UKRAINE: AIR WARFARE AND AIR DEFENSE IN HIGH-DENSITY CONFLICT

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On February 24, the Russian armed forces launched a lightning offensive on Ukraine. This attack was preceded by a bombardment carried out by cruise missiles, including 3M14E Kalibr, KH-555 and KH-101, 9M728 Iskander-K semi-ballistic missiles and KH-31P anti-radar missiles. These missiles targeted Ukrainian air bases, ground/air defense sites, air surveillance radar sites and command posts. Barely 4 hours later, Russian ground forces crossed the Ukrainian border while a particularly daring and risky helicopter assault was launched against the Hostomel airport.

Several hundred missiles were launched during these first hours, destroying on the ground a good part of the Ukrainian fighter force—which had been spread over several bases—the main long-range ground/air defense sites made up of S-300 systems, as well as a good number of air surveillance radars. If this first phase strongly resembled the operations carried out by Western forces, the rest was radically different.

Partial and Short-Lived Air Superiority

An offensive preceded by the firing of cruise missiles and anti-radar missiles to eliminate strategic sites and ground/air defenses is not original in itself. It is the prerequisite for all military operations. However, completely neutralizing a ground/air defense and all enemy combat aircraft is generally a long-term operation, lasting from several days to several weeks. And even then, this work is almost never completely finished. During the Kosovo war, despite 58,574 air missions over 78 days—including 4,397 missions to suppress enemy air defenses—neither Serbian fighter aircraft nor ground/air defense were completely neutralized. However, the Serbian ground/air defense and its air force had nothing to compare with what Ukraine can offer, which is much better equipped, both in quantity and quality, not to mention the size of the country.

This first phase of the Russian attack was nevertheless likely to neutralize for a few hours the bulk of the enemy's fighter and ground/air defense; but it was very far from being able to neutralize all the available means.

The Ukrainian fighter aircraft seem to have been hit hard during this first phase; the number of flights remained relatively low afterwards, which seems to indicate that there were few aircraft left able to take to the air. It is unclear whether the Ukrainian aircraft that continued to fly were operating from their air bases or from secondary runways or routes. In the latter case, the ability to operate the aircraft must

have decreased rapidly, as it is very complicated to maintain and refuel sophisticated aircraft, such as combat aircraft outside their support infrastructure. Apart from the losses suffered in combat, this could also explain the slow but gradual disappearance of Ukrainian fighter aircraft from the sky.

The Ukrainian ground/air defense has proven to be much more difficult to neutralize. Not only were not all Ukrainian S-300 systems deployed on the ground—so that a number of the 20 or so S-300 systems in the field were in reserve—but all short- and medium-range systems were generally protected from strikes. In fact, the Ukrainian ground/air defense could still count on a few S-300 batteries and also on several hundred short- and medium-range systems (2K12 KUB (SA-6), 9K37 BUK (SA-11), 9K30 TOR-M1 (SA-15), 9K33M2 Osa-AK (SA-8), 9K35 STRELA-10 (SA-13), and hundreds of MANPADS (SA-7, SA-14, SA-16 and SA-18). Nevertheless, it seems that the air surveillance radar network was durably affected, at least on the eastern part of the country; which means that Ukraine probably did not have a complete air situation anymore. Without this, it is much more difficult to set up a structured anti-aircraft defense. Each weapon system also becomes more vulnerable because it must operate its own surveillance radar and thus reveal its presence, instead of taking advantage of a remote air situation that allows the system to be activated only when a target is in range.

Nevertheless, this partial neutralization and of short duration (a few hours), appeared sufficient for the blitzkrieg hoped for by the Russians. But the failure of the helicopter operation on the Hostomel airport greatly complicated the continuation of the operations.

Russia Facing Ukrainian Ground/Air Defense

As the numerous images broadcast on the internet show, the Ukrainian ground/air defense remains active and is capable of shooting down planes, helicopters and even cruise missiles.

Having engaged its ground forces very quickly without having air superiority, the Russian army found itself very exposed. As a result, Russian helicopters and attack aircraft were forced to take on ground support for the troops, despite the threats, hence the losses suffered. The weather conditions—low ceiling, fog—also hampered air operations. All this may also explain the relative discretion of Russian fighter aircraft during the first days of the conflict.

The lack of guided ammunition also forced the Russian fighter aircraft to operate at low altitude. It

should be remembered that a guided munition costs between 100 and 600 times more than an unguided one, and that the Russians have favored the development of bombing calculators, such as the SVP-24 or GeFest-24, which allows for an CEP (circular error probable) of around 5 meters for a maximum release altitude of 5,000 meters. This is certainly much less precise than a guided bomb, but it is undoubtedly sufficient in the majority of cases for a much lower cost. The other advantage is that the stocks of smooth bombs are very large and easy to replenish, contrary to guidance kits which take a long time to produce; but this means that the planes are more exposed to ground/air systems.

After a period of uncertainty during the first two weeks, SEAD (Suppression of Enemy Air Defenses) missions seem to have been implemented more systematically in order to progressively reduce the most dangerous systems. Recurrent images of SU-30 aircraft equipped with KH-31P anti-radar missiles have been posted on the internet and the use of E95M target drones to attack Ukrainian anti-aircraft defenses is also attested. There have also been reports of the transformation of old AN-2 biplanes into drones to play the same role, but their use has not yet been confirmed. The deployment of electronic warfare aircraft has also been noted in Belarus, suggesting that jamming actions against weapons systems will be implemented.

