VSD+PROPS
Dynamic Soil Vegetation Model
Overview

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model makers

From VSD to VSD+

- Shifting goals:
- biodiversity
  - effects of N deposition on plant species diversity
  - this requires: N availability, C/N ratio, NO_3/NH_4 concentrations, ……
- climate
  - carbon sequestration in forests
  - greenhouse gases (N_2O emissions)

→ **New formulations of C and N processes (explicit C and N balance)**

VSD

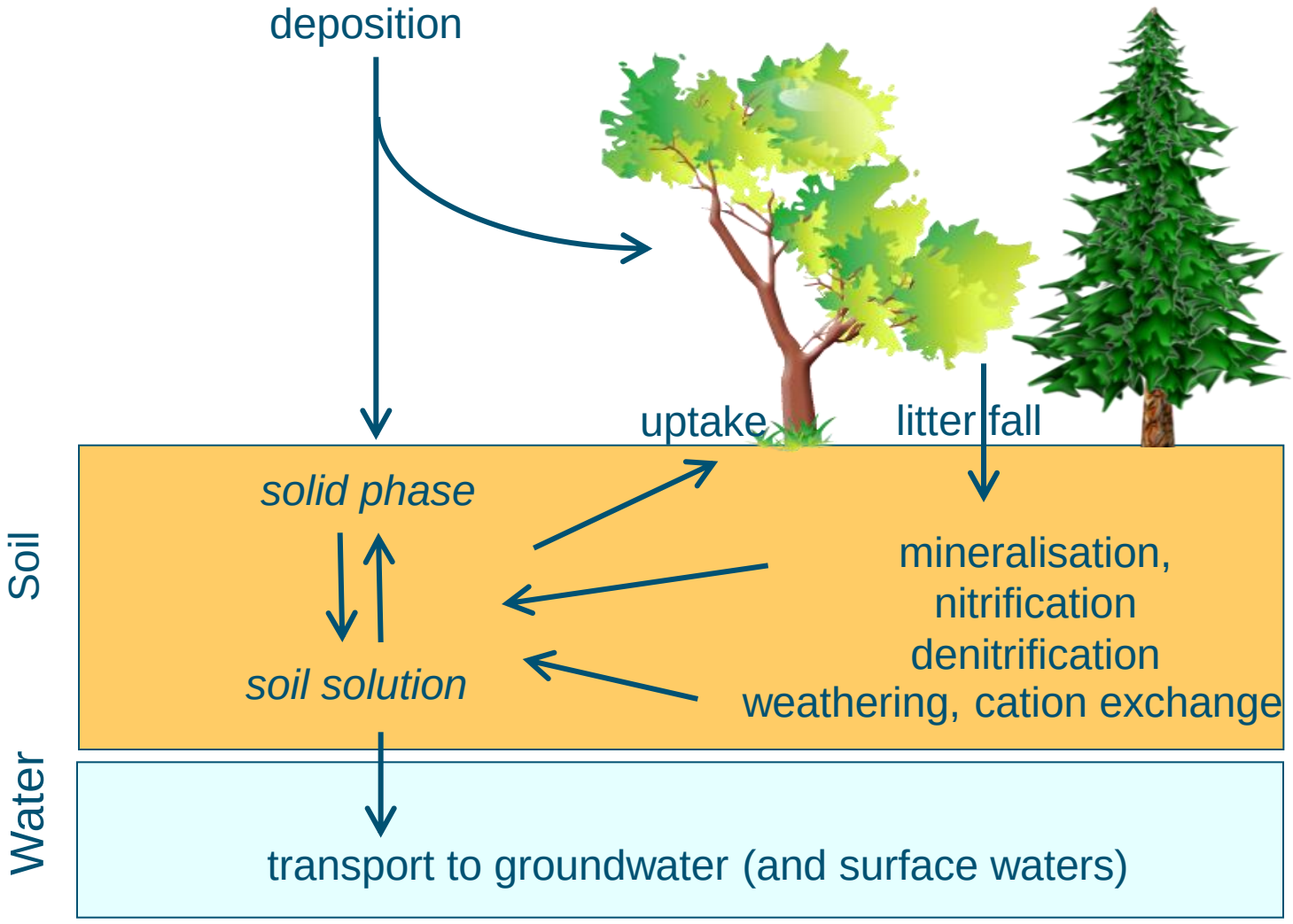
- **V**ery **S**imple **D**ynamic soil acidification model
- to simulate the acidification (and recovery) of non-calcareous (forest) soils
- scenario analyses & target load calculations (& critical loads)
- regional/national scale calculations in support of effects-based work under LRTAP Convention

VSD+

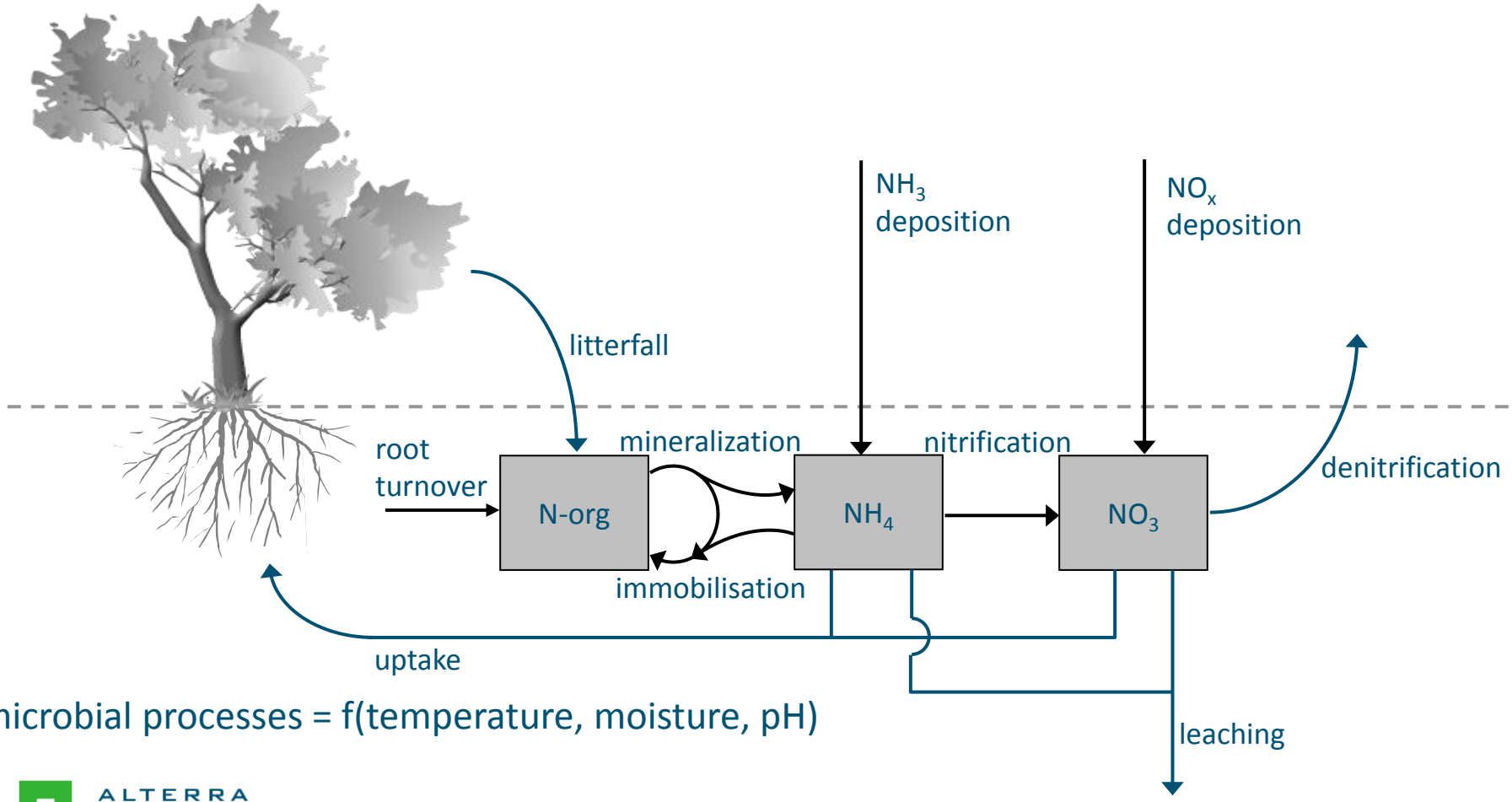
VSD+ (VSD + explicit C and N modelling)

