Recent insights from $^{13}CO_2$ observations at AmeriFlux/BASIN sites: developing contributions to the NACP

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University of Utah

BASIN

Biosphere-Atmosphere Stable Isotope Network

Workshops
Symposia

Research
coordination

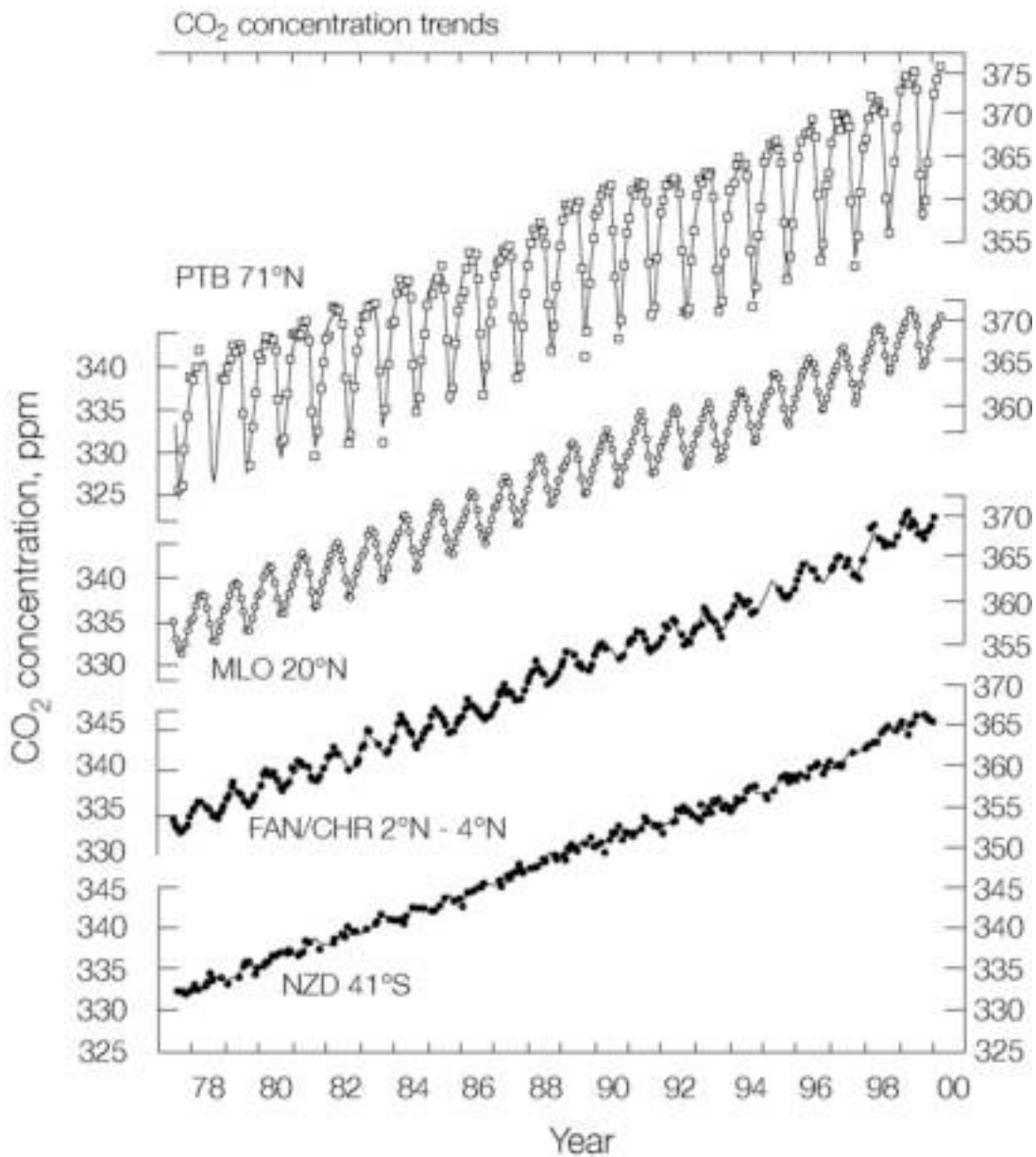
Data
syntheses

Student
Postdoc
training

Database
development

http://BASINisotopes.org

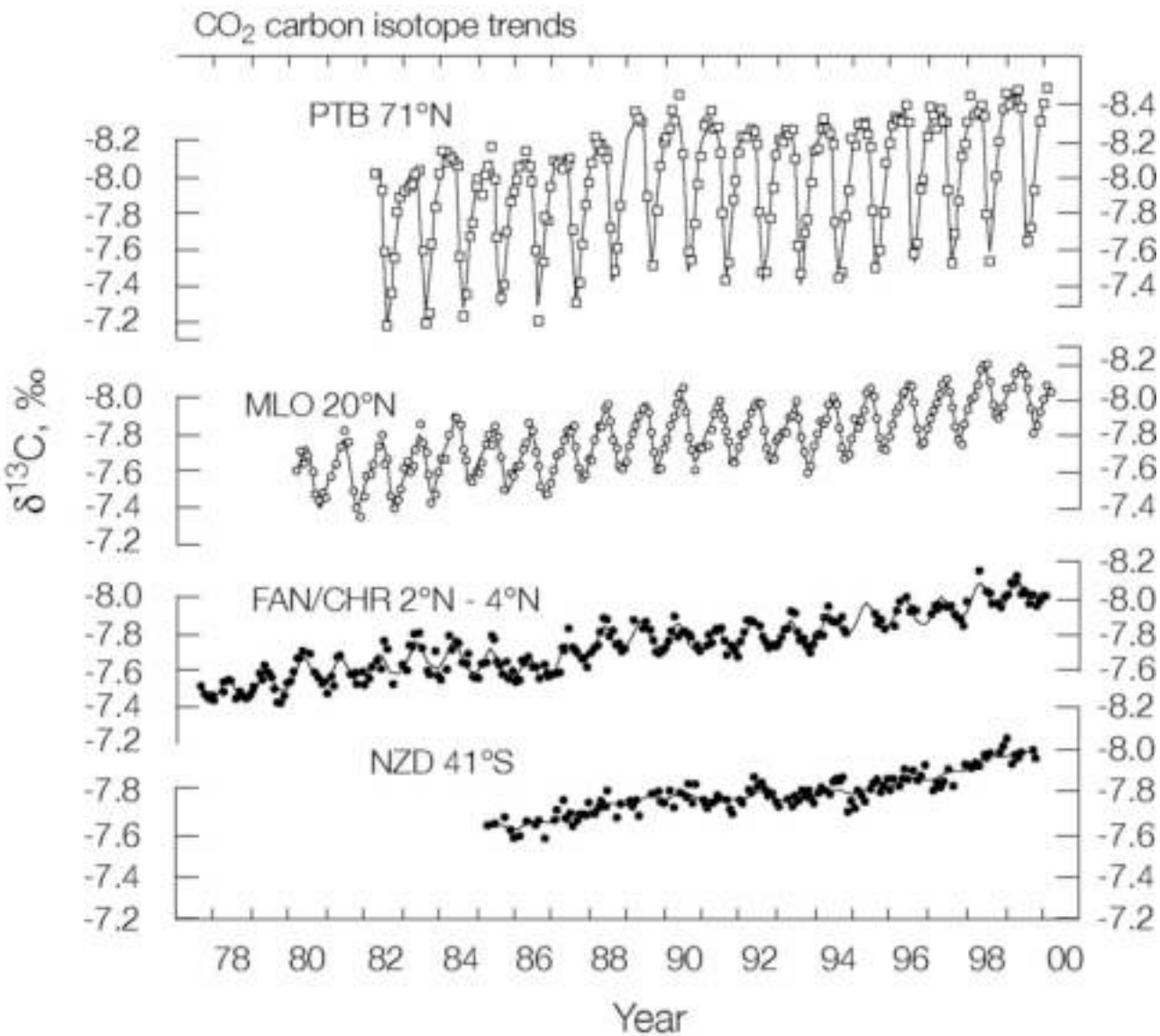
Research Coordination Network



Dave Keeling

