UNIVERSITY of ABERDEEN

Plant & Soil Science

Testing the soil C and N routines for use in JULES in the QUERCC project

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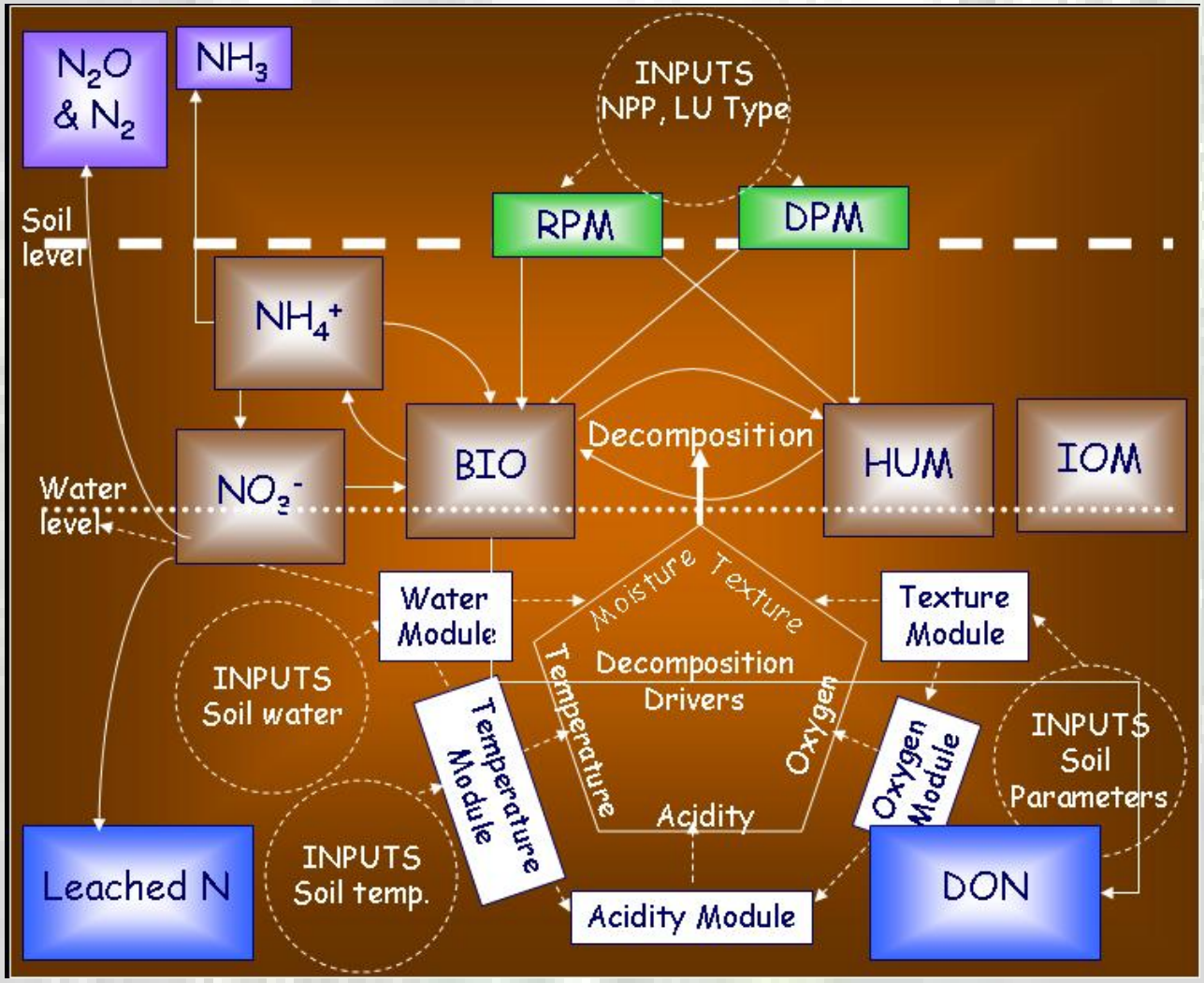
QUEST Quantifying and Understanding the Earth System

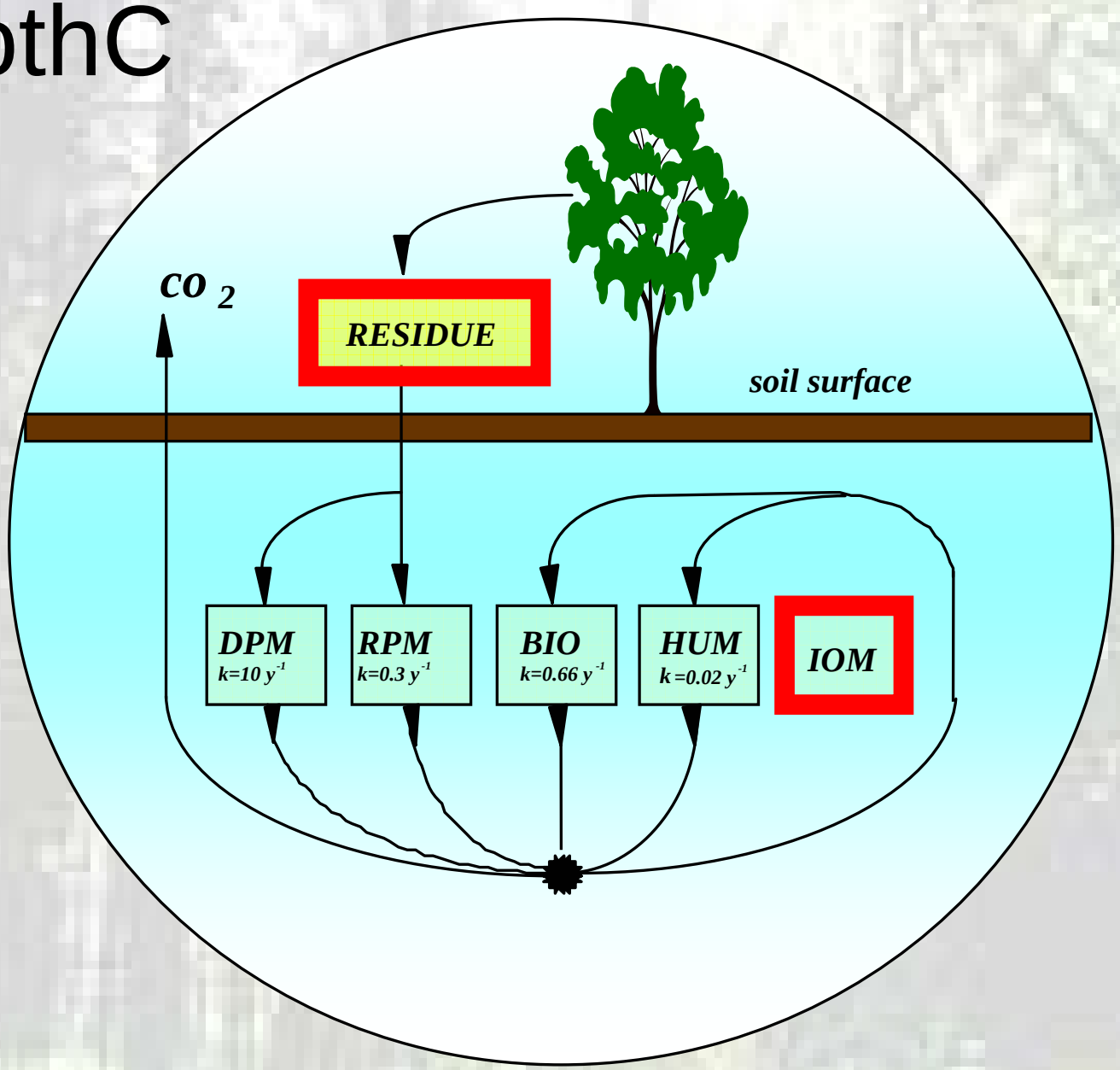
First JULES Science Meeting,
University of Exeter, 28-29th June 2007

Soil C & N routines (Sundial / ECOSSE)



N routines

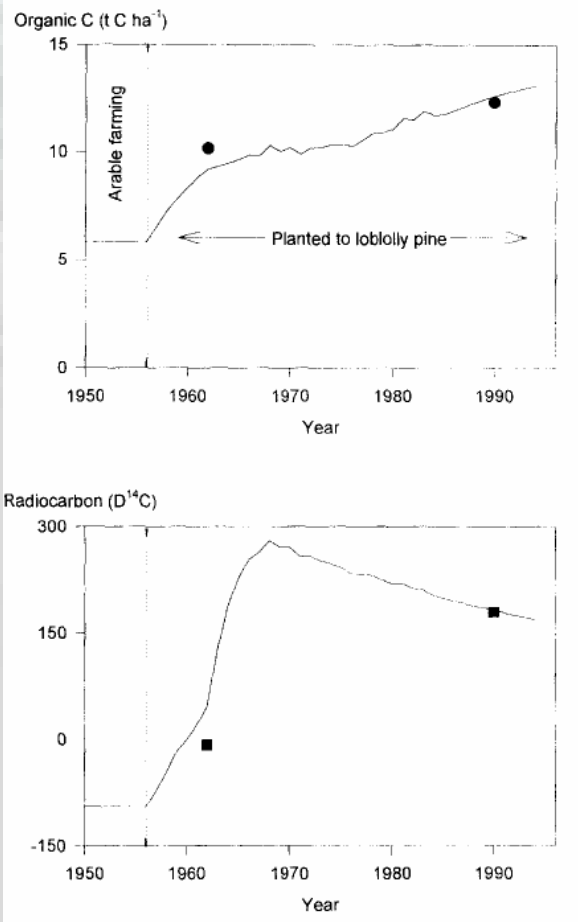
RothC


CO 2
RESIDUE
soil surface
DPM
k=10 y-1
RPM
k=0.3 y-1
BIO
k=0.66 y-1
HUM
k =0.02 y-1
IOM

