Land-atmosphere interactions inferred from CO_2/COS measurements

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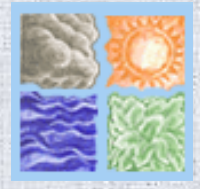
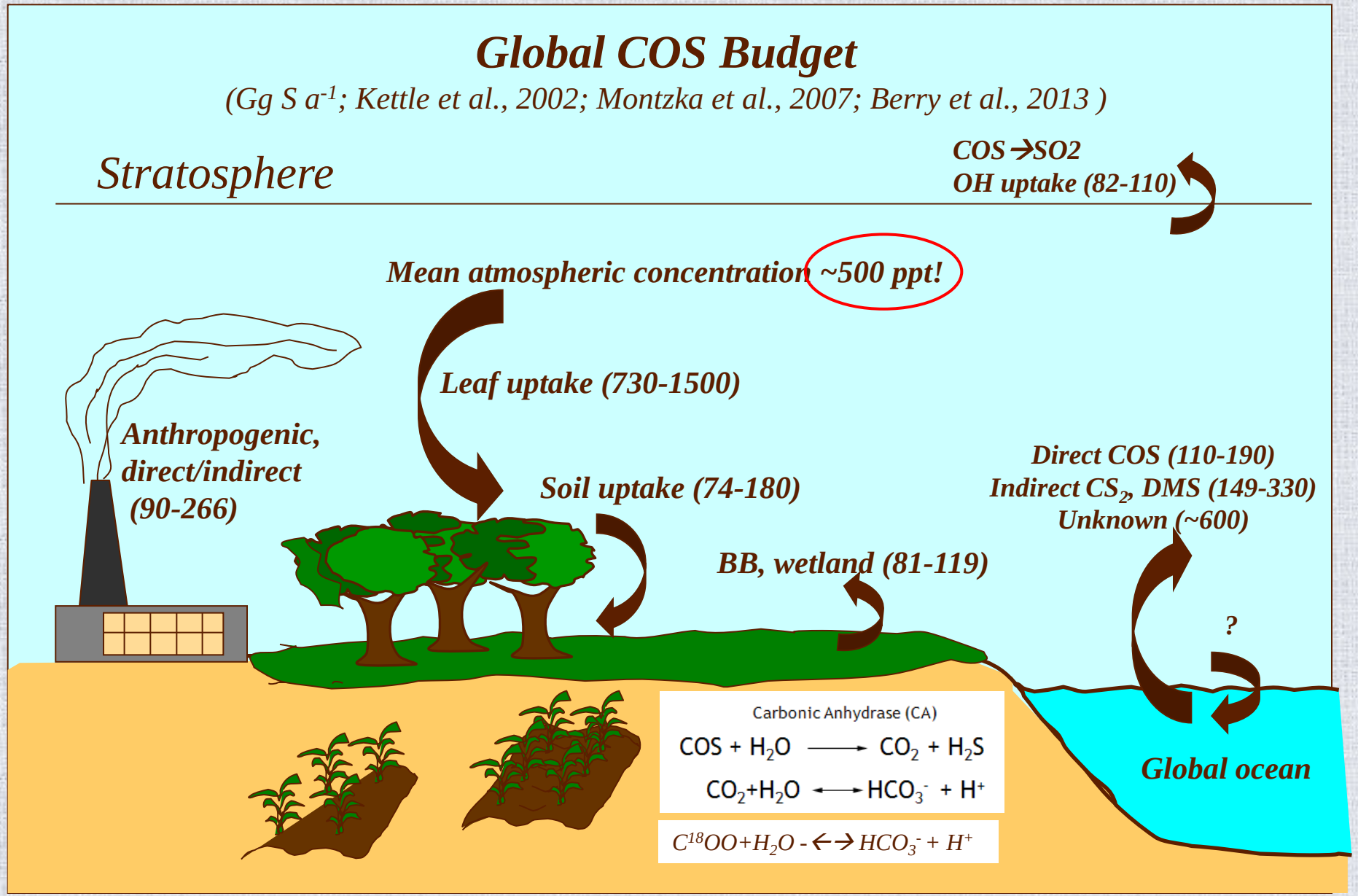
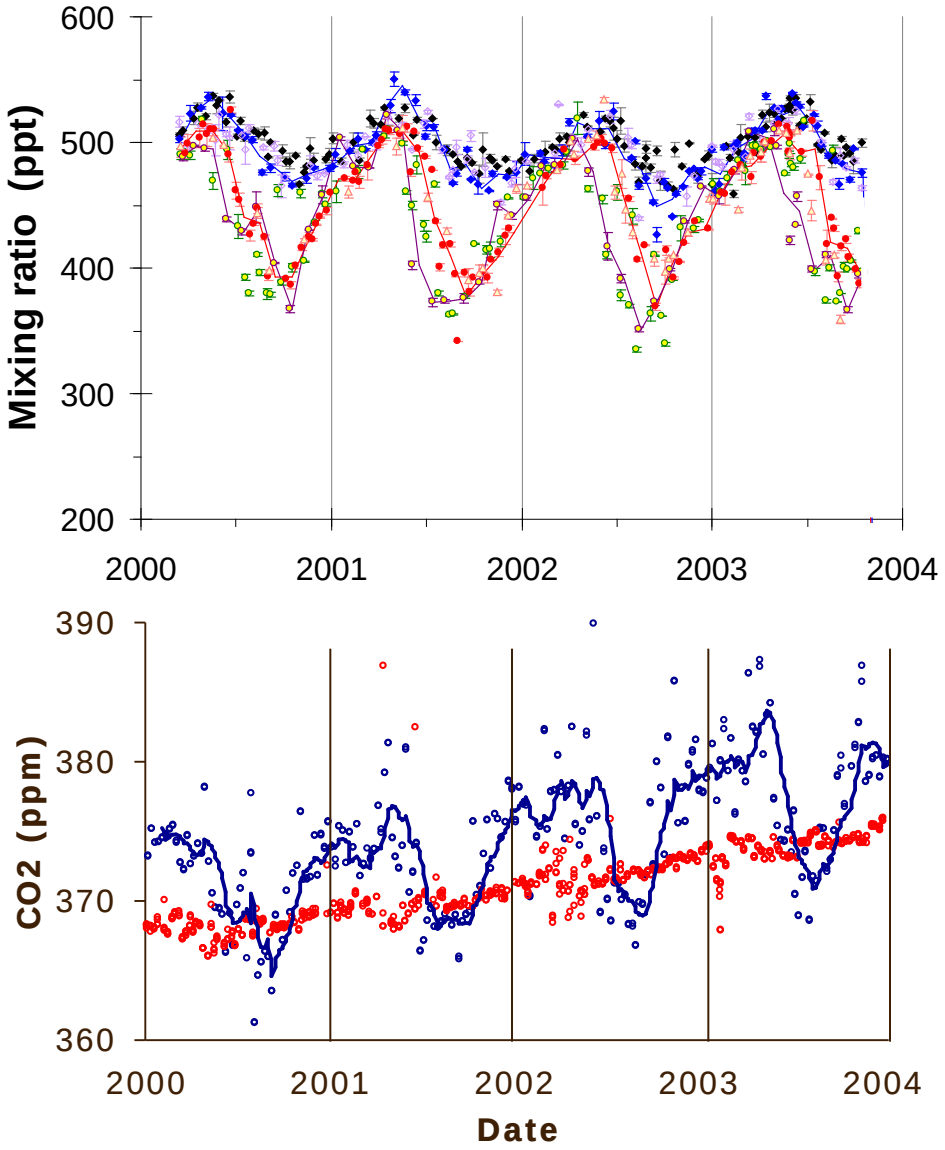


