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Responses of deep ocean carbonate system to carbon reorganization and sea level changes

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Fig. 1: Age model – d18O; + 14C.
Fig. 2: B/Ca (+rep) and d11B for 4 cores;
Fig 3: B/Ca (only show avg) derived CO3 and d13C; vs. pCO2; RSL
Fig. 4: vertical profile for Hol – LGM for Atlantic and Indo-Pacific;
Fig. 5: %CaCO3 vs. DCO3 sensitivity to DCO3 changes; point: sensitive to small change in DCO3 between -25 to -5, i.e., in Indo-Pacific, not in Atlantic.
Fig. xx: WIND 28K %CaCO3, CO3, d13C, CO2. RSL+coral growth time interval.

Fig. x: cartoon from C vertical plus RSL effects

*Fig: From VM28-122 CO3 and d13C*43 to PC61 CO3 (it is difficult to distinguish anything; effects of circulation, vertical distribution and sea level changes are all cancelled)*

Fig. x: high resolution abyssal d13C (N Atl-ODP982, 607, SO-1089, Indian-w28K, Eq Pacific-ODP849)

Fig- hot spots;

Fig- PC61 CaCO3%, CO3 vs PC72 Th CaCO3 – largely water column, not surface productivity

Table, time slices avgs. For VM, GGC15, GGC48, PC61

Further consideration:
Plot: Land biomass: CH4, Speleothem, Italian biomass; No!
SO: upwelling, mention dust in text; just mention in text.

