



An Example of Forest and Plantation Growth-Modelling with a Process-oriented Approach

29.06.2010

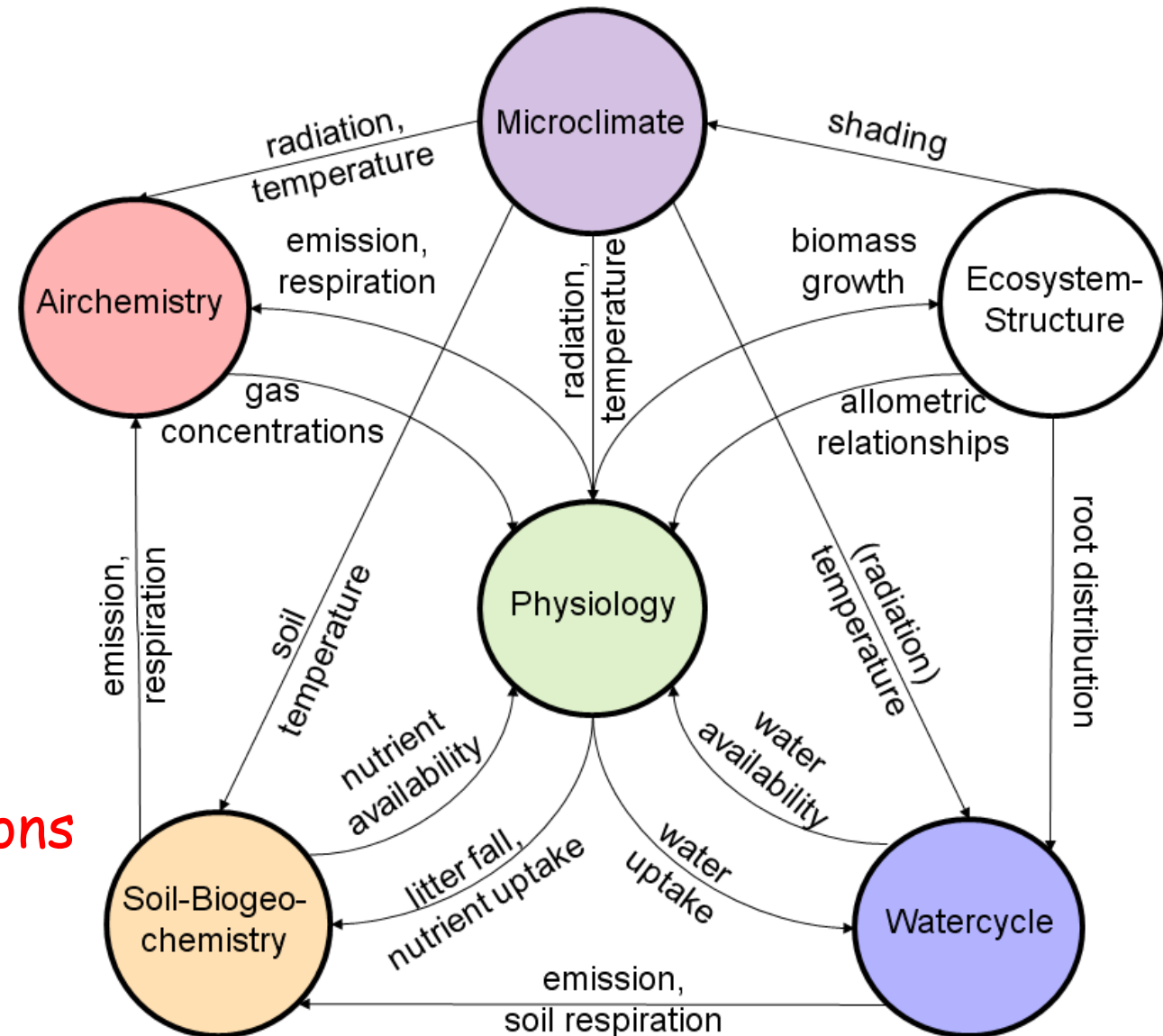
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1. Introduction:

Characteristics of Physiologically-based Ecosystem Models

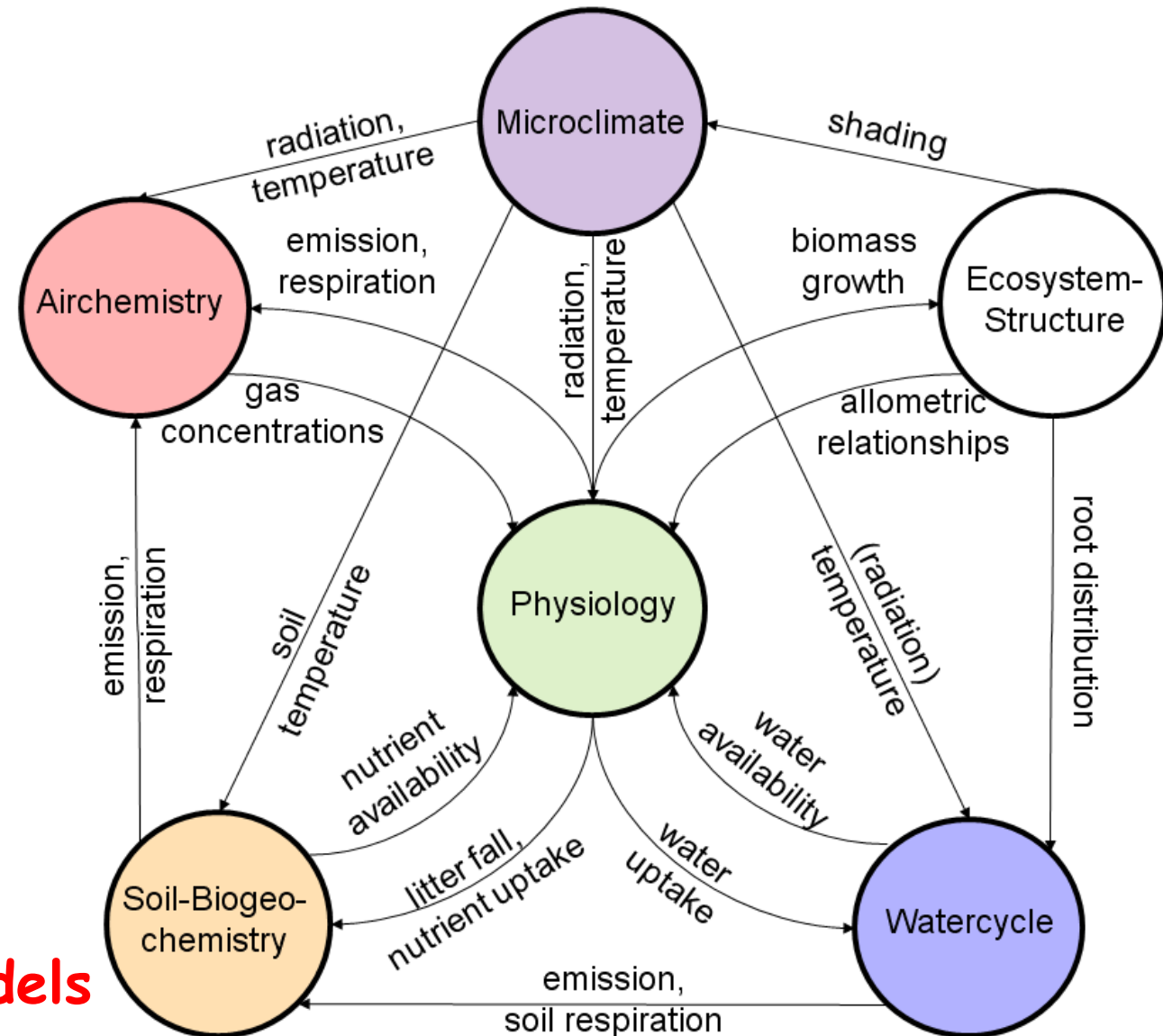
1. physical foundation
→ site independent
2. multiple sensitivity
→ indirect impacts
3. developed from experiments
→ new environmental conditions



