Conclusions

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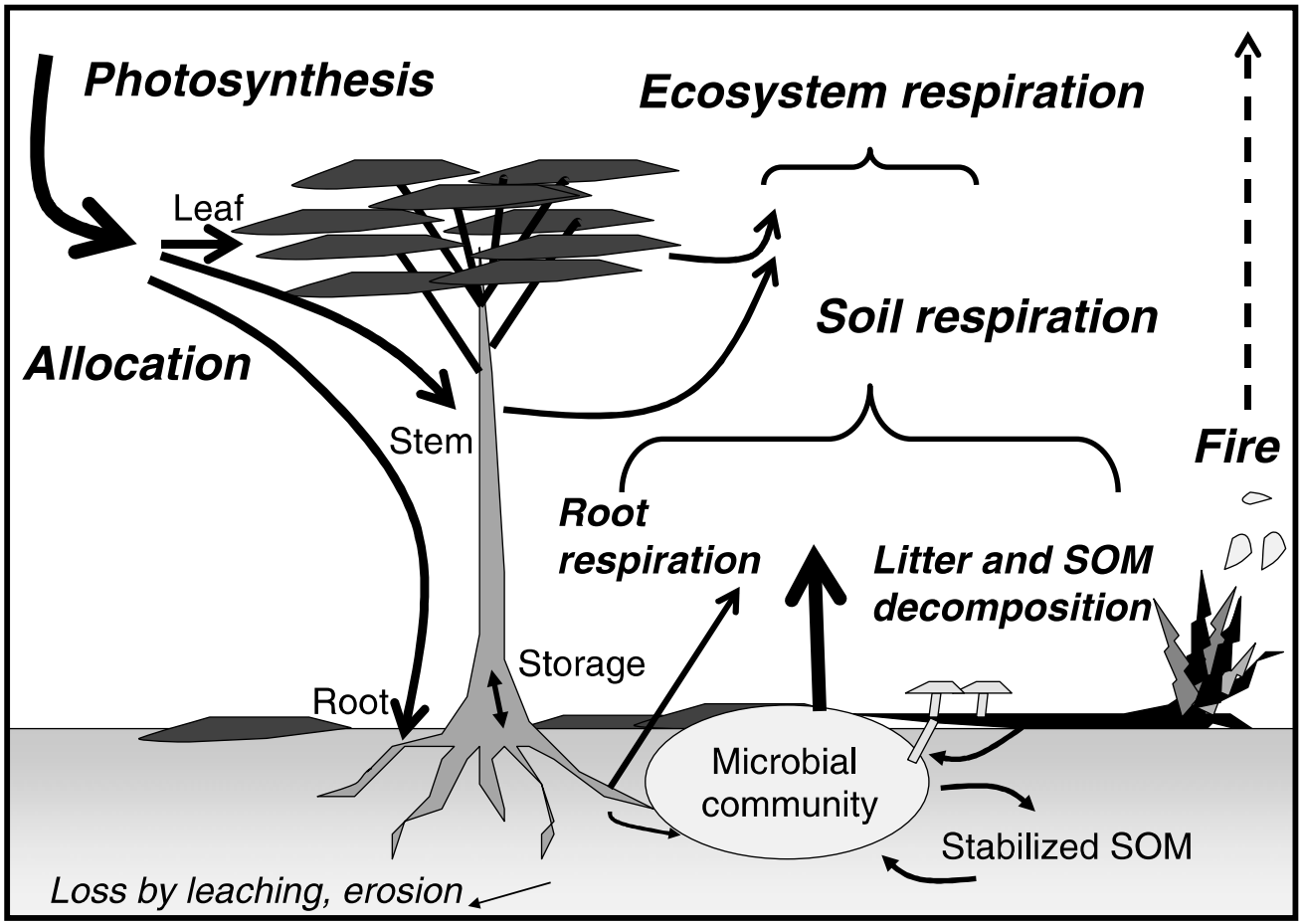
Content

- **Contrasts** between ecotron and field settings
- **Complementarity** of field and ecotron approaches for understanding plant/stand and ecosystem **respiration**
- **Perspectives** (future needs)

Contrasts

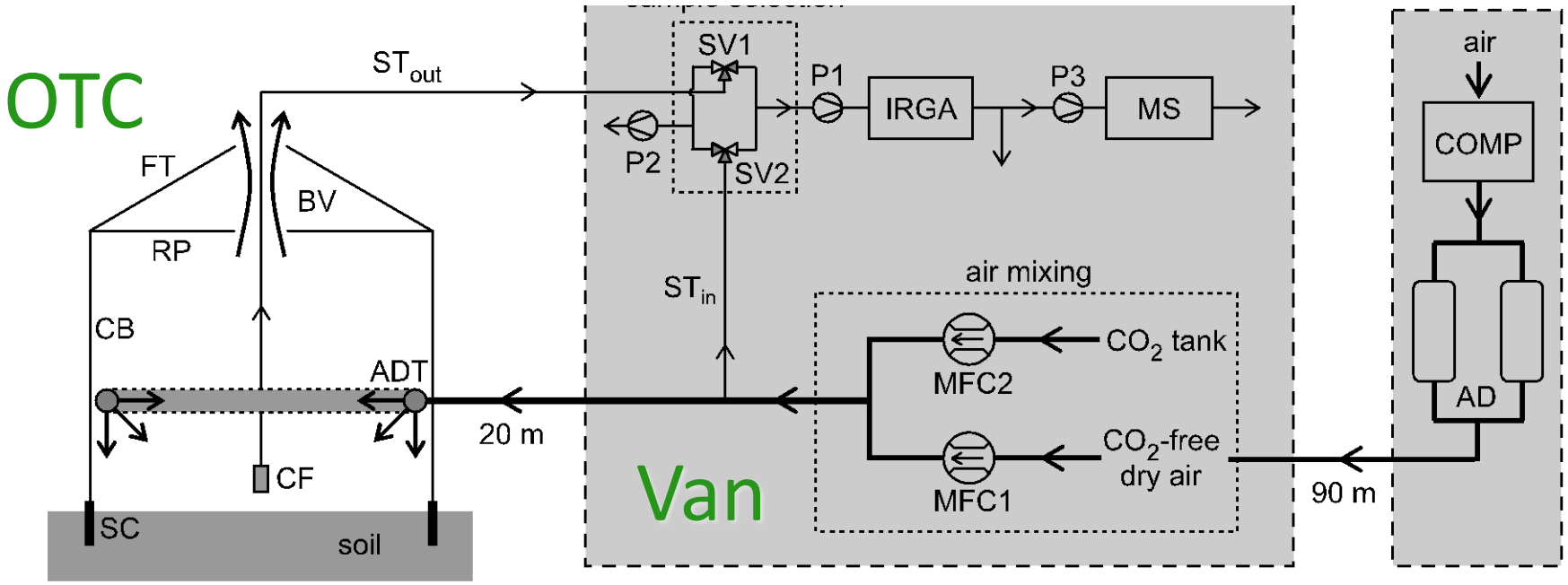
Feature	ECOTRON	FIELD
Biological complexity	can be controlled	always high
Environmental control		
Temporal	yes	no
Spatial	yes	limited
Past/future climate	yes	no – limited
Reproducibility	yes	limited
Importance	**mechanisms**, predictions, tools	**relevance**, develop hypotheses

