Indicators of Global Climate Change 2024:

Annual update of key indicators of the state of the climate system and human influence

Presentation to Earth Information Day by Professor Piers Forster

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Produced by an international team of 61 scientists, including IPCC Lead Authors, Contributing Authors, and Chapter Scientists, from 54 institutions across 17 countries

Summary

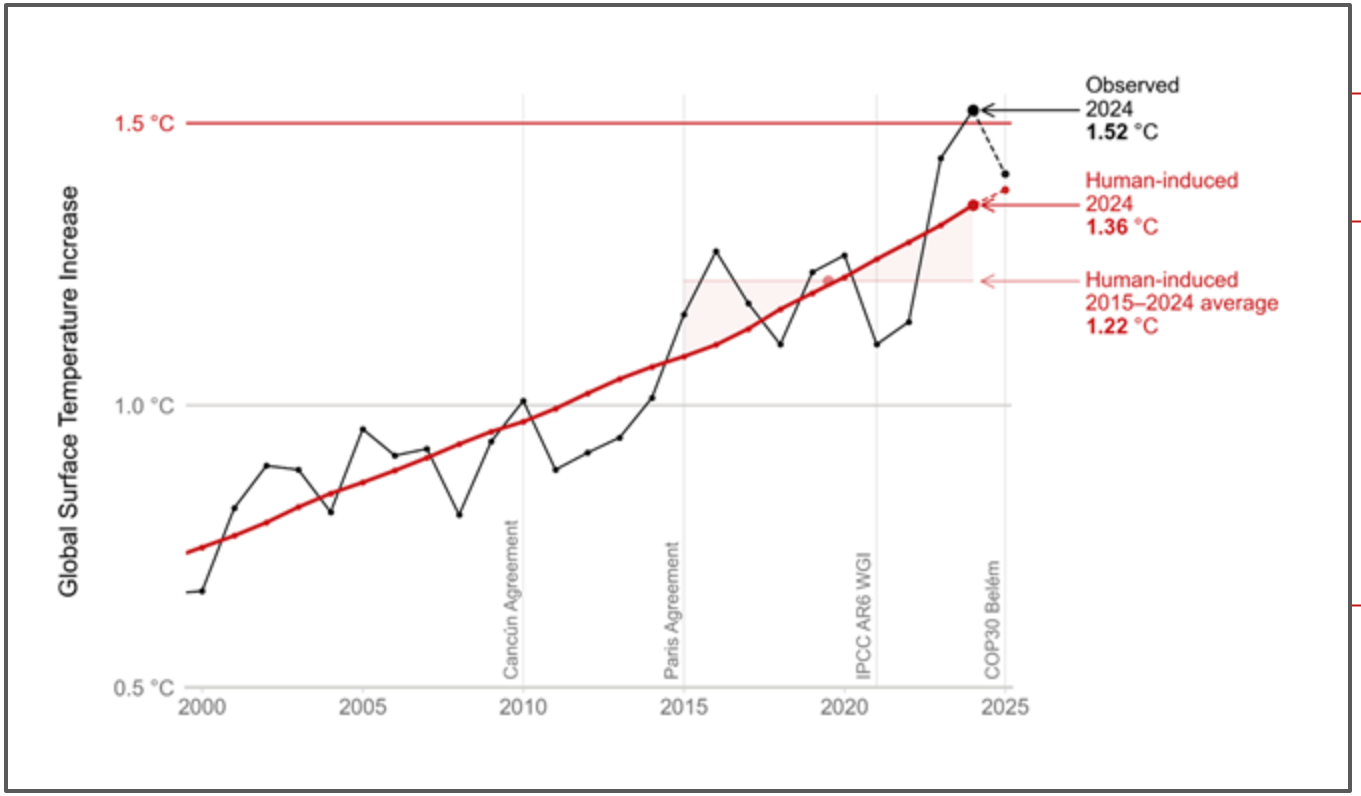
IGCC integrates observations to estimate the human-induced global warming, employing methods and datasets assessed in IPCC AR6:

