Gorbachev's unofficial arms-control advisers

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US NATIONAL ARCHIVES AND RECORDS ADMINISTRATION

After President Ronald Reagan's 1983 Star Wars speech, a puzzled group of Soviet scientists asked US colleagues opposed to ballistic-missile defense if they had changed their minds.

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This is an account of the contributions of a group of Soviet experts—three physicists and a historian—to ending the Cold War. They had the ear of Soviet leader Mikhail Gorbachev; but they realized that any Soviet initiatives would have to work in Washington as well. So they reached out to partner with nongovernmental organizations in the US that shared their goals. That's how I came to be involved.

For the November 1989 issue of PHYSICS TODAY (page 39) I wrote an article on nongovernmental arms-control research, which I subtitled "the new Soviet connection." For many years now, I've been intending to write another retrospective account of those men and events. When one of the four, Sergei Kapitsa, died last year at the age of 84, I could delay no longer.

In the meantime some excellent books have analyzed the broader history of which my story is a part.[1] Where specific references are not given here, the reader can find backup material in those books.

The Committee of Soviet Scientists

On 23 March 1983, President Ronald Reagan gave what came to be known as his Star Wars speech, in which he called

> upon the scientific community in our country, those who gave us nuclear weapons, to turn their great talents now to the cause of mankind and world peace, to give us the means of rendering these nuclear weapons impotent and obsolete . . . [by] eliminating the threat posed by strategic nuclear missiles.

A few months later, the Federation of American Scientists (FAS), of which I was chairman, received a letter from a group that had organized itself within the Soviet Academy of Sciences under the name Committee of Soviet Scientists for the Defense of Peace Against the Nuclear Threat (CSS). The letter recalled that American physicists had played key roles in convincing senior Soviet physicists in the late 1960s that ballistic-missile defenses would be futile and counterproductive: futile because they can be defeated by relatively simple countermeasures, and counterproductive because trying to undo the nuclear-hostage relationship between us and the Soviets would only stimulate a defense–offense arms race.

Those discussions had helped lay the foundation for the 1972 Treaty on the Limitation of Anti-Ballistic Missile Systems (the ABM treaty). The CSS letter asked whether American scientists had changed their minds. A reply was drafted by FAS executive director Jeremy Stone, who had gone to Moscow five times in the late 1960s to argue for the ABM treaty. The FAS had not changed its view, wrote Stone. A few weeks later, we received an invitation to come to Moscow in late November for discussions.

The CSS chairman was fusion physicist Evgeny Velikhov, vice president of the Soviet Academy of Sciences. His three deputy chairs, shown with him

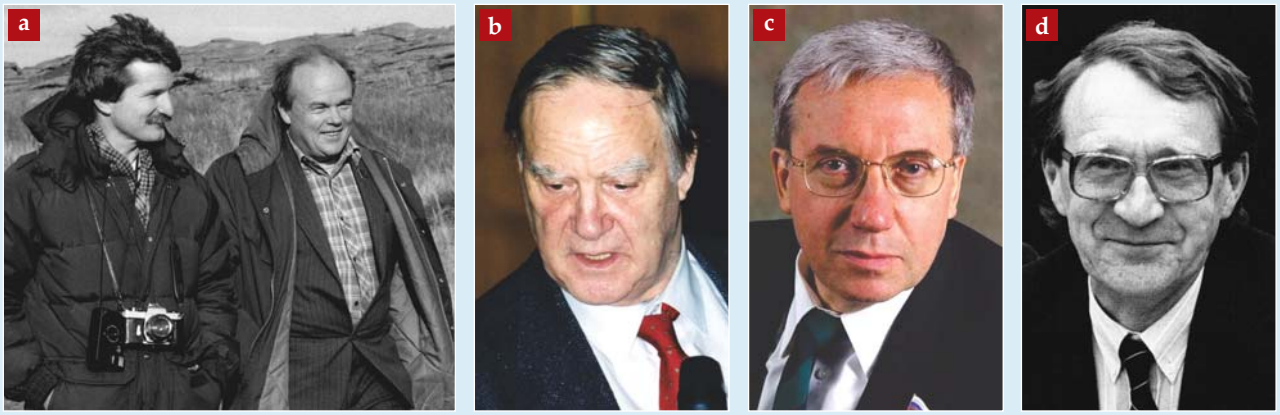

Figure 1. Leaders of the Committee of Soviet Scientists. (a) Evgeny Velikhov (right) with Thomas Cochran of the US Natural Resources Defense Council at a Soviet test site in Kazakhstan in 1986. (Photo from RIA Novosti.) **(b)** Sergei Kapitsa in the 1980s (courtesy of *Scientific American*). **(c)** Recent photo of Andrei Kokoshin (courtesy of Russian International Affairs Council). **(d)** Roald Sagdeev in 1988.

