

Simulating the Late Ordovician with the CCSM3

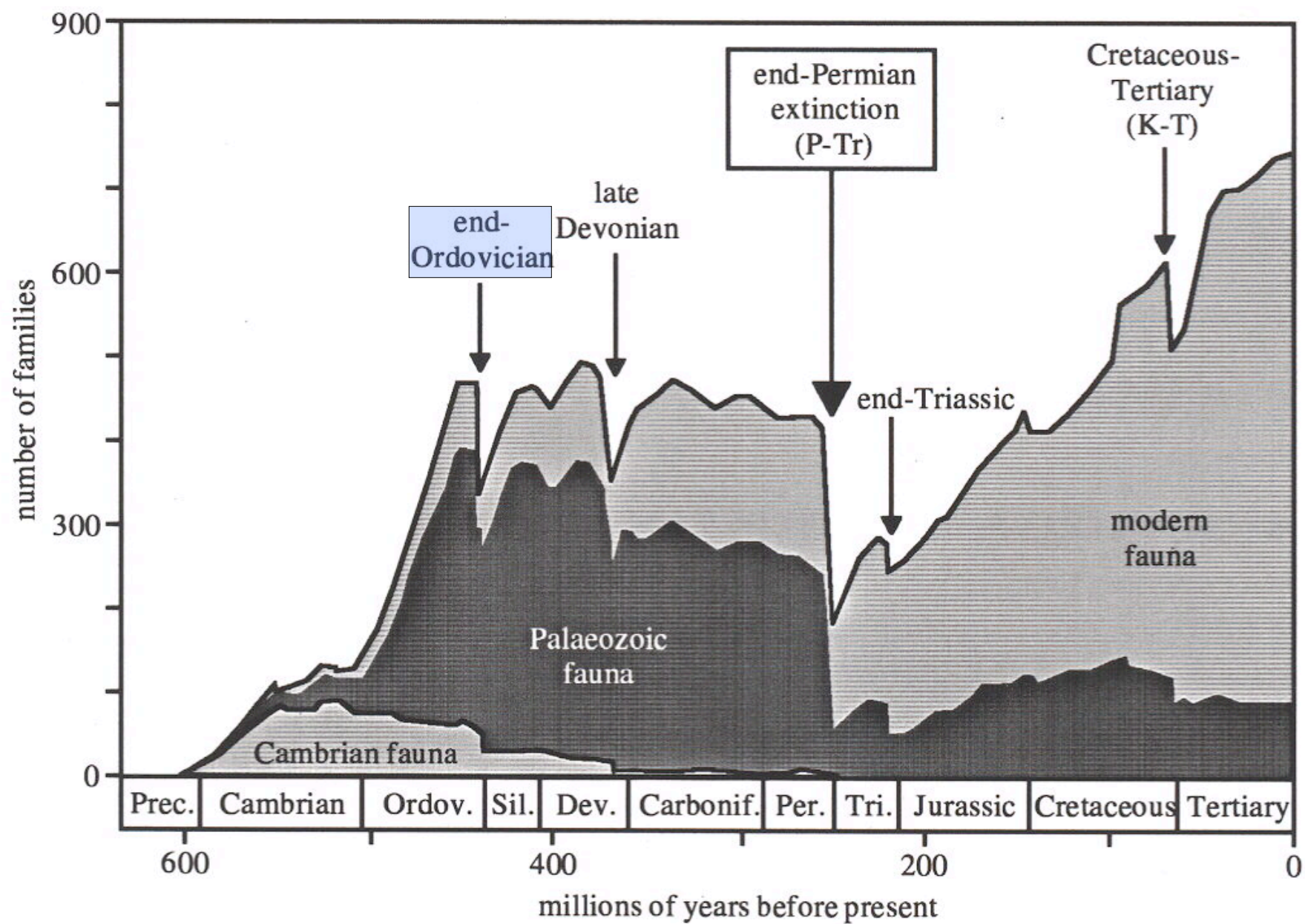
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NCAR/CGD/CCR/Paleo

*PALEOMAP Project

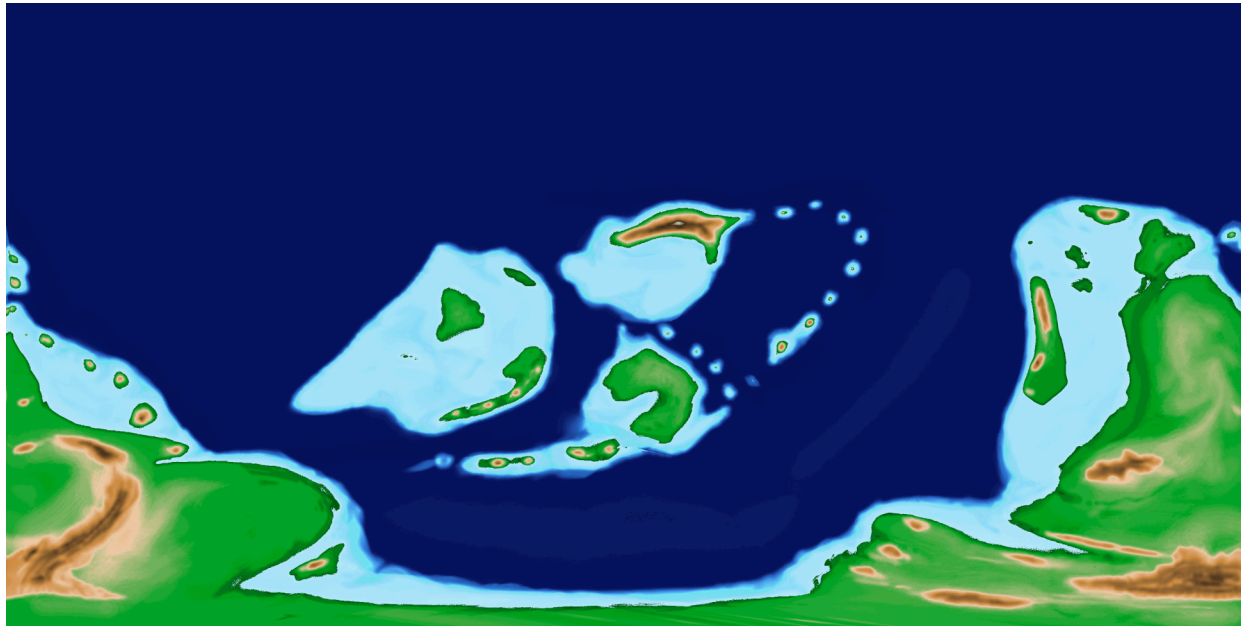
Acknowledgements:

Steve Yeager (NCAR), Gokhan Danabasoglu (NCAR)

