

# Mind the Gap: from research stations to public platforms

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# TALK OUTLINE

## **Part 1 - From research stations: the current knowledge base**

- Climate change - the current knowledge base
- Climate past, present, and future

## **Part 2 - To public platforms: communicating climate science**

- Teaching Physical Geography - the role of teachers
- The research process
- Textbooks vs research papers
- The role of scientists
- Key concepts, exam questions, and useful resources
- Hints for engaging with science outreach





# **PART 1**

## FROM RESEARCH STATIONS



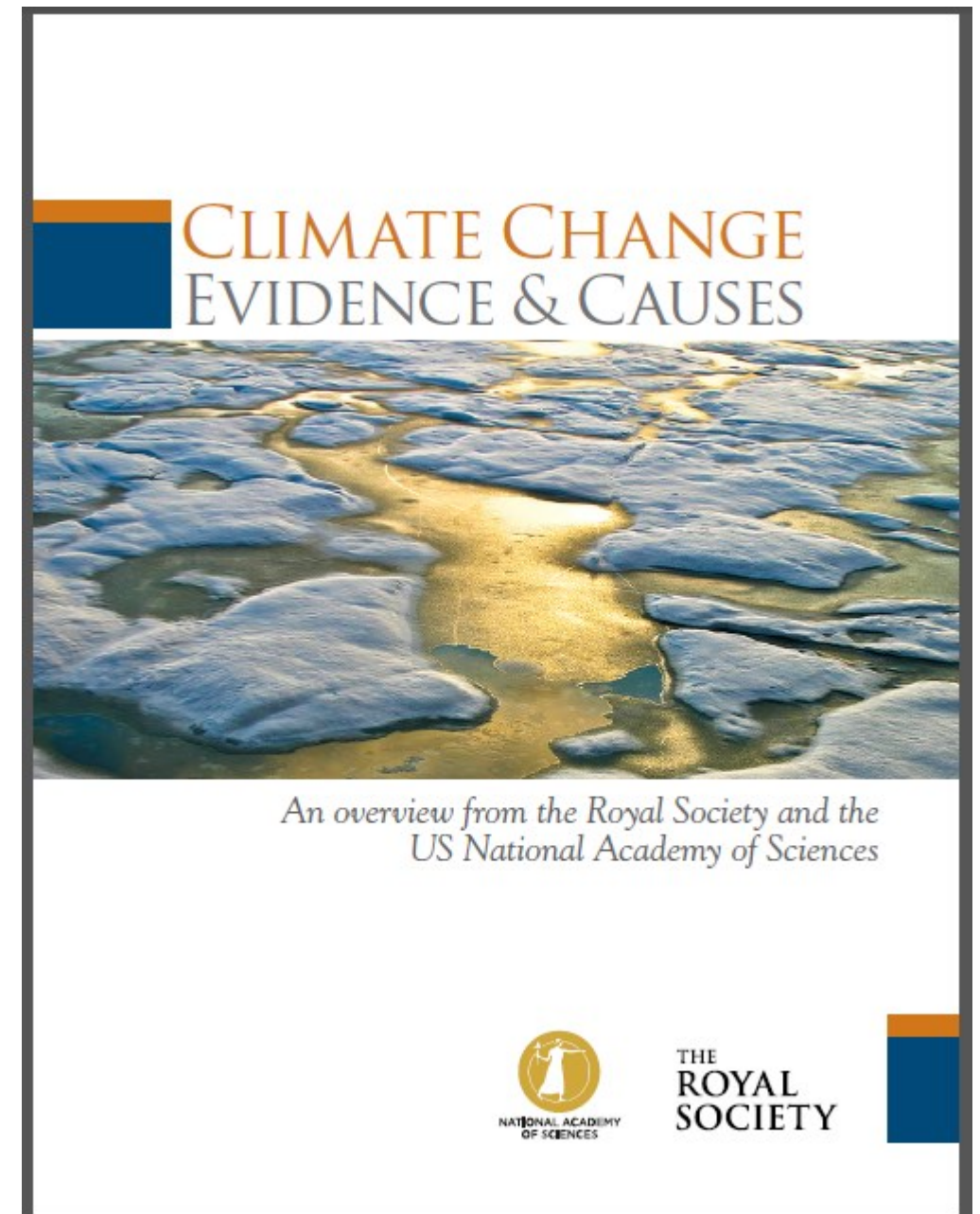


# THE CURRENT KNOWLEDGE BASE

Climate change is one of the defining issues of our time. It is now more certain than ever [...] that humans are changing Earth's climate.

The atmosphere and oceans have warmed, accompanied by sea-level rise, a strong decline in Arctic sea ice, and other climate-related changes.

*Royal Society and the US National Academy of Sciences*

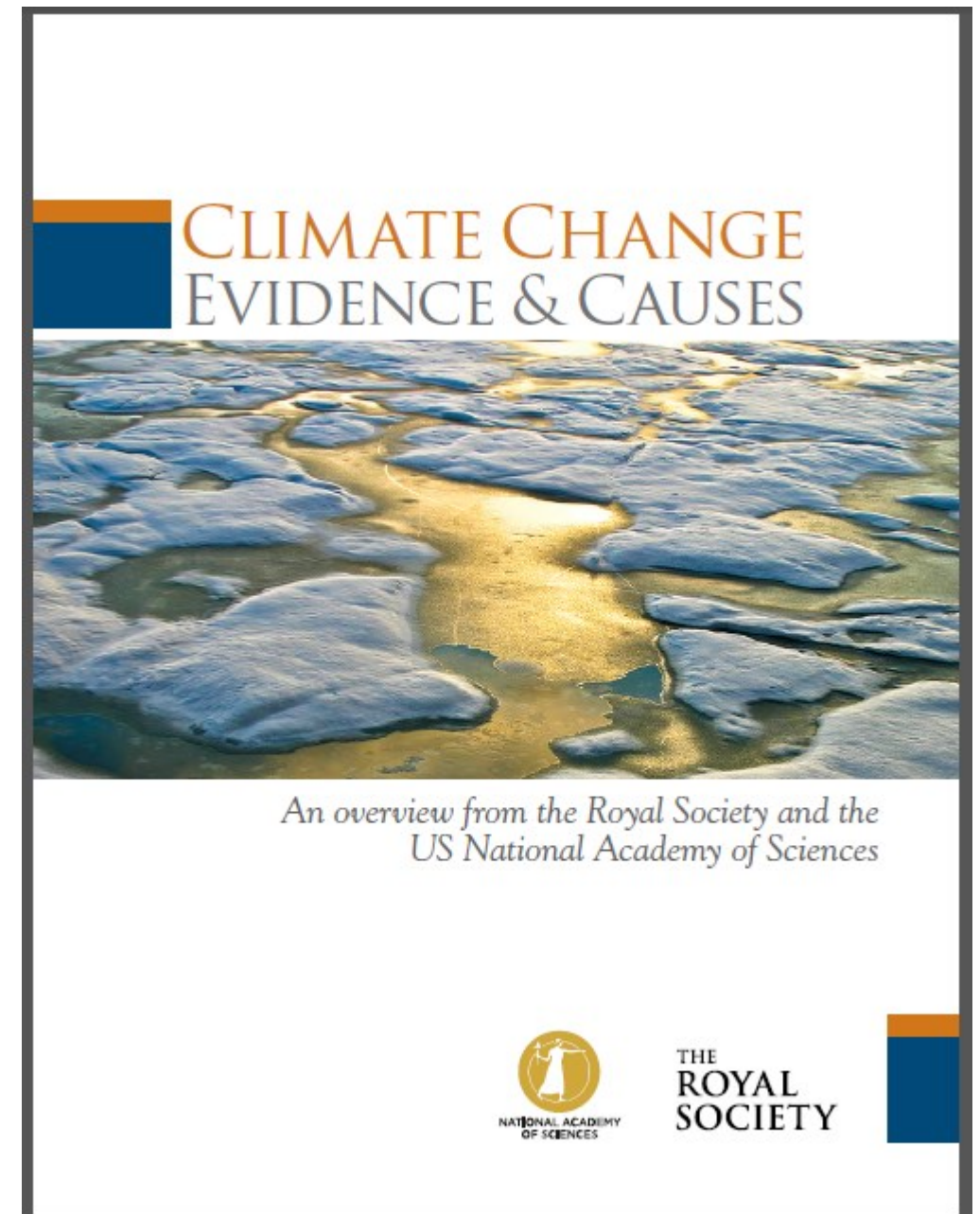


# THE CURRENT KNOWLEDGE BASE

The evidence is clear. However, due to the nature of science, not every single detail is ever totally settled or completely certain. Nor has every pertinent question yet been answered.

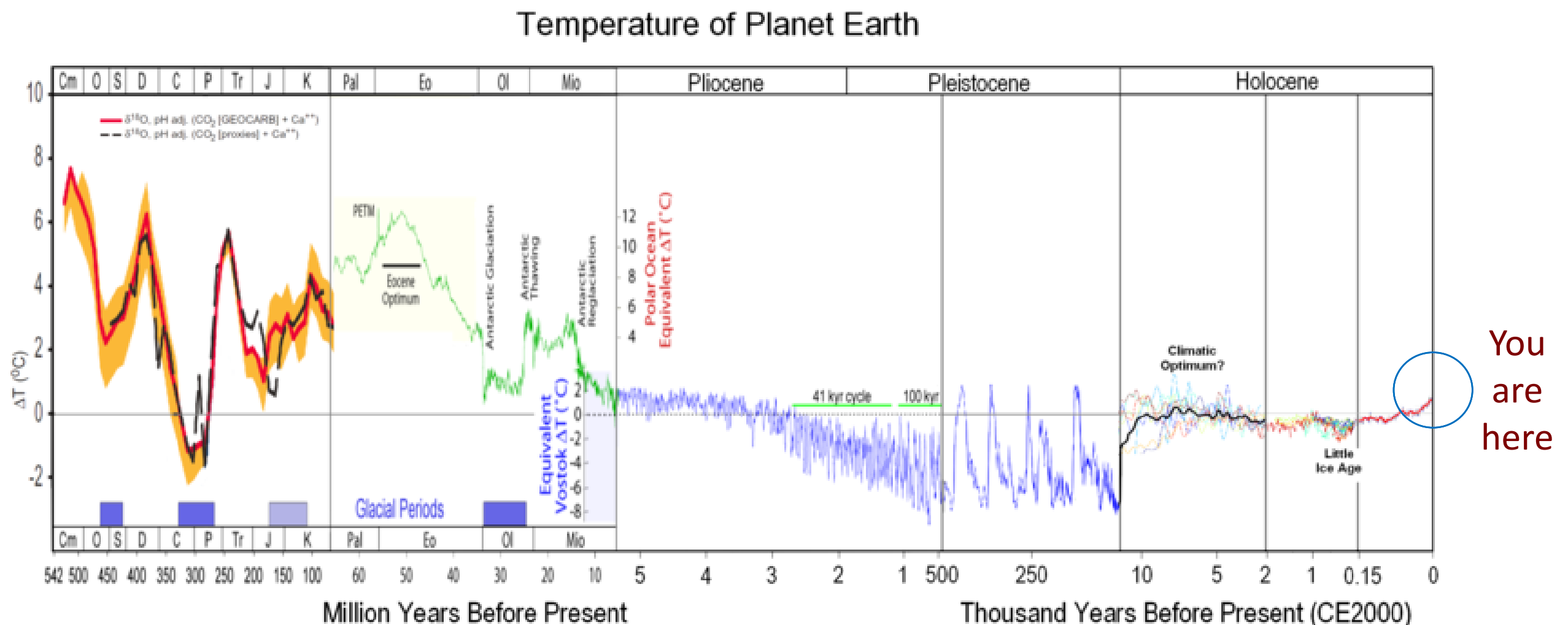
Scientific evidence continues to be gathered around the world, and assumptions and findings about climate change are continually analysed and tested.

