In this chapter, we discuss seven key points that have emerged from our analysis. They have been grouped into two broad categories, one dealing with air superiority and the other with the war at sea.

**AIR SUPERIORITY**

**Base Operability**

Even in our base case, the PLAAF outnumbers the ROCAF by 1.7 to 1; the “large” Chinese force enjoys an even greater quantitative edge. This makes it imperative for the Taiwanese to make the most of their smaller force structure by sustaining their ability to generate sorties over time. Equally, the PRC will undoubtedly attempt to disrupt air base operations with missile and air strikes.

Other RAND analyses suggest that attacks employing sufficient numbers of advanced conventional warheads could in fact cause significant damage to unhardened facilities, aircraft parked in the open, and personnel (Stillion and Orletsky, 1999). Figure 3.1, based on our work, suggests the possible implications. The figure shows results at three levels of ROCAF sortie generation capability: 50, 75, and 100 percent when no U.S. forces are engaged.1 Taiwan achieved successful outcomes (green or yellow—black and medium gray in the figures) in about 60 percent of the cases when its air force was flying at full

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1We removed U.S. forces from the equation to clarify the impact of the changes in Taiwanese sortie rates.
tempo, but only about 40 percent of the time when its sortie generation was reduced by half.²

We therefore conclude that ensuring that their air bases remain operational under wartime stresses must be a primary worry for Taiwanese planners. The following four vulnerabilities stand out in our assessment:

- Aboveground fuel storage tanks and parking facilities for tanker trucks would make appealing targets for missile and air attacks. Any curtailment of aviation fuel supply would have an obvious and deleterious effect on the ROCAF’s operations tempo, an effect that could be fatal in case of a large-scale Chinese assault on the island.

²Recall that even in the “100 percent” case, Chinese air and missile attacks on air bases can have an impact on the ROCAF’s sortie rates. The reductions described here are in addition to these effects.
• Like fuel tank farms, large, unhardened engine and avionics support shops could be put out of action by air- or missile-delivered ordnance or by SOF action.

• Operating surfaces—runways and taxiways—could be potholed with submunitions, and repair operations could be impeded by scatterable mines. Even brief closures will be difficult to tolerate in a pitched battle for air control.

• Finally, although most experts discount the possibility of Chinese weapons of mass destruction (WMD) use against Taiwan, it does not seem unreasonable that the PLA might employ chemical agents against large military targets, such as air bases.

The ROCAF is not ignorant of these threats. It has built at least two large bases buried within mountainsides. Whether future Chinese PGMs will be capable of destroying or blocking the doors into and out of these facilities is unclear, as is the ROCAF’s ability to conduct all aspects of combat base operations within the confines of these bases. In the near term, however, it is likely that some aircraft and personnel will at least be safe from nonnuclear attack while inside these redoubts.

The ROCAF also plans to rely on dispersed operations, including flying aircraft into and out of numerous highway strips scattered across the island. This strategy, while increasing survivability against certain kinds of threats, carries significant costs as well. Dispersal greatly complicates logistics, for example, and requires duplication of maintenance manpower and equipment across all the alternate operating sites. It also may significantly increase the dispersed unit’s vulnerability to SOF attacks.3

In many regards, the ROCAF’s bases face a situation similar to that confronted by NATO’s air forces in the Central Region of Europe in the 1970s and 1980s. Like the Taiwanese, NATO strategists faced an

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3In this, the ROCAF high command may face the same dilemma that confronted U.S. Army Air Forces Commander Lieutenant General Walter C. Short at Pearl Harbor in early December 1941. Forewarned of possible hostilities with Japan, he chose to gather the aircraft under his charge from their dispersed locations to make them easier to protect against enemy saboteurs. In so doing, he created a nice, concentrated target for the fighters and bombers of the Imperial Japanese Navy on December 7. For more on the difficulties inherent in dispersed operations, see Stillion and Orletsky (1999).
adversary who outnumbered them and to whom the first move was conceded. That first move was expected to include massive air, missile, and SOF attacks on a number of targets in NATO’s rear area, including the alliance’s air bases.

