

Fotossíntese em meio aquático.
Modelos de Produção Primária.
Papel dos produtores primários no ciclo
de carbono. Parte 1

PPM

Vanda Brotas

31 de Outubro 2019

31 de Outubro 2019 e 21 de Novembro, temas a abordar:

- Alterações climáticas: CO₂ atmosférico
- Importância do Fitoplâncton no ciclo de carbono
- Fotossíntese Aquática
- Métodos para medir a Produção Primária in situ
- Curvas Irradiância – Produção Primária
- Modelos de Produção Primária usados em Deteção Remota

Objetivos /competencias a adquirir para os alunos

Reconhecer a importancia dos Produtores primários no ciclo de carbono.

Discutir o aumento de CO₂ atmosférico e alterações climáticas

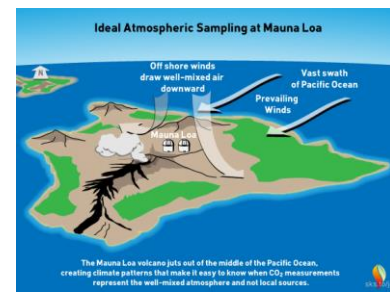
Rever conhecimentos sobre Fotossíntese (para os biólogos), apresentação das bases sobre Fotossíntese

Curvas Produção – Irradiância, perceber a sua importancia, relacionar com o que se passa na coluna de água

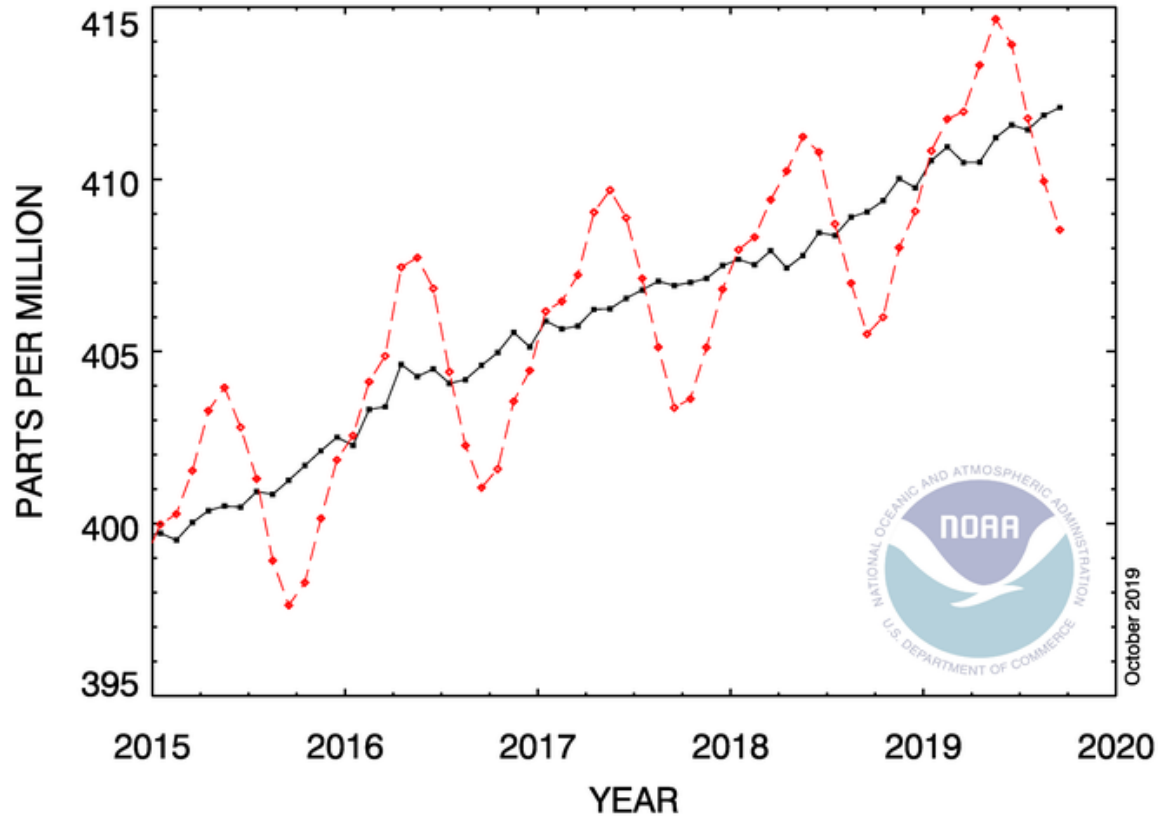
Modelos Produção Primária (PP), do mais simples ao modelo que estima a PP por satélite