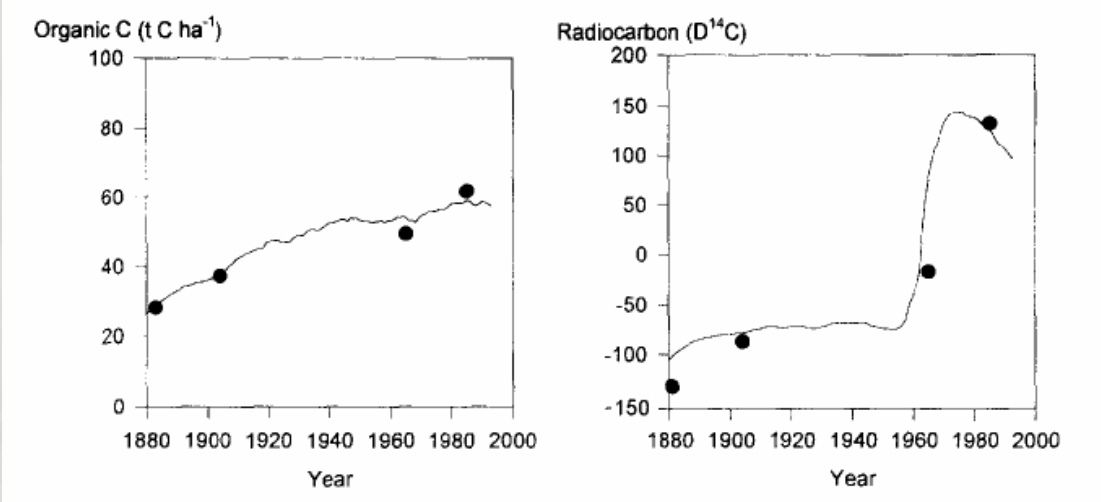
Testing the soil C routines

RothC – widely tested for SOC

Woodlands:



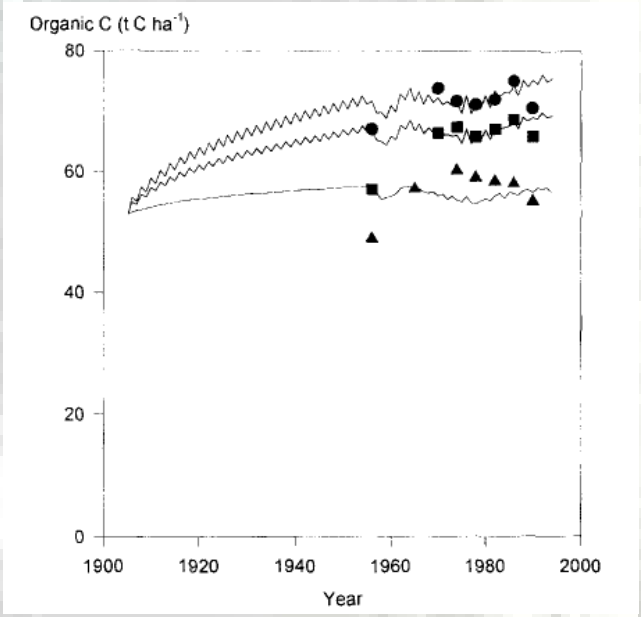
Calhoun Forest, NC, USA
(loblolly pine plantation)



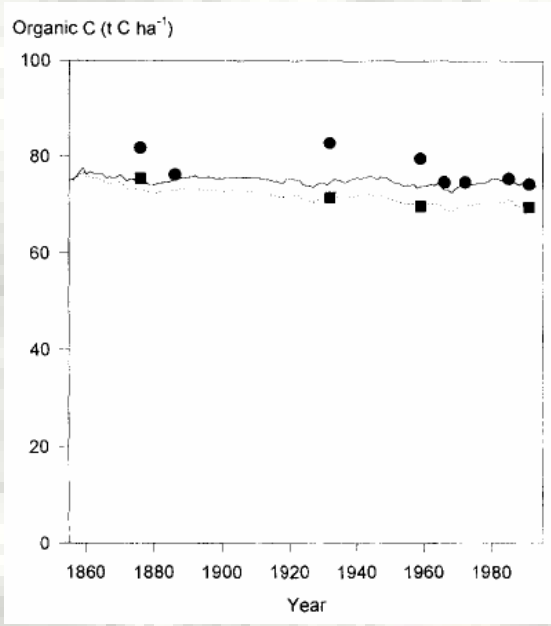
Geescroft Wilderness, UK
(natural regeneration from cropland)

RothC – widely tested for SOC

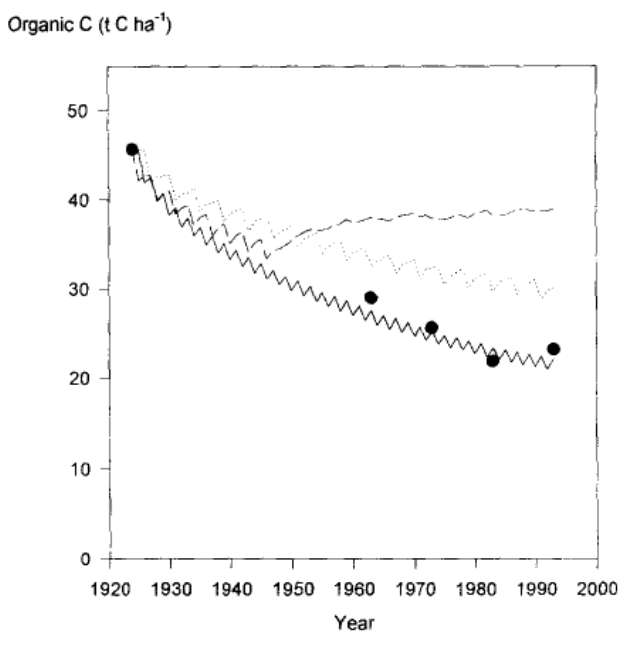
Croplands & Grasslands:



Bad Lauchstädt, Germany
(crop rotation)

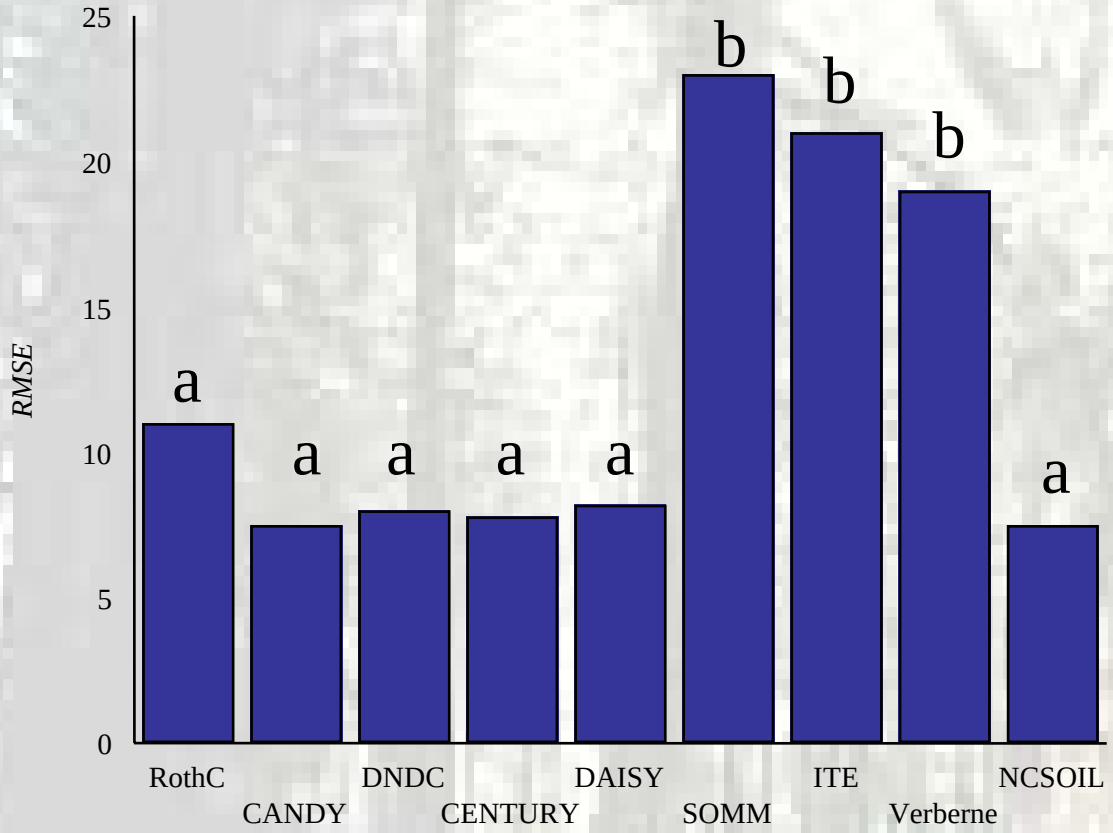


Park Grass, UK
(permanent grassland)



Waite, S Australia
(grass to crop rotation)

Comparison to other soil C models



Using the Root Mean Square Error (RMSE) to compare performance, the models fell into two groups with "group a" models having significantly ($p<0.05$) lower errors than "group b" models.

