

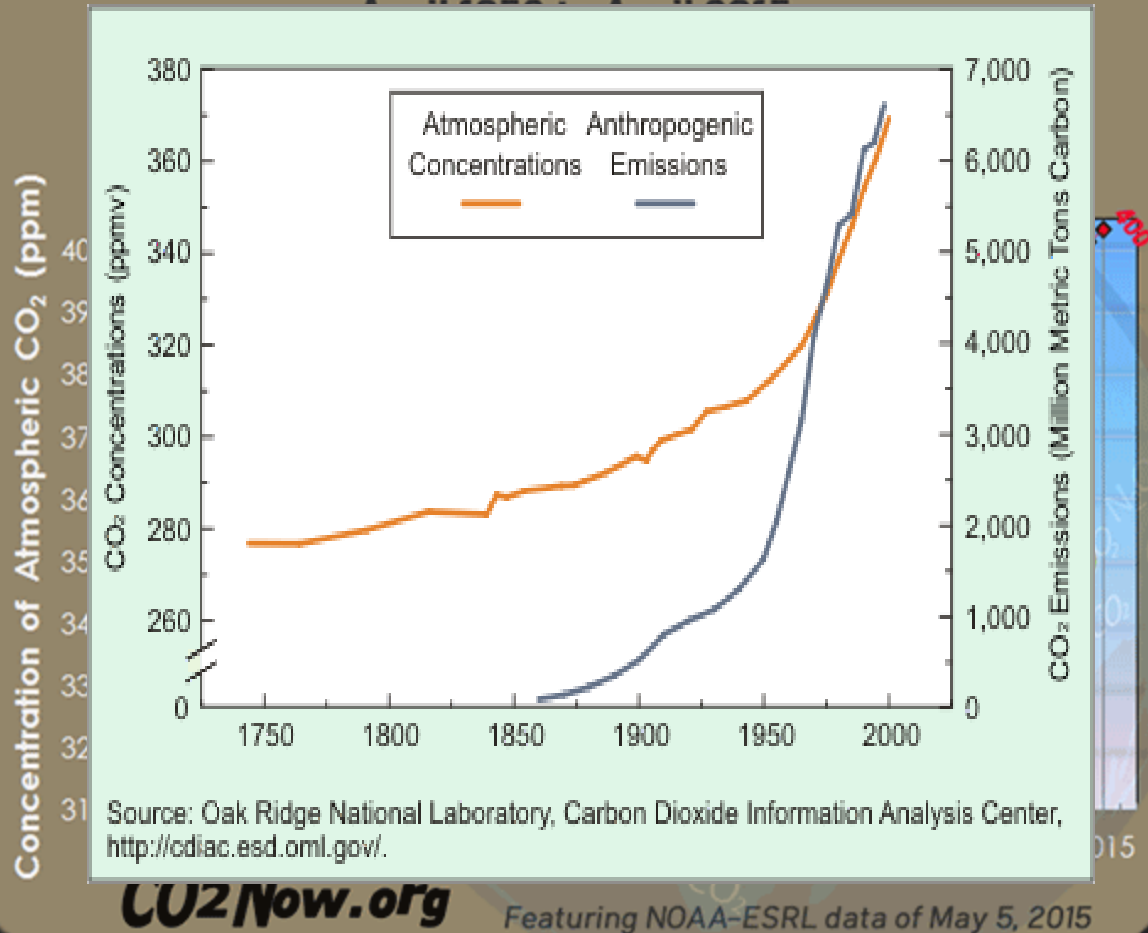
Climate Change, Carbon Dioxide and Aerobiology