Pathways of carbon flow through ecosystems



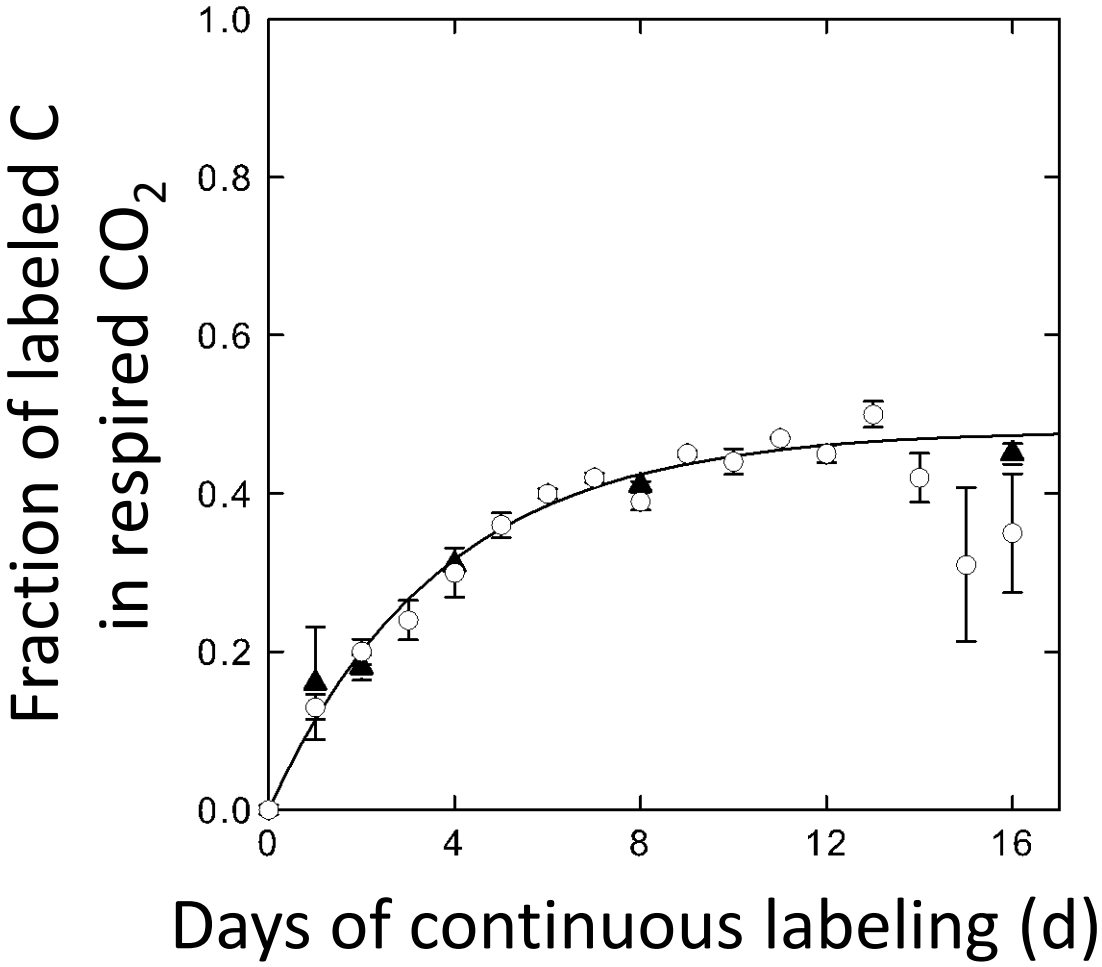
TRUMBORE 2006 *Global Change Biology*

Grünschwaige pasture



GAMNITZER et al. 2009 *New Phytologist*

Tracer kinetics in grassland ecosystem respiration



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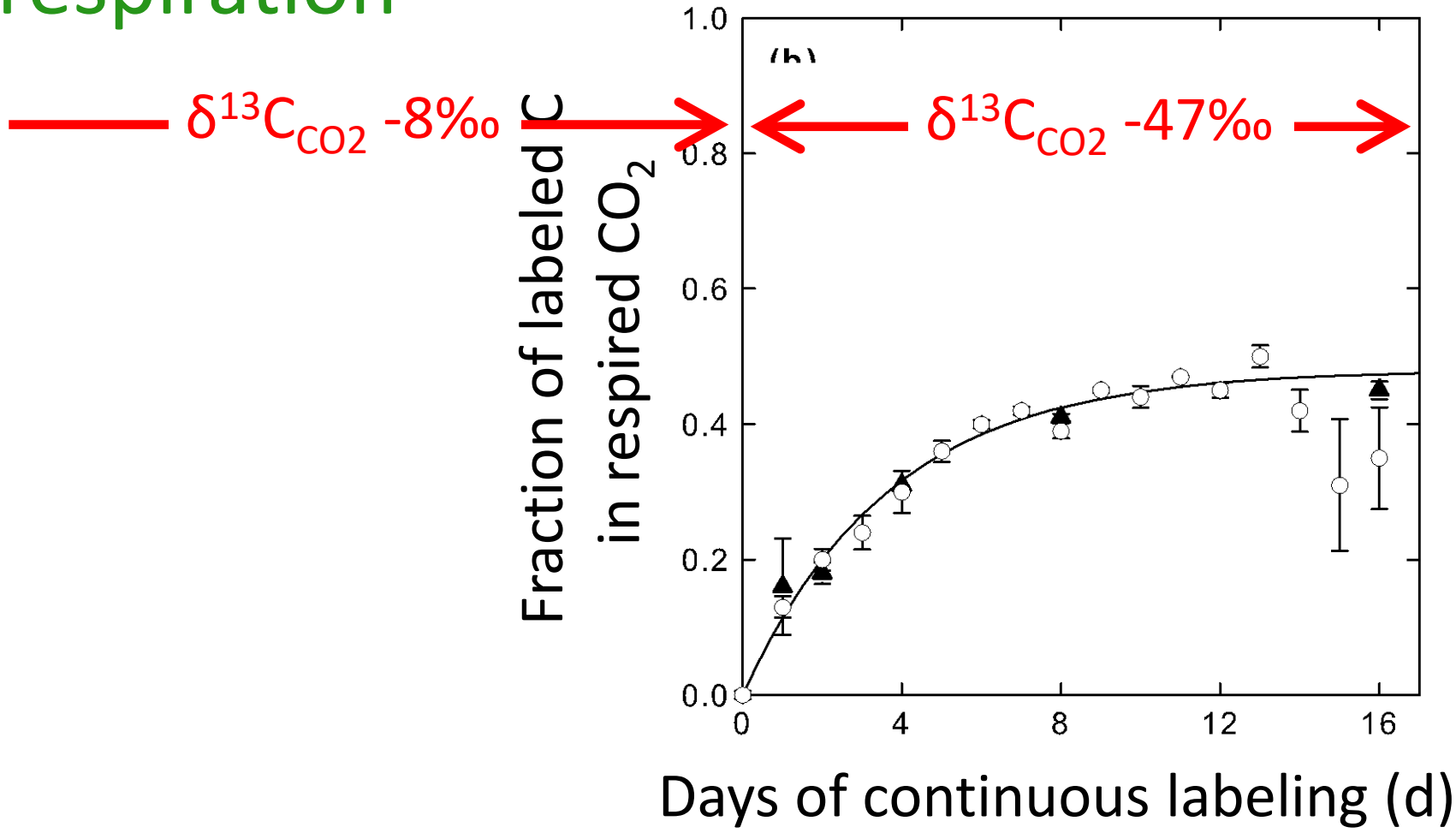
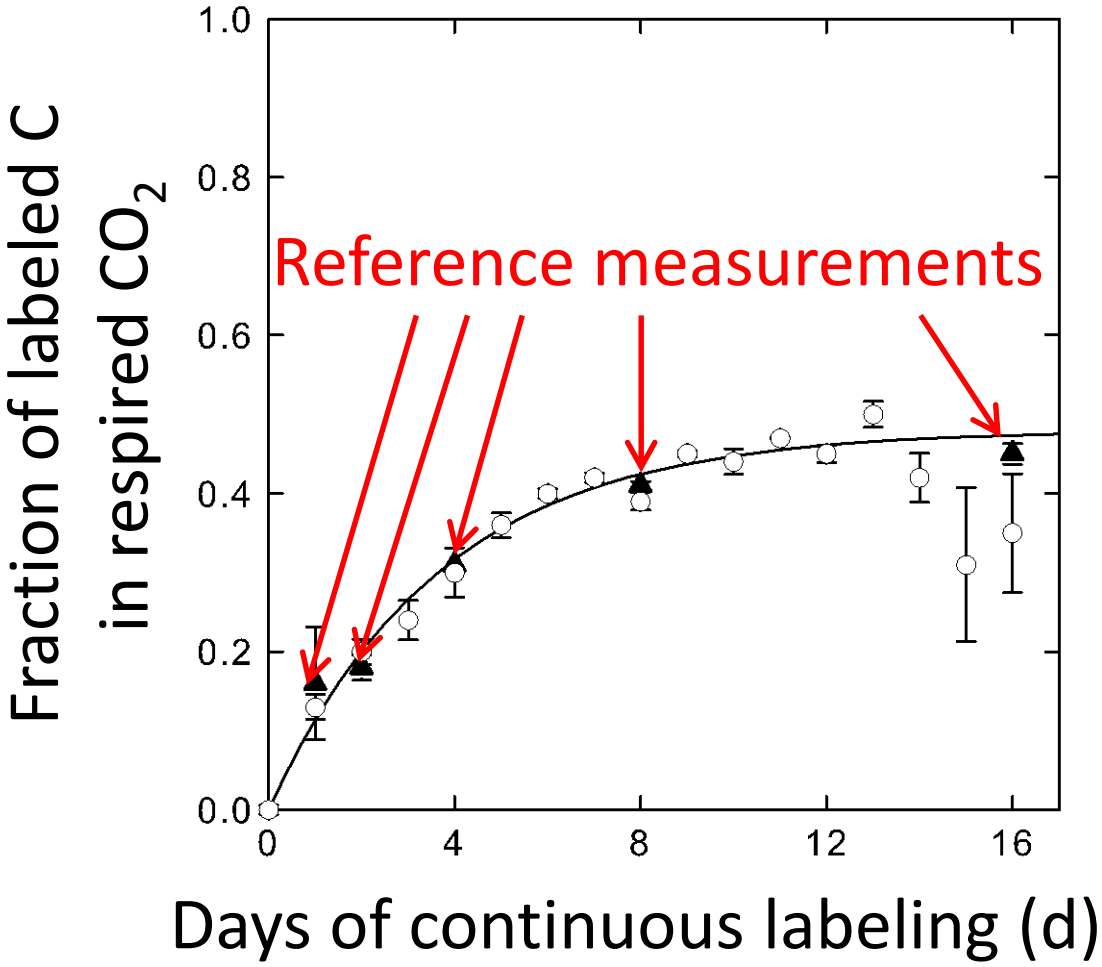