*Royal Society and the US National Academy of Sciences*



# PAST CLIMATE CHANGE

- The Earth's climate is **naturally variable**
- This is mainly due to its orbit around the sun
- Over millions (or billions) of years, climate has fluctuated a great deal

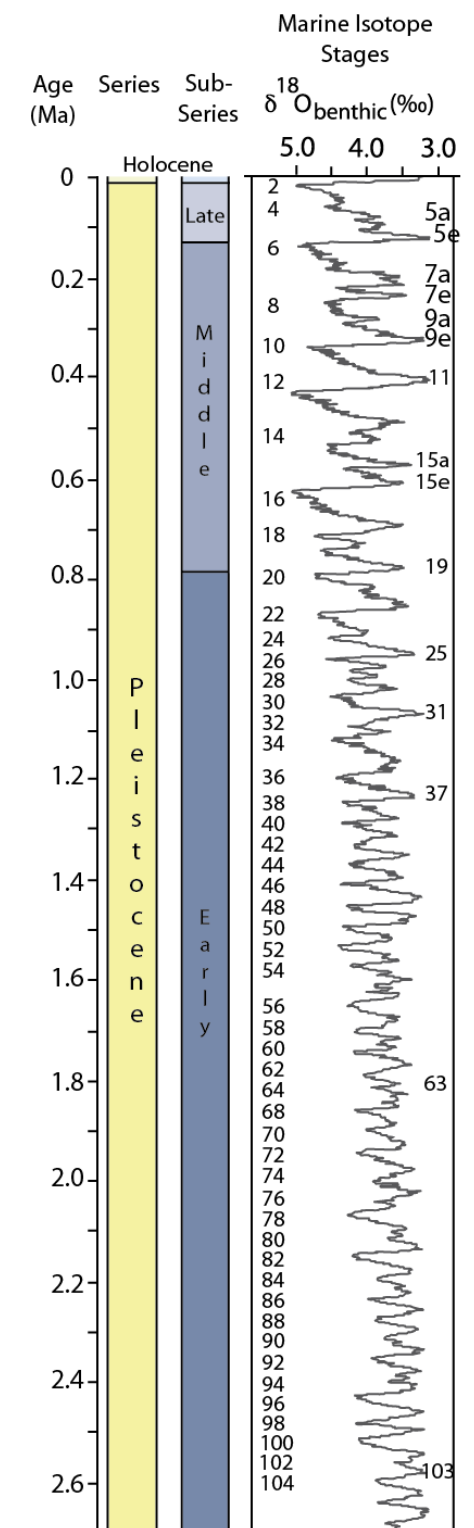
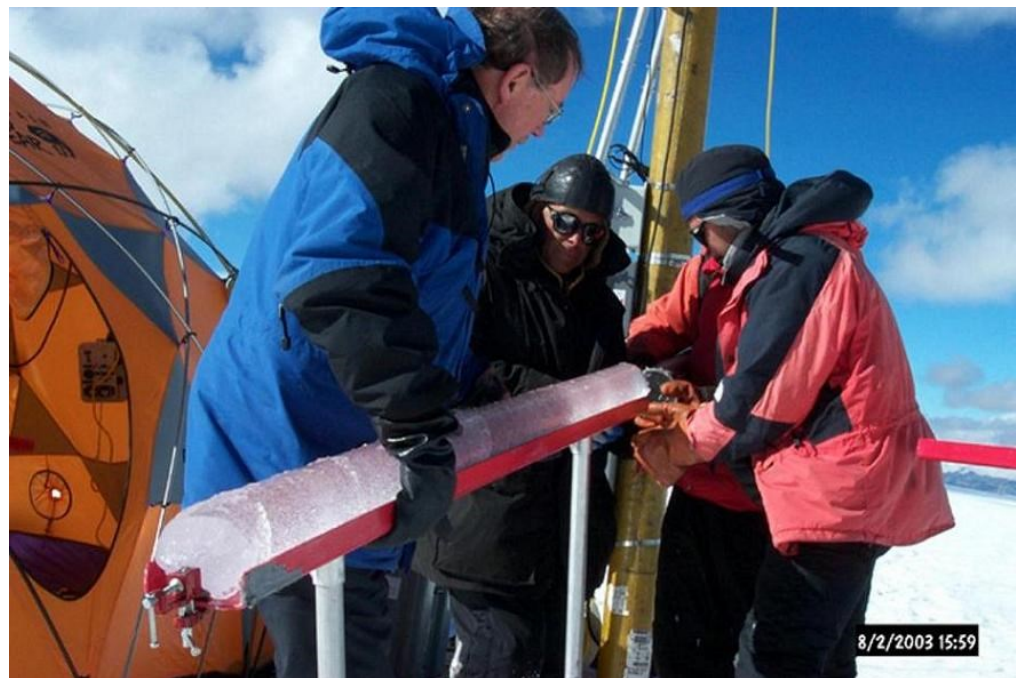




# PAST CLIMATE CHANGE

**The Quaternary** is the most recent geological time period (2.58 million years to present)

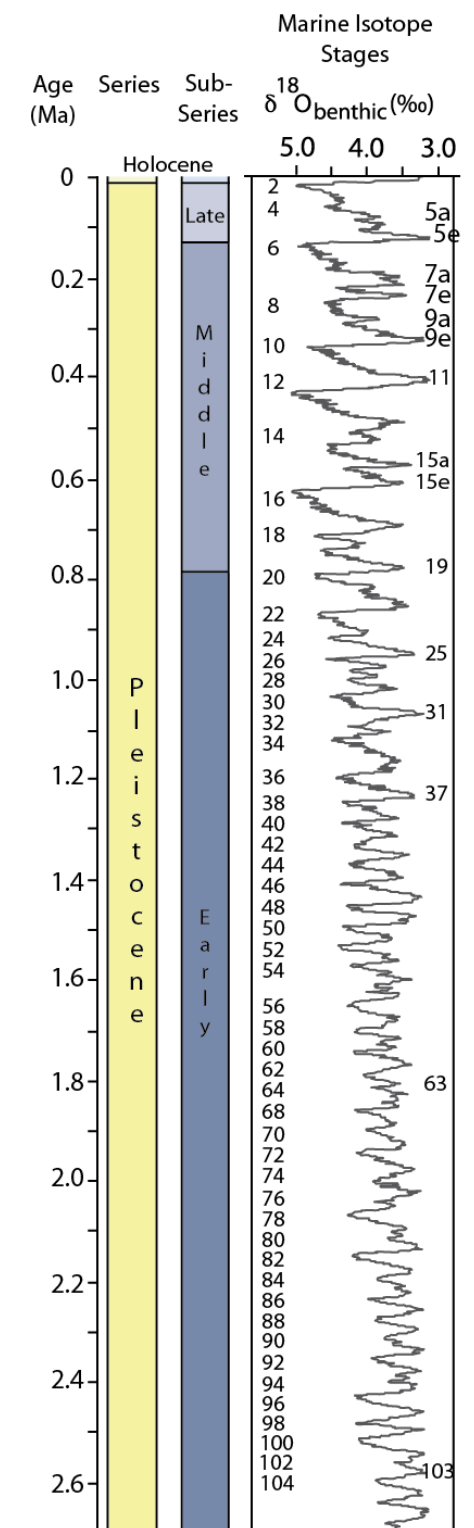
- **The records are very well preserved**
  - so we can develop **high precision...**
  - ...and **high resolution** reconstructions
- **Characterised by large, often rapid, climate changes**
  - Warm interglacials and cold glacials
  - Evidence of natural change





# PAST CLIMATE CHANGE

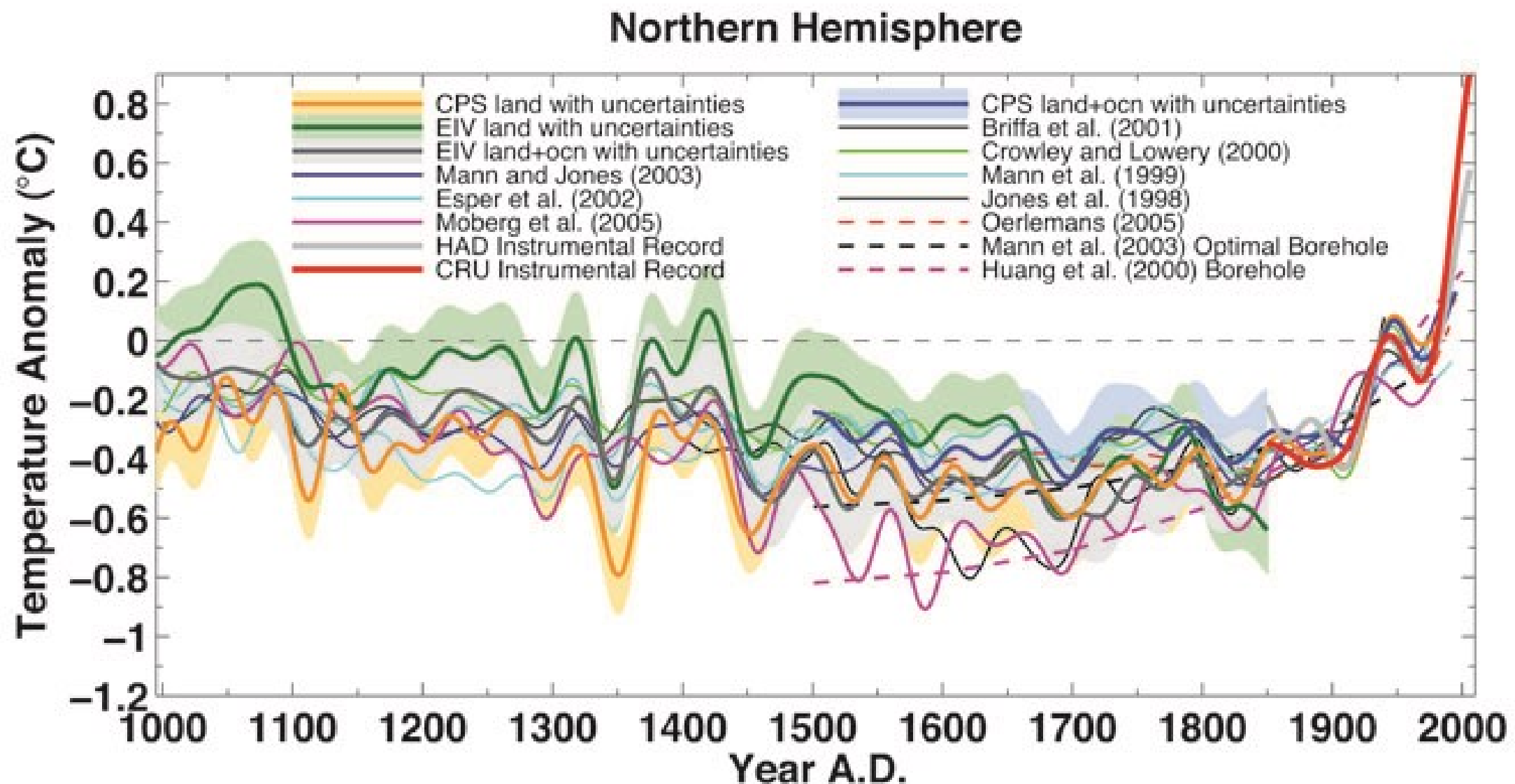
- Observations of recent climate change are only as long as the written record – i.e. since people have been ‘monitoring’
- So we rely on proxy evidence (ice cores, fossils etc.) if we want to look further into the past
- **Studying the past allows us to:**
  - Place current changes into a longer-term context
  - More fully understand present day processes
  - Enhance the accuracy and precision of our models of future environmental change





