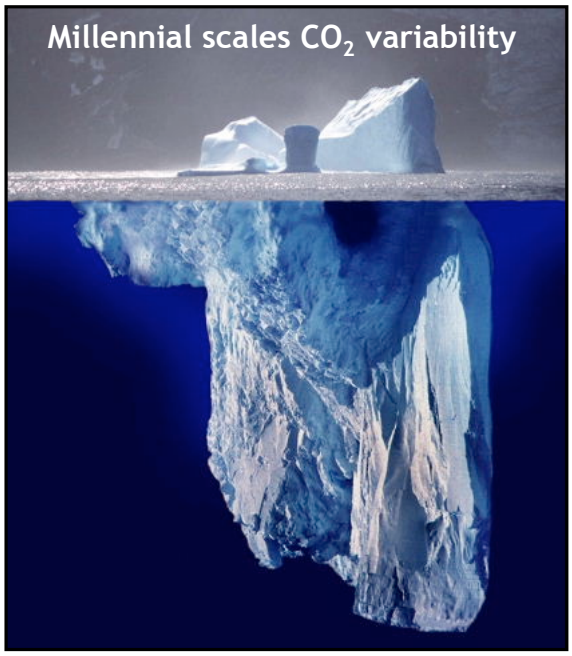
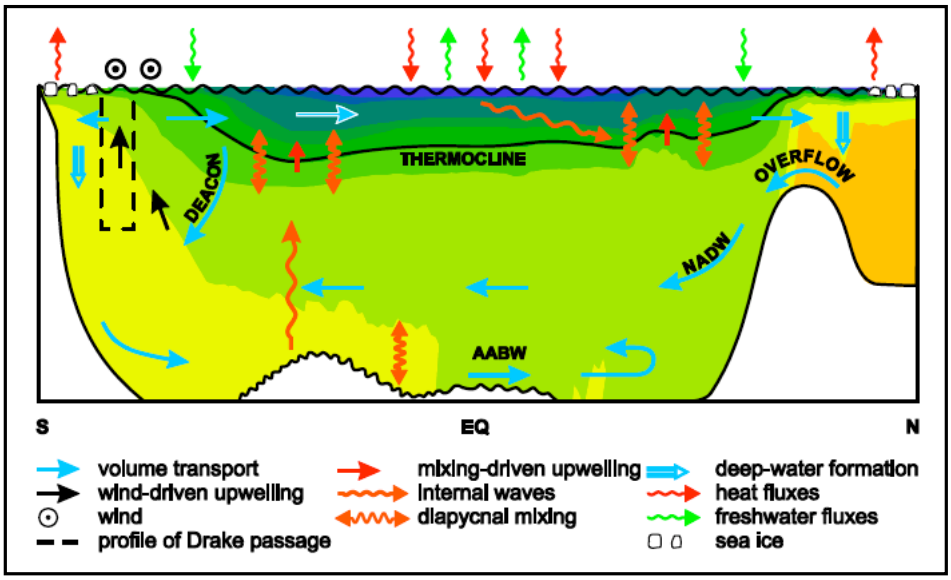


Outline

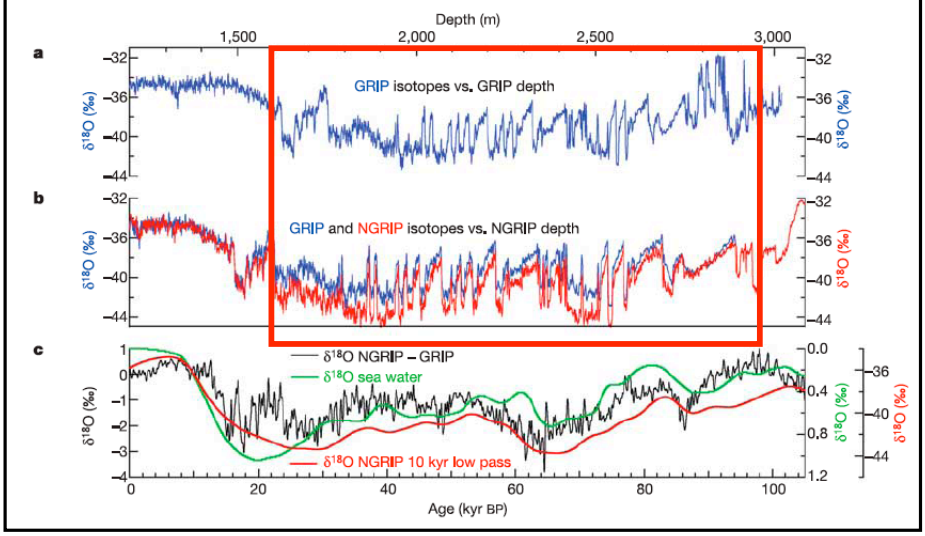
(1) Dansgaard-Oeschger (D/O) & Heinrich events

