MILITARIZING OUTER SPACE

Astroculture, Dystopia and the Cold War

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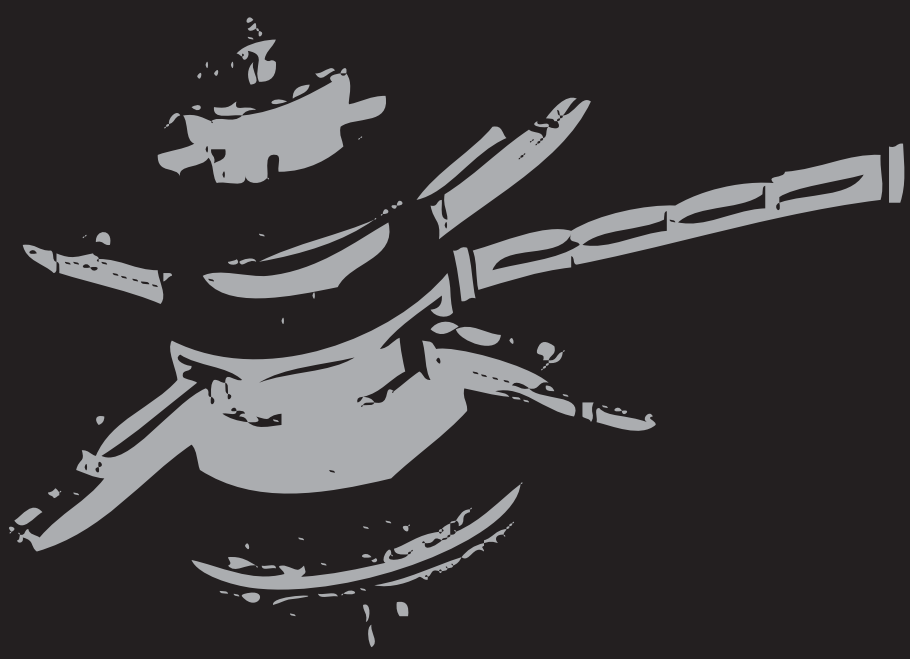

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CHAPTER 2

Cold War – But No War – in Space

Michael J. Neufeld

Space war has been a fixture of astroculture since the blossoming of science fiction in the late nineteenth century. Battles with aliens, space fighters, ray guns and laser weapons have been depicted in novels, comic books, movies and computer games, and this genre got a new lease on life with the release of the *Star Wars* motion picture in 1977. Yet in the more than seventy years since the end of the Second World War, when outer space was first penetrated by the V-2 ballistic missile, no hostile military action between two powers has ever taken place outside the atmosphere. Weapons, including nuclear warheads, have been tested in space and nations have destroyed their own spacecraft in anti-satellite (ASAT) systems tests. The Cold War between the United States, the Soviet Union and their allies drove the expenditure of trillions of dollars on military space systems. The end of that contest around 1990 did not significantly change the trajectory either. Still, no shots – or lasers – have been fired in engagements between space powers.[1]

During the Cold War, space near the earth militarized but did not weaponize. Multiple national security satellite systems were put into space, but no weapons were permanently stationed in orbit or on the moon. The great-power consensus behind that process, which has had only a partial basis in international law and has sometimes looked like it might collapse, has remained in place until today because military satellite systems have stabilized, rather than destabilized, world order. While nuclear deterrence was the fundamental reason why the Cold War became, in the words of historian

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John Lewis Gaddis, 'the long peace' (at least in terms of great-power war, not the devastating proxy wars in the so-called Third World), reconnaissance and early warning spacecraft made a nuclear war much less likely.[2] Nuclear arms control and eventual reduction were only possible because the superpowers could use 'national technical means of verification,' in the deliberately vague language of US-Soviet treaties, to determine how many delivery systems the other side had and what their capability was. Navigation and geodetic satellites were launched to make nuclear targeting much more accurate, and became critical to precision conventional strikes on earth after the Cold War was over, yet they are now essential to civilian life through vehicle and handheld navigation systems. In short and on balance, the militarization of near-earth space has been a positive force for global stability and the global economy, notwithstanding repeated threats to destabilize the regime with space weaponry. One more aspect is equally striking: the gulf between space fiction and space reality in the military realm only widened during and after the Cold War. Space war makes for popular entertainment, but so far, at least, it has made very little military or political sense.

I Militarizing outer space, 1943–62

Cold War military activity in outer space can be divided into three periods. First came an era in which spaceflight and satellite technology was in the process of invention (1943–62), and no international consensus existed about what was the proper role of the military in space. The superpower nuclear-arms race threatened to extend into earth orbit. Second was a period (1963–83) in which the two sides accepted a de facto regime of stability. No weapons were deployed in space, although some were tested. Finally came a brief period at the end of the Cold War (1983–89) in which President Ronald Reagan's Strategic Defense Initiative (SDI) threatened to collapse that regime. But the crisis was short-lived because the Cold War ended, effectively restoring the status quo.

In the first phase, it is important to note that near-earth space was a military realm from the moment a human device first entered it. If we take the now widely accepted definition of its lower boundary as 100 km (62.1 miles), then a German V-2 missile passed that line sometime in 1943, and routinely travelled through space during attacks on Allied cities beginning in September 1944. After the war, captured or reproduced V-2s became the starting point of the American and Soviet ballistic missile programs and were also deployed to gather scientific data on the upper atmosphere and near space useful for both military and civilian purposes.[3] Only the military services of the great powers had the capability to launch anything into space, whether a sounding rocket, a satellite or a deep-space probe, well past the formation of the US civilian National Aeronautics and Space Administration (NASA) in 1958. The agency depended on military rockets for much of its early history.

Thus the militarization of space was not a process that began after the Soviet Union launched Sputnik in 1957 on an intercontinental ballistic missile (ICBM). Rather, near-earth space partly "civilianized" after 1958, as non-military space agencies and corporations began to launch payloads. Military and intelligence services still controlled the majority of everything sent into space. The militarization of space was not an intrusion upon a civilian realm, rather it was an expansion of national security systems in a space that had been military from the outset.

The first serious discussions of military space operations began at the end of the Second World War. Already on 15 May 1945, just two weeks into his captivity, Wernher von Braun (1912–77) handed two British interrogators a document, 'Survey of Development of Liquid Rockets in Germany and Their Future Prospects.' Among his breathtaking predications was a piloted space vehicle or station: 'The whole of the earth's surface could be continuously observed from such a rocket. The crew could be equipped with very powerful telescopes' and observe 'ships, icebergs, troop movements, constructional work, etc.' He also mentioned a space mirror, lightly constructed and 'kilometers' in diameter, which could focus sunlight to modify the weather or destroy things on earth. Both ideas were taken from the 1920s books of Hermann Oberth (1894–1989), who von Braun considered to be his inspiration and mentor. Oberth was one of the few interwar space theoreticians who had seriously examined military uses of space travel; he also mentioned long-range missile attacks with poison-gas warheads in 1929.[4] But von Braun's comments aside, most late-Second World War and postwar discussion focused on the missile warfare introduced by the Germans. The farsighted Commanding General of the US Army Air Forces, General Henry H. 'Hap' Arnold (1886–1950), discussed a future 'manless' air force and after Hiroshima noted the possibility of nuclear-armed ICBM attacks from space, as did several other postwar experts.[5]

A few definitions are in order here. Ballistic missiles of the V-2's range and longer travel through outer space, but as the launch point and target are both at the surface, I wish to exclude them from my definition of space war and military space systems, otherwise they would take up too much of the narrative. Practically speaking, it is easiest to focus on military and national security systems in earth orbit or beyond, as they stay in space on a longer or quasi-permanent basis. Any weapon stationed in orbit, even ones designed to attack ICBMs or ground facilities, can be included in the definition of space warfare, as can any ground-based military systems designed to attack space-based assets. But as noted previously, the capability to wage space war has never come to fruition beyond a few limited, ground-based ASAT systems. Virtually all military and national security spacecraft are passive, that is, without any offensive capability.

