

# Future perspectives in agroecological modelling with Daisy

Efstathios (Stathis) Diamantopoulos and the  
Agro-hydrology group,  
Assoc. Professor of Biophysical Modelling  
[ed@plen.ku.dk](mailto:ed@plen.ku.dk)



UNIVERSITY OF COPENHAGEN

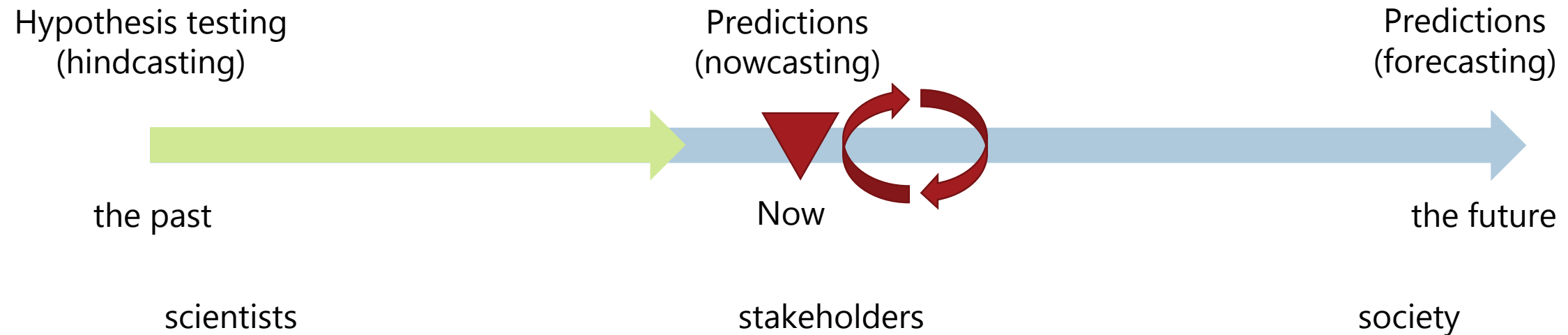


# Outline

1. Why do we even need models?
2. Daisy as knowledge integrator
3. Challenges
4. Future perspectives
5. More Challenges

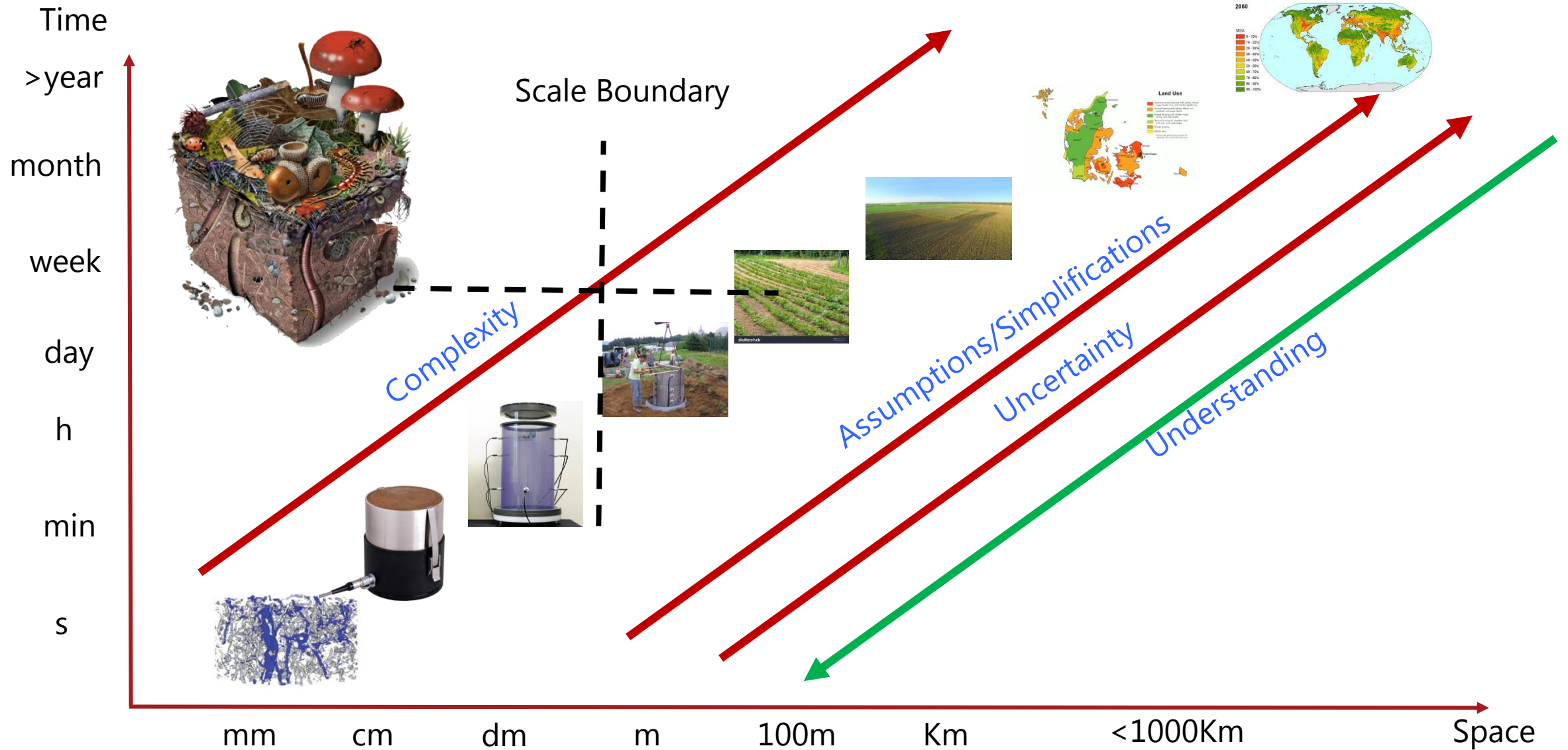
# Why do we even need (agro-ecological) models?