(2) last glacial termination

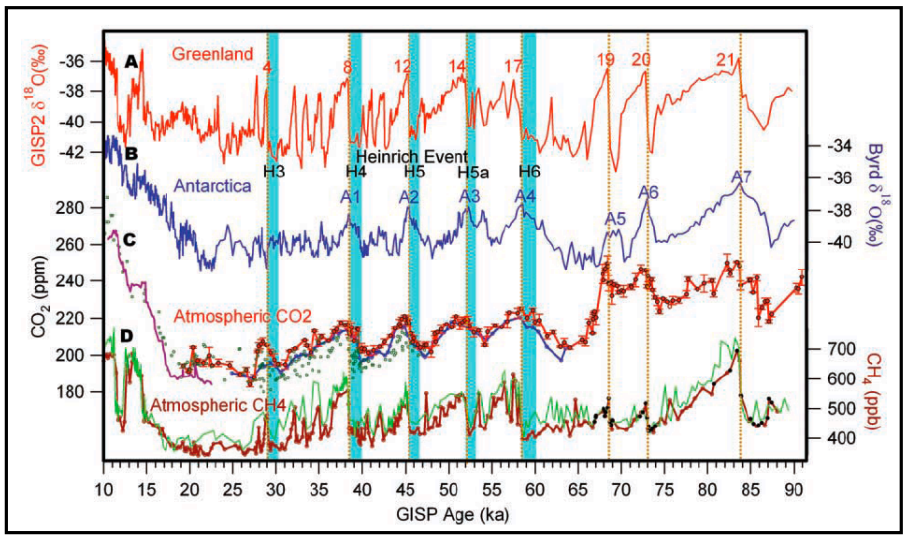
(3) sea-level change



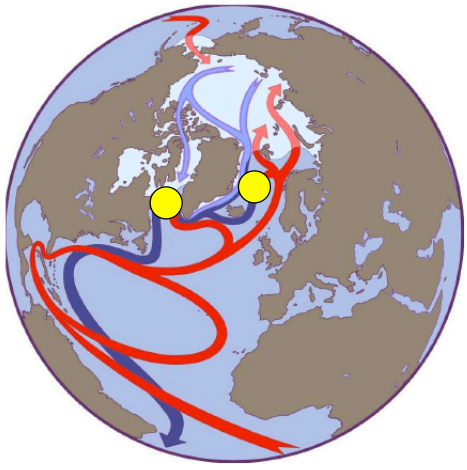
Kuhlbrodt et al., 07



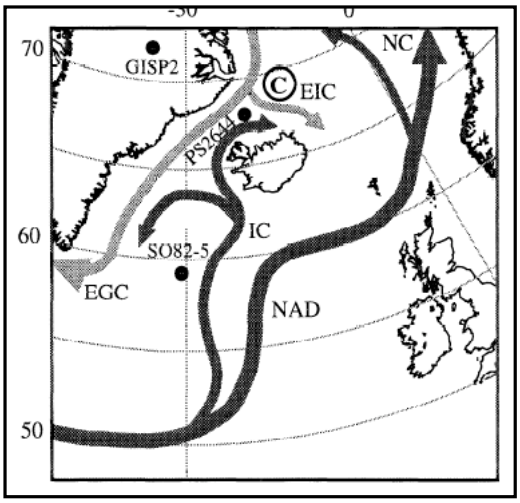
NGICP, 06



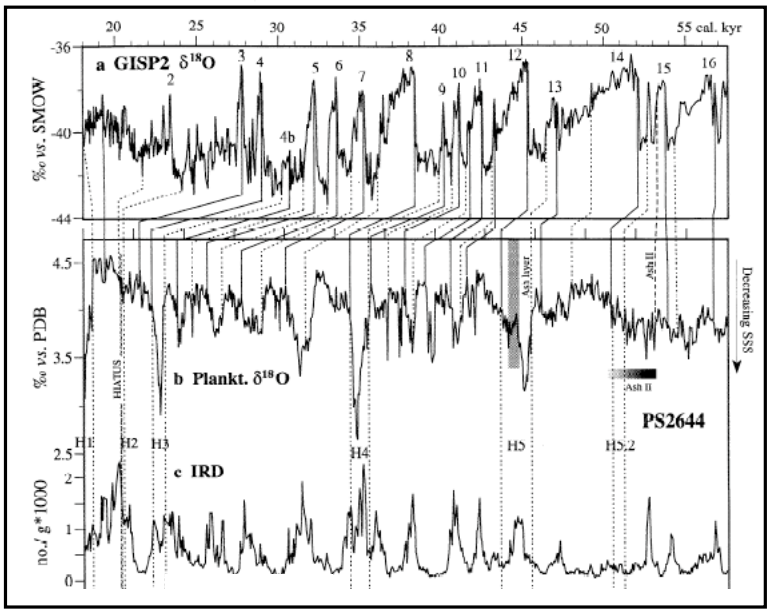
Ahn & Brook, 08



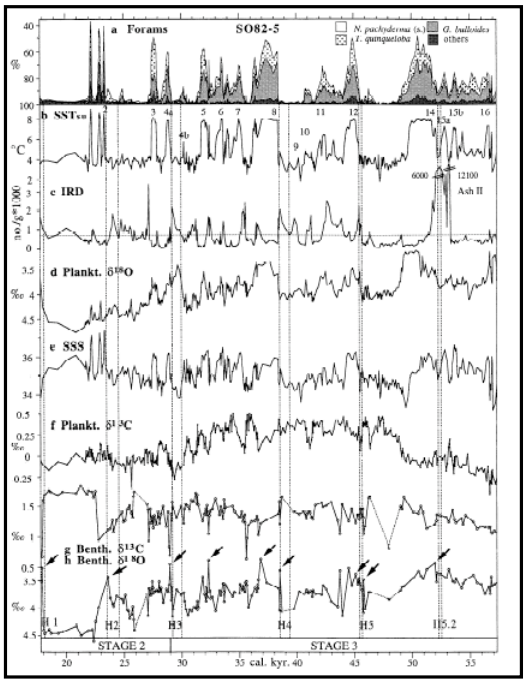
Circulation of the northern Atlantic and Arctic oceans. This simplified cartoon shows surface currents in red and North Atlantic Deep Water (NADW) in blue. The winter sea ice cover (white) is held back in the Atlantic sector by the warm North Atlantic Current.



