

US Geological Survey PRISM Project

CO2 paleoclimate
OCEAN stable isotope
ice sheet aabw
fossil pollen
ALBEDO ANALOG
cryosphere
AMOC atmosphere
alkenone SEA ICE
DEEP TIME carbon
IPCC radiolarian

Pliocene Paleoclimate Research



PRISM

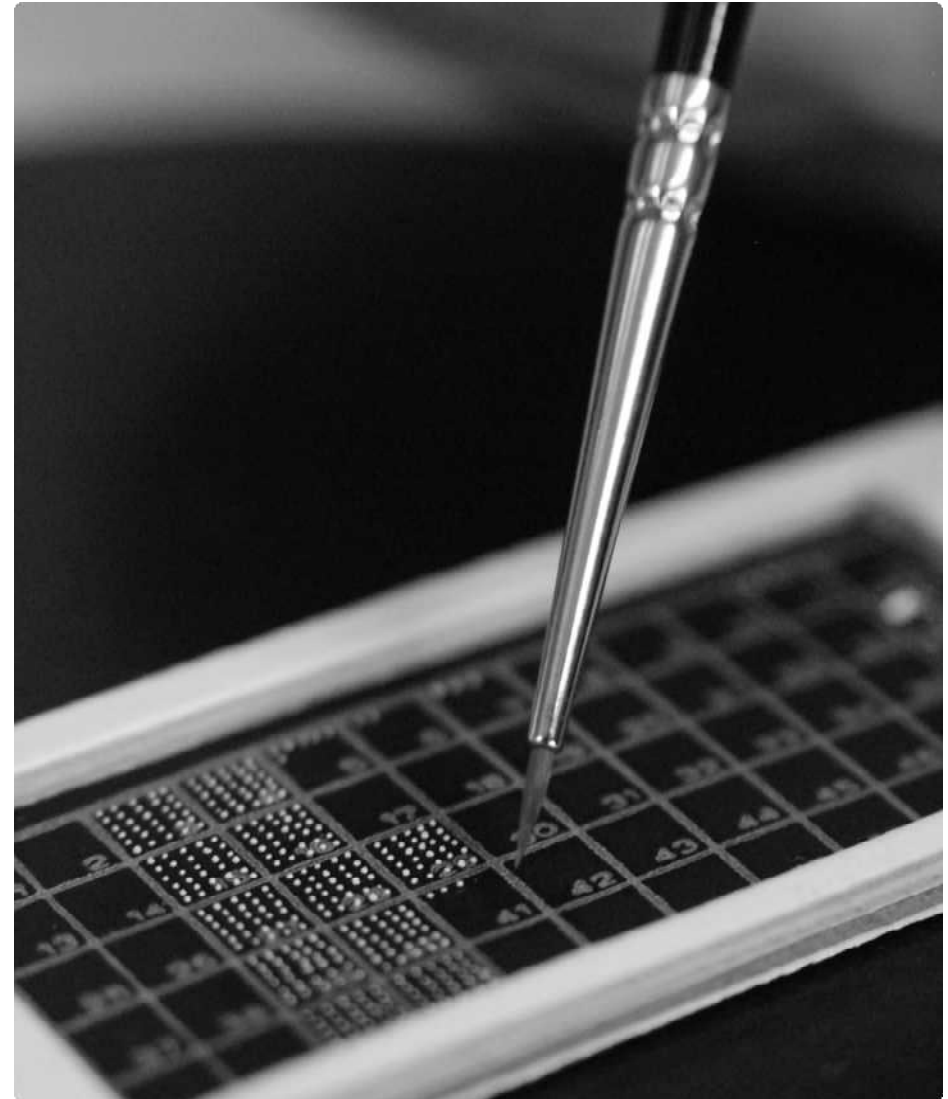


Harry J.
Dowsett



U.S. Geological Survey | Reston, VA
Eastern Geology & Paleoclimate Science
Center

