The Security of Andersen AFB:

China's Long-Range Precision Striking Capabilities

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Introduction

The United States has considerable economic and security interests in the Asia-Pacific region, and uses its security umbrella to deter aggression between allies and adversaries that would threaten stability. As such, the United States depends on forward military bases to position its armed forces in the Asia-Pacific region to both deter conflicts and maintain the capability to prevail in any that arise. Today, China threatens the United States' access to its forward bases with long-range precision strike capabilities: ballistic and cruise missiles, principally. While the United States' most-backward of its sufficiently-forward bases[1]—Andersen AFB at Guam—has traditionally operated outside of China's anti-access envelope, China recently has fielded longer-range weapons systems that can reach Andersen AFB. This analysis questions whether these new weapons systems endow China with sufficient capabilities to target Andersen AFB considerably and thus whether China can restrict the United States' access to Andersen AFB's assets during conflicts. As such, this analysis will help determine the extent to which China can hedge against the United States' force posture through targeting its forward bases.

Conventional Wisdom Several recent analyses of the balance of power between China and the United States slate Andersen AFB as the United States' best bet for generating airpower by making two claims. First, they argue that Andersen AFB is far more secure than the United States' more forward air bases. Over one thousand missiles threaten the United States' Kadena AB at Japan—these analyses articulate—making Andersen AFB more secure in relative terms. Second, they argue that China's long-range striking capabilities that threaten Andersen AFB are of sufficiently low qualities or inventory sizes that China cannot threaten the United States' basing

[1] Analysts consider Andersen AFB to be the farthest-backward base that the United States can operate from during conflicts against China, should the United States wish to use its fighter aircraft. For justification, see Josh S. Tupler, "Perils in the Pacific: Assessing American Air Power Projection over Taiwan and the South China Seas," (Undergraduate Senior Thesis, Dartmouth College, 2016), 53,

access there credibly. As such, the conventional wisdom on the topic of Andersen AFB's security dismisses the significance of China's ballistic and cruise missile threats to it. However, China's long-range precisions strike capabilities grow in quality and size each year. The conventional wisdom might prove true for prior balance of power estimates, but China's anti-access envelope has grown considerably in recent years. As such, this analysis will question whether the conventional wisdom about Andersen AFB's security—that it is relatively secure due to China's low-quality and low-inventory size long-range precision strike capabilities—holds true today or whether the trend lines are shifting.

Analytical Approach To analyze Andersen AFB's security, this analysis will focus on three principal components of the question: first, China's capability to strike Andersen AFB with new long-range weapons system; second, the United States' capability to defend against strikes that target Andersen AFB; and third, the damage that strikes against Andersen AFB would cause the United States' valuable airpower assets staged there. As such, this analysis will not identify implications that strikes against Andersen AFB have for both China's and the United States' military operations during conflicts in the Asia-Pacific region. Doing so would involve determining both damage to Andersen AFB's assets and how that damage alters the balance of power between China and the United States during conflicts. Instead, this analysis will determine whether, and to what extent, China's long-range strike capabilities threaten Andersen AFB's security credibly and significantly. To do so, it will identify: first, likely parameters of China's and the United States' missions to strike or defend Andersen AFB; and second, the amounts of damage that China can plausibly deliver to Andersen AFB's assets. Determining the amounts of damage will involve modeling ballistic and cruise missile strikes against Andersen AFB, using randomness across many simulations.

Findings of Analysis This analysis has two principal findings. First, China is likely able to land considerable numbers of ballistic and cruise missiles at Andersen AFB prior to or soon

after the start of hostilities, while the United States' aircraft remain staged on the ground. It is unclear how many missiles China might launch, but China is capable of launching at least some missiles, as the United States will be severely constrained in intercepting China's missile launch platforms. Due to the numbers of missiles in China's inventory, it is likely that considerable numbers of launched missiles will "leak" through the United States' defenses to deliver damage to Andersen AFB. Second, plausible numbers of missiles that China can land at Andersen AFB will cause large amounts of damage to the United States' airpower assets. Unless the United States' defenses are highly effective at intercepting incoming missiles—on the order of 90 or more percent—even small salvos of missiles launched toward Andersen AFB will render dozens of aircraft inoperable. While this analysis does not model strikes against other assets at Andersen AFB, such as fuel tanks or aircraft hangars, the trend lines of China's long-range strike capabilities are clear: should China strike Andersen AFB with plausible numbers of missiles, its assets will suffer considerable damage.

Implications of Analysis There are three general implications that stem from this analysis. First, long-range precision strikes that target Andersen AFB's assets would shift the balance of power in the Asia-Pacific region toward China. Should the United States loss basing access to Andersen AFB, its capability to generate sufficient airpower to prevail in conflicts against China might be lost. While this analysis does not draw definitive conclusions about these operational implications for conflicts between China and the United States, it might be enough to say that China's long-range strikes might be sufficiently damaging to force the United States to base its valuable airpower assets elsewhere. Second, and related to the first, the United States might be unable to fulfill its security commitments throughout the Asia-Pacific region should it lose basing access to Andersen AFB. The United States' force posture depends heavily on air bases to project power, and as such, the United States requires secure basing access during conflicts. Should China have the capability to strike Andersen AFB, and any bases more forward, the United States will have few to no other options for generating airpower with technologically advanced but limited-

in-range fighter aircraft. Third, security in the Asia-Pacific region will be increasingly unstable as China's anti-access weapons systems grow in quality and inventory sizes. This analysis demonstrates that striking Andersen AFB would be an at least competitive mission between China and the United States. As such, China's leadership might feel emboldened to posture aggressively toward neighbors unprotected by the United States' security umbrella. In turn, the United States' allies might take up additional defensive measures to hedge against an increasingly threatening China. While this analysis does not present definitive conclusions about the altered balance of power between China and the United States, its findings' trend lines that privilege China's military capabilities indicate that the Asia-Pacific region might lose the stability that the United States' alliance structure and forward posture confer.

Roadmap This analysis will proceed in three component parts. First, this analysis will identify the importance of Andersen AFB to both China and the United States. To do so, it will review each nation's force posture and vital interests in the Asia-Pacific region to identify the characteristics of likely conflicts between them. Then, it will discuss how each nation has focused on Andersen AFB due to the strategic value it presents an both an asset and a target, and how this translates to conflicts between the two nations. Second, this analysis will determine China's capability to strike Andersen AFB and the United States' capability to defend Andersen AFB. It will analyze the military strategy of each nation to identify likely parameters of missile strikes against Andersen AFB, which will service the analysis of damage that China might deliver to Andersen AFB. Third, this analysis will model damage that China's ballistic and cruise missiles will deliver to the United States' aircraft staged at Andersen AFB. It will use one Monte Carlo method variant by simulating random missile attacks many times to determine, on average, how many aircraft will be rendered inoperable for missile salvos of given sizes and characteristics.

The Importance of Andersen AFB

The United States' Vital Interests

The United States has at least two vital interests in the Asia-Pacific region. The first is the security of American allies, and the second is the region's value as an economic market.[2] While these interests are not unique to the Asia-Pacific region, ongoing trends endow them with considerable importance. For one, the region's security environment is increasingly unstable. China's territorial disputes in the East and South China Seas[3] involve nations that the United States' has formal security alliances with: Japan and the Philippines.[4] Should military skirmishes escalate and the United States step in to protect its allies, American forces would find themselves in a conflict with China. China's relations with Taiwan are increasingly strained as well.[5] While China maintains that Taiwan is part of "one China" rather than sovereign,[6] China's recent defense white papers identify reunification with Taiwan as one of its core interests.[7] Should China use force to reunify with Taiwan, the United States might assist Taiwan militarily: three Joint Communiqués and the Taiwan Relations Act articulate that the United States does not support unilateral changes to the status quo in the Taiwan Strait.[8] Escalation of these flash points (both those over the East and South China Seas, and Taiwan) risks conflict between China and the United States. In addition to these security concerns, the United States has considerable interests in the Asia-Pacific region's economic value. Its economies account for over 50 percent of American

[2] Michael Green, Kathleen Hicks, and Mark Cancian, *Asia-Pacific Rebalance 2025: Capabilities, Presence, and Partnerships*, (Washington, D.C.: Center for Strategic and International Studies (CSIS), 2016), 10.
[3] *Military and Security Developments Involving the People's Republic of China 2017*, (Washington, D.C.: Office of the Secretary of Defense, 2017), 8.
[4] Ronald O'Rourke, *Maritime Territorial and Exclusive Economic Zone (EEZ) Disputes Involving China: Issues for Congress*, (Washington, D.C.: Congressional Research Service, 2017), 6, 79-80.
[5] *NIDS China Security Report 2017 Change in Continuity: The Dynamics of the China-Taiwan Relationship*, (Tokyo, Japan: The National Institute for Defense Studies, 2017).
[6] "Military and Security Developments Involving the People's Republic of China 2017," 82.
[7] *Defense of Japan (Annual White Paper)*, (Tokyo, Japan: Japan Ministry of Defense, 2016), 86.
[8] "Military and Security Developments Involving the People's Republic of China 2017," 82.

exports and 60 percent of global gross domestic product (GDP),[9] and China is "the United States' largest source of imports, second-largest trading partner, and third-largest export market."[10] The United States is deeply interested in hedging against regional instability—such as conflicts in the East China Sea—that would disrupt its trade and investment activities.[11] Accordingly, both allied commitments and economic interests relations suggest that the United States would engage in conflicts against China to protect its vital interests in the Asia-Pacific region.

The United States' Military Strategy and Force Posture

The United States maintains that to secure its vital interests in the Asia-Pacific region, it should be able to defeat would-be adversaries in all contingencies.[12] Fielding and posturing its forces for this mission promotes stability in at least two ways. First, the United States deters adversaries from engaging in costly conflicts that they cannot win; and second, the United States reassures its allies that they are secure and do not need to posture aggressively or forcefully change the status quo. This argument is straightforward: the United States' security umbrella convinces adversaries and allies that aggression is unproductive, as the United States will defeat adversaries and protect its allies writ large.

To prevail in conflicts in the Asia-Pacific region, the United States' military strategy involves forward deploying air and naval assets to bases in or near the Asia-Pacific region.[13] This

[9] Matthew P. Goodman, *Opportunities to Expand U.S. Trade Relationships in the Asia-Pacific Region*, (Washington, D.C.: House Ways & Means Committee Subcommittee on Trade, 2017), 2-3.
[10] Josh S. Tupler, "Perils in the Pacific: Assessing American Air Power Projection over Taiwan and the South China Seas," (Undergraduate Senior Thesis, Dartmouth College, 2016), 11.
[11] O'Rourke, "Exclusive Economic Zone (EEZ)," 65.
[12] Tupler, "Perils in the Pacific," ix.
[13] Forward deployment refers to forces that are positioned within given military theaters, rather than those maintained on the continental United States. See e.g., Christopher J. Bowie, *The Anti-Access Threat and Theater Air Bases*, (Washington, D.C.: Center for Strategic and Budgetary Assessments, 2002), i, Michael Green, Kathleen Hicks, and Mark Cancian, *Asia-Pacific Rebalance 2025: Capabilities, Presence, and Partnerships*, (Washington, D.C.: Center for Strategic and International Studies (CSIS), 2016), 32-47.

operational concept—known as power projection[14]—compensates for the disadvantage of the United States' distance from the Asia-Pacific region. While China is located roughly 160 km from Taiwan, the United States' closest continental military bases are located over 10,000 km from Taiwan.[15] Moving American forces across the Pacific Ocean would be time consuming and, as such, degrade the United States' capability to move forces into combat areas efficiently and respond rapidly to crises. However, the United States permanently bases air, naval, and ground assets in several strategic locations: Japan, South Korea, Guam, Hawaii, and Alaska all host American military bases.[16] While this strategy increases the response times of the United States' forces generally, its primary advantage is enhancing the United States' capability to achieve air superiority.[17] Controlling the skies allows air forces the freedom to target the enemy's air, naval, and ground assets.[18] In addition, air forces that control the skies—as well as their naval and ground forces—are significantly less susceptible to attack.[19] Cliff et al., explains that by "obtaining air superiority, one can restrict enemy air, air defense, and ground forces' operational movements while ensuring that one's own ground and navy forces have effective cover from the air to carry out their operations."[20] Accordingly, both China's and the United States' force planners,[21] and many recent analyses,[22] position air superiority as central to the outcome of likely conflicts against China. Forward air bases enhance the United States' capability to achieve control of the skies by

[14] Bowie, "The Anti-Access Threat and Theater Air Bases," i.
[15] Eric Heginbotham, *The U.S.-China Military Scorecard: Forces, Geography, and the Evolving Balance of Power, 1996–2017*, (Santa Monica, Calif.: RAND Corporation, 2015), 327.
[16] Green, Hicks, and Cancian, "Asia-Pacific Rebalance 2025," 34-35.
[17] Tupler, "Perils in the Pacific," 16.
[18] Tupler, "Perils in the Pacific," 16.
[19] Tupler, "Perils in the Pacific," 16.
[20] Roger Cliff, Shaking the Heavens and Splitting the Earth: Chinese Air Force Employment Concepts in the 21st Century (Santa Monica, Calif.: RAND Corporation, 2011), xvii.
[21] Heginbotham, "The U.S.-China Military Scorecard," 10.
[22] See e.g., Eric Heginbotham, The U.S.-China Military Scorecard: Forces, Geography, and the Evolving Balance of Power, 1996–2017, (Santa Monica, Calif.: RAND Corporation, 2015), Eric S. Gons, "Access Challenges and Implications for Airpower in the Western Pacific," (PhD diss., Pardee RAND Graduate School, 2010), Josh S. Tupler, "Perils in the Pacific: Assessing American Air Power Projection over Taiwan and the South China Seas," (Undergraduate Senior Thesis, Dartmouth College, 2016).

generating larger numbers of sorties,[23] which are determined largely by the times that aircraft must spend flying to and from their bases.[24] While sortie rates required to achieve air superiority vary by factors such as aircraft type,[25] basing forwardly allows the United States to increase the number of aircraft it has in combat areas generally and thus its chances of controlling the skies.

The United States' operational concepts for fighting conflicts against China vary. American force planners might choose to attack mainland China, which strategy is known as the Joint Concept for Access and Maneuver in the Global Commons (JAM-GC).[26] However, due to the escalatory nature of this approach, force planners might restrict American forces to areas off China's coast (such as around Taiwan or the Spratly Islands).[27] In either case, the United States requires access to secure air bases to stage and deploy aircraft due to the importance of generating sorties to achieve air superiority. While the United States Air Force (USAF) has permanent bases at Japan, South Korea, Guam, Australia, Hawaii, and Alaska,[28] the bases it will operate from during conflicts against China are uncertain: there are both political questions—such as whether Japan or South Korea would grant the USAF basing access on their mainlands[29]—and military questions—such as whether operating from the most forward bases at Japan are operational or have had their infrastructure attacked. The USAF will use various aircraft to achieve air superiority. These include fighter aircraft—such as F-15s, F-18s, and F-22s[30]—and force enablers—such as airborne early warning and control (AEW&C) aircraft and tanker aircraft for refueling.[31]

[23] Air sorties refer to operational flights by military aircraft. One air sortie refers to one flight by one aircraft. See e.g., Josh S. Tupler, "Perils in the Pacific: Assessing American Air Power Projection over Taiwan and the South China Seas," (Undergraduate Senior Thesis, Dartmouth College, 2016), 13.
[24] Tupler, "Perils in the Pacific," 143.
[25] For relevant aircraft characteristics, see Josh S. Tupler, "Perils in the Pacific: Assessing American Air Power Projection over Taiwan and the South China Seas," (Undergraduate Senior Thesis, Dartmouth College, 2016), 141-148, 183-184.
[26] This JAM-GC operational concept is the successor to the AirSea Battle operation concept. See Heginbotham, "The U.S.-China Military Scorecard," 348.
[27] Tupler, "Perils in the Pacific," ix.
[28] Green, Hicks, and Cancian, "Asia-Pacific Rebalance 2025," 34-35.
[29] Eric S. Gons, "Access Challenges and Implications for Airpower in the Western Pacific," (PhD diss., Pardee RAND Graduate School, 2010), 53-55.
[30] Tupler, "Perils in the Pacific," 184.
[31] Gons, "Access Challenges and Implications for Airpower in the Western Pacific," 57.

The United States Navy (USN) can supplement the USAF's mission of air superiority by deploying carrier strike groups (CSGs), which feature aircraft carriers and carrier air wings that include F/A-18 fighter and AEW&C aircraft, among others.[32] Whether the USN deploys any aircraft carriers is determined by similar political or military questions, such as where the USN would position its aircraft carriers and whether those positions would put the carriers at risk. The central point here is that the United States' combat missions in the Asia-Pacific region would require fighter, AEW&C, and possibly tanker aircraft to fight and patrol combat zones (such as Taiwan's or the Spratly Islands' airspace).

