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Middle Miocene Climate–Carbon Cycle Dynamics: Keys for Understanding Future Trends on a Warmer Earth?

Supplemental Text

Benthic foraminiferal $\delta^{13}C$ measurements at Site U1443

Due to low abundance or absence of *Cibicidoides wuellerstorfi* and *Cibicidoides mundulus* within Cores U1443A-15H and U1443B-15H, *Planulina renzi* was analyzed in six samples (Samples U1443B-15H-1, 111-112 cm, U1443B-15H-1, 115-116 cm, U1443B-15H-1, 121-122 cm, U1443B-15H-1, 125-126 cm, U1443A-15H-4, 39-40 cm, U1443A-15H-4, 41-42 cm) and *Cibicidoides havanensis* was analyzed in Sample U1443B-15H-1, 137-138 cm. $\delta^{13}C$ measurements in these samples do not show systematic deviations from surrounding samples, in which *Cibicidoides wuellerstorfi* and *Cibicidoides mundulus* were analysed, and are reported without any correction for vital effects.

Osangularia culter was measured in Sample U1443B-15H-1, 113-114 cm. Comparison of *O. culter* $\delta^{13}C$ values with those of *C. wuellerstorfi* and *C. mundulus*, in samples where these taxa co-occur, shows a mean +0.17 ‰ deviation for $\delta^{13}C$ of *O. culter* in relation to *C. wuellerstorfi*/*C. mundulus* (Supplemental Table S1). We therefore, adjusted the $\delta^{13}C$ measurement of Sample U1443B-15H-1, 113-114 cm accordingly.

Supplemental Table S1: Offsets between $\delta^{13}C$ measurements of *Cibicidoides wuellerstorfi*/*Cibicidoides mundulus* and *Osangularia culter*. Differences (Δ) are calculated as: *C. wuellerstorfi*/*C. mundulus* values minus *O. culter* values.

Sample	*C. wuellerstorfi*	*C. mundulus*	*O. culter*	$\delta^{13}C$ (‰)	$\Delta\delta^{13}C$ (‰)
353-U1443B-14H-4W, 61-62 cm	5	1	0	0.88	0.069
353-U1443B-14H-4W, 61-62 cm	0	0	2	0.811	
353-U1443B-14H-4W, 69-70 cm	3	2	0	0.879	-0.009
353-U1443B-14H-4W, 69-70 cm	0	0	2	0.888	
353-U1443B-15H-3W, 66-67 cm	0	3	0	1.152	0.215
353-U1443B-15H-3W, 66-67 cm	0	0	2	0.937	
353-U1443B-16H-5W, 11-12 cm	0	3	0	0.771	0.155
353-U1443B-16H-5W, 11-12 cm	0	0	2	0.616	
353-U1443B-16H-5W, 33-34 cm	0	3	0	0.864	0.322
353-U1443B-16H-5W, 33-34 cm	0	0	2	0.542	
353-U1443B-16H-5W, 53-54 cm	0	4	0	1.004	0.167
353-U1443B-16H-5W, 53-54 cm	0	0	2	0.837	
353-U1443B-16H-5W, 55-56 cm	0	3	0	1.021	0.449
353-U1443B-16H-5W, 55-56 cm	0	0	2	0.572	
353-U1443B-16H-5W, 61-62 cm	0	3	0	0.857	0.033
353-U1443B-16H-5W, 61-62 cm	0	0	2	0.824	
				Mean deviation:	**0.175**

The following titles relate to tables and figures in other Supplemental Material files:

Supplemental Table S2: Tie points between U1337-U1338 benthic foraminiferal isotope records and ET and ET+0.3P target from Laskar et al. (2004).

Supplemental Table S3: Tie points used for correlation of $\delta^{13}C$ records from Sites 751, 1146, 1236, 1237 and U1443 to composite record from U1337-U1338. For Site 1171, we used the revised age model from Holbourn et al. (2007).

Supplemental Figure S1: Revised sedimentation rates for Sites 1146, 1236, 1237, U1337, U1338 and U1443.

Supplemental Figures S2a and S2b: U1337 and U1338 benthic foraminiferal $\delta^{18}O$ records (3 point moving average of linear interpolated data in 1 kyr resolution) tuned to ET+0.3P with tie points (red vertical lines). Gray lines indicate additional correlation points, which were not used to derive age model. Red arrows mark tie between U1337 and U1338 records. Gray curve represents 405 kyr filtered (Gaussian filter centered at frequency of 0.00247 with a bandwidth of 0.0005) eccentricity from Laskar et al. (2004) with numbering scheme of 405 kyr cycles following Wade and Pälike (2004). ET+0.3P maxima and corresponding $\delta^{18}O$ minima are coded with the first three digits of their ages in the La04 solution (Laskar et al., 2004); letters a, b, c mark prominent precessional peaks (maxima in Southern Hemisphere insolation).

Supplemental Figures S3a and S3b: (a) Evolution of benthic foraminiferal $\delta^{13}C$ gradient between Pacific Ocean Sites 1146, 1236, 1237 and U1338 and Southern Ocean Site 1171. **(b)** Evolution of benthic foraminiferal $\delta^{13}C$ gradient between Pacific Ocean Sites 1146, 1236, 1237 and U1338 and Indian Ocean Site U1443. Site 1146: 2091 m water depth; Site 1236: 1323 m water depth; Site 1237: 3212 m water depth; Site U1338: 4463 m water depth; Site U1443: 2925 m water depth.

Supplemental Figure S4: Comparison of 19 kyr Gaussian filtered (frequency = 0.053; bandwidth = 0.01) U1337-U1338 $\delta^{18}O$ and $\delta^{13}C$ isotope composite record between 14.7-16.2 Ma with orbital precession parameter from Laskar et al. (2004).

References

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