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How an India-Pakistan nuclear war could start—and have global consequences

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ABSTRACT
This article describes how an India-Pakistan nuclear war might come to pass, and what the local and global effects of such a war might be. The direct effects of this nuclear exchange would be horrible; the authors estimate that 50 to 125 million people would die, depending on whether the weapons used had yields of 15, 50, or 100 kilotons. The ramifications for Indian and Pakistani society would be major and long lasting, with many major cities largely destroyed and uninhabitable, millions of injured people needing care, and power, transportation, and financial infrastructure in ruins. But the climatic effects of the smoke produced by an India-Pakistan nuclear war would not be confined to the subcontinent, or even to Asia. Those effects would be enormous and global in scope.

KEYWORDS
Nuclear war; South Asia; Kashmir; cold start; tactical nuclear weapons; nuclear winter

It is the year 2025, and terrorists attack the Indian Parliament. In December 2001, a terrorist attack on the Indian Parliament resulted in the deaths of 12 people, including the 5 terrorists. This time, however, the attacks kill many more members of the Indian government. As happened in January 2002, both sides mobilize and deploy their troops along the border between the countries and in the disputed area of Kashmir. Because of the high tensions on both sides, skirmishes break out, and there are deaths on both sides. Since the Indian government has lost so many leaders, the Indian Army decides to act on its own, crossing the border into Pakistan with tanks and also the de facto border, known as the Line of Control, in Kashmir.

Pakistani generals panic and decide that the only way they can repulse an invasion by the superior Indian forces is with nuclear weapons. On the first day of the nuclear war, they use 10 tactical atomic bombs – each with a yield of 5 kilotons, or less than half the power of the bomb dropped on Hiroshima – inside their own borders, detonating them at low altitude, as air bursts against the Indian tanks. On the second day, after Pakistan uses another 15 tactical nuclear weapons, the Indians figure that if they attack Pakistani military targets with nuclear weapons, it might stop the war. The Indians use 20 strategic weapons detonated as airbursts, two over the Pakistani garrison in Bahawalpur and 18 above Pakistani airfields and nuclear weapons depots. Unlike Pakistan's tactical weapons, which were used in remote areas, these weapons start immense fires, with massive smoke emissions that rise into the upper atmosphere, as happened in Hiroshima after it was bombed by the United States in 1945, and as happened in San Francisco in 1906 as the result of fire following an earthquake.

The Indian escalation does not work. Rather than stopping its nuclear attacks, on the third day Pakistan uses 30 airbursts – 20 above garrisons in Indian cities and 10 over Indian naval bases and airfields in urban areas – and launches another 15 tactical nuclear weapons at Indian troops. India responds with nuclear airbursts over 10 Pakistani navy, army, and air force bases, all located in urban areas. Now the escalation cannot be stopped. There are anger, panic, miscommunication, and the following of pre-determined protocols on both sides. Over the next three days, Pakistan uses the rest of its strategic arsenal, with 120 weapons decimating Indian cities; India responds with another 70 airbursts, but reserves 100 weapons in its arsenal, thinking that they will deter any attack from China and ignoring a tragic reality: The Indian nuclear arsenal had just failed to deter a war with Pakistan that killed tens of millions of people immediately and would create enormous environmental impacts, causing famines that affect millions – or even billions – around the world. Figure 1 shows the locations of the 250 urban targets in our scenario.