There are at least two important takeaways from this discussion of the United States' military strategy and force posture in the Asia-Pacific region. First, the United States uses expensive, limited, and vulnerable assets to prevail in maritime conflicts. Specifically, to generate sorties for air superiority, the United States requires various aircraft, and either air bases or aircraft carriers. Air bases feature many vulnerable assets: "runway surfaces, unprotected aircraft, hardened aircraft shelters, fuel supplies, and logistics facilities."[33] While adversaries' capabilities to attack these assets vary by factors such as their missile arsenals or the locations of USAF air bases, "only a small number of accurate missiles" is required to shut an air base down for several days or weeks.[34] The United States can repair air bases or replace aircraft during conflicts,[35] but during short conflicts, effective missile attacks threaten the USAF's capabilities to generate large numbers of sorties to achieve air superiority. Missile attacks against aircraft carriers threaten their operational capacities similarly: the United States operates 11 aircraft carriers,[36] and successful attacks against any would cause force planners to take pause and likely move them from vulnerable positions. Second, the United States accordingly prioritizes the security of its air bases and aircraft carriers during conflicts. Due to the advantages that air superiority confers, American force

[32] Tupler, "Perils in the Pacific," 93.
[33] Heginbotham, "The U.S.-China Military Scorecard," 46.
[34] Heginbotham, "The U.S.-China Military Scorecard," xxiii.
[35] Airfield Damage Repair Operations, (Washington, D.C.: Department of the Air Force, 2008).
[36] Green, Hicks, and Cancian, "Asia-Pacific Rebalance 2025," 124.

planners require some minimum threshold of security for bases and carriers. Specifically, these assets must be (at least) sufficiently survivable to generate enough sorties to achieve air superiority. While the USAF might be able to repair small runway damages within four to eight hours,[37] runways inoperable for weeks or dozens of damaged aircraft will likely not meet this threshold.

China's Vital Interests

The Chinese Communist Party (CCP), China's ruling party, prioritizes economic growth and the security of China's sovereignty and territorial integrity.[38] Achieving these vital interests, among others, demonstrates the CCP's capability to strengthen the country and allows the CCP to derive legitimacy from China's citizens.[39] Two of the CCP's foreign policy initiatives designed to service these vital interests—territorial claims in the East and South China Seas,[40] and the One China policy with rhetoric about reunification[41]—position China at odds with the United States' vital interests and security commitments in the Asia-Pacific Region. Recognizing the United States' regional security commitments and interests, the CCP maintains that the United States' power projection capabilities obstruct China's capabilities to realize its own vital interests.[42] For example, the economic value of resources such as hydrocarbons at least partly motivate China's claims to areas of the South China Sea. Should territorial disputes escalate to conflicts between China and its neighbors, the United States' security commitments might obstruct China's capabilities to achieve its territorial interests. Chinese academic and military writings evidence this perspective in arguing that the United States' forward bases and frequent military exercises,

[37] Heginbotham, "The U.S.-China Military Scorecard," 60.
[38] "Military and Security Developments Involving the People's Republic of China 2017," 37.
[39] Jordan Wilson, *China's Expanding Ability to Conduct Conventional Missile Strikes on Guam*, (Washington, D.C.: U.S.-China Economic and Security Review Commission, 2016), 4.
[40] O'Rourke, "Exclusive Economic Zone (EEZ)."
[41] "Defense of Japan," 86.
[42] Wilson, "China's Expanding Ability to Conduct Conventional Missile Strikes on Guam," 4-5.

among others, are designed to "'strategically encircle' or 'contain' China."[43] This thinking is informed partly by China's experience during the March 1996 Taiwan Strait Crisis, during which the United States responded to China's aggression toward Taiwan by sending two aircraft carriers into the Taiwan Strait.[44] The United States' display of force indicated to the CCP that China would be unable to strong-arm Taiwan's reunification in the face of overwhelming American military power. Today, Chinese analysts identify Taiwan as a "key point" and an "unsinkable aircraft carrier" in the United States' encirclement strategy, as an independent Taiwan leaves open the option of containing China militarily, politically, and economically.[45]

China's Military Strategy and Force Posture

For over two decades, China's armed forces—the People's Liberation Army (PLA)—have undergone robust modernization to hedge against the United States' power projection capabilities.[46] Specifically, China has fielded strategic denial capabilities designed to deter or counter the intervention of third parties—principally American forces—during regional conflicts. Western analysts refer to these as anti-access/area-denial (A2/AD) systems,[47] while Chinese analysts refer to them as "anti-intervention" systems.[48] Anti-access systems include ballistic and cruise missiles used to attack point targets such as military bases.[49] Area-denial systems include counter-air and counter-maritime assets to attack aircraft and surface ships (i.e., surface-to-air missiles (SAMs) and anti-ship ballistic and cruise missiles (ASBMs/ASCMs)).[50] China's anti-access weapons systems imperil the United States' power projection capabilities significantly: in

[43] Wilson, "China's Expanding Ability to Conduct Conventional Missile Strikes on Guam," 5.
[44] Cliff, *Shaking the Heavens and Splitting the Earth*, 40.
[45] Wilson, "China's Expanding Ability to Conduct Conventional Missile Strikes on Guam," 5.
[46] Green, Hicks, and Cancian, "Asia-Pacific Rebalance 2025," 15.
[47] Dennis M. Gormley, Andrew S. Erickson, and Jingdong Yuan, *A Low-Visibility Force Multiplier: Assessing China's Cruise Missile* Ambitions (Washington, D.C.: National Defense University Press, 2014), 76.
[48] Heginbotham, "The U.S.-China Military Scorecard," 4.
[49] Tupler, "Perils in the Pacific," 14.
[50] Tupler, "Perils in the Pacific," 14-15.

targeting its forward bases and aircraft carriers, ballistic and cruise missiles would degrade the United States' capability to generate the sorties necessary for air superiority.[51] For the first time since the Cold War ended, the USAF "would not be able to regard [its] bases as sanctuaries safe from enemy attack in a conflict."[52]

China's defense spending has grown "11 percent per year between 1996 and 2015" in inflation-adjusted terms.[53] While this trend has privileged the PLA's forces generally, its anti-access weapons systems "[have] arguably been the most prominent aspect of the PLA's modernization."[54] The PLA Rocket Force (PLARF)—referred to previously as the Second Artillery Force—has "dramatically expanded the number and improved the quality of its conventional ballistic and cruise missile forces over the past 15 years."[55] The PLA Rocket Force's indigenous Dongfeng conventional ballistic missile inventory includes short- and medium-range ballistic missiles (SRBMs/MRBMs) that can saturate point targets—such as air bases—hundreds to thousands of kilometers from mainland China. The PLA Rocket Force likely has over 1,200 DF-11 and DF-15 SRBM variants, which can deliver 500-800 kg warheads to targets roughly 300 km—600 km away. China's SRBM-equipped brigades are based to reach Taiwan.[56] In addition, the PLA Rocket Force has likely between 100 and 300 DF-16 and DF-21C MRBMs. The DF-16 MRBM can travel between 800 km and 1,000 km, and is accordingly well suited to target the United States' bases at Okinawa, Japan. The DF-21C MRBM can travel 2,500 km and can target any of the United States' bases at Japan. Also, The PLA Rocket Force has developed precision ground-launched cruise missiles (GLCMs) as well—CJ-10s—which can travel 1,500 km—2,000

[51] Heginbotham, "The U.S.-China Military Scorecard," 46.
[52] Cliff, *Shaking the Heavens and Splitting the Earth*, 326.
[53] Heginbotham, "The U.S.-China Military Scorecard," xx.
[54] Heginbotham, "The U.S.-China Military Scorecard," 28, also see Jordan Wilson, *China's Expanding Ability to Conduct Conventional Missile Strikes on Guam*, (Washington, D.C.: U.S.-China Economic and Security Review Commission, 2016), 7.
[55] Heginbotham, "The U.S.-China Military Scorecard," 47.
[56] Heginbotham, "The U.S.-China Military Scorecard," 48.

km. With small circular error probables (CEPs) of 5 to 20 km and 400 kg warheads, these can target the United States' bases at Japan.[57]

It follows that the PLA Rocket Force's ballistic and cruise missile inventories give American force planners serious pause about basing close to mainland China for two reasons. First, American bases on Japan are positioned within the envelope of thousands of missiles. Kadena Air Base (Kadena AB)—which is located on Okinawa, Japan, and is considered the USAF's most important air base on Japan due to its size and proximity to likely flash points—is vulnerable to hundreds of MRBMs and possibly over 1,000 GLCMs. The USAF's other air bases on Japan face similar MRBM and GLCM threats. While analysts disagree about the size and quality of the PLA Rocket Force's inventory, Heginbotham et al., illustrate that ballistic and cruise missile attacks against Kadena AB would delay its operations for either days or weeks.[58] Defense systems might mitigate these risks, but the envelope of China's anti-access weapons systems extends clearly across the USAF's forward force posture in Japan. Second, PLA's military strategy indicates that it is likely to attack USAF bases with ballistic and cruise missiles during the opening days of conflicts.[59] Recognizing the importance of air superiority, Chinese military writings articulate that denying enemies the capability to generate sorties is central to the PLA's air superiority strategy.[60] To do this, the PLA Rocket Force is likely to attack aircraft while they are staged on the ground—"the eagles in their nests,"[61] so to speak. Limitations to this strategy include political decisions—such as whether China would choose to attack enemy territory directly—and military decisions—such as what portion of its ballistic and cruise missile inventory the PLA Rocket Force should devote to attacks on enemy air bases. However, the key point here is that China's capabilities and military strategy suggest that the USAF's forward bases within

[57] The values in this paragraph come from Heginbotham et al., in the "Force Structure" section of Scorecard 1. See: Heginbotham, "The U.S.-China Military Scorecard," 47-54 (in particular, see Table 3.1 on page 48).
[58] Heginbotham, "The U.S.-China Military Scorecard," 56-65.
[59] Cliff, *Shaking the Heavens and Splitting the Earth*, 47-113.
[60] Heginbotham, "The U.S.-China Military Scorecard," 46.
[61] John Stillion and David T. Orletsky, Airbase Vulnerability to Conventional Cruise-Missile and Ballistic-Missile Attacks: Technology, Scenarios, and U.S. Air Force Responses (Santa Monica, Calif.: RAND Corporation, 1999), 5.

China's anti-access envelope would not be "sanctuaries from Chinese attack."[62] Rather, these likely "will be rendered at least temporarily unusable," with their aircraft either damaged or destroyed.[63]

One important takeaway from China's anti-access strategy is that geography endows China with asymmetrical advantages that allow "the weak to defeat the strong."[64] The United States has limited basing options near likely flash points: only two bases are within unrefueled fighter range of Taiwan—Kadena AB—and only three are within 1,500 km of Taiwan.[65] This increases the effectiveness of China's threats against USAF as saturating small numbers of points targets with ballistic and cruise missiles is more effective than spreading them across many bases. While the United States might field similar ballistic and cruise missiles to target mainland China,[66] the PLAAF's basing structure is far more robust. With 39 bases within unrefueled fighter range of Taiwan,[67] China would "be relatively less affected by U.S. attacks than U.S. forces would be by similar types of Chinese strikes."[68] The takeaway is that the United States' forward force posture is constrained by both the limited numbers of bases available to American forces and the insecurity of American bases relative to China's anti-access weapons systems.

Role of Andersen AFB

American force planners cannot know with certainty whether the PLA will use ballistic and cruise missiles to attack the USAF's bases during conflicts. In addition, American force planners cannot know with certainty whether ballistic and cruise missile attacks would be sufficiently effective to prevent the USAF from generating enough sorties to achieve air superiority. However, these both remain either possible or likely: analysts agree that the United States should

[62] Cliff, *Shaking the Heavens and Splitting the Earth*, 237.
[63] Cliff, *Shaking the Heavens and Splitting the Earth*, 238.
[64] Heginbotham, "The U.S.-China Military Scorecard," 272.
[65] Heginbotham, "The U.S.-China Military Scorecard," 54-55.
[66] Heginbotham, "The U.S.-China Military Scorecard," 327.
[67] Heginbotham, "The U.S.-China Military Scorecard," 56-65.
[68] Heginbotham, "The U.S.-China Military Scorecard," 149.

expect China to attack its bases during the opening days of conflicts, and that these attacks might diminish sortie generation capabilities considerably.[69] American force planners have at least three options to hedge against this threat. First, the United States can attack mainland China and target the PLA's A2/AD capabilities. While this strategy—conceptualized by JAM-GC[70]—might restrict the PLA's capability to deny the USAF access to bases within the ranges of the PLA's missiles, it is highly escalatory:[71] attacking mainland China would shift conflicts from Taiwan or the Spratly Islands only to China also, which might cause China to respond proportionately aggressively in turn. Second, the United States can use active defenses—such as point-defenses to intercept missiles—or passive defenses—such as base hardening or dispersal of aircraft across additional bases—to hedge against insecurity.[72] While these would likely lessen the threats of China's anti-access weapons systems, China would remain able to send large numbers of ballistic and cruise missiles to USAF bases within China's anti-access envelope. The United States might intercept some missiles, and passive defenses might restrict the effectiveness of those that leak through, but this option does not offer certainty to American force planners: missiles will likely target some or many runways and aircraft effectively. Third, the United States can operate from bases more backward than those at Japan. Specifically, the USAF can operate from Andersen AFB at Guam.[73]

Analysts consider Andersen AFB at Guam as the United States' best option to both limit escalation during conflicts with China and increase the chances that the USAF's basing access

[69] See e.g., Roger Cliff, *Shaking the Heavens and Splitting the Earth: Chinese Air Force Employment Concepts in the 21st Century* (Santa Monica, Calif.: RAND, 2011), Eric Heginbotham, *The U.S.-China Military Scorecard: Forces, Geography, and the Evolving Balance of Power, 1996–2017*, (Santa Monica, Calif.: RAND Corporation, 2015), Eric S. Gons, "Access Challenges and Implications for Airpower in the Western Pacific," (PhD diss., Pardee RAND Graduate School, 2010).

[70] Heginbotham, "The U.S.-China Military Scorecard," 42.

[71] Tupler, "Perils in the Pacific," ix.

[72] Bowie, "The Anti-Access Threat and Theater Air Bases," 53-64.

[73] See e.g., Eric Heginbotham, The U.S.-China Military Scorecard: Forces, Geography, and the Evolving Balance of Power, 1996–2017, (Santa Monica, Calif.: RAND Corporation, 2015), Eric S. Gons, "Access Challenges and Implications for Airpower in the Western Pacific," (PhD diss., Pardee RAND Graduate School, 2010), Josh S. Tupler, "Perils in the Pacific: Assessing American Air Power Projection over Taiwan and the South China Seas," (Undergraduate Senior Thesis, Dartmouth College, 2016).

will remain secure. Andersen AFB is roughly 3,000 km from mainland China and thus is outside the envelope of China's SRBM, MRBM, and GLCM inventory.[74] This provides the USAF security from the majority of China's anti-access threats and, as such, limits the strategic value in attacking mainland China. However, operating from Andersen AFB during conflicts against China complicates the United States' sortie generation mission. Fighter aircraft would require multiple aerial refuelings to fly the roughly 3,000 km to likely flash points, and the force enablers necessary for aerial refueling—tankers and AEW&Cs—would require additional fighter jets for security.[75] As such, USAF operations from Andersen AFB require more aircraft to generate sorties than Kadena AB would, which limits Andersen AFB's sortie generation capabilities.[76] However, force planners must determine which bases can generate the most sorties in the face of anti-access threats. Likely missile attacks would disrupt Kadena AB's sortie generation capabilities either partially or wholly.[77] It follows that while Andersen AFB complicates sortie generation missions, it's sortie generation capabilities are considerable relative to an inoperable Kadena AB.