- dynamic modelling of soil acidification
- soil eutrophication (N availability)
- carbon sequestration

VSD+


deposition
uptake
litter fall
solid phase
soil solution
mineralisation,
nitrification
denitrification
weathering, cation exchange
Soil
Water
transport to groundwater (and surface waters)

N processes in VSD+



microbial processes = f(temperature, moisture, pH)

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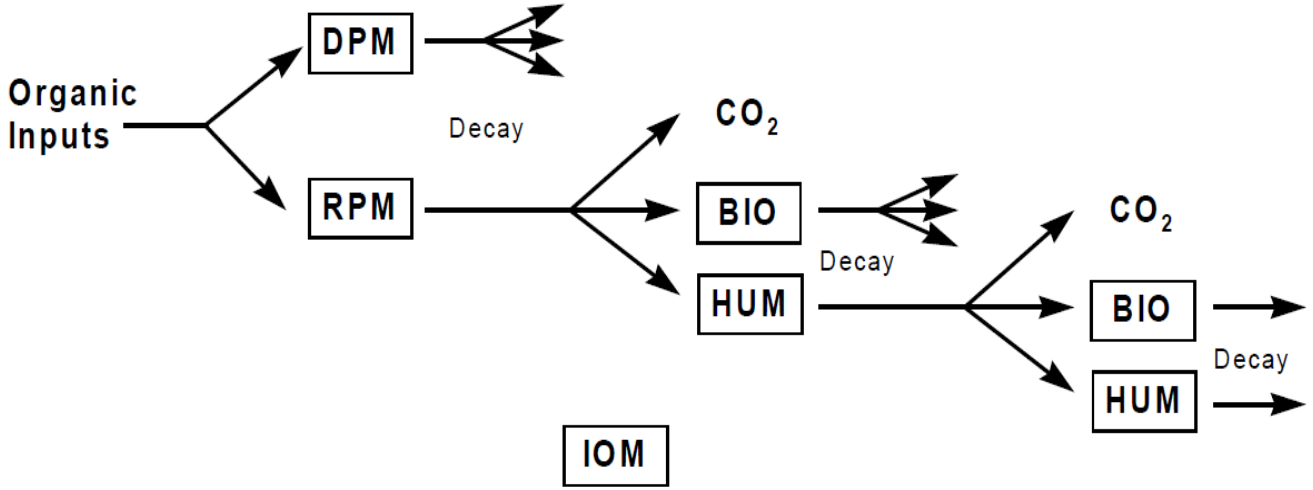
RothC model

C pools:

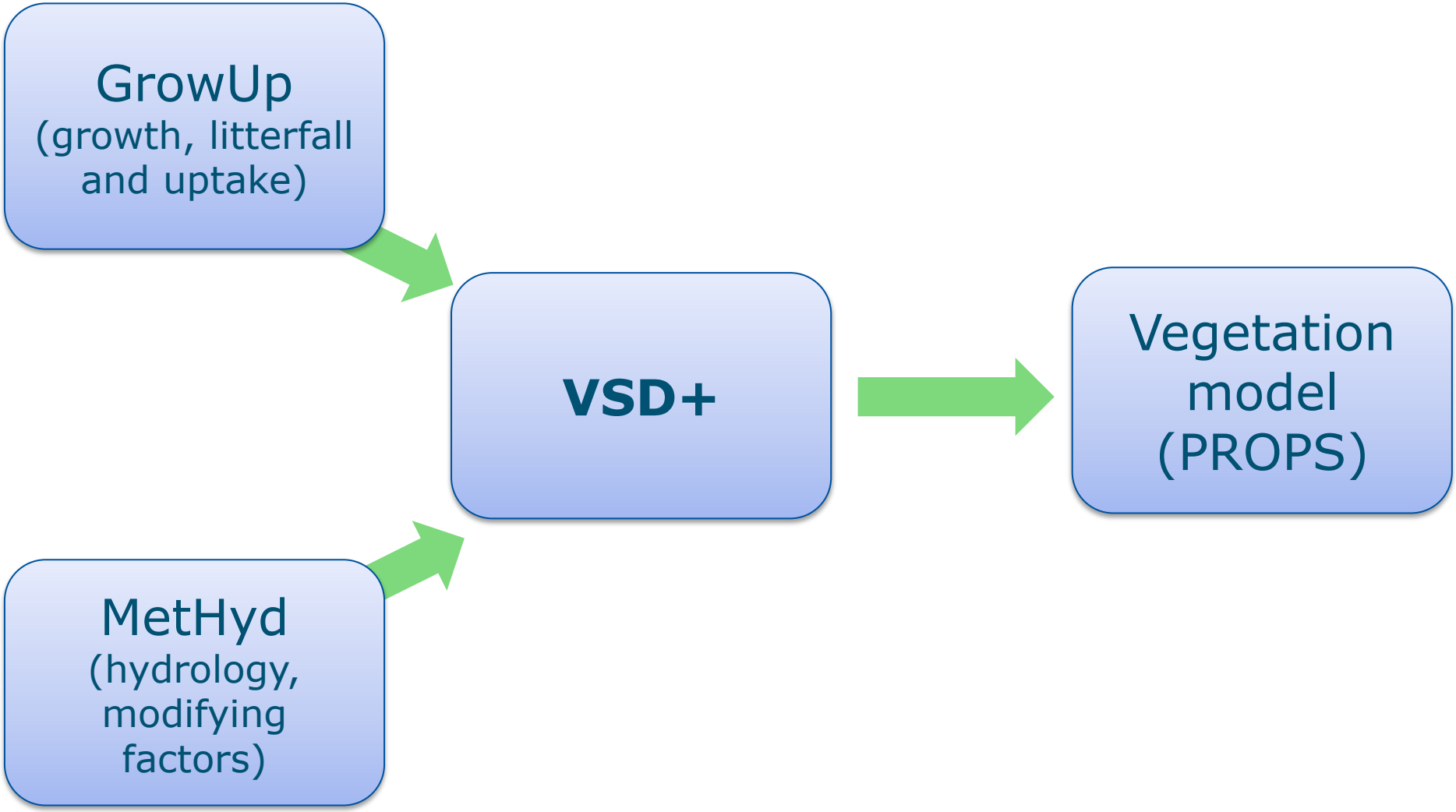


RPM : Resistant Plant Material
DPM : Decomposable Plant Material
BIO : Microbial Biomass
HUM : Humified OM
IOM : Inert Organic Matter

N dynamics:

- fixed N contents for DPM, RPM and BIO
- $N_{HUM} = f(N_{DPM}, f_{RPM}, f_{BIO})$, but is reduced when N uptake > N deposition + N mineralisation

