Birds and Climate Change – Fall 2023

COURSE STRUCTURE - Rubrik

Some housekeeping:

I will use canvas.

What I expect of you:

- Read the assigned paper and prepare for the class discussion. Submit the comments on the assigned paper by using the "6 questions".
- In each class we will discuss one (or more) paper(s) that you have read and analyzed. As I need to read all your analyses ahead of time your preparation for the class needs to reach me and Sophia not later than 8 am on the day of the class. The assignments will be on CANVAS at least a week ahead of time.
- The assignments will count for 40% of your grade. If you submit the assignment in time (8 am) you get 2 points; if you submit it late, but still ahead of the class you get 1 point; otherwise you get 0 points. There are 22 assignments for a total of 44 points.

Birds and Climate Change – Fall 2023

Some housekeeping (continued):

- One discussion topic will usually be covered in ± 3 papers. The discussion topic for the next two classes are in module 1 “phenology”. We will discuss the Crick 1997 and the McCleery and Perrins 1998 papers on 24 August. Your participation in class counts for 20% of the grade.
- Start thinking about a topic for your final presentation; you will need to form groups of 2 students. By week 7 (3 Oct) each group will present ideas for the presentation that we will discuss in class to refine them. You identify any topic about birds and climate change that you find interesting and each search for 3 publications that are related to the topic. You then combine the papers of the group, place them in a logical context and sequence and
- In the final 2 classes (28, 30 November) each group will have 12 minutes for the final presentation. The presentation counts for 40% of the grade.
- The final 20% of the grade are based on your participation in class.

Topics – papers Fall 2023

class #	day		Module	Topic	papers read by date
1	Tue	22-Aug	0	introduction	intro lecture
2	Thur	24-Aug	1	phenology	Crick 1997, McCleery & Perrins 1998
3	Tue	29-Aug	1	phenology	Visser 2003
4	Thur	31-Aug	1	phenology	Torti 2005
5	Tue	5-Sep	2	plasticity	Matthysen 2011
6	Thur	7-Sep	2	plasticity	Ardia 2006
7	Tue	12-Sep	2	plasticity	Charmantier 2008
8	Thur	14-Sep	3	mismatch	Visser 1998
9	Tue	19-Sep	3	mismatch	Both 2006 (Ficedula)
10	Thur	21-Sep	3	mismatch	Saino 2011
11	Tue	26-Sep	4	migration	Jonzen 2006,2007), Both 2007
12	Thur	28-Sep	4	migration	Helm 2019
13	Tue	3-Oct	0	presentation ideas	presentation ideas
14	Thur	5-Oct	0	presentation ideas	presentation ideas
0	Tue	10-Oct		FALL BREAK	
15	Thur	12-Oct	4	migration	VanDoren 2021
16	Tue	17-Oct	5	mountains	Freeman 2018
17	Thur	19-Oct	5	mountains	Campos-Cerquira &Wunderle 2017
18	Tue	24-Oct	5	mountains	Barve 2016
19	Thur	26-Oct	6	acid rain	Graveland 1997
20	Tue	31-Oct	6	acid rain	Hames 2002
21	Thur	2-Nov	6	acid rain	Fabian 2007
22	Tue	7-Nov	7	tropical birds	Smart 2021
0	Tue	9-Nov		Indigenous Peoples' Day	
23	Tue	14-Nov	7	tropical birds	Jirinec 2021
24	Thur	16-Nov	8	community	Stenseth 2015
25	Tue	21-Nov	8	evolution-overview	Radchuk 2019
0	Thur	23-Nov	0	Thanksgiving break	
xx	Tue	28-Nov		presentation projects	group 1
xx	Thur	30-Nov		presentation projects	group 2

grading

Each Homework:

Submitted by the deadline: 2 points

Submitted after the deadline : 1 points

Not submitted or late : 0 points

There will be 22 home works, so a maximum of 44 points

Absence of class with no valid reason: - 1 point

Active participation in class: max 22 points

Final presentation = 44 points

Total : 110 points

Structure of a typical scientific paper

Introduction: what is known (based on the literature) about a particular question/problem; what is not known; what questions, therefore must be studied; in the final paragraph of the introduction you find what the paper is about.

Material and Methods: what data were collected, how, where, when, using which system? (some journals at end)

Results: describes in a logical sequence the results obtained.

Discussion and conclusions: discusses how the results provide new insights; discusses possible shortcomings; contrasts results with previous results obtained by others; places the results in a broader context; leads to the conclusions; potentially what is the next question that should be addressed

How to read a scientific paper?
(see general documents: the 6 questions)

The Six Questions

for each paper that you read briefly answer following questions
and post the answers on Canvas

1. What is the question studied?
2. What is the broader problem addressed?
3. Comment on the validity of the conclusions
4. Why should we care about this study?
5. What is the next step you would carry out?
6. Is there anything you did not understand ?

Possible Topics for Readings, Class Discussions and Essays

Topics currently planned:

1. CC and changes in phenology;
2. CC and plasticity of the responses;
3. CC and ecological mismatch;
4. CC and changes in migratory behavior;
5. what is special about mountains?
6. effects of acid rain; (CC is part of Global Change)
7. effects of CC on tropical birds;
8. evolutionary responses to CC ;
9. CC effects at the community level; changes in species distribution

CLIMATE: A VERY BRIEF INTRODUCTION

Climate is the most fundamental component of the physical environment.

Weather: Current conditions—temperature, precipitation, humidity, cloud cover.

Climate: Long-term description of weather, based on averages and variation measured over decades; includes daily and seasonal cycles, as well as yearly and decadal cycles.

Climate

The sun is the ultimate source of energy that drives the global climate system.

Energy gains from solar radiation must be offset by energy losses if Earth’s temperature is to remain the same.

Climate

The atmosphere contains greenhouse gases that absorb and reradiate the infrared radiation emitted by Earth.
Water vapor (H20) - Carbon dioxide (CO_2) - Methane (CH_4) - Nitrous oxide (N_2O)

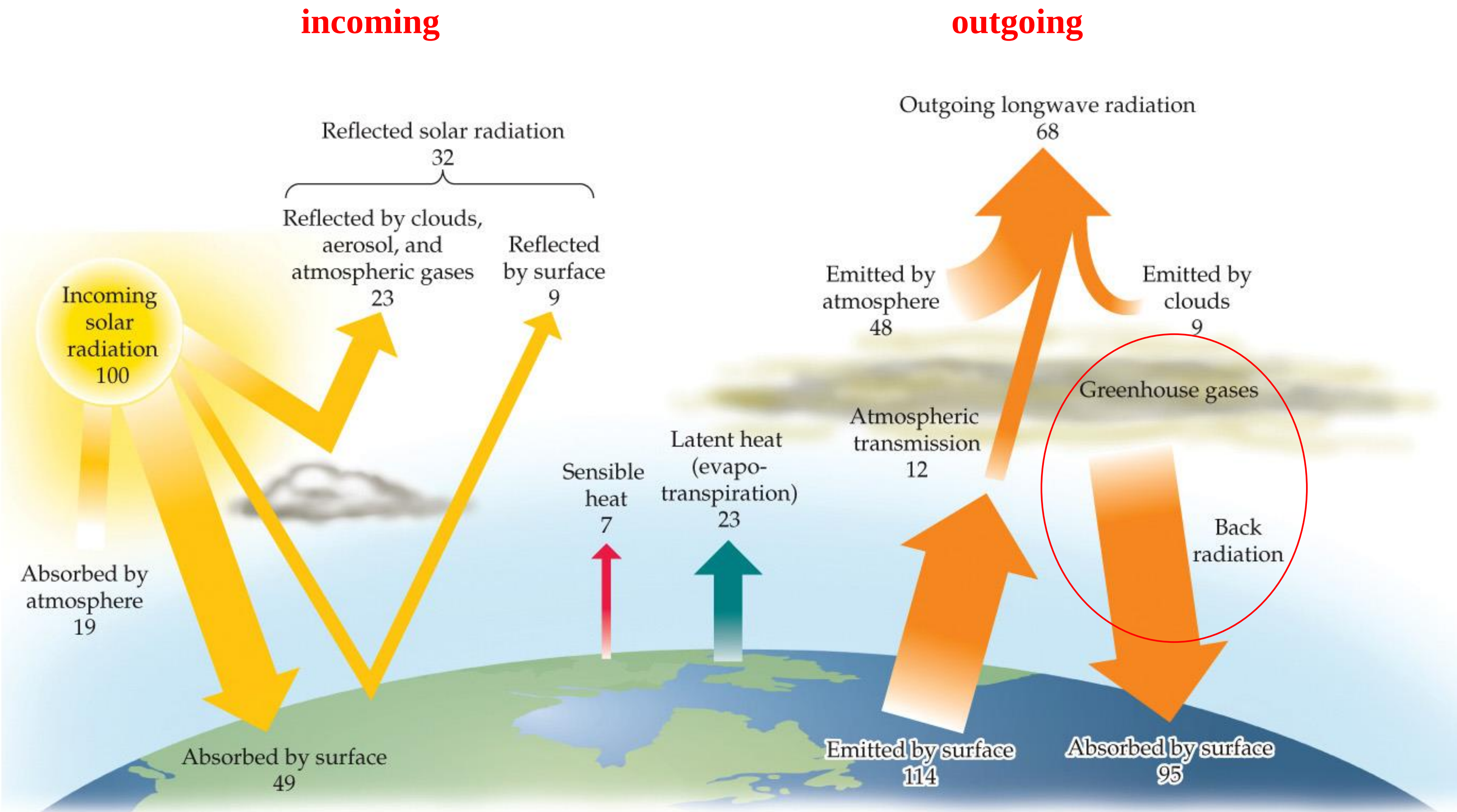
Without greenhouse gases, Earth's climate would be about 33°C cooler.

Over geological and historic time climate has varied

Increased concentrations of greenhouse gases **due to human activities** are altering Earth's energy balance, changing the climate system, and causing global warming.

Current climate change is due to increased CO_2 and other gases in the atmosphere **due to human activities**.

Earth's Energy Balance (numbers are %): the top of Earth's atmosphere receives 342 watts (W) of solar radiation per square meter each year.



ECOLOGY 4e, Figure 2.4

23% Latent heat flux through evaporation

7% sensible heat flux (conduction, convection)

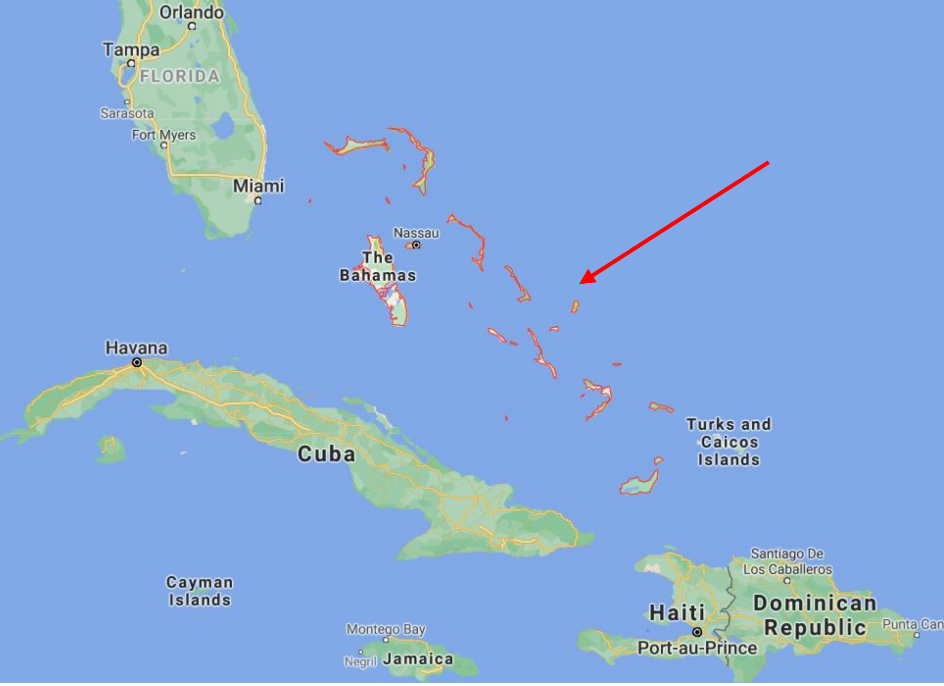
Climate

Climate is characterized by average conditions; but extreme conditions are also important to organisms because they can contribute to catastrophic mortality or extreme reproduction

Climate determines the geographic distribution of organisms.