1. Introduction:

Drawbacks of Physiologically-based Ecosystem Models

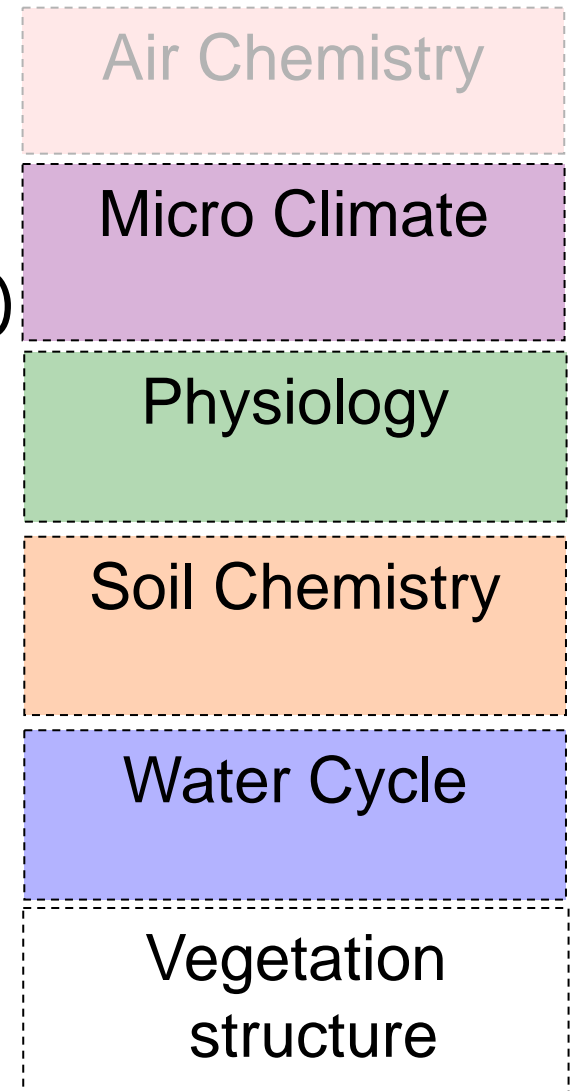
1. physical foundation
→ unknown gene variability
2. multiple sensitivity
→ difficult analysis
3. developed from experiments
→ knowledge gaps
- mostly 1 dimensional models



