



LSCE

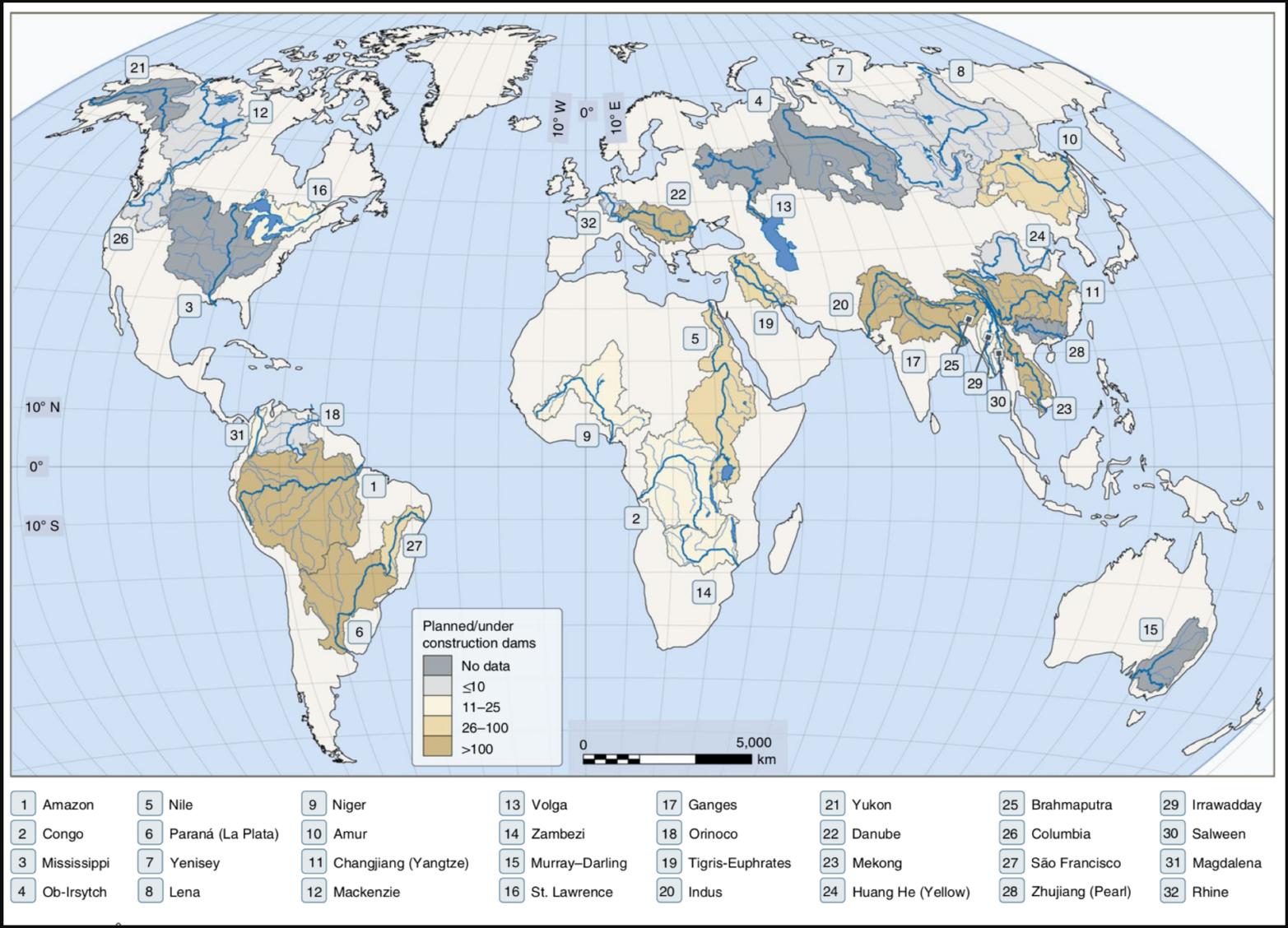
LABORATOIRE DES SCIENCES DU CLIMAT
& DE L'ENVIRONNEMENT

Did the evolution of tropical river systems impact the Cenozoic climate system ?

A preliminary study with the IPSL-CM5A2 earth system model.

