FEATURE

Revised Maritime Spacepower Theory

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Abstract

This article introduces a novel spacepower theory that draws inspiration from maritime concepts. Unlike previous theories that categorized space elements into brown space or blue space, this theory presents four distinct elements: brown space, green space, blue space, and terrestrial effects. Instead of focusing exclusively on one element, this article emphasizes the collective use of these elements to effectively harness spacepower for achieving national objectives. Drawing on historical maritime precedence, the article explores how maritime theories have been applied to spacepower concepts and introduces the revised maritime spacepower theory. The new facets of this theory are summarized and applied to the ongoing space weaponization debate, demonstrating how the theory reveals relevant nuances to facilitate consensus among divergent perspectives. The intended outcomes of this theory are to aid spacepower advocates in effectively communicating spacepower to broader audiences, support policy makers in regulating space development, and inspire space strategists to creatively apply spacepower to achieve national objectives.

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The United States has long leveraged spacepower to attain its national goals. The Department of Defense's *Defense Space Strategy* succinctly defines *spacepower* as "the sum of a nation's capabilities to leverage space . . . activities in peace or war in order to attain national objectives."[1] To effectively organize and employ spacepower, a foundational framework is provided by spacepower theory. In line with this objective, the United States demonstrated its commitment to preserve spacepower by reactivating the US Space Command (USSPACECOM) and establishing the US Space Force (USSF) in 2019.[2] Despite the advancements made by these organizations, the absence of a unified theory hinders the informed utilization of spacepower to realize national objectives.

Currently, spacepower theories usually fall into either the "brown water" or "blue water" models, terms borrowed from maritime applications. The debate between proponents of these theories has become polarized, with each side considering the

[1] *Defense Space Strategy* (Washington, DC: Department of Defense, June 2020), https://media.defense.gov/.

[2] US Space Command Public Affairs, "US Space Command Recognizes Establishment," USSPACECOM.mil, 9 September 2019, https://www.spacecom.mil/; and Department of Defense, "Department of Defense Establishes U.S. Space Force," 20 December 2019, https://www.spaceforce.mil/.

other as part of the problem.[3] Brown water advocates express concerns that the implementation of blue water thinking will result in exorbitant costs and disregard the necessary support for space operations on Earth. On the other hand, blue water proponents perceive their brown water counterparts as lacking innovation and impeding the realization of spacepower's full potential.

The existing division between these two camps poses a significant obstacle to making meaningful progress in the field of spacepower. To paraphrase Abraham Lincoln, a Space Force divided cannot stand.[4] Compounding the issue, par-ticipants exacerbate this divide by employing different definitions, leading to mis-communication, which is further intensified when weapons come into play. Without a substantial effort to bridge this gap, both perspectives will encounter challenges in fostering innovation and advancing US spacepower. Ironically, this debate revolves around a false dichotomy, obscuring opportunities for collaboration and progress.

Space development must not be limited to the confines of brown water or blue water concerns alone. It is crucial to consider both perspectives when formulating policies and strategies. Moreover, there are four distinct perspectives that should be independently developed and collectively applied to ensure the effectiveness of space operations: "brown space," "blue space," "green space," and "terrestrial effects." These perspectives draw upon maritime experiences and are adapted to the space domain by considering factors such as operating location, purpose, and capability. By embracing these multifaceted perspectives, a comprehensive and robust approach to space development and operations can be achieved.

This article presents an enhanced maritime spacepower theory that provides clear definitions and practical guidance for effectively applying spacepower. The historical origins of this analogy in maritime practices will be explored, examining the usage of brown water, blue water, and green water ships. By gaining insights into how the US Navy developed and utilized brown, blue, and green water thinking, we can establish more precise applications to spacepower.

Next, the article critically examines previous maritime spacepower theories, emphasizing their limited focus on specific aspects of spacepower. Then, a comprehensive spacepower framework is developed, incorporating brown, green, and blue space thinking. This framework considers the spacecraft's operational environment, mission objectives, and design characteristics. Additionally, the influence of terrestrial effects on space operations is carefully analyzed and integrated.

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[3] Brent Ziarnick, "The Battle for the Soul of the Space Force," *The Hill*, 23 August 2019, https://thehill.com/.

[4] Abraham Lincoln, "A House Divided Speech," 16 June 1858, in *Collected Works of Abraham Lincoln*, ed. Roy P. Bassler, posted on National Park Service website, 10 April 2015, https://www.nps.gov/.

Subsequently, the article applies this framework to the contentious subject of space weaponization, illustrating how tailored policies can effectively safeguard the space environment while ensuring the protection of vital space assets. Finally, the article concludes with practical recommendations on leveraging this theory, demonstrating how each component aligns with national policy objectives, and outlining areas that warrant further research.

By presenting this revised maritime spacepower theory, this article aims to foster a deeper understanding of spacepower dynamics, promote coherence in military space operations, and guide strategic decision making in the space domain.

Origins of Maritime Analogy

Before delving into the development of a maritime spacepower theory, it is crucial to gain a thorough understanding of the maritime origins of blue, brown, and green water within their original contexts. The US Navy classifies rivers and estuaries as *brown water*, the open ocean as *blue water*, and coastal waters as *green water*.[5] These designations are visually derived, reflecting the characteristics of each region.