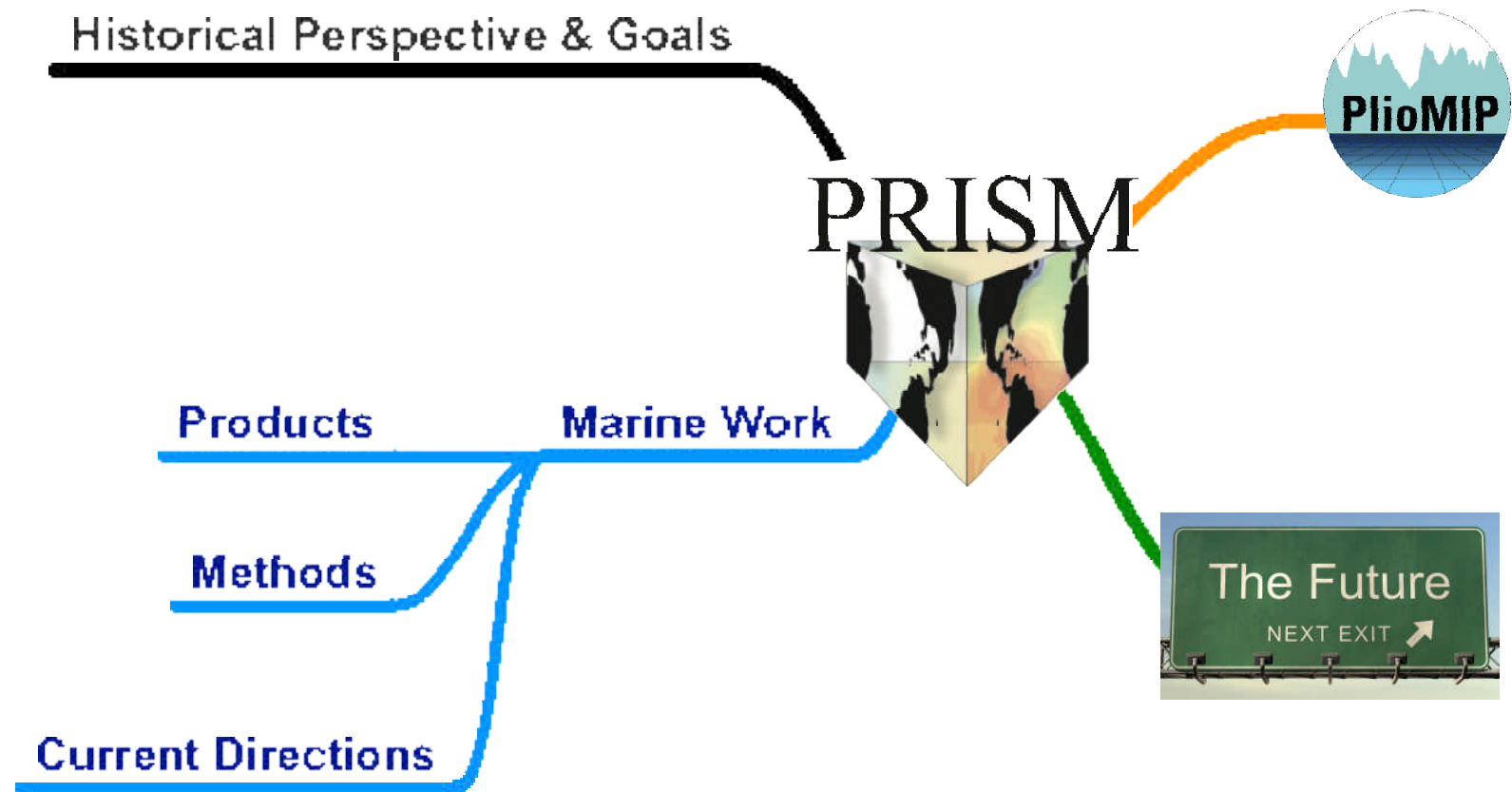
Northumbria/GMU



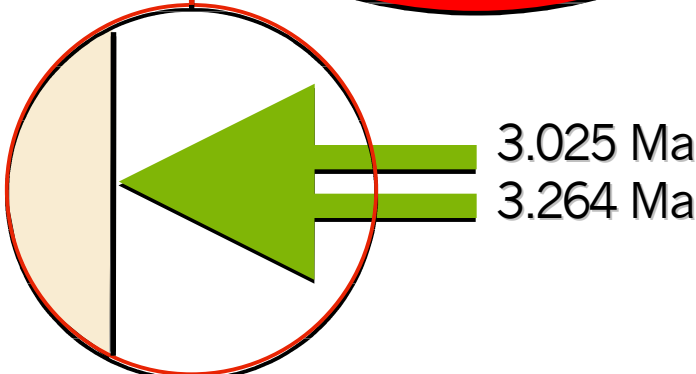
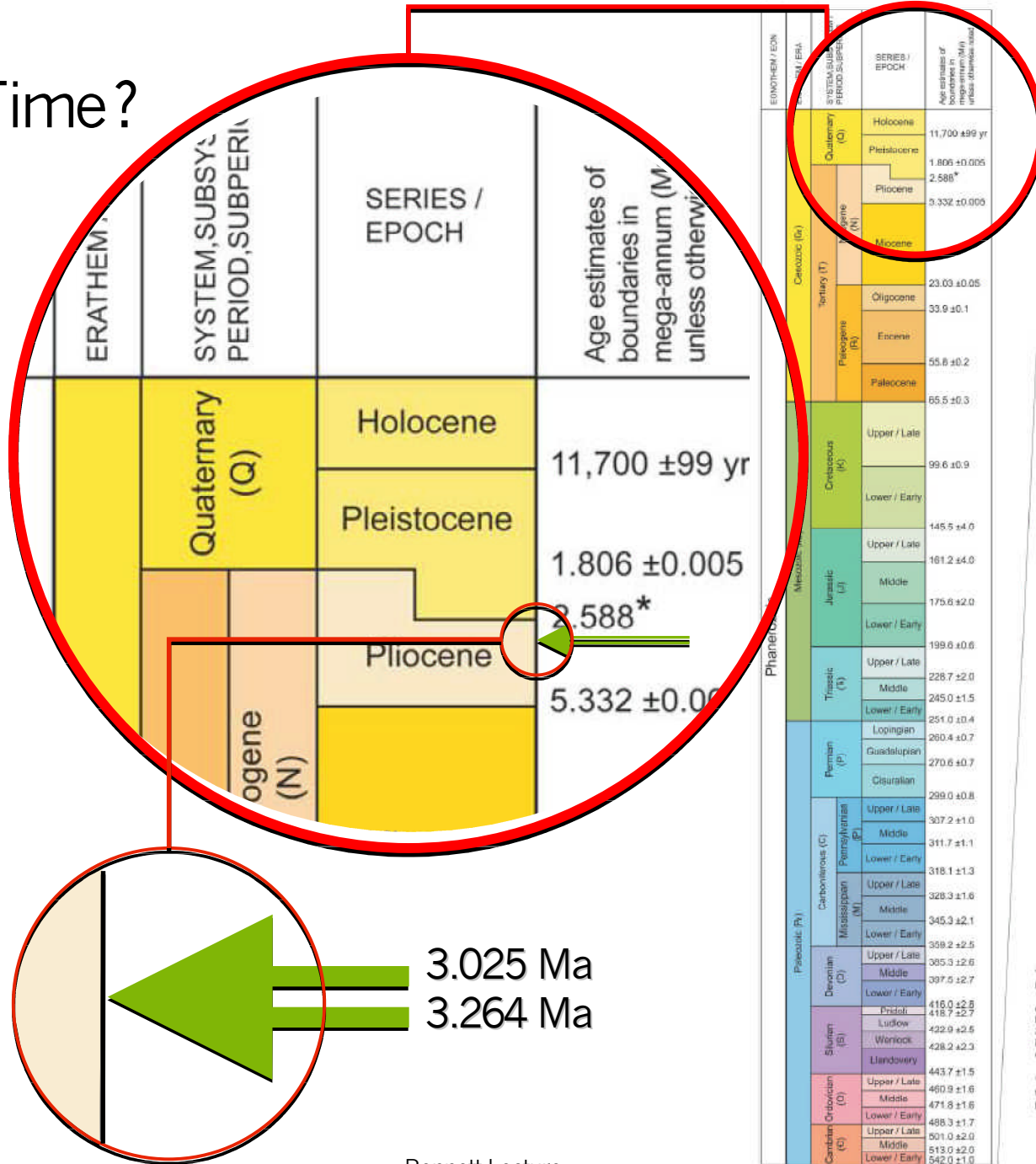
PRISM/PlioMIP Collaboration

Pliocene Research, Interpretation and Synoptic Mapping Project
Pliocene Model Intercomparison Project





Deep Time?



ERATHEM / EON	SYSTEM / PERIOD / SUBPERIOD	SERIES / EPOCH	Age estimates of boundaries in mega-annum (Ma) unless otherwise noted	
Phanerozoic (Pz)	Quaternary (Q)	Holocene	11,700 ± 99 yr	
		Pleistocene	1.806 ± 0.005	
	Pliocene	Pliocene	2.588*	
		Pliocene	5.332 ± 0.005	
	Neogene (N)	Pliocene	Pliocene	5.332 ± 0.005
			Pliocene	5.332 ± 0.005
		Miocene	Miocene	5.332 ± 0.005
			Miocene	5.332 ± 0.005
		Oligocene	Oligocene	23.03 ± 0.05
			Oligocene	33.9 ± 0.1
Eocene	Eocene	55.8 ± 0.2		
	Eocene	65.5 ± 0.3		
Mesozoic (Mz)	Cretaceous (K)	Upper / Late	145.5 ± 4.0	
		Lower / Early	99.6 ± 0.9	
	Jurassic (J)	Upper / Late	161.2 ± 4.0	
