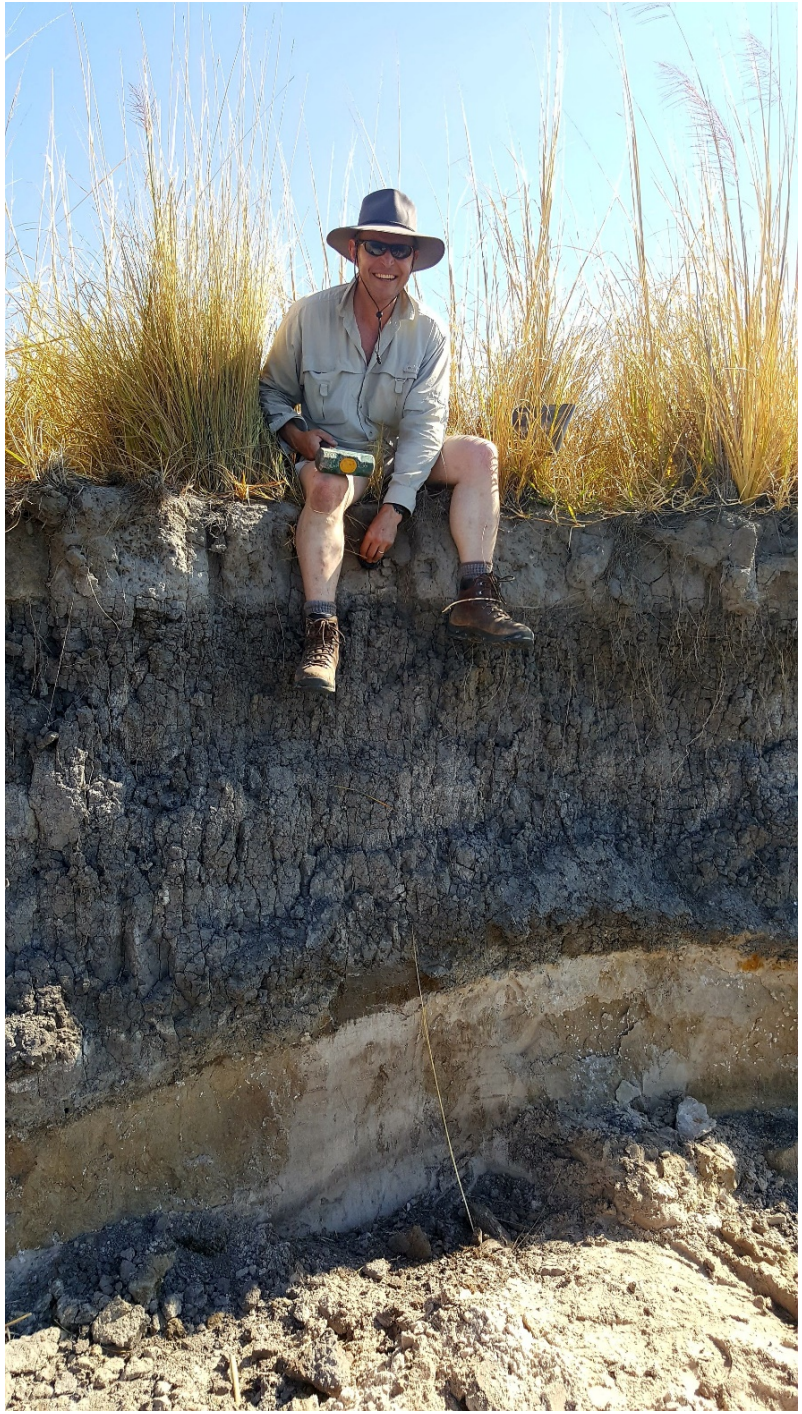
Climate change & our future in Wales

Stephen Tooth
Department of Geography & Earth Sciences
Aberystwyth University
set@aber.ac.uk







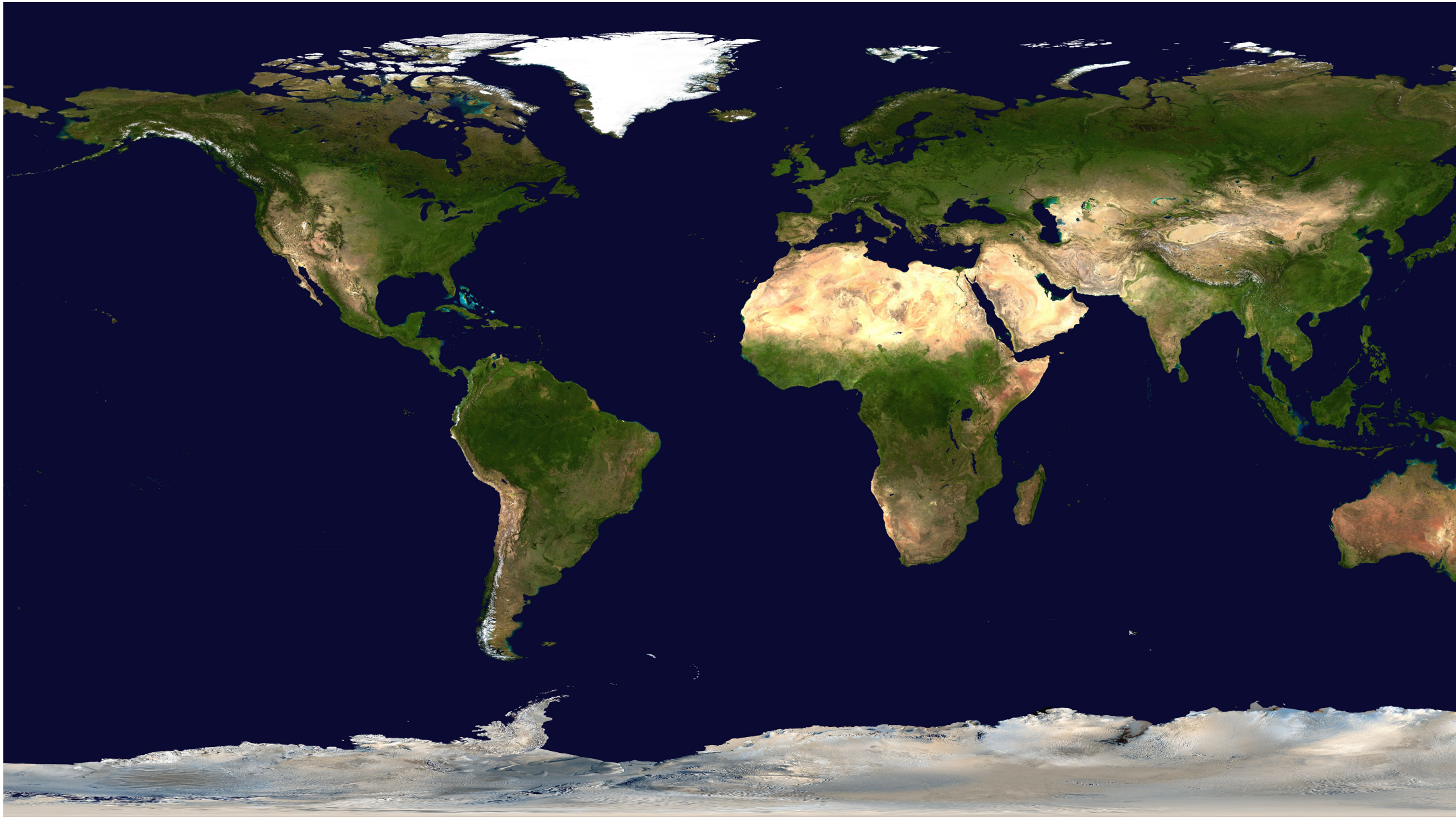


About myself

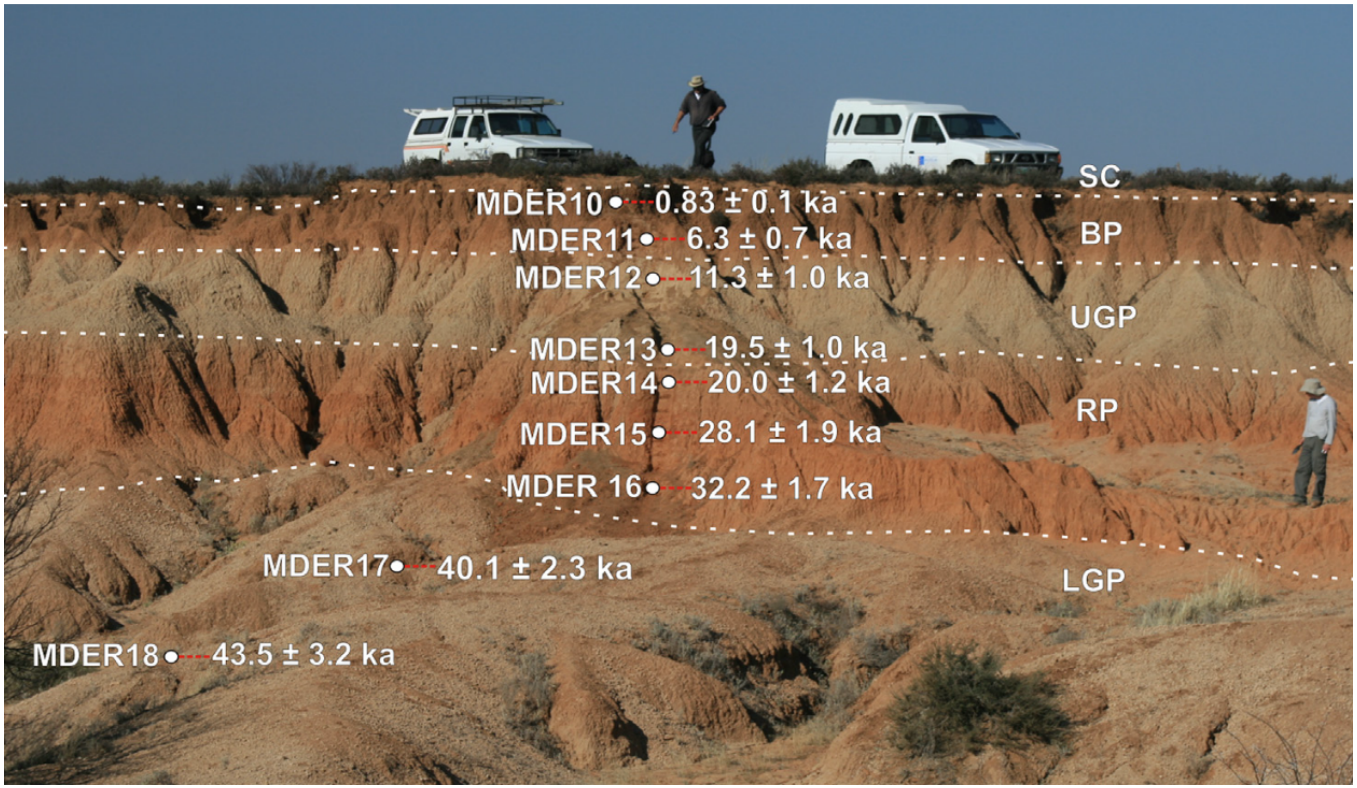
geographer, physical g
geomorphologist, geo
environmental scientist,

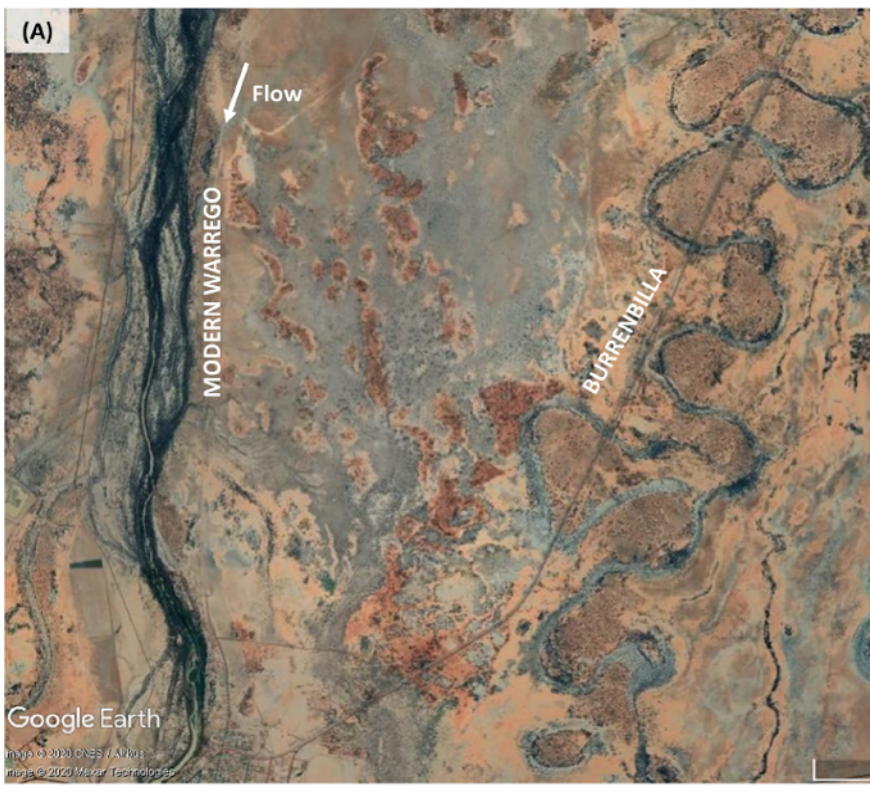






rivers, wetlands, deserts, landscape response to environmental (incl. climate) change,
human-environment interactions, geoheritage, art-science collaborations, science communica


SC
MDER10 • 0.83 ± 0.1 ka
MDER11 • 6.3 ± 0.7 ka
BP
MDER12 • 11.3 ± 1.0 ka
UGP
MDER13 • 19.5 ± 1.0 ka
MDER14 • 20.0 ± 1.2 ka
RP
MDER15 • 28.1 ± 1.9 ka
MDER 16 • 32.2 ± 1.7 ka
MDER17 • 40.1 ± 2.3 ka
LGP
MDER18 • 43.5 ± 3.2 ka


(A)
Flow
MODERN WARREGO
BURRENBILLA
Google Earth





GS10810
CLIMATE CHANGE:
IMPACTS, PERCEPTIONS, ADAPTATIONS

Lecture topics

Impacts		
Week 1	Lecture 1	Introduction to the module
	Lecture 2	The emergence of the 'climate change debate'
Week 2	Lectures 3-4	The science of climate change
Week 3	Lectures 5-6	The geographical dimensions of climate change
Perceptions		
Week 4	Lectures 7-8	The politics of climate change science
Week 5	Lectures 9-10	Climate change, industry & NGOs
Week 6	Lectures 11-12	Climate change economics & the politics of carbon markets
Week 7	Lectures 13-14	Climate change & the everyday: public perceptions, experiences & the place of local knowledge
Adaptations		
Week 8	Lecture 15	Carbon budgeting approaches
	Lecture 16	Carbon offsetting schemes
Week 9	Lectures 17-18	Possible adaptations towards a low carbon, sustainable economy
Week 10	Lectures 19-20	Living a low carbon lifestyle

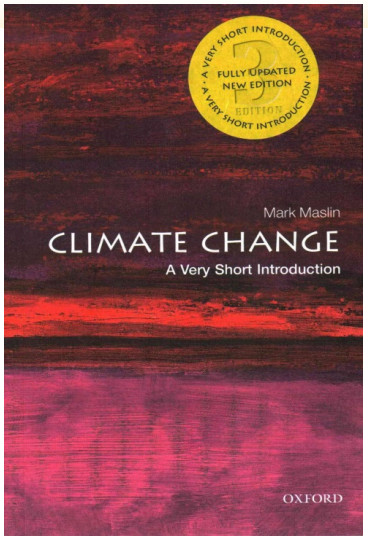
What this module will do:

- give you some background to the key characters in change debate
- present the facts (so far as they are known) & separ information from fiction & disinformation
- establish where facts & information stops & where c subjective, value judgements start

What this module will not do:

- tell you what to think
- tell how to evaluate & reconcile different value judge
- tell you how to act

all of this is up to you

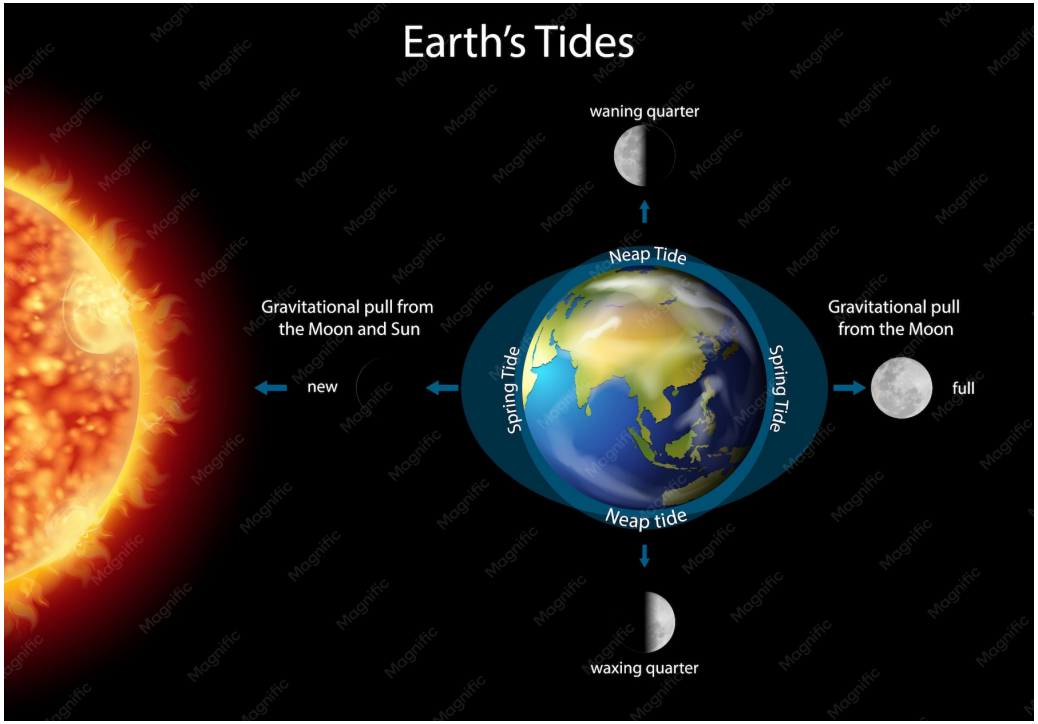


Maslin 2

The rest of today's talk

1. ~~About myself~~
2. **Environmental rhythms**
3. **Climate & environmental change: the general picture so far (physical systems)**
4. **Future projections (& how can we know what's coming?)**
5. **The situation in Wales**
6. **Group activity (?)**
7. **Other threats to the environment & nature**
8. **What can we do?**

