
Modelling Land Use Change
with CoupModel
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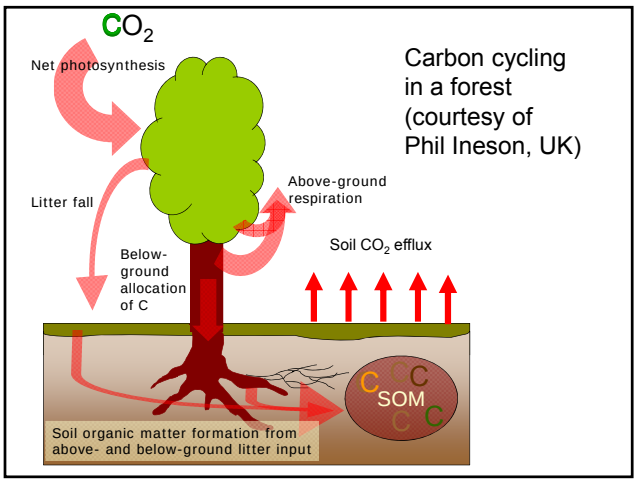
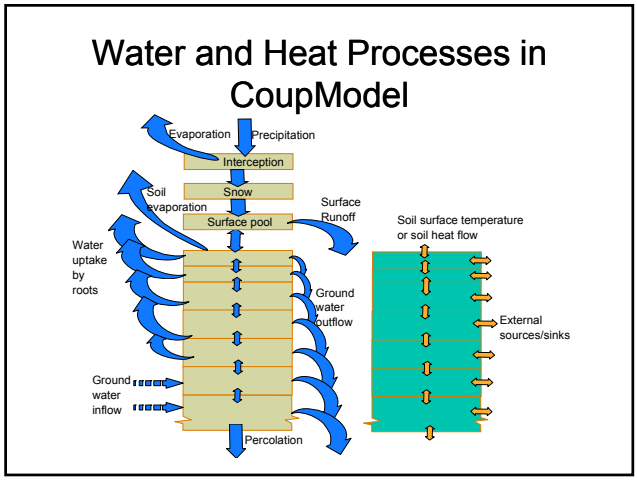
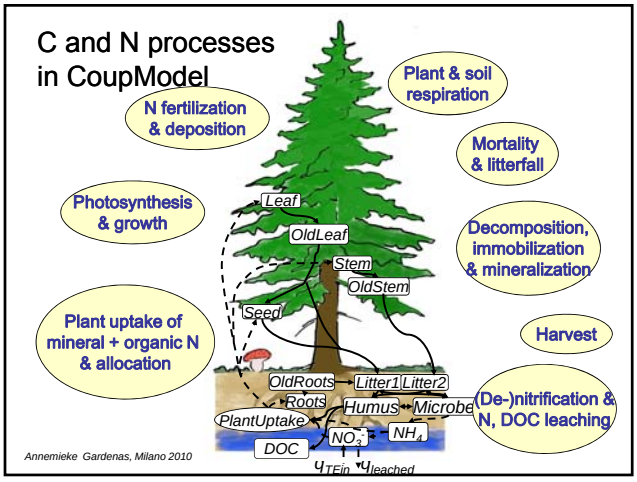
SLU
Foto Johanna Sjöberg


CO_2
Net photosynthesis
Litter fall
Above-ground respiration
Soil CO_2 efflux
Below-ground allocation of C
SOM
Soil organic matter formation from above- and below-ground litter input
Carbon cycling in a forest (courtesy of Phil Ineson, UK)


Water and Heat Processes in CoupModel
Evaporation
Precipitation
Interception
Snow
Soil evaporation
Surface pool
Surface Runoff
Water uptake by roots
Ground water outflow
Ground water inflow
Percolation
Soil surface temperature or soil heat flow
External sources/sinks


