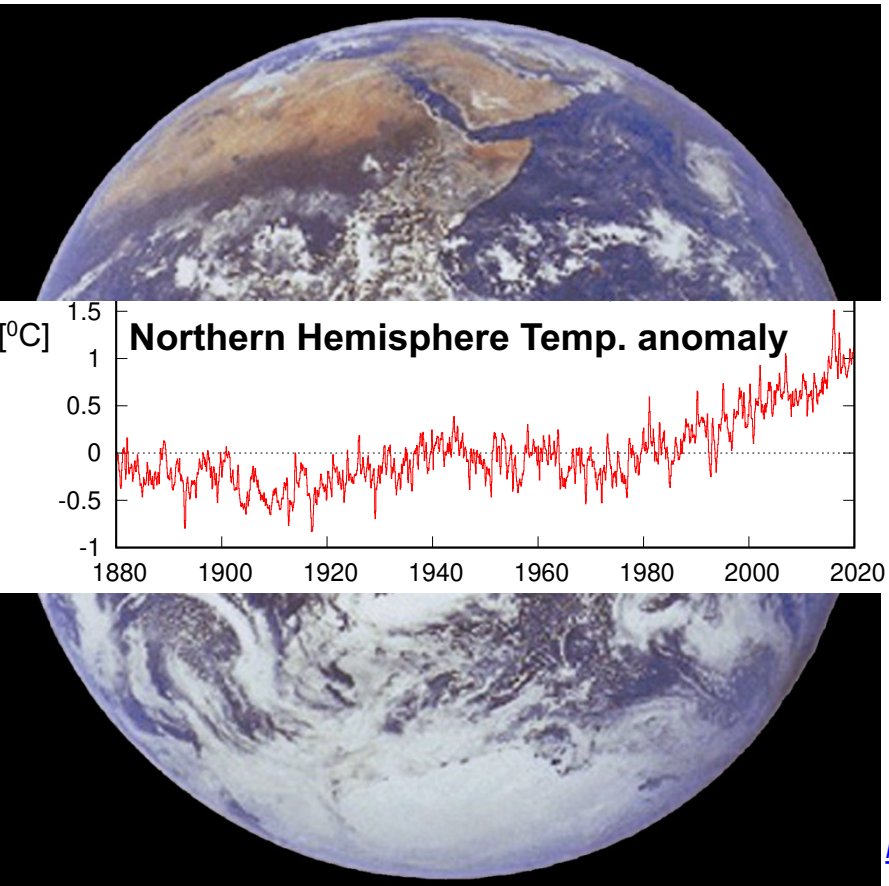
Vorlesung “Planetare Gesundheit - Wie steht es um Patientin Erde?

Veränderte Klimazonen



Gerrit Lohmann

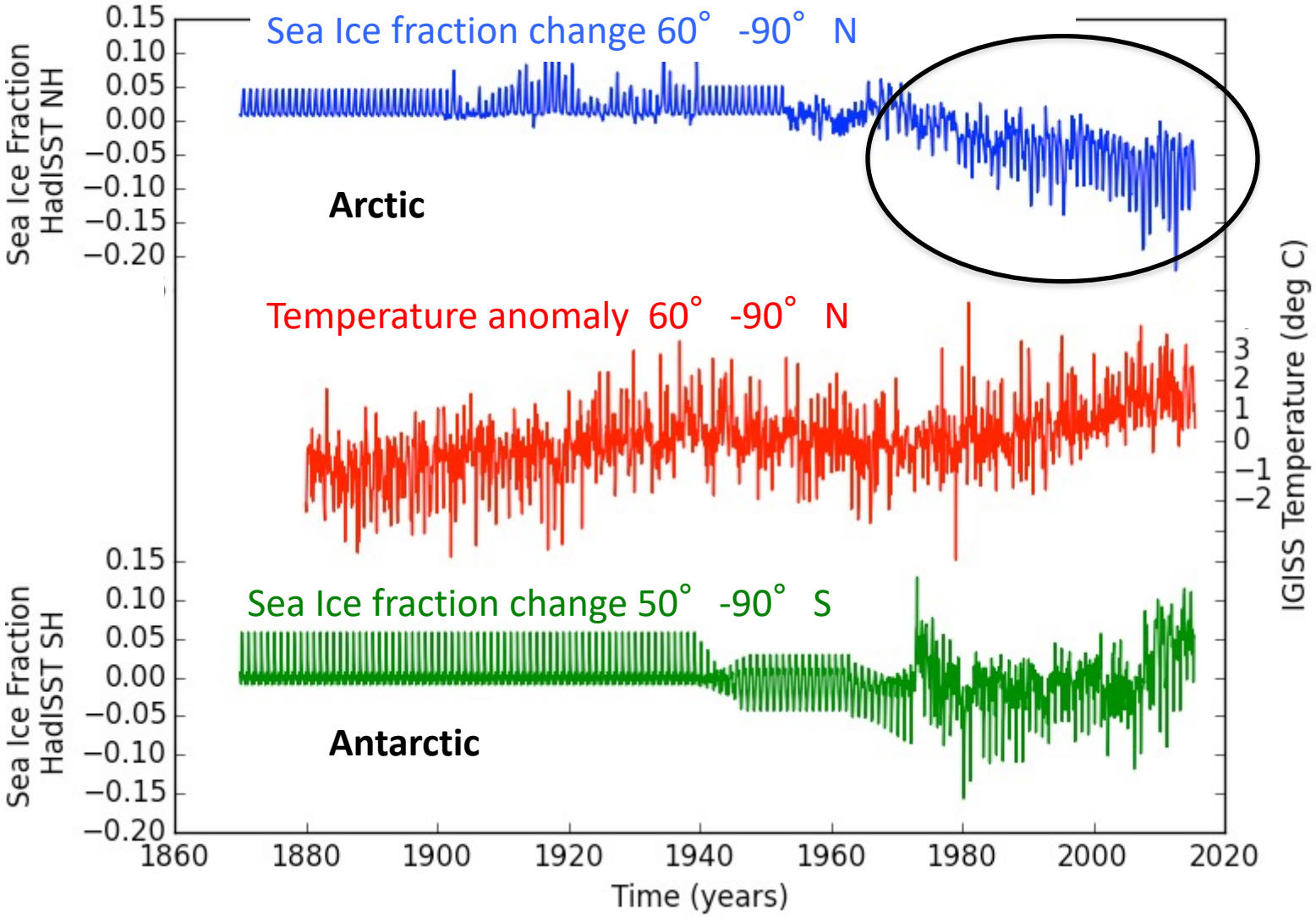
Alfred Wegener Institut

& Universität Bremen

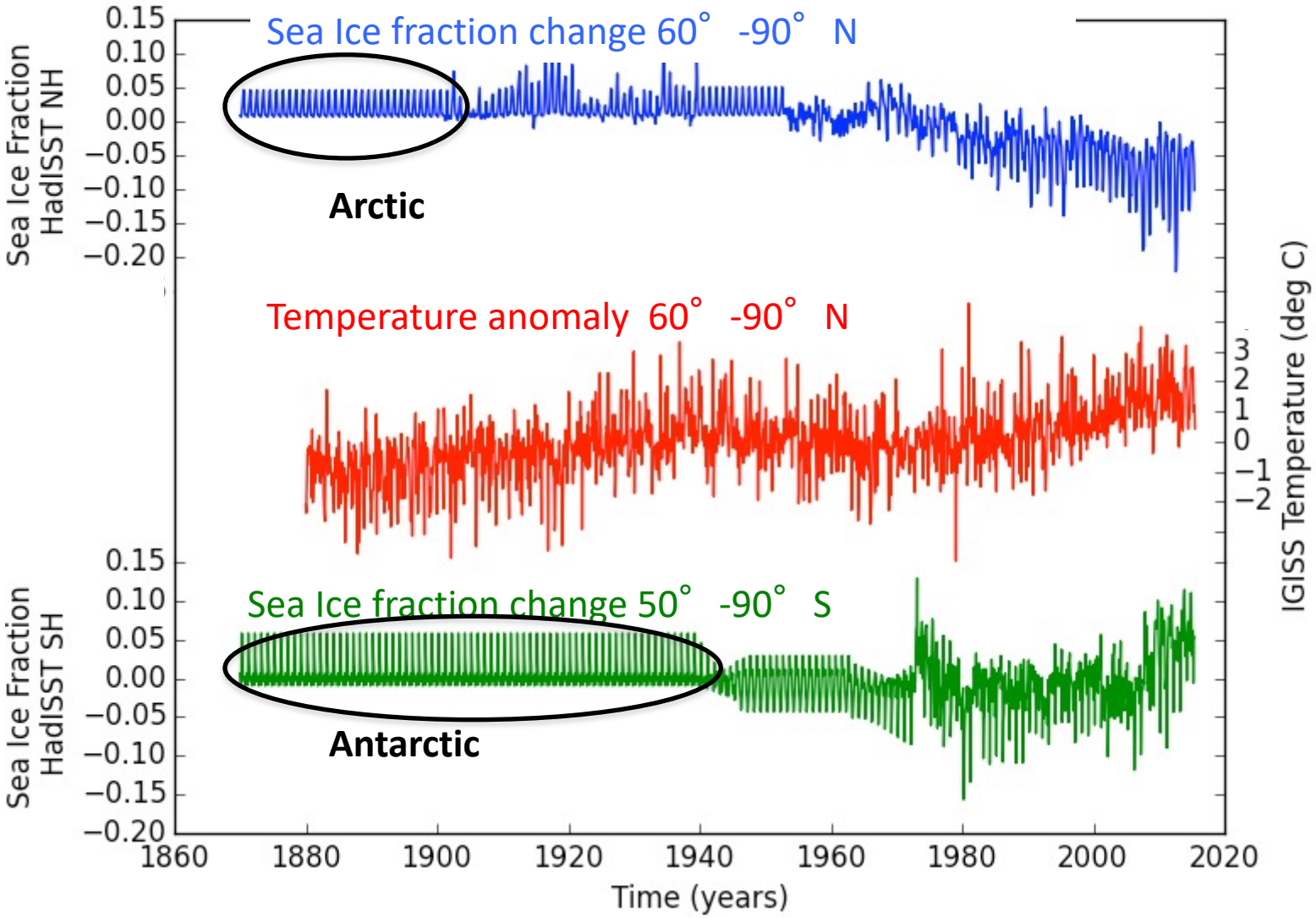
Aachen 10.11.2021

https://rwth.zoom.us/j/95580211741?pwd=enNWbTJnRnM0dzVYSUhSUUE2SzJ1UT09

Rückgang des Arktischen Meereises



Lückenhafte Information Meereis



Das „Klimadilemma“

- Die Aufzeichnungen direkter Temperatur-messungen sind kurz und fallen bereits in der Phase starken Einflusses des Menschen.

- Für die Zeit vor instrumentellen Aufzeichnungen ist man auf indirekte Informationen über vergangene Umweltbedingungen angewiesen

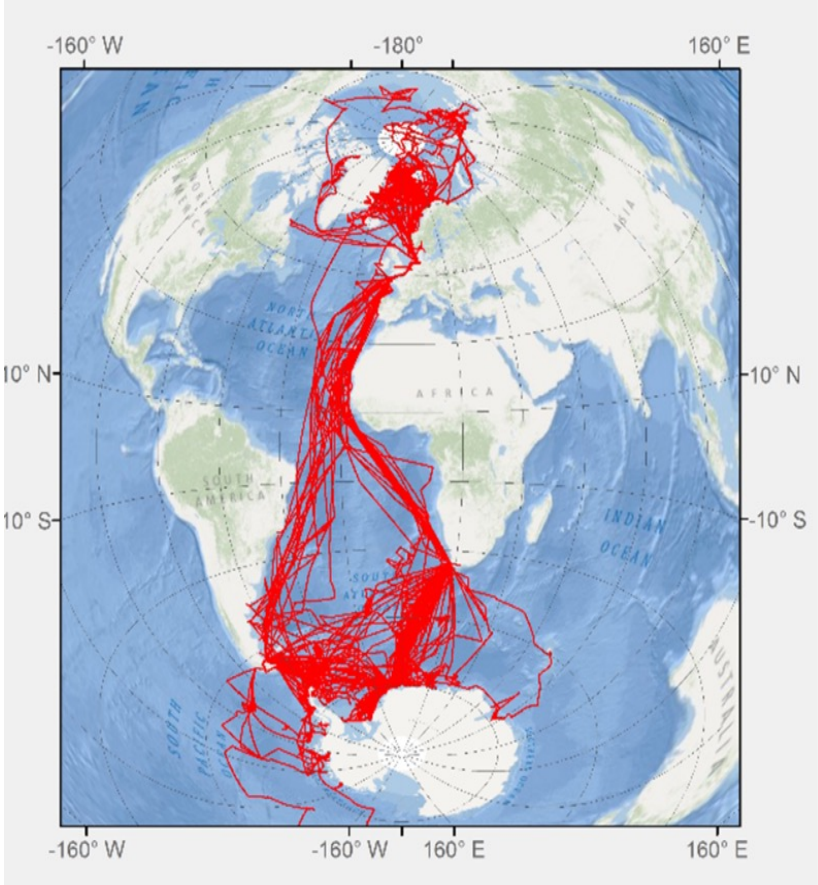
AWI in Deutschland

ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

Bremerhaven

Forschungsinfrastruktur

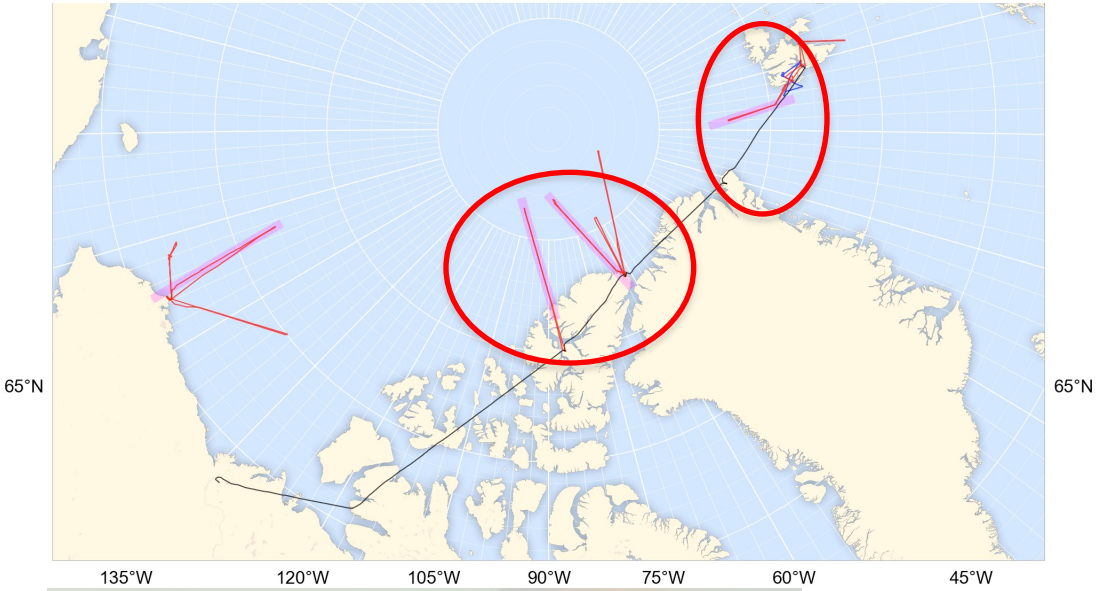
Research Icebreaker „POLARSTERN



https://www.awi.de/expedition/schiffe/polarstern.html
Mosaic Expedition: https://mosaic-expedition.org/
https://mosaic-expedition.org/expedition/

Meereis: Beobachtungen

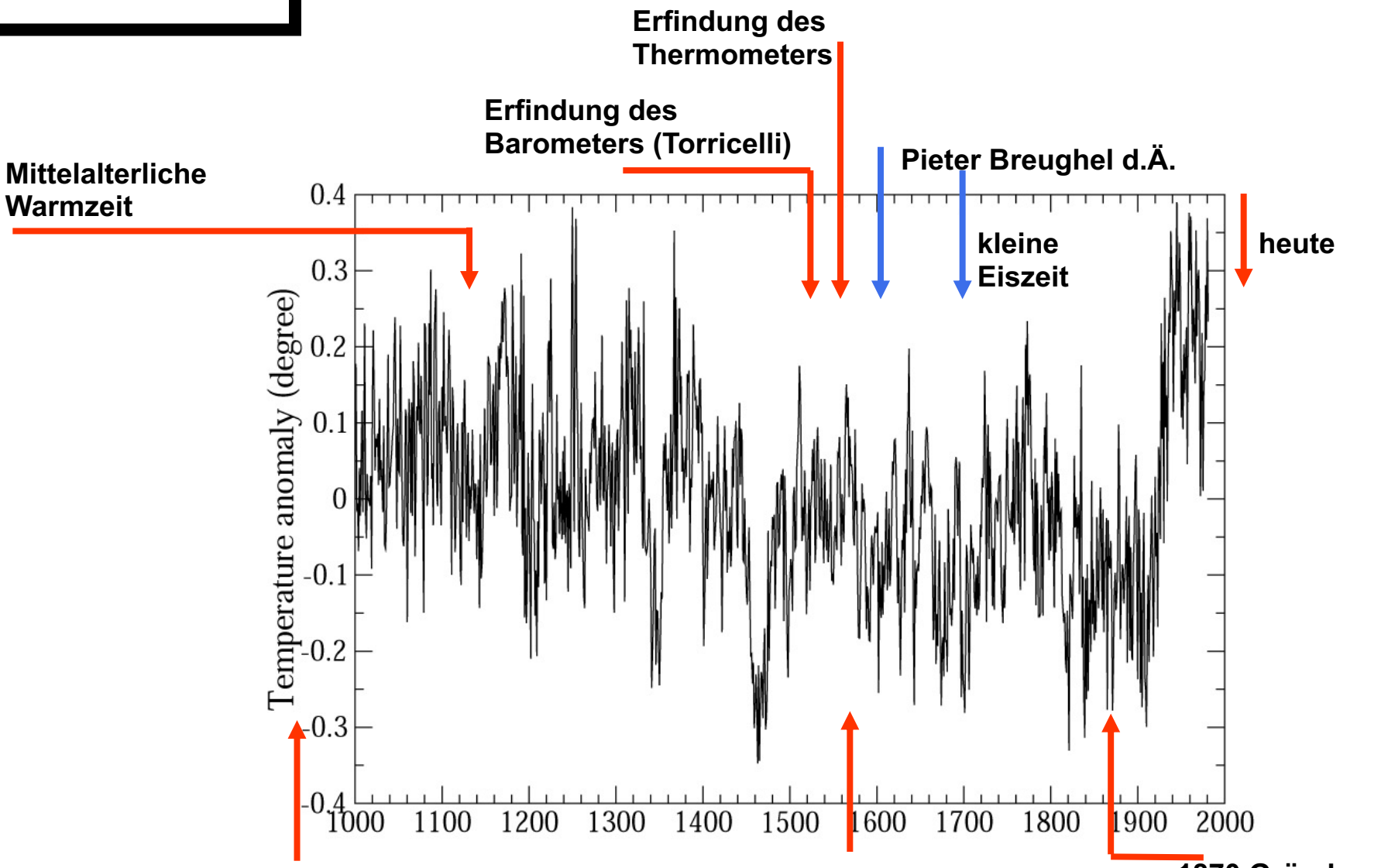
Frühjahr 2015



Regionen von Eismessungen mit Polar 5/6: Lincoln Sea and Fram Straße

Geschichte

letzte **1000 Jahre**



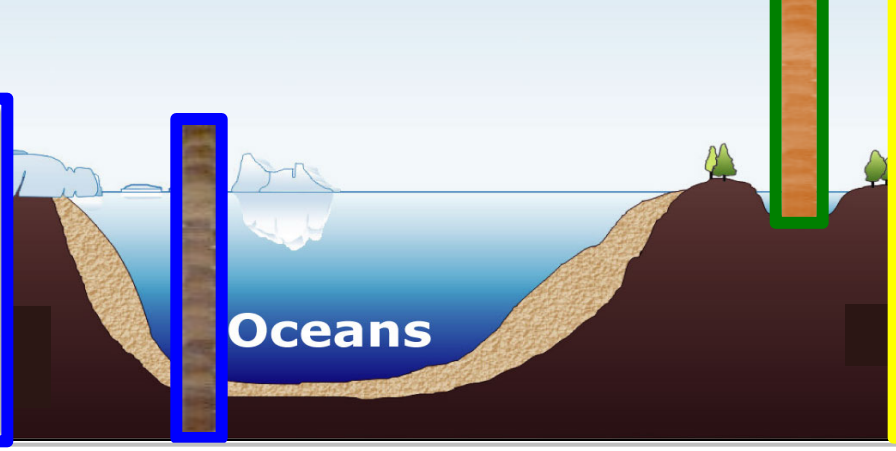
Analysewerkzeuge zum Klima

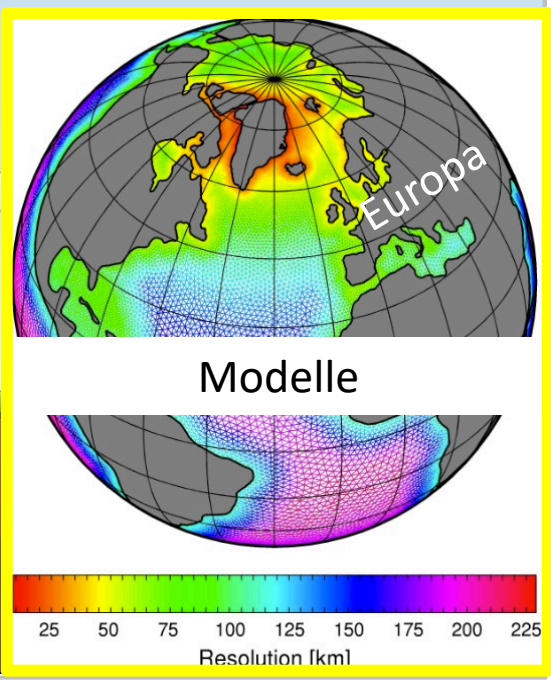
Eisbohrungen

Marine Sedimente

Seesedimente /Permafrost

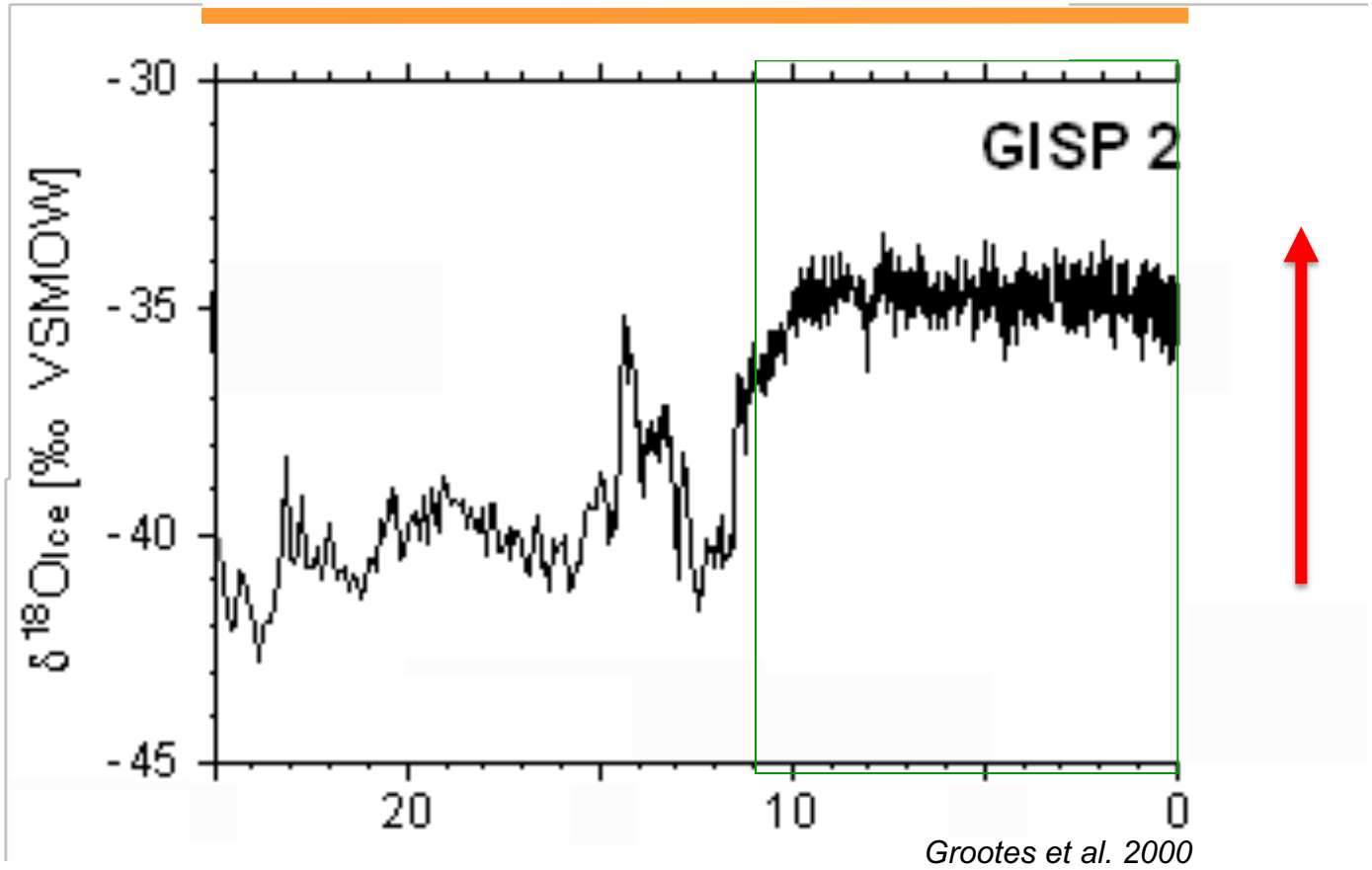
Beobachtungen, Rekonstruktionen & Modelle





Klimatrends auf verschiedenen Zeitskalen

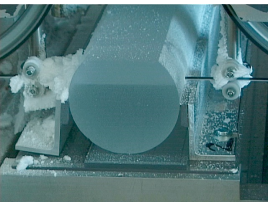
Grönländischer Eiskern



Tausend Jahre vor heute

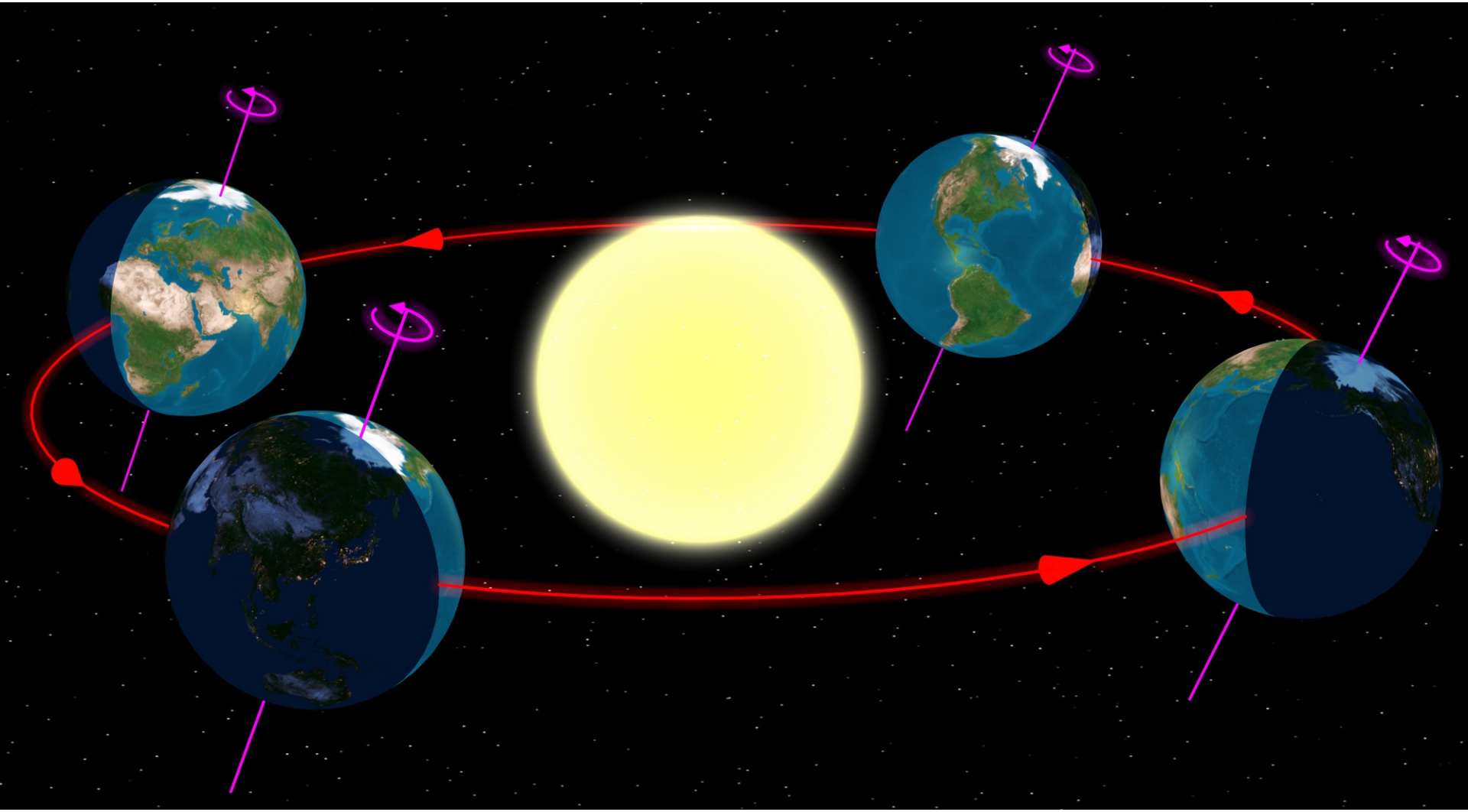
Treibhausgas Konzentrationen: Eiskerne

414

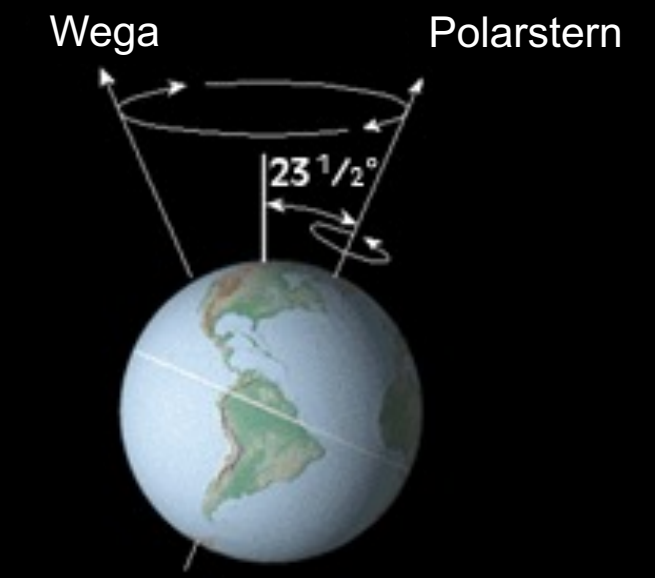


Zeit (Tausend Jahre vor Heute)

Geometrie der Bewegung der Erde um die Sonne



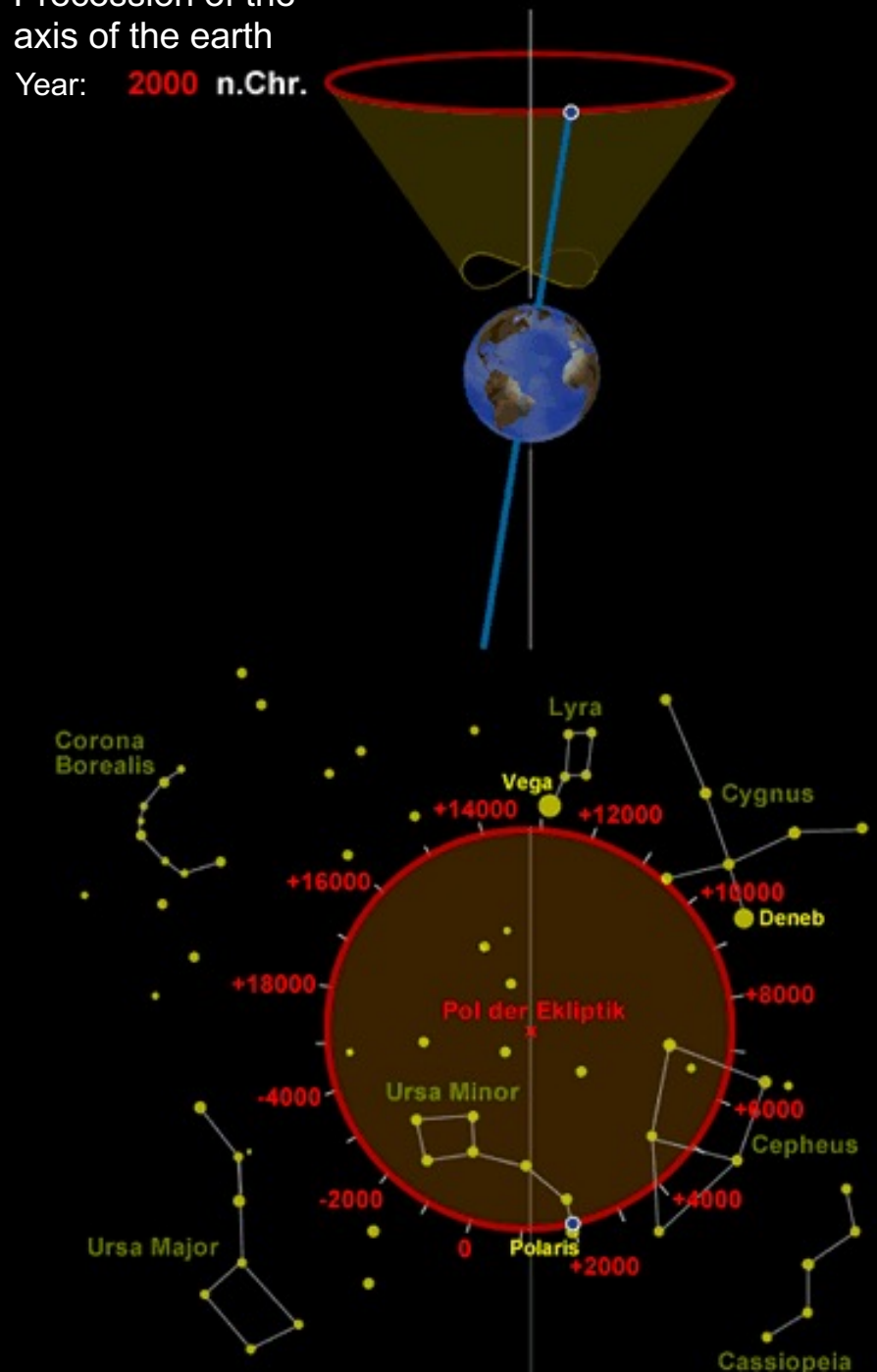
https://en.wikipedia.org/wiki/Season#/media/File:BlueMarble_monthlies_animation.gif

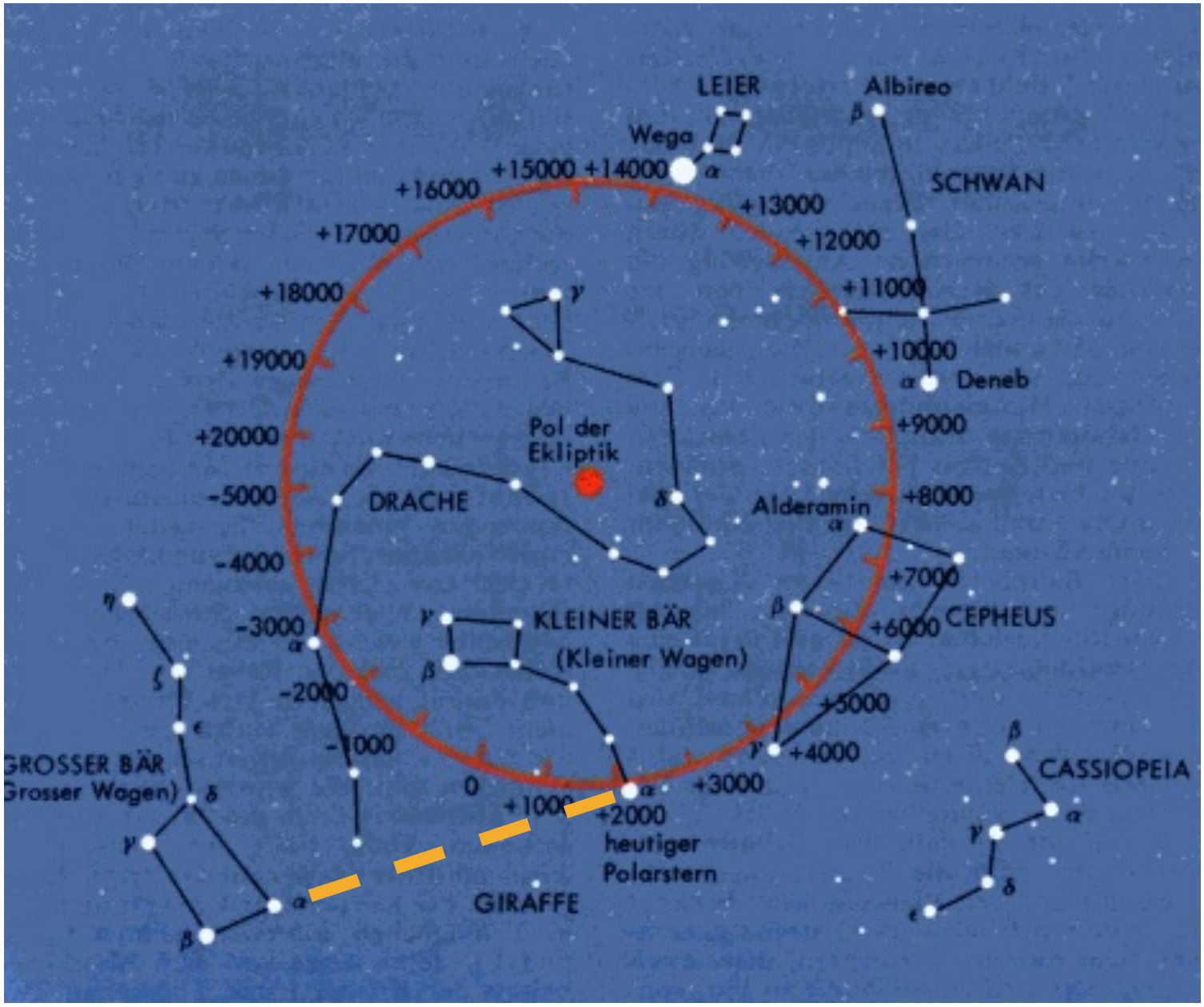


Präzession

Neigung

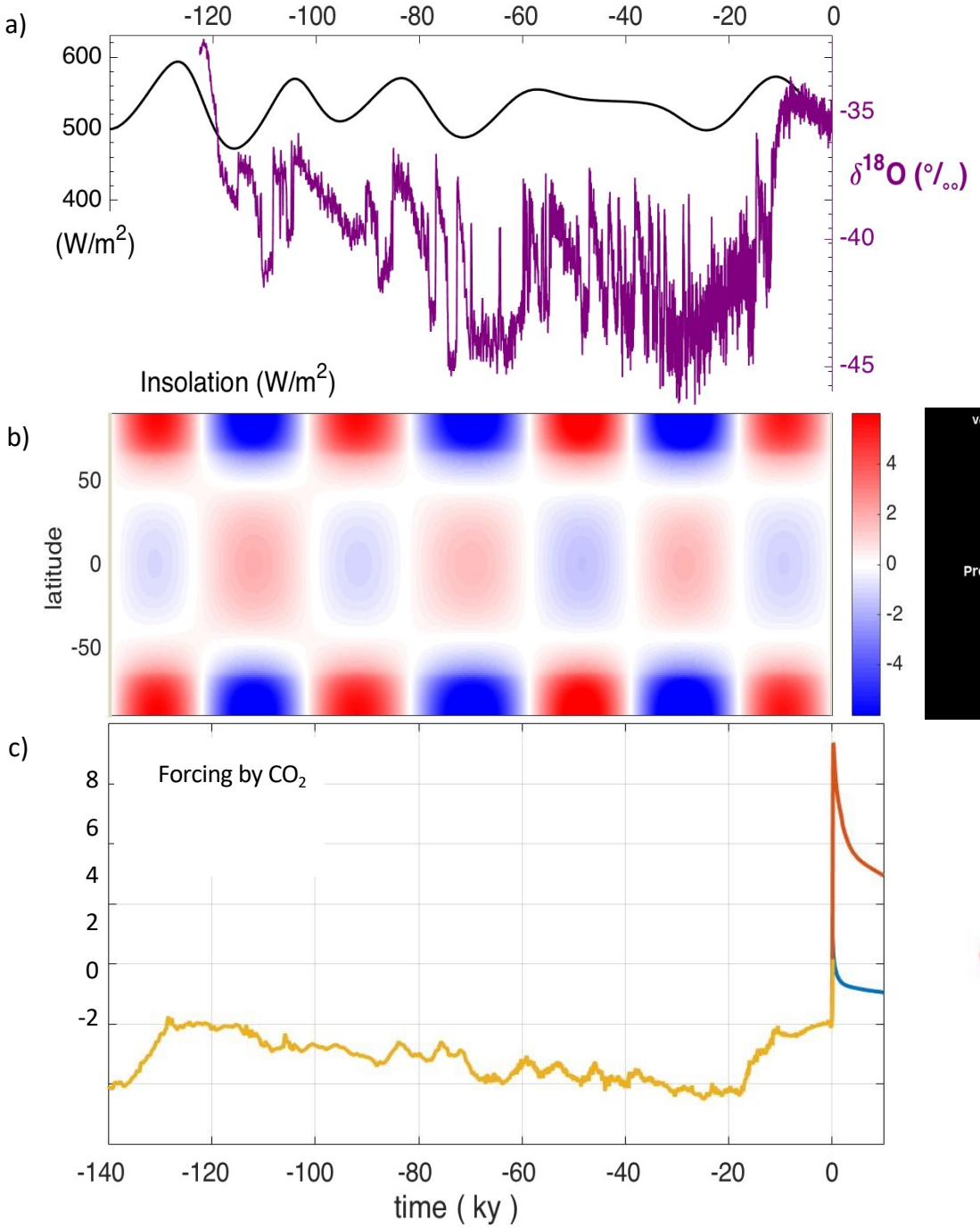
Exzentrizität


Precession of the
axis of the earth
Year: 2000 n.Chr.
Lyra
Corona
Borealis
Vega
Cygnus
+14000
+12000
+16000
+10000
Deneb
+18000
+8000
Pol der Ekliptik
-4000
Ursa Minor
+6000
Cepheus
-2000
+4000
Ursa Major
0
Polaris
+2000
Cassiopeia

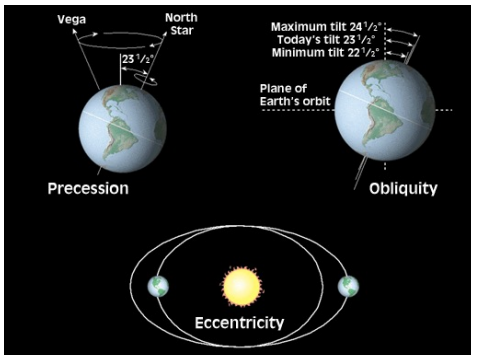

LEIER
Wega
α
Albireo
β
SCHWAN
+15000
+14000
+16000
+13000
+17000
+12000
+18000
+11000
γ
+19000
+10000
α
Deneb
+20000
+9000
Pol der
Ekliptik
-5000
DRACHE
δ
Alderamin
α
+8000
-4000
+7000
η
γ
KLEINER BÄR
(Kleiner Wagen)
β
-3000
α
β
+6000
CEPHEUS
ζ
-2000
ε
+5000
-1000
γ
+4000
GROSSER BÄR
(Grosser Wagen)
δ
0
α
+3000
+1000
+2000
heutiger
Polarstern
γ
α
β
GIRAFFE
β
CASSIOPEIA
α
γ
δ
ε

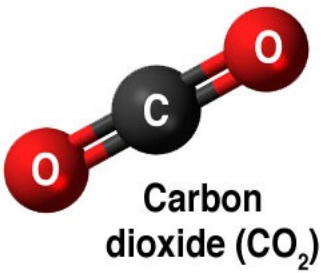
lokale Sommer Einstrahlung

Einstrahlung im Jahresmittel



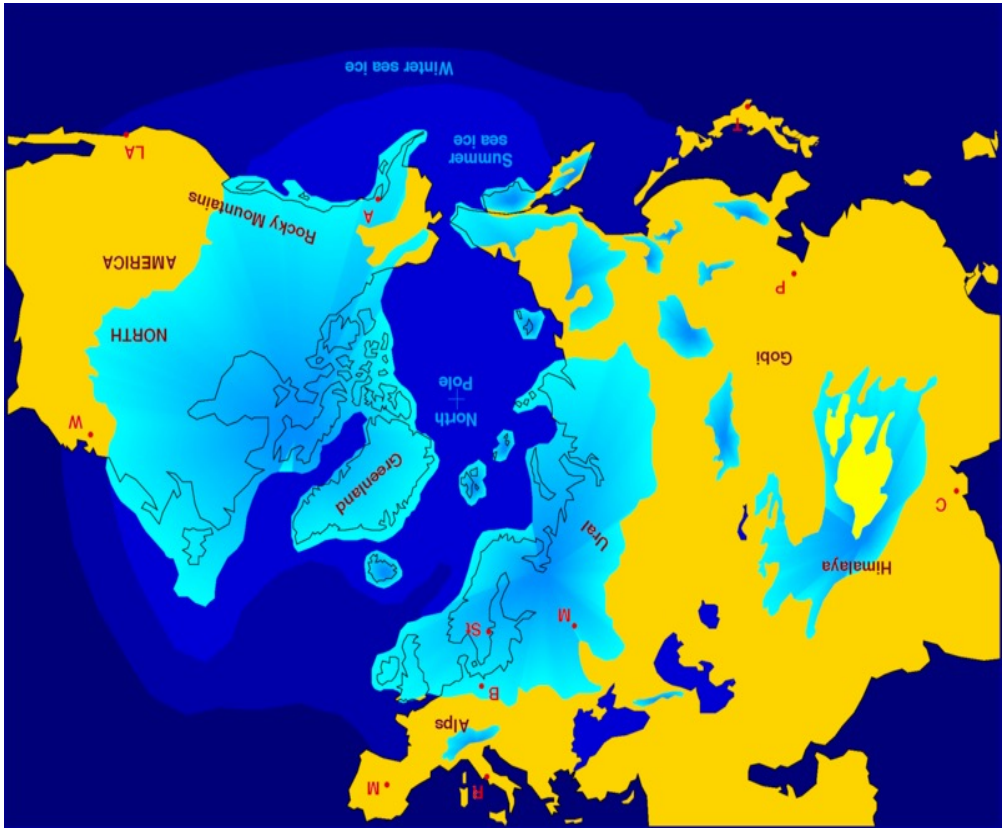
Klimakurve





Lohmann et al., 2020

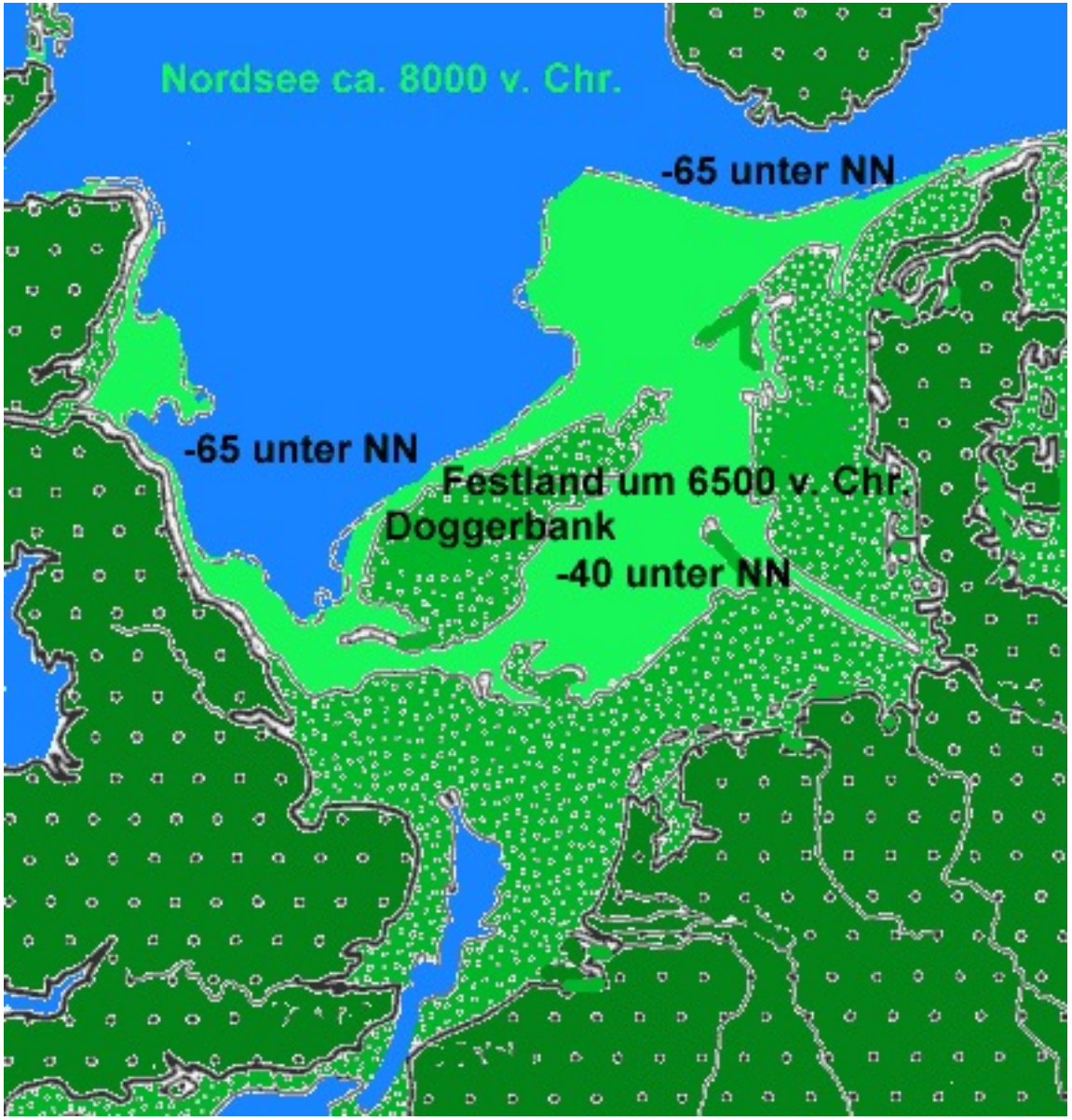
Eiszeitklima: Vereisung der Nordhemisphäre



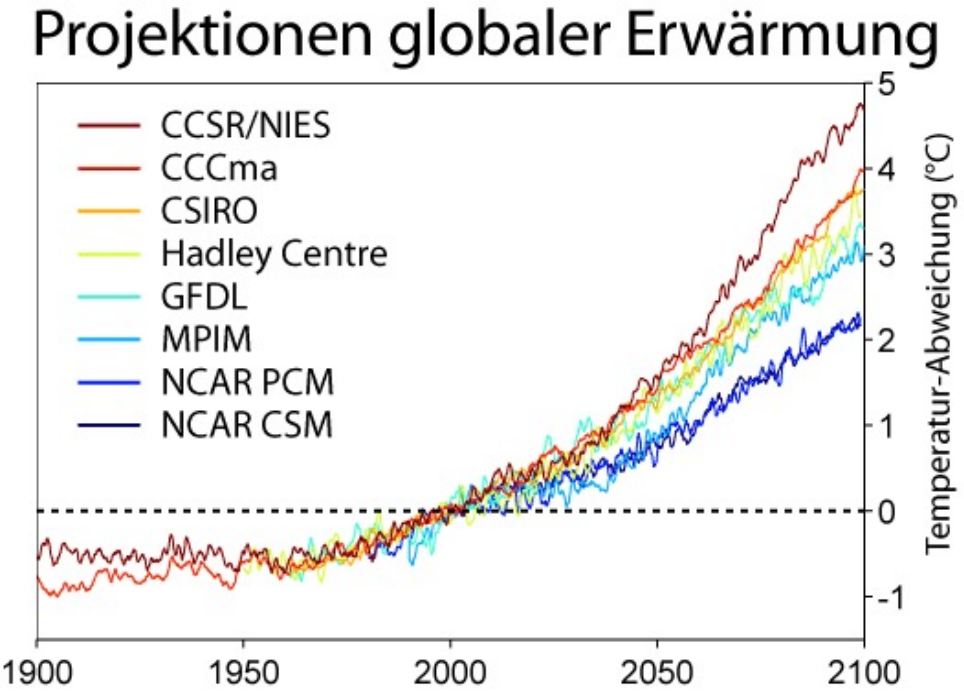
Der Aufbau mächtiger Eisschilde führte zu einer Meeresspiegelabsenkung von 120 m

Klimazonen heute und in der Eiszeit

[from: Ruddiman, 2008]

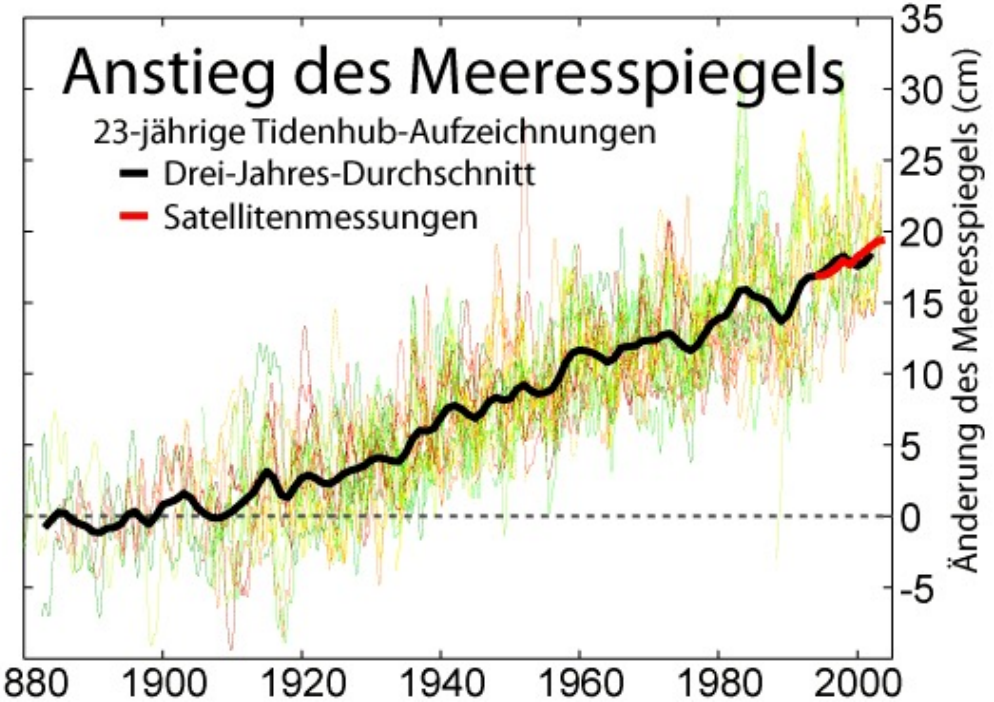


Brexit
6000 v. Chr.

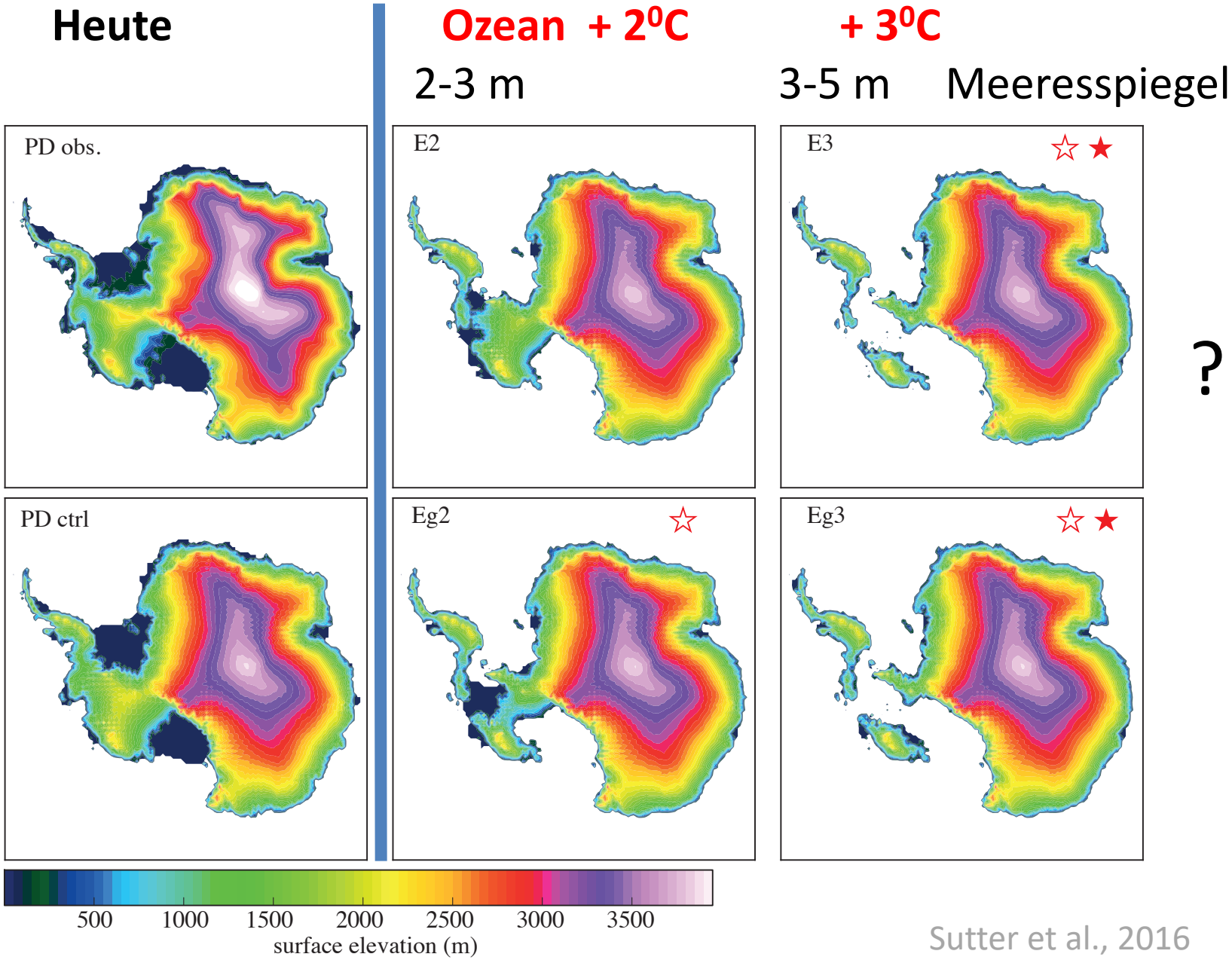


Einige Projektionen der Temperaturentwicklung bis 2100.

Der gemessene Anstieg des Meeresspiegels zwischen 1900 und 2000 beträgt 18,5 cm und erhöht sich weiter.



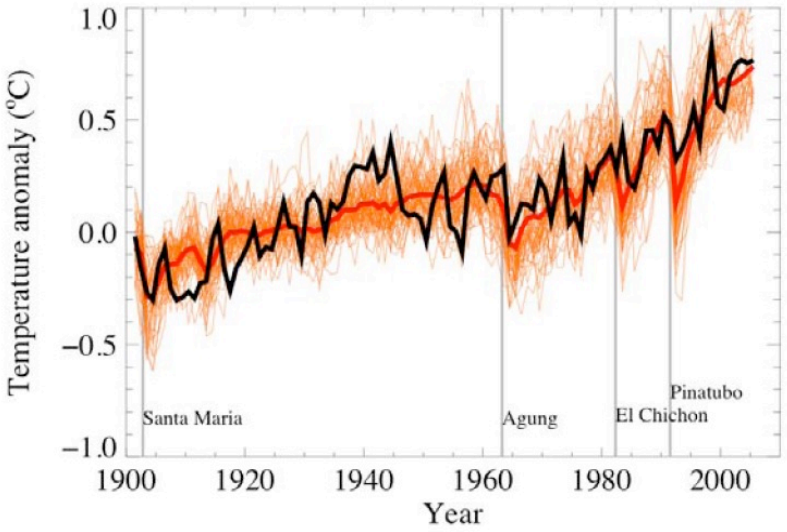
Modell: Eis der Antarktis in einer wärmeren Erde



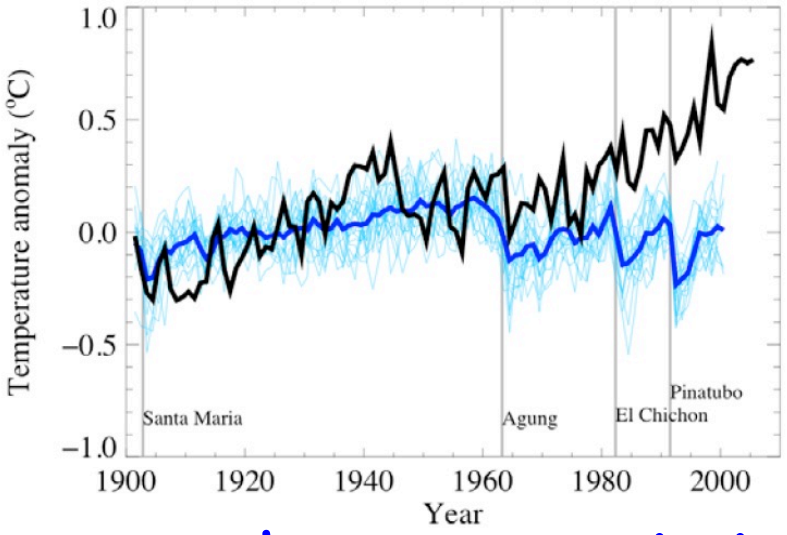
Sutter et al., 2016

Zuordnung in der Modellwelt

a greenhouse gas emissions



b



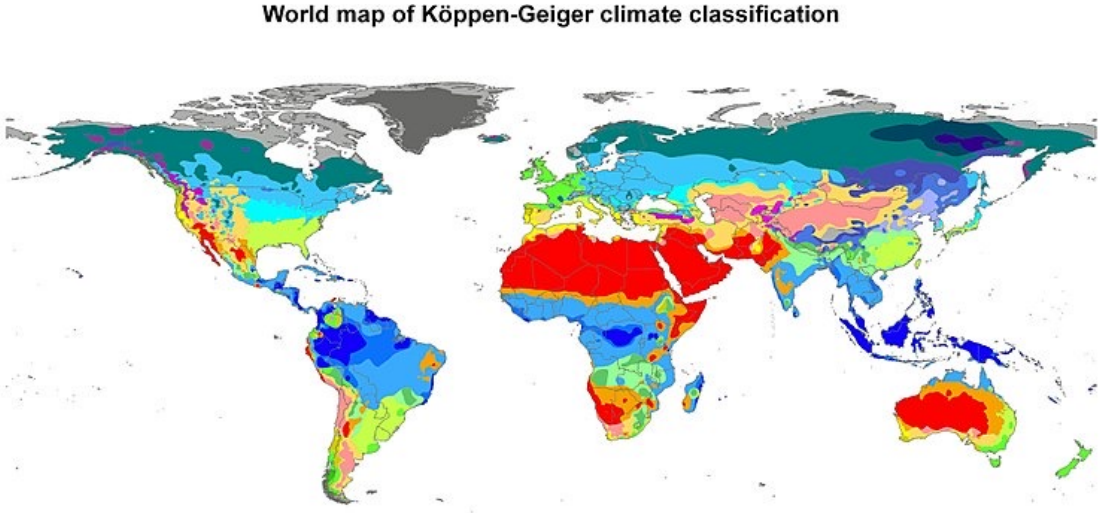
no greenhouse gas emissions

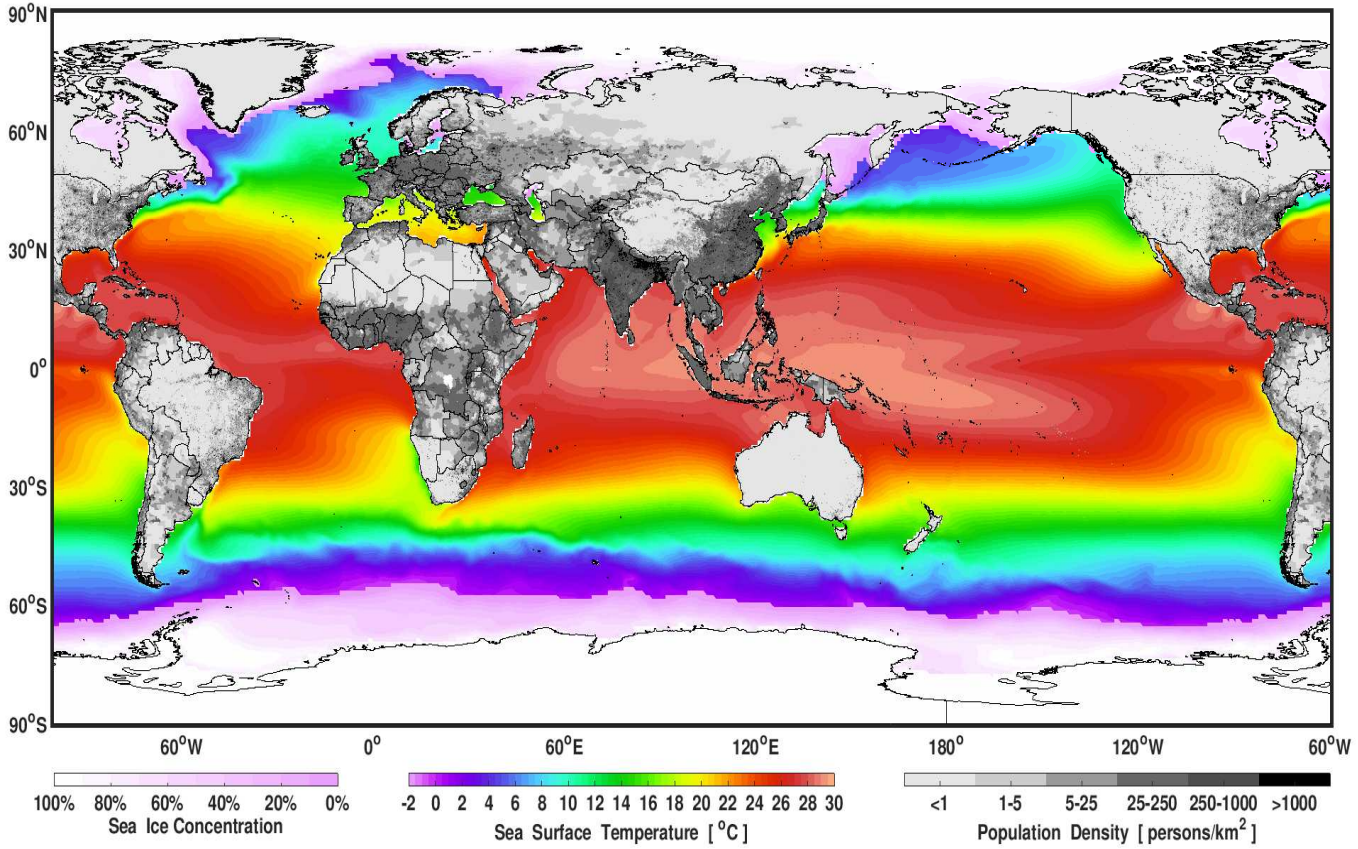
- fragt, ob die beobachteten Änderungen konsistent sind
- erwartete Antworten auf Antriebe inkonsistent mit alternativen Erklärungen

Erwärmung der letzten 50 Jahre sind von Menschen verursacht

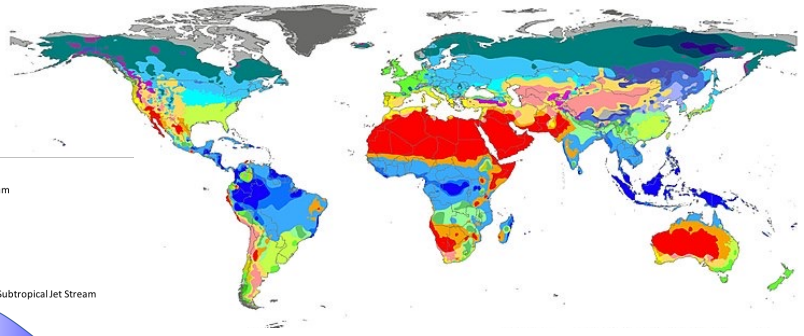
Physiknobelpreis

Klimazonen

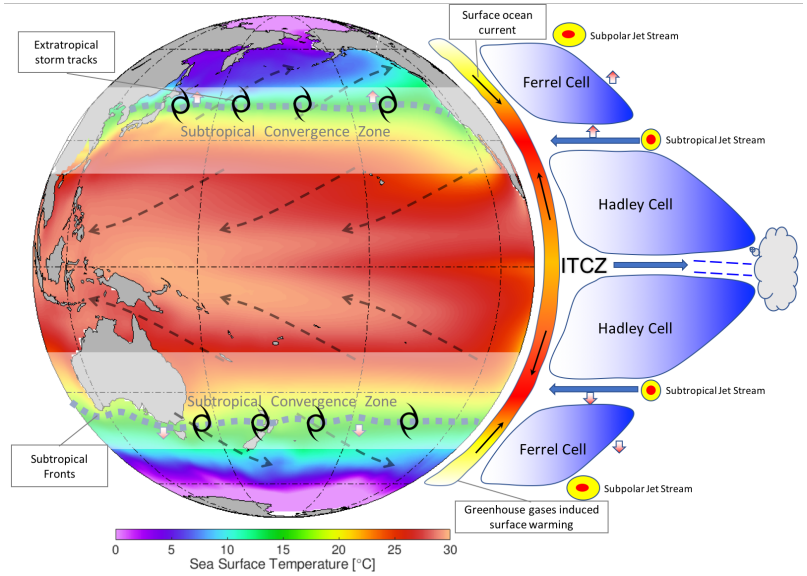

World map of Köppen-Geiger climate classification

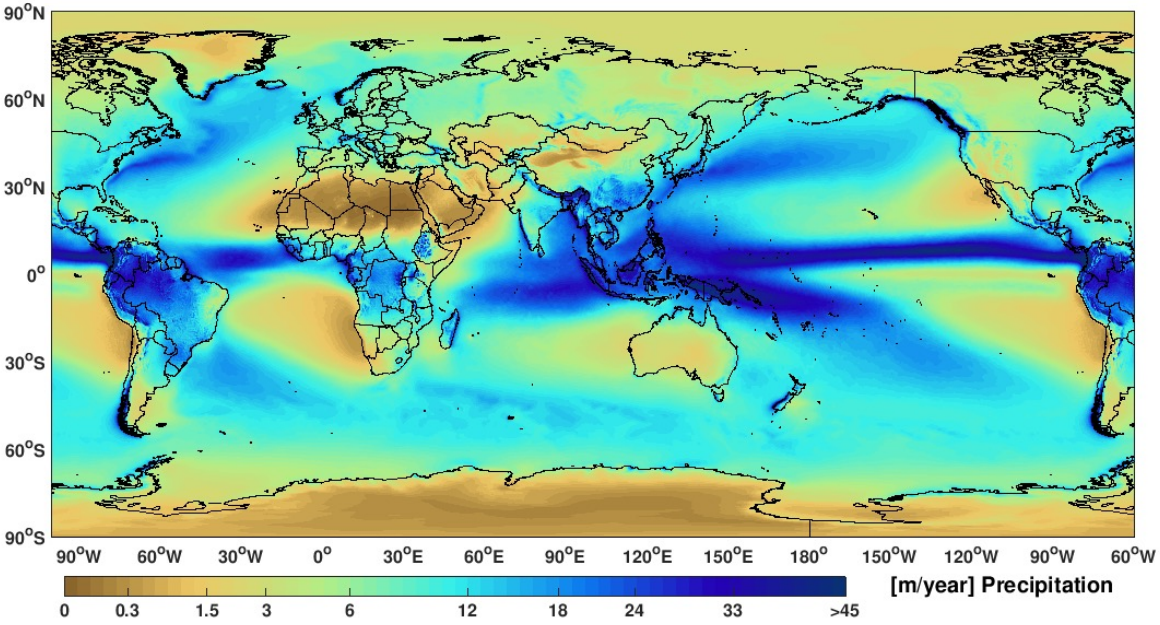

90°N
60°N
30°N
0°
30°S
60°S
90°S
60°W
0°
60°E
120°E
180°
120°W
60°W
100% 80% 60% 40% 20% 0%
Sea Ice Concentration
-2 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Sea Surface Temperature [°C]
<1 1-5 5-25 25-250 250-1000 >1000
Population Density [persons/km²]

Klimazonen



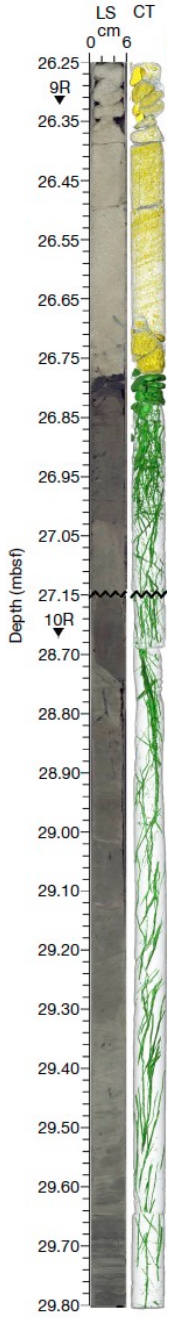
Zirkulation



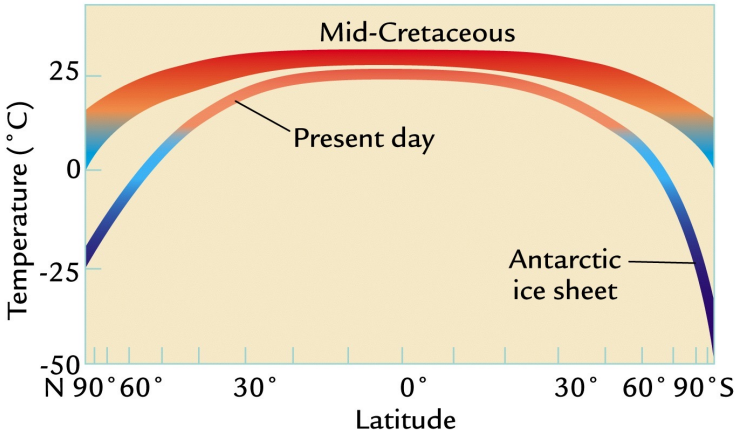


Niederschläge

Kreidezeit 100 Millionen Jahre vor heute

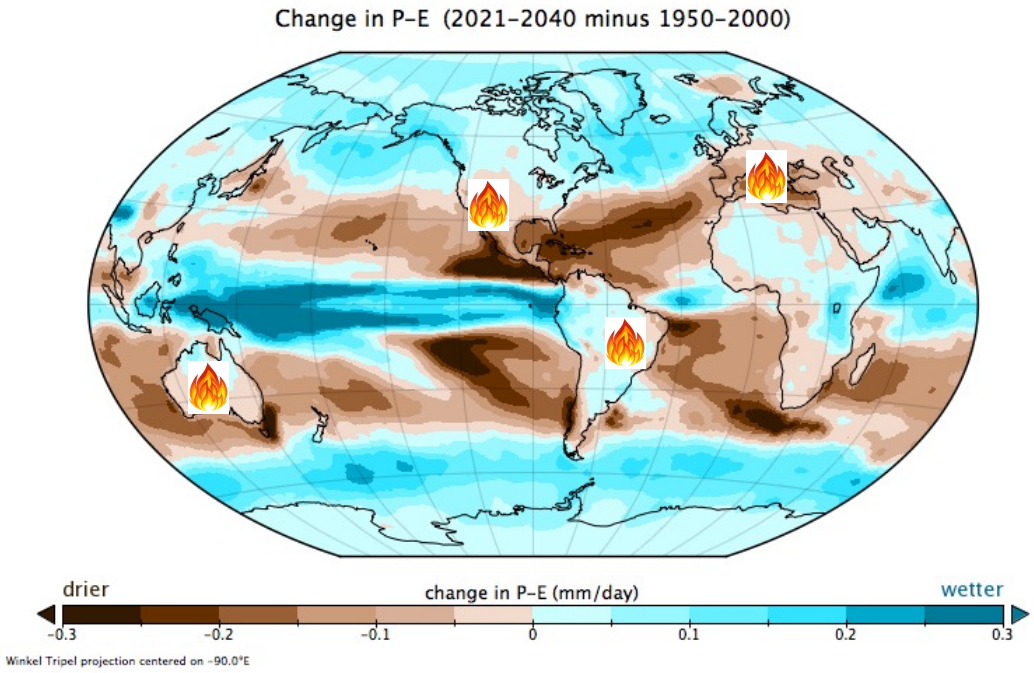


„super-Treibhausgas Klima“



Klages et al. (2020) Nature

Änderungen im Wasserkreislauf

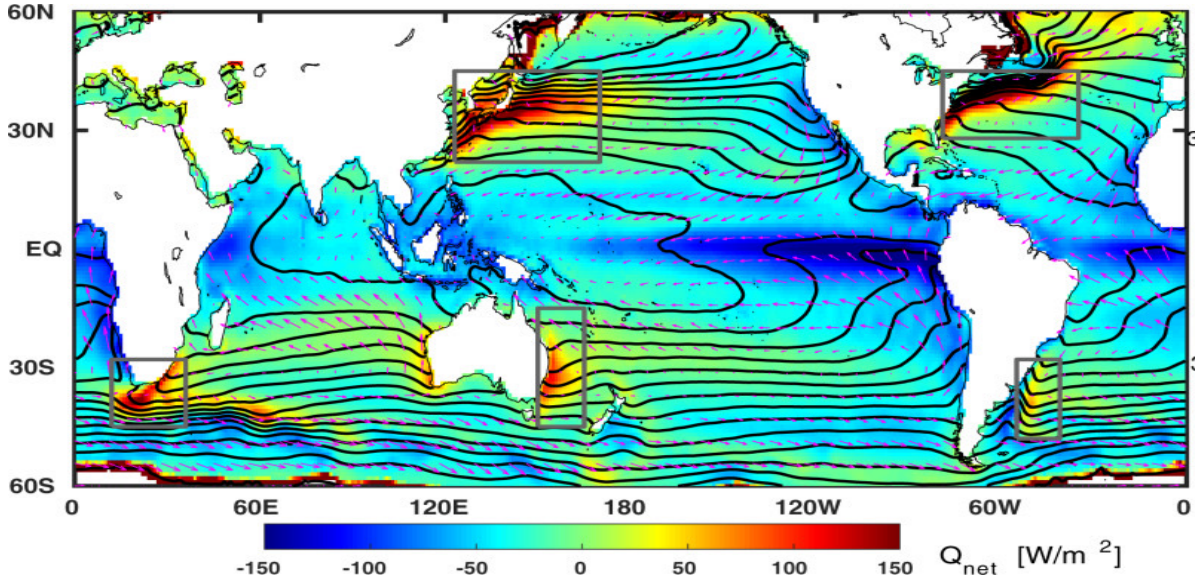


trockener

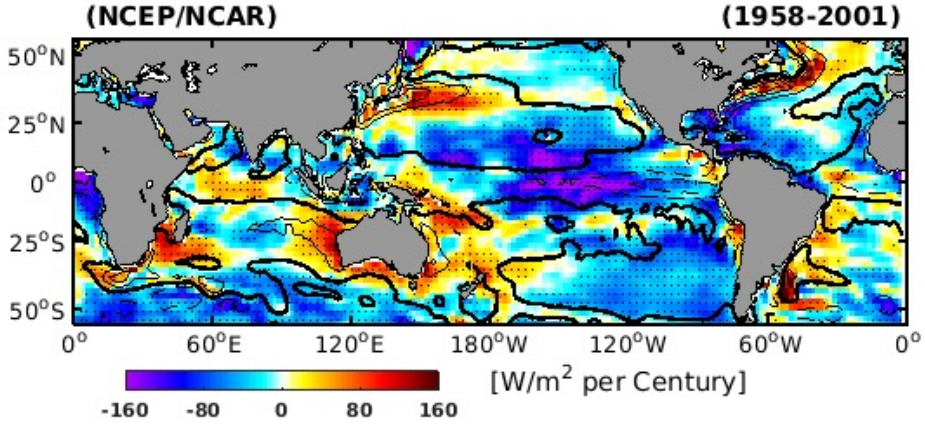
feuchter

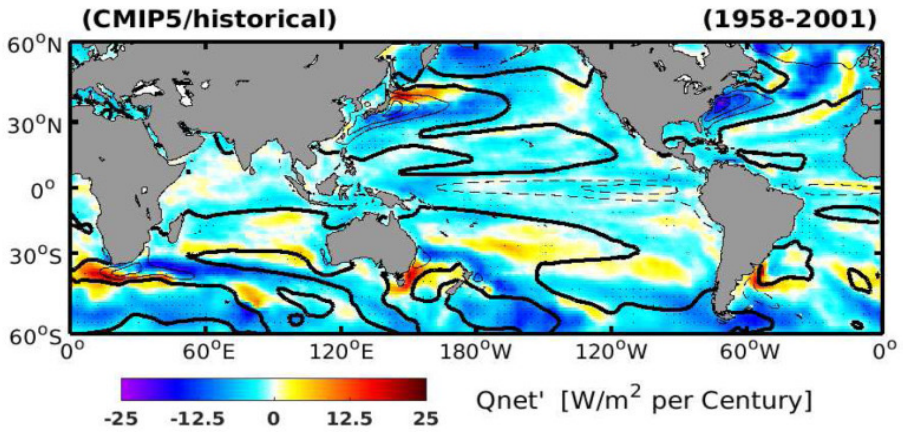
Seager et al. 2010

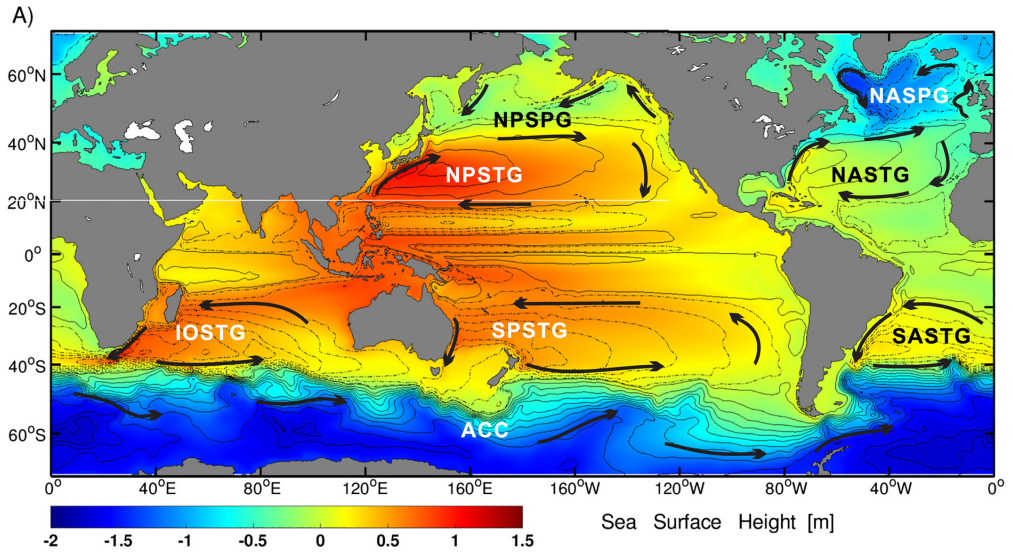
Änderungen



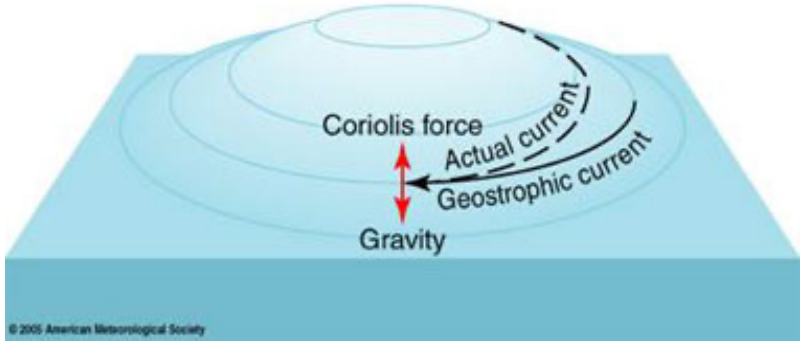
Yang and Lohmann et al. (2016). JGR-Ocean.



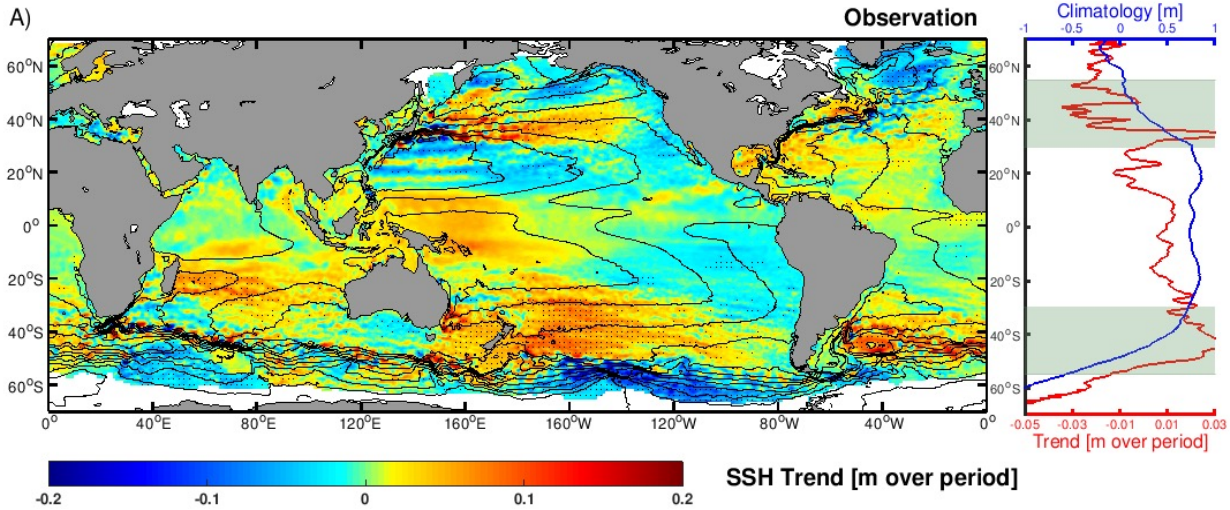




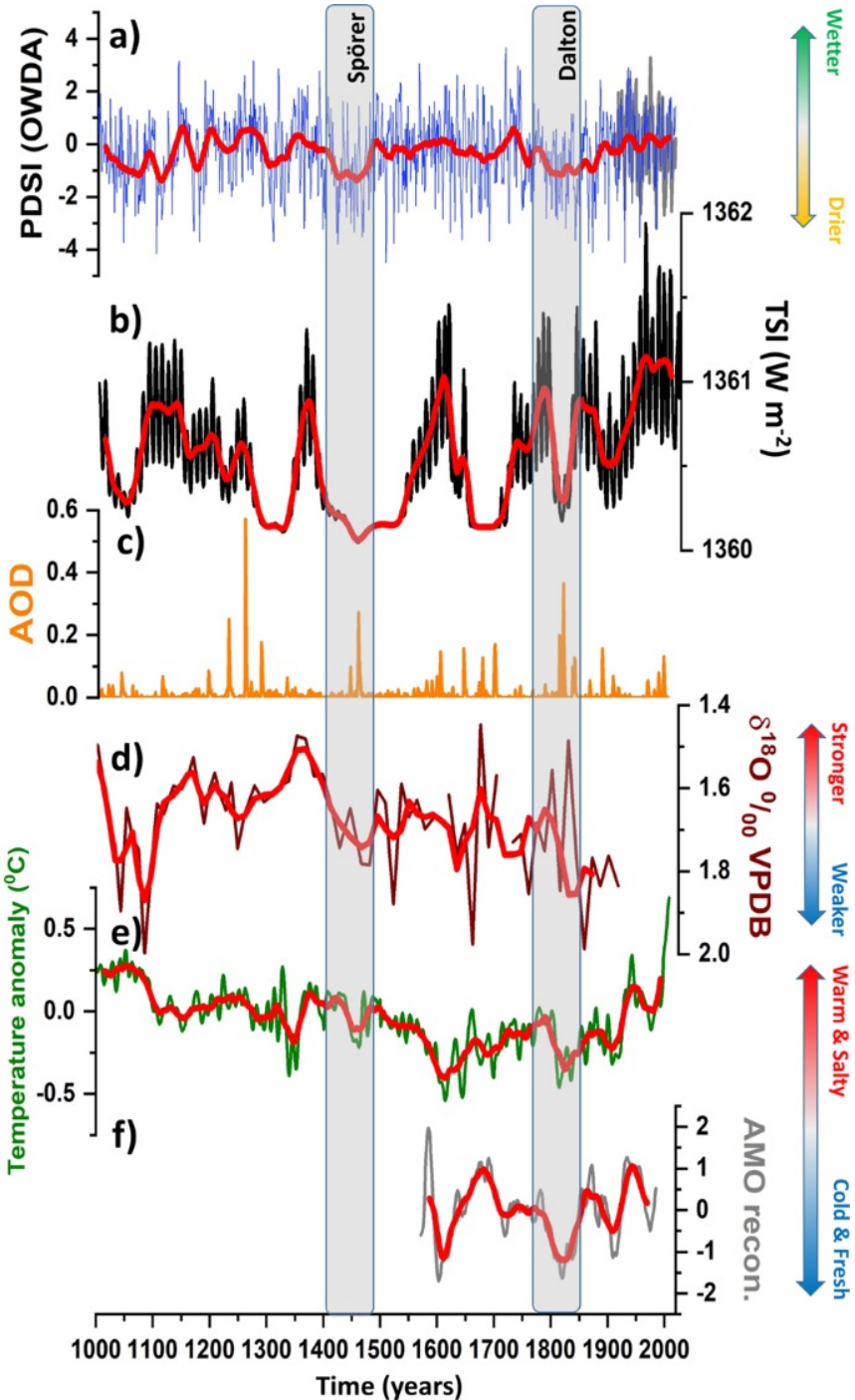
Yang and Lohmann et al. (2020a) GRL

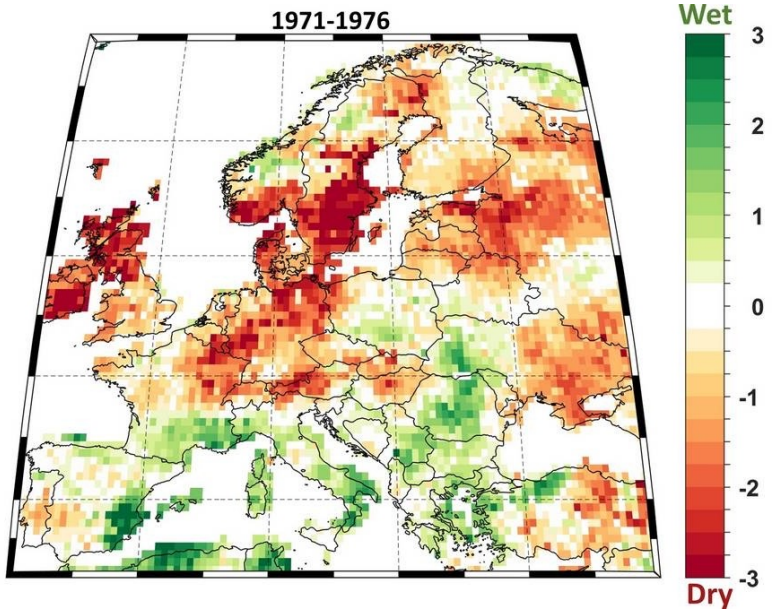


http://oceanmotion.org/html/background/geostrophic-flow.htm



Extreme trockene Perioden abgeleitet aus vielfältigen Paläoklimadaten





Herausforderungen

- Verbesserte Modelle
- Verbesserte Interpretation von Daten
- Zeitskalen
- Extreme