

Cenozoic changes in the Indonesian Throughflow and their impact on global climate

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THROUGHFLOW PROJECT

Three objectives:

1. To assess the influence of closing of the Indonesian deep-water passage and narrowing of the Indo-Pacific gateway on circulation and climate.
To provide boundary conditions for the other THROUGHFLOW projects (including assessment of the dispersal patterns of organisms).

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2. To test the influence of changes in $p\text{CO}_2$ on the ITF during the Oligocene.
To understand why Oligocene climate is apparently rather insensitive to changes in $p\text{CO}_2$.

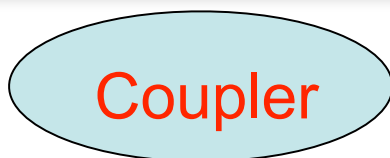
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3. To test if increasing glaciation in Antarctica leads to a northward shift of the tropical rainbelt in the ITF region.

NCAR Community Climate System Model (CCSM3)

Atmosphere & Land Surface

- T42 ($\sim 2.8^\circ$ lat-lon), 26 levels
- State-of-the-art radiation scheme and cloud physics
- Soil, snow and runoff modules



Ocean & Sea Ice

- Primitive equations – free surface
- $\sim 1^\circ$ resolution globally, 0.3° in the tropics (incl. ITF), 40 levels
- Comprehensive sea-ice dynamics