Nevertheless, given the number of ground/air systems in the Ukrainian arsenal and the many very short-range missiles delivered by the West, Russian aircraft are not in a position to operate without any threat on Ukrainian territory, especially for those operating closest to the ground, such as helicopters or SU-25 and SU-34 attack aircraft. Unless such aircraft are not used, attrition will remain inevitable.

Russian Ground/Air Defense

Russia does not seem to have modified its defensive system; only two or three S-400s seem to have been deployed on Belarusian territory and, a priori, one in the north of Donbass; but none on Ukrainian soil. The ground/air defense around Moscow, Saint Petersburg, the Kaliningrad enclave, Crimea, the Murmansk region and the Russian Far East continues to hold the bulk of the S-400 systems. The rest of the country is still mostly protected by S-300P systems, whose replacement by S-350s is just beginning. This may explain why the OTR-21 Tochkaukrainian missiles launched at the Russian air bases of Tarantog and Millerovo were able to get through, knowing that the former had, for any protection, only an old S-300P located 50 km to the east, which was incapable of handling a ballistic missile, and the latter had no ground/air system within 200 km. The missiles could therefore not be intercepted. Although Russia has one of the densest air defense networks in the world, total anti-aircraft protection

is impossible, given the vastness of the territory. Only the most strategic sites are systematically protected. This explains why two Ukrainian Mi-24 helicopters were able to carry out a raid on Belgorod, a city with no strategic installations and therefore no particular means of protection. Air defense is not a kind of magic that can create an invisible shield to protect a territory.

With regard to the invading forces, anti-aircraft cover was provided but in a very incomplete manner. As plethoric as the Russian anti-aircraft arsenal is, it is not sufficient to ensure the protection of all deployed forces. Ground/air systems, such as the Tor-M1, the 2K22M1 Tunguska and the old 9K35 Strela-10 and OSA have been supplemented by systems normally used for static protection, such as the Pantsir-S2, but in insufficient numbers to be able to provide protection for all the armored and supply columns.

Another problem is that Russia is now facing an air threat from drones, such as the TB-2, or the locally built Punisher. These relatively small and slow drones are particularly difficult for ground/air systems to detect while in motion. To be effective, the radars must be in a static position. Indeed, the speed of the vehicle and the movements accompanying it considerably hinder the detection of relatively slow targets because they are drowned in the Doppler speeds of the moving environment. These systems were designed to detect aircraft, missiles or helicopters, moving at much higher speeds and not likely to blend in with the environment. Empirically, we can consider that a drone moving at less than 200 km/h will be very difficult to detect by a moving radar. It should be considered that this problem will be aggravated by the arrival of suicide drones that the Americans are planning to deliver to Ukraine.

Russia has also deployed medium-range ground/air systems, such as the BUK-M1-2, whose interception capabilities are more extensive, with even an anti-ballistic missile capability up to 20 km.

All these anti-aircraft systems, far from having been demerited, have been able to shoot down Ukrainian aircraft and TB-2 drones—at the end of March, 35 of the 36 TB-2s delivered would have been shot down (information to be confirmed) when they were in a position to do so, i.e., in operation and in a fixed position. However, the enormous logistical problems encountered by the Russian army, particularly in terms of refueling, meant that a good number of these ground/air systems were "dry," which meant that they were mechanically inactive due to a lack of electrical power; hence the number of pieces of equipment abandoned on site. Under these conditions, the Ukrainians were able to widely broadcast images of TB-2 drones destroying ground/air systems, which does not mean, however, that they had defeated them.

The other deficit of the Russian army is in the area of air surveillance. While the Russian territory is dotted with numerous air surveillance radars interconnected with anti-aircraft defense, this is not the case in Ukraine, where ground/air systems are generally isolated, which greatly reduces their overall effectiveness, as they are unable to function as a network and do not benefit from depth in surveillance. It would appear that at least two A-50 radar aircraft have been deployed to Belarus to compensate for this lack.

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This is the first time since the Second World War that we are witnessing a high-intensity war in the third dimension in Europe, bringing into direct confrontation two armies with a set of first-rate capabilities (air force, dense and relatively modern ground/air defense, drones) and a more or less similar technological level. Three lessons can already be drawn from this conflict:

1. Faced with a country richly endowed with ground/air systems, it is impossible to completely eliminate the threat. This means that aircraft flying over the protected territory must accept risks, and therefore inevitably suffer losses. Even old systems remain a threat that should not be neglected;

2. in addition to missiles, the appearance of drones on the battlefield maintains a permanent air threat, practically impossible to suppress, which requires a respectable number of anti-aircraft/anti-drone systems capable of protecting ground forces, notably armored formations and logistical convoys which are particularly vulnerable;

3. High-intensity warfare requires a very high consumption of ammunition, which implies that the use of guided ammunition, which is in limited supply due to its price, will be reduced over time. As the rate of industrial production is incompatible with the level of consumption, the air forces will have to rapidly accept the use of unguided munitions (much easier and quicker to produce) and therefore to operate at lower altitudes, i.e., within the firing volume of practically all ground/air systems.

Unlike all Western military operations conducted over the past several decades, where air dominance has always been achieved, a high-intensity war will require aircraft to operate in a constantly contested

and threatening space. Losses will be inevitable, and therefore sufficient equipment must be available to deal with attrition. This only serves to remind us of what the relative operational comfort of the last few decades has made us forget—that any military equipment that is supposed to go into combat must be considered "expendable," if not consumable.

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Featured image: The MiG-29S.