What keeps me up at night

A discussion of existential threats to mankind: Talk given at Westminster Place

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Pessimism followed by some optimism

1. As a former chair of the governing board of the Bulletin of Atomic Scientists and a long time member, I am frequently asked about why I, a personality psychologist and psychometrician, am involved in an organization dedicated to alerting people about existential threats to mankind.
2. This talk is a partial answer to those questions.
   - My background and why I worry
   - Early exposure to nuclear risks
   - Life time exposure to the science of climate change
   - Long time familiarity with computers and artificial (as well as real) intelligence
   - Steps we can take
3. It is meant also to remind us all that these existential threats are still with us and are getting worse.
4. And I will conclude with some cautious hope about steps we can all take.

A (not very good) surfer from California

80 years of the nuclear age

I was not quite one year old when the nuclear age started.

1. The Manhattan Project led to Alamogordo and the Trinity test (White Sands Proving Ground) July 16, 1945.
2. Hiroshima (August 6, 1945)
3. Nagasaki (August 9, 1945)

I grew up with people who had been at Los Alamos or had been at the early tests of nuclear weapons. Leo Szilard and Johnny Von Neumann were family friends. Walter Munk, who had been at multiple weapons tests was a great source of inspiration. Scientists talk and debate.

Operation Crossroads, Bikini, 1946

After WWII, the US held two demonstration/tests at Bikini Atoll in the Marshall Islands. Able was air launched (and missed the target), Baker was 90 feet below sea level. Observers from around the world were invited to see the power of nuclear weapons.

Operation Crossroads, Baker Test was 23 Kilo Tons Hiroshima was 15KT, Nagasaki was 21 KT

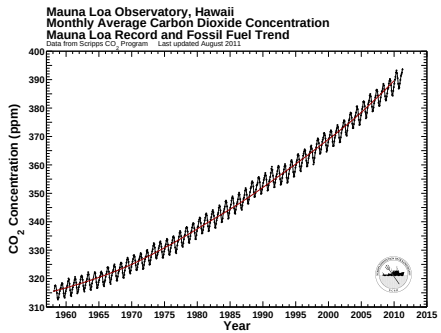
My father had been in the US Navy and was chief oceanographer at the Bikini tests
We had the unclassified *Life Magazine* photo essay on Operation Crossroads which I read (looked at the pictures) while in elementary school.

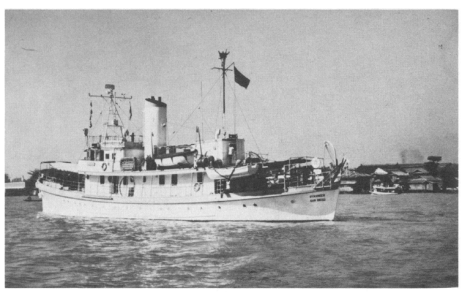
Atoms for Peace, Geneva, 1955

When I was 10, my father was at the Atoms for Peace Conference in Geneva. It was the first major global conference on peaceful nuclear technology, organized as part of Eisenhower's Atoms for Peace initiative.
A 10KW nuclear reactor was on display.
It was memorable.

Good luck

1. I grew up on the coast of California with world class scientists and did not know that was unusual.
2. Climate change and the problem of CO2 was a typical dinner table conversation.
3. When I was a less than happy 10th grader and surfer "wanna be", Anton Bruun, a visiting Danish oceanographer suggested that I should go to sea with him.
4. So, at age 14 I joined Anton on a 90 day oceanographic expedition from San Diego to Thailand that explored among other things, the Mariana Trench. This and two subsequent expeditions changed me from a not very good surfer to an aspiring young scientist.

