

**Carbon isotope offsets between benthic foraminifer species of the genus  
*Cibicides (Cibicoides)* in the glacial sub-Antarctic Atlantic**

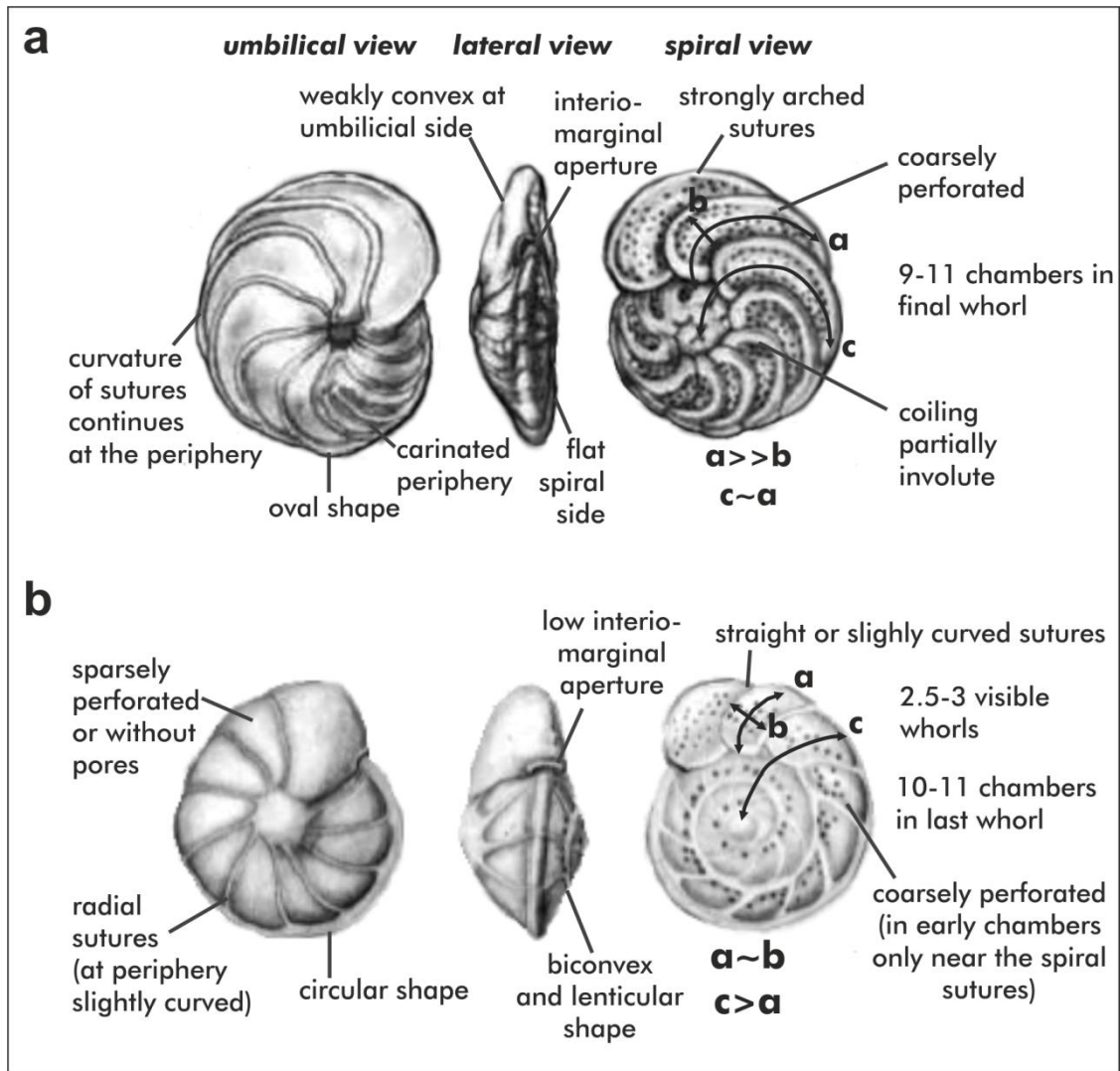
Julia Gottschalk<sup>1,2\*</sup>, Natalia Vázquez Riveiros<sup>1,3</sup>, Claire Waelbroeck<sup>3</sup>, Luke C. Skinner<sup>1</sup>,  
Elisabeth Michel<sup>3</sup>, Jean-Claude Duplessy<sup>3</sup>, David Hodell<sup>1</sup>, Andreas Mackensen<sup>4</sup>