Pierre Sepulchre & Julia Bres

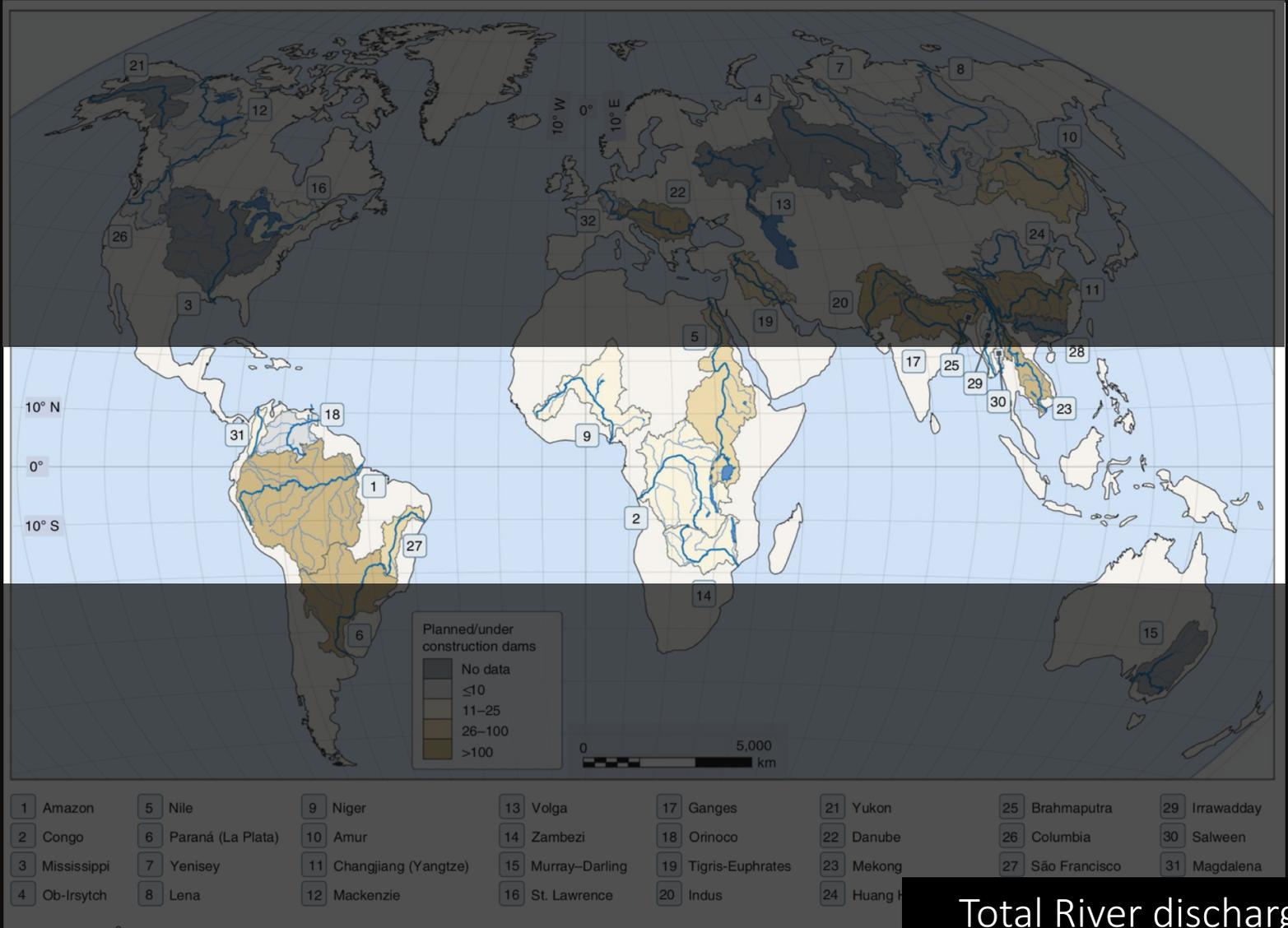
Rivers as a major component of the global freshwater balance



From Best J. , Nature Geoscience, 2019.