Climate

Extreme drought, extreme temperatures or other extreme events can also have devastating effects



Hurricane Dorian

Aug 24, 2019 – Sep 10, 2019

Hurricane Dorian was an extremely powerful and catastrophic Category 5 Atlantic hurricane, which became the most intense tropical cyclone on record to strike the Bahamas, and tied for strongest landfall in the Atlantic basin. It is also regarded as the worst natural disaster in The Bahamas' recorded history. Wikipedia

Two endemic bird species of the Bahamas, were last seen before Dorian and are now probably extinct

In 2018 Matthew Gardner and David Pereira reported the rediscovery of the **Bahama nuthatch** that had not been seen since Hurricane Matthew in 2016. Sadly, the species is unlikely to have survived Dorian.

https://ebird.org/species/bnhnut2

Example: **Widespread Mortality in Pinon Pines caused by** extreme high temperatures and a historic drought from 2000 to 2003 which killed large areas of pinon pines *(Pinus edulis}* throughout the southwestern United States. plus a **bark beetle outbreak** in 2002

(A)

ECOLOGY 4e, Figure 2.3 (Part 1)

Climate Variation over Geologial Time

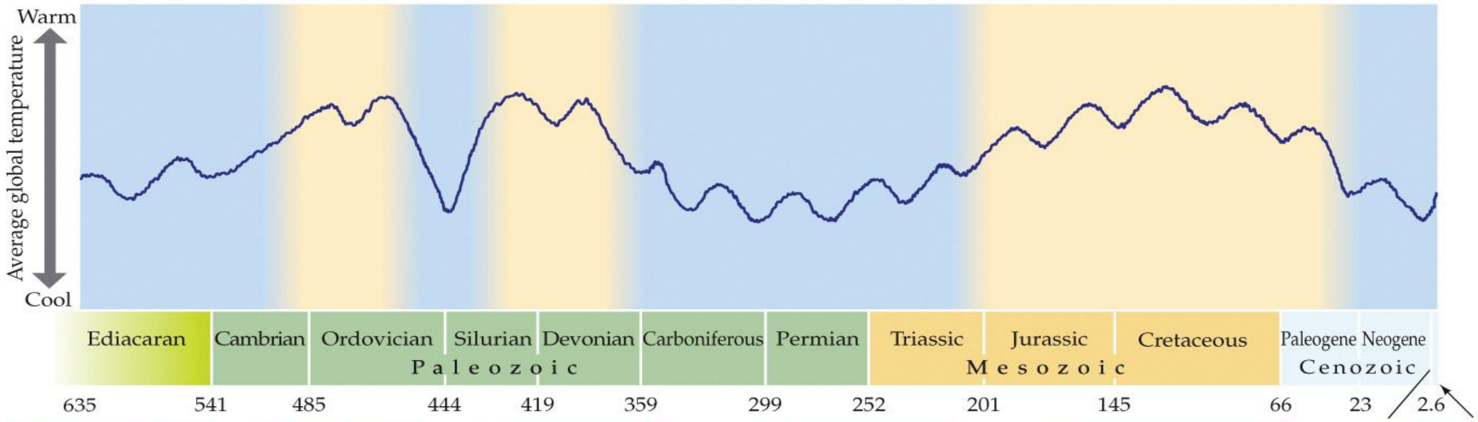
Climate has also changed over geological time scales

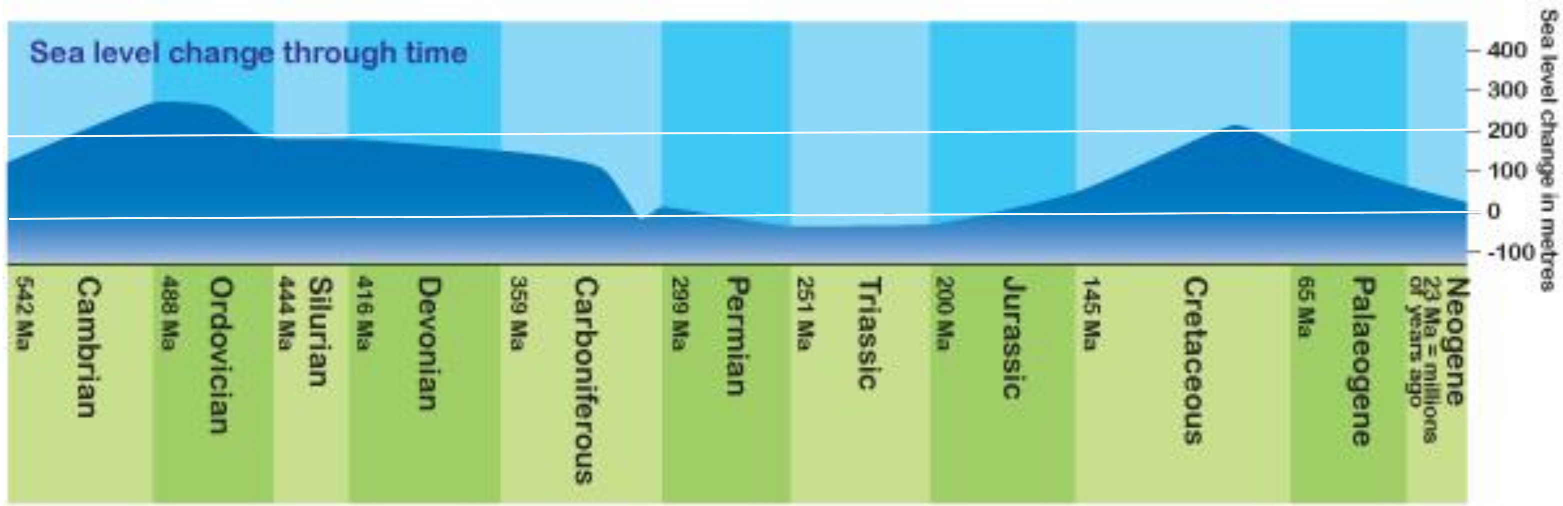
Climate change over geological time is one of the many factors that influences the distribution of animals and plants

Geological time scale: Average Global Temperature and sea level

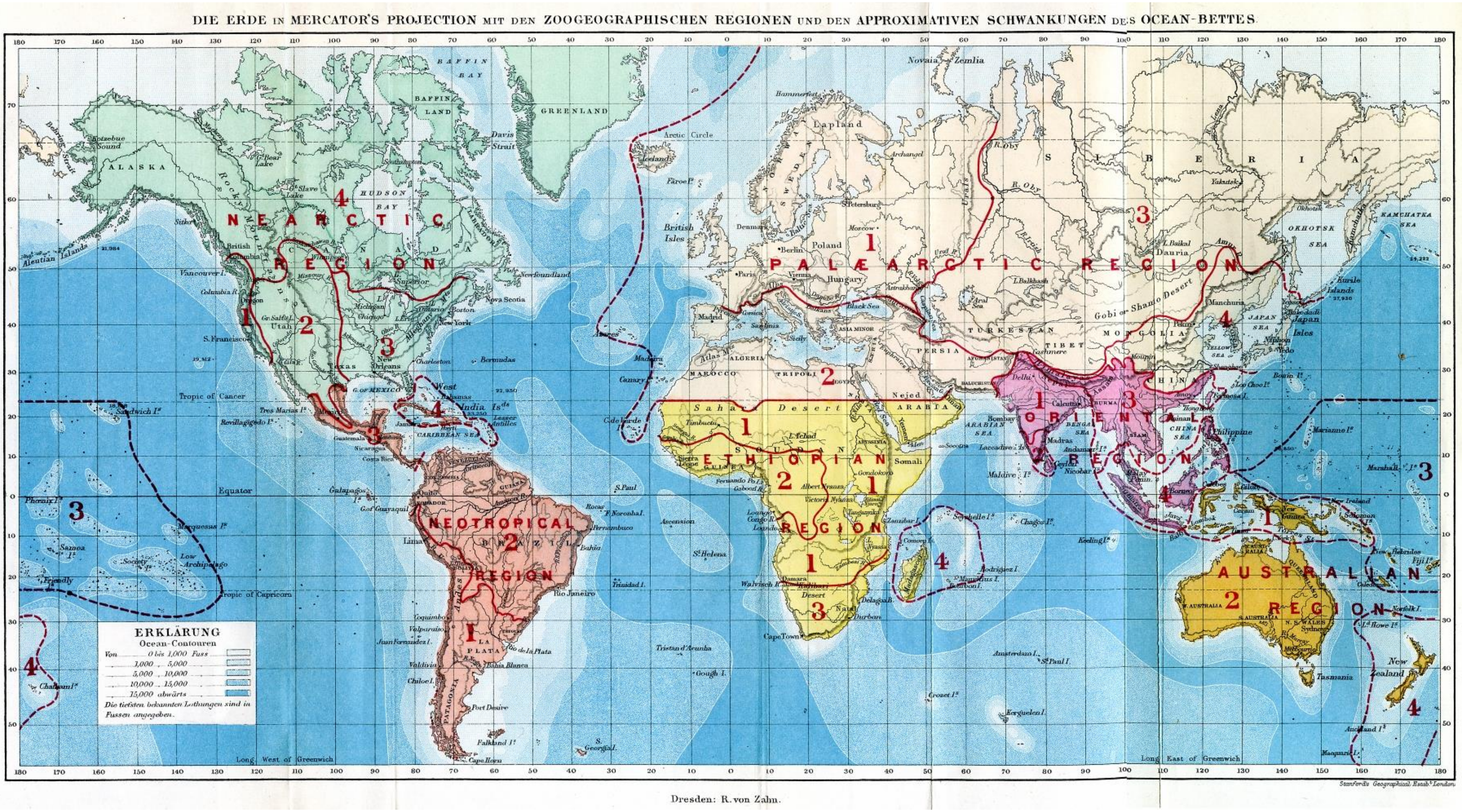
Temperature and Sea level and are linked

Sea level has varied by more than 200 m over time





The 6 zoogeographic regions according to Alfred Russel Wallace 1876



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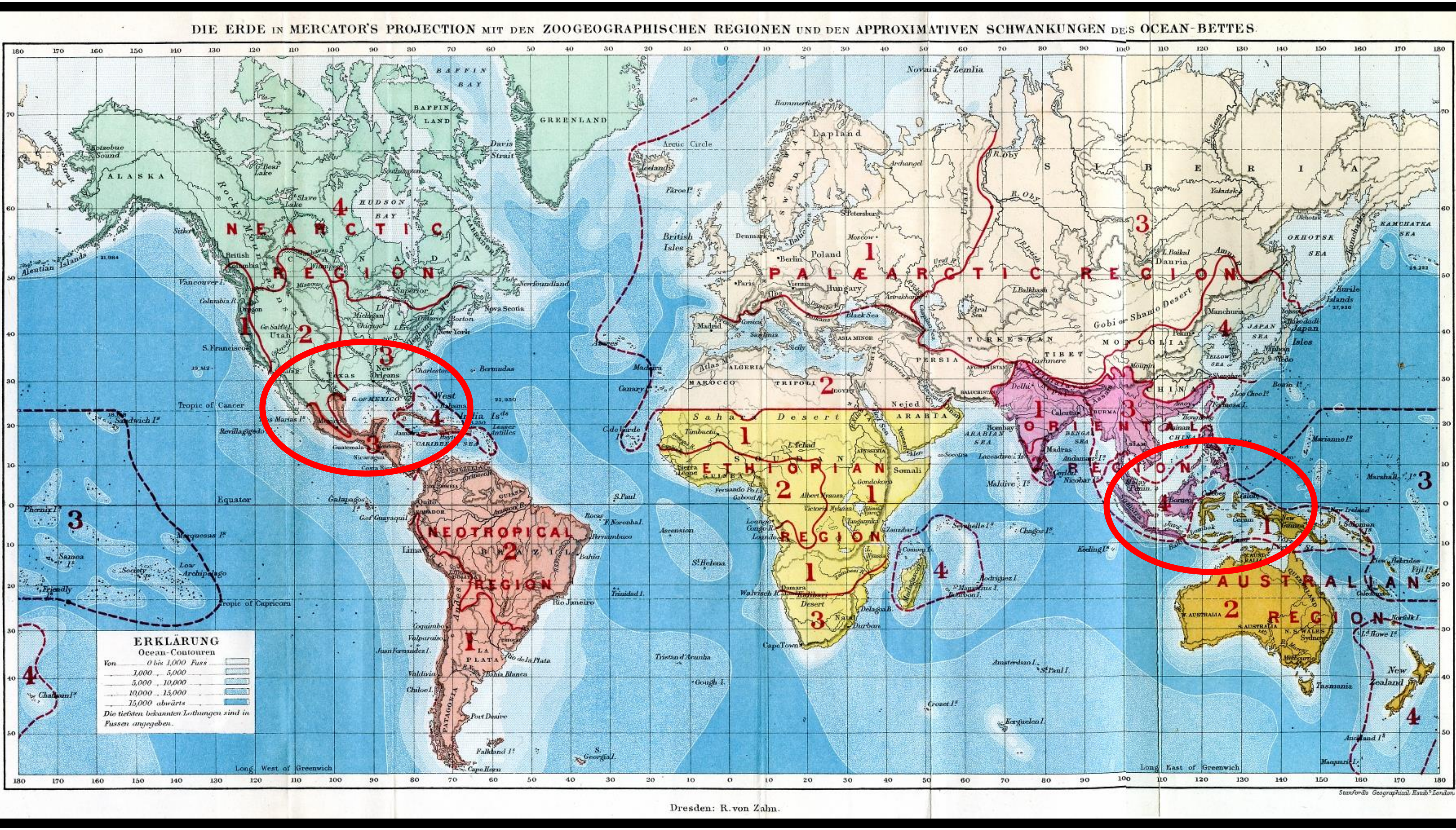
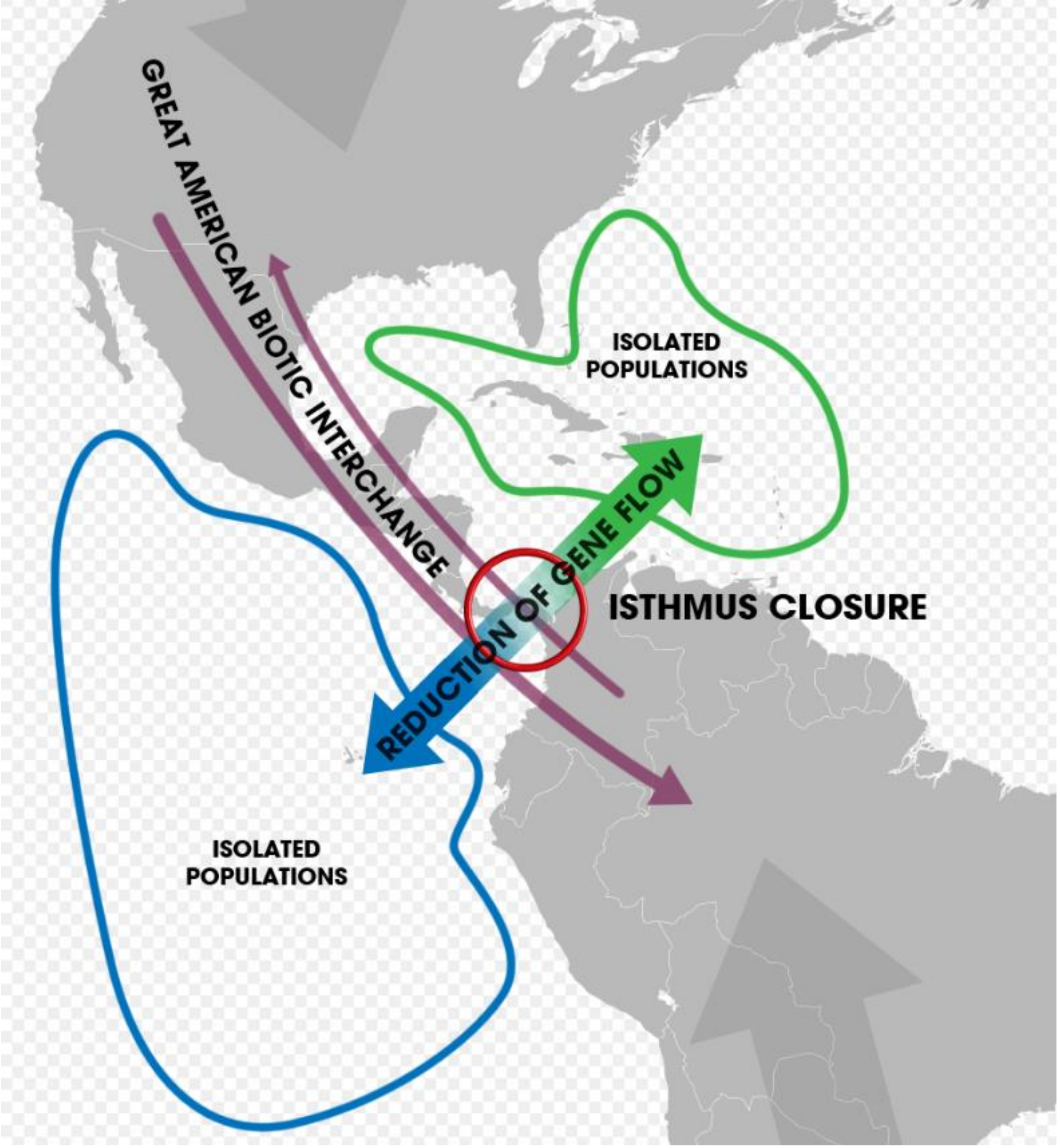


Cause of difference and similarities between Nearctic and Neotropic fauna and flora

About 5 million years ago, the North American, South American, and Caribbean Plates converged. The rise of the Isthmus of Panama restricted water exchange between the Atlantic and Pacific, and their salinities diverged. The isthmus diverted waters that once flowed through the Seaway. The Gulf Stream began to intensify.



