RUNNING FLUX TOWER SITES

1. Relevance

2. Implementation and monitoring issues

3. Observations in South America

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SUMMARY

1. Issues tower flux sites can contribute

Regional and global climate changes

Role of the biosphere in the global C cycle

Mitigation of greenhouse effect and the C market

Ecosystem and climate models, Interdisciplinary scientific projects

2. Measuring surface exchanges: the eddy covariance method

Surface balance (radiation, water, energy)

The eddy covariance method

3. Instrumentation

4. Estimating ecosystem fluxes

The concept of fetch, Spectral relationships, Averaging options

Webb correction, Energy closure

Diel and seasonal variability

Biometric stock changes

5. Monitoring sites over tropical ecosystems

Tropical forest

Savanna

Agrosystem (sugar cane)

6 relevant reasons why to conduct studies with tower fluxes

1.1. Regional climate changes

1.2. Global climate changes

1.3. Role of the biosphere in the global C cycle

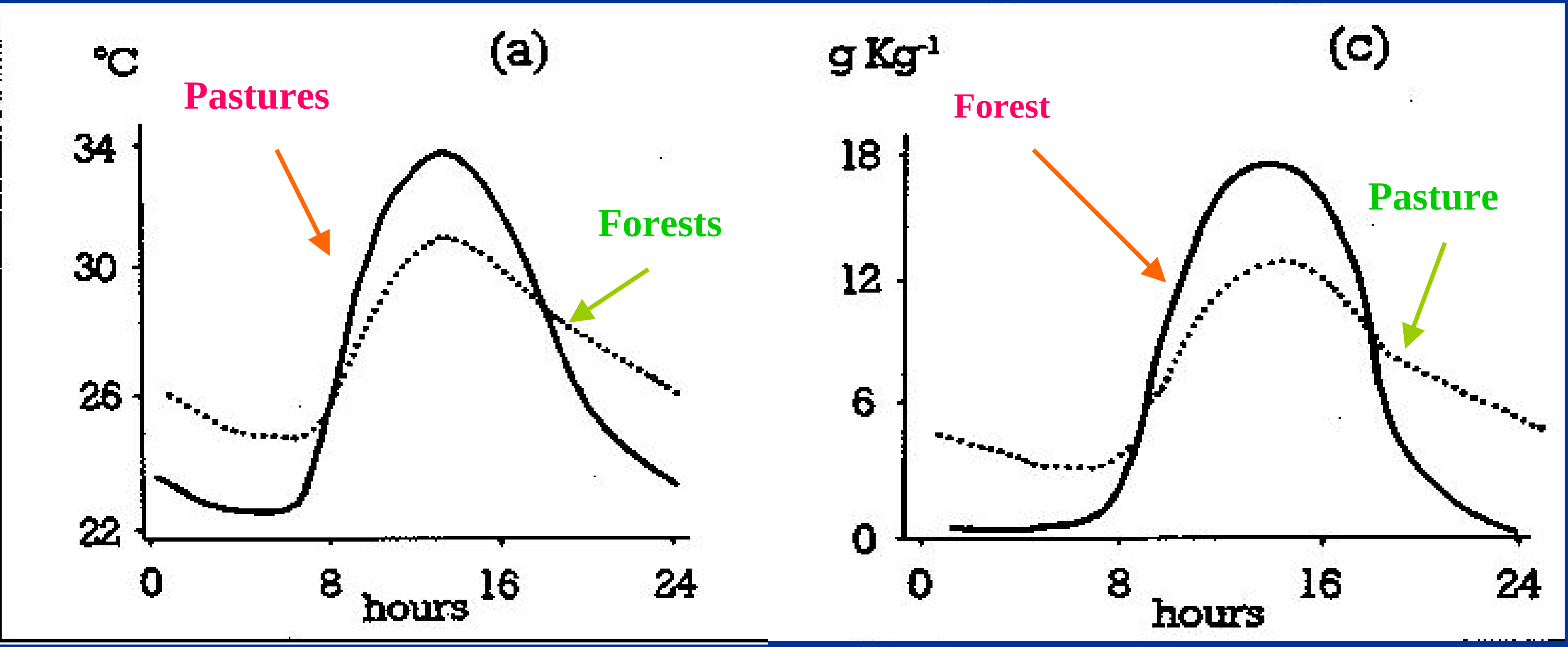
1.4. Mitigation of greenhouse effect and the C market

1.5. Ecosystem and climate models

1.6. Interdisciplinary scientific projects

Regional Climate Changes

Changes of air temperature and humidity in Amazonia deforestation (dry season)



Air temperature

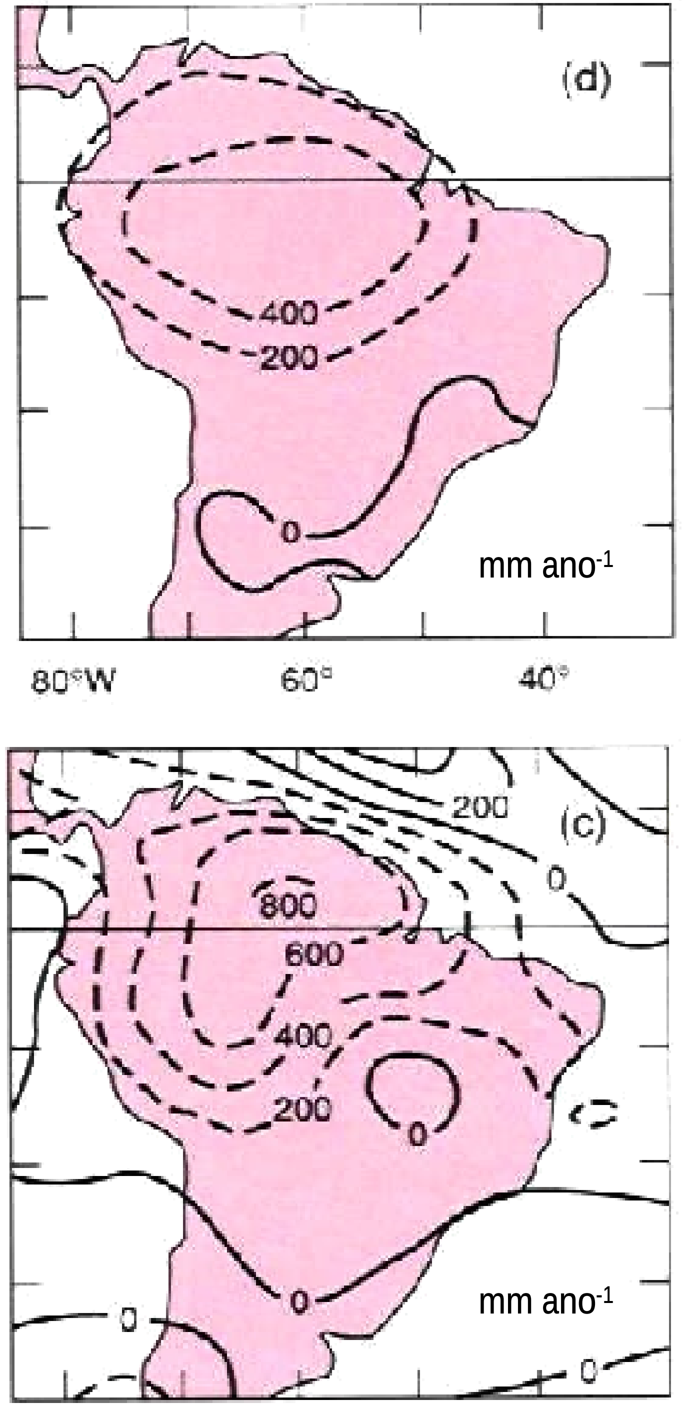
Specific humidity deficit

Source: Gash et al. (1996)