In the United States immediately after the Second World War, the Navy and Air Force funded a feasibility study of a satellite and what military and

civilian uses it might have. The Air Force and its think tank, Research and Development (RAND), noted its potential for reconnaissance. But the post-war satellite projects quickly died in the budget cutbacks of the late 1940s, and long-range missile programs were greatly reduced. Interest revived after the 1949 Soviet atomic bomb test and especially after the North Korean invasion of the South in June 1950, which stoked fears of a Soviet attack on Western Europe. RAND began new reconnaissance satellite studies in 1951, leading to the Project Feedback report of 1954, the first formal proposal for what such a vehicle might look like.[6] A year earlier, President Dwight Eisenhower (1890–1969) had come into office. He was deeply concerned by the impenetrability of the Soviet Union and its potential capability to pull off a Pearl Harbor-style surprise attack with nuclear weapons. One of America's central strategic problems was a Soviet Union very difficult to infiltrate with human spies and conventional technology, making Soviet military capabilities hard to estimate. The vast USSR landmass was largely inaccessible except through dangerous and illegal aircraft overflights.[7]

Reconnaissance thus dominated secret US discussions of the military uses of outer space in the 1950s. As is well known from the work of Walter McDougall, Cargill Hall and Dwayne Day, in 1954 Eisenhower formed a secret advisory group on the surprise-attack threat called the Technological Capabilities Panel (TCP). It recommended a stopgap, high-altitude reconnaissance aircraft (the U-2), a reconnaissance satellite and a scientific satellite for the International Geophysical Year (1957–58) to establish a 'freedom of space' precedent. Lawyers had already argued that national airspace ended with the atmosphere and that outer space was like the high seas, an international commons, although no one could predict whether the Soviets would accept that. Eisenhower also approved crash program status for the Atlas ICBM project in 1954, based on breakthroughs in thermonuclear warheads light enough to be launched by more reasonably sized missiles.[8] The Soviet strategic position, on the other hand, was dominated by what it saw as a threatening encirclement by US bases and allies, as well as by a growing threat of direct attack from North America. Hence dictator Josef Stalin (1878–1953) wanted to create nuclear weapons, long-range aircraft and missiles to attack the United States and its allies. Military satellites were not a priority, although space advocates inside the Soviet Union were well aware of the possibilities.[9]

In Western Europe, discussions of military space technology were equally theoretical. When the spaceflight movement revived in the early 1950s, with the creation of the International Astronautical Congress and Federation, British and German advocates made utopian proposals that spaceflight should be carried out by a civilian international organization such as the United Nations. But as von Braun pointed out to Arthur 'Val' Cleaver (1917–77) of the British Interplanetary Society (BIS), 'we should stop bewailing the fact that our beloved space travel idea is being pulled into the capacious maw of the military,' because

only it had the money.[10] Even that dictum did not apply in Western Europe, as the United Kingdom and France, the only two nations trying to remain great powers, could not afford substantial rocket programs, let alone space activities. The United Kingdom built its own nuclear-armed bomber force, but postponed long-range missile development until the late 1950s. France invested more, but only began to accelerate its rocket projects when Charles de Gaulle returned to power in 1958.[11] The net result was that until after Sputnik, satellites with national security purposes were primarily an American concern. But US military satellite projects remained underfunded before 1957 because the president was a fiscal conservative who worried that the existing military buildup was already a threat to the American system of government.[12]

In the US public realm, but quite separate from the many images of space warfare and alien attacks in the flourishing subculture of popular science fiction, there were new discussions of military spaceflight in the early 1950s. Notably, when the first in a series of *Collier's* magazines focusing on space came out in March 1952, its main article, written by Wernher von Braun, advocated an all-purpose space station that could observe and dominate the Soviet Union. It could include nuclear missiles, in a sub-station orbiting ahead of the main station, which would exercise control over targeting. In other places, von Braun contemplated using them for preventive, nuclear first strikes to rob the Soviet Union of its space capability. Von Braun and his friends later whitewashed his station advocacy as part of a master plan for peaceful human spaceflight, but he was probably the first person to advocate 'space superiority' through control of orbital space as a means to ensure American victory in the Cold War. After Sputnik, von Braun, his Army superior General Bruce Medaris (1902–90) and others made statements that orbital space and even the moon was the new 'high ground' that had to be controlled, otherwise the world faced Soviet domination.[13]

Behind the scenes, US Air Force (USAF) officers had sponsored a series of studies of military space planes, perhaps armed, that reflected their view that space was the natural extension of their turf. Yet the Eisenhower administration was resistant to proposals for deploying weapons in space that might trigger an arms race, threatening the assets they thought were really important: reconnaissance vehicles. In 1956 the USAF formalized the spy satellite project as Weapons System WS-117L. But the only space program with authorization to build hardware was Vanguard, the US Navy project to launch a satellite for the International Geophysical Year. It was the 'stalking horse' to establish the 'freedom of space' principle for later reconnaissance missions, while simultaneously garnering international prestige for the United States in the Cold War. Or so it was hoped.[14]

The Soviets themselves had established a scientific satellite project in response to the American public announcement in late July 1955, which led to a very large vehicle that was launched as Sputnik 3 in 1958. The first, minimal Sputnik, however, was a late 1956 initiative of Sergey P. Korolyov's

design bureau, when fears mounted that the United States might get to orbit first. It was launched, to world acclaim, on 4 October 1957. Sputnik 2, carrying an ill-fated dog, was even more of an improvisation, thrown together within a month after the unexpected international acclaim for the first. The Sputniks made an extraordinary impression on American elites and the public, but also on Europe and the emerging nations in the Global South. Soviet claims as to the superiority of socialism became more credible in the latter. The satellites also legitimized previous ICBM test announcements, making the nuclear threat to America and its allies seem much more real.[15]

The Soviet Army's missile troops, which Soviet Premier Nikita Khrushchev made in 1959 into a separate military service, the Strategic Rocket Forces, had launched these missions. The USSR Academy of Sciences' prominent role in public announcements and international meetings was window-dressing in a space program that was controlled by the military and its industrial design bureaus. The Academy's only substantive role was in the creation of scientific experiments.[16]

The category of civilian spaceflight thus was effectively invented by the United States in the course of creating NASA out of the National Advisory Committee for Aeronautics in 1958. Eisenhower, Senate Majority Leader Lyndon Johnson (1908–73) and other members of the political elite were motivated by both domestic and foreign policy considerations. They were annoyed by the interservice rivalry that grew out of the existing, often bitter competition for roles in ballistic missiles, particularly between the Army and the Air Force.[17] Both services had presented proposals for human spaceflight and made claims to run the whole space program. But equally critical was the global image the US government wanted to project in the Cold War. Space accomplishments that countered Soviet firsts could reassure allies and influence the new nations in the Global South rapidly being created by the devolution of European empires. In the face of relentless Soviet propaganda about America's militarism and imperialism, "peaceful" and "scientific" space exploration looked better when it was carried out by a civilian agency. NASA was in fact embedded in the national security establishment, with deep connections to the Central Intelligence Agency (CIA) and the military services. For the sake of its image, it had to obscure those links as far as was feasible.[18]

Although Eisenhower restrained and channeled the space ambitions of the armed services, the Space Race sparked by the Sputniks dramatically accelerated spending on national-security space systems, notably reconnaissance. The Air Force WS-117L project spun off the Satellite and Missile Observation System (SAMOS), which encompassed both reconnaissance and signals intelligence payloads, and Missile Defense Alarm System (MIDAS), the earliest experiment in creating a warning satellite network to scan the Soviet Union for launches. While SAMOS got all the early publicity regarding space reconnaissance, the program that was really important, CORONA, was conducted in total secrecy. It was to be a stopgap system using film-return capsules, until

the SAMOS TV or film read-out spacecraft worked, which they never did. Officially, the Eisenhower administration cancelled the WS-117L firm-return project in early 1958, while reconstituting it as a super-secret, joint CIA-USAF program on the model of the U-2. Launches were hidden under the appellation Discoverer, which supposedly were carrying defense science payloads. Twelve straight failures were only tolerated by the US political system because of the perceived urgency of the project. Finally, in August 1960, Discoverer 13 made the first successful return of a capsule from orbit; a couple of weeks later Discoverer 14 returned the first photos of the Soviet Union from space. It came less than four months after the embarrassing shoot-down of Francis Gary Powers's aircraft ended U-2 overflights of the Soviet Union. CORONA went on to become the mainstay of US overhead reconnaissance

