Some References on the Greenhouse Effect and Climate Science

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Mike Alexander suggested I provide some references relevant to climate science and the greenhouse effect. There's a vast literature ranging from popular to technical. Listed below are items that I think LCTG members might like.

Sources

- Number one is the online course offered online by Penn State. Mike, Jerry Slate, Carl Lazarus, Harry Forsdick, and I went through the twelve modules of Penn State's Earth 103. These are at `https://www.e-education.psu.edu/earth103/node/508`. This was worth doing and our discussions of the material were a welcome diversion in this time of pandemic. The course is intended for undergraduates with little familiarity with science.
- Spencer R. Weart, *The Discovery of Global Warming*, revised and expanded edition, 230 pp., 2008. Harvard University Press. This may be the best way to get into the subject of climate science. I strongly recommend it. The book gives an excellent account of the history of the rise of climate science. Weart describes the relatively recent growth of understanding of the complexity of Earth's climate system — how energy arrives from the Sun and how it is distributed across Earth by oceans, atmosphere, and seasons. It is a first rate piece of history of science. He also does an excellent job of describing the difficulties scientists face when they try to influence public opinion and policy, and he gives the reader a feeling for the human side of the various scientists who have advanced understanding of Earth and its climate.
- Sarah Dry, *Waters of the World* (U. Chicago Press, 368 pp., 2019) writes for the general public. Her book gives a history of the people and their insights and research efforts that revealed the complex flows of the oceans that move heat energy from one part of the globe to another. These discoveries were essential to the gradual recognition of the global nature of weather and climate.

- Spencer R. Weart has set up a website that provides a hyperlinked version of his book. The hyperlinks provide much more detail about climate science than his relatively brief book. The site is on the server of the American Institute of Physics and provides accessible (understandable) elaborations of many details. Highly recommended. `https://history.aip.org/climate/index.htm`

- Raymond Pierrehumbert wrote a short article in *Physics Today* that I found particularly enlightening about the greenhouse effect. `http://geosci.uchicago.edu/%7Ertp1/papers/PhysTodayRT2011.pdf`. He also compares the spectral radiations at the tops of the atmospheres of Venus, Earth, and Mars.

- The American Chemical Society (ACS) has an informative website at `https://www.acs.org/content/acs/en/climatescience/about.html`. This site is nicely laid out; you can use it to gain an overview, and you can use it to dig deeper into details. The explanation of the greenhouse effect is good.

- Harries, J. E. (2000). "Physics of the Earth's radiative energy balance." *Contemporary Physics*, **41**(5), 309–322. doi:10.1080/001075100750012803 url to share this paper: `sci-hub.st/10.1080/0010751007500128` Good explanation of the uncertainties in attempts to model Earth's radiation balance (ERB). The major uncertainty is the effect of clouds. But the very complexity of the possible feedbacks is also a major source of uncertainty.

- Large, complex computer models play a critical role in climate science. The previous two items allude to the centrality of computer models in studies of climate. Jerry Slate found a good discussion of this topic at `https://www.carbonbrief.org/qa-how-do-climate-models-work`. This website describes general features of climate models and how they have been expanded and extended to include ever more phenomena.