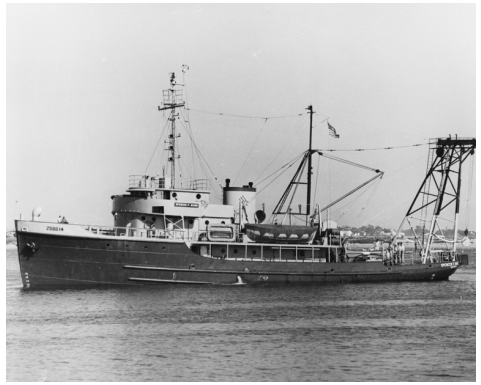


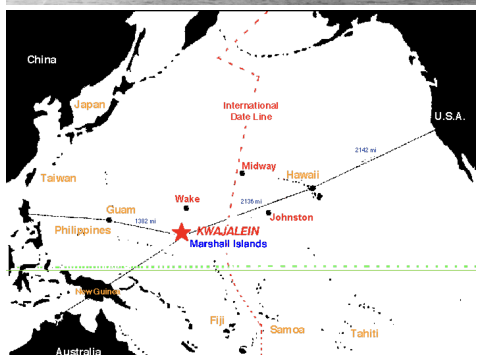


The RV *Stranger* on the Chao Phya River, Thailand.

Oceanography and nuclear tests

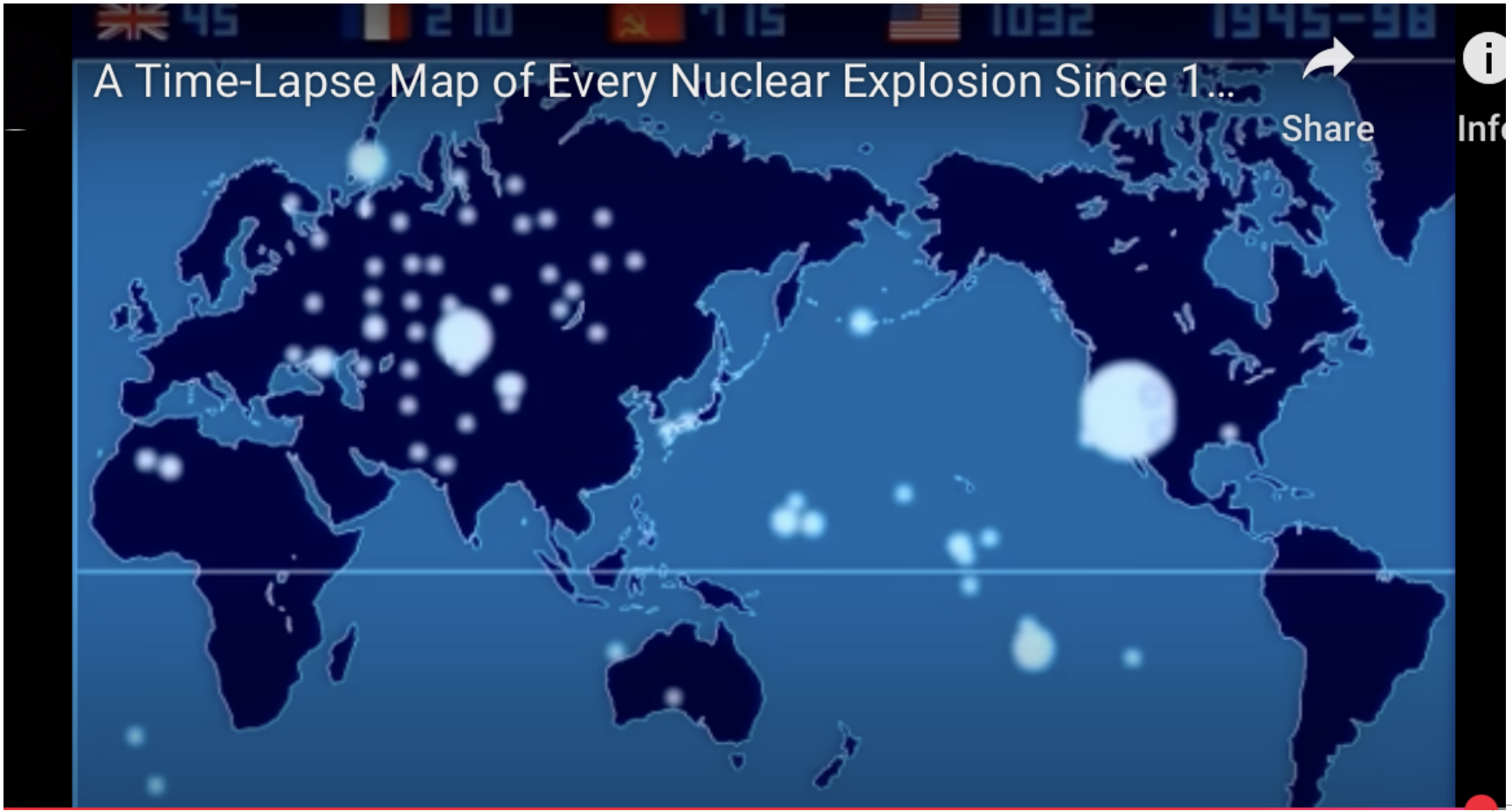
1. Two subsequent expeditions went from San Diego to Point Barrow (Nuvuk), Alaska (on an ex-tuna clipper meant for the tropics) and from Fiji to Funafutii to Onotua to Kwajalein to Samoa to Hawaii (on an ex sea going tug).
2. On my third expedition, while on Kwajalein, I saw an high altitude nuclear test at Johnson Island, more that 1200 miles away. It lit up the sky for about 10 minutes. It was the last such test. *Starfish Prime* was a 1.4 Mt high altitude (400 Km) blast.
3. As a 17 year old, it made a lasting impression and partly explains my anti-nuclear concerns and active support of the Bulletin of Atomic Scientists.





