

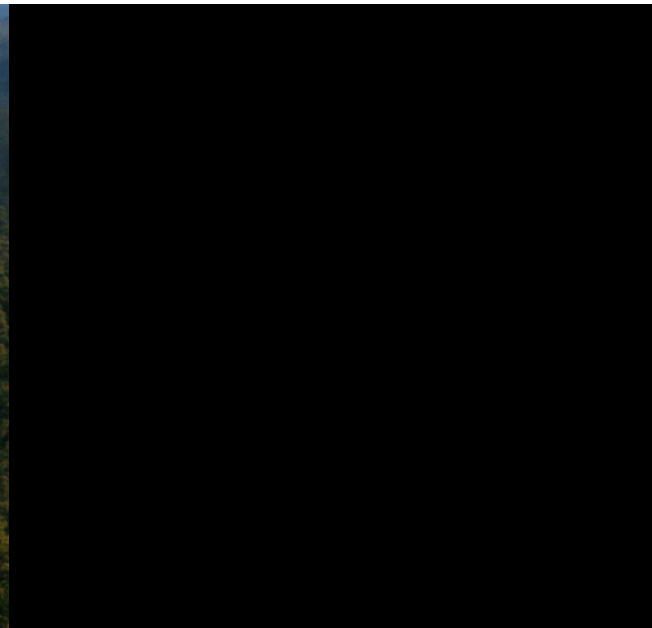
Biogeochemistry is Physics?

First an intro

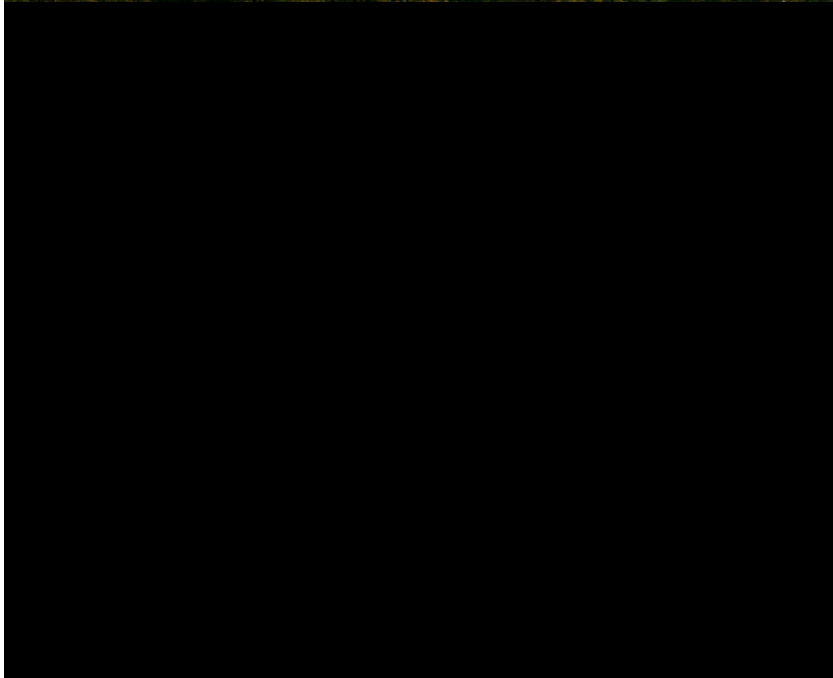
- “I’m from New Jersey; I don’t expect much. If the world ended today, I would adjust.” – John Gorka



©2005 WmLiu



PHILLYSKYLINE.COM : ATLANTIC CITY FROM THE PINE BARRENS





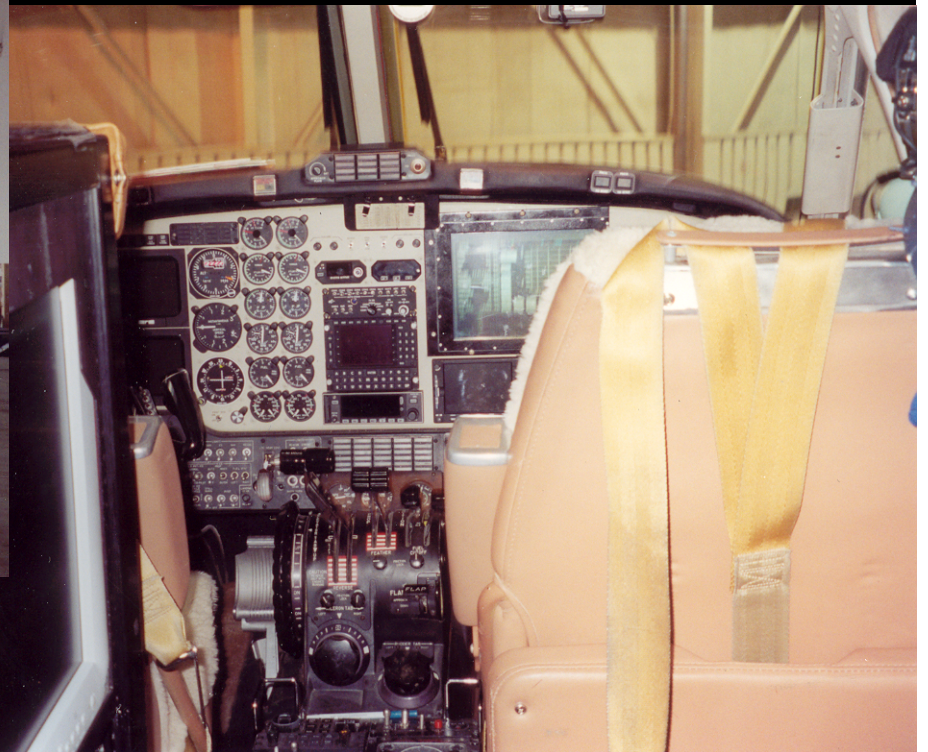
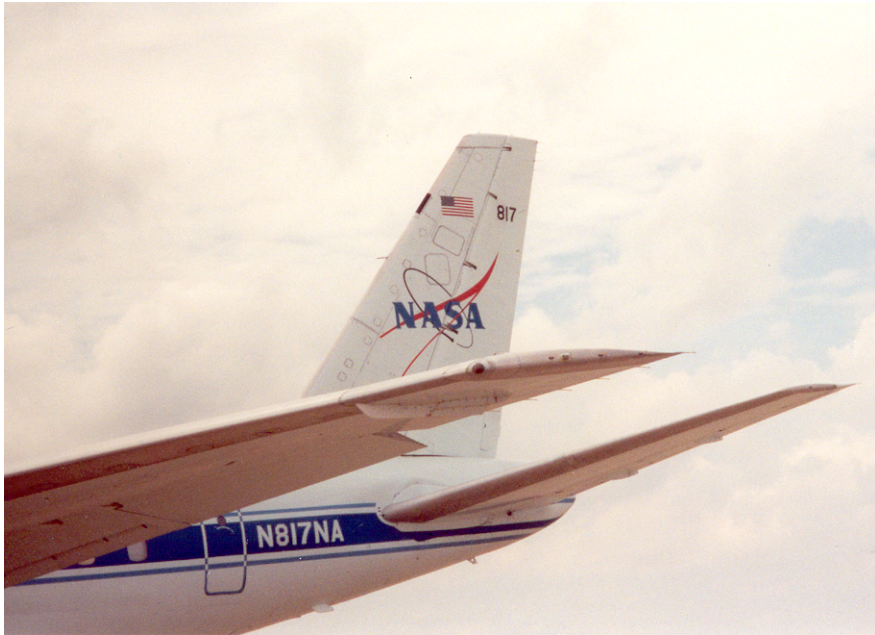
CV

- 1993-1997 B.A. Computer Science and Environmental Studies, Oberlin College
- 1997-1999 Internships at US EPA and US Forest Service
- 1998-2000 M.A. University of Minnesota, Geography
- 2000-2001 Research fellow, UMN, Forest Resources
- 2002-2006 Ph.D. Penn State, Meteorology
- 2006-2007 Advanced Study Program Postdoc, NCAR
- 2007-2011 Assistant Professor, UW-Madison
- 2011- Associate Professor, UW-Madison

CV

- ~~1993–1997 B.A. Computer Science and Environmental Studies, Oberlin College~~
 - Was a computer nerd at a hippie school, turned down MIT as a rebellious teen
 - Probably would have been richer if I stuck with computers, but really liked ecology
- ~~1997–1999 Internships at US EPA and US Forest Service~~
 - Paid to go hiking in the woods and write unused databases in byzantine bureaucracy
 - Decided to go to grad school when bored with work world, liked idea of human-environment
- ~~1998–2000 M.A. University of Minnesota, Geography~~
 - Went to program that offered most funding and best parties, learned human and physical geographers don't get along, lucky to meet my advisor, but then he leaves, I briefly follow
- ~~2000–2001 Research fellow, UMN, Forest Resources~~
 - Was told to build a flux tower from scratch with no experience. Boss quits partway
 - First inkling of weird joint pains. Got married. Wife gives up on science jobs
- ~~2002–2006 Ph.D. Penn State, Meteorology~~
 - Followed advisor to middle of nowhere Pennsylvania, M.S. paper rejected
 - Buy a house, learn that I have psoriatic arthritis, wife gives birth week after pre-lims
- ~~2006–2007 Advanced Study Program Postdoc, NCAR~~
 - Applied to UW on a whim after workshop. Offered position with one-year post-doc option
 - Moved a 3-year old to Boulder. Skied a lot. Unwittingly ran an airborne field campaign and workshop
- ~~2007–2011 Assistant Professor, UW Madison~~
 - Second child born two weeks after moving, three days before teaching first class ever
 - Win the grant funding lottery, have another kid, have a new “family”, get older, not wiser
- ~~2011–Associate Professor, UW Madison~~
 - Early tenure decision forced by an outside offer, students graduate, run grad program
 - Hit funding drought, need new research directions, go on sabbatical!







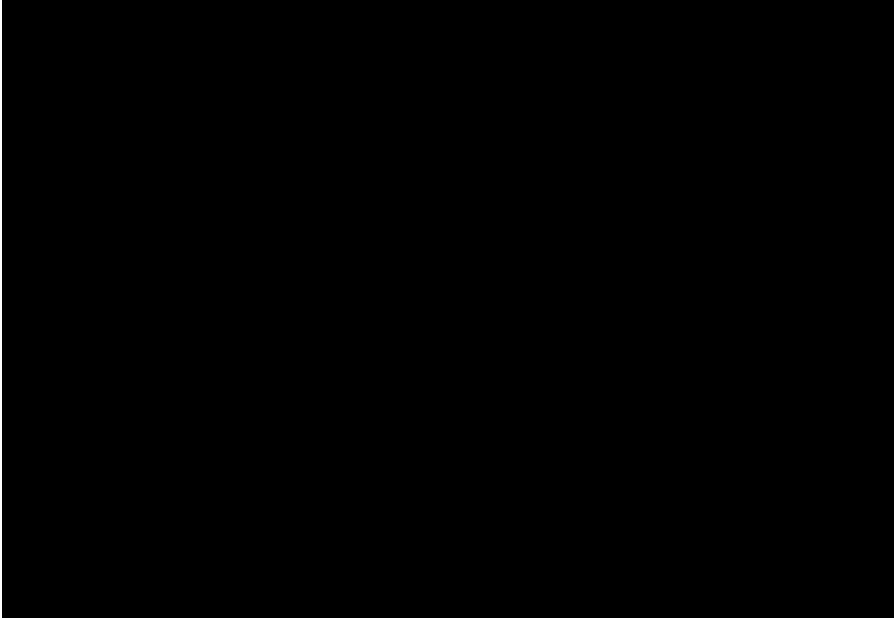
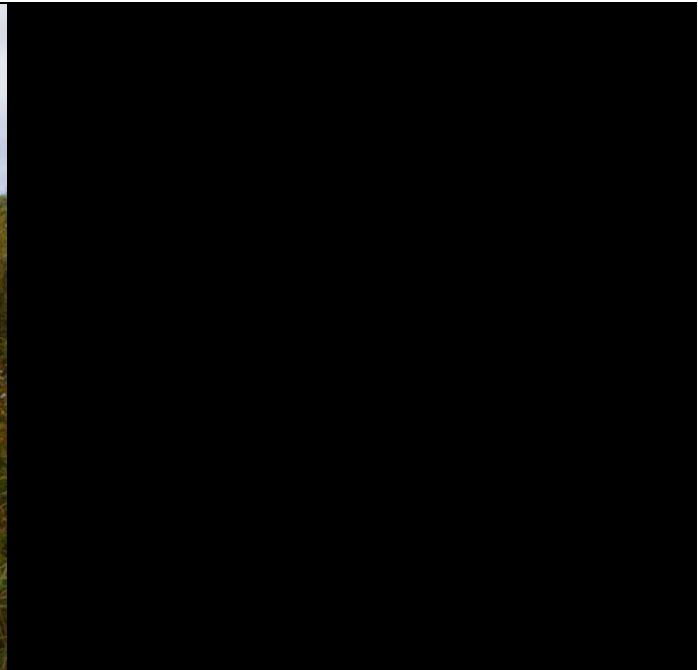