*Quantification and communication of uncertainties !*



**How easy is it?**

# Challenges-Complexity/Scale dependence/Boundaries



Picture from Soil Hydrology and Biophysics, Shelker and Or, Oregon State

# Models as knowledge integration tools

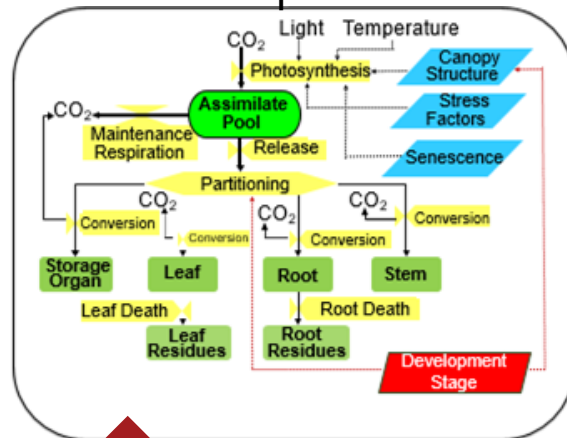
Weather



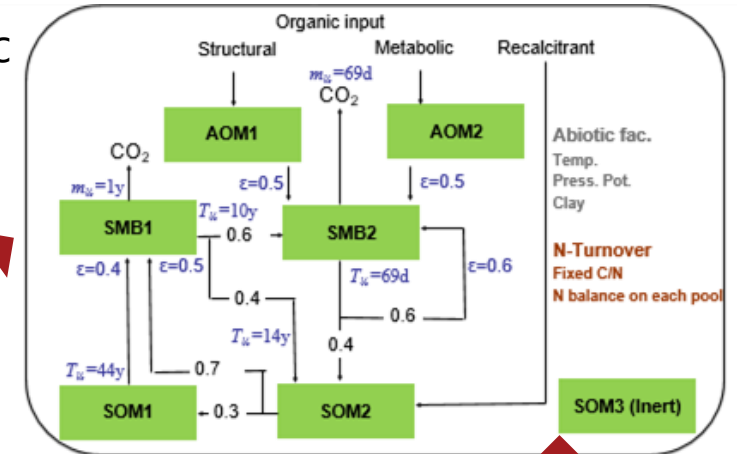
Management



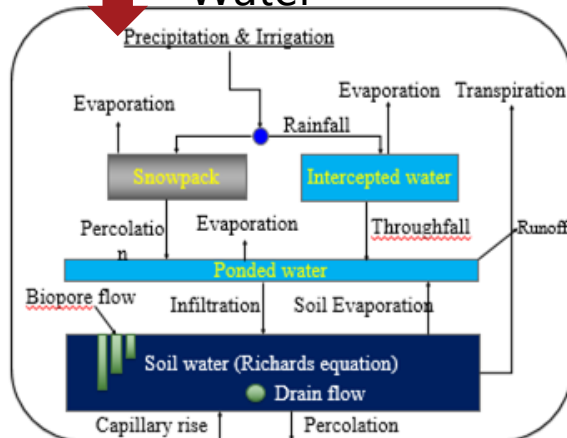
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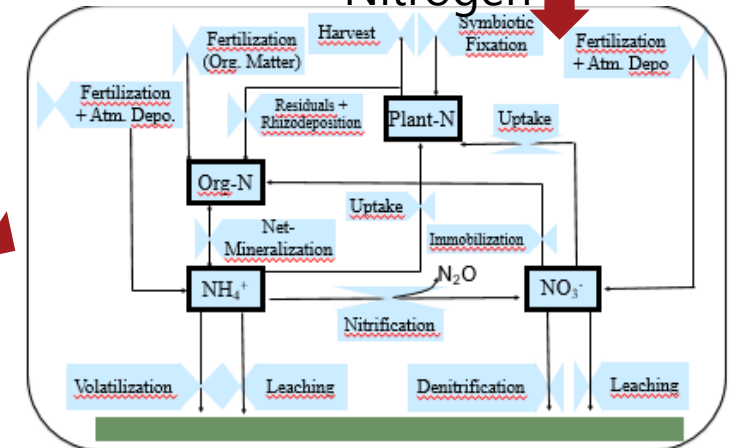
Organic Matter



Water

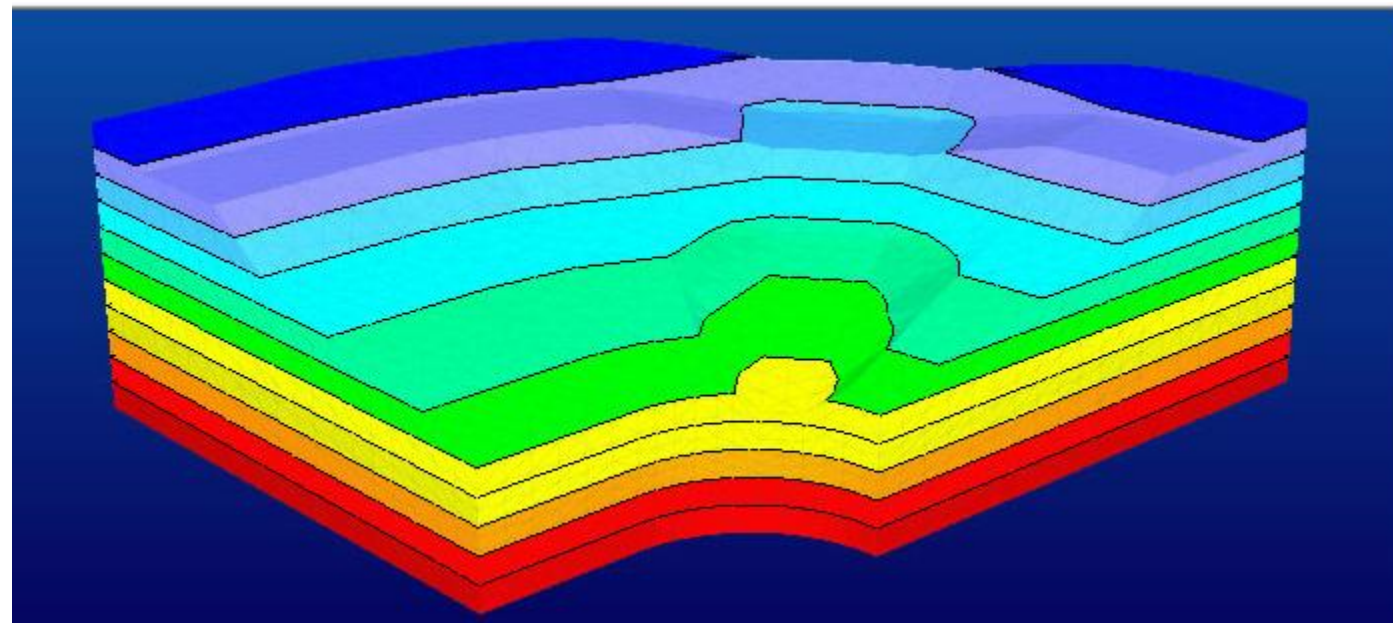
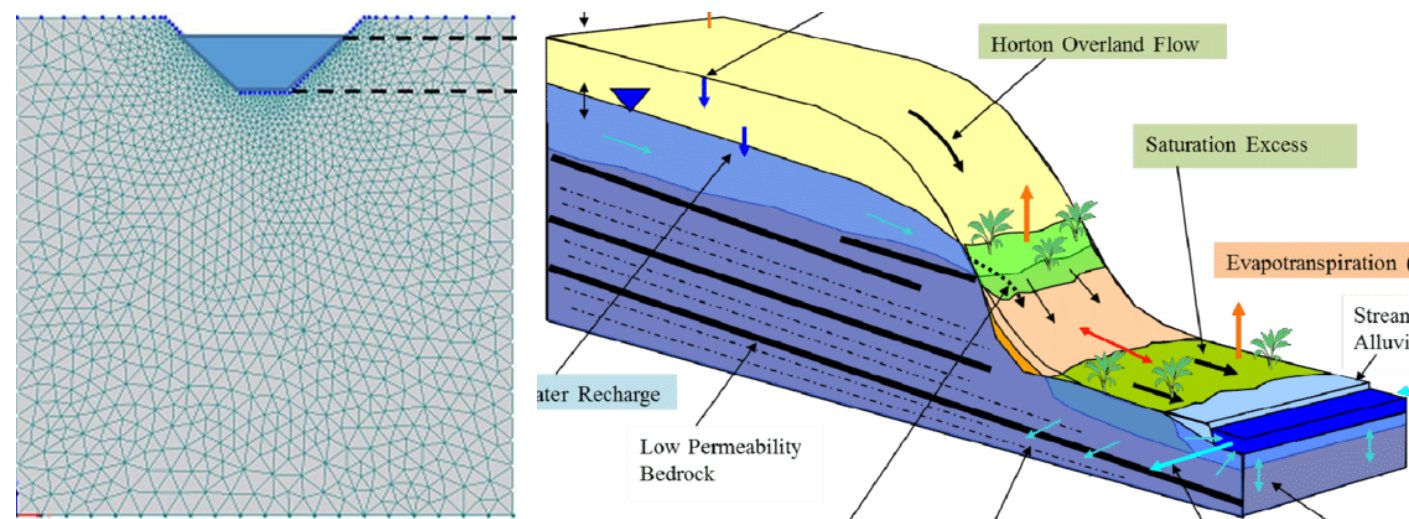