Nuclear testing over 55 years

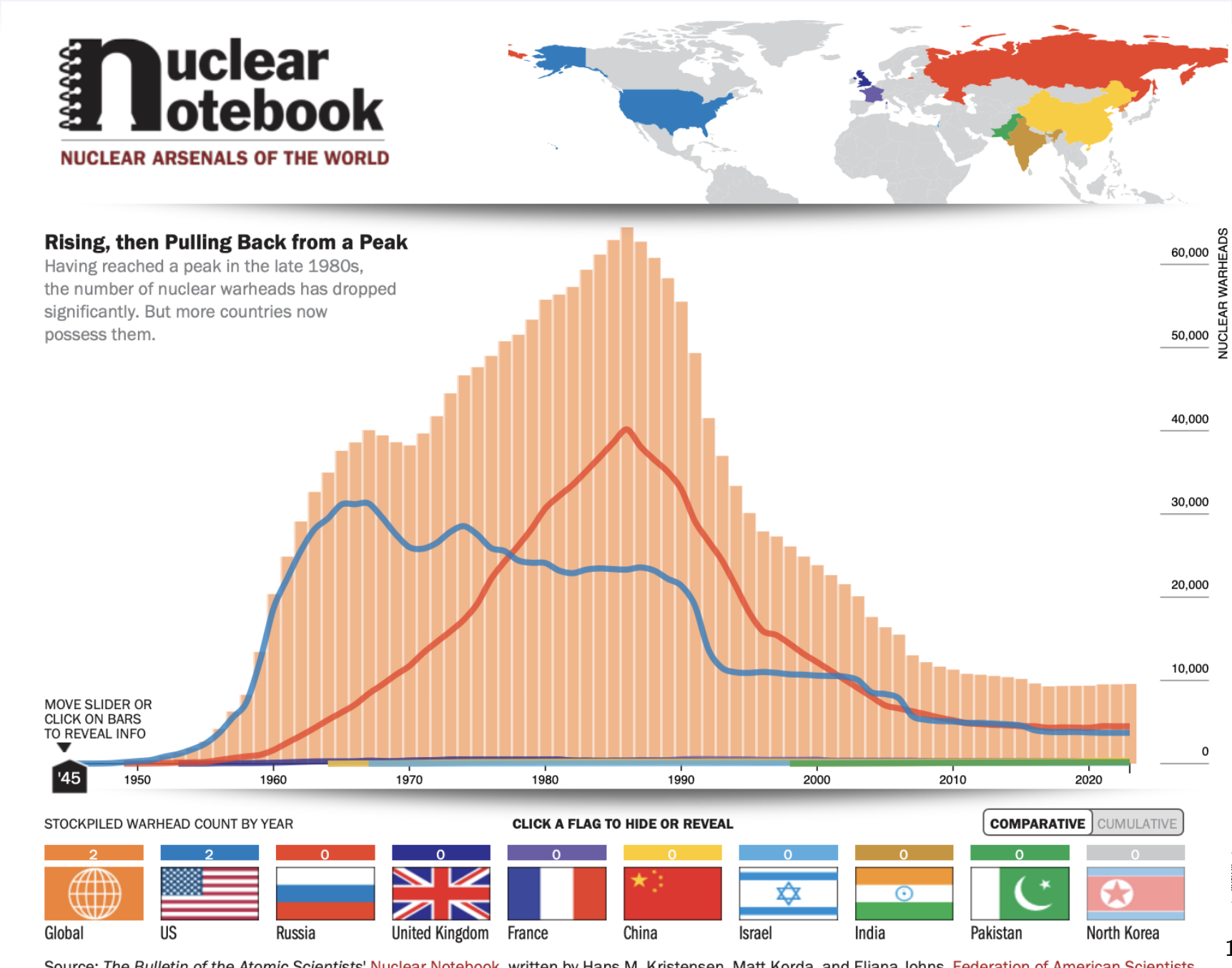
Isao Hashimo: Time lapses of nuclear explosions 1945-1968
https://www.youtube.com/watch?v=LLCF7vPanrY



