

The Discovery of Global Warming

Read all about it!

Excellent book and
even better website
by Spencer Weart



<http://www.aip.org/history/climate/index.htm>

(Or just google: weart global warming)

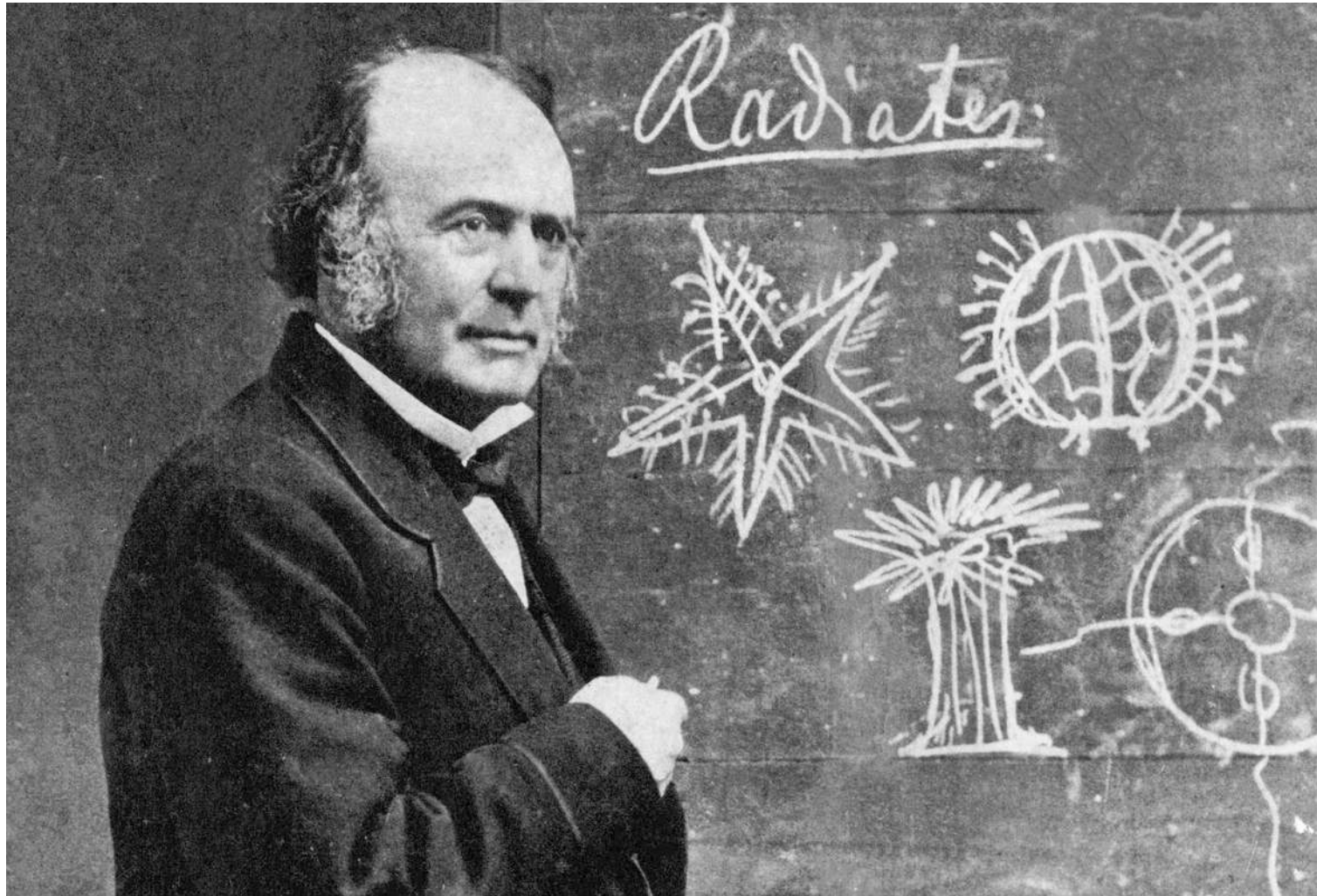
Why is it so warm?