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Figures

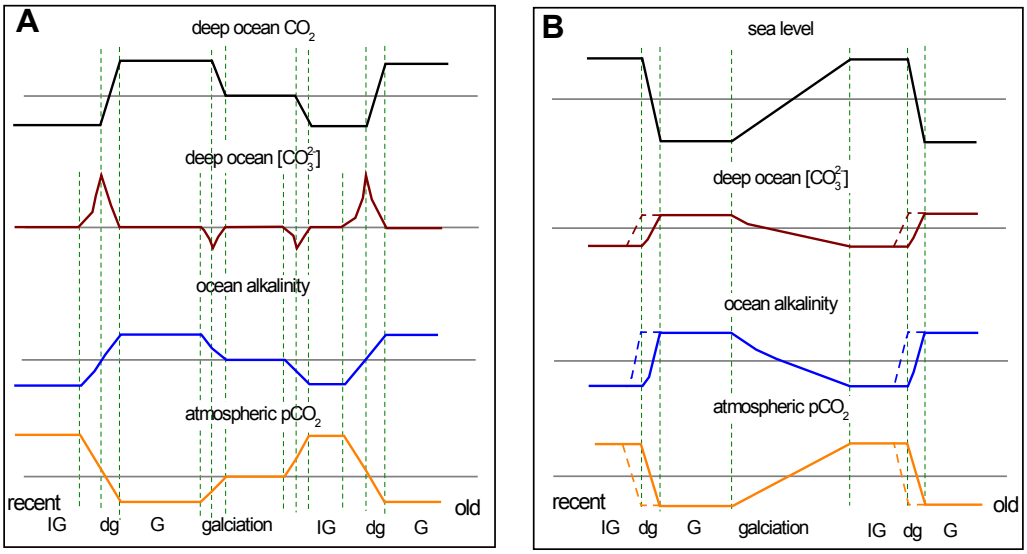