Between 1949 and 1992 the US fought the USSR; we blew up Nevada, they blew up Kazakhstan

Cuban missile crisis and the limited test ban treaty

1. From October 16 to October 28, 1962 the US and the USSR almost went to war over the Soviet placement of missiles in Cuba.
   - Even though he thought they were under attack, the Soviet admiral, Vasili Arkhipov, did not approve launching nuclear torpedoes from the submarine B-59 against the US Navy. By not starting WWIII, he saved the world. We might not be so lucky again.
2. On August 5, 1963 President Kennedy and Premier Khrushchev signed a treaty to prohibit nuclear weapons test in the atmosphere .
3. Based on discussions between Reagan and Gorbachev, the Intermediate-Range Nuclear Forces Treaty was signed to limit weapons with ranges of 500 to 5,500 kilometers (December 8, 1987). US and Soviet Union reduced the total number of weapons (from 70,300) , but there are still 3,904 on high alert!


Nuclear Notebook
NUCLEAR ARSENALS OF THE WORLD
Rising, then Pulling Back from a Peak
Having reached a peak in the late 1980s, the number of nuclear warheads has dropped significantly. But more countries now possess them.
NUCLEAR WARHEADS
60,000
50,000
40,000
30,000
20,000
10,000
0
MOVE SLIDER OR CLICK ON BARS TO REVEAL INFO
'45
1950
1960
1970
1980
1990
2000
2010
2020
STOCKPILED WARHEAD COUNT BY YEAR
CLICK A FLAG TO HIDE OR REVEAL
COMPARATIVE
CUMULATIVE
2 Global
2 US
0 Russia
0 United Kingdom
0 France
0 China
0 Israel
0 India
0 Pakistan
0 North Korea
Source: The Bulletin of the Atomic Scientists' Nuclear Notebook, written by Hans M. Kristensen, Matt Korda, and Eliana Johns, Federation of American Scientists