To counter this, NATO made enormous investments in passive defenses to ensure air base operability. Fuel storage was buried and pipelines were laid so aircraft could be fueled from hydrants in the floors of their shelters rather than by vulnerable tanker trucks. Maintenance facilities were hardened. Engineering equipment was procured, and stockpiles of runway-repair materials were laid in. Ground and aircrew regularly practiced performing their duties while wearing chemical protective suits. While not inexpensive, these efforts would have been critical to keeping NATO’s airpower in the fight had war erupted along the old inner-German border.

We strongly suggest that the ROCAF consider adopting this approach to maintaining air base operability. In the near term, the best available answer to the PRC’s improving missile forces may be to pour lots of concrete on and around their likely targets, which almost certainly include Taiwan’s air bases.

**Advanced Air Weapons**

Currently, the Chinese and Taiwanese air forces have rough parity in terms of the air-to-air weapons they deploy. Both sides field short-range infrared (IR)-guided AAMs, such as the U.S. AIM-9 or the Russian R-73/AA-11 and medium-range semiactive radar-homing (SARH) weapons, such as the AIM-7 and AA-10. In addition to importing foreign designs, both the PRC and the ROC manufacture IR and SARH AAMs.

SARH missiles require that the launching aircraft illuminate the target during the weapon’s fly-out time. This limits the pilot’s ability to either engage a second target or engage in offensive or defensive maneuvering and is a distinct disadvantage in air-to-air combat. Currently neither air force has more modern, “fire-and-forget” BVR missiles, such as the U.S. AMRAAM or Russian R-77/AA-12, in its inventory. Both sides are actively pursuing such a capability, how-
ever, with the Chinese frequently reported as pressing Russia to sell the AA-12.4

Figure 3.2 shows the effects of adding BVR capabilities to one or both sides.5 It shows that the best outcomes for Taiwan occur, as expected, when only the ROCAF fields AMRAAM-type weapons. The first and third bars show that the ROC does fairly well as long as “BVR

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4 Several reports suggest that Russia has in fact agreed to sell the AA-12 to China (see, for example, Sae-Liu, 1999). Nonetheless, we have yet to see any credible evidence supporting this.

5 We allowed ROCAF F-16s to shoot AMRAAMs and PLAAF Su-27s, Su-30s, and J-10s to carry AA-12s. In the base case, this gave the PRC a starting total of 96 AA-12 shooters versus 162 AMRAAM carriers for Taiwan. We gave each side sufficient missiles to fight for four days. If one or the other had some missiles but not enough to last for the full four days, we expect that the results would vary more or less linearly toward one of the four depicted cases, depending on how quickly each side ran out. That is, if Taiwan had enough AMRAAMs for two days and China enough AA-12s for three, we would anticipate seeing two days of combat that looked like the first two days of the “both” case, one day that resembled the “AA-12 only” outcomes, and a fourth that broadly resembled the “No BVR” case.
parity” is maintained. Although the proportions change to its disfavor, Taiwan still “wins” about 65 percent of the cases when both sides are equipped with BVR weapons.

The most troublesome case is obviously one in which the PLAAF acquires a BVR capability while the ROCAF does not. Under these conditions, 65 percent of the outcomes were coded as red while less than 15 percent are green. This clearly indicates the importance to Taiwan of maintaining at least “AMRAAM parity”; the recent decision by the U.S. government to provide AMRAAM to the ROCAF if China acquires the AA-12/R-77 is an important and welcome hedge against Taiwan falling behind in this corner of the cross-strait arms race. It also prudently avoids accelerating the introduction of these weapons into the China-Taiwan balance; any unilateral advantage enjoyed by Taiwan would almost certainly be short-lived, and our work suggests that the mainland does better when both have BVR weapons than when neither do.6 Maintaining the current status quo in this area, then, may be to Taiwan’s advantage.

**Training Quality**

For this study we assumed that Taiwanese aircrew were significantly more capable than their mainland counterparts. We based this judgment on two primary factors:

- ROCAF pilots get significantly more flying time each year than do PLAAF airmen. The training standard for Taiwanese fighter pilots is between 150 and 180 hours per year, while PLAAF pilots may as little as 80 hours in the air each year.7 That is hardly

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6Even a mediocre pilot can become a serious threat if equipped with an AMRAAM-type missile. Because these weapons are easier to use than older SARH missiles and allow multiple simultaneous engagements, they may reduce the advantage enjoyed by a better-trained pilot in air-to-air combat. A certain minimum competence is still required to employ the missiles effectively, and the superior pilot will continue to have an edge if the fight goes beyond the BVR encounter and becomes a close-in maneuvering battle. However, our finding that China’s air force fares better if both sides have advanced AAMs, versus the current situation, is consistent with this hypothesis.