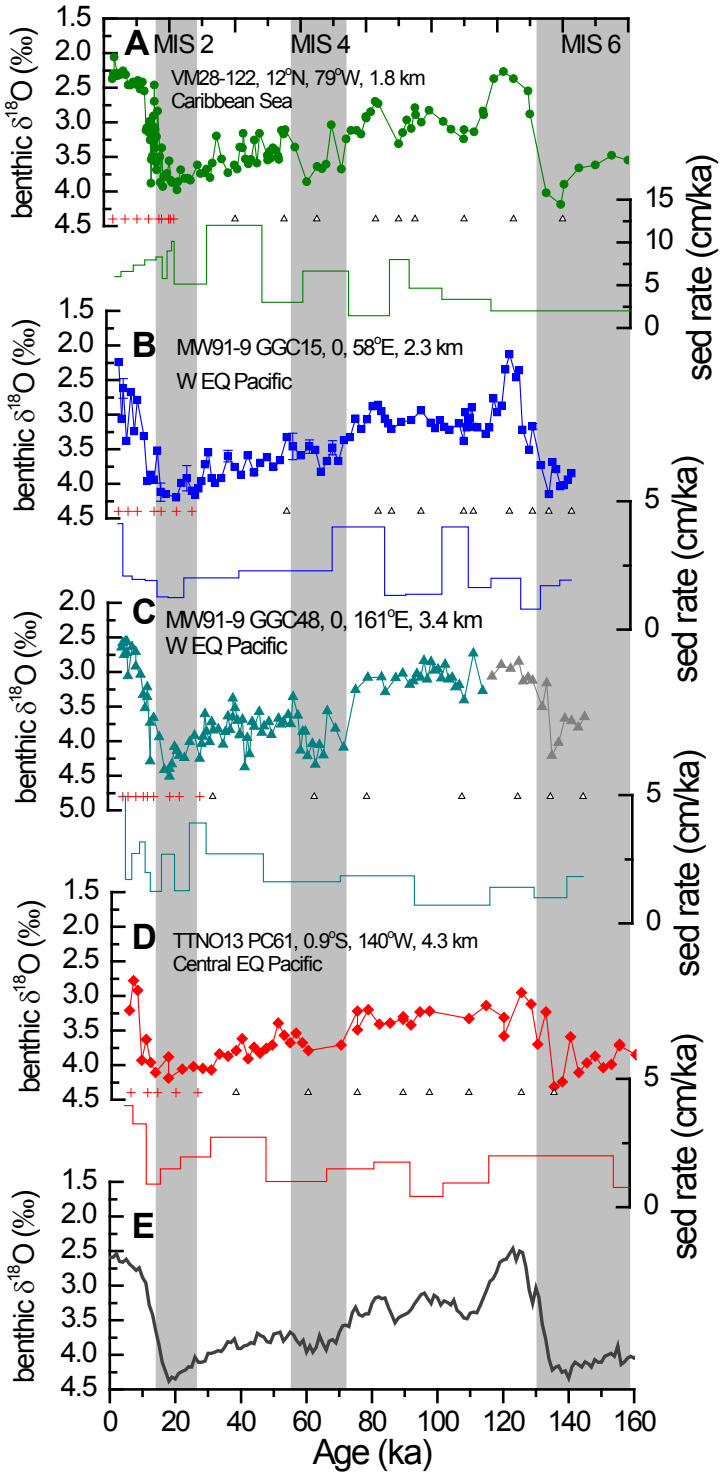
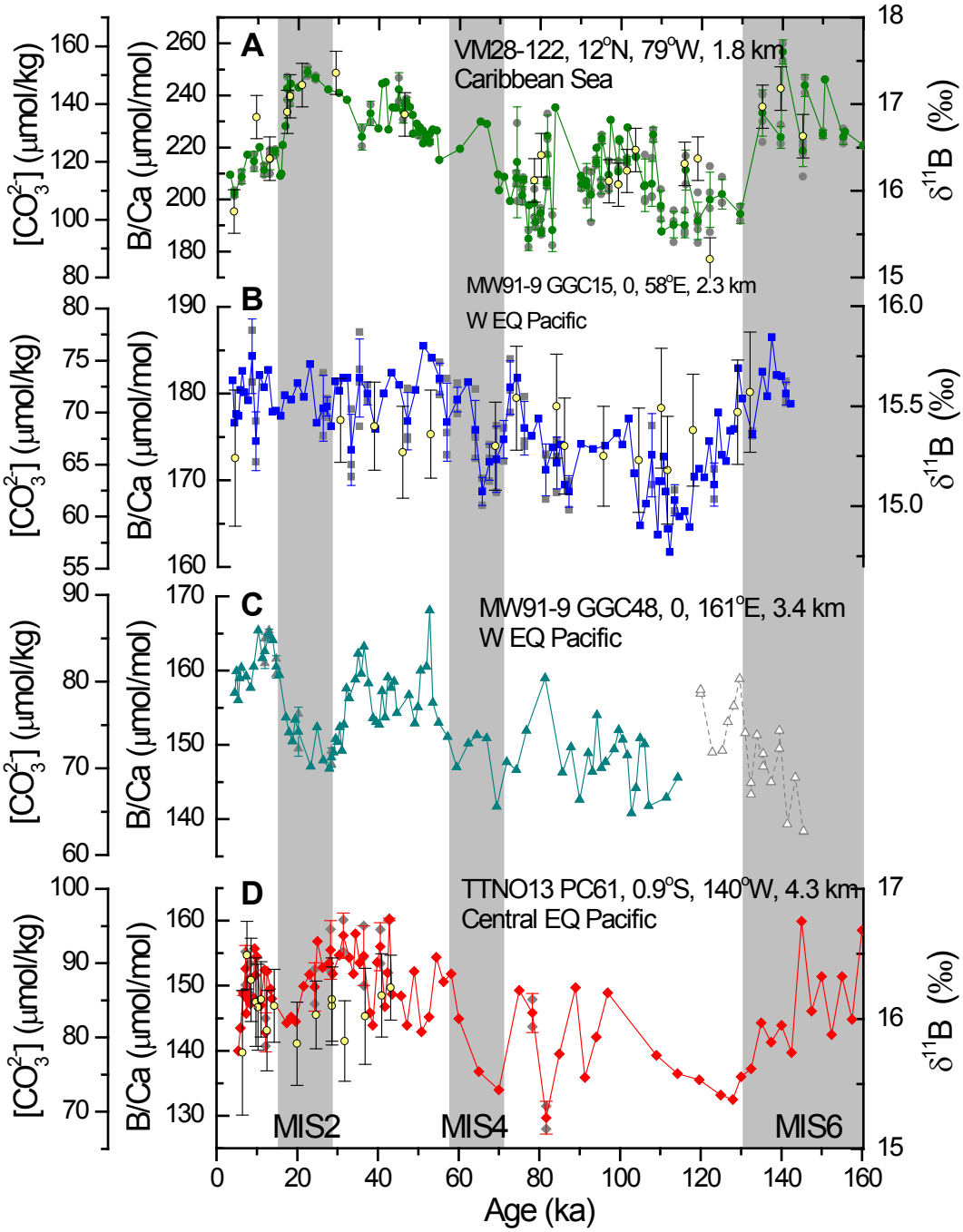