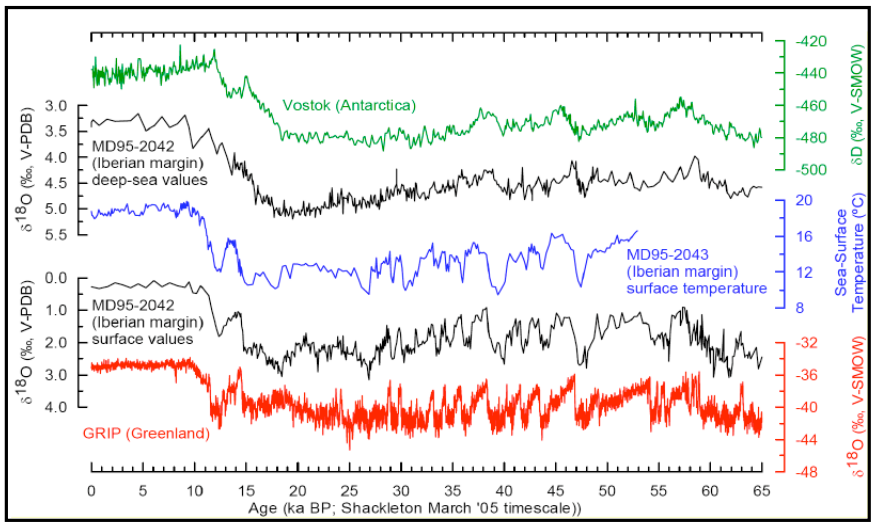
van Kreveld et al., 00

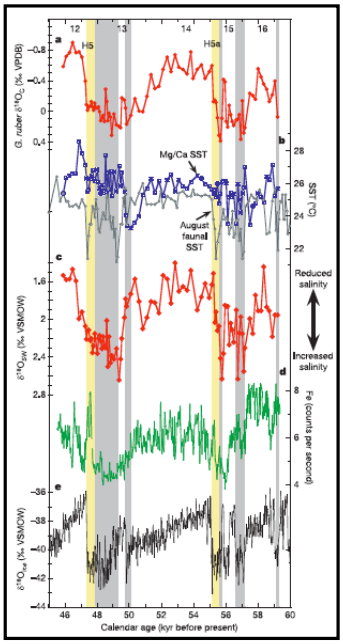


van Kreveld et al., 00

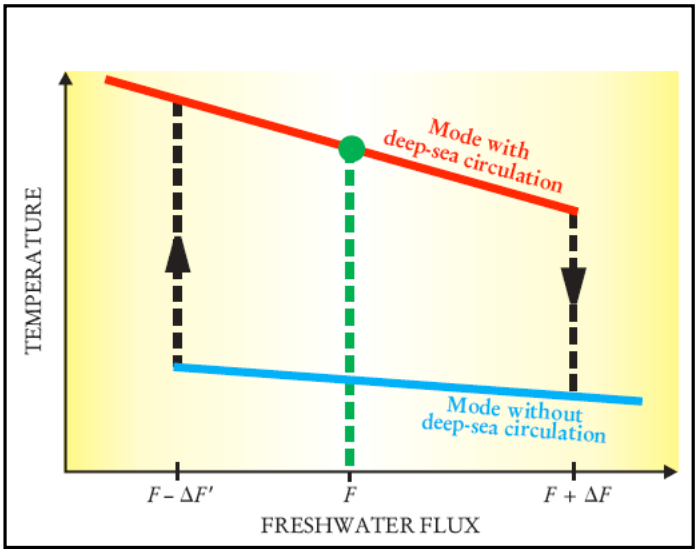


van Kreveld et al., 00

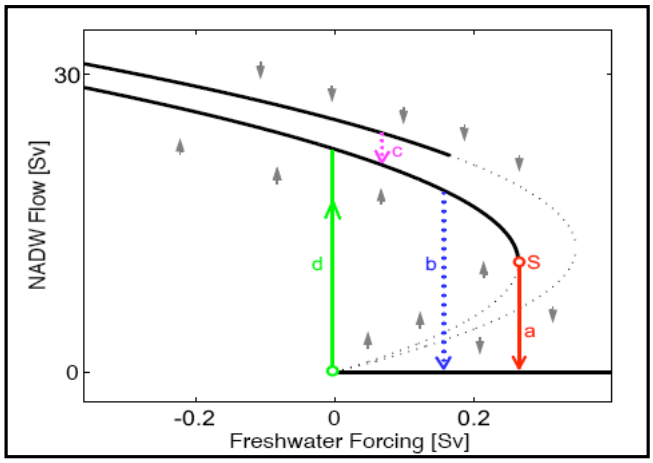




Schmidt et al., 06

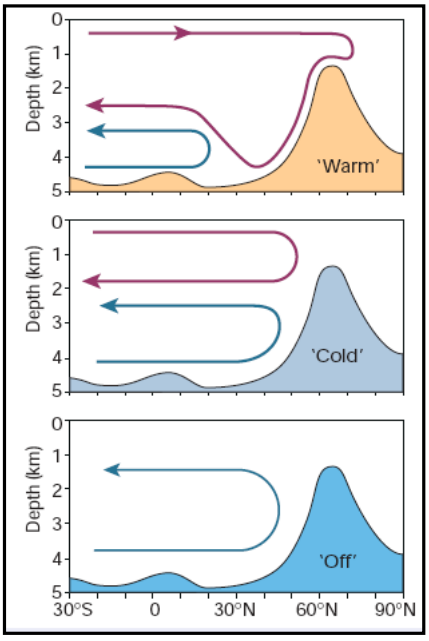


Rahmstorf, 01

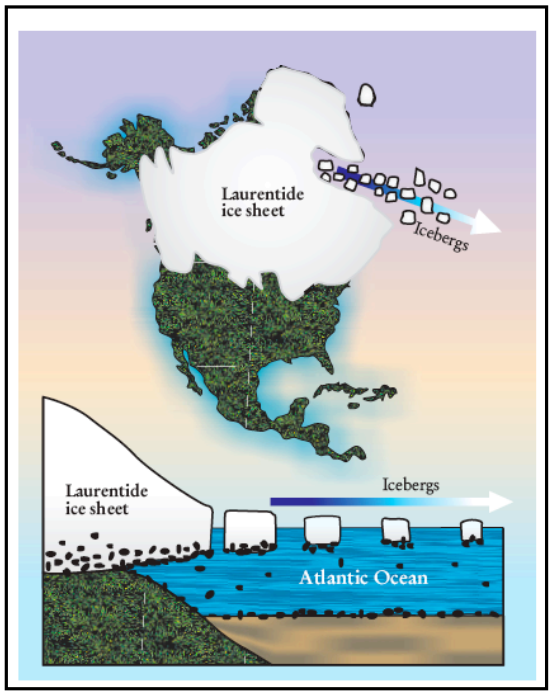


Rahmstorf, 06

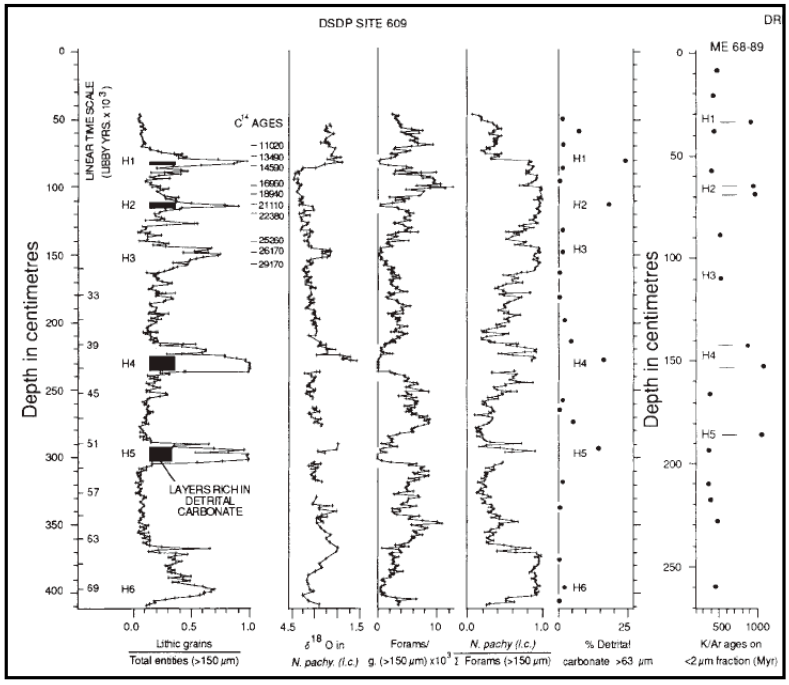
Schematic stability diagram for the Atlantic THC, with solid black lines indicating stable equilibrium states and dotted black lines unstable states. Transitions are indicated by arrows: (a) advective spindown, (b) convective shutdown, (c) transition between different convection patterns, and (d) restart of convection. "S" marks the Stommel bifurcation beyond which no NADW formation can be sustained.



