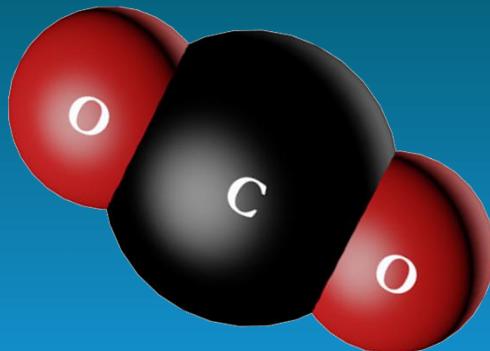
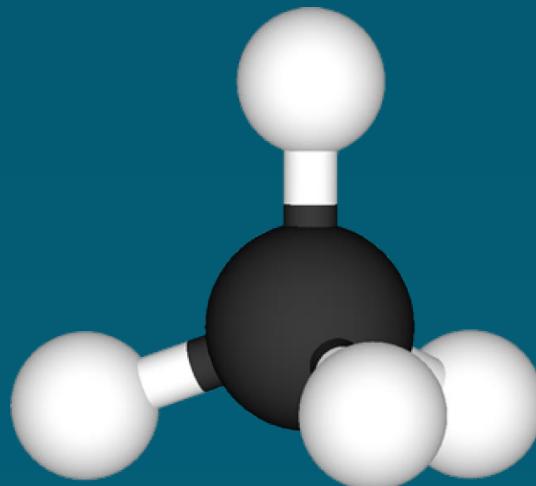
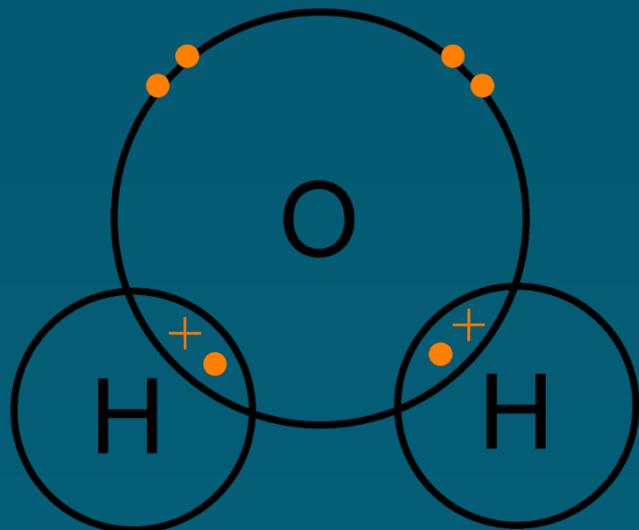


Teacher Notes

- Resources:
 - Would I Lie To You? climate change cards – on window ledge in science office. 30 packs – 10-15 needed per class if working in threes/pairs

Starter: What's the link?



Name the three substances.
What topic links them?

Greenhouse Gases

Success Criteria

Aiming for...

4

- Describe the greenhouse effect
- Name three greenhouse gases
- State some human activities that affect the proportion of greenhouse gases in the atmosphere

6

Same as 4 **and**:

- Explain the greenhouse effect
- Explain how greenhouse gases increase the temperature of the atmosphere
- Explain how human activity can change the proportion of greenhouse gases in the atmosphere
- Explain the importance of peer-reviewed evidence