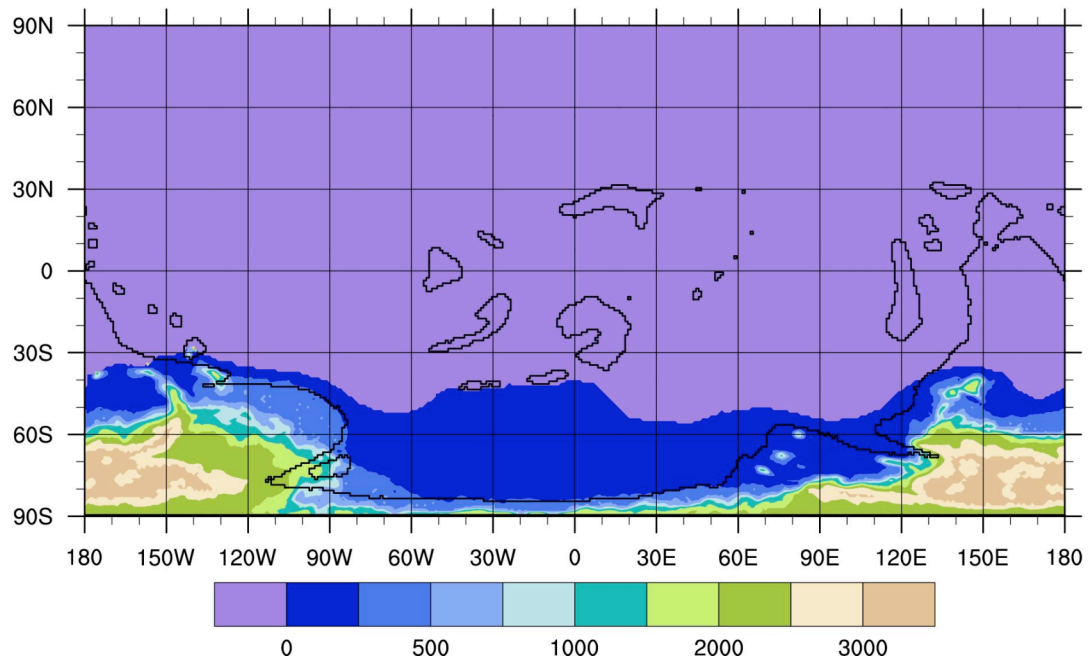


Latest Ordovician (Hirnantian) 445Ma

Land
Distribution

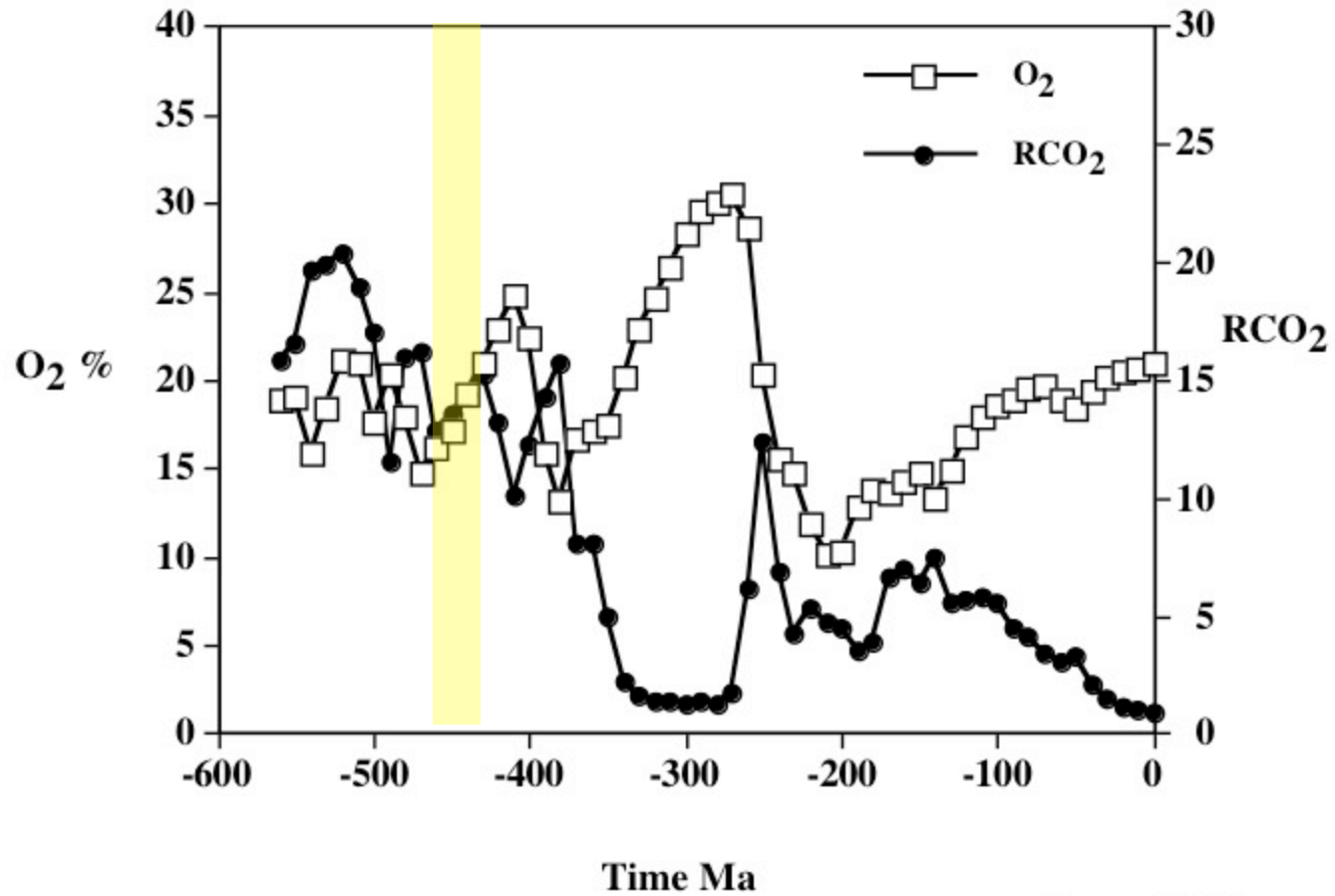


Ice
Thickness
(meters)



Courtesy of
C. Scotese
(PALEOMAP)

445Ma ~15 x Pre-Industrial CO₂



Berner (2005)

Ordovician Modelling Literature Review

Hermann, et al., papers: Geology (2003), Paleogeography, Paleoclimatology, Paleoecology (2004, 2004).

AGCM (w/slab ocean) coupled to ice sheet model, GENESIS
OGCM, MOM

Poussart, et al, Paleoceanography (1999)

EMBM (energy/moisture balance model) <-> OCGM (MOM)

Crowley and Baum, Journal of Geophysical Research, (1995)

AGCM (GENESIS) and EBMs

Model Info: what we have done so far...

T31 x gx3 Fully Coupled CCSM3, 100 years

ATM: CH₄/N₂O = Pre-Industrial
CFCs = 0

Cold Summer Orbit: ecc = .06, obl = 22°, precession = 270°

Solar Constant = - 4.5% of Pre-Industrial (-10.8 W/m² forcing)

CO₂ = 15 x Pre-Industrial (+14.5 W/m² forcing)

Net Forcing = +3.7 W/m² (~2xCO₂ forcing)