in figure 1, were

▶ Sergei Kapitsa, accelerator physicist. The son of Nobel laureate Pyotr Kapitsa, Sergei was well known in the Soviet Union for his long-running weekly TV science program, *Evident, but Incredible*.

▶ Andrei Kokoshin, an engineer turned military historian and theorist who headed the political-military division of the Soviet academy's Institute of the USA and Canada.

▶ Roald Sagdeev, an eminent plasma theorist who for the previous 10 years had been director of the Soviet academy's Space Research Institute.

All four CSS leaders were fluent in English and comfortable with their American counterparts. Velikhov was the head of the Soviet magnetic-fusion program, which collaborated with fusion programs in the West. He had been a frequent visitor to the Plasma Physics Laboratory at Princeton University, my home institution. When he welcomed me to Moscow the first time, he wore a Princeton tie.

Sagdeev was similarly in the vanguard of the Soviet opening to the West. He had attended the second Atoms for Peace Conference in Geneva in 1958. As head of the Space Research Institute, he opened up the Soviet space-science program to international collaboration. Kapitsa, too, had worked to break down the communication barriers between the Soviet Union and the West. Starting in 1982 he had arranged for the publication of the Russian edition of *Scientific American*, which in those days published important articles on nuclear arms control.

Since its creation in 1945 by former Manhattan Project scientists, the FAS had been involved in efforts to halt the nuclear arms race. Starting in 1957 some of our elders had been engaged in dialogs with Soviet scientists through the Pugwash conferences on science and world affairs (see the article by Joseph Rotblat in PHYSICS TODAY, June 2001, page 50). In 1981 the National Academy of Sciences' Committee on International Security and Arms Control had begun its own dialog with a counterpart group (also chaired by Velikhov) in the Soviet academy so that it could advise the US government about opportunities for arms control. But the FAS was free to engage in more freewheeling cooperation with the CSS.

Nuclear winter

The month before our November 1983 trip to Moscow, Kapitsa had become visible in the US as a commentator from Moscow on television programs about the "nuclear winter" calculations that had recently been announced by US and Soviet scientists. Nuclear winter was the popular term used to describe the anticipated cooling effects on the global climate of the black smoke from cities incinerated by nuclear attack.[2]

It was Kapitsa, a remarkable example of the Russian intelligentsia, who pointed out the relevance of Lord Byron's poem "Darkness," written in 1816, the "year without a summer." The April 1815 eruption of Mount Tambora in the East Indies had injected a large quantity of sulfate aerosols into the stratosphere. The sunlight-reflecting aerosols caused summer frosts and crop failures throughout the Northern Hemisphere. Byron's poem powerfully conveys the dread inspired by that event two centuries ago. It begins

> 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.

In March 1985 Gorbachev was elected general secretary of the Communist Party, the most powerful position in the Soviet Union. What we hadn't known in 1983 and 1984 was that Velikhov was part of Gorbachev's brain trust. Gorbachev and his liberal advisers wanted to end the nuclear arms race.

The Reagan administration that came into office in 1981 was very different from the Reagan administration that six years later cooperated with Gorbachev on nuclear weapons reduction. Building

on programs begun under President Jimmy Carter, the Reagan administration at first planned to deploy more than 10 000 highly accurate nuclear warheads for "counterforce" attacks on Soviet targets such as missile silos.

The delivery vehicles included MX land-based ballistic missiles, Trident II submarine-launched ballistic missiles, air- and sea-launched nuclear-armed cruise missiles, and Pershing II terminally guided intermediate-range ballistic missiles. (See the article by Harold Feiveson and me in PHYSICS TODAY, January 1983, page 36.)

At the same time, however, inflammatory statements by national security officials in the early Reagan administration, about the possibilities of fighting and winning a nuclear war, had helped to trigger a major political uprising in the US. The Nuclear Weapons Freeze Campaign was advocating for an end to the arms race through local and state referenda.