2. Method:

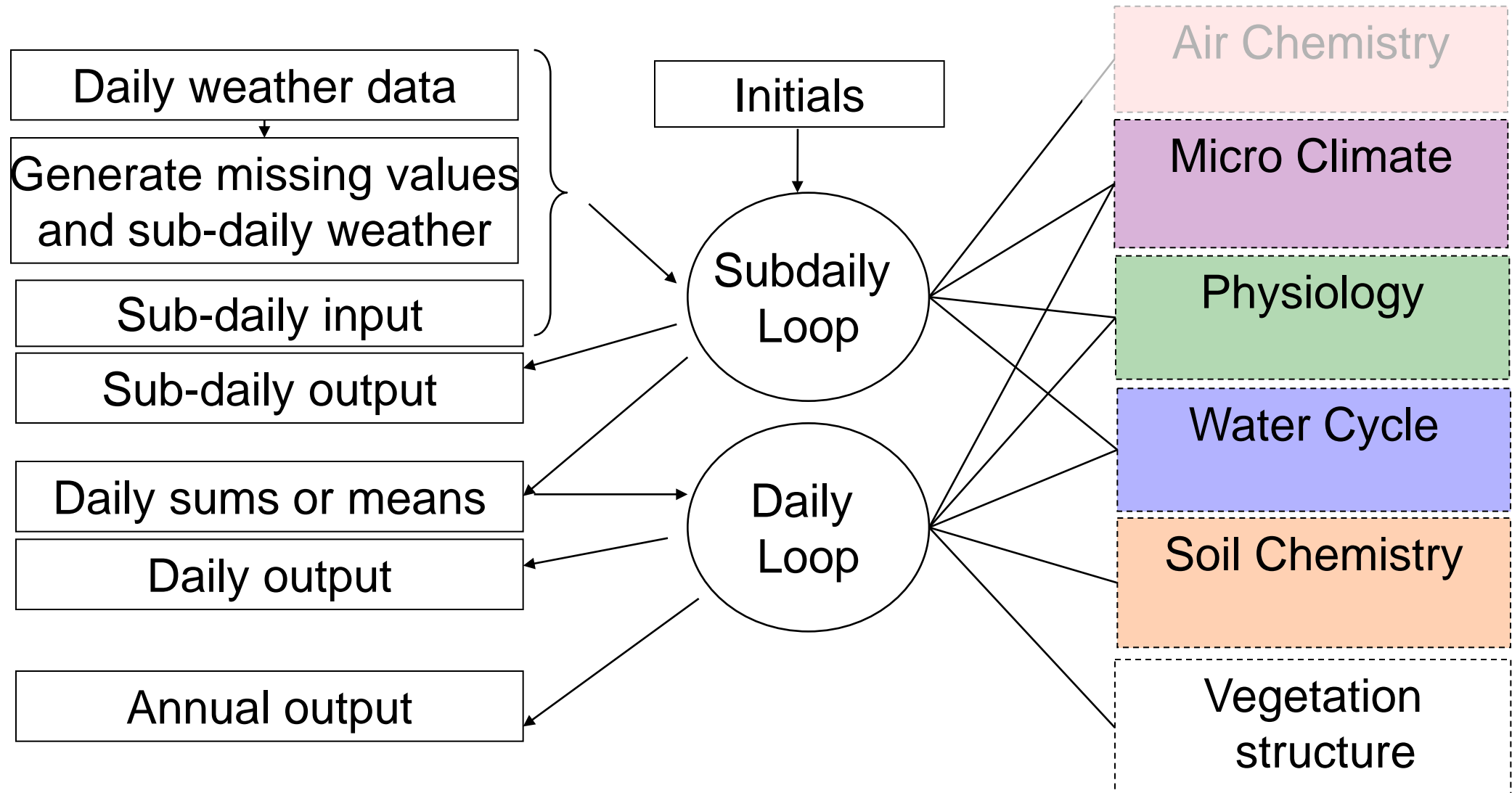
PSIM/DNDC Models

1. ECM/DNDC (Empirical Canopy Model)
 → empirical radiation and temperature extinction
 physically-based soil temperature
2. PSIM/Farquhar (Physiological Simulation Model)
 → sun/shade differentiated assimilation
 sink-strength driven allocation of C and N
3. DNDC (DeNitrification-DeComposition)
 → mineralization, nitrification, and denitrification
4. DNDC
 → evaporation according to Thornthwaite (or P&T);
 transpiration based on water use efficiency;
 percolation with mod. Richards-Equation
5. modified TREEDYN
 → height/diameter based on stem growth
 empirical mortality



2. Method:

MoBiLE FRAMEWORK



2. Method:

FRAMEWORK ADVANTAGES

- Flexible selection of biosphere process-groups according to aims
- Flexible selection of models within each process group
- Simple introduction of new models or model versions (distributed workload)
- Simulations with different model combinations based on the same boundary conditions (model comparison)

3. Simulation Examples

A) Beech Forest (Hesse, France)

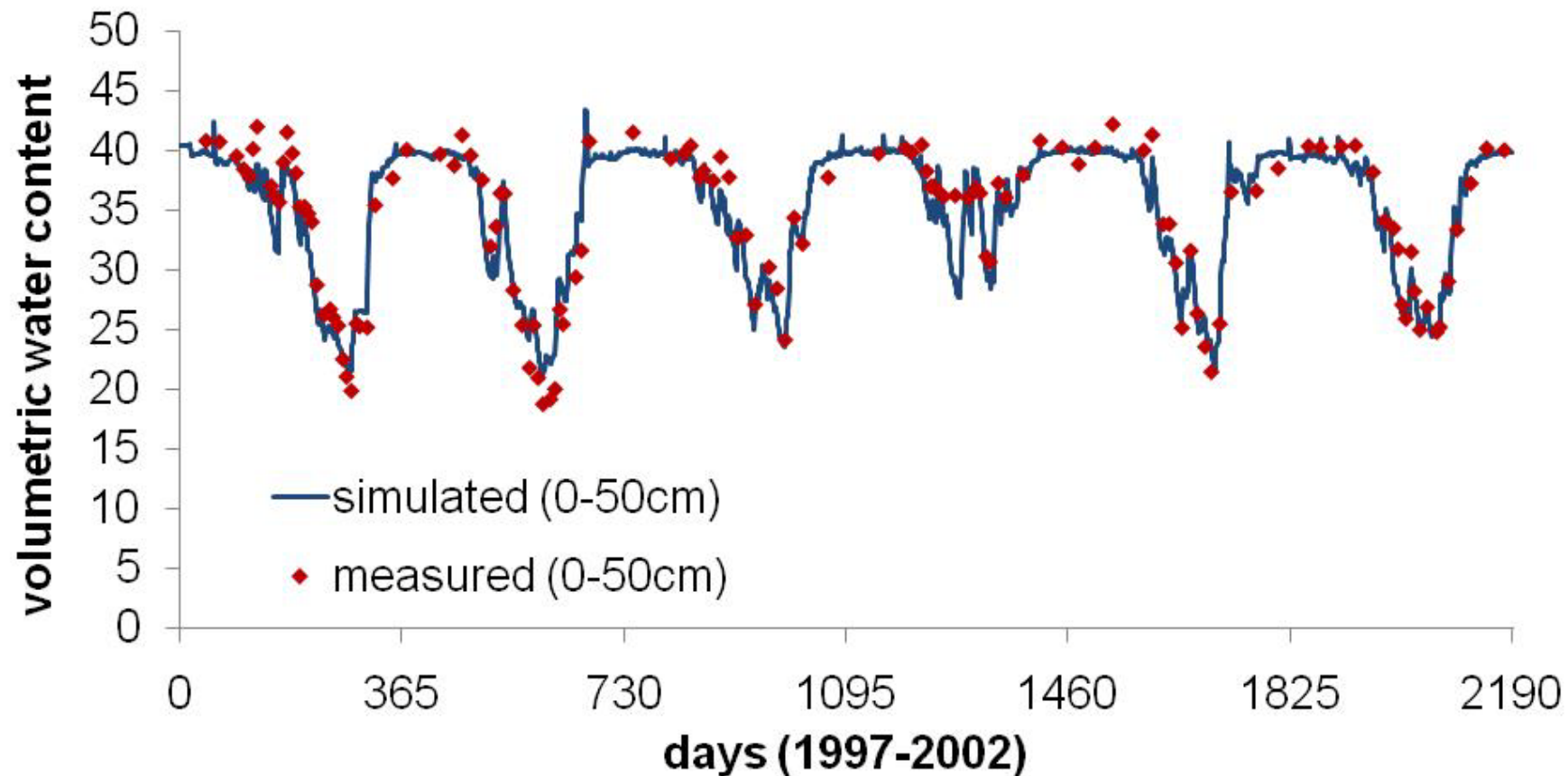
- Initialization of height and DBH from inventory and soil survey (soil depth, soil density, field capacity...)
- Input is daily climate from 1997-2008, + thinning



3. Simulation Examples

A) Beech Forest (Hesse, France)