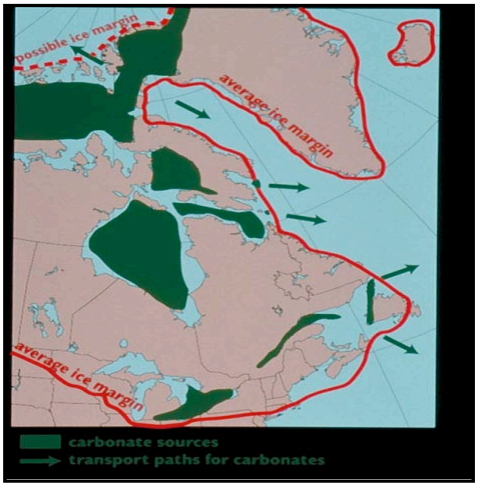
Rahmstorf, 02

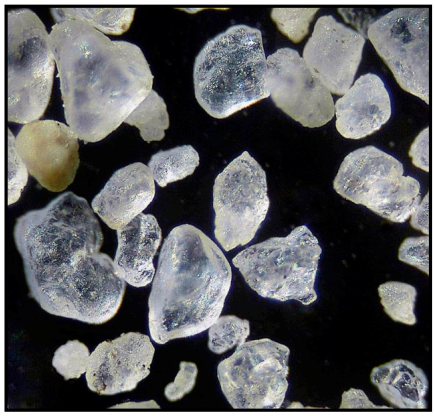


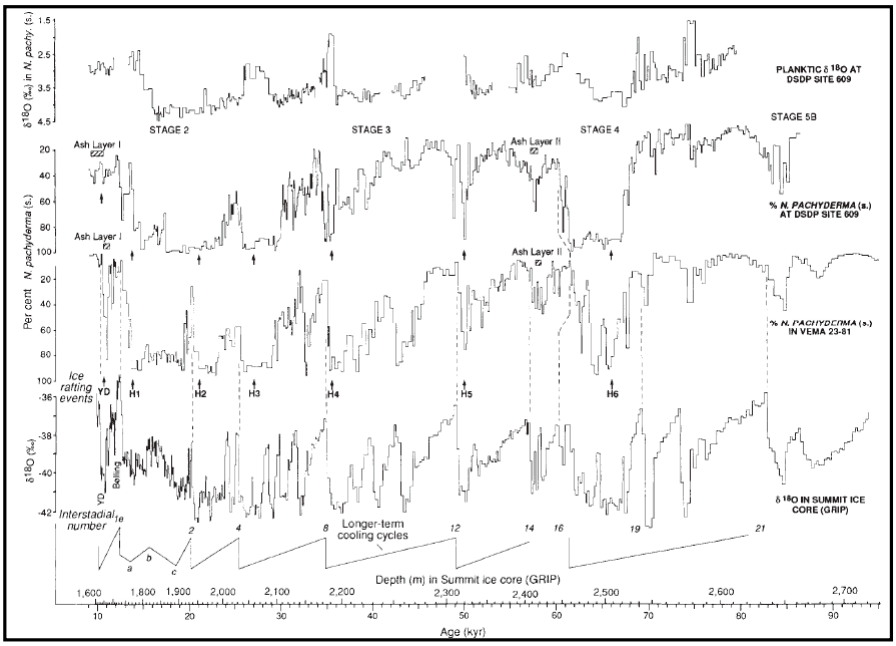
Bard, 02



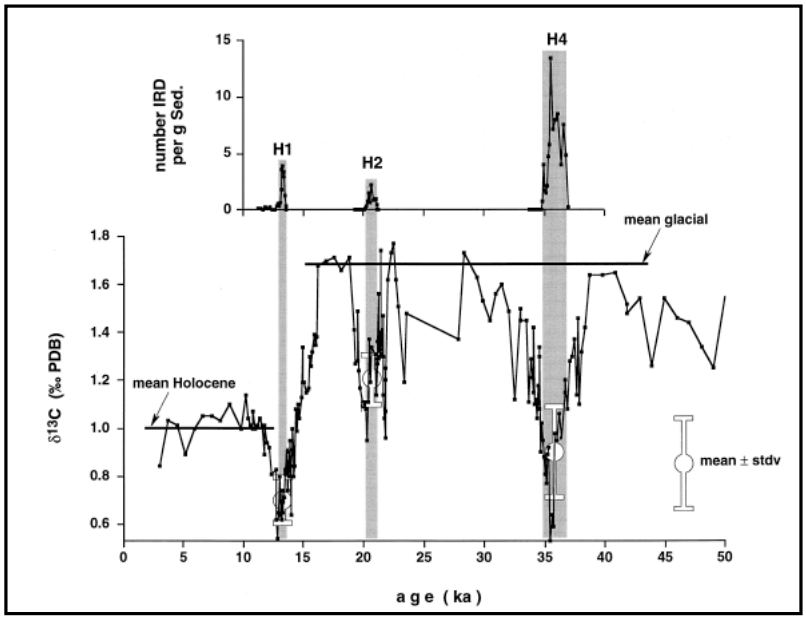
Bond et al., 92


possible ice margin
average ice margin
average ice margin
carbonate sources
transport paths for carbonates

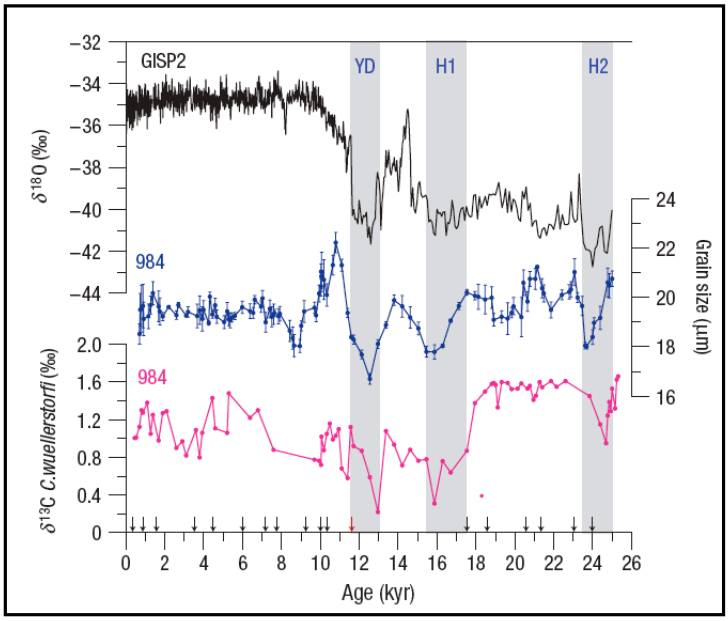



PLANKTIC δ18O AT DSDP SITE 609
STAGE 2
STAGE 3
STAGE 4
STAGE 5B
Ash Layer I
Ash Layer II
% N. PACHYDERMA (s.) AT DSDP SITE 609
% N. PACHYDERMA (s.) IN VEMA 23-81
δ18O IN SUMMIT ICE CORE (GRIP)
Ice rafting events
YD
H1
H2
H3
H4
H5
H6
Bølling
Interstadial number
Longer-term cooling cycles
Depth (m) in Summit ice core (GRIP)
Age (kyr)