VSD+ tool set



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VSD+ tool set

VSD+

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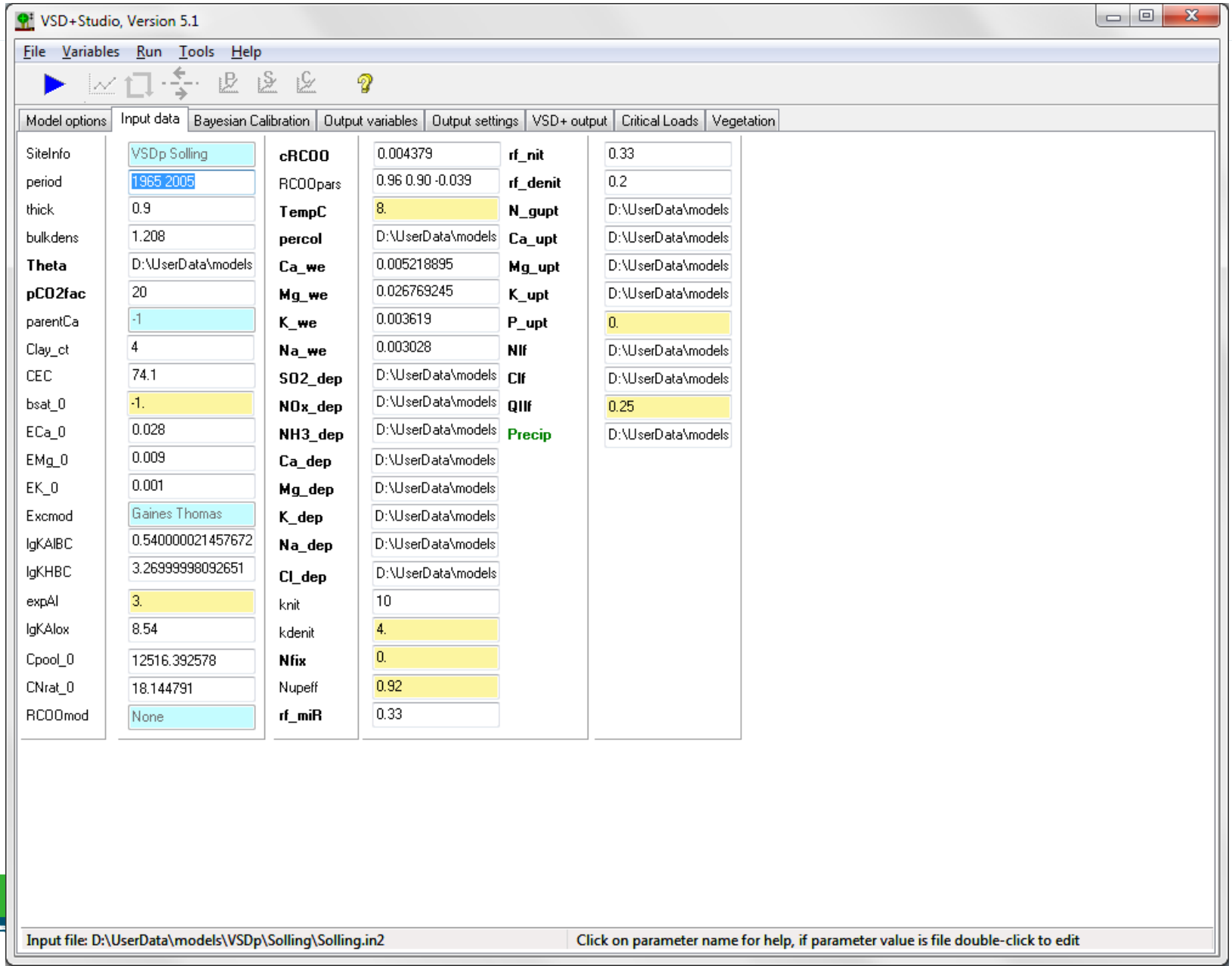
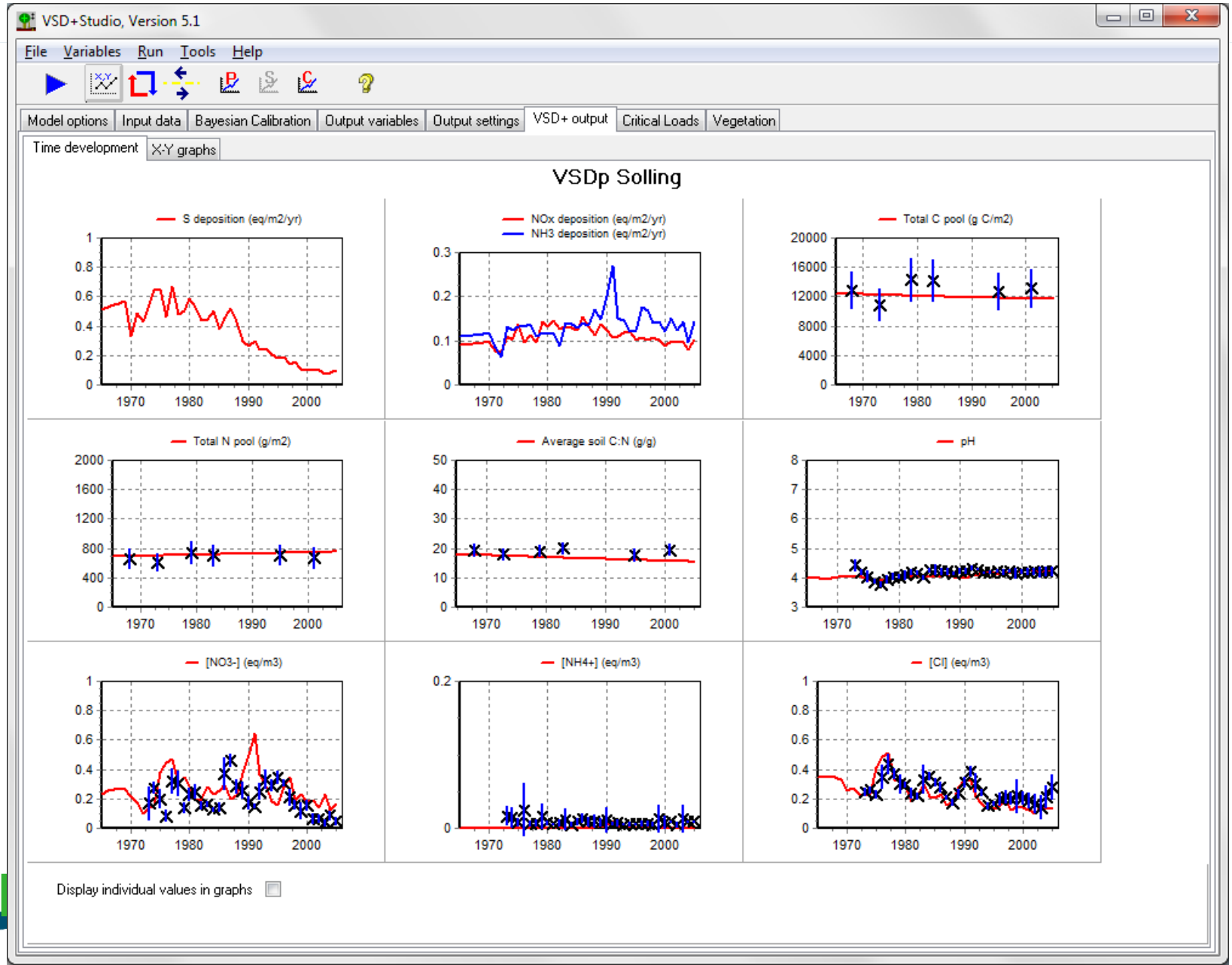
VSD+ user interface (screenshots)



