Solving the planktic foraminifera carbon isotope conundrum for paleoceanographic applications

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It is generally assumed that the $\delta^{13}C$ of surface-dwelling species such as *Globigerinoides ruber* or *Trilobatus sacculifer* track the $\delta^{13}C$ of dissolved inorganic carbon because $\delta^{13}C_{DIC}$ is incorporated into foraminifera shells with a 1:1 relationship (Spero, 1992). This would imply that downcore $\delta^{13}C$ records from species that inhabit the same mixed layer environment and seasonal distribution should parallel each other with offsets attributed to differences in vital effects. However, this is not what is observed when records from different species are compared. My colleagues and I have argued that differences in the response of species such as *G. ruber* and *T. sacculifer* to $[CO_3^{2-}]$ change through time could explain such observations (Spero et al., 1997). Here, I apply a simple model, first proposed by Spero et al., (1999), to simultaneously deconvolve changes in $\delta^{13}C_{DIC}$ and $[CO_3^{2-}]$ from Late Quaternary *G. ruber* and *T. sacculifer* $\delta^{13}C$ records. Combined carbon isotope records from Caribbean core, V28-122, demonstrate that glacial $[CO_3^{2-}]$ was ~100 μmol/kg higher during the last glacial maximum relative to core top pre-anthropogenic $[CO_3^{2-}]$. More important, the $\delta^{13}C_{DIC}$ reconstruction we obtain for the LGM indicates a +0.5‰ positive shift in $\delta^{13}C_{DIC}$ rather than the decrease in $\delta^{13}C_{DIC}$ suggested in the original records. Such a $\delta^{13}C_{DIC}$ increase is consistent with the effect of air:sea equilibration at cooler LGM surface temperatures. A surface deglacial $\delta^{13}C_{DIC}$ decrease and recovery is now seen which tracks changes in atmospheric $\delta^{13}C$ from ice cores. These results suggest we can now directly deconvolve surface $\delta^{13}C_{DIC}$ and $[CO_3^{2-}]$ from paired species mixed layer $\delta^{13}C$ records.