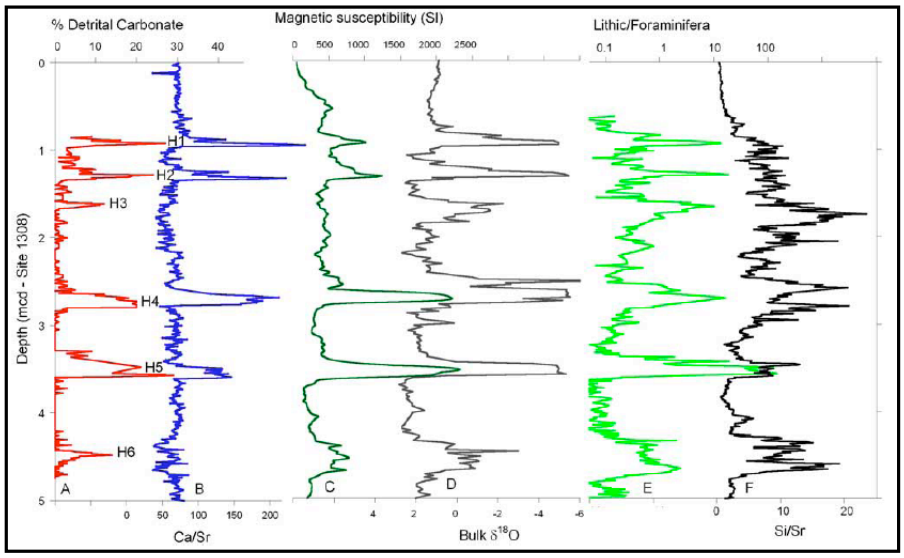
Bond et al., 93



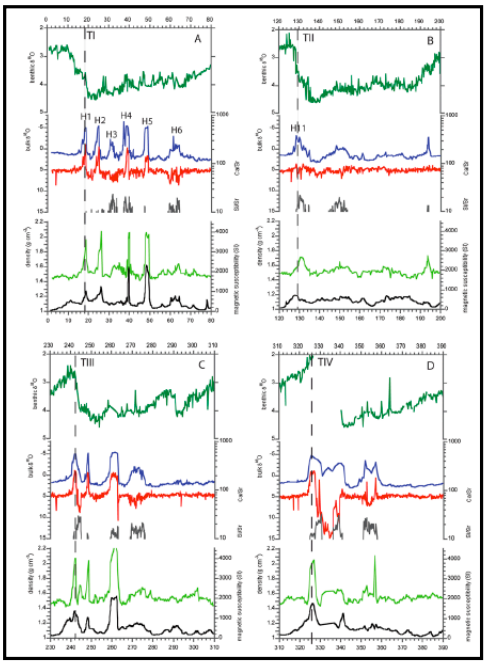
Baas et al., 98



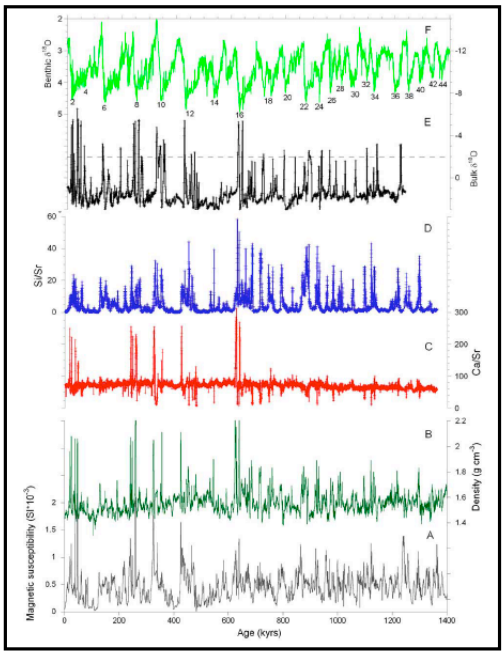
Praetorious et al., 08



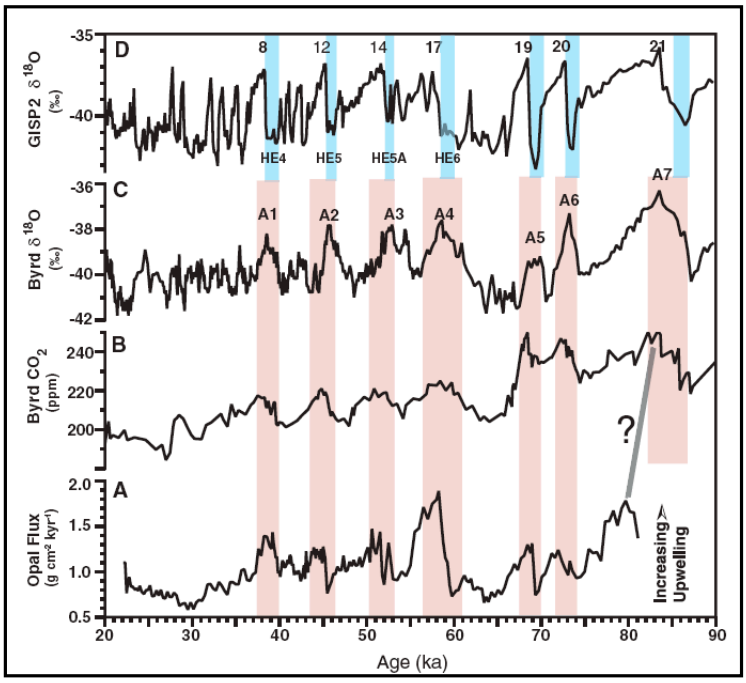
Hodell et al., 09



Hodell et al., 09

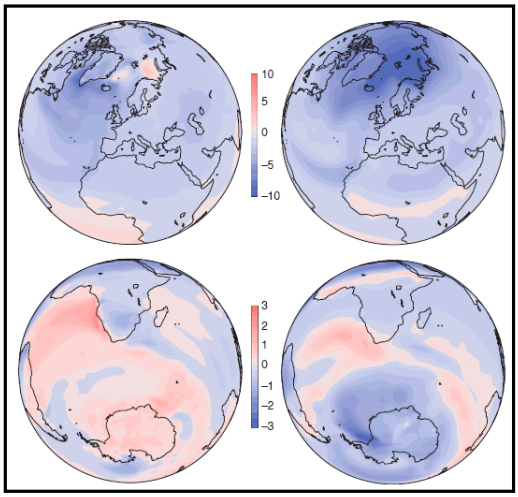


Hodell et al., 09



Anderson et al., 09

bipolar seesaw

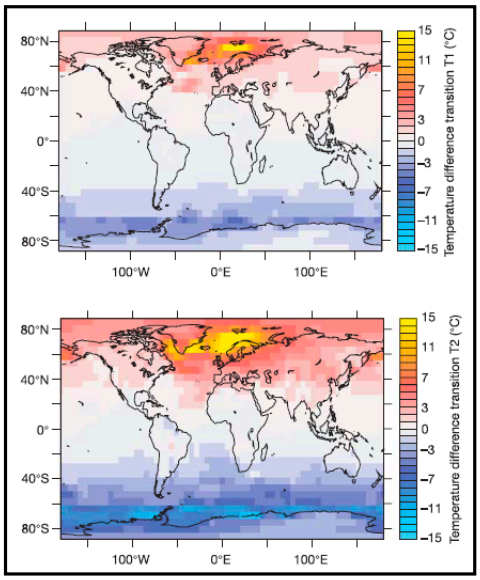


Stocker, 02

Changes in Earth's surface temperature due to a collapse of the Atlantic THC, as simulated by two coupled atmosphere-ocean climate models. In both models, cooling is strongest in the North Atlantic and extends over much of the Northern Hemisphere (top). Predicted changes in the Southern Hemisphere (bottom), especially over Antarctica, are not yet consistent across different models. A sudden resumption of the THC would lead to the reverse response: a rapid warming in the north and some cooling in the South Atlantic and Indian oceans.

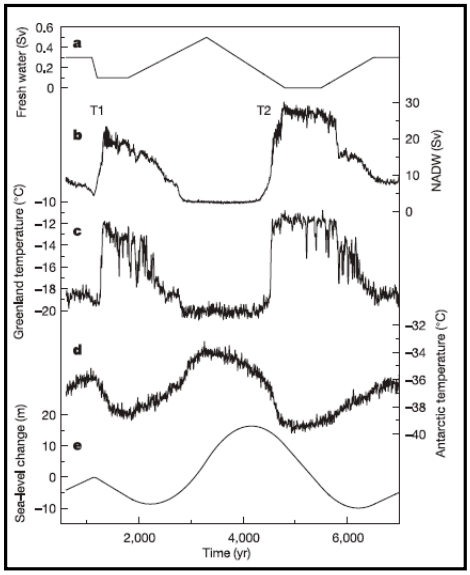
partial "off" to "on" state

"off" to "on" state



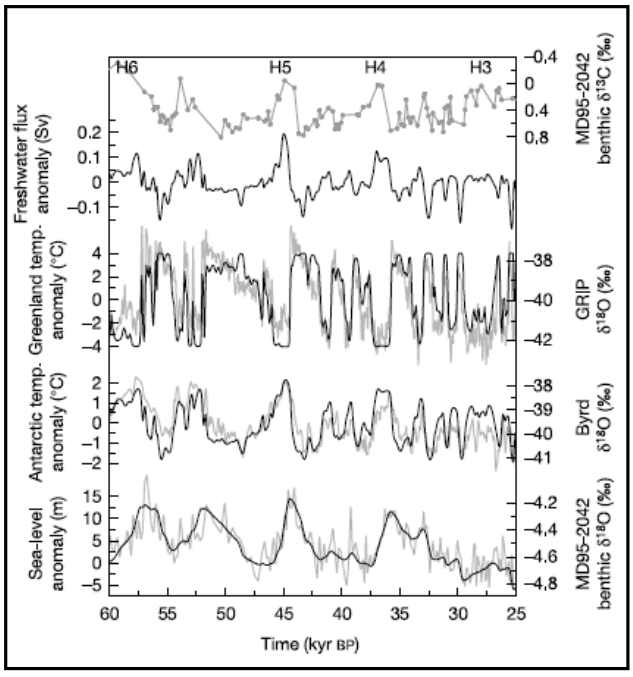
Knutti et al., 04

Temperature changes simulated for two stadial–interstadial transitions. Transition T1 is from a partial 'off' to a THC 'on' state, transition T2 from a completely collapsed THC state to a strong THC 'on' state. These patterns are in agreement with proxy evidence for the long-lasting DO events following a Heinrich event (T2) and for the shorter DO events, which have a weak or no clear counterpart in the south (T1).

