Explaining the Geologic CO2 Record: Concerns and Solutions

3rd annual Biochar workshop
Butte College, CA

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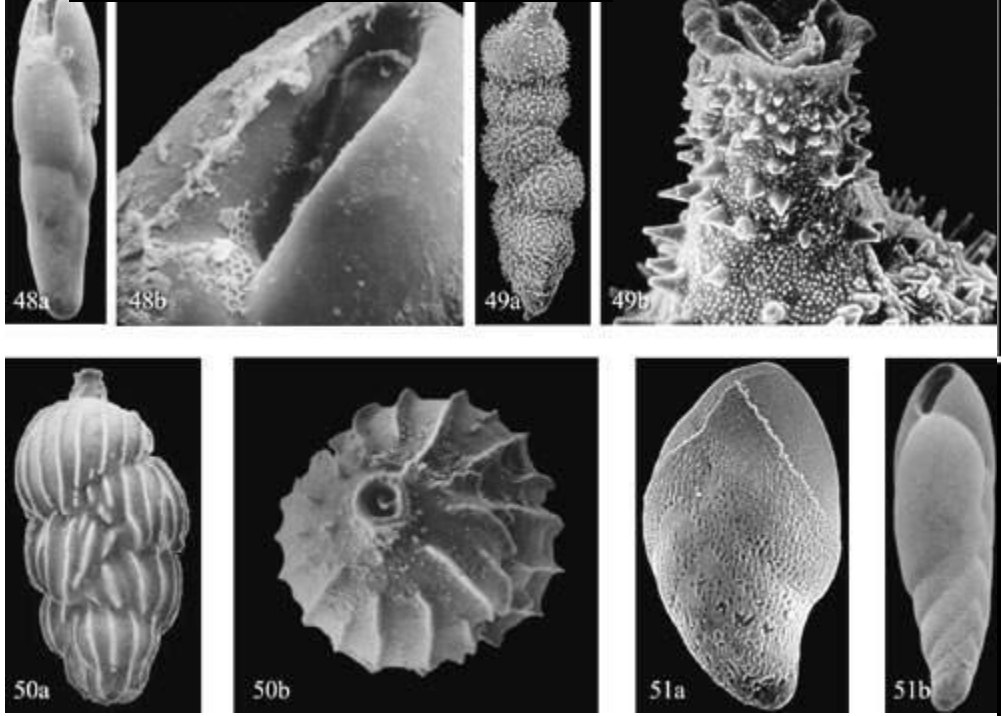
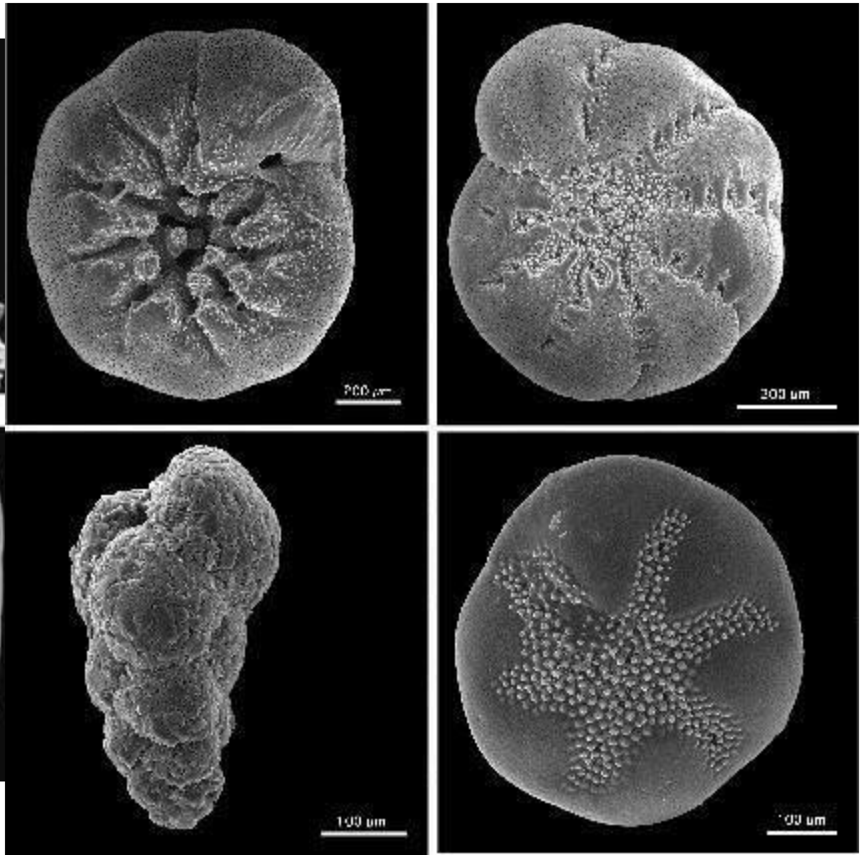
2/27/2020