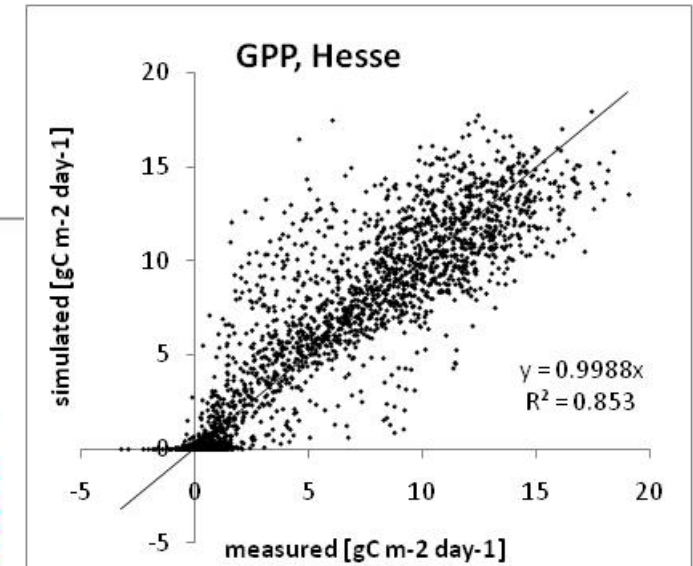
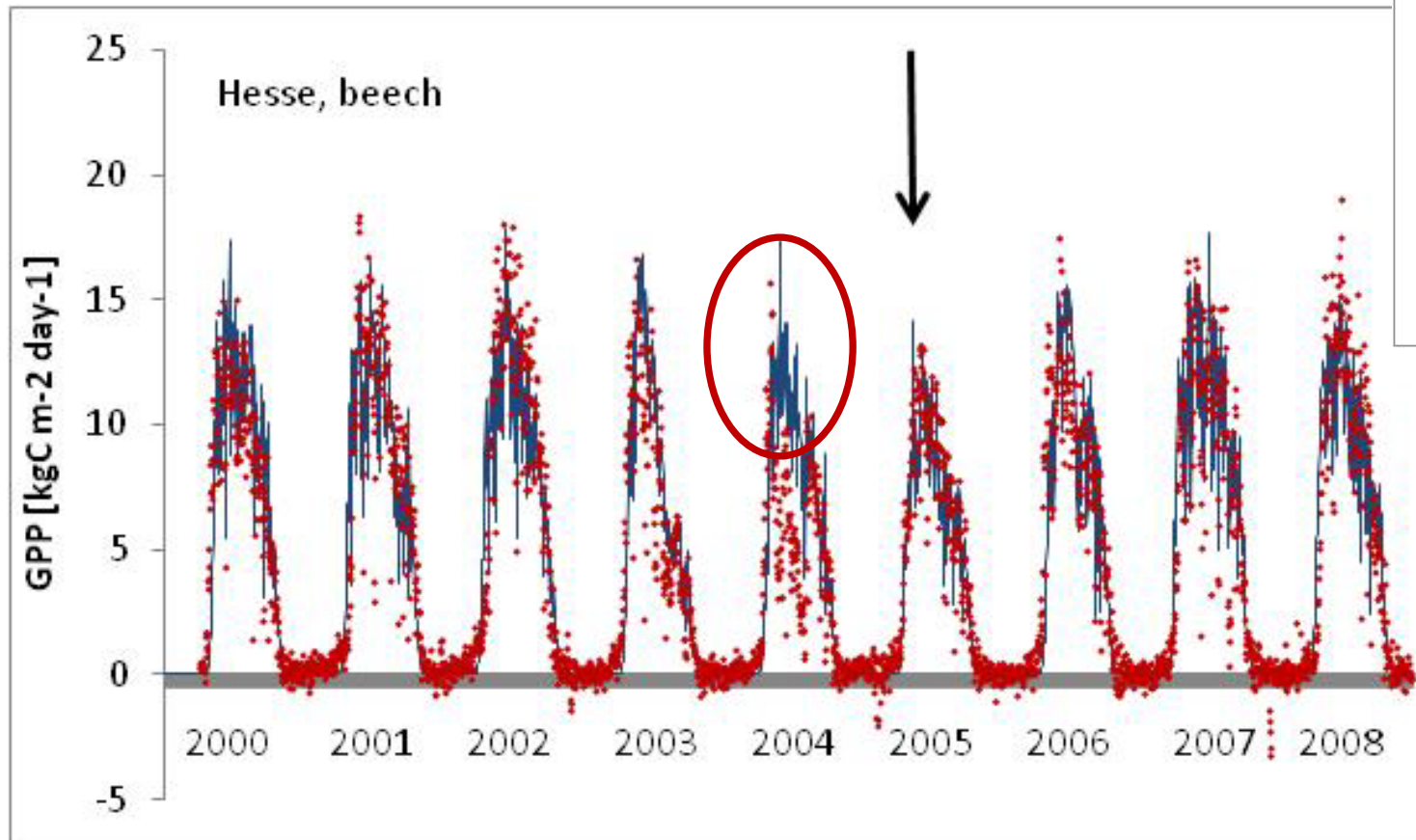
- constraint Water Use Efficiency (uptake control)



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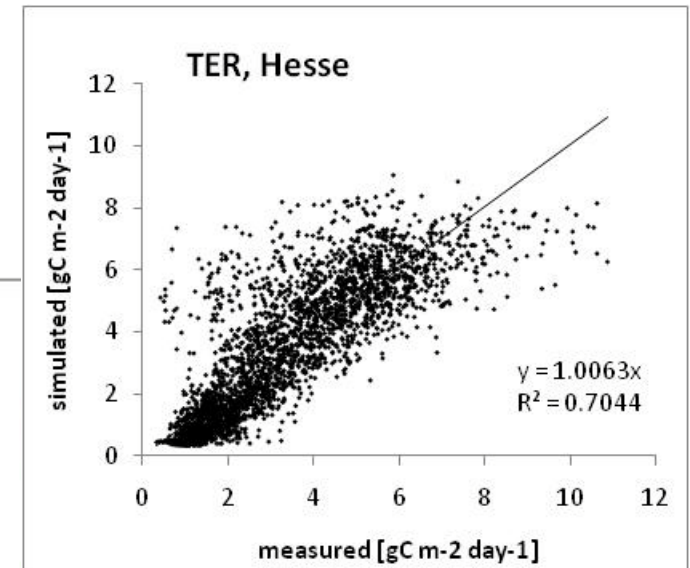
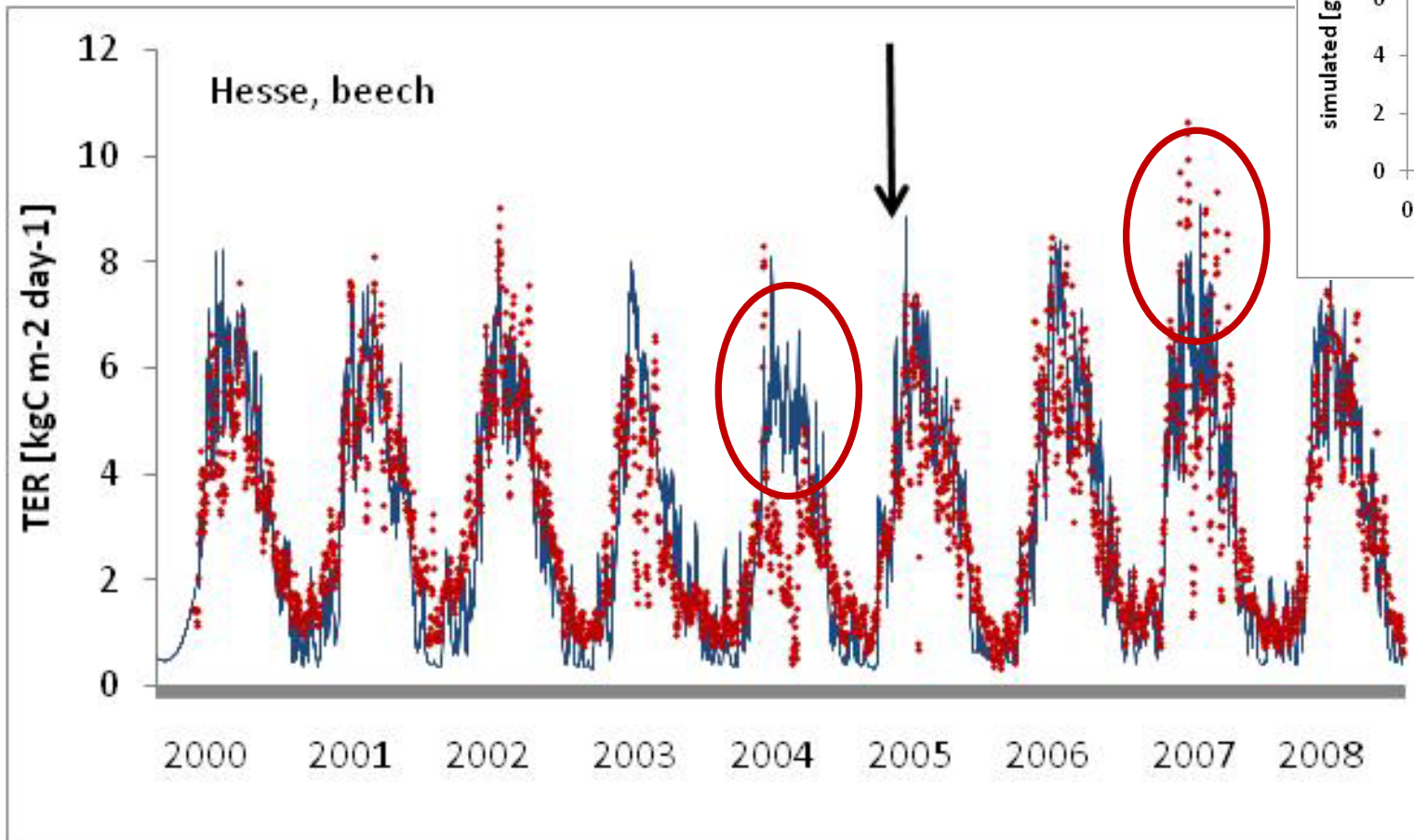
- constraint photosynthesis