A unilateral moratorium

Gorbachev's first initiative, on 30 July 1985, was to declare a unilateral moratorium on nuclear weapons tests for the remainder of the year—to be extended indefinitely if the US reciprocated. The Reagan administration did not reciprocate, but Gorbachev later announced a series of extensions, ultimately to February 1987.

Reagan administration spokesmen argued that the Soviet Union had chosen to stop testing only after deploying a whole new generation of warheads. By contrast, they said, the US needed to test new warheads for the MX and Trident II missiles and for Edward Teller's antimissile x-ray lasers. The lasers, Teller proposed, would be powered by nuclear explosions. Moreover, they contended, a test moratorium could not be verified.[3]

As figure 2 shows, however, the US at that time was able to detect even low-yield explosions in Soviet Central Asia. The figure displays a 1979 seismogram from the US–Norwegian NORSAR seismic array that I personally showed to Gorbachev in July 1986. It reveals that NORSAR detected a half-kiloton chemical explosion at the Soviet Union's main test site in Kazakhstan—during an earthquake far away in the Western Pacific.[4]

In October 1985, a few months after Gorbachev's moratorium announcement, I met Velikhov in Copenhagen at a conference celebrating the centennial of Niels Bohr's birth. Velikhov suggested that since the US government was not interested in a mutually verified test moratorium, perhaps some nongovernmental organization might be interested in verifying that the Soviets were not testing, even at low yields.

Over the next several months, I learned that there were Western groups interested in just such an opportunity. When I visited Moscow in April, Velikhov greeted me with his customary "Do you have any good ideas?" I responded by suggesting that we invite those groups to Moscow for a workshop.

The workshop was held the following month, with delegations representing three Western organizations: Jack Evernden, a senior seismologist from the US Geological Survey; Nicholas Dunlop and Aaron Tovish of the Parliamentarians for Global Action, accompanied by a second seismologist, Charles Archambeau (University of Colorado); and a group from the Natural Resources Defense Council (NRDC) organized by physicist Thomas Cochran, shown in figure 1a.

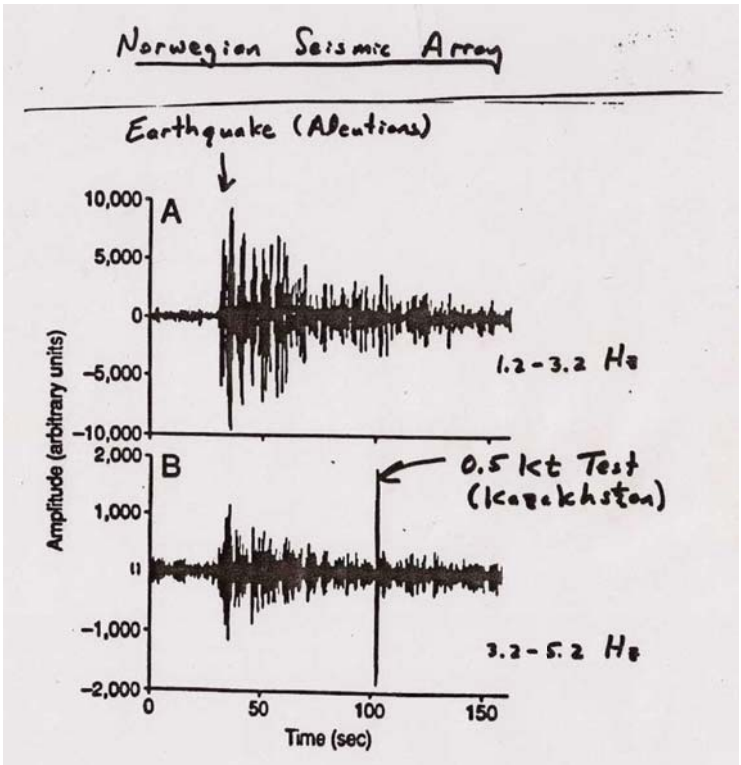

Figure 2. Seismogram from the US–Norwegian seismic array, dated 14 September 1979 and marked up by the author. The 1.2- to 3.2-Hz frequency band, labeled A, shows only the magnitude-5.8 earthquake that day near the Aleutian Islands off the Soviet Far East. But the 3.2- to 5.2-Hz band below it has a much weaker earthquake signal, which doesn't mask the signal from the detonation of 500 tons of chemical explosive 4000 km away at the Soviet Semipalatinsk test site in Kazakhstan.[4]