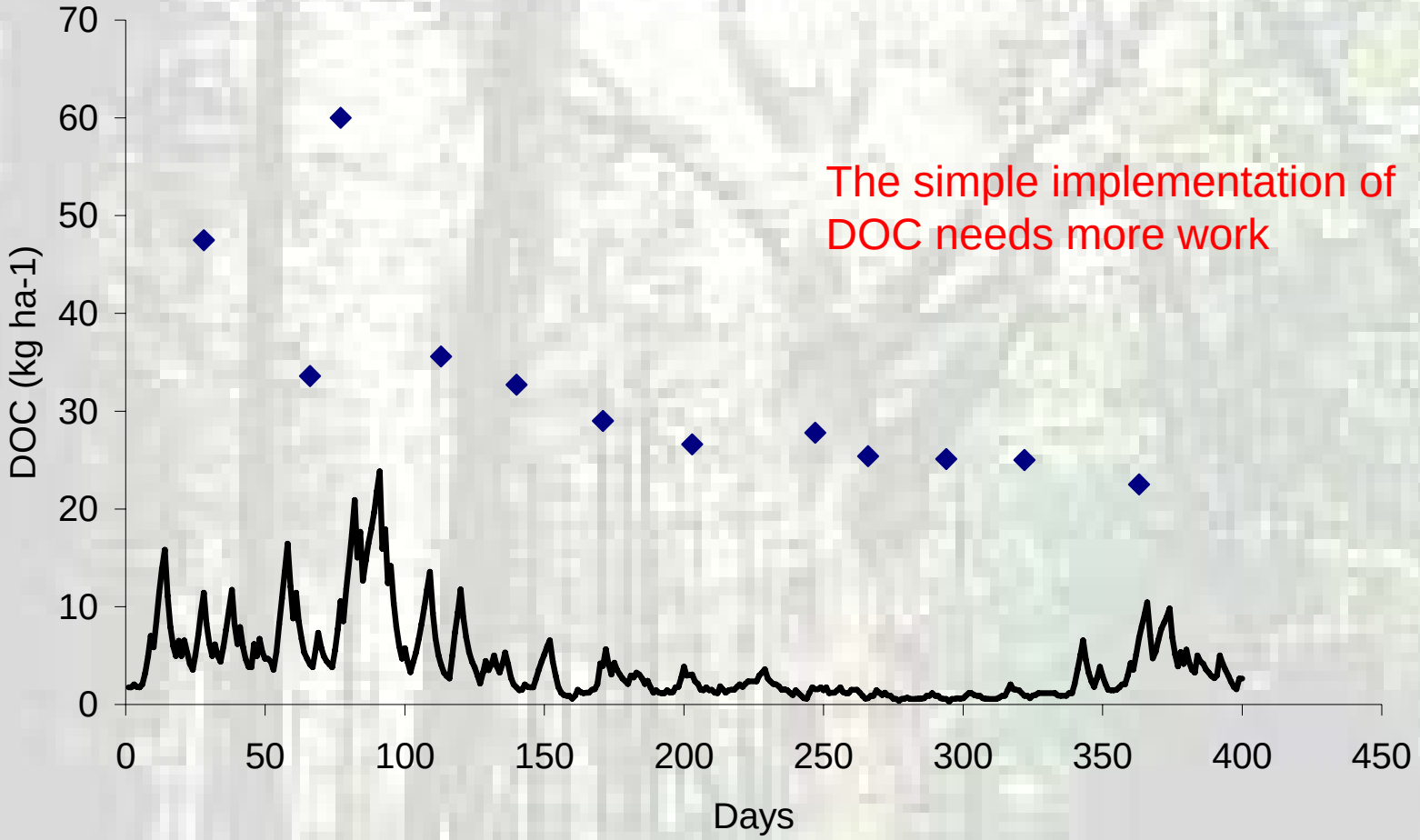
Still to do on soil C…

- Test in a wider range of climatic zones / biomes (ongoing within QUERCC)
- Test how coupled system responds within JULES (ongoing within Hadley Centre Project / QUERCC)
- Improve DOC routines – see next slides

DOC

- Field measurements available only for organic soils
- Sixteen plots, identical starting conditions for model
- DOC routines need more work

