



# IAS MAGAZINE

Indian Association of Sedimentologists

## William Happer, Ph.D (Princeton)



*Born in Vellore on July 27 1939,  
Grade School Education in Kodaikanal,  
and grew up in Madurai, Tamil Nadu, India*

*William Happer, Ph.D The Cyrus Fogg  
Brackett Professor Emeritus in the  
Department of Physics at Princeton  
University, New Jersey, USA*



*William Happer (1982):  
The Inventor of Sodium Laser Guide*

The "IAS Magazine" is an online "fellowship magazine of the Indian Association of Sedimentologists (IAS) which publishes news about science, people, the society and articles of general interest science and achievements of Sedimentologists | allied scientists of international repute and their contributions relevant to the society. The Magazine is being published online biannually in June and December. The authors may submit their articles to the Magazine online at Journal of The Indian Association of Sedimentologists (peer reviewed). The guidelines for the format of the articles are given on the same website.

Editor: G. M. Bhat

DOI: <https://doi.org/10.51710/jias.v4i1>

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### **Publisher:**

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## Biography

### William Happer, Ph.D. (Princeton): The Consequential Climate Physicist

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#### Abstract

William Happer, born in Vellore (1939), Tamil Nadu, India is an American icon on Climate Physics. He is currently the Cyrus Fogg Brackett Professor Emeritus in the Department of Physics at Princeton University, New Jersey, USA. Amid numerous brilliant Climate Researchers, William Happer has distinguished himself as “The Consequential Climate Physicist” for the following reasons. 1. He has over 300 publications, which include (a) 18 Premier Climate Physics Articles, (b) 32 Articles, Commentaries, Interviews, Lectures, Testimonies, and Podcasts, and (c) 157 Atomic, Molecular, and Optical Physics Publications. 2. He is not only an eminent Climate Physicist, but also a great communicator, inventor, educator, motivator, historian, humorist, and public servant under two American Presidents (George H. W. Bush and Donald J. Trump). 3. His seminal climate message is simply the following. Because of the heavy saturation of the CO<sub>2</sub> absorption-emission bands of Earth’s atmosphere, additional CO<sub>2</sub> can only have a very small effect on climate. Even doubling of CO<sub>2</sub> will only amount to an increase of <1°C in Temperature. 4. Importantly, William Happer’s single greatest gift to the world is his brilliant and uncanny ability to convert complex Climate-Physics knowledge into simple, easy-to-understand, narratives and communicate them to the masses via a plethora of print and digital media relentlessly. Consequently, Climate Researchers, with alternative viewpoints to Anthropogenic Global Warming (AGW), have been successful not only in exposing the Climate Scam but also in rescuing humanity from a near extinction due to the insane Net-Zero nonsense.

**Keywords** William Happer, Gladys Morgan Happer, World War II, .CO<sub>2</sub> Coalition, Sodium Guide Star laser, JASON, Climate Change, Net-Zero nonsense, Climate Scam, Climate Emergency, Anthropogenic Global Warming (AGW), Climate Physics, Princeton University, Hillsdale College, Tamil Nadu, Vellore, John Lyndall, Svante Arrhenius, Charles Keeling, Richard Lindzen, William van Wijngaarden, Patrick Moore, Steve Koonin, John Christy, Roy Spencer, Freeman Dyson, Gerrit Van der Lingen, Fred Singer, Rhodes Fairbridge, John Damuth, John Clauser, Judith Curry, Willie Soon, Alex Epstein, Michael Kelly, Mathew Ridley, Anthony Watts, George H. W. Bush, Donald J. Trump, Martin Durkin, Tom Nelson, D. Chandrasekharam.

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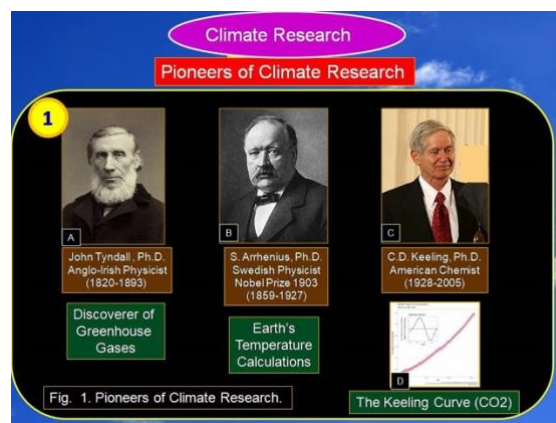
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### Introduction

The Net-Zero policy presents a clear and present danger to humanity under the illusion of “Climate Change.” Our current existential battle with the global elites and their climate orthodoxy agenda is crucial and immediate (Gore, 2007; Epstein, 2022; Lee et al., 2023). Climate research has come a long way since the discovery of greenhouse gases by Tyndall (1861) (Fig. 1), and early calculations of Earth’s temperature by Arrhenius (1896a, b). Today, satellite measurements of Temperature (Christy, 2022) and field measurements of CO<sub>2</sub> (“The Keeling Curve”, NOAA, 2024) are the norm. Despite these advances made by numerous brilliant researchers (see the following section “Global Climate Researchers with Alternative Viewpoints”), the Intergovernmental Panel on Climate Change (IPCC) forces the irrational NetZero Policy with a calamitous end to humanity (Epstein, 2022, Shanmugam, 2023). In averting this calamity, William Happer and his colleagues have played a vital role in exposing the “Climate Scam”. The primary purpose of this article is to compile his contributions using his publications, podcasts, and other works in documenting Happer’s enormous efforts of epic proportions in dismantling the myth of Climate Emergency and related Net-Zero Policy. I also attempt to illustrate how his formative years in India, Scotland, and America during World War II had

prepared him to become a professional Climate Physicist. This biographical account of William



Happer is the fifth in a series following the other four giants in geological and physical sciences, namely (1) Prof. George Devries Klein (Shanmugam, 2018), (2) Prof. T. N. Muthuswami Iyer (Shanmugam, 2022), (3) Prof. Zeng Zhao Feng (Shanmugam, 2023a), and (4) Prof. J. Robert Oppenheimer (Shanmugam, 2023b). These biographies are intended for readers primarily in the Global South, such as India, Sri Lanka, China, and Africa.

In distinguishing the importance of Happer’s research domain, publication type, and authorship position, Bibliography is grouped into

four parts. The first three parts are authored by William Happer and co-authors totalling 207 published works. All four parts account for 383 research works:

- Part 1: 18 Premier Climate Physics Articles.
- Part 2: 32 Articles, Commentaries, Interviews, Lectures, Testimonies, and Podcasts.
- Part 3: 157 Atomic, Molecular, and Optical Physics Publications.
- Part 4: 176 Related Publications.

Screenshots from William Happer’s video lectures contain Time Code (Green box at the bottom left of images) that can be correlated with running time of his Videos on YouTube and related Transcripts. This format would allow the reader to comprehend Happer’s views in his own words. In these videos, Happer speaks in such simple layman terms, anyone can understand the central message, which is that the climate emergency and the Net-Zero policy are nothing more than a scam to deceive primarily the Global South.

**Global Climate Researchers with Alternative Viewpoints**

There are a large number of Climate Researchers with alternative viewpoints to the orthodoxy of Anthropogenic Global Warming (AGW) all over the world (Fig. 2A and B). Unfortunately, they are often subdued by the noise of the Main Stream Media (MSM), most academic institutions, and political groups with an agenda to



promote AGW. Fortunately, unbiased climate research has been part of history. One of the early researchers on Climate was Svante Arrhenius from Sweden (See Section “A Great Historian of Climate-Change Irony”). Arrhenius was the first person to seriously try to calculate the effects of more CO<sub>2</sub> on plant growth.

The “Climate: The Movie (The Cold Truth)” (Durkin, Martin and Nelson, Tom, 2024) is the best collection of interviews with Climate Researchers on alternative viewpoints to the



orthodoxy of Anthropogenic Global Warming (AGW). These distinguished scientists and film makers from around the world include the following:

**Mr. Martin Durkin,**

Director of the popular movie “The “Climate: The Movie (The Cold Truth).” He is an English television producer and director who has been commissioned by Britain's Channel 4. He is best known for directing The Great Global Warming Swindle (2007).

**Mr. Tom Nelson,**

Producer of the popular movie “The “Climate: The Movie (The Cold Truth).” He is an American Podcaster focusing on Climate and Energy realism. Tom Nelson has an M.S. degree in Electrical and Electronics Engineering. He was involved in tech and software for many years. He is a Member of CO<sub>2</sub> Coalition.

**Prof. William Happer,**

Ph.D. in Physics. 1964. Princeton University, Co— Founder and Chairman of CO<sub>2</sub> Coalition. He is one of the scientists who commented on the ongoing Climate Scam in the popular movie “The “Climate: The Movie (The Cold Truth).”

**Prof. Richard Lindzen**

Ph.D. in Applied Mathematics in 1964. Harvard University. Lindzen is an American atmospheric physicist known for his work in the dynamics of the middle atmosphere, atmospheric tides, and ozone photochemistry. He is the author of more than 200 scientific papers. From 1972 to 1982, he served as the Gordon McKay Professor of Dynamic Meteorology at Harvard University. In 1983, he was appointed as the Alfred P. Sloan Professor of Meteorology at the Massachusetts Institute of Technology (MIT), where he would remain until his retirement in 2013. Lindzen has disputed the scientific consensus on climate change and criticizes what he has called "climate alarmism.” Member of CO<sub>2</sub> Coalition.

**Prof. Steve Koonin**

Ph.D. in Theoretical Physics in 1975. MIT. Koonin is an American theoretical physicist and former director of the Center for Urban Science and Progress at New York University. He is also a professor in the Department of Civil and Urban Engineering at NYU's Tandon School of Engineering. From 2004 to 2009, Koonin was employed by BP as the oil and gas company's Chief Scientist. From 2009 to 2011, he was Under Secretary for Science, Department of Energy, in the Obama administration. He is currently with Stanford University's Hoover Institution.

**Dr. Roy Spencer**

Ph.D. in Meteorology in 1982. University of Wisconsin–Madison. Spencer is an American meteorologist and climate scientist. He is a principal research scientist at the University of Alabama in Huntsville, and the U.S. Science Team leader for the Advanced Microwave Scanning Radiometer (AMSR-E) on NASA's Aqua satellite. He has served as senior scientist for climate studies at NASA's Marshall Space Flight Center. He is known for his satellite-based temperature monitoring work, for which he was awarded the American Meteorological Society's Special Award. Regarding climate change, Spencer is a "lukewarmer", with the view that anthropogenic greenhouse gas emissions have caused some warming, but that influence is small compared to natural variations in global average cloud cover. He wrote several political books slamming what he calls "hysteria" about climate change, he says hurt both science and the people.

**Prof. John Christy**

Ph.D. in Atmospheric Sciences in 1987. University of Illinois at Urbana–Champaign. Christy is a climate scientist at the University of Alabama in Huntsville (UAH) whose chief interests are satellite remote sensing of global climate and global climate change. He is best known, jointly with Roy Spencer, for the first successful development of a satellite temperature record. He is the distinguished professor of atmospheric science and director of the Earth System Science Center at the University of Alabama in Huntsville (UAH). He was appointed Alabama's state climatologist in 2000. For his development of a global temperature data set from satellites, he was awarded NASA's Medal for Exceptional Scientific Achievement and the American Meteorological Society's "Special Award." In 2002, Christy was elected Fellow of the American Meteorological Society.

**Dr. Willie Soon**

Ph.D. in Aerospace Engineering [with distinction] in 1991. University of Southern California. Soon is a Malaysian astrophysicist and aerospace engineer who was long employed as a

part-time externally funded researcher at the Solar and Stellar Physics (SSP) Division of the Harvard–Smithsonian Center for Astrophysics. Soon is an anthropogenic climate change denier, disputing the scientific understanding of climate change, and contends that most global warming is caused by solar variation rather than by human activity.

**Dr. Patrick Moore**

Ph.D. in Forestry in 1974. University of British Columbia. Moore is a Canadian industry consultant, former activist, an early member and past president of Greenpeace. Canada. Since leaving Greenpeace in 1986, Moore has criticized the environmental movement for what he sees as scare tactics and disinformation, saying that the environmental movement "abandoned science and logic in favor of emotion and sensationalism". Member of CO<sub>2</sub> Coalition.

**Prof. John Clauser**

Ph.D. in Physics in 1969. Columbia University. Clauser is an American theoretical and experimental physicist known for contributions to the foundations of quantum mechanics, in particular the Clauser–Horne–Shimony–Holt inequality. He later served as the Clark Blanchard Millikan Professor of Engineering at the California Institute of Technology (Caltech). 2022 Nobel Prize winner in Physics. In May 2023, Clauser joined the board of the CO<sub>2</sub> Coalition, a climate change denial organization. Later that year, Clauser called himself a "climate denier" and claimed "there is no climate crisis".<sup>[12][13][14][15]</sup> Clauser's views on climate change have been described as "pseudoscience". His belief that cloud cover has more of an impact on Earth's temperature than carbon dioxide emissions is contradicted by the overwhelming scientific consensus on climate change.<sup>[12][13][14][15]</sup> Observational evidence shows the overall current cloud feedback amplifies global warming and does not have a cooling effect.

**Dr. Matthew Wielicki**

Ph.D. in Earth Science from UCLA. Formerly University of Alabama,

**Dr. Nir Shaviv,**

Ph.D. in Physics during 1994-96. Israel Institute of Technology in Haifa. In 2006–2012, he was an Associate Professor, and full professor since 2012 at Racah Institute of physics at the Hebrew University of Jerusalem. . In 2014, he became a member of the Institute for Advanced Study in Princeton, and served as the chairman of The Racah Institute of Physics between 2015 and 2019. Shaviv has been one of the proponents of a cosmic ray climate link. In 2003 he has shown that the cosmic ray flux over the past billion years can be reconstructed from the exposure ages of Iron

meteorites, which these flux variations are expected from spiral arm passages, and they correlate with the appearance of ice age epochs on Earth. In a later work with Ján Veizer, it was demonstrated that the temperature reconstruction over the Phanerozoic correlates with the cosmic ray flux, but it does not correlate with the CO<sub>2</sub> reconstruction, thus placing an upper limit on the effects of CO<sub>2</sub>. This prompted several reactions by the climate community and rebuttals by Shaviv and his colleagues.

#### **Prof. Ross McKittrick**

Ph.D. in Economics in 1996. University of British Columbia. He is a Canadian economist specializing in environmental economics and policy analysis. He is a professor of economics at the University of Guelph, and a senior fellow of the Fraser Institute. McKittrick has authored works about environmental economics and ones denying the scientific consensus on climate change,<sup>[1]</sup> including co-authoring the book *Taken by Storm: The Troubled Science, Policy and Politics of Global Warming*, published in 2002. He is the author of *Economic Analysis of Environmental Policy*, published by the University of Toronto Press (Wikipedia, 2025c).

#### **Dr. Benny Peiser**

Ph.D. in cultural studies (Kulturwissenschaften) in 1993. Frankfurt University. Born of German parents in Haifa, Israel, in 1957, Peiser's family soon returned to Germany. He grew up in Frankfurt and "spent the first 35 years of his life" in Germany. Upon completing his doctoral degree, Peiser moved to Liverpool, England, to take up a position as lecturer at Liverpool John Moores University. Peiser has denied the reality of anthropogenic climate change in a number of editorials and speaking engagements. Benny Peiser is director of global warming denialist think-tank The Global Warming Policy Foundation.

#### **Mr. Tony Heller**

B.S. in Geology, Arizona State University, M.S. in Electrical Engineering, Rice University Boston University Geology Northern Arizona University Computer Science Colorado State University Computer Science University of New Mexico Geochemistry Lifelong environmentalist. Member of CO<sub>2</sub> Coalition.

#### **Dr. Hamish Mykura (Passed away in 2023)**

PhD in environmental sciences. A British television executive, who spent more than a decade producing and commissioning for National Geographic, Channel 4, and the BBC. Hamish Mykura was the head of documentaries at the UK's Channel 4, which premiered the documentary on 8 March 2007 entitled "The Great Global Warming

Swindle". That was a British polemical documentary film directed by Martin Durkin. Wikipedia (2024a).

#### **Dr. Tim Ball (1938-2022)**

Ph.D. in Geography with a specific focus on Historical Climatology in 1983. Queen Mary University of London. Tim Ball was a British-born Canadian public speaker and writer who was a professor in the Department of Geography at the University of Winnipeg from 1971 until his retirement in 1996. Ball became active in promoting rejection of the scientific consensus on global warming. Wikipedia (2024b).

#### **Professor Robert M. "Bob" Carter (1942-2016)**

Ph.D., University of Cambridge. Robert M. Carter was an English paleontologist, stratigrapher and marine geologist. He was professor and head of the School of Earth Sciences at James Cook University in Australia from 1981 to 1998, and was prominent in promoting climate change denial. Wikipedia (2024c).

#### **Nigel Calder (1931-2014)**

Between 1956 and 1966, Calder wrote for the magazine *New Scientist*, serving as editor from 1962 until 1966. Calder participated in making the film *The Great Global Warming Swindle*. Wikipedia (2024d).

#### **Nigel Lawson (1932-2023)**

Lawson was a British politician and journalist. A member of the Conservative Party, he served as Member of Parliament for Blaby (England) from 1974 to 1992, and served in Margaret Thatcher's Cabinet from 1981 to 1989. Prior to entering the Cabinet, he served as the Financial Secretary to the Treasury from May 1979 until his promotion to Secretary of State for Energy. He was involved with the climate change denial movement and believed that the impact of man-made global warming had been exaggerate. Wikipedia (2024e).

#### **Professor Fred Singer (1924-2020)**

Ph.D. in Physics in 1948. Princeton University. Fred Singer was an Austrian-born American physicist and emeritus professor of environmental science at the University of Virginia. He was trained as an atmospheric physicist. He was known for rejecting the scientific consensus on several issues, including climate change. He designed mines for the U.S. Navy during World War II, before obtaining his Ph.D. in physics from Princeton University in 1948 and working as a scientific liaison officer in the U.S. Embassy in London. Singer prepared an NIPCC report called "Nature, Not Human Activity, Rules the Climate,"

published in March 2008 by the Heartland Institute, a conservative think tank. Wikipedia (2024f).

#### **Professor Patrick Michaels (1950-2022)**

Ph.D. in Ecological Climatology in 1979. University of Wisconsin-Madison. Patrick Michaels was an American agricultural climatologist. Michaels was a senior fellow in environmental studies at the Cato Institute until 2019. Until 2007, he was research professor of environmental sciences at the University of Virginia, where he had worked from 1980. He was a well known climate change denier. Wikipedia (2024g). I have added the following 16 scientists to the above list of “Global Climate Researchers with Alternative Viewpoints.”

