Climate and Health Effects of Regional Nuclear War

How sudden global cooling could produce a "nuclear famine"

Script to accompany IPPNW powerpoint presentation

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TITLE SLIDE:

We know that a large scale nuclear war involving a substantial portion of the nuclear arsenals of the United States and Russia would have devastating consequences far beyond these two countries and would constitute a truly global catastrophe. In the late 1980s, Carl Sagan and a respected team of climate scientists described the "nuclear winter" that would result from such an exchange of thousands of nuclear weapons.

Recent studies by O. B. Toon of the University of Colorado at Boulder, Alan Robock of Rutgers University, and their colleagues have shown that even a "limited" nuclear conflict, involving as few as 100 Hiroshima-sized bombs, would have global climate implications. Among the most serious consequences, a significant cooling of the earth's surface would curtail growing seasons for a decade or more, affecting the food security of billions of people far removed from the area of conflict.

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Citations:

Toon, Owen B., Richard P. Turco, Alan Robock, Charles Bardeen, Luke Oman,

and Georgiy L. Stenchikov, 2007: Atmospheric effects and societal consequences of regional scale nuclear conflicts and acts of individual nuclear terrorism. Atm. Chem. Phys., 7, 1973-2002.

Robock, Alan, Luke Oman, Georgiy L. Stenchikov, Owen B. Toon, Charles Bardeen, and Richard P. Turco, 2007: Climatic consequences of regional nuclear conflicts. Atm. Chem. Phys., 7, 2003-2012.

Robock, Alan, 2007: Climate effects of a regional nuclear conflict. IPRC Climate, 7, no. 1, 16-18.

Mills, Michael J. Owen B. Toon, Richard P. Turco, Douglas E. Kinnison, Rolando R. Garcia. Massive global ozone loss predicted following regional nuclear conflict. PNAS, 2008;105(14):5307-5312.

Robock, Alan, Luke Oman, and Georgiy L. Stenchikov, 2007: Nuclear winter revisited with a modern climate model and current nuclear arsenals: Still catastrophic consequences. J. Geophys. Res., 112, D13107, doi:2006JD008235.

Toon, Owen B., Alan Robock, Richard P. Turco, Charles Bardeen, Luke Oman, and Georgiy L. Stenchikov, 2007: Consequences of regional-scale nuclear conflicts. Science, 315, 1224-1225.

(All articles available at http://envsci.rutgers.edu/~robock/nuclear)

SLIDE 2:

For the next 20 minutes, we will look at these findings in detail and explore the implications for public health, security, and nuclear weapons policy.

Following a brief introduction to the medical consequences of nuclear war, we will explain the concept of nuclear winter as the context for the most recent scientific findings on the climatic effects of nuclear war as it might be fought today.

After summarizing the findings themselves, we will examine the potential impact of nuclear-war-induced climate disruption on agriculture and food supplies, and the threat this will pose to the survival of a billion or more of the world's most at-risk populations.

Finally, we will look at the policy implications of this much-needed factual reminder that nuclear weapons are not only the most destructive and inhumane

weapons ever created, but that they are also incompatible with human survival. If even a relatively small nuclear exchange can have such devastating, perhaps irreversible, effects, then the only responsible course of action is to achieve a nuclear-weapons-free world through negotiation and adoption of a Nuclear Weapons Convention.

SLIDE 3:

Our medical knowledge about the effects of nuclear war can be traced back to the US atomic bombings of Hiroshima and Nagasaki, at the end of World War II. A Hiroshima-sized bomb contains the equivalent of 15 kilotons -- that is 15 thousand tons -- of TNT. A weapon of this size can destroy a small city in a matter of moments, as was the case in Hiroshima, where more than 150,000 people died as a result of this one bomb.

SLIDE 4:

The medical effects of a nuclear explosion over a populated city depend on a number of factors: the size and yield of the weapon; whether it is exploded on the ground or in the air; population density; and weather conditions. The typical effects of a Hiroshima-size bomb have been well documented, and are summarized in this slide.

A 2002 study published in the British Medical Journal projected that a 12.5-kiloton nuclear explosion at ground level near the port area of New York City would kill 262,000 people: 52,000 from immediate injuries and the remainder succumbing to radiation sickness. Caring for survivors would also be difficult, if not impossible, with the loss of 1,000 hospital beds in the blast and another 8,700 available beds in areas of high radiation exposure.