2. Environmental rhythms







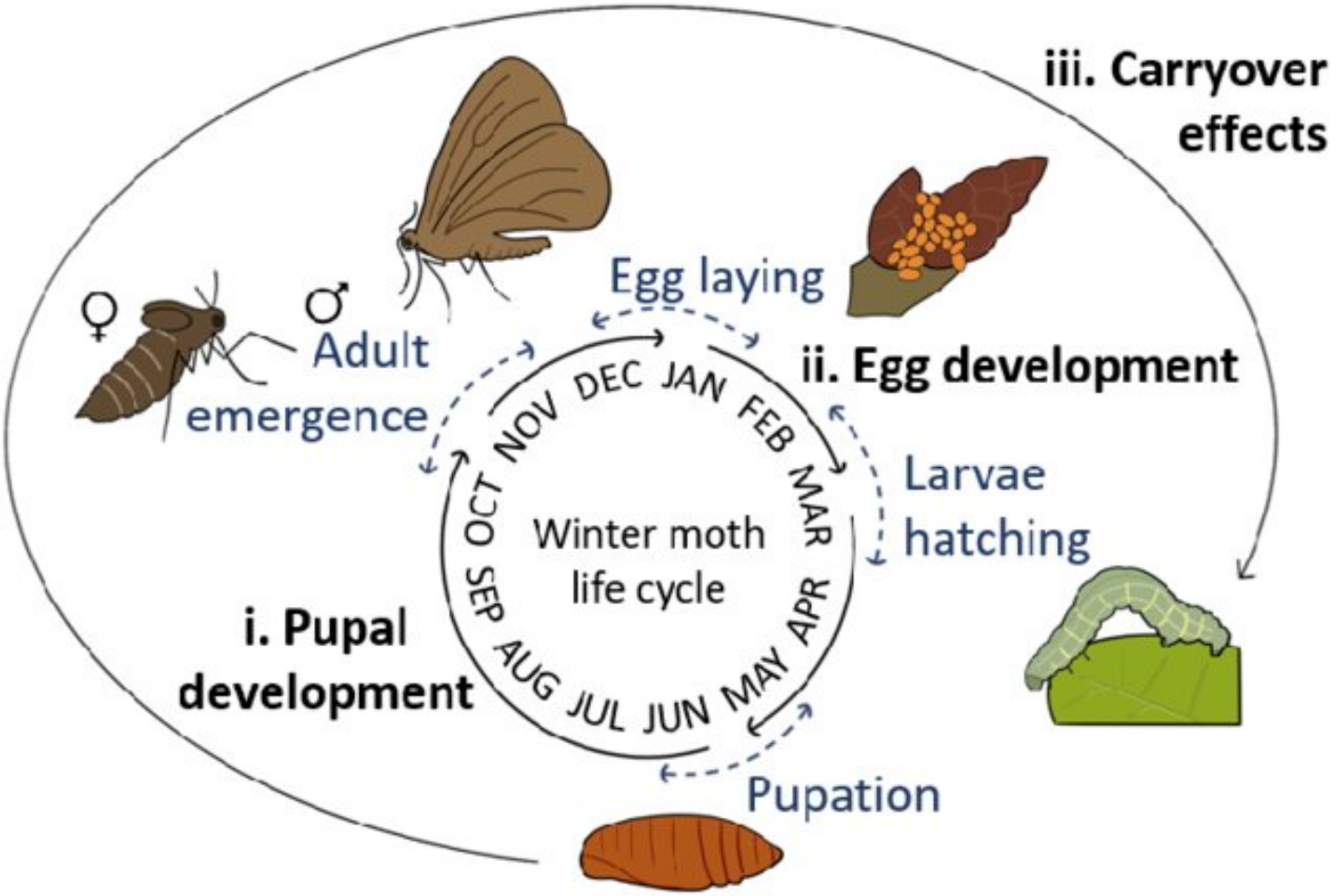






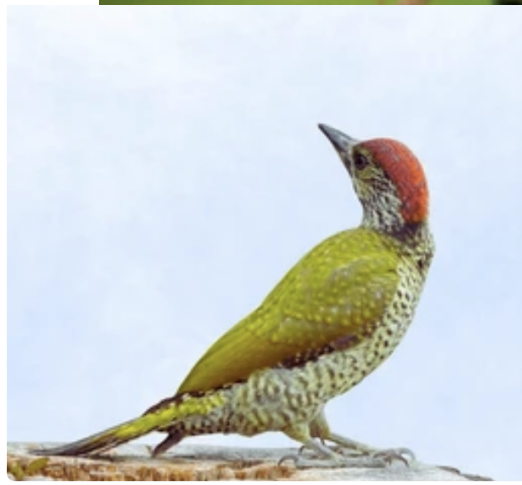








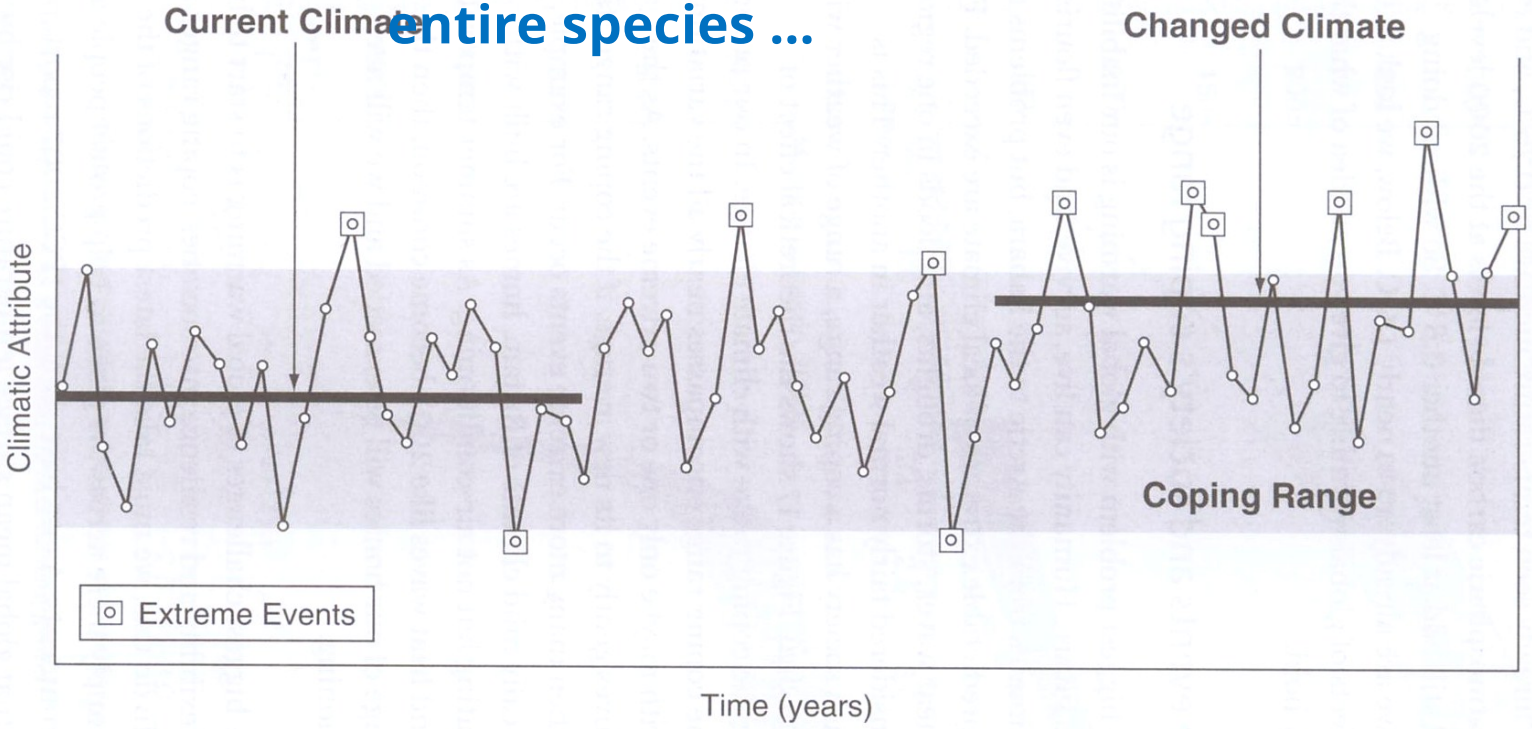




sensitive dependence of many different rhythms (physical + biological)
for healthy ecosystems
(“windows of opportunity” vs “windows of susceptibility”) …

direct human impacts, climate change & extreme events are affecting the biolog cycles of many animals, increasing risks for individuals, populations, communities. entire species …

coping strategies
(e.g. hibernation,
overwintering,
aestivation)
& coping range in relation
to climatic changes
(e.g. in temperature)









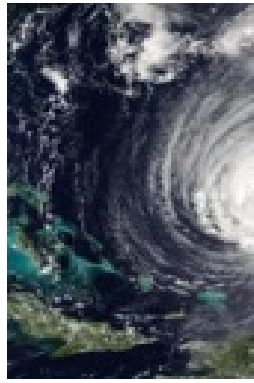
the risk of "phenological mismatches" is also increasing, which means that the "wi opportunity"

3. Climate & environmental change: the general picture so far (physical systems)

- Increased temperatures
- Increased sea level
- Increased size & number of storm waves & extreme wind stor
- Increased size & number of heavy rainfall events
- Increased coastal erosion & increased flooding (of various typ
- Increased size & number of droughts
- Increased size & number of other environmental hazards



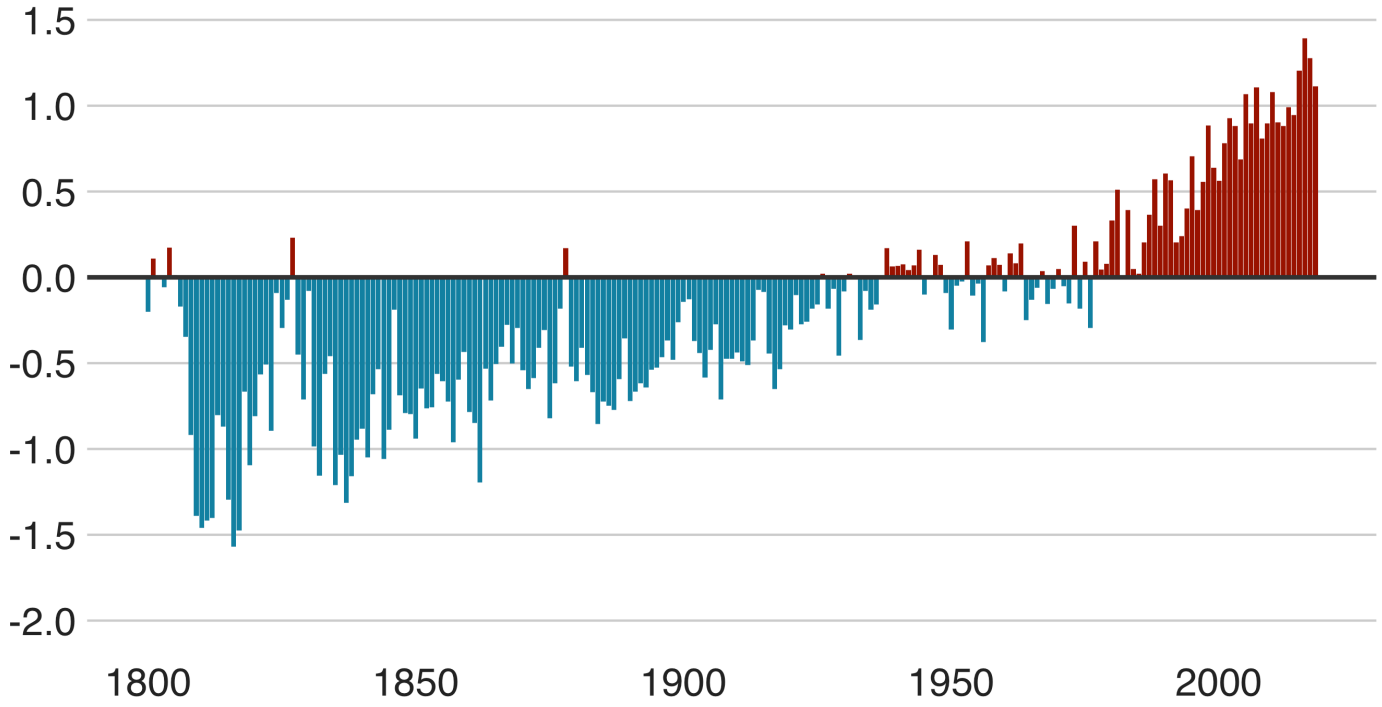




Increased temperatures

The world has been getting warmer

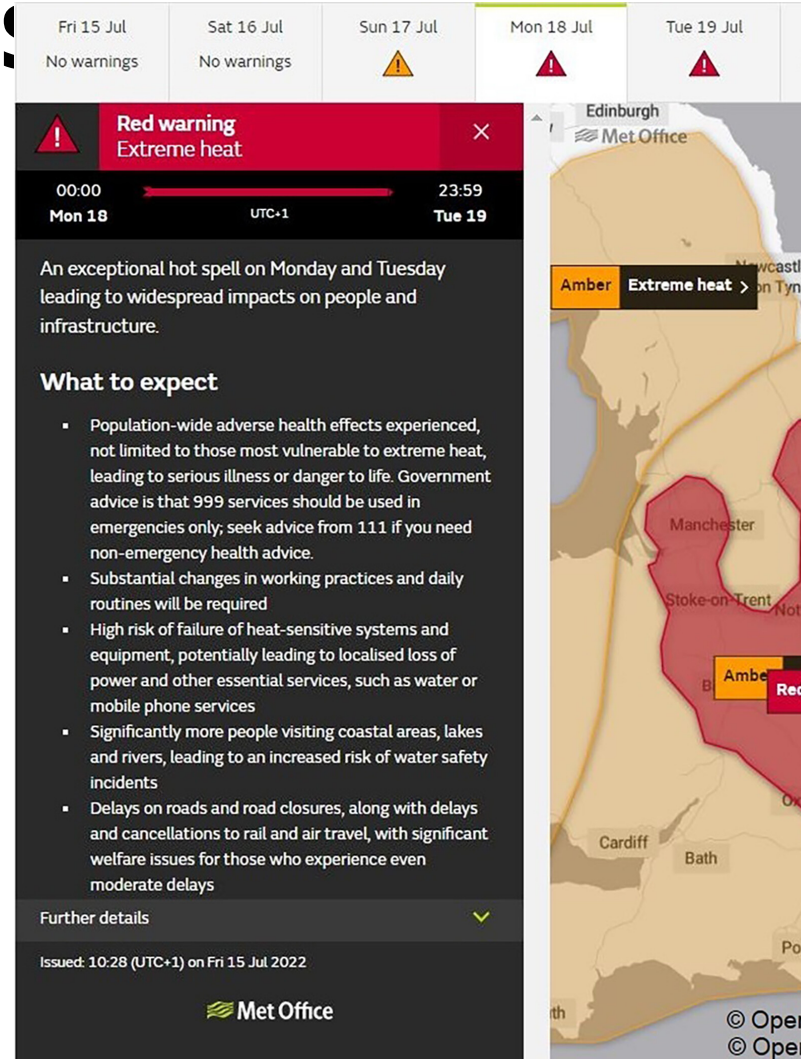
Annual mean land temperature above or below average (°C)



Note: Average is calculated from 1951-1980 land surface temperature data

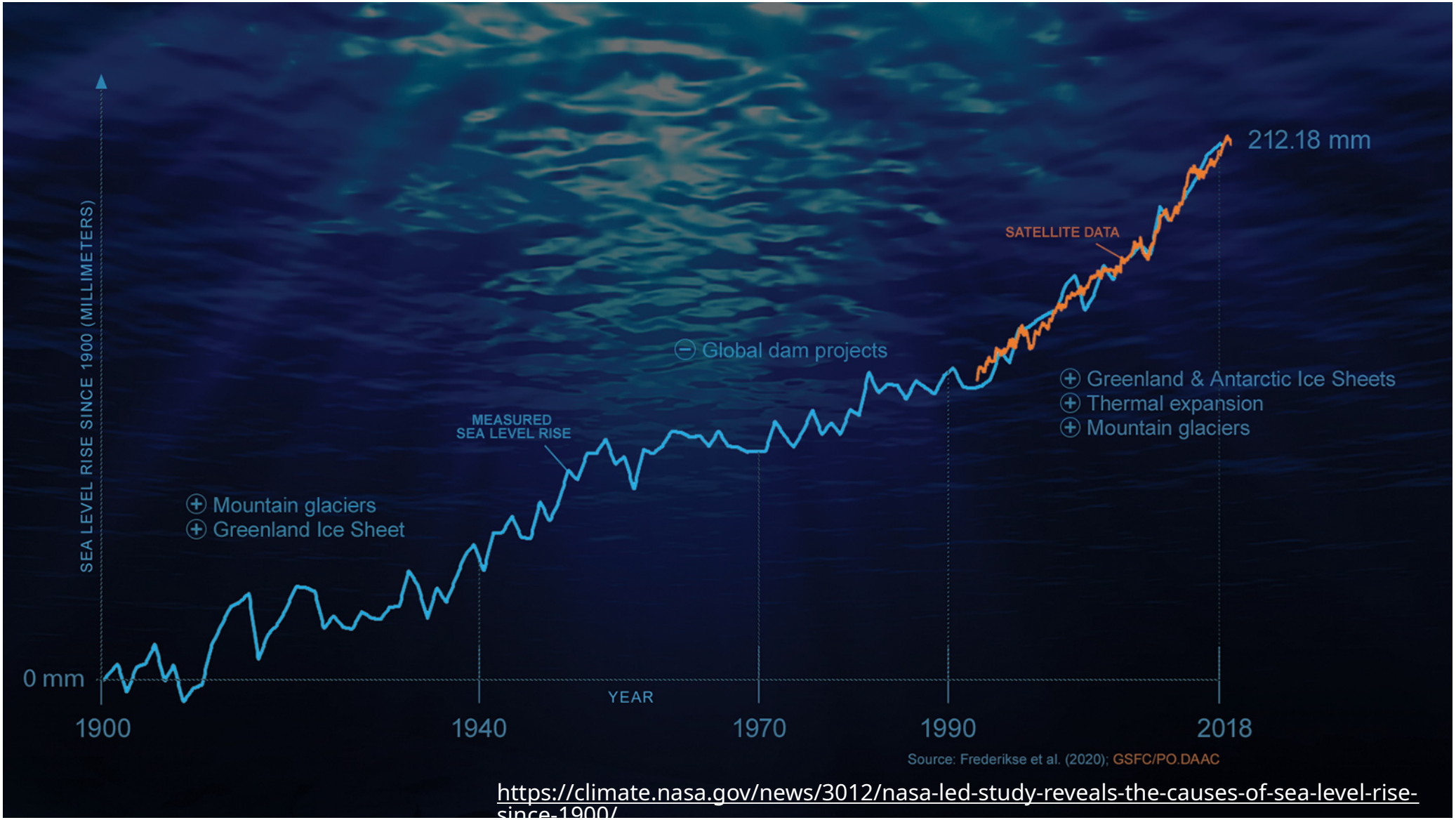
Source: University of California Berkeley