The closure of the Isthmus led to allopatric speciation events of marine organisms isolated on each side (blue and green).

Terrestrial species also migrated between the two continents (the Great American Biotic Interchange) upon the formation of a passable land bridge.

https://en.wikipedia.org/wiki/Isthmus_of_Panama#/media/File:Isthmus_of_Panama_(closure)_-_Speciation_of_marine_organisms_(w_annot).png

Formation of the Isthmus of Panama

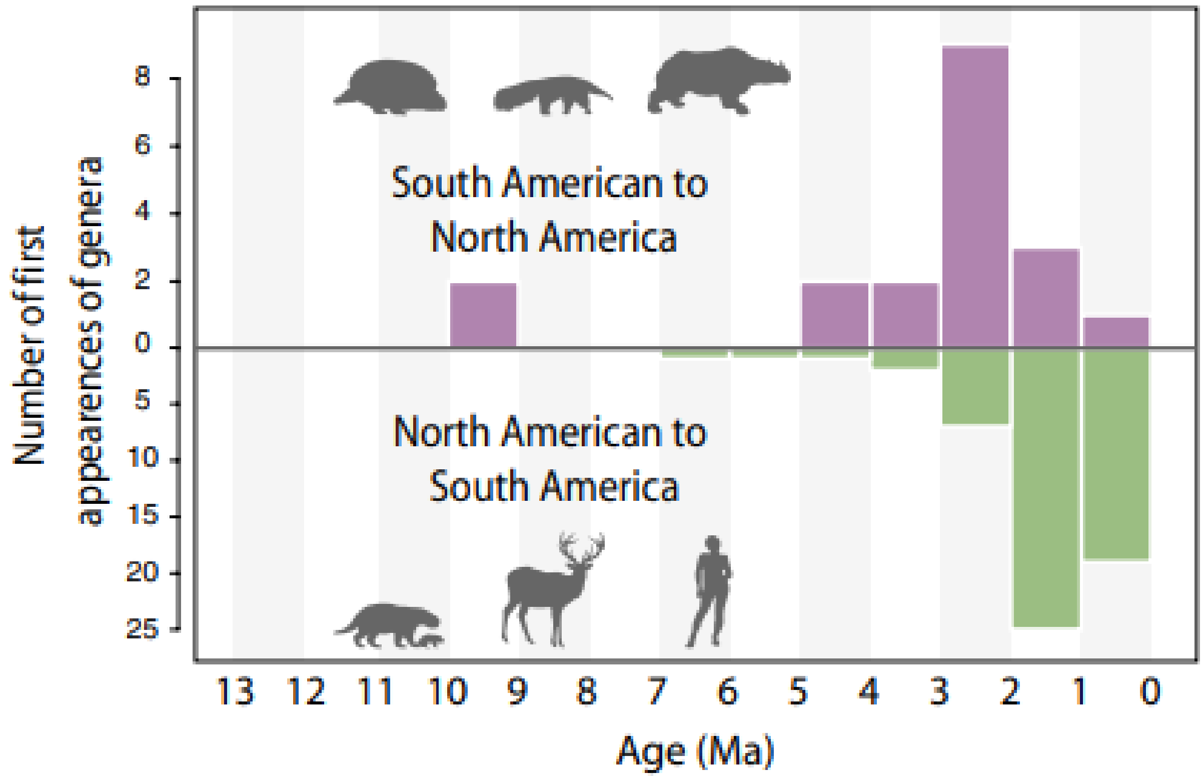


Fig. 5. Frequency of appearances of immigrant vertebrate taxa or their oldest known descendants in opposing continents as observed in well-dated fossiliferous sediments in South and North America per million years. See fig. S3 for further details.

The Great American Biotic Interchange is characterized by a surge in successful dispersals in both directions beginning around 2.6 Ma

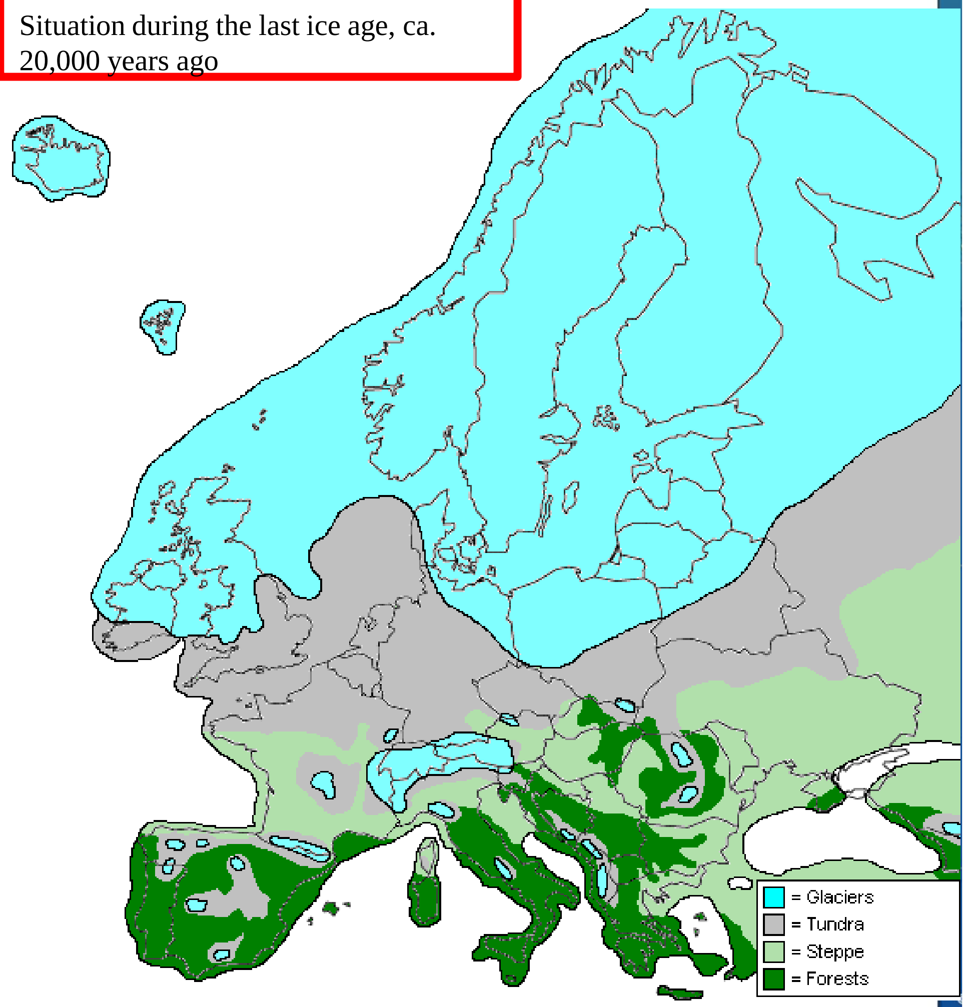
O'Dea *et al.* Sci. Adv. 2016;2:e1600883 17 August 2016

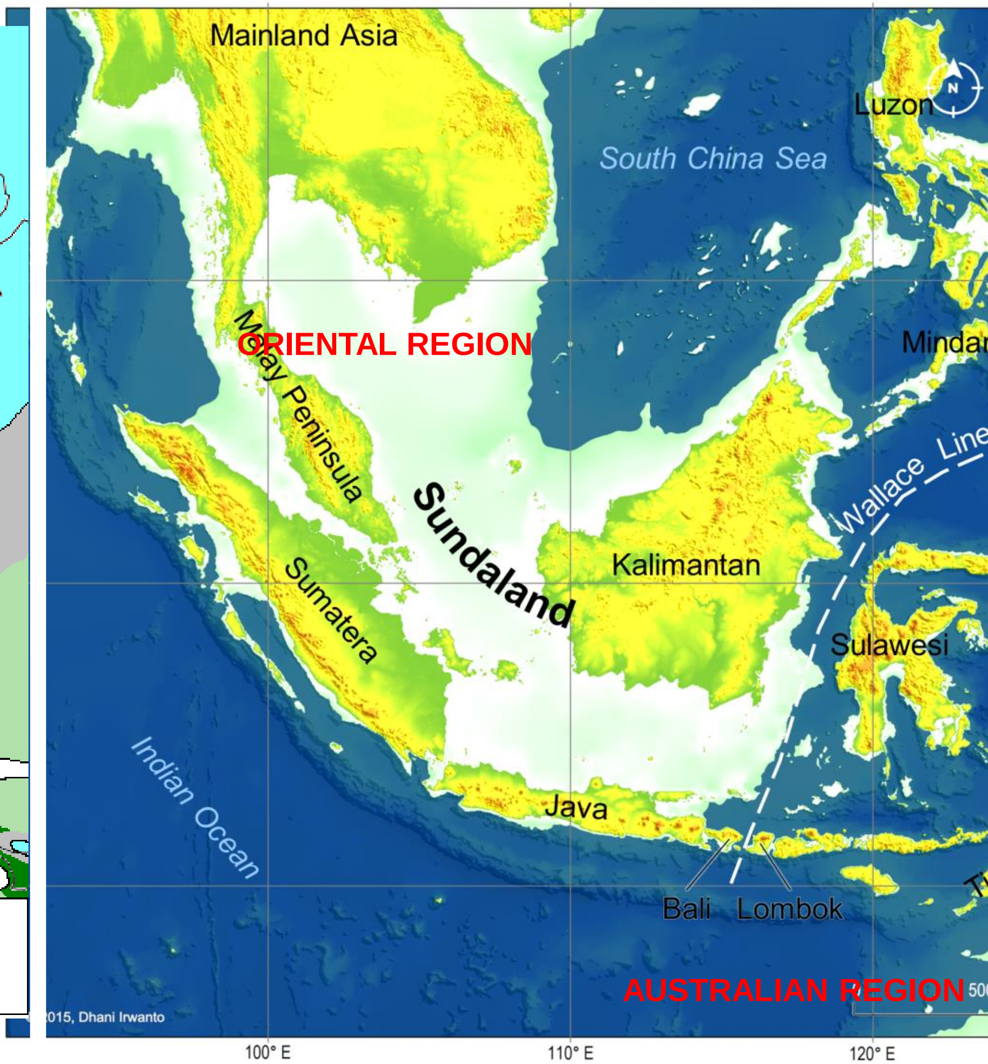
The Wallace Line

The original line, first proposed by Wallace in 1859, delineates flora and fauna of Asia (west of the line) and Australasia (east of the line). It was later modified by TH Huxley to separate the island of Palawan from the Phillipines.

