

Climatic and Humanitarian Impacts of Nuclear War

Alan Robock

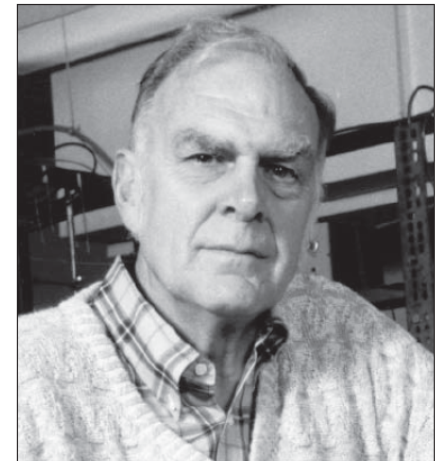
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Physicists Coalition for Nuclear Threat Reduction

F. Sherwood "Sherry" Rowland (1927–2012)

result. Ultraviolet radiation would break down CFCs in the upper atmosphere, freeing chlorine atoms that could each catalytically destroy up to 100,000 ozone molecules. As Sherry later recalled in his autobiography, "With the passage of time, the



F. Sherwood "Sherry" Rowland

As Sherry later asked at a White House climate change roundtable in 1997, "Is it enough for a scientist simply to publish a paper? Isn't it a responsibility of scientists, if you believe that you have found something that can affect the environment, isn't it your responsibility to actually do something about it, enough so that action actually takes place? If not us, who? If not now, when?"

degrees, including the Tyler Prize for Environmental Achievement (1983) and the Japan Prize (1989). He published more than 400 research articles, served as president of the American Association for the Advancement of Science (1993–1994), and was foreign secretary for the U.S. National Academy of Sciences (1994–2002).

In addition to his remarkable and diverse scientific accomplishments, Sherry was a natural and gracious mentor who invariably brought out the best potential in each of his students and colleagues. Considered an icon of the atmospheric sciences, Sherry touched countless lives and personally inspired hundreds of students, technicians, and faculty around the world.

"What's the use of having developed a science well enough to make predictions if, in the end, all we're willing to do is stand around and wait for them to come true?" *The New Yorker*, June 9, 1986.

1. Nuclear winter theory

2. Analogs, to test the theory

3. Policy implications

4. Doing something about it

(You can join the Physicists Coalition for Nuclear Threat Reduction.)

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This presentation is based on the following recent papers:

- Coupe, Joshua, Charles G. Bardeen, Alan Robock, and Owen B. Toon, 2019: Nuclear winter responses to global nuclear war in the Whole Atmosphere Community Climate Model Version 4 and the Goddard Institute for Space Studies ModelE. *J. Geophys. Res. Atmos.*, **124**, 8522-8543, doi:10.1029/2019JD030509.
- Jägermeyr, Jonas, Alan Robock, Joshua Elliott, Christoph Müller, Lili Xia, Nikolay Khabarov, Christian Folberth, Erwin Schmid, Wenfeng Liu, Florian Zabel, Sam S. Rabin, Michael J. Puma, Alison C. Heslin, James Franke, Ian Foster, Senthod Asseng, Charles G. Bardeen, Owen B. Toon, and Cynthia Rosenzweig, 2020: A regional nuclear conflict would compromise global food security. *Proc. Nat. Acad. Sci.*, **117**, 7071-7081, doi:10.1073/pnas.1919049117.
- Lovenduski, Nicole S., Cheryl S. Harrison, Holly Olivarez, Charles G. Bardeen, Owen B. Toon, Joshua Coupe, Alan Robock, Tyler Rohr, and Samantha Stevenson, 2020: The potential impact of nuclear conflict on ocean acidification. *Geophys. Res. Lett.*, **47**, e2019GL086246, doi: 10.1029/2019GL086246.
- Robock, Alan, Owen B. Toon, and Charles G. Bardeen, 2019: Comment on "Climate impact of a regional nuclear weapons exchange: An improved assessment based on detailed source calculations" by Reisner et al. *J. Geophys. Res. Atmos.*, **124**, 12,953-12,958, doi:10.1029/2019JD030777.
- Robock, Alan, Owen B. Toon, Charles G. Bardeen, Lili Xia, Hans Kristensen, Matthew McKinzie, R. J. Peterson, Cheryl Harrison, Nicole S. Lovenduski, and Richard P. Turco, 2019: How an India-Pakistan nuclear war could start-and have global consequences. *Bull. Atomic Scientists*, **75**:6, 273-279, doi:10.1080/00963402.2019.1680049.
- Scherrer, Kim J. N., Cheryl S. Harrison, Ryan Heneghan, Eric Galbraith, Charles G. Bardeen, Jonas Jägermeyr, Nicole S. Lovenduski, August Luna, Alan Robock, Jessica Stevens, Samantha Stevenson, Owen B. Toon, and Lili Xia, 2020: Marine wild-capture fisheries after nuclear war. *Proc. Nat. Acad. Sci.*, in press.
- Toon, Owen B., Charles G. Bardeen, Alan Robock, Lili Xia, Hans Kristensen, Matthew McKinzie, R. J. Peterson, Cheryl Harrison, Nicole S. Lovenduski, and Richard P. Turco, 2019: Rapid expansion of nuclear arsenals by Pakistan and India portends regional and global catastrophe. *Science Advances*, **5**, eaay5478, doi:10.1126/sciadv.aay5478.
- Yu, Pengfei, Owen B. Toon, Charles G. Bardeen, Yunqian Zhu, Karen H. Rosenlof, Robert W. Portmann, Troy D. Thornberry, Ru-Shan Gao, Sean M. Davis, Eric T. Wolf, Joost de Gouw, David A. Peterson, Michael D. Fromm, and Alan Robock, 2019: Black carbon lofts wildfire smoke high into the stratosphere to form a persistent plume. *Science*, **365**, 587-590, doi:10.1126/science.aax1748.





Illustration by Jon Lomborg

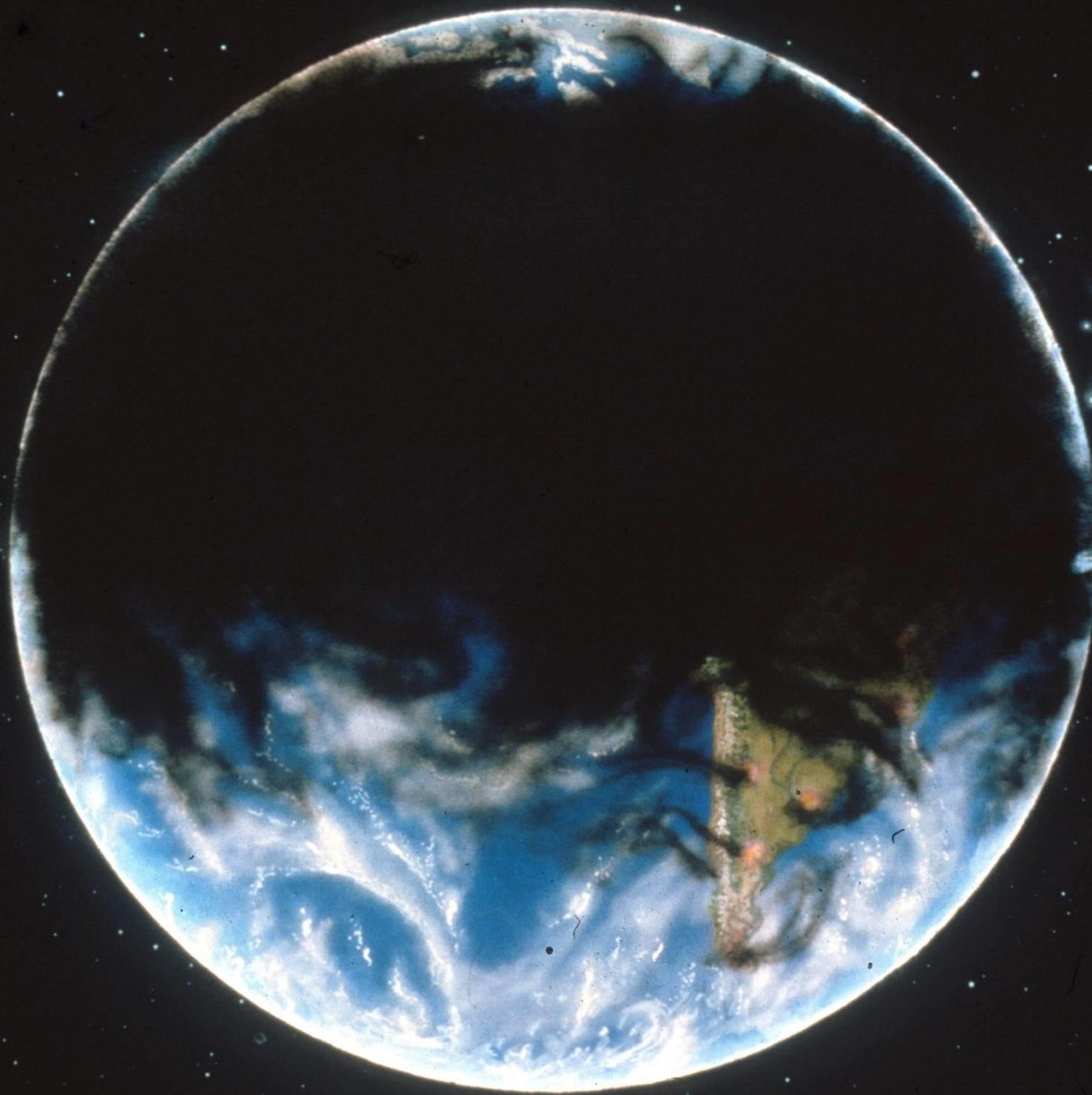


Illustration by Jon Lomborg

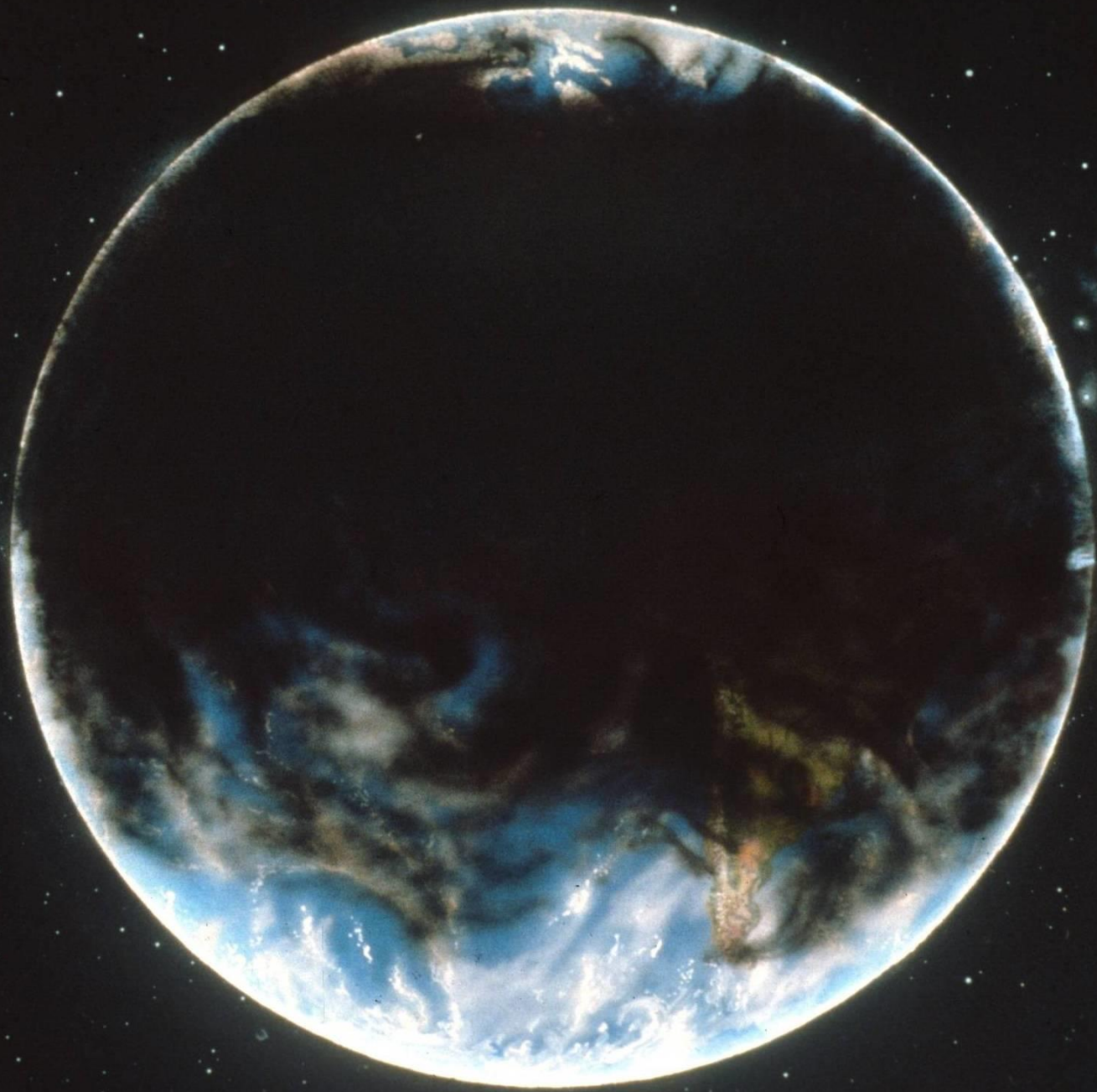


Illustration by Jon Lomberg



Nuclear Winter

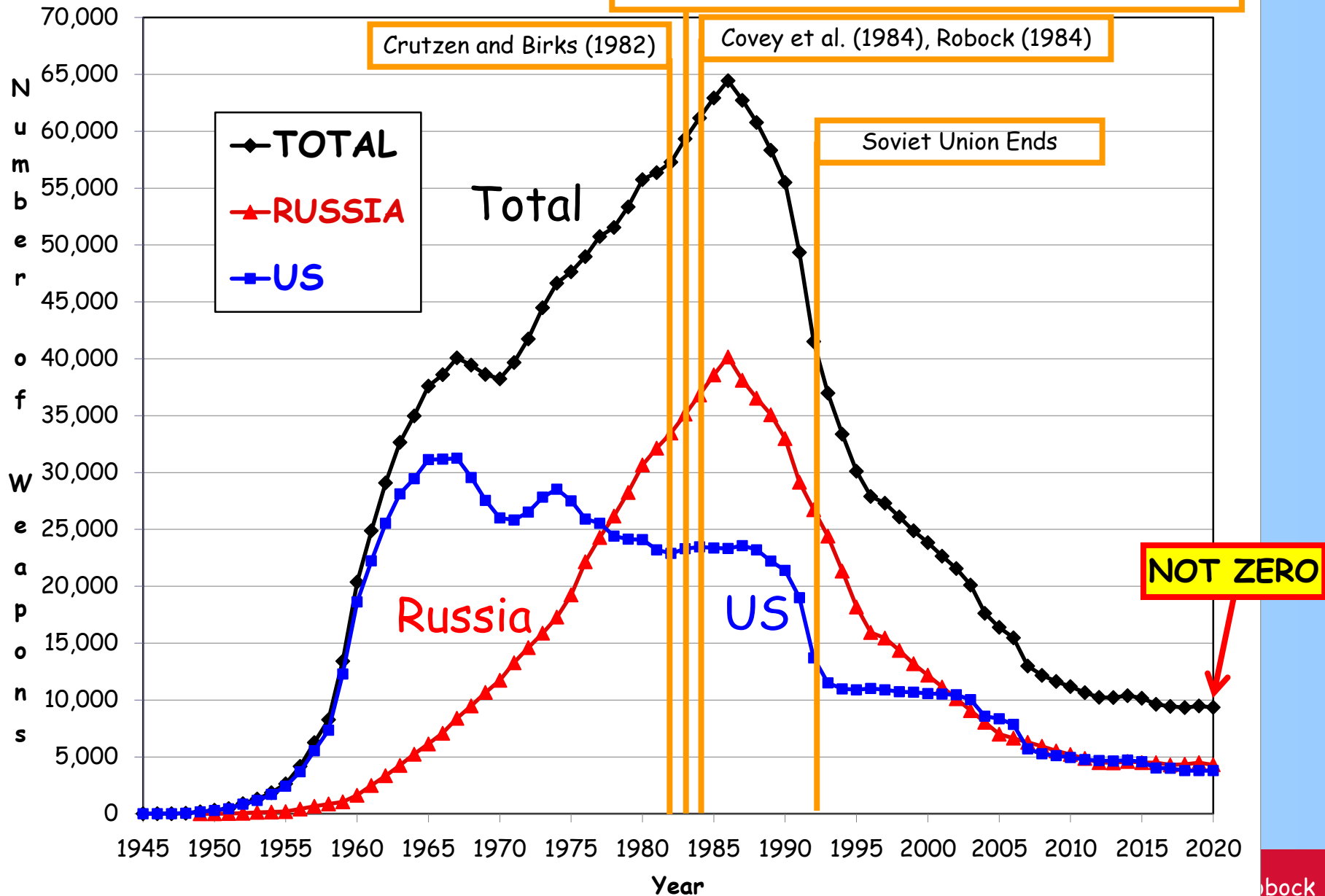
Cold, Dry, Dark, and More UV
Crops Dying and Global Famine

History of Deployed Nuclear Warheads

Aleksandrov and Stenchikov (1983), Turco et al. (1983)

Crutzen and Birks (1982)

Covey et al. (1984), Robock (1984)



Ronald Reagan:

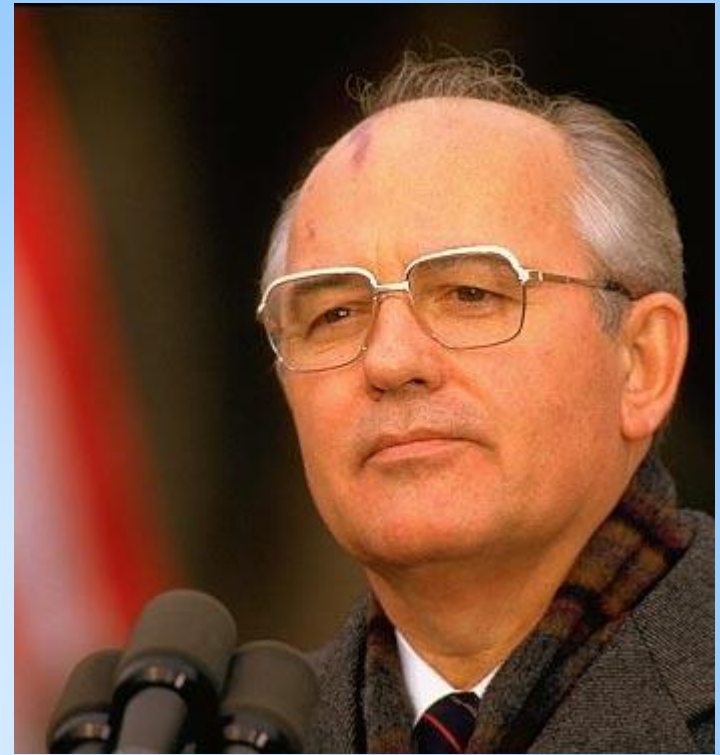
When asked about the effects of nuclear war in a February 12, 1985 interview in the *New York Times* said,



"A great many reputable scientists are telling us that such a war could just end up in no victory for anyone because we would wipe out the earth as we know it. And if you think back to ... natural calamities - back in the last century, in the 1800's, ... volcanoes - we saw the weather so changed that there was snow in July in many temperate countries. And they called it the year in which there was no summer. Now if one volcano can do that, what are we talking about with the whole nuclear exchange, the nuclear winter that scientists have been talking about? It's possible ..."

Mikhail Gorbachev:

"Mikhail Gorbachev explains
what's rotten in Russia"
by Mark Hertsgaard
Salon.com, Sept. 7, 2000



"Models made by Russian and American scientists showed that a nuclear war would result in a nuclear winter that would be extremely destructive to all life on Earth; the knowledge of that was a great stimulus to us, to people of honor and morality, to act in that situation."

Thirty-eight years after the threat of nuclear winter was discovered, we now ask:

1. Although the Cold War and its associated nuclear arms race are over, could remaining nuclear arsenals still produce nuclear winter?
2. What would be the consequences of the use of a much smaller number of nuclear weapons in a regional nuclear conflict?

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1. Although the Cold War and its associated nuclear arms race are over, could remaining nuclear arsenals still produce nuclear winter? **YES, AND IT WOULD LAST LONGER THAN WE THOUGHT BEFORE.**
2. What would be the consequences of the use of a much smaller number of nuclear weapons in a regional nuclear conflict? **NOT NUCLEAR WINTER, BUT MILLIONS DEAD FROM BLAST, RADIOACTIVITY AND FIRES, AND SEVERE IMPACTS ON GLOBAL AGRICULTURE AND FOOD AVAILABILITY FOR A DECADE.**

UPSHOT-KNOTHOLE

Nevada Proving Ground - Complete destruction of House No. 1 located 3,500 feet from ground zero, by the March 17, 1953 atom blast at Yucca Flat. The time from the first to last picture was 2 1/3 seconds. The camera was completely enclosed in a 2-inch lead sheath as a protection against radiation. The only source of light was that from the bomb.



Photos courtesy of National Nuclear
Security Administration / Nevada Site
Office.

<http://www.nv.doe.gov/library/photos/>



Photo courtesy of National Nuclear Security Administration / Nevada Site Office.



Photo courtesy of National Nuclear Security Administration / Nevada Site Office.



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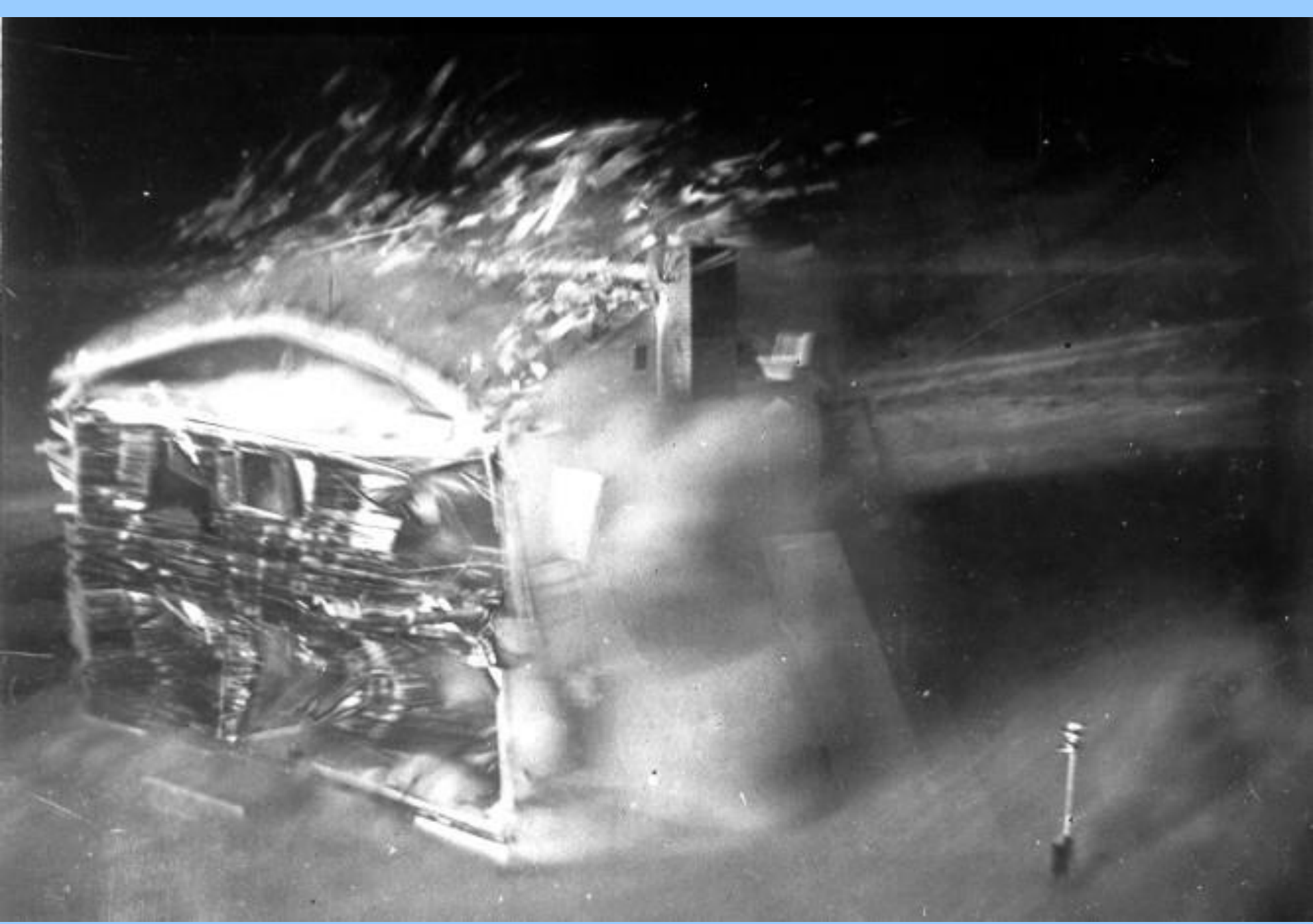


Photo courtesy of National Nuclear Security Administration / Nevada Site Office.