		Middle	175.6 ± 2.0	
	Triassic (T)	Upper / Late	199.6 ± 0.6	
		Middle	228.7 ± 2.0	
	Permian (P)	Lower / Early	245.0 ± 1.5	
		Lopingian	251.0 ± 0.4	
	Carboniferous (C)	Guadalupian	260.4 ± 0.7	
		Osagean	270.6 ± 0.7	
Paleozoic (Pz)	Carboniferous (C)	Upper / Late	299.0 ± 0.8	
		Middle	307.2 ± 1.0	
	Mississippian (M)	Lower / Early	311.7 ± 1.1	
		Upper / Late	318.1 ± 1.3	
	Devonian (D)	Upper / Late	328.3 ± 1.6	
		Middle	345.3 ± 2.1	
	Silurian (S)	Lower / Early	358.2 ± 2.5	
		Upper / Late	358.5 ± 2.6	
	Ordovician (O)	Middle	397.5 ± 2.7	
		Lower / Early	416.0 ± 2.8	
Cambrian (C)	Pragian	418.7 ± 2.7		
	Ludlow	422.9 ± 2.5		
Cambrian (C)	Wenlock	428.2 ± 2.3		
	Llandovery	443.7 ± 1.5		
Cambrian (C)	Upper / Late	460.9 ± 1.6		
	Middle	471.8 ± 1.6		
Cambrian (C)	Lower / Early	488.3 ± 1.7		
	Upper / Late	501.0 ± 2.0		
Cambrian (C)	Middle	513.0 ± 2.0		
	Lower / Early	542.0 ± 1.0		

