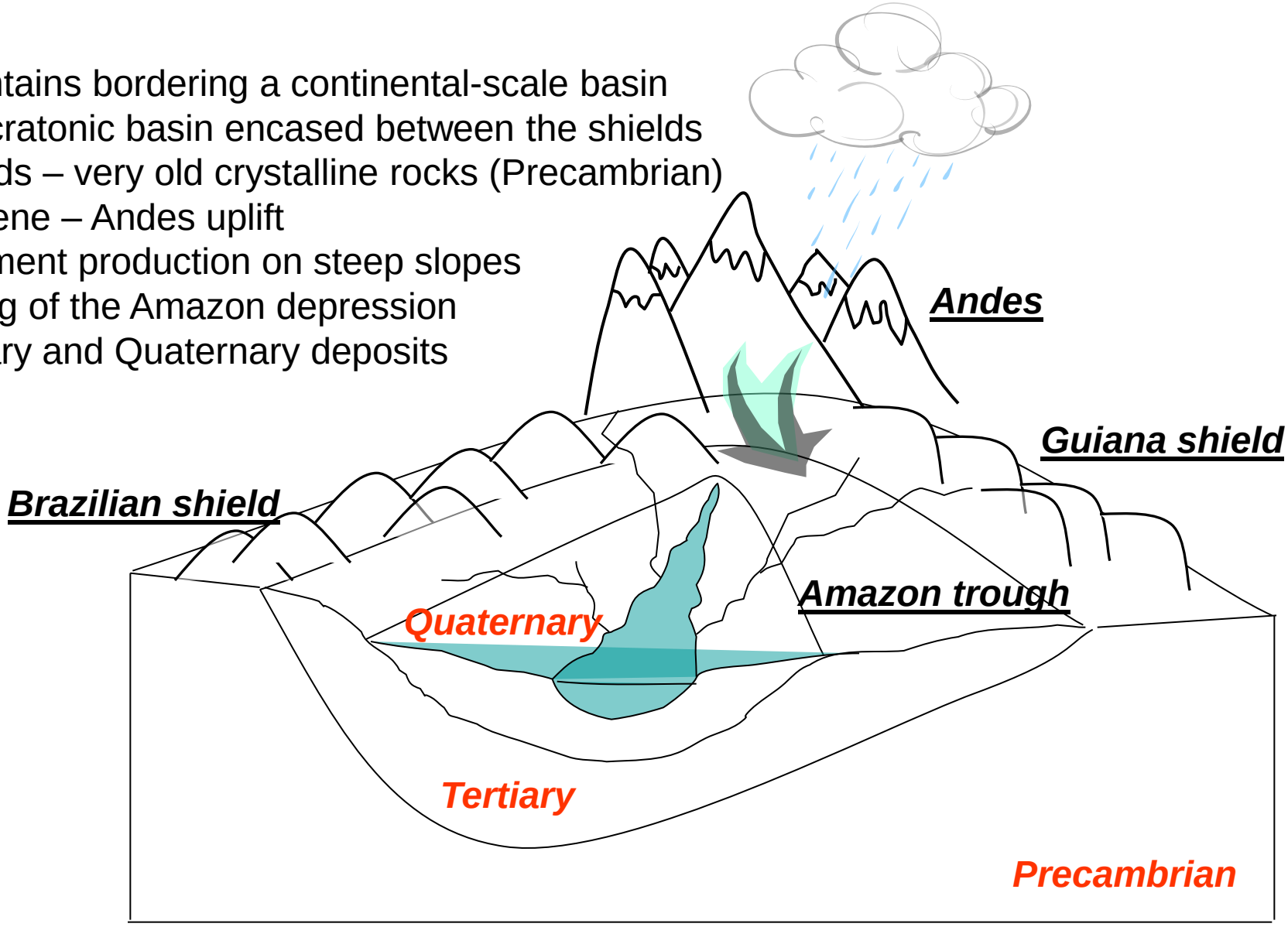
Amazon basin – geography

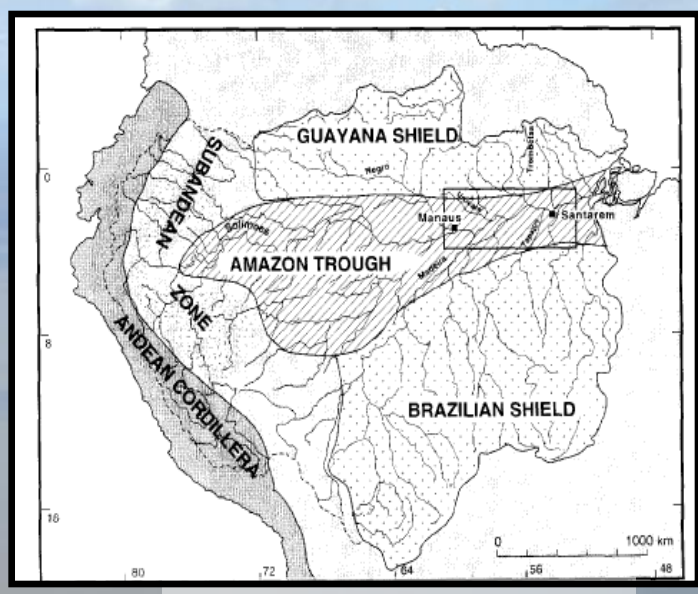
- Parallel 5°N to 17°S
- Amazon basin: **6.3 million km²**
- Amazon region (e.g Tocantins basin – **7.0 million km²**)
- Area of the USA – ~9.600.000 km²
- Amazon **73%** of the area of the **USA**
- Seven countries of South America
  - Brazil – 64%
  - Colombia – 16%
  - Bolivia – 16%
  - Ecuador - 2%
  - Guyana – 1.4%
  - Peru – 0.6%
  - Venezuela – 0.1%

- Mountains bordering a continental-scale basin
- Intercratonic basin encased between the shields
- Shields – very old crystalline rocks (Precambrian)
- Miocene – Andes uplift
- Sediment production on steep slopes
- Filling of the Amazon depression
- Tertiary and Quaternary deposits



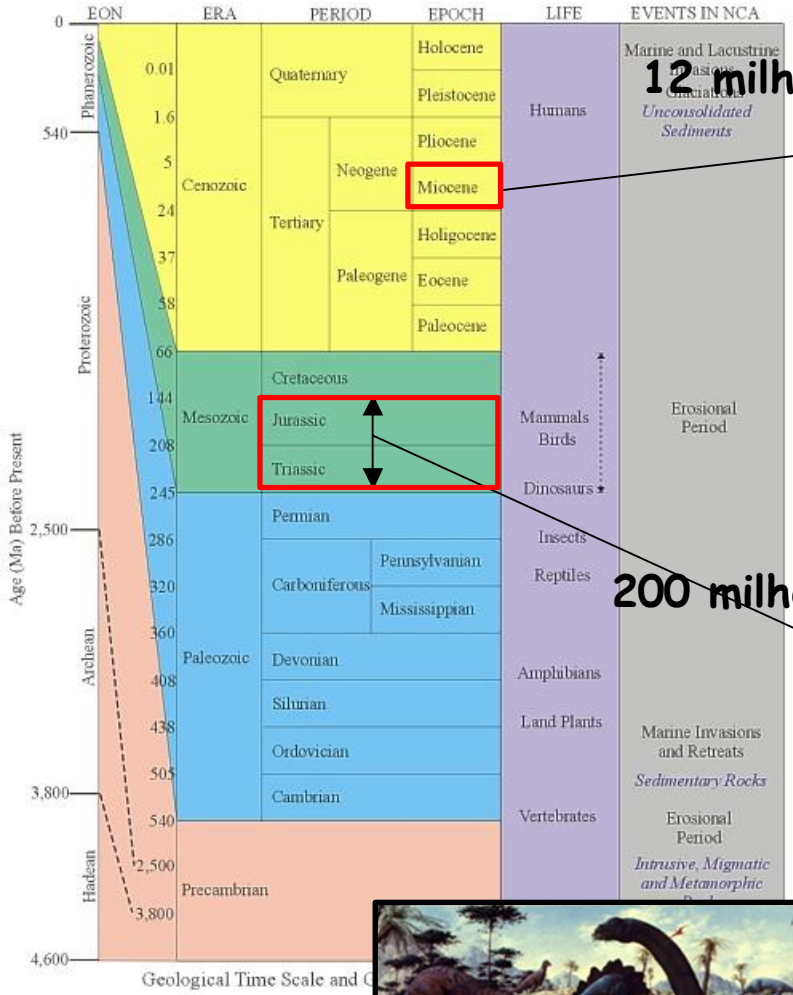
Amazon basin – Structural settings

- East – Andean cordilheira (3.000 to 7.000 meters)
- North – Guyana shield (200 to 500 meters)
- South – Brazilian shield (200 to 500 meters)
- Center - Amazon trough

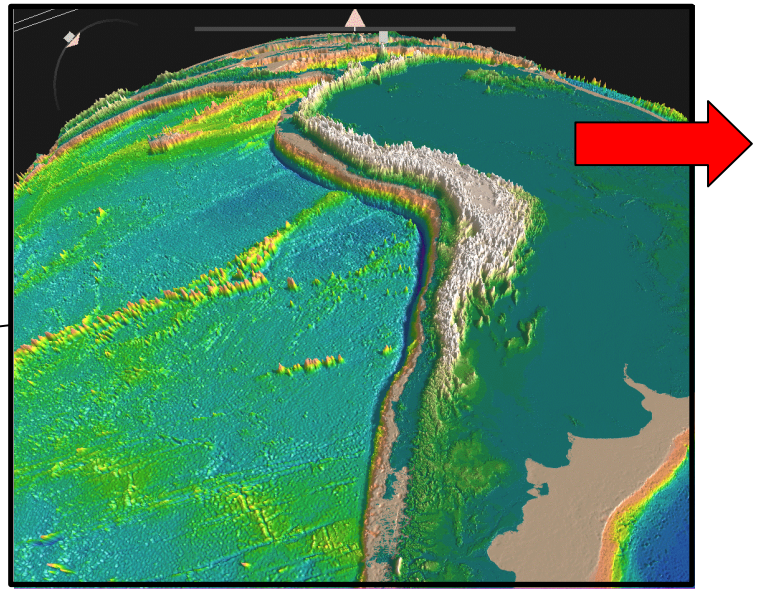


Source: Gaillardet et al. (1997)