3. Simulation Examples

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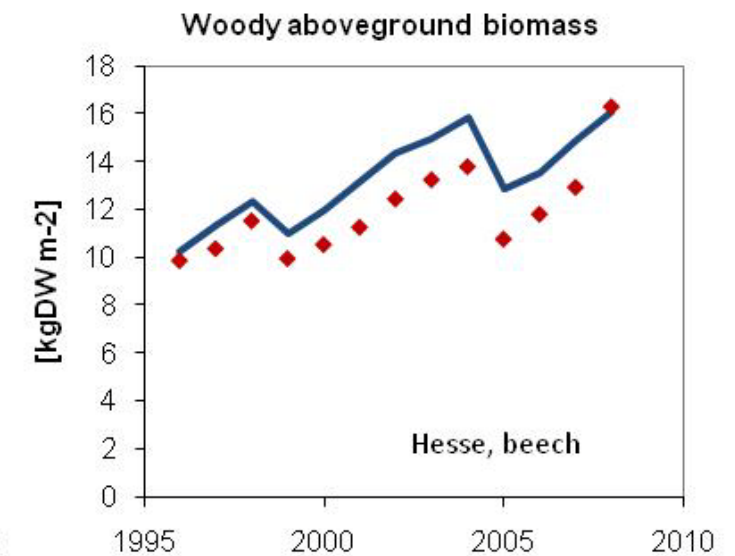
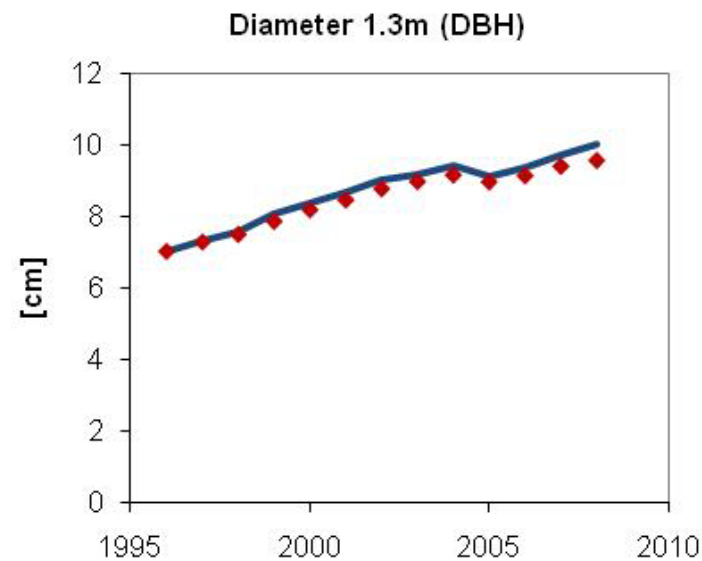
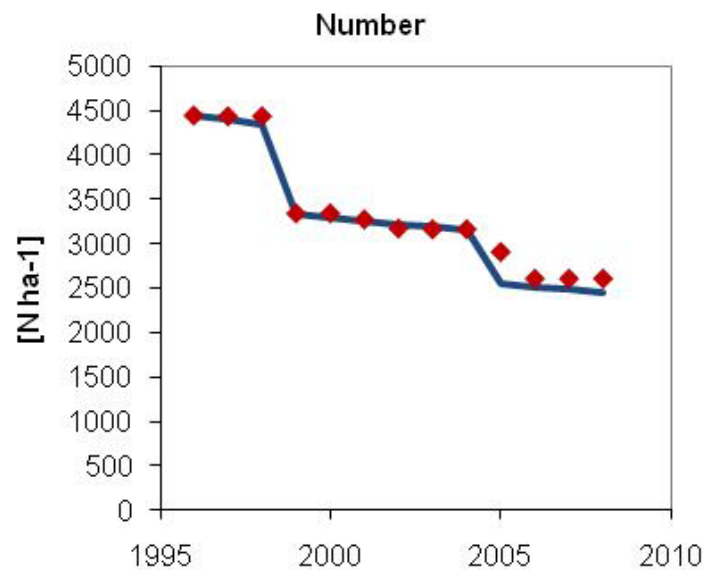
- constraint maintenance respiration