CO₂ Atmospheric Concentration

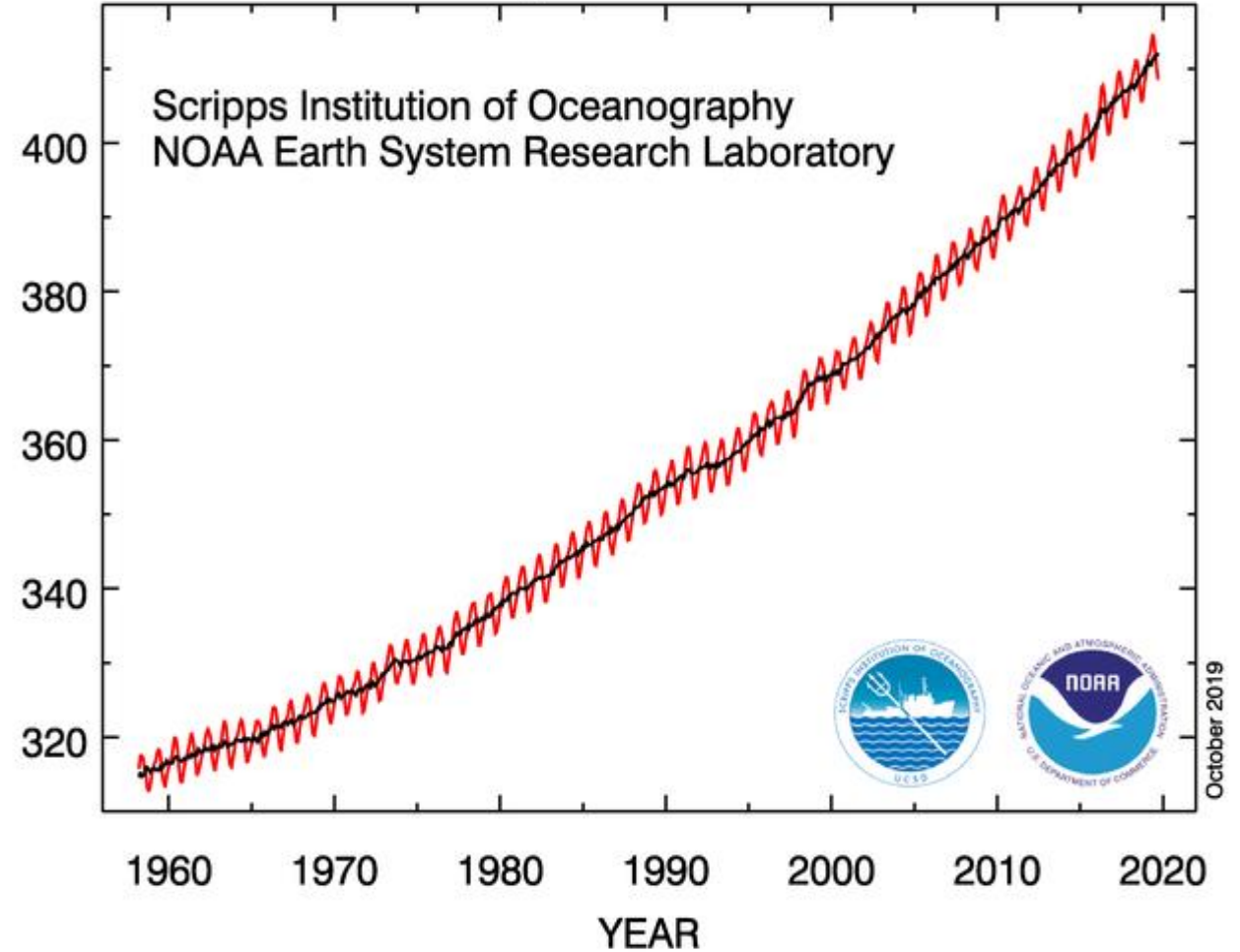
- The global CO₂ concentration increased from ~277ppm in 1750 to 408.54 ppm in September 2019



RECENT MONTHLY MEAN CO₂ AT MAUNA LOA



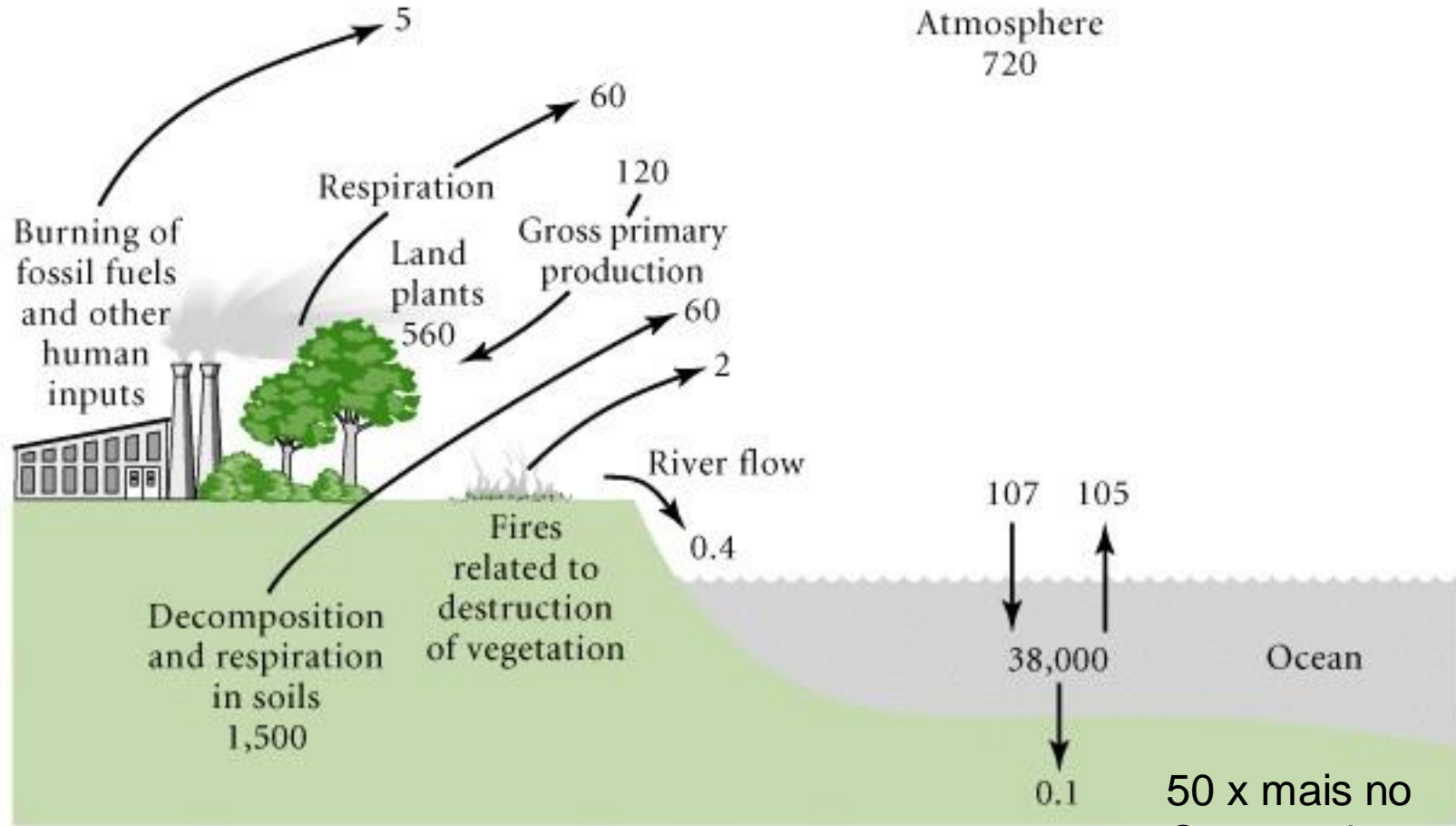
Atmospheric CO₂ at Mauna Loa Observatory



