Factors Influencing Decomposition of Surface Litter from the Cerrado in Central Brazil

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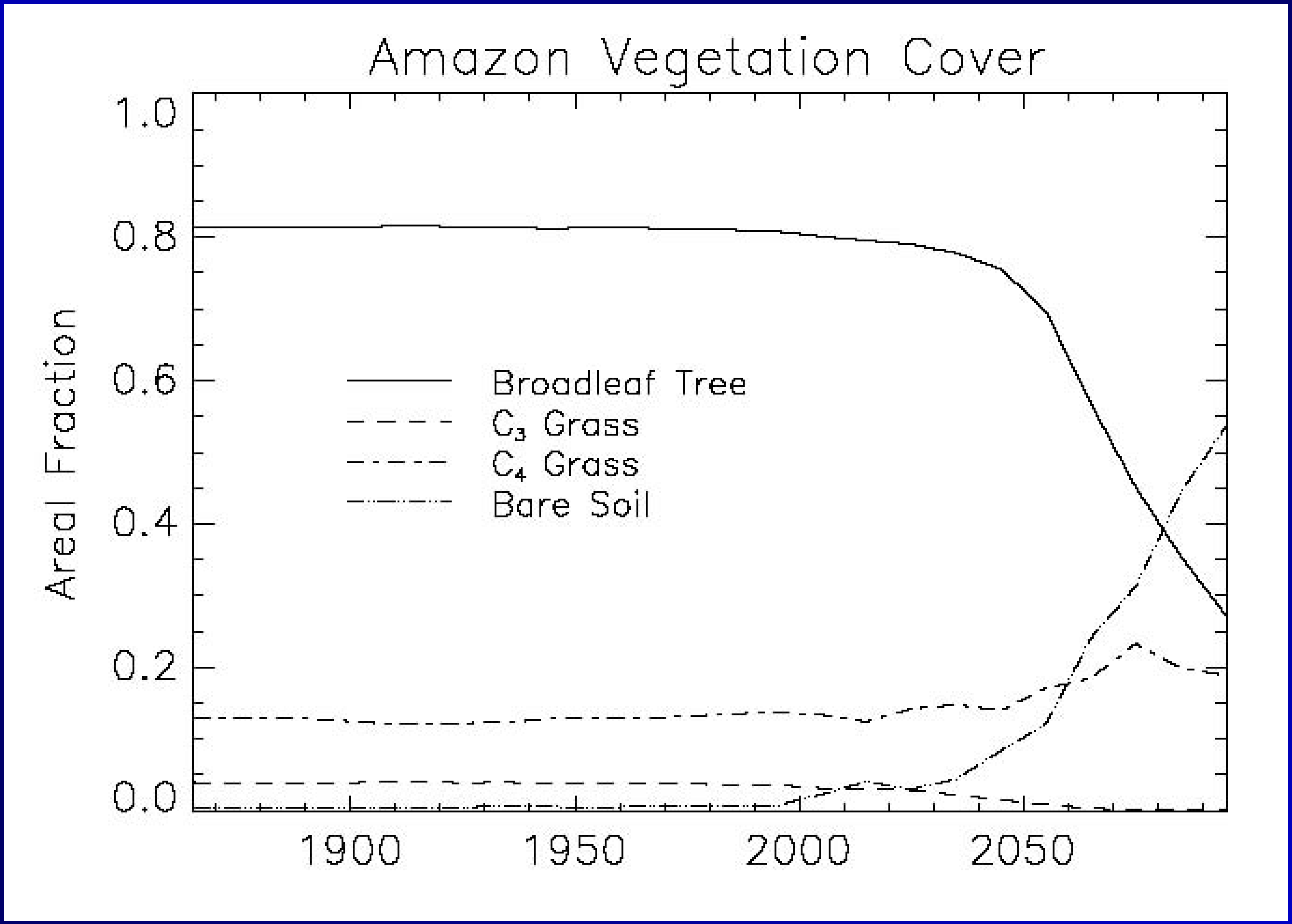
OUTLINE

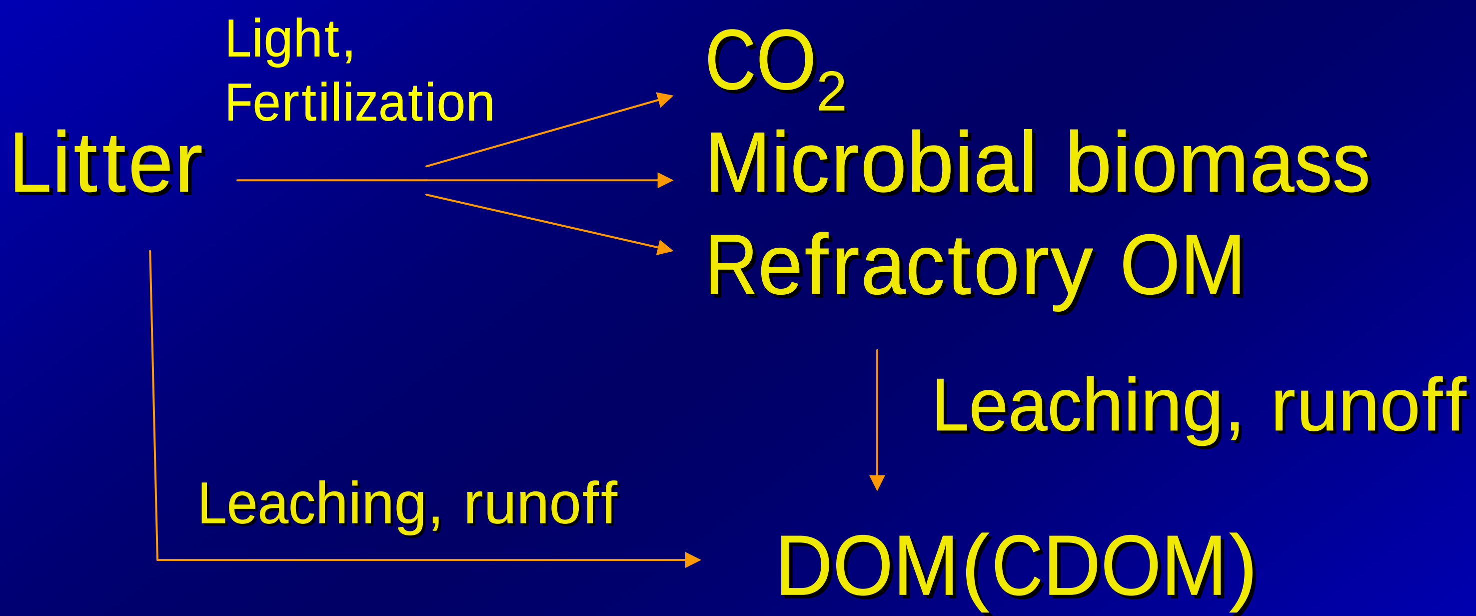
- Pathways for effects of light and fertilization on surface litter decomposition
- Action spectra for photodecomposition
- Comparisons to field studies
- Fertilization effects