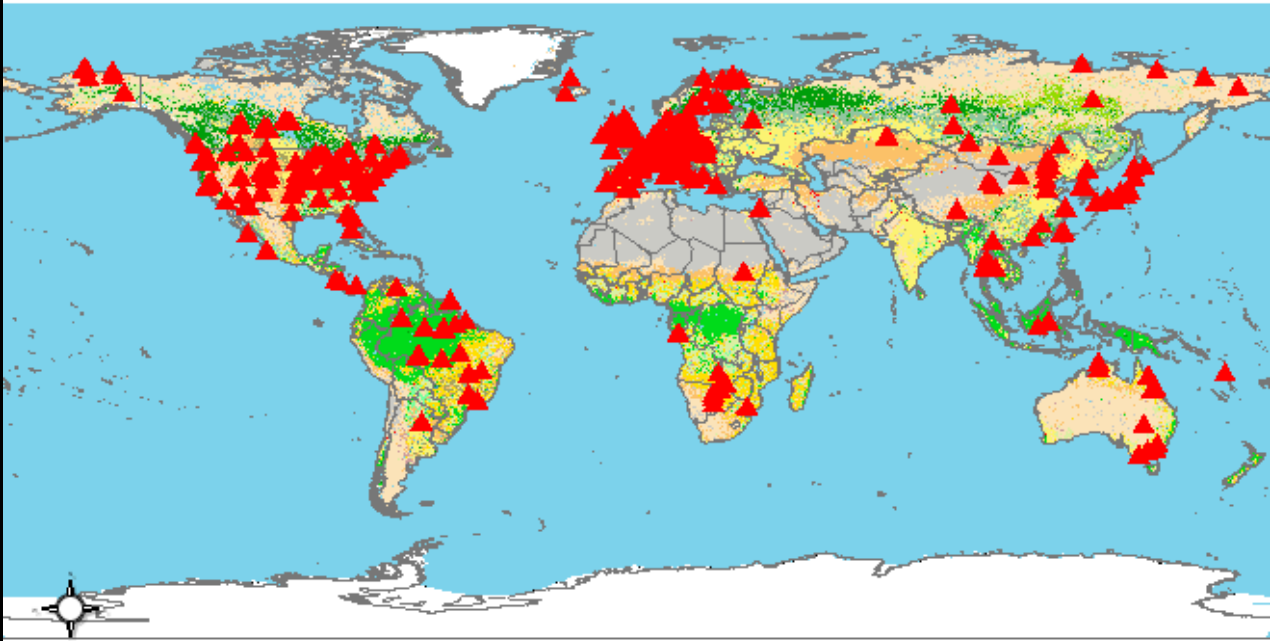






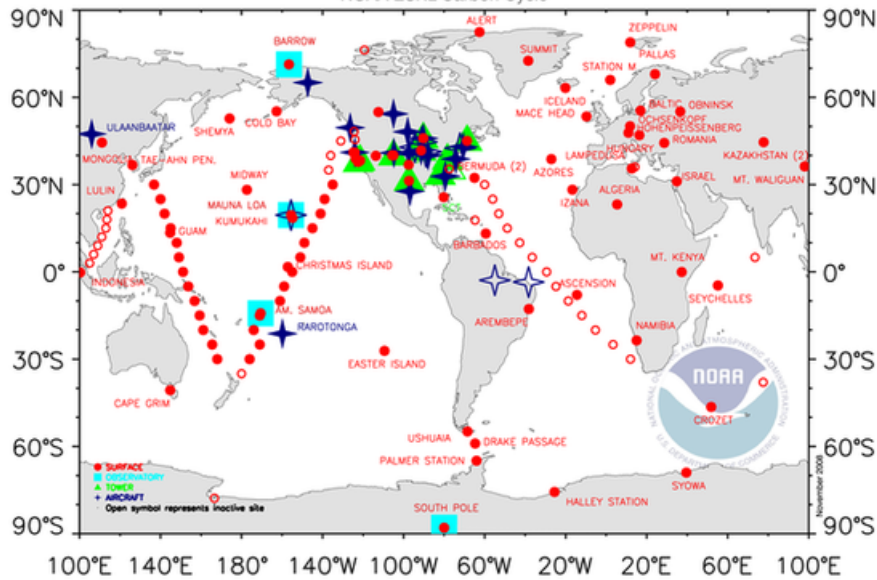




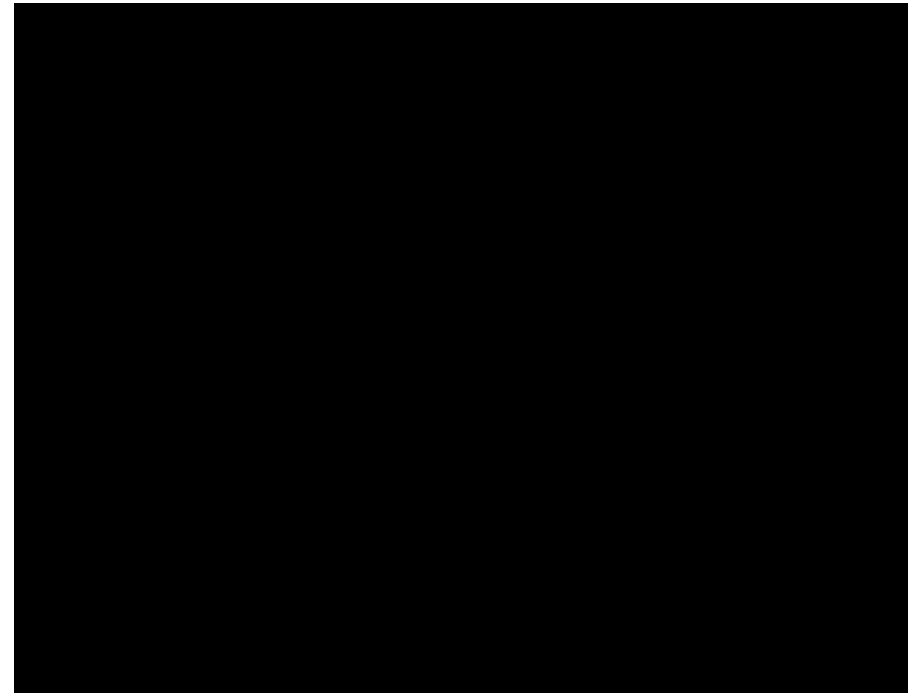


Measurement Programs
NOAA ESRL Carbon Cycle

0 5472km



NOAA ESRL Carbon Cycle operates 4 measurement programs. Semi-continuous measurements are made at 4 baseline observatories and from tall towers. Discrete surface and aircraft samples are measured in Boulder, CO. Presently, atmospheric carbon dioxide, methane, carbon monoxide, hydrogen, nitrous oxide, sulfur hexafluoride, the stable isotopes of carbon dioxide and methane, and halocarbon and volatile organic compounds are measured. Contact: Dr. Pieter Tans, NOAA ESRL Carbon Cycle, Boulder, Colorado, (303) 497-6678, pieter.tans@noaa.gov, <http://www.esrl.noaa.gov/gmd/ccgg/>.

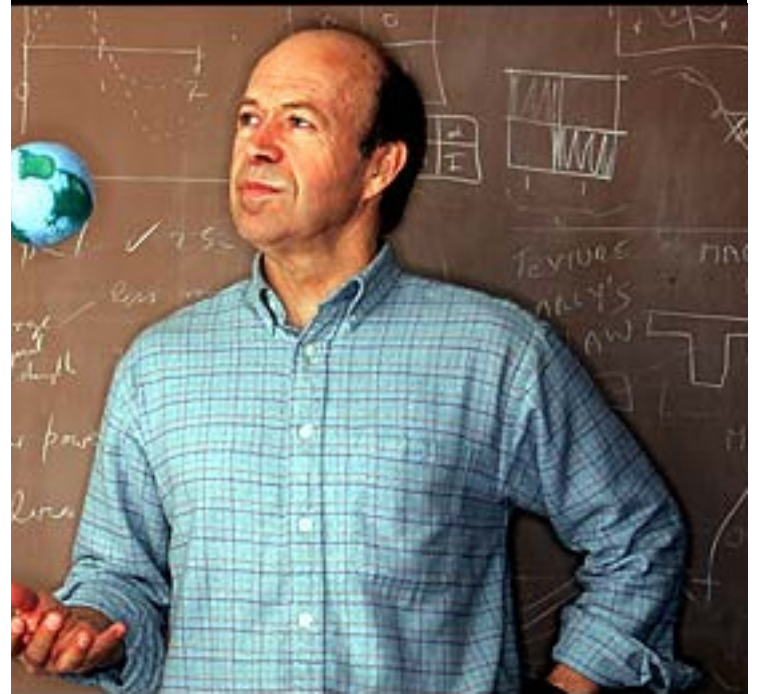


Willow Creek - NetCam SC IR - Thu Sep 20 11:31:17 2012
Temperature: 36.0 °C internal, 9.0 °C outside
RH: 0%, Pressure: 944.0 millibars
Exposure: 400

Physics?



Or... Why **Climate Scientists** will never hug **Ecologists** again



Arrhenius, S., 1896. On the influence of carbonic acid in the air upon the temperature of the ground.

if the quantity of carbonic acid increases in geometric progression, the augmentation of the temperature will increase nearly in arithmetic progression

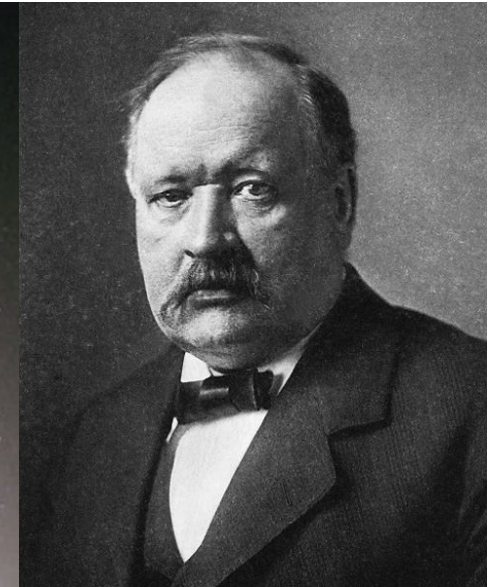
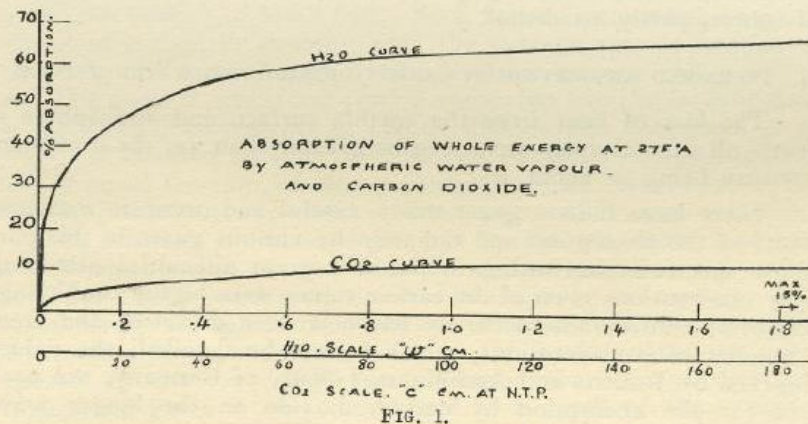


TABLE II.—ABSORPTION EXPONENTS FOR CARBON DIOXIDE.
 Band 4 to 4.6 μ by H. Schmidt (1913).
 Band 13 to 16 μ by Rubens and Aschkinass (1898).

