"3rd Latin America Conference on Sustainable Development of Energy, Water and Environmental Systems SDEWES"
São Paulo, July 25, 2022

Climate change and the challenge of regional and global sustainability

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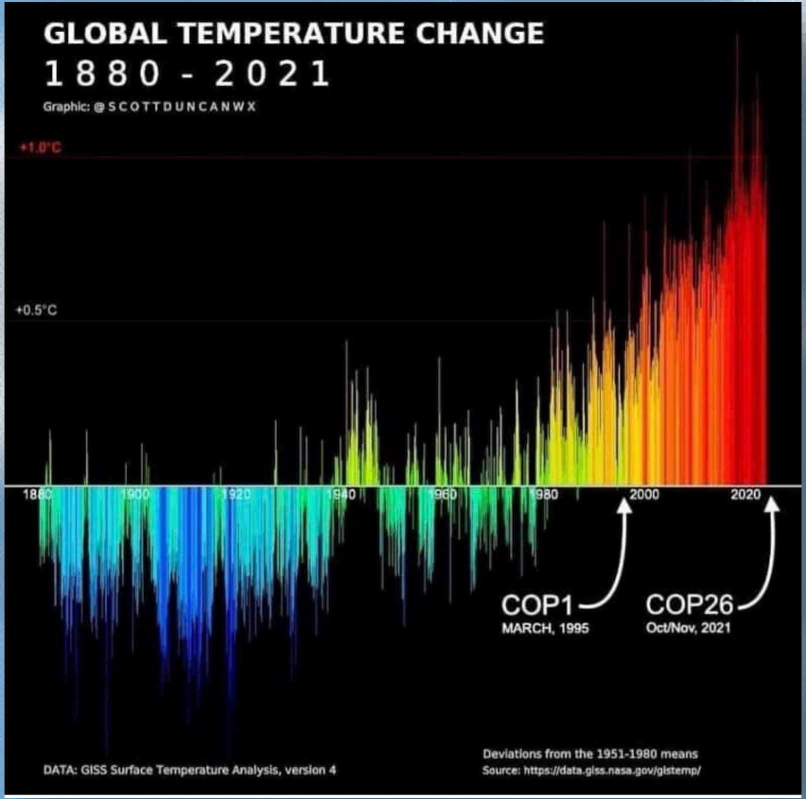
A little bit of history

The Stockholm United Nations Conference on the Human Environment – happened in 1972, 50 Years ago

Rio 92: 30 Years ago

Rio+20: 10 Years ago

We are at the COP-26: in 2021



Climate change science is very solid

The UN 17 sustainable developing goals

SDG 13: many other SDG depends on a stable climate

[Credit: NASA]

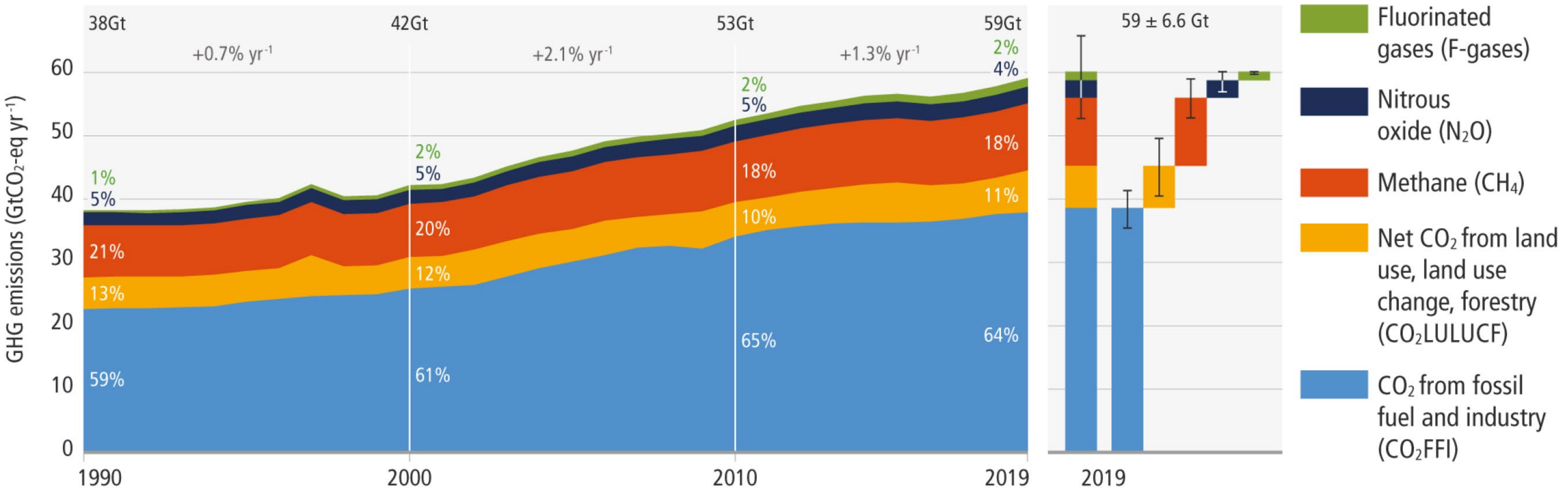
"Recent changes in the climate are widespread, rapid, and intensifying, and unprecedented in thousands of years.

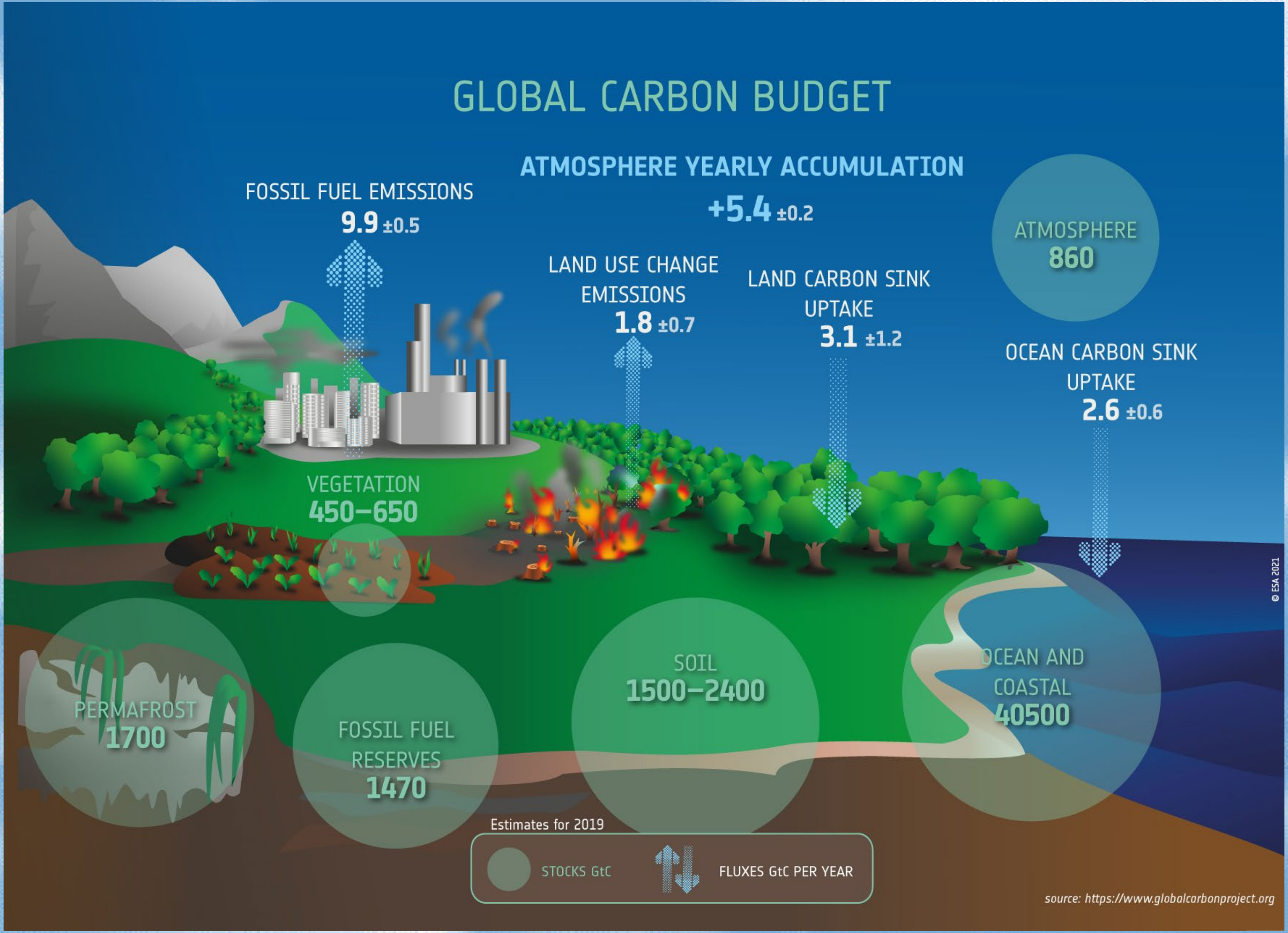
[Credit: Peter John Maridable | Unsplash]

"Unless there are immediate, rapid, and large-scale reductions in greenhouse gas emissions, limiting warming to 1.5°C will be beyond reach.

Global net anthropogenic emissions have continued to rise across all major groups of greenhouse gases.

a. Global net anthropogenic GHG emissions 1990–2019 (6)




GLOBAL CARBON BUDGET
ATMOSPHERE YEARLY ACCUMULATION
+5.4 ±0.2
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Estimates for 2019
STOCKS GtC
FLUXES GtC PER YEAR
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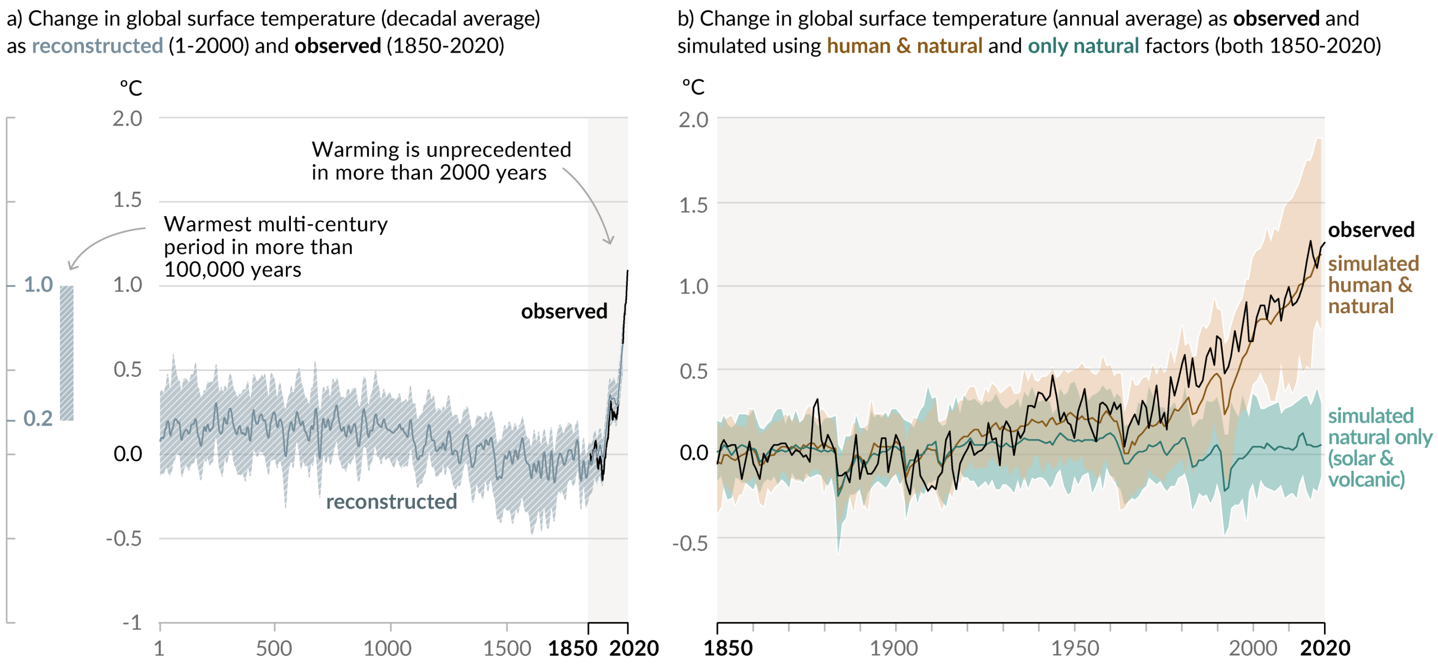
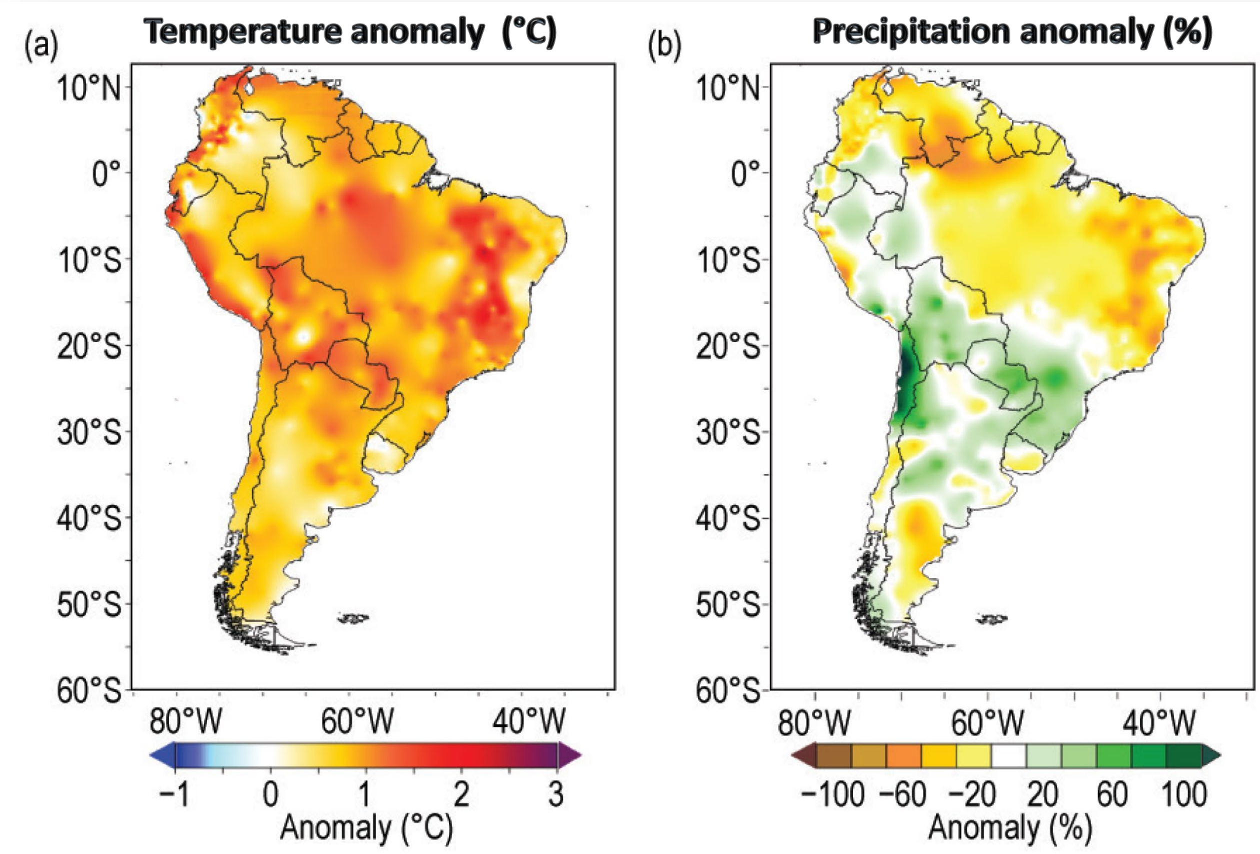
source: https://www.globalcarbonproject.org

Human influence has warmed the climate at a rate that is unprecedented in at least the last 2000 years

Changes in global surface temperature relative to 1850-1900



South America: (a) temperature anomaly (°C) and (b) precipitation anomaly (%)

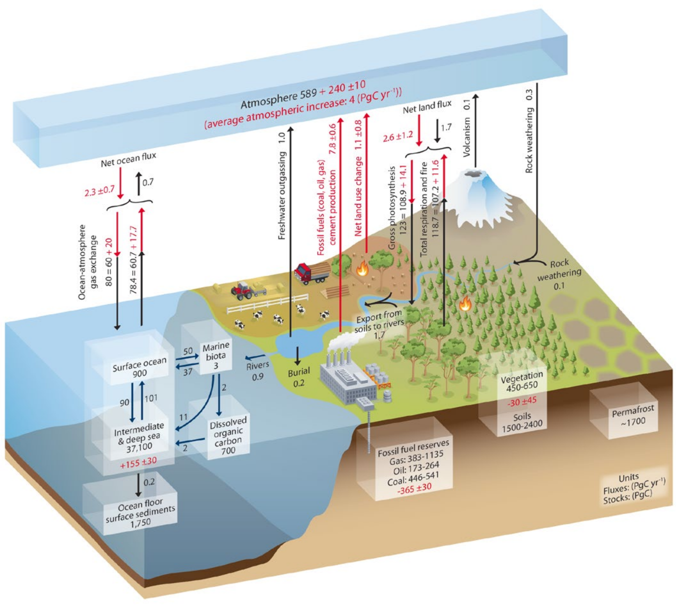


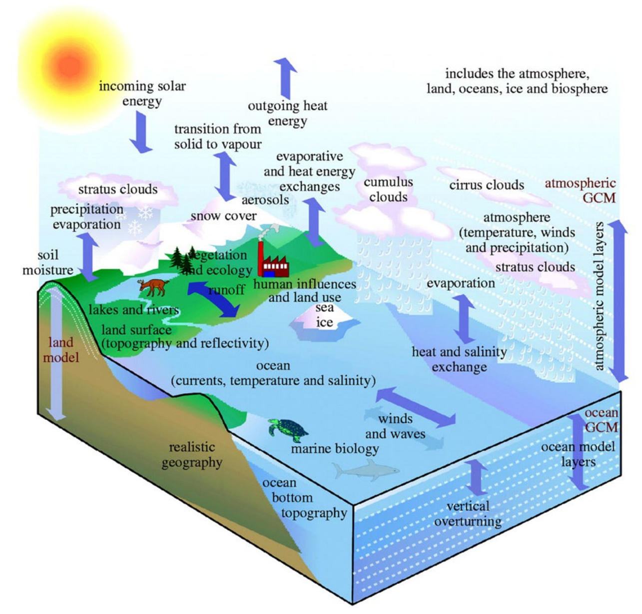
Período de base: 1981–2010.

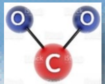
Fonte: State of the Climate in 2015, Bull. Amer. Meteor. Soc., 97 (8), 2016.

Ciclo global do carbono

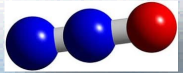
O complexo sistema climático terrestre

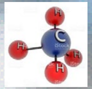






Concentrações de CO_2, CH_4 e N_2O





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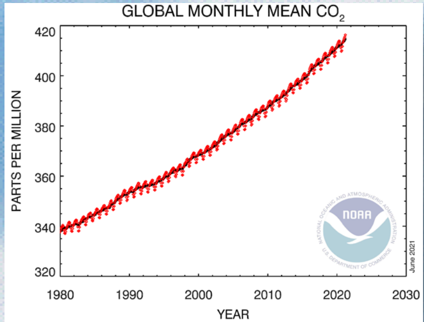
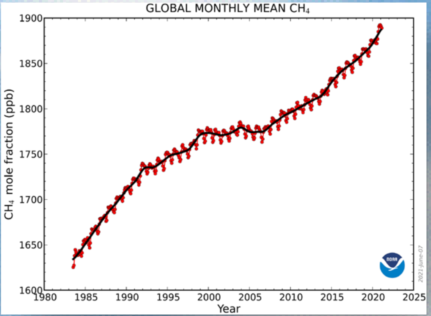
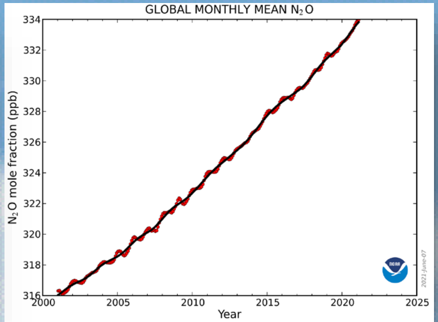
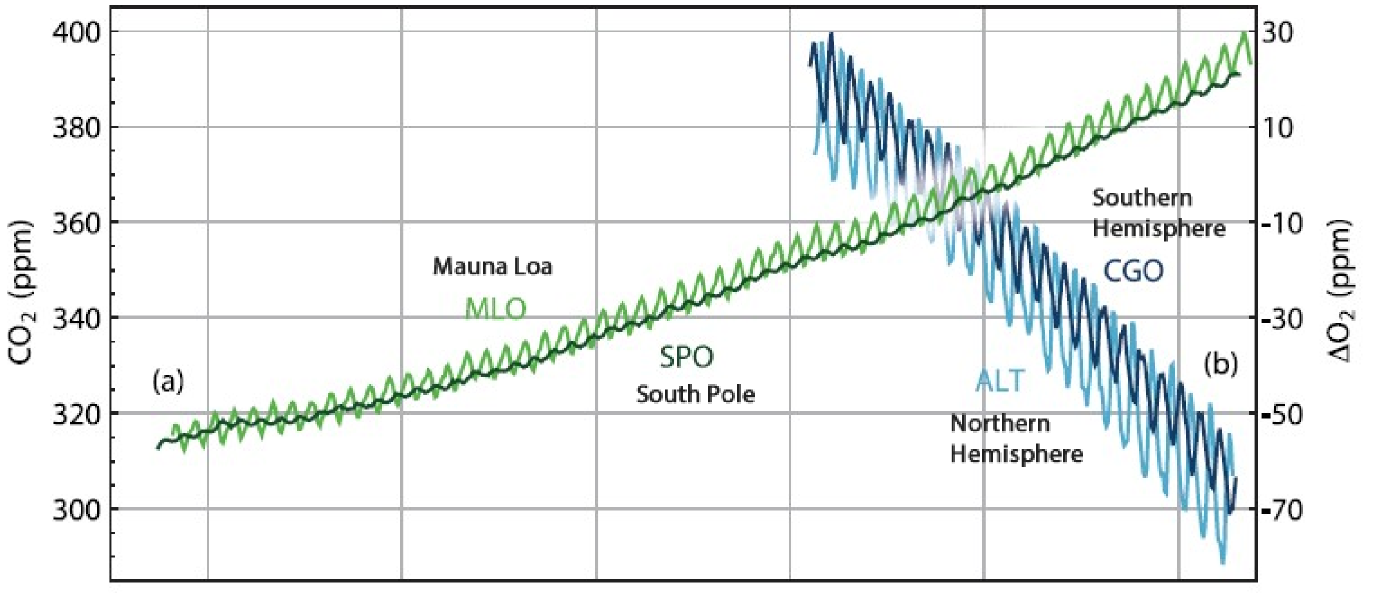






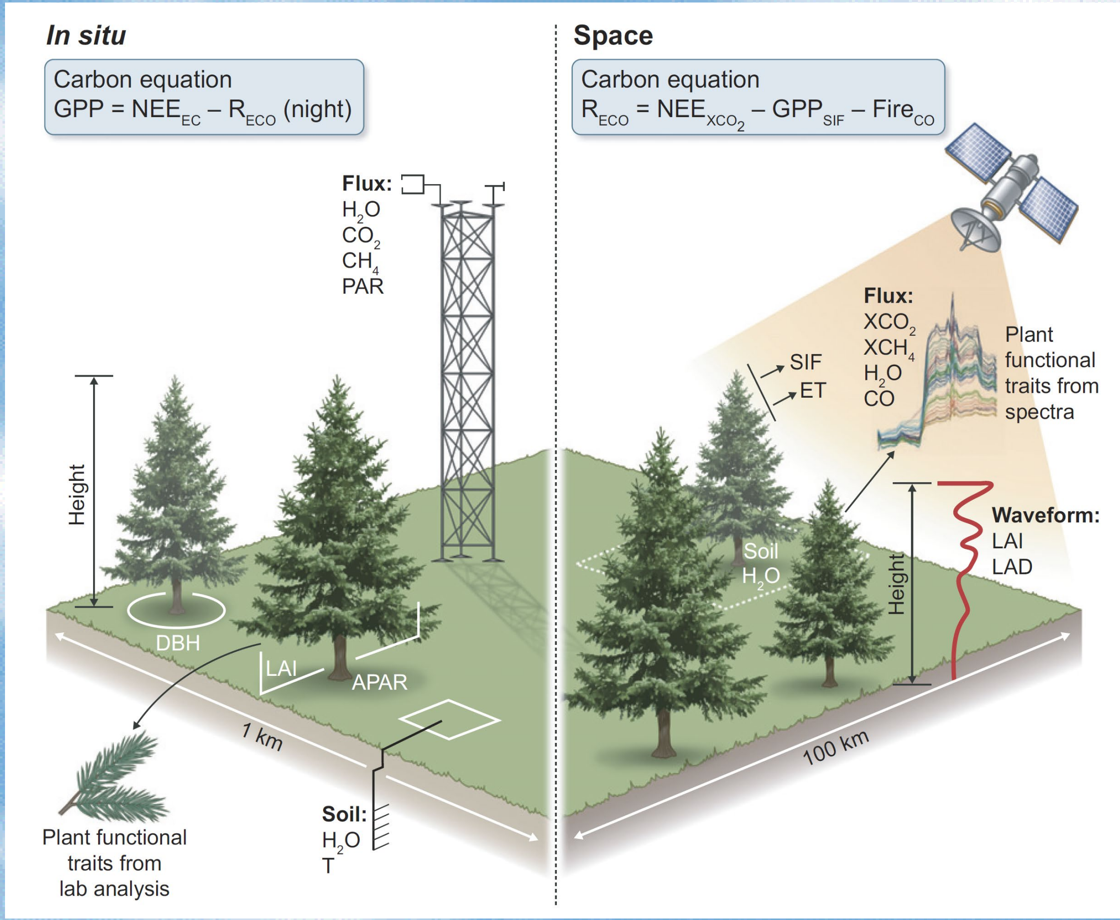
Desmatamento de florestas tropicais: **17% das emissões**
Queima de combustíveis fósseis: **83% das emissões**

Aumento de CO_2 e diminuição de O_2



1950 2015

Medindo fluxos de carbono do espaço e no solo



Flux towers in the sky: global ecology from space David Schimel New Phytologist (2019) 224: 570–584 doi: 10.1111/nph.1593

Medidas por sensoriamento remoto:
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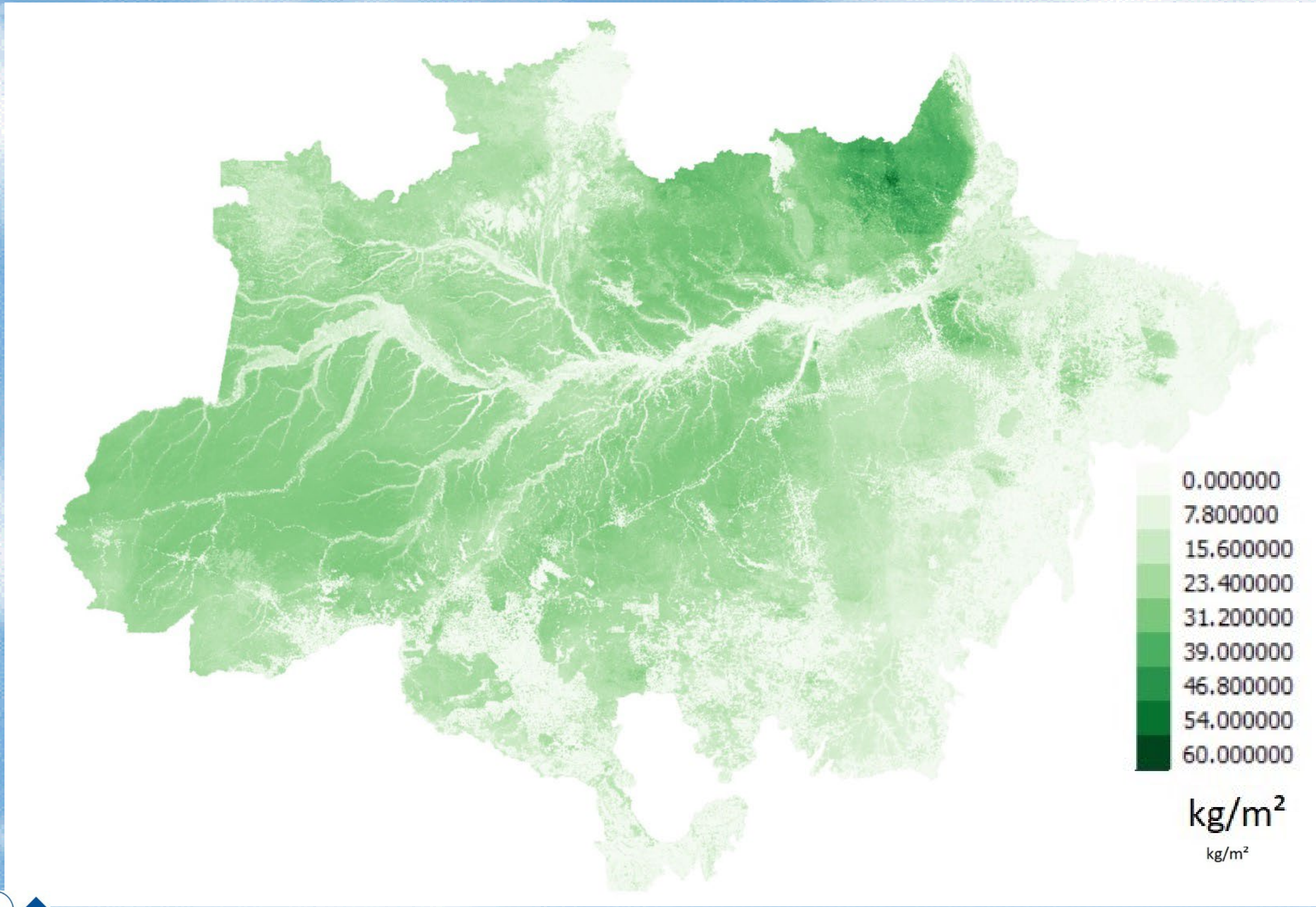
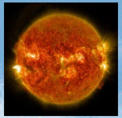
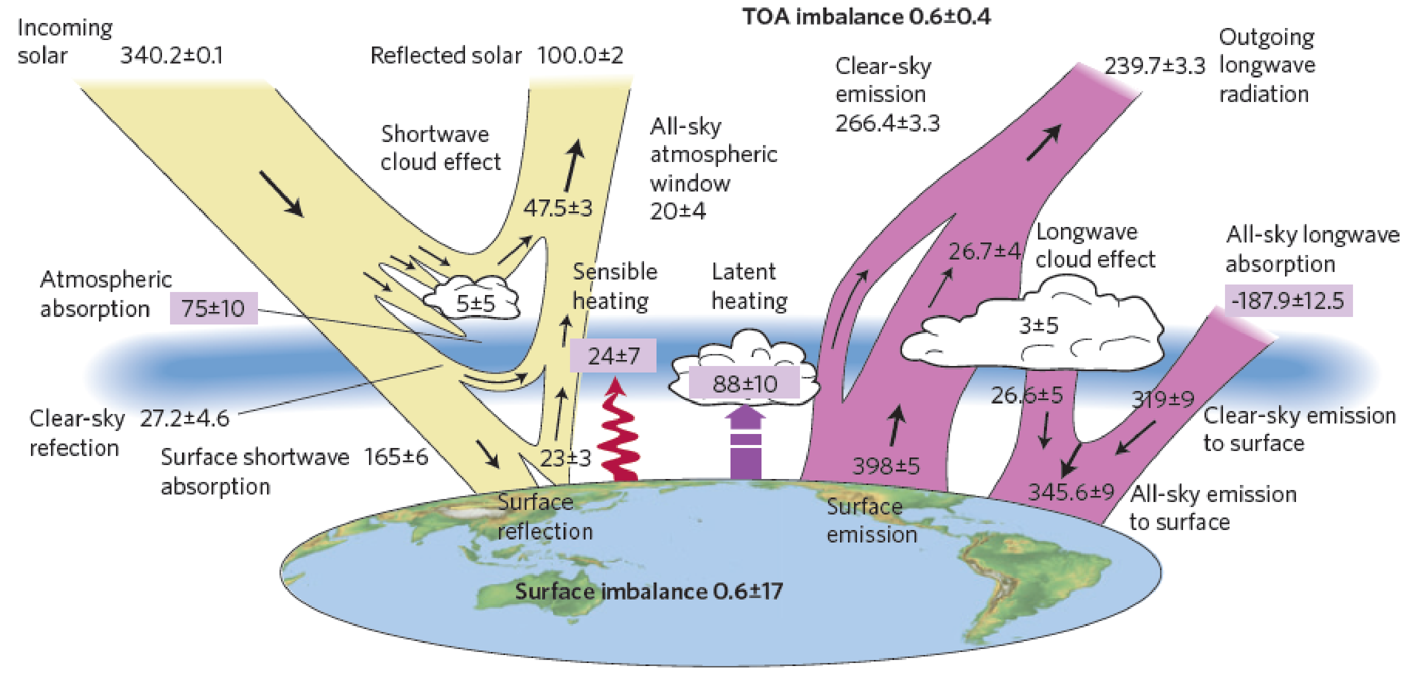
Amazon forest biomass distribution map in Kg/m²



Ometto et al., 2022



Balanço de energia do nosso planeta (W/m²)



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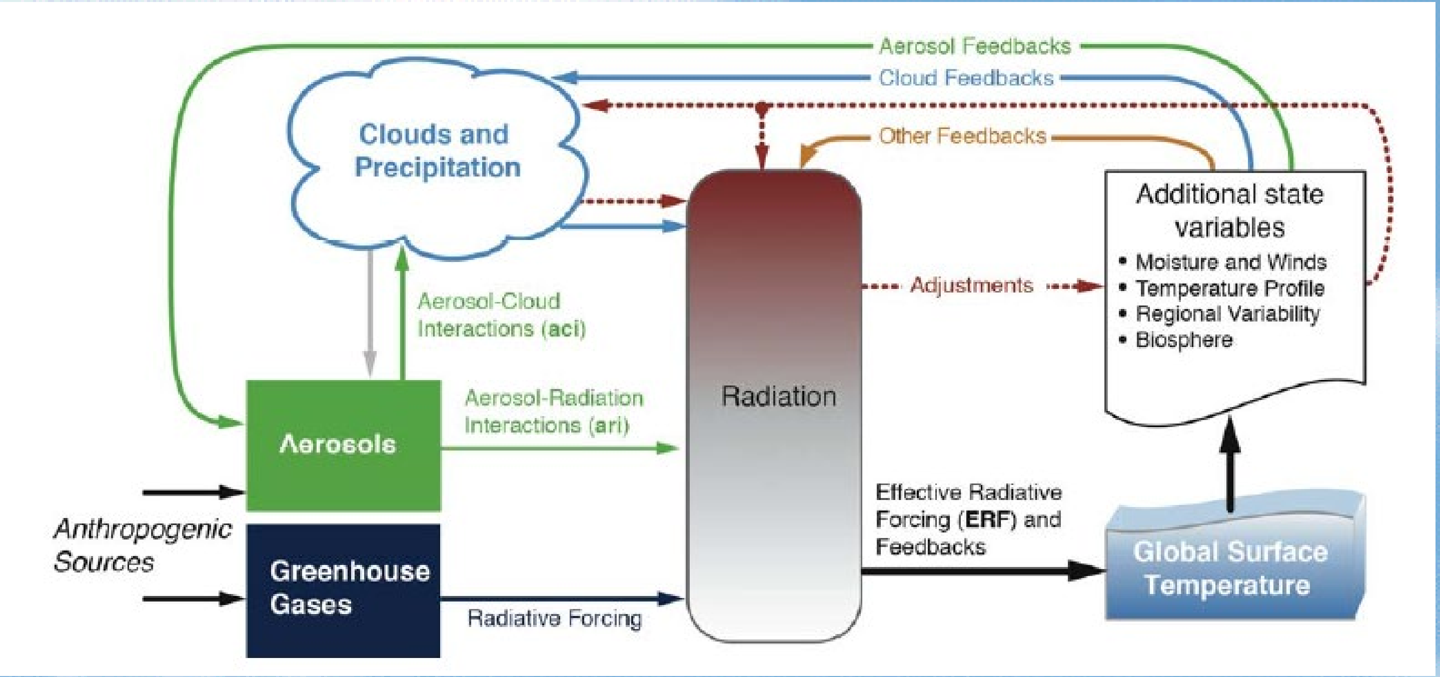
Forçante radiativa e os feedbacks do sistema climático global



IPCC AR5, Chapter 7, 2013

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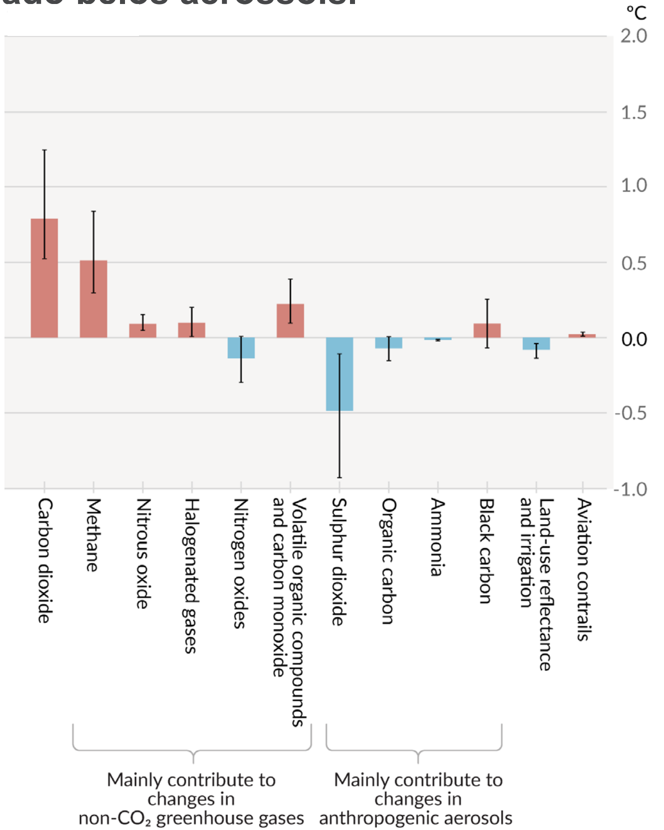

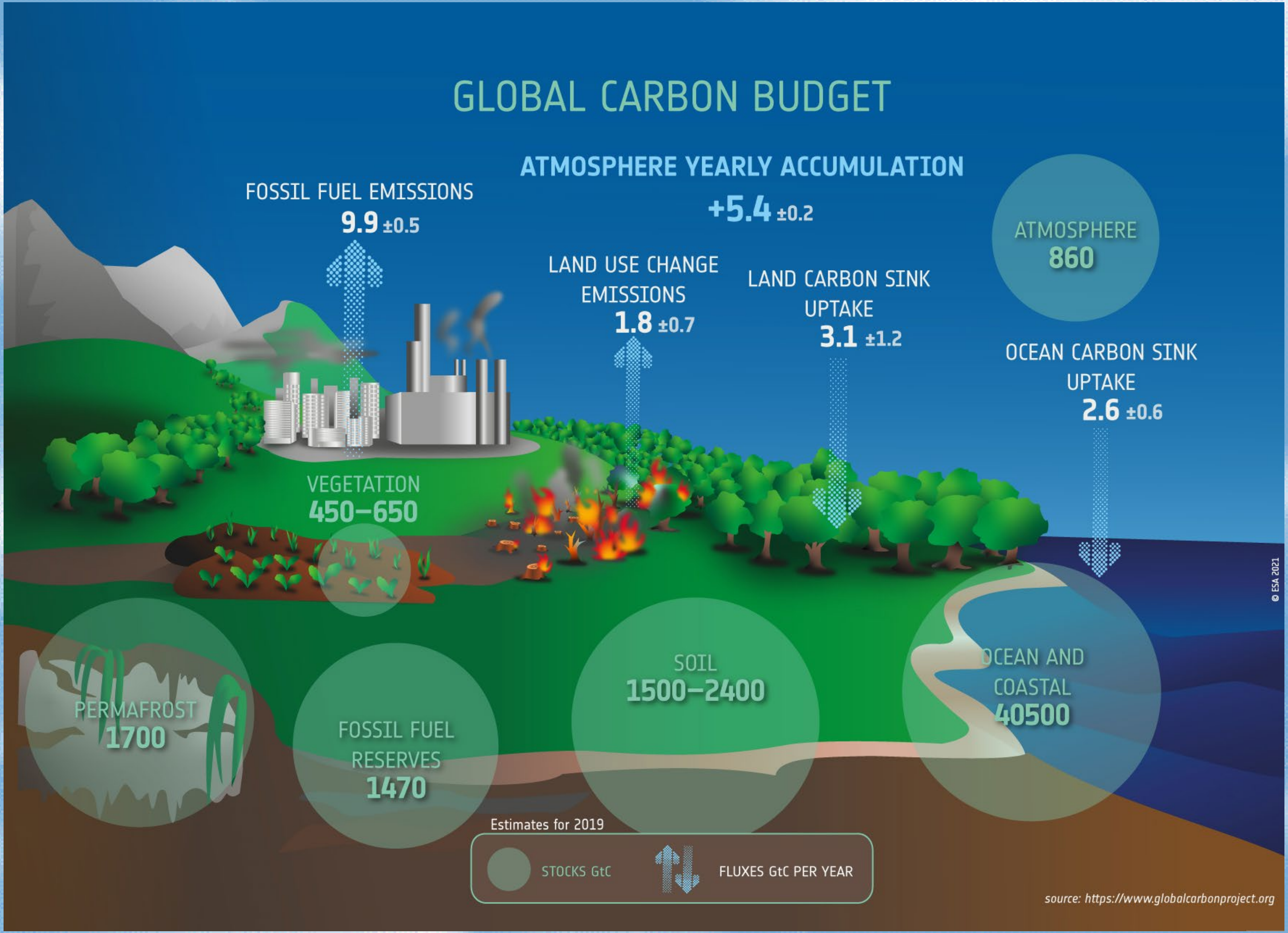
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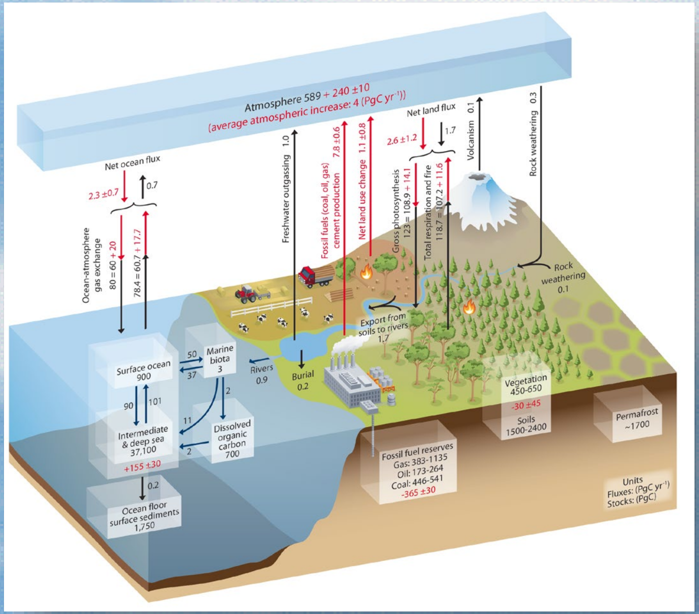

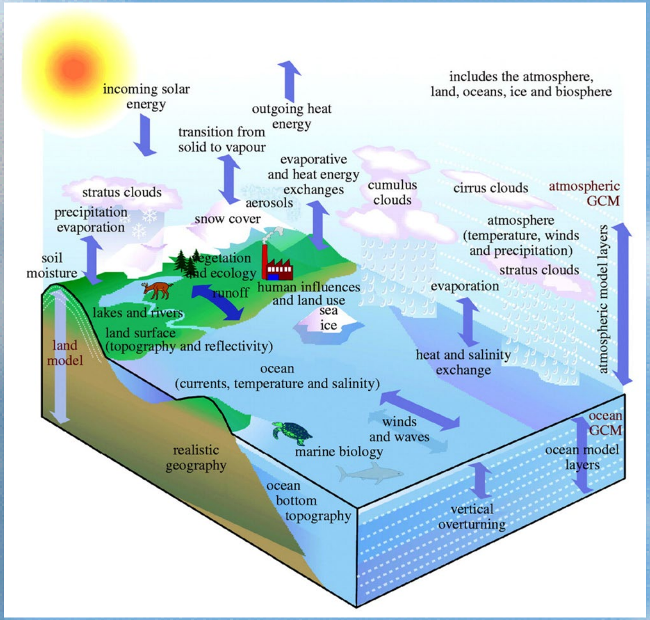

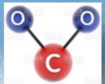

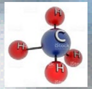

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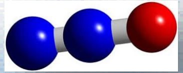

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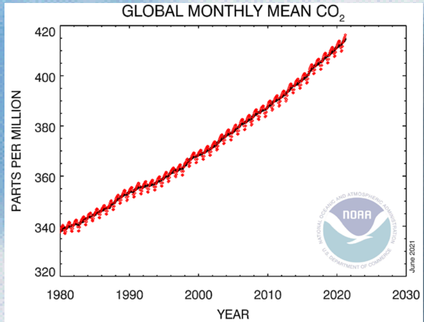

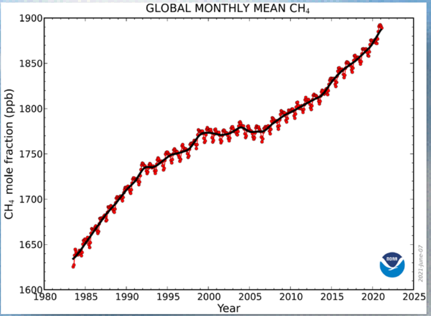

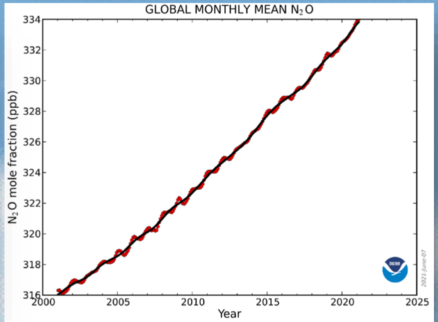

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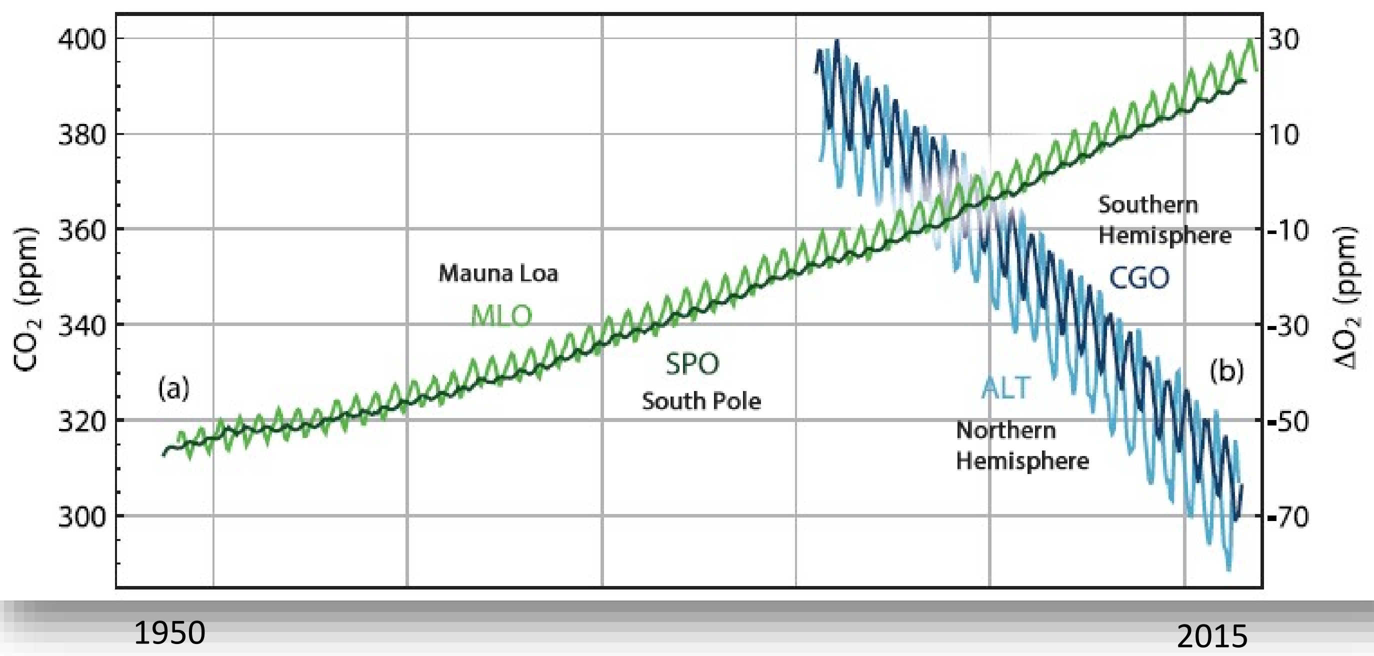

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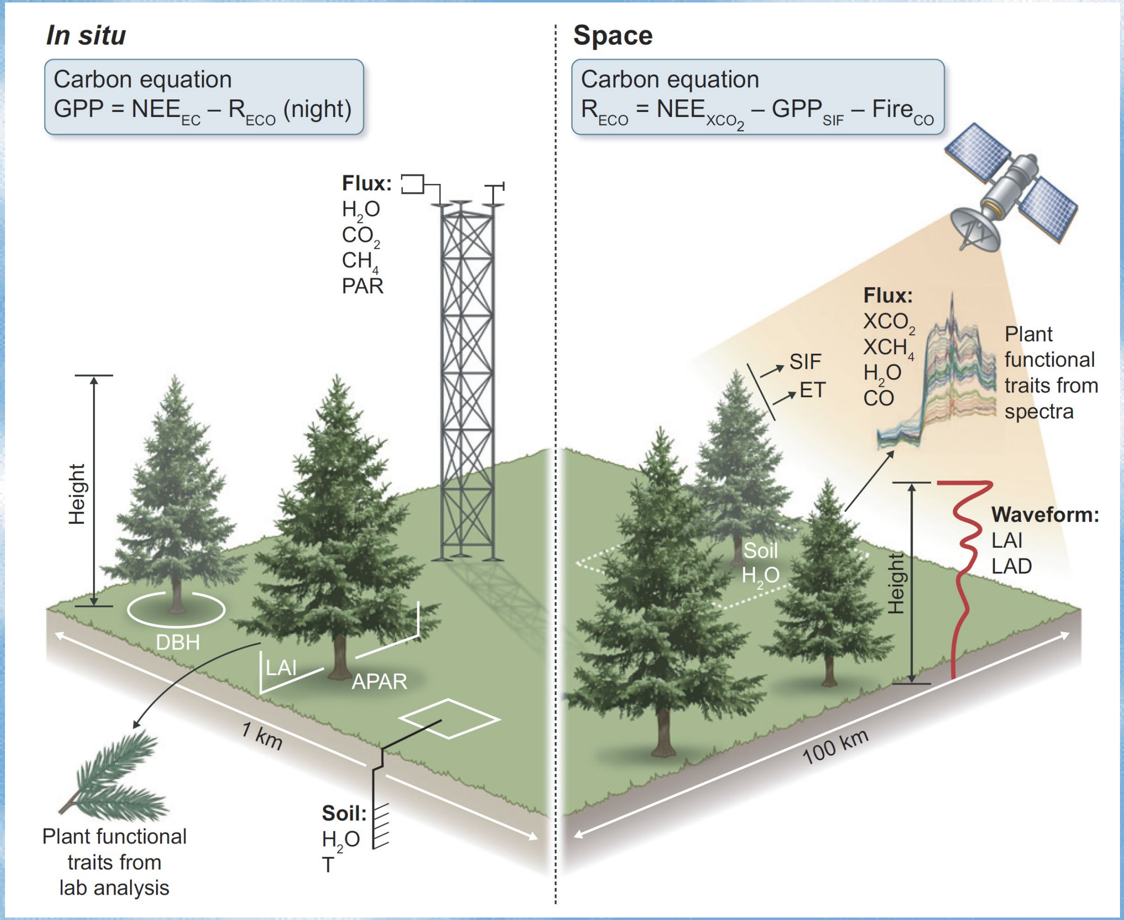

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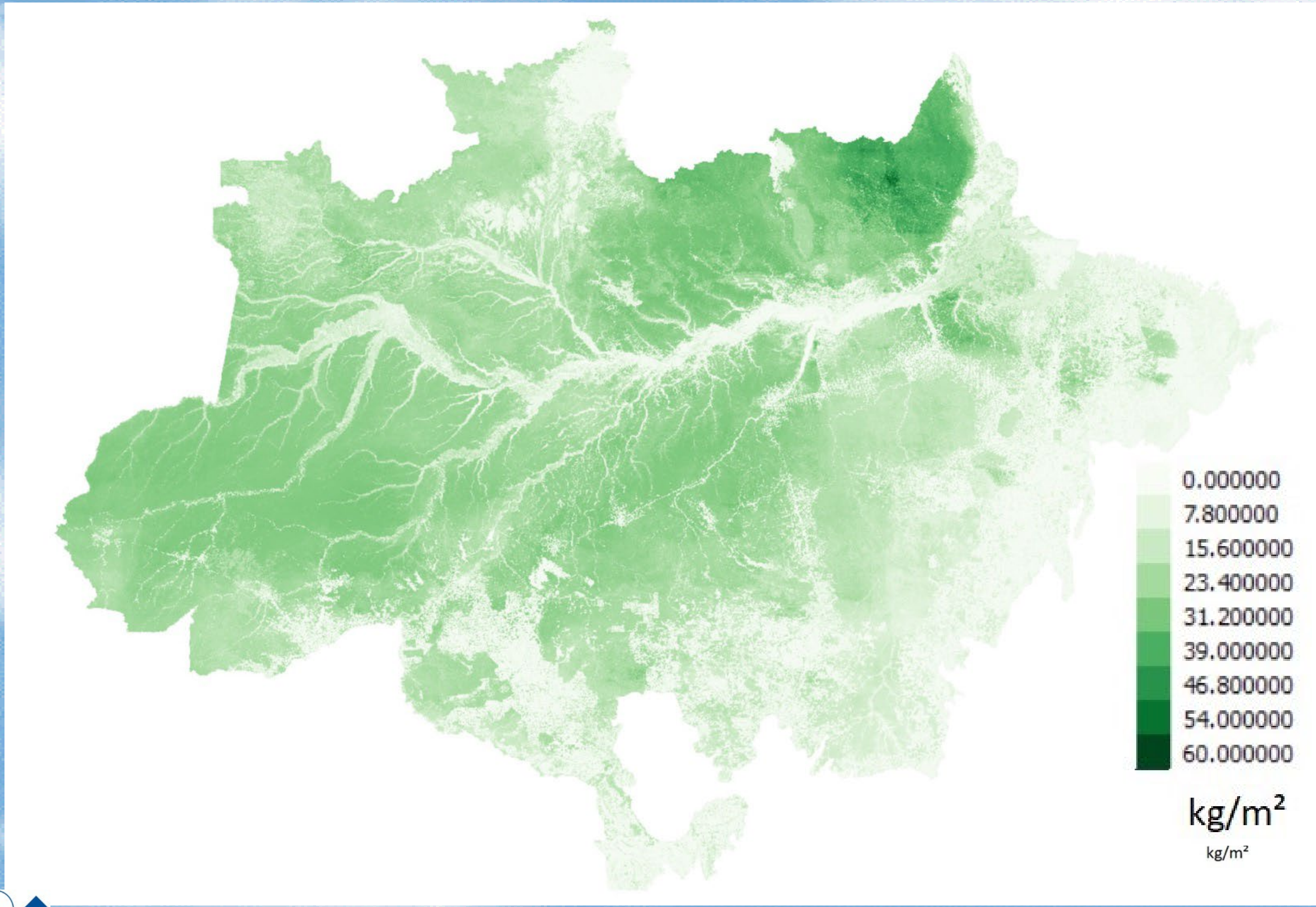

Ometto et al., 2022

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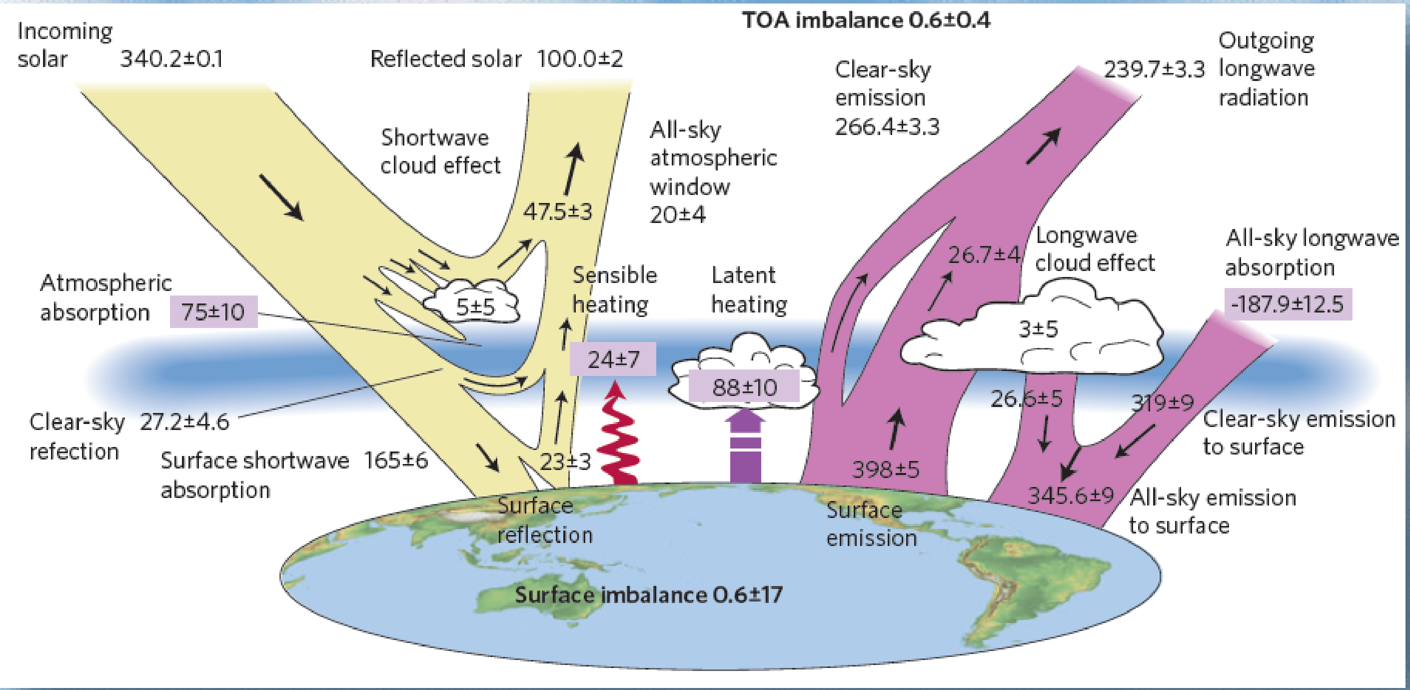

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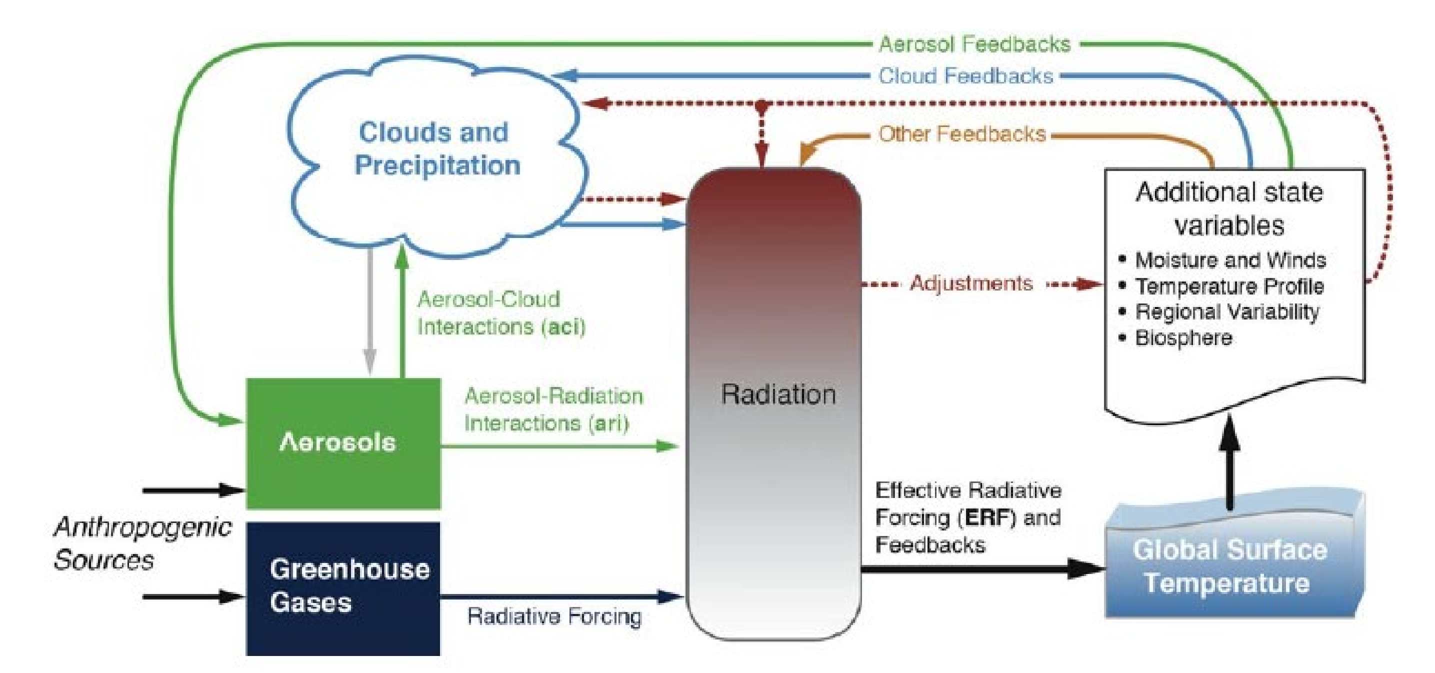
Forçante radiativa e os feedbacks do sistema climático global



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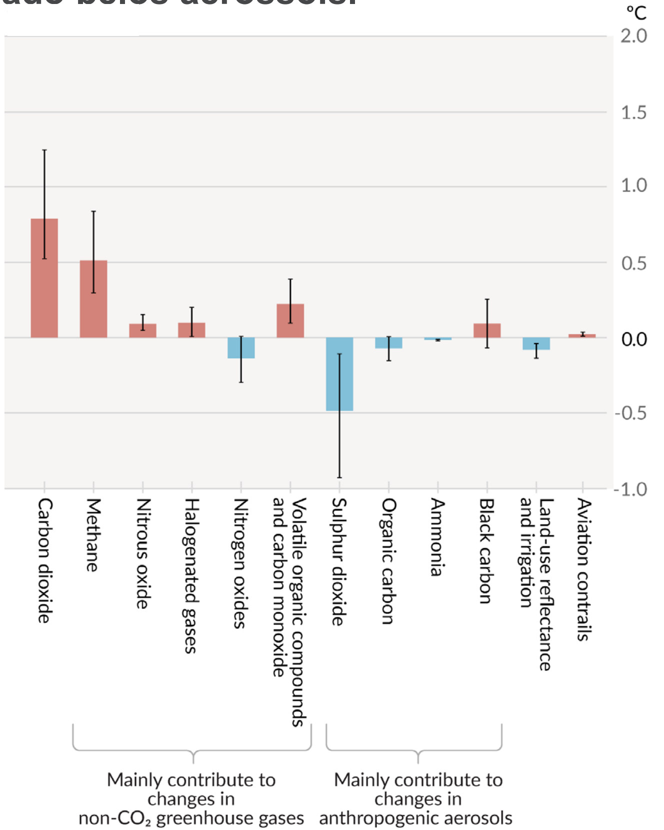
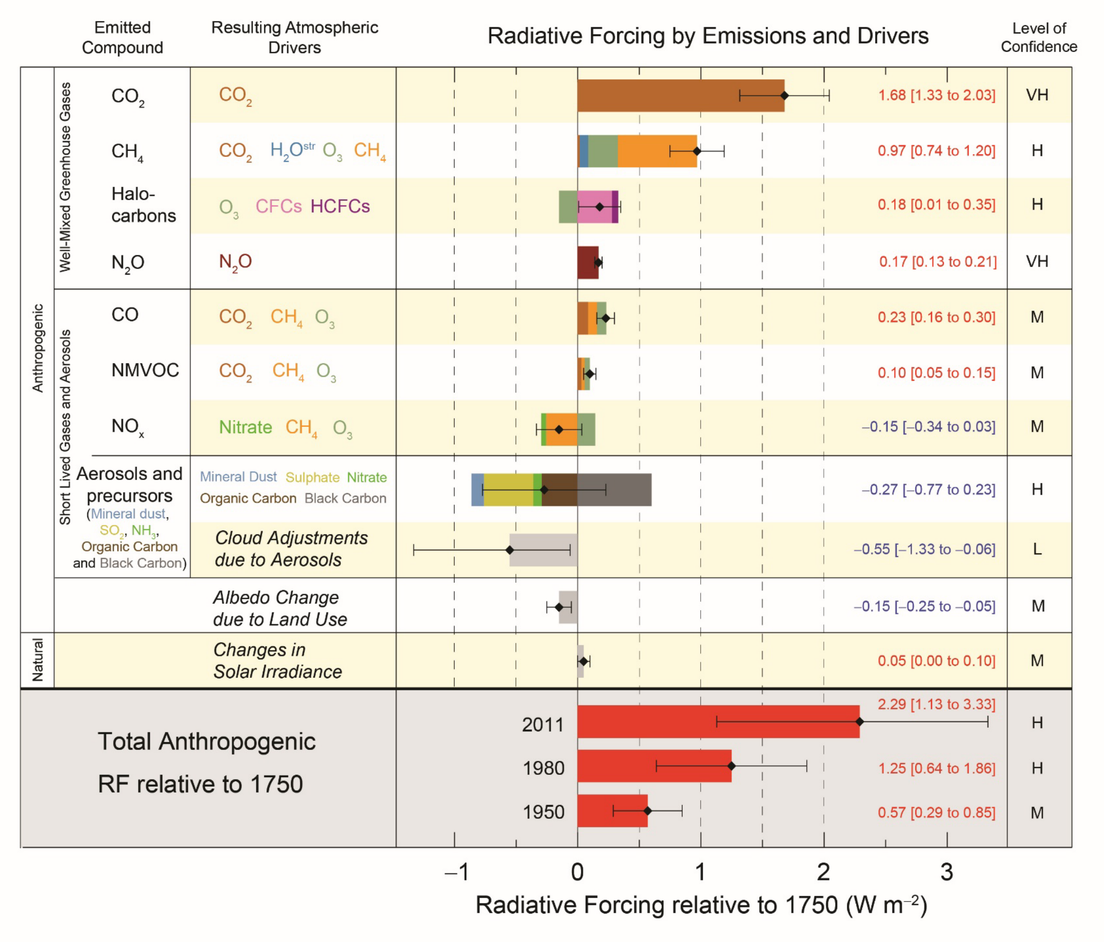
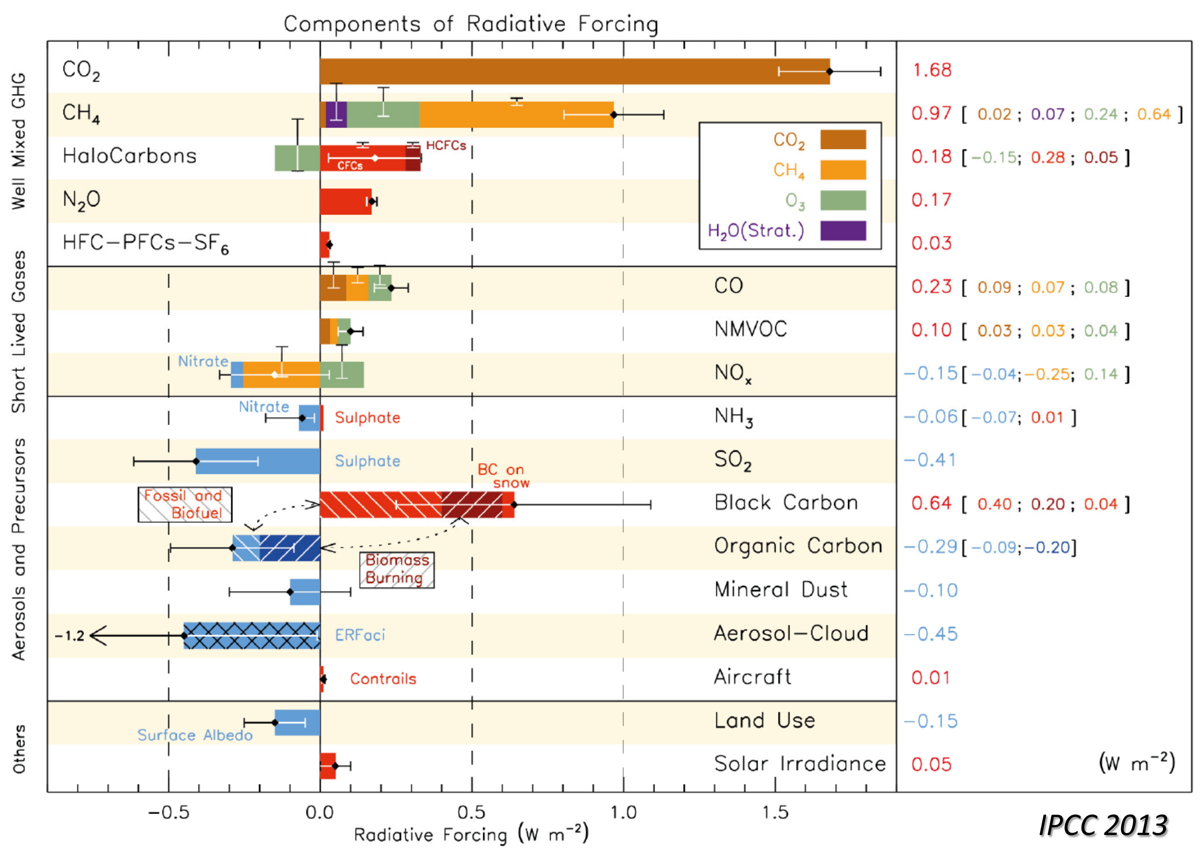


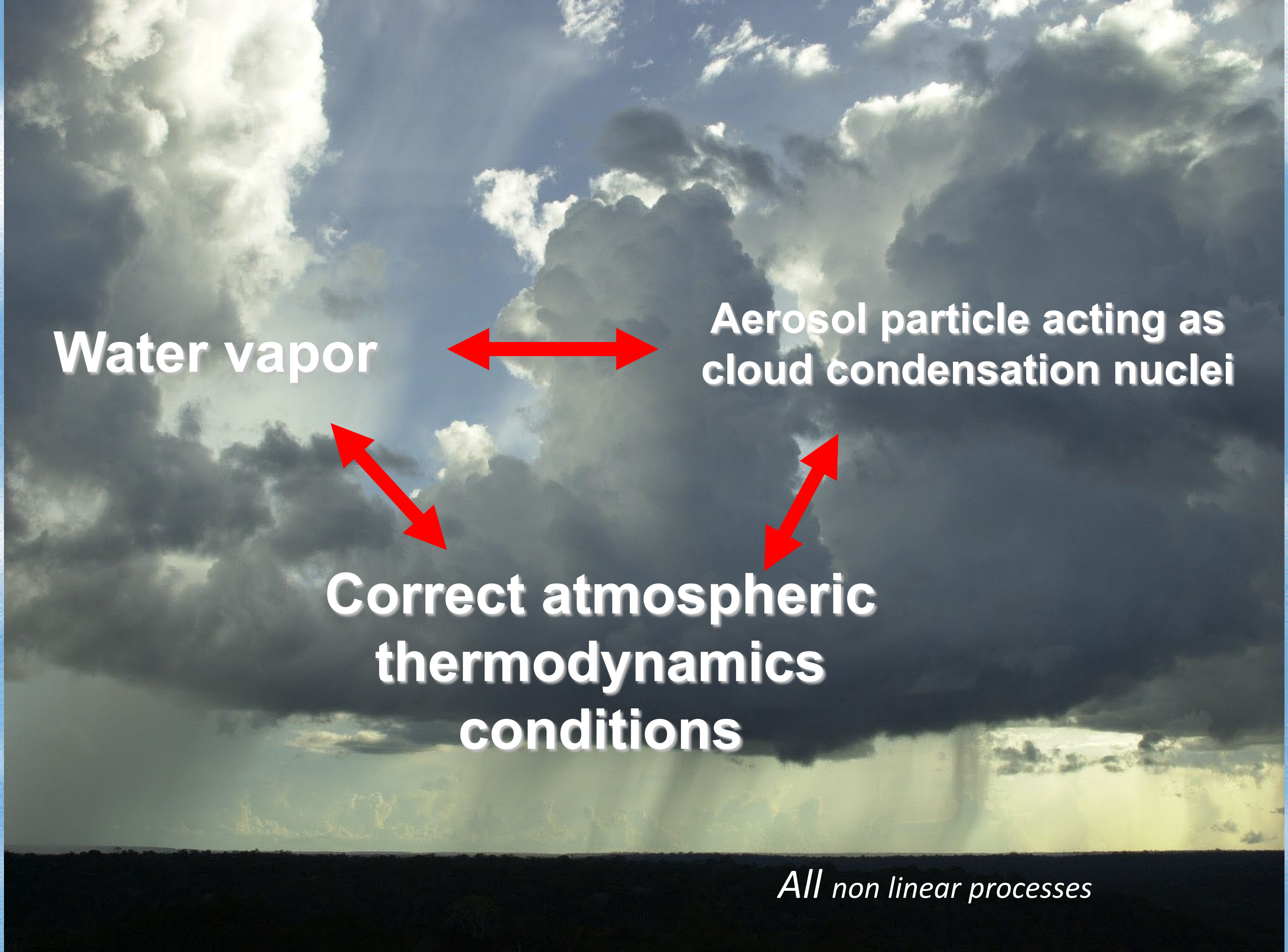
A forçante radiativa do sistema climático terrestre



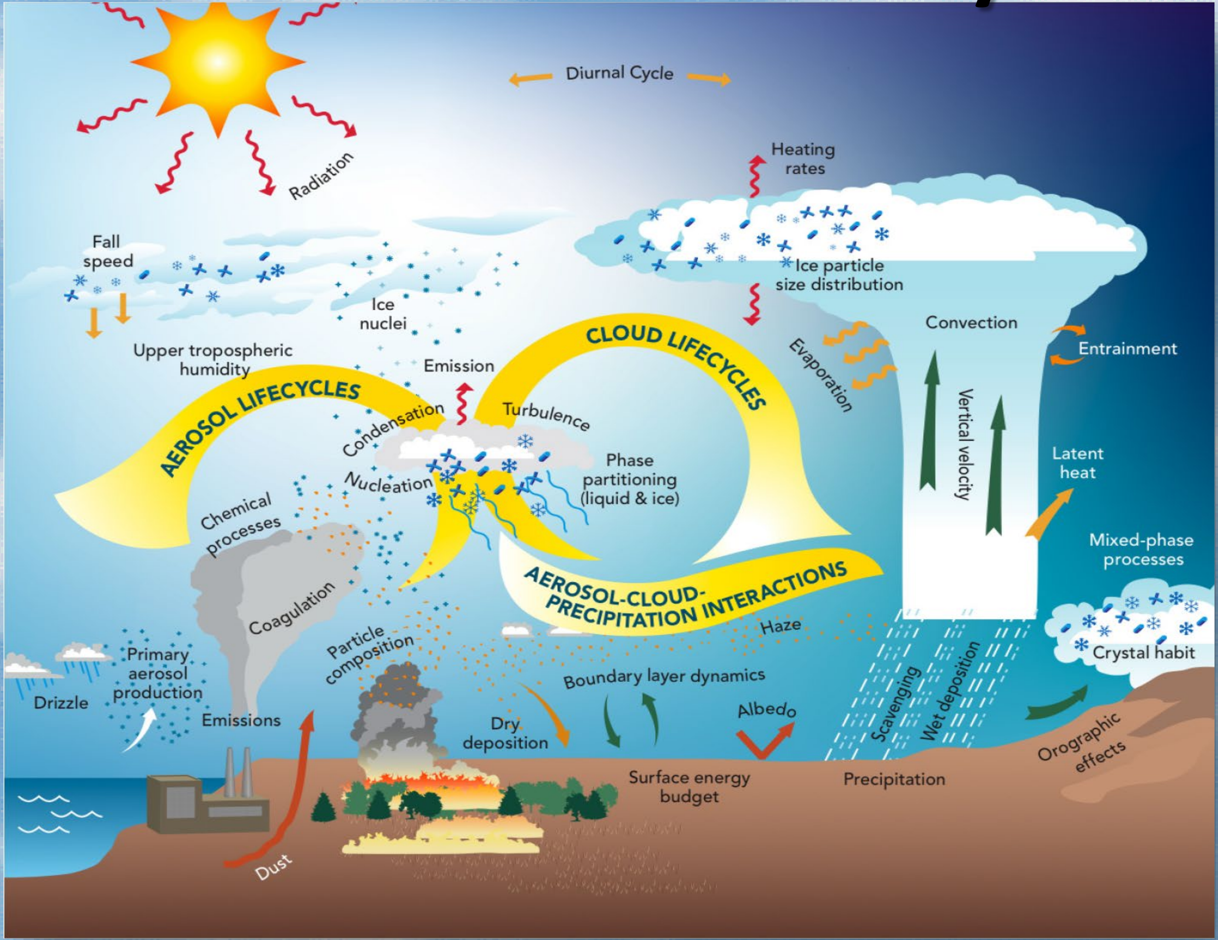
Radiative forcing of climate change from 1750 to 2011

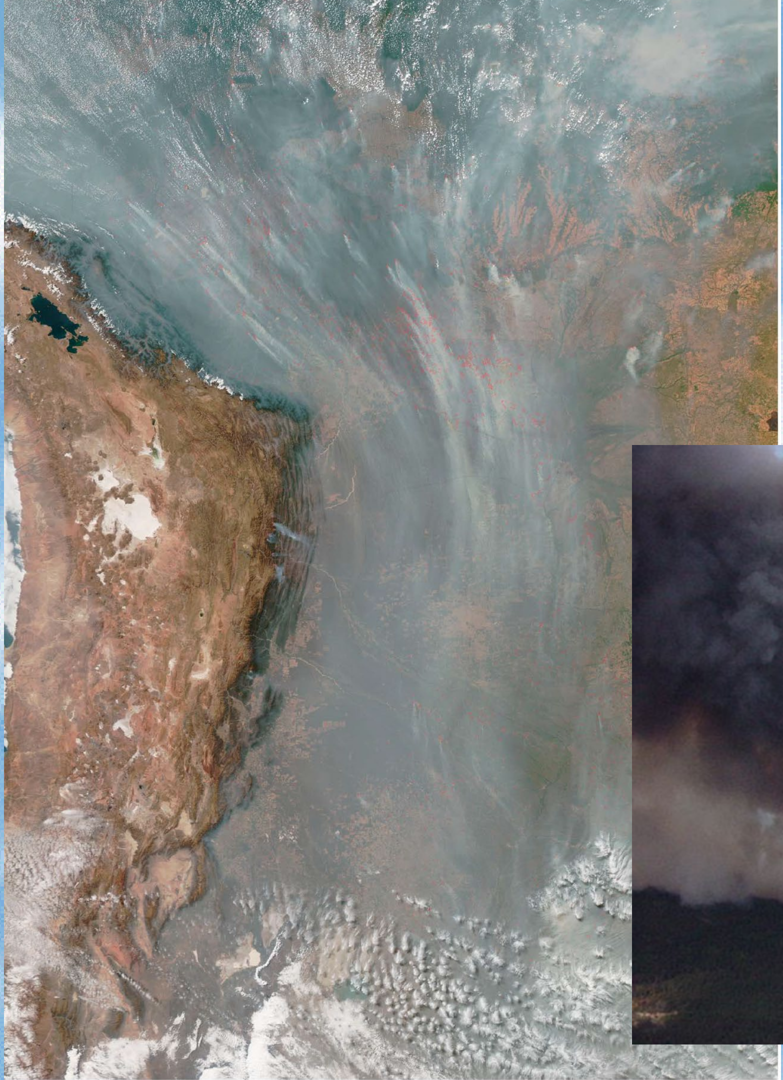


IPCC 2013


Water vapor
Aerosol particle acting as cloud condensation nuclei
Correct atmospheric thermodynamics conditions
All non linear processes

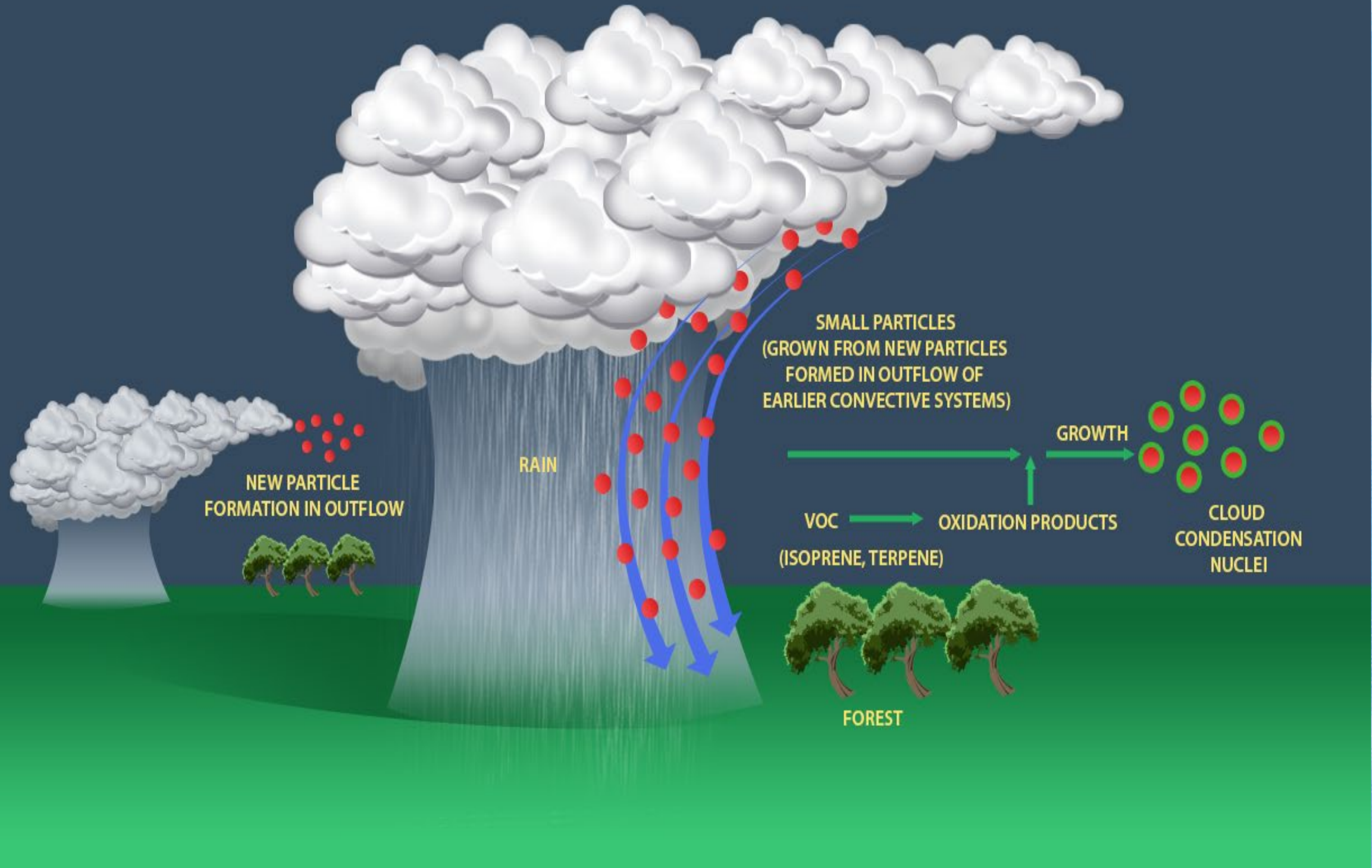
Aerosol and cloud lifecycles

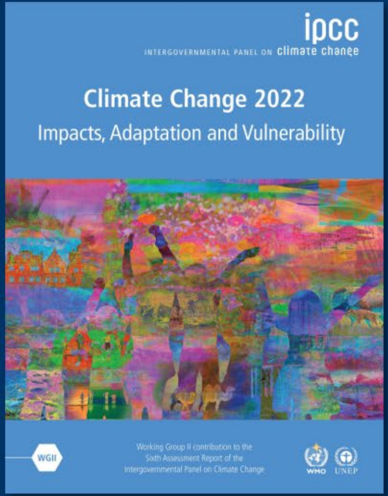




Aerosol emissions make the high variability visible – it also applies to aerosol composition and the trace gases!

Clouds as active aerosol processors in the atmosphere





“ A evidência científica é inequívoca: mudanças climáticas são uma ameaça ao bem estar humano e à saúde do planeta.
Qualquer atraso em uma ação global, coordenada e conjunta, levará a perda de uma breve janela, que se fecha rapidamente, para assegurar um futuro habitável.

ipcc
INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP


[Credit: Peter John Maridable | Unsplash]

“ A menos que haja reduções imediatas, rápidas e em grande escala nas emissões de gases de efeito estufa, limitar o aquecimento a 2,0 ° C pode ser impossível

ipcc
INTERGOVERNMENTAL PANEL ON climate change
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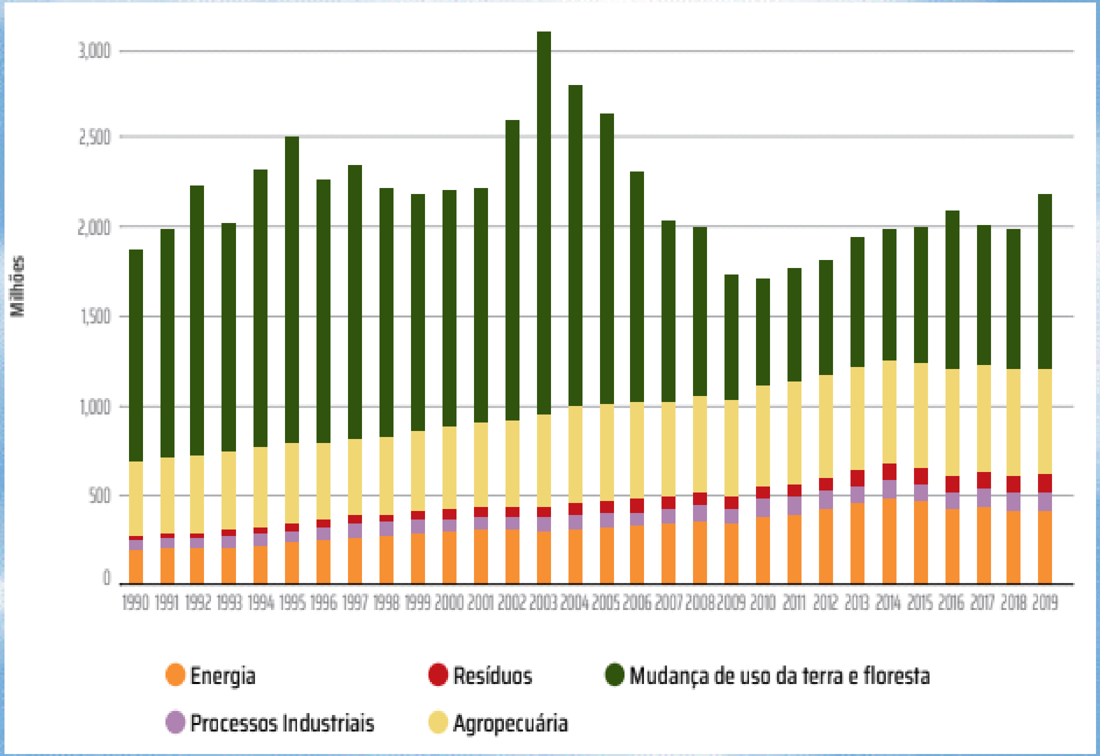
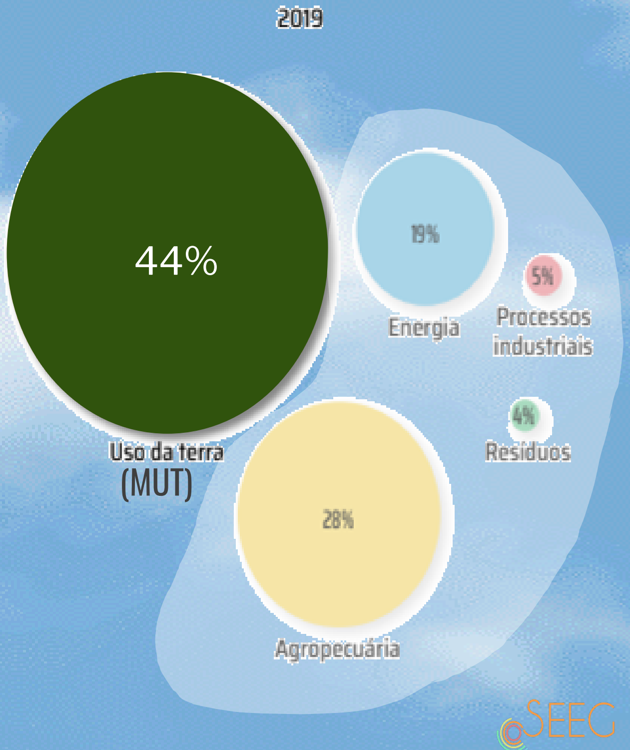
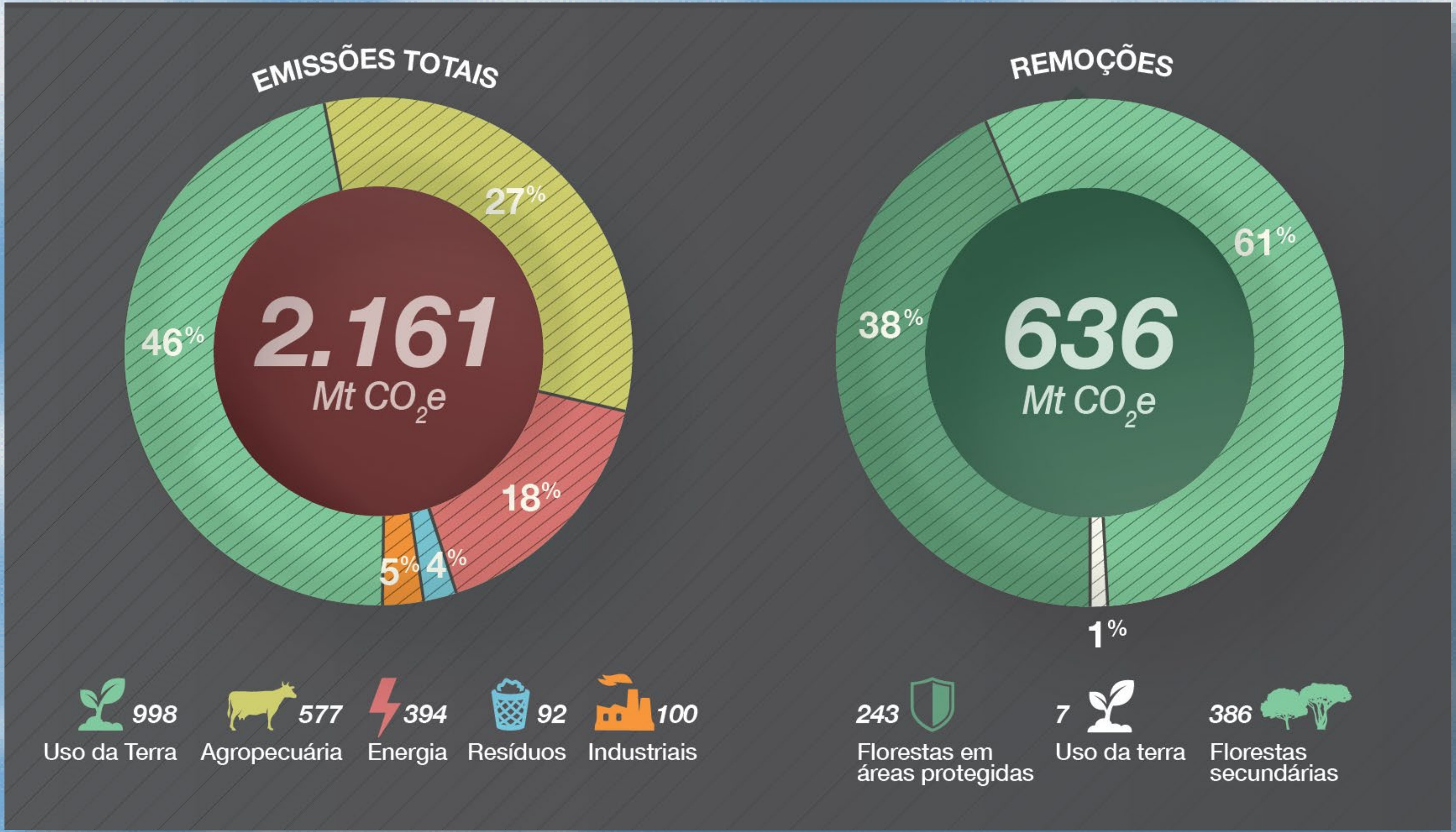
GHG Emissions from Brazil

Land use change is responsible for 44% of Brazil GHG emissions in 2019



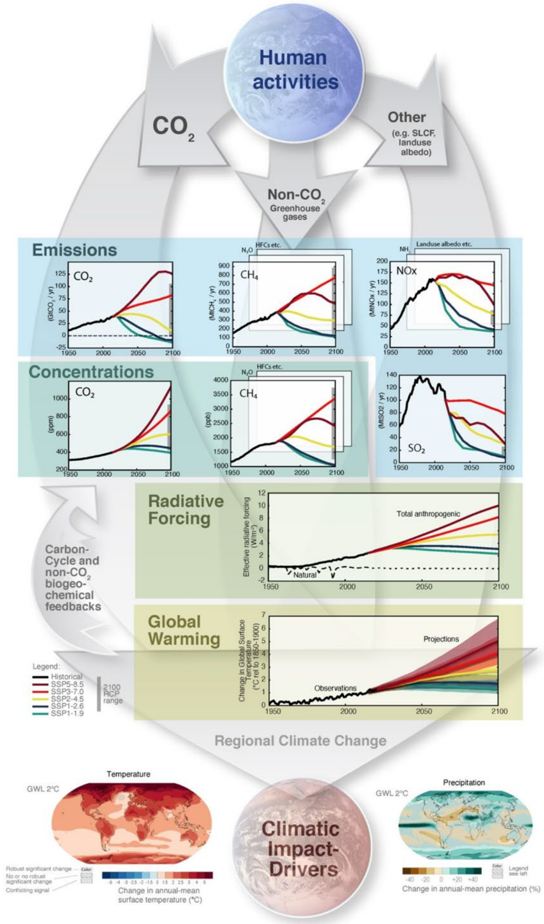


Emissions and sinks of GHG in Brazil – SEEG 2020



http://seeg.eco.br/infografico

Emissions → Concentrations → Radiative Forcing → Warming → Impacts



Future emissions cause future additional warming, with total warming dominated by past and future CO_2 emissions

a) Future annual emissions of CO_2 (left) and of a subset of key non-CO_2 drivers (right), across five illustrative scenarios

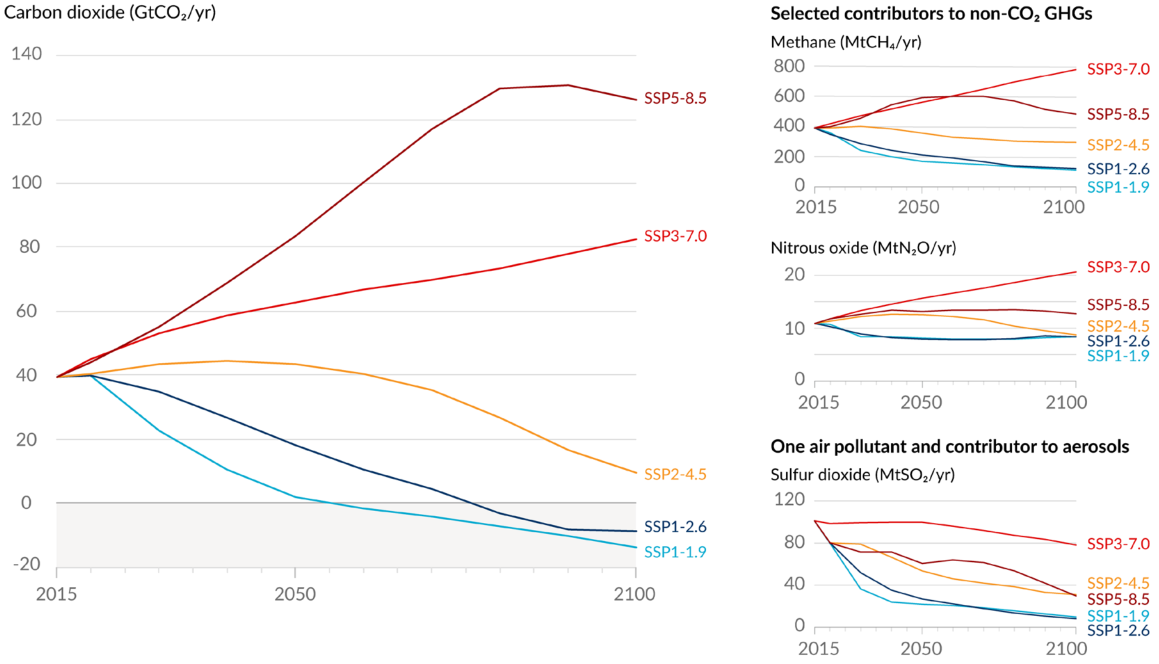


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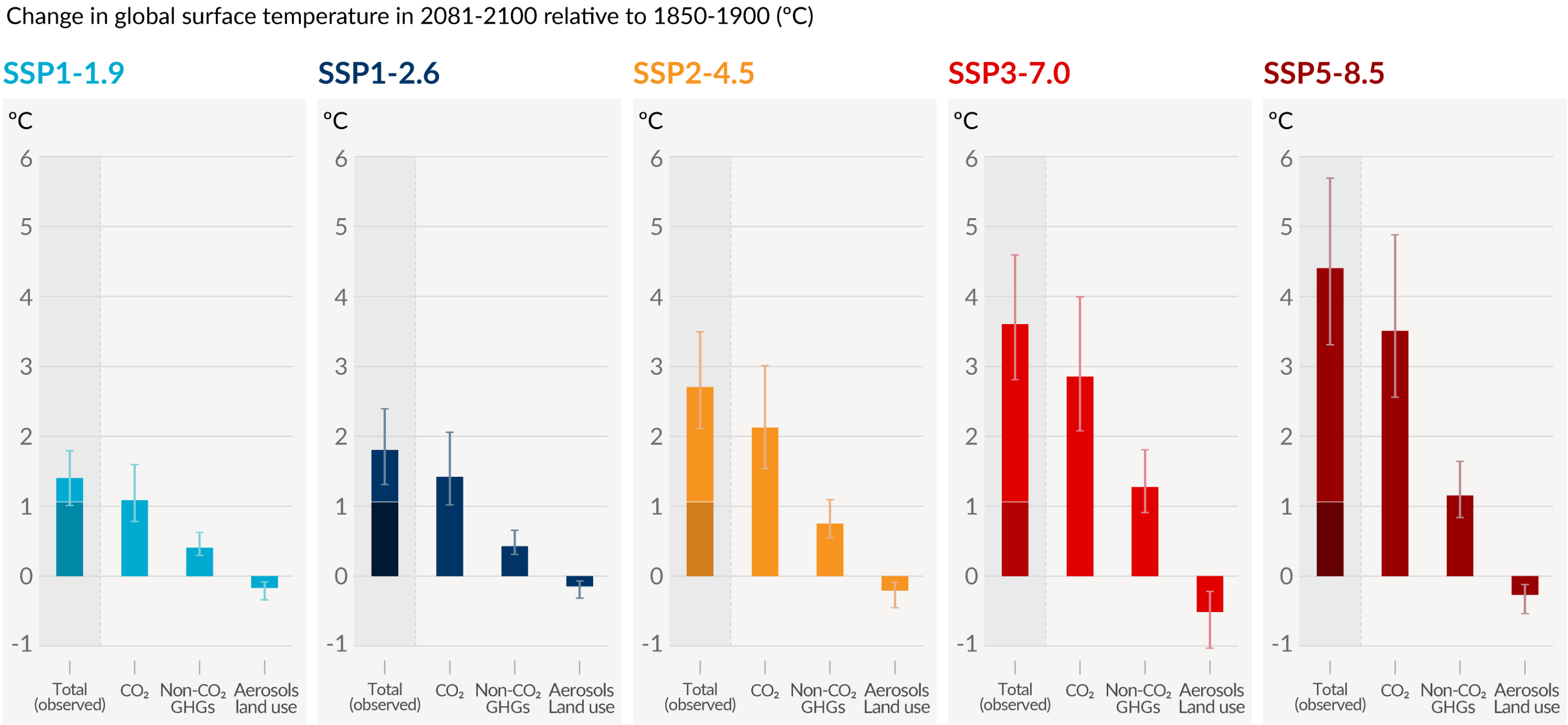
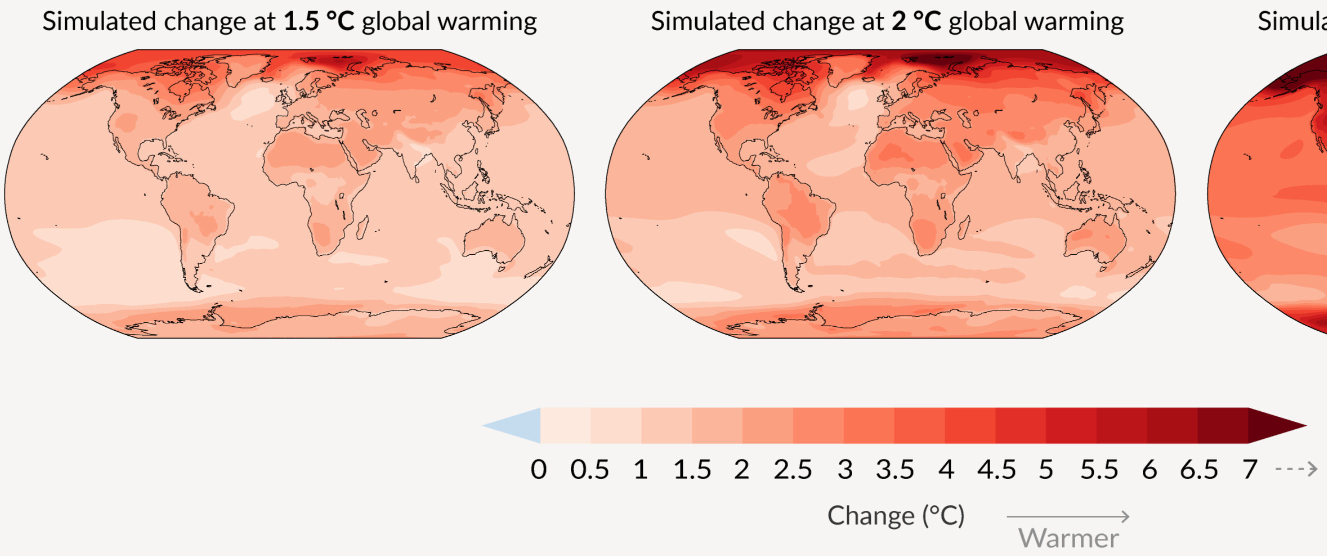
Figure SPM.4



With every increment of global warming, changes get larger in regional mean temperature, precipitation and soil moisture

b) Annual mean temperature change (°C) relative to 1850-1900

Across warming levels, land areas warm more than oceans, and the Arctic and Antarctica warm more than the tropics.



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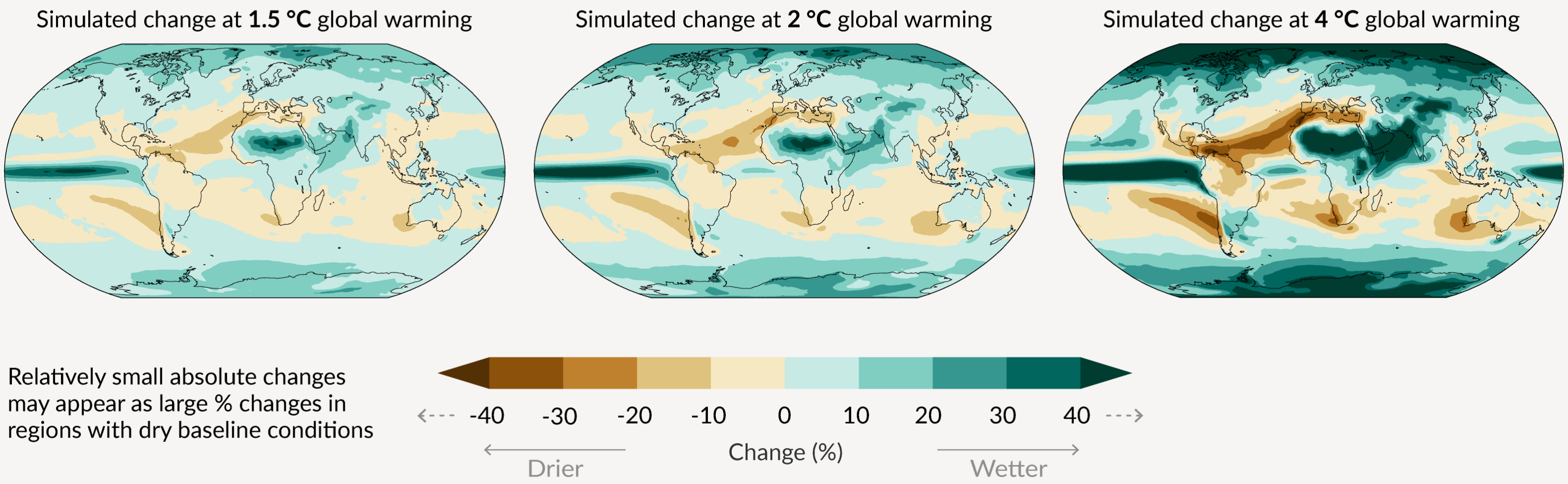
c) Annual mean precipitation change (%) relative to 1850-1900

Precipitation is projected to increase over high latitudes, the equatorial Pacific and parts of the monsoon regions, but decrease over parts of the subtropics and in limited areas of the tropics.

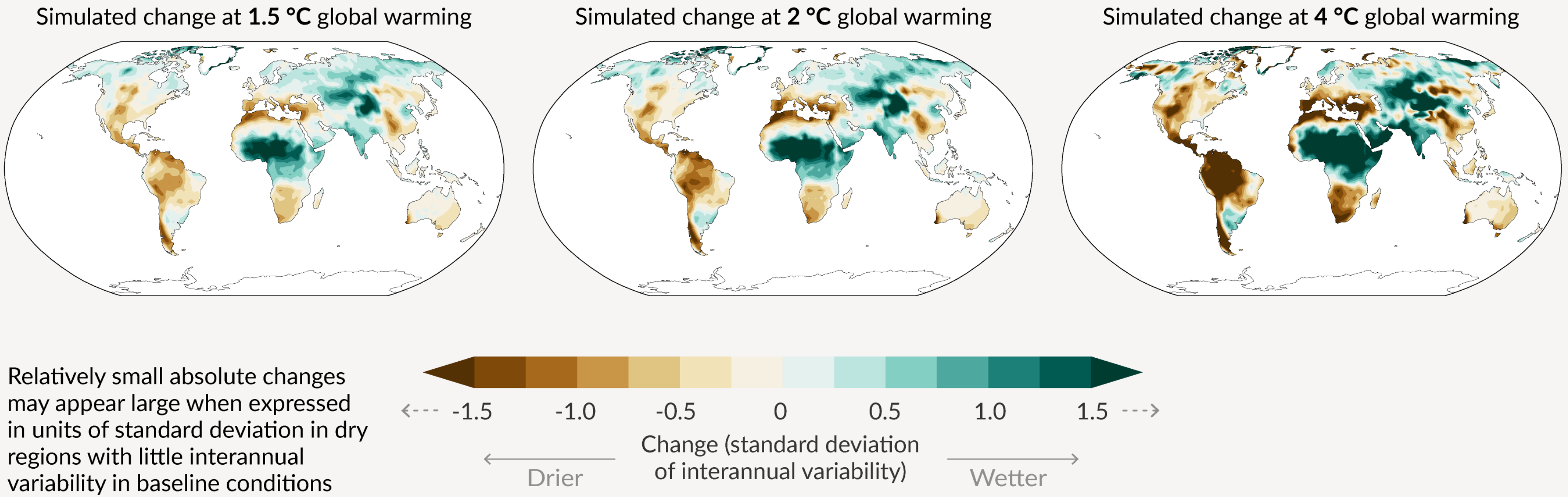


Relatively small absolute changes may appear as large % changes in regions with dry baseline conditions

With every increment of global warming, changes get larger in soil moisture

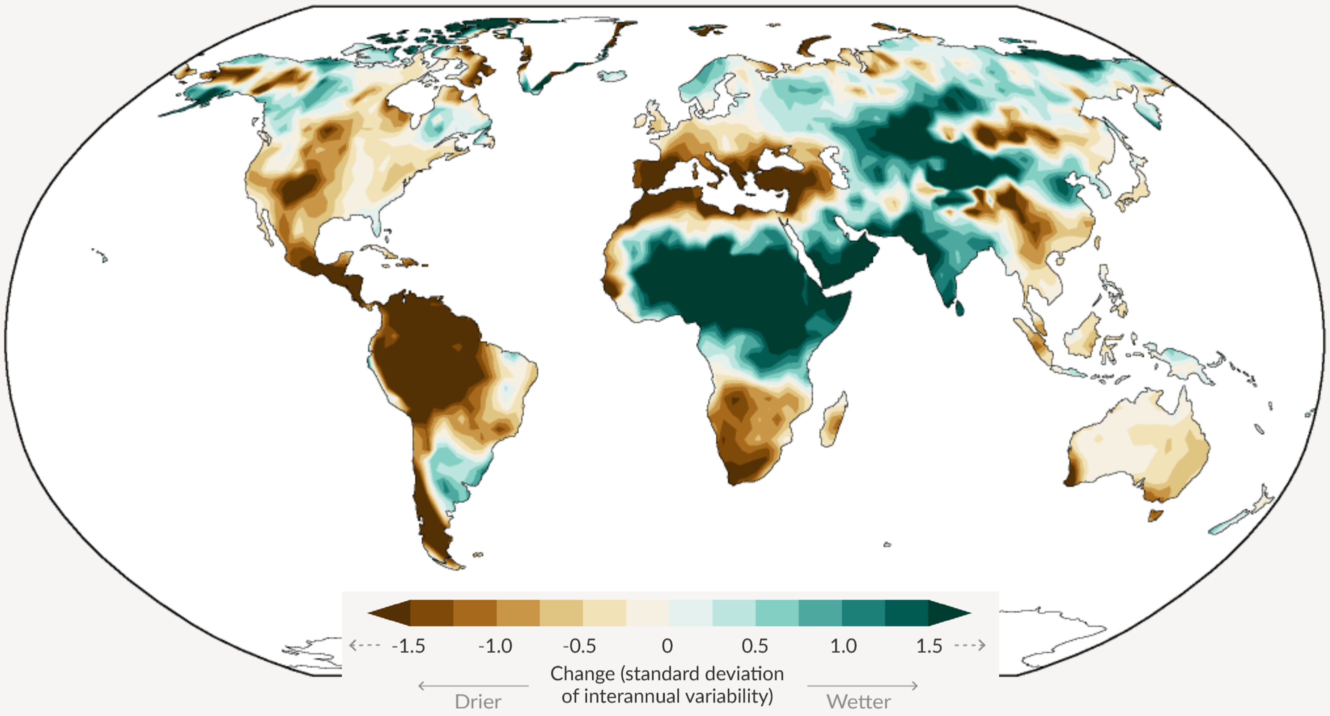
d) Annual mean total column soil moisture change (standard deviation)

Across warming levels, changes in soil moisture largely follow changes in precipitation but also show some differences due to the influence of evapotranspiration.



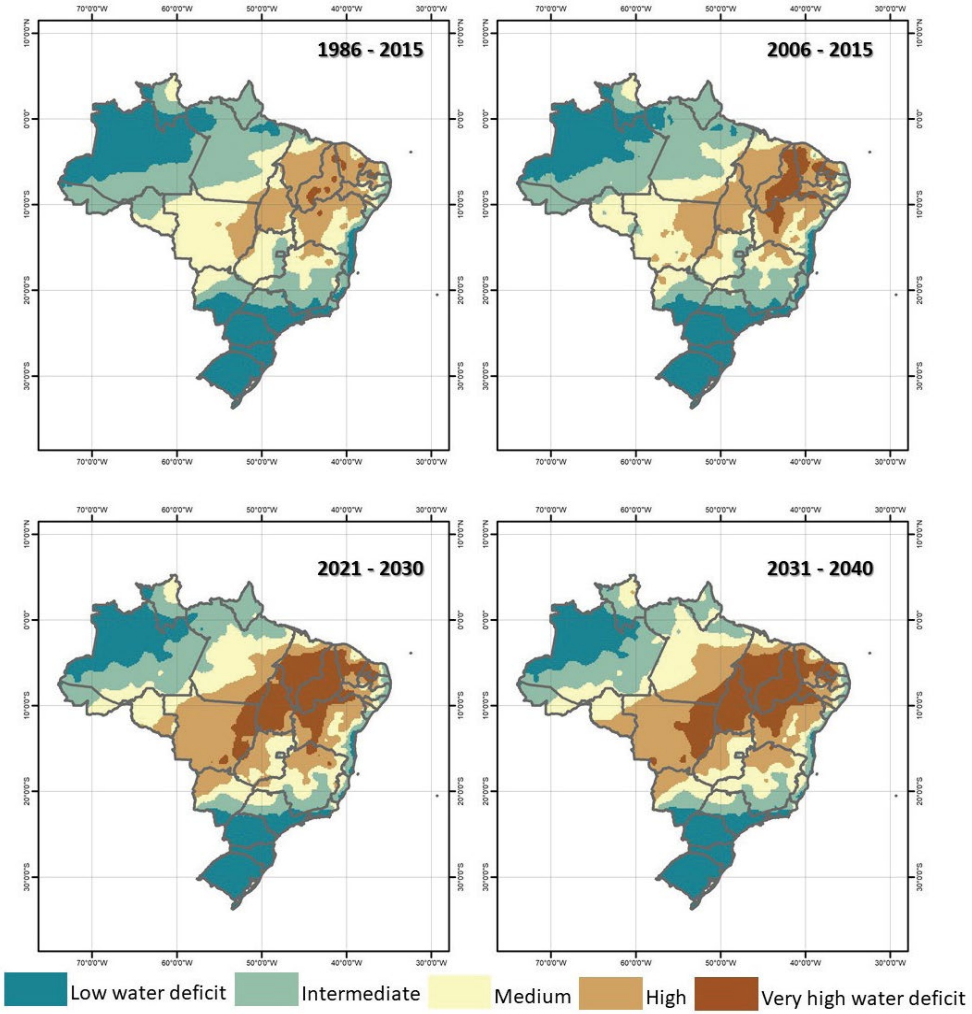
Relatively small absolute changes may appear large when expressed in units of standard deviation in dry regions with little interannual variability in baseline conditions

Soil humidity with 4 degress warming



EMBRAPA: Water déficit in Brazil 1986-2040

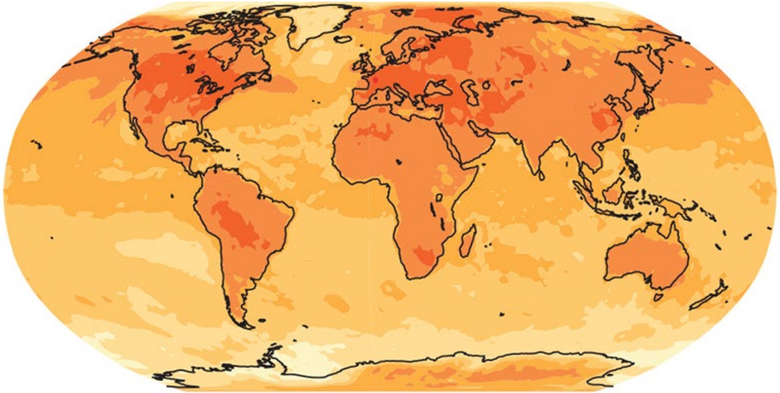
Brazil is already becoming a dryer country



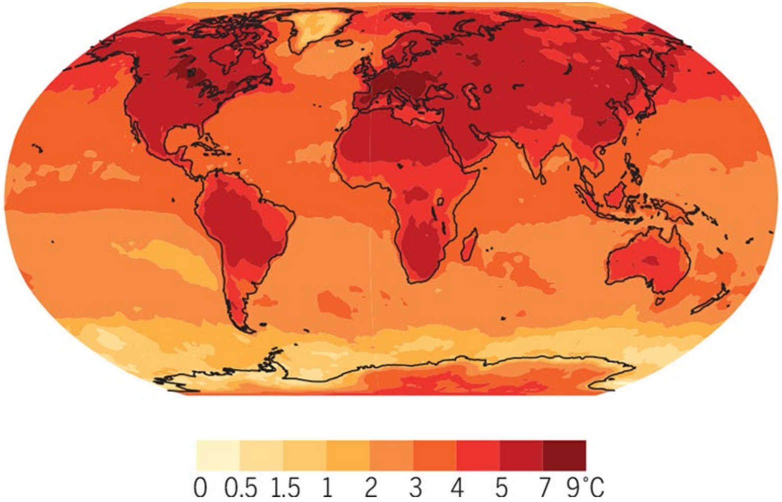
Embrapa Informática Agropecuária, 2019

Aumento futuro nas temperaturas máximas

COM redução de emissões



SEM redução de emissões



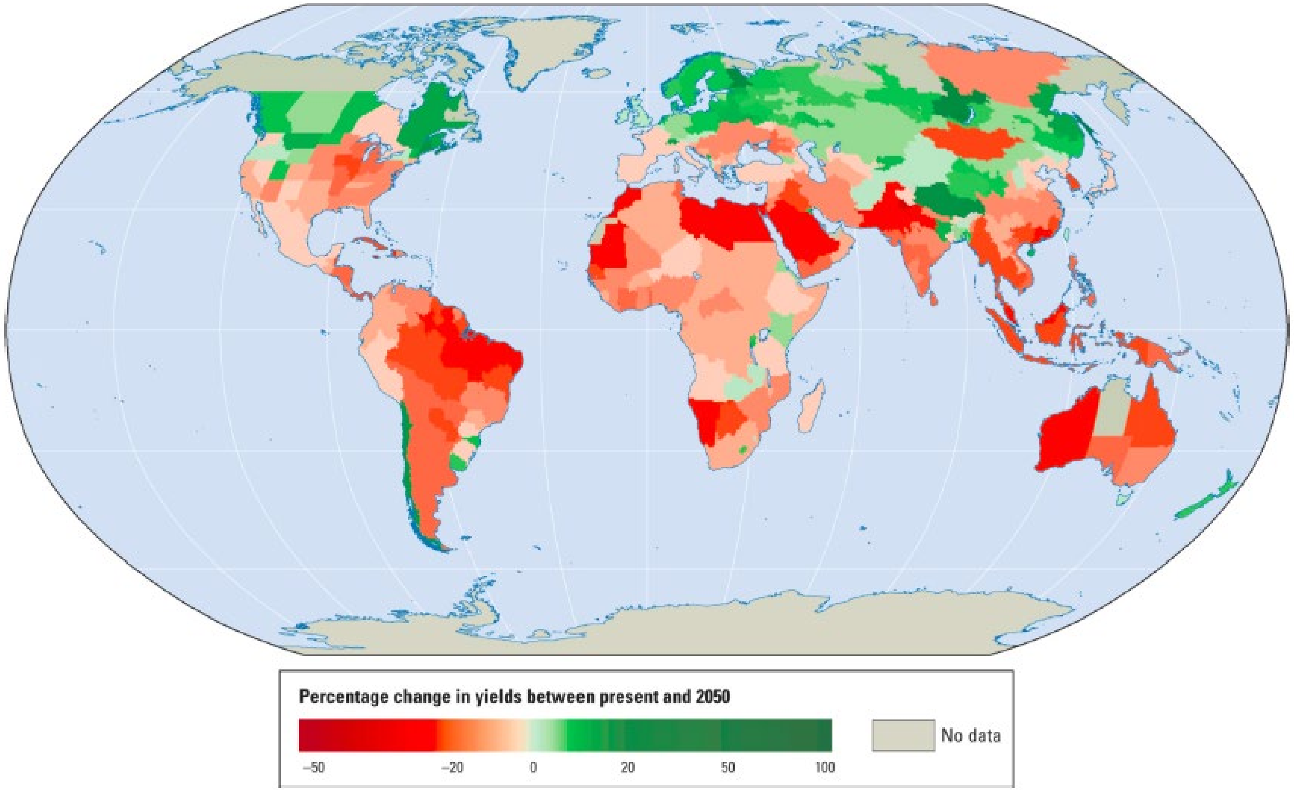
Future rises in peak temperature

The increase in the maximum 20-year return value of maximum daytime temperature late this century (2081–2100) relative to 1986–2005, based on the average of many climate models, is shown. Projections based on a strong mitigation scenario [Representative Concentration Pathway (RCP) 4.5] (top) and a high-emission scenario (RCP8.5) (bottom) are shown.

Science
AAAS

Steven C. Sherwood Science 2020;370:782-783

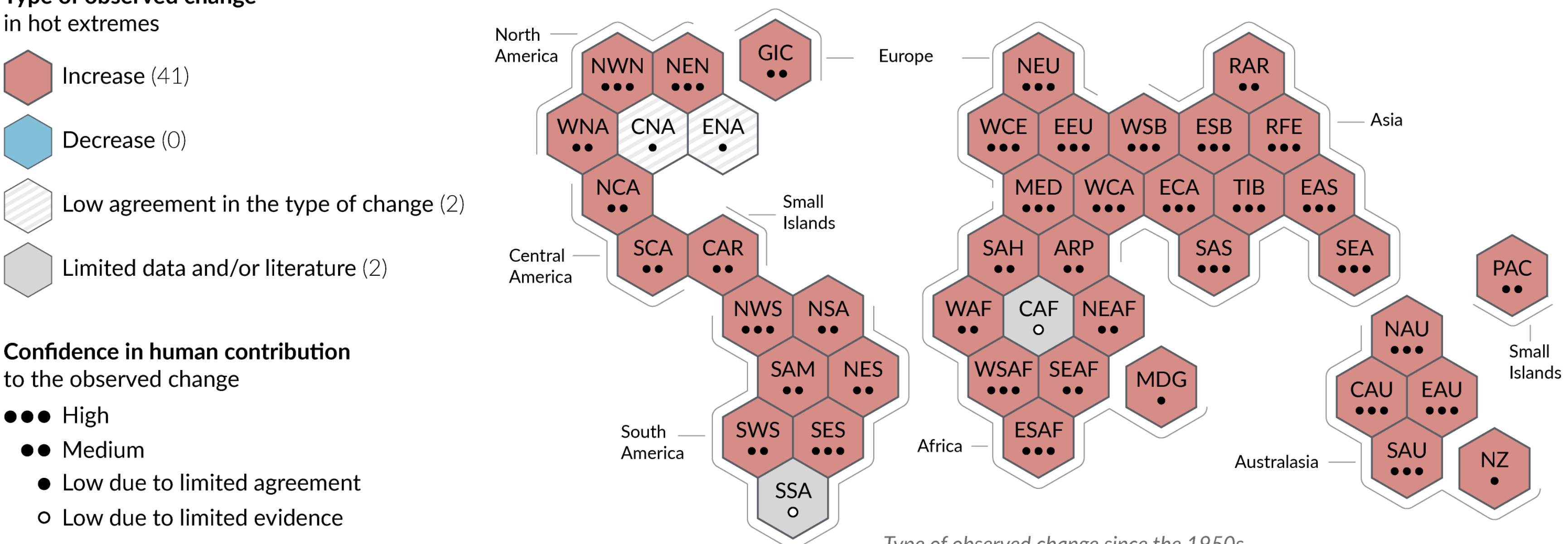
Risks: Impacts on food yield in a 3°C hotter planet



World Economic Forum: Glo

Climate change is already affecting every inhabited region across the globe, with human influence contributing to many observed changes in weather and climate extremes

a) Synthesis of assessment of observed change in **hot extremes** and confidence in human contribution to the observed changes in the world's regions



Type of observed change since the 1950s

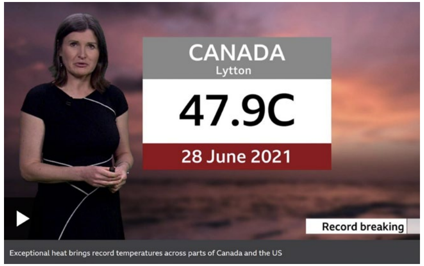
Extreme weather events more frequent all over the places

Cientistas associam fortes chuvas na Europa às mudanças climáticas

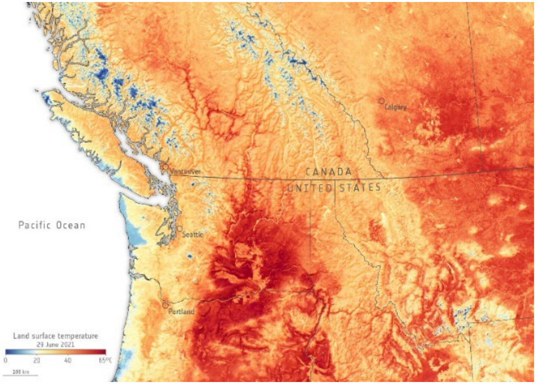
Chuvas sem precedentes deixam 126 mortos na Europa e disparam alerta contra mudanças climáticas

Precipitação bate recordes na Alemanha e, com mais de 1.300 desaparecidos, número de vítimas deve aumentar

Hundreds died in the West's heat wave in June 2021.



52 Celsius in California



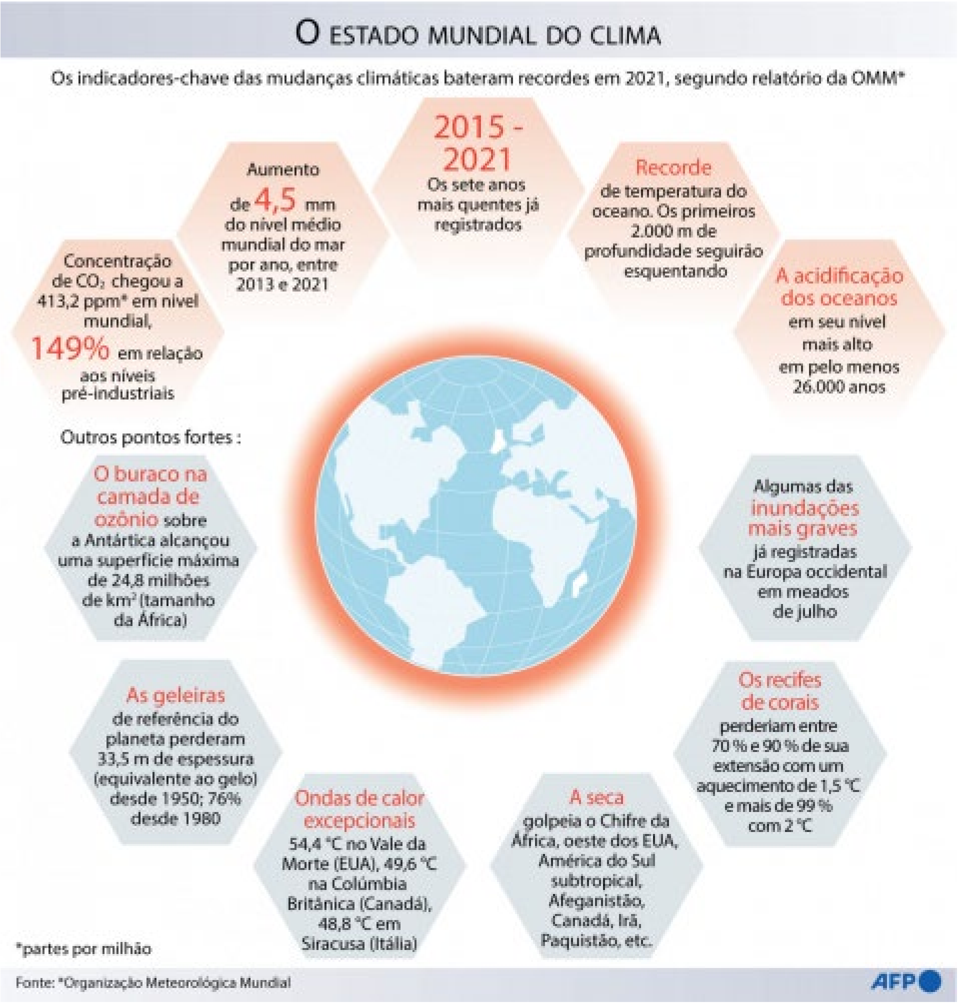
MAIOR CHUVA EM UM SÉCULO NA ALEMANHA

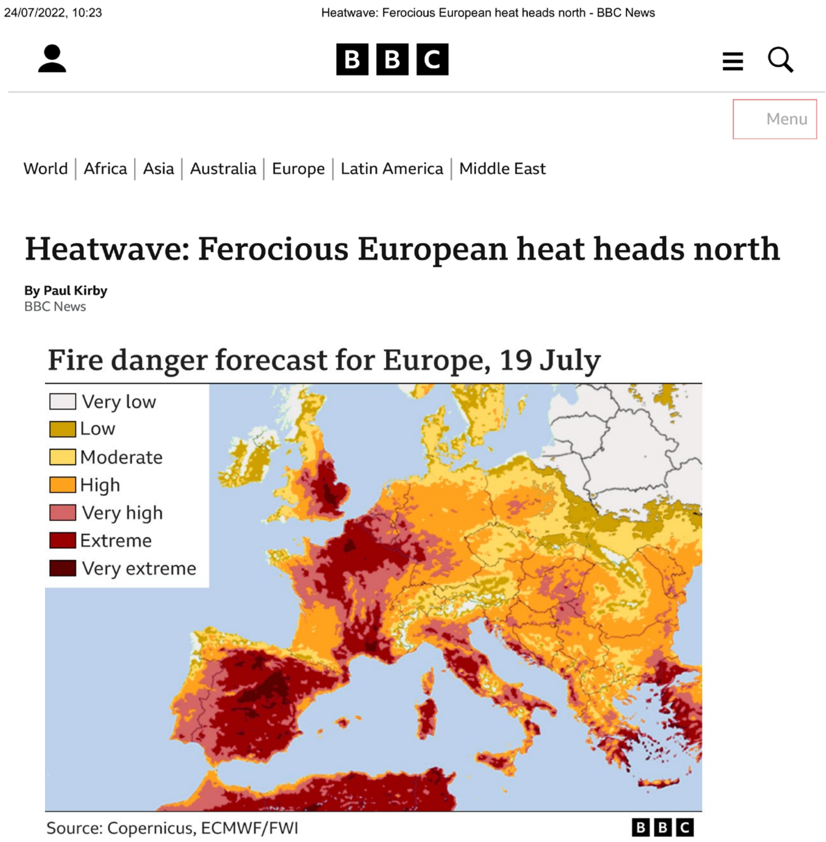
O desastre da chuva na Alemanha e Bélgica fez com que diversos cientistas estudiosos das mudanças climáticas alertasse que estes eventos extremos de precipitação tendem a se tornar cada vez mais comuns.

Central Brazil: The strongest drought in 100 years

Negro River: Highest level in 119 Years in Manaus in 2021

Strong heat wave reach Europe, Asia, and North America simultaneously




24/07/2022, 10:23 Heatwave: Ferocious European heat heads north - BBC News

BBC

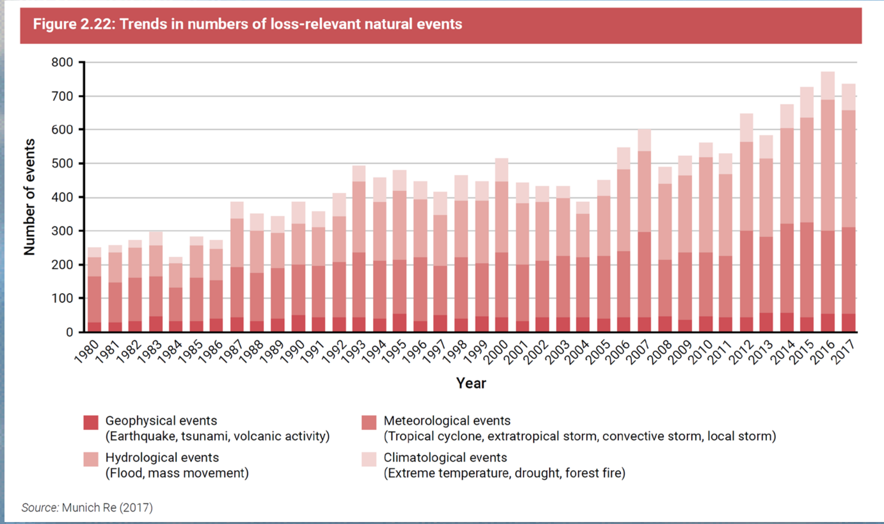
Menu

World | Africa | Asia | Australia | Europe | Latin America | Middle East

Heatwave: Ferocious European heat heads north

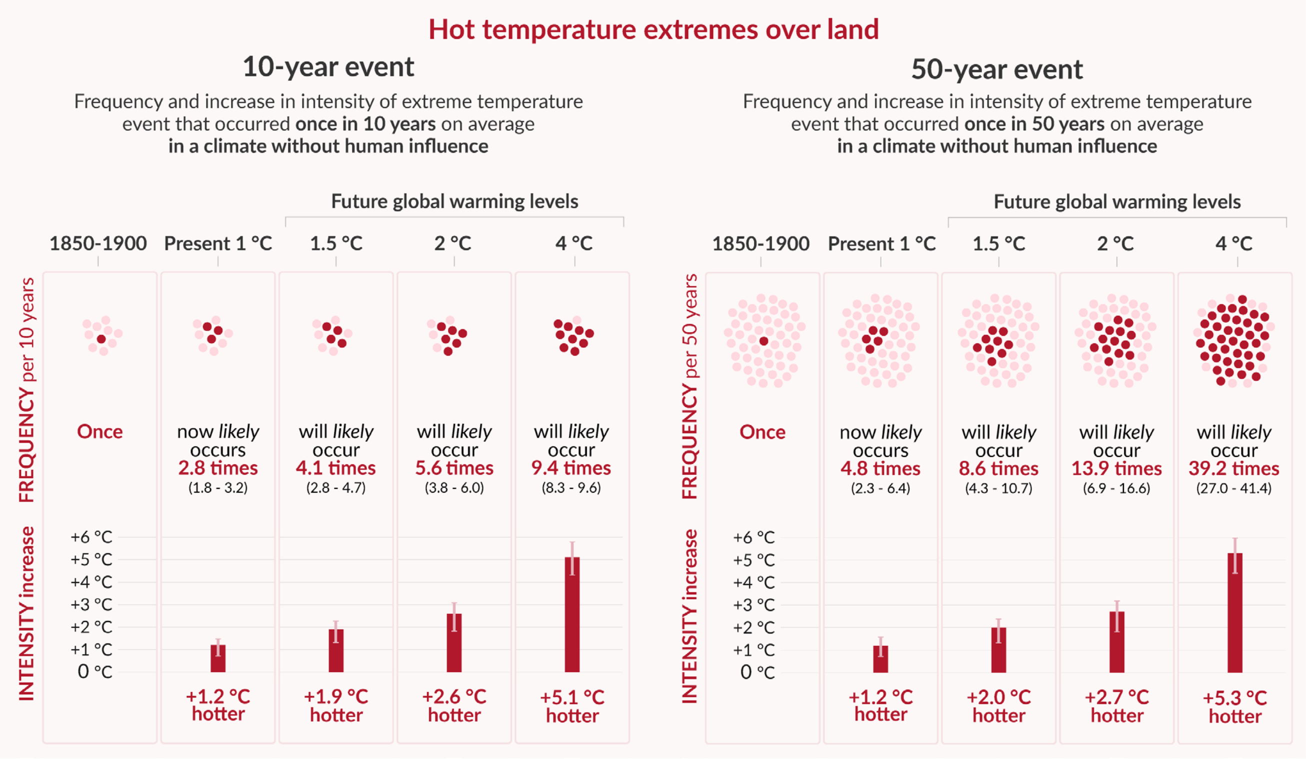
By Paul Kirby
BBC News

Riscos: Aumento na intensidade e frequencia de eventos climáticos extremos



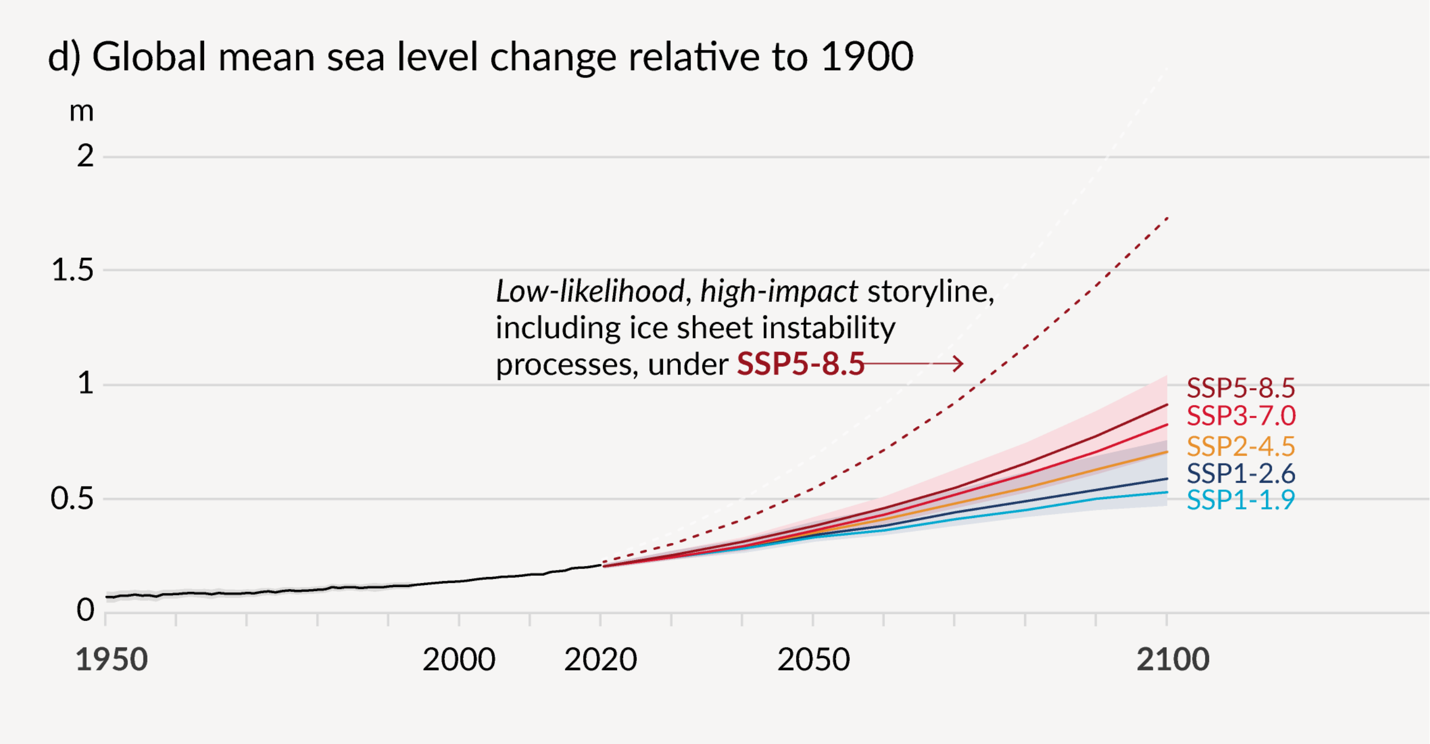
Já está ocorrendo desde a década de 80

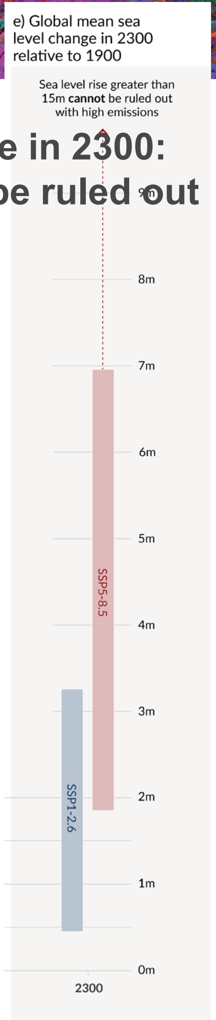
Projected changes in extremes are larger in frequency and intensity with every additional increment of global warming



Human activities affect all the major climate system components, with some responding over decades and others over centuries

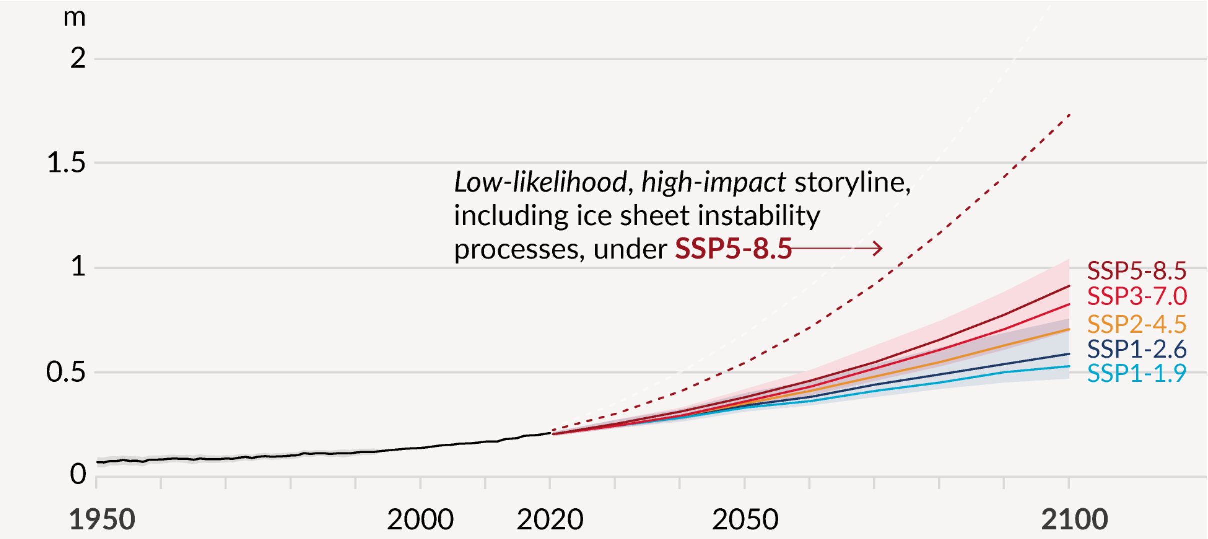
Global sea level rise in 2300: 15 meters can not be ruled out

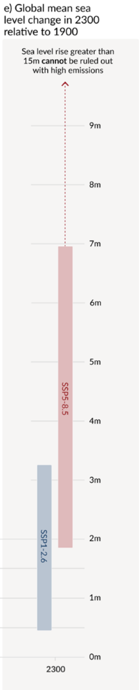




Aumento projetado do nível do mar até 2100

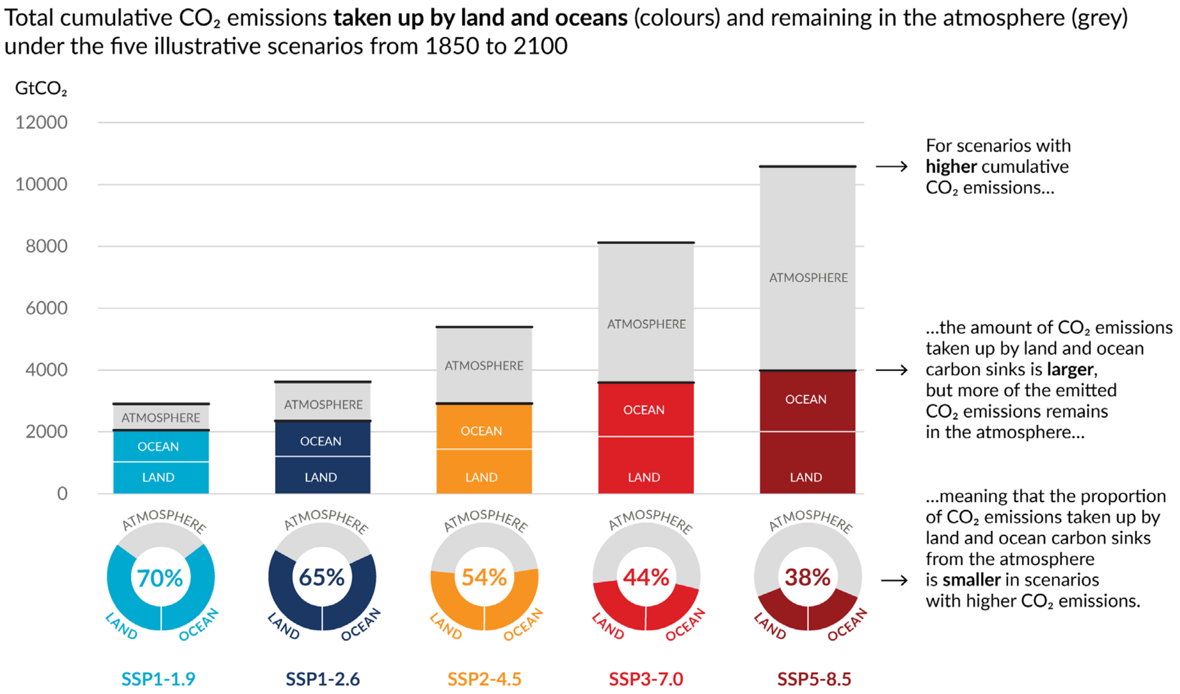
Em 2300: potencial aumento de até 15 metros



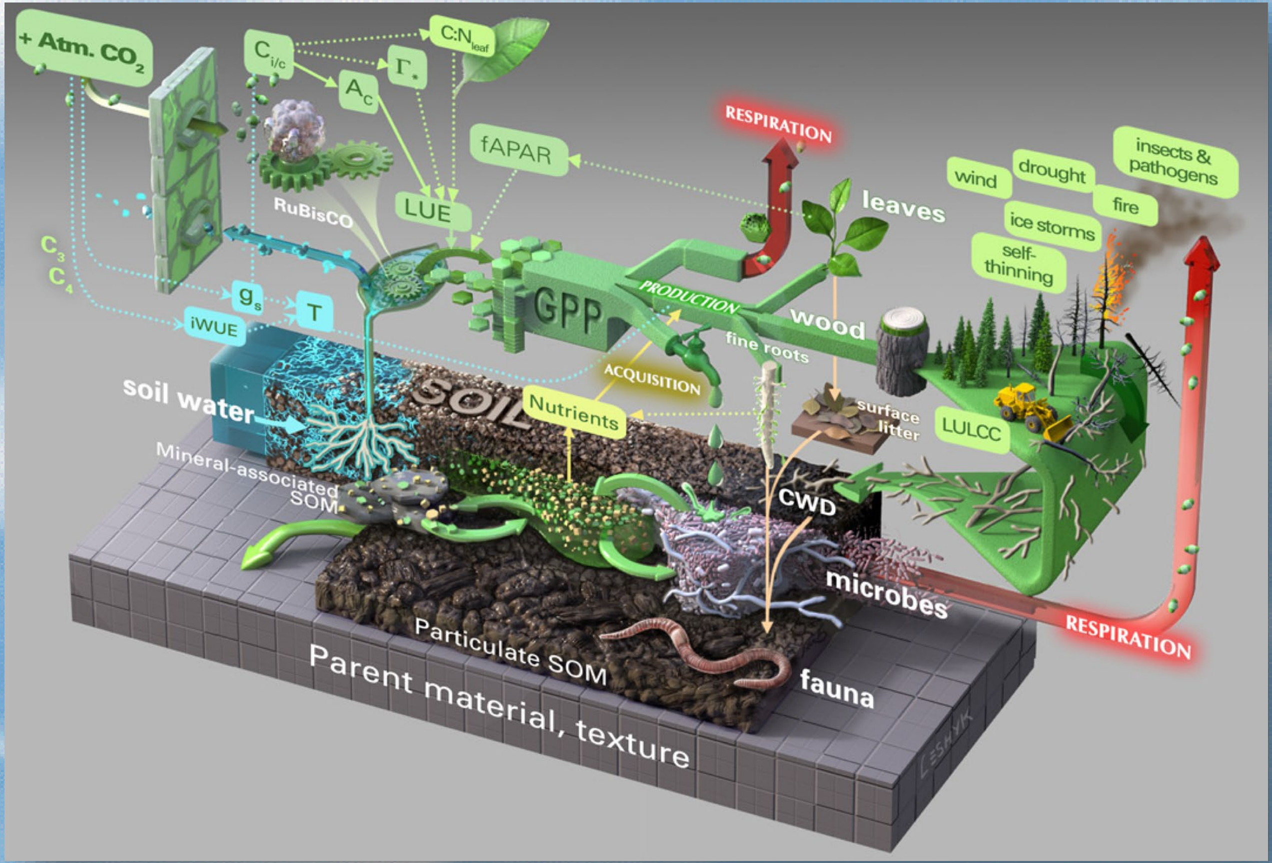


O nível médio do mar aumentou em 0.20 m entre 1901 e 2018. A taxa de aumento foi de 1.35 mm/ano entre 1901 e 1990, aumentando para 3.7 mm/ano entre 2006 e 2018.

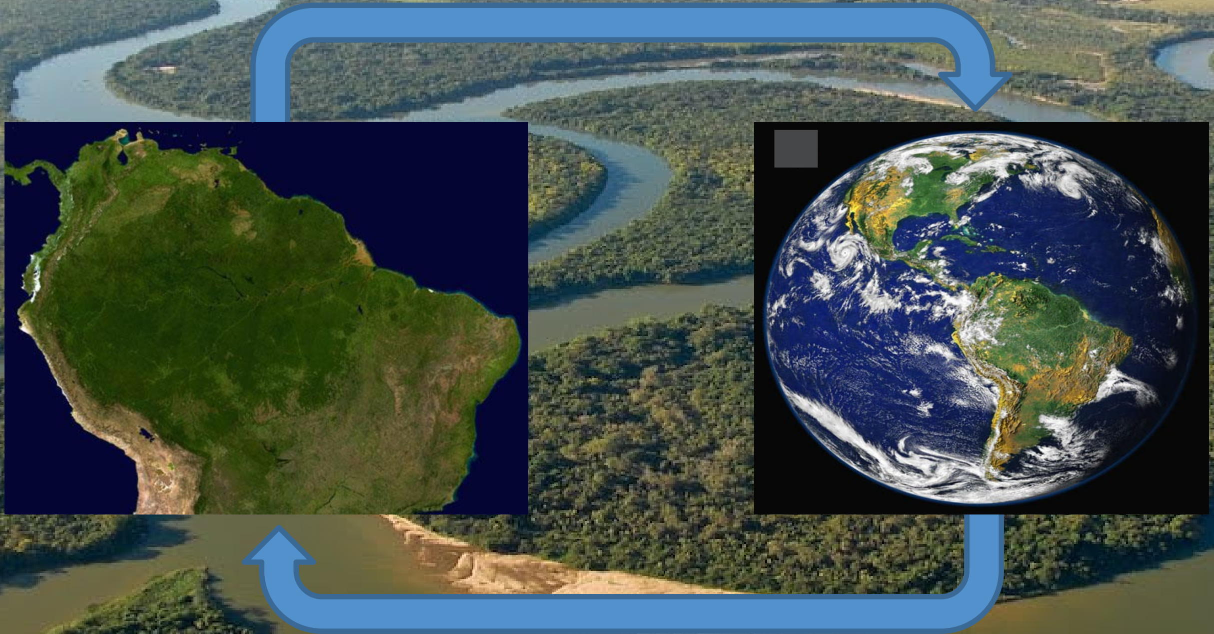
The proportion of CO_2 emissions taken up by land and ocean carbon sinks is smaller in scenarios with higher cumulative CO_2 emissions



A complexa ciclagem de carbono em florestas tropicais: desmatamento, fotosíntese, carbono no solo, etc...



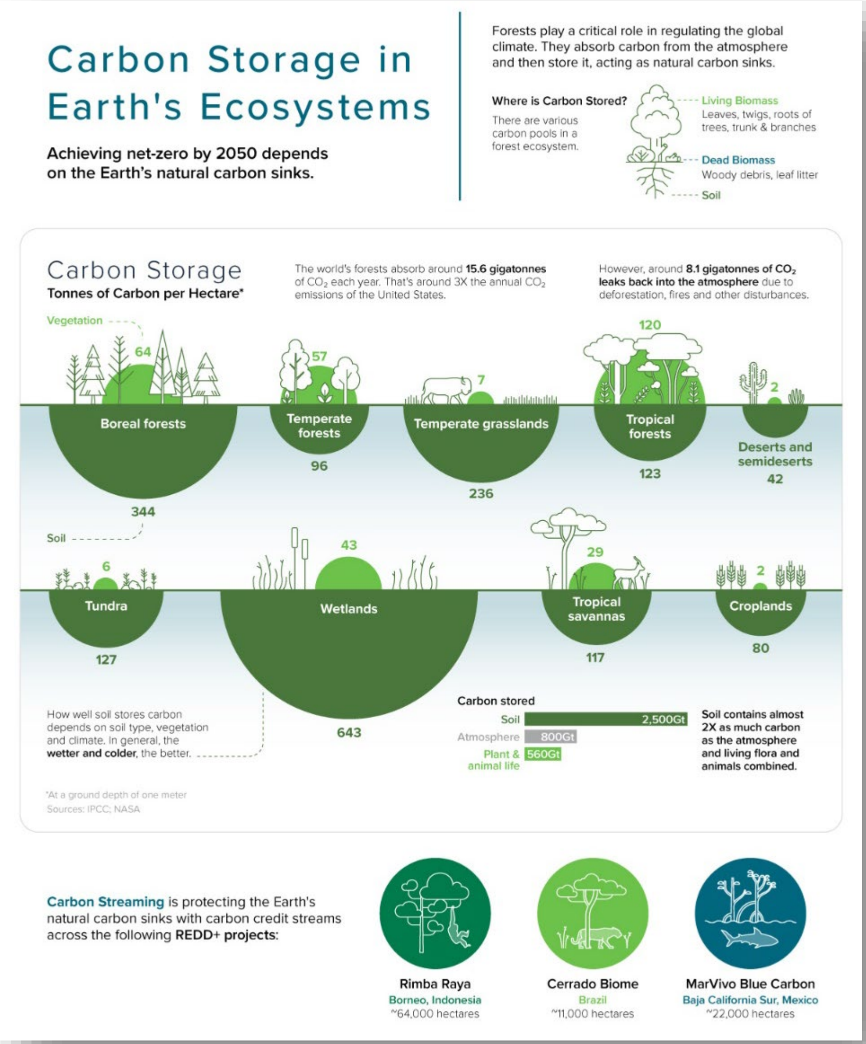
Amazonia and global climate change: a two ways path



Deforestation versus climate change

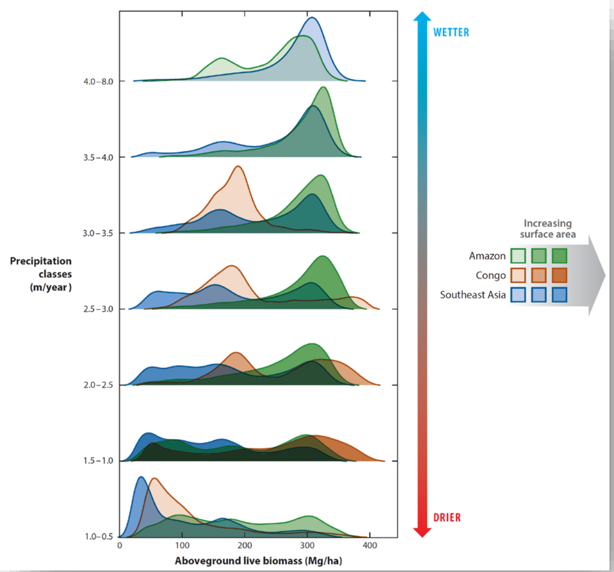
Achieving net-zero by 2050 depending on the Earth´s natural carbon sinks

Amazonia is critical for that with 120 billion tons of carbon



Carbon versus precipitation

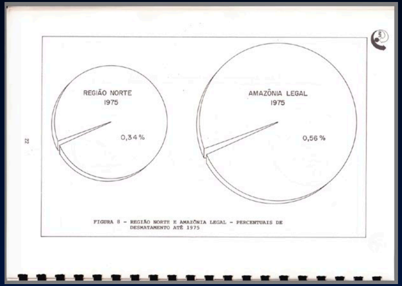
Amazon, Congo Basin, and Southeast Asia

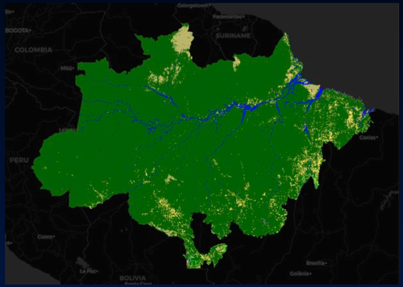


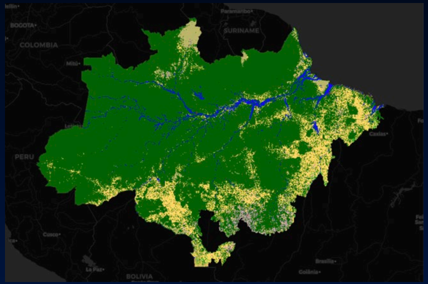
Paulo Brando et al., Annu. Rev. Earth Planet. Sci. 2019. 47:555–81

Carbon and hydrological cycles closely linked

Evolução do desmatamento na Amazônia brasileira







1975

0,5 %

1988

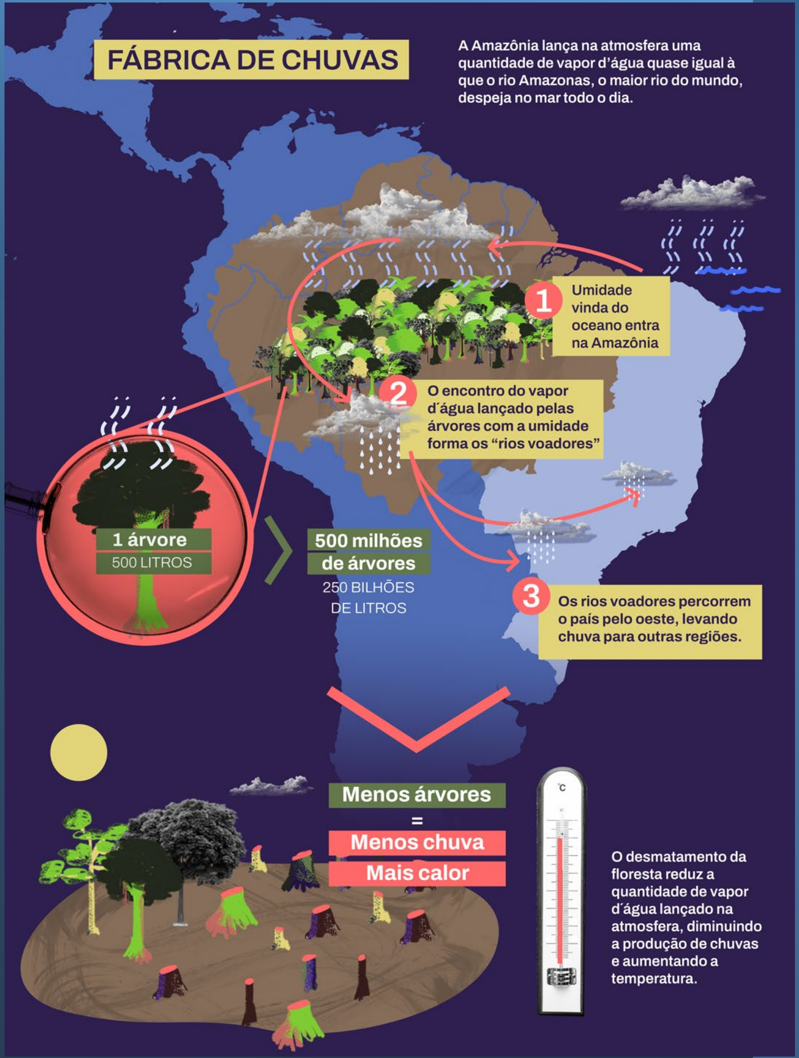
5,0 %

2018

19 %

Souce: Prodes/INPE, MapBiomas

A Amazônia é critica para o transporte de vapor de água para o Brasil central e sul



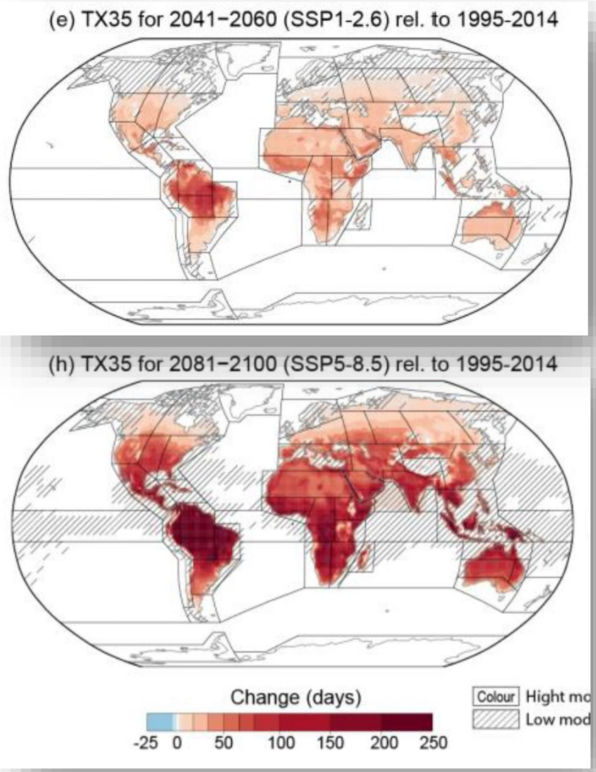
InfoAmazonia, 2022

Cenário 2.6

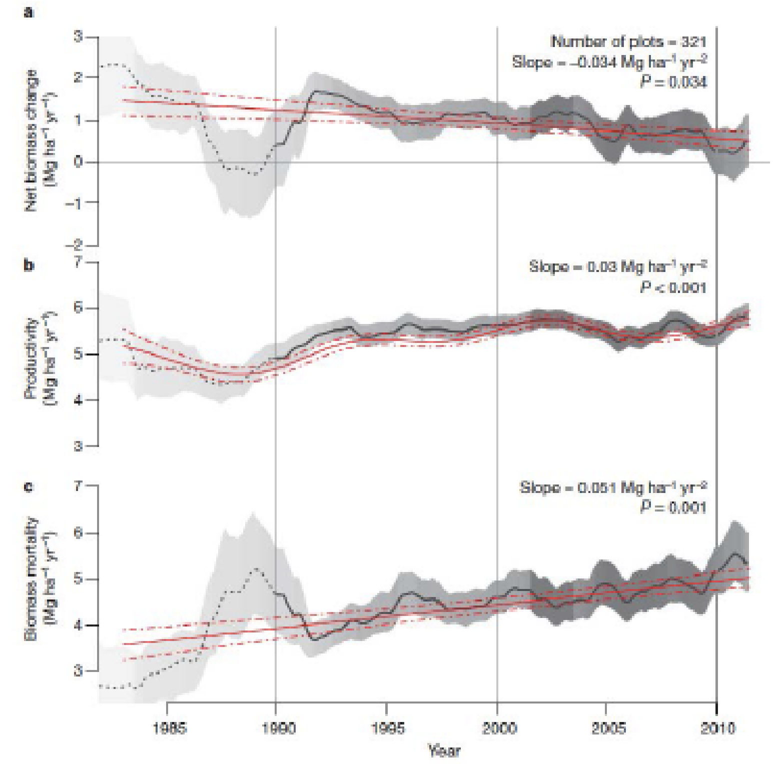
Número de dias por ano com temperatura máxima passando de 35 graus

Cenário 8.5

Simulações CMIP6



Ciclo do Carbono: A Amazônia armazena 100-150 Tg C (10 anos de queima de combustíveis fósseis)



(Brienen et al., 2015)

Fluxo líquido de carbono hoje: ZERO

Mortalidade das árvores: aumento significativo

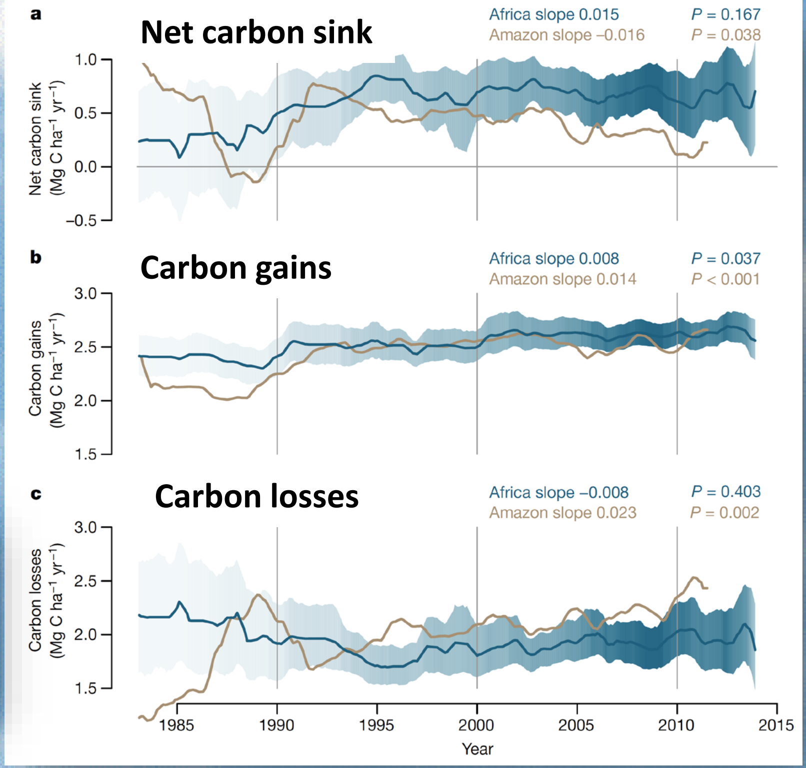
nature

March 5, 2020

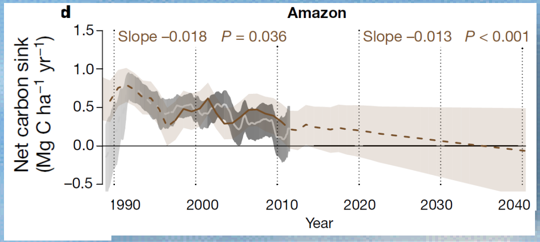
Article

Asynchronous carbon sink saturation in African and Amazonian tropical forests

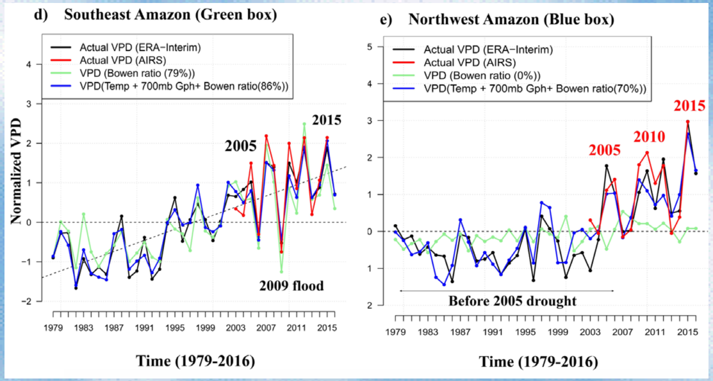
Long-term carbon dynamics of structurally intact oldgrowth tropical forests in Africa and Amazonia.

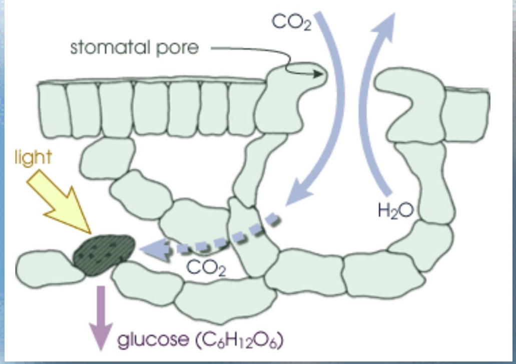


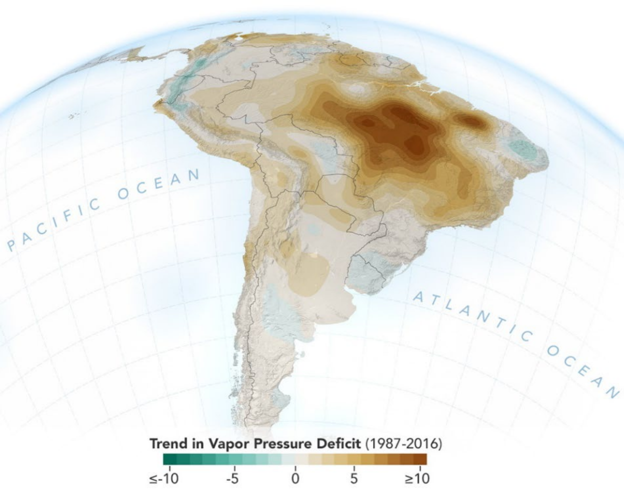
Net Carbon sink 1990-2040



Aumento do Déficit de Pressão de Vapor na atmosfera amazônica: decréscimo na evapotranspiração







O déficit da pressão de vapor ou VPD é a diferença entre a quantidade de umidade no ar e quanta umidade o ar pode conter quando está saturado

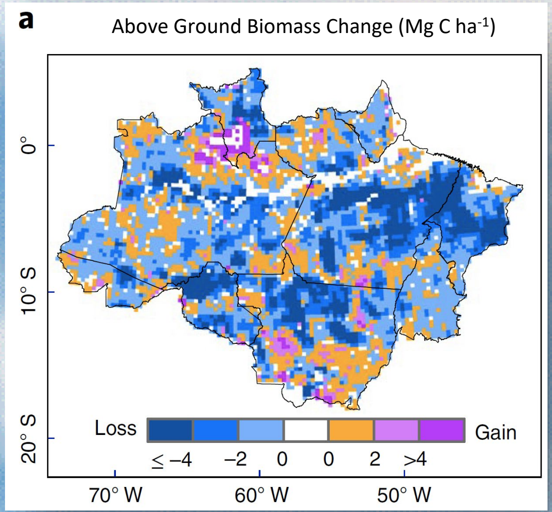
O aumento da VPD combinado com o decréscimo da fração evaporativa são as primeiras indicações de mecanismos de feedback positivos na Amazônia.

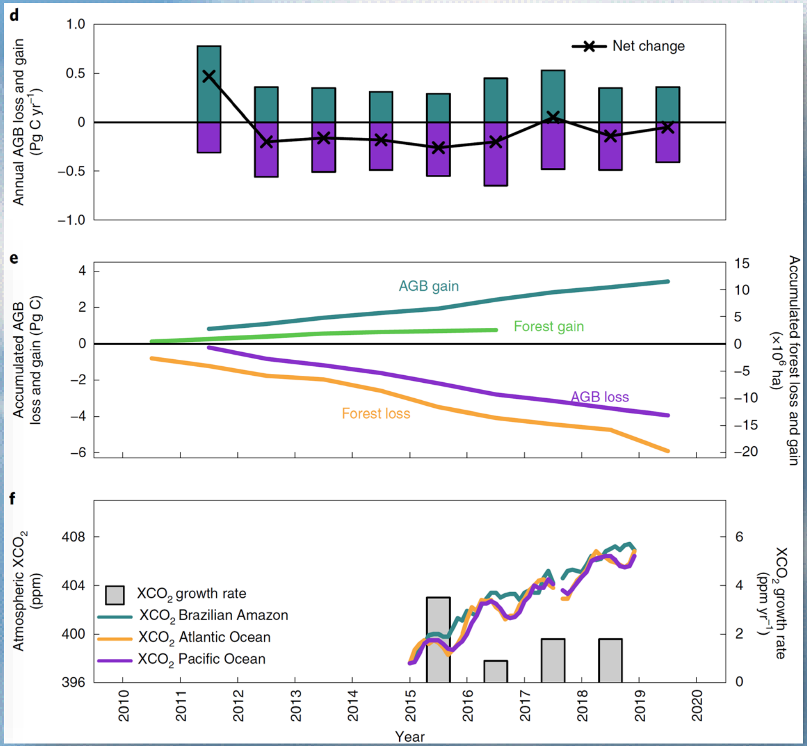
Barkhordarian et al., Nature Scientific Reports, doi : 10.1038/s41598-019-51857-8, 2019


ARTICLES | FOCUS
https://doi.org/10.1038/s41558-021-01026-5
nature climate change
Check for updates

Carbon loss from forest degradation exceeds that from deforestation in the Brazilian Amazon

Yuanwei Qin[1], Xiangming Xiao[1], Jean-Pierre Wigneron[2], Philippe Ciais[3], Martin Brandt[4], Lei Fan[5], Xiaojun Li[2], Sean Crowell[6], Xiaocui Wu[1], Russell Doughty[1,7], Yao Zhang[8], Fang Liu[9], Stephen Sitch[10] and Berrien Moore III[6]

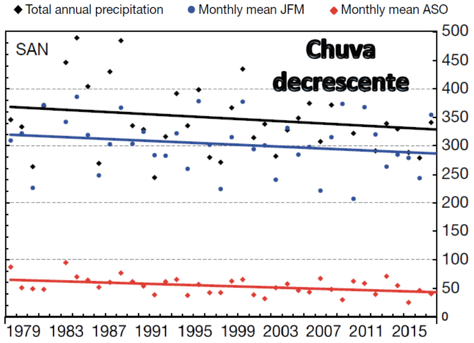


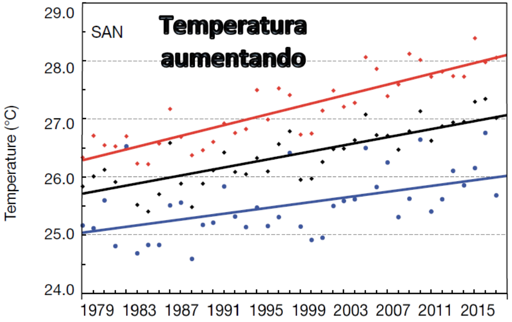


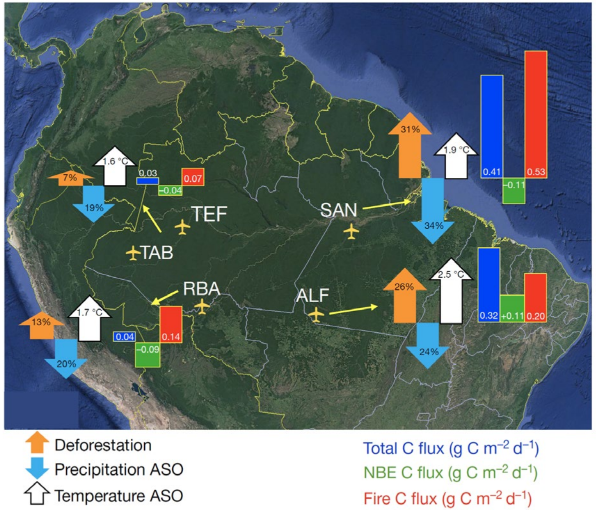
Durante 2010–2019,a Amazônia brasileira teve uma perda bruta cumulativa de 4,45 Pg C contra um ganho bruto de 3,78 Pg C, resultando em uma perda líquida de biomassa de 0,67 Pg C. A degradação florestal (73%) contribuiu três vezes mais para a perda bruta de biomassa do que o desmatamento (27%), Isso indica que a degradação florestal se tornou a maior processo que leva à perda de carbono.

Yuanwei Qin et al., Nature Climate Change, Maio de 2021

Balanço de carbono na Amazônia: desmatamento e mudança climática







Amazonia pode já estar se tornando uma fonte importante de carbono para a atmosfera global

Balanço de carbono para a região de Alta Floresta de 2010 a 2018

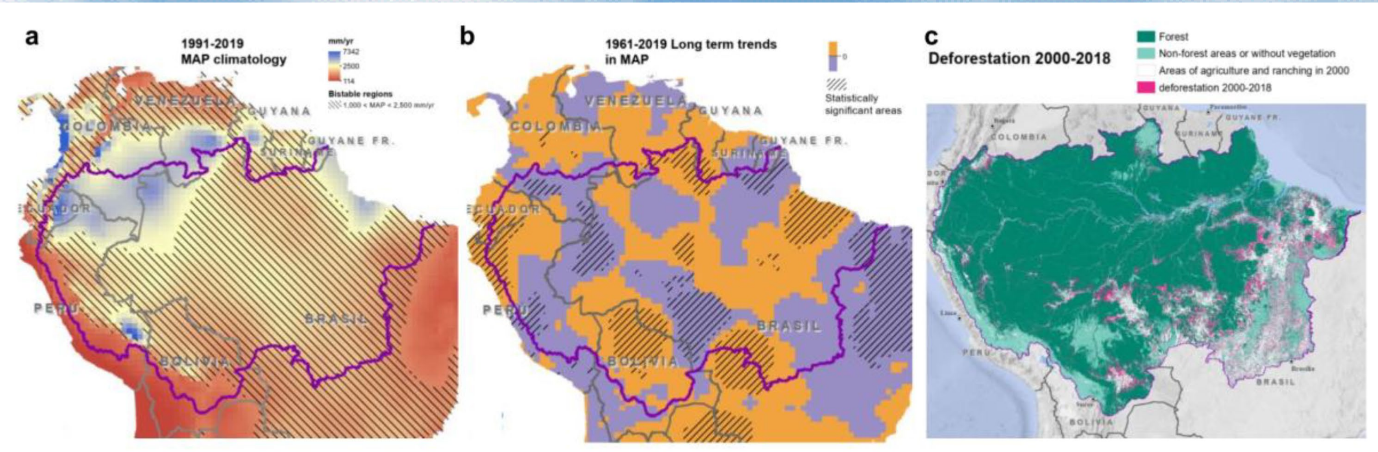
Total Carbon Balance: +0.32 PgC y^{-1}

Fire Carbon Balance: +0.20 PgC y^{-1}

NBE (Net Biome Exchange) C Balance: +0.11 PgC y^{-1}

Gatti et al., Nature, 2021

Tipping points?
Forest resilience is being reshaped across the Amazon



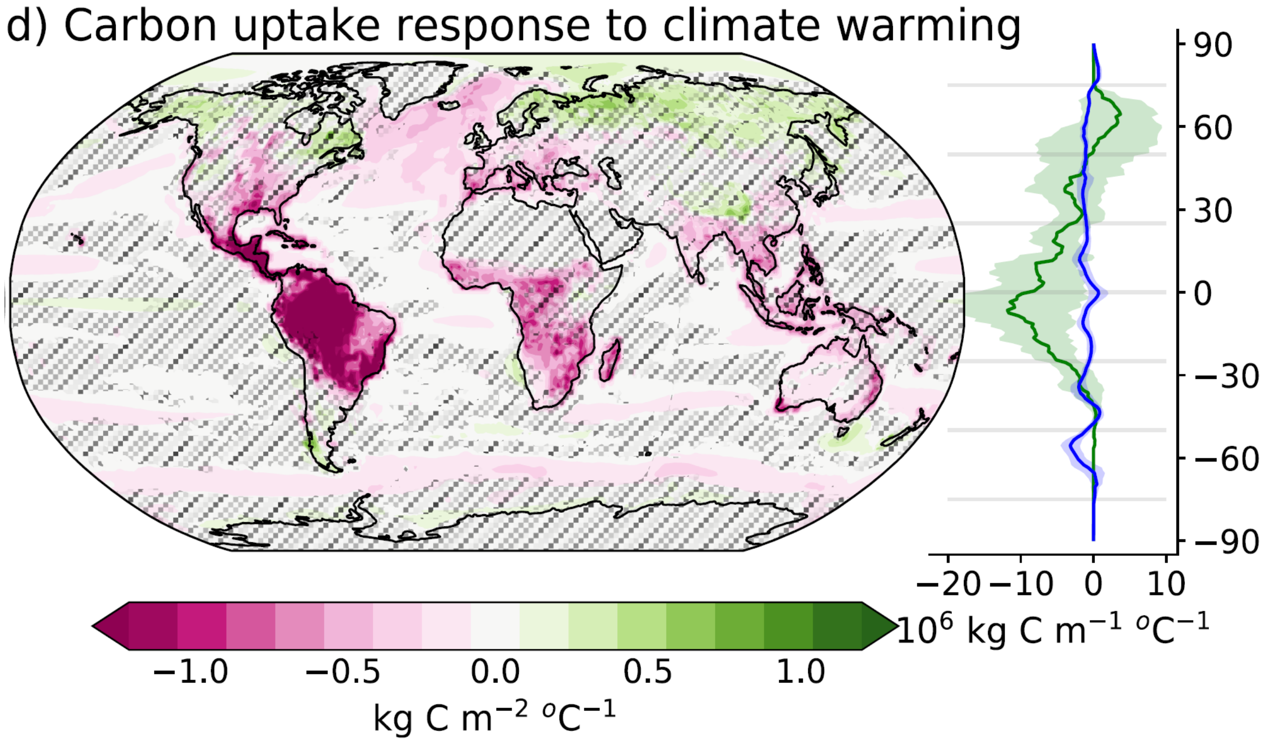
(A) Amount of annual rainfall 209 and bistable regions, where the system could become trapped in a low tree cover state due to disturbances, for instance from extreme events, deforestation, and degradation. (B) Observed trends in annual rainfall condition change. (C) Deforestation frontiers.

Table 1. Amazonian tipping points, their stressors, disturbances and feedbacks involved.

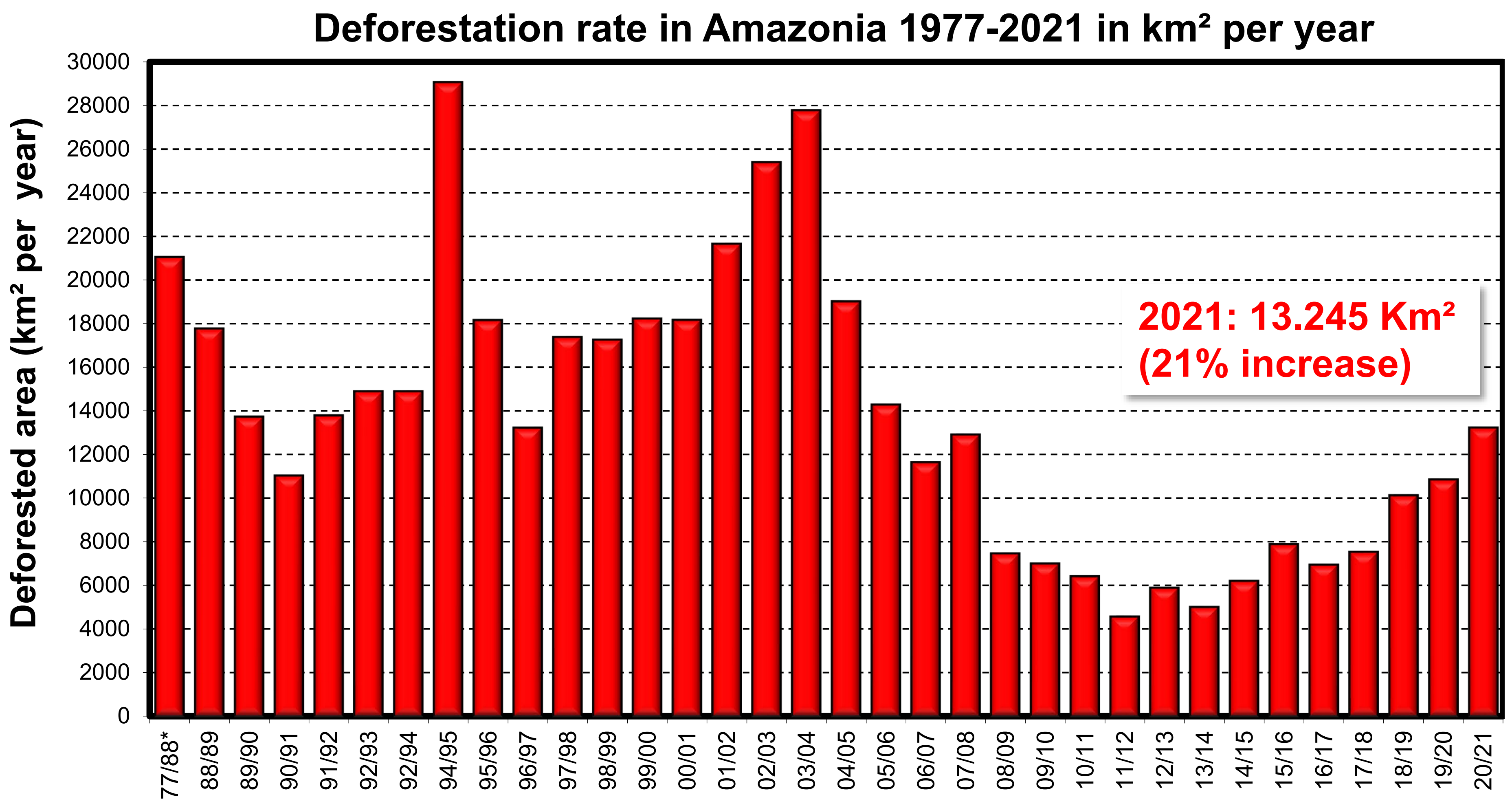
Stressors	Tipping points	Related disturbances	Positive feedback components	Evidence types
Rise in temperature	> 2°C global, > 2.5° C local	Heat waves, droughts, fires	Forest - rainfall - fires	Modelling, paleorecords, current observations
Annual rainfall	< 1,000 mm MAP	Droughts, storms, windthrows, floods	Forest - rainfall - fires	Modelling, paleorecords, current observations
Rainfall seasonality	7 months DSL > 400 mm MCWD	Droughts, fires	Forest - rainfall - fires	Modelling, paleorecords, current observations
Accumulated deforestation	> 20 % of whole Amazon system	Droughts, deforestation, fires	Forest - rainfall - fires - deforestation	Modelling

Hirota et al., SPA 2022

What about Amazonia? Could become a carbon source?



P.S: Amazonia contains 120 GtC (10 years of fossil fuel emissions)


Deforestation rate in Amazonia 1977-2021 in km² per year
Deforested area (km² per year)
30000
28000
26000
24000
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
2021: 13.245 Km²
(21% increase)
77/88*
88/89
89/90
90/91
91/92
92/93
92/94
94/95
95/96
96/97
97/98
98/99
99/00
00/01
01/02
02/03
03/04
04/05
05/06
06/07
07/08
08/09
09/10
10/11
11/12
12/13
13/14
14/15
15/16
16/17
17/18
18/19
19/20
20/21

COP-26: The Glasgow climate pact

- The COP-26 shows the large distance between Science and geopolitical interests
- IPCC: We need to reduce emissions by 45% till 2030

- Increase in temperature with all pledges: 3.2 Celsius, instead of 1.5 Celsius

- Agreement on zero deforestation globally by 2030. Brazil commitment of zero deforestation in 2028

- Agreement on methane reductions: 30% by 2030
  - Impacts on cattle on Brazil: gains on productivity
  - Impact on natural gas production and use: gains in productivity

- Global carbon market rules settle down

- No acceptance of “loss and damages”

UN CLIMATE CHANGE CONFERENCE UK 2021
IN PARTNERSHIP WITH ITALY

COP-26: The Glasgow climate pact

- Net zero targets: ideally: 2030 for developed countries and 2040 for developing countries
- Reality: COP-26 recommends that this target be reached by the “Middle of the century”.
- India: 2070, China: 2060, Brazil: 2050, Germany 2045, USA: 2040.

- First time ever that any COP documents mention fossil fuels. No mention to phase out coal, and pledge to reduce subsides to ”inefficient fossil fuels”.

- Financial help to developing countries to reduce their emissions and adapt to climate change: NO. Target was US$100 billions per year. COP-26: we wee negotiate this at COP-27.

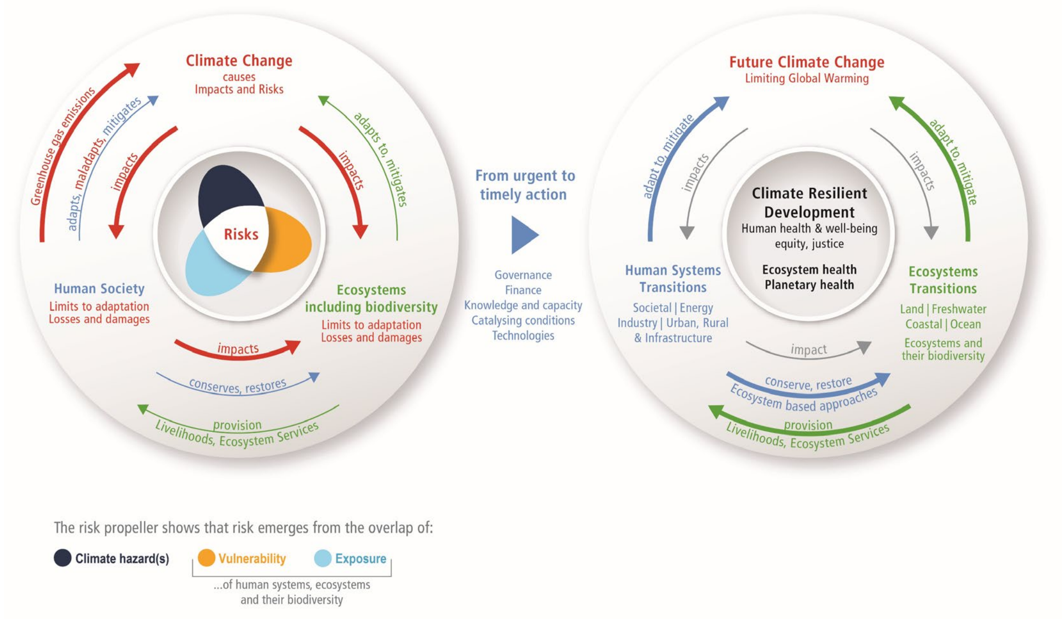
- Recommendations and commitments from Paris agreement and Glasgow pact are not mandatory. They are only political commitments...

The need to change the socio-economic system

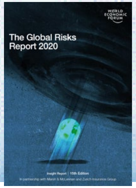
Dos riscos climáticos ao desenvolvimento resiliente ao clima

Principais interações e tendencias

Opções para reduzir o risco climático e construir resiliência



Fórum Econômico Mundial: O relatório dos Riscos Globais em 2020



Os 5 maiores riscos globais em termos de probabilidades 2007-2020

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1st	Infrastructure breakdown	Blow up in asset prices	Asset price collapse	Asset price collapse	Storms and cyclones	Income disparity	Income disparity	Income disparity	Interstate conflict	Involuntary migration	Extreme weather	Extreme weather	Extreme weather	Extreme weather
2nd	Chronic diseases	Middle East instability	China economic slowdown	China economic slowdown	Flooding	Fiscal imbalances	Fiscal imbalances	Extreme weather	Extreme weather	Extreme weather	Involuntary migration	Natural disasters	Climate action failure	Climate action failure
3rd	Oil price shock	Failed and failing states	Chronic diseases	Chronic disease	Corruption	Greenhouse gas emissions	Greenhouse gas emissions	Unemployment	Failure of national governance	Climate action failure	Natural disasters	Cyberattacks	Natural disasters	Natural disasters
4th	China hard landing	Oil price shock	Global governance gaps	Fiscal crises	Biodiversity loss	Cyberattacks	Water crises	Climate action failure	State collapse or crisis	Interstate conflict	Terrorist attacks	Data fraud or theft	Data fraud or theft	Biodiversity loss
5th	Blow up in asset prices	Chronic diseases	Deglobalization (emerging)	Global governance gaps	Climate change	Water crises	Population ageing	Cyberattacks	Unemployment	Natural catastrophes	Data fraud or theft	Climate action failure	Cyberattacks	Human-made environmental disasters

Economic Environmental Geopolitical Societal Technological

Os 5 maiores riscos globais em termos de impactos 2007-2020

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1st	Blow up in asset prices	Blow up in asset prices	Asset price collapse	Asset price collapse	Fiscal crises	Financial failure	Financial failure	Fiscal crises	Water crises	Climate action failure	Weapons of mass destruction	Weapons of mass destruction	Weapons of mass destruction	Climate action failure
2nd	Deglobalization	Deglobalization (developed)	Deglobalization (developed)	Deglobalization (developed)	Climate change	Water crises	Water crises	Climate action failure	Infectious diseases	Weapons of mass destruction	Extreme weather	Extreme weather	Climate action failure	Weapons of mass destruction
3rd	Interstate and civil wars	China hard landing	Oil and gas price spike	Oil price spikes	Geopolitical conflict	Food crises	Fiscal imbalances	Water crises	Weapons of mass destruction	Water crises	Water crises	Natural disasters	Extreme weather	Biodiversity loss
4th	Pandemics	Oil price shock	Chronic diseases	Chronic disease	Asset price collapse	Fiscal imbalances	Weapons of mass destruction	Unemployment	Interstate conflict	Involuntary migration	Natural disasters	Climate action failure	Water crises	Extreme weather
5th	Oil price shock	Pandemics	Fiscal crises	Fiscal crises	Energy price volatility	Energy price volatility	Climate action failure	Infrastructure breakdown	Climate action failure	Energy price shock	Climate action failure	Water crises	Natural disasters	Water crises

Economic Environmental Geopolitical Societal Technological

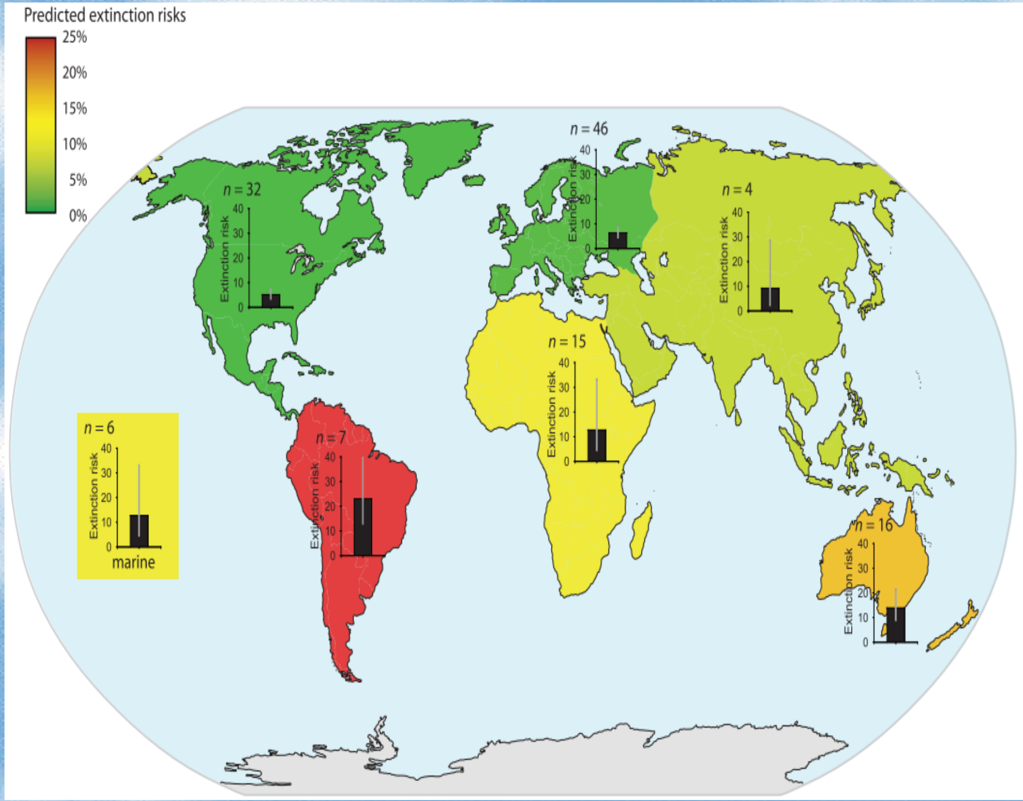
2020

- Extreme weather
- Climate action failure
- Natural disasters
- Biodiversity loss
- Human-made environmental disasters

P.S.: Não são preocupações de cientistas, ONGs ou grupos ambientais, mas do WEF…

Source: World Economic Forum Global Risks Perception Survey 2019-2020.

Risco de perdas de espécies biológicas

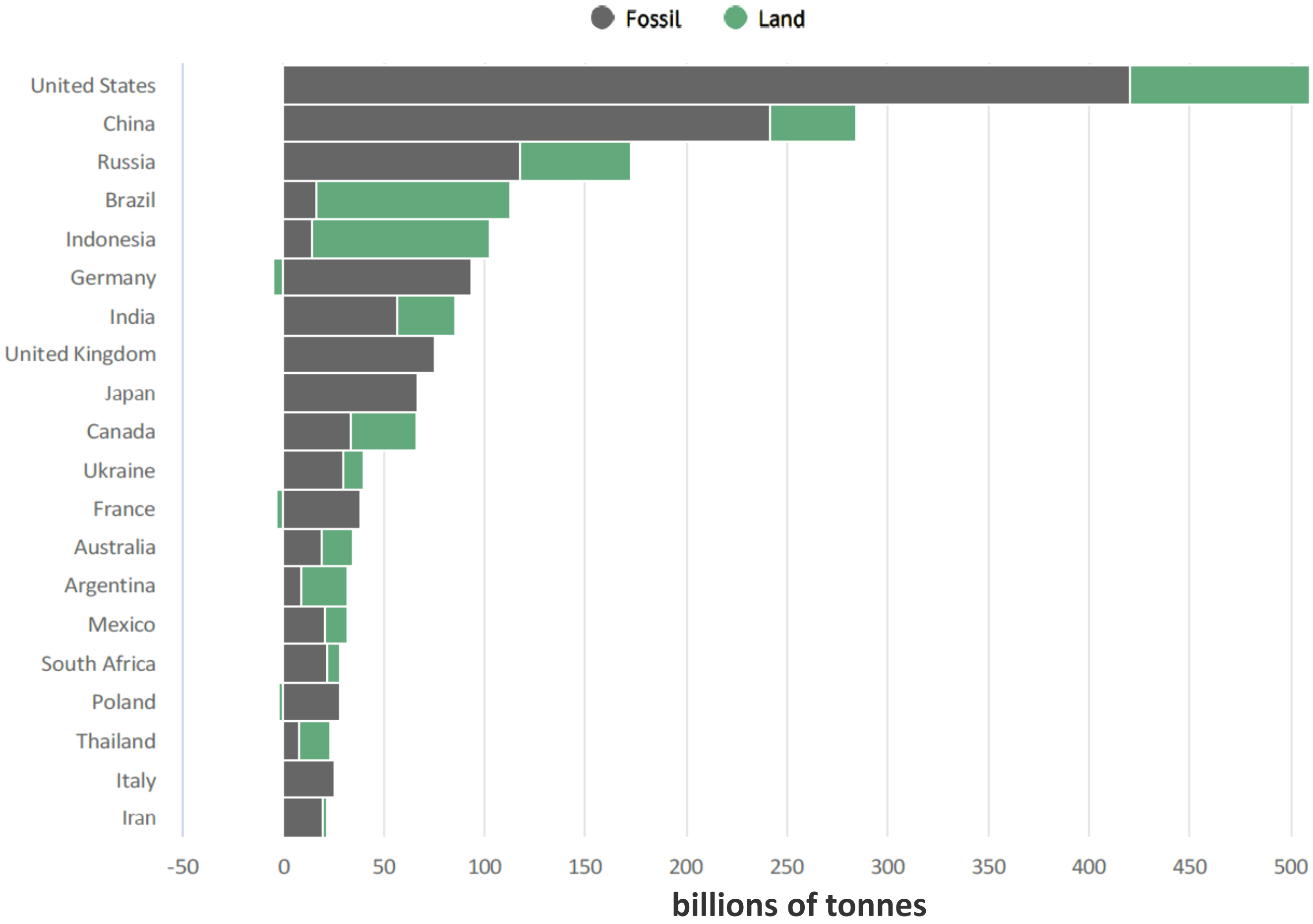


Os maiores riscos: América do Sul, Austrália (14 a 23%)

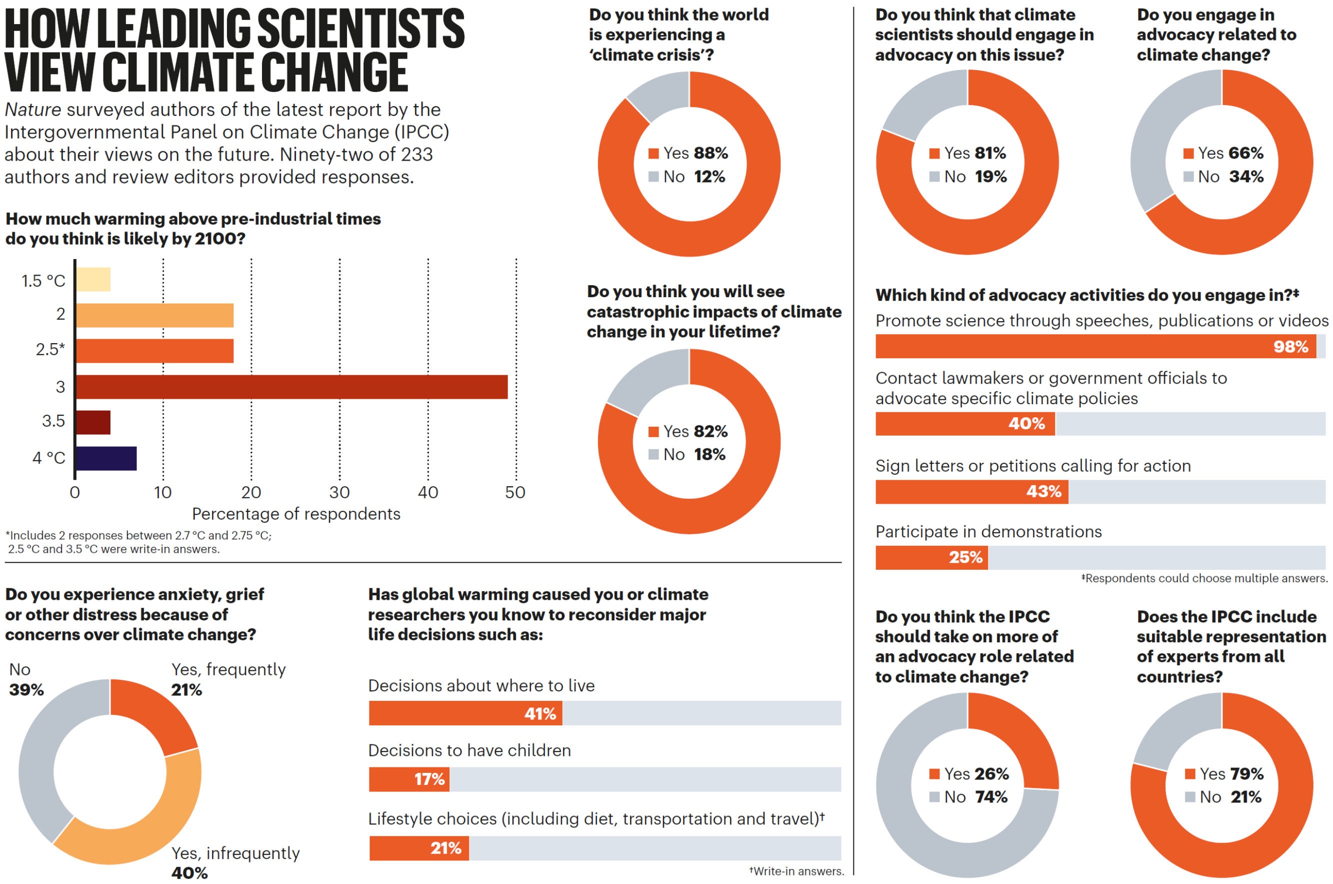
Fonte: Urban M.C-Nature, 2015


Will fusion power run out of fuel before it even gets started? p. 1372
Building amines from nitriles pp. 1382 & 1433
Most turtles and tortoises age slowly pp. 1384, 1459, & 1466
Science
$15
24 JUNE 2022
SPECIAL ISSUE
science.org
AAAS
A CHOICE OF FUTURES
Humanity can still avert climate catastrophe p. 1392

The 20 largest contributors to cumulative CO2 emissions 1850-2021, billions of tonnes



https://www.carbonbrief.org/analysis-which-countries-are-historically-responsible-for-climate-change



Nature Vol 599, 4/Nov/2021

There are options available **now** in every sector that can at least **halve** emissions by 2030

Demand and services

Energy

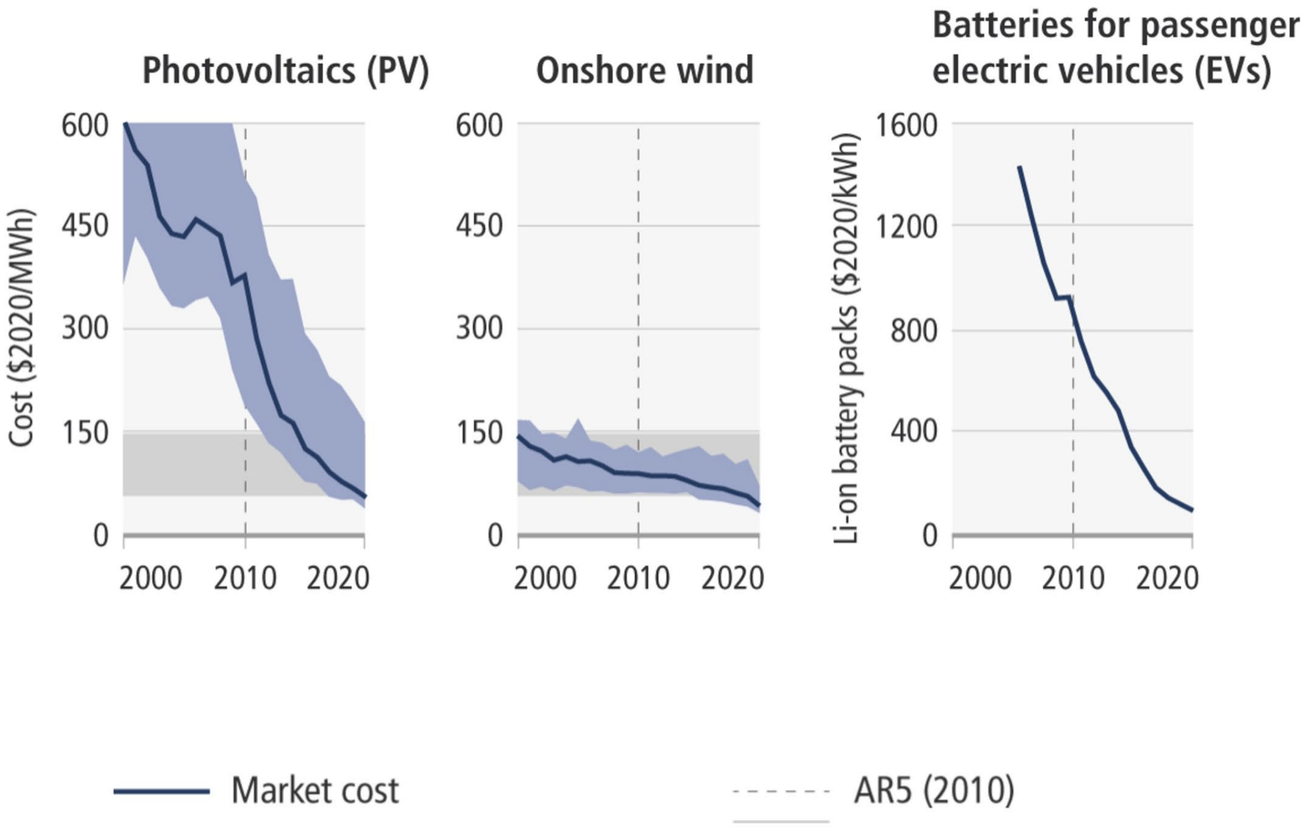
Land use

Industry

Urban

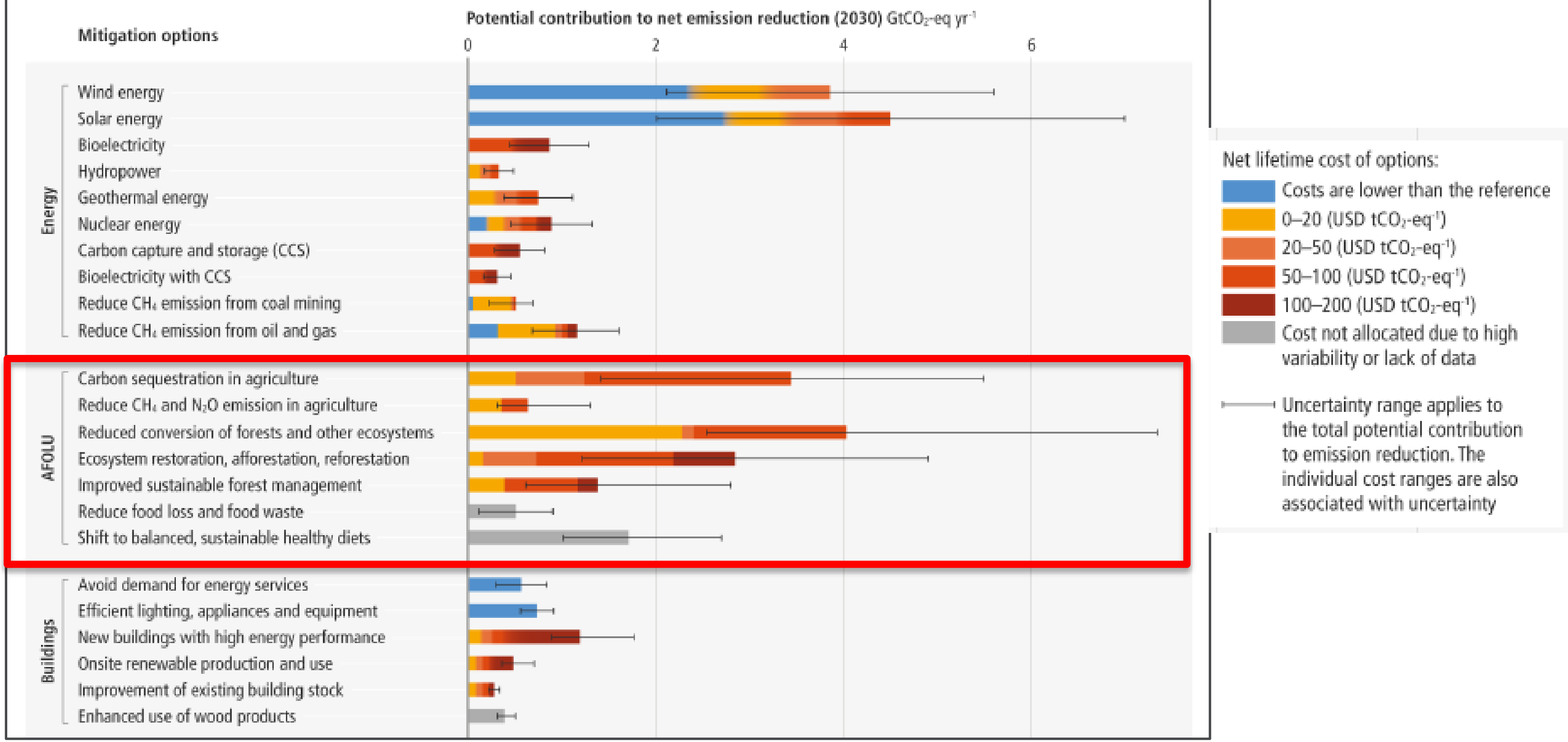
Buildings

Transport



In some cases, costs for renewables have fallen below those of fossil fuels.

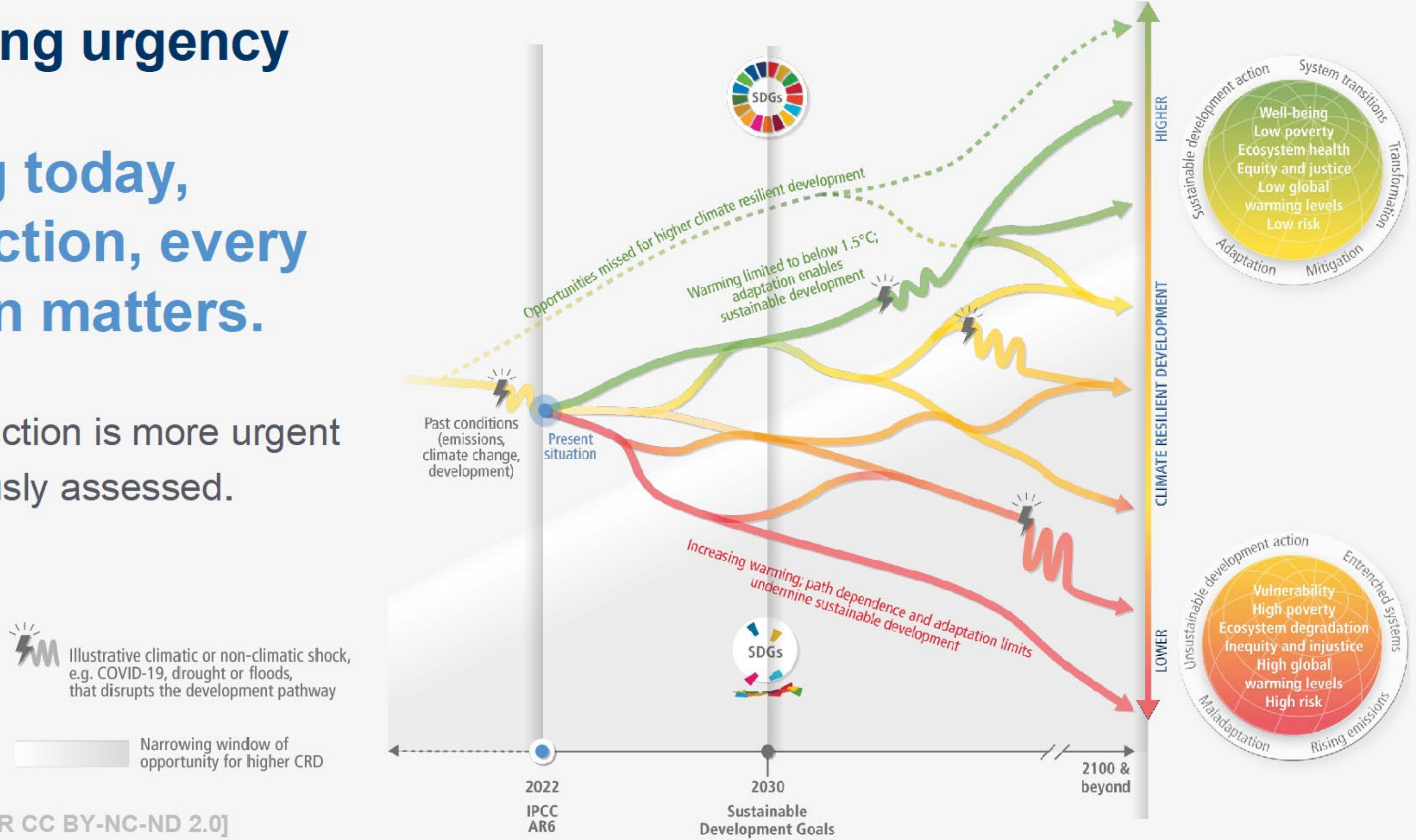
Many options available now in all sectors are estimated to offer substantial potential to reduce net emissions by 2030. Relative potentials and costs will vary across countries and in the longer term compared to 2030.



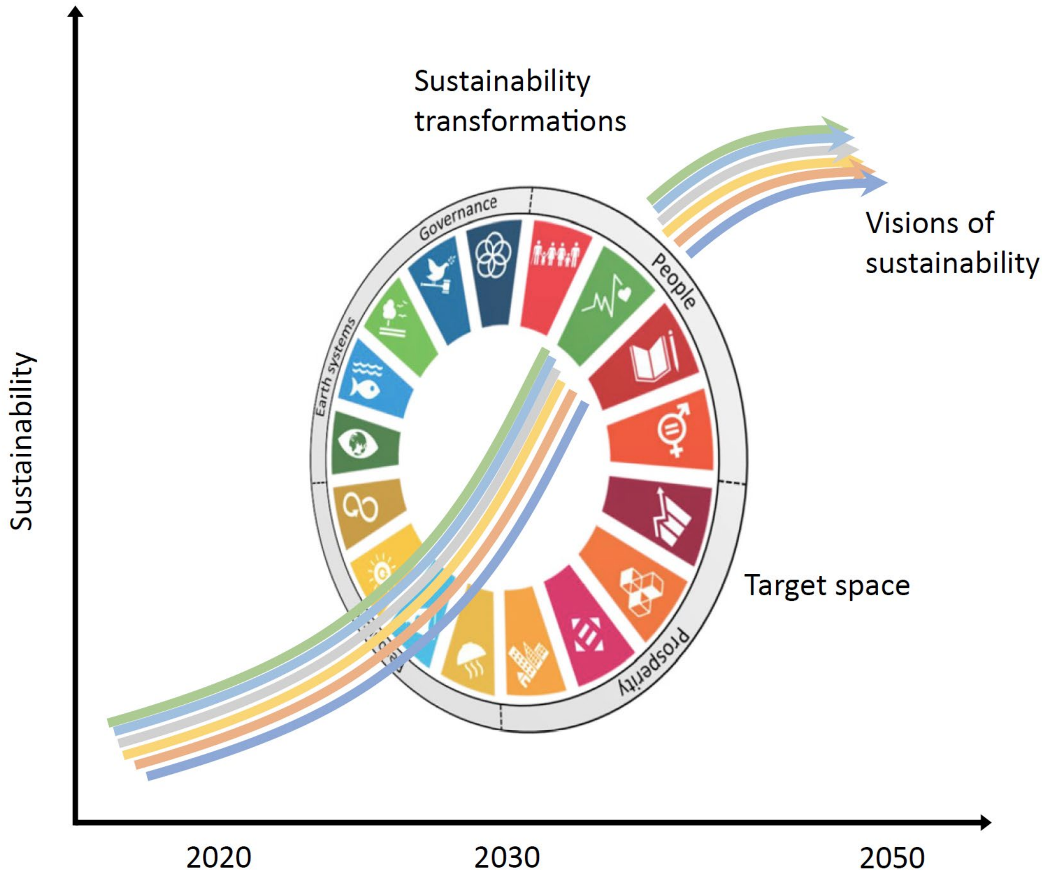
Increasing urgency

Starting today, every action, every decision matters.

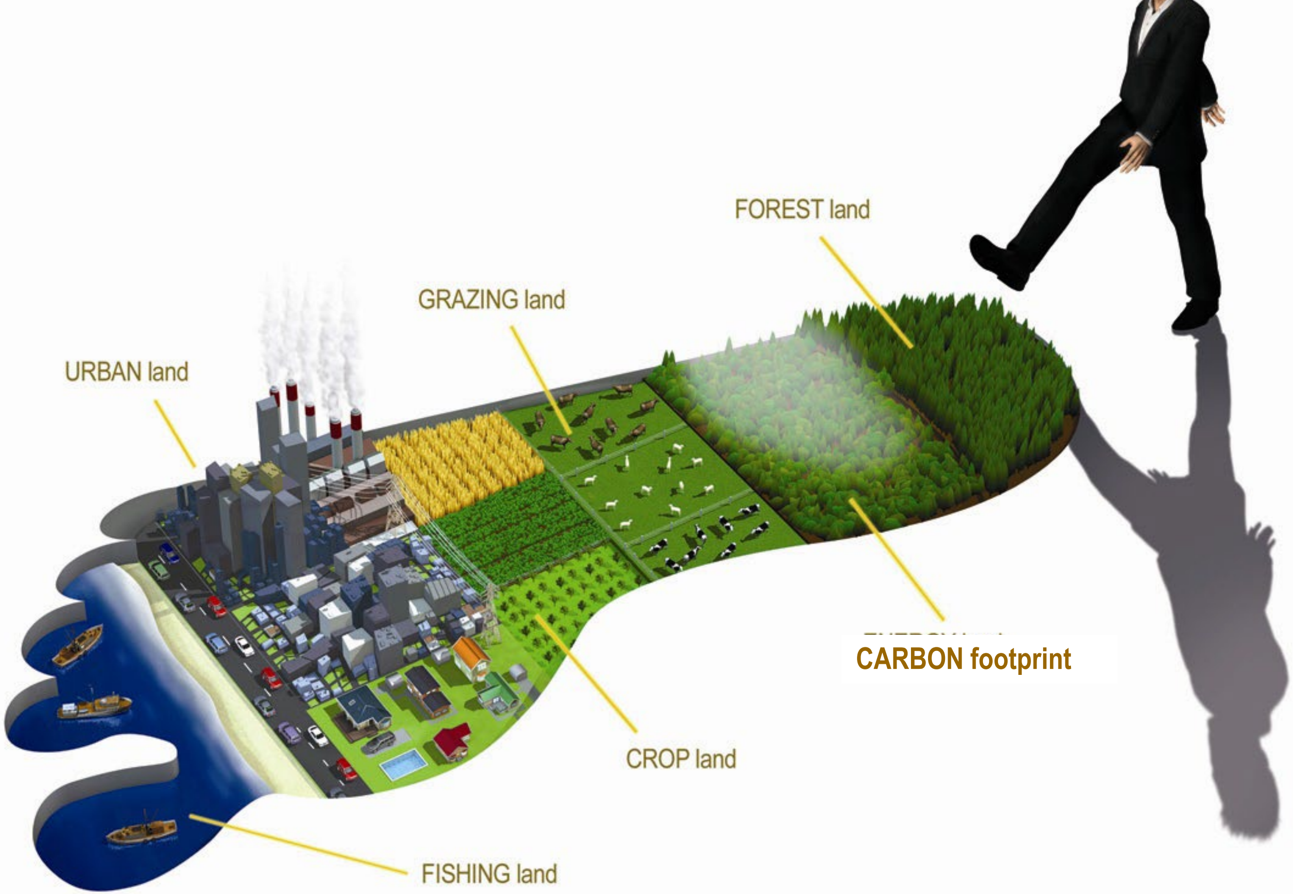
Worldwide action is more urgent than previously assessed.



Transformações da sociedade 2020-2050 visando a sustentabilidade



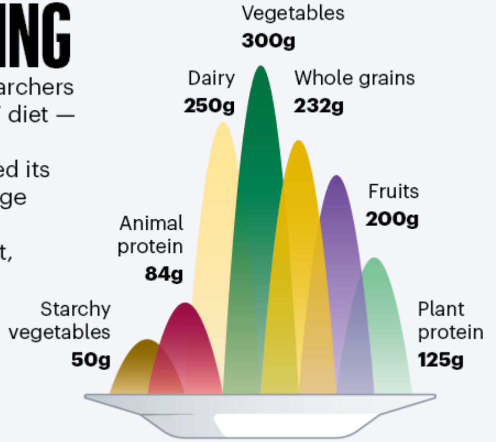
Reduzir nossa pegada ecológica



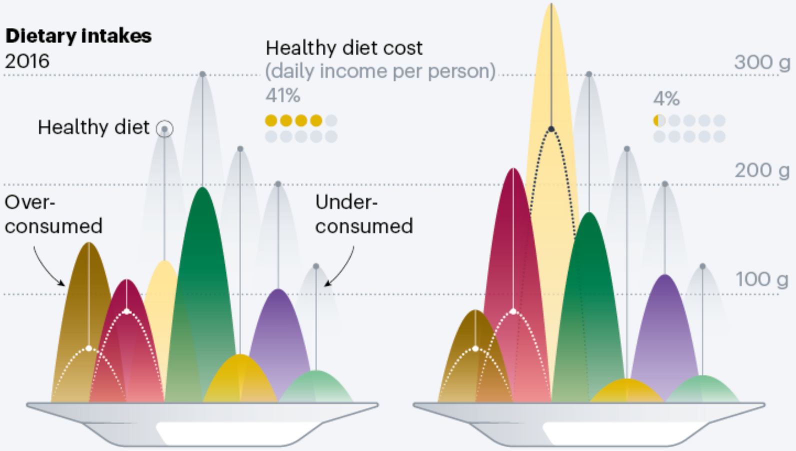
HEALTHY EATING

A commission of food researchers devised a 'planetary health' diet — meant to be nutritious and sustainable — and compared its composition with the average diets in different regions. Further studies showed that, in many regions, following the proposed diet would be prohibitively expensive.

