Carbon storage in old-growth forests

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Issues

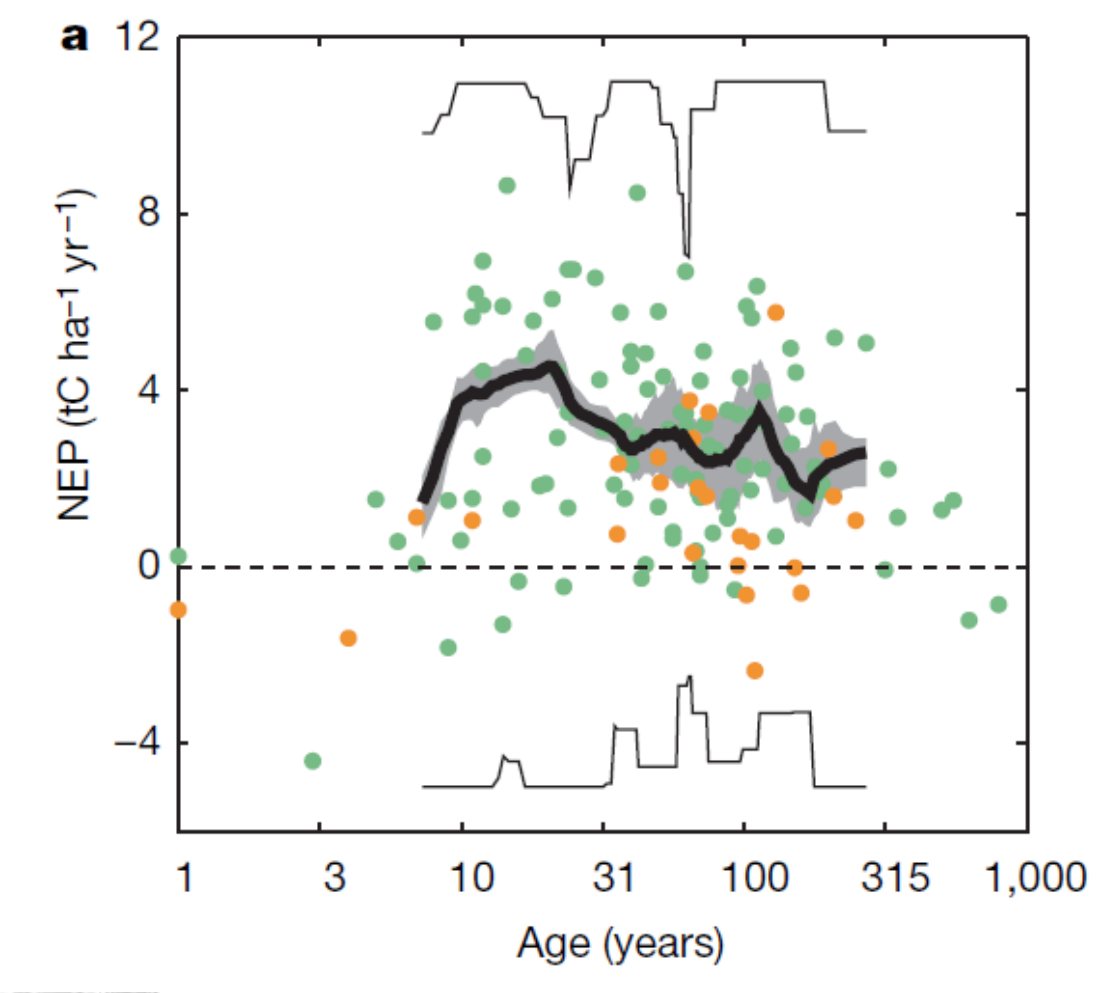
1. Research in the Hainich NP and Iphofen
2. My ideas of burning issues in Soil Science
3. Teaching and Research Initiatives

Introduction

C sink of forest soils

OSU, 2014

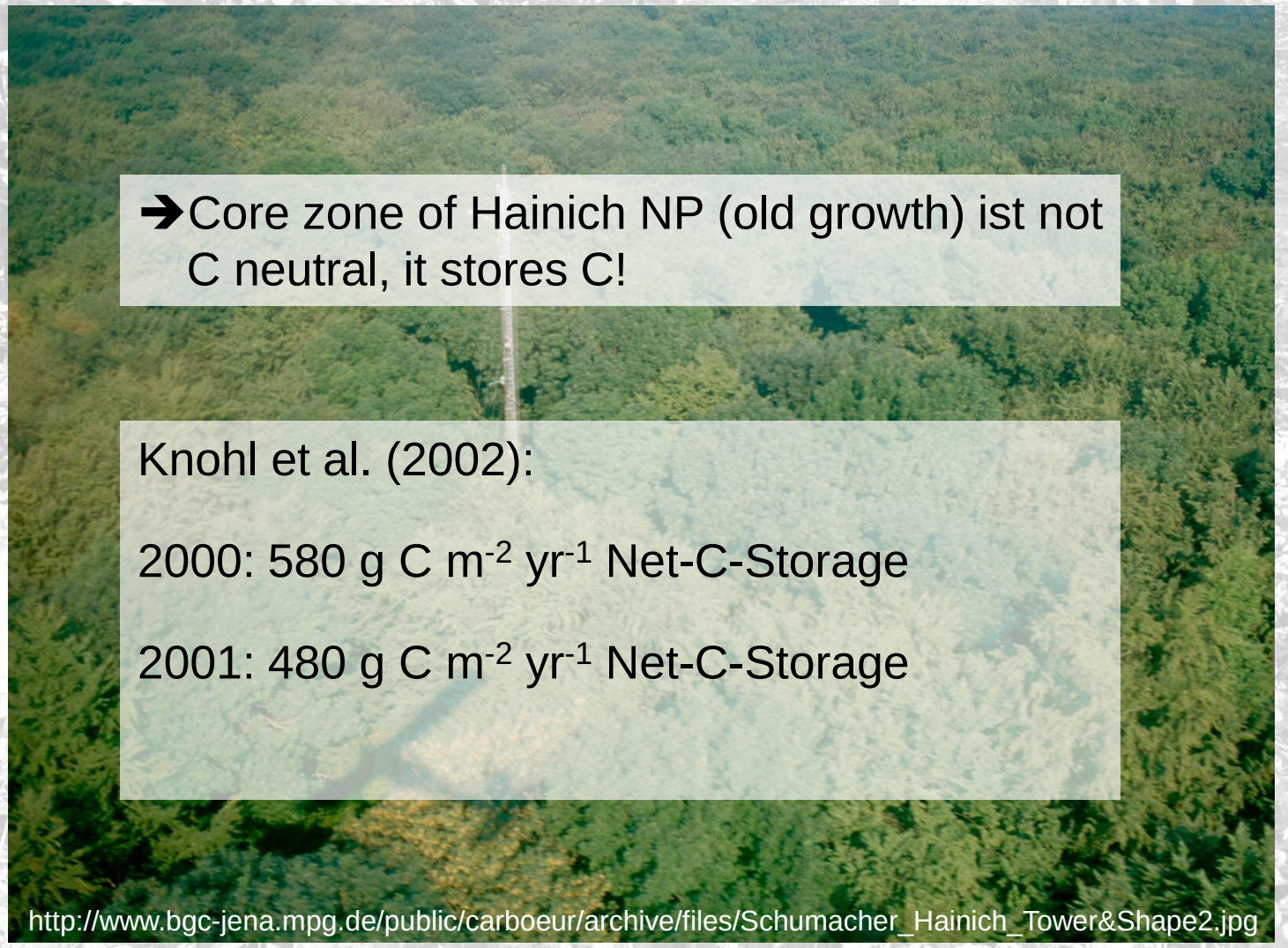
Net ecosystem production and forest age



Luyssaert et al., 2008

Motivation

Result EC tower MPI for Biogeochemistry Jena



➔Core zone of Hainich NP (old growth) ist not C neutral, it stores C!

Knohl et al. (2002):

2000: 580 g C m^{-2} yr^{-1} Net-C-Storage

2001: 480 g C m^{-2} yr^{-1} Net-C-Storage

http://www.bgc-jena.mpg.de/public/carboeur/archive/files/Schumacher_Hainich_Tower&Shape2.jpg