Figure 2.1 President Dwight Eisenhower (1890–1969) shows off the Discoverer 13 capsule in an August 1960 press conference, likely at the White House. It was the first man-made object recovered from orbit. With him are (from left) Secretary of the Air Force Dudley Sharp, Secretary of Defense Thomas Gates, Air Force Chief of Staff Thomas White, White House Press Secretary James Hagerty (in back), Colonel Charles Mathison and White House Appointments Secretary Thomas Stephens. All are pretending it was for a defense science program, when it was the first successful test of the CORONA film-return system. The capsule now sits in the National Air and Space Museum's main hall in Washington, DC.
Source: Courtesy of National Archives and Records Administration.

in the 1960s, supplemented by higher-resolution systems and by signals intelligence satellites, the first of which was launched by the US Navy even before Discoverer 13. In September 1961 President John F. Kennedy created the National Reconnaissance Office (NRO), jointly staffed by the CIA and the Defense Department. Even the name was a secret. Effectively the United States now had three major space programs: civilian (mostly NASA), military (mostly USAF) and intelligence (NRO) (Figure 2.1).[19]

The Soviets countered US military missions in space with a barrage of propaganda about American aggressiveness. US reconnaissance satellites were a particular sore point, and Khrushchev and his spokespeople refused to publicly acknowledge the 'freedom of space' principle. There was a lot of hypocrisy in that stand. Korolyov had received approval in principle in 1956 to pursue a reconnaissance satellite, although it was in part his own stalking horse for a human spacecraft: he imagined the same large capsule could be used to recover either the entire camera system (not just the film) or a cosmonaut. After the Space Race began, the Soviet leadership approved both the Zenit for reconnaissance and the Vostok for humans. The effort to develop Vostok in a military-industrial establishment strained by the ballistic missile race resulted in delays to Zenit. The first successful flights were in spring and summer 1962. Half a year earlier, in October 1961, the Soviet government had authorized a major expansion of military satellite programs in view of a perceived American militarization of space (Figure 2.2).[20]

Soviet attempts in the United Nations to have reconnaissance satellites declared illegal under international law forced the United States into a diplomatic counteroffensive. Its representatives argued for the legitimacy of 'peaceful' (rather than 'nonmilitary') space activity, implying the inclusion of passive military systems. President Kennedy and his advisers believed, with good reason, that overhead photography of the Soviet Union was critical to US national security. This imagery certainly improved nuclear targeting, but it also greatly reduced the gnawing uncertainty about Soviet capability, which had led to fear-mongering assertions of a 'bomber gap' and a 'missile gap' during the mid- to late 1950s.[21]

If the ongoing diplomatic battle over space was not disturbing enough, the United States and Soviet Union each conducted three space nuclear tests in 1962, the largest and most spectacular being the United States' Starfish Prime, a 1.4 megaton explosion 400 km (250 miles) over the Pacific Ocean. It produced an electromagnetic pulse that damaged electrical and telephone equipment in Honolulu, Hawaii, almost 1,450 km (900 miles) away. The United States had earlier conducted other high-altitude and space nuclear tests in 1958, testing concepts for missile defense, including the possibility of creating an artificial radiation belt to damage incoming warheads. Trapped energetic particles from Starfish Prime actually disabled several satellites. That same year, Defense Secretary Robert McNamara (1916–2009) authorized the

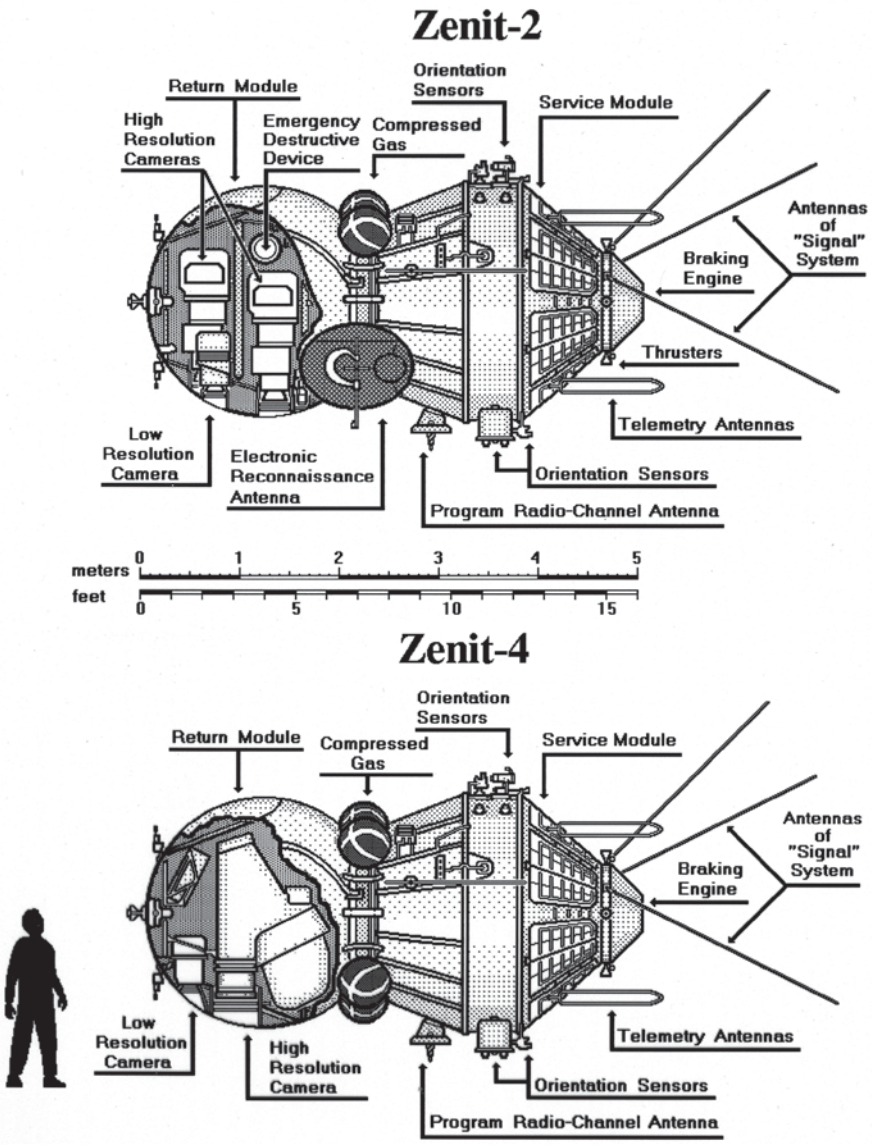

Figure 2.2 Zenit 2 and Zenit 4 were the initial and high-resolution versions of the first Soviet reconnaissance satellite. Based on the Vostok human spacecraft, Zenit returned its entire camera system, not just the film, in its spherical re-entry module. Zenit 2 was first launched in spring 1962 and Zenit 4 in late 1963. In 1970 they were replaced by more advanced spacecraft.

Source: Peter A. Gorin, 'Zenit: The First Soviet Photo-Reconnaissance Satellite,' *Journal of the British Interplanetary Society* 50.11 (November 1997), 441–8, here 442. Courtesy of British Interplanetary Society.

Army and the Air Force each to set up a limited anti-satellite capability with their own nuclear-armed missiles on two different Pacific islands. It was to be a possible emergency response to any Soviet orbital bombs.[22] There was every reason to believe that any future war would include nuclear combat in space. Thus, the de facto arrangement that soon emerged – space could be militarized but not weaponized – was still nowhere to be seen in 1962.