Accordingly, Andersen AFB has featured prominently in recent analyses of the balance of military power between China and the United States. Heginbotham et al., Gons, and Tupler all use Andersen AFB as the principal or only location to generate sorties during conflicts against China.[78] In addition, the United States has indicated that Guam—its "permanent aircraft carrier"[79]—is increasingly important to its operational concept for projecting power into the Asia-Pacific region. Since 2000, the United States has budgeted billions of dollars to transform Guam into a "strategic hub" and enhance the United States' "deterrence and power projection" capabilities

[74] Heginbotham, "The U.S.-China Military Scorecard," 48.
[75] Tupler, "Perils in the Pacific," 51.
[76] Tupler, "Perils in the Pacific," 53.
[77] Heginbotham, "The U.S.-China Military Scorecard," 57-65.
[78] See e.g., Eric Heginbotham, *The U.S.-China Military Scorecard: Forces, Geography, and the Evolving Balance of Power, 1996–2017*, (Santa Monica, Calif.: RAND Corporation, 2015), Eric S. Gons, "Access Challenges and Implications for Airpower in the Western Pacific," (PhD diss., Pardee RAND Graduate School, 2010), Josh S. Tupler, "Perils in the Pacific: Assessing American Air Power Projection over Taiwan and the South China Seas," (Undergraduate Senior Thesis, Dartmouth College, 2016).
[79] Ben Bohane, "America's 'permanent Aircraft Carrier' in Guam Ramps Up Its Bases," ABC News.

in the Asia-Pacific region.[80] Andersen AFB rotates and exercises with long-range bomber and fighter aircraft regularly;[81] it houses the USAF's largest munitions depot in the Pacific—100,000 bombs;[82] and the United States is building a second pipeline[83] on it to supplement its already substantial aviation fuel supply—66 million gallons.[84] To be sure, the United States is not certain to project power from only Andersen AFB during conflicts against China. Should conflicts remain limited, American forces might feel comfortable or be capable of generating sorties from Kadena AB at Okinawa. The United States might generate sorties from aircraft carriers also. Still, due to China's anti-access threats and strategies, it is prudent for force planners and analysts to consider scenarios in which the United States can rely on neither Kadena AB nor aircraft carriers.

China profiles Andersen AFB as a high-value target due to its strategic importance to the United States. PLA-affiliated writings refer to Guam as an "anchor"[85] and a "chess piece of the utmost importance"[86] in the United States' oft discussed containment strategy, due to its position relative to China's anti-access envelope. The United States' buildup of Guam and operational concepts for fighting in the Asia-Pacific region present "[definite] threat[s]" to China, some PLA officers noted in 2014.[87] As such, one PLA expert called for China to "have an attack means able to reach Guam."[88] PLA-affiliated writings frequently discuss two geographic areas in the United States' "encirclement" strategy: the "first island chain" (which includes Japan), and the "second island chain" (which is "pivoted at Guam").[89] The PLA's official newspaper argued in 2012 that

[80] Shirley A. Kan, Guam: U.S. Defense Deployments, (Washington, D.C.: Congressional Research Service, 2014), 1, 6.
[81] Wilson, "China's Expanding Ability to Conduct Conventional Missile Strikes on Guam," 13, also see Heginbotham, "The U.S.-China Military Scorecard," 41.
[82] Carnes Lord and Andrew S. Erickson, "Guam and American Security in the Pacific," in Rebalancing U.S. Forces: Basing and Forward Presence in the Asia-Pacific (2014), 17.
[83] Green, Hicks, and Cancian, "Asia-Pacific Rebalance 2025," vi.
[84] Gons, "Access Challenges and Implications for Airpower in the Western Pacific," 82.
[85] Wilson, "China's Expanding Ability to Conduct Conventional Missile Strikes on Guam," 5.
[86] Wilson, "China's Expanding Ability to Conduct Conventional Missile Strikes on Guam," 7.
[87] Wilson, "China's Expanding Ability to Conduct Conventional Missile Strikes on Guam," 7.
[88] Wilson, "China's Expanding Ability to Conduct Conventional Missile Strikes on Guam," 7.
[89] Wilson, "China's Expanding Ability to Conduct Conventional Missile Strikes on Guam," 7.

while the United States' bases on the first island chain can "no longer contain China," the PLA must extend its anti-access envelope to the second.[90]

Recent developments in the PLA's force modernization program are oriented toward denying the United States access to forward bases on the second island chain in general and Guam in particular. First, the PLA Rocket Force has fielded its first intermediate-range ballistic missile (IRBM)—the DF-26—recently, which it displayed at a military parade in September 2015.[91] Some analysts have dubbed the DF-26 the "Guam-killer" or "Guam Express" due to its 3,000 km—4,000 km range that allows China to deliver the weapon to Guam.[92] PLA-affiliated publications articulate that the DF-26 is designed to target "invading" or "encroaching" adversaries, as it can "neutralize" Andersen AFB.[93] The Academy of Military Science, the PLA's "leading academic research organ,"[94] further detailed the DF-26's use: "Penetration warheads would be used to damage area type targets such as airfields and ports, piercing and exploding warheads would be used to destroy hardened targets such as bunkers and cave depots, and fuel-air explosive warheads would be used against electromagnetic targets such as command organizations and computer centers."[95] Heginbotham et al., estimates that the DF-26's CEP is between 30 and 300 m.[96] While DF-26's inventory size is uncertain, Heginbotham et al., explains that roughly 50 to 100 IRBMs would be required to attack Andersen AFB's runways sufficiently to deny it sortie generation capabilities for over one week.[97] Second, China has upgraded its bomber aircraft and equipped them with air-launched cruise missiles (ALCMs) that can reach Guam. The PLAAF's H-6K "Badger" bombers have Russian Saturn D-30KP-2 turbofan engines that help them achieve an

[90] Wilson, "China's Expanding Ability to Conduct Conventional Missile Strikes on Guam," 7.
[91] *NIDS China Security Report 2016: The Expanding Scope of PLA Activities and the PLA Strategy*, (Tokyo, Japan: The National Institute for Defense Studies, 2016), 50.
[92] Wilson, "China's Expanding Ability to Conduct Conventional Missile Strikes on Guam," 4.
[93] Wilson, "China's Expanding Ability to Conduct Conventional Missile Strikes on Guam," 8.
[94] Andrew S. Erickson, *Chinese Anti-Ship Ballistic Missile Development and Counter-intervention Efforts*, (Washington, D.C.: U.S.-China Economic and Security Review Commission, 2017).
[95] Wilson, "China's Expanding Ability to Conduct Conventional Missile Strikes on Guam," 8.
[96] Heginbotham, "The U.S.-China Military Scorecard," 48.
[97] Heginbotham, "The U.S.-China Military Scorecard," 48, 55-65.

unrefueled combat radius of 3,500 km.[98] In addition, the H-6K's wings feature pylons to carry six CJ-20 "Long Sword" ALCMs,[99] which can travel up to 2,000 km[100] and have CEPs of between 5 and 20 m.[101] Accordingly, the PLAAF has the long-range standoff strike capability to attack Andersen AFB, which requires sending missiles only 3,000 km of the H-6K's 5,700 km striking range. China has likely practiced striking Guam during recent military exercises, in which the PLAAF flew H-6K bomber aircraft on various paths around the East and South China Seas.[102] It follows that the H-6K substantiates the PLA's operational concept of attacking enemy air bases during the opening days of conflicts.

Several recent analyses of the balance of military power between China and the United States have discussed the PLA's growing long-range standoff strike capabilities and implications for the United States' force structure.[103] These analyses acknowledge that the PLA might use its ballistic and cruise missile inventories to target Andersen AFB, but they discount the significance of the threat by making two claims.[104] First, they argue that bomber raids against Andersen AFB would be too complex for the PLAAF to conduct.[105] The PLAAF would be unable to supply the coordination capabilities demanded of operations involving air-launching cruise missiles, possibly due to qualitative factors such as the skillsets and training of PLAAF pilots. Second, these analyses argue that the United States can defend against the threats to Andersen AFB effectively.[106]

[98] Zachary Keck, "Can China's New Strategic Bomber Reach Hawaii?," The Diplomat, last modified 2013, https://thediplomat.com/2013/08/can-chinas-new-strategic-bomber-reach-hawaii/.
[99] "Chinese Xian H-6K with Refuelling Probe Suggests New Missions," Jane's 360.
[100] "CJ-20," Deagel.
[101] Heginbotham, "The U.S.-China Military Scorecard," 48.
[102] "Defense of Japan," 101, also see: Wilson, "China's Expanding Ability to Conduct Conventional Missile Strikes on Guam," 9.
[103] See e.g., Eric Heginbotham, The U.S.-China Military Scorecard: Forces, Geography, and the Evolving Balance of Power, 1996–2017, (Santa Monica, Calif.: RAND Corporation, 2015), Eric S. Gons, "Access Challenges and Implications for Airpower in the Western Pacific," (PhD diss., Pardee RAND Graduate School, 2010), Josh S. Tupler, "Perils in the Pacific: Assessing American Air Power Projection over Taiwan and the South China Seas," (Undergraduate Senior Thesis, Dartmouth College, 2016).
[104] These analyses do not discuss the DF-26 IRBM meaningfully, as the weapon was introduced only recently and was either unavailable or uncertain at the times the analyses were written.
[105] Gons, "Access Challenges and Implications for Airpower in the Western Pacific," 71-72, Tupler, "Perils in the Pacific," 120-121.
[106] Heginbotham, "The U.S.-China Military Scorecard," 63-68, Tupler, "Perils in the Pacific," 120-121.

Analysts envision a two-zone scheme to defend Guam.[107] In the outer-zone, USAF fighter aircraft—such as F-22s—would intercept H-6K bombers before they are able to launch cruise missiles. Analysts claim that the H-6Ks would be required to fly beyond the unrefueled combat radius of the PLAAF's fighters, lowering the mission's bar by allowing the USAF to intercept an unescorted bomber fleet.[108] Heginbotham et al., notes that the USAF's capability to intercept aircraft depends on the "course and status of the larger air superiority battle."[109] Should the bombers evade the outer-zone's defenses, the inner-zone's fighter aircraft staged at Andersen AFB would intercept leaked cruise missiles. Aegis-equipped ships and Patriot surface-to-air missile (SAM) systems, if available, could intercept leaked cruise missiles as well.[110]

Given these possible limitations to the PLAAF's long-range standoff strike capability, analysts exclude the possibility that the USAF will have either limited or no access to Andersen AFB in their calculations of the balance of military power between China and the United States. However, China's expanding anti-access envelope suggests that Andersen AFB might not provide the United States secure basing access during conflicts against China. To help determine whether China can effectively strike Andersen AFB with its ballistic and cruise missiles, the next section of this paper will analyze three key components of the question: China's mission to launch both DF-26 IRBMs and CJ-20 ALCMs toward Andersen AFB; the United States' mission to defend Andersen AFB against these missiles; and the damage that leaked missiles would deliver to Andersen AFB. Analyzing the first two components will involve describing each state's mission to highlight capabilities and constraints that would determine whether landing considerable numbers of IRBMs or ALCMs at Andersen AFB is plausible. Analyzing the third component will involve modeling IRBM and ALCM strikes that target Andersen AFB's aircraft to determine the extent of damage China can cause with plausible missile inventory sizes. This analysis will not draw definitive conclusions about whether China's long-range precision strike capabilities can alter

[107] Carlo Kopp, *Defeating Cruise Missiles*, (Australian Aviation, 2004), 7.
[108] Heginbotham, "The U.S.-China Military Scorecard," 63-68, Tupler, "Perils in the Pacific," 120-121.
[109] Heginbotham, "The U.S.-China Military Scorecard," 63.
[110] Tupler, "Perils in the Pacific," 121.

the balance of power between China and the United States meaningfully. Rather, this analysis will determine how both China and the United States would operate during ballistic and cruise missile strikes against Andersen AFB to identify their likely parameters or characteristics. For example, it will determine the number of missiles China might be capable of sending toward Andersen AFB, and whether the United States can mount effective defenses. In addition, this analysis will determine what expected outcomes of those missile strikes would be. While it will discuss possible operational implications, its principal output will be assessments of damage delivered to Andersen AFB rather than implications for each state's air superiority capabilities.

This analysis is important for at least two reasons. First, China's DF-26 IRBM and CJ-20 ALCM inventories are both relatively new and as such, there are no current analyses of their capabilities to strike their intended targets: Andersen AFB's assets. Analyzing how each weapon system, as well as China and the United States, perform during attacks against Andersen AFB will help determine whether a key component of the United States' basing strategy in the Asia-Pacific region is at risk. In doing so, this analysis will provide foundation that future analyses can use to determine implications that China's extended anti-access envelope has for the balance of power between the United States. Second, and related to the first, China's long-range precision strike capabilities might embolden the CCP to posture aggressively should the United States not have secure basing access for projecting power into the Asia-Pacific region. As such, it is important for regional stability to determine whether China can strike Andersen AFB meaningfully, considering both China's mission to launch missiles and the United States' defensive mission.

The Security of Andersen AFB

The Opening Salvos of War

The PLA's military strategy—enshrined in authoritative documents and PLA-affiliated writings published over several decades—identifies clearly how China intends to defeat the United States during regional conflicts. While unknowable political and military decisions will govern partly how China fights, American force planners might be prudent to expect the PLA to follow its operational concepts during conflicts that the CCP considers vital to its security and China's national interests (such as the forceful reunification of Taiwan).[111] China's interpretations of its security environment have guided its evolving military strategy. In 1993, CCP President Jiang Zemin directed the PLA to prepare for "local high-technology" wars.[112] Specifically, the PLA should prepare to fight wars that are both dominated by "high-technology conditions" and "limited in geographic scope, duration, and political objectives."[113] This interpretation of warfare was informed largely by the United States' objectives performance during the 1990-91 Gulf War, during which the United States routed Iraqi forces with advanced weaponry and limited political and military objectives.[114] The CCP expected the same conditions of its conflicts against the United States, as the 1995-96 Taiwan Strait crisis confirmed: the United States signaled to China that it would use technologically advanced forces to prevent China from forcefully reunifying with Taiwan; and the United States' objectives in assisting Taiwan only would limit the conflict's duration and geographic scope.[115]

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[111] "Defense of Japan," 86.
[112] Roger Cliff et al., Entering the Dragon's Lair: Chinese Antiaccess Strategies and Their Implications for the United States (Santa Monica, Calif.: RAND Corporation, 2007), 21.
[113] Cliff, *Entering the Dragon's Lair*, 21.
[114] Cliff, *Entering the Dragon's Lair*, 22.
[115] Cliff, *Shaking the Heavens and Splitting the Earth*, 40.

The PLA evolved its military strategy to meet two key elements that are central to local high-technology wars. First, China would be disadvantaged seriously relative to technologically superior American forces.[116] The PLA would require strategies to use "inferior weapons to deal with an enemy that has superior arms."[117] Second, China's military disadvantages would place high premiums on achieving its military objectives early.[118] China would prefer to open and close conflicts before the United States could mobilize the full weight of its offensive forces and put the PLA in an "untenable position."[119] As one Chinese analyst noted, local high-technology wars feature "make-or-break" characters.[120] The PLA believed that if the United States prevailed in initial hostilities, American forces would be able to control the battlefield thereafter. To square China's limited capabilities with the tall order of defeating American forces quickly, China adopted an offensive military strategy that emphasized "seizing the initiative" early.[121] China would deliver the first blows preemptively and with surprise to offset the advantages that the United States accrued as its forces mobilized fully. As put by one oft quoted Liberation Army Daily article, "in a high-tech local war, a belligerent which adopts a passive defensive strategy and launches no offensive against the enemy is bound to fold its hands and await destruction."[122]

The PLA's offensive strategy of preemption and surprise is designed to exploit the "window of opportunity" that the United States' initial mobilization period confers.[123] Prior to or soon after the initial declaration of hostilities, the PLA intends to carry out "key-point strikes" that will weaken the enemy's capability to "deploy high-tech weapons or... mount a powerful offensive" considerably.[124] One Chinese analyst argues that this strategy is "the only way to steer the course of war in a direction favorable to China."[125] Notably, key-point strikes include "the enemy's air

[116] Cliff, *Entering the Dragon's Lair*, xv.
[117] Cliff, *Entering the Dragon's Lair*, 24.
[118] Cliff, *Entering the Dragon's Lair*, 28.
[119] Cliff, *Entering the Dragon's Lair*, 29.
[120] Cliff, *Entering the Dragon's Lair*, 23.
[121] Cliff, *Entering the Dragon's Lair*, 28.
[122] Cliff, *Entering the Dragon's Lair*, 29.
[123] Cliff, *Entering the Dragon's Lair*, 31.
[124] Cliff, *Entering the Dragon's Lair*, 31, 34.
[125] Cliff, *Entering the Dragon's Lair*, 32.

command-and-control structure" and "key air-bases."[126] The PLA's goal in attacking enemy air bases is to disadvantage the enemy's ability to achieve air superiority such that China will achieve the offensive edge.[127] The United States' operational concept for controlling the air space during conflicts against China is to generate large numbers of sorties from its forward bases. It follows that the PLA has identified preemptive strikes against the United States' air bases as "the most effective way of seizing air superiority."[128] China's strategy to attack air bases involves "first damaging runways to prevent takeoffs and landings, then destroying aircraft on the ground."[129] China might also attack other elements of air bases that service sortie generation capabilities, such as "fuel and ammunition" depots.[130] In addition to destroying the United States' runways or aircraft necessary for sortie generation, attacking the United States' forward bases "can raise the costs of military action to a level the United States deems unacceptable."[131] This perspective articulates that attacking expensive, limited, and difficult-to-replace aircraft[132] will "compel the enemy to decide to withdraw from the war."[133] To be clear, while the PLA's offensive military strategy of preemption and surprise dates back to the 1990s, recent PLA publications and force modernization trends indicate that this strategy remains central to the PLA's thought. China's 2015 National Security Law and recent "Science of Strategy" publication—an overview of the PLA's military strategy—both highlight the PLA's emphasis on offensive operations; and China continues to prioritize anti-access weapons systems that obstruct the United States' sortie generation capabilities.[134]

The key takeaways from this discussion are twofold. First, China's military strategy prioritizes seizing the initiative through attacks during the opening days of war. The PLA intends

[126] Cliff, *Shaking the Heavens and Splitting the Earth*, 44.
[127] Cliff, *Shaking the Heavens and Splitting the Earth*, xviii.
[128] Cliff, *Entering the Dragon's Lair*, 62.
[129] Cliff, *Entering the Dragon's Lair*, 81.
[130] Cliff, *Entering the Dragon's Lair*, 63.
[131] Cliff, *Entering the Dragon's Lair*, 42.
[132] During short conflicts, the United States would replace killed aircraft with aircraft stationed elsewhere, rather than purchase new aircraft.
[133] Cliff, *Entering the Dragon's Lair*, 42.
[134] "Military and Security Developments Involving the People's Republic of China 2017," 2-3, 38-40.

to hedge against the United States' offensive forces by attacking them at the outset of hostilities, when they remain staged at forward bases and are "most vulnerable."[135] Second, the PLA will target the United States' air bases specifically, to degrade the United States' sortie generation capabilities. China might attack targets such as aircraft, runways, fuel stores, and ammunitions depots. Like the United States, China prioritizes air superiority during maritime conflicts. PLA writings indicate that China believes its best or only method to achieve air superiority is to prevent the United States from generating sorties by targeting its forward bases before American aircraft control the skies.