<https://www.esrl.noaa.gov/gmd/ccgg/trends/>

The dashed red lines with diamond symbols represent the monthly mean values.
The **black lines** with the square symbols represent the same, after correction for the average seasonal cycle

ciclo de carbono



50 x mais no Oceano do que na Atmosfera

$$38\ 000 / 720 = 52$$

Section 22.7 The Global Carbon Cycle Involves Exchanges among the Atmosphere, Oceans, and Land

- Carbon pool involved in the global carbon cycle amounts to 55,000 gigatons (Gt)
 - fossil fuels: 10,000 Gt
 - oceans: 38,000 Gt (bicarbonate and carbonate ions)
 - dead organic matter: 1650 Gt
 - living matter (mostly phytoplankton): 3 Gt
 - terrestrial
 - dead organic matter (in soil): 1500 Gt
 - living matter: 560 Gt
 - atmosphere: 750 Gt

Fluxos Carbono	GT carbono/ ano	
Troca Atmosfera Oceano	2	
Sequestro no fundo do mar	0.1	
Queima de combustíveis fósseis	10	
Produção 1ª Líquida Terrestre	56,4	Carbono (GT)
Produção 1ª Líquida Marinha	48,5	

1 Giga= 10⁹ ton

Pool de carbono	55000
Combustíveis fósseis	10000
No oceano, em íons HCO_3^- e HCO_3^{2-}	38000
No oceano, matéria morta	1650
No oceano, matéria viva	3
Na Terra, matéria morta	1500
Na Terra, matéria viva	560
Atmosfera	750

Explore CO₂ emissions at the global and country levels, compare among countries, visualize, and download data and illustrations (“Emissions” application). Also explore “Outreach” and “Research”.

GLOBAL CARBON ATLAS

The Global Carbon Atlas is a platform to explore and visualize the most up-to-date data on carbon fluxes resulting from human activities and natural processes.
Human impacts on the carbon cycle are the most important cause of climate change.

OUTREACH
Take a journey through the history and future of human development and carbon

GO

EMISSIONS
Explore and download global and country level carbon emissions from human activity.

GO

RESEARCH
Explore and visualize research carbon data, and get access through data providers

GO

All the data is shown in billion tonnes CO₂ (GtCO₂)

