CLIMATE SENSITIVITY DEBATE.

Climate sensitivity is a measure of how much the Earth's average surface temperature will warm if the amount of greenhouse gases in the atmosphere doubles. [1]

Key Aspects

- **The Benchmark**: It is almost always calculated using a doubling of atmospheric carbon dioxide (CO_2) from pre-industrial levels.
- **The Purpose**: It helps scientists estimate how severe future global warming will be based on human emissions. [1, 2, 3, 4, 5]

Two Main Types

Scientists look at climate sensitivity through two primary lenses:

- **Equilibrium Climate Sensitivity (ECS)**: The total, long-term warming after the atmosphere and oceans have completely stabilized. This process takes centuries.
- **Transient Climate Response (TCR)**: The quicker, immediate warming we will experience at the exact moment CO_2 levels finish doubling. [1, 2, 3, 4, 5]

Why It Matters

A higher climate sensitivity means the planet is highly reactive to greenhouse gases, leading to harsher temperature spikes. A lower sensitivity means the planet warms more slowly, giving humanity more time to adapt.

Former NASA scientist **James Hansen and his co-authors** published a high-profile study titled *"Global Warming in the Pipeline"* demonstrating that the **Equilibrium Climate Sensitivity (ECS) for a doubling of atmospheric CO2 is 4.8°C ± 1.2°C**. In subsequent work, Hansen consistently simplified and summarized this finding as a best estimate of **4.5°C**, which is exactly 50% higher than the Intergovernmental Panel on Climate Change (IPCC) baseline. [1, 2, 3, 4]

The Core Disagreement

The difference in these numbers comes down to how scientists measure the Earth's long-term reaction to greenhouse gases: [1]

- **The IPCC Position (3.0°C)**: In its Sixth Assessment Report (AR6), the IPCC narrowed its "likely" ECS range to 2.5°C–4.0°C, establishing **3.0°C as its best estimate**. The IPCC relies heavily on complex **global climate computer models**. [1, 2, 3, 4]
- **The Hansen Position (4.5°C)**: Hansen argues that the IPCC's computer models understate the climate's true sensitivity. His team arrived at the higher figure primarily by analyzing **paleoclimate data**—specifically looking at how the Earth naturally transitioned out of the Last Glacial Maximum. He asserts that real-world history shows the planet's feedback loops are much more aggressive than modern code accounts for. [1, 3]

Why the Gap Exists

Hansen highlights two main areas where he believes mainstream models fail:

- **The Aerosol "Faustian Bargain"**: Human-made pollution (like sulfur aerosols from coal and shipping fuels) actually reflects sunlight and cools the planet. Hansen argues that this cooling effect has been much stronger than the IPCC realizes. As global regulations rapidly clean up air pollution, this "umbrella" is disappearing, revealing the true, harsher warming power of the CO2 already in the atmosphere. [1, 2, 3, 4]
- **Fast Feedbacks**: Hansen's historical data implies that fast-moving feedback mechanisms (such as changes in cloud cover, water vapour, and sea ice) amplify initial warming at a much higher rate than the 3.0°C baseline handles. [1]

The Status of the Scientific Debate

While James Hansen is one of the world's most renowned climate scientists, his 4.5°C figure is **not yet the consensus view**. Many mainstream climate scientists argue his 4.5°C estimate is an outlier that relies on highly subjective interpretations of historical data. However, recent real-world temperature spikes and the rapid acceleration of global warming have forced the scientific community to take his warnings seriously. [1, 2, 3, 4]

The primary groups of scientists and lines of evidence supporting a higher climate sensitivity include: [1, 2]

1. The "Hot Model" Developers (CMIP6 Teams)

When the global climate scientific community rolled out its generation of climate models known as CMIP6 (used for the IPCC Sixth Assessment Report), many of the world's premier modeling institutions independently produced an Equilibrium Climate Sensitivity (ECS) far higher than 3.0°C: [1, 2, 3, 4, 5]