7Published sources such as *The Military Balance* credit the ROCAF with 180 hours per year and the PLAAF with 80–110 depending on the type of aircraft. ROCAF personnel we talked with told us that their training levels were around 150 hours per year, while the PLAAF’s are often closer to 40–60 hours.
enough flying to remain marginally competent in basic airmanship and navigation, let alone to maintain tactical proficiency.

- While the complexity of PLAAF training and exercises has been improving, the quality of training is also higher for ROCAF aircrew.8

That said, we believe that the Taiwanese would benefit from further improving their training. Figure 3.3 shows the results of a set of excursion runs we did (involving no direct U.S. combat involvement) to explore the impact of improved ROCAF training on combat outcomes.9 The left-hand bar shows that Taiwan achieves a green or yellow result about 70 percent of the time when we trained the ROCAF’s aircrew at the baseline 80 percent level. We then added 24

![Figure 3.3—Effects of ROC Training on Case Outcome](https://example.com/image.png)

8 Allen, Krumel, and Pollack (1995, p. 183) report that the PLAAF remains “severely deficient” in many skills, such as low-level flying and dissimilar air combat tactics, that are critical to combat power.

9 This excursion involved 192 model runs in addition to the 1,700-plus already described.
additional F-16s to the ROCAF force structure; with pilots trained to 80 percent, this produced the middle results, which boosted the proportion of defensive-friendly outcomes to 75 percent. The third bar depicts the results when we trained the ROCAF aircrew to 100 percent (e.g., made them the equivalent of U.S. pilots) but took away the extra F-16s. While the overall percentage of good outcomes increased only slightly over the cases with the added fighters, the proportion of green, or “very good,” ones is about 15 percent higher.

The Value of U.S. Involvement

Across the whole range of cases and threats we explored, U.S. involvement made a substantial difference, significantly improving the chances for a successful conclusion to the air war.

Figure 3.4 shows how six alternative packages of U.S. forces affected outcomes.\(^{10}\) It shows that Taiwanese forces alone had good prospects for a successful defense only about half the time. A single carrier air wing (CVW), or 72 F-15Cs flying from Okinawa, jacks that proportion up to about 65 percent.\(^{11}\) Combining the two or adding an extra CVW in the absence of the Okinawa-based fighters generated a successful defense in 80 percent of the cases. The biggest U.S. force we examined, two carriers plus the fighters on Okinawa, produced a Taiwan-favorable outcome in more than 90 percent of the cases.

It is important to note that even the largest levels of U.S. commitment under scrutiny here are quite modest compared with those envisioned for a canonical MTW. The United States has twice

\(^{10}\)This discussion assumes that U.S. and Taiwanese forces will be able to at least keep out of each other’s way in case of war. This is by no means obviously true today, and we will discuss this in the next chapter when we lay out our recommendations for U.S. action.

\(^{11}\)It is interesting that we found the impact of either a CVW or the wing at Kadena to be more-or-less the same across all of our cases. We suspect that this stems from the larger number of F-15s (72 versus 48 F/A-18s in each CVW) being offset by the significantly greater distance the land-based fighters had to fly to get to the combat zone. Our analysis did not include Chinese attacks on either the base on Okinawa or the U.S. carrier(s). Such attacks, if effective, could reduce the impact of U.S. forces from that shown here.
recently (in 1996 and 1999) deployed a pair of carrier groups to the vicinity of Taiwan during periods of heightened cross-strait tension, and the USAF currently bases a full wing of 72 F-15s at Kadena. Yet, these small—by U.S. standards—increments of force appear to make a major difference in the scenario we are considering.