Wave length μ	4.0	4.1	4.2	4.25	4.3	4.4	4.45	4.5	4.6
$10^8 h$	4.1	12.0	33.5	50.0	61.0	38.0	27.2	10.7	11.0
Wave length μ	13	13.5	14	14.25	14.5	15	15.25	15.5	16
$10^8 h$	2.5	6.4	17.8	44.6	58.5	59.3	39.7	15.7	1.0



**Double CO₂ ->
5-6 C increase**



Callendar, G.S., 1938. The artificial production of carbon dioxide and its influence on climate. *QJRMS*, 64, 233-240.

If only were it so simple...



CARBON DIOXIDE FROM FOSSIL FUEL

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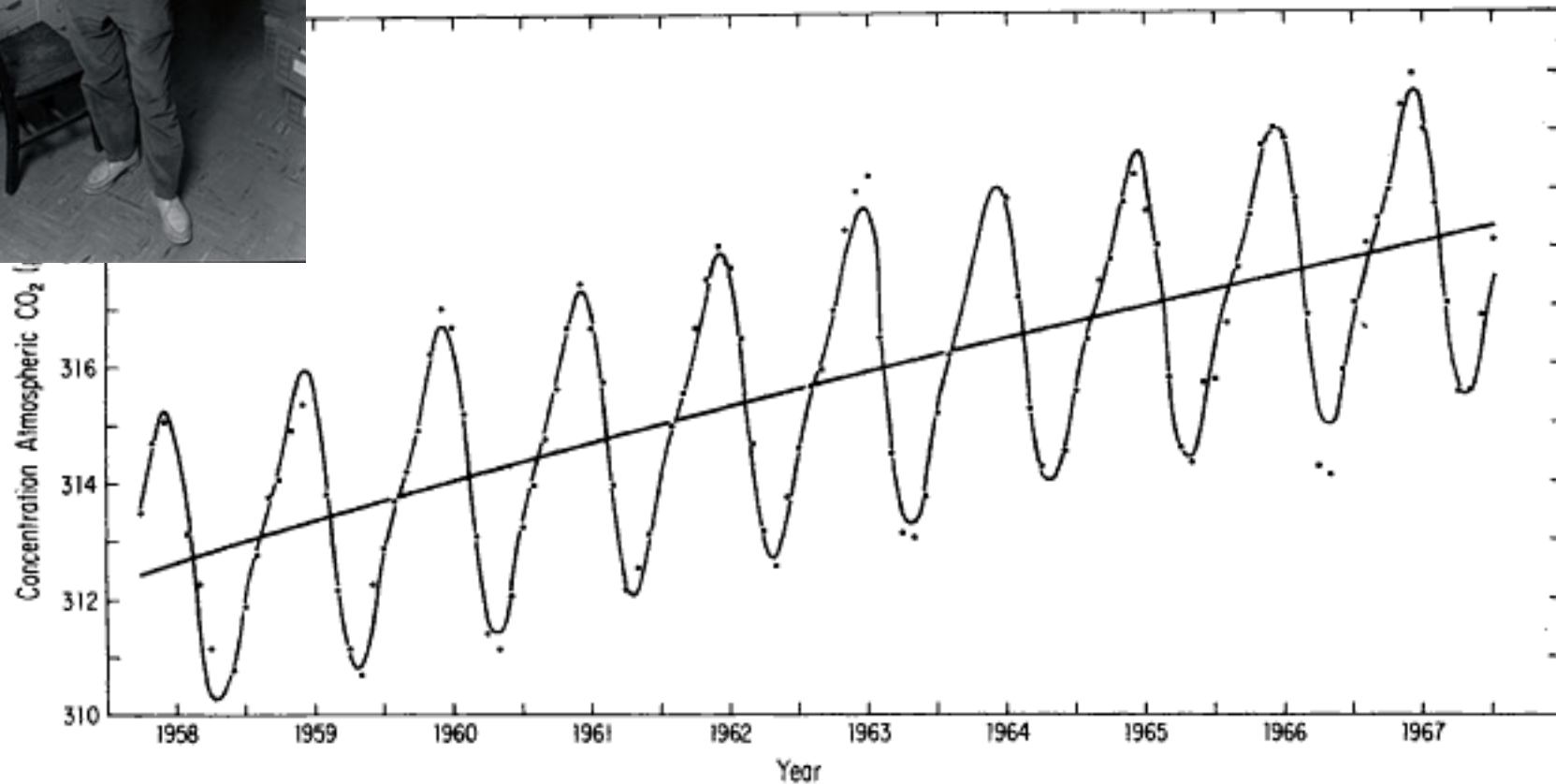
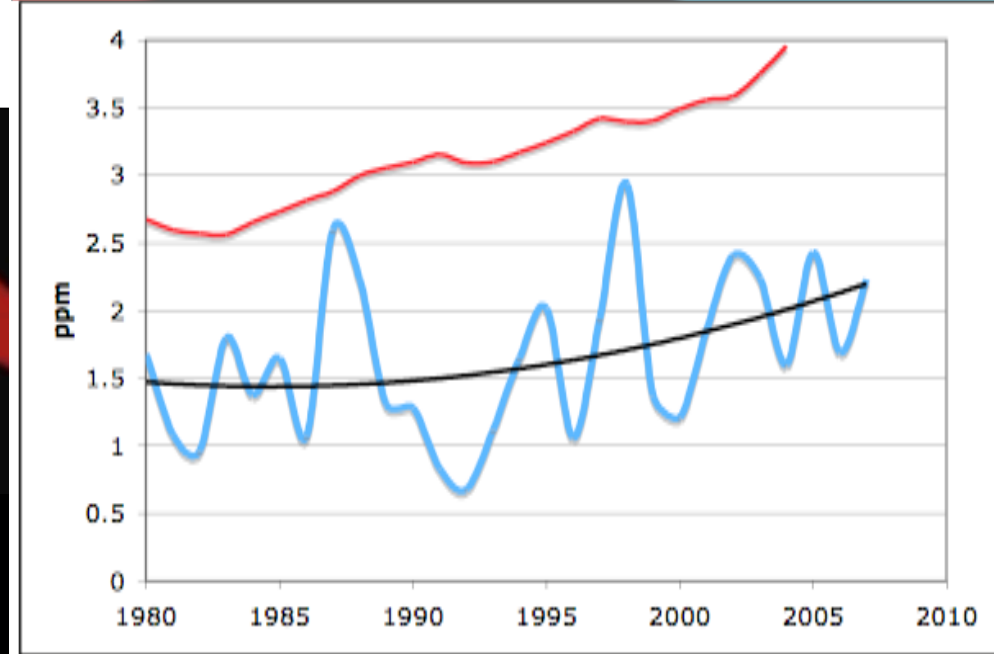
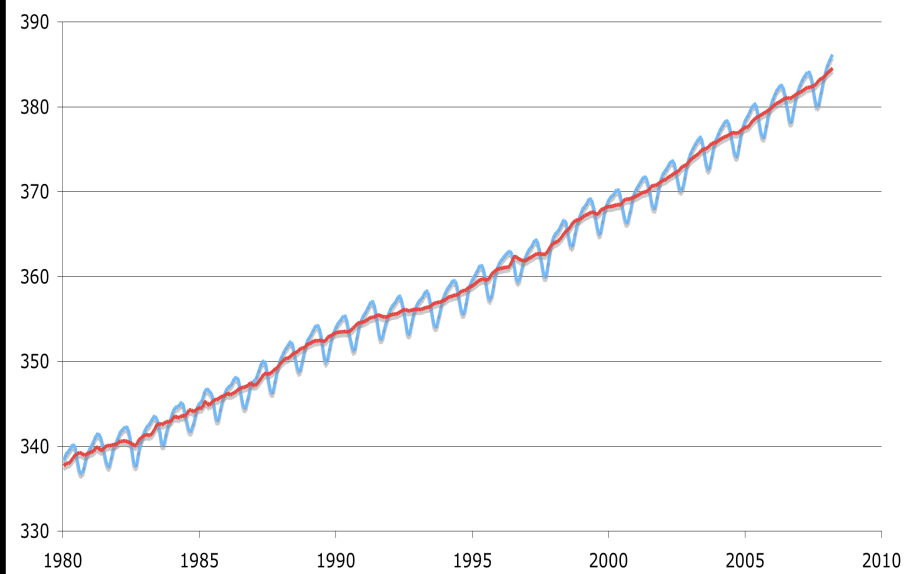


FIG. 5. Long-term variations in the concentration of atmospheric CO_2 at Mauna Loa Observatory. The dots indicate the observed monthly average concentrations. The oscillating curve is a least squares fit of these averages based on an empirical equation containing 6 and 12 month cyclic terms and a trend function. The slowly rising curve is a plot of the trend function, chosen to contain powers of time up to the third.