VSD+ user interface (screenshots)



GrowUp

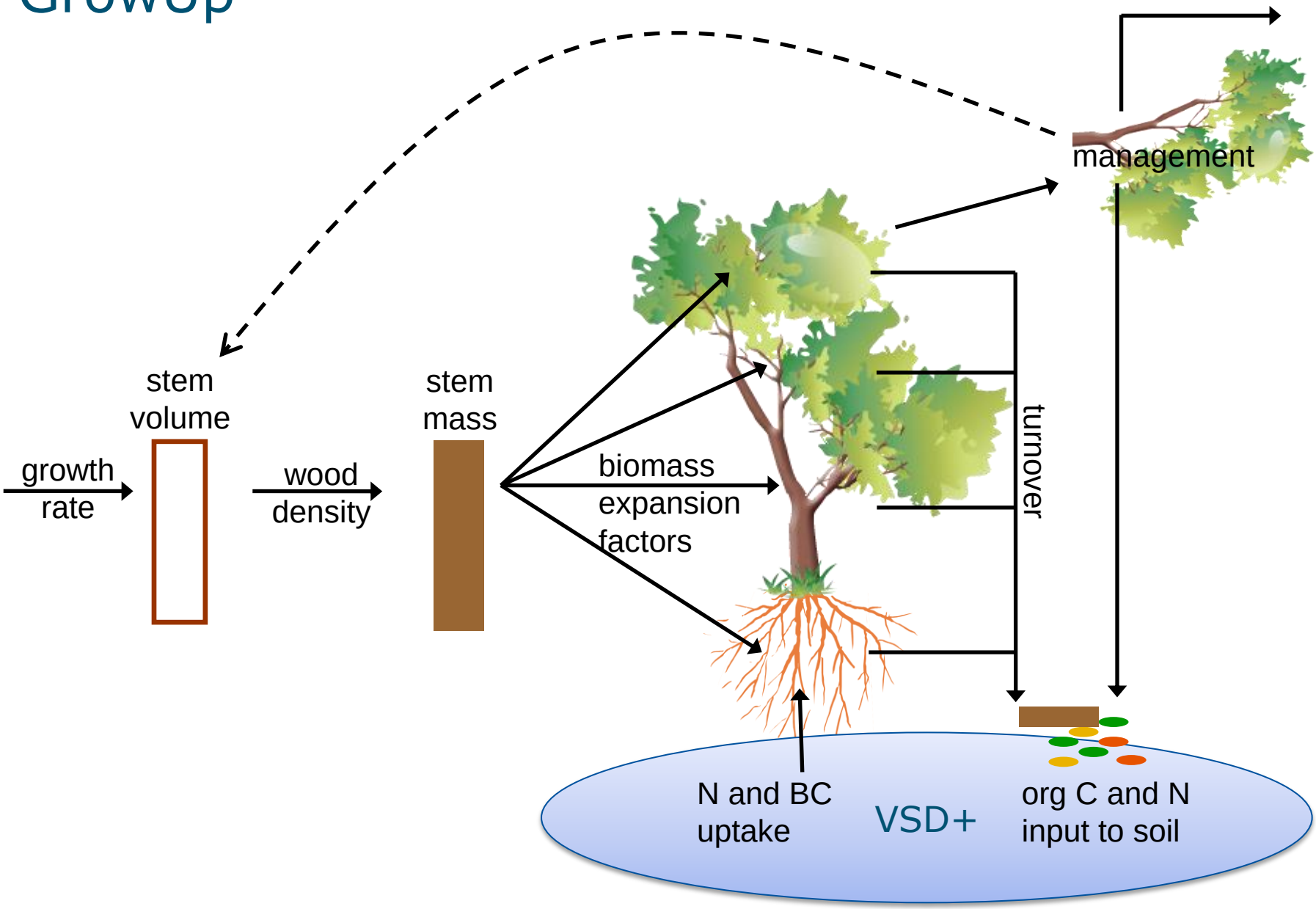
Tool to calculate:

- uptake of N, Ca, Mg and K
- input of C and N from litterfall and root turnover

- for forests only
- includes management actions (planting, thinning, clear-cut)
- two forest types:
    - uniform age
    - mixed uneven aged (natural rejuvenation)

GrowUp available through CCE website

GrowUp


management
stem volume
growth rate
wood density
stem mass
biomass expansion factors
turnover
N and BC uptake
VSD+
org C and N input to soil

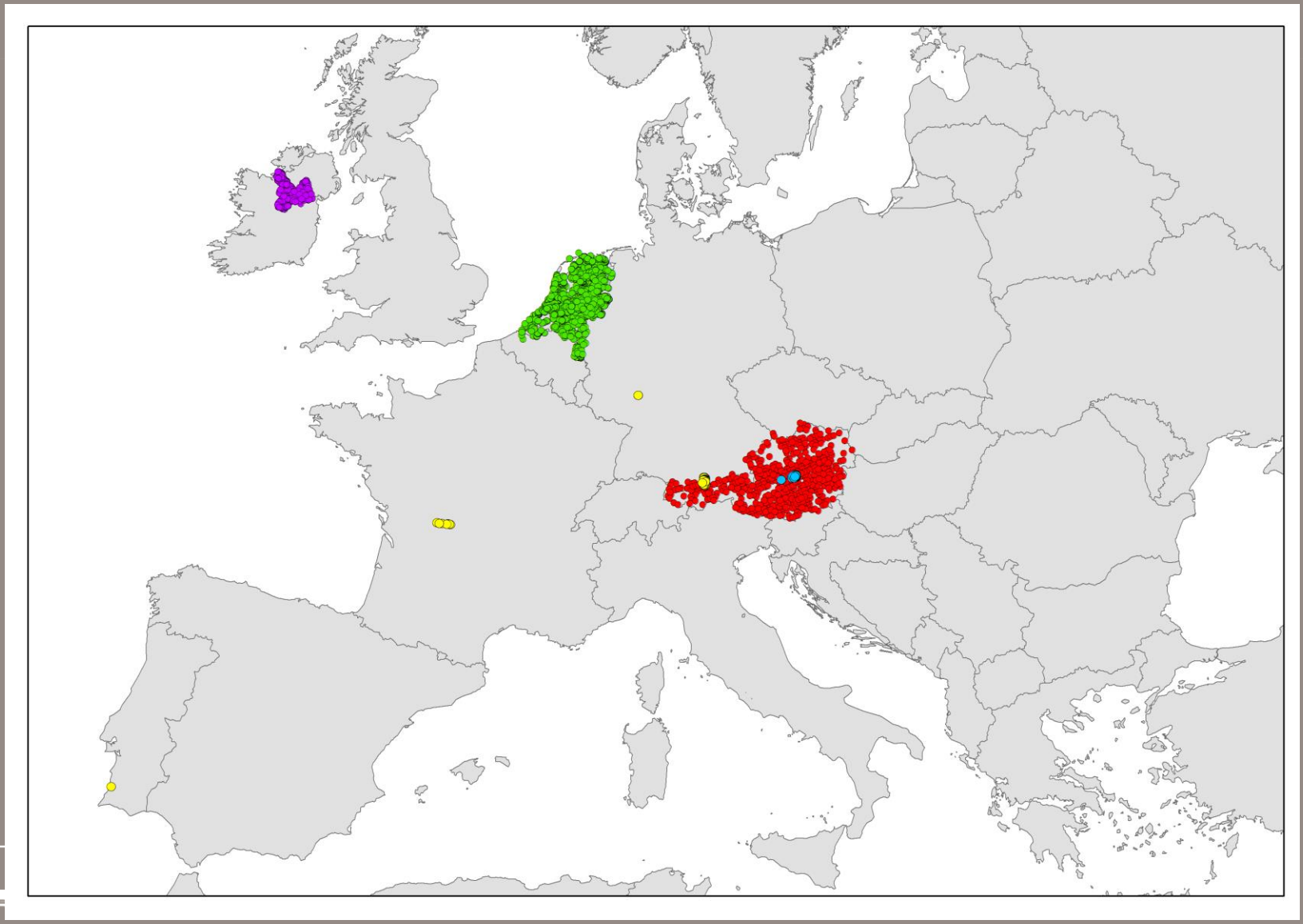
PROPS – **PRO**bability of **P**lant **S**pecies