#### **Professor Freeman Dyson (1923-2020)**

Dyson was a British-American theoretical physicist and mathematician known for his works in quantum field theory, astrophysics, random matrices, mathematical formulation of quantum mechanics, condensed matter physics, nuclear physics, and engineering.<sup>[a][3]</sup> He was professor emeritus in the Institute for Advanced Study (IAS) in Princeton. He received a B.A. from Cambridge University (UK), but did not complete his Ph.D. at Cornell University (USA). Nevertheless, J. Robert Oppenheimer, the Director of IAS, hired Dyson for his brilliant mind in Physics. Happer (2014a) delivered a lecture at Princeton in celebrating the 90<sup>th</sup> Birthday of Freeman Dyson (see Section “A Great Princetonian”). Dyson (2007) explained some of the basic flaws of Climate orthodoxy. Dyson disagreed with the scientific consensus on climate change. He believed that some of the effects of increased CO<sub>2</sub> levels are favorable and not taken into account by climate scientists, such as increased agricultural yield, and further that the positive benefits of CO<sub>2</sub> likely outweigh the negative effects.<sup>[7][8][9]</sup> He was skeptical about the simulation models used to predict climate change, arguing that political efforts to reduce causes of climate change distract from other global problems that should take priority (Wikipedia, 2025b).

#### **Professor George Devries Klein (1933-2018)**

Ph.D. in Geology in 1960. Yale University. George Devries Klein was an iconic sedimentary geologist. He was born in the Hague, The Netherlands (January 21, 1933), immigrated to the United States in 1947, and passed away in Guam (April 30, 2018). He was one of the foremost sedimentary geologists in the world on the application of many facets of earth science. He was an accomplished process sedimentologist, sequence stratigrapher, sandstone petrologist, tectonics specialist, basin analyst, regional geologist, petroleum geologist, and climate scientist. In 1988, the year IPCC was launched, Klein introduced me to the fascinating details of Climate Change. A Special

Issue of the Journal of the Indian Association of Sedimentologists was published in celebrating his scientific contributions (Shanmugam, 2018), which include climate change (Klein, 2016).

#### **Dr. Sherwood Idso (1942-2024)**

Ph.D. in Soil Science (with a minor in Meteorology and Mechanical Engineering in 1968. University of Minnesota. Idso was the president of the Center for the Study of Carbon Dioxide and Global Change, which rejects the scientific consensus on climate change. Previously he was a Research Physicist with the U.S. Department of Agriculture's Agricultural Research Service at the U.S. Water Conservation Laboratory in Phoenix, Arizona, where he worked since June 1967. He passed away in 2024.

#### **Dr. Gerrit Van der Lingen**

Ph.D. Geology, Utrecht University. Retired in New Zealand. Van der Lingen describes himself as a geologist/paleoclimatologist and climate change consultant. He is a founding member of The New Zealand Climate Science Coalition, an organization of climate change skeptics (Van der Lingen, 2016, 2018).

#### **Dr. Ganapathy Shanmugam**

Ph.D. in Geology in 1978. University of Tennessee. G. Shanmugam is a person of Indian origin. He was born in 1944 in Sirkazhi, Madras Presidency, British India. Vellore (Happer's birth place) is about 122 miles North of Sirkazhi. He emigrated to the U.S. in 1970 and became a naturalized U. S. citizen in 1990. He has been married to his American wife, Jean, since 1976. He is a pragmatic and an iconoclastic deep-water process sedimentologist. He was employed by the Mobil Research and Development Corporation, Dallas, Texas (1978-2000). He has over 380 published works, including two volumes of Elsevier's Handbook of Petroleum Exploration and Production (2006 and 2012) and their Chinese editions. His most recent Elsevier book “Mass Transport, Gravity Flows, and Bottom Currents” contains 540 case studies covering environments on Earth, Mars, and Jupiter, but with a majority on deep-water processes on Earth (Shanmugam, 2021). Most of his publications are on Process Sedimentology, Physical Oceanography, and Petroleum Geology. On ResearchGate digital platform, his 287 research works have reached 225,390 Reads and 9,708 Citations on April 9, 2025. His current interest is on Climate Change (Shanmugam, 2022c, 2023c, 2024a, b, c, d, e). Selected publications on Climate Change are:

*Shanmugam, G. (2023c). 200 Years of Fossil Fuels and Climate Change (1900-2100). The Journal of the Geological Society of India, v. 99, 1043-1062.*

Shanmugam, G. (2024b). *Fossil fuels, climate change, and the vital role of CO<sub>2</sub> Plays in Thriving people and plants on planet Earth. Bulletin of the Mineral Research and Exploration*, v. 175, 167-208

Shanmugam, G. (2024e). *The CO<sub>2</sub> Problem: Climate Models vs. Field Measurements. IAS Magazine*. 3(2),1-33.

He is a member of the CO<sub>2</sub> Coalition in the USA.

#### **Prof. Michael Kelly**

Ph.D. in Physics in 1974. University of Cambridge. Kelly was born in New Zealand. He is professor emeritus of technology at the University of Cambridge. See Section “Net Zero: An Engineering Fantasy” below).

#### **Dr. Matthew White Ridley**

D. Phil. In Zoology in 1984. Oxford University. Ridley is a British science writer, journalist and businessman. He is known for his writings on science, the environment, Climate change, and economics, and has been a regular contributor to The Times newspaper. Ridley won a seat in the House of Lords in 2013, a position he has used to discuss climate change. From December 2010 to August 2013, Ridley voiced his skepticism of climate change through his regular column in the Wall Street Journal, “Mind of Matter.” Ridley is an advisor to the Global Warming Policy Foundation (GWPF), a group founded by climate science denier Lord Nigel Lawson.

#### **Prof. Ian Plimer**

Ph.D. in Geology in 1973. Macquarie University. Plimer is an Australian geologist and professor emeritus at the University of Melbourne. He rejects the scientific consensus on climate change. He has been criticized by climate scientists for misinterpreting data and spreading misinformation.

#### **Dr. Judith Curry**

Ph.D. in Geophysical Sciences in 1982. University of Chicago. Curry is an American climatologist and former chair of the School of Earth and Atmospheric Sciences at the Georgia Institute of Technology. Her research interests include hurricanes, remote sensing, atmospheric modeling, polar climates, air-sea interactions, climate models, and the use of unmanned aerial vehicles for atmospheric research. She was a member of the National Research Council's Climate Research Committee, published over a hundred scientific papers, and co-edited several major works.<sup>[2]</sup> Curry retired from academia in 2017. Curry has become known for hosting a blog which is part of the climate change denial [blogosphere](#). In 2013, Curry testified

to the United States Congress that, in her opinion, there is so much uncertainty about natural climate variation that trying to reduce emissions may be pointless.

#### **Bjørn Lomborg**

Ph.D. in Political Science in 1995. University of Copenhagen. Lomborg is a Danish political scientist, author, and the president of the [think tank](#) Copenhagen Consensus Center. He is the former director of the Danish government's Environmental Assessment Institute (EAI) in Copenhagen. He became internationally known for his best-selling book *The Skeptical Environmentalist* (2001). In his subsequent book, *Cool It* (2007), and its film adaptation, Lomborg outlined his views on [global warming](#), many of which contradict the scientific consensus on climate change. Hoover Institution fellow Bjorn Lomborg explains how panic over climate change is doing far more damage than climate change itself. Swapping cheap and dependable fossil fuels for unreliable and expensive renewables costs our economies trillions, but for little environmental gain (Lomborg, 2025).

#### **Alex Epstein**

B.A. in Philosophy. Duke University. Epstein is an American author who advocates for the expansion of fossil fuels and opposes the scientific consensus on climate change. Epstein is the author of *The Moral Case for Fossil Fuels* (2014) and *Fossil Future* (2022), in which he argues for the expanded use of fossil fuels like coal, oil, and natural gas. I reviewed the book (Shanmugam, 2022c). The book is rich in empirical data and common sense, and is a timely masterpiece. Epstein makes a compelling case for more Fossil Fuels (Oil, Coal, and Natural Gas) for the survival of the human race amid the Net-Zero ultimatum on CO<sub>2</sub> emission by 2050. In practice, Fossil Fuels are cheap, reliable, and necessary, whereas Renewable Energy (Wind and Solar) is expensive, unreliable, and a luxury. Petrochemicals are the building blocks of wind turbines and solar panels. At present, humans cannot collect renewable energy without petrochemical-based wind turbines and solar panels (i.e. without emitting CO<sub>2</sub>). It is worth noting that there are 772 Pounds of petrochemical Plastics in each electric car. Therefore, the whole renewable-energy (Wind and Solar) movement is the height hypocrisy!

#### **W. van Wijngaarden**

Ph.D. in Physics in 1986. Princeton University. After a year at Yale University as a research associate, Dr. van Wijngaarden joined the faculty at York University in 1988. He has 75 refereed publications and given over 200 conference presentations and invited seminars. He is very

active on Climate research with William Happer (See Bibliography Part 1).

#### **Dr. John E. Damuth**

Ph.D. in Marine Geology in 1973. Columbia University. Damuth has made significant contributions on climate change with Prof. R. Fairbridge (Damuth and Fairbridge, 1970). Fairbridge was a pioneer in Climatology. They presented data to show that ice-age aridity existed throughout the Amazon Basin during the Late Wisconsin in contrast to the rain forests there now. He authored or co-authored several other climate related publications in the 65-82 while at Lamont-Doherty Geological Observatory (Damuth, 1975; Be et al., 1976). He started following the ongoing AGW controversies when Al Gore published his book in 2007. He recognized that most of the things he put forward in there were wrong based on peer-reviewed papers at that time. Damuth and I worked together in the Geology Research Group at Mobil Research Laboratory in Dallas, Texas. We (Shanmugam, Moiola, Damuth, 1985) co-authored an article "Eustatic control of Submarine fan development".

#### **Prof. Rhodes Fairbridge (1914-2006)**

Ph.D. in Geology in 1941. University of Western Australia. He was an Australian geologist and expert on climate change. He taught at Columbia University in New York from 1955 until his 1982 retirement. While there, he was supervising editor for the Encyclopedia of Earth Sciences. In the early 1960s, he developed the so-called "Fairbridge Curve",<sup>[2][3]</sup> a record of changes in sea levels over the last 10,000 years. In the 1980s Fairbridge wrote about climate's impact on the long-term evolution of shields and peneplains (Wikipedia, 2025e). He was a pioneer of Climate Change. He did not believe in AGW.

#### **Professor D. Chandrasekharam**

Ph.D. in Geology in 1979. IIT Bombay, India. For geologists, climate change is a natural phenomenon. The Earth's climate is now in an interglacial period, and the climate calamities that we experience are a natural phenomenon. Let us agree (swim with the tide) that these changes are being caused by excess CO<sub>2</sub> emissions from the use of Fossil fuels. A low-carbon source of energy is needed to reduce emissions and reduce the use of fossil fuels. What is more important is to find solutions to problems caused by such changes, such as food-energy-water scarcity. The most affected countries are the GCC (Gulf Cooperative Council Countries) and the Middle East and North African Countries. Although desalination technology is providing some solutions, using huge amounts of fossil fuels for desalination is not an economically viable solution. Geothermal-based energy can

provide a viable and sustainable solution to these issues, especially to the water-starved countries that have huge, untapped geothermal sources. As discussed, (Chandrasekharam 2018, 2022, 2023, 2025) geothermal energy can make countries food-water-energy independent and eliminate wars related to water.

#### **Anthony Watts**

Anthony Watts is an American blogger who runs Watts Up With That?, a climate change denial blog that opposes the scientific consensus on climate change. A former television meteorologist and current radio meteorologist, he is also founder of the Surface Stations project, a volunteer initiative to document the condition of U.S. weather stations. The Heartland Institute helped fund some of Watts' projects, including publishing a report on the Surface Stations project, and invited him to be a paid speaker at its International Conference on Climate Change from 2008 to 2014 (Wikipedia, 2025d).

The above selection illustrates the great intellectual strength and academic credentials of researchers who absolutely reject the AGW.

From a critical scientific perspective, it makes no sense to claim that CO<sub>2</sub> is the primary control knob of climate for reasons ranging from lots of contradictory geological/climatological evidence (Idso, 1980; Burner, 2004; Dyson, 2007; Lomborg, 2007; Singer et al., 2009; Watts, 2009; Soon et al., 2015; Christy, 2022; Epstein, 2022; Koonin, 2022; Curry, 2023; Lindzen, 2010, 2023; Moore, 2023; Plimer, 2023; Shanmugam, 2024b; Abbot and Marohasy, 2025).

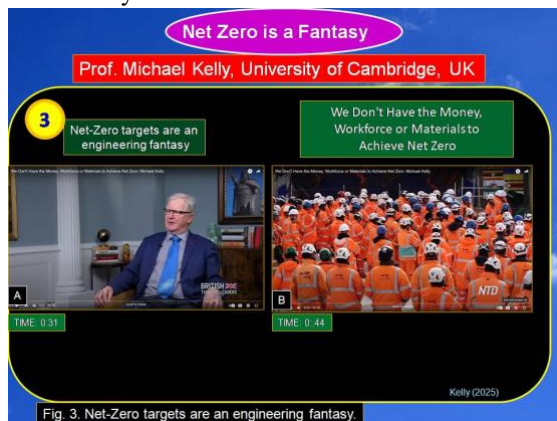
Analogous to William Happer, Lindzen (2010) made some critical points on Climate Change to the Boston Globe (edited auto-generated transcript from video):

- If one asks about is the temperature increasing or decreasing, it's always doing one or the other. I have no concern about that by asking people to worry about whether it's going up or down, you're immediately establishing dishonesty. The Earth is always changing. Climate change is nothing you have to prove. It always is happening. It always has happened. So to make that into something alarming seems to me little bit weird.
- Whenever you see someone say you know instead of answering arguments, how could so many people agree if it weren't true. It should be a red flag. My view is that one is inflated the trivial, which is that temperature is changing. Climate is changing. Man plays some role. There's not much disagreement. With

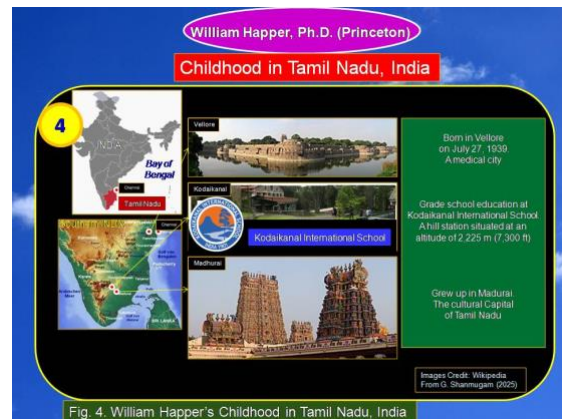
predictions of disaster that are not connected clearly to warming or to our activities or to anything else, and leaving people with the thought that if the first part is true, the second part must be true. That is certainly not the case. And then to add insult to injury, to propose policies that would have nothing to do with any of it, but involve trillions of dollars, and harm too many people is, I think, crossing the line.

### Net Zero: An Engineering Fantasy

The Net-Zero Policy of the UN is the ultimate solution to Climate Emergency. Therefore, it is imperative at the outset to understand its feasibility on local and global levels. Electrical Engineering grid is the critical component of Net Zero targets. This issue has been critically evaluated by Prof. Michael Kelly in the UK. Kelly is a New Zealand-British physicist. He studied Mathematics and Physics to M.Sc. (1971) level at Victoria University of Wellington in New Zealand, and completed a PhD (1974) in solid state physics at the University of Cambridge where he continued post-doctoral work until 1981, when he joined the GEC Hirst Research Centre. He was Prince Philip Professor of Technology in the Department of Engineering of the University of Cambridge from 2002 to 2016. In 2010, Kelly was named by the Royal Society and the University of East Anglia to an independent scientific assessment panel to investigate the Climatic Research Unit email controversy.



Kelly was an UK government scientist when the Climate Change Act launched in 2008, and has been researching the reduction of carbon in Britain since then. He wrote to Energy and Climate Change Secretary Ed Milliband to say that the Net Zero targets are an engineering fantasy—because the costs are enormously prohibitive and the workforce needed is not available. He is calling for open debate on these issues and says engineering's professional bodies are not acting responsibly in their silence. Below are some of his recent comments from an NTD interview with Lee Hall,



which Premiered on February 25, 2025 (Kelly, 2025) (Fig. 3A).

**MICHAEL KELLY:** Just to expand the grid to be able to have enough extra electricity, so that we can have ground transport that's electrified, and all heat that is industrial, commercial, and domestic heat being electrified, we would need to spend on order of 1.4 trillion pounds. We would need 40,000 civil and electrical engineers working. Professional Engineers working fulltime for 30 years and about three times that many skilled trades people.

**LEE HALL:** Coming up on British Thought Leaders, former government scientist, Michael Kelly talks about the costs of Net Zero. He says Britain does not have the money or the workforce (Fig. 3B) to meet the government targets.

**MICHAEL KELLY:** To try and do all this for the whole of the country in 30 years, you would need a Workforce on the scale of the Education Sector or the Health Service. And we just don't have these people. These things are so far from reality and I'm very concerned that engineering profession bodies and the Royal Academy of engineering, indeed the Royal Society, are not pointing out these impossibilities.

**LEE HALL:** Michael says there's no open debate about green issues and scientists are scared to put their head above the fire pit!

**MICHAEL KELLY:** If the climate scientists themselves came out and said "well, our models have been running a bit too hot." It's global warming. It is happening. But not as quite as fast as we have, you know, immediately. That all the research budgets would be slashed, and lots of people would be unemployed. And the professors, who are employing all these younger people do these models, don't want to go.

Watch the full NTD interview on YouTube at <https://www.youtube.com/watch?v=IWn4bWr5IH4>

## Formative Years in India, Scotland, and America during World War II

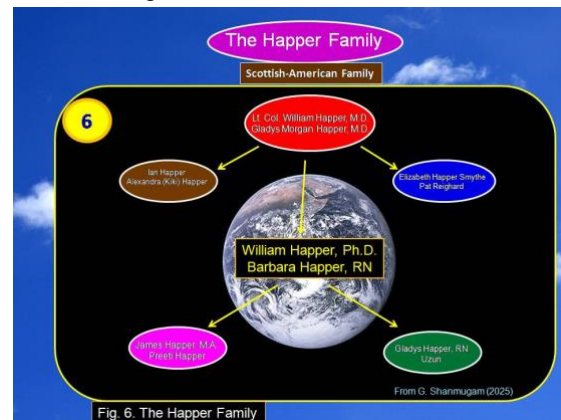
Below is an intriguing story of William Happer's early years, as it was told during an interview with Andy May (Happer, 2021e), which prepared him to be a professional Physicist in later years (Edited text from video transcript):

- WILLIAM HAPPER:** "I was born on 27 July 1939, in Vellore, India (Fig. 4 and 5). My father, also Dr. William Happer, was a Scottish medical officer in the Indian Army (Fig. 6), and my mother, Dr. Gladys Morgan Happer, was a medical missionary for the Lutheran Church of North Carolina.
- On one September, a month after my birth, World War II began with the invasion of Poland by Nazi Germany and its ally, the Soviet Union.
- Britain and France immediately declared war on Germany in support of the poor Poles, the first victims of the Molotov-Ribbentrop non-aggression pact. The United States remained aloof and there were even suggestions by prominent Americans that we cut a deal with the Nazis and divide up the British Empire with the Germans and Japanese. Before my first birthday in India, the French, who had taken the brunt of the Nazi onslaught, made peace. This left only Britain to face the Nazis and their Japanese allies. At the time, there were fears that the rapidly advancing Japanese would soon seize India, so early in the year 1941, my father put me and my mother, pregnant with my brother Ian, on a ship bound for America.
- Our ship sailed around the southern tip of Africa and up the coast of South America to avoid the "wolf packs" of Nazi submarines that were devastating British shipping. We were fortunate to reach the USA safely, and my mother's parents welcomed us into their home in Salisbury, North Carolina. My father and his Indian Army unit were sent first to Iraq, where the government had declared its support for Hitler, and then to Egypt to help oppose Rommel's advance across North Africa.
- My mother's brother, Karl Ziegler Morgan, was one of the first physicists to join the Manhattan Project in Oak Ridge, Tennessee (see Figure 3). Karl was responsible for protecting the workers at Oak Ridge from radiation hazards, and he is often called the "father of health physics." He knew a lot about nuclear physics, but little about medicine, so he persuaded my mother to join him in Oak Ridge



Fig. 5. Great Parents of William Happer. as the first doctor at "X-10," now the site of the Oak Ridge National Laboratory.