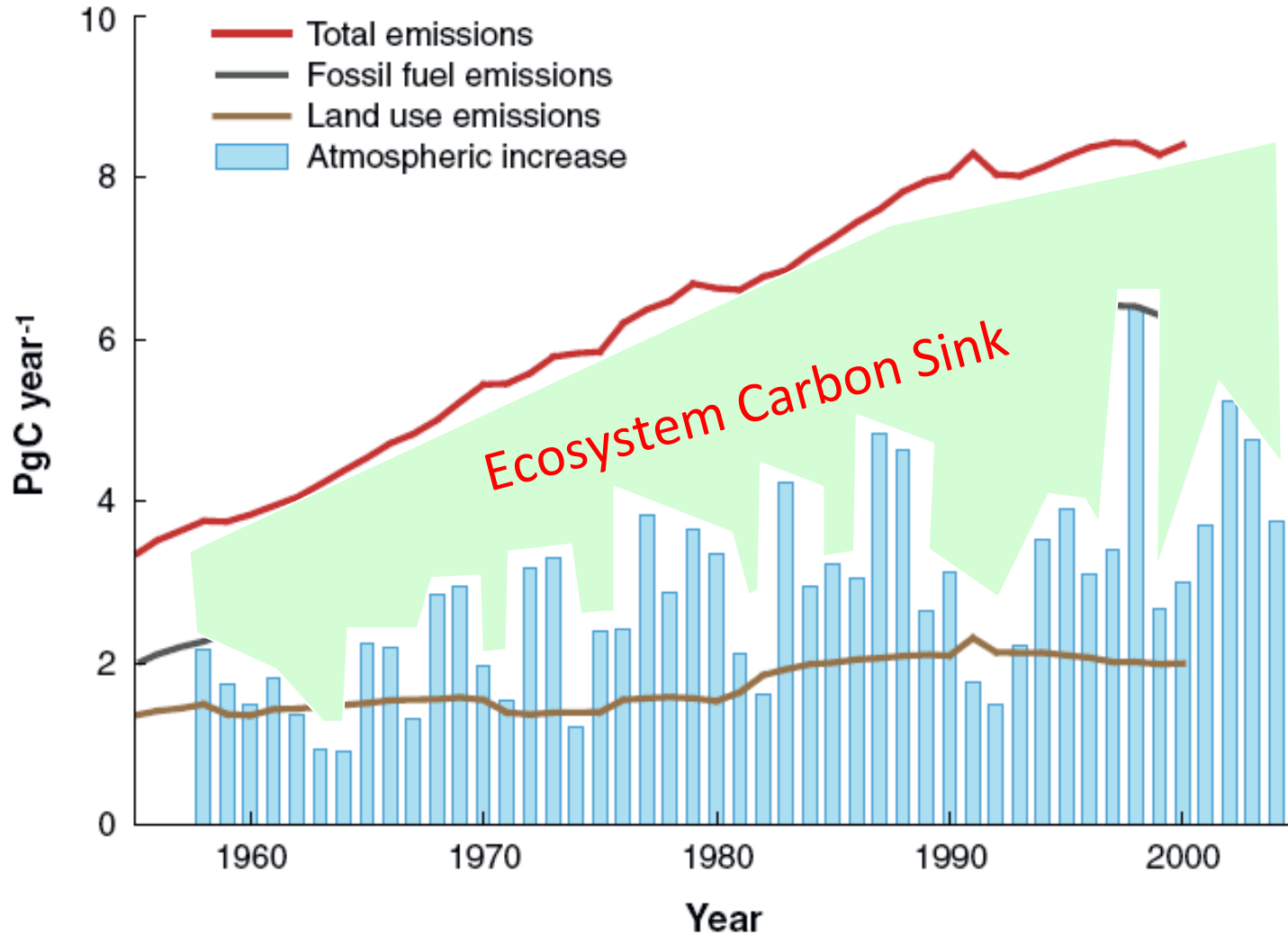
The Beat Goes On...



Data: NOAA/ESRL

Image: They Might Be Giants

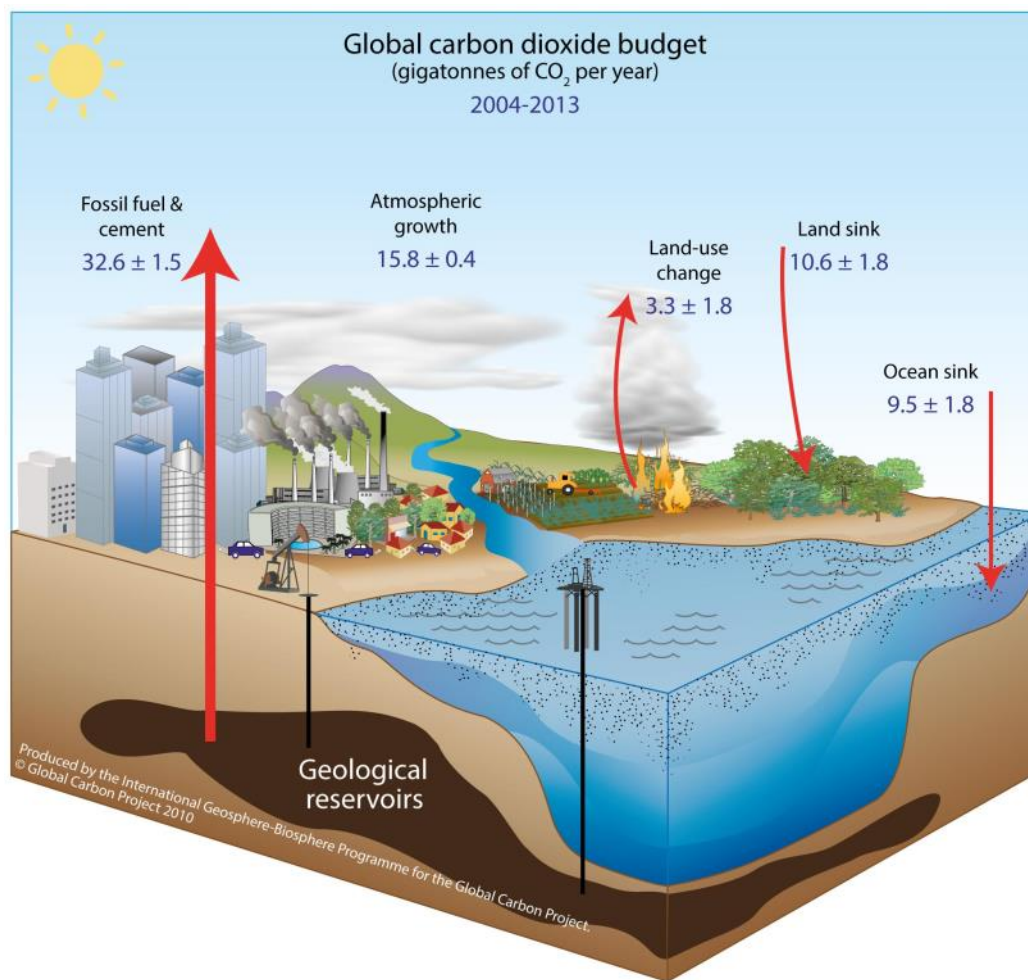
Biology drives Physics



Anthropogenic Perturbation of the Global Carbon Cycle

Perturbation of the global carbon cycle caused by anthropogenic activities, averaged globally for the decade 2004–2013 (GtCO₂/yr)

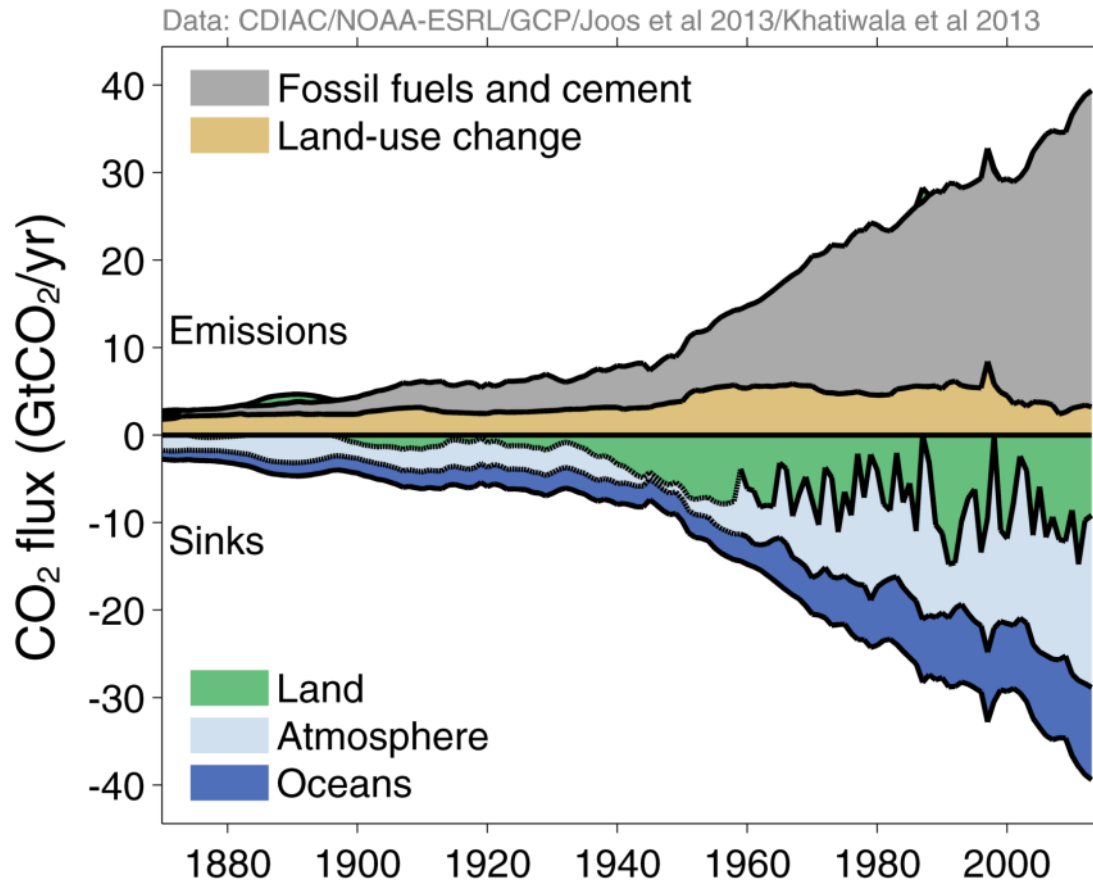
Data: CDIAC/NOAA-ESRL/GCP



Source: [CDIAC](#); [NOAA-ESRL](#); [Le Quéré et al 2014](#); [Global Carbon Budget 2014](#)

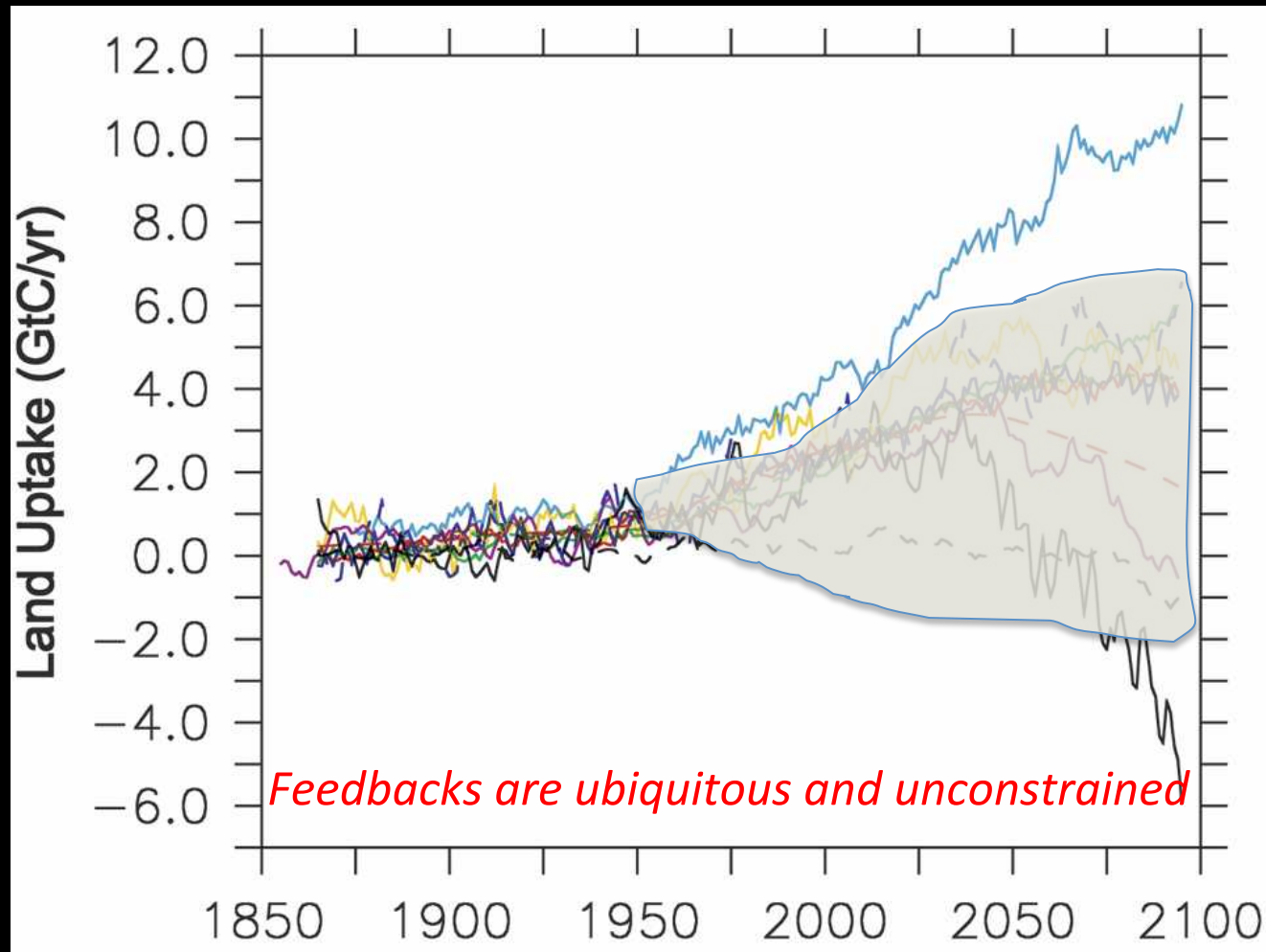
Global Carbon Budget

Emissions are partitioned between the atmosphere, land, and ocean



Source: [CDIAC](#); [NOAA-ESRL](#); [Houghton et al 2012](#); [Giglio et al 2013](#); [Joos et al 2013](#); [Khatiwala et al 2013](#); [Le Quéré et al 2014](#); [Global Carbon Budget 2014](#)

And we fail at modeling it...



