Diurnal and Seasonal Variation of ^{13}C and ^{18}O of Carbon Dioxide in a Norway Spruce Forest Measured with a Tunable Diode Laser Absorption Spectrometer

Nicolas Brüggemann, Hans Papen, Dominik Steigner, Klaus Butterbach-Bahl

Karlsruhe Research Centre
Institute for Meteorology and Climate Research
Atmospheric Environmental Research (IMK-IFU)

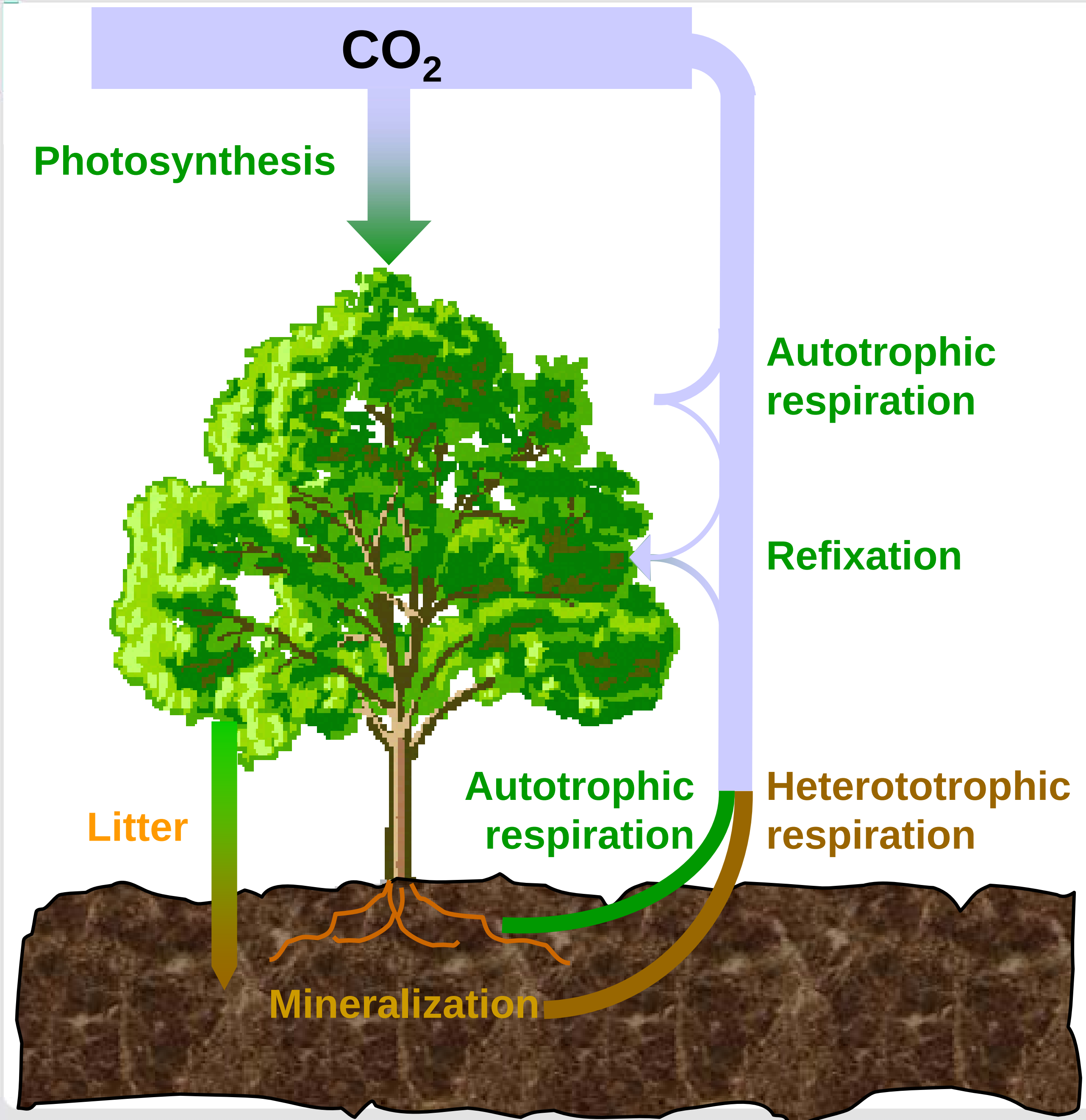
Garmisch-Partenkirchen
Germany

KIT – a Cooperation between
Karlsruhe Research Center
and University of Karlsruhe

Forschungszentrum Karlsruhe
in der Helmholtz-Gemeinschaft
IMK-IFU Garmisch-Partenkirchen