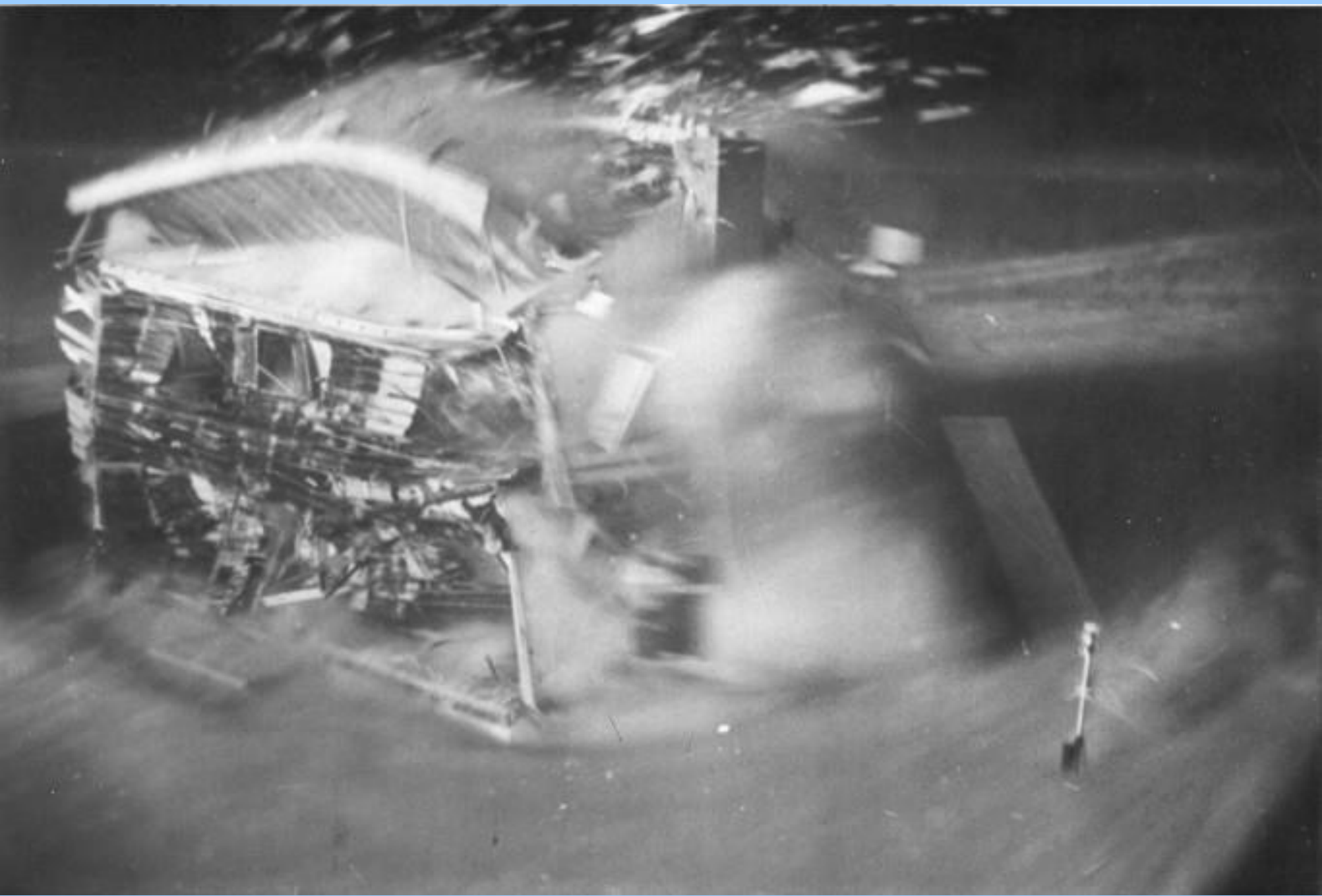


Photo courtesy of National Nuclear Security Administration / Nevada Site Office.



Photo courtesy of National Nuclear Security Administration / Nevada Site Office.



Photo courtesy of National Nuclear Security Administration / Nevada Site Office.

Scenes from the 1992 Gulf War



Hiroshima

August 6, 1945

A 15 kT bomb killed 150,000 people

Note: 15 kT = 0.015 MT = 1/1,000,000 of the 1985 world arsenal
= 3/1,000,000 of the current world arsenal

While current weapons are mostly more powerful than the initial one, if one Hiroshima-sized bomb were dropped every *two hours* from the end of World War II to today, it would still not use up the current arsenal.











The Urakami hypocenter area seen from the air
Looking from north to south.
The entire district was reduced to a burned wasteland.
The area slightly to the left of center is the hypocenter.

THE STORY OF AN EYEWITNESS

By Jack London

Collier's, the
National Weekly

May 5, 1906



Within an hour after the earthquake shock the smoke of San Francisco's burning was a lurid tower visible a hundred miles away. And for three days and nights this lurid tower swayed in the sky, reddening the sun, darkening the day, and filling the land with smoke.

... I watched the vast conflagration from out on the bay. It was dead calm. Not a flicker of wind stirred. Yet from every side wind was pouring in upon the doomed city. East, west, north, and south, strong winds were blowing upon the doomed city. The heated air rising made an enormous suck. Thus did the fire of itself build its own colossal chimney through the atmosphere. Day and night this dead calm continued, and yet, near the flames, the wind was often half a gale, so mighty was the suck.



This photograph, taken from a series of kites five weeks after the great earthquake of April 18, 1906, shows the devastation brought on the city of San Francisco by the quake and subsequent fire. (photo courtesy of Harry Myers)

AMBIO

A JOURNAL OF THE HUMAN ENVIRONMENT



Nuclear War: The Aftermath

Paul Crutzen
and **John Birks**
discussed the effects of
a nuclear holocaust on
ozone.

They were the first to
point out that there would
be massive fires, and that
the smoke from these
fires could change
climate.

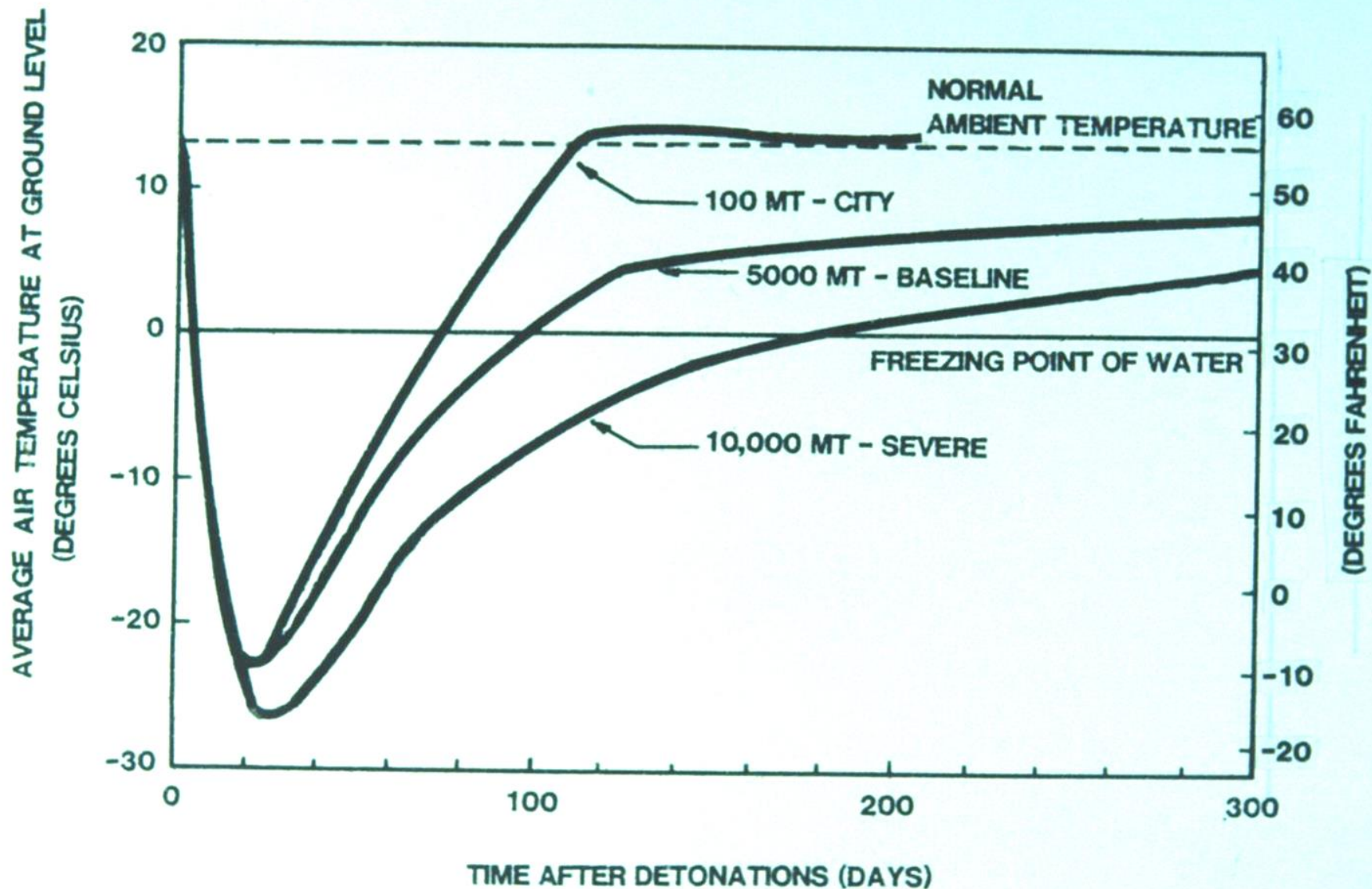
TTAPS

Richard **T**urco, Brian **T**oon, Tom **A**ckerman, Jim **P**ollack, and Carl **S**agan, 1983: Nuclear winter: Global consequences of multiple nuclear explosions, *Science*, **222**, 1283-1292.

The famous **TTAPS** paper - one of the two first climate model simulations of nuclear winter.

Gave **Nuclear Winter** its name.

Used a single column radiative-convective climate model which represented the entire Northern Hemisphere by one column and calculate the vertical distribution of temperature change for annual average radiation out to 300 days.

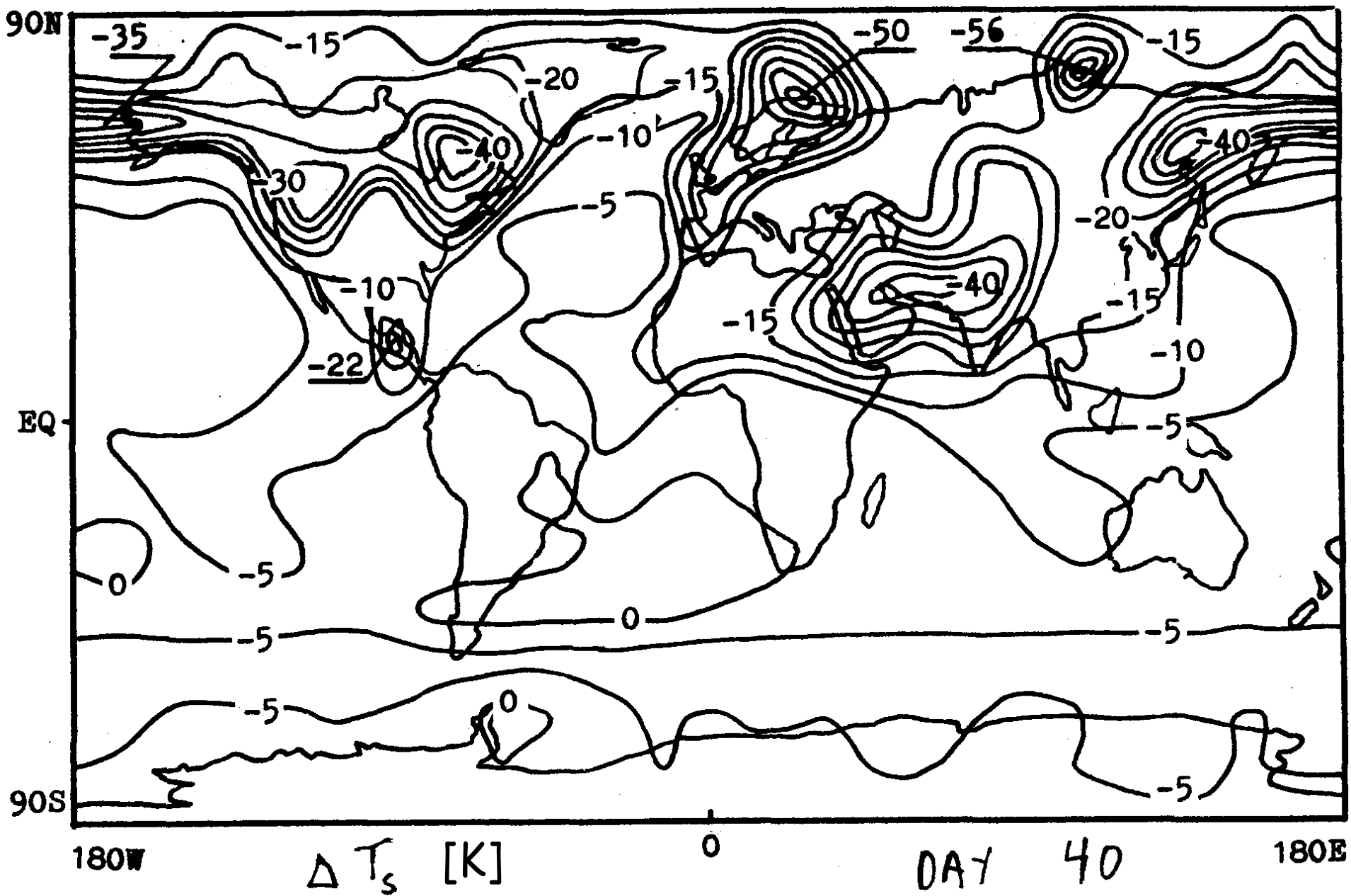


Vladimir V. **Aleksandrov** and Georgiy L. **Stenchikov**, 1983:
On the modelling of the climatic consequences of the
nuclear war. *Proc. Applied Math.*, Computing Centre,
USSR Academy of Sciences, Moscow, 21 pp.

First published model simulation of nuclear winter.

First three-dimensional simulation using a general
circulation model (GCM) - simulated 400 days with
annual average radiation.

Used two-level Mintz-Arakawa GCM, with $12^{\circ} \times 15^{\circ}$ lat-lon
grid.



Curt Covey, Steve Schneider,
and Starley Thompson, 1984:
Global atmospheric effects
of massive smoke injections
from nuclear war: Results
from general circulation
model simulations. *Nature*,
308, 21-25.

Used NCAR GCM to simulate the
temperature effects for 20
days for winter, spring, and
summer conditions.

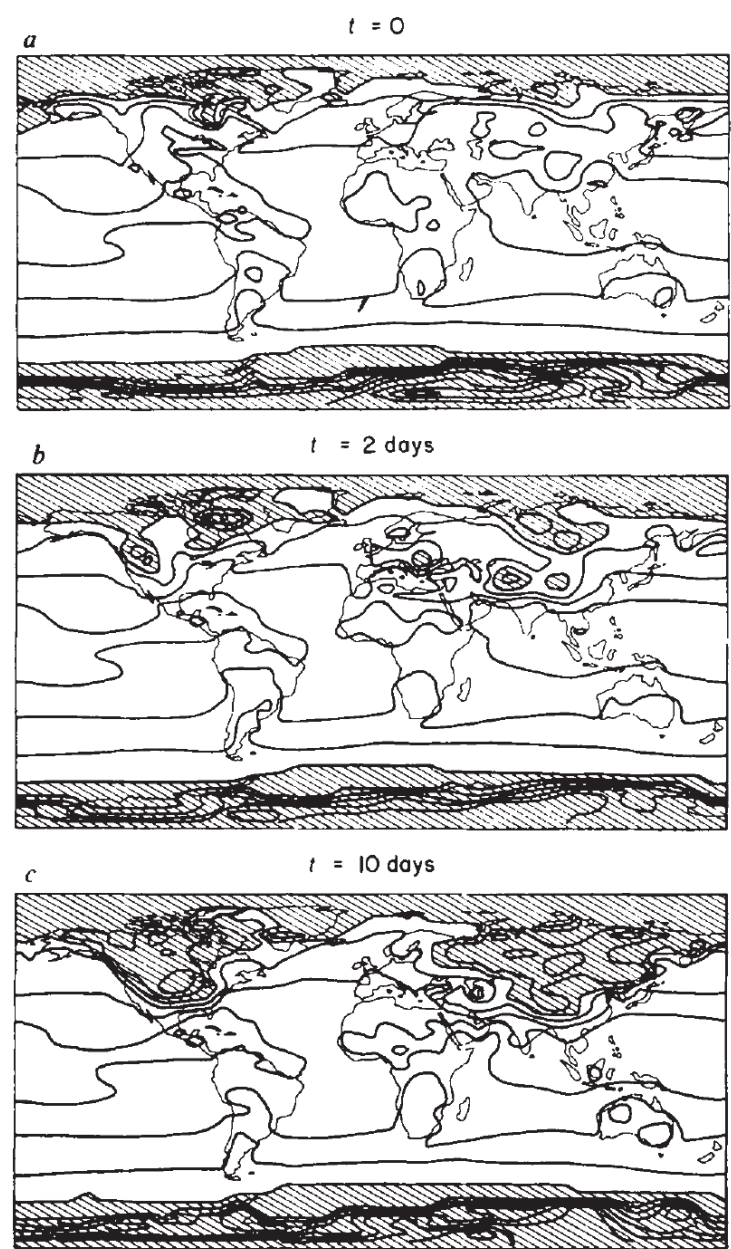


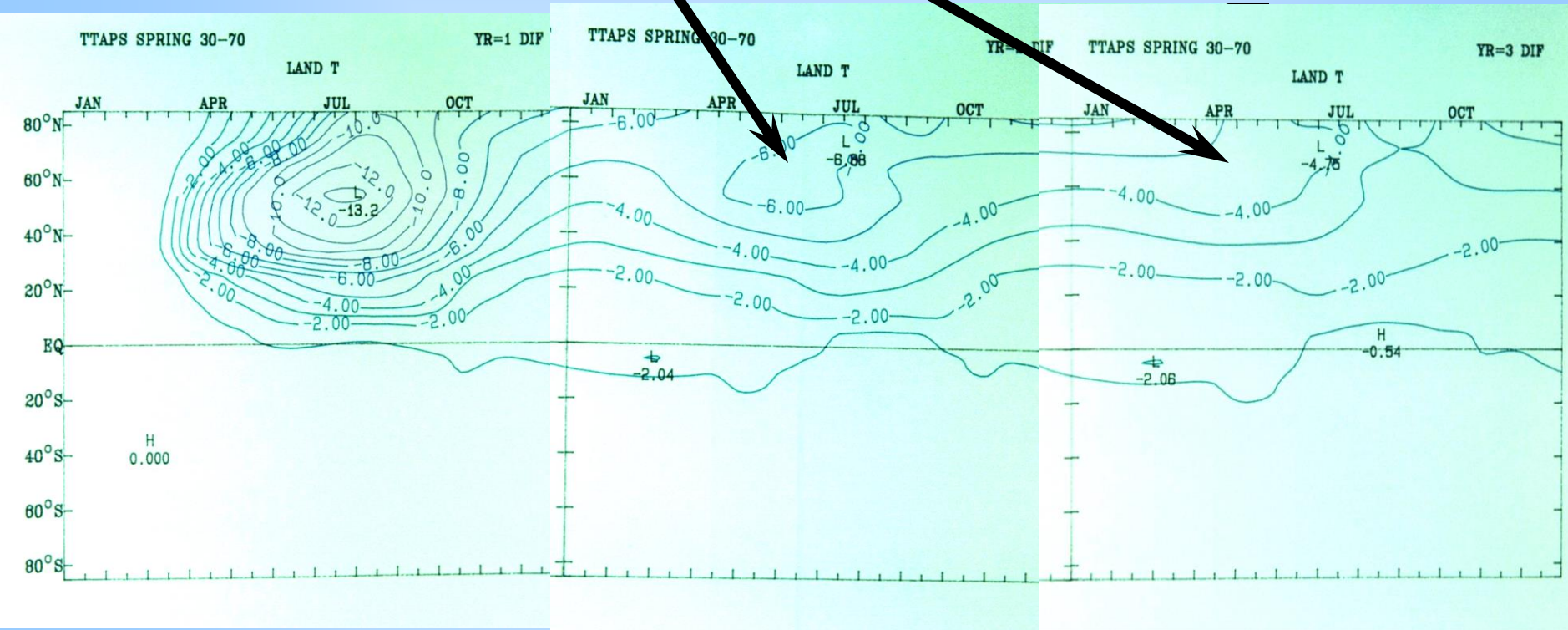
Fig. 3 Surface temperature (T) at three selected instants of time: $t=0$ is the time at which smoke was added to the atmosphere in the summer case. Temperature contours are drawn for every 10 K. Areas with $T < 270$ K (that is, well below freezing) are shaded. The warmest contour value in the tropics is 300 K.

Robock, Alan, 1984: Snow and ice feedbacks prolong effects of nuclear winter. *Nature*, **310**, 667-670.

Used an energy balance climate model and showed that snow and ice feedbacks prolong the surface temperature effects for several years.

Did simulations for nuclear holocaust starting in all four seasons.

Snow-albedo feedback






Rich Turco Brian Toon Tom Ackerman Alan Robock Gera Stenchikov
 Fall American Geophysical Union Meeting, December 2019


THEY EXIST

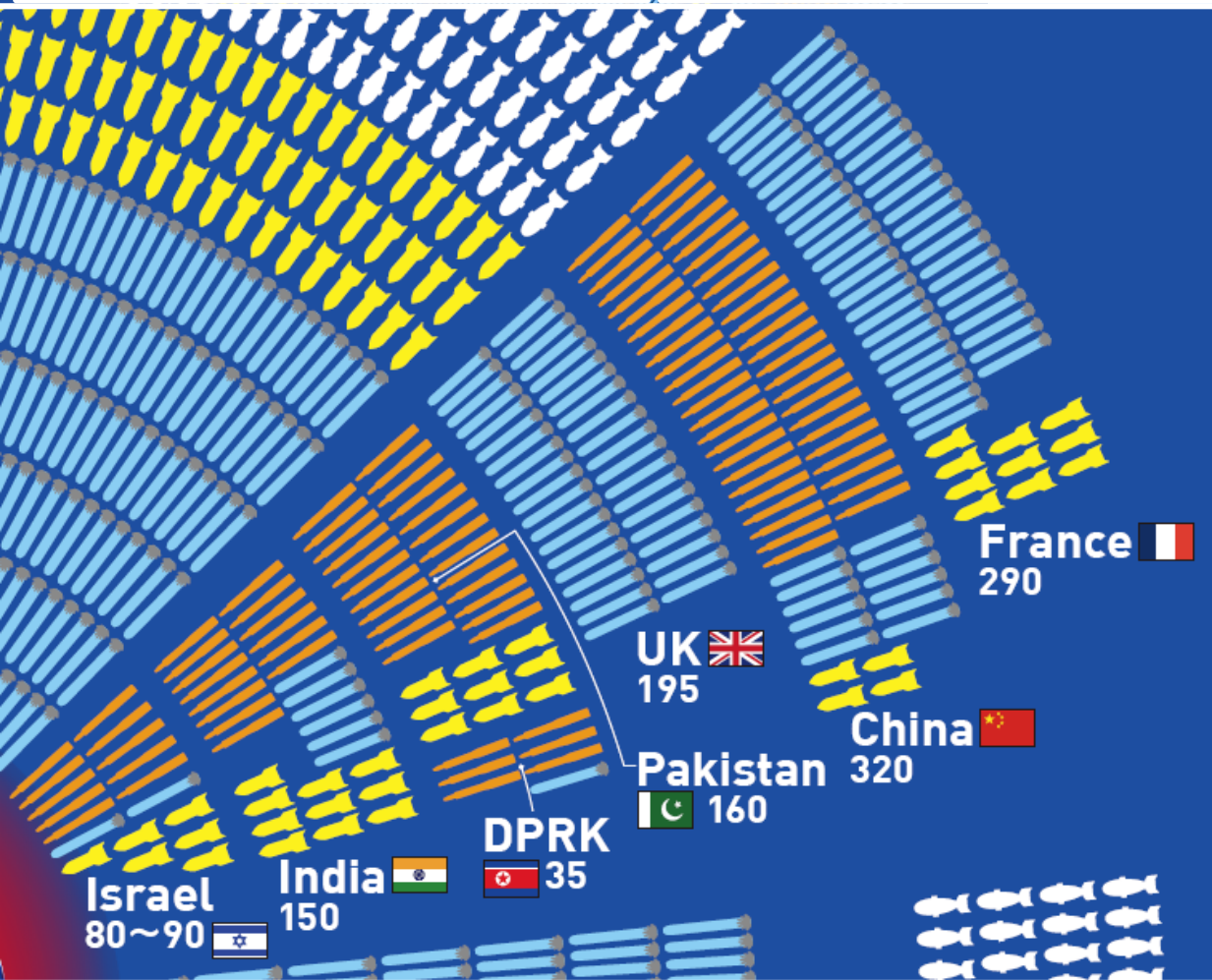
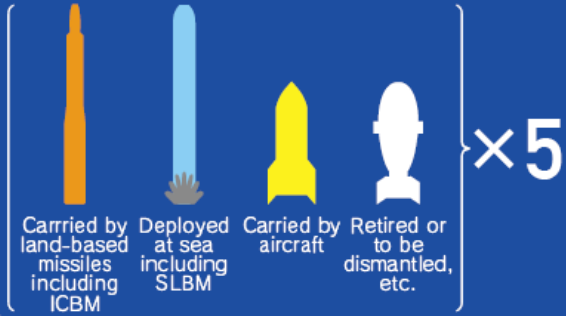
The World's Nuclear Warheads Count June 2020

Russia 6,370

Carried by land-based
missiles including ICBM1,606 
Deployed at sea
including SLBM1,620
Carried by aircraft1,080
Retired or to be dismantled, etc.2,060

US 5,800

Carried by land-based
missiles including ICBM800 
Deployed at sea
including SLBM1,920
Carried by aircraft1,080
Retired or to be dismantled, etc.2,385



France 290

Deployed at sea
including SLBM240
Carried by aircraft50

China 320

Carried by land-based
missiles including ICBM240
Deployed at sea
including SLBM60
Carried by aircraft20

UK 195

Deployed at sea
including SLBM195

Israel 80~90

Carried by land-based
missiles including ICBM50
Deployed at sea
including SLBM10
Carried by aircraft30

Pakistan 160

Carried by land-based
missiles including ICBM118
Carried by aircraft42

India 150

Carried by land-based
missiles including ICBM70
Deployed at sea
including SLBM30
Carried by aircraft48

DPRK 35

Carried by land-based
missiles including ICBM?
Deployed at sea
including SLBM?

