Relações entre a Fotossíntese e a Atmosfera

Mathias Bortoletto Dunker
Lucas James Faga
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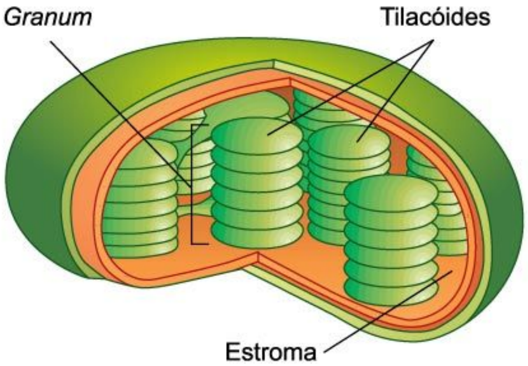
por quê as plantas são verdes?

A amazônia é o pulmão do mundo.

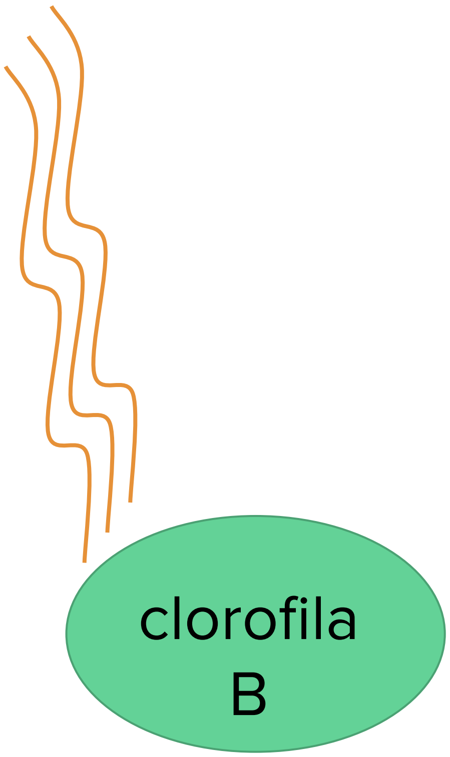
Não! as algas que são.

Por quê as plantas são verdes?

Mecanismo da Fotofosforilação Oxidativa:



clorofila
B


clorofila
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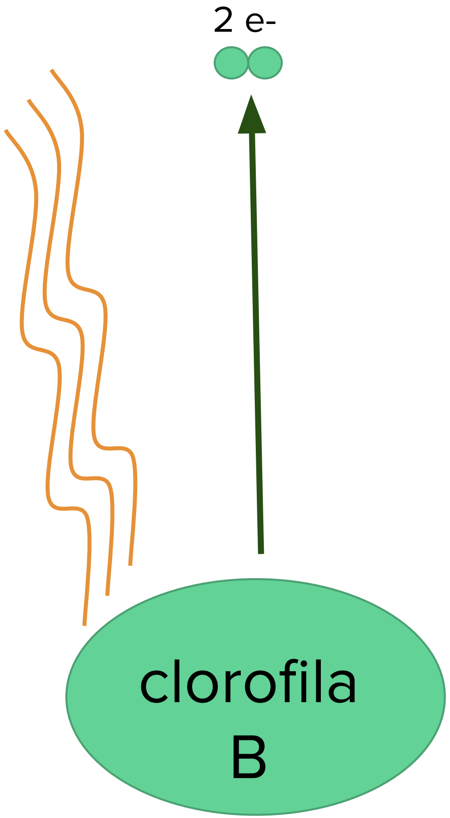
2 e-
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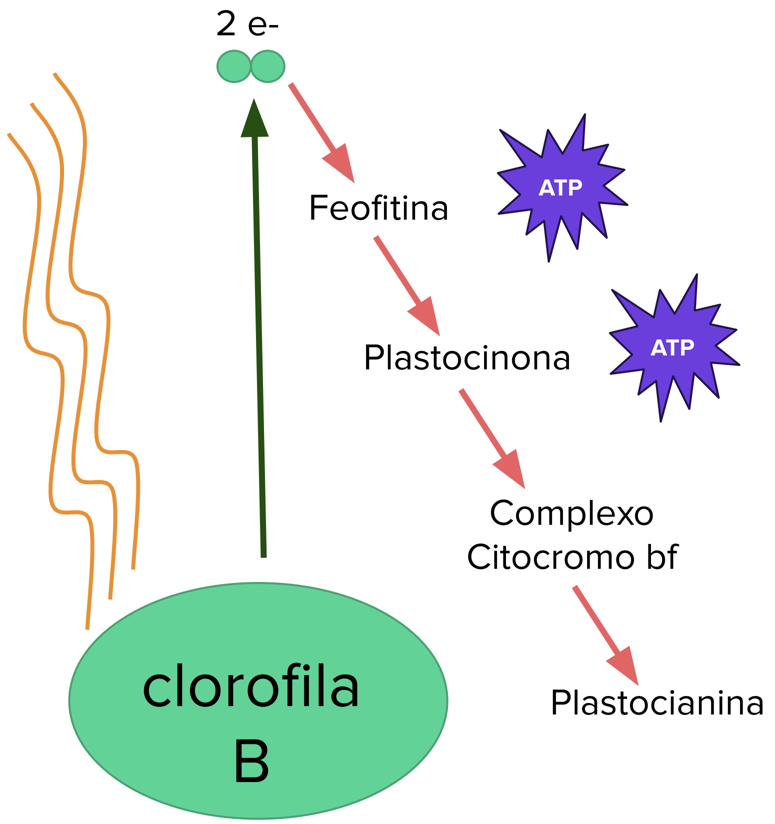
2 e-
Feofitina
ATP
Plastocinona
ATP
Complexo
Citocromo bf
Plastocianina
clorofila
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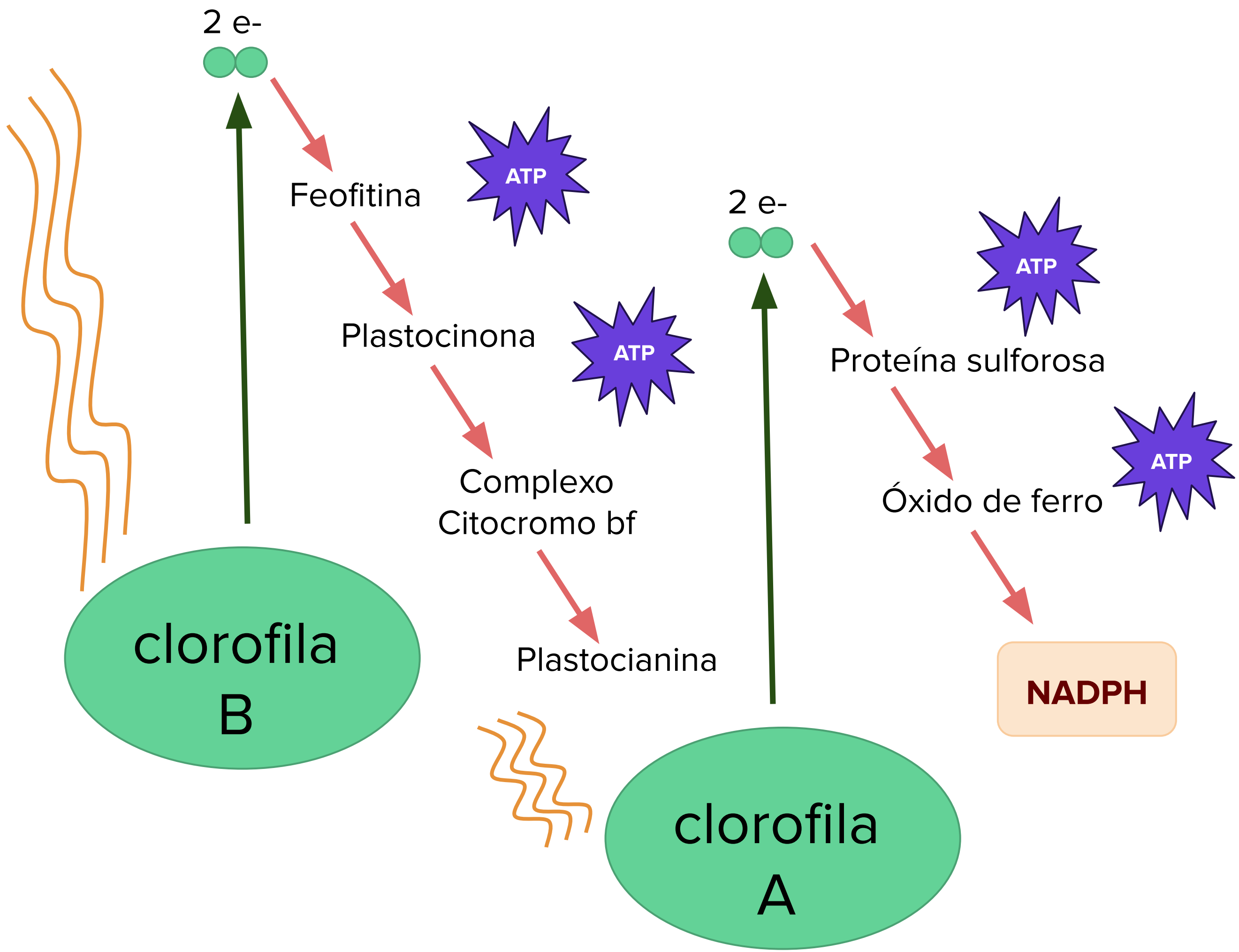
2 e-
Feofitina
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Citocromo bf
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2 e-
Proteína sulforosa
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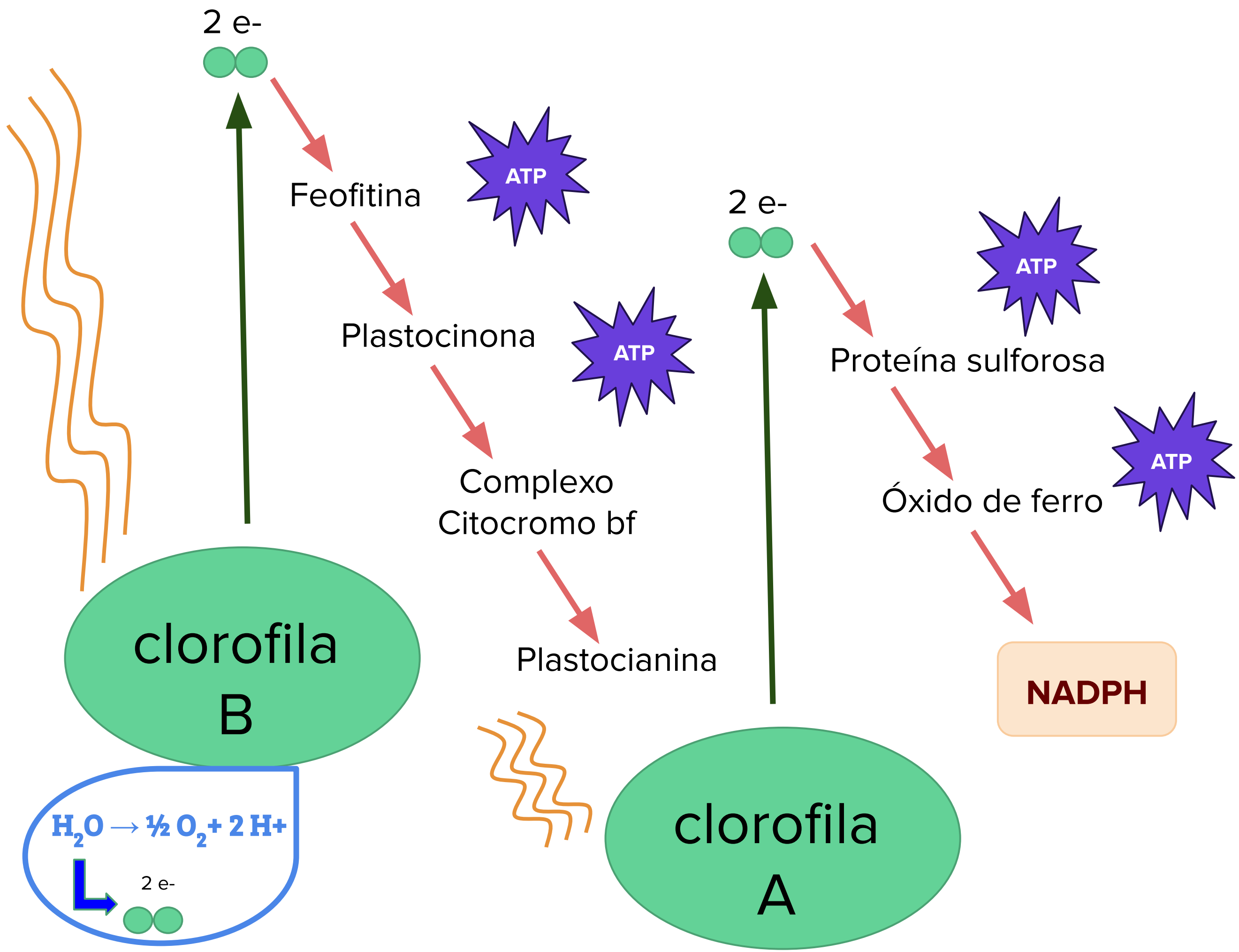
Óxido de ferro
ATP
NADPH
clorofila
A