Jean-Baptiste
Joseph Fourier
1768-1830

- Calculated that the radiation from the Sun was insufficient to make Earth habitable
- Speculated (1824, 1827) that the atmosphere acted like panes of glass in a “hothouse” to let light in but restrict heat from escaping

An Age of Ice!



Louis Agassiz, Swiss Geologist, 1807 - 1873

Glaciers, Moraines, and the Ice Age



Glacial landforms of the alps such as lateral and terminal moraines were eventually mapped over much of Europe and North America

Molecules that Absorb and Emit Heat

- Interested in the Ice Age from his studies in the Alps
- Discovered IR absorption by CO_2 , H_2O and CH_4



John Tyndall, Irish Physicist, 1820 - 1893

Climate Sensitivity



Verlag von Wilhelm Engelmann Leipzig

Gravure Meisenbach Riffarth & Co. Leipzig

Svante Arrhenius

Analyzed years' worth of measurements of IR radiation from the Moon to determine absorption by different thicknesses of the atmosphere

Svante Arrhenius
Swedish Physicist
1859 - 1927

Already knew that CO₂ and other gases absorbed outgoing heat to keep Earth warm ... 1896 paper sought to quantify influence

"That the atmospheric envelopes limit the heat losses from the planets had been suggested about 1800 by the great French physicist Fourier. His ideas were further developed afterwards by Pouillet and Tyndall. Their theory has been styled the hot-house theory, because they thought that the atmosphere acted after the manner of the glass panes of hot-houses."

THE
LONDON, EDINBURGH, AND DUBLIN
PHILOSOPHICAL MAGAZINE
AND
JOURNAL OF SCIENCE.

[FIFTH SERIES.]

APRIL 1896.

XXXI. *On the Influence of Carbonic Acid in the Air upon the Temperature of the Ground.* By Prof. SVANTE ARRHENIUS*.

I. *Introduction: Observations of Langley on Atmospheric Absorption.*

A GREAT deal has been written on the influence of the absorption of the atmosphere upon the climate. Tyndall † in particular has pointed out the enormous importance of this question. To him it was chiefly the diurnal and annual variations of the temperature that were lessened by this circumstance. Another side of the question, that has long attracted the attention of physicists, is this: Is the mean temperature of the ground in any way influenced by the presence of heat-absorbing gases in the atmosphere? Fourier ‡ maintained that the atmosphere acts like the glass of a hot-house, because it lets through the light rays of the sun but retains the dark rays from the ground. This idea was elaborated by Pouillet §; and Langley was by some of his researches led to the view, that "the temperature of the earth under direct sunshine, even though our atmosphere were present as now, would probably fall to -200° C., if that atmosphere did not possess the quality of selective

* Extract from a paper presented to the Royal Swedish Academy of Sciences, 11th December, 1895. Communicated by the Author.

† 'Heat a Mode of Motion,' 2nd ed. p. 405 (Lond., 1865).

‡ *Mém. de l'Ac. R. d. Sci. de l'Inst. de France*, t. vii. 1827.

§ *Comptes rendus*, t. vii. p. 41 (1838).