ERATHEM / EON	SYSTEM / PERIOD / SUBPERIOD	Age estimates of boundaries in mega-annum (Ma) unless otherwise noted	
Proterozoic (P)	Neoproterozoic (Z)	Ediacaran	635
		Cryogenian	850
	Mesoproterozoic (Y)	Tonian	1000
		Stonian	1200
	Paleoproterozoic (X)	Ectasian	1400
		Calymmian	1600
	Archean (A)	Siderian	1800
		Crocothian	2050
	Hadean (HA)	Rhyacian	2300
		Siderian	2500
Hadean (HA)	Neohadean	2800	
	Neohadean	3200	
Hadean (HA)	Neohadean	3600	
	Neohadean	4000	
Hadean (HA)	Neohadean	4800	
	Neohadean	4800	

* Currently, the Pliocene-Pleistocene boundary is placed at the base of the Calabrian Stage at 1.806 Ma. However, the International Commission on Stratigraphy voted in 2009 to lower the boundary to the base of the Gelasian Stage at 2.588 Ma. At the time of this printing, this change is waiting approval by the International Union of Geological Sciences.

** The Ediacaran is the only formal system in the Proterozoic with GSSP. All other units are periods.



General theme of Soviet Era authors. . .

the Arctic ice is a great disadvantage, as are the permanently frozen soil (permafrost), dust storms, dry winds, water shortages in the deserts, etc. if we want to improve our planet and make it more suitable for life, we must alter its climate.

Geoengineering?
(Rusin & Flit, 1960)

Dam the Bering Straights, pump Arctic water to Pacific

Divert major rivers away from Arctic to central Asia

Accelerate the Greenhouse Effect

The US Advanced Research Projects Agency (ARPA) had a classified program Nile Blue investigating National Security implications of deliberate or inadvertant climate modification by the Soviets.

Events leading to the National Climate Program in 1987

- **1970s** Budyko suggested reconstructions of Late Cenozoic (Eemian, Pliocene, Miocene, Eocene) climatic optima as palaeoanalogues for 21st century climate

↑CO₂ in the past meant **warmer** conditions

Set fire to
the coal
mines!



- **Early 1980s** State of climate predictions was less than encouraging to U.S. policy makers
- **1982** NAS suggested new deep time synoptic reconstructions were necessary
- **1988** USGS began its **Warm Pliocene Project** to produce a better synoptic view of the Pliocene; NASA agreed to model Pliocene climate using USGS boundary conditions

PRISM Goals

1. Reconstruct the Pliocene paleoenvironment to better understand the most recent interval of *Global Warmth* similar to that projected for the end of the 21st Century