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Citations:

Lachlan Forrow, Victor W. Sidel, Jonathan E. Slutzman. Medicine and Nuclear War: Preventing Proliferation and Achieving Abolition. IPPNW: Cambridge, MA. 2007.

Ira Helfand, Lachlan Forrow, Jaya Tiwari. Nuclear terrorism. BMJ 2002;24(7333): 356–9.

SLIDE 5:

At the height of the Cold War between the US and the former Soviet Union, when the superpowers were engaged in a heated confrontation that could have resulted in a nuclear war involving thousands of warheads dwarfing the Hiroshima and Nagasaki bombs, Carl Sagan and a group of respected climate scientists, including Richard P. Turco of UCLA and O. B. Toon of the University of Colorado produced what came to be known as the TTAPS study on "nuclear winter."

According to Professor Alan Robock of Rutgers University, "The basic theory of nuclear winter is very simple….Smoke from burning cities would absorb incoming sunlight heating the atmosphere. Dust from ground bursts would reflect sunlight back to space. But both would prevent sunlight from penetrating the atmosphere, making it cold and dark at the Earth's surface. These rapid, large surface temperature drops would make it as cold at the surface in the summer as it gets in the winter."

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Citations:

R. P. Turco, O. B. Toon, T. P. Ackerman, J. B. Pollack, and Carl Sagan. Nuclear Winter: Global Consequences of Multiple Nuclear Explosion. Science 1983;222:1283-1292.

R. P. Turco, O.B. Toon, T. P. Ackerman, J. Pollack, and C. Sagan. Climate and smoke: An appraisal of nuclear winter. Science, 1990;247:166-176.

SLIDE 6:

We use a nuclear war between India and Pakistan as an example of what would happen in an exchange involving only a small fraction of the nuclear weapons that still exist in the world's arsenals. More than 95% of this global stockpile is possessed by the US and Russia, whose tens of thousands of nuclear weapons are capable of producing multiple nuclear winters.

SLIDE 7:

The fact is that any nuclear war on this scale, whether it occurs in South Asia, the Middle East, in Europe, or in some currently unforeseen conflict between the US and Russia, will have the same outcome.

SLIDE 8:

In the case of a war between India and Pakistan involving the hundred or so Hiroshima-sized bombs in their combined arsenals, as many as 20,000,000 people might die as a direct consequence of the nuclear explosions, given the high population density of the cities in South Asia. The effects would not be limited to India and Pakistan. Much of the South Asian subcontinent would suffer the consequences of radioactive fallout, and large areas would be rendered uninhabitable, perhaps for decades.

As we have now learned from climate scientists who have conducted rigorous studies, there would be devastating global effects, as well.

SLIDE 9:

100 nuclear explosions over megacities -- the most likely targets -- would ignite fires that would burn whole cities, lofting soot high into the atmosphere where it would absorb incoming sunlight and produce persistent average surface cooling.

Perhaps more important than the average cooling, there would be decreases in the growing season of 10 to 20 days in many of the most important grain producing areas throughout the world.

SLIDE 10:

We saw similar effects on a much more limited scale during the 1991 Gulf War when large numbers of oil wells burned.

SLIDE 11:

This graph by Alan Robock shows that the debris injected into the atmosphere from the explosions and resulting fires would produce an average surface cooling of -1.25ºC that would last for several years. Even 10 years out, there would be a persistent average surface cooling of -0.5ºC. (Graph courtesy of Alan Robock)

SLIDE 12:

How significant is a temperature drop of 1.25 degrees? We are all concerned

about global warming. This slide shows the total extent of global warming over the last one hundred and twenty years.

SLIDE 13:

And this slide shows how this compares to the abrupt cooling that would take place over a 10-year period after a regional nuclear war.

In fact, such an event would rapidly drop temperatures below anything the earth has experienced in the last millennium, even during the "Little Ice Age" of the 15th century.

SLIDE 14:

In addition to this abrupt and severe cooling, a regional nuclear war would alter precipitation patterns around the world. As we see in this slide, there would be major declines – up to 40% – in many of the world's most important grain growing regions.

SLIDE 15:

And because of this cooling and drying, the crop growing season would be shortened by anywhere from 10 to 30 days in these critically important grain growing regions causing, in some areas loss of the entire crop which would not have time to ripen.

SLIDE 16:

Here is an enlarged detail from the same chart, showing the curtailed crop season in North America…

SLIDE 17:

…and another, showing the curtailed crop season in Europe…

SLIDE 18:

…and in Asia.