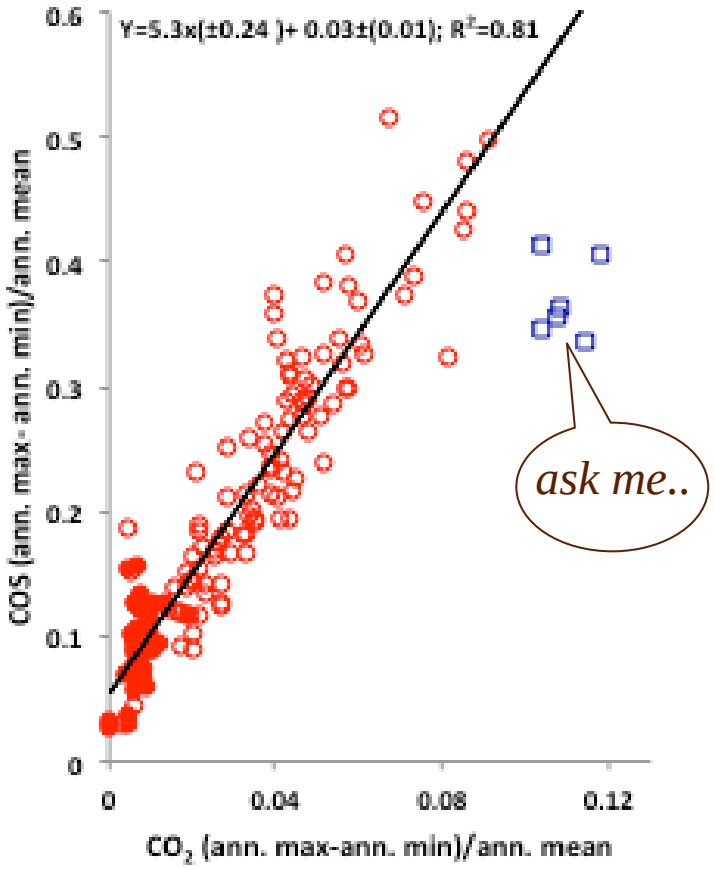
Global COS Budget

(Gg S a^{-1}; Kettle et al., 2002; Montzka et al., 2007; Berry et al., 2013)