Motivation

Litter use and standards-with coppice

Thuringia Basin=

Forest use documents since 14. Century

Strong population growth led to exploitation of forests

Motivation

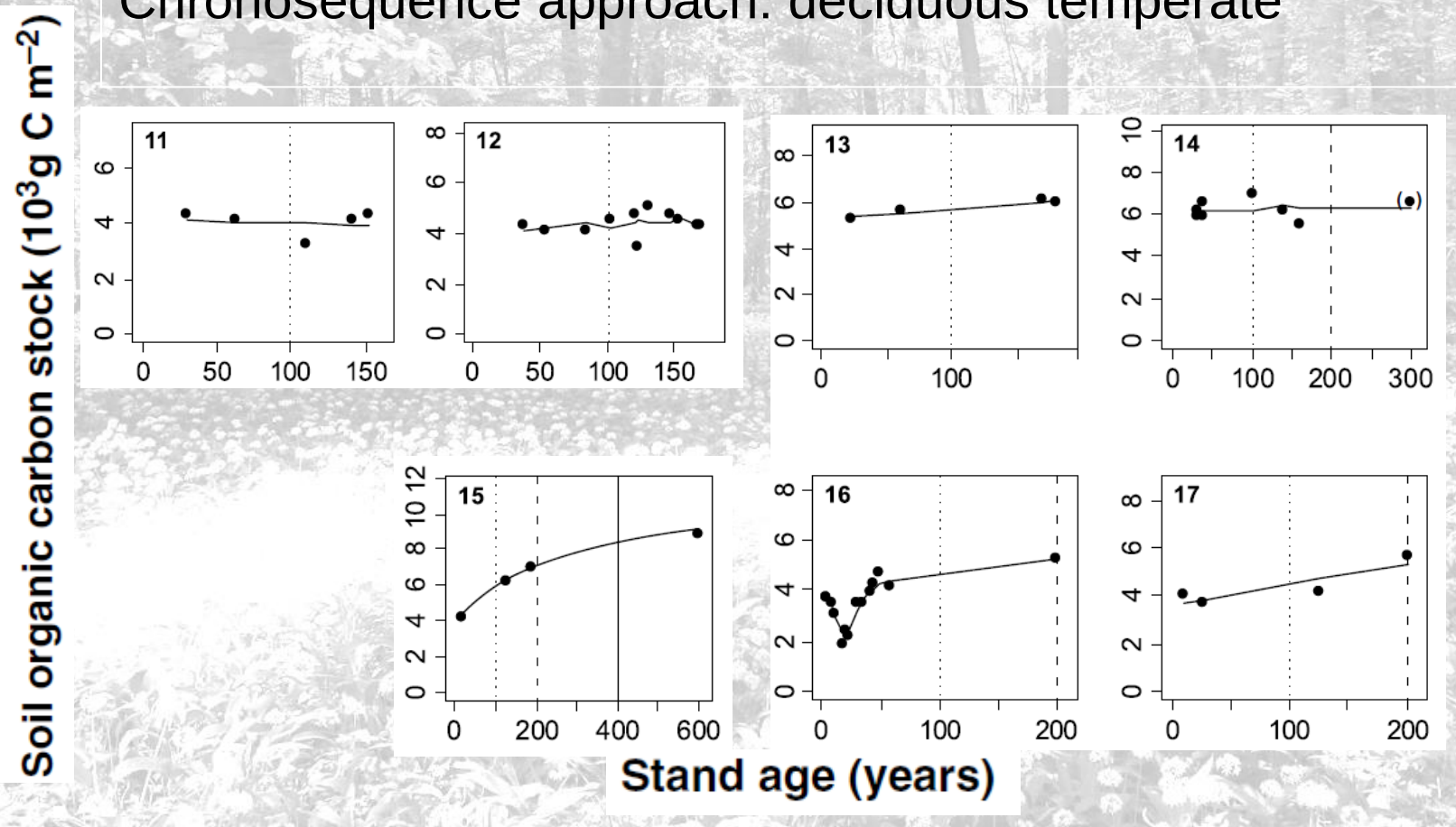
Luyssaert et al., 2008:

“Old-growth forests accumulate carbon for centuries and contain large quantities of it. We expect, however, that much of this carbon, even soil carbon, will move back to the atmosphere if these forests are disturbed.”

- Conceptional models of soil C storage in forests appreciate the role of the successional stage, but no data on this issue has been presented

Motivation

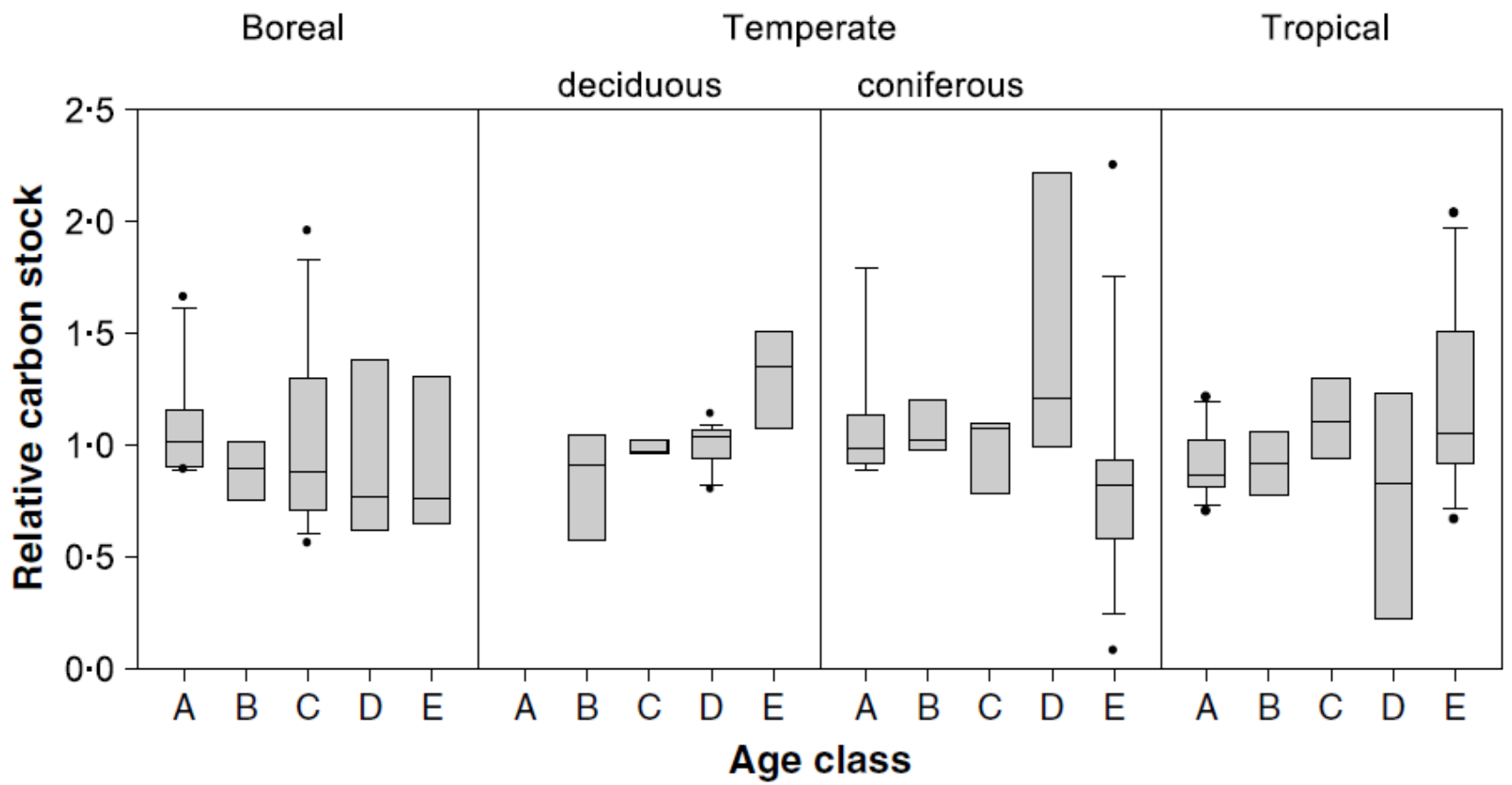
Chronosequence approach: deciduous temperate



Gleixner et al., 2009

Motivation

Age-class approach



Gleixner et al., 2009

Motivation

Chronosequences suggest low C- storage rates

Repeated inventories result in much higher (>50 g m^{-2} yr^{-1}) C-storage rates

Examinations of soil C-storage in old forests are missing

Motivation

Hypotheses:

1. The high net C sink in the core zone of the Hainich NP is a consequence of historic impoverishment of soils

   This leads to the following hypotheses

2. The proportion of humus respiration on ecosystem C uptake is low.

3. Carbon sequestration takes place by continuous growth of the soil profile.

Sites

Hainich NP

Geology:

-Loess on limestone

Soil type:

-(Chromic) Cambisols

Vegetation:

-Beech (180 yrs age)

Land use history:

-Litter use

-1960-1990 GDR Military training area

-1997 National park core zone

Hainich NP

No C export

Hainich NP

Rapid mineralization

Ecosystem dynamics

Forest structure: old-growth forest, near-natural, all age classes

Extreme mull; rapide Mineralization

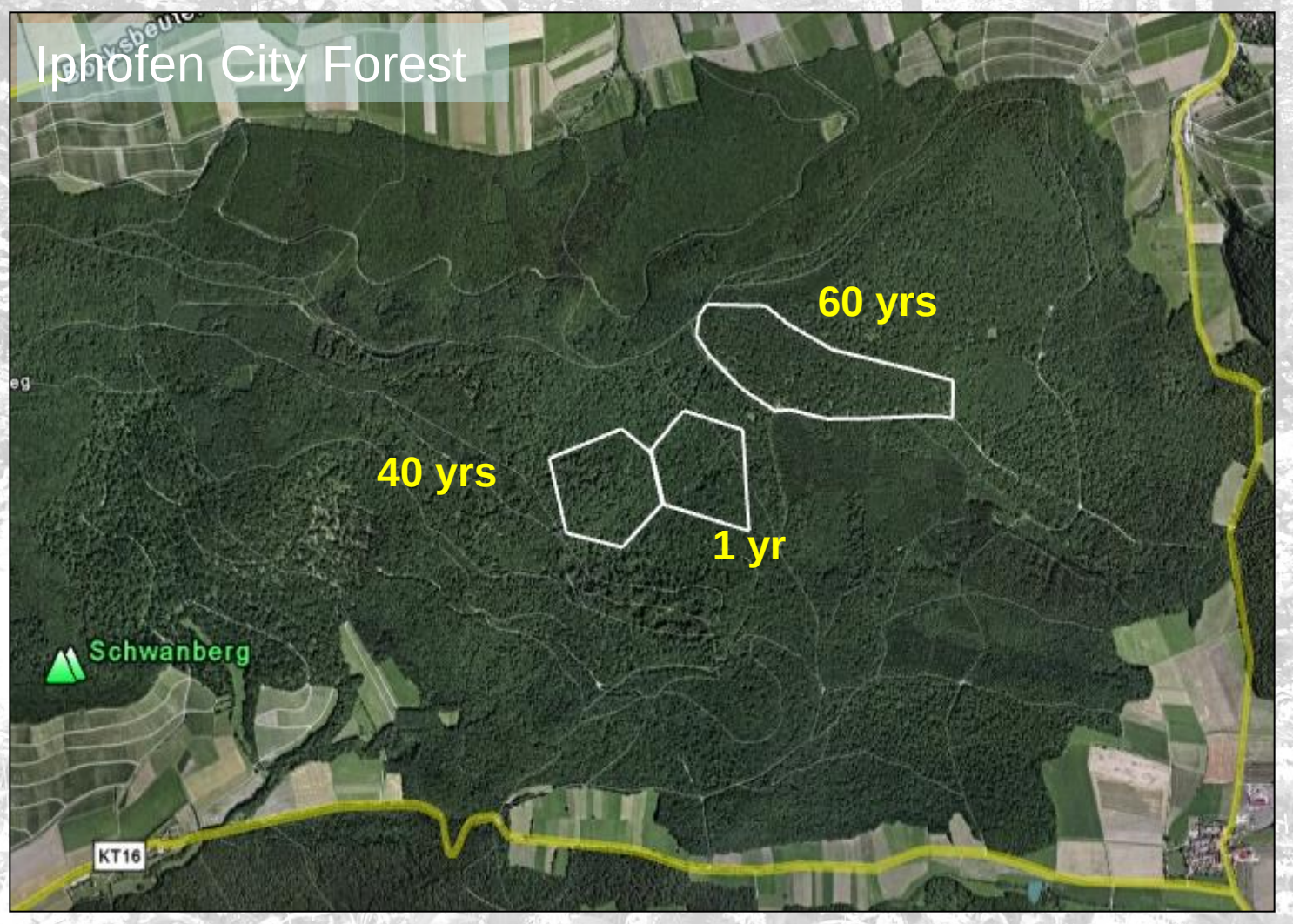
➔ Close to „climax“, matter cycling in equilibrium

Iphofen City Forest

Iphofen City Forest

Iphofen City Forest: 40- year rotation (Mittelwald) since 1418

Iphofen City Forest



Iphofen City Forest

Oak-Hornbeam-Forest

Triassic sand stone

Mesotrophic Cambisols

Loamy Sand

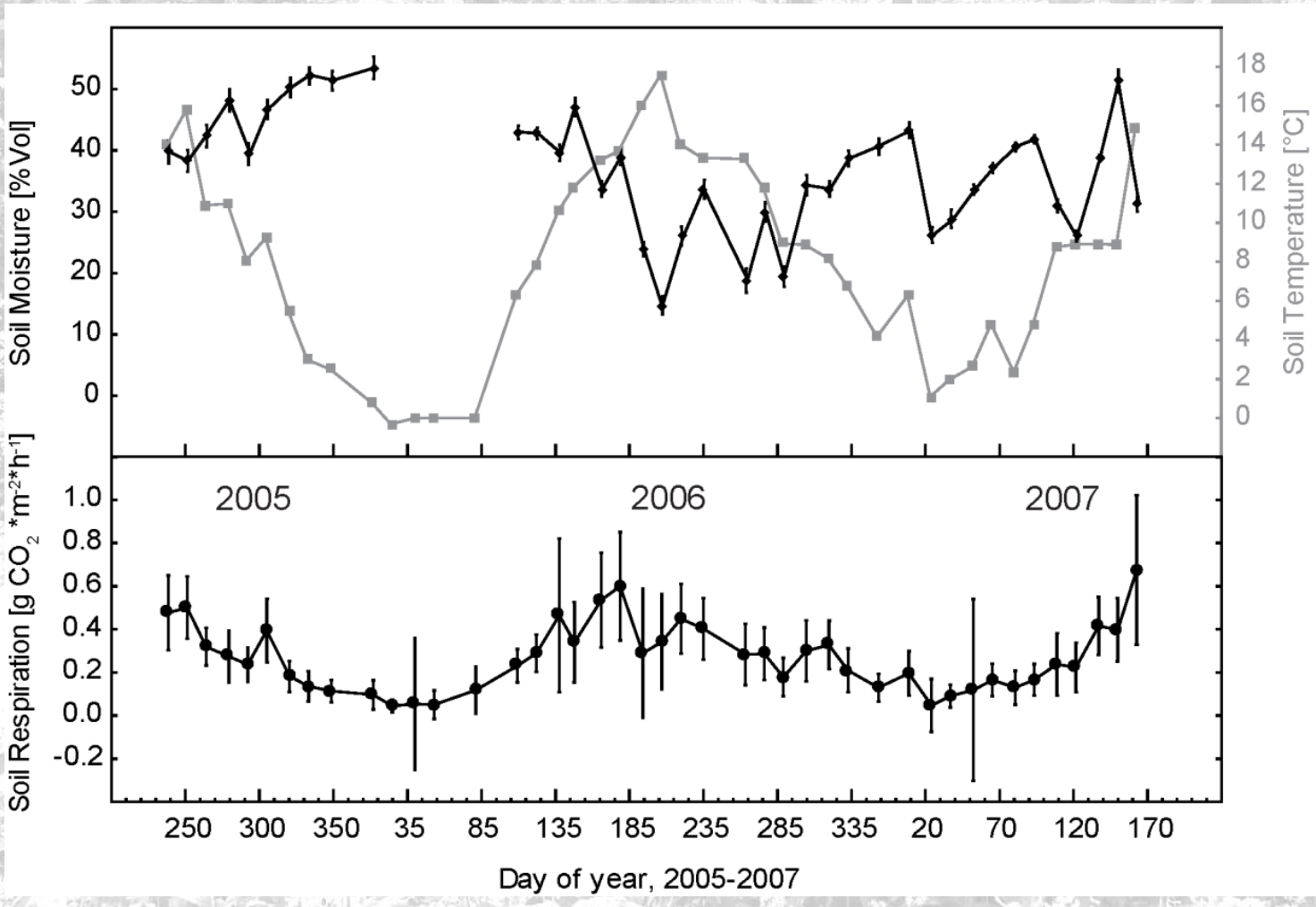
Historic C-Export Hainich

Table 11.3 Carbon export from the Weberstedter Holz study site in the Hainich National Park (NP), Germany, during the time period 1830–2007

Time period	Management	C-export (g C m^{-2} $year^{-1}$)	Total C-export (g C m^{-2})
1830–1920	Coppice-with-standards forest	125 ± 31	10,400
1830–1920	Litter use	29	2,610
1920–1939	Selection forest	68	1,365
1940–1949	Selection forest	120	1,200
1950–1959	Selection forest	254	2,540
1960–1989	Selection forest – extensive management	65	1,950
1990–2007	No management	–	–
1830–2007		110	20,065