Why an India-Pakistan nuclear war really could happen

It is not hard to imagine a skirmish between Indian and Pakistani troops along the Line of Control in Kashmir. However, neither country is likely to start a nuclear war because of such a skirmish. In fact,

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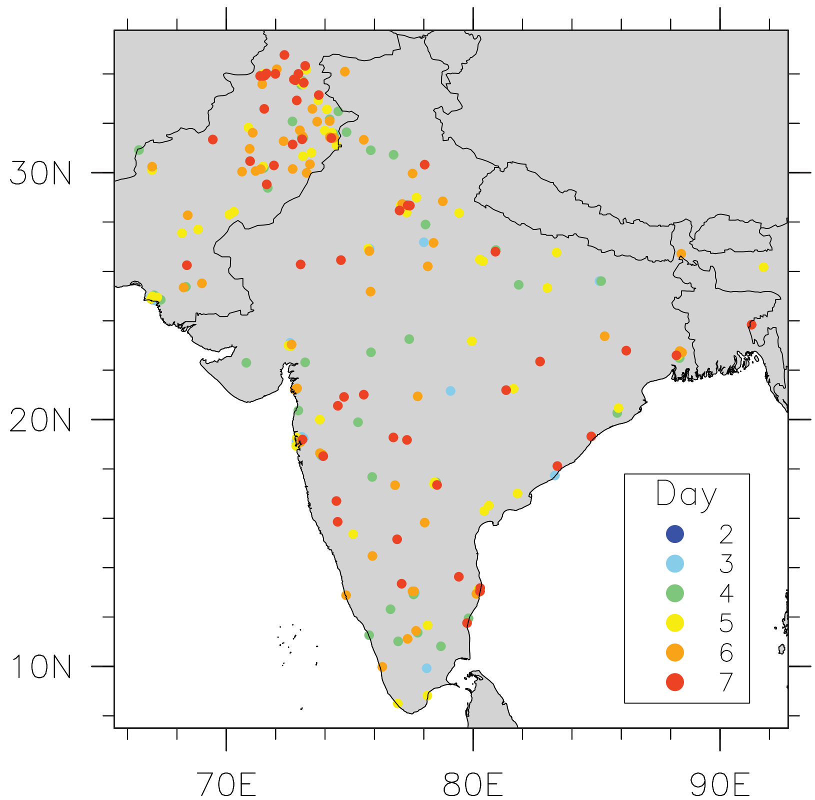

Figure 1. Urban targets in our India-Pakistan scenario. Different colors represent different days of the war. No urban targets are attacked on day 1. In dense urban areas, some of the dots overlap, for instance in Karachi on the southern coast of Pakistan. (Figure S1 from Toon et al. (2019)).

India, unlike Pakistan, has a declared policy of no first use of nuclear weapons. Pakistan says it will only use nuclear weapons if needed to defend itself should "conventional" means of warfare fail. However, these countries have fought four conventional wars (1947, 1965, 1971, and 1999) and had many skirmishes with substantial loss of life since the partition of British India in 1947. In early 2019, in fact, following fighting in Kashmir, India invaded Pakistan by air, and one of the Indian planes was downed inside Pakistan. Fortunately the pilot survived and was returned to India without further warfare. But will we always be so lucky? Just in August 2019, the constitutionally guaranteed special status of the state of Jammu and Kashmir was repealed by India, and the state was locked down by Indian troops to prevent protest. As of this writing, the situation remains tense, and India may reorganize the region into two new union territories that will be governed directly by the Indian Central Government rather than their own local governments.

To investigate the local and global consequences of a nuclear war between India, we (Toon et al. 2019) investigated the possible outcomes of such a war by considering one specific scenario of how it might start. While it is possible to think of many other story lines, the one we used is plausible. It by no means is intended to place blame on one side or the other for the initiation or escalation of the conflict, and such an escalation would not result without bad decisions on both sides, which could be exacerbated by terrorist attacks within either country, panic, loss of communication, technical failures in observing systems, hacking, or misinterpretation of the actions of the other military.

The scenario described here, we assume, would take place in the year 2025, when each country will possess about 250 nuclear weapons. In the end, Pakistan will use all its weapons, while India will reserve 100 of them to defend against future attacks from China, which, after all, is one reason the Indians obtained them in the first place.

The direct effects of this nuclear exchange would be horrible; our group (Toon et al. 2019) estimated that 50 to 125 million people would die, depending on whether the weapons used had yields of 15, 50, or 100 kilotons. (A kiloton is the equivalent of the explosive power of 1,000 tons of TNT.) The ramifications for Indian and Pakistani society would be major and long lasting, with many major cities largely destroyed and uninhabitable, millions of injured people needing care, and power, transportation, and financial infrastructure in ruins.