It seemed unlikely that the Reagan administration would let the US Geological Survey participate. And the Parliamentarians, an international organization, would proceed only if the US joined the Soviet moratorium. Therefore, only the NRDC was in a position to go ahead. Archambeau volunteered to recruit a group of seismologists, and within two months the NRDC established the first of three seismic stations at the Soviet test site in Semipalatinsk (see figure 3). Soon thereafter, Congressman Edward Markey (D-MA) showed the first NRDC seismograph in the House of Representatives.

The fact that the NRDC moved so quickly turned out to be critical. Gorbachev asked Velikhov to brief the Politburo on the NRDC initiative, and many of its members reacted negatively to such unilateral openness. After the Politburo meeting, Gorbachev turned to Velikhov and wondered whether the effort should be allowed to proceed. Velikhov later told me that he responded, "Sorry boss, they [the NRDC] are already here!"

Figure 3. Monitoring a Soviet test site. A team of seismologists sponsored by the Natural Resources Defense Council, a nongovernmental American organization, setting up portable surface seismometers in July 1986 near the Soviet Semipalatinsk test site in Kazakhstan. Later, permanent seismometers were deployed in 100-m-deep boreholes. (Photo courtesy of NRDC.)

After Gorbachev's dramatic demonstration of his declared policy of glasnost (openness) with the NRDC monitoring project, verification no longer appeared to be an insuperable obstacle to a treaty banning underground nuclear testing. The House of Representatives passed a resolution calling for the US to join in a one-year bilateral test moratorium if the Soviet Union accepted on-site inspections. The Reagan administrations pushed back,[5] as did the successor George H. W. Bush administration. But ultimately, just before the 1992 presidential election, President Bush decided not to veto the funding bill for US nuclear activities, even though it included a test-moratorium requirement.

That requirement—the Hatfield-Mitchell-Exon amendment to the Energy and Water Development and Appropriations Act—phased out US nuclear testing except for, at most, 15 tests before 30 September 1996, if they were needed to deal with safety or reliability issues. The Clinton administration took office in January 1993. In May, physicists Sidney Drell, Ray Kidder, and I participated in a two-day meeting on the subject with the leadership of the Department of Energy and its nuclear weapons labs. After that meeting, Energy secretary Hazel O'Leary concluded that no such safety or reliability tests were required.[6]

President Bill Clinton went on to negotiate and sign the Comprehensive Nuclear-Test-Ban Treaty in 1996. Even though the treaty has not yet been ratified by the Senate, the US has not tested a nuclear weapon since September 1992. And Russia has not tested one since the last Soviet test, in October 1990.

Star Wars

Ballistic-missile defense remained a central issue in US–Soviet arms-control discussions for four years after Reagan's 1983 Star Wars speech. The debate had several dimensions, and the CSS group made major contributions in dealing with all of them. The first question was, how should the Soviet Union respond to Reagan's Strategic Defense Initiative (SDI)? Should it undertake a matching program?

Physicist Richard Garwin, a longtime American critic of ballistic-missile-defense programs, played a key role in bringing the Soviet scientists up to speed on the weaknesses of various US ballistic-missile-defense proposals. Those weaknesses included the vulnerability of the huge laser-battle-station orbiters being promoted by the Reagan administration and the difficulty of discriminating against lightweight decoy warheads in space.

In 1983 Velikhov, an expert in high-power lasers, led a critical review of similarly grandiose Soviet proposals for laser ballistic-missile defenses. The following year, Sagdeev and Kokoshin led a CSS expert group that published a report urging an "asymmetric response": Countermeasures, they argued, would be more effective and much less costly than trying to emulate SDI.

Having been advised by Velikhov and Sagdeev, Gorbachev described ballistic-missile defense as "sheer fantasy" in an interview published in the 9 September 1985 issue of *Time* magazine. He also described it as a danger, because it could "whip up the arms race in all areas." Over the next two years, most of the Soviet SDI programs that Gorbachev had inherited were phased out.