Provided by KITopen

Metadata, citation and similar papers at core.ac.uk



Challenge

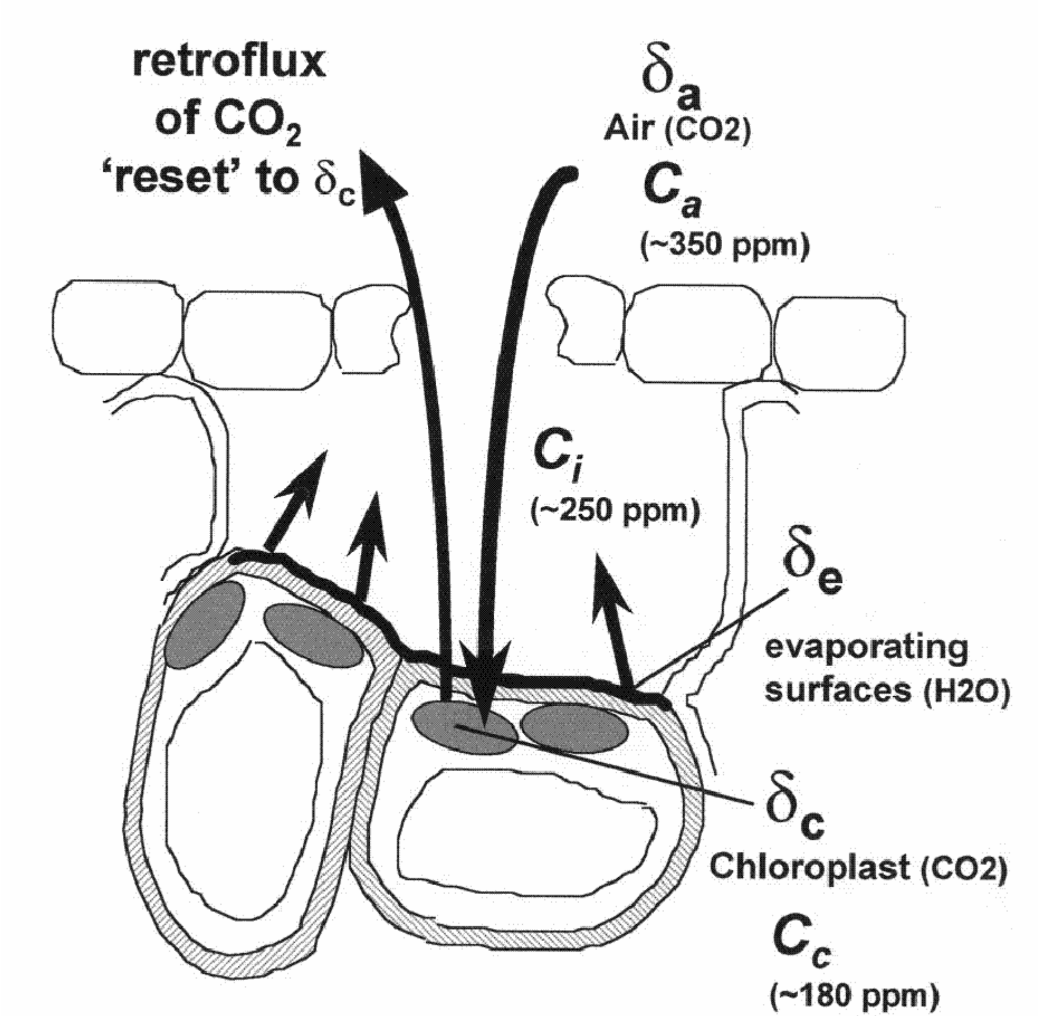
- Disentangling ecosystem CO_2 component fluxes
- Understanding short-term dynamics of CO_2 exchange between ecosystem and atmosphere
- Understanding C fluxes into, within and out of ecosystem

KIT – a Cooperation between
Karlsruhe Research Center
and University of Karlsruhe

HELMHOLTZ GEMEINSCHAFT

Forschungszentrum Karlsruhe
in der Helmholtz-Gemeinschaft
IMK-IFU Garmisch-Partenkirchen

Major steps involved in the ^{18}O isotopic exchange of CO_2 between a C_3 leaf and the atmosphere



Yakir & Sternberg (2000), Oecologia 123, 297–311

Thermodynamic equilibration

$H_2^{16}O + C^{18}O^{16}O$

$\leftrightarrow H_2^{18}O + C^{16}O^{16}O$

catalyzed by carbonic anhydrase

As soil water and leaf water have significantly different $^{18}O/^{16}O$ ratios, a differentiation between plant and soil CO_2 fluxes is possible

TDL instrument: TGA100A (Campbell Scientific, USA)