II The era of relative space stability, 1963–83

The rhythm of space nuclear testing and arguments over military systems reflected the overall state of US-Soviet tension, with periods of maximum stress during the Berlin confrontations of 1958 and 1961–62, and the frightening Cuban Missile Crisis of October 1962. The sobering effect of that latter near-death experience had much to do with why a new space consensus emerged so quickly in 1963. Notably, the Limited Test Ban Treaty of August 1963, signed by the United States, the Soviet Union and the United Kingdom, banned nuclear explosions in outer space, as well as in the atmosphere or under the sea. In October, the two superpowers agreed not to station nuclear weapons in orbit. And the Soviet Union silently dropped its verbal offensive against reconnaissance satellites, now that it had a capability as well. The diplomatic process culminated in the United Nations Outer Space Treaty, signed in 1967, which banned the stationing of 'weapons of mass destruction' in orbit or on other heavenly bodies.[23]

The treaty did not forbid stationing other weapons in space. The de facto agreement not to do so prevailed because of both sides' growing perception that they were better off not starting such an arms race. That did not mean that there were no challenges in this period. Beginning in 1967, the Soviet Union began testing a co-orbital ASAT, in which one orbiting spacecraft maneuvered past a previously launched target, then exploded at a safe distance. While this caused some disturbance in American military circles, many tests were failures, and the United States did not assess it as a significant threat. The United States retained its nuclear-armed interceptors on Pacific islands until 1969 for the Army system and 1975 for the Air Force, but they were then abandoned without any demand for a quid pro quo. Later in the 1970s the USAF began developing a smaller ASAT missile to be launched from a climbing F-15 fighter, a response to renewed Soviet ASAT testing after a long lull. But all systems were only capable of destroying satellites in low-earth orbit (LEO) and, given their minimal and experimental nature, were no more than minor exceptions to the informal regime. Another irritant was Soviet testing of what the United States called a Fractional-Orbital Bombardment System, which could launch a nuclear warhead into a partial orbit to attack the United States from the south, getting around its mostly north-facing warning systems. But it too never seemed like a fundamental threat and, by my definition, should not count as a space weapon as effectively it is a variant ICBM.[24]

The fundamental characteristic of the two decades of relative stability was the deployment of a large number of military space systems by the two superpowers in near-total secrecy, with very little public discussion. These served many purposes, but the four most important were intelligence, early warning, navigation and communications. In each case the United States was two to ten years ahead, but the Soviets mirrored every American system eventually, sustaining strategic stability. The Soviet Space Forces, part of the Strategic Rocket Forces, became the largest launch service in the world – orbiting over fifteen hundred satellites under the generic 'Kosmos' label by the end of 1983. The first Western European military spacecraft appeared around 1970: communications satellites for the United Kingdom and the North Atlantic Treaty Organization (NATO), followed by the French in 1984, but the dominant European space activities were explicitly non-military and cooperative, leading to the formation of the European Space Agency (ESA) in 1975. Beginning in 1970, the Chinese People's Liberation Army began launching satellites too, although they had little national security capability before the 1990s. Thus the superpower military/space duopoly was essentially intact until the end of the Cold War.[25]

Intelligence satellites included photography and signals intelligence, soon joined by radar reconnaissance of surface ships and by radar imaging through clouds. In the 1970s both sides began flying bigger film-return photoreconnaissance spacecraft, followed by the first digital-image-return spacecraft by the United States in 1976 and the Soviet Union in 1982. These had much longer lifetimes in orbit, as they did not have to be abandoned or deorbited when they ran out of film. A related technology for the United States was the Defense Meteorological Satellite system, which began as a program to get more usable CORONA imagery; too much film had been taken of overcast targets. Soon both sides were using weather-satellite images and data produced by both military and civilian constellations to provide global forecasting for their militaries. The Soviets had only one system, as effectively they had only one space program – military (Figure 2.3).[26]

A peculiar dead end of this period, but one that cost billions of dollars and rubles, was the human-operated reconnaissance station, a small, special-purpose spacecraft quite unlike von Braun's gigantic, multi-use, rotating station concepts. In 1963 the Kennedy administration cancelled the Air Force's Dyna-Soar space plane, but authorized the Manned Orbiting Laboratory (MOL), essentially the cover name for a super-high-resolution optical camera operated by military astronauts. The Richard Nixon administration cancelled it in 1969, before it ever flew, as much cheaper robotic systems were in prospect. The Soviets developed a parallel Almaz system and actually flew two stations as Salyuts in the mid-1970s, using the same name as the quasi-civilian stations they pretended to be. Results were not that impressive. One oddity was the incorporation of a cannon to ward off American attackers, probably a response to loose talk about the military applications of

Figure 2.3 In September 2011, the National Reconnaissance Office unveiled the gigantic HEXAGON reconnaissance satellite as part of the organization's fiftieth anniversary party at the National Air and Space Museum's Steven F. Udvar-Hazy Center in Chantilly, Virginia. The vehicle's main imaging system was the KH-9 broad-area-search and mapping camera. HEXAGON carried four film-return capsules significantly larger than the CORONA ones. Operating from 1976 to 1984, it was the last US spy satellite to carry film.
Source: Courtesy of Smithsonian National Air and Space Museum.

the US Space Shuttle authorized in 1972. One possibility discussed was using it to recover or inspect Soviet satellites.[27]

As reconnaissance systems improved, they became a significant factor in the production of relative geopolitical stability and even détente in the 1970s. Historian Gaddis, in his investigation of the causes of the 'long peace,' notes the inherently stabilizing character of a bipolar system between two comparatively evenly balanced blocs on opposite sides of the world that did not much compete economically. He should have put more emphasis on nuclear deterrence. But he also notes the growing global transparency created by satellite technology from the 1960s on, which he calls the 'reconnaissance revolution.' Indeed it is impossible to imagine the major arms control treaties the superpowers concluded in the 1970s without intelligence satellites. It was not that the threat of nuclear war had vanished; there were frightening moments created by the Israeli-Arab war of 1973, by false early-warning alarms and by Soviet fear of the aggressive talk of the Ronald Reagan administration in the early 1980s. The displacement of US-Soviet confrontations to a series of proxy wars, notably in Vietnam, Angola, Ethiopia and Afghanistan, devastated those countries and cost the lives of millions. So the Cold War was hardly a benign 'long peace,' as Gaddis himself acknowledges, but a global catastrophe was avoided and military satellites played no small part.[28]

Early warning satellites themselves contributed to strategic stability, by increasing warning time and decreasing the threat of an accidental nuclear war created by false alarms from radar systems. Radar provided as little as five to fifteen minutes notice of attack. Coming out of the MIDAS program, the US Air Force developed 'Program 461' (the Kennedy administration decided in 1962 to make all national security launches anonymous and all programs hidden behind bland numbers). In 1966 that project launched the first test satellites for a system in polar orbit about 3,000 km (2,000 miles) high, using infrared sensors to look for rocket plumes from launches. But that is not the one that was actually deployed. At about that time, the first successful experimental and commercial geosynchronous and geostationary communication satellites in 24-hour orbits demonstrated the technical maturity of systems stationed there. The Defense Support Program, as the new American system was obscurely named, launched its first-generation satellites between 1970 and 1973. The active constellation, once it was constructed by 1973, always had one spacecraft watching Eurasia from over the Indian Ocean, plus one each staring at the Atlantic and Pacific for submarine-launched ballistic missiles, plus an on-orbit spare. Subsidiary instruments looked for space nuclear explosions.[29]

The Soviets began experimenting with their first early-warning satellite in 1972. They put their primary constellation in highly elliptical, 12-hour orbits with apogees over the northern hemisphere, the same as their Molniya communications satellites. Spacecraft were needed in at least four different orbital planes so that one was always viewing North America. These were supplemented by geostationary satellites after 1985. The Oko system (Old Russian for 'eye') had numerous satellite failures and did not become fully operational until 1982. The Soviets never depended on it as much as the Americans did. Oko also caused a frightening false alarm in 1983 when sunlight reflected off clouds produced a warning of an American missile attack. An alert operator dismissed it as a technical problem. Thus missile early-warning satellites were far from foolproof, but once thoroughly tested they became, on balance, factors for making nuclear war less likely, because they reduced fear of surprise attack and added warning time and knowledge about the other side's capabilities.[30]