BBC



note: this graph does not include 2025 or 2026

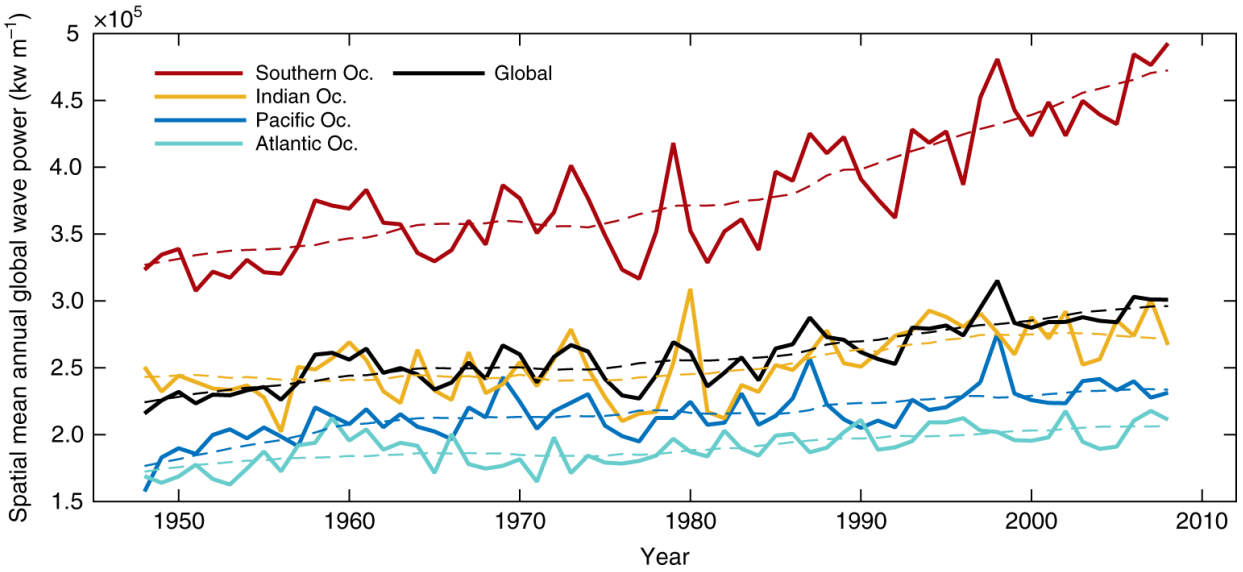
Sea level rise



https://climate.nasa.gov/news/3012/nasa-led-study-reveals-the-causes-of-sea-level-rise-since-1900/

Rise i
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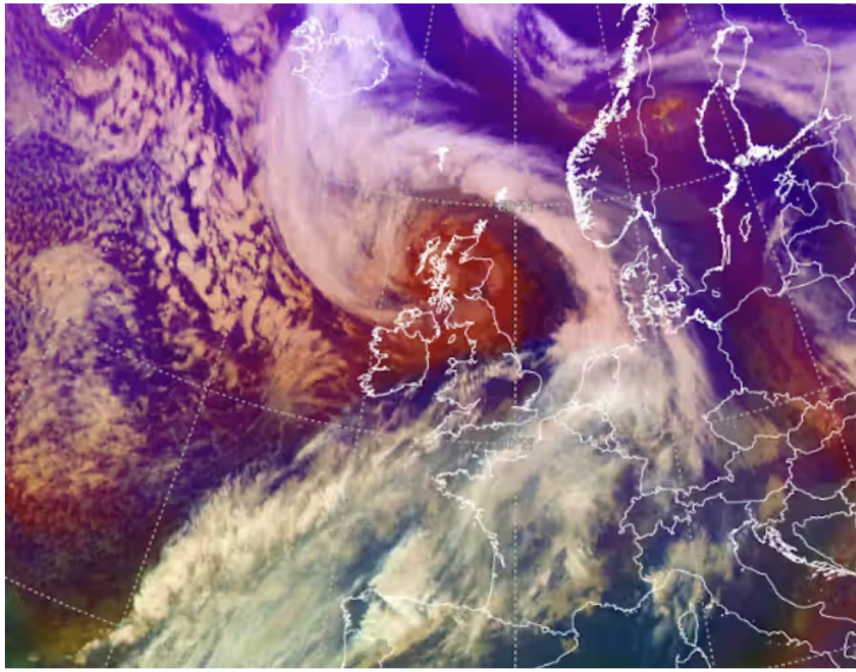
Increased size & number of storm waves & extreme wind storms



Reguero, B.G., Losada, I.J. and Méndez, F.J. A recent increase in global wave power as a consequence of oceanic warming. *Nat Commun* **10**, 205 (2019). https://doi.org/10.1038/s41467-018-08066-0

THE CONVERSATION

Academic rigour, journalistic flair

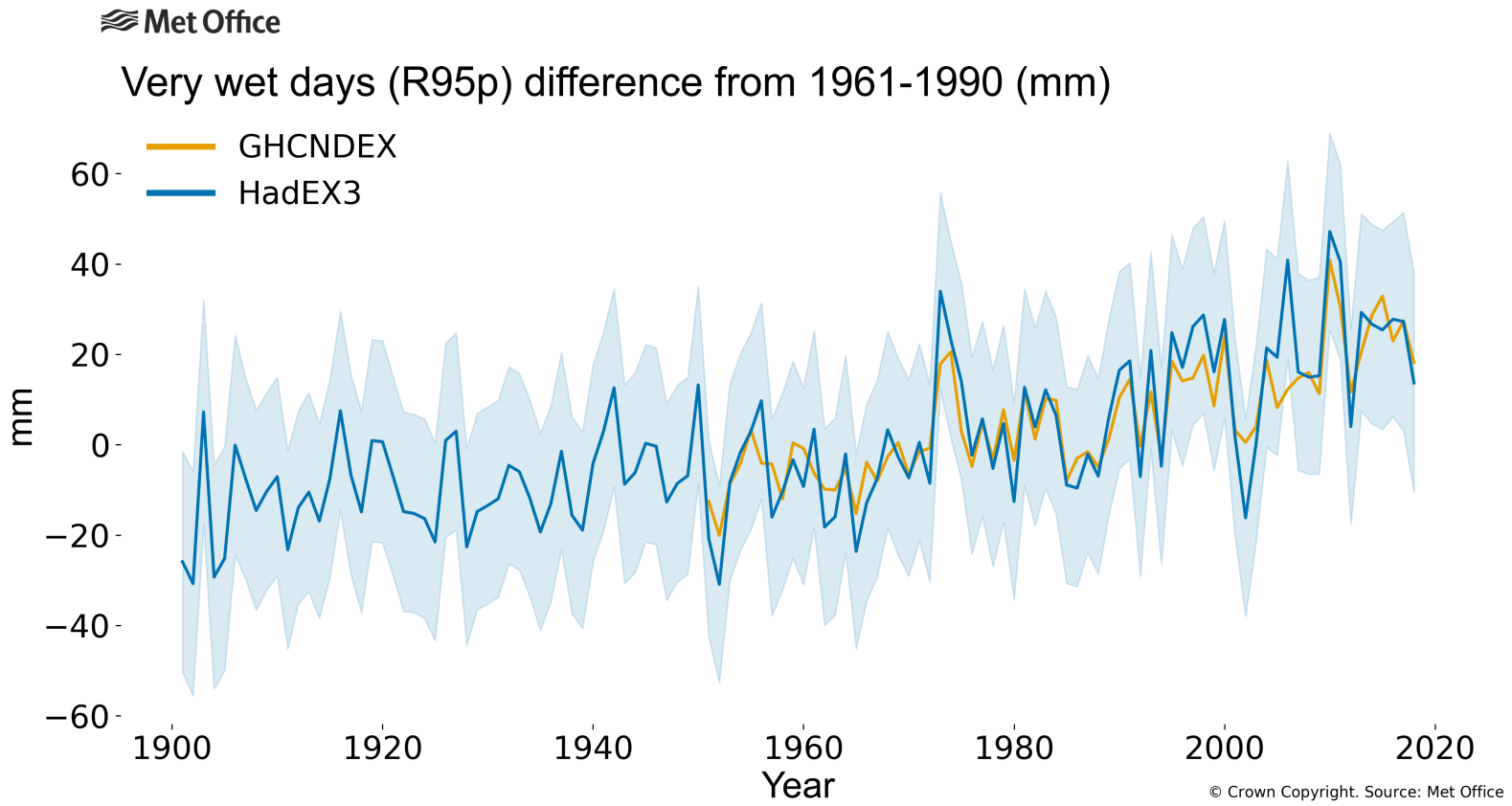


A satellite image of the British Isles during Storm Éowyn's descent. ©EUMETSAT (2025), C

Why meteorologists are comparing Storm Éow

Published: January 24, 2025 3.25pm GMT

Increased size & number of heavy rain events







Increased coastal erosion & increased flooding (of various types)



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[Adapting to coastal change: understanding different points of view in coastal erosion management – Geography Directions]

Increased coastal erosion & increase flooding (of various types)

- Fluvial (river)
- Tidal (coastal)
- Pluvial (rainfall)
- Groundwater

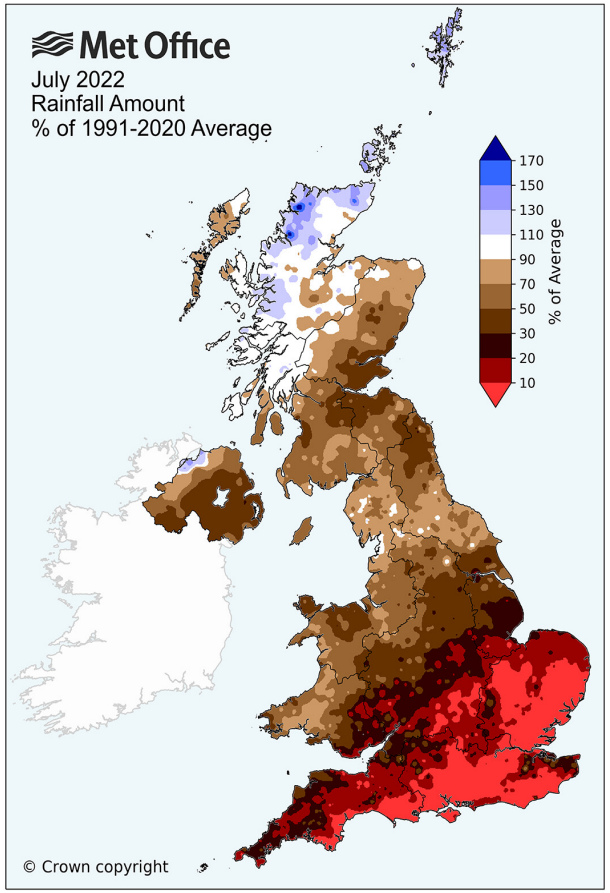


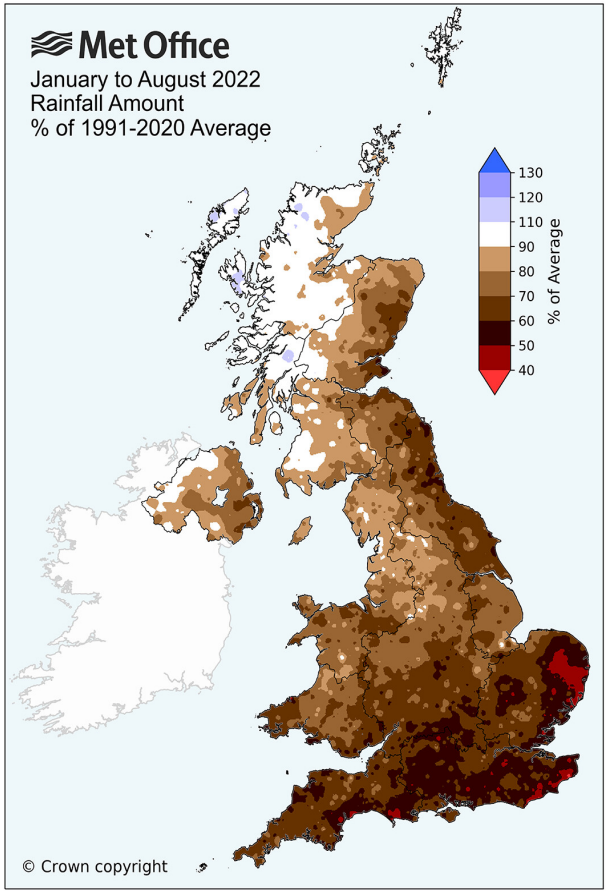






Increased size & number of drought







Pentwyn Reservoir during the 2022 drought. Photo: Alan Hughes via Wikimedia Comm

Increased size & number of other environmental hazards

BBC geomorph News Sport Weather iPlayer Sounds Mor

NEWS

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World Africa Asia Australia Europe Latin America Middle East US & Canada

Kenya landslide: At least 29 killed after heavy rains

23 November 2019 Share



EPA

The landslides were sparked by heavy rain

At least 29 people have died in landslides caused by severe weather in West Pokot county, Kenya.

The landslides, affecting the villages of Nyarkulian and Parua, were reportedly caused by heavy rains.

Officials say the villages have been cut off by flooded roads and at least one bridge was reportedly swept away.

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Asia China India

Afghanistan flash floods kill dozens and destroy 500 homes

26 August 2020



REUTERS

At least 100 people have died in flash flooding in northern Afghanistan's Parwan province, officials say.

The flooding, caused by torrential rains, struck the city of Charikar early on Wednesday morning while people were asleep.

In addition to the fatalities, Afghanistan's disaster management ministry said dozens were injured and nearly 500 houses destroyed.

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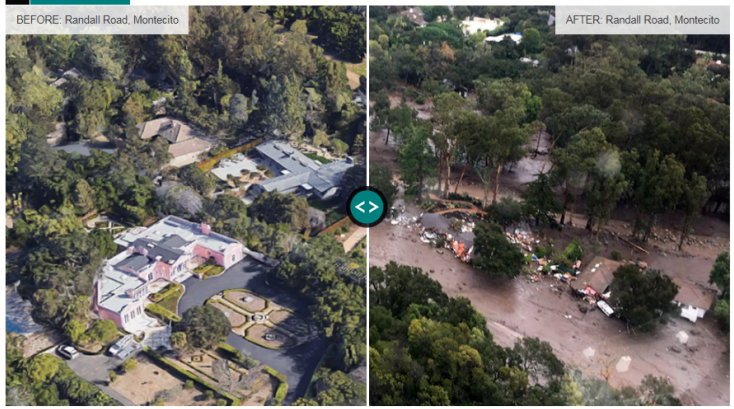
California mudslides: Before and after

11 January 2018 Share

California wildfires

Rescue teams are continuing to search for survivors in southern California after a series of mudslides killed 17 people and swept away more than 100 homes.

INTERACTIVE Use the slider to compare before and after images



BBC For you

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World Africa Asia Australia Europe Latin

Greece wildfires: A new spate of blaze

21 August 2023

Europe heatwaves



EPA-EFE/REX/SHUTTERSTOCK

Greek authorities say high temperatures and g

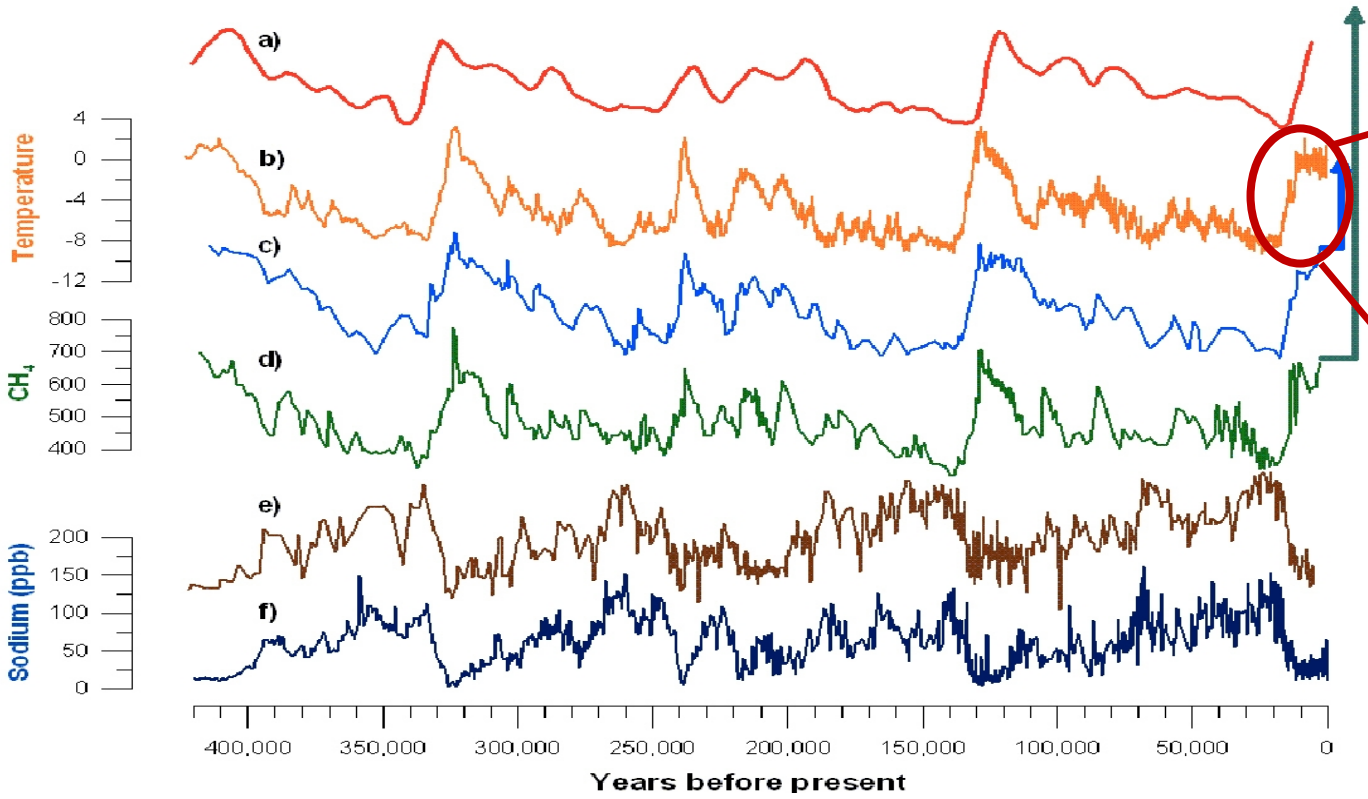
By Kathryn Armstrong
BBC News

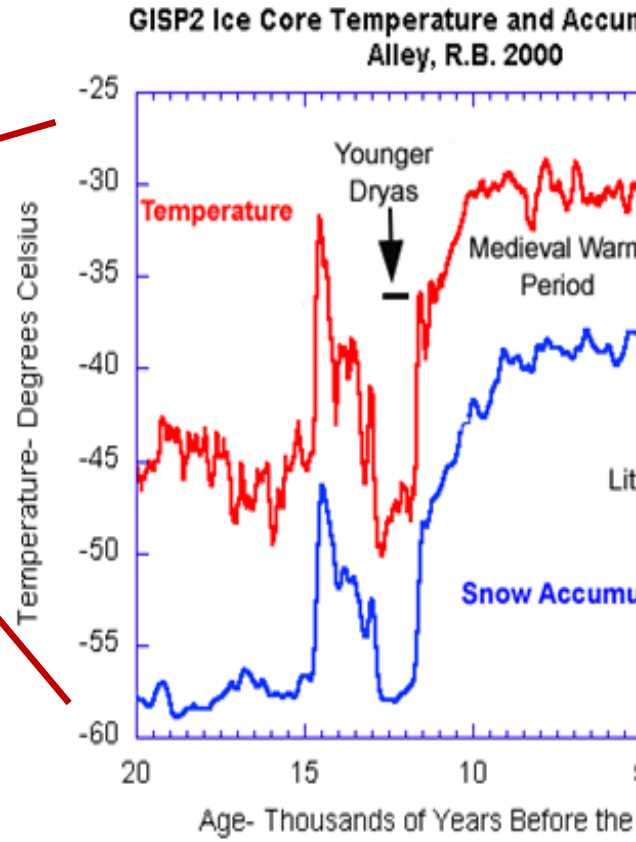
Several parts of Greece are on high alert as ex winds threaten to spark more devastating wild

Extreme fire risk warnings have been issued for Greece, including around Athens.