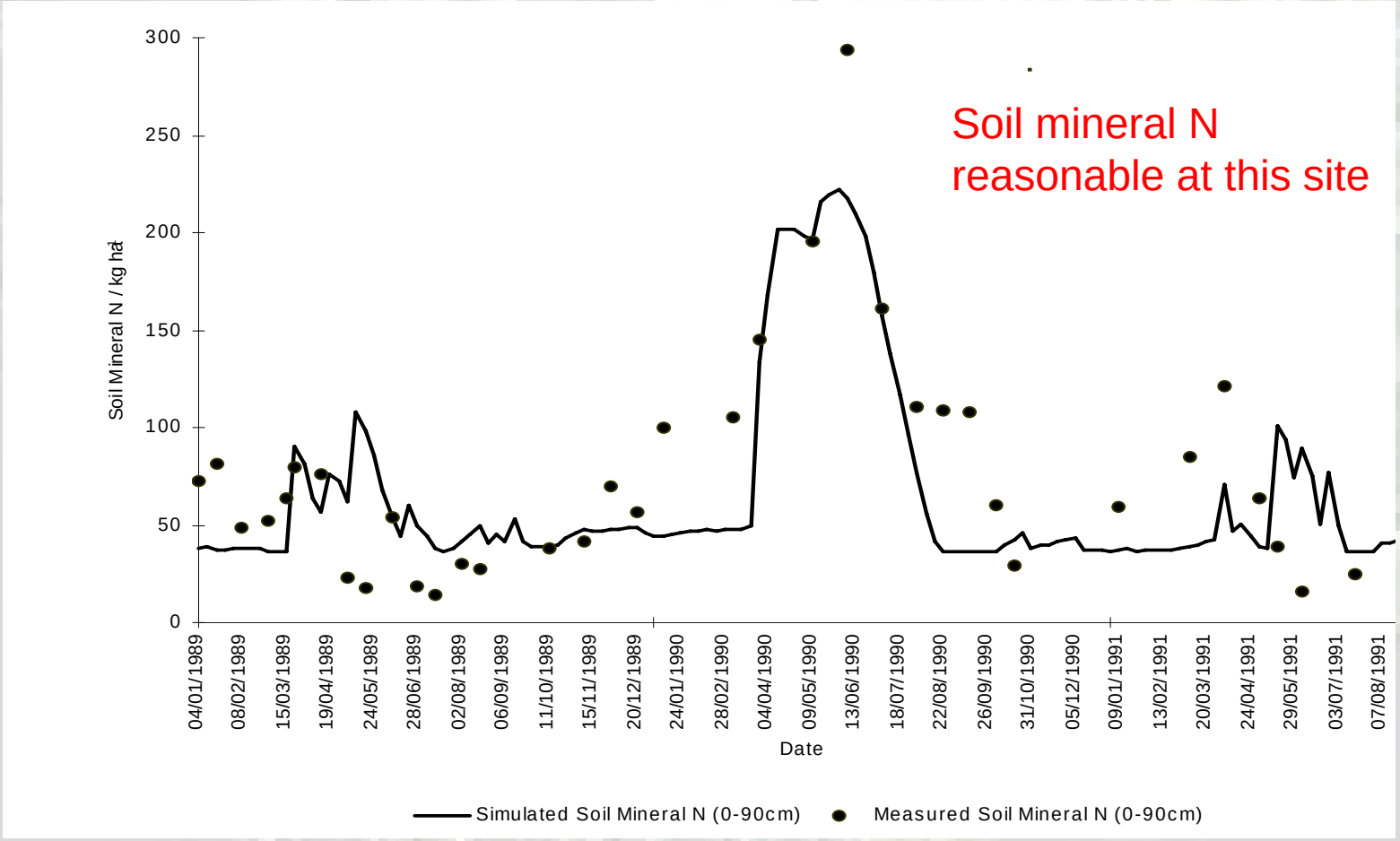
New version of the model – DOC



Ostle & McNamara (unpublished data) Organic soil, Lancaster, UK, DOC

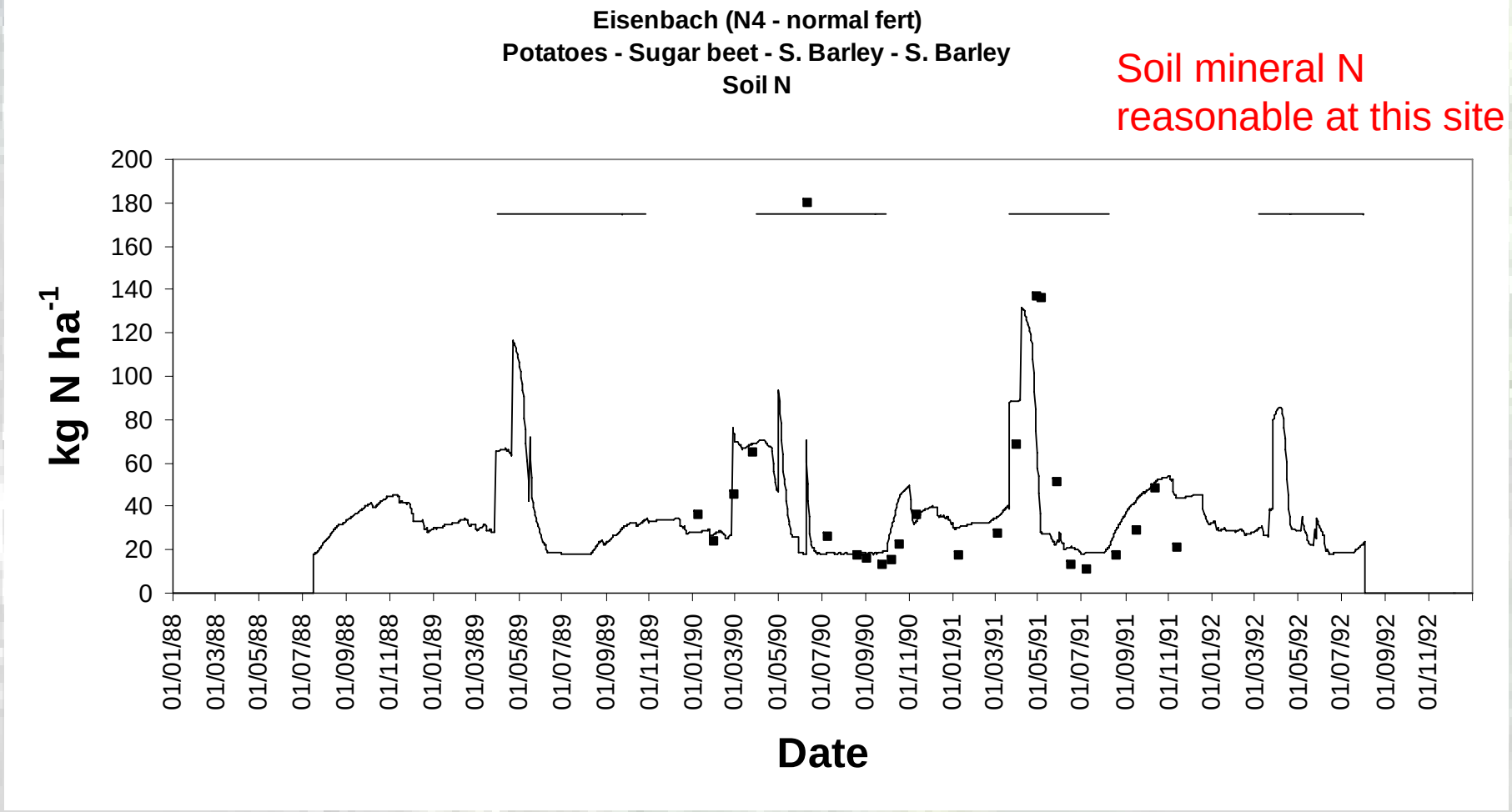
Testing the soil N routines

Previous testing of N routines



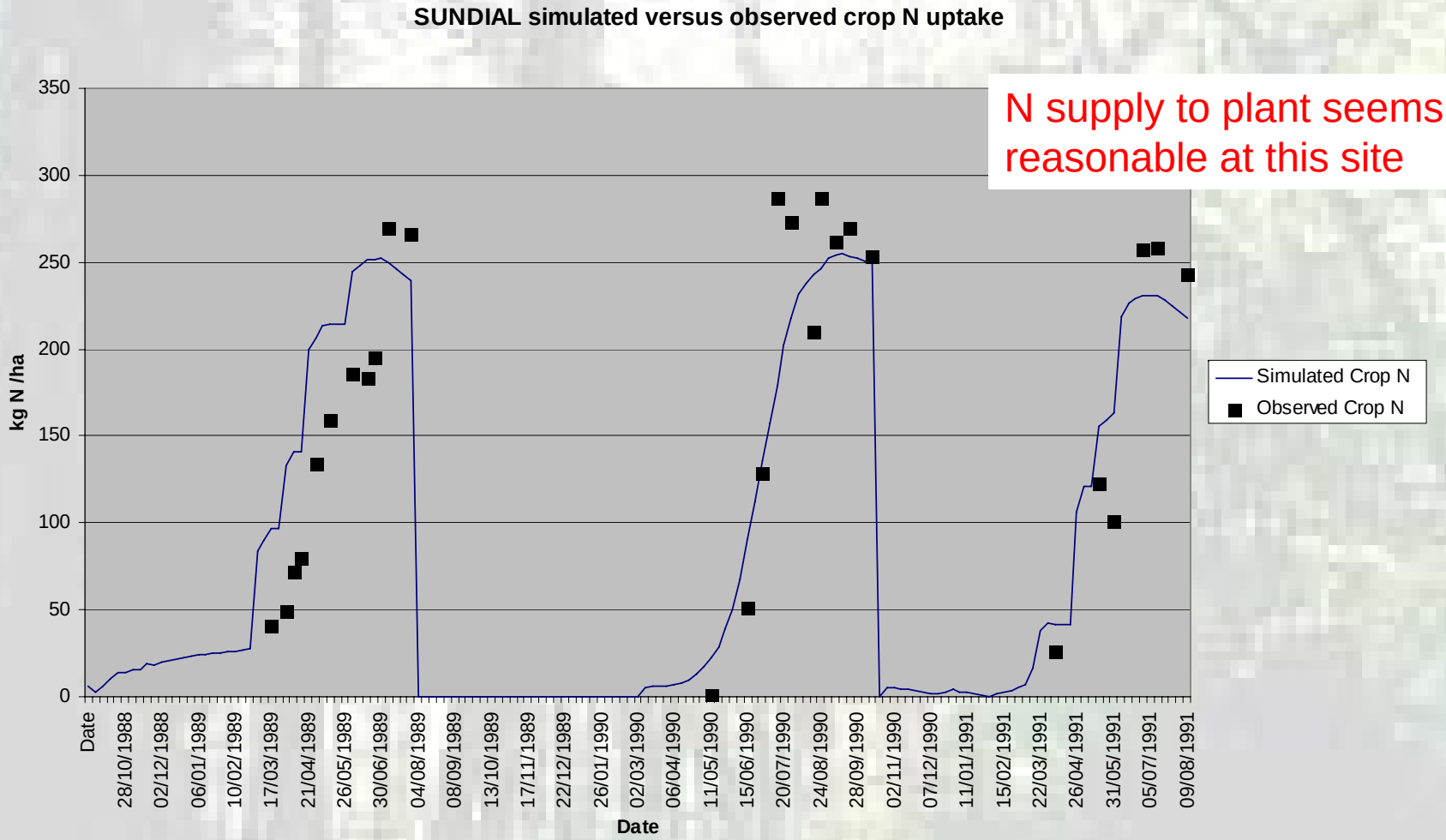
Krummbach, Germany, Normal fertilisation, Soil mineral N (0-50cm)

Previous testing of N routines



Eisenbach, Germany, Normal fertilisation, Soil mineral N (0-50cm)