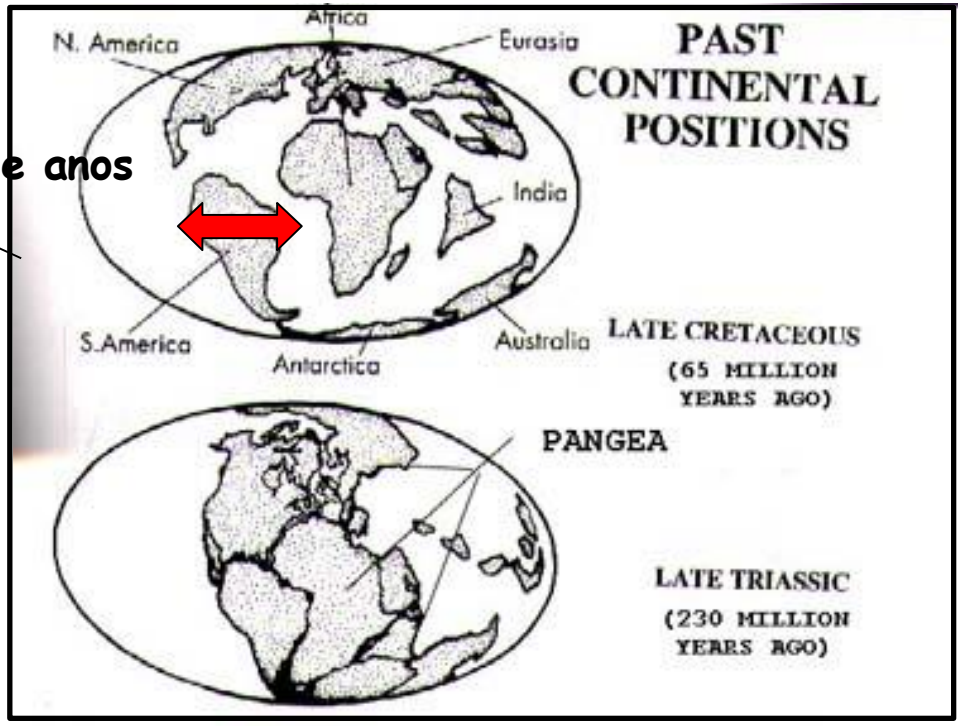
Source: earthobservatory.nasa.gov

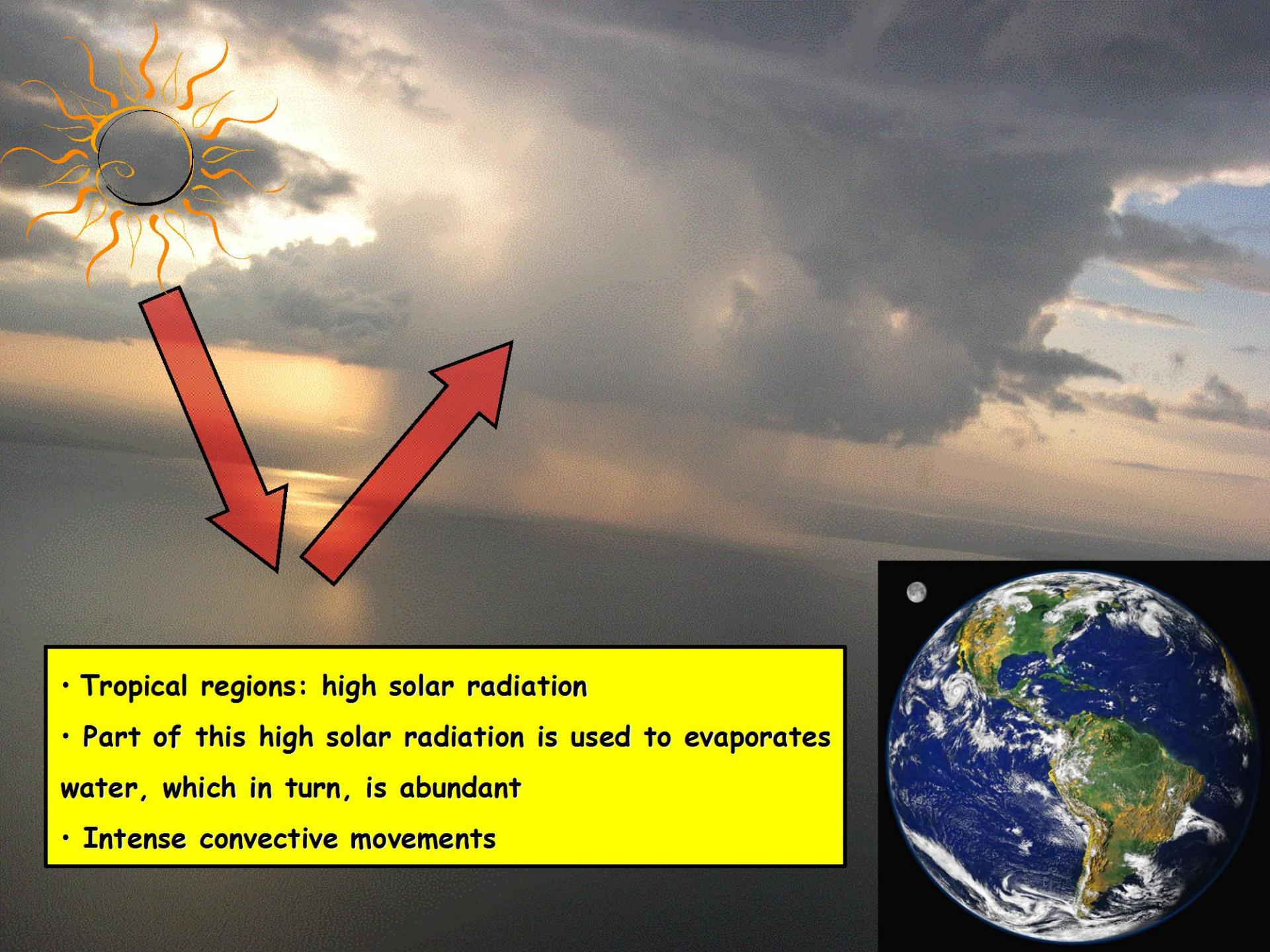


12 milhões de anos



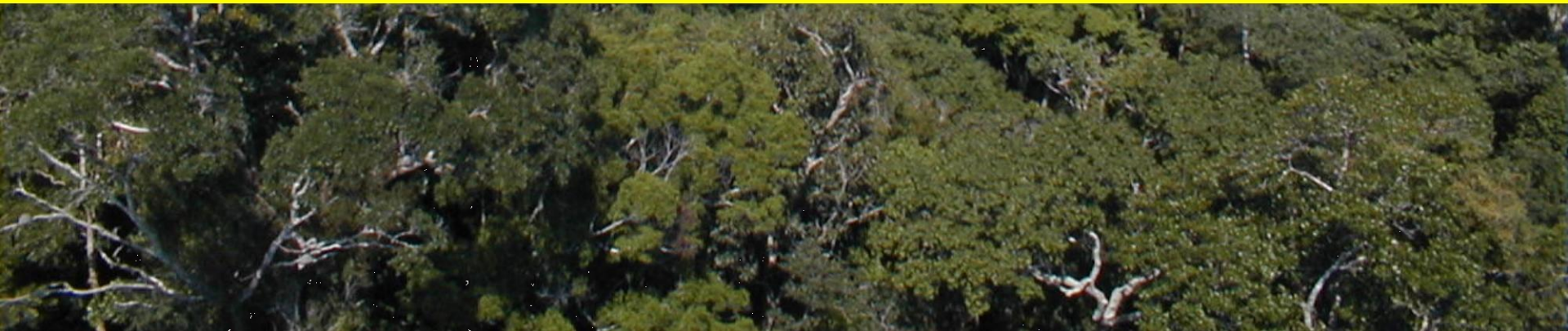
200 milhões de anos





- Tropical regions: high solar radiation
- Part of this high solar radiation is used to evaporates water, which in turn, is abundant
- Intense convective movements

- Intense water recycling by evapotranspiration of the trees
- Therefore, the forest depends on the rainfall, but the rainfall also depends on the fores



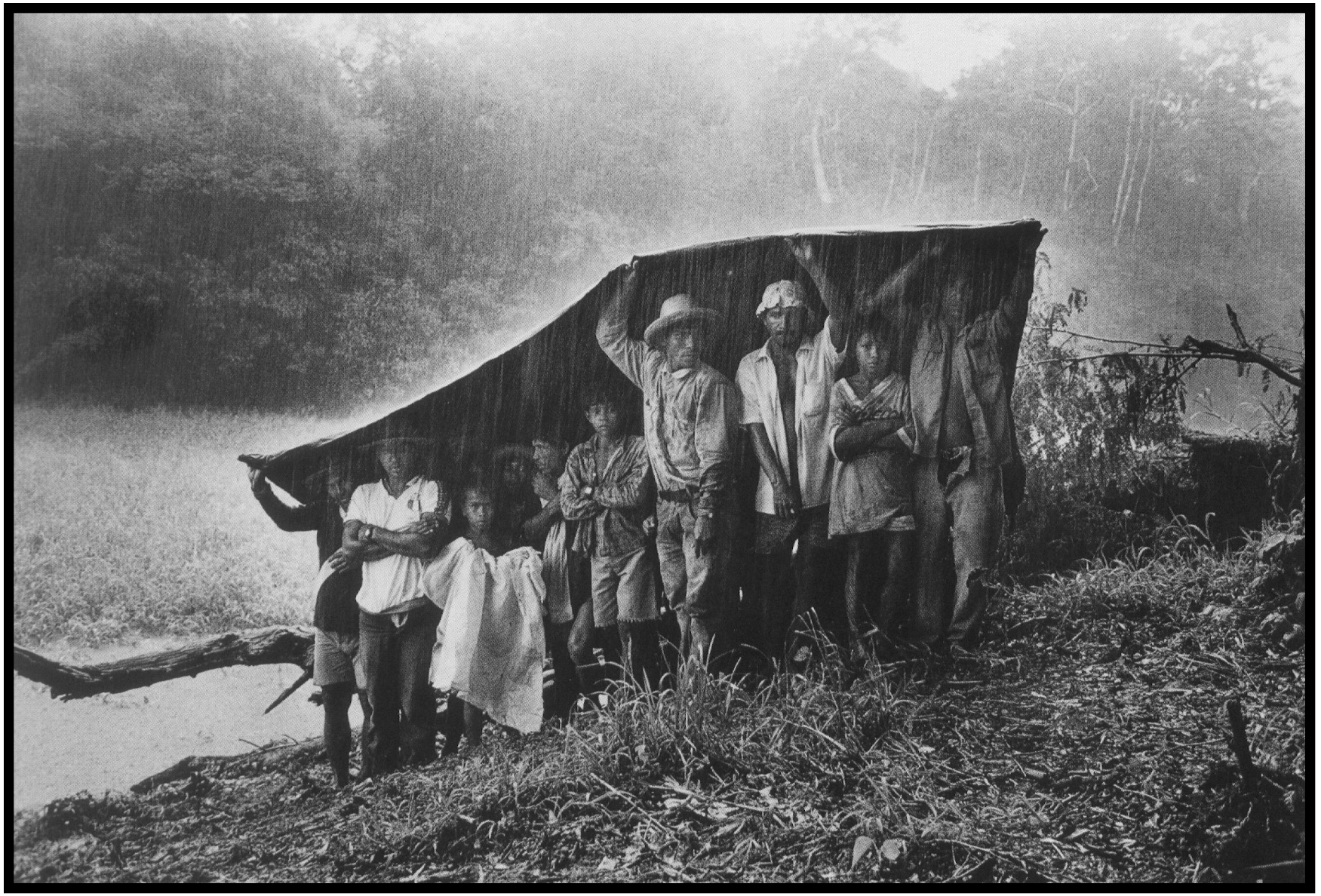
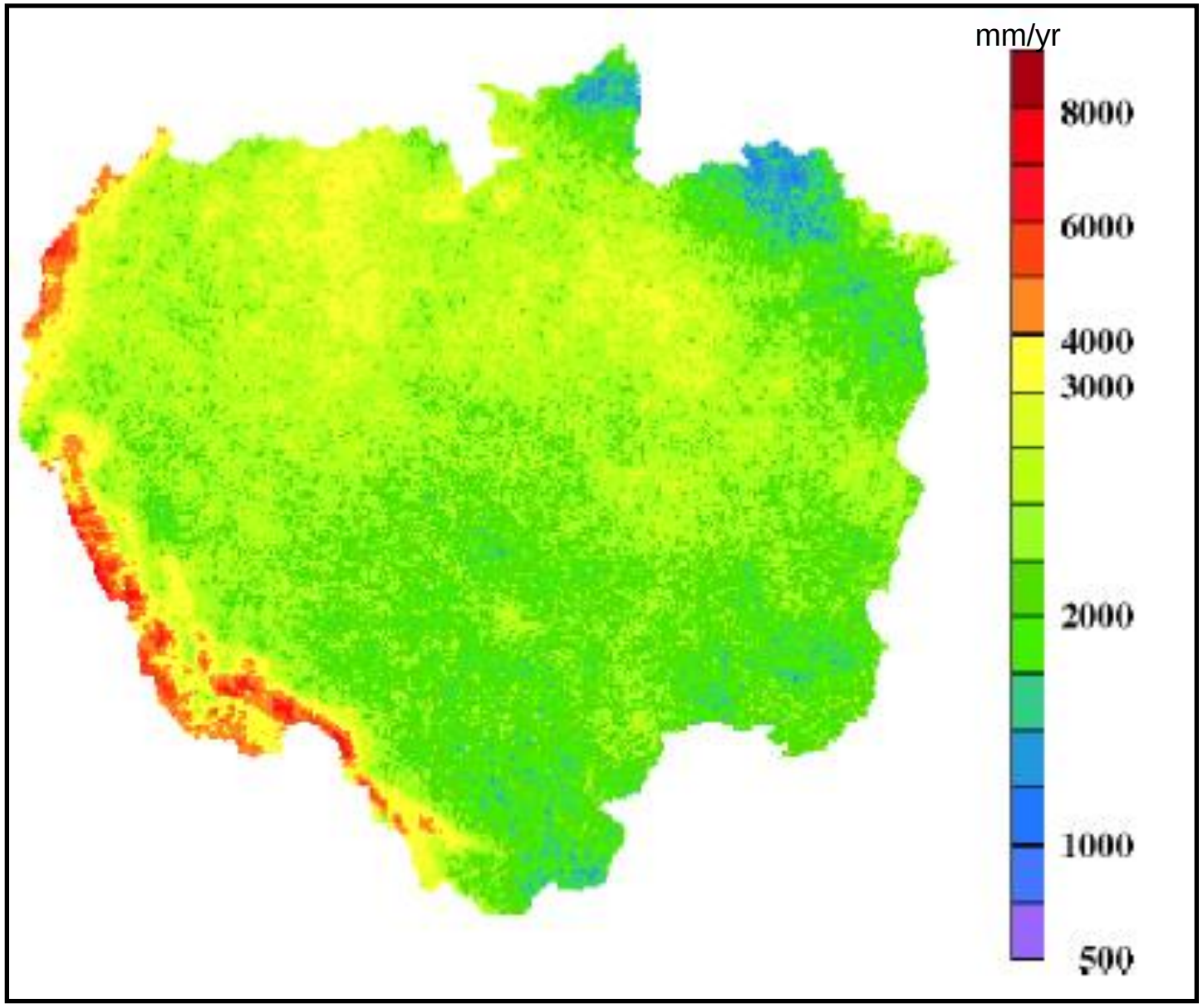
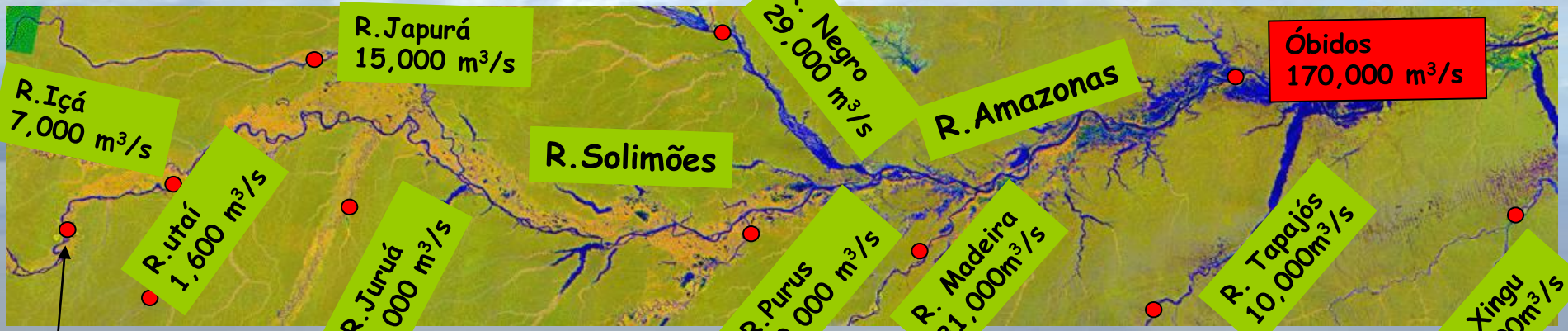