Figure 1. Schematic diagram showing responses of deep ocean [CO32-], whole ocean alkalinity and atmospheric pCO2 to (A) the vertical reorganization of CO2 in the oceans and (B) sea level changes. No scales are given to either axis, and thus the changes are only qualitative to assistant understanding of deep ocean carbonate system. The horizontal grey lines indicate the glacial-interglacial steady-state values. In (B), it is assumed that coral reef growth on shelves are coupled with sea level changes. While this is reasonable during marine transgressions when coral growth declines as sea level drops, a lag in coral reef growth respect to sea level rise is expected during times of regression due to the fact that sea level rise out-speed coral growth on shelves. Therefore, delayed responses (dashed curves) are expected in deep ocean CO32-, oceanic alkalinity and atmospheric pCO2. As can be seen, for scenario (A), no overall correlation between deep ocean CO32- and whole ocean alkalinity is expected. For scenario (B), alkalinity and deep ocean CO32- are expected to change at a ratio of 2:1.

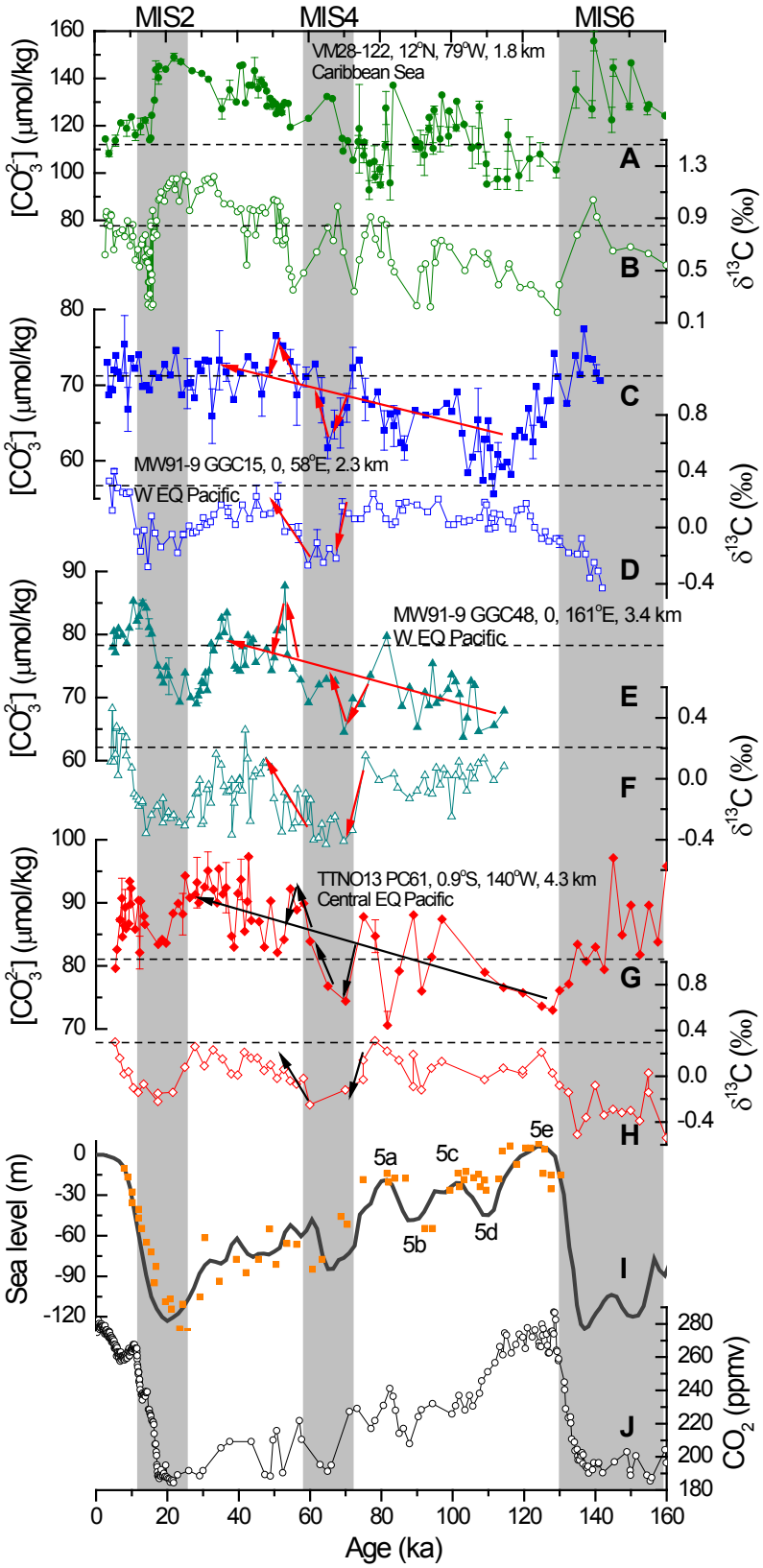


Age model of cores

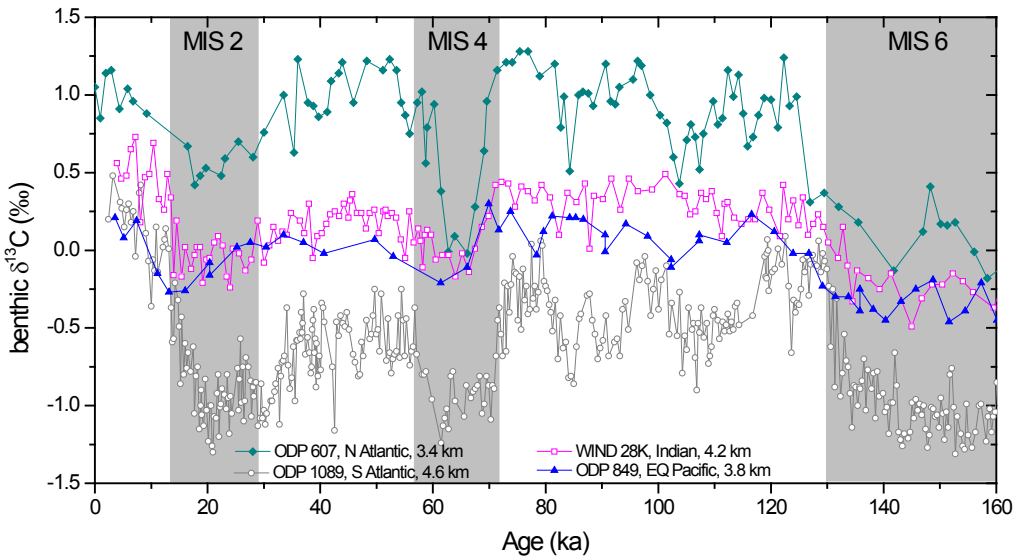


B/Ca and d11B raw data; gray symbols are replicates. Hollow symbols with dashed lines are data that may be biased due to bioturbation.

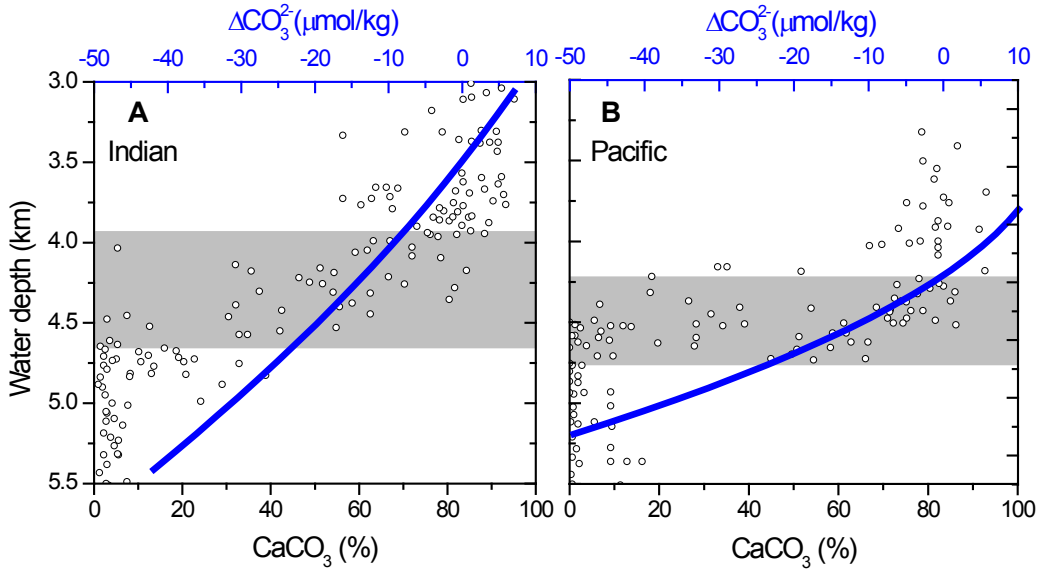
Mention that there is a pressure effect on B/Ca. so the same B/Ca indicates different CO3, d11B.