This can perhaps be seen even more clearly in Figure 3.5, which shows the impact U.S. forces have against the most dangerous PRC threat, the advanced case. Almost 70 percent of the outcomes are red if the United States is not involved. A single carrier or the Kadena wing reduces the proportion of bad cases to about half. Combining the two or engaging two carriers by themselves yields defense-favorable results about 55 percent of the time and provides an even more dramatic increase in the number of green cases. Finally, our largest U.S. force commitment (two CVWs and one land-based FW) helps provide Taiwan with a positive outcome in almost 80 percent of the cases we studied against the advanced PRC threat.

Although the impact of U.S. forces is most dramatic when Taiwan confronts the most severe threats, they can play a significant role
even against the base PLAAF force. Taiwan on its own achieved good outcomes against the base PRC threat in about 65 percent of our simulations but “won” almost 95 percent of them—a 45 percent improvement—when U.S. forces were also engaged.

In sum, then, U.S. forces can make a considerable contribution to Taiwan’s ability to maintain control of the air against all three PRC threats. The United States role appears to become increasingly critical as the PLAAF commits more assets to the operation or becomes more sophisticated.

MARITIME SUPERIORITY

The ASW Dilemma

The Taiwan Strait is a notoriously poor environment for ASW operations. The waters are shallow, heavily trafficked, and generally provide unreliable acoustic propagation. This works heavily in the PLAN’s favor, because the mainland’s single biggest naval advantage over Taiwan lies in its large fleet of submarines.
It is important not to overestimate the potential impact of China’s subs. Most of its underwater order of battle consists of vessels of dubious quality—Chinese copies of obsolete Soviet designs. Further, the training level of the PLAN’s submariners, and the operability level of their boats, is widely regarded as subpar. Nonetheless, China’s enormous numerical advantage coupled with the difficulty Taiwan would have in prosecuting an ASW campaign in the strait could figure heavily in the battle for maritime control. In many of our model runs, Chinese submarines sank a considerable portion of the ROC surface fleet in the opening minutes and hours of the war.

Our analysis found no simple solutions to this dilemma. Taiwan could try to rely on fixed- and rotary-wing aircraft to level the underwater playing field somewhat. However, if the intensity and ferocity of the air war were anything like what was seen in our simulations, it seems unlikely that ASW aircraft would be able to operate effectively. The ROCN’s more modern surface combatants, such as the Cheng Kung and Kang Ting frigates, have fairly up-to-date ASW suites, but China’s Kilo submarines, if properly operated, could prove elusive prey in the difficult environment of the strait.

Faced with this problem, Taiwan might want to consider a naval strategy analogous to the “rope-a-dope” approach to boxing made famous by legendary heavyweight Muhammad Ali. Confronting a stronger but slower adversary, Ali would linger near the edges of the ring, avoiding many punches and deflecting the others and waiting for his opponent to tire. Similarly, we found that the ROCN achieved its best results when it sought to overextend and exhaust the adversary by keeping the bulk of its surface forces out of the strait during the initial hours and days of a confrontation with the PRC. If the Chinese were to attempt to push their submarines further out to engage the ROCN, they quickly found themselves beyond the PLAAF’s air umbrella, exposed to attack by Taiwanese ASW aircraft and helicopters. And, the performance of both airborne and surface ASW systems would improve significantly outside the confined and difficult waters of the strait.

If, on the other hand, the PLAN declined to go after the ROCN, it would face a reasonably intact “fleet-in-being” when it came time to actually move any invasion force across from the mainland. The Taiwanese would still have to cope with the Chinese submarine threat
when the ROCN “rushed” the strait. However, compared with a situation where the two navies have sailed eyeball-to-eyeball in the strait while tensions turned to hostility, it seems much less likely that the Chinese would be able to place their subs in ideal attack positions to target a Taiwanese “rush” against the invasion fleet. The ROCN would likely suffer heavy losses even employing the “rope-a-dope” strategy, but enough combat power could survive to significantly disrupt the Chinese assault.12

Maintaining a Credible Antisurface Warfare Capability

If, however, the main battle forces of the ROCN stay out of the strait during the initial phase of the war, what sort of resistance could the ROC put up against the PLAN’s opening moves? Here, we suggest that Taiwan can capitalize effectively on the inherent strength of its defensive position.