The capital has seen searing temperatures over hover close to 40C (104F).

past climate & environmental changes ....





some very rapid mid-late Pleistocene changes, smaller scale Holocene changes ... driven by orbita
& variations in solar output, plus other contributory factors e.g. icebergs, vegetation feedbac

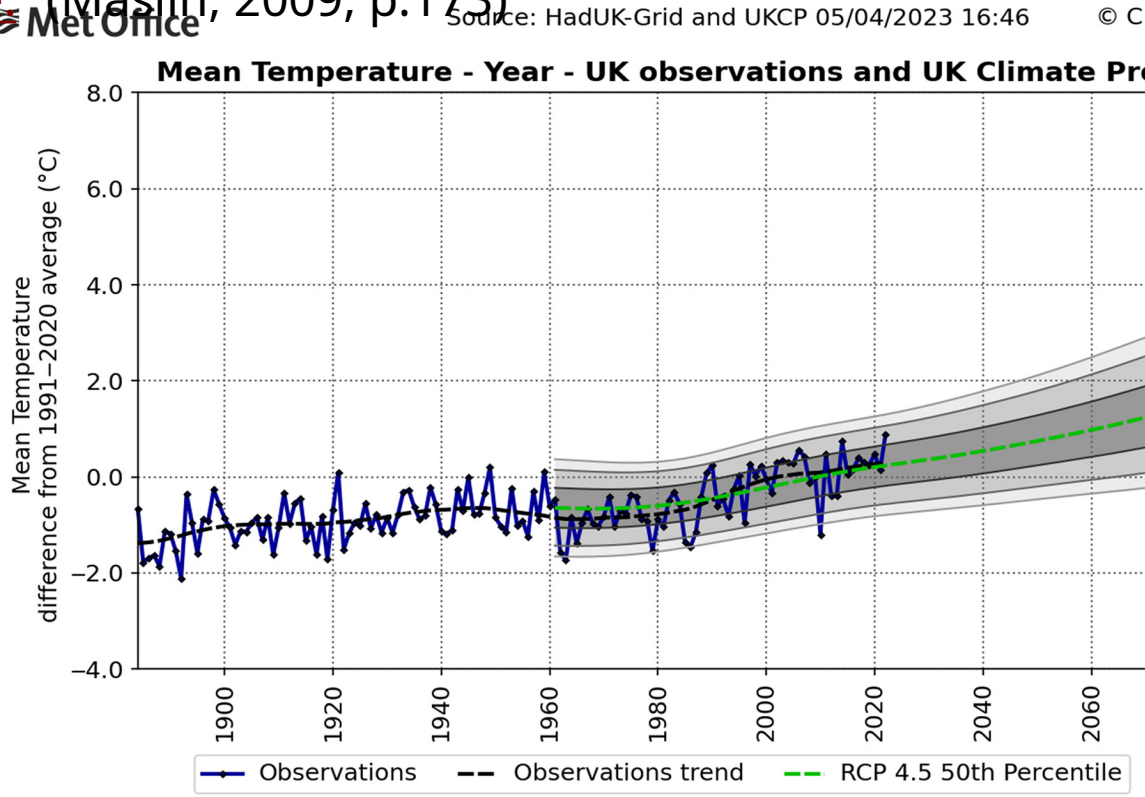
Holocene increase in human population & societal complexity
... climate changes increasingly disruptive for human activities ... but also increasing potential for
disrupt climate ...

... what is different about climate & environmental changes toda
speed of change, loss of habitat, loss of connectivity ...

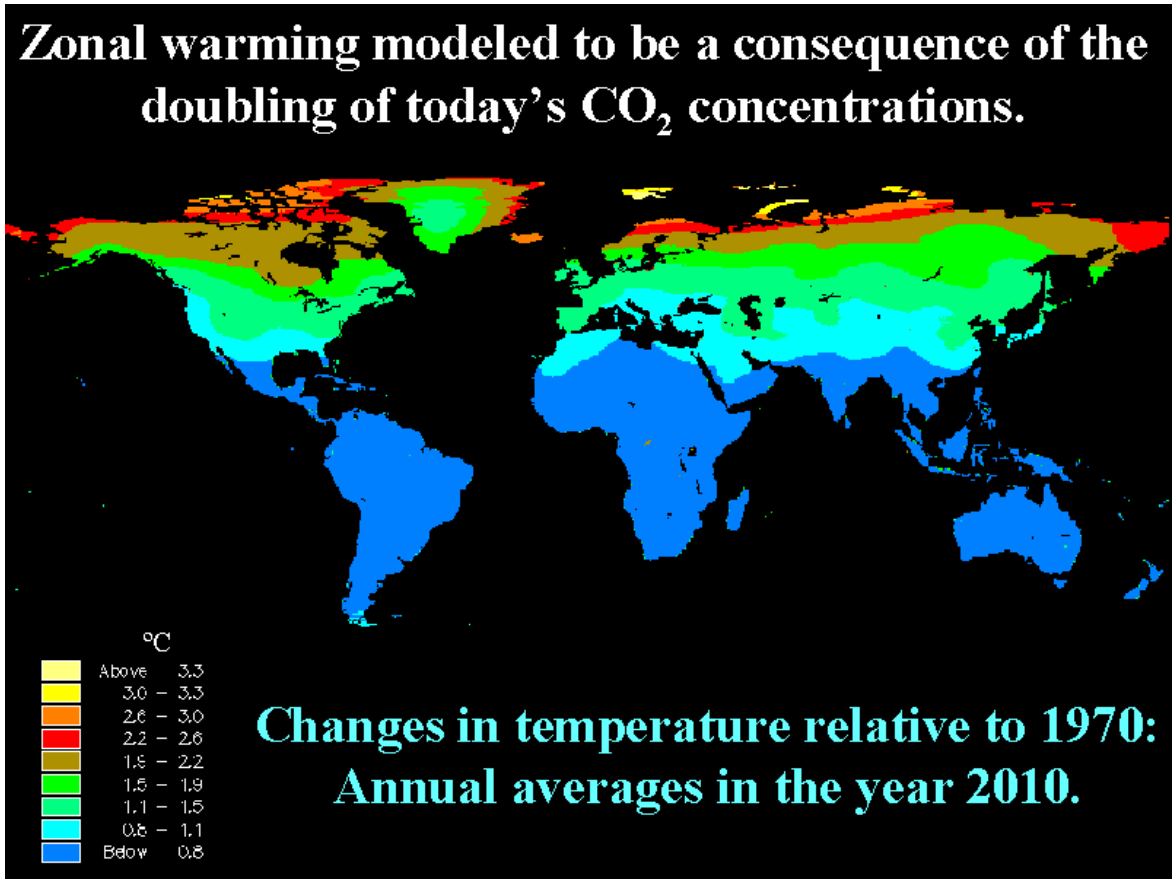
4. Future projections (& how can we know what's coming

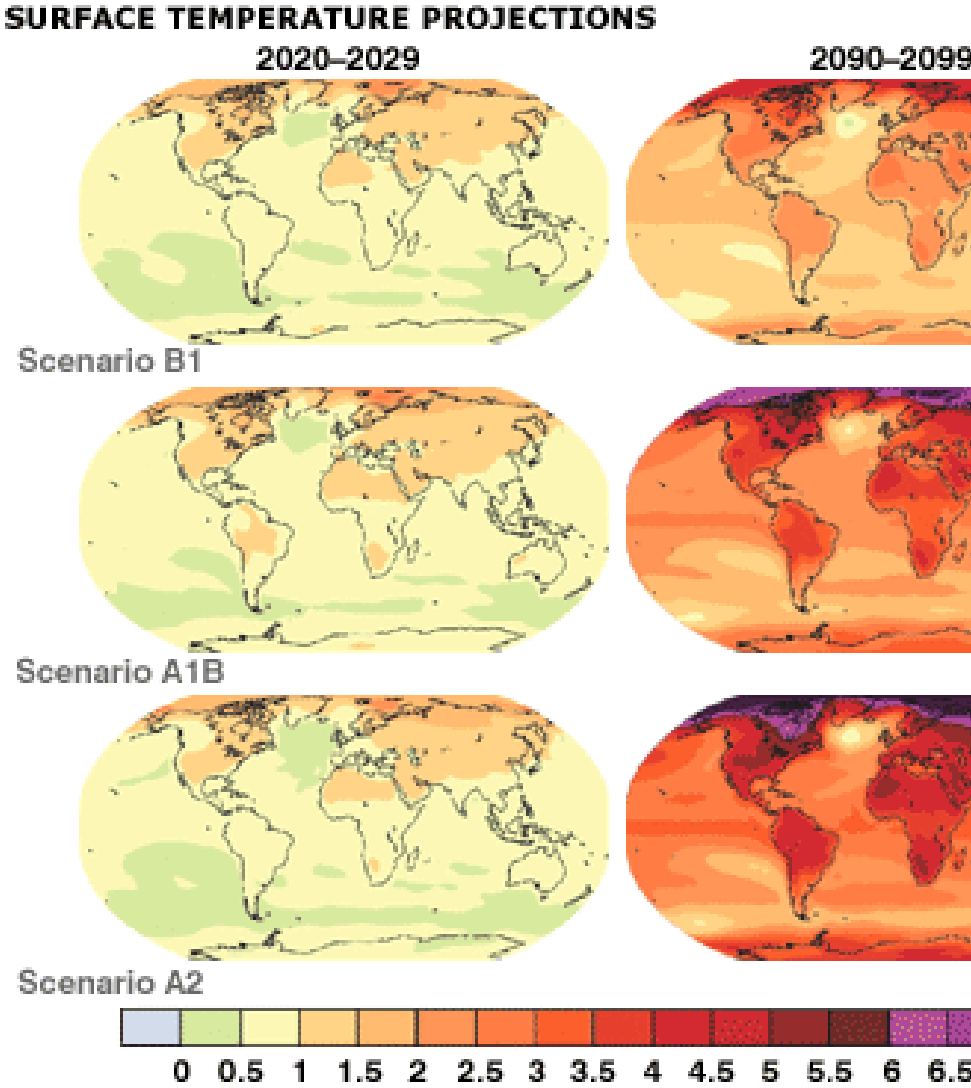
"there is very little doubt that global warming will change our climate in the next century: our bes suggest an average temperature increase of 1.1-6.4 °C (probably about 4 °C), a sea-level rise in th at least half a metre (as long as Greenland & Antarctica don't start to break down), significant cl weather patterns, & more extreme climatic events. This is not the end of the world as envisaged environmentalists in the late 1980s & early 1990s, but it does mean a great deal of misery for b people." (Maslin, 2009, p.173)

Scientists can't even get the weather forecast correct .... so how can they predict the future climate?



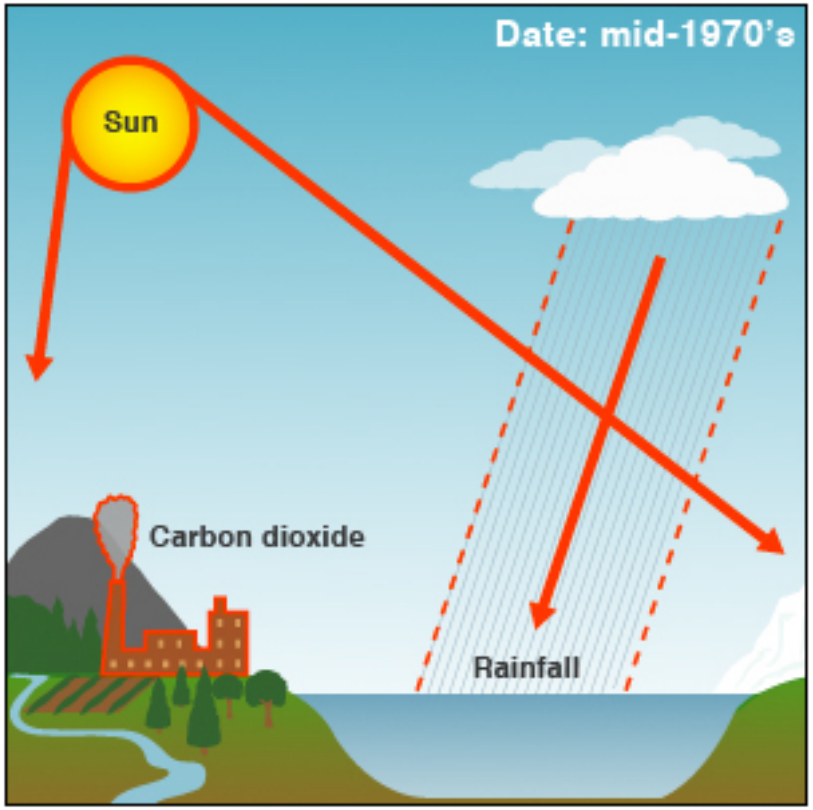
consistent projections from relatively simple early models to more sophisticated later mod
e.g. warming is not evenly distributed regionally … poles warm fastest





BBC NEWS

In pictures: Climate models



Mid 1970s

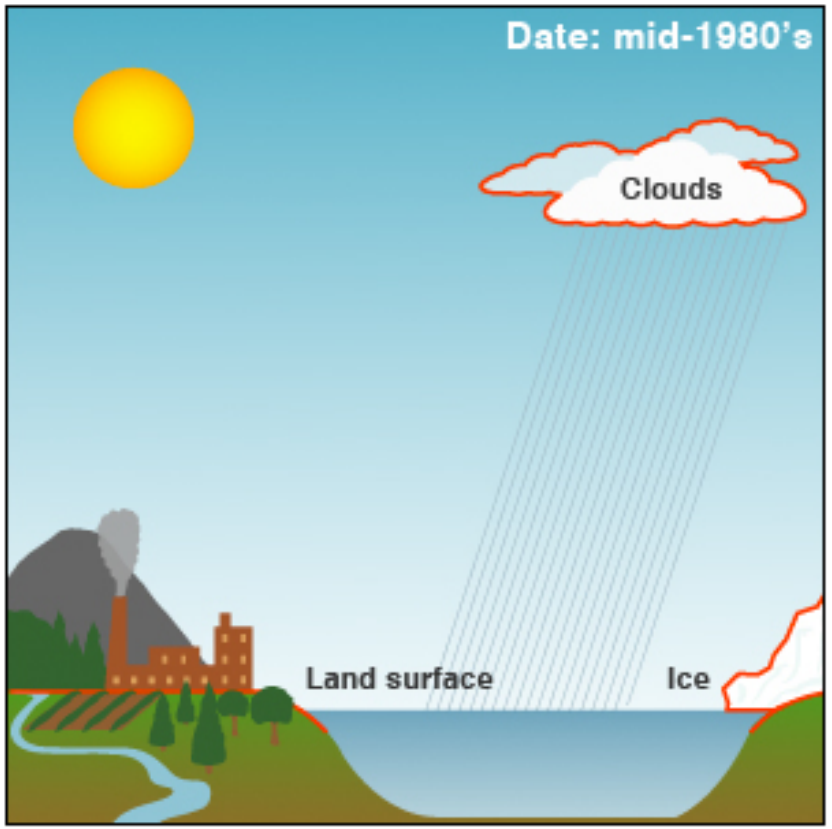
Early climate models were limited. They only included carbon dioxide, heat from the sun (radiation) and rain, but not clouds.

computational climate models solv
mathematical equations that are b
well-established physical laws de
the behaviour of the weather &

two main improvements:
1) understanding of the climate system
2) computing power

BBC NEWS

In pictures: Climate models

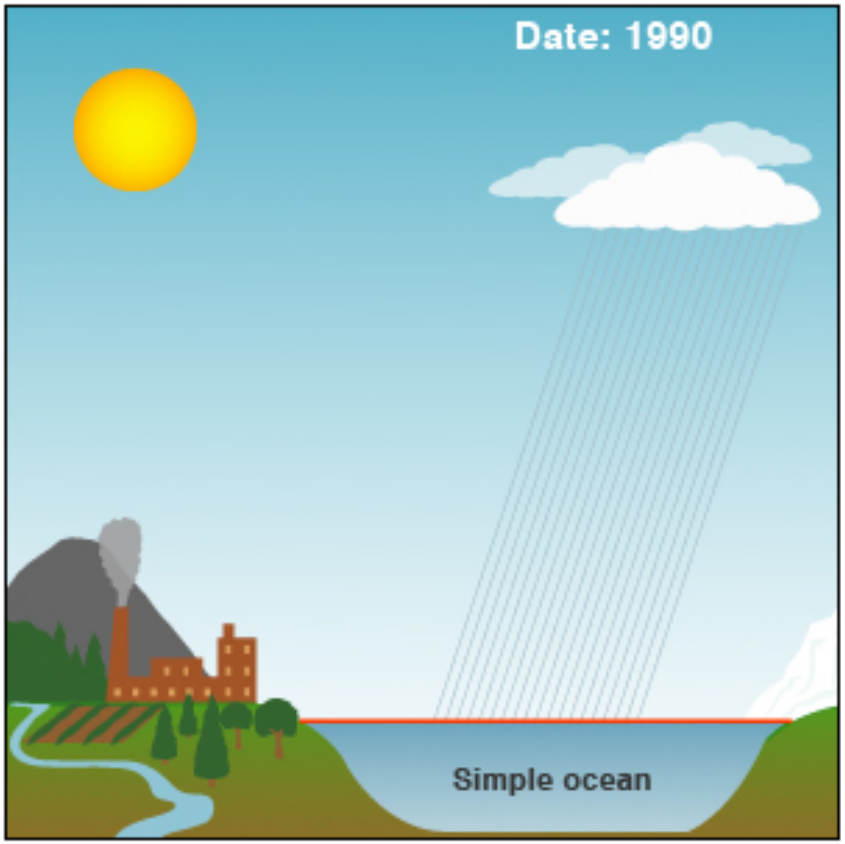


Mid 1980s

Clouds, land surf
were added into
the 1980s. Differ
land behave diffe
deserts and ice a
likely to reflect r
forests are more
absorb it.