Basing at Andersen AFB

Conventional ballistic missiles and cruise missiles are the instruments that China will use to attack the United States' forward bases during the opening days of conflicts.[136] Over the past two decades, China has fielded considerable numbers of SRBMs, MRBMs, and GLCMs that imperil the United States' basing options nearest to mainland China. Heginbotham et al., estimate that Kadena AB at Okinawa—which was traditionally considered the USAF's most important base during conflicts against China due to its size and proximity to likely flash points—is within the range of "hundreds of MRBMs and perhaps more than 1,000 [GLCM] DH-10s."[137] Analyses indicate that this inventory is well-suited to attacking Kadena AB and degrading its sortie generation capabilities considerably. With 108 MRBMs, the PLA could render Kadena AB's two runways inoperable for several days to several weeks.[138] The same number of MRBMs could blanket Kadena AB's parking area four times over, yielding very high probabilities that "every aircraft parked in the area would have a high probability of being damaged."[139] Allocating 108

[135] Cliff, *Entering the Dragon's Lair*, 30.
[136] Cliff, *Shaking the Heavens and Splitting the Earth*, xxiii.
[137] Heginbotham, "The U.S.-China Military Scorecard," 56.
[138] Heginbotham, "The U.S.-China Military Scorecard," 61.
[139] Heginbotham, "The U.S.-China Military Scorecard," 62.

MRBMs between Kadena AB's runways and the parking area would shut the base down for over a week.[140] Heginbotham et al., demonstrates that China's DH-10 GLCMs threaten Kadena AB's infrastructure targets, which include hangars, hardened aircraft shelters (HASs), and fuel stores.[141] Should China launch 60 DH-10s, "every hangar, hardened aircraft shelter, and identified large fuel tank" would have an over 90-percent chance of being hit.[142] Gons estimates that only one-quarter of China's DH-10 inventory would be required to sweep Kadena AB's parking area over three times.[143] It follows that basing at Kadena AB presents considerable threats to the United States' sortie generation capabilities for two reasons. First, attacks that allocate ballistic and cruise missiles between each of Kadena AB's vital organs—runways, parking areas, and infrastructure—offer large odds that the air base will be rendered at least temporarily inoperable. During short and fast-paced conflicts, the United States might then be unable to achieve its military objectives. Second, attacks on Kadena AB's parking areas—should the USAF stage large numbers of fighter aircraft there—would destroy assets that are vital to the United States' air superiority capabilities. The USAF can deploy additional aircraft to Kadena AB after ballistic or cruise missile barrages, but China's capability to sweep the parking area many times over questions that option's efficacy.

To hedge against the severity of ballistic and cruise missile threats, analysts and American force planners have slated Andersen AFB at Guam as the United States' best bet for "assured [basing] access."[144] Operating from Andersen AFB during conflicts near mainland China would involve complex sortie generation missions to achieve air superiority. Andersen AFB's over 3,000 km distance from likely flash points requires the USAF's fighter aircraft to refuel twice during their flights to combat zones.[145] Each refueling zone requires AEW&C and additional fighter aircraft for defense. Analysts demonstrate that Andersen AFB would be able to devote only 96 to 120 of its 250 maximum-on-ground (MOG) parking slot figure to fighter aircraft, with the other

[140] Heginbotham, "The U.S.-China Military Scorecard," 62.
[141] Heginbotham, "The U.S.-China Military Scorecard," 62.
[142] Heginbotham, "The U.S.-China Military Scorecard," 63.
[143] Gons, "Access Challenges and Implications for Airpower in the Western Pacific," 68.
[144] Gons, "Access Challenges and Implications for Airpower in the Western Pacific," 67.
[145] Tupler, "Perils in the Pacific," 51.

130 to 154 parking slots reserved for force enabling or other offensive aircraft.[146] Should the United States hope to achieve air superiority by generating sorties from Andersen AFB, it will likely require operating at-capacity for the duration of the mission. In other words, Andersen AFB can likely ill-afford to have either runways, parking areas, or infrastructure attacked, should it supply the USAF's aircraft during conflicts against China. While analysts have thus-far excluded Andersen AFB from their modeling of China's missile salvos and the subsequent effects on the United States' sortie generation capabilities, China's expanding anti-access envelope warrants questioning whether Andersen AFB will continue to provide the United States "assured [basing] access."[147]

Ballistic Missile Attacks

Ballistic Missile Strategy Seven years ago, China announced its program to develop a conventionally armed ballistic missile that could travel 4,000 km[148]—far enough to reach Andersen AFB from locations 1,000 km within mainland China. Three years ago, China revealed its DF-26 IRBM that met the 4,000 km benchmark and was dubbed the "Guam Killer" or "Guam Express."[149] The PLA is likely to target Andersen AFB with DF-26 IRBMs prior to or soon after the outset of hostilities in two key ways that will degrade the United States' sortie generation capabilities. First, China might target Andersen AFB's two runways to destroy portions of their surfaces such that fighter or tanker aircraft will be unable to use them to for taking off or landing.[150] The PLA's

[146] See e.g., Eric S. Gons, "Access Challenges and Implications for Airpower in the Western Pacific," (PhD diss., Pardee RAND Graduate School, 2010), Josh S. Tupler, "Perils in the Pacific: Assessing American Air Power Projection over Taiwan and the South China Seas," (Undergraduate Senior Thesis, Dartmouth College, 2016).
[147] Gons, "Access Challenges and Implications for Airpower in the Western Pacific," 67.
[148] Heginbotham, "The U.S.-China Military Scorecard," 53.
[149] Wilson, "China's Expanding Ability to Conduct Conventional Missile Strikes on Guam," 4.
[150] See e.g., Eric Heginbotham, *The U.S.-China Military Scorecard: Forces, Geography, and the Evolving Balance of Power, 1996–2017*, (Santa Monica, Calif.: RAND Corporation, 2015), 56-61, Roger Cliff et al., *Entering the Dragon's Lair: Chinese Antiaccess Strategies and Their Implications for the United States* (Santa Monica, Calif.: RAND Corporation, 2007), 81, Eric S. Gons, "Access Challenges and Implications for Airpower in the Western Pacific," (PhD diss., Pardee RAND Graduate School, 2010), 60.

strategy explains that ballistic missile attacks that cut runways are intended to pin aircraft on the ground, allowing the PLA to follow-up with ballistic or cruise missile attacks that target vulnerable aircraft.[151] China can likely equip its DF-26 IRBMs with submunition warheads[152] that distribute runway-penetrating bomblets that are well suited to cutting runways.[153] Ballistic missiles outfitted with submunition warheads designed to cut runways distribute their bomblets in large circular patterns that—in the case of the DF-26—would have diameters of likely 600 feet.[154] Fighter aircraft require one 5,000-foot-long and 50-foot-wide section of runway to take off or land—which figure is referred to as their minimum operation surface (MOS)—and larger aircraft such as tankers require one 7,000-foot-long and 147-foot-wide section.[155] Heginbotham et al., suggest that DF-26 IRBMs warheads outfitted with submunition warheads will distribute their bomblets densely enough such that no 50-foot-wide section of runways would remain undamaged, so long as at least 50 feet of the circular submunition footprint covers the runway.[156] To prevent either fighter or tanker aircraft from using Andersen AFB's two runways temporarily, China would need to launch enough ballistic missiles to cut each runway either two or three times.[157] Second, China might target Andersen AFB's parking spaces to destroy aircraft staged openly. Andersen AFB features only six aircraft hangars[158] and no hardened aircraft shelters.[159] Accordingly, most of Andersen AFB's 250 parked aircraft will park without shelters that offer at least partial protection. Openly staged aircraft have little survivability relative to bomblets that eject fragments outwardly, allowing them to be rendered inoperable by smaller submunitions than those designed to penetrate runways.[160] In this case, China will likely outfit its ballistic missiles with

[151] Cliff, *Entering the Dragon's Lair*, 63.
[152] Wilson, "China's Expanding Ability to Conduct Conventional Missile Strikes on Guam," 8.
[153] Heginbotham, "The U.S.-China Military Scorecard," 58.
[154] Heginbotham, "The U.S.-China Military Scorecard," 58.
[155] Heginbotham, "The U.S.-China Military Scorecard," 57-58.
[156] Heginbotham, "The U.S.-China Military Scorecard," 56-58.
[157] Heginbotham, "The U.S.-China Military Scorecard," 64-65.
[158] Heginbotham, "The U.S.-China Military Scorecard," 63.
[159] The likely explanation for Andersen AFB's lack of hardened aircraft shelters—given its strategic value to the United States—is that traditionally, Andersen AFB has operated outside of China's anti-access envelope and was considered accordingly secure.
[160] Gons, "Access Challenges and Implications for Airpower in the Western Pacific," 235.

warheads that house hundreds of small submunitions to blanket large sections of parking areas.[161] With USAF aircraft pinned on the ground due to ballistic missile attacks that render Andersen AFB's runways temporarily defunct, the PLA could use its ballistic (or cruise) missile arsenal to blanket openly parked aircraft with submunition bomblets.

Ballistic Missile Mission The PLA's Rocket Force launches its DF-26 from mobile transporter-erector-launchers (TELs) that can send missiles toward Andersen AFB from up to 1,000 km within mainland China. The size of China's DF-26 inventory is uncertain, but estimates indicate that the PLA has fielded at least 16 missiles.[162] However, Heginbotham et al., models attacks on Andersen AFB with DF-26 salvos sized at 50 to 100 missiles.[163] Barring China's actual DF-26 inventory size, modeling attacks on Andersen AFB with 50 to 100 IRBMs is valuable for two reasons. First, China might use considerable numbers of missiles in its attacks on high-value targets. Should 50 to 100 missiles be required to deliver considerable damage, it is reasonable to expect that China might allocate those numbers of IRBMs to its attacks. Whether China actually does this is uncertain, but modeling with considerable numbers of missiles will shed light on whether the strategy is plausible and thus whether the United States should expect to defend against salvos of those sizes. Second, China grows its ballistic missiles inventory rapidly. As noted, China's anti-access weapons systems have been central focuses of its growing defense budget. As such, China produces considerable numbers of ballistic missiles each year.[164] Should China not currently have 50 to 100 DF-26 IRBMs, it is reasonable to expect that they might close the gap between their current and desired inventories within only about two years. The DF-26's circular error probable (CEP)—"defined as the radius of a circle within which half of the missiles land for

[161] Heginbotham, "The U.S.-China Military Scorecard," 62.
[162] Ballistic and Cruise Missile Threat, (Washington, D.C.: Defense Intelligence Ballistic Missile Analysis Committee, 2017).
[163] Heginbotham, "The U.S.-China Military Scorecard," 64-65.
[164] Heginbotham et al., note that China produces 68 MRBMs per year. This analysis assumes that China might be able to produce somewhat similar numbers of IRBMs per year as well. See: Heginbotham, "The U.S.-China Military Scorecard," 52.

a given aimpoint"[165]—is between 150 m and 450 m, which is quite large and inaccurate relative to the 5—10 m CEP of China's DF-15B SRBM and the 50 m CEP of China's DF-21C MRBM.[166] Due to the currently small size of China's DF-26 inventory that open-source resources estimate, it is unclear whether the uncertain number of IRBMs that China would launch toward Andersen AFB would degrade its sortie generation capabilities meaningfully. For analytical purposes, this analysis will follow Heginbotham et al.,'s approach by including 50 to 100 DF-26 IRBMs to model attacks against Andersen AFB. That China will launch its DF-26 IRBMs from their mobile TELs makes China's mission of sending missiles toward Andersen AFB relatively simple.

Cruise Missile Attacks

Cruise Missile Strategy During the Gulf War of 1990-91, China witnessed the United States' use of Tomahawk land-attack cruise missiles (LACMs) that demonstrated their value in striking point targets at the outset of hostilities.[167] Specifically, China noted LACMs' long-range standoff strike capabilities that leveraged "precision, stealth, and lethality to hit distant" point targets.[168] While China's aircraft were then outmoded, cruise missiles would be "cheap, accurate, and effective way[s] to improve combat air ability."[169] Put differently, China could use cruise missiles to target the enemy's forces during the opening stages of conflicts. In line with China's focus on local high-technology wars, cruise missiles would allow China to achieve the initiative and lethality that would be "critical in determining winners and losers in modern wars."[170] As such, researchers at the PLA Electronic Engineering Academy concluded that "cruise missiles have... become the ordinance of first choice for the prelude to open conflict."[171]

[165] Stillion and Orletsky, *Airbase Vulnerability*, 8.
[166] Heginbotham, "The U.S.-China Military Scorecard," 48.
[167] Gormley, Erickson, and Yuan, *China's Cruise Missile Ambitions*, 2, 89.
[168] Gormley, Erickson, and Yuan, *China's Cruise Missile Ambitions*, 2.
[169] Gormley, Erickson, and Yuan, *China's Cruise Missile Ambitions*, 90.
[170] Gormley, Erickson, and Yuan, *China's Cruise Missile Ambitions*, 90.
[171] Gormley, Erickson, and Yuan, *China's Cruise Missile Ambitions*, 6.

Cruise missiles are essentially pilotless aircraft that fly toward their targets armed with high explosives.[172] While they are smaller and slower than ballistic missiles, they have several key qualities that make them advantageous in gaining the initiative prior to or soon after conflicts start. For one, cruise missiles are highly accurate. CEPs for today's cruise missiles are between 5 m and 20 m, in many cases.[173] Cruise missiles correct their paths in-flight using position, navigation, and timing (PNT) information gathered from sources such as navigation-positioning satellites.[174] In-flight positioning allows them to fly toward targets both directly and indirectly, allowing for coordinated attacks from various angles.[175] In addition, cruise missiles are equipped with high explosive yields similar to those of ballistic missiles.[176] The United States' Tomahawk LACMs deliver 454 kg payloads, for example.[177] Cruise missiles might have unitary and submunition warhead variants, which can augment their already sizable payloads by optimizing their high explosives for specific targets.[178] For example, unitary warheads are likely most effective at targeting hardened aircraft shelters, while submunition variants are likely most effective at targeting runways.[179] While the ranges of cruise missiles vary, long-range variants travel upwards of 2,000 km often.[180] Finally, cruise missiles are considered very difficult to defend against. They fly at low altitudes and have small radar cross-sections (RCSs), which allows missile defense systems little time to track and intercept detected missiles.[181] Taken together, these advantages provide considerable opportunities to attack distant point-targets such as air bases successfully.

[172] Gormley, Erickson, and Yuan, *China's Cruise Missile Ambitions*, 2.
[173] See e.g., Dennis M. Gormley, Andrew S. Erickson, and Jingdong Yuan, *A Low-Visibility Force Multiplier: Assessing China's Cruise Missile* Ambitions (Washington, D.C.: National Defense University Press, 2014), 76, Eric Heginbotham, *The U.S.-China Military Scorecard: Forces, Geography, and the Evolving Balance of Power, 1996–2017*, (Santa Monica, Calif.: RAND Corporation, 2015), 48.
[174] Gormley, Erickson, and Yuan, *China's Cruise Missile Ambitions*, 40.
[175] Gormley, Erickson, and Yuan, *China's Cruise Missile Ambitions*, 41.
[176] Heginbotham, "The U.S.-China Military Scorecard," 48.
[177] "Tomahawk," Center for Strategic and International Studies (CSIS).
[178] Heginbotham, "The U.S.-China Military Scorecard," 137.
[179] Heginbotham, "The U.S.-China Military Scorecard," 137.
[180] Gormley, Erickson, and Yuan, *China's Cruise Missile Ambitions*, 2.
[181] Gormley, Erickson, and Yuan, *China's Cruise Missile Ambitions*, 2.