Projected Changes in Amazon Vegetation Cover

Cox et al, 2004



Pathways for Plant Litter Transformation and Transport



CDOM is colored (chromophoric) dissolved organic matter
-important in remote sensing of color; UV protection

Biologically Labile and/or Volatile Photoproducts of Aquatic Dissolved Organic Matter (DOM)

$H_2C{=}O$

Formaldehyde

$H_2C(H){=}O$

Acetaldehyde

$H_3C{-}C({=}O){-}CH_3$

Acetone

$HC({=}O){-}C({=}O)H$

Glyoxal

$H_3C{-}C({=}O){-}C({=}O)H$

Methylglyoxal

CO

Carbon Monoxide

COS

Carbonyl Sulfide

$HC({=}O){-}COO^{-}$

Glyoxylate

NH_4^+

Ammonium

CO_2

Carbon Dioxide

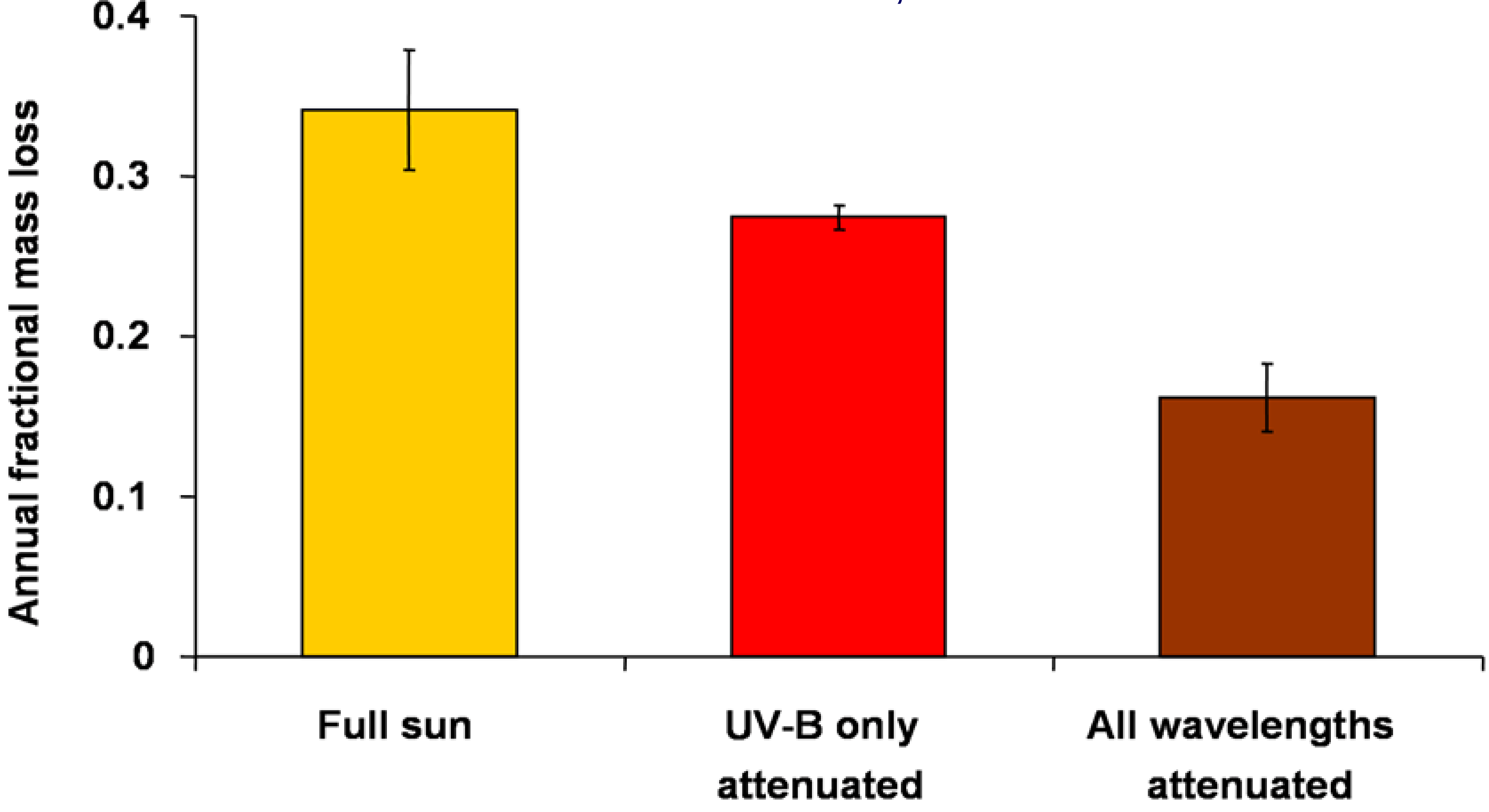
R-C=C-R'