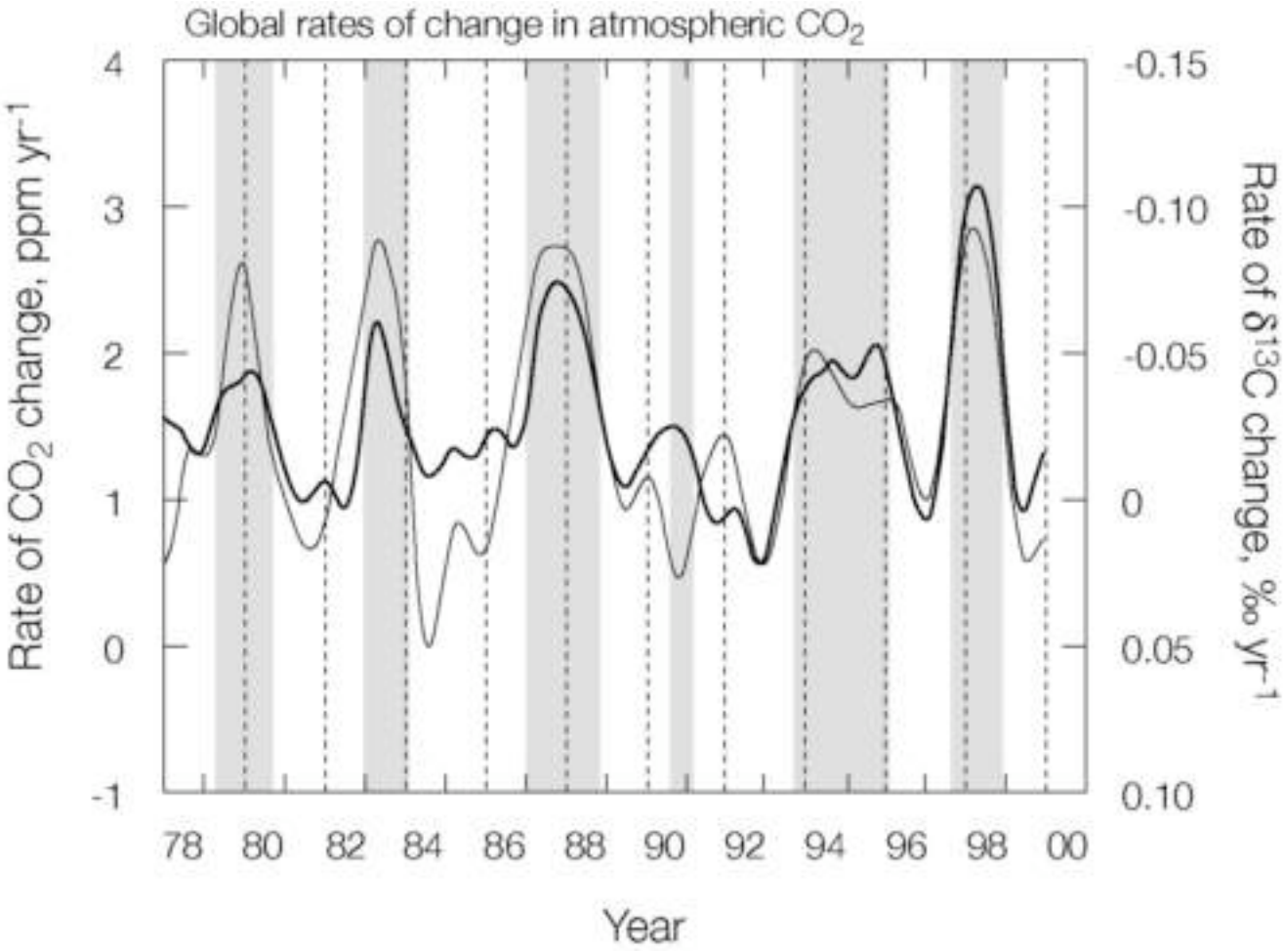
data from Dave Keeling

. . . and you can get stable isotopes from same flask network

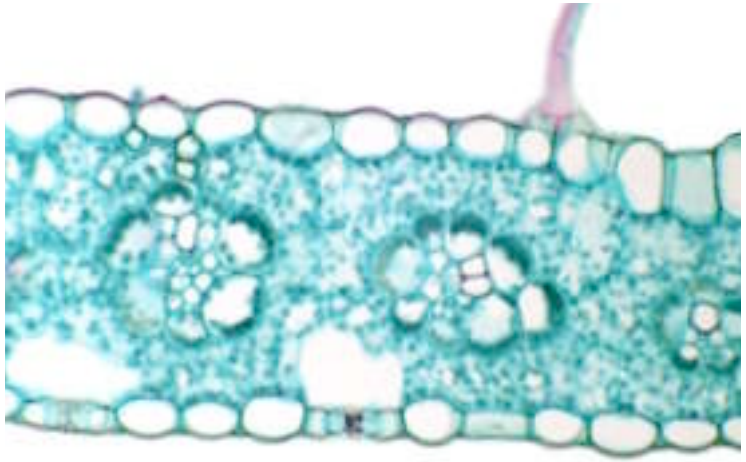


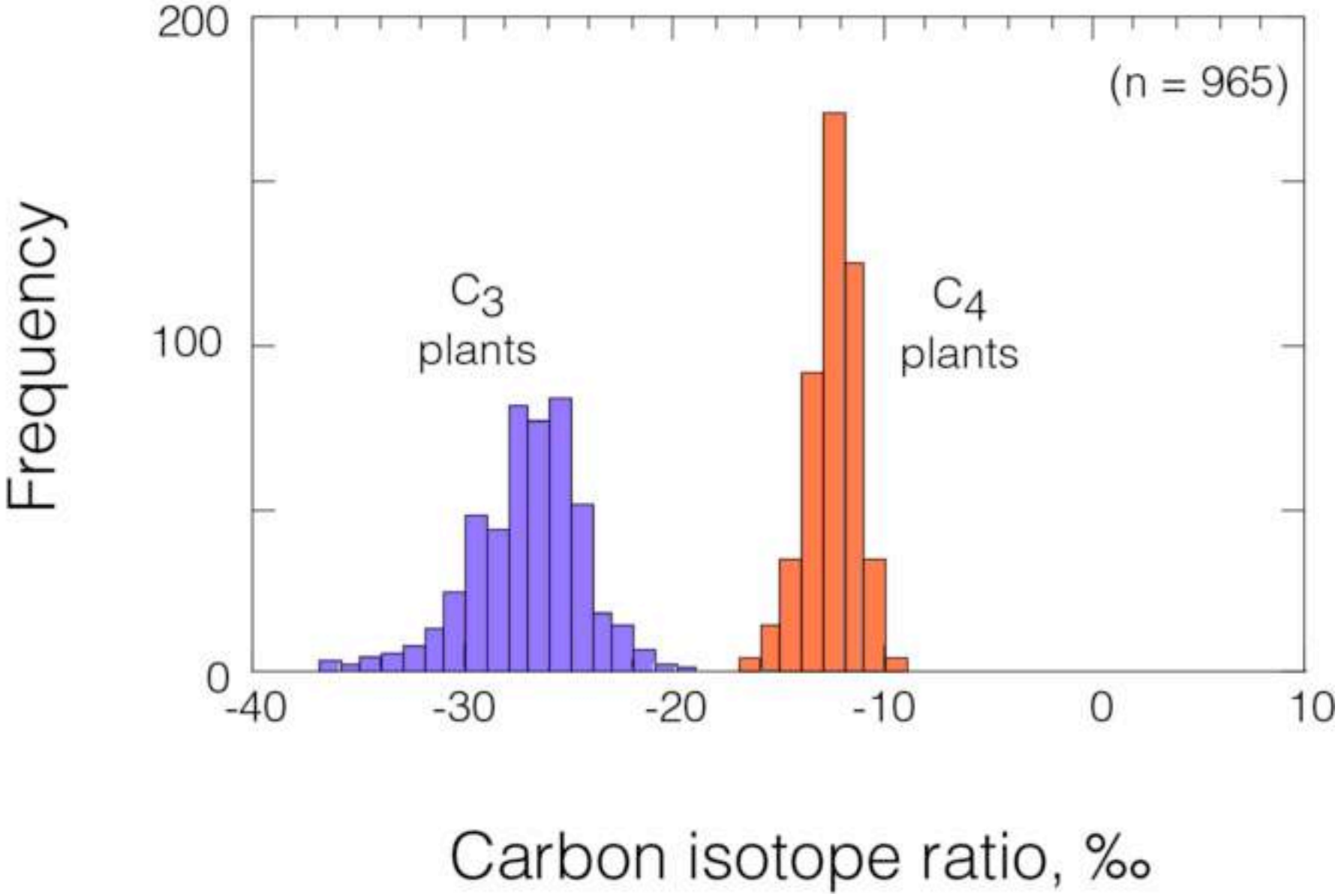
from Dave Keeling

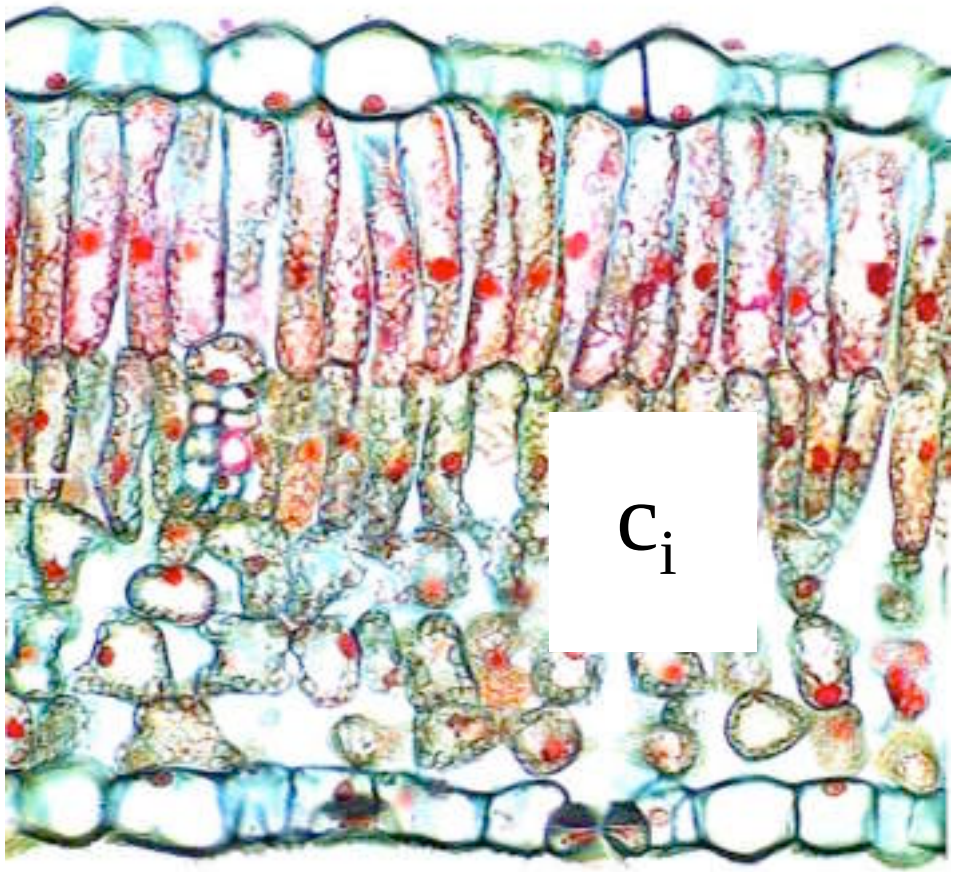
There is a remarkable correlation between [CO_2] and $\delta^{13}C$ changes



from Dave Keeling

C_3		~ 90 %
C_4		~ 10 %


200
100
0
Frequency
(n = 965)
C3
plants
C4
plants
-40
-30
-20
-10
0
10
Carbon isotope ratio, ‰