LND: Glacier in the SH (specified by Scotese), shrub elsewhere

ICE: Initialized with a zero ice state

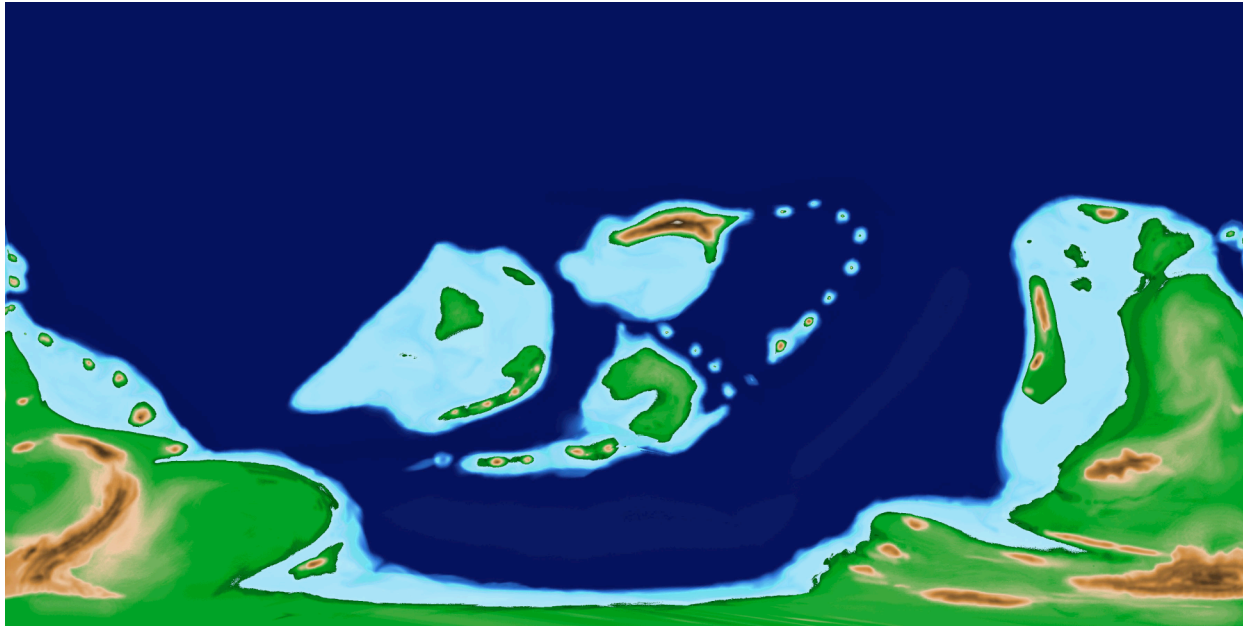
OCN: Rotated mesh

Poles located ~180 degrees apart and on equatorial islands

Initialized with a global zonal T/S profile

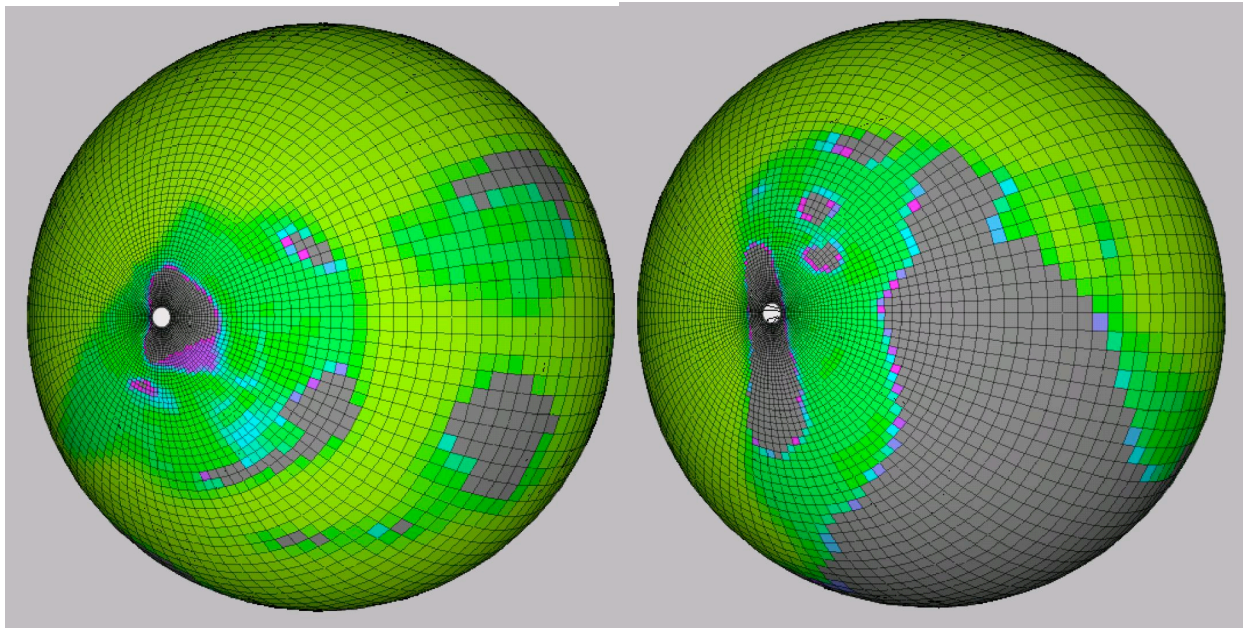
*precession is relative the NH vernal equinox

1x1
Topography/
Bathymetry



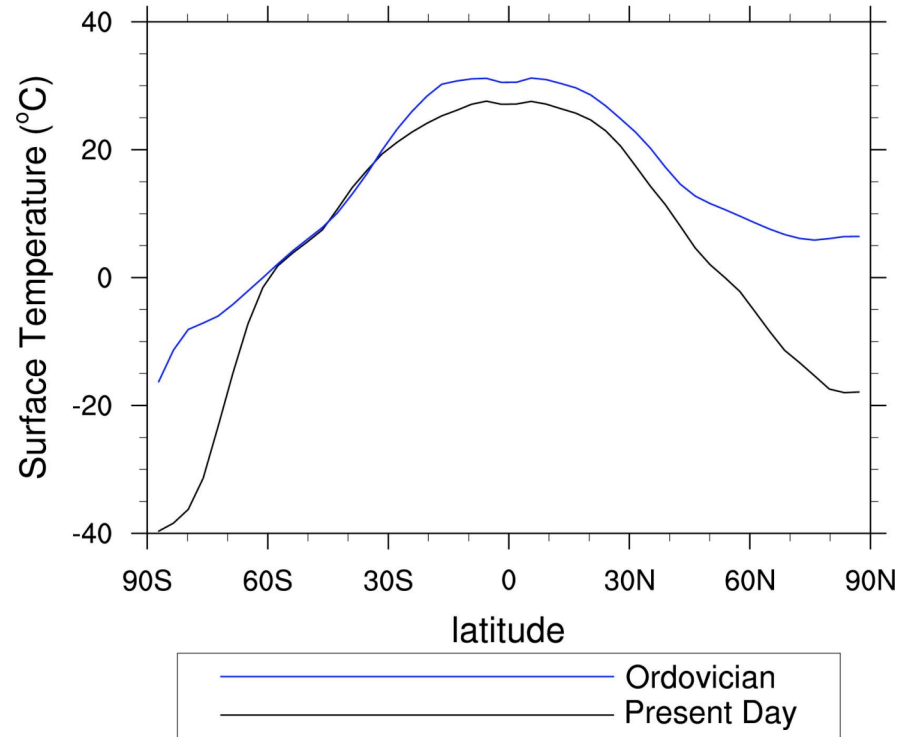
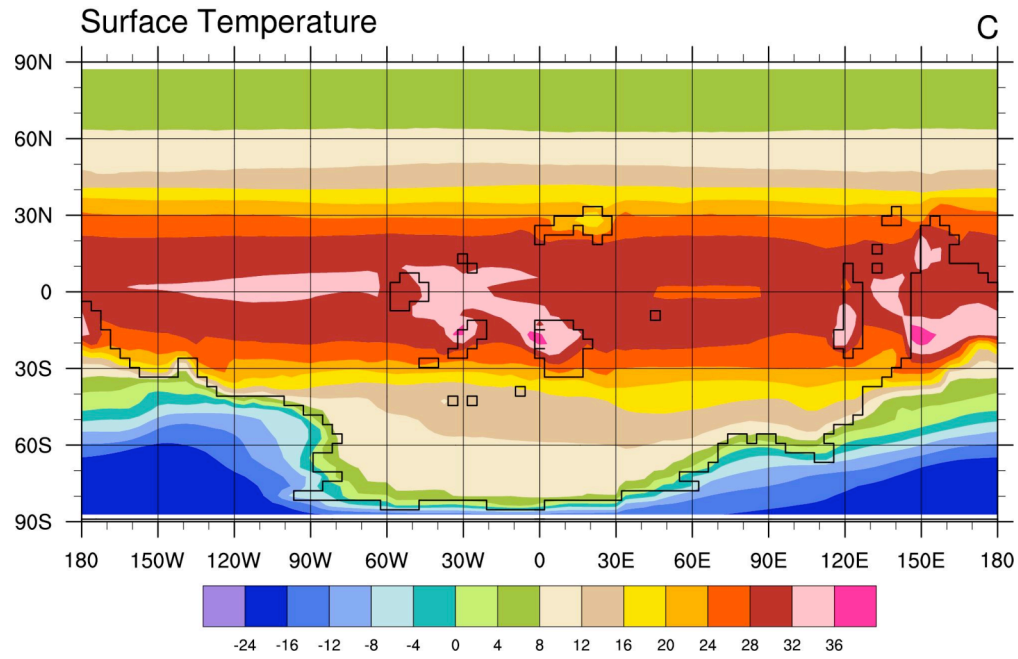
POP
Rotated
Mesh