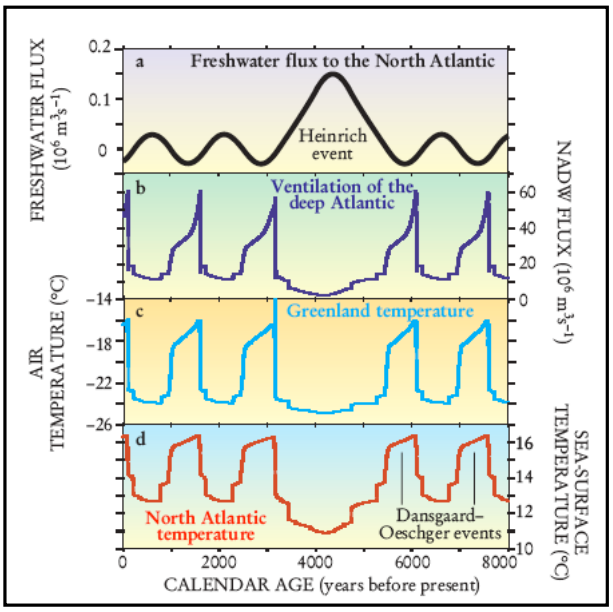


Knutti et al., 04

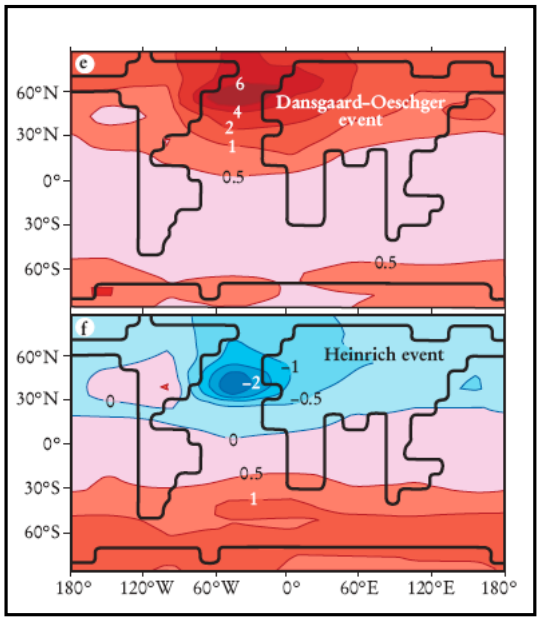
Time evolution of the THC and global sea level and corresponding changes in polar near-surface air temperature in an illustrative scenario of freshwater discharge into the North Atlantic. The fresh water (a) causes abrupt shifts in the North Atlantic deepwater formation (b). The associated massive and abrupt warming events simulated over Greenland (c). Antarctic temperature (d) is influenced by the THC and directly by the freshwater discharge into the North Atlantic.