Why?

FIELDS ARRANGED BY PURITY

→
MORE PURE

SOCIOLOGY IS
JUST APPLIED
PSYCHOLOGY

PSYCHOLOGY IS
JUST APPLIED
BIOLOGY.

BIOLOGY IS
JUST APPLIED
CHEMISTRY

WHICH IS JUST
APPLIED PHYSICS.
IT'S NICE TO
BE ON TOP.

OH, HEY, I DIDN'T
SEE YOU GUYS ALL
THE WAY OVER THERE.



SOCIOLOGISTS

PSYCHOLOGISTS

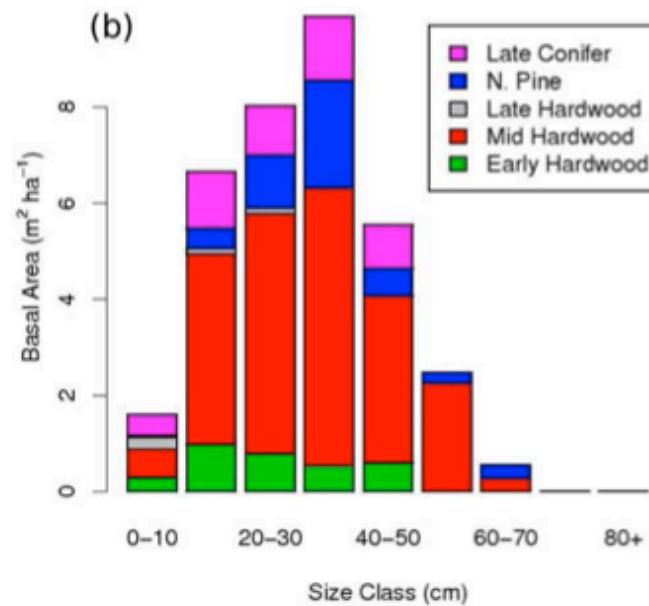
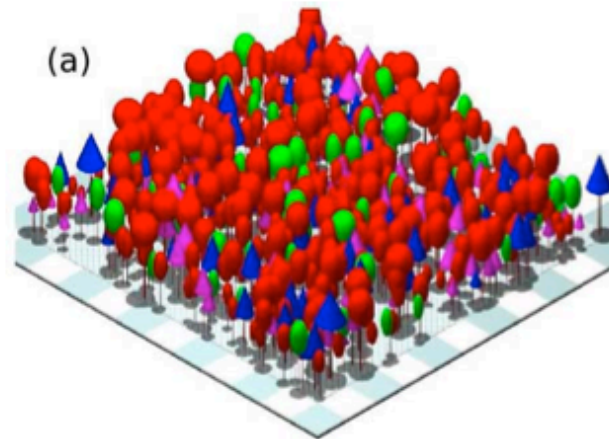
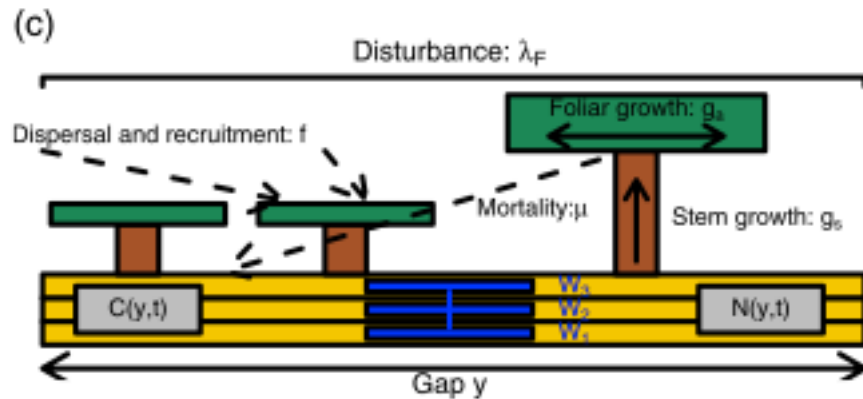
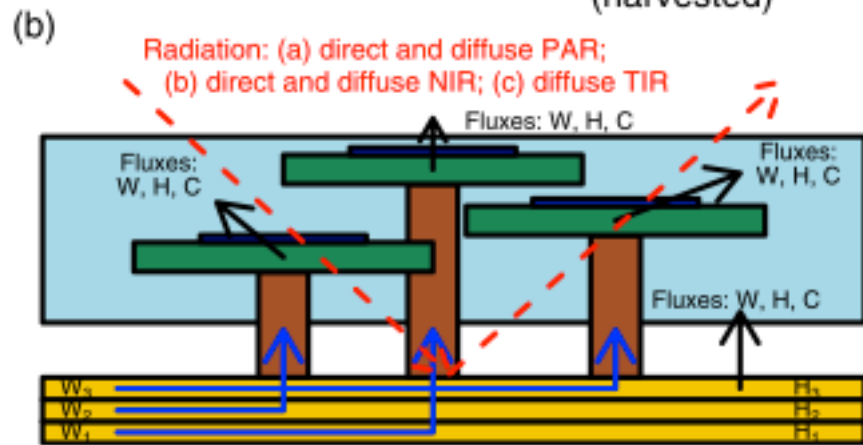
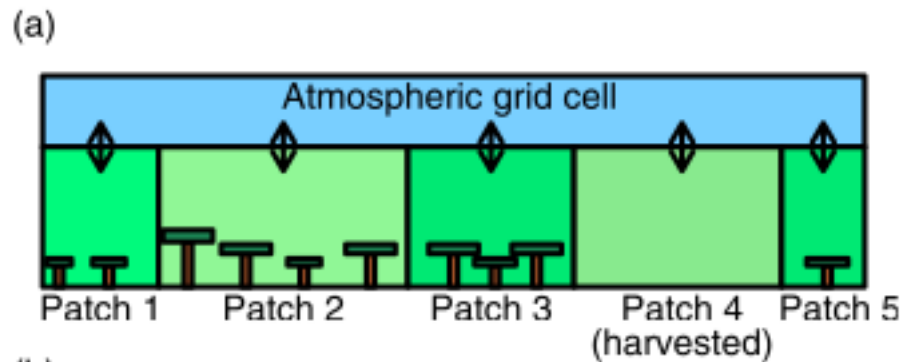
BIOLOGISTS