West
Pole



East
Pole

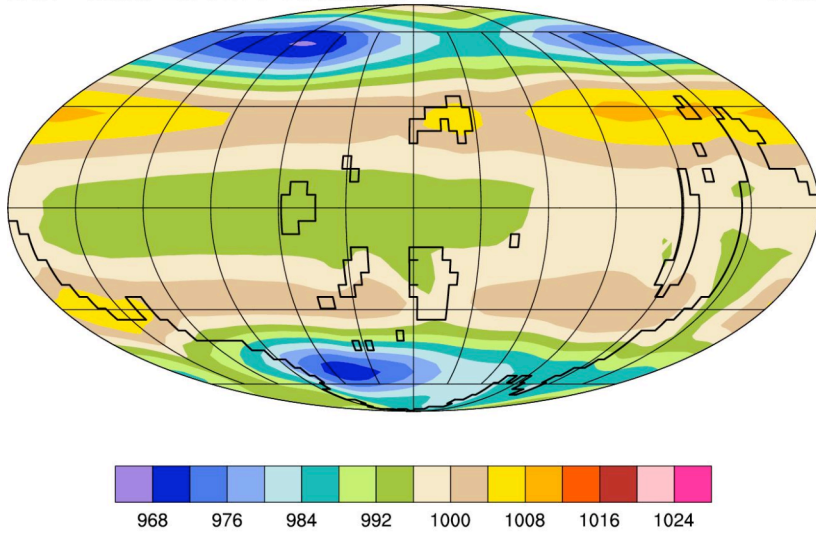
Annual TS ($^{\circ}\text{C}$)



CCSM3

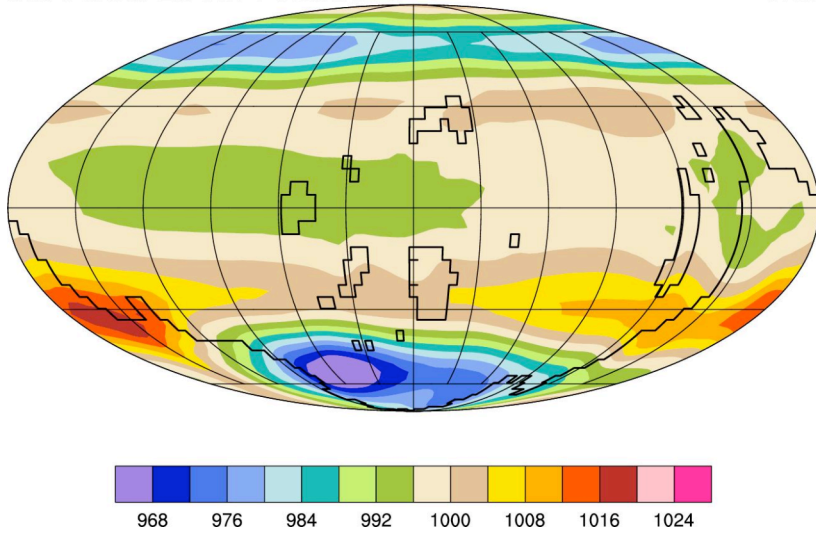
DJF Sea Level Pressure

mb

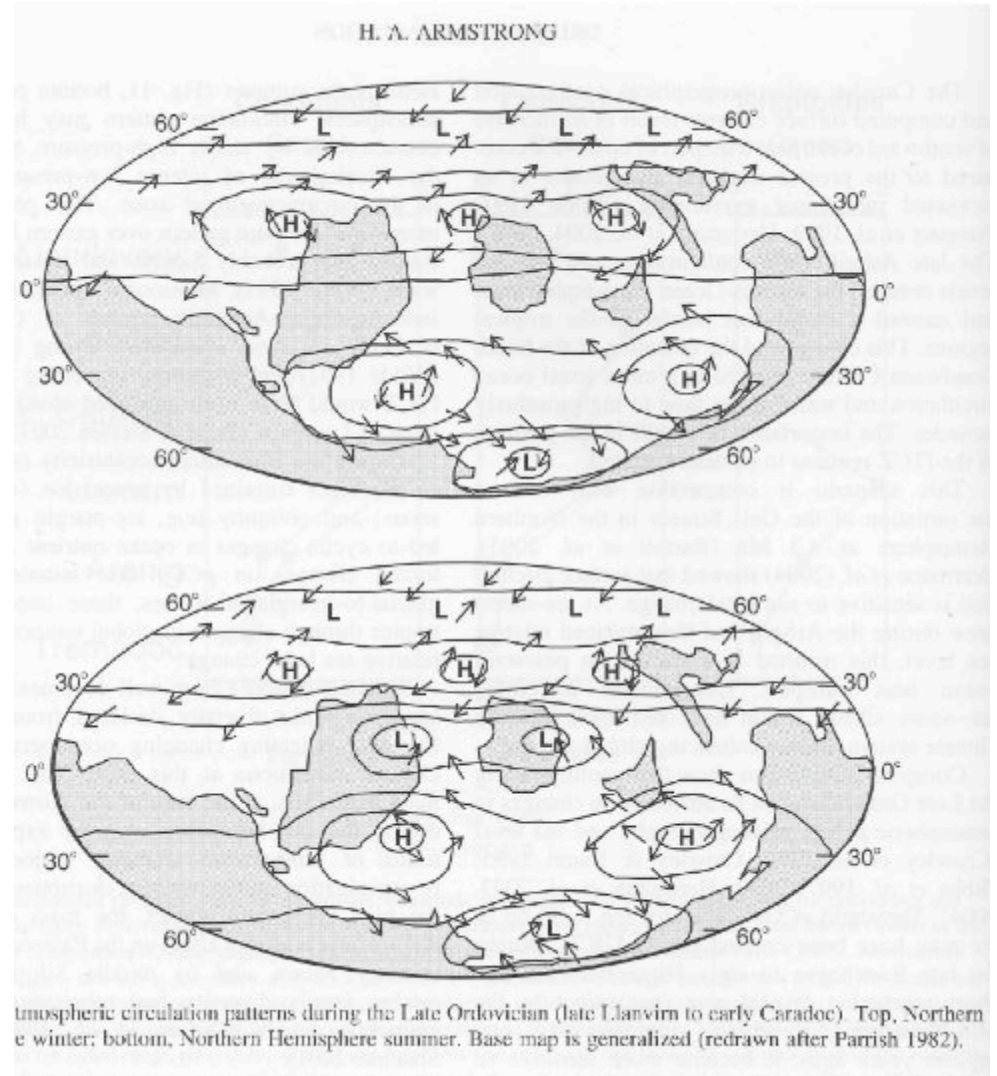


JJA Sea Level Pressure

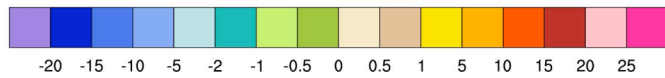
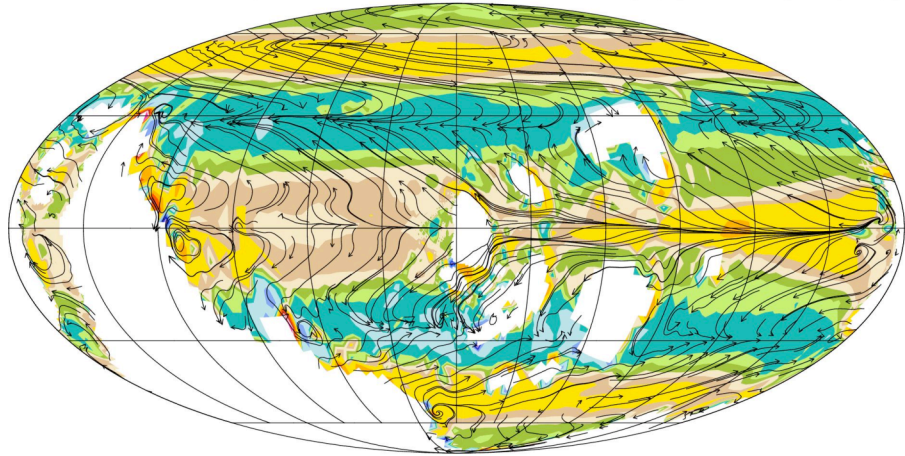
mb