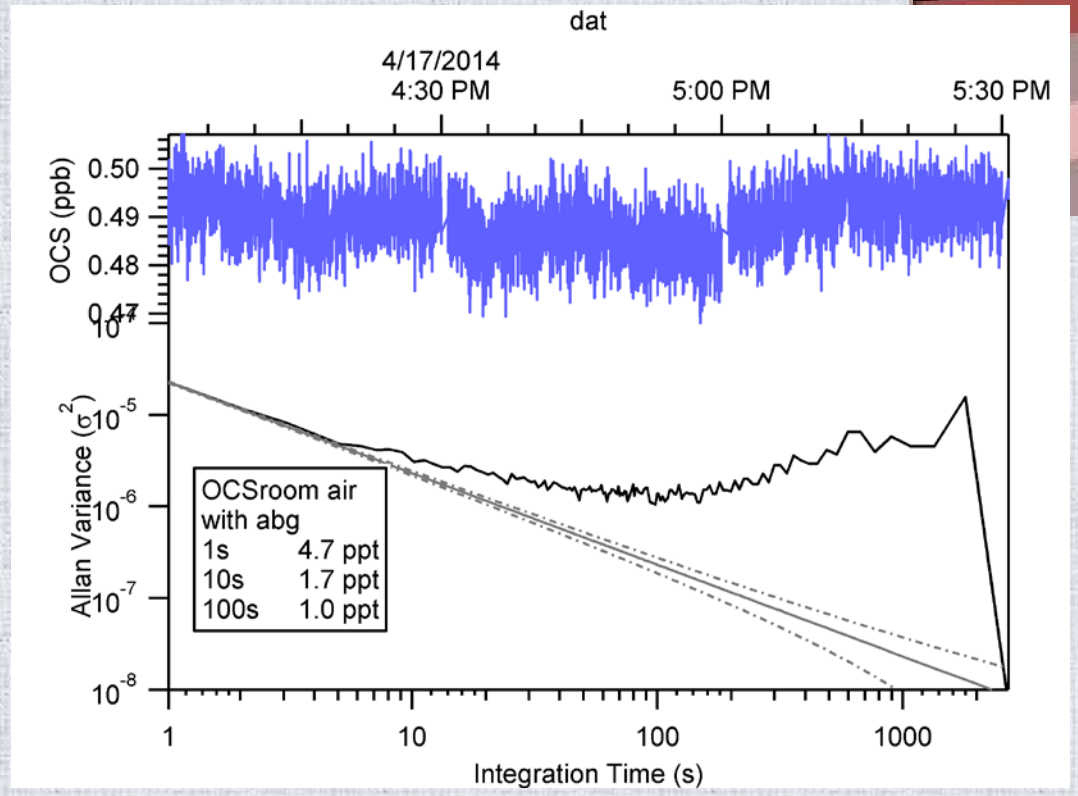


Perspective from the background atmosphere:

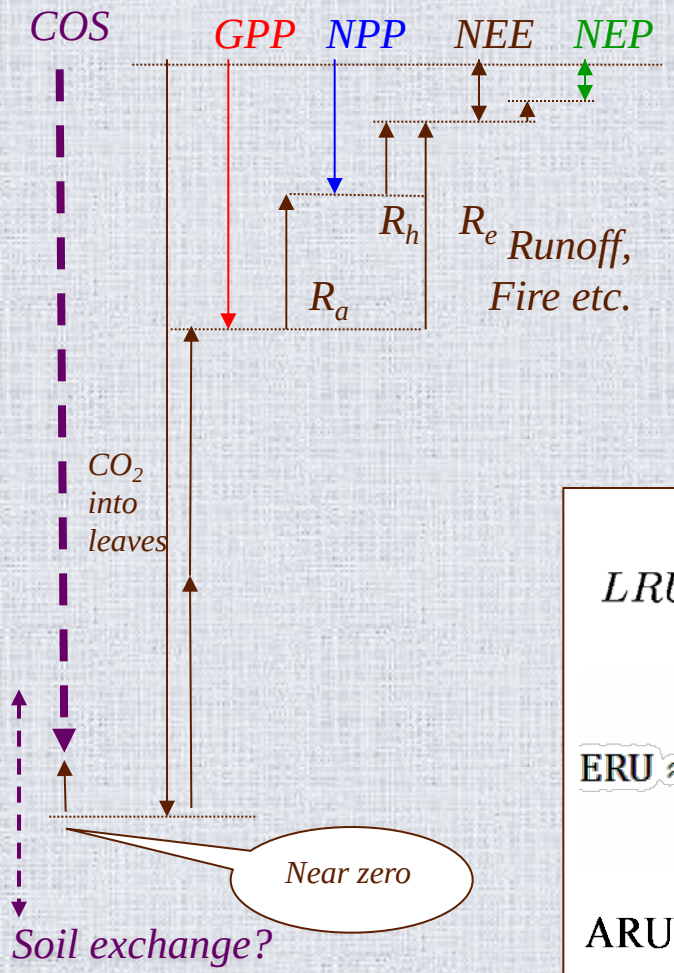




Exiting new technological advances (Quantum cascade, mid IR lasers…)



Changes in ratio of COS to CO_2 uptake across scales



~Constant across species and conditions

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

$$\mathrm{ERU} \approx \frac{\frac{A^{s}_{ecosystem}}{[\mathrm{COS}]}\,LRU}{\frac{\text{Net } CO_2 \text{ exchange}}{[\mathrm{CO_2}]}} \approx \frac{\mathrm{GPP}}{\mathrm{NEE}}$$