C2 - C4

Volatile Organic Compounds

Light-induced Litter Decomposition in Patagonian Steppe

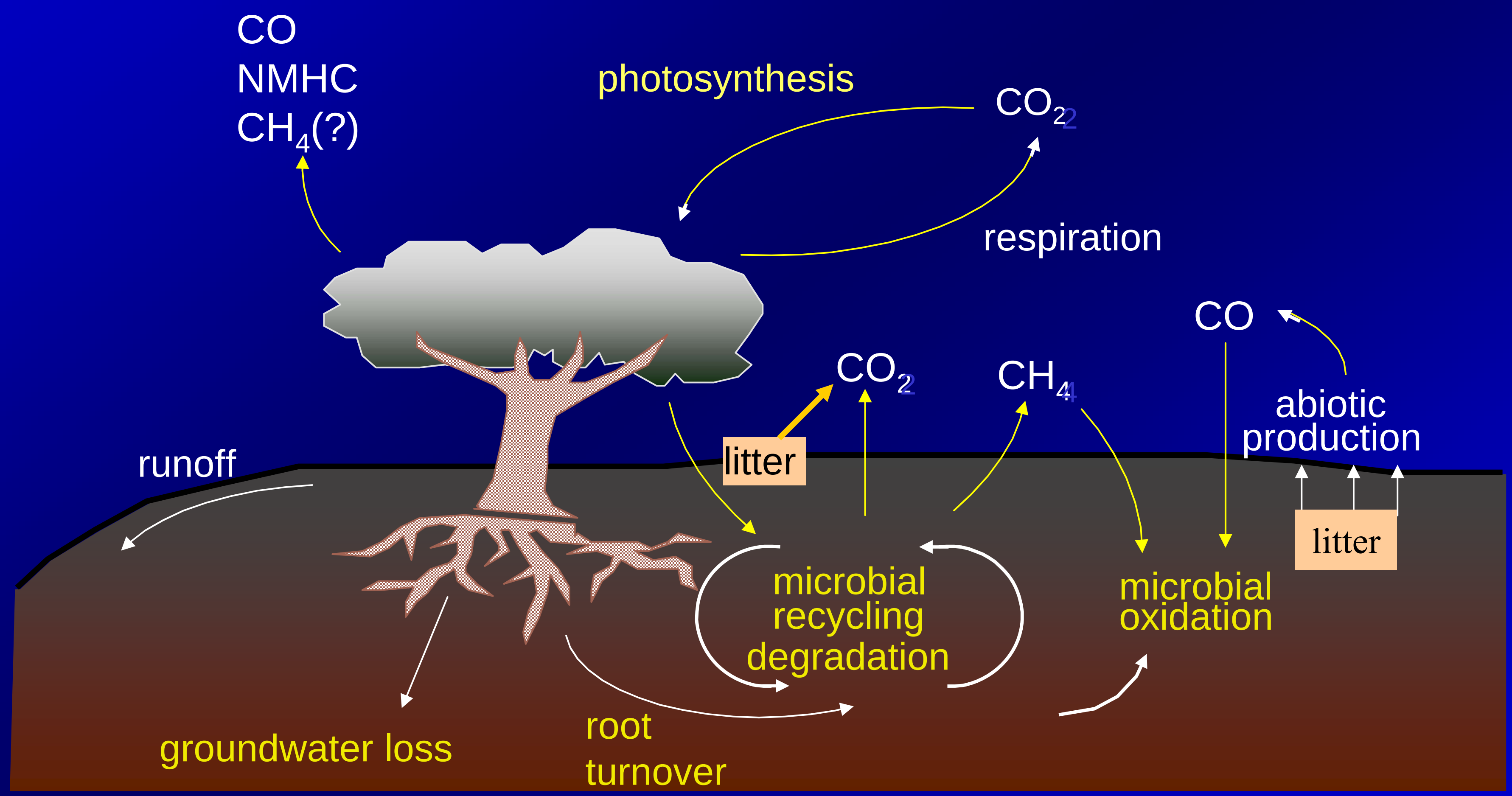
Austin and Vivanco, 2006



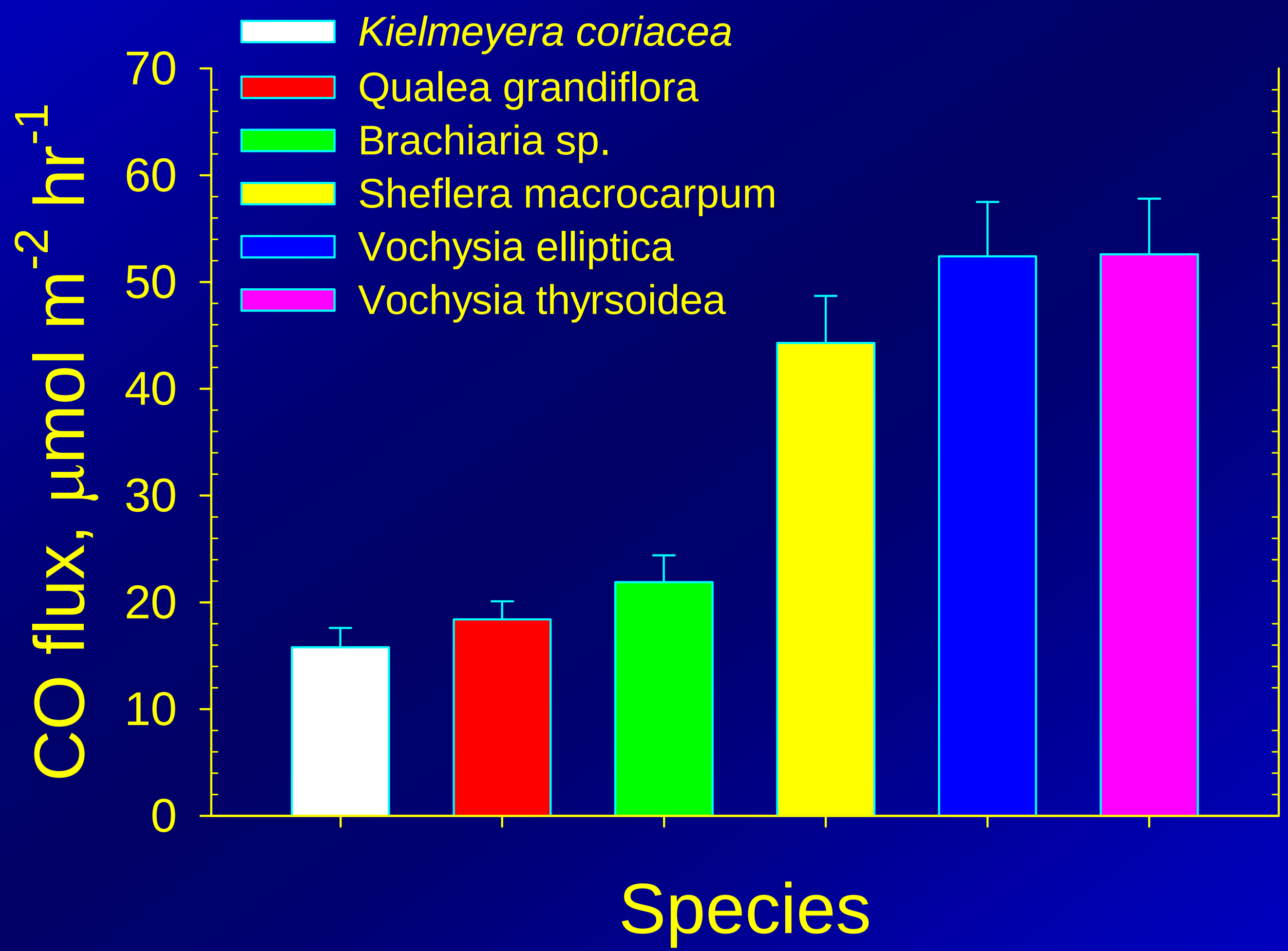
Competing Effects of Solar Ultraviolet Radiation on Plant Litter Decomposition

- Enhances decomposition by direct photoreactions (open, arid ecosystems)
- Slows decomposition by inhibition of decomposers (e.g. fungi)
- Changes leaf composition in growing plants thus altering decomposition

Processes Driving Trace Gas Exchange In Terrestrial Ecosystems



CO Fluxes From Sunlight-Exposed Litter



Developing Relationships Required to Model Sunlight-Induced Decomposition of Plant Litter

General Approach: Determine action spectra using Rundel technique (Rundel, *Physiol. Plant.*, 58, (1986) 360-366.)