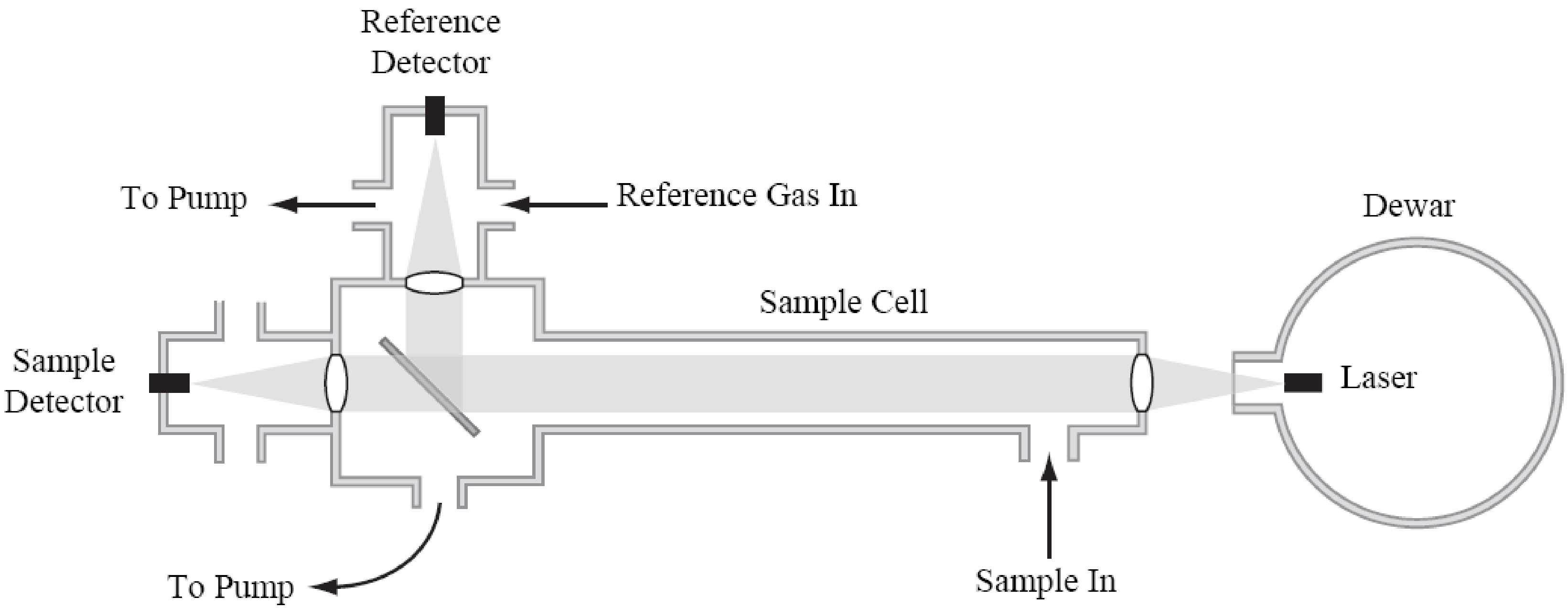


FIGURE OV2.1-1. Schematic Diagram of TGA100A Optical System

KIT – a Cooperation between
Karlsruhe Research Center
and University of Karlsruhe

Forschungszentrum Karlsruhe
in der Helmholtz-Gemeinschaft
IMK-IFU Garmisch-Partenkirchen

Instrumental setup for CO_2 isotope measurements

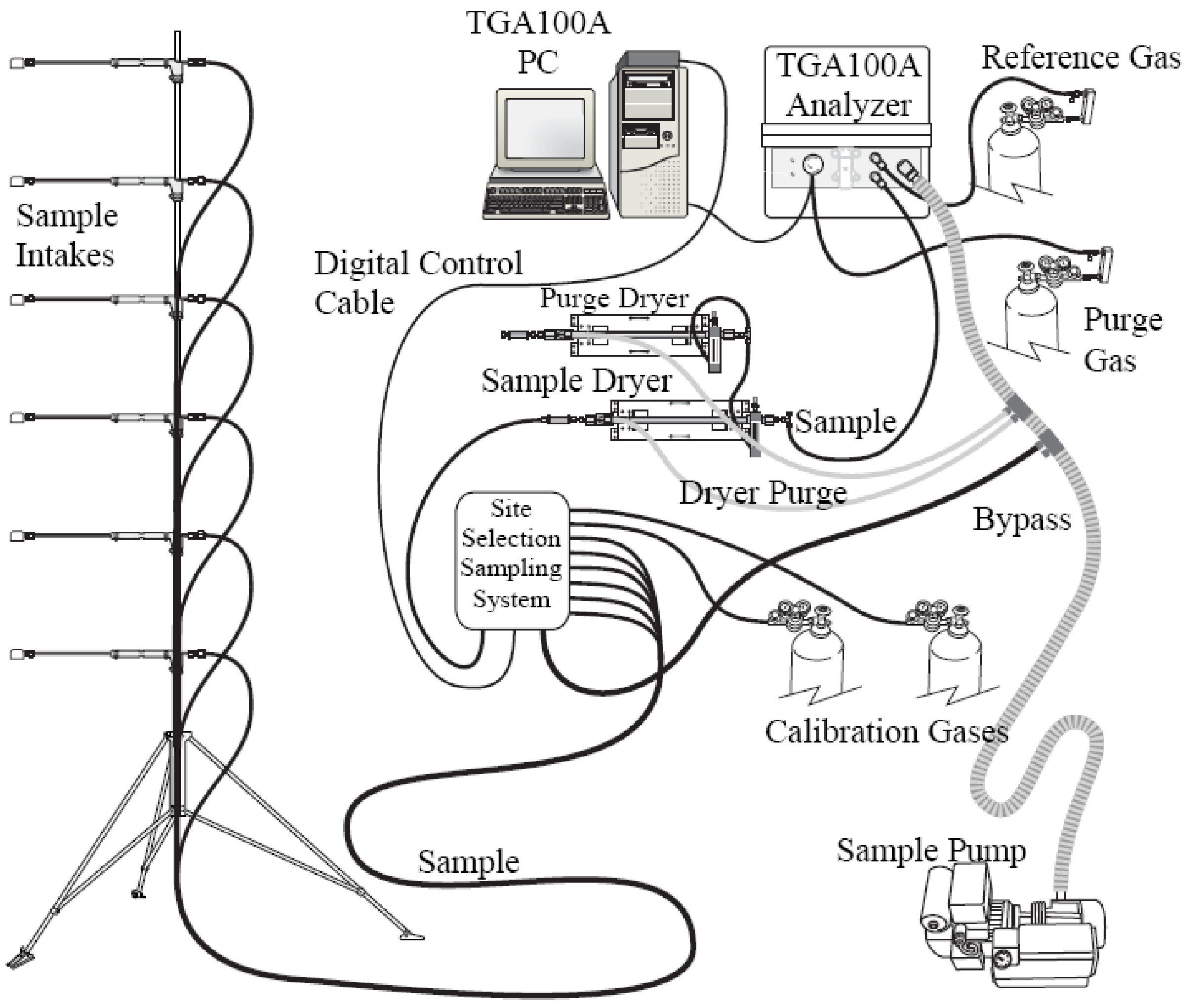


FIGURE OV6.4-1. Example CO_2 Isotope Application

KIT – a Cooperation between
Karlsruhe Research Center
and University of Karlsruhe