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

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

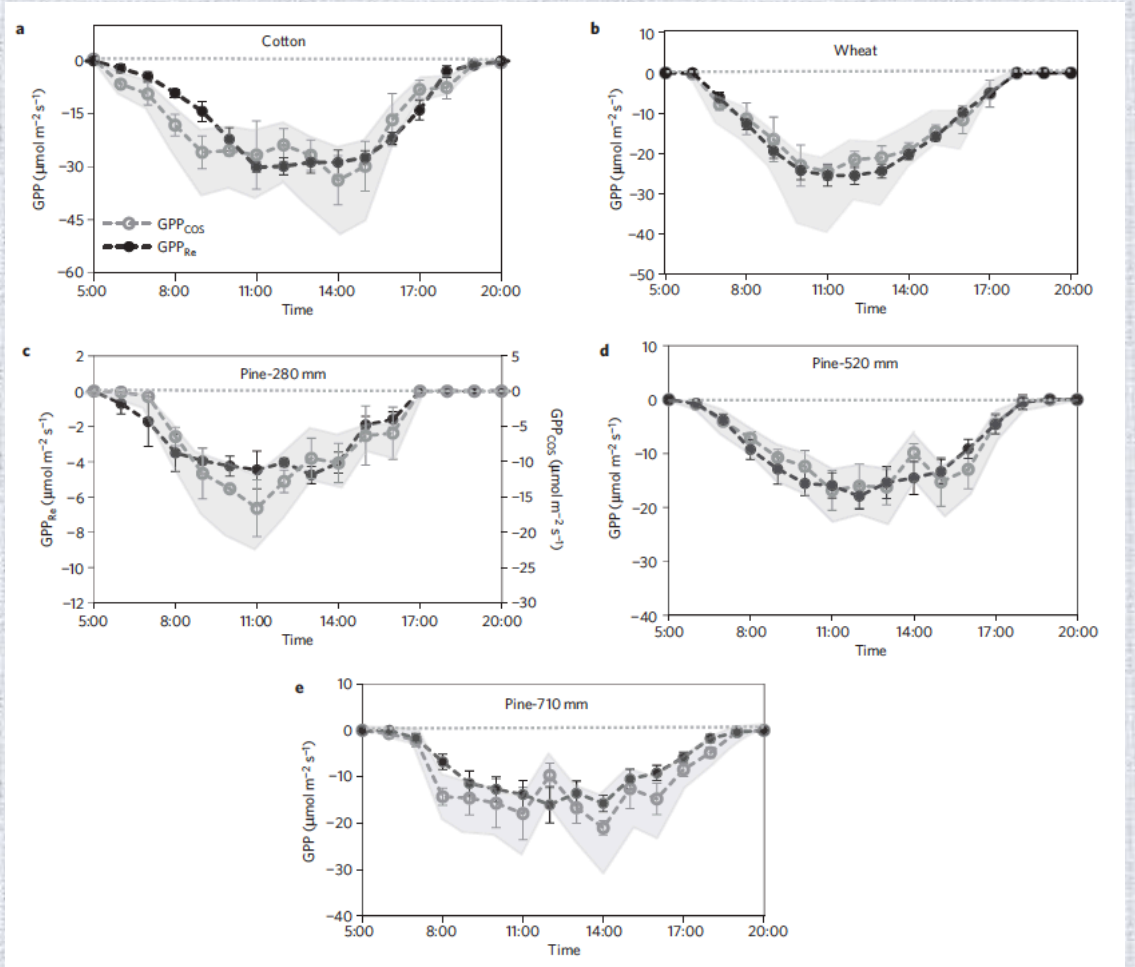
$$GPP = F^{\cos}\frac{[CO2_a]}{[COS_a]}\spadesuit\frac{1}{LRU}$$

GPP/NEE= 1.9 to 2.2

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

Berry et al., 2013

Global Biogeochemical Cycles

RESEARCH ARTICLE
10.1002/2013GB004644

Constraining surface carbon fluxes using in situ measurements of carbonyl sulfide and carbon dioxide

Key Points:
- Carbonyl sulfide can be measured in situ using a laser absorption

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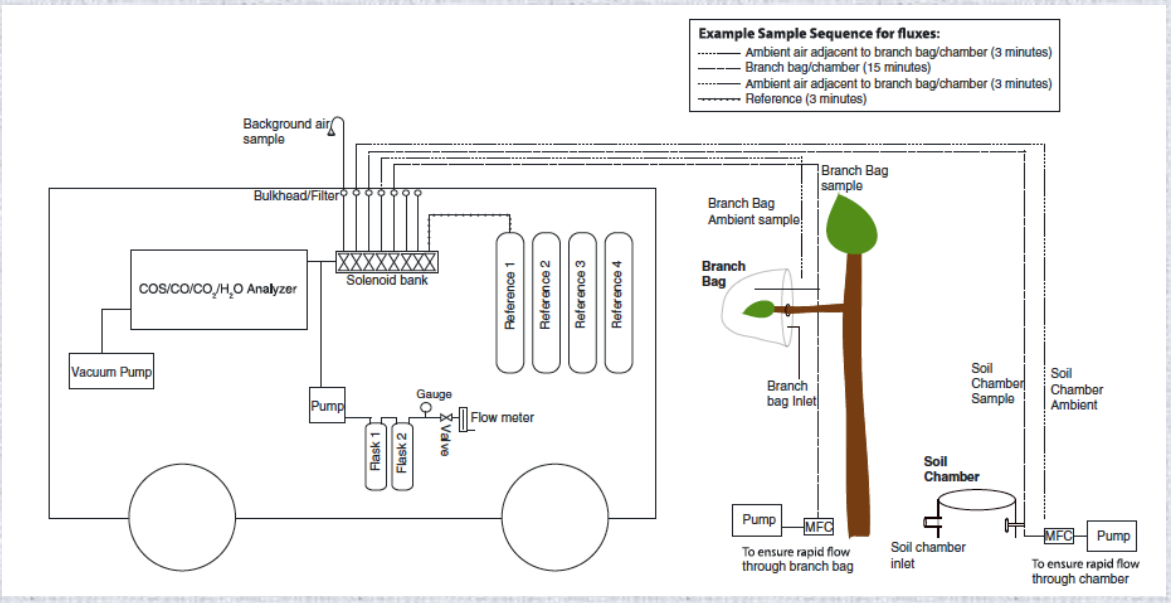

