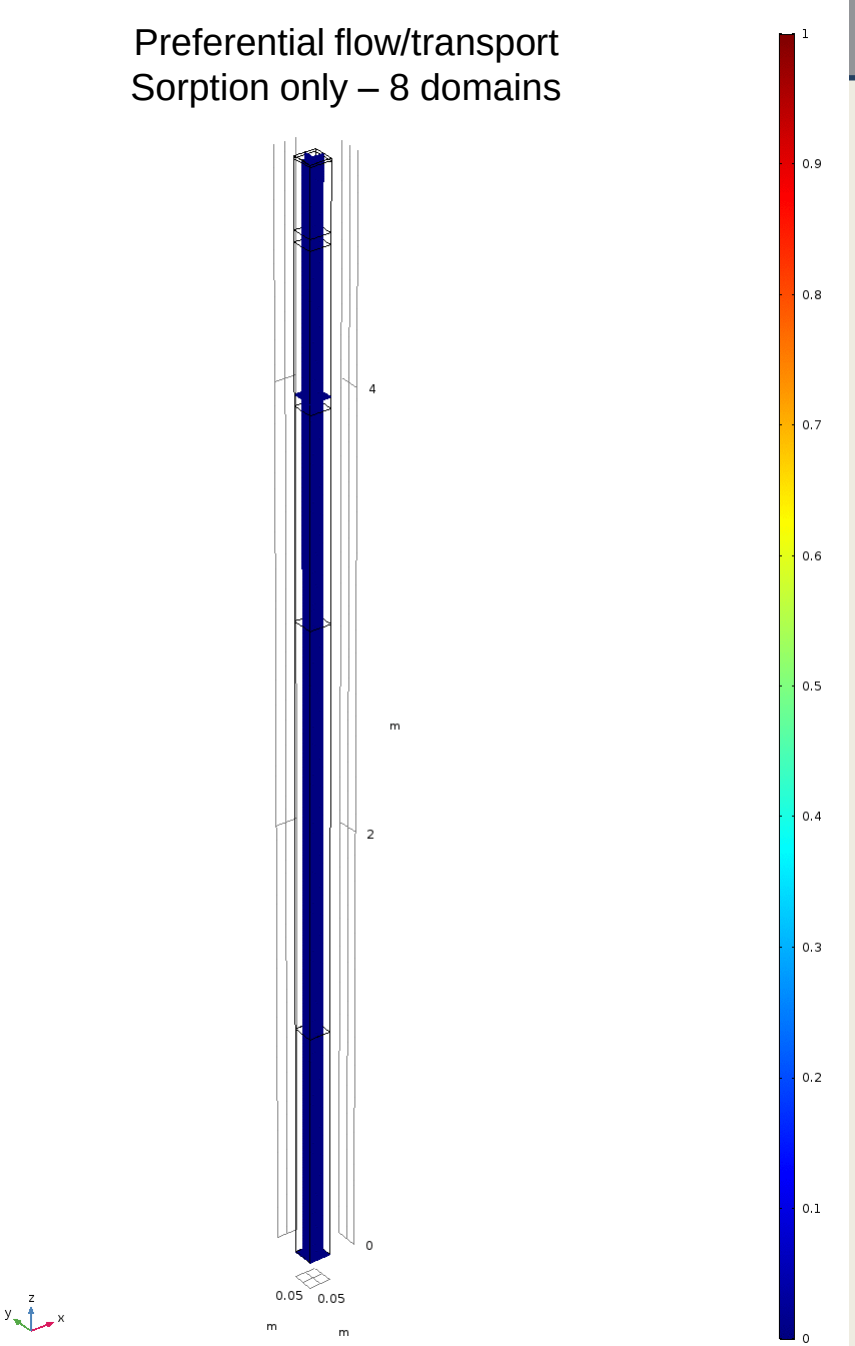
GLY5 [µg/L] Time=40 s

Preferential flow/transport
Sorption and degradation – 8 domains



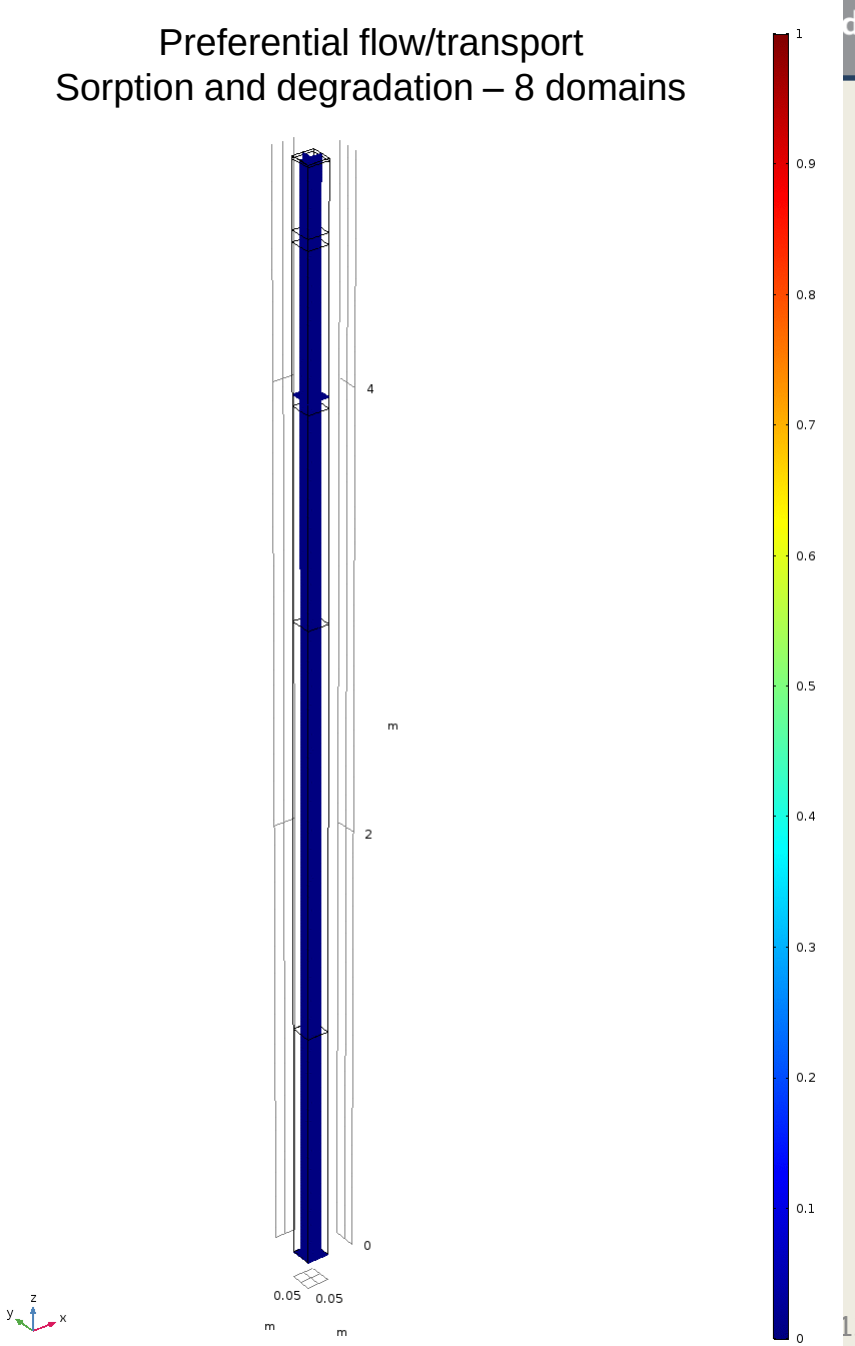
GLY2 [µg/L] Time=40 s

Preferential flow/transport
Sorption only – 8 domains



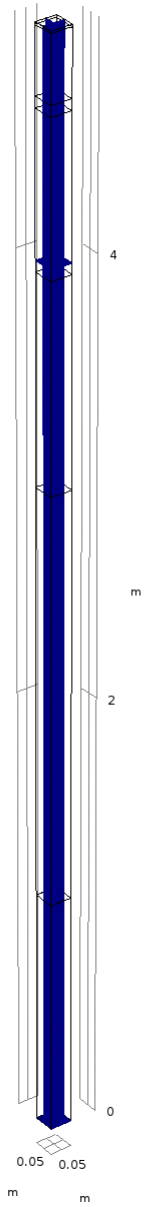
GLY5 [µg/L] Time=40 s