- Human activities have caused around **1.22°C** of global warming to date
- This human-caused warming is rising at the unprecedented rate of **0.27°C per decade**
- The remaining carbon budget is being rapidly depleted: **130 billion tonnes** for a 50% chance of remaining below 1.5°C (from 1 January 2025)

IGCC integrates data from a diverse array of global observation systems, including emissions inventories, atmospheric monitoring networks, satellite-based platforms, and in situ measurements. This work is made possible through the sustained contributions of the Global Climate Observing System (GCOS), the World Meteorological Organization (WMO), its members, and numerous other partners. Their continued commitment and collaboration are gratefully acknowledged.

Our 2024 assessment	Synthesis
53.6 $GtCO_2e$ (2014-2023 average)	Global GHG emissions remain at an **all-time high**, primarily due to increasing emissions from fossil fuels and industry Fossil fuels account for around 70% of emissions.

Change to AR6 number (55.9 $GtCO_2e$) is due to a systematic downward revision in CO_2-LULUCF and CH_4 emission estimates

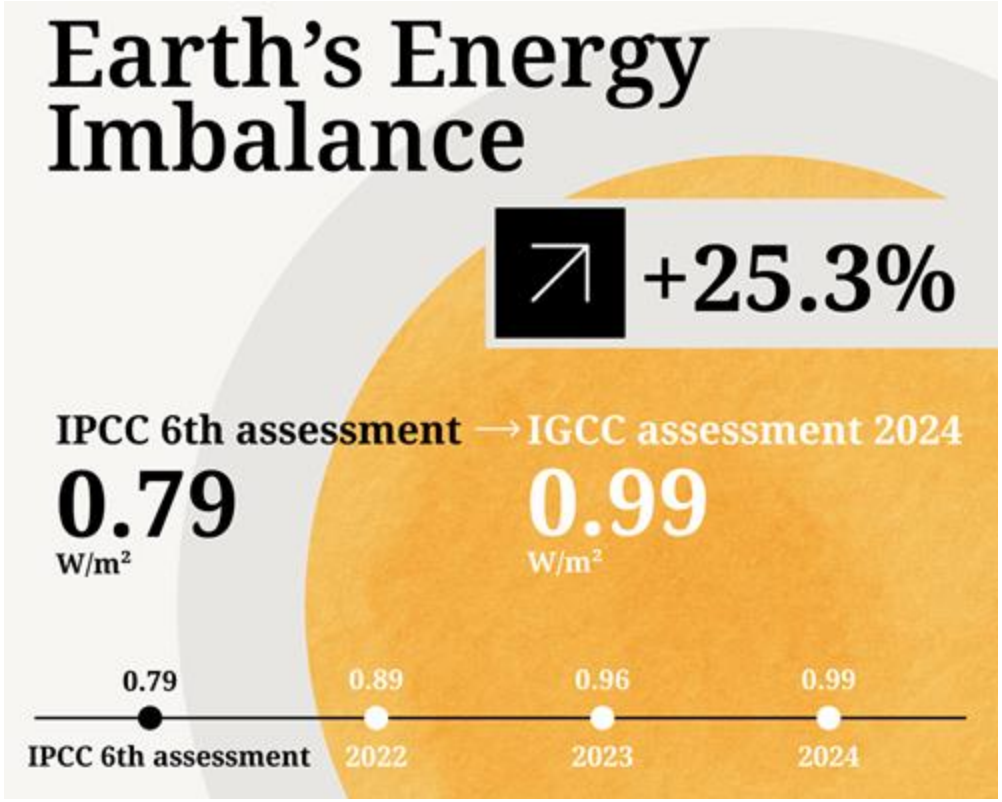


Synthesis

Human activities have caused around **1.22°C of global warming** to date

This human-caused warming is rising at the **unprecedented rate** of 0.27°C per decade

The three methods for the basis of the AR6 assessment are retained, but each has new input data