GAMNITZER et al. 2009 *New Phytologist*

Tracer kinetics in grassland ecosystem respiration



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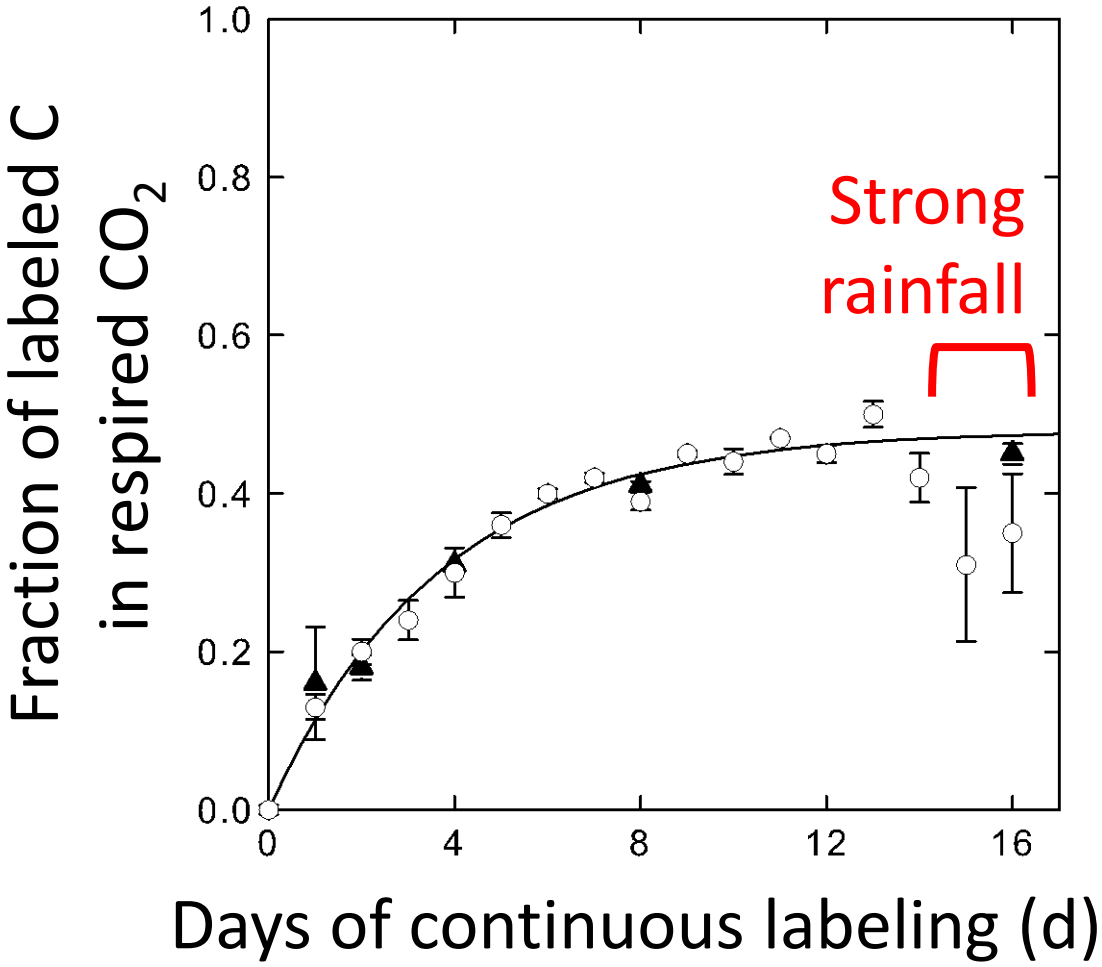

GAMNITZER et al. 2009 *New Phytologist*

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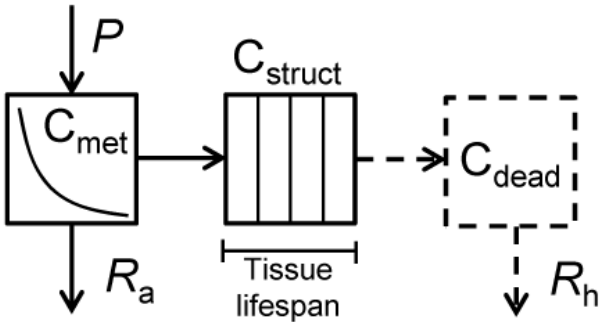
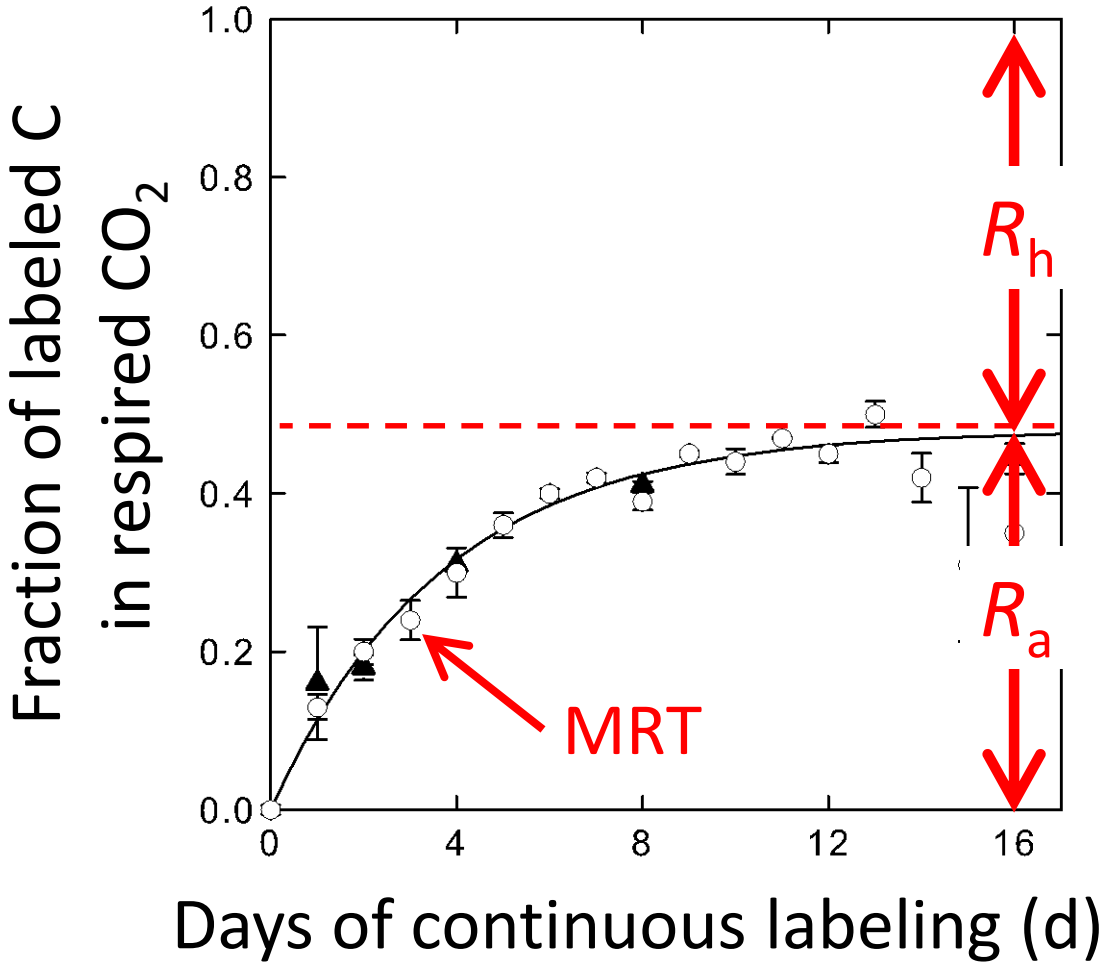
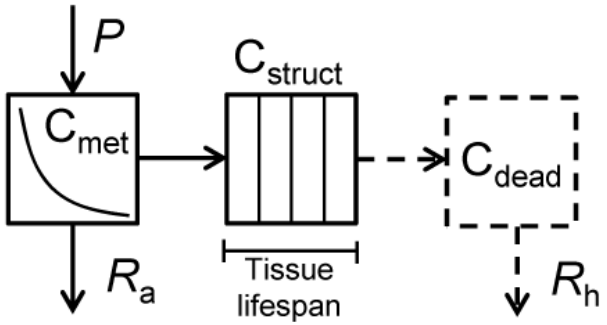