Total River discharge : 1 Sv
Dai et Trenberth, 2002

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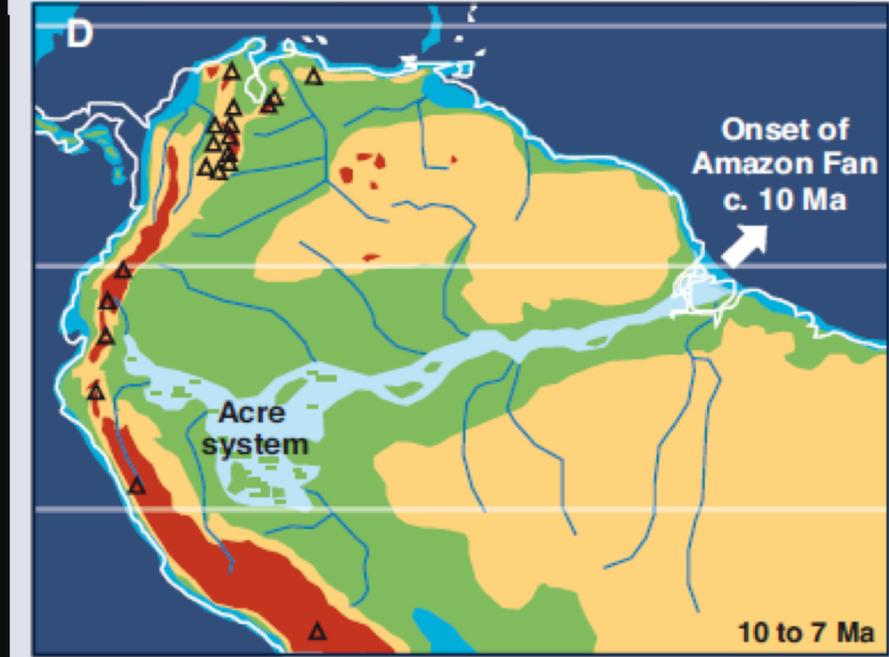
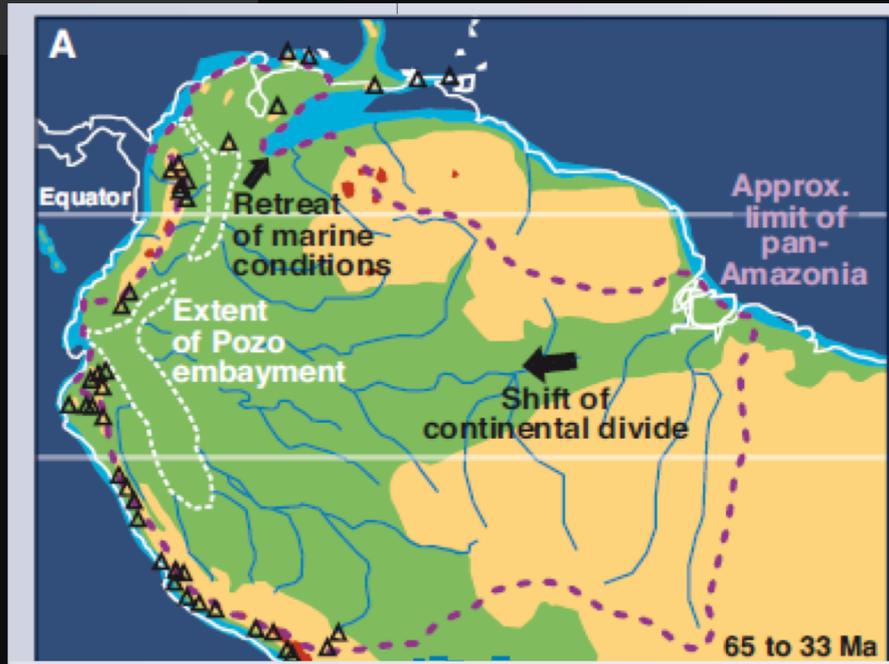
Total River discharge : 1 Sv
 Amazon (#1): 20%
 Congo (#2) : 4%
 Dai et Trenberth, 2002

Cenozoic uplifts are associated with river basin rerouting.