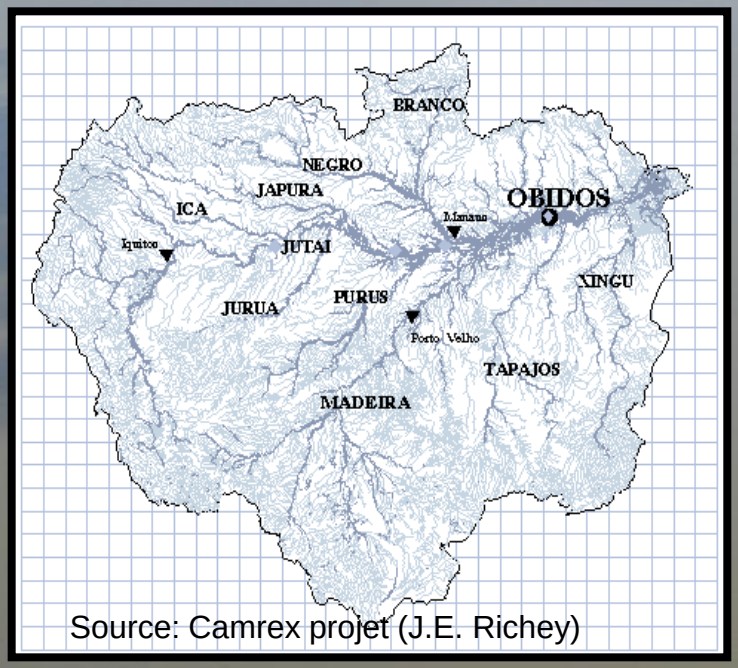
Photo: Pedro Martinelli

Photo: Pedro Martinelli



Annual rainfall fields (mm/yr) derived from an AVHRR satellite index. Source:Richey et al. 2001.





Source: Camrex projet (J.E. Richey)

Amazon x Mississipii

- Total length = **6,771 km x 3,705 km**
- Basin area = **6,300,000 km² x 3,200,000 km²**
- Avergae discharge = **170,000 m³/s x 17,330 m³/s**

Figure 6.4 **Stretch of the Amazon River, showing lenticular islands dividing the stream-bed into a master channel and one or more side channels, or *paranás*. Selected soundings (in metres) from the 1967 hydrographic survey by the Brazilian Navy; datum is mean lower low-water stage. (Taken, together with most water surface lines, from Brasil, *Rio Amazonas, Cartas de Praticagem da Flotilha do Amazonas*, Marinha do Brasil, Sheets P 4 106 A and B, 2nd ed., 1970. Original scale 1:100,000. Approximate outline of terra firme lakes, and boundary between uplands and floodplains, from aerial photographs.)**

River depths in meters after the Negro and Solimões confluence.

Source: Sternberg, H.O.Water and wetlands of Brazilian Amazonia: An uncertain future. In: The fragile tropics of Latin America: Sustainable management of changing environmets. Ed. Nishizawa T, and Uitto J., United Nations University Press, Tokyo, 1995.

Photo: Antonio Nobre

Photo: Antonio Nobre

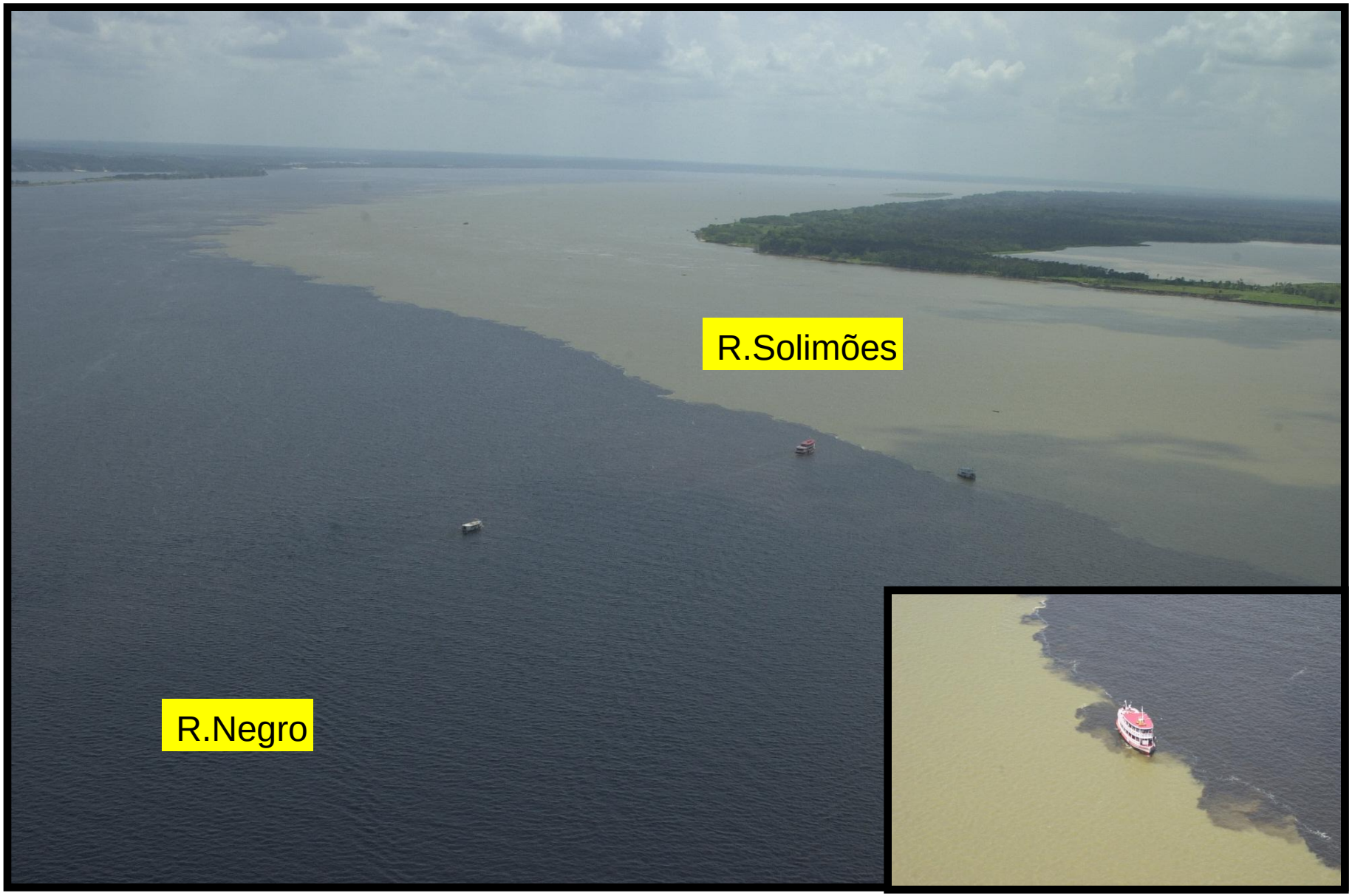


Photo: Antonio Nobre


R. Negro
black-water
R. Amazon
white-water

R.Amazon just before the R.Tapajós confluence

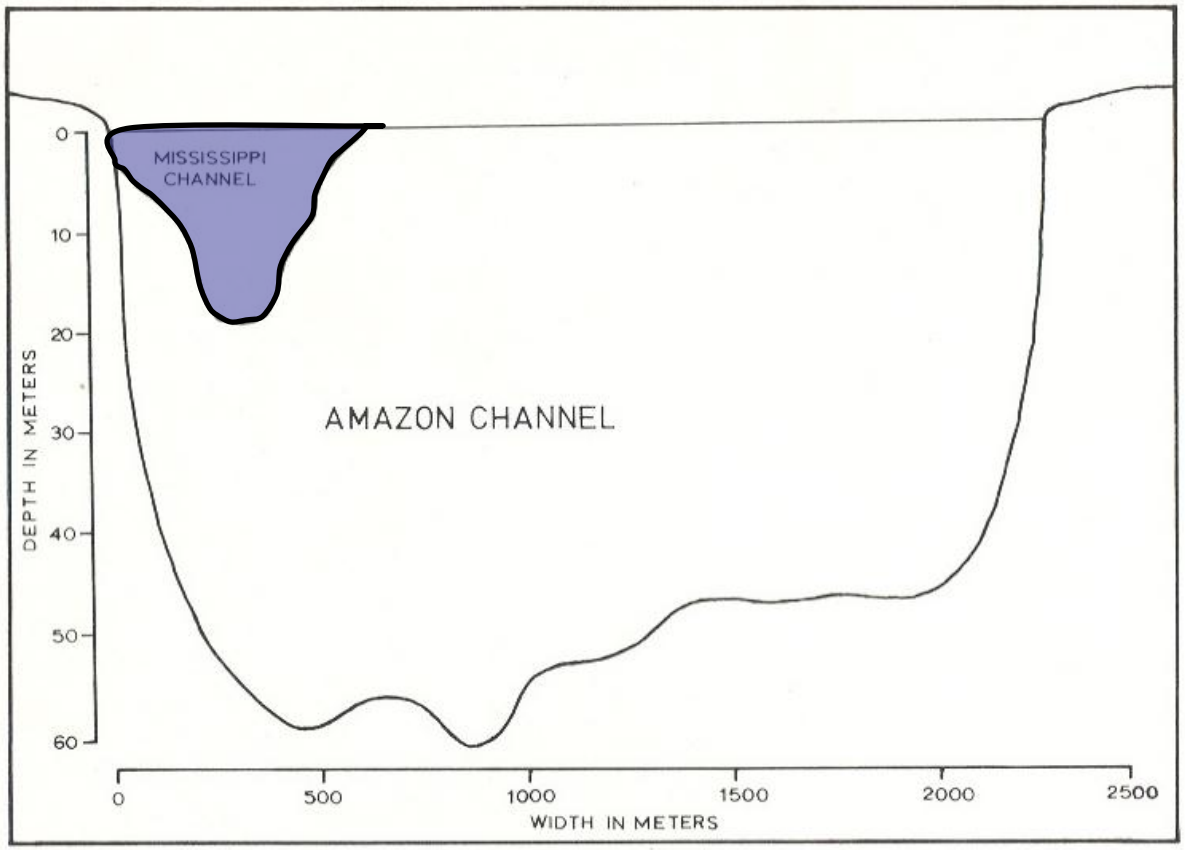
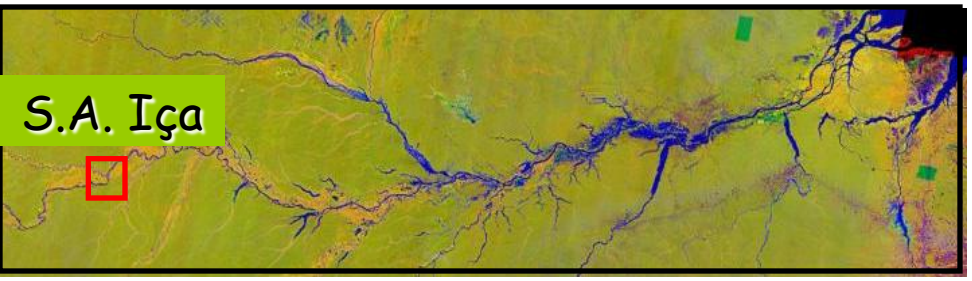
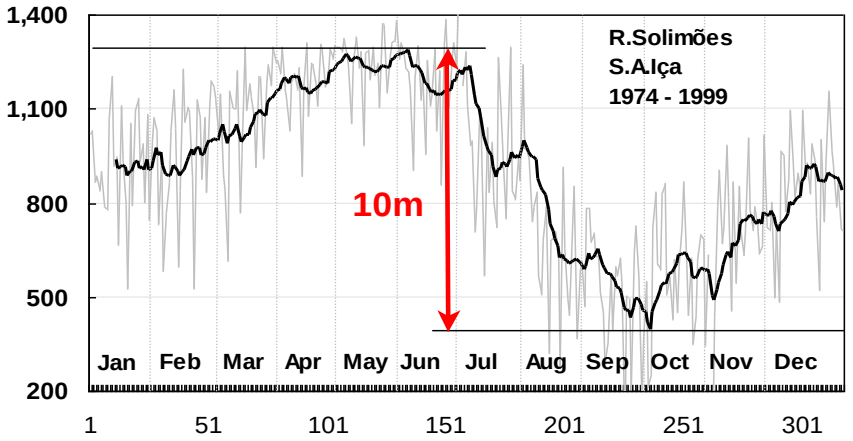
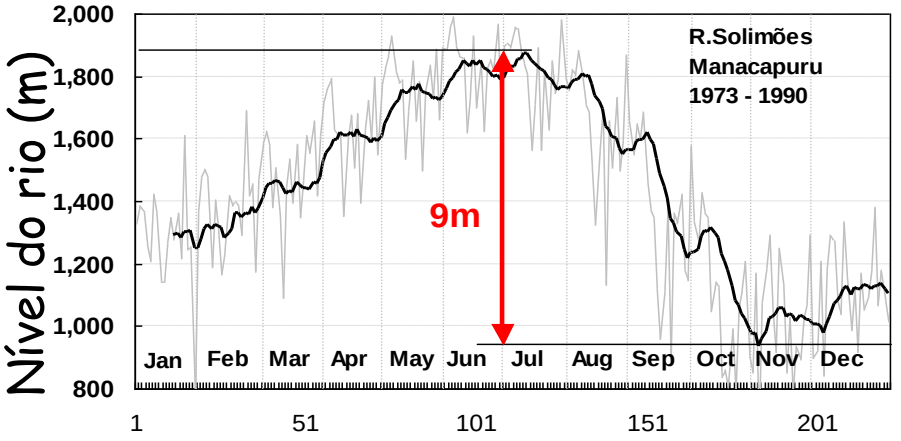