Steps:

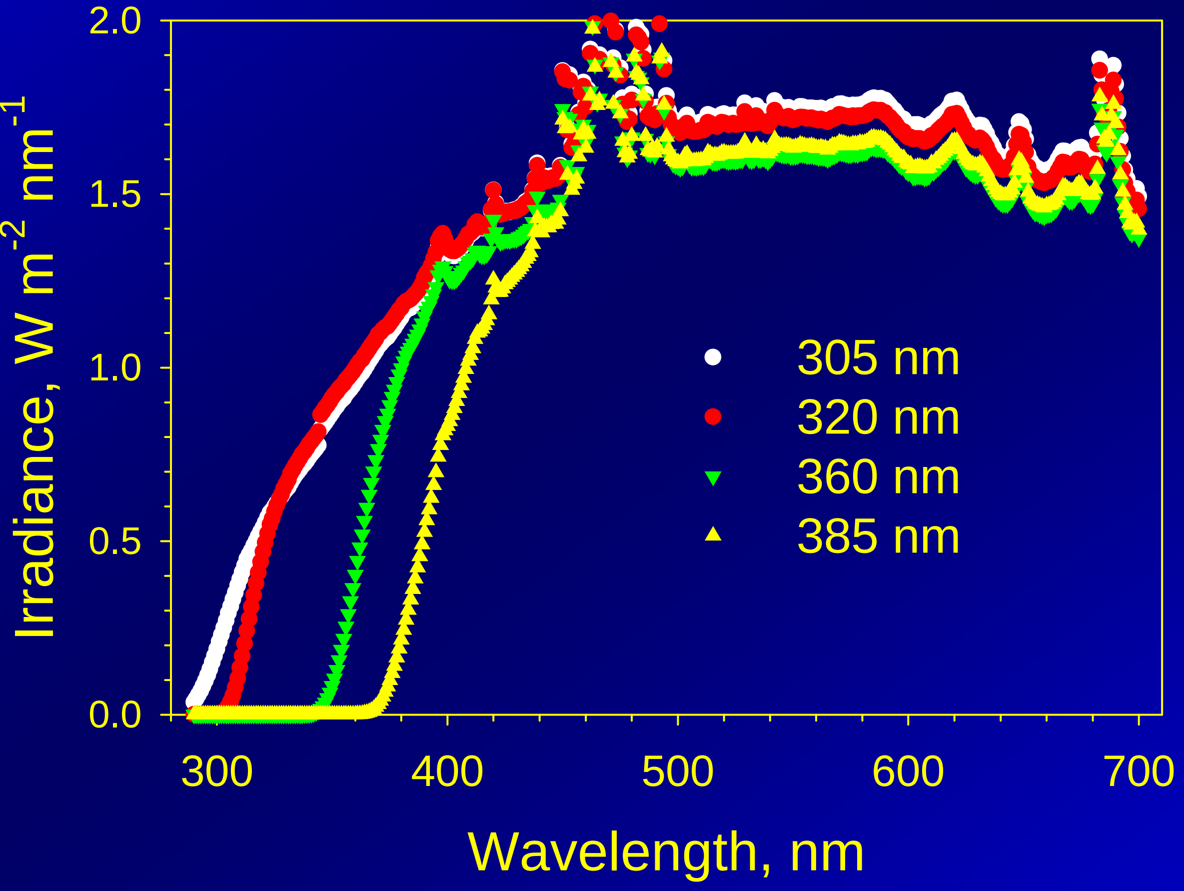
-Determine decomposition rates by following certain indicators, e.g. weight loss, CO_2 or CO production using filters that block UV

-Measure irradiance of filtered light

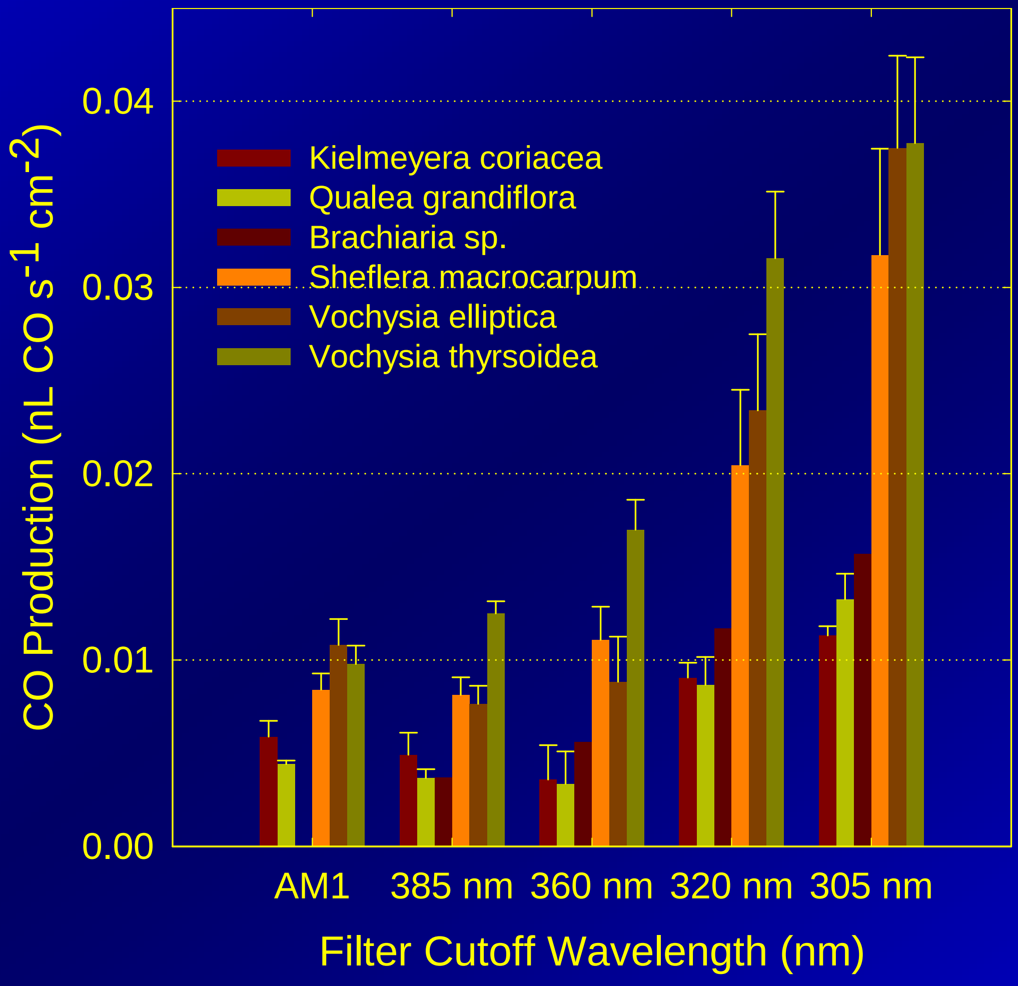
-Fit the data using exponential (or other) equation of form (EXP (a + b * Wavelength)

-Use Excel Solver to compute values of a and b that minimize difference between observed and computed decomp rates

Filtered Irradiance Used to Determine Action Spectra For Litter Decomposition



CO Production from Various Cerrado Litter Sources Exposed to Filtered Simulated Solar Radiation