Navigation satellites, an application scarcely imagined before the Space Race, began in the wake of Sputnik. Two engineers at the Johns Hopkins University's Applied Physics Laboratory outside Baltimore, a major US Navy contractor, noticed that tracking the Doppler shift in Sputnik's radio transmission as it moved toward or away from the observer, which was used to determine its orbit, could be turned around to fix a position on earth, if the orbit was well known. That led to the Navy's Transit system, the primary purpose of which was to provide locations to ships at sea, particularly ballistic-missile submarines. Without Transit, there was little chance that the inertial guidance systems in the latter's missiles would have a launch position

precise enough to hit their targets in a nuclear war. The first successful launch was in 1960 and the system became operational in 1964. Transit was sometimes used by the other services for positioning and civilian users even adopted it for surveying and other applications.[31]

Beginning in the late 1960s, a sometimes tense collaboration between the Navy and the Air Force led to a much more accurate system based on another principle, very precise time delivered by satellite atomic clocks. This became the Air-Force-operated Global Positioning System (GPS), which began launching satellites in 1978 and came into limited operations in the early 1980s. The Soviets imitated Transit and followed that with the first launch of the GPS-clone GLONASS system in 1982. These mature navigation systems really came into their own only after the end of the Cold War and made little direct contribution to the era of relative stability in spaceflight. Transit's role was especially ambiguous, as it primarily increased submarine-launched missile accuracy, as did GPS, although never enough that the Soviets felt their nuclear forces were threatened by a first strike from those weapons (unlike US land-based ICBMs). But the increasing dependency of both sides on new satellite systems tended to reinforce the unwritten consensus not to deploy active military space systems – when tension between the superpowers did not override that consensus, as it did after President Ronald Reagan's 1983 'Star Wars' speech.[32]

The final major category of new military space systems during the 1963–83 period was that of communications. American discussions go back to the RAND report of 1946, and there was extensive experimentation in the early years of the Space Race, using both NASA and commercial satellites. After first thinking that global military communications would be more cheaply and easily done by leasing commercial satellite circuits, Defense Secretary McNamara authorized the Initial Defense Satellite Communications System in 1964. First launches came in 1966. Commercial leasing did not provide the high level of security and flexibility required for many military missions, although it continues down to the present as a supplement. The first dedicated military satellites were in near-geosynchronous orbits that drifted around the earth, but the second-generation system, first launched in 1971, was in geostationary orbit. They were supplemented by a wide variety of other satellites, some dedicated to the Navy or to tactical use, leading to a forest of acronyms. As befits their unitary space program, the Soviets deployed Molniya satellites for both military and civilian use in highly elliptical orbits beginning in 1965 and small, low-earth-orbit Strela satellites for tactical, store-and-dump communications starting in 1964. Beginning in the late 1970s the Soviet Union added several large geostationary systems. As noted previously, the United Kingdom and NATO put their first geostationary communications satellites up around 1970, at first simply buying American satellite technology and launch services. Overall, these systems, much like navigation satellites, empowered global military operations but also

fortified the credibility of nuclear deterrence, a foundation stone of the 'long peace' and global stalemate. Increasing dependency on space communications further reinforced the systemic stability of the military space consensus – assuming again that neither superpower made a move to destabilize it – as happened in 1983.

III Stability threatened and stability restored, 1983–89

President Reagan's 23 March 1983 national address on ballistic missile defense – soon dubbed the 'Star Wars' speech, from the feature film series that launched in 1977 – was a milestone moment. It signaled a prospective overthrow of the de facto consensus on space weapons by contemplating active anti-missile and anti-satellite systems in orbit, such as laser battle stations. It provoked an enormous uproar, notably in American and European media, popular culture and policy circles, reinforced by the Soviet propaganda about the US threat to global peace through advanced weapons development. Its popular label itself was a nod to the prevalence of space war in contemporary science fiction and astroculture, and to public fear that such a war might actually happen.

Yet in hindsight, 'Star Wars' seems ephemeral as a political and military phenomenon. By 1986 the president was already discussing arms control treaties with the new Soviet leader, Mikhail Gorbachev (1931–). By 1988 the Cold War appeared over, as was confirmed by the collapse of Eastern European communist governments in 1989 and of the Soviet Union itself in 1991. As a result, Reagan's grandiose Strategic Defense Initiative (SDI) dwindled to a minimal, ground-based ICBM defense in the 1990s. The military space reality of 1993 was little different from that of 1983, except that Russian systems were in decay due to the economic collapse that followed the Soviet Union's breakup.[33]

Although Reagan's speech was sudden and unexpected, even among Washington defense intellectuals, as it stemmed from the president's personal, somewhat fantastical wish to abolish the threat of nuclear annihilation, it came against a background of years of rising tension. The overall state of US-Soviet relations was, as always, primary, with military space systems playing only a subsidiary role. The détente of the early and mid-1970s slowly fell apart, partly as a result of Soviet and Cuban intervention in Angola and Ethiopia, followed by the Soviet invasion of Afghanistan at the end of 1979. The Strategic Rocket Forces pursued a relentless ICBM buildup and modernization, moderated only by the détente arms control treaties. American defense officials worried that deterrence could be destabilized by a growing Soviet first-strike threat; not surprisingly, the other side felt the same way about US capabilities. The Soviets resumed their co-orbital ASAT tests in 1976 and that same year authorized a large directed-energy (laser or particle-beam) weapons development program that increasingly agitated

conservative US officers and defense intellectuals. Reagan's election in 1980 signaled a new, hard-line approach to the Cold War, but it had already revived under President Jimmy Carter, especially because of Afghanistan. The Reagan administration immediately accelerated the development of the F-15-launched ASAT missile after it came into office in 1981. Yet the 'Star Wars' speech was an inflection point in military space history, as it threatened the emergence of a whole new orbital regime.[34]

The early public controversy over SDI was dominated by the most futuristic solutions promoted by Hungarian-American physicist Edward Teller (1908–2003) and other hard-line Cold Warriors from the nuclear-weapons establishment, notably the nuclear-pumped X-ray laser station, which would annihilate itself in a nuclear explosion while sending out laser beams to destroy Soviet ICBMs and warheads in flight. To provide a complete defense, however, would require many layers, including expanded space-based early-warning systems, ground-based anti-ballistic missiles (ABMs), and perhaps boost-phase intercept systems, either missiles or directed energy weapons, to destroy ballistic missiles early in flight, when their rocket plumes made them most identifiable. In reality, the Strategic Defense Initiative Organization (SDIO) and other US military services and agencies quickly retreated from exotic ideas like the X-ray laser, and realized that a perfect defense had always been impossible. By the later 1980s SDIO settled on small, maneuverable, non-explosive impactors (first nicknamed 'smart rocks,' and when further downsized and improved, 'brilliant pebbles'), based on orbiting satellites and ground-based missiles (Figure 2.4).[35]

The Soviet reaction was mixed. Pavel Podvig argues that far from unnerving the Soviet military, 'Star Wars' empowered its defense establishment to try to accelerate funding for its directed-energy, ASAT and ABM programs. The first flight of the new Energia superbooster in 1987, which was also designed to carry the Buran Space Shuttle, launched a test version of the Skif-DM laser battle station. Gorbachev and the party leadership imposed strict controls on testing due to the growing rapprochement with the Reagan administration, but the vehicle failed to orbit anyway. Peter Westwick, on the other hand, has shown that the Soviet political leadership was 'obsessed' by SDI and by the alleged 'space strike' potential of US battle stations against ground targets, something the American side found hard to understand. Yet by 1987 Gorbachev had de-linked SDI from arms control, perhaps because the Soviet military argued that it could easily be defeated by countermeasures. It appears that Soviet elites were far from united about what SDI meant, and that balance changed quickly over time. In any case, Gorbachev's domestic and foreign initiatives soon overtook both sides' weapons developments, resulting in nothing new being deployed before the Cold War petered out.[36]

