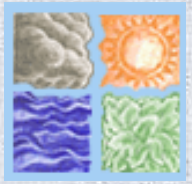
CO_2 exchange inferred from measurements of COS (or: COS, as the new isotope…)

Dan Yakir[1],
Max Berkelhammer[2], Hulin Chen[2] Jhon Miller[3]

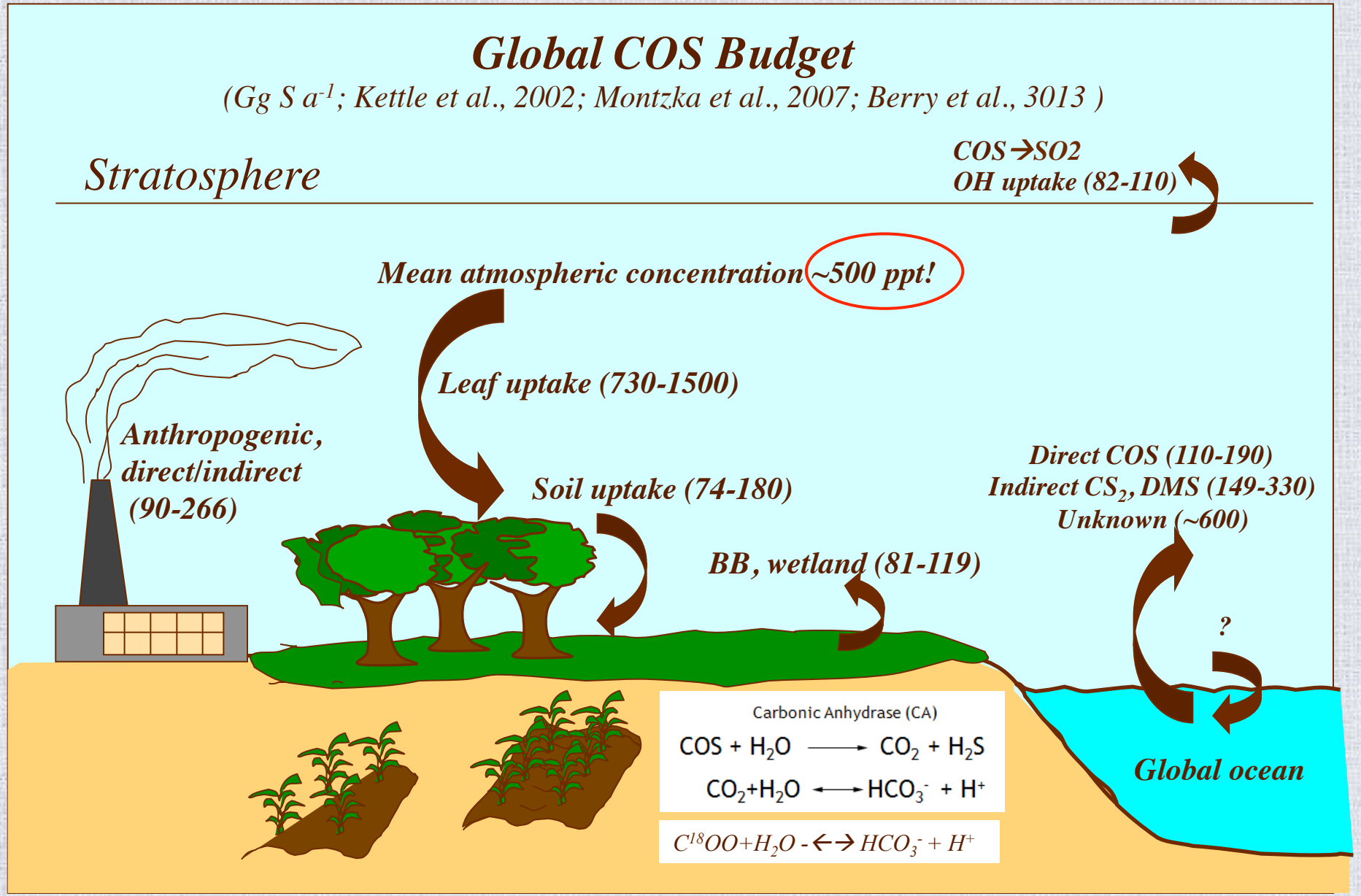
[1]Earth & Planetary Sciences, Weizmann Institute