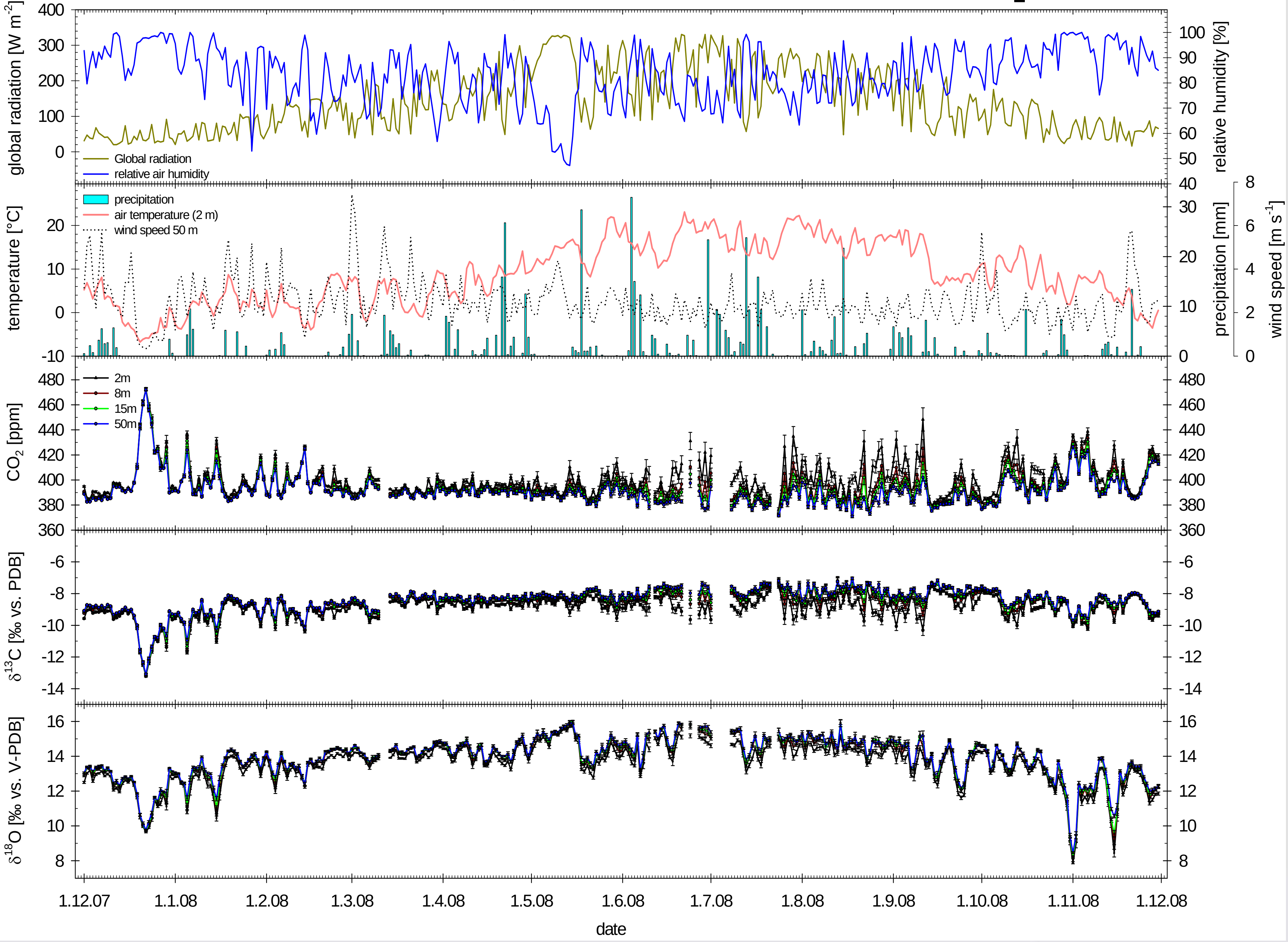
Forschungszentrum Karlsruhe
in der Helmholtz-Gemeinschaft
IMK-IFU Garmisch-Partenkirchen