The SDI debate did draw Western European elites and publics into a controversy over space militarization unlike anything that had occurred earlier. The space nuclear tests of 1958 and 1962 had inevitably produced media

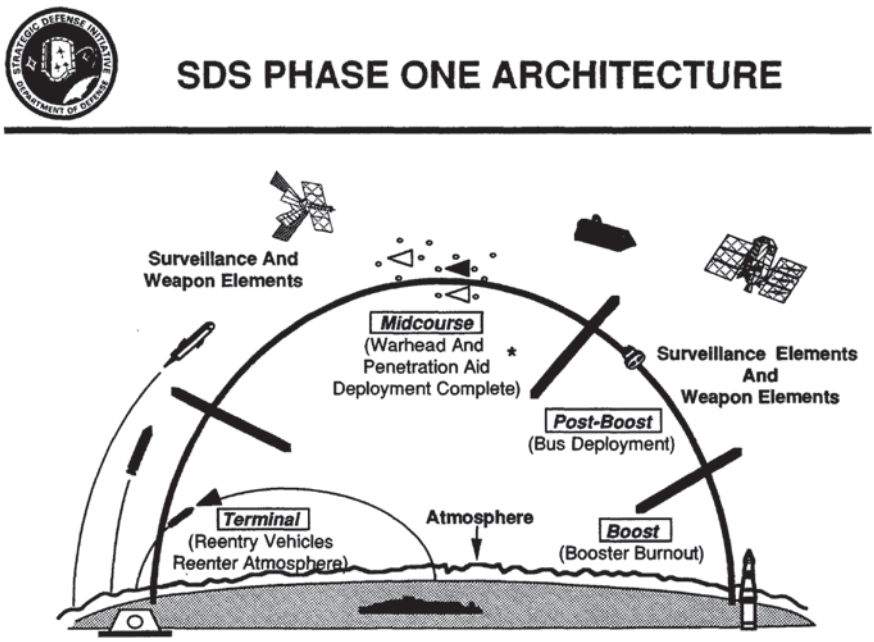

Figure 2.4 This illustration from March 1989 shows the later, more modest version of the Strategic Defense System (SDS), part of President Reagan's Strategic Defense Initiative (SDI). It depicts missile defense based on kinetic impactors rather than the earlier, more exotic proposals for X-ray lasers in orbit.
Source: Courtesy of Ballistic Missile Defense Organization.

commentary and peace protests, although scholarship on this topic is minimal. But Bernd Mütter's analysis of how outer space was treated in West Germany's media, particularly television, shows that discussion of the military uses plummeted after Sputnik and did not revive until the SDI debate. Before then it was almost a taboo topic, as West German journalists only wanted to present spaceflight in the context of science and exploration. Their reporting covered what NASA and European civilian space agencies were doing. The journalists were profoundly uncomfortable with any other dimension, reflecting a deep, post-Second World War pacifism in their audience. But 'Star Wars' provoked several to denounce the American initiative on television. The applicability of Mütter's study to other Western European countries is unknown, but it would not be surprising if there was also a studied ignorance of, or reluctance to talk about, military space applications until the 'Star Wars' controversy of the mid-1980s.[37]

Certainly, the debate agitated Europeans who distrusted the Reagan administration or the United States generally, notably on the left. The president's announcement also caught military and political elites connected to

the United States and NATO by surprise and disturbed British and French leaders regarding the future viability of their limited nuclear deterrents. But the nations closest to the United States wanted to receive part of the billions Reagan planned to spend on SDI, to benefit its industry and keep up technologically. The United Kingdom signed a memorandum of understanding for participation in late 1985 and West Germany in early 1986. The fear of technological eclipse drove France, at that time not part of the NATO military structure and led by socialist President François Mitterrand (1916–96), to launch an independent initiative, EUREKA, to foster mostly civilian research at home and cooperating Western European countries. In the end, the United States did not spend much money on space weapons and missile defense in Europe, but that was hard to anticipate as the Reagan administration's rhetoric was grand and virtually no one foresaw the imminent collapse of the Soviet bloc.[38]

In the midst of the SDI controversy, the Soviet Union announced it was suspending ASAT tests in 1983, to bolster its arguments for a treaty against space weaponization. In 1985 the US Congress suspended flights of the F-15-launched missile. Although SDI dragged on into the early 1990s and was not without a technological legacy in the United States in the areas of rocket and spacecraft development, electronics and ground-based missile defense, the net impact of the furor on the de facto space regime was effectively zero. The only difference is that the United States was now a hyperpower, greatly superior to every other nation in military and space capability, while Russian budget crises led to declines in the competence and capability of its aerospace industry and military space infrastructure.

IV Military space in a post-Cold War world

In place of the bipolar military space world of the 1980s arose a multipolar one in which China, notably, became the new challenge to US hegemony. Its destruction of one of its own defunct weather satellites in 2007 in an ASAT test created a cloud of orbital debris and further inflamed American military leaders and policy-makers who were already suspicious of the People's Republic. Under the conservative George W. Bush administration, air-force-connected advocates for 'space control' through US domination of near-earth space with weapons grew in influence and volubility.[39]

Their reasoning, and that of their Chinese counterparts, was driven by the realization that American forces had become completely dependent upon military space infrastructure, in part because it also greatly increased battlefield effectiveness. In the Persian Gulf War of 1991, navigation, early warning, reconnaissance, communications and weather satellites, first launched in the strategic competition with the Soviet Union, were critical to the decisive victory over a regional power, Iraq. The next year, Air Force Chief of Staff General Merrill A. McPeak (1936–) called that conflict the 'first space war,' not in the sense used

in this essay, but rather to emphasize the centrality of space resources to the ground, air and anti-missile battle.[40] So-called drone warfare after 2001 is a further expression of that capability, as large remotely piloted reconnaissance and attack aircraft like the Predator are typically flown through communication satellites and depend on GPS for navigation. The United States can now not afford to do without such an infrastructure, and other large and medium-sized powers need to ally themselves with the United States or develop their own capability if they do not wish to be completely outclassed. It is no wonder that the Chinese and the resurgent Russians continue to work on ASATs and other military space systems. Moreover, all sides have limited anti-missile capability that can be used to shoot down low-earth-orbit satellites.

Yet in the more than a quarter century since the end of the Cold War, outer space still remains without orbiting weapons. The possibility of igniting a new arms race and destabilizing the environment for all space infrastructure, civilian and military, are powerful disincentives to the United States, Russia, China or anyone else violating the de facto regime. Moreover, the militarization of space from geostationary orbit on down has on the whole been a force for global stability, even if it may now contribute to local instability, notably in US attacks in the Middle East in the 'war on terror.' Military space systems made arms control treaties possible and nuclear war less likely during the Cold War and after. The rise of global transparency has only accelerated since the mid-1980s, as commercial imaging satellites have made high-resolution capability widely available even to human-rights groups and journalists. Threats to weaponize space will continue, dependent on the state of great-power competition, but there seems to be every hope that stability in that realm will continue as our dependency on space assets grows. Uncomfortable as the conclusion may be for some, it is apparent that, on the whole, the militarization of space has been, on balance, a positive force for peace.

Finally, I cannot help but note the complete disjuncture between space war in astroculture and the actual evolution of military space technology in the Cold War and after. On the one hand, we have the long-standing and ongoing popularity of space battles in the *Star Wars* and *Star Trek* movie franchises and in video games and novels and so forth. They make for drama and entertainment and sometimes for social comment. On the other, we have the development of a complex host of satellites for different military purposes, most of which are invisible to the public, either out of secrecy or media and public disinterest, leading to potential problems with civilian, democratic control. For much of the public, infrastructure is boring, even when it is civilian and open. One only notices its absence when it does not work. Thus it is not surprising that science fiction has largely operated in discourses disconnected from the dull but critical reality of the military in space since Sputnik.