- **The NCAR Team (USA):** The **National Center for Atmospheric Research** updated its flagship model (CESM2), which suddenly calculated an ECS of **5.3°C**.
- **The UK Met Office:** Their advanced climate model (UKESM1) jumped to an ECS estimate of **5.4°C**.
- **The Canadian Centre for Climate Modelling and Analysis:** Their CanESM5 model calculated an ECS of **5.6°C**. [1, 2, 3, 4, 5]

In total, roughly **one-quarter of the modern CMIP6 models** predicted an ECS above 4.7°C. The scientists heading these institutional models argued that their results were a natural consequence of building more realistic, higher-resolution physics into the software. [1, 2, 3]

2. Cloud Feedback Researchers (Zelinka et al.)

Climate scientists specializing in the atmosphere have identified why newer models run so hot. Prominent researchers like **Mark Zelinka** and his colleagues published landmark studies in *Geophysical Research Letters* proving that the higher sensitivity is driven by **cloud feedback loops**. [1, 2]

As the Earth warms, ice in low-level clouds over the Southern Ocean melts into liquid water. Zelinka's research demonstrated that as these clouds lose ice, they become thinner, lose their ability to reflect sunlight, and cause the planet to absorb vastly more solar radiation. These scientists argue that if these cloud equations are accurate, the Earth is inherently more sensitive to carbon dioxide than the IPCC's conservative consensus implies. [1, 2, 3, 4, 5]

3. Paleoclimate Experts looking at Tipping Points

Scientists tracking the Earth's deep history note that ancient warm periods—such as the Pliocene epoch or the Paleocene-Eocene Thermal Maximum (PETM)—warmed at a magnitude that cannot be explained if climate sensitivity is only 3°C. Research published through initiatives like the **Deep South National Science Challenge** suggests that "hot models" are highly useful because they are the only ones capable of accurately replicating the extreme heat experienced in Earth's deep past. [, 2]

Why doesn't the IPCC just use these higher numbers?

The IPCC did not ignore these scientists, but it chose to downweight their results in its official baseline. Mainstream climate scientists, such as **Gavin Schmidt** (Director of the **NASA Goddard Institute for Space Studies**), pointed out a major flaw: while these high-sensitivity models simulated future clouds incredibly well, they failed to accurately simulate the *past*. When forced to recreate the temperature trend of the 20th century, these high-sensitivity models predicted far more warming than humanity actually observed. [1, 2, 3]

As a result, the IPCC compromise was to filter out the raw averages of these "hot models" to keep their baseline at 3.0°C. However, the debate remains fiercely active because real-world global temperatures have been accelerating rapidly, causing some scientists to wonder if the "hot models" were right about our future all along. [1, 2, 3, 4]

Under current emissions conditions and global policies, the Earth is likely to reach the doubling point for pre-industrial carbon dioxide (\(CO_{2}\)) **around the year 2050**. [1]

The Target Metric

- **Pre-Industrial Baseline**: **280 parts per million (ppm).**
- **The Doubling Point**: **560 ppm**. [1, 2, 3]

Current Trajectory and Calculations

The timeline is dictated by current atmospheric trends and the accelerating accumulation of emissions:

- **Where We Stand Now**: As of mid-2026, global atmospheric \(CO_{2}\) levels have surpassed **432 ppm**. This means we have already crossed a milestone of being over **54% higher** than pre-industrial baselines. [1, 2]
- **The Gap to Fill**: The atmosphere requires an additional 128 ppm of CO2 to reach the 560 ppm threshold. [1]
- **Annual Growth Rate**: According to the **World Meteorological Organization (WMO)**, human activities and weakening natural carbon sinks have pushed the annual CO2 growth rate up, averaging an increase of **3.5 to 3.75 ppm per year** during peak cycles. [1, 2]
  If current trends continue without a rapid, structural peak and decline in fossil fuel consumption, the math puts the doubling point **between 2050 and 2060**. If global

emissions continue to rise unchecked rather than stabilizing, it could occur slightly sooner, closer to **2045**. [1]