1 Gigatonne (Gt) = 1 billion tonnes = 1×10^{15} g = 1 Petagram (Pg)

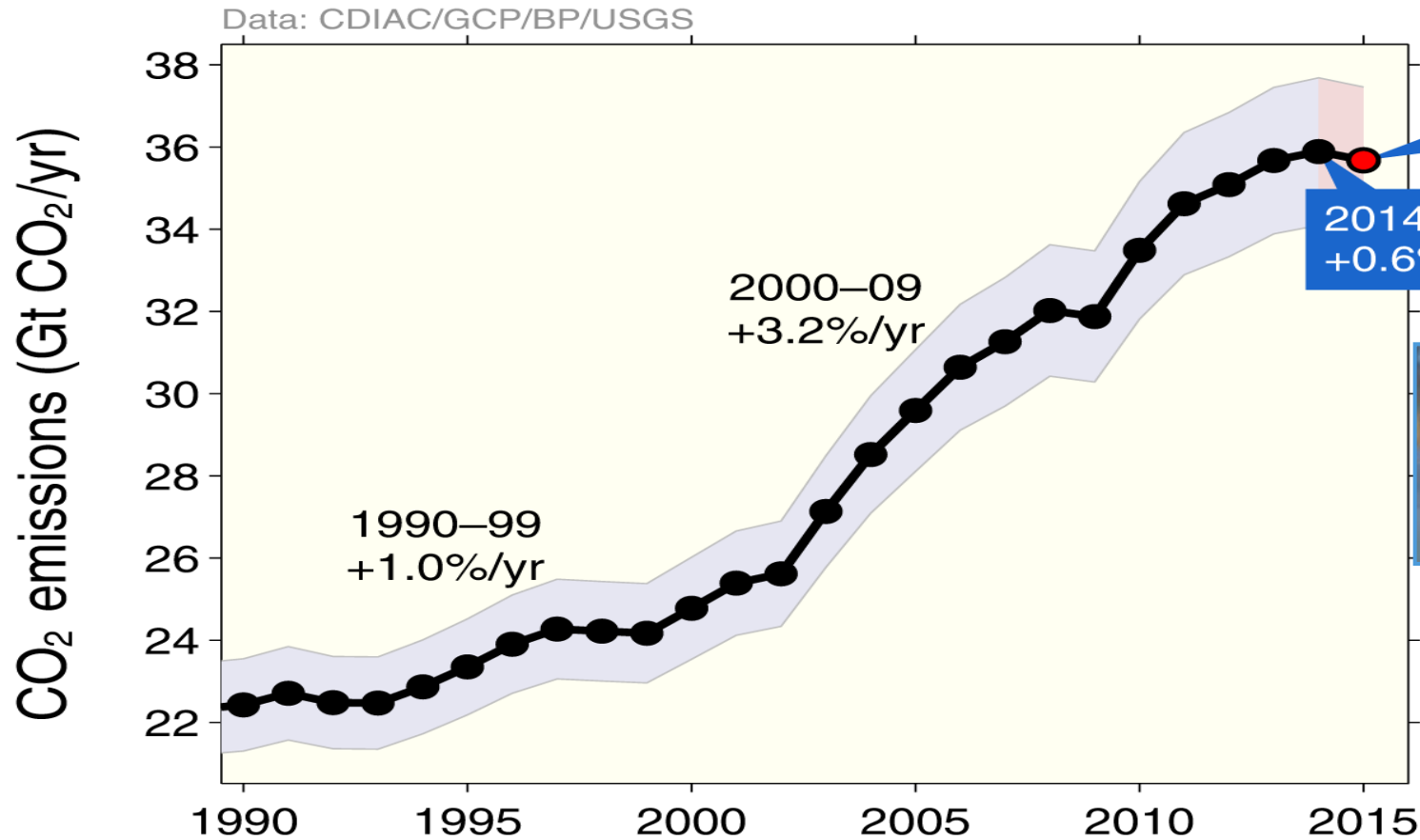
1 kg carbon (C) = 3.664 kg carbon dioxide (CO₂)

1 GtC = 3.664 billion tonnes CO₂ = 3.664 GtCO₂

Emissions from fossil fuel use and industry

Global emissions from fossil fuel and industry: 35.9 ± 1.8 GtCO₂ in 2014, 60% over 1990

● Projection for 2015: 35.7 ± 1.8 GtCO₂, 59% over 1990



= 10 GT Carbon

37 GT CO₂ / 3.664
= 10 GT Carbon

Projection 2015
35.7 Gt CO₂
-0.6% decline
(-1.6% to +0.5%)

