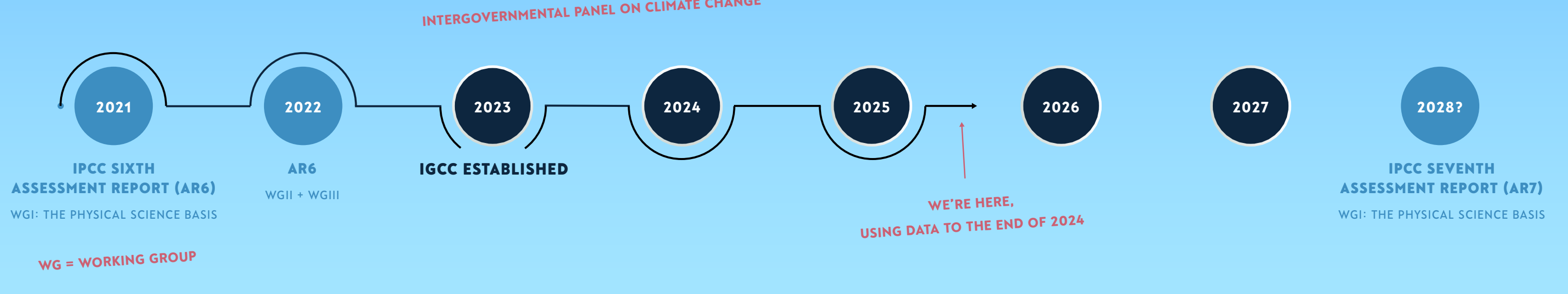
INDICATORS OF GLOBAL CLIMATE CHANGE

IGCC | 2025

WHY IS THIS UPDATE IMPORTANT?

The IGCC project bridges the gap between IPCC reports, bringing decision makers and the public the latest climate science each year.