Gleixner et al., 2009

Soil C Efflux Hainich



Gleixner et al., 2009

Mapping all trees Hainich

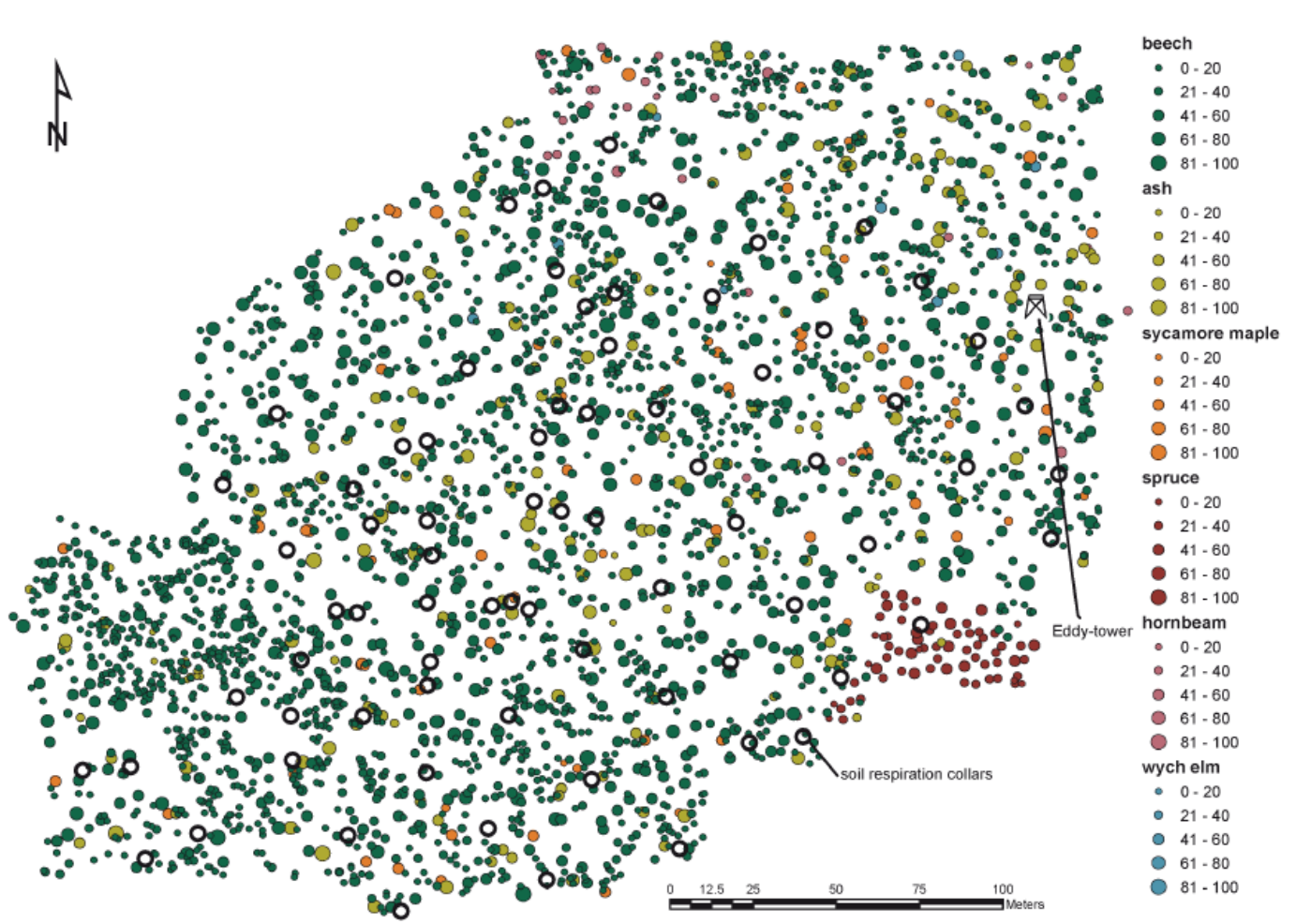
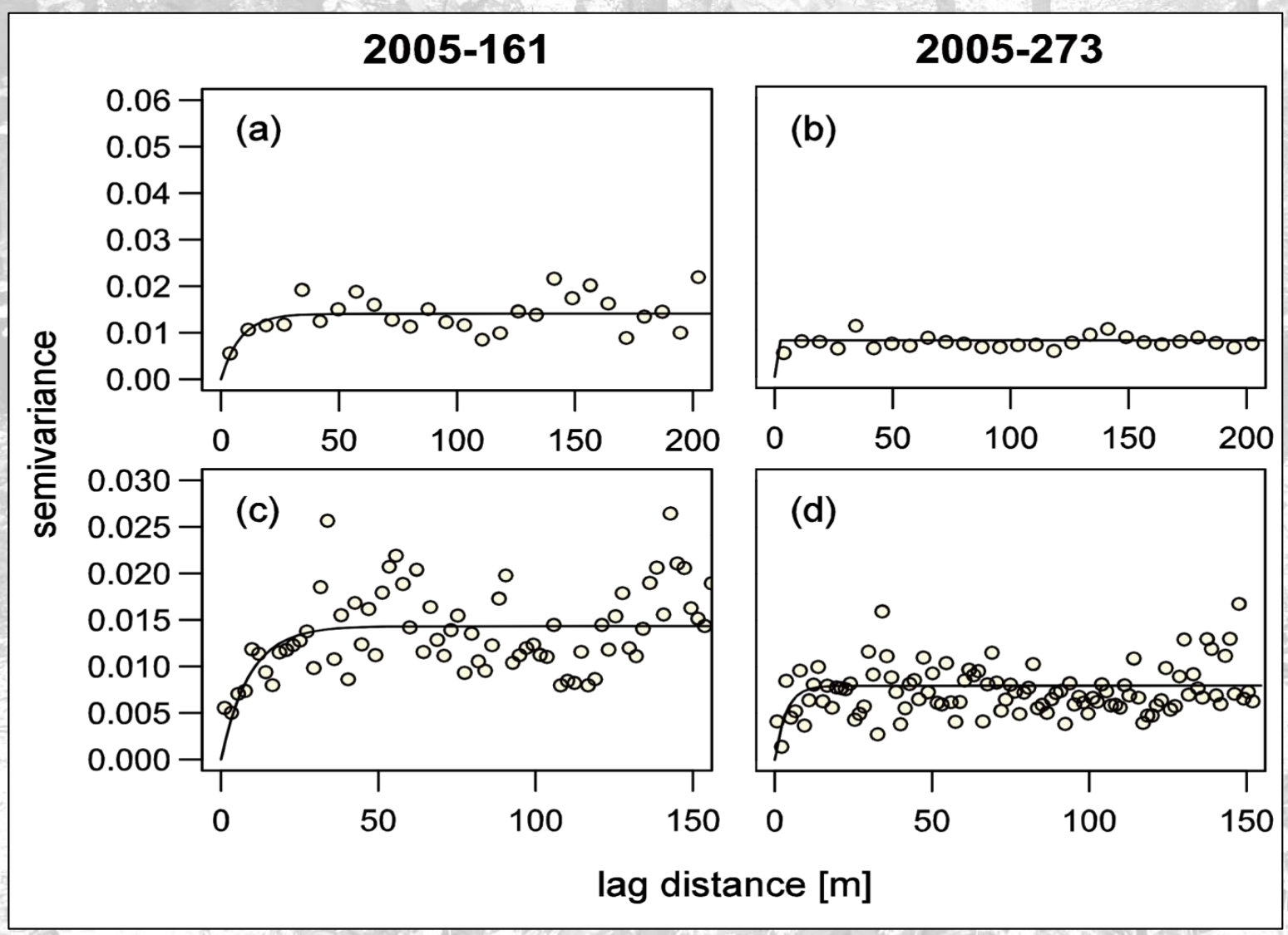


Abb. 3: *Position, Baumart und Brusthöhendurchmesser aller Bäume im Untersuchungsgebiet*

Jurasinski et al., 2012

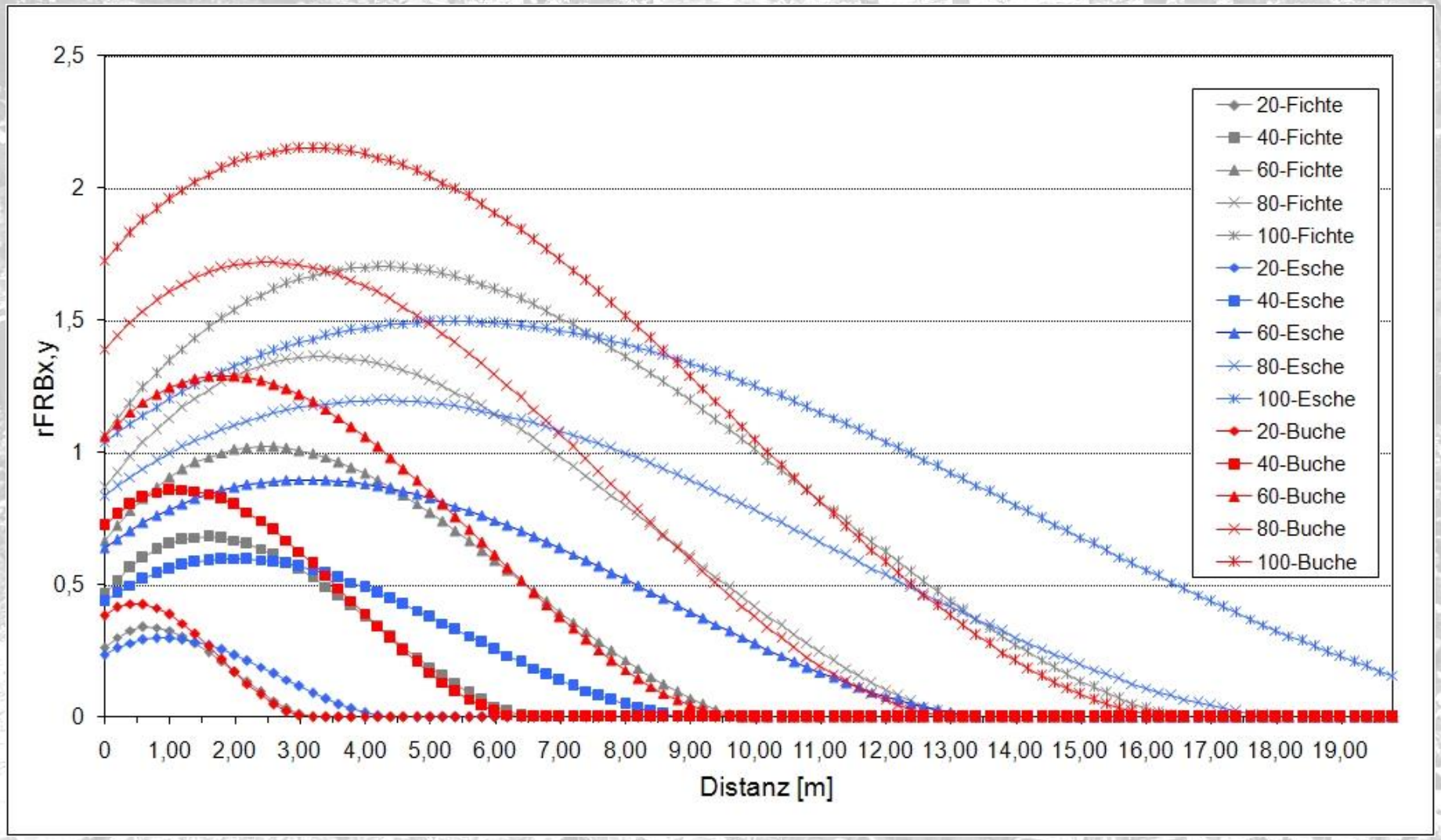
Semivariograms of soil CO_2 efflux Hainich