Lewis H. Ziska, PhD, USDA-ARS, Crop Systems and Global Change Laboratory



CSTE Pollen Summit

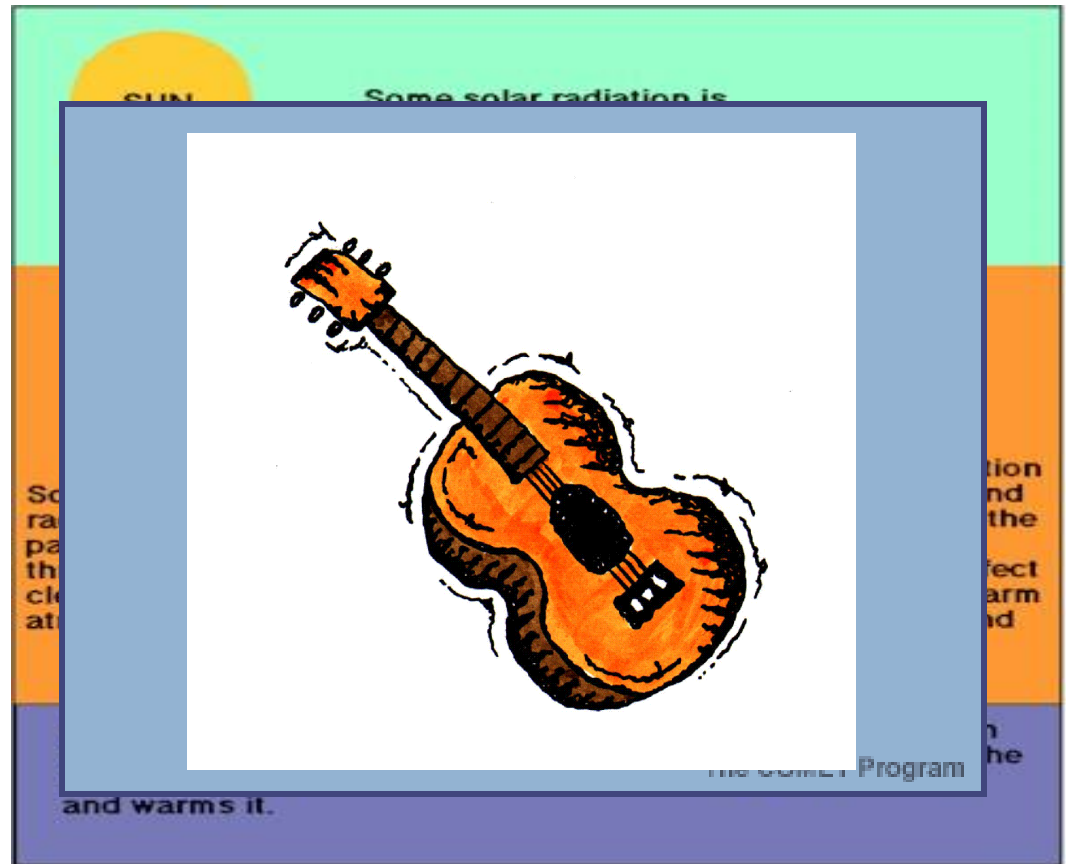
Atmospheric CO₂



So what if CO₂ goes up?