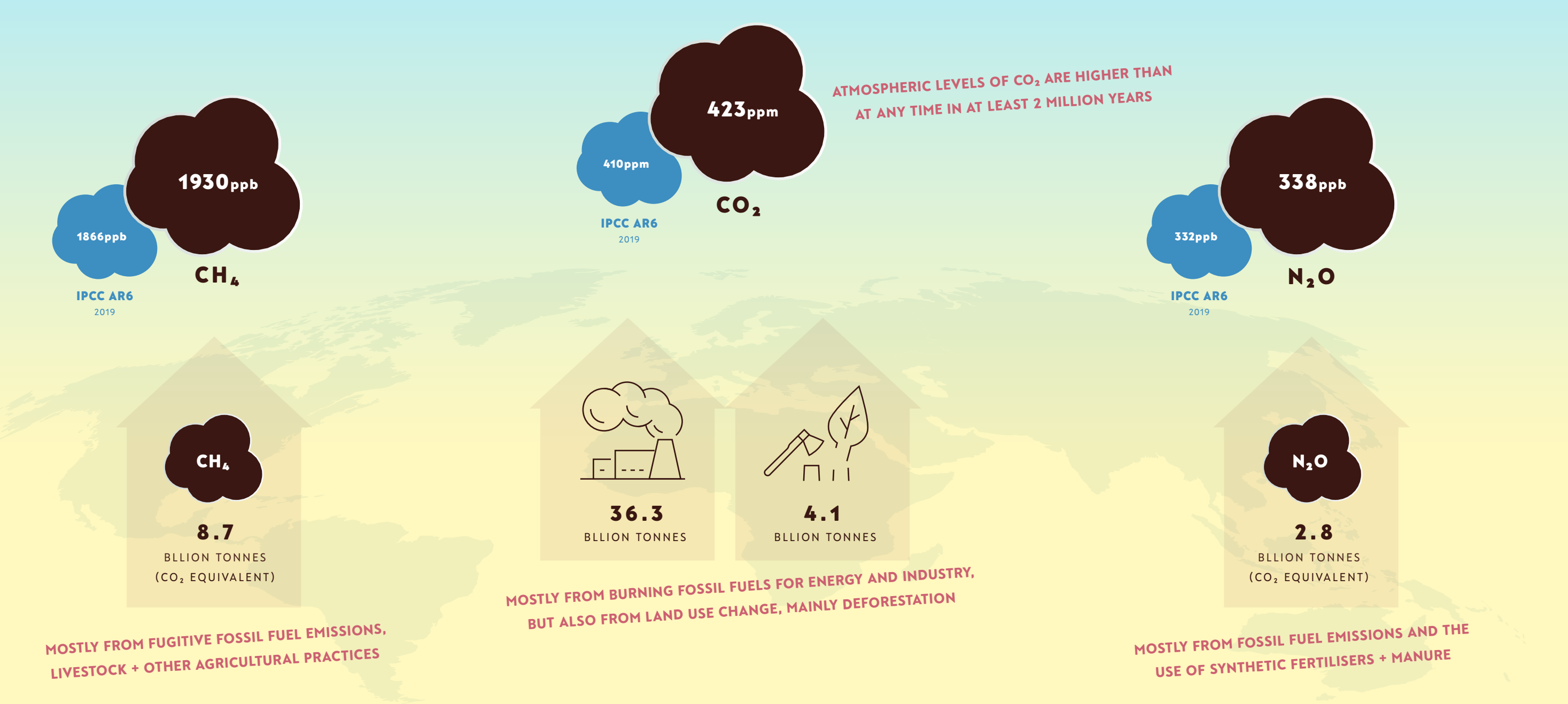


IGCC includes IPCC veterans and early-career scientists. They produce this to keep you informed.

WHAT'S THE LATEST SCIENCE TELLING US?

Humans are heating Earth at a rate of **0.27°C** per decade — the highest rate since records began.

This heating is due to carbon dioxide (CO_2) and other greenhouse gases (GHGs) accumulating in the atmosphere, blocking outgoing infrared radiation. As less heat escapes to space, an energy imbalance is created. Earth heats up.



GHGs — Over the past decade, on average we emitted **53.6 billion tonnes** of greenhouse gas emissions into the atmosphere every year.

WEIGHT WISE, THAT'S EQUIVALENT TO 5.25 MILLION EIFFEL TOWERS

CO_2 — In 2024, **42.4 billion tonnes was CO_2**. The rest consisted of methane (CH_4), nitrous oxide (N_2O) and F gasses (HFCs, PFCs, SF_6, NF_3).

Record **greenhouse gas emissions** over the past decade — combined with less cooling from **aerosols** (tiny, light-scattering pollution particles) — have led to an especially high rate of heating.

PRODUCED MAINLY BY BURNING FOSSIL FUELS, AEROSOLS HAVE LONG ACTED AS AN INVISIBLE BRAKE ON HEATING BY REFLECTING SUNLIGHT AND ALTERING CLOUD FORMATION

THE LEVEL AND RATE OF HEATING IS UNPRECEDENTED

Human-induced heating has risen to an average of **1.22°C** over the most recent decade (2015 - 2024).

DECADAL AVERAGE

CHANGE IN GLOBAL MEAN SURFACE TEMPERATURE (GMST)

When scientists talk about limiting global heating to 1.5°C or 'well below 2°C', they are referring to the average global temperature increase over decades, rather than any single year's temperature.

ANNUAL AVERAGE

CHANGE IN GMST, 2024

Human activity drove **1.36°C** of heating in 2024.

Including natural climate variability, total temperature rise was **1.52°C**.