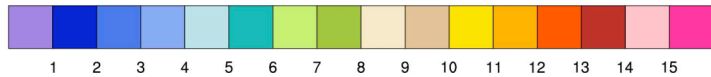
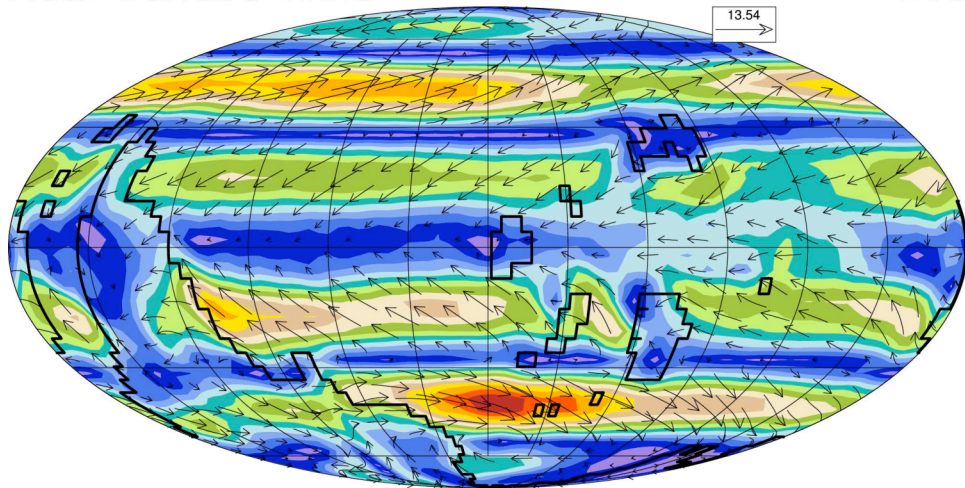
Proxy Estimate



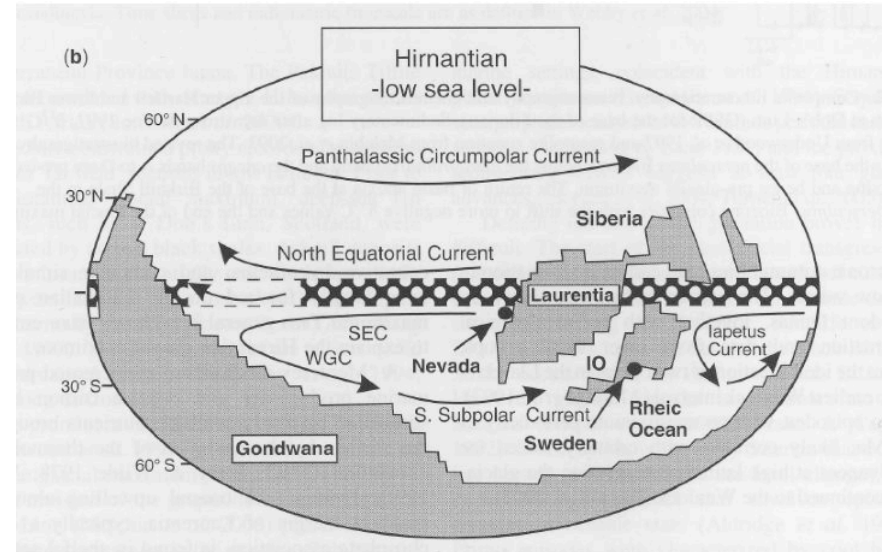
100m WVEL ($10^{-4} \times \text{cm/s}$) 4m Ocean Currents

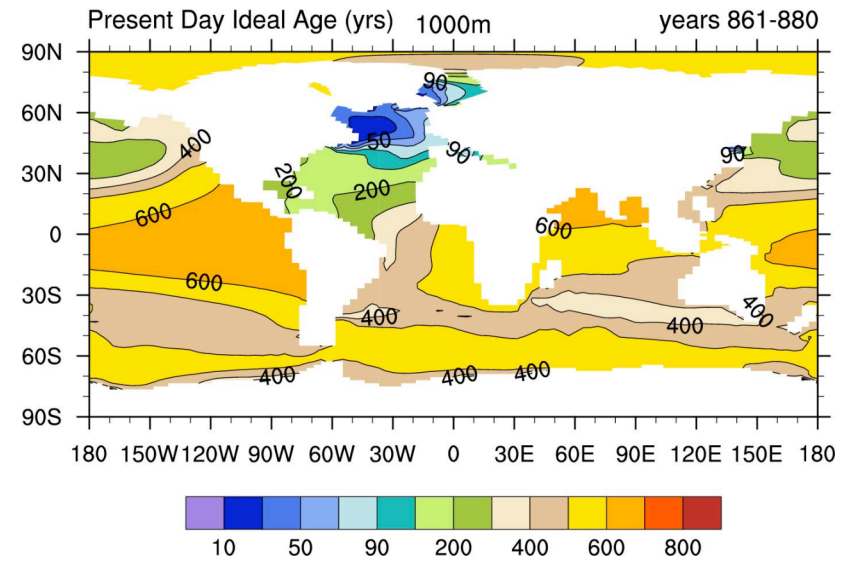
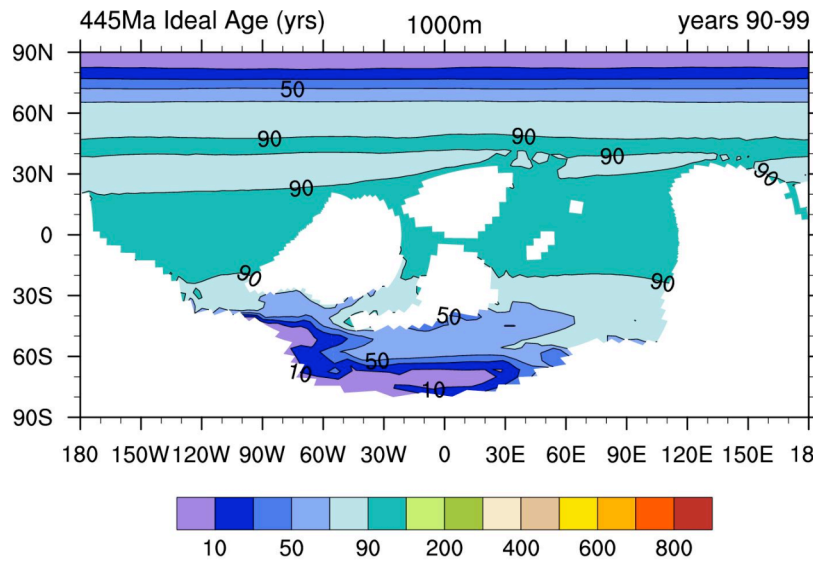
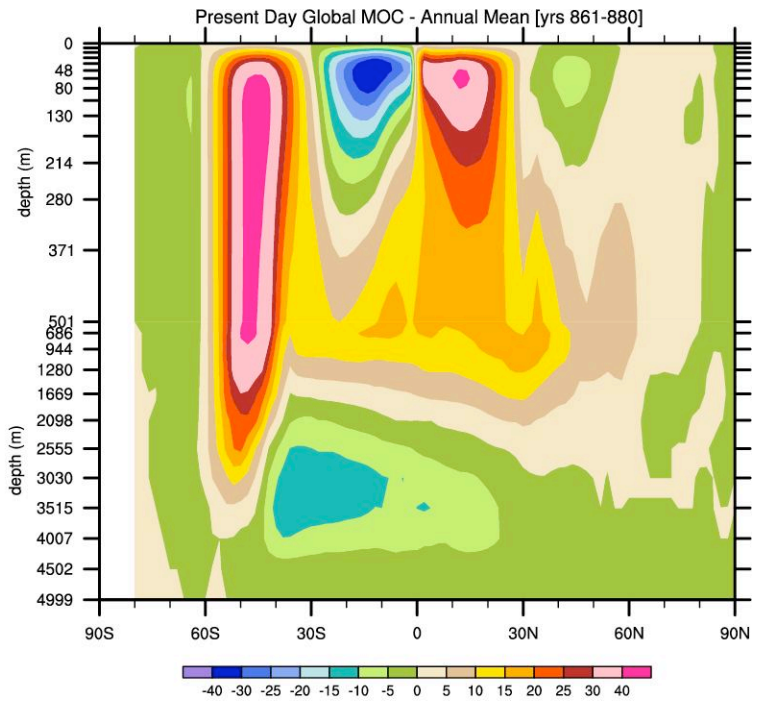
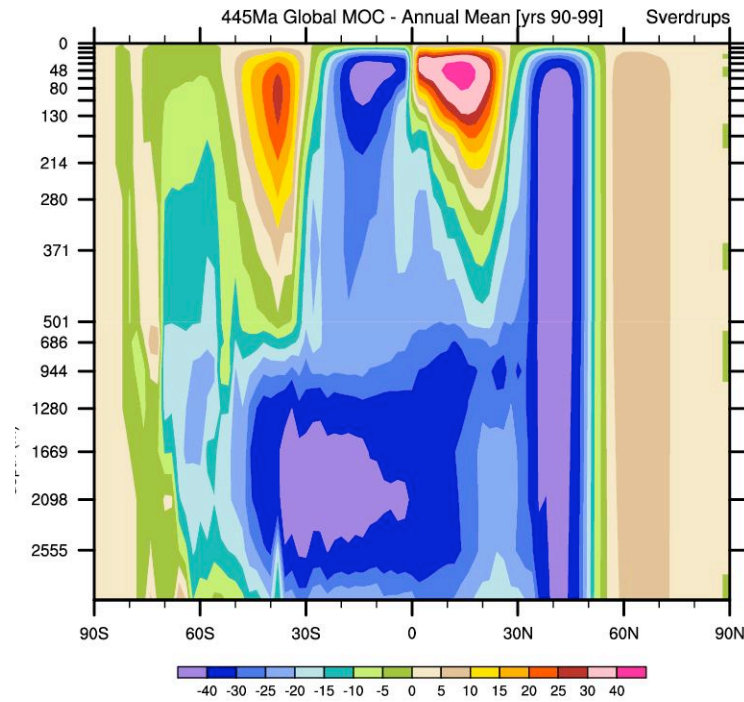