2 e-
Feofitina
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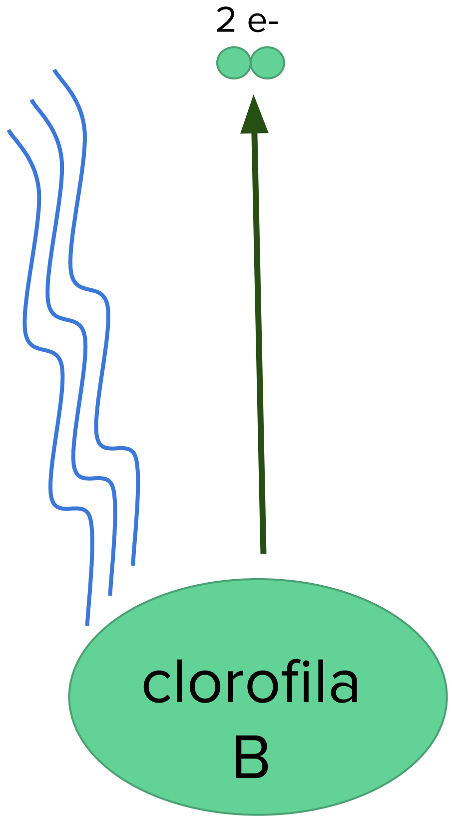
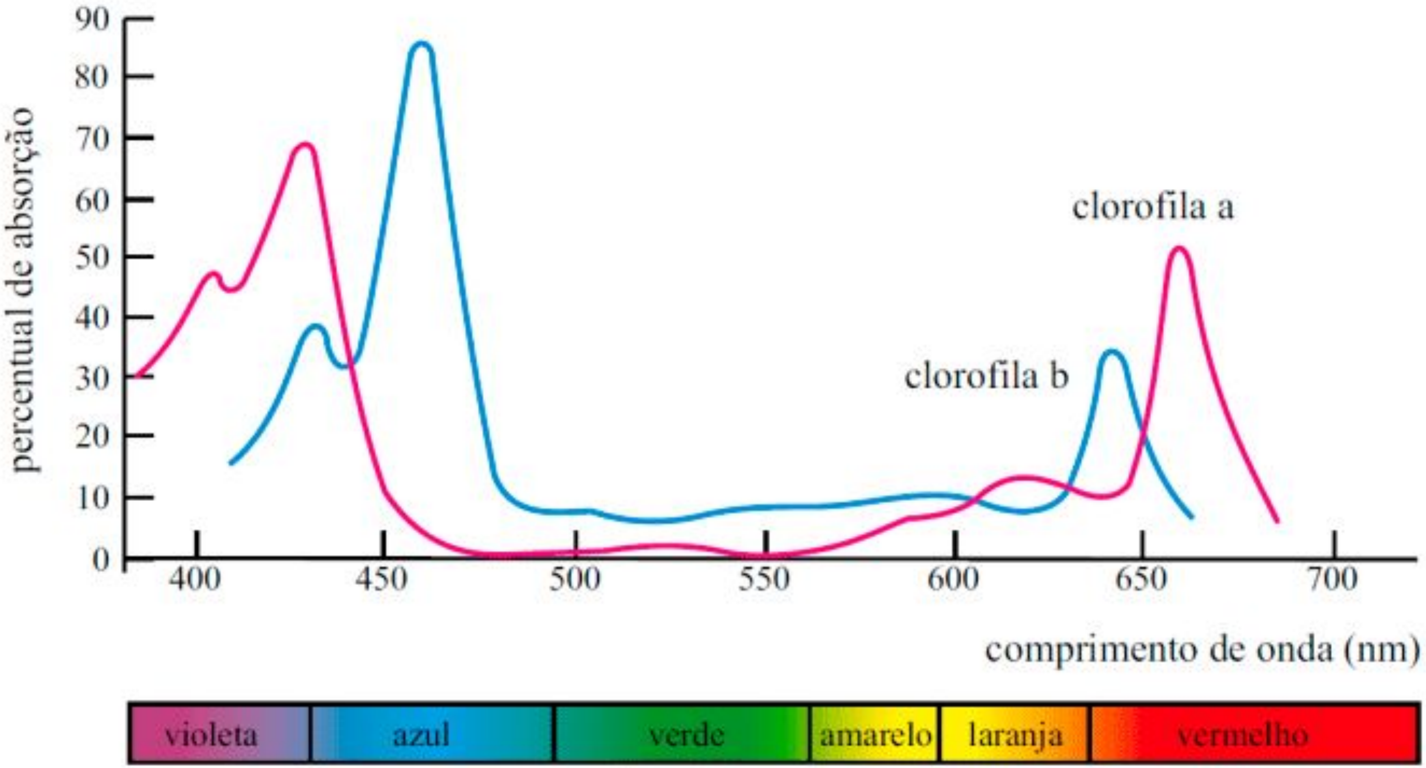
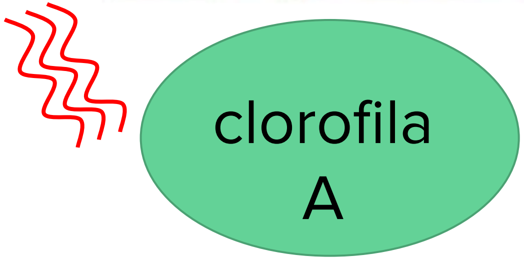
ATP
Complexo Citocromo bf
Plastocianina
2 e-
Proteína sulforosa
ATP
Óxido de ferro
ATP
NADPH
clorofila B
$H_2O \rightarrow ½ O_2 + 2 H+$
2 e-
clorofila A

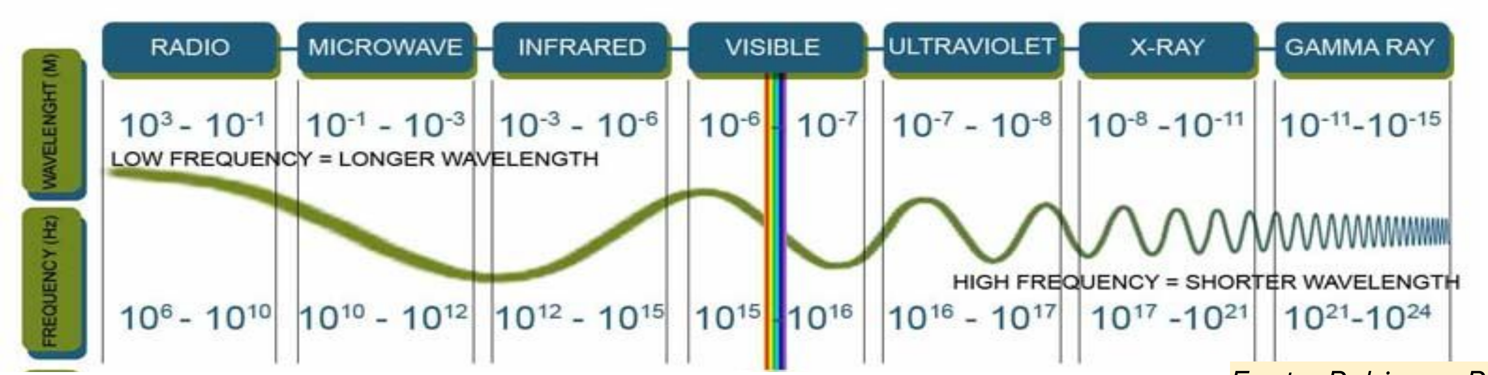




Fonte: Blog do Enem [1]



Porque a planta é verde?

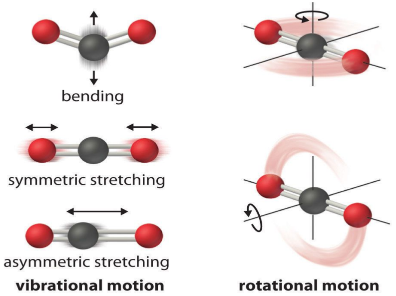


Fonte: Robinson Rolim Resseti [2]

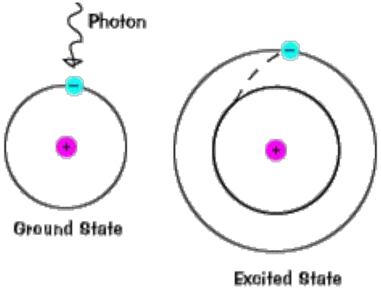
Tipos diferentes de Espectros Moleculares:

Espectro Vibracional/Rotacional

Fonte: Abud Science [3]

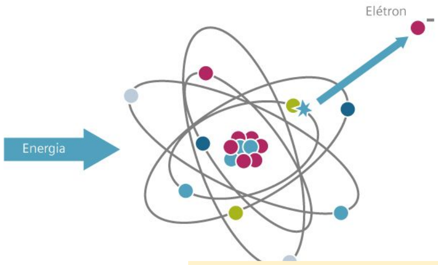


Espectro Eletrônico de Banda



Fonte: NASA [4]

Radiação Ionizante

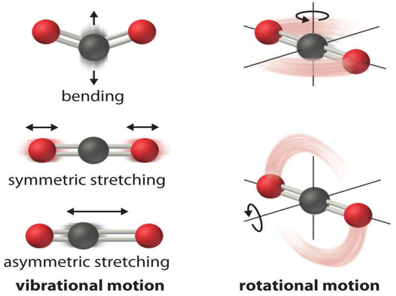


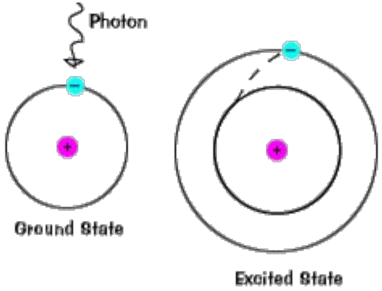
Fonte: Radiação Médica [5]