I. An indirect effect of rising carbon dioxide: warmer temperatures.

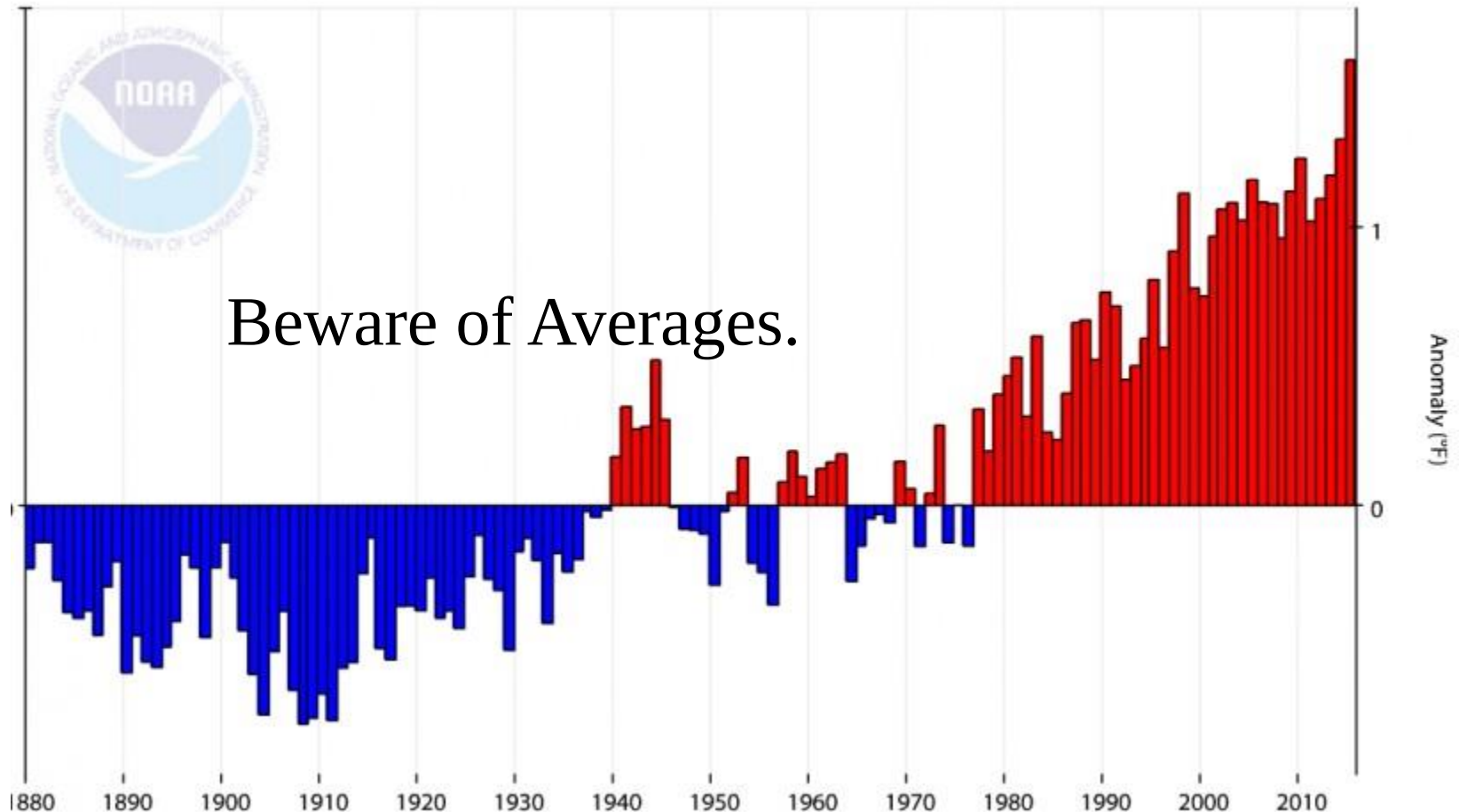
Gas	%
Nitrogen (N ₂)	78.1
Oxygen (O ₂)	20.1
Argon (Ar)	0.93
Carbon Dioxide (CO ₂)	0.04 up to 0.100
Water (H ₂ O)	0.05 to 1.00



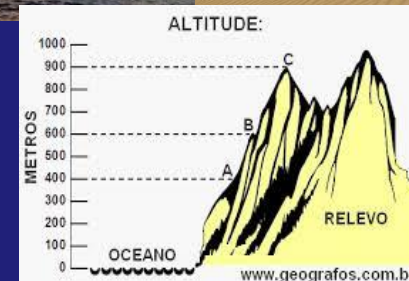
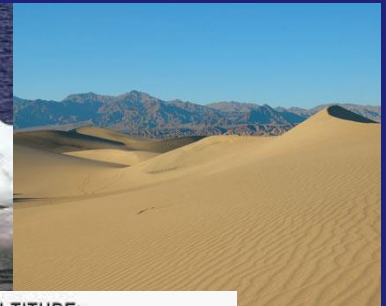
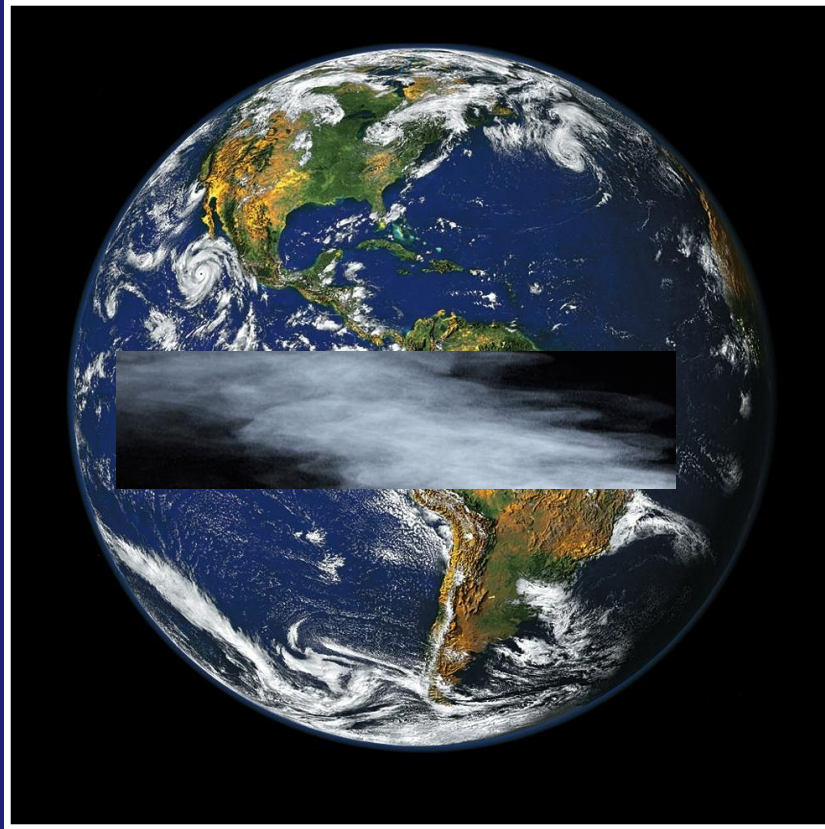
No H₂O and CO₂? Surface temperature would be -18°C. With H₂O and CO₂? Surface temperature is 15°C.

