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Global Challenges and Threats of Hypersonic Weapons: The Russian Context

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Abstract

This article presents the results of research that set out to identify and characterize the challenges and threats to international security posed by the use of hypersonic weapons. The research process mainly employed the critical assessment of the literature, systemic and comparative analyses and generalization. As a result of the research, it was established that hypersonic weapons are an indispensable tool in the conducting of international competition by the Russian Federation and can be treated on par with nuclear weapons. Due to its attributes, it meets the criteria of an offensive weapon and poses certain uncertainties and real threats to the international security environment mainly because, so far, the capabilities to intercept and destroy it in the active phase of flight to the target has not been acquired. The Russian Federation considers hypersonic weapons as an excellent tool for applying pressure and aggression, allowing it to conduct international competition in the gray zone and achieve foreign policy objectives without the need for direct military confrontation. Due to its ability to cause almost immediate operational and strategic effects, it accelerates the dynamics of conflict escalation and rapidly affects the transition from a state of stability to international instability. It cannot be ruled out that in the third decade of the 21st century hypersonic weapons may be the key element determining the Russian Federation's achievement of global dominance.

Keywords

defense, hypersonic weapons, rivalry, Russian Federation, threats

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1. Introduction

In late December 2018, Russia successfully tested a missile system Avangard (2018) with a hypersonic glider vehicle. According to press reports, this nuclear-capable strategic glider launched an old Russian SS-19 ballistic missile (Troianovski, 2018) from southwestern Russia flew about 3,500 miles to a target on the Kamchatka Peninsula, reaching speeds of up to 20,000 mph.[1] Russian sources have noted and the U.S. have confirmed that this new maneuverable hypersonic missile cannot be intercepted by existing air and missile defense systems due to its high velocity and unpredictable flight trajectory (Georgiou, 2018). Most of the existing U.S. anti-missile systems are capable of countering medium- and long-range ballistic missiles launched from the Middle East region. A few dozen sets deployed in Alaska and California can intercept classic Russian ballistic missiles, but they are too few to provide effective cover against Russian hypersonic missiles in the future. In fact, the capabilities of the Ground-Based Interceptors (GBIs), are highly limited. Introduced into operational service in 2004, the GBIs were first tested against true ICBM only in 2017 (Homeland, 2017). Furthermore, the first salvo fire, which constitutes the cornerstone of the missile interception strategy, was conducted only in 2019 (Homeland, 2019). This means that the GBI is still in an experimental phase of development, even though it has been operationally deployed. Therefore, it is highly debatable if this weapon can intercept modern Russian MIRVed ICBMs employing a range of penetration aids. One might be tempted to conclude that due to poor technological sophistication, no state in the world currently possesses hypersonic weapons to counter missile capabilities (Woolf, 2020).

The Russian Federation's drive to acquire a large number of hypersonic missiles (Kristensen & Korda, 2021) in the future poses new challenges and threats to international security. This is supported by the following arguments. First, hypersonic missiles are highly maneuverable. Second, it is difficult to precisely identify not only the target of an attack but even the state on which a hypersonic missile will fall, which can lead to alarms being raised in several neighboring states simultaneously. Third, in the situation of a crisis of a political-military nature, active retaliation must be expected (Arbatov et al., 2019). Fourth, there is no technical possibility to distinguish between a hypersonic missile armed with a conventional payload and a missile carrying a nuclear weapon. Fifth, because of the limited time between the detection of a missile and its detonation, as well as ambiguities about the target of an attack, the decision-making process of the attacked party is complicated. Consequently, a state possessing nuclear weapons may be inclined to use them and undertake, large-scale, warning or preemptive strikes due to potential or perceived threats to its civilian or military infrastructure (Arbatov et al., 2019).

The problematic situation thus identified leads to the formulation of the main research problem: What challenges and threats to international security do Russian hypersonic weapons pose? The main research problem was fragmented and the following specific problems were identified:

1) What are the characteristics of hypersonic weapons?

2) What strategic implications does the use of hypersonic weapons entail?

This article presents the results of research that set out to identify and characterize the challenges and threats to international security posed by the use of hypersonic weapons. The solution of the main research problem was possible thanks to the systemic approach, which allowed us to examine the interactions, interdependencies and relationships between the

[1] The range of the glider is up to 6,000 kilometers, the flight time can be up to 35 minutes and the accuracy of hitting the target is 30 meters (Russia, 2019).

threats resulting from the use of the Russian hypersonic weapons and the participants of the international security environment with regard to the present and the future. This article does not provide a catalog of every possible threat, but focuses on a cross-cutting identification of the most significant causes affecting the lowering of the level of security and an indication of the risk for international instability. One of the key factors determining that crises may arise rapidly is the ability of hypersonic missiles to carry nuclear payloads. This results in the complexity of system interactions between the use of hypersonic weapons and the management of the nuclear weapons. The research process mainly employed the critical assessment of the literature and a systemic analysis. Comparative analyses and generalization were also helpful, which allowed us to determine strategic trends in the use of hypersonic weapons and the escalation of crisis situations as well as countering negative phenomena related to their use.