PRISM Goals

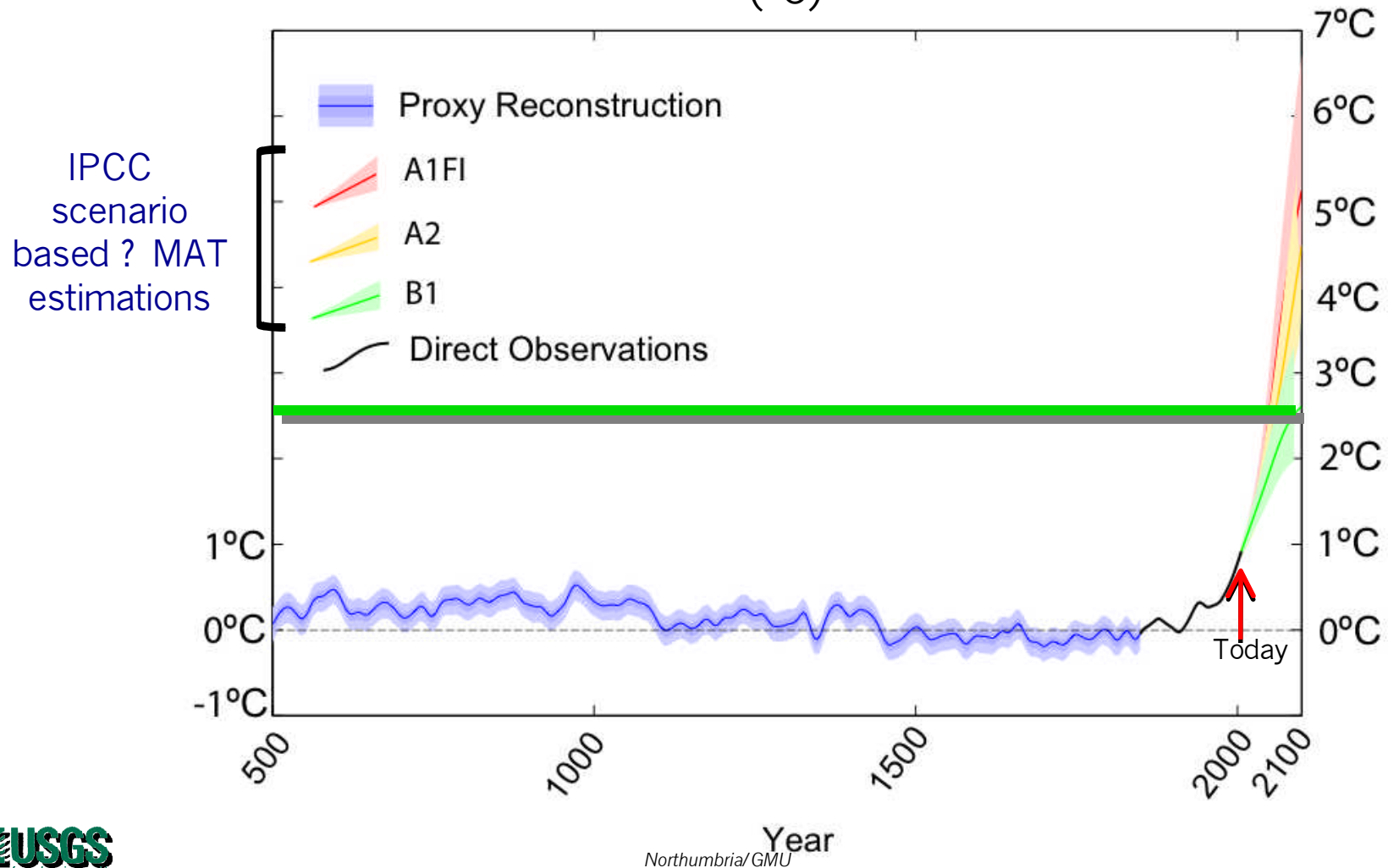
2. Provide digital data sets of boundary conditions that can be used to *initialize* and *verify* [Pliocene] paleoclimate simulations.

		X-Axis: - (degrees_east)									
		-173.50	-172.50	-171.50	-170.50	-169.50	-168.50	-167.50	-166.50	-165.50	-164.50
Y-Axis: - (degrees_north)	71.50	-0.6	-0.6	-0.5	-0.4	-0.4	-0.4	-0.4	-0.4	-0.3	-0.3
	70.50	-0.0	0.1	0.2	0.3	0.4	0.4	0.4	0.5	0.4	0.4
	69.50	0.5	0.6	0.9	1.0	1.1	1.2	1.2	1.1	0.9	0.9
	68.50	0.7	0.9	1.3	1.4	1.5	1.6	1.7	1.8	NaN	NaN
	67.50	NaN	0.9	1.3	1.6	1.7	1.9	2.2	2.4	NaN	NaN
	66.50	NaN	NaN	NaN	NaN	NaN	2.1	2.4	2.6	NaN	NaN
	65.50	NaN	NaN	NaN	NaN	2.1	2.3	NaN	NaN	NaN	NaN
	64.50	NaN	NaN	NaN	2.3	2.5	2.7	2.9	NaN	NaN	NaN
	63.50	3.3	3.1	3.0	3.0	3.1	3.3	3.5	3.7	3.8	3.8
	62.50	3.8	3.6	3.5	3.5	3.5	3.7	3.9	4.1	NaN	NaN
	61.50	4.4	4.2	4.0	4.0	3.9	4.0	4.2	4.3	NaN	NaN
	60.50	5.2	4.9	4.6	4.5	4.4	4.4	4.5	4.6	NaN	NaN
	59.50	6.1	5.8	5.3	5.1	5.0	4.9	4.9	5.0	5.1	5.1
	58.50	6.9	6.7	6.2	6.0	5.8	5.7	5.6	5.6	5.6	5.6
	57.50	7.5	7.4	7.1	6.9	6.8	6.6	6.4	6.4	6.4	6.4
	56.50	7.9	7.9	7.7	7.6	7.6	7.5	7.3	7.3	7.4	7.4
	55.50	8.1	8.1	8.1	8.1	8.1	8.1	8.2	8.2	8.2	8.2
	54.50	8.2	8.3	8.3	8.4	8.5	8.6	8.7	8.8	8.8	8.8
	53.50	8.4	8.5	8.5	8.6	8.7	8.8	9.0	9.1	9.1	9.1
	52.50	8.8	8.8	8.9	9.0	9.1	9.2	9.3	9.3	9.3	9.3
51.50	9.2	9.2	9.3	9.4	9.5	9.5	9.6	9.6	9.6	9.5	
50.50	9.6	9.6	9.7	9.7	9.8	9.8	9.8	9.8	9.8	9.7	