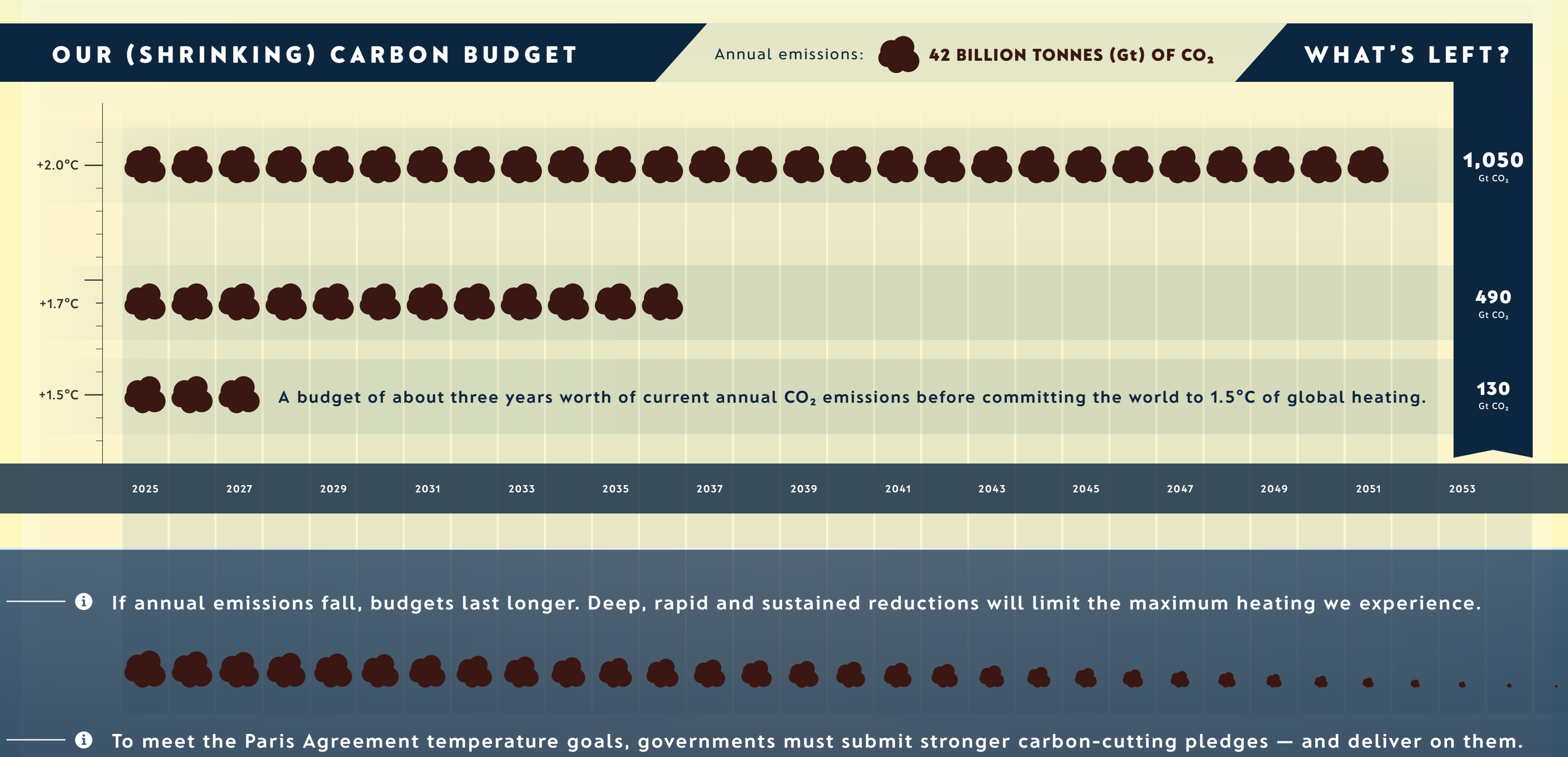
Average global temperature rise of **1.22°C** has already caused irreversible changes — unprecedented for thousands, if not hundreds of thousands, of years. As the world nears 1.5°C of heating, extreme temperatures will have the most profound impacts on people and nature.

THE UPDATED CARBON BUDGET

- In 2020, the IPCC calculated the remaining carbon budget for 1.5°C at about **500 billion tonnes**.
- At the start of 2025, the remaining carbon budget for 1.5°C stood at around **130 billion tonnes**.

IMMEDIATE, RAPID EMISSION REDUCTIONS COULD KEEP 1.5°C ACHIEVABLE LATER THIS CENTURY (THROUGH INDUSTRIAL-SCALE CARBON REMOVALS)

OUR (SHRINKING) CARBON BUDGET



If annual emissions fall, budgets last longer. Deep, rapid and sustained reductions will limit the maximum heating we experience.