2. Characteristics of hypersonic weapons

The Russian Federation, through the application of new technologies, has succeeded in the sphere of hypersonic long-range precision-guided missiles (Kucharczyk, 2020), which represent new capabilities of strategic and operational importance (Weitz, 2020). They include maneuvering re-entry ballistic missiles, hypersonic guided cruise missiles (HCVs), and boost-glide missile systems (HGVs) (Heinrich & Weiland, 2009, p. 2). The acquisition of precision control devices has made it possible to create maneuverable self-guided warheads (HCVs), at the end of their flight trajectory. In some cases, it is not a reentry maneuver of the vehicle with the warhead, but a controlled flight of the missile itself, which can change its trajectory several times to confuse air defenses, as is the case with the Iskander-M or Kinzhal ballistic missiles. Boost-glide systems (HGVs) represent hypersonic glide vehicles which are delivered to or slightly above the upper atmosphere by carrier rockets traveling at high speeds of about 7000 m/s. At altitudes above 80 km, speeds in excess of Mach 25 are achieved. After separation from the platform, the warhead enters the atmosphere and moves independently at high speed, gradually slowing down. It is essentially a new type of precision-guided weapon with special features, both in terms of the principle of motion and the trajectory of flight. These features make it a special type of offensive weapon, which was not included in the earlier provisions of international agreements. For this reason, it is not subject to the current rules of arms systems control (Arbatov et al., 2019). Hypersonic weapons are at an early stage of development, so there are a number of technical barriers to achieving design maturity. These include the need to cope with extreme temperatures and to have a guidance system that can provide sufficient accuracy under very difficult maneuvering conditions, i.e., while flying at hypersonic speeds. It is also difficult to manage thermal loads due to the fact that the temperature increases with increasing speed and density of the atmosphere. Another problem to be solved is the enormous aerodynamic force that the warhead's delivery must withstand during flight. These variables must be managed not only to maintain the structural integrity of the explosive delivery means, but also to ensure the functionality of the onboard instrumentation (Borrie et al., 2019).

The advantage of hypersonic weapons in comparison with classical subsonic missiles is the relatively short flight time and high resistance to enemy defense systems. At the same time, however, it has no other advantages compared to the latest generation of classical Cruise self-guided missiles, which perform flights at very low altitudes. In contrast, the flight of a hypersonic missile takes place at altitudes of 20 to 30 km, which theoretically increases the possibility of its detection from the ground by 10-20% compared to cruise missiles

(Speier et al., 2017). This means that the detectability, especially in the infrared range, by satellites and reconnaissance aircraft can be practically compensated by the short flight time and penetration capabilities of existing defense systems. The strategic use of hypersonic weapons is judged to be more effective compared to self-guided subsonic missiles, at least in terms of organizing and coordinating a massive, offensive strike or integrating it into a broader retaliatory strike conducted with all weapons at hand. However, a strike by itself would not be capable of leading to strategic instability, although effective tracking and interception of hypersonic missiles requires the construction and deployment of new, expensive surveillance and air defense systems. It should be noted, however, that the actual range of prototypes and procured hypersonic missiles does not exceed 1,000-1,500 km, which is still at least twice the range of modern, subsonic strategic missiles launched from aircraft or submarines. At the same time, hypersonic cruise missiles have the lowest average velocity of all prospective types of long-range hypersonic precision weapons (Arbatov et al., 2019). Boost-glide systems, on the other hand, even with conventional weaponry, can seriously disrupt strategic stability. There are several reasons for this. In addition to its global range and high airspeed of up to Mach 25, the delivery medium has a much smaller profile than a typical missile of comparable range, and much of its trajectory is outside the range of existing missile early warning systems. A launched carrier rocket can be detected by reconnaissance satellites, which are able to spot its streak, but sensors cannot obtain accurate trajectory information and track the flight of the warhead despite its brightness being comparable to thunderstorm lightning (Erwin, 2018). Missiles also cannot be tracked by ground-based radars (Acton, 2015, p. 2). Second, a missile detached from its warhead is able to maneuver during its flight to the target, both in altitude and heading. The ability to make maneuvers of up to several thousand kilometers makes it unclear to the end what the target of the flight is, especially for a single or group strike, in an area of high infrastructural density (Arbatov et al., 2019).