SLIDE 19:

The most important direct effect of these changes in temperature and precipitation would be a decrease in global food production. While there are no accurate estimates of the shortfall in food production available at this time, there is historical experience from previous cooling episodes which suggests the impact on food supplies would be very large.

An early, not well documented, but prolonged episode of global cooling took place between 536 and 554, and may have been precipitated by a large volcanic eruption in Indonesia, in the Sunda Strait between Java and Sumatra. The historical record from this period is quite fragmentary, but references to extensive crop failure and severe famine are found in documents from Byzantium, China, Korea, and Japan, and the archeological record suggests a devastating drought in South America and the western United States.

SLIDE 20:

In 1783-1784 the Laki volcano in Iceland erupted for eight months, filling the atmosphere with particles, cooling the Eurasian land mass, and causing a collapse of the Indian and African monsoons. The inundation of the Nile river was insufficient in both 1783 and 1784. About one sixth of the population of Egypt had either died or left the country by January 1785, as a consequence of famine from the resulting crop failures.

Moreover, as documented by Luke Oman, Alan Robock, and their co-authors in a 2006 study, the same event contributed to famine in India and China in 1783; as well as the Great Tenmei Famine in Japan, from 1783-1787, caused by the collapse of the East Asian monsoon and locally exacerbated by the Mount Asama eruption of 1783.

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Citation:

Oman, Luke, Alan Robock, Georgiy L. Stenchikov, and Thorvaldur Thordarson, 2006: High-latitude eruptions cast shadow over the African monsoon and the flow of the Nile. *Geophys. Res. Lett.*, **33**, L18711, doi:10.1029/2006GL027665.

SLIDE 21:

In 1815 the Tambora volcano exploded in Indonesia — the largest volcanic eruption in recorded history. The result was global cooling over the next year that produced "the year without a summer" in 1816. Global temperatures fell only 0.7 degrees C., but there was a dramatic shortening of the growing season around the world.

SLIDE 22:

In the Northeastern United States and Eastern Canada, which were particularly hard hit, four major frosts occurred during the course of the summer — June 6-11, July 9-11, August 21, and August 30. New England and Quebec experienced a major snow storm in June. These periods of frost caused extensive damage to crops, particularly to the most important crop, corn (maize), much of which was destroyed. The resulting shortages led to the extensive slaughter of livestock that could not be fed, and to a doubling in grain prices throughout the area.
In the North America, where population density was still quite low, there was relatively little hunger, except in some isolated rural communities. In the more densely populated countries of western and northern Europe the effects were far more severe with the widespread crop failures leading to outright famine. As described in a letter published in an Albany, New York newspaper that year, "From the Baltic to Breslau the greater part of the land sewn with winter wheat has been obliged to be ploughed up, and of the corn that remains standing scarcely one third part of a crop is to be expected." Famine was reported in Ireland, the German states, Switzerland, and France, and again a doubling of prices for grain occurred. In Europe, a much greater disaster was averted only because of the very strong harvest in 1815, which had left grain stocks high at the outset of the famine, and another strong harvest in the summer 1817. As it was, "In the spring of 1817 pallid, half starved people were wandering the fields, hunting for, and grubbing up, overlooked and rotting potatoes of the last year's crop." Crop failures and famine were also reported in India.

SLIDE 23:

During all of these prior events, crop failures were due primarily to cooling, a decrease in sunlight available for photosynthesis, and lower precipitation; several other factors might affect the size of available food stocks in the event of a regional nuclear war. Newly published studies have shown that the soot injected into the atmosphere would cause severe ozone depletion. This would cause extensive damage to many crops which are sensitive to ultraviolet light. Furthermore, food that was grown might be diverted to industrial use. Today

ethanol production is already using significant quantities of grain that would otherwise be available as food or livestock feed.

In the event that a regional nuclear war involved petroleum producing countries, or disrupted shipping from petroleum producing countries, there might be increased diversion of grain to ethanol production to try to make up for this shortfall. Further there would be less petroleum available to power irrigation pumps, tractors and other farm machinery, to transport crops to market, and to make fertilizer and pesticides. Finally, if a regional war resulted in significant radioactive contamination of one or more major food producing countries, large quantities of food might need to be destroyed and significant areas of crop land might need to be taken out of production.

