HYPERSONIC MISSILES VS STRATEGIC STABILITY

HYPERSONIC CRUISE MISSILE "X-51A" U.S. Air Force graphic HYPERSONIC BOOST-GLIDE VEHICLE Artist's Concept

Hypersonic Missiles: key elements





Hypersonic missiles are firstly defined by their ability to reach and maintain **hypersonic speeds**, i.e. speeds exceeding Mach 5. Hypersonic missiles follow a **non-ballistic atmospheric trajectory**, flying between 18 and 60 ml in altitude. Hypersonic missile are capable to **manoeuvre** and to change the point of impact throughout all their flight.

Understanding the difference between Hypersonic missiles and Ballistic missiles



2.000

4.000

6.000

8.000

Range (km)

10.000

12.000

14,000

16,000

Ballistic missiles (BM) fly at much higher altitudes than hypersonic missiles and follow relatively predictable trajectories.

A typical BM will travel in outer space with an arch-shaped trajectory.

Hypersonic missiles follow a non-ballistic trajectory; they would operate at altitudes significantly below those of ballistic missiles.

Moreover....

They are capable to maneuver during all their flight.

It is possible to predict the destination of any given ballistic missile payload by using spacebased and ground-based early-warning systems.

Maneuverability and unusual altitudes can result in their being invisible to earlywarning systems for much of their trajectory

Summarizing the key differences

What is setting the difference between ballistic missiles and hypersonic missiles?

Both can reach hypersonic speeds

BUT

1) Trajecotry and altitude

<u>Hypersonic missiles</u> follow a non-ballistic atmospheric trajectory for part or all of their flight.

<u>Ballistic missiles</u> follow an arch-shaped and relatively predictable trajectory. Ballistic missiles travel in outer space for most of their flight.

2) Manoeuvrability

<u>Hypersonic missiles:</u> change course up to the last minutes of flight

<u>Ballistic missiles</u>: predictable ballistic trajectory. Only if equipped with a Maneuverable re-entry vehicle (MARV) they offer a chance to maneuver in the terminal phase of their flight (30 seconds before impact)



RAND RR2137-1.3

BALLISTIC MISSILE DETECTION...



Space-based early-warning systems can track a ballistic missile in the boost-phase of its flight.

This allows an opponent to make a first assessment of the target of the missile and to calculate the warning-time at his disposal.

After the detection by satellites systems, a ballistic missile would then be detected from thousands of miles away by powerful **ground-based** early-warning radars, which would further confirm the trajectory and the impact point.

It is estimated that space assets would guarantee a warning-time of approximately 30 minutes in the case of an ICBM travelling from the Russian bases of Dombarovsky or Tatishchevo to U.S. Warren Air Force base.

...AND HYPERSONIC DETECTION



Hypersonic missiles, like ICBMs, will be detectible in their initial boost-phase by satellite early warning systems.

Thereafter, by flying at lower altitudes than ballistic missiles, they will cease to be detectible.

After the "unobservable" phase, hypersonic missiles flying at heights between 18 and 25 miles will become detectible when travelling within about 250 to 370 miles of a ground-based radar.

Even if detected, there will be a high degree of uncertainty about their destinations.

In a context in which an early-warning radar, like the U.S. *Pave Paws* radar or the Russian *Voronezh* radar, is the target, the early-warning-time would be limited to **two and a half minutes** in the case of a hypersonic missile travelling at Mach 10.

HGV

Hypersonic Glide Vehicle (Long-range capability)



- An HGV is an unpowered vehicle capable of gliding on the upper atmosphere at hypersonic speeds. It is equipped with a small propulsion system for orientation and directional control.
- Mounted atop of a large rocket, usually an existing type of ICBM, which will propel the HGV at hypersonic speeds.
- Release from the booster rocket can take place between 25 miles and 60 miles above the earth's surface. Then, the HGV will glide to its target along a relatively flat trajectory.

Hypersonic Cruise Missile (Tactical-range capability)



- An HCM is a cruise missile capable of operating at hypersonic speeds, flying at 20 km to 50 km in altitude.
- In concept, these systems consist of two stages: the firststage rocket booster and the second stage powered by a scramjet engine which generates thrust from a supersonic airflow.
- HCMs will fly at lower altitudes than HGVs, i.e. between 12 miles and 30 miles above the earth's surface.

Hypersonic and great power competition

Hypersonic missiles:

- Compress the warning-time that will follow the detection of a hypersonic strike (and the time at disposal to decision-makers to elaborate and communicate a response)
- The targets of a hypersonic strike will be unpredictable, holding large areas at risk.
- Potentially overcome the most advanced missile defense systems



Map 1. China's Nuclear and Conventional Missile Bases and Launch Brigades. (Fiona S. Cunningham and M. Taylor Fravel, "Assuring Assured Retaliation: China's Nuclear Posture and U.S.-China Strategic Stability," International Security, Vol. 40, No. 2 (Fall 2015), p. 43)

Why the Hypersonic Arms race?