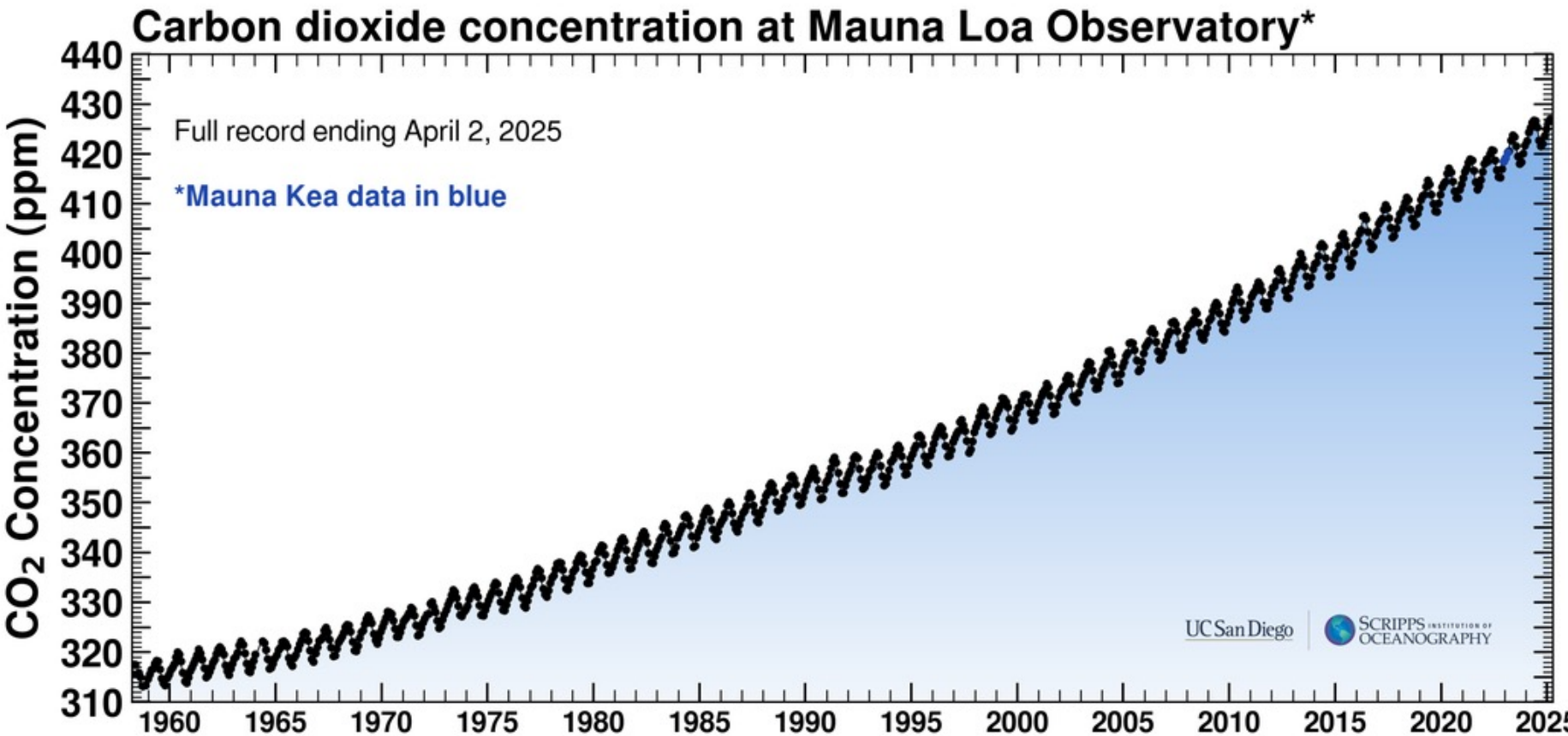
However, that means we still have missiles launch on warnng

1. The recent book by Annie Jacobson *Nuclear war: a scenario* discusses the implications of launch on warning and gives a minute by minute account of what could happen.
   - Based on interviews with Bill Perry (former Secretary of Defense, Richard Garwin (designer of the H bomb) and other well informed academics and defense specialists.
   - Some of her sources are or were members of the Science and Security Board of the BAS.
2. Because of distrust, poor evaluation of threat and general mistakes, even one rogue state with 1 or 2 missiles could start a complete nuclear exchange.
   - The recent movie *House of Dynamite* considers two missiles from (probably) North Korea and the problem of a response that would involve missiles going over Russia.
3. This would be the end of civilization.

But there are other manmade threats: Climate change

1. We have known since Svante Arrhenius in 1895 that CO_2 reduces the transparency of the atmosphere to infra-red radiation.
2. The complete burning of fossil fuels would release in a few centuries the carbon sequestered over millions of years.
3. This would lead to an even greater greenhouse effect and substantial global warming.
4. The question in the 1950s-1960s was how much was CO_2 increasing and could this be measured.
5. The oceanographic question was how much CO_2 was being sequestered in the oceans.
6. NU Chemistry Ph.D Charles David Keeling working at SIO, started collecting the long term time series data set now known as the Keeling Curve. His son, Ralph, continues the collection.
7. This is an example of the importance of longitudinal data sets.