A preschooler, I went with my mother to Oak Ridge, then a closed city of hastily erected barracks, board walks, muddy streets, and tight security. But I was able to observe scientists of all stripes.... most importantly, my physicist-uncle, Karl Morgan. He served as a father figure during the war when I did not know if my real father was alive or dead. It was this experience that convinced me that a career in physics would be wonderful if I could measure up to what was required.



- Fortunately, my father survived the war and brought us back to India, where we remained until 1948. I went to the International School at Kodaikanal, at an altitude of about 7,000 ft. in the mountains between Tamil Nadu and Kerala in South India. On the first Indian Independence Day, 15 August 1947, I watched the Union Jack flag come down over my father's government hospital in Madurai, and the Indian tricolor go up to replace it. There were bands and speeches by my father and by his Indian friend and colleague, Dr. Vadimalayan, the new head of the hospital. I will never forget 30 January 1948, the somber day when Mohandas K. Gandhi was assassinated. There were tense hours of waiting to see if the assassin had been a Hindu or a Muslim. The atrocities of the partition of India and Pakistan had already been bad enough. Had

the assassin been a Muslim, there would have been unthinkable carnage.

- Later in 1948, we returned to my father's home in Scotland, where we stayed with his mother in her little flat in Edinburgh. My brother Ian and I went to the James Gillespies School. We did our best to disguise our North Carolinian mother tongue, so the other boys could understand us, and vice versa.
- In 1949, Scotland was overrun with returning colonials like us and still recovering from the damage of World War II. It was hard for my father to find a suitable job, and my mother missed America. So, in 1950 we once again set sail for America.
- I was fortunate to win a Morehead Scholarship to the University of North Carolina in 1956, where I majored in physics. On the advice of my Uncle Karl, I entered graduate school at Princeton University in 1964, where I measured the magnetic moments of radioactive nuclear isotopes in which the  $f7/2$  shell was partially filled. This provided incisive tests for the nuclear shell model, for which Maria Goeppert Mayer received the Nobel Prize about that time.
- What I learned during my post-doctoral years turned out to be very useful for subsequent work on climate.
- Several of my Princeton professors had ties to Columbia University, and they helped me get a postdoctoral position there under Bob Novick in 1964. Bob and his colleague, Allen Lurio, introduced me to optical pumping, a way to transfer order from light to atoms or molecules, without the need to make an atomic beam, as I had done in my thesis work. Optical pumping involved subtle details of the interaction of radiation with matter.... one of the key issues in greenhouse warming. What I learned during my post-doctoral years turned out to be very useful for subsequent work on climate. I was also fortunate to meet Barbara Baker, then a nurse at Columbia Presbyterian Hospital, who became my wife and has been a wonderful companion and friend ever since. Our two children, Jim and Gladys, were born in New York City.
- After the 1970 US invasion of Cambodia, our physics building was seized by protesters. With other physics faculty and students, I was held captive for several days. The pretext was that several senior physics professors, notably Mal Ruderman and Henry Foley, were members of JASON, a group that did classified and unclassified studies for the US government. Having had several sleepless nights becoming acquainted with the protesters, while defending

our cherished equipment with other young faculty members, I decided that JASON must be a pretty good organization if it had enemies like these. So, when Henry Foley asked me to join JASON a few years later, I was honored to do so. JASON continues to do valuable work for the USA, and I am still a member" (see Section "A Great Inventor and Educator" below).

- William Happer also shared some personal stories with me via Email. One of them dealt with a man-eating tiger that was attacking villagers in the hills near Kodaikanal where he was attending school (Fig. 5). In his April 7, 2025 Email to me, Happer wrote that "I am trying to find a better copy of the attached photo (Fig. 7), taken in mountains near Kodaikanal. Besides the poor tiger and the cobra, the photo includes me, my younger brother Ian, my father and a medical colleague of our father. The photo was probably taken in 1947 or 1948 when I was a school boy in Kodaikanal. The location was not far from Kodaikanal in the same mountainous area. The tiger had killed several villagers and it was tracked down and shot by Jesuit priests from a nearby monastery. The poor snake probably did no one any harm but was a target of opportunity. My father, the district medical officer, had taken me and my brother to the monastery that day as part of his duties to ensure that proper sanitary practices were observed in the monastery kitchen and other facilities. It was all very accidental.
- His mother's respectful name was Gladys Ammagaru (Fig. 8). She was a medical doctor. She conducted research in universities in the U.S. and in Switzerland. She taught medicine in Vellore (1935-36) and in Guntur (1936-37) in India. She was a medical doctor at the U. S. Department of Energy's Oak Ridge National Laboratory in Tennessee during World War II (1944-45). At the same time, Ernest O. Lawrence supervised the electromagnetic isotope separation process at the Radiation Laboratory at Berkeley and at Oakridge, Tennessee during the Manhattan Project (See Oppenheimer Biography by Shanmugam, 2023b). Happer's mother was greatly responsible for him developing interest in Science. She died in a road accident at the age of 59 in North Carolina (Fig. 8).

The above section represents only a portion of his "Personal Story" among other topics covered by Andy May, which include the following topics (Happer, 2021e):

#### **William Happer Interview 1**

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 Is Global Warming a good thing? 43  
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Fig. 7. Will Happer with a man-eating tiger and a cobra, Tamil Nadu, India.



Fig. 8. Dr. Gladys Morgan Happer, M.D. Mother of William Happer.

**A Great Achiever**

William Happer is a scientist of great achievement by any standard

Table 1. William Happer: A Great Achiever.			
Serial Number	Year	Achievements and Honors	Comments
1.	1960	B.S. in Physics from the University of North Carolina	
2.	1964	Ph.D. in Physics from Princeton University	
3.	1966	Alfred P. Sloan fellowship	
4.	1971-1979	Director of Columbia University's Radiation Laboratory	
5.	1976	Fellow of the American Physical Society	
6.	1976	Alexander von Humboldt award	
7.	1976	JASON advisory group	
8.	1980	Joined Princeton University's faculty	
9.	1982	William Happer™ Inventor of Sodium Laser Guide Star	Monumental achievement
10.	1987-1990	Chairman of the Steering Committee of JASON, a group of scientists and engineers who advise agencies of the Federal Government on matters of defense, intelligence, energy policy and other technical problems	U.S. Government
11.	1991-1993	U.S. Dept of Energy: Director of Energy Research	President George H. W. Bush. \$3 Billion Budget
12.	1995	Member of the American Academy of Arts and Sciences	
13.	1995-2005	Eugene Higgins Professor of Physics and Chair of the Princeton University Research Board	Appointment
15.	1996	Member of the National Academy of Sciences	
16.	1997	Herbert P. Broida Prize	
17.	2000	Davison-Germer Prize	
18.	2000	Thomas Alva Edison patent award	
19.	2002-2006	Chair of the National Research Council's Standing Committee on Improvised Explosive Devices that supported the Joint Improvised Explosive Devices Defeat Organization of the Department of Defense	U.S. Government
20.	2003-Present	The Cyrus Fogg Brackett Professor of Physics at Princeton University	Appointment
21.	2015	Frederick Seitz Memorial Award	Climate Research
22.	2015	Co-Founder and Chairman of the CO <sub>2</sub> Coalition.	Momentous
23.	2016-2018	Chair of the Board of the Richard Lounsbery Foundation	

24.	2018-2019	Deputy assistant to the president and senior director for emerging technologies at the White House National Security Council	President Donald J. Trump
25.	2020	Senior Fellow at the Independent Institute	
26.	Up to 2025	William Happer's Publications selected for this article: 207 References Part 1: 18 References Part 2: 32 References Part 3: 157	Total Number of Publications by Happer: >300

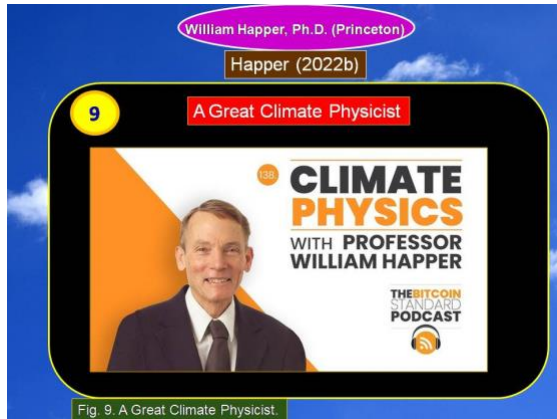


Fig. 9. A Great Climate Physicist.

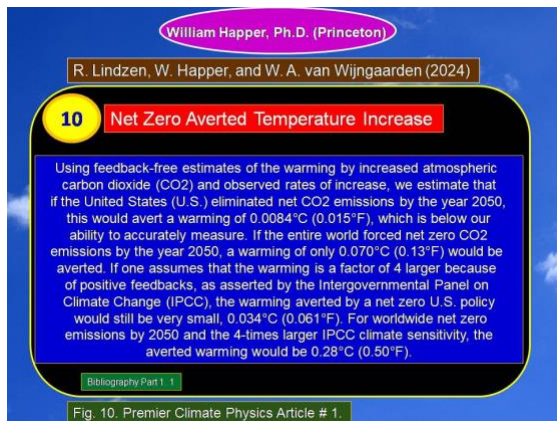


Fig. 10. Premier Climate Physics Article # 1.

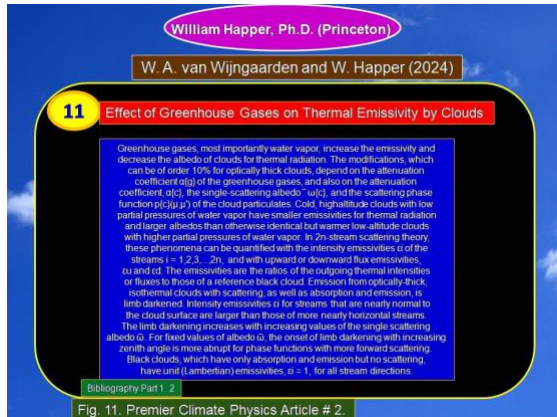


Fig. 11. Premier Climate Physics Article # 2.

Serial Number	Year	Articles, Commentaries, Interviews, Lectures, Testimonies, and Podcasts	Authors
1	1972	➤ Optical Pumping	Happer, W. (1972).
2	1994	➤ Atmospheric-turbulence compensation by resonant optical backscattering from the sodium layer in the upper atmosphere	Happer, W., G. J. MacDonald, C. E. Max, and F. J. Dyson, 276 (1994).
3	2009	➤ Congressional Testimony. Statement of William Happer before the U.S. Senate Environment & Public Works Committee. February 25, 2009.	Happer, W. (2009).
4	2012	➤ YouTube Video. Opinion: Climate Change: The Green Scare. Wall Street Journal.	Happer, W. (2012)
5	2013	➤ Commentary in Defense of Carbon Dioxide. The demonized chemical compound is a boon to plant life and has little correlation with global temperature. Independent Institute	Happer, W. and H. H. Schmitt (2013)
6	2014	➤ Why has global warming paused?	Happer, W. (2014a).
7	2014	➤ Princeton's William Happer rebuts myth of carbon pollution	Happer, W. (2014b).
8	2015	➤ At the Crossroads, Session II. Not a Pollutant: CO2 is The Gas of Life	Happer, W. (2015).
9	2015	➤ Fundamentals of Ocean pH	Cohen, R. and W. Happer (2015)
10	2017	➤ The Real Story on Climate Change. ICON Lecture Series Chapel Hill, North Carolina	Happer, W. (2017)
11	2020	➤ CLINTEL lecture William Happer in Amsterdam	Happer, W. (2020a)
12	2020	➤ The Staff of The Best Schools Interviews William Happer. Independent Institute	Happer, W. (2020b)
13	2021	➤ YouTube Video. How to Think About Climate Change. National Leadership Symposium at Hillsdale College, Phoenix, Arizona	Happer, W. (2021a)
14	2021	➤ YouTube Video. Is There a Climate Crisis? The Science Says Not Now and Not in the Future. Independent Institute	Happer, W. (2021b)
15	2021	➤ William Happer Interview. Andy May Petrophysicist.	Happer, W. (2021c)
16	2021	➤ Methane and climate	van Wijngaarden, W. A., and W. Happer (2021)
17	2022	➤ YouTube Video. Elimination of CO2 is a suicide pact – Professor William Happer on climate change misconceptions. BizNews TV	Happer, W. (2022a)
18	2022	➤ YouTube Video. 138. Climate Physics w/Professor William Happer	Happer, W. (2022b)
19	2022	➤ Responses and Declaration on the "CFTC Climate-Related Financial Risk RFI" 87 Fed. Reg. 34856 (June 8, 2022) HIDEOE (Hawaii Department of Education) (2022)	Happer, W., Lindzen, R. (2022)
20	2022	➤ Infrared Forcing by Greenhouse Gases	van Wijngaarden, W. A., and W. Happer (2022)
21	2023	➤ Beacon Post. My Oppenheimer Reminiscences. The Beacon. Independent Institute.	Happer, W. (2023a)
22	2023	➤ YouTube Video. The Crusade against Carbon Dioxide. Institute of Public Affairs, Australia.	Happer, W. (2023b)
23	2023	➤ YouTube Video. "CO2, The Gas of Life"-Dr. William Happer. October 3, 2023. Old Guard Summit, Springfield, New Jersey.	Happer, W. (2023c)
24	2023	➤ Testimony of Professor William Happer on Kansas State Senate Bill No. 224. "An Act concerning environmental, social and governance standards" by the Committee on Federal and State Affairs	Happer, W. (2023d)
25	2024	➤ YouTube Video. Will Happer: Radiation transfer in clouds European Institute for Climate and Energy EIKE. 16th International EIKE Climate and Energy Conference, IKEK-16, 14-15 June 2024, Vienna.	Happer, W. (2024a).
26	2024	➤ Video. Dr. William Happer Discusses Sodium Guide Star Laser. CO2 Coalition	Happer, W. (2024b).
27	2024	➤ Emissions of Anesthetic Gases Cause Negligible Warming	Soepyan, Frits, Byron, William Happer, Gregory Wrightstone (2024)
28	2024	➤ The "Climate: The Movie (The Cold Truth)"	Durkin, Martin and Nelson, Tom (2024)
29	2024	➤ Nutritive Value of Plants Growing in Enhanced CO2 Concentrations (eCO2)	Glatzle, A. James D. Ferguson, William Happer, Patrick Moore, Gary Ritchie, Frits Byron Soepyan, Gregory Wrightstone (2024)
30	2025	➤ Podcast # 265 "Will Happer. Casual brilliance".	Tom Nelson (2025)
31	2025	➤ Radiation Transport in Clouds	van Wijngaarden, W. A., and W. Happer (2025)
32	2025	➤ Freedom Research Podcast # 18 EXCLUSIVE: Interview with Prof. William Happer Climate Scare Is Based on Lies	Happer (2025).

William Happer, Ph.D. (Princeton)

W. A. van Wijngaarden and W. Happer (2023)

**12 Radiation Transfer in Cloud Layers**

For 2n-stream radiation transfer theory, a stack of m clouds can be represented as an equivalent cloud, indexed by  $c=1, 2, 3, \dots, m$ , and characterized by  $2n \times 2n$  scattering matrices  $S^c(\mu)$ , that describe how the cloud interacts with 2n streams of axially symmetric incoming radiation, propagating in upward and downward Gauss-Legendre sample directions. Some of the radiation is transmitted, some is absorbed and converted to heat and some is scattered into 2n outgoing streams along the directions of the incoming streams. The clouds are also characterized by  $2n \times 1$  thermal source vectors  $L^c(\mu)$ , that describe the thermal emission of radiators along the same directions. The cloud parameters and gas molecules. The  $2n \times 2n$  scattering matrix of the equivalent cloud,  $S^e(\mu) = S^m(\mu)S^{m-1}(\mu) \dots S^2(\mu)S^1(\mu)$ , is the Redheffer star product of the scattering matrices  $S^c(\mu)$  of the individual clouds. The  $2n \times 1$  thermal source vector for the equivalent cloud  $L^e(\mu) = L^m(\mu) + S^m(\mu)L^{m-1}(\mu) + S^m(\mu)S^{m-1}(\mu)L^{m-2}(\mu) + \dots + S^m(\mu)S^{m-1}(\mu) \dots S^2(\mu)L^1(\mu)$  is a linear combination of the thermal source vectors of the individual clouds. The  $2n \times 2n$  discrete Green's matrices  $G^c(\mu, \mu')$  can be constructed from the scattering matrices  $S^c(\mu)$  of individual clouds. The Green's matrices  $G^c(\mu, \mu')$  and the equivalent thermal source vector  $L^e(\mu)$  are analogous to the equivalent resistance and the equivalent electromotive force of Thomson's theorem for a network of electrical circuits. Illustrative numerical examples are given for single clouds, 3-cloud stacks and 10-cloud stacks. These methods are useful for modeling radiation transfer in Earth's atmosphere, which can be represented by layers of invisible clouds, consisting of clear air and greenhouse gases, or visible clouds which also include condensed water, smog, etc.

Fig. 12. Premier Climate Physics Article # 3. Bibliography Part 1 3

William Happer, Ph.D. (Princeton)

W. A. van Wijngaarden and W. Happer (2023)

**13 Instantaneous Clear Sky Radiative Forcings of Halogenated Gases**

The clear sky instantaneous radiative forcings of the 14 halogenated gases previously shown to have the largest contribution to global warming, were found. The calculation used the absorption cross sections for the halogenated gases which are assumed to be independent of temperature as well as over 1.3 million line strengths for the 5 naturally occurring greenhouse gases, H<sub>2</sub>O, CO<sub>2</sub>, O<sub>3</sub>, CH<sub>4</sub> and N<sub>2</sub>O, from the Hitran database. The total radiative forcing of the halogenated gases at their 2020 concentrations is 0.52 (0.67) W/m<sup>2</sup> at the tropopause (mesopause). Over half of this forcing is due to CFC11 and CFC12 whose concentrations are declining as a result of the Montreal Protocol. The rate of total forcing change for all 14 halogenated gases is 1.5 (2.2) mW/m<sup>2</sup>year at the tropopause (mesopause). The calculations assumed a constant altitude concentration for all halogenated gases except CFC11, CFC12 and SF<sub>6</sub>. Using the observed altitude dependence for those 3 molecules reduced their radiative forcings by about 10%. The global warming potential values were comparable to those given by the Intergovernmental Panel on Climate Change. The contribution of a gas to global warming was estimated using the forcing power per molecule defined as the derivative of its radiative forcing with respect to its column density. For the present atmosphere, the per-molecule forcing powers of halogenated gases are orders of magnitude larger than those for the 5 naturally occurring greenhouse gases because the latter have much higher concentrations and are strongly saturated. But, the rates of concentration increase of the 5 main greenhouse gases are orders of magnitude greater than that of any halogenated gas. Assuming the temperature increase caused by each gas is proportional to its radiative forcing increase, the 14 halogenated gases are responsible for only 2% of the total global warming.