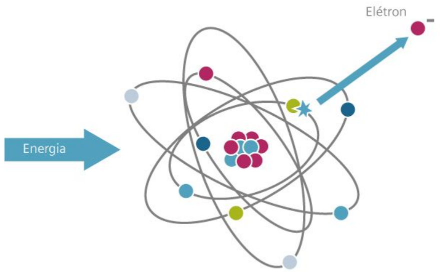
Espectro Vibracional/Rotacional

Espectro Eletrônico de Banda

Radiação Ionizante



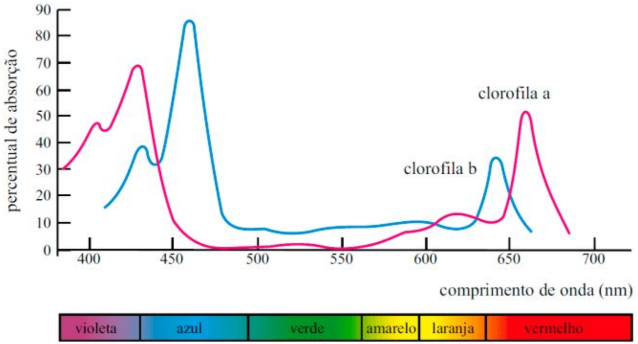




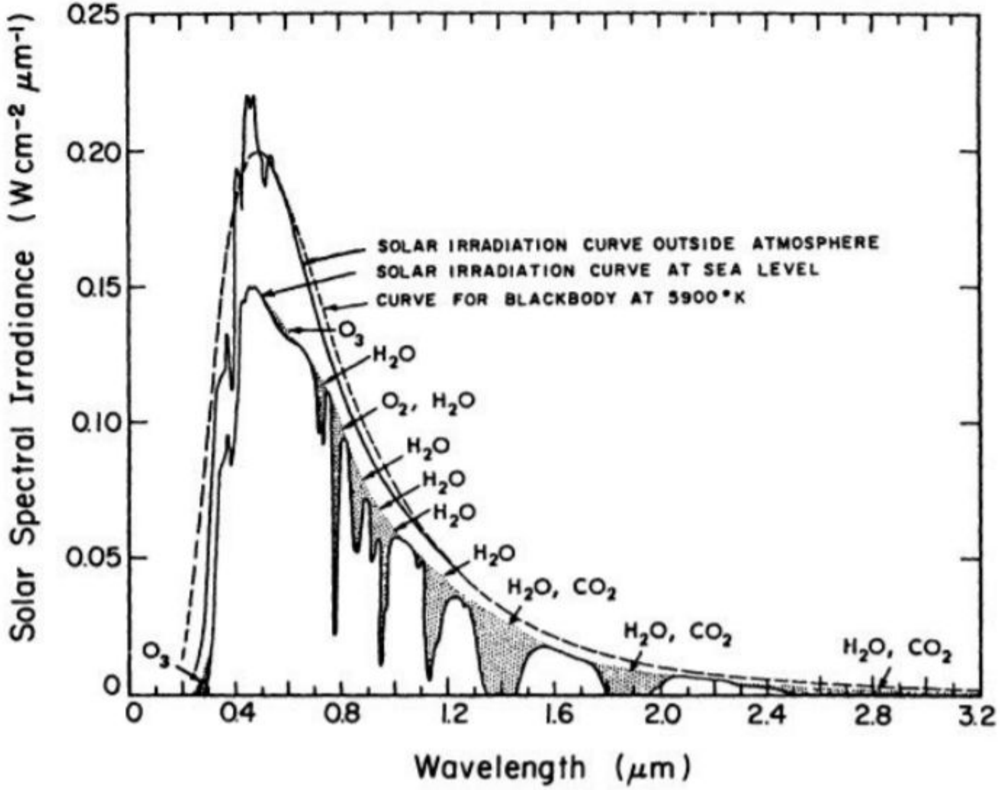
10^5 Hz 10^{13}Hz 10^{17} Hz 10^{19}Hz

10^{14} - 10^{16} Hz

luz visível

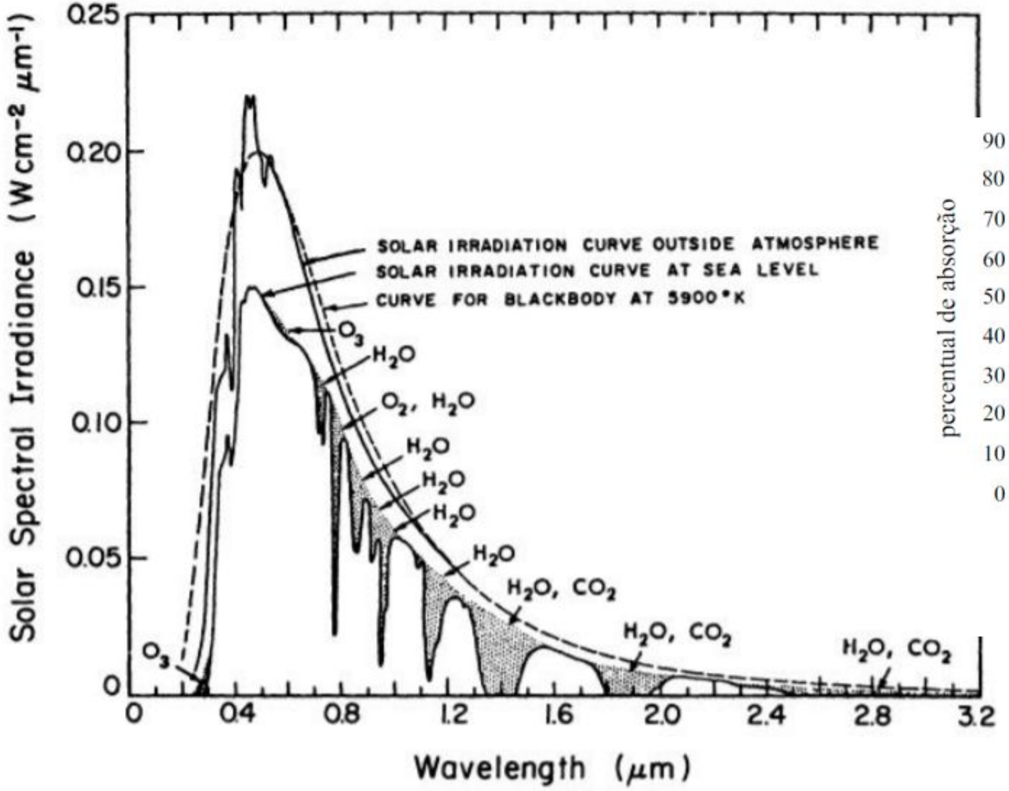


Espectro de emissão solar:

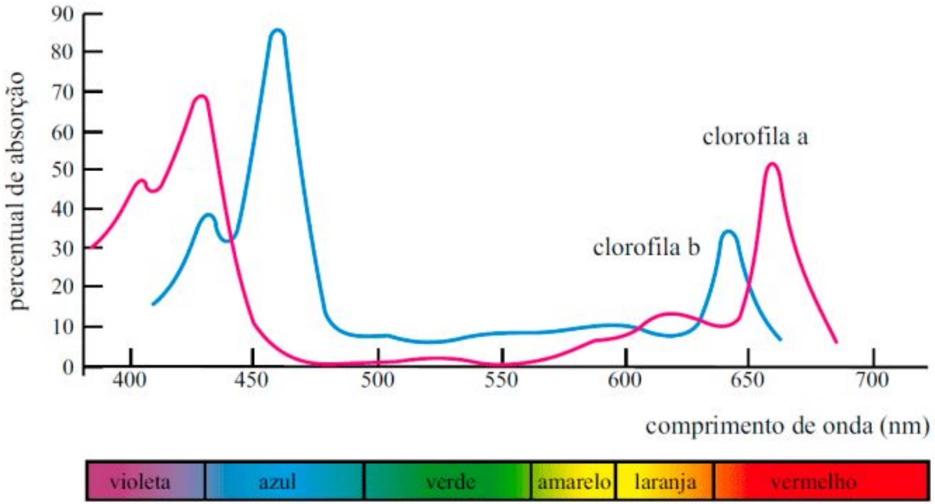


Fonte: Eduardo Landufo [6]

Espectro de emissão solar:



Mas então por que não uma clorofila preta?



Fonte: Eduardo Landufo [6]

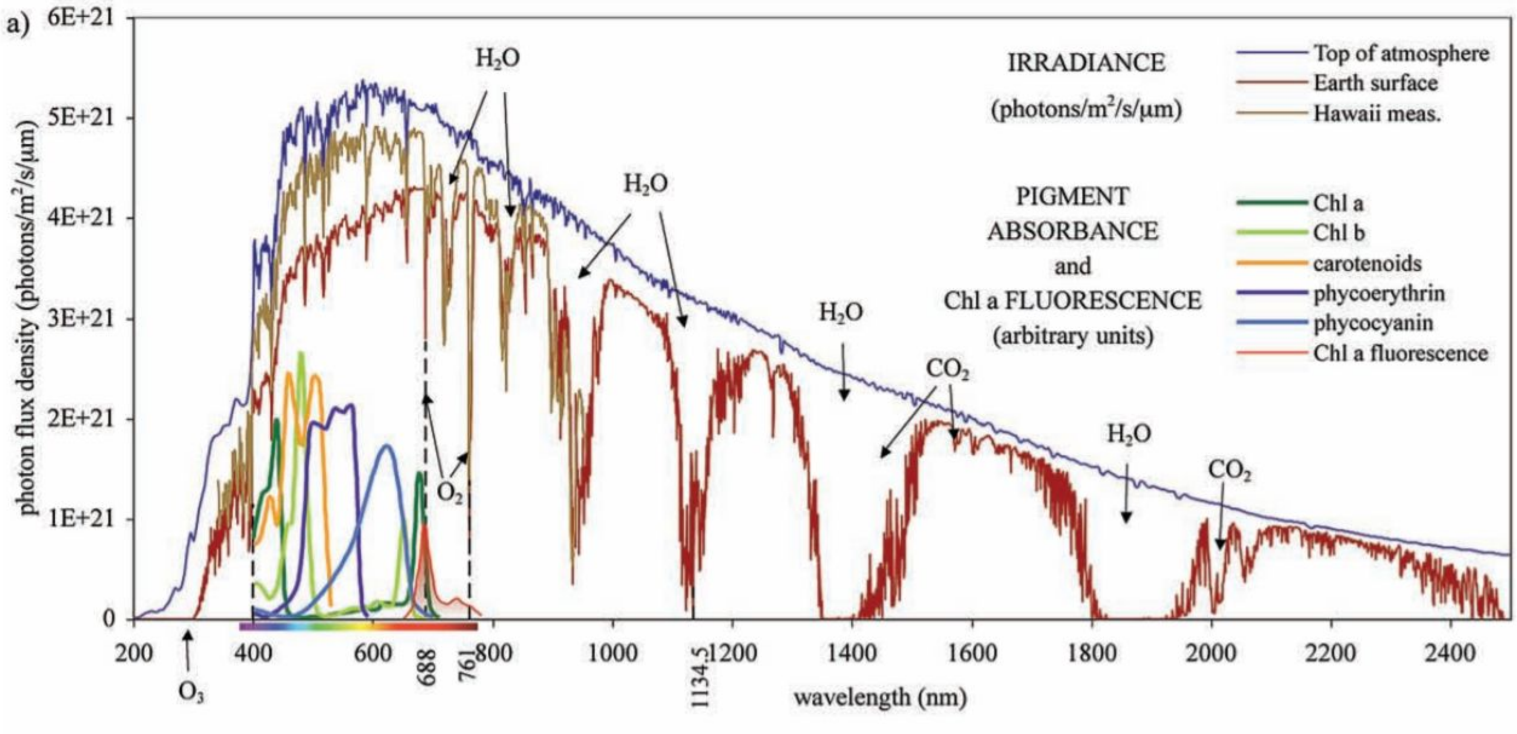
Mas então por que não uma clorofila preta?