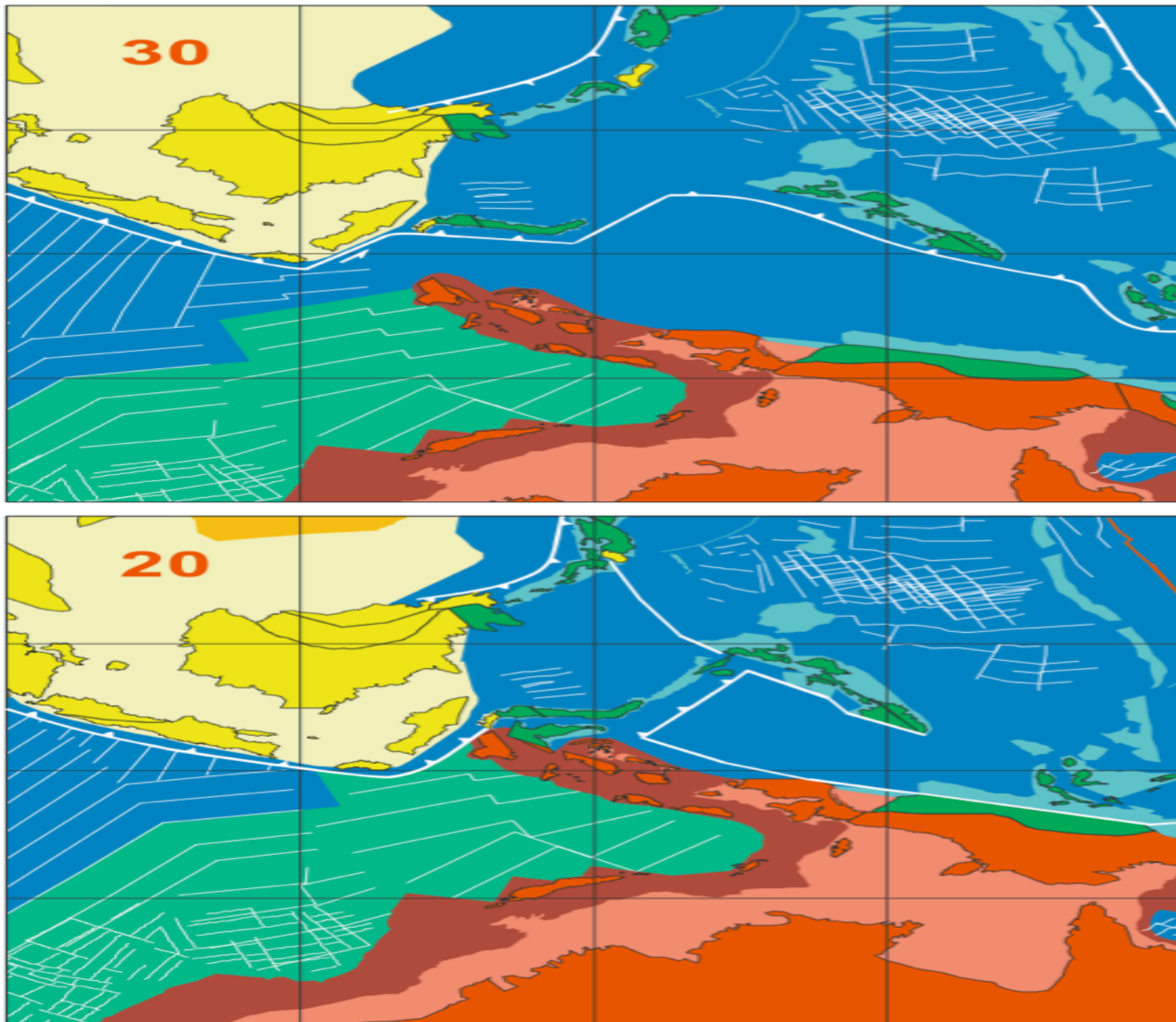


Objective 1

- Two different experiments with CCSM3:
 setting A → 30 Ma ago (ITF wide and deep)
 setting B → 20 Ma ago (ITF narrower and shallower)
- Indonesian paleogeography according to R. Hall.