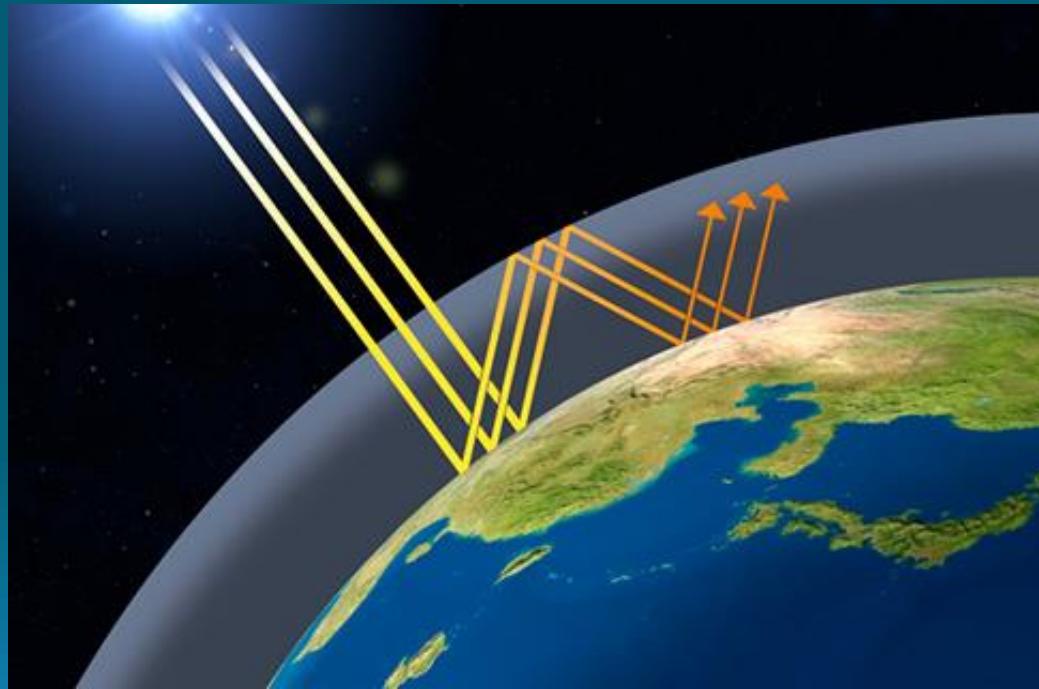
8

Same as 6 **and**:

- Justify why scientists and the public may disagree about the cause of climate change
- Explain the difference between global warming and the greenhouse effect
- Evaluate evidence to suggest if global warming is man-made or natural.

Greenhouse gases

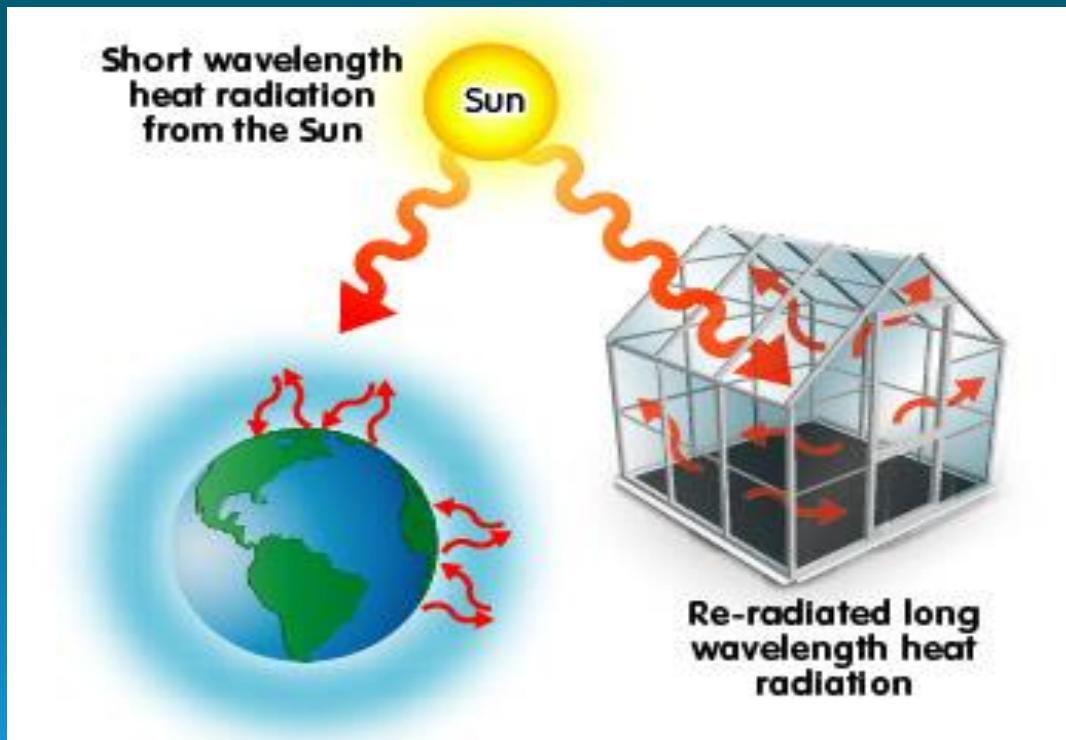
- Greenhouse gases in the atmosphere maintain temperatures on Earth high enough to **support life**.