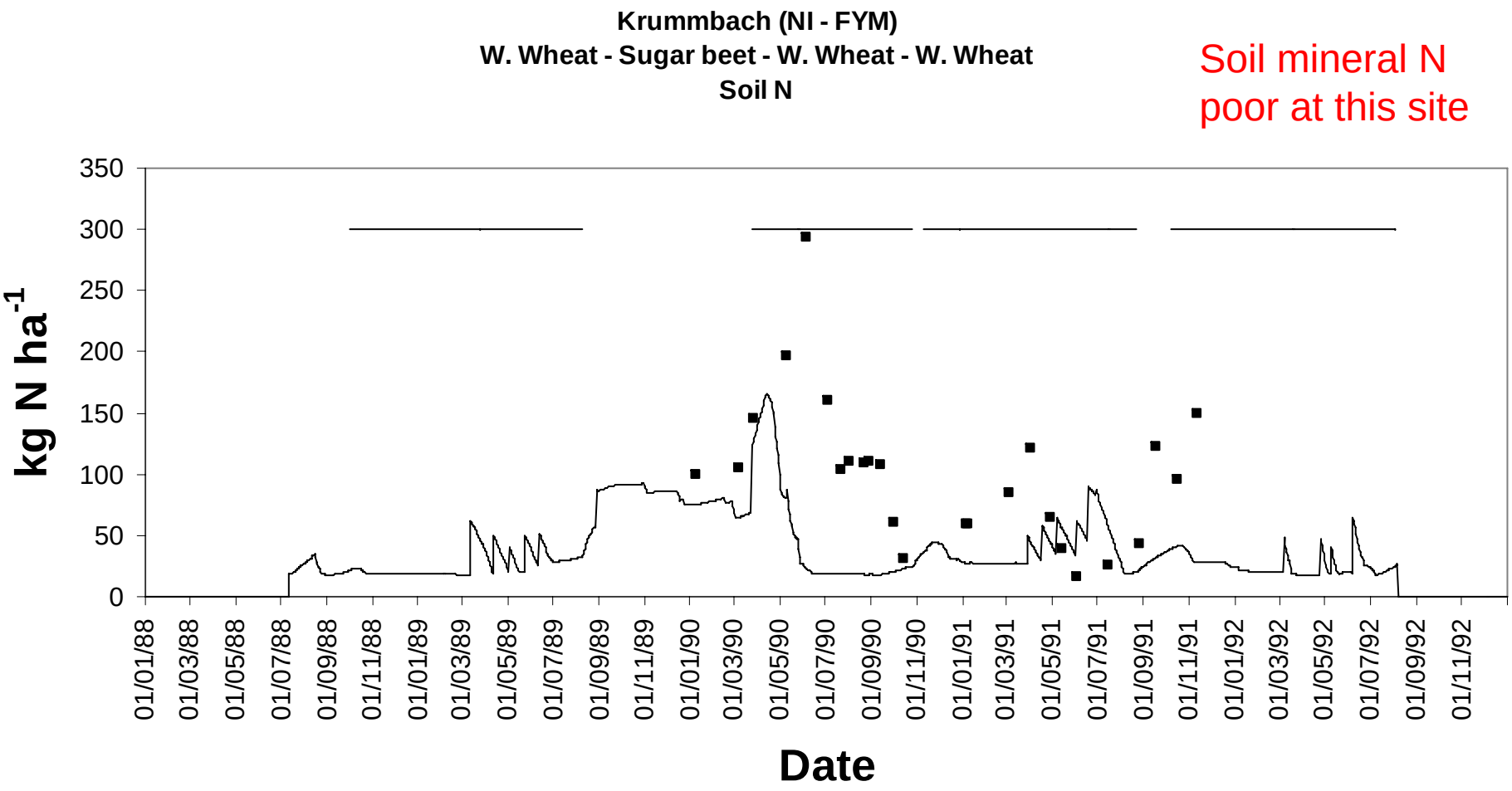
Previous testing of the model



N supply to plant seems reasonable at this site

Krummbach, Germany, High fertilisation, Crop N uptake

Previous testing of N routines

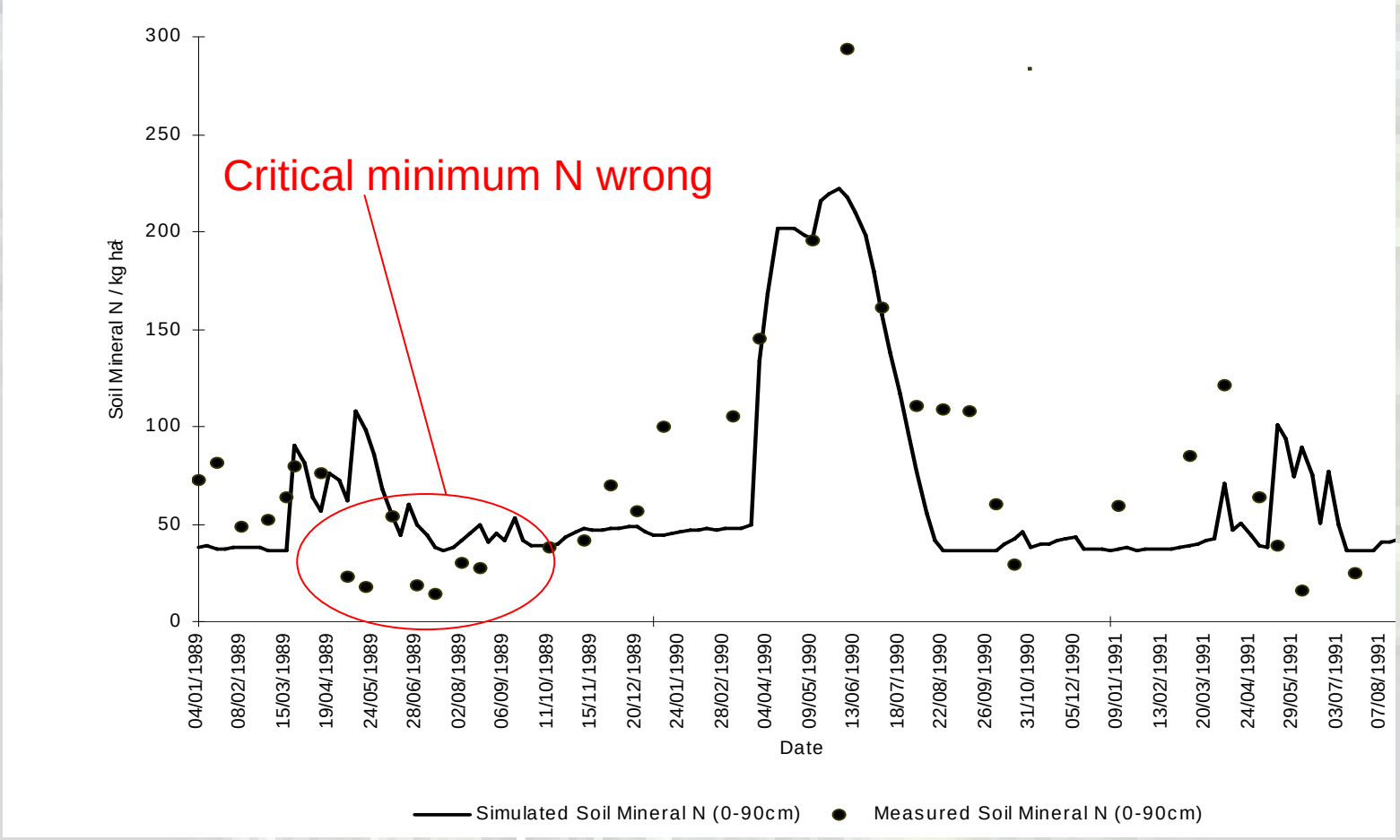


Krummbach, Germany, High fertilisation, Soil mineral N (0-50cm)

Recent model developments

- Initialisation using RothC
- Layering (5cm layers whole profile)
- Improved denitrification routines
- Incorporation of partial nitrification to produce N_2O and NO
- Simulation of saturated soils (above field capacity)
- Change to critical minimum N assumptions