Bibliography Part 1 4

Fig. 13. Premier Climate Physics Article # 4.

William Happer, Ph.D. (Princeton)

W. A. van Wijngaarden and W. Happer (2023)

**14 Atmosphere and Greenhouse Gas Primer**

We discuss how greenhouse gases affect radiation transfer in Earth's atmosphere. We explain how greenhouse gases like water vapor or carbon dioxide, differ from non-greenhouse gases like nitrogen or oxygen. Using simple thermodynamics and fluid mechanics, we show that a planet with sufficiently high concentrations of greenhouse gases must develop a convecting troposphere. The planet must also develop a non-convecting stratosphere above the tropopause. In the simplest approximation of an atmosphere that is transparent to sunlight and has frequency independent opacity for thermal radiation, one can find simple formulas for the tropopause altitude, and for the altitude profiles of pressure and temperature. The troposphere is nearly isentropic and the stratosphere is nearly isothermal. Earth's real atmosphere is much more complicated but it does have a troposphere and a stratosphere. Between the surface and the tropopause the entropy per kilogram of real tropospheric air increases slowly with altitude. The entropy increases much more rapidly with altitude in the stratosphere. The stratosphere has a nearly isothermal lower part and a hotter upper part due to absorption of solar ultraviolet radiation by ozone. The thermal opacity of the real atmosphere has a complicated frequency dependence due to the hundreds of thousands of vibration-rotation transitions of its greenhouse molecules. Unlike the simple model where nearly all radiation to space originates at the tropopause, altitude, radiation to space from Earth's real atmosphere originates from both the surface and all altitudes in the troposphere. A small additional amount of radiation originates in the stratosphere. When these complications are taken into account, model calculations of the thermal radiation spectrum at the top of the atmosphere can hardly be distinguished from satellite observations.

Bibliography Part 1 5

Fig. 14. Premier Climate Physics Article # 5.

William Happer, Ph.D. (Princeton)

W. A. van Wijngaarden and W. Happer (2023)

**15 2n-Stream Thermal Emissions from Clouds**

We analyze thermal emission of radiation in homogeneous clouds. The clouds have negligible horizontal variation, but the temperature can vary vertically. The radiation at optical depth  $\tau$  above the cloud bottom is characterized by intensity values  $I(\mu, \tau)$  at 2n Gauss-Legendre direction cosines  $\mu$ , the roots of the 2nth Legendre polynomial.  $P_{2n}(\mu)=0$ . Scattering matrices describe the intensity fraction with incoming direction cosine  $\mu'$  that is scattered to intensity with outgoing direction cosine  $\mu$ . Green's function matrices describe radiation generated by infinitesimally thin layers of cloud particulates, thermally emitting at the source optical depth  $\tau'$ . For thin isothermal clouds of optical thickness  $\tau \ll 1$ , thermal emission is mainly determined by the single scattering albedo  $\omega$ . The emitted intensity is limb darkened and depends little on the scattering phase function. For optically thick isothermal clouds, with  $\tau \gg 1$ , purely absorbing clouds with  $\omega=0$  become perfect blackbodies and emit isotropic Planck intensity. Thick isothermal clouds with moderate single scattering albedos emit substantially less thermal radiation than black bodies and the emission depends strongly on the anisotropy of the scattering phase function. Clouds with strong forward scattering are "blackier" and emit the most thermal radiation. There is limb darkening which is most pronounced for strongly forward-scattering phase functions. The limb darkening in thick isothermal, scattering clouds is not due to temperature gradients, as it is for the Sun. With scattering, nearly vertical radiation produced by thermal emission escapes through the surface more efficiently than nearly horizontal radiation. There is limb darkening even for purely absorbing particulates for clouds with hot interiors.

Bibliography Part 1 6

Fig. 15. Premier Climate Physics Article # 6.

William Happer, Ph.D. (Princeton)

C. A. de Lange, J. D. Ferguson, W. Happer3, and W. A. van Wijngaarden (2022)

**16 Nitrous Oxide and Climate**

Higher concentrations of atmospheric nitrous oxide (N<sub>2</sub>O) are expected to slightly warm Earth's surface because of increases in radiative forcing. Radiative forcing is the difference in the net upward thermal radiation flux from the Earth through a transparent atmosphere and radiation through an otherwise identical atmosphere with greenhouse gases. Radiative forcing normally measured in W m<sup>-2</sup>, depends on latitude, longitude and altitude, but it is often quoted for the tropopause, about 11 km of altitude for temperate latitudes, or for the top of the atmosphere at around 90 km. For current concentrations of greenhouse gases, the radiative forcing per added N<sub>2</sub>O molecule is about 250 times larger than the forcing per added carbon dioxide (CO<sub>2</sub>) molecule. This is due to the heavy saturation of the absorption band of the relatively abundant greenhouse gas, CO<sub>2</sub> compared to the much smaller saturation of the absorption bands of the trace greenhouse gas N<sub>2</sub>O. But the rate of increase of CO<sub>2</sub> molecules, about 2.5 ppm/year (part per million by mole), is about 3000 times larger than the rate of increase of N<sub>2</sub>O molecules, which has held steady at around 0.0085 ppm/year since the year 1985. So, the contribution of nitrous oxide to the annual increase in forcing is 200/3000 or about 1/15 that of CO<sub>2</sub>. If the main greenhouse gases, CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O have contributed about 0.3 C/decade of the warming observed over the past few decades, this would correspond to about 0.00064 K per year or 0.064 K per century of warming from N<sub>2</sub>O. Proposals to place harsh restrictions on nitrous oxide emissions because of warming fears are not just fed by those facts. Restrictions would cause serious harm, for example, by jeopardizing world food supplies.

Bibliography Part 1 7

Fig. 16. Premier Climate Physics Article # 7.

William Happer, Ph.D. (Princeton)

W. A. van Wijngaarden and W. Happer (2022)

**17 2n-Stream Conservative Scattering**

We show how to use matrix methods of quantum mechanics to efficiently and accurately calculate axially symmetric radiation transfer in clouds, with conservative scattering of arbitrary anisotropy. Analyses of conservative scattering, where the single scattering albedo is  $\omega=1$  and no energy is exchanged between the radiation and scatterers, began with work by Schwarzschild, Milne, Edington and others on radiative transfer in stars. There the scattering is isotropic or nearly so. It has been difficult to extend traditional methods to highly anisotropic scattering, like that of sunlight in Earth's clouds. The 2n-stream method described here is a practical way to handle highly anisotropic, conservative scattering. The basic concept of the 2n-stream method is an extension of Wick's seminal work on transport of thermal neutrons by isotropic scattering to scattering with arbitrary anisotropy. How to do this for finite absorption and  $\omega=1$  was described in our previous paper (arXiv:2205.08713v2). But those methods fail for conservative scattering, when  $\omega=1$ . Here we show that minor modifications to the fundamental 2n-stream theory for  $\omega=1$  make it suitable for  $\omega=1$ .

Bibliography Part 1 8

Fig. 17. Premier Climate Physics Article # 8.

William Happer, Ph.D. (Princeton)

W. A. van Wijngaarden and W. Happer (2022)

**18 2n-Stream Radiative Transfer**

We use 2n streams, where n is an integer, of axially symmetric radiation to solve the equation of transfer for a layered medium. This is a generalization of Schwarzschild's classic 2-stream model. As is well known, using only the first 2n Legendre polynomials to describe the angular dependence of radiation reduces the equation of transfer to a first order differential equation in a space of 2n dimensions. It is convenient to characterize the radiation as 2n stream intensities propagating at zenith angles having cosines called the 2n Gauss-Legendre cosines defined to be solutions of equaling the Legendre polynomial of degree 2n to zero. We show how to efficiently and accurately solve the equation of transfer with vector and matrix methods analogous to those used to solve Schroedinger's equation of quantum mechanics. To model strong forward scattering, like that of visible light by Earth's clouds, we have introduced a new family of phase functions. These gave the maximum possible forward scattering gain  $\rho$  for a phase function constructed from the first 2p Legendre polynomials, where p is an integer. We show illustrative examples of radiative transfer phenomena calculated with this new method.

Bibliography Part 1 9

Fig. 18. Premier Climate Physics Article # 9.

William Happer, Ph.D. (Princeton)

W. A. van Wijngaarden and W. Happer (2021)

**19 Relative Potency of Greenhouse Molecules**

The forcings due to changing concentrations of Earth's five most important, naturally occurring greenhouse gases, H<sub>2</sub>O, CO<sub>2</sub>, O<sub>3</sub>, N<sub>2</sub>O and CH<sub>4</sub> as well as C<sub>4</sub>F<sub>8</sub> and SF<sub>6</sub> were evaluated for the case of a cloud-free atmosphere. The calculation used over 1.5 million lines having strengths as low as 10<sup>-21</sup> cm. For a hypothetical optically thin atmosphere, where there is negligible saturation of the absorption bands, or interference of one type of greenhouse gas with others, the per-molecule forcings are of order 10<sup>-22</sup> Watts for H<sub>2</sub>O, CO<sub>2</sub>, O<sub>3</sub>, N<sub>2</sub>O and CH<sub>4</sub> and of order 10<sup>-24</sup> Watts for C<sub>4</sub>F<sub>8</sub> and SF<sub>6</sub>. For current atmospheric concentrations, the per-molecule forcings of the abundant greenhouse gases H<sub>2</sub>O and CO<sub>2</sub> are suppressed by four orders of magnitude. The forcings of the less abundant greenhouse gases, O<sub>3</sub>, N<sub>2</sub>O and CH<sub>4</sub>, are also suppressed, but much less so. For C<sub>4</sub>F<sub>8</sub> and SF<sub>6</sub>, the suppression is less than an order of magnitude because the concentrations of these gases is very low. For current concentrations, the per-molecule forcings are two to four orders of magnitude greater for O<sub>3</sub>, N<sub>2</sub>O, CH<sub>4</sub>, C<sub>4</sub>F<sub>8</sub> and SF<sub>6</sub> than those of H<sub>2</sub>O or CO<sub>2</sub>. Doubling the current concentrations of CO<sub>2</sub>, N<sub>2</sub>O or CH<sub>4</sub> increases the forcings by a few per cent. A concentration increase of either C<sub>4</sub>F<sub>8</sub> or SF<sub>6</sub> by a factor of 100 yields a forcing nearly an order of magnitude smaller than that obtained by doubling CO<sub>2</sub>. Important insight was obtained using a harmonic oscillator model to estimate the power radiated per molecule. Unlike the most intense bands of the 5 naturally occurring greenhouse gases, the frequency-integrated cross sections of C<sub>4</sub>F<sub>8</sub> and SF<sub>6</sub> were found to noticeably depend on temperature.

Bibliography Part 1 10

Fig. 19. Premier Climate Physics Article # 10.

William Happer, Ph.D. (Princeton)

W. A. van Wijngaarden and W. Happer (2020)

**20** Dependence of Earth's Thermal Radiation on Five Most Abundant Greenhouse Gases

The atmospheric temperatures and concentrations of Earth's five most important, greenhouse gases, H<sub>2</sub>O, CO<sub>2</sub>, O<sub>3</sub>, N<sub>2</sub>O and CH<sub>4</sub> control the cloud-free thermal radiative flux from the Earth to outer space. Over 1.3 million lines, having strengths as low as 10<sup>-27</sup> cm of the HITRAN database were used to evaluate the dependence of the forcing on the gas concentrations. For a hypothetical, optically thin atmosphere, where there is negligible saturation of the absorption bands, or interference of one type of greenhouse gas with others, the per-molecule forcings are of order 10<sup>-22</sup> W for H<sub>2</sub>O, CO<sub>2</sub>, O<sub>3</sub>, N<sub>2</sub>O and CH<sub>4</sub>. For current atmospheric concentrations, the per-molecule forcings of the abundant greenhouse gases H<sub>2</sub>O and CO<sub>2</sub> are suppressed by four orders of magnitude. The forcings of the less abundant greenhouse gases, O<sub>3</sub>, N<sub>2</sub>O and CH<sub>4</sub>, are also suppressed, but much less so. For current concentrations, the per-molecule forcings are two to three orders of magnitude greater for O<sub>3</sub>, N<sub>2</sub>O and CH<sub>4</sub> than those of H<sub>2</sub>O or CO<sub>2</sub>. Doubling the current concentrations of CO<sub>2</sub>, N<sub>2</sub>O or CH<sub>4</sub> increases the forcings by a few per cent. These forcing results are close to previously published values even though the calculations did not utilize either a CO<sub>2</sub> or H<sub>2</sub>O continuum. The change in surface temperature due to CO<sub>2</sub> doubling is estimated taking into account radiative convective equilibrium of the atmosphere as well as water feedback for the cases of fixed absolute and relative humidities as well as the effect of using a pseudo adiabatic lapse rate to model the troposphere temperature. Satellite spectral measurements at various latitudes are in excellent quantitative agreement with modelled intensities.

Bibliography Part 1 11

Fig. 20, Premier Climate Physics Article # 11.

William Happer, Ph.D. (Princeton)

B. H. McGuyer, R. Marsland, III, B. A. Olsen, and W. Happer (2013)

**24** Cusp Kernels for Velocity-Changing Collisions

We introduce an analytical kernel, the "cusp" kernel, to model the effects of velocity-changing collisions on optically pumped atoms in low-pressure buffer gases. Like the widely used Kellison-Storer kernel [J. Kellison and J. E. Storer, *J. Appl. Math.* **10**, 243 (1952)], cusp kernels are characterized by a single parameter and preserve a Maxwellian velocity distribution. Cusp kernels and their superpositions are more useful than Kellison-Storer kernels, because they are more similar to real kernels inferred from measurements or theory and are easier to invert to find steady-state velocity distributions.

Bibliography Part 1 15

Fig. 24, Premier Climate Physics Article # 15.

William Happer, Ph.D. (Princeton)

R. Marsland III, B. H. McGuyer, B. A. Olsen, and W. Happer (2013)

**21** Spin-velocity correlations of optically pumped atoms

We present efficient theoretical tools for describing the optical pumping of atoms by light propagating at arbitrary directions with respect to an external magnetic field, at buffer-gas pressures that are small enough for velocity-selective optical pumping (VSOP) but large enough to cause substantial collisional relaxation of the velocities and the spin. These are the conditions for the sodium atoms at an altitude of about 100 km that are used as pedestals for adaptive optics in modern ground-based telescopes to correct for aberrations due to atmospheric turbulence. We use spin and velocity relaxation modes to describe the distribution of atoms in spin space (including both populations and coherences) and velocity space. Cusp kernels are used to describe velocity-changing collisions. Optical pumping operators are represented as a sum of poles in the complex velocity plane. Signals simulated with these methods are in excellent agreement with previous experiments and with preliminary experiments in our laboratory.

Bibliography Part 1 12

Fig. 21, Premier Climate Physics Article # 12.

William Happer, Ph.D. (Princeton)

T. T. Bhamre, R. Marsland, III, I. K. Kominis, B. H. McGuyer, and W. Happer (2013)

**25** Collision Kernels from Velocity-Selective Optical Pumping with Magnetic Depolarization

We experimentally demonstrate how magnetic depolarization of velocity-selective optical pumping can be used to single out the collisional cusp kernel best describing spin- and velocity-relaxing collisions between potassium atoms and low-pressure helium. The range of pressures and transverse fields used simulate the optical pumping regime pertinent to sodium pedestals employed in adaptive optics. We measure the procession of spin-velocity modes under the application of transverse magnetic fields, simulating the natural configuration of mesospheric sodium optical pumping in the geomagnetic field. We also provide a full theoretical account of the experimental data using the recently developed cusp kernels, which realistically quantify velocity damping collisions in this optical pumping regime. A single cusp kernel with a sharpness  $s=132$  provides a global fit to the K-He data.

Bibliography Part 1 16

Fig. 25, Premier Climate Physics Article # 16.

William Happer, Ph.D. (Princeton)

B. H. McGuyer, T. Xia, and W. Happer (2013)

**22** Hyperfine frequencies of 87Rb and 133Cs atoms in Xe gas

The microwave resonant frequencies of ground-state 87Rb and 133Cs atoms in Xe buffer gas are shown to have a relatively large nonlinear dependence on the Xe pressure, presumably because of RbXe or CsXe van der Waals molecules. The nonlinear shifts for Xe are opposite in sign to the previously measured shifts for Ar and Kr, even though all three gases have negative linear shifts. The Xe data show striking discrepancies with the previous theory for nonlinear shifts. Most of this discrepancy is eliminated by accounting for the spin-rotation interaction in addition to the hyperfine-shift interaction in the molecules. To the limit of our experimental accuracy, the shifts of 87Rb and 133Cs in He, Ne, and N<sub>2</sub> were linear with pressure.

Bibliography Part 1 13

Fig. 22, Premier Climate Physics Article # 13.

William Happer, Ph.D. (Princeton)

S. Kadlecěk, T. Walker, D. K. Walter, C. Erickson, and W. Happer (2000)

**26** Spin-axis Spin-axis relaxation in spin-exchange collisions of alkali atoms

We present calculations of spin-relaxation rates of alkali-metal atoms, due to the spin-axis interaction acting in binary collisions between the atoms. We show that for the high-temperature conditions of interest here, the spin-relaxation rates calculated with classical-path trajectories are nearly the same as those calculated with the distorted-wave Born approximation. We compare these calculations to recent experiments that used magnetic decoupling to isolate spin relaxation due to binary collisions from that due to the formation of triplet van der Waals molecules. The values of the spin-axis coupling coefficients deduced from measurements of binary collision rates are consistent with those deduced from molecular decoupling experiments, and follow a physically plausible scaling law for the spin-axis coupling coefficients.

Bibliography Part 1 17

Fig. 26, Premier Climate Physics Article # 17.

William Happer, Ph.D. (Princeton)

B. H. McGuyer, Y.-Y. Jau, and W. Happer (2013)

**23** Simple method of light-shift suppression in optical pumping systems

We report a simple method to suppress the light shift in optical pumping systems. This method uses only frequency modulation of a radio frequency or microwave source, which is used to excite an atomic resonance, to simultaneously lock the source frequency to the atomic resonance and lock the pumping light frequency to suppress the light shift. We experimentally validate the method in a vapor-cell atomic clock and verify the results through numerical simulation. This technique can be applied to many optical pumping systems that experience light shifts. It is especially useful for atomic frequency standards because it improves long-term performance, reduces the influence of the laser, and requires less equipment than previous methods.

Bibliography Part 1 14

Fig. 23, Premier Climate Physics Article # 14.