$CO_2 \Rightarrow CH_2O$

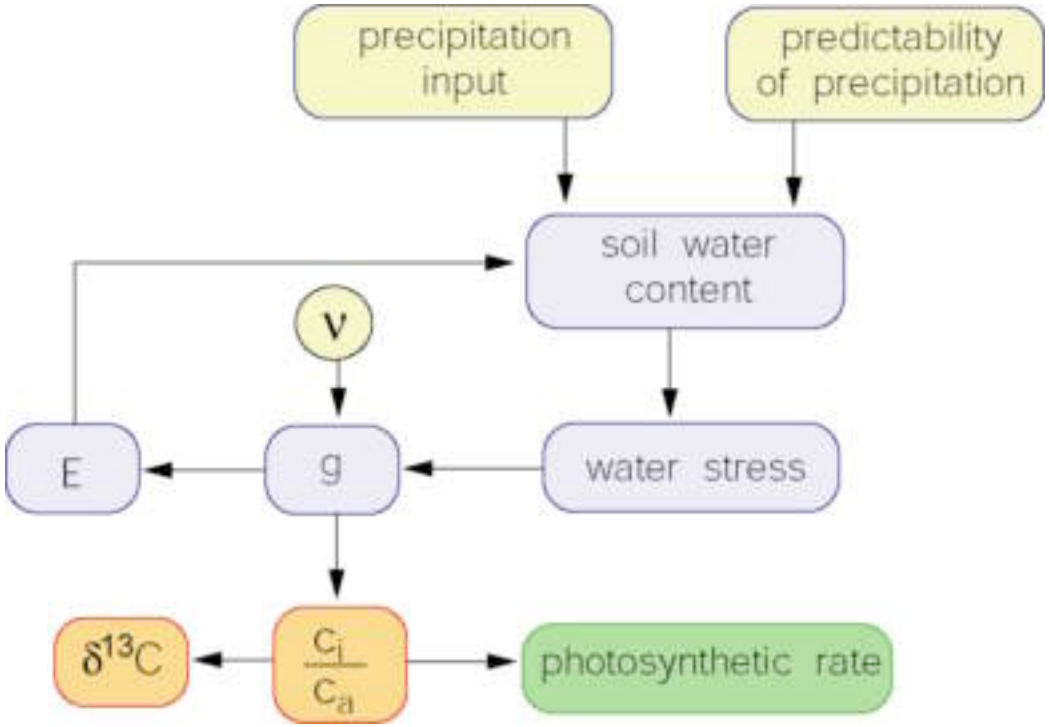
b = 27 ‰

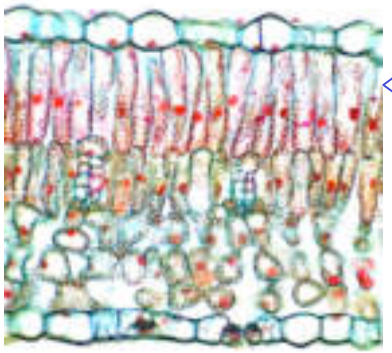
$^{13}CO_2$

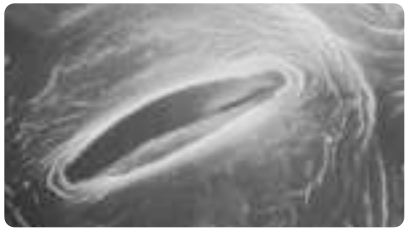
a = 4.4 ‰

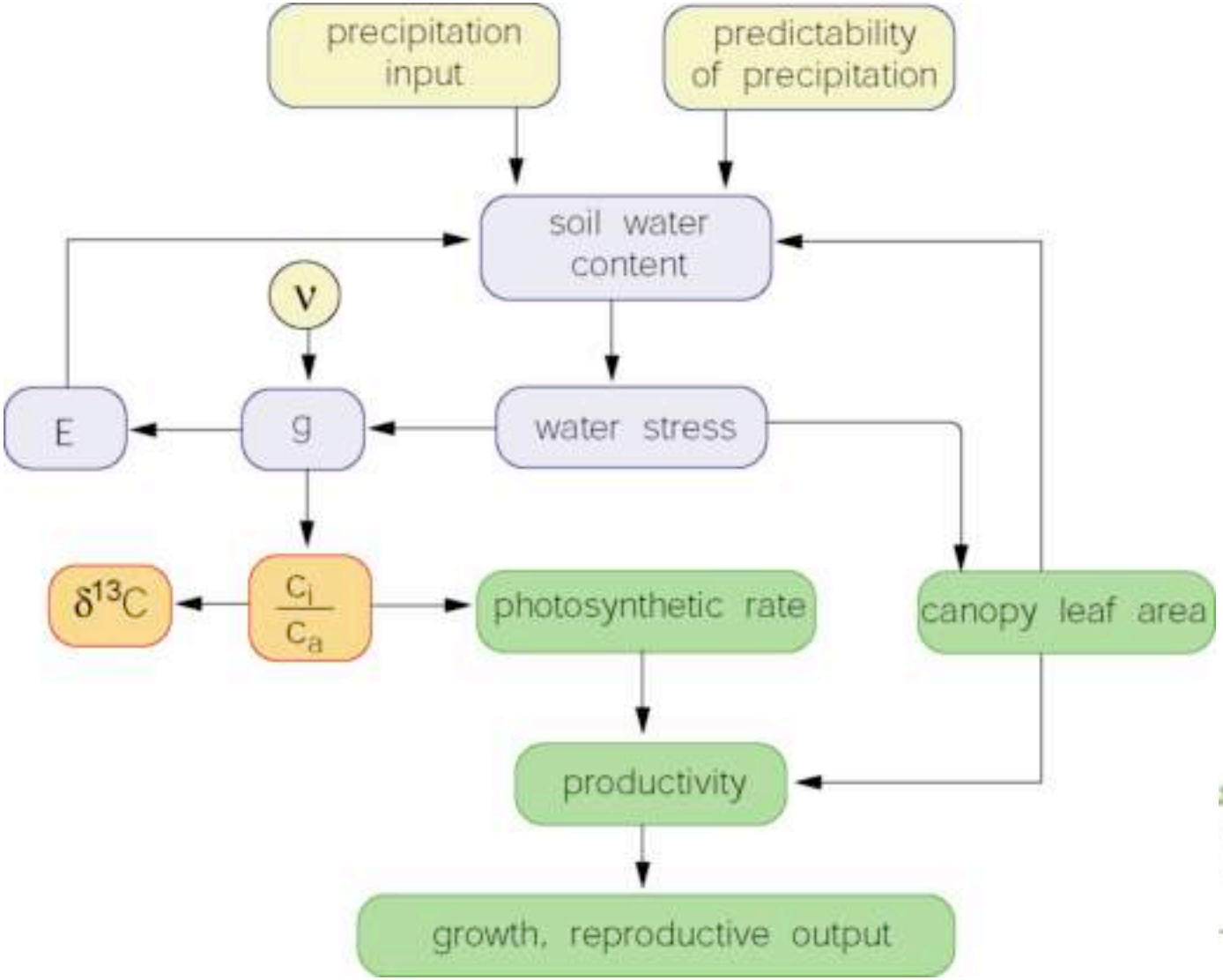
c_a

$$\delta^{13}C_p = \delta^{13}C_a - a - (b - a)c_i/c_a$$


precipitation input
predictability of precipitation
soil water content
ν
E
g
water stress
δ13C
ci/ca
photosynthetic rate






precipitation input
predictability of precipitation
soil water content
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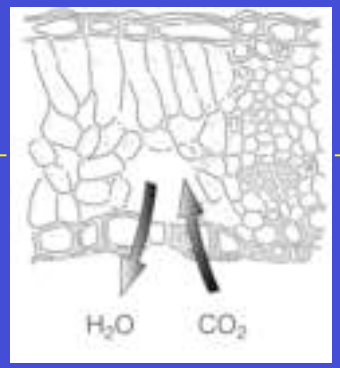
photosynthetic rate
canopy leaf area
productivity
growth, reproductive output

Factors influencing isotopic content of ecosystem respiration



$\delta^{13}C$ of respired CO_2

stomatal conductance

c_i/c_a

photosynthesis

$\delta^{13}C$ of fixed carbon

faster (days)

