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One Small Step: Anticipatory Diplomacy in Outer Space

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Summary

The $350 billion space industry could grow to more than $1 trillion by 2040, spurring international interest in harnessing space resources. But this interest will bring with it a challenge: while existing international agreements like the Artemis Accords promote the peaceful and shared exploration of celestial bodies, they do little to address differences between existing scientific research activities and emerging opportunities like lunar mining, particularly for water ice at polar latitudes and in the perpetually shaded depths of certain craters. Lunar water ice will be a vital resource for outer space exploration and development efforts because it can be used to make hydrogen fuel cells, rocket fuel, and drinking water for astronauts. It will also be cheaper than transporting water from Earth's surface into outer space, given the moon's lower surface gravity and proximity to human space operations on its surface and beyond. The moon harbors other valuable long-term commodities like helium-3, the fuel needed for low-emissions nuclear fusion energy.

However, current multilateral agreements do not address whether nongovernmental operators can claim territory on celestial bodies for their use or own the resources they extract. Further, the space object registration process is currently used for satellites and other spacecraft while in orbit, but it does not include space objects intended for use on the surface of celestial bodies, such as mining equipment. These gaps leave few options for the United States or other Artemis Accords nations to resolve conflicts over territorial claims on a celestial body. In the worst-case scenario, this increasing competition for resources—especially with other major space powers like China and Russia—could escalate into military conflict.

Adopting new treaties or amendments to the existing Outer Space Treaty (OST) for modern space use is a slow process that may fail to meet the urgency of emerging space resource issues. However, the United States has another diplomatic avenue for faster action: revision of the existing United Nations' Guidelines for the Long-term Sustainability of Outer Space under the auspices of the U.N. Committee on the Peaceful Uses of Outer Space (COPUOS). Such a process avoids the decade-long deliberations of a formal treaty amendment. The United States should thus lead the development of multilateral protocols for extracting resources from celestial bodies by proposing two updates to either the COPUOS Guidelines, the OST, or both. First, there should be an updated registration process for all space objects, which should specify the anticipated location, timeline, and type(s) of operation to establish usage rights on a particular part of a celestial body. Second, the United Nations should establish a dispute resolution process to allow for peaceful resolution of competing claims on celestial surfaces. These strategies will lay the necessary foundation for peacefully launching new mining operations in space.

Challenge and Opportunity

Right now, outer space is akin to the Wild West, in that the opportunities for scientific innovation and economic expansion are numerous, yet there is little to no political or legal infrastructure to facilitate orderly cooperation between interested terrestrial factions. For example, any nation claiming mining rights to lunar territory is on shaky legal ground, at best: the Outer Space Treaty and the subsequent Guidelines for the Long-term Sustainability of Outer Space, promulgated by the U.N. Committee on the Peaceful Uses of Outer Space, do not provide legally sound or internationally recognized development rights, enforcement structures, or deconfliction mechanisms. If one claimant allegedly violates the territorial rights of another, what legal systems could either party use to press their case? Moreover, what mechanisms would avert potential escalation toward militarized conflict? Right now, the answer is none.

This is an unfortunate obstacle to progress given the enormous economic potential of outer space development in the coming decades. To put the potential value in perspective, the emerging $350 billion space industry

could grow to more than $1 trillion by 2040, motivating significant international interest. One potentially lucrative subset of operations is space mining, a sector valued at $1 billion today with a potential value of $3 billion by 2027. Once operational, space mining would be a valuable source of rare earth elements (e.g., neodymium, scandium, and others), 60% of which are currently produced in China. Rare earth elements are necessary for essential technologies such as electric vehicles, wind turbines, computers, and medical equipment. Additionally, in the event that nuclear fusion becomes commercially viable in the long-term future, space mining will be an essential industry for securing helium-3 (He-3), an abundant isotope found on the moon. Recent increases in fusion investment and a breakthrough in fusion research show the potential for fusion energy, but there is no guarantee of success. He-3 could serve as a critical fuel source for future nuclear fusion operations, an emerging form of energy production free of carbon emissions that could provide humanity with the means to address global climate and energy crises without losing energy abundance. The abundance of lunar He-3 could mean having access to secure clean energy for the foreseeable human future.

Furthermore, human exploration and development of outer space will require water, both in the form of drinking water for crewed missions and in the form of rocket propellant and fuel cell components for spacecraft. As it costs over $1 million to transport a single cubic meter of water from Earth's surface into low Earth orbit, extracting water from the lunar surface for use in outer space operations could be substantially more economical due to the moon's lower escape velocity—in fact, lunar water ice is estimated to be worth $10 million per cubic meter.