Ex: The Andes and the Amazon

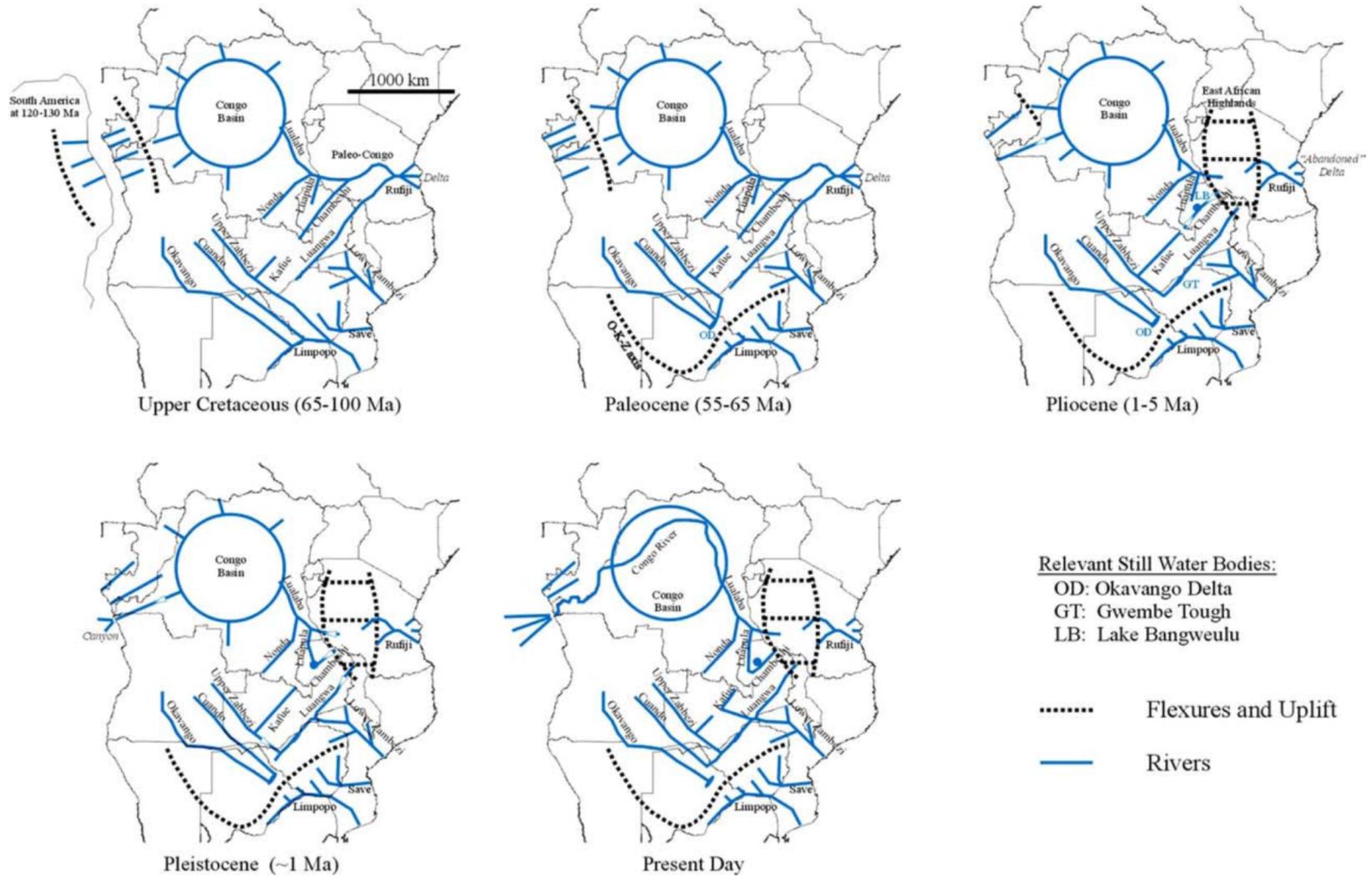


Hoorn et al., 2010ab



Cenozoic uplifts are associated with river basin rerouting.
 Ex : The east african rift system and the Congo river

J. Stankiewicz, M.J. de Wit | Journal of African Earth Sciences 44 (2006) 75–84



Questions:

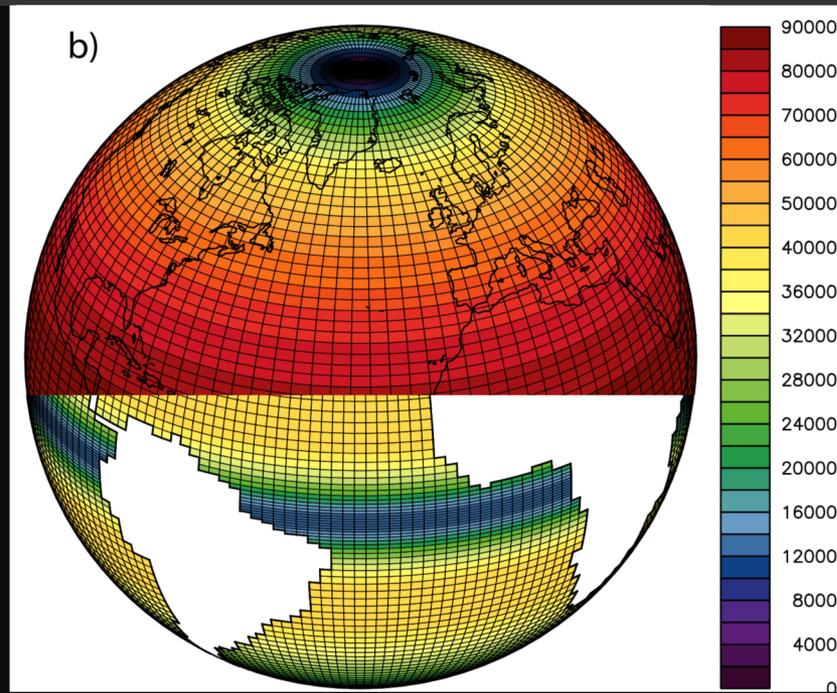
- Are the changes in locations and intensity of freshwater discharge important or not for Cenozoic climate ?
- How do they compare to the direct impact of topography ?
- Example of the Congo river.