- Water vapour (H_2O), carbon dioxide (CO_2) and methane (CH_4) are greenhouse gases

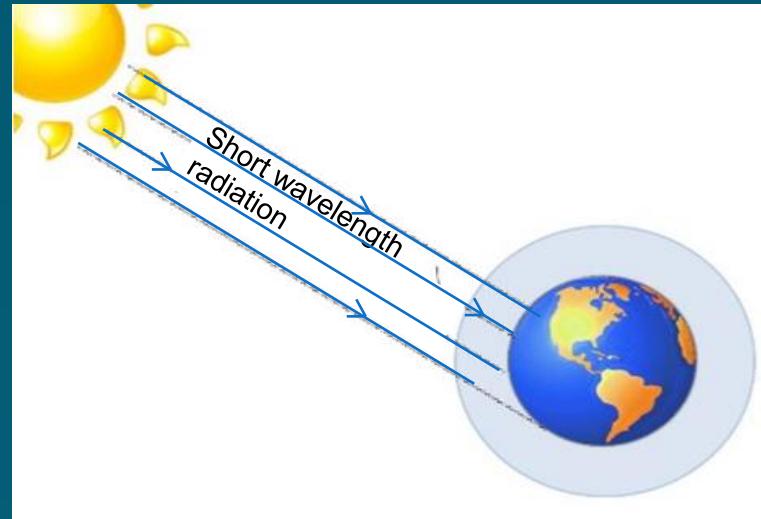
Greenhouses

- Greenhouses allow **short-wavelength** radiation from the Sun through
- But the glass **absorbs** the **long-wavelength** radiation emitted from *inside* the greenhouse
- This keeps the plants inside the greenhouse warm.