Department

oblock
ences





What if India and Pakistan had a nuclear war?

Imagine a skirmish in Kashmir escalating, due to poor communication, misunderstanding, panic, and fear.

What would be the consequences of a regional nuclear war using 100 15-kT (Hiroshima-size) weapons?

This would be only 0.03% of the current world arsenal.

Scenario: Weapons dropped on the 50 targets in each country that would produce the maximum smoke.

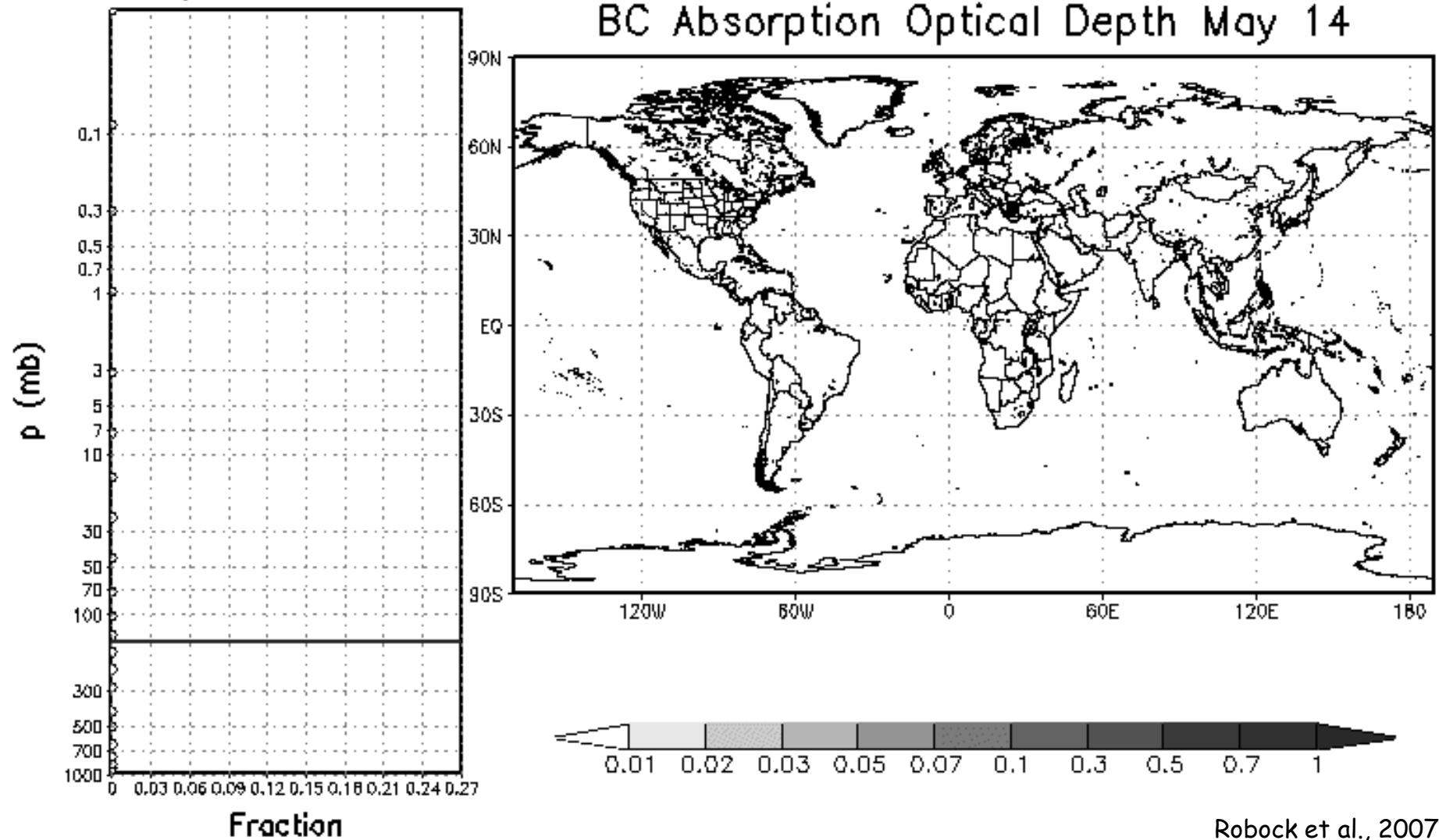
20,000,000 people would die from direct effects, half of the total fatalities from all of World War II.

Portions of megacities attacked with nuclear devices or exposed to fallout of long-lived isotopes would likely be abandoned indefinitely.

5 million tons of smoke injected into the upper atmosphere, accounting for fuel loading, emission factors and rainout.

BC per model level

BC Absorption Optical Depth May 14



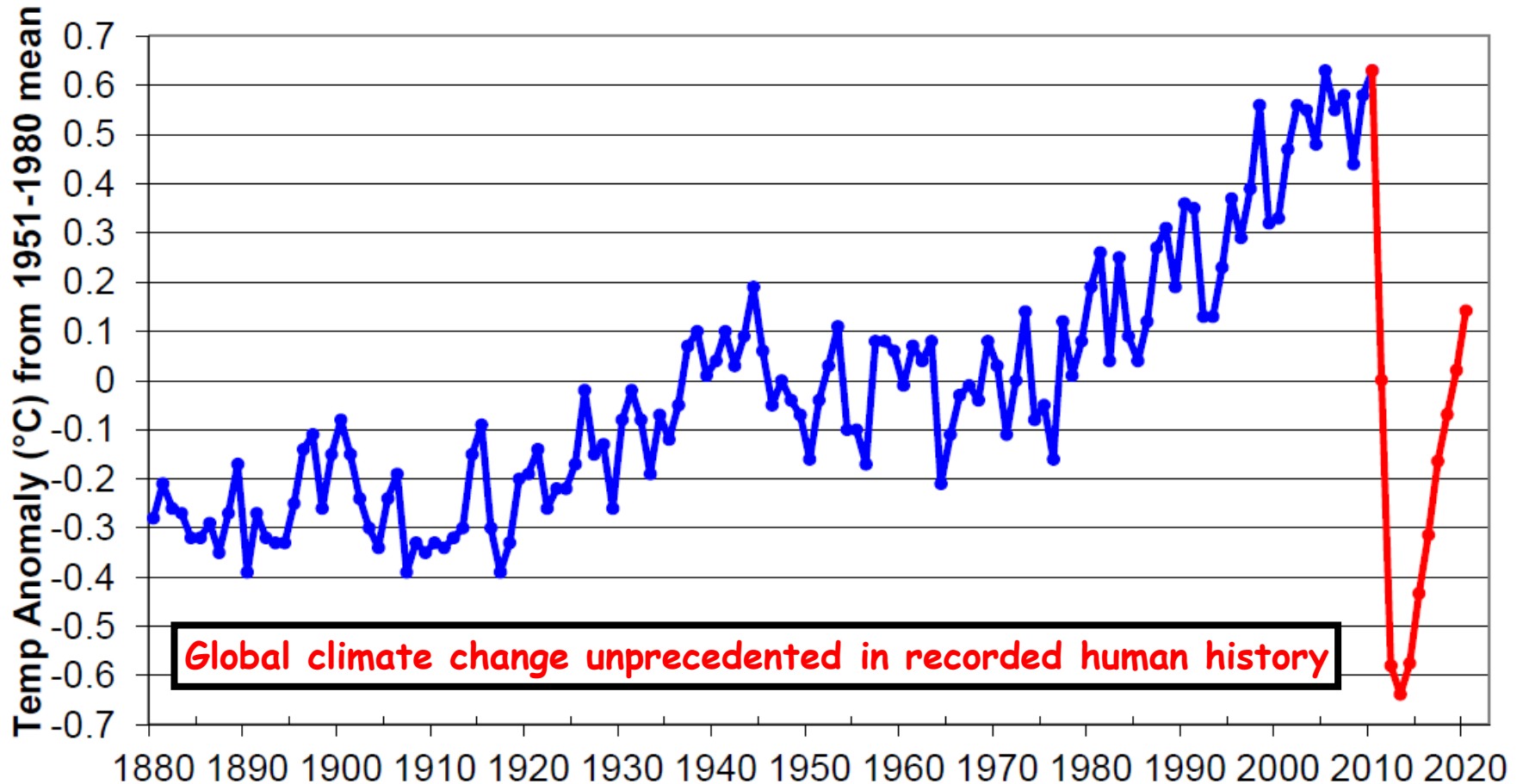
Robock et al., 2007a

Daily smoke loading from one ensemble member.

Absorption optical depth of 0.1 means that 90% of radiation reaches the surface.

GISS Global Average Temperature Anomaly

+ 5 Tg smoke in 2011



Robock et al., 2007a

Two other climate models have now simulated the impacts of 5 million tons of smoke injected into the upper atmosphere from fires from nuclear attacks.

Stenke, Andrea, et al., 2013: Climate and chemistry effects of a regional scale nuclear conflict, *Atmos. Chem. Phys.*, **13**, 9713-9729, doi:10.5194/acp-13-9713-2013.

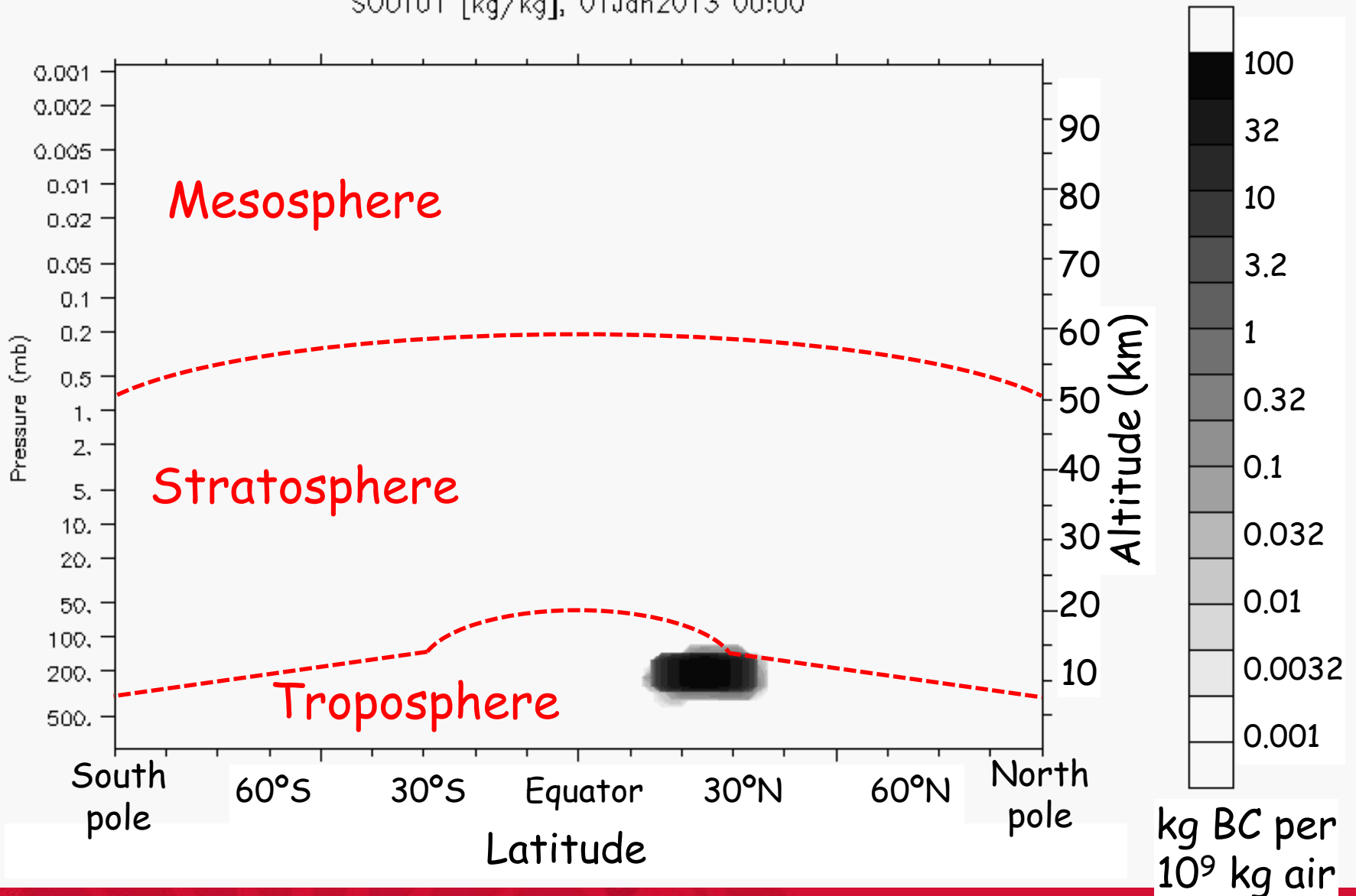
Mills, Michael J., Owen B. Toon, Julia Lee-Taylor, and Alan Robock, 2014: Multi-decadal global cooling and unprecedented ozone loss following a regional nuclear conflict. *Earth's Future*, **2**, 161-176, doi:10.1002/2013EF000205.

All three find global cooling for more than a decade, unprecedented in recorded human history.

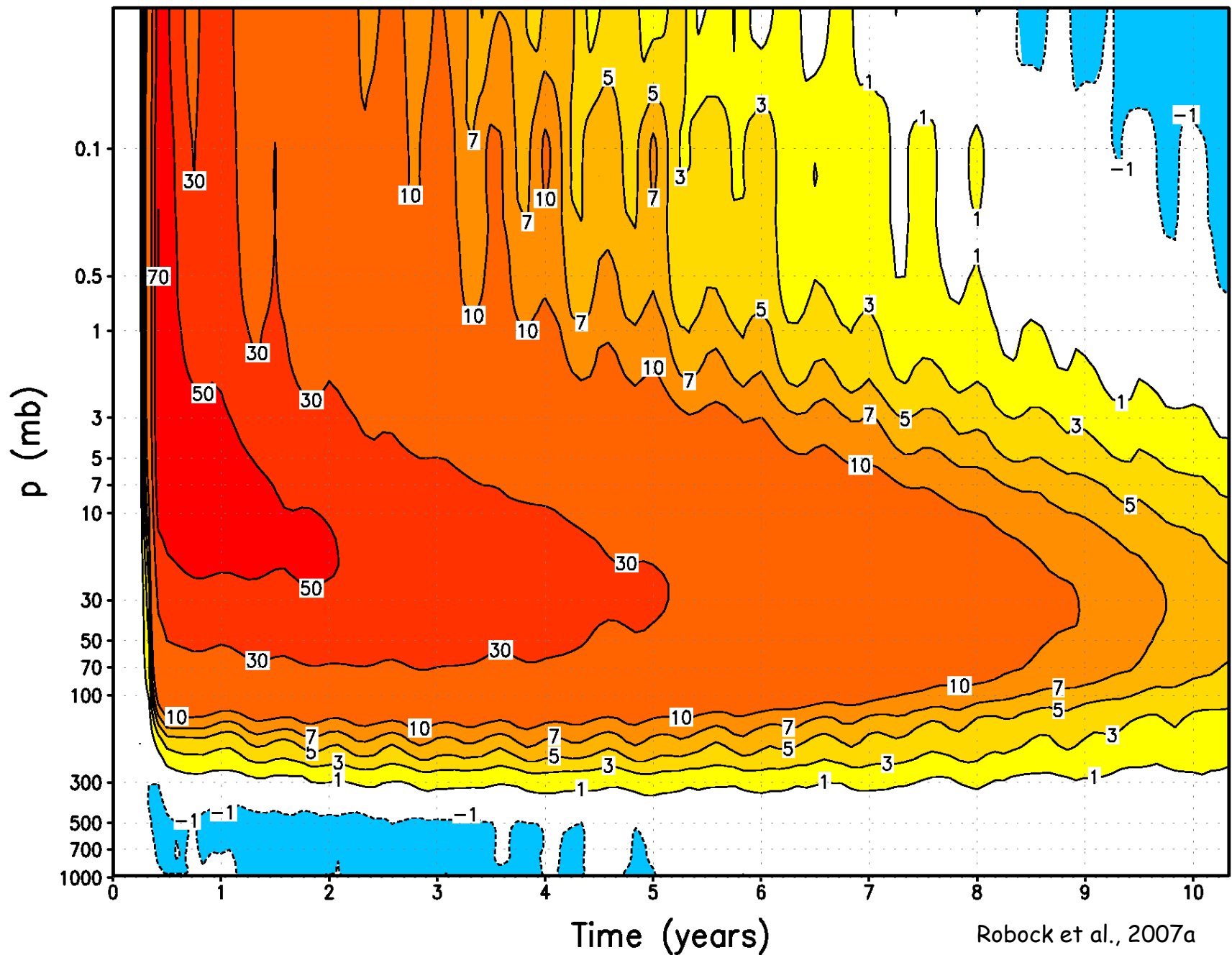
(This is from "only" 100 15-kt bombs, much less than 1% of the global nuclear arsenal.)

Black carbon mass mixing ratio

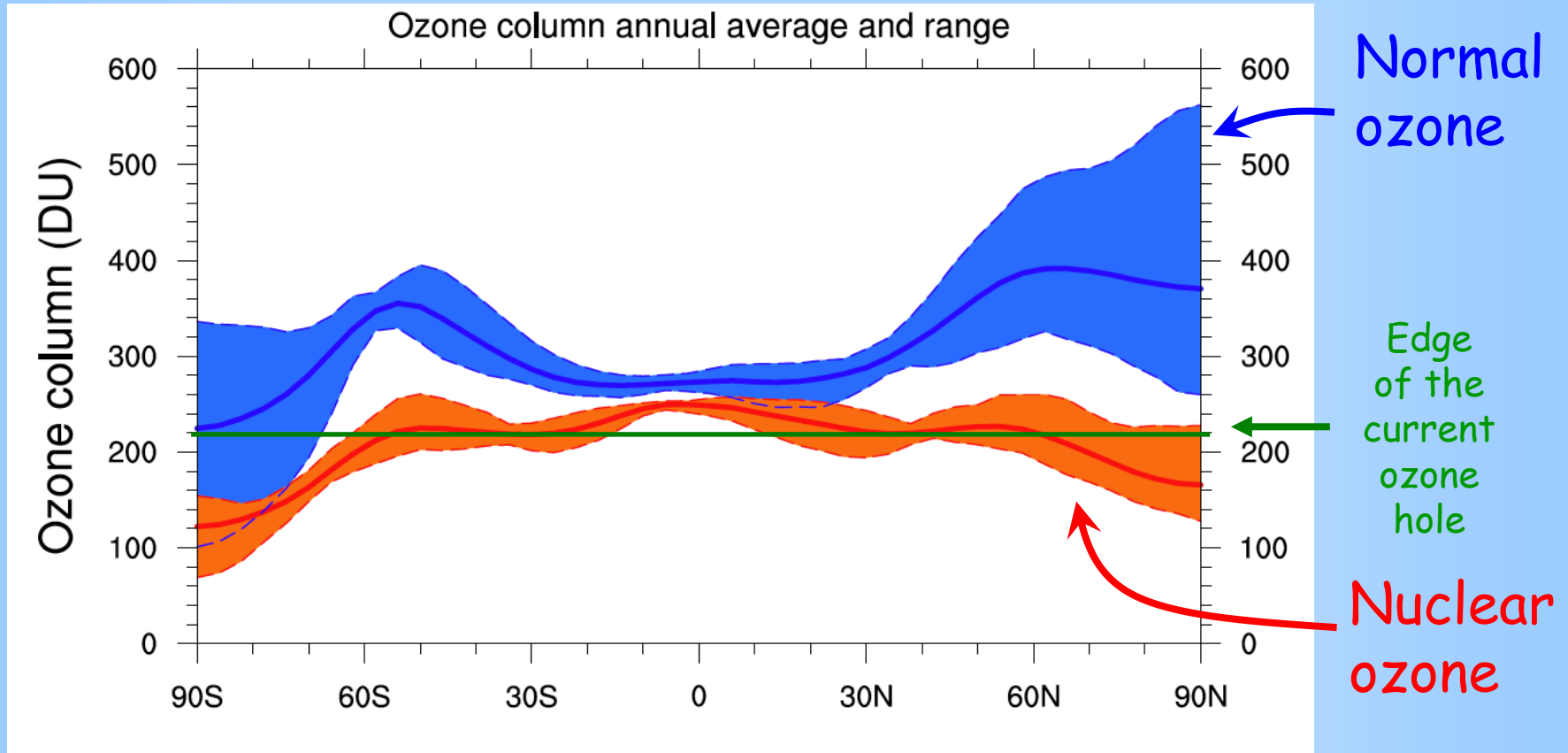
SOOT01 [kg/kg], 01Jan2013 00:00



Change in Global Temperature ($^{\circ}\text{C}$) Profile



Ozone depletion 3 years after soot injection



Mills, Michael J., Owen B. Toon, Richard P. Turco, Douglas E. Kinnison, and Rolando R. Garcia, 2008: Massive global ozone loss predicted following regional nuclear conflict, *Proc. Nat. Acad. Sci.*, **105**, 5307-5312.

Consequences of severe ozone loss and enhanced UV

Human health

A fair-skinned North American would receive a painful, noticeable sunburn after 6 minutes in the sun at noon in June.

Increased skin cancer rates

Land crops and ecosystems

Plant height, shoot mass, and foliage area would be reduced.

Beneficial soil bacteria would be disrupted.

Genetic damage would accumulate over generations.

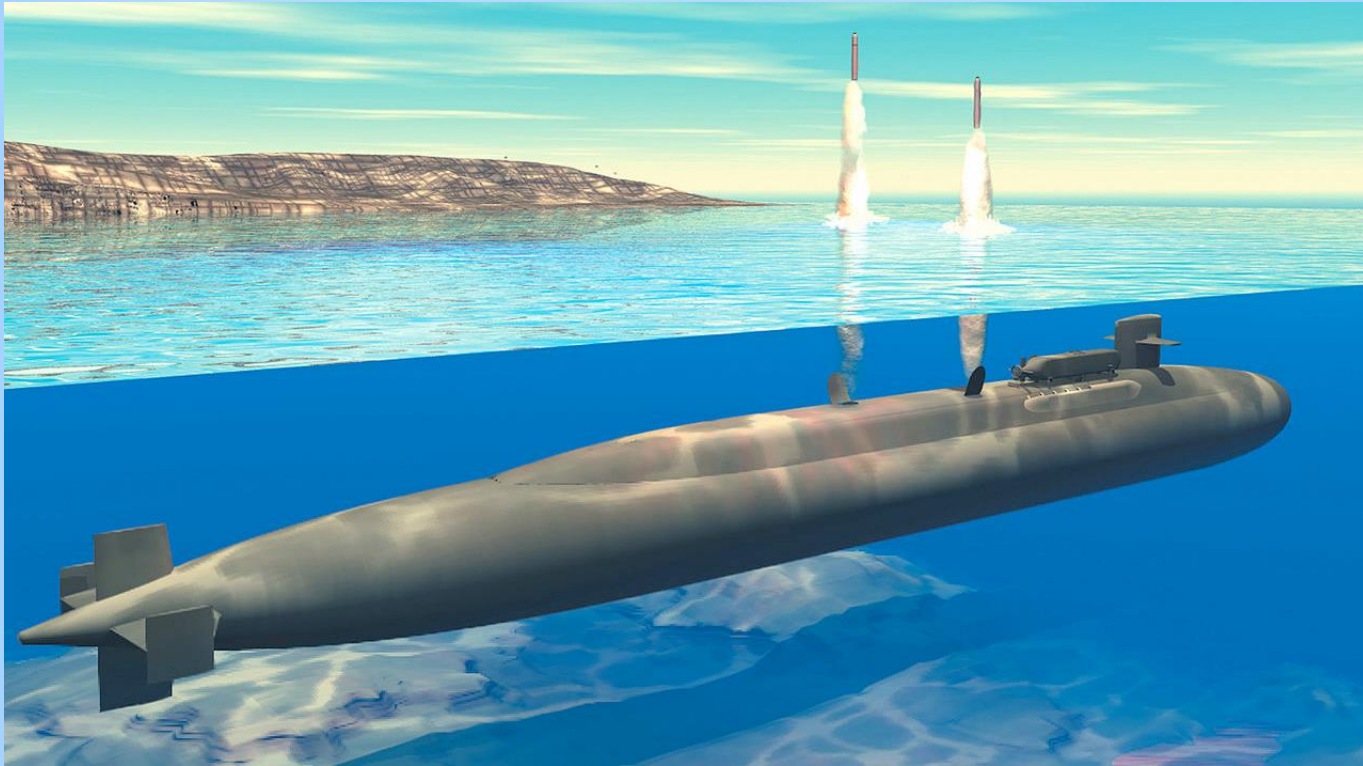
Plants would be more susceptible to attack by insects and pathogens.