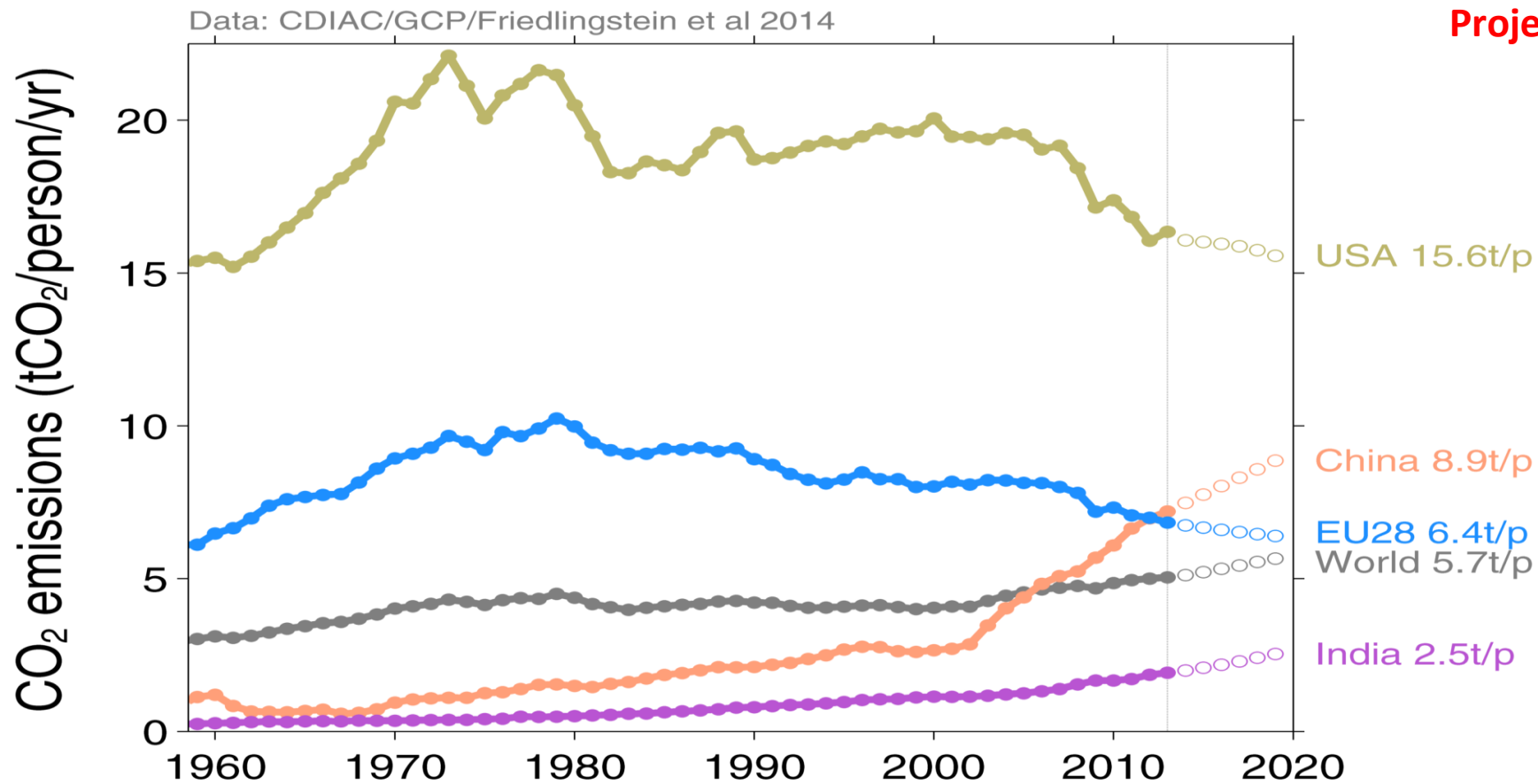
2014: 35.9 Gt CO₂
+0.6% increase



Uncertainty is $\pm 5\%$ for one standard deviation (IPCC "likely" range)

Top Fossil Fuel Emitters (Per Capita)

The divergence between EU28 and Chinese per capita emissions is likely to continue
 USA continues with high and India with low per capita emissions



Economic growth based on IMF projections, fossil fuel intensity based on 10-year trend

Source: [CDIAC](#); [Friedlingstein et al 2014](#)