Near Surface Wind



Armstrong reconstruction based on MOM OGCM

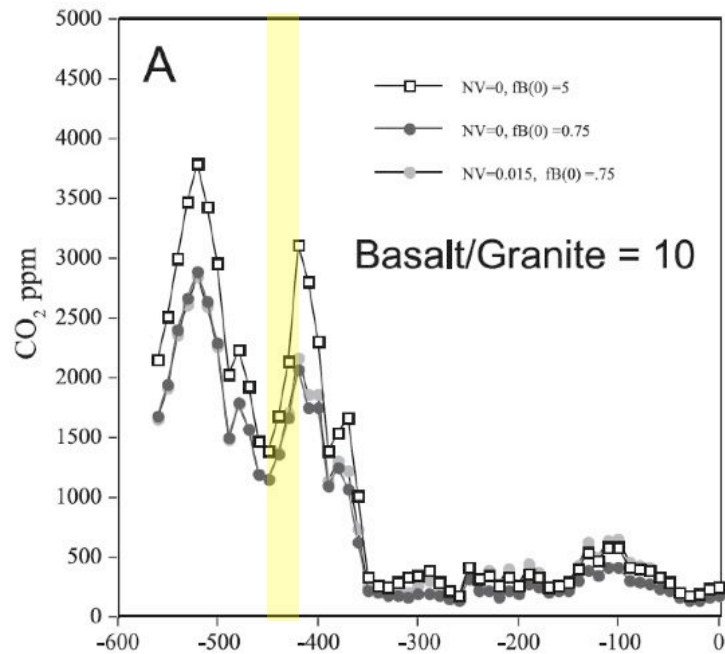




Future Plans...

1. Adjust land types to classification more appropriate for the Ordovician (rock and moss)
2. Add topography to the ocean floor to help simulate the a more realistic circumpolar ocean current in the arctic. (currently this is too strong).
3. Adjust CO₂ forcing to most recent estimates (B. Berner). Currently using a 15x pre-industrial value which produces a net forcing too warm to grow an ice sheet.
4. Once we are able to grow and sustain ice, we will try to force an ice sheet model with CCSM3 results.

CAN NEW CO₂ ESTIMATES SUSTAIN ICE? ...



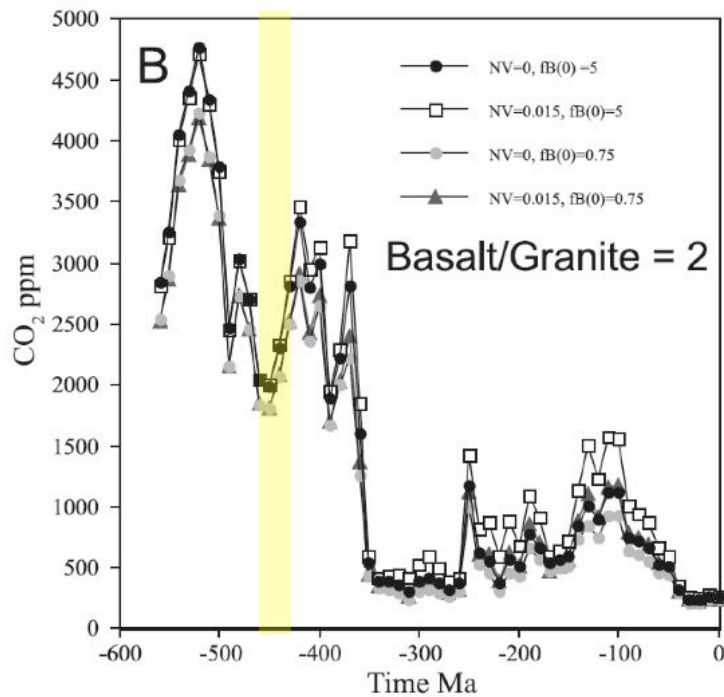
$$\text{CO}_2 = 1100 \sim 3.9 \times \text{PI}$$