William Happer, Ph.D. (Princeton)

C. J. Erickson, D. Levron, W. Happer, S. Kadlecěk, B. Chann, L. W. Anderson, and T. G. Walker (2000)

**27** Spin Relaxation Resonances Due to the Spin-Axis Interaction in Dense Rubidium and Cesium Vapor

Resonances in the magnetic decoupling curves for the spin relaxation of dense alkali-metal vapors prove that much of the relaxation is due to the spin-axis interaction in triplet dimers. Initial estimates of the spin-axis coupling coefficients for the dimers (likely accurate to a factor of 2) are  $|\lambda|/h = 290\text{MHz}$  for Rb, 2500MHz for Cs.

Bibliography Part 1 18

Fig. 27, Premier Climate Physics Article # 18.

## A Great Climate Physicist

The true strength of William Happer as a world-renowned Climate Physicist is his 300 publications (Table 2) (Fig. 9), which include (a) 18 Premier Climate Physics Articles (Figs. 10 to 27), (b) 32 Articles, Commentaries, Interviews, Lectures, Testimonies, and Podcasts, and (c) 157 Atomic, Molecular, and Optical Physics Publications (Part 3 in Bibliography).

His seminal climate message, based on quantum mechanics is simply the following. Because of the heavy saturation of the CO<sub>2</sub> absorption-emission bands of Earth's atmosphere, CO<sub>2</sub> can only have a very small effect on climate. Even doubling of CO<sub>2</sub> will only amount to an increase of <1°C in Temperature (van Wijngaarden and Happer, 2020). An explanation of this crucial topic is covered below under the section "A Great Historian, Humorist, and Savior of CO<sub>2</sub>".

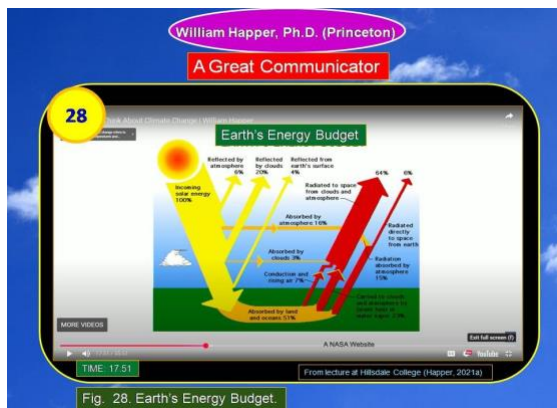


Fig. 28. Earth's Energy Budget

## A Great Communicator

William Happer has over 300 published works (Tables 2 and 3). His format of communication includes (1) Articles, (2) Commentaries, (3) Interviews, (4) Lectures, (5) Testimonies, and (6) Podcasts (Table 2).

William Happer has the unique communication skills to deliver his message using a perfect blend of science, history, logic, common sense, on-the-spot demonstration using CO<sub>2</sub> meter, and brilliant humor. As a consequence, his lectures are not only enlightening but also entertaining. A case in point is his lecture "How to Think About Climate Change" given at the National Leadership Symposium at Hillsdale College. Phoenix, Arizona (Happer, 2021a). Below is a segment from the auto-generated edited transcript from YouTube video:

Here is a picture of Earth's energy budget (Fig. 28). I mentioned we're warmed by the sun. About half of the sunlight eventually gets to the surface. The thing that prevents it all from reaching the surface are clouds. Other parts of America, like New Jersey now, are covered with clouds, so you

don't get any sunlight directly. And some of it is absorbed. But the half that does reach the ground, on average, heats the ground. And so the ground gets hotter. You can notice that in the afternoon. If you go out, and if you're a gardener like me, you can put your hands in the soil. And it's nice and warm. It makes the corn grow. And that has to be released. If you keep piling heat up, it gets hotter, and hotter, and hotter. So it's released by radiation to space, which is that red arrow going up. So the ground transports solar heating upward. Near the surface, the first few kilometres, a good fraction of that heat is not carried by radiation at all. It's completely immune to anything you do to CO<sub>2</sub>. But once you get up to 10 kilometres or so, most of that heat transport goes into radiation, this infrared radiation I mentioned.

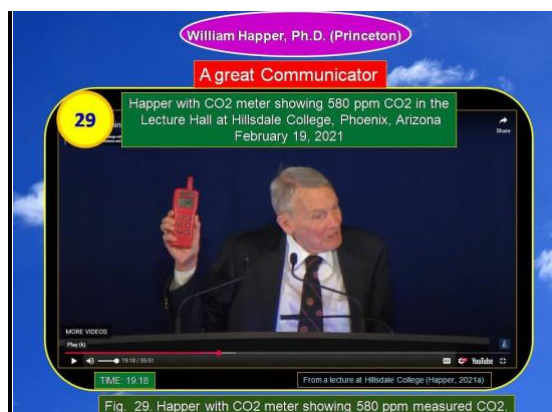
So let's talk about CO<sub>2</sub>. Number one, it's not a pollutant at all. We breathe out lots of CO<sub>2</sub>.

Many people are surprised to learn that they exhale a little more than two pounds of CO<sub>2</sub> a day! So, you people in this room are putting out a lot of CO<sub>2</sub>. I actually brought a CO<sub>2</sub> meter here, which I'm going to turn on. It takes about 30 seconds to warm up. But we will see what the levels are. Before I came down here, my wife, Barbara, and I measured the CO<sub>2</sub> on our balcony outside. And it's about 400 parts per million (ppm) outside this building. So this is warming up now. I'll show what the results are here in a minute. But our breath is not that different from the output of a power plant. Power plants take in normal air, and they burn a fair amount of the oxygen out of the air in burning coal, or natural gas, or oil. And the result that comes out of the stack is mostly the nitrogen that was already there, a little bit of oxygen that wasn't used up, and water vapor, and CO<sub>2</sub>. And our breath, except for having a lot more oxygen, so you can give mouth-to-mouth resuscitation. You couldn't do it if your breath was like a power plant. It's very similar to the power plant. It's about 4% CO<sub>2</sub>, 6% water. Power plant has a bit more CO<sub>2</sub> and correspondingly less oxygen. But our breath is definitely not a pollutant. In fact, our breathing reflex is entirely determined by CO<sub>2</sub>. It's not determined by oxygen at all.

It's not a lack of oxygen, it's too much CO<sub>2</sub> that makes you exhale. This is a picture of my wife, Barbara, in New Jersey on a new solar farm. And we'd just seen how well solar farms and windmills work in Texas. [LAUGHTER] And they never did work terribly well. But we have to be grateful for nature. She seems to have a sense of humor and has taught us a good lesson, I hope, although people seem to be slow learners. But the problem with renewable energy-- solar, wind--is they take up a lot of space. I preferred this field when it was nice and green instead of these weedy panels. They're quite weedy now. This was soon after it was built. They

don't work at all at night. So you need something else to provide electrical power at night. They don't work if it's a cloudy day. They don't work terribly well in the winter when the sun is low. So, it's pure virtue signaling. They make no economic sense unless you've massively subsidized by the state and federal governments. Here is an early wind farm in California. It's beginning to fall to pieces. But all wind farms fall to pieces. Nobody quite knows how we're going to dispose of all of this junk when it no longer works. It has much the same problems as solar.

And by the way, I have this CO<sub>2</sub> meter running now. The outside air is 400 ppm. And I'm not sure you can see this, so I'll read it out to you. But it's 580 in here (Fig. 29). So what this means-- this is not a whole lot higher than the 400 ppm outside. During lunch, we had this out. And it was 1,000 where we were having lunch. But it makes the point that CO<sub>2</sub> levels are never stable, you know? People are panicking about one or two parts per million of CO<sub>2</sub>. This is-- oh, now it's at 608. That's probably because I breathed on it. [LAUGHTER]. Hot air sets it off. [LAUGHTER]. These are interesting, too. I sometimes take it out on my back porch. And at the end of a summer day, the CO<sub>2</sub> levels on my back porch drop to maybe 300, way below the outside air. That's because the trees and grass in my backyard have sucked most of the CO<sub>2</sub> out of the air. And then if I get up early the next morning and I look at the meter, it's up to 600. So just from morning to night, CO<sub>2</sub> doubles in the air. It doubles and halves, doubles and halves. At least during the growing season, that's quite common. And we have these hysterics about CO<sub>2</sub> increasing by 30% or 40%. It's amazing. OK. So why the frenzy over CO<sub>2</sub>? The frenzy over CO<sub>2</sub> is because it is a greenhouse gas. That is true. CO<sub>2</sub> is a greenhouse gas.



### A Great User of Common Sense

Below is a segment from his lecture at Hillsdale College (Happer, 2021a):

So just about everyone wants to live in a clean environment. I do. I'm sure everyone here does. 871 And this is a photograph (Fig. 30)--I hope it shows up on the screen. I don't see it just yet-- of 872 Shanghai. And that's real air pollution. You can just barely see the bottle-opener building in the 873 back through all the haze. And some of this is actually due to burning coal. But a bigger fraction 874 is due to dust from the Gobi Desert. They've had this type of pollution in Shanghai since the days 875 of Marco Polo and long before. And part of it is burning rice fields, the stubble in the fields, 876 which is traditionally done there. And this is the kind of thing that I do not support. I wouldn't 877 want to live in a city like that. And if there's anything to do that will make it better, I would 878 certainly support that. But none of this has anything to do with CO<sub>2</sub>. CO<sub>2</sub> is a gas you can't see 879 (Fig. 31), smell, or taste. So harebrained schemes to limit emissions of CO<sub>2</sub>, which is actually 880 beneficial, as I'll explain a little bit later, will only make it harder to get rid of real pollutants, like 881 the pollutant I showed you in Shanghai.



Fig. 30. Real air pollution in Shanghai, China.

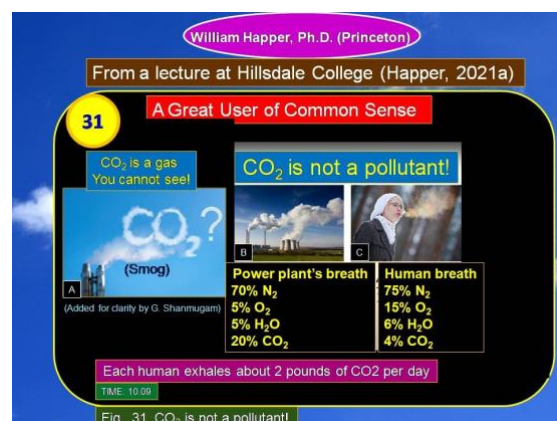


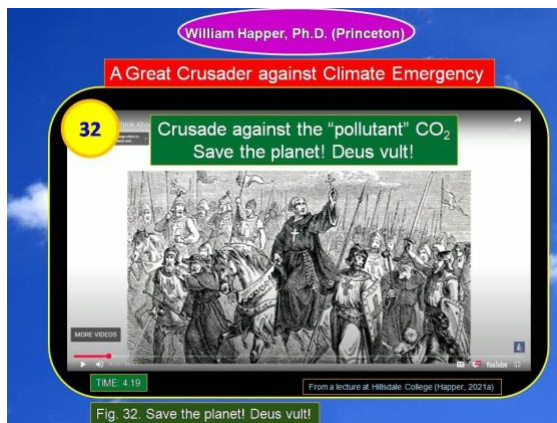
Fig. 31. CO<sub>2</sub> is not a pollutant!

### A Great Crusader against Climate Emergency

Below is a segment from his lecture at Hillsdale College (Happer, 2021a):

The best way to think about the frenzy over climate is it's kind of a modern version of the

medieval crusades. You remember that the motto of the crusaders was *Deus Vult*, "God Wants It." (Fig. 32). And it's hard to pick a better virtue-signaling slogan than that. But so far, most of the climate enthusiasts have not gone that far. Some have, actually. They claim they're doing God's work. Because of decades of propaganda, many Americans, perhaps including some of you here today, think there really is a climate emergency. Those who think that way, in many cases they mean very well. But they've been misled by decades of misinformation. So as a scientist who actually knows a lot about climate, and I set out many of our climate research centers when I was at the Department of Energy in the early 1990s (under President George H. W. Bush), I can assure you that there is no climate emergency. There will not be a climate emergency. And crusades have always ended badly. They brought discredit to the supposed righteous cause.



They brought hardship and death to multitudes. And policies to address this phony climate of emergency will cause great damage to American citizens and to their environment.

### **A Great Destroyer of the myth "97% of scientists agree on Climate Emergency"**

Below is a segment from his lecture at Hillsdale College (Happer, 2021a):

Well, you often-- when you raise these issues, the hard scientific issues with your opponents, the fanatics, the response is, how can you say that 97% of scientists agree that there is a terrible emergency here that we have to cope with?

Let's see if I can get this back again. And there are several things you should say. You should say, first of all, in science, truth is not voted on. It's not like voting on a law. It's determined by how well your theory agrees with observations and experiments. I just showed you that the theories of warming are grossly wrong. They're not even close. And yet we're making our policy decisions based on these theories, these computer models that don't

work. So that's one point, is that it doesn't matter how many people say there's an emergency. If it doesn't agree with the experiment, it's wrong. And it's definitely wrong.

The second thing is even when people agree in science, people think of scientists as somehow these incorruptible, priestly people. They're not that at all. They have all the same faults as everybody else. And they're frequently wrong. A good example of that was continental drift. When I was a student in the '50s, nobody with any self-respect in geology admitted to believing in continental drift, although it had been proposed by Alfred Wegener, a German scientist in the '20s and '30s (Fig. 33). And it was based on very good, hard evidence. An example is shown below.

The fact, for example, that Africa, and South America, and India, and Antarctica fit together like a jigsaw. So you've taken a jigsaw apart. So that's pretty suggestive, I would say. And secondly, if you look at the fossils in these continents from 300 million years ago, 400 million years ago today, they go smoothly from South America to Africa, or from Africa to India, or even into Antarctica, that you find fossils of the same organisms even though there's thousands of kilometres of sea separating them today. And so that, again, suggests that these were connected. But nevertheless, in spite of this quite persuasive evidence, Wegener was scorned and mocked all his life. He died falling into a crevasse in Greenland, exploring, looking for fossils. It's sort of a sad ending.

But he was absolutely right. And the clincher actually came when we finally declassified the World War II North Atlantic magnetic anomaly data, which we had been sitting on for 10 years, which showed a conveyor belt of crust being formed starting mid-Atlantic region and going out, left and right, toward America, toward Europe. So there was absolutely no question that the sea floor was splitting, spreading. That's the one bit of evidence that Wegener did not have. But he had lots of other evidence that should have persuaded people. So this is just one example. I could tell you many others of scientific consensus that made no sense. This one is interesting because it had no political background. It was pure science. But it does illustrate the fallibility of scientists and the groupthink that goes in science. If you wanted to advance as a young geologist, you could write a paper scolding Wegener in 1950 and get promoted right away, even though your paper was completely wrong. And once you get tenure, you're there for good.

[LAUGHS] [LAUGHTER]

So let me-- this is probably a little too long a lecture. So let me bring it to a close. And I'll take

some questions. So the takeaway message is that the policies to slow CO<sub>2</sub> emissions, they're based on flawed computer models which exaggerate warming by factors of two or three, probably more. That's message number one. So why do we give up our freedom?

What do we do we give up our automobiles? Why do we give up a beefsteak because of this model that doesn't work? And well, at number two, it's that if you really look into it, more CO<sub>2</sub> actually benefits the world. So what are we doing? This beneficial molecule that's making plants grow better, that's giving us a little less harsh winters, a slightly longer growing season, why is that a pollutant? It's not a pollutant at all. And we should have the courage to do nothing about CO<sub>2</sub> emissions. Nothing needs to be done. So thank you. I'll stop at this point, yep.

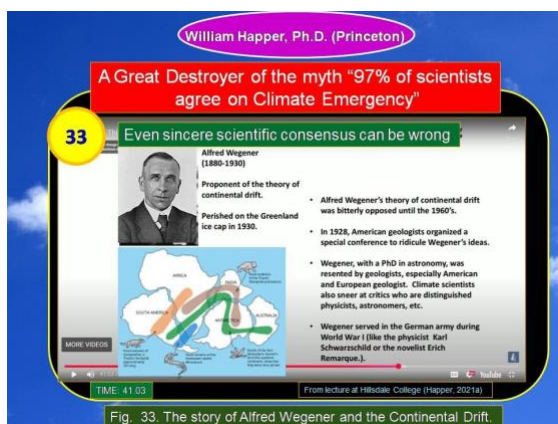


Fig. 33. The story of Alfred Wegener and the Continental Drift.

### A Great Historian on Greenhouse Gases

Below is a segment from his lecture at Hillsdale College (Happer, 2021a):

Greenhouse gases were discovered in the 1850s by this man (Fig. 34). This is John Tyndall (1861), who was an Anglo-Irish physicist working in London. And he was the first one who discovered

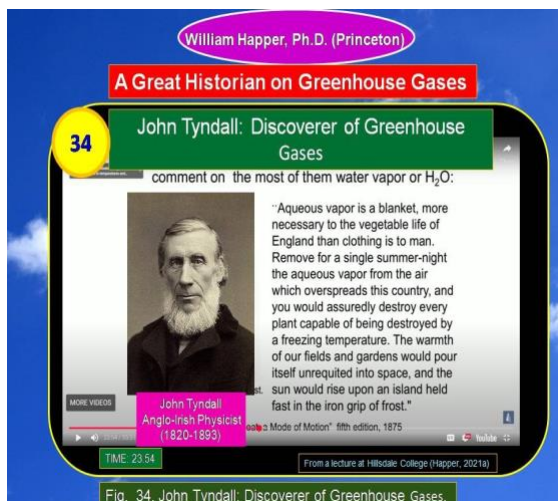
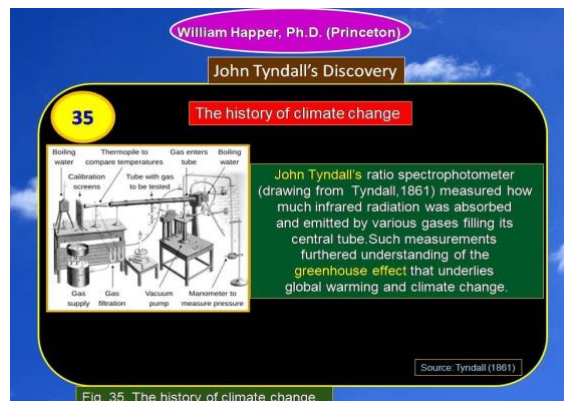


Fig. 34. John Tyndall: Discoverer of Greenhouse Gases.

that water vapor, or carbon dioxide, or ether, or alcohol intercepts thermal radiation (Fig. 35). He, as is appropriate for an Anglo-Irishman, his source of heat was a teakettle. [CHUCKLES] So he had this hot tea kettle boiling on a stove. And then he had a pipe through which the radiation from the tea kettle could go. And he noticed that certain gases, like CO<sub>2</sub>



or, especially, water vapor, would block most of that heat radiation, whereas the normal atmospheric gases, nitrogen and oxygen, would not. So we now call the gases that block the heat greenhouse gases. And CO<sub>2</sub> is, indeed, a greenhouse gas. It's not a very good greenhouse gas at today's concentrations.