The development of hypersonic weapons is not without impact on other areas of national defense. The limited flight time of hypersonic missiles forces the development of space-based countermeasure systems. It also encourages the development of automated interceptor systems, which are likely to undertake future combat without human intervention. With extremely difficult problems to overcome, once a hypersonic missile is launched, the attraction of pre-emptive strikes to neutralize the remaining missiles before they are used is likely to increase. Finally, Russia's sale of hypersonic systems to states such as India, Iran, Syria, or Turkey, and perhaps even Venezuela or Cuba, cannot be ruled out, which would certainly greatly complicate the international security situation (Cummings, 2019).

One of the key factors in the development of precision-guided weapons will be their capabilities to integrate and share information between reconnaissance, command, and missile systems. The networking of offensive weapons will help close the existing time gap in the cycles of fire interactions. The capabilities to locate, identify and track targets and assess the effects of their flare will be improved, and losses from own fire will be minimized. Networking will provide real-time fire interaction capabilities and battlefield situation assessment based on the most reliable sources (Koudelka, 2005). Linking the physical and virtual worlds together will create new opportunities for the application of hypersonic weapons and increase the likelihood of success in future combat. However, as new missile systems are developed, the proper balance between technology and the ability to create effects in the battlespace must be maintained to prevent over-reliance on the virtual world. Otherwise, cross-linking may become an Achilles' heel in the development of precision-guided weapons (Koudelka, 2005).

3. Strategic implications of the use of hypersonic weapons

Hypersonic weapons, because of their attributes, pose serious threats to international security. Strategically, it can affect rapid changes in stability (Speier et al., 2017). If used in the future against states with limited nuclear response capabilities, it can be assumed with a high degree of probability that major forces will be paralyzed before they can respond in any way. Such a prospect could lead the attacked states to seek to launch their nuclear missiles at all costs, without any warning and rather do so blindly, which could lead to serious emergencies. Second, due to the great difficulty in defending against hypersonic missiles strikes, which are relatively small in scope, they can pose serious threats to force projection, even for those states that possess serious military capabilities. Therefore, hypersonic weapons have a certain value for strategic deterrence (Speier et al., 2017).

The principles of the use of hypersonic weapons in the Russian Federation have not been doctrinally unambiguously clarified (Sheremet & Voloshin, 2016). It is assumed that the capabilities of hypersonic weapons will not always be treated as strategic, but depending on how they are used, they can have strategic effects. One factor complicating its classification as a specific type of weapon is that hypersonic systems can be equipped with both conventional and nuclear warheads. Although in this respect they are no different from many other dual-use systems, such as self-guided cruise missiles or ballistic missiles, the nature of some hypersonic systems and the situations in which they may be used make it difficult to overcome this ambiguity (Woolf, 2020). Uncertainties about the strike target and ambiguities about the warhead armament complicate the correct assessment of the operational situation, especially when the attacker has not communicated his intentions. In addition, because of the limited flight time of the missile and the difficulty in identifying it, reconnaissance systems may not be able to generate reliable warning information in time. Hence, the risk of misunderstanding is very high, especially when considering that neither intercontinental ballistic missiles nor hypersonic missiles have ever been used in combat and it is unknown how both existing early warning and command systems will respond to their use (Borrie et al., 2017). Even if we assume that hypersonic warheads will be detected in time and correctly identified, it will still not be known until the last moment whether the target of the strike will be a conventional or nuclear object. Consequently, this situation could lead to an unintended nuclear escalation (Borrie et al., 2019).

The source of escalation due to uncertainty in most cases is the nuclear capability of hypersonic missiles. Hypersonic systems provide niche capabilities, and a small number of warheads may be in the future sufficient to destroy an adversary's security-critical facilities (Woolf, 2020). Again, it is important to emphasize that it is extremely difficult to eliminate ambiguity about the type of payload that hypersonic systems carry, so the likelihood of miscalculation and escalation of conflict is very high. Even if a particular state knew that a missile fired in its direction was conventionally armed, it might still consider it a strategic weapon, regardless of how it was perceived by the attacking state, and conclude that a strategic response even with nuclear weapons was perfectly reasonable. Again, the short time to make a decision and respond correctly complicates efforts to take control of the escalating conflict (Borrie et al., 2019).