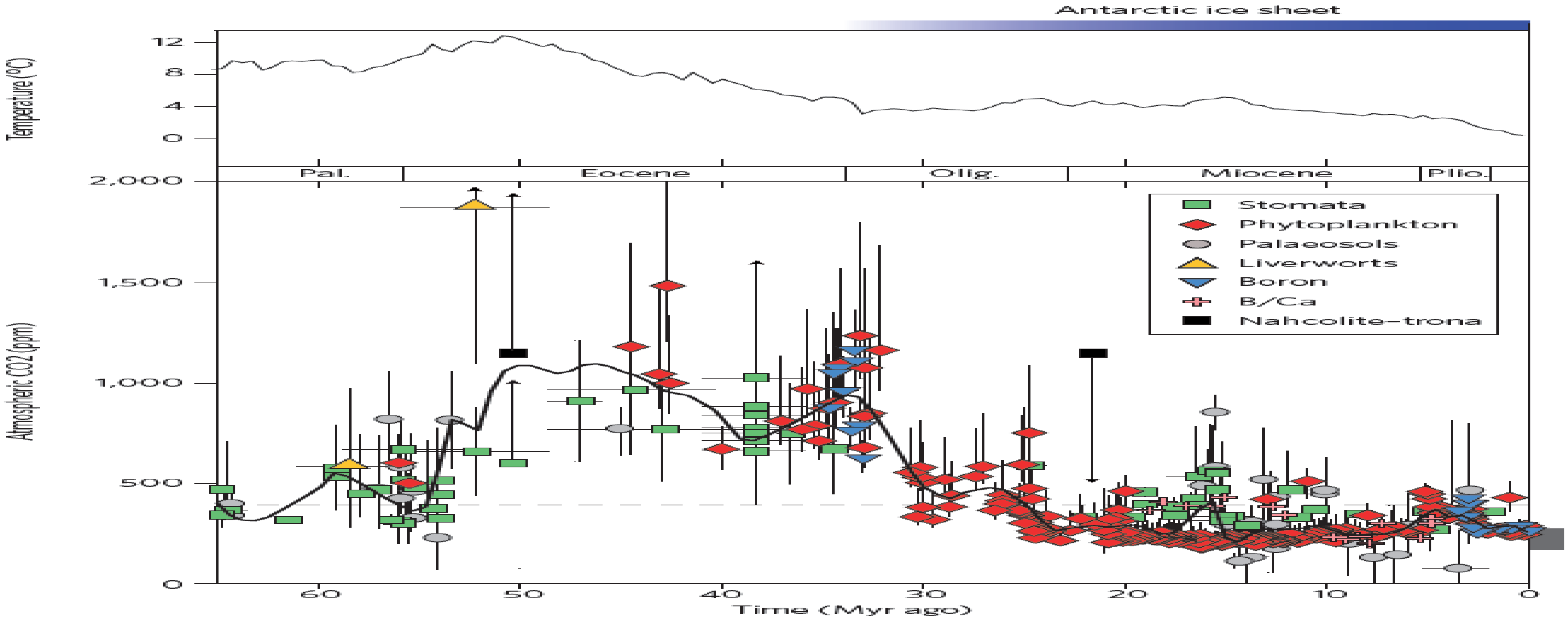
See BIOCHAR PAGE:

https://denverclimatestudygroup.com/?page_id=28

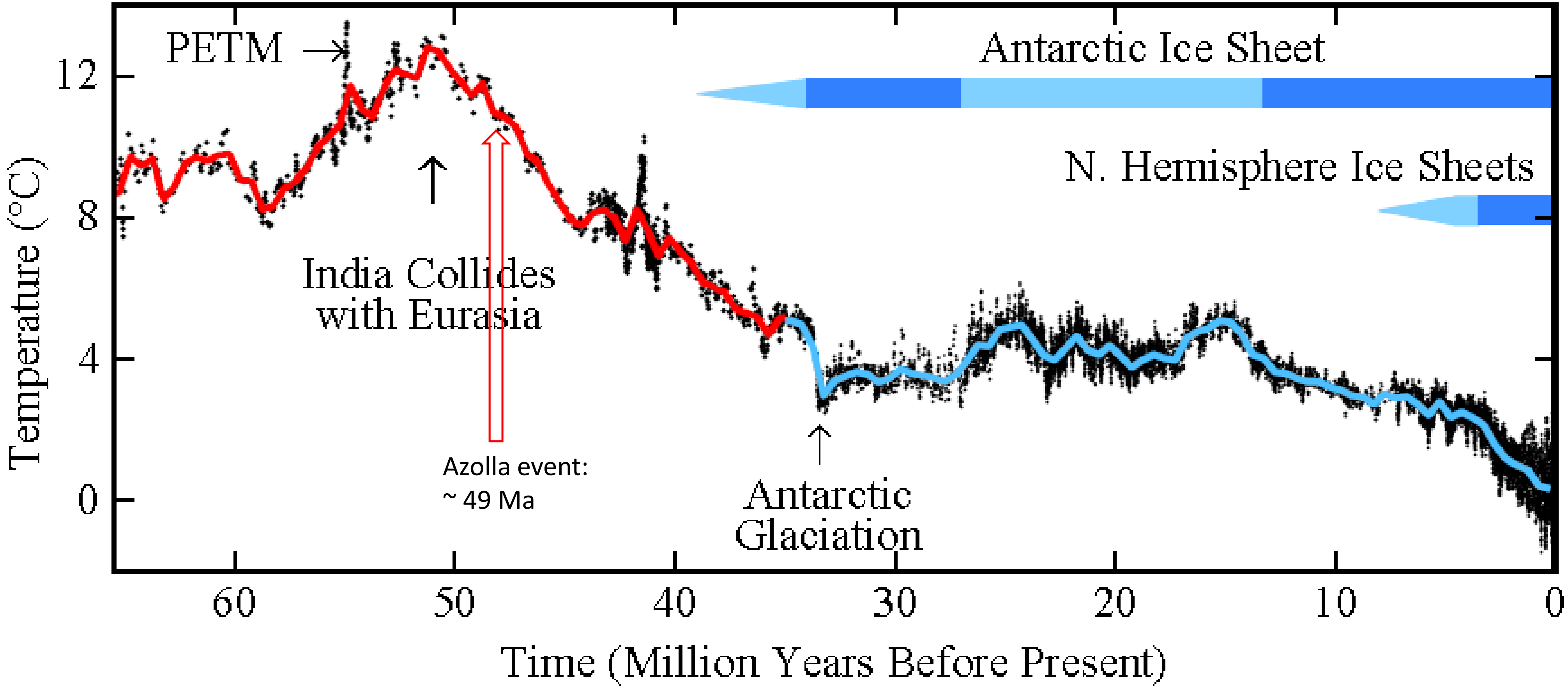
PROXY DATA: BENTHIC FORAMS





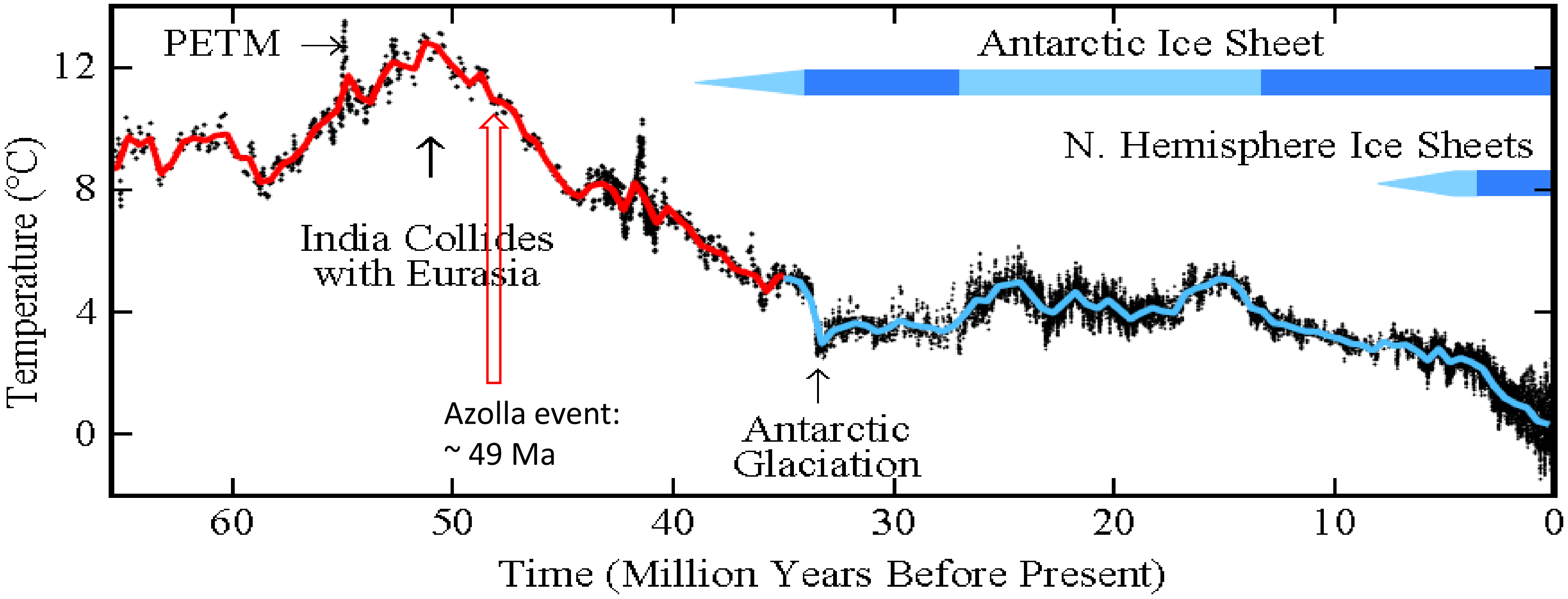

Antarctic ice sheet
Temperature (°C)
12
8
4
0
Pal.
Eocene
Olig.
Miocene
Plio.
2,000
1,500
1,000
500
0
Atmospheric CO2 (ppm)
Stomata
Phytoplankton
Palaeosols
Liverworts
Boron
B/Ca
Nahcolite–trona
60
50
40
30
20
10
0
Time (Myr ago)