In 2005, the United States Director of National Intelligence learned that China had developed long-range cruise missiles; four years later, U.S. Air Force National Air and Space Intelligence Center (NASIC) reported that China had developed the ground-launched CJ-10 and the air-launched YJ-63 cruise missiles.[182] The CJ-10 "Long-Sword" could travel about 1,500 km, and the YJ-63's range was limited to under 200 km,[183] which limited the PLA's cruise missile envelope to the "First Island Chain." However, China has since developed several air-launched variants of the CJ-10 cruise missile. Open-source resources estimate that the current model—the CJ-20 ALCM—can travel 2,000 km.[184] The PLAAF's H-6K Badger can engage in combat missions up to 3,500 km away[185] and carry six CJ-20 ALCMs,[186] allowing China the capability to send cruise missiles to targets roughly 5,500 km from either China's mainland or the H-6K's last refueling point. China's CJ-20 ALCMs have reported CEPs of 5 m—20 m[187] and rely on several guidance systems including satellite navigation, inertial navigation, and terrain following.[188] CJ-20 ALCMs have both unitary and submunition warhead variants; the unitary warhead likely includes between 350 kg and 500 kg of high explosives;[189] and the submunition warhead carries likely 166 bomblets that have roughly 1.4 kg (or 3 lb) of high explosives each.[190] Today, the size of China's CJ-20 ALCM inventory is uncertain. Heginbotham et al., estimate that China currently has between 450 and 1,250 LACMs total, split between ground-, sea-, and air-launched variants.[191] This analysis assumes an even split between each of the three variants, yielding low and high CJ-20 inventory estimates of 150 and 416 ALCMs. The IISS Military Balance 2017 report lists that China has 60 H-6K aircraft split between three bomber regiments.[192] This analysis assumes that

[182] Gormley, Erickson, and Yuan, *China's Cruise Missile Ambitions*, 30.
[183] Gormley, Erickson, and Yuan, *China's Cruise Missile Ambitions*, xix.
[184] "CJ-20."
[185] Keck, "China's New Strategic Bomber."
[186] "Chinese Xian H-6K"
[187] Heginbotham, "The U.S.-China Military Scorecard," 48.
[188] Jeffrey Lin and P.W. Singer, "China Shows Off Its Deadly New Cruise Missiles," Popular Science, last modified 2015, https://www.popsci.com/china-shows-its-deadly-new-cruise-missiles.
[189] Heginbotham, "The U.S.-China Military Scorecard," 48.
[190] Gons, "Access Challenges and Implications for Airpower in the Western Pacific," 235.
[191] Gons, "Access Challenges and Implications for Airpower in the Western Pacific," 235.
[192] "Chapter Six: Asia," The Military Balance 117, no. 1 (2017): 283-284, doi:10.1080/04597222.2017.1271212.

bombers are allocated evenly among the regiments, allowing 20 each. One regiment with 20 bombers equipped with six CJ-20s each amounts to a force of 120 ALCMs; similarly, two regiments yields 240 ALCMs; and three regiments yields 360 ALCMs.

China is likely to use cruise missiles to seize the initiative at the outset of hostilities in two key ways. First, China might target Andersen AFB's parking area to destroy aircraft staged on the ground. Previous analyses suggest that cruise missiles equipped with submunition warheads are effective at blanketing parking areas with bomblets, such that each bomblet is likely to render aircraft inoperable.[193] In this scenario, China might first attack Andersen AFB's runways with ballistic missiles—preventing aircraft from using them to take off—and second attack its aircraft, newly pinned on the ground, with cruise missiles. To be sure, China can use DF-26 IRBMs equipped with submunition warheads to attack aircraft as well; Heginbotham et al., notes that doing so may be more effective than using cruise missiles equipped with submunition warheads.[194] It is uncertain how China will prioritize DF-26 IRBMs and CJ-20 ALCMs to attack Andersen AFB's aircraft, due to unknown information such as each missile's inventory size. However, China has incentives to use both ballistic and cruise missiles—each presents its own difficulties for the United States' defenses, and using more rather than less missiles will increase the likelihood that China renders sufficient numbers of aircraft inoperable. It follows that this analysis will model both DF-26 IRBM and CJ-20 ALCM attacks on Andersen AFB. Second, China might target Andersen AFB's other components that enable its sortie generation capabilities. Specifically, China might attack point targets such as fuel stores, weapons depots, and hangars.[195] CJ-20 ALCMs attached with unitary warheads are accurate and deliver large high explosive yields, which Heginbotham et al., explain allow China significant capabilities to attack point targets.[196] For

[193] See e.g., Eric S. Gons, "Access Challenges and Implications for Airpower in the Western Pacific," (PhD diss., Pardee RAND Graduate School, 2010), 235, John Stillion and David T. Orletsky, Airbase Vulnerability to Conventional Cruise-Missile and Ballistic-Missile Attacks: Technology, Scenarios, and U.S. Air Force Responses (Santa Monica, Calif.: RAND Corporation, 1999).
[194] Heginbotham, "The U.S.-China Military Scorecard," 63.
[195] Heginbotham, "The U.S.-China Military Scorecard," 46.
[196] Heginbotham, "The U.S.-China Military Scorecard," 46.

example, to generate sorties using 96 F-22 aircraft and their force enablers, Andersen AFB would require using 2.95 million gallons of fuel per day.[197] Open-source imagery suggests that partially buried fuel tanks (up to about 50 m in diameter) would supply the operation's fuel;[198] cruise missiles are likely capable of damaging these, which would threaten Andersen AFB's sortie generation capabilities over time.

Cruise Missile Mission Since 1999, the PLAAF has emphasized air-to-surface combat to achieve air superiority, such that its first listed objective of "air offensive combat" is to "attack enemy ground (or water) targets."[199] The PLAAF's operational concept for air-to-surface combat has at least three guiding principles: surprise, preemption, and concentration.[200] Along these lines, the PLAAF will commence its "air raids" or "air strikes" with "initial strikes" to attack the enemy's key-point targets—Cliff et al., note that most PLA sources list combat airfields and combat aircraft first.[201] The PLAAF's "strike groups" include mainly bomber and fighter aircraft,[202] and will likely carry out long-range and precision standoff strikes.[203] Bombers would carry long-range standoff weapons (such as CJ-20 ALCMs), while fighter aircraft would likely carry either air-to-air or air-to-surface missiles, contingent on the mission and each fighter's variant. While there are at least three variants of strikes—concentrated, simultaneous, and continuous—the PLAAF would likely use the "concentrated strike" formation to attack Andersen AFB with cruise missiles.[204] Concentrated attacks are intended to saturate targets with robust defenses and large areas, such that they will "shock the enemy and completely destroy targets."[205] Generally, cruise missiles intended to destroy key-point targets—such as aircraft parked in shelters or openly—would fare

[197] Gons, "Access Challenges and Implications for Airpower in the Western Pacific," 82.
[198] See coordinates at: 26.58722, 112.89166 and 27.22147, 111.66599 —the author used Google Maps, Satellite View to do so.
[199] Cliff, *Shaking the Heavens and Splitting the Earth*, 71.
[200] Cliff, *Shaking the Heavens and Splitting the Earth.*
[201] Cliff, *Shaking the Heavens and Splitting the Earth*, 109.
[202] Cliff, *Shaking the Heavens and Splitting the Earth*, 94.
[203] Cliff, *Shaking the Heavens and Splitting the Earth*, 109.
[204] Cliff, *Shaking the Heavens and Splitting the Earth*, 72.
[205] Cliff, *Shaking the Heavens and Splitting the Earth*, 92.

best against enemy defenses when concentrated: for simple illustration, if the probability of kill of one cruise missile against a target is 0.75, the probability of one cruise missile's success against this target is 0.75, while the probability of two cruise missile's success against this target is 0.94.[206] It follows that concentrated and long-range standoff strikes would service the PLAAF's mission of seizing the initiative during the early stages of conflicts, should the PLAAF be able to overwhelm Andersen AFB's defenses. In addition to substantiating already-discussed PLA thought, the key takeaways here twofold: first, the PLAAF is likely to leverage strike groups of bomber and fighter aircraft to send ALCMs toward Andersen AFB; and second, the PLAAF is likely to concentrate its attacking forces during this mission to saturate Andersen AFB's defenses and alter the balance of air power rapidly.

China's military capabilities and strategy allow this analysis to make basic assumptions about how the PLAAF would conduct bomber raids to send air-launched cruise missiles toward Andersen AFB. Four guiding components of the PLAAF's bomber raids are: raid aircraft; basing options; surge capabilities; and aircraft flight paths. Each is uncertain but will help determine general characteristics of the PLAAF's bomber raids against Andersen AFB—for example, how many missiles China might launch—and how the United States might defend against them.

First, the PLAAF is likely to raid with H-6K bomber aircraft escorted by fighter aircraft. While China has other H-class bomber aircraft,[207] China has prioritized its H-6K fleet recently by: enabling them to carry 6 ALCMs, rather than the 4 that the H-6M can carry;[208] extending their ranges to 3,500 km with imported turbofan engines;[209] and introducing components such as glass cockpits with advanced avionics.[210] It is plausible that China might include other H-6 class

[206] In this case, the target is "killed" if any cruise missiles hit it. The equation used here is: $p(\text{kill}) = 1 - (1 - p(\text{success}))^n$, where p(success) is the probability that cruise missiles success (0.75 in this case) and ^{n} is the number of missiles (1 and 2 in this case).
[207] "Chapter Six: Asia," 283.
[208] Sebastien Roblin, "China's H-6 Bomber: Everything You Want to Know About Beijing's 'B-52' Circling Taiwan," The National Interest, last modified December 2016, 2.
[209] Keck, "China's New Strategic Bomber."
[210] "H-6K Air Striking Platform," Global Security.

bombers in its raids, but this analysis excludes that possibility for simplicity. As mentioned, China has three H-6K bomber regiments that might include 20 aircraft each. In addition, China is likely to escort its H-6K bomber aircraft with fighter aircraft.[211] This analysis assumes that China uses longer-range fourth-generation fighter aircraft for this mission: the Su-27 and J-11 air superiority fighters, which have combat radii of 1,500 km and are equipped with air-to-air missiles.[212] The IISS Military Balance 2017 report lists that China has 147 Su-27 and J-11 aircraft total.[213] China might plausibly use other fourth-generation aircraft, such as the J-10, Su-30, and J-16 fighters.[214] However, both J-10 and Su-30 aircraft have smaller combat radii of 1,000 km,[215] which will allow them to escort the H-6K bombers shorter distances before having to allow the bombers to fly unescorted; and China has very few J-16 aircraft,[216] making it less likely that bomber raids would include them.

Second, this analysis assumes that China bases its H-6K bomber aircraft at the PLAAF's 8th Bomber Division air bases in the Shaodong and Leiyang areas of mainland China.[217] Open-source imagery shows about 20 H-6K bomber aircraft at each base,[218] which would allow them to contribute two regiments to the bomber raid in total. Each base is located between 500 km and 1,000 km from portions of China's coastline that the H-6Ks are likely to fly across,[219] which will allow them to launch CJ-20 ALCMs toward Andersen AFB without refueling aerially. The math here is straightforward: bombers must travel to distances roughly 2,000 km from Andersen AFB

[211] Analysts consider escorts likely or beneficial components of China's bomber raid mission. See e.g., Eric Heginbotham, The U.S.-China Military Scorecard: Forces, Geography, and the Evolving Balance of Power, 1996–2017, (Santa Monica, Calif.: RAND Corporation, 2015), Eric S. Gons, "Access Challenges and Implications for Airpower in the Western Pacific," (PhD diss., Pardee RAND Graduate School, 2010), Josh S. Tupler, "Perils in the Pacific: Assessing American Air Power Projection over Taiwan and the South China Seas," (Undergraduate Senior Thesis, Dartmouth College, 2016).
[212] See e.g., "Su-27 Specifications," Global Security, "Shenyang J-11 Air Superiority Fighter," Military Today.
[213] "Chapter Six: Asia," 284.
[214] Heginbotham, "The U.S.-China Military Scorecard," 77.
[215] See e.g., "Su-30 Flanker," Global Security, "Chengdu J-10 Multirole Fighter," Military Today.
[216] "Chapter Six: Asia," 284.
[217] See footnote with coordinates below.
[218] See coordinates at: 13.566627, 144.911810 and 13.590658, 144.920823—the author used Google Maps Satellite View to do so.
[219] The geographic corridors China's H-6K aircraft are likely to fly through is discussed later in this section. The 500 km and 1,000 km values included here were calculated by the author.

to launch their cruise missiles;[220] positions 2,000 km from Andersen AFB are roughly 1,000 km—1,500 km off mainland China's coast, as low and high estimates; and travelling to 1,000 km or 1,500 km off mainland China's coast from 500 km or 1,000 km inside mainland China would require bombers to travel at least 1,500 km or at most 2,500 km—each of those estimates are well below the H-6K aircraft's 3,500 km unrefueled combat radius.[221] (This analysis will soon discuss which specific launch points China might fly its cruise missiles to, and which geographic corridors the escorted H-6K bombers might fly through.) Due to their smaller combat radii, this analysis assumes that China bases its fighter aircraft near China's coastline, such that they can escort the H-6K bombers farthest. In this case, China's fighters would launch roughly 30 minutes or one hour after its bomber aircraft do: H-6K bombers cruise at 850 kph;[222] H-6K bombers would meet fighter aircraft at China's coastline, between 500 km and 1,000 km away; flying 500 km at 850 kph would take 35 minutes, and flying 1,000 kph at 850 kph would take 70 minutes.

Third, this analysis assumes that China can surge between 200 and 300 aircraft at once. Surges—simply put—are large "waves" of aircraft that would help the PLAAF overwhelm enemy forces, whether those are air-, sea-, or ground-based. Surges are contingent on the number of bases that would allow China's fighter aircraft to fly to combat zones without aerial-refueling, which process would take time and likely diminish China's surge capabilities; Tupler estimates that China can surge 200 aircraft when operating from bases closest to the Spratly Islands in the South China Sea, and China can surge 300 aircraft when operating from bases closest to Taiwan.[223] Both 200 and 300 aircraft are Tupler's low estimates.[224] Given the position of the H-6Ks' bases relative to the coast, it is likely that China will fly its bombers near either those bases near the Spratly Islands of those bases near Taiwan. This analysis assumes that these surging estimates apply to

[220] The 2,000 km figure comes from the range of CJ-20 ALCMs. See e.g., Eric Heginbotham, *The U.S.-China Military Scorecard: Forces, Geography, and the Evolving Balance of Power, 1996–2017*, (Santa Monica, Calif.: RAND Corporation, 2015), 48, "CJ-20," Deagel.
[221] Keck, "China's New Strategic Bomber."
[222] "H-6K," Deagel.
[223] Tupler, "Perils in the Pacific," 59-61.
[224] Tupler, "Perils in the Pacific," 61.

China's fighter aircraft only: the H-6K bombers are staged at bases roughly 1,000 km within mainland China; as such, they are excluded from the surge capability estimates of 200 and 300 aircraft, which Tupler reserves for fighter aircraft within the unrefueled range of either the Spratly Islands or Taiwan. Accordingly, this analysis assumes that the H-6Ks' bases are capable of surging at least one regiment—of roughly 20 aircraft—each.