3. Simulation Examples

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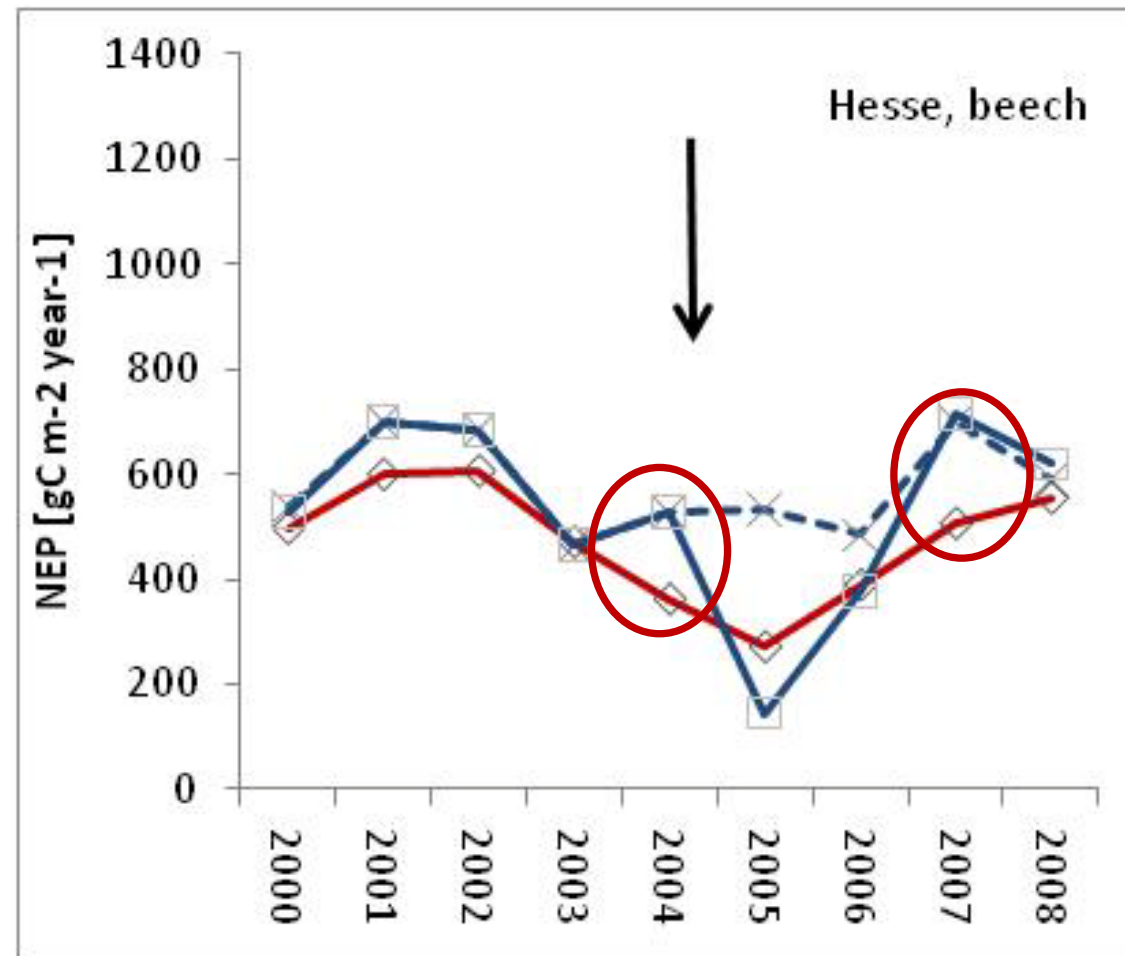
- constraint mortality



3. Simulation Examples

A) Beech Forest (Hesse, France)

→ annual net ecosystem productivity



3. Simulation Examples

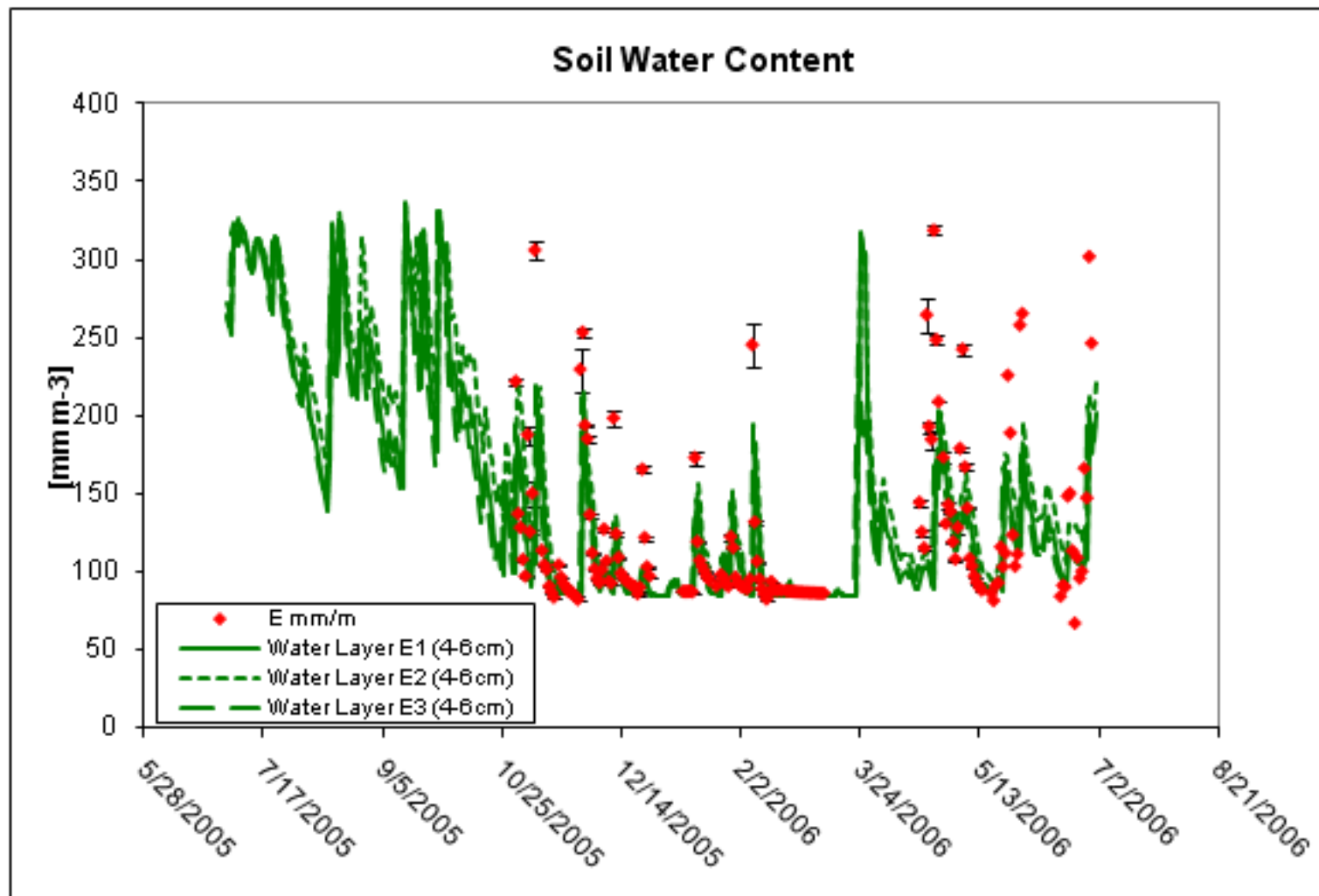
B) Eucalypt plantation (Victoria, South Australia)