The Reagan administration argued, however, that the Soviet Union had a huge ballistic-missile-defense program that was in some respects far ahead of ours. Two pieces of purported evidence were shown in ominous artist's renderings in the US Defense Department's annual glossy report *Soviet Military Power 1985*. One was described as a huge radar facility being built near Krasnoyarsk; the other as a laser ballistic-missile-defense installation at the Sary Shagan test site in Kazakhstan.

The Krasnoyarsk facility, sited in the middle of Siberia, violated the ABM treaty's requirement that all early-warning radars be located on the periphery of the country, facing outward so that they could not be used to guide ballistic-missile interceptions above the country. In 1987 Velikhov, again invoking glasnost, invited NRDC's Cochran to organize a group of congressmen and journalists to inspect the Krasnoyarsk radar. The following year, the Soviet government offered to dismantle it.[7]

Velikhov also proposed in 1987 that the Soviet Union open up the Sary Shagan laser facility for inspection. The request was at first refused, but Velikhov did get permission in 1989, and he invited Cochran to organize an inspection, in which I participated. The buildings associated with the beam director that *Soviet Military Power 1985* had featured contained a set of ruby lasers with a total output of about 100 W and a 20-kW carbon dioxide laser.[8] At the time, the US was testing a *megawatt* mid-IR advanced chemical laser at the White Sands Proving Ground in New Mexico. After our return, we showed pictures of the Soviet lasers to a group of US weapons lab experts. "Toys!" one of them exclaimed.

Until 1987, ballistic-missile defense was the

focus of the US–Soviet arms-control debate. The Soviets proposed deep cuts, but only if the US stayed within the confines of the ABM treaty. The Reagan administration refused to commit to any constraints on SDI, and the result was a stalemate.

But the technical criticisms of SDI within the US by Garwin and others took their toll. An increasingly skeptical Congress limited the SDI program to R&D, and it rejected the administration's attempt to reinterpret the ABM treaty. Thus the program began to appear less threatening. In February 1987 Alexander Yakovlev, a key Gorbachev adviser, wrote a memo urging Gorbachev to decouple the SDI and nuclear disarmament issues. Andrei Sakharov, after his release from a seven-year exile in Gorki in December 1986, argued publicly that SDI would collapse under its own weight. He urged Gorbachev not to miss the opportunity to negotiate deep cuts with Reagan.

Gorbachev quickly agreed. In December 1987 he and Reagan signed the Treaty on Intermediate-Range Nuclear Forces (INF), which eliminated all 2611 Soviet and US land-based nuclear missiles with ranges between 500 km and 5500 km. They also agreed on the outlines of the 1991 Strategic Arms Reductions Treaty (START), which would cut the two countries' deployed strategic-warhead inventories approximately by half.

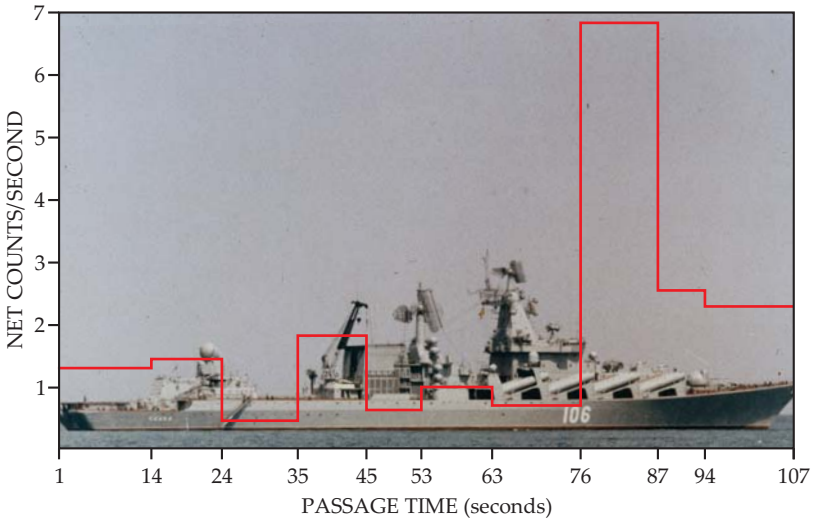

Figure 4. Soviet demonstration in July 1989 of the detection of a nuclear warhead aboard a Soviet cruiser. A neutron detector on a helicopter flying past the cruiser at a distance of 30 meters recorded plutonium-240 fission-neutron counts as a function of passage time. The large peak around 80 s on the superposed histogram of neutron counts minus background reflects the presence of a single nuclear-armed cruise missile in the front row of launchers. That peak represents a signal eight standard deviations above background.[11]

Demonstrating detectors

In 1989 Velikhov and Cochran organized another initiative to resolve an issue related to START. The Soviets wanted to include long-range, sea-launched nuclear cruise missiles in the treaty. But the US argued that nuclear-armed cruise missiles were indistinguishable from conventional cruise missiles. Velikhov therefore obtained permission from Gorbachev to demonstrate the detection of a nuclear warhead on a cruise missile aboard a Soviet cruiser in the Black Sea off Yalta.