<sup>1</sup>Godwin Laboratory for Palaeoclimate Research, Department of Earth Sciences, University of Cambridge, Cambridge CB2 3EQ, UK; <sup>2</sup>Institute of Geological Sciences and Oeschger Center for Climate Change Research, University of Bern, Baltzerstr. 1-3, 3012 Bern, Switzerland; <sup>3</sup>Laboratoire des Sciences du Climat et de l'Environnement, LSCE/IPSL, CNRS-CEA-UVSQ, Université de Paris-Saclay, 91198 Gif-sur-Yvette, France; <sup>4</sup>Alfred Wegener Institute for Polar and Marine Research, 27568 Bremerhaven, Germany

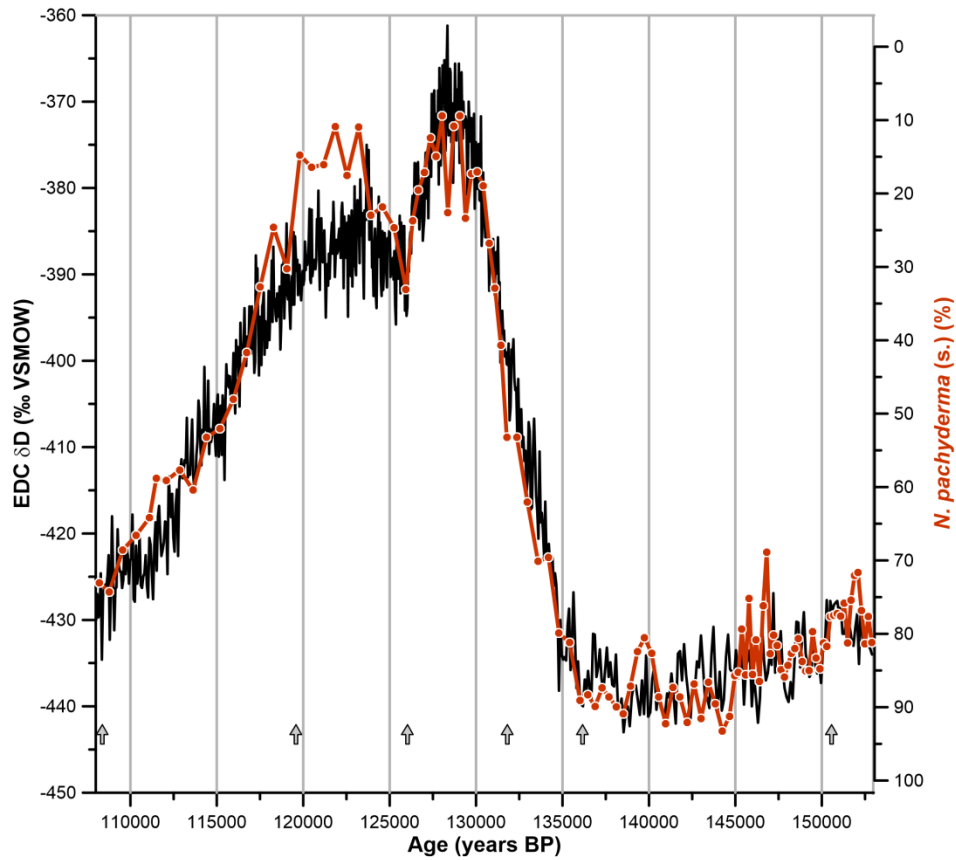
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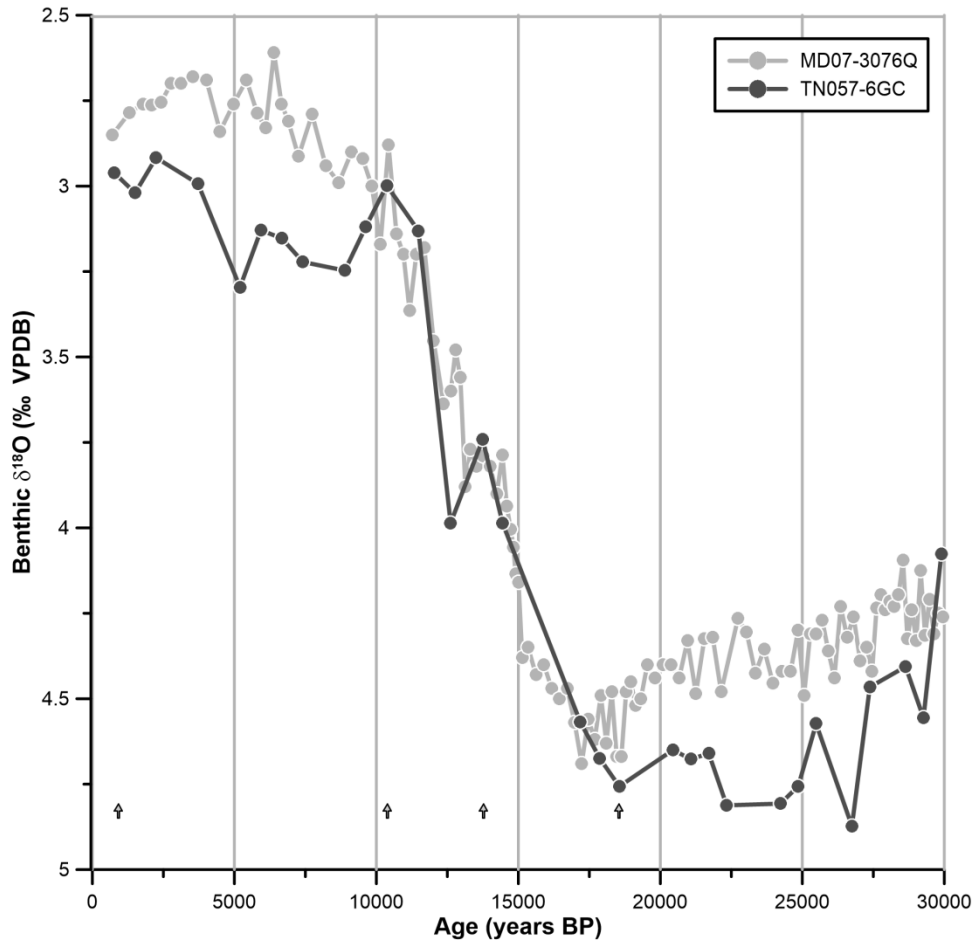
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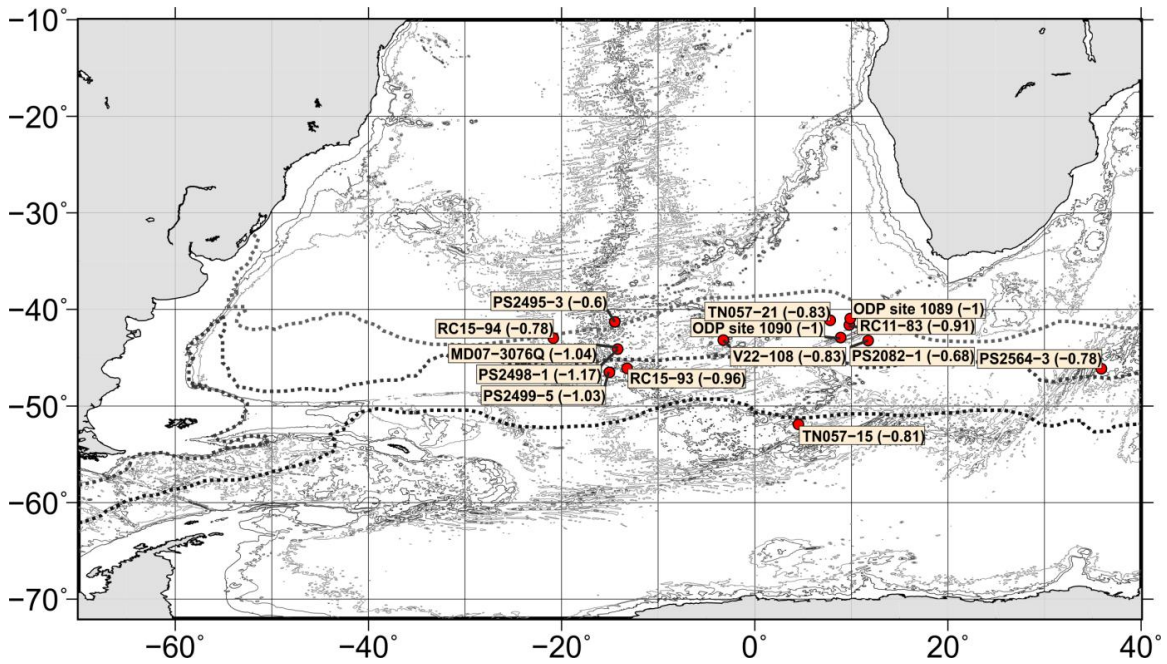
**Figure S1.** Major characteristics of the sensu stricto morphotypes of a) *C. wuellerstorfi* (top) and b) *C. kullenbergi* (bottom); adapted from *Loeblich and Tappan*, [1988].