MIS2
MIS4
MIS6
VM28-122, 12°N, 79°W, 1.8 km
Caribbean Sea
A
B
C
MW91-9 GGC15, 0, 58°E, 2.3 km
W EQ Pacific
D
MW91-9 GGC48, 0, 161°E, 3.4 km
W EQ Pacific
E
F
TTNO13 PC61, 0.9°S, 140°W, 4.3 km
Central EQ Pacific
G
H
5a
5b
5c
5d
5e
I
J
[CO3 2-] (µmol/kg)
δ13C (‰)
Sea level (m)
CO2 (ppmv)
Age (ka)

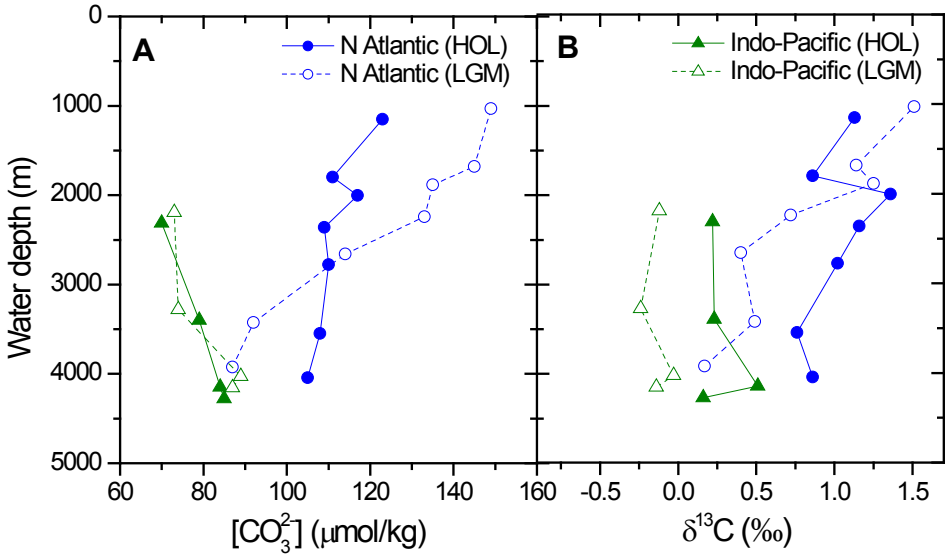
Key figure of CO3 and d13C during the last full glacial/interglacial cycle, compared with RSL and pCO2.



Points: (1) global d13C excursion at MIS4. (2) Roughly stable but lower d13C relative to Holocene d13C during MIS5.



CaCO3 is sensitive to -25 to -5 umol/kg change in DCO3.