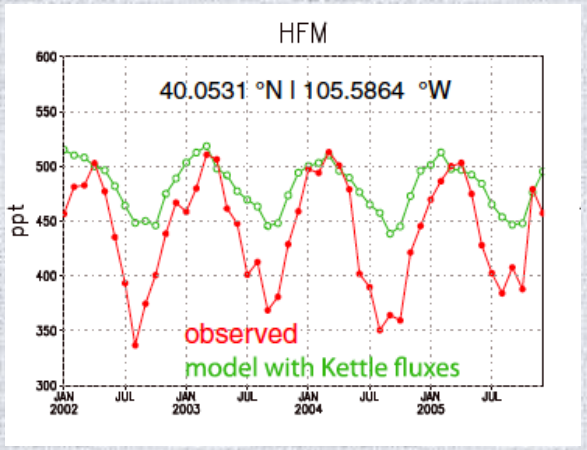

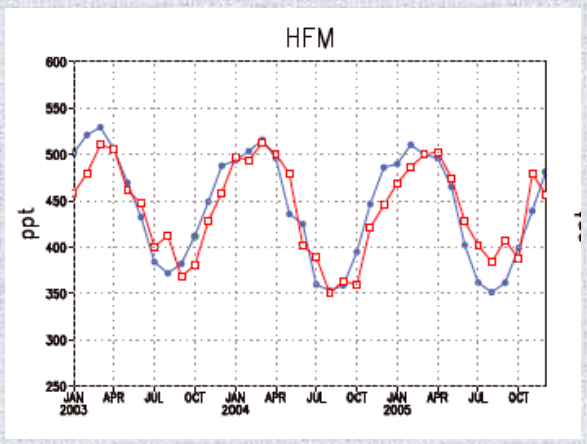

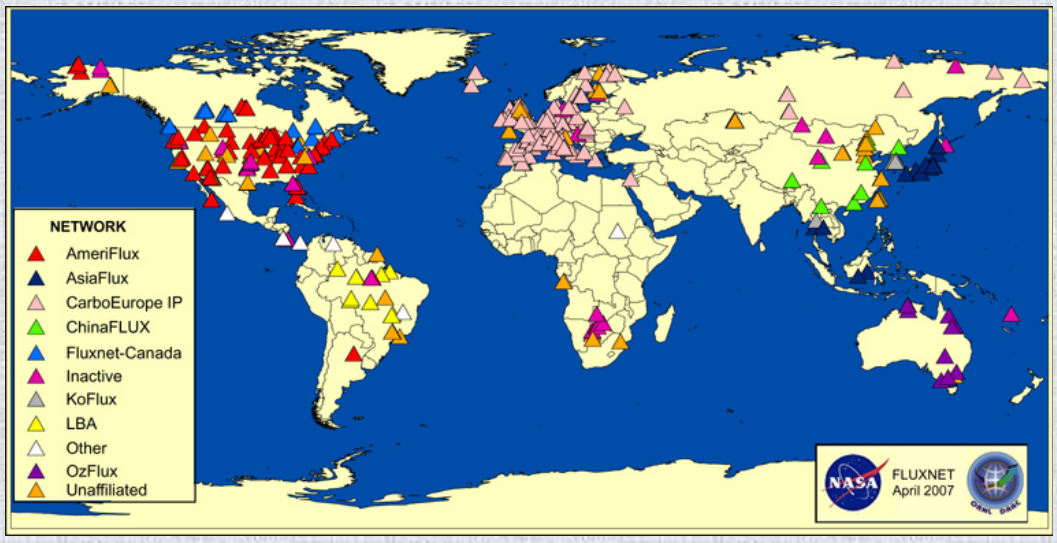
NETWORK
AmeriFlux
AsiaFlux
CarboEurope IP
ChinaFLUX
Fluxnet-Canada
Inactive
KoFlux
LBA
Other
OzFlux
Unaffiliated
NASA
FLUXNET
April 2007