Fig. 3 Cross-section of the bed of the Lower Amazon near Óbidos (its narrowest place) compared with that of the Mississippi at Vicksburg. After: Davis 1964.

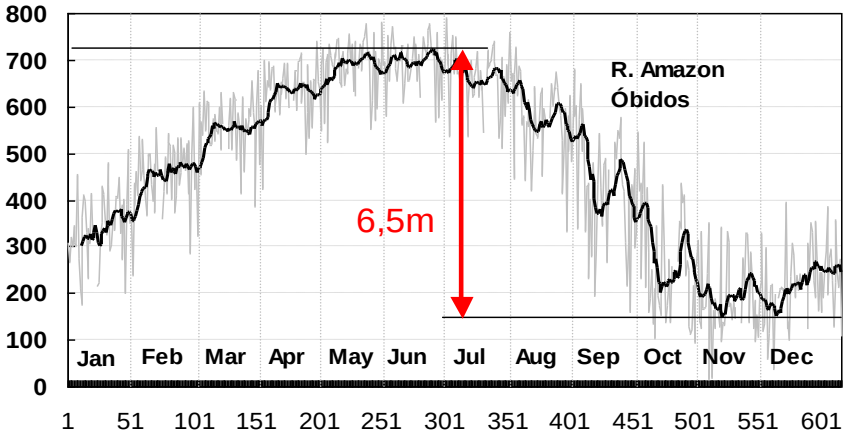

S.A. Iça

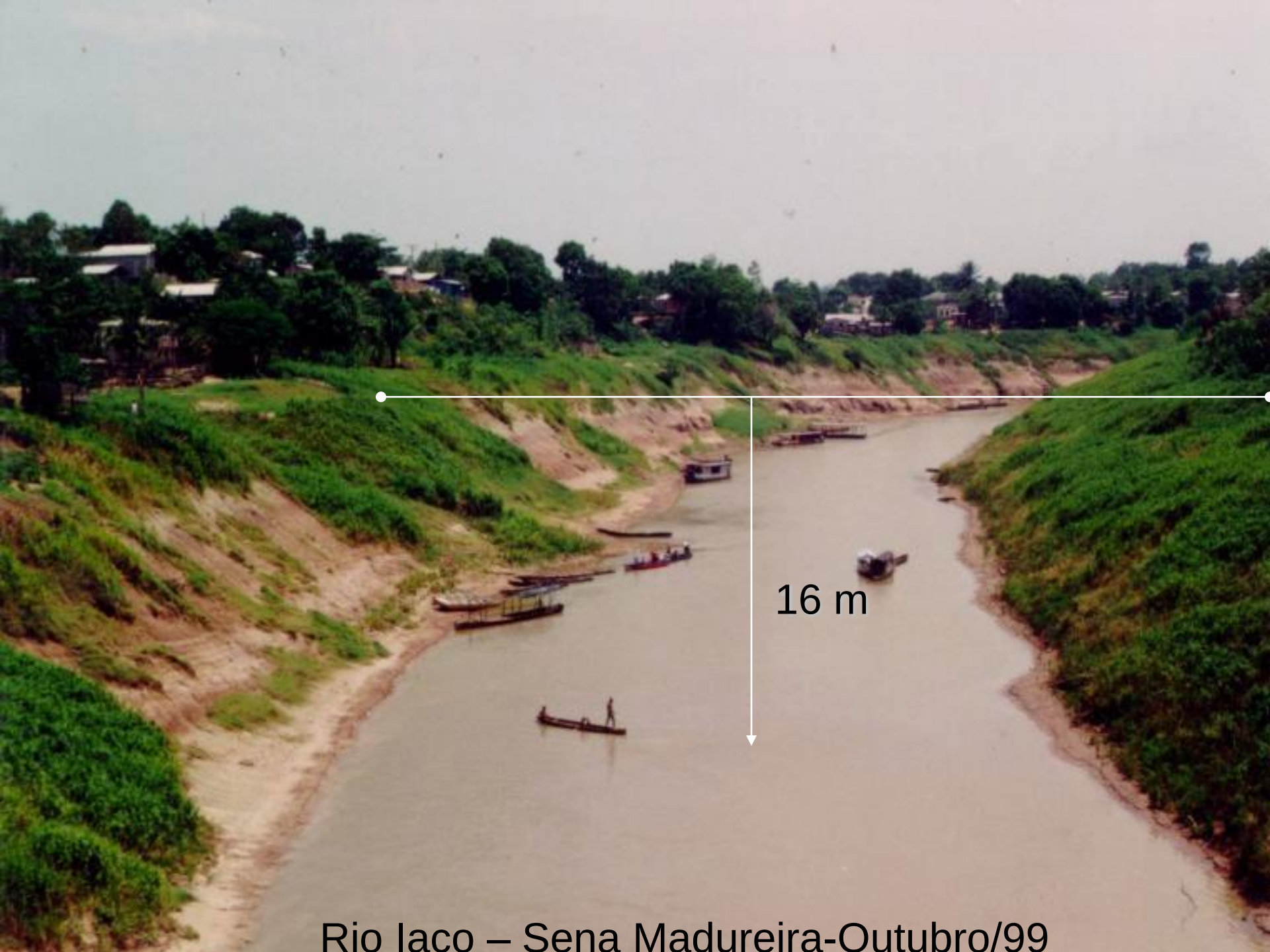

R.Solimões
S.A.Içа
1974 - 1999
10m
1,400
1,100
800
500
200
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
1 51 101 151 201 251 301


Manacapuru


Nível do rio (m)
R.Solimões
Manacapuru
1973 - 1990
9m
2,000
1,800
1,600
1,400
1,200
1,000
800
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
1 51 101 151 201


Óbidos


R. Amazon
Óbidos
6,5m
800
700
600
500
400
300
200
100
0
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
1 51 101 151 201 251 301 351 401 451 501 551 601



Rio Iaco – Sena Madureira-Outubro/99

Rio Iaco – Sena Madureira-Fevereiro/00

Amaral, 2000

Dry Season (June–November)

Wet Season (December–May)