Weak Spatial Auto-correlation

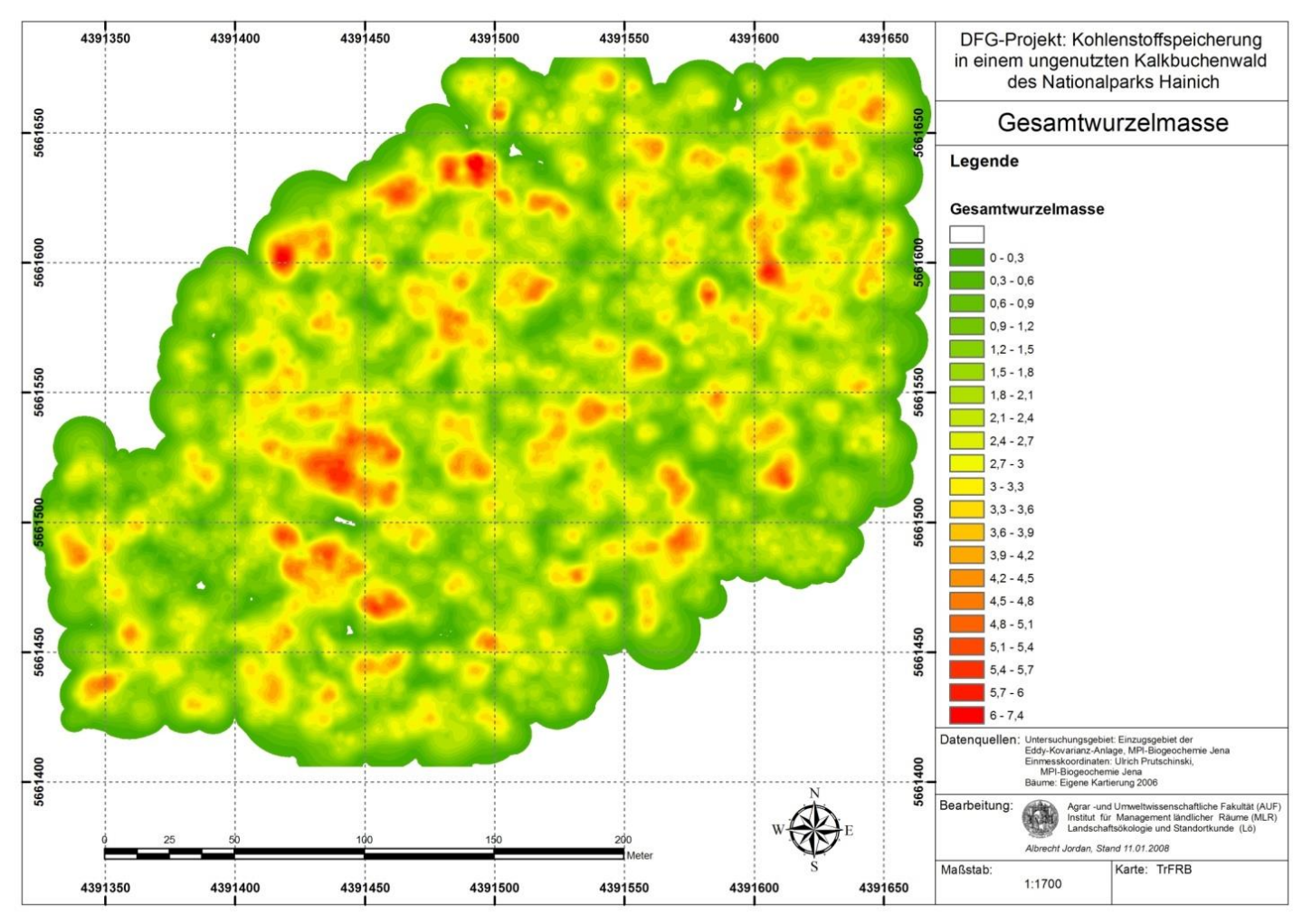
➔ Range-9m

Fine root model



Jurasinski et al., 2012

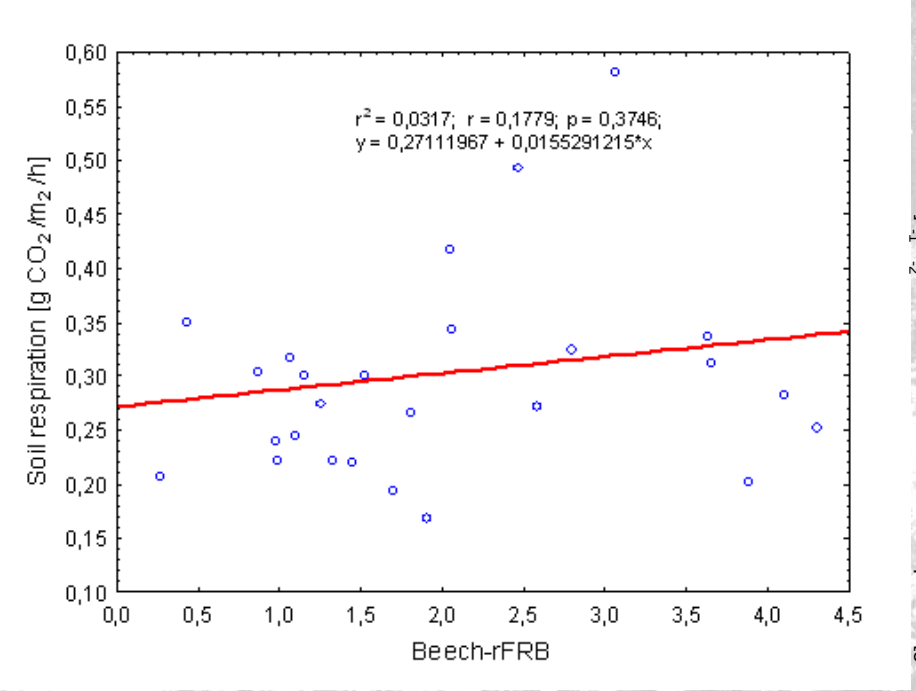
Modeled fine root biomass



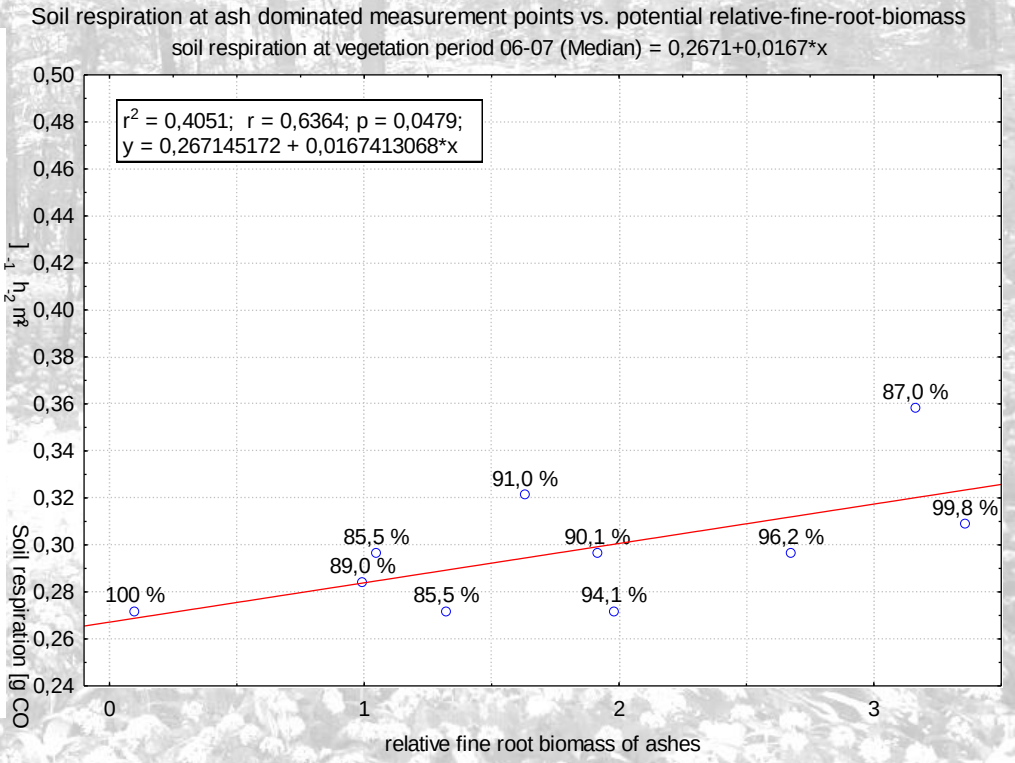
Jurasinski et al., 2012

Model performance

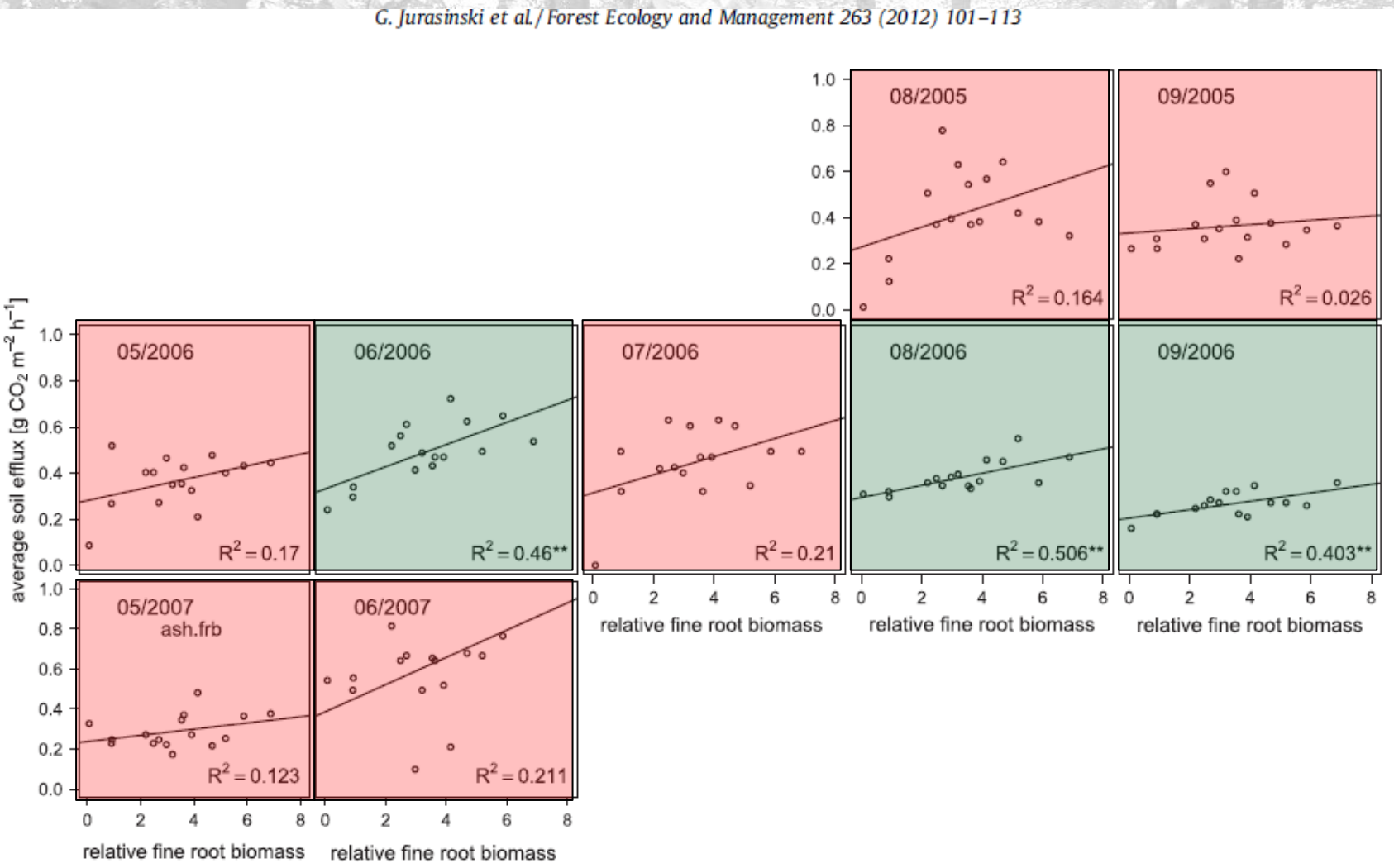
Beech



Ash



Monthly model performance



Jurasinski et al., 2012

Discussion model performance

1. Ash model performs better

2. Poor fit in July 2006 due to drought?

3. Fine root dynamics instead of fine root biomass?