Fourth, this analysis assumes that China's H-6K bomber and fighter aircraft fly to the CJ-20 ALCM launch points through two geographic corridors: the Bashi Channel—between Taiwan and the Philippines—or between Taiwan and Japan—such as the Miyako Strait, which is roughly 350 km southwest of Okinawa. There are several justifications for this assumption. For one, China is less likely to fly directly over either Japan, Taiwan, or the Philippines during bomber raids. Flying over Japan or Taiwan would risk detection from ground-, sea-, and air-based radars or defenses which this analysis assumes are likely to engage China's bomber and fighter aircraft;[225] and flying over the Philippines risks detection similarly, with uncertain risk of engagement. Instead, flying over water through the Bashi Channel or between Taiwan and Japan would distance China's raid from these threats more so than flying over land would. While there are caveats to this strategy (which the next section will discuss), this analysis assumes that China chooses to hedge against threats that are likely over mainlands—such as radars and surface-to-air missile systems—by flying over waters that are less likely to present China's raid with the same threats. Also, flying through these corridors allows China's Su-27 and J-11 aircraft to escort the H-6K aircraft sufficiently far for the bombers to launch their CJ-20 ALCMs. As mentioned, launching ALCMs 2,000 km away from Andersen AFB would position the H-6K aircraft about 1,000 km—1,500 km away from China's coastline, which is the general area that China's fighter aircraft base at. That range of distances falls under or at the 1,500 km unrefueled combat radius benchmark of China's Su-27 and J-11 fighter aircraft.[226] While China's H-6K aircraft can possibly

[225] Defenses would include principally SAM systems, such as China's long-range S-300PMU SAM systems. For the list of China's SAM systems, see: "Chapter Six: Asia," 284.
[226] See e.g., "Su-27 Specifications," Global Security, "Shenyang J-11 Air Superiority Fighter," Military Today.

fly toward the Celebes Sea and below the Philippines without refueling, this mission would require either: the Su-27 and J-11 escorts to refuel at least once, which increases the complexity by requiring force enablers such as tanker and AEW&C aircraft; or flying China's H-6K bomber aircraft without escorts as they approached their CJ-20 ALCM launch points. This analysis excludes this as possible. The final justification for this assumption is that China flew H-6K aircraft through both the Miyako Strait and Bashi Channel during recent military exercises,[227] which opens the possibility that China might do so during bomber raids against Andersen AFB as well.

There are three key takeaways from these general characteristics of China's bomber raid. First, China is likely to raid with at least one H-6K regiment—estimated at 20 bombers—escorted by fighter aircraft. While China has three H-6K bomber regiments and additional regiments of other H-class bomber aircraft,[228] is it unclear how many China will allocate to bomber raids against Andersen AFB. Still, it is reasonable to expect that China will dedicate one H-6K regiment to them. It follows that assuming China's H-6K bombers are equipped with six CJ-20 ALCMs each, China would be capable of launching 120 cruise missiles toward Andersen AFB. With 147 total Su-27 and J-11 fighter aircraft[229] and the capacity to surge between 200 and 300 aircraft,[230] this analysis assumes that China could reasonably escort its bomber regiment(s) with two or more fighter regiments of roughly 20 aircraft. Surges happen periodically rather than continuously; given the importance of the H-6K bomber mission in the PLA's military thinking, China might choose to either diminish or refrain from surges during the times of bomber raids such that its H-6K bombers have large numbers of escorting fighter aircraft available. Second, China is likely to send its bombers either through the Bashi Channel or between Taiwan and Japan. China has other options—such as flying over or south of the Philippines—but China's best bet to hedge against defensive systems might be to fly over water and with escorts, which requires China to use these two geographic corridors. Third, the characteristics of China's bomber raid are uncertain. Whether

[227] "Defense of Japan," 101.
[228] "Chapter Six: Asia," 284.
[229] "Chapter Six: Asia," 284.
[230] Tupler, "Perils in the Pacific," 61.

China dedicates one or two bomber regiments is unknown, and accordingly, the number of cruise missiles China would launch toward Guam is unknown. However, in making and explaining assumptions, this portion of the analysis has reasoned that China might dedicate one bomber regiment with 120 total CJ-20 ALCMs to fly through either—or both—of two geographic corridors. This says nothing definite about how many cruise missiles might land on Andersen AFB, which is contingent on both how many bomber regiments China actually dedicates to its mission, and how effective USAF defenses—discussed in the next section—are at hedging against China's bomber raid threat. Rather, this portion of the analysis has identified plausible ranges of possibilities for each variable that will contribute to China's bomber raid. American force planners, when considering defensive options or the scale of the threat to Andersen AFB, likely will face similar uncertainties and identify plausible ranges of possibilities also.

United States' Defensive Mission

The United States' mission to defend Andersen AFB against China's DF-26 IRBMs and CJ-20 ALCMs comes in two parts. First, the United States might prevent both China's TELs from launching DF-26 IRBMs and China's H-6K bomber aircraft from launching CJ-20 ALCMs.[231] This operational concept is characterized as shooting the "archer" rather than the "arrow"[232]—the United States would not intercept individual missiles, but instead would intercept those missiles' launch platforms. The United States would use various weapons systems—such as fighter aircraft and shipborne systems—for these "outer zone" defenses.[233] Second, the United States might intercept missiles that "leak" through outer zone defenses from launch platforms—the TELs and H-6K bomber aircraft—during their flight paths toward Andersen AFB.[234] To intercept ballistic missiles, the United States uses point-defenses such as the Patriot SAM and Terminal High

[231] Kopp, "Defeating Cruise Missiles," 7.
[232] Tupler, "Perils in the Pacific," 61.
[233] Kopp, "Defeating Cruise Missiles," 7.
[234] Kopp, "Defeating Cruise Missiles," 7.

Altitude Area Defense (THAAD) weapons systems;[235] and to intercept cruise missiles, the United States uses fighter aircraft, seaborne weapons systems, and point-defenses[236] (specifically, Patriot SAM systems).[237] Intercepting in-flight ballistic and cruise missiles comprises the "inner zone" of this two-zone defensive scheme.[238] In practice, the United States' capability to implement two defensive zones around Andersen AFB is likely constrained by geographic and military factors. As such, the United States will likely rely on inner rather than outer zone defenses that will allow at least some IRBMs and ALCMs to "leak" and land at Andersen AFB during saturated ballistic and cruise missile attacks.

Outer Zone Defenses The United States likely will have limited capabilities to implement outer zone defenses that would intercept ballistic missiles' and cruise missiles' launch platforms. The PLA Rocket Force launches its DF-26 IRBMS from mobile TELs based on mainland China. Neutralizing China's TELs would require the United States to first locate them and second destroy them—likely with either air-to-surface missiles (ASMs) launched from fighter aircraft or surface-to-surface missiles (SSMs) launched from either ground- or sea-based missile platforms. Barring the United States' capability to achieve this military objective, this defensive measure is limited by its highly escalatory nature. Launching missiles toward assets based on China's mainland enlarge conflicts beyond the threshold that the United States would likely prefer to achieve limited objectives—such as the forceful reunification of Taiwan with China. Whether the United States would choose to locate and destroy China's DF-26 IRBM TELs during conflicts is unknown: those involved in force planning will make those decisions as crises arise. Should the United States attempt this mission, at least some TELs are likely to evade destruction and launch their DF-26 IRBMs—locating and destroying all TELs is unlikely. As such, this analysis assumes that either all or at least some DF-26 IRBM TELs are able to launch their missiles toward Andersen AFB.

[235] Wilson, "China's Expanding Ability to Conduct Conventional Missile Strikes on Guam," 15.
[236] Kopp, "Defeating Cruise Missiles," 7.
[237] Wilson, "China's Expanding Ability to Conduct Conventional Missile Strikes on Guam," 15.
[238] Kopp, "Defeating Cruise Missiles," 7.

Similarly, the United States might attempt to send missiles toward China's H-6K air bases to destroy their bombers while staged on the ground. This analysis codes this scenario as highly escalatory and excludes it as possible. Should the United States attempt to do so, at least some H-6K bombers will likely evade destruction, which would allow surviving H-6K bombers to attempt their raid mission still. Rather, the United States' preferred operational concept to intercept China's H-6K bombers is destroying them in-flight and outside of mainland China's air space.[239] This mission would require both AEW&C and fighter aircraft: AEW&C aircraft—specifically Boeing E-3 Sentries—would detect and track China's bomber raid aircraft; and fighter aircraft—F-22s, for example—would use information supplied from AEW&C aircraft to destroy China's raid aircraft.[240] Assuming that China's raid aircraft fly through the two geographic corridors mentioned previously, there are two general parameters the United States would consider in positioning its AEW&C aircraft for this mission. First, the AEW&C aircraft would ideally be positioned to detect bomber raid aircraft most efficiently, such that the United States can screen given geographic areas for raid aircraft with as few AEW&C aircraft possible. In practice, this suggests the United States would position its AEW&C aircraft between the two geographic corridors this analysis has identified as likely paths for raid aircraft. AEW&C aircraft have radars to detect and track aircraft within circular areas of roughly 375 km radii.[241] As such, screening the Bashi Channel—about 400 km wide—would require one E-3 Sentry; and screening the area between Taiwan and Japan—about 1,000 km wide—would require two E-3 Sentry aircraft.[242] Assuming that China's raid aircraft fly through these corridors, positioning AEW&C aircraft between them will minimize the complexity of their missions. Second, the AEW&C should be positioned sufficiently far from mainland China that they remain secure from anti-aircraft threats—such as SAM systems—but sufficiently close to mainland China that they are able to

[239] See e.g., Josh S. Tupler, "Perils in the Pacific: Assessing American Air Power Projection over Taiwan and the South China Seas," (Undergraduate Senior Thesis, Dartmouth College, 2016), 61, Carlo Kopp, *Defeating Cruise Missiles*, (Australian Aviation, 2004), 7.
[240] Carlo Kopp, *Defeating Cruise Missiles*, (Australian Aviation, 2004), 7.
[241] "E-3 Sentry (AWACS)," U.S. Air Force.
[242] Distances calculated by author using Google My Maps.

detect raid aircraft early enough to allow USAF fighter aircraft time to engage the PLAAF aircraft.

In practice, positioning the AEW&C aircraft between the two geographic corridors places them outside of the envelope of China's ground-based anti-aircraft weapons platforms.[243] Whether this allows USAF fighter aircraft enough time to engage China's raid aircraft—this mission's second component—is complicated. Should the United States maintain combat air patrols (CAPs) around the AEW&C aircraft—which would involve fighter aircraft flying continuously around the two geographic corridors the AEW&C aircraft screen—fighter aircraft would be available readily to engage detected raid aircraft. However, maintaining at least two CAPs around the two geographic corridors is an unrealistic option. In this scenario, the USAF is generating sorties from Andersen AFB due China's anti-access threats to the USAF's other forward bases. As such, Andersen AFB would likely need to supply fighter aircraft for the two CAPs. With its MOG of 250 aircraft, Andersen AFB does not have the operational capacity to supply the sorties required for this mission.[244] The USAF might expand its basing capacity—by building new air bases near Andersen AFB, for example—but generating enough sorties for two CAPs would require hundreds of aircraft.[245] Accordingly, this analysis codes this option of maintaining two CAPs as uncertain at best and excludes it as possible. Alternatively, the United States might be able to generate sorties from Andersen AFB once AEW&C aircraft have detected raid aircraft. Positioning AEW&C aircraft between the two geographic corridors would allow them to detect raid aircraft when they are roughly 1,000 km from their launch points, which are 2,000 km from Andersen

[243] The maximum distance that China's SAM systems can detect and intercept aircraft at is likely 400 km (S-400 SAM). Distances calculated by author using Google My Maps. For China's complete SAM system portfolio, see: "Chapter Six: Asia," The Military Balance 117, no. 1 (2017): 284, doi:10.1080/04597222.2017.1271212.

[244] Assumptions for aircraft requirements for additional CAPs are discussed briefly in footnote 241. For information on Andersen AFB's MOG figure, see e.g., Eric S. Gons, "Access Challenges and Implications for Airpower in the Western Pacific," (PhD diss., Pardee RAND Graduate School, 2010), Josh S. Tupler, "Perils in the Pacific: Assessing American Air Power Projection over Taiwan and the South China Seas," (Undergraduate Senior Thesis, Dartmouth College, 2016).

[245] Analysts explain that one CAP of six aircraft around Taiwan's airspace, when generating sorties from Andersen AFB, would exhaust Andersen AFB's operational capacity (i.e., would use all 250 slots in its MOG). This analysis assumes that producing additional CAPs around AEW&C patrol zones to intercept bombers would require similar numbers of aircraft (i.e., additional 250 aircraft requirements).

AFB. Given that China's H-6K bomber aircraft cruise at 850 kph[246] and USAF fighter aircraft cruise about 1,000 kph,[247] China's bombers could traverse the 1,000 km to their launch points in about 70 minutes while the USAF fighters could traverse the 2,000 km to those launch points in about two hours. It follows that neither maintaining once CAP around each of the two geographic corridors, nor generating sorties to them after detection of China's raid aircraft, are plausible options for the United States. As such, intercepting China's H-6K bombers as an outer zone defensive strategy is uncertain at best. To be sure, there are other options for the United States to intercept H-6K bombers, such as positioning aircraft carriers near the two geographic corridors or operating from forward air bases on Japan or the Philippines. However, both of those strategies are uncertain as well: positioning aircraft carriers near mainland China would put them at risk of China's anti-ship weapons systems—such as its DF-21D anti-ship ballistic missile, dubbed the "carrier killer"[248]—and basing access in Japan and the Philippines during conflicts against China might be restricted.[249]

The key takeaway from this discussion is that the United States' capability to implement outer zone defenses—which would intercept the DF-26 IRBMs' and CJ-20 ALCMs' launch platforms—are constrained severely. For one, attacking DF-26 TELs and H-6K bombers based on mainland China is escalatory; and should the United States attempt to track and destroy these weapons systems, it is unlikely that all will be neutralized. In addition, there are considerable barriers that obstruct the United States' capability to intercept H-6K bomber aircraft during their raids: while the United States can position it's AEW&C aircraft to screen raid aircraft, supplying fighter aircraft to engage them—through either combat air patrols or generating sorties from Andersen AFB after detection—is uncertain at best. This does not suggest that possibilities to intercept raid aircraft do not exist: CAPs are possible technically, and either carrier strike groups or basing closer to mainland China might allow the sufficient sortie generation capacity to engage

[246] "H-6K."
[247] Tupler, "Perils in the Pacific," 183-184.
[248] Wilson, "China's Expanding Ability to Conduct Conventional Missile Strikes on Guam," 4.
[249] Wilson, "China's Expanding Ability to Conduct Conventional Missile Strikes on Guam," 53-55.

raid aircraft effectively. Still, this discussion highlights the considerable possibility that both ballistic and cruise missiles might leak through what would be the United States' outer defensive zone, requiring inner zone defenses to intercept missiles.

Inner Zone Defenses The United States' inner defensive zone would leverage several weapons systems to intercept leaked missiles that are in-flight toward Andersen AFB. Intercepting DF-26 IRBMs would require point-defense systems that detect, track, and engage ballistic missiles during their terminal phases, as they reenter the atmosphere from suborbital trajectories. To protect Andersen AFB specifically, the United States would layer point-defenses: likely shipborne Aegis Combat Systems, ground-based Patriot SAM systems, and ground-based THAAD systems.[250] The effectiveness of layered ballistic missile defenses (BMDs) is contingent on such variables as the number of point-defense systems the United States allocates to Andersen AFB and the number of DF-26 IRBMs China launches. However, all systems will intercept missiles successfully with probabilities of less than one.[251] It follows that for given numbers of point-defense systems, China can increase its chances of landing ballistic missiles at Andersen AFB successfully by increasing the number missiles it sends. Consider this simple illustration: if the United States' BMD systems collectively have a 0.75 probability of intercepting ballistic missiles successfully, chance they intercept one ballistic missile successfully is 0.75, whereas the probability they intercept two successfully is 0.56, and so on.[252] Two trends from this are clear. First, missile defense systems with probabilities of intercepting missiles successfully that are less than one will allow, on average, some missiles to leak. Second, the chances of missiles leaking increases as the number of missiles increase. As such, while it is uncertain how uncertain numbers of United States' point-defense systems perform against uncertain numbers of missiles, at least some of China's DF-26 IRBMs are likely to leak through this second defensive layer and land at Andersen AFB.

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[250] Wilson, "China's Expanding Ability to Conduct Conventional Missile Strikes on Guam," 15.

[251] Each point-defense system's effectiveness will vary, but as a rule, point-defense systems are less than perfectly effective.

[252] The equation used here is: $p(\text{intercept}_{\text{all}}) = 1 - (1 - p(\text{intercept})^{n})$ where $p(\text{intercept}_{\text{all}})$ is the probability that all missiles are intercepted, p(intercept) is the collective probability that the BMD systems intercept missiles (0.75 in this case), and ^{n} is the number of leaked missiles to intercept.

To intercept leaked CJ-20 ALCMs sent from China's H-6K bombers, the United States will use weapons systems with the same general defense characteristics of BMD systems. To detect and track cruise missiles for engagement, the United States prefers to use airborne rather than ground-based radars.[253] Airborne radars with look-down capabilities can detect low-flying cruise missiles easily;[254] conversely, ground-based radars have limited lines of sight relative to low-flying cruise missiles that hug the Earth's curvature, allowing less time to intercept cruise missiles after detection.[255] As such, the United States will likely use AEW&C aircraft—such as the E-8 JSTARS—to first detect and track leaked CJ-20 ALCMs.[256] For interception, the United States will likely use fighter aircraft—such as F-22s[257]—and point-defenses—such as Patriot SAM systems.[258] It is uncertain how this layered defensive scheme will perform relative to China's cruise missile raid: fighter aircraft might be unable to intercept every cruise missile they track, and point-defenses intercept cruise missiles with probabilities less than one, allowing some to leak on average. However, the same trends that characterize intercepting ballistic missiles hold true for cruise missiles: some missiles will evade past fighter aircraft and point-defenses, and the chances of that happening increase with greater numbers of missiles.