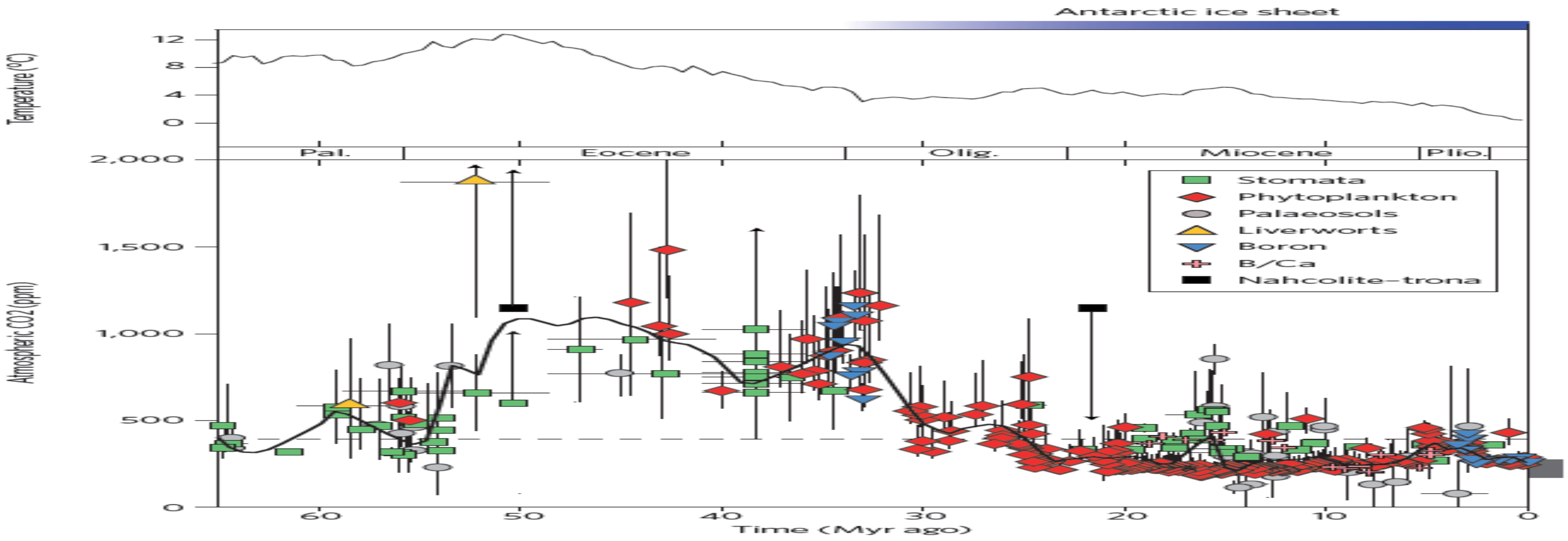
Global Deep Ocean Temperature



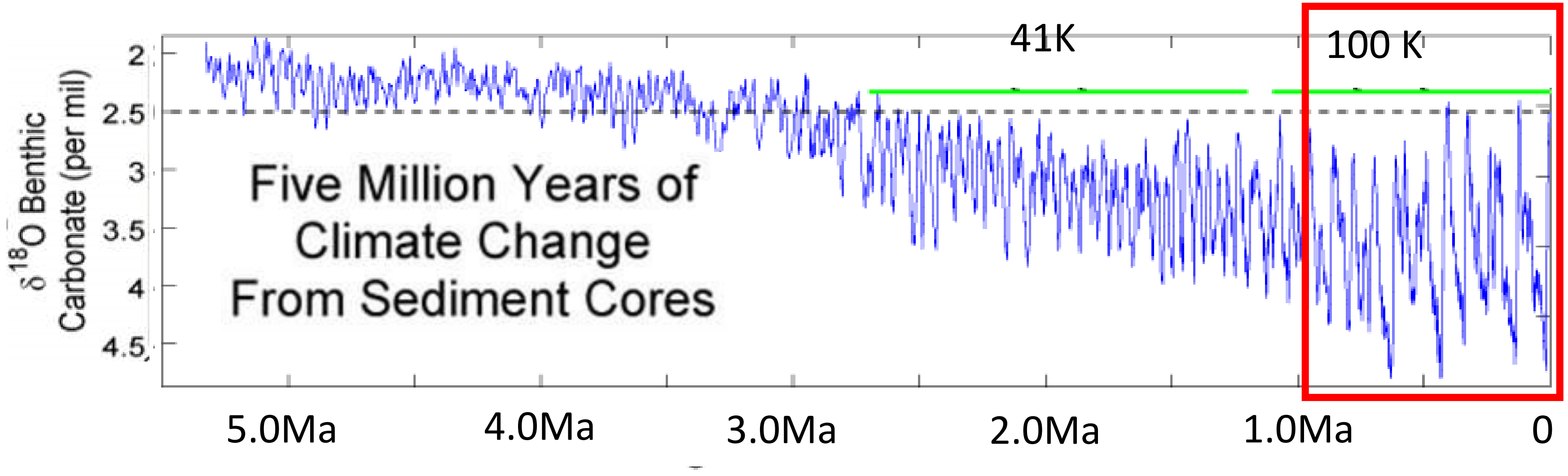
Azolla event:
~ 49 Ma

Global Deep Ocean Temperature