KIANG, SIEFERT, GOVINDJEE, BLANKENSHIP:

“ A banda de Chappuis para O3 (500-700nm) altera o pico da densidade de fluxo de fótons do Sol do seu comprimento usual de 600nm (detectados no topo da atmosfera) para 685nm na superfície terreste, o que pode explicar porque a clorofila prefere o vermelho ao verde.

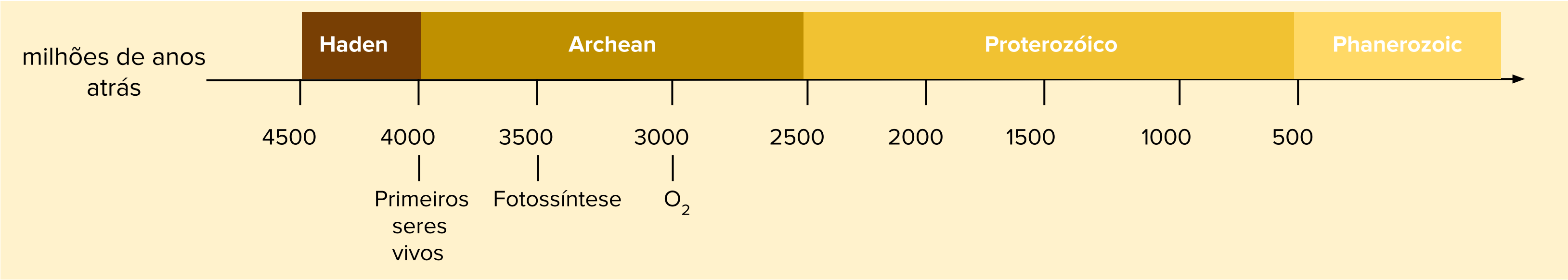
Dessa forma, parece que o pico de absorção na janela do vermelho foi uma adaptação para aproveitar a janela de transmitância do Sol com a maior abundância de fótons, janela cujos limites são definidos tanto pelo espectro solar quanto pela própria presença de O2 e O3. Note que se considerarmos na superfície terresre o espectro em termos de fluxo de energia, o pico acontece em 480-490nm, mas como para a fotossíntese conta-se fótons, e não energia, o pico acaba sendo deslocado”

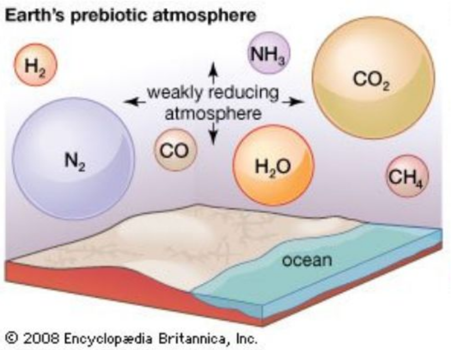
Fonte: Spectral Signatures of Photosynthesis. I. Review of Earth Organisms [7]

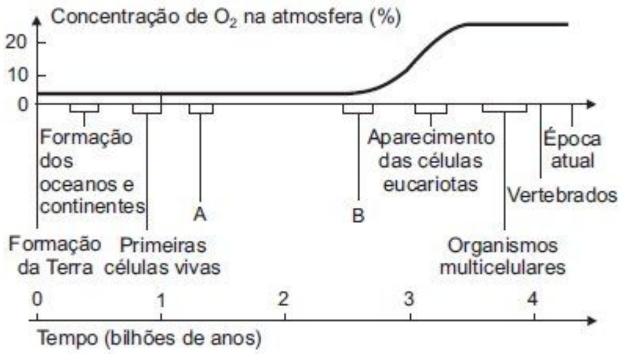


Fonte: Spectral Signatures of Photosynthesis. I. Review of Earth Organisms [7]

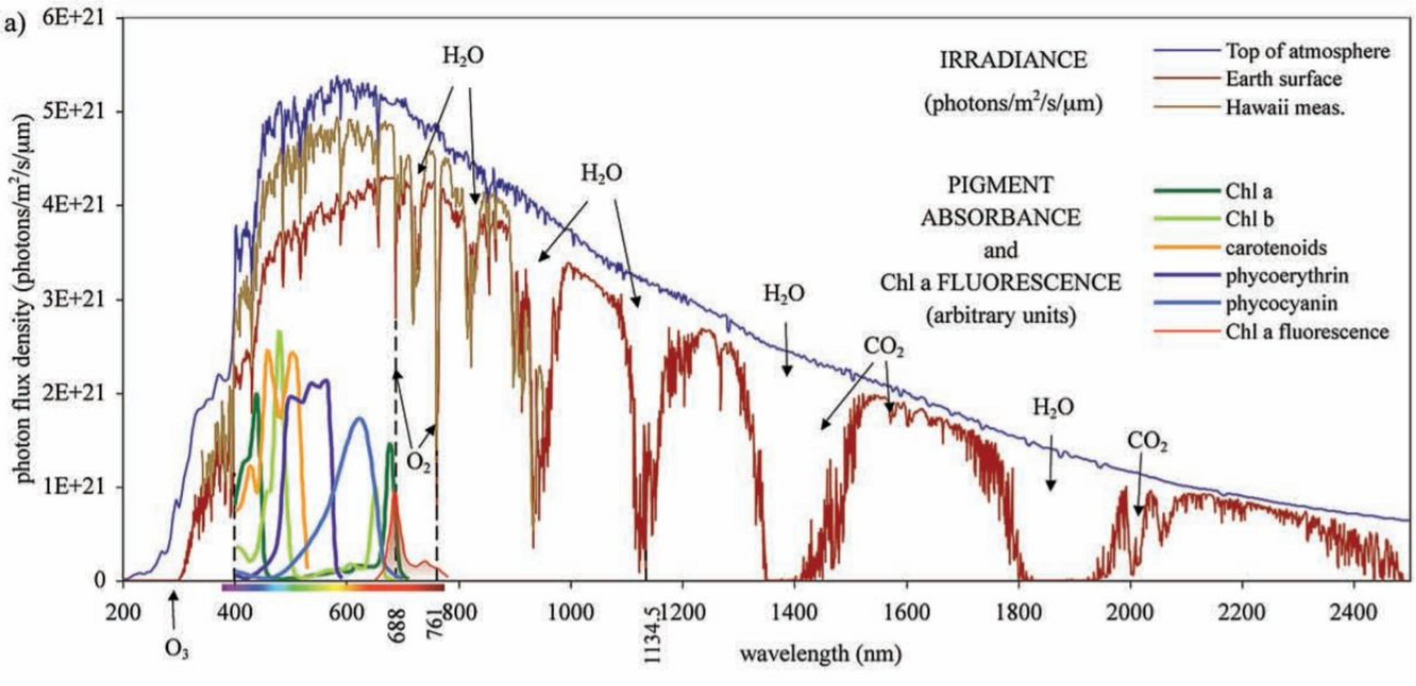
Mas isso é válido nas condições da atmosfera primitiva?







CESAR e SEZAR. *Biologia*. São Paulo: Saraiva, 2002, v.1.



The earliest version of the pathway almost certainly was anaerobic, both not requiring and not tolerating the presence of O_2.

Photosynthetic phyla include the cyanobacteria, proteobacteria (purple bacteria), green sulfur bacteria (GSB), firmicutes (heliobacteria), filamentous anoxygenic phototrophs (also often called the green nonsulfur bacteria), and acidobacteria.

Fonte: Early Evolution of Photosynthesis [8] influência da atmosfera na fotossíntese

X

influência da fotossíntese na atmosfera

influência da atmosfera no processo de fotossíntese

Table 4.1 Summary of changes in the physical, chemical, and biological environment that may be driving temporal changes in the structure and dynamics of the tropical forest biome

Driver	Hypothesis	Description of mechanism	Level of driver	Impact of driver	Scale of change[a]	Type of change[b]	Extent of change[c]	Absolute annual change[d]	Theoretical consistency of effects?[e]	Mechanism experimentally demonstrated?	Key prediction
Air temperature	Air temperature	Long-term temperature increases affect photosynthesis, increasing/decreasing growth rates	Physical	Growth	Regional	Point	Global	+ 0.024°C	No	Yes	Growth rate changes correlate with local temperature trends
Air temperature	Respiration costs	Long-term temperature increases increase respiration rates decreasing growth rates	Physical	Growth	Regional	Point	Global	+ 0.024°C	Yes	Yes	Growth rate changes correlate with increases of minimum temperatures
Air temperature	Soil warming	Long-term temperature increases soil nutrient availability, increasing or decreasing growth rates	Physical	Growth	Regional	Point	Global	+ 0.024°C	No	Partially[f]	Growth rate changes correlate with local temperature trends with highest relative increases on
Solar radiation	Global dimming	Long-term decreases in insolation affects photosynthesis increasing/decreasing growth rates	Physical	Growth	Regional	Point	Regional/or near-global	$-0.30\ W\ m^{-2}$	No	Partially[f]	Growth rate changes correlate with local insolation trends
Solar radiation	Changing energy budget	Recent increases in solar radiation due to decreased cloudiness increases	Physical	Growth	Regional	Point	Regional	$+0.13\ W\ m^{-2}$	Yes	Yes	Growth rate changes correlate with local insolation trends
CO_2	light use efficiency	Long-term atmospheric CO_2 increases increase photosynthesis, increasing growth rates	Chemical	Growth	Global	Point	Global	+ 1.53 ppm	Yes	Yes	Growth rate increases across most forests with greatest absolute increase in nutrient-rich aseasonal forests

Fonte: Tropical forests and global atmospheric change, Malhi and Phillips [10]

Temperatura do ar/solo

A temperatura estimula as reações enzimáticas de todos os processos.

em particular, para florestas tropicais:

- taxas de crescimento correlacionadas com menores temperaturas

  → **respiração domina**

- taxas de crescimento correlacionadas com maiores temperaturas -> fotossíntese domina