Defense Takeaways There are two key takeaways of this discussion about defending against China's ballistic and cruise missile threats toward Andersen AFB. First, outer and inner zone defenses perform both uncertainty and imperfectly. The United States might attack China's DF-26 TELs and H-6K bomber air bases, or may not to hedge against escalation; the United States may attempt to intercept China's H-6K bombers, but may be unable to due to sortie generation constraints presented by Andersen AFB's 2,000 km distance from possible CJ-20 ALCM launch points; and the United States might implement point-defenses to intercept leaked missiles that

[253] Kopp, "Defeating Cruise Missiles," 7.
[254] Kopp, "Defeating Cruise Missiles," 7.
[255] Gormley, Erickson, and Yuan, *China's Cruise Missile Ambitions*, 1-2.
[256] Kopp, "Defeating Cruise Missiles," 7.
[257] Kopp, "Defeating Cruise Missiles," 7.
[258] Wilson, "China's Expanding Ability to Conduct Conventional Missile Strikes on Guam," 15.

perform poorly due to relatively large DF-26 IRBM and CJ-20 ALCM salvos that overwhelm the United States' weapons systems. As such, the second takeaway is that some ballistic and cruise missiles are likely to leak through any defensive schemes described in this section of the analysis. The number of missiles that leak through is contingent on the performance of both China's and the United States' weapons systems—the number of missiles China can launch, and the effectiveness of the United States' outer and inner zone defenses—but it is clear that China has considerable capabilities to launch ballistic and cruise missiles toward Andersen AFB, and some are mathematically likely to land due to unlikely defenses.

Model of Ballistic and Cruise Missile Attacks

This analysis has discussed why Andersen AFB is important to the balance of power between China and the United States; how China's military strategy and capabilities threaten Andersen AFB's security; and how the United States might defend against China's ballistic and cruise attacks. While Andersen AFB once operated well outside of China's anti-access envelope, this analysis has questioned whether Andersen AFB can provide the United States "assured [basing] access" still.[259] To determine Andersen AFB's survivability relative to China's anti-access weapons systems, this analysis develops models of long-range precision-strike that target Andersen AFB's vital organs. Specifically, the models determine the damage that DF-26 IRBM and CJ-20 ALCM salvos deliver to USAF aircraft staged at Andersen AFB. As noted, the number of ballistic and cruise missiles that leak through defenses and land at Andersen AFB depends on the uncertain sizes and characteristics of both China's missile salvos and the United States' defenses. To hedge against the uncertainty, this analysis models salvos of all sizes across plausible ranges—the baseline case for CJ-20 ALCMs models 0—120 missiles, and the baseline case for DF-26 IRBMs models

[259] Gons, "Access Challenges and Implications for Airpower in the Western Pacific," 67.

0—50 missiles;[260] and of varying characteristics—the baseline case being CEPs of 12.5 m for CJ-20 ALCMs and CEPs of 50 m for DF-26 IRBMs, for example. As such, this analysis models the relationships between the numbers of leaked missiles and the numbers of aircraft rendered inoperable, on average, of missile salvos of varying sizes and characteristics. This approach is analytically valuable for at least two reasons. First, it hedges against the uncertainty surrounding long-range precision strikes that target Andersen AFB. It is unknown how many missiles China will send and how the United States' defenses will perform, which together determine the number of leaked missiles that land at Andersen AFB. In modeling missiles salvos of variable sizes, this analysis determines not how many missiles might leak, but rather the damage delivered by plausible numbers of leaked missiles. Second, this approach determines how missile salvos vary by missile characteristics. Specifically, it performs sensitivity analyses by modeling salvos that include missiles of varying warheads, CEPs, and yields. As such, this approach controls for uncertainty surrounding the quality of China's weapons systems.

Modeling Approach There are at least two ways to model ballistic and cruise missile salvos that target openly parked aircraft. The first involves using the CEP and lethal radii of missiles to determine the probability that missile salvos of given sizes will destroy given targets.[261] One key limitation to this method is its failure to account for collateral damage: one missile might fail to kill its target but kill another instead.[262] To hedge against this limitation, the second approach—which this analysis employs—simulates where missiles are likely fall relative to given targets, and what damage those missiles then deliver to *all* targets, for missile salvos of given sizes and characteristics. This analysis leverages randomness across many iterations—an approach referred

[260] The CJ-20's baseline high estimate of 120 missiles is justified by the possibility that China uses one regiment of 20 aircraft with six weapons each to raid, which was discussed previously. The DF-26's baseline high estimate of 50 missiles is justified by Heginbotham et al., who use 50 IRBMs as the lower of two figures during simulations of attacks on Andersen AFB's runways. See Heginbotham, "The U.S.-China Military Scorecard," 48, 55-65.

[261] See the survival probability equation (0.5 ^ (n * (RL / CEP) ^ 2)) and justification at from Qui Yong, used by Gons 2011, at: Qiu Yong, Preliminary Study on the Threat of Precision Strike Conventional Weapons to Nuclear Weapons, (International Network of Engineers and Scientists Against Proliferation), http://www.inesap.org/sites/default/files/inesap_old/bulletin17/bul17art17.htm.

[262] For the purposes of this analysis, "kills" refer to outcomes in which the target is rendered inoperable. Aircraft need not be destroyed altogether, but rather, must lose their operational capacity at a minimum.

to as the Monte Carlo method[263]—to determine the average or expected damage of given missile salvos. To simulate missile salvos, this analysis developed one computer science tool that uses missile characteristics—such as CEPs and warhead variants—to simulate the process of missiles falling on air bases relative to their targets. Running the simulation many times allows the tool to determine, on average, the damage that those missiles deliver to air base assets—in this case, openly parked aircraft.[264] This subsection will review the tool's component parts that explain determinative characteristics of ballistic and cruise missile attacks.

First, the tool selects targets randomly and assigns them to leaked missiles. This assumes that the United States does not know which target China has sent each missile toward, meaning that one leaked missile can land at any targets not already selected and assigned. This is the case in practice: the United States does not know which targets the cruise missiles it intercepts are heading toward, and China does not know which cruise missiles will be intercepted and thus which targets leaked cruise missiles will hit. Second, the tool determines where each missile falls relative to its target by selecting radii and angles from the target's center; the tool uses normal distributions from the missiles' CEPs and random integers between one and 360 for the missiles' angles.[265] Missiles are assigned GPS coordinates with their radii and angles relative to their targets' GPS coordinates. Third, the tool asks each target whether it falls within the lethal radius of any leaked missiles. Lethal radii are determined by the warhead variants and yields of missiles. Unitary warheads deliver one relatively large high explosive blast from yields that are on the order of around 500 kg for ballistic and cruise missiles. High explosives of given yields deliver overpressures that diminish with distance from their blast centers; to extrapolate the lethal radii of given yields for given targets, the tool determines the maximum distance that the minimum overpressure required to kill that target travels from the blast center. For example, openly parked aircraft are

[263] For more information on the Monte Carlo method in a similar application, see: Heginbotham, "The U.S.-China Military Scorecard," 59.
[264] The tool is written in the Python computer programming language. The tool's code is available at https://github.com/drewleonard/gov90-monte-carlo.
[265] For inspiration for and justification of this method, see: Heginbotham, "The U.S.-China Military Scorecard," 59.

killed by overpressures of around 20 kilopascals (kPa); yields of 450 kg deliver 20 kPa up to 30 meters from the center of the blast.[266] Should any unitary warhead missiles fall closer to given targets than those warheads' lethal radii, the target is marked as killed. Differently, submunition warheads distribute many small bomblets across circular footprints of varying dimensions. Similar to Stillion and Orletsky and Gons, this analysis assumes that bomblets eject fragments outwardly to kill their targets.[267] The lethal radius of each small bomblet is then a function of the sensitivity of openly parked aircraft to the bomblet's distribution of fragments (determined by its yield). Three pound bomblets distribute eject fragments such that aircraft parked within about eight meters would be killed.[268] The tool assumes that bomblets are distributed without overlap throughout the entire submunition footprint, and dives the footprint's area by the collective area that the bomblet's lethal radii cover to determine the probability that targets within the footprint are killed. The tool measures the expected number of aircraft killed by missiles equipped with submunition warheads by adding the likelihoods that targets that fall within given numbers of submunition footprints are killed. Fourth, the tool repeats this process of simulating missiles falling around their targets and counting the number of aircraft killed many times for each number of leaked missiles within given ranges to determine how many aircraft missile salvos of different sizes would kill. The tool uses GPS coordinates and variable missile characteristics supplied explicitly, allowing it to model ballistic and cruise missile attacks against different air bases, against different targets, and with different characteristics.

Modeling Results This analysis finds five key takeaways from simulations of DF-26 IRBM and CJ-20 ALCM attacks against aircraft parked openly at Andersen AFB. First, relatively few ballistic and cruise missiles equipped with submunition warheads render relatively large numbers

[266] Value calculated by the author using the "cube rule." For information on the "cube rule," see: Gons, "Access Challenges and Implications for Airpower in the Western Pacific," 235-236. For overpressure data for parked aircraft and other air base assets, see: Yong, "Preliminary Study on the Threat of Precision Strike Conventional Weapons to Nuclear Weapons."

[267] Stillion and Orletsky, *Airbase Vulnerability*, 12-13, Gons, "Access Challenges and Implications for Airpower in the Western Pacific," 235-236.

[268] Value comes from converting 29 feet to eight meters. See Gons, "Access Challenges and Implications for Airpower in the Western Pacific," 235-236.

Figure 01

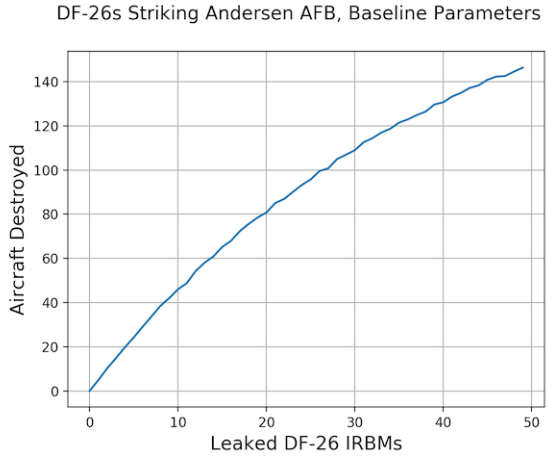


Figure 02

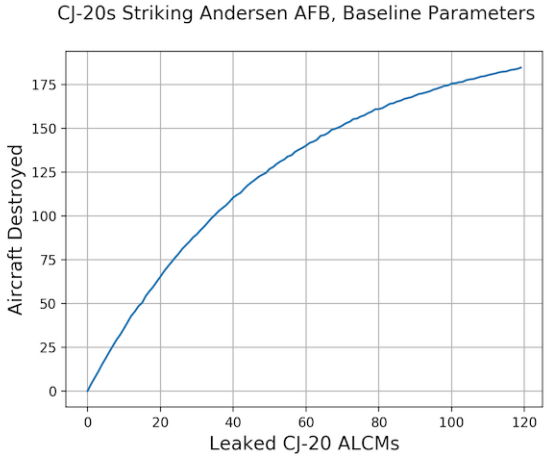


Figure 03

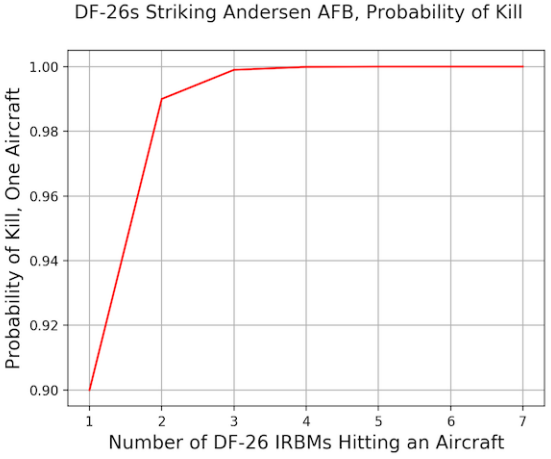


Figure 04

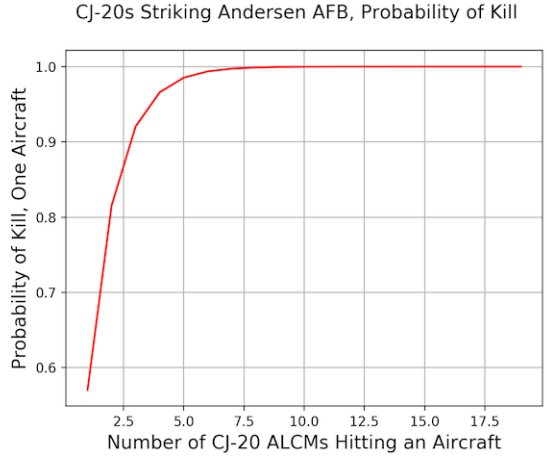


Figure 05

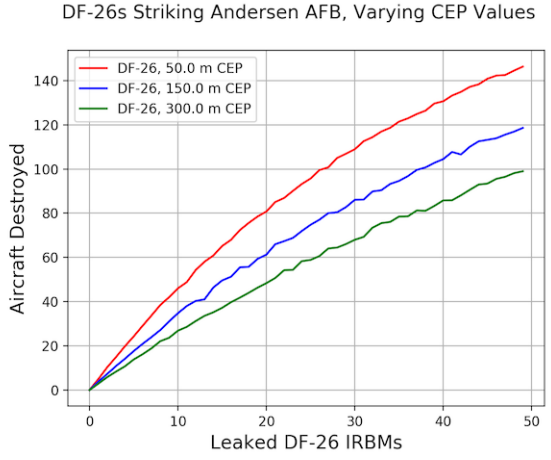


Figure 06

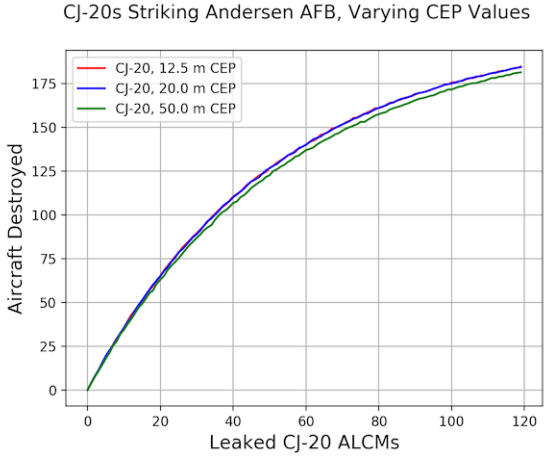


Figure 07

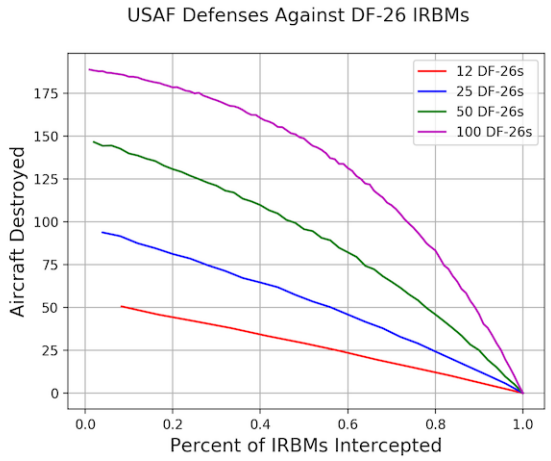


Figure 08

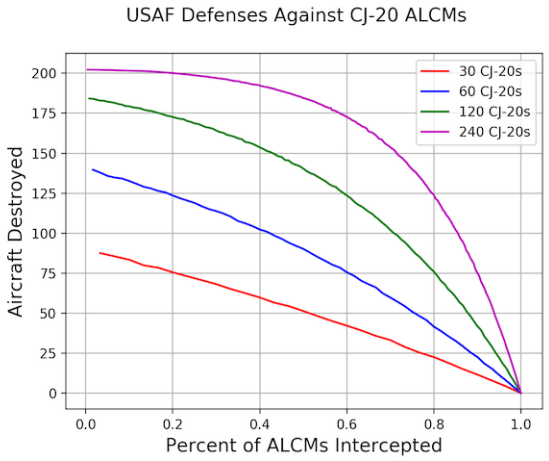


Figure 09

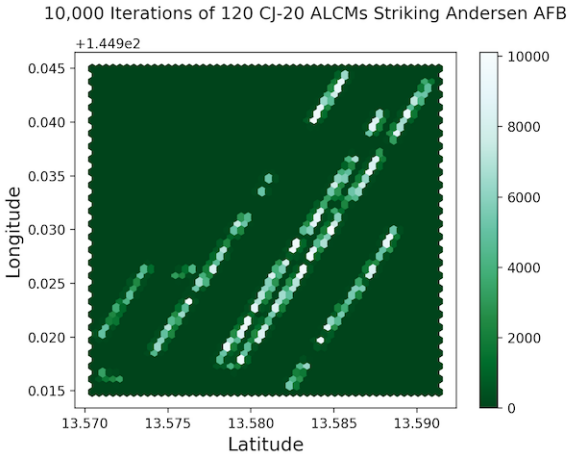
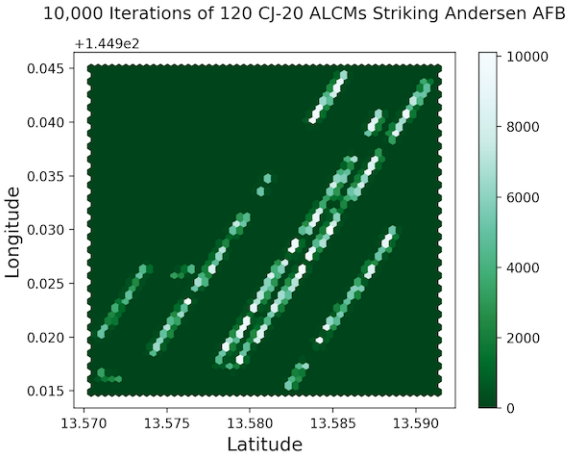


Figure 10



of aircraft inoperable (see Figure 01 and Figure 02). About three DF-26 IRBMs or three CJ-20 ALCMs render 15 aircraft inoperable; about 20 DF-26 IBRMs or 25 CJ-20 ALCMs render 80 aircraft inoperable; and about 45 DF-26 IRBMs and 60 CJ-20 ALCMs render 140 aircraft inoperable. Due to their similar payloads and submunition footprint lethal radii, both DF-26 IRBMs and CJ-20 ALCMs perform alike and effectively. Should China land less than ten ballistic or cruise missiles at Andersen AFB's parking area from salvos of dozens or hundreds, over at least thirty aircraft would be rendered inoperable.