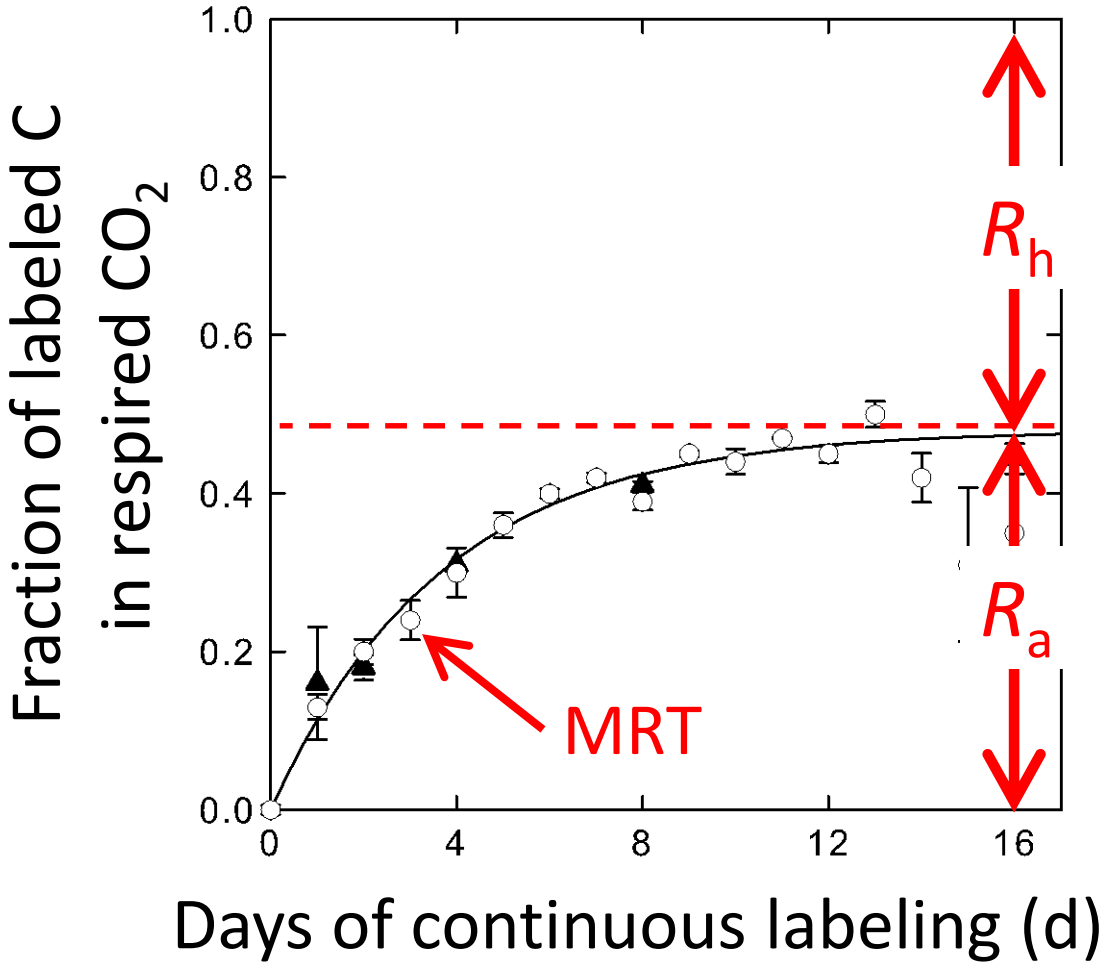
GAMNITZER et al. 2009 *New Phytologist*

SCHNYDER et al 2017 *Advances in Photosynthesis and Respiration*

Tracer kinetics in grassland ecosystem respiration



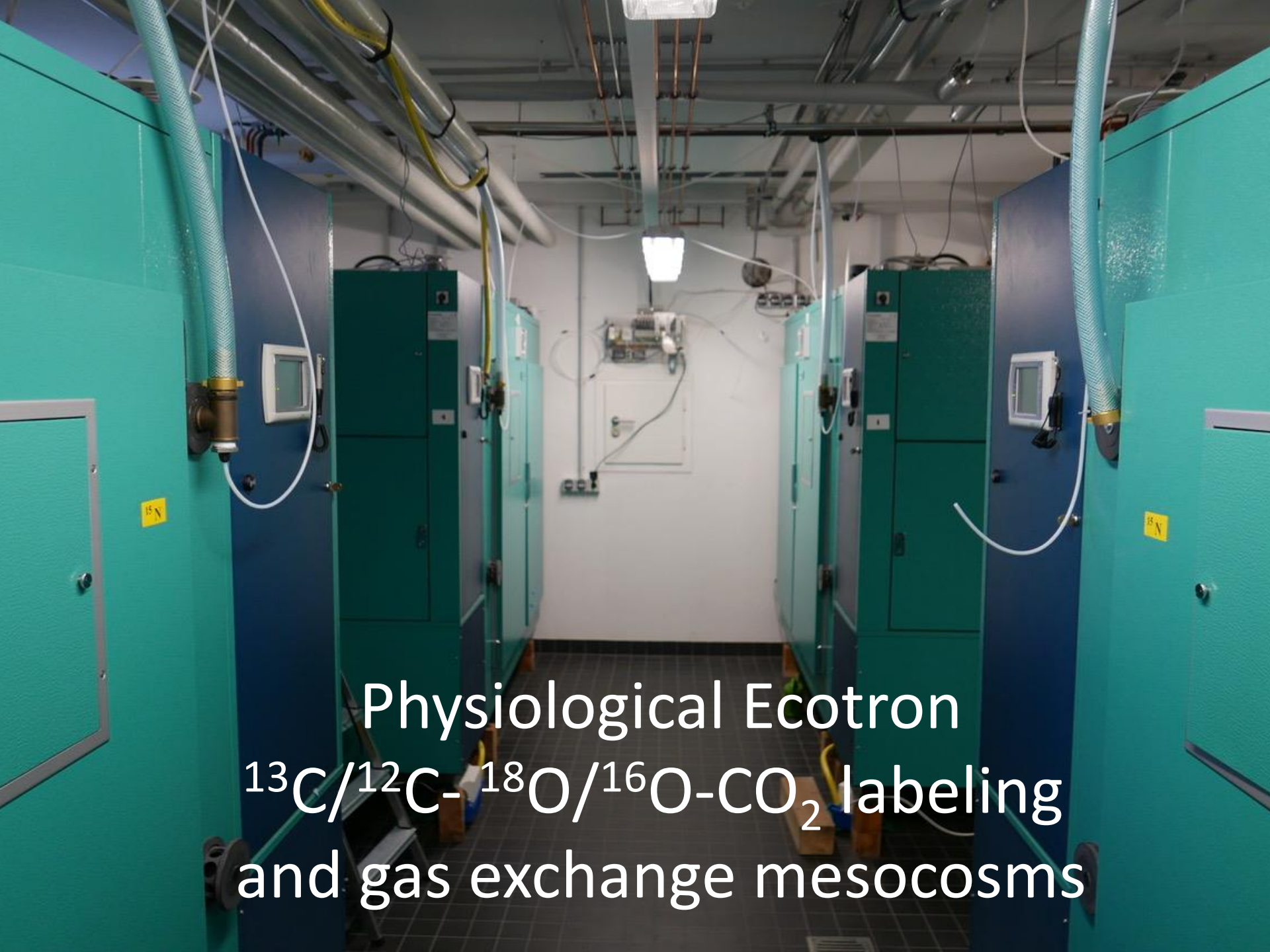
QUESTIONS:
- model valid?
- Same kinetics in shoot and roots?
- Substrate identity?



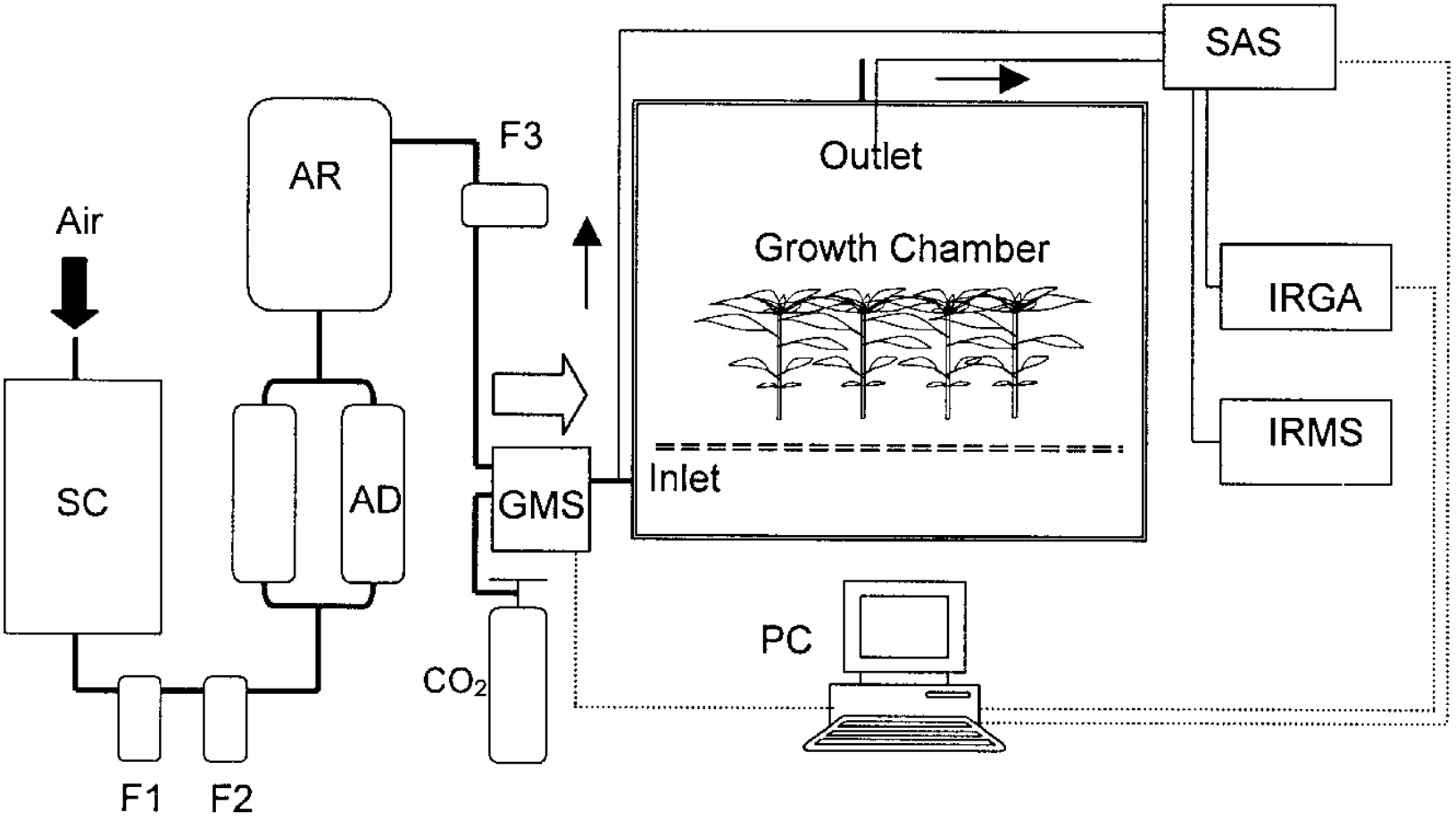
GAMNITZER et al. 2009 *New Phytologist*
SCHNYDER et al 2017 *Advances in Photosynthesis and Respiration*

Hypothesis testing in ‚Physiological Ecotron‘

- Steady-state
- 1 plant species (*Lolium perenne*) growing on washed sand ‚soil‘with nutrient solution
- no heterotrophic respiration
- Shoot and root respiration


Physiological Ecotron
$^{13}C/^{12}C$- $^{18}O/^{16}O$-CO_2 labeling
and gas exchange mesocosms