Physical Consequences: Temperature

Global Land and Ocean Temperature Anomalies, January-December

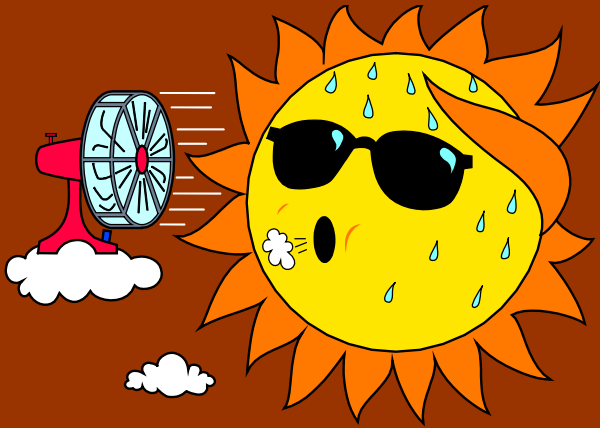


Temperature increase is not uniform



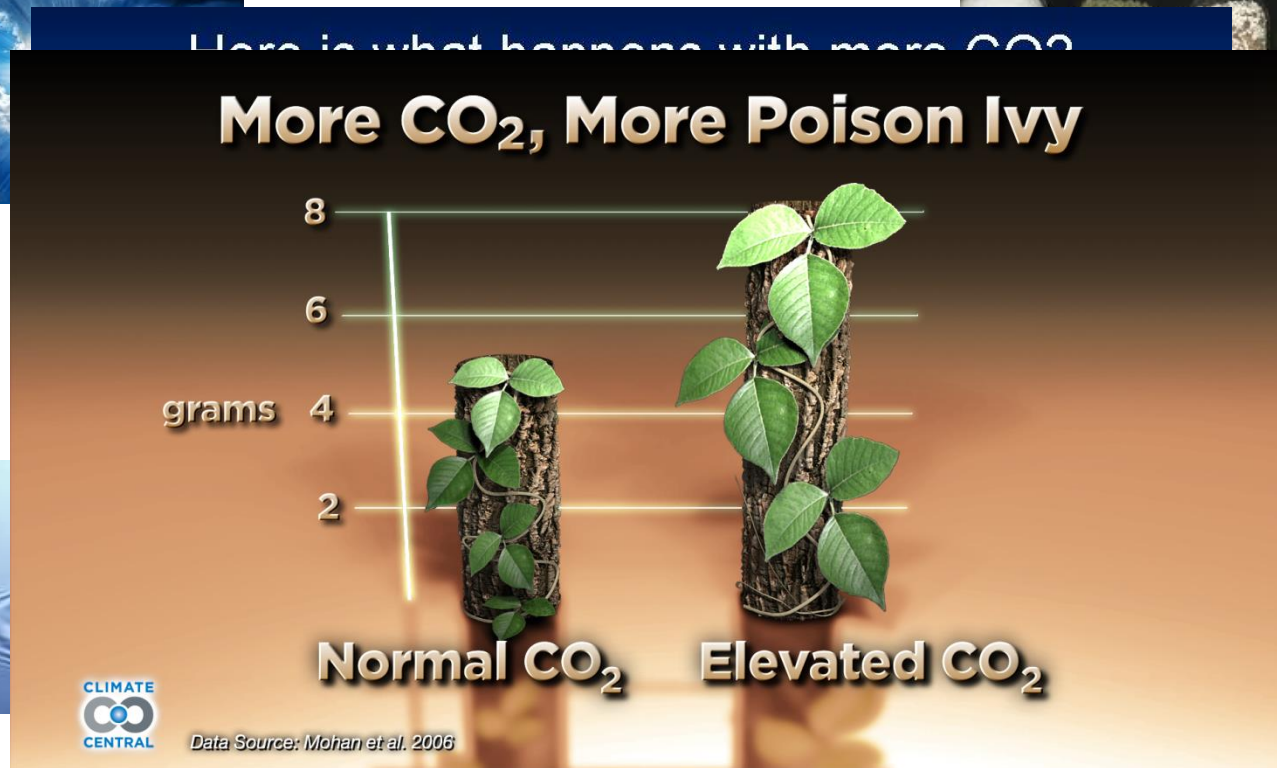
If water vapor is high, it will be the dominant warming gas....little effect of CO_2
If water vapor is low, adding CO_2 will increase the surface temperature. Differential rate of warming may drive extreme events.