Svante Arrhenius

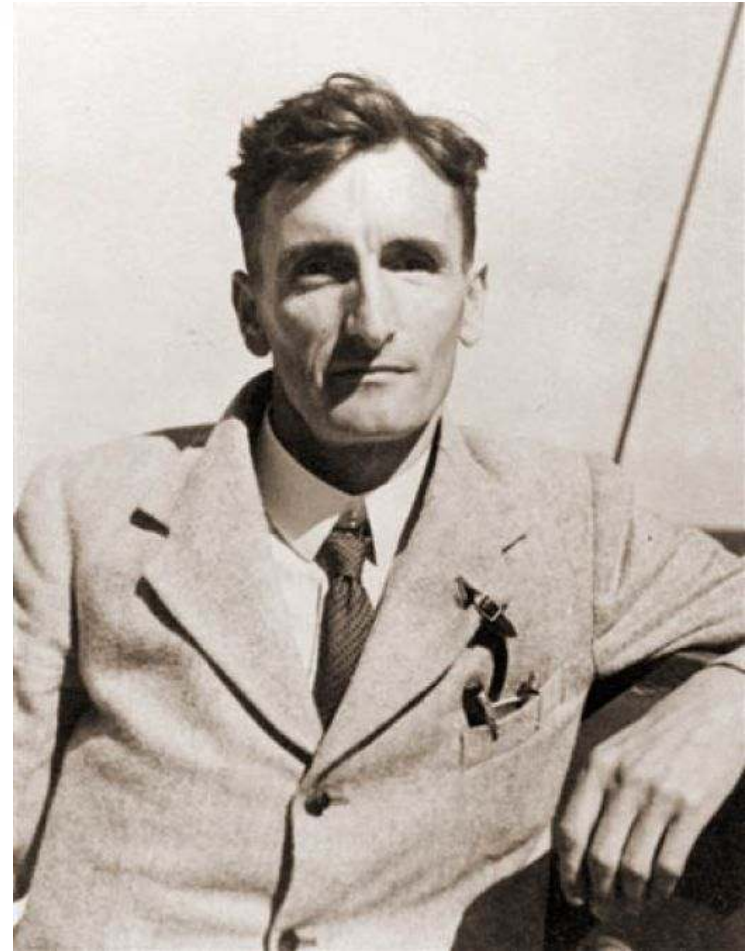
- “any doubling of the percentage of carbon dioxide in the air would raise the temperature of the earth's surface by 4°; and if the carbon dioxide were increased fourfold, the temperature would rise by 8°.”
- "Although the sea, by absorbing carbonic acid, acts as a regulator of huge capacity, which takes up about five-sixths of the produced carbonic acid, we yet recognize that the slight percentage of carbonic acid in the atmosphere may by the advances of industry be changed to a noticeable degree in the course of a few centuries.”
- “Is it probable that we shall in the coming geological ages be visited by a new ice period that will drive us from our temperate countries into the hotter climates of Africa? There does not appear to be much ground for such an apprehension. The enormous combustion of coal by our industrial establishments suffices to increase the percentage of carbon dioxide in the air to a perceptible degree.”

Das Werden der Welten [1907]

Does the Sea Buffer Atmospheric CO₂?

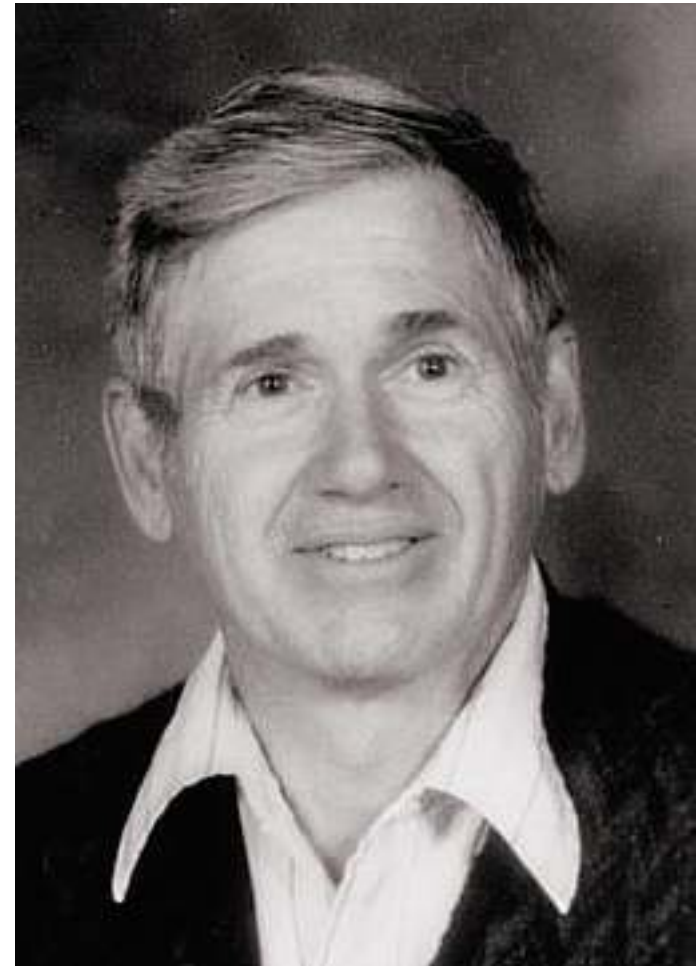
- Arrhenius thought the oceans would absorb most CO₂
- Callendar sought to measure CO₂ in air
- Might delay a “return of the deadly glaciers”