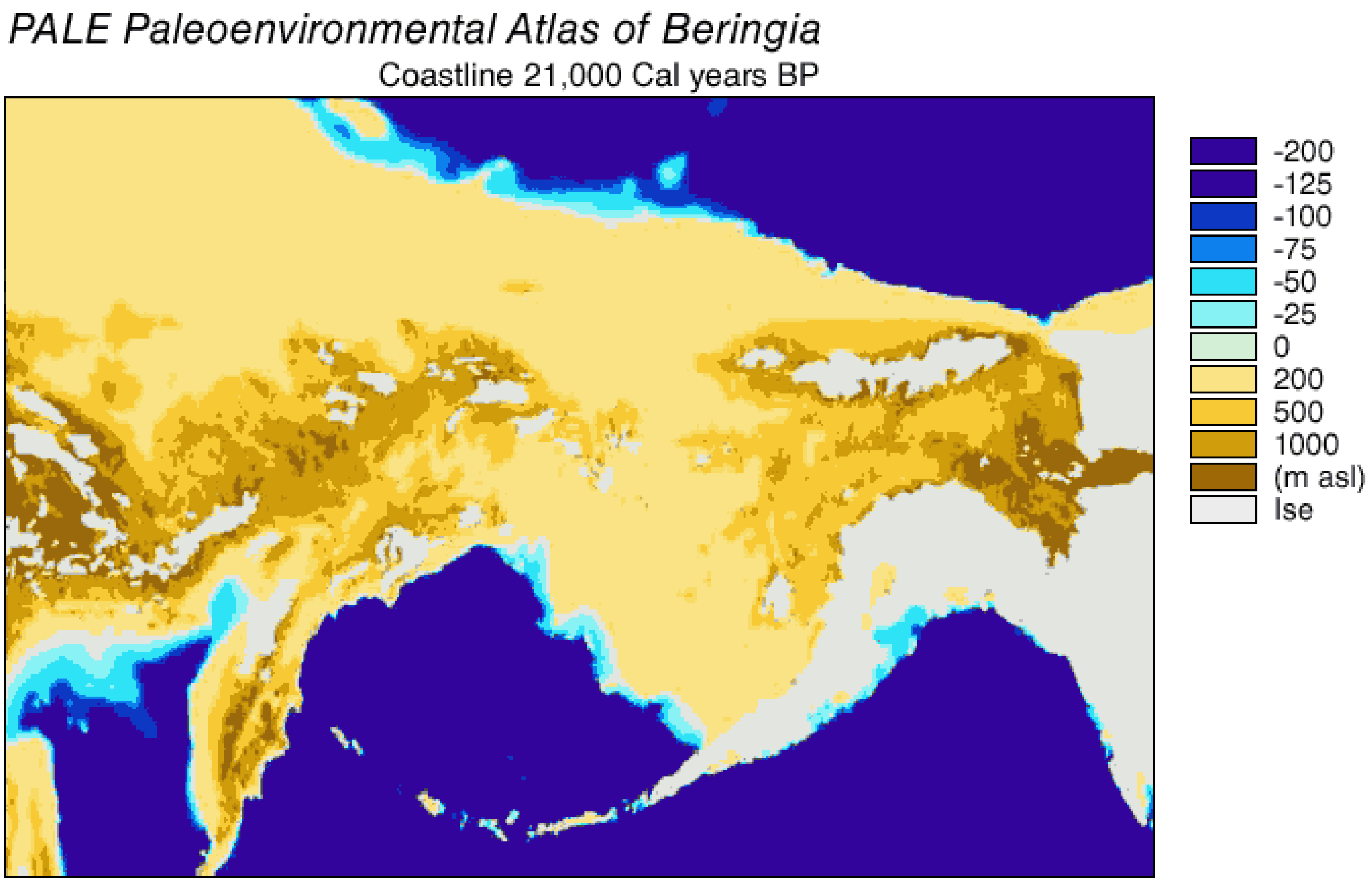
Most recent glaciation

Situation during the last ice age, ca. 20,000 years ago

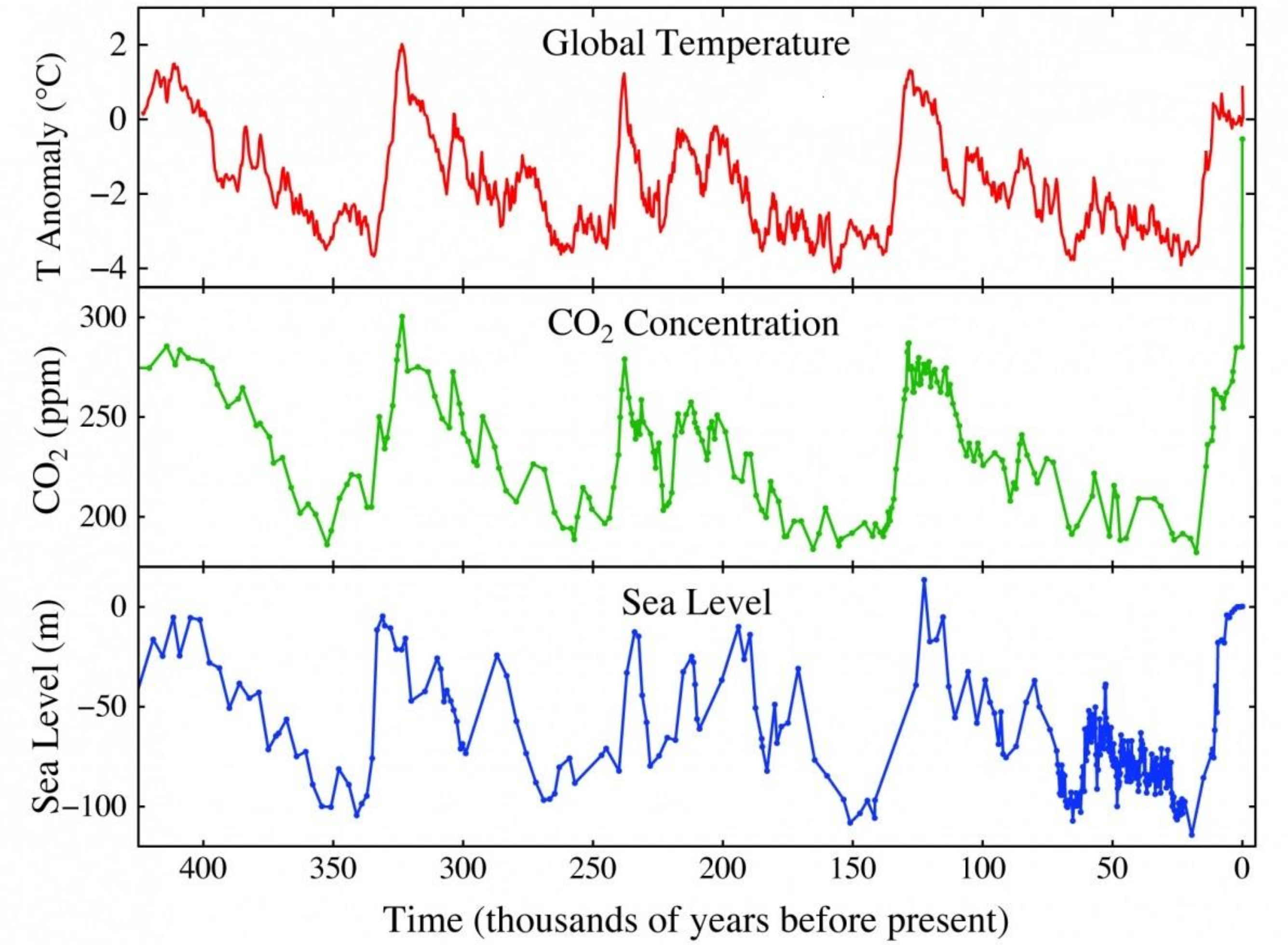




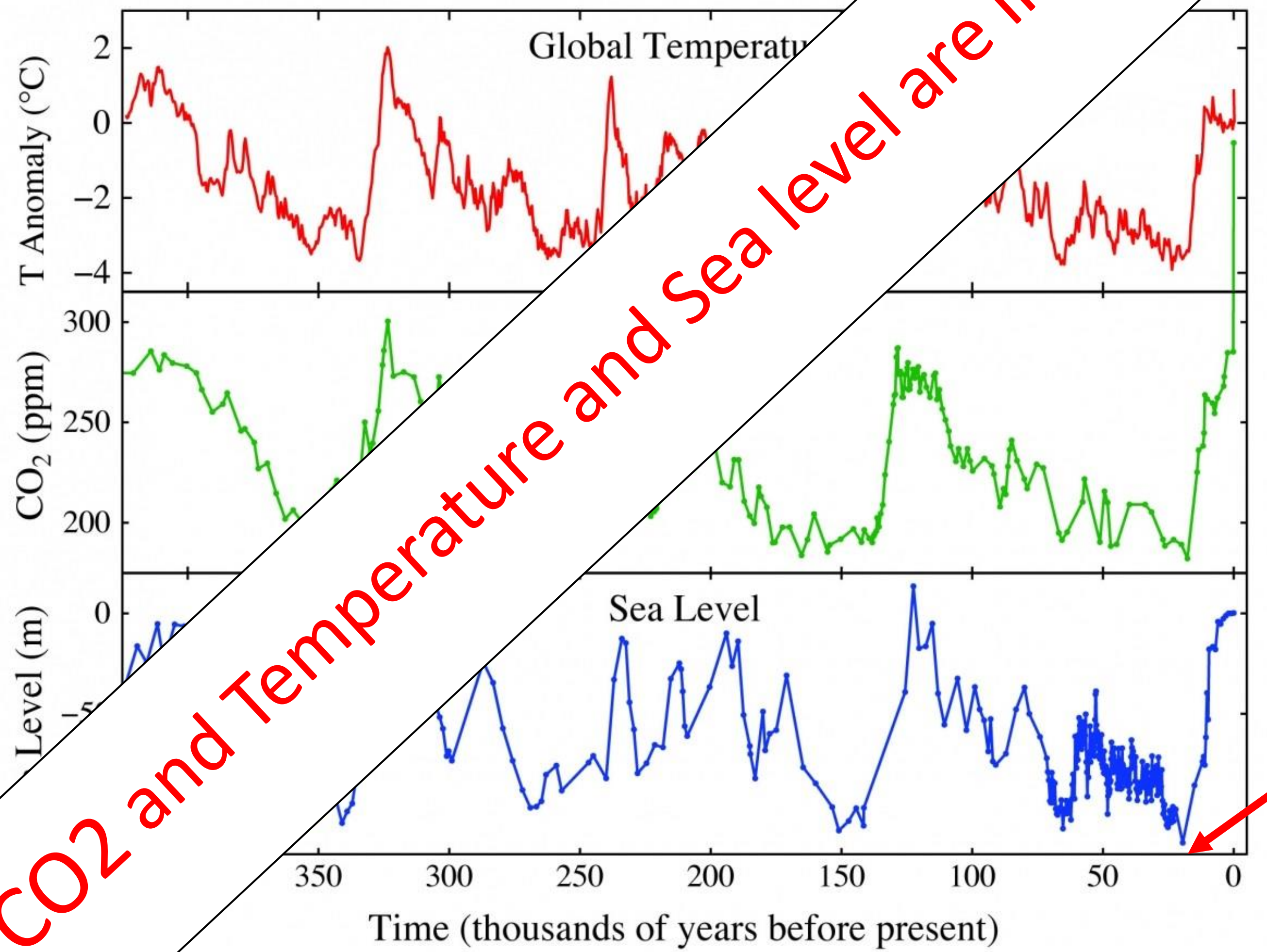
21,000 years ago to now



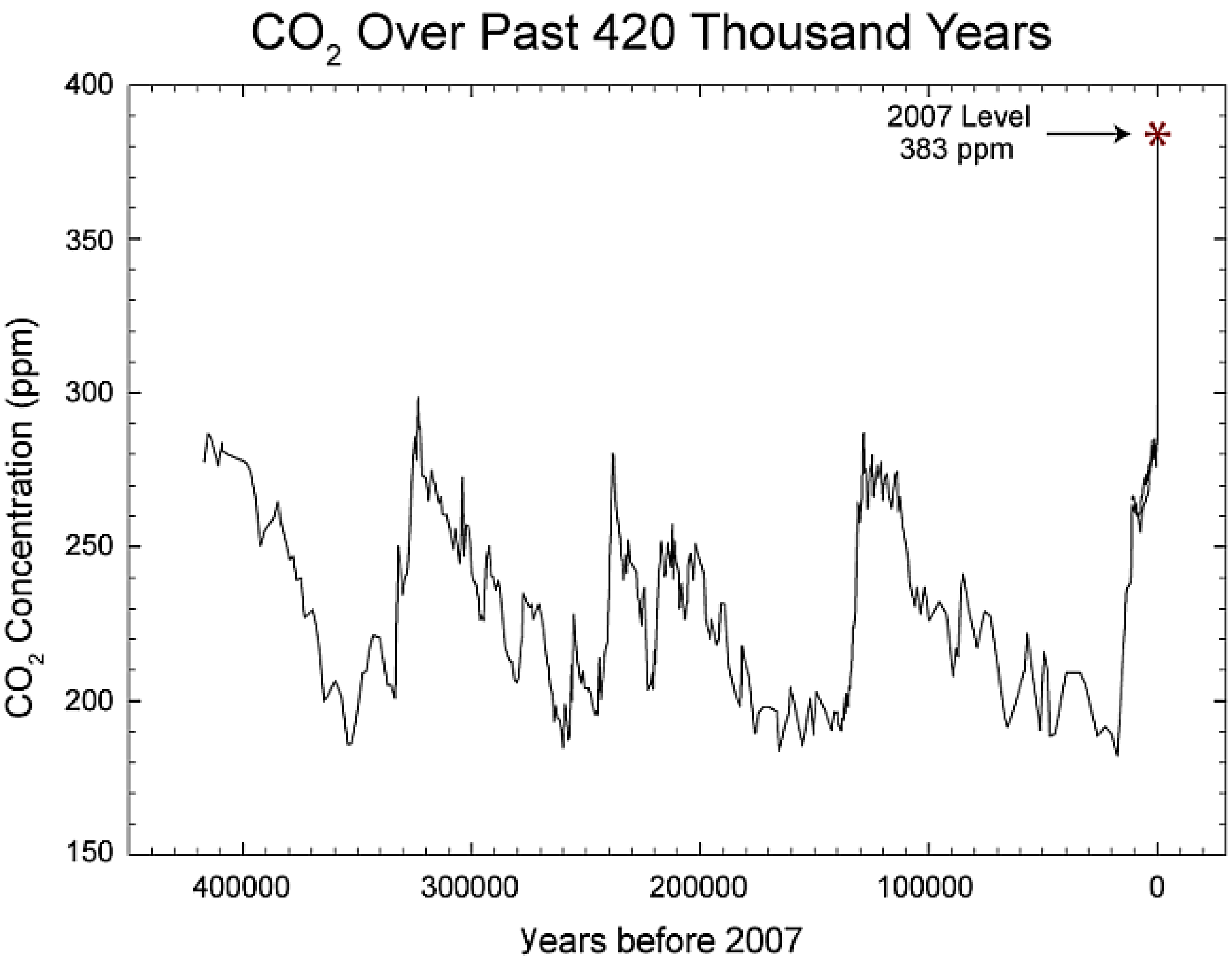
THE LAST 420 THOUSAND YEARS



THE LAST 420 THOUSAND YE



CO2 and Temperature and Sea level are linked

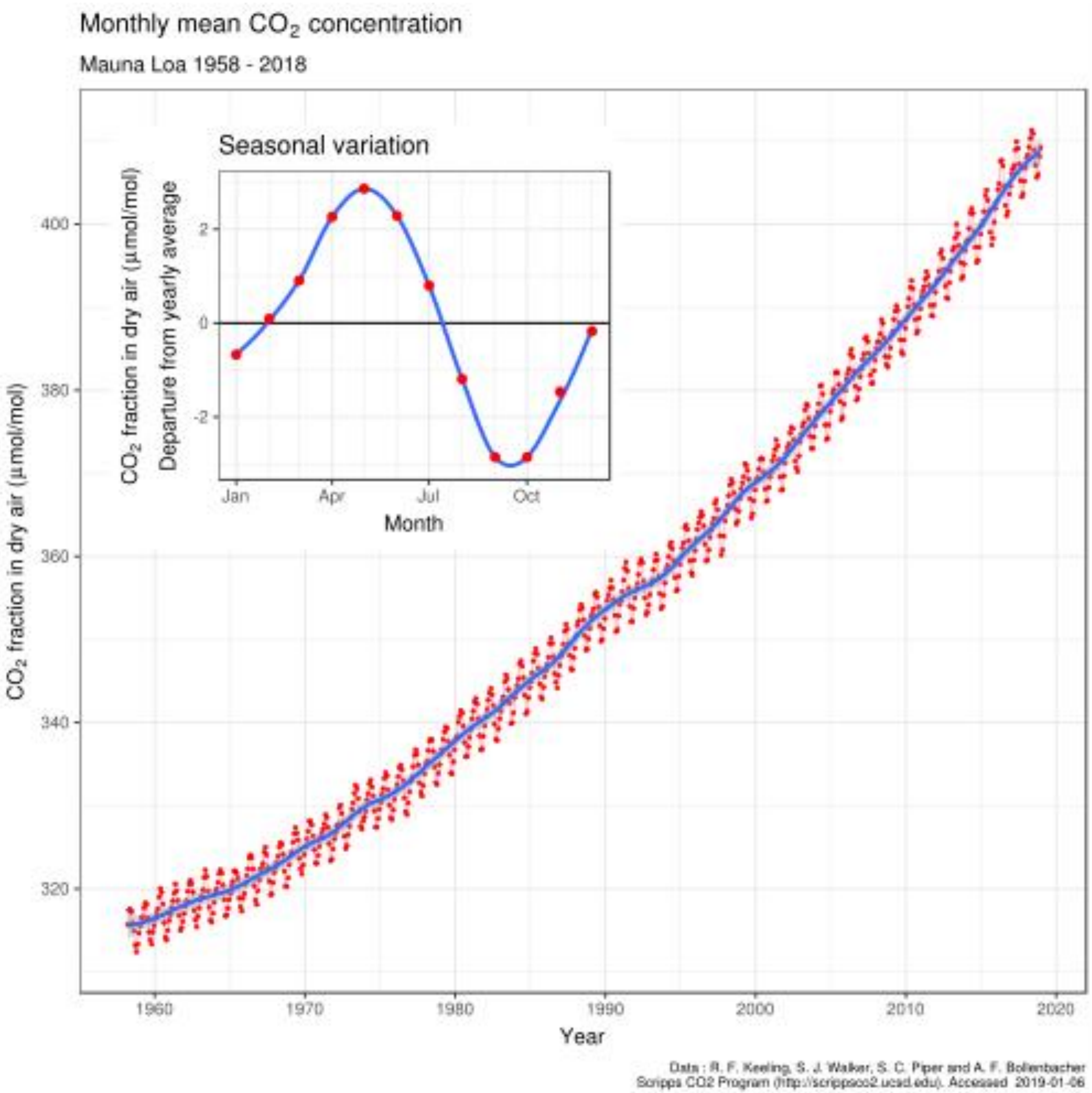


Current climate change is due to increased CO2 and other gases in the atmosphere **due to human activities**.