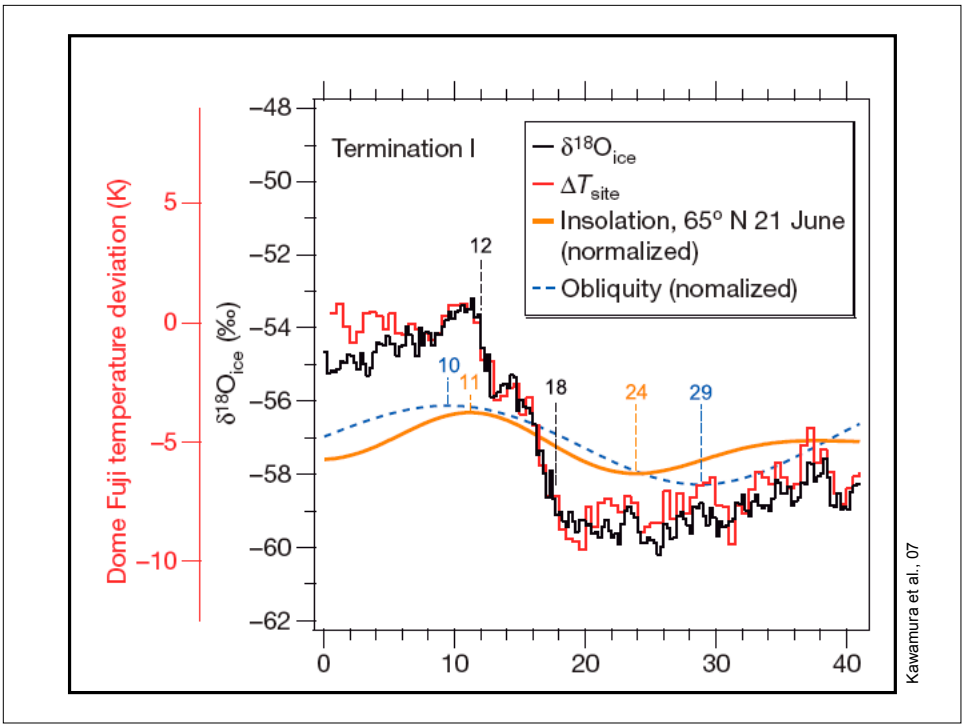
Knutti et al., 04

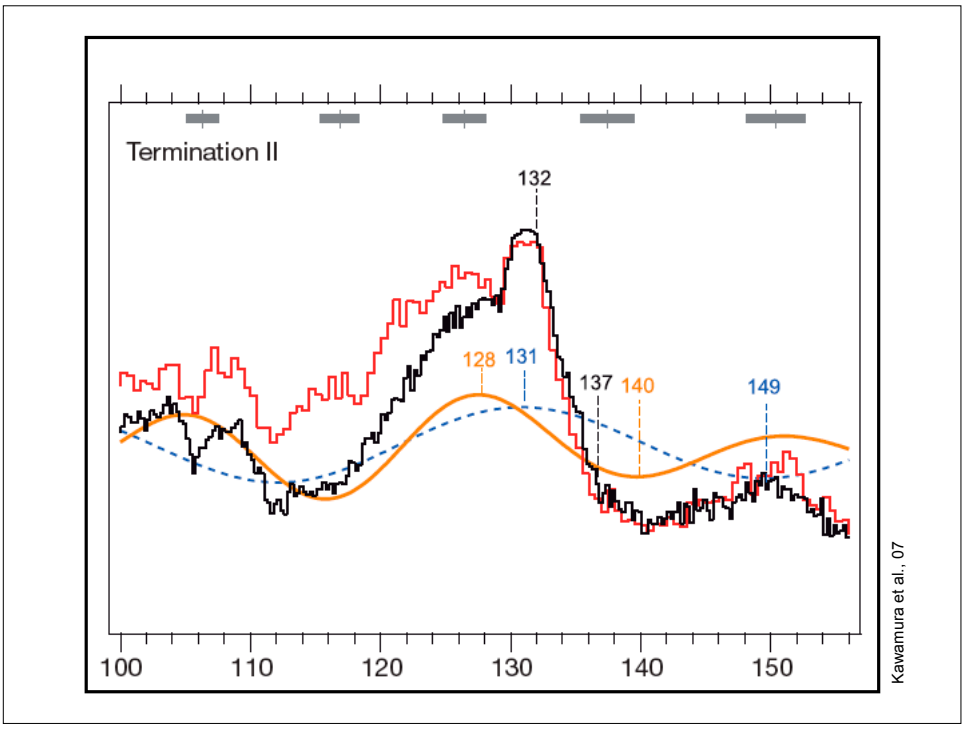


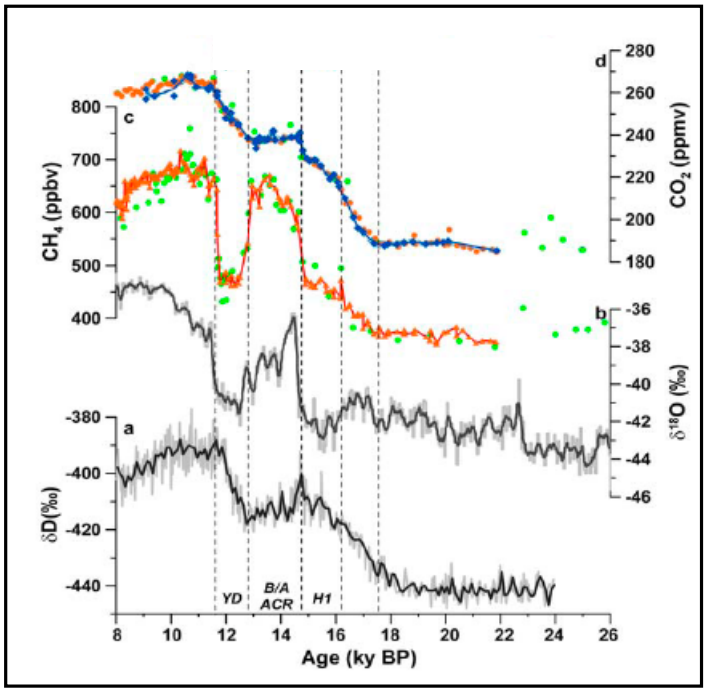
Ganopolski & Rahmstorf, 01

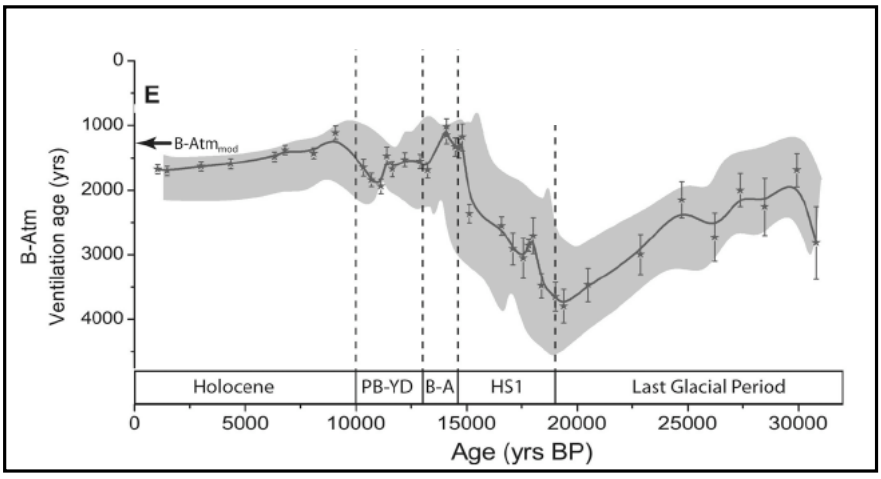


Ganopolski & Rahmstorf, 01

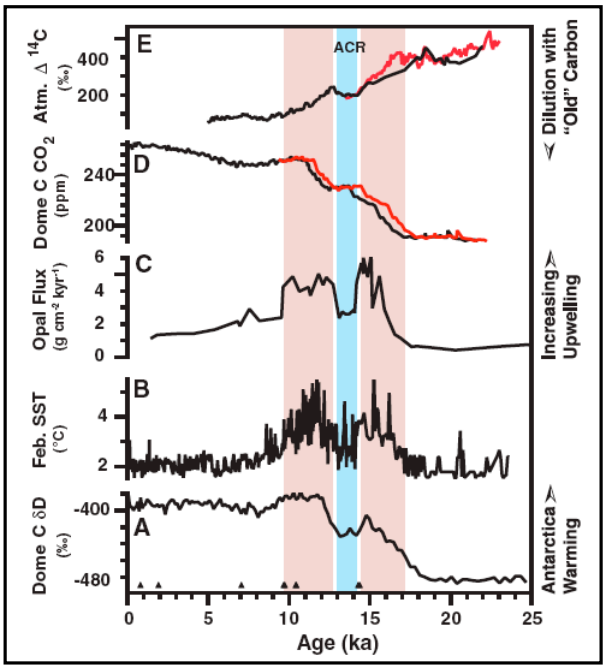

Termination I
$\delta^{18}O_{ice}$
ΔT_{site}
Insolation, 65° N 21 June (normalized)
Obliquity (nomalized)
Dome Fuji temperature deviation (K)
$\delta^{18}O_{ice}$ (‰)
12
10
11
18
24
29
Kawamura et al., 07