4. Role of competition: Mixed stand instead of pure stand?

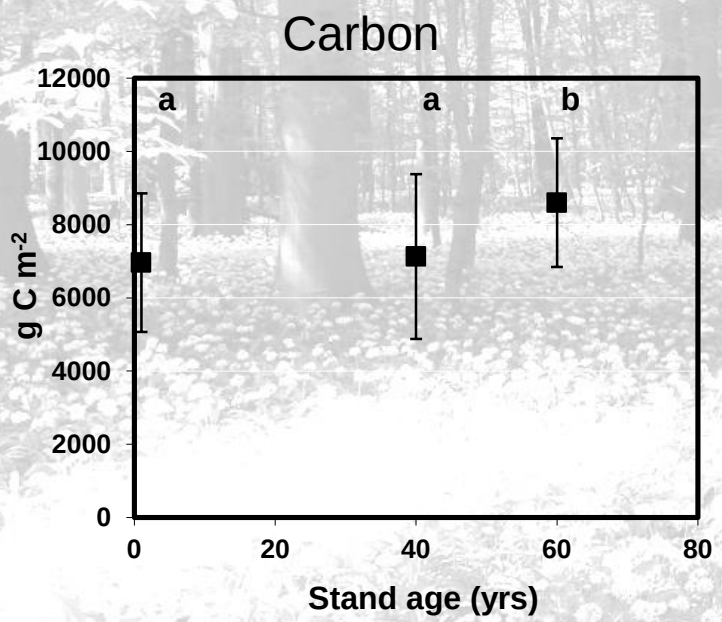
➔ Soil CO_2 efflux is a fraction of total soil C turnover

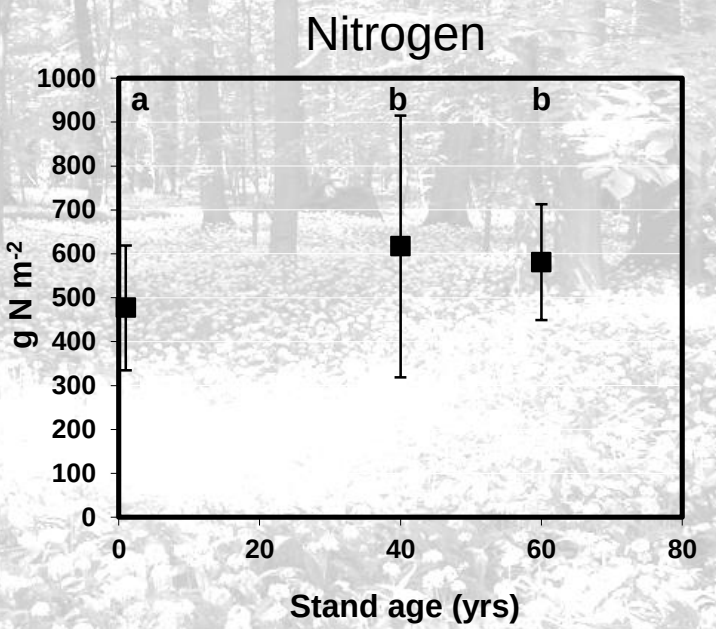
Results Iphofen

Sampling

10 x 3 undisturbed 10 cm diameter cores until lithic contact

Results Iphofen





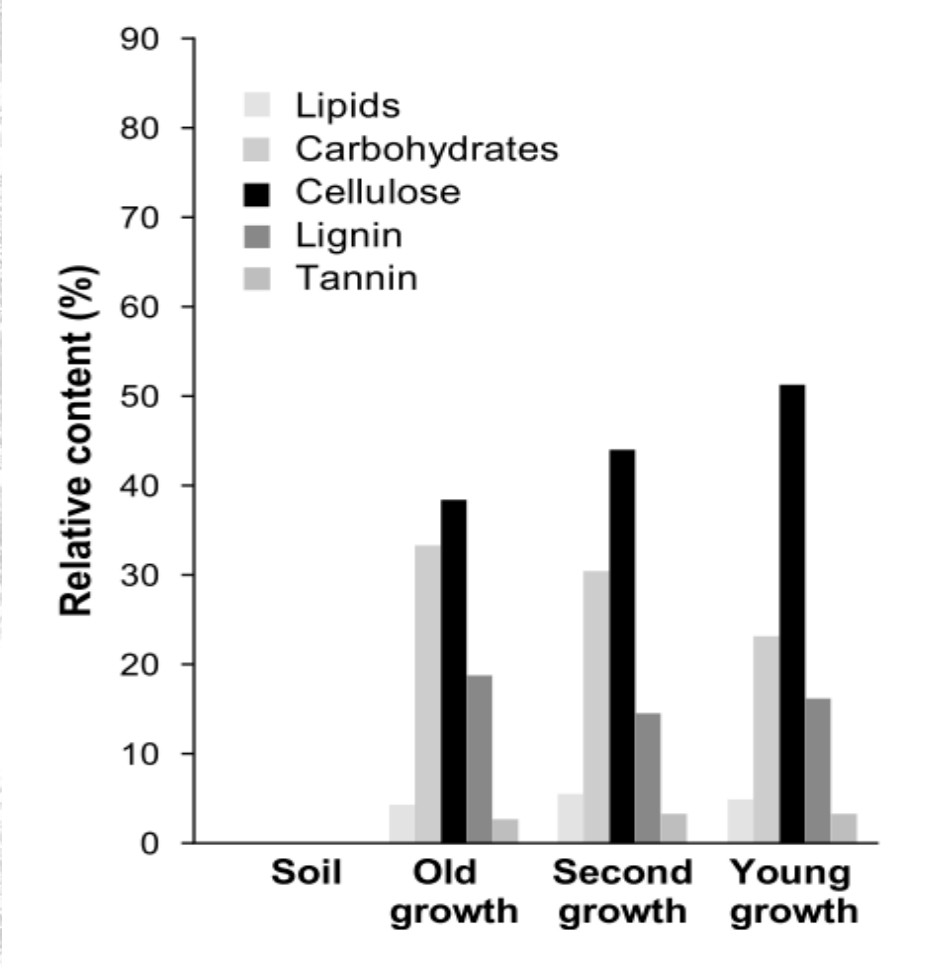
Year 0 - 40: 4.4 g C m^{-2} yr^{-1}

Year 40 - 60: 73 g C m^{-2} yr^{-1}

Results Iphofen

- During Rotation: N- Accumulation
- Then: C- Accumulation
- Build-up of necromass and non-structural carbohydrates? (*Sun et al., 2004)*

Like this?

