

# Energy Budget Changes Since 1950

In more recent years, changes in the atmosphere have also caused unbalance in these equations, with another departure from equilibrium. At least part of these changes is due to human activities.

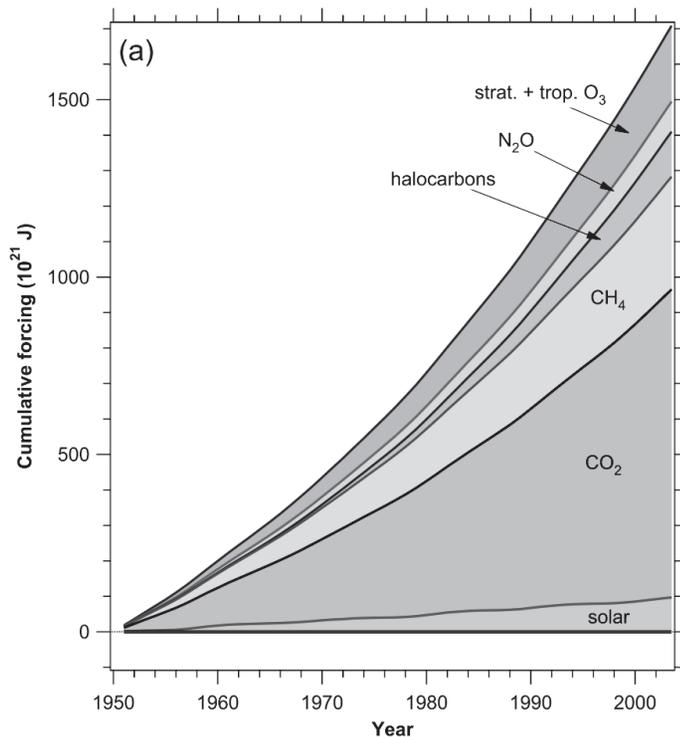


Figure (a) depicts items that have caused changes in the energy budget since 1950. Called forcing agents, these absorb additional energy in the atmosphere (enhanced greenhouse effect). The greenhouse gasses shown in the figure:

- carbon dioxide –  $\text{CO}_2$
- methane –  $\text{CH}_4$
- halocarbons,
- nitrous oxide -  $\text{N}_2\text{O}$
- stratospheric + tropospheric ozone -  $\text{O}_3$

have increased in the atmosphere mostly due to human activities. A natural change from variations in the Sun's output is also shown along the bottom of the graph. This figure shows the cumulative effect of small changes. The additional heat trapped each year continues to add up to a warmer Earth.

Knowing how much additional heat was absorbed (because we know how much of these gasses were emitted) the question becomes: where did the energy go? Figure (b) partitions the added energy shown above based on observed changes in the Earth system. So far, a small amount of the energy has gone into warming the ocean – the part of the Earth that stores the most energy. Some has escaped Earth in the form of increased IR emission because of warmer temperatures. Some was reflected to space by aerosols (mostly volcanic in origin) in the stratosphere. The remainder (white band) is inferred to have been reflected due to aerosols (mostly pollution) in the troposphere, and other effects such as a changing reflection of the land surface due to deforestation, for example.