- Setting of both experiments using mean boundary conditions for the Oligocene/Miocene boundary.
- Comparison of the output climates for settings A and B.

Objective 1

R. Hall,
Throughflow NTA1, Royal Holloway 2010



Objective 1

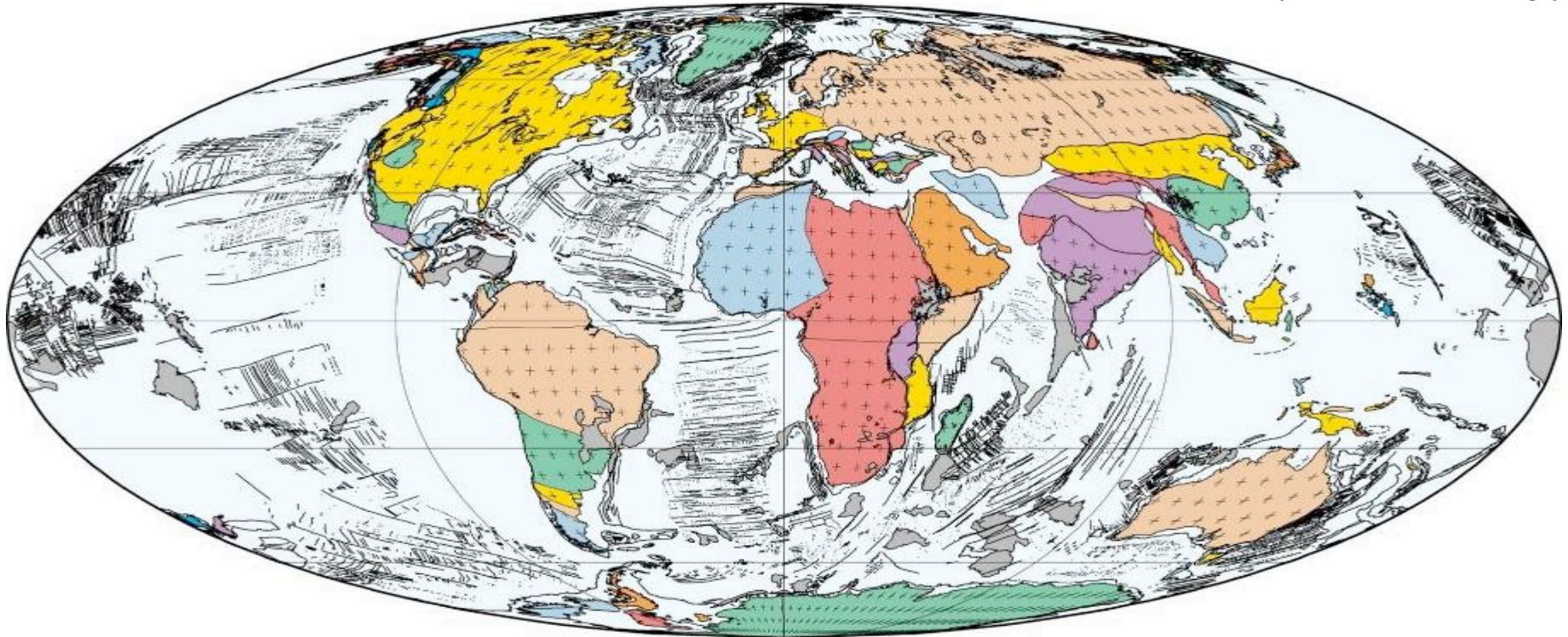
Setting mean b.c. for the (-30, -20) Ma interval