Large scale deforestation in Amazonia

(numerical studies with biosphere-atmosphere General Circulation Models)

(Nobre 1991, Rowntree 1996)



Reduction in evaporation ≈ 30%

Reduction in precipitation ≈ 10 - 20%

⇒ Potential amazonian savanization

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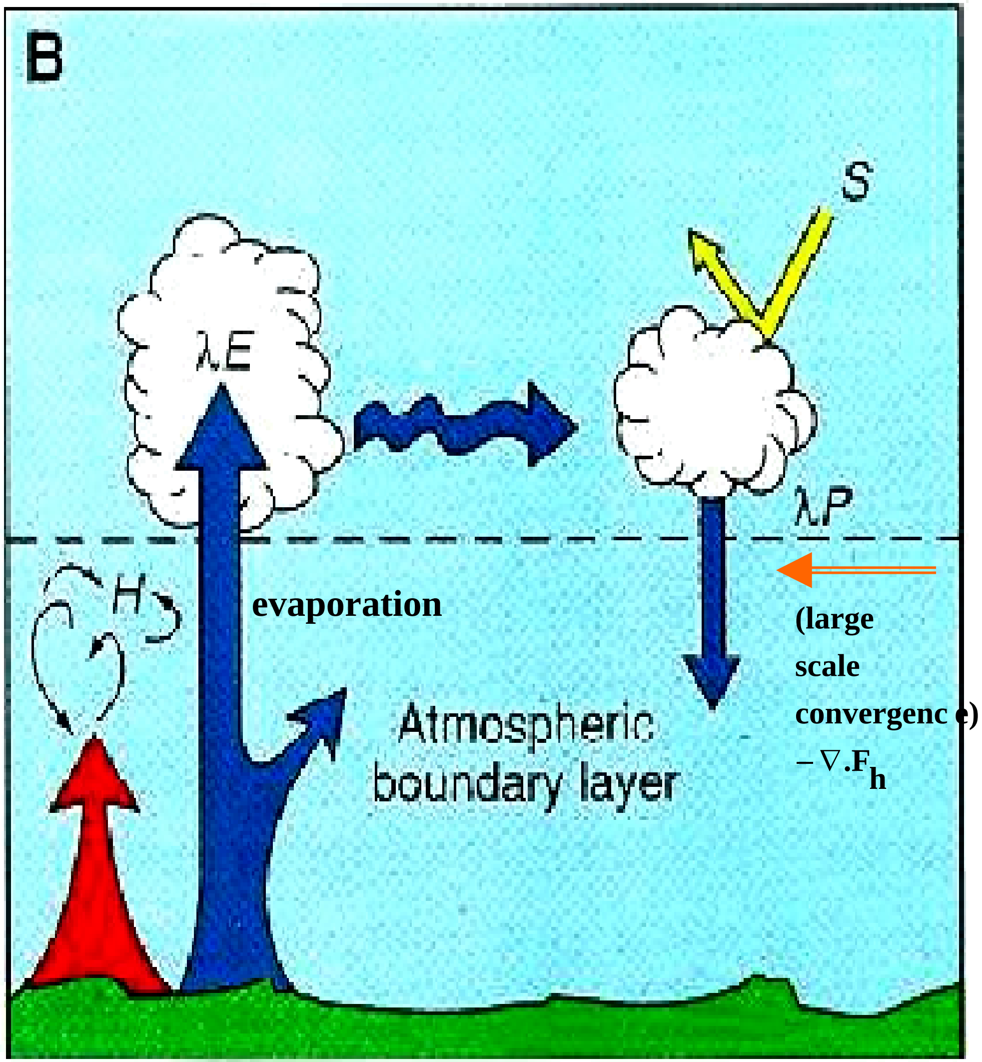
Why should precipitation change ?



Evaporation decreases

$$P = E - \nabla.F_h$$

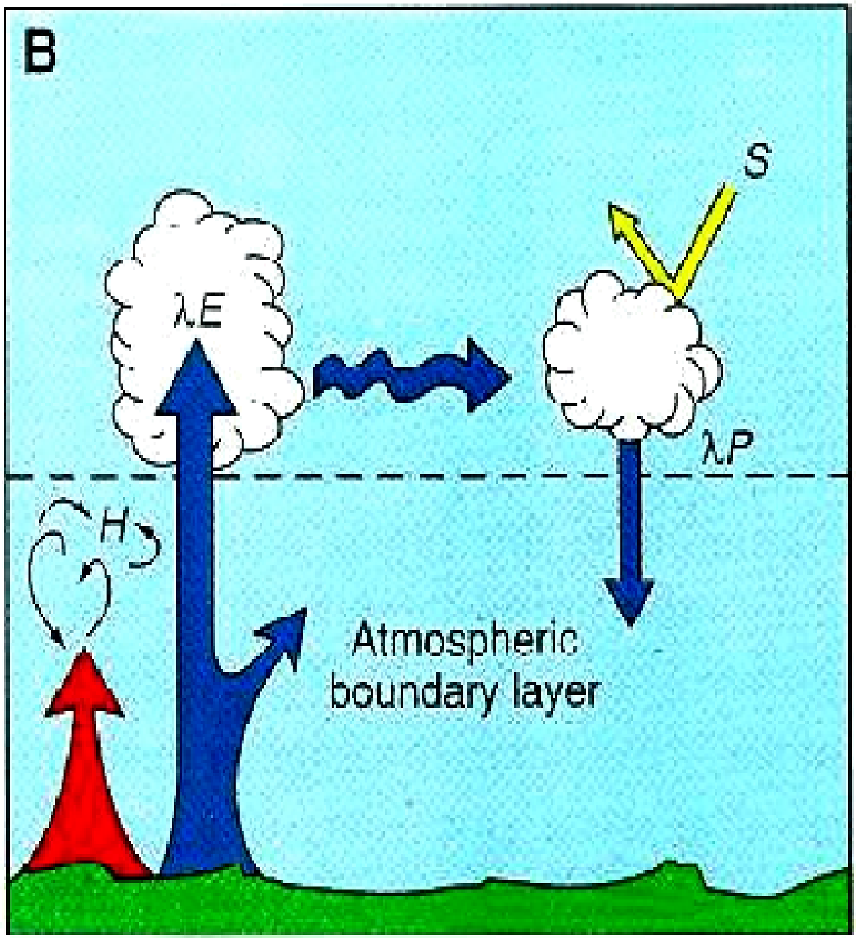
Precipitation decreases ?

… only if Large scale convergence flux do not balance

The partition between H and E (measured by the tower flux) controls boundary layer structure and shallow cumulus cloud development

E (evaporation)

H (Sensible heat flux)



- Regional Climate changes

Do century-scale deforestation in sub-tropics lead to changes in regional climate ?