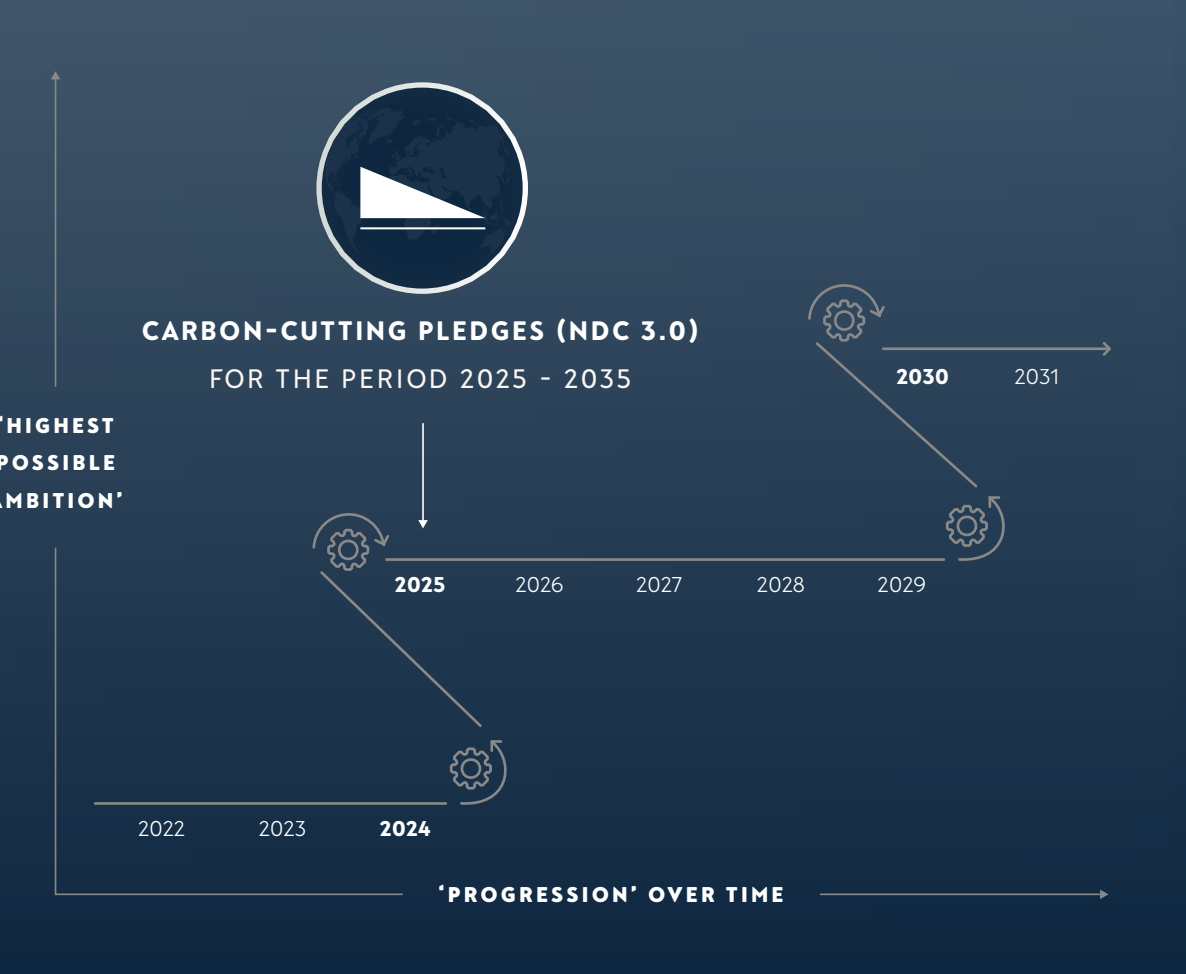
To meet the Paris Agreement temperature goals, governments must submit stronger carbon-cutting pledges — and deliver on them.

WHAT ARE NATIONALLY DETERMINED CONTRIBUTIONS (NDCs)?

In 2025, nations are required to submit their third installments of carbon-cutting climate plans (NDCs 3.0) to