Notes

1. A possible minor exception are claims that American military satellites have been "illuminated" by Soviet/Russian or Chinese lasers, temporarily blinding them. These claims remain unproven. See Jeffrey T. Richelson, *America's Space Sentinels: The History of the DSP and SBIRS Satellite Systems*, [1999], 2nd edn, Lawrence: University Press of Kansas, 2012, 76–7; and Dean B. Cheng, 'The Long March Upward: A Review of China's Space Program,' in Paul G. Gillespie and Grant T. Weller, eds, *Harnessing the Heavens: National Defense Through Space*, Chicago: Imprint Publications, 2008, 151–63, here 161. I want to acknowledge the influence of Alex Roland's paper, 'Cold War in Space,' given at the *Embattled Heavens* conference that is the origin of this book. All Internet sources were last accessed on 15 July 2020.
2. John Lewis Gaddis, 'The Long Peace: Elements of Stability in the Postwar International System,' *International Security* 10.4 (Spring 1986), 99–142; idem, *The Long Peace: Inquiries into the History of the Cold War*, New York: Oxford University Press, 1987; Odd Arne Westad, *The Global Cold War: Third World Interventions and the Making of Our Times*, Cambridge: Cambridge University Press, 2005.
3. Michael J. Neufeld, *The Rocket and the Reich: Peenemünde and the Coming of the Ballistic Missile Era*, New York: Free Press, 1995; David H. DeVorkin, *Science with a Vengeance: How the Military Created the US Space Sciences after World War II*, New York: Springer, 1992; Matthias Uhl, *Stalins V-2: Der Technologietransfer der deutschen Fernlenkwaffentechnik in die UdSSR und der Aufbau der sowjetischen Raketenindustrie 1945 bis 1959*, Bonn: Bernard & Graefe, 2001. Much has been made of the first successful A4 (later V-2) launch on 3 October 1942, also by me, but its apogee was about 80–90 km. It was a milestone for the program and for the history of rocketry, but the first missile with range long enough to ascend beyond 100 km altitude was probably fired on 14 April 1943. See the July 1943 document 'Versuchsschießen A4' pictured in Walter Dornberger, *Peenemünde: Die Geschichte der V-Waffen*, Frankfurt am Main: Ullstein, 1989, photo insert. A V-2 launched vertically from an island off Peenemünde on 14 September 1944 reached 176 km (102 miles); see Wernher von Braun to Arthur C. Clarke, 30 August 1951, US Space and Rocket Center Archives, Wernher von Braun Papers, file 400–2.
4. Wernher von Braun, 'Survey,' in Fritz Zwicky, *Report on Certain Phases of War Research in Germany*, vol. 1, Pasadena: Aerojet Engineering Corporation, 1945, 66–72; Hermann Oberth, *Die Rakete zu den Planetenräumen* [1923], Nuremberg: Uni-Verlag, 1960, 86–9; and idem, *Wege zur Raumschiffahrt* [1929], Bucharest: Kriterion, 1974, 199–200. The American rocket pioneer Robert Goddard (1882–1945) mentioned long-range rocket attacks in 1916 when he first wrote to the Smithsonian Institution looking for support for his experiments; see Goddard to 'President, Smithsonian Institution, 27 September 1916,' in Esther C. Goddard and G. Edward Pendray, eds, *The Papers of Robert H. Goddard*, vol. 1: *1898–1924*, New York: McGraw-Hill, 1970, 170–5, here 171.
5. Roger D. Launius, 'National Security, Space and the Course of Recent U.S. History,' in Gillespie and Weller, *Harnessing the Heavens*, 5–23, here 7; Paul B. Stares, *The Militarization of Space: U.S. Policy, 1945–1984*, Ithaca: Cornell

University Press, 1985, 23–9; Walter A. McDougall, *…The Heavens and the Earth: A Political History of the Space Age*, New York, Basic, 1985, 88.

6. Ibid., 101–2; Jeffrey T. Richelson, *America's Secret Eyes in Space: The U.S. Keyhole Spy Satellite Program*, New York: Harper & Row, 1990, 2–8. The Douglas Aircraft Company first report for the air force (effectively RAND report no. 1), 'Preliminary Design of an Experimental World-Circling Spaceship,' 2 May 1946, can be downloaded at http://www.rand.org/pubs/special_memoranda/SM11827.html.
7. See McDougall, *…The Heavens and the Earth*, 112–15; R. Cargill Hall, 'Postwar Strategic Reconnaissance and the Genesis of Corona'; and Dwayne A. Day, 'A Strategy for Reconnaissance: Dwight D. Eisenhower and Freedom of Space,' in idem, John M. Logsdon and Brian Latell, eds, *Eye in the Sky: The Story of the Corona Spy Satellites*, Washington, DC: Smithsonian Institution Press, 1998, 86–142, 260–79. See also Sean N. Kalic, *US Presidents and the Militarization of Space, 1946–1967*, College Station: Texas A&M University Press, 2012, 26–35.
8. McDougall, *…The Heavens and the Earth*, 106–15; Hall, 'Postwar Strategic Reconnaissance'; Day, 'A Strategy for Reconnaissance,' 86–142; R. Cargill Hall, 'The Eisenhower Administration and the Cold War: Framing American Astronautics to Serve National Security,' *Prologue: Quarterly of the National Archives and Records Administration* 27.1 (Spring 1995), 58–72; Christopher Gainor, 'The Atlas and the Air Force: Reassessing the Beginnings of America's First Intercontinental Ballistic Missile,' *Technology and Culture* 54.2 (April 2013), 346–70; and his contribution, Chapter 3 in this volume.
9. Asif A. Siddiqi, *The Red Rocket's Glare: Spaceflight and the Soviet Imagination, 1857–1957*, Cambridge: Cambridge University Press, 2010, 241–314; idem, 'Soviet Space Power During the Cold War,' in Gillespie and Weller, *Harnessing the Heavens*, 135–50.
10. Alexander C. T. Geppert, 'Space *Personae*: Cosmopolitan Networks of Peripheral Knowledge, 1927–1957,' *Journal of Modern European History* 6.2 (2008), 262–86, here 280–3; Von Braun to Cleaver, 12 May 1951, US Space and Rocket Center, Wernher von Braun Papers, file 400–2.
11. See Stephen Robert Twigge, *The Early Development of Guided Weapons in the United Kingdom, 1940–1960*, Chur: Harwood, 1993; Olivier Huwart, *Du V2 à Véronique: La naissance des fusées françaises*, Paris: Marines éditions, 2004; and Doug Millard, 'A Grounding in Space: Were the 1970s a Period of Transition in Britain's Exploration of Outer Space?,' in Alexander C. T. Geppert, ed., *Limiting Outer Space: Astroculture after Apollo*, London: Palgrave Macmillan, 2018, 79–99 (= *European Astroculture*, vol. 2).
12. McDougall, *…The Heavens and the Earth*, 126–34.
13. Michael J. Neufeld, '"Space Superiority": Wernher von Braun's Campaign for a Nuclear-Armed Space Station, 1946–1956,' *Space Policy* 22.1 (February 2006), 57–62; idem, 'The "Von Braun Paradigm" and NASA's Long-Term Planning for Human Spaceflight,' in Steven J. Dick, ed., *NASA's First 50 Years: Historical Perspectives*, Washington, DC: NASA, 2010, 325–47; William E. Burrows, 'Beyond the Blue Horizon: Lunar Missile Base Concepts in the Early Cold War,' in Gillespie and Weller, *Harnessing the Heavens*, 25–34. For a genealogy of the 'high ground' trope, see Alexander Geppert and Tilmann Siebeneichner's contribution, Chapter 1 in this volume.