Hypothesis:

Croplands reduce local evaporation (positive feedback)

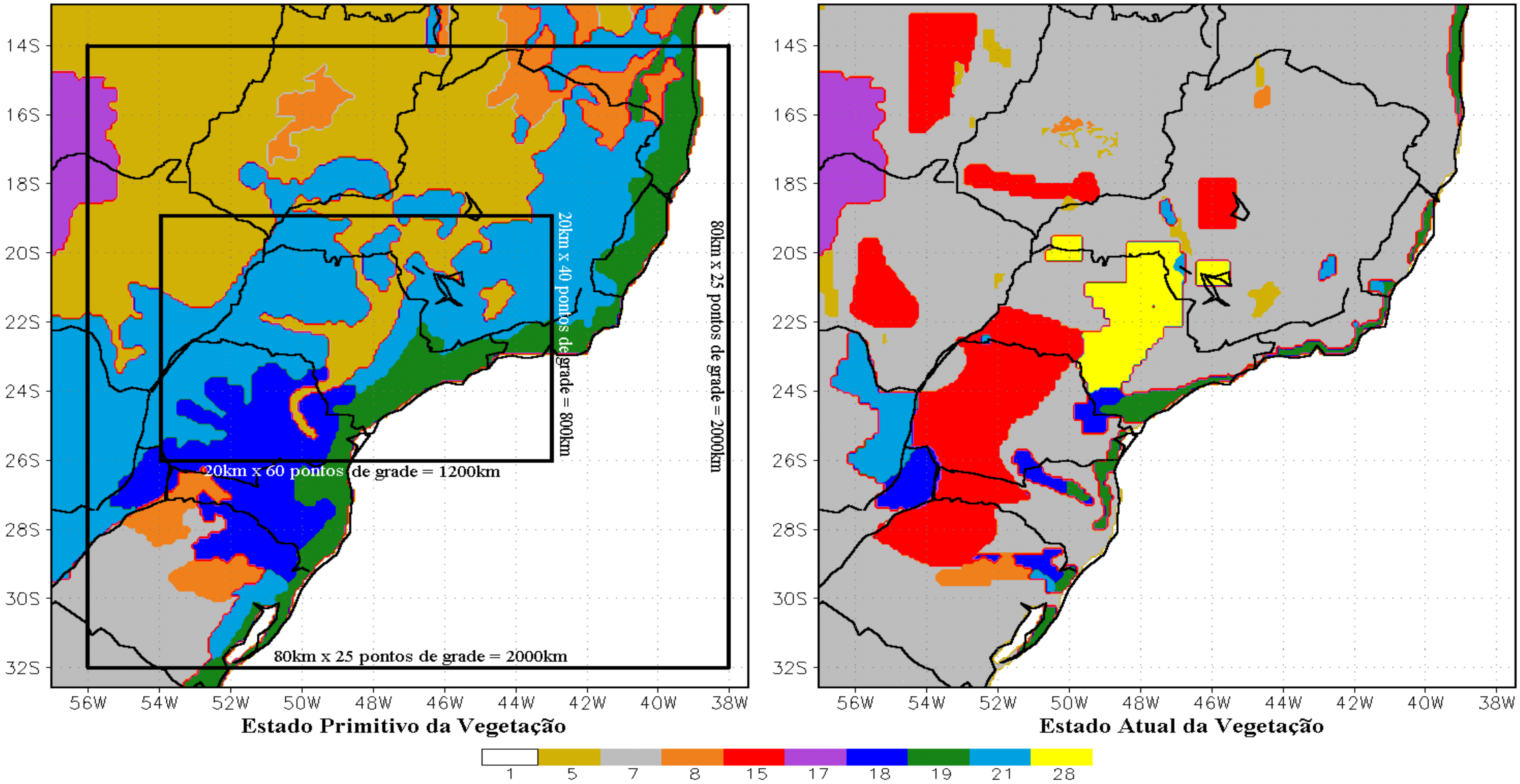
Energetics of cold frontal systems prevail over convective rainfall (negative feedback)

Are there changes in precipitation ?

Primitive vegetation

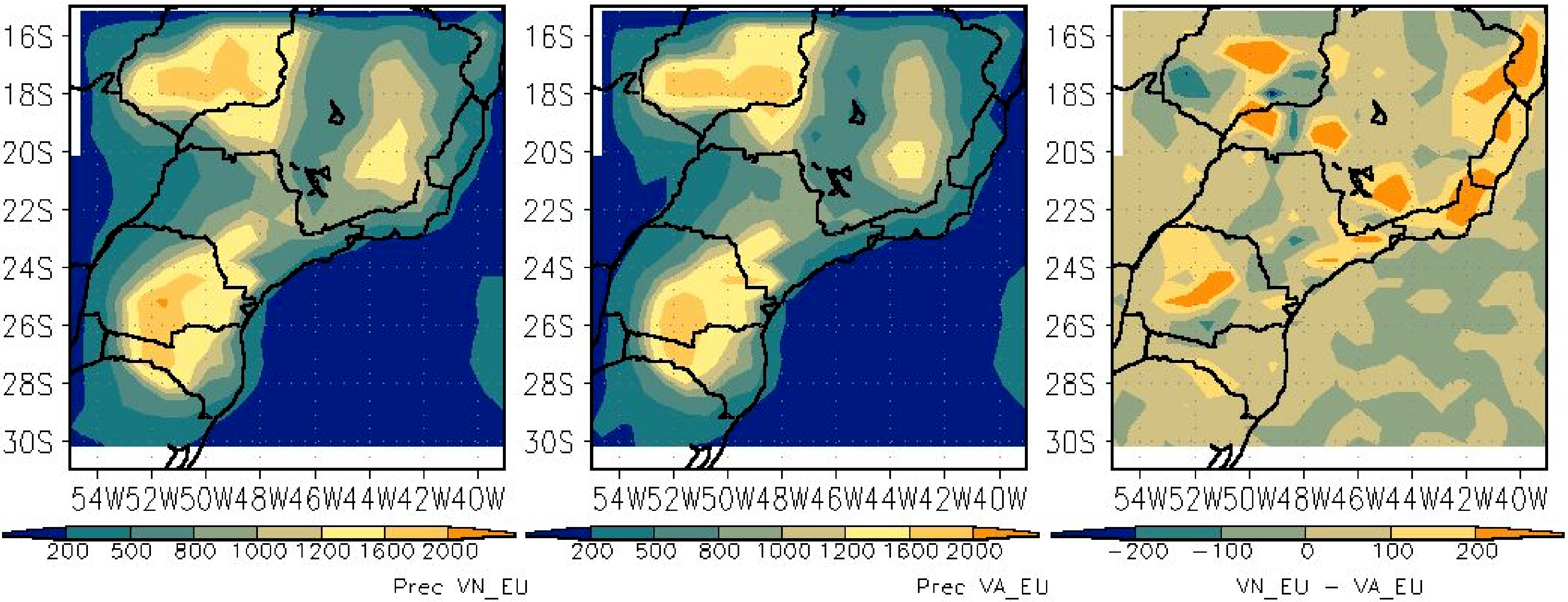
Present vegetation

(R. Negrón-Juárez, PhD thesis IAG/USP)



1. Água 5. Cerrado restrito (Deciduos Broadleaf Tree) 7. Pastagem (Short Grass) 8. Campo Sujo (Tall Grass) 15. Soja 17. Pantanal (Bos or Marsh) 18. Floresta Ambrófila Mista (Evergreen Neeadleleaf Forest) 19. Mata Atlantica-Floresta Ombrofila densa Evergreen Broaleaf Forest) 21. Mata Atlantica do Interior-Floresta Ombrofila Decidua (Deciduous Broadleaf Forest) 28.Cana-de-açúcar