Whether or not hypersonic systems are a destabilizing factor in the international security situation, their operational use in the future contributes to broader contemporary strategic trends. The relationship between the development of weapons capabilities and the ways in which they can be used raises broader concerns, particularly about the ability to defend against hypersonic missiles and provide security for space infrastructure. Nuclear-armed states also appear to be keeping a close eye on new hypersonic strike capabilities,

carefully assessing the level of threat to their own nuclear retaliation capabilities. Accordingly, it is possible that doctrinal changes could be made that would expand the range of conditions deemed necessary for nuclear weapons to be deployed. Also, attempts by some states to raise the combat readiness of their nuclear forces in response to a potential adversary acquiring new hypersonic systems cannot be ruled out. Such actions certainly lead to destabilization of the security situation and foster unnecessary international tension (Borrie et al., 2019).

Looking at the issue of the use of hypersonic weapons in a broader sense, one may conclude that their ability to relatively easily defeat air and missile defenses and the relatively short time to react and make the right strategic decision may have a particularly negative impact on the security in regions where the international situation is tense, for example between Iran and Israel or North Korea and Japan. Regional conflicts may evolve to involve superpowers supporting states on opposing sides, which may lead to even greater escalation and negatively affect the stability of international security (Speier et al., 2017). In such a situation, the primary role of external actors would not necessarily change. There would certainly be an equalization of power, but external powers could suddenly find themselves in a state of direct confrontation. Patronage states, on the other hand, would be satisfied with the resulting so-called "leverage" effect. In addition, smaller states threatening hypersonic strikes could gain influence over the world powers, especially if they had the assurance of armed intervention by their supporters. It should also be noted that the destructive effects of hypersonic weapons could lead to a lowering of the threshold for initiating conventional military activities. On the other hand, the powerful destructive capabilities of hypersonic weapons can have strategic effects and make the acquisition of hypersonic technology a desirable political goal for many states (Speier et al., 2017).

The Russian Federation may use precision-guided weapons, which include hypersonic missiles, in local, regional, and global conflicts in both offensive and defensive actions. Since 2012, however, it is believed that precision weapons will become a means to achieve decisive victories in conflicts, especially those of a global nature. Marshal N. Ogarkov predicted that precision-guided weapons would improve the destructive capabilities of conventional weapons by at least an order of magnitude, but by no means did he predict that they would become crucial in achieving victories. In the last decade, there has been a tendency to make Russian precision weapons strategic (Gormley, 2016, p. 6), especially since the acquisition of hypersonic capabilities, on the grounds that they can prevent an adversary from using nuclear or satellite weapons, as well as neutralize so-called anti-access capabilities (Acton, 2013). However, it seems that the emergence of new hypersonic weapons primarily means a change in the whole approach to military force as a foreign policy instrument. According to Alexei Ivanovich Podberezkin, the military-technical revolution, consisting in the creation of new types of precision weapons, has not only caused major changes in the balance of military and political power in the world, but also contributed to radical changes in the art of war. By this, the armed forces become useful again, both in small and large conflicts (Podbieriezkin, 2013). The author predicted that due to the availability of precision-guided weapons, the use of armed forces to conduct international competition will become common again and its importance will increase, due to the high effectiveness of hypersonic weapons in conducting regional and local conflicts (Podbieriezkin, 2013). Unfortunately, such a view contradicts the opinions of most Russian experts who believe that the role of armed struggle in achieving political goals is limited. Others believe that in seeking to impose one's will on the opponent, with the use of hypersonic weapons, it is easier to execute strikes against key civilian and military targets deployed throughout the opponent's territory. Since conquering territory and maintaining it is now becoming increasingly difficult, it is anticipated that future wars using hypersonic weapons will focus on forcing a specific adversary's behavior, with political objectives being more limited in nature. If the attacker chooses not to use

ground troops and the armed struggle is limited to air strikes, then certainly by eliminating all important facilities, conditions will be created to end the conflict. However, the political objectives will, after all, inherently have to be limited (Mahnken, 2013).

