Climate change:
An introduction to the key issues

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We will summarise...

- Basic climate science
- Key climate change so far
- Key climate change to come
- Key climate impacts
- Carbon reduction pathways
- Carbon footprints

Brief note on sources

- Main source:
  - Intergovernmental Panel on Climate Change (IPCC)
  - UN advisory body
  - Regularly brings together 1000s of climate researchers to summarise latest scientific evidence

Basic climate science

Greenhouse effect & global warming

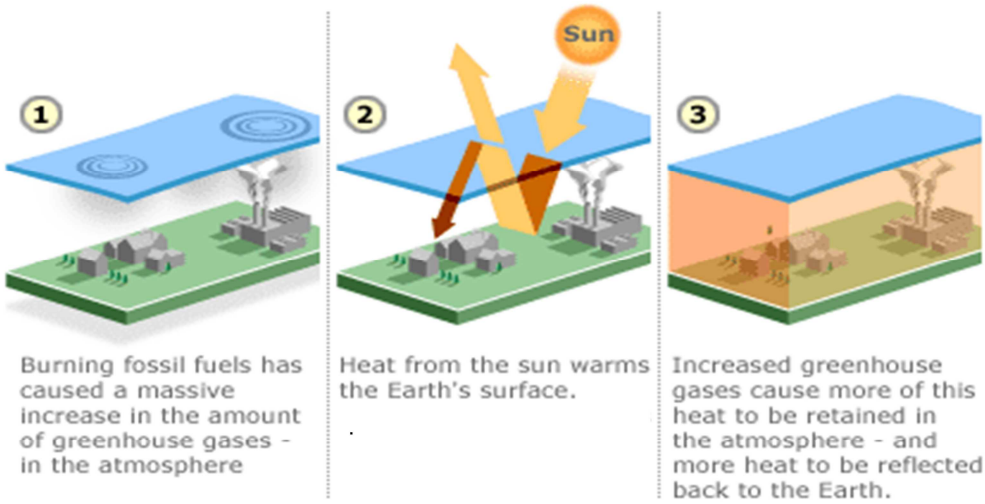


Diagram from BBC website

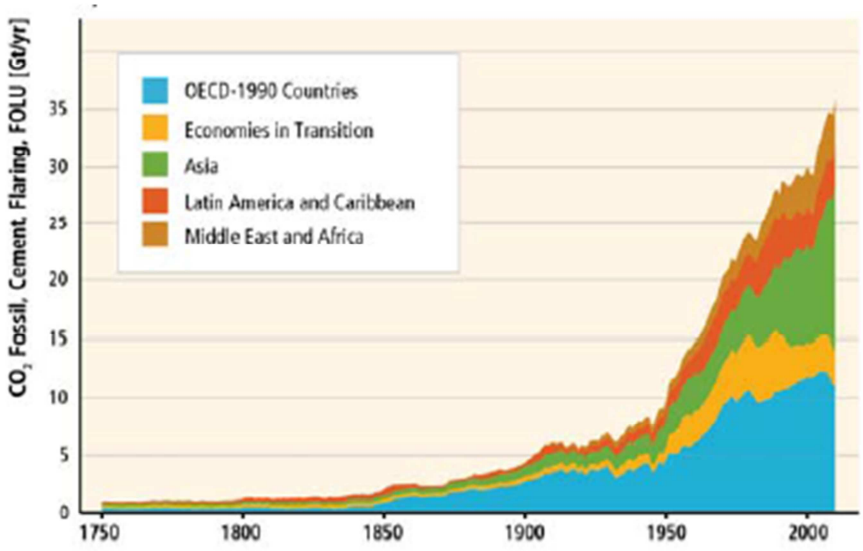
Main greenhouse gases emitted by human activity

Greenhouse gas (GHG)	*Main anthropogenic (human) sources*
Carbon dioxide (CO_2)	• **burning fossil fuels (coal, oil, gas)** • **deforestation**
Methane (CH_4)	• cattle etc • gas pipeline leaks • paddy fields
Nitrous oxide (N_2O)	• artificial fertilisers • nylon production
'F' gases/ Halocarbons (HFCs, PFCs, SF_6)	• refrigerators • air-conditioning • electronics industry