$^{13}C/^{12}C$- $^{18}O/^{16}O$-CO_2 gas exchange mesocosms

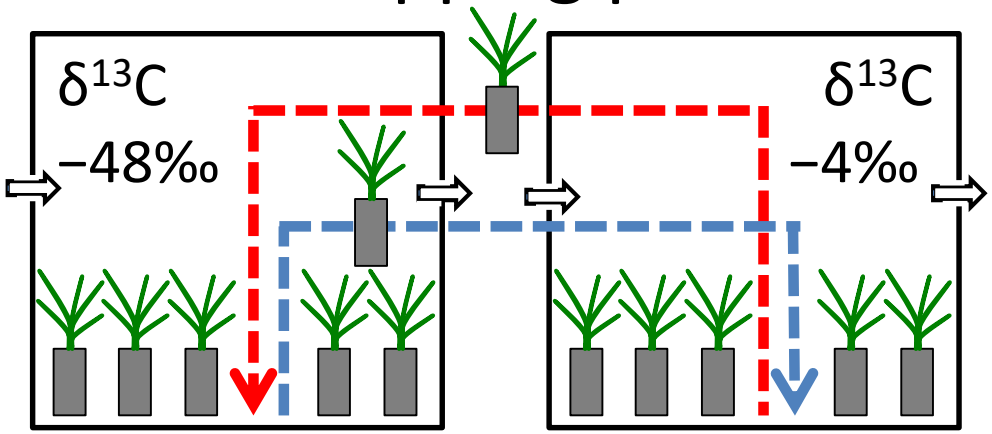


SCHNYDER et al 2003 *Plant Cell Environ*

$^{13}CO_2$ labeling strategies

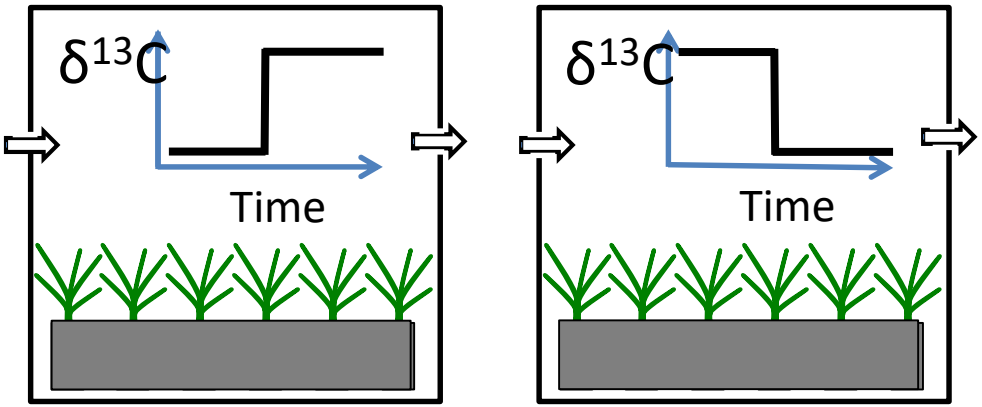
Individual plants

Swapping plants



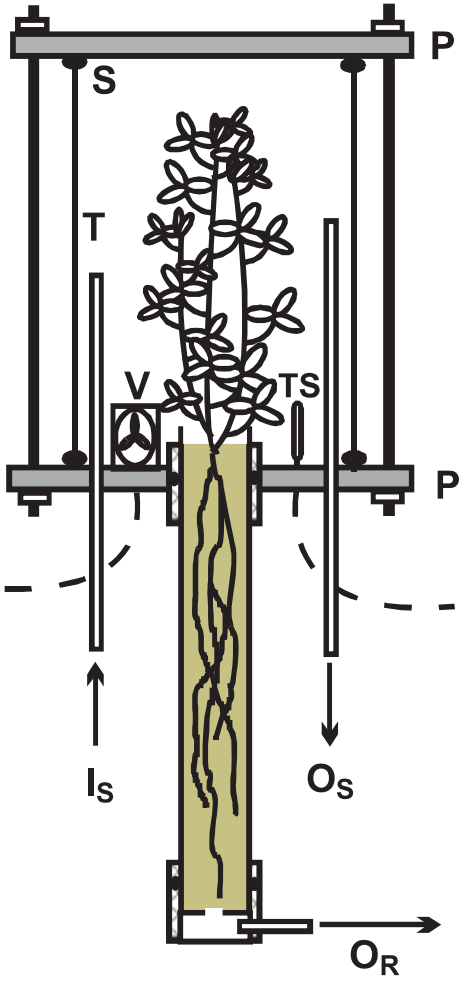
Plant stands/
canopies

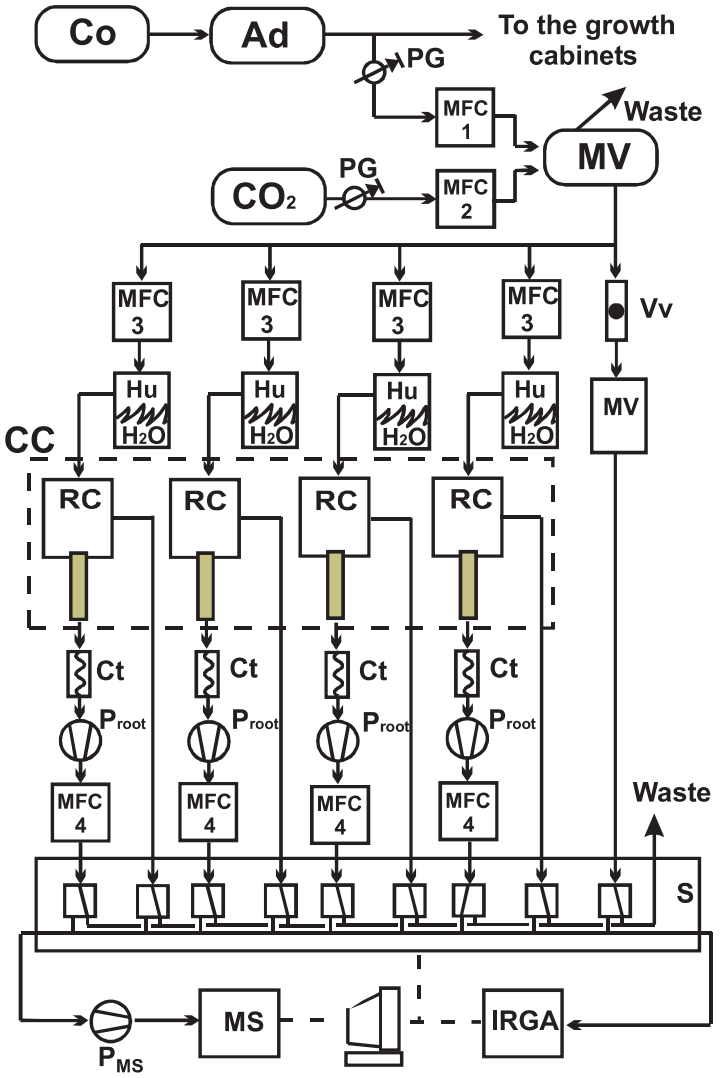
Switching $^{13}CO_2$ supply



after SCHNYDER et al 2017 *Advances in Photosynthesis and Respiration*

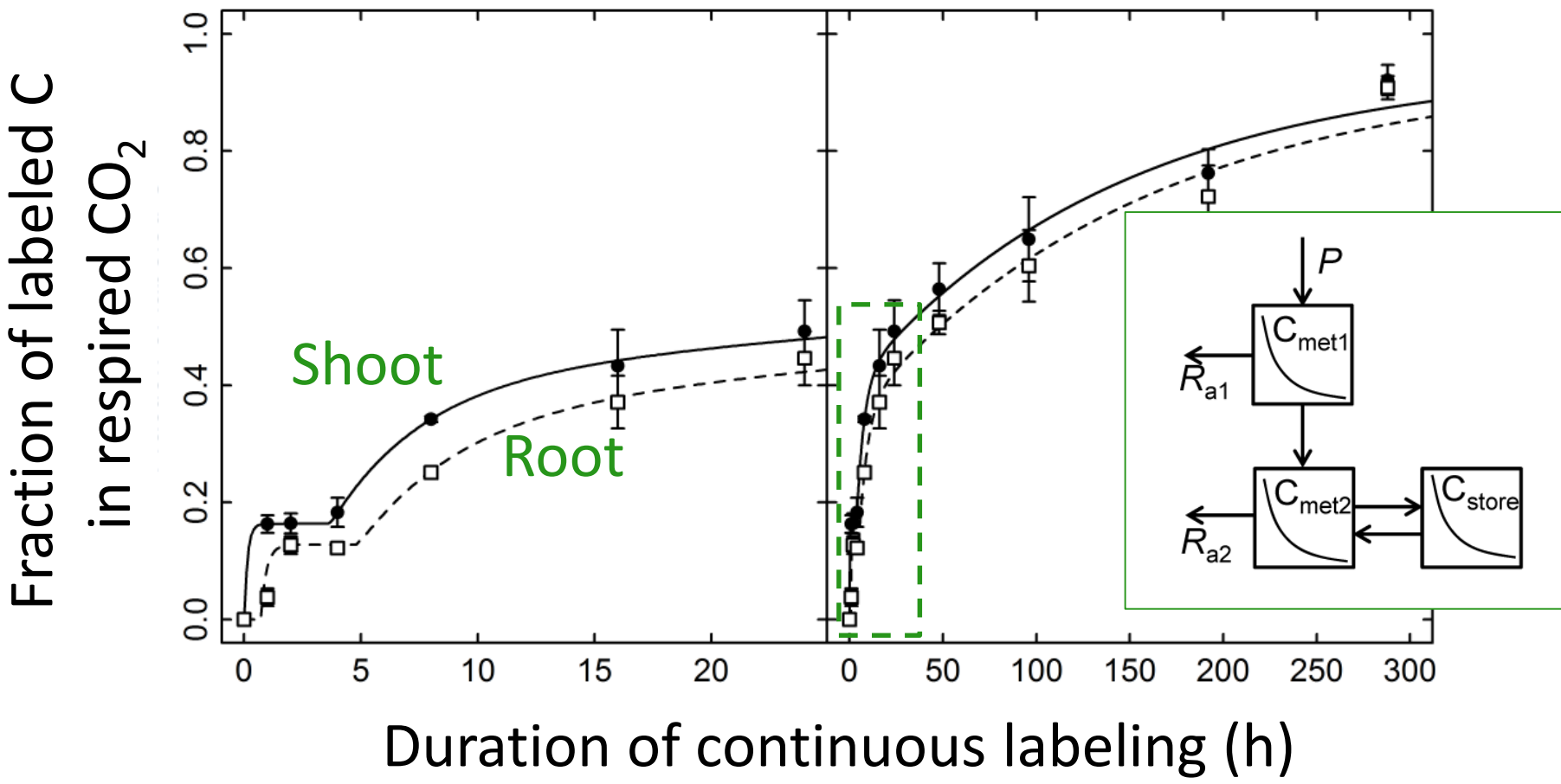
Shoot and root respiration





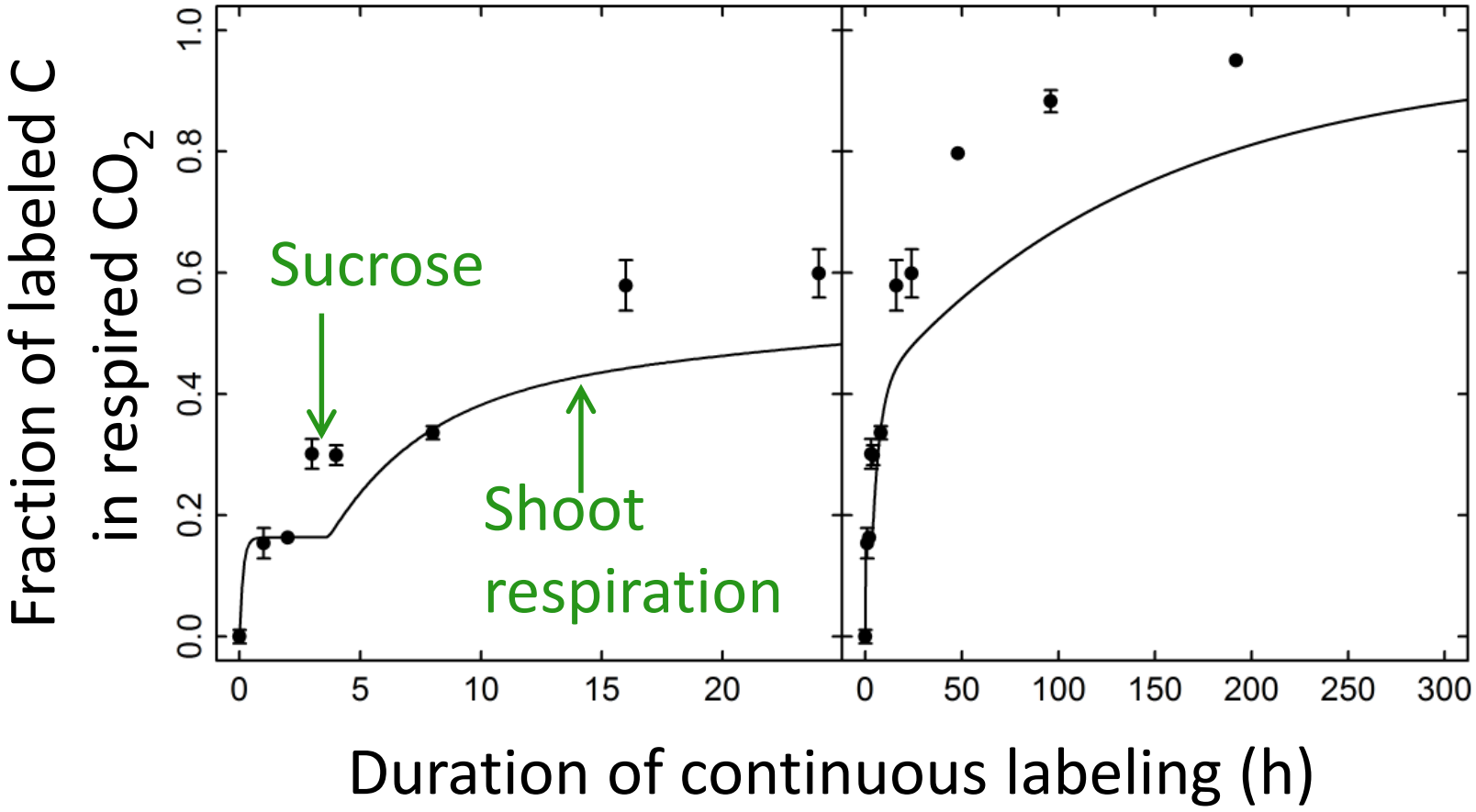
LÖTSCHER et al. 2003 *New Phytologist*

^{13}C tracer kinetics in shoot and root respiration of *Lolium perenne*



after LEHMEIER et al 2008 *Plant Physiology*

^{13}C tracer kinetics in leaf sucrose and whole shoot respiration



SCHNYDER et al 2017 *Advances in Photosynthesis and Respiration*