C and N processes in CoupModel
N fertilization & deposition
Plant & soil respiration
Mortality & litterfall
Photosynthesis & growth
Decomposition, immobilization & mineralization
Plant uptake of mineral + organic N & allocation
Harvest
(De-)nitrification & N, DOC leaching
Leaf
OldLeaf
Stem
OldStem
Seed
OldRoots
Litter1
Litter2
Roots
Humus
Microbe
PlantUptake
NO_3
NH_4
DOC
u_{TEin}
$u_{leached}$
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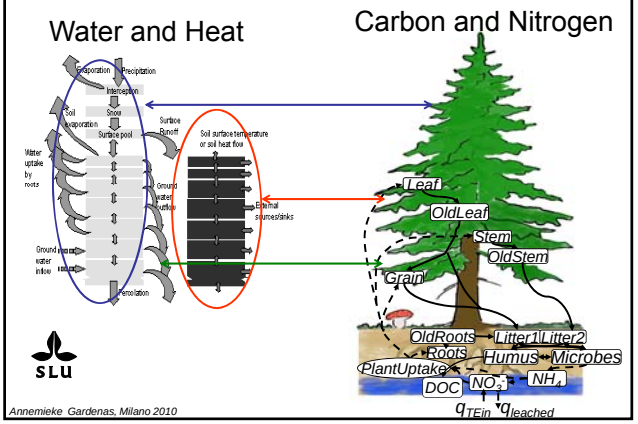
CoupModel



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OUTLINE

- Plant morphology
- Perrennual *versus* (bi-)annual
  - Management
  - Litterfall
- Plant N demand & allocation pattern
- Plant radiation use efficiency

Plant morphology

- *Canopy height, LAI, albedo, root distribution*
- *Regulating water and energy balance*

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Plant morphology - Explicit big Leaf

1) *Static:* Albedo, Root depth
2) *Driving: Canopy height, LAI*
3) *Dynamic: LAI, Canopy height*

- number of parameters 4 extra
+ flexibility

Example parameter
of LAI dynamic: g C/ LAI

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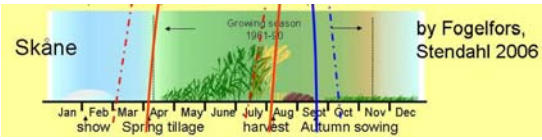
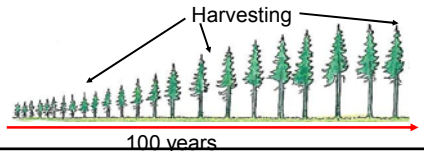
Perennial *vs.* Annual

Time scale: Forest 100 years and arable land 1-2 years
- Management
- Litter fall





After:
Swedish Forestry Board, 1996 pp66.

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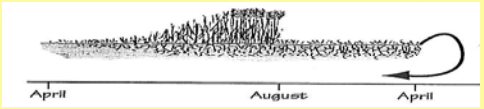
Perennial vs. Annual – Litter fall

- Plant life cycle:
  sowing, emergence, leafing, seed building, seed maturing, harvest



Source:
K. Blombäck, 1998, pp.18 by Hans Fryck

- Quantity a) constant rate,
  b) seasonality f(Tsum)
- Quality – C/N ratio of different plant compartments, re-translocation

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Perennial *vs.* Annual - Management

Processes	F. *vs.* A.	Parameters
N fertilization - mineral - manure	=, Δ	day, dissolution rate, $N\text{-}NH_4$ Manure: 5 additional parameters
Ploughing -deep ploughing -surface cultivation	Δ (=)	A: day, depth; day, depth
Harvesting	Δ	day, % of each C pool to harvest or to litter

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Plant N uptake and allocation

- *Uptake of N:*
  Root uptake of mineral N, organic N and N-fixation by leaves
- *Optimum N % of different plant compartments*