The model: IPSL-CM5A2

(Sepulchre et al., *Geoscientific Model Development under review*.
Discussion available at:

<https://www.geosci-model-dev-discuss.net/gmd-2019-332/>)

- Low resolution (i.e. CMIP5-like) earth system model.
- Runs fast (100years/day)

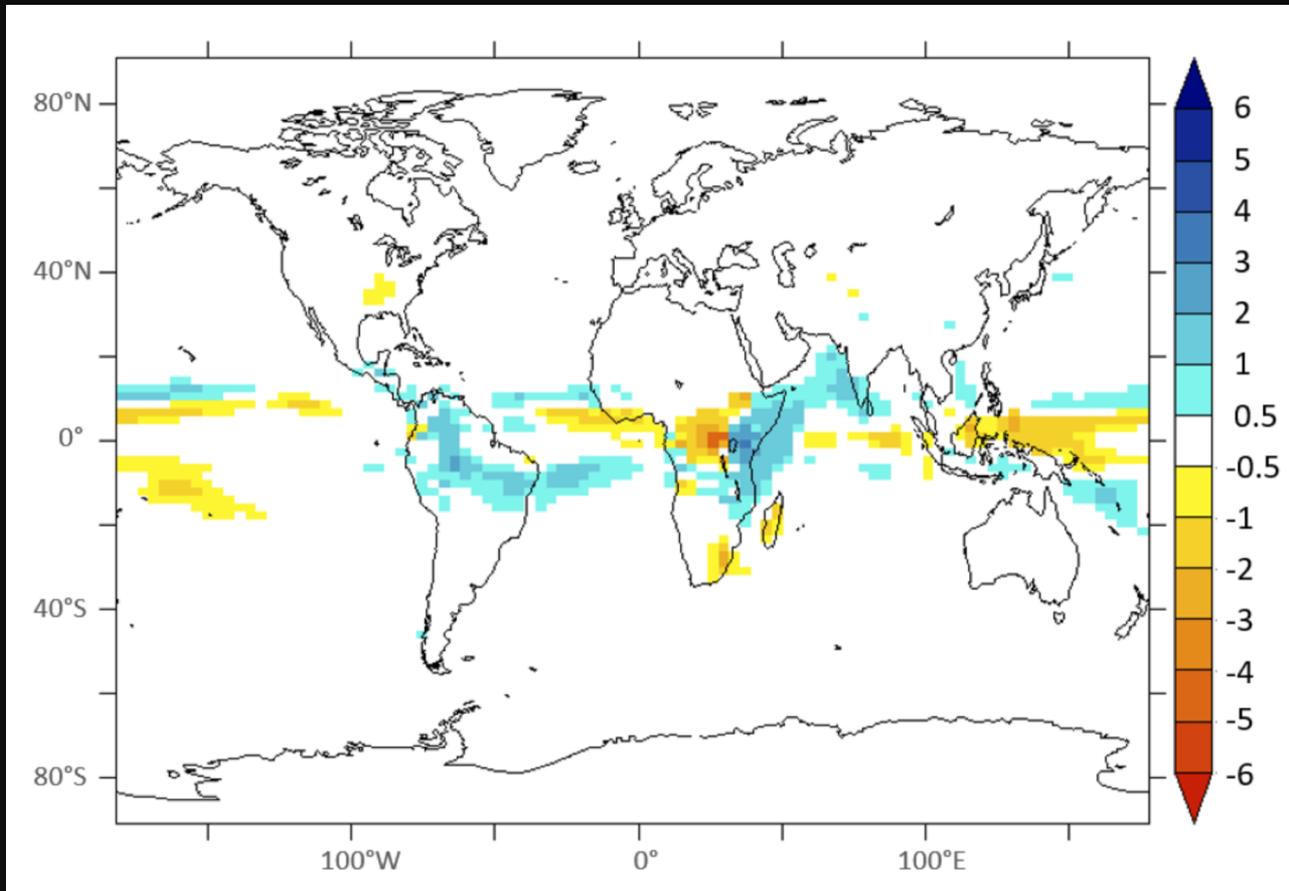


The experimental design

| Name | Difference with pre-industrial |
|-------------|---|
| NORIFT | No east-african topography |
| NORIFTtrout | NORIFT + Congo river rerouted to Indian ocean |