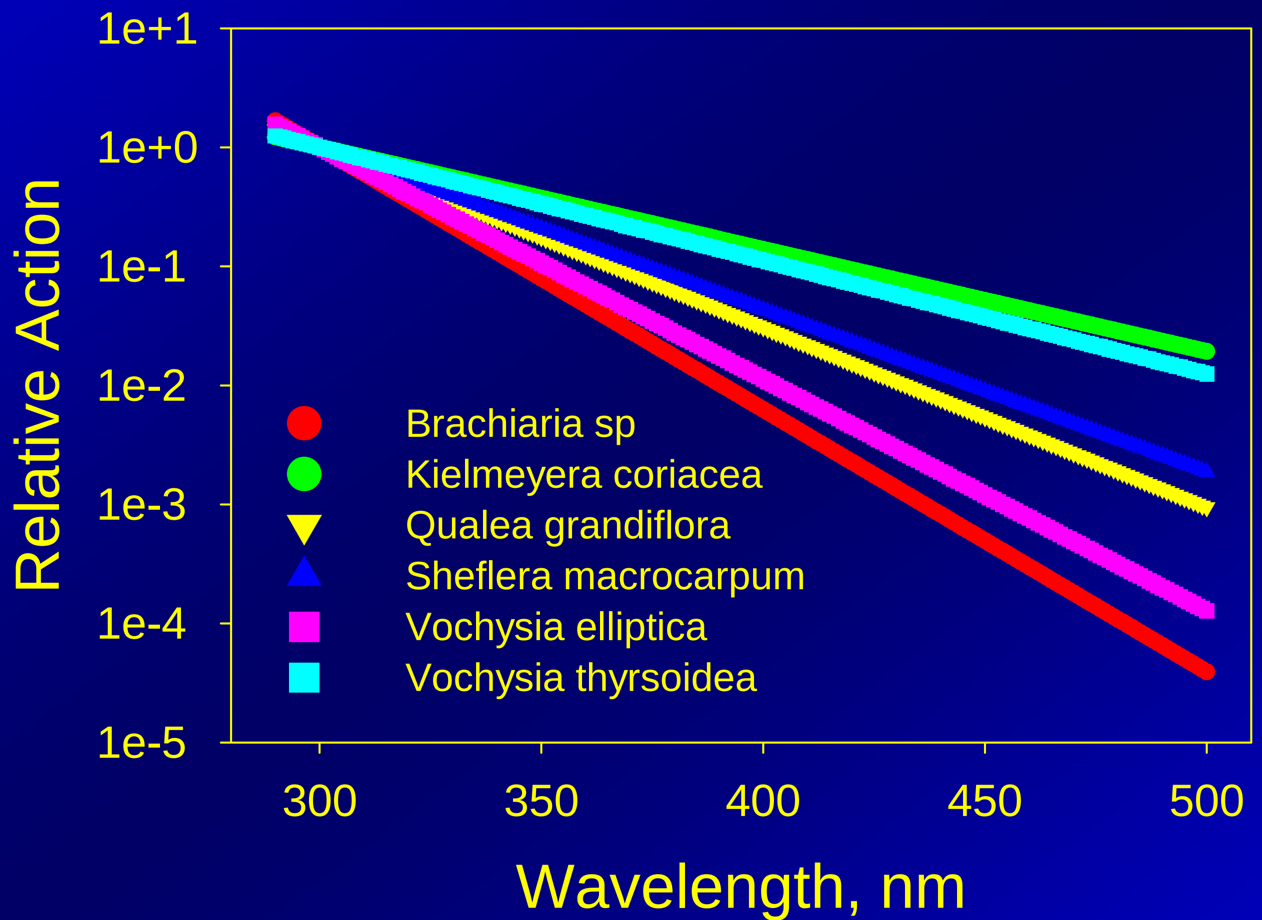


Equation and Data Describing Litter Photodegradation Fluxes

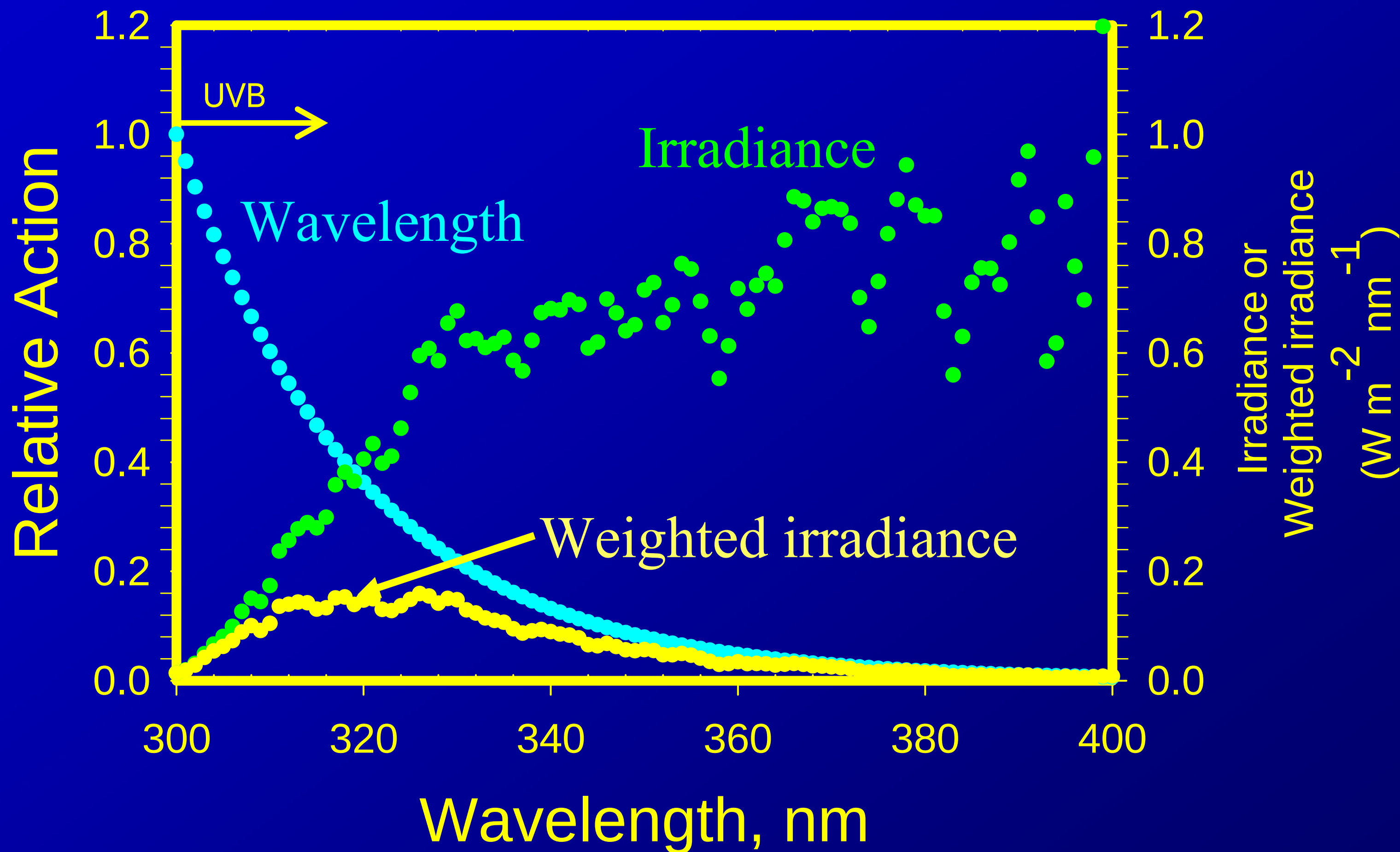
$$\text{Flux} = a\ \exp^{-b\lambda}$$

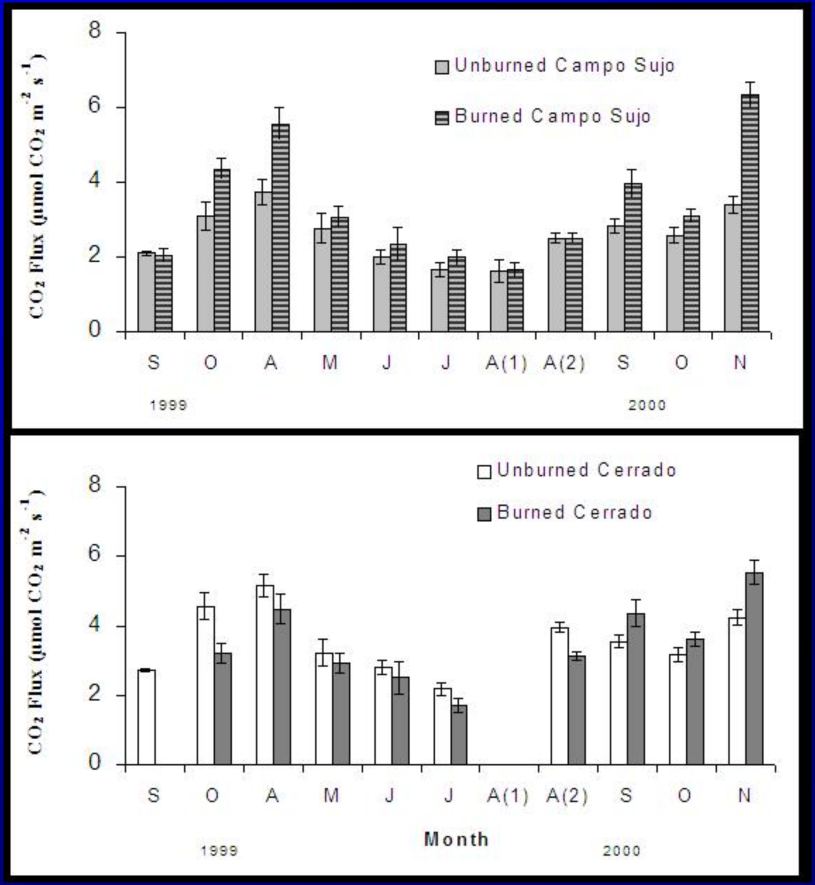
Species	a	b	RMSE	Sun Flux
Kielmeyera coriacea	-2.37	-0.0198	0.00131	0.0028
Qualea grandiflora	3.12	-0.0348	0.00165	0.0031
Brachiaria sp.	8.63	-0.0507	0.00417	0.0034
Sheflera macrocarpum	2.78	-0.0314	0.00484	0.0073