the UN, outlining their commitments from 2025 to 2035.

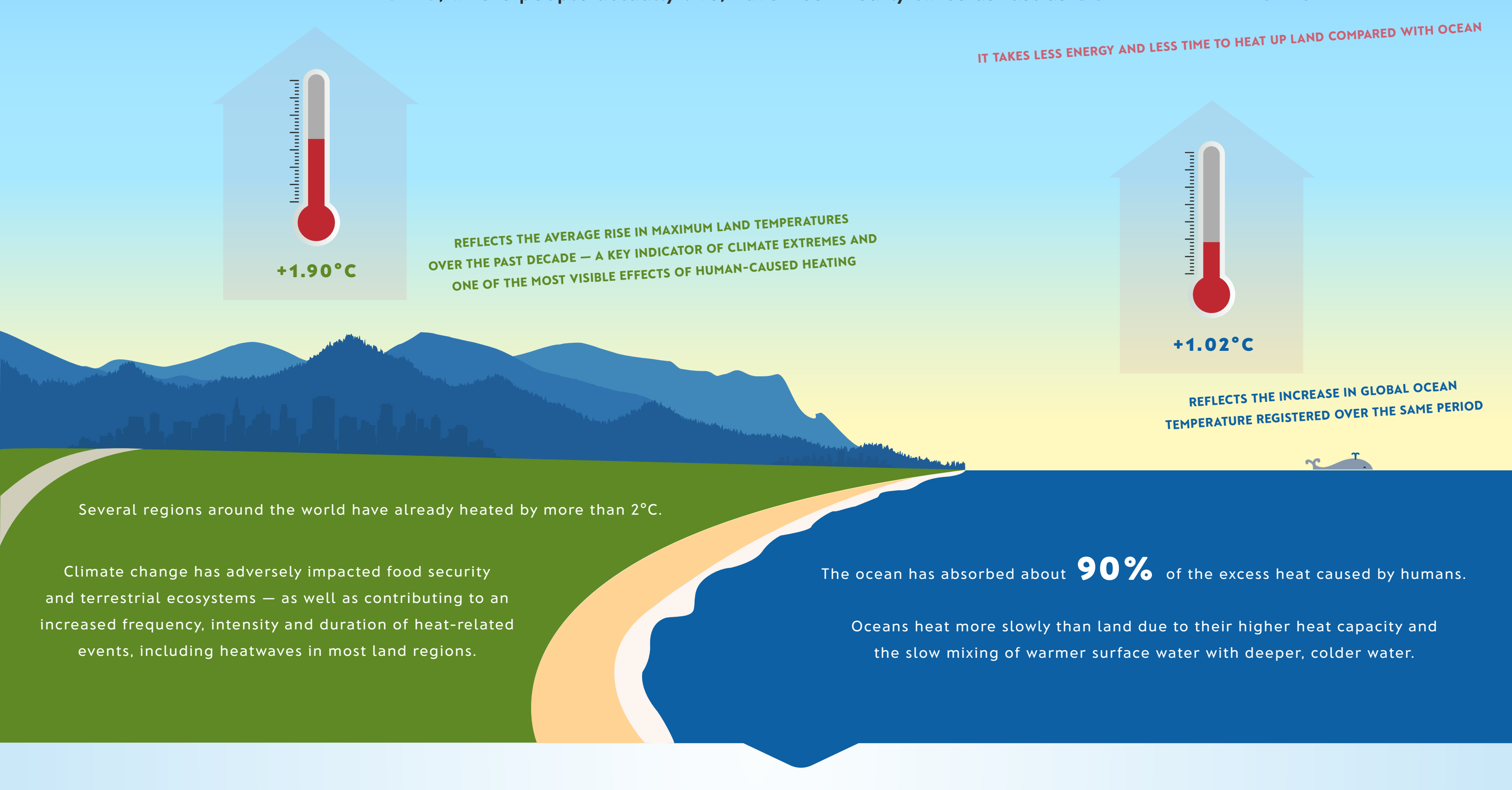
The Paris Agreement requires nations to update their NDCs every five years, with each new round representing a **'PROGRESSION'** from the previous one, and demonstrating the **'HIGHEST POSSIBLE AMBITION'** to achieve its goals.