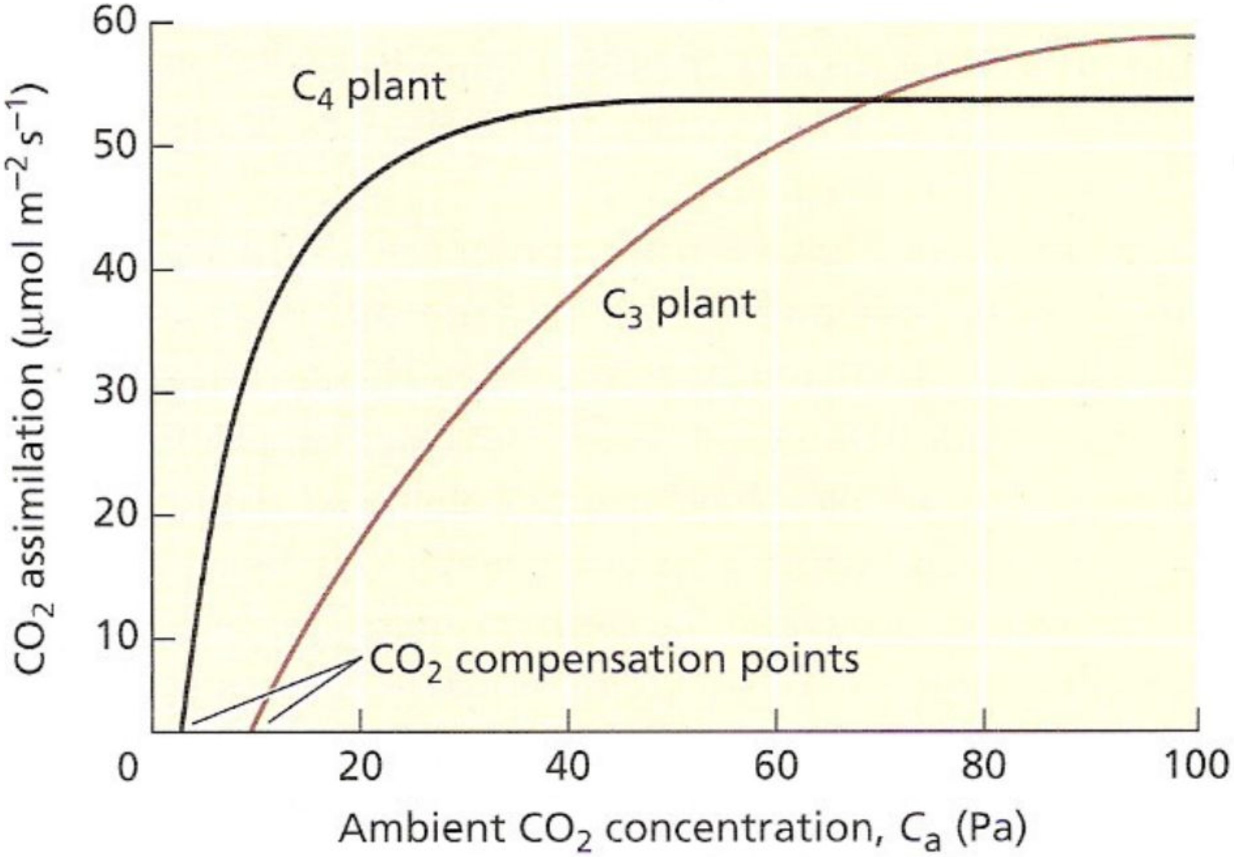
  → **fotossíntese domina**

- taxas de crescimento correlacionadas com mudanças na temperatura, mas efeitos são desproporcionalmente maiores e positivos em florestas de solo pobre em nutrientes

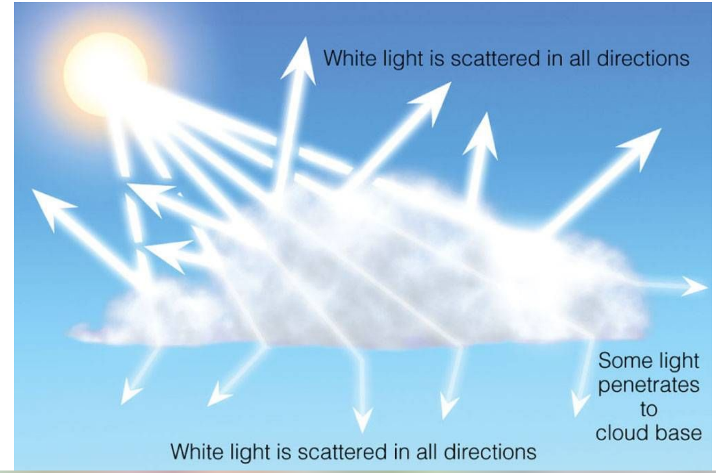
  → **aquecimento do solo**

Fonte: Tropical forests and global atmospheric change, Malhi and Phillips [10]

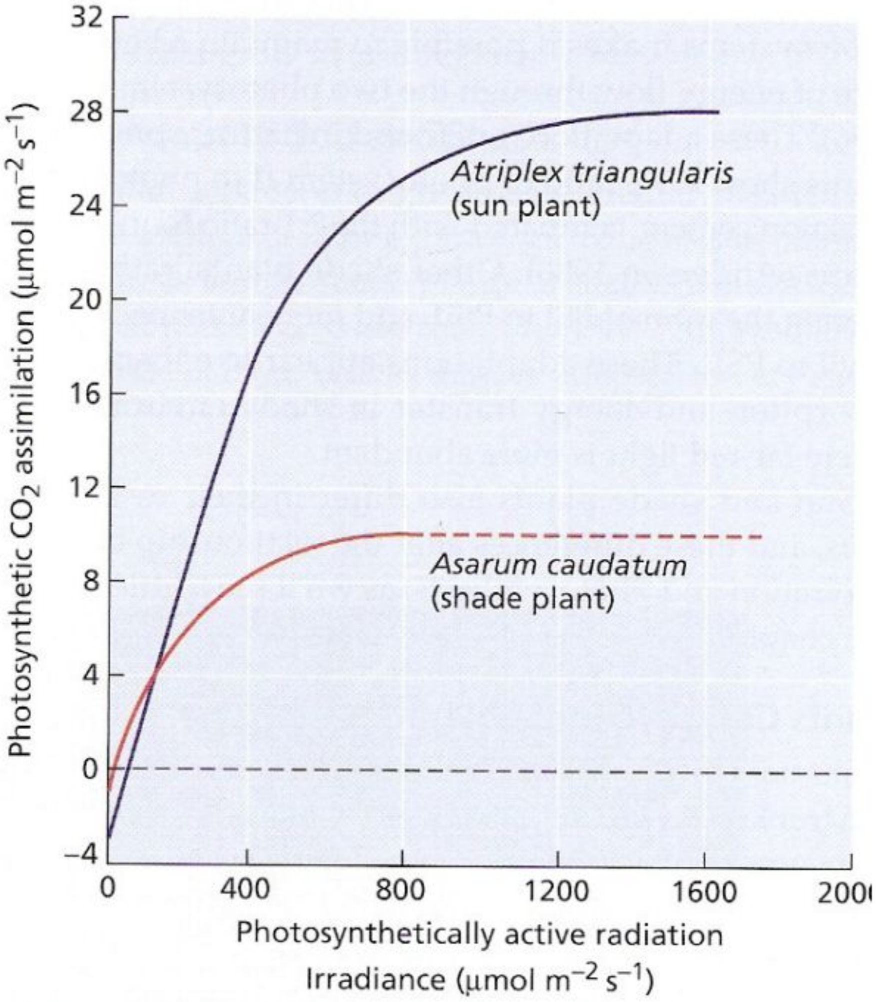
Concentração de CO_2



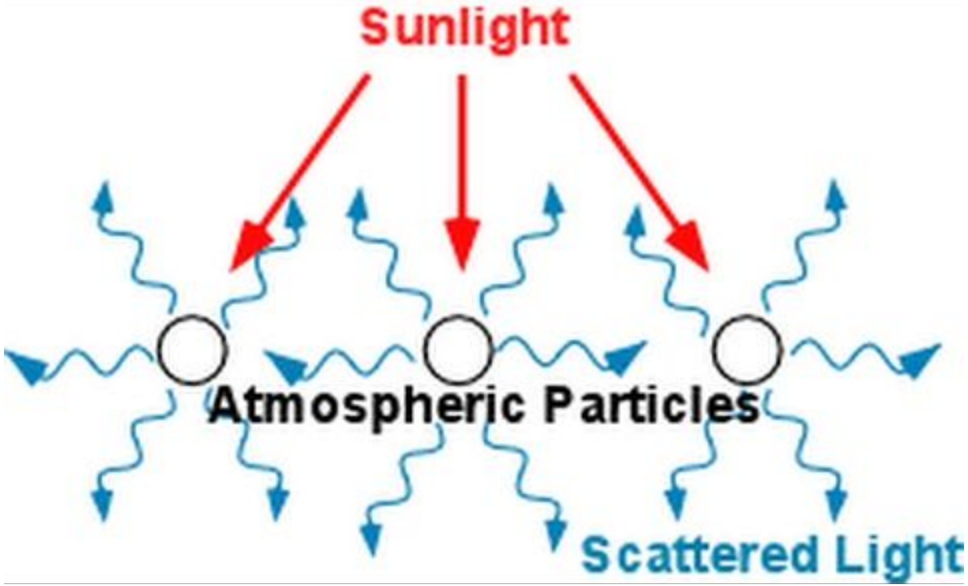
Incidência solar



Fonte: NASA [14]



Incidência solar: aerossol



Fonte: NASA [11]

influência da fotossíntese na atmosfera

Influência da fotossíntese na atmosfera

Afinal, a amazônia é de fato “o pulmão do mundo”?

Emmanuel Macron
@EmmanuelMacron

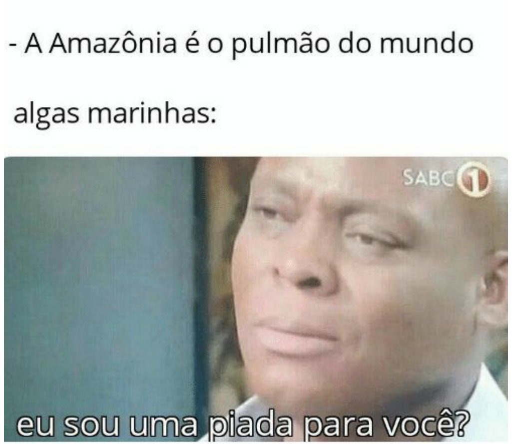
Our house is burning. Literally. The Amazon rain forest - the lungs which produces 20% of our planet’s oxygen - is on fire. It is an international crisis. Members of the G7 Summit, let's discuss this emergency first order in two days! #ActForTheAmazon

161K 5:15 PM - Aug 22, 2019

89.5K people are talking about this

Influência da fotossíntese na atmosfera

Afinal, a amazônia é de fato “o pulmão do mundo”?