Brown water primarily encompasses rivers, inlets, and bays that are situated close to the shore. To illustrate this concept, figure 1 portrays the Bristol Channel, which effectively exemplifies brown water in its central location.[6]

On the other hand, blue water regions correspond to the deeper expanses of the open sea, such as the Atlantic Ocean west of the United Kingdom. These areas are characterized by vast stretches of uninhibited water.[7]

Green water serves as a transitional zone between brown and blue water, predominantly found near coastlines.[8] An illustrative instance of this region is the English Channel, clearly depicted at the bottom of figure 1.

The terminology associated with these water regions extends to the types of vessels operating within each area. Blue water ships refer to ocean-going vessels, brown water craft navigate within brown water regions, and green water ships operate in the areas that bridge the two domains.

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[5] *Naval Operational Concept: Implementing Maritime Strategy* (Washington, DC: Department of the Navy, 2010), 8, https://irp.fas.org/.

[6] "Brown water." Merriam-Webster.com Dictionary, Merriam-Webster, accessed 14 March 2023, https://www.merriam-webster.com/; and Diptarka Ghosh, "Bristol Channel," *WorldAtlas*, 25 March 2021, https://www.worldatlas.com/.

[7] Philip Babcock Gove, ed., *Webster's Third New International Dictionary of the English Language Unabridged* (Springfield, MA: Merriam-Webster Inc, 1993), 242.

[8] Gove, ed., *Webster's Third New International Dictionary*, 947.

Figure 1. Visual depiction for blue, brown, and green water[9]

While a visual derivation may suggest a range-based definition for naval capabilities, it is crucial to recognize that the operating regions play a significant role in driving mission and structural distinctions among naval vessels operating within these areas. This section aims to shed light on the operational and design variances exhibited by brown, blue, and green water vessels.

The US Navy's development of brown and blue water vessels during the Barbary Wars and US Civil War serves as a historical reference point, highlighting the evolution of these capabilities. Subsequently, the article will shift its focus to green water craft, which emerged in the early 2000s as the US Navy addressed emerging threats and expanded its mission scope. Additionally, one must acknowledge the influential role played by land forces operating at ports and along the coastline, as they exert significant impact on naval operations. The article will also consider this region in its analysis.

Rather than exclusively relying on a single element, it is imperative to harness the collective potential of each element to effectively achieve national objectives.

[9] Jamie Harris, "Nasa photo reveals UK as seen from the International Space Station," *Irish Independent*, 17 April 2019, https://www.independent.ie/.

By integrating and leveraging the strengths of brown, blue, and green water capabilities, a comprehensive approach can be adopted to address the diverse challenges and opportunities in the maritime domain.

Early US History

In early US history, naval vessels operating in different types of water demonstrated operational and design differences, playing crucial roles in achieving national objectives. Although the US initially sold off its navy, the nation embarked on a rebuilding effort from 1794 to 1798 to protect its merchant ships in the Mediterranean Sea.[10] As former colonies, the US had relied on the British Royal Navy for protection, but with American Independence, this support ceased. To safeguard their commercial interests from European powers and Barbary pirates operating far away, the US constructed six super frigates These impressive three--masted vessels, exceeding 150 feet in length, were specifically designed to challenge the largest naval ships of that era.[11] Serving as the early blue water fleet, these heavy frigates were capable of safely traversing the open seas and defending against other naval vessels.

Simultaneously, the US developed brown water vessels known as the Jefferson gunboats to combat the pirates. President Thomas Jefferson requested these cost-effective ships as a means of coastal defense. While some gunboats sank during their Atlantic crossings, their relatively small size and shallow draughts allowed them to navigate shallow waters and rivers, reaching the North African coastline to engage pirate forts.[12] The Jefferson gunboats exemplified early American brown water capabilities due to their operating environment, physical construction, and intended purpose. The United States required both blue and brown water capabilities to defeat the Barbary pirates and protect its interests overseas.

Decades later, the American Civil War demanded the deployment of uniquely designed naval vessels to secure victory. President Lincoln had two primary objectives for the US Navy: blockading Southern ports to disrupt resupply and supporting army campaigns along the Mississippi River.[13] Blue water naval ships implemented the Anaconda Plan to enforce the blockade, while brown water gunships were developed to patrol the Mississippi River. Blue water vessels had to withstand

[10] Naval History and Heritage Command, "The Establishment of the Department of the Navy," US Navy, 13 November 2017, https://www/history.navy.mil/.

[11] Roger Archibald, "Six Ships that Shook the World," *American Heritage of Invention & Technology* 13, no 2 (Fall 1997), 24, https://www.inventionandtech.com/.

[12] Donald Canney, *Sailing Warships of the US Navy* (Annapolis, MD: Naval Institute Press, 2001), 196.

[13] American Battlefield Trust, "The Navies of the Civil War," 2023, https://www.battlefields.org/.

deep-sea conditions, operate for extended periods, and disrupt Confederate maritime activities. Frigates and Sloops of War were well-suited for this mission, possessing the ability to navigate the open seas and bring substantial firepower against the Confederacy.[14]

During the Civil War, the Union Navy utilized the blockade to disrupt Confederate sea lines of communication and "fracture Confederate distribution and sustainment."[15] Meanwhile, river steamers were converted into gunboats to support brown water operations along the Mississippi River.[16] These gunboats possessed the ability to navigate riverways and were armed to deliver effects inland. According to historical accounts, the brown water fleet "had as much effect in reducing the South to submission as the greater battles fought in the East."[17] Despite the significance of their contributions, President Lincoln's brown water navy faced challenges in competing for naval funding against the traditional blue water fleet. Blue water sailors and officers derisively referred to the gunboats as "stinkpots" and "turtles," considering them unfit for true naval professionals. Furthermore, brown water commanders often received more support from the Army than the Navy.[18] In response, naval officers developed different tactics and perspectives to optimize the use of these distinct capabilities. Similar to the Barbary Wars, the United States needed to employ both capabilities—blue water and brown water—to achieve success in the Civil War.