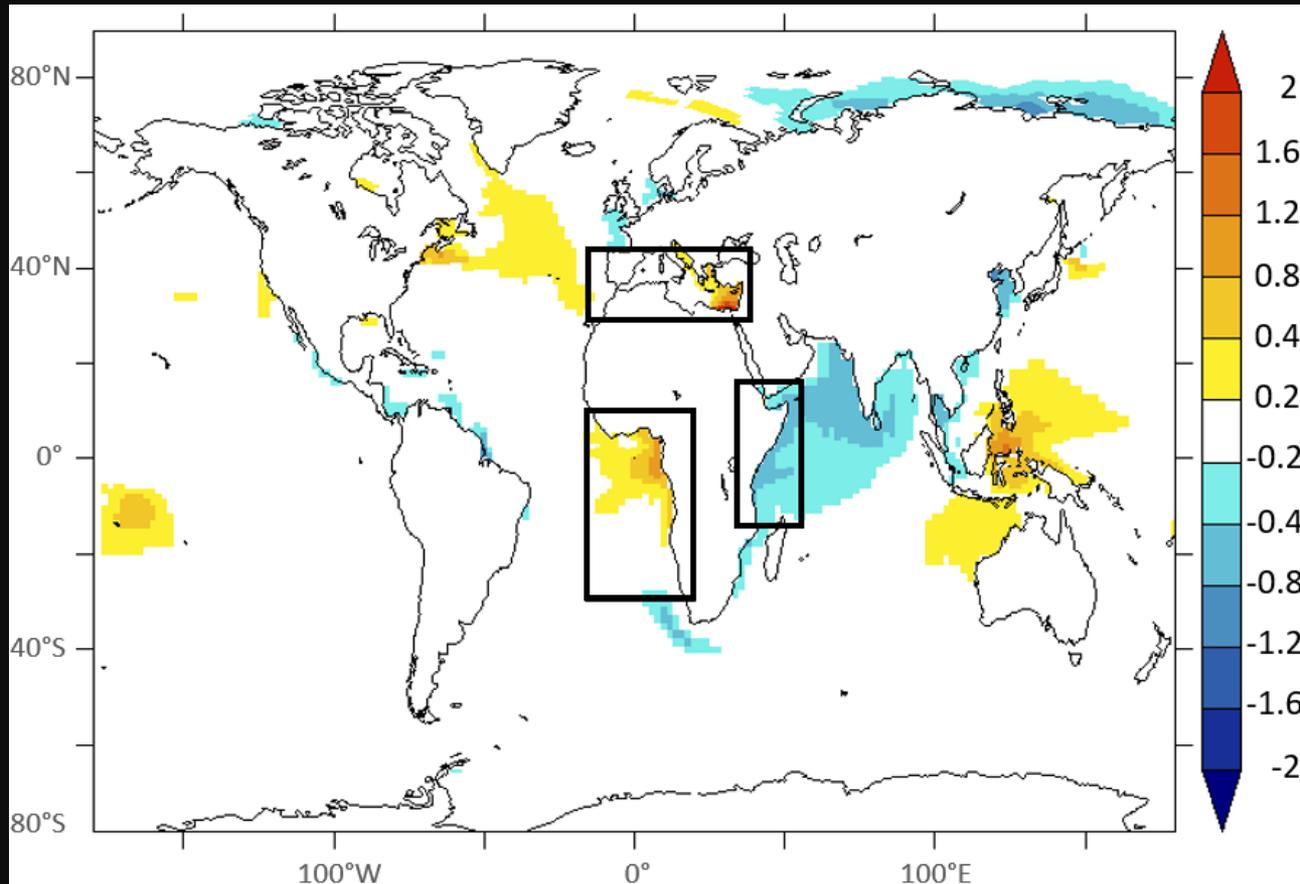
Topography alters the hydrological cycle. Rainfall anomaly (mm/d)

$\Delta(\text{NORIFT} - \text{Control})$



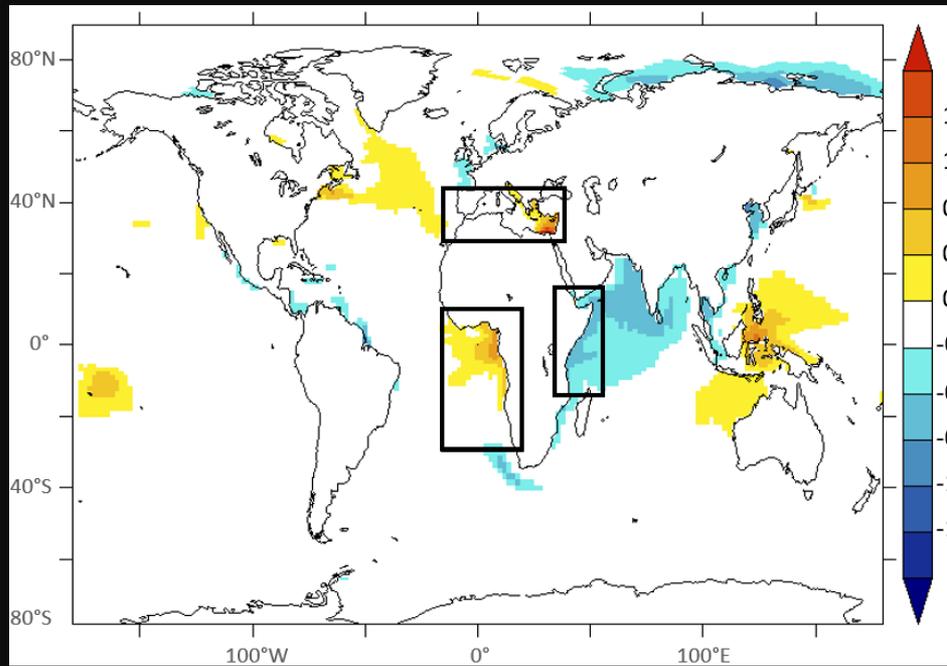
In turn, topography alters surface salinity patterns.
(psu)