Preferential flow/transport
Sorption and degradation – 8 domains



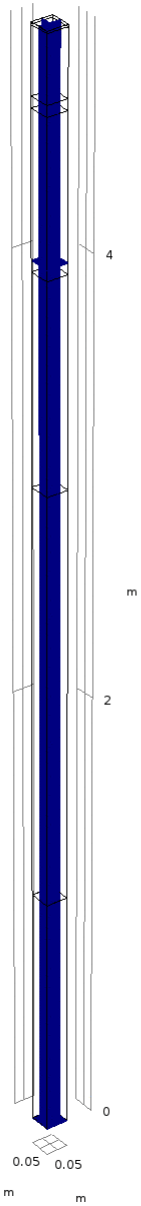
GLY5 [µg/L] Time=40 s

Preferential flow/transport
Sorption - 8 domains



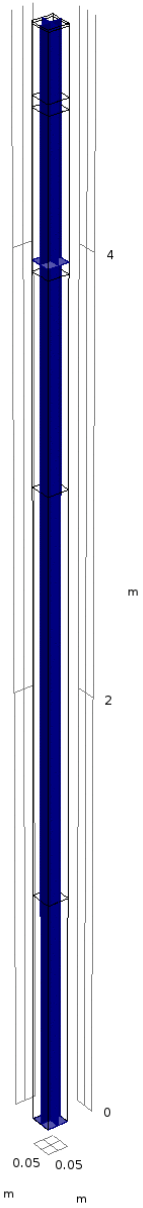
GLY3A [µg/L] Time=4

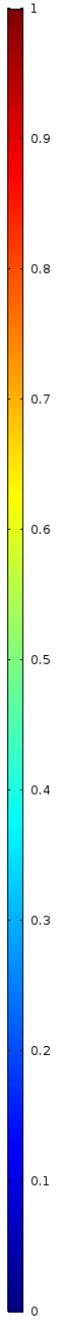
Preferential flow/transport
Double sorption - 8 domains

