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On new developments in accelerator mass spectrometry and how they promote our understanding of global carbon cycle dynamics during the last deglaciation

Julia Gottschalk[1,2], Robert F. Anderson[1], David A. Hodell[3], Alfredo Martinez-Garcia[4], Alain Mazaud[5], Elisabeth Michel[5], Luke C. Skinner[3], Anja Studer[4], Sönke Szidat[6], Lena M. Thöle[2], and Samuel L. Jaccard[2]

[1]Columbia University of the City of New York, Lamont-Doherty-Earth Observatory, United States of America (jgottsch@ldeo.columbia.edu)

[2]Institute of Geological Sciences and Oeschger Center for Climate Change Research, University of Bern, Bern, Switzerland

[3]Godwin Laboratory for Palaeoclimate Research, Earth Sciences Department, University of Cambridge, Cambridge, UK

[4]Max Planck Institute for Chemistry, Climate Geochemistry Department, Mainz, Germany

[5]Laboratoire des Sciences du Climat et de l'Environnement, LSCE/IPSL, Université de Paris-Saclay, Gif, France

[6]Department of Chemistry and Biochemistry and Oeschger Centre for Climate Change Research, University of Bern, Bern, Switzerland

Ocean-atmosphere ^{14}C disequilibria of the surface and deep ocean reflect past changes in the efficiency of ocean-atmosphere CO_2 exchange and ocean mixing, while it may also be related to variations in global-ocean respired carbon content. A full assessment of the oceanic mechanisms controlling deglacial changes in atmospheric CO_2 is complicated by a lack of high-resolution ^{14}C ventilation age estimates from the Southern Ocean and other key regions due to low foraminiferal abundances in marine sediments in those areas. Here we present high-resolution deglacial ^{14}C ventilation age records from key sites in the Atlantic and Indian Sector of the Southern Ocean obtained by radiocarbon analyses of small benthic and planktic foraminiferal samples (<1 mg $CaCO_3$) with the UniBe Mini-Carbon Dating System (MICADAS). Our analyses specifically circumvent foraminiferal sample size requirements related to “conventional” accelerator mass spectrometer analyses involving sample graphitization (>1 mg $CaCO_3$ in most laboratories). Complementing multi-proxy analyses of sea surface temperature (SST) changes at these sites allow the construction of a radiocarbon-independent age model through a stratigraphic alignment of SST changes to Antarctic (ice core) temperature variations. We demonstrate the value of refining the age models of our study cores on the basis of high-resolution sedimentary U- and Th flux estimates, which allows an improved quantification of surface ocean reservoir age variations in the past. The resulting deep-ocean ventilation age changes are compared against qualitative and quantitative indicators of bottom water $[O_2]$ variations, in order to assess the role of Southern Ocean overturning dynamics in respired carbon changes at our study sites. We discuss the implications of our new radiocarbon- and bottom water $[O_2]$ data for the ocean’s role in atmospheric CO_2 changes throughout the last deglaciation, and evaluate down-stream effects of southern high-latitude surface ocean reservoir age anomalies.