The ROCN is currently in the early stages of procuring up to 50 Kuang Hua VI missile boats. This vessel is planned to be small, stealthy, and well-armed with four antiship missiles. Operating close to Taiwan’s coastline, where search and targeting radars will have difficulty discerning targets amid the clutter, the Kuang Hua VI class could prove a potent source of firepower even if the ROCN’s frigates and destroyers were not in the vicinity. Indeed, the absence of large ROCN warships could reduce problems with identification, friend or foe (IFF), and improve Taiwan’s overall ability to locate, target, and engage PLAN surface ships.

Stealthy, lethal missile boats could be made even more effective in combination with shore-based defenses. Mobile antiship missile launchers, well-protected against Chinese SOF, would provide additional firepower to Taiwan’s initial defense. These missiles should, for

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12Taiwan’s difficulties in the ASW area may also impact the kinds of solutions that are appropriate for its future ballistic missile defense (BMD) system. Any sea-based platform that needed to be in the strait to be effective would become an obvious target for China’s submarines and would be at great risk for the reasons outlined above. Conversely, a system that could retain its punch while standing off north, south, or east of the island would gain significantly in survivability.
the near future at least, greatly outrange the PLAN’s guns, allowing them to be highly survivable in a “shoot-and-scoot” mode.\textsuperscript{13}

Targeting will potentially be a problem for both missile boats and shore defenses. Fixed radar sites will almost certainly be prime targets for Chinese ballistic missiles in the first wave of attacks. Mobile surveillance systems, including the ROCAF’s E-2T Hawkeye radar aircraft, may be more survivable but could be at least partially neutralized by Chinese jamming. If the radars can operate, high-speed sensor-to-shooter data links will be needed to ensure that fires are delivered in a timely manner. Keeping Taiwan’s navy largely off the battlefield will simplify these problems—any big ship “out there” will be Chinese—but the ROC must consider how best to build a robust and highly responsive C\textsuperscript{2} intelligence, surveillance, and reconnaissance network to support whatever antisurface warfare strategy it proposes to follow.\textsuperscript{14}

\textbf{The U.S. Role}

We have already touched on the contribution that one or two U.S. carrier battle groups could make to the air defense of Taiwan. In the time frame we are considering, the Chinese will also have no reliable counter to the maritime warfare capabilities of a CVBG. In several war games conducted using Harpoon, two U.S. CVBGs operating east of Taiwan were able to decimate the PRC’s surface and submarine fleets even when the PLAN’s best combatants—Sovremenny destroyers and \textit{Kilo} submarines—were put in advantageous firing positions and allowed to fire the first salvo at H hour.

In our assessment of the U.S role in the maritime campaign, three functions in particular caught our imaginations.

\textsuperscript{13}Similarly, advanced mobile air defenses like man-portable missiles and the Avenger system currently fielded by the ROC Army could be very valuable counters to Chinese airborne or heliborne assault troops. Taiwan should distribute these weapons widely throughout the ground forces.

\textsuperscript{14}At the risk of being redundant, we also wish to note that neither missile boats nor shore-based missile launchers, nor even the most mobile of surveillance radars are likely to last long if the PLA has achieved any significant degree of air superiority. Thus is the outcome, or progress, of the air war a determining factor in the sea battle.
First, any submariner worth his salt will say that the best ASW weapon is another attack boat.\textsuperscript{15} The SSNs that travel with most U.S. CVBGs completely outclass anything that the PLAN is likely to field in the next 20 years, let alone five. One or two modern U.S. submarines operating in the Taiwan Strait could redress Taiwan’s shortfalls in ASW capability, provide vital intelligence support to the ROC, and put formidable antisurface warfare striking power just off the Chinese coast—if appropriate rules of engagement could be worked out.

For example, the United States and Taiwan could “quarter” the strait, with one ROCN sub in each of the sectors near the Taiwanese coast and two U.S. SSNs divided between two sectors nearer the mainland. Each sub could then treat its zone as a weapons-free zone for ASW hunter-killer operations. Requirements for coordination between ROCN surface forces and U.S. submarines could be minimized by simply keeping ROCN combatants east of the center line of the strait, if indeed they are in the strait at all.\textsuperscript{16}

Second, the United States could also help provide surveillance and targeting for the surface battle. USAF E-3 AWACS aircraft operating from Guam or Japan, along with Navy E-2 Hawkeyes, could supplement Taiwan’s radar picture of the battlespace, while other intelligence collectors—such as electronic and signals intelligence (ELINT and SIGINT) platforms—could likewise augment the ROC’s capabilities in these areas. Again, the ability to rapidly establish and maintain the appropriate data links would be all-important in ensuring that the right information flowed to the right places in time to be exploited.