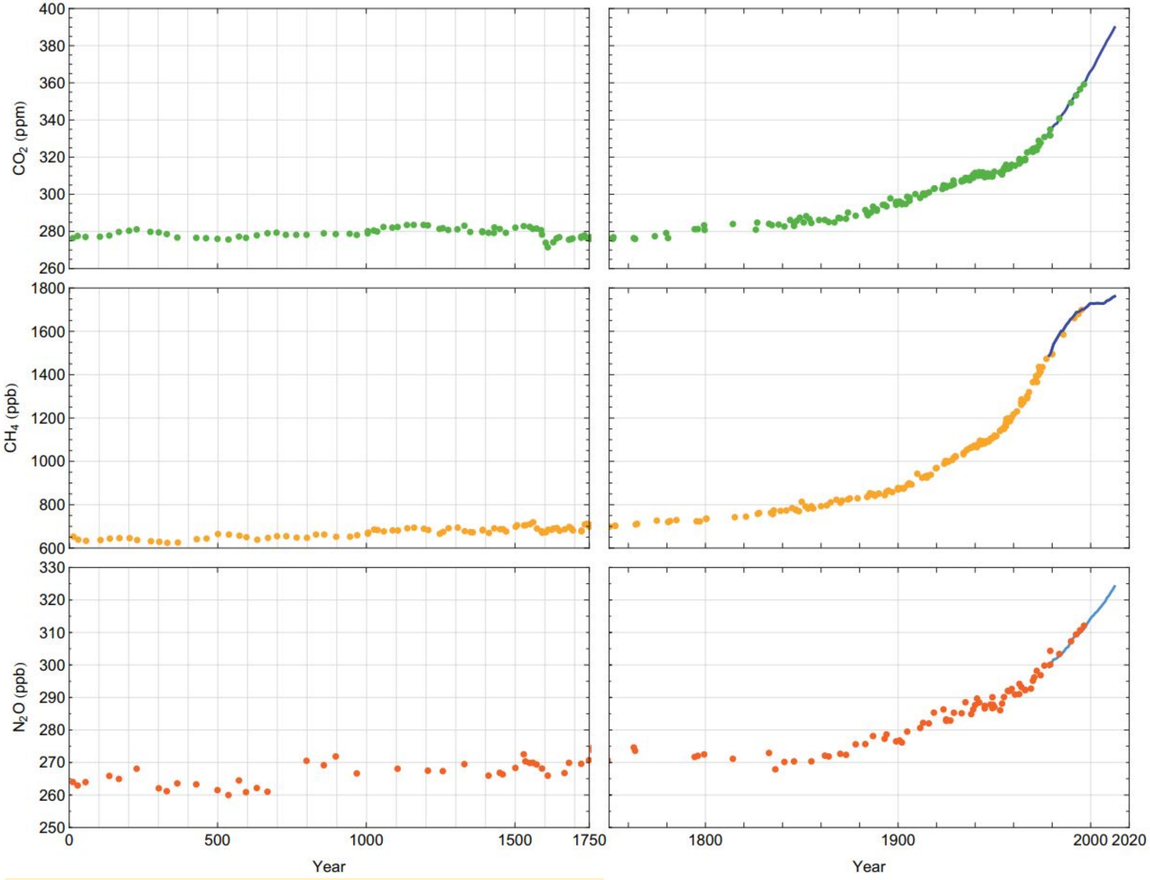


Influência da fotossíntese na atmosfera

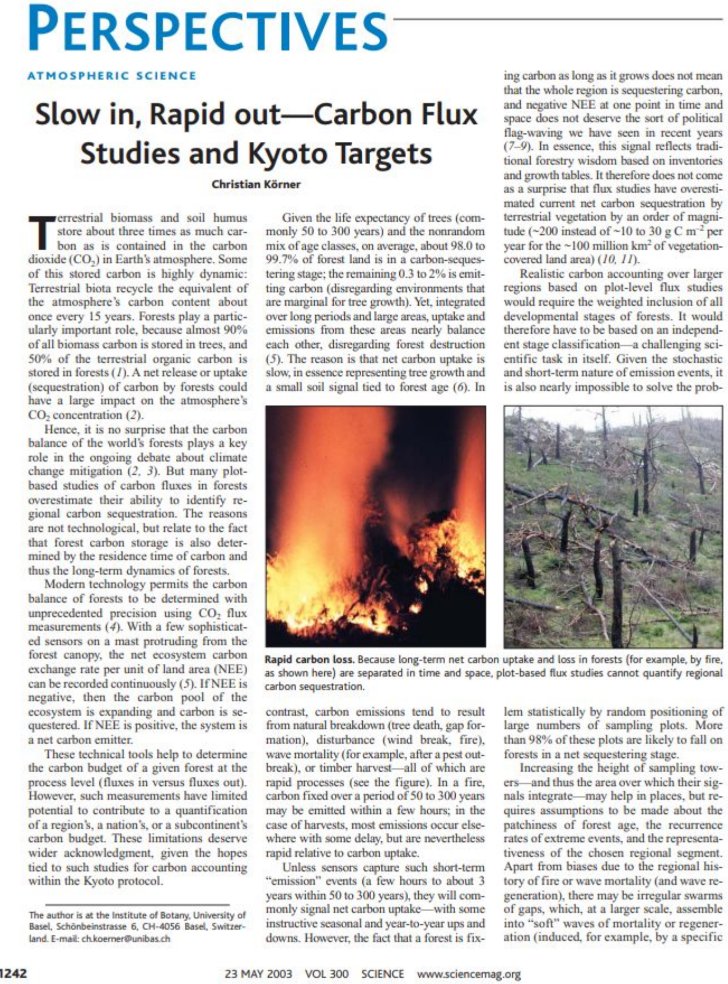
Afinal, a amazônia é de fato “o pulmão do mundo”?

- Clímax ecológico
- Atmosférico no período pré-industrial
- Atmosférico no período pós-industrial

Período pré-industrial



Fonte: IPCC AR5 Climate Change 2013 [12]



PERSPECTIVES

ATMOSPHERIC SCIENCE

Slow in, Rapid out—Carbon Flux Studies and Kyoto Targets

Christian Körner

Terrestrial biomass and soil humus store about three times as much carbon as is contained in the carbon dioxide (CO_2) in Earth's atmosphere. Some of this stored carbon is highly dynamic: Terrestrial biota recycle the equivalent of the atmosphere's carbon content about once every 15 years. Forests play a particularly important role, because almost 90% of all biomass carbon is stored in trees, and 50% of the terrestrial organic carbon is stored in forests (*1*). A net release or uptake (sequestration) of carbon by forests could have a large impact on the atmosphere's CO_2 concentration (*2*).

Hence, it is no surprise that the carbon balance of the world's forests plays a key role in the ongoing debate about climate change mitigation (*2, 3*). But many plot-based studies of carbon fluxes in forests overestimate their ability to identify regional carbon sequestration. The reasons are not technological, but relate to the fact that forest carbon storage is also determined by the residence time of carbon and thus the long-term dynamics of forests.

Modern technology permits the carbon balance of forests to be determined with unprecedented precision using CO_2 flux measurements (*4*). With a few sophisticated sensors on a mast protruding from the forest canopy, the net ecosystem carbon exchange rate per unit of land area (NEE) can be recorded continuously (*5*). If NEE is negative, then the carbon pool of the ecosystem is expanding and carbon is sequestered. If NEE is positive, the system is a net carbon emitter.

These technical tools help to determine the carbon budget of a given forest at the process level (fluxes in versus fluxes out). However, such measurements have limited potential to contribute to a quantification of a region's, a nation's, or a subcontinent's carbon budget. These limitations deserve wider acknowledgment, given the hopes tied to such studies for carbon accounting within the Kyoto protocol.

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Given the life expectancy of trees (commonly 50 to 300 years) and the nonrandom mix of age classes, on average, about 98.0 to 99.7% of forest land is in a carbon-sequestering stage; the remaining 0.3 to 2% is emitting carbon (disregarding environments that are marginal for tree growth). Yet, integrated over long periods and large areas, uptake and emissions from these areas nearly balance each other, disregarding forest destruction (*5*). The reason is that net carbon uptake is slow, in essence representing tree growth and a small soil signal tied to forest age (*6*). In contrast, carbon emissions tend to result from natural breakdown (tree death, gap formation), disturbance (wind break, fire), wave mortality (for example, after a pest outbreak), or timber harvest—all of which are rapid processes (see the figure). In a fire, carbon fixed over a period of 50 to 300 years may be emitted within a few hours; in the case of harvests, most emissions occur elsewhere with some delay, but are nevertheless rapid relative to carbon uptake.

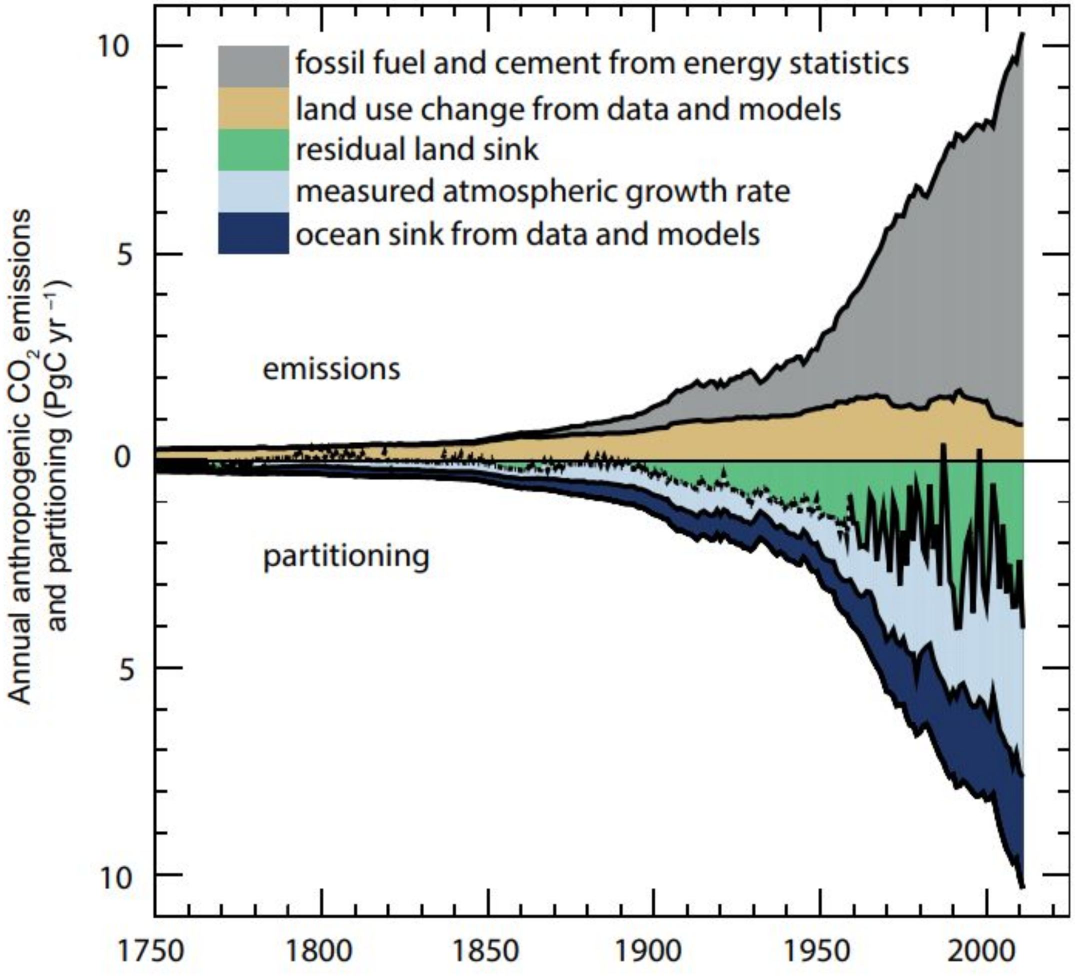
Unless sensors capture such short-term "emission" events (a few hours to about 3 years within 50 to 300 years), they will commonly signal net carbon uptake—with some instructive seasonal and year-to-year ups and downs. However, the fact that a forest is fixing carbon as long as it grows does not mean that the whole region is sequestering carbon, and negative NEE at one point in time and space does not deserve the sort of political flag-waving we have seen in recent years (*7–9*). In essence, this signal reflects traditional forestry wisdom based on inventories and growth tables. It therefore does not come as a surprise that flux studies have overestimated current net carbon sequestration by terrestrial vegetation by an order of magnitude (~200 instead of ~10 to 30 g C m^{-2} per year for the ~100 million km^2 of vegetation-covered land area) (*10, 11*).

Realistic carbon accounting over larger regions based on plot-level flux studies would require the weighted inclusion of all developmental stages of forests. It would therefore have to be based on an independent stage classification—a challenging scientific task in itself. Given the stochastic and short-term nature of emission events, it is also nearly impossible to solve the problem statistically by random positioning of large numbers of sampling plots. More than 98% of these plots are likely to fall on forests in a net sequestering stage.