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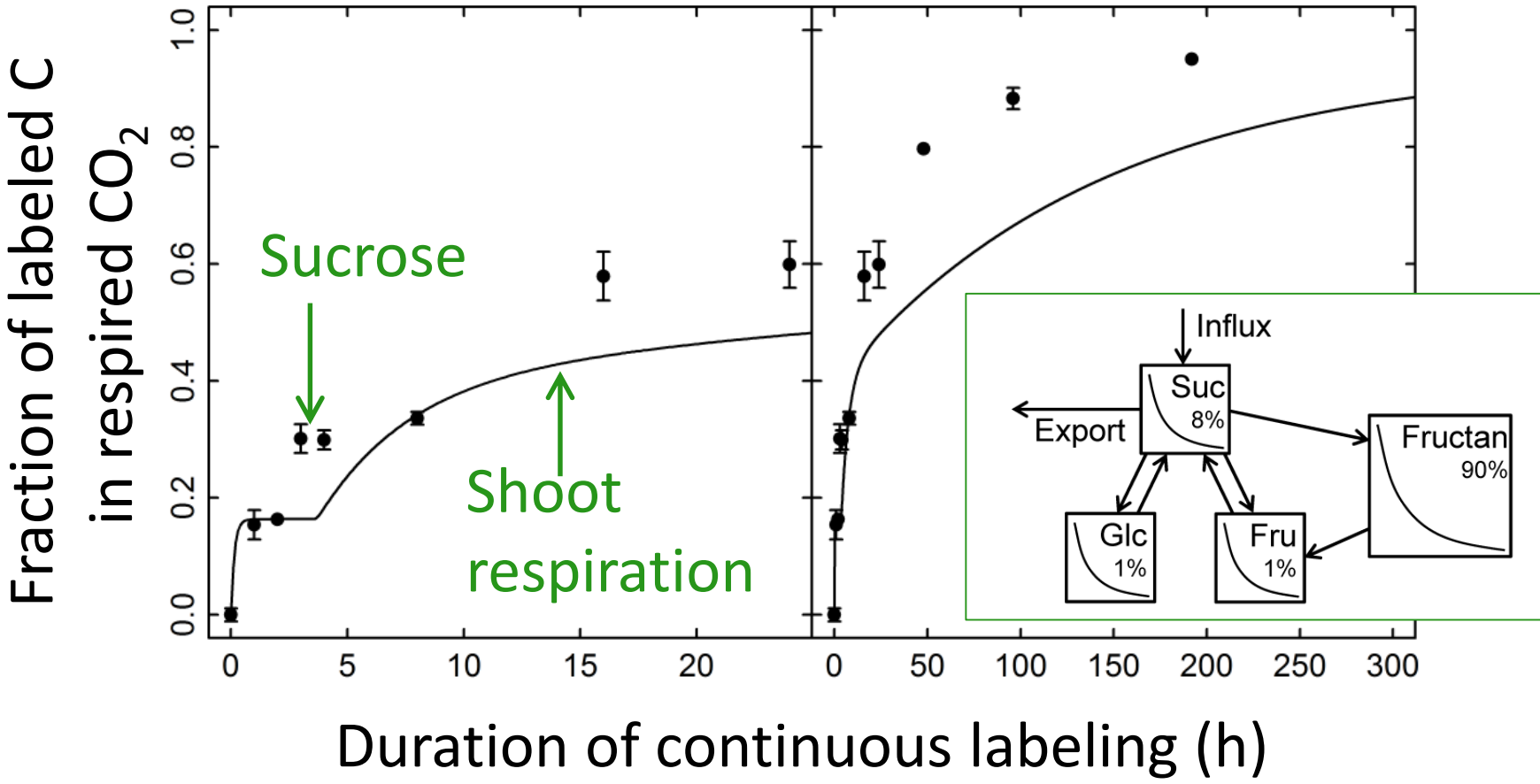


SCHNYDER et al 2017 *Advances in Photosynthesis and Respiration*

Future demands

Advance from observational/**empirical** knowledge
to a more **process**-based understanding

STORKEY et al. 2015 *Nature*
Park Grass Experiment, Rothamsted, UK

Future demands

Role of Ecotrons

- Disentangle natural system (functional) complexity
  - Reducing/managing/controlling biological complexity
  - steady-state approaches
  - Climatic drivers (CO2, T, rH, ...)
- Testing hypotheses derived from field studies
- Improving mechanistic understanding of natural systems

Testing (physiological, ecological, evolutionary) hypotheses across scales of biological organisation

- Organ
- Plant
- **Plant-MO** (symbiont-pathogen-heterotrophs) models
- Artificial **communities**
- Model **ecosystems**