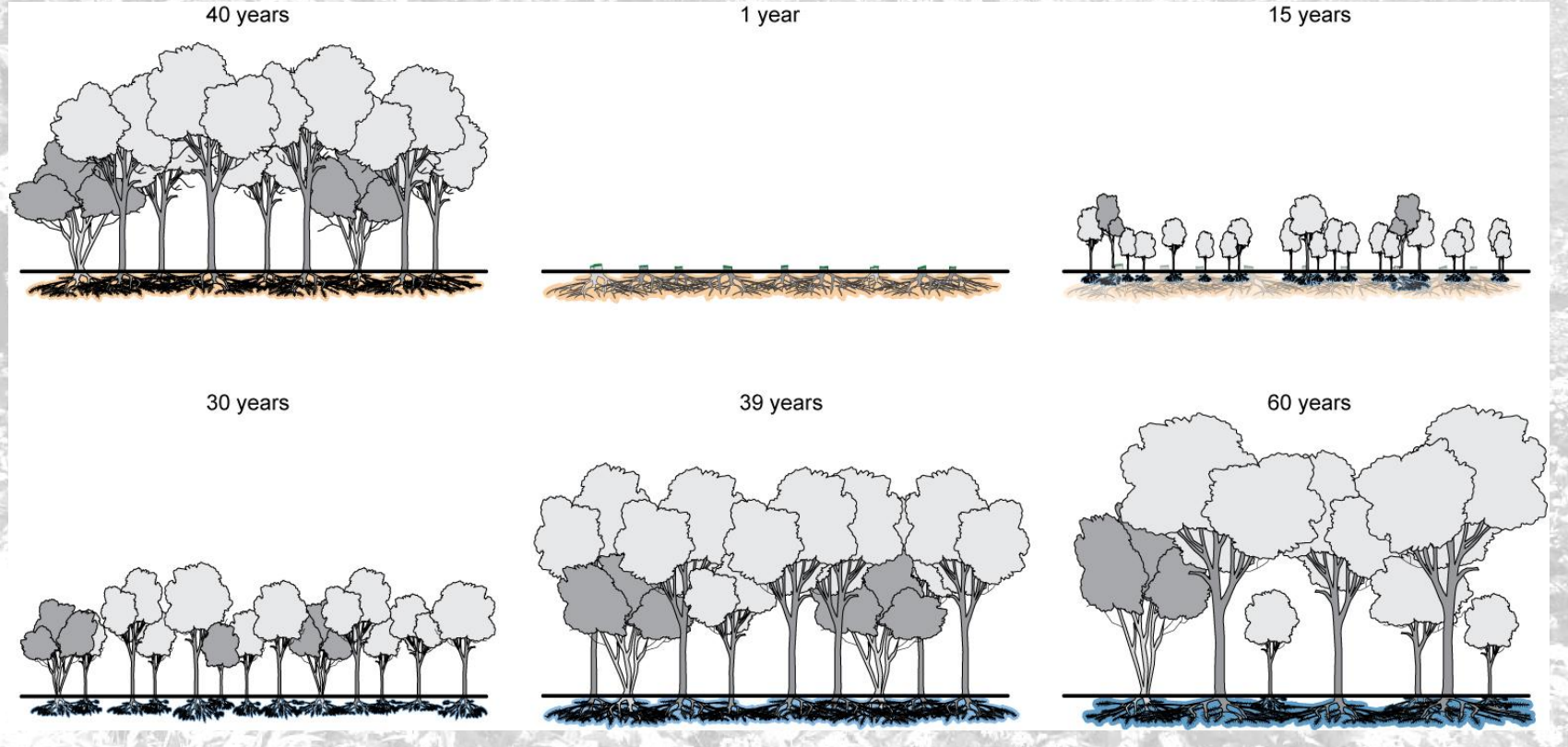


(altered, following Entry and Enningham, 1984)

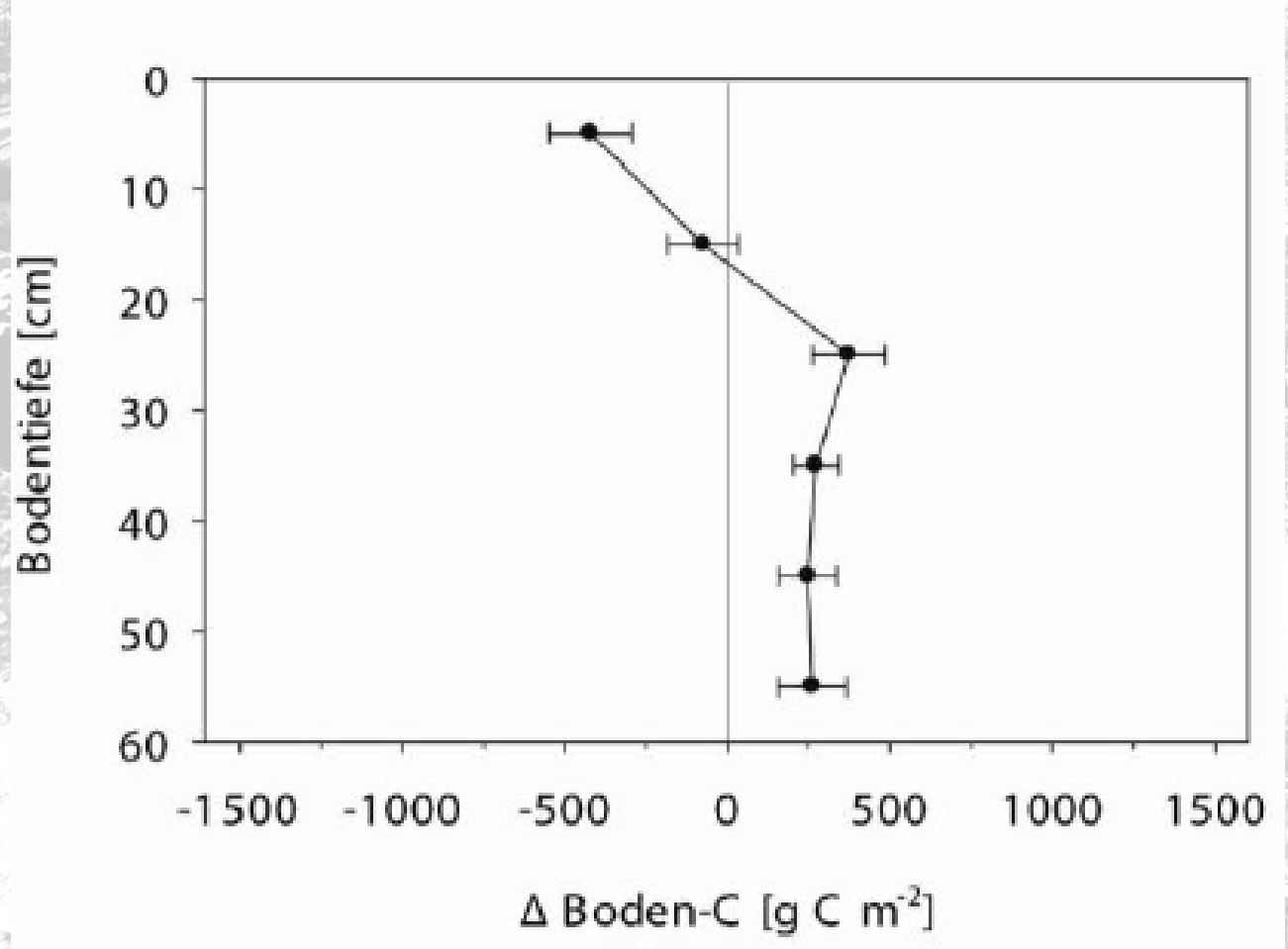
Results Iphofen

- Increased C-storage 40 -60 yrs following cut
- N-storage during rotation
- C/N ratio widens 40 -60 yrs following cut
- Rhizosphere controls C sequestration