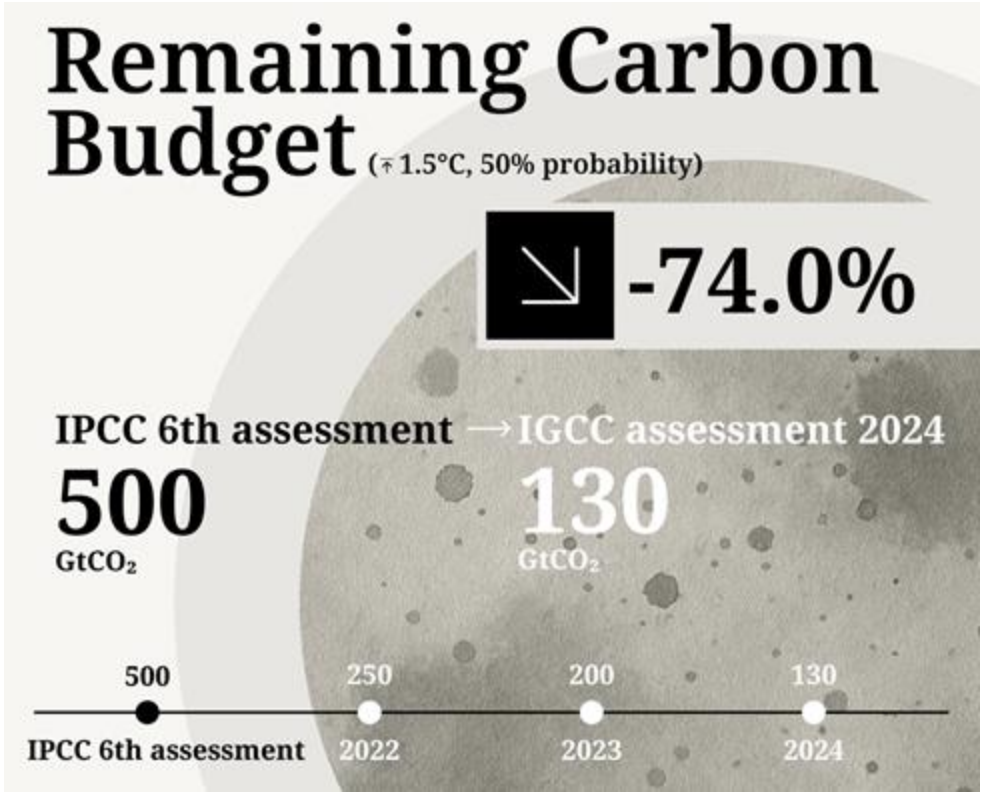


Ocean heat content time series extended from 2018 to 2024 using all five of the AR6 datasets. Other heat inventory terms updated