$$= 7.3 \text{ W/m}^2 \text{ CO}_2 \text{ Forcing}$$

$$\text{Net Forcing} = \text{Solar} + \text{CO}_2$$

$$= -10.8 + 7.3$$

$$= -3.5 \text{ W/m}^2 \text{ COOLING}$$



$$\text{CO}_2 = 1700 \sim 6 \times \text{PI}$$

$$= 9.6 \text{ W/m}^2 \text{ CO}_2 \text{ Forcing}$$

$$\text{Net Forcing} = \text{Solar} + \text{CO}_2$$

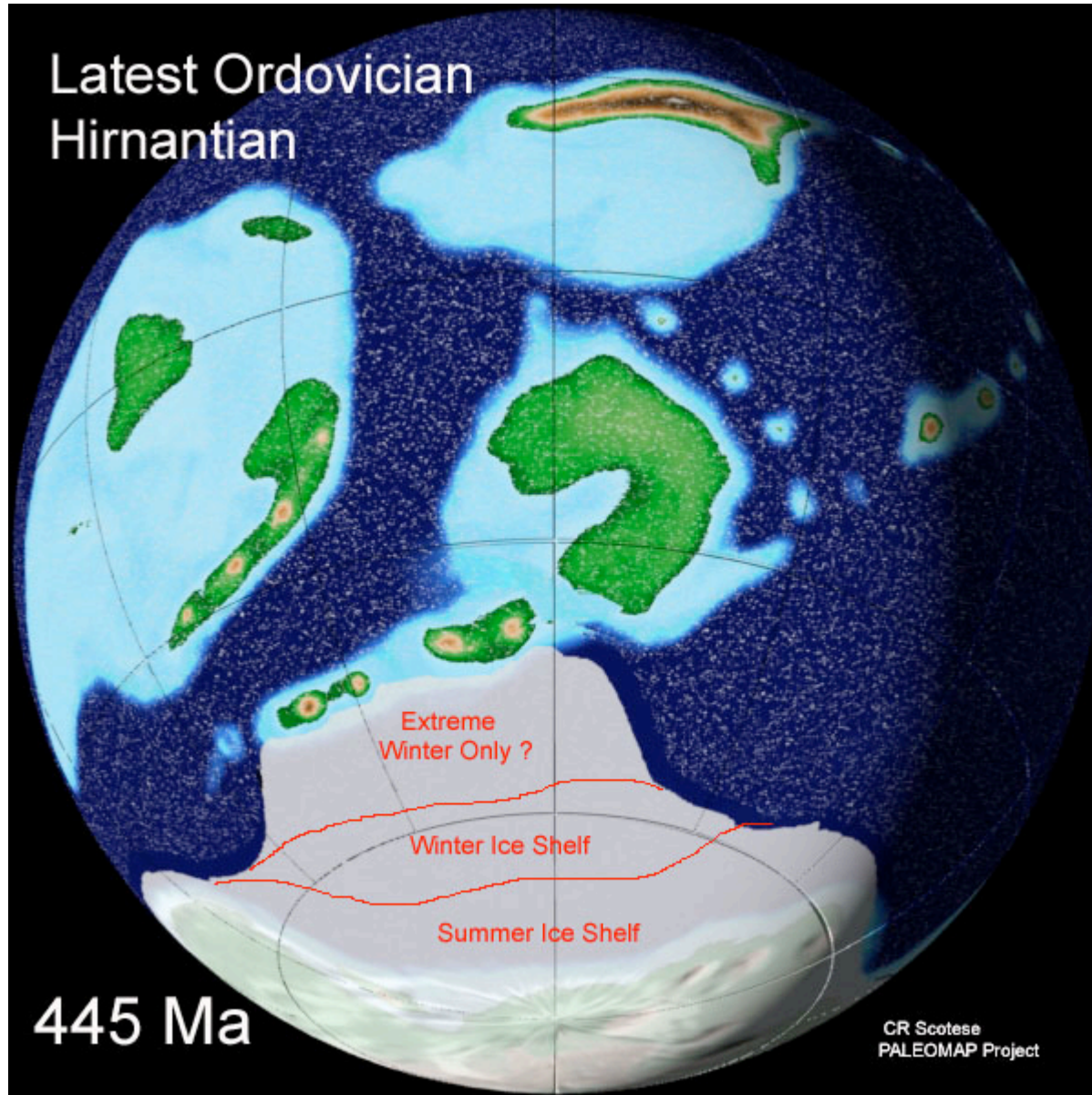
$$= -10.8 + 9.6$$