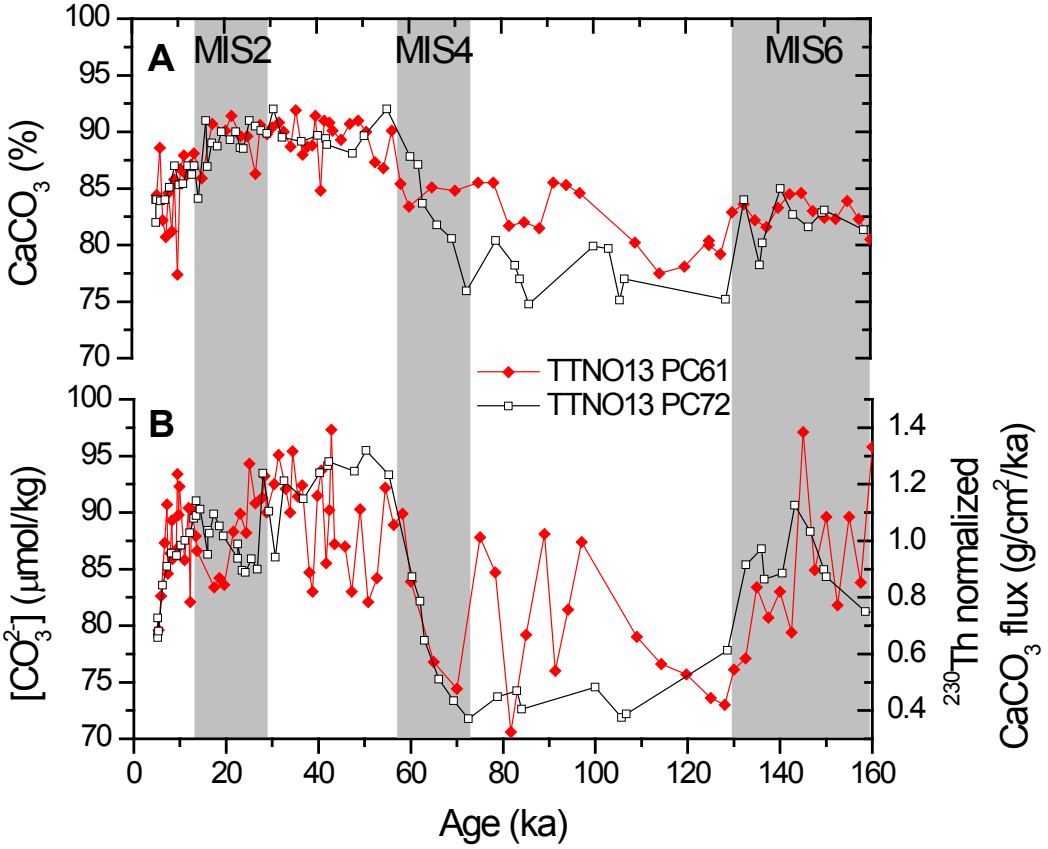


Point: Deep Atlantic experienced large decline in CO3, but the small volume of Atlantic may contribute a relatively small decrease in global CO3. Furthermore the higher CO3 at intermediate Atlantic may compensate any decrease in deep Atlantic.
Pacific witnessed a relatively small rise below about 3.5 km, in contrast to large changes in N Atlantic and large changes in benthic d13C. However the volume of Pacific is large. Thus the global mean change in CO3 between HOL and LGM may be very small.
LGM water depths are adjusted by -120 m.