The atmosphere contains greenhouse gases that absorb and reradiate the infrared radiation emitted by Earth.

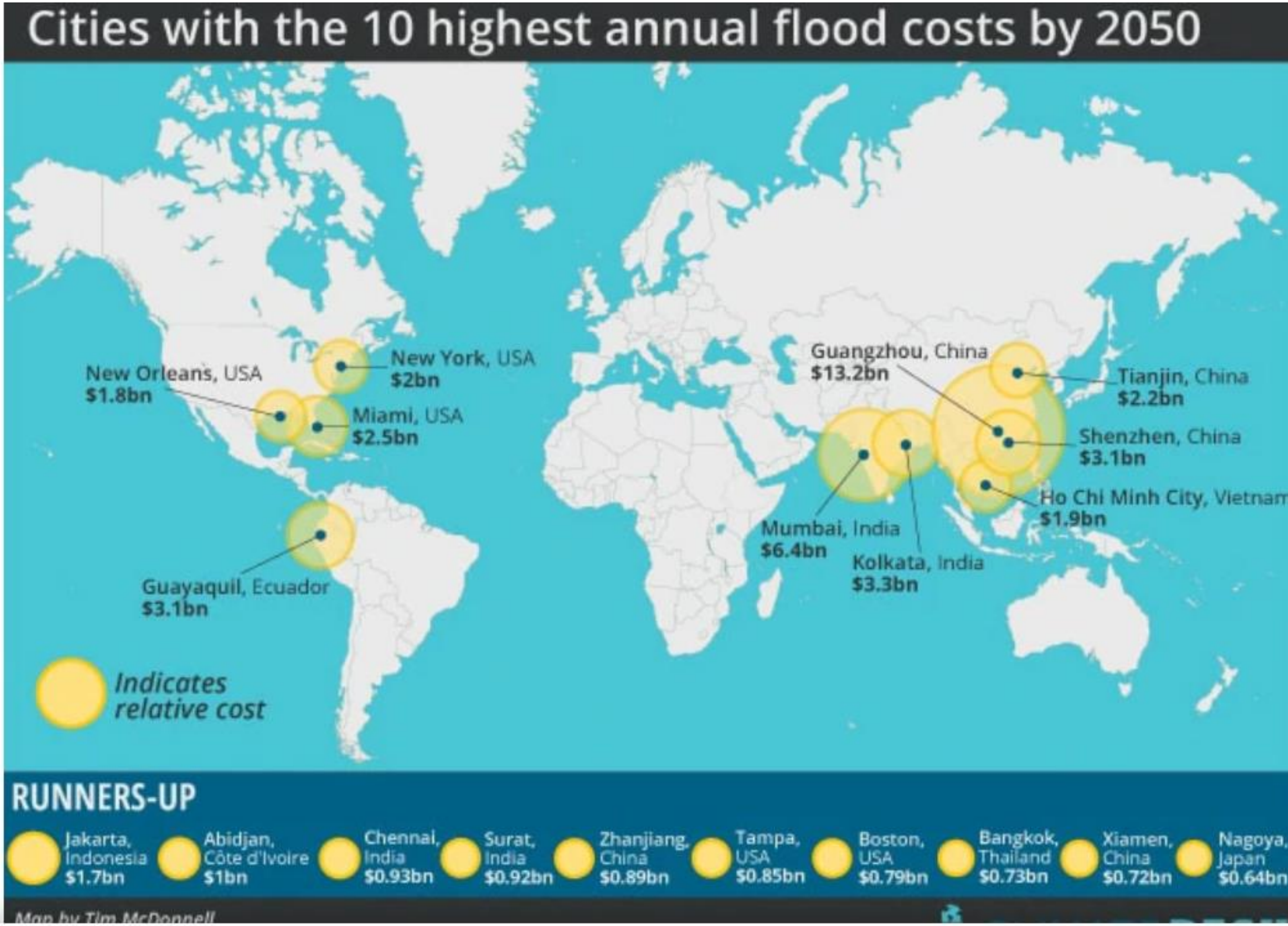
Water vapor (H2O) - Carbon dioxide (CO2) - Methane (CH4) - Nitrous oxide (N2O)

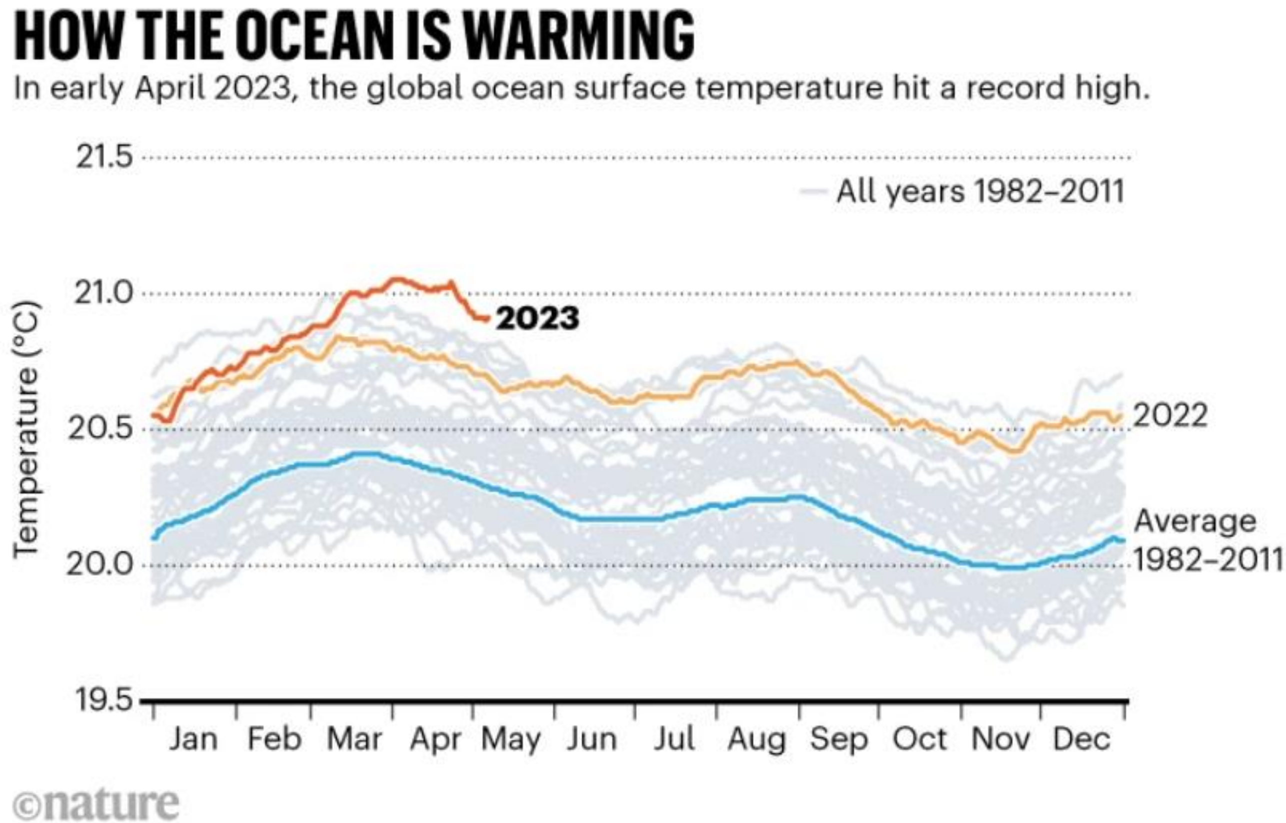
This is the problem we are talking about



Monthly mean CO_2 concentration
Mauna Loa 1958 - 2018
Seasonal variation
CO_2 fraction in dry air (µmol/mol)
Departure from yearly average
2
0
-2
Jan
Apr
Jul
Oct
Month
CO_2 fraction in dry air (µmol/mol)
400
380
360
340
320
1960
1970
1980
1990
2000
2010
2020
Year
Data : R. F. Keeling, S. J. Walker, S. C. Piper and A. F. Bollenbacher
Scripps CO2 Program (http://scrippsco2.ucsd.edu). Accessed 2019-01-06

Impact on humans





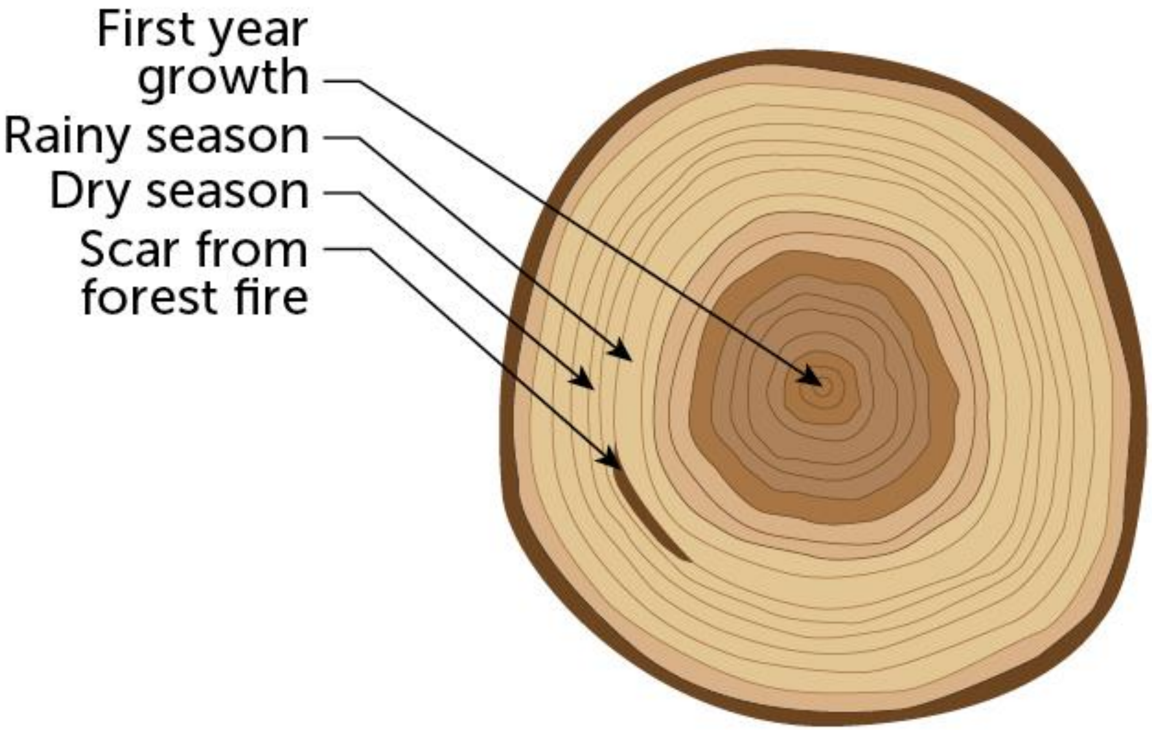
Source: climatereanalyzer.org; NOAA Optimum Interpolation SST (OISST)

We are probably looking at a string of record highs over the next year or so," says Josh Willis, an oceanographer at NASA's Jet Propulsion Laboratory in Pasadena, California. "This coming year is gonna be a wild ride if the El Niño really takes off."

Nature May 2023

Dendrochronology can be used to describe and understand the effects of climate change, especially drought, using tree rings over the last several thousand years

Valerie Trouet 2020
Tree story – The History of the World Written in Rings



https://www.sciencenews.org/article/tree-story-book-explores-what-tree-rings-can-tell-us-about-past

How frequent are extreme events?