The space mining sector and lunar development also offer promise far beyond Earth. Our moon is the perfect "first port of call" as humanity expands into outer space. It has lower surface gravity, polar ice deposits, and abundant raw materials such as aluminum, and its status as our closest celestial neighbor make it the ideal layover supply depot and launch point for spacecraft from Earth heading deeper into our solar system. Spacecraft could be launched from Earth with just enough fuel to escape Earth's gravity, land and refuel on the moon, and launch far more efficiently from the moon's weaker gravity elsewhere into the system.

All in all, the vast untapped scientific and economic potential of our moon underscores the need for policy innovation to fill the gaps in existing international space law and allow the development of outer space within internationally recognized legal lines. The imperative for leading on these matters falls to the United States as a nation uniquely poised to lead the space mining industry. Not only is the United States one of the global leaders in space operations, but U.S. domestic law, including the Commercial Space Launch Competitiveness Act of 2015, provides the U.S. private sector some of the necessary authority to commercialize space operations like mining. However, the United States' rapid innovation has also led the way to a growing space industry internationally, and the sector is now accessible to more foreign states than before. The internationalization of the space economy further highlights the gaps and failings of the existing space policy frameworks.

Two main challenges must be addressed to ensure current governance structures are sufficient for securing the future of lunar mining. First is clarifying the rights of OST State Parties and affiliated nongovernmental operators to establish space objects on celestial bodies and to own the resources extracted. The OST, the primary governing tool in space (Figure 2), establishes that no State that signed the treaty may declare ownership over all or part of a celestial body like the moon. And despite the domestic authority bestowed by the 2015 Commercial Space Launch Competitiveness Act, the multilateral OST does not address whether nongovernmental operators can claim territory and own resources they extract from celestial bodies. Thus, the OST promotes the peaceful and shared exploration of space and scientific research but does little to address differences between research operations and new commercial opportunities like lunar mining. This leaves few options to resolve conflicts that may arise between competing private sector entities or States.

Even if domestic authorization of mining operations were sufficient, a second challenge has emerged: ensuring transparency and recordkeeping of different operations to maintain peaceful shared operations in space. Through the OST and the Registration Convention, States have agreed to inform the U.N. Secretary General of space activities and to maintain a record of registered space objects (including a unique identifier, the location and date of launch, and its orbital path). But this registration process covers space objects simply at a geospatial position in

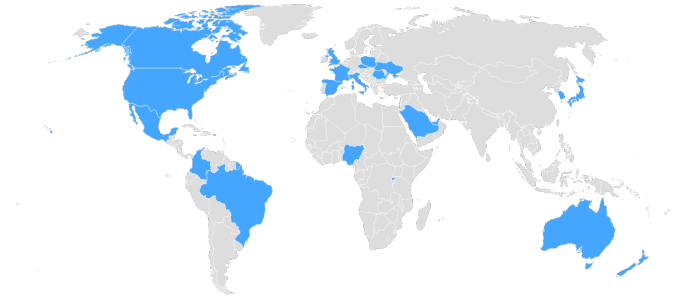
orbit, and there are gaps in the process for space objects intended for use on the surface of celestial bodies and whether a spacecraft that was designed for one purpose (i.e., landing) can be repurposed for another purpose (i.e., mining). This leaves little recourse for any group that seeks to peacefully pursue mining operations on the moon's surface if another entity also seeks to use that land.

In spite of these gaps, the U.S. government has been able to move forward with scaling up moon-related space missions via NASA's bipartisan Artemis Program and the corresponding Artemis Accords (Figure 2), a set of bilateral agreements with updated principles for space use. The Accords have 24 signatories who collectively seek to reap the benefits of emerging space opportunities like mining. In part, the Artemis Accords aim to remedy the policy gaps of previous multilateral agreements like the OST by explicitly supporting private sector efforts to secure valuable resources like He-3 and water ice.

Artemis Accords

Map showing the signatories and non-signatories of the Artemis Accords as of 8 June 2023

Signatories

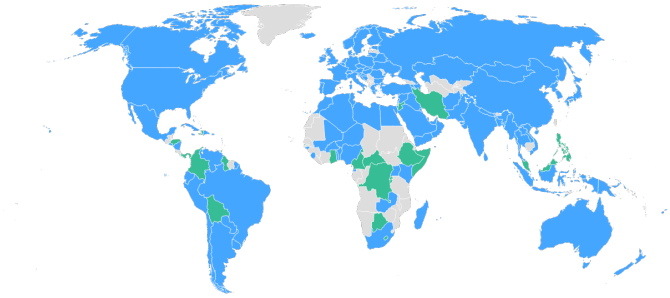


Map: Federation of American Scientists • Created with Datawrapper

Outer Space Treaty

Map showing parties and signatories to the Outer Space Treat.