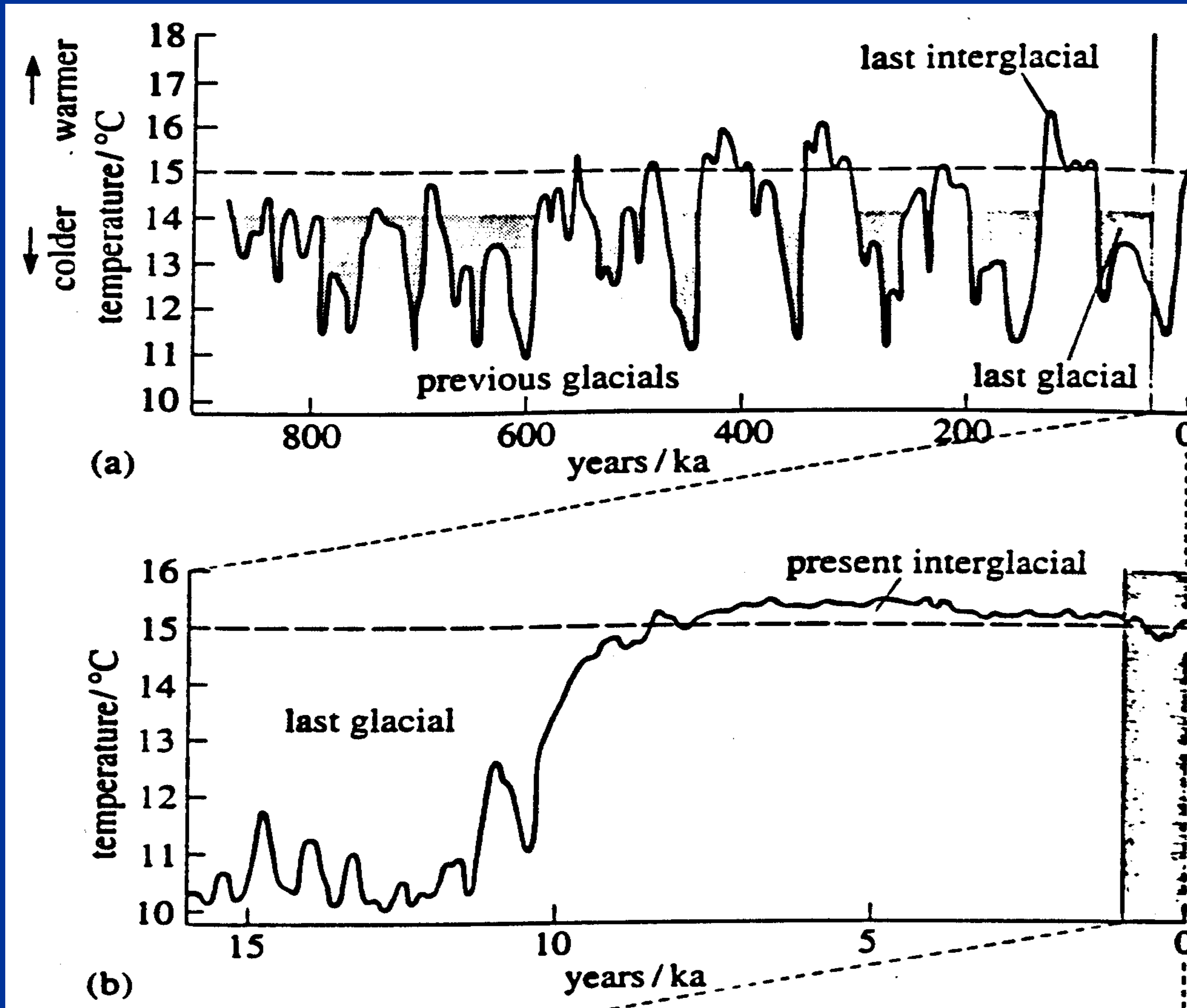
Present vegetation: mostly reduces precipitation, increasing over sparse areas

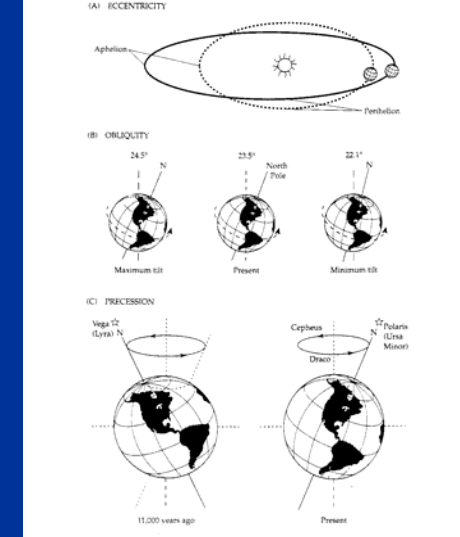


Precip wet season	**Precip wet season**	**Precip (mm / yr)**
Primitive vegetation	**Present vegetation**	**Primitive minus Present**

Robinson Juárez (PHd thesis, IAG/USP)

Global climate changes





Croll-Milankovitch Cycles

Obliquity ~ 40.000 yr

Orbit excentricity ~ 100.000 yr

Precession ~19 - 24.000 yr

Estimated global-mean surface temperature changes (from proxy data) over

(a) past million years

(b) past 16000 years

We are moving to a glacial

Horizontal dashed line is global mean surface temperature at the beginning of 20th century.

Source: Warr and Smith (1953)