CHEMISTS

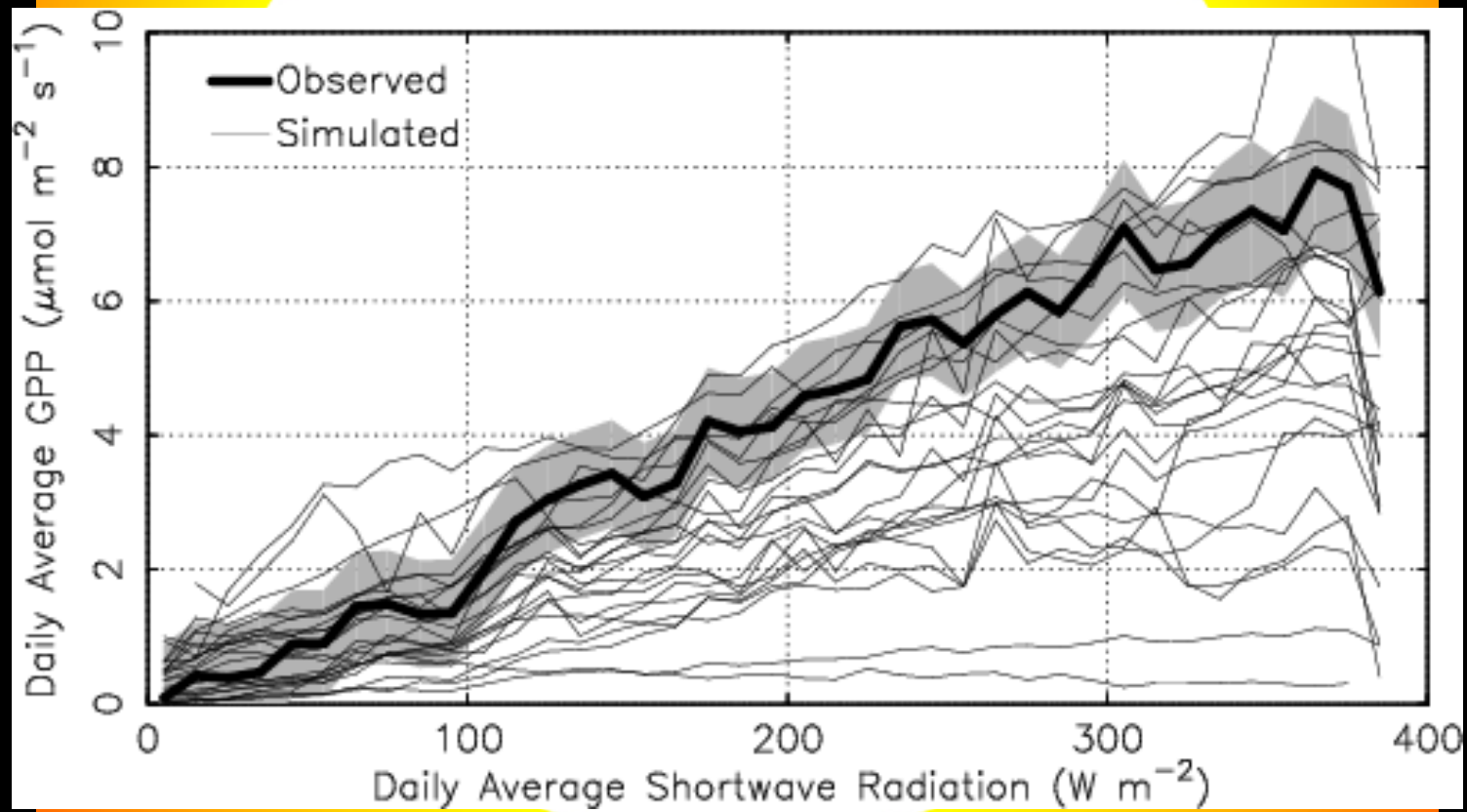
PHYSICISTS

MATHEMATICIANS

Medvigy et al., 2009

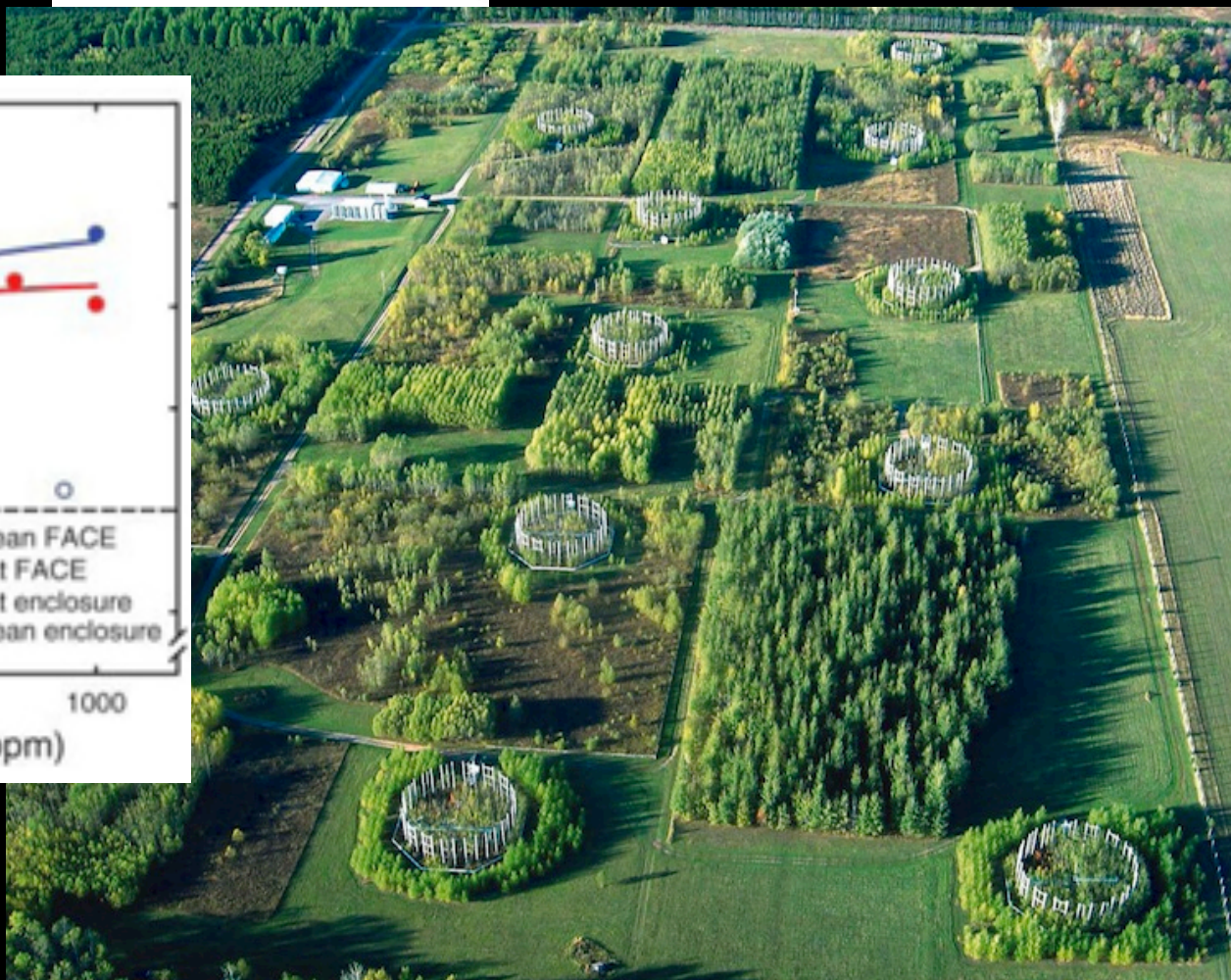
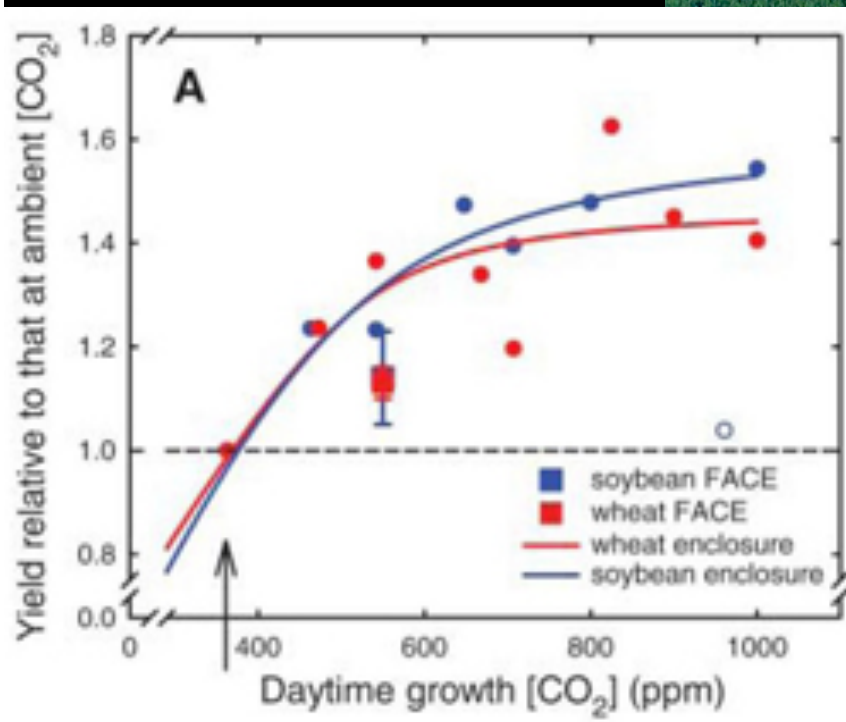