$\Delta(\text{NORIFT} - \text{Control})$



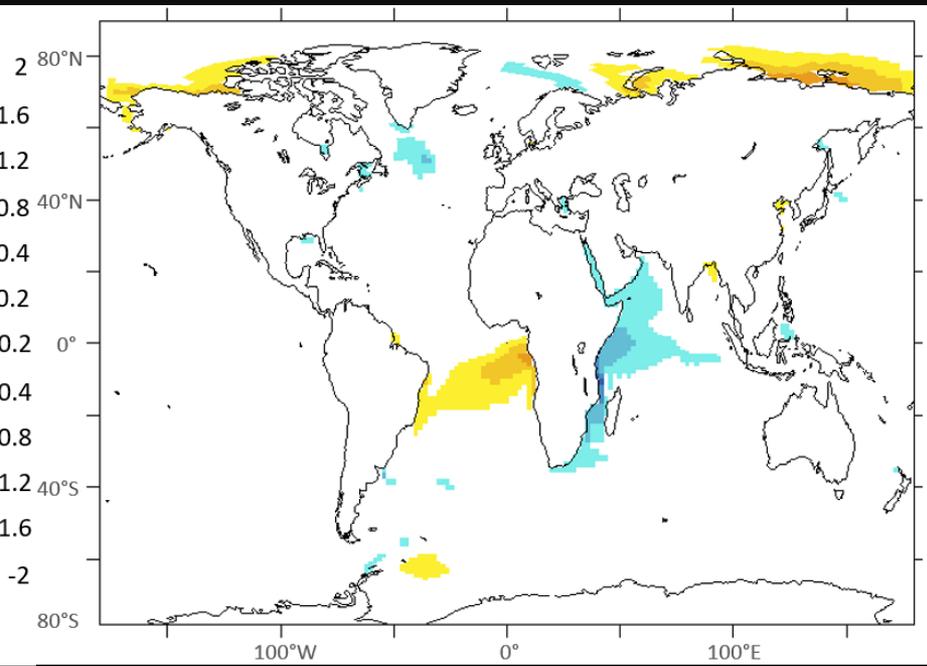
Additional effect of routing on salinity (psu)