But the climatic effects of the smoke produced by an India-Pakistan nuclear war would not be confined to the subcontinent, or even to Asia. Those effects would be enormous and global in scope.

The smoke of war

We calculated the climatic effects of different amounts of smoke injected into the stratosphere as a result of nuclear war using a state-of-the-art climate model, as detailed in our study (Toon et al. 2019). A nuclear war between the United States and Russia could produce 150 teragrams (one teragram equaling one million tons) of smoke, which would create nuclear winter, with surface temperatures below freezing even in summer (Coupe et al. 2019).

For the India-Pakistan case, the amount of smoke would depend on how large the strategic weapons of the two countries might be. We have assumed that Indian and Pakistani strategic weapons are currently the size of the Hiroshima bomb (approximately 15 kilotons), but by 2025, both countries could have 50 kiloton or 100 kiloton bombs. India tested a weapon with a yield of 40 to 50 kilotons in 1998. In the India-Pakistan scenario, we calculated a total of 16.1 teragrams of black carbon injected into the upper atmosphere (11 from India and 5.1 from Pakistan) for weapons with yields of 15 kilotons; 27.3 teragrams (19.8 from India and 7.5 from Pakistan) for 50 kiloton weapons; and 36.6 teragrams (27.5 from India and 9.1 from Pakistan) for 100 kiloton weapons. The smoke would be heated by sunlight and lofted high into the stratosphere, where it could remain for years, since it doesn't rain in the stratosphere. Figure 2 shows that global average temperature and precipitation would be significantly lowered over the course of years, and Figure 3 shows how land and ocean temperatures would change separately, also showing a map of the temperature change for the middle scenario (27.3 teragrams of smoke from 50-kiloton detonations) in the second year after the war, when there would be the maximum effects.

A nuclear winter would halt agriculture around the world and produce famine for billions of people. Though not of the scale of the US-Russia nuclear war referenced earlier, all of the three scenarios described in the hypothetical India-Pakistan nuclear war just described would produce severe effects for periods of years. We have calculated how food production would change in China (Xia and Robock 2013; Xia et al. 2015) and the United States (Özdoğan et al., 2013) for specific crops for a case of 5 teragrams of smoke – that is, a case involving significantly less smoke than any of the three India-Pakistan scenarios described here. We are now using detailed calculations of how specific food crops globally would respond to the resulting temperature, precipitation, and sunlight reductions for