Previous testing of N routines

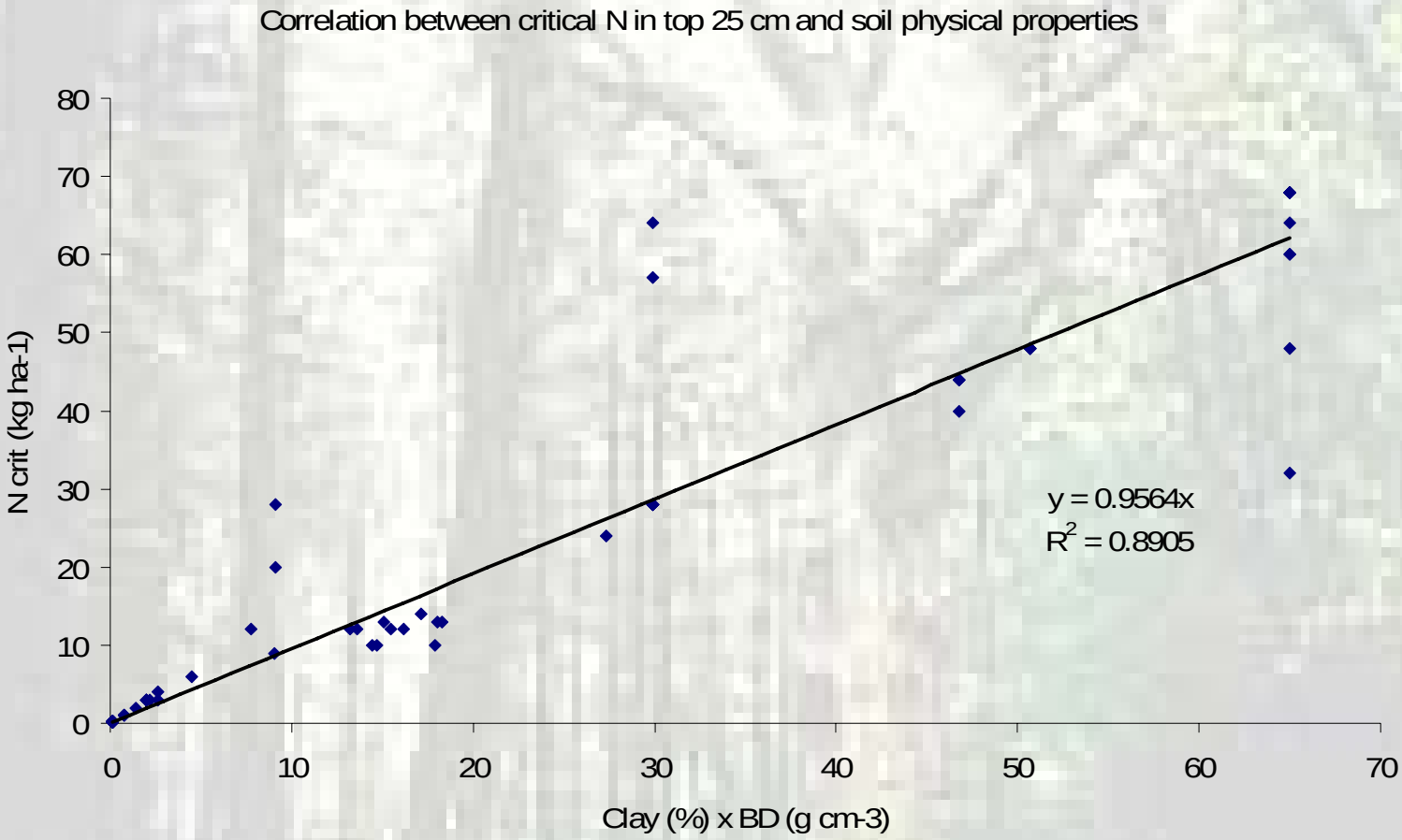


Krummbach, Germany, Normal fertilisation, Soil mineral N (0-50cm)

Critical mineral N

- Obvious disparity between modelled baseline mineral N and measurements
- Old model: Ncrit = 5+(0.15 x clay)
  - OK for silty loam, no good for heavy clay or organic soils
- Related to ‘surface area density’ of soil
- Close correlation with clay, bulk density
- Ncrit α (clay x BD)?

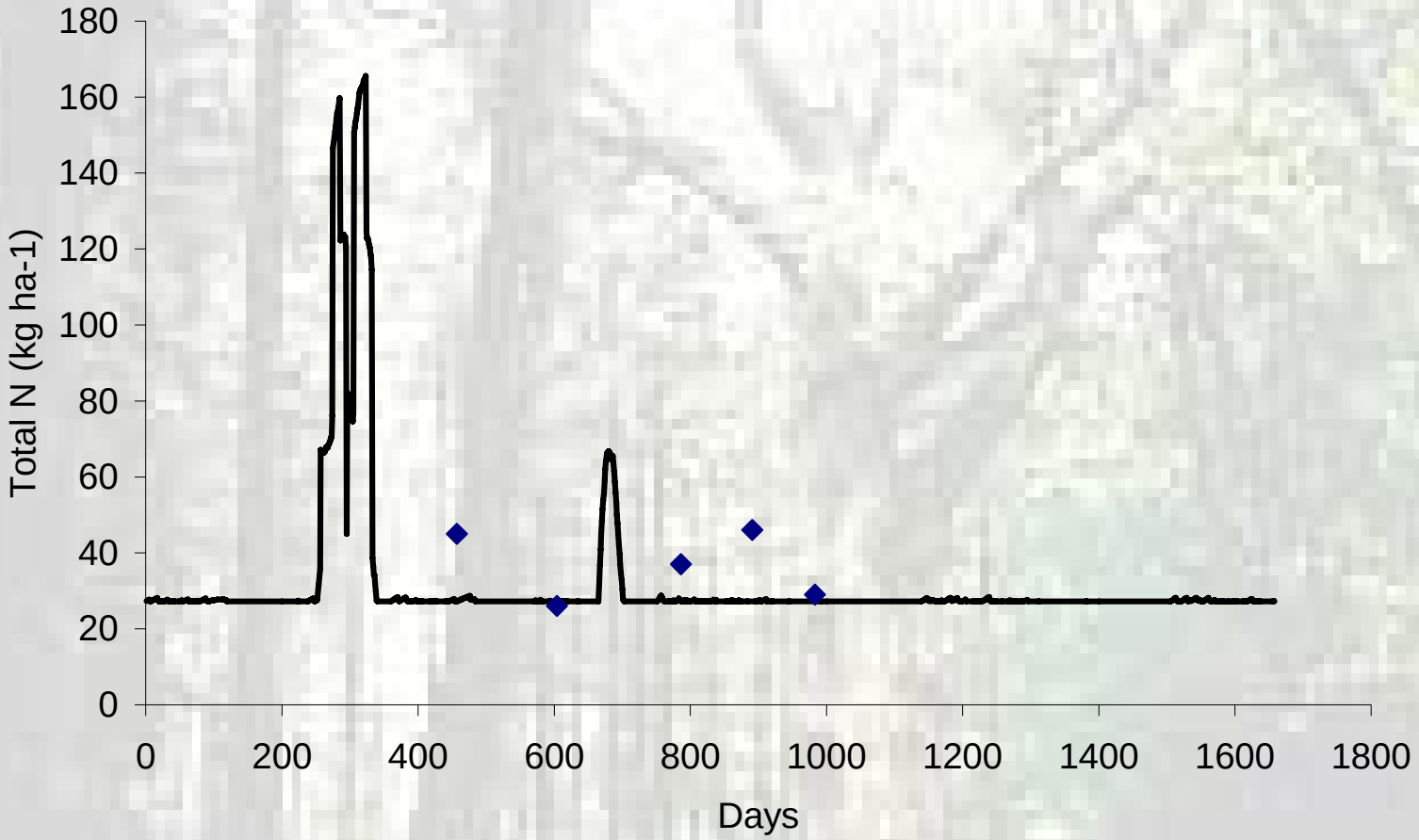
Critical mineral N



Critical mineral N

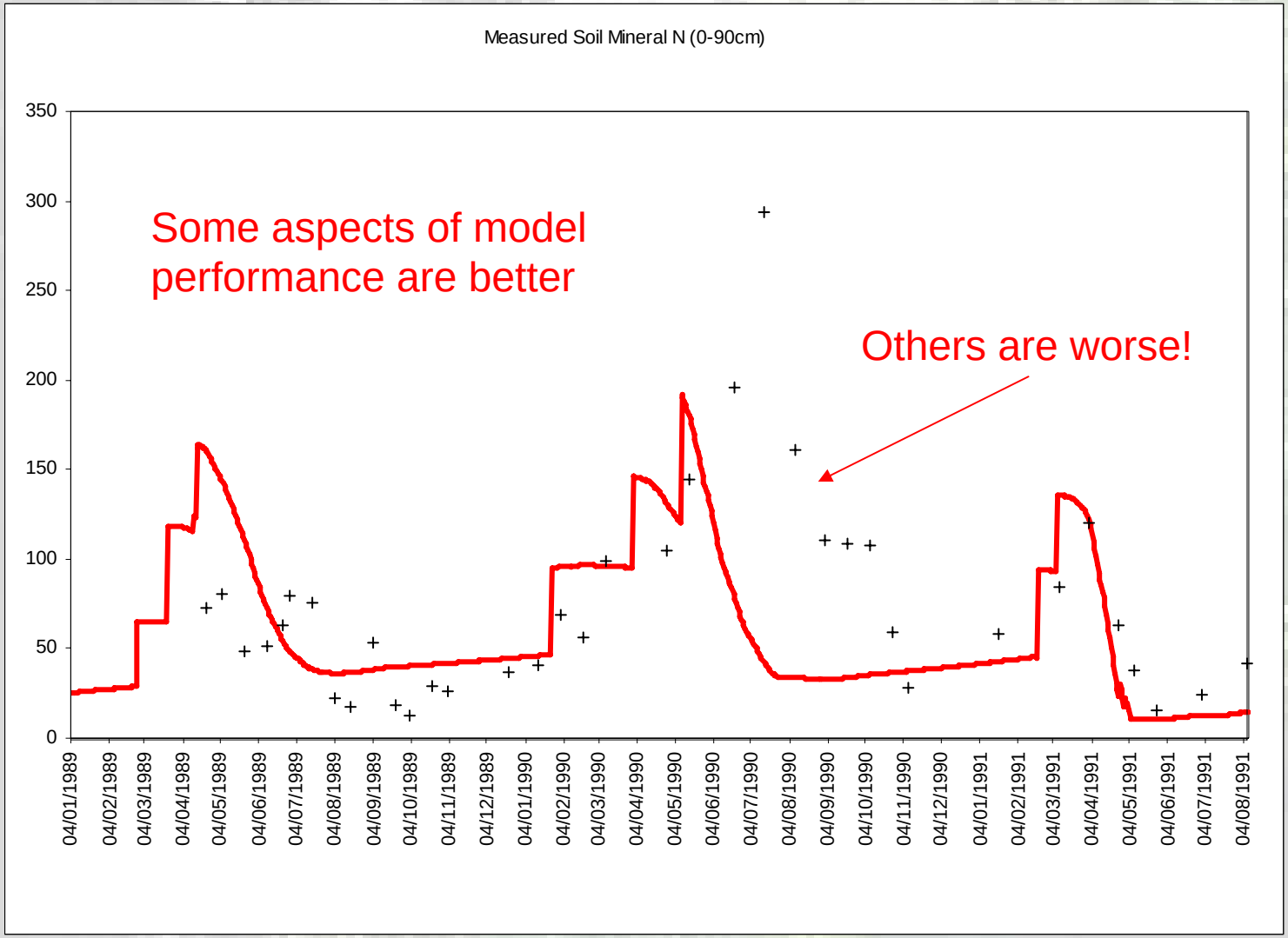
- Baseline values now work for
  - Heavy clay
  - Sandy loam
  - Silt Loam
  - Peaty loam
  - Organic soils
- $R^2 = 0.89$
  - $R^2 = 0.76$ for clay alone, 0.57 for BD