**Figure S2.** Age model of the interval spanning Marine Isotope Stage 5 and 6 (including termination II) of sediment core MD07-3077; age-depth markers (arrows) have been obtained by a stratigraphic alignment of abundance variations of the cold-water planktonic foraminifer *Neogloboquadrina pachyderma* (s.) (orange) with Antarctic temperature variations represented by the  $\delta D$  variability of the Antarctic EDC ice core (black) [Jouzel *et al.*, 2007] and are listed in Supplementary Table S1.



**Figure S3.** Age model of sediment core TN057-6GC based on a stratigraphic alignment of benthic foraminifer (*C. kullenbergi*)  $\delta^{18}\text{O}$  variations in TN057-6GC (dark grey) and MD07-3076Q (light grey); tie points are indicated by arrows and are listed in Supplementary Table S2.



**Figure S4.** Map of the South Atlantic showing core sites that are characterized by low ( $<-0.6$  ‰ VPDB) benthic  $\delta^{13}\text{C}$  during the last glacial maximum (values are given in parentheses). Stippled lines indicate the position of major fronts (from south to north: Polar Front, sub-Antarctic Front, sub-Tropical Front). Core locations and references are given in Supplementary Table S4.

Depth MD07-3077 (cm)	Corrected depth MD07-3077 (cm)	Age AICC2012 (years BP)	Approach	Reference
MIS 6 - 5				
1932.0	1932.0	108391	%Nps aligned to EDC $\delta$ D	this study
2030.6	1989.6	119571	%Nps aligned to EDC $\delta$ D	this study
2068.5	2027.5	126030	%Nps aligned to EDC $\delta$ D	this study
2136.3	2095.3	131800	%Nps aligned to EDC $\delta$ D	this study
2164.9	2123.9	136155	%Nps aligned to EDC $\delta$ D	this study
2305.8	2264.8	150577	%Nps aligned to EDC $\delta$ D	this study
MIS 12 - 11				
4263.0	4222.0	371040	%Nps aligned to EDC $\delta$ D	[Vázquez Riveiros <i>et al.</i> , 2010]
4304.0	4263.0	375713	%Nps aligned to EDC $\delta$ D	[Vázquez Riveiros <i>et al.</i> , 2010]
4392.0	4351.0	389532	%Nps aligned to EDC $\delta$ D	[Vázquez Riveiros <i>et al.</i> , 2010]
4572.0	4531.0	404446	%Nps aligned to EDC $\delta$ D	[Vázquez Riveiros <i>et al.</i> , 2010]
4719.0	4678.0	423045	%Nps aligned to EDC $\delta$ D	[Vázquez Riveiros <i>et al.</i> , 2010]
4776.0	4735.0	429131	%Nps aligned to EDC $\delta$ D	[Vázquez Riveiros <i>et al.</i> , 2010]
4807.0	4766.0	434121	%Nps aligned to EDC $\delta$ D	[Vázquez Riveiros <i>et al.</i> , 2010]
4845.0	4804.0	448727	%Nps aligned to EDC $\delta$ D	[Vázquez Riveiros <i>et al.</i> , 2010]

**Table S1.** Age-depth markers for sediment core MD07-3077 obtained via a stratigraphic alignment of abundance variations of the cold-water planktonic foraminifer *N. pachyderma* (s.) (%Nps) with Antarctic temperature variations (identical to the approach adopted for the interval spanning MIS 12 to 11 of Vázquez Riveiros *et al.*, [2010]).

Depth (cm)	Age (yrs BP)	Approach	Reference
5.4	918	Benthic $\delta^{18}\text{O}$ correlation	this study
31.1	10393	Benthic $\delta^{18}\text{O}$ correlation	this study
37.1	13772	Benthic $\delta^{18}\text{O}$ correlation	this study
51.0	18547	Benthic $\delta^{18}\text{O}$ correlation	this study
115.1	38746	Benthic $\delta^{18}\text{O}$ correlation	this study

**Table S2.** Age-depth markers for Cape Basin sediment core TN057-6GC obtained via a stratigraphic alignment of benthic foraminifer (*C. kullenbergi*)  $\delta^{18}\text{O}$  in TN057-6GC and MD07-3076Q.