Fisheries and ocean ecosystems

Phytoplankton activity in the upper layer of the ocean would be inhibited.

Decreased reproductive capacity and impaired larval development of marine animals

One U.S. Trident submarine has 96 nuclear weapons, each 100 or 475 kt, making each Trident more powerful than 1000 Hiroshimas.



The U.S. has 14 Tridents, and that is less than half the U.S. nuclear arsenal.

What would be the consequences of a full-scale nuclear war between the US and Russia?

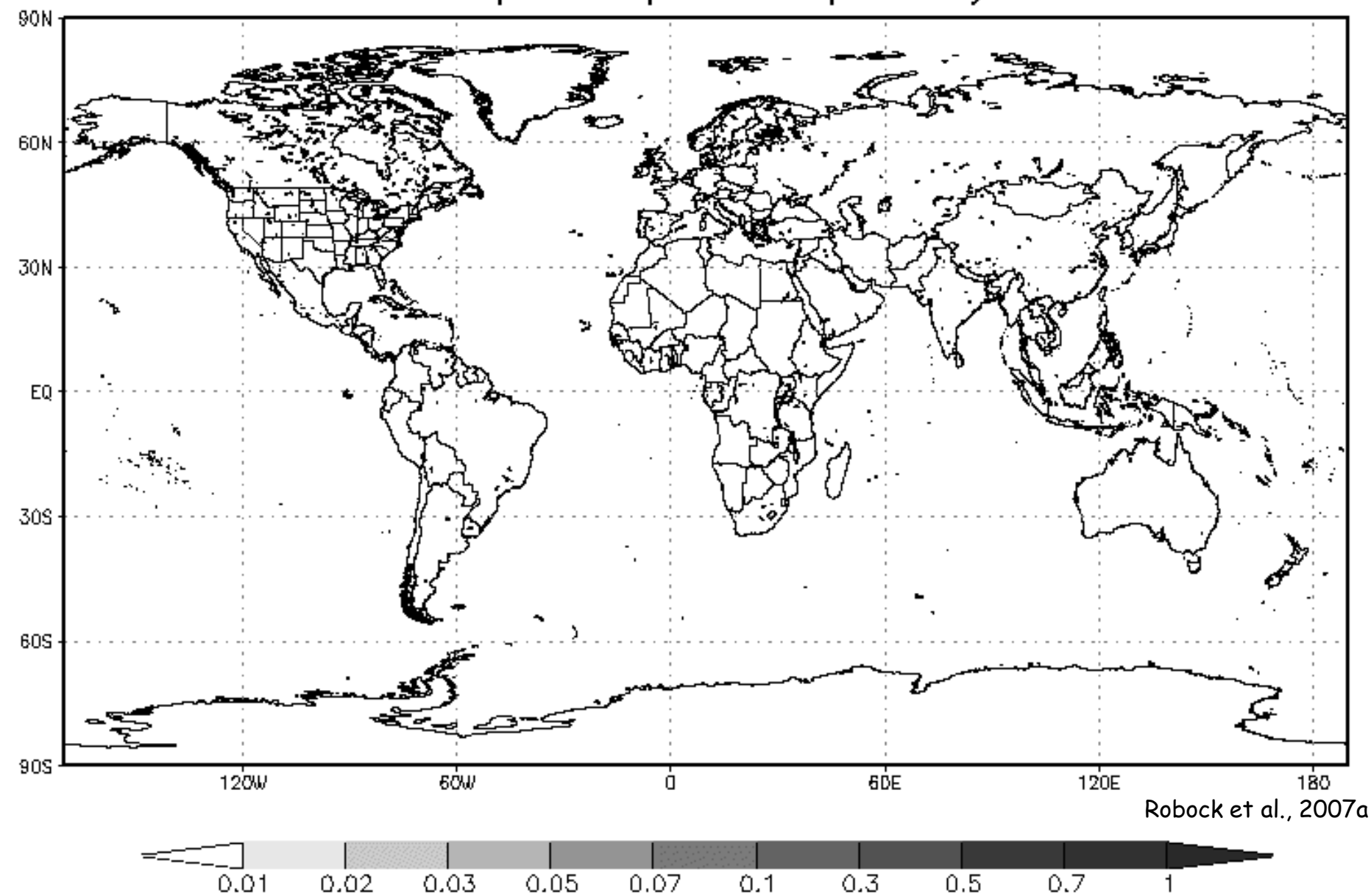
We use the NASA GISS ModelE atmosphere-ocean general circulation model.

- 50 Tg or 150 Tg of smoke into the 300-150 mb layer (upper troposphere) over the US and Russia on May 15
- 30-yr control run, two 10-yr runs (50 Tg or 150 Tg)

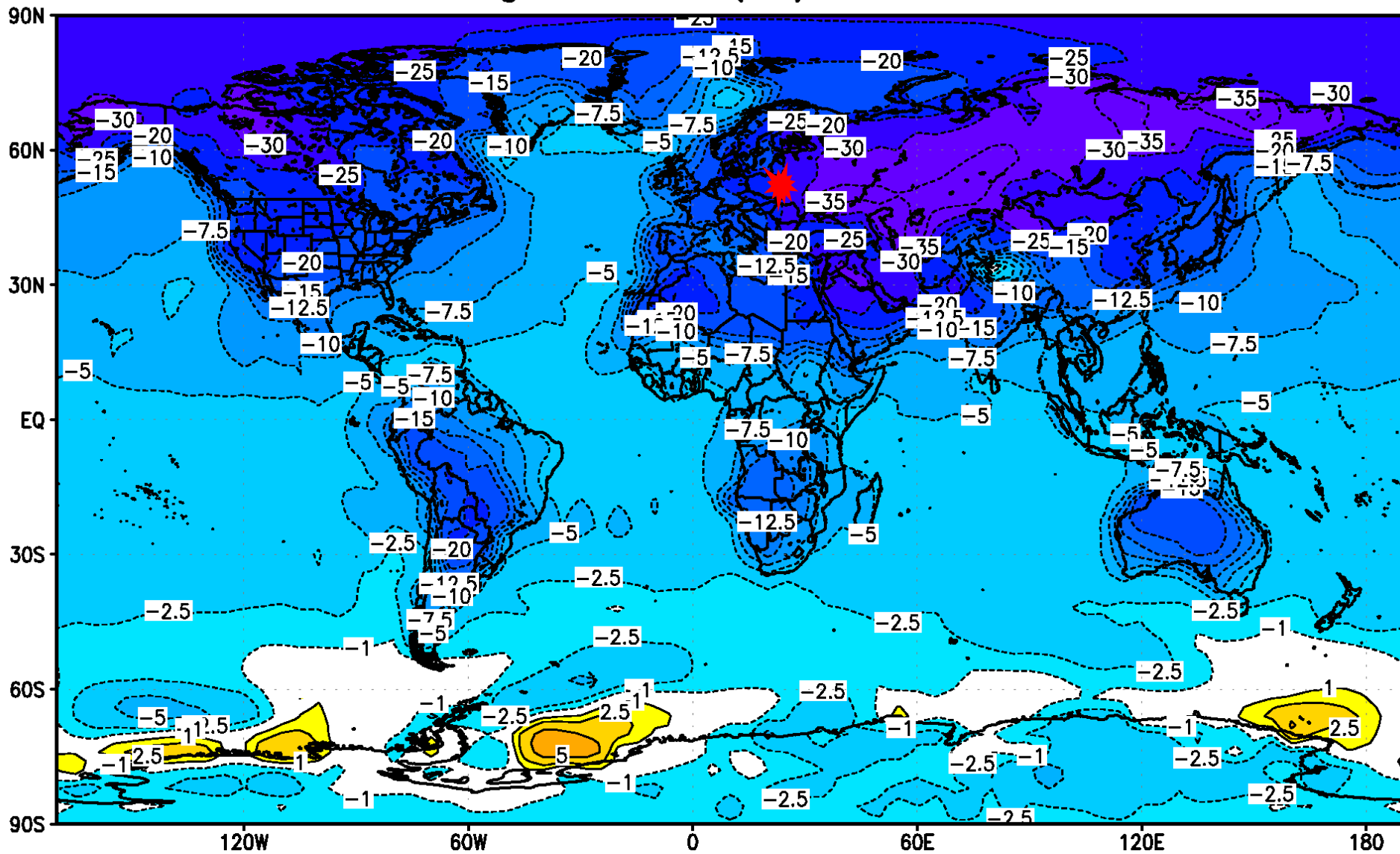
What could produce 150 Tg of smoke?

- standard nuclear winter scenario of 30 years ago
- entire current arsenal if targeted the same way
- only 4000 weapons (2017 global arsenals of New START treaty)

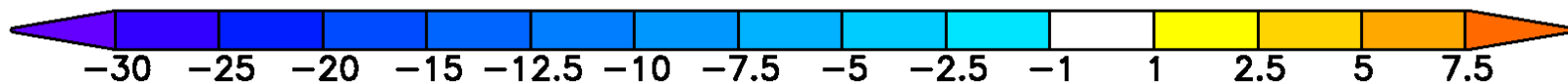
BC Absorption Optical Depth May 14th



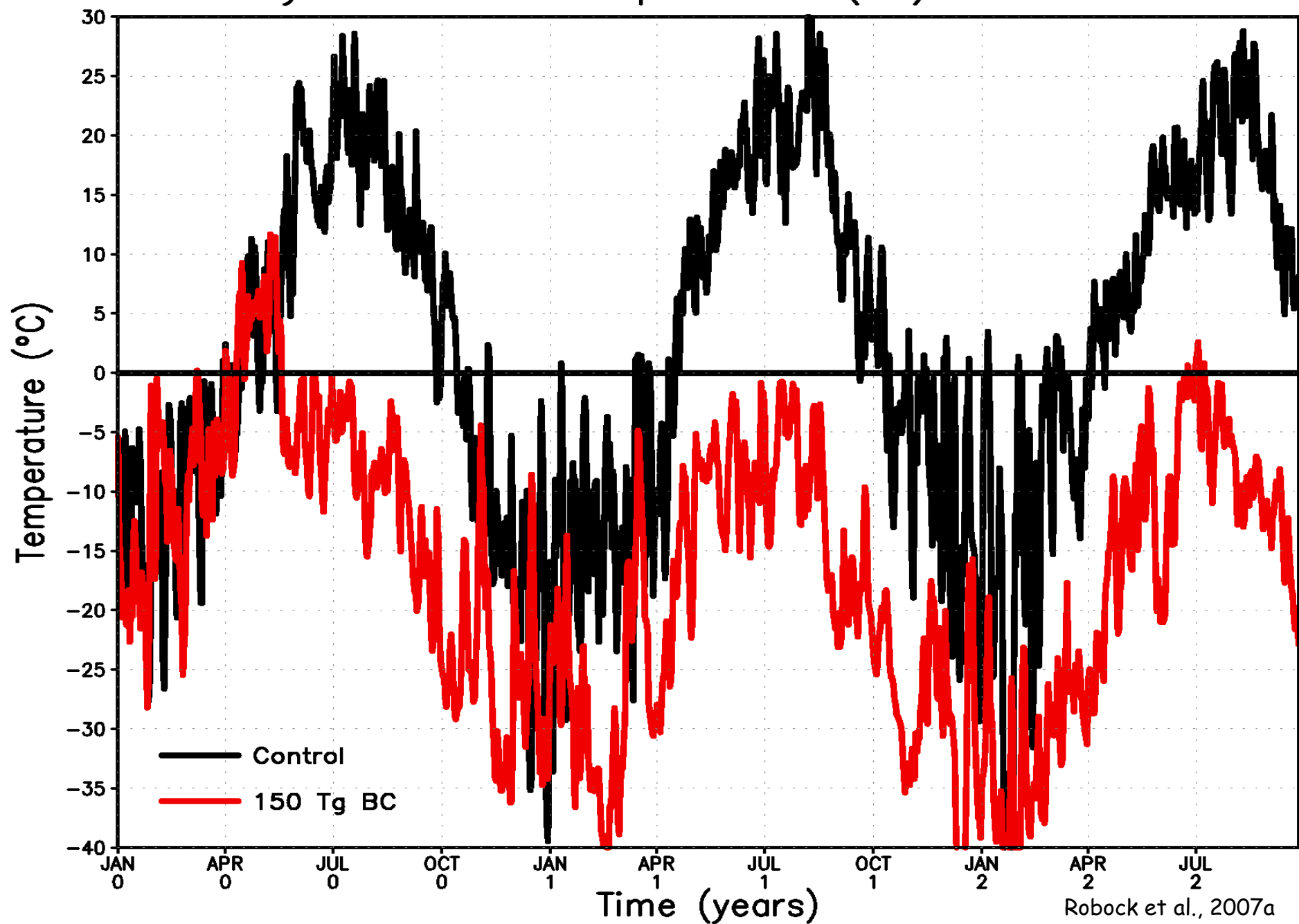
Change in SAT ($^{\circ}\text{C}$) JJA Year 1



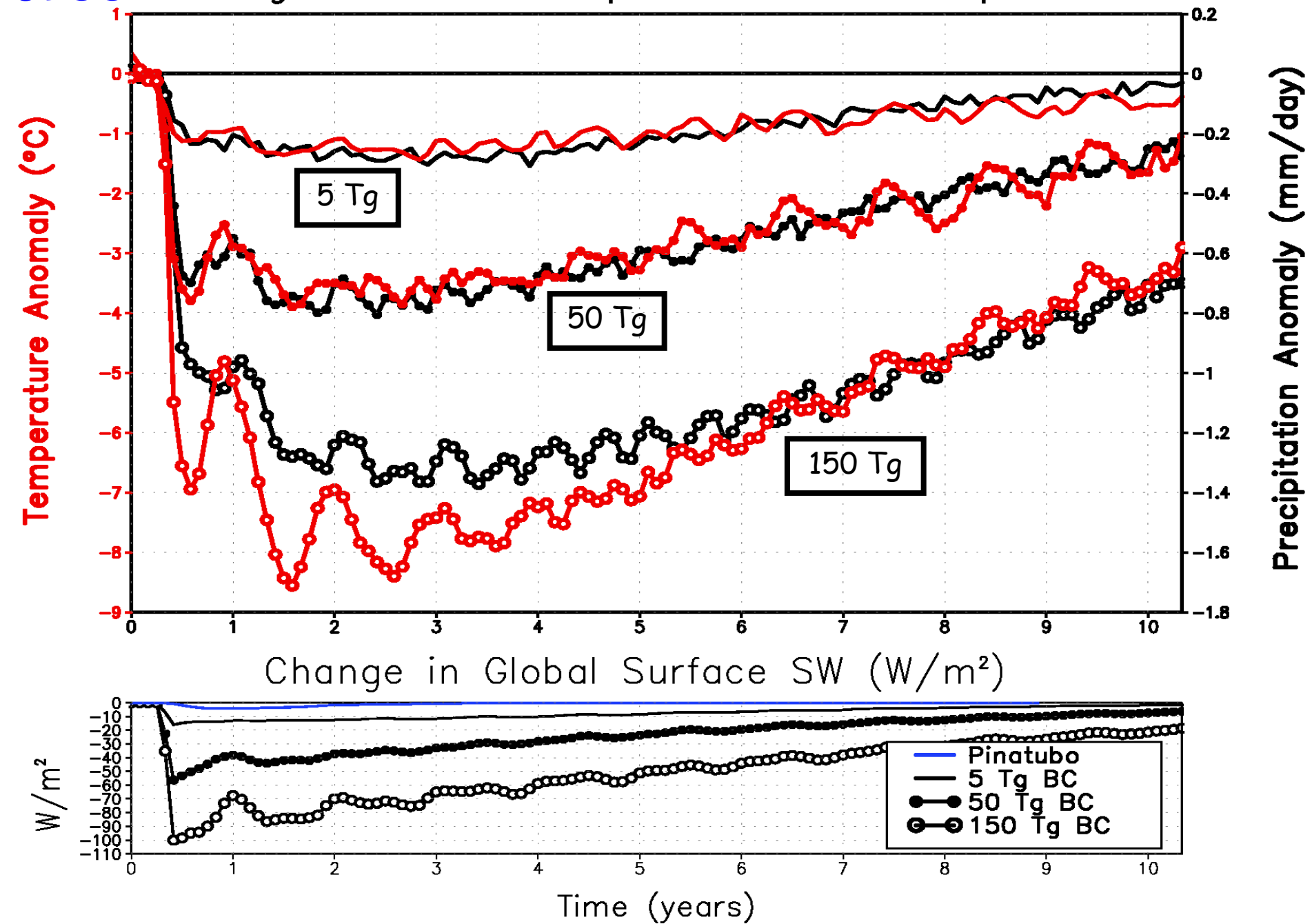
Robock et al., 2007a



Daily Minimum Temperature ($^{\circ}\text{C}$) 50 $^{\circ}\text{N}$ 30 $^{\circ}\text{E}$