NASA – Earth Observatory

r. Amazonas – período de cheia, 2002

Igarapé Jamaracuá, rio Tapajós, período de cheia, foto: Chris Martens

Igarapé do Maicá, rio Tapajós, período de cheia, foto: Chris Martens

Lago Grande, rio Tapajós, período de cheia, foto: Chris Martens

Cheia em Mamirauá – foto: Luiz Claudio Marigo

Cheia em Mamirauá – foto: Luiz Claudio Marigo

Foto: Anônima
Livro; Os Frutos do Tambaqui
Carlos Araujo Lima
Michael Goulding

Foto: Chris Martes

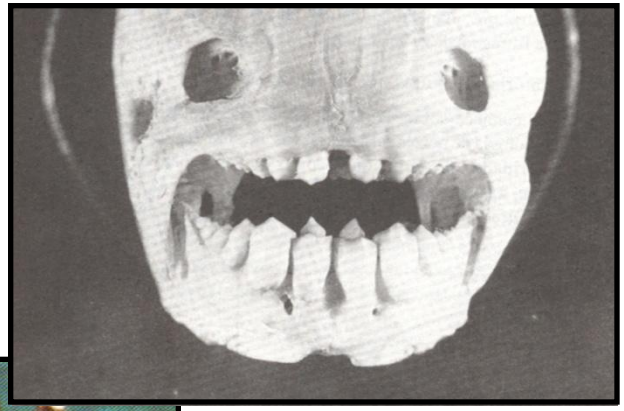


Foto: Anônima
Livro; Os Frutos do Tambaqui
Carlos Araujo Lima
Michael Goulding

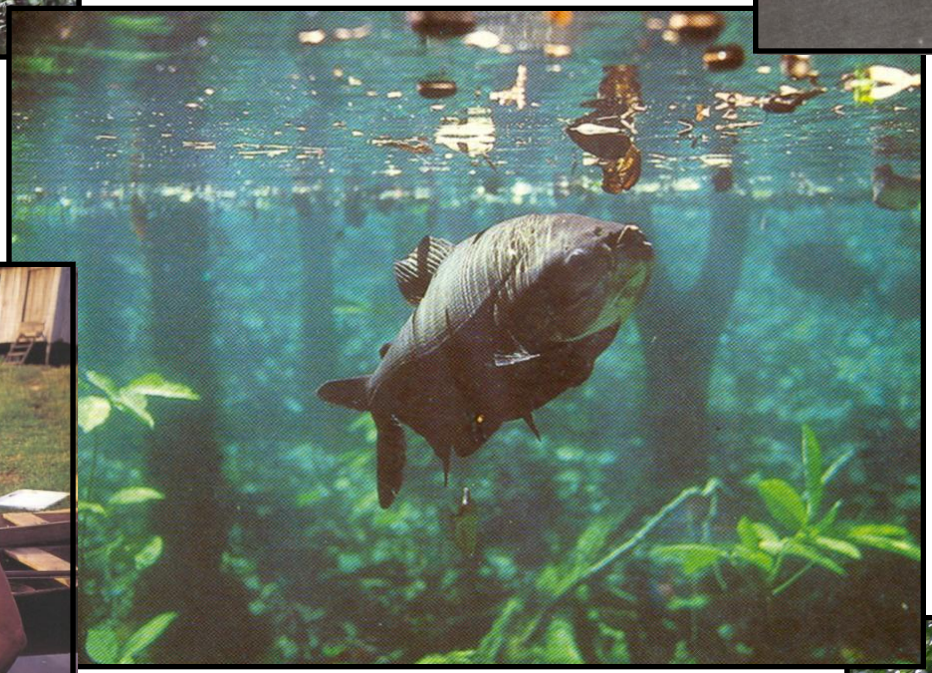


Foto: Michael Goulding

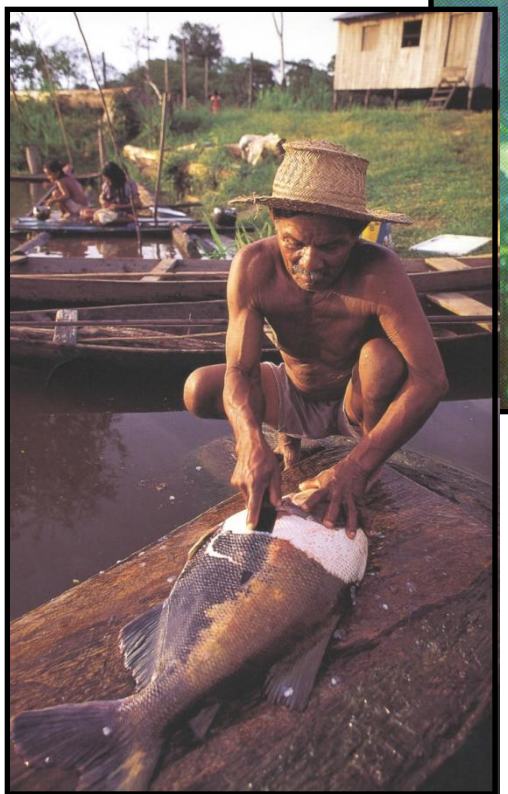
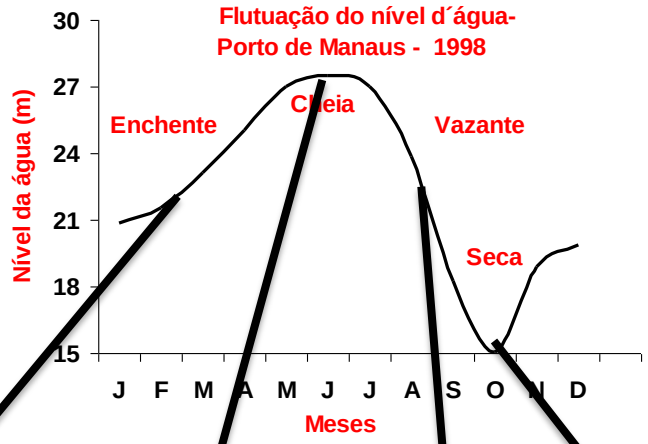
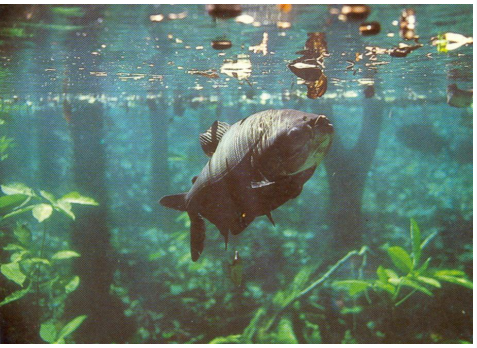
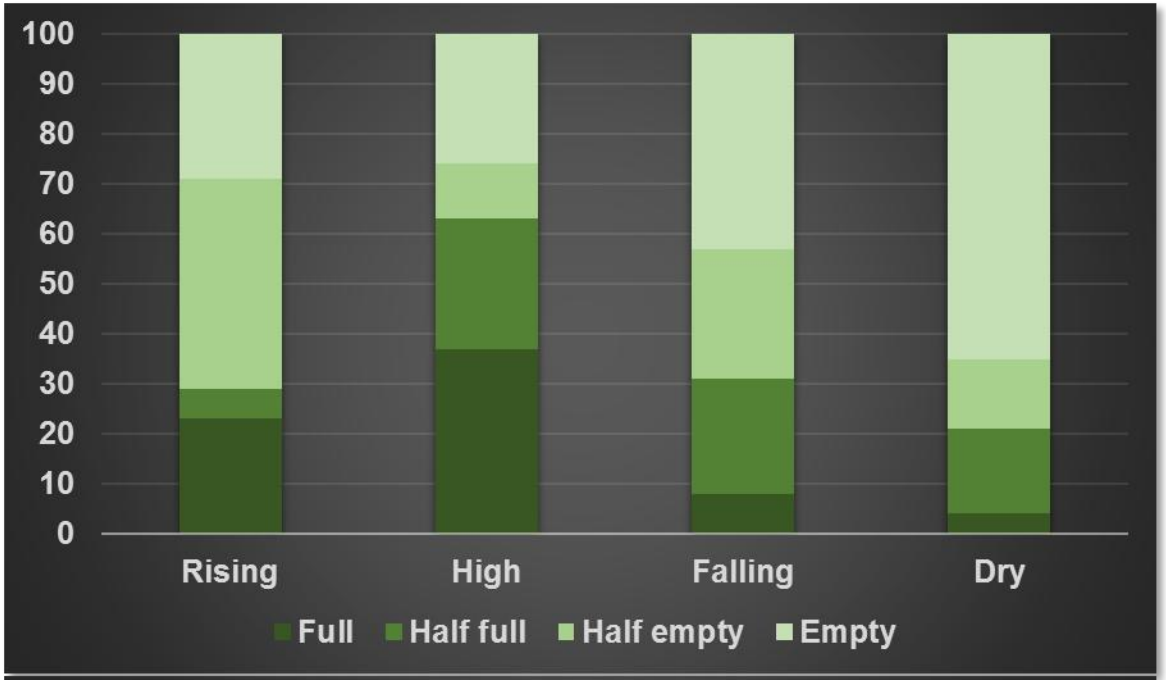


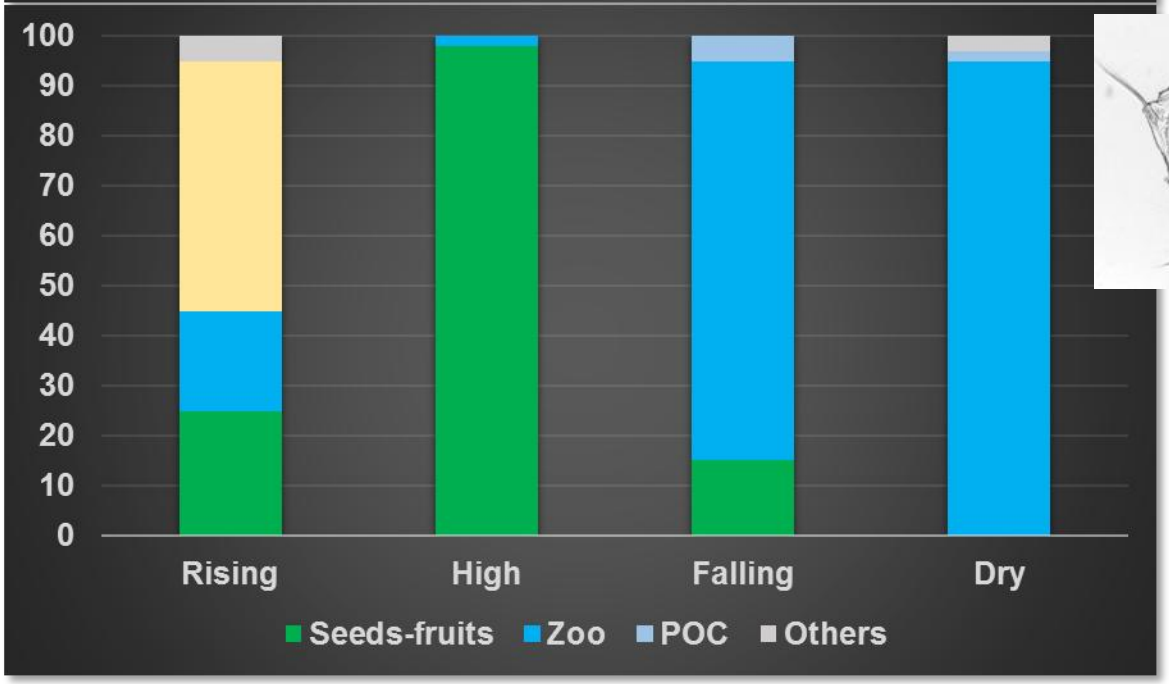
Foto: Luiz Claudio Marigo

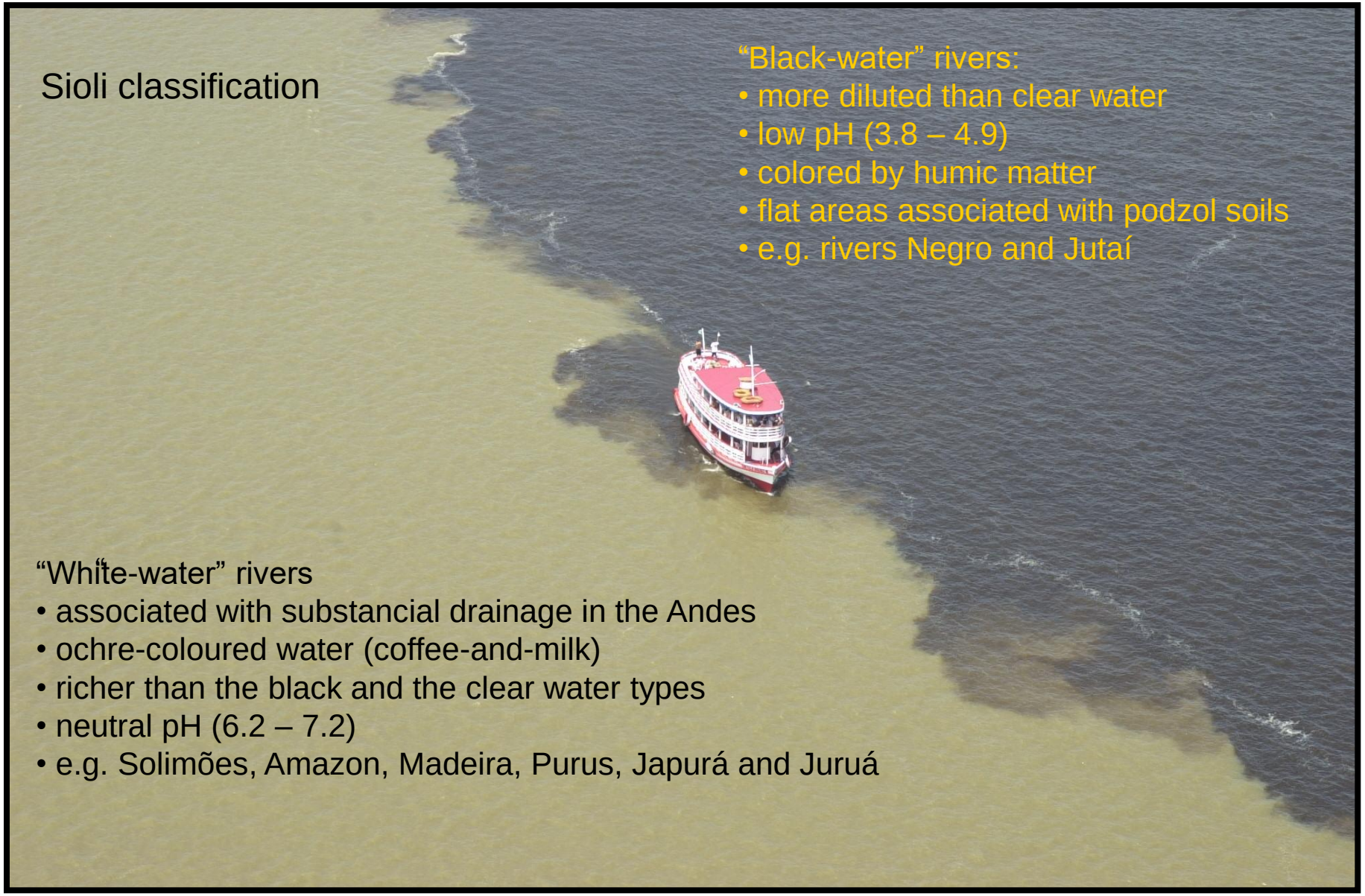

Flutuação do nível d´água-
Porto de Manaus - 1998
Nível da água (m)
30
27
24
21
18
15
Enchente
Cheia
Vazante
Seca
J F M A M J J A S O N D
Meses


Stomach fulness degree (%)
100
90
80
70
60
50
40
30
20
10
0
Rising
High
Falling
Dry
Full
Half full
Half empty
Empty




100
90
80
70
60
50
40
30
20
10
0
Rising
High
Falling
Dry
Full
Half full
Half empty
Empty


100
90
80
70
60
50
40
30
20
10
0
Rising
High
Falling
Dry
Seeds-fruits
Zoo
POC
Others



Sioli classification

"Black-water" rivers:
- more diluted than clear water
- low pH (3.8 – 4.9)
- colored by humic matter
- flat areas associated with podzol soils
- e.g. rivers Negro and Jutaí

"White-water" rivers
- associated with substancial drainage in the Andes
- ochre-coloured water (coffee-and-milk)
- richer than the black and the clear water types
- neutral pH (6.2 – 7.2)
- e.g. Solimões, Amazon, Madeira, Purus, Japurá and Juruá

Photo: Antonio Nobre

"Clear-water" rivers (transparent waters)

- green to olive-green waters
- origin – shields and "terra-firme"
- large rivers and forest creeks (igarapés)
- composition and pH variable
- generally dissolved load is lower than white water rivers
- large rivers – R. Tapajós and Xingu