- Global tectonic boundary conditions:

Bathymetry >> shallow Drake Passage, Paratethys, open Central American seaway, closed Bering Strait

By Lawver, Dalziel, Gahagan

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030 Ma
Early Oligocene

PLATES/UTIG
March 2007

Objective 1

Setting mean b.c. for the (-30, -20) Ma interval

- Global tectonic boundary conditions:
Bathymetry >> shallow Drake Passage, Paratethys, open Central American seaway, closed Bering Strait
Topography >> Tibetan Plateau, Himalayas, Andes, Rocky Mountains
- Atmospheric composition: CO₂ (600 ppm), CH₄, N₂O, ozone, aerosols...
- Orbital parameters and solar constant
- Ice sheets

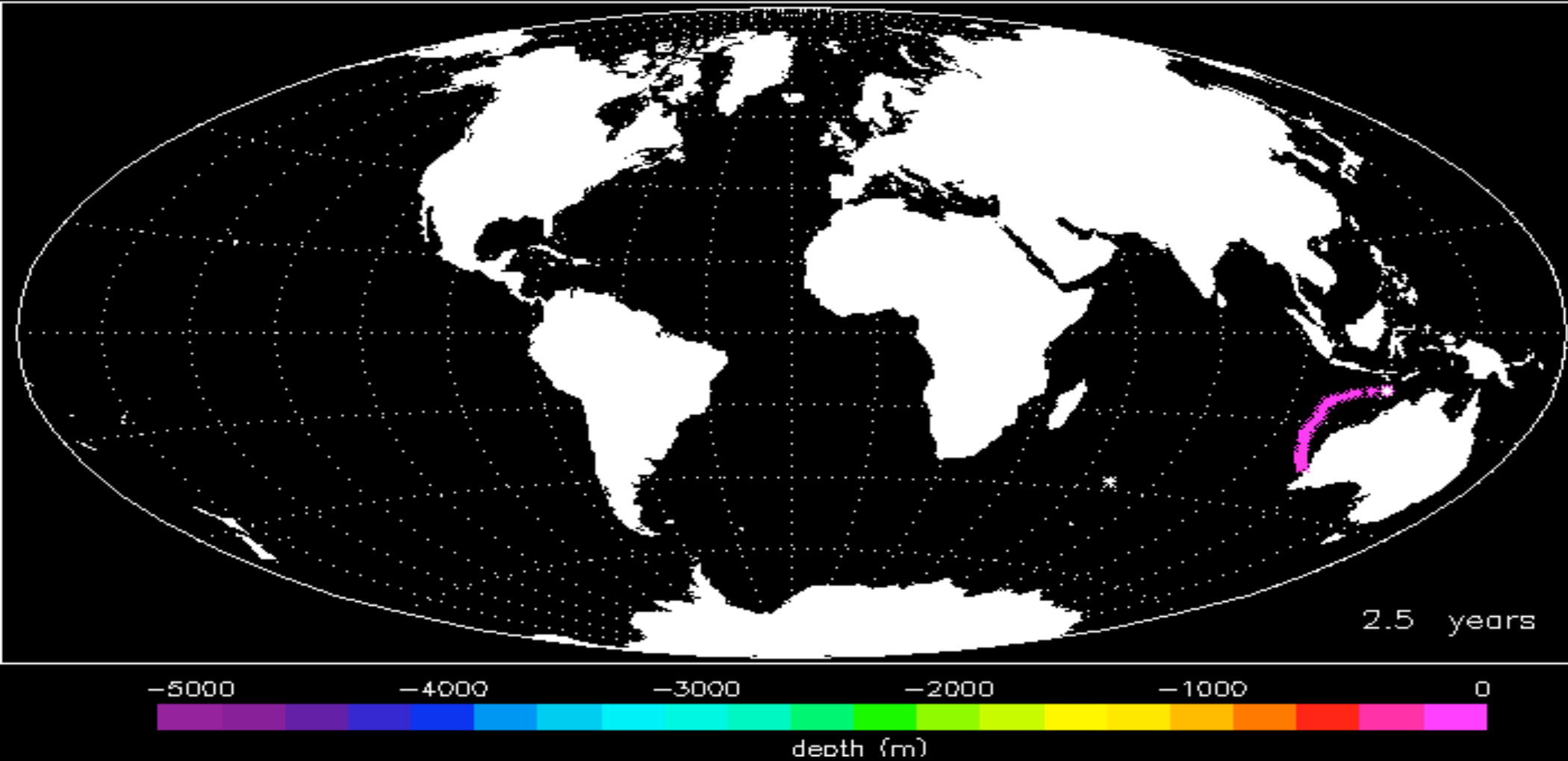
Objective 1

To trace dispersal patterns of marine organisms in the throughflow region by means of streamlines using ARIANE (University of Brest).

- ARIANE is a computational tool (Fortran 90/95) that is dedicated to the offline calculation of 3D streamlines in the output velocity field of an Ocean General Circulation Model.
- Some possible options associated with the use of ARIANE: qualitative diagnostics, quantitative diagnostics, forward or backward integrations.