Model C- storage Iphofen



Results Gleixner Hainich



➔ 165 g C m^{-2} a^{-1}

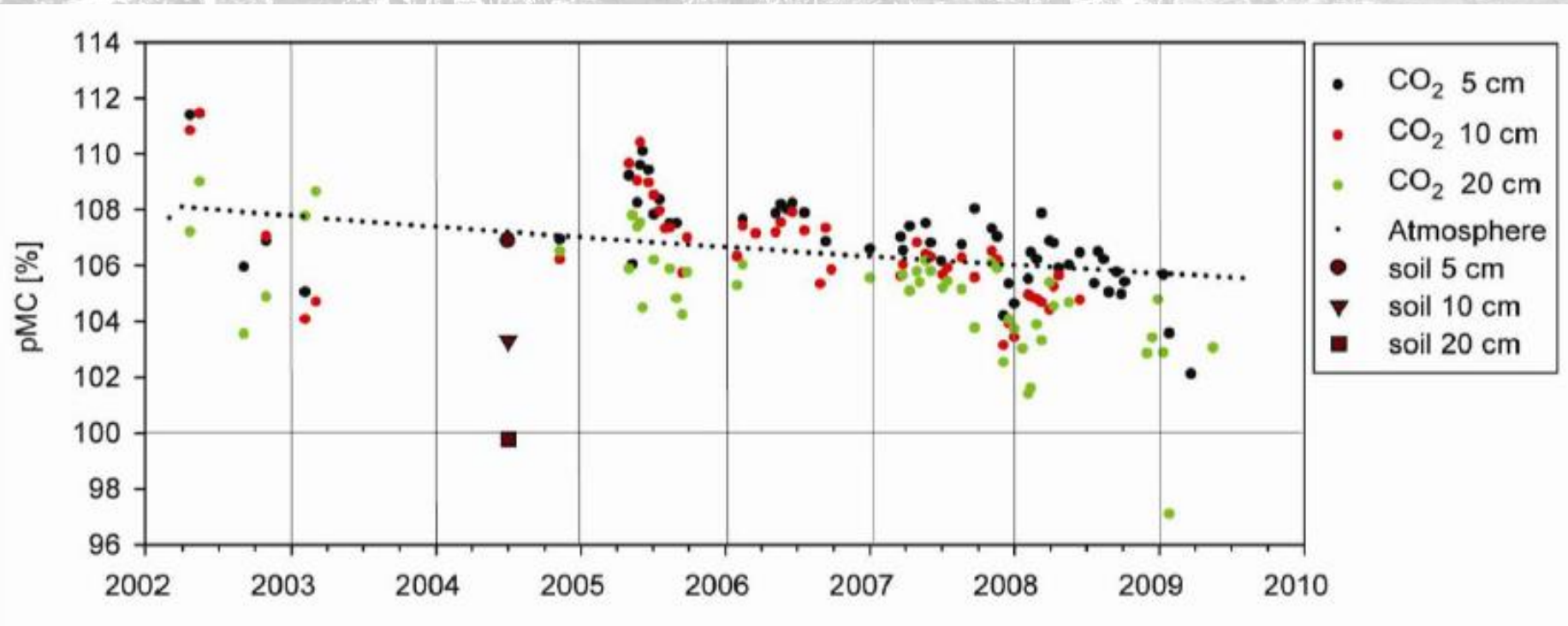
in deep soil

Results Gleixner Hainich

Low 14C- concentration of soil air

➔ Fresh biomass CO_2 source

➔Soil respiration coupled to biomass production

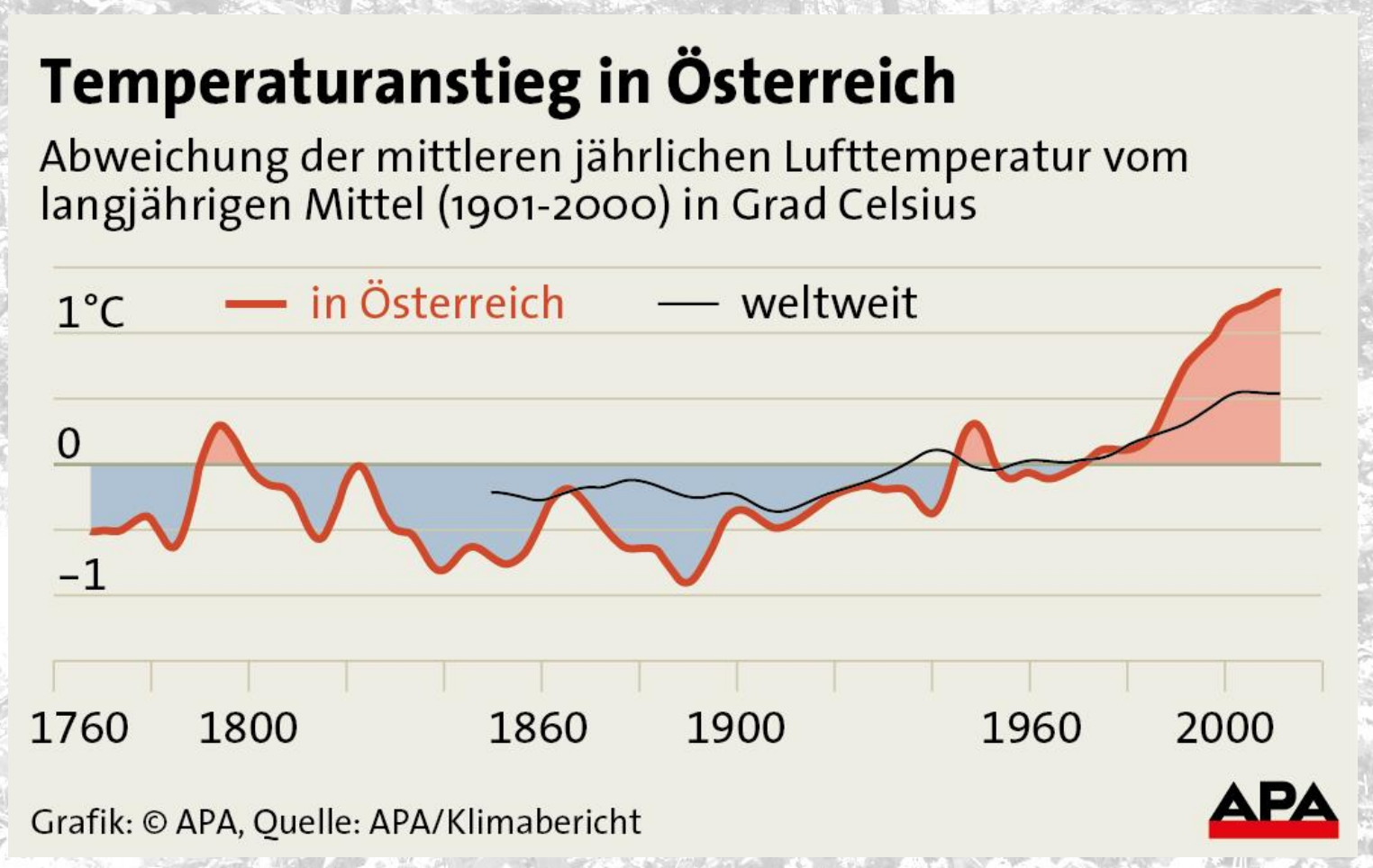


Synthesis

- 165 g C m^{-2} a^{-1} C- storage in old-growth forest
- Source: Not limestone, not humus respiration
- Soil respiration coupled to C turnover
- Soil C sequestration driven by roots
- Long rotation period or discontinued forest use should maximize C sequestration

My ideas of burning issues in Soil Science

kurier.at; September 17, 2014:



Research Initatives

So, what am I burning for?

Organic matter dynamics

- in alluvial and colluvial deposits
- in alpine humus rich soils
- Carbon cycling of Austrian peatlands
- The role of riparian systems on nutrient retention
- Carbon storage in old-growth forests

For tackling these issues, I am looking for cooperation partners, so please contact me:

stephan.glatzel@univie.ac.at

Scientists at the Geoecology Lab:

Dr. Erich Inselsbacher
Ecosystem Ecology

Univ.-Prof. Stephan Glatzel

Ass.- Prof. Dr. Robert Peticzka
Soil Physics, Quaternary Research

Simon Drollinger
Soil Geography

As.-Prof. Dr. Franz Holawe
Climatology

Geoecology Lab:

Geoecology /Soils Teaching:

5 courses to applied field and lab methods (basics, applied and advanced) with about 120 Students (up to 8 parallel courses)

Research:

- So far, specializing in soil physics / quaternary research
- Now new developing focus on soil carbon research

Teaching / Courses:

- Bachelor "Geographie" (Curriculum 2011)
- Master "Geographie", "Raumforschung und Raumordnung", "Kartographie und Geoinformation" (Curriculum 2007)
- Joint-Master-Studium "Urban Studies" (Euromaster in Urban Studies) (Curriculum 2008)
- Lehramtsstudium –"Geographie und Wirtschaftskunde" (Studienplan 2002)
- Diplomstudium "Geographie" (Studienplan 2002)
- Doktoratsstudium

- International Master „Environmental Sciences“

Teaching Initatives

I have different roles with potentially diverging interests, but as a soil scientist

Priority 1: Promote soil knowledge and its scientific basis in the Geography and Environmental Sciences Curricula at the University of Vienna

Priority 2: Explore and exploit opportunities for cooperation in teaching beyond UV`s Dept. of Geography and Regional Research

Thank you for your attention!

Contact:
stephan.glatzel@univie.ac.at

Profile visited
with an
undergraduate
Student
excursion
In July 2014