NOAA-GMD, Boulder, [3]CIREES, UC Boulder

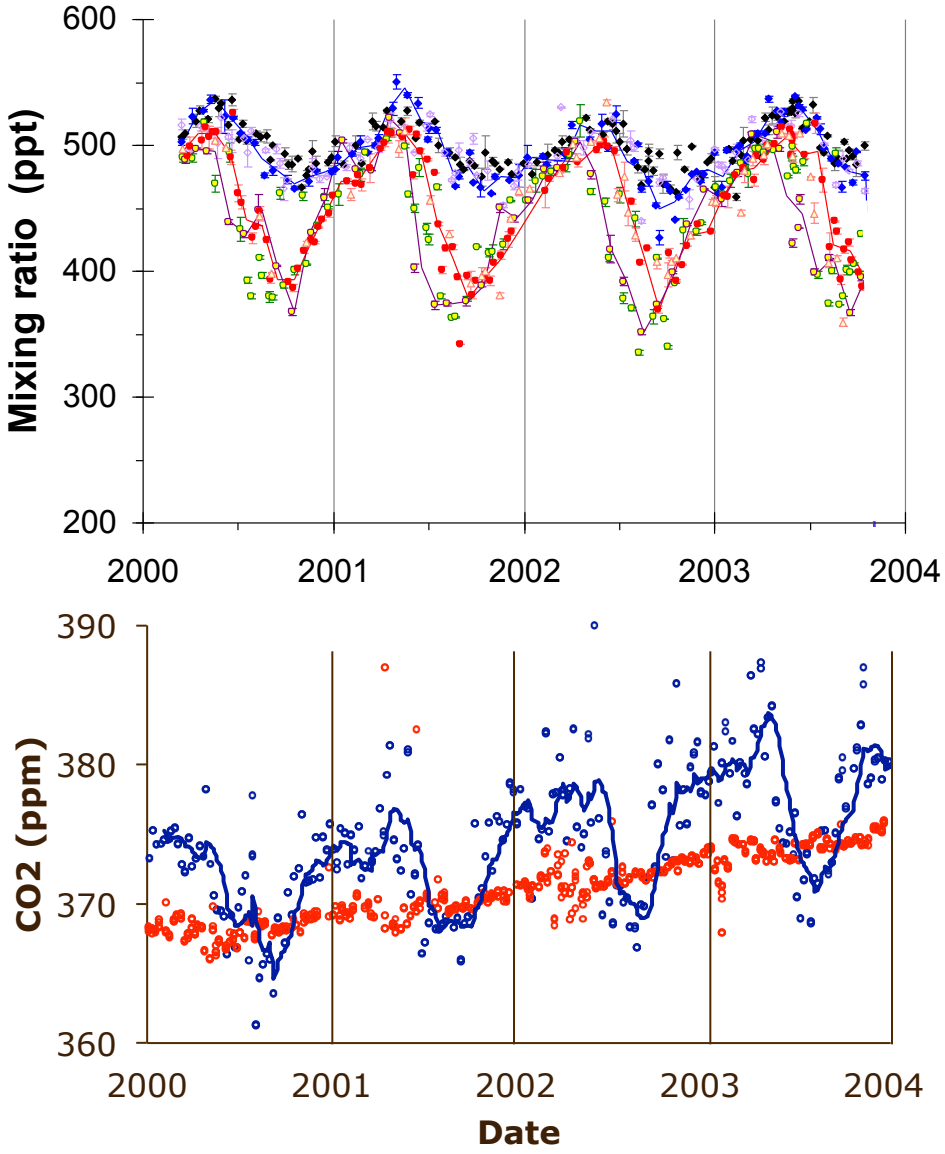


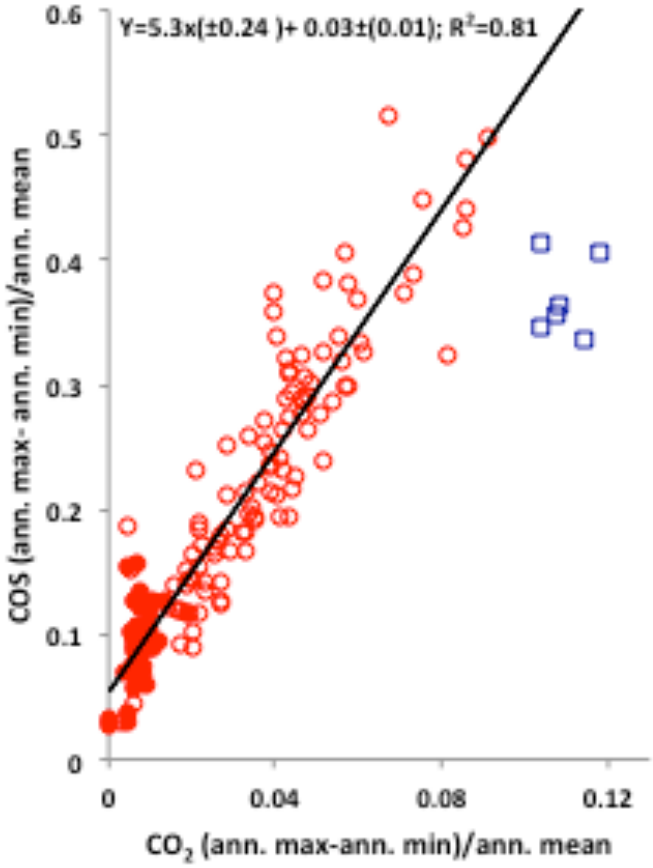
Global COS Budget

(Gg S a^{-1}; Kettle et al., 2002; Montzka et al., 2007; Berry et al., 3013)

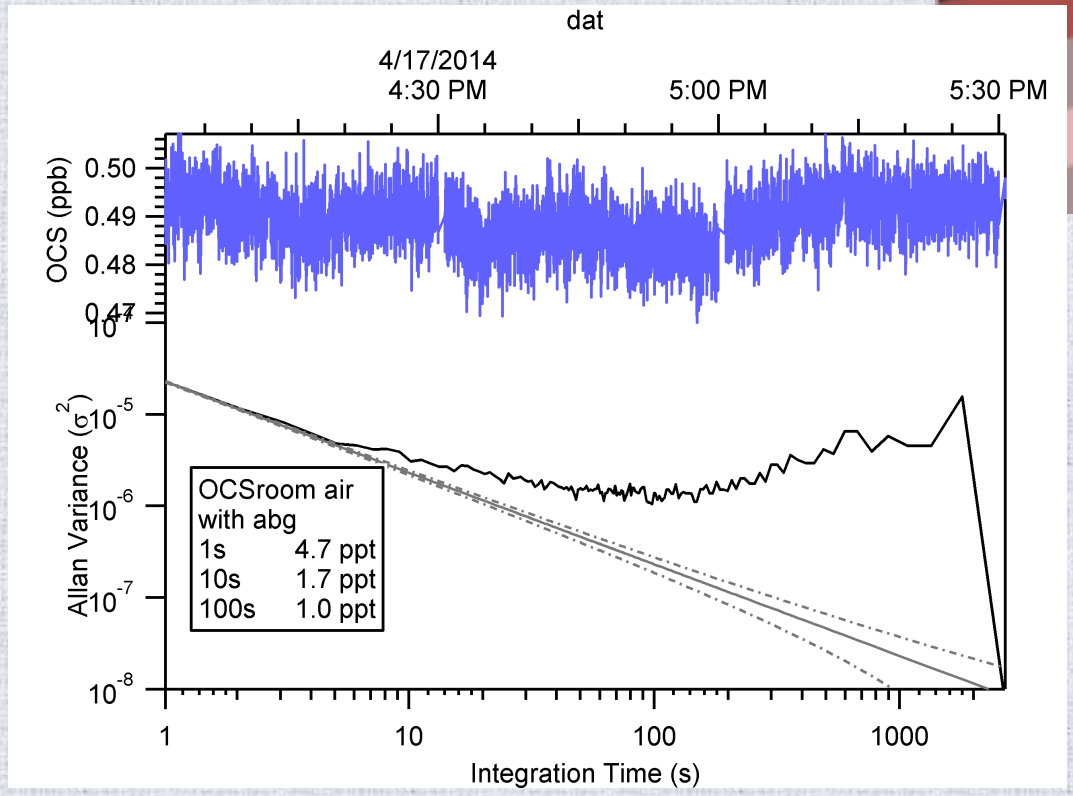


Perspective from the background atmosphere:

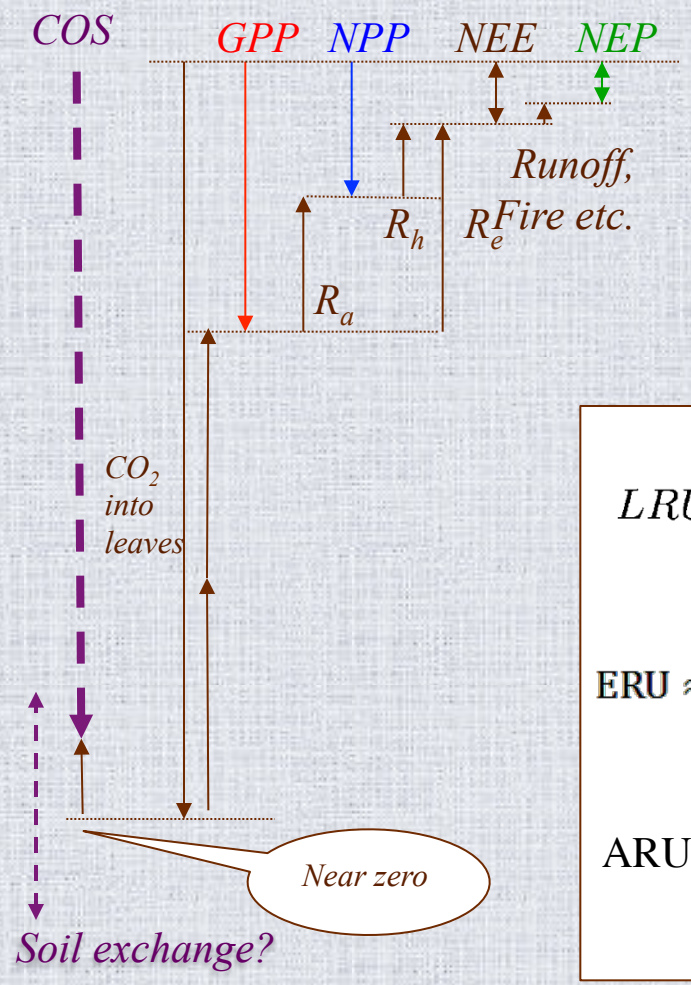




Exiting new technological advances (laser spectroscopy…)



Changes in ratio of COS to CO_2 uptake across scales



~Constant across species and conditions

$$LRU = \frac{A_{COS}}{[\mathrm{COS}]} / \frac{A_{CO_2}}{[\mathrm{CO_2}]} \qquad \sim 1.6 \pm 0.2$$

$$\mathrm{ERU} \approx \frac{\frac{A^s_{\mathrm{ecosystem}}}{[\mathrm{COS}]}}{\frac{\mathrm{Net\ CO_2\ exchange}}{[\mathrm{CO_2}]}} \approx \frac{\mathrm{GPP}}{\mathrm{NEE}} \cdot \mathrm{LRU}$$

$$\mathrm{ARU} = \frac{\mathrm{COSseasonal\_drawdown}}{\mathrm{CO2sessonal\_drawdown}} \cdot \frac{[\mathrm{CO2}]}{[\mathrm{COS}]}$$

$$LRU = \frac{A^{\cos}}{Aco2}\frac{[CO2]_a}{[COS]_a}$$

$$GPP = F^{\cos}\frac{[CO2_a]}{[COS_a]}.\frac{1}{LRU}$$

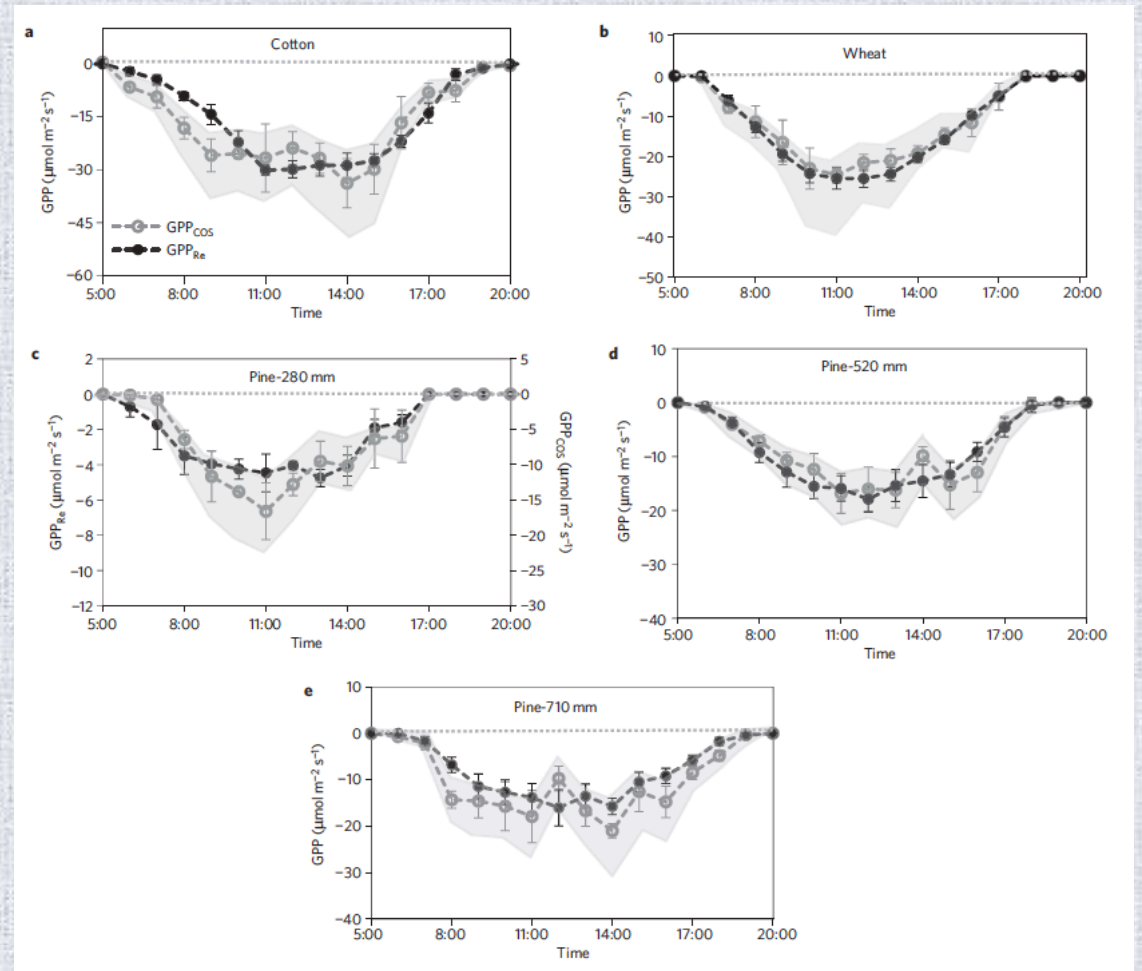
GPP/NEE= 1.9 to 2.2

Such application cannot be done on larger scale

LETTERS
PUBLISHED ONLINE: 17 FEBRUARY 2013 | DOI: 10.1038/NGEO1730
nature geoscience