Valerie Trouet.2020. Tree story – The History of the World Written in Rings

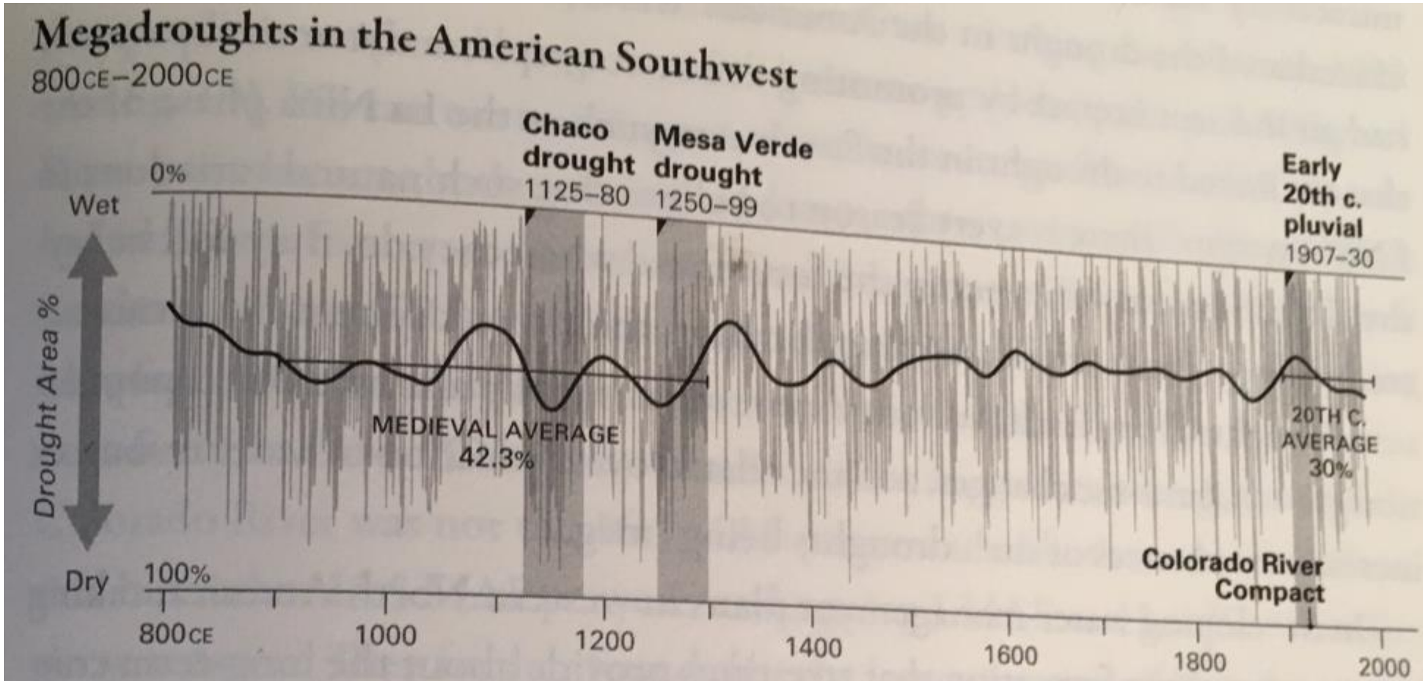
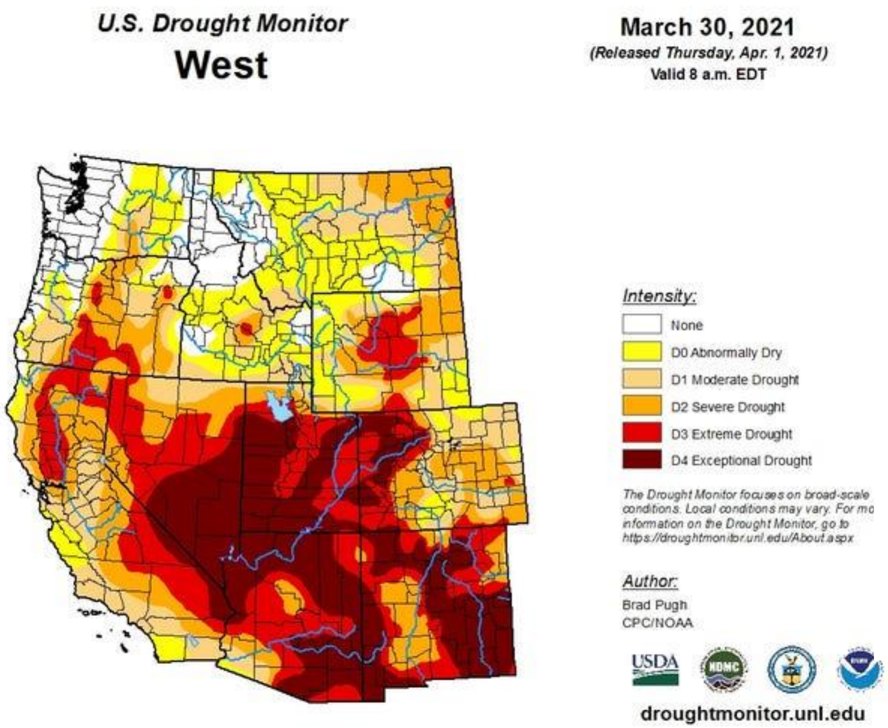
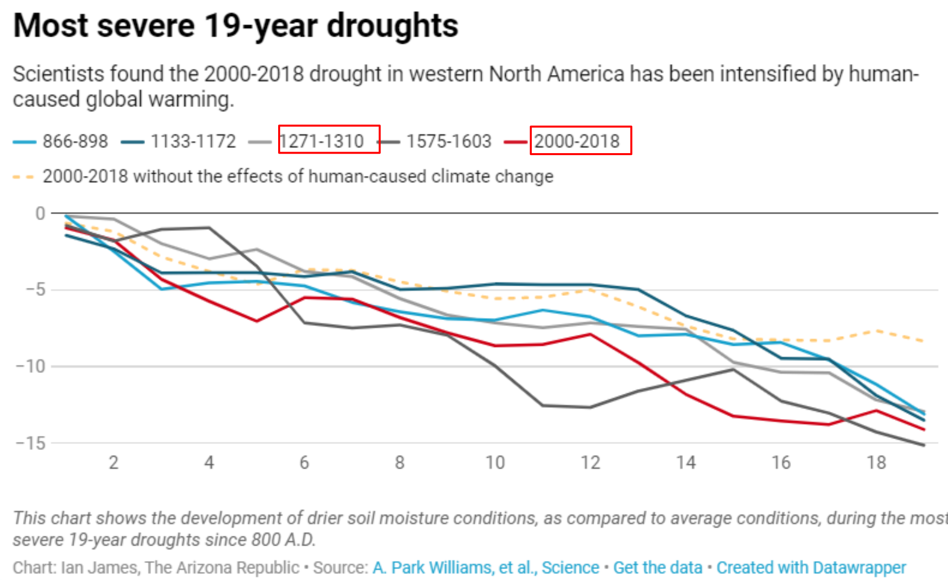


Figure 19 The single greatest megadrought in the North American Drought Atlas is the Chaco megadrought around 1150. The wettest period in the past millennium occurred in the early twentieth century and coincided with the signing of the 1922 Colorado River Compact, an interstate water-rights agreement based on less than 30 years of data.

Anasazi / Pueblo Indians - Mesa Verde National Park

American West





Valerie Trouet.2020. Tree story – The History of the World Written in Rings

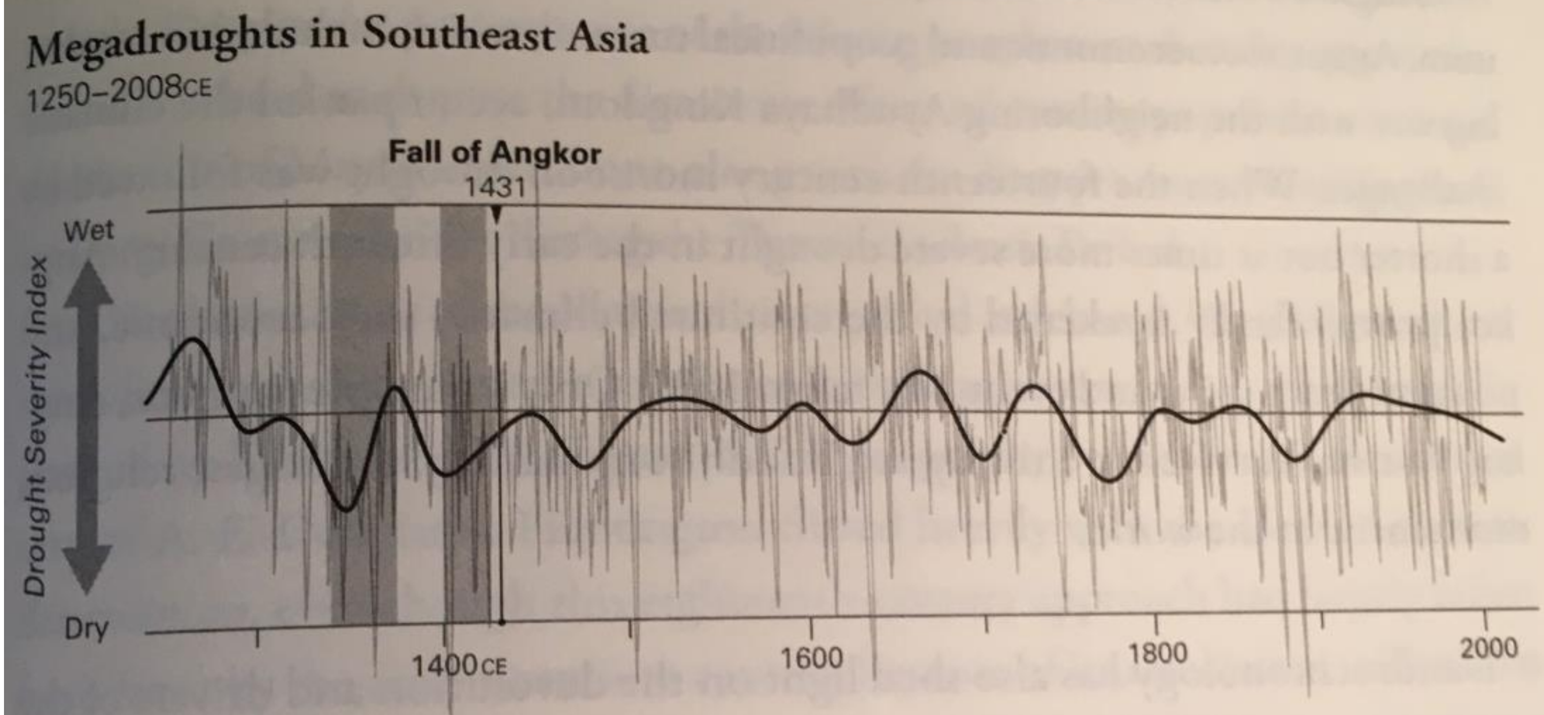


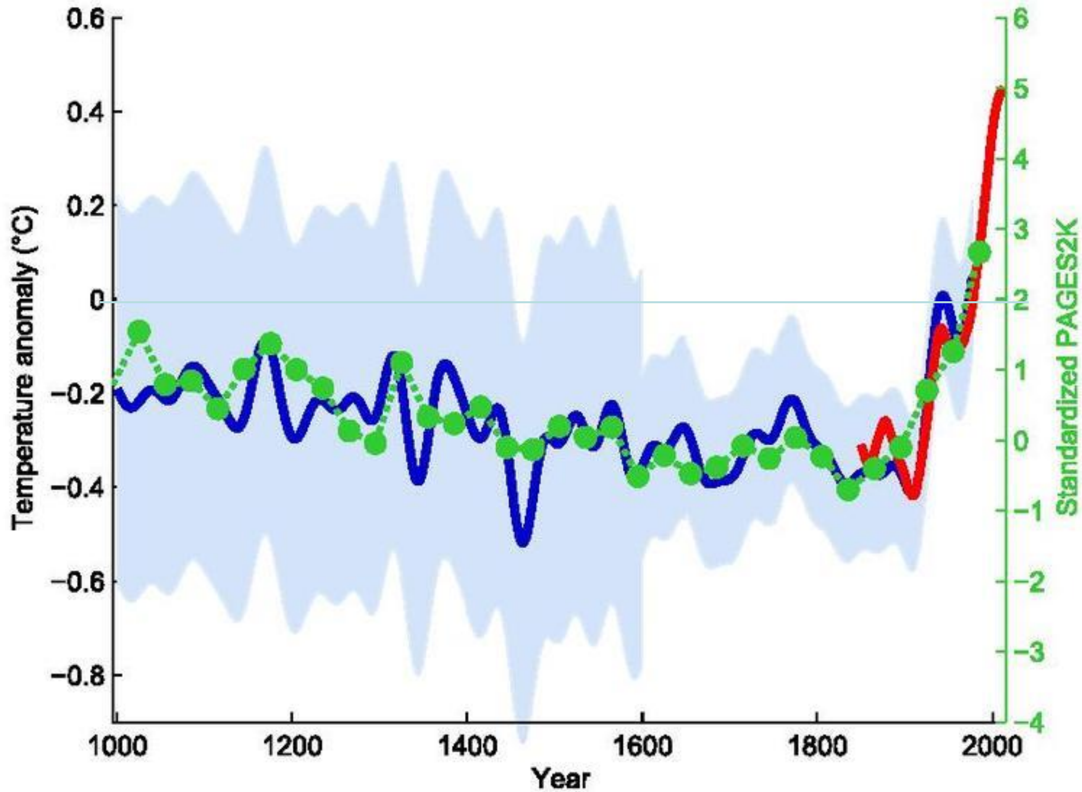
Figure 17 The East Asian summer monsoon became very fickle in the decades leading up to the fall of Angkor. A ca. 35-year drought in the mid-fourteenth century was occasionally interrupted by intense monsoon floods and followed by a shorter but at times more severe drought in the early fifteenth century. Angkor's hydraulic infrastructure was not fit to handle such abrupt switches from drought to flood and vice versa.

Angkor Wat

By Kheng Vungvuthy - Own work, CC BY-SA 4.0,
https://commons.wikimedia.org/w/index.php?curid=90594782

TEMPERATURE VARIATIONS IN THE LAST 1000 YEARS: THE HOCKEY STICK GRAPH

Gradual temp decline to 1850 illustrated in Pieter Bruegel the Elder, *Hunters in the Snow (Winter)*, 1565 – with the Little Ice Age in the late middle ages



The original northern hemisphere hockey stick graph of Mann, Bradley & Hughes 1999, smoothed curve shown in blue with its uncertainty range in light blue, overlaid with green dots showing the 30-year global average of the PAGES 2k Consortium 2013 reconstruction. The red curve shows measured global mean temperature, according to HadCRUT4 data from 1850 to 2013.