So, although nations have the freedom to set the ambition of their emission reduction pledges, these commitments are expected to increase over time to collectively meet the temperature goals of the Paris Agreement.



THE 'LAND-OCEAN HEATING CONTRAST'

LAND TEMPERATURES, where people actually live, have risen nearly twice as fast as **OCEAN TEMPERATURES**.



Several regions around the world have already heated by more than 2°C.

Climate change has adversely impacted food security and terrestrial ecosystems — as well as contributing to an increased frequency, intensity and duration of heat-related events, including heatwaves in most land regions.

The ocean has absorbed about **90%** of the excess heat caused by humans.

Oceans heat more slowly than land due to their higher heat capacity and the slow mixing of warmer surface water with deeper, colder water.

Variations in large-scale weather patterns can cause more heat to be buried in the deeper ocean, temporarily reducing the rate of surface temperature rise. The **OCEAN** acts like a giant sponge for heat.

Tracking this energy imbalance is a vital indicator of longer-term heating and climate change.

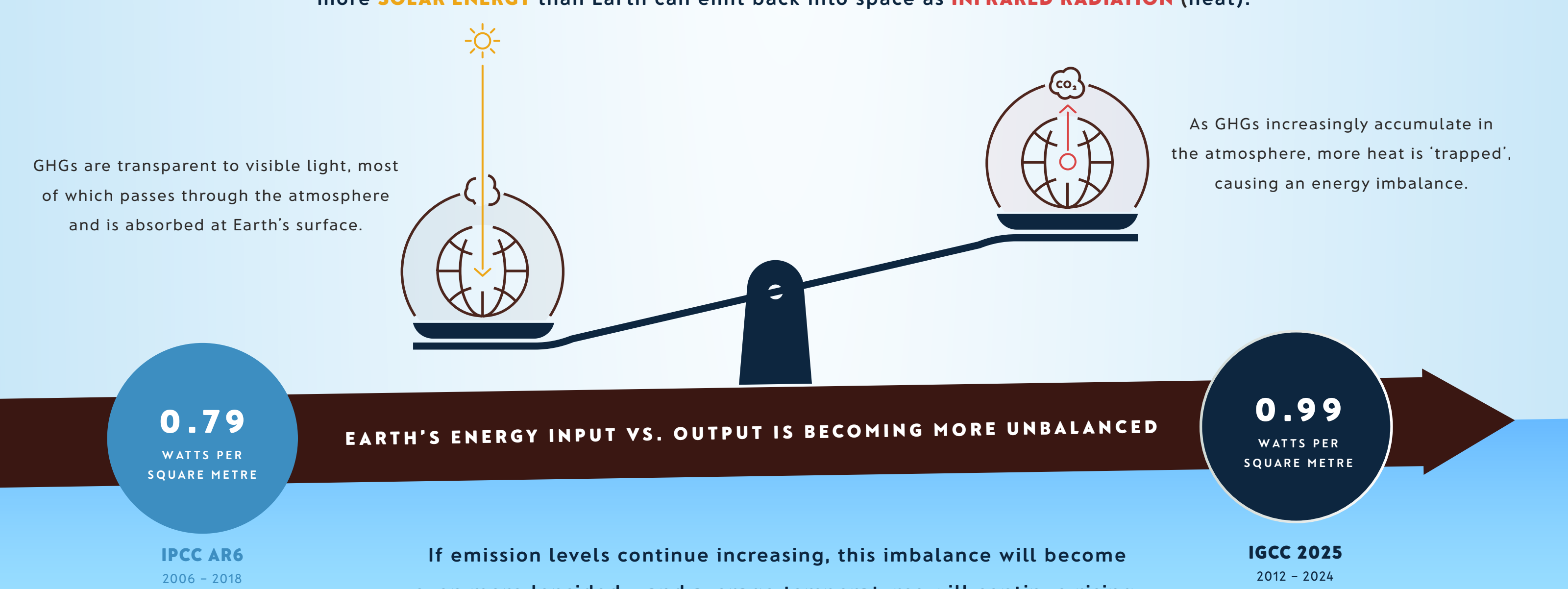
PARTICULARY FOR MONITORING THE FUTURE EXTENT OF CLIMATE CHANGE

EARTH'S ENERGY IMBALANCE (EEI)

Measures the build-up of excess heat in the climate system due to human-caused GHG emissions, which trap more **SOLAR ENERGY** than Earth can emit back into space as **INFRARED RADIATION** (heat).

GHGs are transparent to visible light, most of which passes through the atmosphere and is absorbed at Earth's surface.

As GHGs increasingly accumulate in the atmosphere, more heat is 'trapped', causing an energy imbalance.



IPCC AR6
2006 – 2018

If emission levels continue increasing, this imbalance will become even more lopsided – and average temperatures will continue rising.

IGCC 2025
2012 – 2024

WHAT ABOUT SEA-LEVEL RISE?

Human-caused heating is **accelerating the pace of sea-level rise**. This has profound consequences for coastal ecosystems, safety, and planning — because it raises the baseline for extremes caused by storm surges, waves and tides.

Sea-level rise is driven by three main factors:

i. **Thermal expansion** — warmer water takes up more space than colder water
ii. **Glacier melt** — mountain glaciers are melting worldwide
iii. **Ice sheet loss** — Greenland and Antarctica are losing ice at accelerating rates.

Global mean sea level has risen by **22.8cm**, 1901-2024

Now rising about **4mm** (3.91mm) per year.