SLIDE 24:

At this point in time, we are ill prepared to deal with a major fall in world food supply. As of mid August of 2007, global grain stocks were approximately 322 million tons with annual consumption at 2,098 million tons. Expressed as days of consumption world grain stocks are therefore approximately 56 days, lower than at any point in the last 50 years, and dramatically lower than the 100 to 120 days of consumption available in the 1980s and 1990s. These stocks would not provide any significant reserve in the event of a sharp decline in global production.

SLIDE 25:

At our current baseline there are already millions of people suffering chronic malnutrition. While there is considerable academic debate about the exact scope of global malnutrition, and even about the best way to define malnutrition, the average adult needs somewhere between 1,800 and 2,000 calories per day, depending on his or her stature, to meet basic metabolic requirements and to sustain a minimal level of physical activity. Requirements for children are dependent on age and size. There are more than 800 million people in the world whose daily caloric intake falls below these minimum requirements. Each year some five million children in this group starve to death. A small further decline in available food would put this entire group at risk.

SLIDE 26:

Given these conditions, even a modest, sudden decline in agricultural production could trigger massive famine. Because it is not the amount of food that is

available — the total amount that has been harvested — that is important in causing a famine. It is the amount of food that is accessible, that people can put on their tables that determines whether there is famine or not. And a very small decline in available food can trigger a very large decline in accessible food.

SLIDE 27:

Looking at the historical record again, at the time of the great Bengal famine of 1943, food production was only 5% less than it had been on average over the preceding five years, and it was actually 13% higher than it had been in 1941, when there was not a famine. But in 1943, after the Japanese occupation of Burma, which had historically exported grain to Bengal, the decline in food production was coupled with panic hoarding. The price of rice rose nearly five fold, making food unaffordable to large numbers of people. These two factors, hoarding and the severe increase in rice prices, caused an effective inaccessibility of food far more severe than the actual shortfall in production. And three million people starved to death.

SLIDE 28:

In the event of a major global cooling episode with widespread crop failures, a similar scenario would unfold on a global scale. Whatever the initial shortfall in agricultural production — and it might be much higher than the modest 5% drop that triggered the Bengal famine — there would be widespread panic, particularly if there were a general understanding that crops would continue to fail for a number of years. In 1972, the price of both wheat and rice doubled simply in response to a tightening of world food stocks to just under 60 days of consumption.

In this setting we would expect to see much greater rises in grain prices worldwide. These price increases would put a crippling burden on whole countries which import large portions of their food supply and would make food unaffordable for hundreds of millions of individuals who are already malnourished precisely because of their inability to afford adequate food even at current world prices.

SLIDE 29:

In addition we would probably see hoarding on a global scale. In September 2002, Canada, faced with a sharp decline in wheat production because of drought conditions, suspended wheat exports for a year. The next year the

European Union took similar action, as did Russia. And in August 2004 Vietnam indicated it would not export rice until the following spring.

In response to the evolving energy crisis in 2009, many countries began to hoard food. As the *New York Times* reported on June 30, “At least 29 countries have sharply curbed food exports in recent months, to ensure that their own people have enough to eat, at affordable prices...The restrictions are making it harder for impoverished importing countries to afford the food they need.”

In the event of a regional nuclear war, the grain exporting states would be faced with major crop losses and the prospect of bad harvests for the next several years. It is probable that they would take similar action, and refuse to export whatever grain surplus they might have, retaining it instead as a domestic reserve. This year global grain consumption is about 2,098 million tons, of which 220 million tons, or 11% is imported. Many countries which currently do not have major problems with widespread malnutrition are nonetheless dependent on imported food.

For example, North Africa, home to more than 150 million people, with average caloric consumption well above the minimal level, imports 45% of its food. A number of other countries in the Middle East, plus Malaysia, South Korea, Japan and Taiwan, are also dependent on imports for 50% or more of their grain consumption. The wealthier of these countries might initially be able to obtain some grain on the international market by bidding up the price, but as the extent of the global crop failures became clear, grain producing countries would tighten their export bans, and the hundreds of millions of people dependent on grain imports would also face starvation.

We have seen the emergence of a “global food crisis” in 2008 because of market forces that are placing growing pressure on food supplies and prices, even without the sudden, catastrophic disruption that would be caused by a nuclear war.