"Global" trajectory in the OPA model

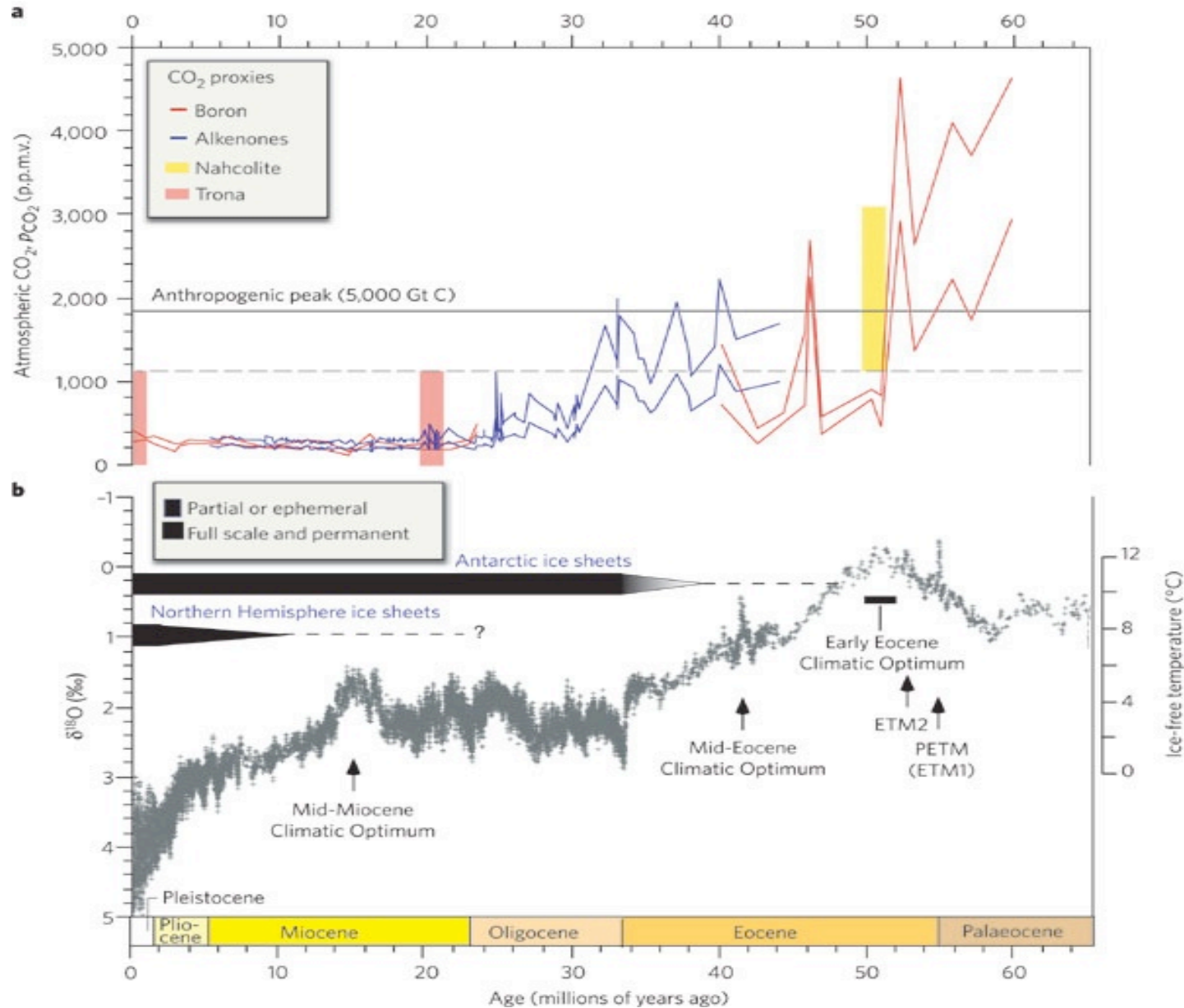
<http://www.univ-brest.fr/lpo/ariane>



<http://stockage.univ-brest.fr/~grima/Ariane/ariane.html>

Objective 2

To test the influence of changes in pCO₂ during the Oligocene.

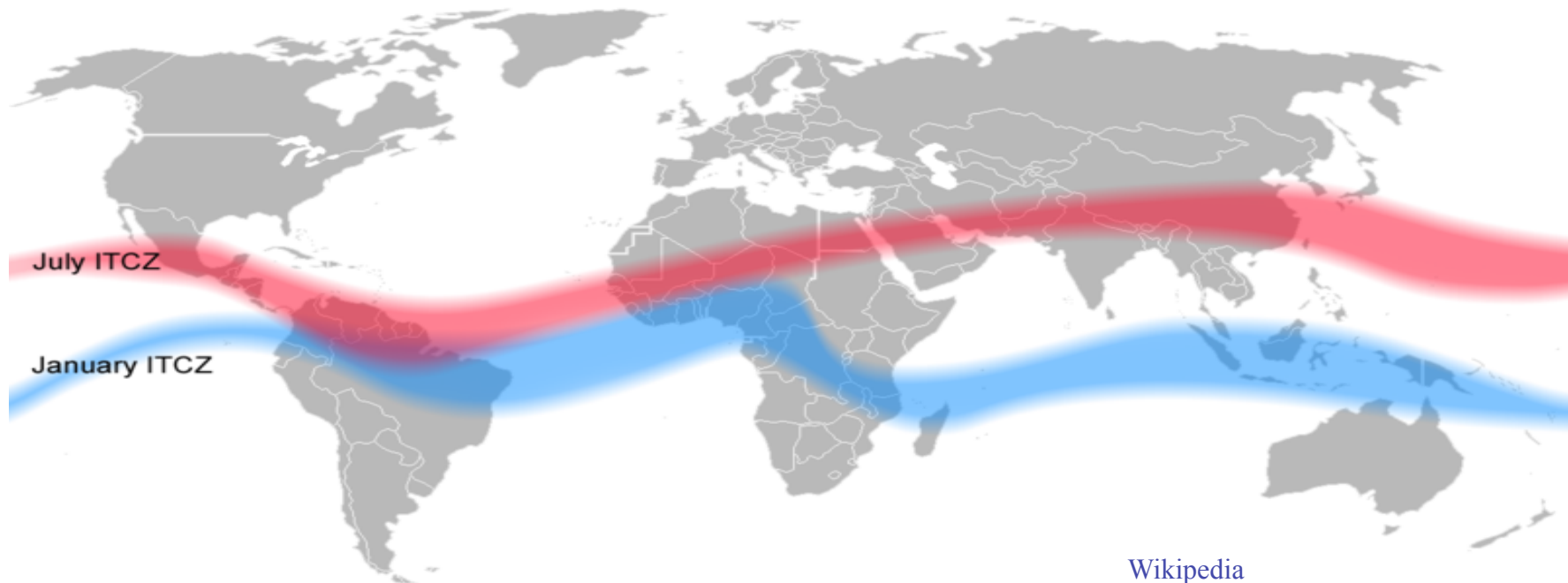


Zachos, Dickens, Zeebe (2008)