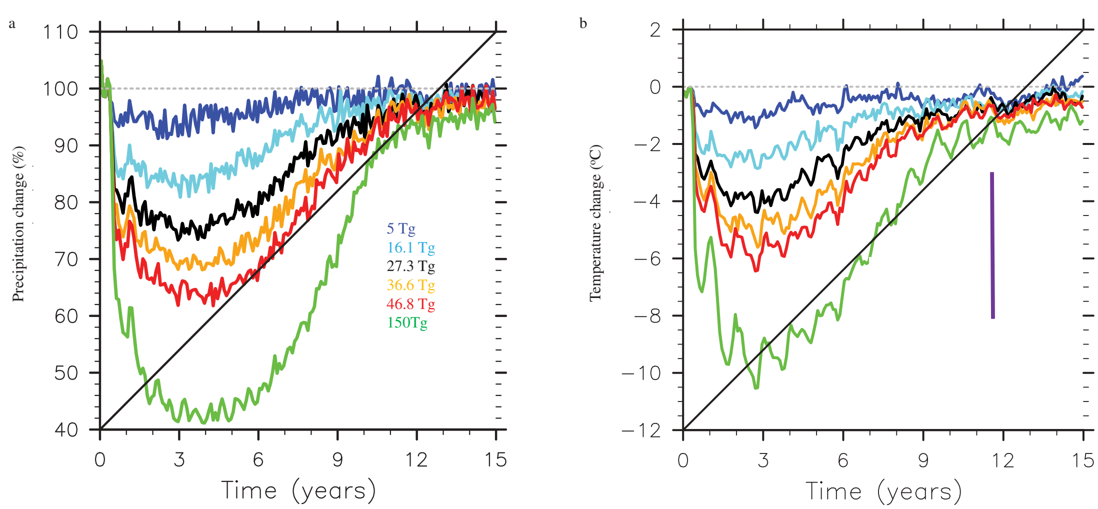

Figure 2. Global average precipitation (a) and global average temperature (b) show the climate response to different amounts of black carbon emitted into the upper atmosphere from fires following nuclear war. The vertical purple bar represents the range of temperatures during the height of the last ice age about 20,000 years ago. (Figure 5 from Toon et al. (2019)).