$\Delta(\text{NORIFT} - \text{Control})$

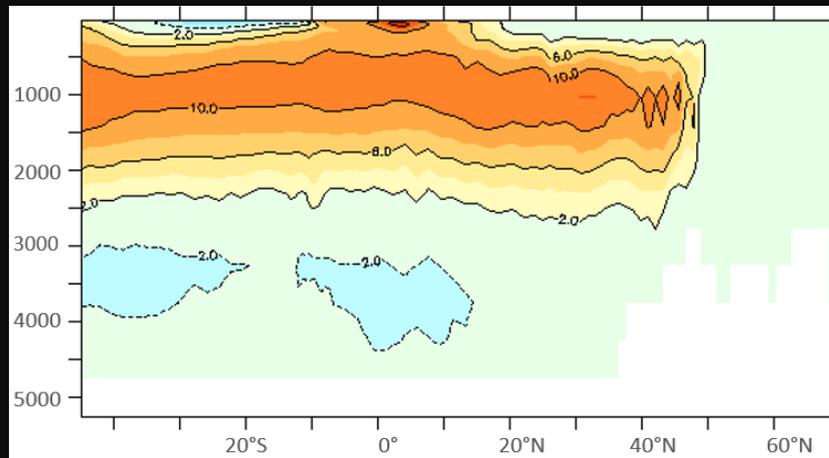


Topography effect

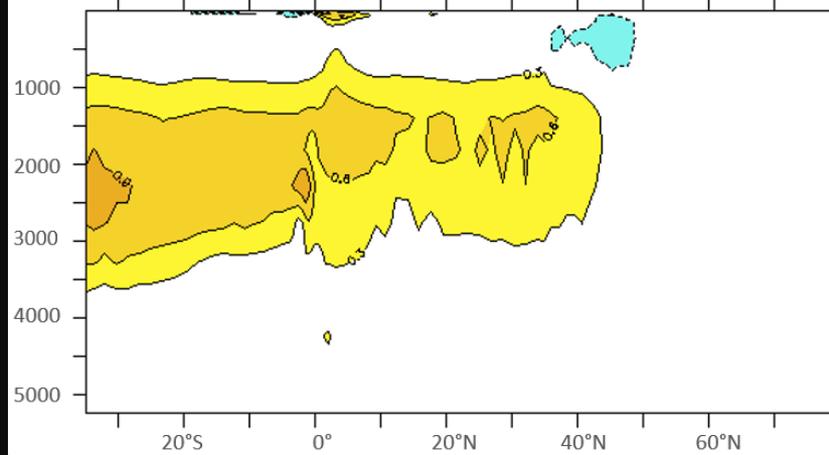
$\Delta(\text{NORIFT}_{\text{rout}} - \text{NORIFT})$



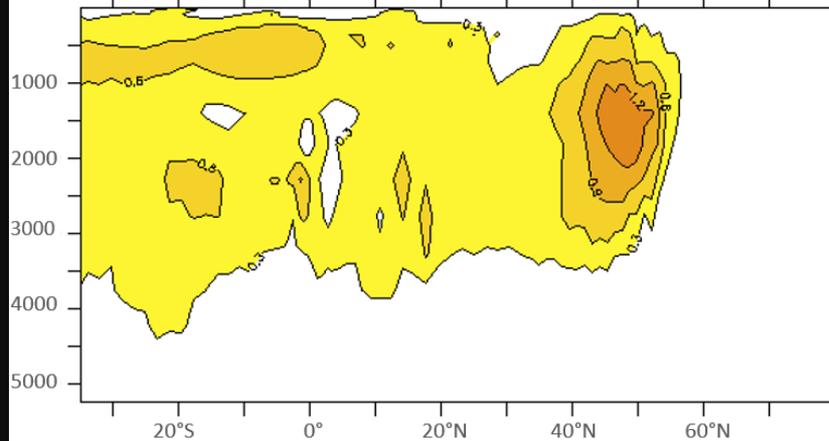
+ routing effect



Control
Atlantic MSF
(Sv)



NoRift-Control



NoRiftrout-
NoRift

Take-away message

- Not accounting for river routing gives only a partial view of the topography effect on climate.
- Here we provide only very preliminary results obtained with sensitivity experiments.
- Correctly quantifying this effect requires data to constrain the river fluxes in time and space.
- The sign of the routing signal might change depending on the basin considered.

Large river system during the African Humid Period !

What consequences for the Atlantic dynamics ?

Skonieczny et al., Nature comm., 2015

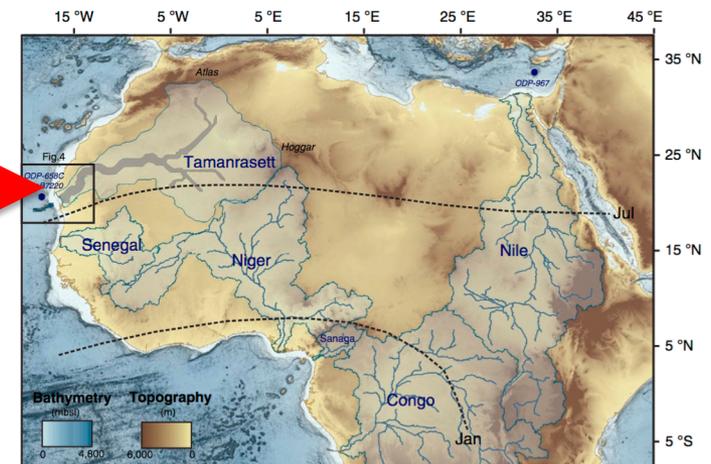


Figure 1 | Hydrological context of Africa. Map of the main rivers of the Mediterranean, West African Tropical and Equatorial margins and associated watersheds. The present-day active Nile, Senegal, Niger, Sanaga and Congo rivers watershed are drawn in light blue (adapted from the USGS Hydro database). The outlines and the main course of the Tamanrasett paleowatershed¹⁸ are drawn in blue and grey, respectively. The newly identified Tamanrasett paleodrainage (this study) as well as Cap Timiris Canyon¹⁵ (Fig. 4) are drawn in dark blue. January and July present-day ITCZ positions (dotted lines) as well as Geob7920 core, ODP658 and ODP967 sites used in Fig. 2 are also plotted.