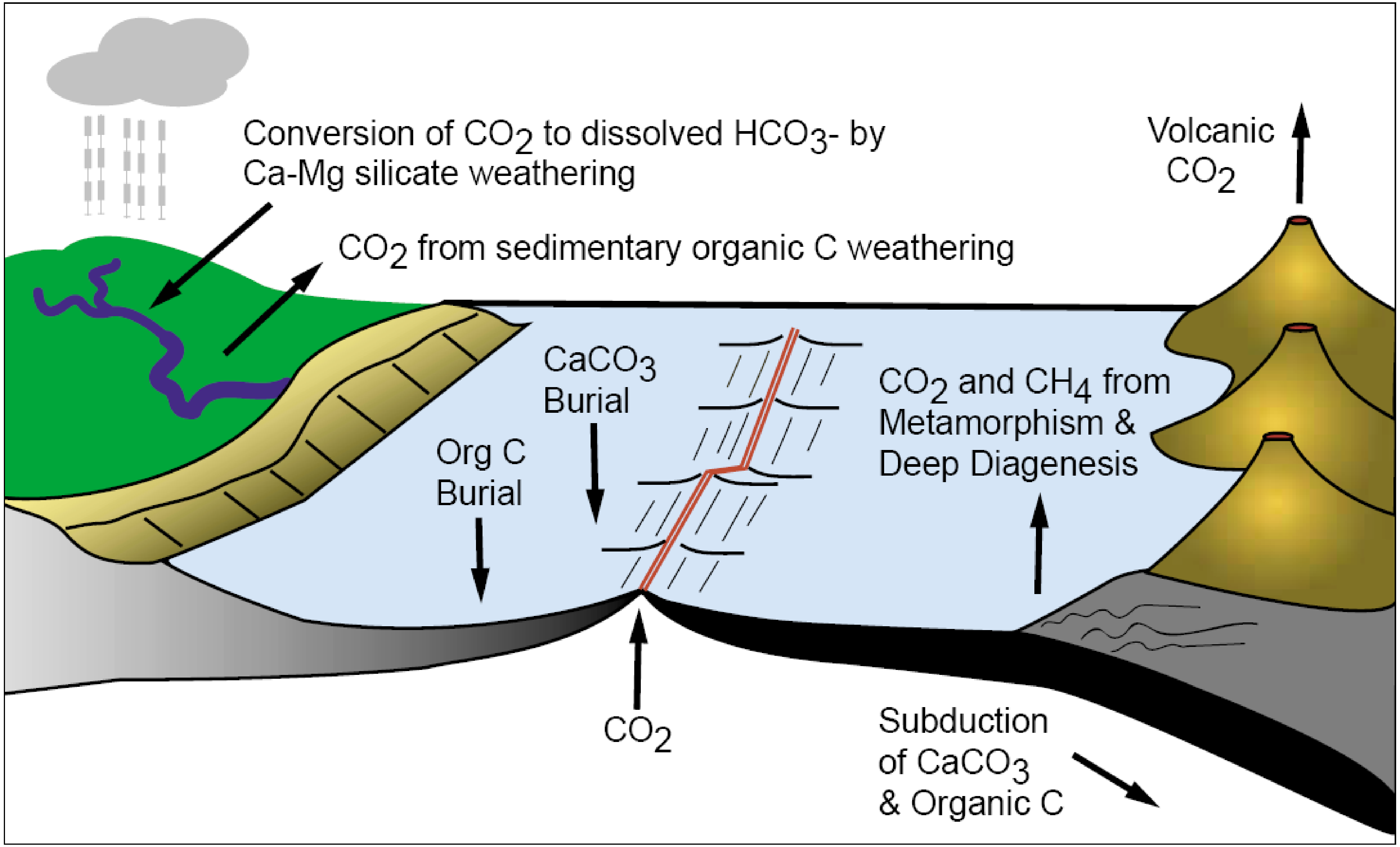


Climate Changes from Ocean Sediment Cores, since 5 Ma. Milankovitch Cycles



When CO_2 levels get below ~400-600 ppm Orbital parameters become more important than CO_2