Light

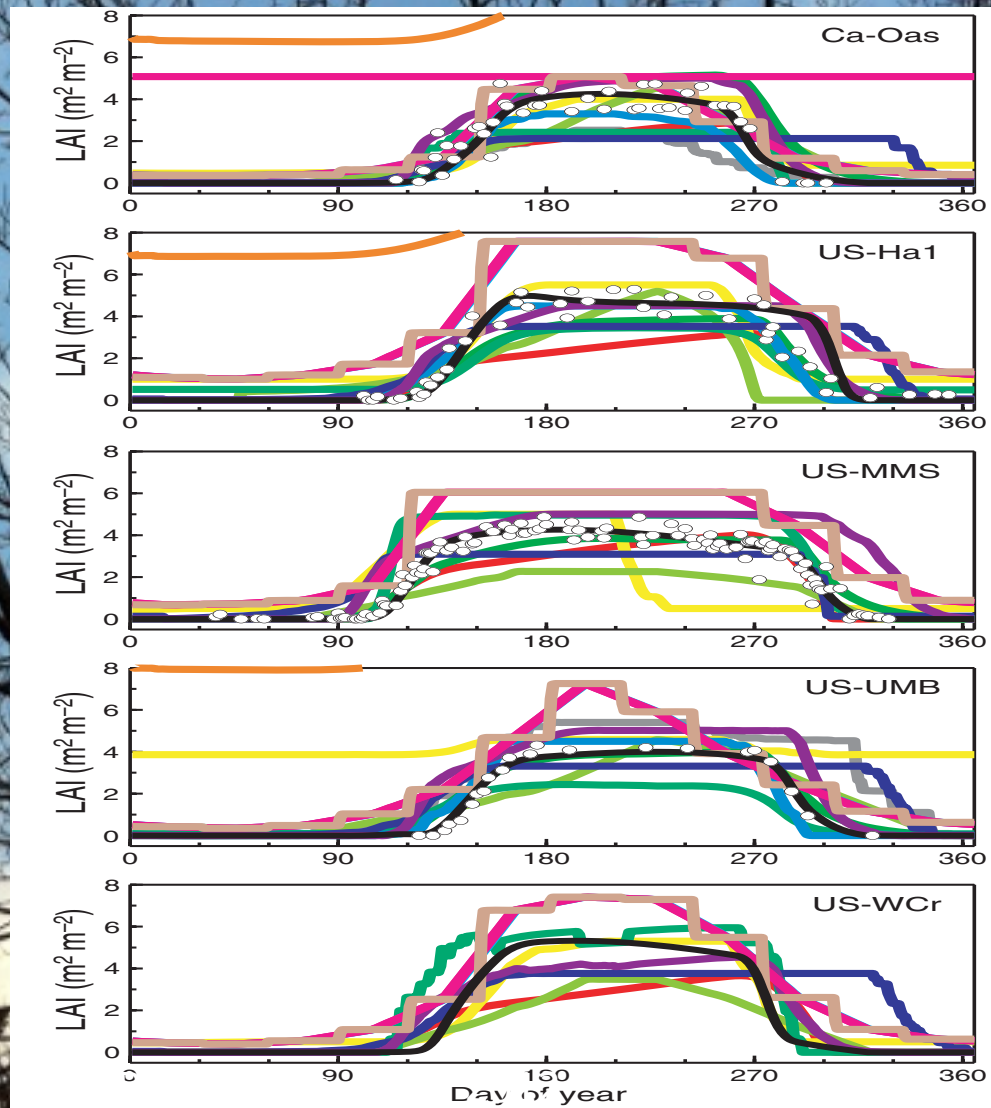




Long et al., 2006

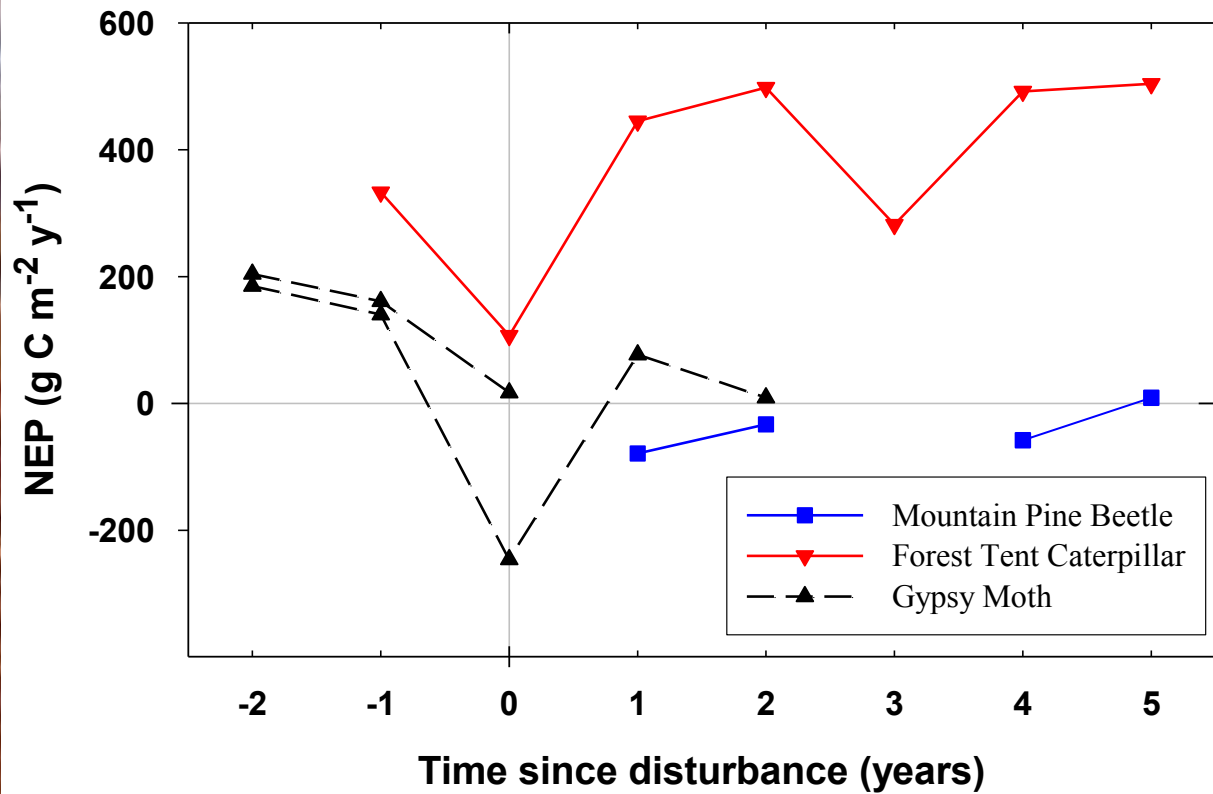


Indirect Climate: Phenology

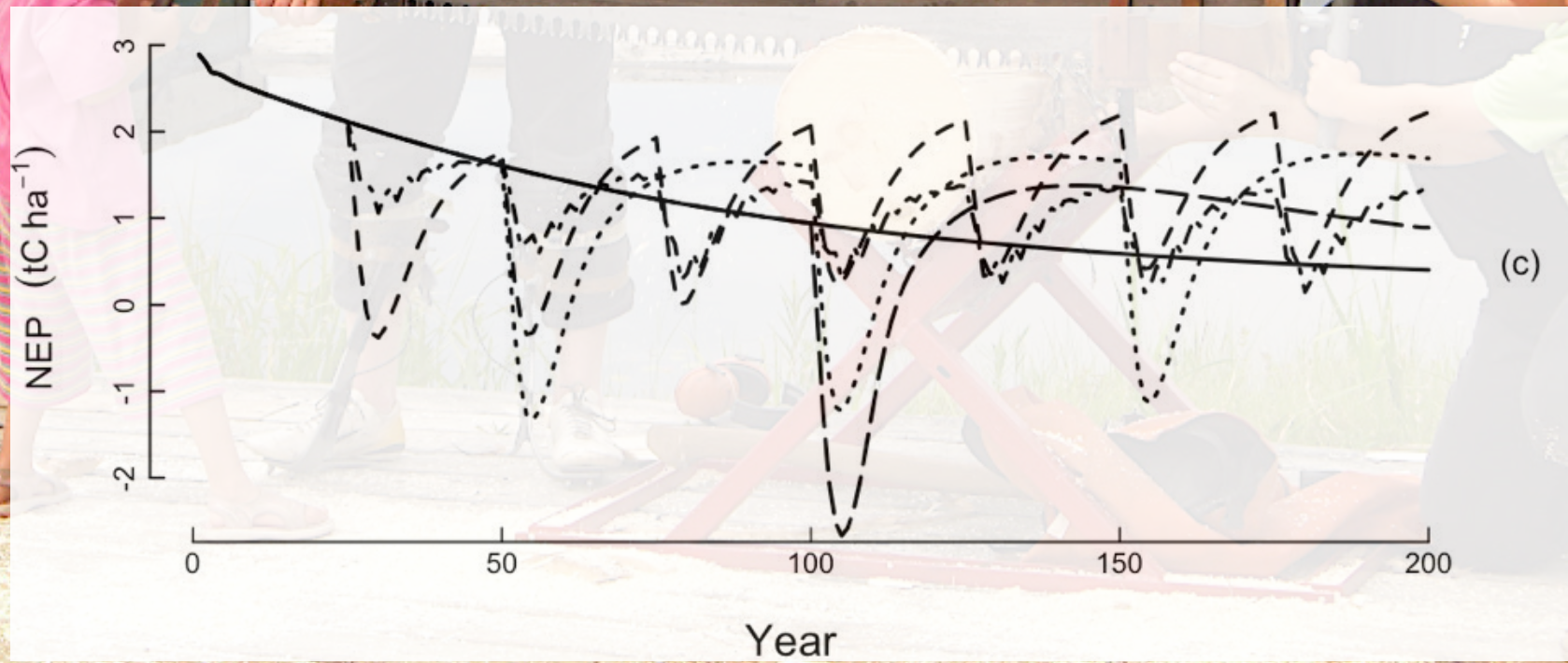
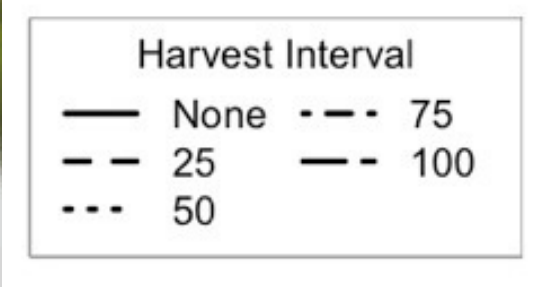


Pests

Amiro et al., 2010



People!

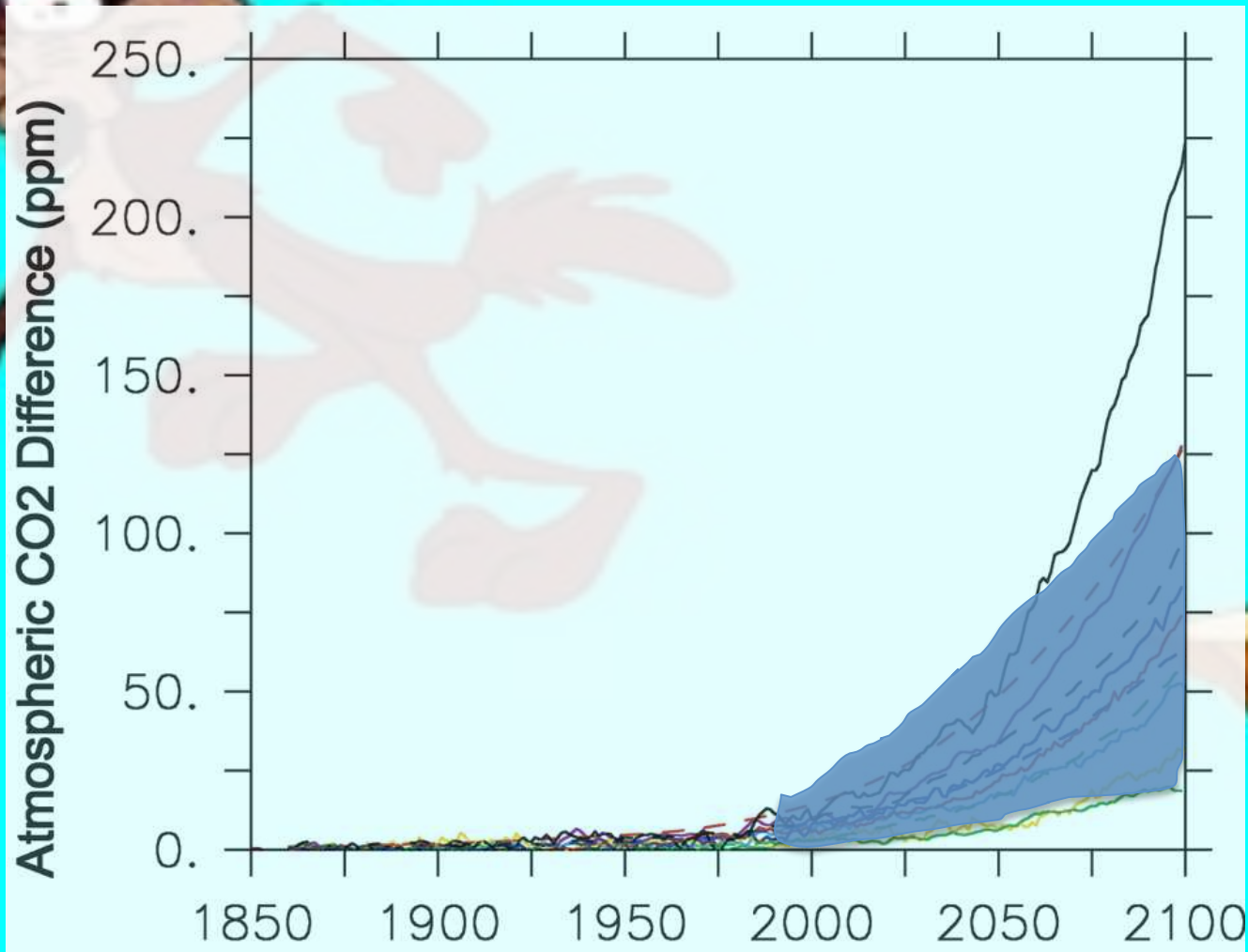


Gower et al., (never) submitted

What else?

- Microbes, fungi, earthworms
- Herbivores (deer)
- Shading, resource competition
- Genetic variation
- Dispersal, recruitment, adaptation/evolution
- Fire, extreme events, feedbacks
- Acclimation
- Riverine export
- Ahhhh!

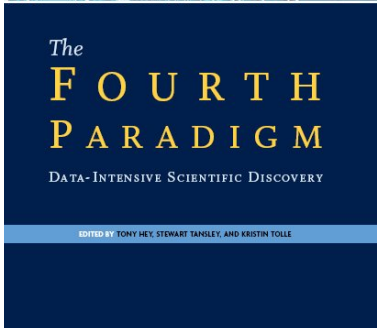
It Matters...



Friedlingstein et al., 2006

What to do?

4th Paradigm: Confronting science with intensive data



NSF Advances in Biological Informatics
M. Dietze, A. Desai, D. LeBauer, R. Kooper