### A Great Historian, Humorist, and Savior of CO<sub>2</sub>

Below is a segment from his lecture at Hillsdale College (Happer, 2021a):

So let me show you. This is something I want you to remember. This is an important slide (Fig. 36). So there's a lot of history here. And so there are two pictures here. The top picture's Max Planck. And Max Planck was the great German scientist who discovered quantum mechanics (Fig. 37 added for clarity by G. Shanmugam). And amazingly, quantum mechanics goes back to greenhouse gas physics, thermal radiation, just what we're talking about today and just what climate fanatics don't understand yet, 100 years after Planck. But Planck understood it very well. And Planck was the first one who was able to show why the radiation from warm bodies has the shape it has. On this picture to the left of Planck and below Schwarzschild-- I'll have more to say about Schwarzschild in a minute-- is a smooth blue curve. And what that is-- again, left to right is wavelength or the frequency, in this case, of light, thermal radiation. And up is the thermal power that's going out to space.

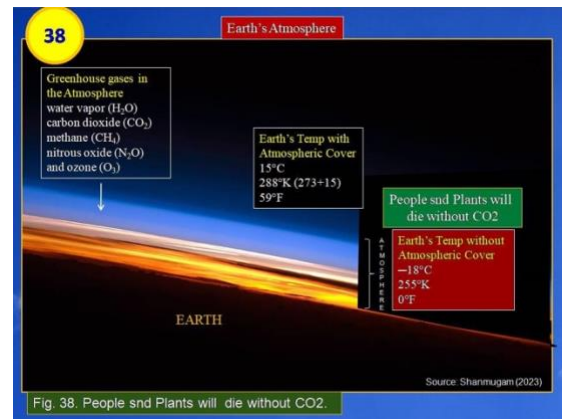
And so if there were no greenhouse gases, the radiation going to space would be that Planck curve, that blue curve there. And that would be the radiation that keeps the Earth cool.

In fact, that's not what you observe if you look down from a satellite. And we have lots of

measurements now. What you see is something that looks a lot like the black curve that's below with lots of jags and wiggles in it. And that curve was first calculated by Karl Schwarzschild, whose picture is below Planck. Karl Schwarzschild was an officer in the German army in World War I. And he did some of his most creative work in the trenches on the Eastern Front, facing Russia. And he, in fact, produced one of the first analytic solutions to Einstein's general theory of relativity while he was there on the front lines. And alas, he died before he got home-- not from Russian bullets, but from an autoimmune disease, which was really tragic. But anyway, Schwarzschild was the theorist who figured out how to calculate how the real Earth works with greenhouse gases. And it is those jagged black lines. Now, the important point here is that you notice there's also a red line on this chart. What the red line is what would happen if you doubled the CO<sub>2</sub> concentration from today's level. So right in the middle of these curves-- I'm sorry. I don't have a laser pointer here. But you can see a gap. And that's due to CO<sub>2</sub> absorbing radiation that would otherwise cool the Earth. If you double the amount of CO<sub>2</sub>, you don't double the size of that gap. You just go from the black curve to the red curve, and you can barely see the difference. So the message I want you to understand, which practically no one really understands, is that doubling CO<sub>2</sub> almost doesn't make any difference. It goes from that black curve to the red curve. And on the basis of this, we're supposed to give up our liberties. We're supposed to

We're supposed to accept dictatorial power by Bernie Sanders and Ocasio-Cortez because of the difference between the red and the black curve. Don't let anyone convince you that that is a good bargain. It is a terrible bargain. The doubling actually does make a little difference. It decreases the radiation to space by about three watts per square meter. In comparison, the total radiation to space is about 300. So it's a 1% effect. It's actually a little less than that. And that's with no clouds. Clouds make everything even less threatening.

Finally, let me point out there is a green curve. That's what happens if you take all the CO<sub>2</sub>

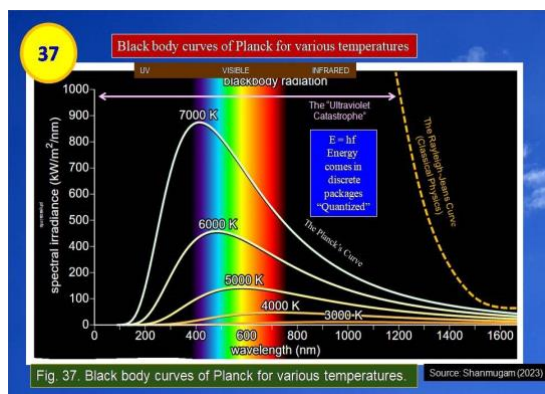
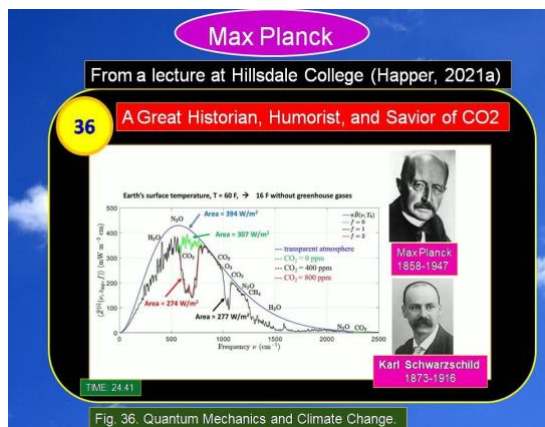


out of the atmosphere. No one knows how to do that. And of course, we'd all die because plants die if you take all the CO<sub>2</sub> out of the atmosphere (Fig. 38 added for clarity by G. Shanmugam). But what this curve is telling you is the greenhouse effect of CO<sub>2</sub> is already saturated. That's the jargon in science. It means it's done all the greenhouse warming it can already, practically. And adding, doubling it practically doesn't make any difference. You could quadruple it. It also practically makes no difference. So the CO<sub>2</sub> effects are strongly, strongly saturated. Now let me move on.

### A Great Revealer of the disconnect between Climate Models and Temperature Observations

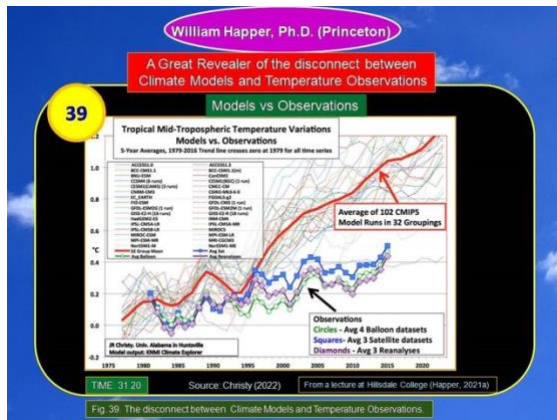
Below is a segment from his lecture at Hillsdale College (Happer, 2021a):

So the top curve is predictions by the international climate alarm establishment (Fig. 39). And the bottom curves, the blue and the green curves, are observations. And so the blue circles are measured by balloons. You probably know that, every day, thousands of balloons are launched around the world in North America, Europe, Asia, and the southern hemisphere. And they measure the temperature as you go up. So we know what the temperature of the atmosphere has been doing from these really good balloon records. And it's the blue curves. And the warming observed from balloons is about a third of the warming that has been predicted by models. And let me also add, nobody knows how



give up the gasoline engines of our automobiles.

much of this warming that's observed is due to CO<sub>2</sub>. There's good reason to think most of it would be there even without an increase in CO<sub>2</sub>, because we're coming out of the long Little Ice Age. And we've been coming out of that since the early 1800s, where



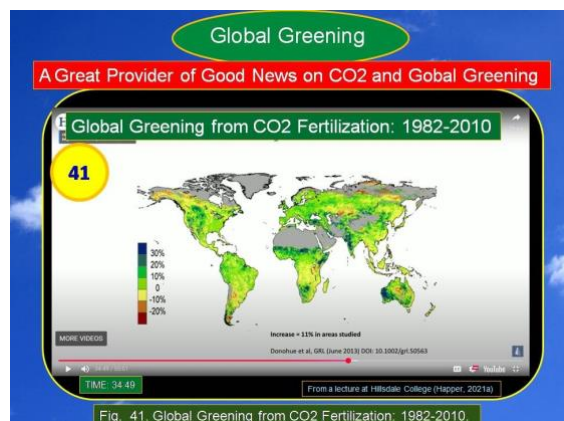
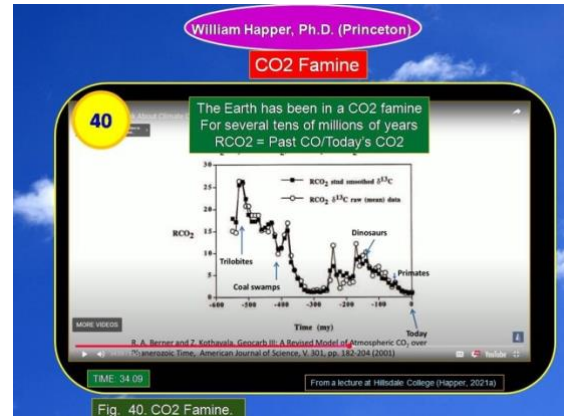
it got much, much colder. And the green curve is measurements from satellites. Very much like the measurement of your temporal scanning thermometer, you can look down from a satellite and measure the temperature of the atmosphere. So the satellites and the balloons agree with each other. And they do not agree with the models. This is nice work by John Christy at the University of Alabama, Huntsville.

### A Great Narrator of Good News on more CO<sub>2</sub> and Global Greening

Below is a segment from his lecture at Hillsdale College (Happer, 2021a):

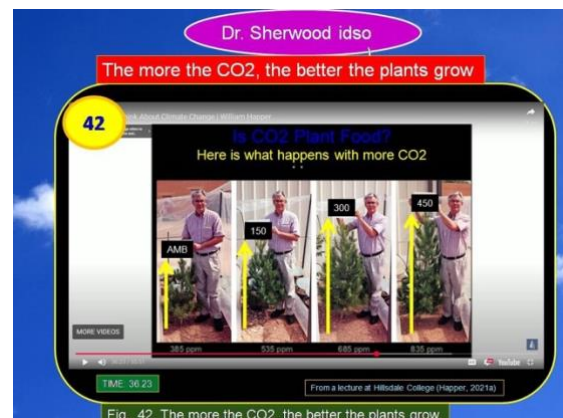
So the alleged harm from CO<sub>2</sub> is from warming. And the warming observed is much, much less 1064 than predictions. In fact, if the warming is as small as we're observing, it's almost certainly 1065 beneficial. It gives a little bit longer growing seasons. You can ripen crops a little bit further 1066 north than you could before. And so it's completely good news in terms of the temperature 1067 directly. But there's even better news. Because in reality, by historical standards, we're living in a 1068 CO<sub>2</sub> famine today. So let me show you that. So this is a picture of our best estimates of past 1069 levels of CO<sub>2</sub> (Fig. 40). So the vertical scale, RCO<sub>2</sub>, is the amount of-- that CO<sub>2</sub> in the past was 1070 greater than it is today. And so you can see on that scale that over most of the past, CO<sub>2</sub> levels 1071 have been five times, 10 times, even 20 times greater than today. And during this entire period-- 1072 this is the so-called Phanerozoic, since the Cambrian era when we have good fossil records. So 1073 we know pretty well what life was doing during that time from the sediments. And all of this 1074 period with much higher CO<sub>2</sub> levels, life flourished on Earth. And in general, it flourished better when there was more CO<sub>2</sub>. So plants really would prefer to have two, three, four times more CO<sub>2</sub> than we have today. And

you can see plants already responding to that. Let me show you an example. This is the greening of the Earth measured from satellite. So this picture shows areas of the Earth that are getting greener over a 20-year period, I think. My eyes aren't good enough to read it, but it's roughly 20 years. And what you



notice is that everywhere, especially in arid areas, the Sahel-- you can see just south of the Sahara, it's greening dramatically (Fig. 41). The Western United States is greening. Western Australia is greening. Western India is greening. And this is almost certainly due to CO<sub>2</sub>.

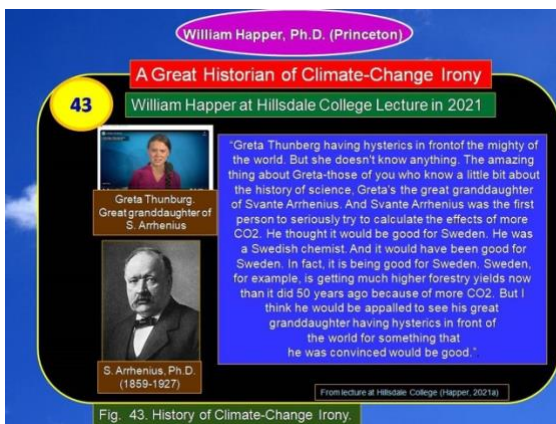
And the reason this happens is that CO<sub>2</sub> allows plants to grow where 50 years ago, it was too dry. So plants are now needing less water to grow than they did 50 or 100 years before. Let me show you another example of what more CO<sub>2</sub> does in terms of making plants grow better. This is a picture



of Dr. Sherwood Idso (Fig. 42). And it was actually an experiment done here in Phoenix back in the '80s. And so this is a pine tree. I think it's a Mediterranean pine, eldarica pine. And on the left, you'll see a pine tree growing in the current CO<sub>2</sub> levels at that time, which was about three--ambient was 380, I believe it says. And on the right are more and more CO<sub>2</sub>. So you can see that the pine trees, the more CO<sub>2</sub> you put in them, the faster they grow. And you can do this with almost any plant. The corn, wheat, cotton, they all grow better with more CO<sub>2</sub>. So this is the so-called pollutant that you hear about with the climate emergency.

### A Great Historian of Climate-Change Irony

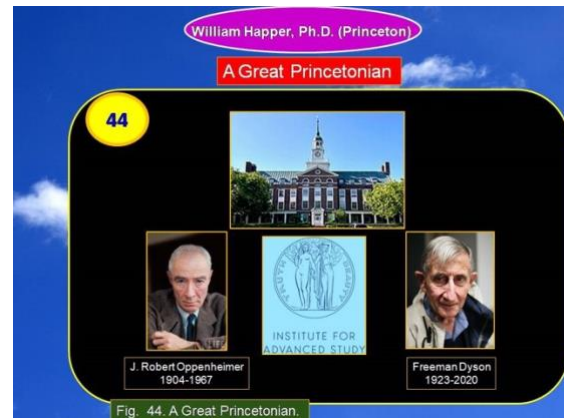
A classic case in documenting Happer as a great historian is his lecture at Hillsdale College (Happer, 2021a) with the following statement (Fig. 43) “Greta Thunberg having hysterics in front of the mighty of the world. But she doesn't know anything. The amazing thing about Greta -those of you who know a little bit about the history of science, Greta's the great granddaughter of Svante Arrhenius. And Svante Arrhenius was the first person to seriously try to calculate the effects of more CO<sub>2</sub>. He thought it would be good for Sweden. He was a Swedish chemist. And it would have been good for Sweden. In fact, it is being good for Sweden. Sweden, for example, is getting much higher forestry yields now than it did 50 years ago because of more CO<sub>2</sub>. But I think he would be appalled to see his great granddaughter having hysterics in front of the world for something that he was convinced would be good.”



### A Great Princetonian

William Happer has been a long-time resident of Princeton, New Jersey where both Princeton University and Institute for Advanced Study (IAS) are located (Fig. 44). Two brilliant minds in Physics, namely J. Robert Oppenheimer and Freeman Dyson, were faculty members at IAS. Oppenheimer was the Director of the IAS. Happer has published the following articles on Dyson and Oppenheimer.

Based on a talk given at the conference “Dreams of Earth and Sky: A Celebration for Freeman Dyson,” Institute for Advanced Study, Princeton, 27 September 2013 (Happer, 2014a): “Freeman Dyson has been interested in climate for most of his life. He coauthored one of the earliest books on the interplay of CO<sub>2</sub> and climate in 1982: “The Long-term Impacts of Increasing Atmospheric Carbon Dioxide Levels”, edited by Gordon J. MacDonald (Ballinger Publishing Company, 2008).”



Happer (2023a) wrote that “Julius Robert Oppenheimer is once more in the news, thanks to the highly publicized film “Oppenheimer.” As a physics graduate student at Princeton University in the early 1960s, I had occasional interactions with Oppenheimer, who was then the director of the Institute for Advanced Study. He was not very friendly to students at this stage of his career. But having suffered more than his share from “the slings and arrows of outrageous fortune,” he remained a sympathetic figure to most students.”

During an interview with Stuart McNish of “Conversations That Matter” held at the Institute for



Advanced Study in Princeton, Freeman Dyson (2015) shared his views on Climate Change. Below is the edited auto-generated transcript of Dyson's comments from the YouTube video (Fig. 45).

**STUART McNISH:** Man-made climate change—where are we at from your perspective? Is it incontrovertible science or are we being led down a path that you are suspicious of?

**FREEMAN DYSON:** Well, first of all, there is man-made climate change. I mean that it's a question how much and is it good or bad. And there are all sorts of questions. The fact that it exists is not a question. Certainly, there is some effect of humans on climate and we have to try to find out what it is? All I would say is first of all, we don't understand the details. It's probably much less than is generally claimed. And much the most important thing is that there are huge non-climate effects of carbon dioxide, which are overwhelmingly favorable, which are not taken into account. To me, that's the main issue. That the Earth is actually growing Greener. This has been actually measured from satellites. The whole earth is growing Greener as a result of carbon dioxide in the atmosphere. So it's increasing agricultural yields. It's increasing the forests. It's increasing all kinds of growth in the biological world. And that's more important and more certain than the effects on climate.

## BREAK

**STUART McNISH:** But so much of that belief is predicated upon models that are represented computer models that take data uh from weather stations around the world and they say that this modeling demonstrates this projections going to work.

**FREEMAN DYSON:** this of course I have always been fighting against. The idea that the models actually are good predictors. And my friend Syukuro Manabe (who won Nobel Prize in Physics in 2021 for physical modeling of Earth's Climate), he's a Japanese climate expert who lives here in Princeton. And he was actually the first person who ever did climate models with increased carbon dioxide just to see what it would do. And he found the warming. And it was less than is now fashionable. But anyway, there was some warming.

**STUART McNISH:** Is this the modeling that goes back to the late 60s?

**FREEMAN DYSON:** yes.

**STUART McNISH:** OK, I was reading about that.

**FREEMAN DYSON:** So anyway, Manabe always said and still he says that these climate models are excellent tools for understanding climate, but they're very bad tools for predicting climate. And the reason is simple. That there are models, which have only a few of the factors in them that may be important. So

you can vary one thing at a time. So you can help it helps to understand if you vary one thing at a time and see what happens, in particularly, carbon dioxide. But there's a whole lot of things they leave out and that's why they're no good for prediction. That the real world is far more complicated than the models.

**STUART McNISH:** And that is the challenge. Isn't it?

**FREEMAN DYSON:** Well, I don't think any of these models can ever be really predictive.

**STUART McNISH:** Because climate is too complex

**FREEMAN DYSON:** Yes

**STUART McNISH:** And there's too many factors at work

**FREEMAN DYSON:** Yes. And you just cannot model everything. it's just, its way out of sight.

Watch the full interview on YouTube at <https://www.youtube.com/watch?v=BQHHdXRuTKI>

## A Great Global Ambassador

Happer is a true Global Ambassador in spreading the message on CO<sub>2</sub> and Climate Change (Table 2 and 3). Below are five examples.