- calculates the chance/probability/suitability that a plant species is present (not abundance!)
- based on measured/measurable abiotic conditions

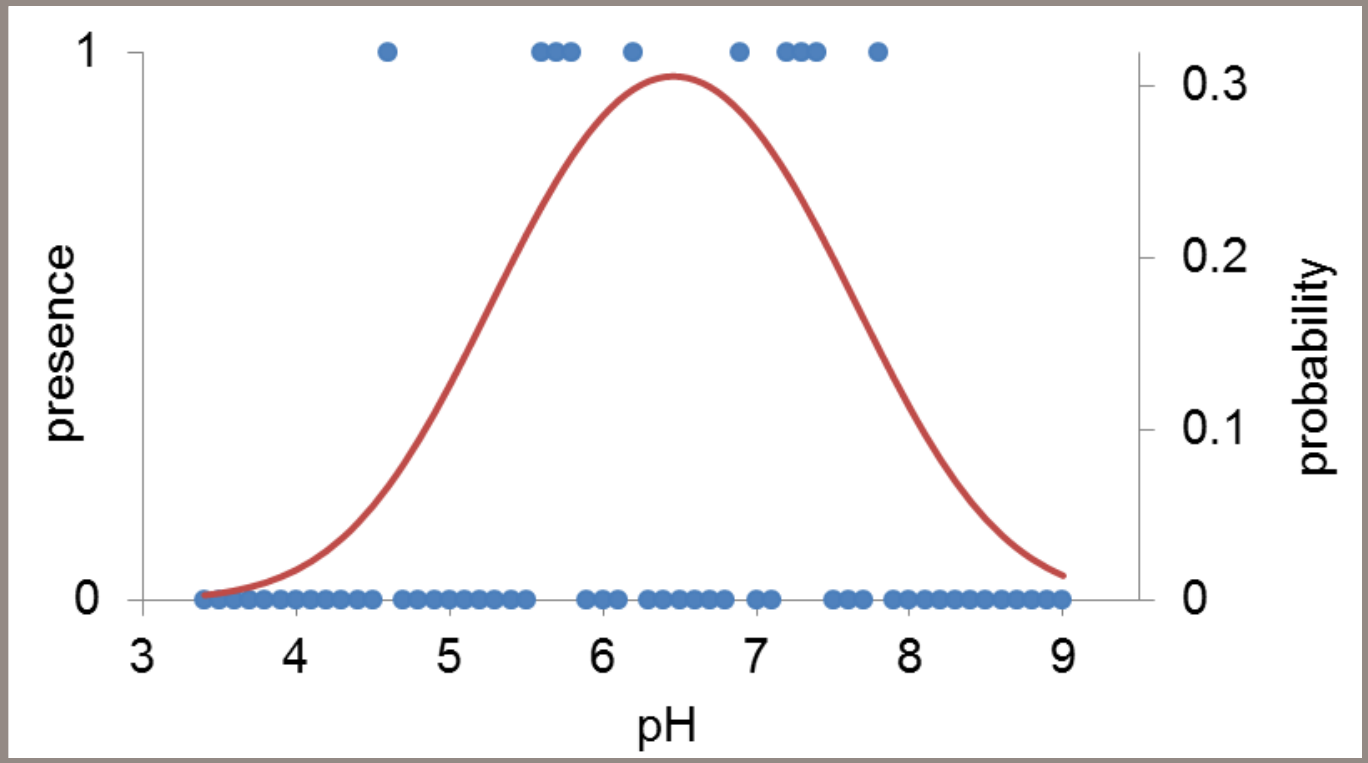
Derived from:

- relevés with simultaneously measured abiotic conditions (N, pH)
- climate data

Relevés with measurements of abiotic conditions



Fitting of response functions



Response functions

2 dimensional response functions:

- pH
- N (N-total, CN, NO_3)

$$\text{logit}(y) = \alpha + \beta_1 pH + \beta_2 N + \gamma_1 pH^2 + \gamma_2 N^2 + \delta pH \cdot N$$

$$\text{probability} = 1/(1+\exp(-\text{logit}(y))$$

Results

Number of plant species with response functions

- pH + N-total: 406
- pH + CN ratio: 330
- pH + NO_3: 146

2. Extension number of species

Problem:

- only few relevés where abiotic conditions have been measured ⇒ response functions for few species
- how to get abiotic conditions for other relevés?

Datasets:

- 'Abiotic' dataset: ± 4600 relevés with measurements of abiotic conditions
- Bioscore dataset: ± 430,000 relevés without abiotic conditions

estimation of abiotic conditions

'Abiotic' dataset
(± 400 species,
response for pH and N)

Sp1
Sp2
|
|
Spn

species that in Bioscore
with response functions
in 'Abiotic' dataset

Bioscore dataset
(430,000 relevés,
± 4,000 species)