Guy Stewart Callendar
English Engineer & Inventor
1898 - 1964



Modern Measurements

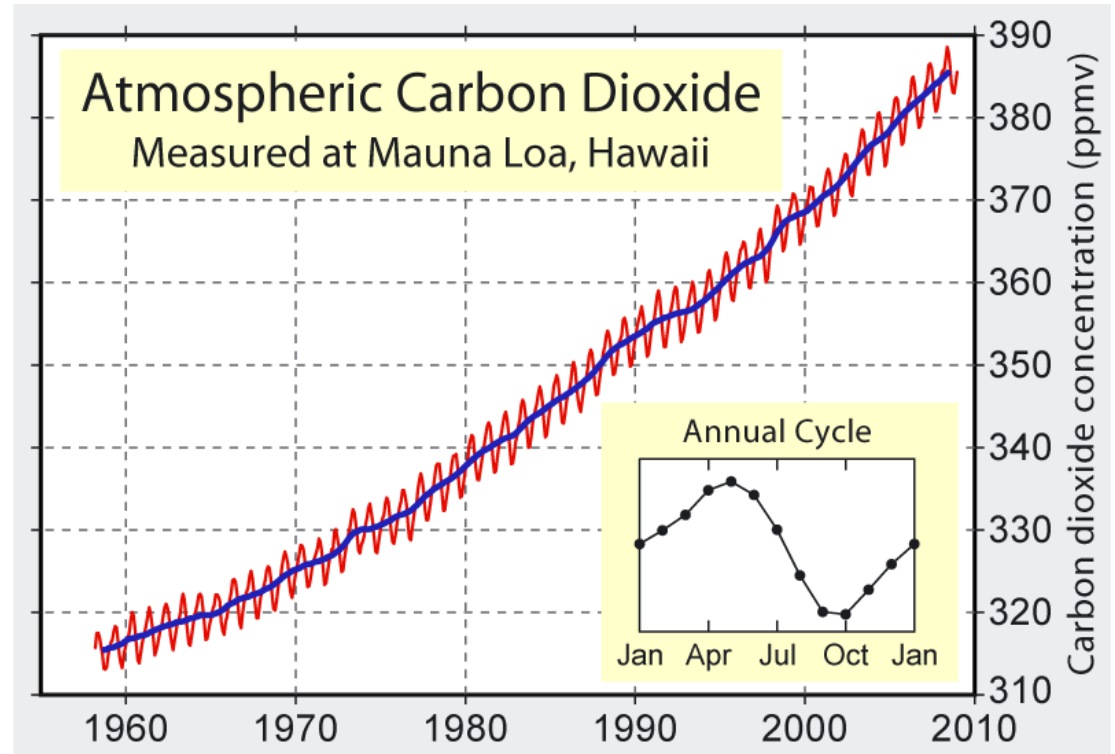
- Callendar had used titration of carbonic acid in water
- Keeling developed a high-precision infrared gas analyzer
- Early experiments in California & Montana
- Set up continuous monitoring in Hawaii in 1958



Charles David Keeling, 1928 - 2005



Roger Revelle
1909 - 1991



“Human beings are now carrying out a large-scale geophysical experiment of a kind that could not have happened in the past nor be repeated in the future. Within a few centuries we are returning to the atmosphere and oceans the concentrated organic carbon stored in the sedimentary rocks over hundreds of millions of years. This experiment, if adequately documented, may yield a far-reaching insight into the processes determining weather and climate.” 1957