Ecosystem photosynthesis inferred from measurements of carbonyl sulphide flux

David Asaf[1], Eyal Rotenberg[1], Fyodor Tatarinov[1], Uri Dicken[1], Stephen A. Montzka[2] and Dan Yakir[1]*



JOURNAL OF GEOPHYSICAL RESEARCH: BIOGEOSCIENCES, VOL. 118, 1–11, doi:10.1002/jgrg.20068, 2013

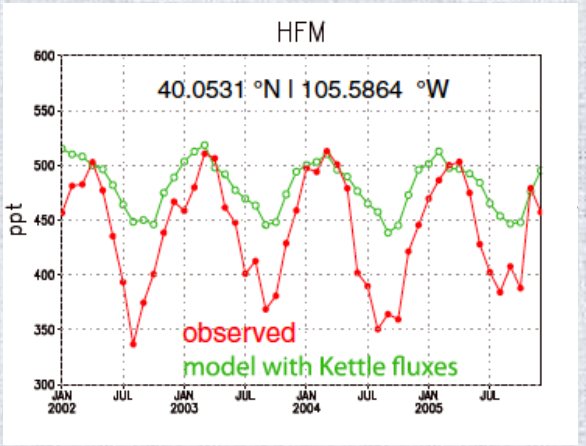
A coupled model of the global cycles of carbonyl sulfide and CO_2: A possible new window on the carbon cycle

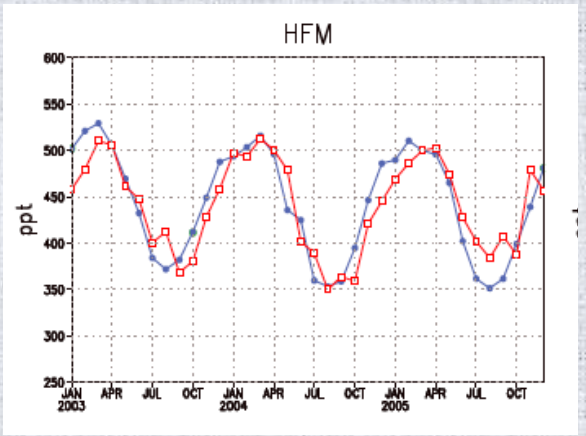
Joe Berry,[1] Adam Wolf,[2] J. Elliott Campbell,[3] Ian Baker,[4] Nicola Blake,[5] Don Blake,[5] A. Scott Denning,[4] S. Randy Kawa,[6] Stephen A. Montzka,[7] Ulrike Seibt,[8] Keren Stimler,[9] Dan Yakir,[9] and Zhengxin Zhu[6]

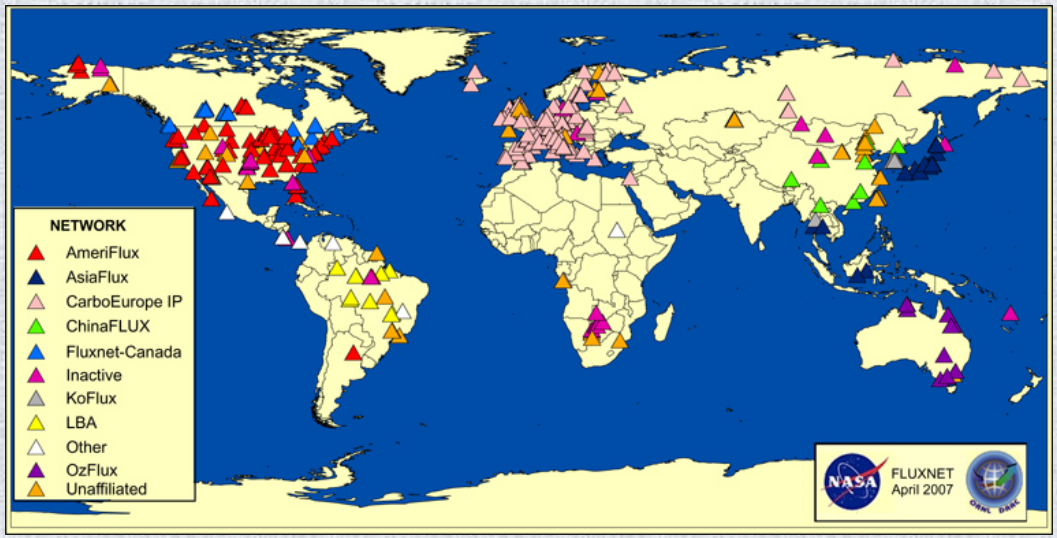
Table 1. A Compilation of the Global Sources and Sinks Used for PCTM Simulations of Atmospheric COS[a]

Sources	*Kettle et al.*, 2002	This Study
Direct COS Flux From Oceans	39	39
Indirect COS Flux as DMS From Oceans	81	81
Indirect COS Flux as CS_2 From Oceans	156	156
Direct Anthropogenic Flux	64	64
Indirect Anthropogenic Flux From CS_2	116	116
Indirect Anthropogenic Flux From DMS	0.5	0.5
Biomass Burning	11	**136**
Additional (Photochemical) Ocean Flux		**600**
Sinks		
Destruction by OH Radical	−94	**−101**
Uptake by Canopy	−238	**−738**
Uptake by Soil	−130	**−355**
Net Total	−5	−2.5