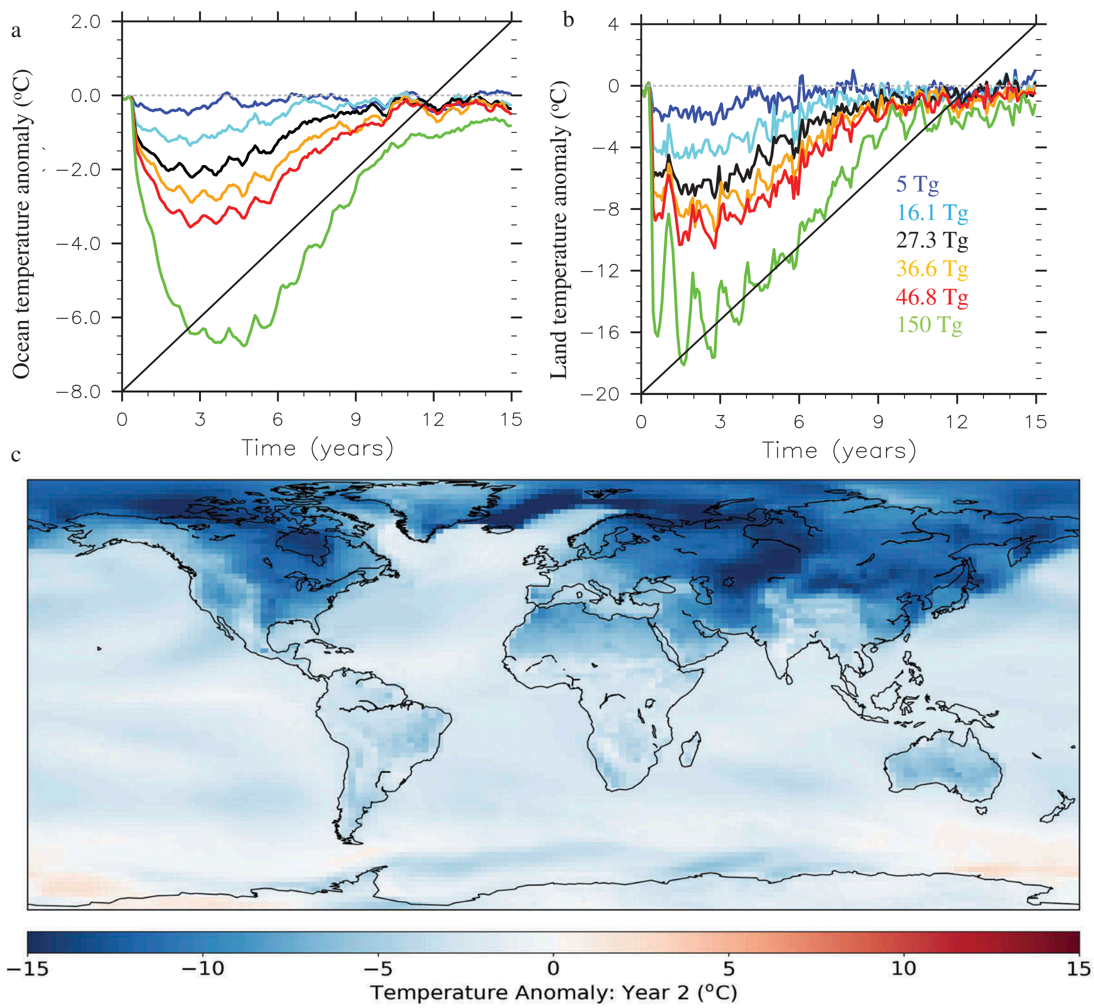

Figure 3. Decline in global average ocean surface temperature (a) and land surface temperature (b) as a function of time. Color-coding shows the assumed black carbon injections. 1 teragram (Tg) is 1 million tons. Panel C illustrates the global distribution of changes in ocean and land surface temperatures averaged over the second calendar year following a conflict beginning in May of year one for a scenario with 50 kt weapons, which results in a 27.3 Tg injection of black carbon. (Figure S6 from Toon et al. (2019)).

various smaller amounts of smoke. Also, ozone would be destroyed as the rising smoke absorbs sunlight and heats the stratosphere (Mills et al. 2014), allowing more ultraviolet light to reach the ground and creating negative effects that we have yet to study.

While we wait for agricultural simulations to be completed, our climate model can calculate a more general measure of environmental health, net primary productivity – a measure of how much carbon dioxide is converted to organic plant matter through photosynthesis after accounting for plant respiration. Net primary productivity is therefore a proxy for how much food could be grown on land and how much food would grow in the oceans for fish. (See Figure 4.) Based on these results, any of the India-Pakistan nuclear cases we posit clearly would cause large reductions in agriculture and food shortages. Depending on whether people hoard food or share, there could be famine for millions or billions of people – even for the smaller amounts of smoke in the scenarios presented here.

Conclusions about limiting and eventually eliminating nuclear weapons

We have investigated some of the more well known, as well as some lesser known, horrific consequences of the hostile use of nuclear weapons. These weapons have, in principle, had only one legitimate purpose: to deter warfare between nations. One could argue that that goal has to date been achieved,