Isotope-specific measurements of

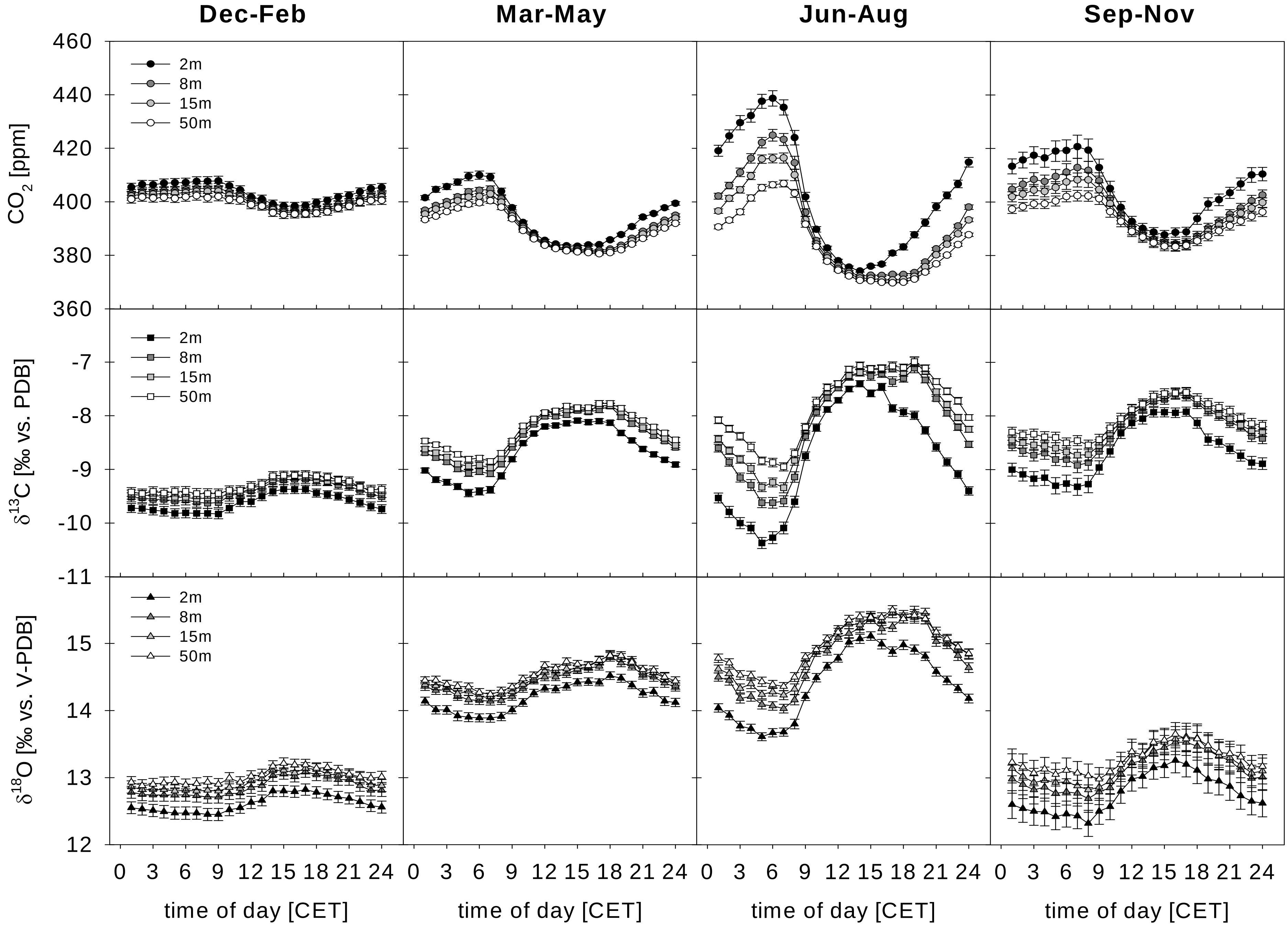
CO_2 profiles

soil respiration

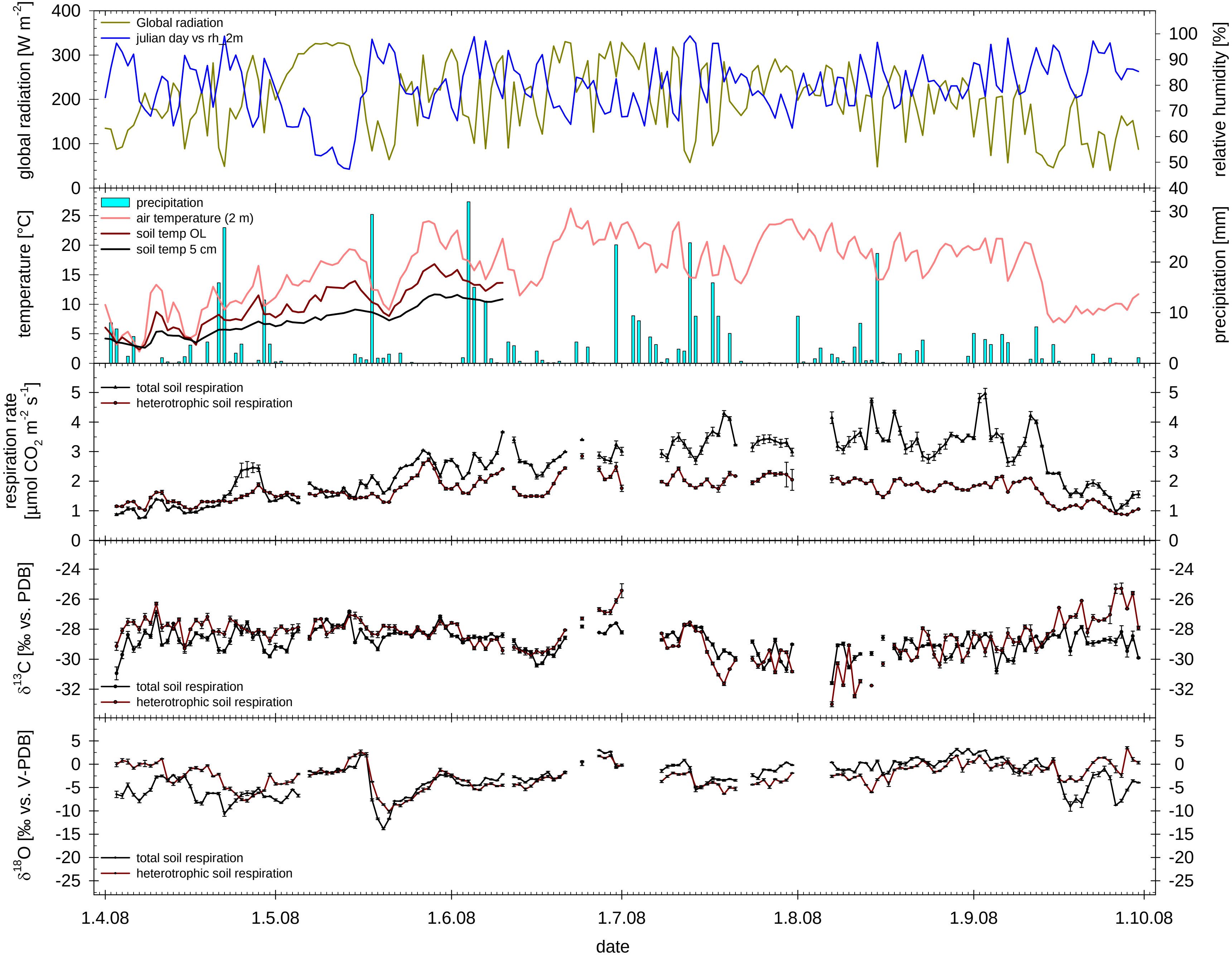
Seasonal courses of meteorological params and ecosystem CO_2, $\delta^{13}C$ & $\delta^{18}O$