Parties Signatories



Map: Federation of American Scientists • Created with Datawrapper

But the Accords do not address the key underlying challenges that could stifle U.S. innovation and leadership in space mining. For instance, while the Accords reaffirm the need to register space objects and propose the creation of safety zones surrounding lunar mining operations, gaps still remain in describing exactly how to register operations on celestial objects. This can be seen in Section 7 of the Artemis Accords, which states that space objects need to be registered, but does not specify what would classify as a "space object" or if an object registered for one purpose can be repurposed for other operations. Further, the Accords leave little room to address broader international tensions stemming from increased resource competition in space mining. While competition can have positive outcomes such as spurring rapid innovation, unchecked competition could escalate into military conflict, despite provisions in the original OST to avoid this.

In particular, preemptive measures must be taken to alleviate potential tensions with other OST signatories in direct competition with the Accords. China and Russia are not party to the Accords and therefore do not need to abide by the agreement. In fact, these nations have declared opposition to the Accords and instead formed their own partnership to establish a competing International Lunar Research Station. As these programs develop concrete lunar applications, designating methods to determine who can conduct what type of operations on specific timelines and in specific locations will be a crucial form of anticipatory diplomacy.

Plan of Action

The United States should propose that when any State registers a space object in advance of operations on a celestial body, it must specify the anticipated location of the operation; the timeline; and the type(s) of operation, described as "intent to" do one or more of the following: mine/extract resources for sale, conduct scientific

research, or perform routine maintenance. This multilaterally developed process would clarify the means to register space objects for peaceful occupation of celestial object surfaces.

Additionally, the United States should propose the implementation of a process for States to resolve disputes through either bilateral negotiation or arbitration through another mutually agreed-upon third party such as the International Court of Justice (ICJ) or the Permanent Court of Arbitration (PCA). Similar disputes related to maritime resource extraction under the United Nations Law of the Sea have been resolved peacefully using the aforementioned bilateral negotiations or third party arbitration. The new dispute resolution process would similarly allow for peaceful resolution of competing claims on celestial body surfaces and resources.

To guide the creation of a space object arbitration process, other such processes like the ICJ, PCA, and International Tribunal of the Law of the Sea can be used as models. The PCA has had success with halting unfair processes and setting up a dialogue between participating parties. It has helped smaller countries set up arbitration processes with bigger ones, such as Ecuador vs. the United States, in which the Republic of Ecuador instituted arbitral proceedings against the United States concerning the interpretation and application of an investment treaty between the two countries. In the short term, existing negotiation avenues will likely be sufficient to allow for dispute resolution. However, as the space industry continues to grow, it may eventually be necessary to establish an internationally recognized "Space Court" to arbitrate disputes. The International Tribunal for the Law of the Sea provides an example of the type of international body that could arbitrate space disputes.

These anticipatory diplomacy steps could be implemented in one of three ways:

1. As a binding amendment to the OST: This would require the most time to implement, but this would also make it enforceable and binding, an obvious advantage. It would also provide an opportunity to bring all the important players to the table, specifically the parties who did not sign the Artemis Accords, and would help to start a discussion on the improvement of diplomatic relations for future space operations.
2. As a nonbinding update to COPUOS Guidelines: This would be faster to implement, but would not be enforceable or binding.
3. As an update to the COPUOS Guidelines followed by an amendment to the OST: This would allow for both quick action in the nearer term and a permanent and enforceable implementation longer-term. Implementing a revised COPOUS could be a precursor to build support for the nonbinding updates to COPUOS. If the model is successful, State Parties would be more likely to agree to a binding amendment to OST. However they are implemented, these two proposed anticipatory diplomacy steps would improve the ability of space faring nations to peacefully use resources on celestial bodies.