Fate of anthropogenic CO₂ emissions (2006-2015)



34.1 GtCO₂/yr
91%



9%
3.5 GtCO₂/yr

Sources = Sinks

16.4 GtCO₂/yr
44%



31%
11.6 GtCO₂/yr



26%
9.7 GtCO₂/yr

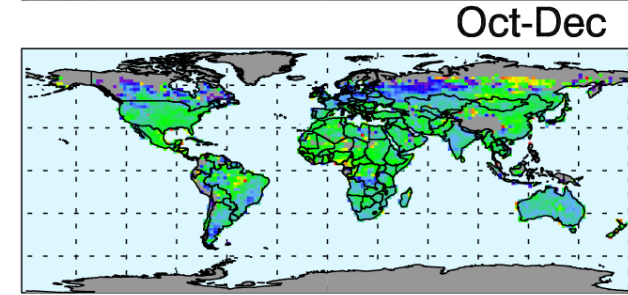
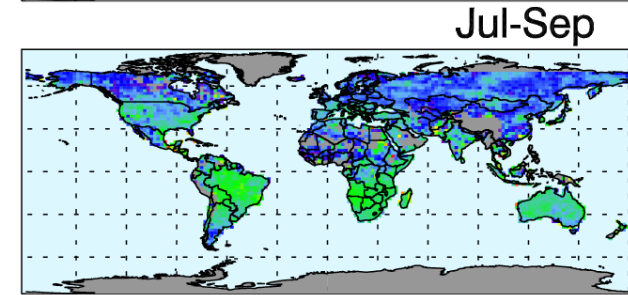
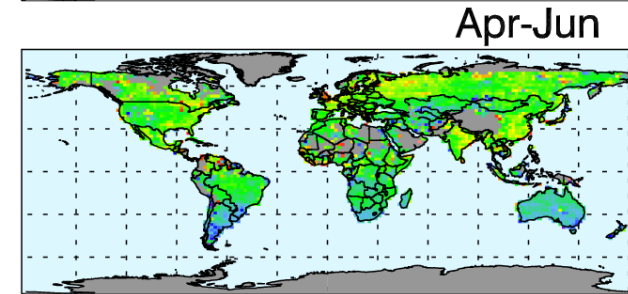
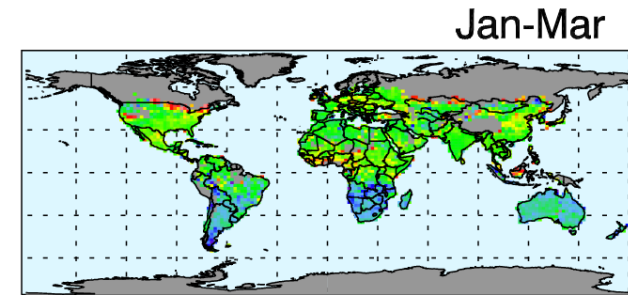
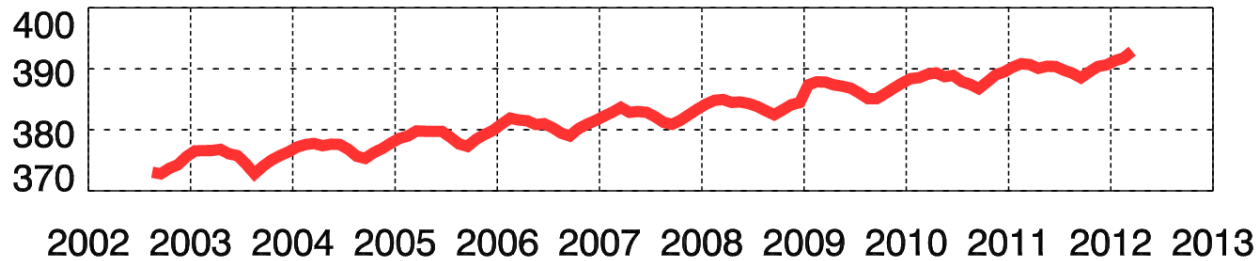
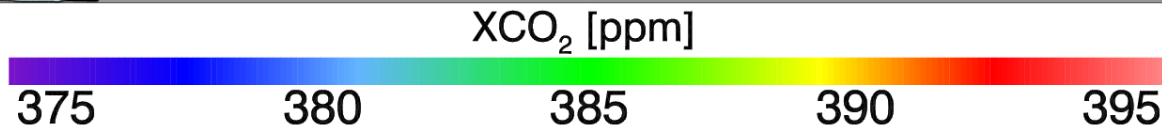
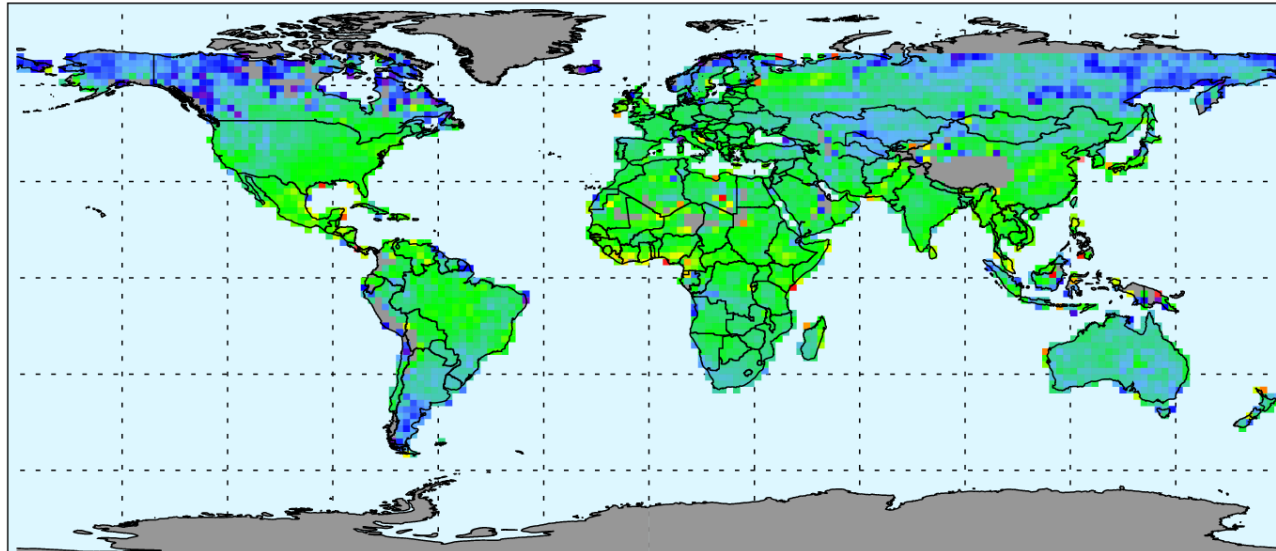