SLIDE 30:

Somewhat paradoxically, the ongoing effects of global warming might make the world more vulnerable in the event of a sudden cooling event. For example, in Africa, according to a recent study by the United Nations Framework Convention on Climate Change, “Increasingly variable growing season conditions are disrupting subsistence agricultural production leading to famine.” Populations already weakened by the negative effects on food production of global warming would be less able to withstand a sudden further decline in accessible food.

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Citation:

UNFCCC. Background paper on impacts, vulnerability and adaptation to climate change in Africa. Africa Regional Workshop on Adaptation. Accra, Ghana; September, 2006. Online at: http://unfccc.int/adaptation/adverse_effects_and_response_measures_art_48/items/3743.php

SLIDE 31:

It is, of course, impossible to estimate with accuracy the full extent of the global famine that would follow a regional nuclear war. But it seems reasonable to conclude that few of the 800 million people who are already malnourished would survive if their already substandard intake decreased by even 10% for a whole year. If the crop failures and resulting food shortages persisted for several years, their fate would be sealed. Additional hundreds of millions whose current intake is marginal, or who live in countries dependent on food imports would also be at risk, particularly if the famine persisted.

Thus, in the event of a protracted global cooling, triggered by a limited, regional nuclear war, it seems reasonable to fear that the total global death toll could exceed one billion from starvation alone.

Even the possibility that a “small” nuclear war could end the lives of a billion people and produce environmental and economic chaos for billions more, warrants a radical reevaluation of nuclear weapons policy and our global gamble that reliance on nuclear weapons is a meaningful and acceptable path to security. We will take up the necessity of global nuclear disarmament in a moment.

SLIDE 32:

Two other issues need to be considered as well. First, there is a very high likelihood that famine on this scale would lead to major epidemics of infectious diseases. The prolonged cooling and resultant famine in 536-545 was accompanied by a major outbreak of plague which developed over the next half century into a global pandemic. The famine of 1816 triggered an epidemic of typhus in Ireland that spread to much of Europe and the famine conditions in India that year led to a an outbreak of cholera that has been implicated in the first global cholera pandemic. The well studied Great Bengal Famine of 1943 was

associated with major local epidemics of cholera, malaria, smallpox, and dysentery.

Despite the advances in medical technology of the last half century, a global famine on the scale anticipated would provide the ideal breeding ground for epidemics involving any or all of these illness. In particular the vast megacities of the developing world, crowded, and often lacking adequate sanitation in the best of times, would almost certainly see major outbreaks of infectious diseases; and illnesses, like plague, which have not been prevalent in recent years might again become major health threats.

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Finally we need to consider the immense potential for war and civil conflict that would be created by famine on this scale. Within nations where famine is widespread there would almost certainly be food riots, and competition for limited food resources might well exacerbate ethnic and regional animosities. Among nations, armed conflict seems highly likely as states dependent on imports adopt whatever means are at their disposal in an attempt to maintain access to food supplies. It is impossible to estimate the additional global death toll from disease and further warfare that this "limited regional" nuclear war might cause, but given the world wide scope of the climate effects the dead from these causes might well number in the hundreds of millions. And in the worst case scenario, such conflict might escalate to…

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…the further use of nuclear weapons.

SLIDE 35:

The possibility that limited nuclear war might have such devastating, world wide consequences has important implications for nuclear policy. First we must understand that it is not only the superpowers who now hold the world hostage. Countries such as India and Pakistan — in fact, any country flirting with the idea of acquiring nuclear weapons — must understand that they too hold the fate of humanity in their hands.

Second, and most important, these findings are a powerful argument against the possession of nuclear weapons by any country, and for the urgent need to abolish these weapons from the arsenals of all nations. While we focused here

on the possibility of a nuclear war between India and Pakistan, the Israeli nuclear arsenal and the possible proliferation of nuclear weapons to Iran is also extremely dangerous. As the world's nuclear superpowers, the US and Russia have a special responsibility to lead by example, to eliminate their own nuclear arsenals, and to fully embrace the goal of a nuclear weapons free world.

The global federation International Physicians for the Prevention of Nuclear War has launched an International Campaign to Abolish Nuclear Weapons. ICAN seeks to promote a Nuclear Weapons Convention — a treaty similar to the Biological and Chemical Weapons Conventions — which will outlaw the possession of nuclear weapons and provide a clear framework for verifiable, multilateral steps to eliminate them from the face of the earth.