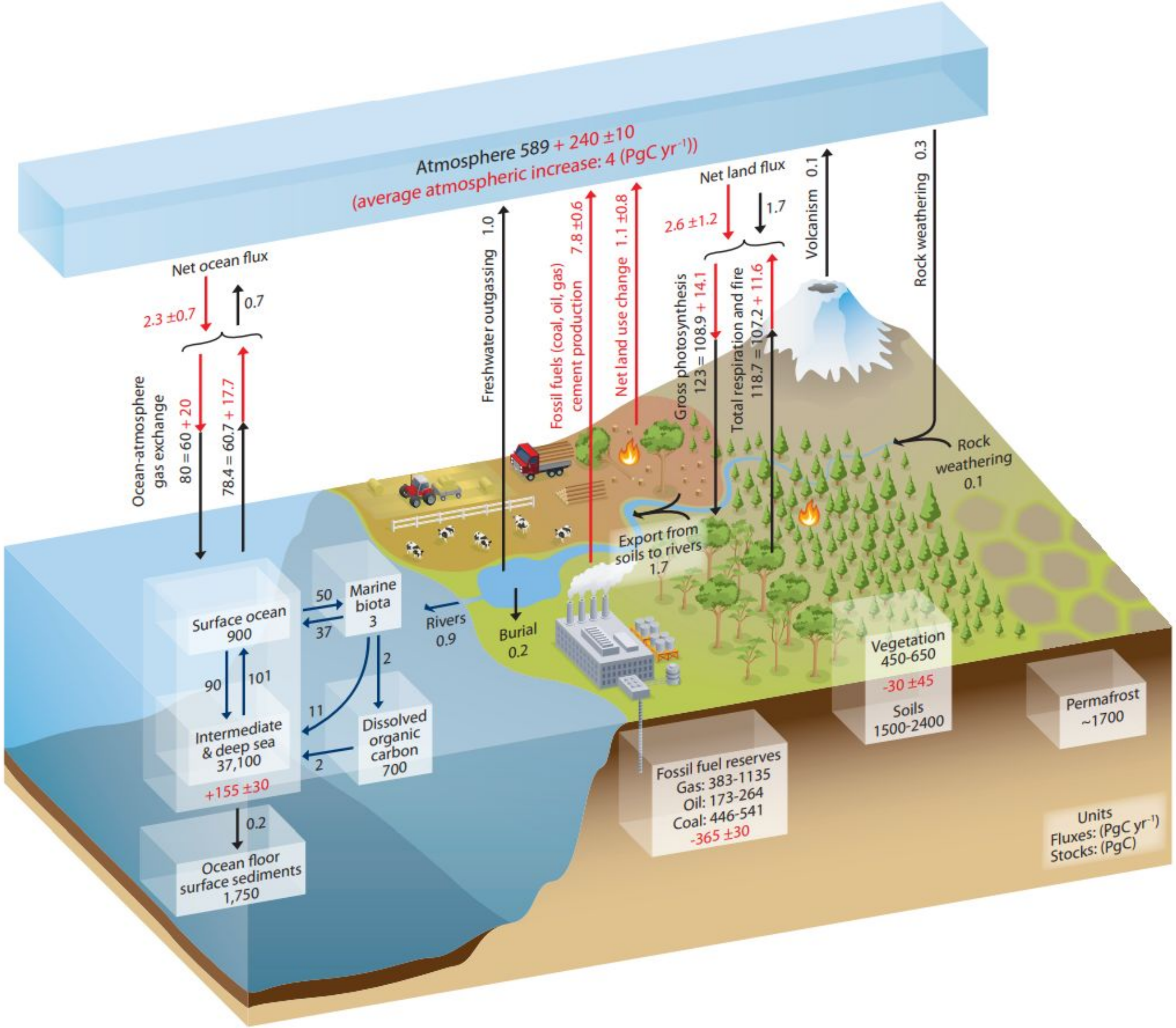
Increasing the height of sampling towers—and thus the area over which their signals integrate—may help in places, but requires assumptions to be made about the patchiness of forest age, the recurrence rates of extreme events, and the representativeness of the chosen regional segment. Apart from biases due to the regional history of fire or wave mortality (and wave regeneration), there may be irregular swarms of gaps, which, at a larger scale, assemble into "soft" waves of mortality or regeneration (induced, for example, by a specific

Rapid carbon loss. Because long-term net carbon uptake and loss in forests (for example, by fire, as shown here) are separated in time and space, plot-based flux studies cannot quantify regional carbon sequestration.

Período pós-industrial

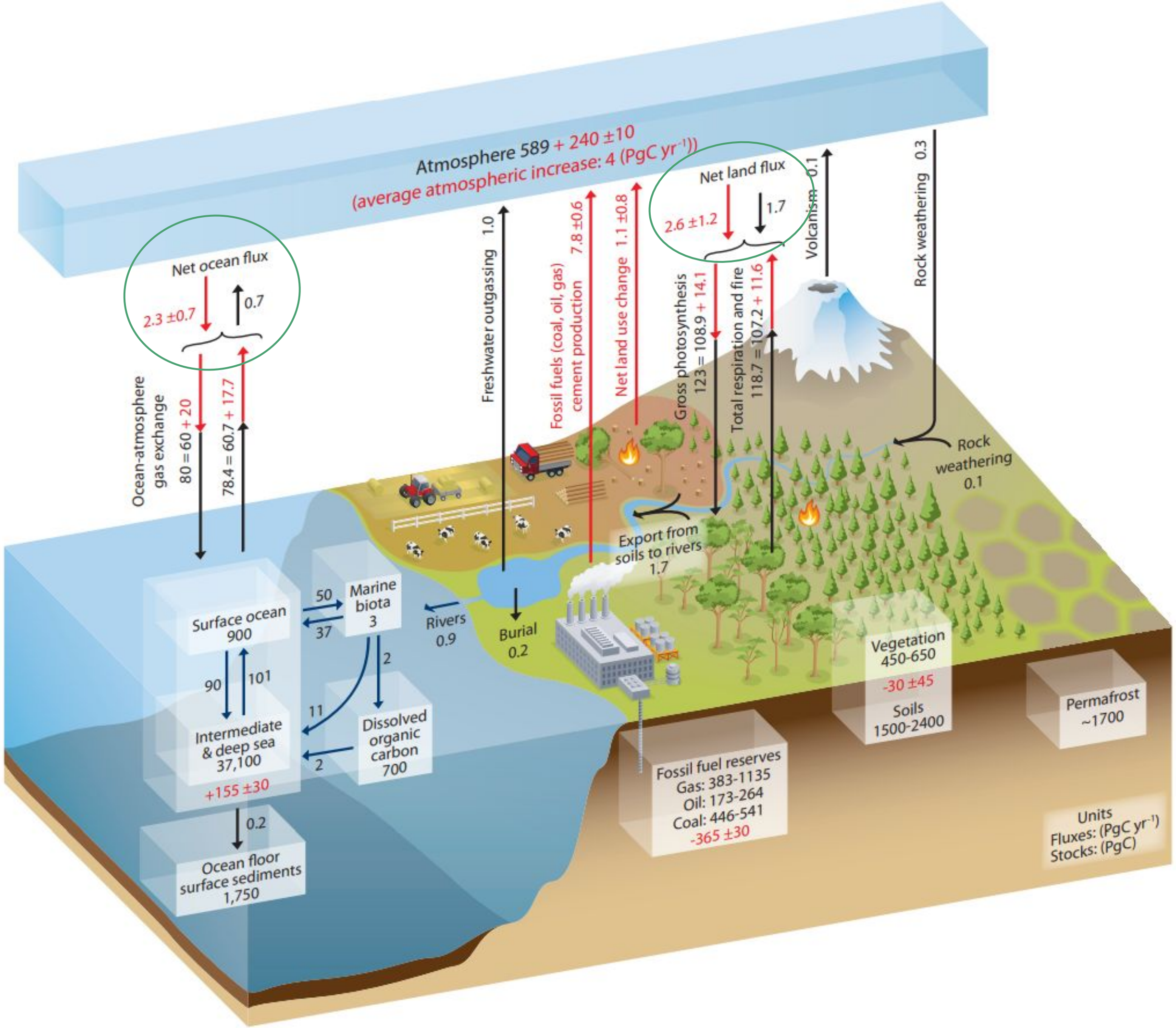


Fonte: IPCC AR5 Climate Change 2013 [12]



By contrast, since the beginning of the Industrial Era, fossil fuel extraction from geological reservoirs, and their combustion, has resulted in the transfer of significant amount of fossil carbon from the slow domain into the fast domain, thus causing an unprecedented, major human-induced perturbation in the carbon cycle.

Fonte: IPCC AR5 Climate Change 2013 [12]