Nitrogen



# Future process implementations I – Daisy 3D

- There are problems that require complex geometries (2D and 3D)
  - Furrow irrigation
  - Hillslope
  - Precision Ag
- Complicated 3D models are needed for effective 1D description
- Daisy 3D will be a leading model worldwide

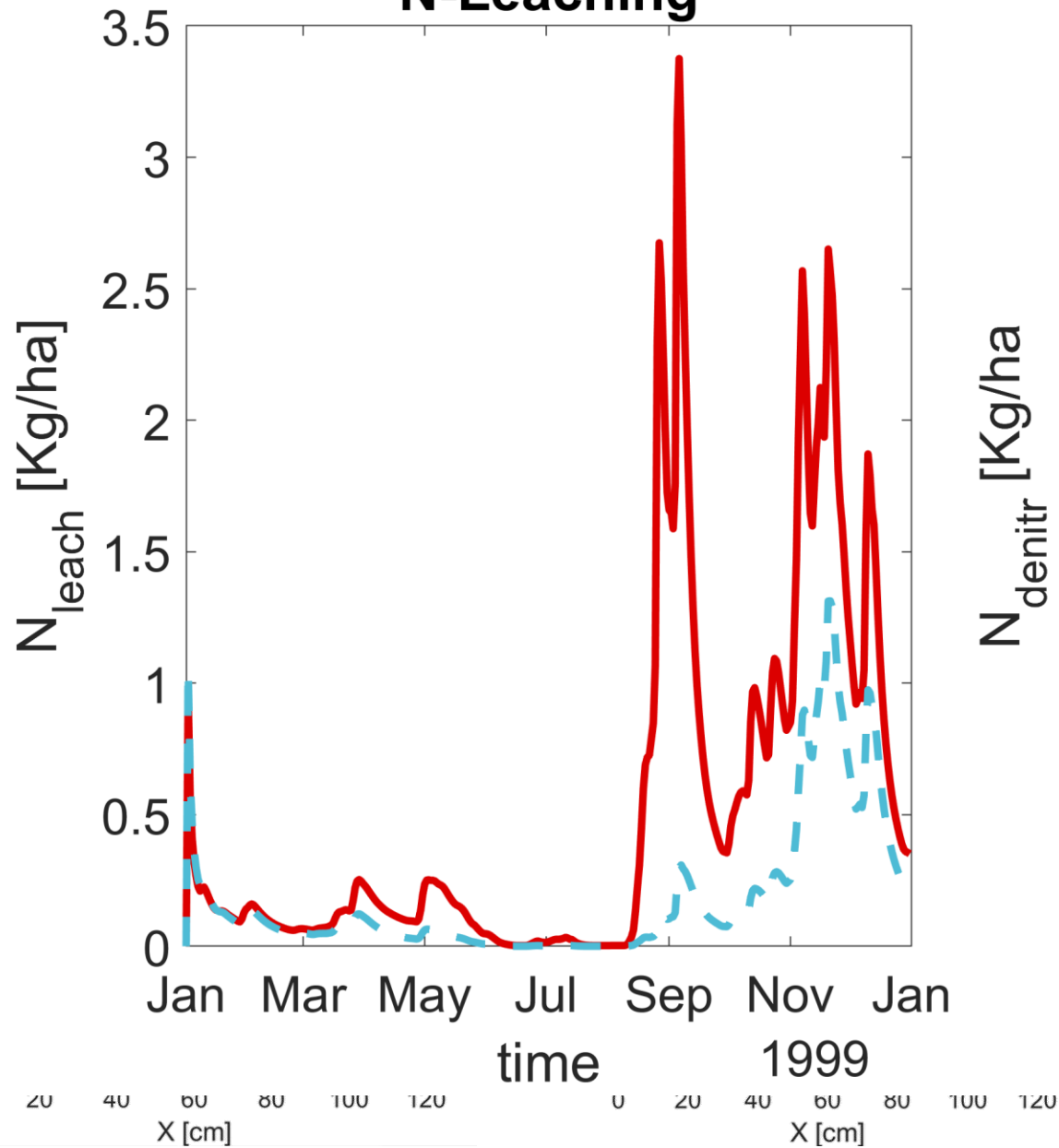