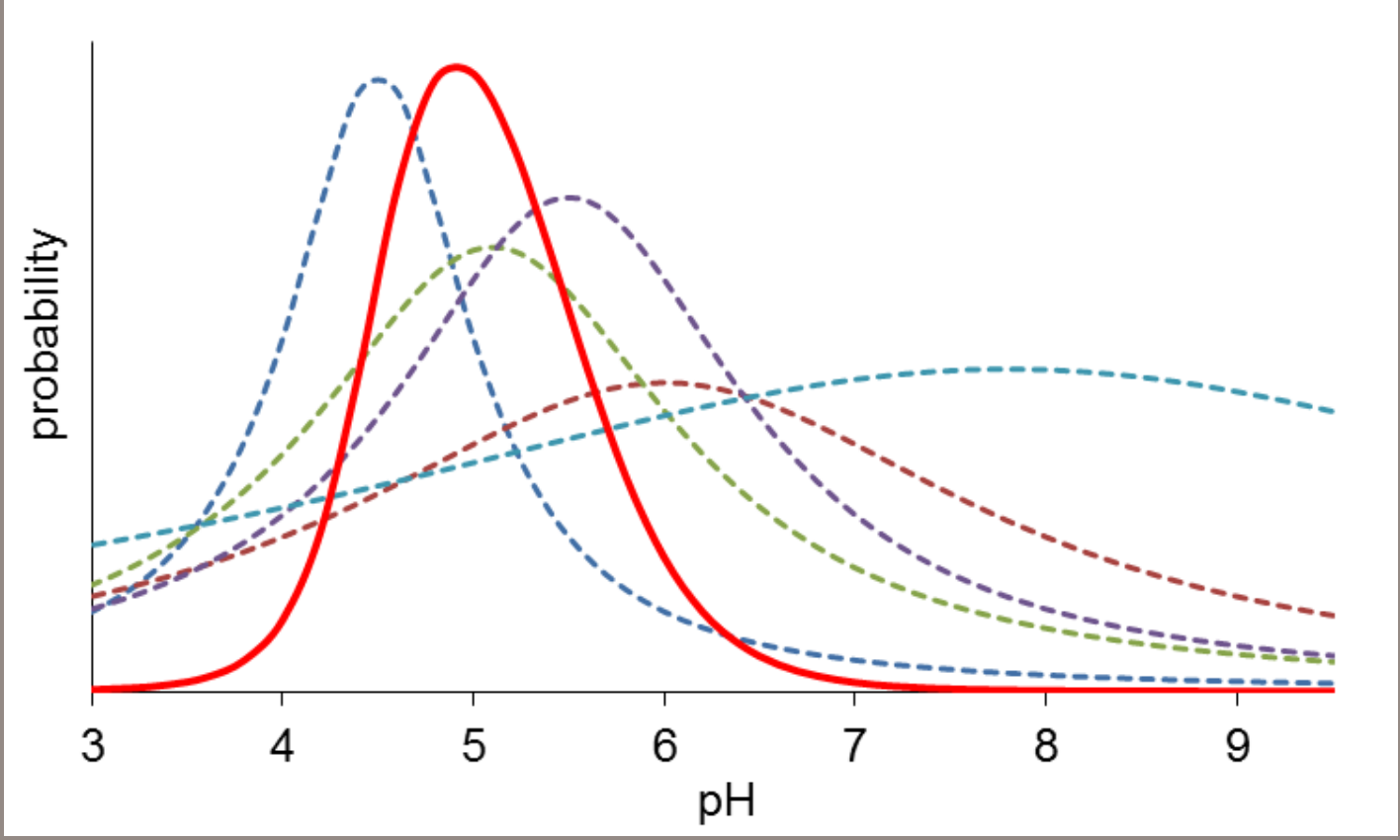
Sp1
Sp2
|
|
Spx

relevé
Sp1
Sp6
SP20
Sp78
Sp145
Sp221
Sp456

estimate pH and N
from species with
response functions

(at least 5 species
from 'abiotic' dataset)

estimation of abiotic conditions



Results

Number of plant species with response functions

'abiotic' database

- pH + N-total: 406
- pH + CN ratio: 330
- pH + NO_3: 146

Bioscore database

- pH + N-total: 2306
- pH + CN ratio: 2309
- pH + NO_3: 1781

PROPS model summary:

Probability *y* for occurrence of a plant modelled as:

$$z = \text{logit}(y) = \log\frac{y}{1-y} = a_0 + \sum_{i=1}^{n} a_i \cdot x_i + \sum_{i=1}^{n}\sum_{j=1}^{n} a_{i,j} \cdot x_i \cdot x_j$$

with $a_{i,j} = a_{j,i}$ for all i,j.

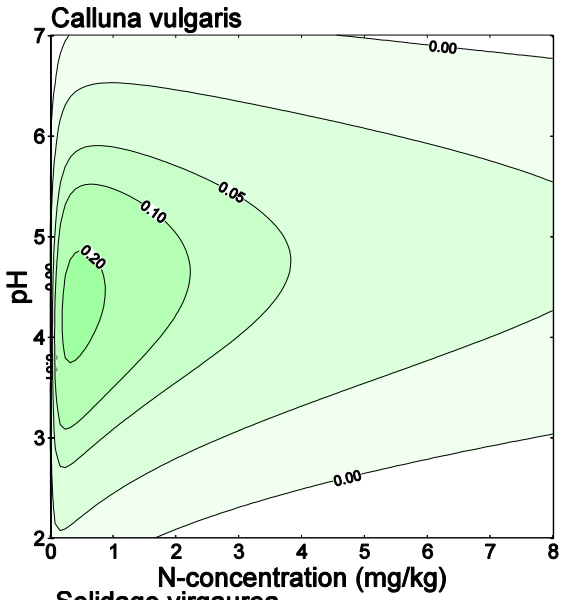
Number of variables x_i is $n = 4$ (normalized/log-transformed):

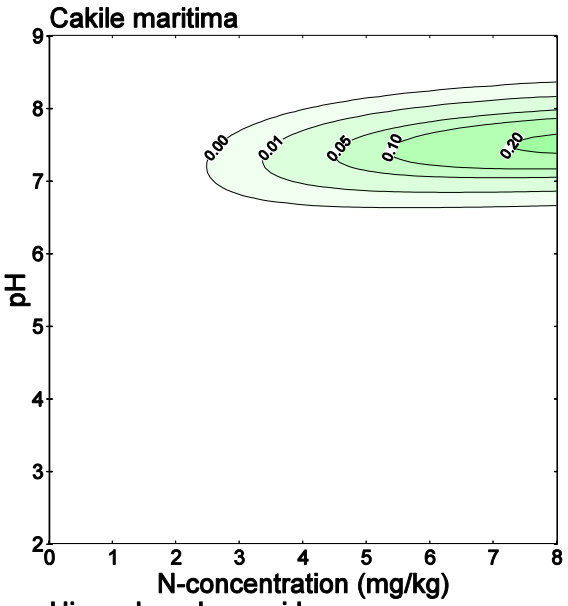
soil solution pH and [N], precipitation, temperature.

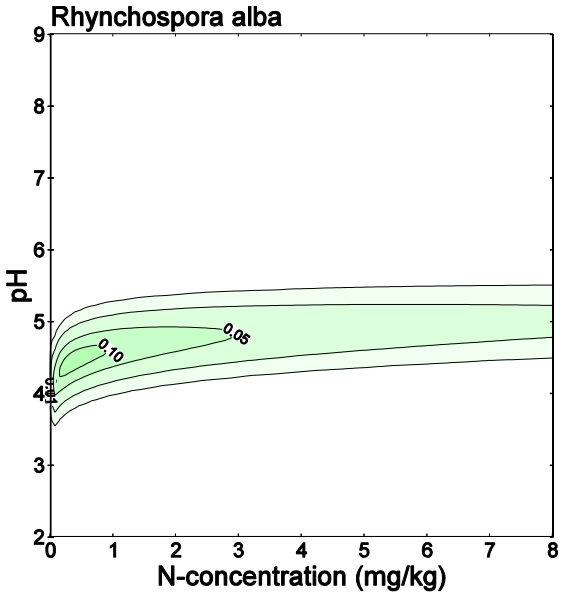
Probability *y* obtained as: $$y = \frac{1}{1+\exp(-z)}$$

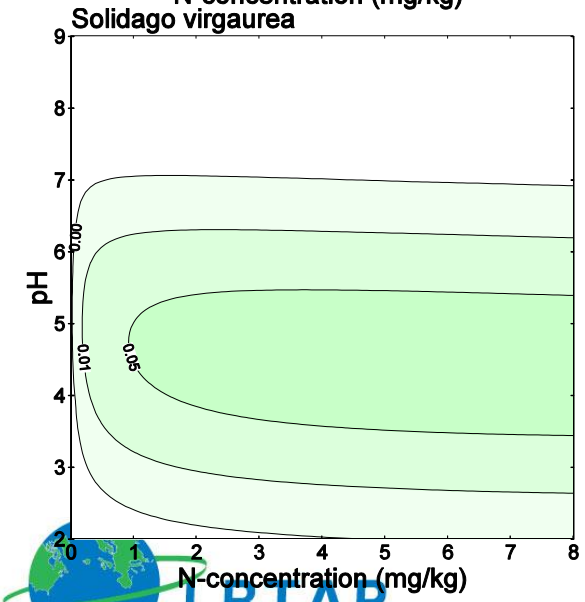
The 15 coefficients for many plant species are derived from relevés with both biotic and abiotic observations and extrapolated …