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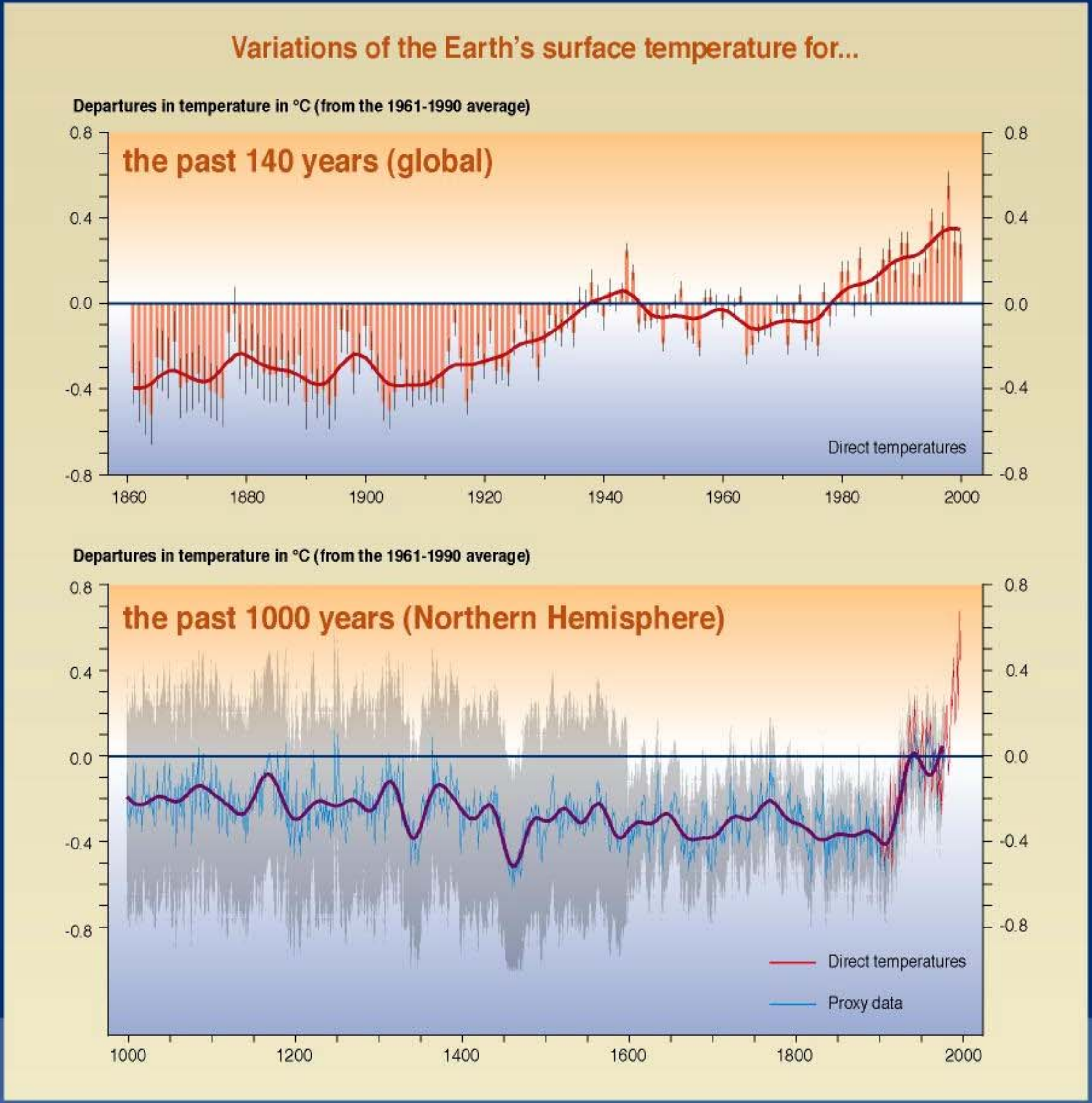
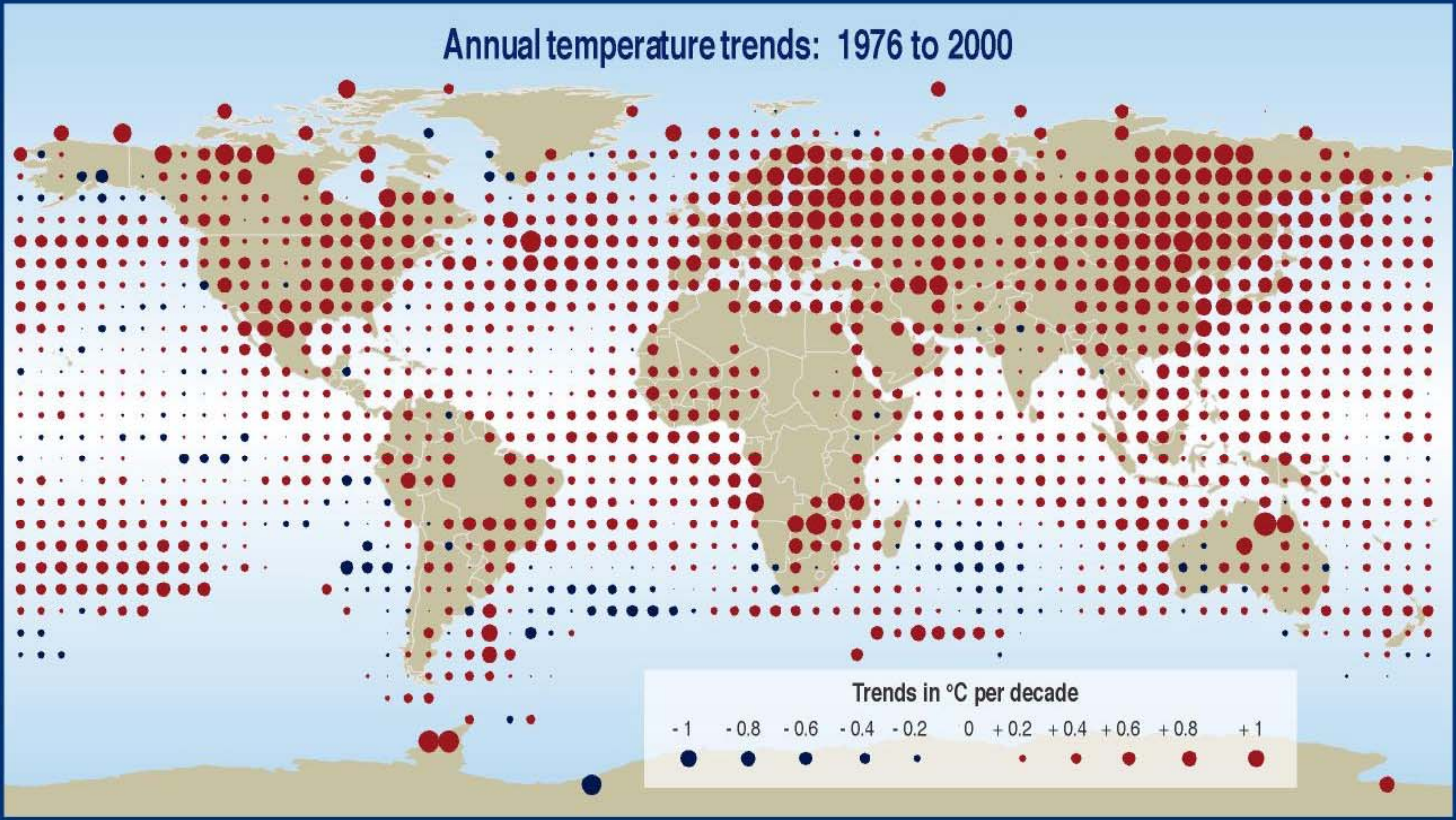