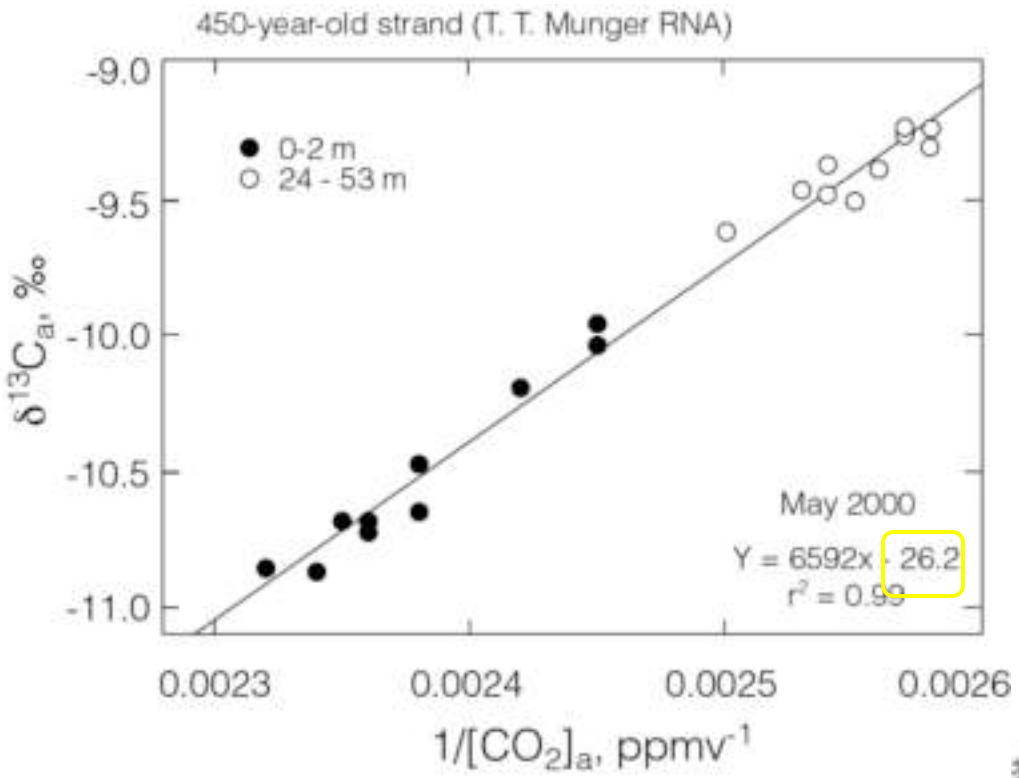
foliar respiration

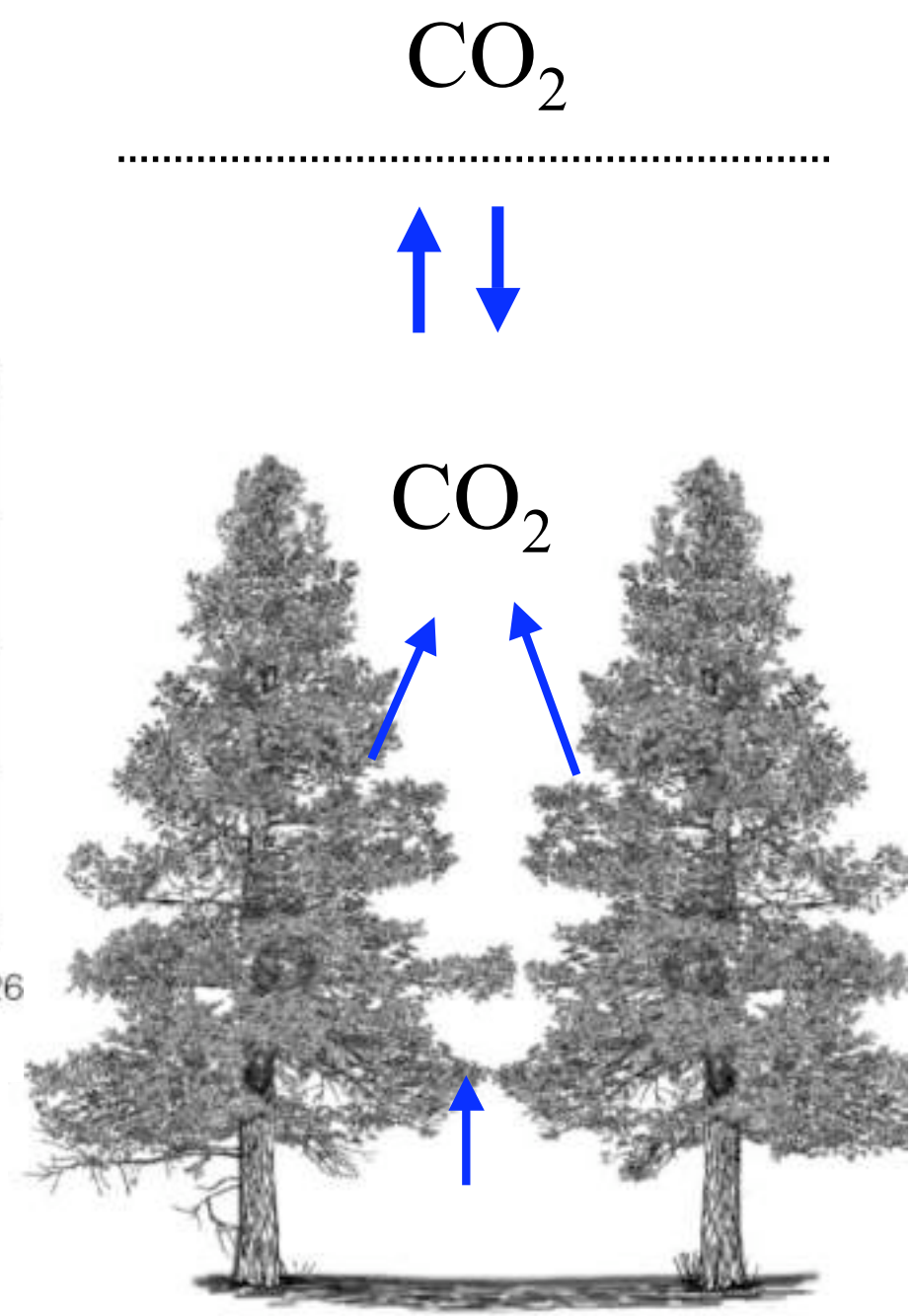
root/rhizosphere respiration

decomp of SOM

slower (years to decades)