Core	Longitude	Latitude	Depth (m)	Region	$\delta^{13}\text{C}$ data reference	Age model reference
W8709A-13PC	-125.80	42.10	2712	NE Pacific	[Lund and Mix, 1998]	[Lund and Mix, 1998]
MD02-2489	-148.92	54.40	3640	NE Pacific	[Gebhardt et al., 2008]	[Gebhardt et al., 2008]
MD07-3076Q	-14.20	-44.10	3777	Sub-Antarctic Atlantic	[Waelbroeck et al., 2011; this study]	[Gottschalk et al., 2015]
MD07-3077	-14.23	-44.15	3776	Sub-Antarctic Atlantic	[Vázquez Riveiros et al., 2010; this study]	[Vázquez Riveiros et al., 2010; this study]
TN057-21	7.80	-41.10	4981	SE Atlantic, Cape Basin	[Ninnemann et al., 1999]	[Barker and Diz, 2014]
ODP site 1090	8.90	-42.91	3702	SE Atlantic, Cape Basin	[Hodell et al., 2003]	[Hodell et al., 2003]
TN057-6GC	8.97	-42.87	3750	SE Atlantic, Cape Basin	<i>this study</i>	<i>this study</i>
MD99-2334K	-10.20	37.80	3166	NE Atlantic, Iberian Margin	[Skinner et al., 2007]	[Skinner et al., 2007]
MD02-2588	25.83	-41.33	2907	SE Atlantic, Agulhas Plateau	[Ziegler et al., 2013]	[Ziegler et al., 2013]
SK129-CR2	76.00	3.00	3800	Eq. Indian Ocean	[Piotrowski et al., 2009]	[Piotrowski et al., 2009]
GeoB9526-5	-18.06	12.44	3223	Subtropical Atlantic Ocean	[Zarriess and Mackensen, 2011]	[Zarriess and Mackensen, 2011]
KNR159-5-GGC125	-45.08	-29.53	3589	SW Atlantic, Brazil margin	[Hoffman and Lund, 2012]	[Hoffman and Lund, 2012]
KNR159-5-GGC22	-43.58	-29.78	3924	SW Atlantic, Brazil margin	[Hoffman and Lund, 2012]	[Hoffman and Lund, 2012]
KNR159-5-GGC54	-43.33	-29.53	4003	SW Atlantic, Brazil margin	[Hoffman and Lund, 2012]	[Hoffman and Lund, 2012]

**Table S3.** Details of sediment cores analyzed in this study.



Core	Latitude	Longitude	Water depth (m)	Glacial $\delta^{13}\text{C}$ (‰ VPDB)	Species	Reference
PS2495-3	-41.28	-14.49	3134	-0.6	<i>Cibicoides</i> spp.	[Mackensen et al., 2001]
PS2082-1	-43.22	11.74	4610	-0.68	<i>Cibicoides</i> spp.	[Mackensen et al., 1994]
RC15-94	-42.98	-20.85	3762	-0.78	<i>Cibicoides</i> spp.	[Ninnemann and Charles, 2002]
PS2564-3	-46.14	35.9	3034	-0.78	<i>Cibicoides</i> spp.	[Mackensen et al., 2001]
TN057-15	-51.9	4.52	3744	-0.81	<i>Cibicoides</i> spp.	[Ninnemann and Charles, 2002]
V22-108	-43.18	-3.25	4171	-0.83	<i>Cibicoides</i> spp.	[Charles and Fairbanks, 1990]
TN057-21	-41.13	7.82	4981	-0.83	<i>Cibicoides</i> spp.	[Ninnemann and Charles, 2002]
RC11-83	-41.6	9.8	4718	-0.91	<i>Cibicoides</i> spp.	[Charles et al., 1996]
RC15-93	-46.1	-13.22	2714	-0.96	<i>Cibicoides</i> spp.	[Charles et al., 1991]
ODP site 1089	-40.94	9.89	4621	-1	<i>Cibicoides</i> spp.	[Hodell et al., 2003]
ODP site 1090	-42.91	8.9	3702	-1	<i>C. kullenbergi</i>	[Hodell et al., 2003]
PS2499-5	-46.51	-15.33	3175	-1.03	<i>Cibicoides</i> spp.	[Mackensen et al., 2001]
MD07-3076Q	-44.1	-14.2	3770	-1.04	<i>C. kullenbergi</i>	[Waelbroeck et al., 2011]
PS2498-1	-44.15	-14.49	3783	-1.17	<i>Cibicoides</i> spp.	[Mackensen et al., 2001]

**Table S4.** Locations and details of core sites that are characterized by very low benthic  $\delta^{13}\text{C}$  during the last peak glacial (Supplementary Fig. S4).