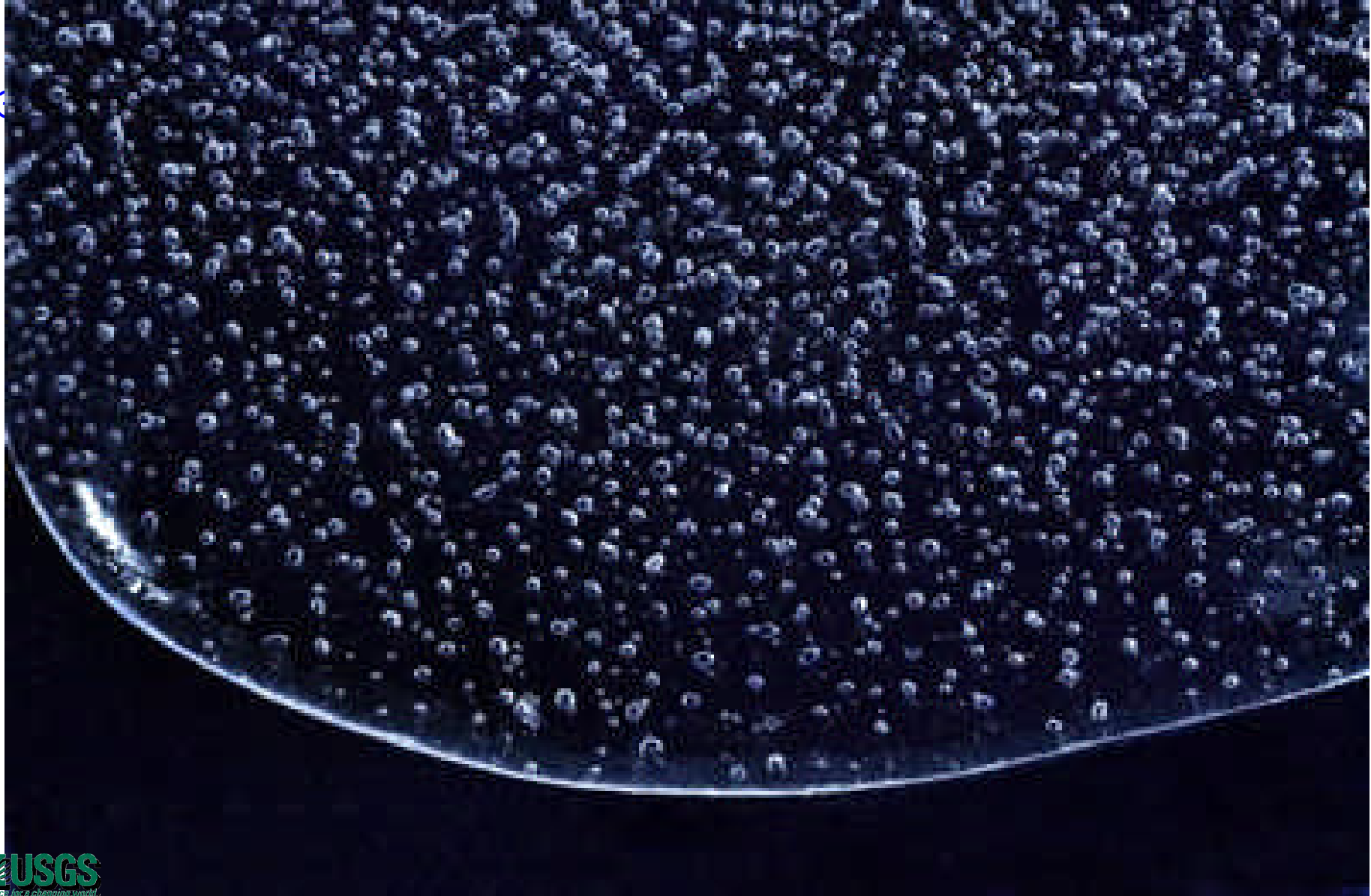
Why the Pliocene?