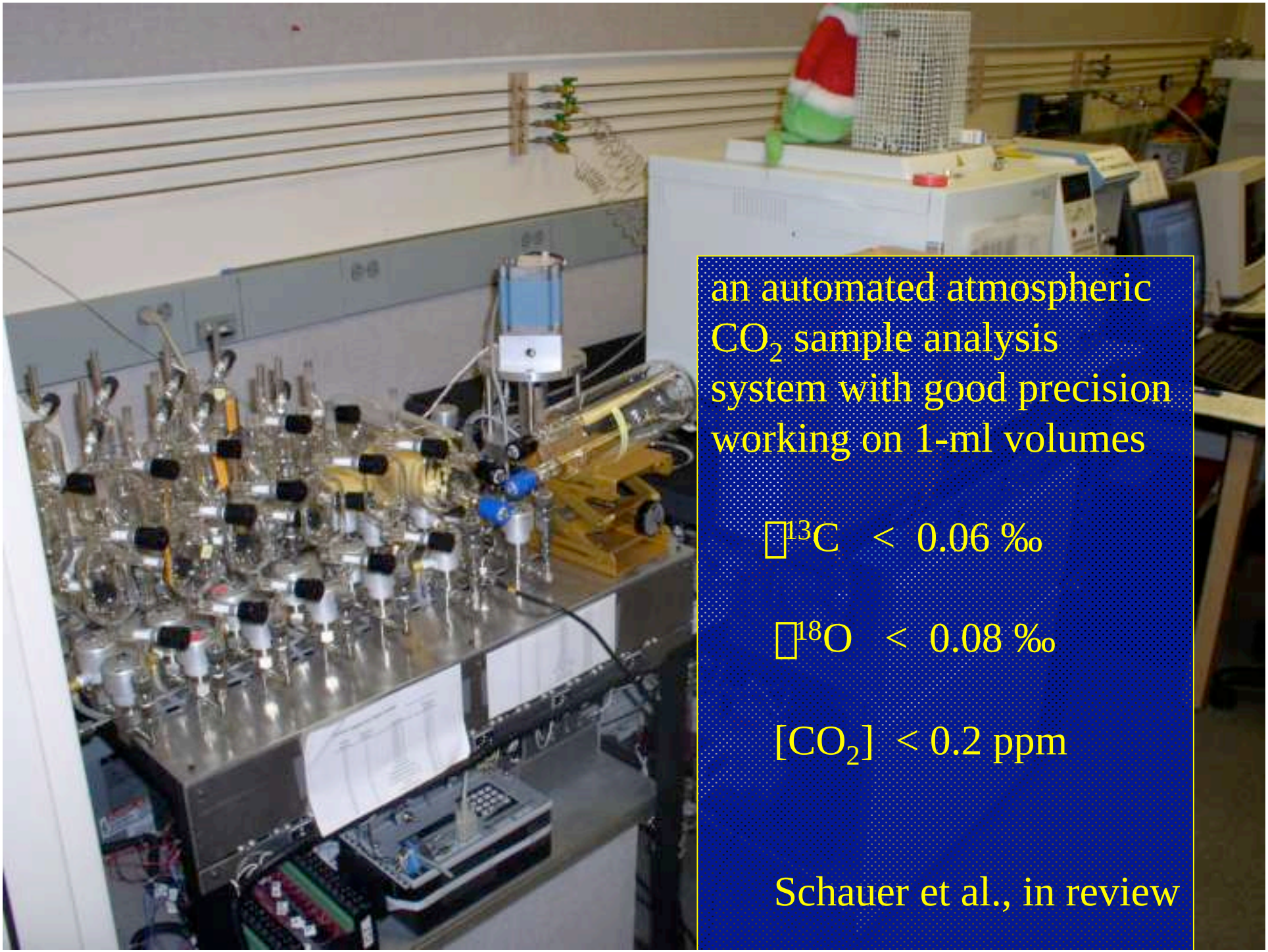
a Keeling plot





$$\delta^{13}C_p = \delta^{13}C_a - a - (b - a)c_i/c_a$$

Andrew Schauer



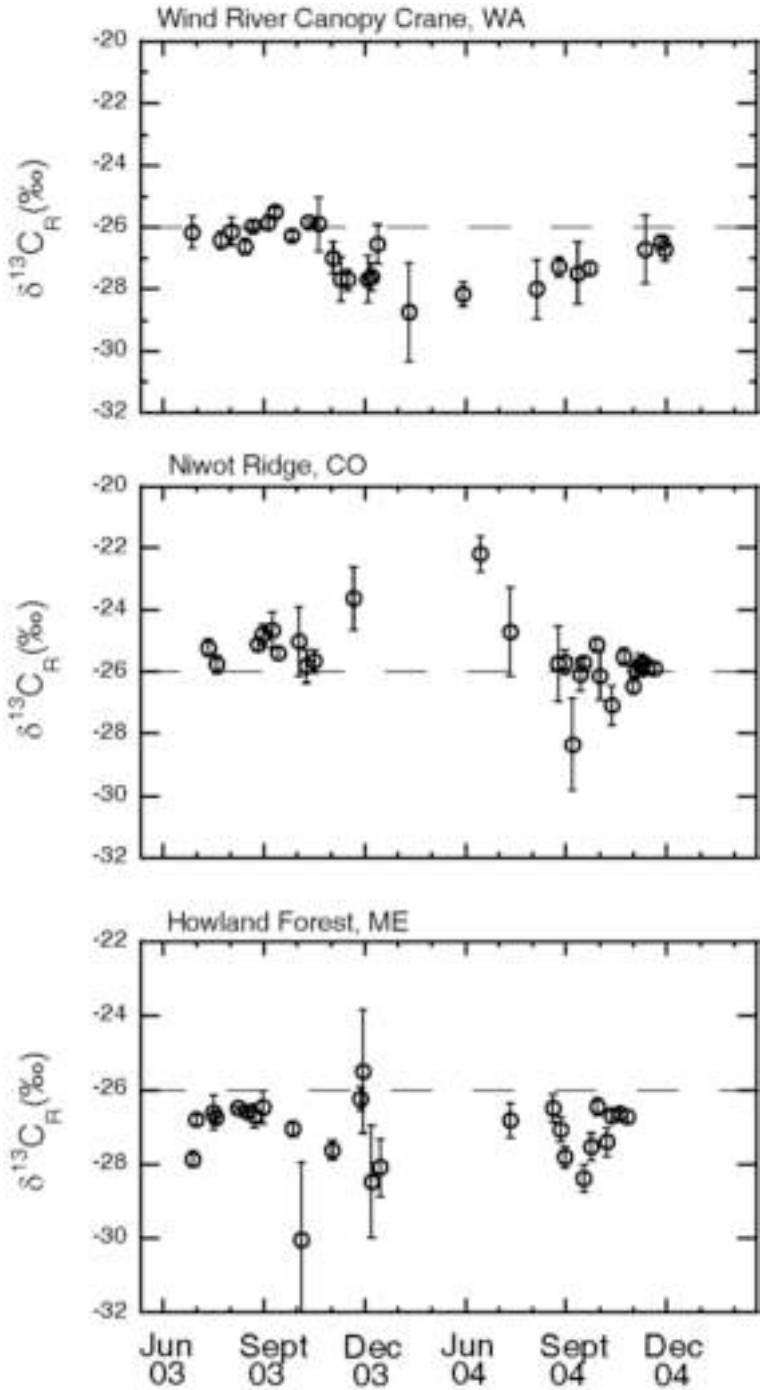
an automated atmospheric CO_2 sample analysis system with good precision working on 1-ml volumes

$\delta^{13}C$ < 0.06 ‰

$\delta^{18}O$ < 0.08 ‰

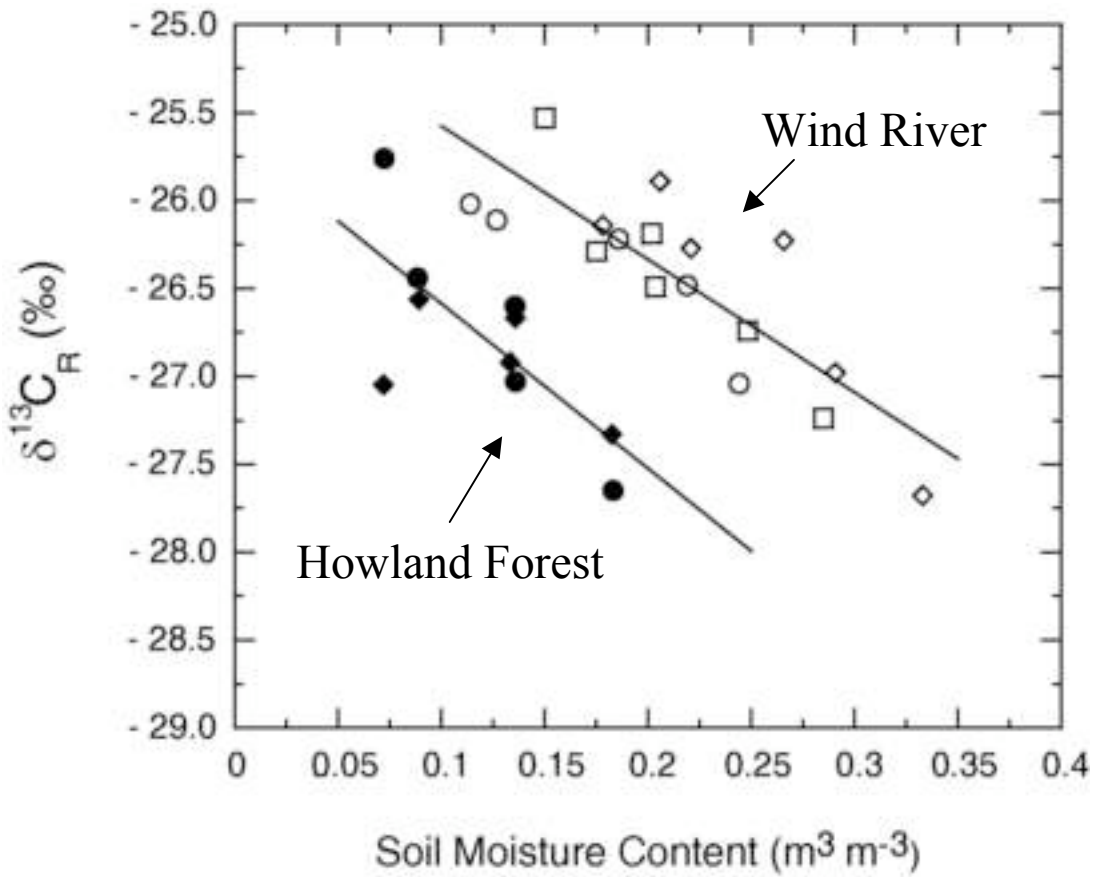
$[CO_2]$ < 0.2 ppm

Schauer et al., in review

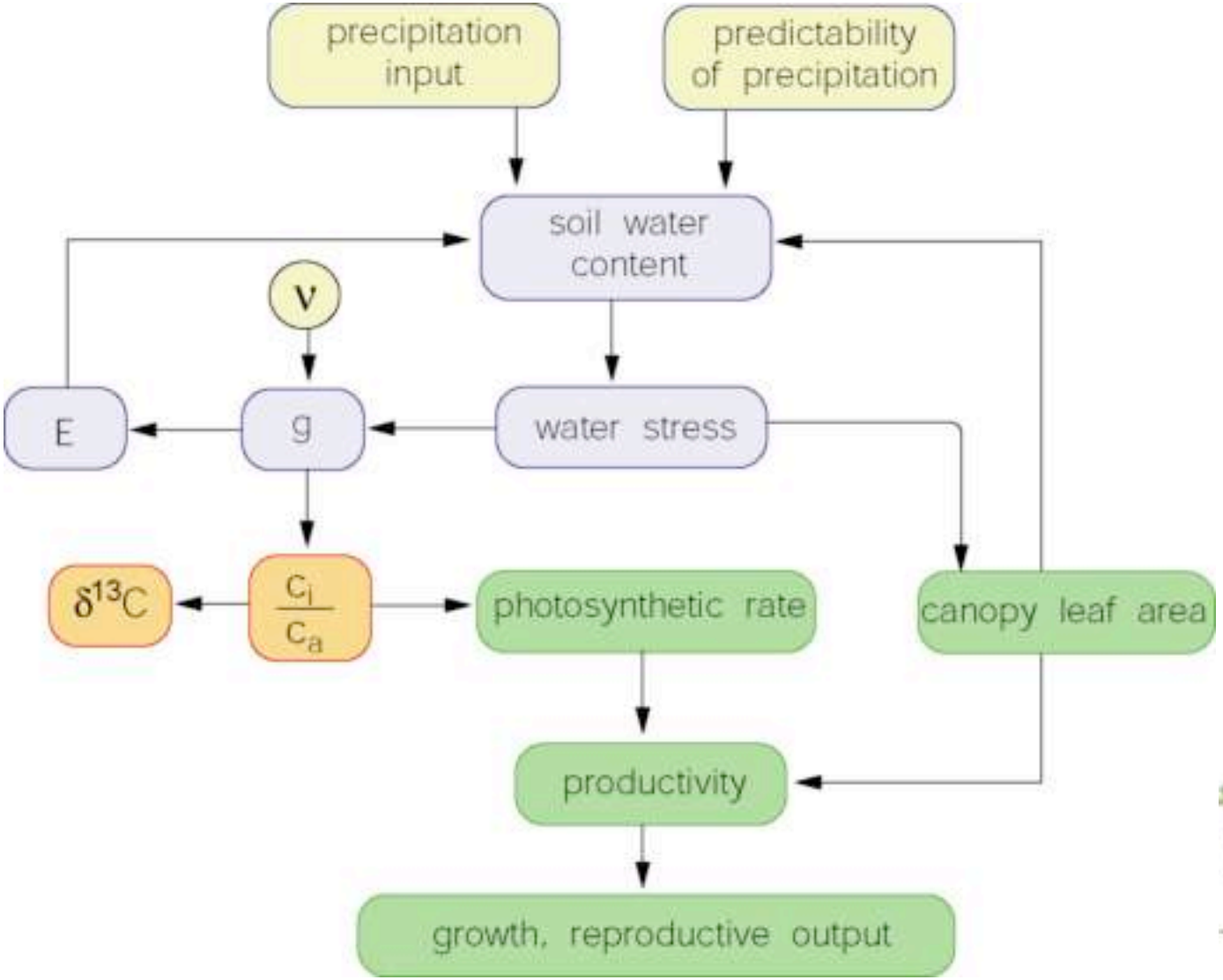


Seasonal patterns of carbon isotope ratios of respired CO_2 fluxes in 3 coniferous forests, representing western, montane and eastern U.S. respectively (from top to bottom).

The $\delta^{13}C_R$ values were closely correlate with the water availability, suggesting a strong stomatal control of canopy gas exchange.