AR6: Global mean sea level had risen by 20.2cm, 1901-2018

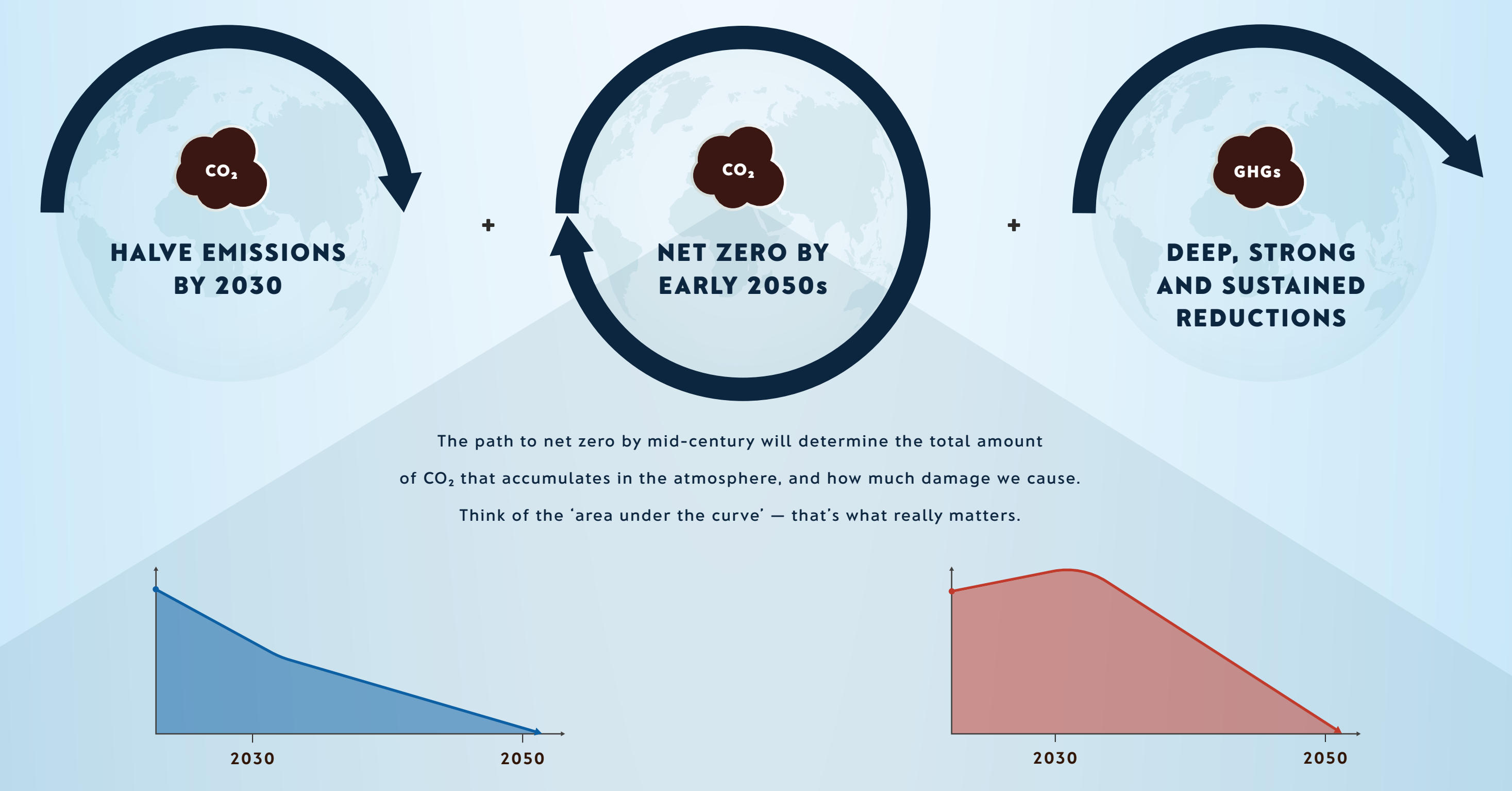
Sea-level rise from global heating will continue for centuries to millennia, due to deep ocean warming and ice sheet mass loss.

STEEP EMISSION REDUCTIONS WOULD SLOW THE RATE OF SEA-LEVEL RISE, BUYING MORE TIME FOR ADAPTATION

THE GOOD NEWS? WE KNOW HOW TO FIX IT

Halving CO_2 emissions as quickly as possible, then achieving net zero CO_2 in the early 2050s — along with rapid, deep, and sustained cuts in other GHG emissions — would hold heating close to 1.5°C.

All GHG emissions should reach net zero roughly two decades later.



LESS CUMULATIVE EMISSIONS, LESS GLOBAL HEATING

Challenging today but less climate impacts and easier for future generations.

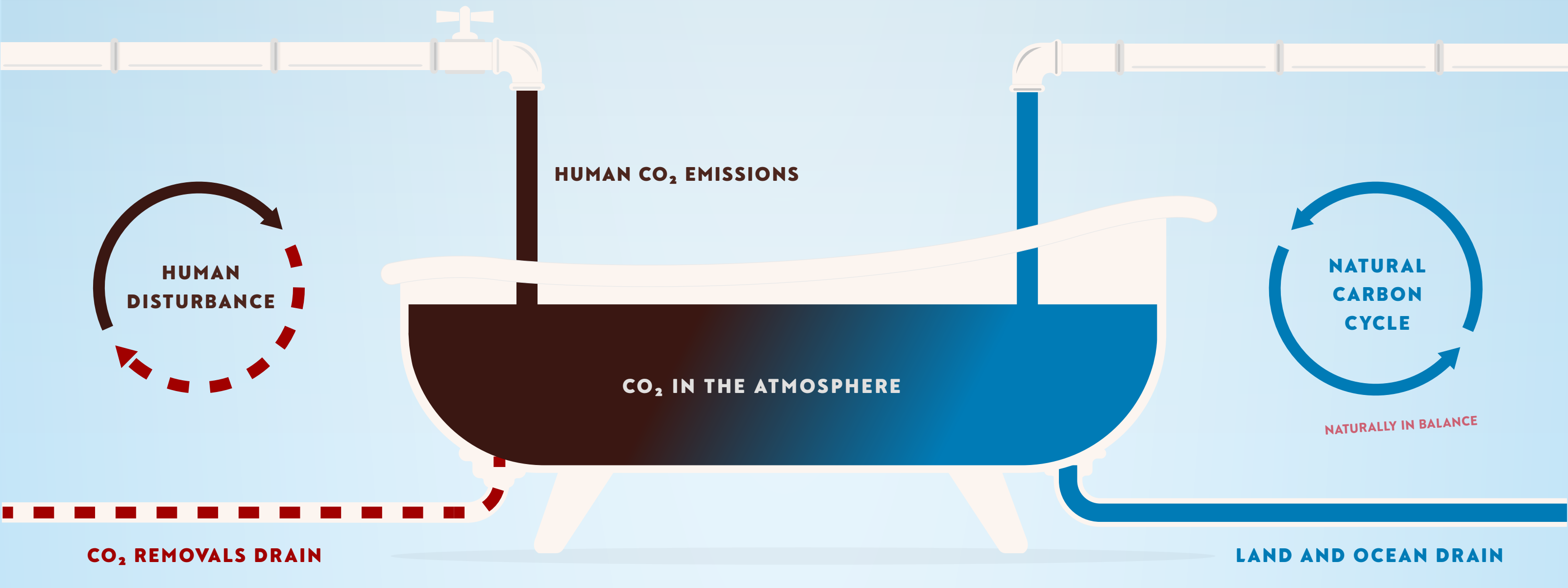
MORE CUMULATIVE EMISSIONS, MORE GLOBAL HEATING