SLIDE 36:

IPPNW was founded in 1980 by physicians from the US and the former Soviet Union who felt a profound responsibility to warn their countries' leaders and the rest of the world about the consequences of nuclear war and the abhorrent nature of nuclear weapons.

IPPNW promoted Soviet-American dialogue at the height of the Cold War; organized demonstrations against nuclear testing; and held symposia around the world to educate the public, policymakers, and the media about the catastrophic effects of nuclear war and the fact that doctors would be unable to provide a meaningful medical response to such unprecedented devastation.

SLIDE 37:

For its work to educate the public, policy-makers, and media about the effects of nuclear war, IPPNW received the UNESCO Peace Education Prize in 1984 and the Nobel Peace Prize in 1985.

Soviet President Mikhail Gorbachev, who met with the Federation's co-founders, Drs. Bernard Lown and Evgueni Chazov in 1987, credited IPPNW with influencing his thinking about nuclear weapons and with his decision to halt nuclear testing. In his book *Perestroika, Gorbachev said:*

"In light of IPPNW's arguments and the strictly scientific data which they possess, there seems to be no room left for politicking. And no serious politician has the right to disregard their conclusions or neglect the ideas by which they take world opinion a stage ahead."

SLIDE 38:

In the 1990s, IPPNW built on its foundation of medical research and education about nuclear war. It established an International Commission to Investigate the Health and Environmental Effects of Nuclear Weapons Production and Testing and worked with the Institute for Energy and Environmental Research to document these effects in book-length studies such as Radioactive Heaven and Earth and Nuclear Wastelands.

IPPNW was one of the first organizations to draw attention to the danger of crude nuclear weapons and radiological weapons in the hands of terrorist organizations and other non-state actors.

SLIDE 39:

Since the end of the Cold War, concerned with the failure of the nuclear weapon states to make good on their disarmament commitments, the emergence of new nuclear weapon states, and the growing danger of nuclear terrorism, IPPNW has continued to meet with nuclear decision makers around the world.

Given the nuclear competition between India and Pakistan, and the catastrophic consequences of a nuclear war between those countries, IPPNW placed special importance on meetings with Pakistani decision makers in Islamabad in 2007, and with the President and Prime Minister of India in 2008. Such meetings, where the medical and scientific facts about nuclear war can be brought into policy debates about disarmament and non-proliferation, are a priority of the International Campaign to Abolish Nuclear Weapons -- ICAN -- launched by IPPNW in 2007.

SLIDE 40:

The goal of ICAN is to reawaken public concern about the growing threat posed by nuclear weapons, and to mobilize civil society to demand a nuclear-weapon-free world through the negotiation and adoption of a Nuclear Weapons Convention.

In 2008 and 2009, ICAN activists will make the case that, along with global warming, nuclear war is the greatest preventable danger facing humankind. IPPNW will promote the Nuclear Weapons Convention both inside and outside the UN, and will focus on specific medical issues, including the climate effects of regional nuclear war ("nuclear famine"), the use of highly enriched uranium

(HEU) in radiopharmaceutical production, and the health impacts of an expanding uranium mining industry.

In 2007 and early 2008, IPPNW successfully launched **ICAN** at the Non-Proliferation Treaty Preparatory Committee conference in Vienna, and at national launch events in Australia, Canada, Denmark, France, India, Norway, Sweden, the UK, and other affiliate countries. ICAN's global partners, in addition to IPPNW's network of more than 60 national affiliates, include the Campaign for Nuclear Disarmament (CND) in the UK, Mayors for Peace, the Abolition 2000 network of disarmament NGOs, the Women's International League for Peace and Freedom, the Nobel Women's Initiative, Mouvement de la Paix, and the World Federation of United Nations Associations (WFUNA).

SLIDE 41:

The choice before us is stark. If we have forgotten the lessons of the Cold War, the current data about the climate effects of nuclear war should bring the stakes back into focus: either we will eliminate nuclear weapons or they will eliminate us.

SLIDE 42:

Alan Robock, Brian Toon, and their colleagues Georgiy Stenchikov and Richard Turco, are all participants in the Intergovernmental Panel on Climate Change, which won the Nobel Peace Prize in 2007.

SLIDE 43:

Professor Alan Robock of Rutgers University has published a wealth of information and educational resources about the climate effects of nuclear war on his website:
http://envsci.rutgers.edu/~robock/nuclear

For more information about ICAN and the Nuclear Weapons Convention, please visit www.icanw.org and www.ippnw.org