Contemporary Era

In the 1990s and 2000s, the US Navy faced nontraditional threats from smaller state and nonstate actors and needed "to develop greater flexibility and a broader range of missions and tasks than in the past."[19] In addition to defensive operations, preventative noncombat activities and enduring relations with partner nations became increasingly important.[20] Green water operations actively focused on critical and congested coasts in the Mediterranean, Red, and Arabian Seas, as well

[14] Mike Barhorst, "A Brief Overview of the US Navy in the Civil War," *Sidney Visitors Bureau*, 2020, http://sidneycivilwar.org/.

[15] Eric Schuck, "Economic Warfare: The Union Blockade in the Civil War," *Naval History*, October 2021, https://www.usni.org/.

[16] Gary Joiner, *Mr. Lincoln's Brown Water Navy: The Mississippi Squadron* (Lanham, MD: Rowman & Littlefield Publishers Inc, 2007), 23.

[17] Joiner, *Mr. Lincoln's Brown Water Navy*, 175.

[18] Joiner, *Mr. Lincoln's Brown Water Navy*, 22–23, 29.

[19] W. L. Greer et al., "Green Water Navy Study," Institute for Defense Analyses, September 2009, ES-1.

[20] Greer et al., "Green Water Navy Study," ES-1.

as throughout the waters in Southeast Asia.[21] Research concluded that green water craft were most effectively designed to be large enough to safely traverse the high seas and reach operating areas, while also being small enough to operate in coordination with partner nation patrol craft to support naval operations in the area. However, the smaller size of green water craft does necessitate more frequent resupply. Vessels of this size fulfill unique roles along contested coastlines, actively securing operations in close proximity to shore and coastal defenses.

Green water vessels occupy a distinctive space between brown water and blue water ships due to their shared mission of sea control with blue water ships and their operational presence in similar waterways as brown water ships. The US Navy often combines the terms *brown water* and *green water* and refers to them collectively as *littoral regions* in joint doctrine. Littoral regions consist of two components: the seaward element, which encompasses the maritime boundary from the shore to the open ocean, and the landward element, which represents the physical land supported by maritime elements.[22] Brown water operations support the landward component, while green water operations support the seaward component. Although modern naval ships have the capability to undertake both landward and seaward missions, it is still important to recognize the independent strategies of brown water and green water vessels and tailor their operations accordingly.

Furthermore, it is crucial to acknowledge the unique role of green water ships, even though blue water vessels historically fulfilled this role in the 1800s. Modern blue water vessels, such as aircraft carriers, tend to avoid confined or restrictive bodies of water along an adversary's littoral.[23] Additionally, the emergence of asymmetric capabilities, including explosive-laden suicide boats, has pushed expensive blue water vessels away from contested littoral regions.[24] In contrast, smaller green water craft were purposefully designed to bridge the gap between brown water and blue water ships, enabling them to maintain sea control in contested littoral regions against naval and coastal threats.

Although land effects do not possess direct maritime capabilities, they still exert influence on maritime operations and are intertwined with coastal defenses and land-based supporting functions. Responding to sea power, states and nonstate

[21] Greer et al., "Green Water Navy Study," 6.

[22] Joint Publication 2-01.3*: Joint Intelligence Preparation of the Operational Environment (*Washington, DC: Joint Chiefs of Staff, 21 May 2014), GL-06, https://irp.fas.org/.

[23] Joint Publication 2-01.3, III-11.

[24] Neil Gadihoke, "Blue-Water Navies in Brown-Water Operations," *SP's Naval Forces*, May 2012, https://www.spsnavalforces.com/.

actors often prioritize the development of coastal defenses, making them the easiest and earliest effects to be established. The US Navy has historically dealt with coastal installations during the Barbary Wars and the Civil War, and continues to consider coastal installations in green water regions such as the South China Sea.[25] To effectively patrol nearby waters, naval vessels must take into account threats originating from land. While this may seem obvious, one of the challenges with the US Navy's Littoral Combat Ships is that they were not designed to withstand hits, and their inadequate design limits their effectiveness in the face of coastal threats.[26]

In addition to coastal threats, land effects also contribute to maritime operations in various ways. Lighthouses and long-range radars enhance maritime domain awareness, enabling the safety, security, economy, and environmental protection of a nation's maritime domain.[27] Furthermore, shipyards are crucial for the construction of ships, and ports serve as vital hubs for vessel resupply, facilitating sustained operations abroad. The absence of these land-based functions in and around friendly coasts would severely hamper maritime operations. Therefore, maritime theories, including any resulting spacepower theories, must consider the terrestrial effects that influence domain operations.

Throughout US history, four distinct components—brown water, green water, blue water, and coastal effects—have shaped and informed maritime operations. Each component covers a specific region and serves a particular purpose, with systems specifically designed for their respective locations and missions. Moreover, the US consistently employs a combination of these components to achieve national objectives. As the maritime usage of brown, green, and blue water extends beyond a simple range from the shore, it is essential for these terms to carry nuanced meanings when applied to space operations theory.