Objective 3

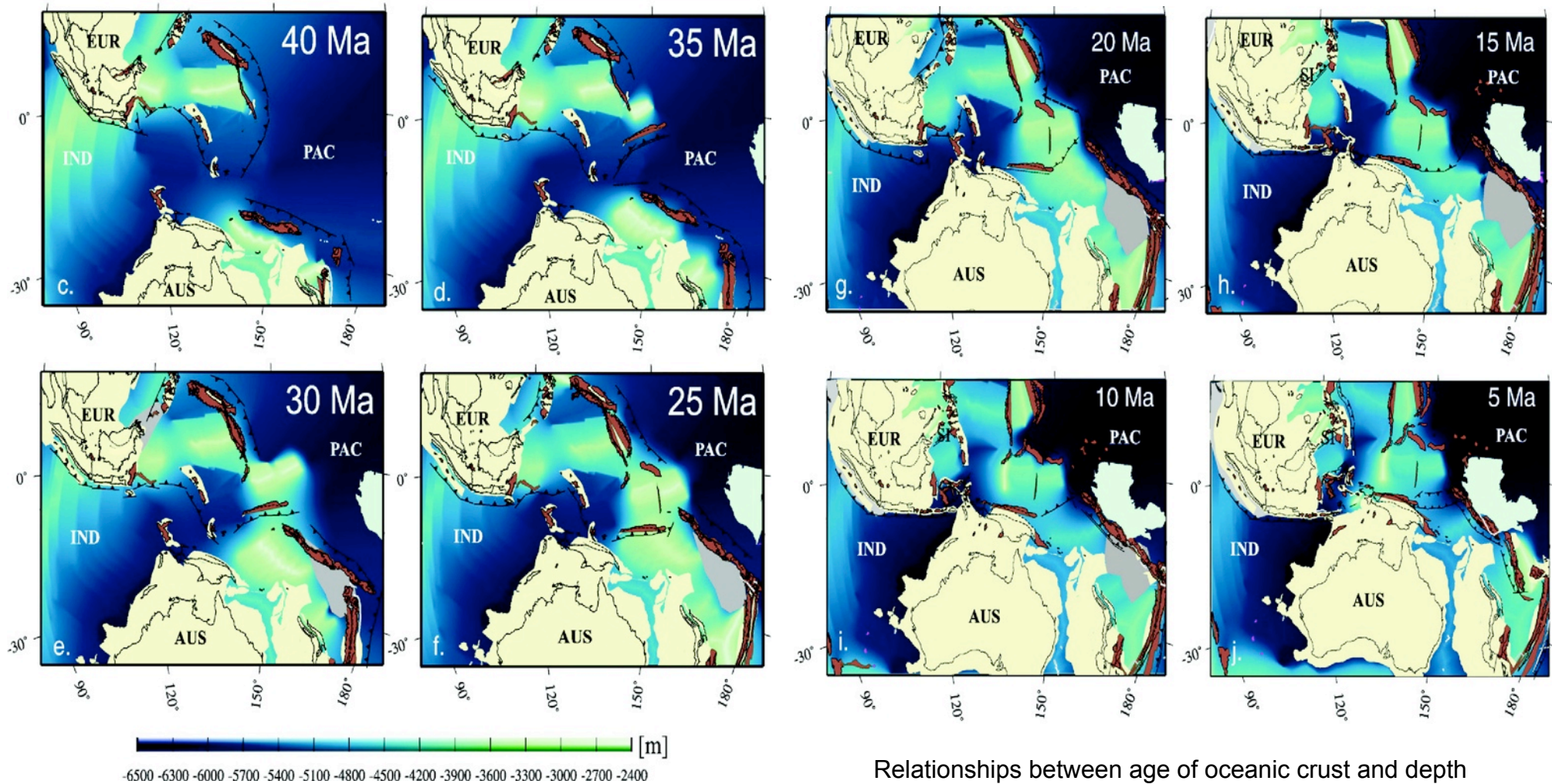
To test if increasing glaciation in Antarctica leads to a northward shift of the tropical rainbelt in the ITF region (Holbourn et al., 2010)

- Strategy: CCSM experiment for 14 Ma with perturbations by prescribed Antarctic ice sheets of different volume and extent.