New version of the model – soil mineral N



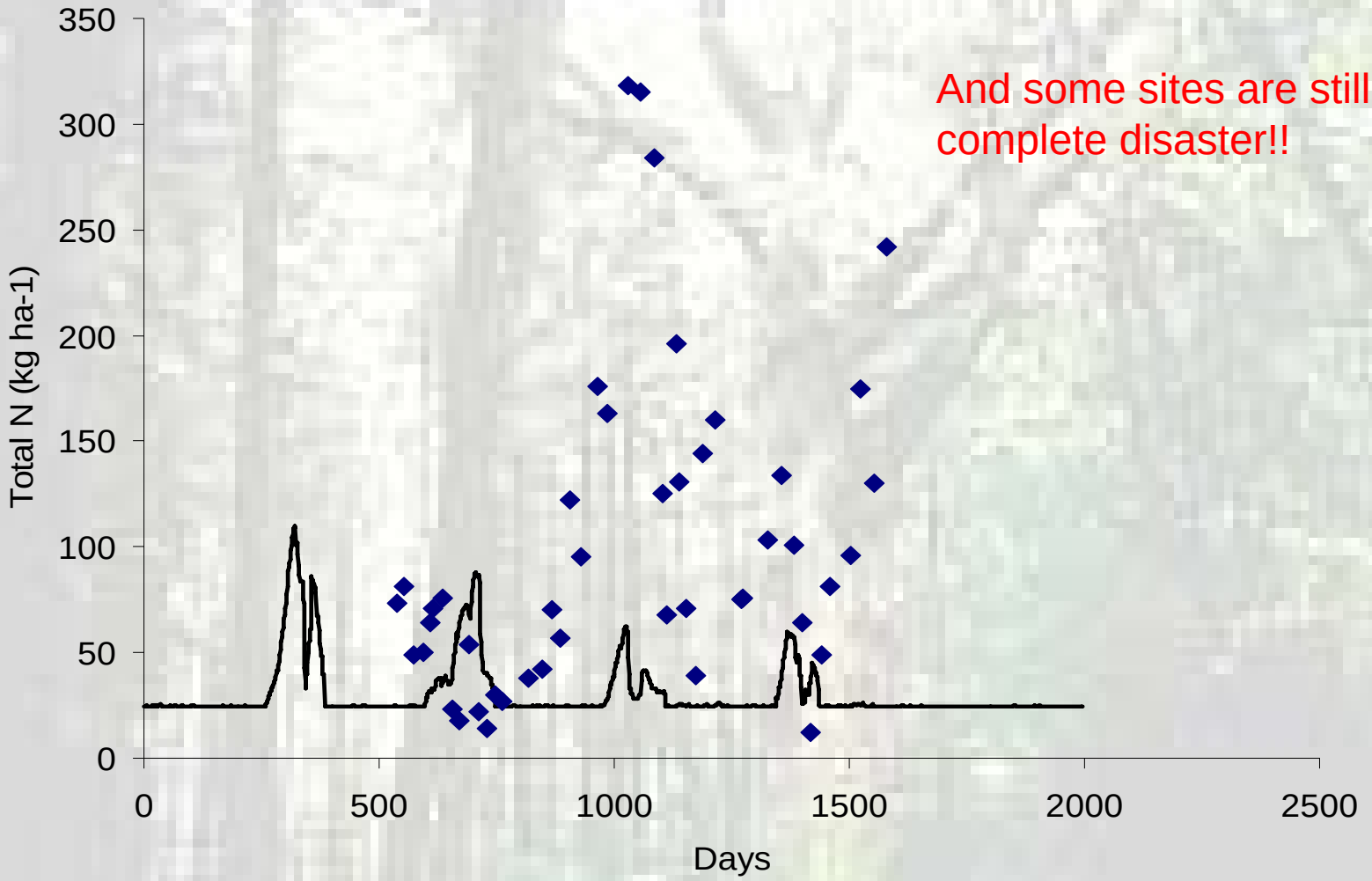
Macdonald *et al*. (1997) Butts, UK, Oil seed rape - wheat rotation, Soil mineral N (0-50cm)

New version of the model – soil mineral N



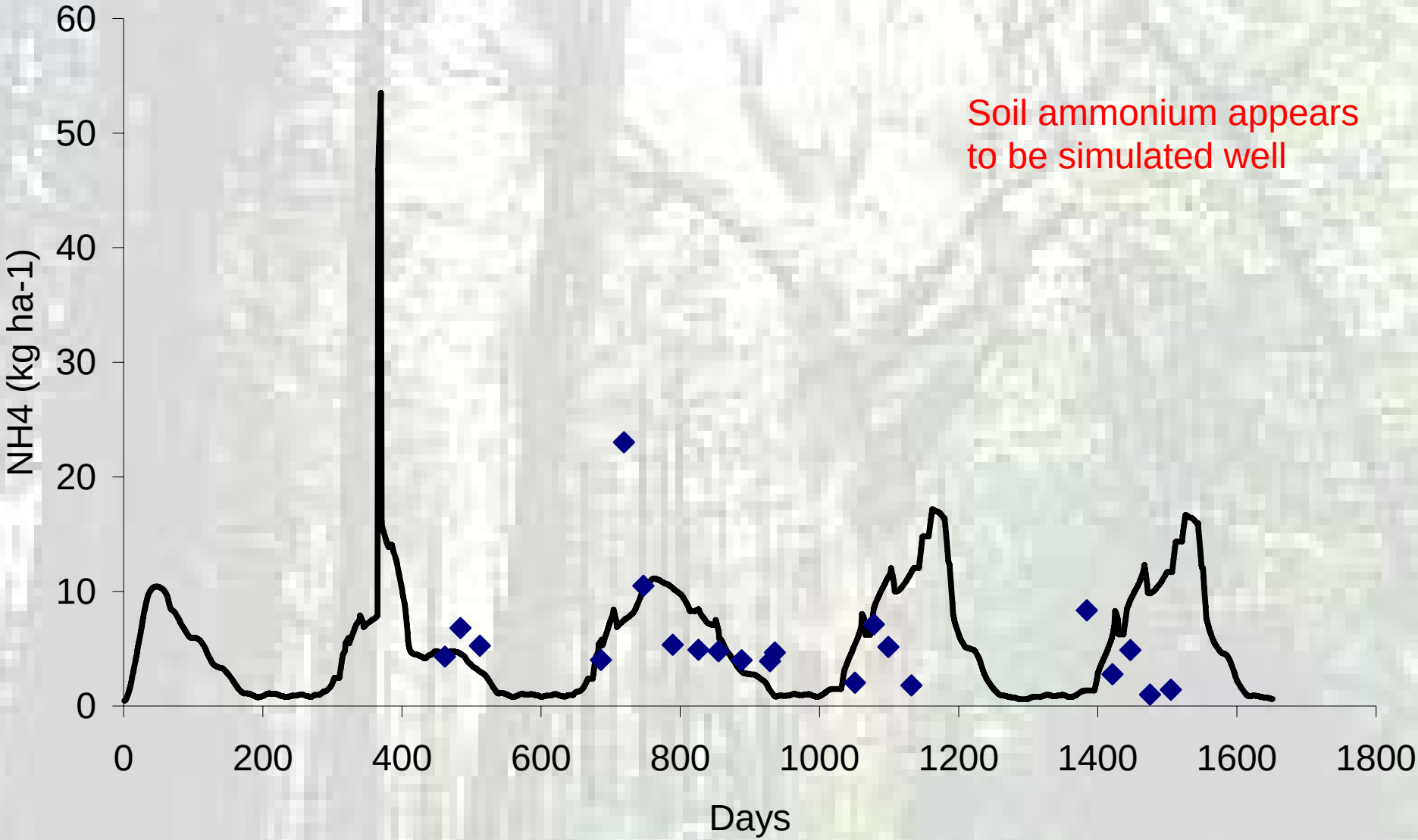
McVoy *et al*. (1995) Krummbach, Germany, Normal fertilisation, Soil mineral N (0-50cm)