Lai et al. GCB, in press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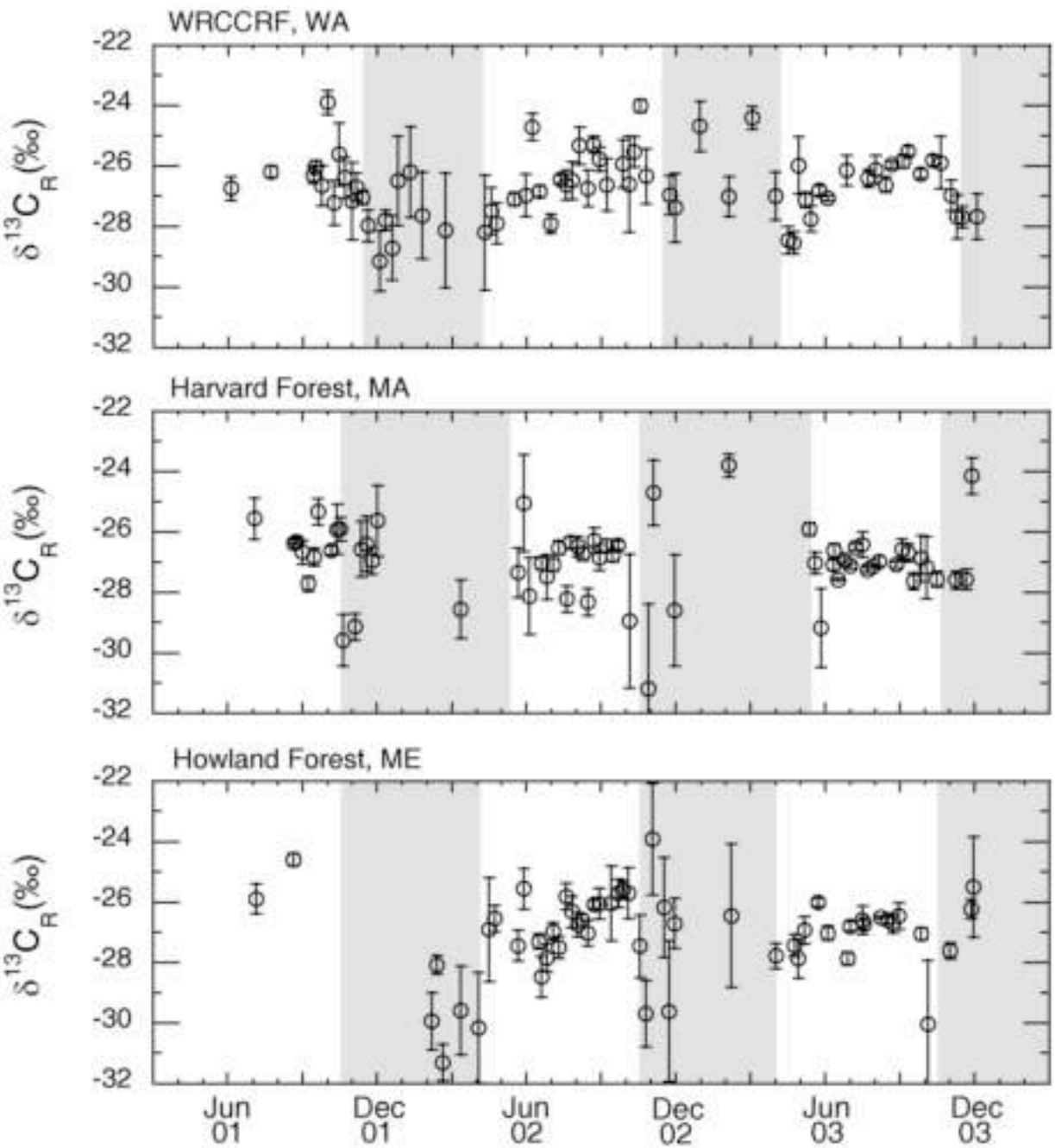
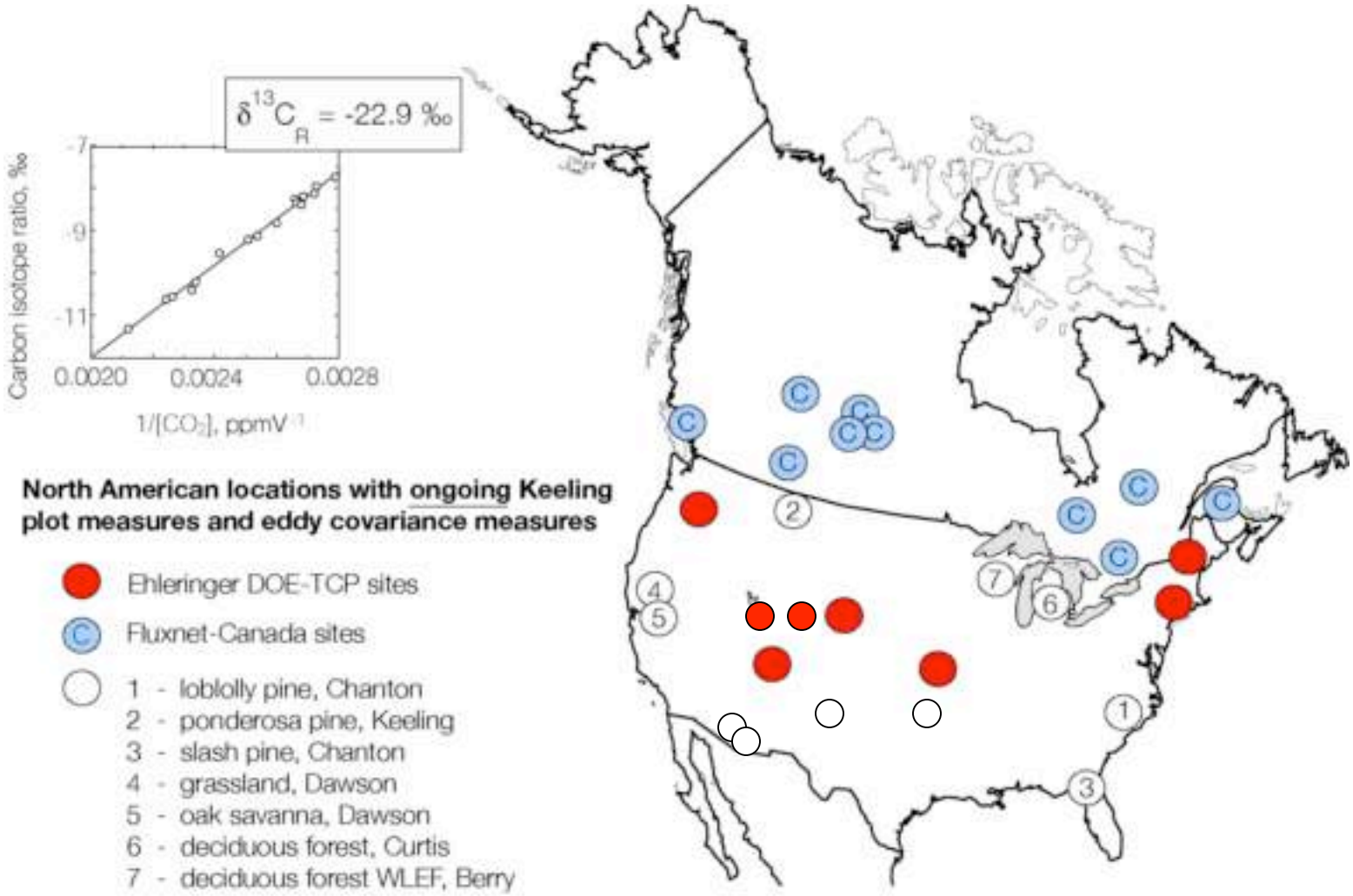


Lai et al. Global Change Biology, in press

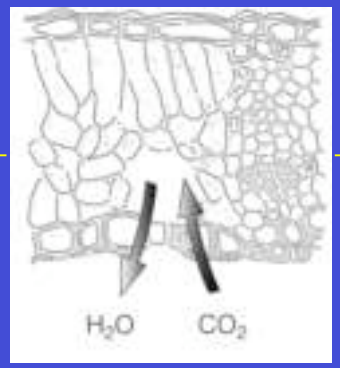
North American sites in the BASIN network



2005 Keeling plot sampling effforts

Ecosystem	Region	Frequency
peatland	Alberta	every 3 weeks
grassland	Arizona	monthly
shrubland	Arizona	monthly
woodland	Arizona	monthly
coniferous forest	British Columbia	every 3 weeks
savanna	California	every 2 weeks
coniferous forest	Colorado	weekly
coniferous forest	Florida	every 2 weeks
coniferous forest	Florida	every 2 weeks
grassland	Kansas	weekly
coniferous forest	Maine	weekly
deciduous forest	Massachussetts	weekly
deciduous forest	Michigan	2-5x/summer
coniferous forest	Montana	monthly
coniferous forest	New Brunswick	every 3 weeks
woodland	New Mexico	daily
grassland	Oklahoma	weekly
deciduous forest	Ontario	every 3 weeks
peatland	Ontario	every 3 weeks
coniferous forest	Oregon	weekly
coniferous forest	Quebec	every 3 weeks
deciduous forest	Saskatchawan	every 3 weeks
coniferous forest	Saskatchawan	every 3 weeks
coniferous forest	Saskatchawan	every 3 weeks
urban	Utah	weekly
coniferous forest	Utah	weekly
deciduous forest	Utah	weekly
coniferous forest	Washington	weekly
deciduous forest	Wisconsin	weekly