The Keeling Curve
A time series of CO_2 since 1958
The iconic graph of CO_2



Data from C.D. Keeling and R. Keeling from SIO

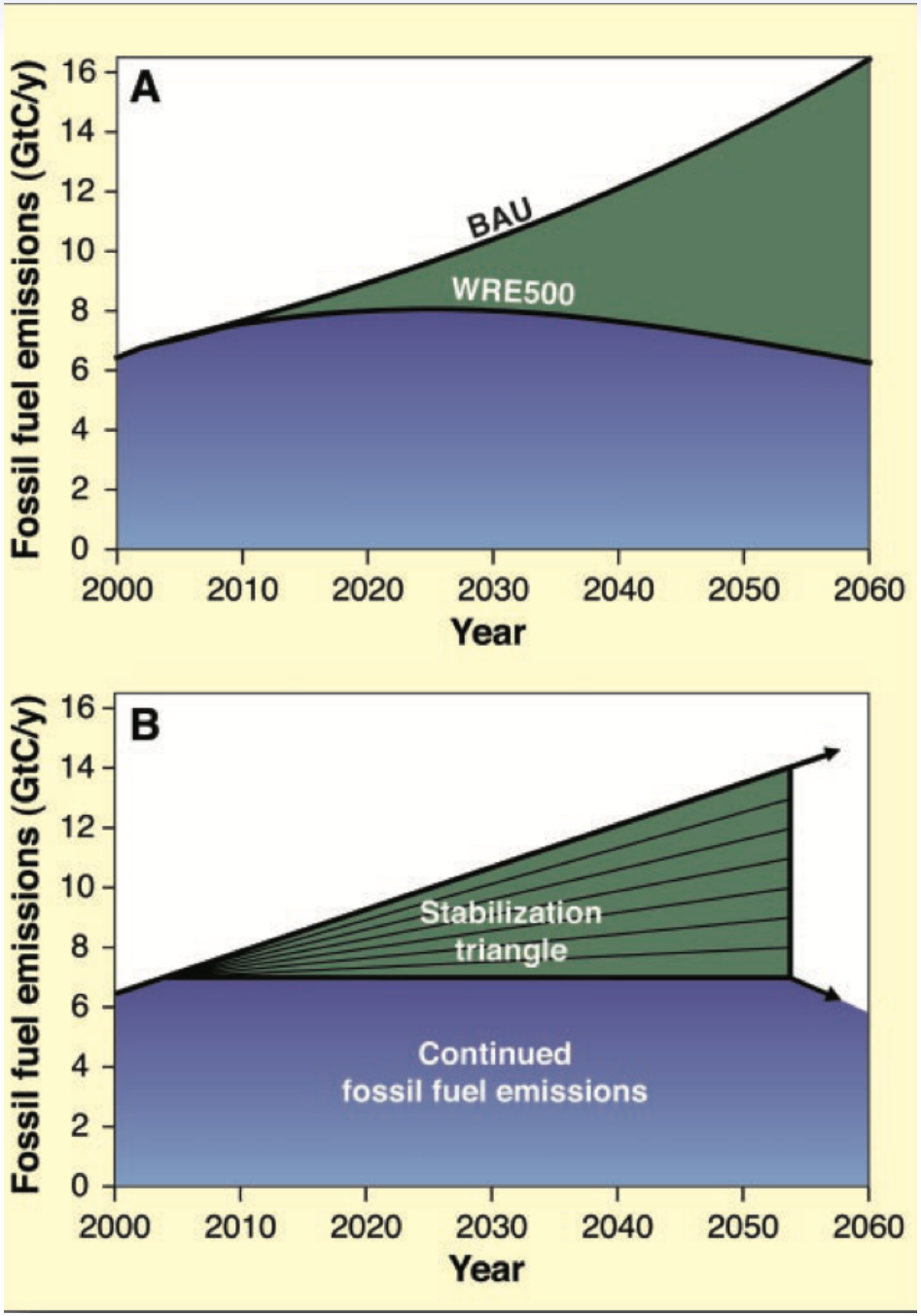
The effect of science education on global policy makers

1. While at Harvard, my father taught a distribution course for non-scientists.
   - Officially called *Population and Natural Resources*
   - Known to students as *pops and rocks*
2. A political science major took the course (as a "distro") and was impressed with the implications of the first 10 years of the Keeling Curve.
3. As a congressman, senator and vice president, he (Al Gore) publicized the need for action. *An inconvenient truth* and *Earth in the balance* were the result.
4. He had some success until the entire issue became very politicized by those who produce fossil fuels.
5. This shows the importance of broad education and also the need for social action to communicate the science.
6. The science has been settled for decades, it is the need to act that has not been recognized enough.