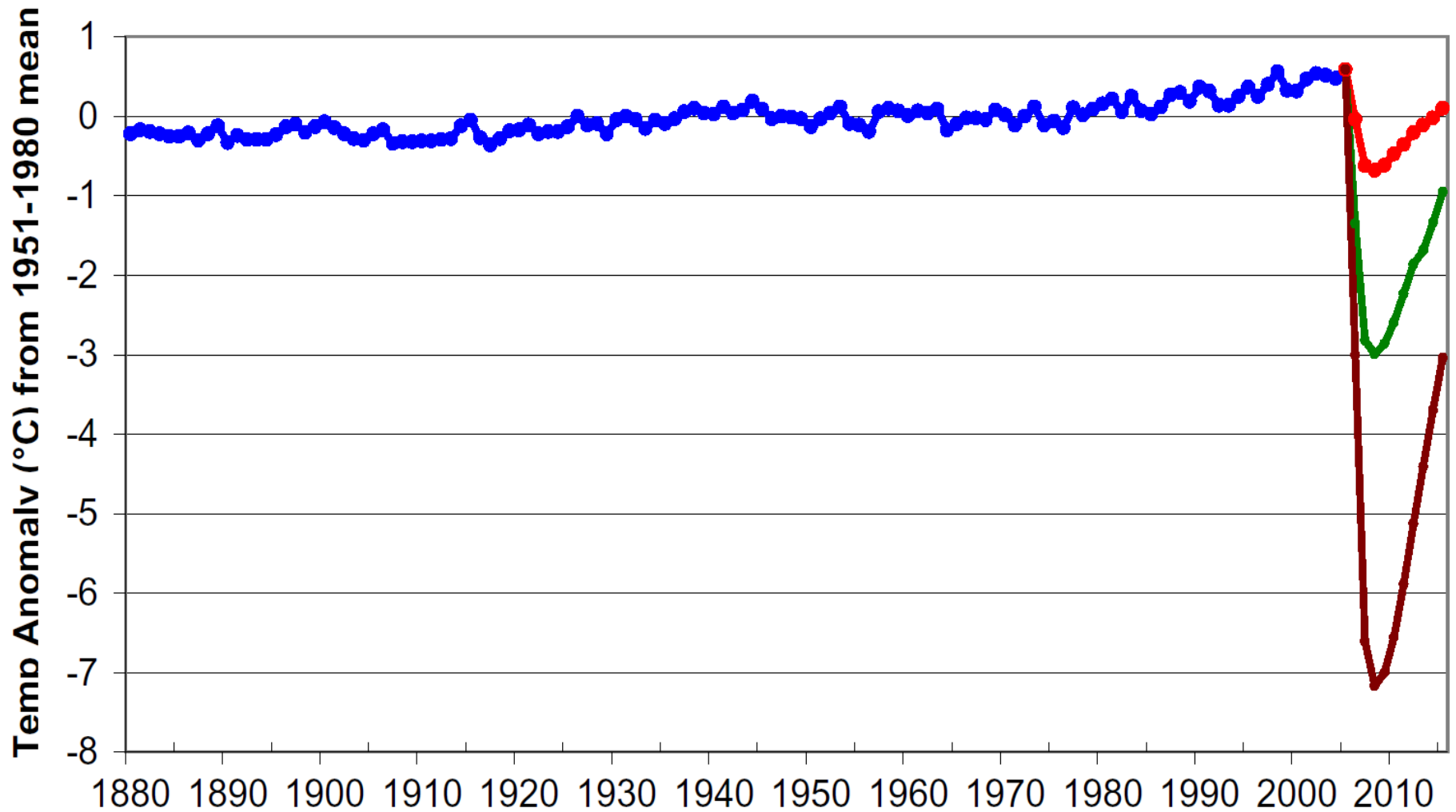


GISS Change in Global Temperature and Precipitation

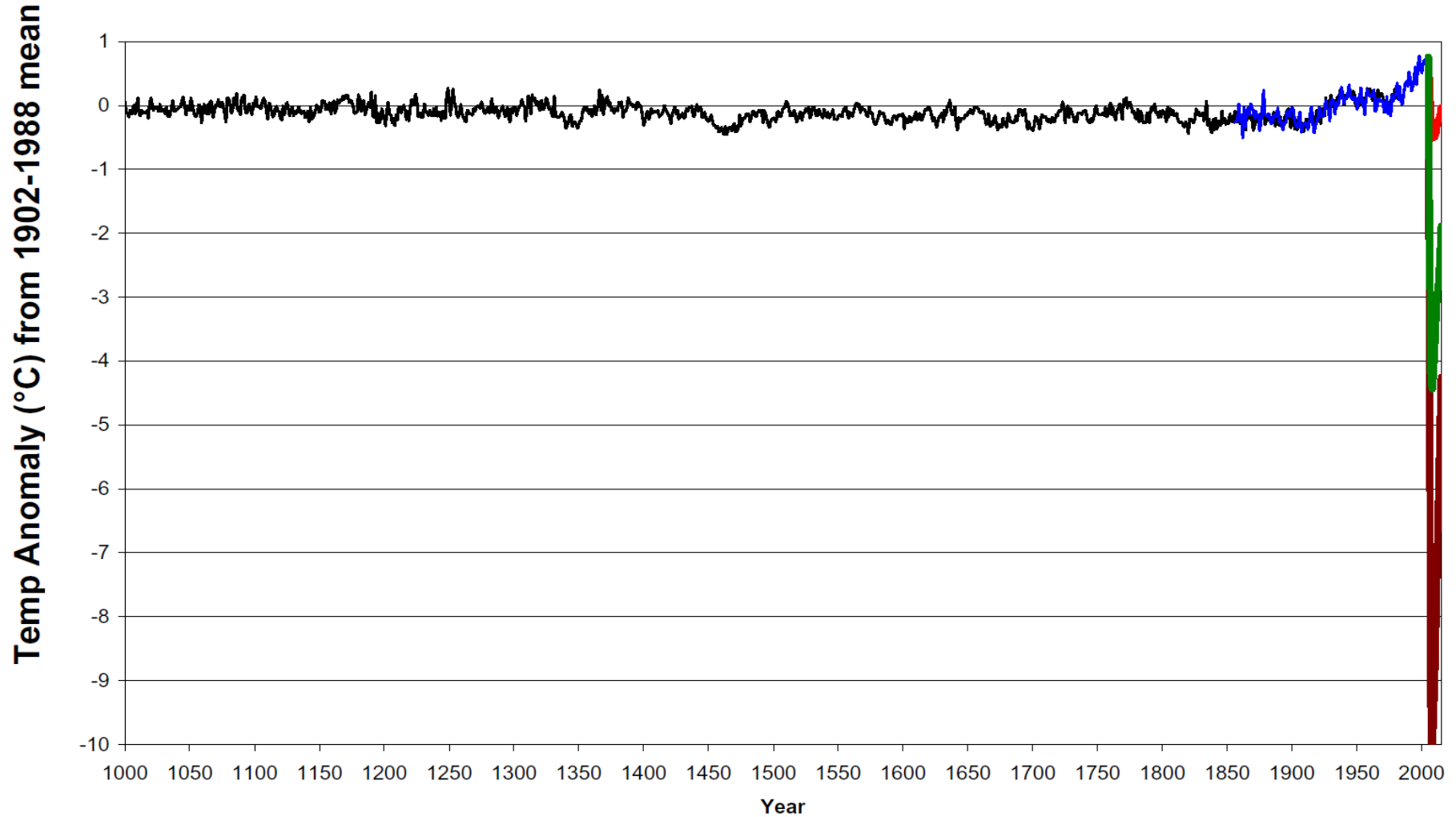


GISS Global Average Temperature Anomaly

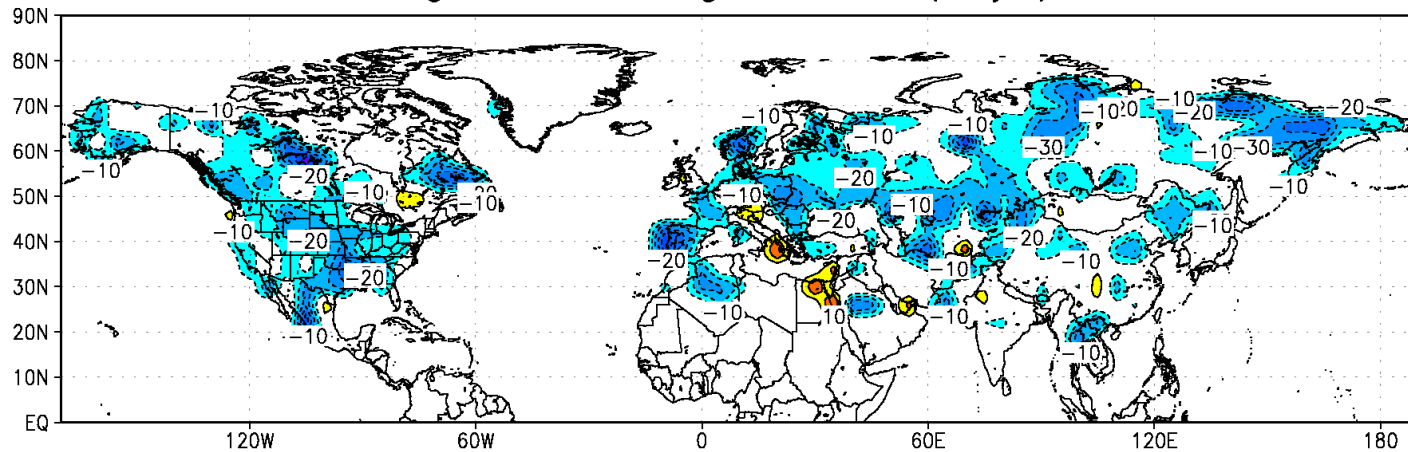
+ 5 Tg, 50 Tg, 150 Tg smoke in 2006



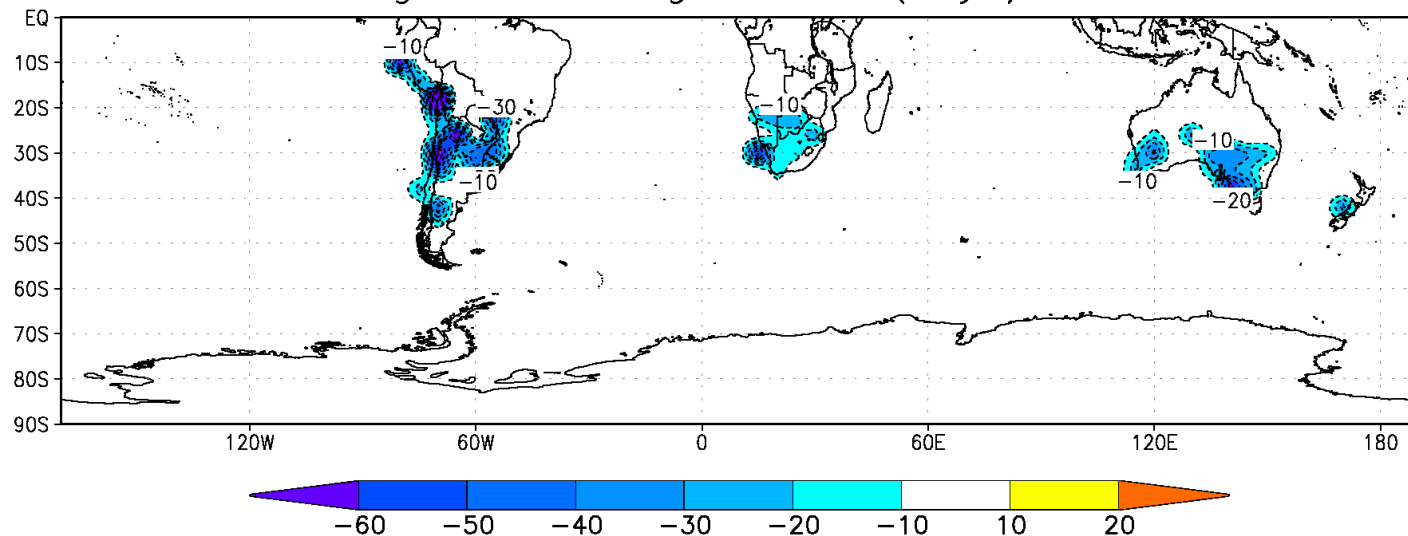
Mann et al. Hockey Stick, CRU Instrumental NH Temperature Anomaly
+ 5 Tg, 50 Tg, 150 Tg smoke in 2006



NH Change in Growing Season (days) Year 1



SH Change in Growing Season (days) Year 1–2

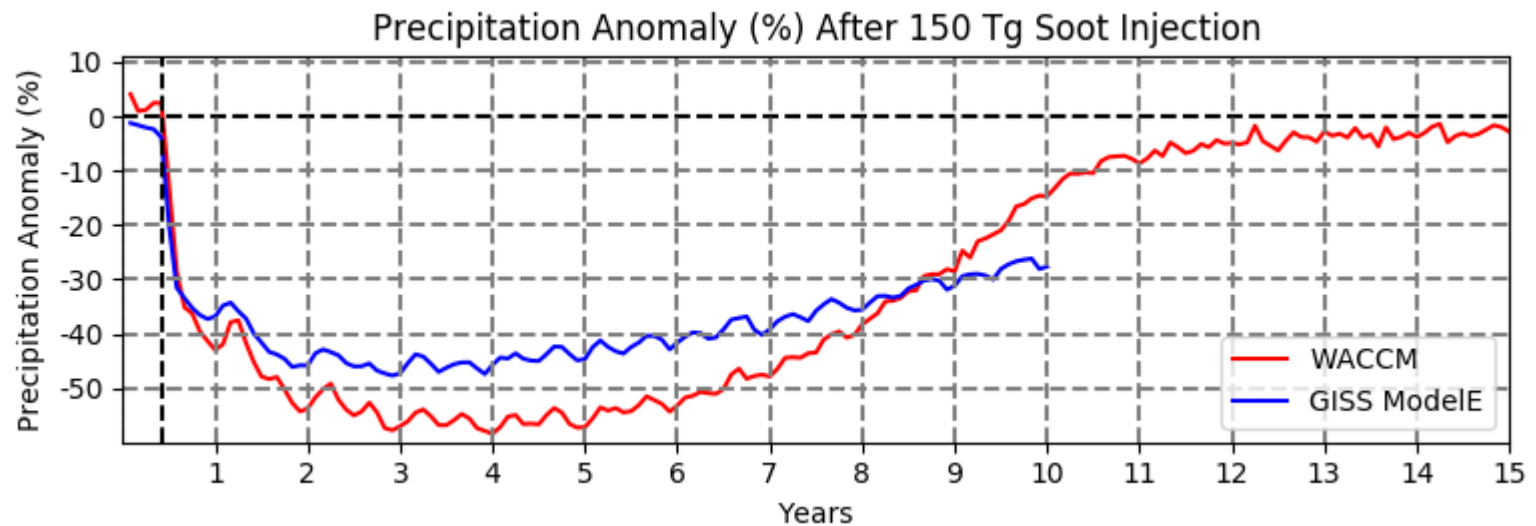
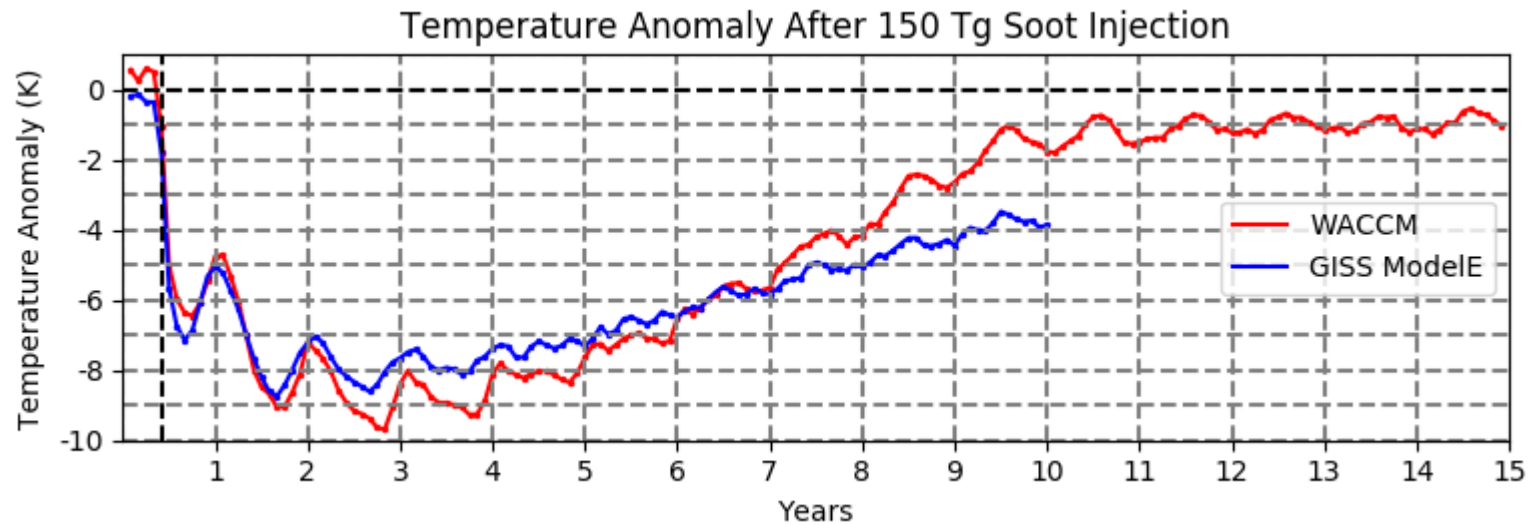


Robock et al.,
2007a

Agricultural effects will include those on temperature, precipitation, reduction of sunlight, and enhancement of ultraviolet radiation.

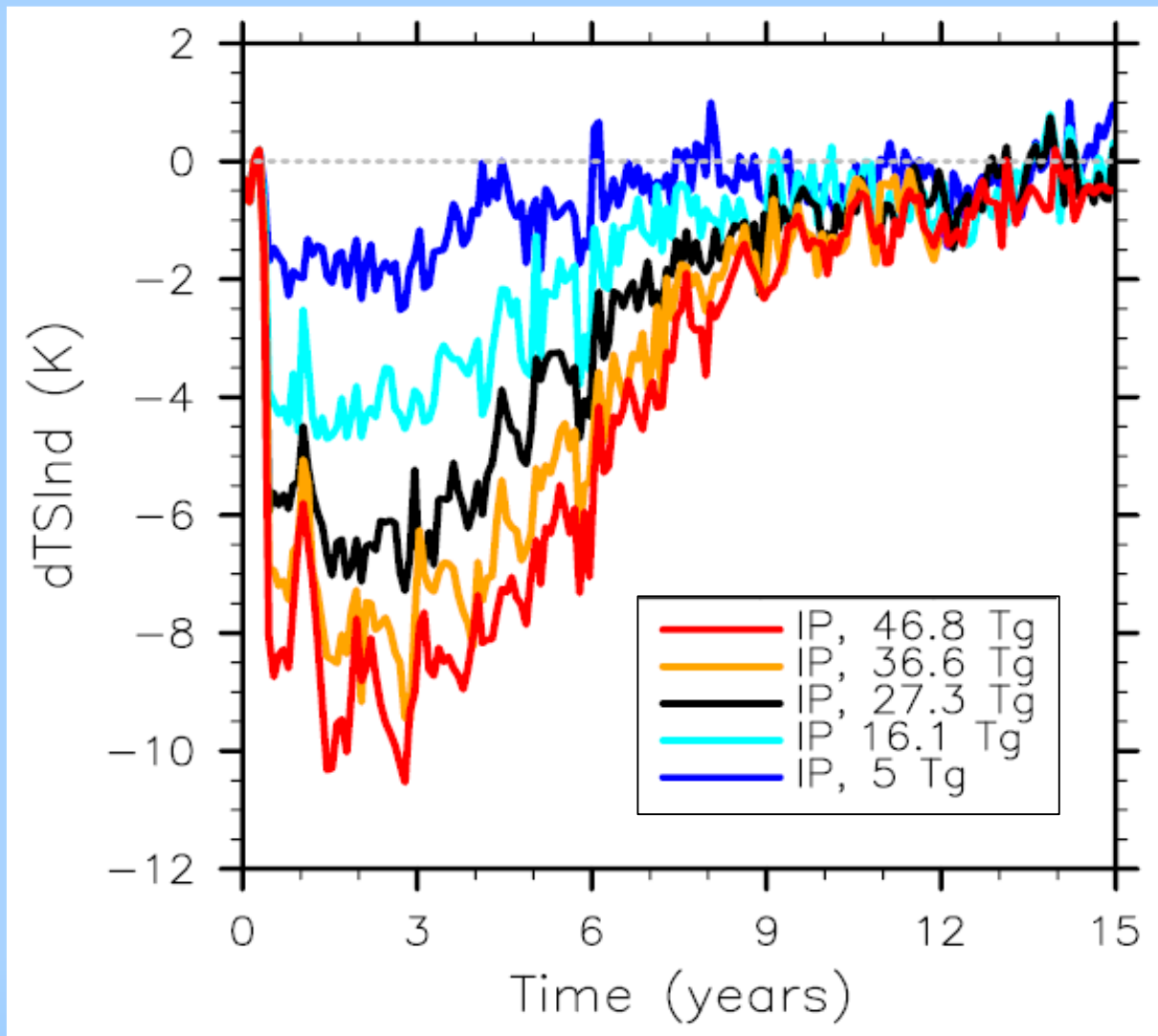
New simulations now being done with the Whole Atmosphere Community Climate Model, version 4 (WACCM4)

- horizontal resolution of $1.9^\circ \times 2.5^\circ$ (lat-lon)
- 66 vertical layers
- model top of 140 km
- transport and removal of soot from fires is handled by the Community Aerosol and Radiation Model for Atmospheres (CARMA), a sectional aerosol model that treats soot as fractal particles and allows them to grow



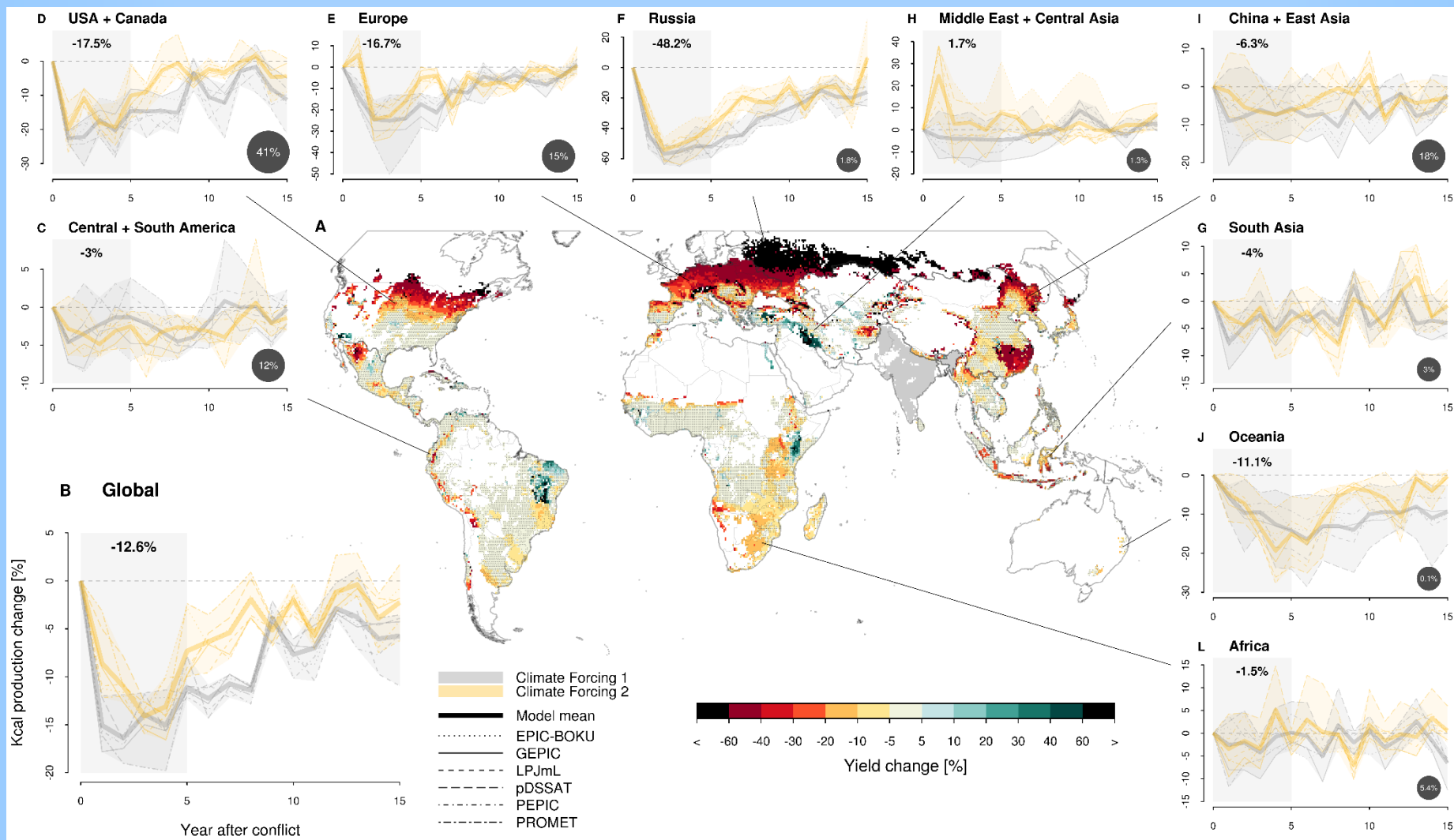
Coupe, Joshua, Charles G. Bardeen, Alan Robock, and Owen B. Toon, 2019: Nuclear winter responses to global nuclear war in the Whole Atmosphere Community Climate Model Version 4 and the Goddard Institute for Space Studies ModelE. *J. Geophys. Res. Atmos.*, **124**, 8522-8543, doi:10.1029/2019JD030509.

Global average **land** surface temperature changes for different soot amounts



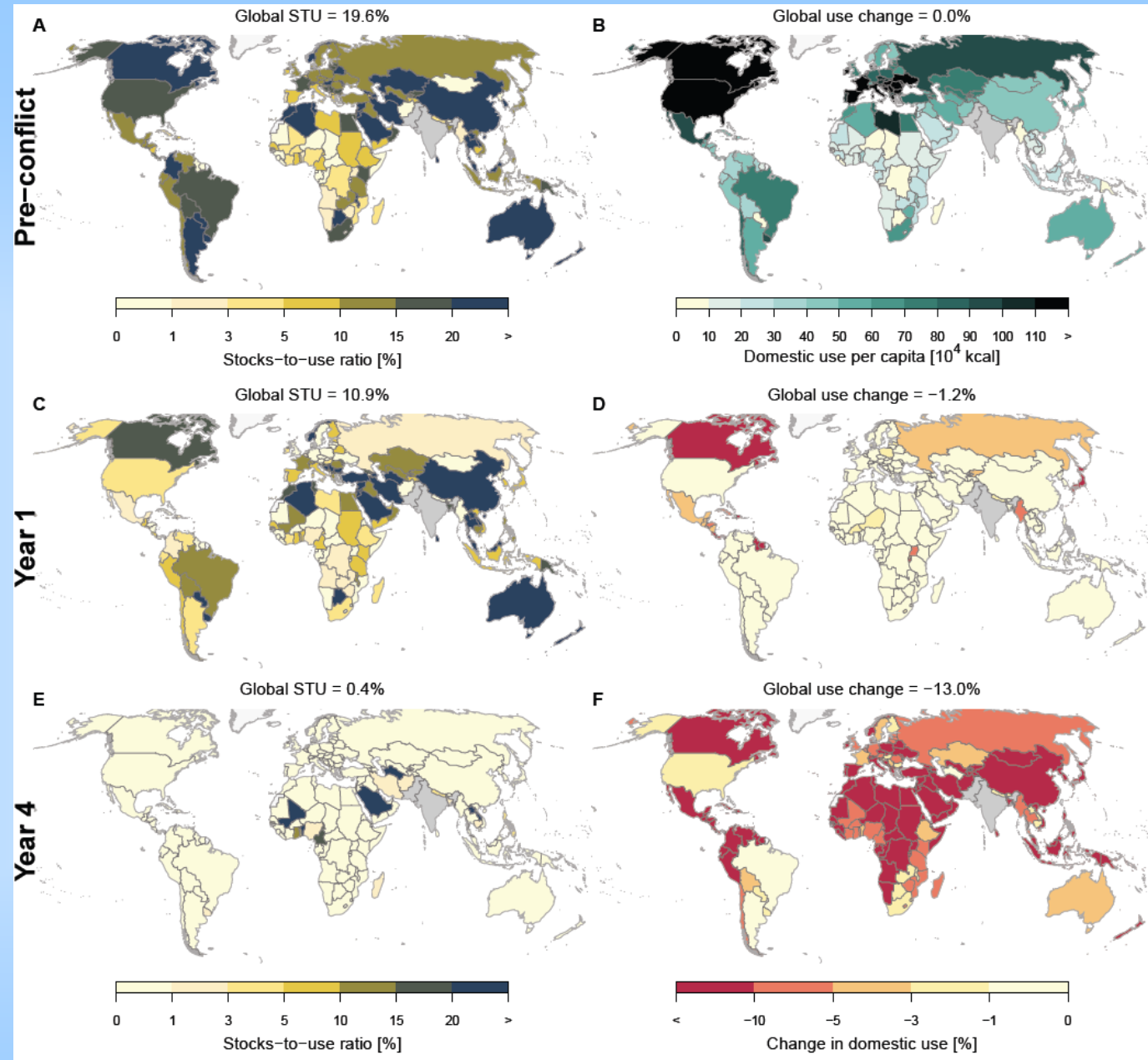
Toon, Owen B., Charles G. Bardeen, Alan Robock, Lili Xia, Hans Kristensen, Matthew McKinzie, R. J. Peterson, Cheryl Harrison, Nicole S. Lovenduski, and Richard P. Turco, 2019: Rapid expansion of nuclear arsenals by Pakistan and India portends regional and global catastrophe. *Science Advances*, 5, eaay5478, doi:10.1126/sciadv.aay5478.