Sagdeev and I had just led a joint FAS–CSS technical study on that subject as part of a larger study on verified elimination of nuclear warheads.[9] Cochran recruited Steve Fetter (University of Maryland), who had done much of the technical analysis in that study. At Yalta, a team led by Fetter demonstrated the detection of gamma rays from a warhead by means of a liquid-nitrogen-cooled high-purity germanium scintillation counter.[10] But the most interesting demonstration at Yalta was carried out by the Soviets. They used a large-area helium-3 neutron counter aboard a helicopter to detect plutonium-240 spontaneous-fission neutrons from shipborne warheads at distances up to 70 meters (see figure 4).[11]

The Soviet detector had been designed by a group at the Kurchatov Institute of Atomic Energy. One group member told me that the detector had been flown past US warships at sea. From the strength of the neutron signal, he asserted, one could estimate the number of nuclear warheads on the ships. I expressed skepticism that the US Navy would allow a Soviet helicopter to get so close. But later I was shown pictures of American sailors waving at that helicopter.

A verified limit on sea-launched nuclear cruise missiles was not included in START. But the US did agree in June 1990 to include a "politically binding" limit of 880 on the number of such missiles each country could deploy. In the fall of 1991, as the Soviet Union began disintegrating, Presidents Bush and Gorbachev ordered not only the elimination of all battlefield nuclear weapons but also the withdrawal to storage of all nuclear-armed cruise missiles from US and Russian submarines and surface warships.

Nineteen years later, the Obama administration finally decided to phase out US sea-launched nuclear cruise missiles altogether. Today the only nonstrategic weapons in the US nuclear arsenal are B-61 bombs, about 200 of which are still deployed at NATO fighter-bomber bases in Europe. Russia is believed to be keeping about 2000 tactical nuclear warheads in central storage.

Nonoffensive defense

The Cold War's principal front was the border between East and West Germany. Huge NATO and Warsaw Pact tank armies confronted each other across that frontier with more than 20 000 tanks on each side. The purpose of those forces was defensive. But the fear of a potential breakthrough by one

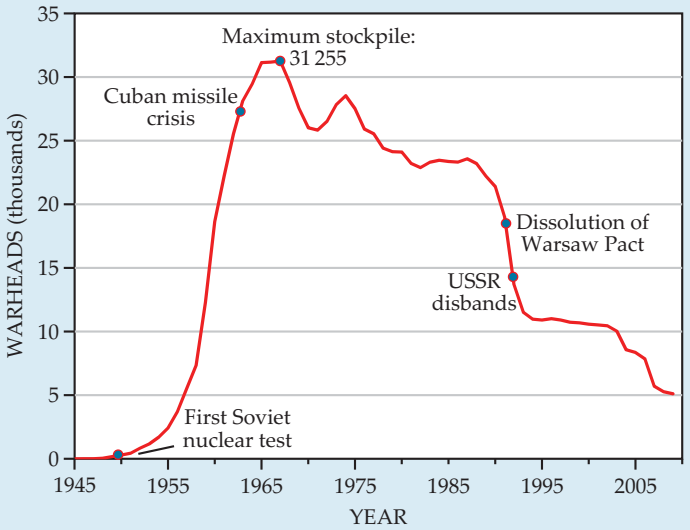

Figure 5. Rise and fall of the US stockpile of nuclear weapons, with important events in US–Soviet relations marked. Russia has not published corresponding data on its stockpile, but its downward trajectory since the late 1980s is believed to be similar.[14]

of the tank armies led to the introduction of battlefield nuclear weapons into Europe—ultimately several thousand on each side, including artillery shells, short-range missiles, and bombs aboard fighter-bombers.