A future beyond our experience

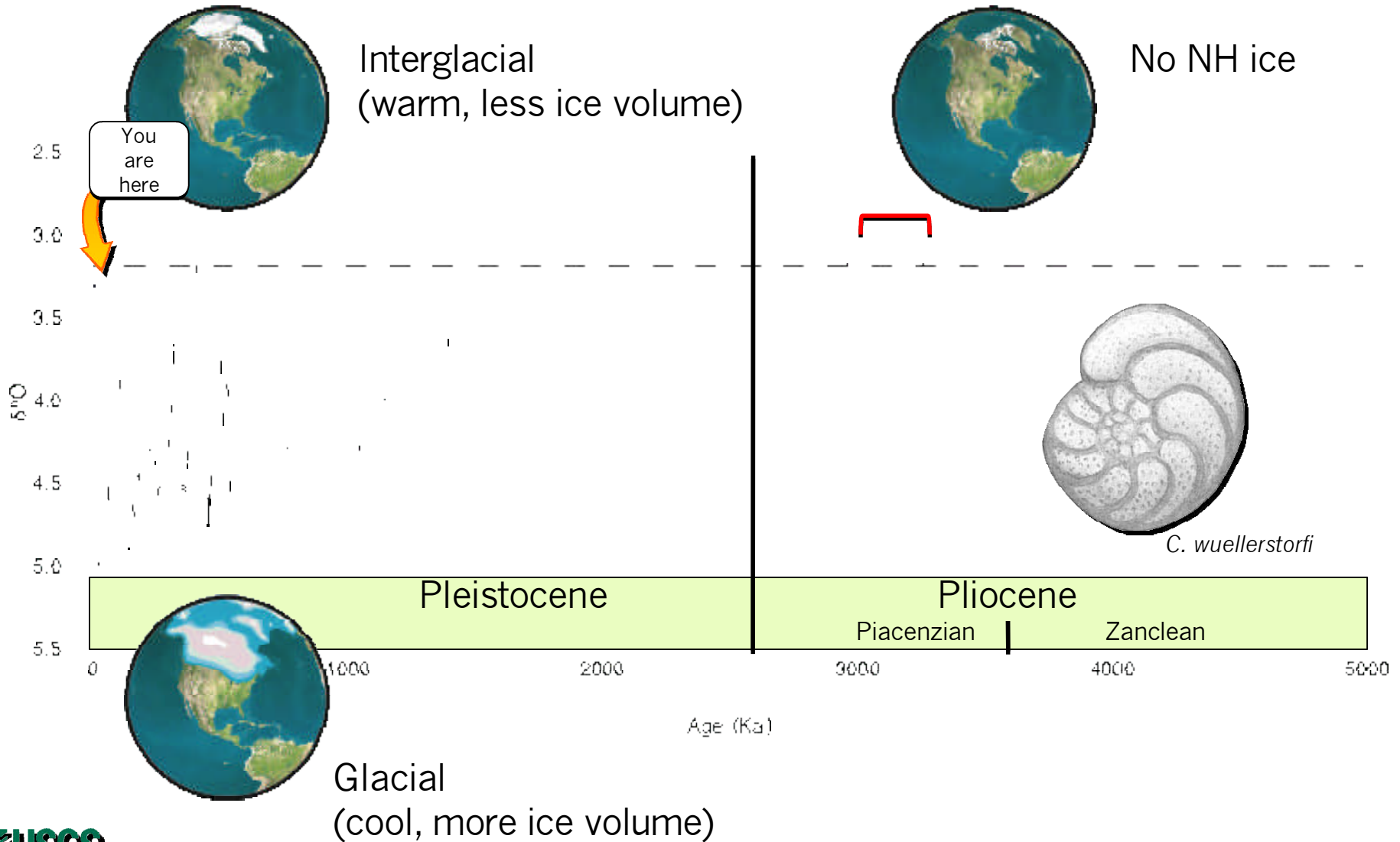
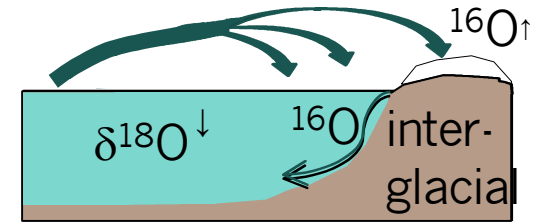
Mean Annual Global Temperature, relative to 1800 1900 (°C)