Objective 1

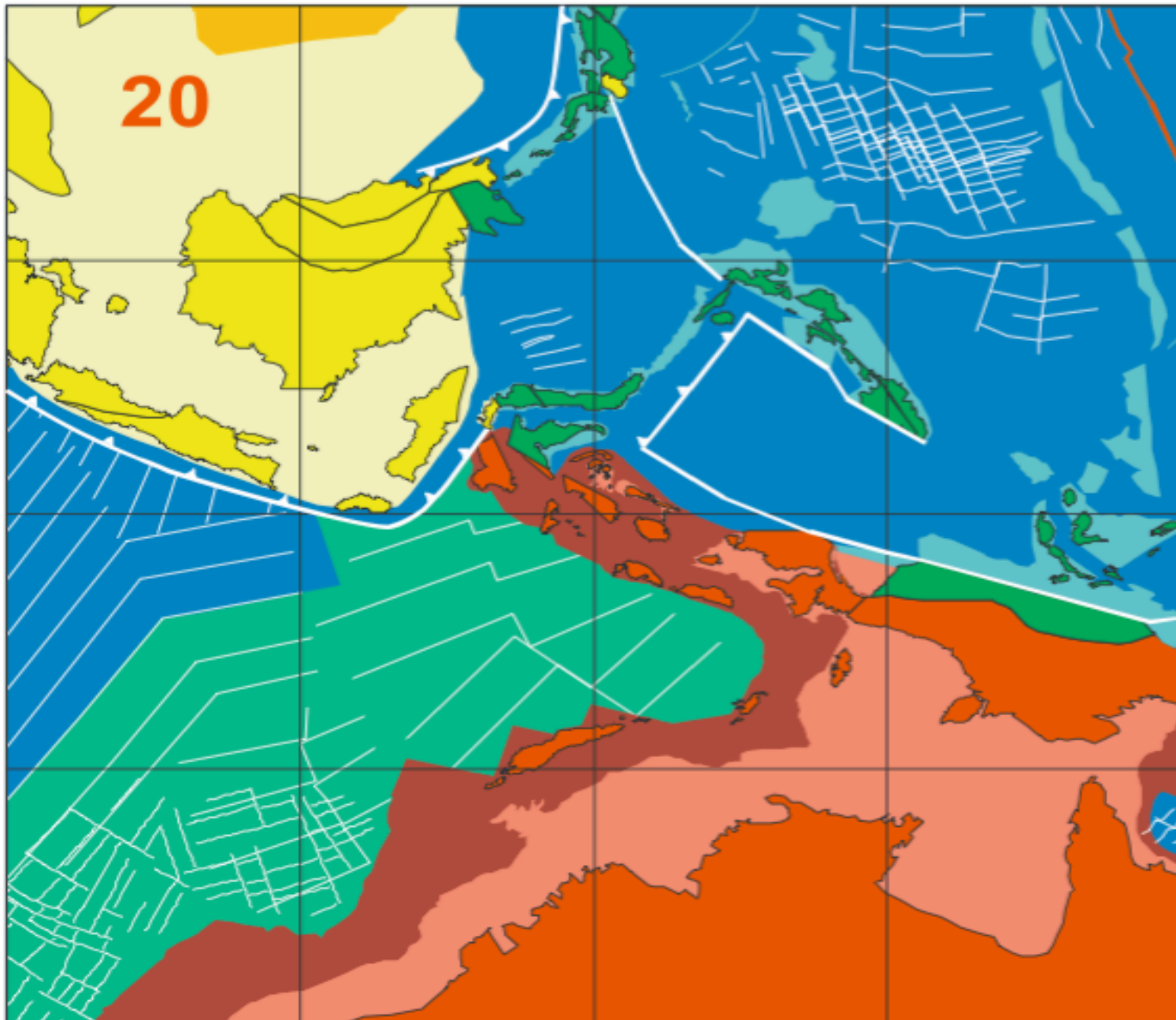
(Gaina and Müller, 2007)



