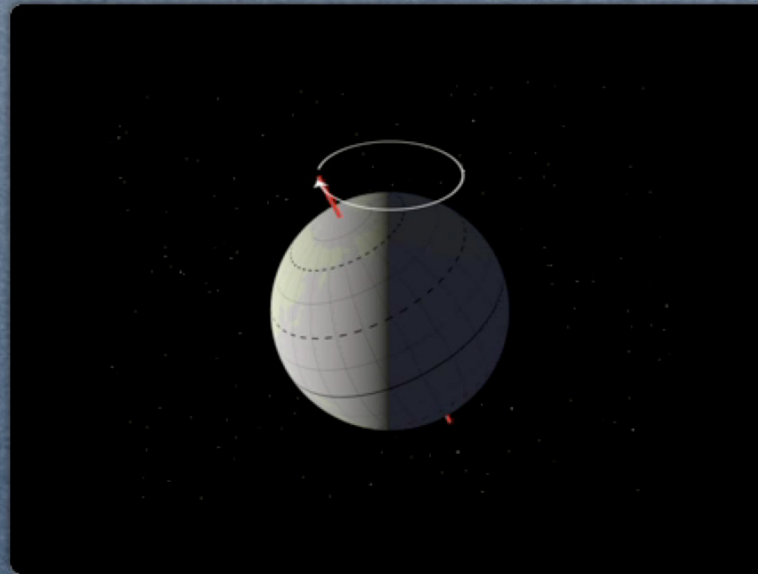


EISZEITEN



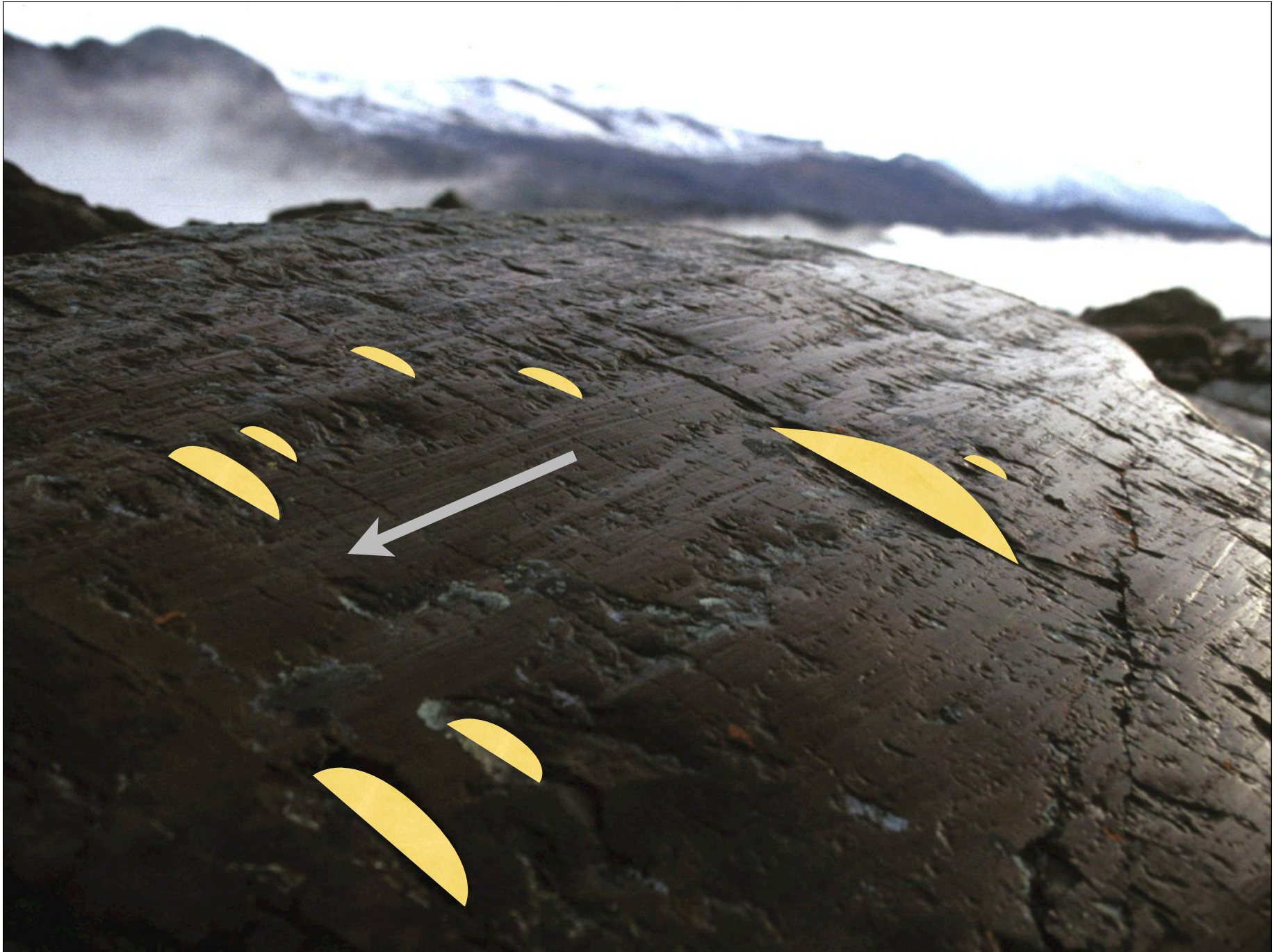
Klimakapriolen der Erdgeschichte

Hannes Grobe * Alfred-Wegener-Institut

Grönland







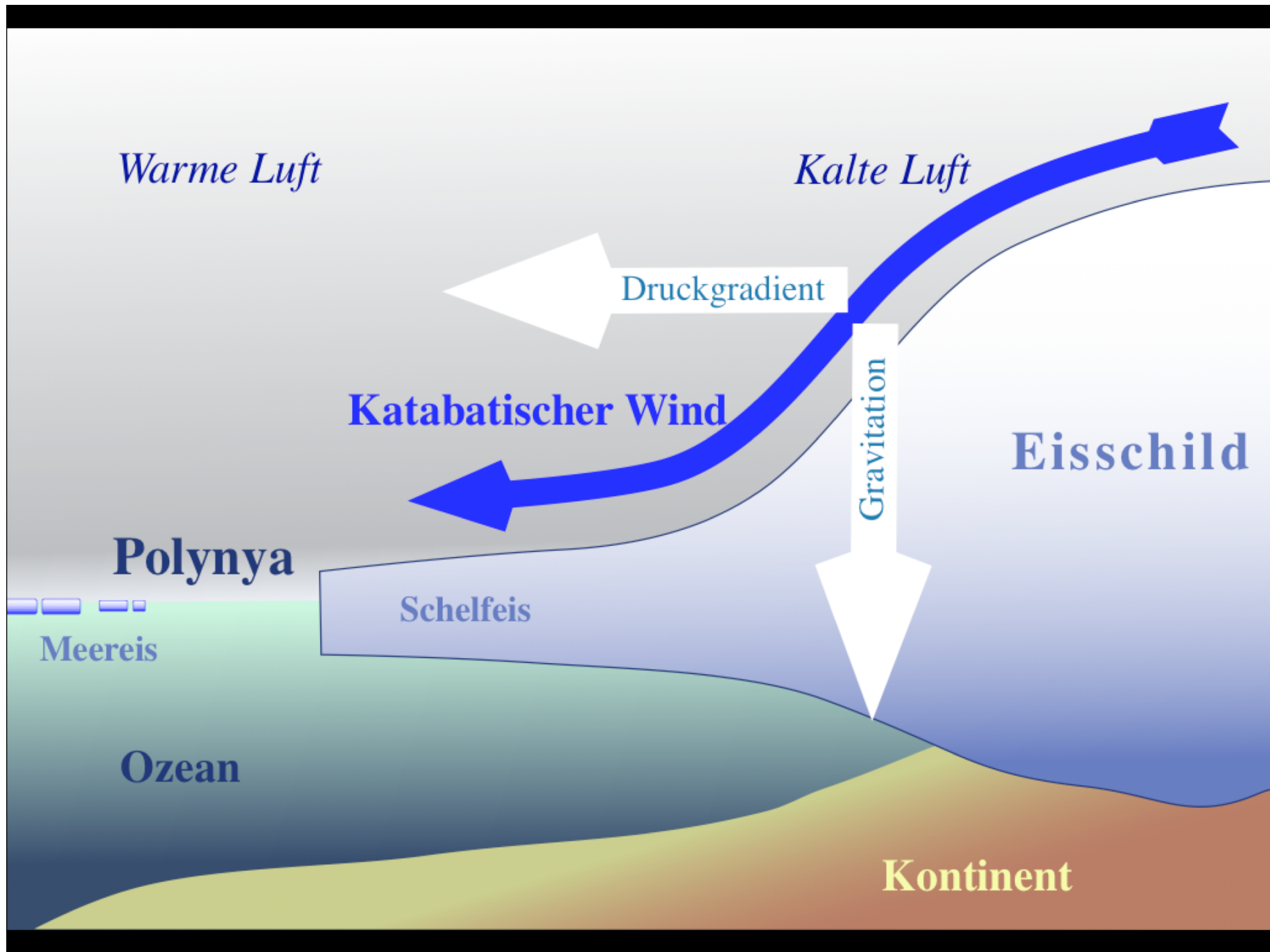


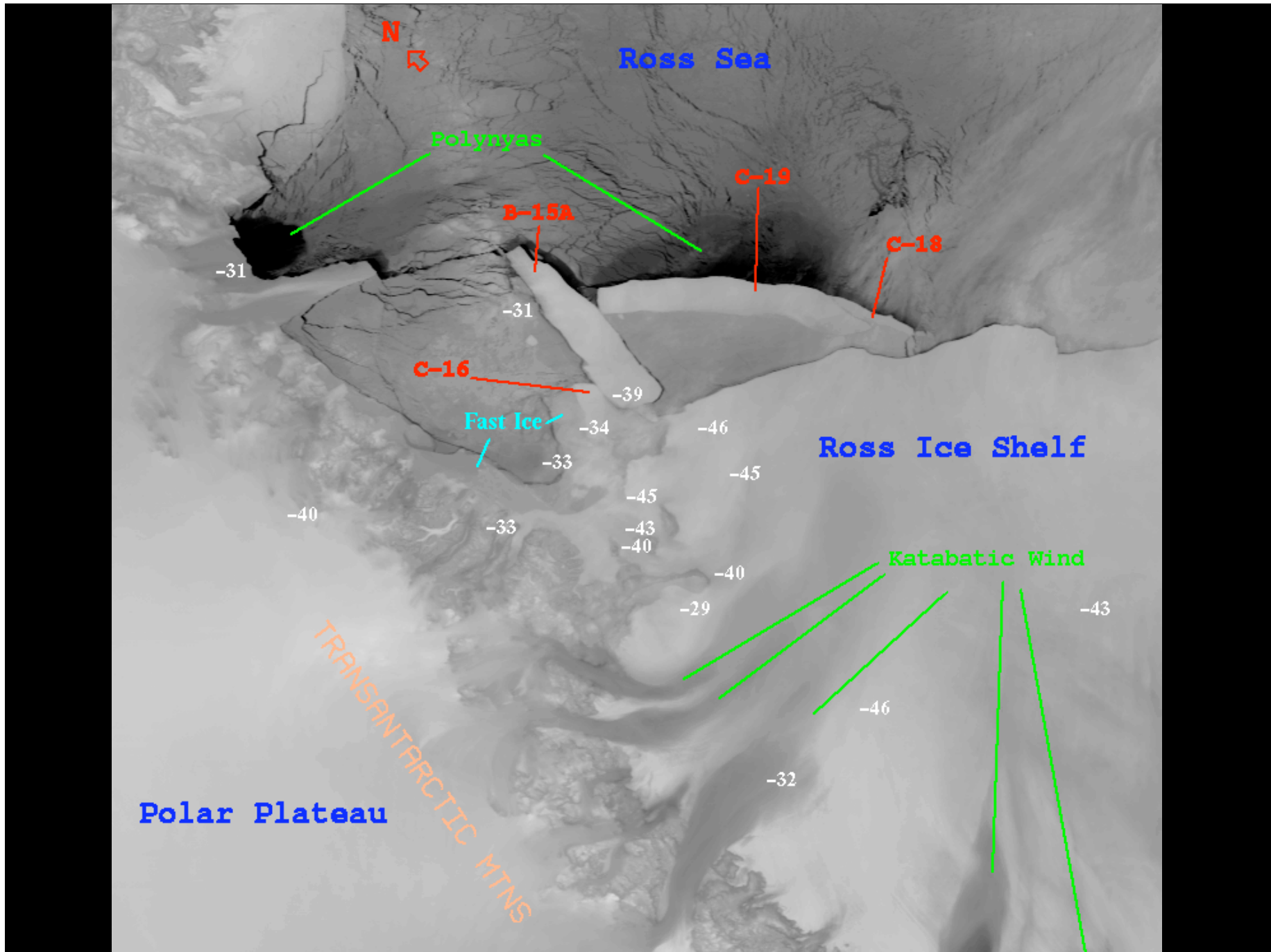
Fündlinge



Feuersteine

Der Steinbrecher John Brett 1858



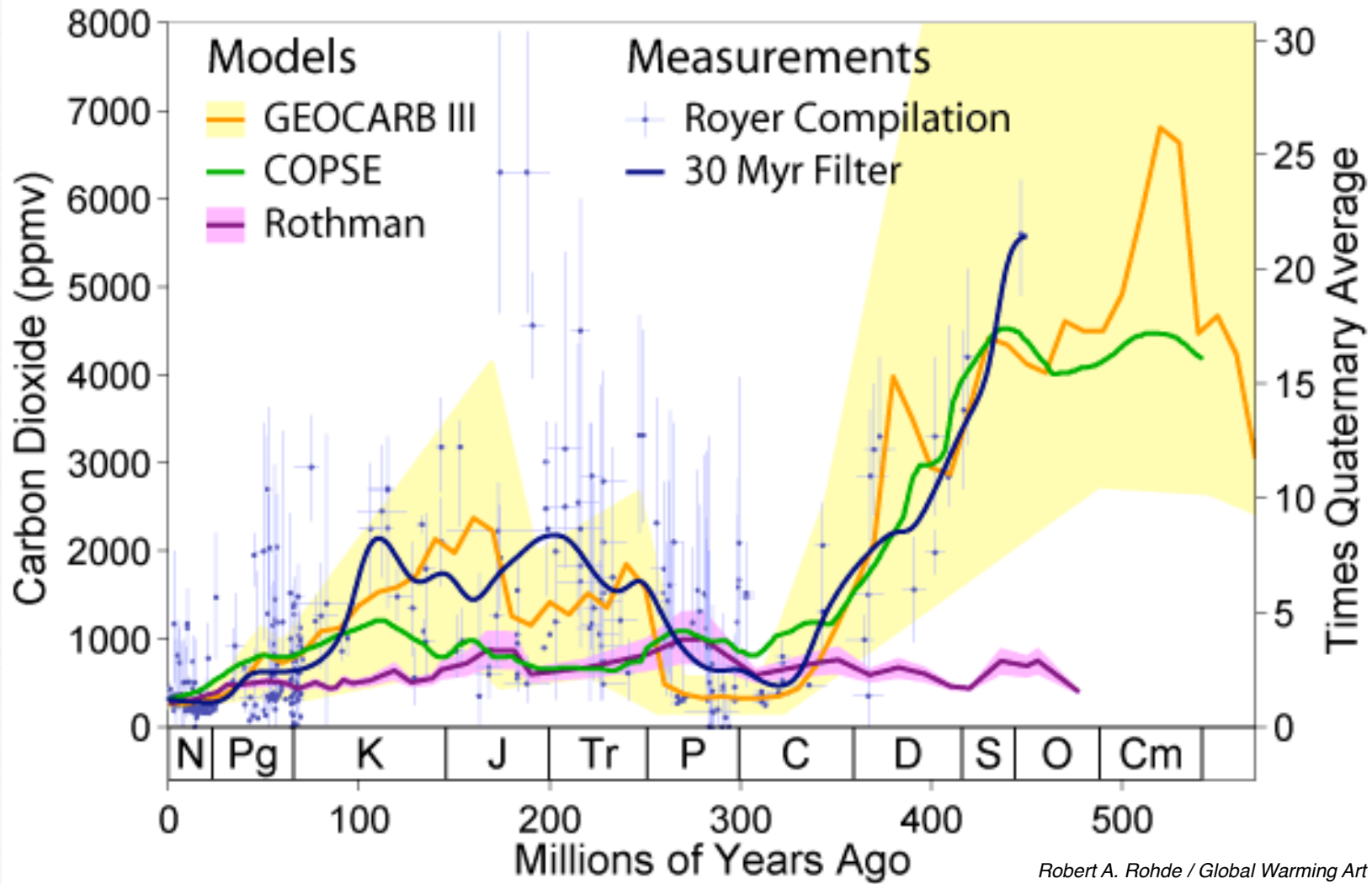