No magic bullet: the need for climate stabilization wedges

1. Rob Sokolow has argued that there is no one thing to do, but if we take many small actions that each grow over time, then we can limit the production of CO_2.
2. So called stabilization wedges, each growing every year can help.
3. Updated in 2020: Contending with climate change: The next 25 years.

S, Pacala and R. Sokolow, (2004) Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies, *Science*
Socolow, R. H. (2020). Contending with climate change: The next 25 years. Bulletin of the Atomic Scientists, 76(6), 294–301. https://doi.org/10.1080/00963402.2020.1846410



1. CO_2 emissions continue to grow if we continue Business as Usual (BAU).
2. Each wedge has a small effect, but they all grow over time.
   - Energy efficiency
   - Fuel shift
   - Nuclear fission
   - Forests and agriculture
3. But we need to not just stop increasing emissions, we need to move the curve down to zero emissions.

Other existential threats

- Originally concerned about the threat of nuclear war, the BAS has enlarged its remit to consider other existential threats.
- One recurring question is what is an existential threat and what is midnight?
- Climate change was first added as a serious concern in 2007
  - The Bulletin had been covering climate and biological risk before, but added these as part of the SASB debate
- Other elements of Pandora's box include
  - Biological risks, both man made and natural
  - Advances in technology such as artificial intelligence

Biological risks

1. As we cut down the rainforests and increase our exposure to wild animals, the possibility of zoonotic diseases, or zoonoses, are infectious diseases that can spread between animals (vertebrates) and humans increases. Malaria, Ebola, Plague are recent examples.
2. Antimicrobial resistance (AMR) is one of the top global public health and development threats. It is estimated that bacterial AMR was directly responsible for 1.27 million global deaths in 2019 and contributed to 4.95 million deaths. (WHO, nd).
3. Lab leaks from experimental studies of infectious disease can happen even with the highest lab security. Many countries do not have even this level of security.
4. Human designed and created viruses are able to be built on the desk top from commercially available reagents.
5. "Mirror Life" is a possible danger.

Artificial Intelligence

1. Using Large Language Models to process information and make recommendations.
2. LLMs show cultural bias based upon the language materials they use for training (Economist, June, 2026).
3. LLMs are very efficient in the rapid targeting of potential threats but mistakes happen.
4. Human judgement and ethics must be considered.

Are we doomed?

1. The Bulletin of Atomic Scientists judges the world to be more dangerous than ever with our current setting to 85 seconds to midnight. But we will remain hopeful. Fear is not a motivator.
2. Humans have responded to threats before. Susan Solomon in her recent *Solvable: how we healed the earth, and how we can do it again* (2024) reviews prior threats that were dismissed by industry but solved by public action. DDT (Rachel Carson and *Silent Spring*), The "Ozone Hole" due to man made chlorofluorocarbons reduced by the Montreal treaty, etc. See also Katherine Hayhoe (2021) *Saving Us: A Climate Scientist's Case for Hope and Healing in a Divided World*.
3. Nuclear threat has been diminished but remains as people think the problem has been solved. It has not. There are still 3,904 warheads on high alert (FAS-BAS). Mistakes happen.
4. Hope for the climate as even NU commits to reducing CO_2.
5. But it is up to us as citizens to make sure that action is taken.