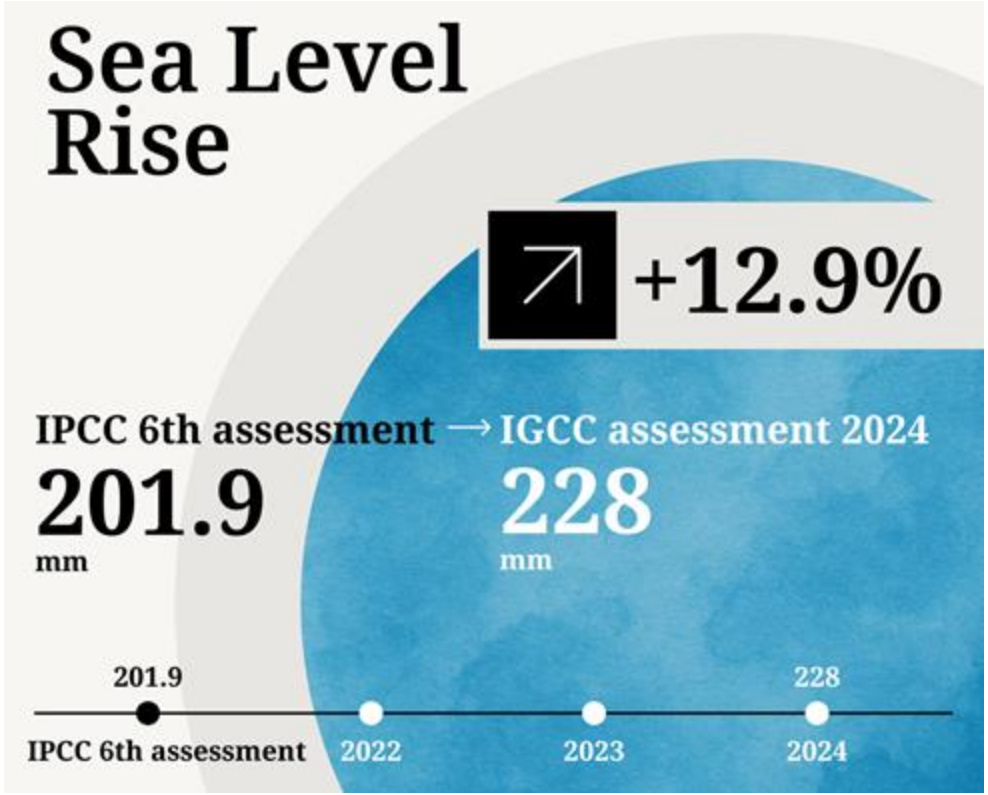
EEI is a crucial indicator for monitoring current and future warming

- New GCOS indicator
- Soon to feature in WMO updates
- ARGO programme critical for ocean heating observations

Our 2024 assessment	Synthesis
0.99 W m^{-2} 2012-2024 average	Heat is accumulating in the Earth's system at an increasing rate – **driving changes in every component of the climate system** 25% increase in energy imbalance is dominated by increase in ocean heat content



Our 2024 assessment	Synthesis
130 $GtCO_2$ (from the start of 2025)	The most recent estimate of human-induced warming brings us closer to 1.5°C, reducing the 1.5°C remaining carbon budget This budget would be exhausted in a **little more than three years** at current emissions levels



Our 2024 assessment	Synthesis
228.0 mm (1901 to 2024) at a rate of 1.85 mm yr^{-1}	Between 2019 and 2024 global mean sea level has increased by around 26 mm The recent rate of increase is **more than double the long-term rate** → Acceleration of sea-level rise continues

AR6 data extended with three of the six datasets from AR6, using latest satellite data

Conclusions

Scientific evidence based on systematic observations presents a **clear, consistent but worsening picture**. Human activities are changing the climate system at a rate and scale not experienced since records began

The findings are aligned with long-standing scientific understanding but also underscore the **accelerating trajectory** of many climate risks and impacts

They also reaffirm the **critical importance of sustained, systematic climate observations**, and the essential role of international collaboration in the generation, integration, and interpretation of data to inform ambitious climate policy and action

Observations and datasets used to produce IGCC indicators include:

- **GHG Emissions** *GCB, PRIMAP, CEDS, EDGAR GFED, Grassi NGHGI, CIP*
- **GHG Concentrations** *NOAA GML, AGAGE*
- **Short-Lived Climate Forcers** *CEDS*, *CAMS, GFED*
- **Natural Forcing** *GloSSAC, OMPS LP,*
- **Earth Energy Imbalance** *incl. IAP, EN4, JNA, NCEI*
- **Surface Temperature** *HadCRUT5*, *NOAA GlobalTemp*, *Kadow, Berkeley Earth, China-MST*
- **Sea Level** *AR6 GMSLR time series (tide gauge and satellite altimetry - AVISO/CNES, CSIRO, NASA/GSFC, NOAA, SL_cci/ESA and University of Colorado)*
- **Global Land Precipitation** *GPCC, CRU TS, GPCP, GHCN*
- **Land Average Maximum Temperatures** *HadEX3, Berkeley Earth, ERA5*

Thank you

Access the publication in Earth System Science Data

Read more about this year's findings

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