- Northward movement of the Indian-Australian plate
- Deep-connection closure during the Oligocene

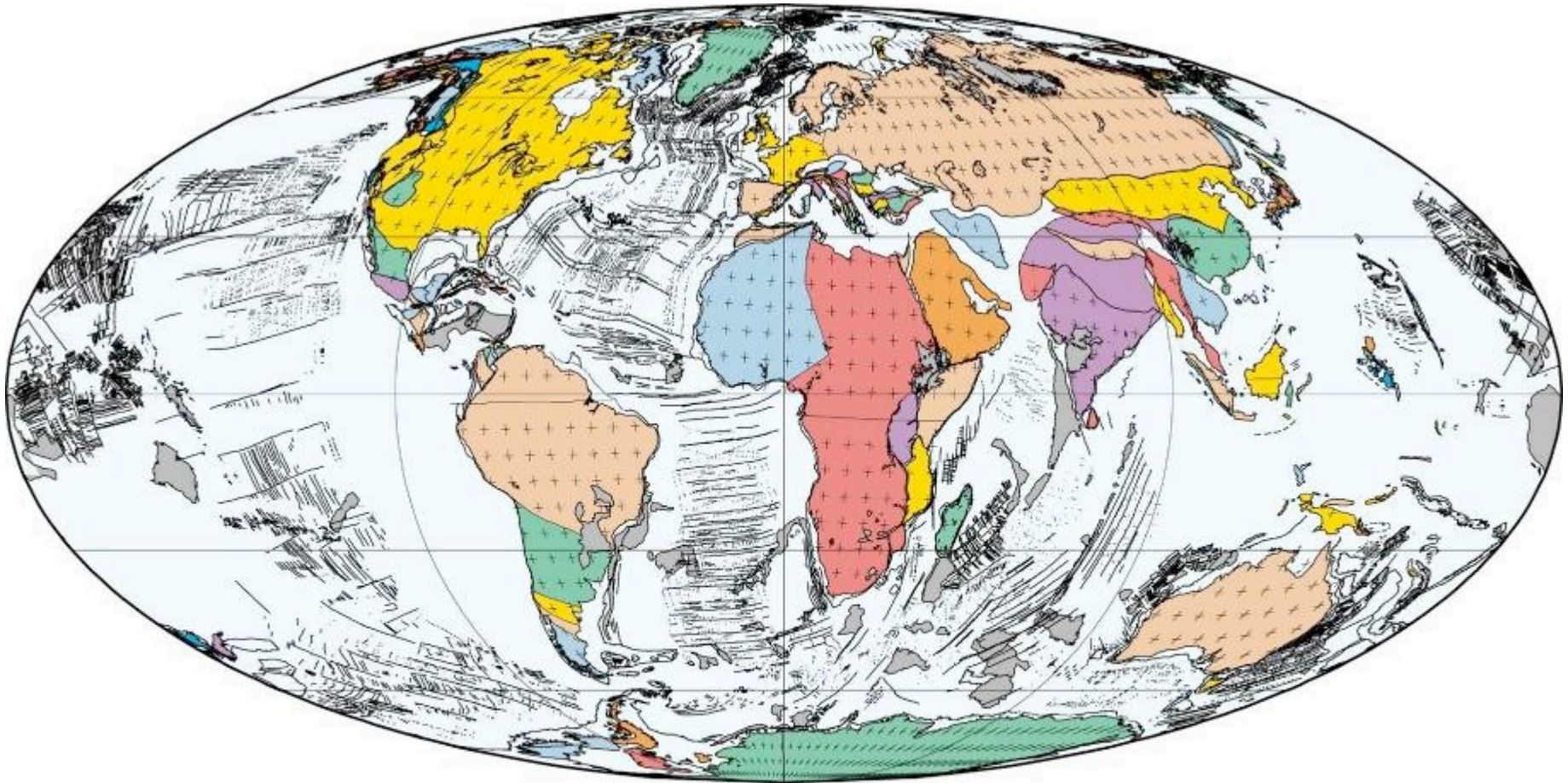
Objective 1

R. Hall,
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Objective 1

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30 Ma
Early Oligocene

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