- Table based on Houghton (2004)
- CO2 is responsible for more than ¾ of warming (IPCC, 2014b)
- Greenhouse gas emissions are often collectively referred to as 'carbon emissions' – the total warming effect of all greenhouse gases can be calculated by added together the emissions of each gas multiplied by scaling factors (called the 'global warming potentials')

Climate change to date

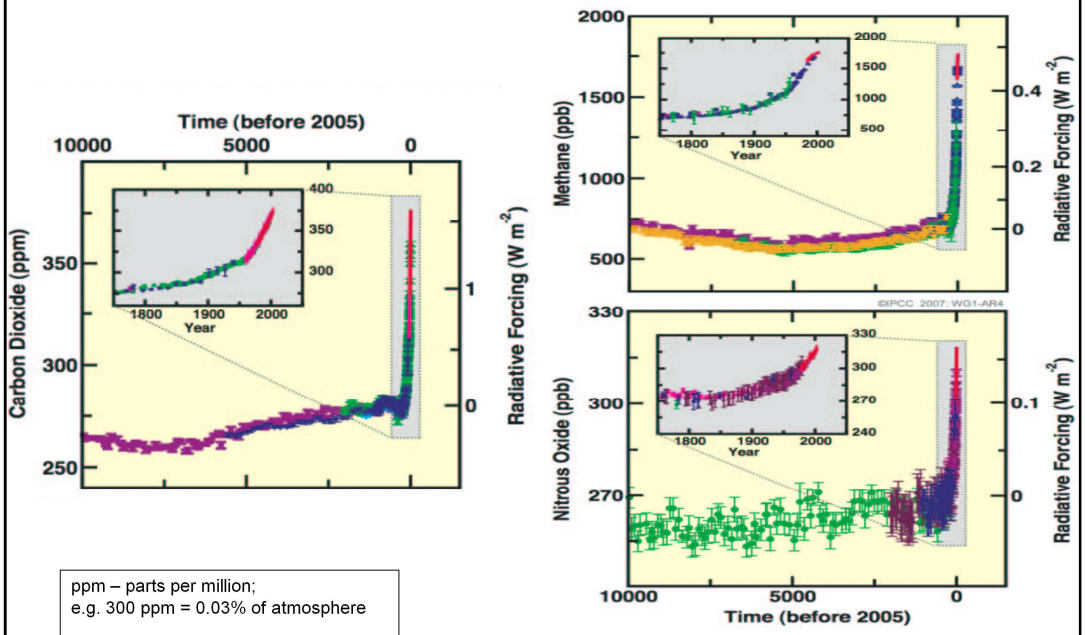
Carbon dioxide emissions, 1750-2010



IPCC (2014)

IPCC (2014b)

Changes in atmospheric levels of GHGs over last 10,000y

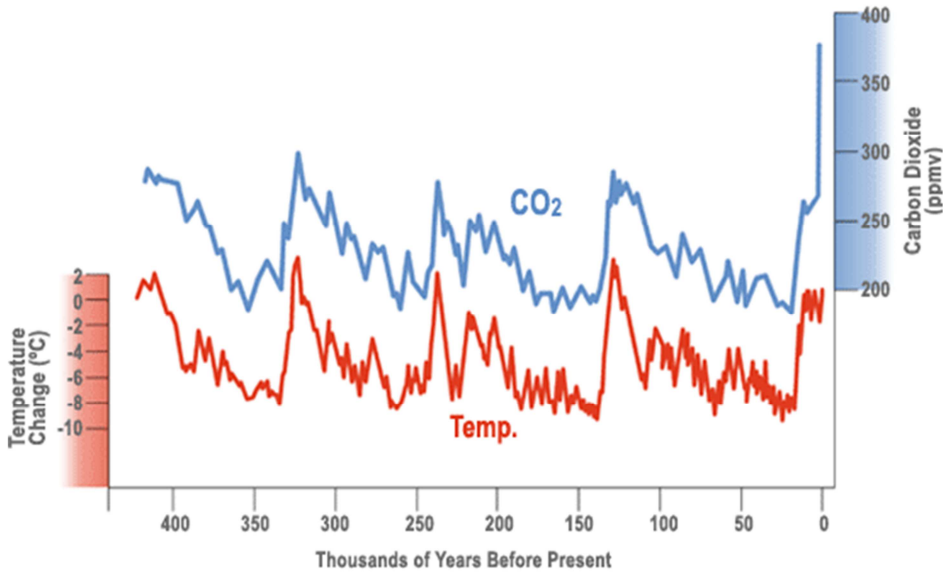


ppm – parts per million;
e.g. 300 ppm = 0.03% of atmosphere

IPCC (2007)

IPCC (2007b)

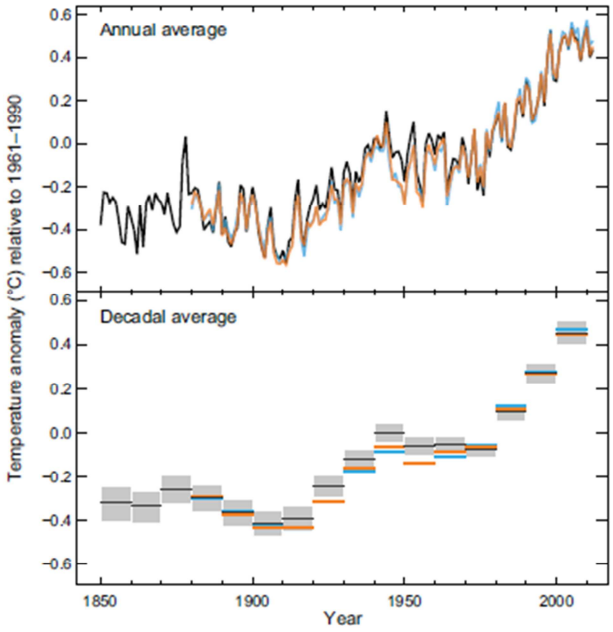
Climate change over last 430,000 y



Petit et al (1999)

- CO2 level in atmosphere and global temperature move up and down together (historically due to 'wobbles' in Earth's orbit around the Sun)
- Temperature difference between the Ice Ages and the warm interglacial periods such as at present has been 4-7ºC (IPCC, 2007c)
- Through fossil fuel burning and other activities, we have raised the CO2 level fair beyond any level seen for at least 430,000y
- Graph data from Petit et al (1999)
- Current temp is 0.85ºC higher than in ~1880 (IPCC, 2013)

Global temperature rise, 1850-2012



IPCC (2013)

IPCC (2013)

Major change, 1900-2010

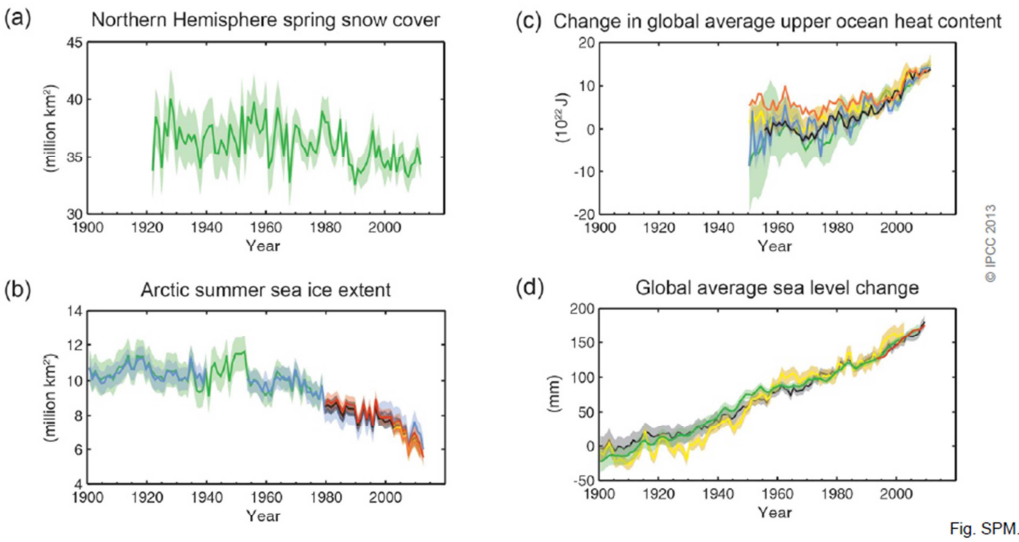


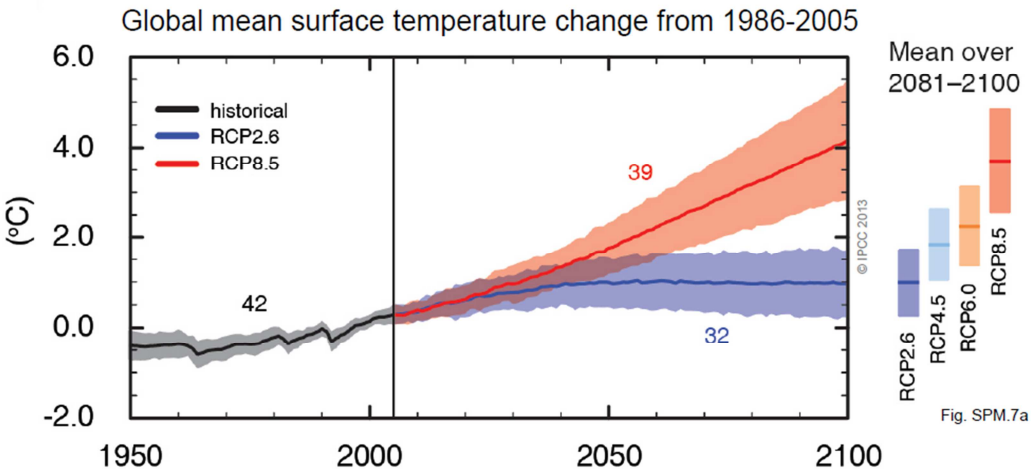
Fig. SPM.3

IPCC (2013)

IPCC (2013)

Climate change to come

Future temperature projections



IPCC (2013)

IPCC (2013)

Major impacts on:

- Fresh water resources
- Coastal areas
- Food supplies
- Human health
- Human security
- Wildlife

• Higher temperatures leads to more energetic/dramatic/extreme weather

• Fresh water resources - dry areas likely to get drier, wet areas get wetter; hundreds of millions more suffering from 'water stress' over next few decades; Increased storminess likely to increase flood risk

• Coastal areas - Sea-level rise will lead to major increase in flooding risk and loss of land; Huge numbers affected (Currently, half world population lives in coastal areas); Mega-deltas of Asia and Africa, and small island states, will be most affected

• Food supplies - major disruption as crop productivity falls in tropics & sub-tropics and, eventually, everywhere

• Human health – much more malnutrition, disease, 'heat stress'

• Human security – more refugees, increasing risk of war

• Potential for massive loss of plant and animal species – coral reefs, rainforests especially under threat

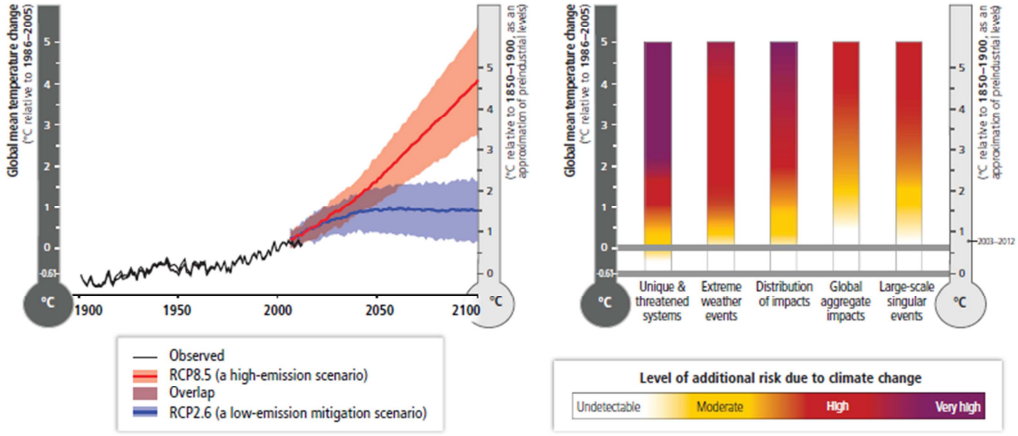
Houghton (2004); IPCC (2007); IPCC (2014a)

Impacts: general aspects

- Warming increases “severe, persistent and irreversible impacts”
- Risks are “greater for disadvantaged people”
- Tipping points: “abrupt”/ “irreversible”
  - e.g. melting of ice sheets, die-back of rainforests/ coral reefs, change in ocean currents, release of frozen methane

IPCC (2014a)

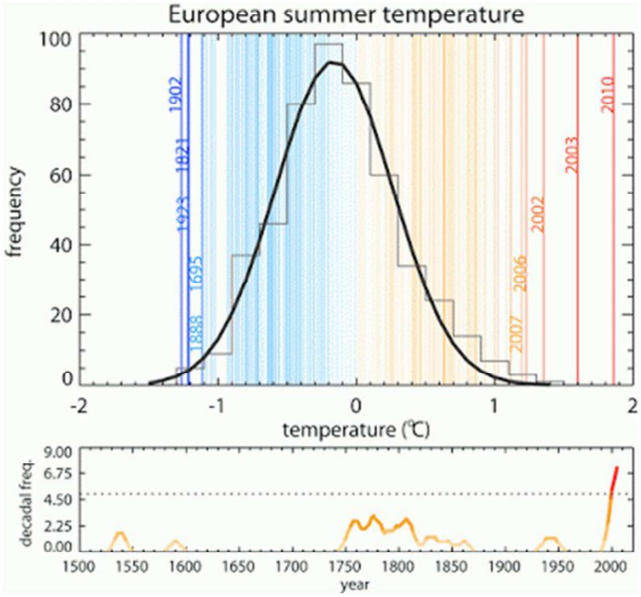
Likelihood of impacts



IPCC (2014)

IPCC (2014a)

Case study: European heatwaves



Barriopedro et al (2011)

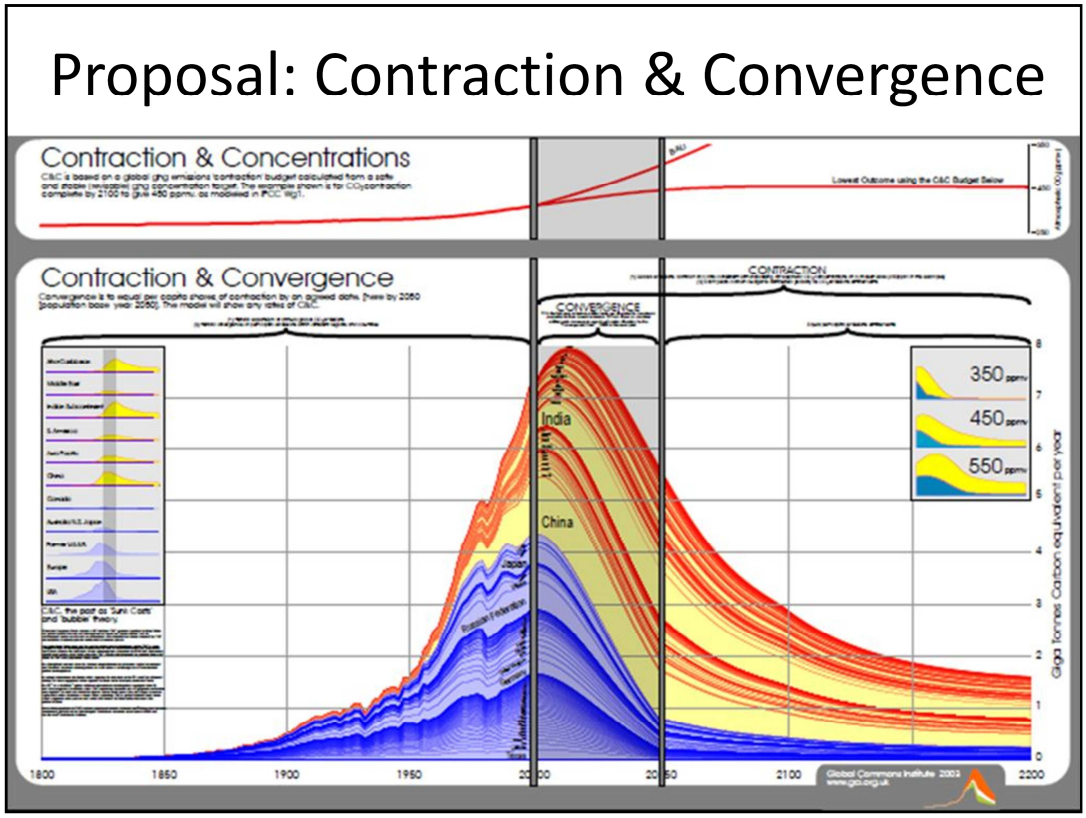
- European heatwaves of 2003 (centred on France/ Italy) and 2010 (centred on Russia) were the two hottest summers in the last 500y. Probability of another summer is 5-10 higher in the next 40y due to climate change (Barriopedro et al, 2011)
- Estimated death tolls (WMO, 2014):
    - 2003: 72,000 people
    - 2010: 56,000 people

Reducing greenhouse gas emissions

Reducing greenhouse gas emissions

- Need to prevent ‘dangerous’ climate change
  - International agreement on threshold of 2°C
- Equity
  - Concept enshrined in international treaties
  - Proposal: equal emissions allowance per person
- ‘Carbon budgets’
  - Allowable emissions over defined period of time
    - Measured in average tonnes of carbon per year
  - Similar to household budget

Proposal: Contraction & Convergence



Global Commons Institute (2003)

Current progress

- Legally binding targets for industrialised countries expired in 2012
- International voluntary emissions targets are still too high
  - e.g. 2020 targets need to be min. 20% lower
  - Global emissions need to peak mid-2010s
- UK legally binding target of 80% cut by 2050
  - Over 25% cut to date, but future action in doubt
  - Loopholes

• Shortcomings of 2020 targets - UNEP (2013)

• Estimates of peak for global carbon emissions to keep to 2C temperature rise is given in IPCC (2007a). Further discussion is in IPCC (2014b).

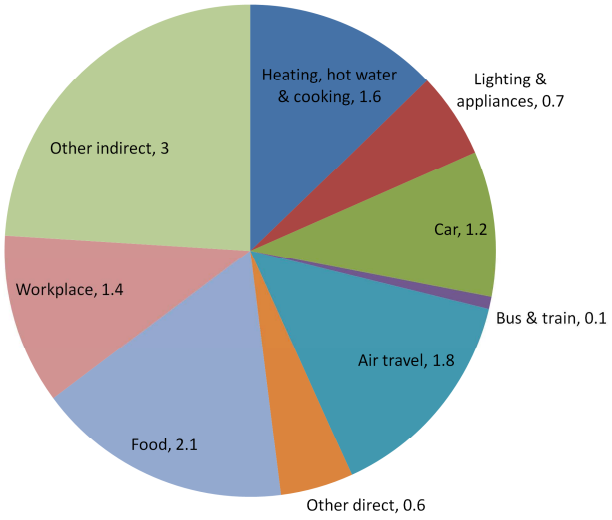
• Current UK emissions - DECC (2013)

Proposal: Zero Carbon Britain

- Ambitious plan to reduce UK carbon emissions to zero in 20 years
- 'Power down'
  - 56% reduction in energy use
  - Energy-efficient buildings; better public transport; healthier diet; electric cars; efficient industry
- 'Power up'
  - Mainly offshore wind + onshore wind; marine; others + connection to EU supergrid
- High employment generation potential

- Carbon budget used for Zero Carbon Britain results in carbon footprint per head of approx 3 tCO_2e
- Centre for Alternative Technology (2010)

Average greenhouse gas emissions per person in UK: 'Carbon footprint'



Source: Goodall (2007)

Total: 12.5 tonnes of carbon dioxide (equiv)

- Goodall (2007), pp73-74 & 233 & 249

Proposals for sustainable living

3 Tonne Club

- Move to average carbon dioxide emissions per person in the UK of 3 tonnes
- Based on carbon budget up to 2050 similar to Zero Carbon Britain
- Equal allowance per person

One Planet Living

- One Planet Living: 10 Principles - BioRegional Development Group (2014)
- Three tonne club - Women's Environmental Network (2008)

Signs of hope?

- Renewable energy technologies
  - Recent rapid global expansion
  - Rapid price falls, especially solar photovoltaics
  - Competing with fossil fuels in some areas
- Political initiatives
  - Climate technology agreements between US and China
  - More countries planning low carbon pathways
- Fossil fuel industry worries
  - Major doubts on oil/ gas exploration cost-effectiveness
  - Investors starting to move away from fossil fuels
- Community energy expansion
  - Germany, Denmark – and Lancaster!

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