Easier today but more climate impacts and much harder for future generations

WHAT DOES 'ACHIEVING NET ZERO' MEAN?

Stabilising global temperatures requires reaching net zero CO_2 — where **HUMAN-CAUSED CO_2 EMISSIONS** are reduced enough to be counterbalanced by durable **CO_2 REMOVAL**.

Achieving net zero CO_2 is the only scientifically established path to stabilise global warming.



THE UNPROVEN OUTLET FOR COUNTERBALANCING UNAVOIDABLE RESIDUAL EMISSIONS — WITH NO GUARANTEE IT WILL WORK AT THE SCALE REQUIRED

THE BEST FORM OF CO_2 'REMOVAL'?

Turning down the tap through emission reductions. Preventing a tonne of CO_2 emissions today will almost always be easier and cheaper than trying to remove CO_2 from the atmosphere later this century.

01

The number one priority is **slashing CO_2 emissions**. That effectively means turning down the tap of fossil fuel emissions, with a view to turning it off completely.

02

When only residual emissions remain (e.g. 5-10%), we must **counterbalance with durable CO_2 removal** methods to prevent re-entry into the atmosphere.

THE MOVE TO CLEAN-ENERGY AND MORE SUSTAINABLE AGRICULTURAL PRACTICES WOULD NEED TO REDUCE EMISSIONS BY ABOUT 90% BEFORE CARBON REMOVAL COULD FEASIBLY PLAY A ROLE IN COUNTERBALANCING RESIDUAL EMISSIONS TO REACH NET ZERO

THE NUMBERS WILL CHANGE, THE TAKEAWAYS WON'T

The team behind the **Indicators of Global Climate Change** will update these indicators next year, but we already know continued emissions will lead to higher temperatures and more severe impacts on people and natural ecosystems.

Next year the data will be different, but the message will be the same. To prevent the worst impacts of climate change, it's the same formula: deep, strong and sustained reductions in GHG emissions.

EVERY CHOICE MATTERS

EVERY TONNE MATTERS

EVERY YEAR MATTERS

BASED ON THE PAPER

'Indicators of Global Climate Change 2024: annual update of key indicators of the state of the climate system and human influence'

Piers M. Forster, Chris Smith, Tristram Walsh, William F. Lamb, Robin Lamboll, Christophe Cassou, Mathias Hauser, Zeke Hausfather, June-Yi Lee, Matthew D. Palmer, Karina von Schuckmann, Aimée B.A. Slangen, Sophie Szopa, Blair Trewin, Jeongeun Yun, Nathan P. Gillett, Stuart Jenkins, H. Damon Matthews, Krishnan Raghavan, Aurélien Ribes, Joeri Rogelj, Debbie Rosen, Xuebin Zhang, Myles Allen, Lara Aleluia Reis, Robbie M. Andrew, Richard A. Betts, Alex Borger, Jiddu A. Broersma, Samantha N. Burgess, Lijing Cheng, Pierre Friedlingstein, Catia M. Domingues, Marco Gambarini, Thomas Gasser, Johannes Gütschow, Masayoshi Ishii, Christopher Kadow, John Kennedy, Rachel E. Killick, Paul B. Krummel, Aurélien Liné, Didier P. Monselesan, Colin Morice, Jens Mühle, Vaishali Naik, Glen P. Peters, Anna Pirani, Julia Pongratz, Jan C. Minx, Matthew Rigby, Robert Rohde, Abhishek Savita, Sonia I. Seneviratne, Peter Thorne, Christopher Wells, Luke M. Western, Guido R. van der Werf, Susan E. Wijffels, Valérie Masson-Delmotte, Panmao Zhai