Second, both DF-26 IRBMs and CJ-20 ALCMs yield diminishing returns—with the number of aircraft rendered inoperable as the metric—as parking spots are saturated with missiles. Due to the relatively large diameter and high kill probability of the missiles submunition footprints, aircraft are rendered inoperable quickly and with high probabilities by only few numbers of missiles (see Figure 03 and Figure 04). Accordingly, China can achieve relatively high chances of rendering given numbers of aircraft inoperable by saturating parking spots with relatively few numbers of missiles.

Third, whether CEP values are low or high affects the performance of both DF-26 IRBMs and CJ-20 ALCMs minimally during attacks against openly parked aircraft (see Figure 05 and Figure 06). This is likely due to large submunition footprints that are likely to blanket several aircraft independent of the location missiles land: should missiles fall far from their targets, they are likely to fall near other aircraft still. To be sure, DF-26 IRBM CEP values matter more (see Figure 05). However, should the DF-26 IRBM have an actual CEP value of 300 m—which estimate is the maximum of the range that Heginbotham et al., present[269]—DF-26 IRBM salvos will still be relatively destructive.

[269] Heginbotham, "The U.S.-China Military Scorecard," 48.

Fourth, the United States' defenses must perform very effectively to hedge against both DF-26 IBRM and CJ-20 ALCM salvos (see Figure 07 and Figure 08). Should the United States intercept 90 percent of a salvo of 20 DF-26 IRBMs, about 15 aircraft are likely to be rendered inoperable; should the United States intercept 90 percent of a salvo of 60 CJ-20 ALCMs, about 20 aircraft are likely to be rendered inoperable. It is important to note that as the numbers of missiles in either DF-26 IRBM or CJ-20 ALCM salvos increase, the United States is required to intercept increasingly high percentages of missiles to protect the same number of aircraft. Intercepting 90 percent of salvos of 30 and 120 CJ-20 ALCMs results in necessarily different numbers of aircraft rendered inoperable, for example.

Fifth, the locations of parking spots matter during ballistic and cruise missile attacks. Aircraft that are more densely parked (i.e., aircraft parked near greater rather than fewer numbers of other aircraft) are more likely to sustain damage than aircraft that are less densely parked, due to the overlap of missiles' submunition footprints (see Figure 09 and Figure 10). This might be expected, but it highlights the importance of dispersal when parking aircraft.[270] While this analysis models missile salvos that target Andersen AFB's most dispersed parking spots, many aircraft would be parked in Andersen AFB's large rectangular parking areas that can park more aircraft in smaller areas. As such, attacking these areas would likely require relatively fewer numbers of missiles to damage relatively larger numbers of aircraft.

Operational Implications At least two operational implications follow from this analysis. First, relatively small sizes of DF-26 IRBM and CJ-20 ALCM salvos might degrade the United States' capability to achieve air superiority considerably during conflicts against China. Recent analyses suggest that operating from Andersen AFB alone would produce an at least contested battle for the air space over Taiwan.[271] This analysis does not assess how many aircraft China would need

[270] Bowie, "The Anti-Access Threat and Theater Air Bases," v.

[271] For conflicting outcomes about the battle for air superiority over Taiwan's airspace, see e.g., Eric S. Gons, "Access Challenges and Implications for Airpower in the Western Pacific," (PhD diss., Pardee RAND Graduate School, 2010),

to render inoperable to obstruct the United States' capability to achieve air superiority, but it is either possible or likely that ballistic or cruise missile attacks will threaten the United States' control of the skies should the USAF lose large numbers of aircraft. Recent models of air superiority battles over Taiwan's airspace suggest that the USAF would lose little to none of its technologically advanced F-22 aircraft during combat against China's fourth-generation fighter aircraft.[272] As China's anti-access doctrine highlights, smart solutions to this balance of power might be to target F-22 or other USAF fighter aircraft when they are staged on the ground.[273] The results of this analysis modeling substantiate this idea: should China send ballistic and cruise missile salvos toward Andersen AFB prior to or soon after hostilities start, it might be able to render dozens of fighter aircraft inoperable, rather render relatively few inoperable during conflict. Second, defending against the ballistic and cruise missile threats will be relatively difficult. Indeed, expecting the United States' defenses to intercept over 90 percent of missiles to still lose over two dozen or more aircraft during expected salvos of expected sizes suggests that the threat might require different solutions than intercepting missiles only. Should China launch its salvos from DF-26 IRBM TELs and H-6K bombers, Andersen AFB might well be indefensible using operational capacity as the metric. Whether the United States is able to minimize the damage is one factor of this equation, but more important is whether the United States can minimize damage against Andersen AFB's portfolio of assets sufficiently such that it maintains sufficient sortie generation capabilities during missions in the Asia-Pacific region.

Josh S. Tupler, "Perils in the Pacific: Assessing American Air Power Projection over Taiwan and the South China Seas," (Undergraduate Senior Thesis, Dartmouth College, 2016).

[272] See e.g., Eric S. Gons, "Access Challenges and Implications for Airpower in the Western Pacific," (PhD diss., Pardee RAND Graduate School, 2010), Josh S. Tupler, "Perils in the Pacific: Assessing American Air Power Projection over Taiwan and the South China Seas," (Undergraduate Senior Thesis, Dartmouth College, 2016), 95-96.

[273] Cliff, *Entering the Dragon's Lair*, 81.

Conclusion

This analysis demonstrated first that Andersen AFB is central to the balance of power between China and the United States, as both nations would prioritize it during serious conflicts against one another; second, that China's military doctrine and expanded anti-access envelope threaten Andersen AFB's security considerably; third, that the United States will have significant difficulties defending against China's DF-26 IRBM and CJ-20 ALCM threats with both "outer zone" and "inner zone" systems; and fourth, that China's weapons systems would render large numbers of aircraft parked openly at Andersen AFB inoperable should relatively few missiles leak through the United States' defenses. In addition, this analysis has discussed potential operational implications for the United States' air superiority capabilities generally and Andersen AFB's sortie generation capabilities specifically during conflicts against China. To be clear, this analysis has not drawn conclusions about whether China's long-range precision strike capabilities prevent the United States from altogether achieving air superiority during conflicts against China. Doing so would require reviewing the United States' capabilities to hedge against the ballistic and cruise missile threat—this might involve intercepting China's IRBM and ALCM launch platforms, layering active defenses such as point-defense weapons systems, and employing passive defenses such as scrambling aircraft once the United States has detected incoming missiles. Each of these might allow the United States to minimize the numbers of missiles that leak and land at Andersen AFB, and as such, the threat might be less severe than this analysis's modeling suggests. However, this analysis explains that China's anti-access envelope has extended to Andersen AFB, and uses Monte Carlo simulations demonstrate that only small numbers of leaked missiles are required to mete out large amounts of damage. To conclude the analysis, this section will first review modeling caveats and areas for future research. Then, it will discuss broader foreign policy implications for the United States and the Asia-Pacific region.

Caveats and Future Research

Modeling Caveats The tool presented in this analysis performs well at its task: modeling missile salvos of given sizes and characteristics against air base assets. However, the tool has at least two limitations that future work should improve. First, the tool is not yet able to discriminate fully between assets on air bases during simulations of missile salvos. Specifically, the tool cannot yet model how attackers might target different assets that allow air bases to generate sorties—partially-buried fuel tanks or aircraft shelters, for example. Attackers are likely to spread their missiles salvos across various air base assets, as destroying one vital organ of an air base might be enough to prevent it from generating sorties. It follows that this model should be able to simulate attacks on all air base assets rather than parking areas only. This improvement would allow simulations to discriminate between different aircraft parking structures as well (one large aircraft across several spots, for example). Making this improvement would require changing the tool's method for assigning missiles to given targets, at least. Second, the tool does not yet model submunition footprints accurately. Specifically, the tool assumes that bomblets are distributed without overlap throughout the submunition footprint; and the tool distributes cruise missile bomblets circularly rather than rectangularly. Each of these might skew the probability that aircraft within the submunition footprint are rendered inoperable. It is uncertain whether correcting these errors would alter the performance of cruise missiles equipped with submunitions in attacks against air bases. However, modeling footprints accurately might allow future research to arrive at more robust conclusions about how to best use cruise missiles to attack parking areas or how to best defend against them.

Future Research Future work should prioritize three key research areas to further understand the extent of China's anti-access threat to Andersen AFB and its implications for the United States' military strategy generally. First, researchers should identify how the United States' outer and inner zone defenses might perform relative to China's weapons systems. While this analysis

has reasoned through the number of missiles China might send toward Andersen AFB, it does not model the number of missiles that will likely leak through the United States' defenses. Rather, it skips this stage and instead models the damage given numbers of leaked missiles deliver. Future work should identify whether the United States can diminish the numbers of cruise missiles that leak and land at Andersen AFB through defensive schemes. In addition, future research might determine whether the United States can neutralize China's IRBM and ALCM launch platforms—TELs and H-6Ks—before they send missiles toward Andersen AFB. For TELs, this might involve sending air-to-surface missiles toward various locations on China's mainland; for H-6Ks, this might involve launching surface-to-surface missiles toward China's bomber air bases. Second, researchers should identify how the United States can leverage passive defenses to protect Andersen AFB's assets during ballistic and cruise missile attacks. Specifically, researchers should determine whether scrambling aircraft, parking aircraft in hardened aircraft shelters, or dispersing aircraft across wider parking areas or nearby airfields would provide the United States reasonable defensive measures against China's anti-access weapons systems. Researchers can improve the tool presented in this analysis to simulate ballistic and cruise missile attacks against mock air bases that feature these characteristics to determine whether any might allow the United States to effectively weather missile salvos. Third, researchers should identify the operational implications for China's anti-access threats to Andersen AFB. This analysis suggests that China is able to degrade Andersen AFB's sortie generation capabilities considerably, but does not determine whether the mix of the United States' defenses would might minimize this threat sufficiently to allow the United States to achieve air superiority in the Asia-Pacific region still.

Responses to the Anti-Access Threat

Analyses note that Andersen AFB's strategic value to the United States is its sortie generation capabilities relative to China's anti-access threat. While Kadena AB's shorter distance to likely flashpoints might allow the United States to achieve air superiority more decisively or

with fewer aircraft, its position within China's anti-access envelope reduces its strategic value so much so that using it to generate sorties during conflicts will produce uncertain outcomes at base. Should anti-access threats imperil Andersen AFB's operational capabilities similarly, as this analysis suggests, it is important to determine how the United States can respond to maintain its offensive edge in the Asia-Pacific region.

There are three general options available. First, the United States can fall back to base still further outside of China's anti-access envelope—which operational concept endowed Andersen AFB's strategic value prior to China's DF-26 IRBM and CJ-20 ALCM developments. This is difficult due to the likely operational implications that basing outside of China's anti-access envelope would entail. Given that China can send DF-26 IRBMs and CJ-20 ALCMs at least 4,000 km from its mainland, generating sorties from secure bases would likely not be possible due to either the length of the flights fighter aircraft would make to likely flashpoints, the number of additional tankers required to supply fighter aircraft enough fuel to fly the distance, or both. Second, the United States can continue to operate from at Andersen AFB and leverage either active or passive defenses to secure its access. Given that operating more at locations more backward than Andersen AFB is difficult and unlikely, the United States might prioritize this option. As mentioned, future research should identify whether there are plausible active or passive defensive measures available to the United States to continue operating from or near Andersen AFB. Third, the United States might attack mainland China to degrade the PLA's anti-access weapons systems, among other targets, such that the United States can deny China access to its asymmetric capabilities. In practice, this might be the United States' best option to maintain basing access and air superiority capabilities during conflicts against China. While basing from Andersen AFB rather than attacking mainland China hedges against escalation, doing so at the expense of the United States' capability to prevail in battles might degrade Andersen AFB's strategic value considerably. To be sure, smart strategy might be both basing at Andersen AFB

and attacking mainland China: the two are not mutually exclusive. However, the latter might be necessary for the former.

While this analysis does not present definitive conclusions about the United States' access to Andersen AFB, it does suggest that its position within China's anti-access envelope degrades its strategic value to the United States considerably. As such, the United States might no longer be able to prevail in conflicts against China without attacking its anti-access weapons systems, at least. While this approach is escalatory, it may be the only option available to the United States should basing at or behind Andersen AFB be implausible. The United States operational concept to neutralize China's anti-access weapons systems to hedge against its asymmetric advantages—JAM-GC—might then be a valuable part of the United States' power projection capabilities.

Foreign Policy Implications

While this analysis does not draw definitive conclusions about the United States' sortie generation or air superiority capabilities, it demonstrates that China's expanded anti-access envelope at least introduces considerable uncertainty about the United States' capabilities to protect its allies during conflicts against China. Whether China will successfully carry out bomber raids or whether the United States' defenses prove effective against ballistic missiles salvos, for example, is unknown. As such, there are at least two implications for the United States' foreign policy that follow from this analysis. First, the United States' security umbrella is less secure than it was prior to China's expanded anti-access envelope, and as such, the Asia-Pacific region might become less secure. Specifically, allies that feel insecure due to the United States' uncertain power projection capabilities might begin to field new weapons or posture aggressively to protect their vital interests. Doing so would reduce regional stability, as states that increase their own security might make others feel less secure in turn. To be sure, this dynamic is already playing out in the Asia-Pacific region: China's force modernization, which the CCP claims is intended to protect

China's vital interests rather than threaten others, has caused China's neighbors to feel decreasingly secure. Second, should anti-access weapons systems proliferate and the United States' forward air baes globally become insecure, the United States' power projection capabilities would diminish considerably. This analysis has substantiated the idea that the United States' basing access in the Asia-Pacific region, and thus capability to fulfill its allied commitments, is either threatened significantly or at least uncertain. This is principally a function of China's new long-range precision strike capabilities. While the United States' adversaries had highly limited ballistic and cruise missile capabilities after the Cold War, both weapons systems are considerably higher in quality today. As such, the possibility that states can threaten the United States' basing access by using relatively inexpensive and long-range missiles might not be limited to China. Should Andersen AFB become considerable insecure and enveloped by China's anti-access weapons systems, the trend might threaten the United States' forward presence globally. This analysis questioned whether the United States can operate sufficiently backward to base outside of feasible anti-access threats. Previous analyses have indicated that operate any *more* backwardly would constrain the United States' power projection capabilities in the Asia-Pacific region considerably. As such, this analysis raises serious questions about what basing options will be available to the United States in future years, and whether those will be sufficiently robust to allow the United States to maintain its global presence.

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Appendix

For the code used to simulate missile strikes, see the following GitHub Repository:

https://github.com/drewleonard/gov90-monte-carlo