Past Maritime Spacepower Theories

Harold Winton, a military theorist, establishes the purpose of theories, stating that they define the field of study, categorize its elements, explain unique phenomena, connect the field to other fields, and anticipate future behavior within

[25] Associated Press, "China has fully militarized three islands in South China Sea, US admiral says," *The Guardian*, 20 March 2022, https://www.theguardian.com/.

[26] Emma Salisbury, "Lessons from the Littoral Combat Ship," *War on the Rocks*, 15 November 2021, https://warontherocks.com/.

[27] Joint Publication 3-32*: Joint Maritime Operations (*Washington, DC: Joint Chiefs of Staff, 20 Sep 2021), GL-6, https://www.jcs.mil/.

the field.[28] When applied to spacepower, Winton argues that a theory should define spacepower, categorize its elements, explain unique phenomena, connect spacepower to other fields, and anticipate future behavior. This section examines existing maritime spacepower theories and utilizes Winton's framework to demonstrate that only partial integration of maritime aspects into spacepower has been achieved.

James Oberg first applied elements of Mahan's seapower theory to spacepower in his book *Space Power*.[29] However, it was in Everett Dolman's controversial work, *Astropolitik*, that the first comprehensive treatment of Mahan was presented. Dolman highlighted Mahan's perspective on British seapower, which was based on controlling chokepoints along critical sea routes, and drew an analogy to the potential control and exploitation of space by dominating access to low Earth orbit.[30] Dolman argued that spacepower holds the key to national wealth and preeminence in the twenty-first century, much like seapower did in the nineteenth century.[31] While *Astropolitik* established a connection between spacepower and seapower, it fell short in categorizing the elements of spacepower within the field, limiting its ability to project this theory forward. Nevertheless, Dolman's controversial work encourages further contemplation on spacepower. John Klein's *Space Warfare* builds upon Dolman's ideas and expands on the maritime spacepower analogy.

In Klein's *Space Warfare*, blue water perspectives are applied to spacepower as he describes the importance of maintaining freedom of action in space amid great-power competition, which he terms the *command of space*. Command of space entails the unrestricted utilization of space while denying adversaries the same ability.[32] Klein draws inspiration from the renowned naval strategist Julian Corbett when introducing the concept of controlling *celestial lines of com-mu-nication*.[33] A state achieves command of space when it can utilize these lines of communication while simultaneously preventing opponents from doing the same. This concept bears similarity to blue water activities in naval operations. Blue water navies were essential in securing sea lines of communication for US merchant ships during the Barbary Wars. Similarly, blue water vessels were utilized in the

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[28] Harold Winton, "An Imperfect Jewel: Military Theory and the Military Profession," *Journal of Strategic Studies* 34, no. 6 (December 2011), 854–56.

[29] Jim Oberg, *Space Power Theory* (Colorado Springs, CO: Government Printing Office, 1999), 137–38.

[30] Everett Dolman, *Astropolitik: Classical Geopolitics in the Space Age* (Portland, OR: Frank Cass Publishers, 2002), 37–39.

[31] Dolman, *Astropolitik*, 183.

[32] John Klein, *Space Warfare: Strategy, Principles, and Policy* (New York: Routledge, 2006), 156.

[33] Klein, *Space Warfare*, 51.

Civil War to blockade Southern ports, denying sea lanes of communication to the Confederacy. While Klein's theory of space warfare aligns well with blue space activities, it does not adequately address the utilization of space systems once a state achieves command of space.

Bleddyn Bowen's *War in Space* is another spacepower theory that builds on a maritime analogy. Bowen presents a compelling theory on how space can support terrestrial operations, stating, "Spacepower exists within a geocentric mindset."[34] He argues that states utilize space to enhance their interests on Earth and employ all instruments of power to achieve their objectives. This aligns with brown water missions, where space systems support other domains, similar to how brown water ships support land operations. Command of space enables states to further pursue their interests on Earth and maintain power in space. Bowen also introduces the concept of geocentric orbits as a cosmic coastline with hostile shores that necessitate strategic maneuvers.[35] This reinforces the brown water analogy and highlights the fact that opponents can contest space from Earth's surface. Space organizations, such as the USSF, are responding to this threat by proliferating Earth orbits with smaller, more affordable satellites instead of relying solely on large flagships.[36] However, Bowen's theory falls short as it downplays the significance of space superiority and the potential for space capabilities beyond geocentric orbits. While decisive blue water battles may be rare, nations without blue water capabilities were unable to project power during the age of sail. Similarly, disregarding the importance of blue space capabilities could leave a state incapable of projecting power as others compete for space resources.[37]

Each of the previous maritime spacepower theorists contributes to spacepower thinking by focusing on specific aspects of spacepower. However, they fail to consider all elements of spacepower. Furthermore, discussions among spacepower advocates, policy makers, and strategists often revolve around the idea that only one aspect of spacepower is necessary. Defense hawks advocate for weaponizing space to achieve command of space, while arms controllers seek to prevent space weaponization and limit space activities to supporting terrestrial operations.[38] In

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[34] Bleddyn Bowen, *War in Space: Strategy, Spacepower, Geopolitics* (Edinburgh, UK: Edinburgh University Press Ltd, 2020), 49.

[35] Bowen, *War in Space*, 115.

[36] Chris Gordon, "Saltzman Unveils 'Theory of Success' as Space Force Debates Future," *Air & Space Forces Magazine*, 22 February 2023, https://www.airandspaceforces.com/.