<u>The recent resurgence of the attempts to militarize</u> <u>hypersonic technologies are part of the U.S.</u> <u>Conventional Prompt Global Strike (CPGS) programme.</u>

<u>Objective</u>: develop fast, long-range, non-nuclear weapons capable of striking targets anywhere in the world "within one hour of time".

<u>Objective</u>: reduce the reliance of forward-deployed bases; also allow the United States to reach targets deep inside an enemy's territory if that area is out of the range of U.S. forces deployed at bases or on naval forces in the region.

<u>Objective</u>: overcome adversaries' air defenses or other capabilities, in particolar A2/AD capabilities, that could deny I U.S. aircraft access to critical targets.

Long-range hypersonic missile strikes could prove valuable if launched early, as a "leading-edge" capability to degrade an opponent's key defensive systems.

Why they did not mount existing ICBMs with conventional warhead in order to do so?

The U.S. did attempt to do that but the program did not receive funding as the Congress was concerned that Russia could misinterpret the launch as a nuclear strike.

Why they cannot use UAVs mounted with with existing missiles?

Drones have proven to be usually highly susceptible to being shot down by modest air-defense systems.

Blinding enemy's sensors and crippling warfighting

capabilities at the outbreak of a conflict between the U.S. and a peer competitor is an objective of utmost importance (e.g. AirSea Battle strategy).

The United States, China and Russia are by far the nations with the most developed hypersonic technologies.

It has been reported that both Russia and China share the concern that "the most important reason to prioritize hypersonic technology development is the necessity to counter specific security threats from increasingly sophisticated U.S. military technology"

The United States:

The 2018 National Defense Strategy identifies hypersonic weapons as one of the key technologies "[ensuring the United States] will be able to fight and win the wars of the future."

Funding requests have increased from \$181.3 million in FY2017 to \$3.2 billion for Army, Navy, and Air Force conventional long-range strike programs in FY2021.

The U.S. are testing various hypersonic weapon systems, both gliders and cruise missiles.

Russia: Russia has fielded in December 2019 two "Avangard" HGVs.

The plan is to deploy twelve Avangard systems of this type at Dombarovskiy by 2027.

The Avangard is supposedly armed with a nuclear warhead.

Russia is close to field the Zirkon hypersonic cruise missiles.

Zirkon is expected to serve as a multi-purpose tactical weapon

China:

China has tested the "DF-ZF" HGV at least nine times since 2014.

China is close to field the Lingyun-1 an hypersonic cruise missile.

It is reported that China could field conventionally armed HGVs in support of its anti-access/area denial strategy

Key destabilizing factors:

Relevant considerations:

Warhead ambiguity: referred as the complexity or the inability to discern if a hypersonic missile is carrying a nuclear or a conventional warhead.

Target ambiguity: Due to the steering ability of HCMs and HGVs, states could believe that their nuclear forces are been targeted while the weapons is intended to hit conventional forces.

Destination ambiguity: An observing state could mistakenly assume that a hypersonic missile is striking its territory while the real target is located, for example, in the territory of a neighbor state.

- Only the United States have conceived the development of hypersonic missile only as a conventional system.
- At present it is not known if China or Russia are going to put nuclear warheads on hypersonic missiles.
- The U.S. might carry out long-range precision strikes against hostile objectives without crossing the nuclear threshold.
- The U.S. might feel more confident and freer to conduct long-range hypersonic strikes, with the risk of crossing an adversary "red line" increasing the risks of escalation.

The case of two equally-matched possessor-states of conventional/nuclear hypersonic missiles:

<u>Lets look at their nuclear forces balance</u>: The possession of hypersonic nuclear missiles will not necessarily bring about an imbalance of nuclear forces if both continue to respect agreed warhead deployment limits.

<u>Will there still be a balance?</u> Yes, but that balance will be unstable because the characteristics of hypersonic missile will be perceived as enhancing first strike capabilities.

What are the potential dangers?

<u>1) The super-accuracy</u> of these weapons could lead one state to believe that a surgical low-yield nuclear attack might be acceptable to an adversary while the other state would see any use of these weapons as an existential threat.

2) <u>An irresponsible leadership</u> could wish to use nuclear or conventionally armed hypersonic systems and accept a low-yield nuclear strike in return. If both sides being willing to accept mutual hypersonic low-yield nuclear strikes, the one who would then find himself at a disadvantage could prefer to escalate.