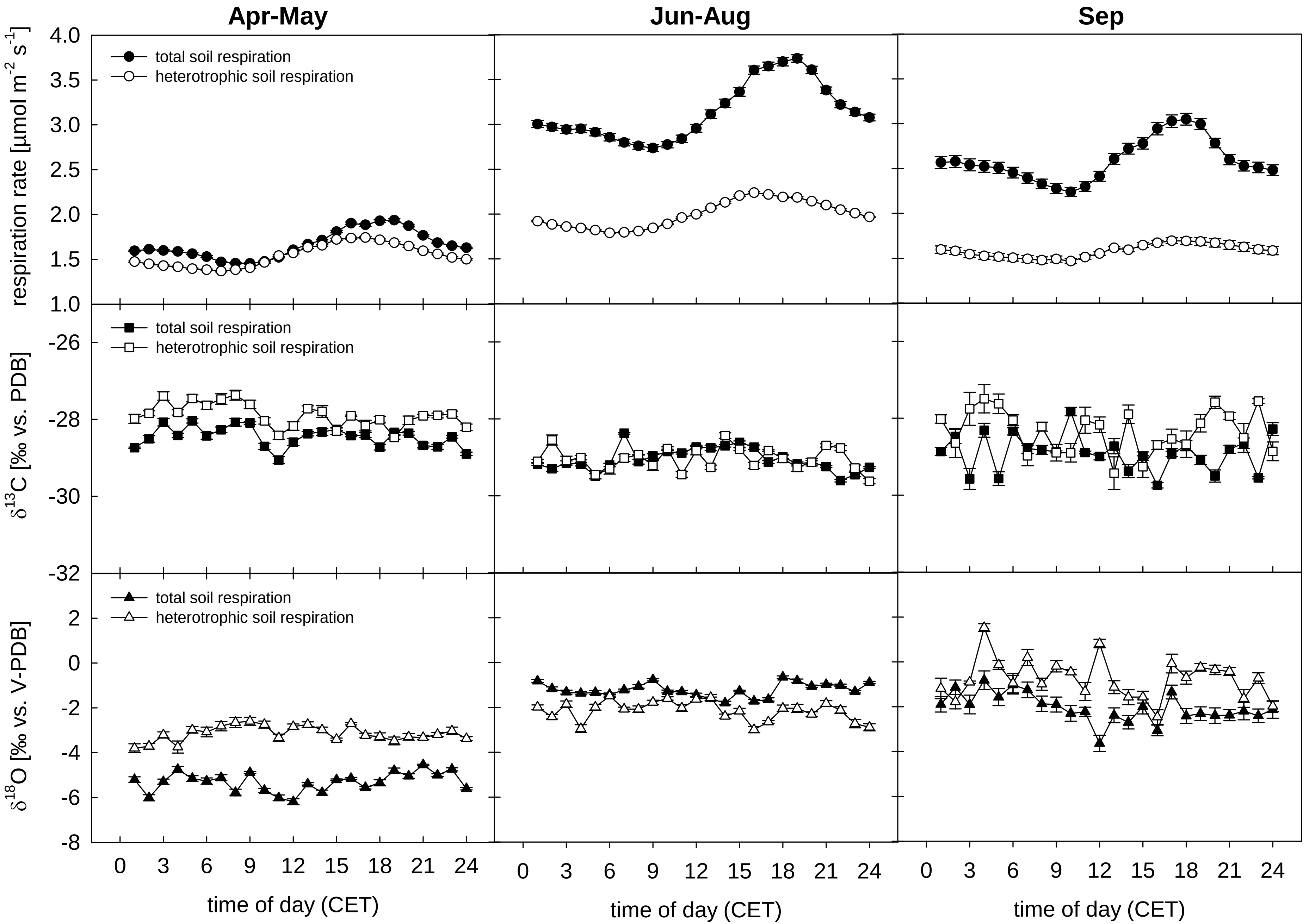
Seasonal variability of diurnal cycles of ecosystem CO_2, $\delta^{13}C$ & $\delta^{18}O$