R. Içá

R. Japurá

R. Jutaí

R. Juruá

R. Solimões

R. Negro

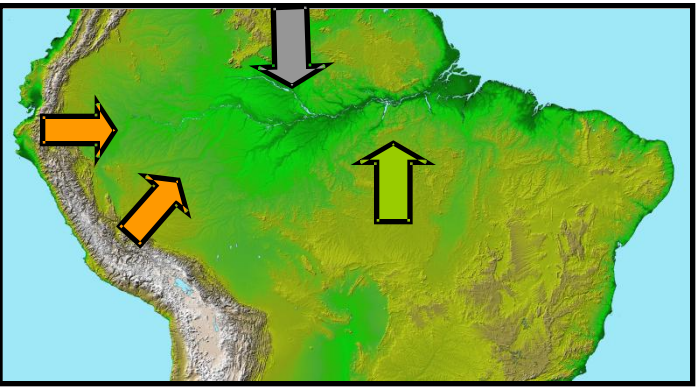
R. Amazonas

R. Purus

R. Madeira

R. Tapajós

Foto: Antonio Nobre



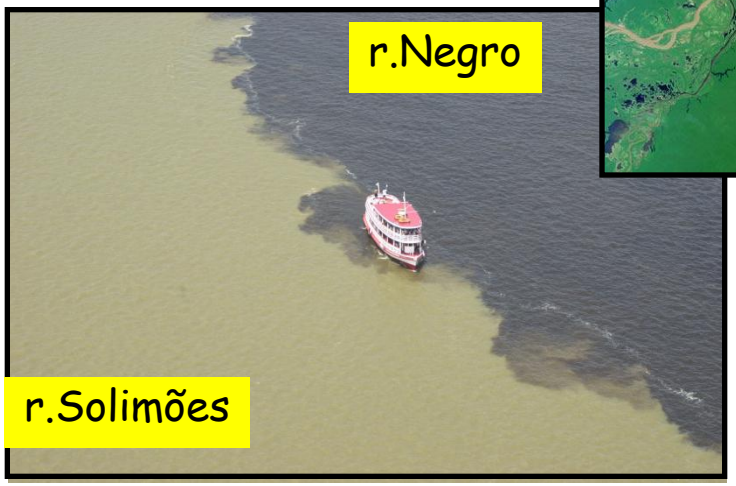
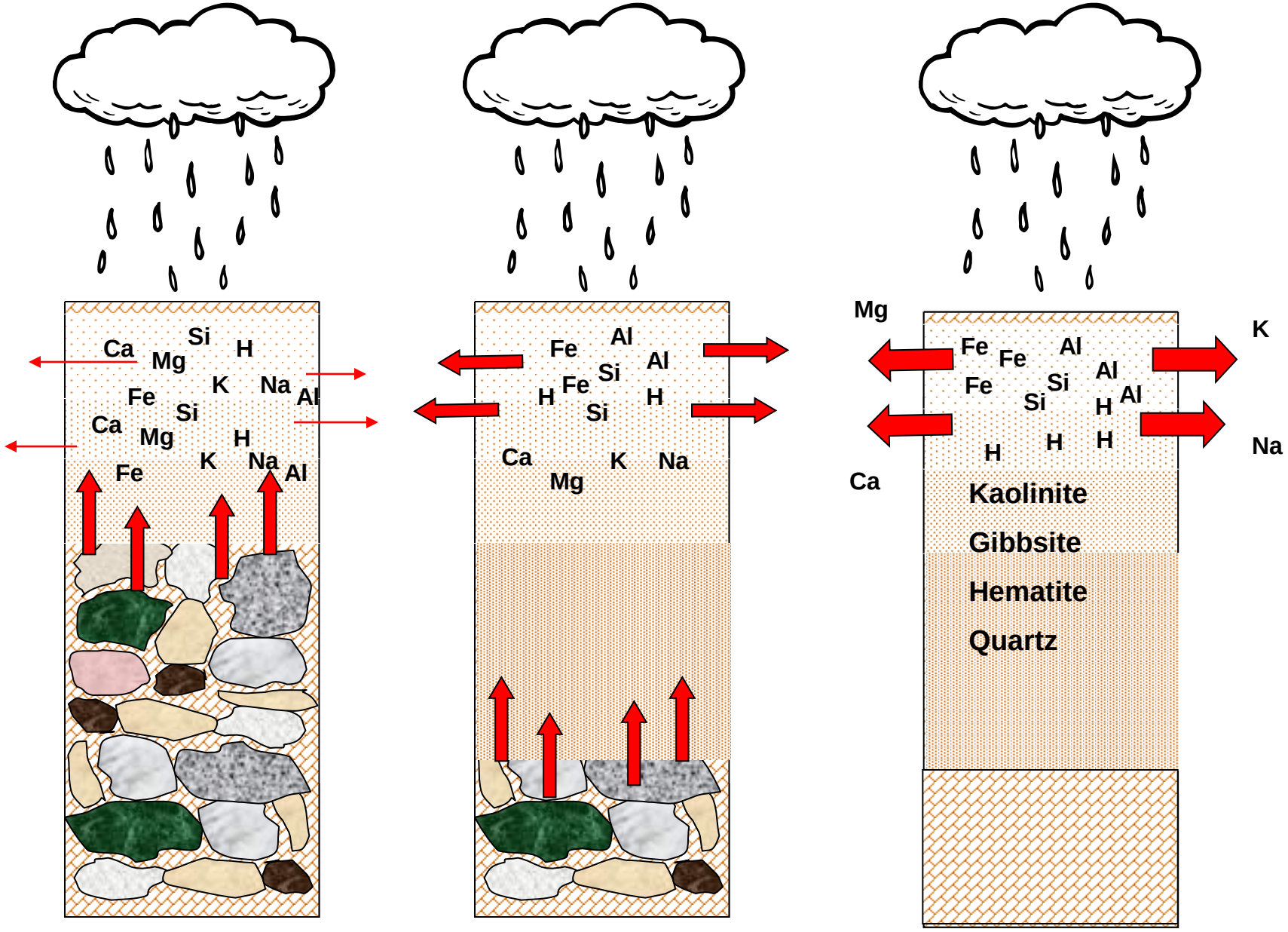


Foto: Antonio Nobre



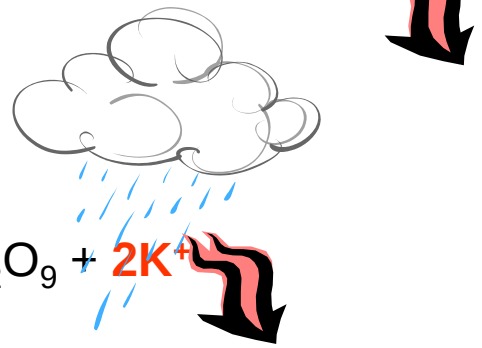
End of Miocene
10-15 million years ago

End of Pleistocene
1 -3 million years ago

Present

$3KAlSi_3O_8 + 2H^+ + 12H_2O = KAl_3Si_3O_{10}(OH)_2 + \mathbf{6H_4SiO_4} + \mathbf{2K^+}$

K-feldspar K-mica Si-dissolved



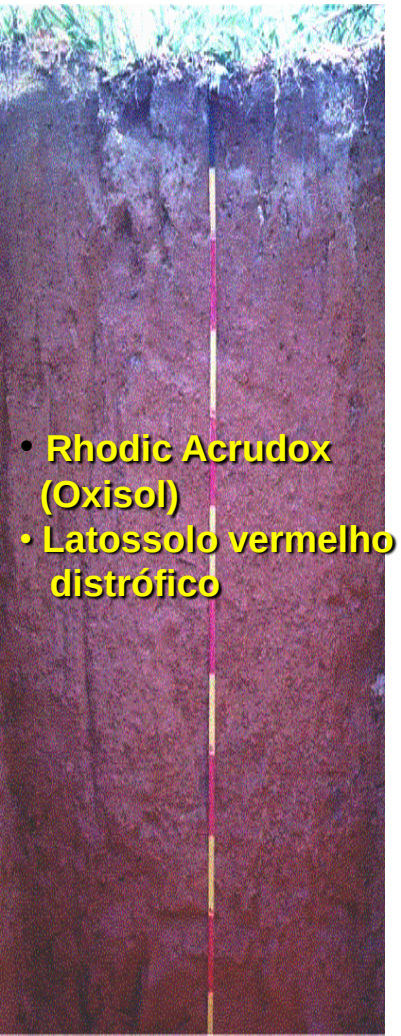
$KAl_3Si_3O_{10}(OH)_2 + 2H^+ + 3H_2O = 3H_4Al_2Si_2O_9 + \mathbf{2K^+}$

K-mica kaolinite

$3H_4Al_2Si_2O_9 + 5H_2O = Al_2O_3{\bullet}H_2O + \mathbf{2H_4SiO_4}$

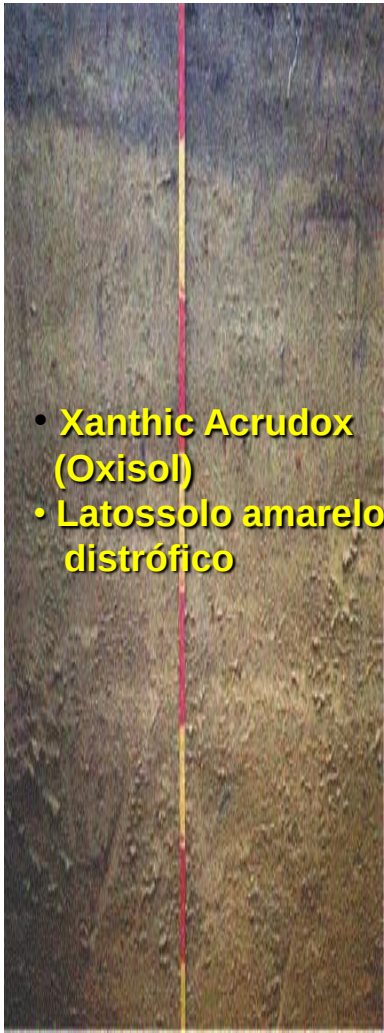
kaolinite gibbsite Si-dissolved

In the Amazon: soils are derived from the very old Precambrian crystalline shields north and south or tertiary sediments originated from pre-weathered materials from the shields and from the Andes.

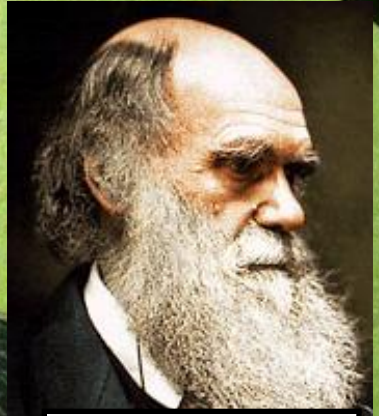


Consequence: soils of the Amazon are generally:

- **deep**
- **quite uniform**
- **very acid**
- **quite poor**
- **kaolinite and oxides of Fe and Al**



"Delight is a weak term to express the feelings of a naturalist who, for the first time, has wandered by himself in a Brazilian forest"
Charles Darwin



Charles Darwin

800 species of mammals

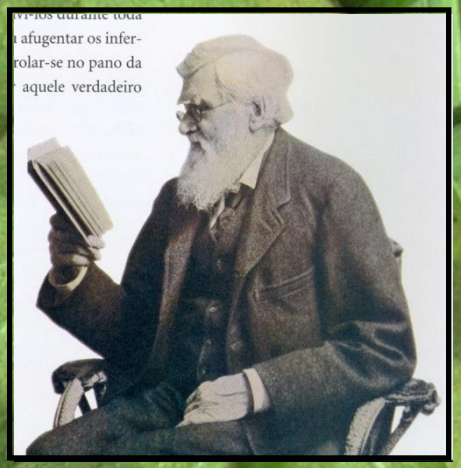
2.000 species of birds

2.500 to 3.000 species of fish

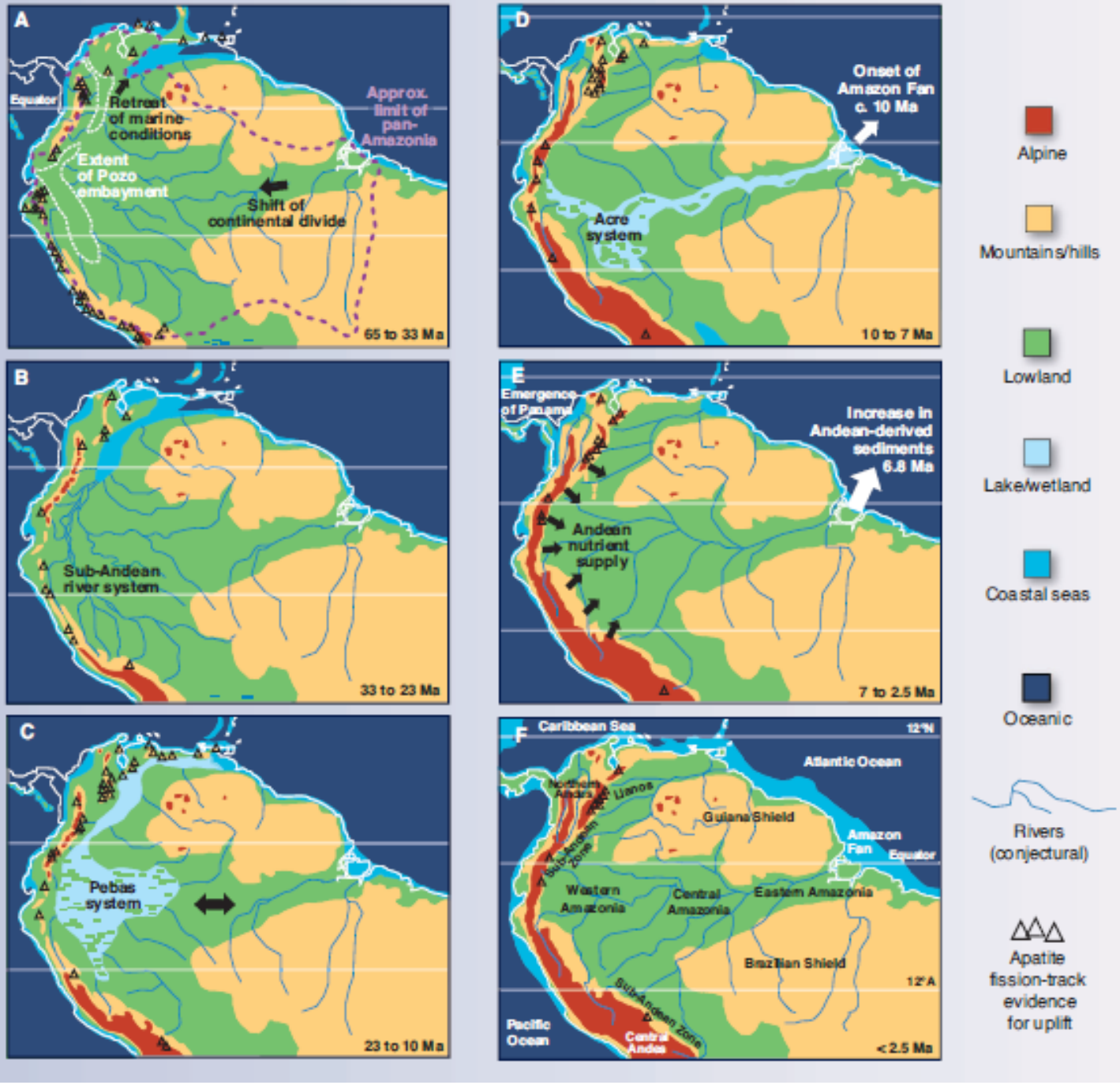
30 to 50 million of insects

- Earth: 250,000 species of angiosperms
  - Tropics: 165,000 species of angiosperms (67%)
    - Neotropics: 90,000 species (55%) only 15% has been described.
      - Amazon: 35,000 species (14%), 4% of the land area on Earth
    - Paleotropics: 70,000 species