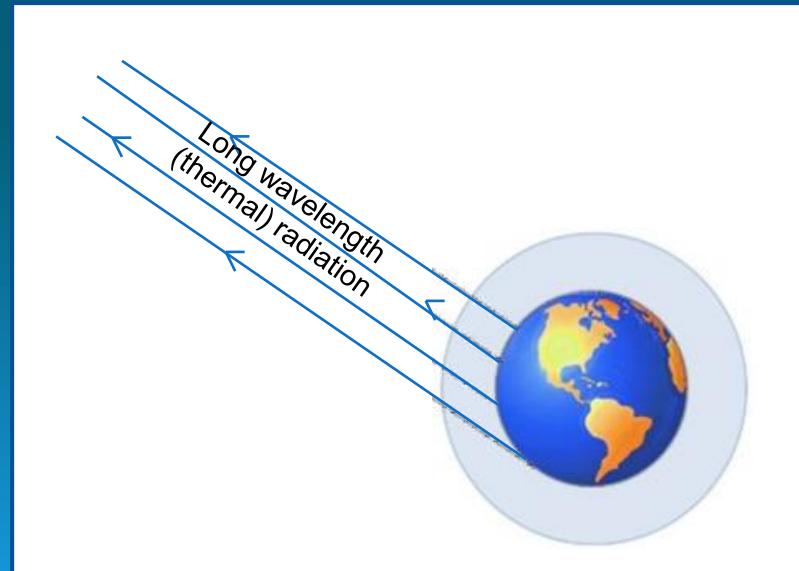


The greenhouse effect

1. The Sun emits **short-wavelength** radiation e.g. ultraviolet light, which warms the Earth

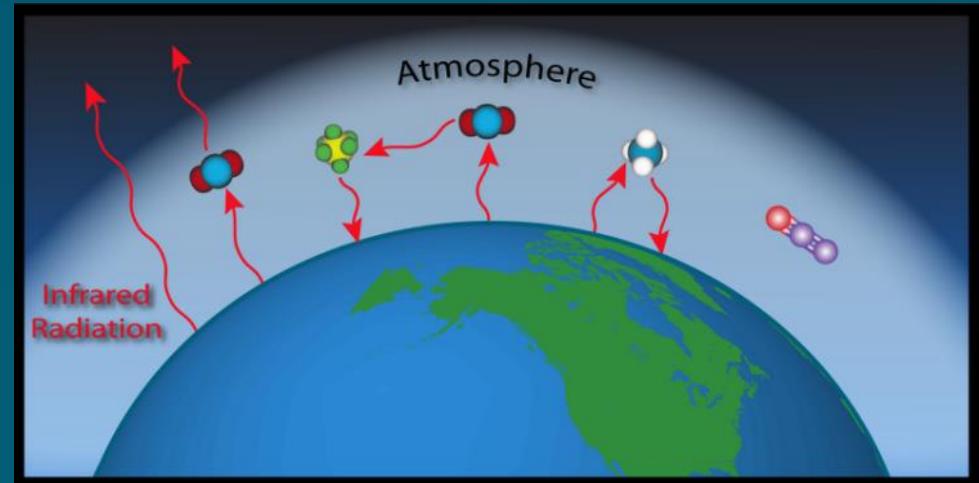


2. The Earth loses heat by emitting **long-wavelength** radiation e.g. thermal infrared.

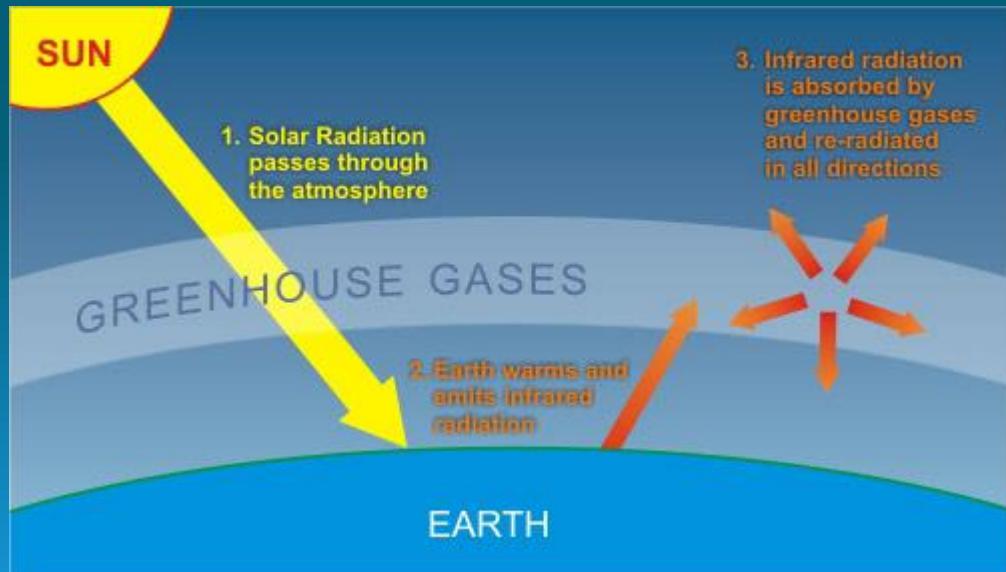


The greenhouse effect

3. Greenhouse gases **absorb** some of the long-wavelength radiation



4. They **re-radiate** this thermal radiation in all directions, including back to Earth. This warms the atmosphere.



The Greenhouse Effect

Some solar radiation is reflected by the Earth and the atmosphere.

Most radiation is absorbed by the Earth's surface and warms it.

Some of the infrared radiation passes through the atmosphere. Some is absorbed and re-emitted in all directions by greenhouse gas molecules. The effect of this is to warm the Earth's surface and the lower atmosphere.

Infrared radiation is emitted by the Earth's surface.

The greenhouse effect

- Without the greenhouse effect, Earth would be **too cold** to support life.
- But humans are increasing the levels of greenhouse gases in the atmosphere, which is warming the Earth **too much**.

<https://www.youtube.com/watch?v=oJAbATJCugs>

Video – greenhouse effect and global warming

Human activities

- Human activities increase the amounts of:
 - Carbon dioxide
 - Methane
- in the atmosphere. You have to learn 2 activities for each off by heart.

Carbon dioxide

Methane

Human activities

- Human activities increase the amounts of:
 - Carbon dioxide
 - Methane
- in the atmosphere. You have to learn 2 activities for each off by heart.

Carbon dioxide

1. Burning fossil fuels for electricity/running cars e.g. combustion of propane:

Write the word and balanced symbol equations in your notes.



2. Deforestation. Cutting down trees reduces the amount of CO₂ absorbed from the atmosphere by photosynthesis



Human activities

- Human activities increase the amounts of:

- Carbon dioxide
- Methane

in the atmosphere. You have to learn 2 activities for each off by heart.



Methane

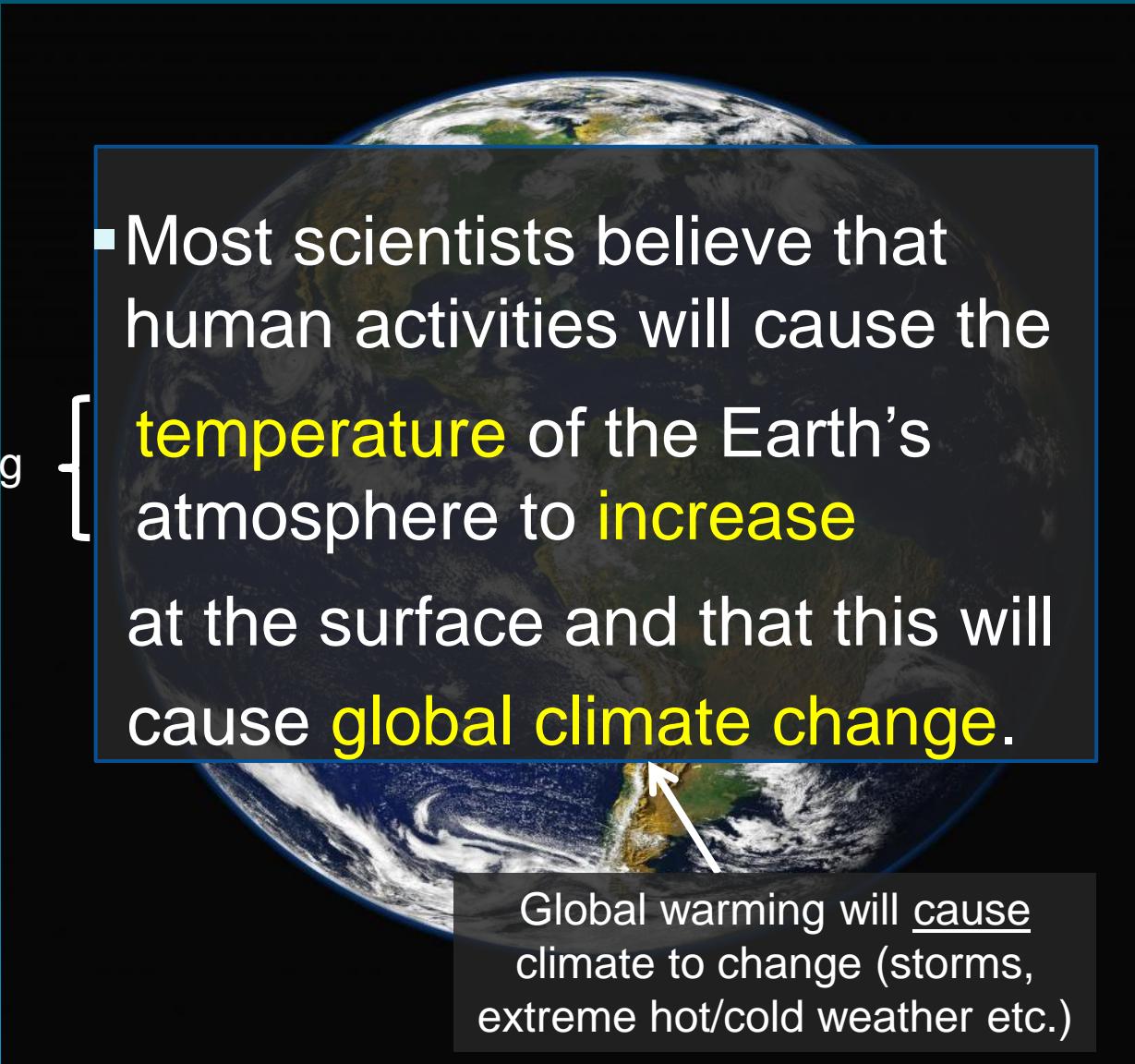
1. **Cattle producing methane.** Cattle reared for humans (to eat as beef or for milk) produce methane
2. **Landfill sites.** The decay of waste in landfill by microorganisms produces methane.



Climate Change

Global warming {

- Most scientists believe that human activities will cause the **temperature** of the Earth's atmosphere to **increase** at the surface and that this will cause **global climate change**.



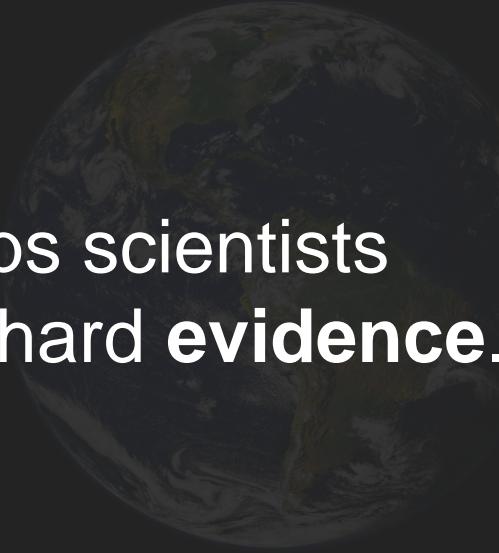
Global warming will cause climate to change (storms, extreme hot/cold weather etc.)

Peer-reviewed evidence

Most scientists believe that human activities will cause the

The peer-review process stops scientists publishing **opinions** rather than hard **evidence**.

at the surface and that this will cause **global climate change**.



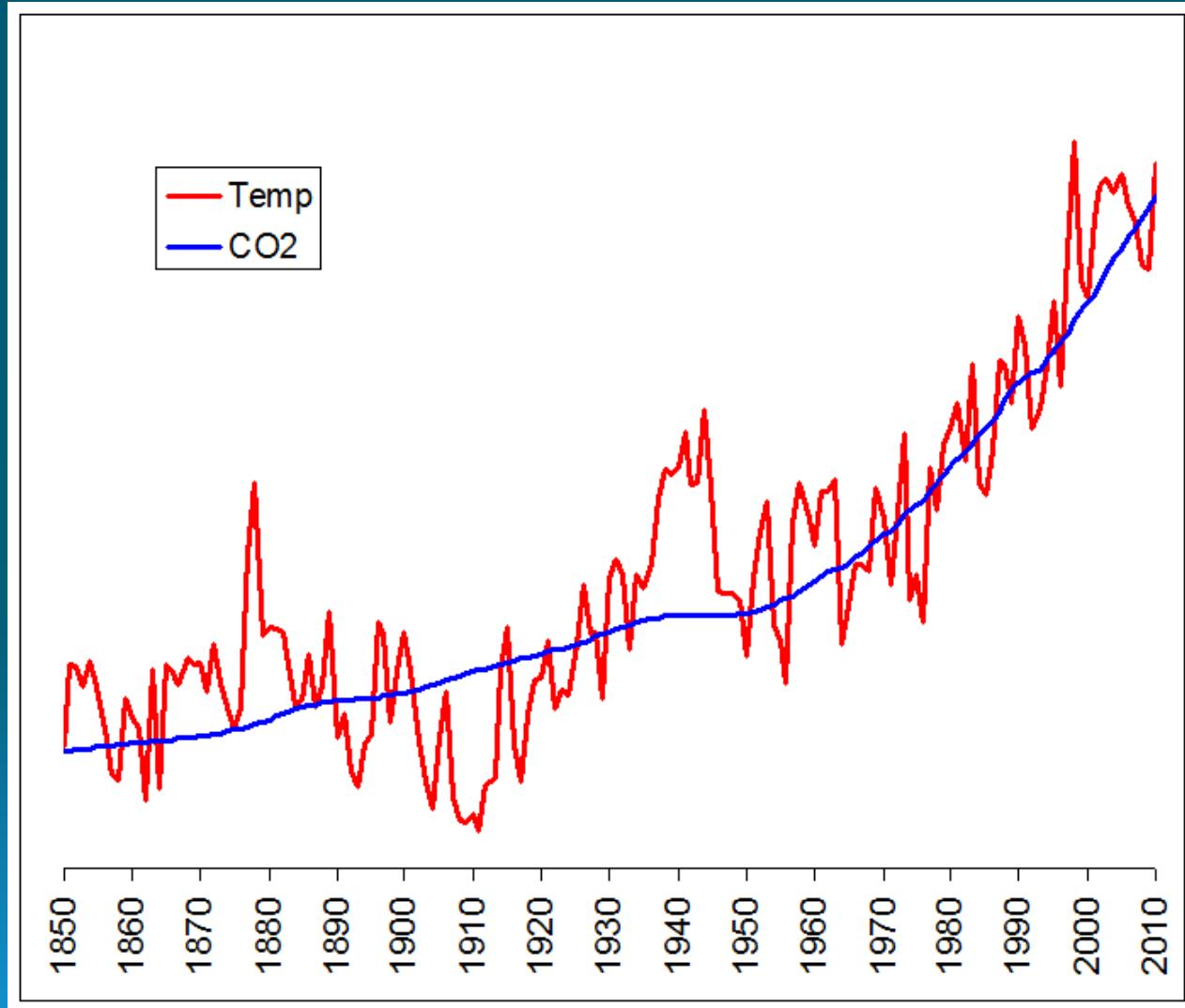
This is based on **peer-reviewed evidence**.

Other scientists (peers) checking the evidence before it is published.



Scientists collecting and analysing data (evidence)

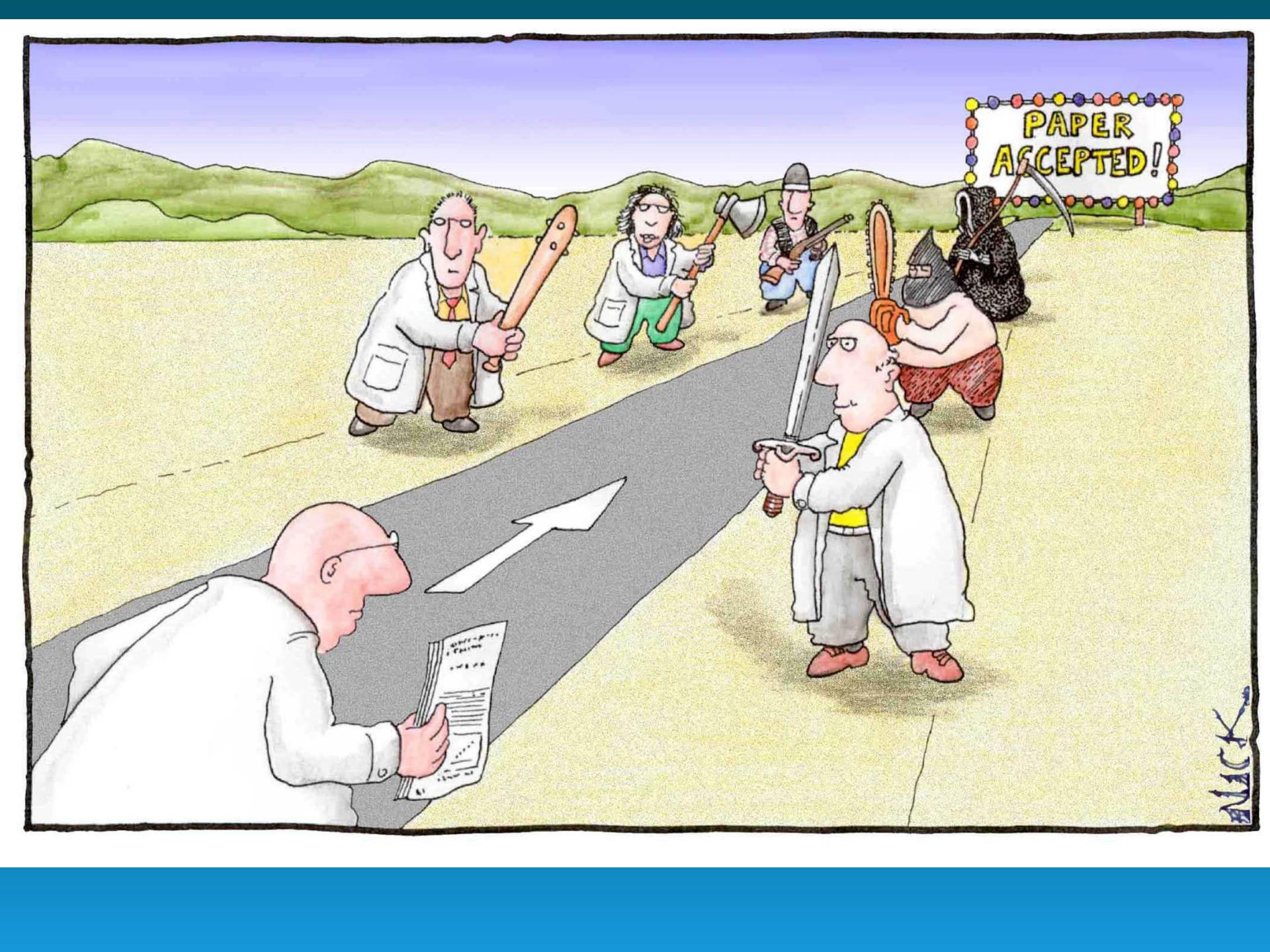
Peer-reviewed evidence



How does this graph show that human activities are causing global warming?

A tiny minority of scientists and many non-scientists think that the CO₂ is not **causing** the increase in temp.

Our knowledge of the greenhouse effect suggests that CO₂ **does** cause global warming.



PAPER
ACCEPTED!

A cartoon illustration depicting a group of researchers in lab coats working on a road to academic success. In the foreground, a researcher lies on the road, reading a newspaper. Behind him, another researcher walks away, carrying a large sword. Further down the road, three other researchers are working: one with a shovel, one with an axe, and one with a chainsaw. In the background, a banner hangs across the road that reads "PAPER ACCEPTED!" in yellow letters, surrounded by colorful balloons. The road leads towards a green landscape under a blue sky.

NICK

Modelling Climate Change

Scientist has hypothesis

Scientist collects data and writes computer program = model

Model ‘predicts’ future

- Modelling something as complex as climate change is difficult!
- Scientists have a duty to report any **uncertainties** in their models.
- **Non-scientists** with a vested interest may present a biased opinion based on only part of the evidence in the media.

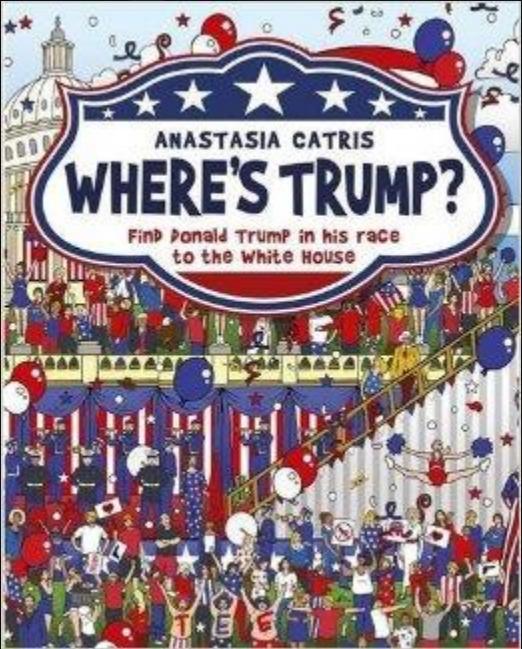
1

In threes/fours: Shuffle the 14 cards.
Deal them out.

2

For the first 7 cards, decide together if the statement is a **truth** or a **lie**. Decide who might say it and write it on the card.

For the last cards, take turns to read the quote to your group and try to convince them it is a truth. Your group has to argue that it is a lie. Decide who makes the best argument and keeps the card. Most cards wins.



One of the cards is a
genuine quote of
US President Donald Trump.
Which one?



On November 6, 2012, Donald Trump tweeted: "The concept of global warming was created by and for the Chinese in order to make U.S. manufacturing non-competitive."

On October 19, 2015, he then tweeted: "It's really cold outside, they are calling it a major freeze, weeks ahead of normal. Man, we could use a big fat dose of global warming!"

Discuss: Why do scientists have a responsibility to communicate their results to a **wide range of audiences?**

Peer-reviewed evidence

- Watch the video:
- <http://www.bbc.co.uk/news/world-australia-37091391>

The politician believes that the data has been ‘corrupted’.



- With the knowledge that scientific evidence must be peer-reviewed, how would you explain to the politician that the data is to be believed?
- *Extension:*
The full version includes a major misunderstanding of how to interpret graphs!
- <https://www.youtube.com/watch?v=LxEHW6Lbu8&t=617s>

Starter: 5, 4, 3, 2, 1

On a mini-whiteboard write:

- 5 gases in the Earth's early atmosphere
- 4 human activities causing an increased greenhouse effect
- 3 greenhouse gases
- 2 methods of reducing the carbon footprint
- 1 argument used by people who don't believe in climate change

Global Climate Change

Success Criteria

Aiming for...

4

- List 4 of the potential outcomes of climate change
- State the definition of *carbon footprint*
- List some ways to reduce a carbon footprint

6

- Same as 4 **and:**
- Explain the possible effects of global climate change and why they are difficult to predict
 - Explain possible methods to reduce emissions
 - Explain some of the problems in trying to reduce emissions

8

- Same as 6 **and:**
- Evaluate the scale, risk and environmental impact of global climate change
 - Justify why reducing greenhouse gas emissions can be difficult to achieve

Effects of Global Climate Change

- You have to know 4 potential effects off by heart:

1. Flooding
2. Extreme weather
3. Changes in rainfall
4. Extinction

Effects of Global Climate Change

- You have to know 4 potential effects off by heart.

1. Flooding
2. Extreme weather
3. Changes in rainfall
4. Extinction

1. As average global temperature increases:
 - Polar ice caps melt
 - Sea level rises
 - Flooding of land results
Flooding causes coastal erosion/habitat loss



Effects of Global Climate Change

- You have to know 4 potential effects off by heart.

1. Flooding
2. Extreme weather
3. Changes in rainfall
4. Extinction



2. Extreme weather events more common and severe e.g. storms
 - Causes damage



Effects of Global Climate Change

- You have to know 4 potential effects off by heart.

1. Flooding
2. Extreme weather
3. Changes in rainfall
4. Extinction

3. Changes in rainfall:

- How much rain
- When it occurs
- Where it occurs

Heavy rain can damage crops.
Lack of rain causes drought.
Affects food production.



Effects of Global Climate Change

- You have to know 4 potential effects off by heart.

1. Flooding
2. Extreme weather
3. Changes in rainfall
4. Extinction

4. As climate changes rapidly, animals and plants cannot adapt to the environment quick enough and die out.



Rodent species on Great Barrier Reef island - first mammal to become extinct due to climate change