[37] Namrata Goswami and Peter Garretson, *Scramble for the Skies: The Great Power Competition to Control the Resources of Outer Space* (London, UK: Lexington Books, 2020) 20.

[38] William Broad, "How Space Became the Next 'Great Power' Contest Between the U.S. and China," *New York Times*, 24 January 2021, https://www.nytimes.com/.

contrast, policy makers and strategists utilize all elements of maritime power to achieve national objectives. Similarly, space development should not be restricted to solely addressing brown space or blue space concerns. All perspectives of spacepower must be considered when formulating policies and strategies. Since a spacepower theory has yet to incorporate all spacepower elements, a new maritime space theory is proposed in the next section that incorporates four distinct perspectives, each requiring consideration for effective space operations. These perspectives draw upon the rich history of maritime operations and are adapted to space by considering operating regions, purposes, and designs.

Revised Maritime Spacepower Theory

This section revises a maritime framework for space operations by identifying four unique categories—brown space, green space, blue space, and terrestrial effects—with three distinct subsets: region, purpose, and design. Following Winton's framework, this theory aims to provide a definition of spacepower and categorize its elements. Spacepower refers to the ability of a state or non-state actor to accomplish tasks in space.[39] This spacepower theory applies to all space operations, past, present, and future, and classifies activities based on their region, purpose, and design. By differentiating activities along these lines, a better understanding of the necessity, utilization, and interaction of these assets with terrestrial and space operations can be gained. Finally, the proposed maritime theory anticipates the evolution of spacepower, enabling policy makers and strategists to effectively manage its development.

The first category is brown space, which draws analogies from brown water. Brown space systems are those that orbit a celestial body, serve a mission supporting operations on that celestial body, and are designed to utilize Kepler's laws to fulfill their mission. Brown water space, or simply brown space, refers to the orbital region surrounding a celestial body. Currently, this is defined as geocentric orbits since space operations predominantly serve Earth's population. In the geocentric sense, low Earth orbit (LEO), medium Earth orbit (MEO), highly elliptical orbit (HEO), and geosynchronous Earth orbit (GEO) are all prime locations for brown space operations due to their orbital relationship with Earth. While it is easier to conceptualize brown space in relation to Earth, future brown space applications could extend to other celestial bodies, such as the Moon or Mars, if they fulfill all three subsets. In addition to orbiting the celestial body, the spacecraft is designed

[39] Brent Ziarnick, *Developing National Power in Space: A Theoretical Model* (Jefferson, NC: McFarland & Company, 2015) 13.

to support operations on that celestial body. For Terran brown space, common missions include satellite communications, intelligence, surveillance, and reconnaissance, precision navigation and timing, environmental monitoring, and missile warning.[40] Brown space systems resemble brown water ships as both operate along their respective coastlines to deliver effects to other domains. While brown water navies' gunboats deliver effects inland, brown space systems deliver effects to the terrestrial domains of land, sea, air, and cyber. Moreover, brown space systems are purpose-built for Bowen's cosmic coastline as they adhere to Kepler's laws of planetary motion to operate and achieve the intended effects.[41]

Intelsat-901 serves as a commercial satellite communications spacecraft operating in the brown space category.[42] This geocentric satellite facilitates communication for users on Earth. It leverages Kepler's three laws of motion and the unique properties of geostationary earth orbit within GEOs to maintain a fixed ground track, making it easily accessible for terrestrial users.[43] To ensure its orbit remains precise, Intelsat-901 has a planned fuel budget. Once the fuel is depleted, the satellite is placed in a graveyard orbit to minimize the risk of collisions in GEO. Intelsat-901 qualifies as a brown space satellite because it orbits a celestial body (Earth), supports operations on Earth (SATCOM), and adheres to Kepler's laws to fulfill its mission. Notably, in early 2020, Intelsat-901 faced challenges in independently performing its mission due to the inability to maintain its designated orbit. However, Mission Extension Vehicle-1 (MEV-1), a green space satellite, prevented its decommissioning.[44]

The second category is green space, encompassing systems that operate around a celestial body and its moons to support space operations in the vicinity. Green space systems prefer Keplerian orbits but require more frequent maneuvering compared to their brown space counterparts. Their primary mission objectives often necessitate maneuvers to deliver desired effects. Like green water craft, green space systems operate in the vicinity of their respective coastlines and deliver effects within their domains. Green water vessels secure congested and contested coasts

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[40] Joint Publication 3-14*: Space Operations (*Washington, DC: Joint Chiefs of Staff, 2020), I-2, https://www.jcs.mil/.

[41] Bowen, *War in Space*, 114–15.

[42] Gunter D. Krebs, "Intelsat-9 (901, 902, 903, 904, 905, 906, 907)," *Gunter's Space Page* (blog), 2023, https://space.skyrocket.de/.

[43] Jerry Sellers, et al., *Understanding Space: An Introduction to Astronautics*, 3 ed. (New York: McGraw-Hill Companies Inc., 2005), 164.

[44] Meghan Bartels, "Ailing Intelsat satellite begins new life in orbit after historic servicing mission success," *Space.com*, 17 April 2020, https://www.space.com/.

to stabilize maritime operations, while green space vessels enhance space operations along the congested cosmic coastline.