Thomas, W.W. (1999) – Biodiversity and Conservation

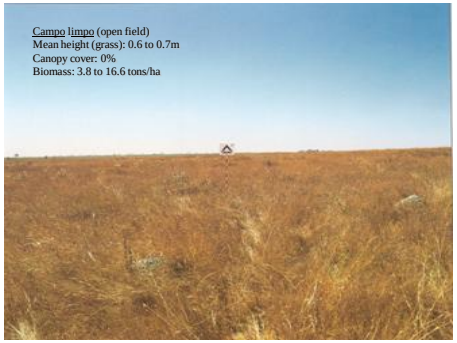


Alfred Russel Wallace


A
Equator
Retreat of marine conditions
Extent of Pozo embayment
Approx. limit of pan-Amazonia
Shift of continental divide
65 to 33 Ma
B
Sub-Andean river system
33 to 23 Ma
C
Pebas system
23 to 10 Ma
D
Onset of Amazon Fan c. 10 Ma
Acre system
10 to 7 Ma
E
Emergence of Panama
Increase in Andean-derived sediments 6.8 Ma
Andean nutrient supply
7 to 2.5 Ma
F
Caribbean Sea
12°N
Atlantic Ocean
Northern Andes
Llanos
Guiana Shield
Amazon Fan
Equator
Sub-Andean Zone
Western Amazonia
Central Amazonia
Eastern Amazonia
Brazilian Shield
12°A
Sub-Andean Zone
Pacific Ocean
Central Andes
< 2.5 Ma
Alpine
Mountains/hills
Lowland
Lake/wetland
Coastal seas
Oceanic
Rivers (conjectural)
Apatite fission-track evidence for uplift

VEGETATION TYPES

SAVANNAH



FOREST

NON-FLOODED FORESTS

TERRA-FIRME

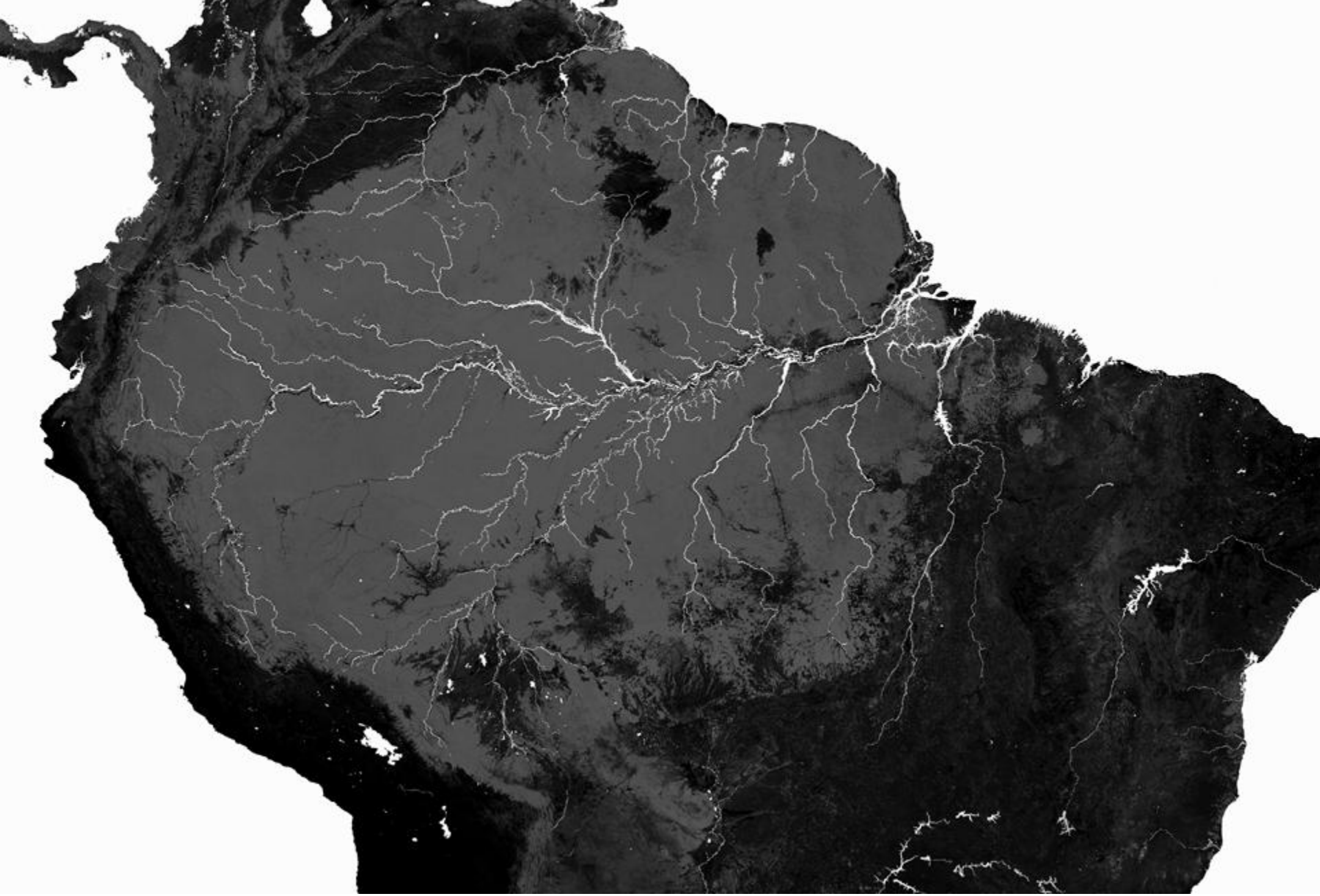
FLOODED FORESTS

WITHE-WATER RIVER

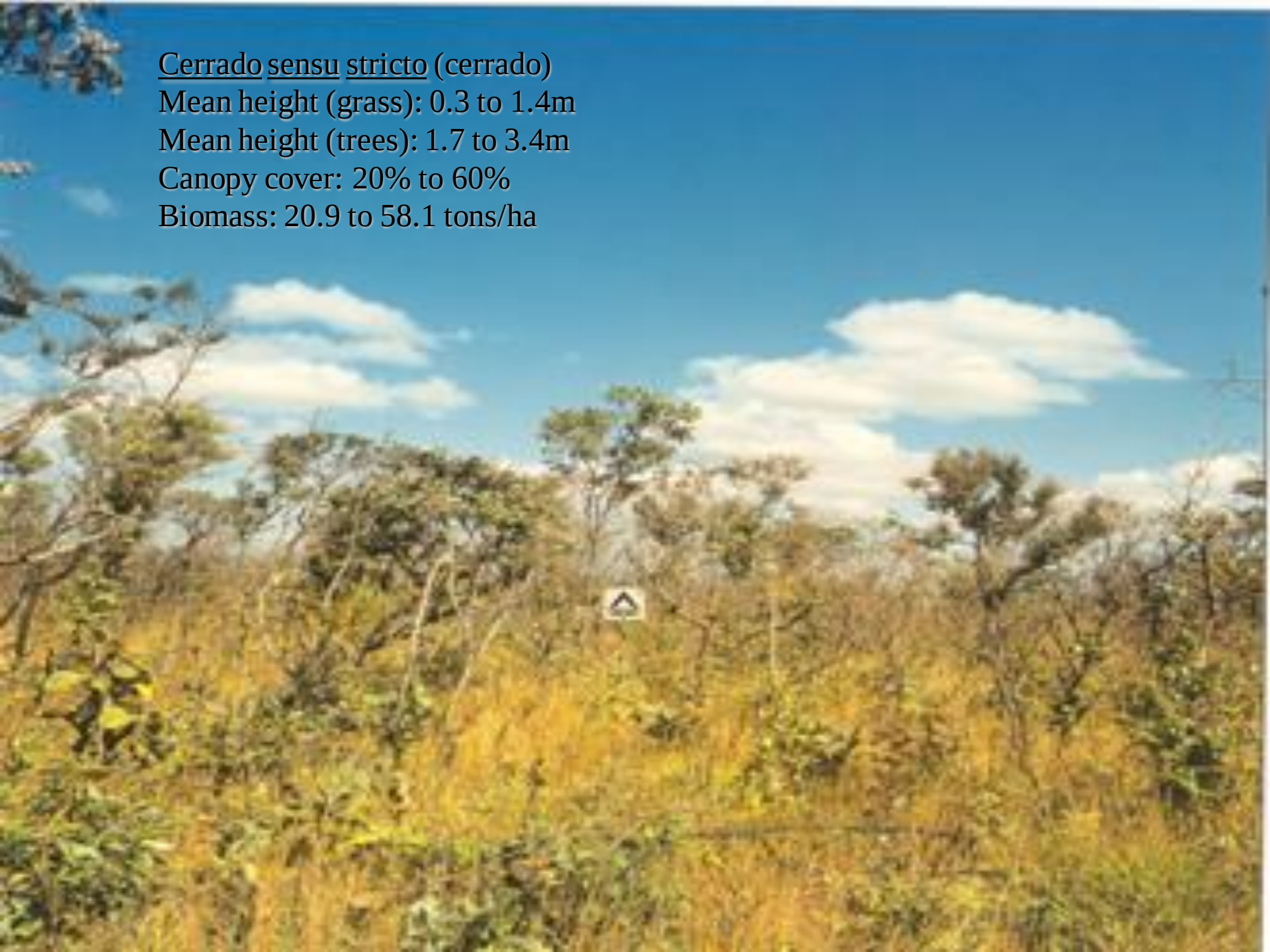
VÁRZEA FOREST

BLACK-WATER RIVER

IGAPÓ



Hansen, M.C., et al.. 2011.
U.S.A. http://dx.doi.org/10.3334/ORNLDAAC/10

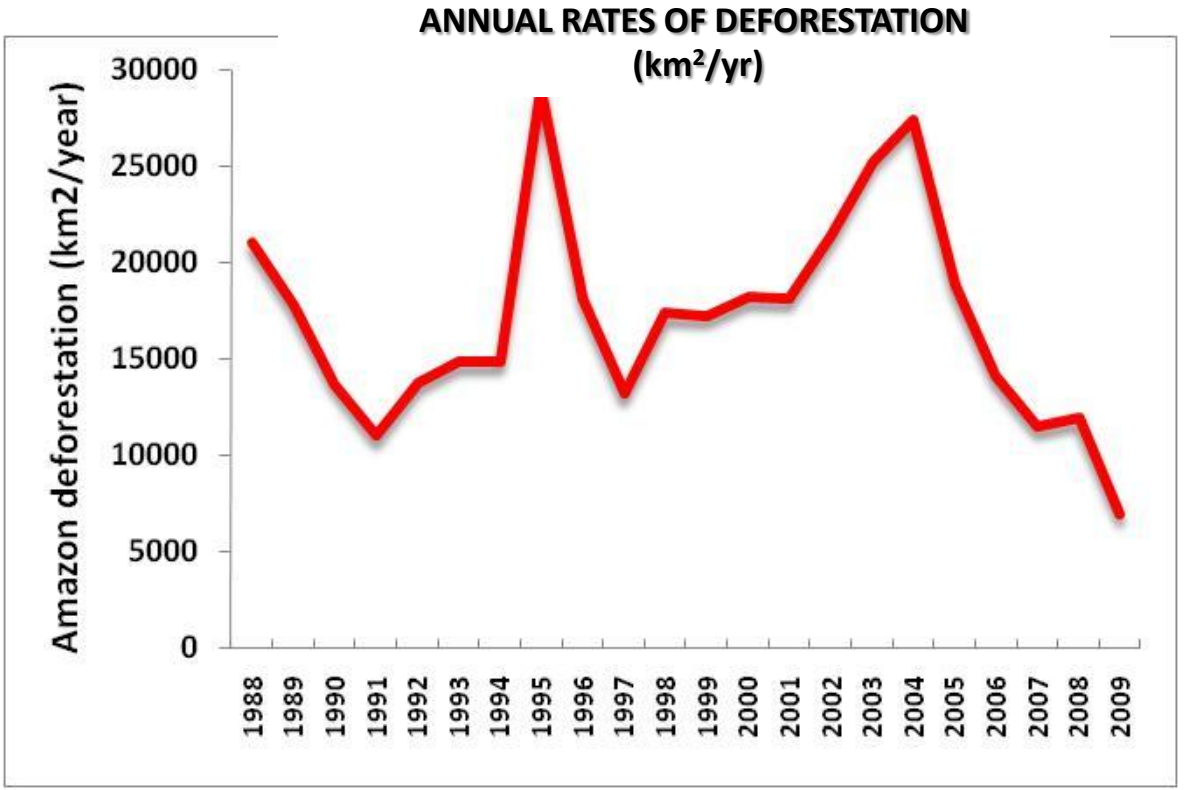

Cerrado sensu stricto (cerrado)
Mean height (grass): 0.3 to 1.4m
Mean height (trees): 1.7 to 3.4m
Canopy cover: 20% to 60%
Biomass: 20.9 to 58.1 tons/ha