Geographical pattern of surface warming - IPPC

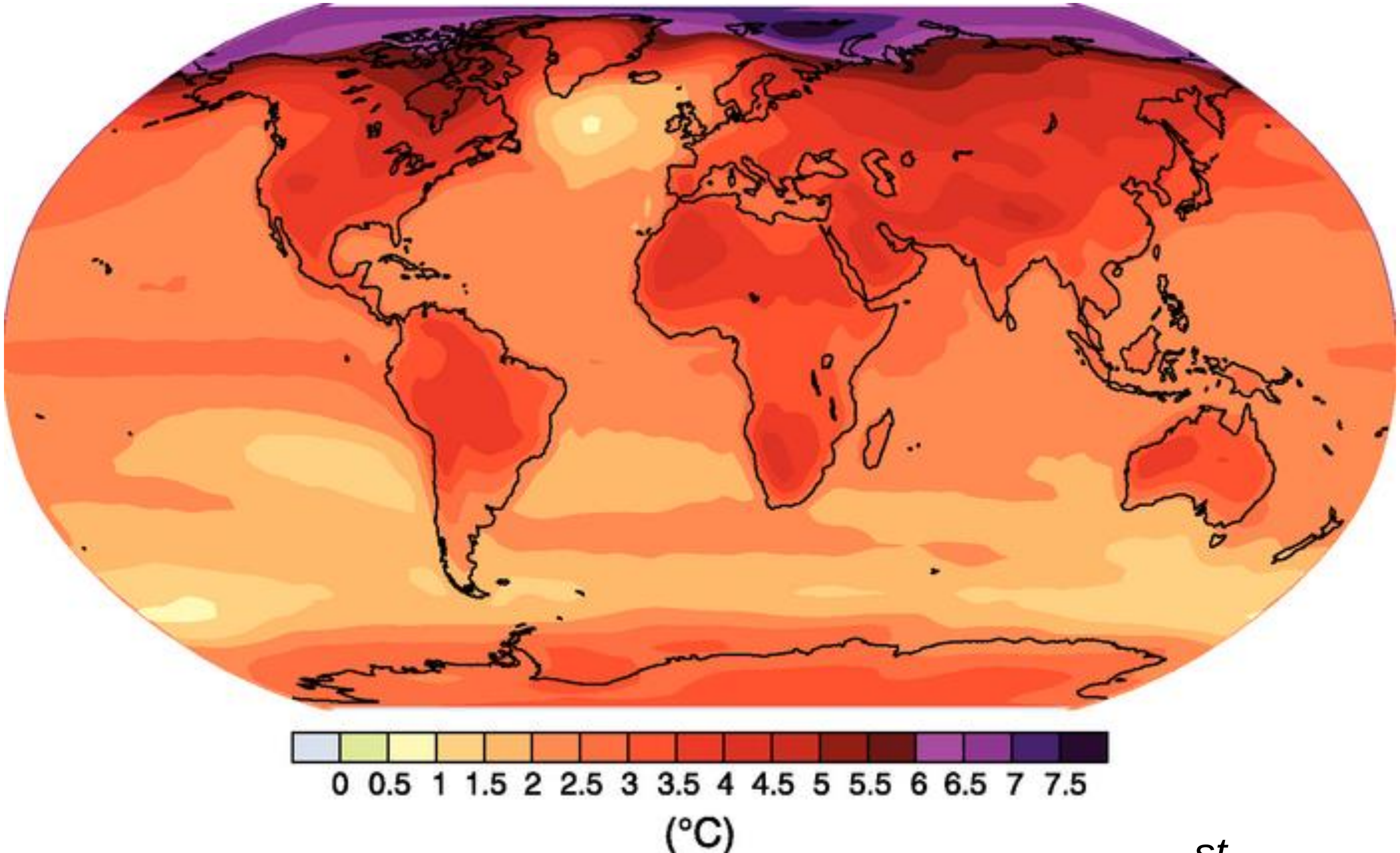
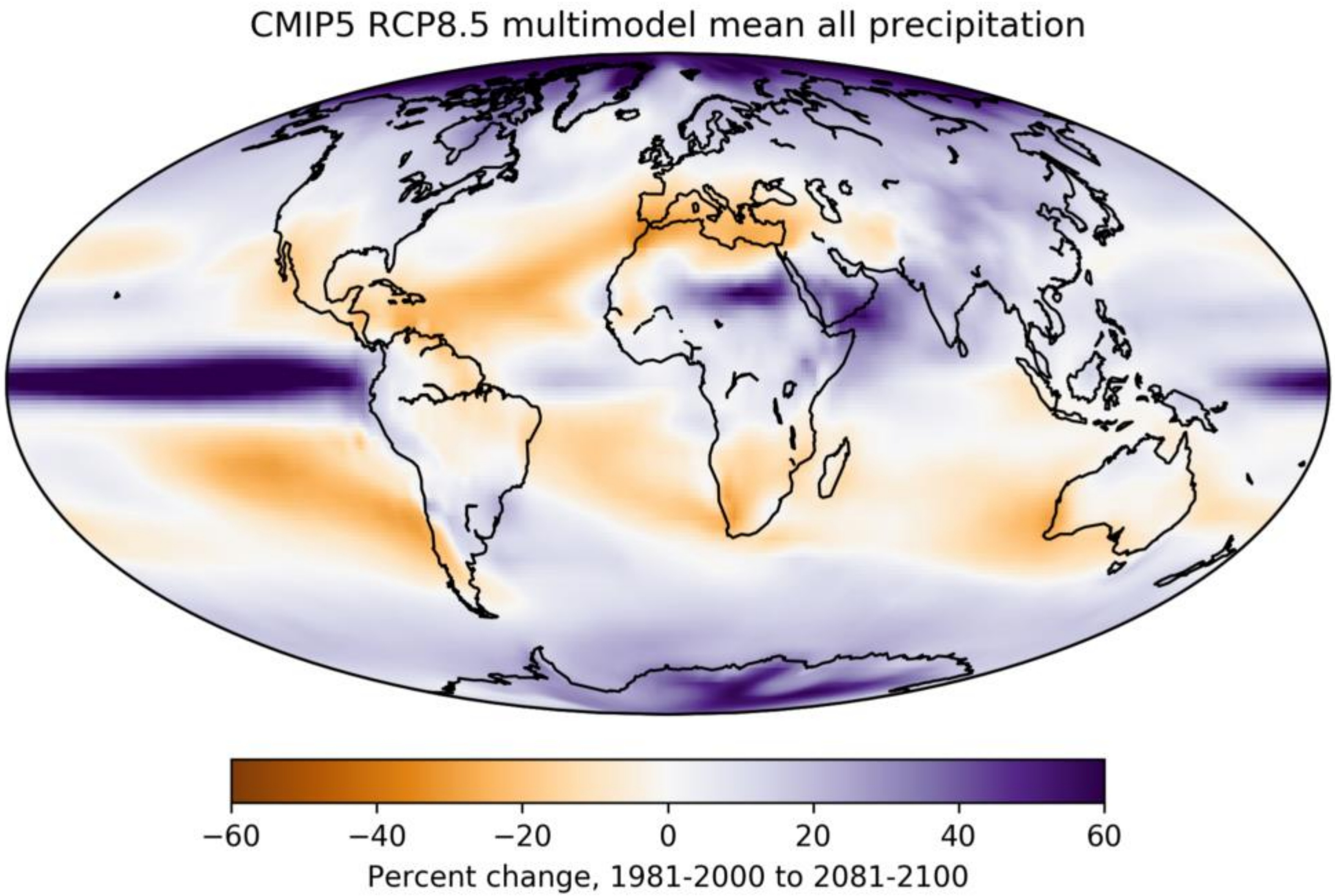


Figure SPM.6. Projected surface temperature changes for the late 21st century (2090-2099). The map shows the multi-AOGCM average projection for the A1B SRES scenario. Temperatures are relative to the period 1980-1999. {Figure 3.2}

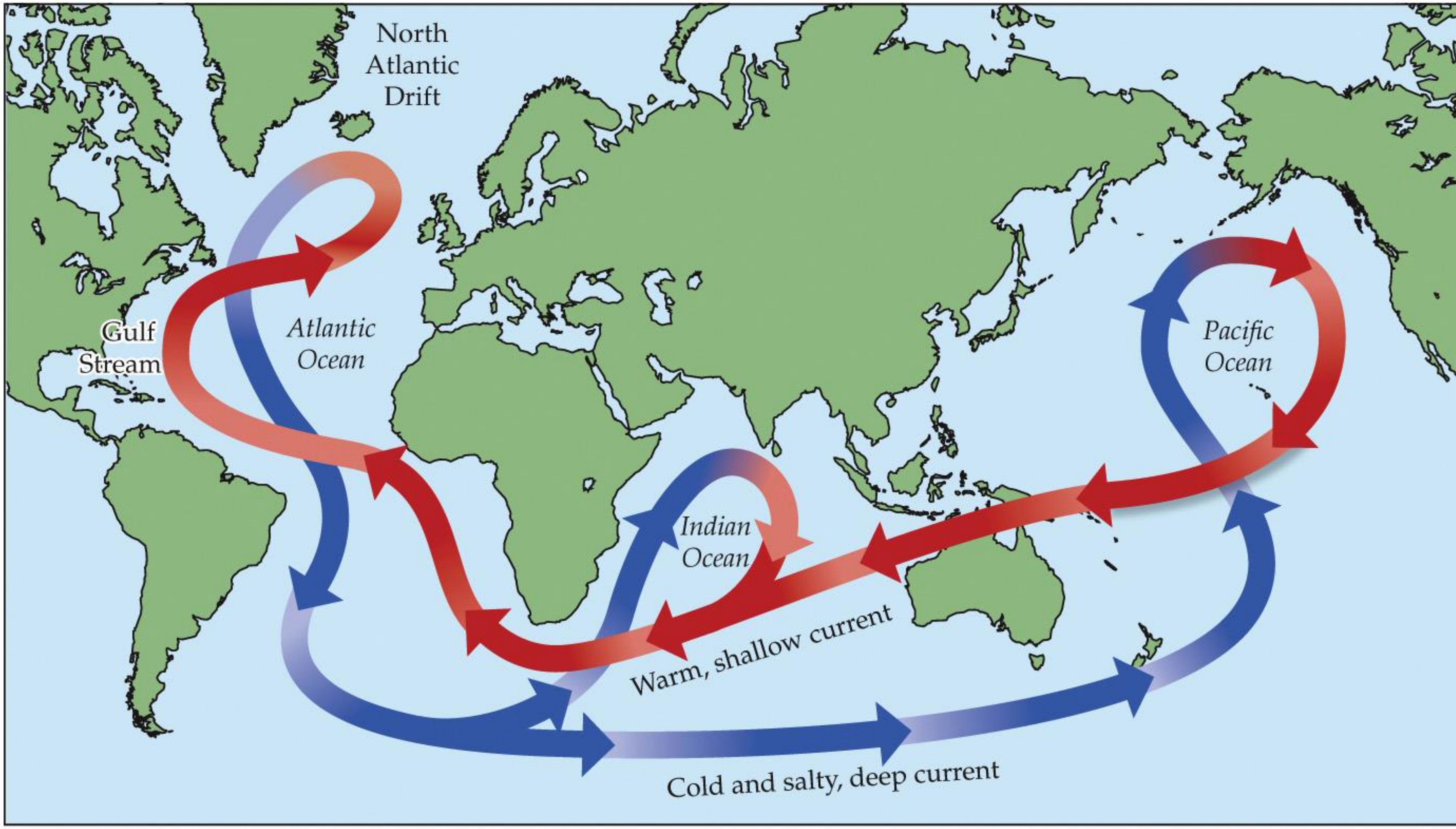
https://archive.ipcc.ch/publications_and_data/ar4/syr/en/figure-spm-6.html



CMIP5 RCP8.5 multimodel average percent change in total precipitation (rain and snow) between 1981-2000 and 2081-2100. Uses one run for each model, 38 models total.

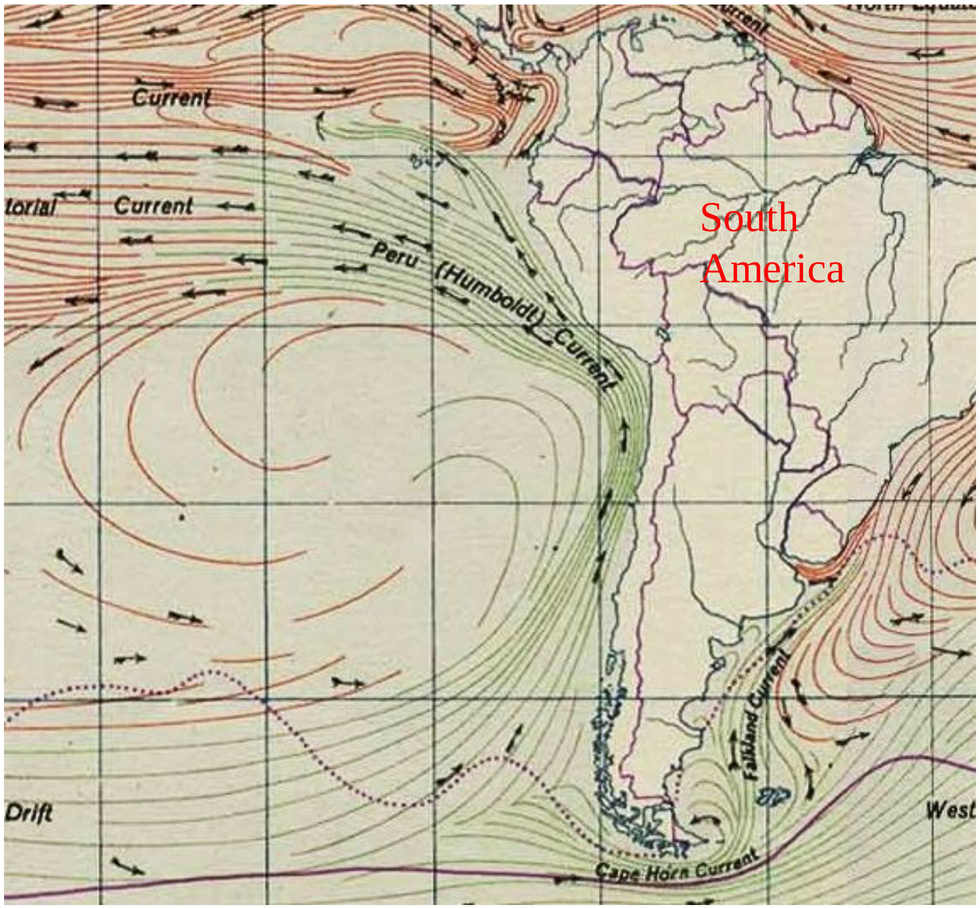
https://www.carbonbrief.org/explainer-what-climate-models-tell-us-about-future-rainfall

Winds and ocean currents result from differences in solar radiation across Earth's surface.
The Great Ocean Conveyor Belt



ECOLOGY 4e, Figure 2.13

The Humboldt Current



The Humboldt current , is a cold, low-salinity ocean current that flows north along the western coast of South America. Upwelling brings nutrients to the surface, which support phytoplankton and ultimately increase biological productivity. Periodically, the upwelling that drives the system's productivity is disrupted by the El Niño-Southern Oscillation (ENSO) event, often with large social and economic impacts.