14. Roy F. Houchin, 'Technology in Transition: Dyna-Soar and the Military Spaceplane,' in Gillespie and Weller, *Harnessing the Heavens*, 177–89, here 177–80; Hall, 'Postwar Strategic Reconnaissance,' 105–10; Day, 'A Strategy for Reconnaissance,' 129–37; Kalic, *US Presidents*, 26, 36–42.
15. Siddiqi, *Red Rocket's Glare*, 324–35.
16. Idem, 'Soviet Space Power.'
17. Michael J. Neufeld, 'The End of the Army Space Program: Interservice Rivalry and the Transfer of the Von Braun Group to NASA, 1958–1959,' *Journal of Military History* 69.3 (July 2005), 737–58.
18. McDougall, *…The Heavens and the Earth*, 164–76; James E. David, *Spies and Shuttles: NASA's Secret Relationships with the DoD and CIA*, Gainesville: University Press of Florida, 2015.
19. See most of the essays in Day, Logsdon and Latell, *Eye in the Sky;* and also Hall, 'Postwar Strategic Reconnaissance'; Day, 'A Strategy for Reconnaissance'; and Mark A. Erickson, 'Reconnaissance and Prestige: The Creation of a Trinitarian U.S. Space Program,' in Gillespie and Weller, *Harnessing the Heavens*, 49–63, here 56–8. CORONA mapping also penetrated the barrier between the secret and unclassified worlds by influencing global geodesy; see John Cloud, 'Imaging the World in a Barrel: CORONA and the Clandestine Convergence of the Earth Sciences,' *Social Studies of Science* 31.2 (April 2001), 231–51.
20. Peter A. Gorin, 'Zenit: The Soviet Response to CORONA,' in Day, Logsdon and Latell, *Eye in the Sky*, 157–70; Siddiqi, 'Soviet Space Power,' 140–1.
21. McDougall, *…The Heavens and the Earth*, 177–94, 344–51; Stares, *Militarization of Space*, 54–91.
22. Ibid., 76–82, 107–8; Jack Manno, *Arming the Heavens: The Hidden Military Agenda for Space, 1945–1995*, New York: Dodd, Mead, 1984, 54–60, 81–5; 'Starfish Prime,' https://en.wikipedia.org/wiki/Starfish_Prime; Gilbert King, 'Going Nuclear over the Pacific,' 15 August 2012, http://www.smithsonianmag.com/history/going-nuclear-over-the-pacific-24428997; and Neufeld, *Von Braun*, 327–8, 332.
23. McDougall, *…The Heavens and the Earth*, 344–8; Stares, *Militarization of Space*, 86–91, 101–2; for the UN treaty text, see http://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introouterspacetreaty.html. See also Luca Follis, 'The Province and Heritage of Humankind: Space Law's Imaginary of Outer Space, 1967–79,' in Geppert, *Limiting Outer Space*, 183–205.
24. Stares, *Militarization of Space*, 80–1, 99–100, 136–45, 206–9; Siddiqi, 'Soviet Space Power,' 145.
25. Ibid., 143–6; Alasdair W. M. McLean, *Western European Military Space Policy*, Aldershot: Dartmouth, 1992, 88–93; Alexander C. T. Geppert, 'European Astrofuturism, Cosmic Provincialism: Historicizing the Space Age,' in idem, ed., *Imagining Outer Space: European Astroculture in the Twentieth Century*, 2nd edn, London: Palgrave Macmillan, 2018, 3–28, here 9–11 (= *European Astroculture*, vol. 1); Cheng, 'The Long March,' 154–5. For more on European attitudes, see Michael Sheehan's contribution, Chapter 4 in this volume.
26. Richelson, *America's Secret Eyes in Space*, 92–143; Siddiqi, 'Soviet Space Power,' 144–5. Seeing what the "other" side was doing took the superpowers into strange territory, including the employment of alleged psychics who might explore things seen in reconnaissance photographs. See Anthony Enns's contribution, Chapter 10 in this volume.

27. Stares, *Militarization of Space*, 97–9, 159–60; Dwayne A. Day, 'Behind the Blue: The Unknown U.S. Air Force Manned Space Program,' in Gillespie and Weller, *Harnessing the Heavens*, 83–93; Siddiqi, 'Soviet Space Power,' 147–8. For more on the Almaz stations, see Cathleen Lewis's contribution, Chapter 12 in this volume.
28. Gaddis, 'The Long Peace'; and idem, *The Long Peace*, 195–245, 291–302; Westad, *Global Cold War*.
29. Richelson, *America's Space Sentinels*.
30. Pavel Podvig, 'History and the Current Status of the Russian Early-Warning System,' *Science and Global Security* 10.1 (February 2002), 21–60; 'US-KM and US-KMO Constellations,' http://www.russianspaceweb.com/oko.html.
31. Richard D. Easton and Eric F. Frazier, *GPS Declassified: From Smart Bombs to Smartphones*, Lincoln: Potomac Books, 2013, 25–9, 42–55. See esp. Paul Ceruzzi's contribution, Chapter 13 in this volume.
32. Easton and Frazier, *GPS Declassified*, 57–107; Podvig, 'Russian Early-Warning System,' 31; Ceruzzi, Chapter 13 in this volume; https://en.wikipedia.org/wiki/Global_Positioning_System.
33. Almost the only general study of SDI, but one that is largely restricted to Reagan and his inner circle, is that of Frances FitzGerald, *Way Out There in the Blue: Reagan, Star Wars and the End of the Cold War*, New York: Simon & Schuster, 2000. Roger Handberg, *Seeking New World Vistas: The Militarization of Space*, Westport: Praeger, 2000, 63–85, gives an overview of SDI's impact on US military space policy. See also Alexander Geppert and Tilmann Siebeneichner's introduction, Chapter 1 in this volume.
34. Stares, *Militarization of Space*, 180–243; Westad, *Global Cold War*, 250–363; and Siddiqi, 'Soviet Space Power,' 145–6.
35. FitzGerald, *Way Out There*; William Broad, *Star Warriors: A Penetrating Look into the Lives of the Young Scientists Behind Our Space Age Weaponry*, New York: Simon & Schuster, 1985.
36. Pavel Podvig, 'Did Star Wars Help End the Cold War? Soviet Response to the SDI Program,' 17 March 2013, http://russianforces.org/podvig/2013/03/did_star_wars_help_end_the_col.shtml; Peter J. Westwick, '"Space-Strike Weapons" and the Soviet Response to SDI,' *Diplomatic History* 32.5 (November 2008), 955–79; and Siddiqi, 'Soviet Space Power,' 144–5. See also Westwick's 'From the Club of Rome to Star Wars: The Era of Limits, Space Colonization, and the Origins of SDI,' in Geppert, *Limiting Outer Space*, 283–302.
37. Manno, *Arming the Heavens*, 82–5; Bernd Mütter, '*Per Media Ad Astra?* Outer Space in West Germany's Media, 1957–1987,' in Geppert, *Imagining Outer Space*, 165–86.
38. McLean, *Western European Military Space Policy*, 40–54; Johannes M. Becker, 'EUREKA: Eine westeuropäische Antwort auf SDI,' in Bernd W. Kubbig, ed., *Die militärische Eroberung des Weltraums*, Frankfurt am Main: Suhrkamp, 1990, vol. 2, 616–43; idem, 'Die SDI-Rahmenvereinbarungen zwischen Bonn und Washington: Eine erste Bilanz,' in ibid., vol. 2, 644–719; Sean N. Kalic, 'Reagan's SDI Announcement and the European Reaction: Diplomacy in the Last Decade of the Cold War,' in Leopoldo Nuti, ed., *The Crisis of Détente in Europe: From Helsinki to Gorbachev, 1975–1985*, London: Routledge, 2009, 99–110; and Geoffrey Lee Williams and Alan Lee Williams, *The European Defence Initiative: Europe's Bid for Equality*, New York: St. Martin's Press, 1986, esp. chapter 13,

'European Defence and the Strategic Defence Initiative,' 200–12. See also Michael Sheehan's contribution, Chapter 4 in the present volume.

39. Cheng, 'The Long March,' 161; Everett C. Dolman, 'Astropolitics and *Astropolitik*: Strategy and Space Deployment,' in Gillespie and Weller, *Harnessing the Heavens*, 111–33, but also the comment by Roger D. Launius, 'National Security,' 12–18, in the same volume.
40. McPeak quoted in David N. Spires, 'Recurring Themes in U.S. Air Force Space History,' in Gillespie and Weller, *Harnessing the Heavens*, 95–109, here 100. See also Handberg, *Seeking New World Vistas*, 87–107.