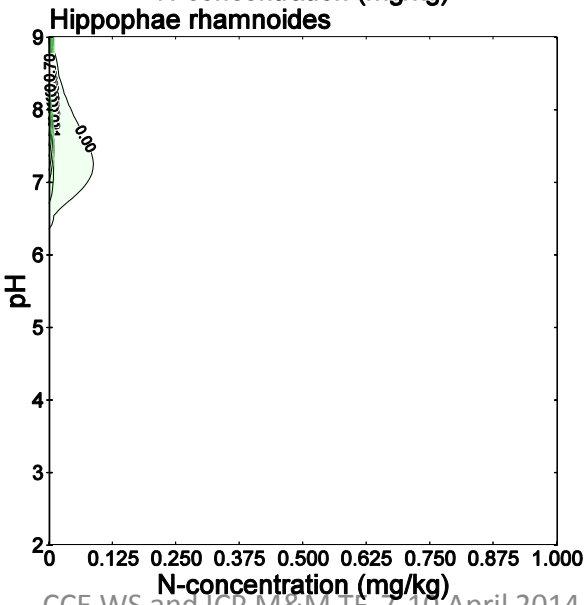
From PROPS DataBase: Isolines of occurrence probability for single species (in [N]-pH plane):











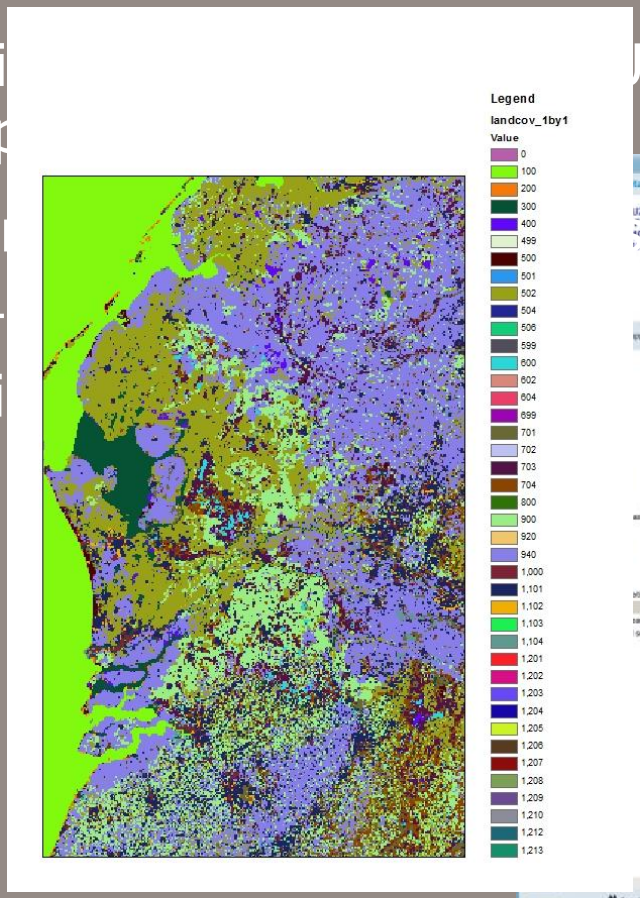
Temp and Precip fixed

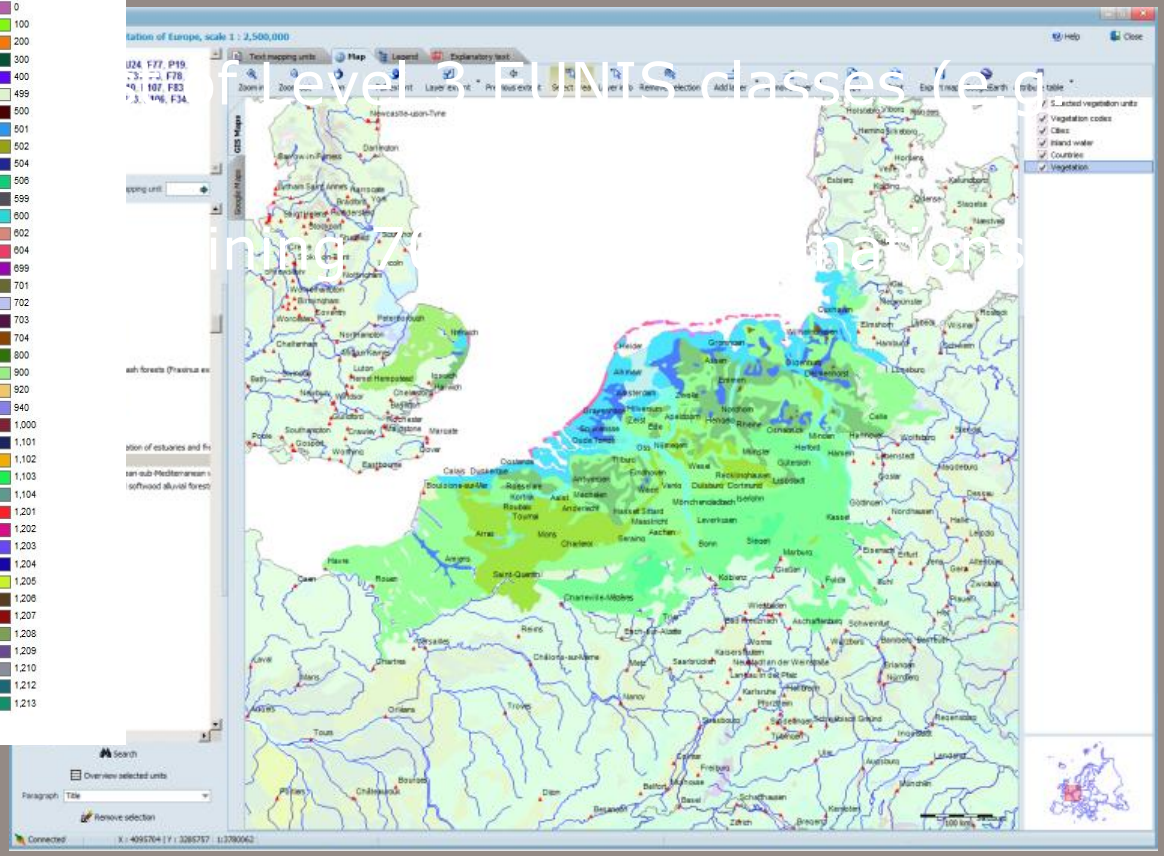
3. Preselect species in PROPS calculations

- 2300 species with response functions
- a-priori selection of species is required
- EUNIS classification is used in M&M work
  $\Rightarrow$ species selection related to EUNIS

Step 1:Overlaying

- overlay of EUNIS map (level 2; e.g. B1) with Map for the Natural Vegetation for Europe.
- thi UNIS class all possible vegetation typ
- co of level 3 EUNIS classes (e.g. B1
- Wi ing Z nations