An example of a green space asset is Northrup Grumman's Mission Extension Vehicle-1 (MEV-1), which operates in geosynchronous orbit, generates space effects, and incorporates additional thrust capability to service multiple spacecraft.[45] MEV-1 successfully docked with Intelsat-901 and relocated the satellite to a new operational position. Furthermore, MEV-1 will perform orbital maintenance maneuvers for the satellite duo, extending Intelsat-901's operational lifespan by another five years.[46] Despite sharing the same orbital regime as Intelsat-901, MEV-1's purpose and design differ significantly. Green space systems, including MEV-1, deliver effects within space, while brown space systems deliver effects to other domains. MEV-1 played a crucial role in preserving freedom of action for brown space systems, much like green water craft promote freedom of action along coasts. Thus, even though they operate in the same region, brown and green space systems possess distinct perspectives due to their distinct purposes, analogous to how brown and green water vessels serve different purposes in a littoral region.

The next category, known as blue space, aims to ensure freedom of action in cislunar space and beyond. Blue space systems operate beyond planetary orbits, support space operations, and ideally have flexibility beyond traditional Keplerian motion. Like their blue water counterparts, blue space systems are designed to operate remotely and conduct extended operations in new locations. These operating locations may include heliocentric orbits centered around the sun or potentially interstellar space in the future.[47] Navigating blue space requires different maneuvering designs. For instance, while Hohmann transfers efficiently adjust orbital altitudes in geocentric orbits, the propellant requirements for a blue space system to perform such maneuvers would exceed the spacecraft's orbital insertion capability. Current interplanetary spacecraft, like the Voyager spacecraft, utilize gravity-assist trajectories by leveraging the gravitational pull of nearby planets to increase velocity.[48]

Although the number of existing blue space systems is limited, advancements in propulsion technology can enhance the feasibility of blue space systems. Concepts such as nuclear fission rockets significantly improve thrust capabilities, reducing flight time between celestial bodies and increasing the likelihood of interplanetary

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[45] Vicki Cox, "Companies demonstrate groundbreaking satellite life-extension service," Northrup-Grumman, 26 February 2020, https://news.northropgrumman.com/.

[46] "Intelsat 901 at 332.5°E" (fact sheet, Intelsat, 2020), https://www.intelsat.com/.

[47] Sellers, *Understanding Space*, 223.

[48] Sellers, *Understanding Space*, 252.

travel.[49] Regardless of the propulsion designs that mature first, the purpose of blue space systems remains centered around exploration, expansion, exploitation, and exclusion.[50] Presently, blue space systems explore the solar system, while commercial entities develop capabilities for creating settlements, expanding into space, and utilizing space resources. As blue space capabilities continue to expand, the potential for conflict between state and nonstate actors increases, and efforts to exclude competitors can be expected. Independent thinking and proactive development of technologies and strategies are crucial for this perspective to effectively utilize blue space systems as capabilities mature.

The final category is terrestrial effects. Terrestrial effects originate from a celestial body and fulfill a mission to support space operations. Identifying terrestrial effects is straightforward as they originate on a celestial body and interact with spacecraft. These effects stem from various domains, including land, sea, air, and cyber, and are among the simplest systems to operationalize in terms of developing space capabilities. Rockets play a critical role in delivering spacecraft to orbit, serving as the initial step before satellites can operate in other regions. However, terrestrial effects encompass more than just rockets and launch infrastructure.

Ground-based space surveillance sensors, such as telescopes and radars, are utilized to track brown and green space systems orbiting the Earth.[51] Ground sites like spacecraft operations control centers and data reception sites also contribute to terrestrial effects by ensuring that satellite constellations meet their mission objectives.[52] Moreover, there exist Earth-based weapons. An early example is the nuclear tests conducted by the United States in 1962 to assess the impact of a nuclear explosion in space.[53] Although not intended as space weapons, the resulting radiation degraded several satellites.[54] The first deliberate destructive antisatellite test was carried out by the Soviet Union in 1968. Subsequently, the United States, China, India, and Russia have conducted a total of 16 antisatellite tests.[55]

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[49] Ronald Humble, Gary Henry, and Wiley Larson, *Space Propulsion Analysis and Design* (New York: McGraw-Hill Companies Inc, 1995) 446.

[50] Joshua Carlson, *Spacepower Ascendant: Space Development Theory and a New Space Strategy* (US: Independently Published, 2020) 175.

[51] Joint Publication 3-14*, ix*.

[52] Wiley Larson and James Wertz eds., *Space Mission Analysis and Design*, 3rd ed. (El Segundo, CA: Microcosm Press and Springer, 2006) 624.

[53] Defense Technical Information Center, *A "Quick Look" at the Technical Results of Starfish Prime, AD-A955 411* (Fort Belvoir, VA: Defense Technical Information Center, 1962), 10, https://apps.dtic.mil/.

[54] Gilbert King, "Going Nuclear Over the Pacific," *Smithsonian Magazine*, 15 August 2012, https://www.smithsonianmag.com/.

[55] Daryl G. Kimball, "U.S. Commits to ASAT Ban," *Arms Control Today*, May 2022, https://www.armscontrol.org/.

Additionally, denial and deception techniques, electromagnetic jammers, cyber-attacks, and directed energy lasers can deliver a range of effects to geocentric spacecraft.[56] Terrestrial effects encompass a broad array of capabilities that both enable and contest freedom of action for spacecraft.