- Initialization with standard seedling dimensions and crude soil survey (soil depth)
- Input is daily climate from 1997-2005, + thinning
- 24 stands for parameterization
- 38 stands for evaluation



3. Simulation Examples

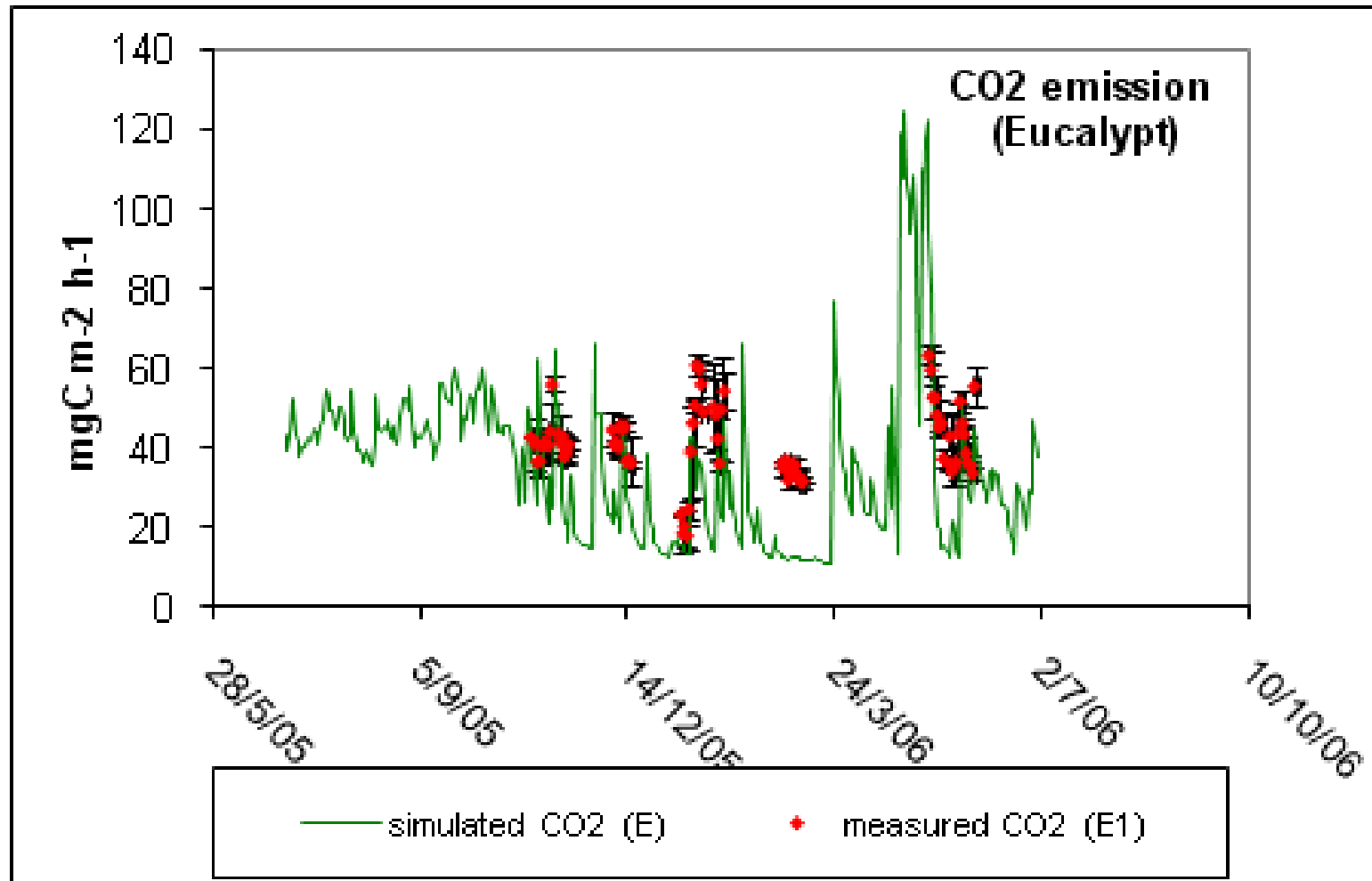
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Miehle et al., in preparation