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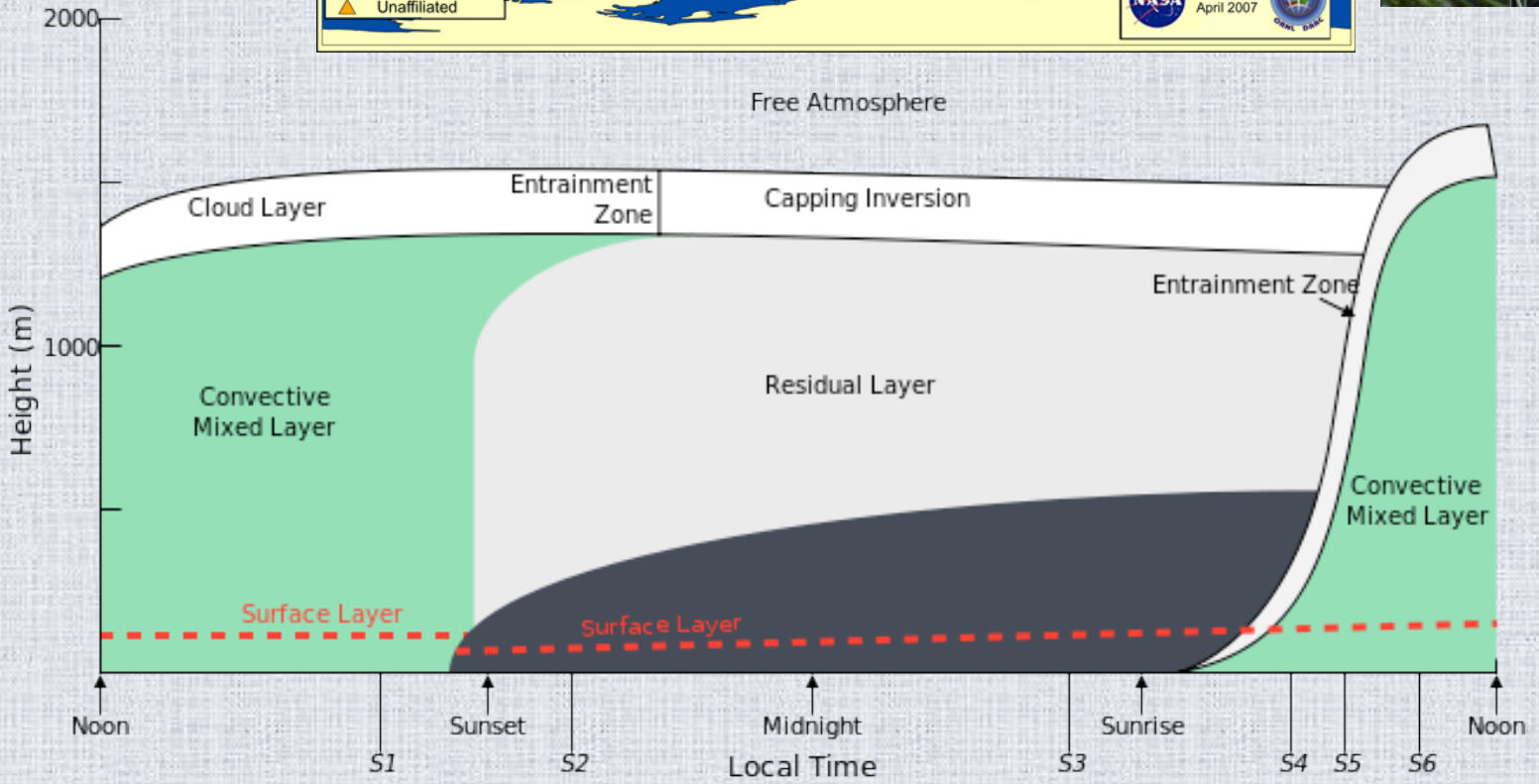
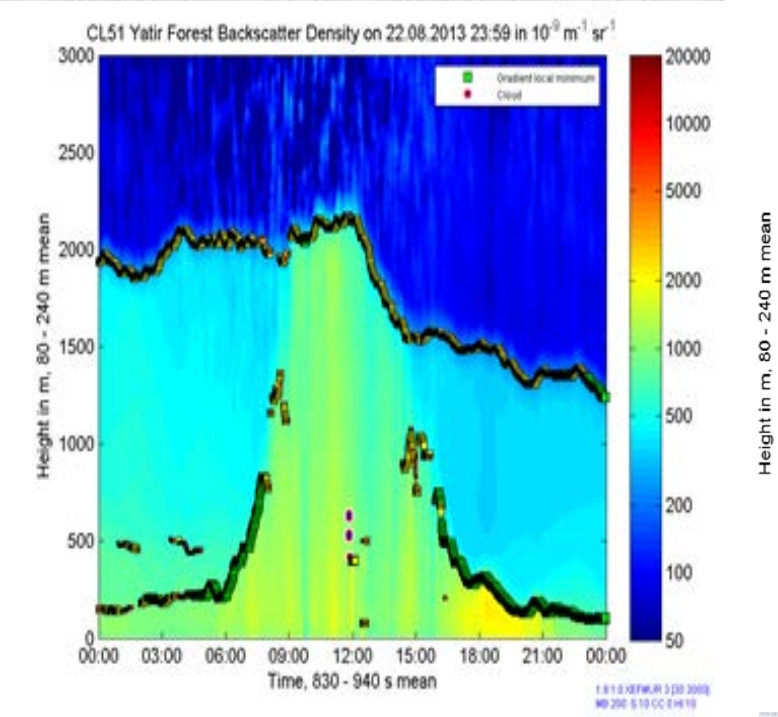
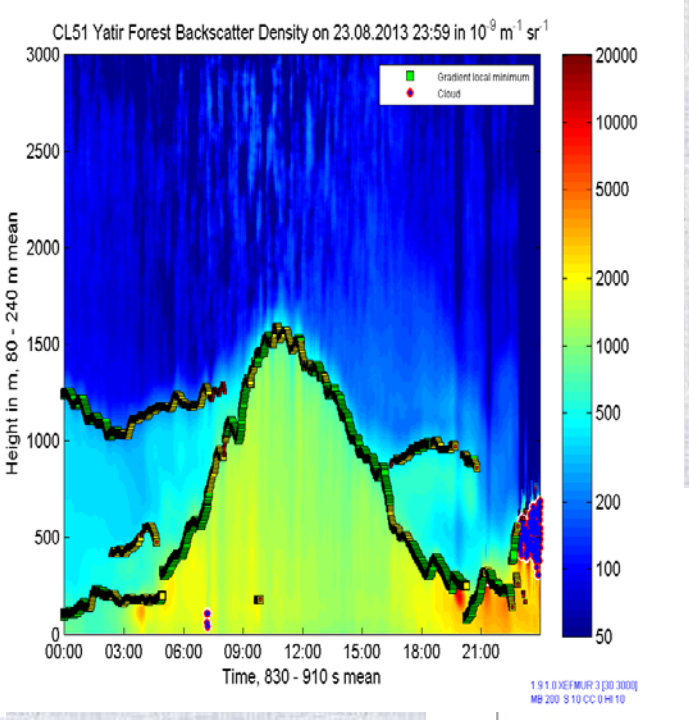