\textsuperscript{15}Historically, submarine-versus-submarine combat has been the exception, not the rule. However, in past wars that featured extensive submarine operations, subs were essentially surface ships that could submerge for brief periods to prosecute an attack or to escape one. Submarine deck guns were as important as torpedoes, and subs were most commonly lost to air attacks on surfaced or diving vessels. Modern submarines, whether conventional or nuclear-powered, operate almost exclusively submerged, which dramatically changes the nature of ASW. Virtually all advanced navies, including the U.S. Navy, rely on their own submarines as a primary weapon against an enemy’s undersea forces.

\textsuperscript{16}Presumably, Taiwan’s surface and subsurface naval forces would have many prewar opportunities to work out procedures to minimize the chances of accidentally engaging one another.
Finally, the USAF maintains a number of B-52H bombers that are equipped and trained to deliver Harpoon antiship missiles. With a range of more than 70 nautical miles, the sea-skimming Harpoon could be fired from outside the range of most Chinese surface-to-air defenses (and all of its ship-based SAMs) and would likely prove lethal against the weak AAW systems fitted to PLAN combatants (not to mention the nonexistent air defenses of the commercial shipping that could constitute the bulk of any invasion fleet). Again, keeping large ROCN surface warships out of the strait would prove advantageous in reducing the likelihood of fratricide from such strikes.

**SUMMING UP**

It may be useful at this juncture to recap the main points.

In terms of the pivotal fight for air superiority, four factors emerge as critical in our analysis:

- *Taiwan’s air bases must remain operable so that the ROCAF’s fighter force can keep up the battle against the PLAAF’s superior numbers.* We recommend increased attention to passive defense and rapid-reconstitution measures.

- *The ROC must maintain at least parity in advanced air-to-air weaponry.* Ideally, Taiwan could enjoy a unilateral advantage in this area; realistically, however, the present status quo may represent the best situation for Taiwan. The U.S. decision to provide AMRAAM if the PRC receives AA-12s is an important and useful hedge.

- *Pilot quality may be Taiwan’s ace in the hole.* PLAAF training is notoriously poor. This is even more reason for Taiwan to ensure that its aircrews are of the highest possible caliber. Our analysis suggests that improved pilot quality may contribute more to favorable air superiority outcomes than would even sizable additions to the ROCAF’s fighter force structure.

- *U.S. involvement is important now and will likely grow increasingly vital.* Even in the near term, U.S. carrier- and land-based fighters could make a combination crucial to Taiwan’s defense. As the PLAAF’s inventory becomes more sophisticated and capable, Taiwan’s need for U.S. assistance will likewise increase.
We can cite three main insights into the naval war in and around the Taiwan Strait:

- *ASW is a critical Taiwanese weakness.* Absent an unexpected acquisition of numerous modern attack submarines, the ROCN will have tremendous difficulty coping with China’s modernizing submarine fleet. We suggest that the ROCN consider keeping its main battle forces out of the strait during the initial phase of a war with the mainland.

- *Fast, stealthy missile boats and mobile, land-based antiship missile launchers can help Taiwan exploit its inherent defensive advantages.* If adequate detection and targeting information can be provided, these weapons could prove highly lethal and relatively survivable even in the chaotic opening hours of a China-Taiwan clash.

- *Again, the U.S. role in the naval campaign could be crucial.* U.S. SSNs could help counter the Chinese submarine threat, U.S. surveillance capabilities could provide vital support to Taiwanese forces, and Harpoon-equipped bombers could provide key early firepower to the naval battle.  

The next and final chapter of this report attempts to tie our findings together into recommendations for near-term U.S. policy on supporting Taiwanese security.

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17Navy F/A-18 strike aircraft can of course also carry Harpoons. However, in the early stages of a China-Taiwan war, we suspect that these aircraft would find their best use in the air-to-air battle. Therefore, we focus on the possible role of long-range, land-based bombers for delivering antiship strikes in the first few days.