Could this be done through bilateral agreements? After all, the United States has shown diplomatic initiative by entering into agreements with countries such as France, Germany, and India with the aim of using space for peaceful purposes and cooperation, though they don't explicitly mention mining. But a bilateral process does not offer good prospects for global solutions. For one, it would be very slow and time-consuming for the United States to enter into bilateral agreements with every major country with stakes in lunar mining. If space mining agreements were to occur on a similar timeline to bilateral trade agreements, each agreement could take from one to six years to take effect. A crucial obstacle is the Wolf Amendment, which prevents the United States from entering into bilateral agreements with China, one of the its major competitors in the space industry. This restriction makes it hard to negotiate bilaterally with an important stakeholder concerning space mining.

Further, reaching these agreements would require addressing aspects of the Accords that have made many major stakeholder countries hesitant to sign on. Thus, an easier path would be to operate diplomatically through the COPUOS, which already represents 95 major countries and oversees the existing multilateral space treaties and potential amendments to them. This approach would ensure that the United States still has some power over

potential amendment language but would bring other major players into some sort of dialogue regarding the usage of space for commercial purposes.

While the COPUOS guidelines are not explicitly binding, they do provide a pathway for verification and arbitration, as well as a foundation for the adoption of a binding amendment or a new space treaty moving forward. Treaty negotiations are a slow, lengthy process; the OST required several years of work before it took full effect in 1967. With many Artemis Program goals reliant upon successful launches and milestones achieved by 2025, treaty amendments are not the timeliest approach. Delays could also be caused by the fact that some parties to the OST may have reservations about adopting an amendment for private sector space use due to another space treaty, the Moon Agreement. This agreement, which the United States is not party to, asserts that "the Moon and its natural resources are the common heritage of mankind and that an international regime should be established to govern the exploitation of such resources when such exploitation is about to become feasible." Thus, countries that have signed the Moon Agreement probably want the moon to operate like a global commons with all countries on Earth having access to the fruits of lunar mining or other resource extraction. Negotiations with these nations will require time to complete.

The U.S. State Department's Office of Space Affairs, under the Bureau of Oceans and Environmental and Scientific Affairs (OES), is the lead office for space diplomacy, exploration, and commercialization and would be the ideal office to craft the required legislation for an OST amendment. Additionally, the Office of Treaty Affairs, which is often tasked with writing up the legal framework of treaties, could provide guidance on the legislation and help initiate the process within the U.S. State Department and the United Nations. Existing U.S. law like the Commercial Space Launch Competitiveness Act, and international treaties like OST and Registration Convention, provide authority for these proposals to be implemented in the short term. However, negotiation of updates to COPOUS Guidelines and amendments to the OST and other relevant space treaties over the next 5 to 10 years will be essential to their long term success.

Finally, the Federal Aviation Administration (FAA) at the Department of Transportation would be the logical federal agency to initially lead implementing the updated registration process for U.S.-affiliated space objects and for verifying the location and intended use of space objects from other nations. FAA implements the current U.S. process for space objects registration. In the long term it could be appropriate to transfer responsibility for space object registration to the rapidly growing Office of Space Commerce (OSC) at the Department of Commerce. Moving responsibilities for implementing space object registration and verification to the OSC would provide opportunities for the office to expand with the rapidly expanding space industry. This change would also allow the FAA to focus on its primary responsibilities for regulating the domestic aerospace industry.

Conclusion

Douglas Adams may have put it best: "Space is big. You just won't believe how vastly, hugely, mind-bogglingly big it is." While Adams was describing the sheer size of space, this description applies just as well to the scale of outer space's scientific and economic prospects. After all, any new economic theater that will grow into a multi-trillion dollar market in just a few decades is not to be taken lightly. But without a plan to avert and resolve potential conflicts with other outer space actors, the United States' future efforts in this emerging theater will be hamstrung. Improved collaboration on space mining provides an opportunity to promote international cooperation and economic development, while military conflict in space poses high risks to the economic potential of the current and future space industry. Transparent and widely agreed-upon frameworks would allow for peaceful competition on scientific research and resource extraction on celestial objects.

Lunar mining has shown promise for providing access to water ice, rare earth metals, He-3, and other raw materials crucial for the further exploration of space. Providing a peaceful and secure source of these materials would build on the bipartisan Commercial Space Launch Competitiveness Act's guidelines for space resource extraction and, in the long run, further enable the modernization and decarbonization of the U.S. electric grid for public benefit.

In order to promote the peaceful exploration and development of space, we must update existing international law—either the COPUOS Guidelines, the OST, or both—to clarify the locations, timeline, and types of outer space operations conducted by state actors. We must also propose deconfliction mechanisms for OST parties to resolve disputes peacefully via bilateral negotiation or arbitration by a mutually acceptable third party like the ICJ or PCA. Just as the United States led the world into the "final frontier" in the 20th century, so too must we lead the next chapter in the 21st. If implemented successfully, the anticipatory space diplomacy we propose will allow for the shared peaceful use of celestial bodies for decades to come.