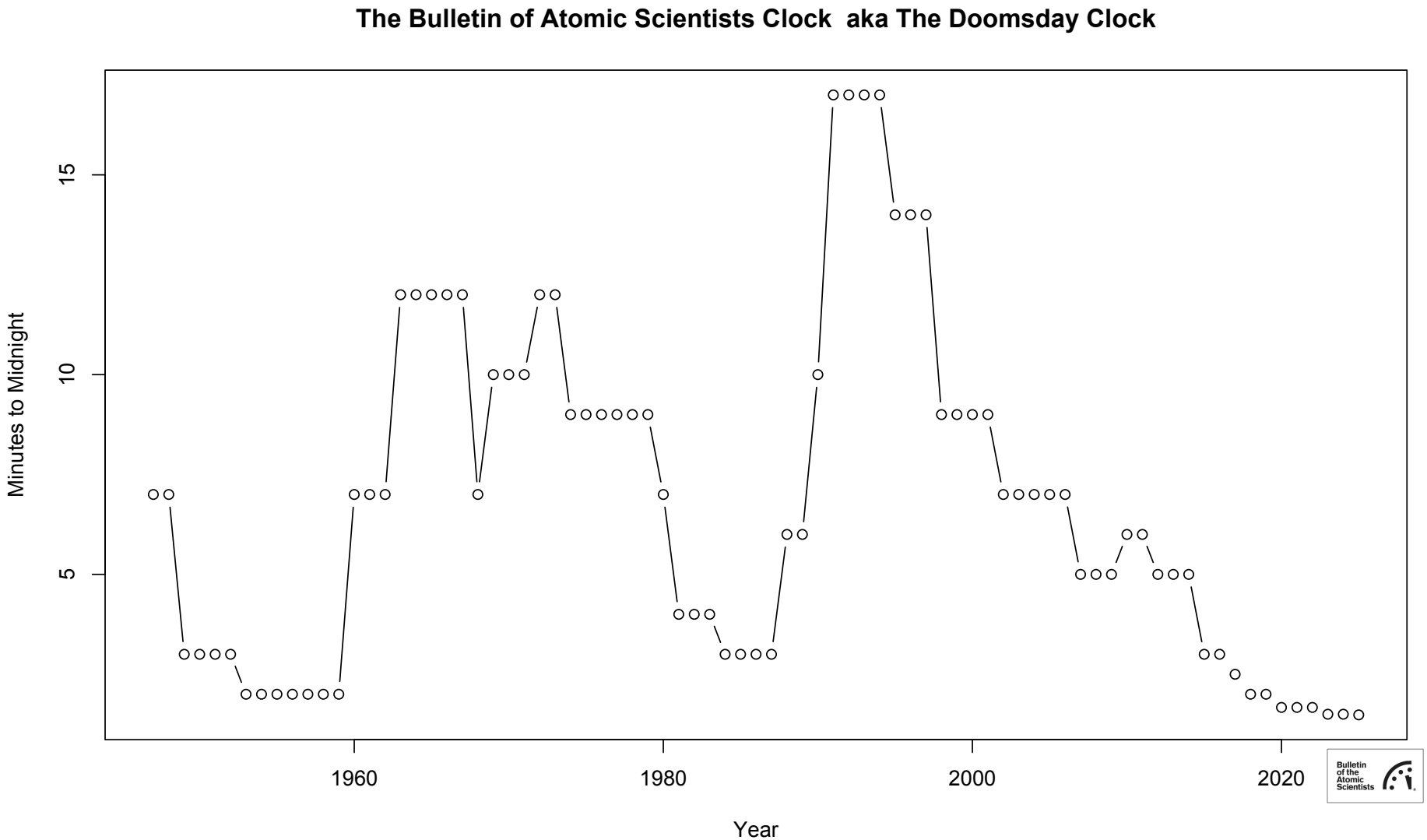
Setting the clock

1. Clearly, the clock is just a metaphor for risk,
2. Twice a year the Scientific Advisory Board meets to discuss "what time is it?"
3. This is basically an advanced seminar with position papers and academic argument (i.e., heated discussion)
4. The clock is moved only if there is consensus of the SASB
5. The position papers are then combined by our editor (with a great deal of editing) into the final statement. https://thebulletin.org/doomsday-clock/2026-statement/

The "Doomsday Clock" of the Bulletin of Atomic Scientists

https://thebulletin.org/doomsday-clock/2026-statement/

The "Doomsday Clock" of the Bulletin of Atomic Scientists
It can move backwards with help from the public



What can we do?

1. Promote the spread of information.
   - Through informing the public by publishing the Bulletin of Atomic Scientists which discusses threats for the non-expert.
   - Through art
     - John Adams opera Dr. Atomic
     - Isao Hashimo's video of nuclear testing
     - Kim Stanley Robinson's *The Ministry for the Future*
2. Staying informed and being involved.
3. Taking political action at the personal, local, state, national and international level. e.g.,
   - Enforcing the recent adoption of the Healthy Building Ordinance in Evanston by insisting that NU act not just talk.
   - Regulating the emissions of CO2 by cars (e.g. California).
4. Care about the future and acting now.
5. Resist threats to the rule of law and to the independence of universities and remember the reasons that Vannevar Bush called for society to support science in *Science, The Endless Frontier*.

The source of my hope