Registo do CO2 atmosférico por satélite

GHG-CCI

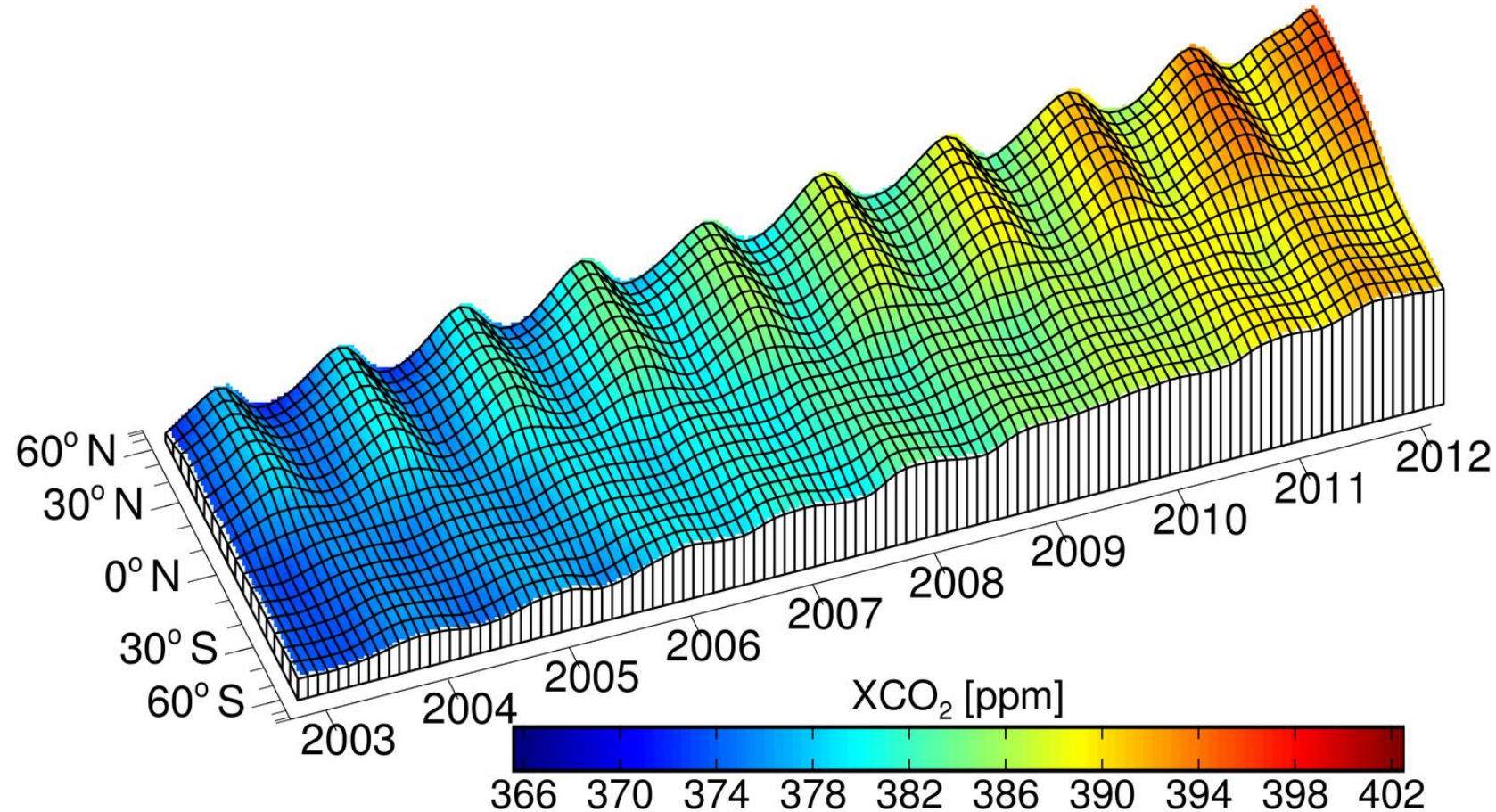
2002-2012

Carbon Dioxide SCIAMACHY/BESD



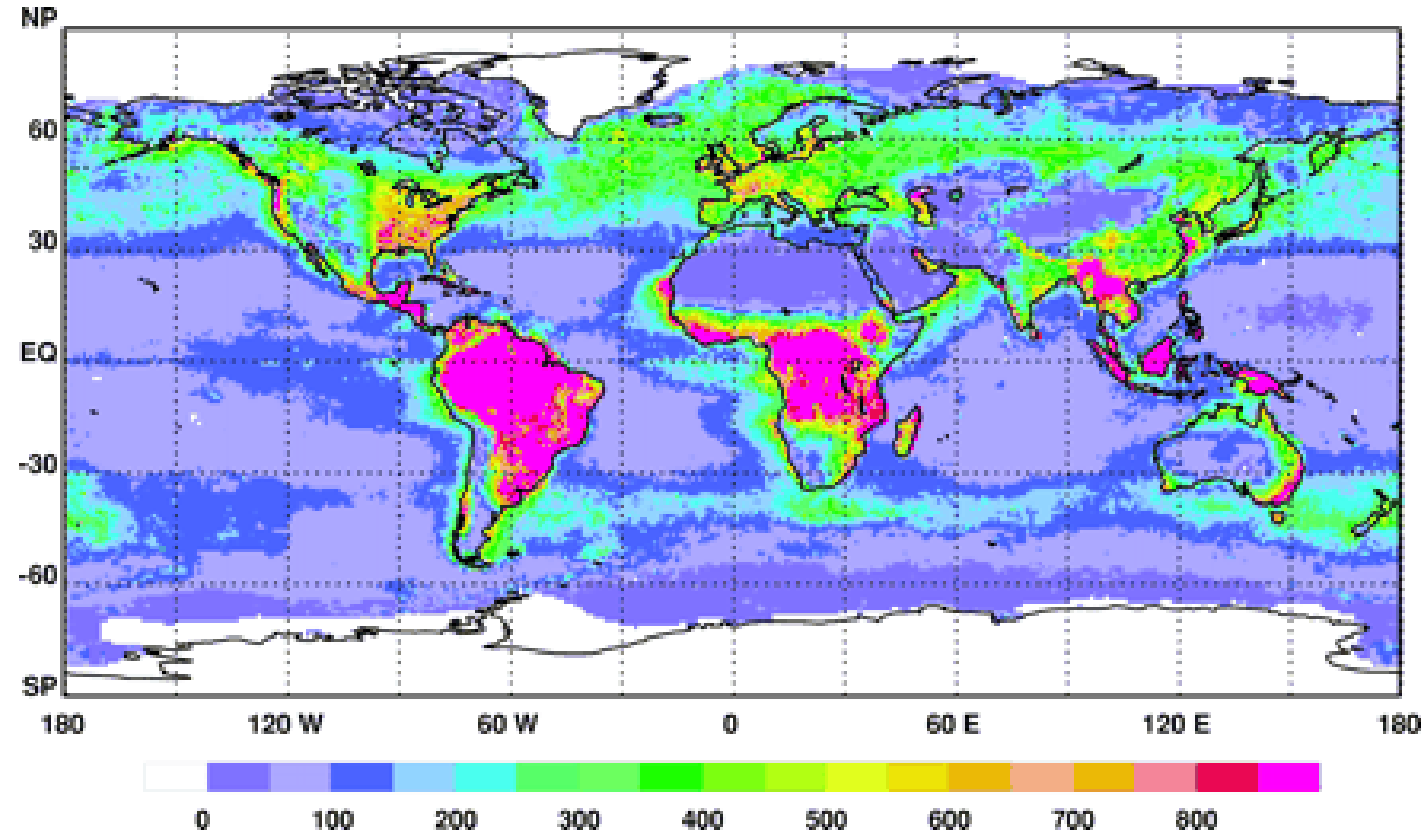
increase of atmospheric CO2 of about 2 ppm each year.

Evolução concentração CO₂ atmosférico: Através da observação por satélites



The maps derived from SCIAMACHY, a spectrometer onboard the European ENVISAT satellite.