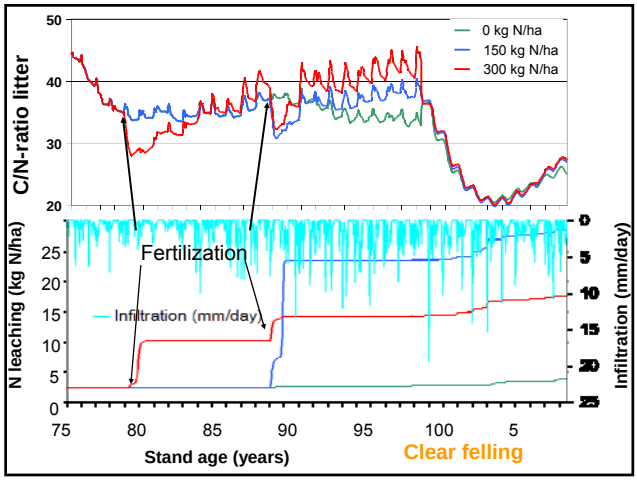
	Forest	Arable
Stem	0.1	<0.5
Leaves	1.5	2.5
Fine roots	1	1.5
Coarse roots	0.07	
Seeds		2.5

Radiation and water use efficiency

- Radiation use efficiency
  ε_L (gDW/MJ)
- Max conductance of water per LAI

Products:

I. Seasonal and yearly variation of litterfall production, $C0_2$-emissions, DOC, NO_3^- and NH_4^+ leaching and information to anlyse their governing processes

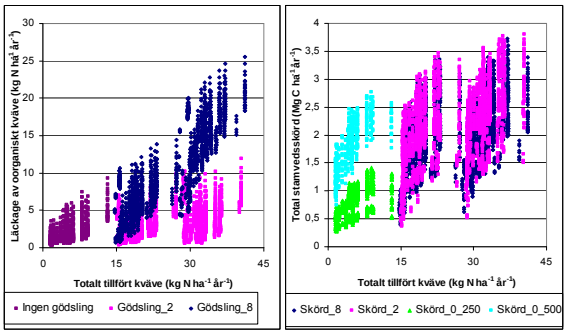


Products:

I. Seasonal and yearly variation of DOC, NO_3^- and NH_4^+ leaching and information to anlyse their governing factors

II. Scenarios of climate change and management

Comparison of ecosystem services for different N fertilization scenarios



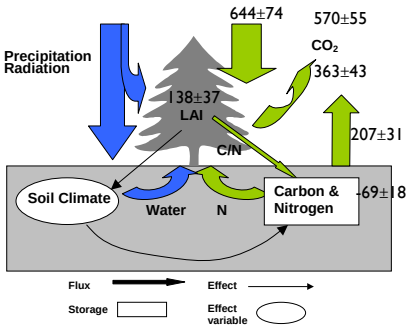
Products:

I. Seasonal and yearly variation of DOC, NO_3^- and NH_4^+ leaching
and information to anlyse their governing factors

II. Scenarios – Comparison of different ecosystem services

III. Uncertainty analyses - GLUE or Bayesian

Uncertainty estimates using GLUE or Bayesian



THANKS !

PhD-course SOM-modelling 23/8-3/9 2010
Models Q, Yasso and CoupModel

References

Jansson P.-E. & Karlberg L. (Eds). 2004. Coupled heat and mass transfer model for soil-plant-atmosphere systems.Royal Institute of Technolgy, Dept of Civl and Environmental Engineering, Stockholm, http://www.lwr.kth.se/Vara%20Datorprogram/CoupModel/index.htm

Gärdenäs, A. Eckersten, H. & Lillemägi, M. 2003. Modeling long-term effects of N fertilization and N deposition on the N balance of forest stands in Sweden. 30 pages. Emergo 2003:3

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Illustrations:
Spruce: Peter Roberemtz, in Gärdenäs et al. 2009
Potato: Google Image:
Plant Life cycle: by Hans Fryck in Blombäck, K, 1998. PhD-thesis pp. 18.
Swedish Forestry Board, 1996, Basic Book for foresters, pp66. (in Swedish)