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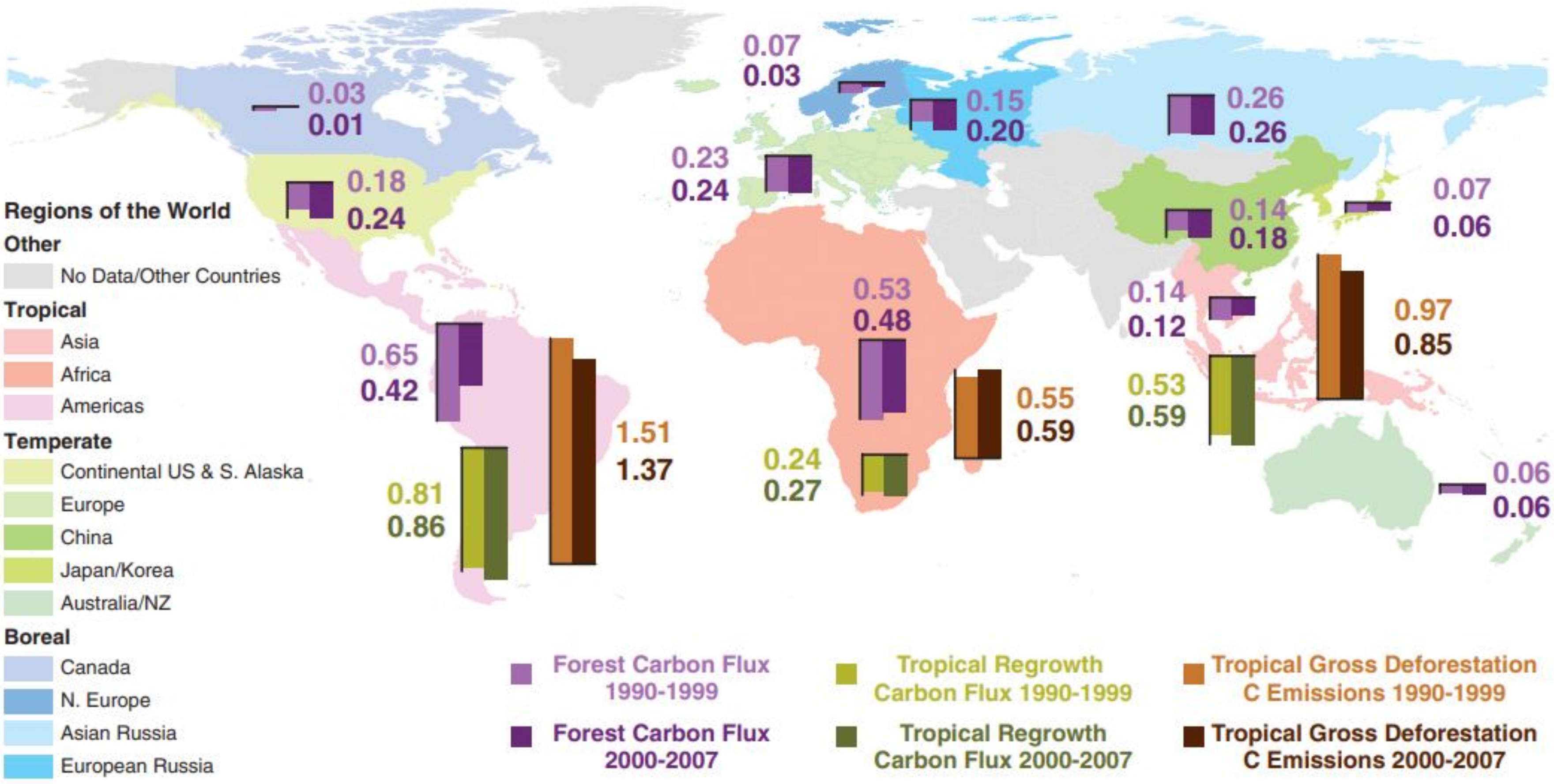
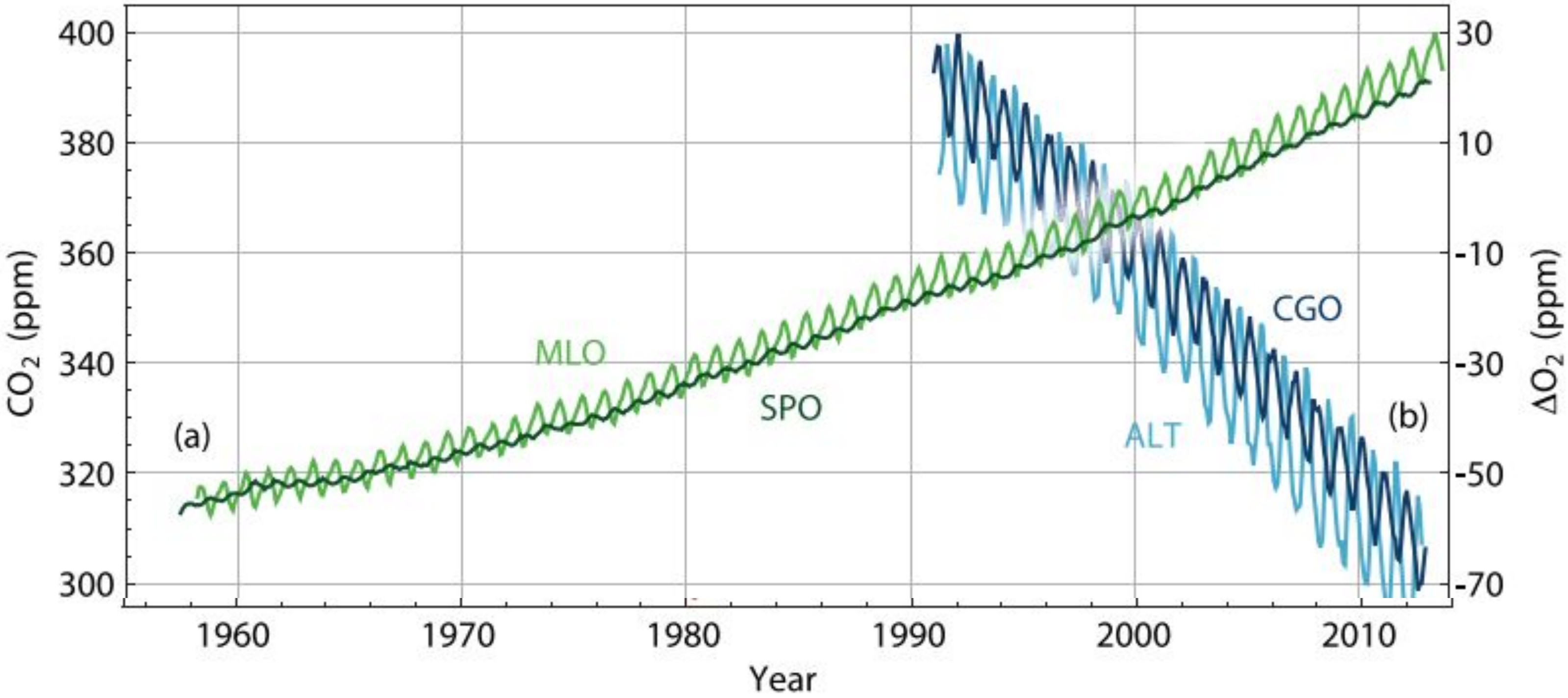
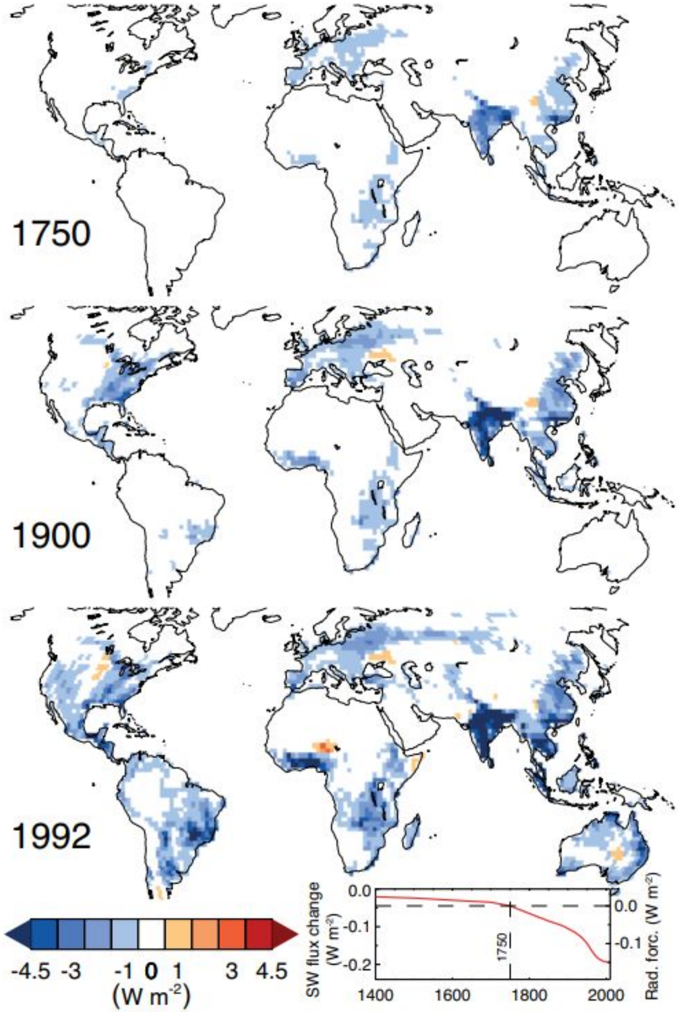


Fonte: Pan et al [13]



Compared to the atmospheric oxygen content of about 21% this decrease is very small; however, it provides independent evidence that the rise in CO2 must be due to an oxidation process, that is, fossil fuel combustion and/or organic carbon oxidation, and is not caused by, for example, volcanic emissions or by outgassing of dissolved CO2 from a warming ocean.

Fonte: IPCC AR5 Climate Change 2013 [12]



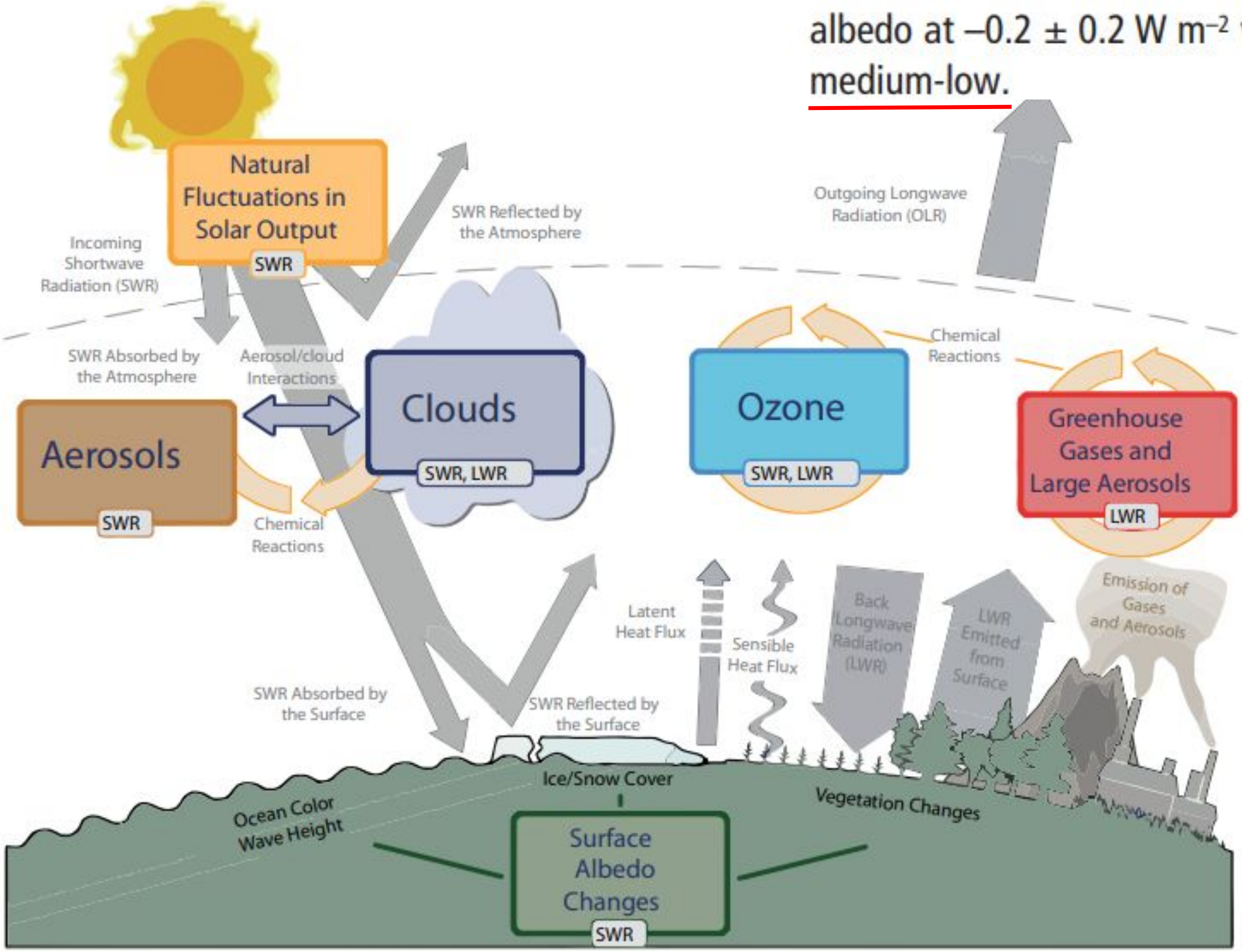
$\text{Albedo}_{\text{Floresta}} < \text{Albedo}_{\text{Área desmatada}}$

$\text{Albedo}_{\text{Floresta}} > \text{Albedo}_{\text{Área queimada}}$ (temporário)

$\text{Albedo}_{\text{Floresta}} > \text{Albedo}_{\text{Área urbana}}$ (ilha de calor)

Fonte: IPCC AR5 Climate Change 2013 [12]

vegetation and the surface radiation processes. On this basis, AR4 gave a best estimate of RF relative to 1750 due to land use related surface albedo at –0.2 ± 0.2 W m^{-2} with a level of scientific understanding at medium-low.



Fonte: IPCC AR5 Climate Change 2013 [12]

Fontes e Referências Bibliográficas

[1] https://blogdoenem.com.br/biologia-enem-velocidade-fotossintese/

[2] http://www.creadigital.com.br

[3] https://sites.google.com/site/abudsci/chemistry/unit-2

[4] https://imagine.gsfc.nasa.gov/

[5] http://www.radiacao-medica.com.br/

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