© Ice Age/Blue Sky Studios

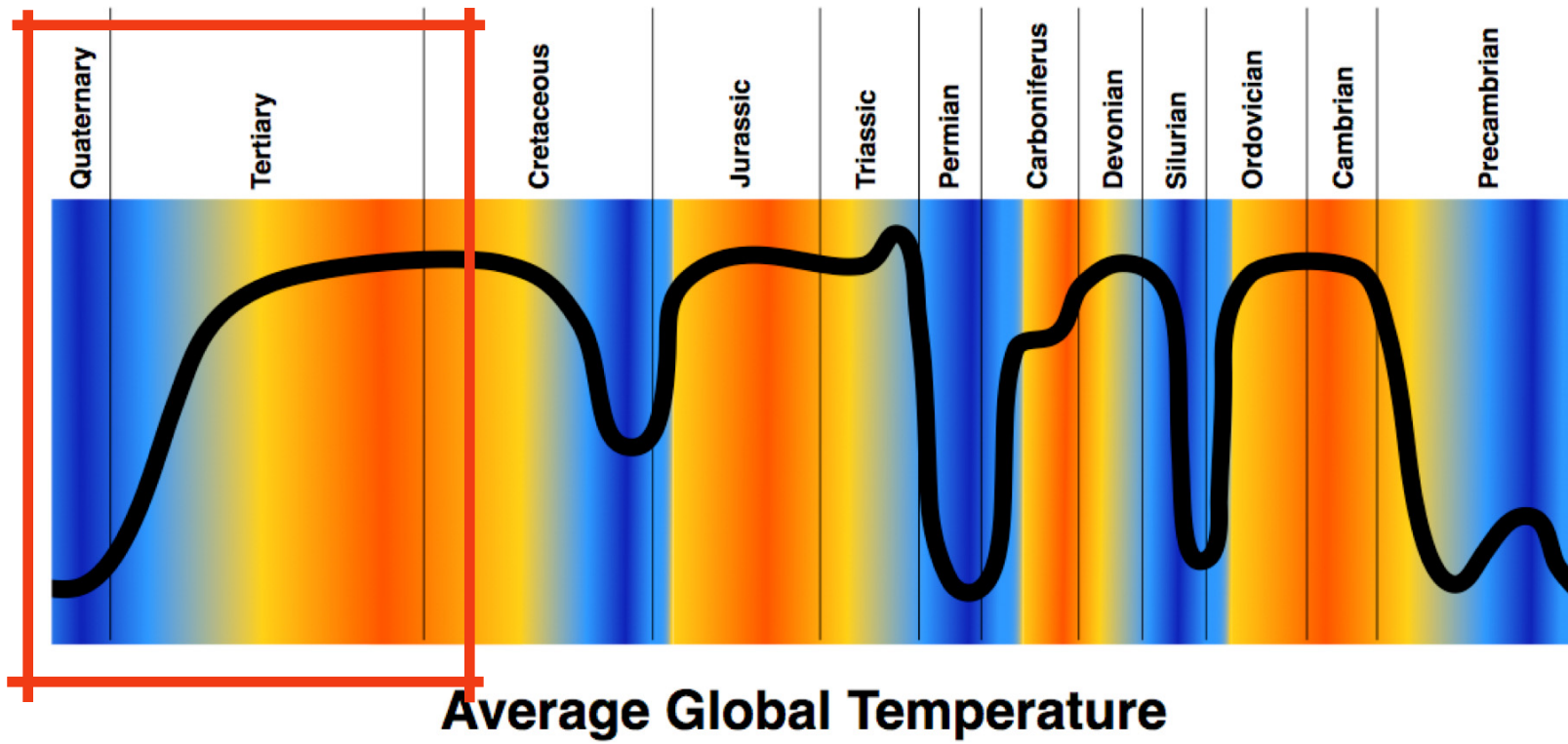
Windkanter

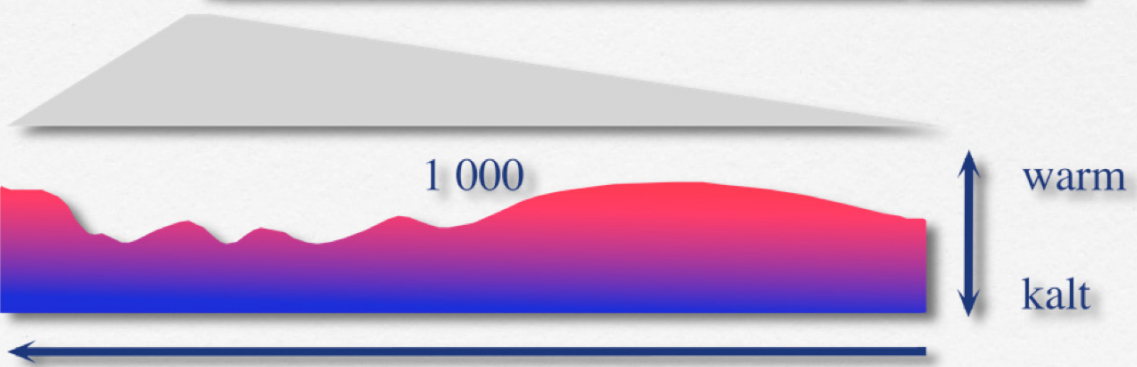
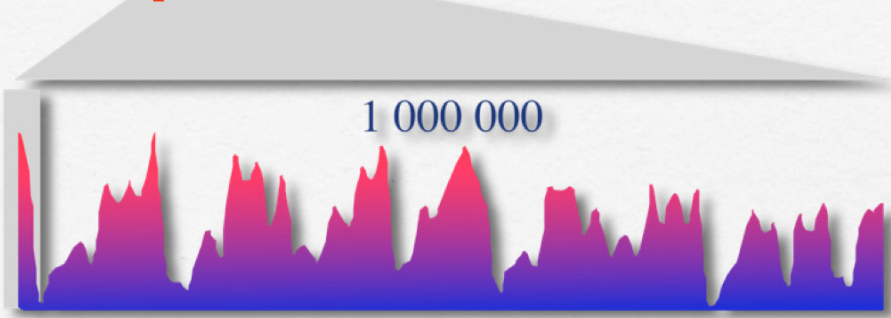
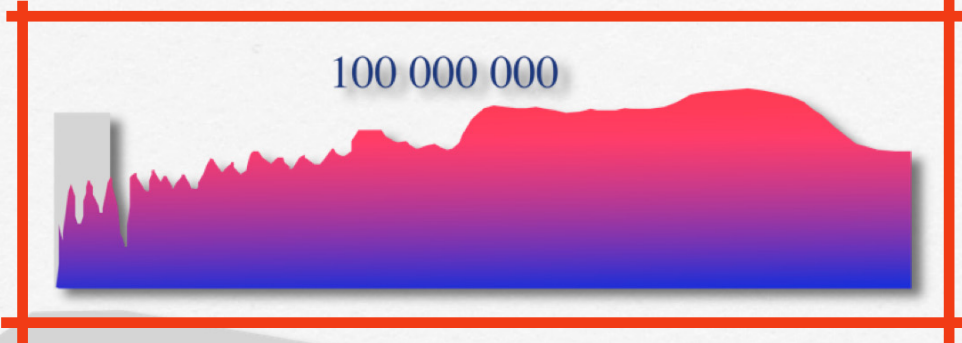
Phanerozoic Carbon Dioxide



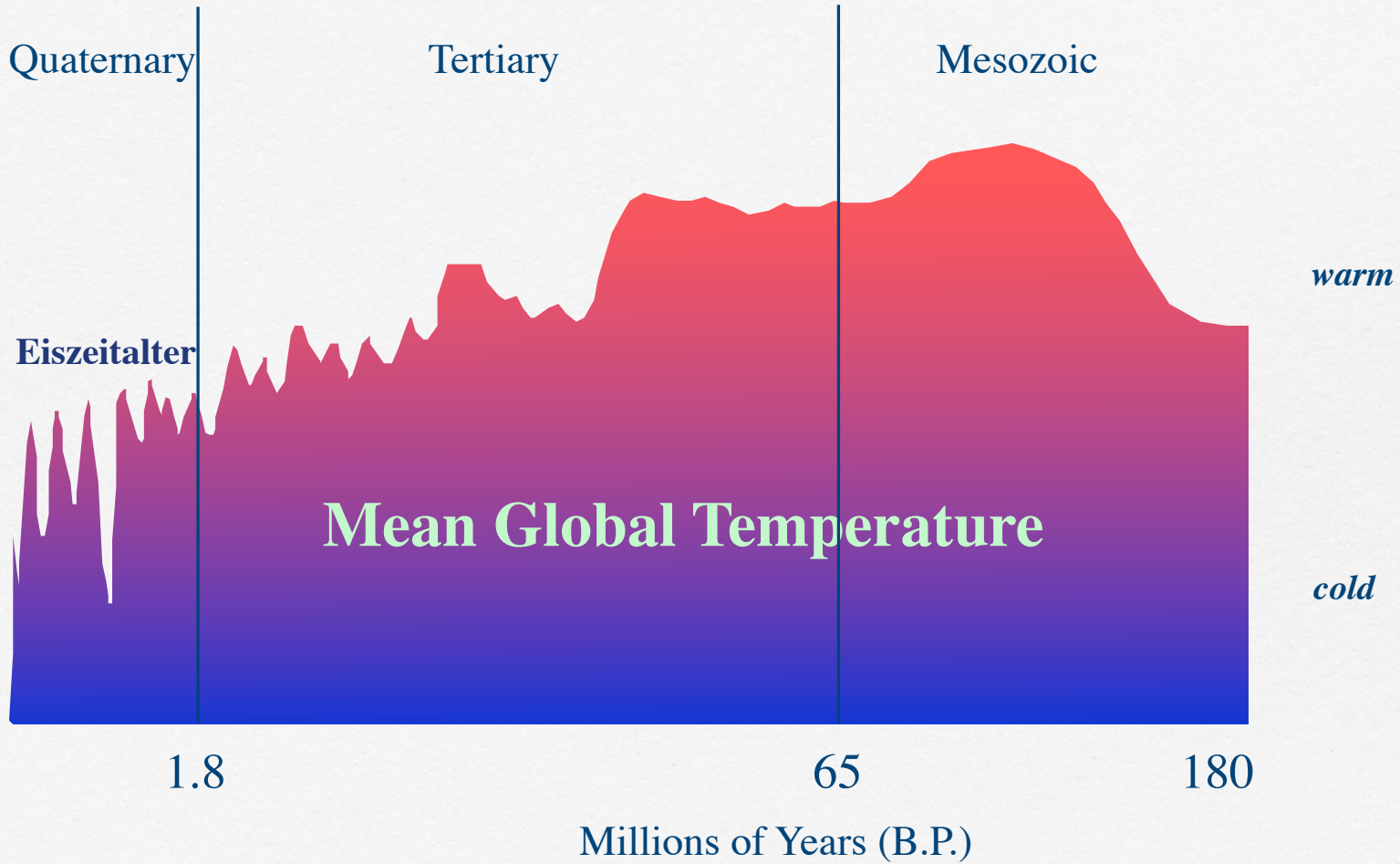
1 Milliarde Jahre

0





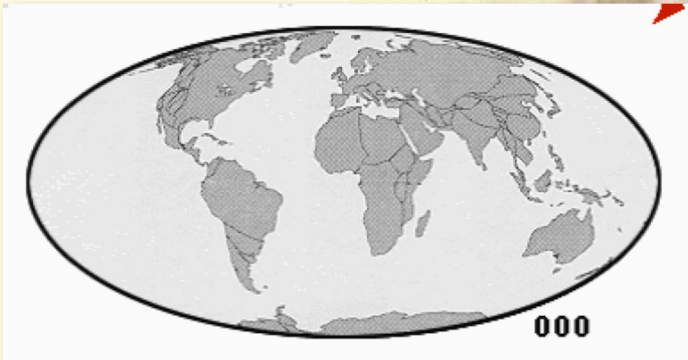
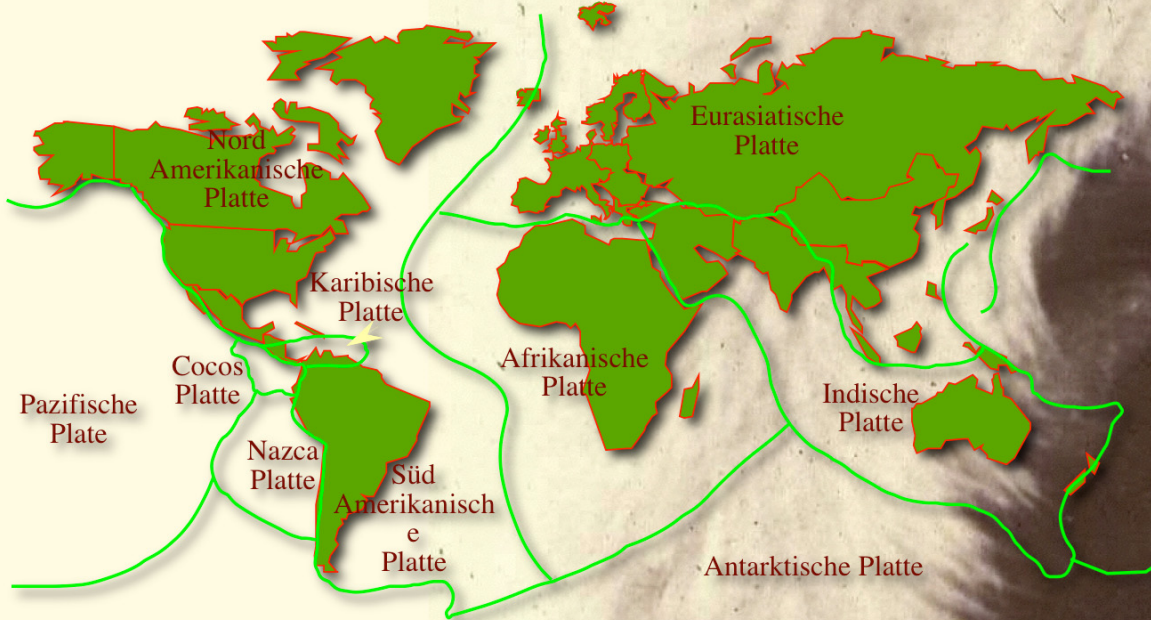
Zeit in Jahren

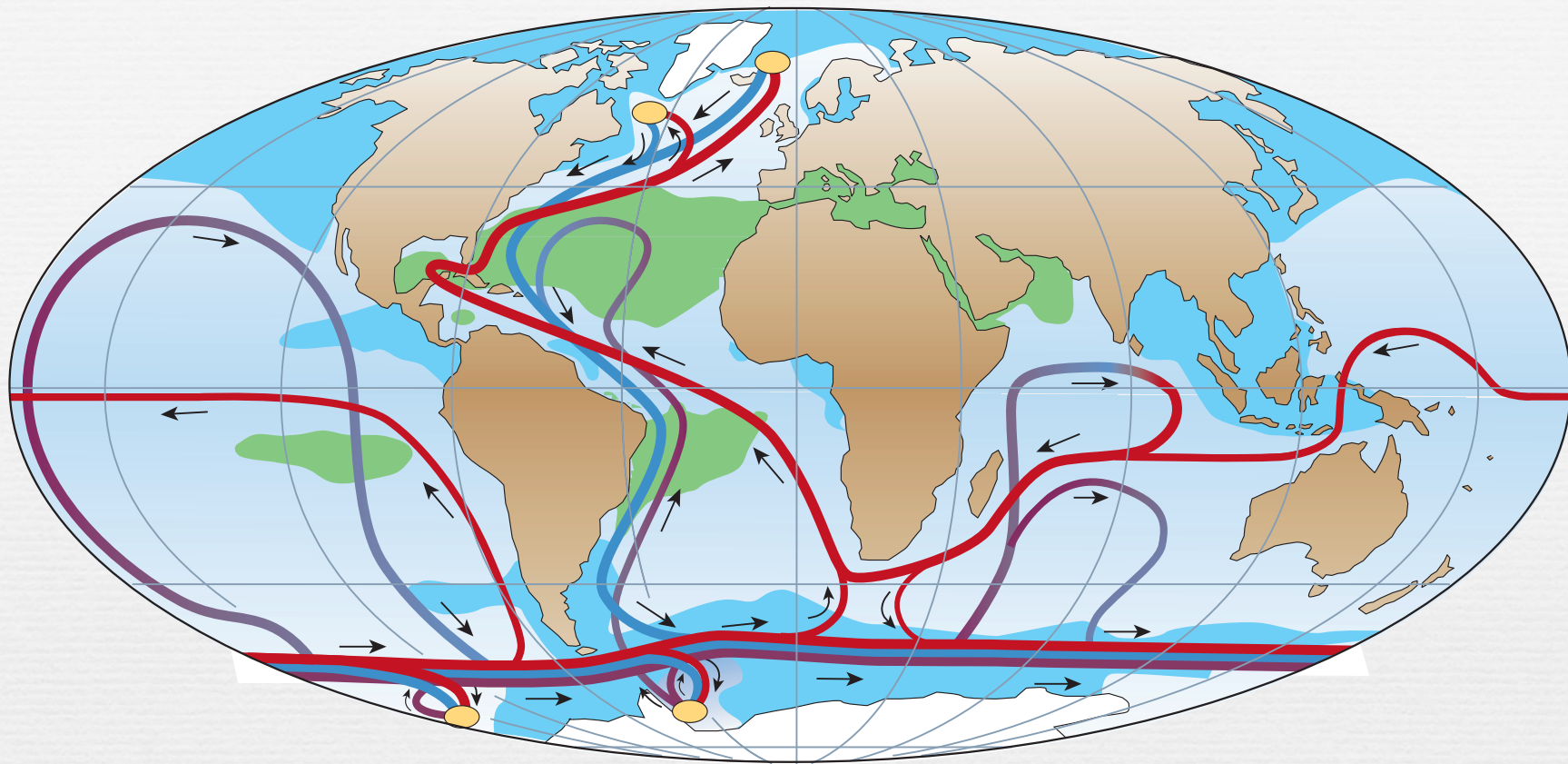


A blue spiral-bound notebook with a silver metal spiral binding at the top. The text is centered on the page.

Wie kommt es zu einem Eiszeitalter ?

(~x00 Millionen Jahre)





— Oberflächenströmung

— Bodenströmung

■ Salinität > 36 ‰

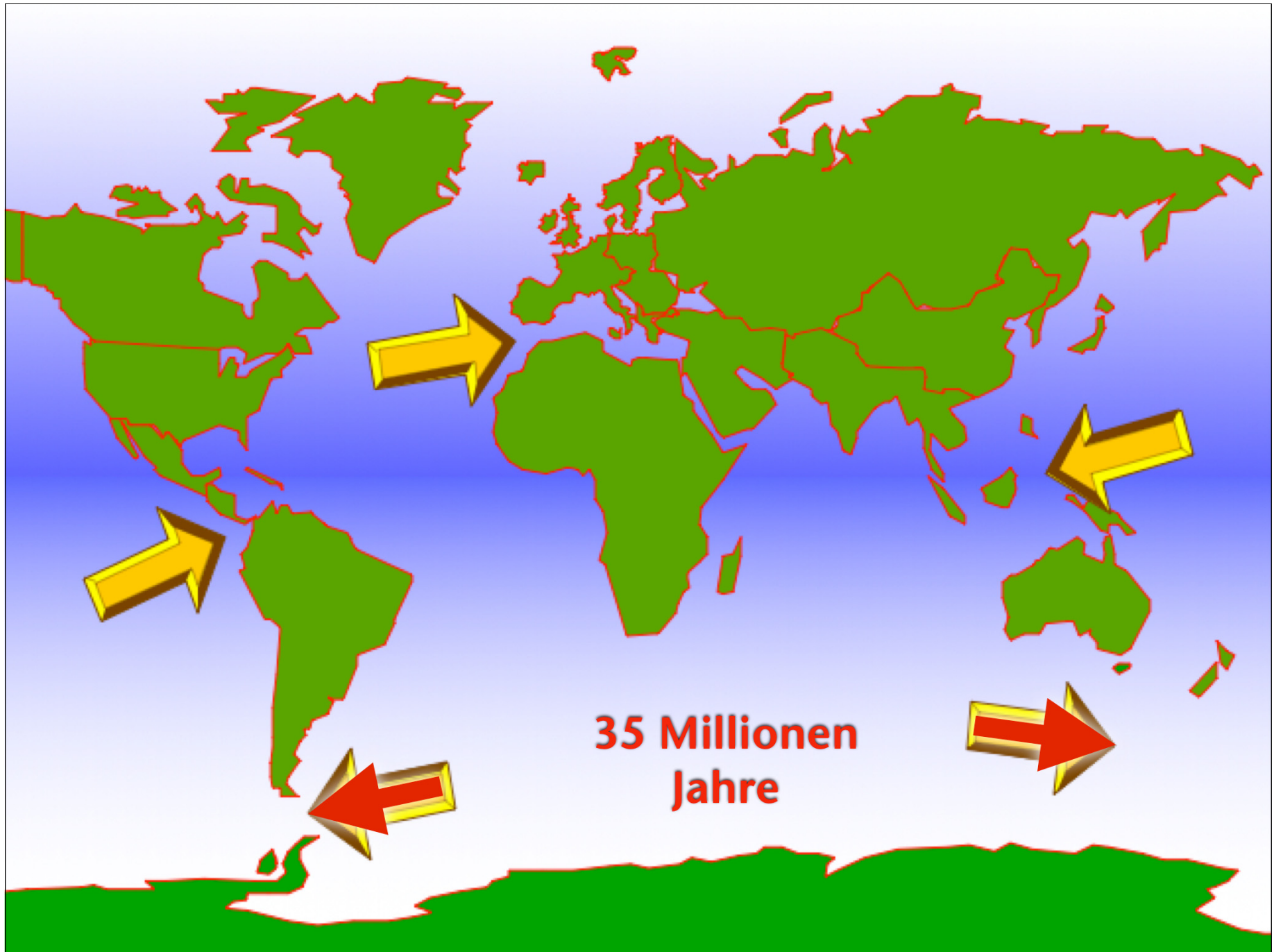
— Tiefenströmung

● Tiefenwasserbildung

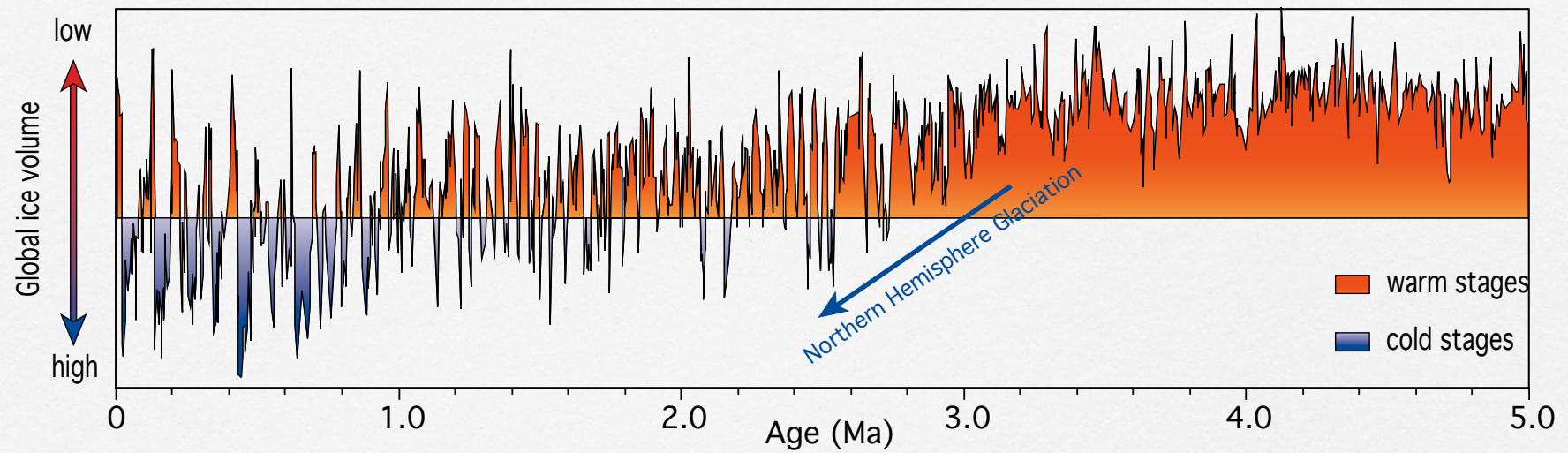
■ Salinität < 34 ‰

Das System der globalen Meeresströmungen

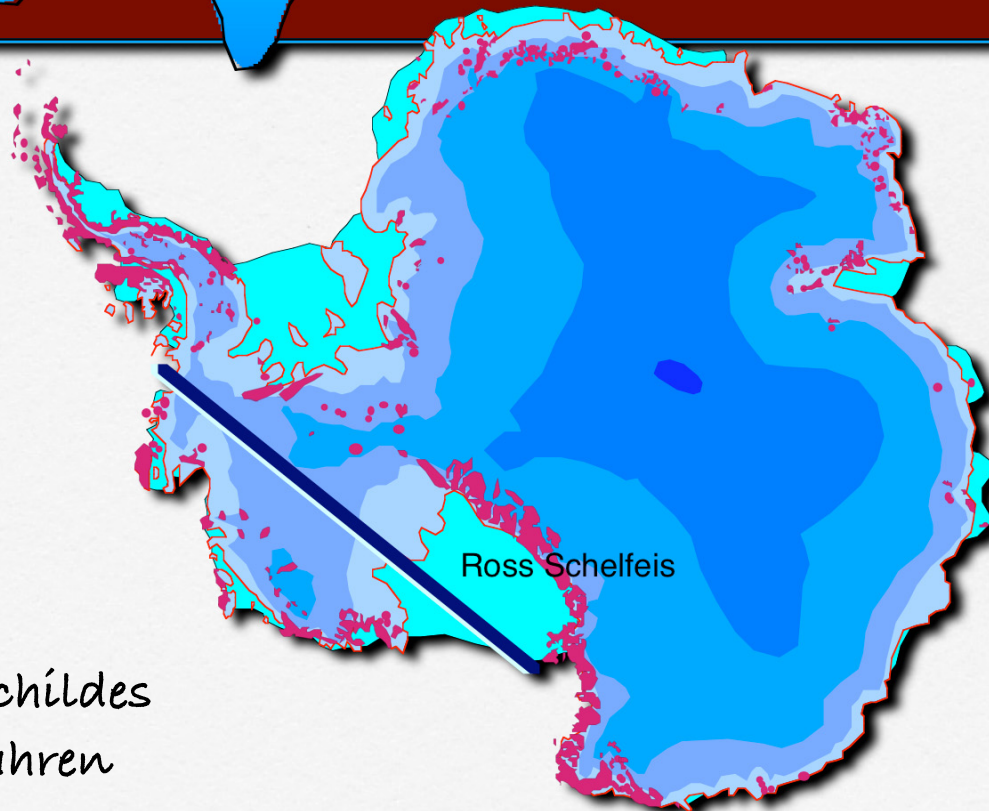
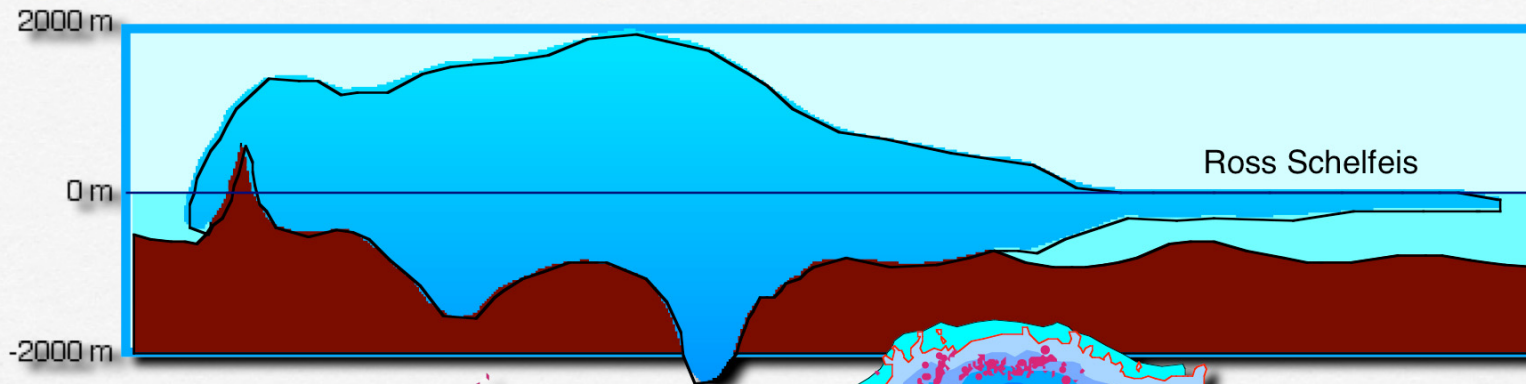
(nach Rahmstorf, 2002)



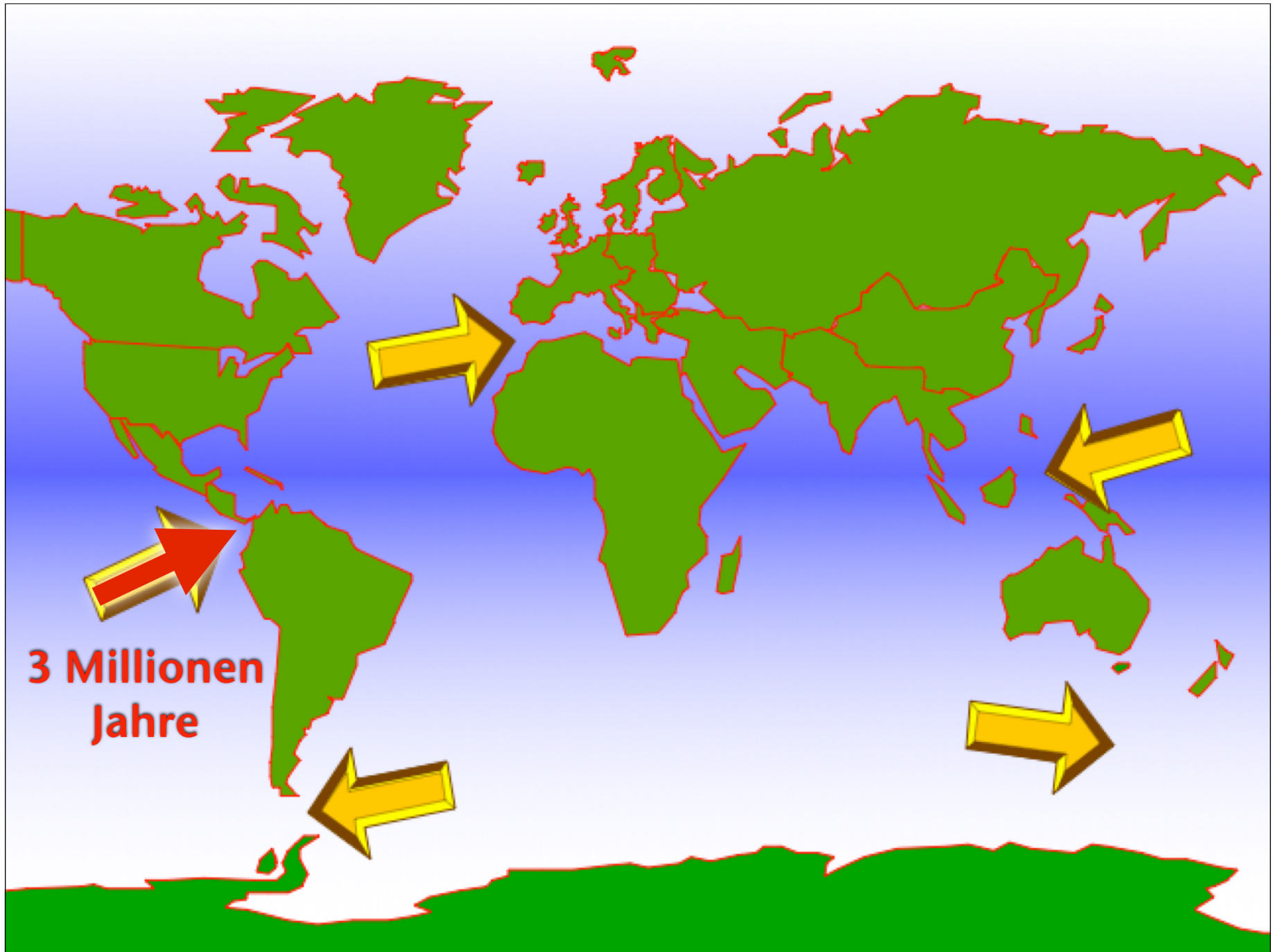
d₁₈O marine climate record

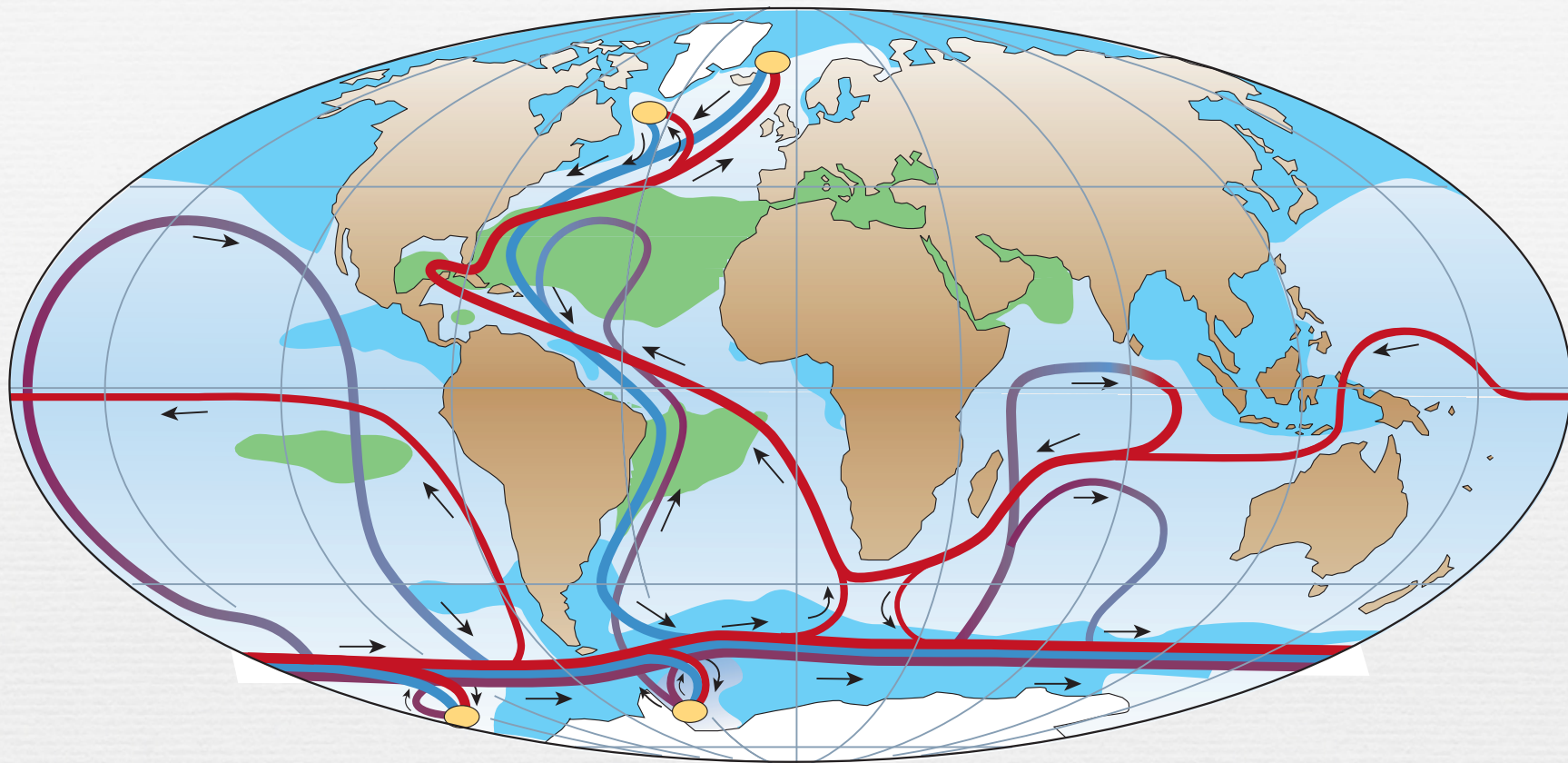


Tiedemann 2007



Aufbau des
Antarktischen Eisschildes
in 35 Millionen Jahren





— Oberflächenströmung

— Bodenströmung

■ Salinität > 36 ‰

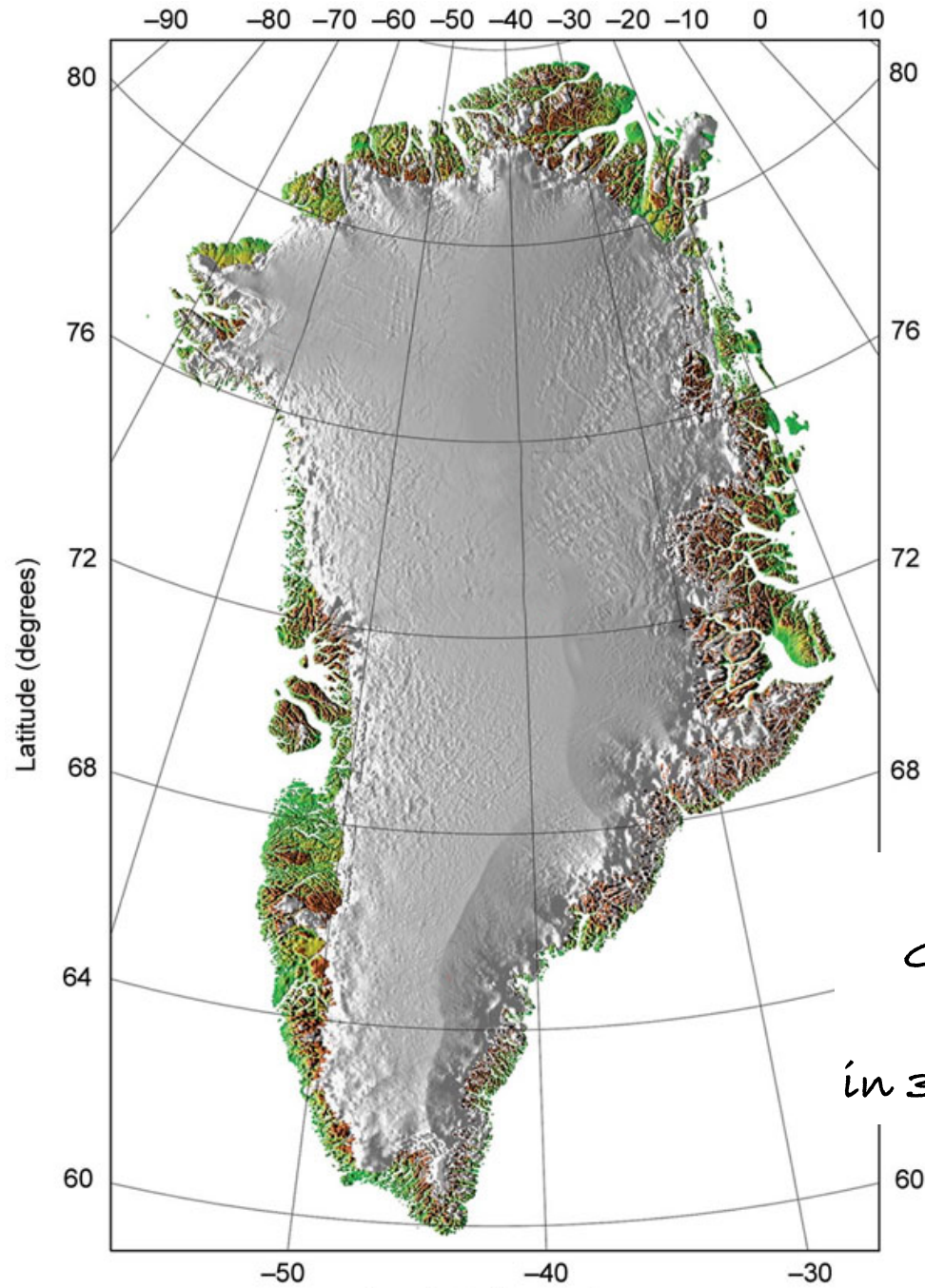
— Tiefenströmung

● Tiefenwasserbildung

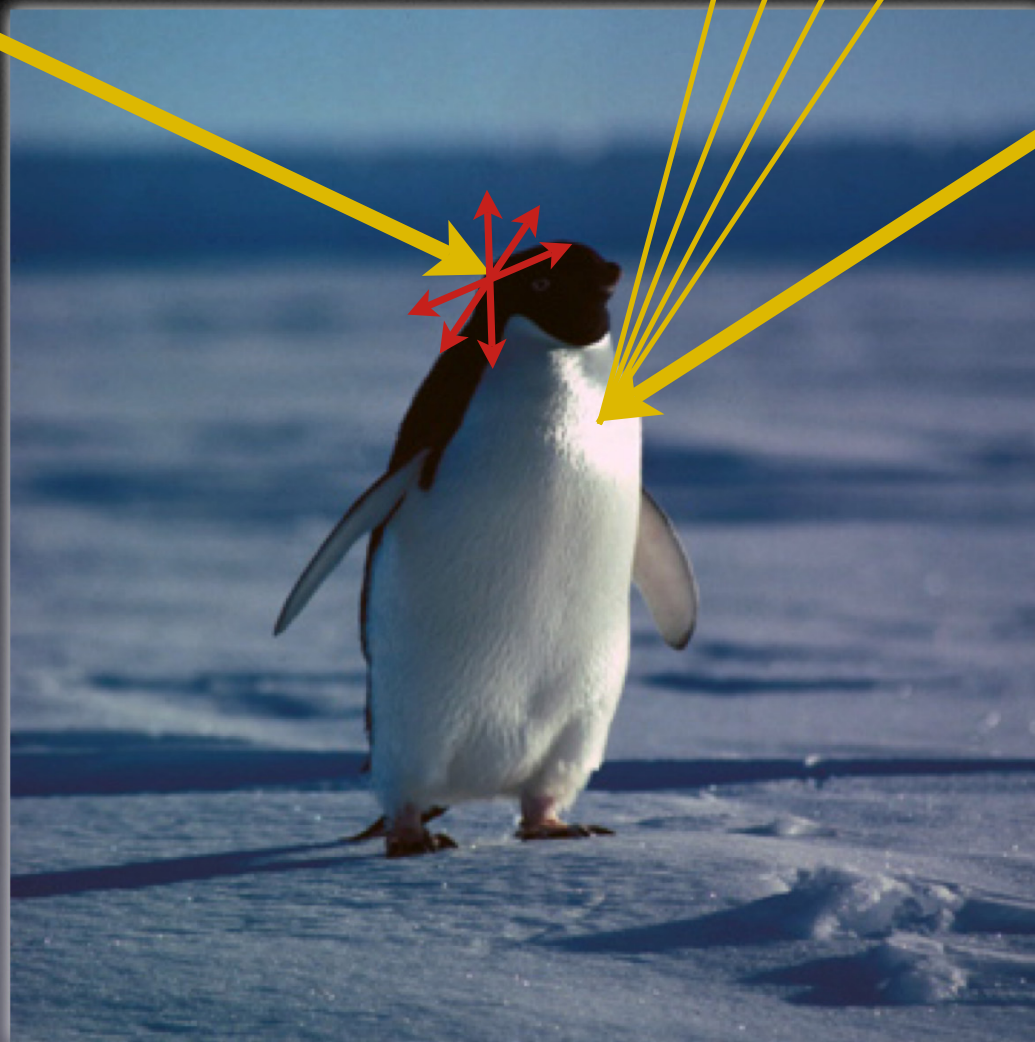
■ Salinität < 34 ‰

Das System der globalen Meeresströmungen

(nach Rahmstorf, 2002)



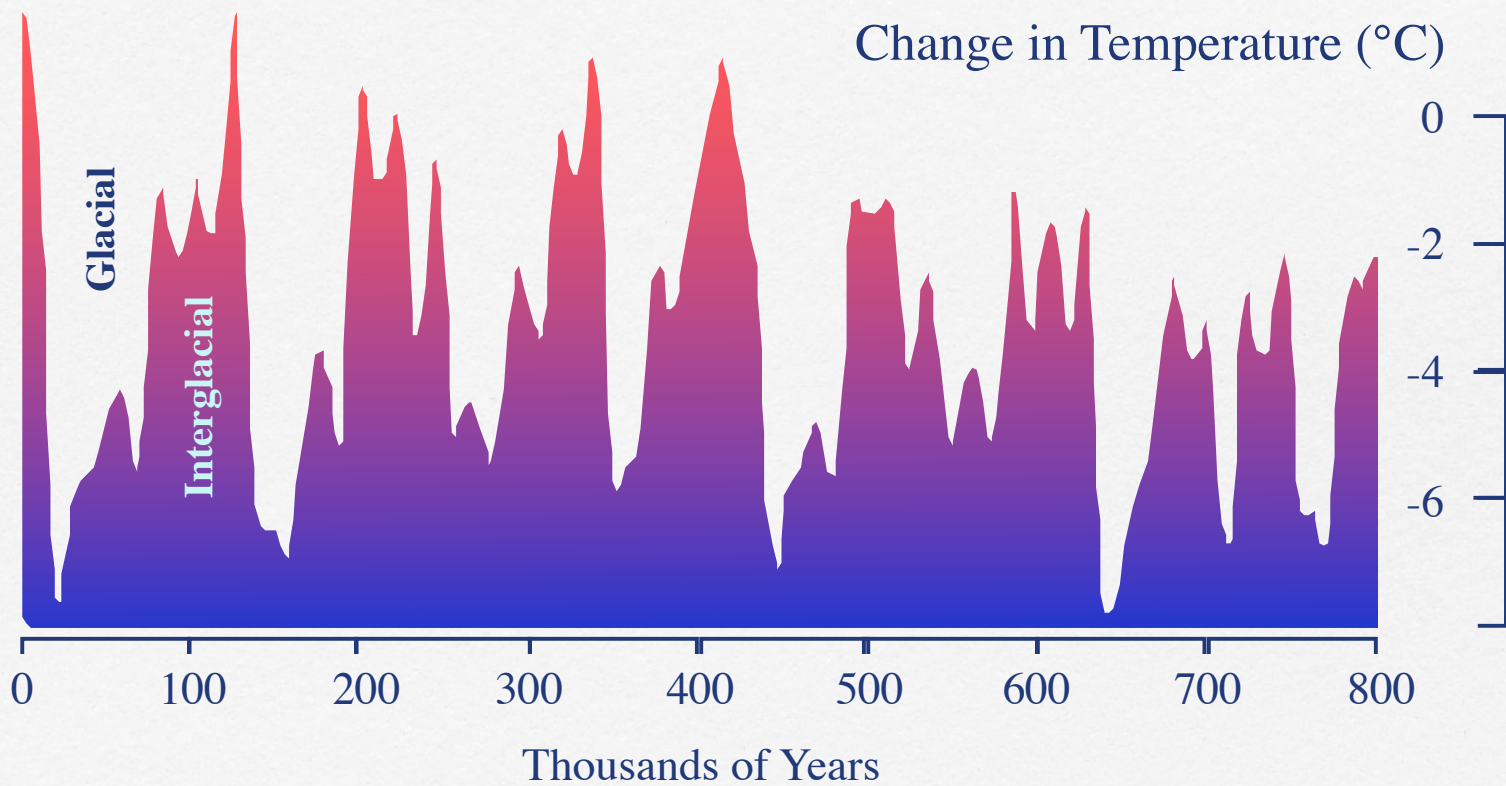
Aufbau des
Grönländischen
Eisschildes
in 3 Millionen Jahren

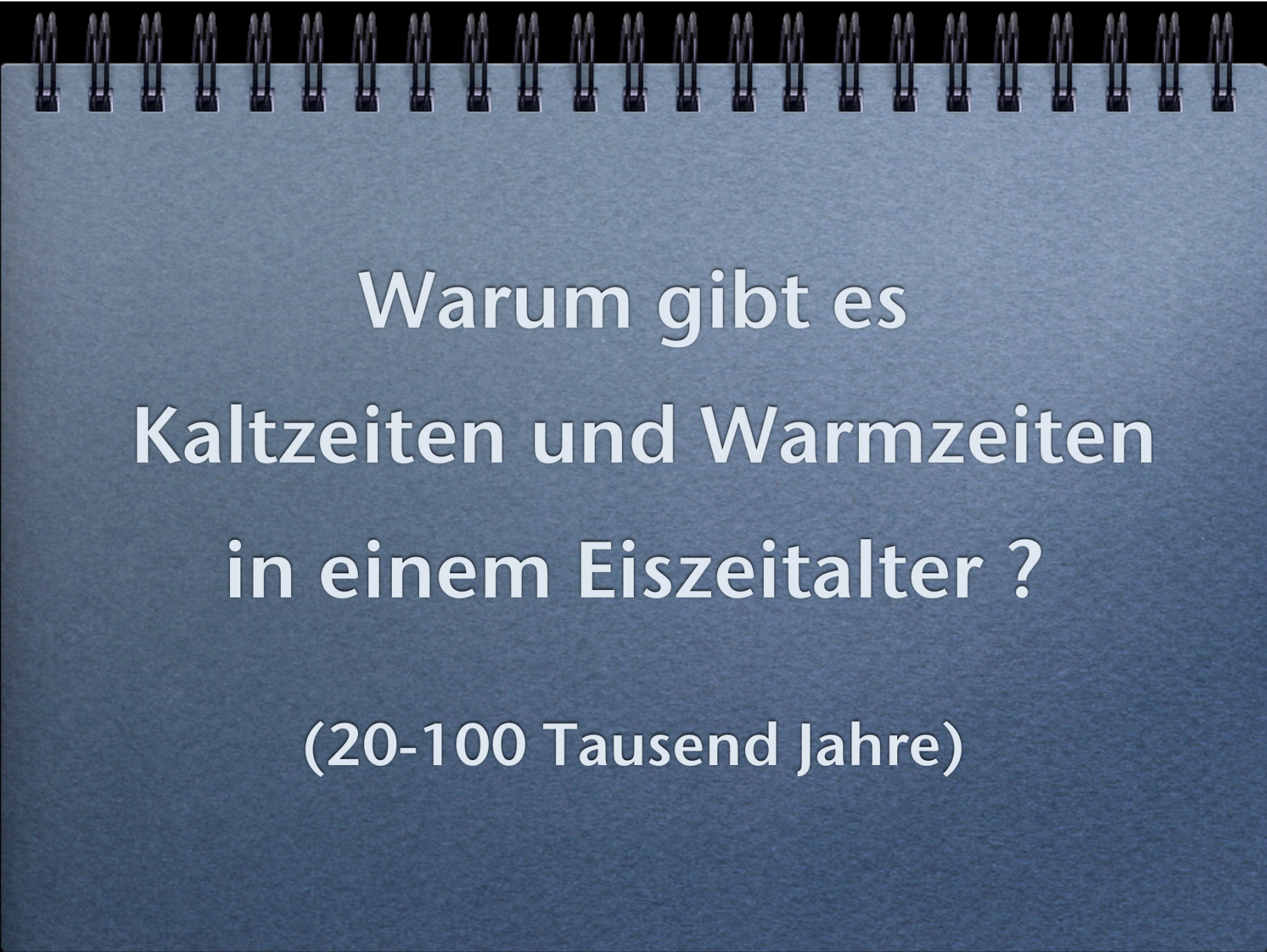


Albedo

Quaternary

Change in Temperature (°C)

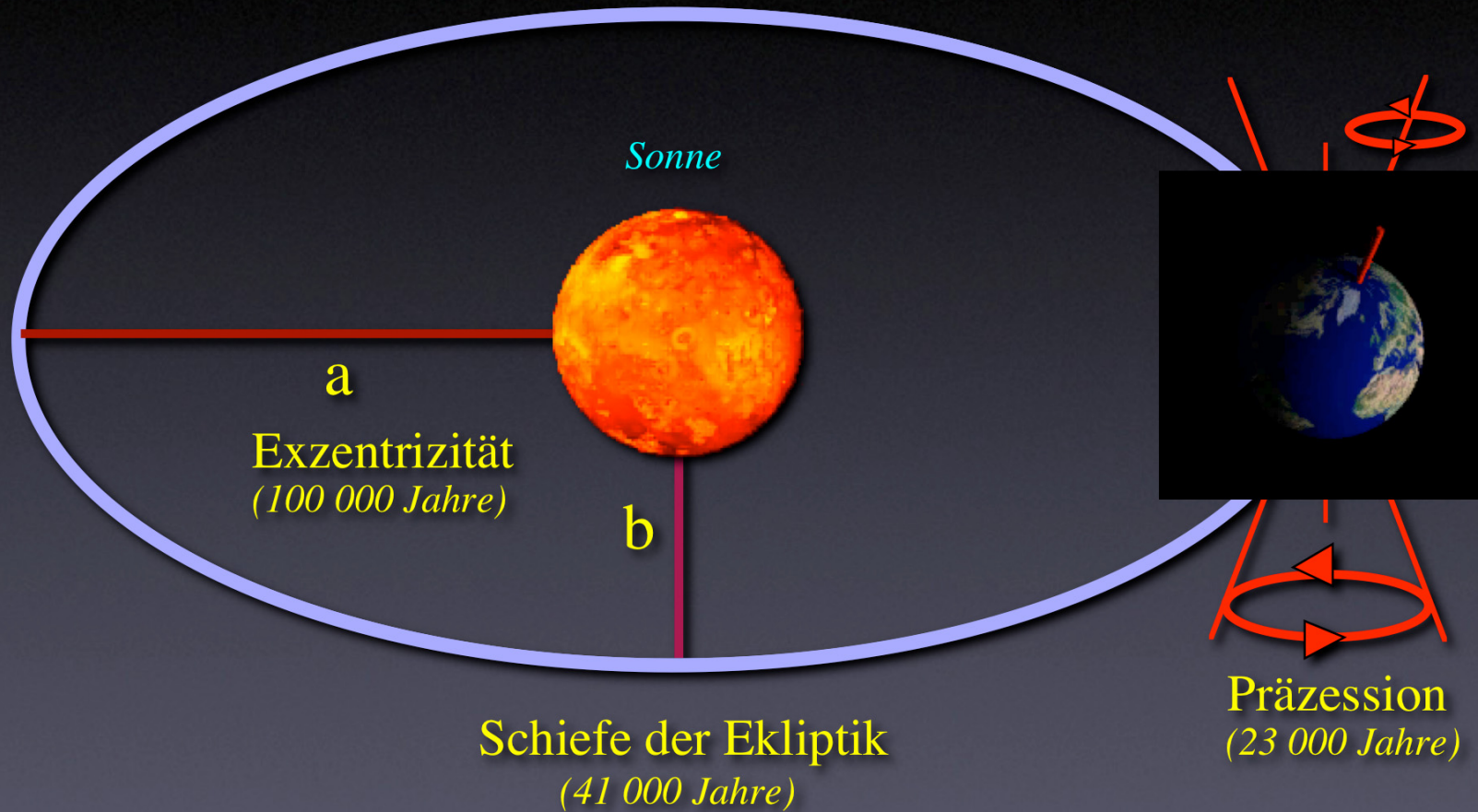


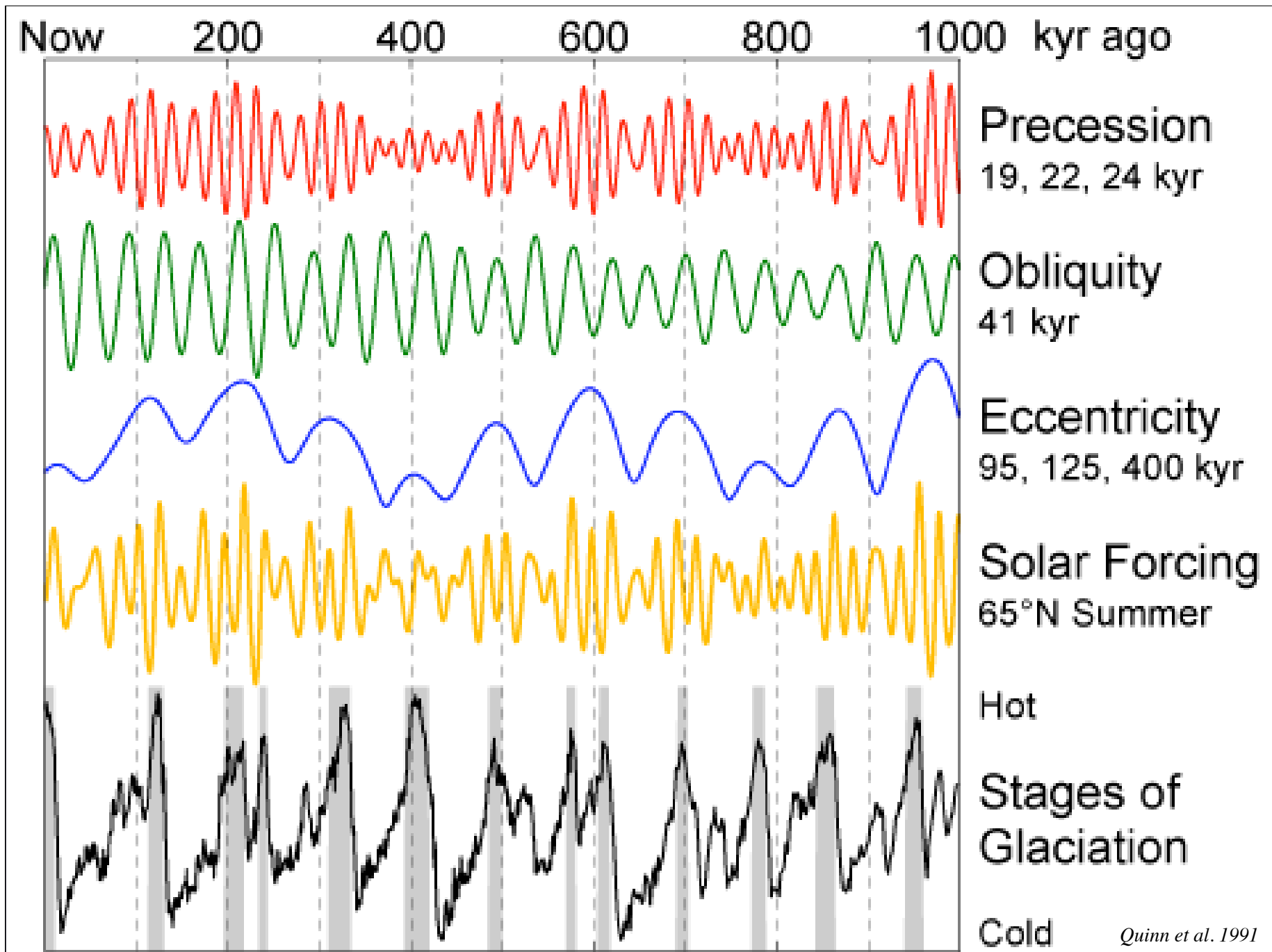
A blue spiral-bound notebook with a silver metal spiral binding at the top. The text is centered on the page in a white, sans-serif font.

Warum gibt es
Kaltzeiten und Warmzeiten
in einem Eiszeitalter ?

(20-100 Tausend Jahre)

Milankovitch Zyklen





Interglacial

high sea level

$\delta_{18}\text{O} = 0 \text{ ‰}$

100 m \approx 1 ‰

Glacial

low sea level

$\delta_{18}\text{O} = 1 \text{ ‰}$

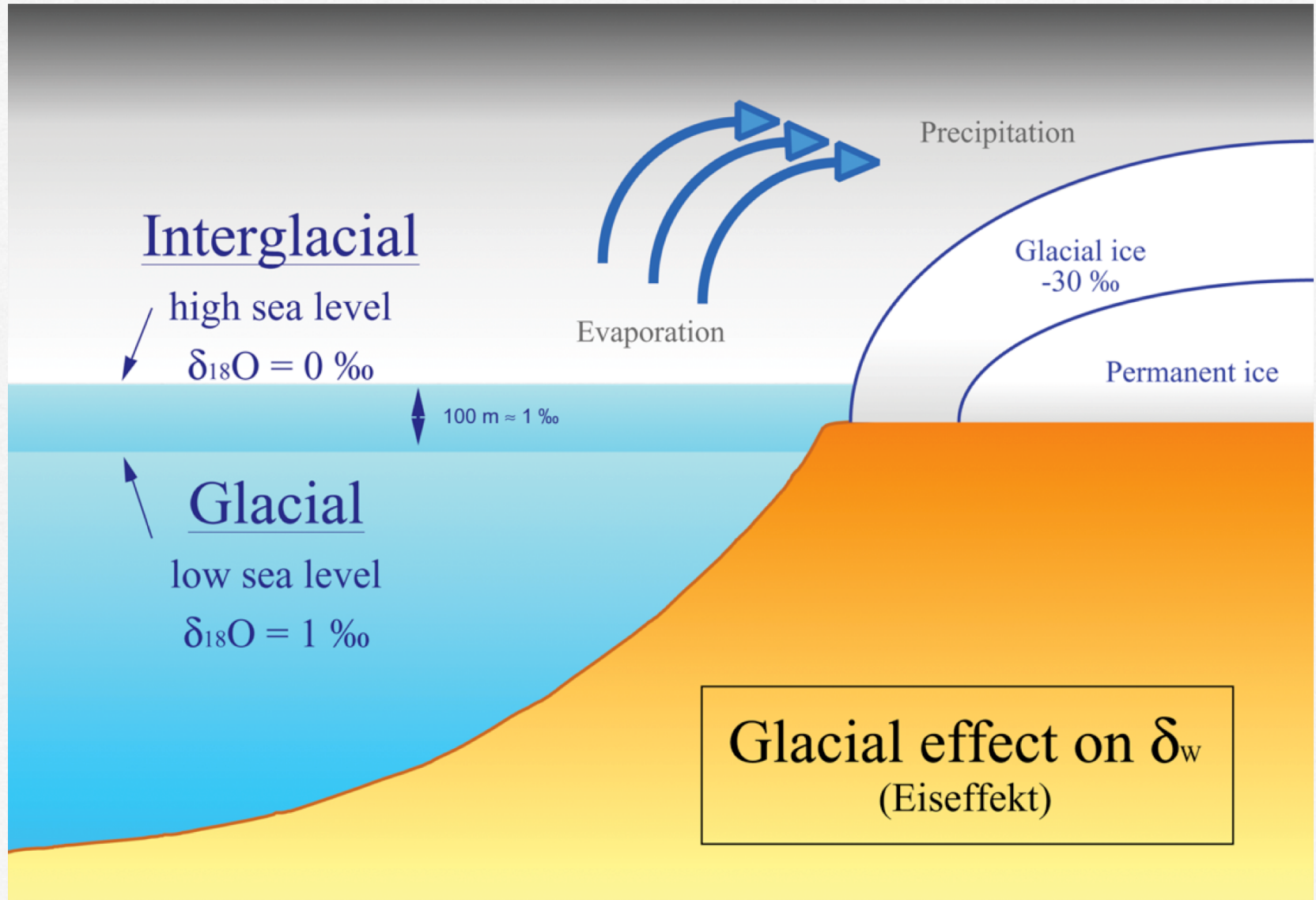
Evaporation

Precipitation

Glacial ice
-30 ‰

Permanent ice

Glacial effect on δ_w
(Eiseffekt)



Mikrofossilien

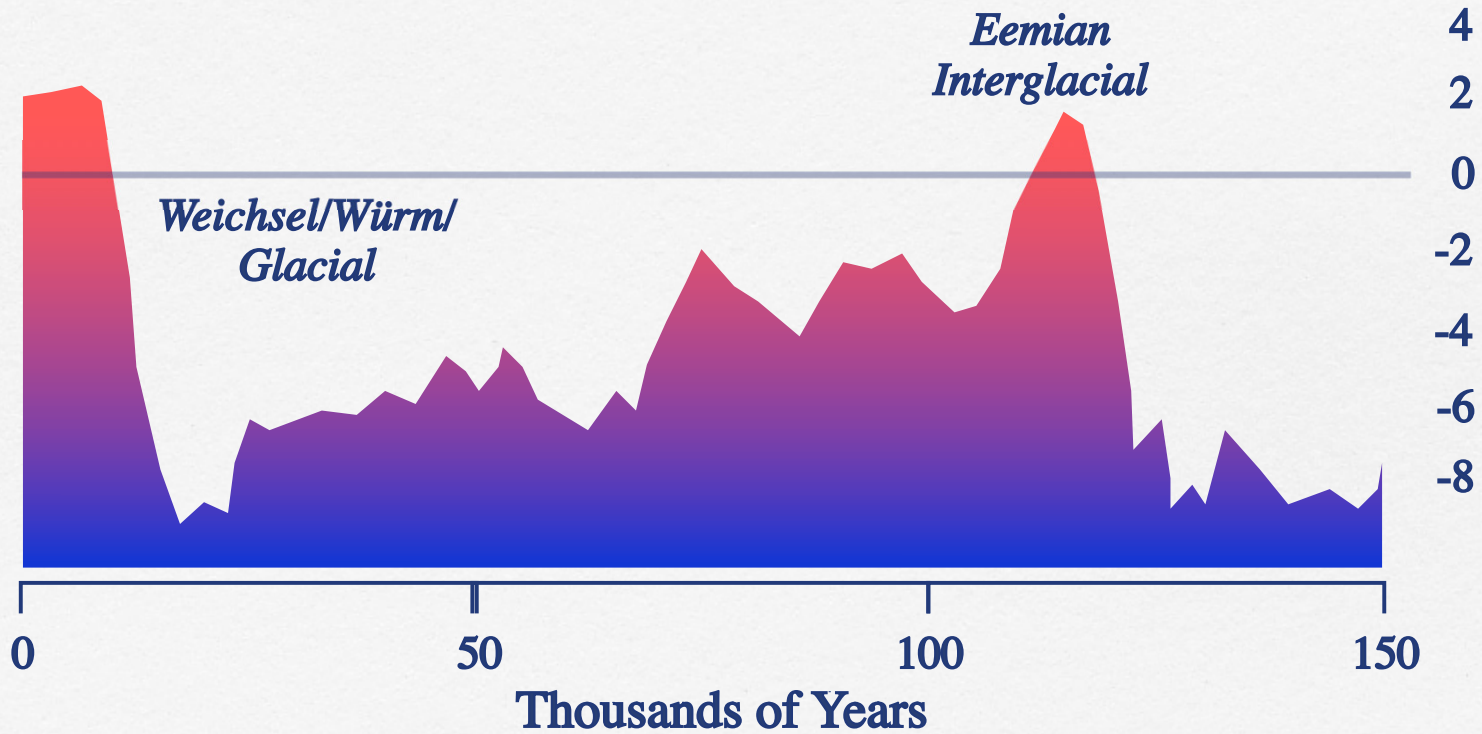


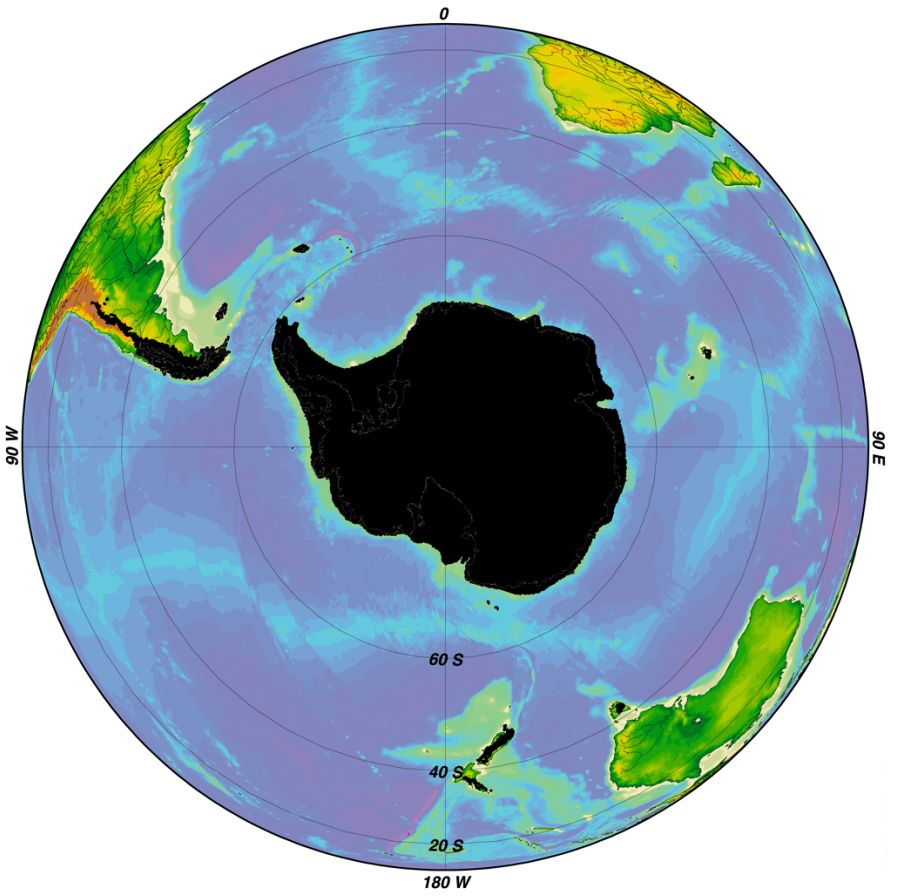
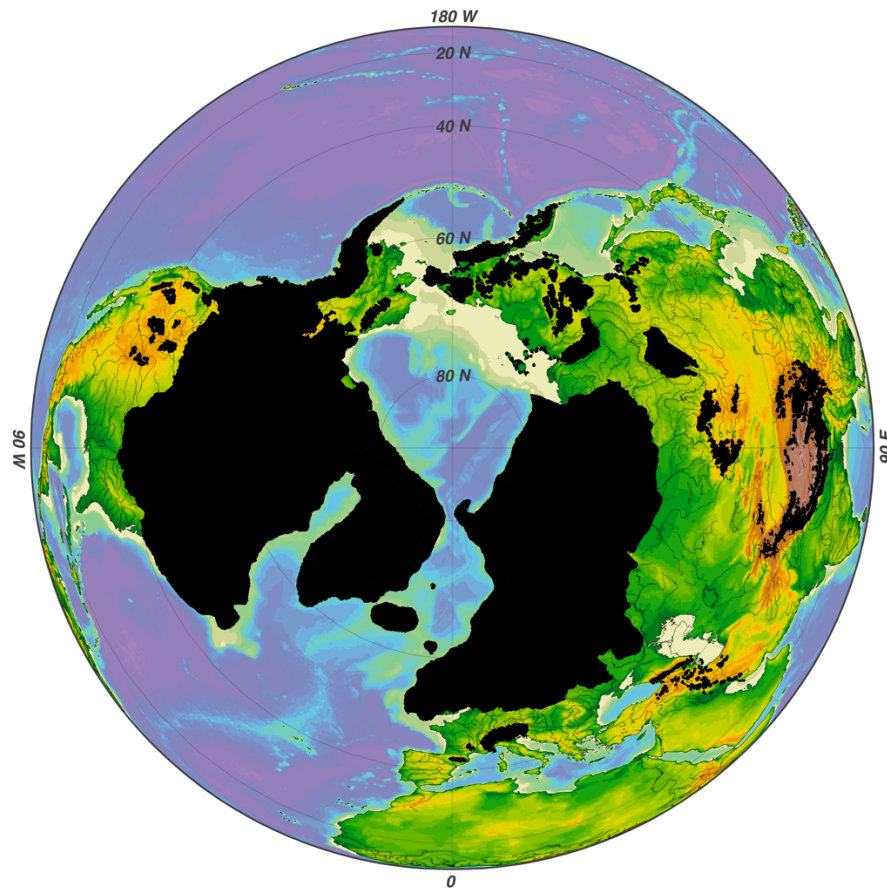
ø 0,5 mm

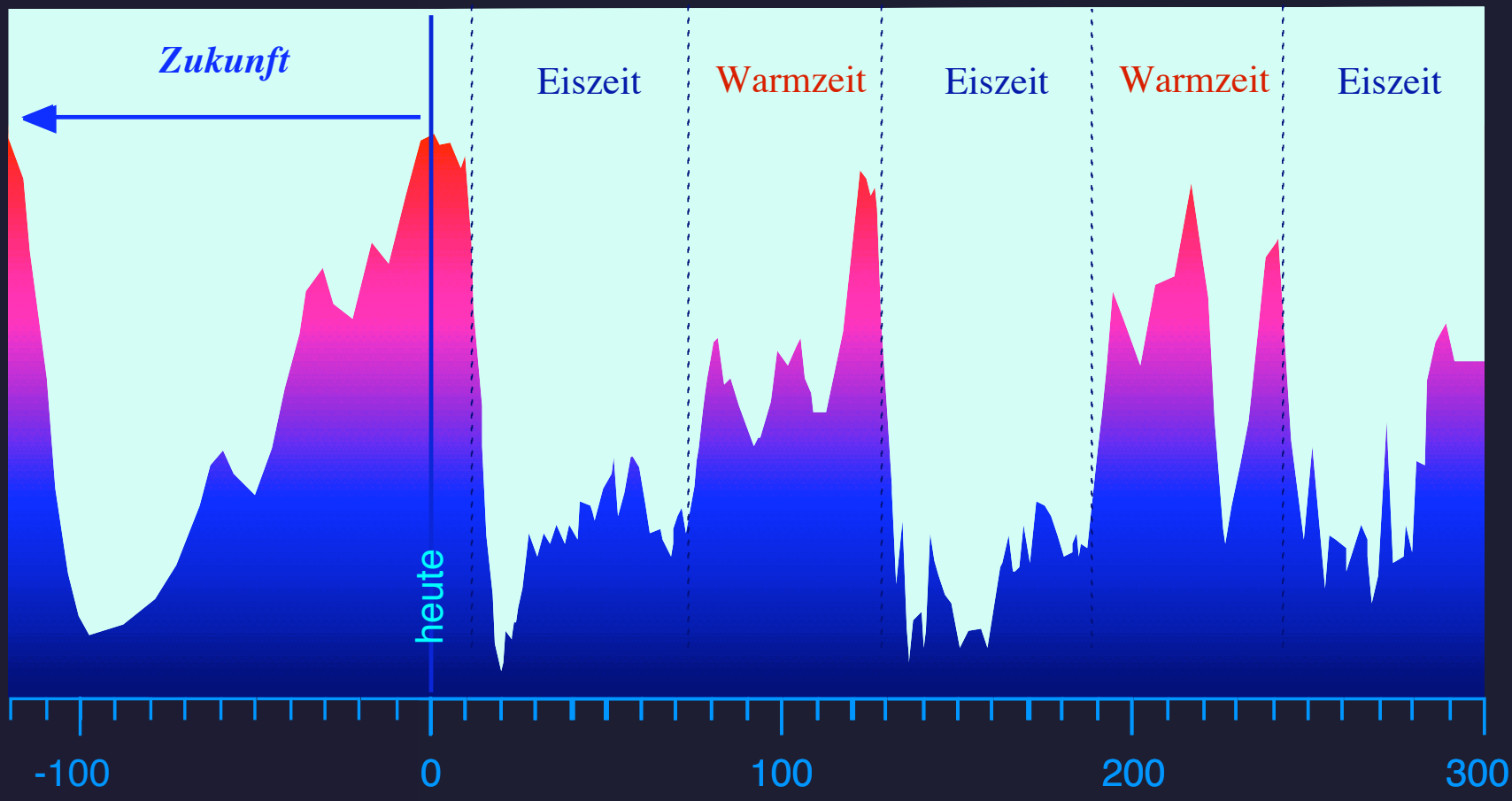
Holocene

Quaternary

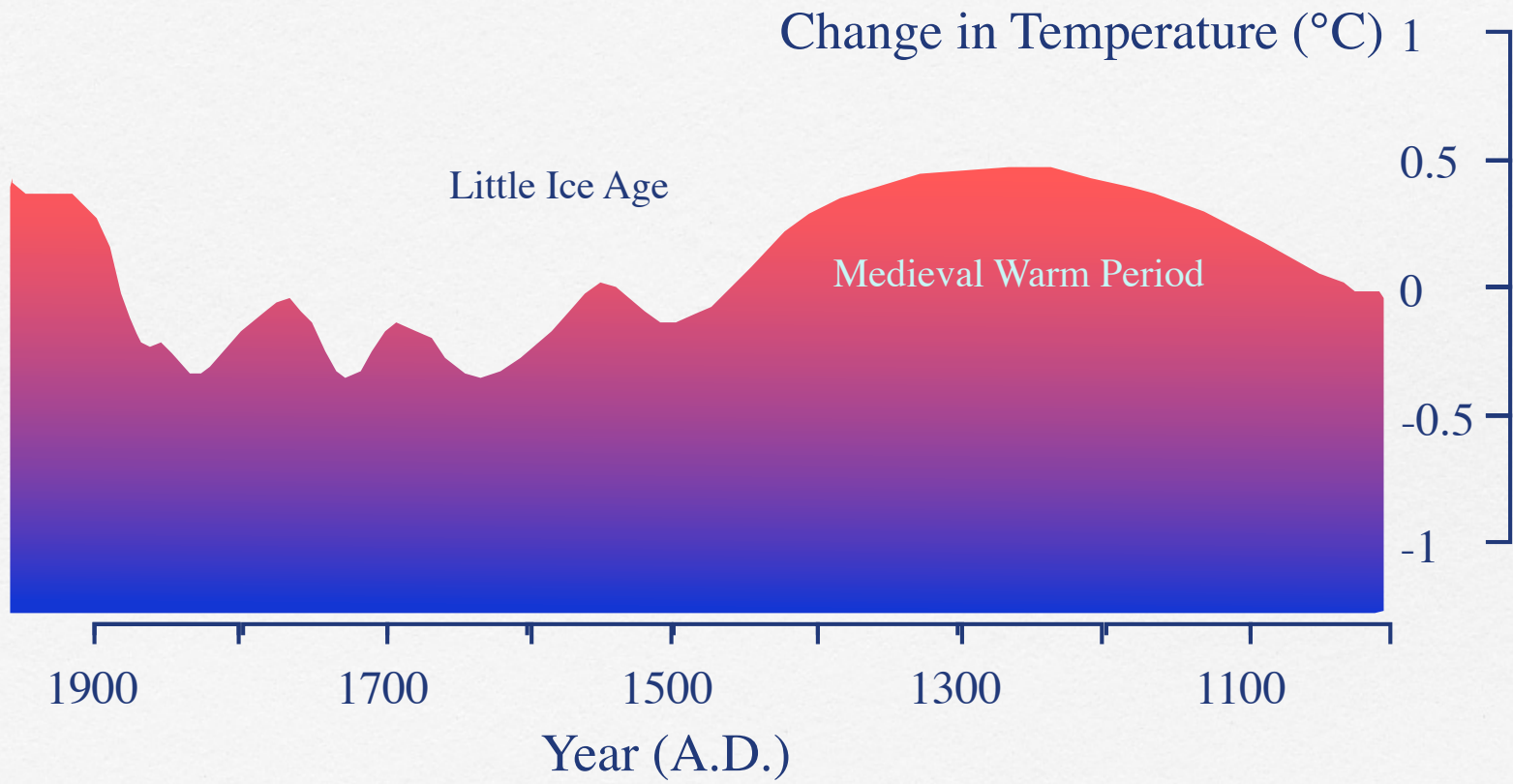
Change in temperature (°C)

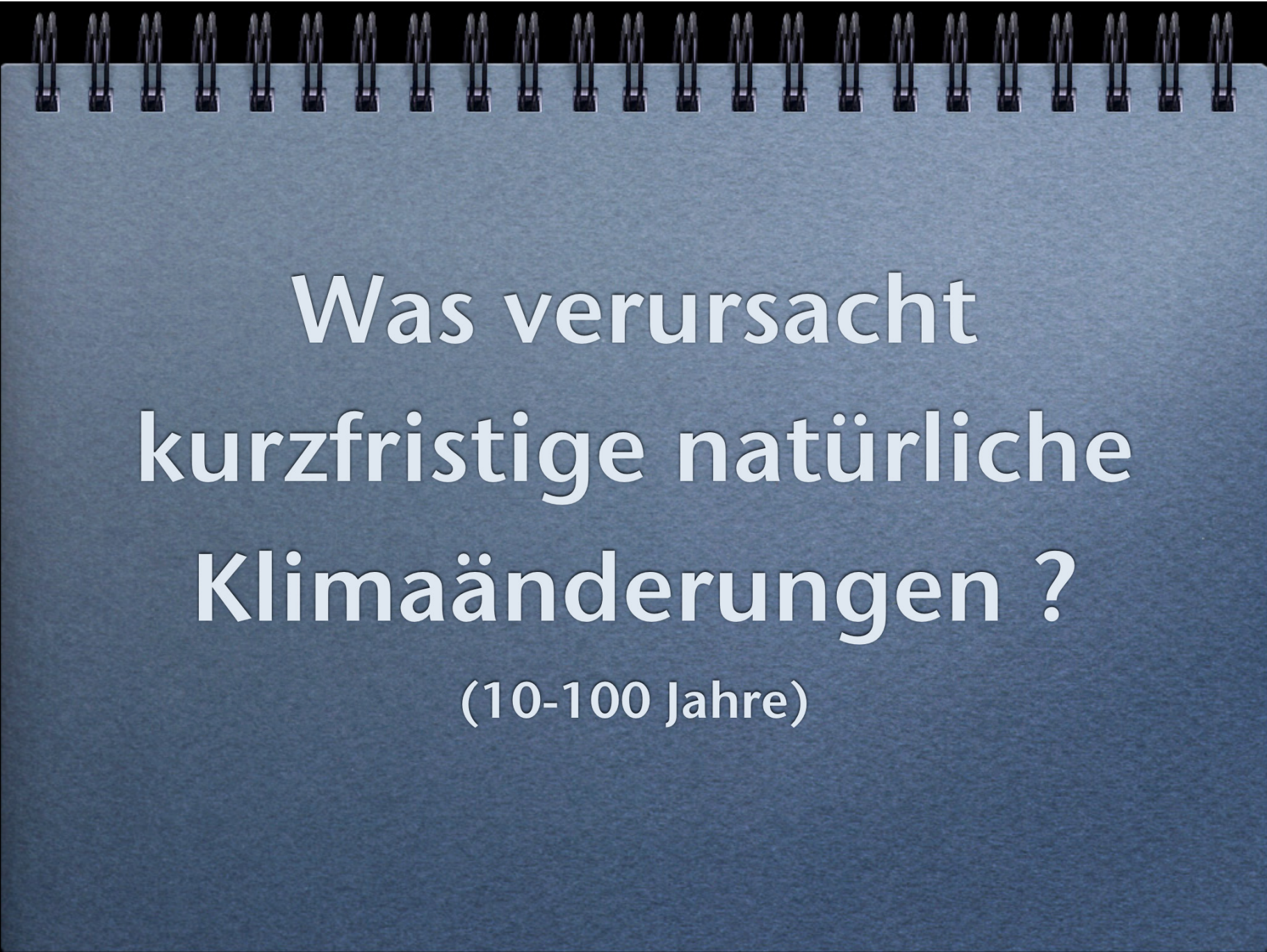






Alter in 1000 Jahren

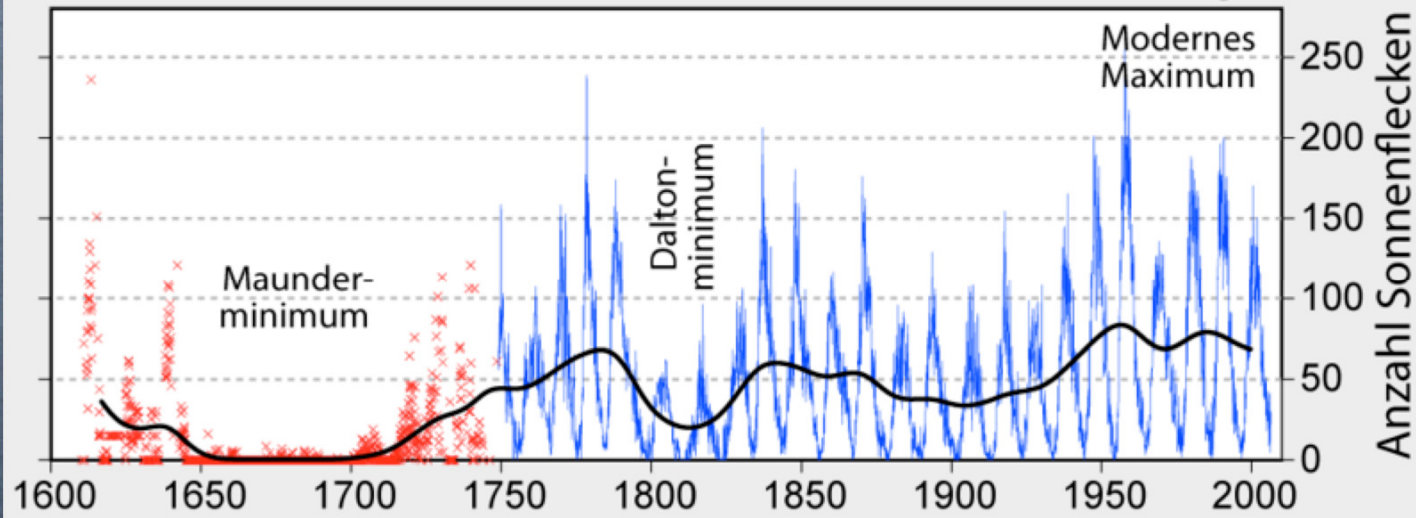


A blue spiral-bound notebook with silver rings at the top. The text is centered on the page.

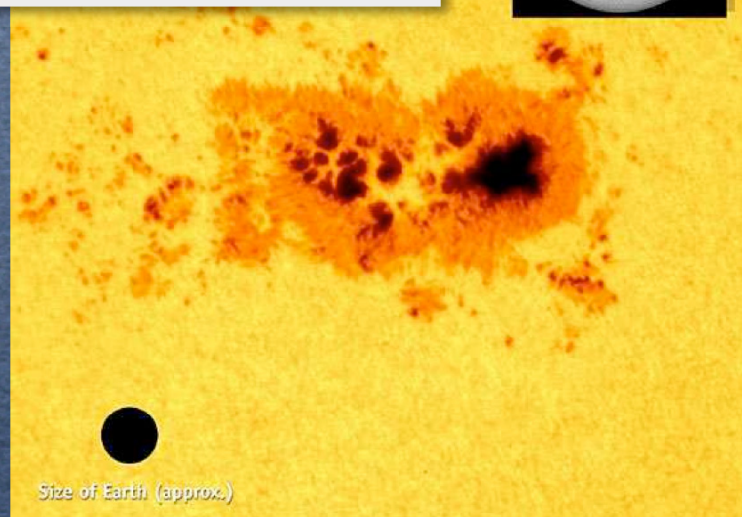
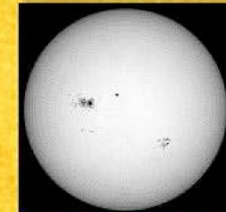
Was verursacht kurzfristige natürliche Klimaänderungen ?

(10-100 Jahre)

400 Jahre Sonnenflecken-Beobachtung



Robert A. Rohde/Global Warming Art



Sonnenflecken



Pieter Bruegel

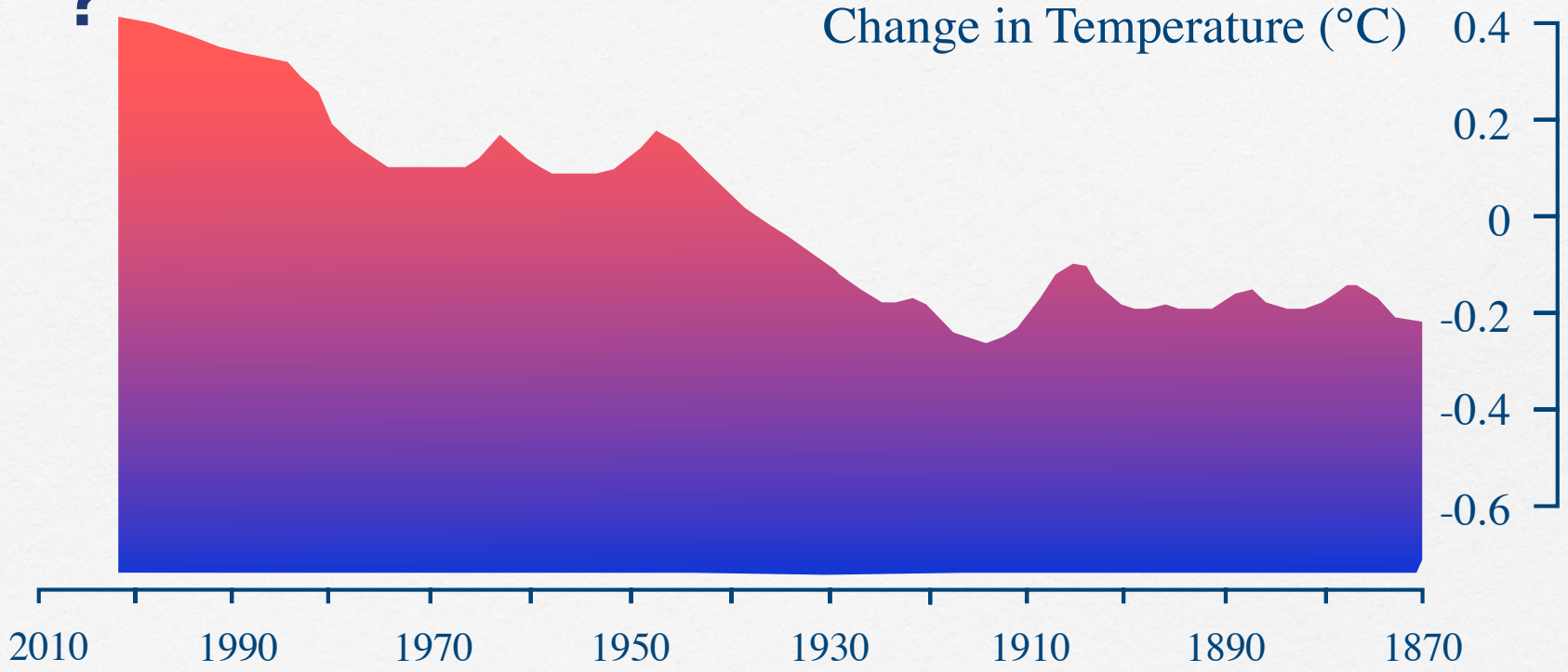
Winter Landscape with a Bird Trap
1565



Antonio Stradivari

?

Change in Temperature (°C)



Year (A.D.)

Klima-
geschichte



Klima-
archive





Korallen

Tropfsteine

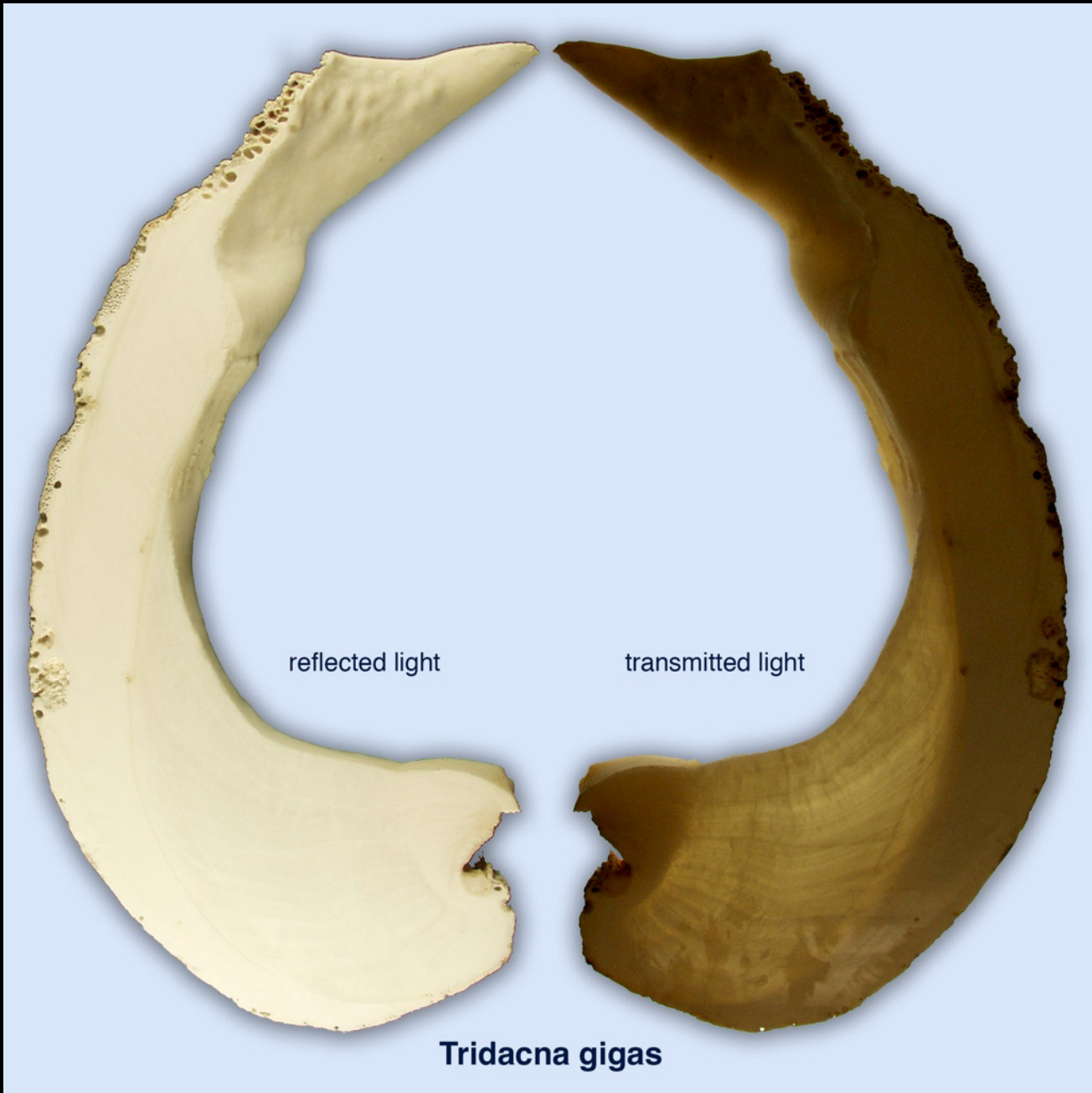






Tridacna gigas

← 55 cm →



reflected light

transmitted light

Tridacna gigas



Geologische Bibliothek

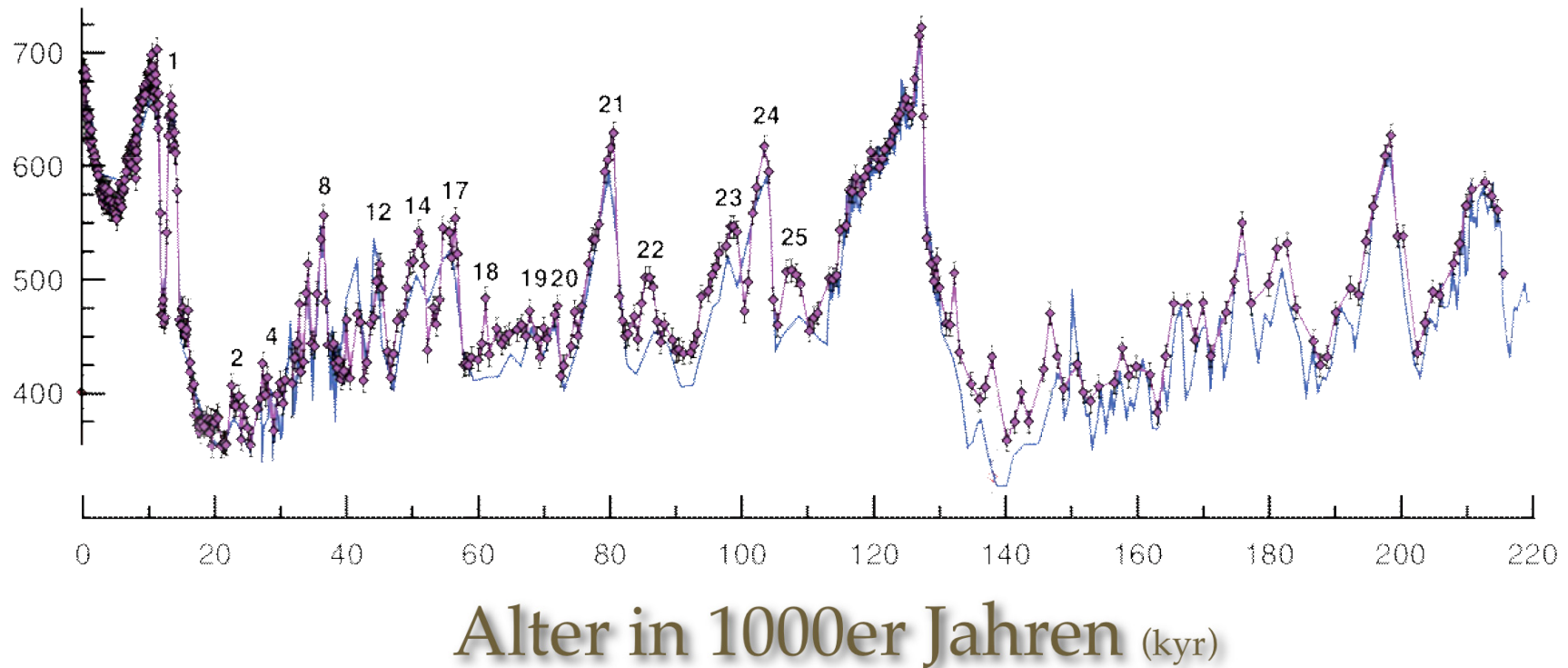


Eis

aktueller Wert
1700 (ppbv)

Methan (ppbv)

Spahni, R et al., Science 2005



Sedimente



Geologische Bohrungen

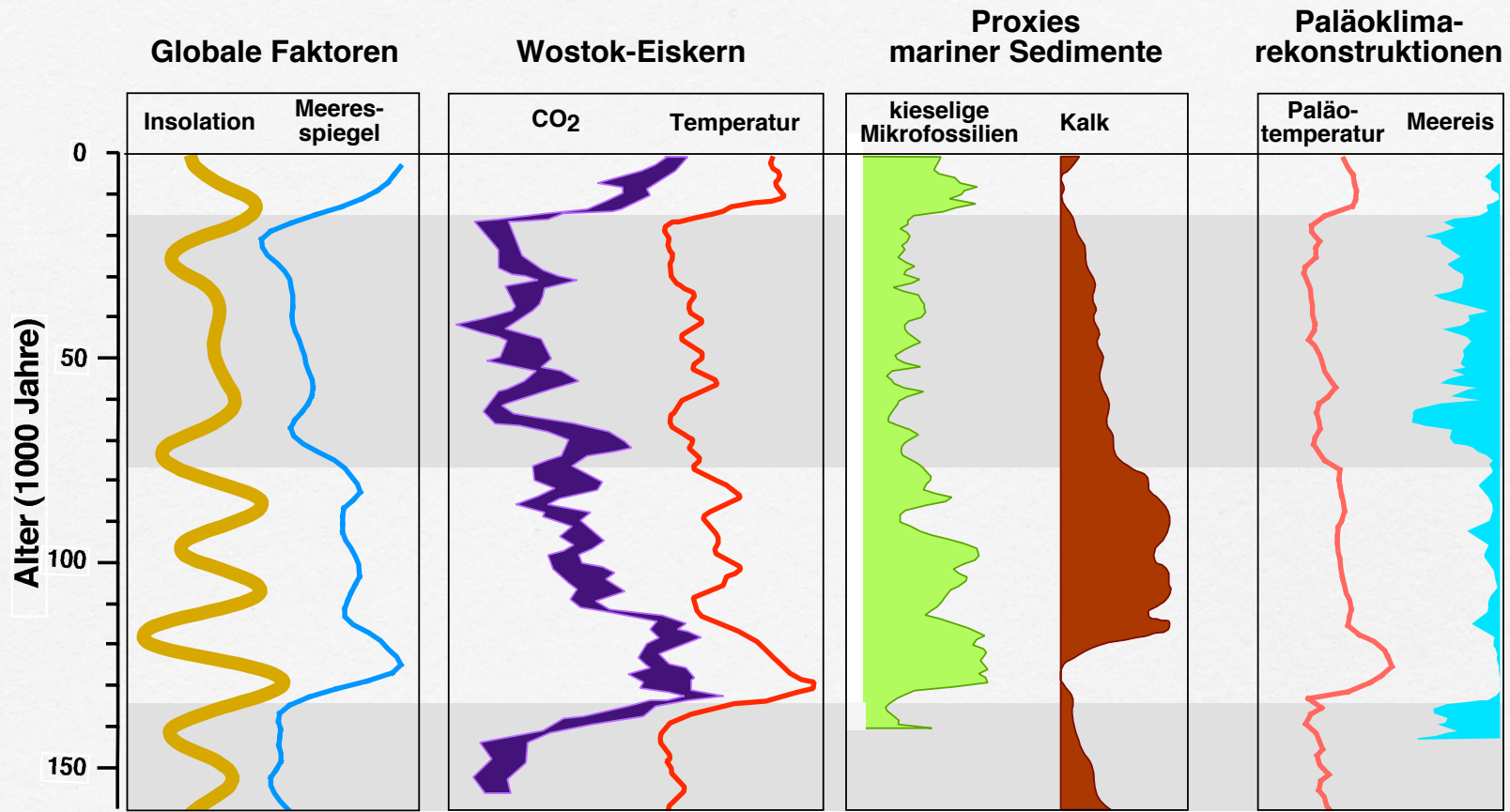


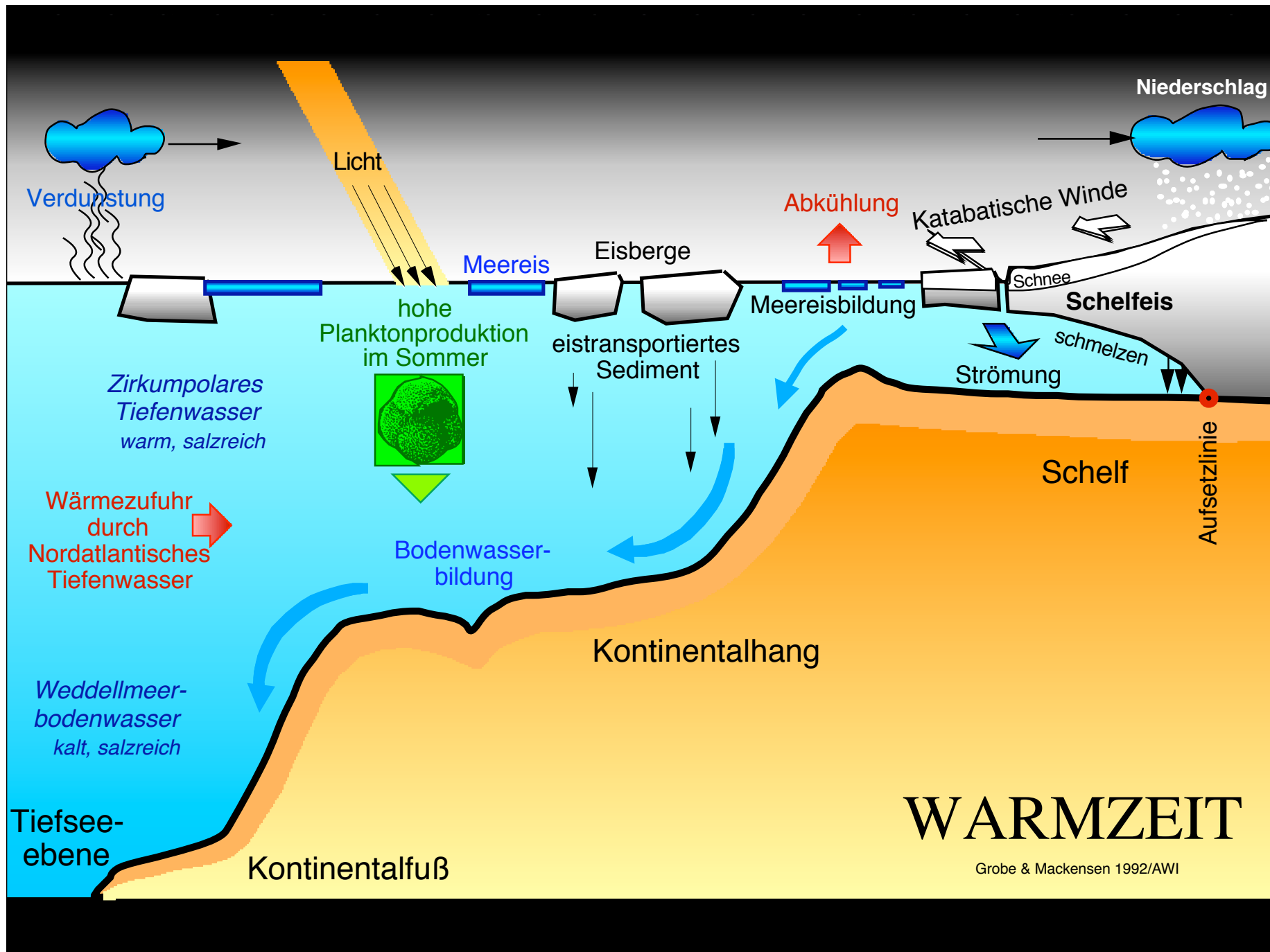
Joides Resolution



Aurora Borealis

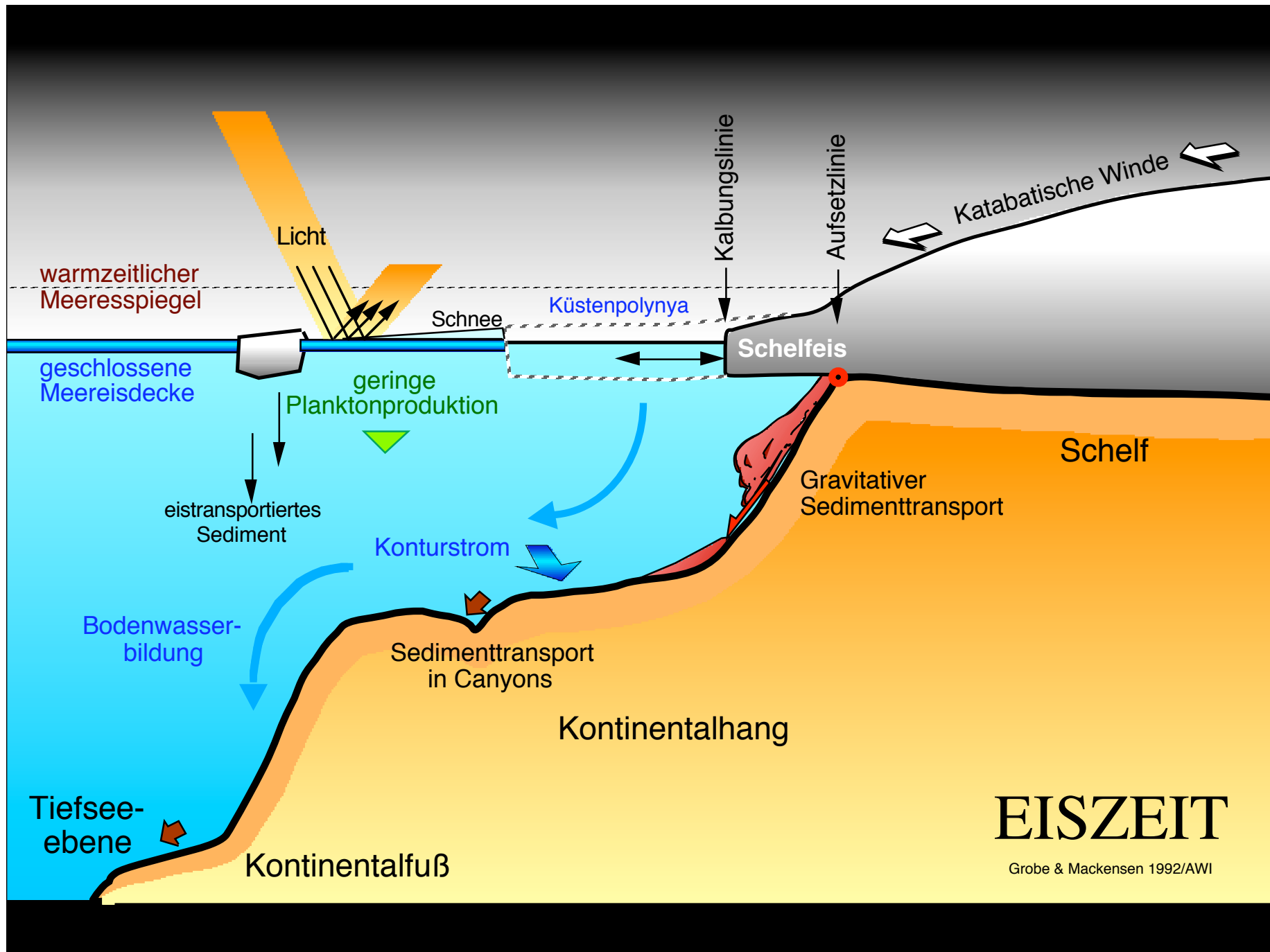






WARMZEIT

Grobe & Mackensen 1992/AWI



warmzeitlicher Meeresspiegel

geschlossene Meereisdecke

Licht

Schnee

Küstenpolynya

Kalbungslinie

Aufsetzlinie

Katabatische Winde

Schelfeis

geringe Planktonproduktion

Schelf

eistransportiertes Sediment

Gravitativer Sedimenttransport

Konturstrom

Bodenwasserbildung

Sedimenttransport in Canyons

Kontinentalhang

Tiefseeebene

Kontinentalfuß

EISZEIT

Grobe & Mackensen 1992/AWI

Entwicklung des CO₂-Gehaltes in der Atmosphäre