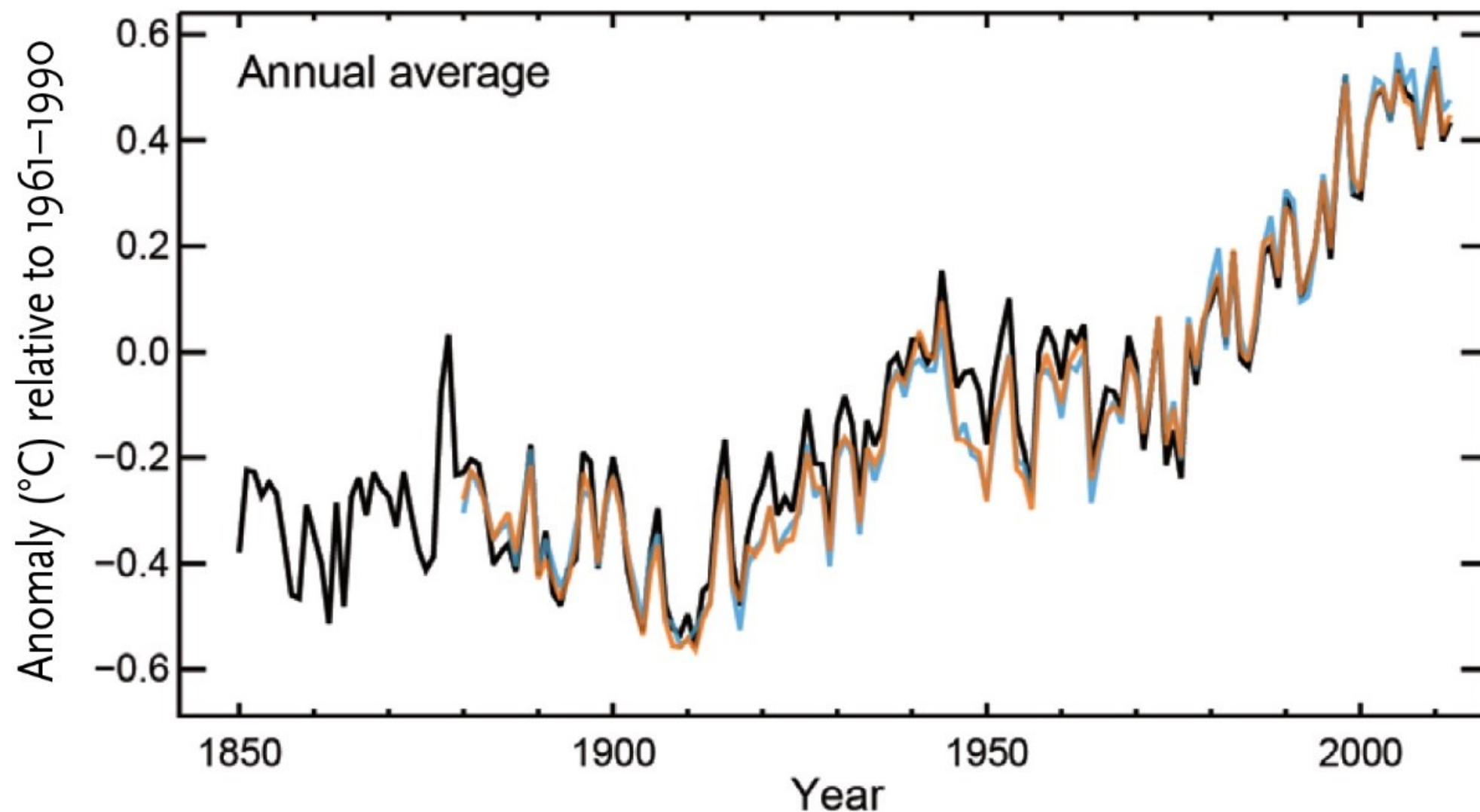
# CURRENT CLIMATE CHANGE

- Based on a number of different records (marine sediments, lake sediment, ice cores, coral cores and tree rings), the temperature is known to be warmer now than it has been in at least the last 1000 years.



# CURRENT CLIMATE CHANGE

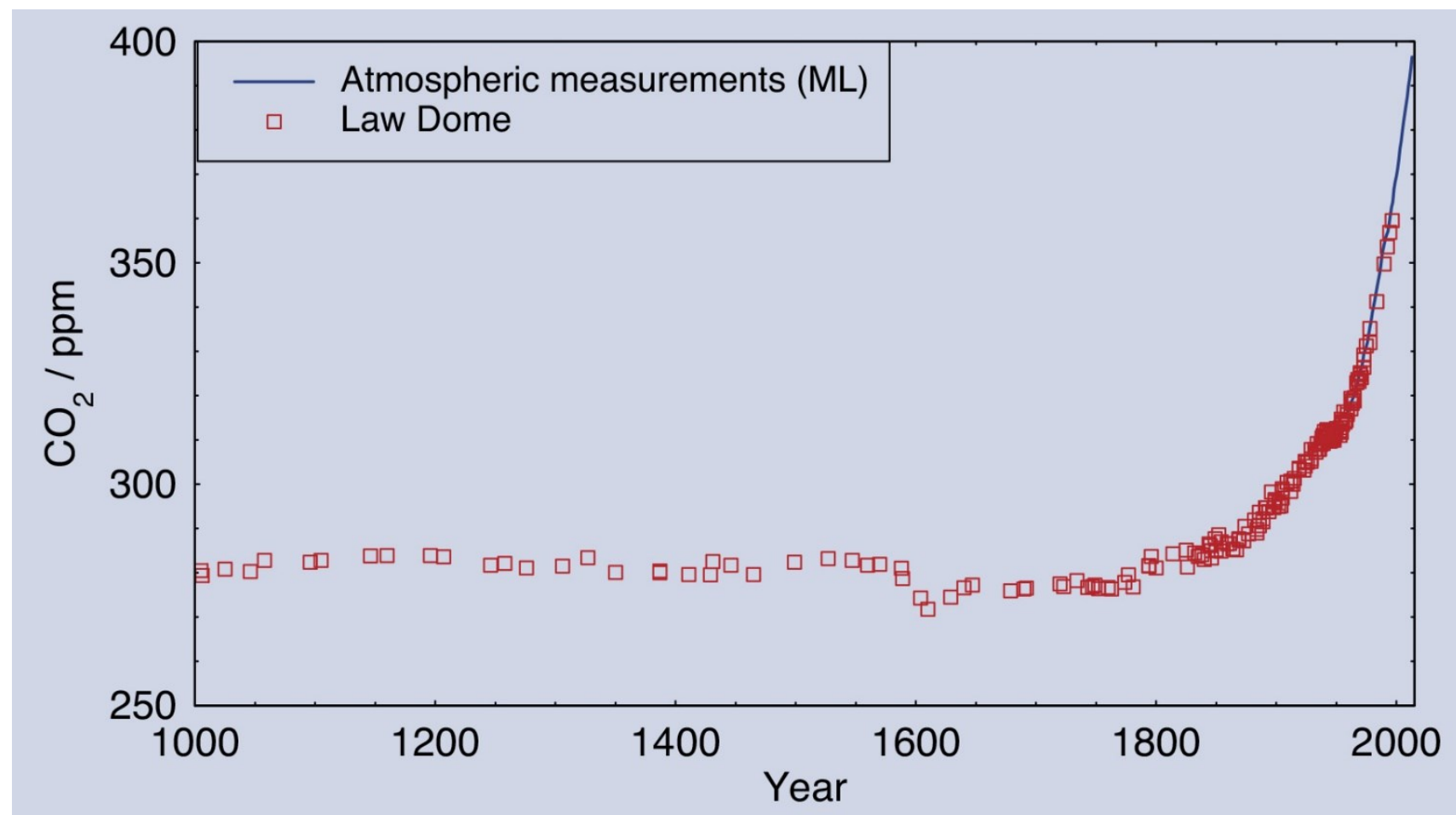
- Since 1900, the global average surface temperature has increased by about 0.8 °C, about 50% of which occurred since the mid-1970s.





# CURRENT CLIMATE CHANGE

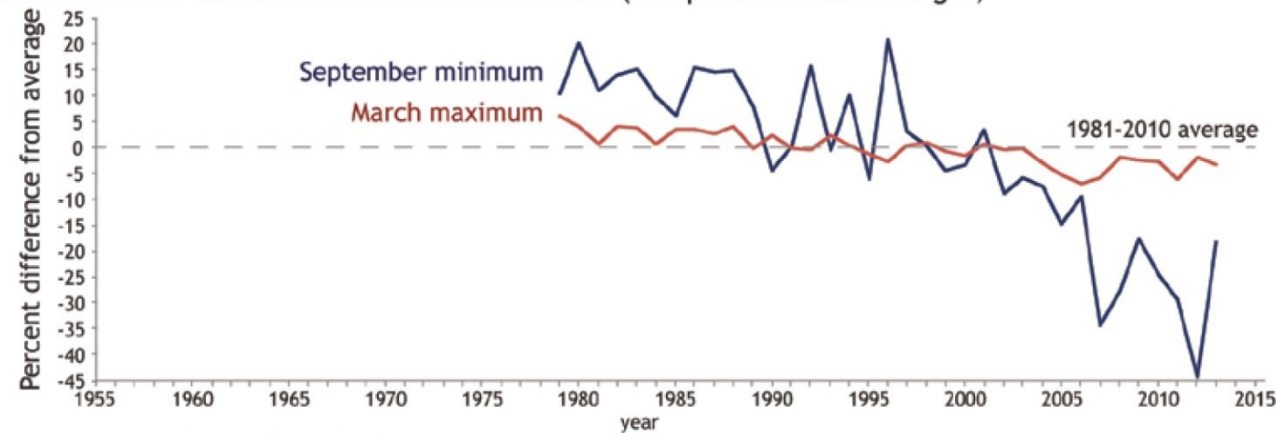
- Measurements of CO<sub>2</sub> in the atmosphere and in air trapped in ice show that **atmospheric CO<sub>2</sub> increased by about 40% from 1800 to 2012**
- **Atmospheric CO<sub>2</sub> is derived from:**
  - Plants and animals
  - Volcanic emissions
  - Fossil fuel combustion
- Each CO<sub>2</sub> source has a unique chemical signature.
- Measurements demonstrate that the rise in CO<sub>2</sub> is largely from combustion of fossil fuels.



# CURRENT CLIMATE CHANGE

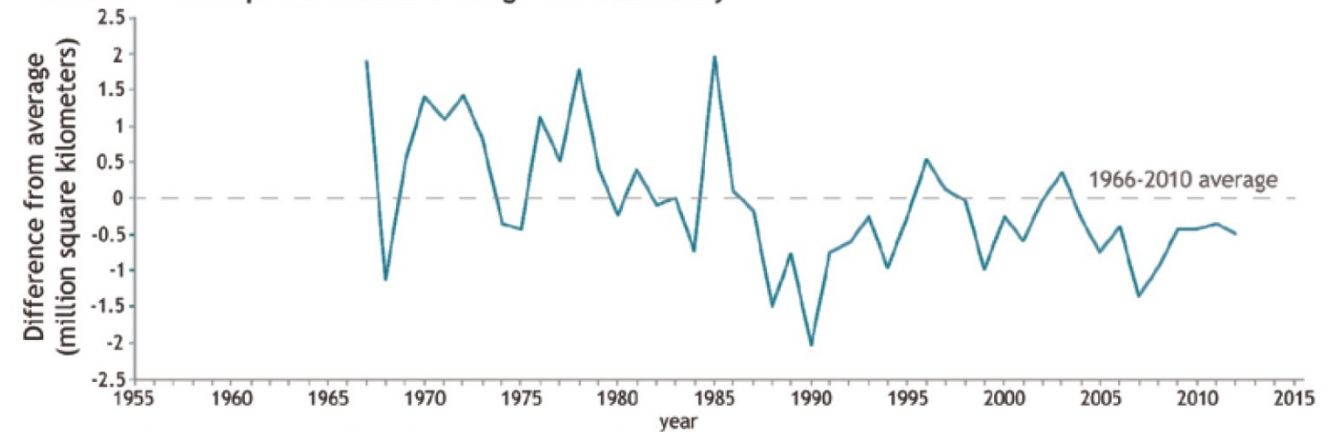
- Other observations provide a more comprehensive picture of warming throughout the climate system.