Long-term carbon cycle: *rocks*



Berner, 2001

Long-term Carbon Cycle: rocks

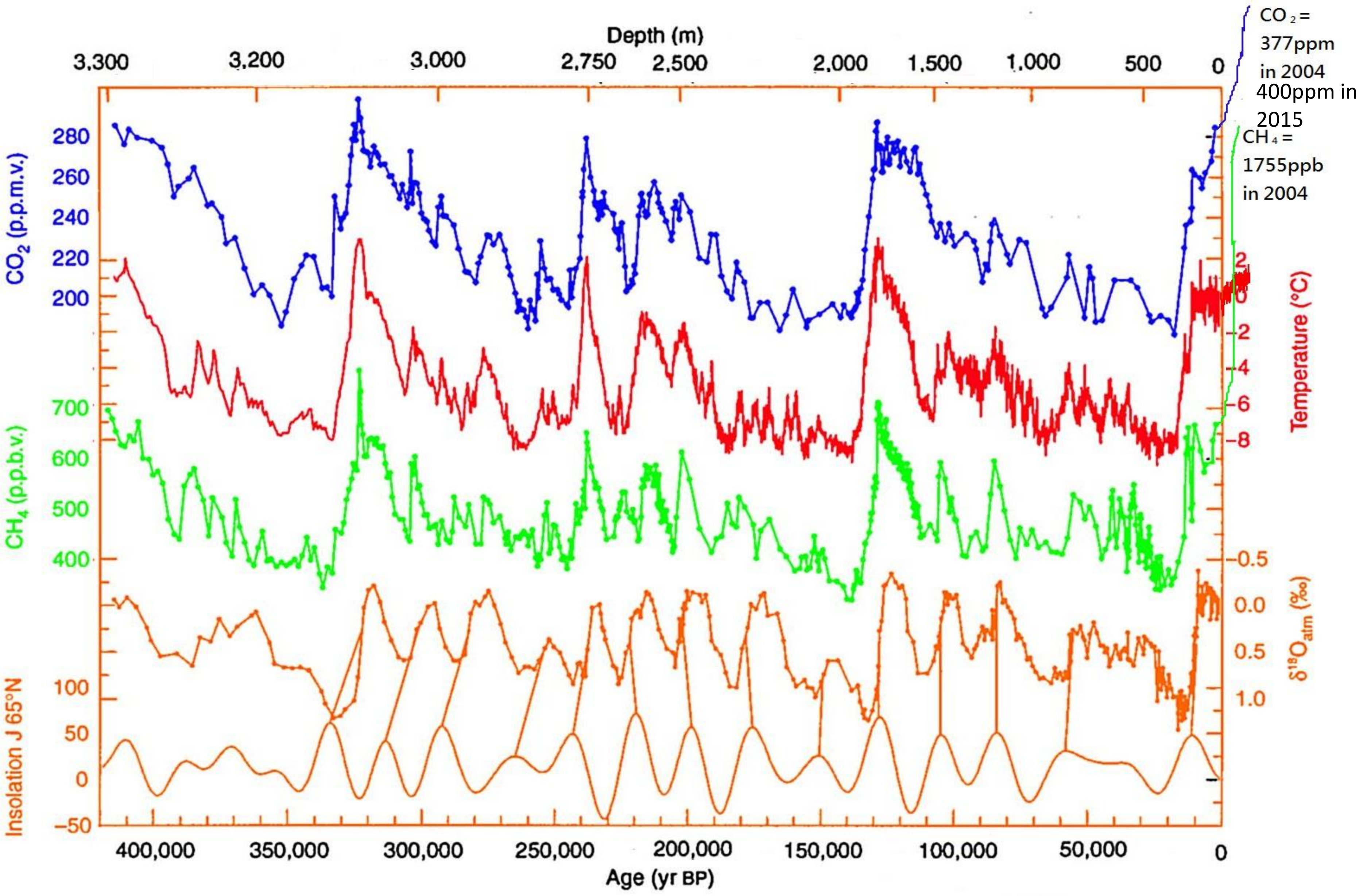
Two generalized reactions…

Photosynthesis/Respiration

$CO_2 + H_20 \leftrightarrow CH_2O + O_2$

Weathering/Precipitation

$CO_2 + CaSiO_3 \leftrightarrow CaCO_3 + SiO_2$



CO₂ = 377ppm in 2004

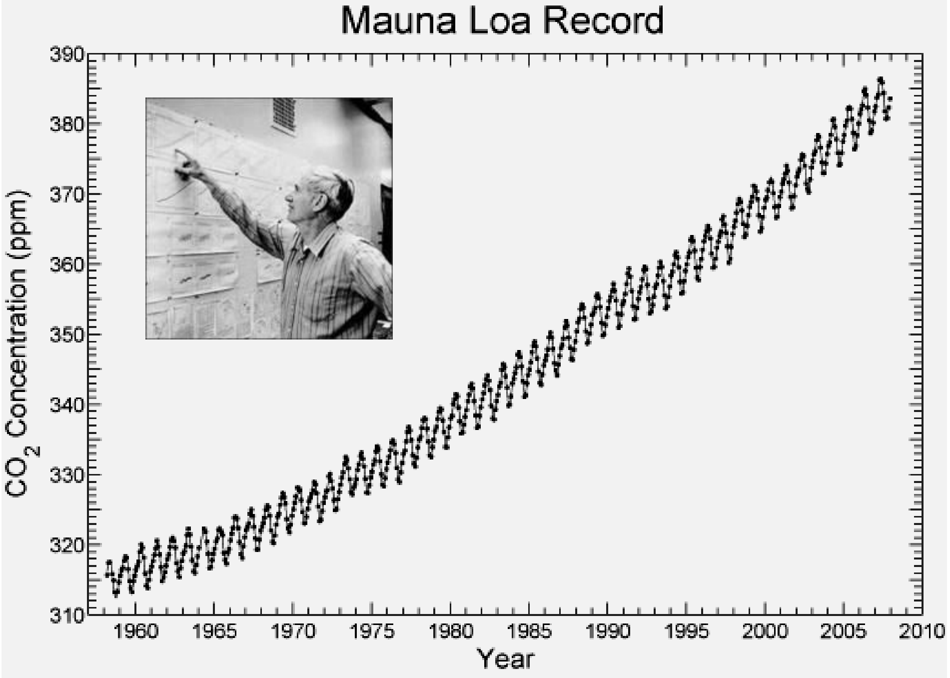
400ppm in 2015

CH₄ = 1755ppb in 2004

http://www.antarcticglaciers.org/climate-change/

3: EMISSIONS FROM HUMAN ACTIVITIES LARGELY TO BLAME

- 40% increase in CO_2
- Dead carbon altering atmospheric C^{14}
- That Carbon is more negative/enriched in C^{12}



Earth's past climate – CO_2 Levels

1. **4,500 to 600 million years: Earth's deep past before the Cambrian (600 MaBP): hot and cold**
2. **600 million to 65 million years : mostly hot-house Earth; 100s parts per million (ppm)**
3. **65 to 1 million years: Climate trend in the Cenozoic – the last 65 million years; proxy data from 3600ppm to <200 ppm.**
4. **Last Million years: 180-280 ppm; how do we know – empirical data – ice core data**
5. **Today (last 100 years): 40% increase to 412 ppm and growing**

Why is BIOCHAR Important ?

Carbon negativity (CO2, CH4, N2O) - How?

- **Fossil fuels are carbon positive; they add more carbon dioxide (CO_2) and other greenhouse gasses to the air and thus exacerbate global warming.**

- **Compost and Ordinary biomass fuels are carbon neutral; the carbon captured in the biomass by photosynthesis would have eventually returned to the atmosphere through natural processes like decomposition.**

- **Sustainable biochar systems can be carbon negative by transforming the carbon in biomass into stable carbon structures in biochar which can remain sequestered in soils for hundreds and even thousands of years. The result is a net reduction of CO_2 in the atmosphere, as illustrated in the diagram.**

http://www.biochar-international.org/biochar/carbon

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Figure 1: Major types of CDR
(https://iopscience.iop.org/article/10.1088/1748-9326/aabf9b/meta#erlaabf9bf2)