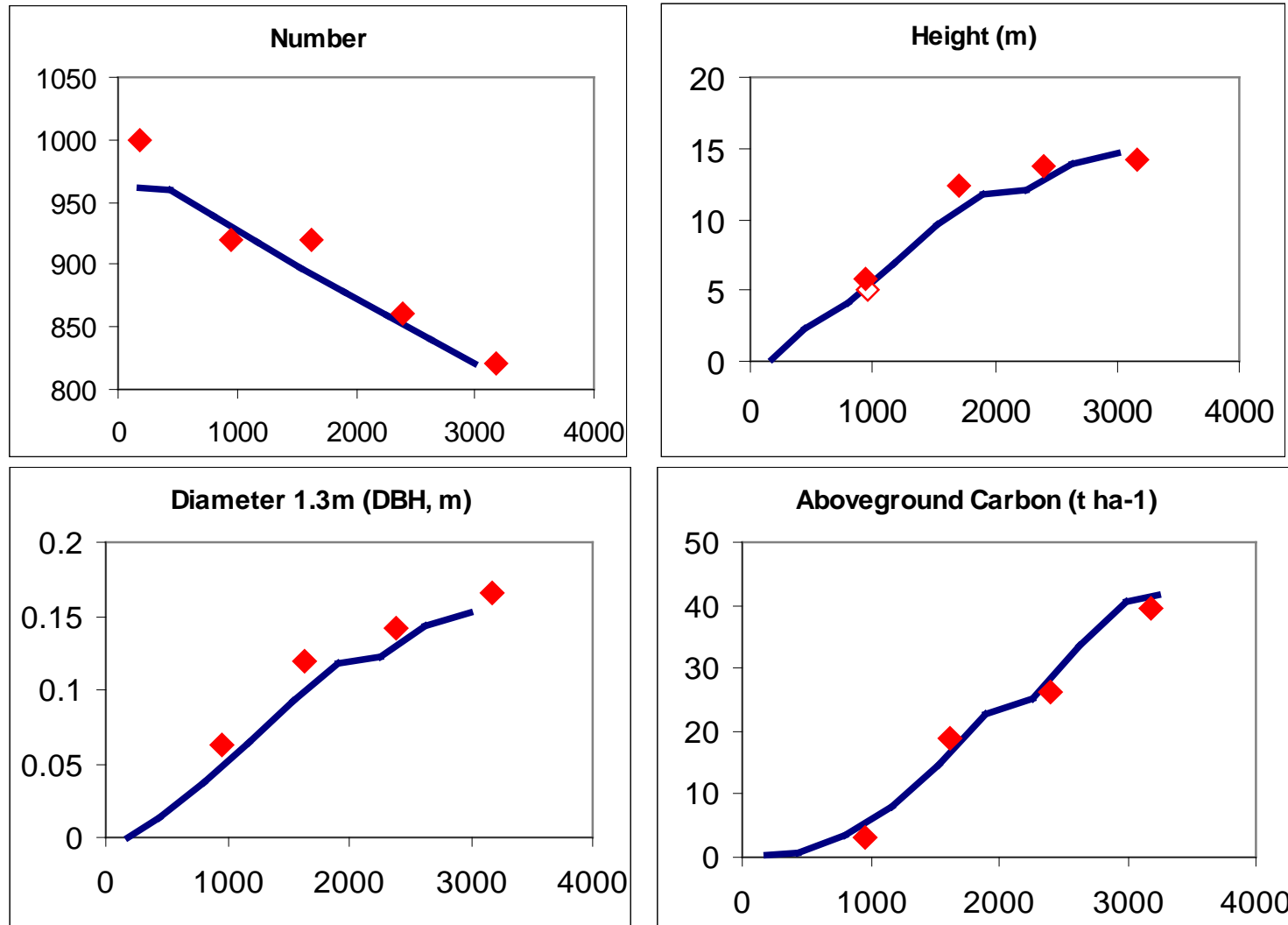
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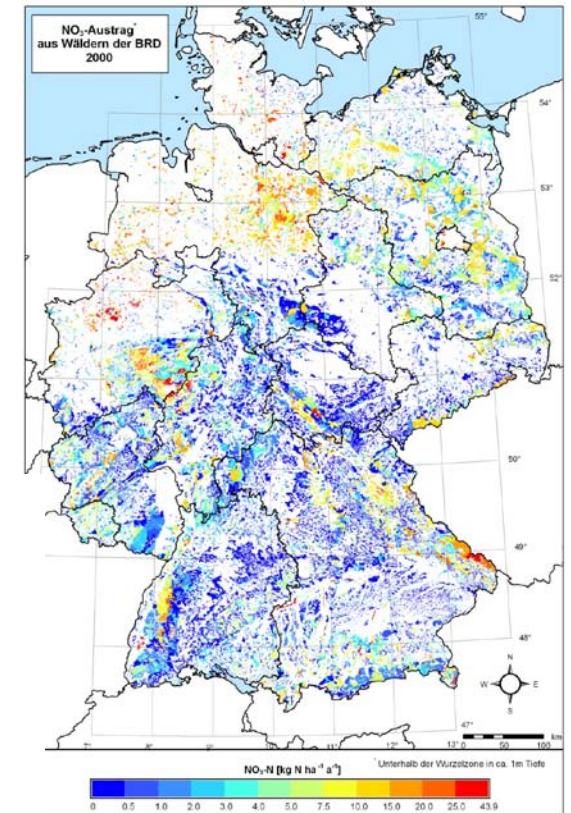
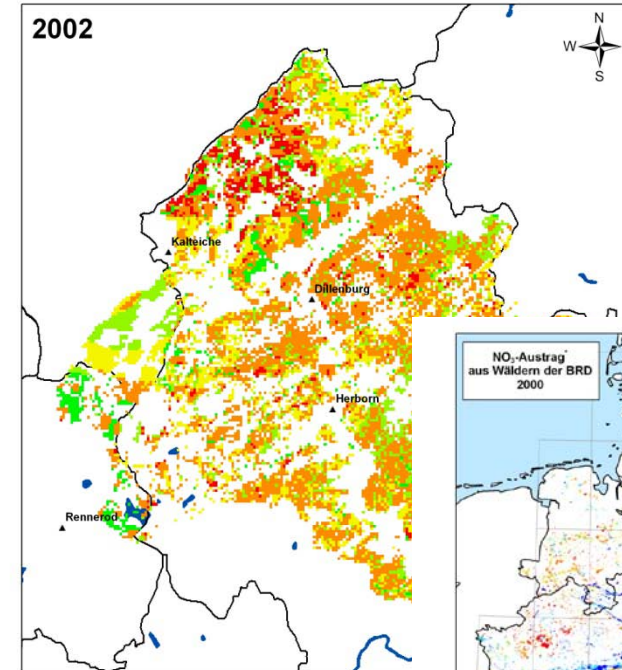


Miehle et al., EJFR, 2010

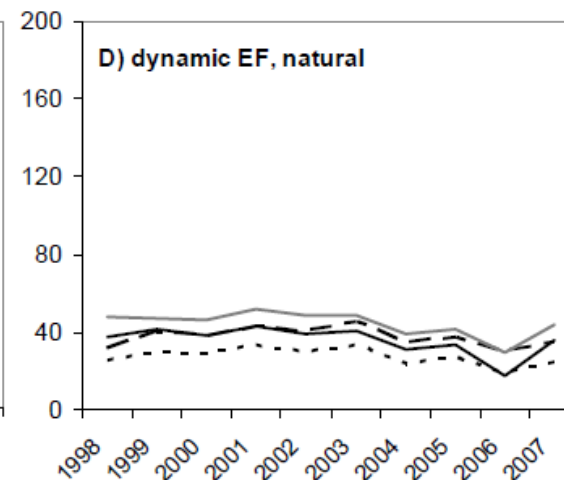
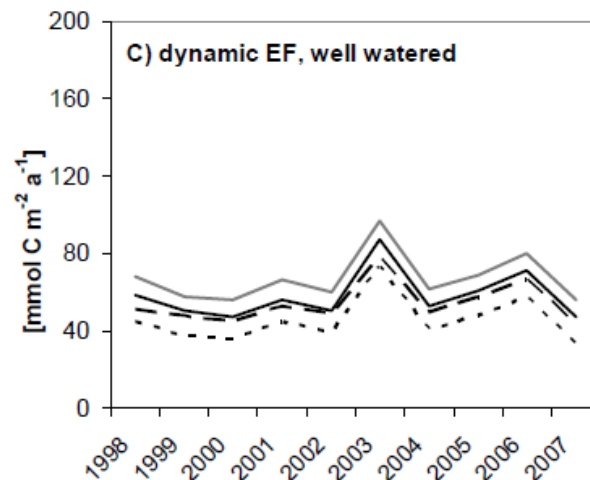
4. Related Research

- Biosphere/hydrosphere exchange
 - nitrate leaching
- Biosphere/atmosphere exchange
 - NO, N₂O emission
 - VOC emission (e.g. isoprene)
 - ozone sensitivity

Simulierter Nitrataustrag für den Lahn-Dill-Kreis
 Deposition erhöht von 0 auf 40 kg ha⁻¹ a⁻¹



Änderung um Faktor:
 Value: 1 (green), 1.25-1.5 (yellow), 1.5-3 (orange), 3-8.2 (red)



5. Outlook

- Coupling with regional models
 - feedbacks between plant and air chemistry
 - impact of water redistribution in a landscape
- Land use changes
 - energy plantations on agricultural land
 - forest plantations on former grassland
- Development of structured biosphere models
 - competition changes
 - management alternatives
 - agroforest



Thank you for your attention

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