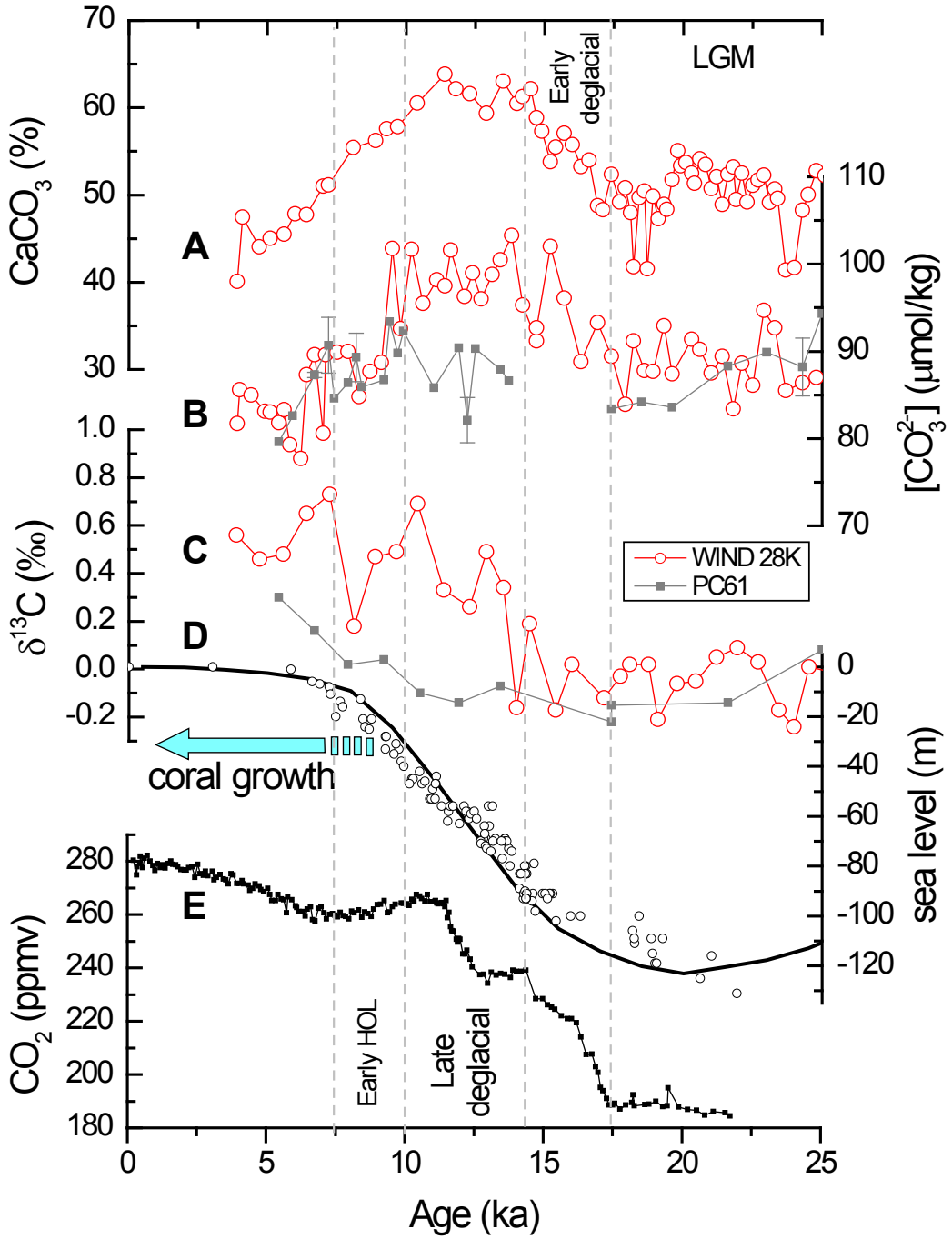
Table 1. Reconstructed deep-water [CO32-] during four time intervals for cores used in this study

Core	Location		Deep-water $[CO_3^{2-}]$ (μmol/kg)					
	(Lat., Long., water depth)	$[CO_3^{2-}]_{sat}$	Late HOL (0-5 ka)	LGM (19-23 ka)	LGM—HOL	MIS 5e (115-130 ka)	MIS 6 (135-145 ka)	MIS6—MIS5e
VM28-122	12°N, 79°W, 1800 m	86	111±4 (2)	145±5 (4)	34±6	105±7 (6)	135±15 (4)	30±17
MW91-9-GGC15	0, 58°E, 2311 m	67	70±2 (3)	73±2 (3)	3±3	66±4 (4)	73±2 (7)	7±4
MW91-9-GGC48	0, 161°E, 3400 m	83	79±2 (2)	74±2 (3)	-5±3	—	—	—
TTNO13 PC61	0.86°S, 140°W, 4276 m	98	86±4 (8)*	87±3 (3)	1±4	75±2 (4)	82±2 (4)	7±3

*: for time interval < 8 ka.



Point: CO3 largely controls seafloor CaCO3 preservation.



T1 CO3 response: