Fundamentals in Ecology

Week 11

Climate change impacts on terrestrial ecosystems

Grossiord Charlotte

Bachelor 2 - SIE

Schedule of the lectures

Final Exam Room Assignments – Student List

68/68	Name First Name	Sciper	Exam classroom
1	Alami-Sounni Kenza Margaux	378944	GC B3 31
2	Alves Deisenhofer Inês	358544	GC B3 31
3	Alvino Démolis Erine Louisiane	372679	GC B3 31
4	August Ambre Pléione Sarah	373133	GC B3 31
5	Bassi Elio Sina	378852	GC B3 31
6	Blassel Lou Sarah	379739	GC B3 31
7	Bocquet Alice Marie Madeleine	379741	GC B3 31
8	Bonaccorsi Costanza	379543	GC B3 31
9	Bonjour Alexandre Jean Romain	363645	GC B3 31
10	Bourgeois Aurélie	374013	GC B3 31
11	Cardillo Raffaele	377113	GC B3 31
12	Cazajous Clément Alain Marie	380218	GC B3 31
13	Cerutti Louma Valentine Jade	341162	GC B3 31
14	Chansel Clémence Madeleine Aline	362934	GC B3 31
15	Chirol Louise Marie Blanche	361712	GC B3 31
16	Corbière Clémence Priscilla Marie	380887	GC B3 31
17	Cuennet Emma Orla Erin	380039	GC B3 31
18	Daha Asma	378328	GC B3 31
19	Dalmia Ayush	402445	GC B3 31
20	De Moura Andrade Bastos Hugo	376713	GC B3 31
21	Degoumois Céleste Eléonore	347352	GC B3 31
22	Della Bruna Jordi	357008	GC B3 31
23	Dorr Paloma Marie Renée Romane Claire Martine	381038	GC B3 31
24	Fragnière Inès	363961	GC B3 31
25	Gelfged Shirel	372639	GC B3 31
26	Gilbert Valentine	373793	GC B3 31
27	Hansen Méline My Linh	378539	GC B3 31
28	Jacob Zoé	381675	GC B3 31
29	Kato Yuzuka	394967	GC C3 30
30	Kieffer Lara Odile	373271	GC C3 30
31	Le Bourgeois Clémence Pauline Charlotte	381448	GC C3 30
32	Lehner Joël	359675	GC C3 30
33	Levi Rebecca	381513	GC C3 30
34	Lopez Mejias Dulce Milagro	399100	GC C3 30
35	Luisoni Solal Léo	364139	GC C3 30
36	Maeda Zoé Miyuki	378803	GC C3 30
37	Maeder Tamara Putri	362710	GC C3 30
38	Maibach Lia	380096	GC C3 30
39	Marino Hildebrand Marco	372566	GC C3 30
40	Martin Adèle Marie Charlotte	376116	GC C3 30
41	Meinke Linnea Lina	361304	GC C3 30
42	Métrailler Paul	379243	GC C3 30
43	Ming Linus Matteo	378544	GC C3 30
44	Miquet-Sage Sven Marcel	364152	GC C3 30
45	Mora Alberto	371958	GC C3 30
46	Nicolet Maylis	380573	GC C3 30
47	Oriol Elise Catherine Jeanne	361171	GC C3 30
48	Ostinelli Lara Lan Anh	379678	GC C3 30
49	Paccaud Vadim	381279	GC C3 30
50	Parrain Antoine	375473	GC C3 30
51	Paulsen Johanna Katharina	380547	GC C3 30
52	Picard Maya Noura Elisabeth	359259	GC C3 30
53	Poupard Thomas Daniel Denis	380159	GC C3 30
54	Prats--Genre Chloé Amelia	362989	GC C3 30
55	Rattin Titouan	362865	GC C3 30
56	Renouil-Hata Noémie	378728	GC C3 30
57	Rolland Quentin Pierre Marie	382007	GC C3 30
58	Romanens Jeanne Aline	363260	GC C3 30
59	Royet Camille	362746	GC C3 30
60	Schlatter Alexandre	345292	GC C3 30
61	Secretan Maël	372572	GC C3 30
62	Sonneville Evelyne Julie Marie	380331	GC C3 30
63	Strazza Maxime Léo	380221	GC C3 30
64	Traber Tobias	380359	GC C3 30
65	Turner Adrien Lorenz Michel	376702	GC C3 30
66	Waig Fang Hernández Leo	373552	GC C3 30
67	Walker Olivia	379263	GC C3 30
68	Wiesmann Nuri Nathanael	379181	GC C3 30

Moodle: Room assignment for the final exam (June 16th)

WEDNESDAY - LECTURES - ENV 220			Week	Teacher
19/2/2025	10h15-12h	The nature of ecology (introduction)	1	T. Battin
26/2/2025	10h15-12h	The physical environment	2	T. Battin
5/3/25	10h15-12h	Adaptations to the environment/Physiological ecology	3	C. Grossiord
12/3/25	10h15-12h	Population structure, dynamics, and regulation	4	C. Grossiord
19/3/25	10h15-12h	Community Ecology I	5	C. Bachofen
26/3/2026	10h15-12h	Community Ecology II	6	C. Grossiord
2/4/26	10h15-12h	Ecosystem ecology I	7	T. Battin
9/4/26	10h15-12h	Ecosystem ecology II	8	T. Battin
16/4/2026	10h15-12h	Biodiversity and conservation ecology	9	C. Grossiord
23/4/2025	Easter Holiday			
30/4/2025	ENAC Week			
7/5/24	10h15-12h	Climate Change impacts on terrestrial ecosystems	10	C. Grossiord
14/5/2024	10h15-12h	Climate Change impacts on aquatic ecosystems	11	T. Battin
21/5/2025	10h15-12h	Restoration ecology. Principles of ecosystem restoration, case studies	12	T. Battin
28/5/2025	10h15-12h	Applied ecology. Review and course wrap-up	13	C. Grossiord

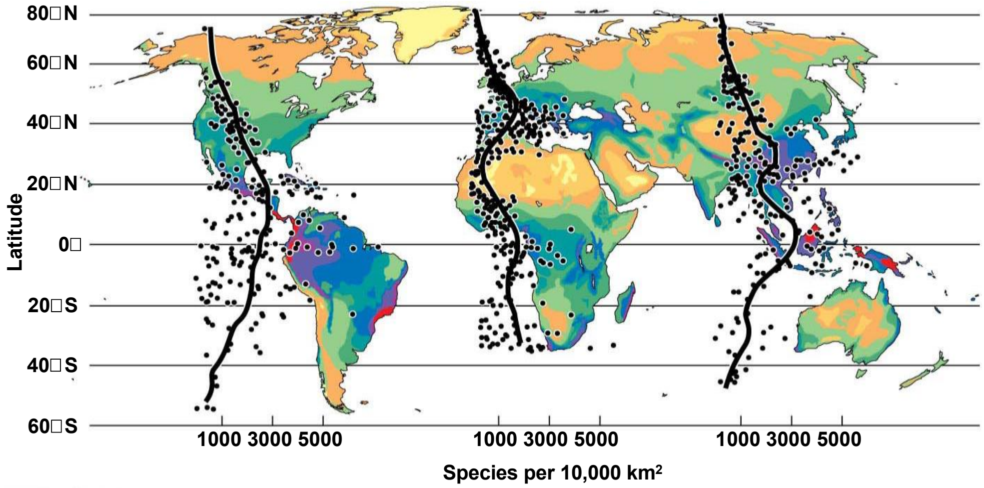
Schedule of the practicals

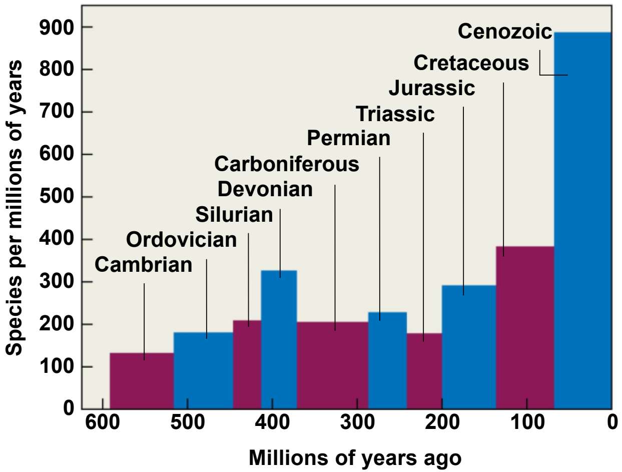
THURSDAY - PRACTICALS - ENV 220			Week	Important deadlines
20/02/25	11h15-13h	Introduction to practicals	1	
27/02/25	11h15-13h	Setting up experiments	2	**Inform the experimental setup to TAs by email by 26/02/25**
6/3/25	11h15-13h	How to write a report	3	
13/03/25	11h15-13h	Introduction to R	4	
20/03/25	11h15-13h	Field measurements 1	5	
27/03/25	11h15-13h	Data visualization in R	6	
3/4/25	11h15-13h	Field measurements 2	7	
10/4/25	11h15-13h	How to do statistical analyses	8	
17/04/25	11h15-13h	Field measurements 3	9	
24/04/25	**Easter Holiday**			
1/5/25	**ENAC Week**			
8/5/25	11h15-13h	Field measurements 4	10	
15/05/25	11h15-13h	Data Analysis/Interpretation	11	**Weighting of plant material in GR B2 423 before 15/05/25**
22/05/25	11h15-13h	Questions / Discussion	12	
REPORT SUBMITTED on MOODLE BY 06/06/25				

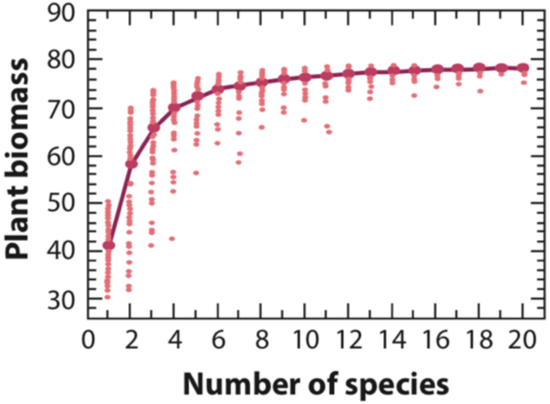
EPFL

What you saw in the previous lecture

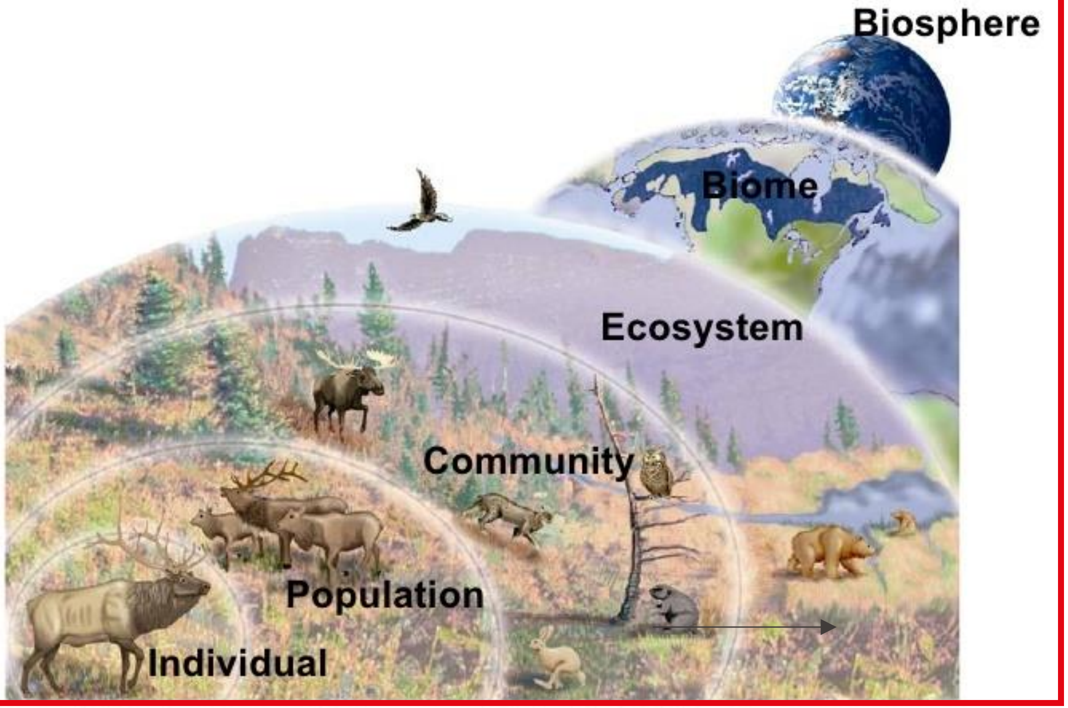
Biodiversity and conservation ecology





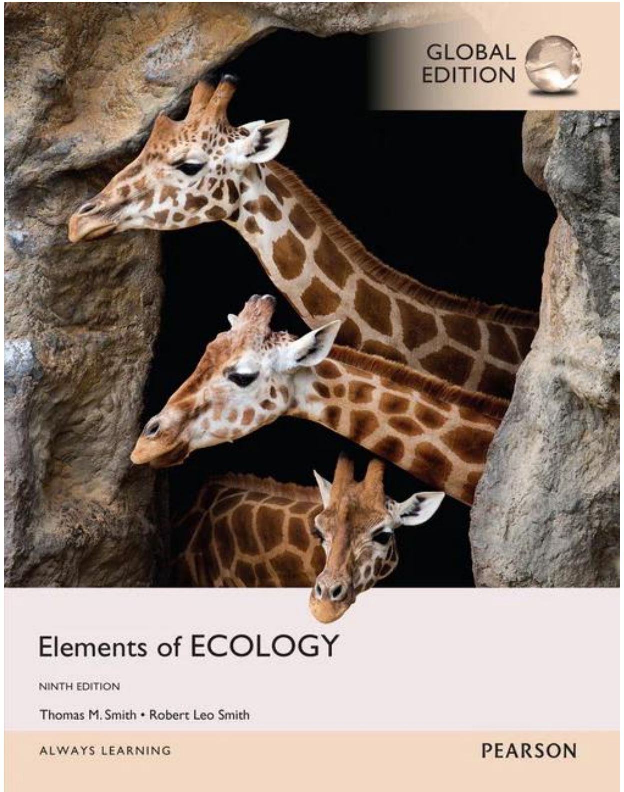


Overview of today's class



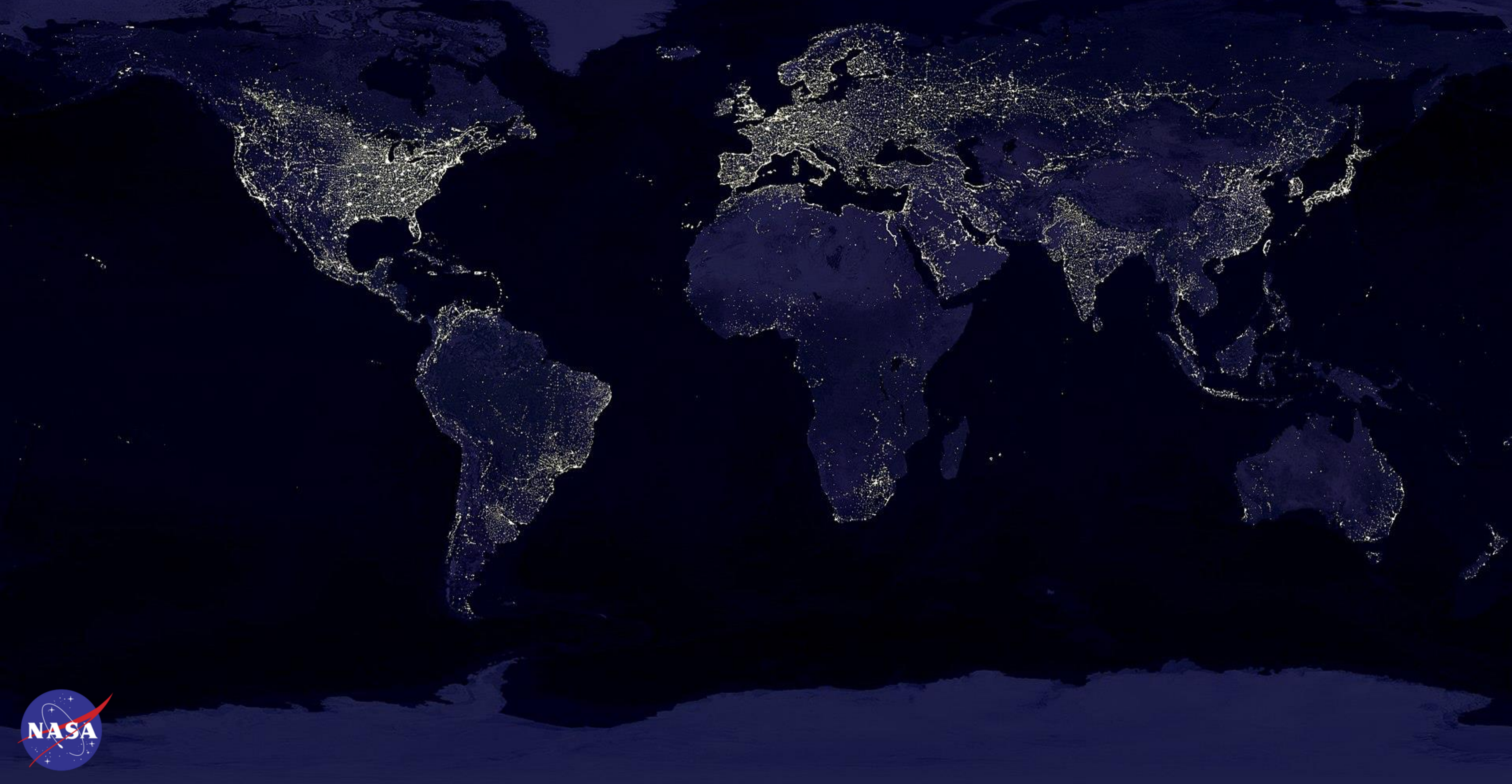
Climate change impacts on terrestrial ecosystems

References to today's class



Smith, TM. & Smith RL. Elements of Ecology, Global Edition (Pearson)

This emblematic picture of the earth by night highlights how much humans influence the planet



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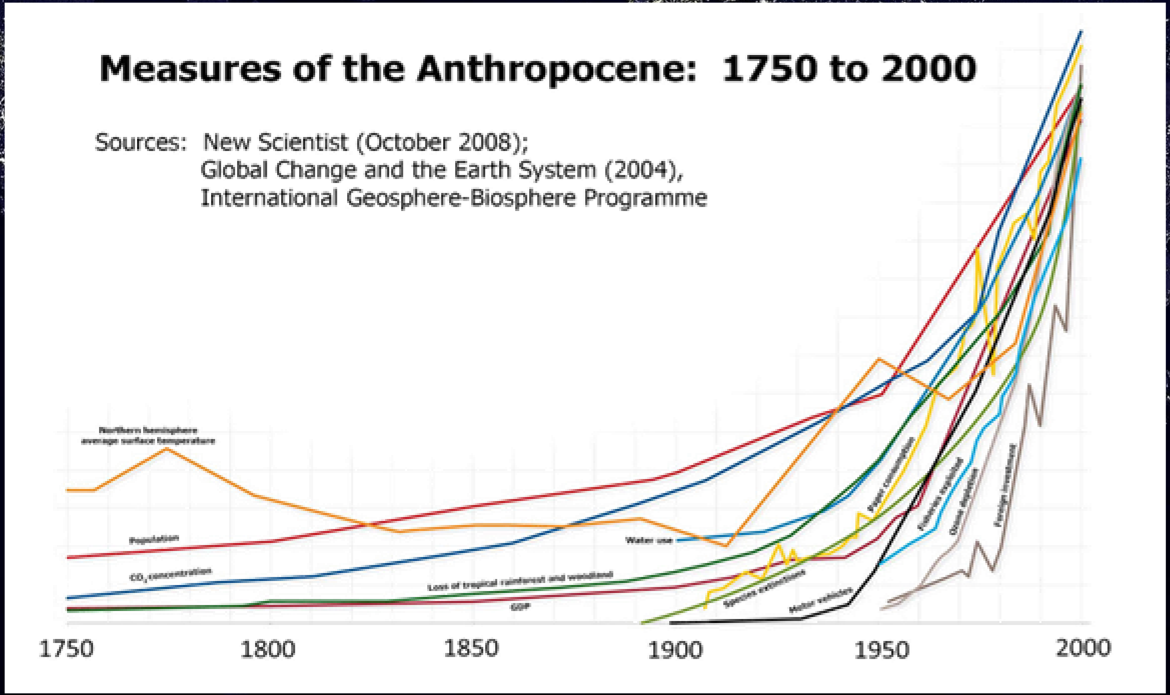
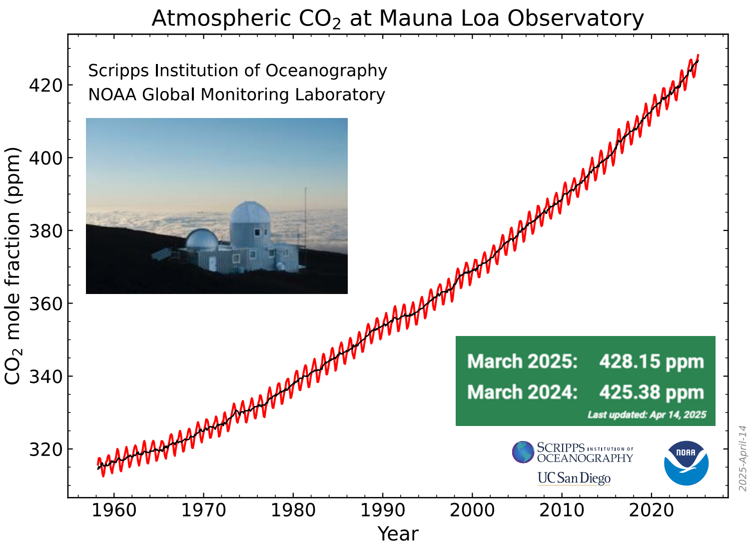
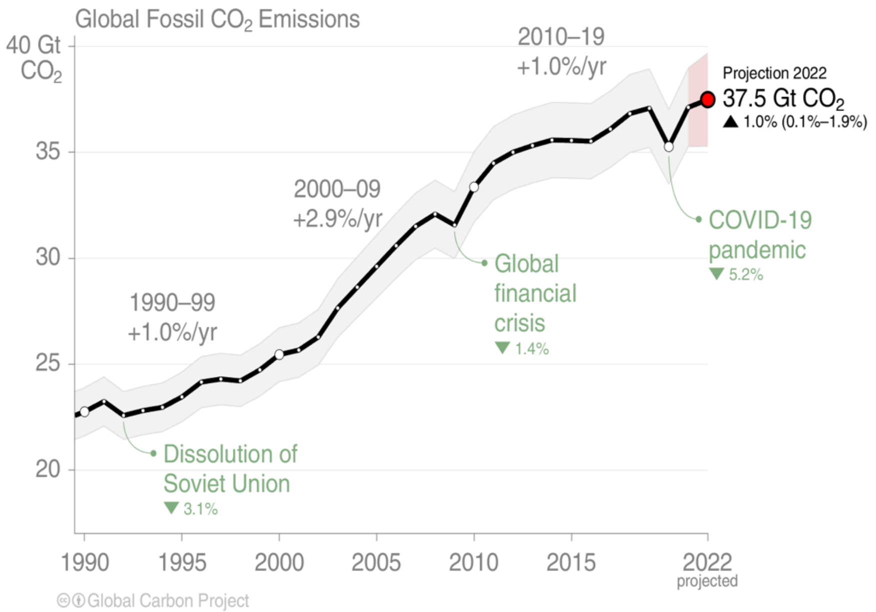


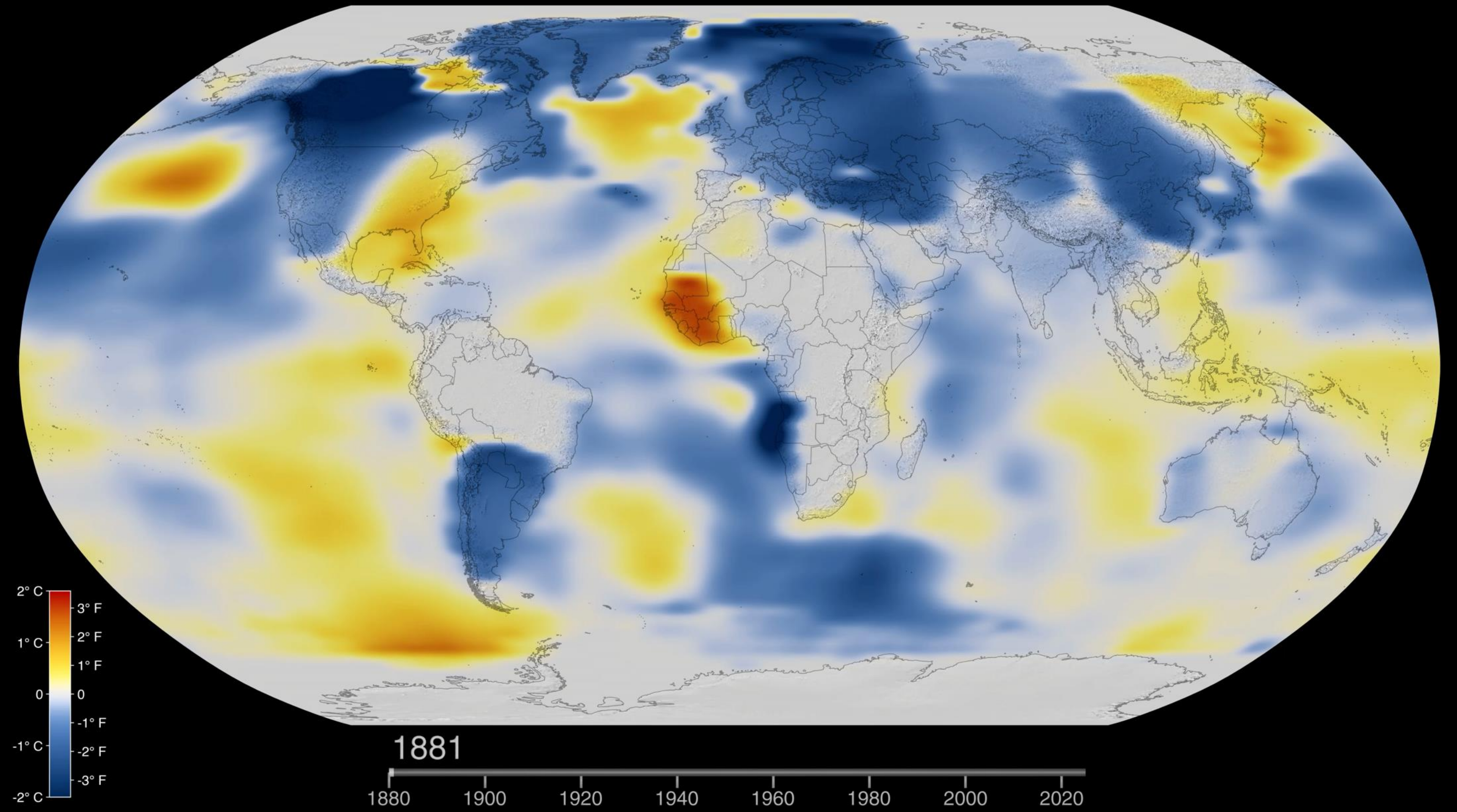
1. Key drivers of climate change

Since the Industrial Revolution began, burning fossil fuels has led to an exponential increase in the concentration of carbon dioxide and other greenhouse gases in the atmosphere.



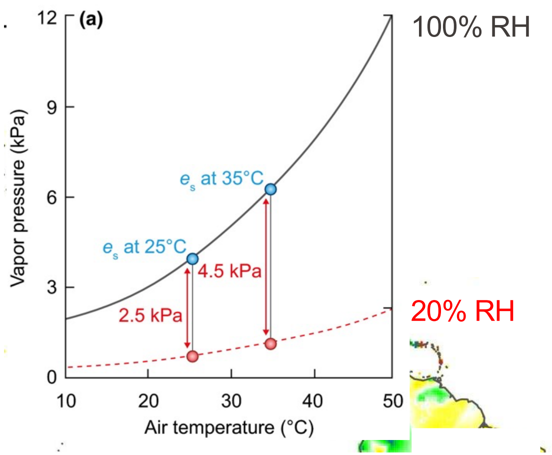
Longest record of direct measurements of CO_2 in the atmosphere.

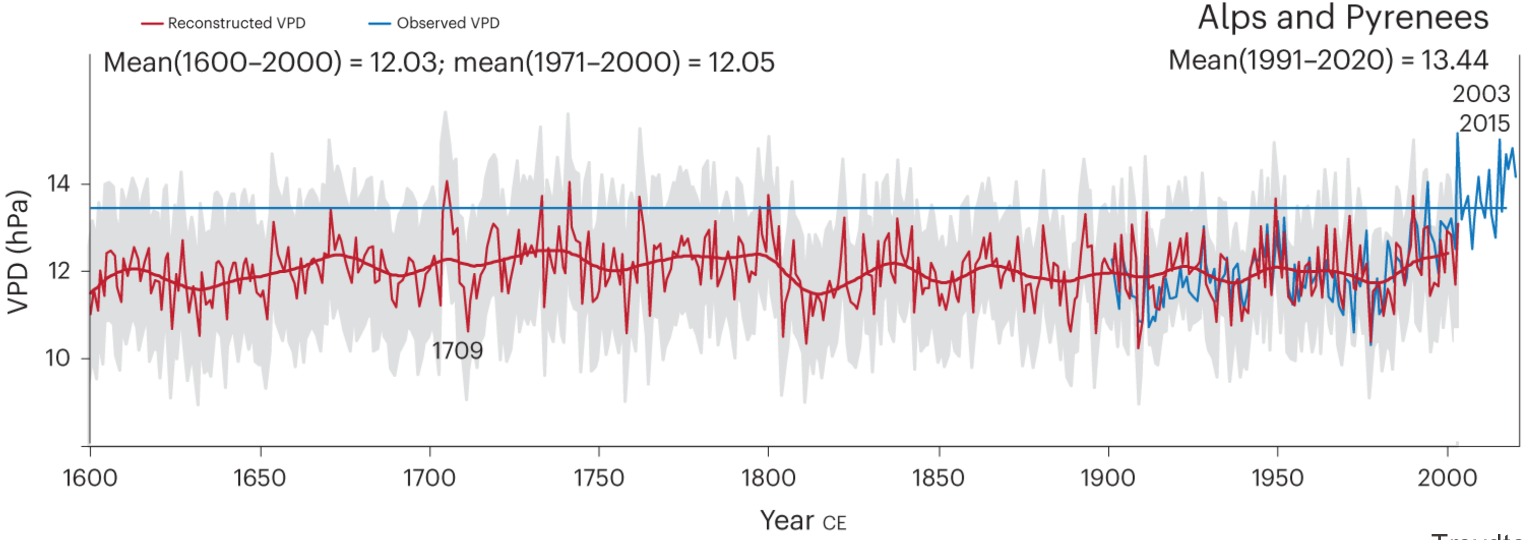



2° C
1° C
0
-1° C
-2° C
3° F
2° F
1° F
0
-1° F
-2° F
-3° F
1881
1880
1900
1920
1940
1960
1980
2000
2020

1. Key drivers of climate change

Rising temperature leads to higher atmospheric water demand, what we call the vapor pressure deficit (VPD)

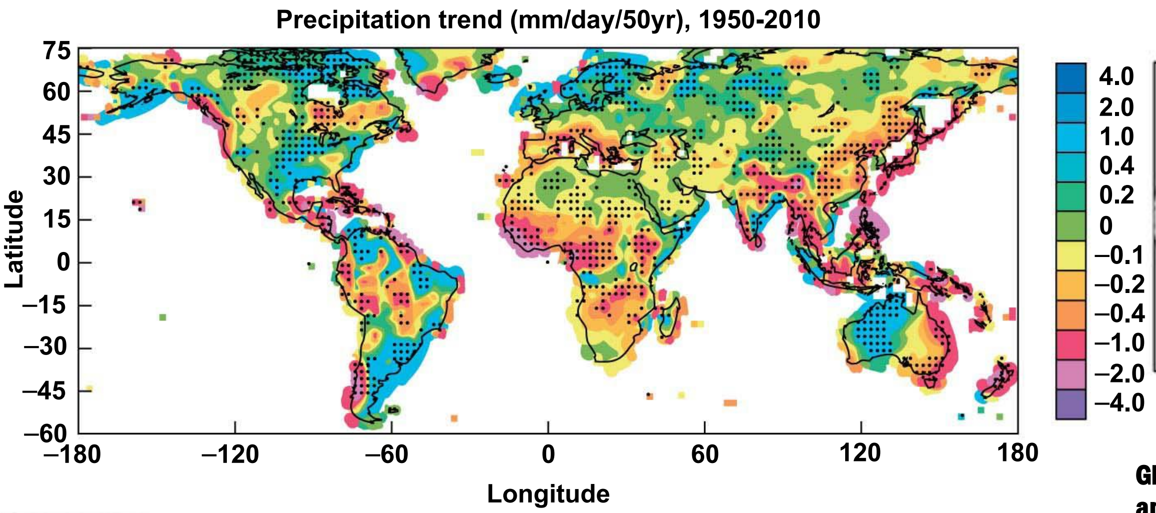


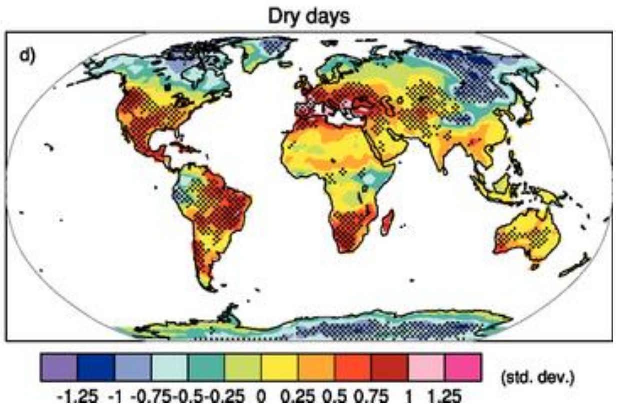


Treydte et al., 2024

1. Key drivers of climate change

Changes in precipitation have not been spatially or temporally uniform in the last century.





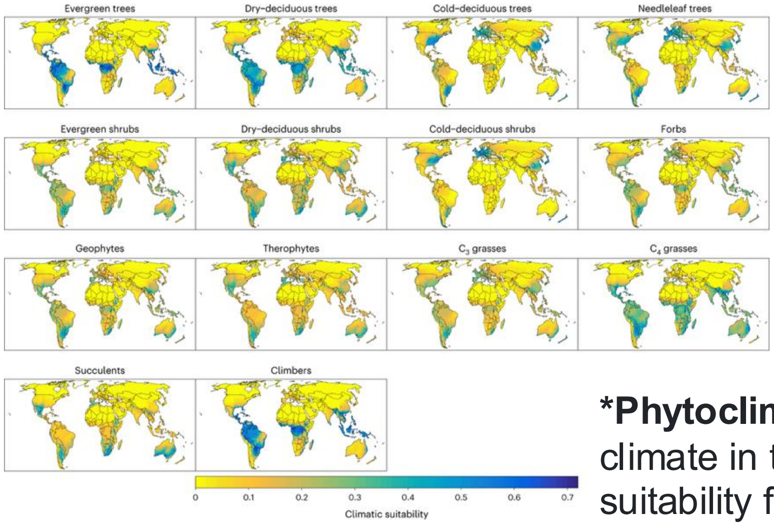
Globally averaged changes in dry days (defined as the annual maximum number of consecutive dry days), IPCC.

We have seen increased **precipitation extremes,** such as extended periods of low precipitation associated with increased drought events. An increase in intense precipitation and flooding is associated with more frequent drying periods.

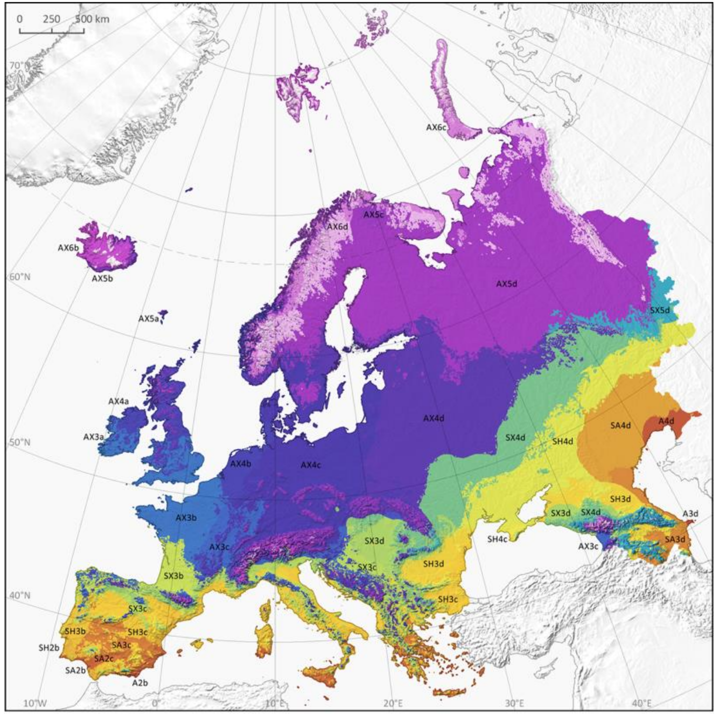
2. Impacts on terrestrial ecosystems

68% of the global land surface will experience a significant change in **phytoclimate*** by 2070 (scenario RCP 8.5).

A profound transformation of the biosphere is underway, requiring a timely adaptation of biodiversity management practices.



*__Phytoclimate__ = the climate in terms of its suitability for species

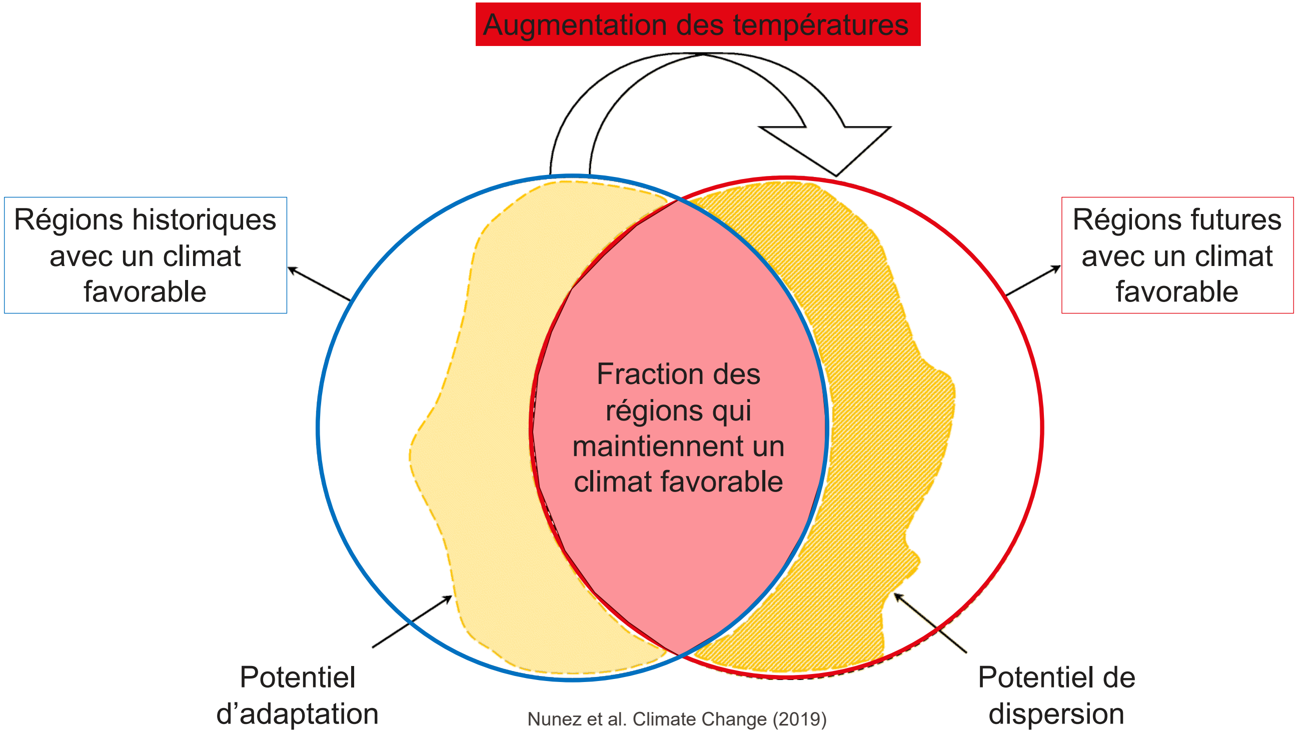


KEY TO PHYTOCLIMATIC UNITS

Aridity	A - Arid			SA - Semiarid			SH - Subhumid			SX - Subxeric				AX - Axeric				
Heat	2. Hot	3. Temp.	4. Cool	2. Hot	3. Temp.	4. Cool	2. Hot	3. Temp.	4. Cool	3. Temp.	4. Cool	5. Cold	6. Very cold	3. Temp.	4. Cool	5. Cold	6. Very cold	7. Nival
Continentality: a. Hyperoc.										SX3a				AX3a	AX4a	AX5a	AX6a	AX7a
b. Oceanic	A2b			SA2b	SA3b		SH2b	SH3b	SH4b	SX3b	SX4b	SX5b		AX3b	AX4b	AX5b	AX6b	AX7b
c. Suboc.				SA2c	SA3c	SA4c	SH2c	SH3c	SH4c	SX3c	SX4c	SX5c	SX6c	AX3c	AX4c	AX5c	AX6c	AX7c
d. Contin.		A3d	A4d		SA3d	SA4d		SH3d	SH4d	SX3d	SX4d	SX5d	SX6d	AX3d	AX4d	AX5d	AX6d	AX7d

2. Impacts on terrestrial ecosystems

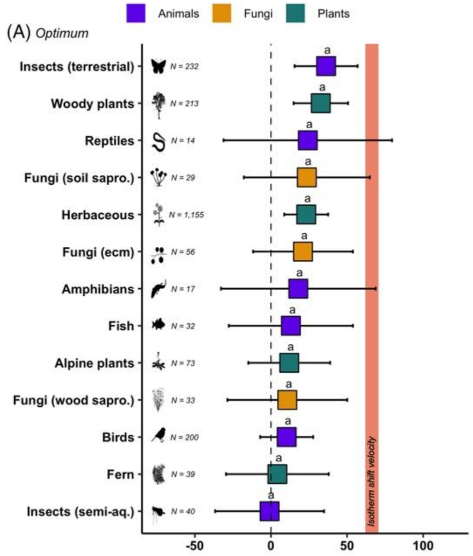
Climate change will have a **direct influence on species' distribution** because of species-specific temperature tolerances.



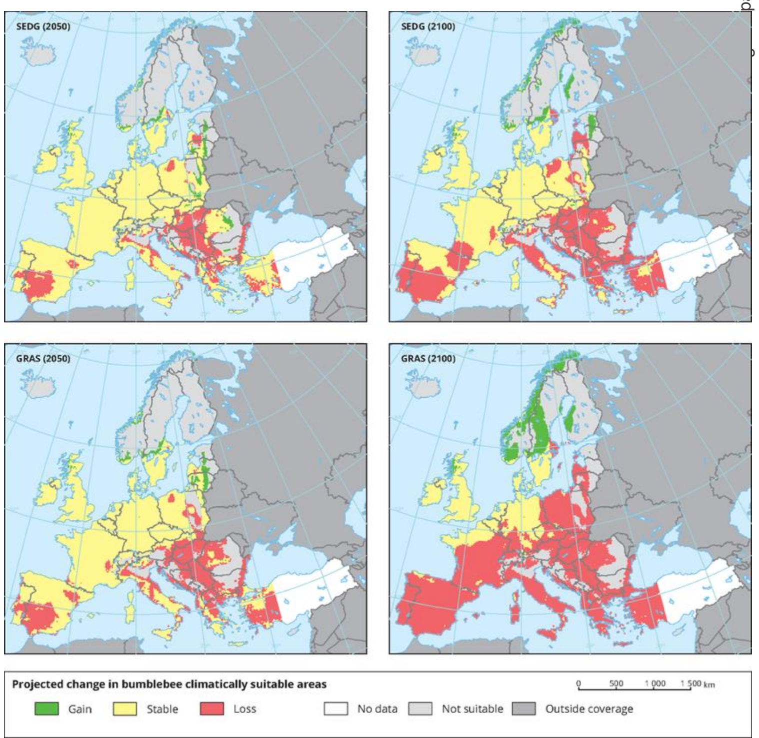
Nunez et al. Climate Change (2019)

2. Impacts on terrestrial ecosystems

The northern (or upper elevation) distribution boundary reflects constraints imposed by minimum temperatures. If dispersal allows, species should track the shifting climate, shifting their distribution poleward in latitude and upward in elevation.



Many species won’t be able to keep track of ongoing climate warming (cf. lecture 4).



The map shows the projected change in the climatic suitable area for the Bumblebee *Bombus terrestris* (the largest and one of the most numerous bumblebee species in Europe) under the combined climate-land use scenario SEDG (Sustainable European Development Goal, including SRES B1) and GRAS.

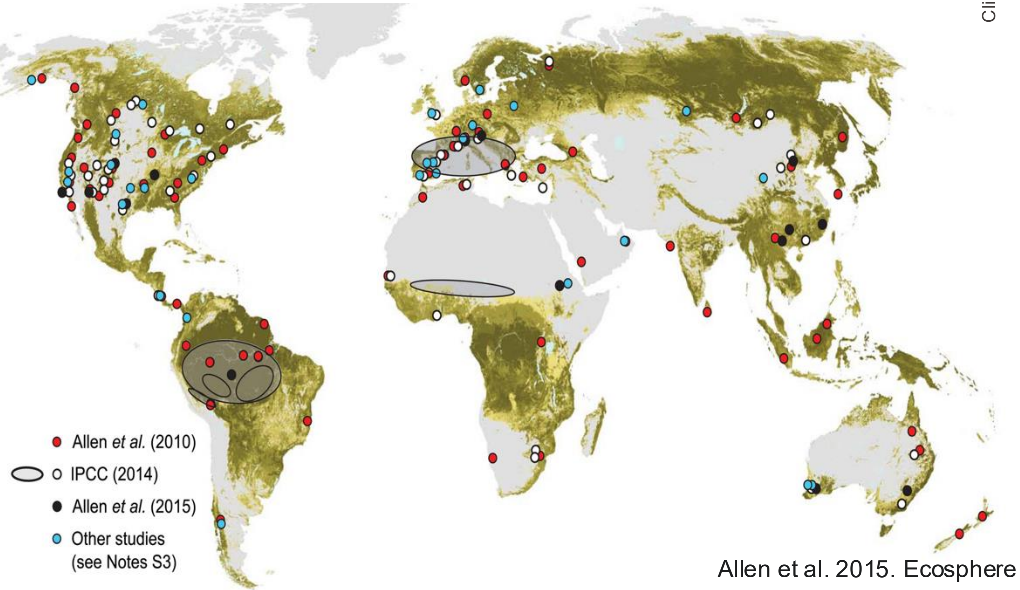
2. Impacts on terrestrial ecosystems

If species cannot shift their distribution, they will be subjected to mortality.

Most regions of the world have experienced significant vegetation mortality due to warmer and drier climates ("hot droughts" or "global-change-type droughts").

Harz National Park, Germany (2018)

Locations of substantial drought- and heat-induced tree mortality around the globe

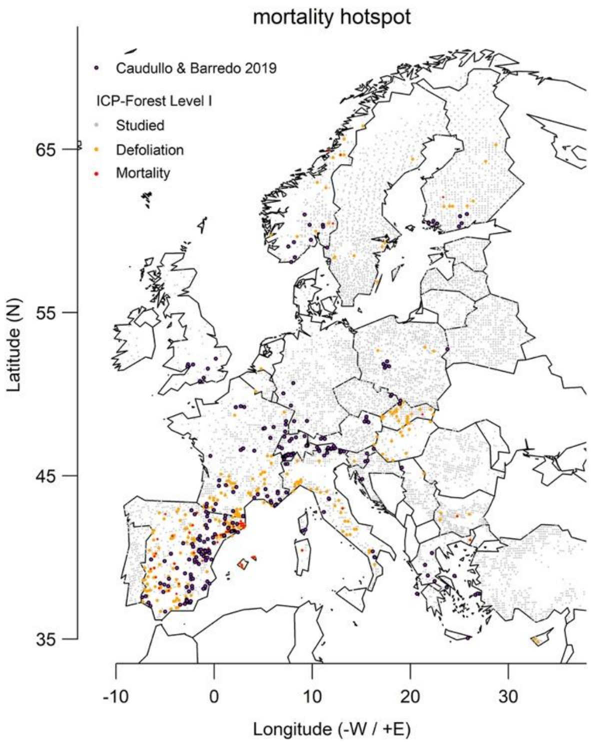


Allen et al. 2015. Ecosphere

EPFL

2. Impacts on terrestrial ecosystems

Mortality is not only a result of lack of water but is increasingly associated with high temperatures and, particularly, VPD rise.



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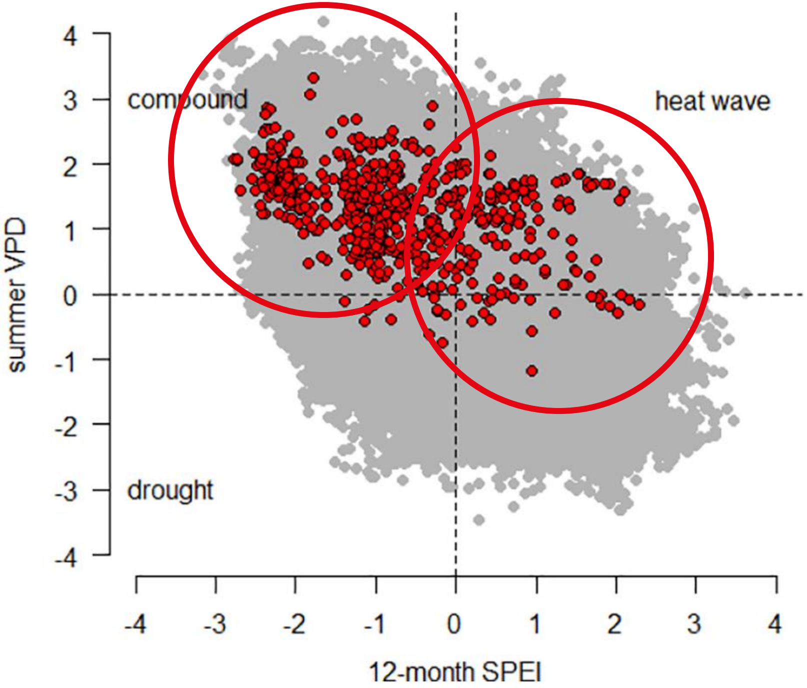


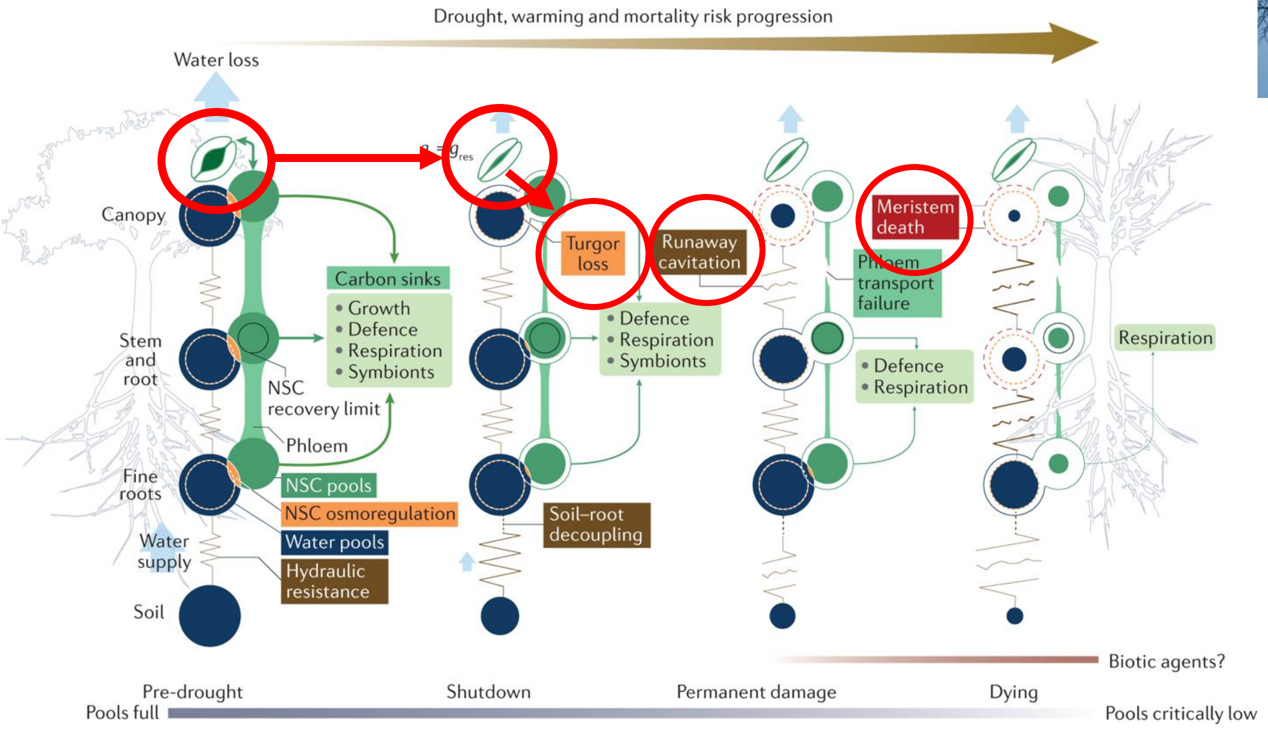
Summer VPD and SPEI index for the years where tree mortality occurred in Europe

Gazol & Camarero 2022 STOTEN

EPFL

2. Impacts on terrestrial ecosystems

How drought leads to plant death

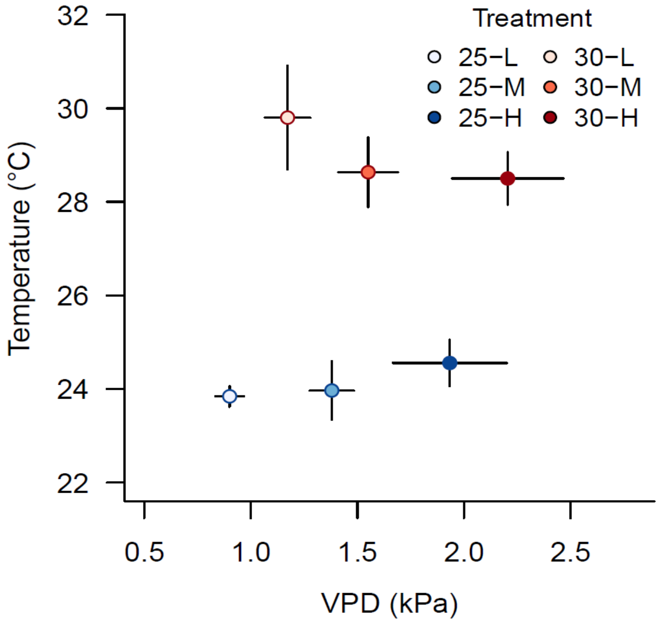


McDowell et al. (2022) *Nature Reviews Earth & Environment*

2. Impacts on terrestrial ecosystems

How does high temperature and VPD lead to plant death?

- **Example of a study investigating these mechanisms**

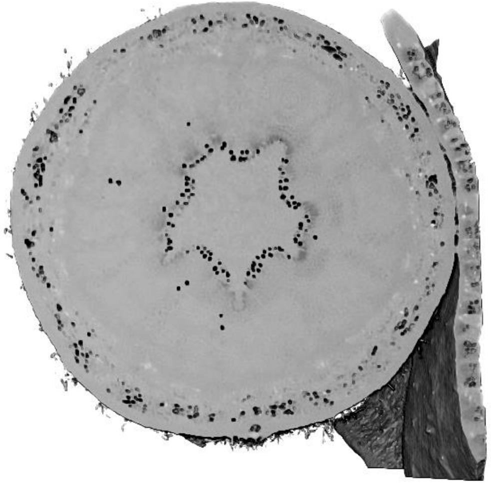


Schoenbeck et al. (2022)

2. Impacts on terrestrial ecosystems

How does high temperature and VPD lead to plant death?

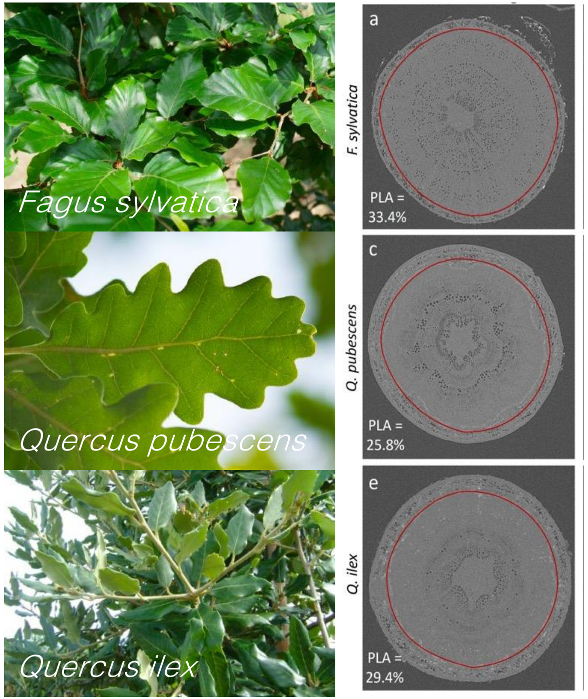
- **Example of a study investigating these mechanisms**

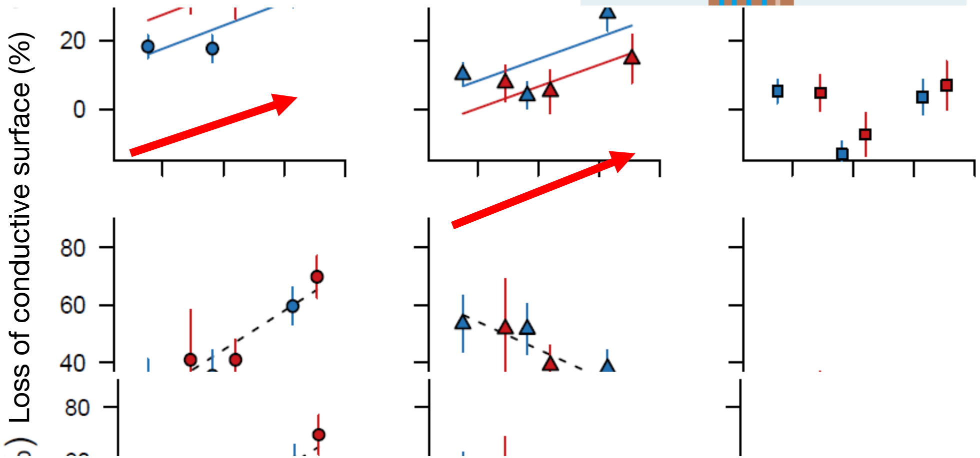


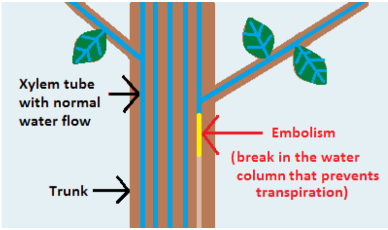
Schoenbeck et al. (2022)

2. Impacts on terrestrial ecosystems

- **Example of a study investigating these mechanisms**







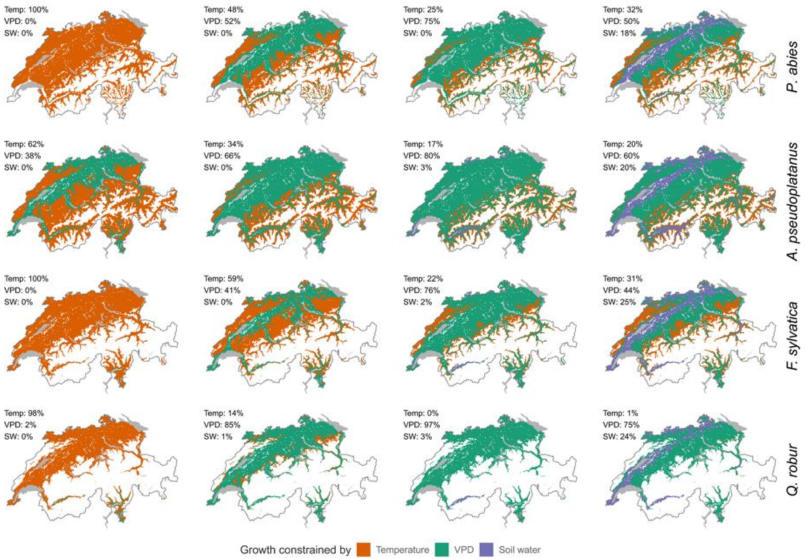
VPD leads to embolism, independently of soil drought, which impairs water transport and leads to desiccation

https://www.youtube.com/watch?v=9sKYRgilA1I

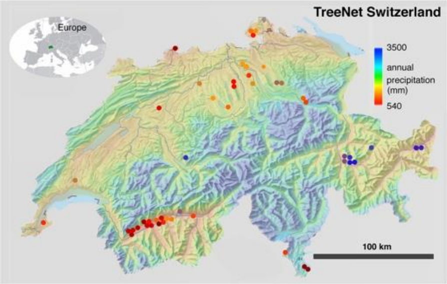
Schoenbeck et al. (2022)

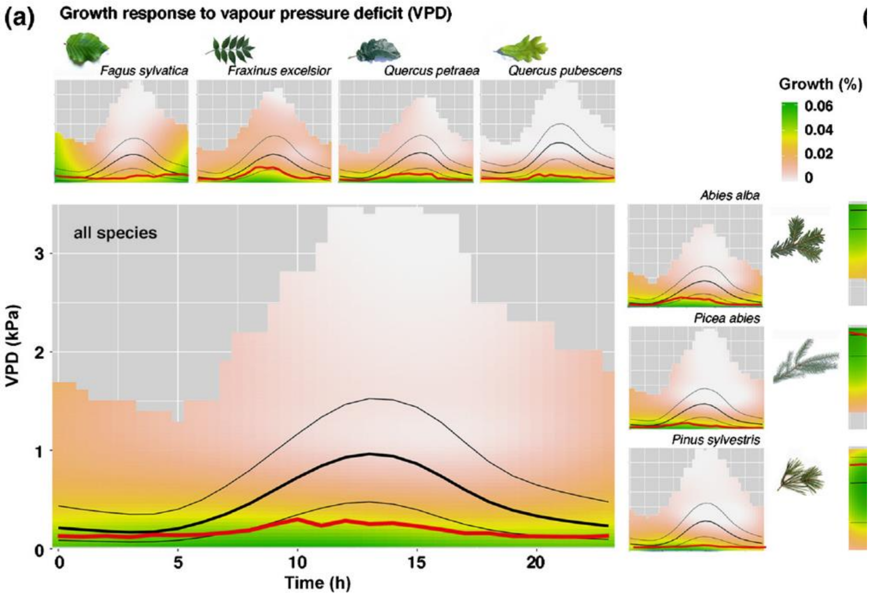
2. Impacts on terrestrial ecosystems

VPD is not only killing plants but also reduces their growth as plants can only grow during periods of low VPD



Trotsiuk et al. (2021) *Journal of Ecology*





Zweifel et al. (2021) *New Phytologist*

2. Impacts on terrestrial ecosystems

Climate change can **increase the fitness of one species at the expense of another**.

- **Example of the mountain pine beetle that attacks most trees in the genus *Pinus*:**

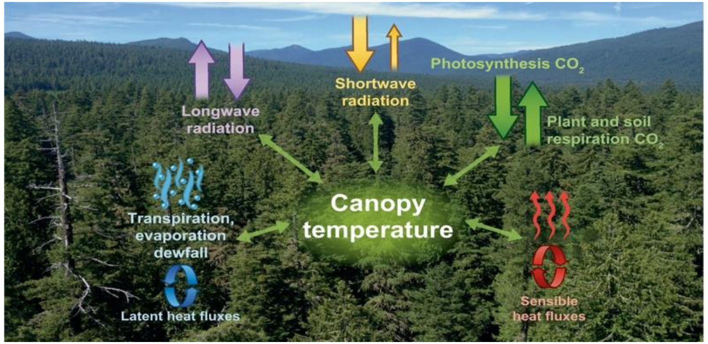
  - Over the past ten years, pine beetle outbreaks have been larger than previously recorded. Regional warming has expanded the beetle range, especially at higher elevations.
  - Warming has affected the beetle's life history: the beetle flight season (flying to attack new trees) starts one month earlier and lasts twice as long.
  - Western North America experienced increased temperatures and drought frequency during this period. This has decreased tree health and increased susceptibility to beetles.

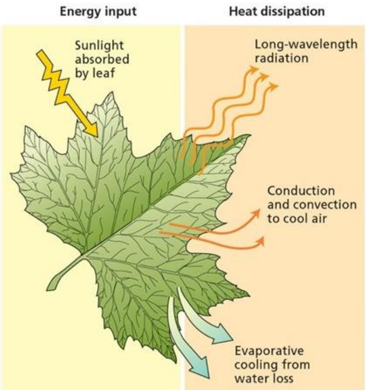
Tree mortality resulting from pine beetle attacks.

Side view of adult mountain pine beetle. USDA Forest Service

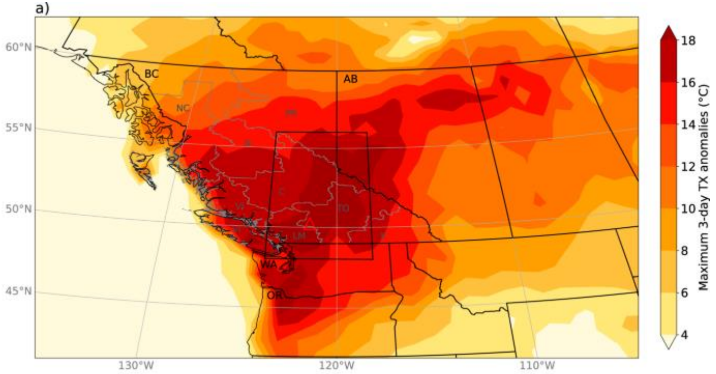
2. Impacts on terrestrial ecosystems

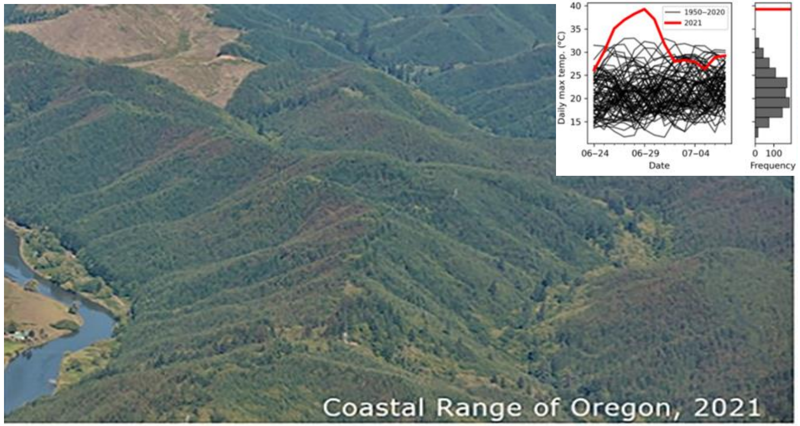
Temperature extremes also lead to canopy scorching because plants can't regulate their temperature anymore





The 2021 Heat dome in the Pacific Northwest

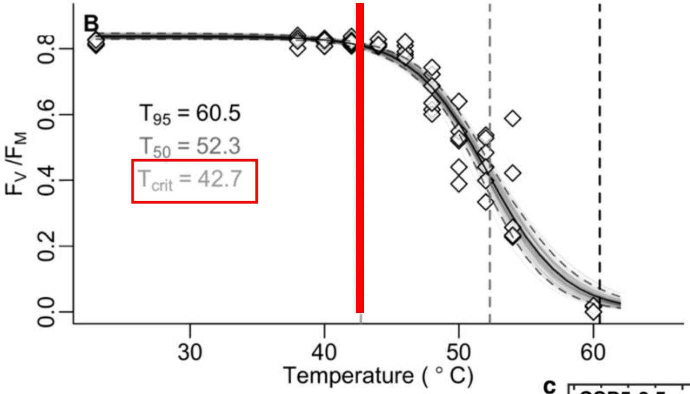




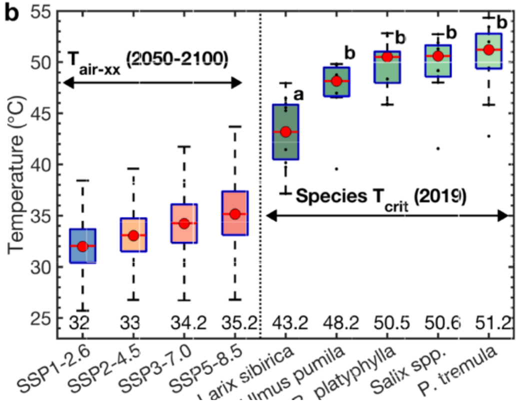
Still et al., (2022)

2. Impacts on terrestrial ecosystems

Warming and more intense heatwaves lead to vegetation surpassing their thermal tolerance.



Estimate species thermal tolerance



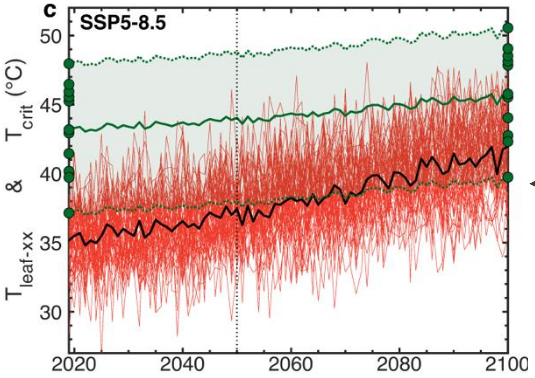
communications earth & environment

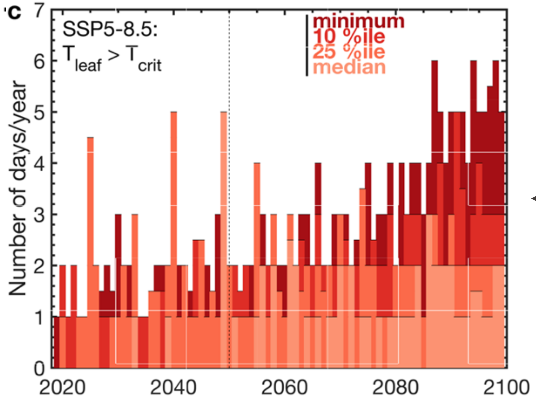
ARTICLE

OPEN

Approaching a thermal tipping point in the Eurasian boreal forest at its southern margin

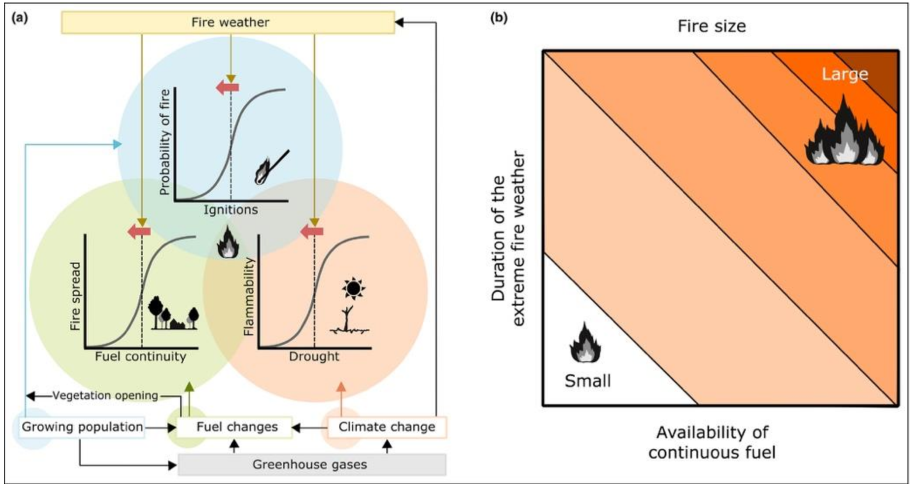
Rao et al., (2023)



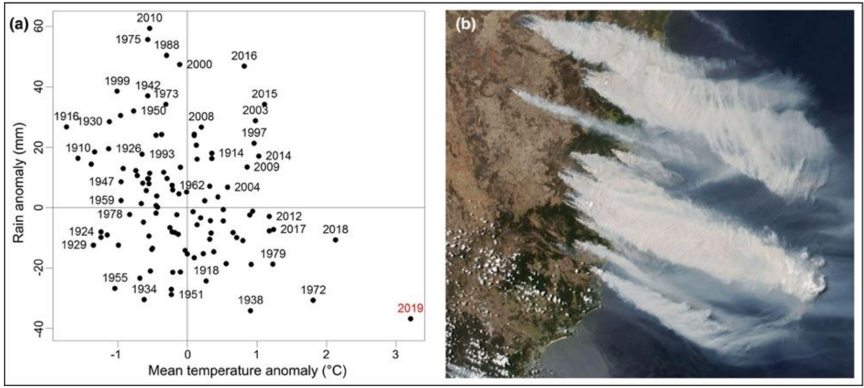


2. Impacts on terrestrial ecosystems

Warming, dry air, and drought increase the risk of wildfires worldwide because vegetation becomes more flammable and climatic conditions increase fire weather (risk of ignition)



→ Cf. last lecture on Applied Ecology



Climatic conditions during the wildfire season in 2019 in Eastern Australia

2. Impacts on terrestrial ecosystems

Planting more trees cannot be a solution to mitigate emissions and impacts of climate change

PLANT A BILLION TREES

Comment on "The global tree restoration potential"

Andrew K. Skidmore[1,2]*, Tiejun Wang[1], Kees de Bie[1], Petter Pilesjö[3]

[1]Faculty of Geo-Information Science and Earth Observation (ITC), University of Twente, 7500 AE Enschede, Netherlands. [2]Department of Earth and Environmental Science, Macquarie University, Sydney, Australia. [3]Department of Physical Geography and Ecosystem Science, Lund University, S-223 62 Lund, Sweden.

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Bastin *et al.* (Reports, 5 July 2019, p. 76) claim that 205 gigatonnes of carbon can be globally sequestered by restoring 0.9 billion hectares of forest and woodland canopy cover. Reinterpreting the data from Bastin *et al.*, we show that the global land area actually required to sequester human-emitted CO_2 is at least a factor of 3 higher, representing an unrealistically large area.

Comment on "The global tree restoration potential"

Simon L. Lewis[1,2]*, Edward T. A. Mitchard[3], Colin Prentice[4], Mark Maslin[1], Ben Poulter[5]

[1]Department of Geography, University College London, London WC1E 6BT, UK. [2]School of Geography, University of Leeds, Leeds LS2 9JT, UK. [3]School of GeoSciences, University of Edinburgh, Edinburgh EH9 3FF, UK. [4]Department of Life Science, Imperial College, Ascot, Berks SL5 7PY, UK. [5]NASA Goddard Space Flight Center, Greenbelt, MD, USA.

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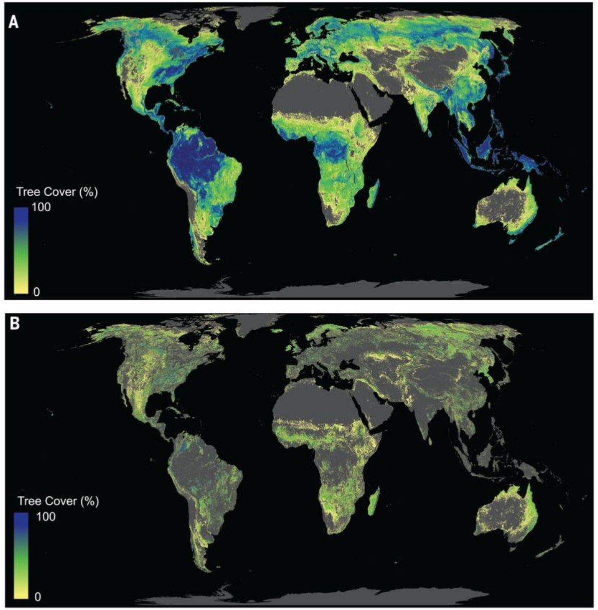
Bastin *et al.* (Reports, 5 July 2019, p. 76) state that the restoration potential of new forests globally is 205 gigatonnes of carbon, conclude that "global tree restoration is our most effective climate change solution to date," and state that climate change will drive the loss of 450 million hectares of existing tropical forest by 2050. Here we show that these three statements are incorrect.

Bastin *et al.*'s estimate (Reports, 5 July 2019, p. 76) that tree planting for climate change mitigation could sequester 205 gigatonnes of carbon is approximately five times too large. Their analysis inflated soil organic carbon gains, failed to safeguard against warming from trees at high latitudes and elevations, and considered afforestation of savannas, grasslands, and shrublands to be restoration.



The global tree restoration potential

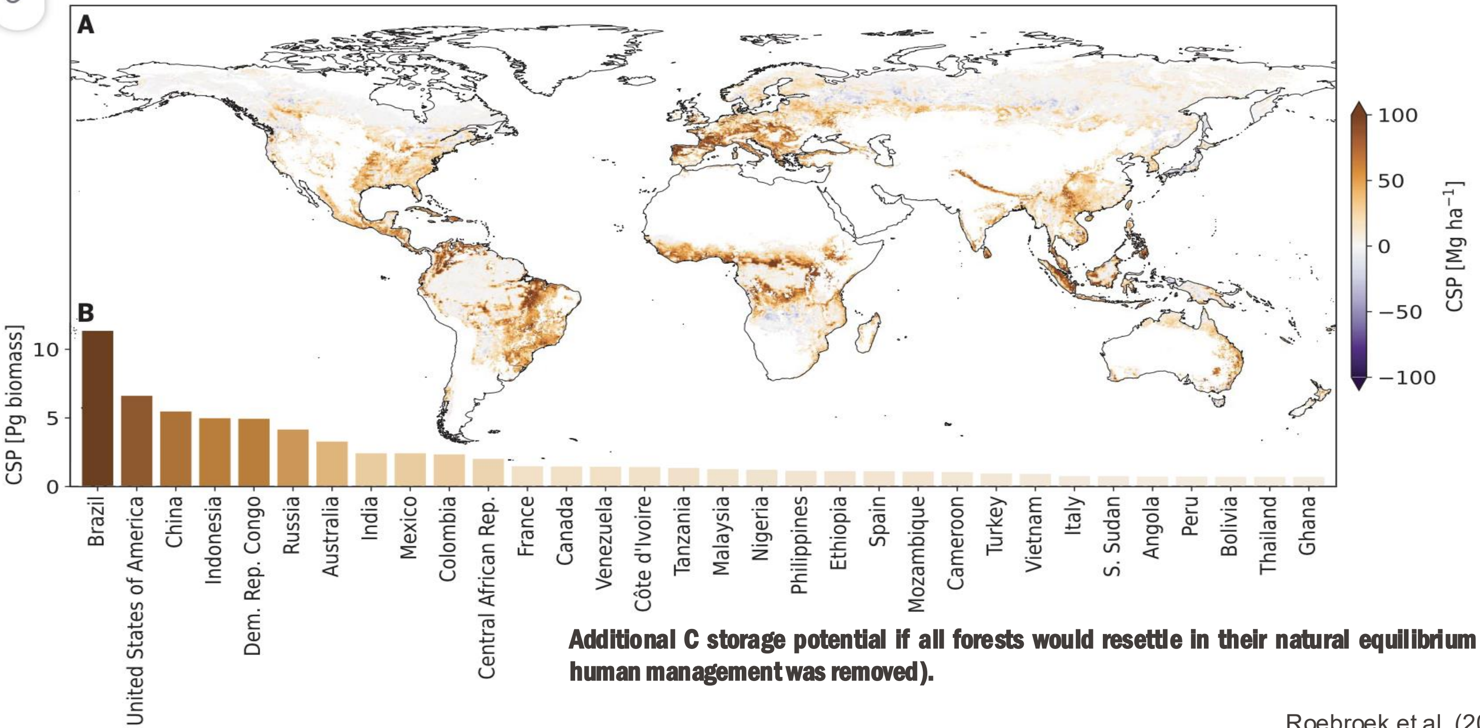
Jean-Francois Bastin[1]*, Yelena Finegold[2], Claude Garcia[3,4], Danilo Mollicone[2], Marcelo Rezende[2], Devin Routh[1], Constantin M. Zohner[1], Thomas W. Crowther[1]

The restoration of trees remains among the most effective strategies for climate change mitigation. We mapped the global potential tree coverage to show that 4.4 billion hectares of canopy cover could exist under the current climate. Excluding existing trees and agricultural and urban areas, we found that there is room for an extra 0.9 billion hectares of canopy cover, which could store 205 gigatonnes of carbon in areas that would naturally support woodlands and forests. This highlights global tree restoration as one of the most effective carbon drawdown solutions to date. However, climate change will alter this potential tree coverage. We estimate that if we cannot deviate from the current trajectory, the global potential canopy cover may shrink by ~223 million hectares by 2050, with the vast majority of losses occurring in the tropics. Our results highlight the opportunity of climate change mitigation through global tree restoration but also the urgent need for action.

EPFL

2. Impacts on terrestrial ecosystems

Forests could increase their aboveground C biomass by up to 44 Pg without management (e.g., harvesting). This is an increase of 15% over current levels, **equating to about 4 years of current anthropogenic CO_2 emissions.**



Additional C storage potential if all forests would resettle in their natural equilibrium (if all human management was removed).

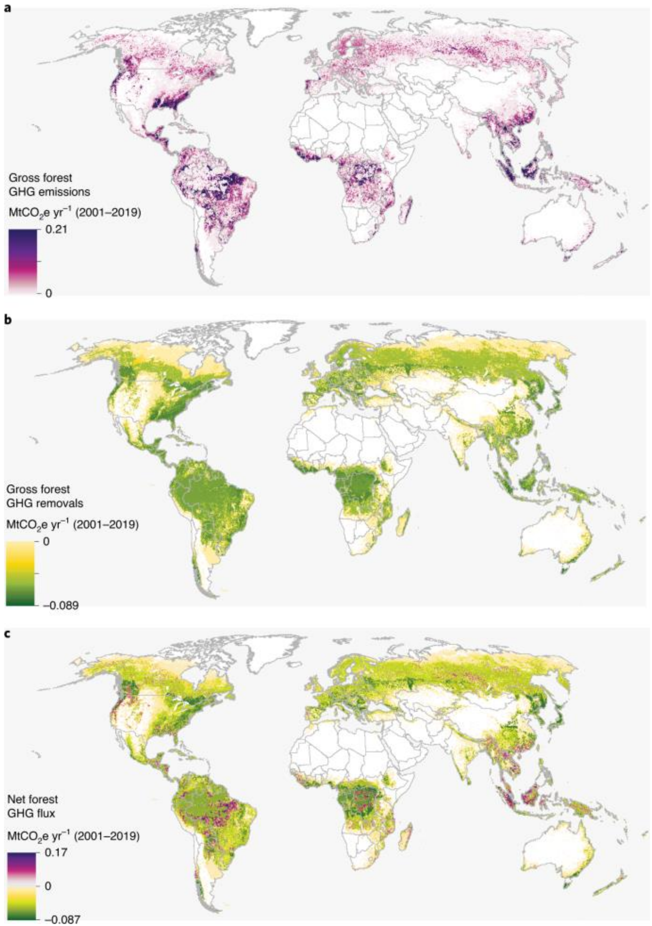
Roebroek et al. (2023) *Science*

2. Impacts on terrestrial ecosystems

Management options for dealing with hot droughts

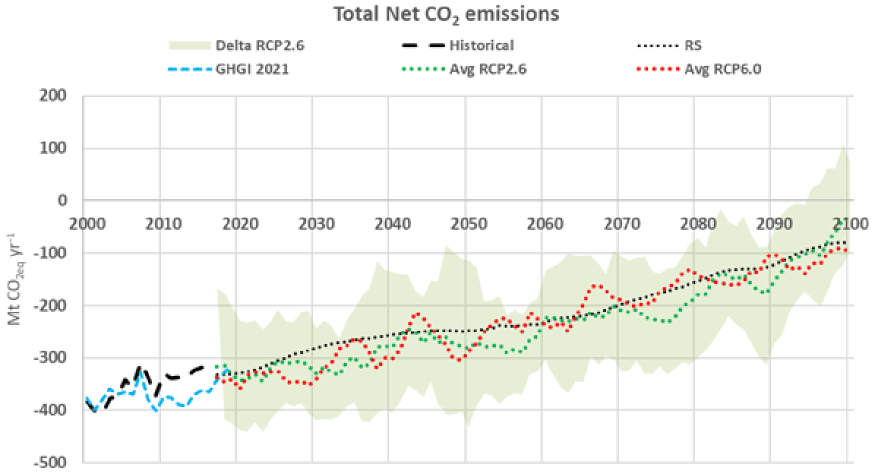
1. Reduce tree density to increase water availability in the soil and reduce competition between individuals.
2. Encourage species tolerant to extreme conditions
3. Forest mulching to reduce erosion and improve soil characteristics
4. Soil amendment (increases drought tolerance)
5. Water retention in deep horizons with impermeable covers (at tree level)
6. Water retention in micro-basins during heavy rainfall
7. Irrigation to keep water stress low during extreme events

2. Impacts on terrestrial ecosystems



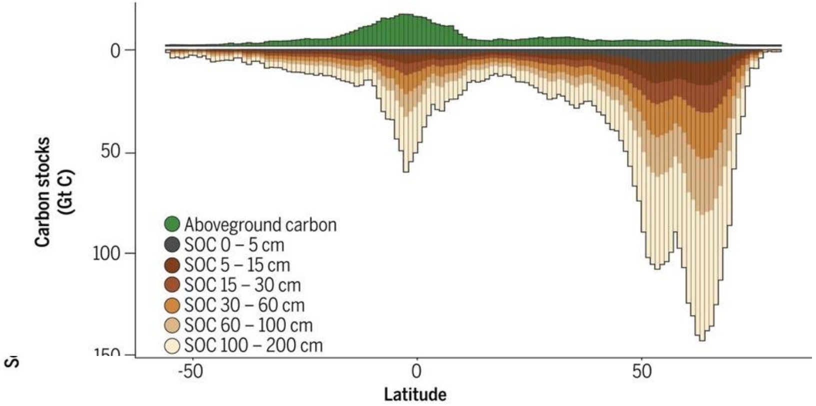
Tropical forests contributed the most to global gross forest fluxes, accounting for 80% of gross emissions and 50% of gross removals

Just six large forested countries (Brazil, Canada, China, Democratic Republic of the Congo, Russia and the United States) accounted for 50% of global gross emissions, 56% of global gross removals.

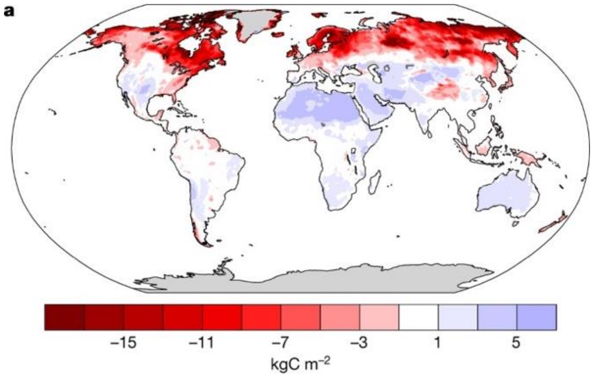


2. Impacts on terrestrial ecosystems

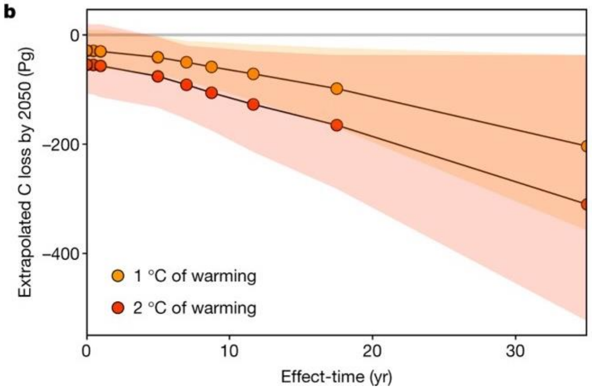
Soil organic C content is higher where rainfall is high, and temperatures are cool. **Warming could lead to high C emissions from these areas because of higher soil respiration**.

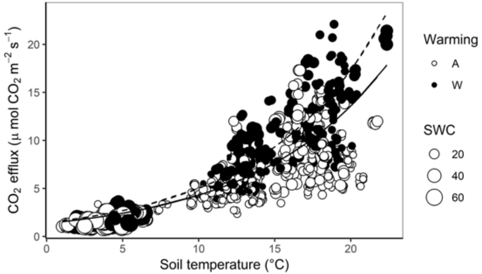


Map of predicted changes in soil C stocks by 2050



Total reductions in the global C pool under 1-2 °C soil surface warming by 2050

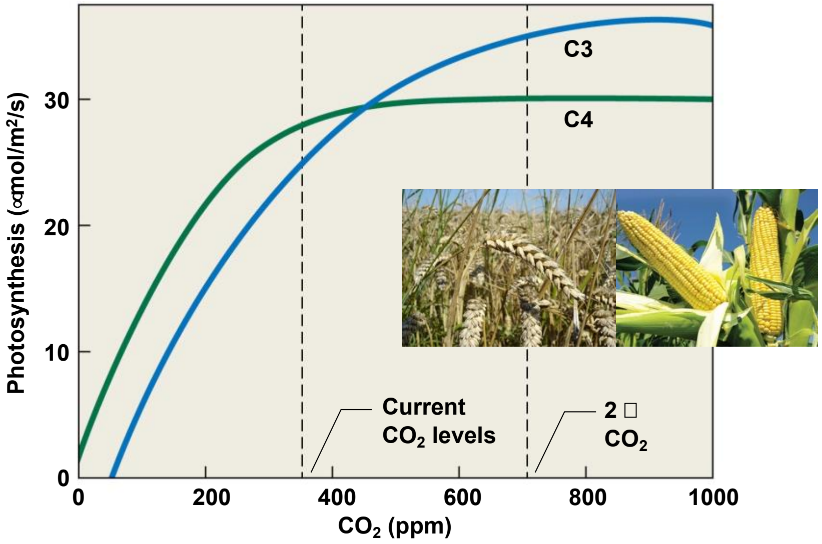




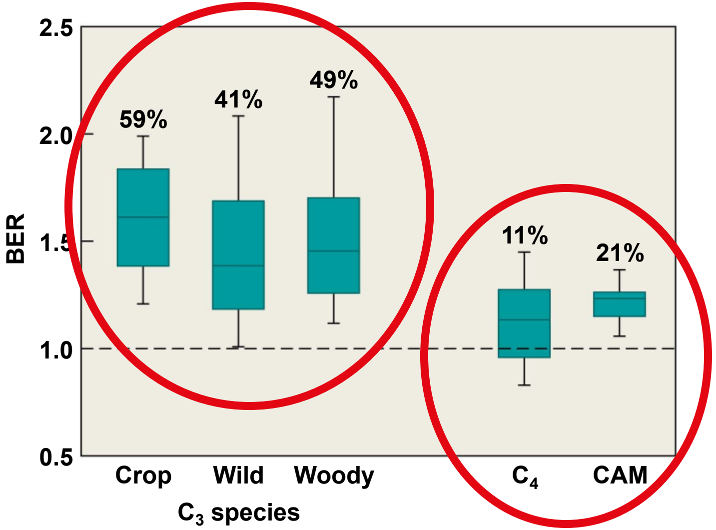
2. Impacts on terrestrial ecosystems

The CO_2 fertilization effect

- As the level of CO_2 increases in the atmosphere, the diffusion gradient between the air and the interior of the leaf increases → more CO_2 moves into the leaf
- Increased CO_2 concentration in mesophyll cells will increase the rate of photosynthesis



Net photosynthesis in relation to atmospheric CO_2 concentration

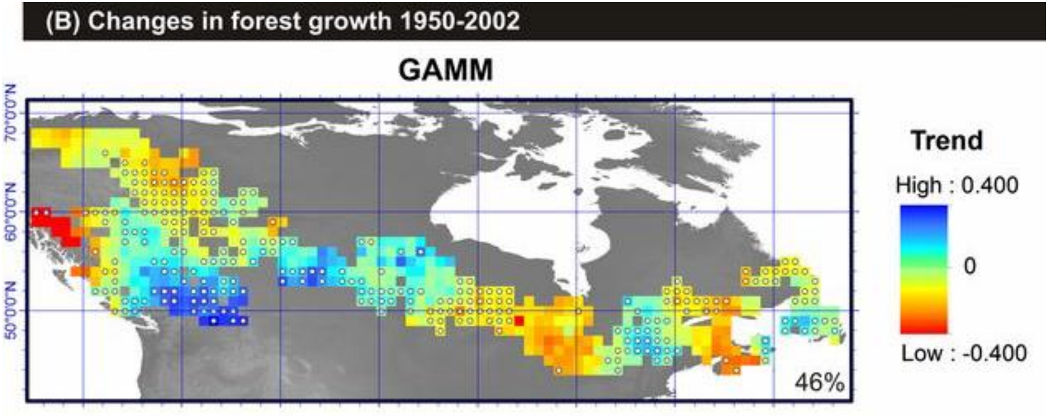


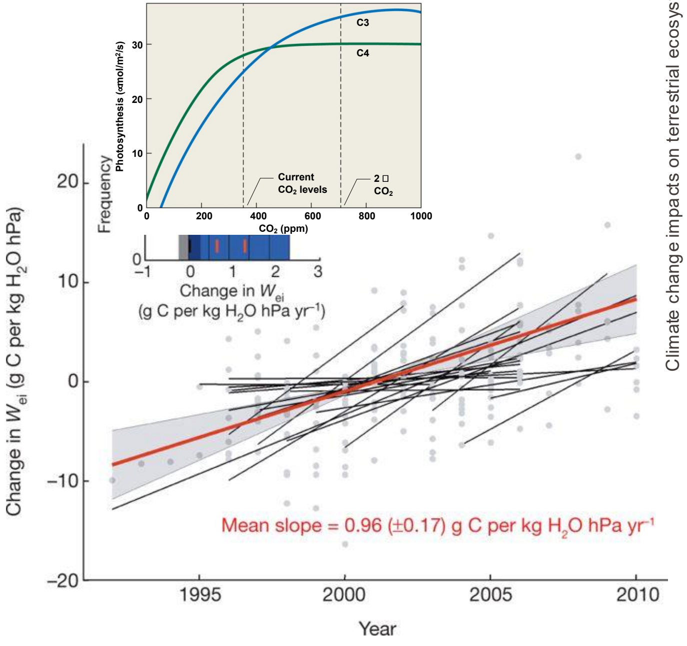
BER is the ratio of biomass growth at elevated and ambient levels of CO_2.

2. Impacts on terrestrial ecosystems

Studies have found a substantial increase in water-use efficiency (WUE) in temperate and boreal forests of the Northern Hemisphere over the past two decades. The observed increase is most consistent with a strong **CO_2 fertilization effect**.

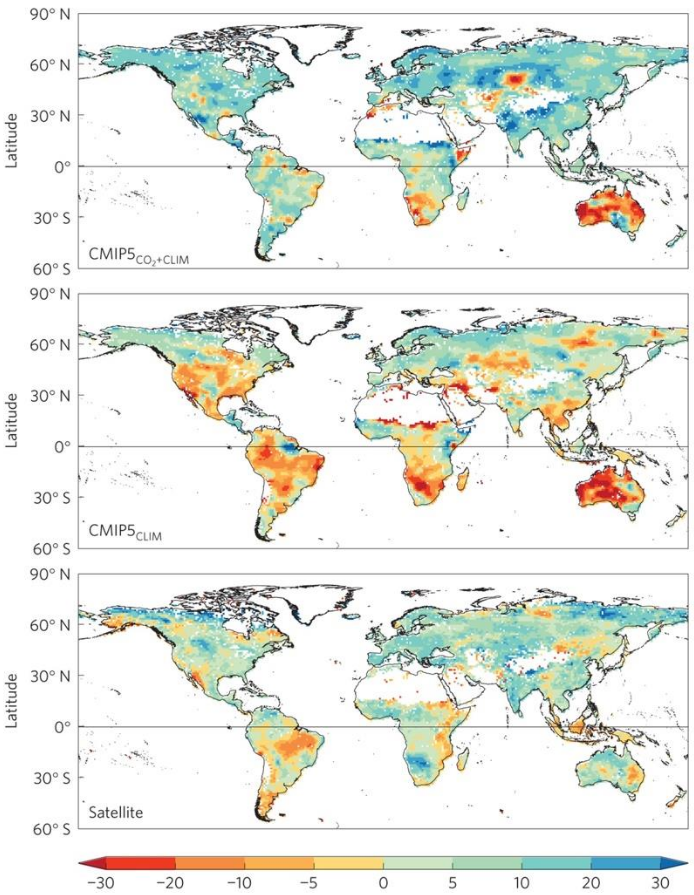
Increasing WUE has been associated with a decreasing evapotranspiration rate, and divergent changes in growth.



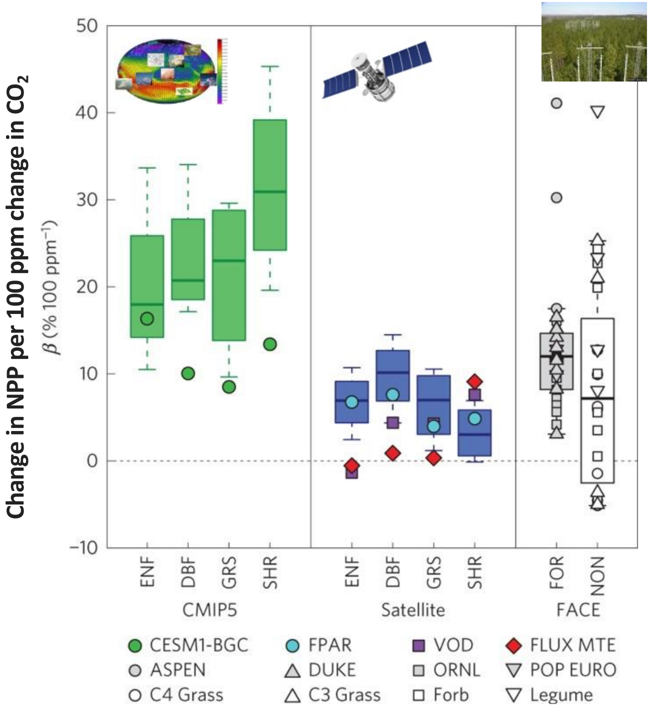


Annual change in water use efficiency ΔW_{ei} , calculated using daytime fluxes from summer months at 14 sites across the Northern Hemisphere. The red line represents the mean trend over all sites, extrapolated over the entire measurement period. Individual site observations and trends are given as grey dots and black lines, respectively.

2. Impacts on terrestrial ecosystems

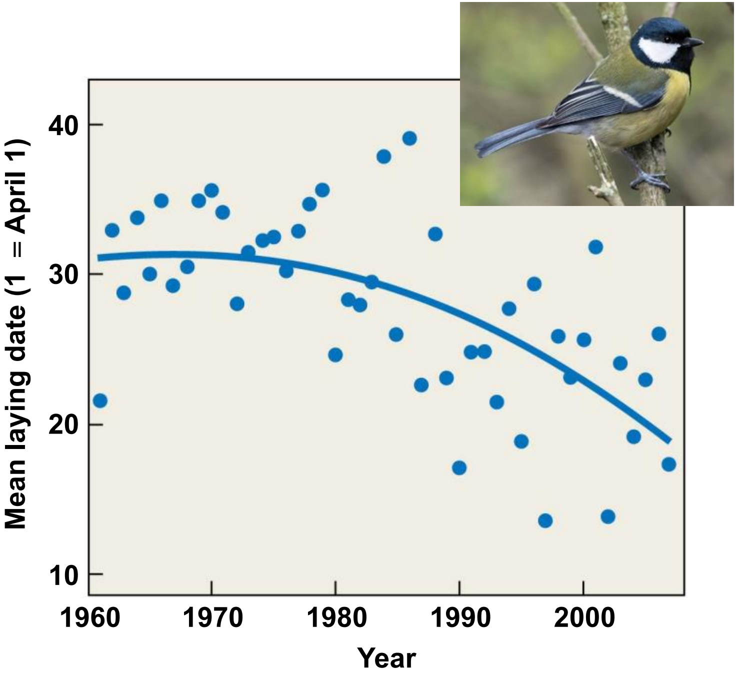


Current models over-estimate the fertilization effect of CO_2 because do not accurately reflect climate feedbacks (e.g., drought impacts) or nutrient limitations

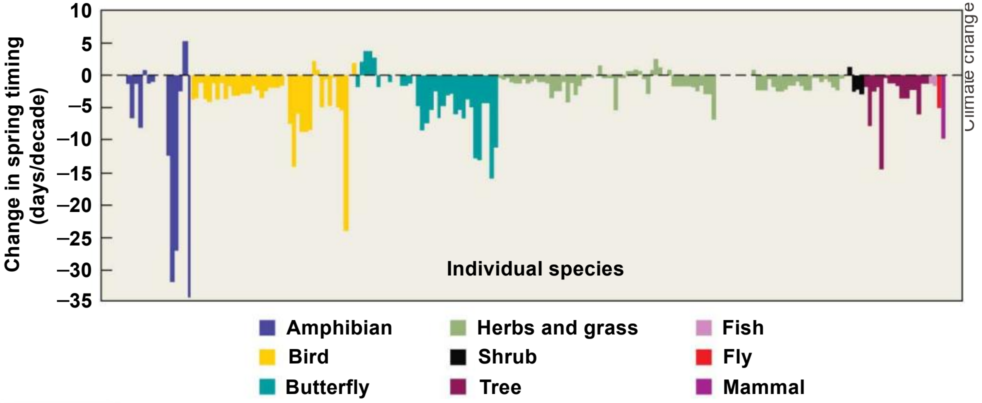


2. Impacts on terrestrial ecosystems

Climate change has **altered the phenology** (i.e., the timing of seasonal activities of organisms) of plant and animal species.

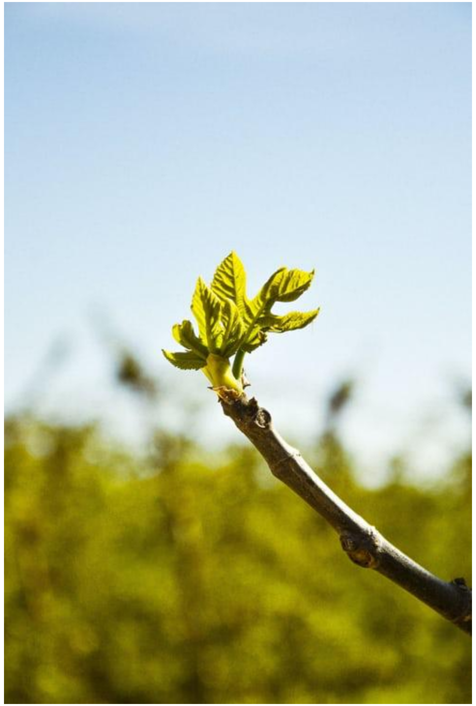


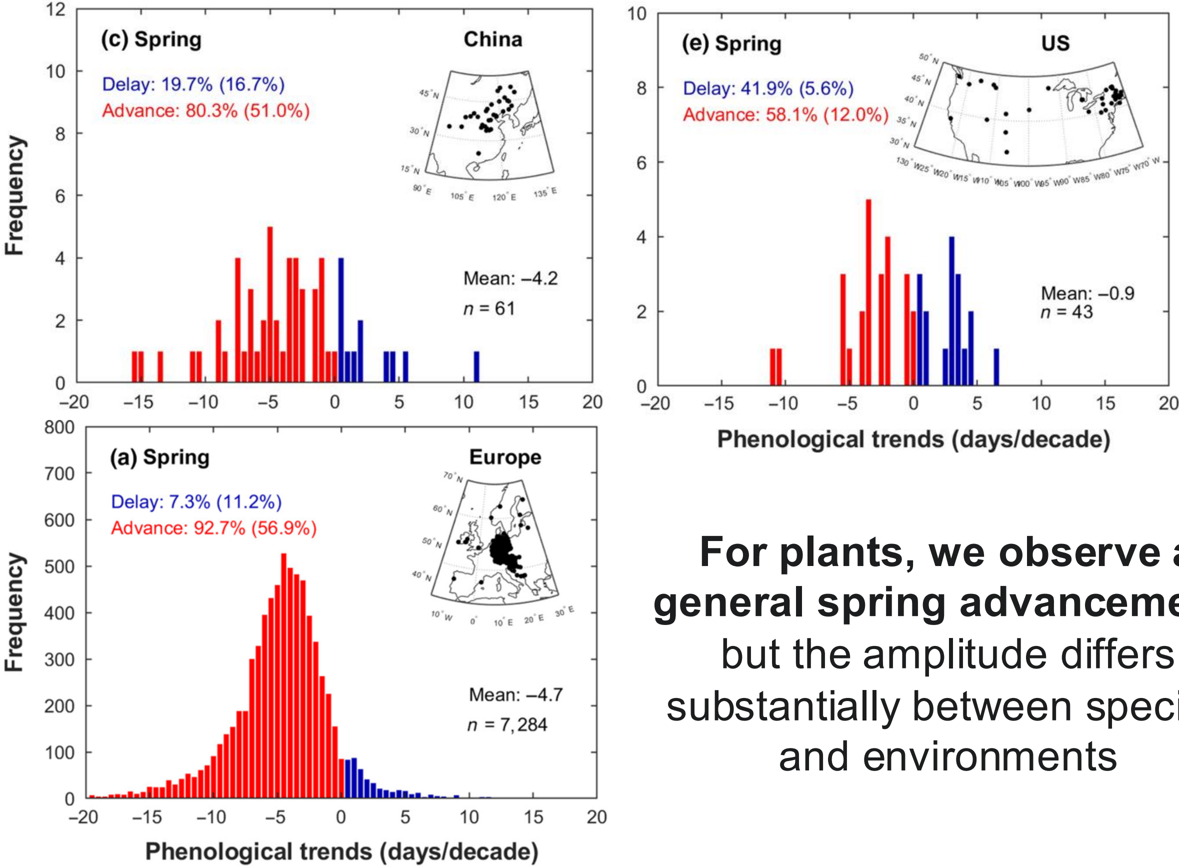
Changes in the timing of reproduction in the great tit as a result of recent climate warming.



Phenological responses of 203 different plant and animal species to recent changes in climate. Observed changes in the timing of spring events are expressed in days per decade for individual species grouped by taxonomy or functional type for the combined data set. Each bar represents a separate, independent species. Negative values indicate advancement (earlier phenology through time), whereas positive values indicate delay (later phenology through time).

2. Impacts on terrestrial ecosystems

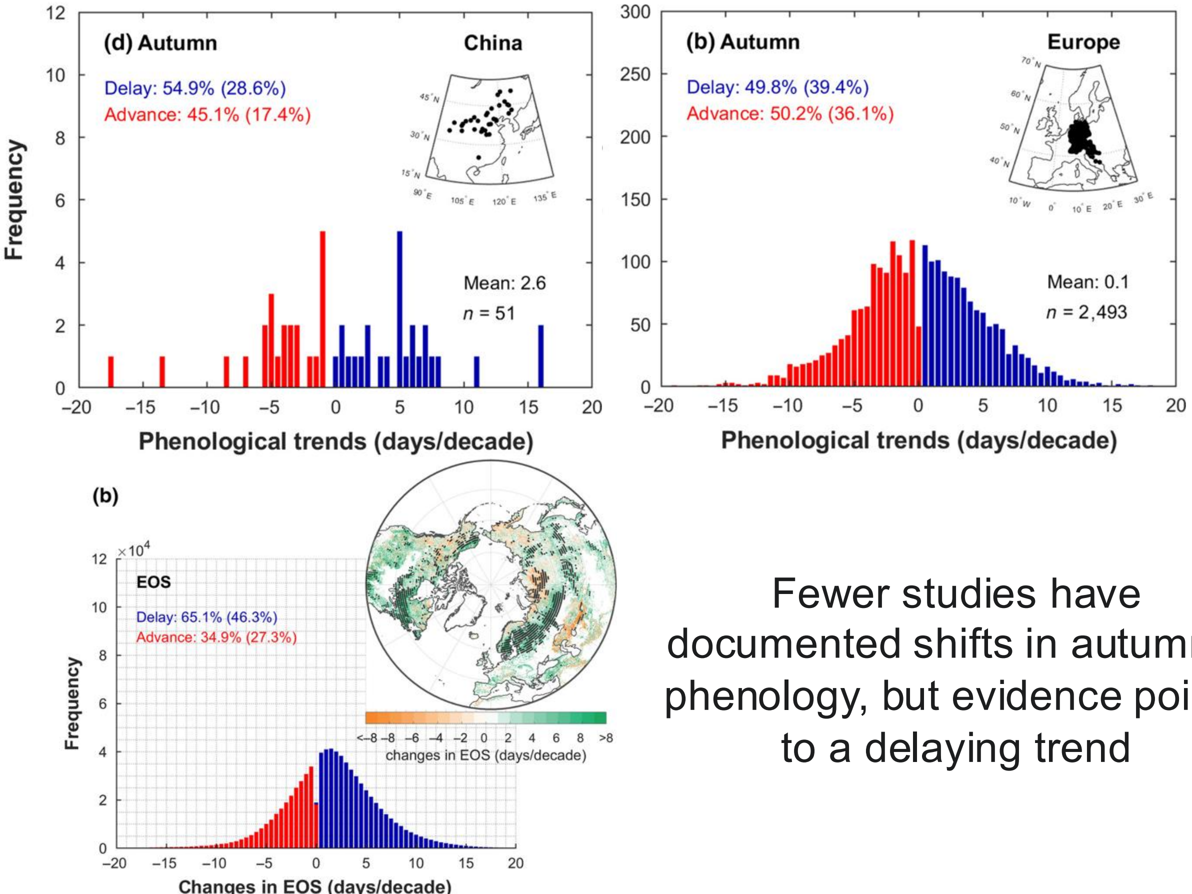




For plants, we observe a general spring advancement, but the amplitude differs substantially between species and environments

Piao et al., 2019; Global Change Biology

2. Impacts on terrestrial ecosystems



Fewer studies have documented shifts in autumnal phenology, but evidence points to a delaying trend

Piao et al., 2019; Global Change Biology

2. Impacts on terrestrial ecosystems

Leaf discoloration of beech
(picture: Christof Bigler, ETH)

Premature leaf discoloration on 17 August 2018 nearby Schaffhausen, Switzerland (picture: Andreas Rigling, WSL)

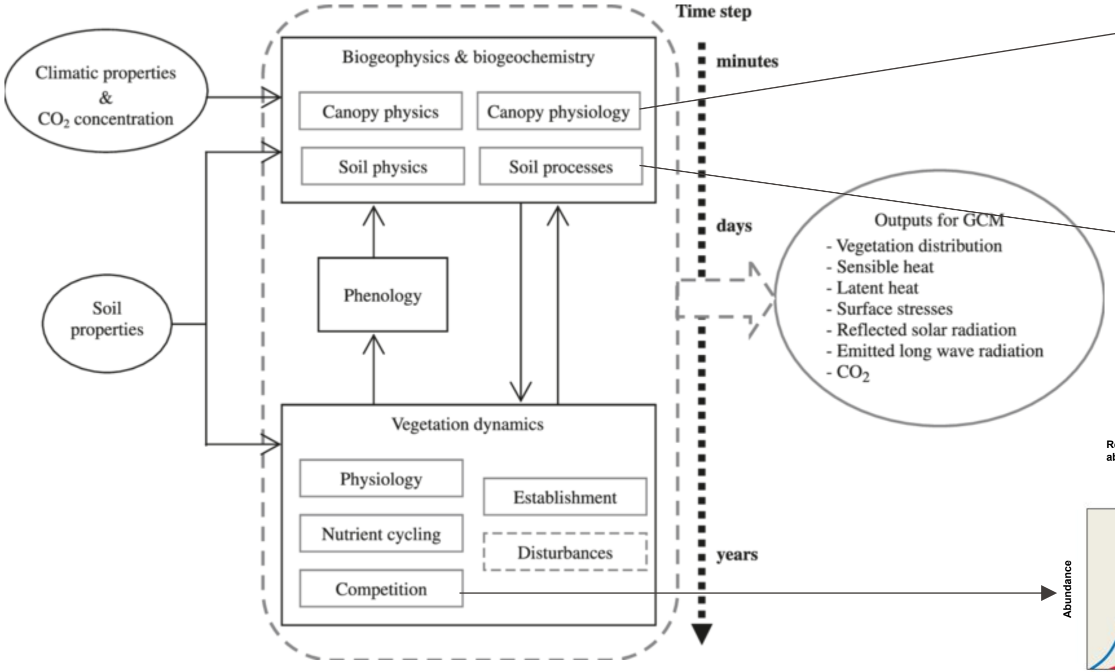
Premature leaf senescence in a European beech

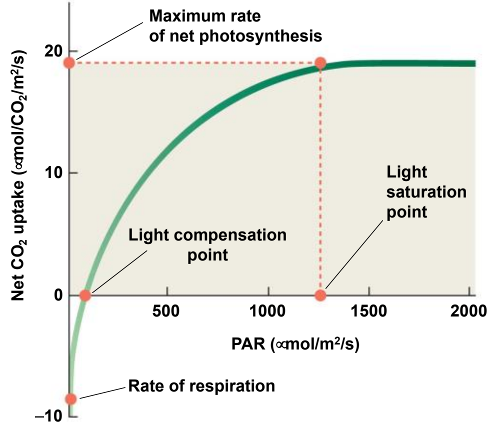
Temperature impacts on leaf senescence timing seem to depend on moisture availability.
Drought leads to earlier leaf senescence.

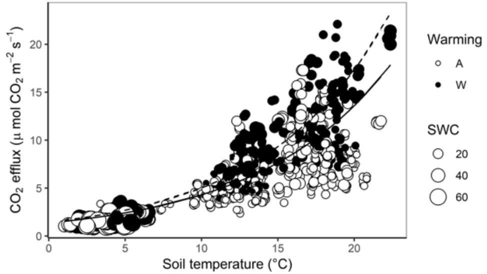
Vitasse & Bigler., 2021; Agricultural & Forest Meteorology; Schuldt et al., 2020; Basic & Applied Ecology

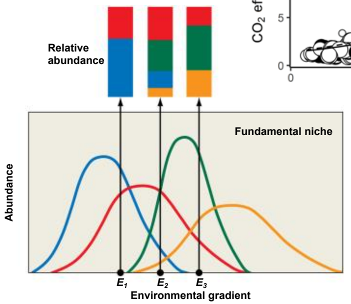
2. Impacts on terrestrial ecosystems

Basic structure of Dynamic Climate-Vegetation Models (DCVMs)



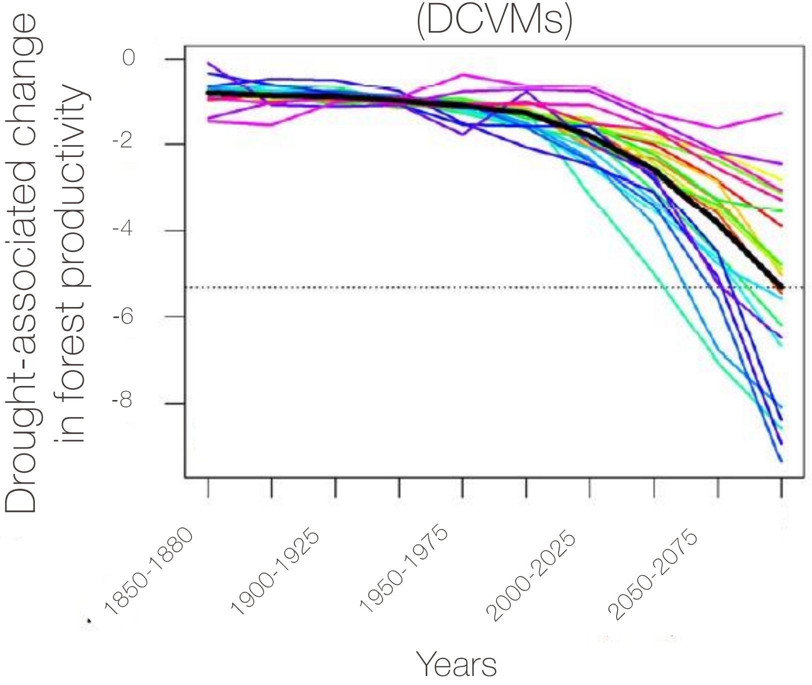




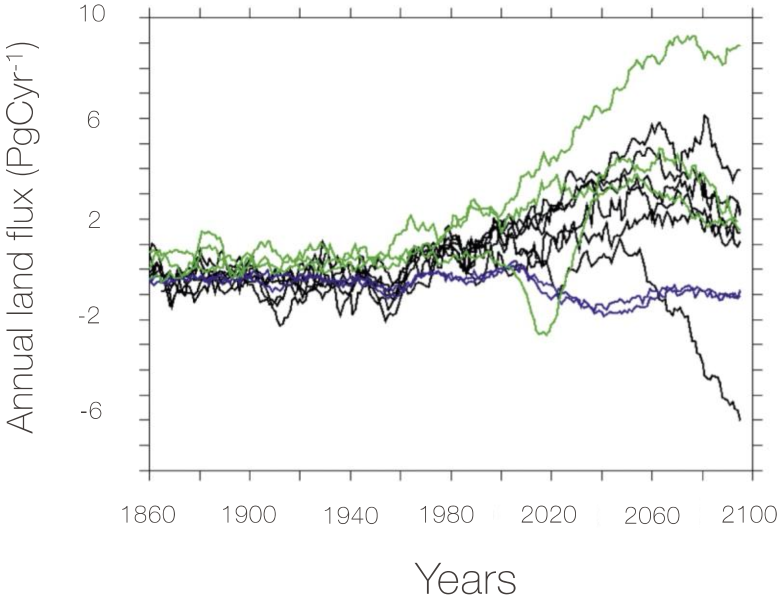


2. Impacts on terrestrial ecosystems

Dynamic Climate-Vegetation Models (DCVMs) → Earth-System Models (ESMs)



Chonggang Xu



Friedlingstein et al., 2014, *J Climate*

2. Impacts on terrestrial ecosystems

There are two major sources of uncertainty in predicting the response of ecological systems to climate change:

- the limitations in our understanding of processes that control the responses of species to climate variation, current distribution and the abundance of species.
- the uncertainly associated with the specific predictions of how the climate in a given region will change in response to increasing greenhouse gases.

What type of investigations are being undertaken to examine possible impacts of future climate change?

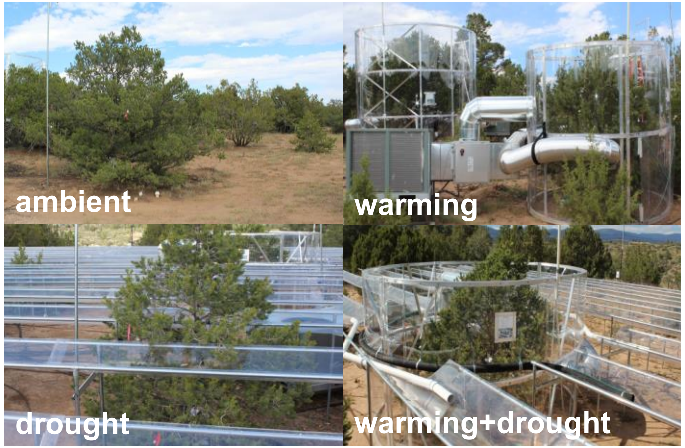
2. Impacts on terrestrial ecosystems

Examples of climate manipulation to study ecosystem responses to climate change in natural ecosystems:

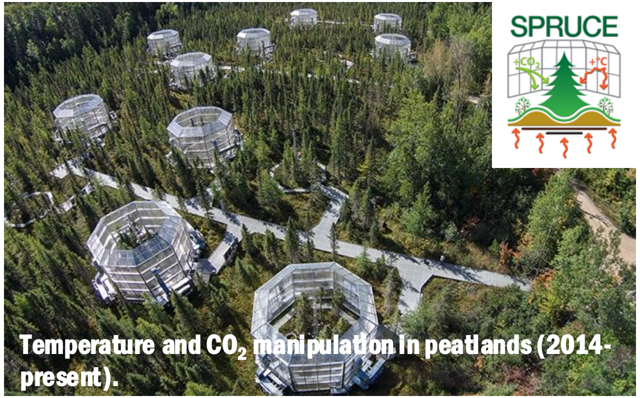
FACE (Free-Air CO_2 Enrichment) experiment, Australia (2010-present).

Most experiments manipulate only one environmental parameter

Temperature and drought manipulation in a semi-arid woodland



Carbon dioxide is stored in three large tanks under pressure as a liquid. During the day, computer systems release the liquid CO_2 and run it through vaporizer pipes that use natural air to convert the liquid to gas form.



Temperature and CO_2 manipulation in peatlands (2014-present).

2. Impacts on terrestrial ecosystems

2. Impacts on terrestrial ecosystems

2. Impacts on terrestrial ecosystems

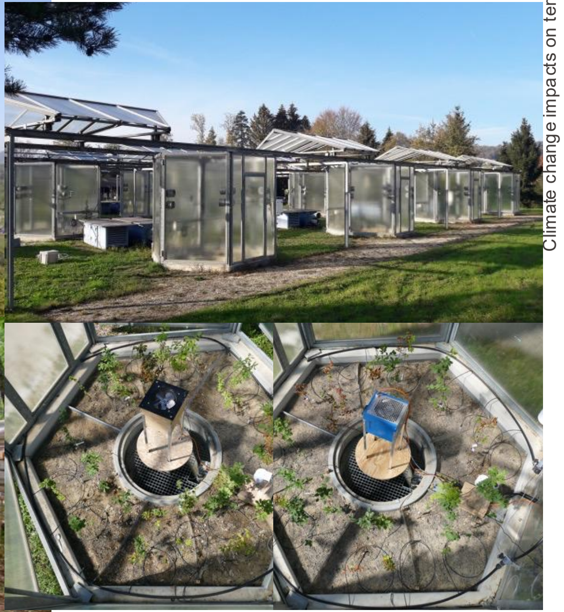
Irrigation vs. drought

Pfynwald irrigation experiment (20 years)
Leuk (WSL)

Drought vs. ambient

Swiss Canopy Crane II (5 years)
Holstein (University of Basel)

Drought vs. heat



Model Ecosystem Experiment (5 years)
Zurich (WSL)

3. Exercices

Question: Provide an argument, including three lines of evidence, to support the argument that global climate change is occurring. Describe the impacts of climate change on terrestrial ecosystems by proving at least 3 examples.

At the exam in 2022

Answer: The temperature of the Earth's surface has been rising consistently over the last century with an average global temperature increase of 1°C since 1900. The impacts of climate change on terrestrial ecosystems include a global loss of biodiversity. Indeed, we see shifts in the distribution of plant and animal species with many species unable to adapt fast enough to these changes, leading to population declines and extinctions. Climate change is also altering the distribution and composition of vegetation. For example, as temperatures warm, tree lines are shifting poleward and upward. Finally, climate change is affecting the delivery of ecosystem services, such as food, fiber, and water. Changes in precipitation patterns are altering crop yields and water availability, and warmer temperatures are increasing the incidence of pests and diseases.

Next week

Climate change impacts on aquatic ecosystems