Table 1. Description of maritime space categories

	Region	Purpose	Design
Terrestrial Effects	Land, Sea, Air, Cyber	Space Focused	N/A
Brown Space	Geocentric Orbits	Terrestrially Focused	Kepler Constrained
Green Space	Geocentric & Cislunar	Space Focused	Kepler Preferred
Blue Space	Cislunar & Heliocentric	Space Focused	Unconstrained

The four maritime space categories differentiate based on region, purpose, and design, as summarized in table 1. When determining the most suitable category for a space system, each subset is prioritized. The first consideration is the region, followed by the spacecraft's purpose. Observers should be able to classify spacecraft into the appropriate categories based on the operating region and observed behavior. However, observed behavior alone does not exclusively determine the spacecraft's purpose. Clues from the spacecraft's design provide further insights for differentiation. For instance, if a spacecraft exhibits characteristics of a brown space function but is excessively equipped with propulsion, power, and attitude control, it may indicate an additional purpose. Moreover, the design subset should be seen as a spectrum, where terrestrial effects or green space capabilities might be poorly applied to function as a blue space capability for interplanetary travel. While such systems may offer limited capabilities to less advanced space powers, they would not compare favorably to intentionally designed blue space systems. Despite this nuanced understanding, the categorization and subsets enable observers to quickly classify and prioritize spacecraft while gaining an understanding of how space systems operate. The next section explores how this differentiation could be applied to enhance space policy and strategy.

Theory Applied to the Weapons Debate

This section focuses on how a revised maritime space theory brings clarity to space policy by addressing the controversial topic of space weapons. After examining relevant treaties, we will explore the major positions in the debate. Subsequently, we will apply the revised maritime spacepower theory to demonstrate

[56] National Air and Space Intelligence Center, *Competing in Space* (Dayton OH: Defense Intelligence Agency, December 2018), 14, https://media.defense.gov/.

how groups can collaborate to safeguard space assets and preserve the geocentric space environment.

The Outer Space Treaty and the proposed Treaty on the Prevention of the Placement of Weapons in Outer Space fail to effectively prevent adversaries from posing threats or causing harm with space weapons. The Outer Space Treaty of 1967 is notable for its ratification by 113 countries. Article IV of the treaty explicitly prohibits "nuclear weapons or any other kinds of weapons of mass destruction" in space or on celestial bodies in any form.[57] However, the treaty does not prohibit the use of other weapons in, to, or from space. Since 1967, antisatellite weapons have been tested and used to threaten space systems.[58] A new treaty—the Prevention of the Placement of Weapons in Outer Space Treaty—has been proposed to restrict the placement of weapons in outer space, but it possesses significant flaws. Specifically, the treaty fails to limit the production, testing, and deployment of weapons actively being developed by its main proponents, Russia and China. [59] As the current and proposed international treaties do not adequately address the escalating threat of weaponized space, policy makers and strategists are engaged in a debate on how to manage the space domain.

Political scientist Karl Mueller has skillfully framed the debate by emphasizing the challenges surrounding the definition of a space weapon and presenting a nuanced spectrum of viewpoints ranging from prosanctuary to proweaponization. First, there is no consensus on the definition of a space weapon. Mueller identifies key considerations for defining a space weapon, including its location, potential targets, attack mechanism, type of effect, and whether the effect extends to other systems.[60] Progress in the weaponization debate should address each of these aspects. Second, advocates of prosanctuary and proweaponization hold diverse beliefs influenced by their worldview, perspectives on international relations, and nationalistic tendencies.[61] Thus far, using partial maritime spacepower frameworks has failed to yield consensus, but the proposed maritime spacepower theory holds the potential to provide a resolution.

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[57] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (Outer Space Treaty), United Nations, New York, 10 October 1967, 2, https://www.nti.org/.

[58] Joel Gehrke, "Russia Threatens Elon Musk's Starlink Satellites," *Washington Examiner*, 27 October 2022, https://www.washingtonexaminer.com/.

[59] "US Ambassador Robert Wood to Conference on Disarmament Plenary Meeting on Agenda Item Three, 'Prevention of an arms race in outer space'" (press statement, US Mission Geneva, 14 August 2019), https://geneva.usmission.gov/.

[60] Karl Mueller, "Totem and Taboo: Depolarizing the Space Weaponization Debate," *Astropolitics* 1, no. 1 (Summer 2003), 6–8.

[61] Mueller, "Totem and Taboo," 9.

First, it is crucial to achieve a clear understanding of space weapons. The revised maritime spacepower theory can be utilized to elucidate the weapon's location and potential targets by applying the four categories. *Terrestrial effects* encompass Earth-based weapons that target space-based systems. *Brown space weapons* refer to space-based weapons that impact Earth. *Green space weapons* denote space-based weapons that affect brown and green space systems. Lastly, *blue space weapons* are designed to target blue space systems in interplanetary regions. These four categories naturally classify space weapons and facilitate more nuanced discussions. With this theory, policy makers and strategists can evaluate whether a decision should apply to all space weapons or a specific category.

Furthermore, the four maritime space categories have implications for the attack mechanism, the type of effect, and the level of discrimination expected from a particular space weapon. Theoretically, a space weapon is employed to harm or damage a space system through kinetic, nonkinetic, reversible, or irreversible means. The category of the space weapon is likely to dictate its practical deployment.