Vochysia elliptica	7.55	-0.0448	0.00421	0.0085
Vochysia thyrsoidea	-0.40	-0.0219	0.00677	0.0093

Action Spectra for Plant Litter Photodecomposition



Wavelength Effects for Sunlight-induced Decomposition of *Brachiaria sp*





Estimated Relationship Between Degradation and Photosynthetically Active Radiation (PAR)

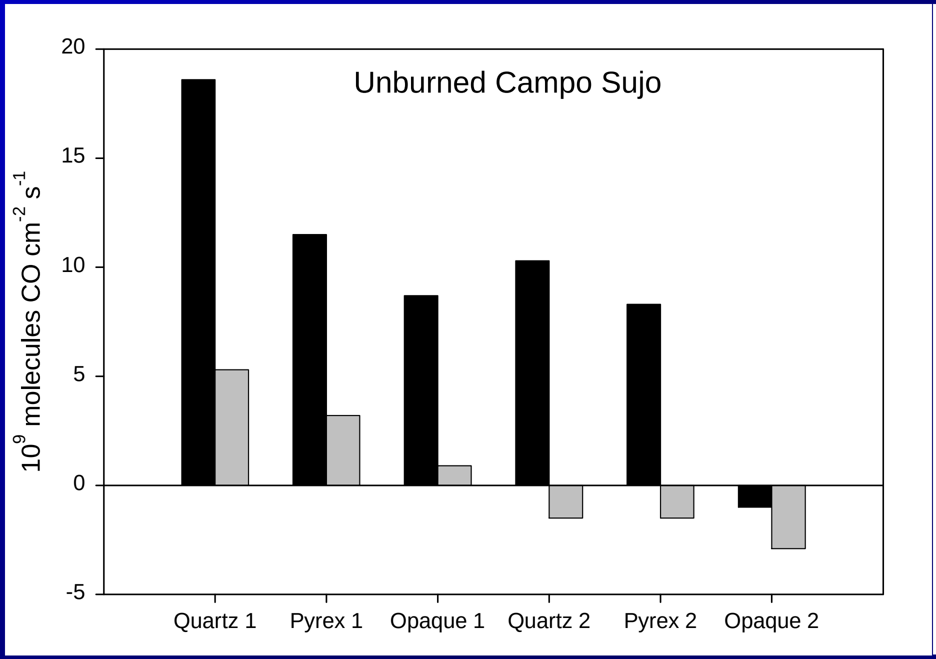
CO flux = 7.5 x 10^{-6} x (PAR)