Red-legged cormorant,

El Niño events, or the **El Niño Southern Oscillation** (ENSO), are longer-scale climate variations that occur every 3 to 8 years and last about 18 months.

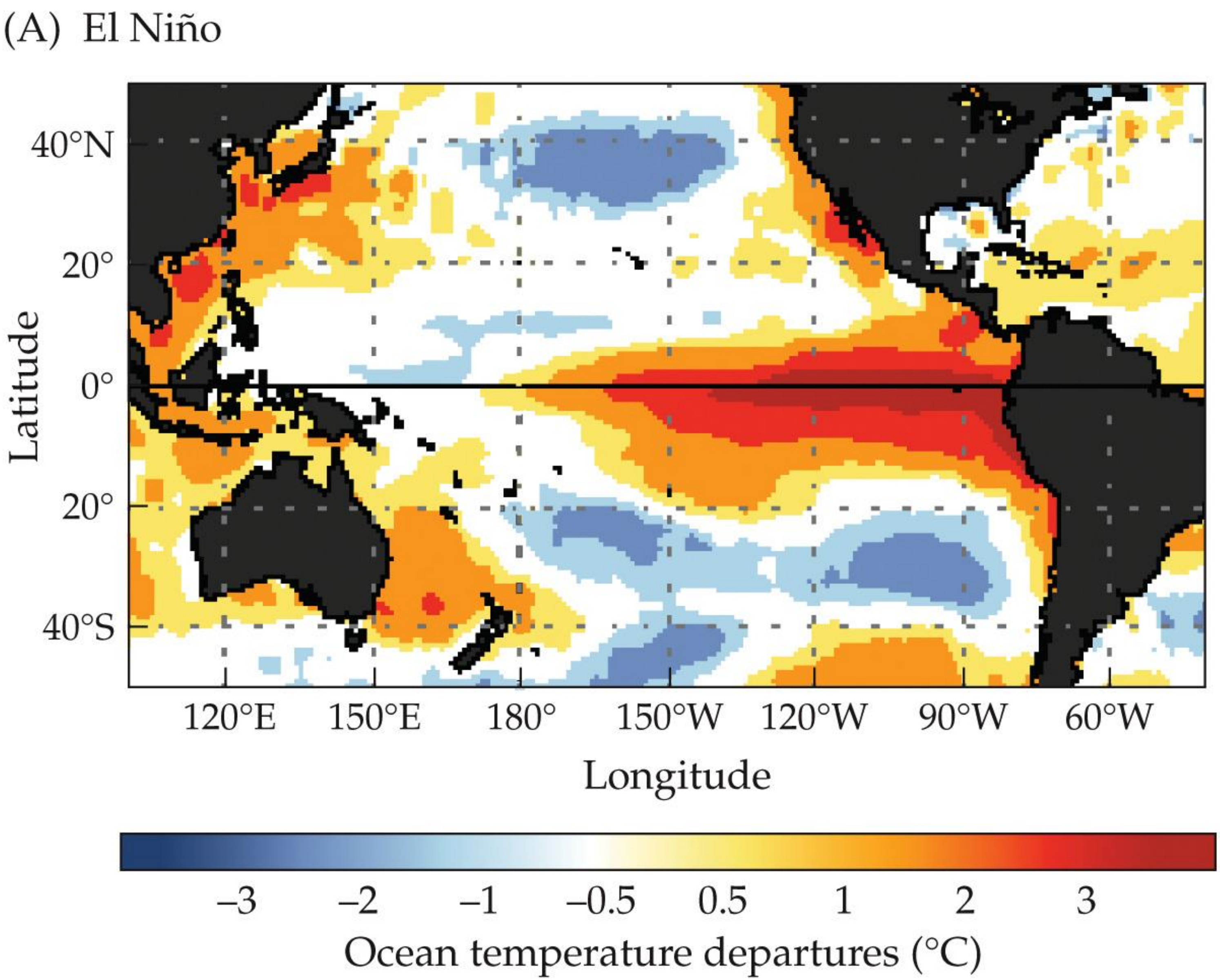
The positions of high- and low-pressure systems over the equatorial Pacific switch, and the trade winds weaken.

The trade winds normally push warm surface water toward Southeast Asia. During El Niño, this is reversed.

Upwelling of deep ocean water off the coast of South America ceases, resulting in much lower fish harvests.

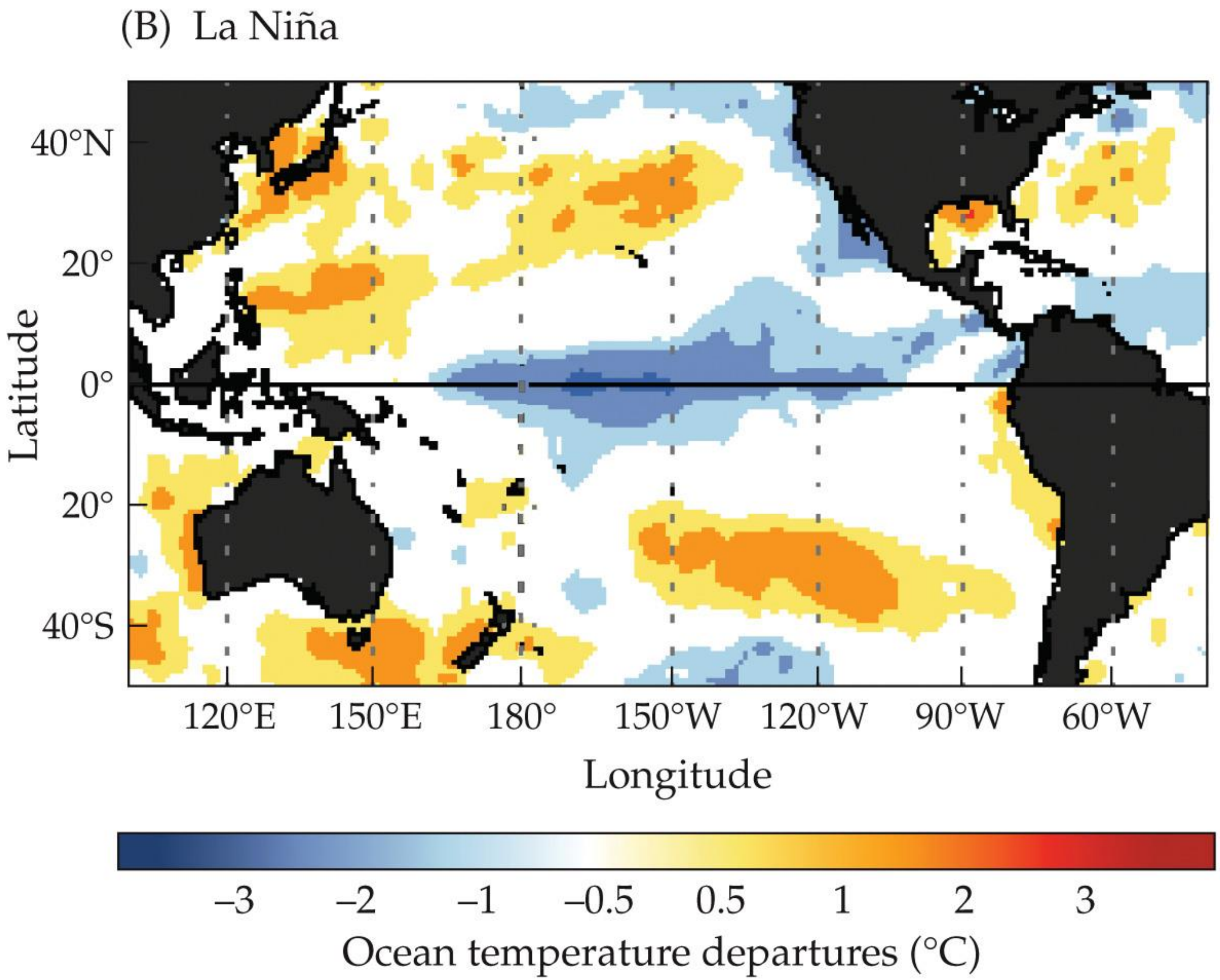
The El Niño Southern Oscillation (ENSO)

Departures from long-term average ocean temperatures in equatorial waters of the Pacific



La Niña

La Niña events are stronger phases of the normal pattern, with high pressure off the coast of South America and low pressure in the western Pacific. They usually follow El Niño, but tend to be less frequent.



ENSO is associated with unusual climate patterns, even in distant places, through its complex interactions with atmospheric circulation patterns.

The **North Atlantic Oscillation** (NOA**)** is a similar atmospheric pressure–ocean current oscillation that affects climate in Europe, northern Asia, and the eastern coast of North America.

The **Pacific Decadal Oscillation** (PDO) affects climate around the North Pacific.

CC and Phenology
Laydates are changing

¨temperature and egg-laying trends across years

R. H. McCleery & C. M. Perrins

Nature **391**, 30–31(1998) | Cite this article

Abstract

Crick *et al.*[1] showed that the laying dates for many British birds have become earlier during 1971-95, which they ascribe to warmer springs resulting from global warming. We provide partial support for this view from a great tit population in Oxfordshire.

Crick et al. 1997

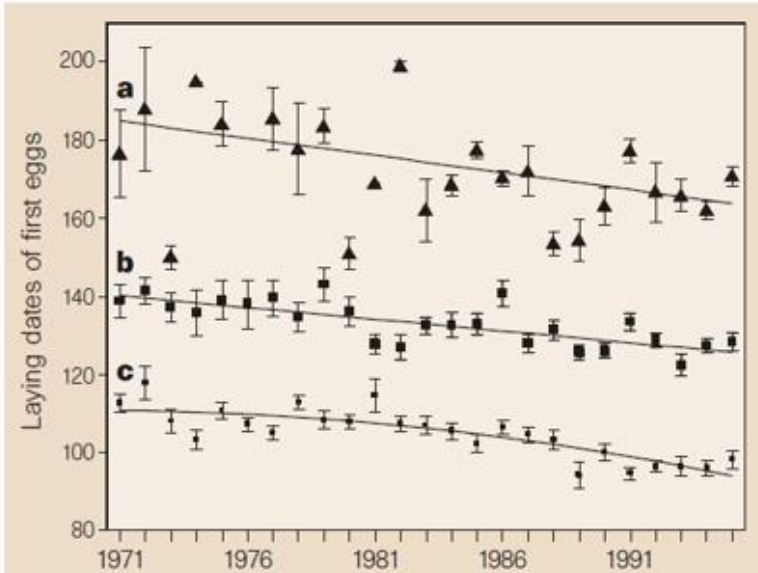


Figure 1 Temporal changes in laying dates for early-, mid- and late-season nesters. **a,** *Miliaria calandra*, $F_{1,23.5} = 5.30$, $P = 0.030$. **b,** *Phylloscopus collybita*, $F_{1,27.1} = 23.00$, $P = 0.0001$. **c,** *Pica pica*, $F_{1,18.9} = 61.89$, $P = 0.0001$. Laying date is numbered such that day 60 is 1 March, 121 is 1 May and so on. Points show annual means ± s.e.m. We analysed between 150 and 5,700 records per species. Laying dates were estimated with an accuracy of at least ±5 days (ref. 3). For each species we selected the most significant of three mixed linear models with Year (for example, **a** and **b**), Year^2 (**c**), or Year and Year^2 combined, fitted as continuous fixed effects; Year was also fitted as a categorical random effect to contend with the non-independence of observations within years.


corn bunting


chiffchaff


magpie

CC and bird phenology:

McCleery and Perrins. 1998. Temperature and egg-laying trends. Nature 391:30-31

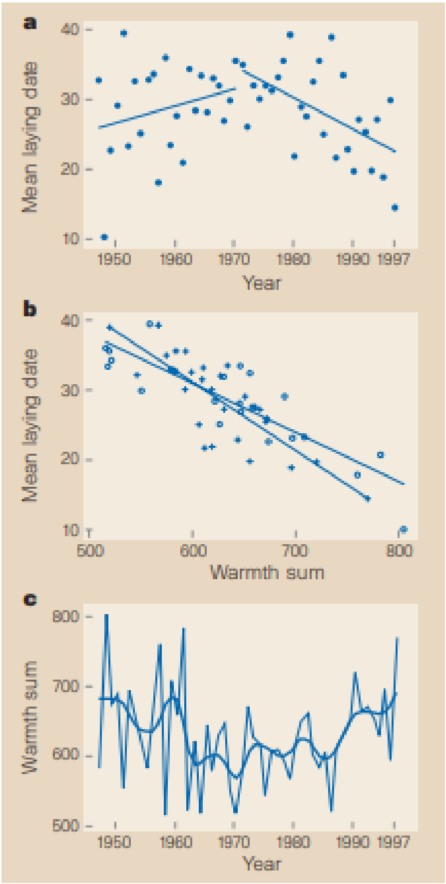


Figure 1 Laying date of Marley great tits and spring temperatures. **a**, Mean laying date (1 represents 1 April) plotted against time. Lines are regressions fitted to the two groups of data. The curvature of the best-fit model was confirmed by polynomial regression, which showed the quadratic term in time to be highly significant ($F = 11.37$, d.f. = 1,47, $P = 0.002$). The upward slope in 1947–70 is not significantly different from 0 (slope = 0.2035, s.e.m. = 0.2054, $t = 0.99$, 21 d.f., $P = 0.333$; if the exceptionally hot and early 1948 is removed the slope becomes 0.01). The tendency for laying to become earlier in 1971–97 is highly significant (slope = −0.4387, s.e.m. = 0.1331, $t = 3.30$, 25 d.f., $P = 0.003$). **b**, Regression of mean laying date for great tits in Marley wood against warmth sum. The data are classified as 1947–70 and 1971–97. The warmth sum is calculated as the sum of the daily maxima from 1 March to 25 April in each year. The difference in slopes for 1947–70, −0.069, and 1971–97, −0.097, is not significant ($F = 3.06$, d.f. = 1,47, $P = 0.087$). The overall slope of −0.083 ± 0.008 s.e.m. is significantly different from 0 ($t = -10.42$, $P < 0.001$). **c**, Temperature trends at Oxford. The thick line is the resistant smoother "4253H, twice"[7].

https://www.countryfile.com/wildlife/great-tit-evolution-in-uk-gardens/