1. Happer, W. (2020a). CLINTEL lecturWilliam Happer in Amsterdam, The Netherlands.
2. Happer, W. (2021a). YouTube Video. How to Think About Climate Change. National Leadership Symposium at Hillsdale College. Phoenix, Arizona, USA. February 19, 2021.
3. Happer, W. (2023b). YouTube Video. The Crusade Against Carbon Dioxide. Institute of Public Affairs. Australia. September 28, 2023.
4. Happer, W. (2024a). YouTube Video. Will Happer: Radiation transfer in clouds European Institute for Climate and Energy EIKE 16th International EIKE Climate and Energy Conference, IKEK-16, 14-15 June 2024, Vienna, Austria.
5. Freedom Research (2025). Podcast # 18. EXCLUSIVE: Interview with Prof. William Happer Climate Scare Is Based on Lies. Videotaped at Princeton, New Jersey, USA.

## A Great Motivator

William Happer has been a great motivating force in spreading his climate knowledge and message.

1. Happer is the Co-Founder and Chairman of the CO<sub>2</sub> Coalition since its founding in 2015. This nonprofit organization has nearly 200 members composed of Scientists, Engineers, Economists, Medical experts including a Nobel prize winner in Physics (John Clauser). Its function is to provide facts, resources, and information about the vital role carbon dioxide plays in our environment.
2. William Happer and Jan Breslow motivated me to join the CO<sub>2</sub> Coalition in 2023. I have been active in publishing his climate messages (Shanmugam, 2023, 2024a, b, c, d). These publications are well received (Fig. 46 added for clarity by G. Shanmugam).

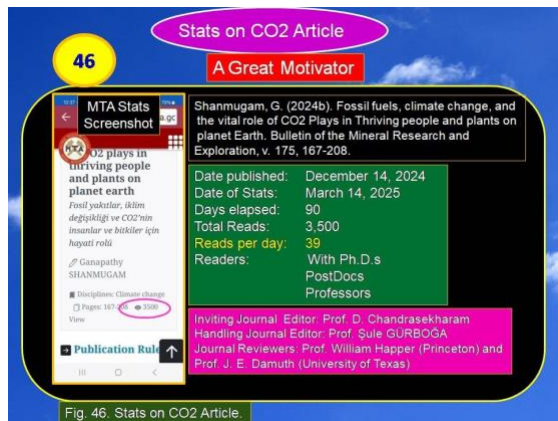


Fig. 46. Stats on CO<sub>2</sub> Article.

## A Great Public Servant under Two American Presidents

Although there were other researchers, such as Steve Koonin who served under the U.S. President Obama, William Happer had the rare distinction of serving under two U. S. Presidents in high-level advisory positions (Fig. 47).

1. On August 5, 1991 he was appointed Director of Energy Research in the Department of Energy (DOE) by the 41<sup>st</sup> U. S. President George W. Bush. While serving in that capacity under Secretary of Energy James Watkins, he oversaw a basic research budget of some \$3 billion, which included much of the federal funding for high energy and nuclear physics, materials science, magnetic confinement fusion, environmental and climate science, the human genome project, and other areas. He remained at the DOE until May 31, 1993 to help the Clinton Administration during the transition period.

2. From 2018 to 2019, Happer served as Deputy assistant to the 45<sup>th</sup> U. S. President Donald J. Trump and as senior director for emerging technologies at the White House National Security Council (Fig. 48).

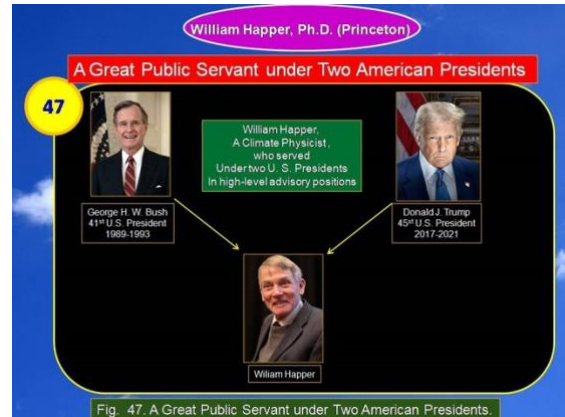


Fig. 47. A Great Public Servant under Two American Presidents.

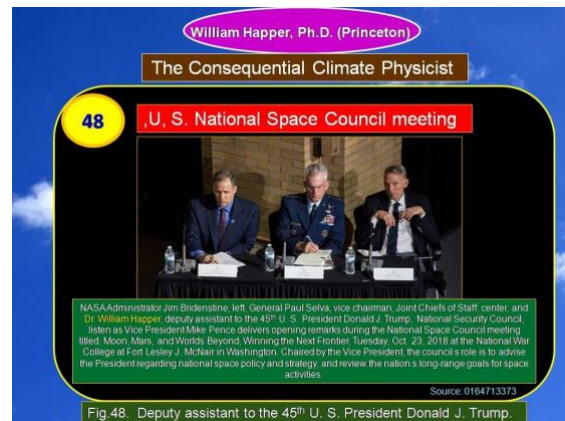


Fig. 48. Deputy assistant to the 45<sup>th</sup> U. S. President Donald J. Trump.

## A Great Inventor and Educator

William Happer (2024b), CO<sub>2</sub> Coalition Chair and Princeton Professor Emeritus, discusses his invention, the sodium guide star laser, part of the Strategic Defense Initiative, that is used in astronomical adaptive optics to correct for the degrading effects of atmospheric turbulence. According to Dr. Ethan Siegel, this invention was "perhaps the most spectacular, revolutionary advance in ground-based astronomy since the invention of photography."

Below is the edited auto-generated transcript of Happer's comments from the video. This is an excellent example of how Happer explains complex Physics in simple, easy-to-understand, layman terms to the public.

This is the sodium guide star. So this was the very first year of the Strategic Defense Initiative you know "Star Wars" and we were challenged as a scientific Community to think of anything that we could that might stop missile attacks from the Russians. And one of the things that was obvious was maybe you can burn them out of the sky with

high power lasers and I remember that Senator Malcolm Wallop (Wyoming: 1977-1995), maybe some of you remember him, was a big fan of that he wanted to put them in space but that's very expensive and difficult. And so an alternative would be to put them on the ground and the reason Senator Wallop didn't like that was because he knew a little bit of physics and the physics is if you take a megawatt laser and you aim it at an incoming attacker from the ground by the time the laser gets to the attacker it's broken up into hundreds of little beams and none of the little beams has enough power to cause any damage. You don't have that problem in space because the laser doesn't have to go through the atmosphere and so this is something that's caused by the little patches of warm and cool air in the atmosphere even if it's a completely Blue Sky it looks perfectly transparent. It's really not for lasers it was known at that time that you could solve this problem if you could measure the distorting effects of the atmosphere. And astronomers knew how to do that. So at night, if you have a really bright star you can measure the incoming radiation. And what happens is the radiation supposed to be a plain wave nice and flat coming from a star, but as it goes through the atmosphere, it gets bent up and twisted and so as it's coming down toward your telescope or going toward the target. If you're going the other way because of this twist it won't focus properly. So you don't get a nice point. You get all sorts of points, hundreds of them. And so the astronomers knew you could fix it by distorting the astronomical mirrors they had what they call Rubber mirrors and so you would squeeze the mirror in just such a way that when this distorted wave would hit the mirror, it would bounce and it come up perfectly flat and then you could focus it. And so that was called "Adaptive Optics". But to make Adaptive Optics work, you had to be able to measure the distortions of the atmosphere and there were only four or five stars at night that were bright enough to do this. And so, unless the Russians were accommodating enough to attack us from the directions of those four or five stars, there was no way we could overcome this Distortion.

We had a very secret meeting in 1982 and there were a number of generals in from the Air Force. And I said, well I know how to make artificial stars because there's a layer of sodium atoms over the Earth at about 100 kilometers and all you have to do is pay to make a laser that will excite the sodium atoms, and then you can make a yellow star wherever you like, including the direction of the target you're trying to kill. And so most of the people at the meeting had never heard of this.

By chance, I knew about it. And to the Air Force's credit, they went back to Washington and they did due diligence. This was all very secret, and

they got back to me. Later in the summer, and said we're going to try it out and we're building a secret observatory in New Mexico, south of Albuquerque, and I was getting quite nervous now because this was many millions of dollars on my suggestion, which had never been tested. But to my relief, they tested it and it worked the first time. So, I got a lot of credit then in the classified World in Washington. Most people didn't hear about it for 15 years when it



was finally Declassified. I will say if you go to any big telescope today around the world, they all have these yellow Guide Stars.

### The Consequential Climate Physicist

Amid numerous brilliant Climate Researchers, William Happer has distinguished himself as "The Consequential Climate Physicist" because of his inherent qualities (Fig. 49).

1. He has over 300 publications, which include (a) 18 Premier Climate Physics Articles, (b) 32 Articles, Commentaries, Interviews, Lectures, Testimonies, and Podcasts, and (c) 157 Atomic, Molecular, and Optical Physics Publications.
2. He is not only an eminent Climate Physicist, but also a great communicator, inventor, educator, motivator, historian, humorist, and public servant under two American Presidents (George H. W. Bush and Donald J. Trump).
3. William Happer's single greatest gift to the world is his brilliant and uncanny ability to convert complex Climate-Physics knowledge into simple, easy-to-understand, narratives and communicate them to the masses via a plethora of print and digital media relentlessly.
4. Happer, in collaboration with his equally brilliant colleagues, has been successful not only in exposing the Climate Scam but also in rescuing humanity from near extinction from the insane Net-Zero nonsense.
5. The sign of this successful turning point is evident globally from major elections that elected candidates who promoted fossil fuels.

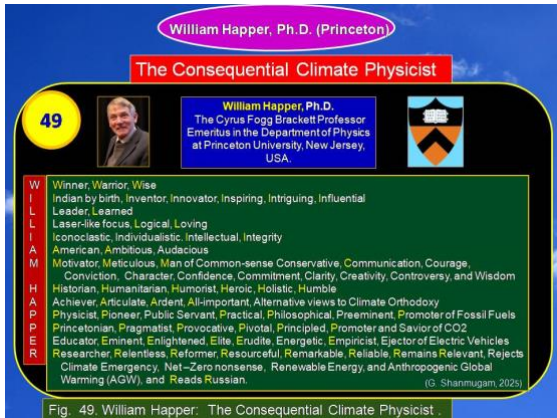


Fig. 49. William Happer: The Consequential Climate Physicist.

For example, Donald J. Trump was elected as the 47<sup>th</sup> U.S. President in 2024. On February 5<sup>th</sup>, 2025, the new US Secretary of Energy Mr. Chris Wright acted to “Unleash Golden Era of American Energy Dominance” by signing his first Secretarial Order directing Department of Energy to take immediate action to unleash American Energy in accordance with President Trump’s executive orders (<https://www.energy.gov/articles/secretary-wright-acts-unleash-golden-era-american-energy-dominance>).

Surprisingly, the Crescent Dunes Solar Energy Project ( Fig. 50A) which was a solar thermal. power project with an installed capacity of 110 megawatt (MW) and 1.1 gigawatt-hours of energy storage located near Tonopah, about 190 miles (310 km) northwest of Las Vegas, 1334

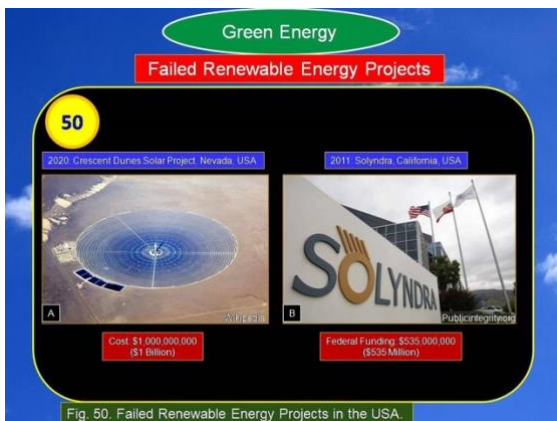


Fig. 50. Failed Renewable Energy Projects in the USA.

Nevada, at an estimated cost of \$1 billion, filed for bankruptcy in 2020 1335 ([https://en.wikipedia.org/wiki/Crescent\\_Dunes\\_Solar\\_Energy\\_Project](https://en.wikipedia.org/wiki/Crescent_Dunes_Solar_Energy_Project)). (Fig. 50B), a renewable energy firm that became a darling of the Obama Administration, shut the doors of its California headquarters Wednesday on August 31, 2011, Solyndra Inc. raising fresh questions from critics about political favoritism and wasted money in the federal loan program. The manufacturer of rooftop solar panels opened its doors in 2005, and in 2009 became the first recipient of an Obama administration energy loan guarantee – a \$535

million federal commitment that helped minimize the risk to venture capital firms backing the solar startup. (<https://publicintegrity.org/politics/obama-backed-solar-firm-collapses-after-big-federal-loan-guarantee/>)

In 2024, the failing of UN economic policies on Climate. For example, the rejection of COP 29 (Baku, Azerbaijan) economic policies by India (Fig.51) (V. Mohan, Times of India, November 24, 2024).



Fig 51 Failed UN economic policies on Climate. Rejection of COP 29 (Baku, Azerbaijan) economic policies by India.

The other example is the faltering of the German economy due primarily to their green energy projects (<https://www.trtworld.com/business/germanys-economy-falters-due-to-an-energys-hock-revealing-flaws-15029268>).

Recently, the World Economic Forum (WEF) founder Klaus Schwab, will "start the process" of stepping down as chair of its board of trustees, a spokesperson for the Geneva-based institution told Reuters on Thursday (April 3, 2025) (<https://www.reuters.com/business/world-economicforum-founder-klaus-schwab-step-down-chair-trustees-ft-reports-2025-04-03/>).

The WEF, which convenes annual gatherings in the Swiss resort of Davos, has been the main venue for the Global Elites to convene, formulate, and implement Climate Policies for the World. This was certainly a massive setback for the Global Climate Change Movement.

Importantly, Net zero is blamed for

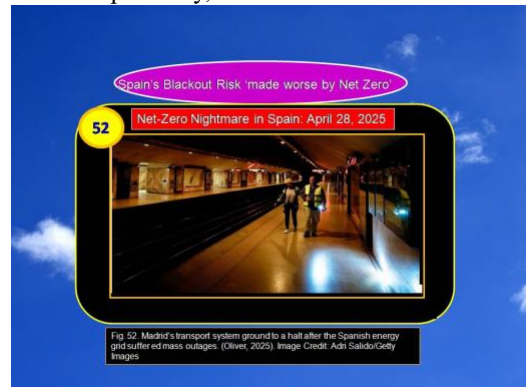


Fig 52 Madrid's transport system ground to a halt after the Spanish energy grid suffer ed mass outages. (Oliver, 2025). Image Credit: Adri Salido/Getty Images

Europe’s biggest power cut (Fig. 52).

Spain, HYPERLINK"<https://www.theguardian.com/world/portugal> "Portugal and some of south-west France suffered a massive power cut on April 28, 2025 (Monday), with major cities including Madrid, Barcelona and Lisbon among those affected. Houses, offices, trains, traffic lights and even the Madrid open tennis tournament were all hit, causing chaos for millions of people and prompting a scramble by the Spanish and Portuguese governments and network operators to understand the problem and race to fix it.

Although exact cause of the power outage is still being investigated, experts say that Net-Zero policies that rely on wind and solar power sources making the electric grid more vulnerable to power outages (Oliver, 2025).

According to pv Magazine (April 22, 2025), "Spain's grid ran entirely on renewable energy for the first time on April 16, with wind, solar, and hydro meeting all peninsular electricity demand during a weekday" (<https://www.pv-magazine.com/2025/04/22/spain-hits-firstweekday-of-100-renewable-power-on-national-grid/> Retrieved May 8, 2025).

According to MIT Technology Review, "Solar panels don't have inertia—they rely on inverters to change electricity into a form that's compatible with the grid and matches its frequency. Generally, these inverters are "grid-following," meaning if frequency is dropping, they follow that drop. In the case of the blackout in Spain, it's possible that having a lot of power on the grid coming from sources without inertia made it more possible for a small problem to become a much bigger one". <https://www.technologyreview.com/2025/05/08/1116166/spain-blackout-grid/> Retrieved May 14, 2025.

These examples undoubtedly suggest that the main platforms for Anthropogenic Global Warming (AGW) and the Renewable Energy scams are failing. Conversely, Climate Scientists who reject AGW and Renewable Energy scams (e.g., William Happer, Richard Lindzen, Patrick Moore, Ian Plimer, John Christy, Alex Epstein, among others) are winning globally.

A Formidable Fact: The Climate Truth must and will Always Prevails. Always!

### Acknowledgements

My primary reason for writing this article was to express my deep gratitude to William Happer for his relentless and tireless contributions to rescue humanity from the Net-Zero madness. The other reason, of course, was that we both (W. Happer and G. Shanmugam) were born in Tamil Nadu, India

during World War II. I thank William Happer for providing key information and images for this article. I also thank his younger sister, Elizabeth Happer Smythe, for locating an old image (1947) of Will with a man-eating tiger and a cobra in India and Mick Kreszoc for his wonderful enhancement of the image with colors. I am indebted to Tamil Orator Ms. Jeya Maran who helped me with information on Tamil Sangam in Madhurai. As always, I am grateful to my wife, Jean Shanmugam, for her general comments. I joined CO<sub>2</sub> Coalition in 2023 mainly due to encouragements from Jan Breslow and William Happer. I thank them both. Most importantly, I thank Dr. Gladys Morgan Happer. I am grateful to Dr. Bashir Ahmad Lone for his meticulous help with formatting the final version.

I am grateful to Prof. G. M. Bhat, current Editor-in-Chief of IAS Magazine for inviting me to submit this review.

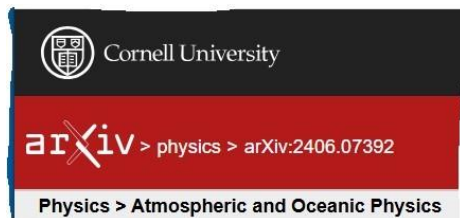
I acknowledge with gratitude the following individuals, institutions, and entities for their contributions that benefited this article.