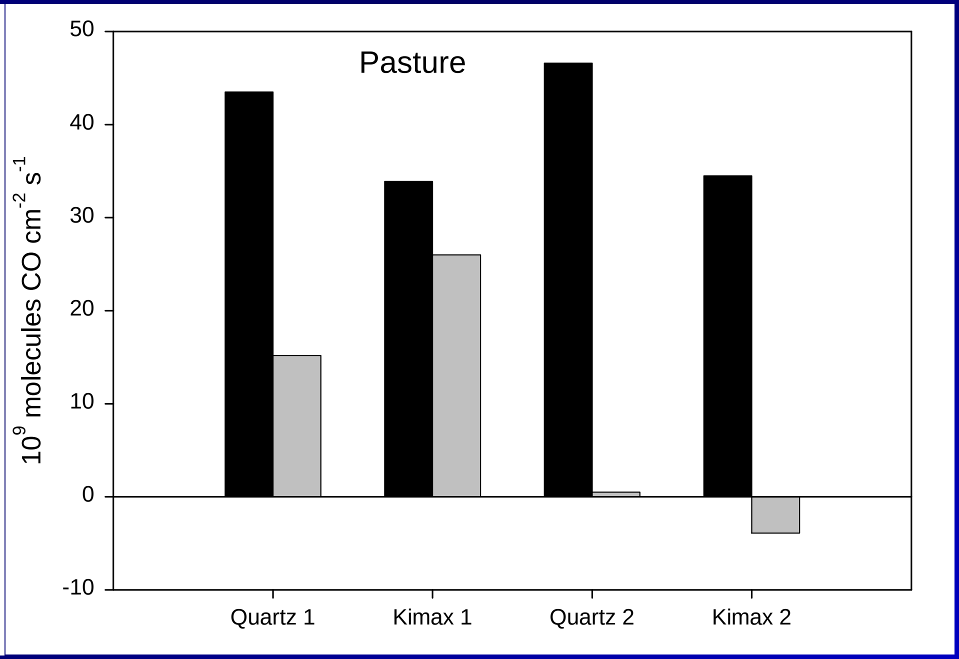
CO_2 flux = (7.5 -15) x 10^{-6} x (PAR)
(PAR expressed as W m^{-2})

For Cerrado CO_2 in dry season est. 0.3-0.6 μmol m^{-2} s^{-1} ~15-30% of observed

Litter CO Fluxes Observed in Cerrado Sites

Kisselle et al., 2002





With litter

Without litter

Fertilizer Effects: Long-term Incubation Experiment

Collect Soil samples
0-10 cm
10-20 cm

↓

Sieving

↓

Addition of Soil and Nutrients to Jars

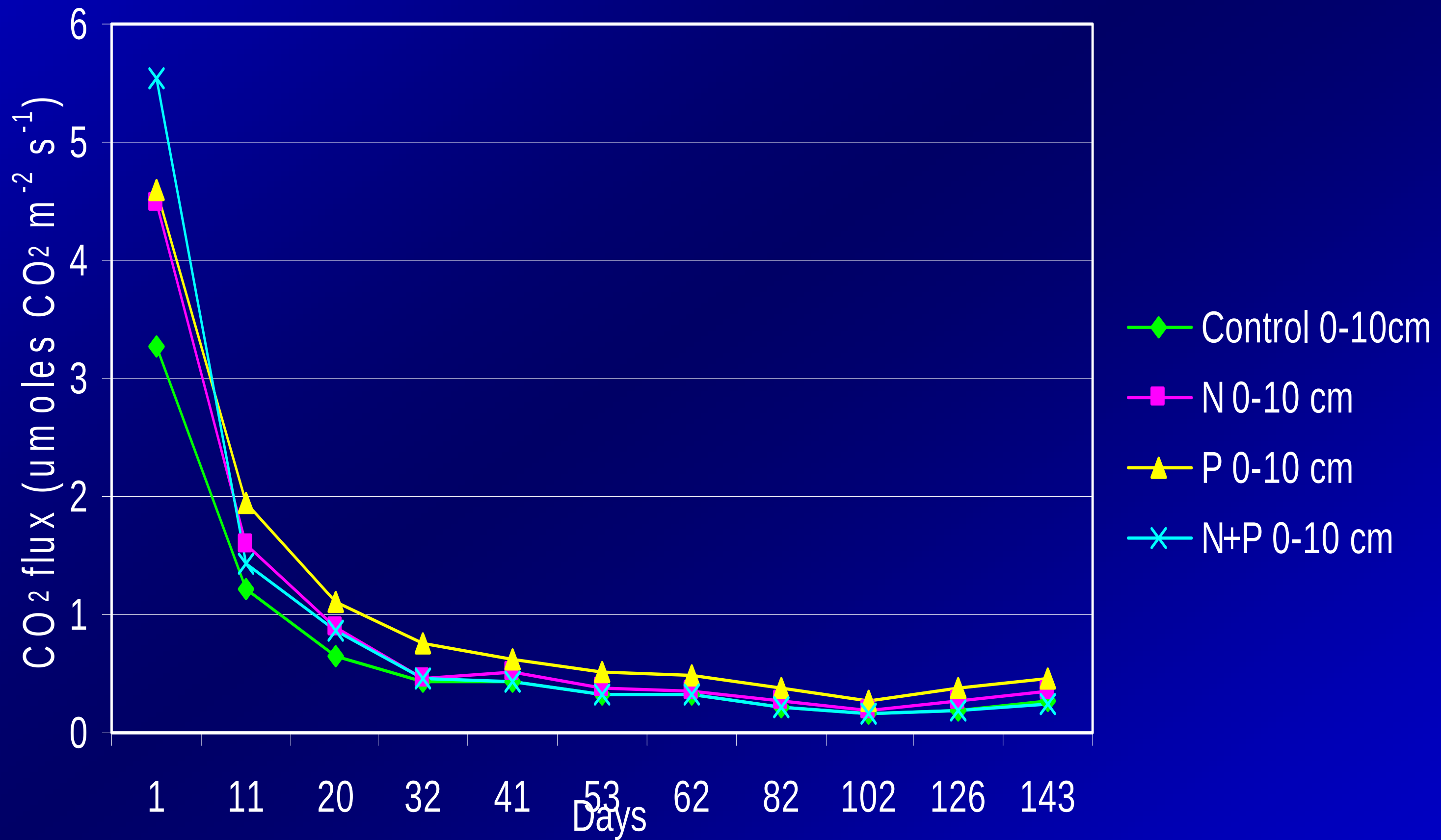
↓

Measure

- CO_2 (Licor)
- CO (Trace A)

- Fertilizers added: N, P, N+P
- All fertilizers added in granular form
- Jars were incubated in the dark at room temperature, at 60% WHC for 143 days.