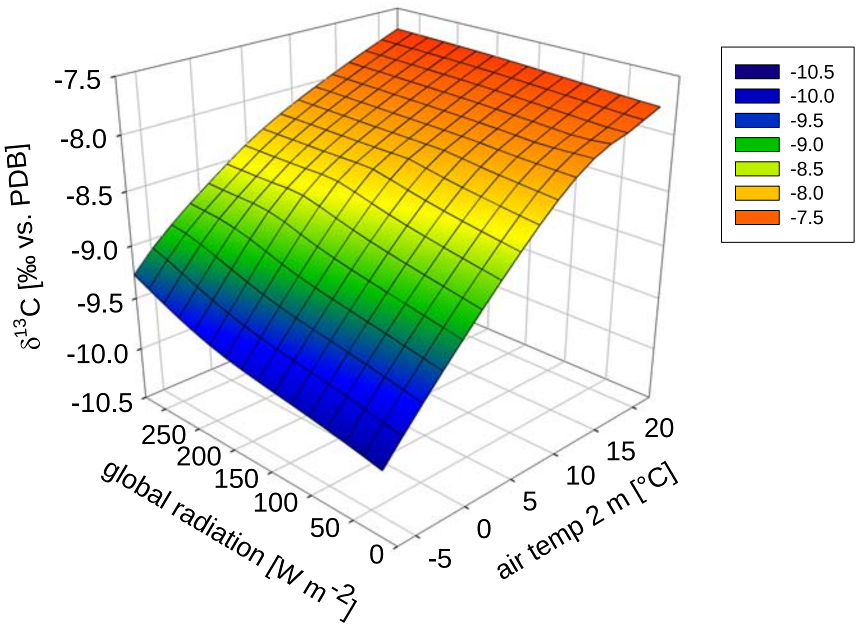
Seasonal courses of meteorological params and soil CO_2, $\delta^{13}C$ & $\delta^{18}O$

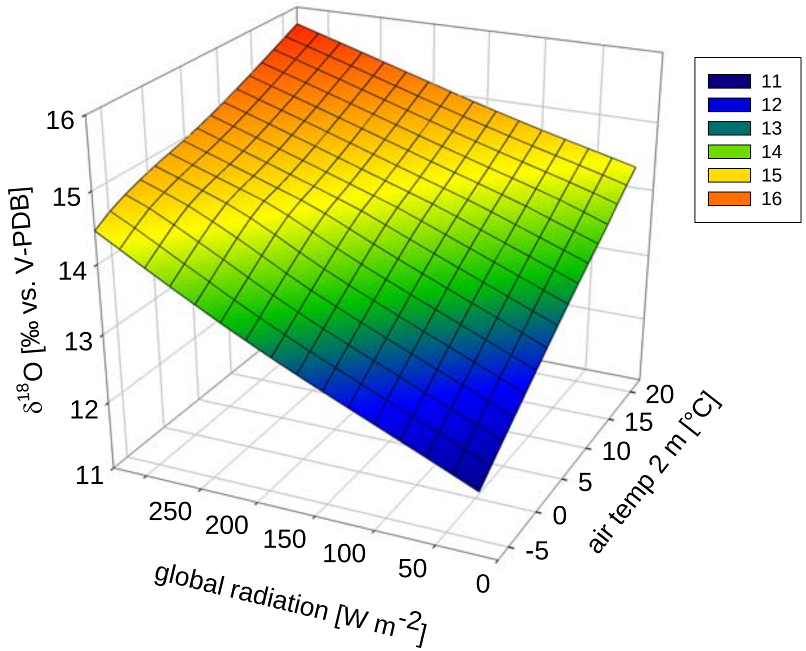


Seasonal variability of diurnal cycles of soil CO_2, $\delta^{13}C$ & $\delta^{18}O$



Dependency of δ¹³C & δ¹⁸O of ecosystem CO_2 on air temperature & global radiation