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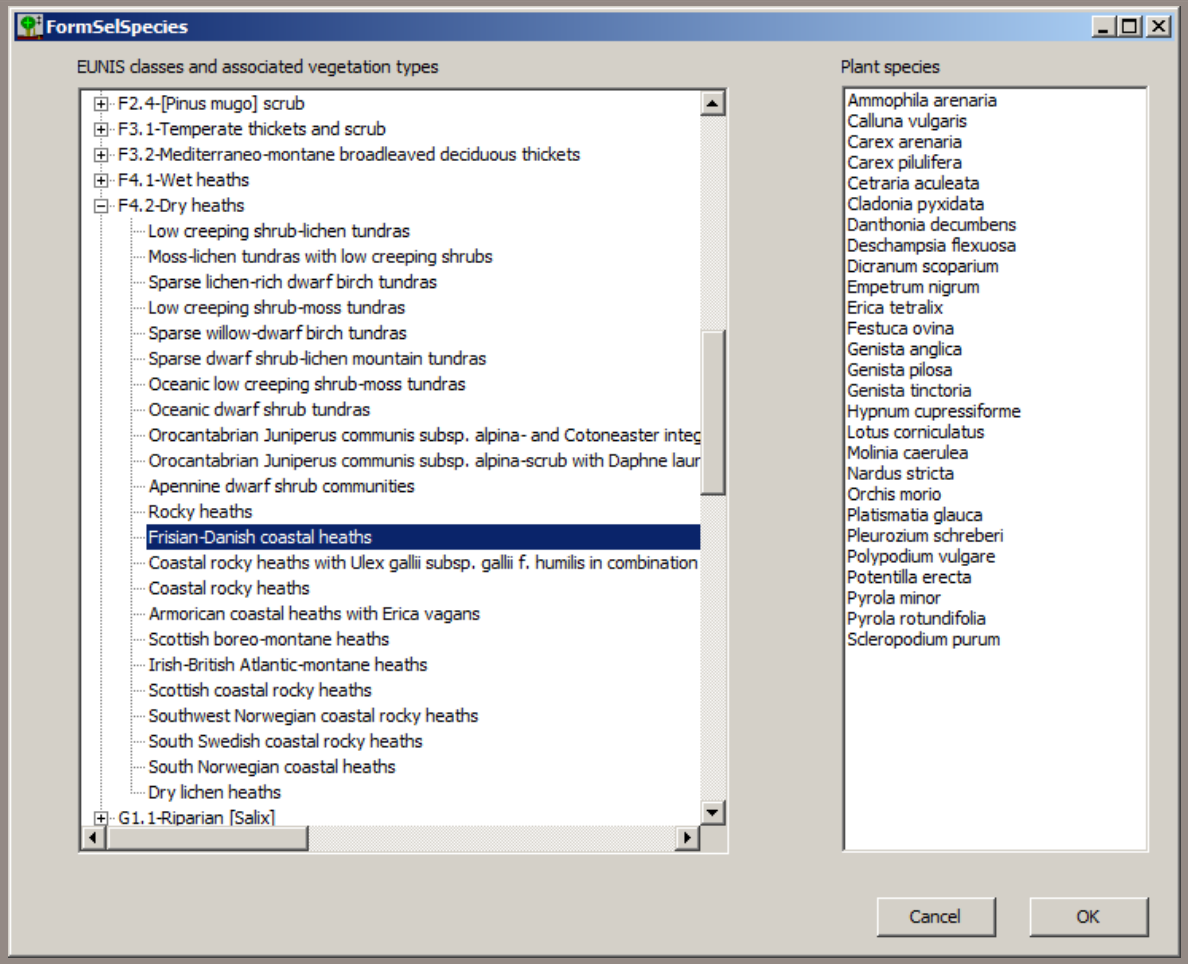
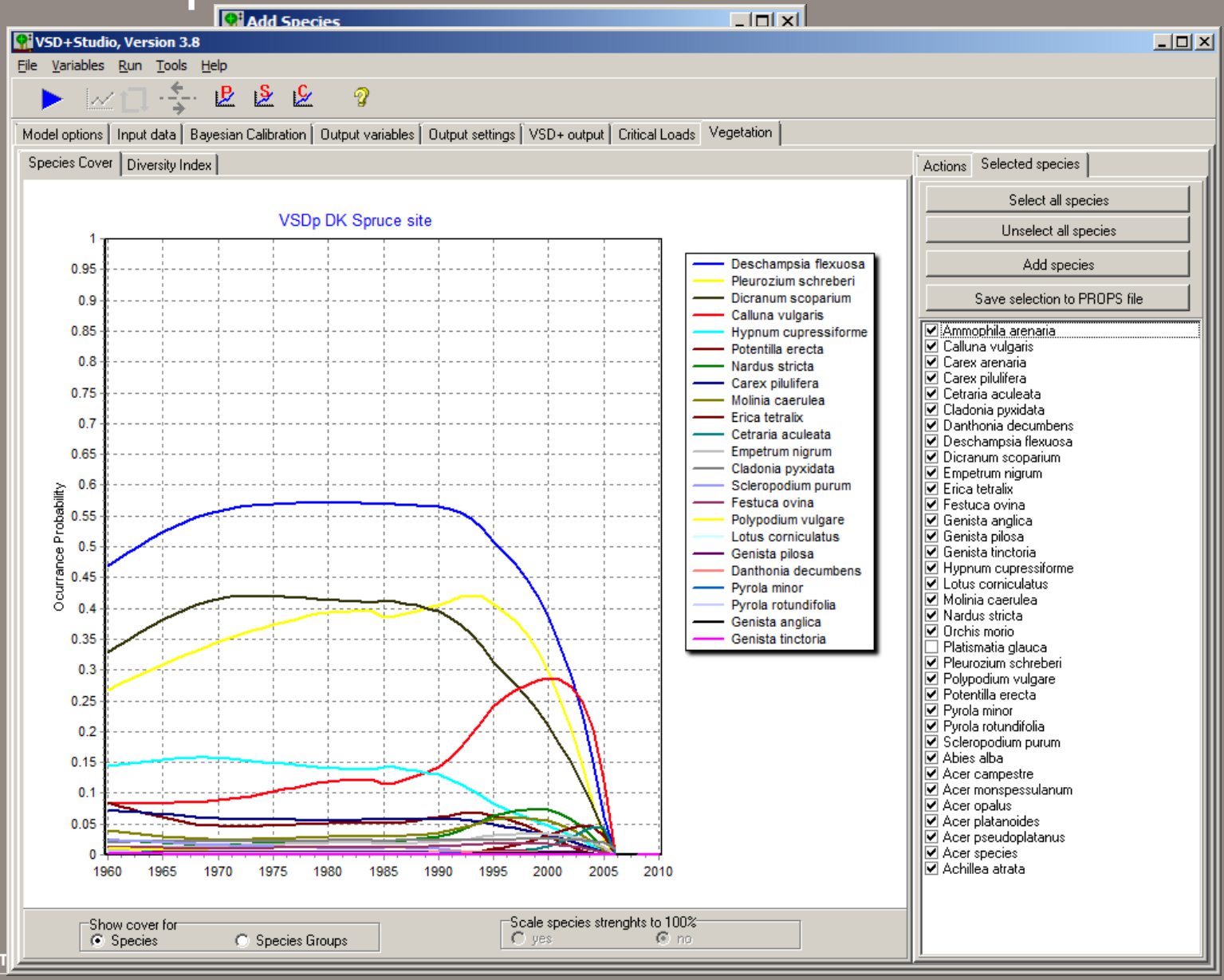
Step 2: species assignment

- For each unit of the EuroVegMap units we got a list of typical/relevant species
- These can be linked to the PROPS list

In VSD+Studio it is implemented as follows:



Species options



Summary

PROPS

- response functions (pH, N, T, prec.) for 2300 species
- a-priori selection of species based on vegetation type

- relatively few species for Scandinavia, Iberic peninsula, south-east of Europe

MetHyd, GrowUp and VSD+PROPS single site versions available from the CCE website:

www.wge-cce.org/Methods_Data/The_VSD_suite_of_models

Also available there: ***Instruction videos***

Questions concerning models: luc.bonten@wur.nl

Thank You! ☺

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Comments? 😐
Questions? ☹