Arctic sea ice minimum and maximum extents (compared to the averages)



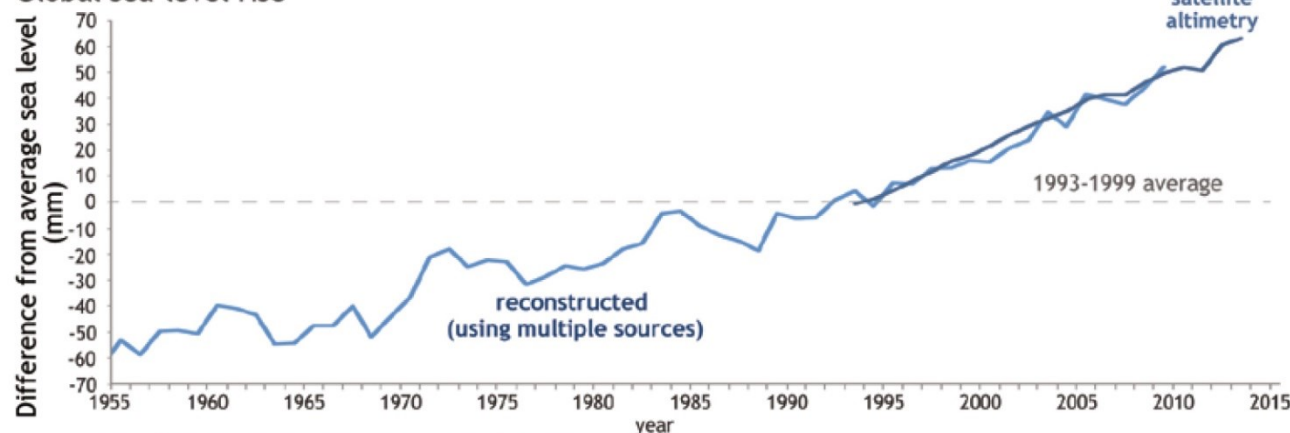
Based on data provided by NSIDC.

Northern Hemisphere annual average snow anomaly



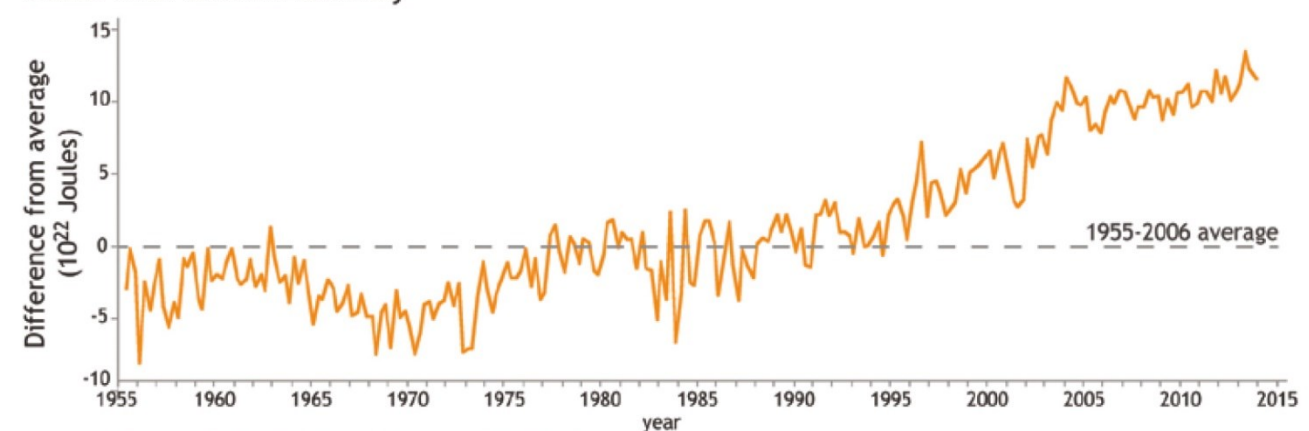
Adapted from Figure 1.1(h) in the BAMS State of the Climate report.

Global sea-level rise



Data from C.K. Shum, Chungyen Kuo, Benoit Muysignac, Junkun Wan.

Ocean heat content anomaly

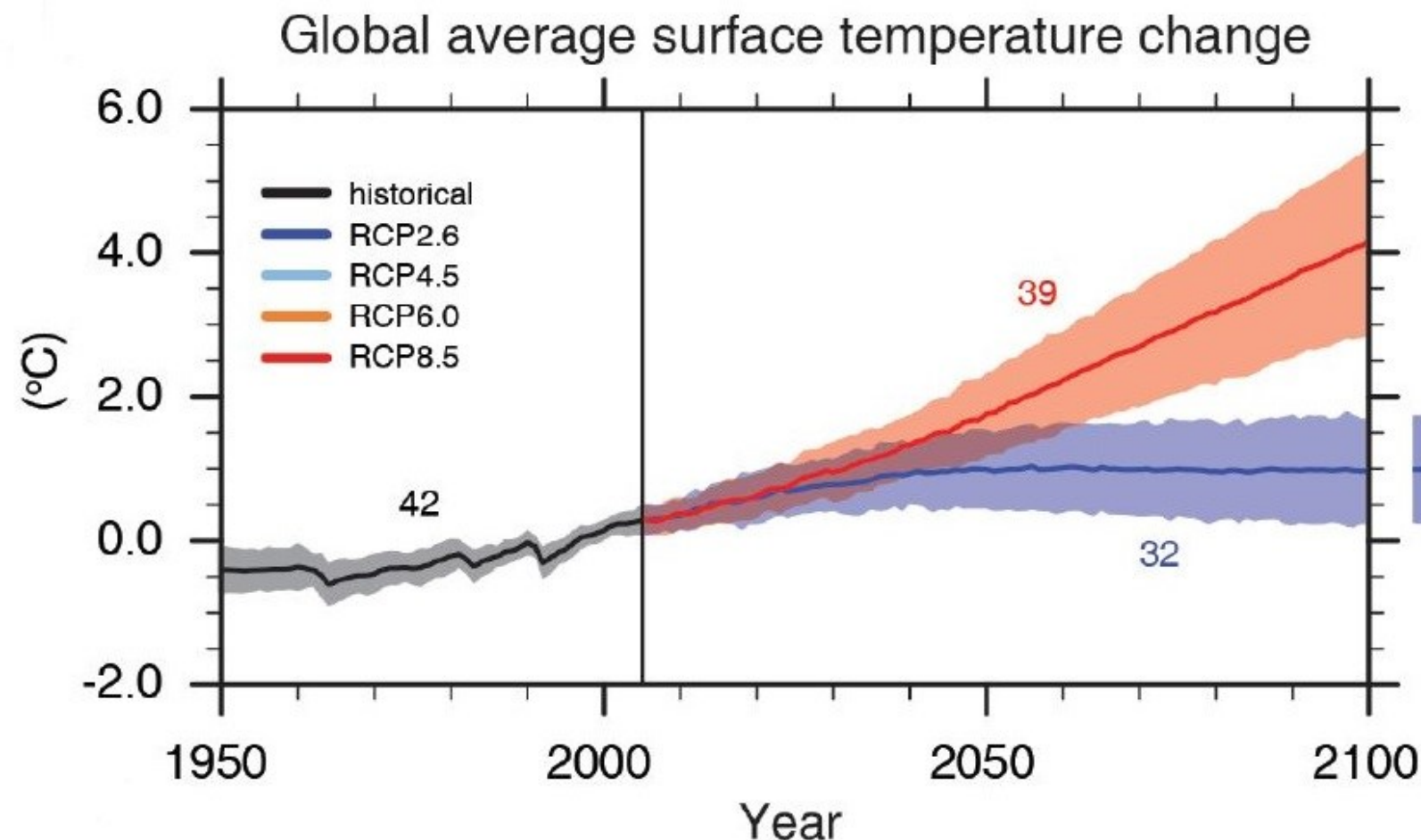


Data provided by the National Oceanographic Data Center.



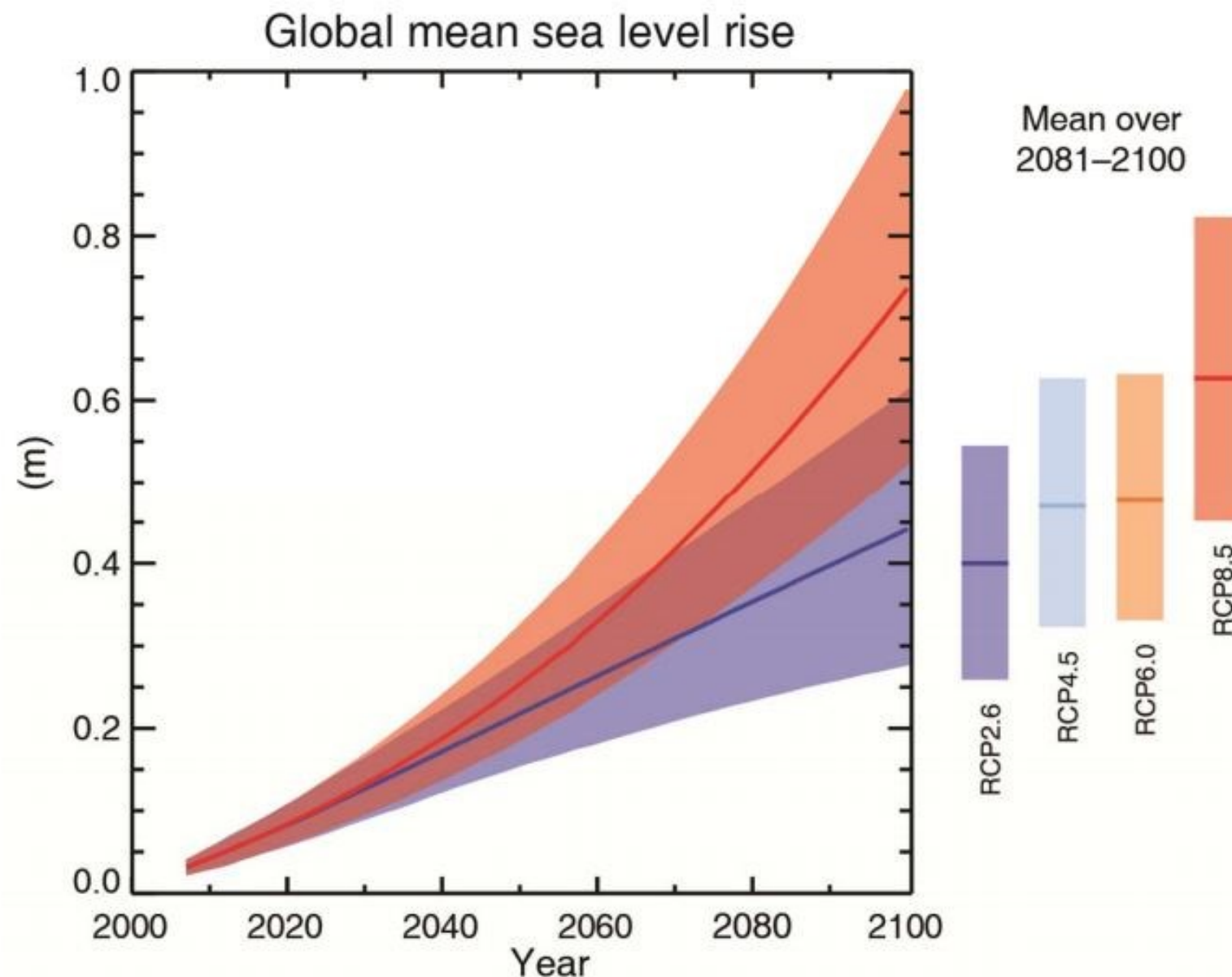
# FUTURE CLIMATE CHANGE

- Temperatures are predicted to rise by around **0.3°C - 4.8°C** by 2100.
- Based on the IPCC's low emissions scenario (**RCP2.6**), with aggressively cut emissions, the mean rise is predicted to be **1°C** by 2100.
- Under a high emissions scenario (**RCP8.5**) with emissions continuing to grow, warming of **3.7°C** is likely by 2100.



# FUTURE CLIMATE CHANGE

- Sea level rise by 2100 is likely to be between **26** and **82 cm**
- Based on the low emissions scenario (**RCP2.6**) the average predicted sea level rise is **40 cm**
- Based on the high emissions scenario (**RCP8.5**) the average predicted sea level rise is **63 cm**





# PART 2

## TO PUBLIC PLATFORMS



# GEOGRAPHY – THE ROLE OF TEACHERS

**Geography is one of the most rapidly changing subjects**

- This makes it exciting, relevant, and societally important

**Geography teachers play an important role in inspiring the next generation to be more environmentally aware, even if they leave the subject**

- It is about:
  - Conveying complex ideas in a manageable format
  - Developing an awareness of the links between systems
  - Highlighting the importance and application of Geography
  - Preparing students for independent learning at university

**Climate change is a complex subject to understand and teach**

- It is politically charged
- The bewildering array of data means that it is often difficult to stay up to date with the current knowledge base



# THE RESEARCH PROCESS

## Analysis



Several months to draft a paper

## Draft manuscript

1 Fine sediment transformation in a Middle Pleistocene glacial-fluvial system  
2  
3 Kathryn R Adamson<sup>1</sup>\*, Jamie C Woodward<sup>2</sup> and Philip D Hughes<sup>2</sup>  
4  
5  
6 <sup>1</sup>Geography, Queen Mary, University of London, London, E1 4NS, United Kingdom  
7 <sup>2</sup>Geography, School of Environment, Education, and Development, The University of  
8 Manchester, Manchester, M13 9PL, United Kingdom  
9  
10 ADAMSON, K. R., WOODWARD, J. C. and HUGHES, P. D., 2014, Fine sediment transformation in a  
11 Middle Pleistocene glacial-fluvial system. *Geografiska Annaler: Series A, Physical Geography*,  
12  
13  
14 ABSTRACT  
15  
16 Pleistocene glacial and fluvial deposits from across Mount Orjen, Western Montenegro have  
17 been used to explore the modification of limestone bedrock and fine grained sediment (<63  
18 µm) within the glacial and proglacial environments. Two types of surface meltwater routes  
19 (MWRs) have been identified on Orjen. Sediments deposited downstream of type 1 MWRs  
20 (bedrock gorges) display a bimodal particle size distribution, where the carbonate silt  
21 fraction has been removed and non-carbonate lithologies have been concentrated. This is  
22 thought to be a result of the chemical weathering and physical sorting of fine grained  
23 limestone sediment within the proglacial fluvial environment. Type 2 MWRs (directly in  
24 front of the former ice margin) contain unimodal particle size distributions, which resemble  
25 the grain size characteristics of the limestone bedrock and glacial till. The fine grained  
26 sediment exported from glaciated catchments during the cold stages of the Pleistocene  
27 would have formed important sources of loess for the large depocentres in Eastern Europe  
28 and the Adriatic Sea. Understanding the transformation of this material, as it is comminuted  
29 and transported within the glacial and fluvial environments, is important for its  
30 identification within other depositional settings. This may provide an important basis for  
31 correlation between Pleistocene terrestrial and marine sedimentary archives.  
32  
33  
34 KEY WORDS  
35  
36 Pleistocene; proglacial; grain size; sediment transformation; limestone

Peer review...

Revisions...

Re-submission...

Several (more) months

Journal publication!

## Conferences



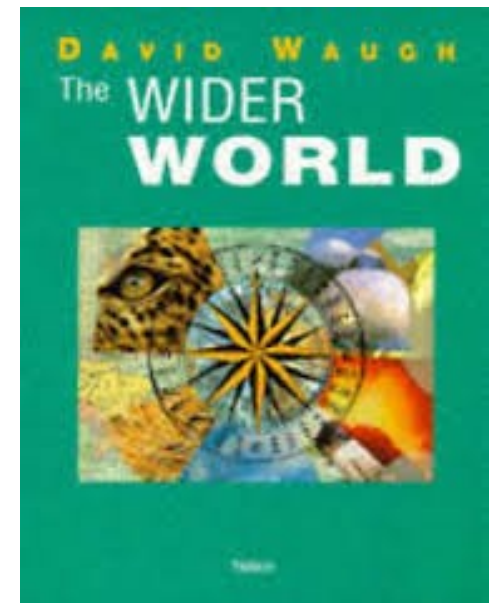
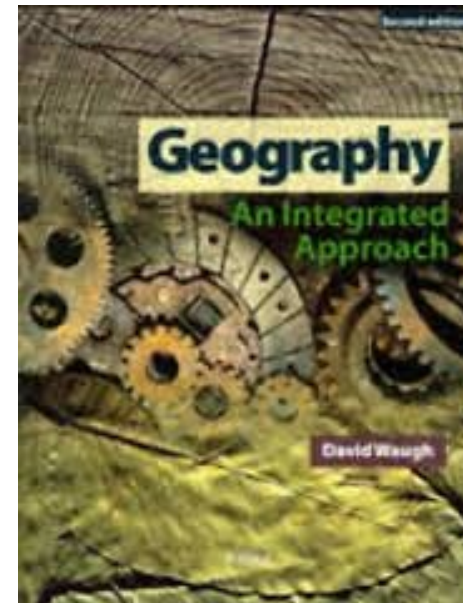
A rapid way to communicate to other scientists



# TEXTBOOKS VS RESEARCH PAPERS

## Textbooks

- Do a great job at synthesizing complex ideas
- They are accessible, provide excellent graphics and neatly packaged case studies...
- ...but they are quickly outdated



## Research papers

- Are at the forefront of geographical ideas. They present emerging theories and paradigms...
- ...but they are largely inaccessible beyond universities and research institutions



How can we start to bridge this divide?



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# THE ROLE OF SCIENTISTS

- Scientists drive the research trajectories
- Scientists know far in advance of the textbooks where their field is going
- Every year, across all disciplines:
- **Over £27 billion is spent on research in the UK alone** (Office for National Statistics)
- **Over 1 million research papers are published each year globally** (Information Research)
- With all of this public funding (and the research output) perhaps scientists have a responsibility to publish their findings more broadly
- After all...
  - enhanced uptake at school level →
  - sustained university numbers →
  - research is safeguarded



# THE ROLE OF SCIENTISTS

- But scientists are not teachers
- We are trained researchers and lecturers and do not necessarily have the skills to address younger age groups – this is a very different approach!
- But at school we have a responsibility to provide an introduction to:
  - The work that climate scientists do
  - The key concepts and theories
  - The scientific terminology
  - The practical importance of Geography
- We need to develop a synergy
- To more effectively (and rapidly) disseminate our research in a way that teachers can package it for their students



# SCIENCE OUTREACH

Science outreach platforms provide an effective way to bridge the gap between scientific knowledge and school curriculums

- There is an increasing emphasis on outreach within research grants

This can take a variety of forms:

- Websites
- Blogs
- Datasets
- Schools talks
- Museum exhibitions
- Newspaper and magazine articles
- And many others

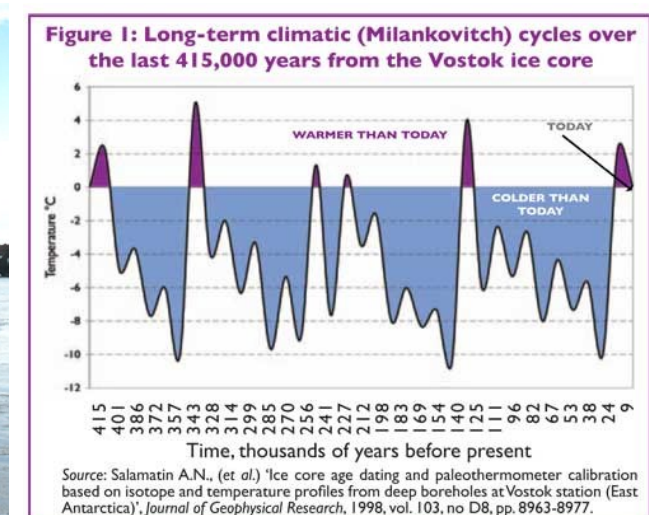




# KEY CONCEPTS

As well as the content, climate change can be used to teach key concepts

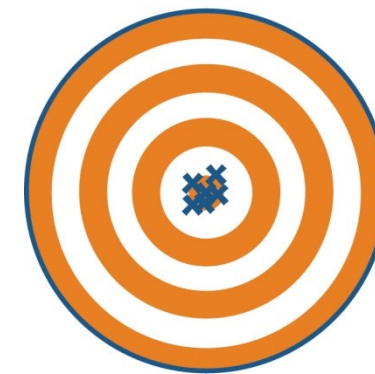
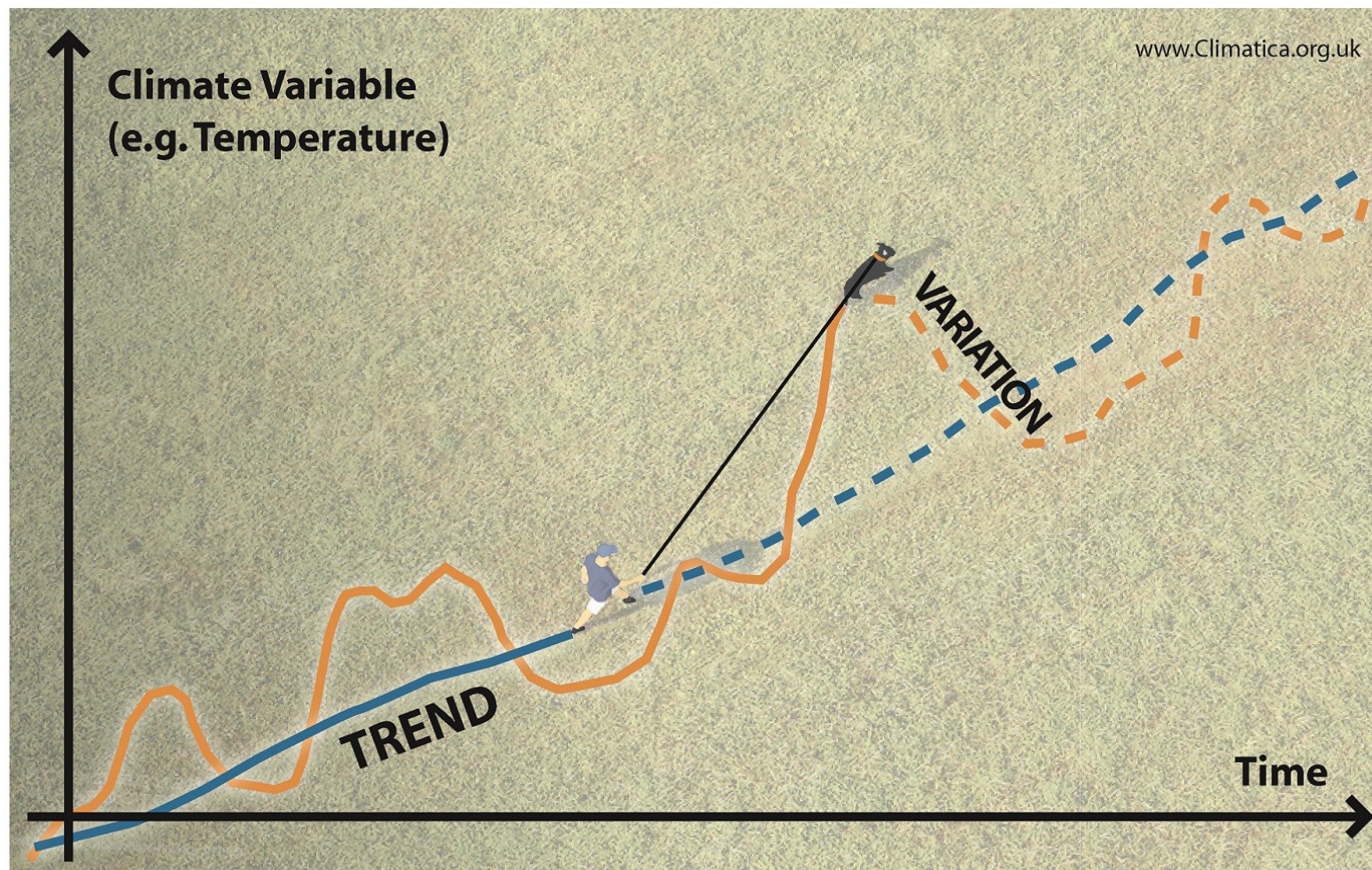
- **Key scientific concepts:**
  - Uncertainty (or 'error margins'), accuracy, and precision
  - Feedback mechanisms and links *between* systems
  - Correlation and causation
  - Long-term change
  - Future projections
  - Human impacts and management strategies
  - Critical thinking and 'flair'





# KEY CONCEPTS

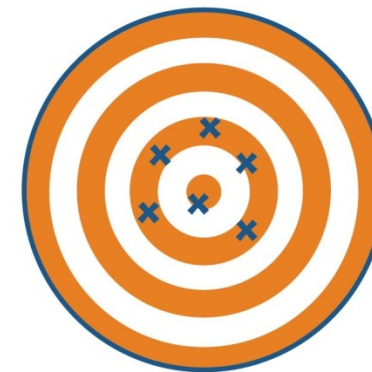
- Trends
- Uncertainty, accuracy, and precision



High Accuracy  
High Precision



Low Accuracy  
High Precision



High Accuracy  
Low Precision

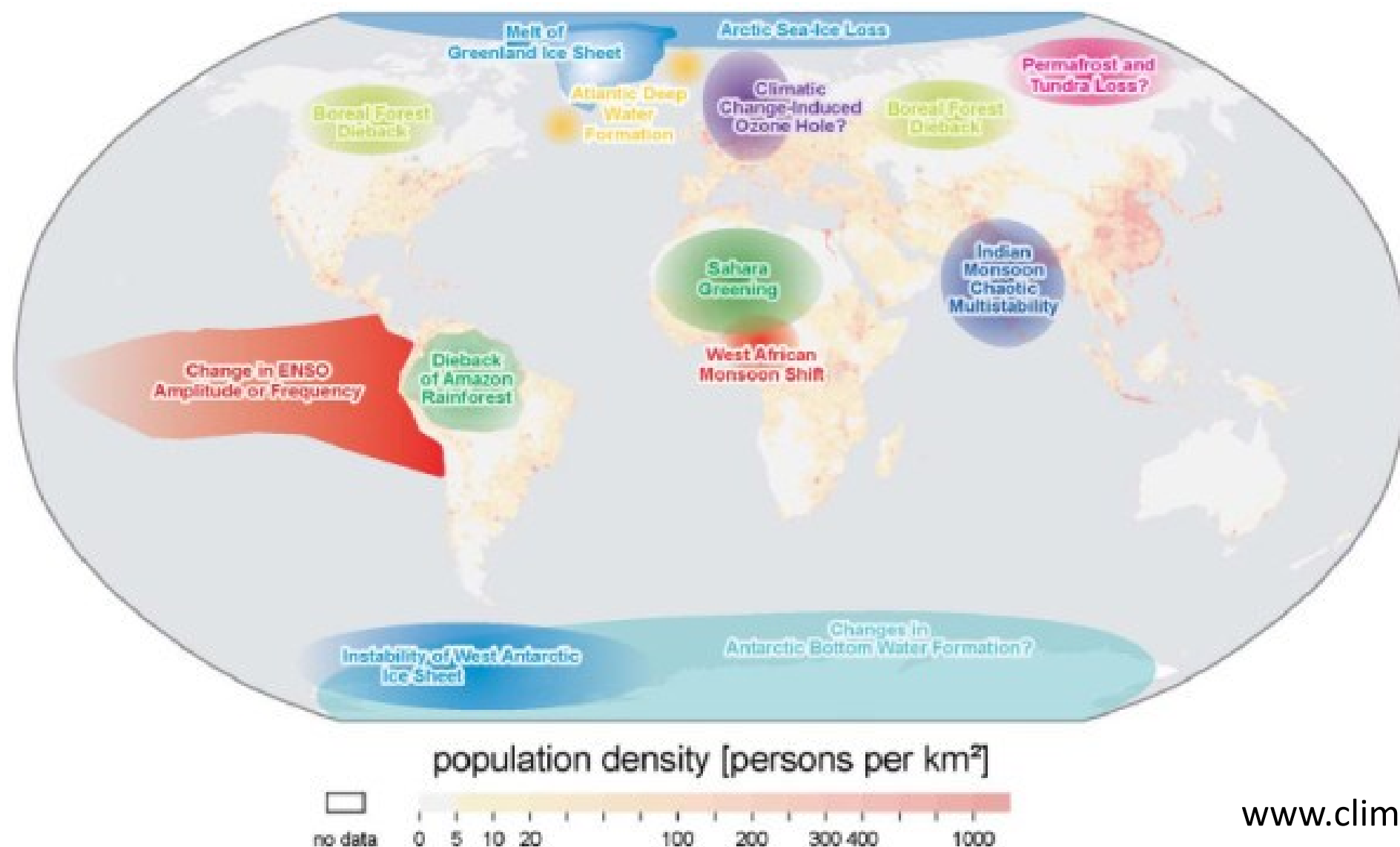


Low Accuracy  
Low Precision



# KEY CONCEPTS

- Feedback mechanisms

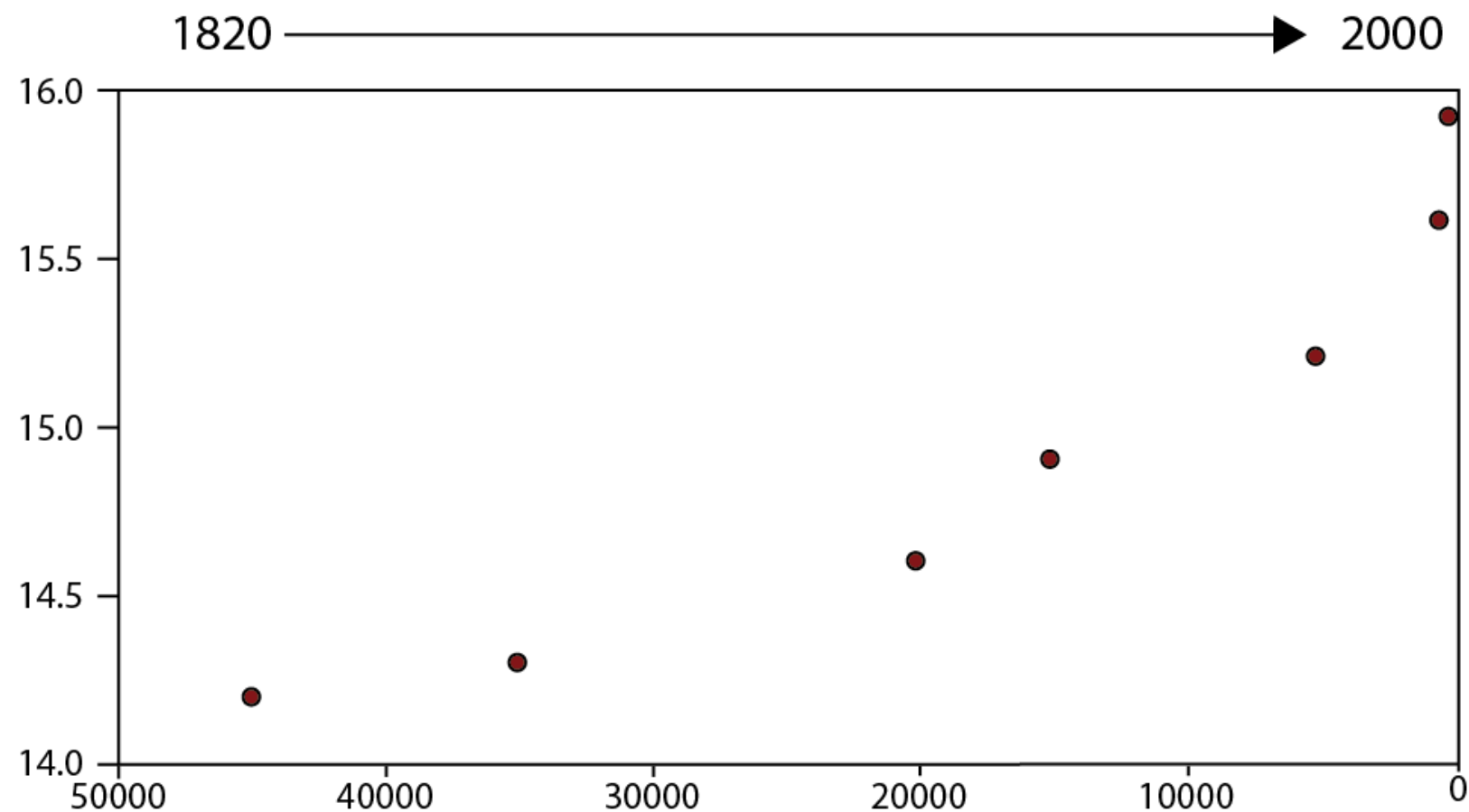


[www.climatica.org.uk](http://www.climatica.org.uk)

Map of positive feedbacks with potential tipping points that could be triggered this century. Question marks (?) indicate system which are not yet fully understood. Figure courtesy of Lenton et al. (2008) (PNAS).

# KEY CONCEPTS

- **Critical thinking and 'flair'**
- **Correlation vs causation**
- There is an important distinction between two variables being correlated and having a cause and effect relationship

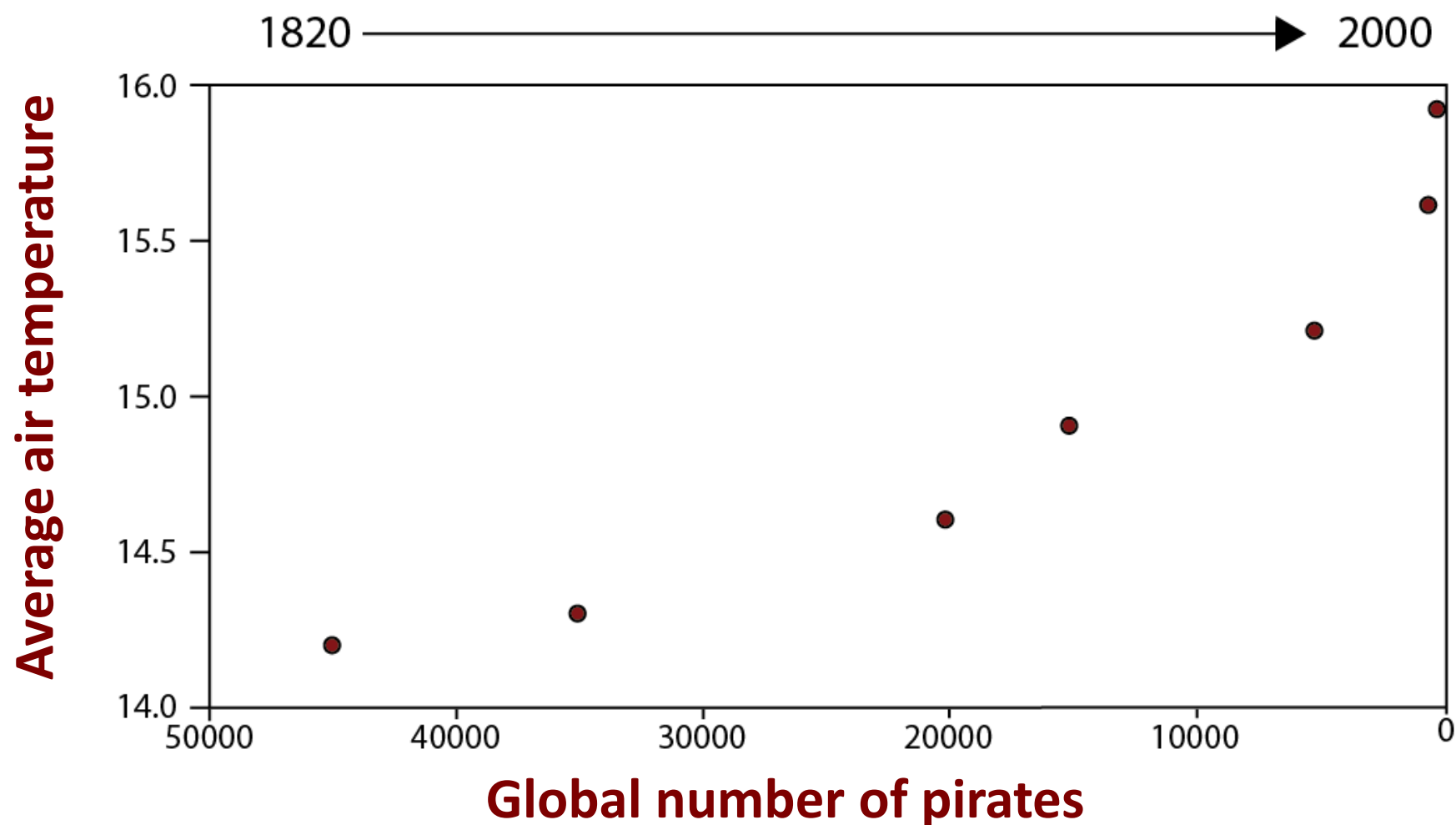


Two variables plotted against one another through time (1820 – 2000).  
They are clearly correlated to one another, but there is no cause and effect relationship.



# KEY CONCEPTS

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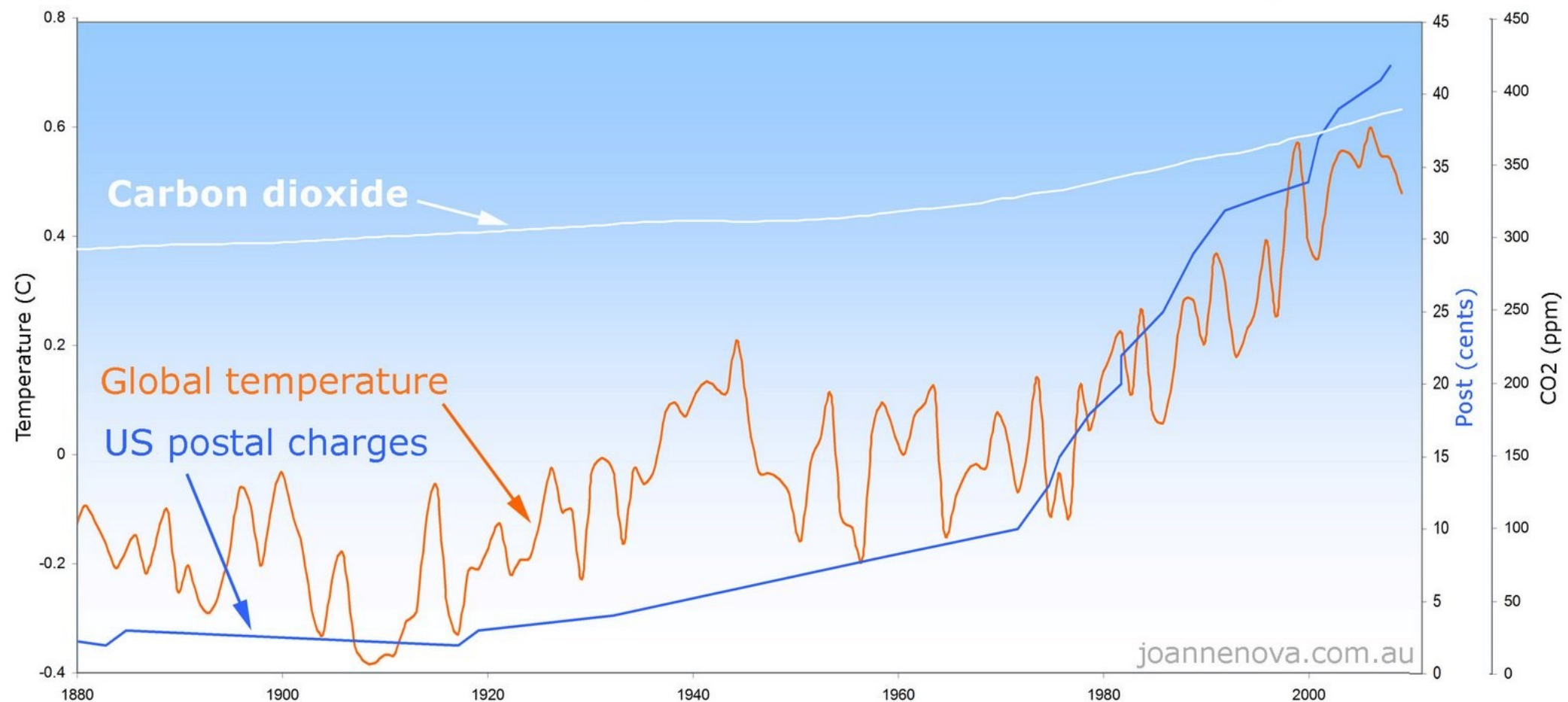


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# KEY CONCEPTS

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- Correlation vs causation
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## US Postal charges drive Global Warming





# EXAM QUESTION EXAMPLE

‘The Earth has a fever, and the fever is rising.... We are what is wrong, and we must make it right.’ (Al Gore, 2007)

In the context of global warming, discuss the extent to which you agree with this statement. (40 marks)

- Knowledge and understanding of the changes in global temperatures both over **long periods of time and in recent decades**, and the **rates of increase** in greenhouse gases (carbon dioxide, methane and nitrous oxide)
- **Critical understanding of the reasons** for these increases
- Knowledge and understanding of the **impacts of these increases**, at a **variety of scales**
- Critical understanding of the means by which **mitigation and/or adaptation** to can be achieved

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- Evidence in the **breadth/depth of supporting evidence** both for and against, using varying locations
- Recognition of the range of **organisations and individuals that have an opinion** on this issue, and the variety of contexts from which they arise e.g. political, economic and scientific
- Recognition of the **complexity of the issue** of global warming; some understanding of the debate surrounding the issue.



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In the context of global warming, discuss the extent to which you agree with this statement. (40 marks)

## Examiner comments:

- **...many answers were simplistic – often based on ill-informed arguments.** These were mostly **lacking in scientific or historical evidence** to support either side of the debate. On the other hand, there were **some students who presented precise details** of the enhanced greenhouse effect with **appropriate use of data** from organisations/pressure groups such as the IPCC and Copenhagen Dilemma. Some even referred to ‘Global Weirding’ - the thoughts of another ‘think-tank’ based in the USA. There was some discussion of **ice core analysis, pollen analysis, dendrochronology, historic data/events and other evidence...**

# RESOURCES EXAMPLES – WEBSITES

[www.climatica.org.uk](http://www.climatica.org.uk)



<http://www.antarcticglaciers.org>



<http://www.skepticalscience.com>



# RESOURCES EXAMPLES – BLOGS

<http://blogs.plos.org/models/>



Sunday, April 06, 2014 | Another PLOS Blog

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## ALL MODELS ARE WRONG

... but some are useful. A grown-up discussion about how to quantify uncertainties in modelling climate change and its impacts, past and future.

[« Older posts](#)

## Whether environmental modellers are wrong

By [Tamsin Edwards](#)  
Posted: March 3, 2014

[SHARE](#) [f](#) [t](#) [e](#) [...](#)

[This is a comment invited by [Issues in Science and Technology](#) as a reply to the article "When All Models Are Wrong" in their [Winter 2014](#) issue. The article is not online there but has been [archived by thefreelibrary.com](#). My comment will appear in the Spring 2014 issue.]

I was interested to read Saltelli and Funtowicz's article "When All Models Are Wrong"<sup>1</sup>, not least because several people sent it to me due to its title and mention of my blog<sup>2</sup>. The article criticised complex computer models used for policy making – including environmental models – and presented a checklist of criteria for improving their development and use.

As a researcher in uncertainty quantification for environmental models, I [stol.ac.uk...](#) transparent and critical of our own

### Comments

- [ATheoK](#) on [Whether environmental modellers are wrong](#)
- [Garhighway](#) on [Whether environmental modellers are wrong](#)
- [davidlhagen](#) on [Pause for thought](#)
- [John Russell](#) on [Pause for thought](#)
- [Tamsin Edwards](#) on [Whether environmental modellers are wrong](#)

### Recent posts

- [Whether environmental modellers are wrong](#)



**Tamsin Edwards, PhD** is a climate scientist at the University of Bristol. She uses computer models to study climate change, what impacts climate change has on sea level and the environment, and how confident we can be in our knowledge of the past and our predictions of the future. Tamsin Edwards

## Arctic Research

*Reports from INTERACT field sites*



[Blogs from the field](#) [Blogs by Station Managers](#) [Blog by TA management team](#) [About INTERACT bloggers](#) [Archived blogs](#)

## Welcome!

aching at Arctic Research Blogs with nine new blogs starting up during places like Zackenberg in Greenland, Oulanka in Finland, Finse in n Sweden and Khibiny in Russia!

logs is a blog site of [INTERACT](#), an EU project that offers researchers ic through a Transnational Access Programme.

ed by researchers\* that are using the opportunity to do field work on a pics, but all related to the Arctic environment. All the different blogs can

### Recent Posts

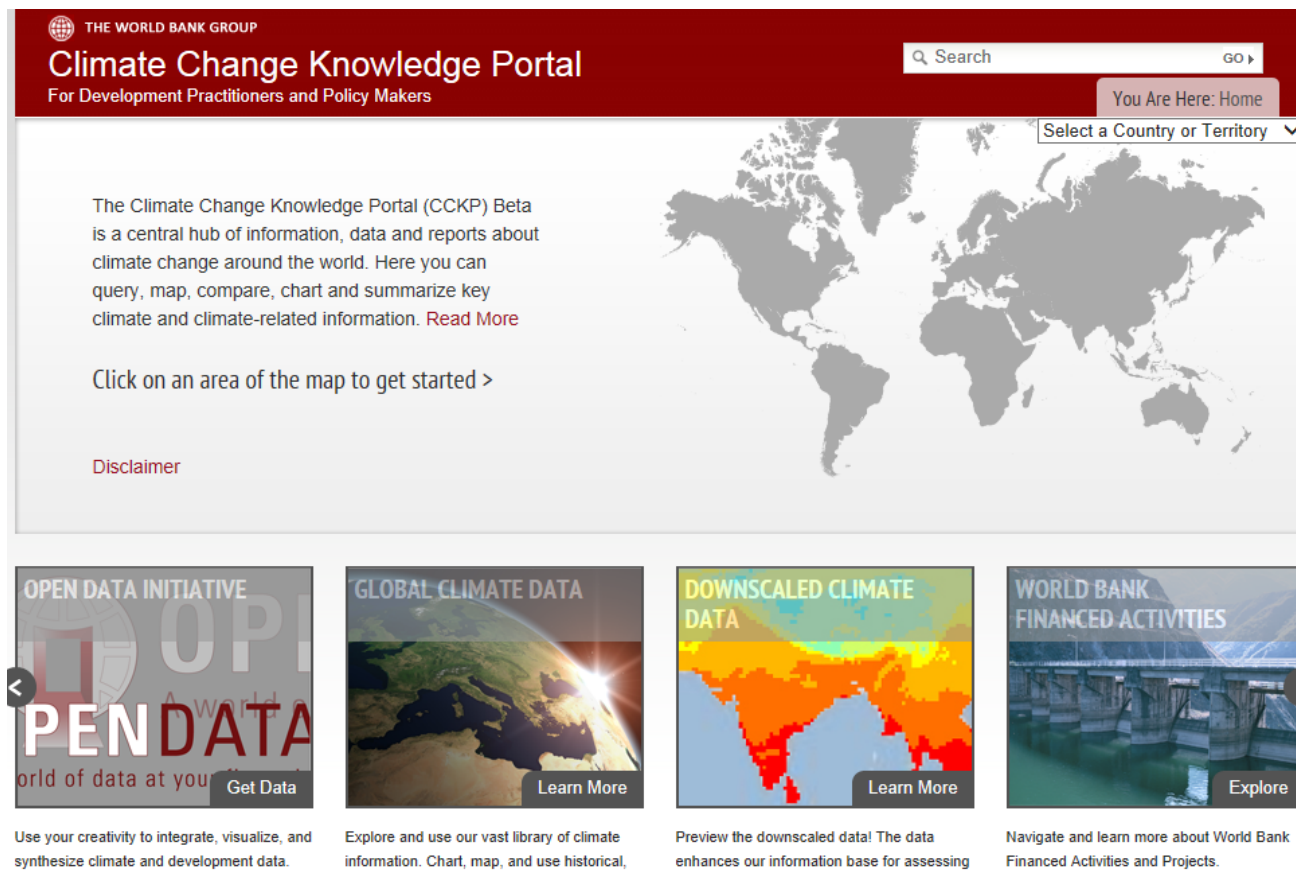
- [Following plant invaders](#)
- [Go west!](#)
- [Get ready for Season 3!](#)
- [Mission accomplished](#)
- [Season's Greetings](#)

### Archives

- [April 2014](#)
- [March 2014](#)
- [February 2014](#)
- [December 2013](#)
- [November 2013](#)
- [October 2013](#)

<http://arcticresearch.wordpress.com/>

# RESOURCES EXAMPLES – DATASETS



THE WORLD BANK GROUP

## Climate Change Knowledge Portal

For Development Practitioners and Policy Makers

Search  GO

You Are Here: Home

Select a Country or Territory

The Climate Change Knowledge Portal (CCKP) Beta is a central hub of information, data and reports about climate change around the world. Here you can query, map, compare, chart and summarize key climate and climate-related information. [Read More](#)

Click on an area of the map to get started >

[Disclaimer](#)

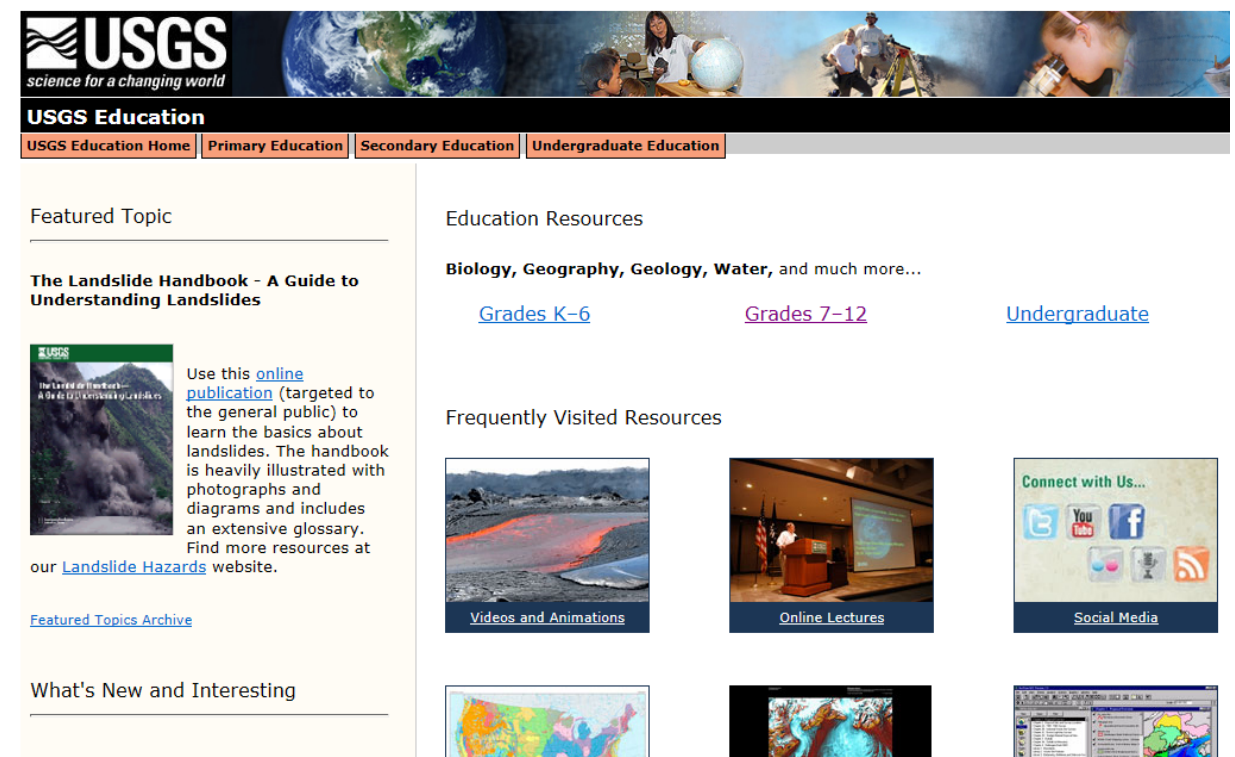
**OPEN DATA INITIATIVE**  
A World of data at your fingertips. [Get Data](#)

**GLOBAL CLIMATE DATA**  
Explore and use our vast library of climate information. Chart, map, and use historical, [Learn More](#)

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Preview the downscaled data! The data enhances our information base for assessing [Learn More](#)

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<http://sdwebx.worldbank.org/climateportal/index.cfm>



**USGS**  
science for a changing world

## USGS Education

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### Featured Topic

#### The Landslide Handbook - A Guide to Understanding Landslides

Use this [online publication](#) (targeted to the general public) to learn the basics about landslides. The handbook is heavily illustrated with photographs and diagrams and includes an extensive glossary. Find more resources at our [Landslide Hazards](#) website.

[Featured Topics Archive](#)

### What's New and Interesting

### Education Resources

**Biology, Geography, Geology, Water, and much more...**

[Grades K-6](#) [Grades 7-12](#) [Undergraduate](#)

### Frequently Visited Resources

[Videos and Animations](#) [Online Lectures](#) [Social Media](#)

<http://education.usgs.gov/>



# HINTS FOR USING SCIENCE OUTREACH

- **Follow the trends in outreach** – explore the options available
- **Get in touch with local universities and museums** – many offer open days, talks, and teachers evenings
- **Sign up to mailing lists**
- **Use Twitter** – follow academics, University departments, research centres, news outlets, and other outreach providers
- **Many datasets exist** – some of the websites listed here provide some useful and highly accessible resources for schools
- **Look beyond the UK** – the European Geosciences Union (EGU), the American Geophysical Union (AGU), NASA, and the United States Geological Survey (USGS) all provide excellent resources for schools and colleges
- **Contact us at Climatica** – if there is something you would like to see, or have any questions, then let us know and we will work it into our site!  
(climaticauk@gmail.com)

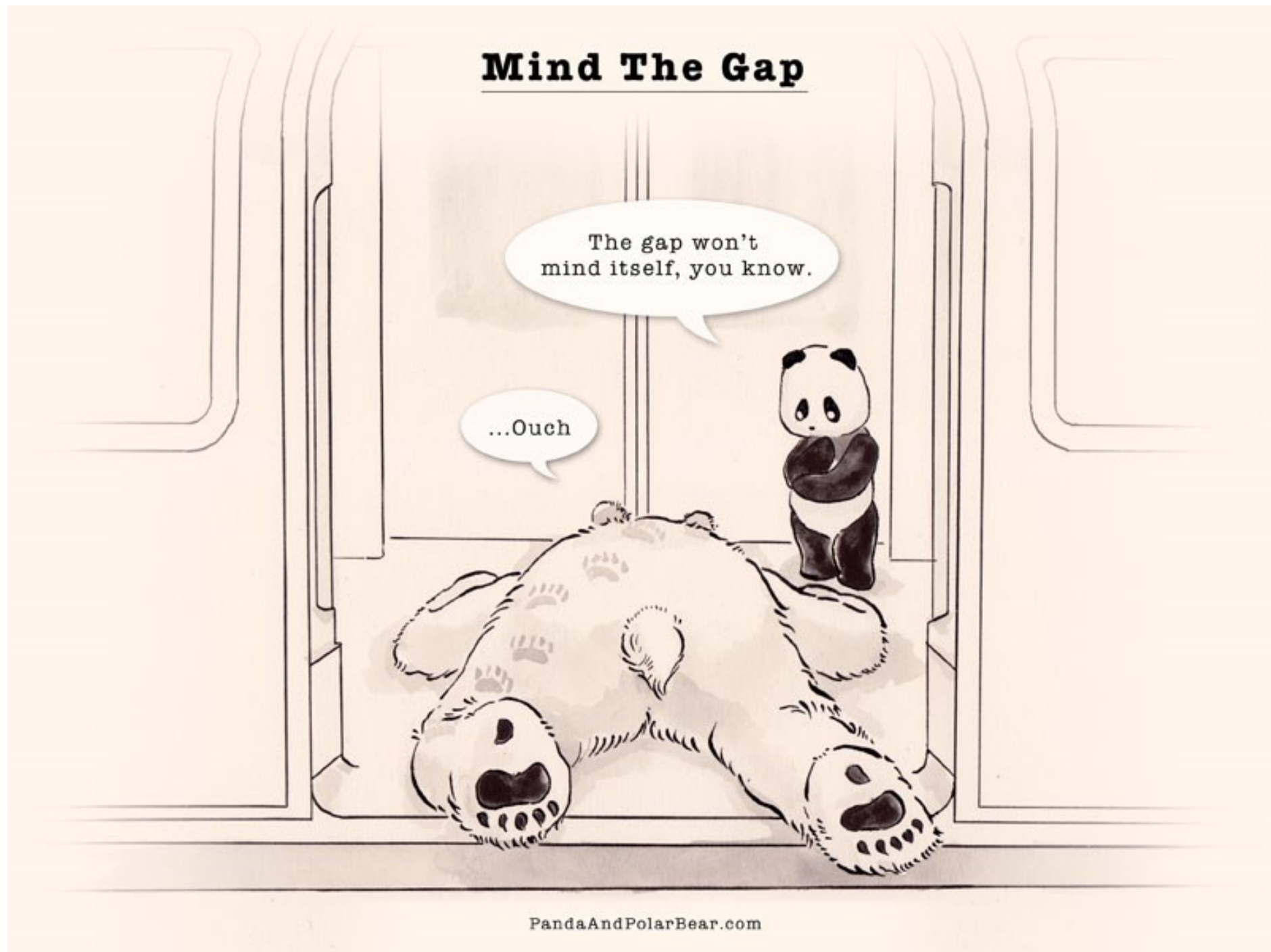
# CONCLUSIONS

## **From research stations to public platforms**

- Scientists drive the research agenda
- But there is a need for more frequent communication to the wider public and schools
- A range of outreach and educational resources exist:
  - Websites, blogs, museum exhibitions, datasets
- Scientists play an important role in making their findings more accessible...
- ...and teachers play an important role in delivering these datasets
- Developing a synergy between teachers and academics is important



# QUESTIONS



# Visit us at **stand 16**

## Enter our prize draw to win a £50 Amazon voucher!





Thank you

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[ocr.humanities@ocr.org.uk](mailto:ocr.humanities@ocr.org.uk)

facebook.com/ocrexams

@ocrexams