Multi-model maize response 5 Tg

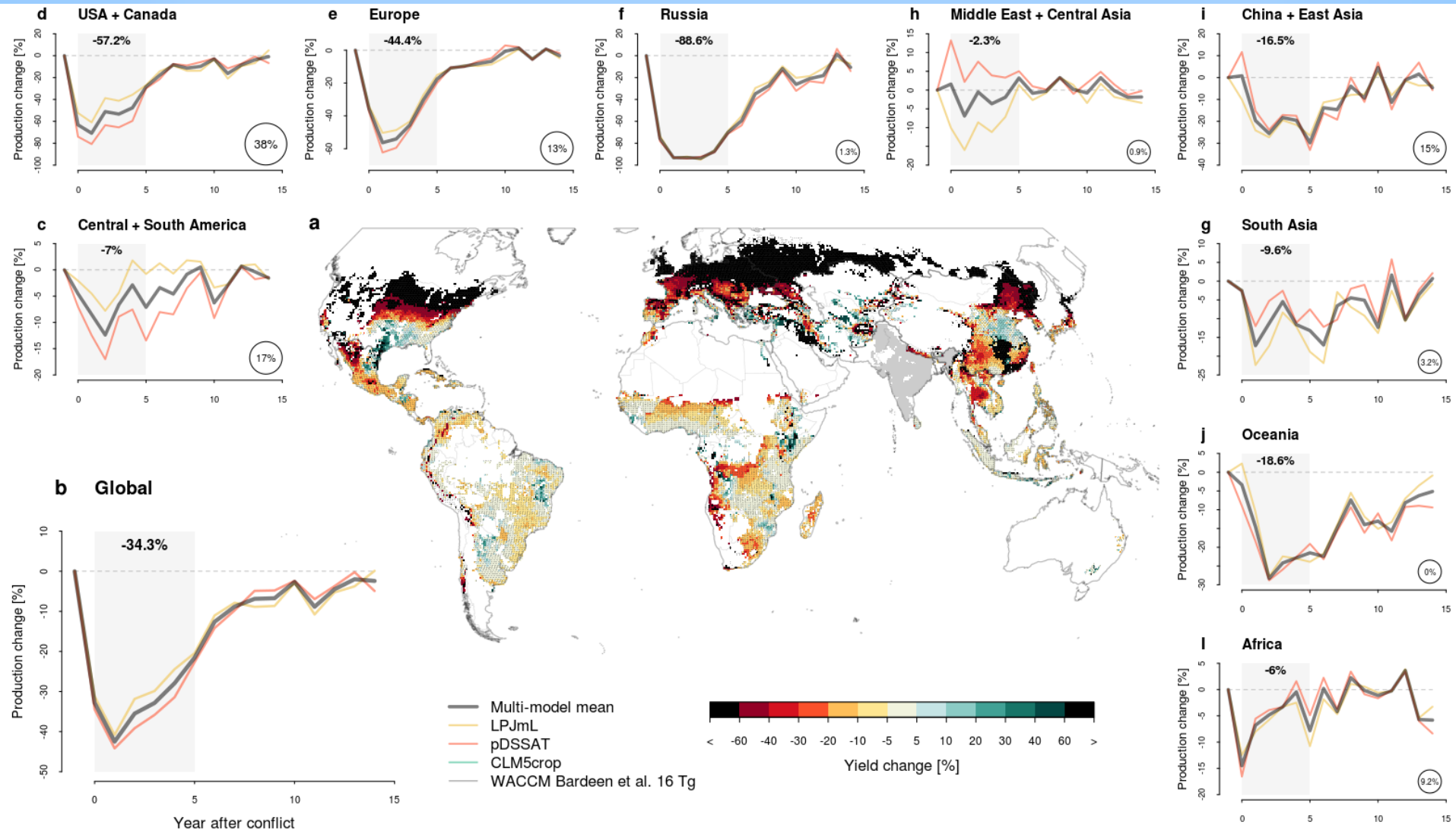


Stocks to
usage ratio
(STU)
indicates food
reserves
relative to
domestic use

Trade buffers
first year
shocks but
impacts
increase in the
following years

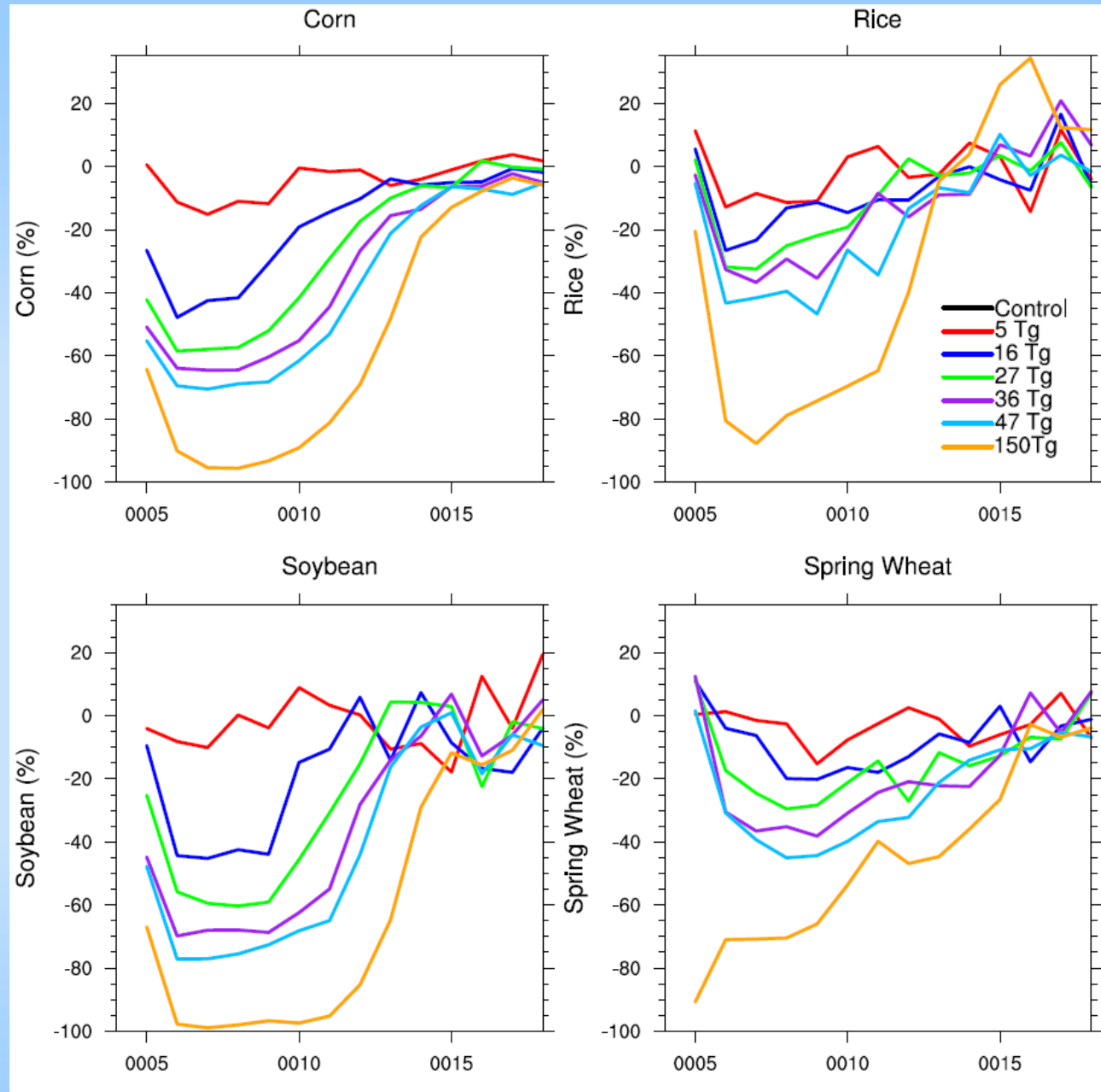


Multi-model maize response 16 Tg



CLM5-crop
simulations in
response to
temperature,
precipitation,
and total solar
radiation changes.

(work in progress
with Lili Xia)



Impacts on Fisheries

BAU = business-as-usual fishing, assuming that there's no change in fishing behavior due to the war

px2 = substantial increase in fishing pressure, e.g., due to lack of food on land raising fish prices (double price of fish)

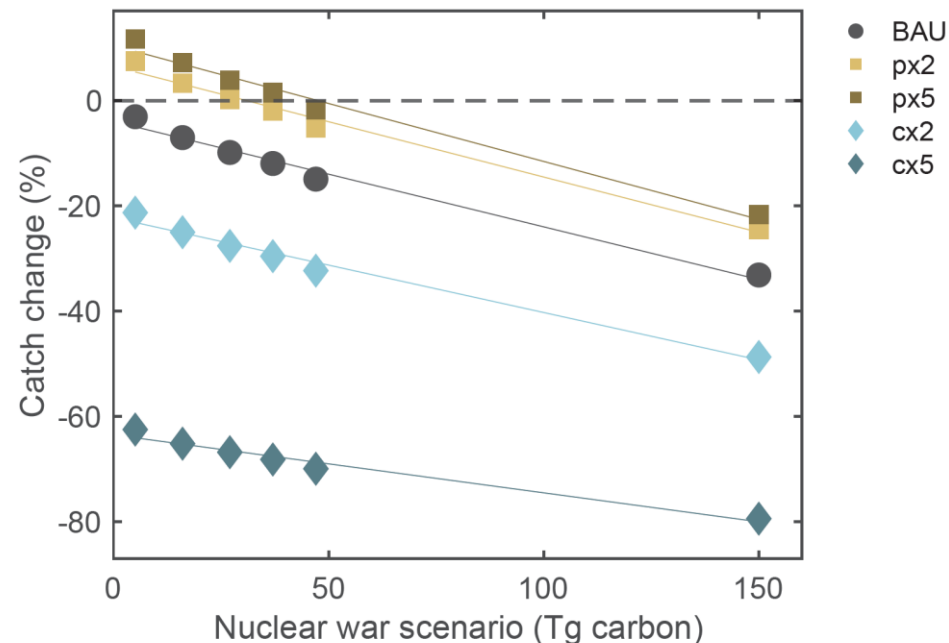
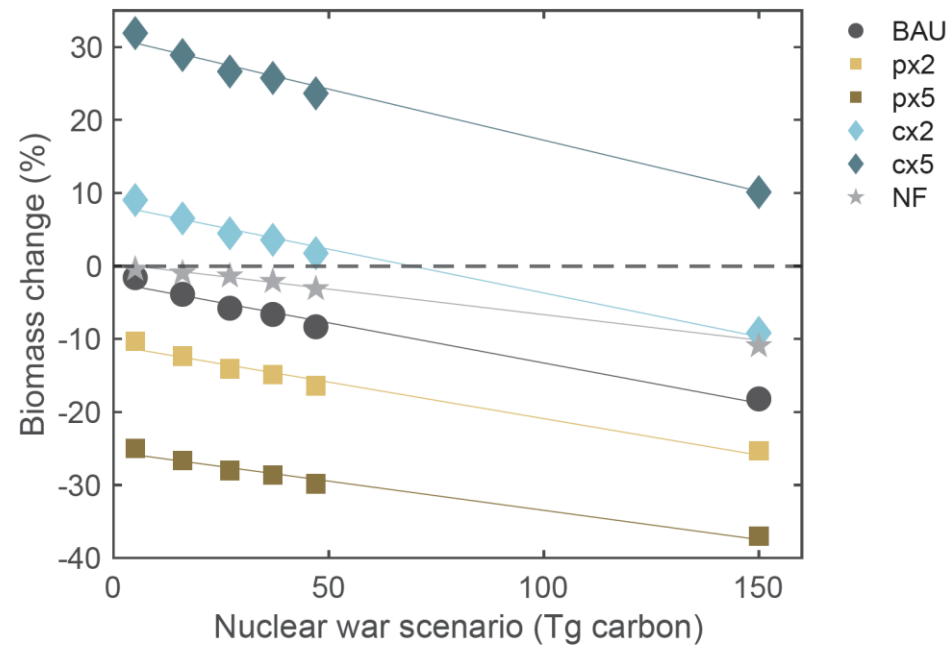
px5 = very large increase in fishing pressure (five-fold increase in price)

cx2 = substantial decrease in fishing pressure, e.g. due to smaller demand, higher fuel prices or damaged infrastructure (double cost of fishing)

cx5 = very large decrease in fishing pressure (five-fold increase in cost of fishing)

NF = no fishing, i.e. showing the effect of nuclear war on the "pristine", unfished ocean

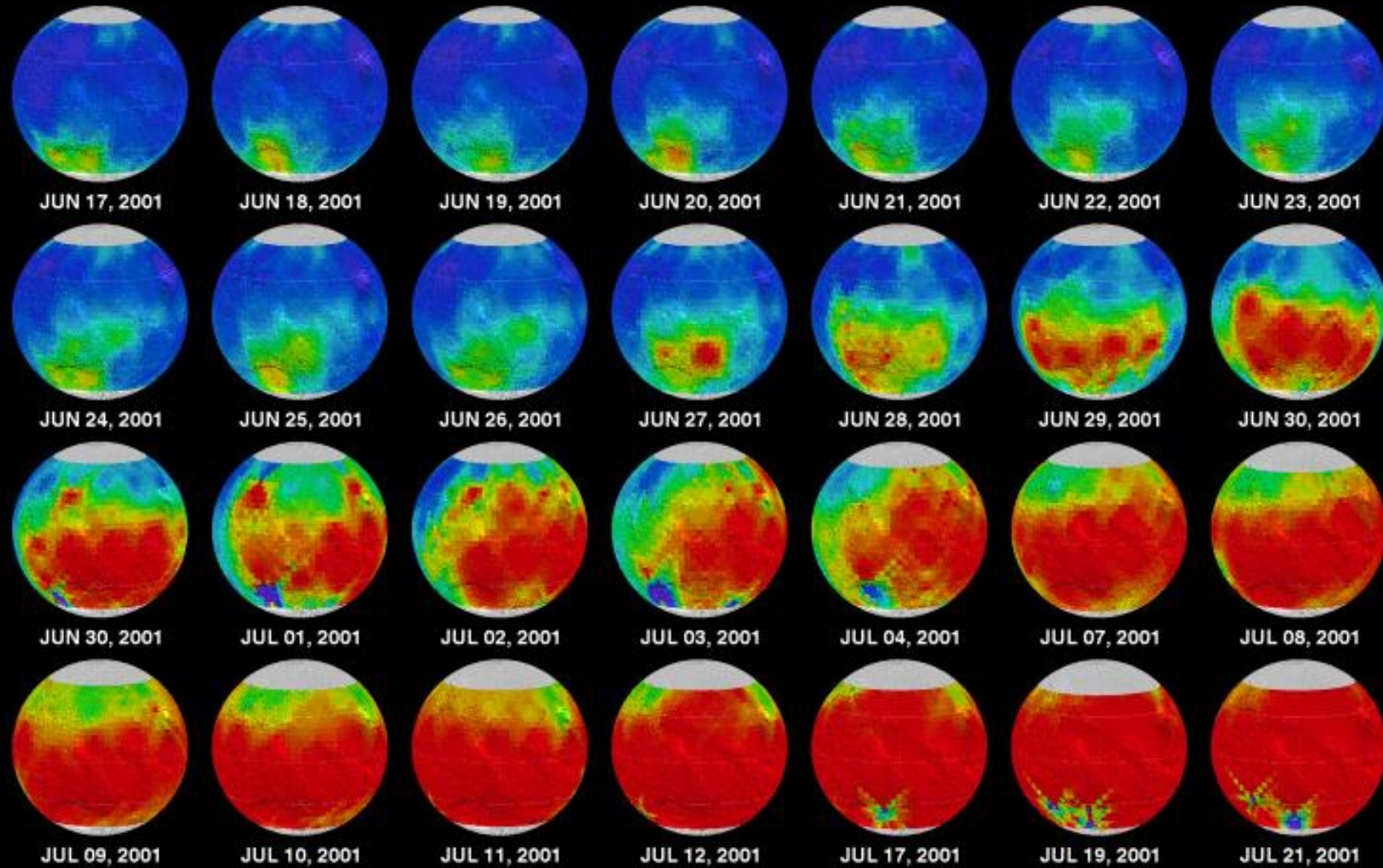
Scherrer, Kim J. N., Cheryl S. Harrison, Ryan Heneghan, Eric Galbraith, Charles G. Bardeen, Jonas Jägermeyr, Nicole S. Lovenduski, August Luna, Alan Robock, Jessica Stevens, Samantha Stevenson, Owen B. Toon, and Lili Xia, 2020: Marine wild-capture fisheries after nuclear war. *Proc. Nat. Acad. Sci.*, in press.



Nuclear Winter Analogs

- Seasonal cycle
- Diurnal cycle (day and night)
- Firestorm: 1906 San Francisco earthquake
- Fires: World War II firestorms
 - Dresden, Hamburg, Darmstadt, Tokyo (“conventional” bombs)
 - Hiroshima, Nagasaki (nuclear bombs)
- Smoke and dust transport, Surface temperature effects
 - Martian dust storms
 - Asteroid impact → dinosaur extinction
 - Forest fires
 - Saharan dust
 - Volcanic eruptions

Martian Dust Storm Activity



270 W

Martian Global Surveyor

Thermal Emission Spectrometer

Asteroid impact or
massive volcanism
wiped out the large
dinosaurs
65,000,000 years
ago.

This was the
beginning of the
Age of Mammals.



Don Davis



Yellowstone, June 8, 2007

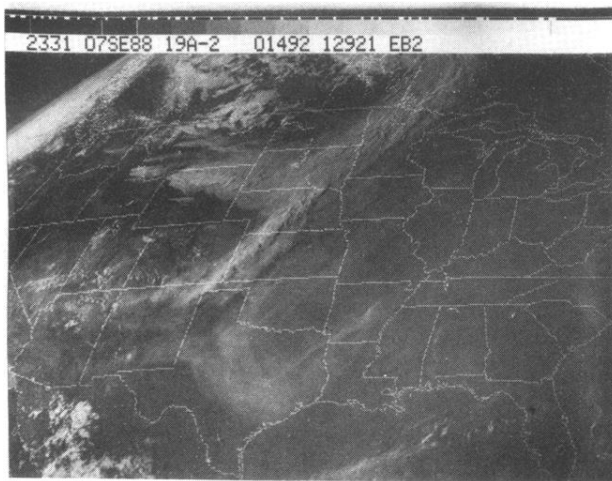


Fig. 13a. GOES satellite image in visible wavelengths, September 7, 1988, 2331 UT (1731 LT: mountain daylight time (MDT)) showing smoke from the Yellowstone forest fires.

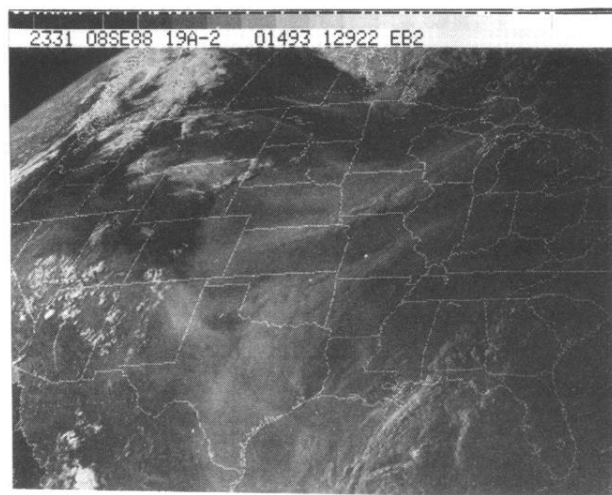


Fig. 13b. As in Figure 13a for September 8, 1988, at the same time. Note the smoke clouds covering most of the Great Plains. In Colorado the western half of the state is black, indicating no smoke since the Front Range of the Rocky Mountains, which runs north-south through the center of the state, blocks the smoke.

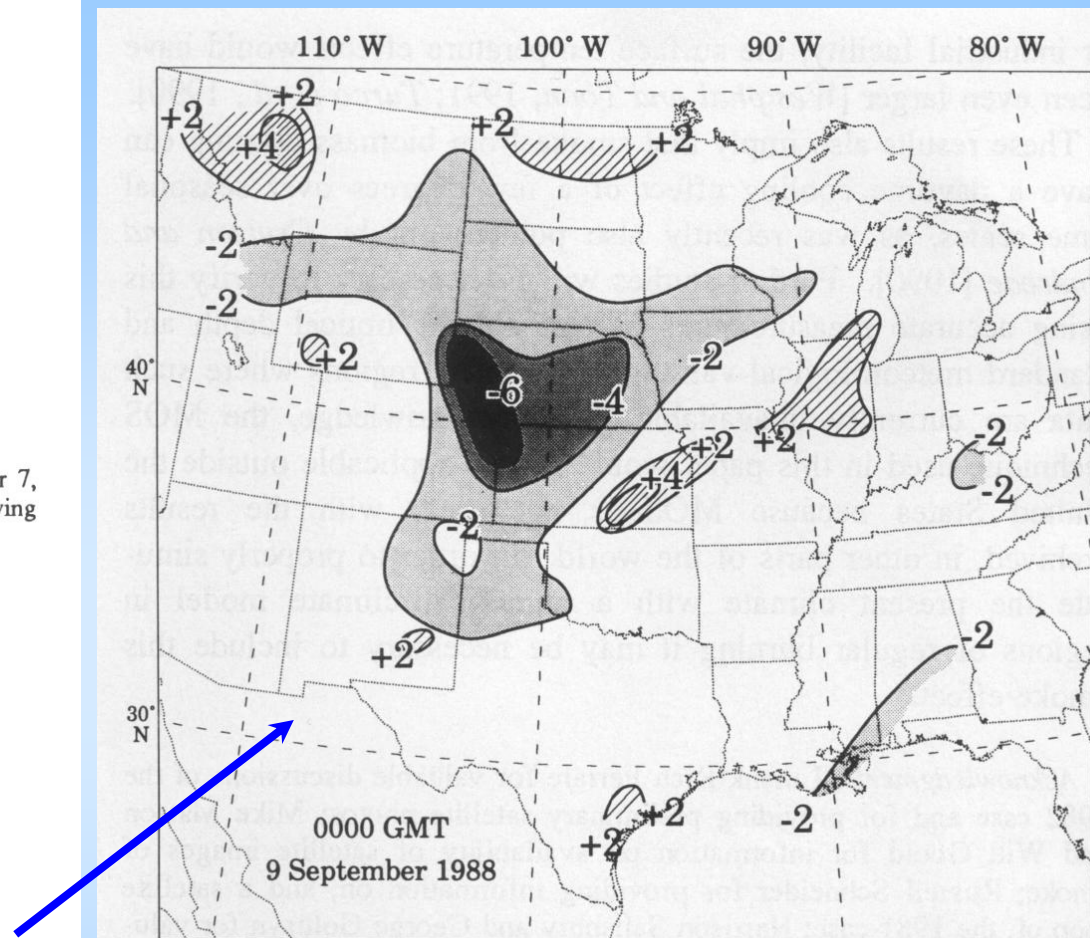


Fig. 15c. As in Figure 15a for 0000 UT September 9, 1988 (1800 LT, September 8), only 29 min after the image shown in Figure 13b, based on the MOS forecasts made 0000 UT on September 8. Again, note the negative MOS error under the smoke-covered region, indicating the cooling effect of the smoke during the daytime.

THE UNTOLD STORY OF PYROCUMULONIMBUS

BY MICHAEL FROMM, DANIEL T. LINDSEY, RENÉ SERVIRANCKX, GLENN YUE, THOMAS TRICKL,
ROBERT SICA, PAUL DOUCET, AND SOPHIE GODIN-BEEKMANN

BAMS SEPTEMBER 2010

When fires initiate or intensify towering thunderstorms, they can inject aerosols into the lower stratosphere that were once thought to originate only from volcanic plumes.