Factors influencing isotopic content of ecosystem respiration



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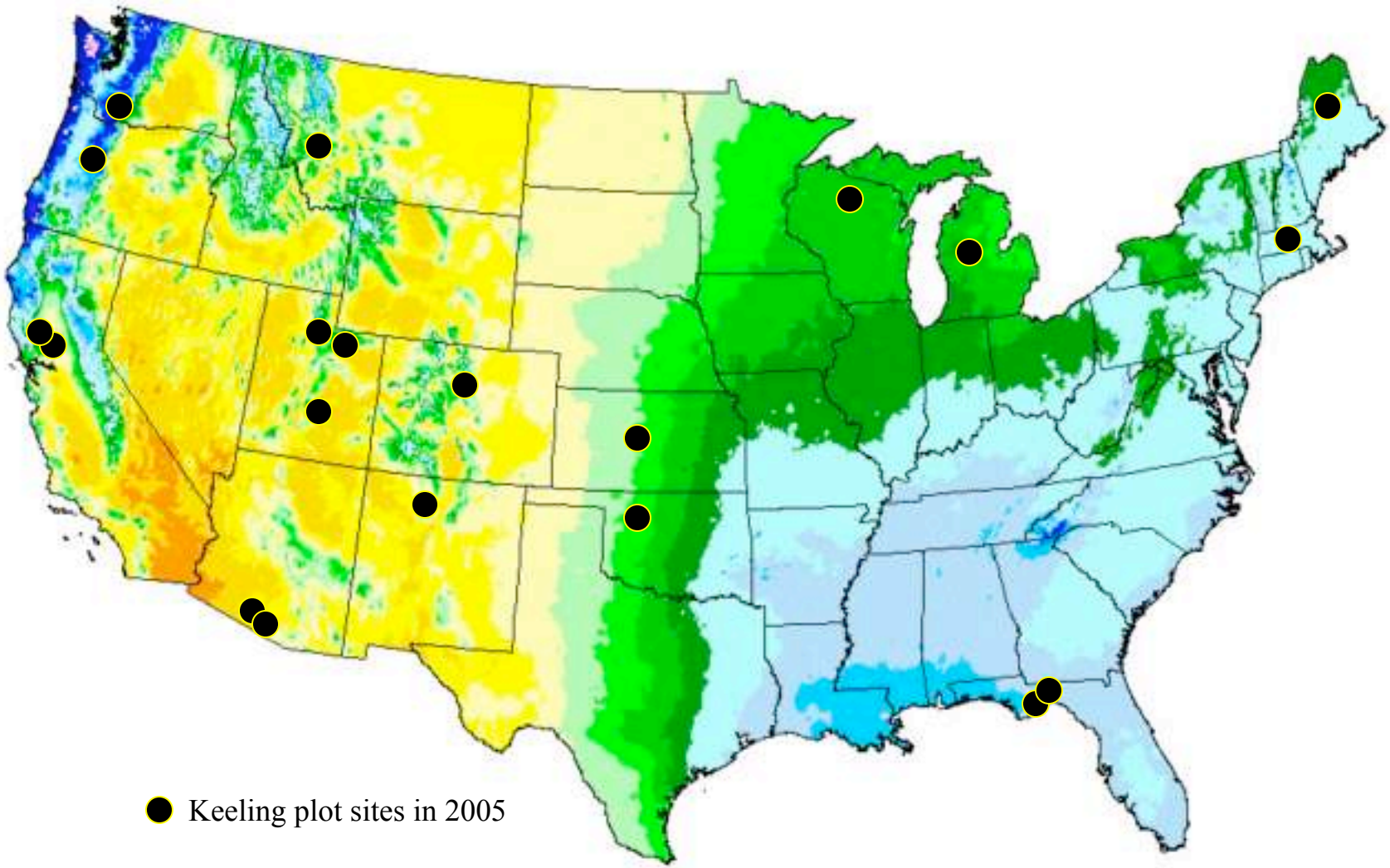
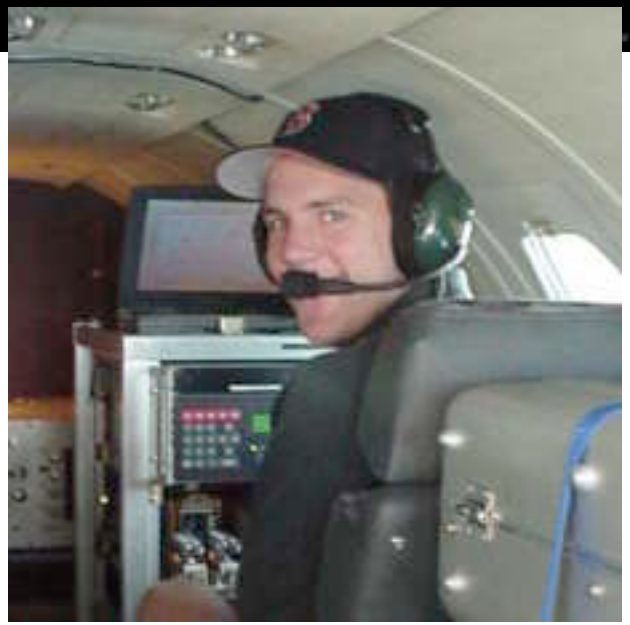
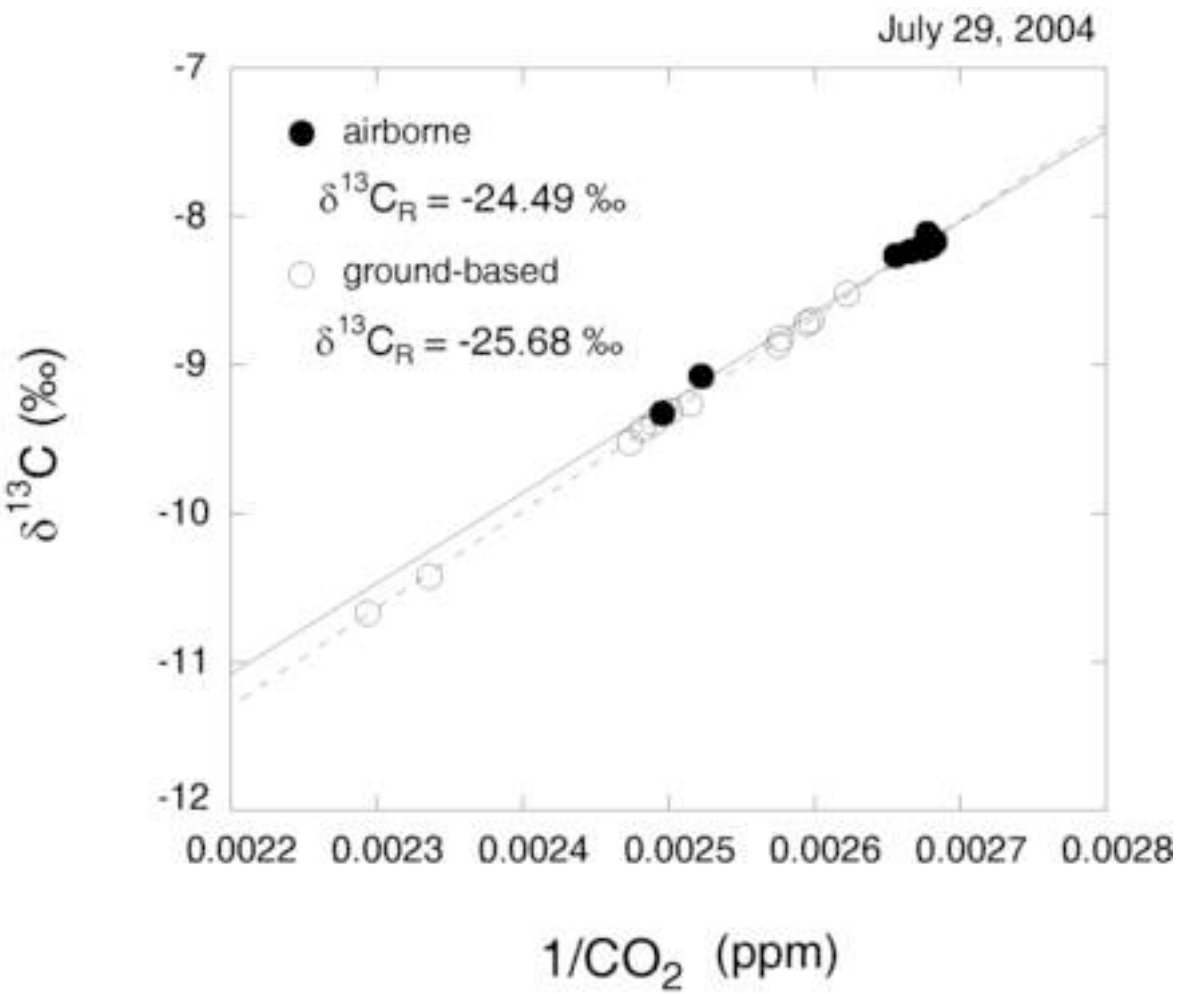
Precipitation across the USA



A montane airborne experiment in collaboration with NCAR



Flasks were collected in the aircraft and on the ground to characterize the isotope signatures at both regional and canopy scales.

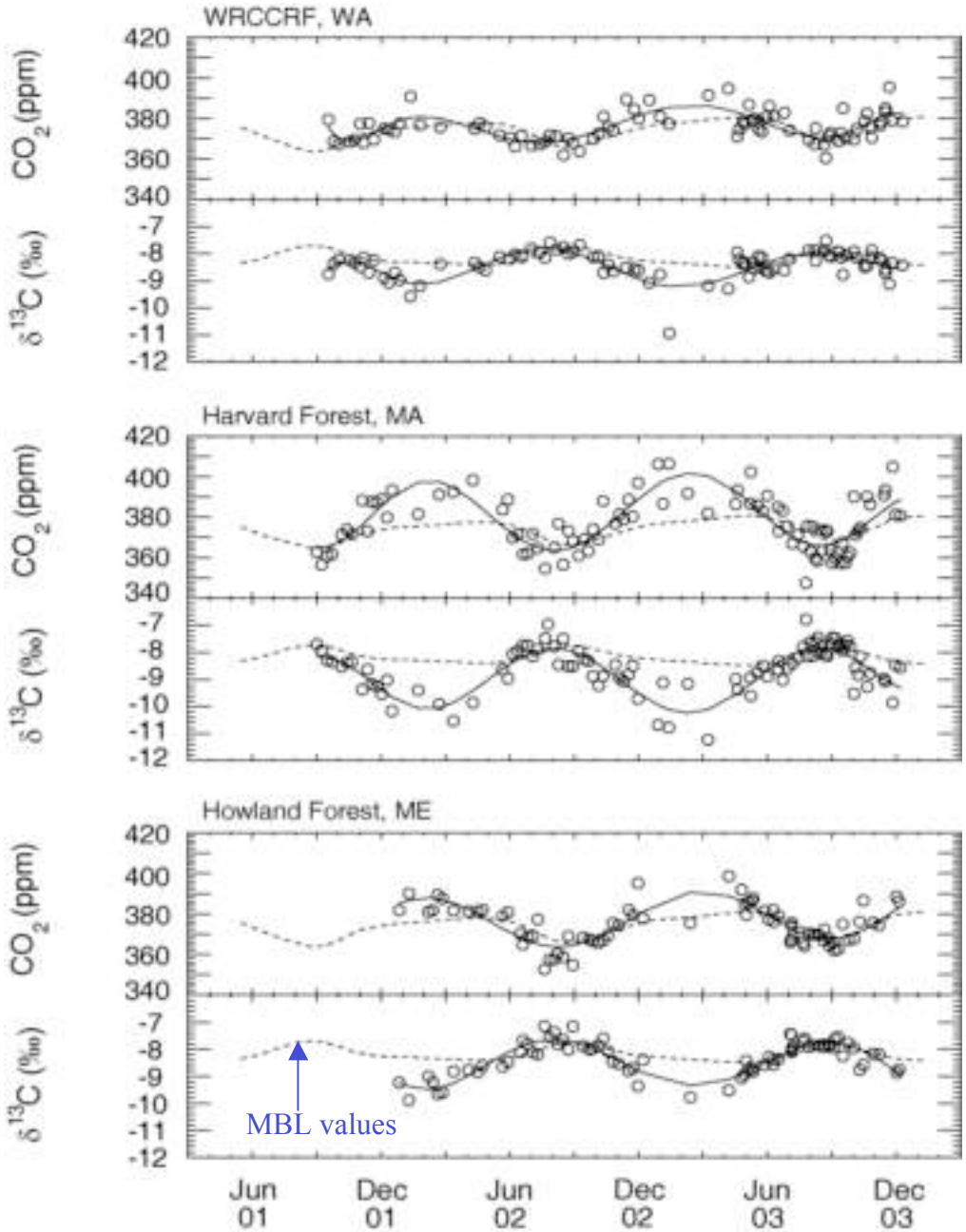


Aircraft measurements represents a regional integration of many sources. The difference between $\delta^{13}C_R$ value measured using aircraft and that measured in the forest canopy partly reflects differences in sampling footprints.

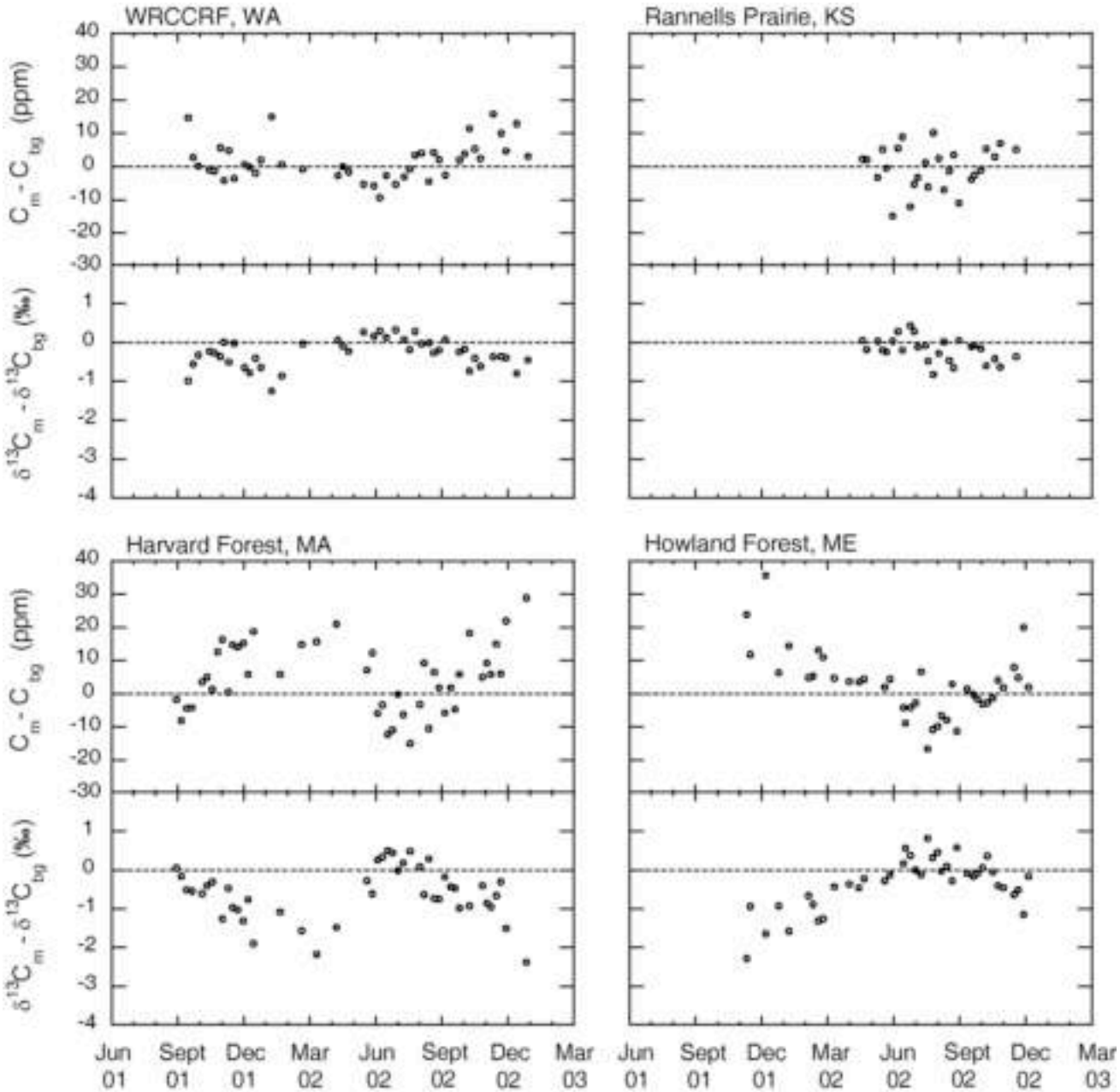
Is this a virtual tall tower?

virtual tall tower sampler for both [CO2] and isotopes

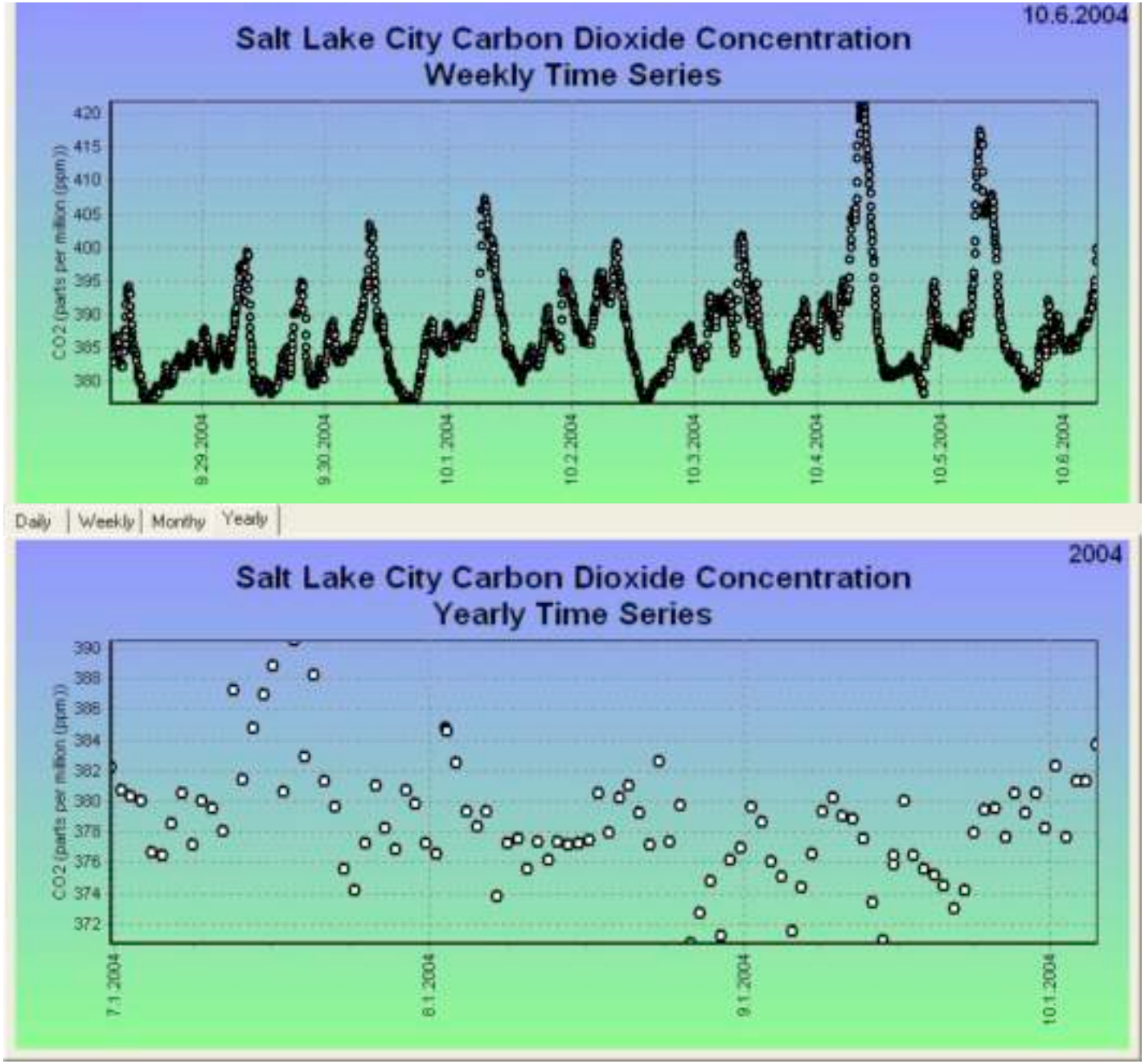
	[CO2]	0.2 ppm
	13-C in CO2	0.06 ‰
	18-O in CO2	0.08 ‰
40	samples per day	
260	days per yer (70% time use)	
10,400	samples per year	
28	sites at 365/yr	
52,000	observation in 5 years/IRMS	
	continuous [CO2]	
	daily isotopes	



Lai et al. Global Change Biology, in press



Lai et al. (2004) Global Biogeochem. Cycles, 18:GB1041



http://ecophys.biology.utah.edu/co2.html