CO₂, warming and public health.



- Changes in range of insect or rodent borne diseases.
- Changes in water or seafood borne diseases.
- Increasing ground-level ozone, and respiratory ailments.
- Contamination of drinking water due to excessive flooding.
- Heat-related deaths / fewer cold related.

Plants are essential to life.



Water

Carbon Dioxide

The rapid increase in atmospheric CO₂ will alter global plant biology.

CO₂, climate, plants and public health

Direct Effects

Allergies

Contact dermatitis

Toxicology

Indirect Effects

Food Supply

Nutrition

Food Safety

Medicine / Narcotics

Spread of disease vectors

Increased pesticide use.

Plant-based Allergies.



Trees



Weeds and Grasses



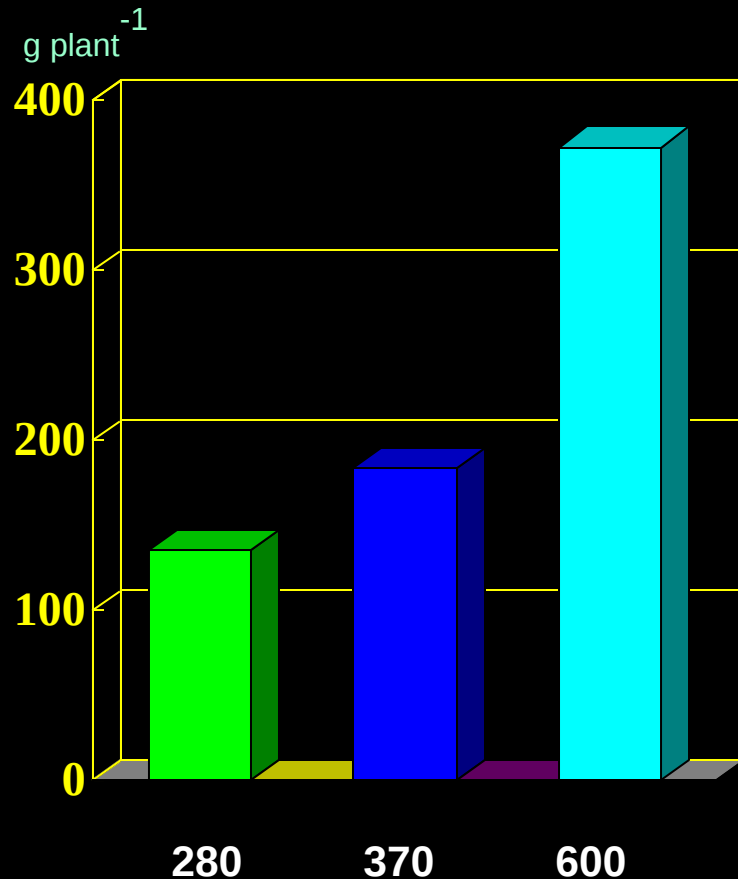
Ragweed

Determining Ragweed Pollen Production



Sampling pollen from ragweed catkins.