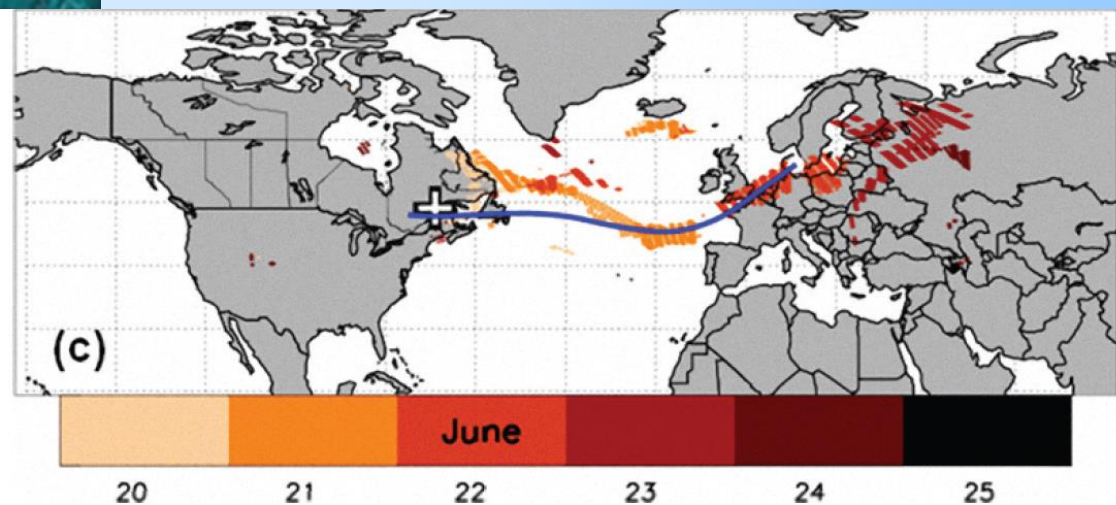
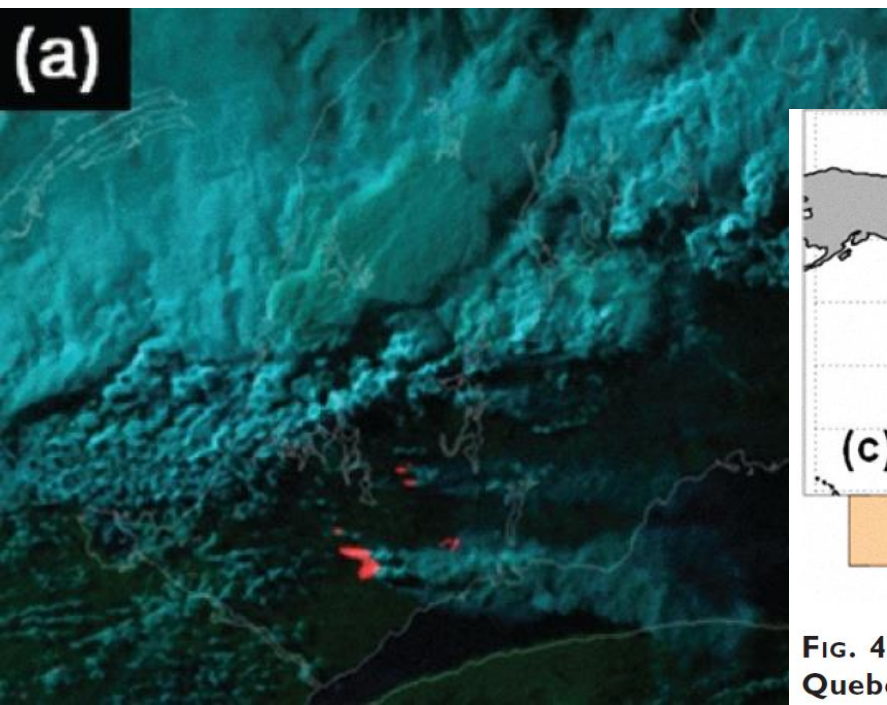


FIG. 4. Composite of AVHRR, AI, SAGE II layer, and trajectory for 1991 Quebec, Canada, pyroCbs. (a) AVHRR RGB image for local evening 19 Jun

Black carbon lofts wildfire smoke high into the stratosphere to form a persistent plume

Pengfei Yu^{1,2,3*}, Owen B. Toon^{4,5}, Charles G. Bardeen⁶, Yunqian Zhu⁵, Karen H. Rosenlof², Robert W. Portmann², Troy D. Thornberry^{1,2}, Ru-Shan Gao², Sean M. Davis², Eric T. Wolf^{5,7}, Joost de Gouw^{1,8}, David A. Peterson⁹, Michael D. Fromm¹⁰, Alan Robock¹¹

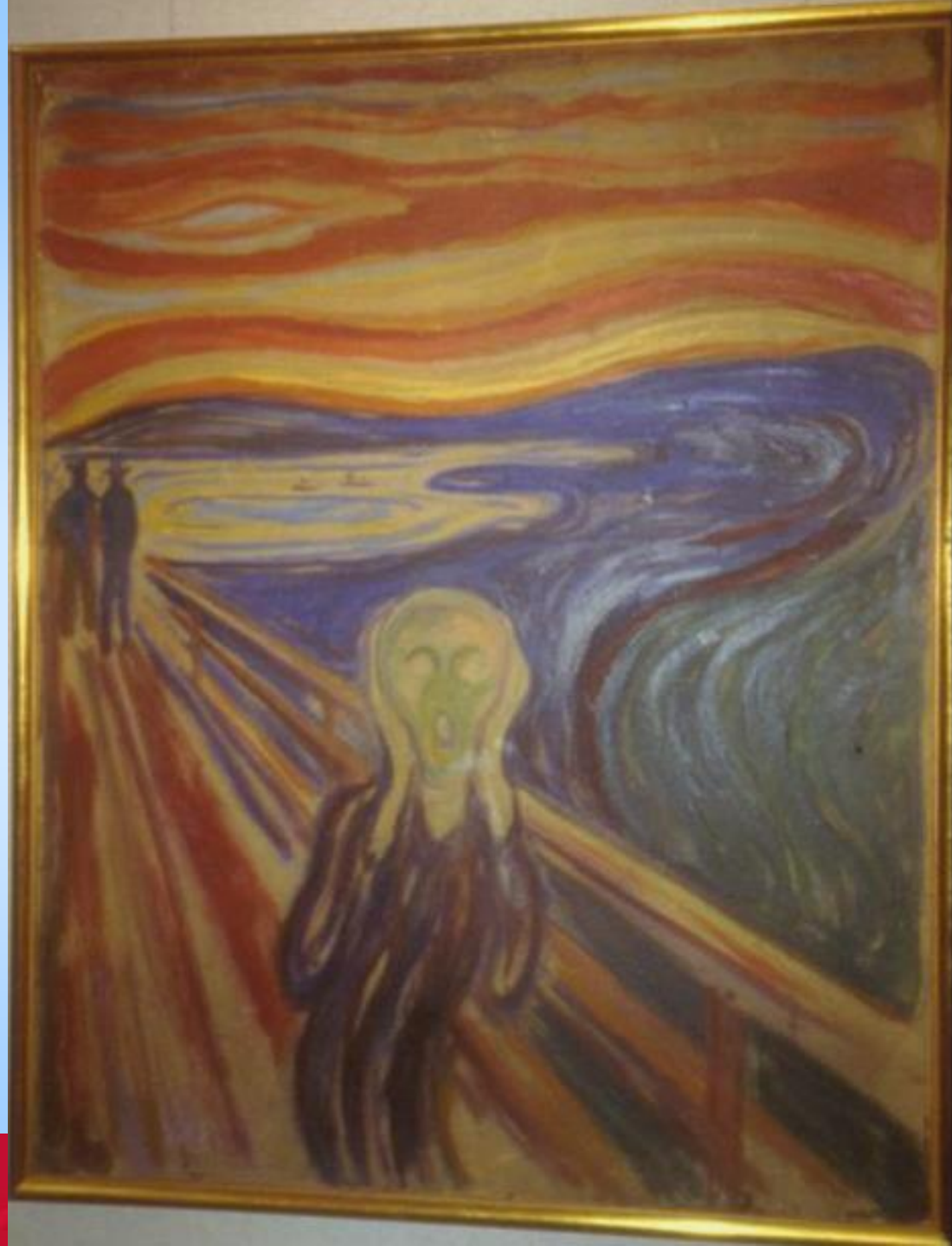
Yu *et al.*, *Science* **365**, 587–590 (2019) 9 August 2019

In 2017, western Canadian wildfires injected smoke into the stratosphere that was detectable by satellites for more than 8 months. The smoke plume rose from 12 to 23 kilometers within 2 months owing to solar heating of black carbon, extending the lifetime and latitudinal spread. Comparisons of model simulations to the rate of observed lofting indicate that 2% of the smoke mass was black carbon. The observed smoke lifetime in the stratosphere was 40% shorter than calculated with a standard model that does not consider photochemical loss of organic carbon. Photochemistry is represented by using an empirical ozone-organics reaction probability that matches the observed smoke decay. The observed rapid plume rise, latitudinal spread, and photochemical reactions provide new insights into potential global climate impacts from nuclear war.

"The Scream"

Edvard Munch

Painted in 1893
based on Munch's
memory of the
brilliant sunsets
following the
1883 Krakatau
eruption.



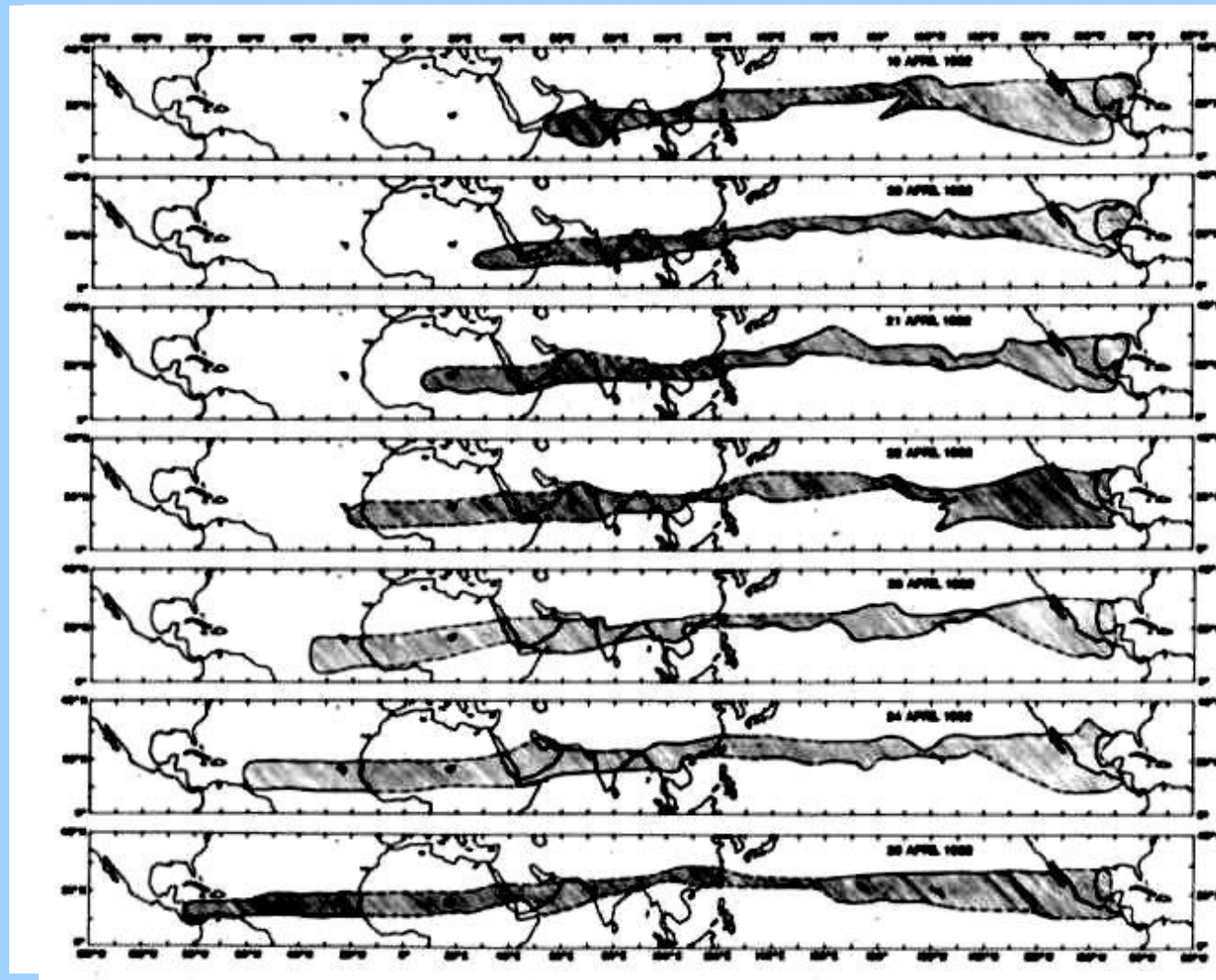


El Chichón, before the 1982 eruptions

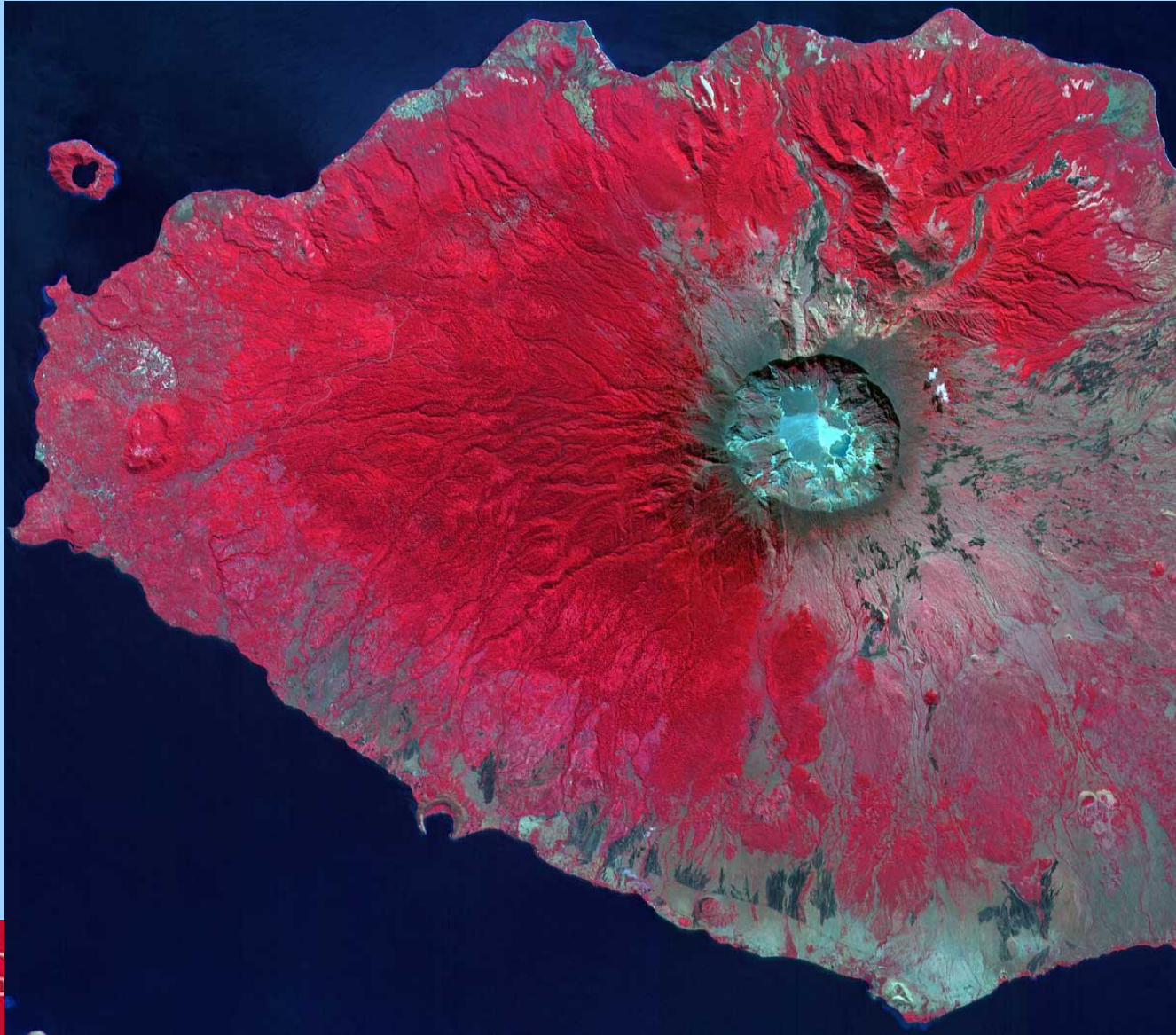


El Chichón, after the 1982 eruptions

El Chichón, 1982



Tambora in 1815, together with an eruption from an unknown volcano in 1809, produced the "Year Without a Summer" (1816)



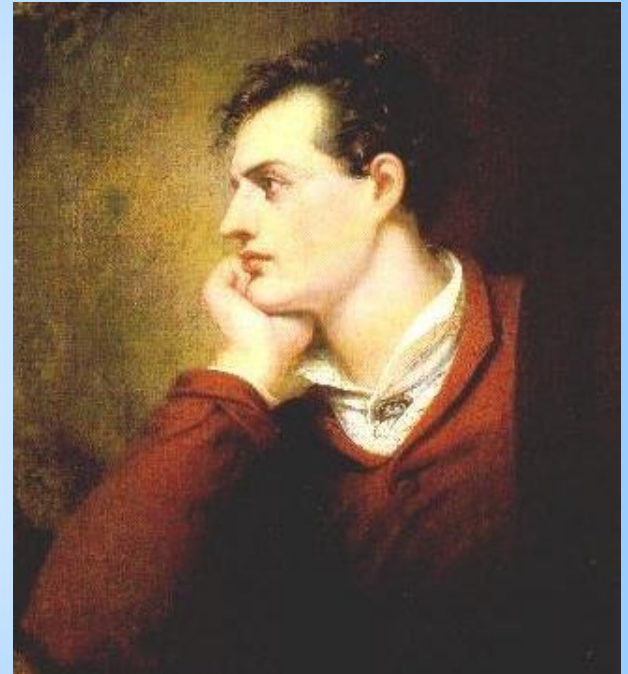
Tambora, 1815, produced the
"Year Without a Summer" (1816)



Percy Bysshe Shelley



Mary Shelley



George Gordon,
Lord Byron

Tambora, 1815, produced the "Year Without a Summer" (1816)

"Darkness" by Byron



I had a dream, which was not all a dream.
The bright sun was extinguish'd, and the stars
Did wander darkling in the eternal space,
Rayless, and pathless, and the icy earth
Swung blind and blackening in the moonless air;
Morn came and went—and came, and brought no day,
And men forgot their passions in the dread
Of this their desolation; and all hearts
Were chill'd into a selfish prayer for light:
And they did live by watchfires—and the thrones,
The palaces of crowned kings—the huts,
The habitations of all things which dwell,
Were burnt for beacons; cities were consumed,
And men were gather'd round their blazing homes
To look once more into each other's face; . . .

Conclusions

A nuclear war between any nuclear states, using much less than 1% of the current nuclear arsenal, would produce climate change unprecedented in human history.

Such a “small” nuclear war could reduce food production by 10% to 40% for a decade, with massive increases in ultraviolet radiation.

Nuclear winter theory is correct.

The current arsenal can still produce nuclear winter, producing global famine.

The effects of regional or global nuclear war would last for more than a decade.

"How does it feel?"

Bob Dylan (1965), *Like a Rolling Stone*



I'm sorry. This has really been a bummer, and it was not nice of me to present you with such a depressing story.

So what do you do with this information?

The most natural reaction is to try to forget it. As Mark Twain said,

"Denial ain't just a river in Egypt."

History of nuclear weapons treaties

Treaties to limit the testing of weapons

Year signed	Treaty
1963	Partial Test Ban Treaty: Prohibited all testing of nuclear weapons except underground.
1974	Threshold Test Ban Treaty (TTBT): This treaty between the United States and the Soviet Union established a nuclear threshold through the prohibition of the testing of new or existing nuclear weapons with a yield exceeding 150 kilotons.
1976	Peaceful Nuclear Explosions Treaty (PNET): This treaty between the United States and the Soviet Union prohibits peaceful nuclear explosions not covered by the Threshold Test Ban Treaty, and verifies all data exchanges and visits to sites of explosions through national technical means.
1996 not yet in force	Comprehensive Test Ban Treaty (CTBT): An international treaty (currently with 181 state signatures and 148 state ratifications) that bans all nuclear explosions in all environments. While the treaty is not in force, Russia has not tested a nuclear weapon since 1990 and the United States has not since 1992.

History of nuclear weapons treaties. Treaties to limit the number of weapons

Year signed	Treaty
1968 into force 1970 extended indefinitely in 1995	Nuclear Non-Proliferation Treaty (NPT): An international treaty (currently with 191 member states) to limit the spread of nuclear weapons. The treaty has three main pillars: nonproliferation, disarmament, and the right to peacefully use nuclear technology. But Article VI, which commits parties to "a treaty on general and complete disarmament" has been ignored.
1972	Interim Agreement on Offensive Arms (Strategic Arms Limitation Treaty - SALT I): The Soviet Union and the United States agreed to a freeze in the number of intercontinental ballistic missiles (ICBMs) and submarine-launched ballistic missiles (SLBMs) that they would deploy.
1972 U.S. withdrew 2002	Anti-Ballistic Missile Treaty (ABM): The United States and Soviet Union could deploy ABM interceptors at two sites, each with up to 100 ground-based launchers for ABM interceptor missiles. In a 1974 Protocol, the US and Soviet Union agreed to only deploy an ABM system to one site, so they could not be used as a nation-wide defense.
1979	Strategic Arms Limitation Treaty (SALT II): Replacing SALT I, SALT II limited both the Soviet Union and the United States to an equal number of ICBM launchers, SLBM launchers, and heavy bombers. Also placed limits on Multiple Independent Reentry Vehicles (MIRVs).
1987 U.S. withdrew 2019	Intermediate-Range Nuclear Forces Treaty (INF): Created a ban on short- and long-range nuclear weapons systems, as well as an intrusive verification regime for the U.S. and Soviet Union.
1991 ratified 1994	Strategic Arms Reduction Treaty (START I): Limited long-range nuclear forces in the United States and the newly independent states of the former Soviet Union to 6,000 attributed warheads on 1,600 ballistic missiles and bombers.
1992 U.S. withdrew 2020	Open Skies Treaty: Establishes a regime of unarmed aerial observation flights over state territories and enhances mutual understanding of and increase transparency in military forces and activities.
1993 never put into force	Strategic Arms Reduction Treaty II (START II): START II was a bilateral agreement between the US and Russia which attempted to commit each side to deploy no more than 3,000 to 3,500 warheads by December 2007 and also included a prohibition against deploying MIRVs on ICBMs
2002 into force 2003	Strategic Offensive Reductions Treaty (SORT or Moscow Treaty): A very loose treaty that is often criticized by arms control advocates for its ambiguity and lack of depth, Russia and the United States agreed to reduce their "strategic nuclear warheads" (a term that remained undefined in the treaty) to between 1,700 and 2,200 by 2012. Was superseded by New Start Treaty in 2010.
2010 into force 2011	New Strategic Arms Reduction Treaty (New START): Replaces SORT treaty, reduces deployed nuclear warheads by about half, will remain in force until at least 2021



President Barack Obama and President Dmitry Medvedev of Russia sign the New START Treaty during a ceremony at Prague Castle in Prague, Czech Republic, April 8, 2010.

New START requires each side, within 7 years of the treaty coming into force, to reduce deployed strategic warheads to a maximum of 1550 per side, but each long-range bomber counts as one warhead no matter how many it has.

Expires Feb. 21, 2021, but can be extended by 5 years if both parties agree, without any further negotiations.

But 4000 nuclear warheads (in the arsenals of Russia and the US under this treaty) are enough to produce nuclear winter.

WEAPONS ALREADY BANNED

There are already international conventions prohibiting biological weapons, chemical weapons, land mines and cluster munitions, but no comparable treaty – as yet – for nuclear weapons. The international community must address this legal anomaly. As with the negotiating

processes that resulted in treaties banning land mines and cluster munitions, likeminded governments should work in close partnership with civil society to bring about a nuclear weapons ban regardless of resistance from states possessing the weapons.



X BIOLOGICAL WEAPONS

Banned under the Biological
Weapons Convention

1972



X CHEMICAL WEAPONS

Banned under the Chemical
Weapons Convention

1993



X LAND MINES

Banned under the Anti-
Personnel Mine Ban Treaty

1997



X CLUSTER MUNITIONS

Banned under the Convention
on Cluster Munitions

2008



NUCLEAR WEAPONS

**NOT YET BANNED
BY TREATY**

WEAPONS ALREADY BANNED

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2008



NUCLEAR WEAPONS

**NOT YET BANNED
BY TREATY**

TPNWW

Comes into force on January 22, 2021!

History of nuclear weapons treaties.

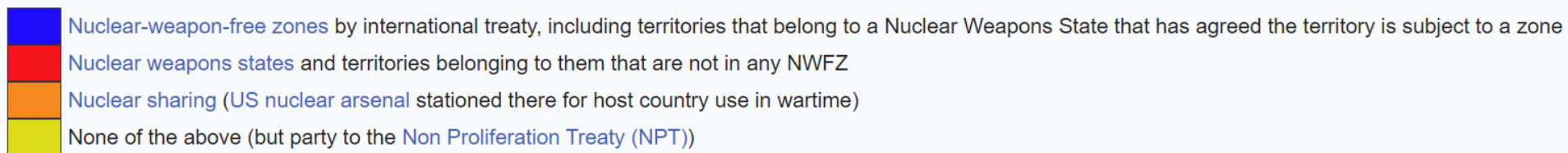
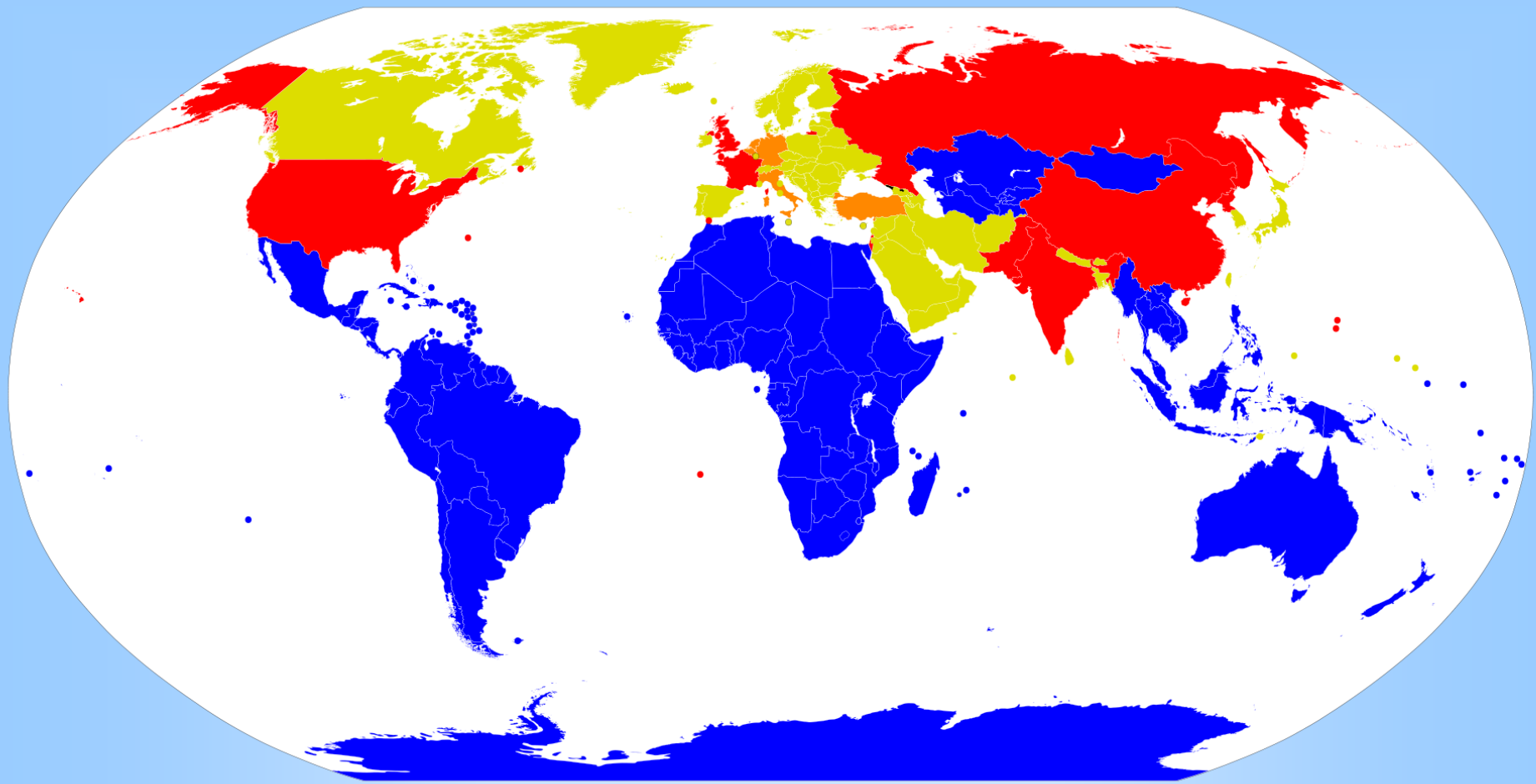
Treaties to ban nuclear weapons in certain places.