## Future process implementations I - Water

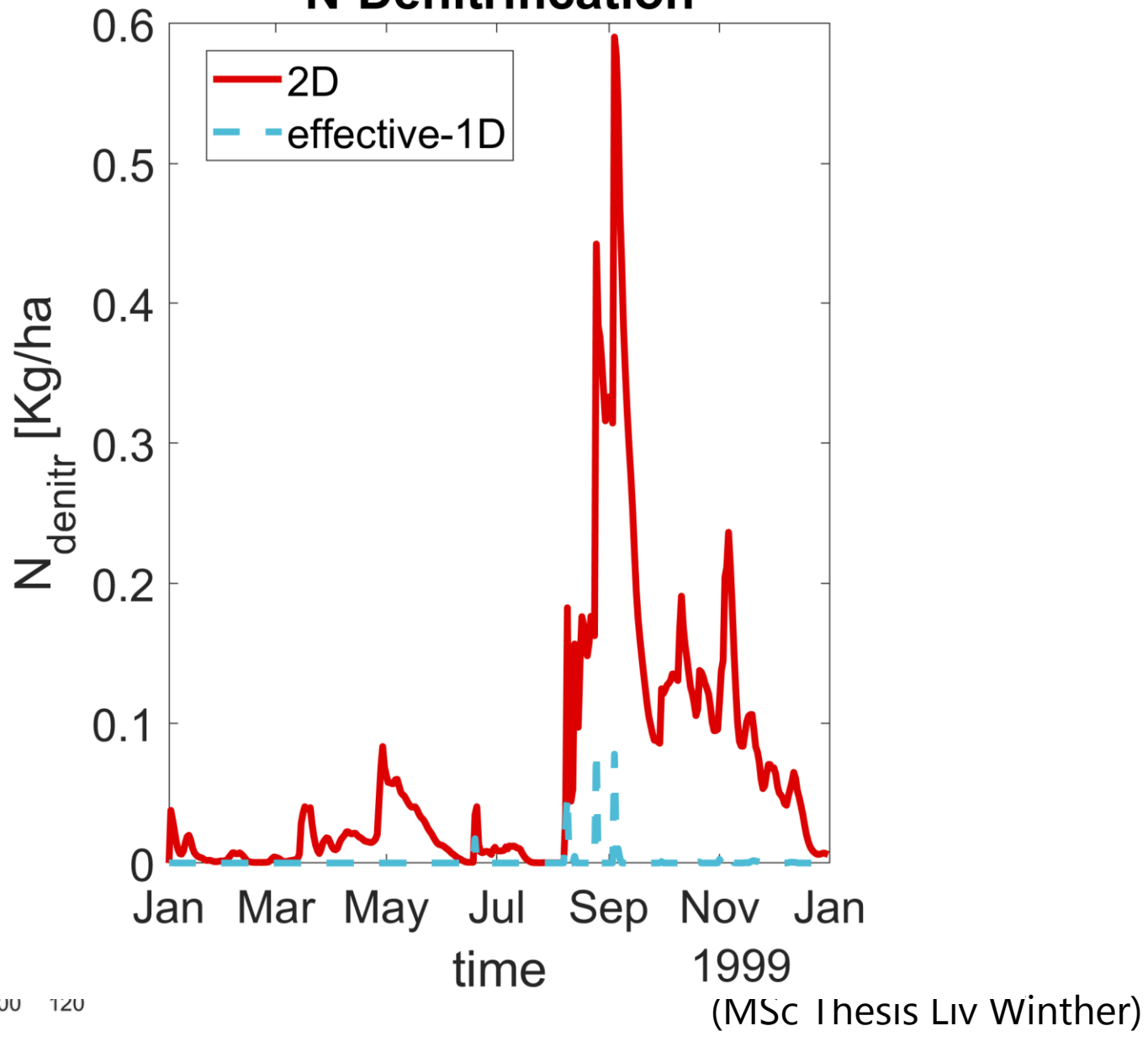
- Hysteresis/Air entrapment (*Diamantopoulos et al., 2021, WRR*)
- Preferential flow of water (*Holbak et al, 2021a,b, WRR*)
- Soil structure
- Organic matter-soil structure interactions (Invited talk)



