Newest Generation of Climate-Model Simulations Pinpoints Anthropogenic Carbon Dioxide Emissions

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Climate change has always happened - what was special about the 20th century?

• Transition from the last ice age to the current warm phase (IPCC 2007, WG1, p. 451):
  • Global-mean warming: about 5 °C
  • Duration about 5000 years

• Ice age → warm phase: 1 °C warming in 1000 years
• 20th century: 1 °C warming in 100 years

• Humanity is warming the global climate at least ten times faster than nature ever could
MPI-ESM: The 2 °C target can be reached if we follow scenario RCP2.6 ...

Observations
Historical
Scenario RCP8.5
Scenario RCP4.5
Scenario RCP2.6

Change in global-mean surface temperature relative to 1986-2005

Giorgetta et al. 2012
...but anthropogenic CO₂ emissions must fall from 2020 onward - by 2100, to 10% of the year-2000 level

Considerable model uncertainty: in several models the 2 °C target is missed even in scenario RCP2.6; often the atmosphere must be “scrubbed” of CO₂

Giorgetta et al. 2012
21st-century $\text{CO}_2$ emissions and global warming

<table>
<thead>
<tr>
<th>Scenario</th>
<th>RCP2.6</th>
<th>RCP4.5</th>
<th>RCP8.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cumulative 21st-century $\text{CO}_2$ emissions (Gt C)</td>
<td>about 500</td>
<td>about 900</td>
<td>about 1900</td>
</tr>
<tr>
<td>Warming relative to late 20th century (MPI-ESM)</td>
<td>about 1 °C</td>
<td>about 2 °C</td>
<td>about 4 °C</td>
</tr>
</tbody>
</table>

• About 1 °C further warming for each 500 Gt C; late 20th century was 1 °C warmer than pre-industrial

• We have another 500 Gt C that we “may” emit without failing to reach the 2 °C target. Current emissions: almost 10 Gt C/year

• We would have another 50 years with current emissions, with nothing left.

• Any further increase now would require even more drastic reductions later.