Future demands

TOOLS

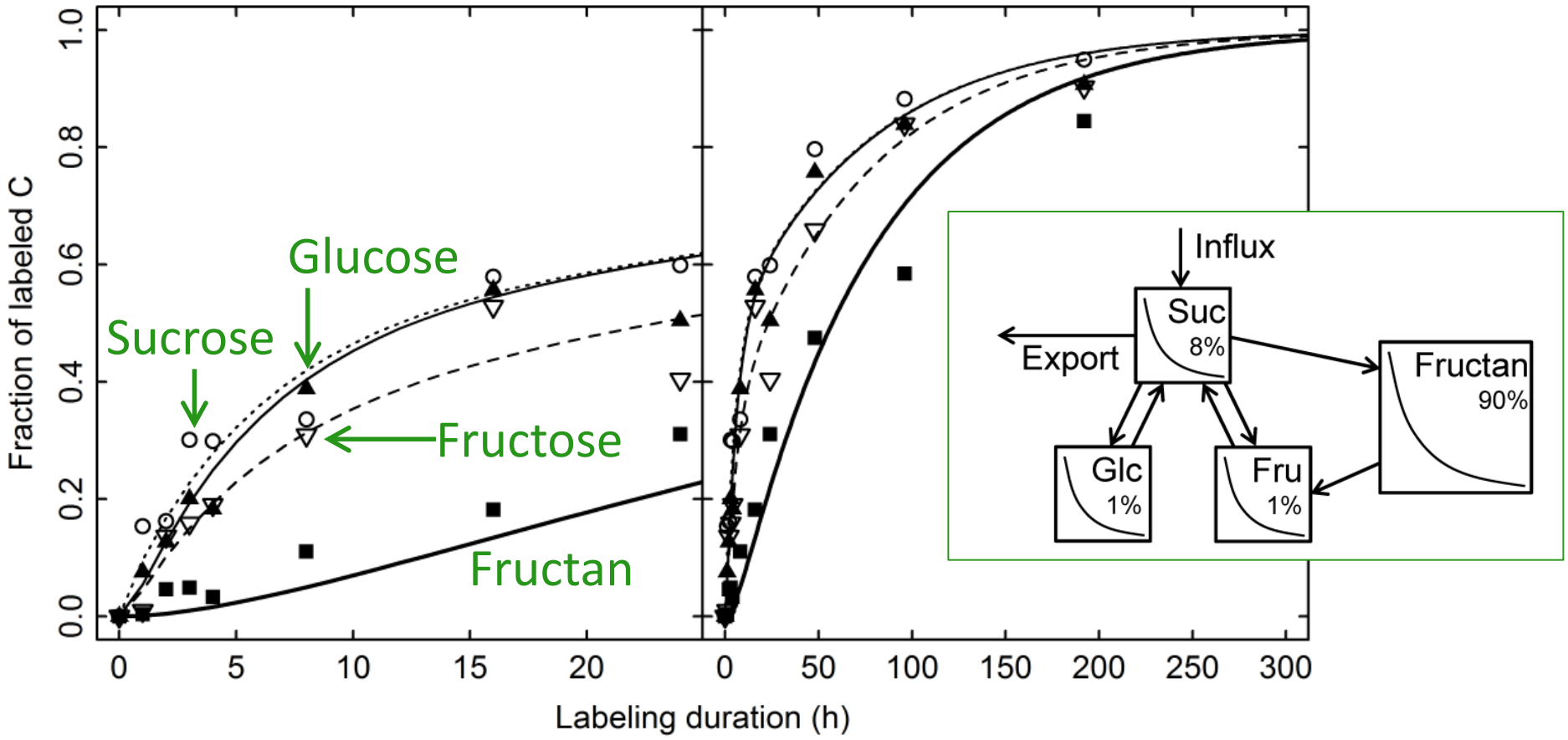
- **Non-destructive**/minimal-invasive **monitoring techniques** (imaging, gases, isotopomers, ...)
- Ecosystem analysis-**computing** skills/mechanistic **modelling**