### N-Leaching



### N-Denitrification



# Gas Dynamics

- Currently simple gas dynamics
- When and where soil gases are produced and emitted
- Transport pathways
- Driving forces for emissions?



# Biological component

- Extrapolating in space and in time
- Potential fluxes
- Splitting ET
- Root water uptake
- Soil-crop interactions



# Towards hybrid modelling?

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## Coupling machine learning and crop modeling improves crop yield prediction in the US Corn Belt

### Water Resources Research

RESEARCH ARTICLE

10.1029/2020WR029328

Key Points:

Deep Learned Process Parameterizations Provide Better Representations of Turbulent Heat Fluxes in Hydrologic Models

### Water Resources Research

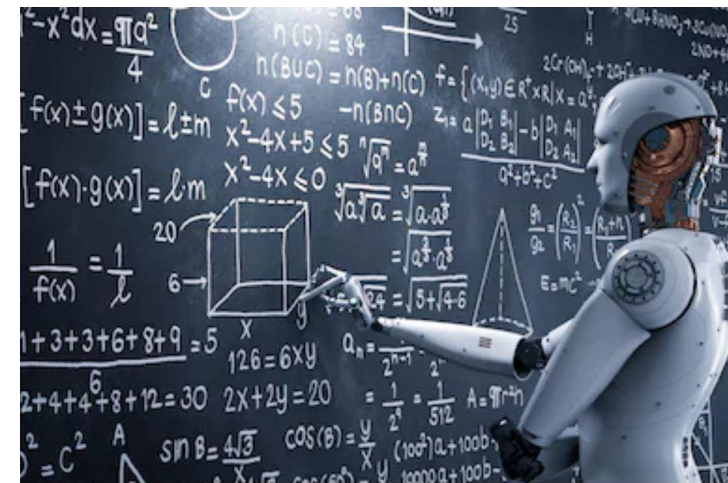
RESEARCH ARTICLE

10.1029/2020WR027642

Key Points:

- Hydraulic conductivity functions were precisely estimated from only volumetric water content data using the proposed framework

Physics-Informed Neural Networks With Monotonicity Constraints for Richardson-Richards Equation: Estimation of Constitutive Relationships and Soil Water Flux Density From Volumetric Water Content Measurements



**Is it only process implementation?**

# A Reproducibility Crisis?

*"Rahmandad and Sterman (2012) sampled one year of articles from System Dynamics Review and found that out (59%) included no equations at all while 2 (7%) reported 'some' equations."*

*"Janssen (2017) investigated the reproducibility of 2367 agent-based models returned from a search of ISI Web of Science. The study found that 50% of publications report complete or 'some' equations. Source code for the models was only available for 10% of the publications; there was a general lack of transparency in how models work."*

- Open source
- Model theory
- Numerical solution



# How we guarantee continuation of Daisy?