Cerrado denso (dense cerrado)
Mean height (trees): 4.2m
Canopy cover: 80%
Biomass: 71.9 tons/ha

AMAZON
Brazilian Legal Amazon: 5 million km²

Total deforested area
700,000 km² (13% BLA)
70 million ha
172 million acre

Amazon average deforestation rate (1988-2009)
17,000 km² per year
1,7 million ha per year
4,2 million acre per year



INPE - PRODES (www.inpe.gov.br/prodes)


1. 11. 2001

Low input agriculture

High input agriculture

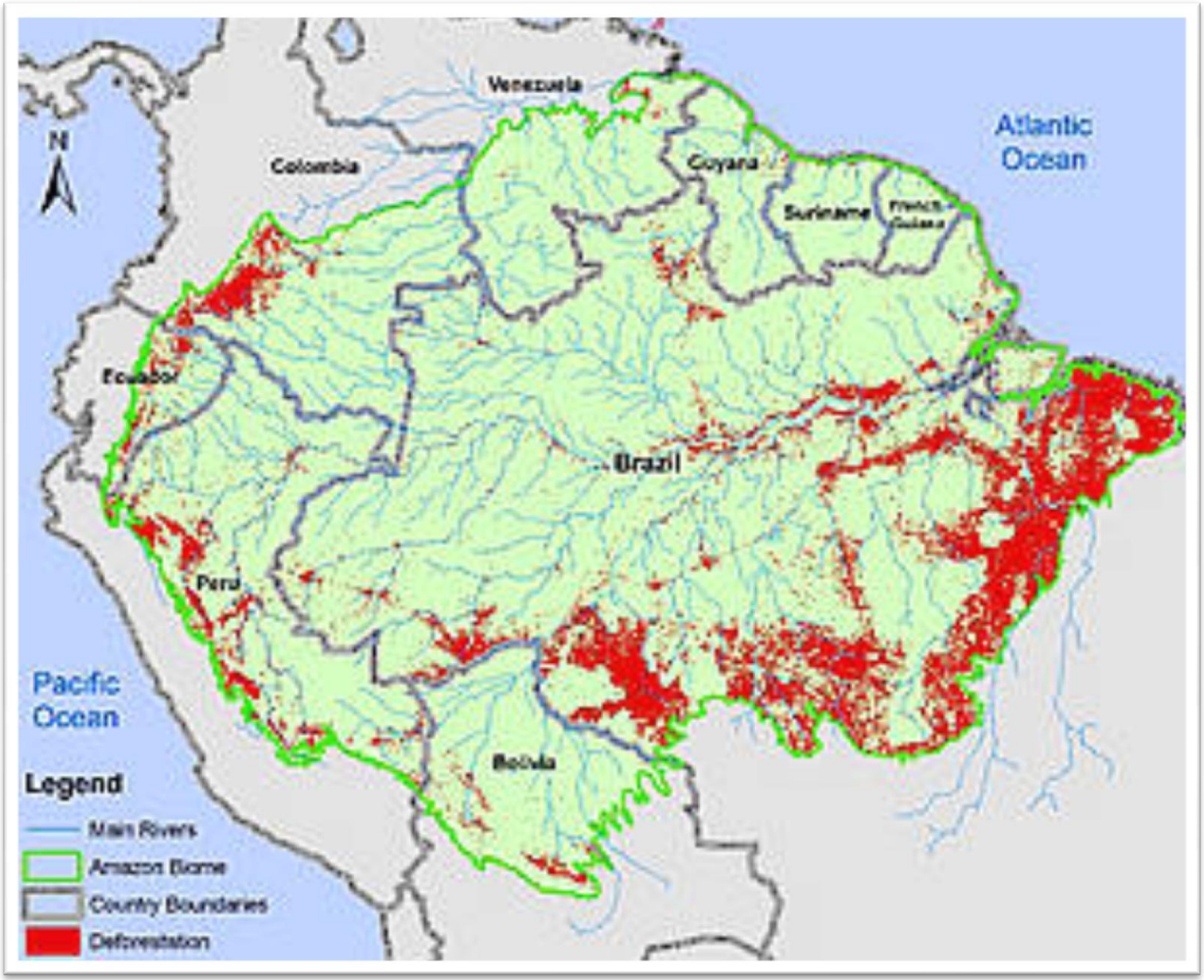
Land intensification

Amazon Transition Forest
250 species per hectare

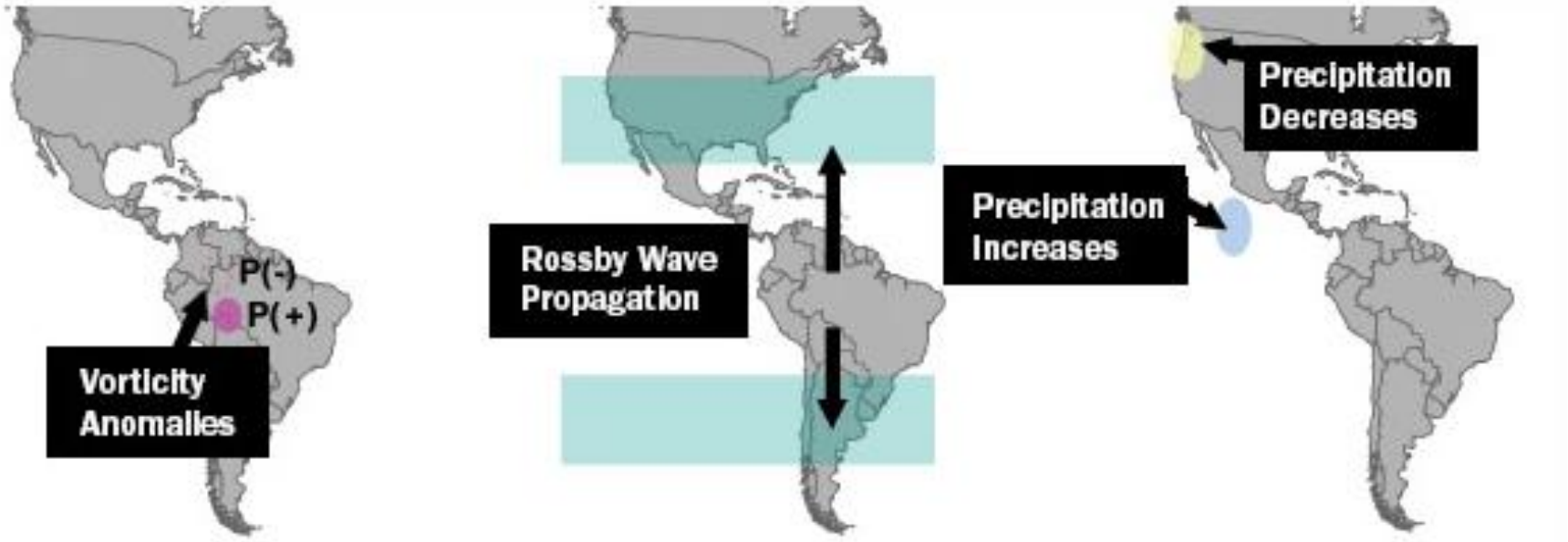
a new style of ecotone…

Soybean field – 1 dominant specie per hectare

- Fertilizers
- Micronutrients
- Lime
- GMOs
- Insecticides,
- Herbicides,
- Fungicides

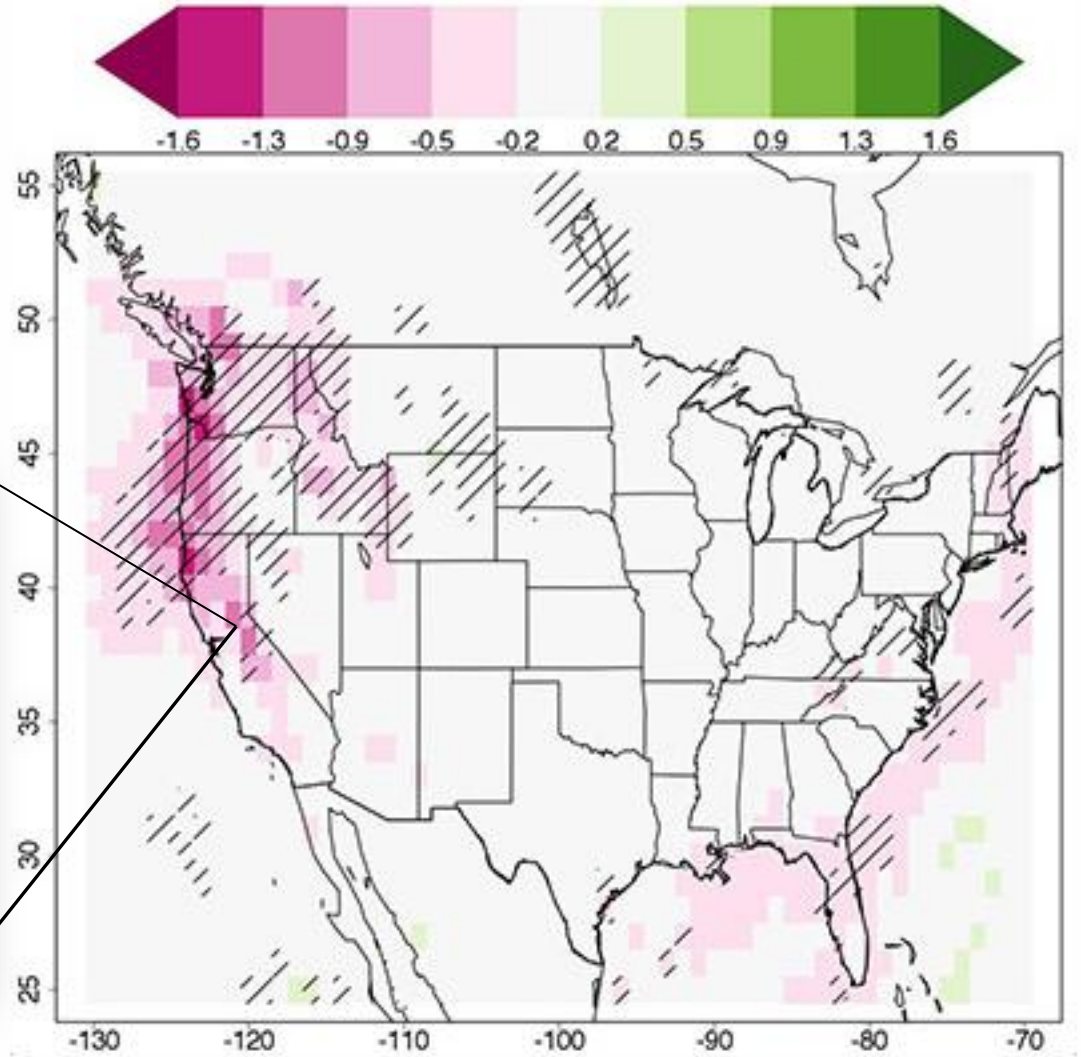

N
Venezuela
Colombia
Guyana
Suriname
Atlantic Ocean
Ecuador
Brazil
Peru
Bolivia
Pacific Ocean
Legend
Main Rivers
Amazon Biome
Country Boundaries
Deforestation

"The big point is that Amazon deforestation will not only affect the Amazon — it will not be contained. It will hit the atmosphere and the atmosphere will carry those responses." – David Medvigy



Simulated Changes in Northwest U.S. Climate in Response to Amazon Deforestation

Journal of Climate
Medvigy *et al*., 2013



The researchers found that deforestation could mean 20 percent less rain for the coastal Northwest. The figure above shows the change (in millimeters per day) in daily average precipitation after total Amazon deforestation compared to before deforestation. The pink to dark-pink range indicates a drop in precipitation of up 1.6 mm less per day once the Amazon is gone. Areas with statistically significant changes are hatched.