- Andy May Petrophysicist
- Angela Wheeler
- Alex Epstein
- The Beacon. Independent Institute
- Bashir Ahmad Lone
- BizNews TV
- CLINTEL
- CO<sub>2</sub> Coalition, Fairfax, Virginia
- Cornell University: arxiv.org
- Elizabeth Happer Smythe
- D. Chandrasekharam, India
- European Institute for Climate and Energy EIKE
- Evangelical Lutheran Church in America (ELCA)
- Freedom Research Podcast # 18
- Ganapati Nayak, Goa, India
- George devries Klein
- Ghulam Bhat, Jammu, India
- Hawaii Department of Education
- Hillsdale College, Phoenix, Arizona
- ICON Lecture Series Chapel Hill, North Carolina
- Independent Institute, Oakland, California
- Insitute for Advanced Study, Princeton, New Jersey
- Institute of Public Affairs. Australia
- Intergovernmental Panel on Climate Change (IPCC)
- International Monetary Fund (IMF)
- Jean Shanmugam
- John E. Damuth
- Journal of the Geological Society of India

- Kansas State Senate Bill No. 224, the Committee on Federal and State Affairs
- Martin Durkin
- Mick Kreszoc
- National Aeronautics and Space Administration (NASA)
- National Oceanic and Atmospheric Administration (NOAA)
- National Research Council (NRC)
- National Space Council
- Oh Boy Productions, VC
- Old Guard Summit. Springfield, New Jersey
- Princeton University
- Publicintegrity.org
- Scripps CO<sub>2</sub> Program
- Southeast Homeschool Convention
- Sundaresan Asokan
- Texas Public Policy Foundation
- Tom Nelson Podcast # 265 “Will Happer: Casual brilliance”.
- United States Department of Agriculture (USDA)
- U. S. Geological Survey (USGS)
- Wickipedia
- William Happer
- World Health Organization (WHO)

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Retrieved March 6, 2025  
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physics.ao-ph  
Net Zero Averted Temperature Increase  
Authors: [R. Lindzen](#), [W. Happer](#), [W. A. van Wijngaarden](#) Abstract: Using feedback-free estimates of the warming by increased atmospheric carbon dioxide (CO<sub>2</sub>) and observed rates of increase, we estimate that if the United States (U.S.) eliminated net CO<sub>2</sub> emissions by the year 2050, this would avert a warming of 0.0084 C (0.015 F), which is below our ability to accurately measure. If the entire world forced net zero CO<sub>2</sub> emissions by the year 2050, a warming of only... ▽ More Submitted 11 June, 2024; originally announced June 2024.
2. [arXiv:2401.03061](#) [[pdf](#), [other](#)] physics.ao-ph physics.optics Effect of Greenhouse Gases on Thermal Emissivity by Clouds  
Authors: [W. A. van Wijngaarden](#), [W. Happer](#) Abstract: Greenhouse gases, most importantly water vapor, increase the emissivity and decrease the albedo of clouds for thermal radiation. The modifications, which can be of order 10% for optically thick clouds, depend on the attenuation coefficient  $\alpha\{g\}$  of the greenhouse gases, and also on the attenuation coefficient,  $\alpha\{c\}$ , the single-scattering albedo  $\omega\sim\{c\}$ , and the scattering p... ▽ More Submitted 5 January, 2024; originally announced January 2024.
3. [arXiv:2310.10622](#) [[pdf](#), [other](#)] Radiation Transfer in Cloud Layers  
Authors: [W. A. van Wijngaarden](#), [W. Happer](#) Abstract: For 2n-stream radiation transfer theory, a stack of m clouds can be represented as an equivalent cloud. Individual clouds, indexed by  $c = 1, 2, 3, \dots, m$  are characterized by  $2n \times 2n$  scattering matrices  $S^{\{c\}}$ , that describe how the cloud interacts with  $2n$  streams of axially symmetric incoming radiation, propagating in upward and downward GaussLegendre sample directions. Some of the radiation is t... ▽ More Submitted 16 October, 2023; originally announced October 2023.
4. [arXiv:2306.13642](#) [[pdf](#), [other](#)] physics.ao-ph physics.chem-ph Instantaneous Clear Sky Radiative Forcings of Halogenated Gases  
Authors: [W. A. van Wijngaarden](#), [W. Happer](#) Abstract: The clear sky instantaneous radiative forcings of the 14 halogenated gases previously shown to have the largest contribution to global warming, were found. The calculation used the absorption cross sections for the halogenated gases which are assumed to be independent of temperature as well as over 1/3 million line strengths for the 5 naturally occurring greenhouse gases: H<sub>2</sub>O, CO<sub>2</sub>, O<sub>3</sub>, CH... ▽ More Submitted 23 June, 2023; originally announced June 2023. Comments: arXiv admin note: text overlap with arXiv:2103.16465, arXiv:2006.03098
5. [arXiv:2303.00808](#) [[pdf](#), [other](#)] Authors: [W. A. van Wijngaarden](#), [W. Happer](#) Abstract: We discuss how greenhouse gases affect radiation transfer in Earth's atmosphere. We explain how greenhouse gases like water vapor or carbon dioxide,

- differ from nongreenhouse gases like nitrogen or oxygen. Using simple thermodynamics and fluid mechanics, we show that a planet with sufficiently high concentrations of greenhouse gases must develop a convecting troposphere. The planet must also deve... ▽ More Submitted 1 March, 2023; originally announced March 2023.
6. [arXiv:2301.08129](#) [[pdf](#), [other](#)] Abstract: We analyze thermal emission of radiation in homogeneous clouds. The clouds have negligible horizontal variation, but the temperature can vary vertically. The radiation at optical depth  $\tau$  above the cloud bottom is characterized by intensity values  $I(\mu, \tau)$  at  $2n$  Gauss-Legendre direction cosines  $\mu_i$ , the roots of the  $2n$ th Legendre polynomial,  $P_{2n}(\mu_i)=0$ . Scattering matrices describe t... ▽ More Submitted 17 January, 2023; originally announced January 2023.
  7. [arXiv:2211.15780](#) [[pdf](#), [other](#)] Authors: [C. A. de Lange](#), [J. D. Ferguson](#), [W. Happer](#), [W. A. van Wijngaarden](#) Abstract: Higher concentrations of atmospheric nitrous oxide (N<sub>2</sub>O) are expected to slightly warm Earth's surface because of increases in radiative forcing. Radiative forcing is the difference in the net upward thermal radiation flux from the Earth through a transparent atmosphere and radiation through an otherwise identical atmosphere with greenhouse gases. Radiative forcing, normally measured in W/m<sup>2</sup>, dep... ▽ More Submitted 28 November, 2022; originally announced November 2022.
  8. [arXiv:2207.03978](#) [[pdf](#), [ps](#), [other](#)] Abstract: We show how to use matrix methods of quantum mechanics to efficiently and accurately calculate axially symmetric radiation transfer in clouds, with conservative scattering of arbitrary anisotropy. Analyses of conservative scattering, where the single scattering albedo is  $\omega \sim 1$  and no energy is exchanged between the radiation and scatterers, began with work by Schwarzschild, Milne, Eddington... ▽ More Submitted 8 July, 2022; originally announced July 2022.
  9. [arXiv:2205.09713](#) [[pdf](#), [ps](#), [other](#)] physics.ao-ph astro-ph.SR 2n-Stream Radiative Transfer Authors: [W. A. van Wijngaarden](#), [W. Happer](#) Abstract: We use  $2n$  streams, where  $n$  is an integer, of axially symmetric radiation to solve the equation of transfer for a layered medium. This is a generalization of Schuster's classic 2 stream model. As is well known, using only the first  $2n$  Legendre polynomials to describe the angular dependence of radiation reduces the equation of transfer to a first order differential equation in a space of  $2n$  dimensio... ▽ More Submitted 1 June, 2022; v1 submitted 19 May, 2022; originally announced May 2022. Comments: 63 pages, 20 figures
  10. [arXiv:2103.16465](#) [[pdf](#), [other](#)] Abstract: The forcings due to changing concentrations of Earth's five most important, naturally occurring greenhouse gases, H<sub>2</sub>O, CO<sub>2</sub>, O<sub>3</sub>, N<sub>2</sub>O and CH<sub>4</sub> as well as CF<sub>4</sub> and SF<sub>6</sub> were evaluated for the case of a cloud-free atmosphere. The calculation used over 1.5 million lines having strengths as low as 10–27 cm. For a hypothetical, optically thin atmosphere, where there is negligible s... ▽ More Submitted 30 March, 2021; originally announced March 2021. Comments: 29 pages, 10 figures. arXiv admin note: substantial text overlap with arXiv:2006.03098
  11. [arXiv:2006.03098](#) [[pdf](#), [other](#)] Dependence of Earth's Thermal Radiation on Five Most Abundant Greenhouse Gases Authors: [W. A. van Wijngaarden](#), [W. Happer](#) Abstract: The atmospheric temperatures and concentrations of Earth's five most important, greenhouse gases, H<sub>2</sub>O, CO<sub>2</sub>, O<sub>3</sub>, N<sub>2</sub>O and CH<sub>4</sub> control the cloud-free, thermal radiative flux from the Earth to outer space. Over 1/3 million lines having strengths as low as 10–27 cm of the HITRAN database were used to evaluate the dependence of the forcing on the gas concentrations. For a hypothetica... ▽ More Submitted 4 June, 2020; originally announced June 2020. Comments: This manuscript has 38 pages containing 15 figures
  12. [arXiv:1302.6894](#) [[pdf](#), [ps](#), [other](#)] astro-ph.IM cond-mat.stat-mech Abstract: We present efficient theoretical tools for describing the optical pumping of atoms by light propagating at arbitrary directions with respect to an external magnetic field, at buffer-gas pressures that are small enough for velocity-selective optical pumping (VSOP) but large enough to cause substantial collisional relaxation of the velocities and the spin. These are the conditions for the sodium ato... ▽ More Submitted 27 February, 2013;

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13. [arXiv:1302.4162](https://arxiv.org/abs/1302.4162) [[pdf](#), [ps](#), [other](#)] physics.atom-ph Hyperfine frequencies of  $^{87}\text{Rb}$  and  $^{133}\text{Cs}$  atoms in Xe gas Authors: [B. H. McGuyer](#), [T. Xia](#), [W. Happer](#) Abstract: The microwave resonant frequencies of ground-state  $^{87}\text{Rb}$  and  $^{133}\text{Cs}$  atoms in Xe buffer gas are shown to have a relatively large nonlinear dependence on the Xe pressure, presumably because of RbXe or CsXe van der Waals molecules. The nonlinear shifts for Xe are opposite in sign to the previously measured shifts for Ar and Kr, even though all three gases have negative linear shifts. The Xe data show s...  $\nabla$  More Submitted 18 February, 2013; originally announced February 2013. Comments: 5 pages, 3 figures. Simple method of light-shift suppression in optical pumping systems Authors: [B. H. McGuyer](#), [Y. -Y. Jau](#), [W. Happer](#) Abstract: We report a simple method to suppress the light shift in optical pumping systems. This method uses only frequency modulation of a radio frequency or microwave source, which is used to excite an atomic resonance, to simultaneously lock the source frequency to the atomic resonance and lock the pumping light frequency to suppress the light shift. We experimentally validate the method in a vapor-cell...  $\nabla$  More Submitted 18 February, 2013; originally announced February 2013. Comments: 4 pages, 5 figures Abstract: We introduce an analytical kernel, the "cusp" kernel, to model the effects of velocity-changing collisions on optically pumped atoms in low-pressure buffer gases. Like the widely used Keilson-Storer kernel [J. Keilson and J. E. Storer, Q. Appl. Math. 10, 243 (1952)], cusp kernels are characterized by a single parameter and preserve a Maxwellian velocity distribution. Cusp kernels and their superpo...  $\nabla$  More Submitted 10 February, 2013; originally announced February 2013. Comments: 4 pages, 2 figures Journal ref: Phys. Rev. Lett. 108, 183202 (2012)
14. [arXiv:1302.0060](https://arxiv.org/abs/1302.0060) [[pdf](#), [ps](#), [other](#)] Depolarization Authors: [T. Bhamre](#), [R. Marsland III](#), [I. K. Kominis](#), [B. H. McGuyer](#), [W. Happer](#) Abstract: We experimentally demonstrate how magnetic depolarization of velocity-selective optical pumping can be used to single out the collisional cusp kernel best describing spin and velocity relaxing collisions between potassium atoms and low pressure helium. The range of pressures and transverse fields used simulate the novel optical pumping regime pertinent to sodium guidestars employed in adaptive opt...  $\nabla$  More Submitted 31 January, 2013; originally announced February 2013. Comments: 5 pages, 3 figures. Abstract: We present calculations of spin-relaxation rates of alkali-metal atoms due to the spin-axis interaction acting in binary collisions between the atoms. We show that for the high-temperature conditions of interest here, the spin relaxation rates calculated with classical-path trajectories are nearly the same as those calculated with the distorted-wave Born approximation. We compare these calculati...  $\nabla$  More Submitted 5 October, 2000; v1 submitted 26 September, 2000; originally announced September 2000. Comments: text+1 figure Authors: [C. J. Erickson](#), [D. Levron](#), [W. Happer](#), [S. Kadlecek](#), [B. Chann](#), [L. W. Anderson](#), [T. G. Walker](#) Abstract: Resonances in the magnetic decoupling curves for the spin relaxation of dense alkali-metal vapors prove that much of the relaxation is due to the spin-axis interaction in triplet dimers. Initial estimates of the spin-axis coupling coefficients for the dimers are 290 MHz for Rb; 2500 MHz for Cs. Submitted 25 September, 2000; originally announced September 2000. Comments: submitted to Physical Review Letters, text + 3 figures Journal ref: Phys. Rev. Lett. 85, 4237 (2000)
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### Part 3: 157 Atomic, Molecular, and Optical Physics Publications

Year	Citation
2013	Bhamre T, Marsland R, Komnins IK, McGuyer BH, Happer W. Collision kernels from velocityselective optical pumping with magnetic depolarization Physical Review a - Atomic, Molecular, and Optical Physics. 87. DOI:10.1103/Physreva.87.043412
2012	McGuyer BH, Marsland R, Olsen BA, Happer W. Cusp kernels for velocity-changing collisions. Physical Review Letters. 108: 183202. PMID 22681073 DOI: 10.1103/Physrevlett.108.183202
2012	Happer W. Review of "Optically Polarized Atoms. Understanding Light-Atom Interactions" Aiaa Journal. 50: 511-512. DOI: 10.2514/1.J051037
2012	Marsland R, McGuyer BH, Olsen BA, Happer W. Spin-velocity correlations of optically pumped atoms Physical Review a - Atomic, Molecular, and Optical Physics. 86. DOI: 10.1103/Physreva.86.023404
2011	Kostinski N, Olsen BA, Marsland R, McGuyer BH, Happer W. Temperature-insensitive laser frequency locking near absorption lines. The Review of Scientific Instruments. 82: 033114. PMID 21456725 DOI: 10.1063/1.3574221
2011	McGuyer BH, Xia T, Jau YY, Happer W. Nonlinear pressure shifts of alkali-metal atoms in Xenon Proceedings of the IEEE International Frequency Control Symposium and Exposition. DOI: 10.1109/FCS.2011.5977737
2011	Olsen BA, Patton B, Jau YY, Happer W. Optical pumping and spectroscopy of Cs vapor at high magnetic field Physical Review a - Atomic, Molecular, and Optical Physics. 84. DOI: 10.1103/Physreva.84.063410
2011	McGuyer BH, Xia T, Jau YY, Happer W. Hyperfine frequencies of 87Rb and 133Cs atoms in Xe gas Physical Review a - Atomic, Molecular, and Optical Physics. 84. DOI: 10.1103/Physreva.84.030501
2011	Ishikawa K, Patton B, Olsen BA, Jau YY, Happer W. Transfer of spin angular momentum from Cs vapor to nearby Cs salts through laser-induced spin currents Physical Review a - Atomic, Molecular, and Optical Physics. 83. DOI: 10.1103/Physreva.83.063410
2010	Morgan SW, Happer W. Optically pumped atoms with velocity- and spin-changing collisions at low gas pressures Physical Review a - Atomic, Molecular, and Optical Physics. 81. DOI: 10.1103/Physreva.81.042703
2010	Xia T, Morgan SW, Jau YY, Happer W. Polarization and hyperfine transitions of metastable Xe129 in discharge cells Physical Review a - Atomic, Molecular, and Optical Physics. 81. DOI: 10.1103/Physreva.81.033419
2009	McGuyer BH, Jau YY, Happer W. New method for light-shift elimination 2009 IEEE International Frequency Control Symposium Joint With the 22nd European Frequency and Time Forum. 1005-1008. DOI: 10.1109/FREQ.2009.5168343
2009	Ma J, Kishinevski A, Jau YY, Reuter C, Happer W. Modification of glass cell walls by rubidium vapor

	Physical Review a - Atomic, Molecular, and Optical Physics. 79. DOI: 10.1103/Physreva.79.042905
2009	McGuyer BH, Jau YY, Happer W. Simple method of light-shift suppression in optical pumping systems Applied Physics Letters. 94. DOI: 10.1063/1.3158961
2008	Gong F, Jau YY, Happer W. Nonlinear pressure shifts of alkali-metal atoms in inert gases. Physical Review Letters. 100: 233002. PMID 18643492 DOI: 10.1103/PhysRevLett.100.233002
2008	Jau YY, Happer W, Gong F, Braun A, Kwakernaak M. End-resonance clock and all-photonic clock Proceedings of Spie - the International Society For Optical Engineering. 6906. DOI: 10.1117/12.773803
2008	Jau YY, Happer W. All-photonic clock: Laser-atomic oscillator 2008 IEEE International Frequency Control Symposium, Fcs. 665-668. DOI: 10.1109/FREQ.2008.4623083
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2007	Jau YY, Happer W. Push-pull laser-atomic oscillator. Physical Review Letters. 99: 223001. PMID 18233280 DOI: 10.1103/Physrevlett.99.223001
2007	Patton B, Ishikawa K, Jau YY, Happer W. Intrinsic impurities in glass alkali-vapor cells. Physical Review Letters. 99: 027601. PMID 17678261 DOI: 10.1103/Physrevlett.99.027601
2007	Ishikawa K, Patton B, Jau YY, Happer W. Spin transfer from an optically pumped alkali vapor to a solid. Physical Review Letters. 98: 183004. PMID 17501572 DOI: 10.1103/Physrevlett.98.183004
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2004	Oreto PJ, Jau YY, Post AB, Kuzma NN, Happer W. Buffer-gas-induced shift and broadening of hyperfine resonances in alkali- metal vapors Physical Review a - Atomic, Molecular, and Optical Physics. 69: 042716-1. DOI: 10.1103 / Physreva.69.042716
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2003	Yuzbashyan EA, Happer W, Altshuler BL, Shastry SB. Extracting hidden symmetry from the energy spectrum Journal of Physics a: Mathematical and General. 36: 2577-2588. DOI: 10.1088/0305-4470/36/10/317
2003	Jau YY, Kuzma NN, Happer W. Magnetic decoupling of <sup>129</sup> Xe-Rb and <sup>129</sup> Xe-Cs binary spin exchange Physical Review a - Atomic, Molecular, and Optical Physics. 67.
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1990	Wu Z, Happer W, Kitano M, Daniels J. Experimental studies of wall interactions of adsorbed spinpolarized <sup>131</sup> Xe nuclei. Physical Review. A. 42: 2774-2784. PMID 9904348
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### Hot Books

I recommend nine books that provide a pragmatic coverage of data and views on Climate Change (Fig. 53).

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HOT BOOKS ON ALTERNATIVE VIEWPOINTS

Recommended nooks on alternative viewpoints to AGW

Lomborg, (2007)

Marohasy (Ed.) (2017)

Koonin (2021)

Singer et al. (2021)

Epstein (2022)

Vinós (2022)

Curry (2023)

Blakely (2024)

Abbot and Marohasy (Eds.) (2025)

Fig.53. Recommended books on alternative viewpoints to AGW.