Support

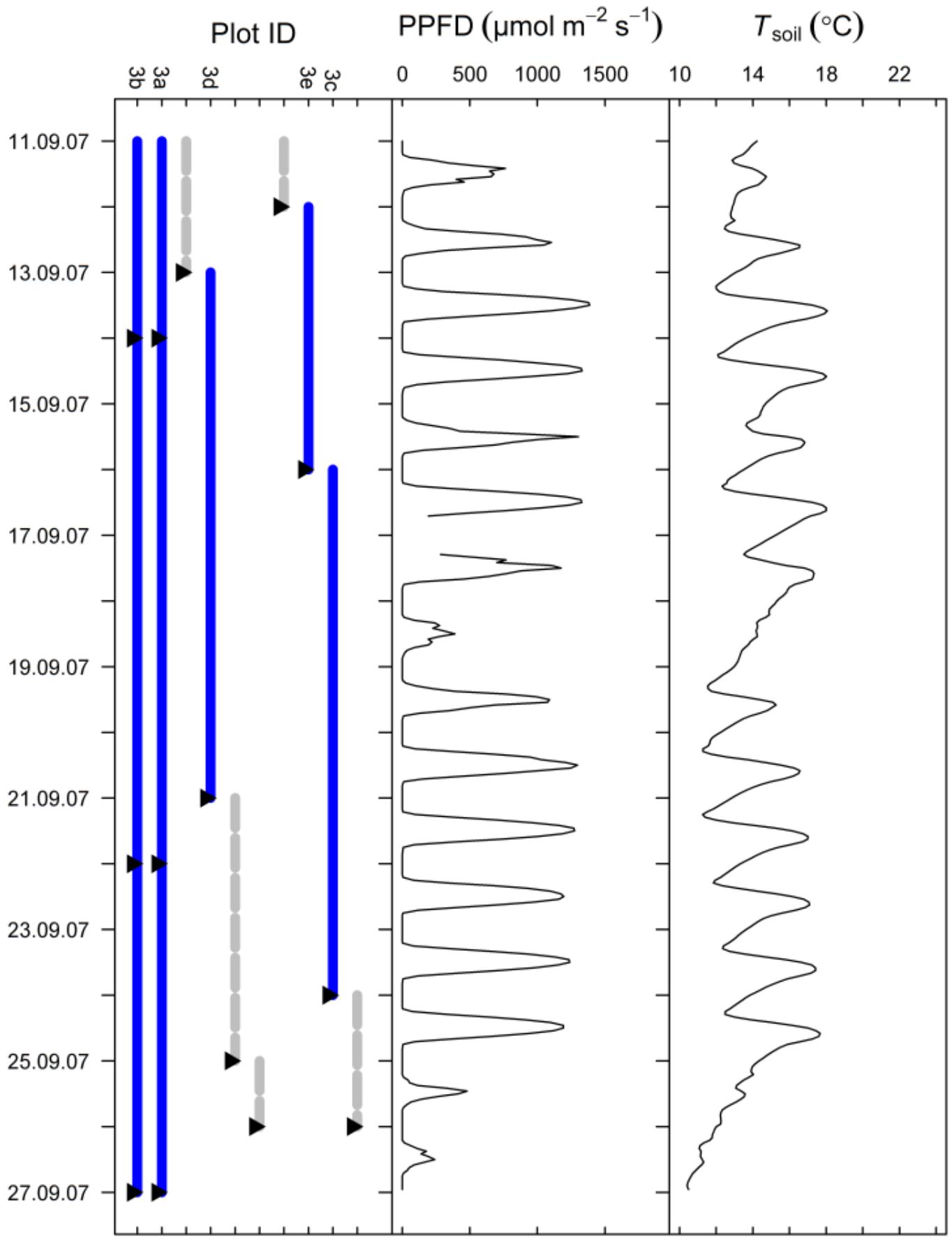
Technische Universität München

Deutsche
Forschungsgemeinschaft

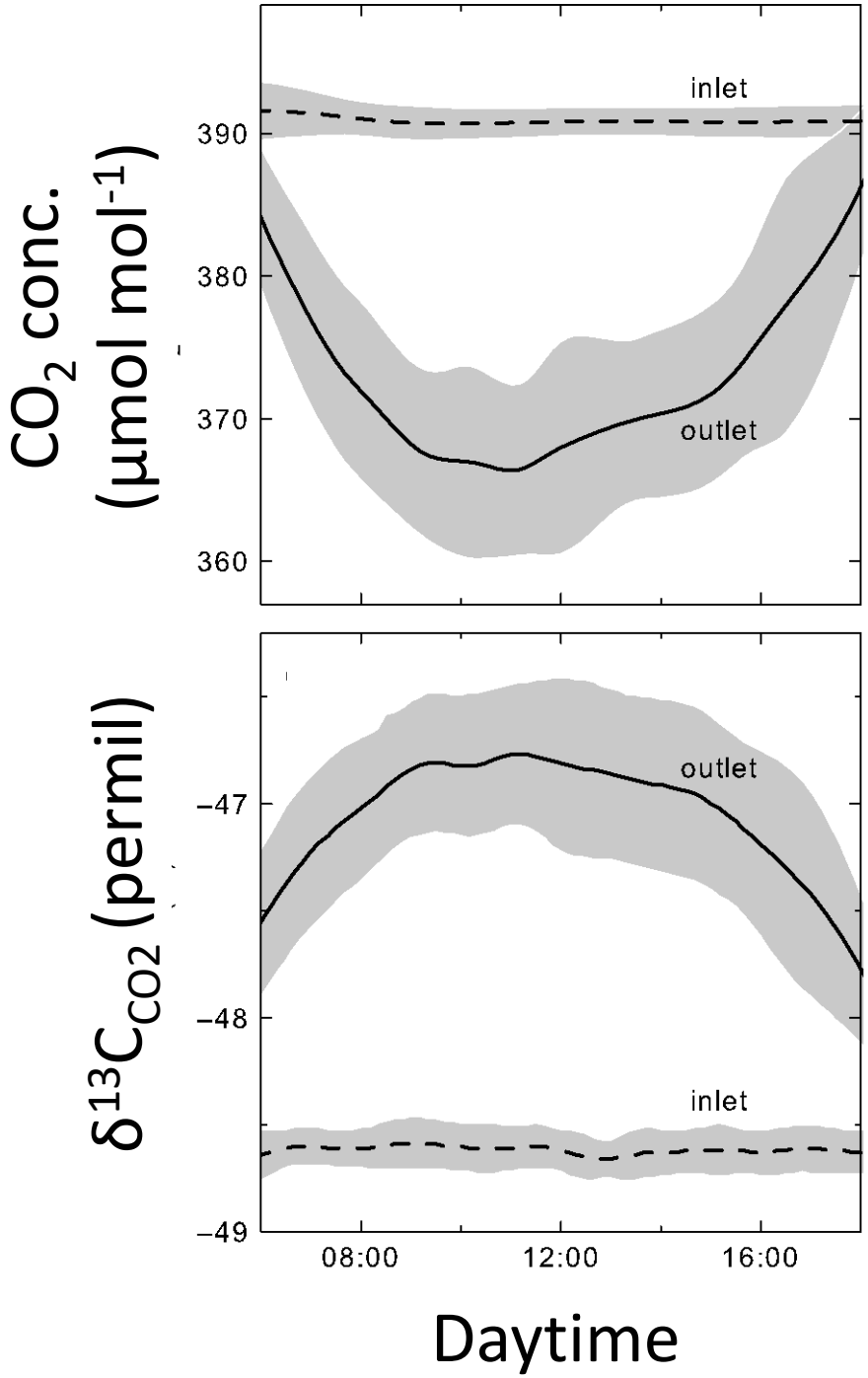
Tracer kinetics in leaf carbohydrates



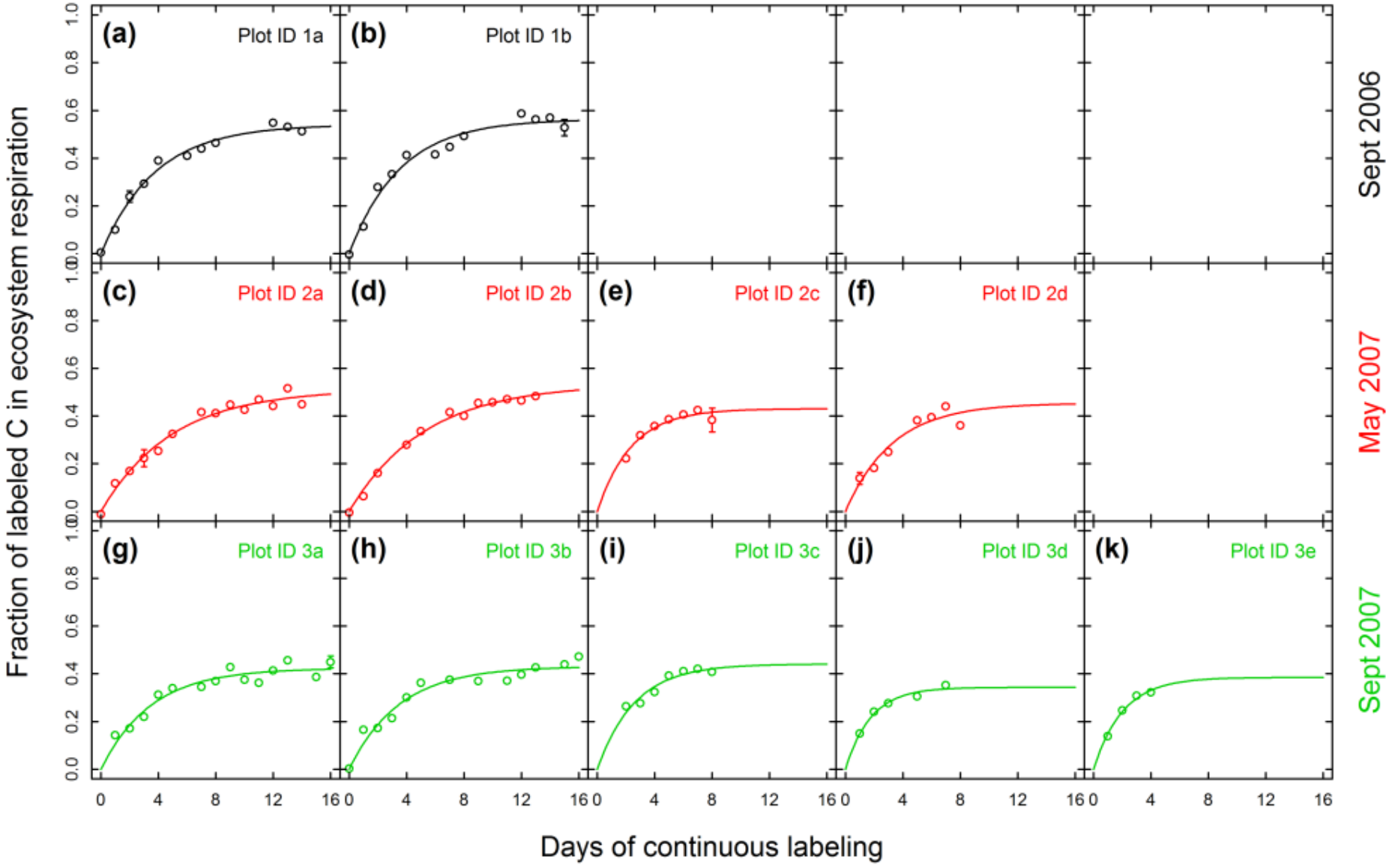
SCHNYDER et al 2017 *Advances in Photosynthesis and Respiration*


Plot ID
PPFD (µmol m^{-2} s^{-1})
T_{soil} (°C)
3b
3a
3d
3e
3c
0
500
1000
1500
10
14
18
22
11.09.07
13.09.07
15.09.07
17.09.07
19.09.07
21.09.07
23.09.07
25.09.07
27.09.07

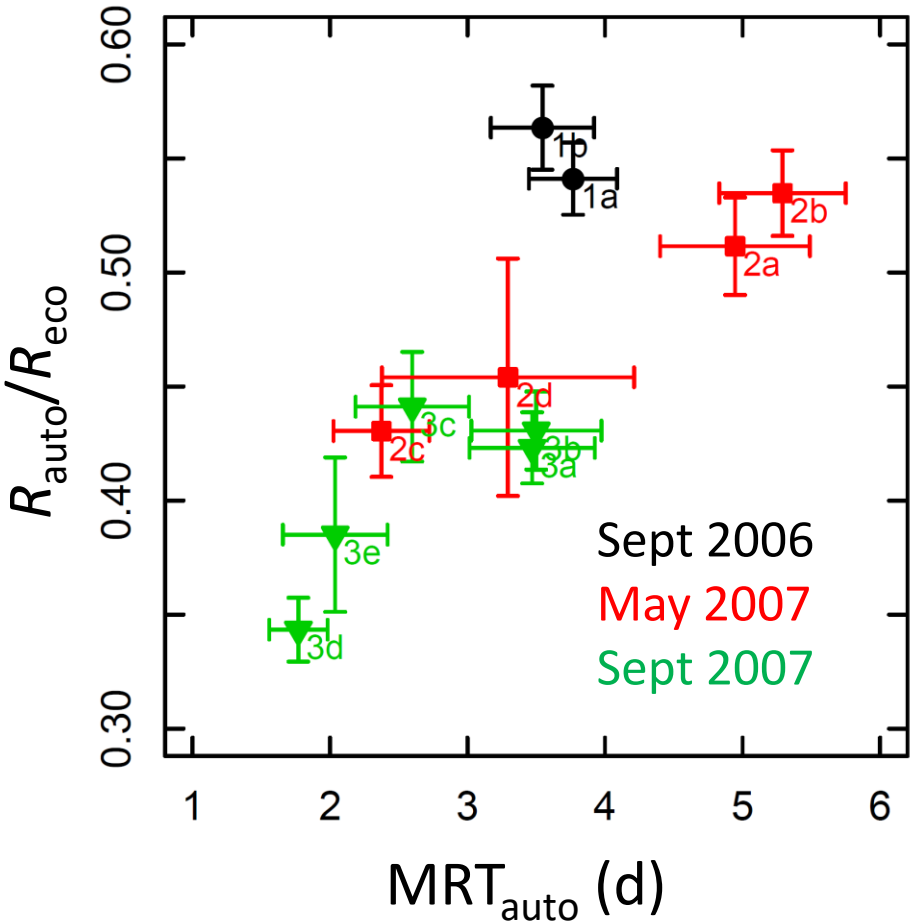
CO_2 concentration and $\delta^{13}C_{CO2}$ during labeling



GAMNITZER et al. 2009 New Phytologist


(a) Plot ID 1a
(b) Plot ID 1b
(c) Plot ID 2a
(d) Plot ID 2b
(e) Plot ID 2c
(f) Plot ID 2d
(g) Plot ID 3a
(h) Plot ID 3b
(i) Plot ID 3c
(j) Plot ID 3d
(k) Plot ID 3e
Sept 2006
May 2007
Sept 2007
Fraction of labeled C in ecosystem respiration
Days of continuous labeling
0.0
0.2
0.4
0.6
0.8
1.0
0
4
8
12
16

Autotrophic contribution to ecosystem respiration correlated with MRT of C in respiratory substrate pool



OSTLER et al. unpublished


Lolium perenne
Poa pratensis
Taraxacum officinale
Trifolium repens

Respiratory substrate from stores at subambient and superambient CO_2