BBC NEWS

In pictures: Climate models

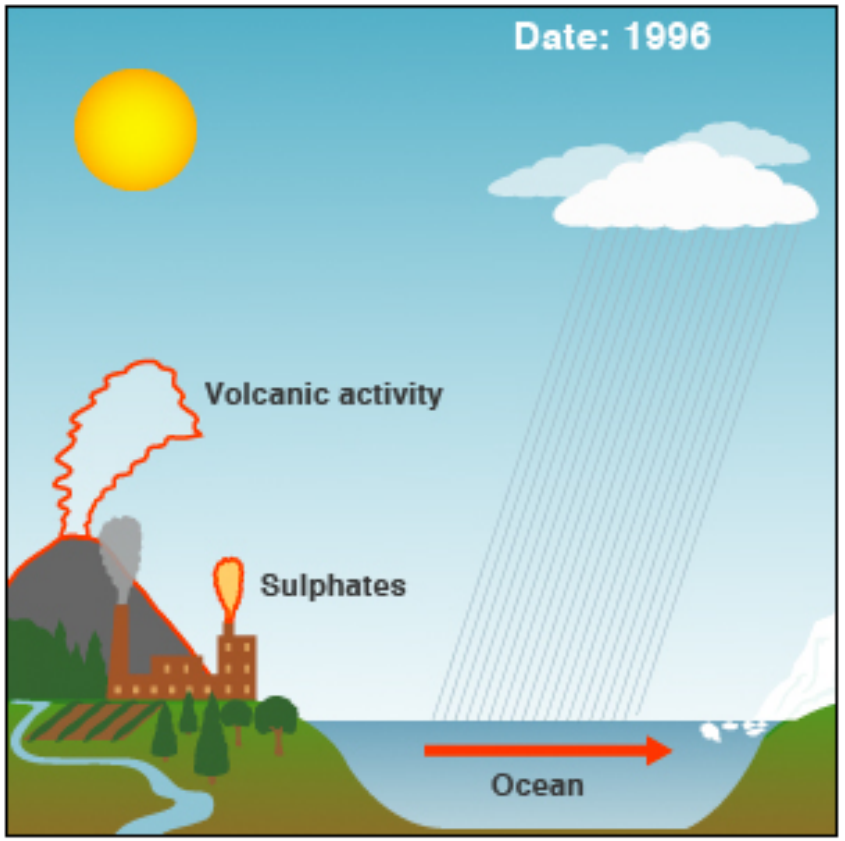


1990 - IPCC's first report

A simple model of the oceans now joins the picture, as the first IPCC report comes out. To begin with, only the top layer of the sea was modelled.

BBC NEWS

In pictures: Climate models

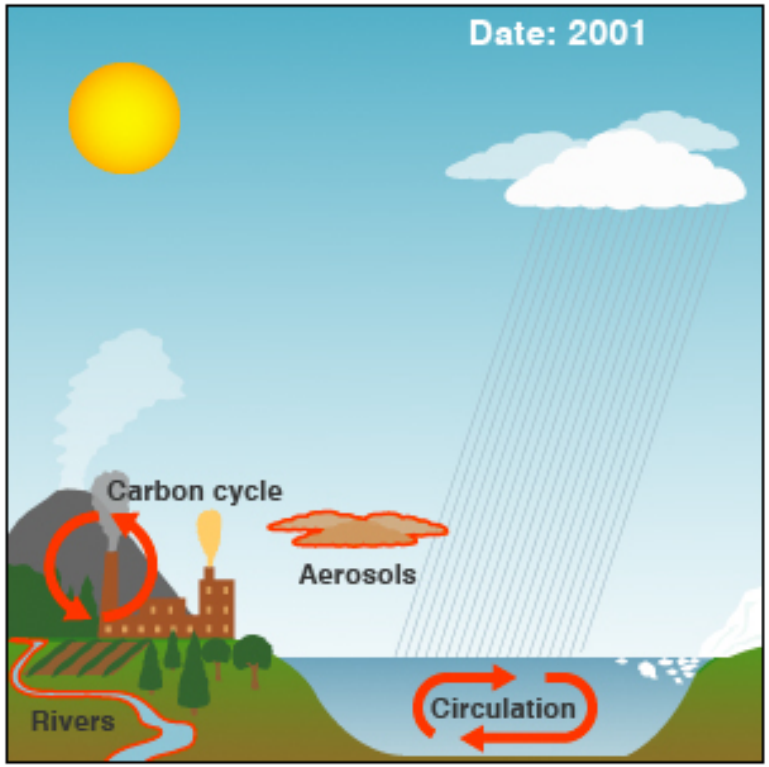


1996 Secon Assessmen

More sophistica the ocean are Volcanoes are Their eruptions particles into th atmosphere, w sunlight and te reduce global t

BBC NEWS

In pictures: Climate models

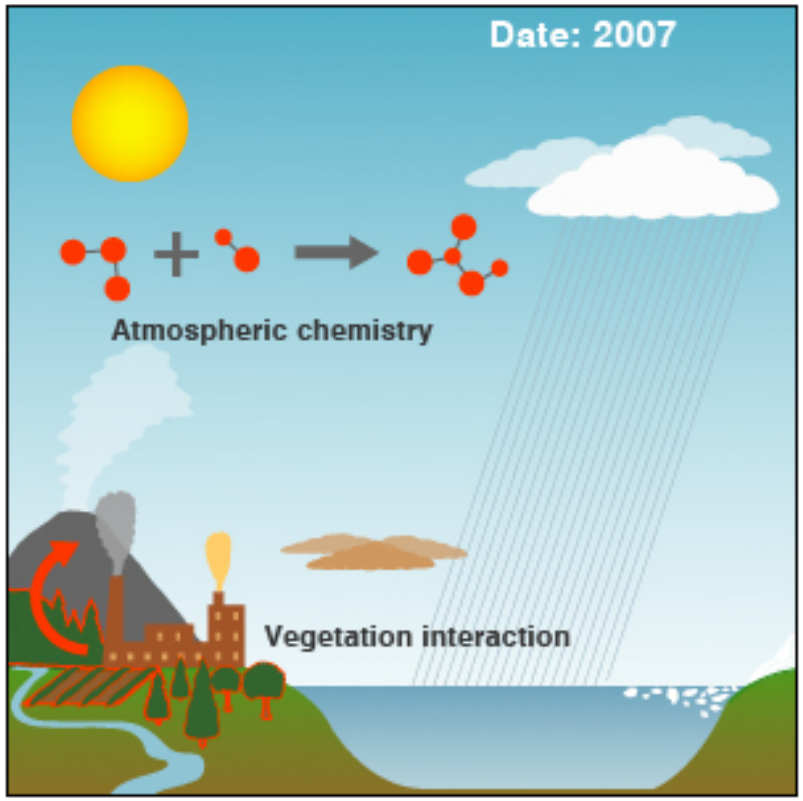


2001 Third Assessment Report

By bringing the carbon cycle into the picture, the different ways C02 is stored and released into the atmosphere gives greater realism to climate models. Understanding of the oceans is deepened.

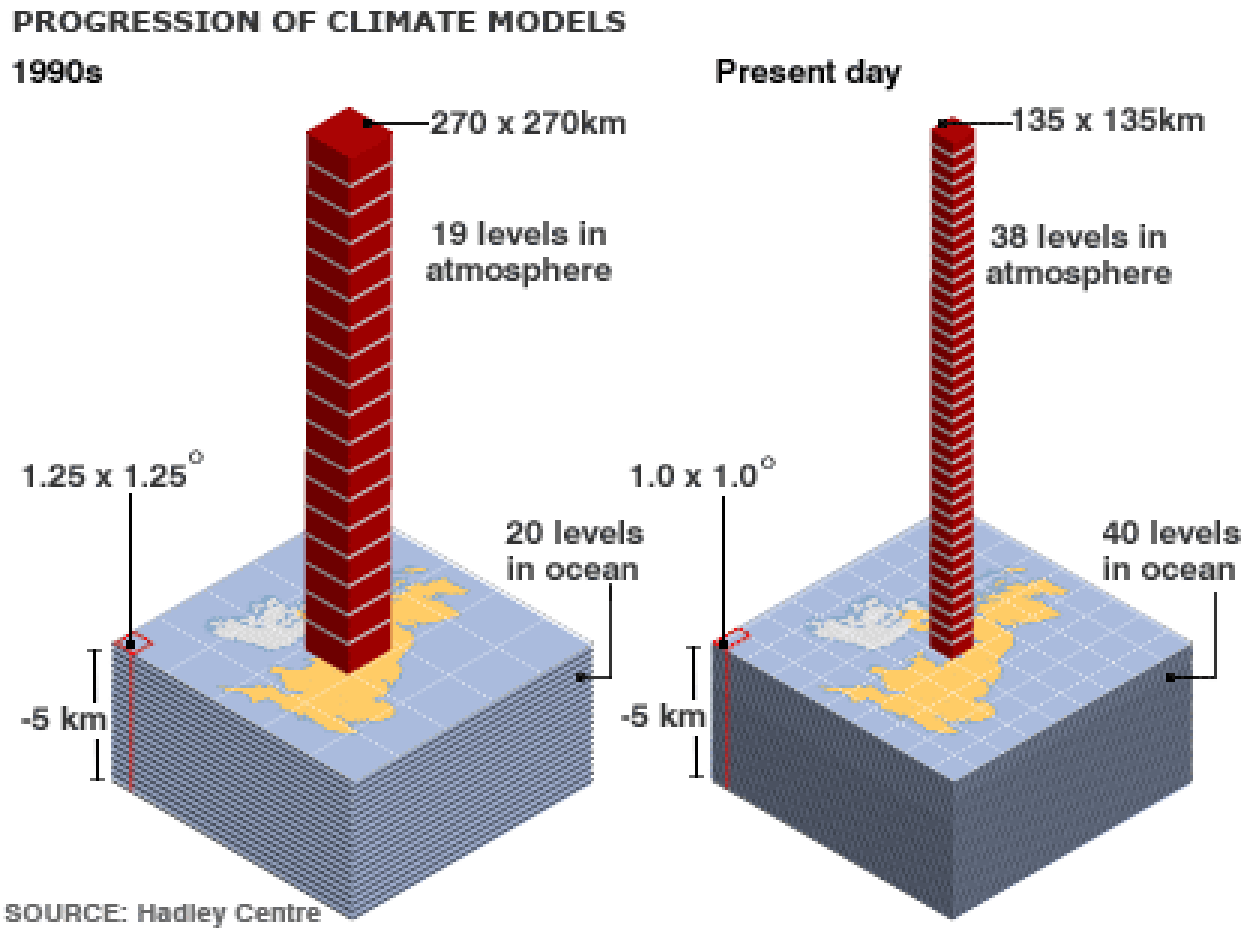
BBC NEWS

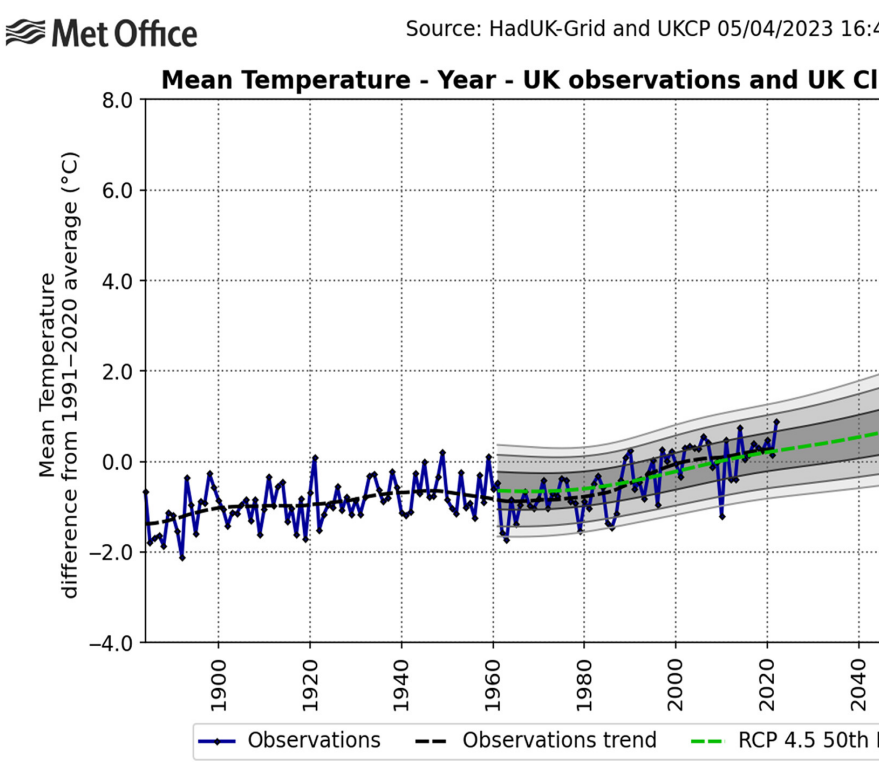
In pictures: Climate models



2007 Fourth Assessment

Chemical react
atmosphere joi
models; they a
produced using
power 256 time
powerful than t
in the 1970s.





the latest Met Office Hadley Centre model, HadGEM1 (which is typical of current state-of-the-art models), uses 135 km by 135 km boxes with 38 levels in the vertical, & includes many of the complexities of the climate system

nonetheless, modeling uncerta
remain ....

1) scientific uncertainties

role of clouds: warming or cooling effect?



cumulus clouds



cirrus clouds

Low level clouds: reflect sunlight & trap little infra-red radiation. Dominant effect is to cool surface climate

High level clouds: let sunlight through & trap infra-red radiation. Dominant effect is to warm surface climate

role of d
etc. on
warming
is also u

) sociopolitical & economic uncertainties, especially future CO_2 emissions

Economic emphasis →

A1 storyline	**A2 storyline**
World: market-oriented Economy: fastest per capita growth Population: 2050 peak, then decline Governance: strong regional interactions; income convergence Technology: three scenario groups: • **A1FI**: fossil intensive • **A1T**: non-fossil energy sources • **A1B**: balanced across all sources	World: differentiated Economy: regionally oriented; lowest per capita growth Population: continuously increasing Governance: self-reliance with preservation of local identities Technology: slowest and most fragmented development
B1 storyline	**B2 storyline**
World: convergent Economy: service and information based; lower growth than A1 Population: same as A1 Governance: global solutions to economic, social and environmental sustainability Technology: clean and resource-efficient	World: local solutions Economy: intermediate growth Population: continuously increasing at lower rate than A2 Governance: local and regional solutions to environmental protection and social equity Technology: more rapid than A2; less rapid, more diverse than A1/B1

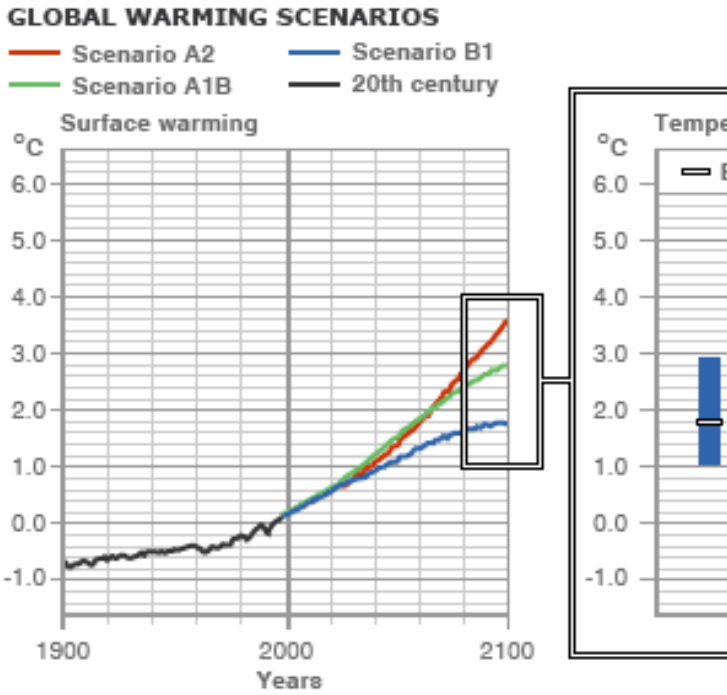
Global integration ↑ Regional emphasis ↓

← Environmental emphasis

IPCC
Special Report on
Emissions Scenarios
(SRES) Storylines

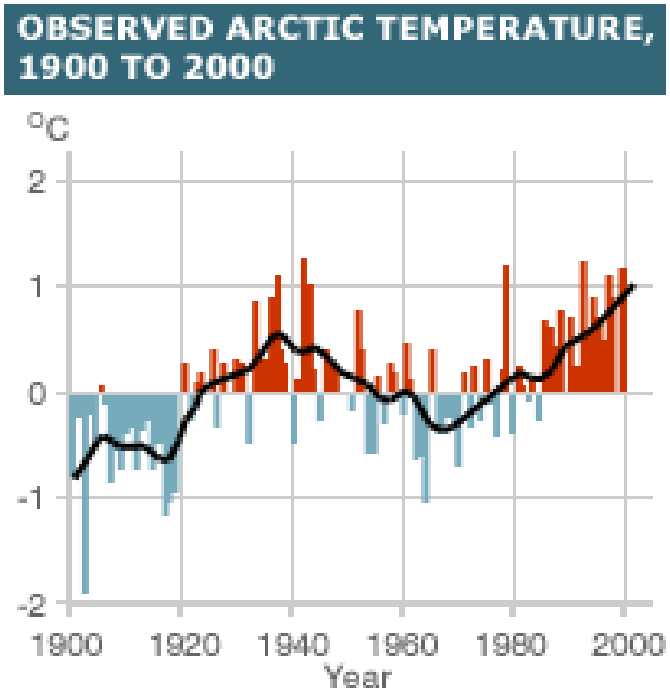
4 main emissions
scenarios
A1, A2, B1, B2

models provide a range
of temperature change
estimates



climate models are tried & tested in various ways, including:

1) hindcasting (reproduce the average climate of the recent past)



2) test short range forecasts against improved observational data collection from satellites & in-situ instruments

3) undertake multiple model runs (same model run many times with changes to parameters to test sensitivity of forecasts)

4) uncertainty representation (assign probabilities to likelihood of ever

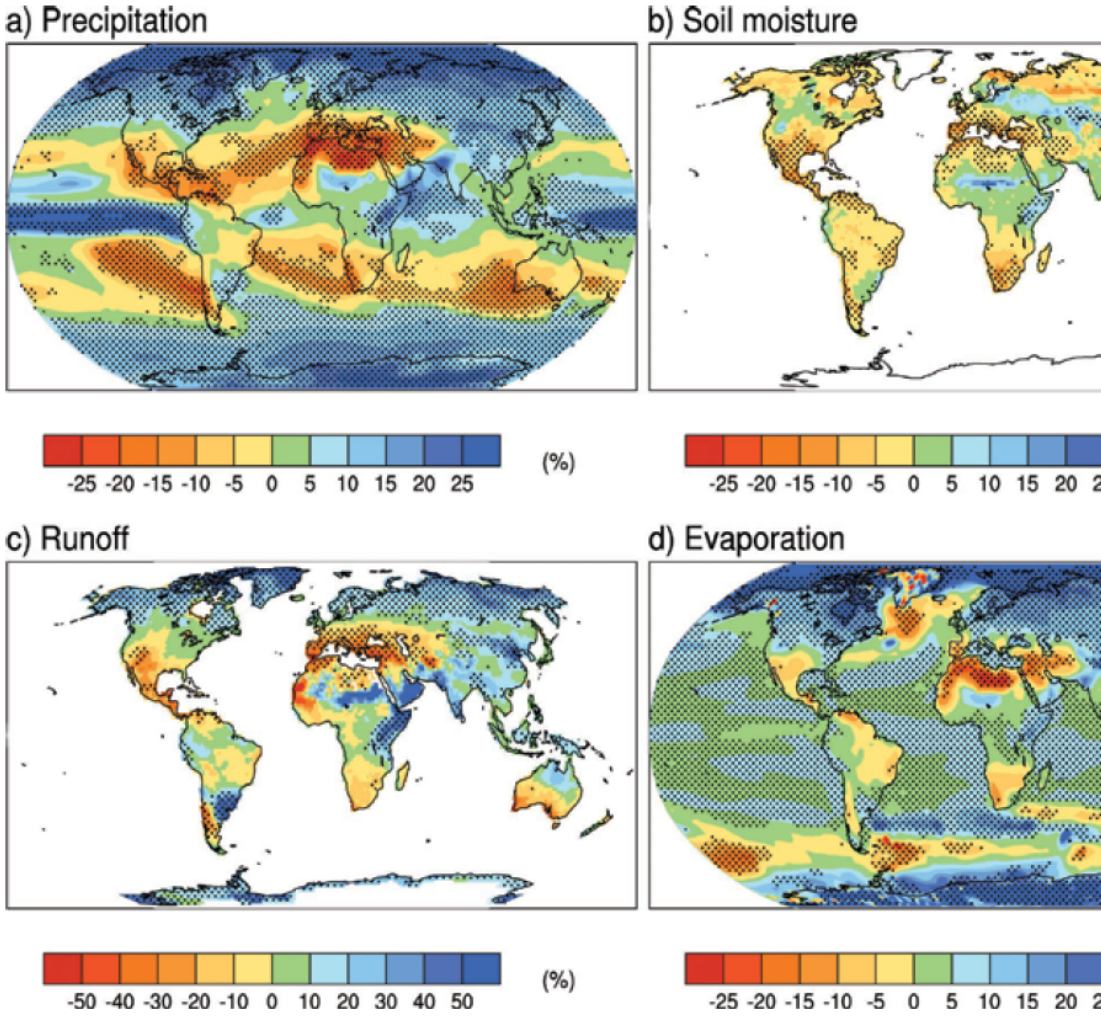
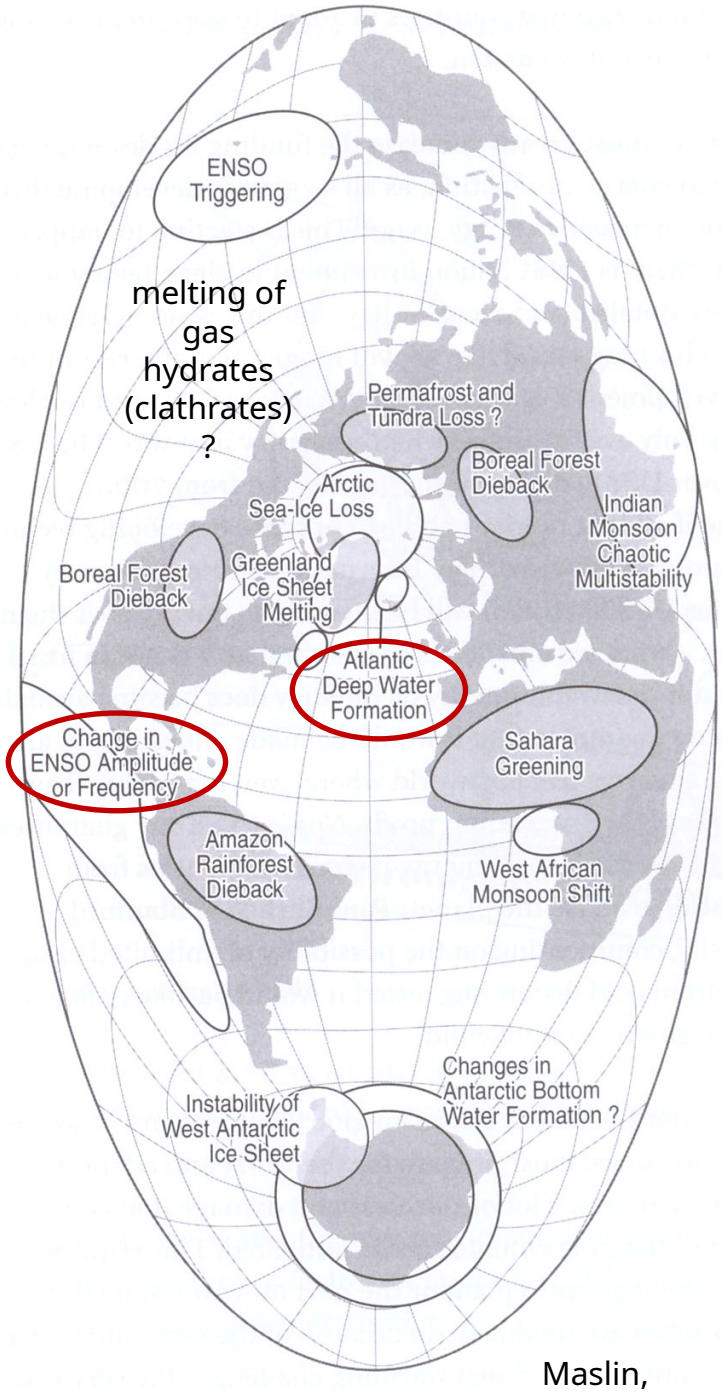


Figure 2.8: Fifteen-model mean changes in (a) precipitation (%), (b) soil moisture content (%), (c) ru evaporation (%). To indicate consistency of sign of change, regions are stippled where at least 80% of the sign of the mean change. Changes are annual means for the scenario SRES A1B for the period 2080 1980–1999. Soil moisture and runoff changes are shown at land points with valid data from at least ten m WGI Figure 10.12]



Potential climate change tipping points

Maslin, 2009

concern remains over tipping points (elements) …

typically unpleasant surprises in the Earth system that may e
a positive feedback on global warming

tipping points exist at:
high latitudes
mid latitudes
low latitudes

many are linked with extreme events (e.g. floods, drought
wildfire)

El Niño southern oscillation

‘Supersizing before our eyes’: UN warns of record El Niño approaching

Event is likely to be largest in at least 1,000 years and will pile extra heat into a world already in a climate crisis

Damian Carrington
Environment editor

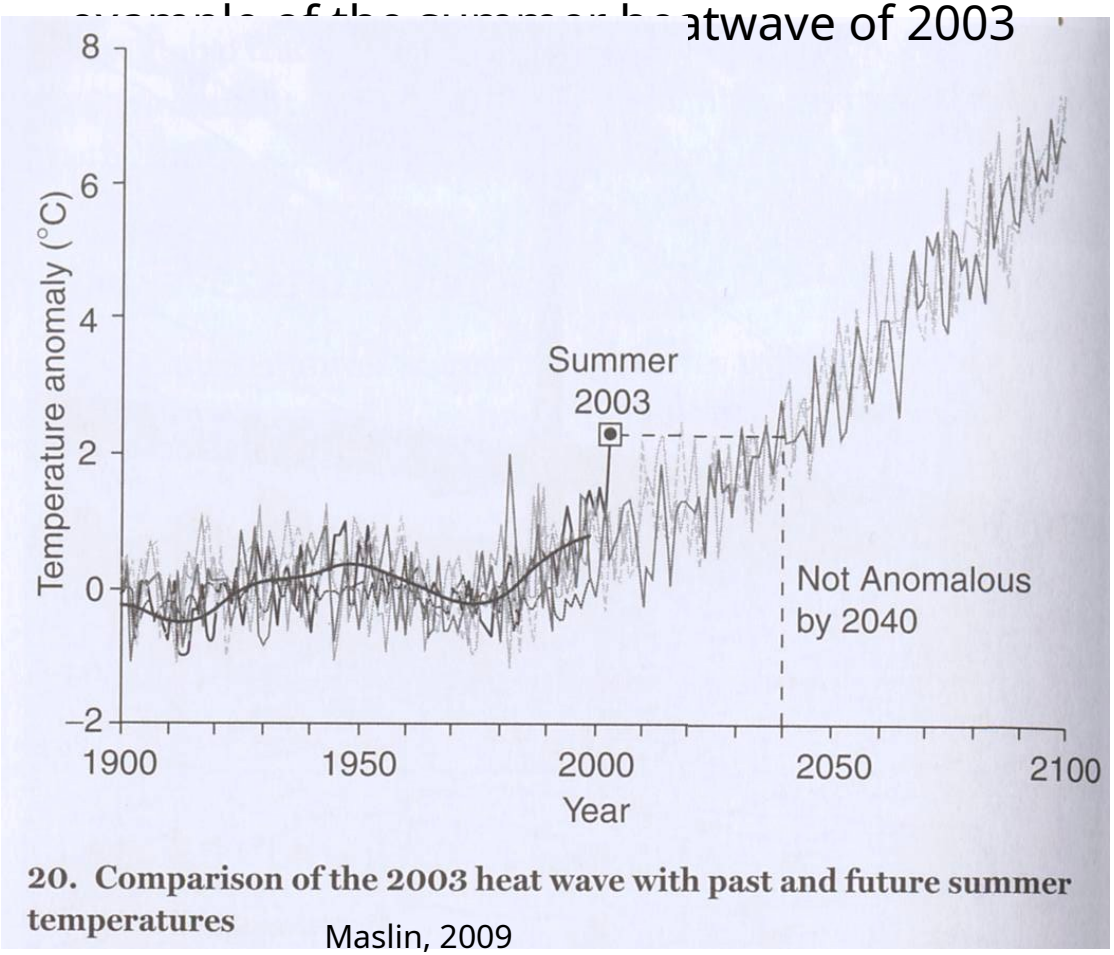
Thu 3 Sep 2026 07.00 BST

Prefer the Guardian on Google



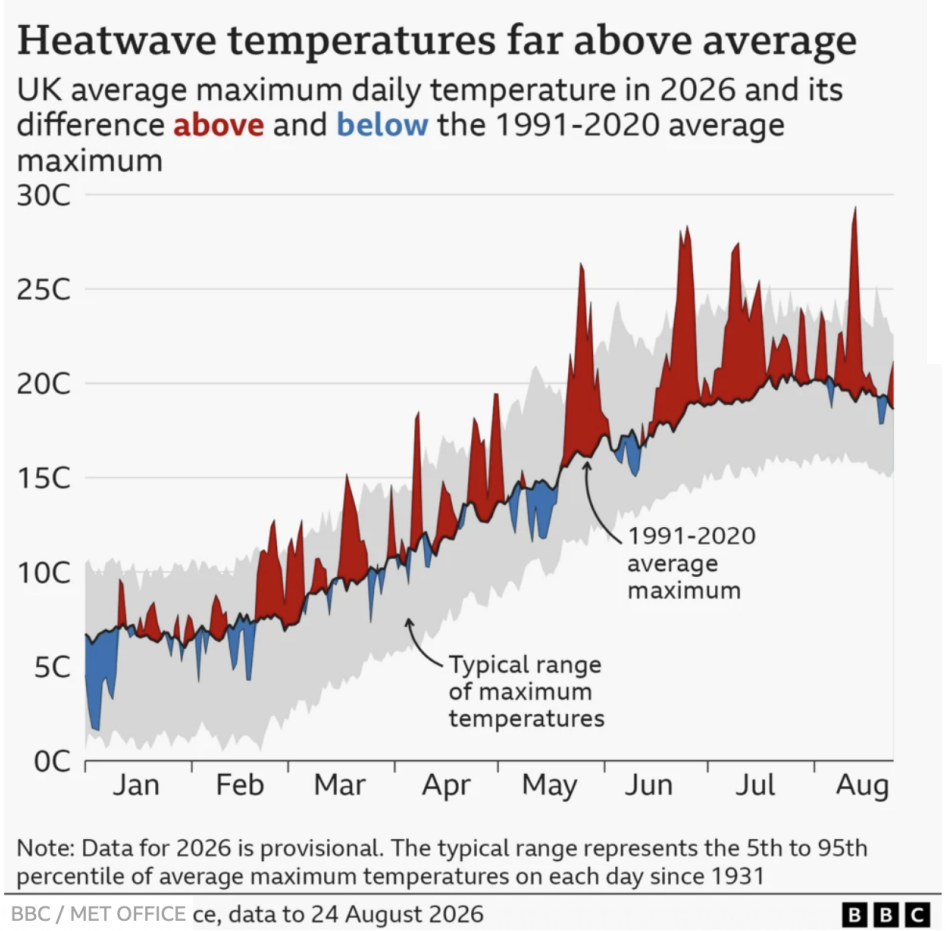
... but how do you identify changes in extremes in naturally-variable climates?

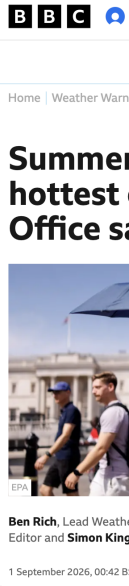
example of the summer heatwave of 2003



20. Comparison of the 2003 heat wave with past and future summer temperatures

Maslin, 2009

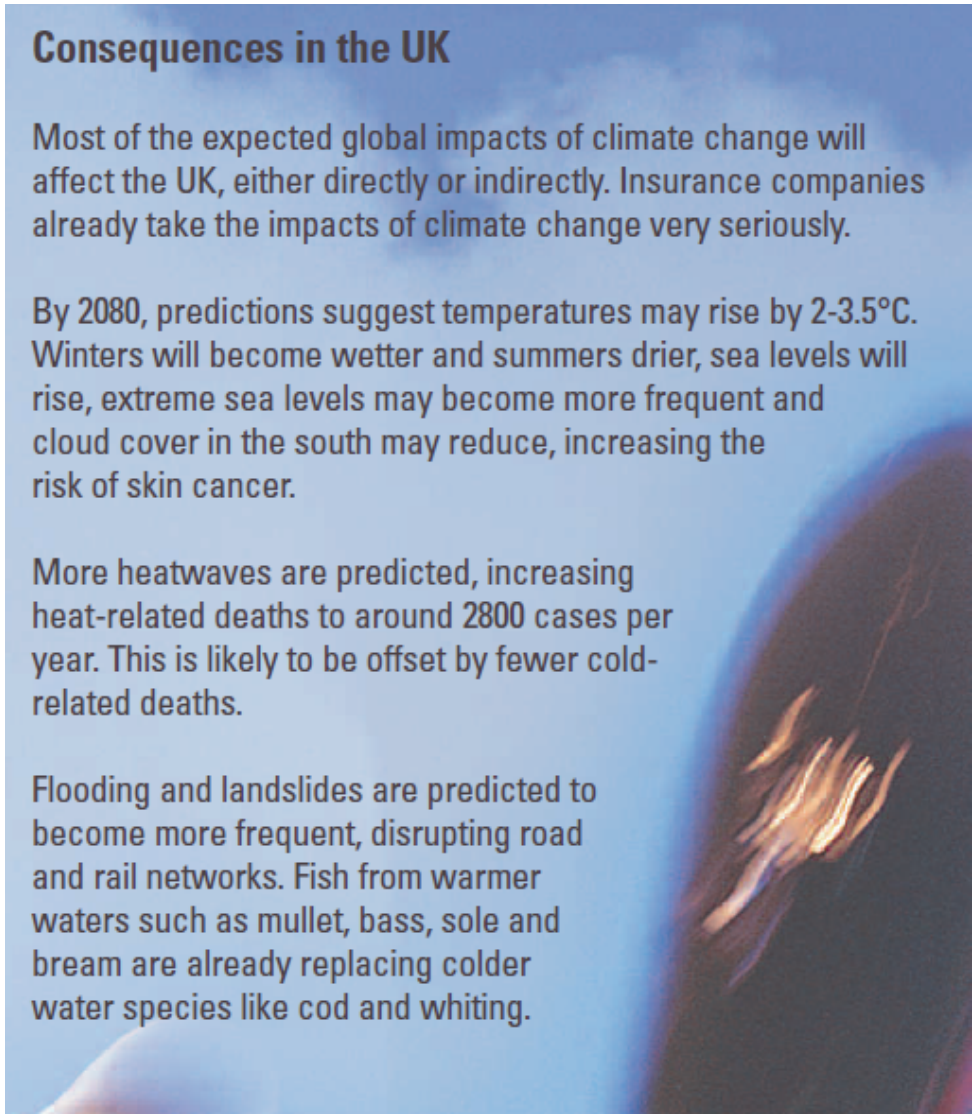




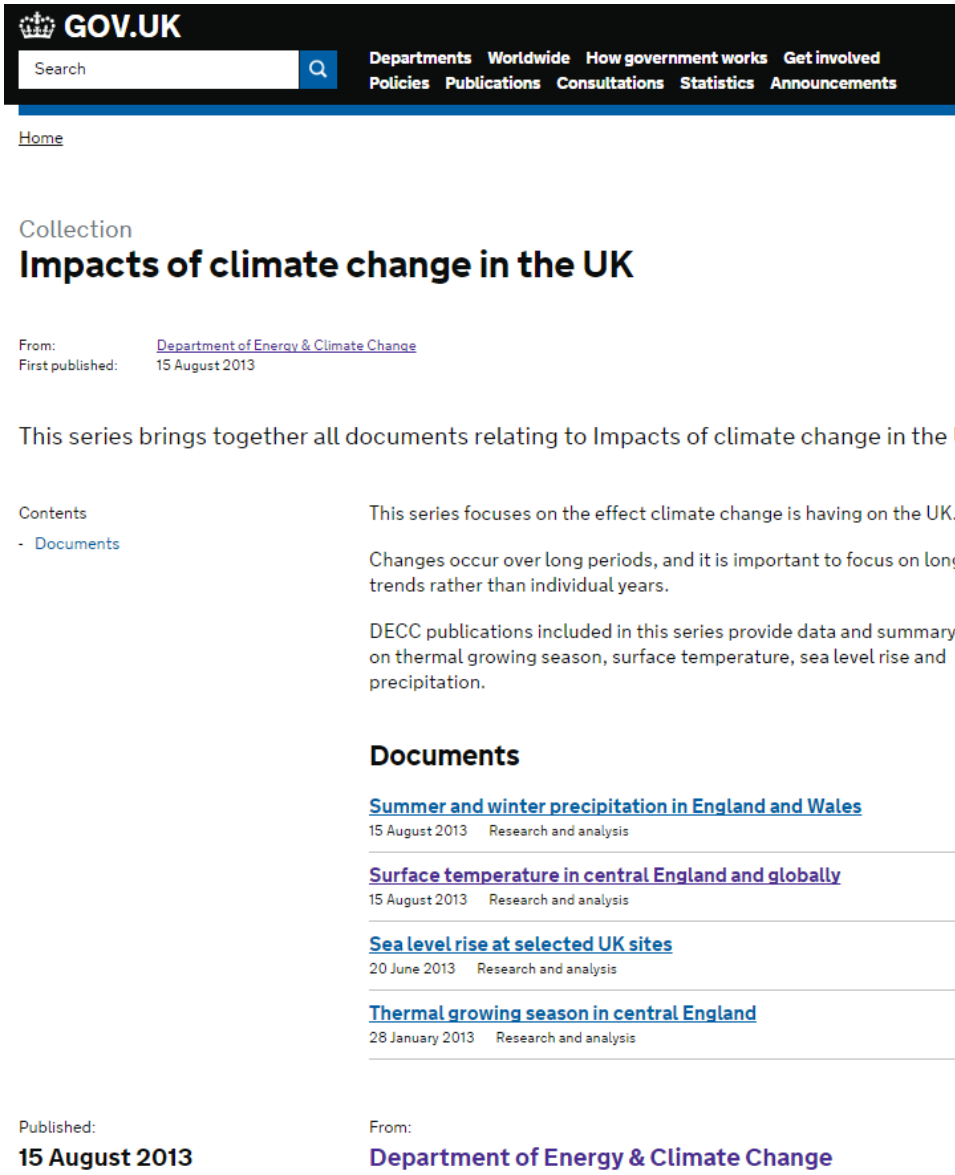
note also: the mean may change but the change in the variability about the mean (i.e. the extremes)

is this what we see in this graph?
the hot extremes becoming more frequent & more variable, the cold extremes becoming less frequent

5. The situation in Wales



Natural Environment Research Council (NERC) leaflet, 2005



https://www.gov.uk/government/collections/impacts-of-climat
he-uk



Annex 1: Climate change evidence

Lead Author: Lucia Watts

External reviewers: Kim Dowsett and Ruth Gregg (Climate change commission)

Current situation, past trends and future outlook for pressures related to climate change

The evidence below sets out

- The past trends and future outlook for pressures related to Climate Change in relation to the broad ecosystems (coastal margins, enclosed farmland, freshwater, marine, mountain, moorland and heath, semi-natural grassland, urban, woodlands) and natural resources (air, soil, water). See method: **Defining the long and short term**
- Any new evidence, strategies, policies and interventions since 2020 that are likely to impact future trends.

It is intended as an update to the relevant trends set out in the 2020 Climate change chapter (NRW, 2021a).

Pressure: Changes in intensity and frequency of weather events

Climate change is projected to increase the frequency and intensity of rainfall, droughts, inland and coastal floods, and heatwaves, which are predicted to further reduce ecosystem resilience, and have a direct impact the ecosystems themselves. Other climate-related weather events could include wildfires, winter and summer storms and high wind events. All these weather events are likely to have negative impacts to both natural ecosystems and human society. This can include loss of habitats, damage to infrastructure and increasing risks to life.

the take-home message? more of the same (or w

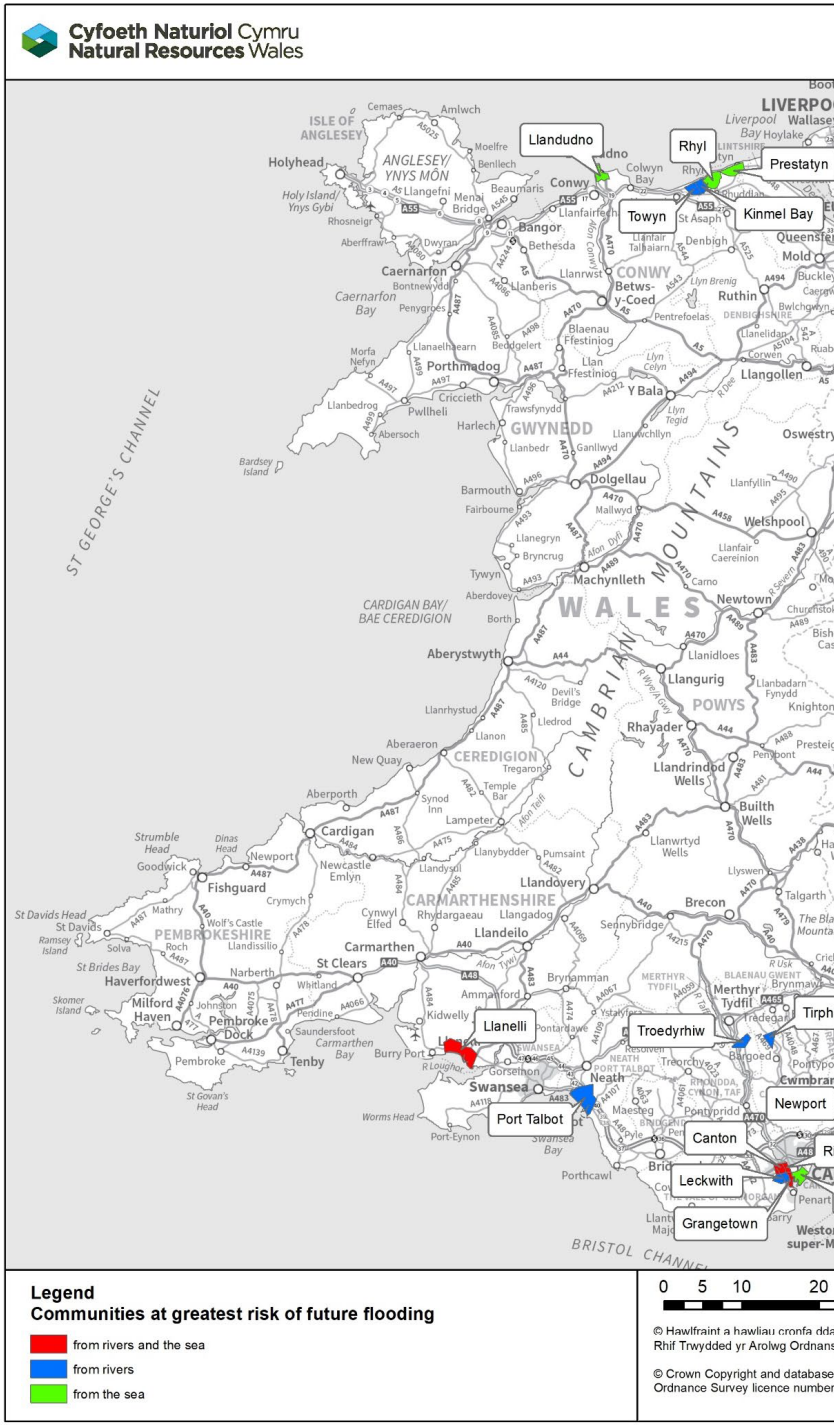
warmer, wetter winters …
hotter, drier summers …
more extremes (storms, heavy rainfall, flooding, he
wildfires) …
sea level rise …
coastal & inland habitat loss …
greater risk of invasive species …

- 71,042 properties at risk of flooding from the sea
- 90,170 properties at risk of flooding from rivers
- Estimated 191,000 people at risk of flooding from the sea
- Estimated 242,000 people at risk of flooding from rivers

Flooding from rivers	People at risk of flooding	Residential properties at risk of flooding	Non-Residential properties at risk of flooding	Key Services* at risk of flooding
2020	242,477	77,818	12,271	1,788
2120	302,908	96,385	15,191	2,225
Difference	+60,431	+18,567	+2,920	+437

Flooding from the sea	People at risk of flooding	Residential properties at risk of flooding	Non-Residential properties at risk of flooding	Key Services* at risk of flooding
2020	191,055	62,087	8,735	1,348
2120	286,232	90,277	13,717	2,251
Difference	+95,177	+28,190	+4,982	+903

regular updates in NRW reports



6. Group activity



**what are some
threats to bees f
changing clima
Aberystwyt
&/or west Wa**

Will bees survive climate change? Scientists have doubts

POSTED ON 2 AUGUST 2025 • BY ALEKSANDRA BORAWSKA-MELNYK



nature communications

Article https://doi.org/10.1038/s41467-025-68085-6

Honey bee food resources under threat from climate change

Received: 4 February 2025
Accepted: 16 December 2025
Published online: 30 December 2025
Check for updates

Andreia Quaresma[1,2,3,4], Johannes M. Baveco[5], Robert Brodschneider[6], Willem Bastiaan Buddendorf[5], Norman L. Carreck[7], Kristina Gratzer[6], Fani Hatjina[8], Ole Kilpinen[9], Ivo Roessink[6], Flemming Vejsnaes[9], Jozef van der Steen[10], M. Alice Pinto[1,12] & Alexander Keller[11,12]

Plant-pollinator interactions are essential for plant productivity but face growing threats from climate change, including vegetation loss and mismatches in flowering. Yet, the consequences for bee food resources remain poorly understood at continental scales. Here, we analyse 2 500 samples collected by honey bees (*Apis mellifera*) between May and August 2023 from 310 locations across Europe using ITS2 metabarcoding. We derive climatic response curves of floral resources and assess exceedance risks of interaction loss under projected climate scenarios. Our findings reveal that rising temperatures and reduced precipitation decrease the diversity of foraging resources across Europe, pushing many plants beyond critical limits. When both warming and drying coincide, the potential for resilience through temporal or spatial buffering is strongly constrained. These declines pose serious risks to bee nutrition, ecosystem functioning, and food security. Our study underscores the urgency of mitigating climate change to preserve vital plant-pollinator systems and the services they sustain.

Ecological Informatics 97 (2026) 103902

Contents lists available at ScienceDirect

Ecological Informatics

journal homepage: www.elsevier.com/locate/ecolinf

Differing effects of climate change on wild bee nesting groups across Europe

António Santos *, Robin Payne, Manuela Branco, José Carlos Franco

Forest Research Centre, Associate Laboratory TERRA, School of Agriculture, University of Lisbon, Portugal

ARTICLE INFO

Keywords:
Wild bees
Climate change
SDMs
Europe
SSPs

ABSTRACT

Wild bees are declining globally, as well as in Europe, and environmental drivers responsible for it are mainly related to climate change. The complex network of environmental effects on groups of bees, mediated by species traits is still not entirely known, especially regarding nesting traits. Therefore, this study assessed the responses of an assemblage of wild bees, according to nesting strategy, to climate change predictors and their distributions, through time. Seventy species were selected, divided into below-ground nesting bees (35) and above-ground nesting bees (35). A stacked species ensemble modelling approach was used, composed of maximum entropy, generalized linear models and random forest algorithms. Furthermore, two Shared Socioeconomic Pathways (SSPs) scenarios were used: SSP 2–4.5 and SSP 3–7.0. Climate predictors consisted of temperature and precipitation variables, selected through multicollinearity analysis by Variance Inflation Factor (VIF). The results showed that temperature variables were more important than precipitation, shown by higher mean variable importance values. Response curves showed that irrespective of nesting group, wild bees responded negatively to increased temperature and precipitation. Multivariate Environmental Similarity Surface (MESS) and uncertainty analysis showed reduced extrapolation, being mostly limited to Southern and Eastern Europe, although it differed by nesting group. Habitat suitability declined more steeply with time and SSP scenarios. Below-ground nesters had higher suitability losses, especially in Southern Europe, worsening at SSP3–7.0. Above-ground nesters gained more suitable habitat, in Eastern and Northern Europe. These findings demonstrate the differences in response of wild bee species to climate change, mediated by species traits and help further assessment of trends in decline of wild bees in Europe.

Science of the Total Environment 1004 (2025) 180761

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Impact of climate change and drought threat on the honey bees food collection

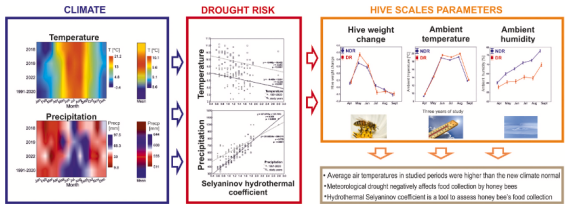
Renata Kędzior [a,*], Agnieszka Ziernicka-Wojtaszek [a], Krystyna Czekońska [b], Sylwia Łopuch [b]

[a] *Department of Ecology, Climatology and Air Protection, University of Agriculture in Krakow, Mickiewicza 21, 31-120, Krakow, Poland*
[b] *Department of Zoology and Animal Welfare, Faculty of Animal Science, University of Agriculture in Krakow, Al. 29 Listopada 56, 31-425, Krakow, Poland*

HIGHLIGHTS

- Average air temperatures in studied periods were higher than the new climate normal.
- Meteorological drought negatively affects food collection by honey bees.
- Hydrothermal Selyaninov coefficient is a tool to assess honey bee's food collection.

GRAPHICAL ABSTRACT



Received: 27 March 2024 | Accepted: 13 July 2024
DOI: 10.1111/1365-2656.14160

REVIEW

How does climate change impact social

Madeleine M. Ostwald[1] | Carmen R. B. da Silva[2] |

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[2]School of Natural Sciences, Macquarie University, Sydney, New South Wales, Australia

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Funding information
Division of Biological Infrastructure, Grant/Award Number: 2102006; Macquarie University

Handling Editor: Rob Salguero-Gómez

Abstract

1. Climatic factors are known to shape variation in social behaviour can di actions between climate and socia resilience to climate change across
2. These interactions are particularly diversity of social states. An emer responses to environmental chang traits, including sociality. Additior drivers of social evolution may prov benefits of social strategies under
3. In this review, we explore these fin how does sociality mediate vulnera mate change impact social organisa with bee sociality that may confer tivity periods, diet breadth, behavi dictions about the impacts of clima of social phenotypes in bees.
4. The social evolutionary consequen erogeneous, depending on such fa traits. Many contexts will see an in warming temperatures accelerate d for rearing a worker brood. More and biotic selective environments in different contexts, with cascadi ecosystem levels.

KEYWORDS
bees, cooperative breeding, functional trai

Available online at www.sciencedirect.com

ScienceDirect

Current Opinion in Insect Science

Review

Bee vulnerability to climate change in a shifting nutritional landscape: why sociality and life-history strategy matter

Brooke Zanco[1,2,3], Ebba Widman[4], Tahlia L. Fulton[5,6], Sarah E Diamond[7], Carmen RB da Silva[2,3] and Fleur Ponton[2,3]

Climate-driven changes in floral resource quantity, timing, and nutritional quality can modulate access to essential nutrients for bees, with consequences for development, reproduction, physiology, and sensitivity to other stressors. Although most nutritionally focused research has centred on managed social bees, most bee species are solitary or non-eusocial and therefore experience nutritional landscapes in fundamentally different ways. Here, we examine how sociality and life-history strategy shape sensitivity to nutritional stress under climate change, and how climate-driven nutritional change could alter the costs and benefits of social behaviours. We argue that social organisation, nesting strategy, diet breadth, foraging range, body size, and colony demography shape exposure to nutritional stress, the capacity to respond to nutritional stress, and its interactions with other stressors. Integrating nutritional ecology with life-history theory will therefore be essential for improving predictions of bee vulnerability and designing conservation strategies that support a broad range of bee taxa.

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Corresponding author: Zanco, Brooke (brooke.zanco@mq.edu.au)

Current Opinion in Insect Science 2026, **77**:101556

This review comes from a themed issue on **Global change biology**

Edited by **Sarah Diamond, Ryan Martin, Mike Moore** and **Carmen da Silva**

For complete overview about the section, refer "Global change biology (2026)"

Available online 6 June 2026

https://doi.org/10.1016/j.cois.2026.101556

2214–5745/© 2026 The Author(s). Published by Elsevier Inc. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).

Introduction

Bees are essential to maintaining terrestrial biodiversity and global food security. Approximately 80% of flowering plant species depend on animal-mediated pollination, and bees are among the most important animal pollinators [1]. Yet bee populations are declining globally, with losses in abundance and diversity linked to interacting pressures including climate change, habitat loss, agricultural intensification, pesticide exposure, and emerging pathogens [2–4].

Nutrition is both directly affected by climate change and is an important mediator of climate-driven stress. Climate change can alter floral abundance, diversity, phenology, and the quantity and biochemical composition of pollen and nectar produced by individual flowers [5,6]. In doing so, it reshapes the nutritional landscape in which pollinators must cope with other environmental pressures. This coupling matters because nutritional state can determine how those pressures translate into physiological and fitness costs (e.g. [7–10]). For instance, nutritional state can shape immune investment and infection outcomes [10], alter the thermal sensitivity of life-history traits [7], constrain development when specific larval nutrients are scarce [9], and modify thermal tolerance [8]. These effects are especially consequential for bees because the larval stage functions as a developmental bottleneck in which adult phenotypes, including size, reproductive potential, and immune competence, are largely determined by nutrition, with limited scope for compensatory adjustments later in life [11,12].