Comparação vegetação terrestre e Fitoplâncton:



- Produtividade primária a partir da detecção por satélite. Field et al, 1998, (NPP, "Net Primary Productivity),

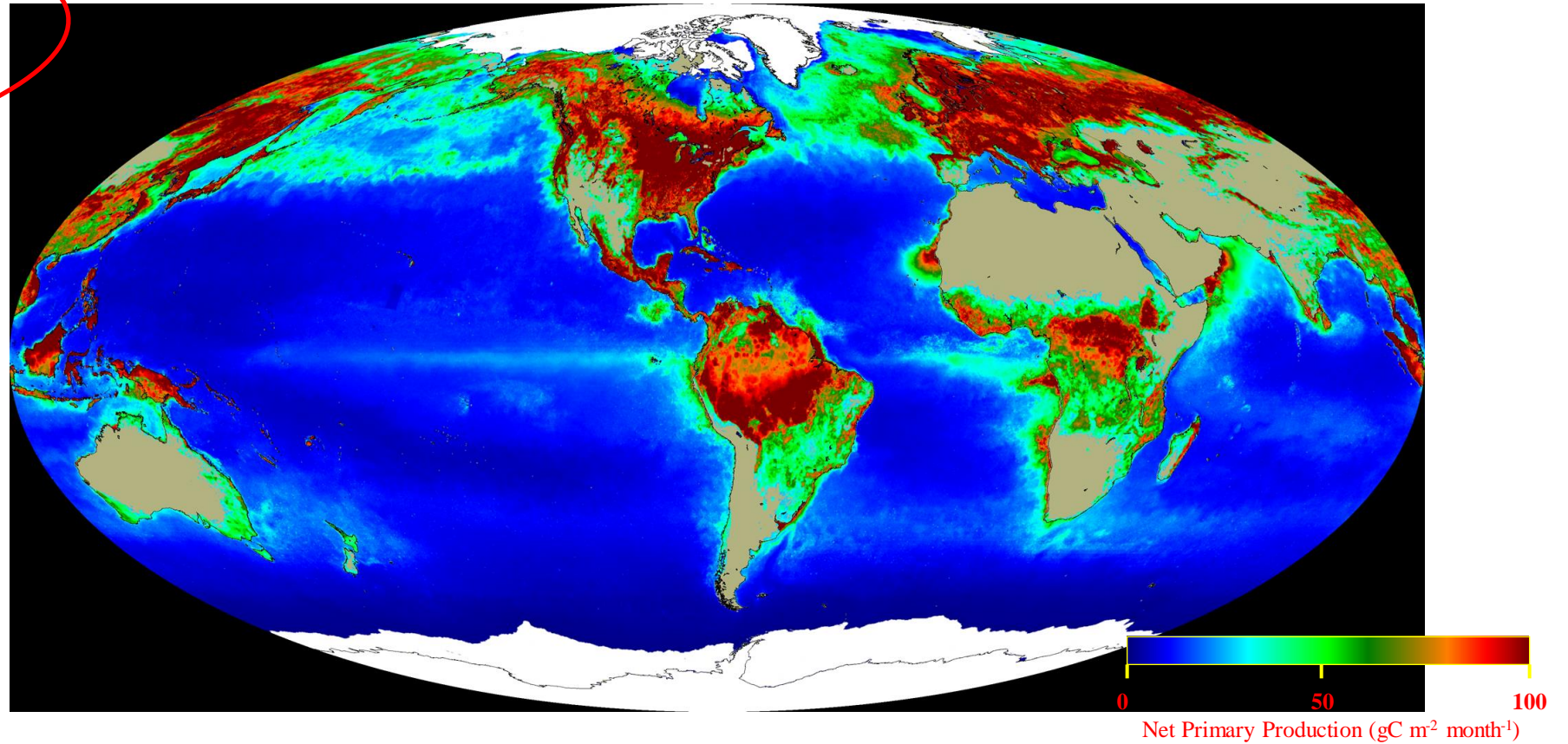
Estimados a partir da modelização de dados de imagens de satélite da concentração da clorofila, de dados de radiação fotossintética

e do parâmetro ϵ , a eficiência fotossintética de utilização da luz (determinado a partir de dados experimentais de campo).

(Global NPP in Pg C y⁻¹)

	Ocean	Land
TOTAL	48.5	56.4

Fitoplancton e ciclo de carbono



-

Biospheric Productivity = 110 - 120 Gt C y⁻¹

-

- **Approx. 50% on land & 50% in the ocean surface**

- **Phytoplankton responsible for >95% of ocean productivity**

Michael Behrenfeld Goddard Space Flight Center, NASA

Continuação na aula de 21 de novembro
2019

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Global Carbon Atlas

Bibliografia

Explore CO₂ emissions at the global and country levels, compare among countries, visualize, and download data and illustrations (“Emissions” application). Also explore “Outreach” and “Research”.

The screenshot shows the Global Carbon Atlas website interface. At the top left, the title "GLOBAL CARBON ATLAS" is displayed. Below it, there are three main sections: "OUTREACH", "EMISSIONS", and "RESEARCH". Each section has a brief description and a corresponding visual element. The "OUTREACH" section features a city skyline illustration. The "EMISSIONS" section shows a world map with black circles of varying sizes representing CO2 emissions by country. The "RESEARCH" section displays a line graph and a heatmap of the world. On the right side of the interface, there is a paragraph of text: "The Global Carbon Atlas is a platform to explore and visualize the most up-to-date data on carbon fluxes resulting from human activities and natural processes. Human impacts on the carbon cycle are the most important cause of climate change." Below this text are three orange buttons labeled "01", "02", and "03".

www.globalcarbonatlas.org