800,000 year composite record of CO₂ variability from Antarctic ice cores

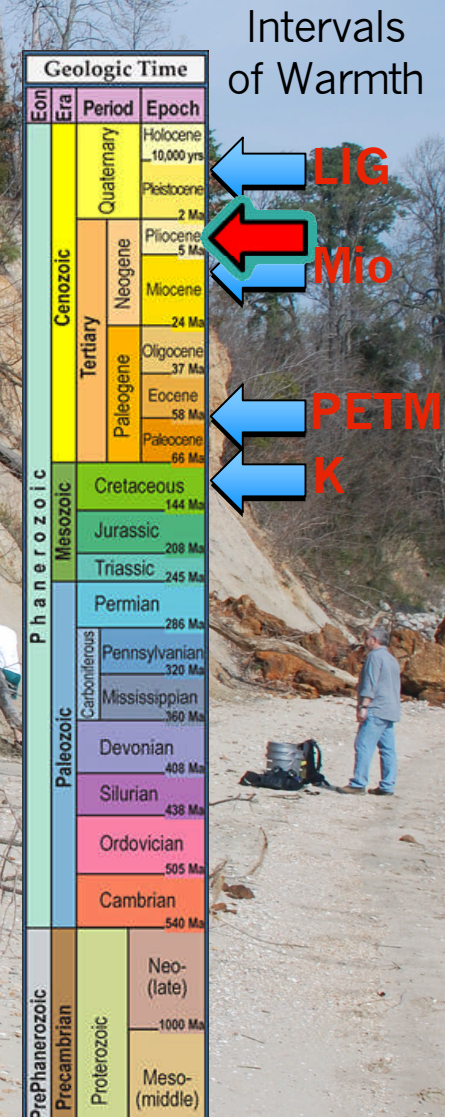


Benthic oxygen isotopes



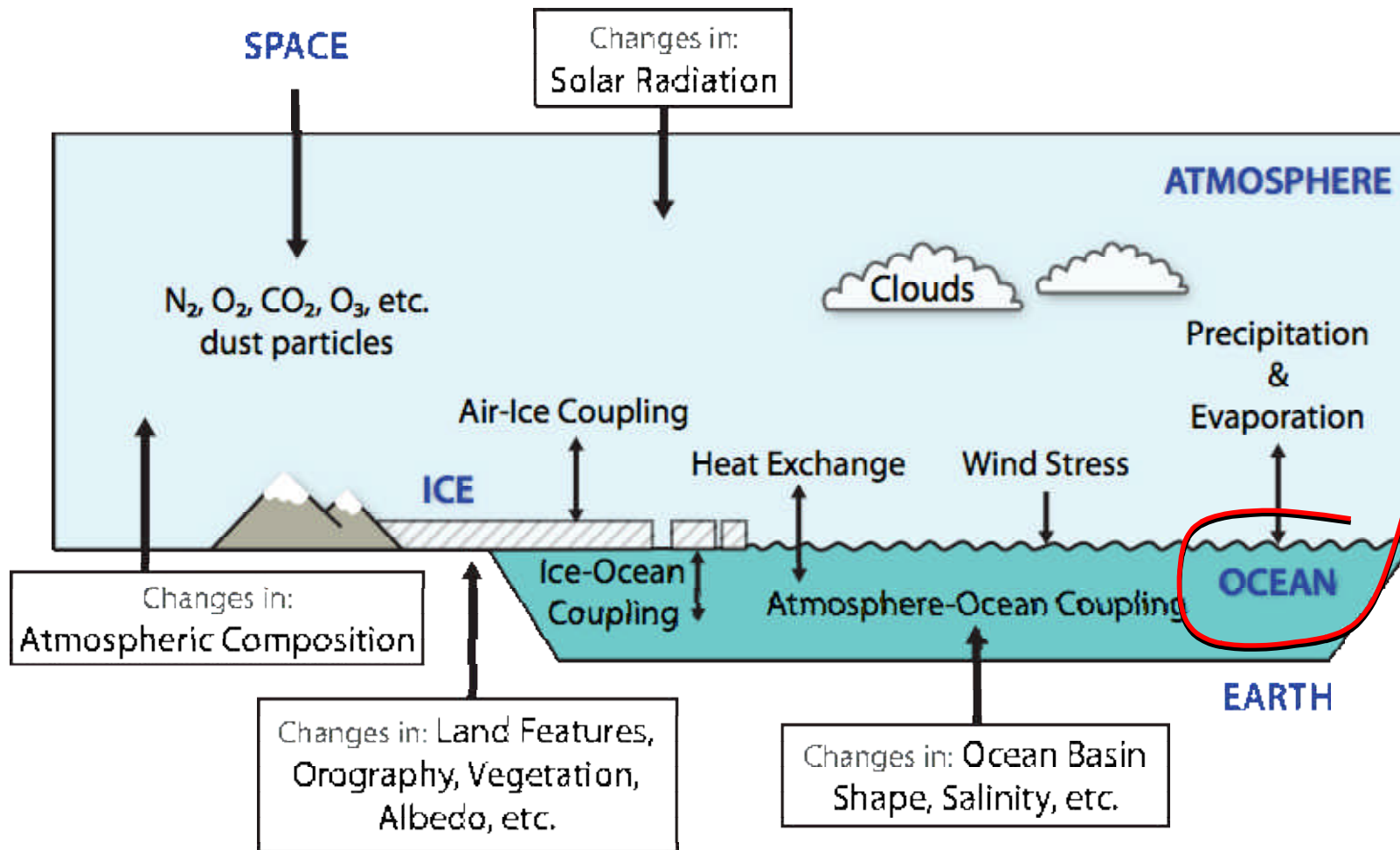
Why the Pliocene?

- The **PETM** was certainly warmer with more CO₂
Boundary conditions, methods
- The **LIG** is certainly more accessible
Not much different from today
- The **Pliocene** is a *compromise*: warming on the order of 2-3°C, boundary conditions mostly identical to present day, within reach of many of the proxy methods used for more recent climate reconstructions, biota extant



Pliocene Yorktown Formation, SE Virginia

Climate System boundary conditions



PRISM3 Data Model Scheme