$$= -1.2 \text{ W/m}^2 \text{ COOLING}$$

THE END

Following slides...extras

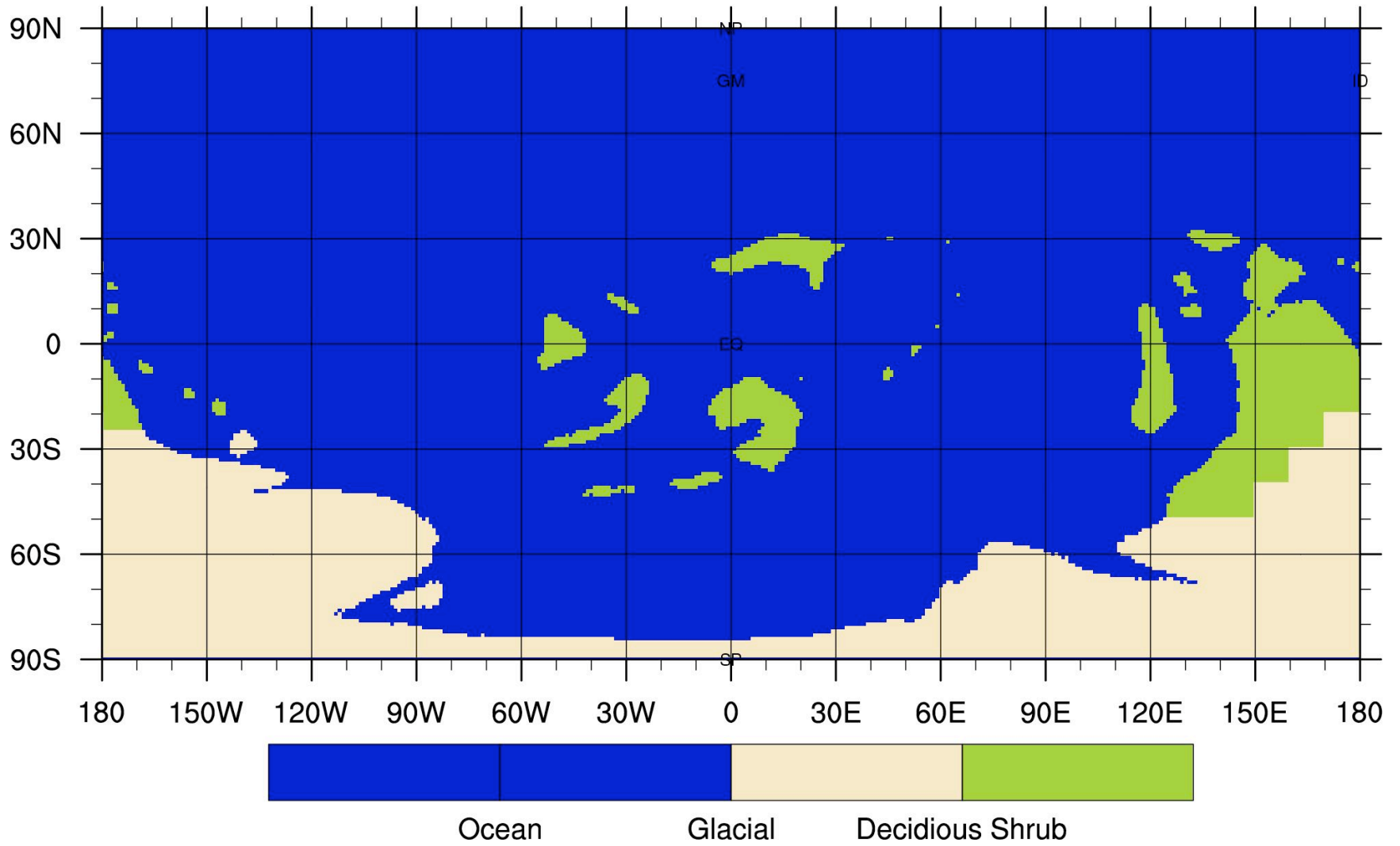
Latest Ordovician
Hirnantian



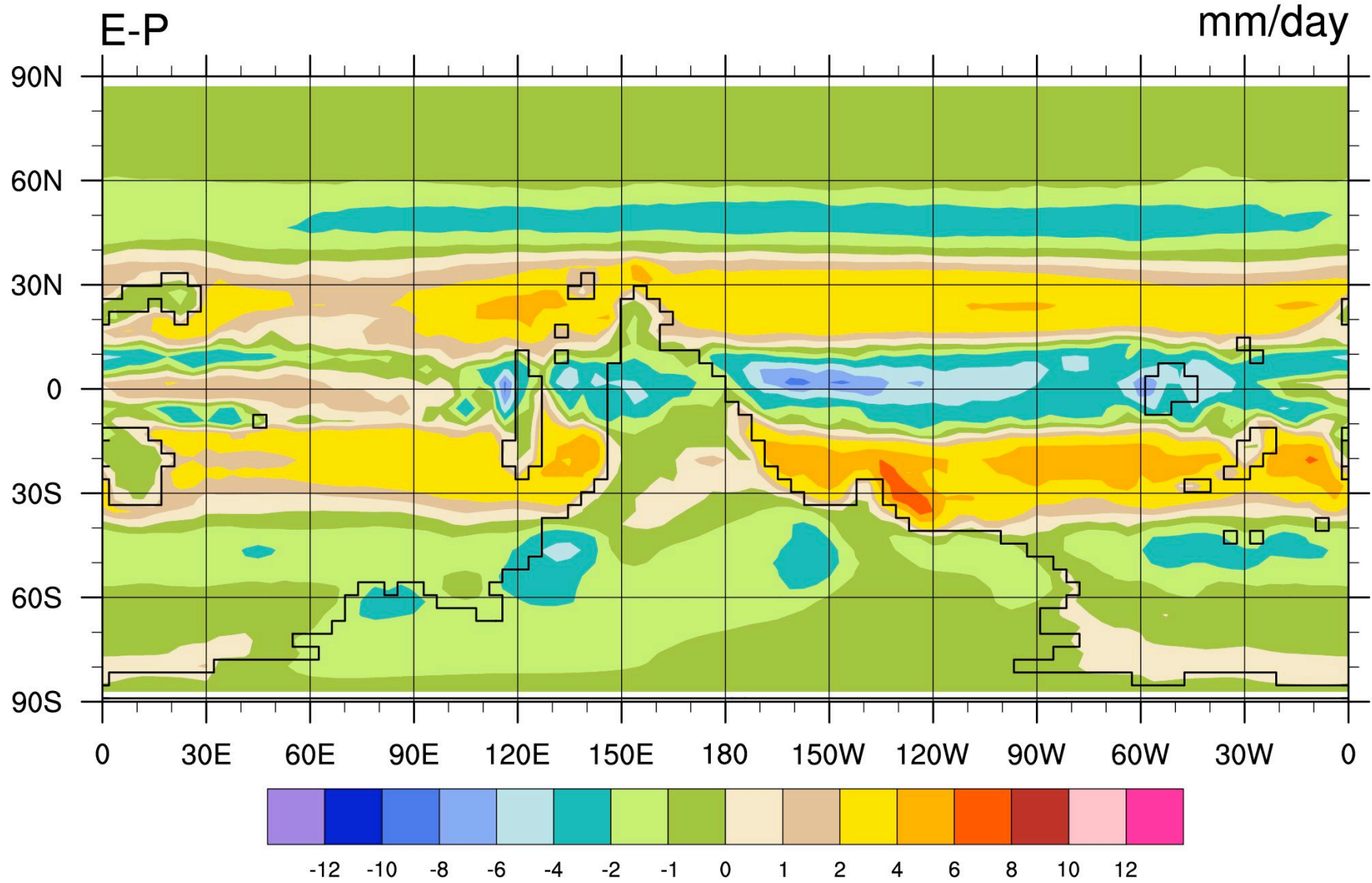
445 Ma

CR Scotese
PALEOMAP Project

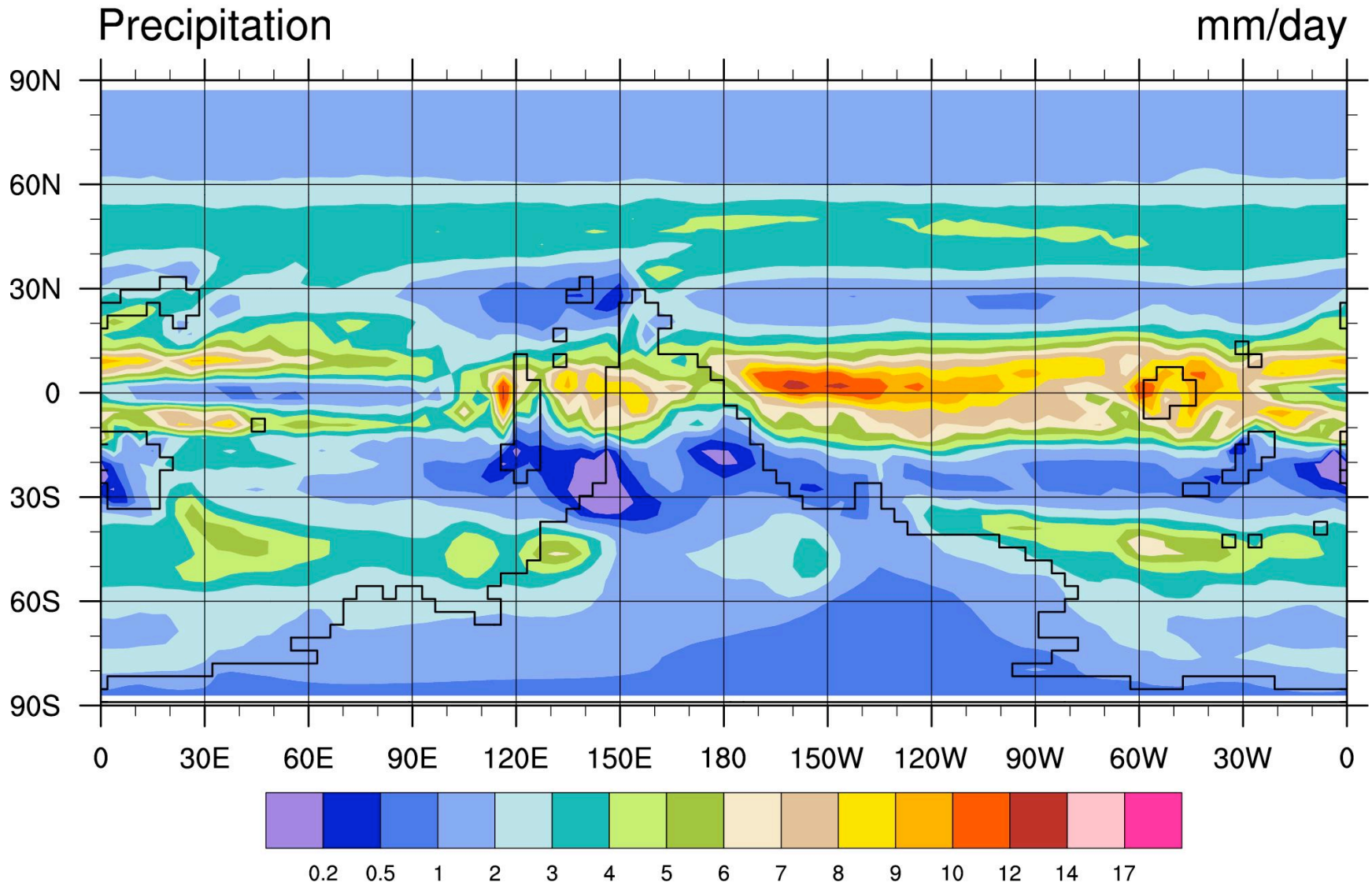
Latest Ordovician (Hirnantian 445Ma) Land Use Types, Test run



Ordovician (445Ma)



Ordovician (445Ma)



Ordovician at Equator