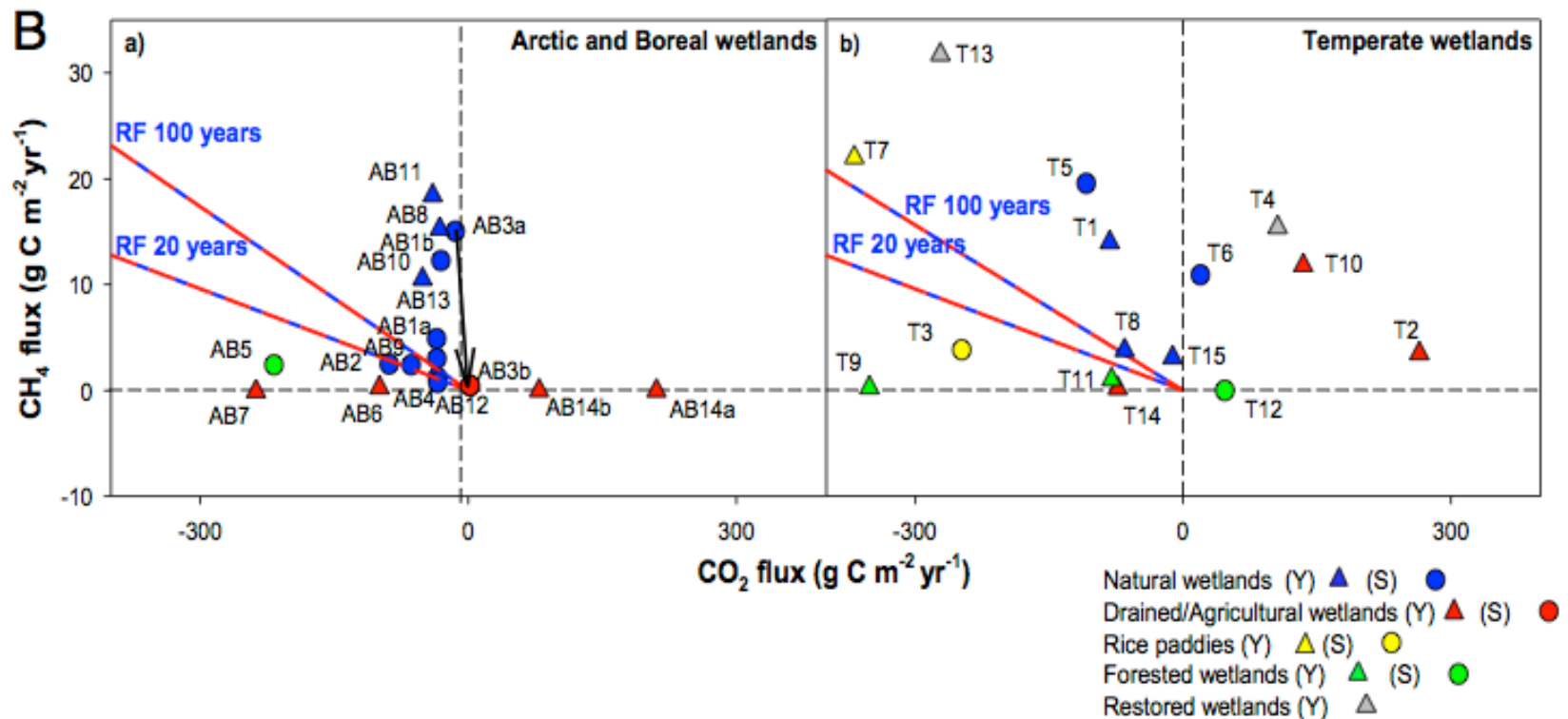
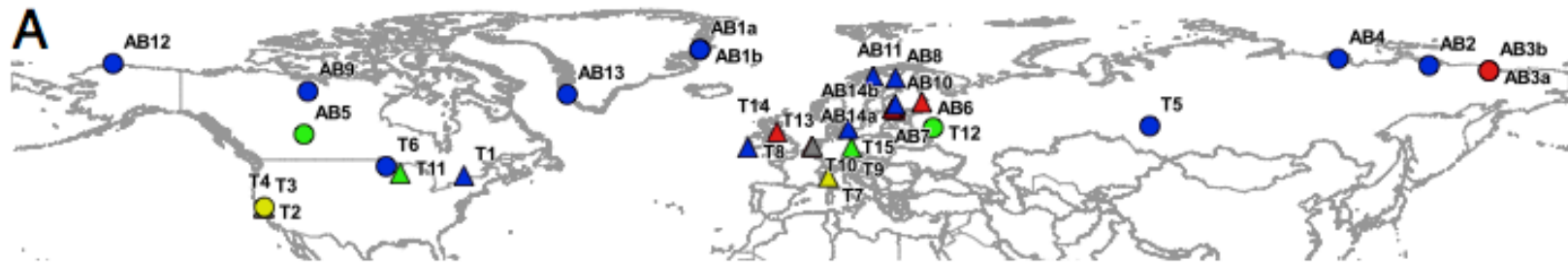
www.pecanproject.org

The uncertain climate footprint of wetlands under human pressure

Ana Maria Roxana Petrescu^a, Annalea Lohila^b, Juha-Pekka Tuovinen^b, Dennis D. Baldocchi^c, Ankur R. Desai^d,

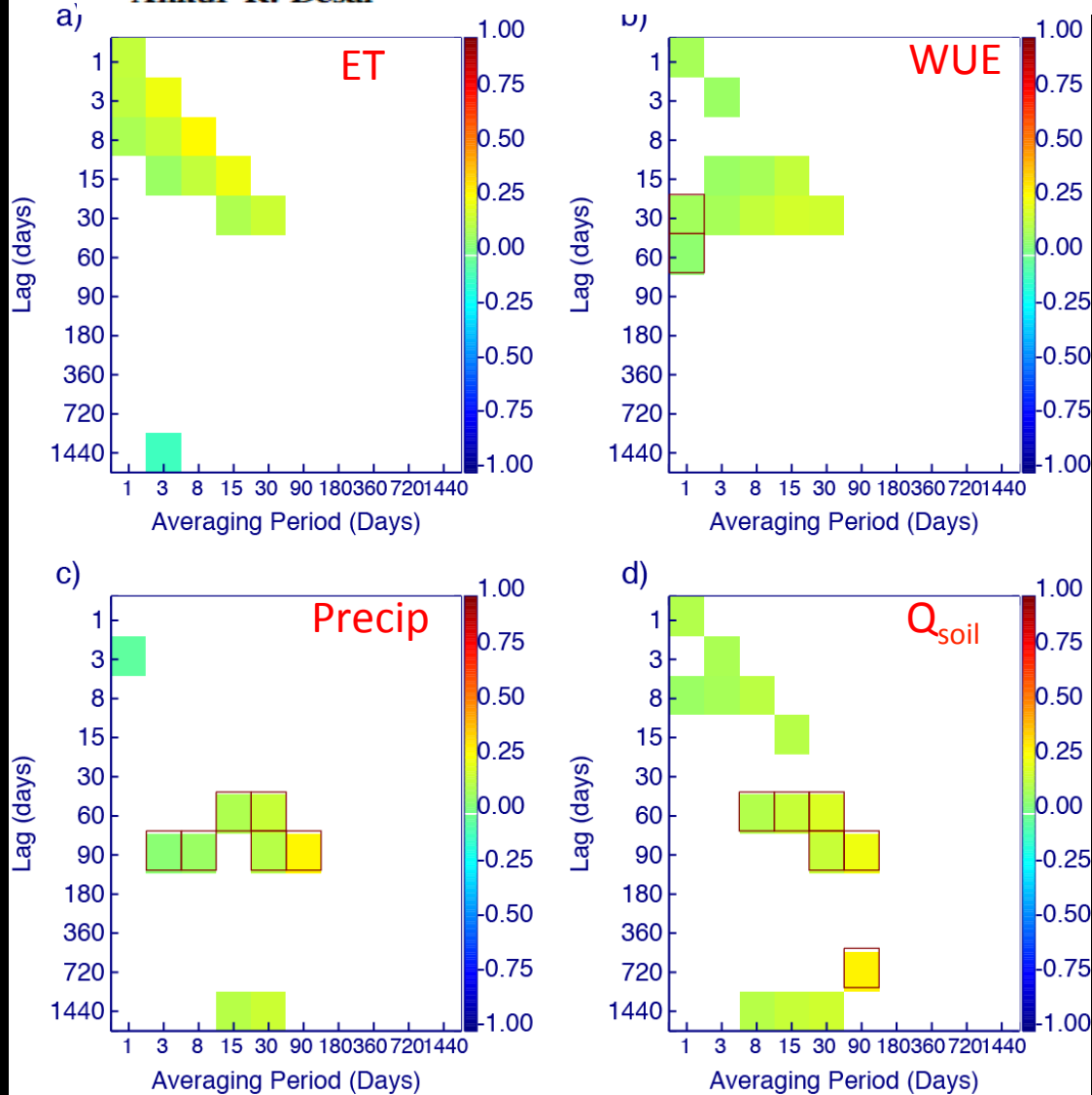
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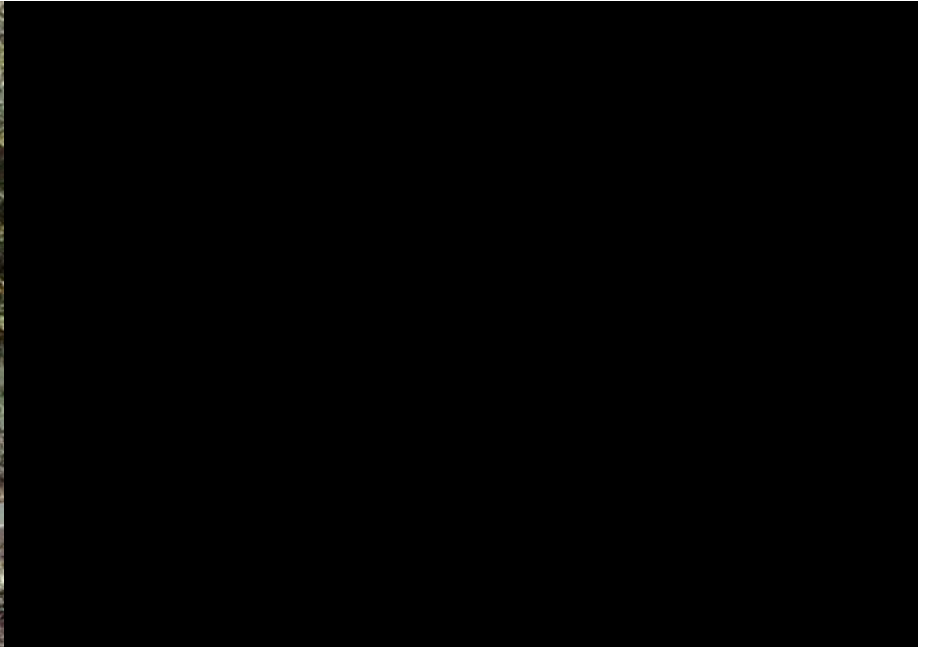
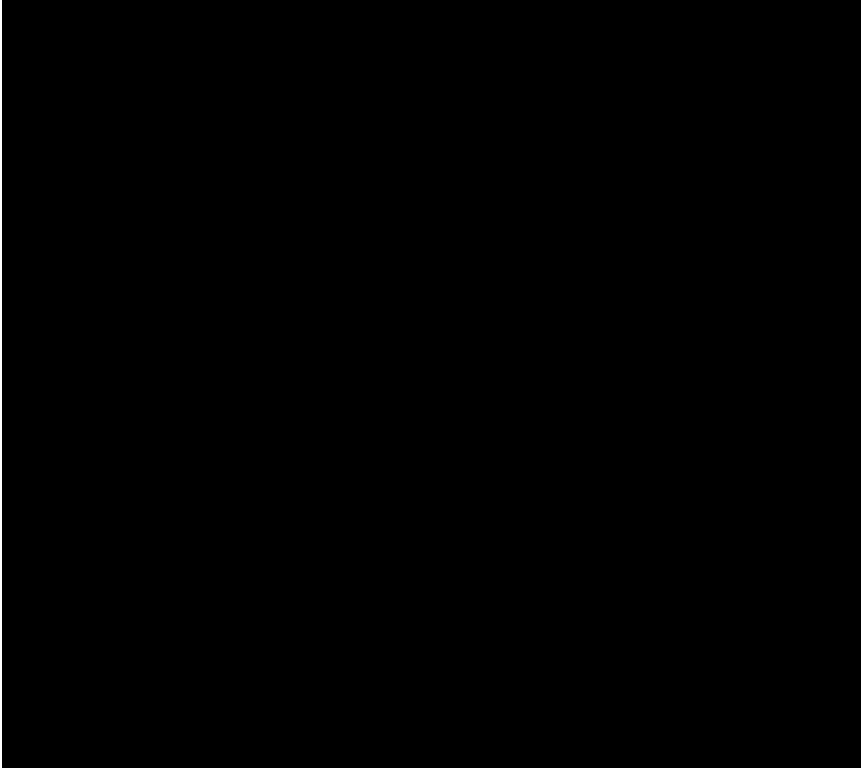


Influence and predictive capacity of climate anomalies on daily to decadal extremes in canopy photosynthesis

Ankur R. Desai



- Earlier season (2-3 month) weekly-seasonal precipitation/soil moisture has strongest predictive effect on ecosystem photosynthesis
- Beyond that autocorrelation dominates



Advice...

- Communicate frequently with your advisor
 - Don't wait until results are perfect or things really fall apart. Write and share a set of goals, show partial results, thought process, drafts
- Even as a student, you are now an independent (apprentice) scholar
 - Seek out your own collaborations, find your own interesting articles to read, take initiative. Use your advisor's network
- If you don't write or communicate your findings, it's not science
 - Thesis writing takes a lot longer than anyone thinks. There are great writing resources on and off campus.
- Graduate school is hard
 - And so is everything else around and beyond it. We all struggle, have life happen around it, and don't achieve as much as we hoped. Seek out multiple mentors, friends outside academia, hobbies. Rely on each other. Focus on people over ideas.