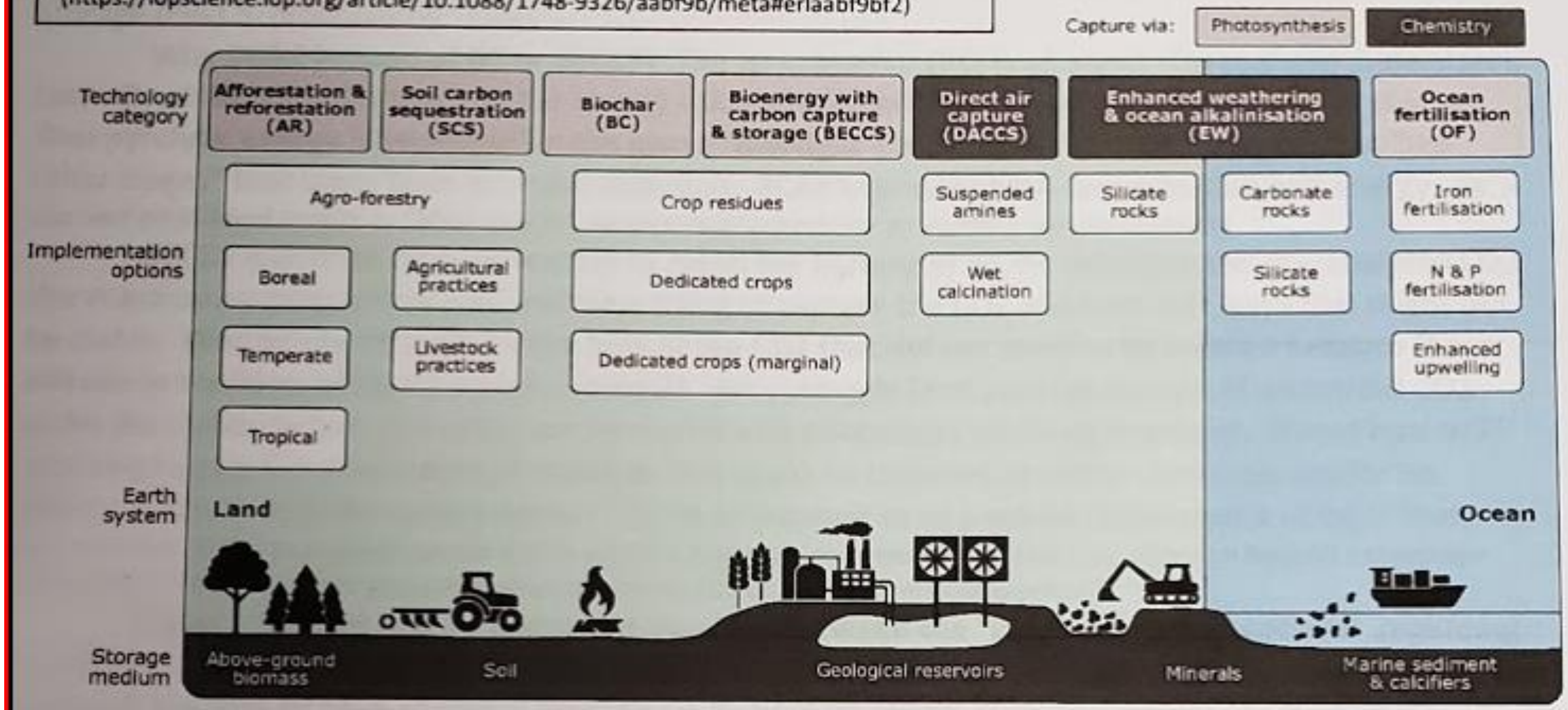
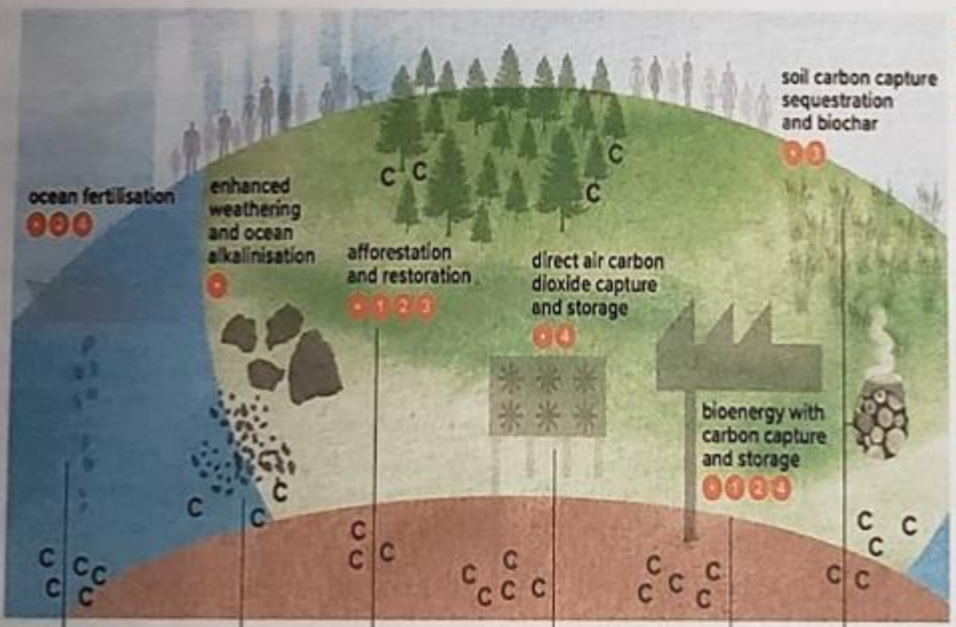


Figure 2: Major types of CDR (Source: Carnegie Council) [Labels add by author.] >>>

Governing Carbon Dioxide Removal



Shared Governance Challenges include:

- Measurement and reporting;
- Speed/scale issues;
- Potential public concerns, including transparency of information, accountability, involvement in decisions;
- Liability and compensation.

Specific Governance Challenges include:

- Managing the competition for land use and related impacts on the SDGs at domestic and transboundary levels;
- Managing risks and potential implications for biodiversity;
- Addressing permanence of CO_2 isolated from atmosphere;
- High costs — land use, capital, deployment, energy — mean policy signals, e.g., price on carbon or other regulation, are needed.

Fertilising ocean ecosystems to accelerate phytoplankton growth, which partly sinks to transport carbon from atmosphere to seabed

Enhancing natural weathering of rocks by extracting, grinding, and dispersing carbon-binding minerals on land, or adding alkaline minerals to the ocean to increase carbon uptake

Planting forests and restoring ecosystems, for long-term carbon storage in above- and below-ground biomass

Using chemical process to capture CO_2 directly from ambient air; using or permanently storing the CO_2

Burning biomass for energy generation capturing and permanently storing the resulting CO_2

Burning biomass under low oxygen conditions, yielding charcoal "biochar" to add to soil and enhance soil carbon levels