Response of common ragweed to CO₂



- **Pollen Production**

280 ppm	4.8 g
370 ppm	10.9 g*
600 ppm	20.5 g*

Antigen Amb a1	ELISA / mg protein
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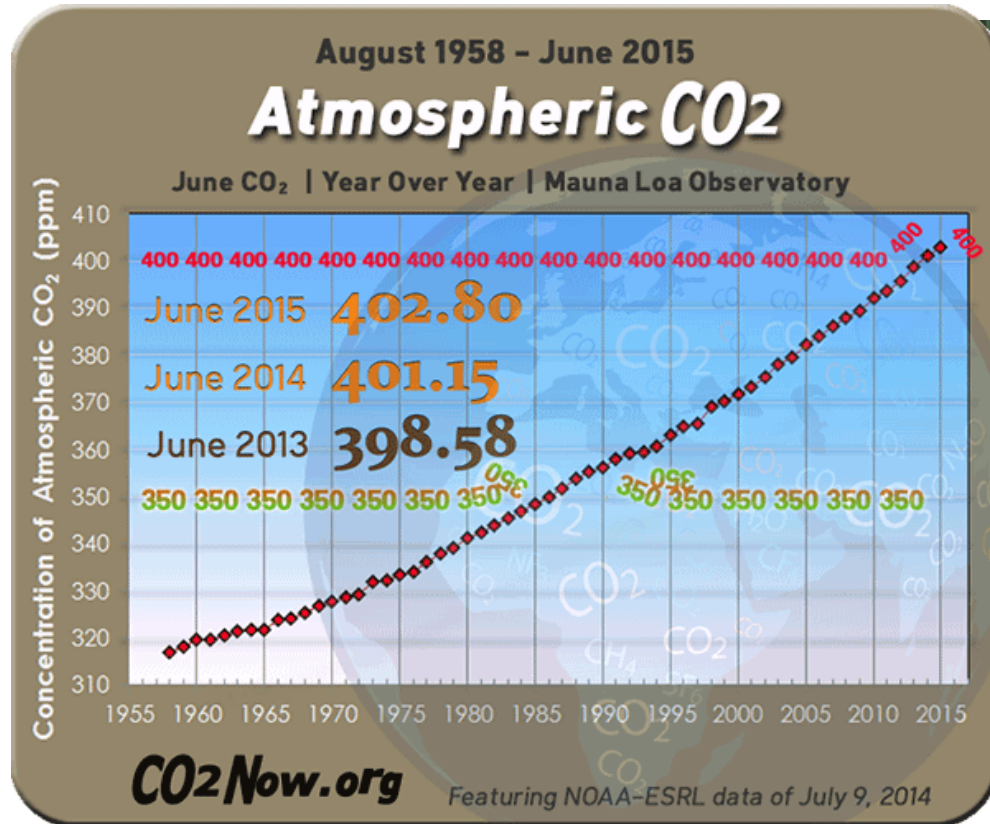
280 ppm	4490
370 ppm	5290
600 ppm	8180*

Chamber Study, USDA

Functional Plant Biology 27:893-898

Functional Plant Biology 32:667-670

From the lab to the “real world”



Ragweed in “real” time.

Using macro-climatic differences in CO₂ and temperature along an urban-rural gradient to study initial growth, productivity and species dynamics of fallow farm soil (ecosystem component = secondary succession).



For each site:

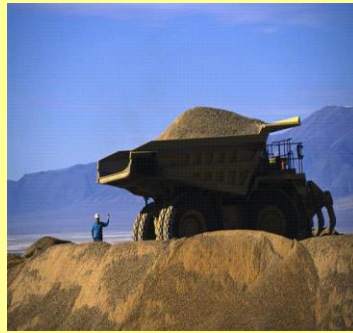
°C

CO₂

1. Dig Plots



2. Move soil



3. Make uniform



4. Monitor



Urbanization and climate change.

Daytime Carbon Dioxide (ppm)

Location	2002	2003	2004	2005
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Rural	381	373	380	386
Suburban	394	370	400	413
Urban	458	520	456	458

Daytime Air Temperature (°C)

Location	2002	2003	2004	2005
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Rural	25.1	22.5	24.4	25.3
Suburban	25.8	23.9	25.3	26.0
Urban	26.6	24.7	26.3	27.2

Night-time Temperature (°C)

Location	2002	2003	2004	2005
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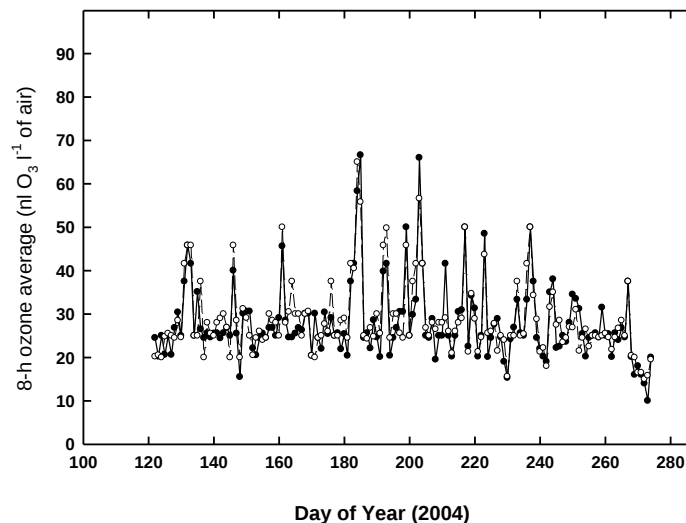
Rural	19.6	18.0	19.0	19.0
Suburban	19.3	18.6	19.2	19.3
Urban	22.3	21.3	22.5	22.7

Change in season length (days)

	2002	2003	2004	2005
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Urban-Rural	36	41	52	39
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What about other meteorological variables?



8-h daytime ozone.
2004 season

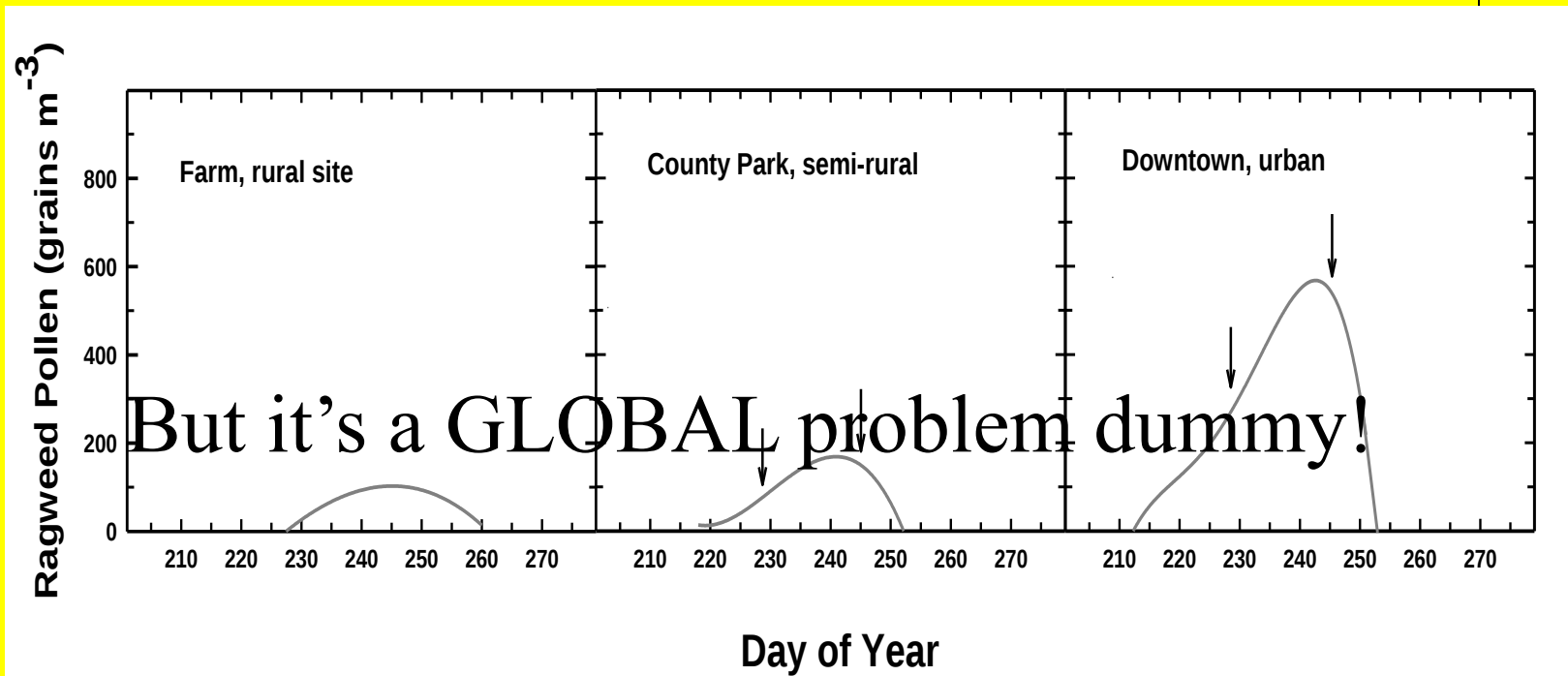
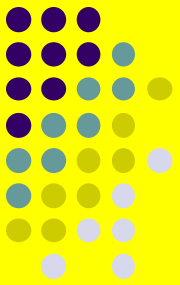
Overall: Urban-induced increases in carbon dioxide, air temperature and growing season are consistent with most IPCC near-term scenarios. With the exception of N deposition, other variables did not differ consistency, but N low relative to soil N.

Can we study the effects of climate change NOW?



Placing four 2x2 m² plots
Near downtown Baltimore.
Use same soil and seed bank
in suburban and rural locations.

Got ragweed?



Urban locale had longer growing season (milder winter), warmer temperatures, and more carbon dioxide.

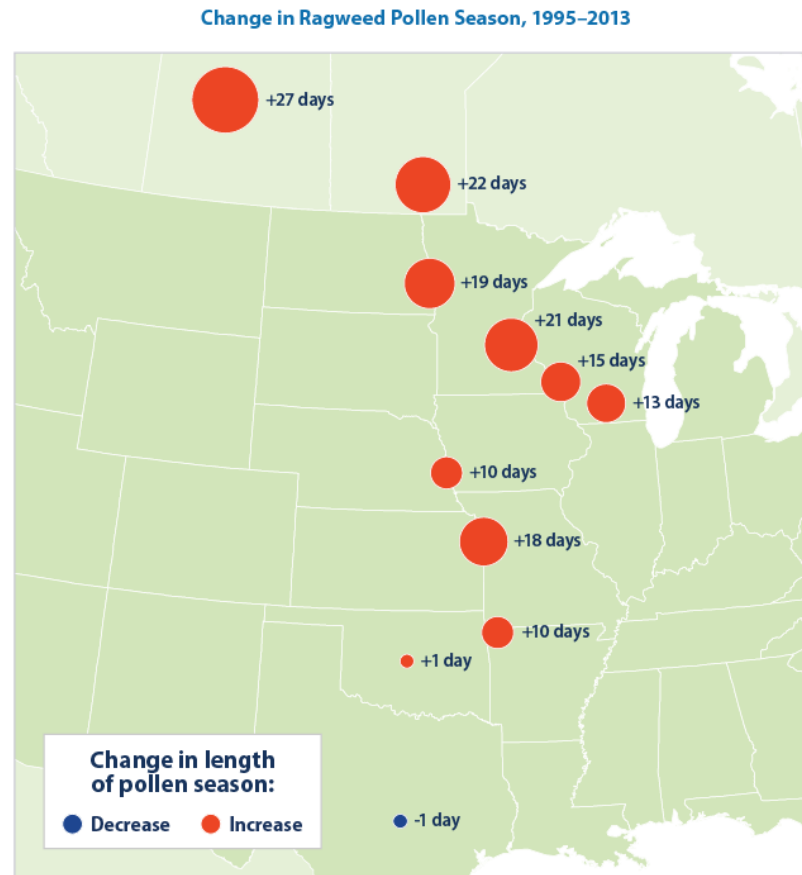


Scaling Up: Warming should increase with increasing latitude.
Is a climate signal apparent with respect to length of ragweed pollen season?

Climate signal: From June 21st to first frost.

Frost Free Days, Pollen Season and Latitude

PNAS, 108: 4248-4251



Data source: Ziska, L., K. Knowlton, C. Rogers, National Allergy Bureau, Aerobiology Research Laboratories, Canada, 2014 update to data originally published in: Ziska, L., K. Knowlton, C. Rogers, D. Dalan, N. Tierney, M. Elder, W. Filley, J. Shropshire, L.B. Ford, C. Hedberg, P. Fleetwood, K.T. Hovanky, T. Kavanaugh, G. Fulford, R.F. Vrtis, J.A. Patz, J. Portnoy, F. Coates, L. Bielory, and D. Frenz. 2011. Recent warming by latitude associated with increased length of ragweed pollen season in central North America. *P Natl. Acad. Sci. USA* 108:4248–4251.

For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at www.epa.gov/climatechange/indicators.