Supplementary Material for: Timing of the descent into the last ice age determined by the bipolar seesaw

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S1. Consistent age models for cores from the deep Cape Basin

Our approach for developing an age model for TNO57-21 follows previous studies that first highlighted a link between Greenland climate variability (if viewed as a surrogate for AMOC variability) and deep water mass mixing in the Cape Basin [*Charles and Fairbanks*, 1992; *Charles et al.*, 1996; *Ninnemann et al.*, 1999; *Piotrowski et al.*, 2005]. We can therefore provide a crude test of our age model by assessing its implications for other deep water proxies from three relatively proximal cores recovered from the deep Cape Basin (TNO57-21, RC11-83 and ODP 1089). In Figure S1 we show records of bulk sediment leachate ε_{Nd} from TNO57-21 and RC11-83 [*Piotrowski et al.*, 2005] and benthic foraminiferal $\delta^{13}C$ from all three Cape Basin cores (tied to our new age scale for TNO57-21 by their records of %$CaCO_3$) [*Charles et al.*, 1996; *Ninnemann et al.*, 1999; *Hodell et al.*, 2001; *Sachs and Anderson*, 2003]. We also show the record of benthic $\delta^{13}C$ from Iberian Margin core MD95-2042, which has been tied to the Greenland temperature record via its record of planktonic foraminiferal $\delta^{18}O$ following Shackleton *et al.* [2000]. All of these records have previously been interpreted (at least in part) to reflect variations in water mass mixing between northern and southern sources of deep water within the Atlantic basin. Our revised age model (as applied to the three Cape Basin cores) is reasonably consistent with this interpretation.

S2. Planktonic faunal assemblages and dissolution

We are confident that the assemblage groups employed here (warm, polar and cold) are not adversely affected by dissolution and that they essentially represent the surface ocean conditions in which they grew. For example, because the warm species generally attain their highest relative abundance during intervals of dissolution (Fig. S2), it could be argued that this is an artefact; perhaps dissolution and fragmentation have concentrated the warm species in preference to other

species. However, the warm species group is comprised of four species that are quite distinct in their susceptibility to dissolution and fragmentation; *G. ruber* and *O. universa* are ranked 1st and 2nd (out of 20) respectively in Berger's [1970] ranking of susceptibility (suggesting that dissolution should cause a *decrease* in the relative abundance of these species but the converse is observed) while *G. truncatulinoides* and *G. hirsuta* are ranked 12th and 13th respectively. And yet all four species show relatively high values during HS1 and variations in *O. universa* are similar to those of *G. hirsuta* throughout the whole record. Furthermore, if dissolution was responsible for concentrating the warm species we should expect a consistent relationship between % warm and preservation and yet none of the warm species peak during HS5a, C19 or C20, when dissolution was intense. Our conclusion is therefore that warm species increased in relation to other species as a function of surface conditions, rather than in response to selective preservation. The polar species group (Fig. S3) again comprises two species with quite different susceptibilities to dissolution; *T. Quinqueloba* and *N. pachyderma* (s) rank 9th and 17th in Berger's [1970] index. And yet both species show similar variations in their relative abundances. Furthermore there is not a consistent relationship between either species' relative abundance and the state of carbonate preservation.

Supplementary Figure Annotations

Figure S1. Applying our tuned age model to other Cape Basin cores via their records of %$CaCO_3$ (G). (A) Preservation in TNO57-21. (B) Bulk sediment ε_{Nd} from TNO57-21 and RC11-83 [*Piotrowski et al.*, 2005]. (C-E) Benthic δ^{13}C for the Cape Basin cores [*Charles et al.*, 1996; *Ninnemann et al.*, 1999; *Hodell et al.*, 2001; *Sachs and Anderson*, 2003]. (F) Benthic δ^{13}C from Iberian Margin core MD95-2042 [*Shackleton et al.*, 2000].

Figure S2: Warm planktonic species. The relative abundance records of warm species (= *G. truncatulinoides* (dextral) + *G. ruber* + *G. hirsuta* + *O. universa*) share common features even though they have very different susceptibilities to dissolution. Furthermore they do not show a consistent relationship with shell fragmentation.

Figure S3: Polar planktonic species. Similar to the previous figure, the relative abundance of polar species (= *N. pachyderma* (sinistral) + *T. quinqueloba*) do not show a not consistent relationship with preservation. Furthermore, each of these species has quite a different susceptibility to the effects of dissolution [*Berger*, 1970]

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