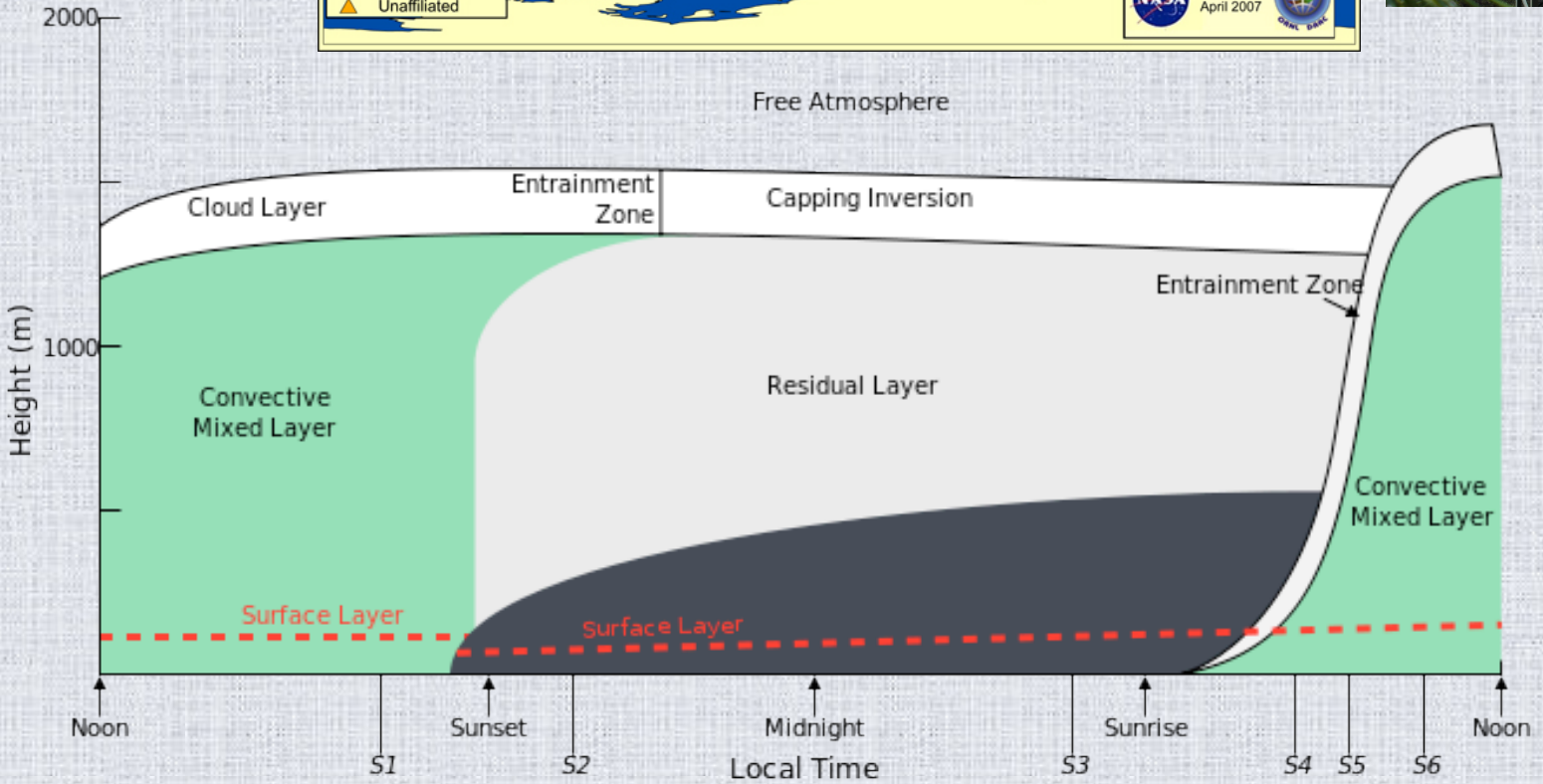
[a]Units are 1.0×10^9 g of sulfur. Fluxes changed in this study are highlighted with bold type.



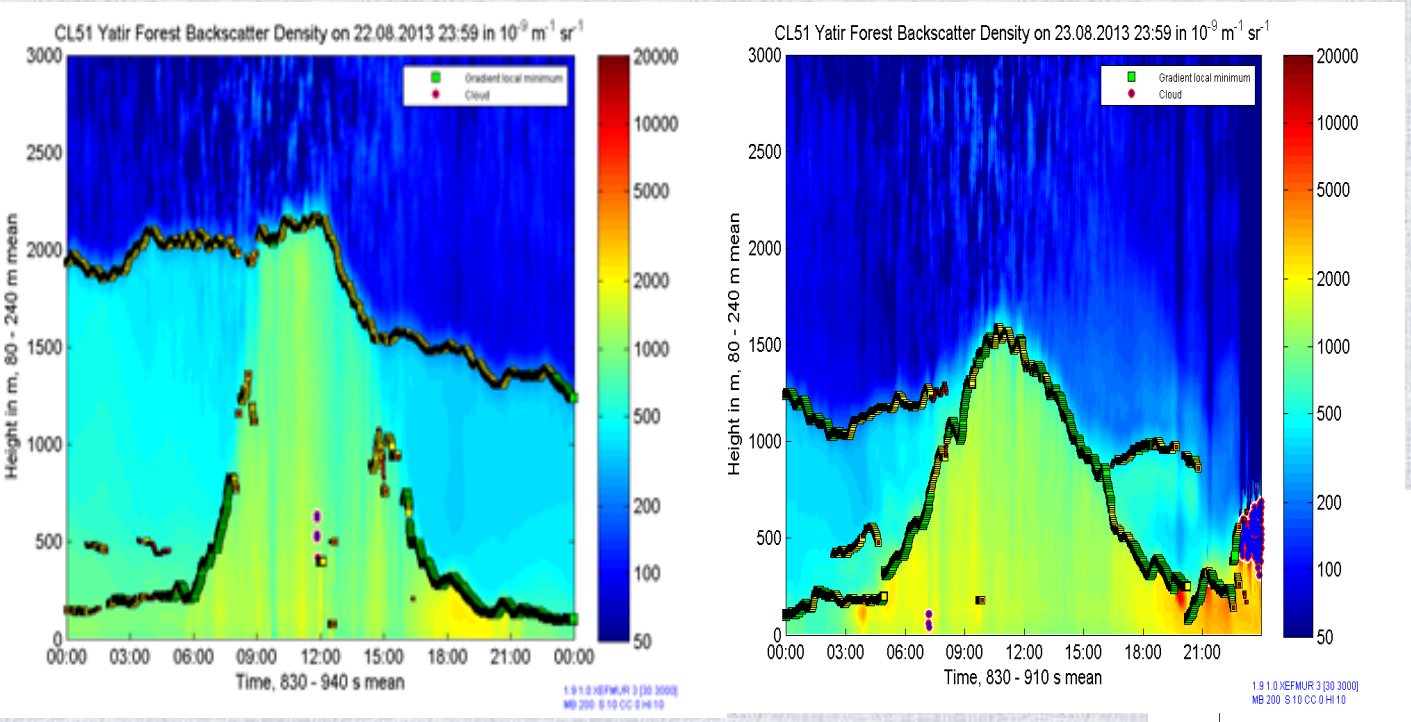



NETWORK
AmeriFlux
AsiaFlux
CarboEurope IP
ChinaFLUX
Fluxnet-Canada
Inactive
KoFlux
LBA
Other
OzFlux
Unaffiliated
NASA
FLUXNET
April 2007


18 9 2007

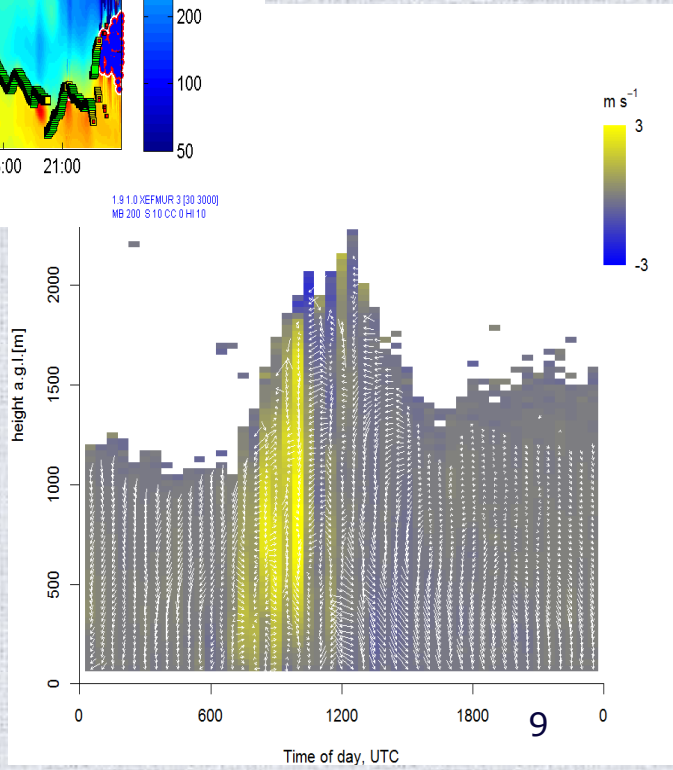

2000
1000
Height (m)
Free Atmosphere
Cloud Layer
Entrainment Zone
Capping Inversion
Entrainment Zone
Convective Mixed Layer
Residual Layer
Convective Mixed Layer
Surface Layer
Surface Layer
Noon
Sunset
Midnight
Sunrise
Noon
S1
S2
S3
S4
S5
S6
Local Time

Perspective from the Planetary Boundary Layer (PBL)



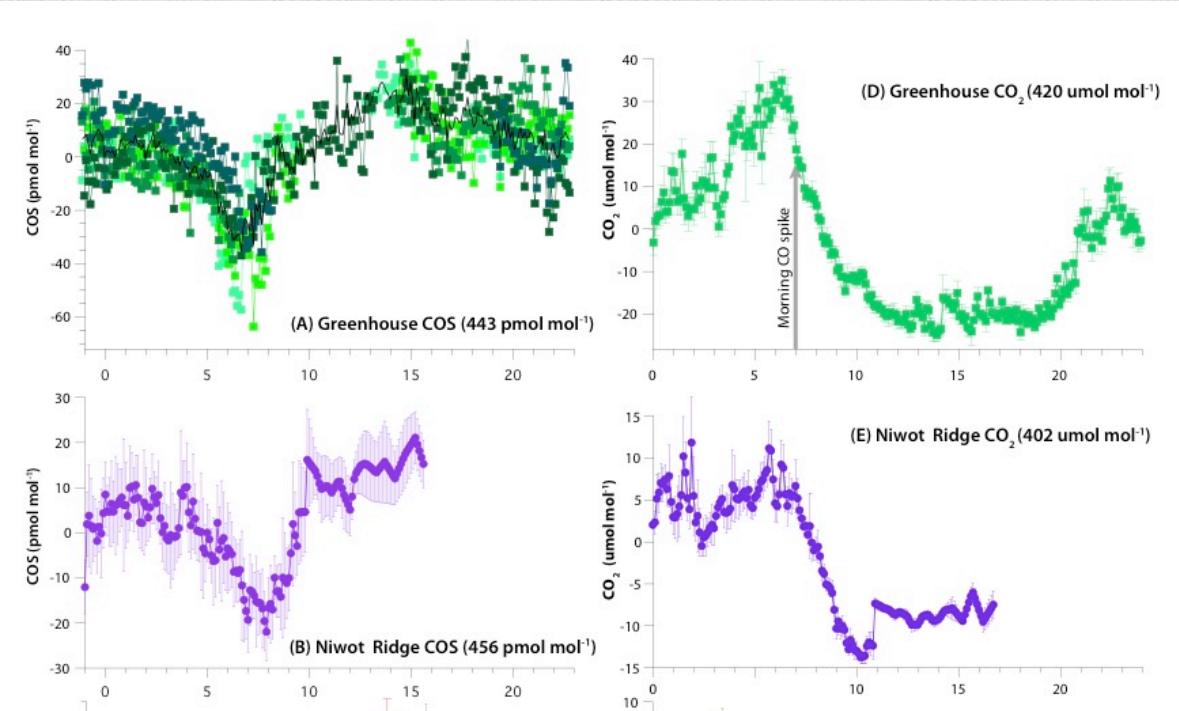
Ceilometer,
two consecutive days

Wind Lidar:

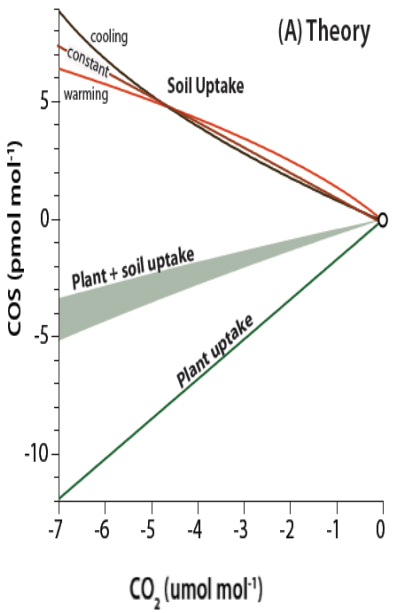


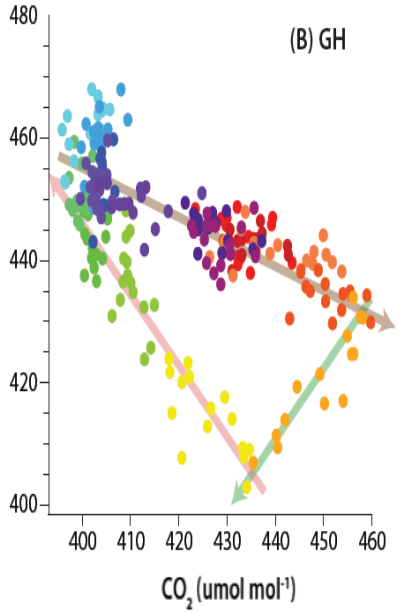
Mauder & Eder, unpublished

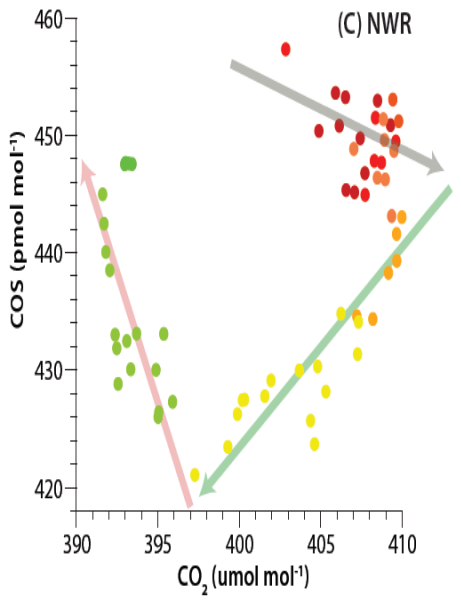
Perspective from canopy air measurements:

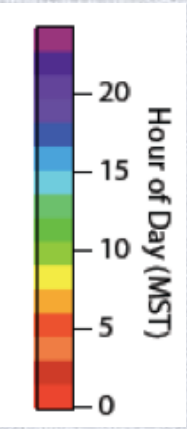


Linking events in the surface layer to the PBL









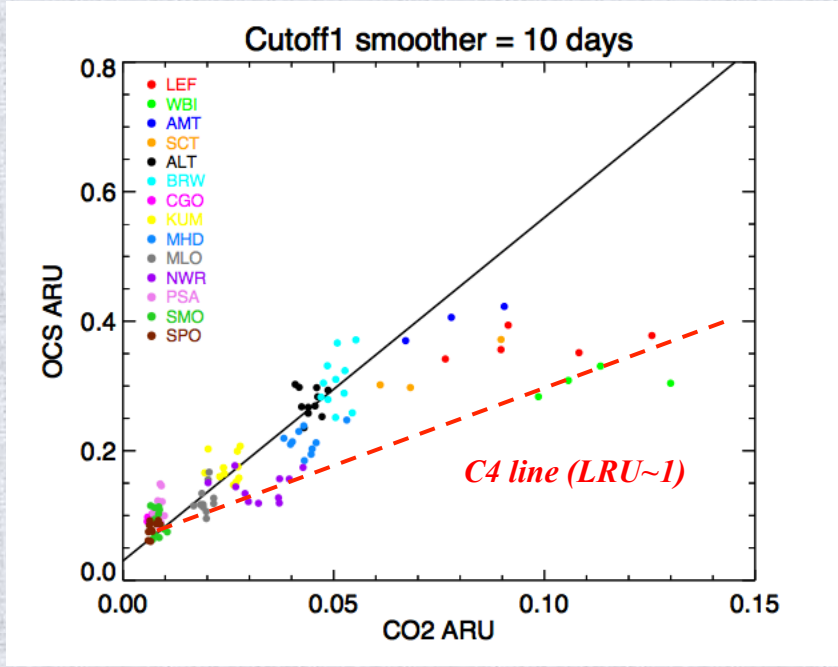
$$\frac{dC}{dt} = k(C_{trop} - C_{surface}) + F_{soil} + F_{leaf} \qquad (7)$$

Equations for both CO_2 and COS with measured NEE and surface C_s solved for k and C_{trop}

Conclusions

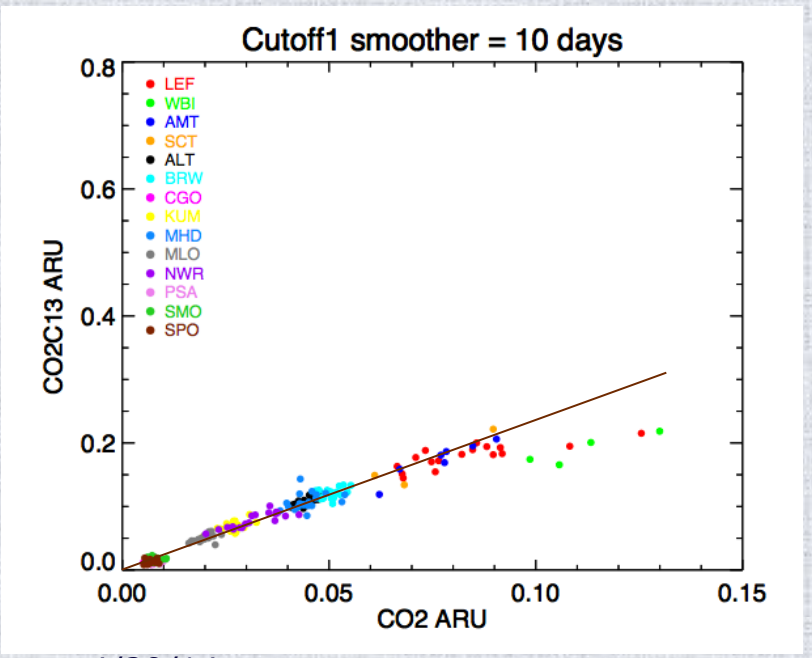
- **COS is a useful tracer of CO2 exchange with the terrestrial ecosystems and will add a powerful tool to a very limited arsenal..**
- **There is no alternative "observational" means to estimate GPP on global scale (new sun fluorescence is also developing)**
- **Incorporating the use of several tracers controlled by different processes (such as COS and CO2) provide additional insights (such as interactions of surface with the PBL)**
- **Developing means to link surface measurements to detect changes in the PBL are important to obtain full perspective of biosphere-atmosphere exchange**