SYR - FIGURE 2-3

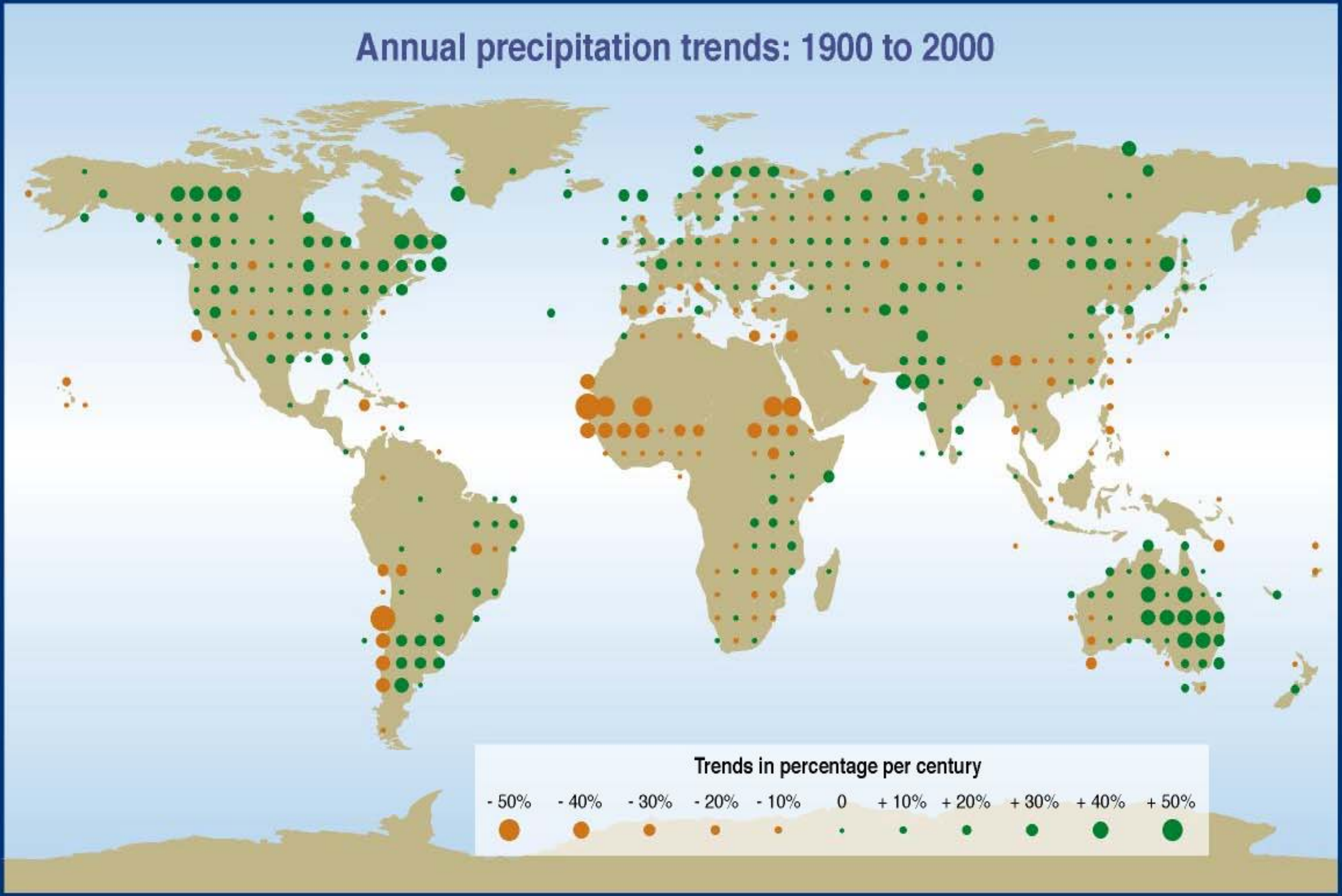
IPCC

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

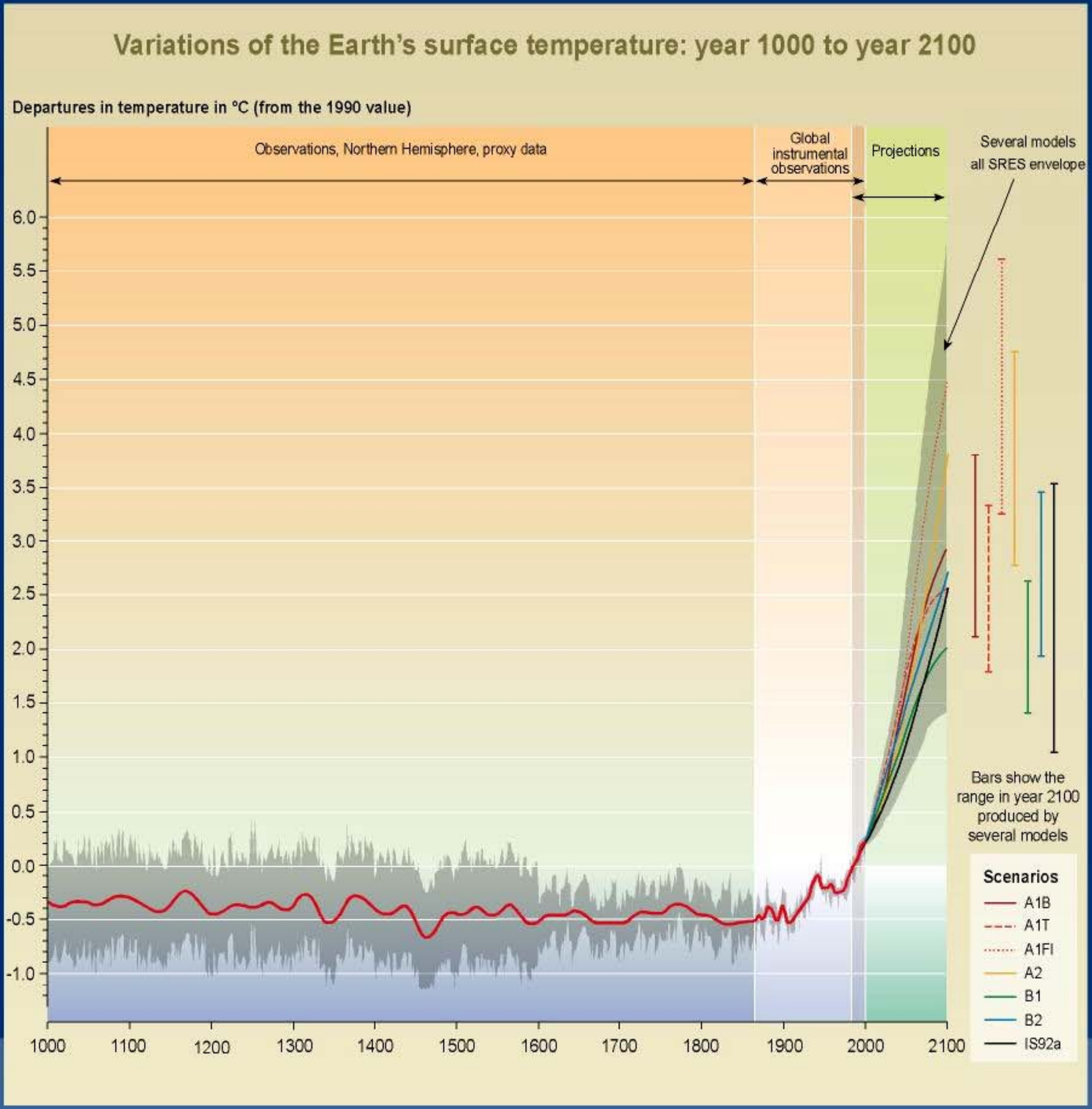
WMO UNEP



SYR - FIGURE 2-6b



SYR - FIGURE 2-6



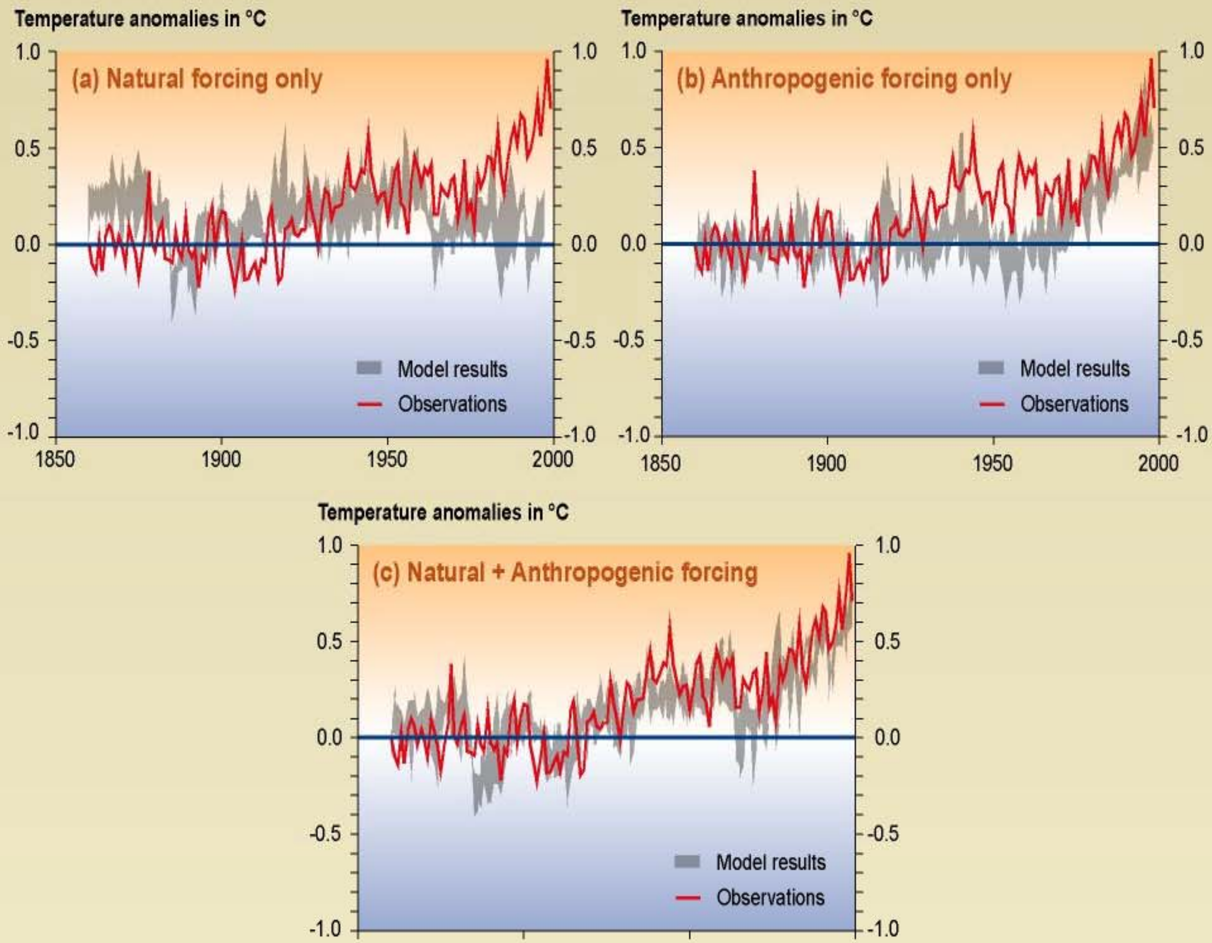
SYR - FIGURE 9-1b

IPCC

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

WMO UNEP

Comparison between modeled and observations of temperature rise since the year 1860



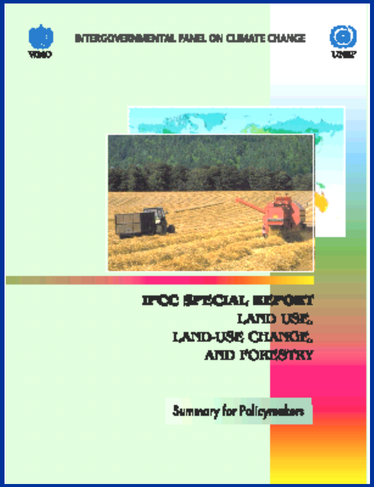
SYR - FIGURE 2-4

Role of the biosphere in the global C balance

1.5. ROLE OF BIOSPHERE IN GLOBAL C BALANCE

3 important points:

- Special Report of the IPCC on LULUCF 2001

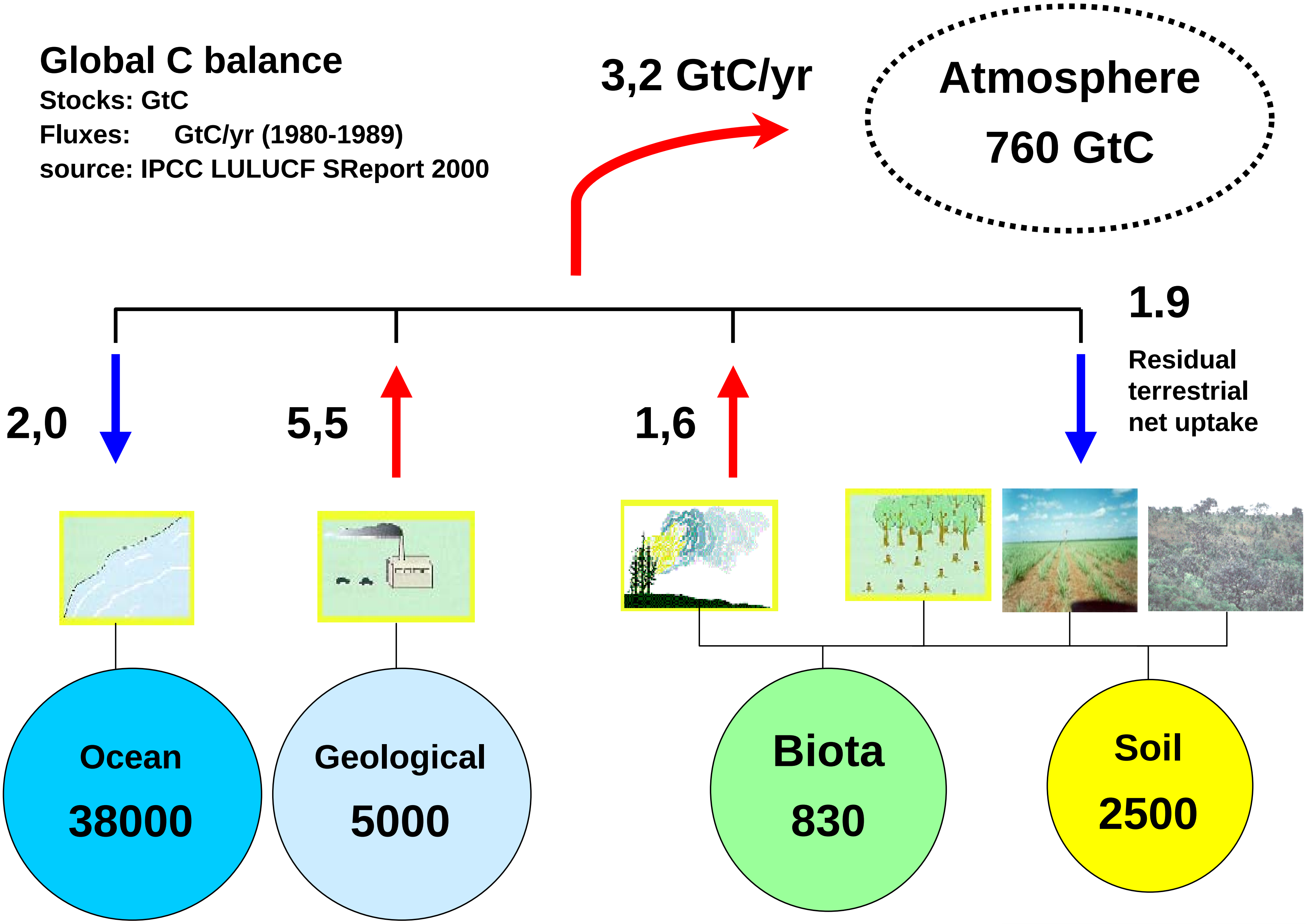


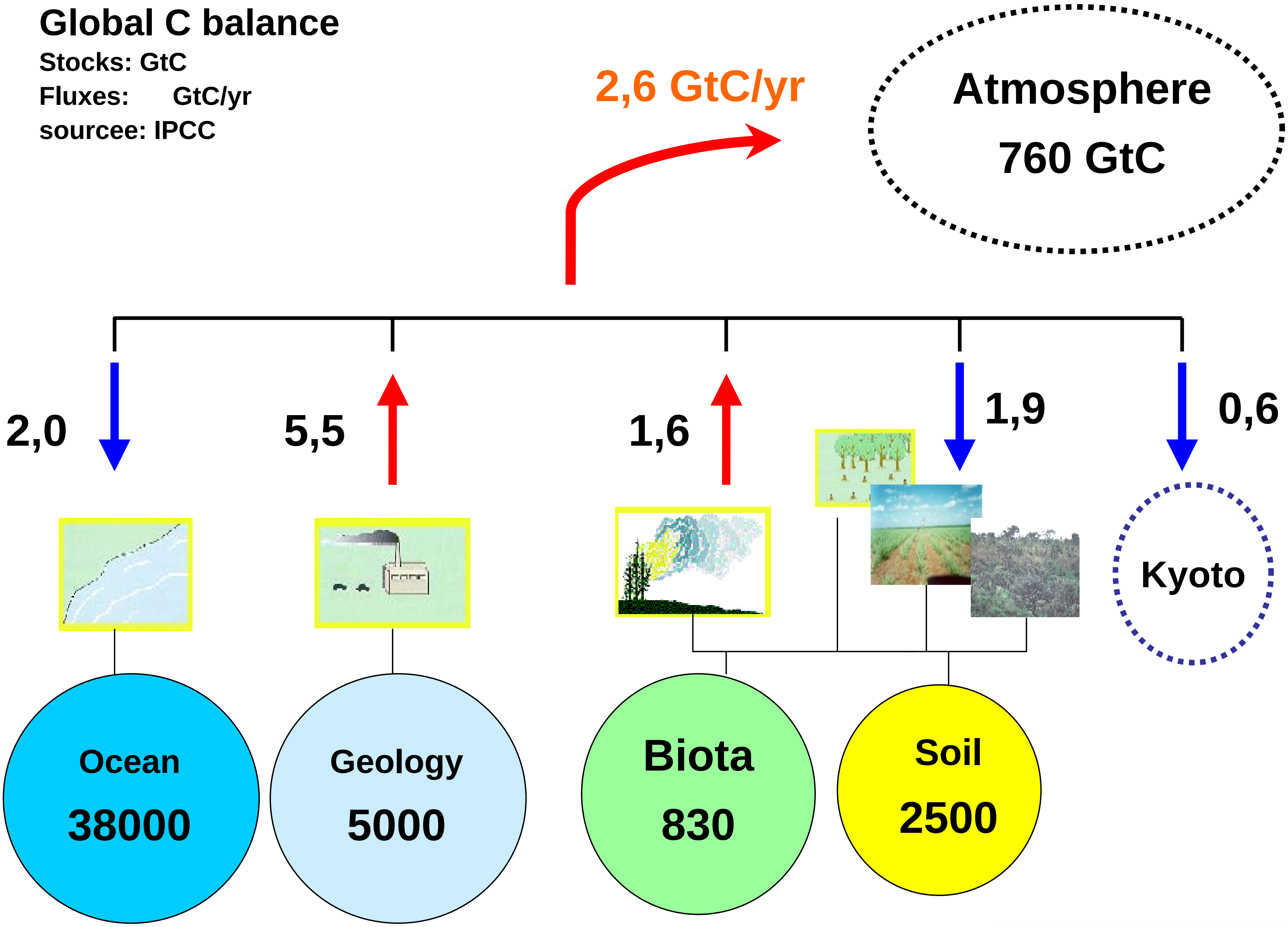
Terrestrial ecosystems should maintain uptake for several decades (CO2 fertilization, nutrient deposition, human practices) but gradually diminishing, but are also threathened by increasing temperature (heterotrophic respiration), degradation (natural disasters) to become a source.

* Terrestrial ecosystems are uptaking C based on:

- estimated global C balance

- evidences that terrestrial tropical ecosystem are C sinks (Schimmel et al, *Science* 2001)


Global C balance
Stocks: GtC