During the 1980s a group of analysts in Western Europe began to develop an alternative approach to European security, which they called "nonoffensive defense." The idea was to modify defenses so as to minimize the adversary's fear that they might quickly become offensive. Some of the analysts organized a working group on conventional forces under the auspices of the Pugwash conferences and invited interested experts from Eastern Europe to join them. Kokoshin was involved in those discussions and quickly became a leading proponent of nonoffensive defense in Moscow.

In 1986 I went to one of those Pugwash workshops. Later Velikhov asked me to suggest invitees to a conference of scientists on reducing the danger of nuclear war that he was planning for February 1987 in Moscow. I suggested three of the leading Western proponents of nonoffensive defense: Anders Boserup of Denmark, Robert Nield of the UK, and Albrecht von Müller of West Germany. Kokoshin was delighted.

The following February, he and I rode together to the conference session at which I was to address a large audience that included Gorbachev. Kokoshin made sure that I included nonoffensive defense in my talk.[12] On that occasion, as on others, I was aware that the Soviet reformers were using me to provide foreign support for their proposals. The fact that I was chairman of an organization called the Federation of American Scientists may have increased my attractiveness as a messenger by suggesting that I was speaking for all American scientists rather than just a small, albeit prestigious, Washington-based nongovernmental organization.

Kokoshin also urged Boserup, Nield, von Müller, and me to write directly to Gorbachev about the importance of nonoffensive defense, and we did so in October 1987. Specifically we suggested the following approach:

> From the Atlantic to the Urals, reduce the numbers of strike aircraft, tanks, armed helicopters and long-range artillery on each side to equal levels well below the current levels of the lower side. . . .
>
> Although the reductions required to reach equality will be unequal, the security of both sides will be increased. . . . Reducing numbers of tanks and artillery available for massed attacks relative to decentralized defensive forces would reduce the capability for capturing foreign territory. And, with the fear of conventional aggression reduced, "battlefield" nuclear weapons could be withdrawn from Europe and destroyed, thereby reducing the danger of nuclear war.

A month later we received a response from Gorbachev, saying that our proposals were very much along the lines of his own thinking.[13] In September 1988 I returned to Moscow with a US group that proposed that the Soviets start with a unilateral withdrawal of 1000 tanks from Eastern Europe. But we had underestimated Gorbachev—and also Sergei Akhromeyev, chief of the Soviet general staff. Akhromeyev agreed that bold steps had to be taken to end the Cold War. In a speech at the United Nations two months later, Gorbachev announced,

> By agreement with our allies in the Warsaw Pact, we have made the decision to withdraw six tank divisions from the German Democratic Republic, Czechoslovakia, and Hungary, and to disband them by 1991. Assault-landing formations and units, and a number of others, including assault river-crossing forces, with their armaments and combat equipment, will also be withdrawn from the groups of Soviet forces situated in those countries. The Soviet forces situated in those countries will be cut by 50 000 persons, and their arms by 5000 tanks. All remaining Soviet divisions on the territory of our allies will be reorganized. They will be given a different structure from today's, which will become unambiguously defensive, after the removal of a large number of their tanks.

The end of the Cold War

Gorbachev's unilateral action laid the foundation for the 1990 Treaty on Conventional Armed Forces in Europe, which verifiably reduced Warsaw Pact tanks, armored combat vehicles, heavy artillery, combat aircraft, and attack helicopters west of the Urals to levels equal to NATO inventories in Western Europe.

Those unilateral reductions of conventional forces made clear that the Soviets would not intervene militarily to block independence movements in Eastern Europe—or even in the non-Russian republics of the Soviet Union. The Berlin Wall fell on 9 November 1989. Two years later, the Soviet Union disintegrated peacefully into 15 separate republics.

Figure 5 shows the rapid rise of the US nuclear weapons stockpile in the 1960s and its precipitous fall in the early 1990s.[14] The beginnings of the descent reflect primarily the reciprocal unilateral actions taken by Presidents Bush and Gorbachev in the fall of 1991 to eliminate most of their countries' nonstrategic nuclear weapons.[15] Underlying those steep cuts were the more gradual cuts made under the 1987 INF treaty and the 1990 START.

Gorbachev and his advisers deserve a lot of the credit for ending the Cold War and for the peaceful downsizing of the enormous nuclear arsenals that it spawned. Hopefully, that downsizing will continue—facilitated by suggestions from concerned physicists.

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