There are two key dilemmas in conducting a hypersonic weapons campaign. First, whether the priorities of fire shock should be directed at military or civilian targets, and whether these should be stationary or perhaps mobile targets Vladimir Slipchenko believed that the main priority in future war would be stationary civilian targets, as they could have an even greater impact on the political will of the opponent than military targets (Slipchenko, 2002). In contrast, Sergei Chekinov and Sergei Bogdanov (2013) emphasized that this can be done selectively against both civilian and military infrastructure. However, mobile targets present a much more difficult challenge than stationary targets. Effectively destroying them requires the networking of both the means of warfare and the elements protecting them (Watts, 2013). However, it seems that a completely different criterion should be followed, namely the criterion of the effects achieved. It is particularly concerned with causing negative cascading effects throughout the defense system of the attacked state. The final criterion for the use of hypersonic weapons against specific objects should be to estimate the impact of their destruction on the possibility of escalating effects, thus creating a specific level of psychological coercion that will convince the enemy of the futility of undertaking further resistance. Of course, targets of strikes can and likely will include those facilities that have both a deterrent effect and practical military value (Burienok, 2013). This means that there is a group of objects that have dual importance. The objects of strategic importance are considered to be those, the destruction of which leads to significant material losses in the economy of the state. They can be, for example, objects of key importance for military production, or those in which hazardous substances are located, and nuclear or hydroelectric power plants. Strikes against them are carried out in order to intimidate and cause fear in a potential adversary and to convince it of the high costs involved in continuing a confrontation with the Russian Federation (Burienok, 2013).

4. Conclusion

As a result of the research, it has been determined that hypersonic missiles are capable of moving at tremendous speeds and maneuvering altitude, reaching a ceiling much lower than classical missiles and making them virtually undetectable to radar. Currently, no country in the world has an effective protection system against a hypersonic missiles attack, which sounds alarming considering that hypersonic weapons will be able to attack any point on the Earth's surface in less than 60 minutes. The attributes possessed by hypersonic weapons render nuclear weapons resources useless, as they can be destroyed at any time. Moreover, due to its high speed and maneuverability, it is impossible to predict the direction of the missile's flight. Admittedly, the closer to the target of the attack, the predictability of the flight path increases, but also the time to react significantly decreases, which makes it practically impossible to take effective preventive action in time.

The Russian Federation has long believed that precision-guided weapons are an indispensable element of modern international competition and warfare, which is why, after the illegal annexation of Crimea, acquiring them to the fullest extent possible was considered the main priority of Russian military modernization. At present, it is the subject of constant experimentation and discussion in Russian political and military circles regarding its role and significance in achieving the goals of international competition. According to military

theorists, its integration with other types of weapons and the activities of special forces, , can bring the greatest benefits, in line with the needs of the operational environment.

Based on an assessment of doctrinal documents (Military, 2014; National, 2015), it can be concluded that large-scale strikes with precision weapons can be executed against a variety of infrastructure facilities already in the initial phase of a conflict, especially those whose destruction will create strategic effects. These may include, for example, oil refineries, nuclear power plants, fuel and toxic material storage facilities (e.g., chlorine and ammonia), and many other critical state infrastructure facilities. In addition, hypersonic weapon strikes can be conducted to deny access to an area of strategic importance and to force the opposing party to behave as expected by the affecting party. It should also not be forgotten that precision-guided weapon systems can be armed with nuclear warheads, which have specific security implications for both militaries and civilians. It should also be noted that modern strategic ballistic missiles are as unstoppable and powerful as hypersonic weapons, but they are already deployed in great numbers. Surely, for some missions, the *Avangard*-like missiles would be better than conventional intercontinental ballistic missiles. But in most cases, like massive countervalue or counterforce strikes, the already existing missiles would serve as effectively as hypersonic. The same goes for non-strategic use of hypersonic weapons. Moreover, the blurring of the boundaries between conventional and nuclear weapons will foster the creation of favorable conditions for the Russian Federation to achieve the goals of international competition. In a situation of rapid technological change seriously affecting the new capabilities of offensive weapons, which undoubtedly include hypersonic weapons, questions arise about the future of strategic stability between the world's major nuclear powers.

Based on the research, it can be concluded that hypersonic weapons, when applied in the future on a large scale, could lead to a revolution in the conduct of international competition and armed struggle in the future. The mass production and widespread use of modern and reliable designs of precision-guided weapons means that these weapons no longer represent a niche capability directed against a limited number of highly profitable targets. In the Russian Federation, hypersonic weapons are treated on a par with nuclear weapons. It is believed that due to its attributes it is an excellent tool for applying pressure and aggression. It is estimated that hypersonic weapons will allow international rivalry to take place in a gray area and achieve foreign policy objectives without the need for direct military confrontation. The capabilities of hypersonic weapons to have near-instantaneous operational and strategic effects may realize concerns about the stability of the international security environment. Modern hypersonic weapons can create crisis situations, accelerate the dynamics of conflict escalation, and rapidly transition from a state of stability to international instability.

The high effectiveness of precision-guided weapons makes it necessary to make doctrinal changes and to adjust the strategy of their use in the future. It may also be a key element in determining whether the Russian Federation will achieve global dominance in the third decade of the 21st century.\

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