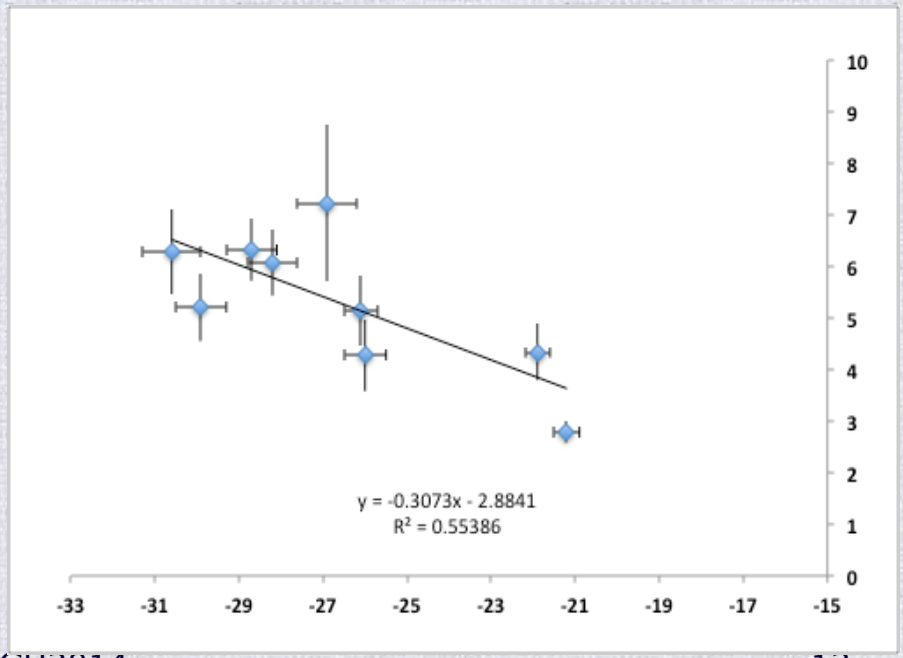
Thank you



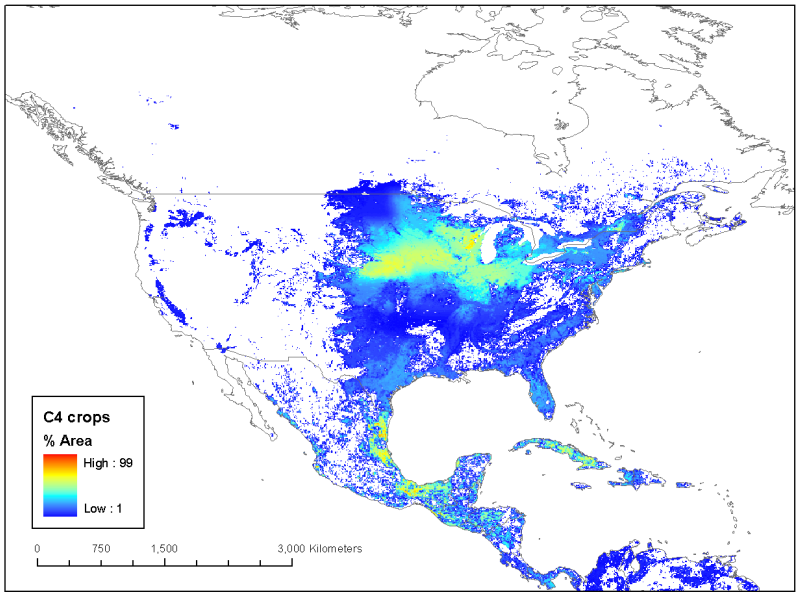
Terrestrial &agricultural sites: Wisconsin; Iowa; S. Carolina

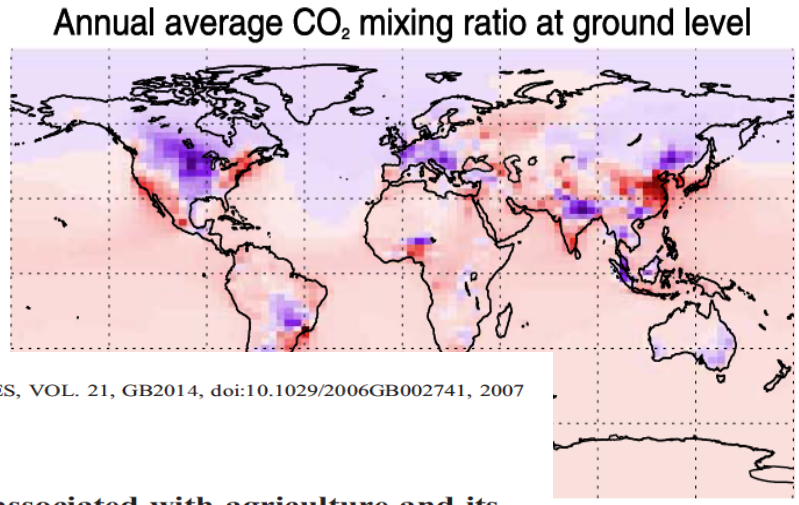
ARU reflects contribution of C4 vegetation





C4 distribution and impact on surface [CO2] (C. Still





GLOBAL BIOGEOCHEMICAL CYCLES, VOL. 21, GB2014, doi:10.1029/2006GB002741, 2007

Click Here for Full Article

Horizontal displacement of carbon associated with agriculture and its impacts on atmospheric CO_2

P. Ciais,[1] P. Bousquet,[1,2] A. Freibauer,[3] and T. Naegler[1,4]

Conclusions

- **COS is a useful tracer of CO2 exchange with the terrestrial ecosystems and will add a powerful tool to a very limited arsenal..**
- **There is no alternative "observational" means to estimate GPP on global scale (new sun fluorescence is also developing)**
- **Incorporating the use of several tracers controled by different processes (such as COS and CO2) provide additional insights**
- **Developing means to link surface measurements to detect changes in the PBL are important to obtain full perspective of biosphere-atmosphere exchange**

Thank you