2000
1000
Height (m)
Free Atmosphere
Cloud Layer
Entrainment Zone
Capping Inversion
Entrainment Zone
Convective Mixed Layer
Residual Layer
Convective Mixed Layer
Surface Layer
Surface Layer
Noon
S1
Sunset
S2
Midnight
Local Time
S3
Sunrise
S4
S5
S6
Noon

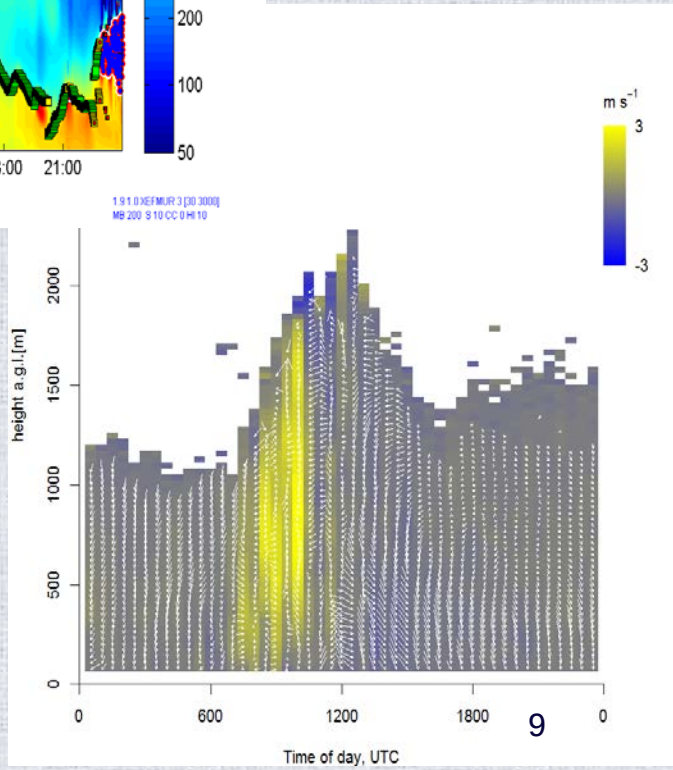
Perspective from the Planetary Boundary Layer (PBL)





Ceilometer,
two consecutive days

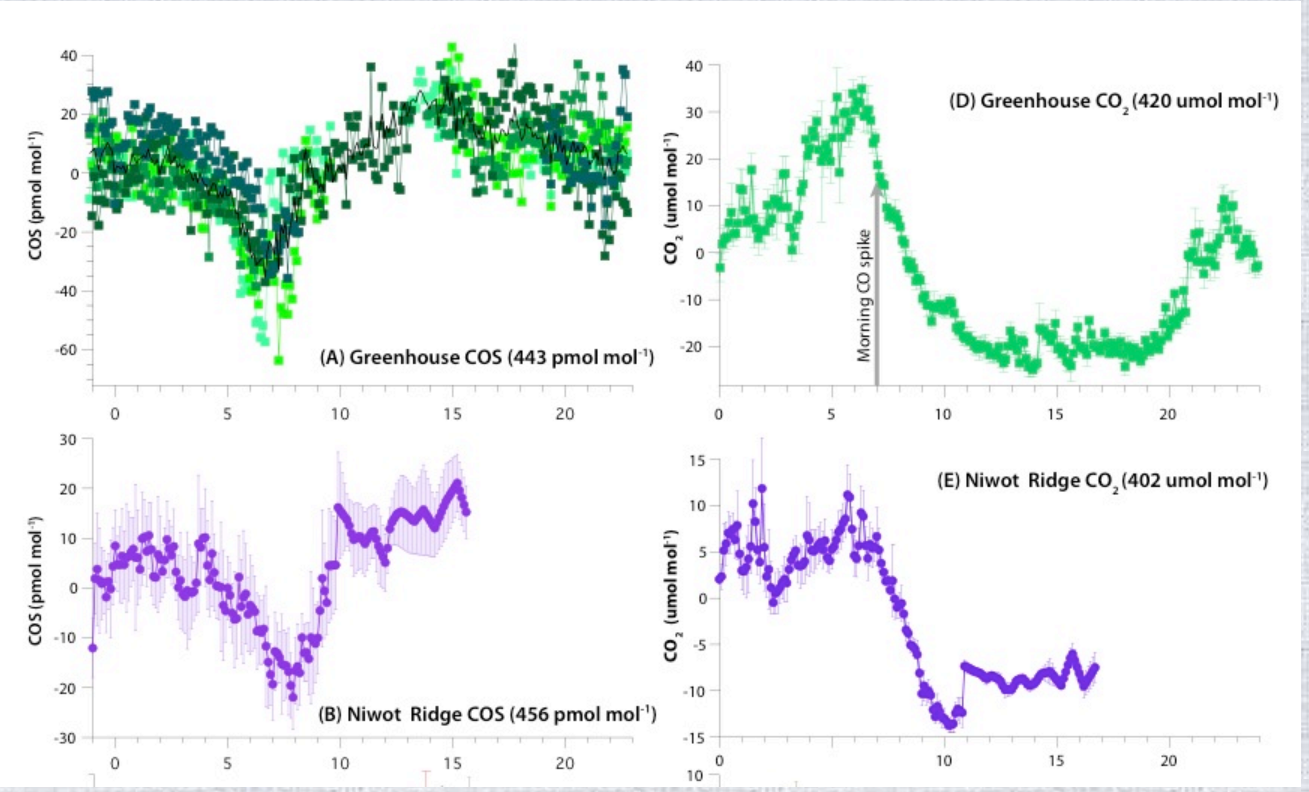
Wind Lidar:



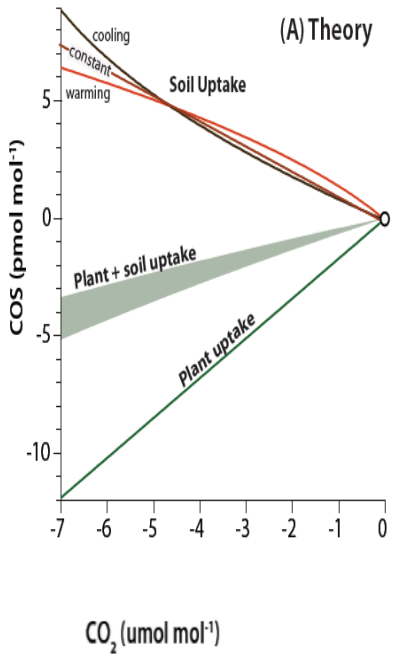
Karlsruhe Institute of Technology

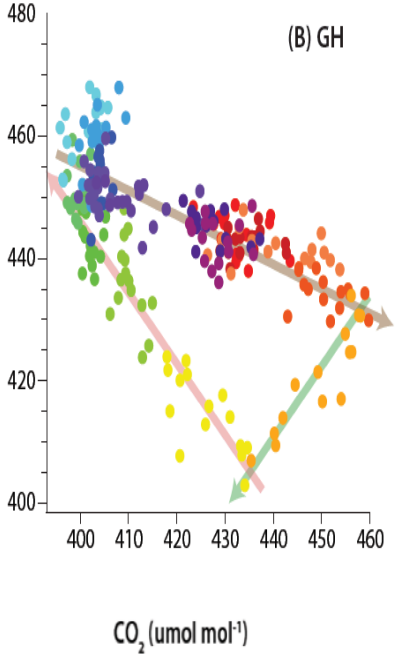
Mauder & Eder, unpublished

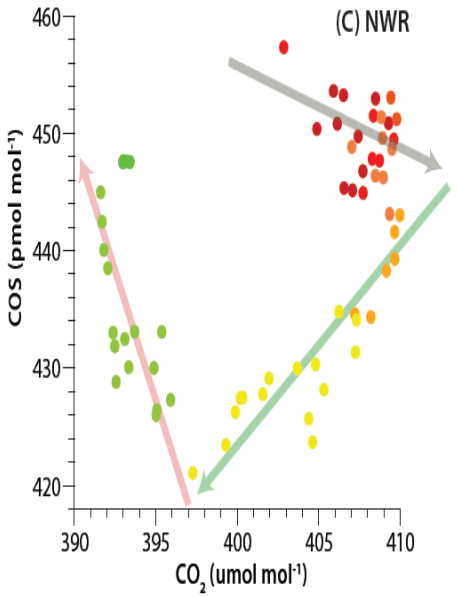
Perspective from canopy air measurements:
Diurnal surface concentration measurements

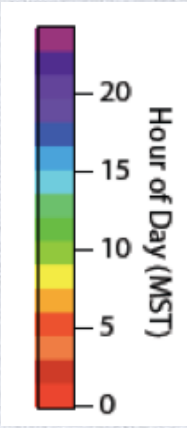


Linking events in the surface layer to the PBL









$$\frac{dC_{cos}}{dt} = k(C_{cos-trop} - C_{cos-surface}) + (F_{cos-soil} + F_{cos-leaf})$$

$$\frac{dC_{co2}}{dt} = k(C_{co2-trop} - C_{co2-surface}) + (F_{co2-soil} + F_{co2-leaf})$$

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 CO_2 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 CO_2) 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