Despite over 24 000 recognised bee species globally [13], nutritionally focused research has overwhelmingly focused on social bees, particularly honeybees (*Apis mellifera*) and bumblebees (*Bombus spp.*), which altogether constitute only a fraction of known species. However, bees span a continuum of social organisation, from solitary nesting to multifemale communal living, with or without reproductive division of labour [14]. Moreover, for some species, sociality is a facultative state, determined by environmental conditions [15]. This is significant given that bee life-history traits, including social organisation and nesting strategy, are

insects

Article

Global Trends in Climate Suitability of Bees: Ups and Dow a Warming World

Ehsan Rahimi [1] and Chuleui Jung [1,2,*]

[1] Agricultural Science and Technology Institute, Andong National University, Andong 36729, Republic of Korea; ehsanrahimi666@gmail.com
[2] Department of Plant Medicals, Andong National University, Andong 36729, Republic of Kore
* Correspondence: cjung@andong.ac.kr

Simple Summary: This study examines the impact of global warming on crucial inse particularly bees. Through species distribution models, we evaluated how climate chang under the SSP585 scenario in the year 2070, affects the climate suitability of 1365 bee s wide. The results unveiled fluctuating suitability patterns: approximately 65% of be potential reductions in their distribution ranges due to climate change. Variation was ob continents, with Africa and Europe experiencing the most pronounced effects and N being the least affected. Climate change is anticipated to significantly alter bee distribu tially disrupting existing plant–bee interactions. This poses ecological challenges that u importance of plant–bee synchrony and the necessity for targeted conservation endeav

Abstract: Bees represent vital natural assets contributing significantly to global food pr the maintenance of ecosystems. While studies on climate change effects impacting maj like honeybees and bumblebees raise concerns about global diversity and crop prod prehensive global-scale analyses remain limited. This study explores the repercussi warming on 1365 bees across seven families of bees worldwide. To compile a robust glo rence dataset, we utilized the innovative '*BeeBDC*' R package that amalgamated over 18 occurrence records sourced from various repositories. Through species distribution mod SSP585 scenario in the year 2070, we assessed how climate change influences the climate bees on a global scale, examining the impacts across continents. Our findings suggested mately 65% of bees are likely to witness a decrease in their distribution, with reductio between 28% in Australia and 56% in Europe. Moreover, our analysis indicated that cli impact on bees is projected to be more severe in Africa and Europe, while North Ameri to witness a higher number (336) of bees expanding their distribution. Climate change effects on bee distributions could potentially disrupt existing pollinator–plant netw ecological challenges that emphasize the importance of pollinator diversity, synchr plants and bees, and the necessity for focused conservation efforts.

Keywords: species distribution models; pollinators; conservation; climate suitabil R package

check for updates

Citation: Rahimi, E.; Jung, C. Global Trends in Climate Suitability of Bees: Ups and Downs in a Warming World. *Insects* **2024**, *15*, 127. https://doi.org/10.3390/insects15020127

Academic Editor: Martin Konvička

Received: 17 January 2024
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Published: 11 February 2024

7. Other threats

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Wales | Wales Politics | Wales Business | North West | North East | Mid | South West | South East | Cymru

'Collapsing wildlife and polluted rivers now a life or death issue'



Only 40% of water bodies in Wales are classed as being in good condition

Steffan Messenger
Wales environment correspondent

29 January 2026 · 358 Comments

A major review of the state of the Welsh environment has warned of "polluted rivers, failing soils" and "collapsing wildlife".

Parts of the country also have some of the worst air quality in Britain - causing up to 1,400 premature deaths a year - according to Natural Resources Wales (NRW).

The organisation, which is often challenged by campaigners over whether it is tough enough on tackling pollution, said it was impossible to "regulate our way out of this", calling for action across society to allow people to live more sustainably.

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'Serious climate breakdown' warning over filthy rivers and flooding



Campaigners warn that from filthy rivers to the threat of flooding, Wales is facing "mounting environmental crises"

Steffan Messenger
Wales environment correspondent

15 February 2026

From filthy rivers to the threat of flooding, Wales is facing "mounting environmental crises on multiple fronts", campaigners have warned.

Friends of the Earth Cymru said a "stark gap" was developing between the public's desire for action on pollution and what politicians were proposing.

They've published a series of reports, shared with **BBC Politics Wales**, compiling data on the state of the environment in all 16 new Senedd constituencies.

Britain is bottom of the 14 nations for biodiversity, having
than any other G7 country and been shown to be one of th
depleted countries on the planet.

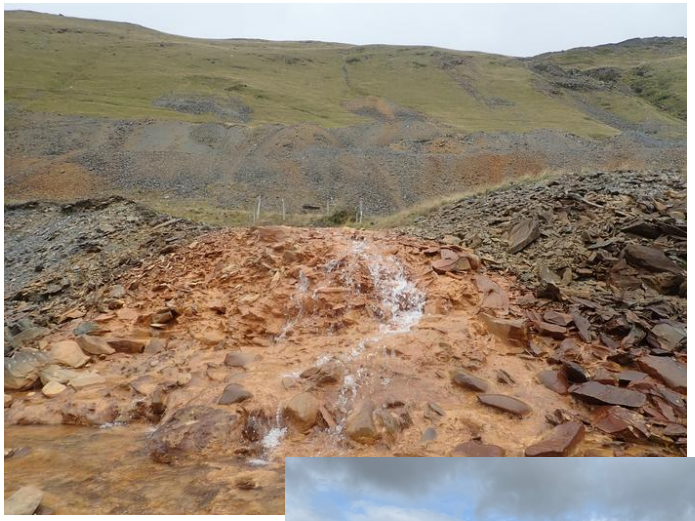
UK ranks lowest of 14 European countries for 'nat connectedness' and wellbeing

Numbers are scores given to each country based on the study

	Nature Connection		Biodiversity		W
Italy		4.67		0.51	
Portugal		4.63		0.51	
Czech R		4.47		0.5	
Bulgaria		4.43		0.49	
France		4.36		0.42	
Greece		4.35		0.55	
Estonia		4.29		0.44	
Spain		4.29		0.49	
Germany		4.27		0.37	
Netherlands		4.21		0.41	
Finland		4.17		0.29	
Sweden		4.05		0.3	
Ireland		3.96		0.28	
UK	14th	3.71	11th	0.32	14

Guardian graphic. Source: Country-level factors in a failing relationship with nature, M
Lewis R Elliott & Mathew P White, Ambio (2022)

Another country-wide factor in nature connectedness wa
a population, with older people tending to enjoy closer re
nature - possibly because there was more around when th
they had more freedom to enjoy it.







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Welsh Water: Sewage dumped in waterways for 600,000 hours

3 April 2023 · 244 Comments



Waters like Llyn Padarn, Gwynedd are being put at risk by sewage discharges

By Peter Gillibrand
BBC News

Water company Welsh Water released sewage into rivers, lakes and the sea around Wales for almost 600,000 hours last year, data shows.

This accounts for more than 25% of all hours of discharges into waterways across Wales and England.

Latest figures also show more than 83,000 spills in 2022 - 77,000 of which were "significant".

The not-for-profit company said removing combined storm overflows (CSOs) was too expensive.

BBC geomorph

NEWS

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Wales | Wales Politics | Wales Business | North West

Ogmore: 2,000 tyre trolleys and fridge river

3 hours ago



One dog walker spent four years organising the multi-agency

By Matt Murray & Tyler Edwards
BBC News

Thousands of tyres, up to 100 trolleys, and a fridge ha from a Welsh river in a major clean-up operation.

The work was the culmination of four years of planning was concerned by huge amounts of rubbish in the River

damming & flow regulation … historical mining impac
water quality declines (sewage, agricultural runoff, microp
flooding & erosion, drought, groundwater abstraction … biod
…
negative impacts on wellbeing

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Science & Environment

Nature deficit disorder 'damaging Britain's children'

By Richard Black
Environment correspondent, BBC News

30 March 2012 | Science & Environment

UK children are losing contact with nature at a "dramatic" rate, and their health and education are suffering, a National Trust report says.

Traffic, the lure of video screens and parental anxieties are conspiring to keep children indoors, it says.

Evidence suggests the problem is worse in the UK than other parts of Europe, and may help explain poor UK rankings in childhood satisfaction surveys.

The trust is launching a consultation on tackling "nature deficit disorder".

"This is about changing the way children grow up and see the world," said Stephen Moss, the author, naturalist and former BBC Springwatch producer who wrote the Natural Childhood report for the National Trust.

"The natural world doesn't come with an instruction leaflet, so it teaches you to use your creative imagination.

"When you build a den with your mates when teamwork - you disagree with each other, you you work together again - it's like a team-build were nine."

The trust argues, as have other bodies in prev dissociation of children from the natural world culture" of indoor parental guidance impairs th experience.



Children "learn by doing" in the natural environment, says the National Trust

"… the importance of early-life & family-based interventions …"



Human connection to nature has declined 60% in 200 years, study finds

The Guardian

SOCIETY & NATURAL RESOURCES
https://doi.org/10.1080/08941920.2024.2310219

Routledge
Taylor & Francis Group

Check for updates

The Collective Memory of the Fluvial Environment: The Loss of a Healthy Natural Environment in the City of Toledo (Spain) through Pollution

Marta Aguilar[a], Jose M. Bleda[b], Beatriz Larraz[c], and Raúl Urquiaga[c]

[a]Department of Sociology, Universidad de Sevilla, Sevilla, Spain; [b]Department of Sociology, Universidad de Castilla-La Mancha, Toledo, Spain; [c]Department of Applied Economy I, Universidad de Castilla-La Mancha, Toledo, Spain

"Analysis of the testimonies which make reference to the environment reveals very conflicting feelings. They begin by expressing feelings associated with a living, natural, healthy river that transmits well-being before turning to feelings related to a dead, polluted & unhealthy river. This confirms the thesis of Pretorius (2021) about the strong connection that is established between human beings & a vibrant natural environment.

… the people of the city of Toledo started looking for other places for leisure, pastimes or work. It is at this point, in the seventies of the 20th century, when a certain social & political movement arose to defend the use & enjoyment of the Tagus River, a movement which has since diminished."

WEIRD MEME · Join
Doug Hensley · 6d ·

#nature #stream 😆



122K 566 comme

Like Comment S

8. What can we do?

Ffilm a Thrafodaeth Gyhoeddus
Film and Public Discussion

Briffio Argyfwng y Bobl
People's Emergency Briefing

Gwyddonwyr a
Chris Packham, Deborah Meaden
and Scientists.

Neuadd Goffa, Penparcau
Hydref 1 Oct 7-9pm

Beth allwn ni ei wneud am yr argyfwng hinsawdd?
What can we do about the climate crisis?

Croeso i bawb!
Welcome to all!
Free - Am ddim

Te / Coffi a Chacen!
Tea / Coffee and Cake!

People's Emergency Briefing

Ffilm

Neuadd Goffa Penparcau Hall



Emergency... What emergency?
Ymateb i'r argyfwng hinsawdd

50-min film (16+) with leading UK experts and the latest climate evidence.
Why does it matter to us?
Health, food, cost of living, nature, security...
With optional facilitated discussion.

Thursday 1st October
Nos lau 1af o Hydref
7pm

Croeso cynnes i bawb - All welcome
Yn rhad ac am ddim / Free

www.nebriefing.org/peb https://sites.google.com/view/peb-broddyfi

Donald J. Trump
@realDonaldTrump

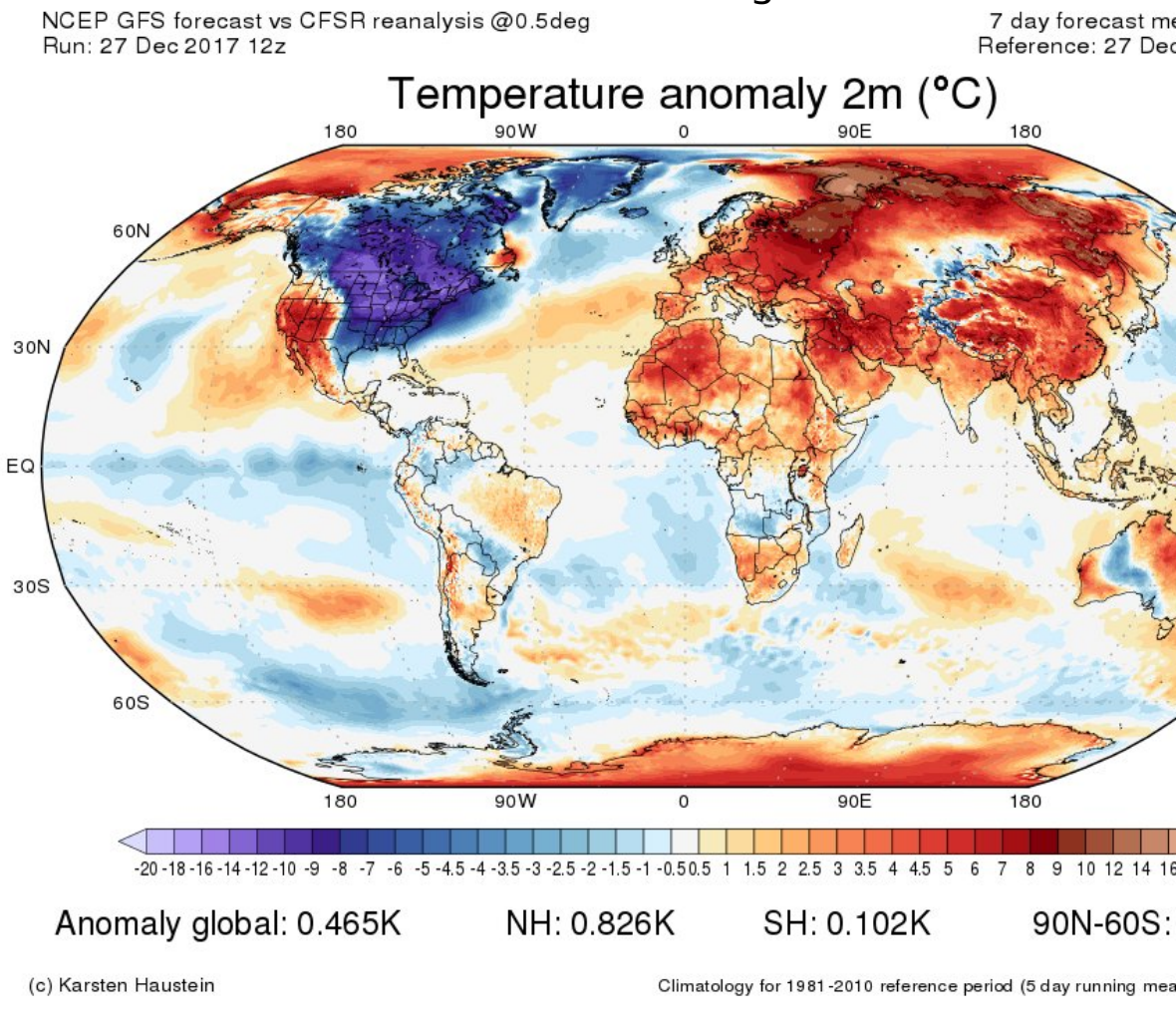
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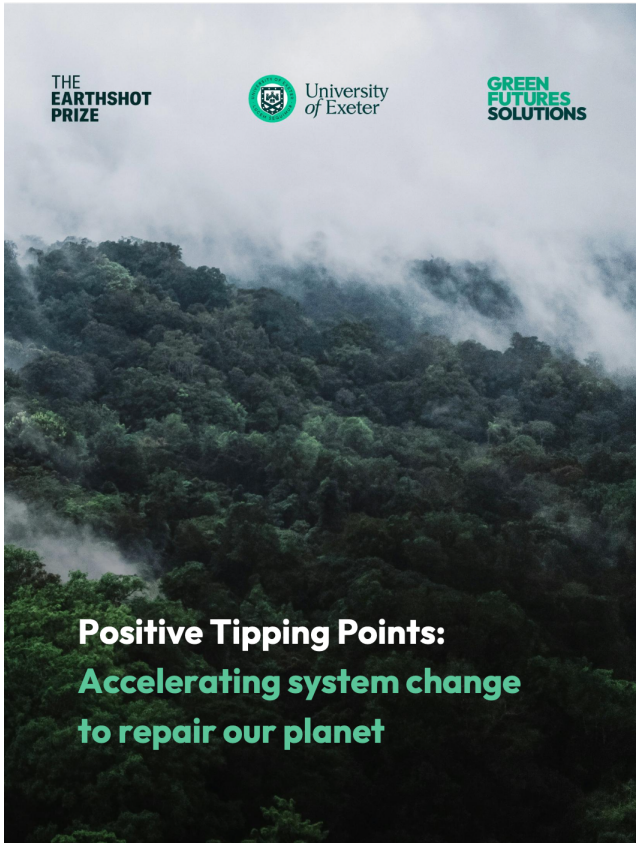
In the beautiful Midwest, windchill temperatures are reaching minus 60 degrees, the coldest ever recorded. In coming days, expected to get even colder. People can't last outside even for minutes. What the hell is going on with Global Waming? Please come back fast, we need you!

9:28 PM - 28 Jan 2019

Q: how can we have simultaneously extremely cold & ext
weather?

A: i) seasonal differences globally; ii) owing to an outbre
here is an example from a period of unusually frigid weather in Dec
polar vortex
when parts of the United States were 15 to 30°F (8.3 to 16.7°C) co
average, but the world *as a whole* was about 0.9°F (0.5°C) warmer th
2000 average





The planet is fast approaching **negative tipping points**, such as the dieback of Amazon rainforest, where catastrophic harm to ecosystems becomes irreversible. Yet, the same science provides an opportunity with **positive tipping points**, a threshold where progress can become rapid & self-reinforcing. For example, when adoption lowers costs, success attracts further investment & new policy spreads to other geographies, creating a cascade effect of progress.

"Positive Tipping Points: Accelerating System Change to Repair our Planet", furthers Professor Tim Lenton's pioneering research, by expanding positive tipping point science to all five Earthshots: Protect & Restore Nature, Clean Our Air, Revive Our Oceans, Build a Waste-Free World, & Fix Our Climate. The Earthshot Prize will use the findings to identify


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Rewilding

Rewilded land remains green amid drought-stricken English countryside, images show

Sandra Laville

Fri 21 Aug 2026 06.00 BST

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A stream winds through fields on the Holnicote estate. The rewilding projects he water during extreme rainfall'. Photograph: Steve Sayers/National Trust Images

National Trust's Holnicote estate says restored wetlands and rivers offer proof of resilience to drought, wildfires and flooding

an example: peatland, floodplain wetland resto part of wider ecological efforts

can we find the necessa political & economic levers to e positive tipping poi

Questions?



Fig. 1. Progress in global environmental change?
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