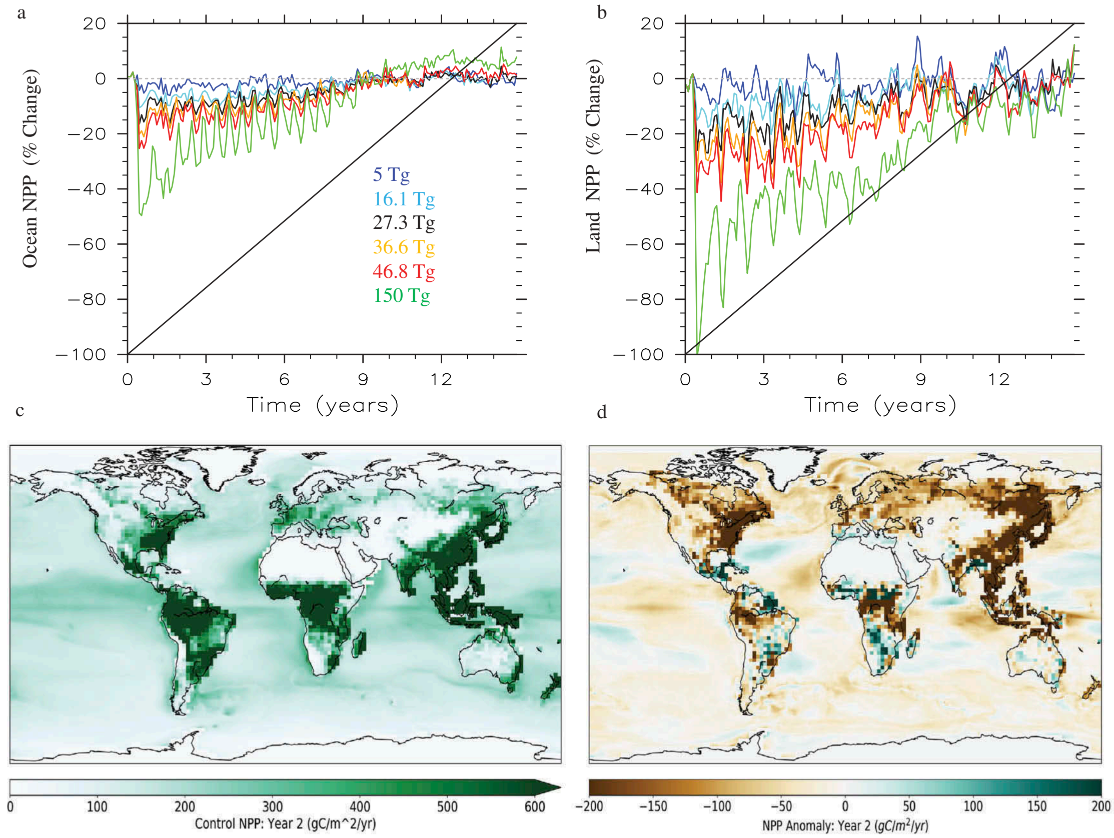

Figure 4. Globally-integrated monthly-averaged net primary productivity (NPP) change over the oceans (a) and land masses (b) for different amounts of smoke. NPP is a measure of how much carbon dioxide is converted to organic plant matter through photosynthesis after accounting for plant respiration, and is typically expressed as grams of carbon per square meter per year (gC/m^2/yr). Panel C gives the global distribution of annual average NPP for the baseline control run. Panel D shows the change from the baseline averaged over the second calendar year following a nuclear conflict which starts in May of year one for the scenario with 50 kt weapons and a 27 Tg injection of smoke (Figure 6 from Toon et al. (2019)).

inasmuch as no global military conflicts have occurred since World War II. On the other hand, the existence of enormous arsenals of nuclear weapons during this time has not prevented terrorism or countless regional, territorial, and politically motivated military actions, taking in aggregate a terrible human toll. It would be foolhardy, of course, to suggest that an effective way to stop warfare would be to arm all nations with nuclear weapons as local deterrents. Contrarily, we understand, in the 21st century, that establishing mechanisms for conflict negotiation and resolution on a global international basis is the only safe and practical way to end the carnage. We are not Pollyannas. But it should be the mission of every concerned citizen, particularly those in positions of influence, to work toward the abolition of nuclear weapons, within the context of global peace and security mechanisms.

During our lifetimes, we have seen progress toward this goal, especially through a series of specific nuclear arms treaties among the major nuclear powers, as well as peace programs and policies developed by the United Nations. For example, as of this writing, 32 nations have ratified the 2017 United Nations Treaty on the Prohibition of Nuclear Weapons, while 79 nations have signed the treaty; when 50 nations have ratified it, the treaty will come into force. However, the nine current nuclear weapons states, and many of their allies, have resisted this effort. These privileged countries, in general, want to proceed more slowly and carefully, with stepped reductions in, or stabilization of, existing nuclear arsenals. We would certainly applaud a progressive and well-thought-out nuclear weapons reduction and elimination plan for the world.

But it seems that some nations are instead headed for a replay of the old "Cold War." Not only has nuclear proliferation not ended, but additional countries are considering going nuclear. Instead of extending and expanding existing treaties, the United States and Russia are choosing to upgrade their arsenals and are talking about new generations of nuclear weaponry more effective than the old variety. "Rogue" nations – notably North Korea – are proceeding apace with their nuclear weapons programs despite hollow claims that they plan to denuclearize. And contemporary terrorist groups are seeking nuclear capability in an increasingly loose global bazaar for such devices. In this situation, and in light of the science we are familiar with, we must endorse forceful actions to limit and eventually eliminate nuclear weapons as a means of assuring peace. There is a way, and it must be achieved.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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