Termination II
132
128
131
137
140
149
Kawamura et al., 07

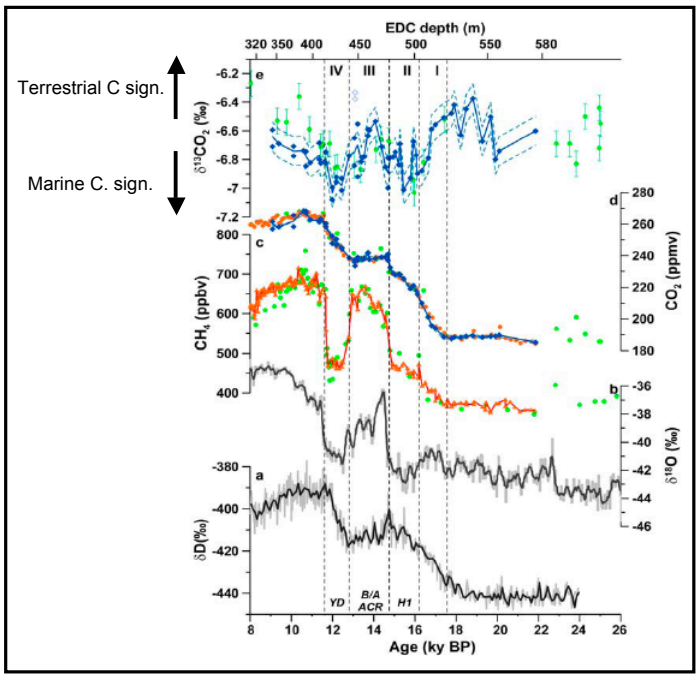




Skinner et al., 10

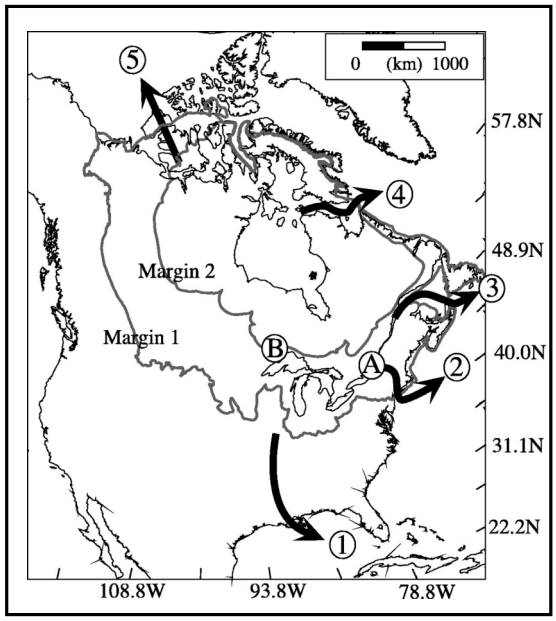


Anderson et al., 09

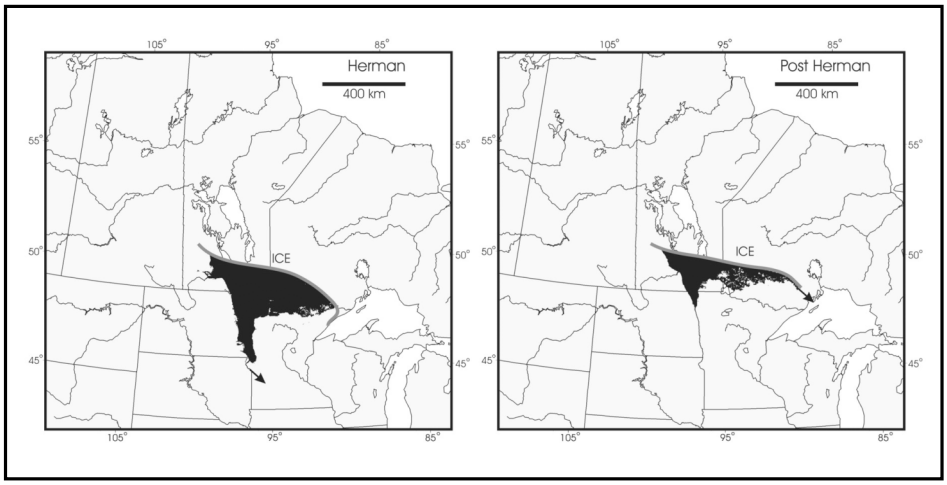


Lourantou et al., 10

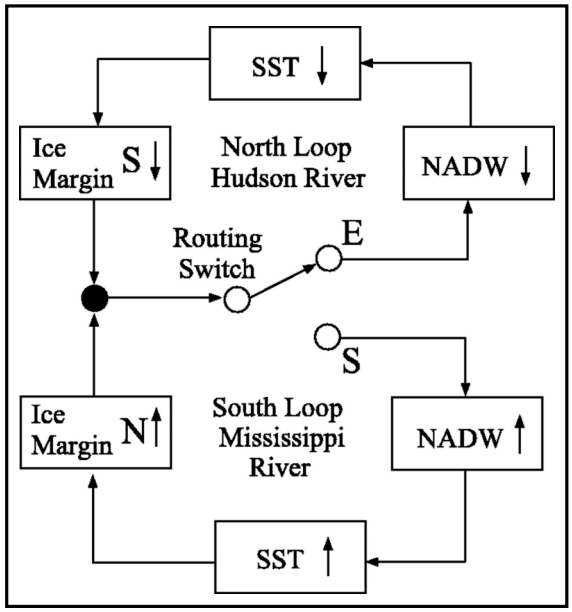
Younger Dryas



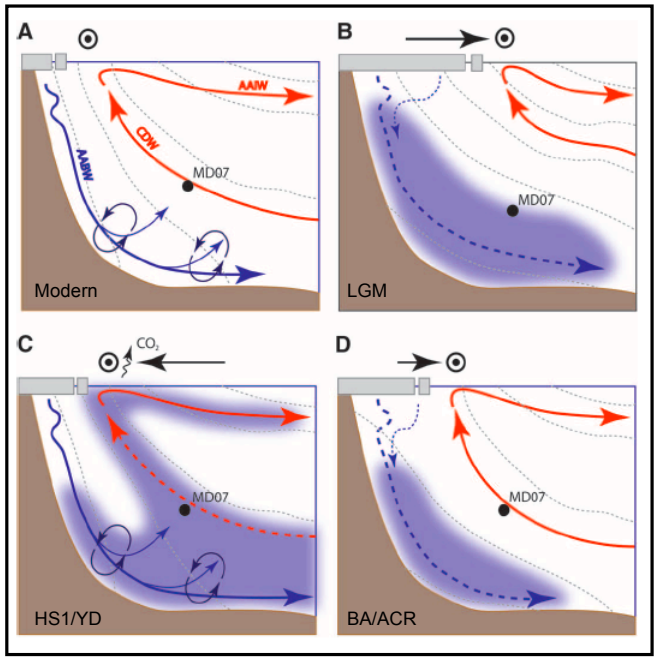
Clark et al., 01



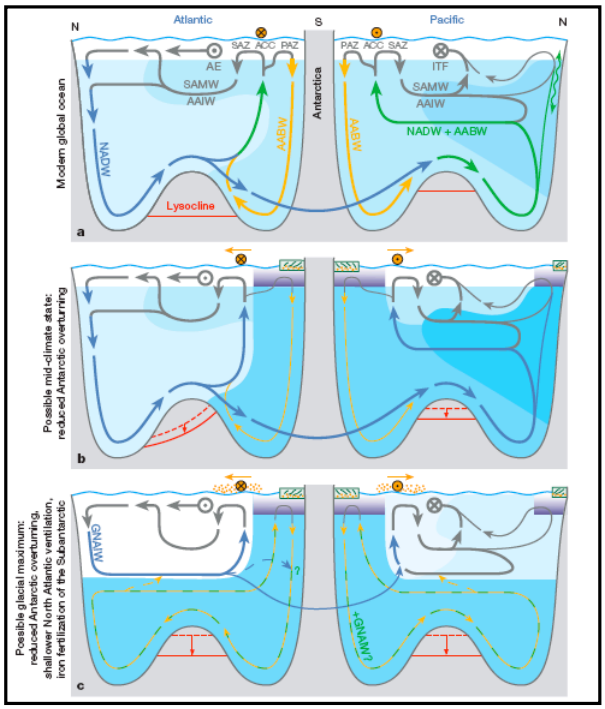
Broecker, 03



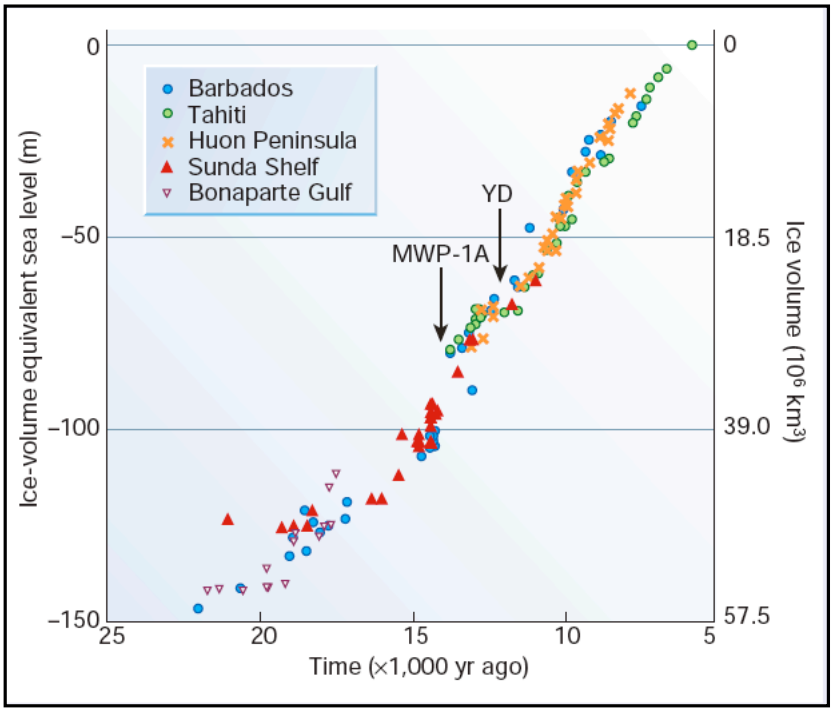
Clark et al., 01



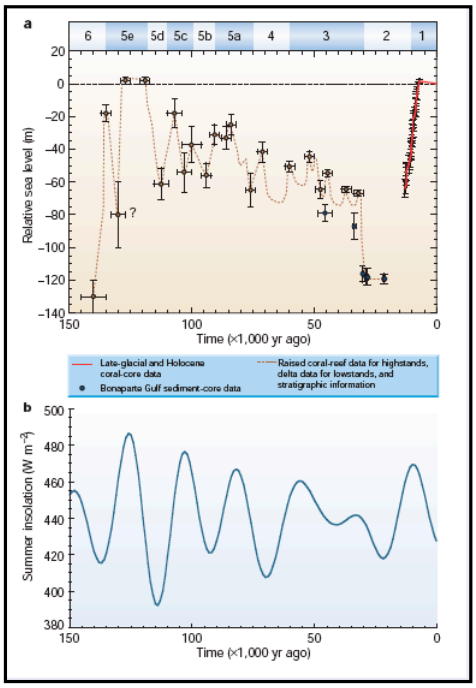
Skinner et al., 10



Sigman et al., 10



Lambeck et al., 02



Lambeck et al., 02