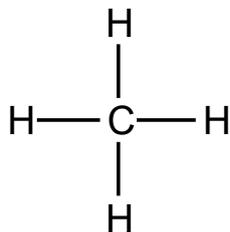




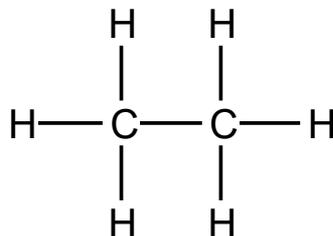
[WWW.CHEMSHEETS.CO.UK](http://www.chemsheets.co.uk)

ALKANES

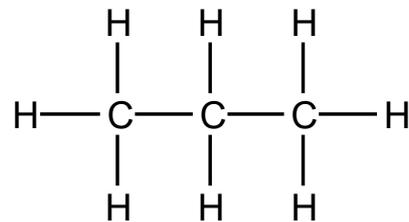
methane CH_4



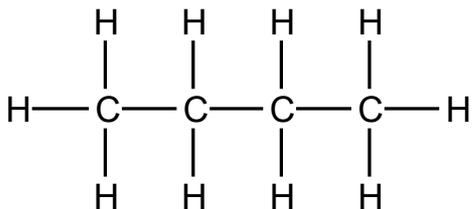
ethane C_2H_6



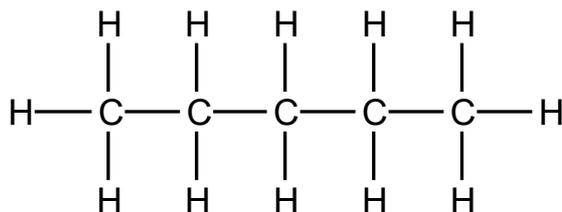
propane C_3H_8



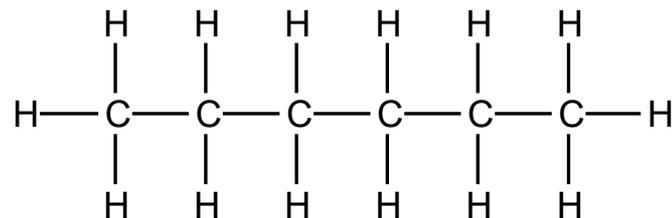
butane C_4H_{10}



pentane C_5H_{12}

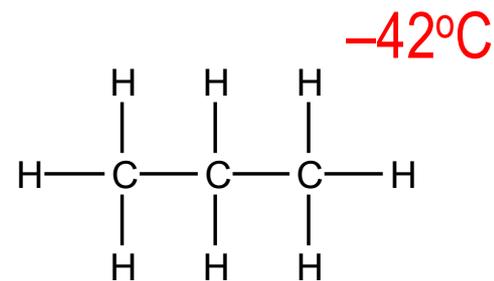
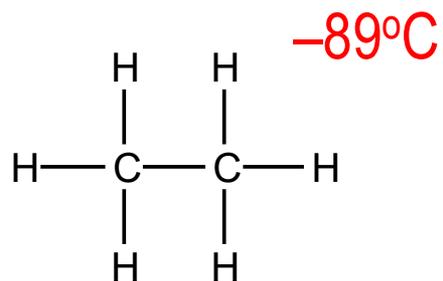
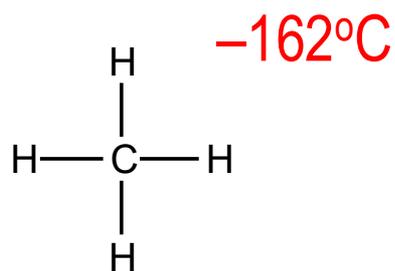


hexane C_6H_{14}

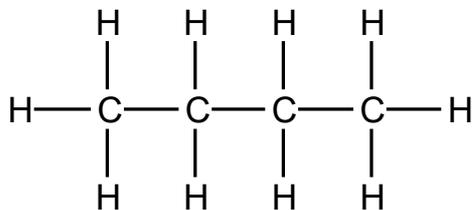


Saturated
hydrocarbons

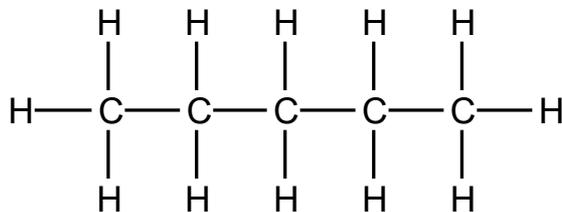
$\text{C}_n\text{H}_{2n+2}$



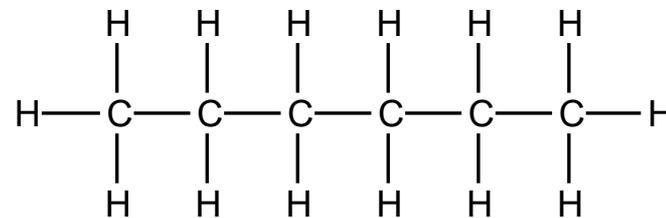
-1°C



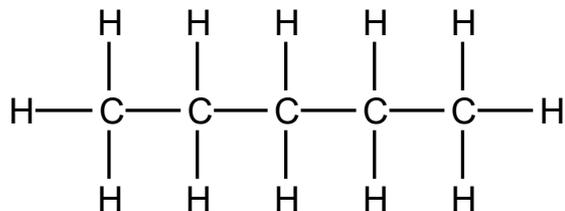
36°C



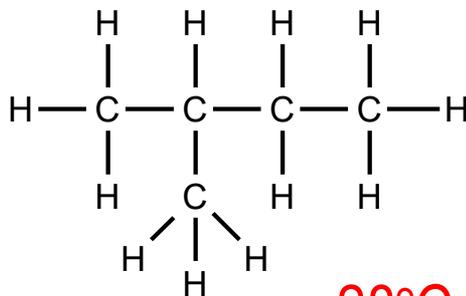
69°C



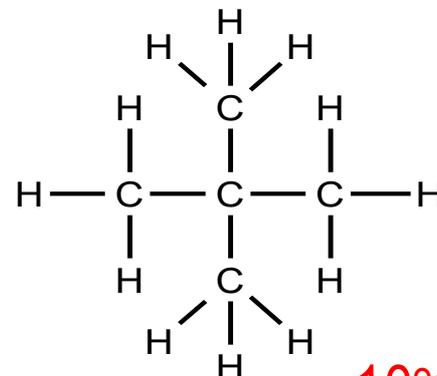
Longer chains \rightarrow higher boiling points due to more electrons which means stronger van der Waals' forces between molecules



36°C



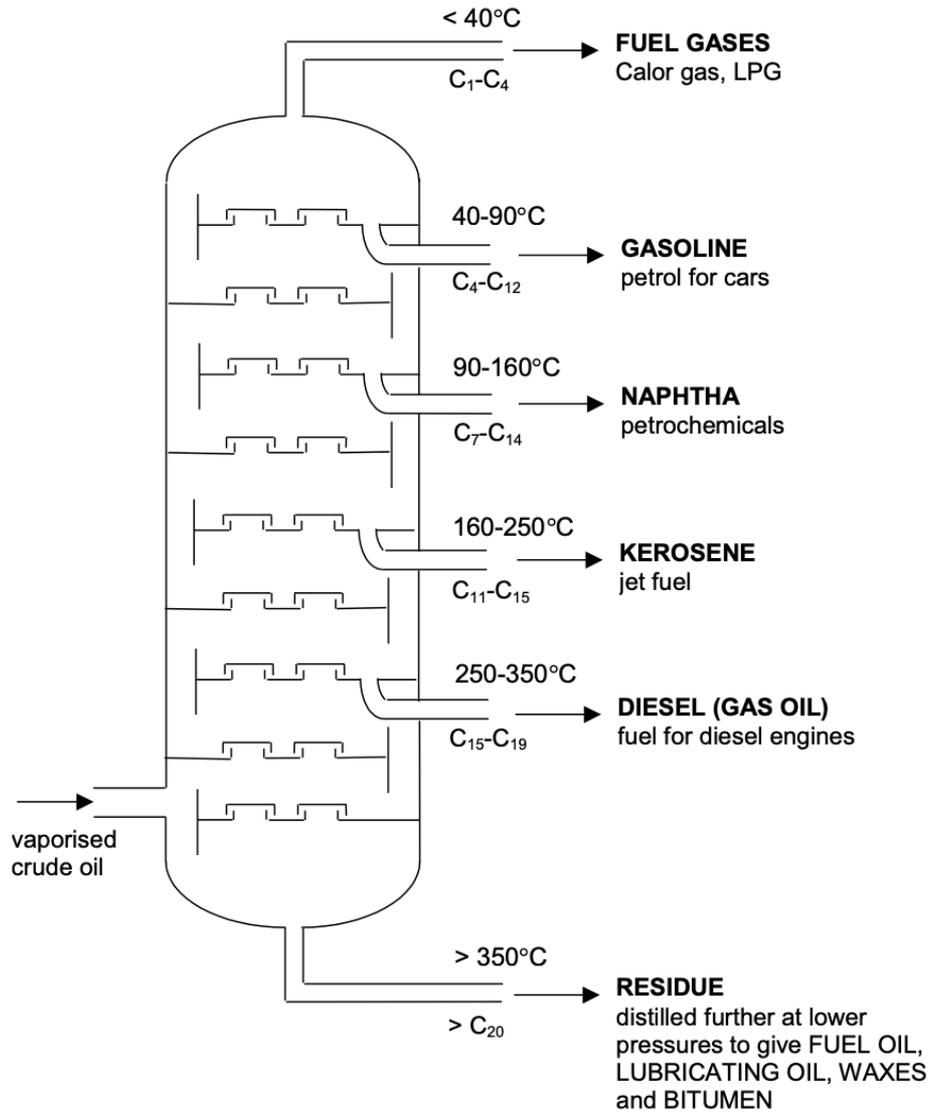
28°C



10°C

More branching → lower boiling points due molecules not packing as close together and so weaker van der Waals' forces between molecules

Fractional Distillation

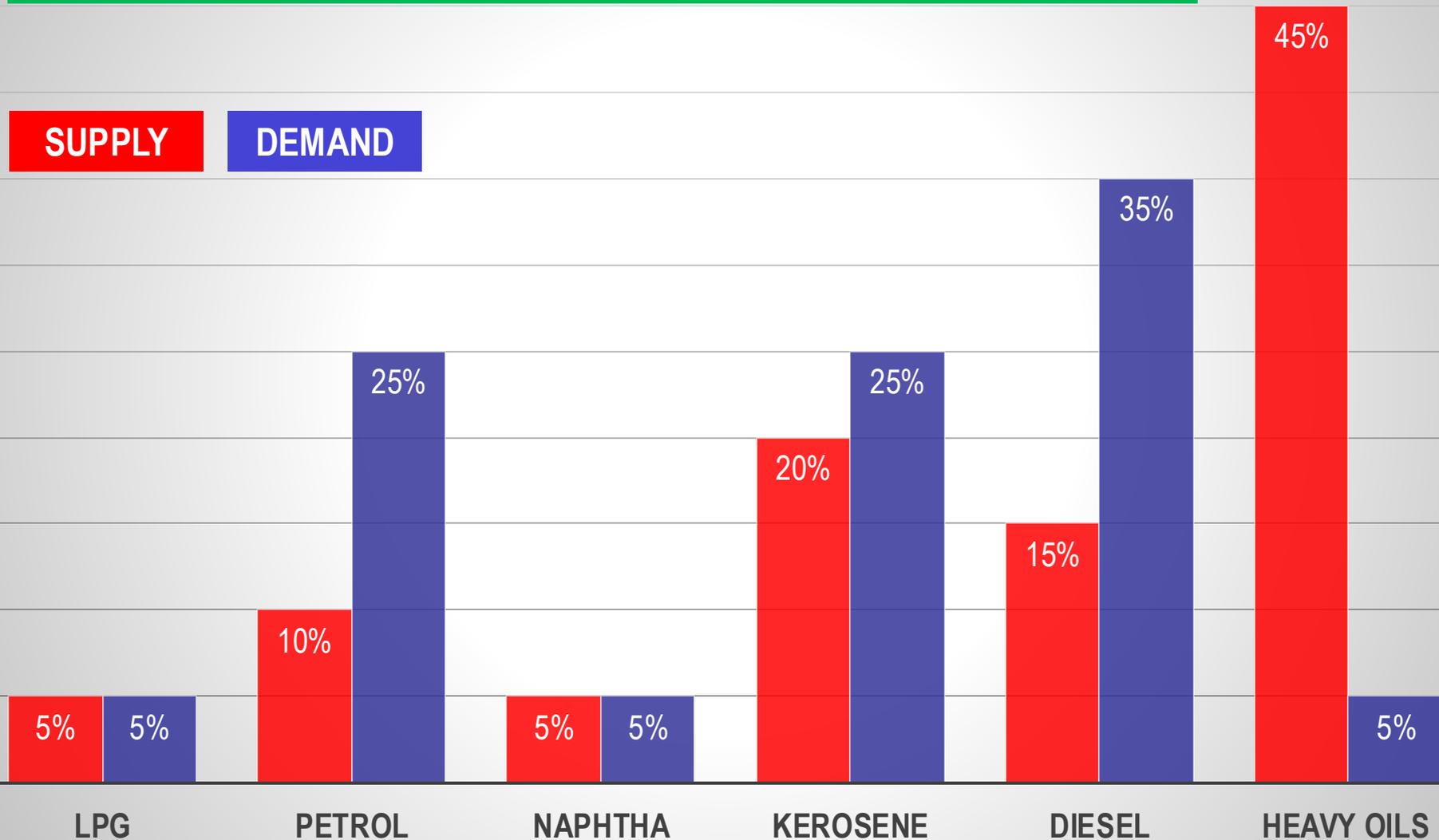


Cracking

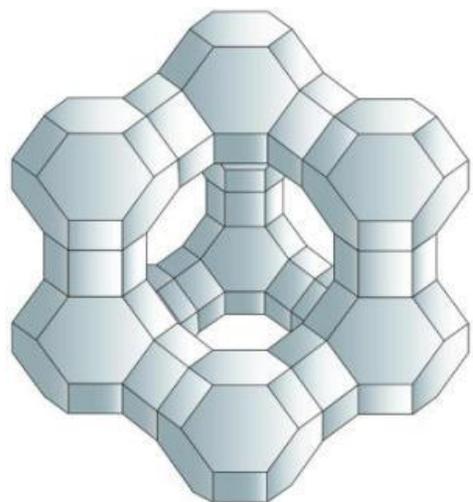
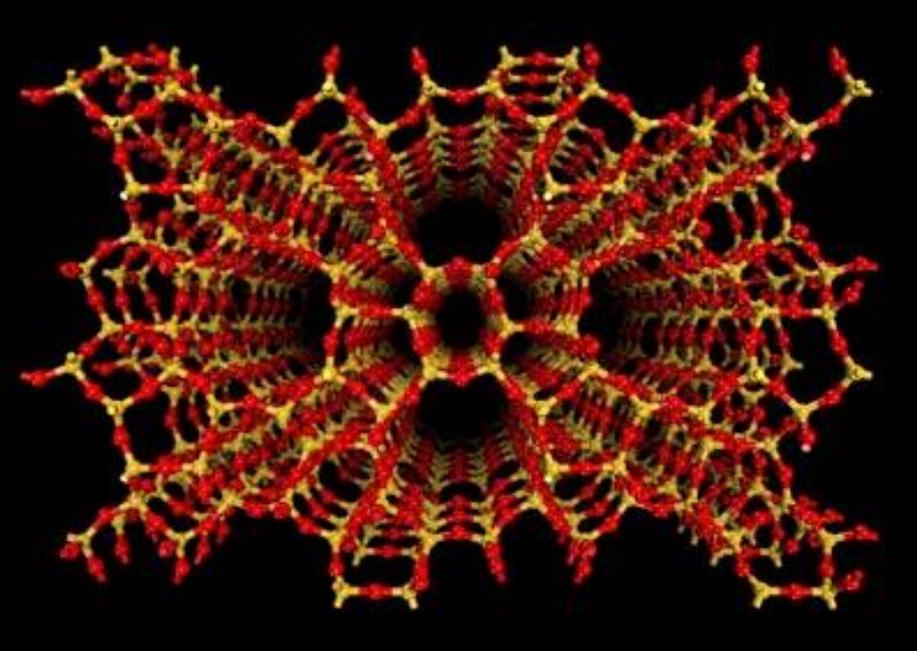
TYPICAL SUPPLY/DEMAND FOR CRUDE OIL FRACTIONS

SUPPLY

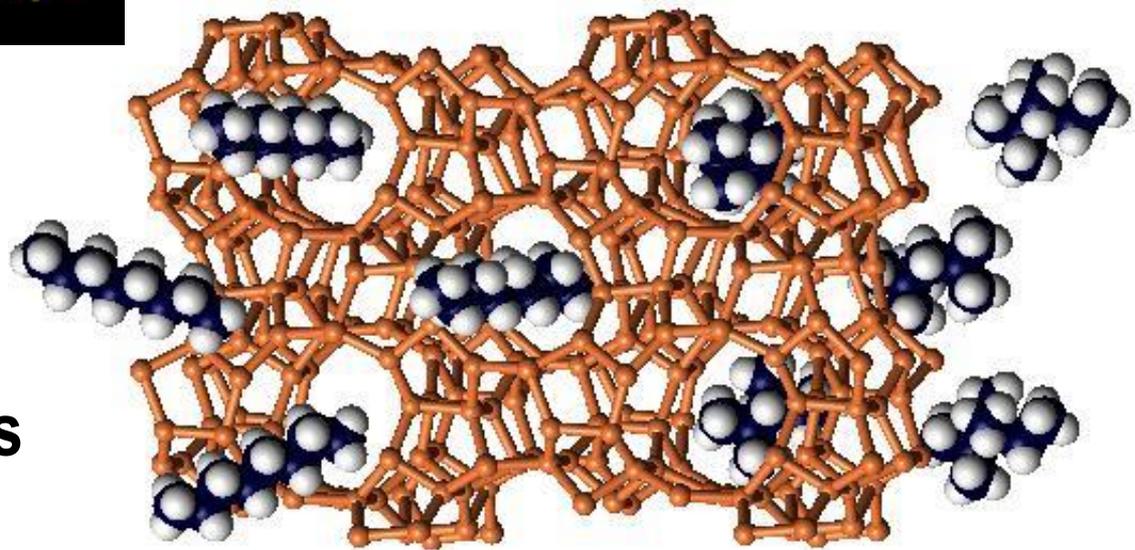
DEMAND



Thermal cracking		Catalytic cracking
900°C	Temperature	450°C
70 atm	Pressure	1-2 atm
none	Catalyst	zeolites
alkenes	Products	Motor fuels Aromatic hydrocarbons Cyclic alkanes Branched alkanes



**Zeolite
catalysts**

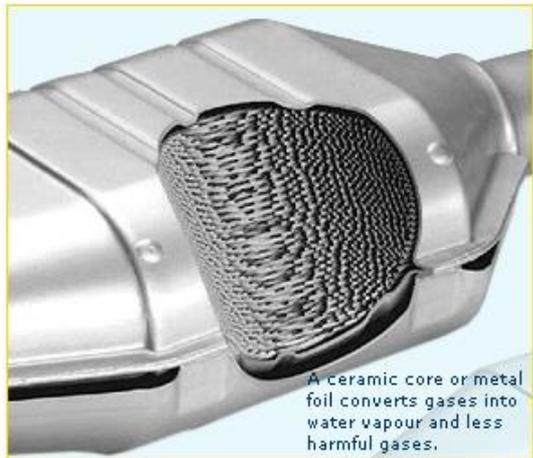
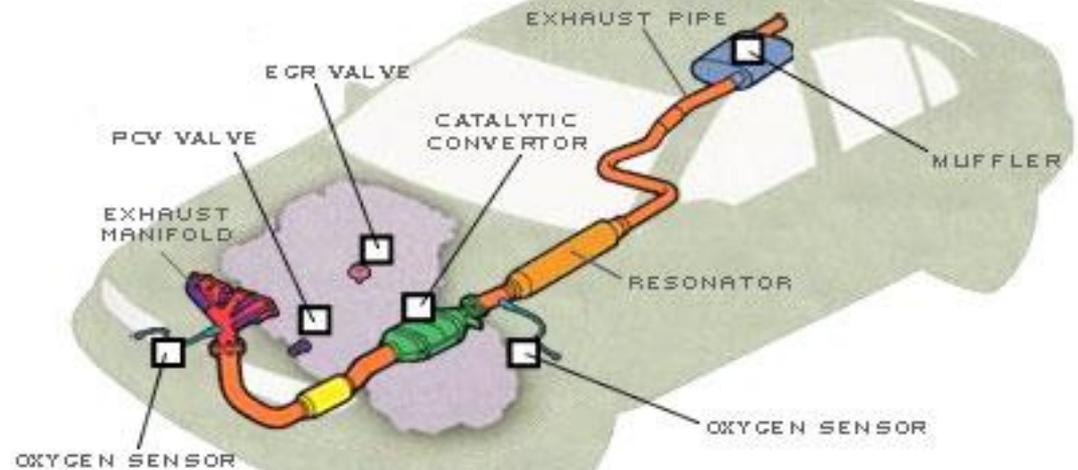


Burning alkanes

Substance formed	How it is formed	Potential problems	Ways to reduce the problem
Carbon dioxide CO₂	Complete combustion (reaction with oxygen) of C in fuel	Greenhouse gas causing global warming	Burn less fossil fuels
Carbon monoxide CO	Incomplete combustion (reaction with oxygen) of C in fuel	Toxic	Ensure there is a good supply of air/oxygen when burned
Carbon (soot) C	Incomplete combustion (reaction with oxygen) of C in fuel	Blackens buildings Global dimming	Ensure there is a good supply of air/oxygen when burned
Sulfur dioxide SO₂	Combustion of S (reaction with oxygen) in fuel	Acid rain	Remove S from fuel before burning; or remove SO ₂ from fumes after burning (flue gas desulfurization)
Nitrogen oxides NO & NO₂	Reaction of N ₂ in air with O ₂ in air at very high temperatures (often in engines or furnaces)	Acid rain	For engines use a catalytic converter
Unburned fuel	Not all fuel burns	Wastes fuel, harmful & a greenhouse gas	Ensure correct fuel:air mixture when fuel is burned

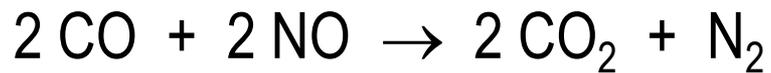
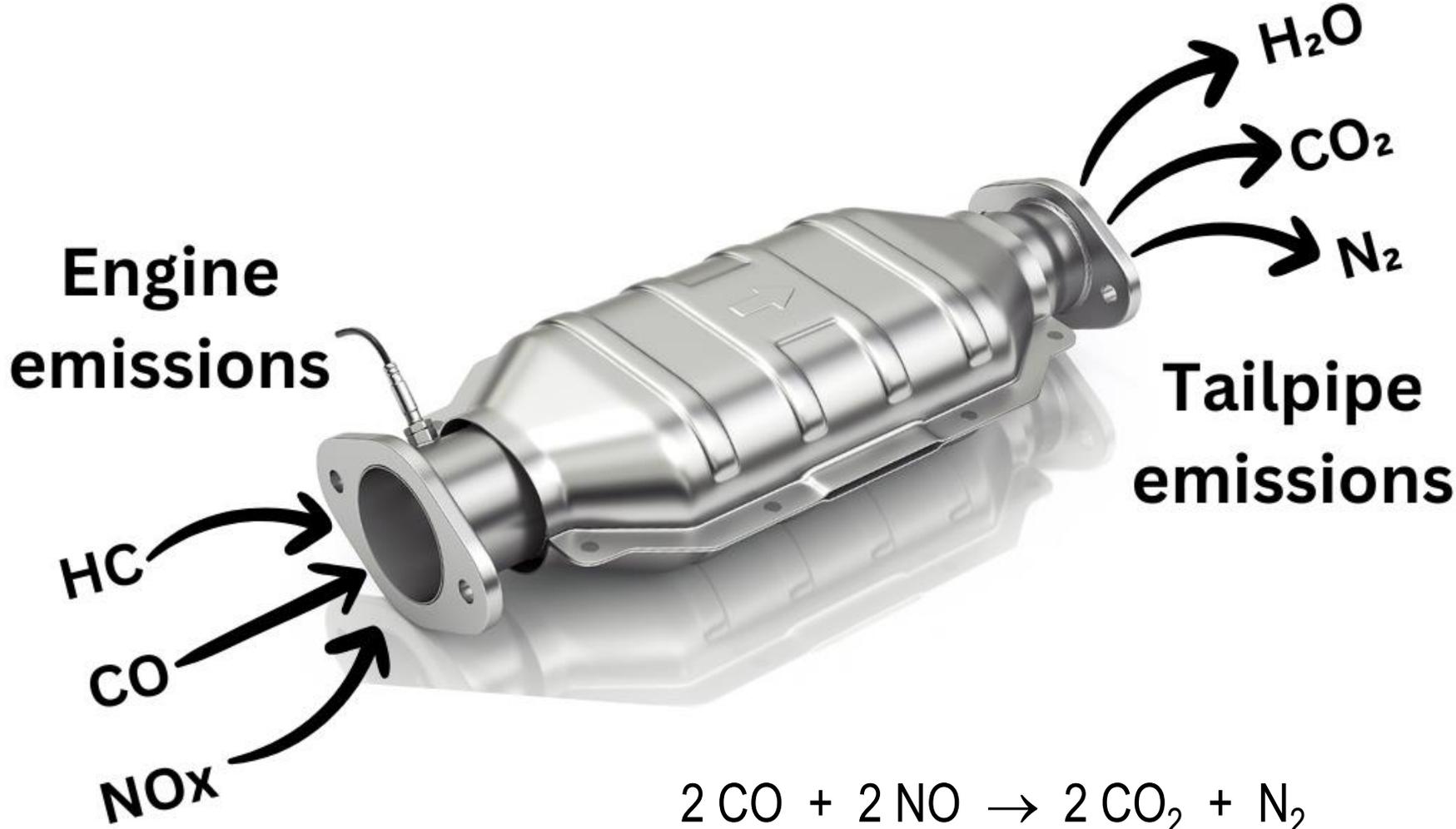
Catalytic converters in cars

EXHAUST & EMISSIONS SYSTEM



A ceramic core or metal foil converts gases into water vapour and less harmful gases.





Sulfur dioxide & acid rain



Branches from a tree in Germany's Black Forest show needle loss and yellowing caused by acid rain



**Acid rain making a lake
too acidic for fish**



1908

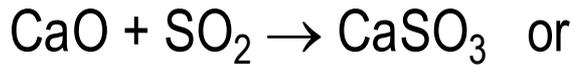


**Impact of acid rain on
stonework**

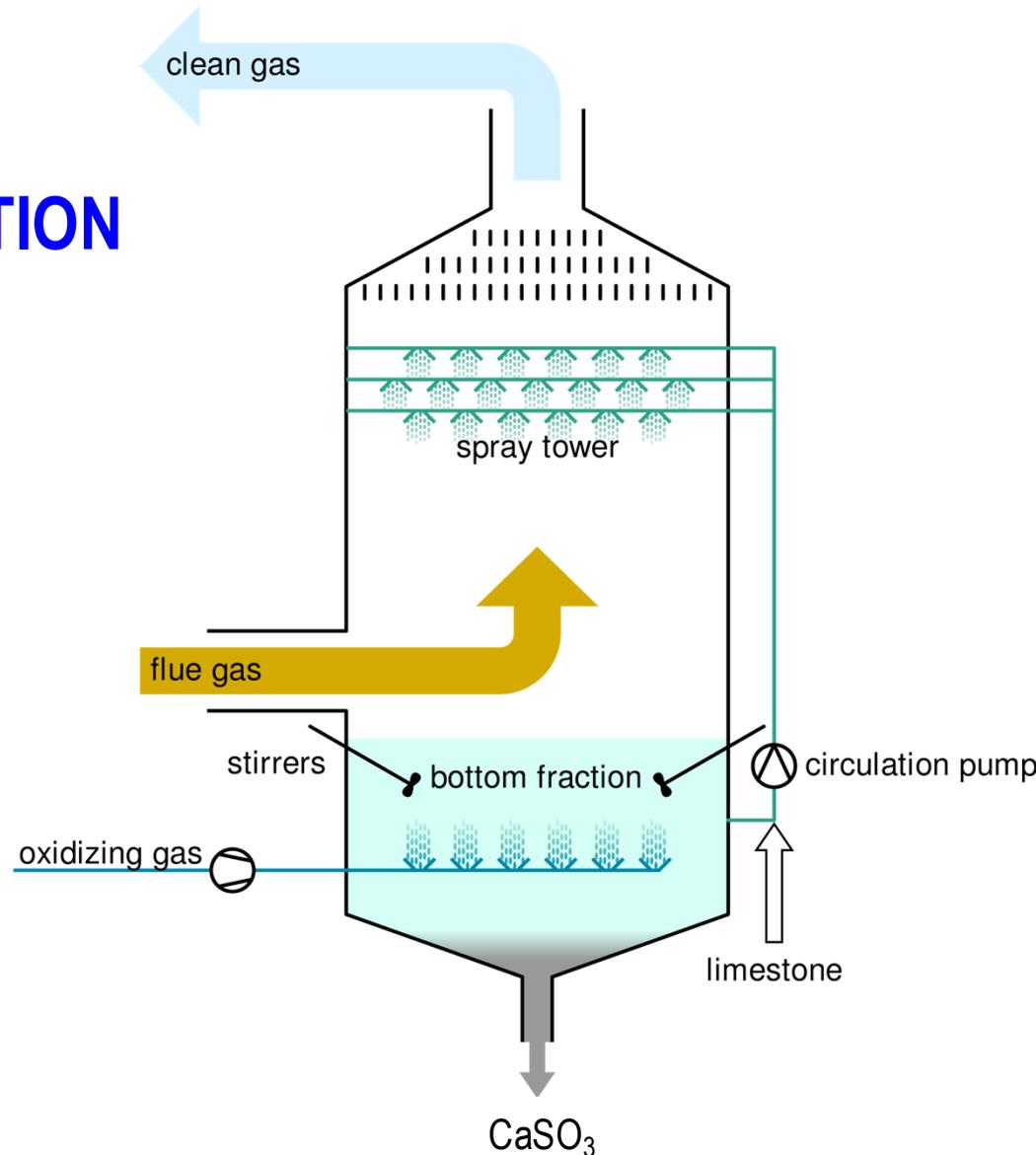
1968

FLUE GAS DESULFURISATION

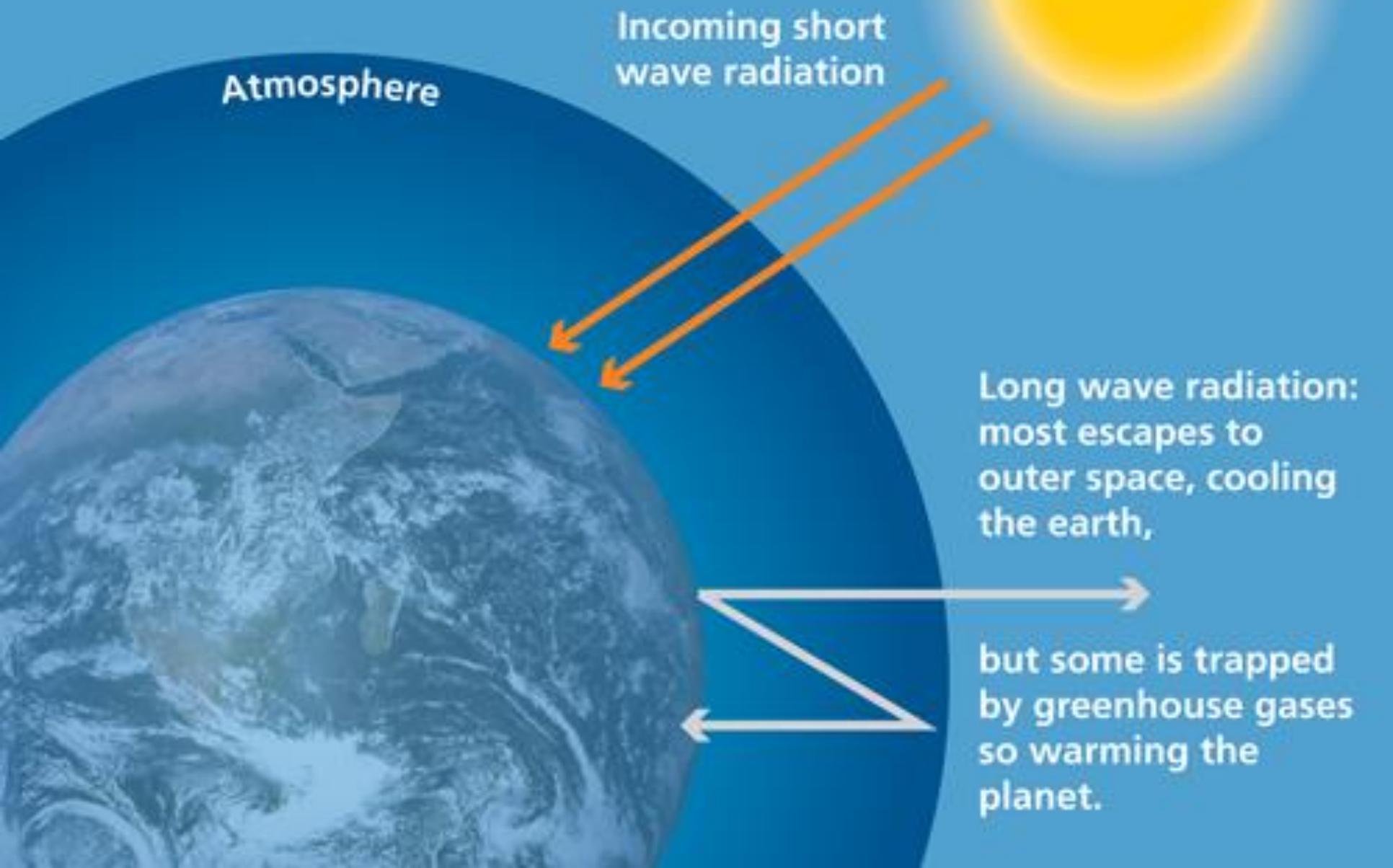
Pass flue gases through mist containing CaO / CaCO_3



Acid-base reaction



Greenhouse Gases



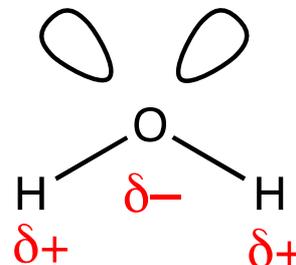
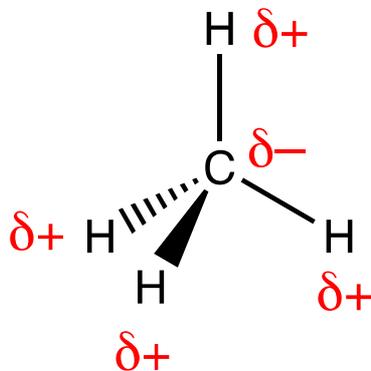
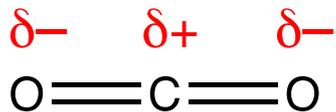
Incoming short
wave radiation

Atmosphere

Long wave radiation:
most escapes to
outer space, cooling
the earth,

but some is trapped
by greenhouse gases
so warming the
planet.

Greenhouse gases – contain POLAR BONDS

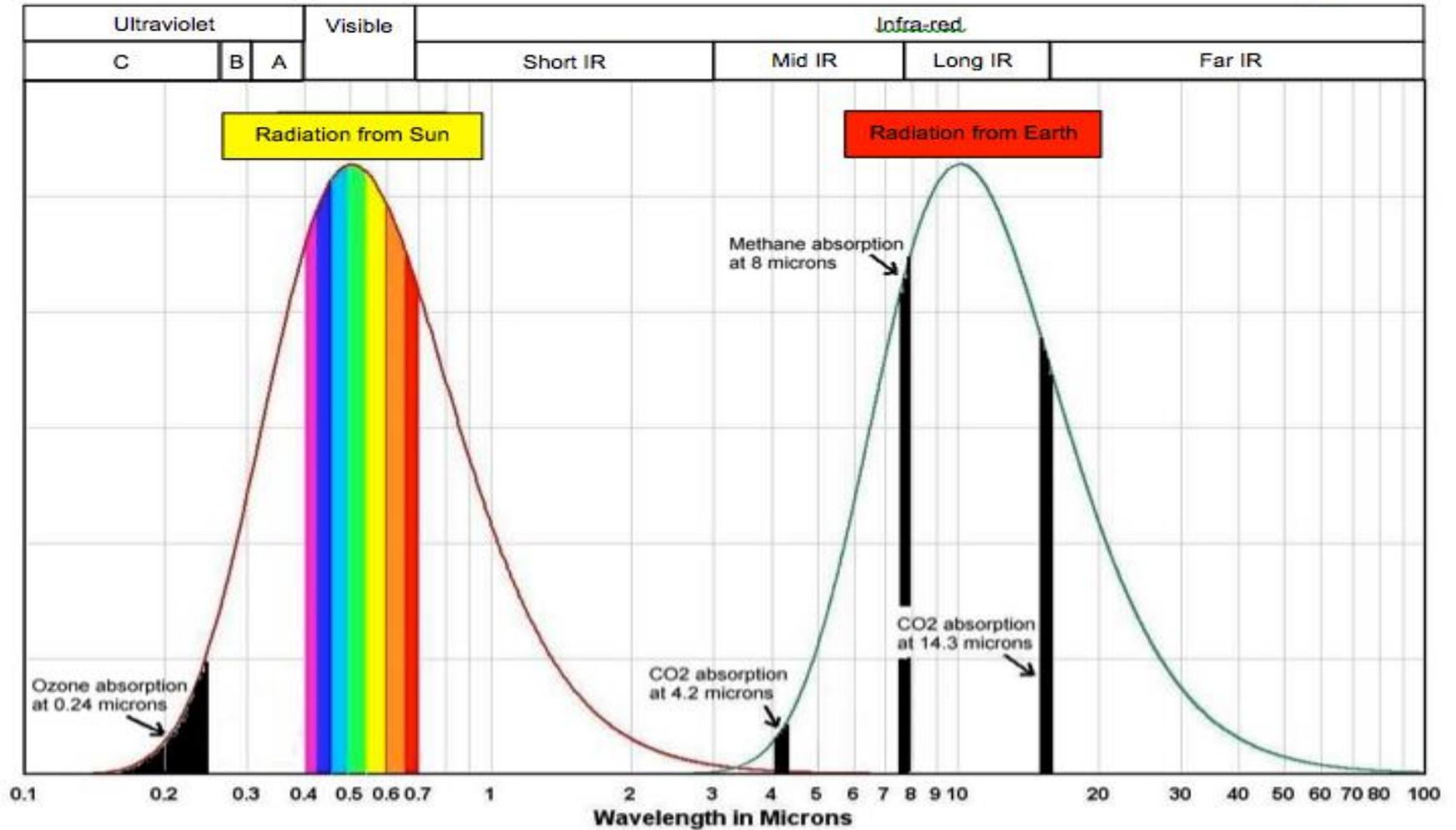


Non-greenhouse gases – NO POLAR BONDS



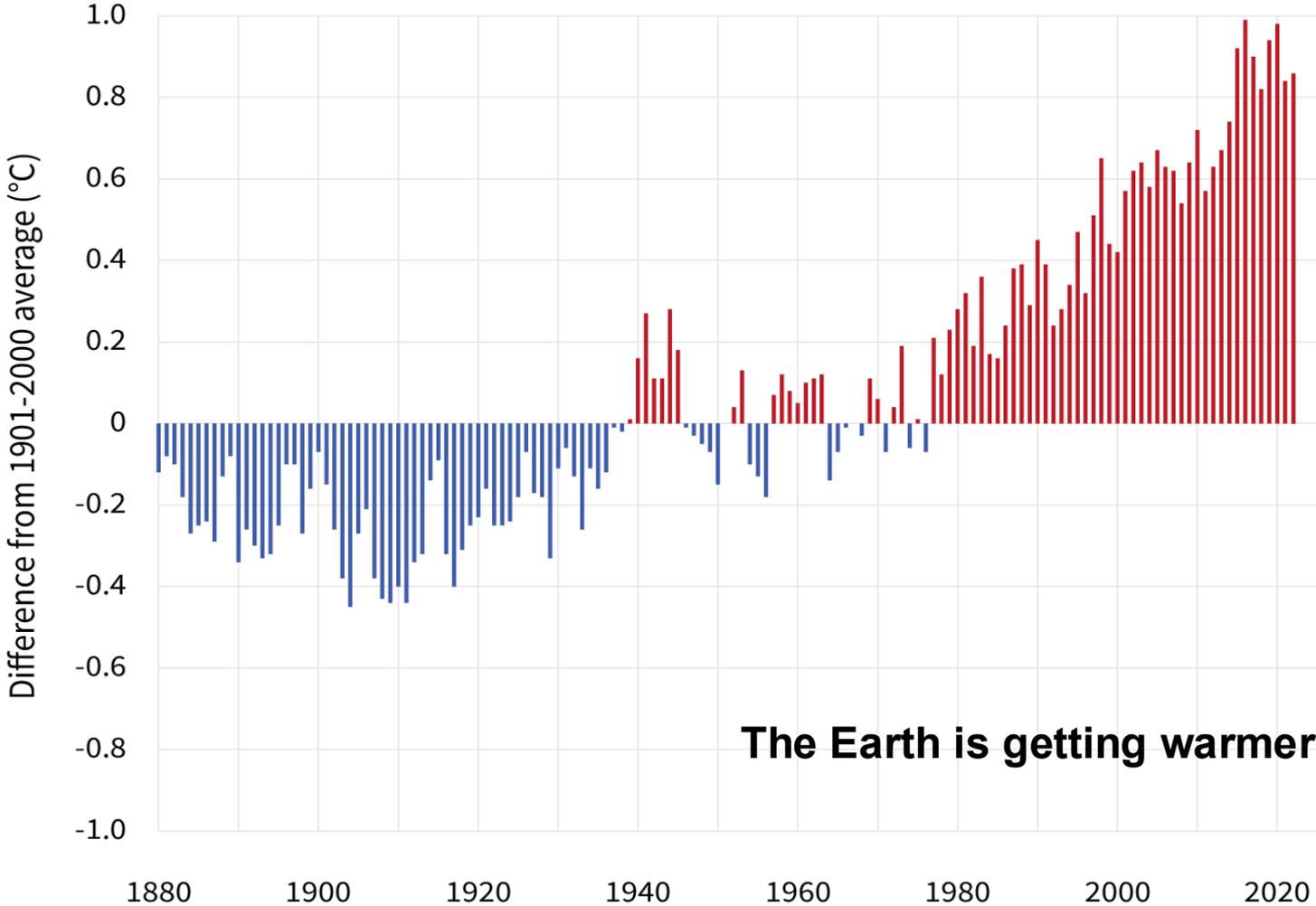
Ar

Increasing wavelength



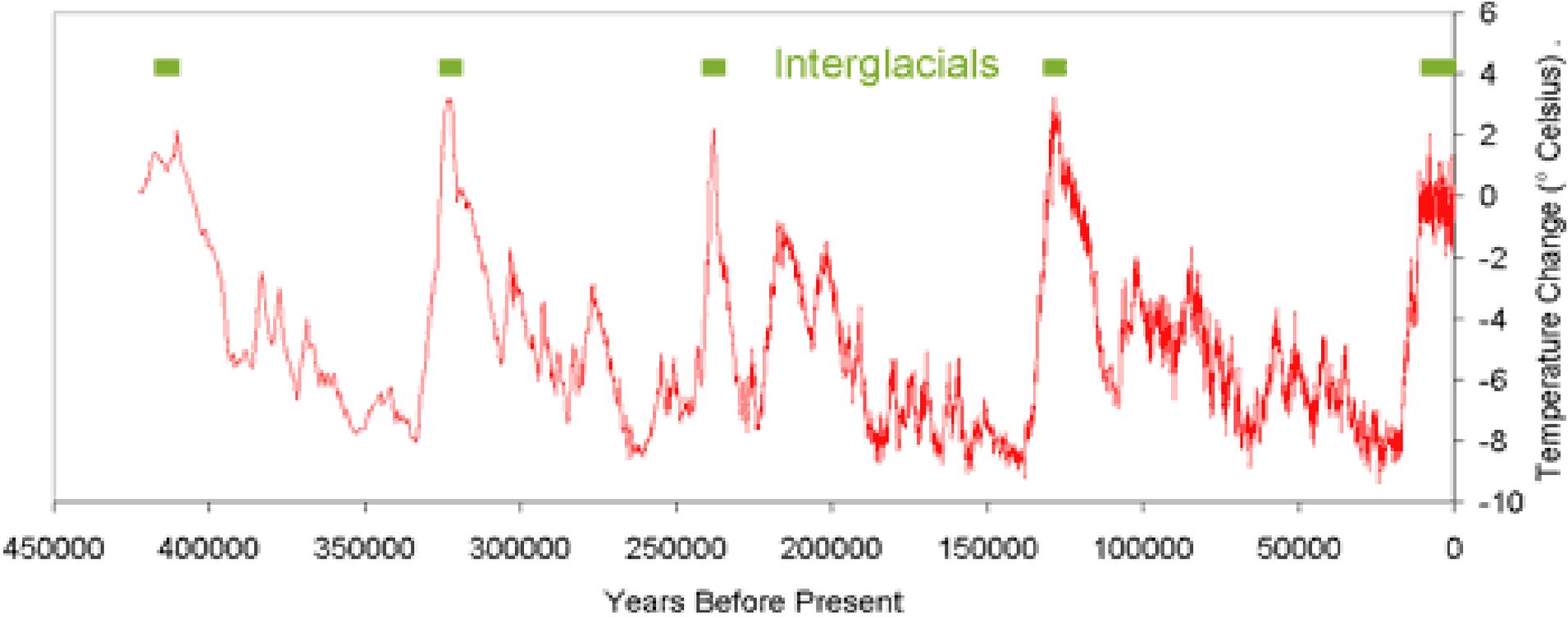
Adapted from www.planetforlife.com & Hodder AQA GCSE Chemistry (2016) (Grime & Henry)

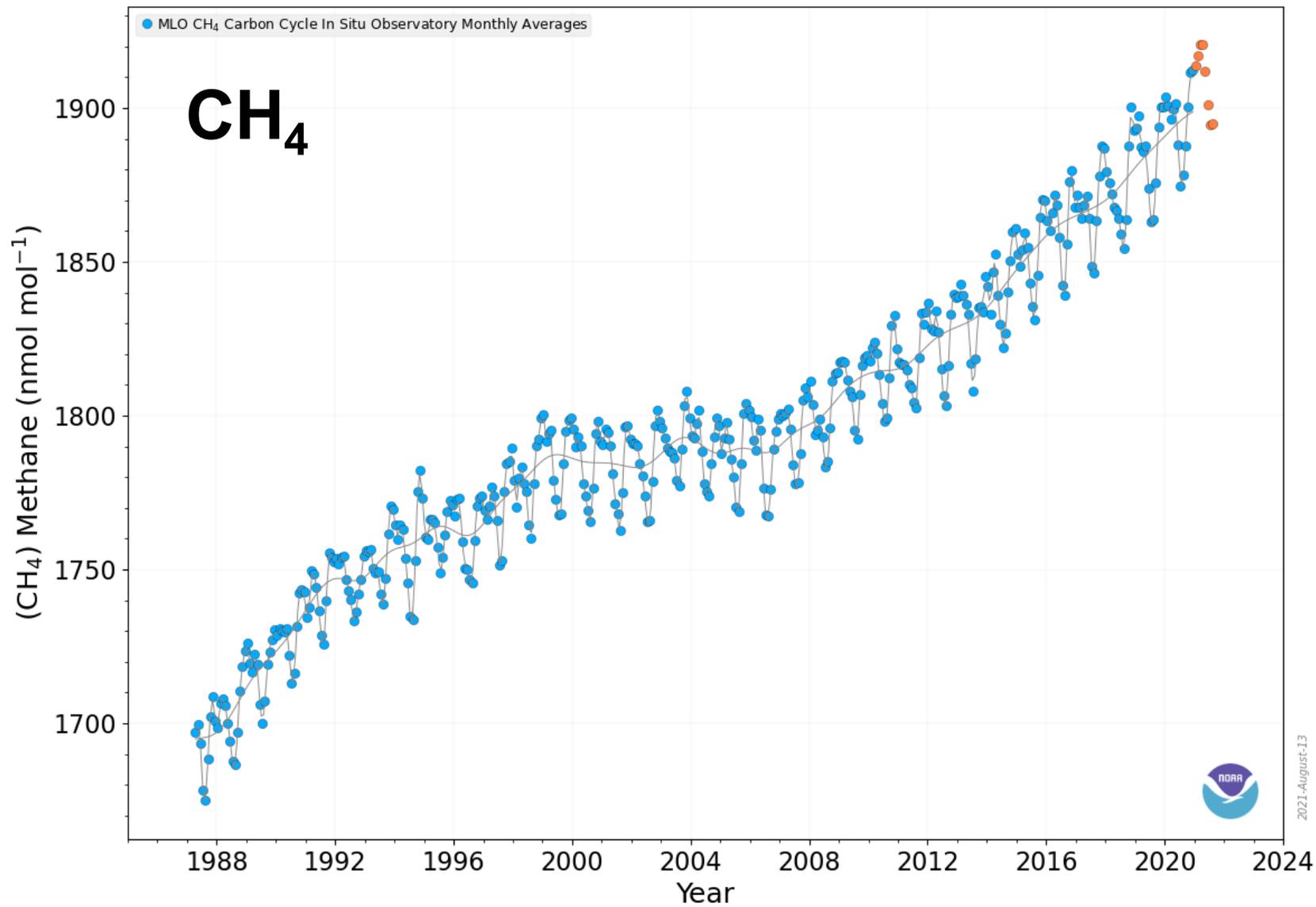
GLOBAL AVERAGE SURFACE TEMPERATURE



The Earth is getting warmer

It MIGHT be a natural variation, but most scientists think the increase is too much too quickly to be so.





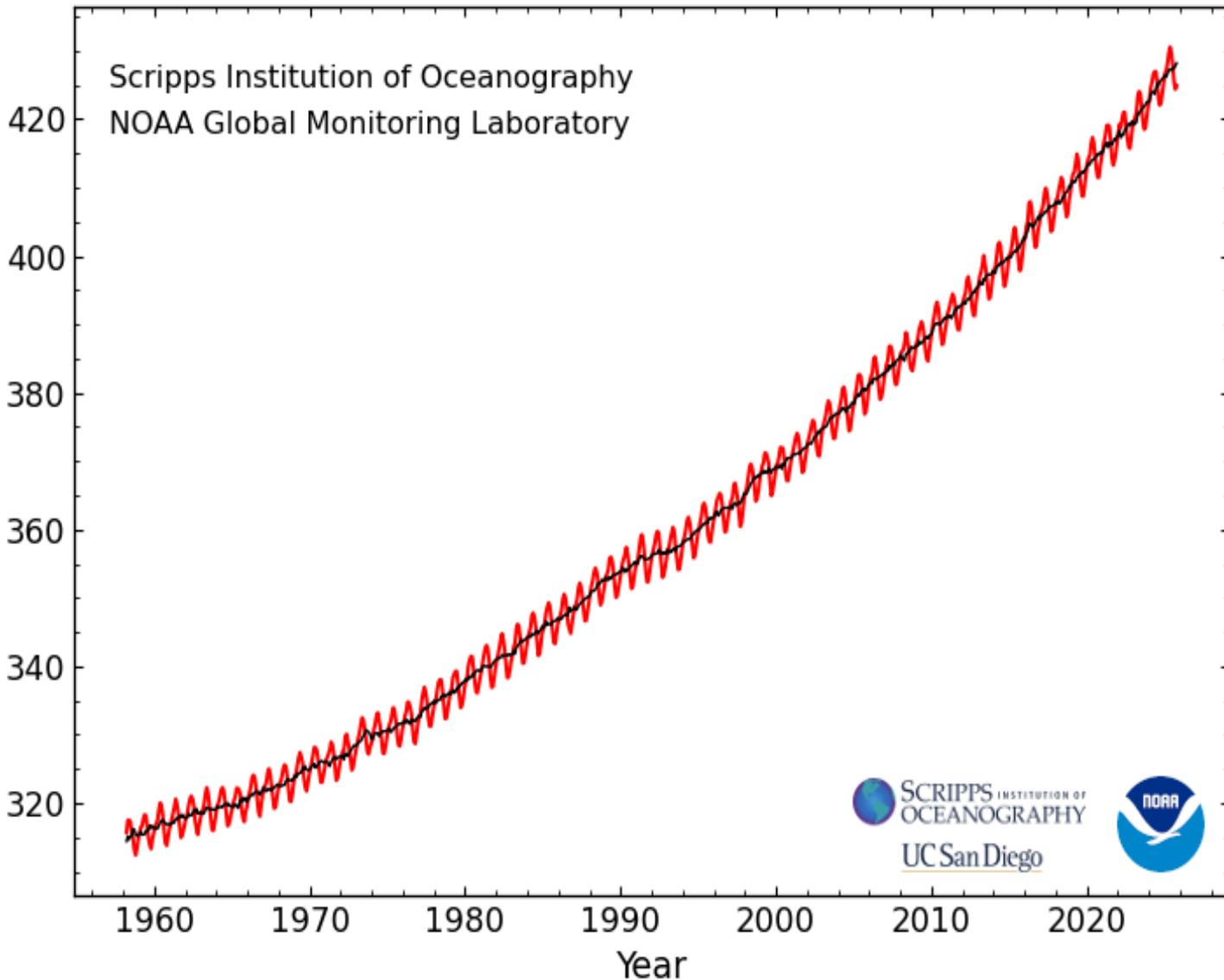
2021-August-13



Images from Wikipedia & modernfarmer.com

CO₂

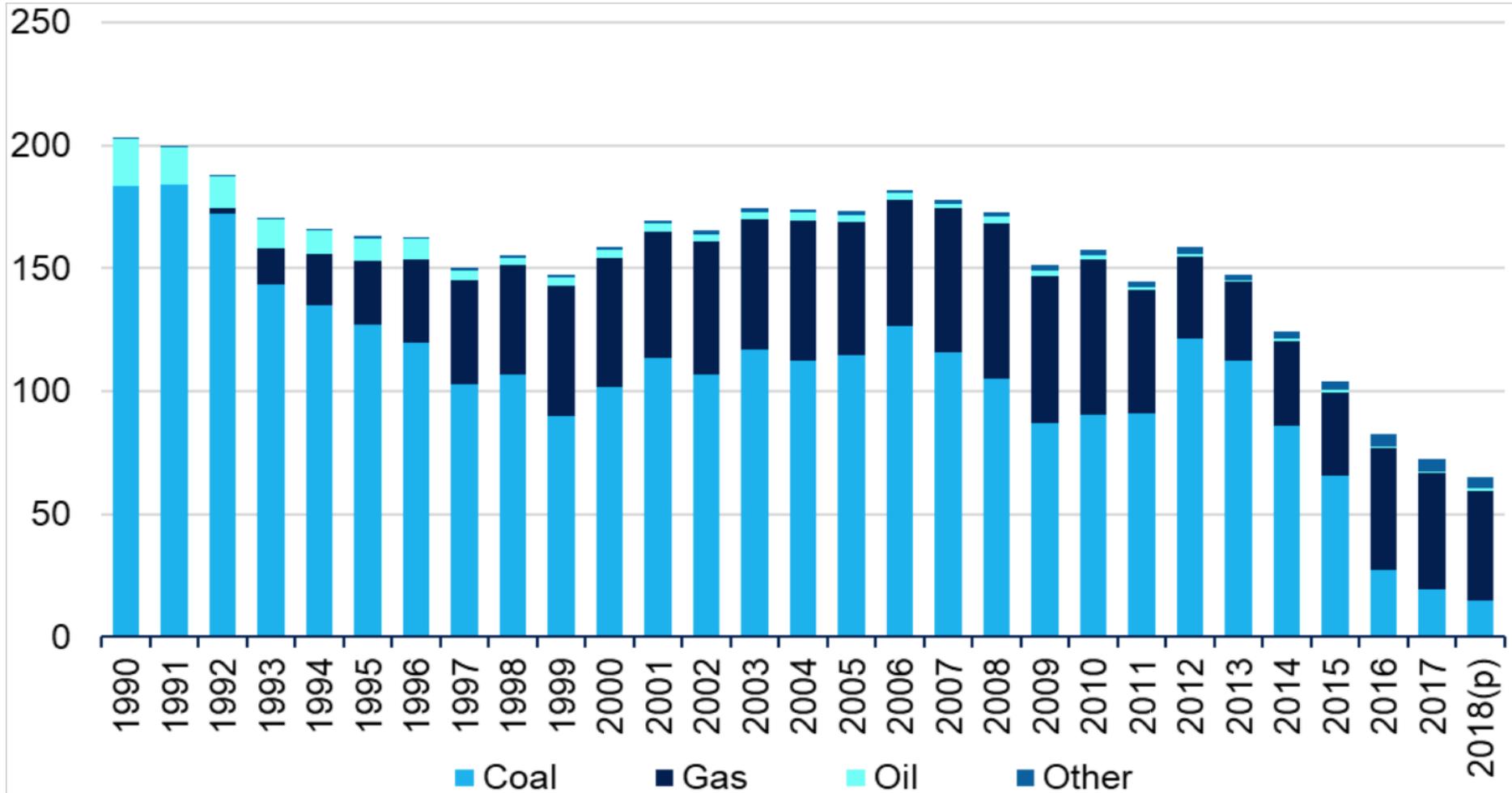
CO₂ mole fraction (ppm)





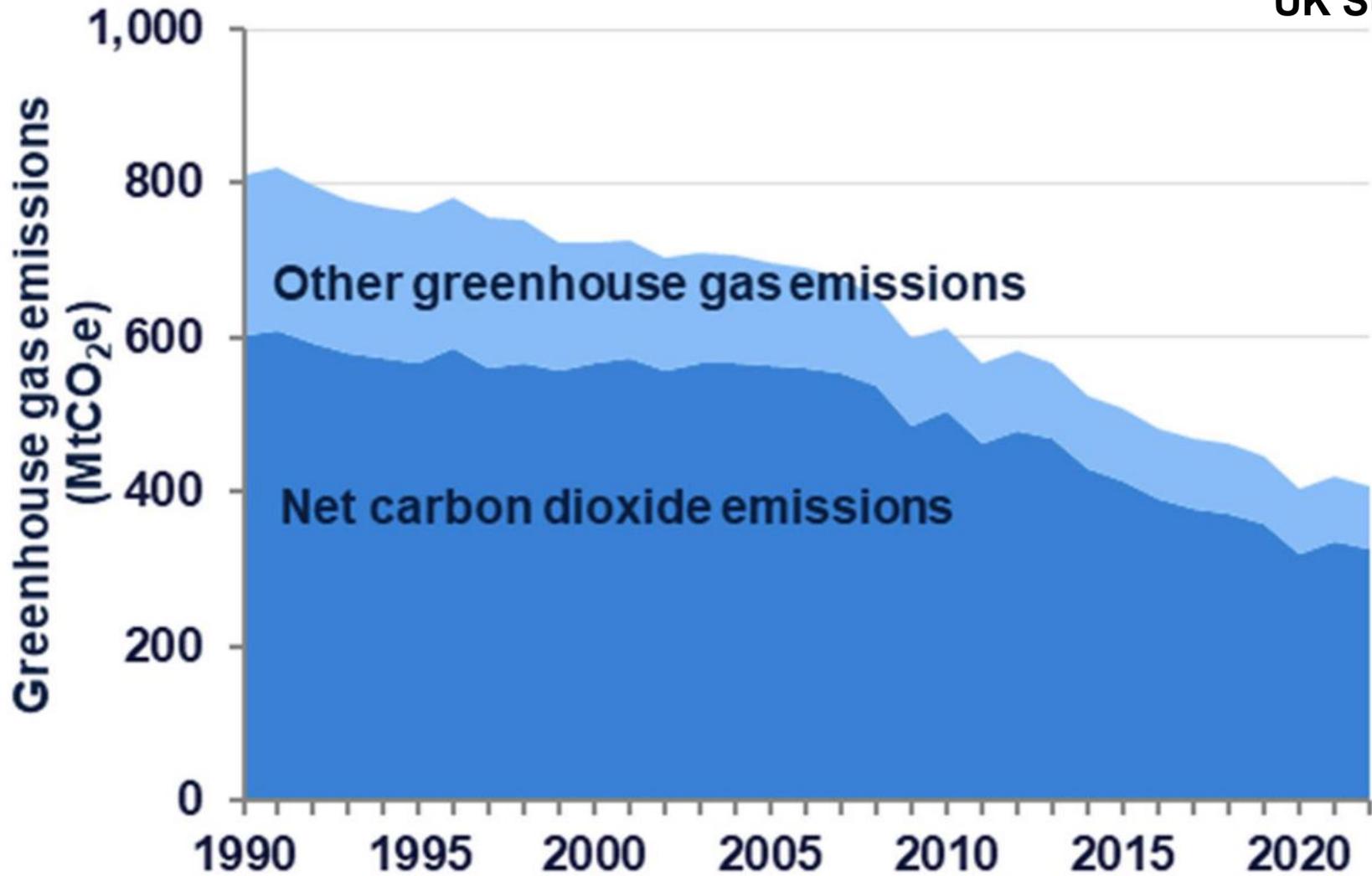
Images from Wikipedia

Figure 4: Carbon dioxide emissions from electricity generation, UK, 1990-2018 (MtCO₂)

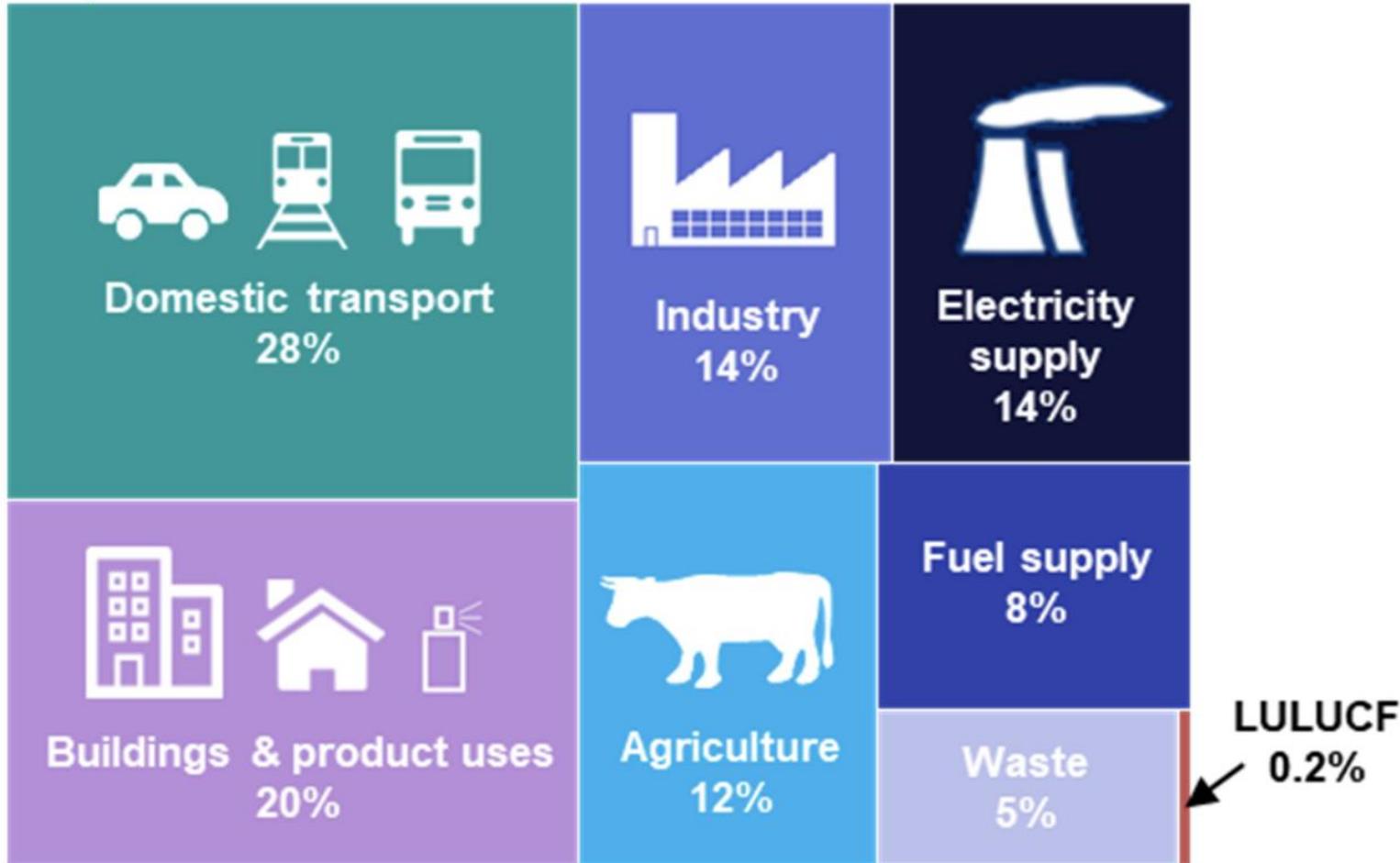


Source: Tables 1 & 2, Provisional UK greenhouse gas emissions national statistics 1990-2018 Excel data tables

Note: (p) 2018 estimates are provisional.



Domestic transport was the largest emitting sector in the UK in 2022, responsible for over a quarter of emissions.



Most sectors saw a fall in emissions from 2021 to 2022, with a fall in heating use due to warmer weather the largest factor in the overall fall.

	2021-2022 % change	2019-2022 % change	1990-2022 % change
Total greenhouse gas emissions	↓ 4%	↓ 9%	↓ 50%
Domestic transport	↑ 2%	↓ 10%	↓ 12%
Buildings & product uses	↓ 13%	↓ 12%	↓ 24%
Industry	↓ 5%	↓ 8%	↓ 63%
Electricity supply	↑ 1%	↓ 5%	↓ 73%
Agriculture	↓ 2%	↓ 3%	↓ 12%
Fuel supply	↓ 1%	↓ 17%	↓ 60%
Waste	↔ 0%	↓ 10%	↓ 74%

The Land Use, Land Use Change and Forestry (LULUCF) sector is not shown as it is volatile year-to-year and represents a small proportion of total UK emissions (0.2% in 2022).