Frequently Asked Questions

How much would this proposal cost?

There would be no additional cost to the recommendation outside of existing costs for diplomatic and U.N. activities. The Artemis Program is expected to cost $93 billion through 2025 and Congressional appropriators are already questioning the billion-dollar price tag for each planned launch. Thus, clarifying these legal frameworks may help incentivize private innovation and reduce launch costs. This proposal may facilitate economic benefits at virtually no extra cost. Therefore, the United States and Artemis Accords nations have a vested interest to ensure that these continuing investments result in successful missions with as few additional costs as possible. This proposal will likely also facilitate further private investment and innovation and protect against risk to investment from military conflict.

How does this proposal parallel existing international agreements?

Another similar treaty, the Antarctic Treaty of 1961, is a great example of how different countries can unite and create a dialogue to effectively manage and share a common resource. Although the region is used for various scientific purposes, all countries can do so in a peaceful and cooperative manner. This is in part because the Antarctic treaty has been systematically updated to reflect the changing times, especially concerning the environment. The OST has not undergone any such changes. Thus, updating the COPUOS would provide a means for the United States to take the lead in ensuring that space remains a common shared resource and that no country can unfairly claim a monopoly over it.

When, if ever, will nuclear fusion be viable?

Nuclear fusion is currently not commercially viable. However, significant interest and investment is currently centered around this potential energy source, and breakthroughs in the technology have been recently reported by leading researchers in the field. Access to He-3 will be critical if and when this industry is commercially viable.

How would the effectiveness of these guidelines be evaluated?

The OST currently allows State Parties to observe space flights and access equipment for any other OST State Party. One way States could use this power to ensure these guidelines are followed is for States and the COPUOS to track how many and what types of space object operations occur on celestial bodies. (The U.S. Department

of Defense already tracks over 26,000 outer space objects, but cross-referencing with COPUOS could help differentiate between debris and state objects of interest.) Interested or concerned parties could verify the accuracy of registered operations of space objects on celestial bodies led by other States, and any violations of the new guidelines could be referred to the new dispute resolution process.

In the United States, the Guidelines would be ratified in the same way as other United Nations regulations and international treaties, in the form of an executive agreement. These are directly implemented by the president and do not require a majority in the Senate to be passed but are still legally binding.

How feasible is it for an individual country to add guidelines to a United Nations treaty? Is there precedence for it?

The purpose of a neutral organization like the United Nations is to engage in meaningful dialogue between powerful countries. Since space is a common shared resource, it is best to ensure that all parties have a stage to be part of talks that deal with the sharing of resources. Suggesting guidelines to a popular treaty is a good place to start, and the United States can show leadership by taking the first step while also advocating for terms that are beneficial to U.S. interests.

All the signatories of the COPOUS meet every year to discuss the effectiveness of the treaty, and countries propose various statements to the chair of the committee. (The United States' statements from the 65th meeting of the committee in 2022 can be found here.) Although there is no obvious precedent where a statement has directly been converted into guidelines, it would still be useful to make a statement regarding a possible addition of guidelines, and one could reasonably hope it could open doors for negotiations.

How effective would the arbitration process be?

Arbitration processes such as those described in the U.N. Conventions on the Law of the Sea ensure that powerful countries are not able to dominate smaller countries or frighten them with the possibility of war. Although the verdict of the arbitration process would have to be enforced by OST States, it provides a peaceful alternative to immediate military conflict. This would at least halt disputed proceedings and give time for States involved with the dispute to gather resources and support. The existence of an arbitration process would reinforce the principle that all OST States, both small and large, are entitled to access space as an equal resource for all.

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Dr. Stephen Cutie is a bioengineer, policymaker, and former CCST science fellow in the office of California Senator Richard Pan. With a research background in heart regeneration and evolutionary biology, he earned his PhD in bioengineering from University of California–San Francisco and University of California, Berkeley. Stephen's policy work includes designing viral surveillance legislation, health committee policy analysis, and administrative budget negotiations and advising his office on health, housing, human services, environmental, and elections issues.

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FAS DAY ONE PROJECT

About the Day One Project

The Federation of American Scientists' Day One Project is dedicated to democratizing the policymaking process by working with new and expert voices across the science and technology community, helping to develop actionable policies that can improve the lives of all Americans.

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