Year signed	Treaty
1961	Antarctic Treaty: Prohibits any measures of a military nature, including basing or testing nuclear weapons, in Antarctica
1967	Latin America Nuclear Weapons Free Zone Treaty (Treaty of Tlatelolco): Prohibits Latin American states from not only acquiring and possessing nuclear weapons, but also from allowing the storage or deployment of nuclear weapons on their territories by other states.
1967	Outer Space Treaty: Prevented states from placing nuclear weapons or other weapons of mass destruction into Earth's orbit, and prohibited states from installing such weapons on the Moon or celestial bodies or stationing them in outer space in any other manner.
1971	Seabed Arms Control Treaty: This treaty prevents the introduction of international conflict and nuclear weapons in areas already free of them.
1985 in force 1986	South Pacific Nuclear Weapons Free Zone Treaty (Treaty of Rarotonga): Prohibits the manufacture, possession, or control of nuclear explosives, the dumping of radioactive wastes at sea within the defined zone, and the testing or stationing nuclear explosive devices within state territories.
1995 in force 1997	Southeast Asia Nuclear-Weapon-Free Zone Treaty (Bangkok Treaty): Prohibits nuclear weapons in Brunei Darussalam, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam.
1996	African Nuclear-Weapons-Free Zone Treaty (Treaty of Pelindaba): Ensures the denuclearization of Africa.
2006 in force 2009	Central Asia Nuclear-Weapon-Free-Zone Treaty (CANWFZ): Prohibits nuclear weapons in Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan.
2017 in force 2021	Treaty on the Prohibition of Nuclear Weapons: Prohibits possession, manufacture, development, and testing of nuclear weapons, stationing and installment of nuclear weapons or assistance in such activities, by its parties.

History of nuclear weapons treaties.

Treaties to ban nuclear weapons in certain places.

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Nobel Peace Prizes for Advocating Nuclear Disarmament (from <https://www.nobelprize.org/prizes/lists/all-nobel-peace-prizes>)

Year	Nobel Laureates
1959	Philip Noel-Baker "He engaged in intense efforts to prevent nuclear war between the United States and the Soviet Union."
1962	Linus Pauling "He spoke and wrote against the nuclear arms race, and he was a driving force in the Pugwash movement. ... He was one of the prime movers who urged the nuclear powers the USA, the Soviet Union and Great Britain to conclude a nuclear test ban treaty."
1982	Alva Myrdal "She worked actively to persuade the superpowers to disarm. The nuclear race was a major concern, and she fought for nuclear weapons-free zones in Europe." and Alfonso García Robles "played a key part in the laborious efforts to make Latin America a nuclear-free zone. ... He was lauded as 'Mr. Disarmament.'"
1985	International Physicians for the Prevention of Nuclear War "IPPNW held annual congresses to tell the world about the consequences of nuclear war. Extensive nuclear explosions could prevent sunlight from reaching the earth. The resulting drop in temperature would cause a 'nuclear winter.' The organization recommended a nuclear test ban and demanded that the great powers should refrain from first use in conflict situations."
1995	Joseph Rotblat and Pugwash Conferences on Science and World Affairs "for their efforts to diminish the part played by nuclear arms in international politics and, in the longer run, to eliminate such arms"
2005	International Atomic Energy Agency (IAEA) and Mohamed ElBaradei "for their efforts to prevent nuclear energy from being used for military purposes and to ensure that nuclear energy for peaceful purposes is used in the safest possible way"
2017	International Campaign to Abolish Nuclear Weapons (ICAN) "for its work to draw attention to the catastrophic humanitarian consequences of any use of nuclear weapons and for its ground-breaking efforts to achieve a treaty-based prohibition of such weapons"

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Bulletin of the Atomic Scientists

IT IS 5 MINUTES TO MIDNIGHT



Feature

Self-assured destruction: The climate impacts of nuclear war

Alan Robock and Owen Brian Toon

Bulletin of the Atomic Scientists

68(5) 66–74

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DOI: 10.1177/0096340212459127

<http://thebulletin.sagepub.com>



<http://climate.envsci.rutgers.edu/pdf/RobockToonSAD.pdf>

Nuclear states claim they maintain their arsenals not to use them, but for deterrence.

Clearly, nuclear weapons do not deter attacks by terrorists or cyberwarfare, or attacks on nuclear nations by conventional weapons. Examples (**nuclear nation in red**):

Soviet takeover of Eastern Europe: US

Six-Day War: Israel, Egypt, Jordan, and Syria

Malvinas [Falkland Islands] War: UK, Argentina

Afghanistan: USSR

Afghanistan: US

Vietnam: US

Nuclear states claim they maintain their arsenals not to use them, but for deterrence.

But do nuclear weapons deter attacks by other nuclear states? There has been no major war between nuclear powers since World War II. Why?

Significant contributors:

- General decline in violence

- Growth in international commerce

- Increase in number of democracies

- NATO, UN, EU, acceptance of national boundaries

It is impossible to know the role of nuclear deterrence, but if it is important, the real question is:

Will deterrence last forever?

Nuclear Close Calls

by Sarah Witmer, August 31, 2017

Severity Index

- 1-Very slight alarm, quickly resolved.
- 2-More serious incident with general risk, quickly resolved.
- 3-Specific, serious risk possibly leading to escalation with other state. Requires more complex resolution.
- 4-Serious risk to wider public; has potential to cause widespread casualties and damage beyond military personnel and property, or to cause escalation in conflict.
- 5-Nuclear devices detonate and cause casualties, or confrontation nearly leads to the use of nuclear devices.

Nuclear Close Calls

by Sarah Witmer, August 31, 2017

October 27, 1962 is now commonly referred to as "Black Saturday" as it was the most dangerous day of the Cuban Missile Crisis, when both the United States and the Soviet Union came close to initiating nuclear attack multiple times.

Cruise missiles pointed at the United States

Soviet base in Cuba, Severity: 4

In the early morning of October 27, the Soviets deploy nuclear cruise missiles in firing position to within 15 miles of the U.S. naval base at Guantanamo Bay. The U.S. remains completely unaware.

Wartime radio frequencies signal war

Soviet Union, Severity: 4

U2 spy plane enters Soviet air space

United States, Severity: 4

Meanwhile, an American U2 spy plane enters Soviet air space, attracting the attention of Soviet MIG interceptors, which are ordered to shoot the plane down. American fighter planes loaded with nuclear missiles and ordered to shoot at their own discretion are sent to escort the U2 plane back to American ground.

U2 spy plane shot down over Cuba

United States, Severity: 5

Submarine almost launches nuclear torpedo

Soviet Union, Severity: 5

Perhaps most seriously, eleven U.S. Navy destroyers and aircraft carrier U.S.S. Randolph corner a nuclear-armed Soviet submarine near Cuba. Authorized to launch nuclear torpedoes without express permission from Moscow, two of the three submarine officers onboard vote to launch. The third officer, Vasili Arkhipov, refuses to authorize the launch. Had any other officer been in Arkhipov's place—whether one who agreed with the two other officers, or one who was more easily pressured by the other officers to authorize the launch—nuclear war likely would have occurred.



Nuclear Close Calls

by Sarah Witmer, August 31, 2017

September 26, 1983—Radar malfunction warns of missile attack

Soviet Union, Severity: 4

The Soviet soldier on duty, Stanislav Petrov, suspects a malfunction and does not call for a retaliatory Soviet strike. (Documented in the movie, "The Man Who Saved the World," available on Amazon Prime)

November 2-11, 1983—NATO military exercise Able Archer 83 interpreted as attack

Soviet Union, Severity: 4

August 19-21, 1991—Coups leaders confiscate nuclear briefcases from Gorbachev

Soviet Union, Severity: 4

January 25, 1995—Scientific rocket launch from Norway interpreted as nuclear missile

Russia, Severity: 4

May-June, 1999—Conflict almost includes nuclear weapons

India and Pakistan, Severity: 5

The incident escalates until both sides threaten to use nuclear weapons. The crisis is temporarily defused by mediation from President Clinton.

May 23, 2008—Fire in missile silo burns unnoticed

United States, Severity: 4

August 5, 2014—Nuclear power plant sabotaged

Belgium, Severity: 4

How many other incidents were there that were kept secret?

How much longer will our luck hold out?

Box 8.3 | Volcanic Eruptions as Analogues

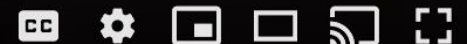
Volcanic eruptions provide a natural experiment of a stratospheric aerosol cloud that can serve to inform us of the impacts of the proposed production of such a cloud as a means to control the climate, which is one method of geoengineering (Rasch et al., 2008); see Section 7.7. For example, Trenberth and Dai (2007) showed that the Asian and African summer monsoon, as well as the global hydrological cycle, was weaker for the year following the 1991 Mt Pinatubo eruption, which is consistent with climate model simulations (Robock et al., 2008). MacMynowski et al. (2011) showed that because the climate system response of the hydrological cycle is rapid, forcing from volcanic eruptions, which typically last about a year, can serve as good analogues for longer-lived forcing. The formation of sulphate aerosols, their transport and removal, their impacts on ozone chemistry, their RF, and the impacts on whitening skies all also serve as good analogues for geoengineering proposals. Volcanic impacts on the carbon cycle because of more diffuse radiation (Mercado et al., 2009) and on remote sensing can also be useful analogues, and the impacts of contrail-generated sub-visual cirrus (Long et al., 2009) can be used to test the long-term impacts of a permanent stratospheric cloud.

Smoke from fires generated by nuclear explosions on cities and industrial areas, which could be lofted into the stratosphere, would cause surface cooling and a reduction of stratospheric ozone (Mills et al., 2008). Volcanic eruptions that produce substantial stratospheric aerosol clouds also serve as an analogue that supports climate model simulations of the transport and removal of stratospheric aerosols, their impacts on ozone chemistry, their RF, and the climate response. The use of the current global nuclear arsenal still has the potential to produce nuclear winter, with continental temperatures below freezing in summer (Robock et al., 2007a; Toon et al., 2008), and the use of only 100 nuclear weapons could produce climate change unprecedented in recorded human history (Robock et al., 2007b), with significant impacts on global agriculture (Ozdogan et al., 2013; Xia and Robock, 2013).

TEDx Talk
Hoboken, NJ
June 28, 2013

<http://www.youtube.com/watch?v=qsrEk1oZ-54>

▶ ⏸ 🔊 0:24 / 17:57



Nuclear winter - still possible but preventable: Alan Robock at TEDxHoboken

29,655 views • Aug 31, 2013

👍 324 💬 18 ➦ SHARE ≡ SAVE ⋮

A man with short grey hair and glasses, wearing a blue button-down shirt and dark trousers, is speaking on a stage. He is gesturing with his hands. The background is dark with large, stylized, colorful geometric shapes in shades of red, orange, and blue.

TEDx Talk

Denver

November, 2017

<https://www.youtube.com/watch?v=M7hOpTOIPGI>

0:55 / 14:58



I've studied nuclear war for 35 years -- you should be worried. | Brian Toon | TEDxMileHigh

3,527,906 views • Feb 1, 2018

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Edit profile

Alan Robock 

@AlanRobock

Climate scientist, working on nuclear winter, volcanic eruptions and climate, geoengineering, and global warming. envsci.rutgers.edu/~robock

 Manasquan, NJ, USA  climate.envsci.rutgers.edu/nuclear/

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Mexico hosted the **Second Conference on the Humanitarian Impact of Nuclear Weapons** in Nayarit, February, 2014, attended by 146 nations, the United Nations, Red Cross, Red Crescent, and civil society.



First week of Ban negotiations at UN, March 27-31, 2017

The New York Times

<https://nyti.ms/2uRgH4p>

AMERICAS

A Treaty Is Reached to Ban Nuclear Arms. Now Comes the Hard Part.

By RICK GLADSTONE JULY 7, 2017

UN Treaty on the Prohibition of Nuclear Weapons

Significance and Impact of the Treaty

Delegitimizes nuclear weapons. This treaty is a clear indication that the majority of the world no longer accepts nuclear weapons and do not consider them legitimate weapons, creating the foundation of a new norm of international behavior.

Changes party and non-party behavior. As has been true with previous weapon prohibition treaties, changing international norms leads to concrete changes in policies and behaviors, even in states not party to the treaty. This is true for treaties ranging from those banning cluster munitions and land mines to the Convention on the law of the sea. The prohibition on assistance will play a significant role in changing behaviour given the impact it may have on financing and military planning and preparation for their use.

UN Treaty on the Prohibition of Nuclear Weapons

Significance and Impact of the Treaty

Completes the prohibitions on weapons of mass destruction. The treaty completes work begun in the 1970s, when chemical weapons were banned, and the 1990s when biological weapons were banned.

Strengthens International Humanitarian Law (“Laws of War”). Nuclear weapons are intended to kill millions of civilians – non-combatants – a gross violation of International Humanitarian Law. Few would argue that the mass slaughter of civilians is acceptable and there is no way to use a nuclear weapon in line with international law. The treaty strengthens these bodies of law and norms.

Removes the prestige associated with proliferation. Countries often seek nuclear weapons for the prestige of being seen as part of an important club. By more clearly making nuclear weapons an object of scorn rather than achievement, their spread can be deterred.

Treaty to Prohibit Nuclear Weapons Passes Important Threshold

Fifty countries have now ratified the treaty, so it will become international law. The United States and the eight other nuclear-armed powers reject it but have failed to stop its advance.



António Guterres, the United Nations secretary general, with papers second from right, at the signing of the Treaty on the Prohibition of Nuclear Weapons in 2017. Don Emmert/Agence France-Presse — Getty Images

<https://www.nytimes.com/2020/10/25/world/americas/nuclear-weapons-prohibition-treaty.html>

By Rick Gladstone

Oct. 25, 2020



The 50th
ratification
occurred on
October 24,
2020, the 75th
anniversary of
the founding of
the United
Nations. It will
come into force
on January 22,
2021.

#NuclearBan

WISH YOU WERE HERE.





R-12 ROCKET (SS-4)

Middle range ballistic rocket belonging to the Strategic Rocket Troops

Length: 22.1 m

Diameter: 1.65 m

Weight: 27 200 Kg

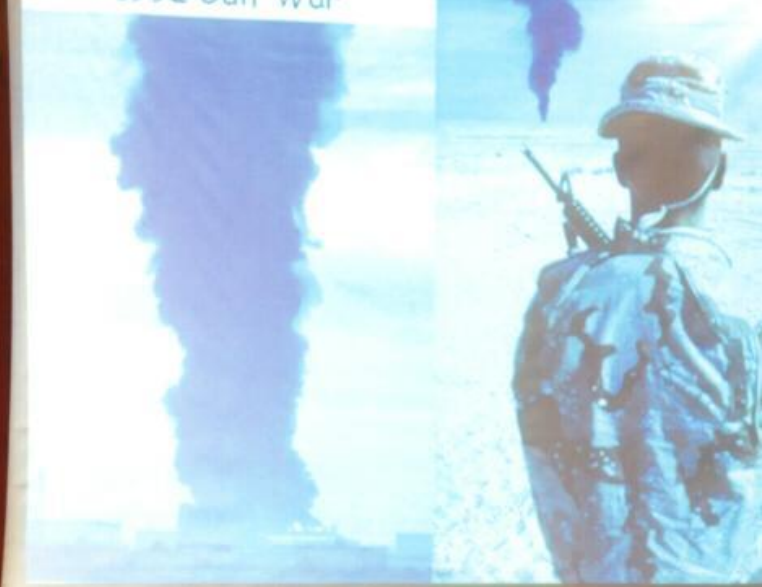
Range: 700 to 2100 Km

Power of nuclear load: 1 megaton (77 times more powerful than the bomb which devastated Hiroshima).

Three regiments arrived in Cuba with a total of 36 operational rockets with 36 nuclear heads. These were positioned at three ports: Bahia Honda, Mariel and Casilda at the Pinar del Rio province.

The exhibit is a replica donated by the Soviet Government during the early years of the Revolution.

Scenes from the
1992 Gulf War



By a debutant
Sept. 14 de 2010



Fidel Castro Ruz

Reflexiones
Sept. 23, 2010



"While the United States and Russia each committed to reducing their operative nuclear arsenals down to some 2,000 weapons in April 2010 in Prague, the only way to prevent a global climate catastrophe from taking place would be by eliminating nuclear weapons."

A lecture by a professor, or a feature film?



The Opinion Pages | OP-ED CONTRIBUTORS

Let's End the Peril of a Nuclear Winter

By ALAN ROBOCK and OWEN BRIAN TOON FEB. 11, 2016



NUCLEAR ARMS CONTROL IN REVERSE

After end of the Cold War US activists moved on to other issues. But the anti-nuclear-arms-control people did not.

2002: G. W. Bush took US out of ABM Treaty and Russia began to develop new types of delivery vehicles. China began to build up.

2018: Trump Administration took US out of agreement that froze Iran's nuclear program. Seeks regime change instead.

2019: Took US out of 1987 Intermediate-Range Nuclear Forces Treaty under which US and Soviet Union had destroyed all ~2700 land-based missiles with ranges between 500 and 5500 km.

2020: Took US out of Open Skies Treaty

Discussed conducting a rapid nuclear test

Declined to extend New START Treaty, which limits US and Russian long-range missiles, bombers and associated deployed warheads.

The U.S. President can take these immediate steps to make the world safer from nuclear war:

1. Take US land-based missiles off hair-trigger alert.
2. Give up sole presidential authority to launch nuclear weapons.
3. Extend the New START Treaty with Russia for another five years. No Congressional approval needed.
4. Change our nuclear policy to one of no first use of nuclear weapons. All options do not need to be on the table.
5. Stand down our land-based missiles and begin to dismantle them as part of a rapid reduction of our nuclear arsenal. No treaty with Russia is needed to do this.

In the longer term, there are additional steps to take.

Work with our allies, Russia, China, and Iran to re-establish our participation in the Iran agreement that prevents them from developing their own nuclear weapons, the Joint Comprehensive Plan of Action.

Halt the nuclear modernization program that is scheduled to cost more than \$1 trillion over the next decade.

Sign the Treaty on the Prohibition of Nuclear Weapons, which will lead to the goal of a world free of nuclear weapons as clearly stated by former presidents Reagan and Obama, but toward which there has been little progress so far.

"Every gun that is made, every warship launched, every rocket fired signifies, in the final sense, a theft from those who hunger and are not fed, those who are cold and are not clothed. This world in arms is not spending money alone. It is spending the sweat of its laborers, the genius of its scientists, the hopes of its children."

President Dwight D. Eisenhower, April 16, 1953

"For the greatest benefit to mankind"

Alfred Nobel



The Norwegian Nobel Committee has decided to award the

2017 NOBEL PEACE PRIZE

to:



International Campaign to Abolish Nuclear Weapons (ICAN)

"for its work to draw attention to the catastrophic humanitarian consequences of any use of nuclear weapons and for its ground-breaking efforts to achieve a treaty-based prohibition of such weapons."

 Nobelprize.org

Illustrations: Niklas Elmehed. Nobel Prize Medal: © The Nobel Foundation. Photo: Thomas Widerberg.



Beatrice Fihn
Executive Director of ICAN
Nobel Peace Prize Lecture
December 10, 2017

The story of nuclear weapons will have an ending, and it is up to us what that ending will be.

Will it be the end of nuclear weapons, or will it be the end of us? One of these things will happen.

The only rational course of action is to cease living under the conditions where our mutual destruction is only one impulsive tantrum away.

Conclusions

Nuclear weapons can be used if they exist.

A nuclear war could start tomorrow by accident, hackers, computer failure, bad sensors, or unstable leaders.

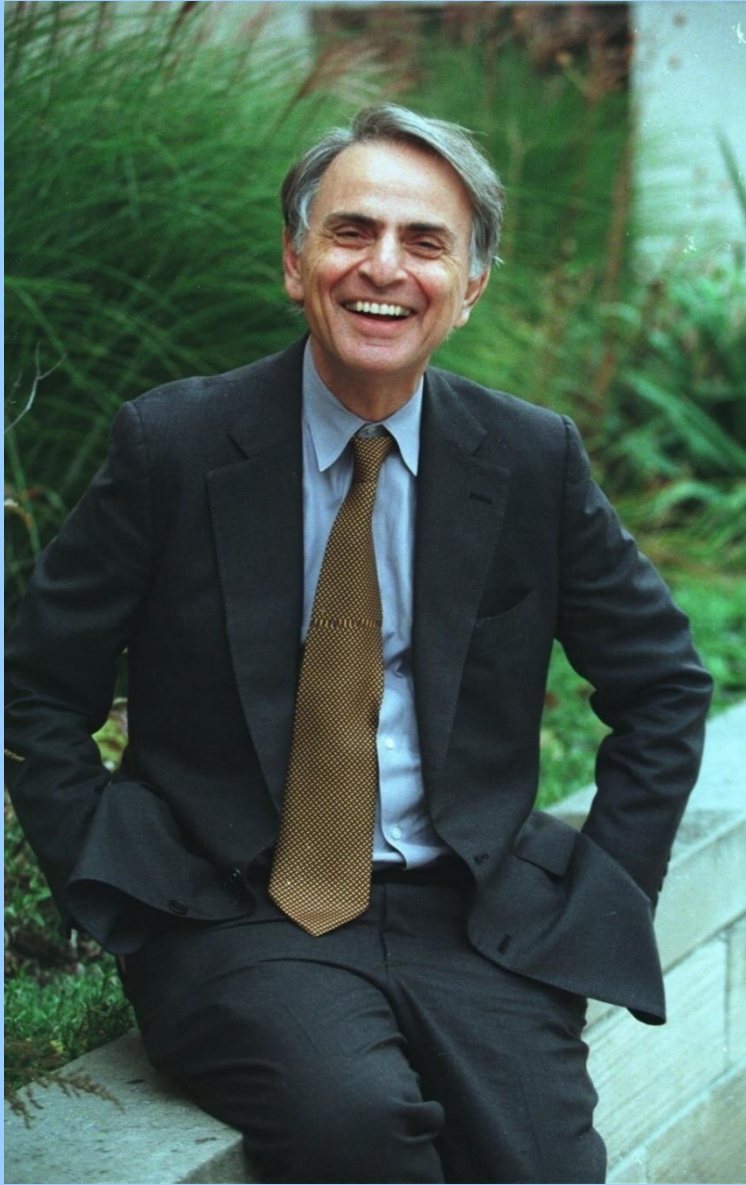
Nuclear arsenals do not deter attacks from non-nuclear states, terrorists, or pandemics.

The only way deterrence could work between nuclear states is if states believe other states are willing to kill themselves by using their nuclear weapons, and if there is a guarantee that there will no unintended use.

The only way to prevent a global catastrophe is to get rid of nuclear weapons.

Policy Implications

1. **Immediate American and Russian reductions** to the same arsenal sizes of the other nuclear nations, about 200 weapons each, would maintain the nuclear deterrence of each and **prevent nuclear winter**.
2. **Nuclear abolition** will **prevent nuclear famine**.



"For myself, I would far rather have a world in which the climatic catastrophe cannot happen, independent of the vicissitudes of leaders, institution, and machines. This seems to me elementary planetary hygiene, as well as elementary patriotism."

-Carl Sagan

"Elementary planetary hygiene" demands that we eliminate nuclear weapons faster than the current pace.



For more about this work, go to

<http://climate.envsci.rutgers.edu/nuclear/>

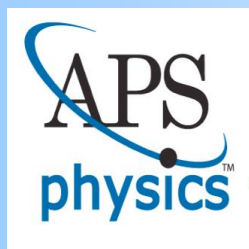
You can join the Physicists Coalition for Nuclear Threat Reduction at <http://physicistscoalition.org/>, a project to engage and activate the US physics community.

Sponsored by American Physical Society, partnered with the APS Office of Government Affairs, with support from the Carnegie Corporation

Steered through the Princeton Program on Science and Global Security

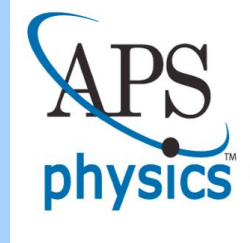
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The Physicists Coalition for Nuclear Threat Reduction

<http://physicistscoalition.org/>



Goals

- Education: Inform and engage the physics community
- Advocacy: Build the Coalition for organized advocacy

The purpose of the first goal is to serve the second goal.

Engaging and recruiting

- Through site visits, such as today (team of 12 experts available)
- Open to all physical scientists, including those in engineering science

Advocacy

- By informed "citizen-scientists" (not experts)
- Centrally facilitated (to make easy and minimize time consumption)
- To Congress and other stake holders