By Kerri Smith
Design by Jasiek Krzysztofiak

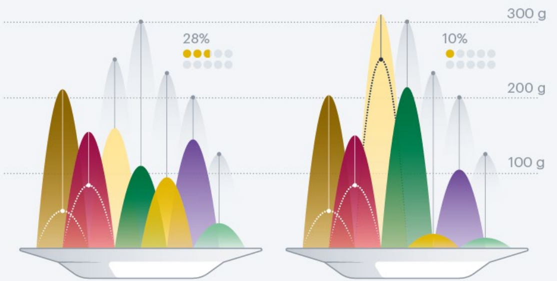


Planetary health diet
grams per day



Global average

North America



Latin America and Caribbean

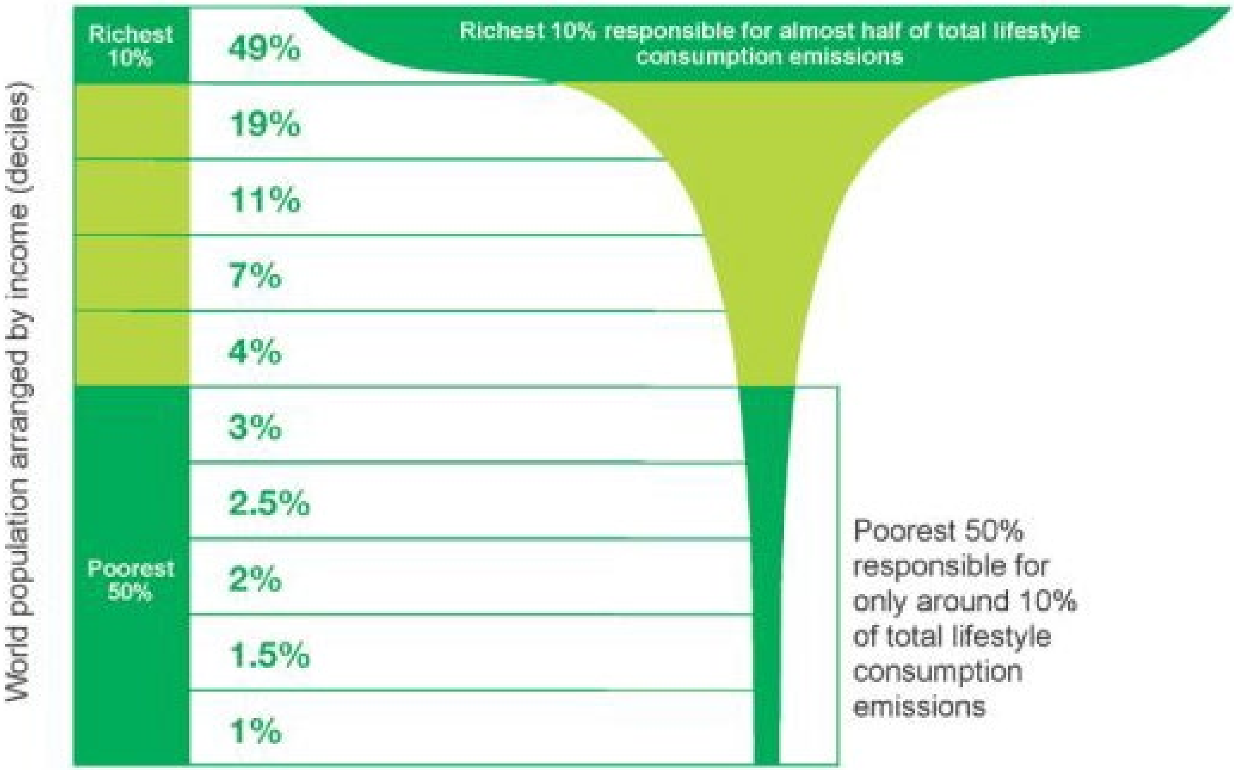
Europe and Central Asia

Sub-Saharan Africa

Percentage of GHG emissions by the world population

The 10% richer emits 49% of GHGs

The most vulnerables 50% poorer emits 10%



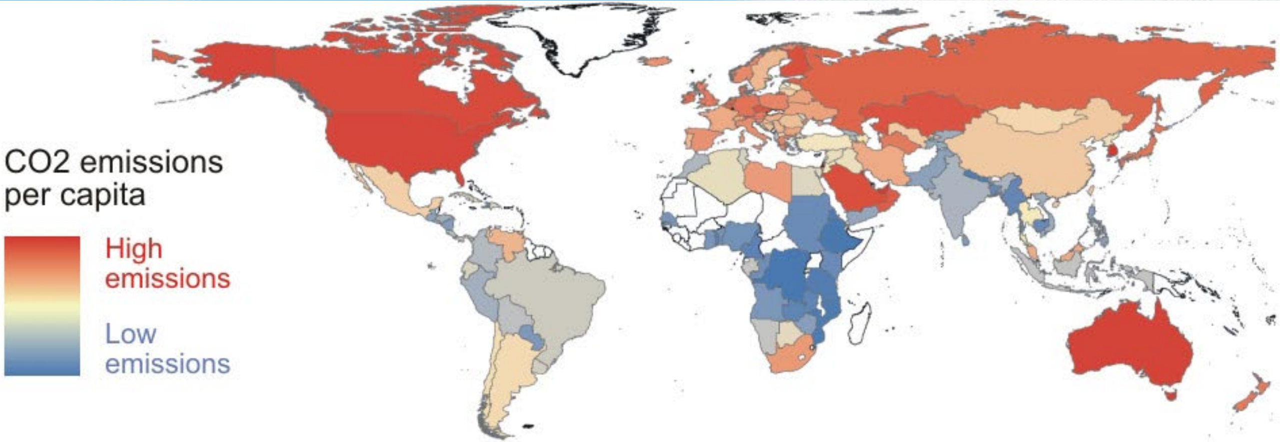
Source: Oxfam

How to build a safe and fair space for humanity?

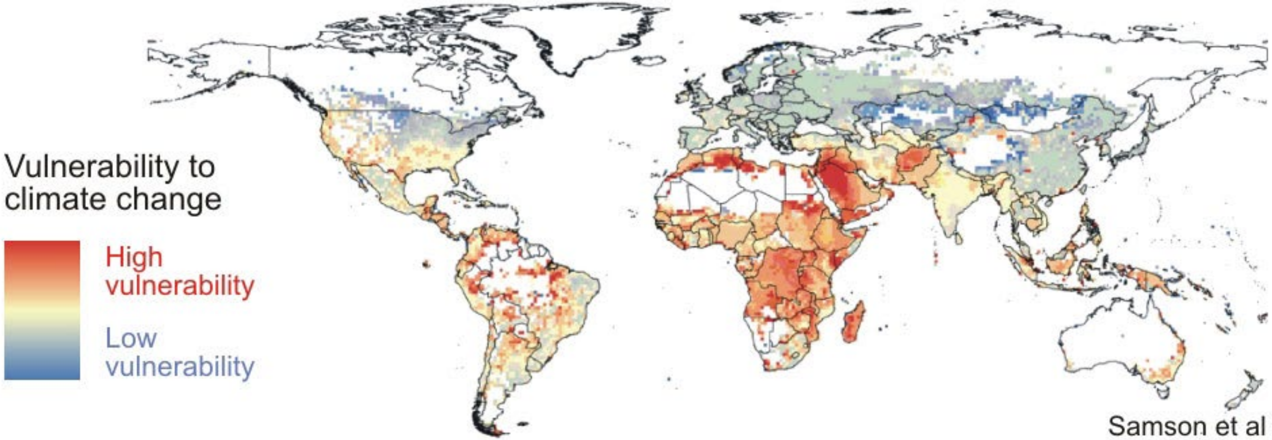
Combining the Earth System with socioeconomic aspects

We need solid and interdisciplinary science to build this space

Steffen et al. 2015, Science



Those who contribute the least greenhouse gases
will be most impacted by climate change



Samson et al 2011

Olhem para o futuro

As seis grandes transformações necessárias para o mundo em 2050

Energia

Decarbonização, eficiência, acesso à energia

Consumo e Produção Sustentáveis

Uso de recursos, economia circular, suficiência, poluição

Alimentos, Usos da Terra & Biosfera

Intensificação sustentável, oceanos, biodiversidade, florestas, água, dietas saudáveis, nutrientes

Objetivos de Desenvolvimento Sustentáveis:

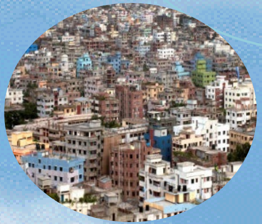
- Prosperidade
- Inclusão social
- Sustentabilidade
- Paz social

Revolução Digital

Inteligência artificial, big data, biotecnologia, nanotecnologia, sistemas autonômos

Cidades

Moradia, mobilidade, Infraestrutura sustentável, água, poluição



Capacitação Humana & Demografia

Educação, saúde, envelhecimento, mercado de trabalho, gênero, desigualdade

The UN 17 sustainable developing goals

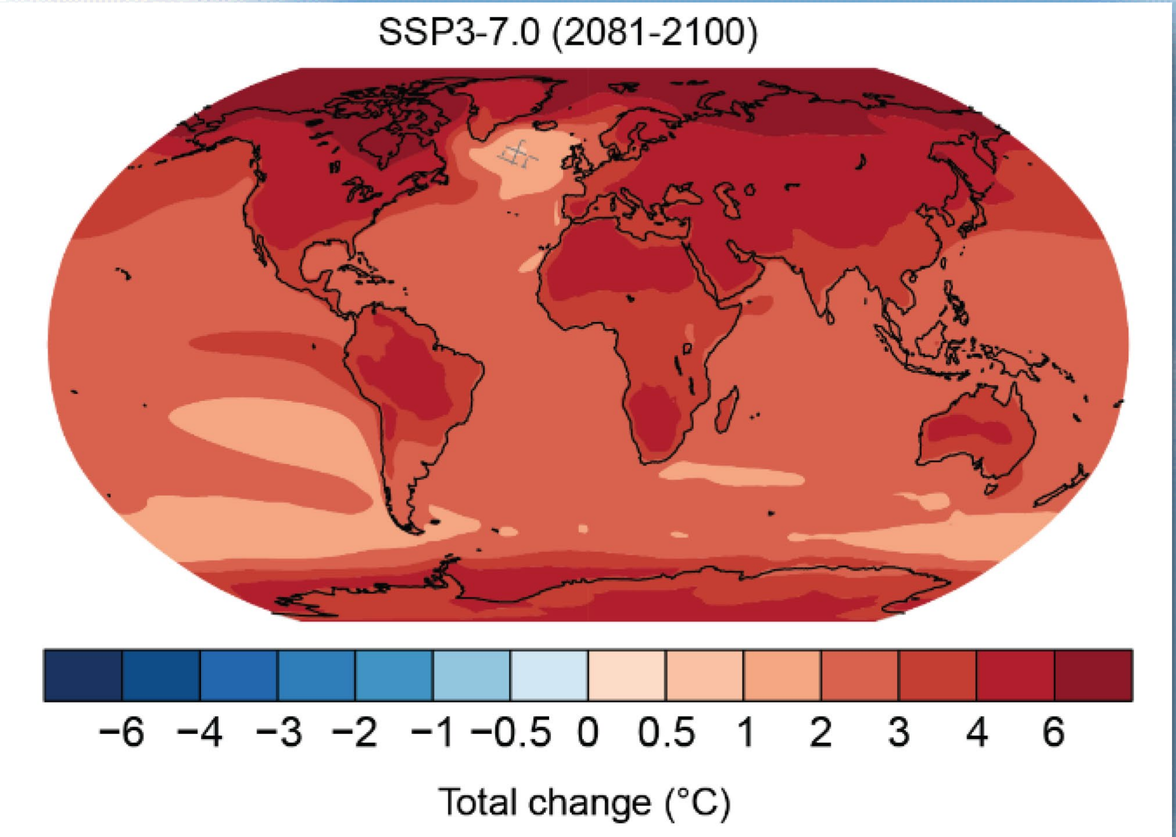
SUSTAINABLE DEVELOPMENT GOALS

SUSTAINABLE DEVELOPMENT GOALS

SDG 13: many other SDG depends on a stable climate

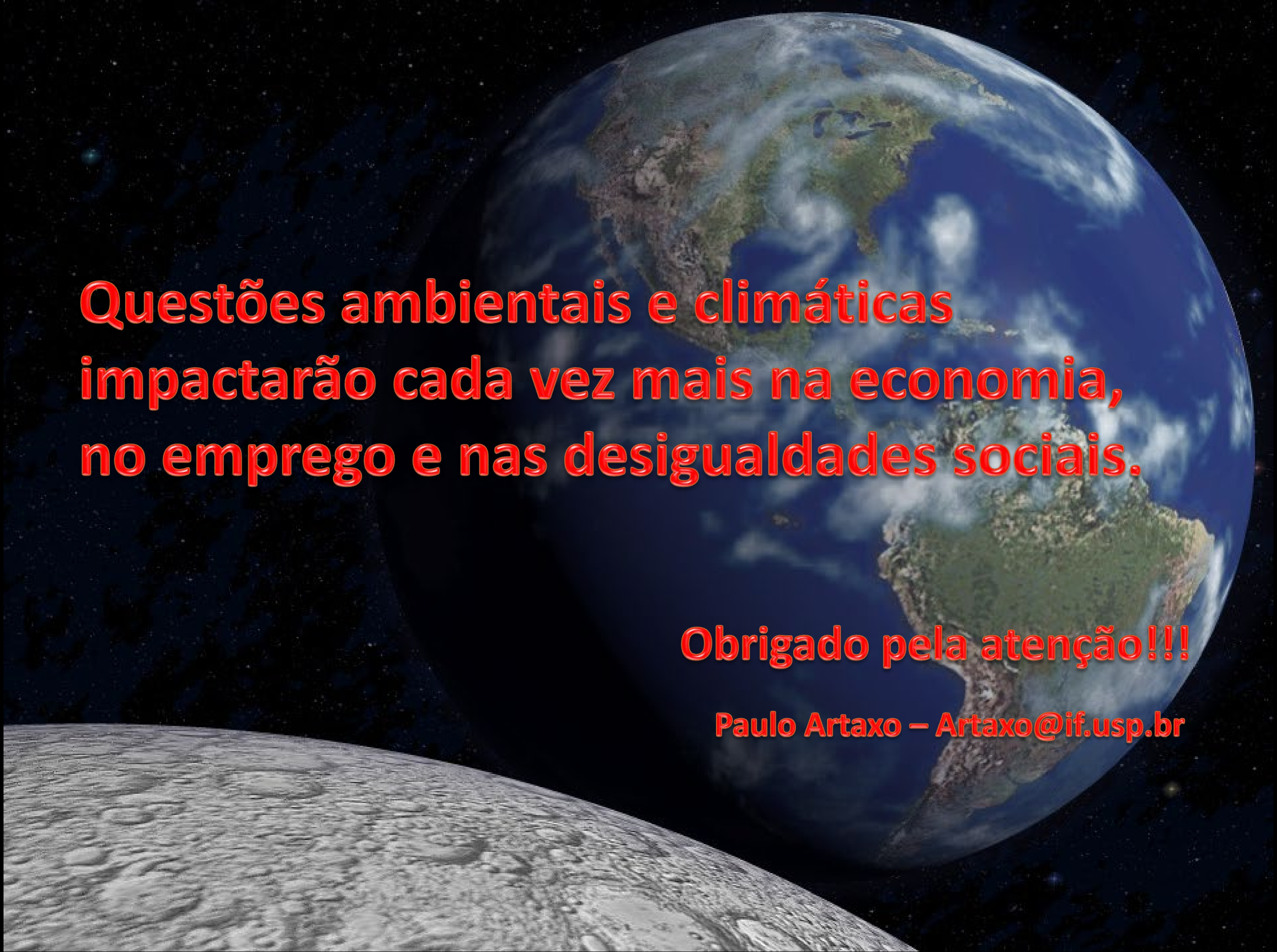
Climatic and environmental issues will have strong economic and social impacts, including jobs, and socioeconomic inequalities

Welcome to the new climate of our planet



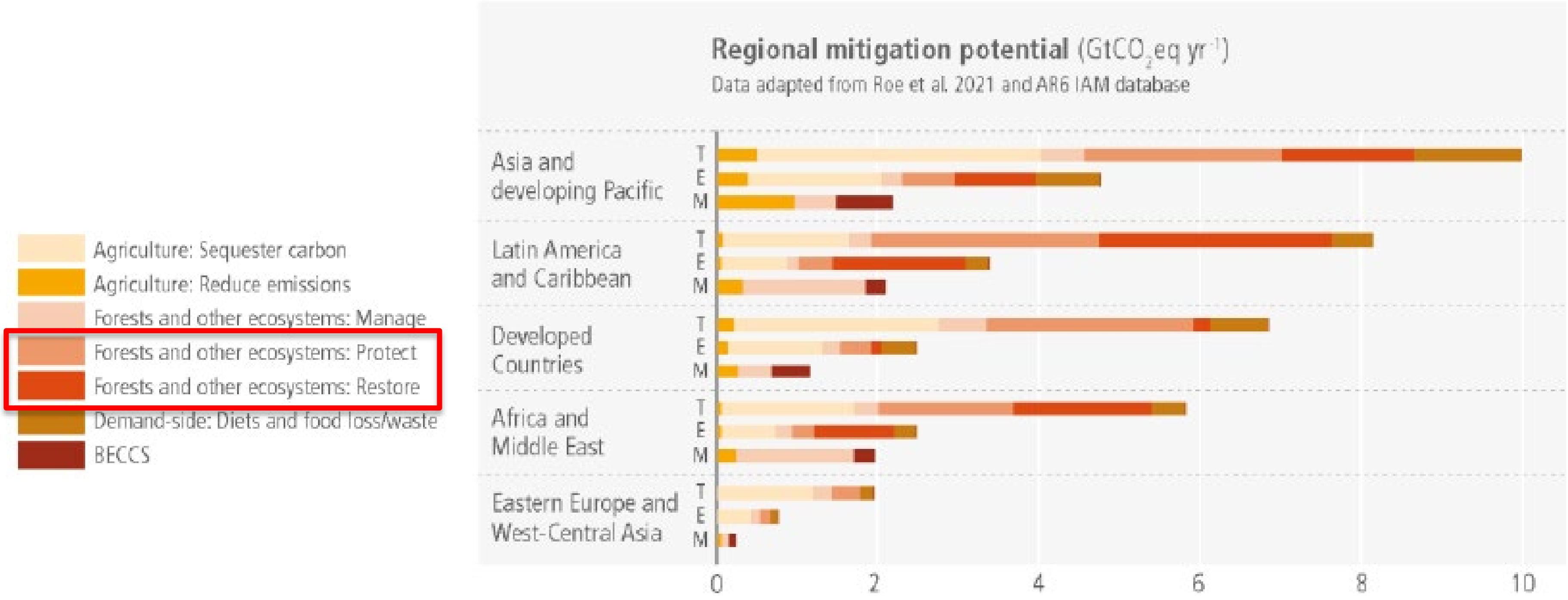
Thanks!!!

Paulo Artaxo – artaxo@if.usp.br

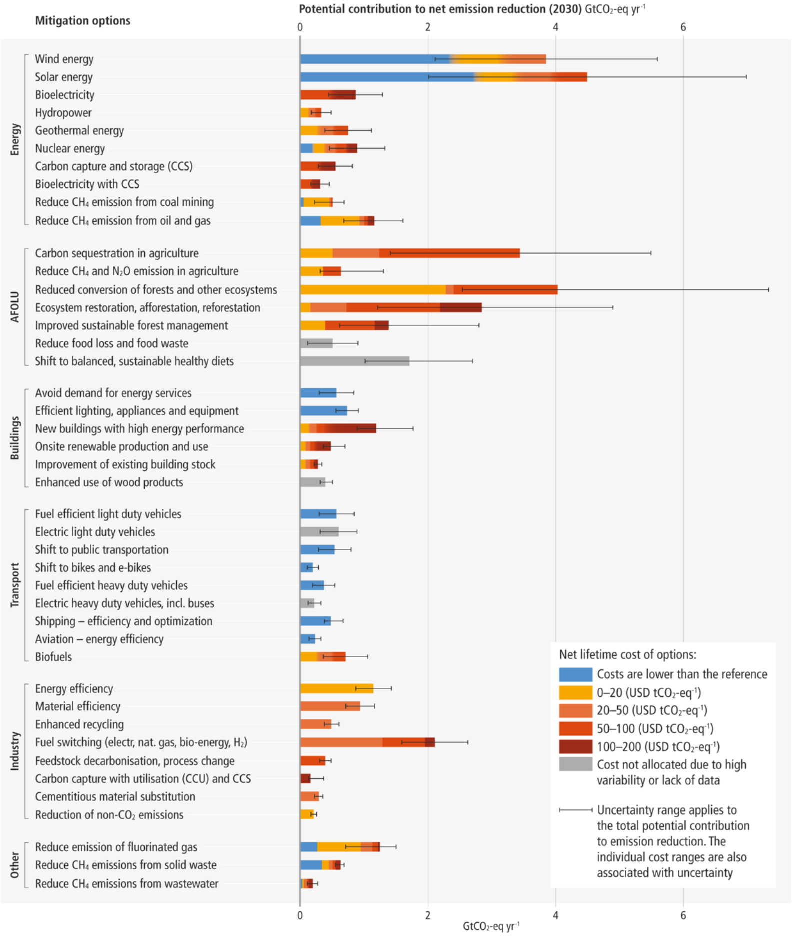

Questões ambientais e climáticas
impactarão cada vez mais na economia,
no emprego e nas desigualdades sociais.
Obrigado pela atenção!!!
Paulo Artaxo – Artaxo@if.usp.br

Extra slides

Potencial regional de mitigação - AFOLU

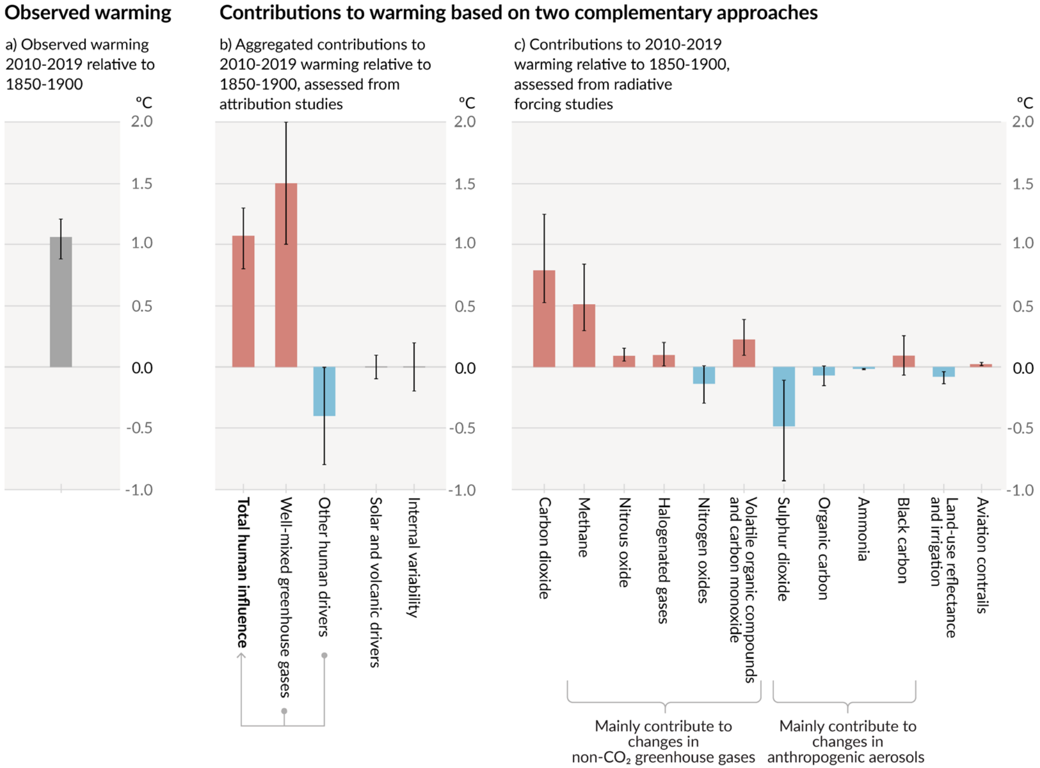


Many options available now in all sectors are estimated to offer substantial potential to reduce net emissions by 2030. Relative potentials and costs will vary across countries and in the longer term compared to 2030.



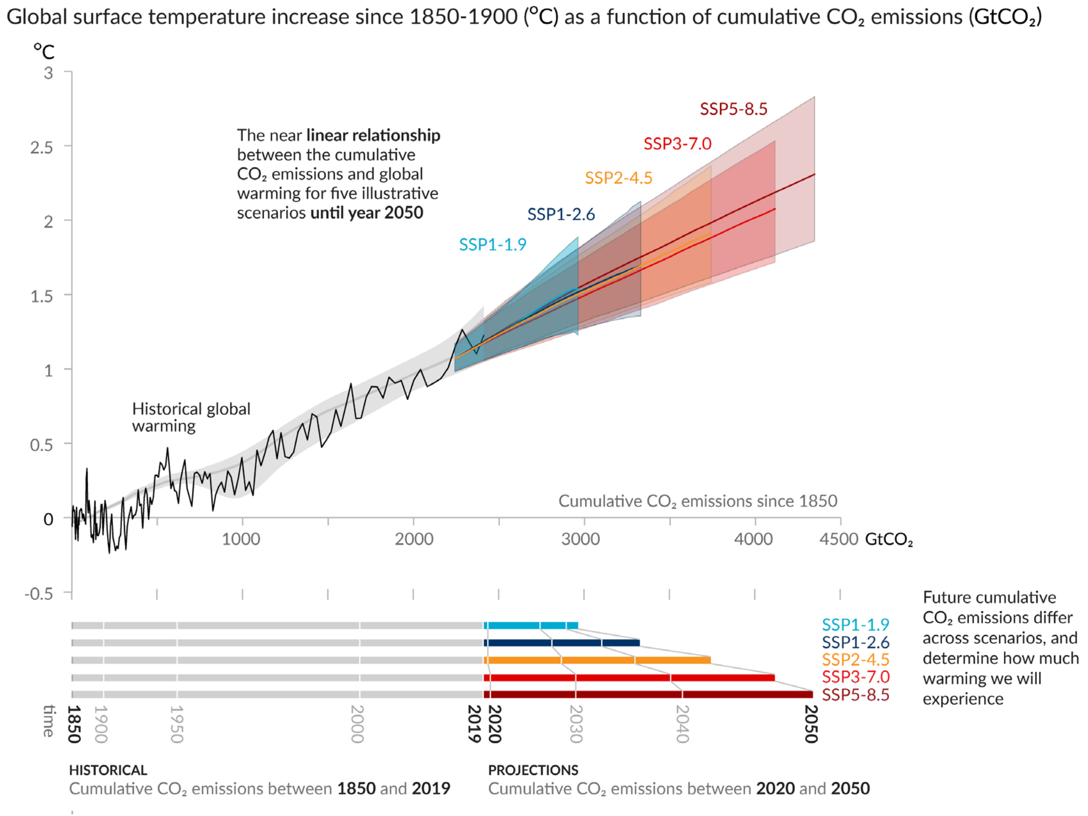
Observed warming is driven by emissions from human activities, with greenhouse gas warming partly masked by aerosol cooling

One third of warming is being masked by aerosols

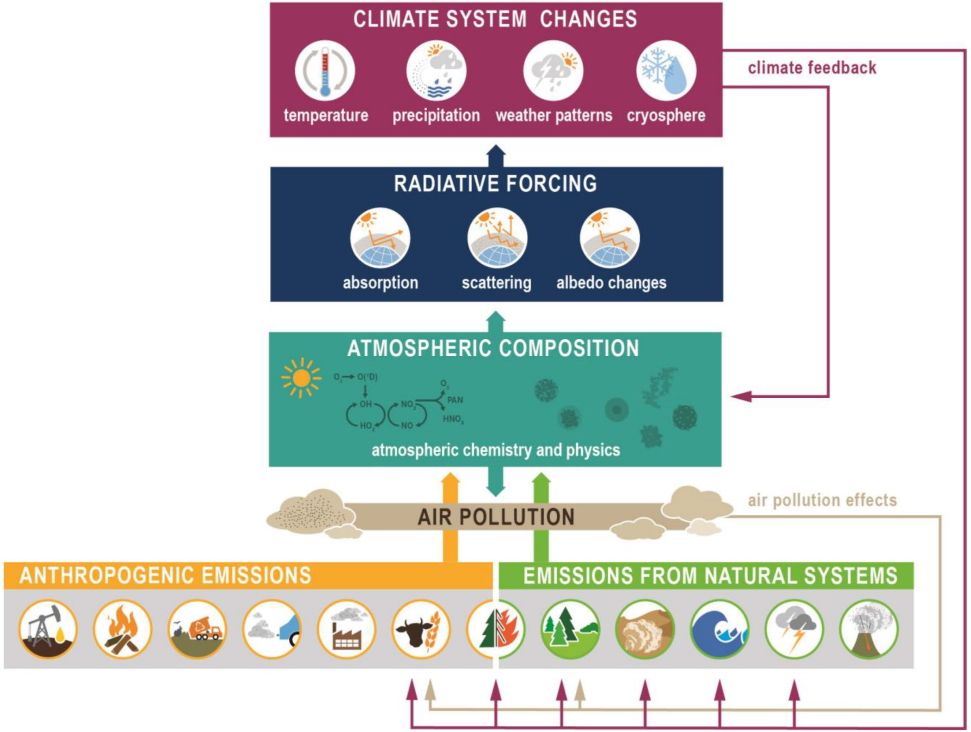


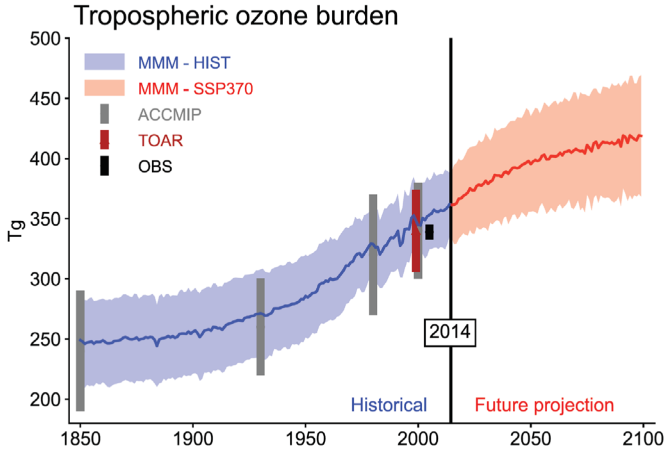
Every ton of CO_2 emissions adds to global warming

Increase in temperature in 2050 (30 years from now)

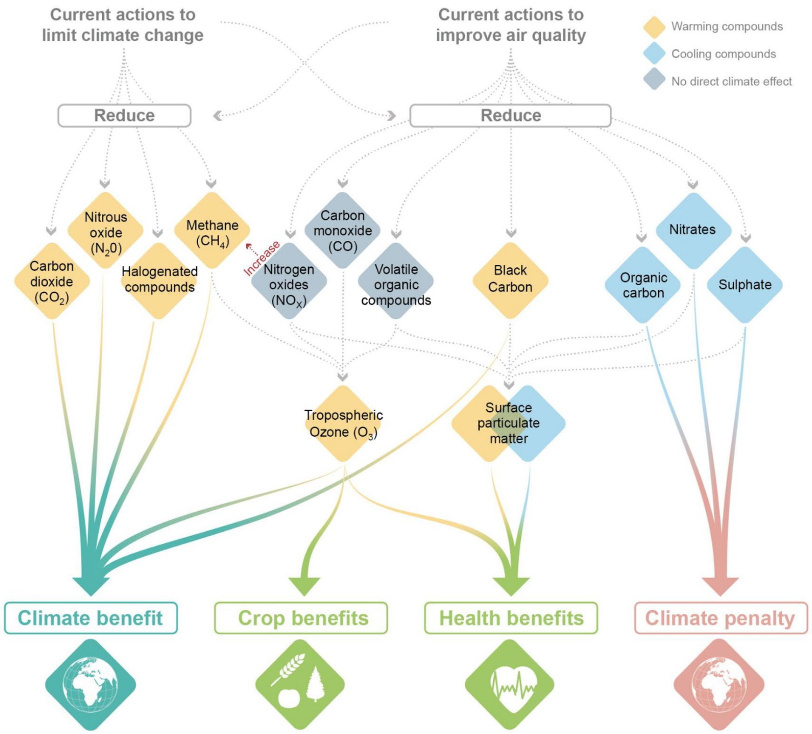


Sources and processes contributing to SLCF and their effects on the climate system





Climate change and air quality are so intimately linked that addressing one issue affect the other one

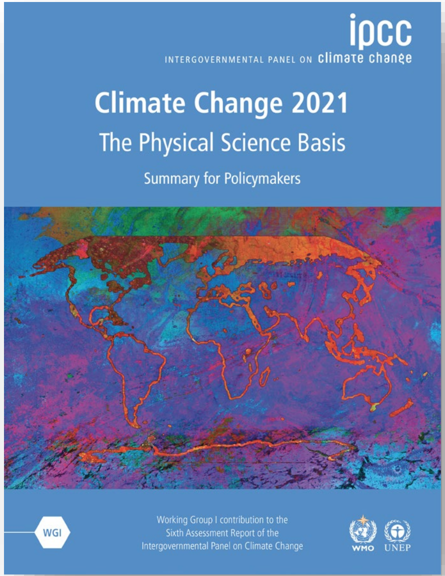


6

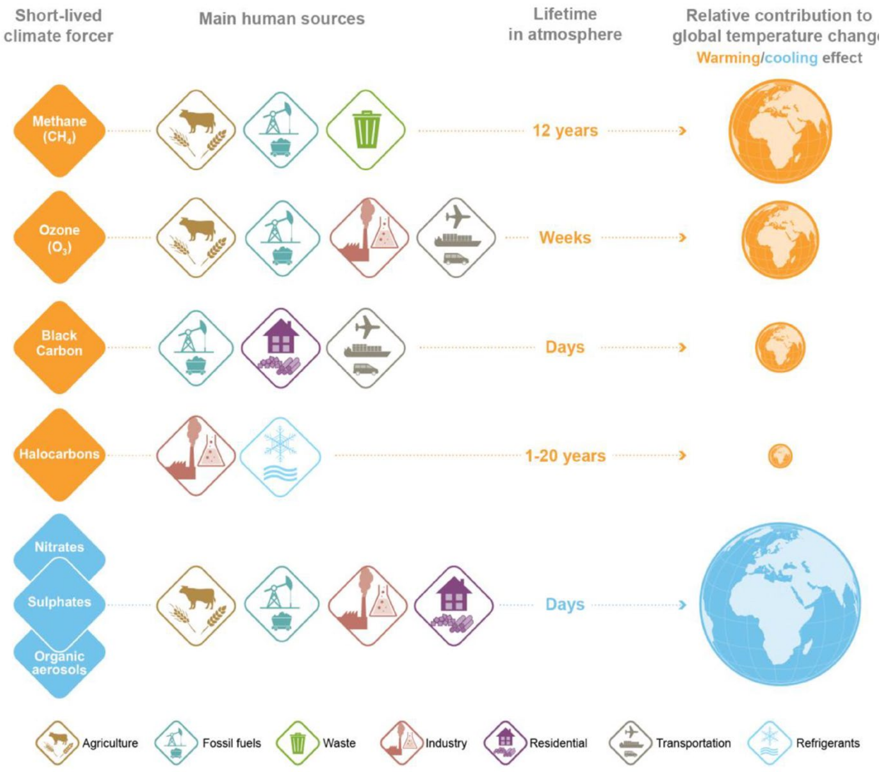
Short-lived Climate Forcers

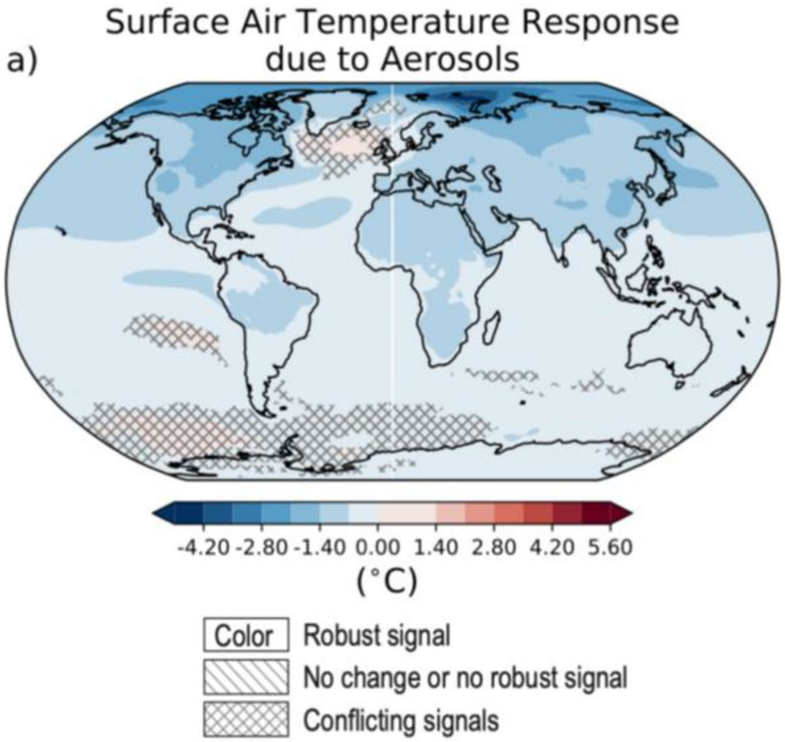
Coordinating Lead Authors:
Sophie Szopa (France), Vaishali Naik (United States of America)

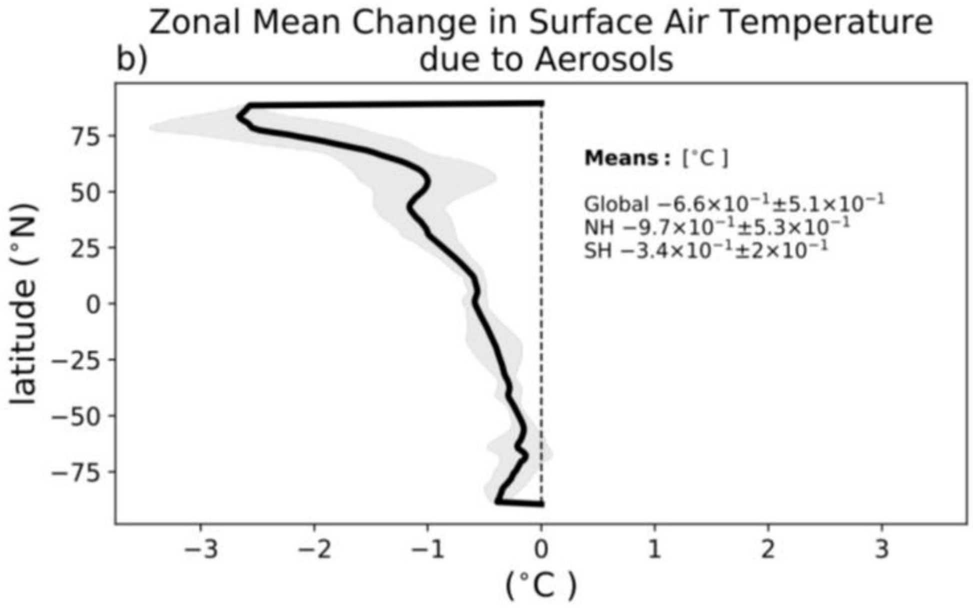
Lead Authors:
Bhupesh Adhikary (Nepal), Paulo Artaxo (Brazil), Terje Berntsen (Norway), William D. Collins (United States of America), Sandro Fuzzi (Italy), Laura Gallardo (Chile), Astrid Kiendler-Scharr (Germany/Austria), Zbigniew Klimont (Austria/Poland), Hong Liao (China), Nadine Unger (United Kingdom/United States of America), Prodromos Zanis (Greece)



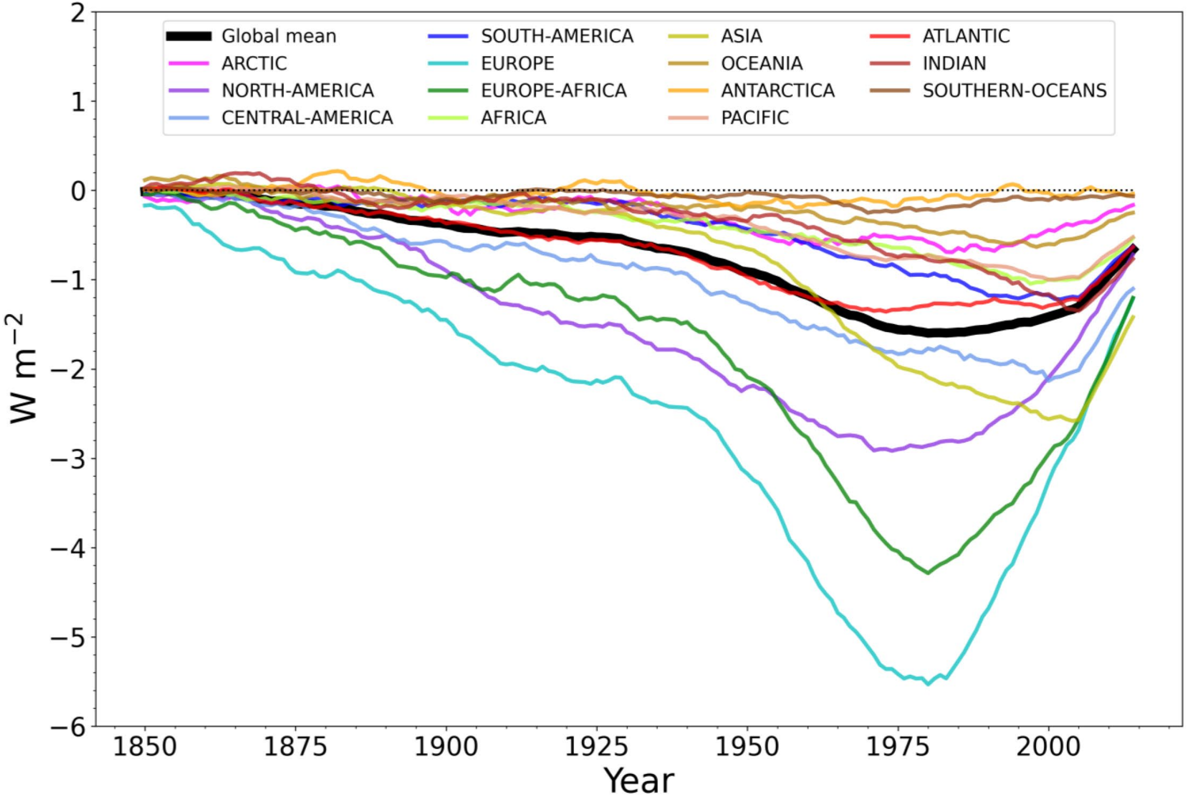
Short lived climate forcers : The quick fix?




a)
Surface Air Temperature Response due to Aerosols
-4.20 -2.80 -1.40 0.00 1.40 2.80 4.20 5.60
(°C)
Color Robust signal
No change or no robust signal
Conflicting signals


b)
Zonal Mean Change in Surface Air Temperature due to Aerosols
latitude (°N)
75
50
25
0
−25
−50
−75
−3 −2 −1 0 1 2 3
(°C)
Means: [°C]
Global −6.6×10−1±5.1×10−1
NH −9.7×10−1±5.3×10−1
SH −3.4×10−1±2×10−1

Temporal regional mean net effective radiative forcing due to aerosols



Climate change is already affecting every inhabited region across the globe, with human influence contributing to many observed changes in weather and climate extremes

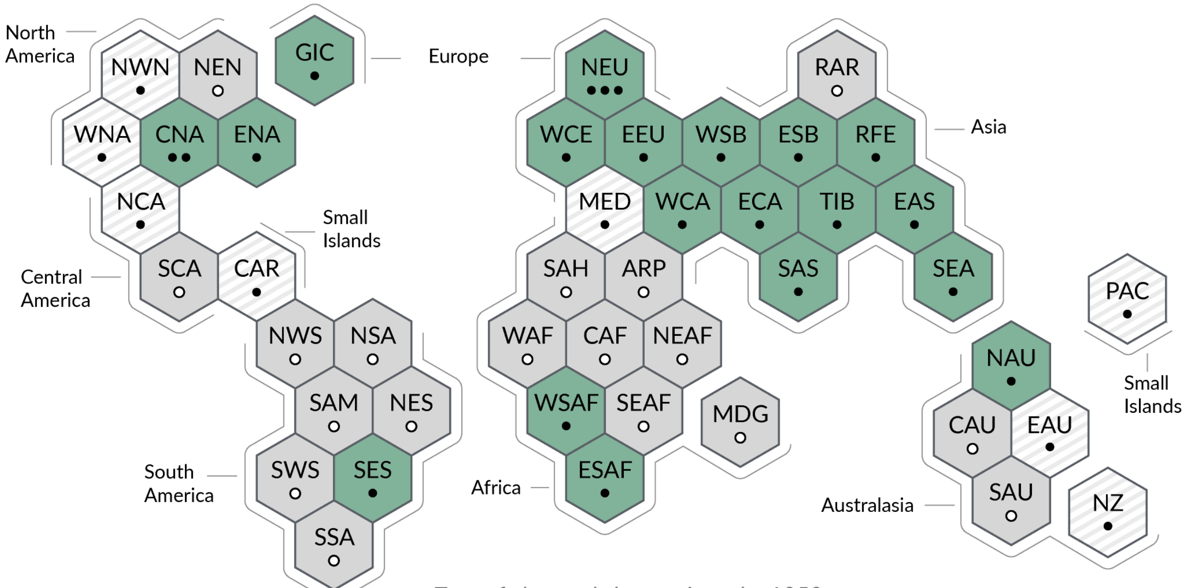
b) Synthesis of assessment of observed change in **heavy precipitation** and confidence in human contribution to the observed changes in the world's regions

Type of observed change
in heavy precipitation

- Increase (19)
- Decrease (0)
- Low agreement in the type of change (8)
- Limited data and/or literature (18)

Confidence in human contribution
to the observed change

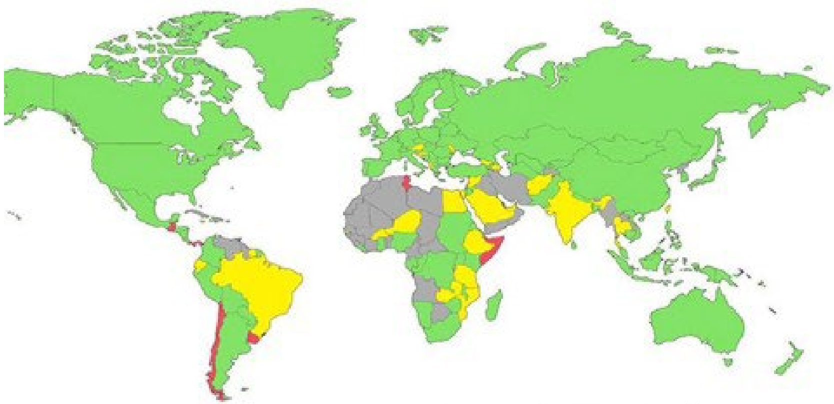
- ●●● High
- ●● Medium
- ● Low due to limited agreement
- ○ Low due to limited evidence



Type of observed change since the 1950s

Military Perspectives on Climate Change From Around the World

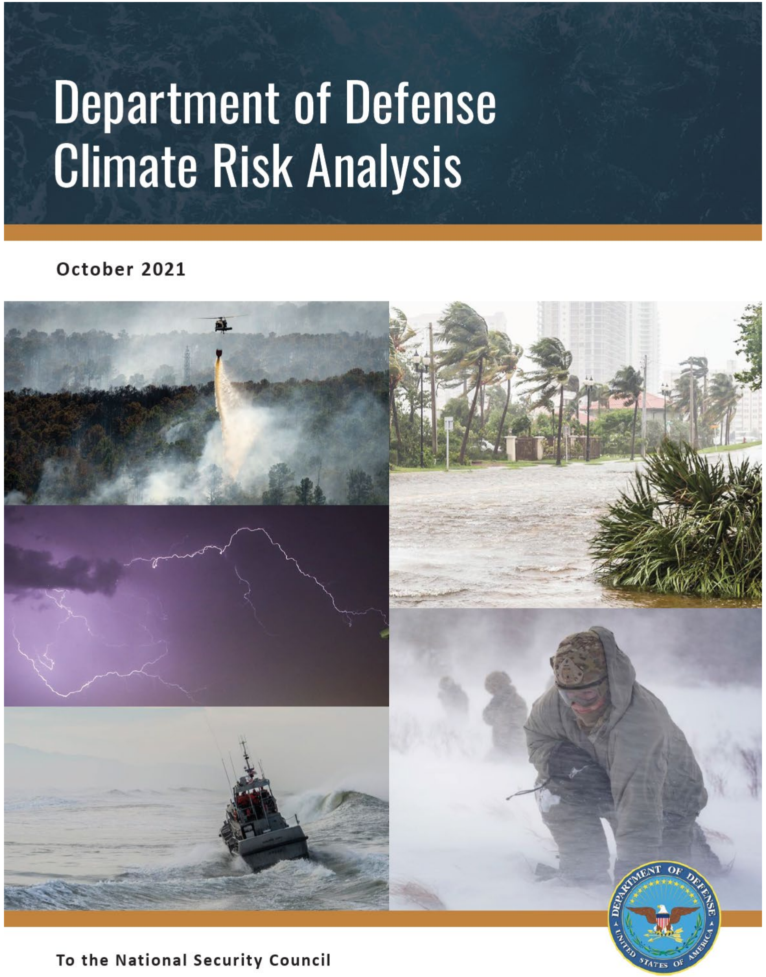
Level of Concern about how Climate Change Threatens Security

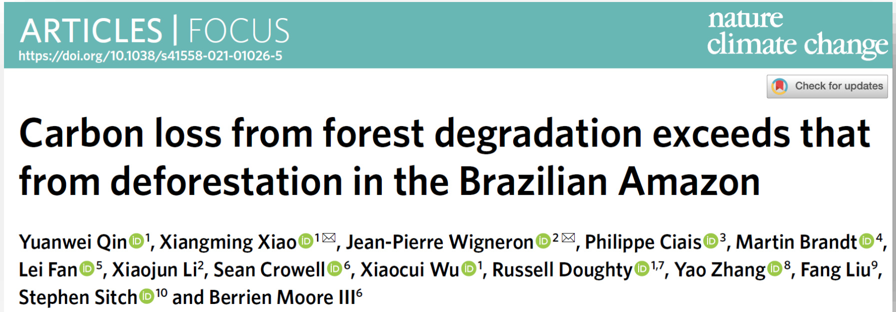


Green – Climate is a national security threat
Yellow – Climate is an environmental issue
Red – Climate is not a defined concern
Grey – No information available

https://www.americansecurityproject.org/climate-security/

https://media.defense.gov/2021/Oct/21/2002877353/-1/-1/0/DOD-CLIMATE-RISK-ANALYSIS-FINAL.PDF

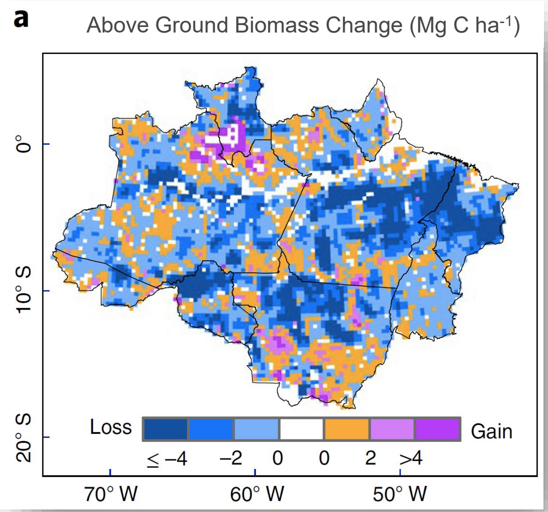


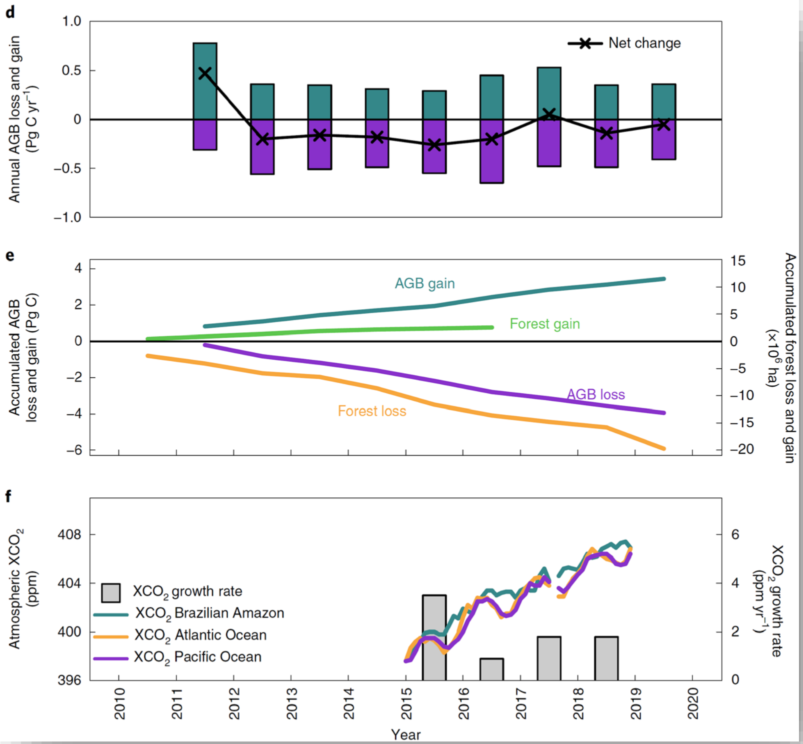


ARTICLES | FOCUS
nature climate change
https://doi.org/10.1038/s41558-021-01026-5
Check for updates

Carbon loss from forest degradation exceeds that from deforestation in the Brazilian Amazon

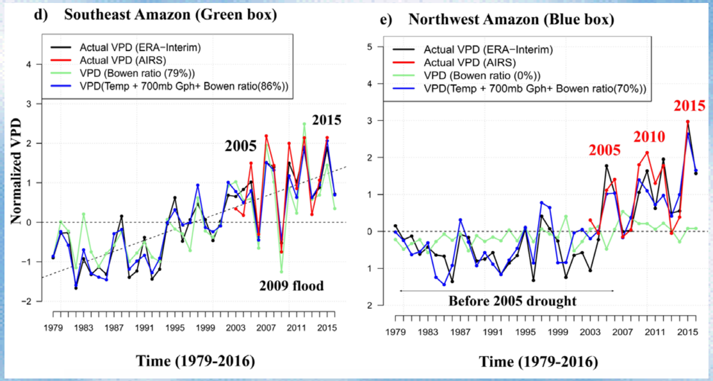
Yuanwei Qin[1], Xiangming Xiao[1✉], Jean-Pierre Wigneron[2✉], Philippe Ciais[3], Martin Brandt[4], Lei Fan[5], Xiaojun Li[2], Sean Crowell[6], Xiaocui Wu[1], Russell Doughty[1,7], Yao Zhang[8], Fang Liu[9], Stephen Sitch[10] and Berrien Moore III[6]

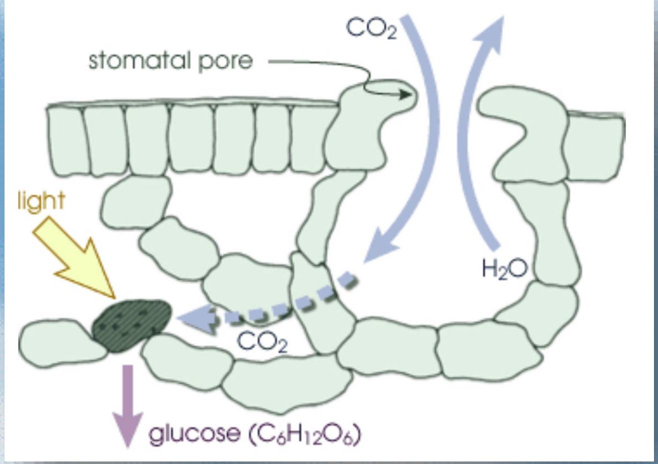


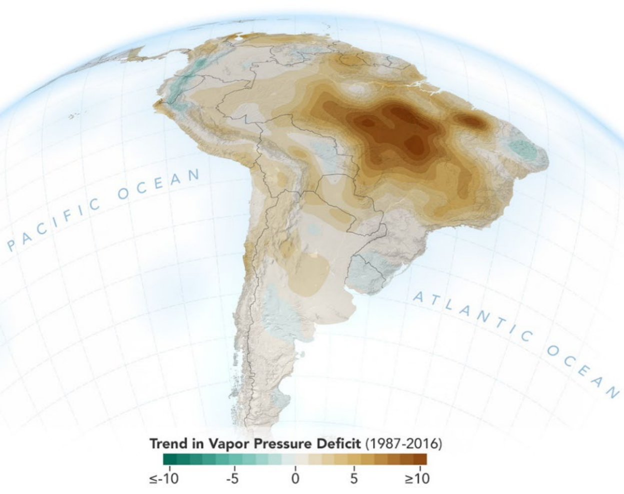


Yuanwei Qin et al., Nature Climate Change, Maio de 2021

Increase in the Vapor Pressure Deficit: Decrease in evapotranspiration in Amazonia

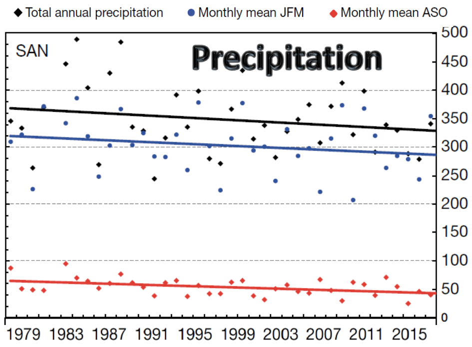




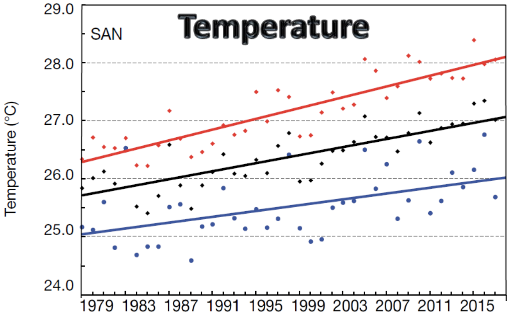


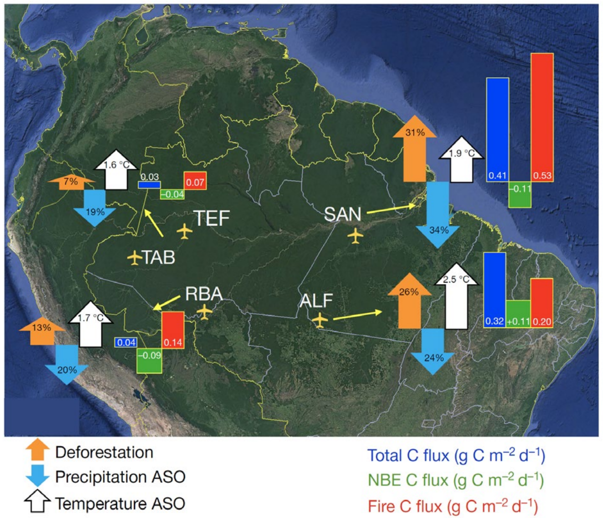
The increase in Vapor Pressure Deficit are the first indication of positive feedbacks mechanisms in Amazonia

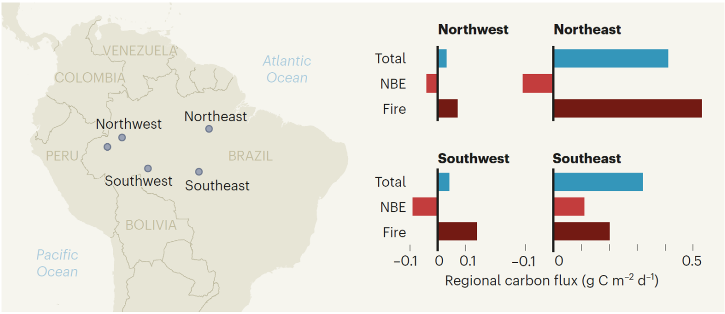
Barkhordarian et al., doi : 10.1038/s41598-019-51857-8, 2019



Carbon balance in Amazonia: for some areas already a source







Carbon balance in Alta Floresta from 2010 to 2018
Total Carbon Balance: +0.32 PgC y^{-1}
Fire Carbon Balance: +0.20 PgC y^{-1}
NBE (Net Biome Exchange) C Balance: +0.11 PgC y^{-1}

Gatti et al., Nature, 2021

[Credit: Evgeny Nelmin | Unsplash]

"To limit global warming, strong, rapid, and sustained reductions in CO_2, methane, and other greenhouse gases are necessary.

This would not only reduce the consequences of climate change but also improve air quality.

Thank you.

More Information:

IPCC: www.ipcc.ch

IPCC Secretariat: ipcc-sec@wmo.int

IPCC Press Office: ipcc-media@wmo.int

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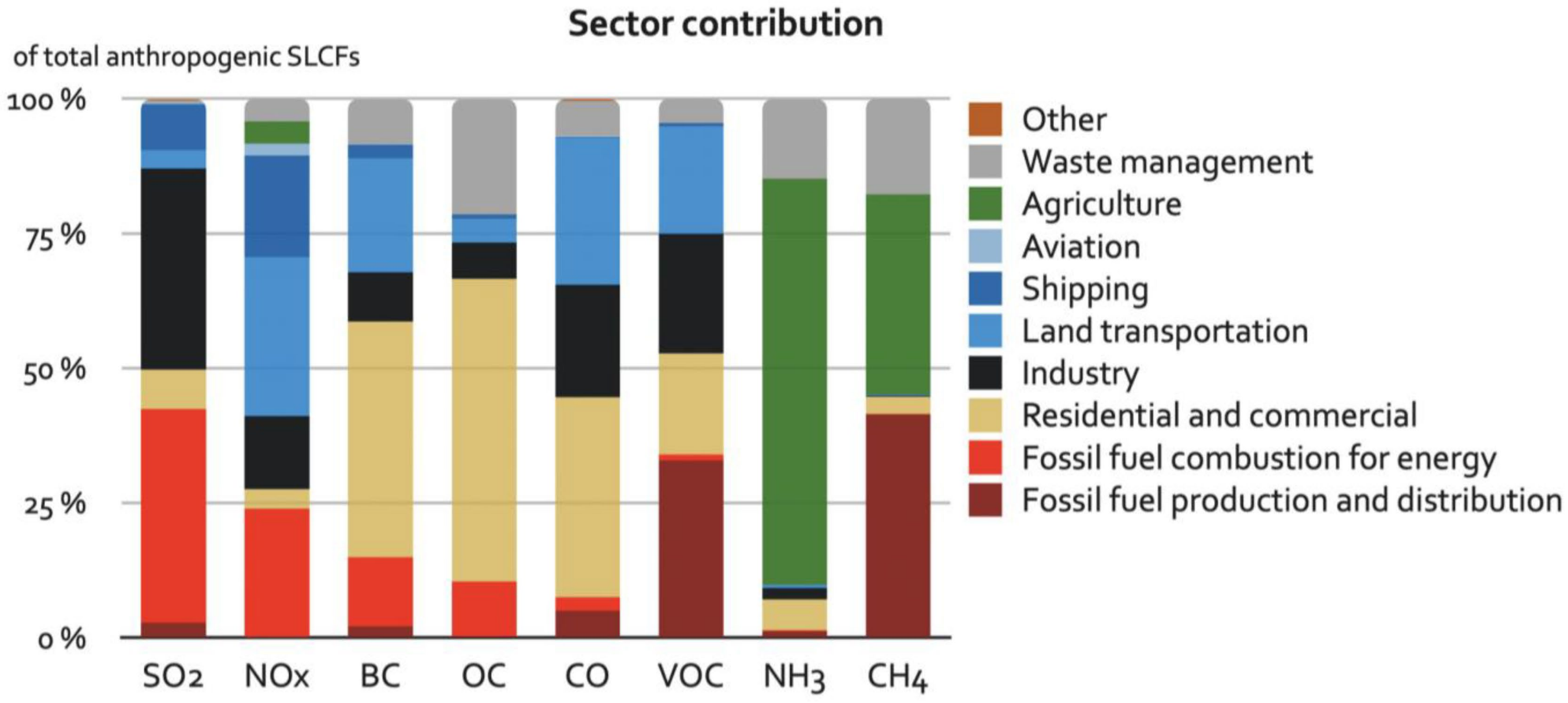
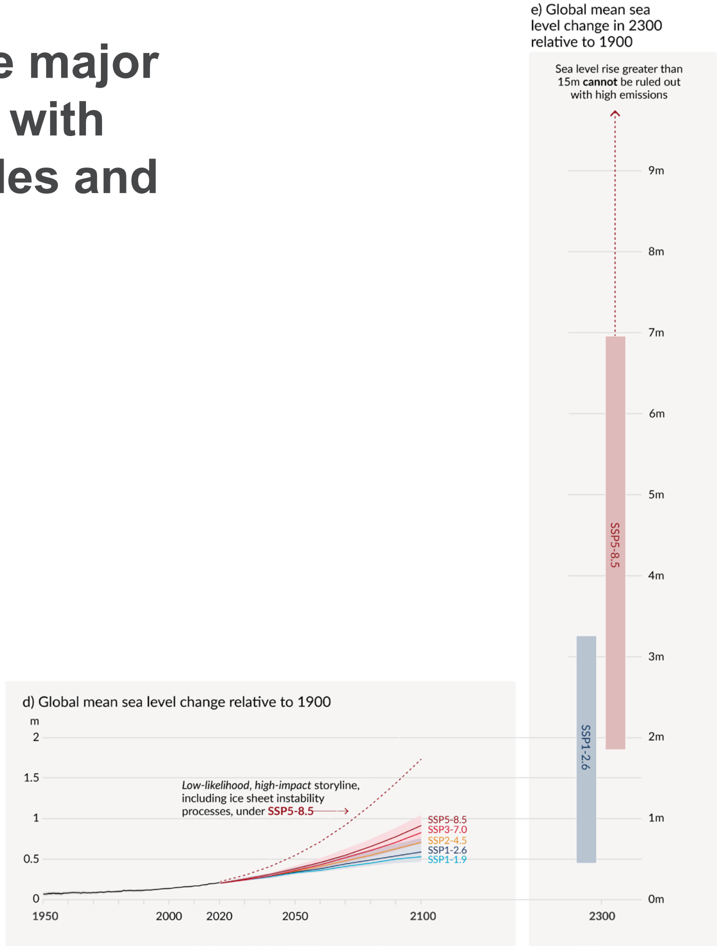
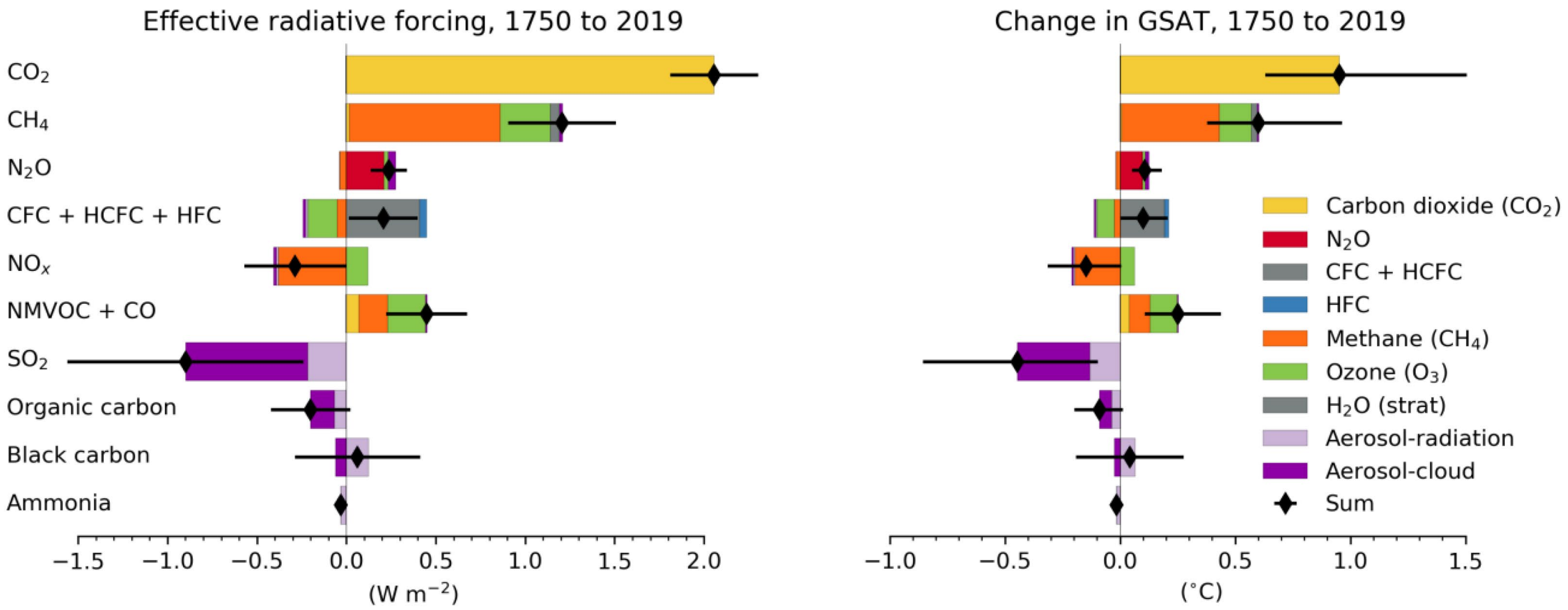
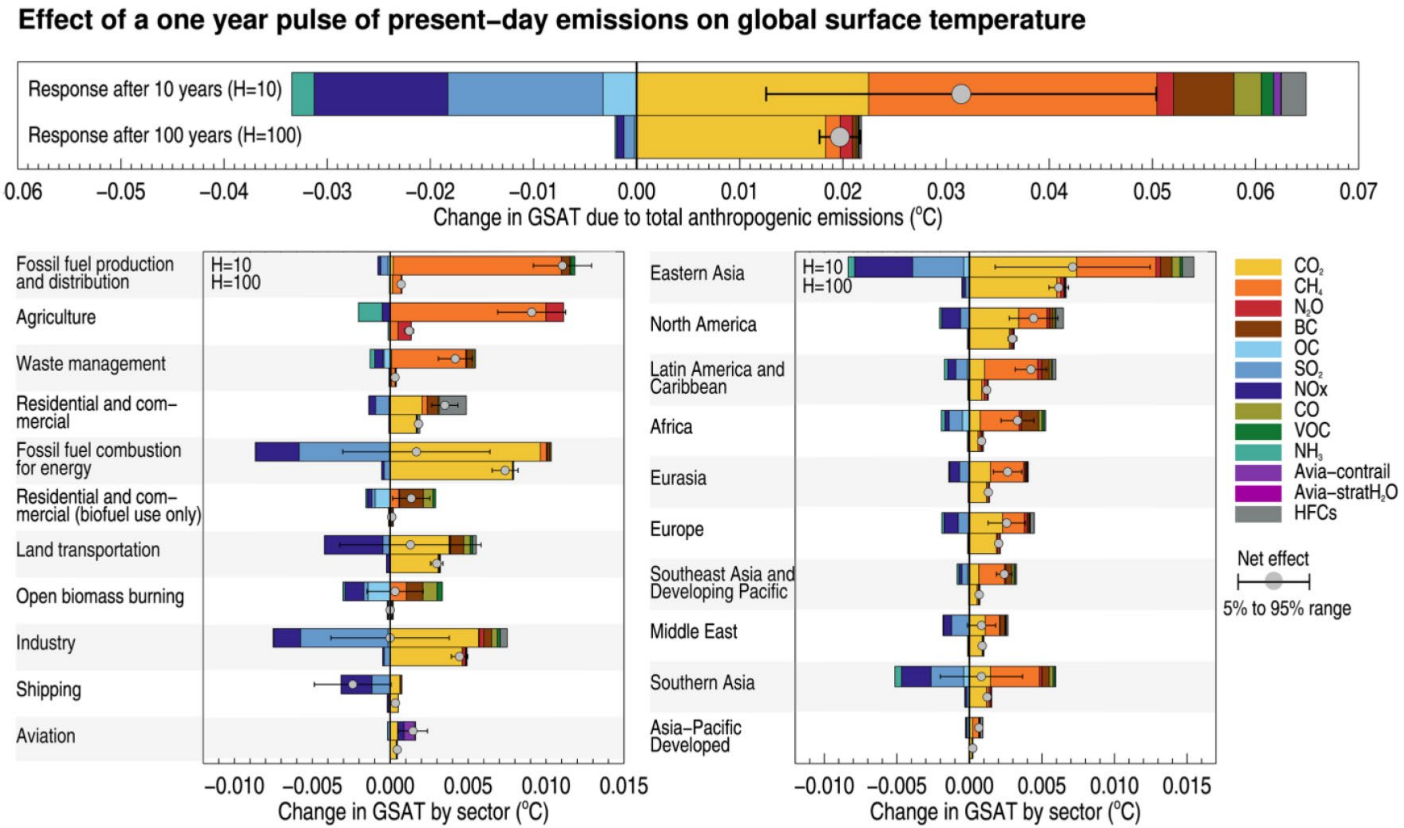

Sector contribution
of total anthropogenic SLCFs
100 %
75 %
50 %
25 %
0 %
SO2
NOx
BC
OC
CO
VOC
NH3
CH4
Other
Waste management
Agriculture
Aviation
Shipping
Land transportation
Industry
Residential and commercial
Fossil fuel combustion for energy
Fossil fuel production and distribution

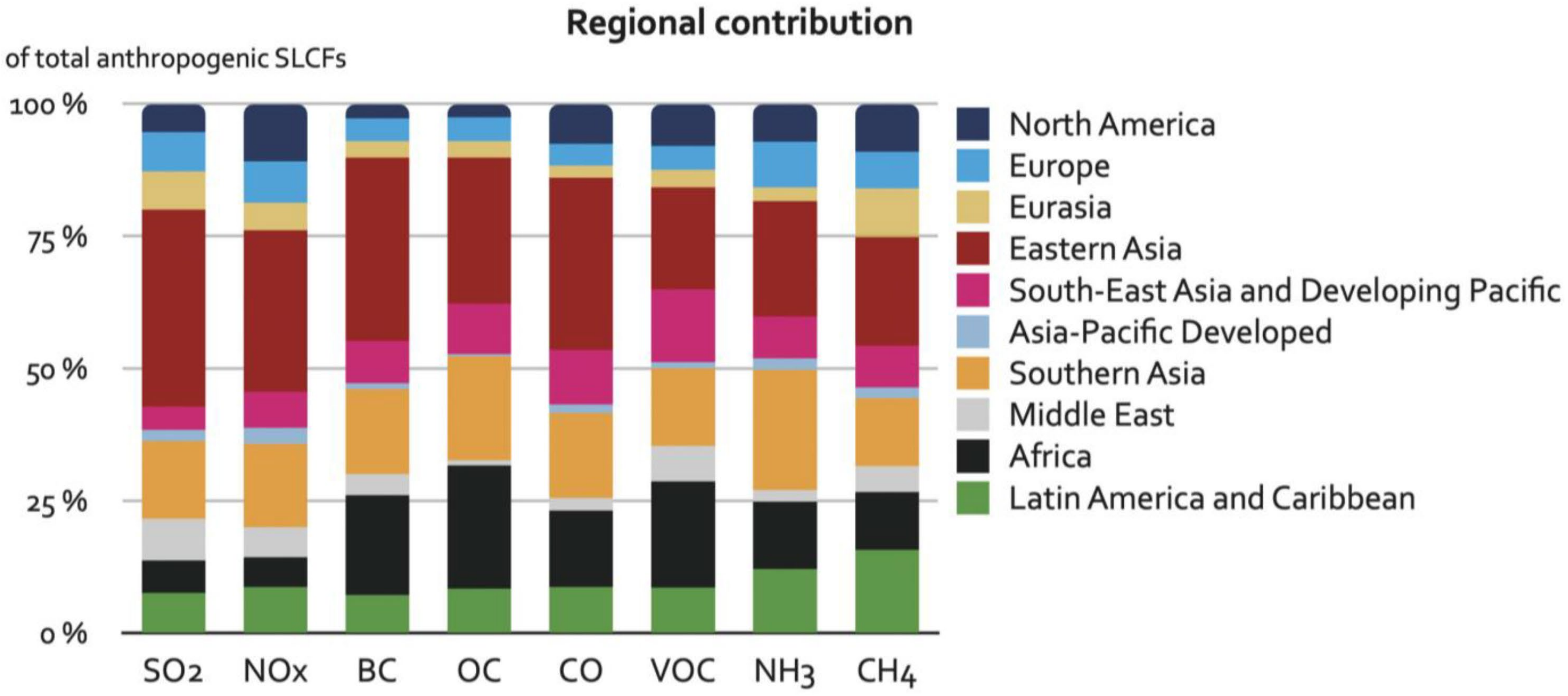
Human activities affect all the major climate system components, with some responding over decades and others over centuries

Figure SPM.8



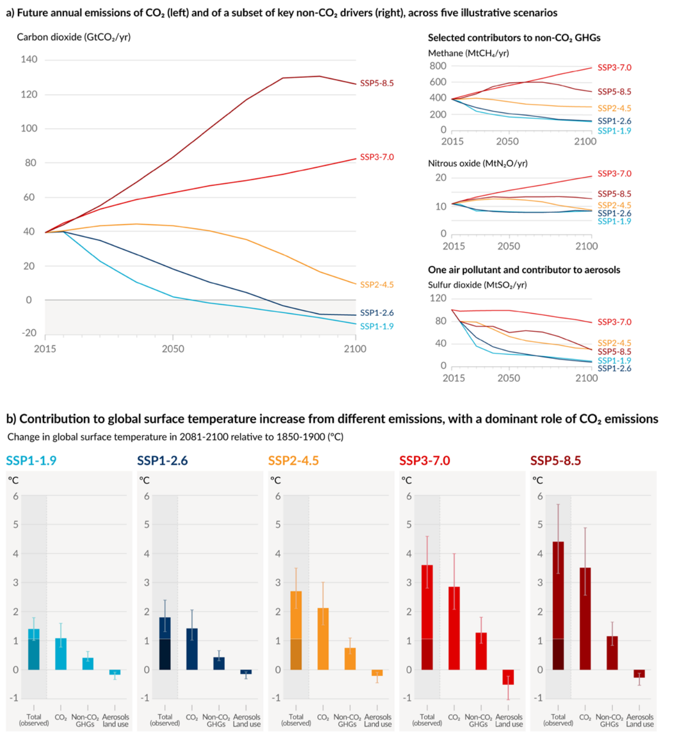

Effective radiative forcing, 1750 to 2019
Change in GSAT, 1750 to 2019
CO_2
CH_4
N_2O
CFC + HCFC + HFC
NO_x
NMVOC + CO
SO_2
Organic carbon
Black carbon
Ammonia
−1.5 −1.0 −0.5 0.0 0.5 1.0 1.5 2.0
(W m^{-2})
−1.0 −0.5 0.0 0.5 1.0 1.5
(°C)
Carbon dioxide (CO_2)
N_2O
CFC + HCFC
HFC
Methane (CH_4)
Ozone (O_3)
H_2O (strat)
Aerosol-radiation
Aerosol-cloud
Sum


Effect of a one year pulse of present–day emissions on global surface temperature
Response after 10 years (H=10)
Response after 100 years (H=100)
-0.06 -0.05 -0.04 -0.03 -0.02 -0.01 0.00 0.01 0.02 0.03 0.04 0.05 0.06 0.07
Change in GSAT due to total anthropogenic emissions (°C)
H=10
H=100
Fossil fuel production and distribution
Agriculture
Waste management
Residential and commercial
Fossil fuel combustion for energy
Residential and commercial (biofuel use only)
Land transportation
Open biomass burning
Industry
Shipping
Aviation
-0.010 -0.005 0.000 0.005 0.010 0.015
Change in GSAT by sector (°C)
Eastern Asia
North America
Latin America and Caribbean
Africa
Eurasia
Europe
Southeast Asia and Developing Pacific
Middle East
Southern Asia
Asia–Pacific Developed
-0.010 -0.005 0.000 0.005 0.010 0.015
Change in GSAT by sector (°C)
CO_2
CH_4
N_2O
BC
OC
SO_2
NOx
CO
VOC
NH_3
Avia–contrail
Avia–stratH_2O
HFCs
Net effect
5% to 95% range


Regional contribution
of total anthropogenic SLCFs
100 %
75 %
50 %
25 %
0 %
SO2
NOx
BC
OC
CO
VOC
NH3
CH4
North America
Europe
Eurasia
Eastern Asia
South-East Asia and Developing Pacific
Asia-Pacific Developed
Southern Asia
Middle East
Africa
Latin America and Caribbean

Future emissions cause future additional warming, with total warming dominated by past and future CO_2 emissions

Figure SPM.4



Total warming (observed warming to date in darker shade), warming from CO_2, warming from non-CO_2 GHGs and cooling from changes in aerosols and land use

BY THE NUMBERS

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78,000+ review comments

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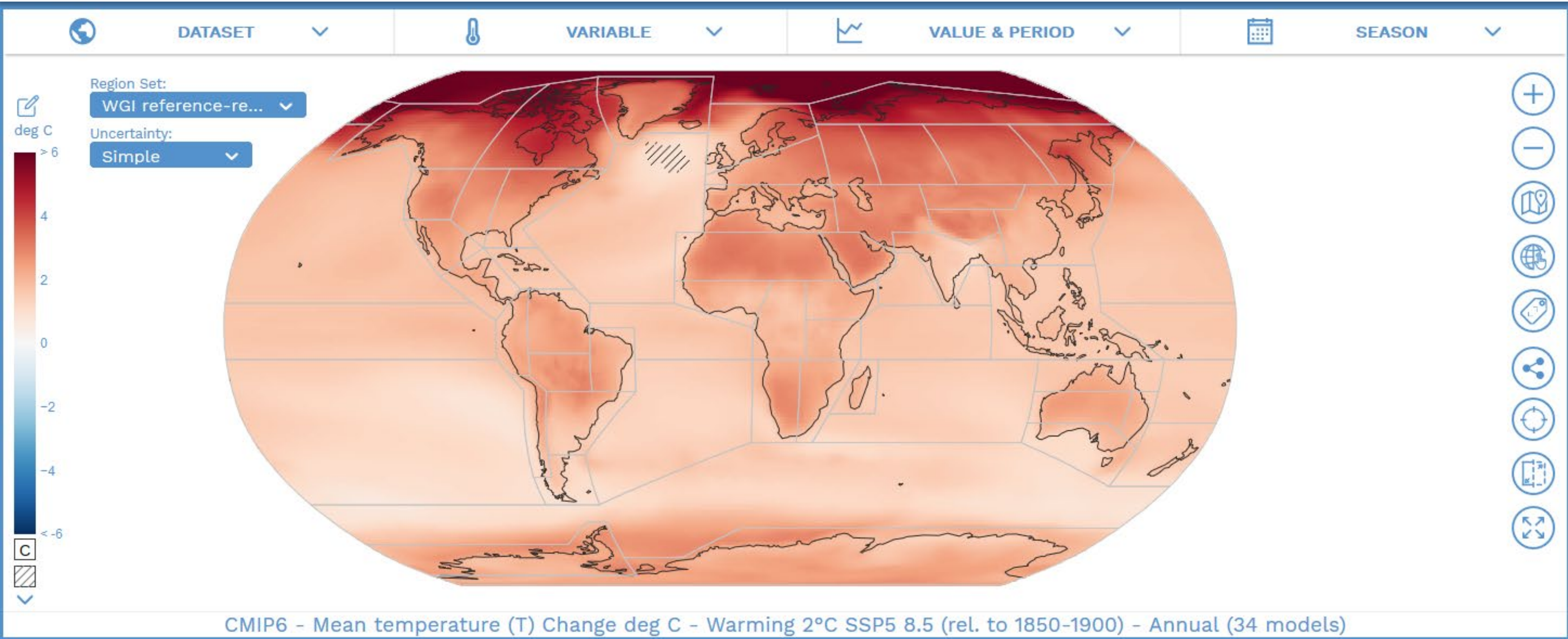
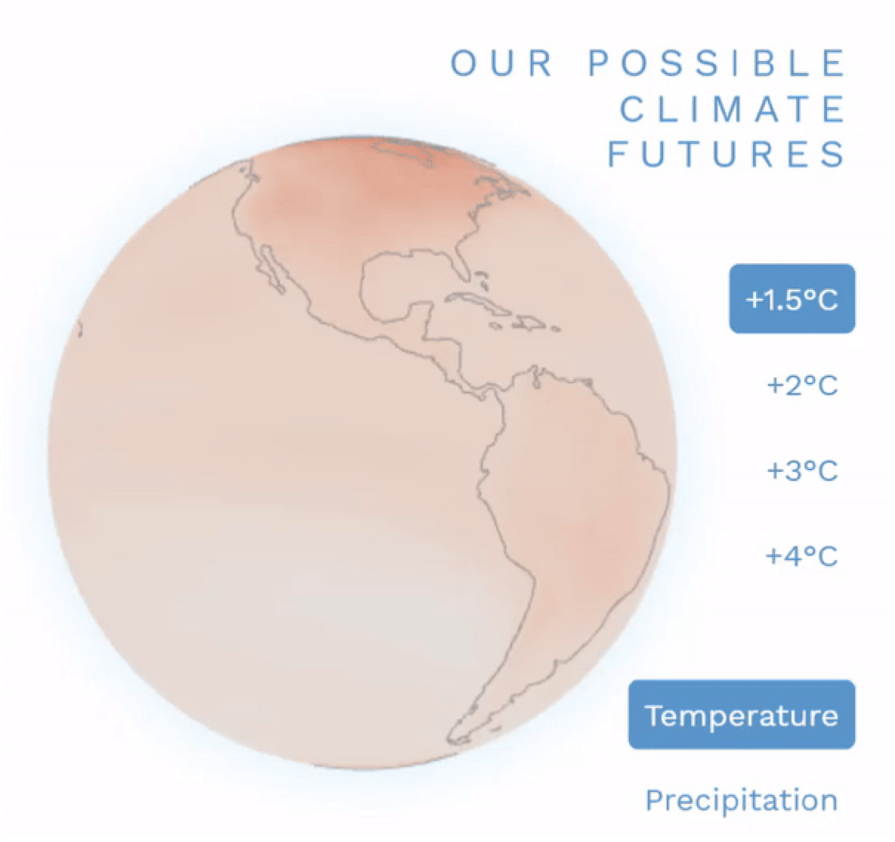
Interactive Atlas

interactive-atlas.ipcc.ch



Interactive atlas

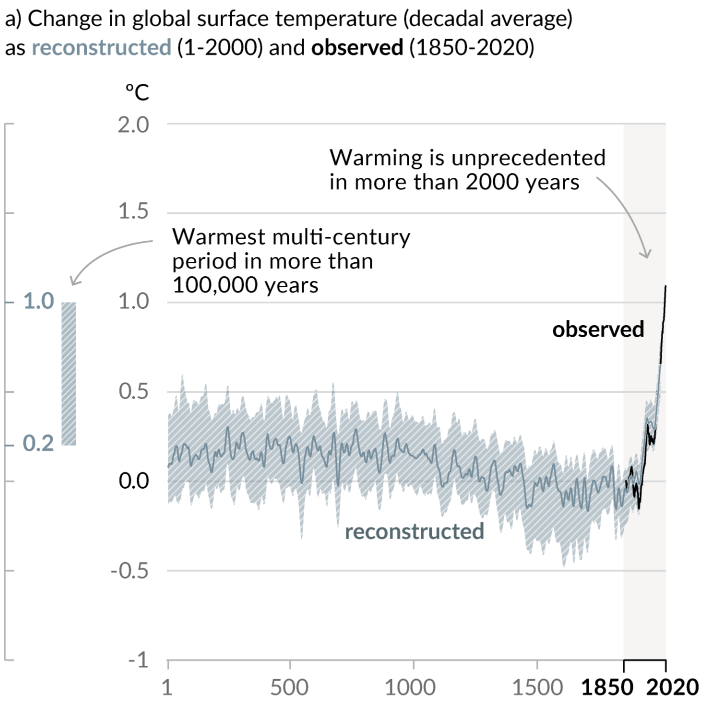


https://interactive-atlas.ipcc.ch/

#IPCCData #IPCCAtlas

Human influence has warmed the climate at a rate that is unprecedented in at least the last 2000 years

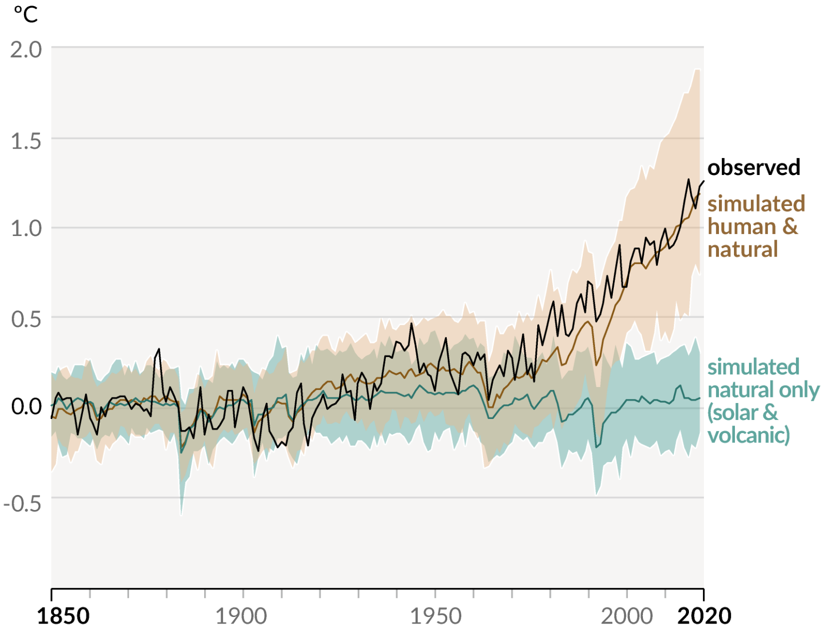
Figure SPM.1



Human influence has warmed the climate at a rate that is unprecedented in at least the last 2000 years