New version of the model – soil mineral N



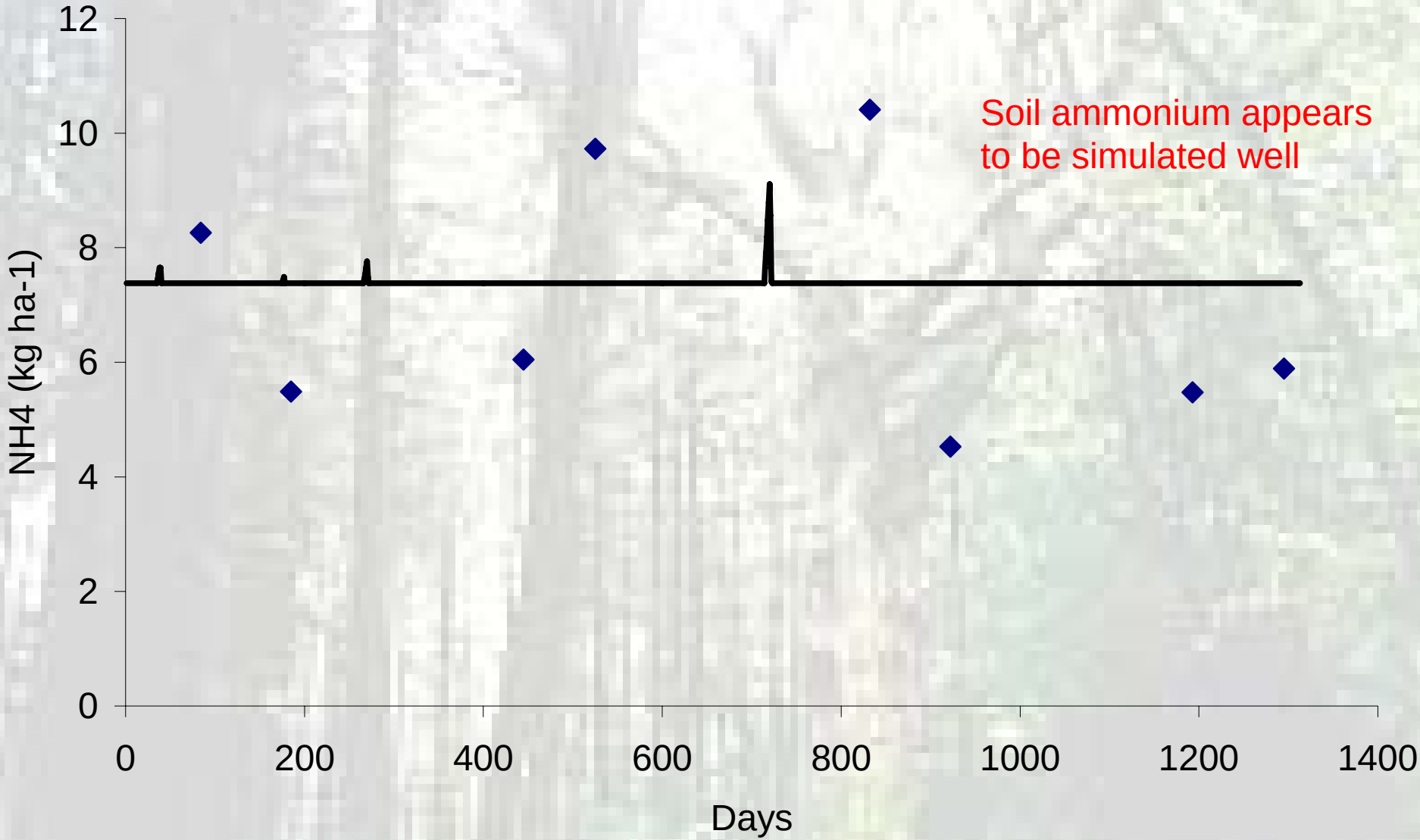
McVoy *et al*. (1995) Krummbach, Germany, High fertilisation, Soil mineral N (0-50cm)

New version of the model – soil ammonium



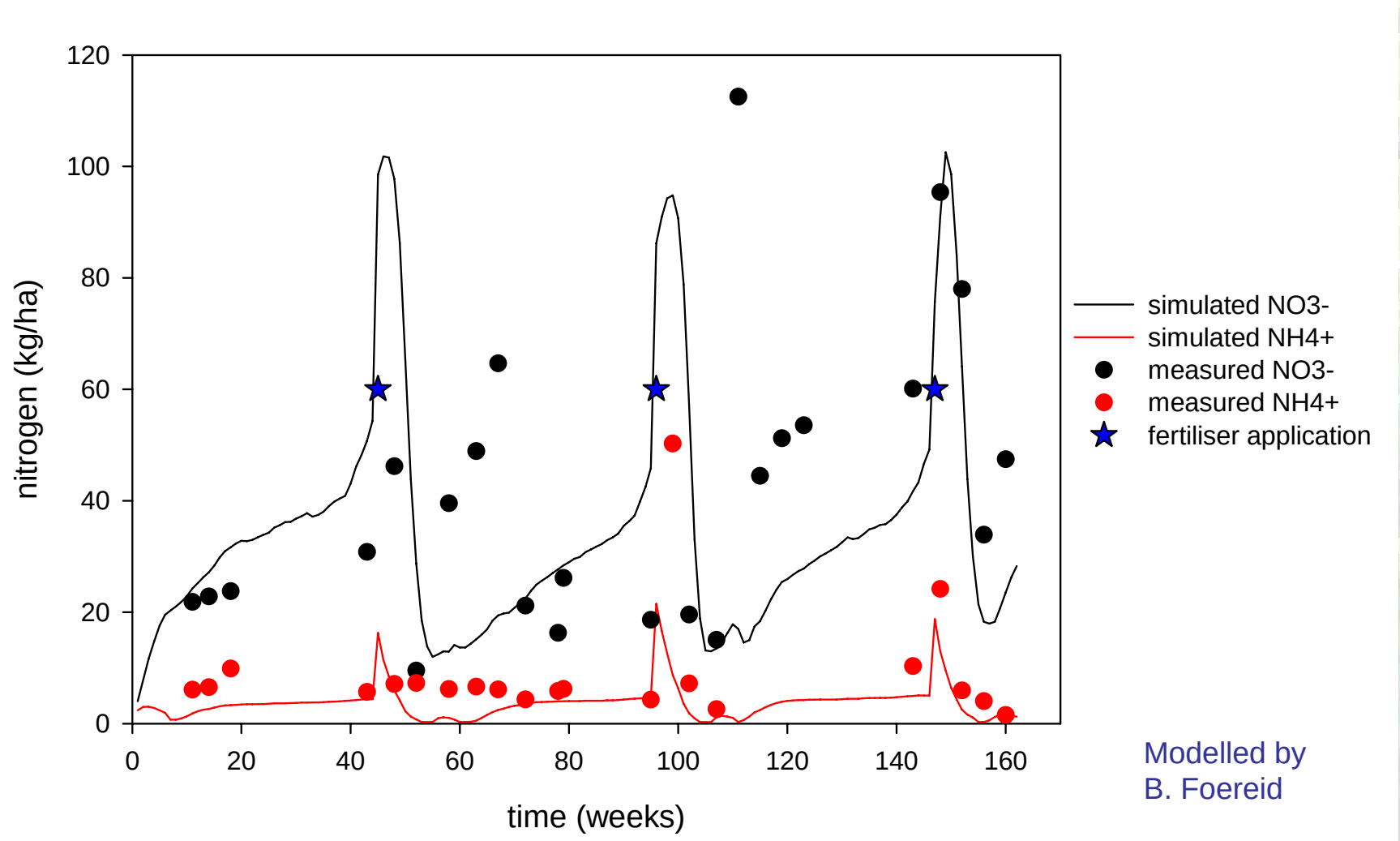
Regina *et al*. (2004) Cultivated organic soil (potatoes), S. Finland, Soil NH4 (0-50cm)

New version of the model – soil ammonium



Ute Skiba, unpublished data. Tulloch - organic soil - Scotland Soil NH_4

New version of the model – soil nitrate



Regina *et al*. (2004) Cultivated organic soil (S. barley), S. Finland, Soil nitrate (0-50cm)

N_2O & CH_4

- Soil C and N routines are getting there
- CH_4 and N_2O emissions need further parameterisation – this is ongoing work in CarboEurope, ECOSSE and NitroEurope

Ongoing work

- N_2O
- CH_4
- Characterisation of other vegetation types
- Data acquisition (Great Plains)
- Test for other biomes and climate zones
- Refine and improve the model for different soil types and conditions

An example – improved N_2O routines

In Sundial / ECOSSE, emissions of N are simulated due to denitrification and partial nitrification, the emissions are then partitioned into emissions of N_2 and N_2O.

Sundial / ECOSSE will be modified by cloning some of the subroutines from DayCent model to simulate NO emissions. Influce of Snow melting on NO emissions will be added.

Sundial / ECOSSE will be calibrated in some of the core sites of NitroEurope IP using Bayesian Calibration method to reduce the parameter uncertainty.

Sundial / ECOSSE will be calibrated, evaluated and reformulated for simulation of NO and N_2O emission estimates from site scale to regions scale in ongoing Nitroeurope IP project.

Work by Jagadeesh Yeluripati