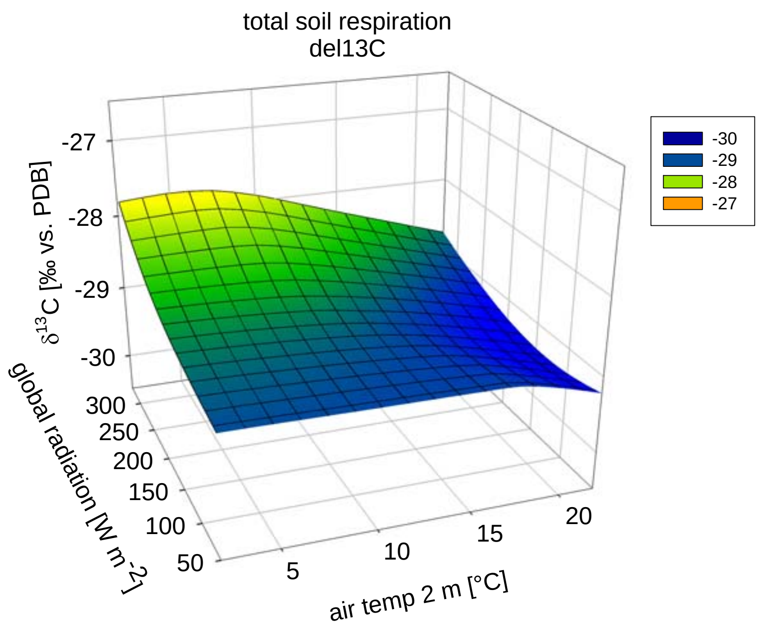


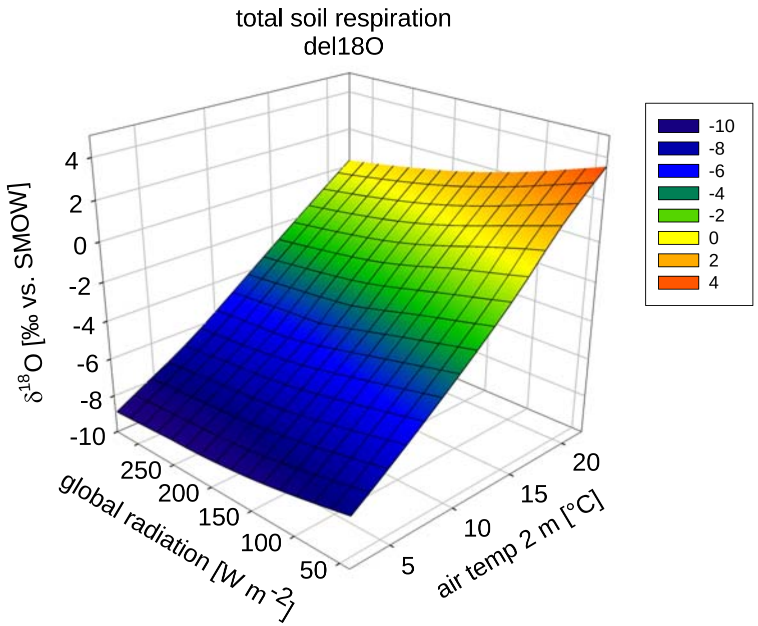


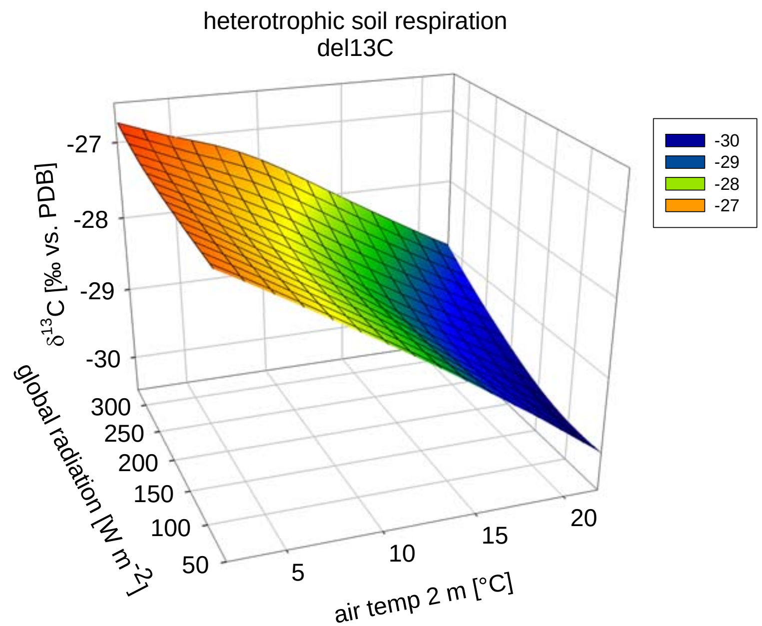
KIT – a Cooperation between
Karlsruhe Research Center
and University of Karlsruhe

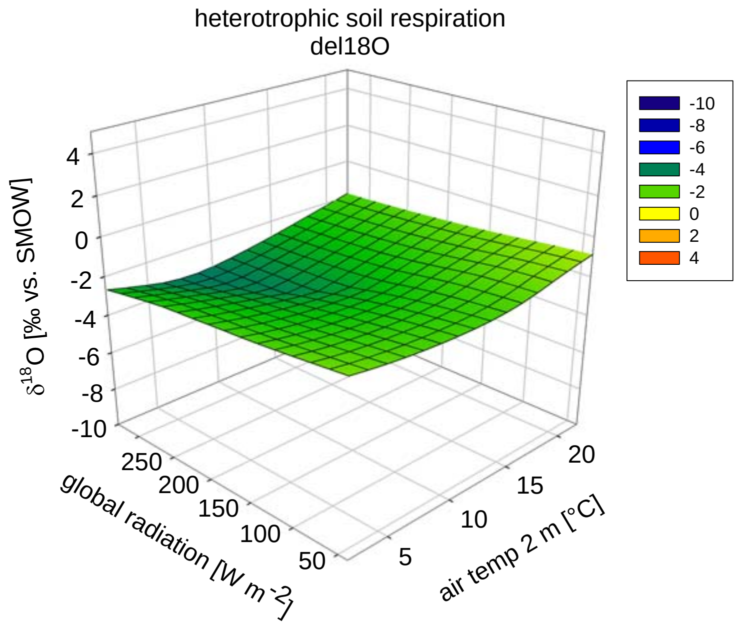
Forschungszentrum Karlsruhe
in der Helmholtz-Gemeinschaft
IMK-IFU Garmisch-Partenkirchen

Dependency of $\delta^{13}C$ & $\delta^{18}O$ of total and heterotrophic soil respiration on air temperature & global radiation









KIT – a Coopera
Karlsruhe Rese
and University c

Conclusions

Karlsruhe Institute of Technology

- Isotope-specific laser absorption spectroscopy is an extremely powerful tool for long-term monitoring of C and O isotope ratios of CO_2 with high time resolution
- There are significant seasonal differences in $\delta^{13}C$ and $\delta^{18}O$ of ecosystem CO_2, with the highest values in summer at high temperatures and high light intensities
- There is a significant differences not only in the magnitude, but also in C and O isotope ratios of soil respired CO_2