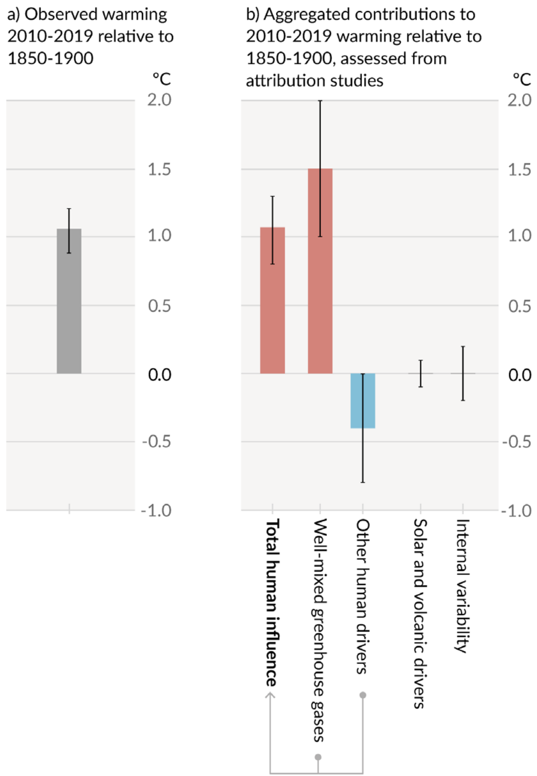
Figure SPM.1

b) Change in global surface temperature (annual average) as **observed** and simulated using **human & natural** and **only natural** factors (both 1850-2020)



Observed warming is driven by emissions from human activities, with greenhouse gas warming partly masked by aerosol cooling

Figure SPM.2



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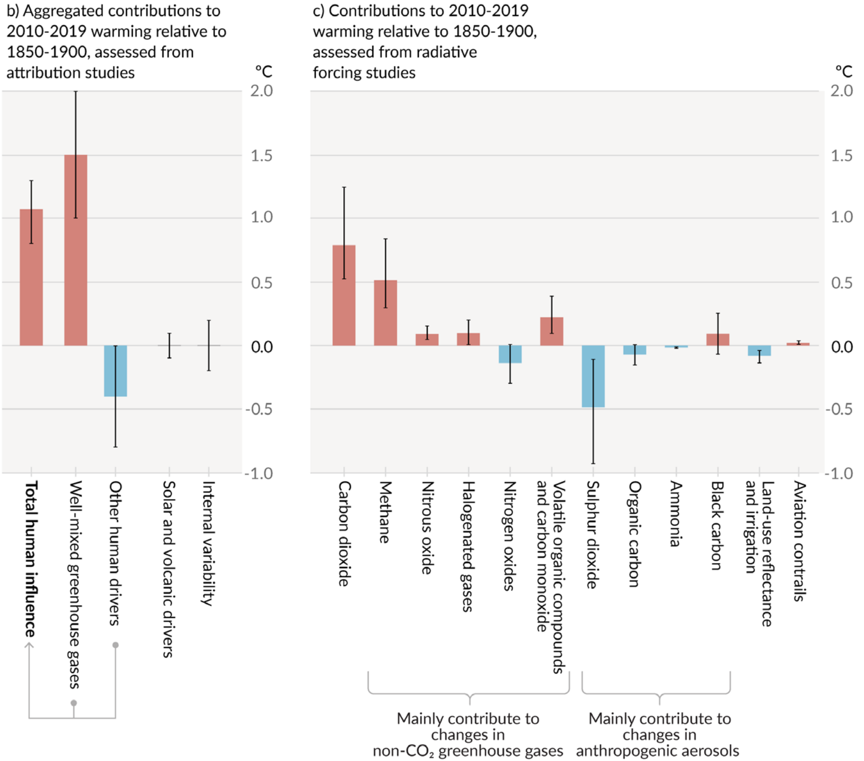

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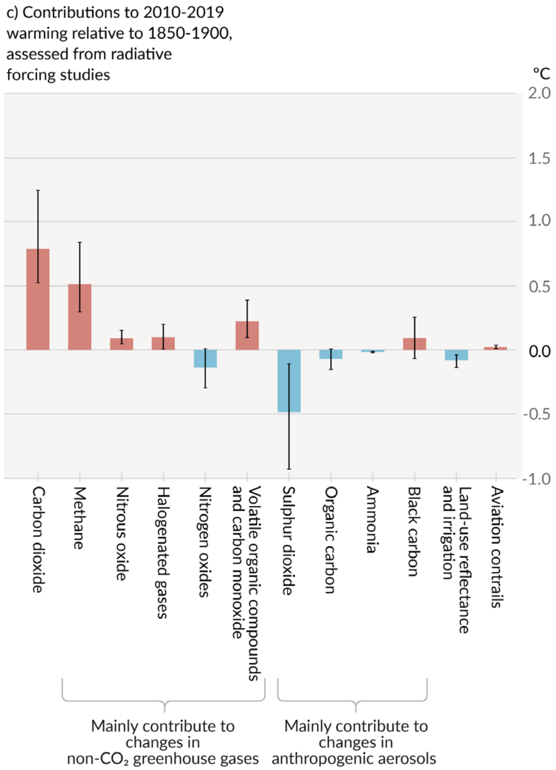

Climate change is already affecting every inhabited region across the globe, with human influence contributing to many observed changes in weather and climate extremes

Figure SPM.3

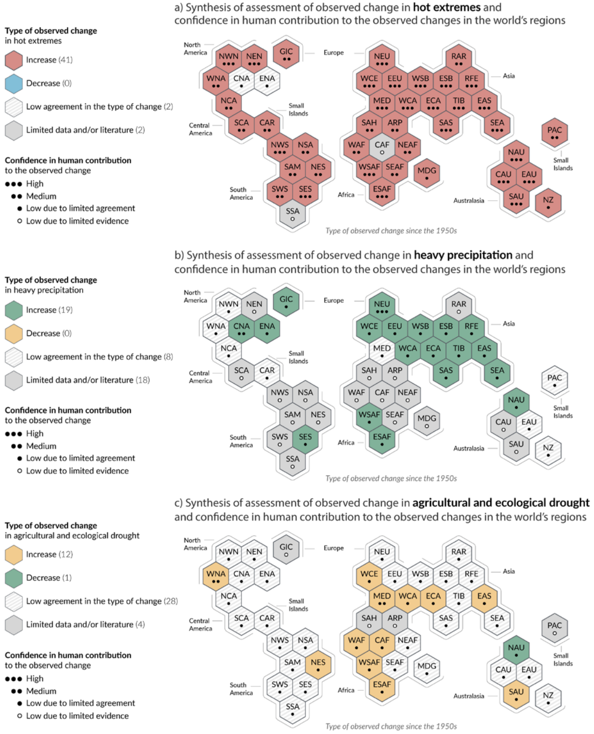

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Figure SPM.3

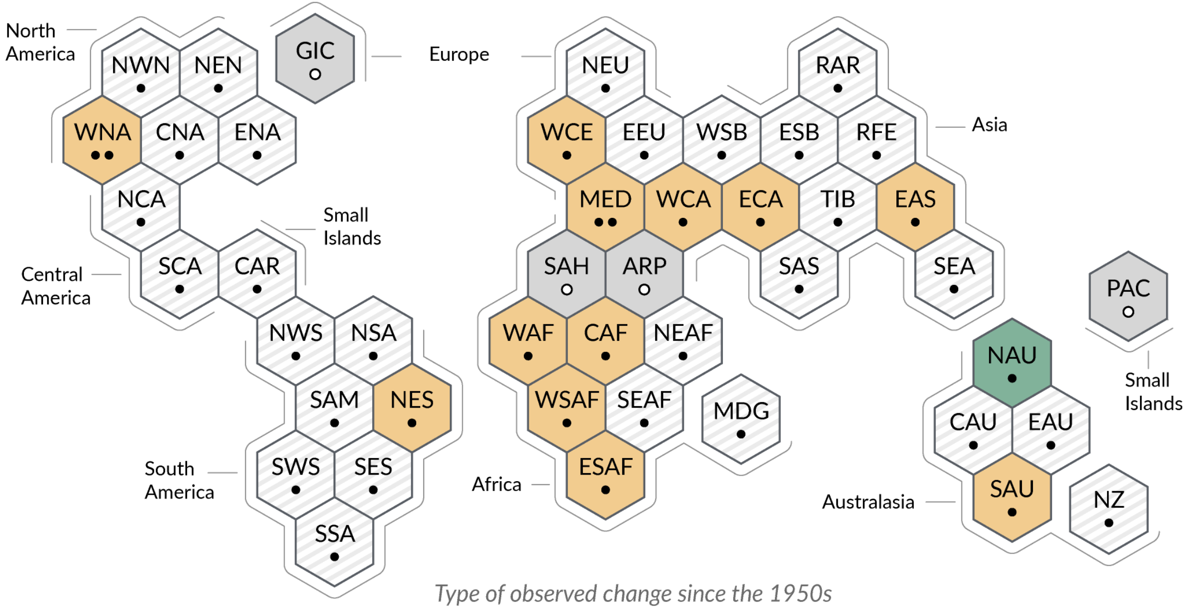
c) Synthesis of assessment of observed change in **agricultural and ecological drought** and confidence in human contribution to the observed changes in the world's regions

Type of observed change
in agricultural and ecological drought

- Increase (12)
- Decrease (1)
- Low agreement in the type of change (28)
- Limited data and/or literature (4)

Confidence in human contribution
to the observed change

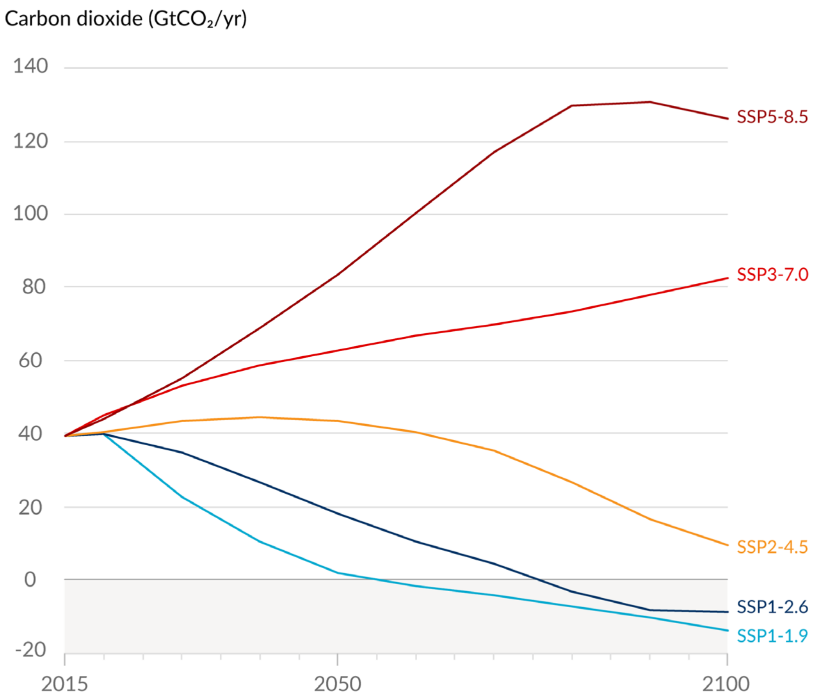
- ●●● High
- ●● Medium
- ● Low due to limited agreement
- ○ Low due to limited evidence



Type of observed change since the 1950s

Future emissions cause future additional warming, with total warming dominated by past and future CO_2 emissions

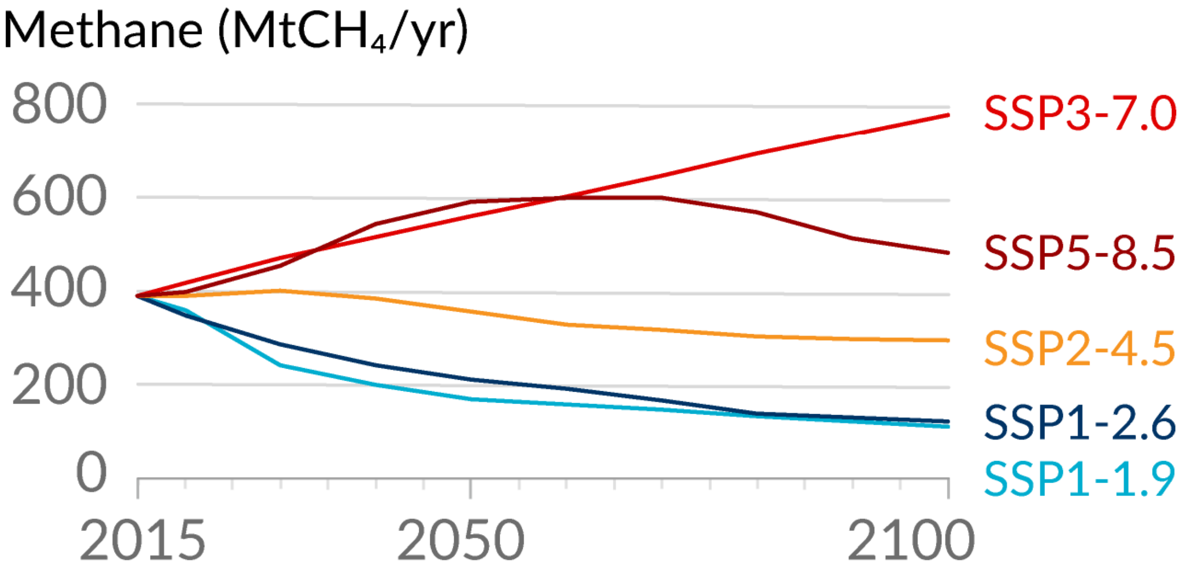
Figure SPM.4



Future emissions cause future additional warming, with total warming dominated by past and future CO_2 emissions

Figure SPM.4

Selected contributors to non-CO_2 GHGs



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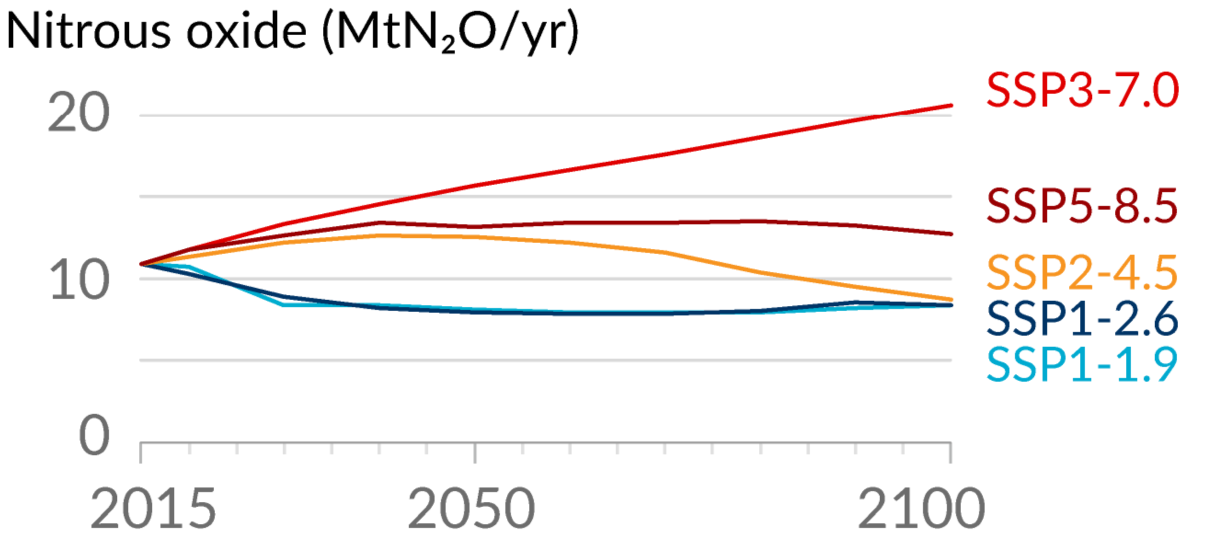
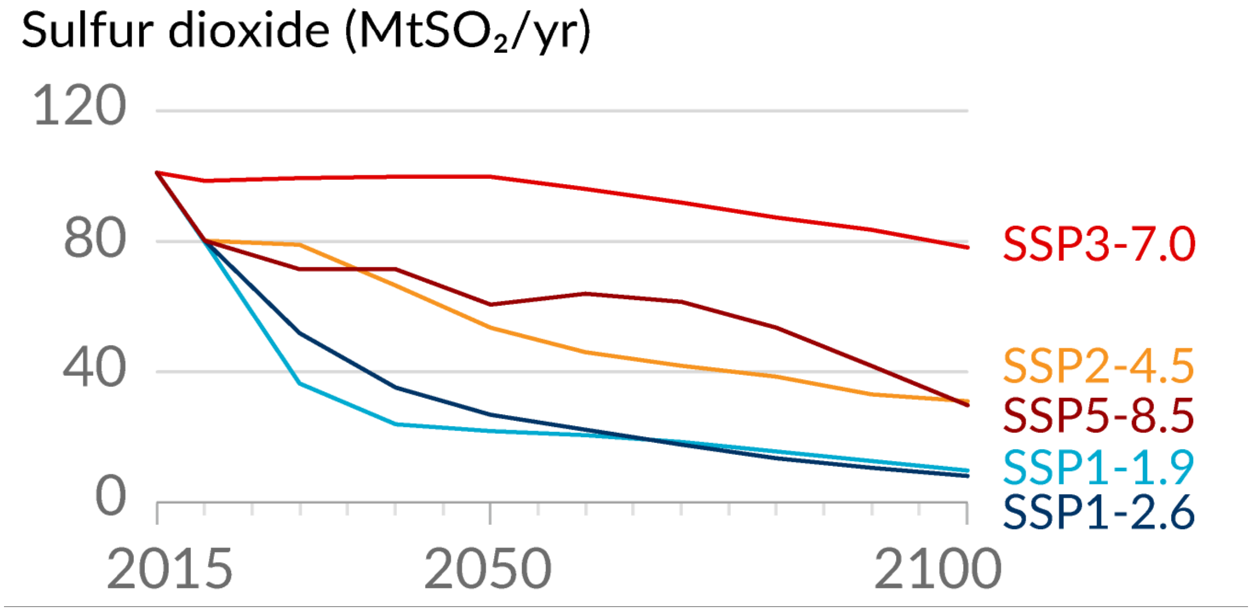


Future emissions cause future additional warming, with total warming dominated by past and future CO_2 emissions

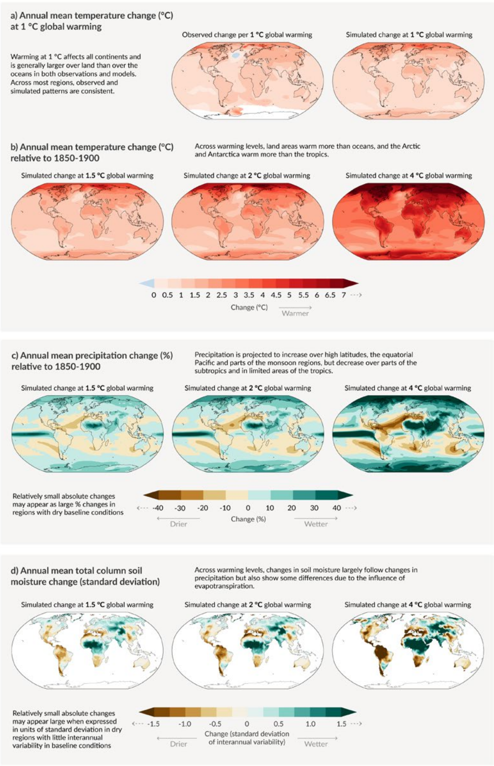
Figure SPM.4

One air pollutant and contributor to aerosols



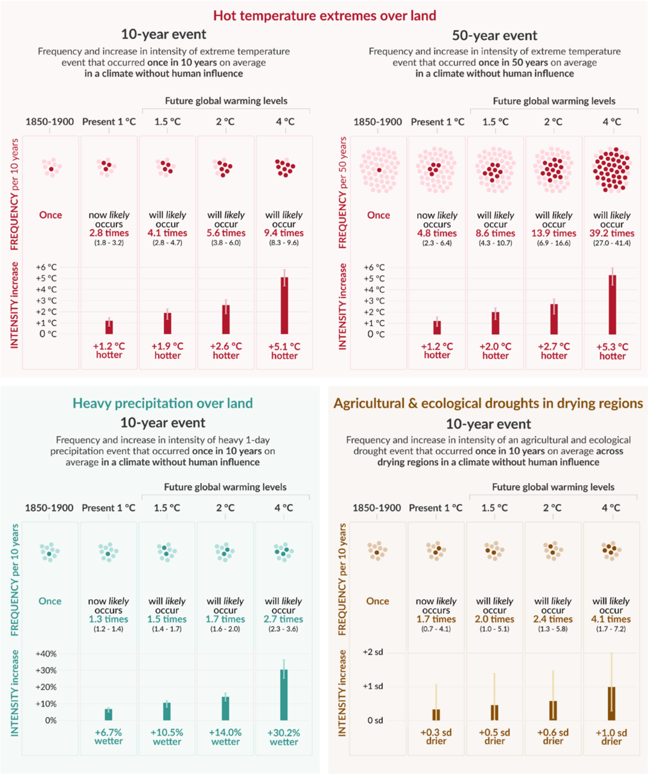
With every increment of global warming, changes get larger in regional mean temperature, precipitation and soil moisture

Figure SPM.5



Projected changes in extremes are larger in frequency and intensity with every additional increment of global warming

Figure SPM.6



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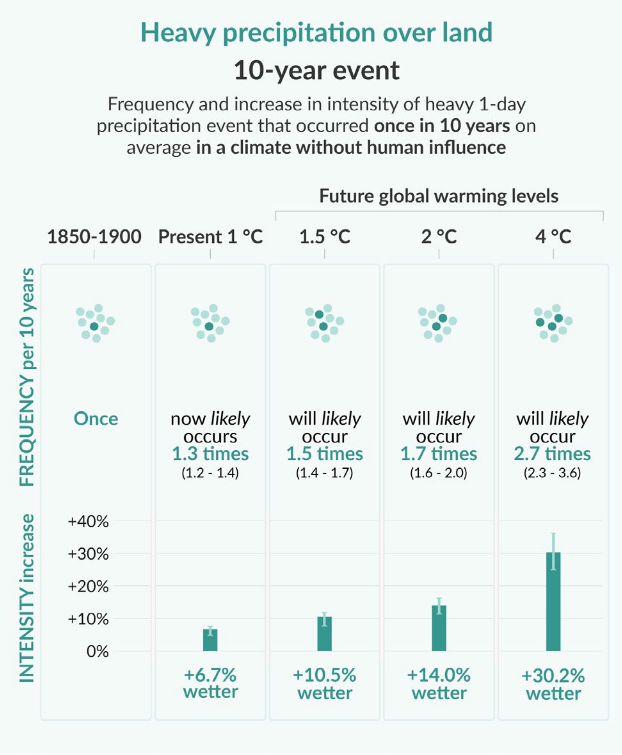

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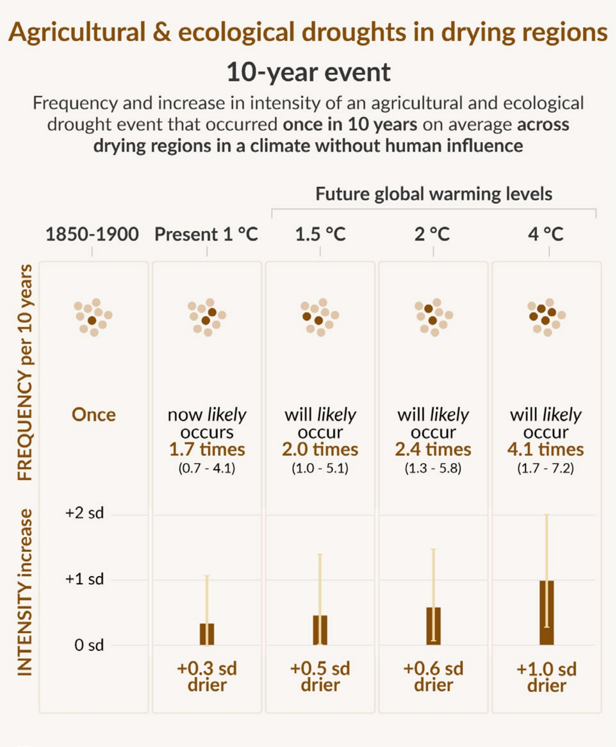
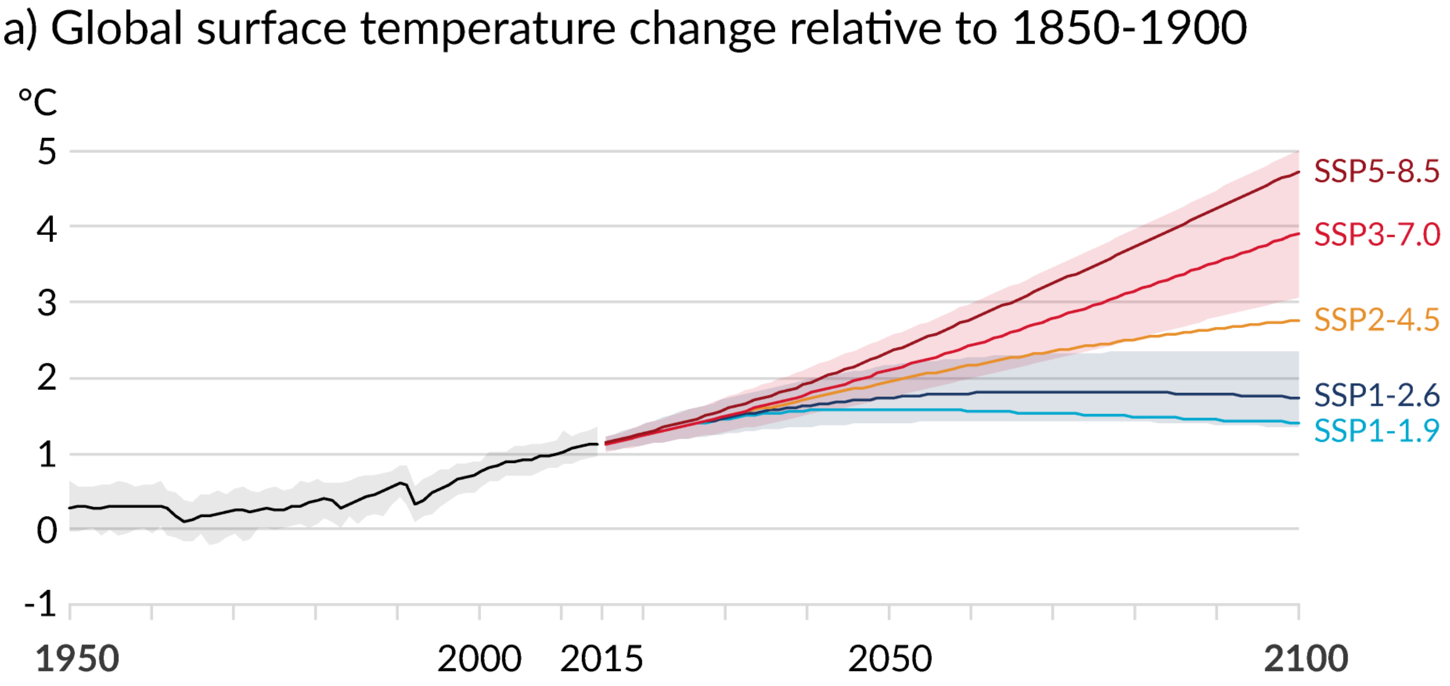


Human activities affect all the major climate system components, with some responding over decades and others over centuries

Figure SPM.8



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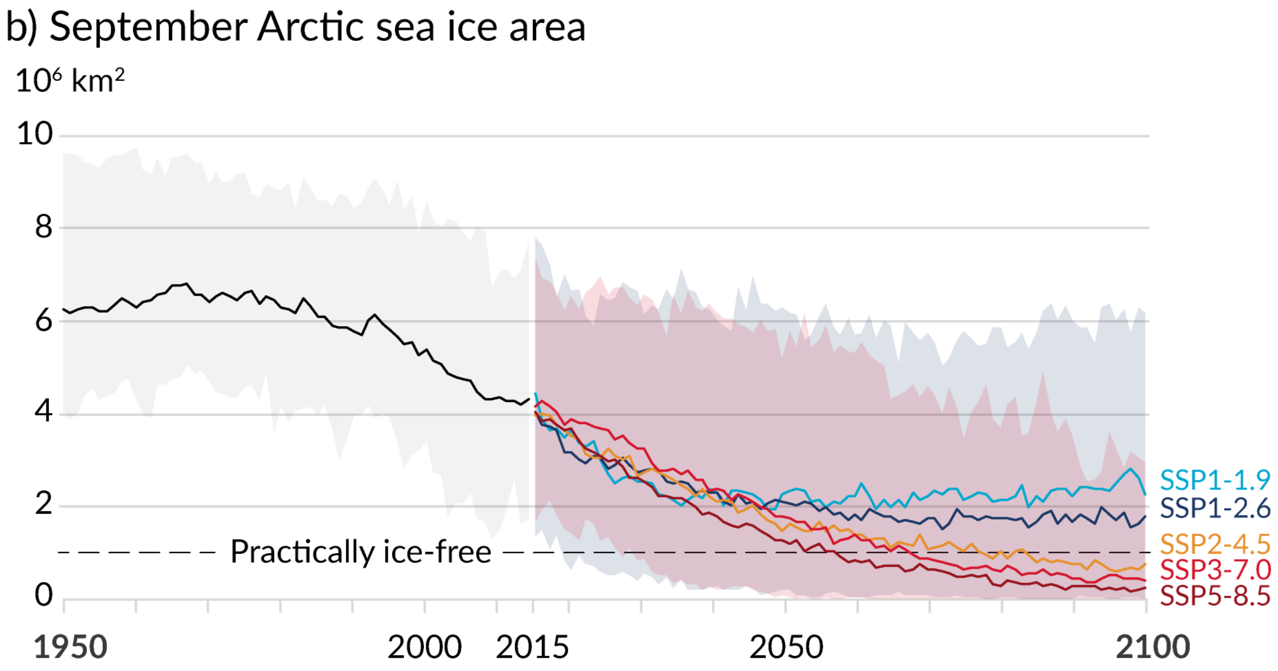

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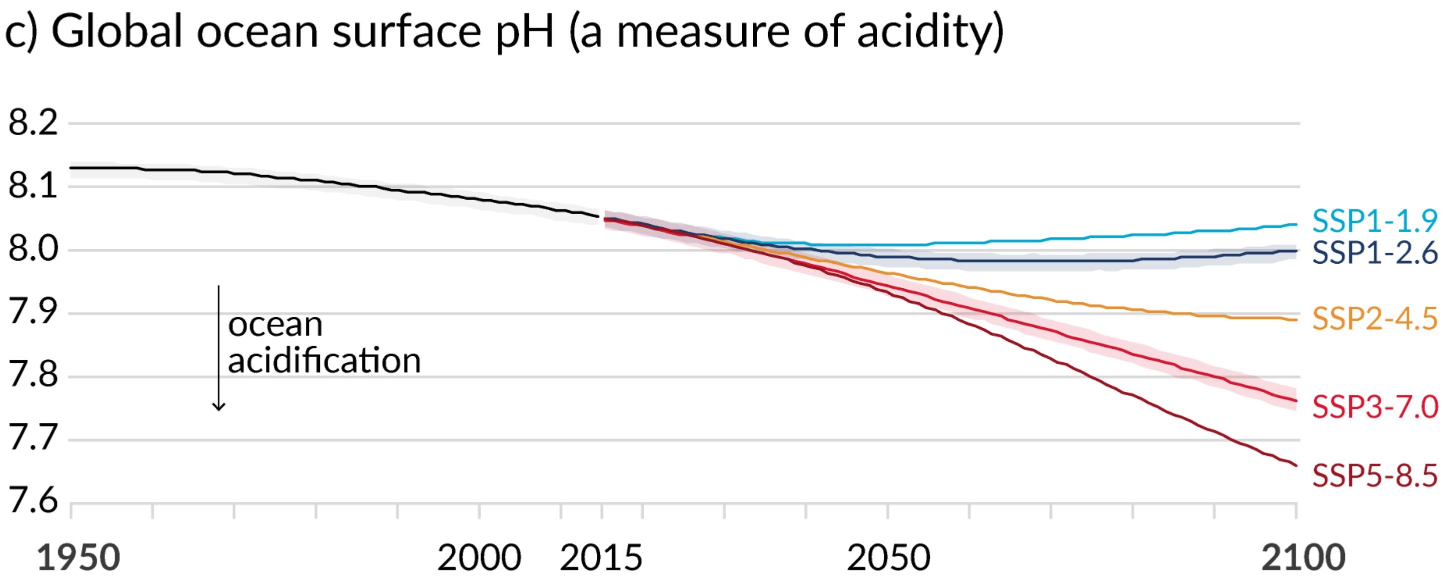
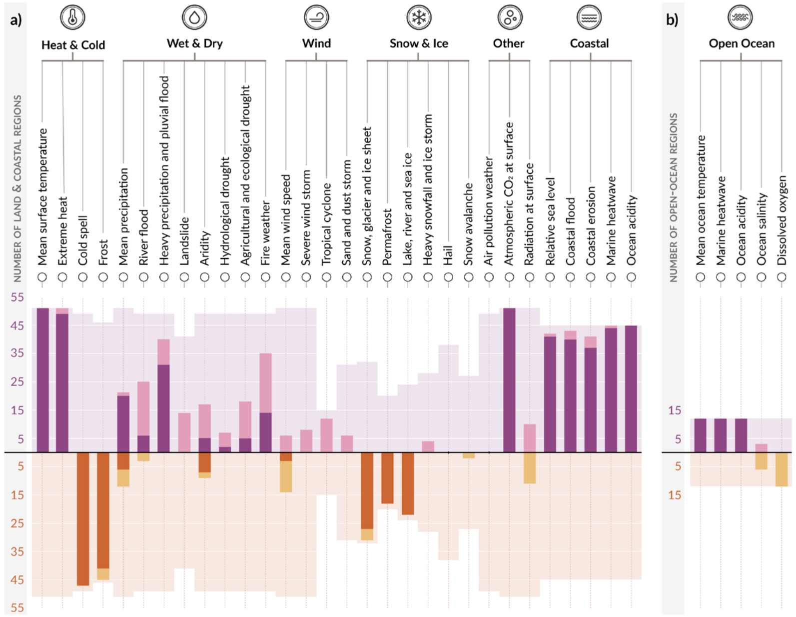


Multiple climatic impact-drivers are projected to change in all regions of the world

Figure SPM.9

Number of land & coastal regions (a) and **open-ocean regions** (b) where each **climatic impact-driver** (CID) is projected to increase or decrease with ***high** confidence* (dark shade) or ***medium** confidence* (light shade)



BAR CHART LEGEND

- Regions with *high confidence* increase
- Regions with *medium confidence* increase
- Regions with *high confidence* decrease
- Regions with *medium confidence* decrease

LIGHTER-SHADED 'ENVELOPE' LEGEND

The height of the lighter shaded 'envelope' behind each bar represents the maximum number of regions for which each CID is relevant. The envelope is symmetrical about the x-axis showing the maximum possible number of relevant regions for CID increase (upper part) or decrease (lower part).

ASSESSED FUTURE CHANGES

Changes refer to a 20–30 year period centred around 2050 and/or consistent with 2°C global warming compared to a similar period within 1960-2014 or 1850-1900.

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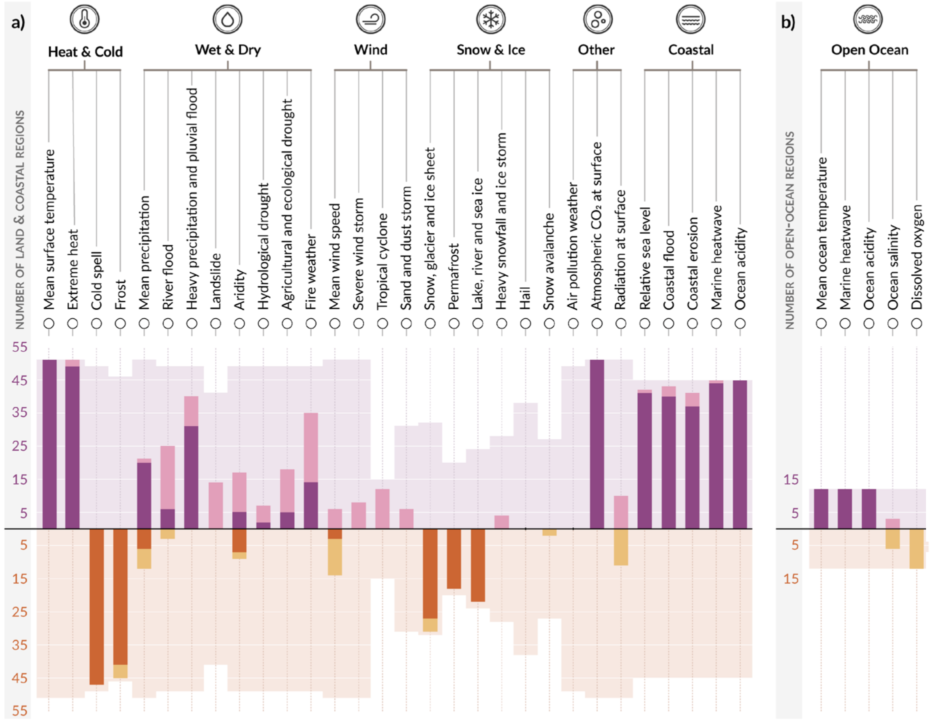

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- Regions with ***high** confidence* **increase**
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Every tonne of CO_2 emissions adds to global warming

Figure SPM.10

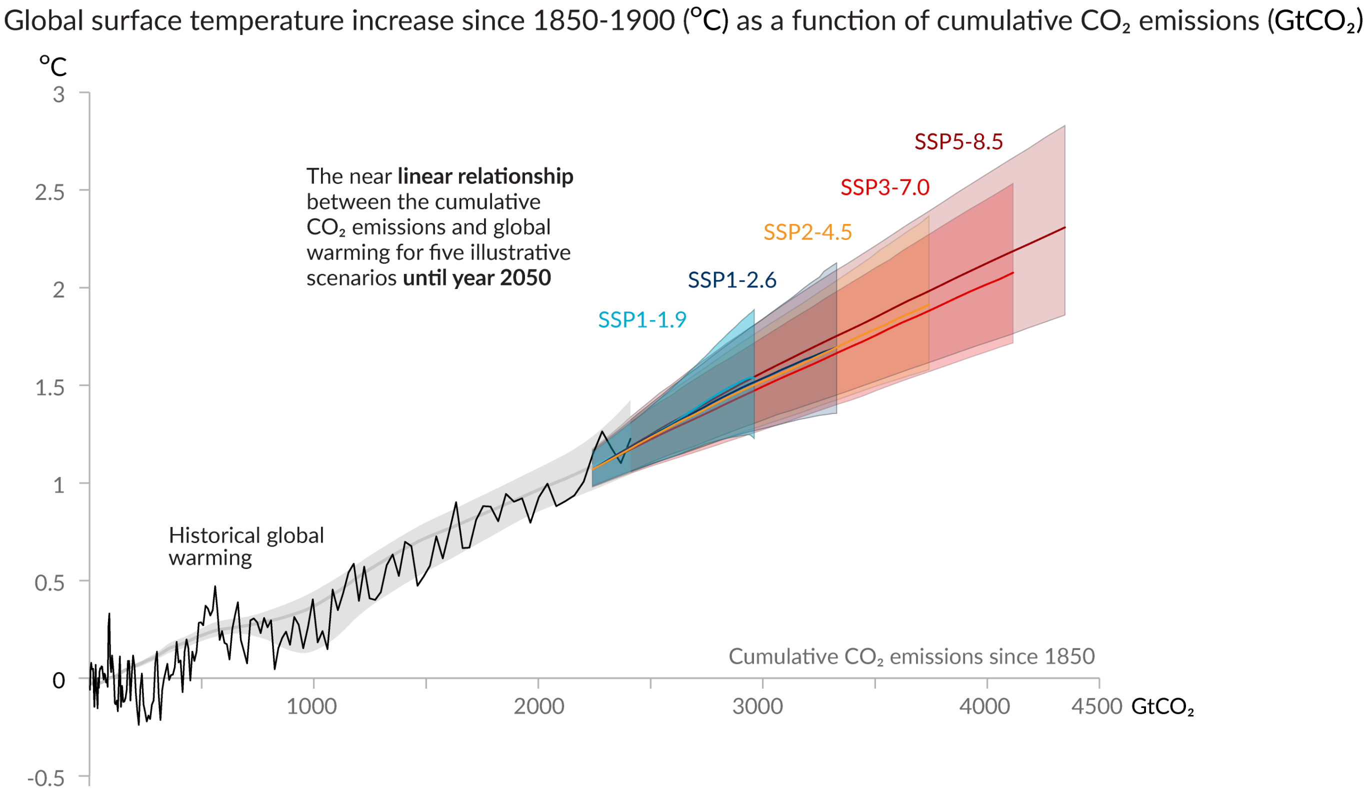

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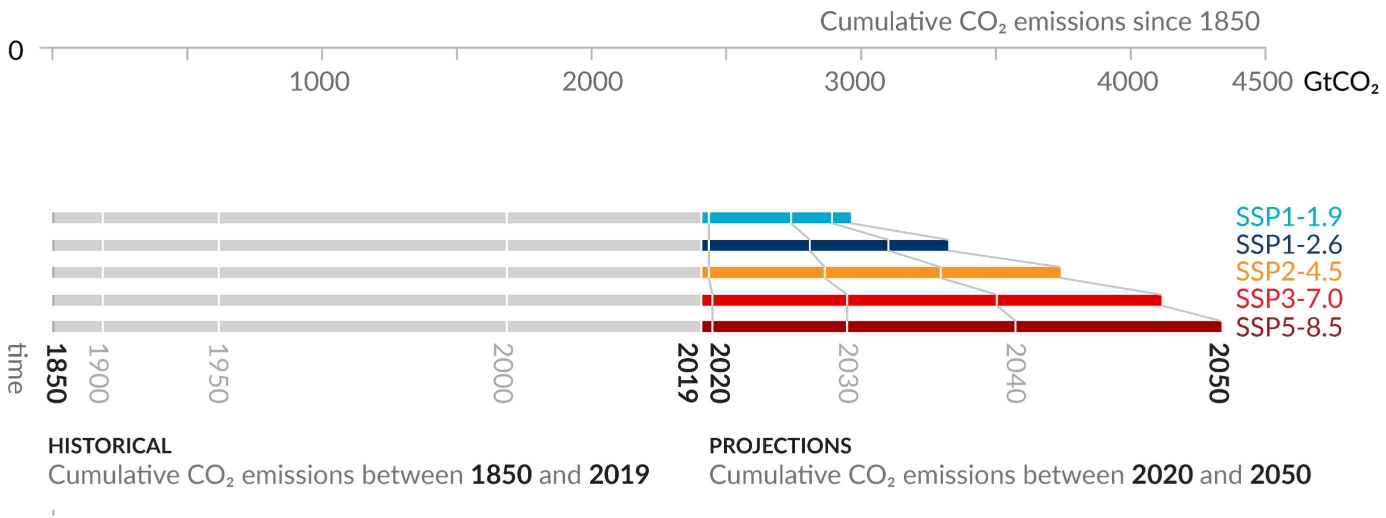
Figure SPM.10



Future cumulative CO_2 emissions differ across scenarios, and determine how much warming we will experience

[Credit: Yoda Adaman | Unsplash]

“It is indisputable that human activities are causing climate change, making extreme climate events, including heat waves, heavy rainfall, and droughts, more frequent and severe.

[Credit: Hong Nguyen | Unsplash]

“Climate change is already affecting every region on Earth, in multiple ways.

The changes we experience will increase with further warming.

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INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP

[Credit: Jenn Caselle | UCSB]

"There's no going back from some changes in the climate system…

INTERGOVERNMENTAL PANEL ON climate change

ipcc

WMO UNEP

[Credit: Andy Mahoney | NSIDC]

"…However, some changes could be slowed and others could be stopped by limiting warming.

INTERGOVERNMENTAL PANEL ON climate change


[Credit: Shari Gearheard | NSIDC]

“There’s no going back from some changes in the climate system. However, some changes could be slowed and others could be stopped by limiting warming.

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Effect of dedicated air pollution or climate policy on population-weighted $PM_{2.5}$ concentrations ($\mu g\ m^{-3}$) and share of population (%) exposed to different PM2.5 levels across selected world regions.