Fluxes: GtC/yr (1980-1989)
source: IPCC LULUCF SReport 2000
3,2 GtC/yr
Atmosphere
760 GtC
1.9
Residual terrestrial net uptake
2,0
5,5
1,6
Ocean
38000
Geological
5000
Biota
830
Soil
2500



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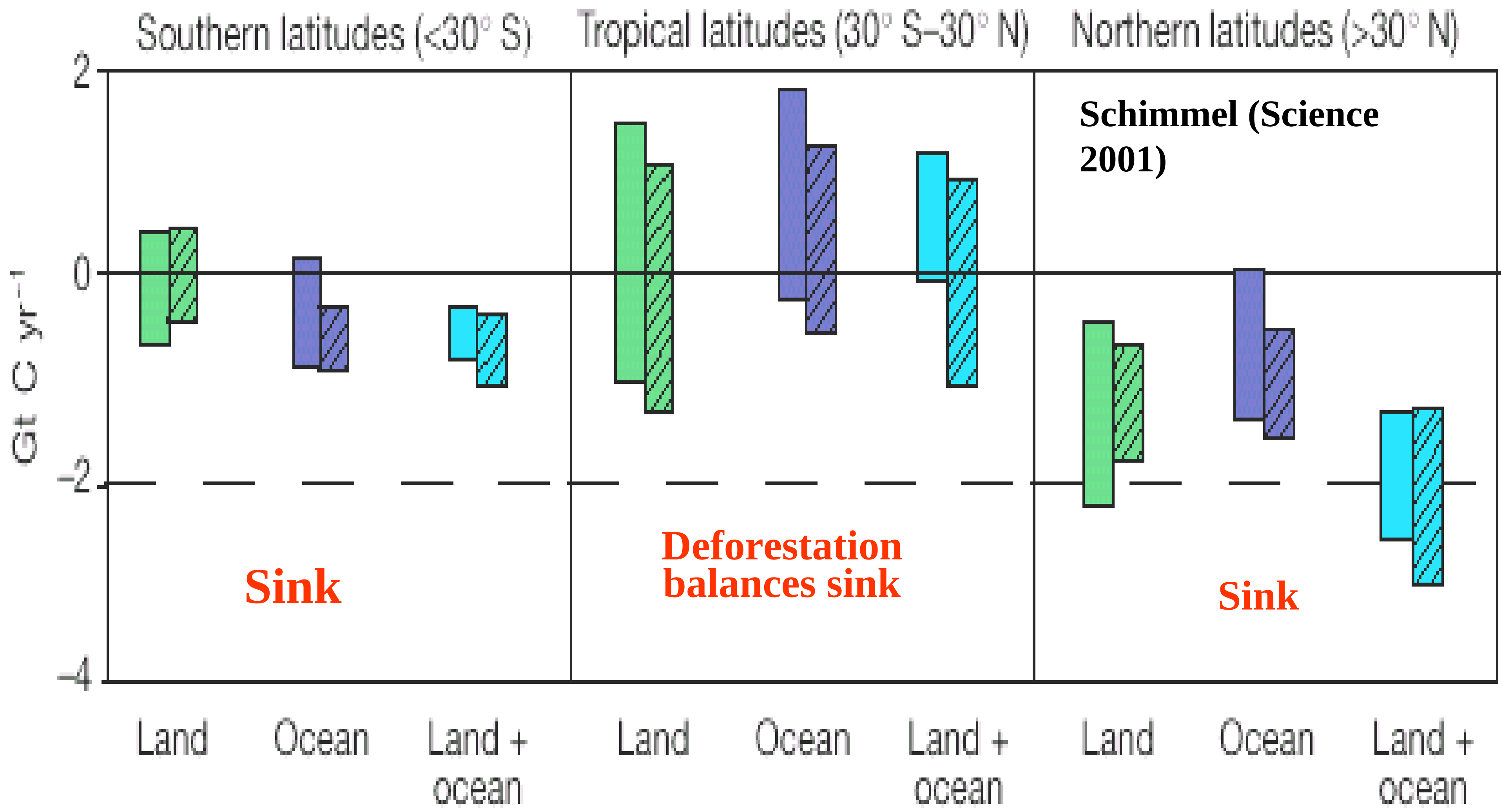

Figure 1 Zonal distribution of terrestrial and oceanic carbon fluxes. These data were deduced from eight inverse models using different techniques and sets of atmospheric observations after accounting for fossil-fuel emissions (not shown)[13]. Results are shown for the 1980s (plain bars) and for 1990–96 (hatched bars). The bars indicate