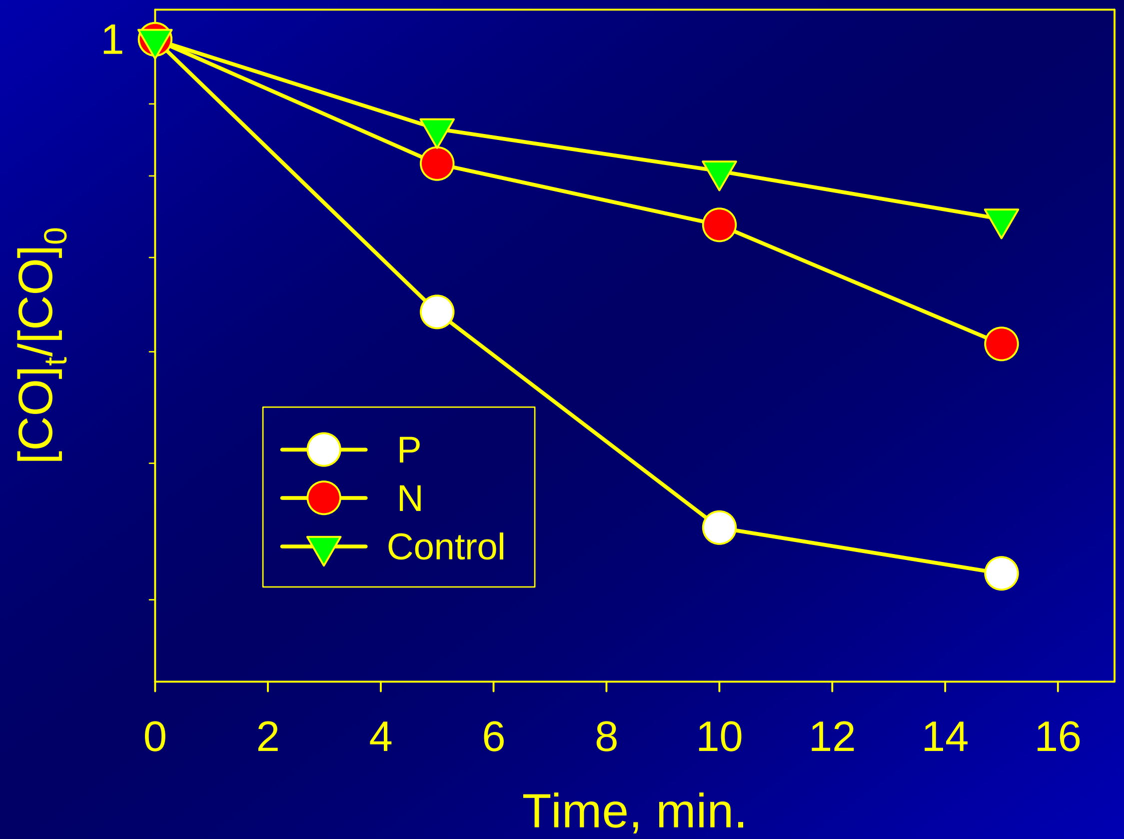
Fertilization Effects on Average CO_2 Flux from Soils (0-10 cm Depth)



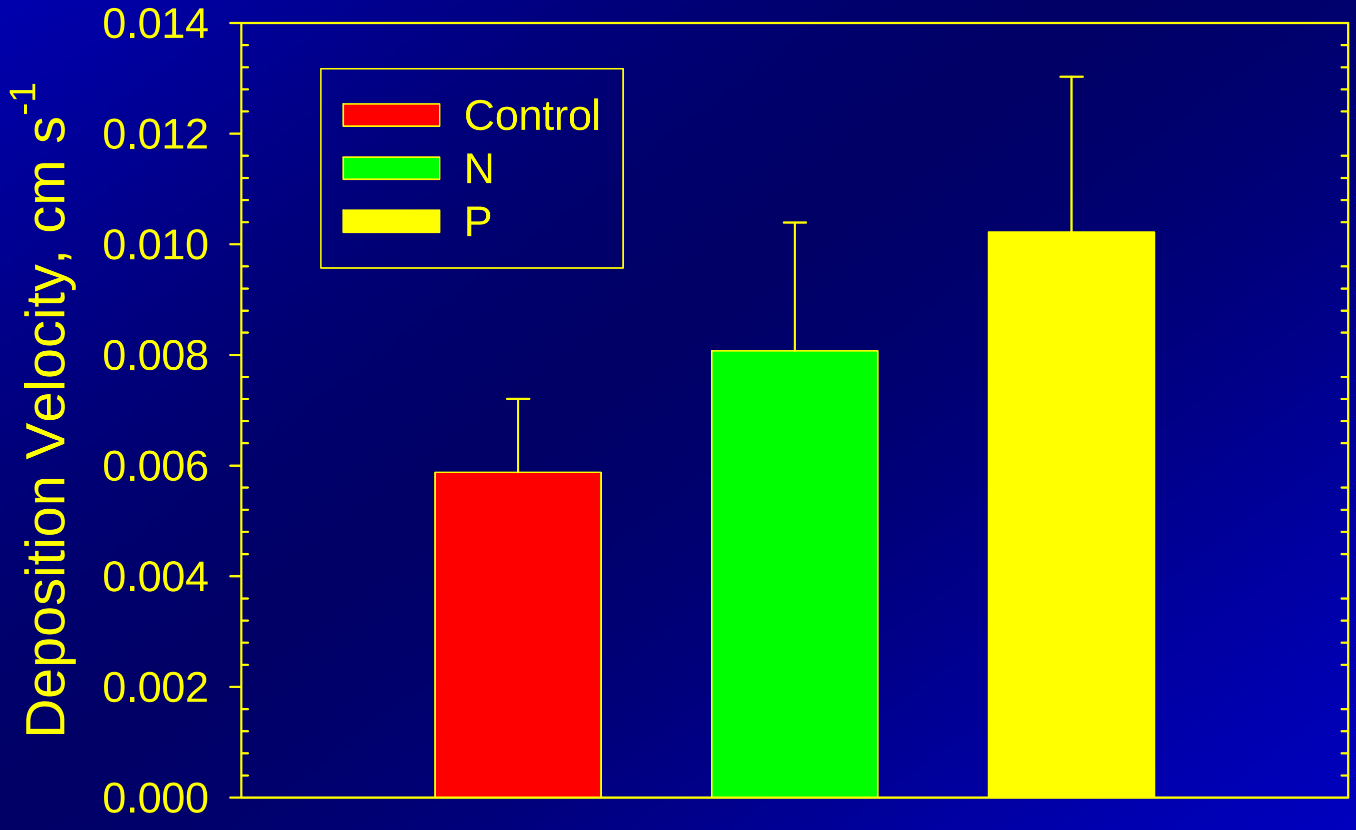
Fertilization Effects on Exponential Decay Constants for the Active and Slow C Pools in Cerrado Soils

Treatments	Original Soil Depth (cm)	Act. C k_a	Slow C k_s
Control	0-10	0.52	0.03
N		1.03	0.03
P		2.26	0.02
N+P		0.62	0.03
Control	10-20	0.06	0.00
N		0.13	0.00
P		0.23	0.01
N+P		0.13	0.01

CO Uptake By Cerrado Soil Treated with Fertilizer



Deposition Velocities for CO Uptake By Soil Treated With Fertilizer



Summary of Results and Conclusions

- Litter photodegradation is a significant CO source and loss pathway for surface litter in the Cerrado during dry season.
- Action spectra for litter photodegradation are species dependent and induced primarily by UV component of sunlight
- Fertilizer addition, esp. P, increases the microbial respiration of the labile C of surface SOM from Cerrado s.s. and enhances CO uptake