Russian Nuclear doctrine countermoves:

The 2014 Russian Military Doctrine regards as a "military threat", as well as a risk for their deterrent capability, the "deployment of strategic non-nuclear systems of high-precision weapons".

The doctrine considers conventional hypersonic conventional weapons (or strategic non-nuclear high-precision weapons) to be equivalent to nuclear weapons in terms of their implications for deterrence.

<u>The Russian perspective</u> of the potential of hypersonic weapons is strictly tied to the consideration of the U.S. BMD deployment in Romania and Poland

It seems that Moscow believes that the coupled deployment of the U.S. antiballistic missile defense system and development of hypersonic technologies increases the potential for a successful U.S. preemptive strike against Russian nuclear missiles

Russia fear the increase in the risk of a successful U.S. preemptive strike against Russia's land-based strategic nuclear forces

China perspectives:

China's perception is shaped by the fact that U.S. CPGS weapons could force China into a "disadvantaged, passive position" by weakening the Chinese nuclear counterstrike capability.

It is also reported that China is worried about the potential combination of high-precision warhead delivery methods with low-yield nuclear warheads; such weapons would be "tactically usable".

These factors are contributing to the Chinese decision to raise the alert of nuclear forces and build a launch-on-warning capability.

high-yield option: 10 W88 warheads low-yield option: 20 B61 bombs *The B61 bombs (0.3-kiloton yield), set to detonate at an Fushun altitude that maximizes Pyongyang effectiveness while minimizing fallout. The fallout patterns and casualty Seou figures were generated using unclassified U.S. Defense **Department software, called Hazard Prediction and** Pyongyang AProgue state armed with a nuclear weapon Assessment Capability. (Keir A. Lieber and Daryl G. Press, The New Era Hiroshima of Counterforce: Technological Change and the Future of Nuclear Deterrence, Fukuoka

A surgical low-yield nuclear strike could boost the confidence of an irresponsible leadership that the attack is "acceptable"

Results:

International Security, Vol. 41, No. 4

(Spring 2017), pp. 9-49).

- all five targets destroyed
- 2–3 million dead (in North/South Korea)

a

Results:

- all five targets destroyed
- fewer than 100 dead (at target sites)

Seoul

These scenario are particularly risky if one considers that our nuclear era is characterized by the "substitution of crises for wars." Nuclear competition is a "competition in risk taking". In the words of former US Secretary of State John Foster Dulles, "The ability to get to the verge without getting into the war is the necessary art (...) If you try to run away from it, if you are scared to go to the brink, you are lost." It's the art of going until the threshold of war to leverage and to exploit on the opponent's desire to avoid war. **http://www.eastpendulum.com/oth-gbr-ces-radars-tres-longues-portees-chinois

Let's consider a scenario in which the U.S. launch a small fleet of **conventional air-launched HCMs from the Philippine Sea towards the Fujian Province** (facing the Taiwan Strait).

The Mach 8 HCMs would fly the 800 miles to their targets in about 10 minutes. Their mission would be the destruction of coastal defences, as well as communication nodes and power plants, in order to disable Chinese command-and-control capabilities

Several Chinese early-warning radars pointed at Taiwan would detect the incoming HCMs flying as low as 12-15 miles in altitude from about 500 miles away. **This would provide about 6 minutes warning-time.**

How would the Chinese government cope with such a short decision time and with target and warhead ambiguities, especially with warhead ambiguity?

Could the use of hypersonic weapons at an early stage of a conventional conflict result in such damage to vital Chinese assets that Chinese decision-makers would decide to escalate to an all-out war?



Which kind of Arms Control measures?

<u>Short-term measures</u>

Unilateral: Different deployment sites for nuclear and conventional hypersonic missiles

Unilateral: enhance the survivability of early warning and command-and-control assets

Multilateral: Exchanging assurances that early-warning radars and satellite will not be targeted

Multilateral: Sharing information about "red lines", to reduce escalatory risks

Negotiation of a Treaty

Numerical limits on the deployment of conventional and nuclear hypersonic missiles.

On-site inspections to lower the risks associated with the warhead ambiguity

Fixed places of deployment of hypersonic missiles following the model of the ABM treaty

Matteo Frigoli is a graduate who has recently obtained a master's degree in Law and International Studies at the University of Parma (Italy).

His focus is on arms control and conflict studies, on the effects and causes of the weaponization of outer space and on the impact of emerging technologies on international security. He worked as an external researcher for the European Space Policy Institute and for the Center for Geopolitical and International Studies.

He is now working as Strategy&Defense Manager at Mondo Internazionale (Italian based ONG).

Mail: matteo.frigoli@mondointernazionale.com