There are similarities between terrestrial effects and green space weapons in that they both target geocentric spacecraft. Terrestrial effects extend to geocentric orbits, a realm where friendly, neutral, and adversary spacecraft routinely traverse. Consequently, those who employ terrestrial effect weapons should minimize debris generation to prevent collateral damage and preserve the space environment for the freedom of action of friendly and neutral entities. The same principle applies to green space weapons as they impact the same geocentric region. Terrestrial and green space weapons that deviate from this category are prime candidates for prohibition through treaties or international norms, as they do not benefit any long-term space user.

Brown space weapons are distinct in that they are employed against terrestrial targets. These weapons could prove valuable in a joint operation, especially in situations where access to land, sea, and air domains is denied. However, it is important to note that brown space systems traverse a cosmic coastline, regularly crossing over friendly, neutral, and adversary countries. Consequently, brown space weapons are likely to face opposition from prosanctuary advocates and moderate proweaponization advocates who prioritize stability in international relations. This opposition may lead to a consensus to restrict or ban brown space weapons.

In contrast, blue space weapons are designed to cover vast distances and operate in a less crowded region of space. Prosanctuary advocates are unlikely to garner enough consensus to ban all blue space weapons, as there is no compelling reason to do so beyond philosophical or moral concerns. The deployment of a blue space weapon does not inherently destabilize international relations since most countries have yet to field blue space systems. The issue of arms control for blue space

weapons may gain more traction when states believe they have the capability and interest in deploying such systems.

Given the broad categorization of space weapon types, there is potential for prosanctuary and proweaponization advocates to find common ground in banning terrestrial and green space weapons that cause damage to the space environment. Other proweaponization advocates can develop policies to limit terrestrial and green space weapons to those that can selectively target potential objects in geocentric orbits without generating debris. Additionally, states could invest in debris removal systems that can clean up the space environment during peacetime operations and, if necessary, eliminate adversary systems in wartime scenarios. This approach allows states to develop the means to protect and defend their space capabilities while preserving the space environment. Such a capability promotes the responsible use of space, and could influence international norms of behavior.[62] Although some nations may still pursue the development and use of terrestrial and green space weapons that generate debris, they would face greater resistance from the international community if non–debris-generating weapons are developed and responsibly demonstrated.

By developing a nuanced capability, arms controllers and space controllers have something of value. Arms controllers would appreciate the ability to restrain weapon development and mitigate space debris, while space operators would benefit from the capability to protect spacecraft from both debris and other space-based threats. Finding a nuanced solution may be the only way to achieve consensus on space policy that endures across different administrations with varying perspectives on space weapon concepts.

Applying the revised maritime spacepower theory to the debate on space weaponization enables policy makers and strategists with opposing views to engage in a clearer discussion and explore unique solutions while upholding international commitments. This framework allows policy makers to regulate weapon development based on specific categories instead of pursuing a one-size-fits-all approach.

Recommendation

This maritime spacepower theory establishes four categories—brown space, green space, blue space, and terrestrial effects—that apply to all space operations. Differentiating space activities based on operating region, purpose, and spacecraft

[62] *Tenet Derived Responsible Behaviors in Space* (Washington, DC: Office of the Secretary of Defense, February 2023), 4, https://media.defense.gov/.

design enhances our understanding of the need for distinct categories, the utilization of spacecraft types, and their interactions in both terrestrial and space operations. Spacepower advocates can employ this framework to communicate space capabilities to wider audiences and establish connections between abstract space concepts and maritime operations.

Further research should be conducted to examine how innovation can be applied to each element. The distinct categories of space operations offer opportunities for innovators to advance capabilities in unique ways that leverage the specific environments. Brown, green, and blue space thinking present different constraints for developers to harness. For example, brown space capabilities can support terrestrial operations related to the celestial body in orbit. In the case of Earth operations, space-based solar power could be a potential brown space capability to enhance terrestrial operations. This concept involves geocentric satellites collecting solar energy and transmitting it to terrestrial collectors.[63] Future green space systems could focus on debris mitigation or on-orbit refueling, utilizing geocentric satellites to achieve space-focused effects. Lastly, blue space research could concentrate on developing new propulsion systems to revolutionize blue space capabilities.

The proposed theory also carries strategic implications, necessitating further analysis to explore a variety of space strategies that incorporate all categories of spacepower. One approach could involve continuing brown space support to bolster national power while enhancing green space capabilities to preserve freedom of action, with dedicated research directed toward the development of new blue space technologies. While the mentioned approach may prove advantageous for advanced space powers, other space powers may benefit from different strategies. For instance, a country with a limited budget could prioritize the development of niche capabilities in specific elements of spacepower and establish partnerships with other nations. By forming collective partnerships, each member can secure their national objectives. The ideal combination of spacepower elements can differ significantly between countries and in various scenarios. Therefore, conducting further research to propose diverse combinations of space power elements, along with their corresponding advantages, would be invaluable for policy makers and strategists.

Furthermore, the suggested maritime theory anticipates the evolution of spacepower, offering policy makers and strategists a valuable tool to proficiently oversee its development. Like maritime power, spacepower achieves maximum effectiveness

[63] Sarah Gerrity and Daniel Wood, "Space Based Solar Power," US Department of Energy, 2014, https://www.energy.gov/.

when all categories are taken into account and utilized to bolster grand strategy. Focusing solely on brown space or blue space is suboptimal. Instead, strategists and policy makers should embrace all four elements of maritime spacepower and devise approaches that blend them harmoniously to enhance the accomplishment of national objectives. By employing the framework provided by the four elements of maritime spacepower, debates can be clarified, and significant avenues for progress can be explored. ✪

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