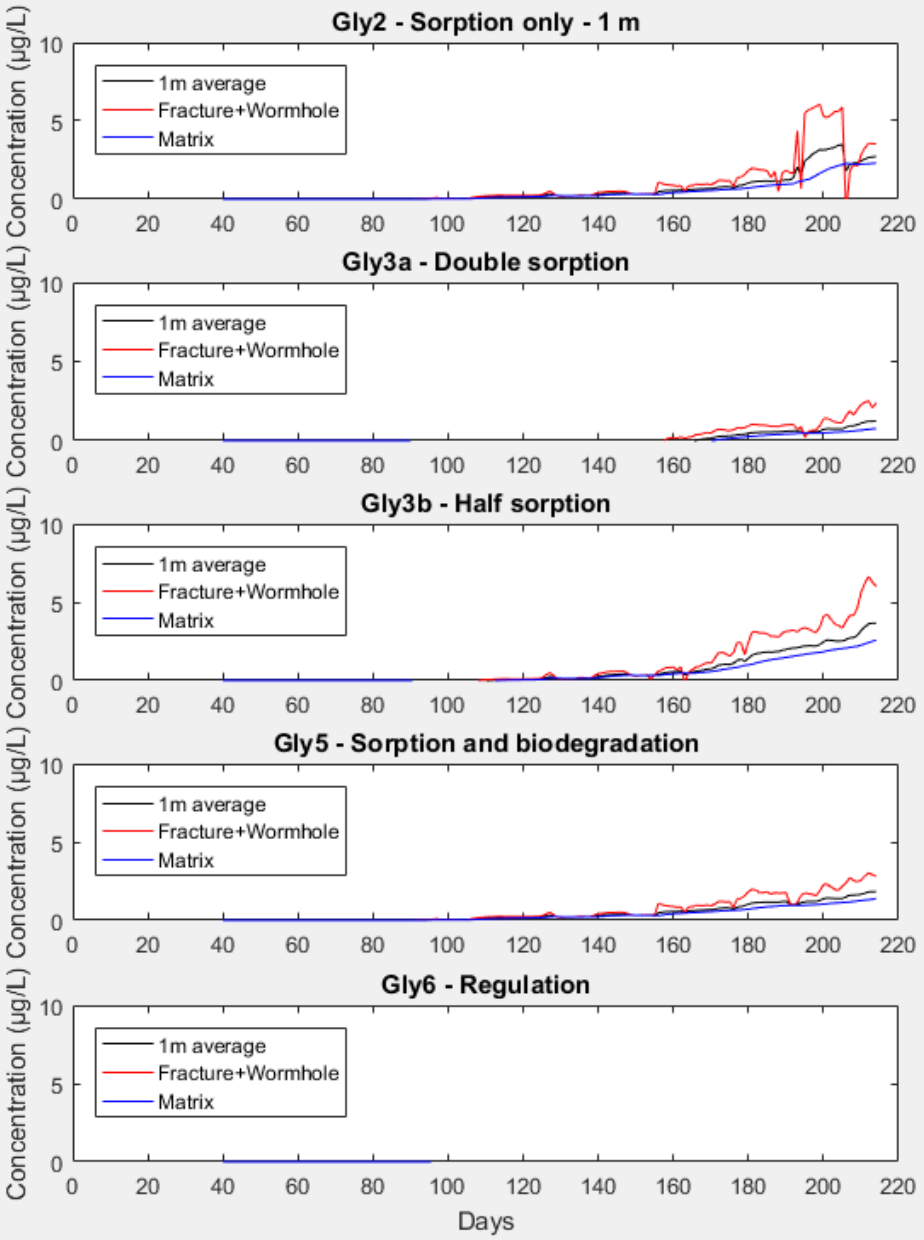


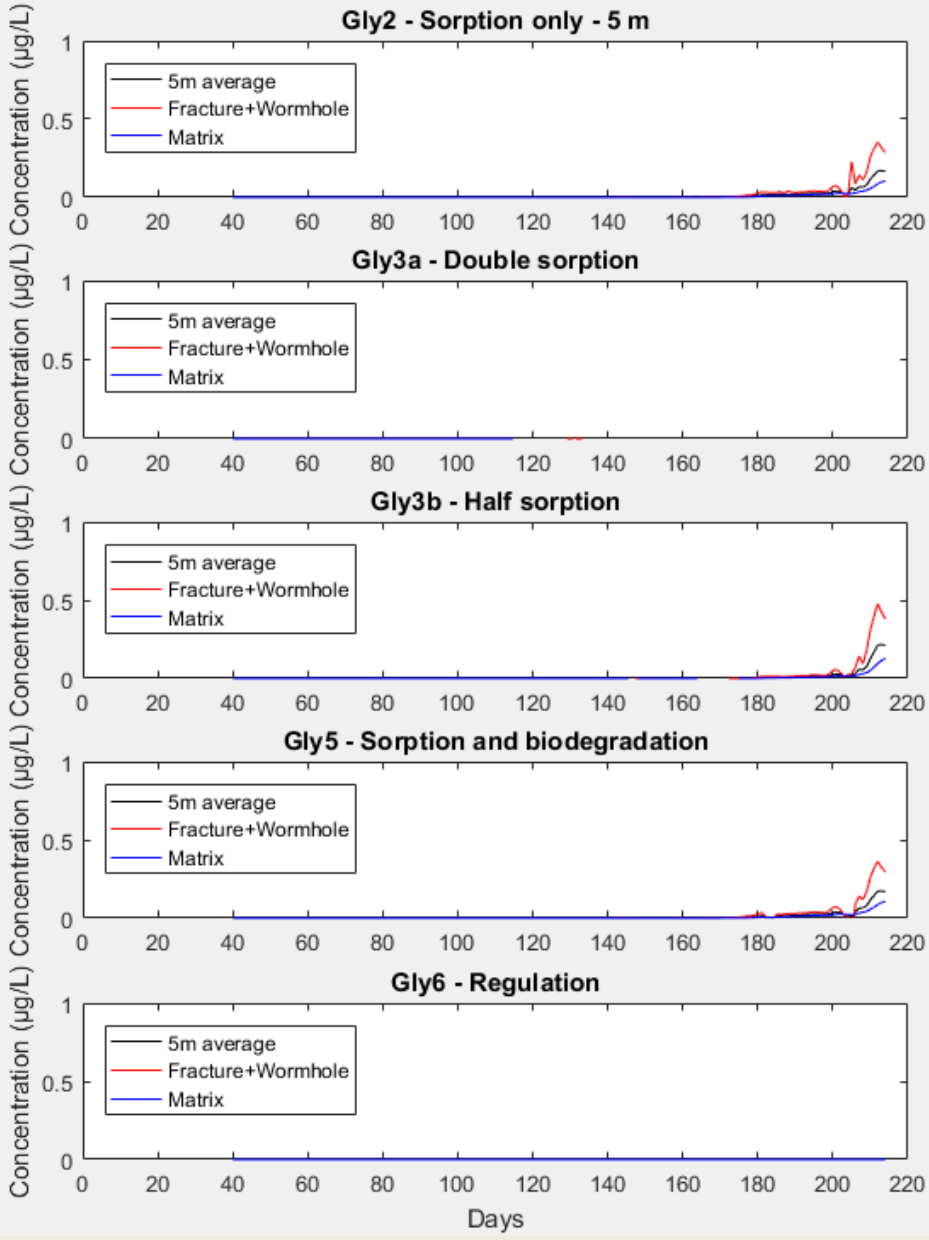
GLY3B [µg/L] Time=40 s

Preferential flow/transport
Half sorption - 8 domains






Gly2 - Sorption only - 1 m
Gly3a - Double sorption
Gly3b - Half sorption
Gly5 - Sorption and biodegradation
Gly6 - Regulation
1m average
Fracture+Wormhole
Matrix
Concentration (µg/L)
Days


Gly2 - Sorption only - 5 m
Gly3a - Double sorption
Gly3b - Half sorption
Gly5 - Sorption and biodegradation
Gly6 - Regulation
5m average
Fracture+Wormhole
Matrix
Concentration (µg/L)
Days

Answers

Why is glyphosate detected in high concentrations in groundwater beneath fractured clayey soils after heavy rain or snowmelt events?

- No, this behaviour is not captured by the regulatory model concept!
- Taking preferential transport processes into account is imperative for being able to adequately assess the leaching risk
  - Particularly important for settings constrained by highly dynamic natural upper and lower boundary conditions.
- The sorption in the macropore/fracture domain can have an effect on long-term leaching.
- Degradation seems to play a minor role.

Don’t forget fractures!

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http://pesticidvarsling.dk