5 November 2019

C2G
Carnegie Climate Governance Initiative

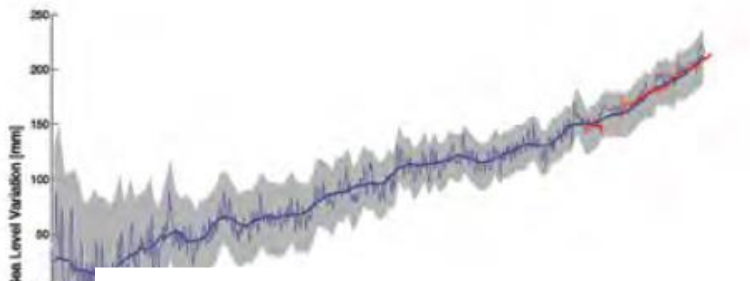
CARNEGIE COUNCIL

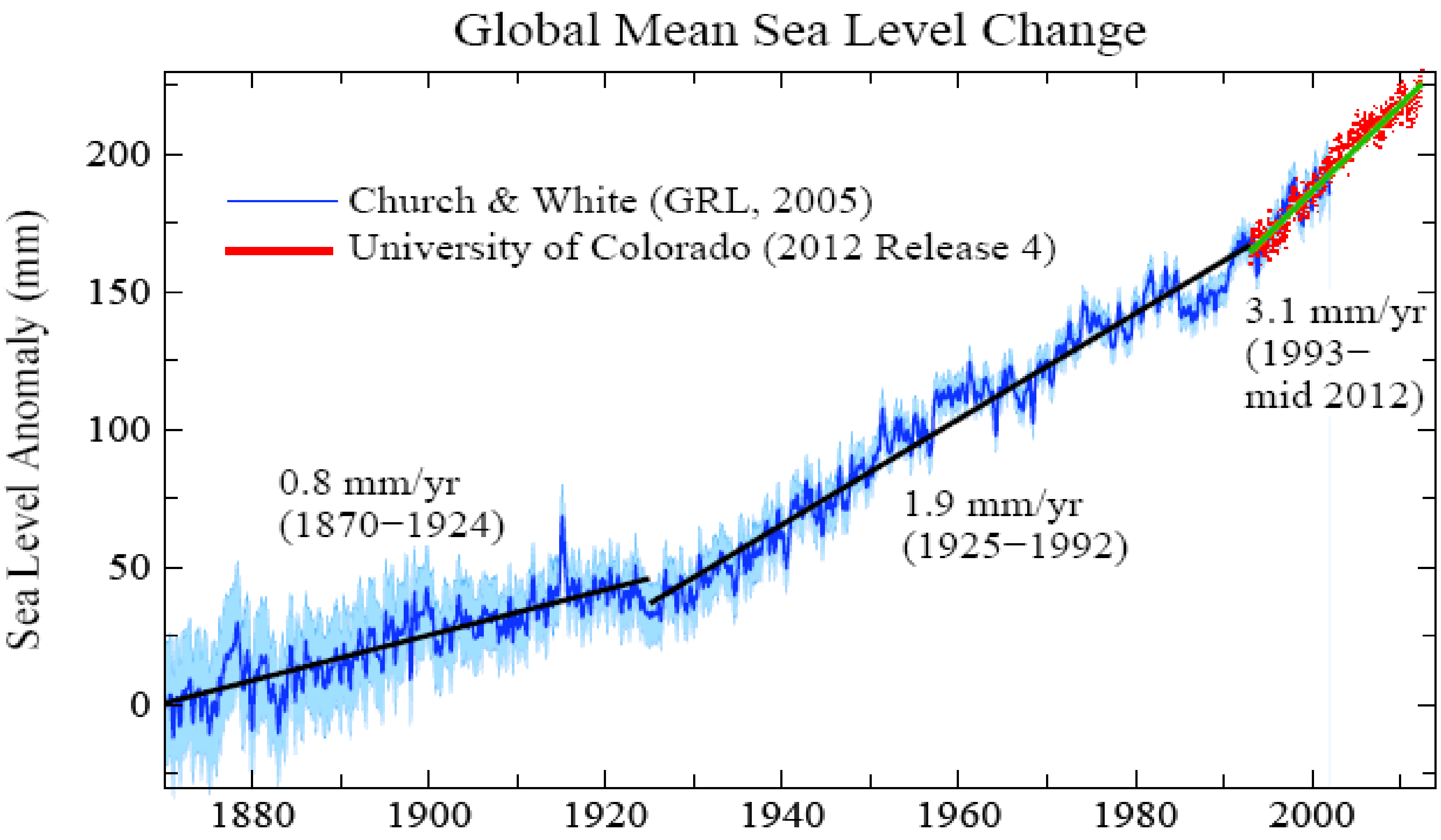
c2g2.net · contact@c2g2.net

OF EW AR DACCS BECCS BC&E SCS

OCEAN ACIDIFICATION

14: HOW FAST IS SEA LEVEL RISING?





Blue: Sea level change from tide-gauge data *(Church J.A. and White N.J., Geophys. Res. Lett. 2006; 33: L01602)*
Red: Univ. Colorado sea level analyses in satellite era *(http://www.columbia.edu/~mhs119/SeaLevel/)*.

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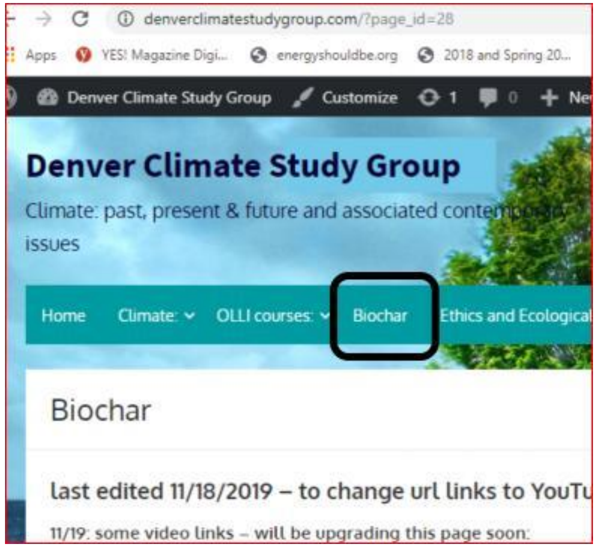

Denver Climate Study Group

Climate: past, present & future and associated contemporary issues

Biochar

last edited 11/18/2019 – to change url links to YouTu

11/19: some video links – will be upgrading this page soon: