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**CHINESE SPACE COOPERATION IN LATIN AMERICA:
IMPLICATIONS FOR UNITED STATES SPACE
SECURITY**

by

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IMPLICATIONS FOR UNITED STATES SPACE SECURITY**

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ABSTRACT

This thesis aimed to analyze Sino-LAC space cooperation to answer the following questions: what are the motivations behind Sino-LAC space cooperation, and what do the parties stand to gain? How is Sino-LAC space cooperation structured, and is China promoting long-term technological dependencies? What challenges does this pose to U.S. space security, and is U.S. space policy effectively responding to regional Chinese proliferation within the space domain? Ultimately, LAC countries seek Chinese space cooperation for two primary reasons: the need to acquire Chinese-built space capabilities to benefit national socioeconomic development or for mutual technological development to achieve sovereign space autonomy. This thesis argues that in relation to the less-developed space nations, China uses space cooperation as one tool to control developing economies and as a method to exert its geopolitical influence within the western hemisphere. In relation to the major-developed space nations, China uses space cooperation to advance its space capabilities in the western hemisphere. In both cases, China mostly designs Sino-LAC space cooperation to foster long-term space engagements and potential dependencies while promoting China's international space projection goals. Furthermore, this thesis concludes that a threat to U.S. space security due to Sino-LAC space cooperation is feasible, and that U.S. space policy is not appropriately implemented to predict, detect, and deter such a concern.

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LIST OF ACRONYMS AND ABBREVIATIONS

ABAE	Bolivarian Agency for Space Activities (Agencia Bolivariana para Actividades Espaciales)
ABE	Bolivian Space Agency (Agencia Boliviana Espacial)
AEB	Brazilian Space Agency (Agência Espacial Brasileira)
APOSOS	Asia-Pacific ground-based Optical Space object Observation System
APSCO	Asia-Pacific Space Cooperation Organization
ARSAT	Argentine Satellite Solutions Company (Empresa Argentina de Soluciones Satelitales)
BRI	Belt and Road Initiative
BRICS	Brazil, Russia, India, China, and South Africa
CASC	China Aerospace Science and Technology Corporation
CAST	China Academy of Space Technology
CBERS	China-Brazil Earth Resources Satellite
CCF	China-CELAC Forum
CCP	Chinese Communist Party
CDB	China Development Bank
CELAC	China-Community of Latin American and Caribbean States (China-Comunidad de Estados Latinoamericanos y Caribeños)
CGWIC	China Great Wall Industries Corporation
CLA	Alcantara Launch Center (Centro de Lançamento de Alcântara)
CLBI	Barreira do Inferno Launch Center (Centro de Lançamento da Barreira do Inferno)
CLEP	Chinese Lunar Exploration Program
CLTC	China Satellite Launch and Tracking Control General
CNES	Center for Space Studies in France (Centre National D’Etudes Spatiales)
CNOIS	National Center for Satellite Imagery Operations (Centro Nacional de Operaciones de Imágenes Satelitales)
CNSA	China National Space Administration
CONIDA	National Commission of Aerospace Research and Development (Comisión Nacional de Investigacion y Desarrollo Aeroespacial)

COPUOS	Committee on the Peaceful Uses of Outer Space
DIACE	Astronomy and Space Sciences Directorate (Dirección de Astronomía y Ciencias Espaciales)
DIAPG	Space and Geomatics Applications Directorate (Dirección de Aplicaciones Espaciales y Geomática)
DIME	diplomatic, information, military, and economic
DITEC	Space Technologies Directorate (Dirección de Tecnología Espacial)
DOCSTA	Doctoral Program on Space Technology Applications
EO	Earth observation
ESA	European Space Agency
ETC	Education and Training Center
GEO	geosynchronous Earth orbit
GNSS	Global Navigation Satellite System
IGMA	International GNSS Monitoring and Assessment
INPE	National Institute of Space Research (Instituto Nacional de Pesquisas Espaciais)
LAC	Latin America and the Caribbean
LEO	low Earth orbit
MASTA	Master's program in Space Technology Applications
MoU	memorandum of understanding
NASA	National Aeronautics and Space Administration
NSP	national space policy
PLA	People's Liberation Army
PNAE	National Space Activities Program (Programa Nacional de Atividades Espaciais)
PPWT	Treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force against Outer Space Objects
PRC	People's Republic of China
PROSUR	Forum for the Progress and Development of South America (Foro para el Progreso y Desarrollo de América del Sur)
SAC	Scientific Applications Satellites (Satélite de Aplicaciones Científicas)
SAOCOM	Argentine Microwave Observation Satellite (Satélite Argentino de Observación Con Microondas)

SATCOM	satellite communication
SCD	Data Collection Satellite (Satélite de Coleta de Dados)
SGDC	Geostationary Defense and Strategic Communications Satellite (Satélite Geoestacionário de Defesa e Comunicações Estratégicas)
SMMS	Small Multi-Mission Satellite
SSA	space situational awareness
SSF	Strategic Support Force
TSA	technology safeguard agreement
UNASUR	Union of South American Nations
UNOOSA	United Nations Office for Outer Space Affairs

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I. INTRODUCTION

The U.S. military considers the space domain a contested, degraded, and operationally limited environment due to the threats posed by China, Russia, and other possible adversaries.¹ The recent reestablishment of U.S. Space Command and the U.S. Space Force's creation are responses to advancing adversarial threats and the need to defend space capabilities and maintain space superiority. In 2016, the Chinese government published its second policy paper on Latin America and the Caribbean (LAC). It stated that China would actively explore space cooperation in fields such as telecommunication, remote-sensing, satellite data applications, and ground infrastructure.² That same year, the Chinese government also published a white paper on its space activities, envisioning China as a space power in all respects that utilizes outer space for peaceful purposes.³

Recent U.S. government studies have exposed how China could challenge the United States within the space domain via its own hemisphere. A 2019 report to Congress by the U.S.-China Economic and Security Review Commission found that “Beijing uses its space program to advance its terrestrial geopolitical objectives... while also using diplomatic ties to advance its goals in space, such as by establishing an expanding network of overseas space ground stations.”⁴ The report continues to warn that China's promotion of launch services, satellites, and other space technologies deepens participants' reliance on China for space-based services.

¹ U.S. Air Force, *Counterspace Operations*, AFDP 3-14 (Maxwell AFB, AL: Curtis E. Lemay Center, 2018), 1, https://www.doctrine.af.mil/Portals/61/documents/AFDP_3-14/AFDP-3-14-Counterspace-Ops.pdf.

² China Ministry of Foreign Affairs, *China's Policy Paper on Latin America and the Caribbean 2016* (Beijing, China: China Ministry of Foreign Affairs, 2016), pt. IV, https://www.fmprc.gov.cn/mfa_eng/zxxx_662805/t1418254.shtml.

³ China State Council, *White Paper on China's Space Activities in 2016* (Beijing, China: China State Council, 2016), pt. I, http://english.www.gov.cn/archive/white_paper/2016/12/28/content_281475527159496.htm.

⁴ Carolyn Bartholomew and Robin Cleveland, *2019 Report to Congress of the US-China Economic and Security Review Commission* (Washington, DC: U.S.-China Economic and Security Review Commission, 2019), 16, <https://www.uscc.gov/sites/default/files/2019-11/2019%20Annual%20Report%20to%20Congress.pdf>.

A. MAJOR RESEARCH QUESTION

What are the motivations behind Sino-LAC space cooperation, and what do the parties stand to gain? How is Sino-LAC space cooperation structured, and is China promoting long-term technological dependencies with LAC countries? What challenges does this pose to U.S. space security, and is U.S. space policy effectively responding to the reality of regional Chinese proliferation within the space domain? This thesis will explore regional Chinese influence within the space domain, analyze if and how China's space engagement builds long-term technological dependencies, and consider implications for U.S. space security in the western hemisphere. It will also recommend U.S. policy actions to deter potential space security concerns.

B. SIGNIFICANCE OF THE RESEARCH QUESTION

The end of the Cold War created a period when the United States no longer saw great power intervention into the LAC region as a threat to U.S. interests and national security. But China is now a global power capable of challenging the dominant U.S. position in the region; it is also no secret that the United States considers China its primary challenger within the space domain. Department of Defense publications and independent reports have emerged over the past decade that highlight the advancements of Chinese military space capabilities and their inherent threats to U.S. space systems architectures and the ability to support global warfighting efforts.

The amount of Chinese investment and influence in the LAC region have reintroduced the scenario where great power competition could threaten national security due to declining U.S. regional influence. Previous research on Chinese-LAC space cooperation hinted that the subject is primarily absent from scholarly and policy literature.⁵ Instead, published work on Chinese-LAC relations has focused on trade agreements, commodity exports, and investments between the two regions.

⁵ Julie Michelle Klinger, "A Brief History of Outer Space Cooperation Between Latin America and China," *Journal of Latin American Geography* 17, no. 2 (2018): 46, <https://doi.org/10.1353/lag.2018.0022>.

Table 1 lists the eight LAC countries with a national space program, six of which have a history of space cooperation with China. Argentina, Bolivia, Brazil, Peru, and Venezuela have well-documented space partnerships with China. The Mexican government announced in 2019 that a Chinese-backed multilateral space organization invited the Mexican Space Agency to join as a permanent member, marking the first example of Sino-Mexican space cooperation.⁶ (Yet the organization’s website still lists Mexico as an observer state, not a member state.)⁷

Table 1. LAC countries with national space agencies against Chinese space cooperation.⁸

	Chinese Space Cooperation
Argentina	Yes
Bolivia	Yes
Brazil	Yes
Colombia	No
Mexico	Yes
Paraguay	No
Peru	Yes
Venezuela	Yes

The research conducted in this thesis intends to analyze Sino-LAC space partnerships and uncover any long-term technological dependencies behind them. Additionally, it will outline how these countries benefit from these partnerships and if China is advancing its space influence and capabilities in the western hemisphere. Finally, it will examine U.S. space policy and strategy to determine if the United States is postured to meet the growing Chinese space influence in the region.

⁶ “Invitan a AEM a ser miembro permanente de la APSCO” [AEM is invited to become a permanent APSCO member], Gobierno de México [Mexican Government], accessed January 11, 2021, <http://www.gob.mx/aem/prensa/invitan-a-aem-a-ser-miembro-permanente-de-la-apsco-199663?idiom=es>.

⁷ “Member States-APSCO,” Asia-Pacific Space Cooperation Organization, accessed August 23, 2020, http://www.apsco.int/html/comp1/channel/Member_States/25.shtml.

⁸ Adapted from Klinger, “A Brief History of Outer Space Cooperation Between Latin America and China,” 55–57.

C. LITERATURE REVIEW

Since 2008, the Chinese government has published two policy papers on Latin America and the Caribbean. While the first policy paper did not mention space cooperation, it stated that China would actively carry out military exchanges and defense cooperation with LAC countries.⁹ The subsequent 2016 policy paper introduced space cooperation under the subject of further strengthening cooperation in the economic field.¹⁰ China stated it would explore cooperation in areas such as communication and remote-sensing satellites, satellite data applications, aerospace infrastructure, space education and training, and space technology to assist with domestic issues, such as disaster mitigation and agricultural monitoring.¹¹ Additionally, the policy paper highlighted China's recent South-South cooperation and intent at trilateral cooperation with countries and organizations outside the LAC region.

A 2018 article by Julie Klinger briefly summarizes the history of outer space cooperation, including signed treaties and satellite projects, between China and LAC countries from 1984–2017.¹² The article consolidates some of the bilateral and multilateral partnerships that are independently examined throughout this thesis. It is one of few examples of published work on the subject of Sino-LAC space cooperation. Klinger argues “that the geography of evolving China-Latin America relations cannot be understood without considering the role of outer space science, technology, and policy.”¹³ Her geopolitical approach to Sino-LAC space cooperation stresses the bilateral importance of these engagements to the advancement of environmental sciences, climate change research, disaster monitoring, and development projects. These engagements are key to

⁹ China Ministry of Foreign Affairs, *China's Policy Paper on Latin America and the Caribbean 2008* (Beijing, China: China Ministry of Foreign Affairs, 2008), pt. IV, <https://china.usc.edu/chinas-policy-paper-latin-america-and-caribbean>.

¹⁰ China Ministry of Foreign Affairs, *China's Policy Paper on Latin America and the Caribbean 2016*, pt. IV.

¹¹ China Ministry of Foreign Affairs, pt. IV.

¹² Klinger, “A Brief History of Outer Space Cooperation Between Latin America and China,” 56–57.

¹³ Klinger, 48.

understanding that the political economy of Sino-LAC cooperation is more complex than the commodity-based trade and investment relations found mainly in the published literature on general Sino-LAC partnerships.

In her study on Sino-Latin American space cooperation, Laura Delgado-López illustrates how the varying national priorities of LAC countries translate into unique space relationships with China.¹⁴ Delgado-López argues that developing LAC countries' domestic interests drive country-by-country variances in space cooperation with China. These regional drivers influence bilateral partnerships with China, as more LAC countries utilize and justify space capabilities as a development tool to deliver critical national services. Furthermore, she claims these apolitical Chinese partnerships are more important than relationships with the United States, or at least indifferent to the effect on them.¹⁵ Delgado-López acknowledges that LAC countries have vast natural resources that China wants but argues that the belief that Chinese space cooperation is a lure to bring LAC countries under its influence is too simplistic.¹⁶

One of the significant Sino-LAC economic cooperation programs is named China-Community of Latin American and Caribbean States (China-Comunidad de Estados Latinoamericanos y Caribeños [CELAC]), abbreviated as the China-CELAC Forum (CCF) in English. The CCF's purpose is to promote the development of the comprehensive cooperative partnership between China and the 33 member states of CELAC.¹⁷ The forum proposed a 2015–2019 cooperation plan that focused on applying space technology for risk management, disaster prevention and reduction, evaluation of crop production, and climate change impacts. As of January 2020, CELAC membership has dropped to 32 states due to Brazil suspending its membership.

¹⁴ Laura M. Delgado-López, "Sino-Latin American Space Cooperation: A Smart Move," *Space Policy* 28, no. 1 (February 1, 2012): 7–14, <https://doi.org/10.1016/j.spacepol.2011.12.009>.

¹⁵ Delgado-López, 8.

¹⁶ Delgado-López, 9.

¹⁷ "Basic Information about China-CELAC Forum" (China Ministry of Foreign Affairs, April 2016), http://www.chinacelacforum.org/eng/ltjj_1/P020161207421177845816.pdf.

Three major multilateral cooperation entities with space influence involving China and at least one LAC country are the United Nations Office for Outer Space Affairs (UNOOSA), the Chinese-led Asia-Pacific Space Cooperation Organization (APSCO), and the economic grouping of Brazil, Russia, India, China, and South Africa (BRICS). Within UNOOSA, the Committee on the Peaceful Uses of Outer Space (COPUOS) was created in 1959 to “govern the exploration and use of space for the benefit of all humanity: for peace, security and development.”¹⁸ COPUOS committee membership has evolved from having three LAC countries in 1959 to having 16 LAC members in 2019. APSCO includes the Republic of Peru as a member state.¹⁹ BRICS, as the acronym defines, includes Brazil.

Between 1967–1996, COPUOS adopted five international treaties and five sets of principles on space-related activities.²⁰ These well-established treaties and regulations make up the foundation for space law and policy. However, many states argue that gaps in these treaties allow an arms race to occur in outer space.²¹ Thus, Russia and China proposed a draft treaty in 2008, later updated in 2014, called the Treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force against Outer Space Objects (PPWT). The PPWT recognizes that existing international agreements cannot entirely prevent the placement of weapons in outer space, and its approval aims to address this.²² A U.S. staff research report claims that China heavily supports this treaty because it would preserve its counter-space capabilities by allowing the continual development of

¹⁸ “Committee on the Peaceful Uses of Outer Space,” United Nations Office for Outer Space Affairs, accessed August 23, 2020, <https://www.unoosa.org/oosa/en/ourwork/copuos/index.html>.

¹⁹ Asia-Pacific Space Cooperation Organization, “Member States-APSCO.”

²⁰ “Space Law Treaties and Principles,” United Nations Office for Outer Space Affairs, accessed August 23, 2020, <https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties.html>.

²¹ “Proposed Prevention of an Arms Race in Space (PAROS) Treaty,” Nuclear Threat Initiative, accessed August 23, 2020, <https://www.nti.org/learn/treaties-and-regimes/proposed-prevention-arms-race-space-paros-treaty/>.

²² Louis de Gouyon Matignon, “Treaty on the Prevention of the Placement of Weapons in Outer Space,” Space Legal Issues, May 8, 2019, <https://www.spacelegalissues.com/treaty-on-the-prevention-of-the-placement-of-weapons-in-outer-space-the-threat-or-use-of-force-against-outer-space-objects/>.

ground-based counterspace measures.²³ However, the United Nations Conference on Disarmament, which has nine LAC country members, has not formally met to discuss the proposed treaty.²⁴

Under Chinese sponsorship, APSCO was established in 2008 and provides a multilateral cooperative mechanism for eight developing countries to facilitate resource sharing in space science, technology, and applications.²⁵ In 2015, APSCO held a Development Strategy Forum in Beijing with the theme of “The Belt and Road Initiative [BRI] for facilitating space capabilities building of the Asia-Pacific countries.”²⁶ With observers from Chile and Mexico, the forum concluded that the BRI conforms to the mission of APSCO. The BRI, much like space cooperation, is an infrastructure tool used by China to expand its influence and foster long-term relationships.

The Chinese government includes space cooperation as a component of the BRI and often refers to these projects as the Space Silk Road or the BRI Space Information Corridor.²⁷ Both a member of APSCO and the BRI, Pakistan was granted access to China’s BeiDou global navigation satellite’s restricted high-precision signal.²⁸ While China claims the BRI has no relation to alliances in the geopolitical or military realms, BeiDou provides military services to the People’s Liberation Army (PLA). The Pakistan model illustrates an

²³ Alexander Bowe, *China’s Position on a Code of Conduct in Space* (Washington, DC: U.S.-China Economic and Security Review Commission, 2017), 3, <https://www.uscc.gov/research/chinas-position-code-conduct-space>.

²⁴ Center for Nonproliferation Studies, “UN and CD Membership,” Nuclear Threat Initiative, July 14, 2015, https://media.nti.org/pdfs/apmuncd_8.pdf.

²⁵ “About Asia-Pacific Space Cooperation Organization,” Asia-Pacific Space Cooperation Organization, June 6, 2018, <http://www.apsco.int/html/comp1/content/WhatIsAPSCO/2018-06-06/33-144-1.shtml>.

²⁶ Amy Ouyang, ed., *APSCO Quarterly Report* (Beijing, China: Asia-Pacific Space Cooperation Organization, 2016), <http://www.apsco.int/upload/file/20180309/2019030610192821583.pdf>.

²⁷ “China Regional Snapshot: Space,” The House Committee on Foreign Affairs Republicans, March 16, 2021, <https://gop-foreignaffairs.house.gov/china-regional-snapshot-space/>.

²⁸ Bartholomew and Cleveland, *2019 Report to Congress of the US-China Economic and Security Review Commission*, 370.

alternative to reliance on American military satellite systems.²⁹ Access to this restricted Chinese space technology could extend to other organization members, within APSCO or the BRI, or sway observer nations to become permanent members.

APSCO member states pledged to follow four principles and five actions to deepen comprehensive partnerships further. According to the 2018 APSCO Development Vision 2030 document, the last decade produced achievements in satellite data sharing, 13 different space science and technology projects, and professional education and training.³⁰

BRICS is the last of three major multilateral organizations involving China considered for this review, consisting of five major emerging countries and economies.³¹ In its latest 2019 declaration, BRICS expressed concern about the possibility of an arms race in outer space and reaffirmed its stance on the peaceful uses of outer space.³² But, several setbacks have hindered Brazil's space progress; it has found itself in last place among the BRICS countries in space development.³³ Brazil may be disproportionately gaining a space advantage from the organization.

Within BRICS, China's longest-standing bilateral space-cooperation venture in the LAC region is the China-Brazil Earth Resources Satellite (CBERS). This agreement with Brazil was signed in 1988 and ultimately produced a family of six remote-sensing satellites utilized in sectors such as agriculture, environmental protection, forestry, and geology.³⁴

²⁹ Rob Miltersen, "Chinese Aerospace Along the Belt and Road," *Air University*, China Aerospace Studies Institute, June 15, 2020, 13.

³⁰ Asia-Pacific Space Cooperation Organization, *Development Vision 2030 of The Asia-Pacific Space Cooperation Organization (APSCO)* (Beijing, China: Asia-Pacific Space Cooperation Organization, 2018), <http://www.apsco.int/upload/file/20190304/2019030411022230805.pdf>.

³¹ "What Is BRICS?," Brazil Ministry of Foreign Affairs, accessed August 23, 2020, <http://brics2019.itamaraty.gov.br/en/about-brics/what-is-brics>.

³² "11th BRICS Summit - Brasília Declaration," Brazil Ministry of Foreign Affairs, November 14, 2019, <https://www.gov.br/mre/en/contact-us/press-area/press-releases/11th-brics-summit-brasilia-declaration>.

³³ James Clay Moltz, "Brazil's Space Program: Dreaming with Its Feet on the Ground," *Space Policy*, Brazil's space program, 33 (2015): 13–19, <https://doi.org/10.1016/j.spacepol.2015.05.001>.

³⁴ "CBERS FAQ," Instituto Nacional de Pesquisas Espaciais [National Institute for Space Research], accessed August 23, 2020, <http://www.inpe.br/faq/index.php?pai=17>.

Various space organizations are responsible for different functions of the program, including the PLA's China Satellite Launch and Tracking General (CLTC), which is dedicated to the telemetry, tracking, and command of Chinese space missions.³⁵

Argentina presents another example where bilateral space cooperation with China involves the CLTC. In 2015, as part of a controversial economic and trade agreement, the Argentinian Congress approved the construction and use of a Chinese-run satellite launch and tracking facility in Argentina's southern Neuquén province.³⁶ The stated mission of this facility is to track Chinese unmanned missions to Mars and the Moon. However, the lack of Argentinian oversight prompted local opposition to speak out about the potential for possible military use.³⁷ These sentiments were shared in 2019 by Admiral Craig Faller, the commander of U.S. Southern Command, when he stated that "Beijing could be in violation of the terms of its agreement with Argentina to only conduct civilian activities and may have the ability to monitor and potentially target U.S., allied, and partner space activities."³⁸ Despite this, Argentina and China have recently resumed plans to cooperate in outer space exploration and exchange data and research findings between their national space agencies.³⁹ This new plan diverges from the previous Argentinian administration's attempts to restore U.S. relations by halting space cooperation with China. This agreement could increase Chinese space capabilities in the western hemisphere at the expense of U.S.-Argentine relations.

³⁵ "China Satellite Launch and Tracking Control General," Nuclear Threat Initiative, January 31, 2013, <https://www.nti.org/learn/facilities/124/>.

³⁶ Uki Goñi, "Argentinian Congress Approves Deal with China on Satellite Space Station," *The Guardian*, February 26, 2015, <https://www.theguardian.com/world/2015/feb/26/argentina-congress-china-satellite-space-station>.

³⁷ Goñi.

³⁸ Lara Seligman, "U.S. Military Warns of Threat From Chinese-Run Space Station in Argentina," *Foreign Policy*, February 8, 2019, <https://foreignpolicy.com/2019/02/08/us-military-warns-of-threat-from-chinese-run-space-station-in-argentina/>.

³⁹ Patrick Gillespie, "China and Argentina Resume Joint Venture for Space Exploration," *Bloomberg*, August 7, 2020, <https://www.bloomberg.com/news/articles/2020-08-07/china-and-argentina-resume-joint-venture-for-space-exploration>.

Historically, the United States, through the U.S. Army and the National Aeronautics and Space Administration (NASA), is credited with helping Chile achieve its first space activity milestones in the 1950s. Although Chile no longer has a national space agency, the Chinese Academy of Sciences and Chile's National Commission for Scientific and Technological Research have established scientific collaboration.⁴⁰ The result is the formation of the Chinese Academy of Sciences' South America Center for Astronomy, also known as the China-Chile Joint Center for Astronomy. This institute was founded in 2013 to develop collaboration in astronomical research between the two countries and serves as a space collaboration center for other South American countries. According to InvestChile, the national foreign investment promotion agency, plans are in the works for China's first Chilean investment in science and astronomical exploration in the form of an astronomical observatory and an Astroscience Park.⁴¹

InvestChile also says that Chile will be home to seventy percent of the world's astronomical infrastructure within the next few years.⁴² Chilean officials have voiced concerns of an asymmetrical relationship due to China's substantial investment and agreements where Chinese scientists could apply for observation time allotted to Chile at facilities throughout the country.⁴³ If the projects are successful, this could open Chile to more substantial Chinese investment and utilization of the space domain in the western hemisphere. A regional framework may be established where China uses the Chilean model to open bilateral or multilateral agreements with other LAC nations.

In his 2018 thesis, U.S. Air Force Captain Angel Serna examined Peru, Argentina, and Venezuela's space programs and the need to engage in international space cooperation due to their limited indigenous capabilities and desire to become technologically

⁴⁰ "Overview – CASSACA," Chinese Academy of Sciences South America Center for Astronomy, accessed August 24, 2020, <http://www.cassaca.org/en/news/>.

⁴¹ "Astronomy: China to Install Megaproject in Chile," InvestChile, March 2019, <http://blog.investchile.gob.cl/astronomy-china-to-install-megaproject-in-chile>.

⁴² InvestChile.

⁴³ Lucien O Chauvin and Barbara Fraser, "Beijing's South American Gambit," *Nature* 569, no. 179 (May 9, 2019): 3.

independent.⁴⁴ He further noted that the increase in global space providers created a large market for LAC countries to cooperate in harnessing space capabilities as a socioeconomic developmental tool. The strong desire to become technologically independent may create incentives for long-term space cooperation with China due to lower satellite program costs and fewer political and technical restrictions than those required by the United States.

U.S. Air Force Major Matt Garvin's 2014 thesis examined how international and domestic factors influenced national space programs in Latin America.⁴⁵ His research discovered that the fundamental driver for determining the international orientation of these space programs is the desire for economic development.⁴⁶ His findings appear to remain valid as the bilateral and multilateral space agreements between China and LAC countries examined are backed by massive Chinese investment and remain consistent with Delgado-López's school of thought. Additionally, he outlines challenges to U.S. space cooperation, such as export control regulations, that drove LAC countries to pursue space collaborations with countries like China.

A 2018 article in the *Journal of Aeronautical History* reviewed space activities in seven South American countries.⁴⁷ The article referenced the 2008 creation of a legal entity called the Union of South American Nations (UNASUR) that consolidated many LAC countries to mirror the European Union organization. In 2011, the defense ministers of 11 countries agreed to create a South American Space Agency.⁴⁸ Unfortunately, governments could not agree on funding the creation of such an agency, but it remains a goal in the region. Last year, many countries withdrew from UNASUR, and a new southern bloc

⁴⁴ Angel E. Serna, "The U.S.-Latin America Space Cooperation Equation" (master's thesis, Naval Postgraduate School, 2018), 78, <https://calhoun.nps.edu/handle/10945/58368>.

⁴⁵ Matthew B. Garvin, "Launching Latin America: International and Domestic Factors in National Space Programs" (master's thesis, Naval Postgraduate School, 2014), <https://calhoun.nps.edu/handle/10945/44569>.

⁴⁶ Garvin, 98.

⁴⁷ Bruno Victorino Sarli et al., "Review of Space Activities in South America," *Journal of Aeronautical History* 8 (September 11, 2018): 208–32.

⁴⁸ Sarli et al., 210.

formed without Venezuela.⁴⁹ The Foro para el Progreso y Desarrollo de América del Sur (Forum for the Progress and Development of South America [PROSUR]) counted its founding members Argentina, Brazil, Chile, Colombia, Ecuador, Paraguay, and Peru. This new right-wing political bloc committed to renew and strengthen regional integration could revive the work of a South American Space Agency. Without Venezuela, there could also exist the possibility that the United States has more potential for space cooperation with the PROSUR member states.

In summary, published literature does not examine Sino-LAC space cooperation concerning China's potential to entwine space partnerships into long-term technical engagements and dependencies. Klinger's school of thought stresses the importance of multilateral space cooperation to understand the geopolitics of Sino-LAC relations. She highlights a long history of space-related scientific and technological exchanges and frames Sino-LAC nations' relations as more profound than generally presumed. Delgado-López, Garvin, and Serna come to the same conclusion that domestic factors play a significant role in LAC countries' need to advance native space capabilities. This school of thought leads to the possibility that LAC countries could leverage Chinese space cooperation to achieve future domestic goals despite being courted into long-term technical dependencies.

D. POTENTIAL EXPLANATIONS AND HYPOTHESIS

The major research question examines how China is advancing its space partnerships and capabilities in Latin America while broadening its long-term engagements and influence. Extensive Chinese investment and cooperation can create opportunities for LAC countries to enter into agreements to improve their technological competencies and aid in socioeconomic development. In return, China benefits from increasing its geopolitical presence and economic control in the western hemisphere by funding and developing space capabilities, building space infrastructure, and collaboratively sharing space systems and space data.

⁴⁹ Patricia Luna, "South American Leaders Launch New Bloc to Replace Unasur," Associated Press, March 22, 2019, <https://apnews.com/3cc29c66207249e18871ce8daeb56a1e>.

China appears to select LAC countries for space cooperation based on an asymmetrical advantage. China enters bilateral and multilateral agreements with most of the investment and technological know-how to develop long-term technological dependencies. Research shows that more technologically developed countries, such as Argentina and Brazil, prefer joint development and avoid asymmetrical advantages that result in heavy Chinese reliance. Overall, LAC countries continue to seek and gain substantial Chinese investment in different sectors of their space program. China strategically leverages Sino-LAC space cooperation as a geopolitical tool to increase its control of developing space economies and challenges regional U.S. space hegemony by providing an alternative Chinese Communist Party (CCP) cooperation model.

U.S. organizations have voiced concerns regarding the space infrastructure that China has built, such as the facility in the Neuquén Province in southern Argentina. There is a global focus on the Chinese tracking station in Argentina because of the secretive nature of its operations and the fear of dual civilian-military use. With Chinese plans to develop new and expand existing space research projects throughout LAC, China will increase its space capabilities in the western hemisphere due to becoming the preferred space partner of choice. Continuous space cooperation between China and LAC countries may progress into programs and agreements that result in heightened U.S. concerns because U.S. security policy focuses heavily on the Middle East and Asia.

E. RESEARCH DESIGN

The research conducted in this thesis will be organized into two sets of case studies. Using the metrics introduced by Froehlich, Soria, and De Marchi, I have categorized the countries listed in Table 1 into “major-developed” and “less-developed” space nations.⁵⁰ The level of development is based on the capacities and capabilities of those nations’ satellites. The major developed nations own satellite communication (SATCOM), Earth observation (EO), and scientific satellites. The less-developed nations possess capabilities

⁵⁰ A. Froehlich, D.A.A. Soria, and E. De Marchi, *Space Supporting Latin America: Latin America’s Emerging Space Middle Powers* (Springer International Publishing, 2020), 41.

in at least one sector, but not all three. This case-study structure may show causal relations between native space capabilities and the level of Chinese space cooperation.

The less-developed nations include Bolivia, Peru, and Venezuela. Peru and Venezuela are nations that have capacities in two space sectors. Mexico also falls under this category; however, it was not considered a case study due to its uncertain level of Chinese space cooperation. Peru has EO and scientific satellite capabilities and shared Chinese space resources due to its membership in APSCO.⁵¹ Venezuela has space capabilities in SATCOM and EO. Bolivia, the least space-developed nation considered, has purchased and only possesses SATCOM capabilities. Bolivia presents a peculiar case because it has comparatively limited Chinese cooperation and has not always selected China as its space partner of choice.⁵²

The major-developed space nations to be examined are Argentina and Brazil, which have considerable satellite capabilities in all three sectors. Brazil is said to have had 16 SATCOM, 8 EO, and 20 scientific satellites.⁵³ Argentina is slightly behind Brazil in quantity, with 8 SATCOM, 9 EO, and 10 scientific satellites, but may be more advanced in certain technology sectors.

These case studies allow the thesis to focus on developmental differences in Sino-LAC space cooperation and to determine whether China approaches cooperation with the same agenda and policies and how each country benefits. These case studies can be weighed against U.S. space security interests to determine if a credible concern exists.

Various sources in the literature review deal with different aspects of space cooperation. Since the literature on Chinese-LAC space cooperation is scarce, primary sources will be official Chinese policies, literature on LAC space history and capabilities,

⁵¹ “Data Sharing Service Platform,” Asia-Pacific Space Cooperation Organization, July 6, 2018, <http://www.apsco.int/html/comp1/content/DataSharingServiceNetwork/2018-07-06/62-184-1.shtml>.

⁵² Klingner, “A Brief History of Outer Space Cooperation Between Latin America and China,” 58.

⁵³ Froehlich, Soria, and De Marchi, *Space Supporting Latin America: Latin America’s Emerging Space Middle Powers*, 41.

national space program documents, bilateral and multilateral space cooperation documents, and various online news outlets.

Furthermore, the U.S. government and non-governmental institutions have published numerous documents on space security and military doctrine. These include books, academic journals, congressional reports, think-tank studies, and official documents on space strategy and security issued by Department of Defense agencies. These documents will aid in analyzing the perceived threat to U.S. space dominance and provide policy recommendations and areas of future interest.

F. THESIS OVERVIEW

This thesis will be organized into four chapters. After the introduction, the following two chapters will attempt to show a correlation between national space development and the level of Chinese space cooperation in less-developed Bolivia, Peru, and Venezuela, and then in more-developed Argentina and Brazil. Examining these links should reveal what all parties hope to gain and how China combines space cooperation and long-term technological engagements to expand its influence in the western hemisphere. The fourth and concluding chapter will summarize the research, highlight findings, and discuss the implications on U.S. space security. Finally, it reviews U.S. space policy and offers recommendations to deter Chinese space security threats and strengthen and expand U.S.-LAC space cooperation.

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II. CASE STUDIES: LESS-DEVELOPED SPACE NATIONS

This chapter introduces the case studies of Bolivia, Peru, and Venezuela. These countries were selected and grouped because they each have a national space agency, a history of Chinese space cooperation, and “less-developed” space capabilities. This chapter is important because each case-study nation relied almost exclusively on Chinese space agreements to acquire its most advanced satellite capabilities and applications through different cooperation methods. This highlights a successful Chinese alternative to the United States for developing countries in the LAC region to acquire space capabilities to satisfy national development goals and advance technological competency. Space capabilities are becoming more affordable and accessible, and non-space fairing countries in the region have Bolivia, Peru, and Venezuela as cooperation models to consider China as the space partner of choice.

These Andean nations have long recognized the benefits of applying space technologies towards domestic development and regional prestige. In the 1970s, organizations among the governments of Bolivia, Colombia, Ecuador, Peru, and Venezuela unsuccessfully attempted to establish a joint Andean satellite system with hopes of regional space sovereignty and independence from U.S. hemispheric leadership.⁵⁴ Ultimately, Bolivia, Peru, and Venezuela led independent efforts to obtain space capabilities, and Chinese space cooperation aligned with their national space agency’s efforts.

Peru placed a higher emphasis on financial and technological return on investment when determining its space partner of choice. Peru’s comparatively stable political history and favorable cooperation with U.S., European, and Chinese agencies suggested a high level of pragmatism influenced its space program’s progression and partnerships.⁵⁵ Populist leaders and their politics played a more significant role in establishing bilateral Chinese space cooperation for Bolivia and Venezuela. Ex-Venezuelan President Hugo

⁵⁴ Mehak Sarang, “Changing Objectives in Achieving Space Sovereignty in Latin America,” in *Space Fostering Latin American Societies: Developing the Latin American Continent through Space, Part I* (Springer International Publishing, 2020), 125–33.

⁵⁵ Serna, “The U.S.-Latin America Space Cooperation Equation,” 74.

Chávez utilized his nation's Chinese-built communications satellite to expand his Bolivarian revolution to rural communities within and beyond Venezuela's borders.⁵⁶ Similarly, ex-Bolivian President Evo Morales leveraged the successes of acquiring a Chinese-built national communications satellite to bolster his populist image and exploited the technology to broadcast his state-run propaganda. Furthermore, these Bolivian and Venezuelan regimes likely initiated space cooperation with China to express anti-U.S. sentiments.⁵⁷ Consequently, China leveraged Bolivian and Venezuelan politics to increase its space cooperation and influence in the LAC region.

In turn, China used space cooperation as one of its tools to advance the People's Republic of China's (PRC) domestic, geopolitical, and global economic ambitions. Since the 2008 Chinese white paper on Latin America and the Caribbean, China's official policy on establishing regional partnerships has depended on LAC nations recognizing Chinese sovereignty over Taiwan.⁵⁸ Furthermore, China's 2016 white paper on space activities lists drivers for sustaining space exchanges and cooperation in the LAC region. One of the white paper's fundamental policies aims to strengthen bilateral and multilateral cooperation based on common goals and serves the Belt and Road Initiative.⁵⁹ Bolivia, Peru, and Venezuela have each signed a memorandum of understanding (MoU) with China to join the BRI framework.⁶⁰ Furthermore, China foresees APSCO, where Peru is a member state, playing an essential role in regional space cooperation in the western hemisphere. The BRI and APSCO are multilateral cooperation mechanisms with high potential to incorporate new LAC member states, helping China shape long-term technological dependencies and control the space economies of less-developed LAC space nations.

⁵⁶ Garvin, "Launching Latin America," 84.

⁵⁷ Garvin, 84.

⁵⁸ China Ministry of Foreign Affairs, *China's Policy Paper on Latin America and the Caribbean 2008*, pt. III.

⁵⁹ China State Council, *White Paper on China's Space Activities in 2016*, pt. V.

⁶⁰ Christoph Wang, "Countries of the Belt and Road Initiative (BRI)," Green Belt and Road Initiative Center, accessed September 14, 2020, <https://green-bri.org/countries-of-the-belt-and-road-initiative-bri>.

A. BOLIVIA

The Plurinational State of Bolivia is a landlocked country with a highly diverse geography that poses socioeconomic development challenges. The Andean region towers over 3,000 meters above sea level and covers twenty-eight percent of the national territory; the sub-Andean valley region covers thirteen percent of the territory and is characterized by its agricultural activity; and the plains cover fifty-nine percent of the territory and include the forest regions of the country.⁶¹ Bolivia estimates a national population of 11.8 million people in 2021, with almost half of the population living in the great Andean plateau representing the country's western portion.⁶² As a result, the topography outside the plateau poses many natural obstacles to domestic development and the delivery of essential services for more than half of Bolivia's population. Despite being one of the poorest countries in the region, with sixty percent of the population living in poverty,⁶³ President Morales, Bolivia's first indigenous president, pursued a national space program to benefit the Bolivian people.

1. Space Activities Overview

Bolivia's constitution establishes that the state is obligated to provide access to basic domestic services as a foundation of human rights.⁶⁴ Bolivia considers telecommunications to include voice, data, and video, one of these basic services. Furthermore, Bolivia's socioeconomic development plan states that every citizen will have access to all basic services by 2025. Because private companies seldom expand services to remote regions, the state estimates 25,000 rural towns with populations fewer than 350 are

⁶¹ "Aspectos geográficos" [Geographical aspects], Instituto Nacional de Estadísticas [National Institute of Statistics], April 2020, <https://www.ine.gob.bo/index.php/bolivia/aspectos-geograficos/>.

⁶² "Población y hechos vitales" [Population and vital facts], Instituto Nacional de Estadísticas [National Institute of Statistics], accessed March 10, 2021, <https://www.ine.gob.bo/index.php/censos-y-proyecciones-de-poblacion-sociales/>.

⁶³ Robert C. Harding, *Space Policy in Developing Countries: The Search for Security and Development on the Final Frontier* (New York: Routledge, 2013), 162.

⁶⁴ Agencia Boliviana Espacial [Bolivian Space Agency], *Plan Estratégico 2016–2020 [Strategic Plan 2016–2020]* (La Paz, Bolivia: Agencia Boliviana Espacial [Bolivian Space Agency], 2016), 1, <https://www.abe.bo/files/planificacion/PlanEstrategicoABE2016-2020.pdf>.

without telecommunication services.⁶⁵ The decision to acquire its own communications satellite was made in 2009, giving Bolivia the freedom to use SATCOM capabilities to achieve domestic development goals.

The Bolivian Space Agency's (Agencia Boliviana Espacial [ABE]) initial mission was to manage and implement this newfound SATCOM program, the Túpac Katari 1, or TKSAT-1. Bolivian law created ABE in 2010 as a strategic national public enterprise under the Ministry of Public Works, Services, and Housing supervision.⁶⁶ Within the legal decree that established ABE, the Bolivian government also authorized a \$250 million loan from the China Development Bank (CDB) to largely finance the construction and operational handover of a communications satellite built by the PRC's China Great Wall Industries Corporation (CGWIC).⁶⁷ ABE personnel received technical training in China to perform all satellite operations and management functions through this agreement.⁶⁸ The national space agency's role has expanded to include the management of national space programs and technical exchanges to transform ABE into a leading provider of public services.⁶⁹

Following the success of its communications satellite acquisition, ABE explored means to expand its space-based capabilities. However, due to shifting economic conditions, ABE abandoned the initiative to procure an EO satellite.⁷⁰ Six prospective bidding nations lined up in 2014 for the estimated \$100 million program, including the

⁶⁵ Agencia Boliviana Espacial [Bolivian Space Agency], 2.

⁶⁶ “¿Qué es la ABE?” [what is ABE?], Agencia Boliviana Espacial [Bolivian Space Agency], accessed January 20, 2021, <https://www.abe.bo/nosotros/que-es-la-abe/>.

⁶⁷ “Historia” [History], Agencia Boliviana Espacial [Bolivian Space Agency], accessed January 21, 2021, <https://www.abe.bo/nosotros/historia/>.

⁶⁸ “Rumbo a China 64 técnicos Bolivianos para capacitarse en el manejo del satélites” [64 Bolivian technicians head to China for satellite training], Bolivia, October 29, 2012, <https://www.bolivia.com/tecnologia/visionarios/sdi/49226/rumbo-a-china-64-tecnicos-bolivianos-para-capacitarse-en-el-manejo-del-satelites>.

⁶⁹ Agencia Boliviana Espacial [Bolivian Space Agency], “¿Qué es la ABE?” [what is ABE?].

⁷⁰ Agencia Boliviana Espacial [Bolivian Space Agency], *Plan Estratégico 2016–2020* [Strategic Plan 2016–2020], 11.

United States, Russia, France, and China.⁷¹ It is not certain if Bolivia favored a second Chinese contract, but multiple highly developed bidders may have signaled a pragmatic approach to Bolivia's subsequent satellite acquisition.

As a cheaper alternative, ABE settled with purchasing satellite imagery from foreign providers. ABE established the Earth Observation Laboratory (Laboratorio de Observación de la Tierra) to analyze satellite imagery and perfect the technical expertise needed for a future EO satellite program.⁷² This observatory is collocated in an existing satellite ground station, and it manages projects and agreements with national and international organizations and institutions. Imagery and products originate from but are not limited to NASA, European Space Agency (ESA), Japan, and Brazil.⁷³ Similarly, a mobile terrestrial weather station allows access to meteorological satellite imagery.⁷⁴ The variety of EO imagery allows ABE to provide the state with socioeconomic and environmental products and solutions.

In January 2020, Bolivia unveiled its latest space capability and corresponding partnership with China. ABE's La Guardia Earth Station began offering a ground-based service capable of monitoring and controlling new satellite deployments from launch to orbit utilizing the station's existing TKSAT-1 antenna and trained personnel.⁷⁵ Bolivian officials credit the Chinese government and companies for their contributions to the

⁷¹ Peter B. de Selding, "Prospective Bidders Line up for Bolivian Imaging Satellite Program," SpaceNews, June 6, 2014, <https://spacenews.com/40815prospective-bidders-line-up-for-bolivian-imaging-satellite-program/>.

⁷² Omar Valdez Muñoz, "ABE cuenta con equipos para análisis de imágenes de satélites de observación de la Tierra" [ABE has equipment for analyzing Earth observation satellite images], Agencia Boliviana Espacial [Bolivian Space Agency], September 28, 2018, <https://www.abe.bo/abe-cuenta-equipos-analisis-imagenes-satelites-observacion-la-tierra/>.

⁷³ "Observación de la Tierra" [Earth observation], Agencia Boliviana Espacial [Bolivian Space Agency], accessed February 13, 2021, <https://www.abe.bo/actividades/observacion-de-la-tierra/>.

⁷⁴ Agencia Boliviana Espacial [Bolivian Space Agency], *Plan Estratégico 2016–2020* [Strategic Plan 2016–2020], 12.

⁷⁵ Omar Valdez Muñoz, "Lanzamiento del servicio de estación terrena" [Launch of Earth station services], Agencia Boliviana Espacial [Bolivian Space Agency], January 10, 2020, <https://www.abe.bo/lanzamiento-del-servicio-de-estacion-terrena/>.

success of the project.⁷⁶ The inauguration ceremony of the Earth Station Services was attended by the PRC's Ambassador to Bolivia and by CGWIC representatives to symbolize China Aerospace Science and Technology Corporation (CASC) as the first company to use the capability. This partnership signifies a successful decade of Sino-Bolivian space cooperation and the likelihood for continual engagements.

The director of ABE reported that TKSAT-1 generated \$100 million in revenue after five years.⁷⁷ With a 15-year satellite life span, the \$302 million satellite program⁷⁸ will ultimately pay for itself. The director further stated in 2019 that the satellite would reach its practical occupational limit, roughly eighty-five percent of its maximum capacity, by the end of the year.⁷⁹ The success of TKSAT-1 led Bolivia to consider acquiring a second communications satellite. ABE delivered a 2018 press release highlighting the process of approving the Túpac Katari II, with 10 times its predecessor's capacity at the cost of \$250 million.⁸⁰ Hopes for a proposed 2021 launch have vanished, and it is unclear where in the acquisition process this program currently rests.

a. Satellite Operations

Acquiring a high-tech satellite is a common route to propel a developing space agency into the modern age of space capabilities. In 2013, Bolivia entered that realm after

⁷⁶ Omar Valdez Muñoz, "El embajador Huang Yazhong en Bolivia asiste a la ceremonia de inicio del proyecto de reforma de la estación terrestre de satélite Boliviano" [Ambassador Huang Yazhong attends the opening ceremony of the project to reform Bolivia's satellite ground station], Agencia Boliviana Espacial [Bolivian Space Agency], January 25, 2020, <https://www.abe.bo/el-embajador-huang-yazhong-en-bolivia-asiste-a-la-ceremonia-de-inicio-del-proyecto-de-reforma-de-la-estacion-terrestre-de-satelite-boliviano/>.

⁷⁷ Omar Valdez Muñoz, "Cinco años del lanzamiento del satélite Túpac Katari" [Five years since the launch of the Túpac Katari satellite], Agencia Boliviana Espacial [Bolivian Space Agency], January 2, 2019, <https://www.abe.bo/cinco-anos-del-lanzamiento-del-satelite-tupac-katari-2/>.

⁷⁸ Omar Valdez Muñoz, "Bolivia parece tener argumentos para afrontar la misión del segundo Túpac Katari" [Bolivia appears to have arguments for a second Túpac Katari mission], Agencia Boliviana Espacial [Bolivian Space Agency], November 14, 2018, <https://www.abe.bo/bolivia-parece-argumentos-afrontar-la-mision-del-segundo-tupac-katari/>.

⁷⁹ "Stk llegará a su 'límite práctico ocupacional' hasta fin de año" [stk will reach its 'practical occupational limit' by the end of the year], Jornada, February 19, 2019, <https://jornada.com.bo/stk-llegara-a-su-limite-practico-ocupacional-hasta-fin-de-ano/>.

⁸⁰ Muñoz, "Bolivia parece tener argumentos para afrontar la misión del segundo Túpac Katari" [Bolivia appears to have arguments for a second Túpac Katari mission].

receiving the first signals from its Chinese-built TKSAT-1 communications satellite.⁸¹ President Morales witnessed the launch on December 21, 2013, from China's Xichang Satellite Launch Center.⁸² The contract with CGWIC provided Bolivia with services beyond the construction, launch, and satellite handover. The package solution included ground control stations, satellite application systems, technical training, and orbit and frequency management.⁸³ Three years after creating Bolivia's space agency, China deployed the turn-key satellite platform, a feat unquestionably impossible for Bolivia to accomplish on its own.

The SATCOM capabilities of TKSAT-1 became operational a few months after launch. The satellite operates in four different frequencies, enabling business and domestic services to reach remote and disperses areas within Bolivia and throughout the South American continent.⁸⁴ TKSAT-1 delivers voice, data, and video communication services, prioritizing satellite internet and television. Dozens of satellite television channels are freely available to anyone with a television and a \$40 satellite receiver kit.⁸⁵ Though, Bolivia guarantees satellite access to citizens that cannot afford service costs via free public centers. Thousands of these community technology centers have been built in remote rural areas with programs to promote economic growth, networking, and training opportunities.⁸⁶

⁸¹ Sarli et al., "Review of Space Activities in South America," 212.

⁸² "China Successfully Launched TKSAT-1 Communications Satellite," China Great Wall Industry Corporation, December 27, 2013, http://www.cgwic.com/news/2013/1227_Launched_TKSAT-1_Communications_Satellite.html.

⁸³ China Great Wall Industry Corporation.

⁸⁴ "Informacion de TKSAT-1" [TKSAT-1 information], Agencia Boliviana Espacial [Bolivian Space Agency], accessed February 11, 2021, <https://www.abe.bo/actividades/telecomunicaciones/>.

⁸⁵ Omar Valdez Muñoz, "Breve resumen del origen y actualidad de la Agencia Boliviana Espacial" [Brief summary of the origin and present of the Bolivian Space Agency], Agencia Boliviana Espacial [Bolivian Space Agency], March 21, 2019, <https://www.abe.bo/breve-resumen-del-origen-actualidad-la-agencia-boliviana-espacial/>.

⁸⁶ Natalia I Vargas-Cuentas and Avid Roman-Gonzalez, "The Space Technology to Solving Societal Issues in Bolivia: An Overview," in *International Astronautical Congress - IAC 2017* (Adelaide, Australia, 2017), 6, <https://hal.archives-ouvertes.fr/hal-01640966>.

Command and control of TKSAT-1 is accomplished via two Bolivian satellite ground stations, the Amachuma station in La Paz and the La Guardia station in Santa Cruz. Chinese on-site support operators assisted until March 2016, but ABE personnel have been entirely responsible for all aspects of daily satellite operations since then.⁸⁷ Bolivia owns both stations, and Bolivian companies constructed them; however, Chinese contractors defined the technical specifications.⁸⁸ Additionally, the Amachuma ground station includes a telecommunications port that serves as a hub to provide services to various other public and private clients.⁸⁹ As a result, Bolivia can use TKSAT-1's capabilities to generate commercial income while providing free services to meet domestic promises.

2. Sino-Bolivian Space Cooperation

Since ABE's inception, Chinese space cooperation has been an integral part of Bolivia's national space program's evolution. Bilateral space cooperation with China officially began in 2010 with the signing of the MoU to develop TKSAT-1.⁹⁰ Bolivia signed the \$300 million CGWIC contract to construct and deliver the communications satellite package the following year, eighty-five percent of which was funded by the CDB's loan.⁹¹ Three years later, Bolivia operationally accepted TKSAT-1 and had the national means to command and control the satellite via two ground stations with expertly trained ABE personnel.

CGWIC's package deal allowed Bolivian professionals to receive training from Chinese space experts. Bolivia initially sent 64 ABE technicians to China in 2012 to train

⁸⁷ Agencia Boliviana Espacial [Bolivian Space Agency], *Plan Estratégico 2016–2020 [Strategic Plan 2016–2020]*, 11.

⁸⁸ Agencia Boliviana Espacial [Bolivian Space Agency], 10.

⁸⁹ Agencia Boliviana Espacial [Bolivian Space Agency], "Informacion de TKSAT-1" [TKSAT-1 information].

⁹⁰ Froehlich, Soria, and De Marchi, *Space Supporting Latin America: Latin America's Emerging Space Middle Powers*, 192.

⁹¹ Andrew Wight, "China, Eyeing Bolivia's Lithium Riches, Helps Country into Space," *The Sydney Morning Herald*, February 20, 2018, <https://www.smh.com.au/world/south-america/china-eyeing-bolivia-s-lithium-riches-helps-country-into-space-20180220-p4z0yz.html>.

in the technical and management aspects of TKSAT-1 and other space technologies.⁹² Then, in 2013, 10 more ABE technicians went to China to learn telecommunications port engineering and operations.⁹³ China also assists in the training and education of students involved in the aerospace fields. In 2016, ABE developed the country's first specialized study program in space application, utilizing partnerships and technology transfers between Bolivia's Mayor of San Andres University and CGWIC.⁹⁴ Additionally, scholarships for a Master's program in Space Technology Applications (MASTA) and a Doctoral Program on Space Technology Applications (DOCSTA) are available through ABE and hosted at Beihang University, previously known as the Beijing University of Aeronautics and Astronautics.⁹⁵ These postgraduate programs specialize in microsatellite technology, space systems and operations, and space law and policy.

3. Analysis

The acquisition of TKSAT-1 provided Bolivia with immediate cost-cutting benefits, nationalistic pride, the means to fulfill its constitutional obligations and meet national socioeconomic development goals. Within four years of establishing ABE, Bolivia successfully expanded SATCOM services to thousands of neglected rural communities and most of the LAC region. China played a fundamental role in developing Bolivia's national space program. In turn, ABE's director stated to continue deepening the pragmatic cooperation between China and Bolivia within the Chinese Space Silk Road framework.⁹⁶

⁹² Bolivia, "Rumbo a China 64 técnicos Bolivianos para capacitarse en el manejo del satélites" [64 Bolivian technicians head to China for satellite training].

⁹³ "Envían diez becarios a China a capacitarse en operación de telepuertos para manejo de satélite" [Ten fellows fly to China to train in satellite management], Noticias de Universidades de Bolivia [Bolivian Universities News], July 26, 2013, <https://www.universidadesbol.com/2013/07/envian-diez-becarios-china-capacitarse.html>.

⁹⁴ Vargas-Cuentas and Roman-Gonzalez, "The Space Technology to Solving Societal Issues in Bolivia: An Overview," 6.

⁹⁵ Vargas-Cuentas and Roman-Gonzalez, 7.

⁹⁶ Muñoz, "El embajador Huang Yazhong en Bolivia asiste a la ceremonia de inicio del proyecto de reforma de la estación terrestre de satélite Boliviano" [Ambassador Huang Yazhong attends the opening ceremony of the project to reform Bolivia's satellite ground station].

A decade following ABE's foundation, the future of Sino-Bolivian space cooperation remains linked with ongoing partnership programs.

During this boom period of Sino-Bolivian space cooperation, U.S. relations with Bolivia heavily declined. In recent years, President Morales accused the United States of undermining his presidency and expelled the U.S. ambassador, U.S. law enforcement, and development cooperation agencies, and terminated U.S.-Bolivia bilateral investment treaties.⁹⁷ The United States Agency for International Development suspended assistance in 2013, ending a 50-year, \$2 billion legacy of improving Bolivian citizens' lives. In contrast, between 2009–2020, state-run Chinese banks loaned an estimate of \$3.4 billion to the Bolivian government and state-run enterprises⁹⁸ for development and infrastructure projects valued at \$5.1 billion.⁹⁹ Nearly all projects were categorized under the BRI framework, including the TKSAT-1 satellite program.

With his left-wing populism and strong desire to empower Bolivia's poor and indigenous population, President Morales' political ideals aligned with China's policies towards the LAC region. Official Bolivian narrative states that "Bolivia and China enjoy a cooperative, "horizontal" relationship based on their complementary economic needs and shared political worldview."¹⁰⁰ Although Morales was removed from power after the controversial national elections of 2019, his 14-year presidency and successful Movement Toward Socialism (Movimiento al Socialismo) party platform led to the 2020 election of a new president loyal to the Morales' regime. Under continual socialist party leadership and declining U.S. relations, Bolivian politics may be a strong factor in defining China as its partner of choice for space cooperation.

⁹⁷ "U.S. Relations With Bolivia," United States Department of State, January 19, 2021, <https://www.state.gov/u-s-relations-with-bolivia/>.

⁹⁸ "China-Latin America Finance Database," The Dialogue, accessed August 17, 2020, https://www.thedialogue.org/map_list/.

⁹⁹ "China Global Investment Tracker," American Enterprise Institute, accessed September 17, 2020, <https://www.aei.org/china-global-investment-tracker/>.

¹⁰⁰ Emily Achtenberg and Rebel Currents, "Financial Sovereignty or A New Dependency? How China Is Remaking Bolivia," North American Congress on Latin America, August 10, 2017, <https://nacla.org/blog/2017/08/11/financial-sovereignty-or-new-dependency-how-china-remaking-bolivia>.

B. PERU

The Republic of Peru is an Andean nation with a South Pacific coastline and borders five South American countries. Roughly one-third of its estimated 32.2 million population resides in the western coastal plains, one-half in Andean highlands.¹⁰¹ The remainder is spread along the eastern Andean slope and among the jungles of the Amazon basin. Peru experienced favorable economic circumstances between 2004–2013,¹⁰² allowing the government to take a significant step in developing its national space program by acquiring its first national satellite. A dramatic decline in poverty and unemployment over the last decade has improved Peru’s domestic conditions, and its economy is one of the best performing in the region.¹⁰³ Although it is challenging to quantify space capabilities’ contributions to Peru’s socioeconomic success, the nation’s enduring history of space advancements and partnerships indicates a future of long-lasting international space cooperation.

1. Space Activities Overview

Peru officially entered the national space scene on June 11, 1974, with the passage of a law that created the National Commission of Aerospace Research and Development (Comisión Nacional de Investigación y Desarrollo Aeroespacial [CONIDA]) to serve as the Peruvian national space agency. CONIDA’s mission is to utilize science and space technologies to generate products and services that contribute to the nation’s socioeconomic development and security.¹⁰⁴ It aims to place Peru as a regional space leader and a prominent presence in the international space community.

¹⁰¹ “Peru - The World Factbook,” Central Intelligence Agency, March 5, 2021, <https://www.cia.gov/the-world-factbook/countries/peru/#geography>.

¹⁰² Froehlich, Soria, and De Marchi, *Space Supporting Latin America: Latin America’s Emerging Space Middle Powers*, 415.

¹⁰³ Central Intelligence Agency, “Peru - The World Factbook.”

¹⁰⁴ “¿Qué hacemos?” [What do we do?], Comisión Nacional de Investigación y Desarrollo Aeroespacial [National Commission of Aerospace Research and Development], November 17, 2020, <https://www.gob.pe/4108-comision-nacional-de-investigacion-y-desarrollo-aeroespacial-que-hacemos>.

The Peruvian space agency's technical branch is structured into five sub-divisions to achieve its national space objectives. Two divisions handle CONIDA's space education and observational research.¹⁰⁵ The Space Studies Directorate (Dirección de Estudios Espaciales) promotes nationwide space education and interfaces with foreign and domestic institutions and companies to develop specialized training and programs. CONIDA's Astronomy and Space Sciences Directorate (Dirección de Astronomía y Ciencias Espaciales [DIACE]) carries out broad electromagnetic spectrum research and develops and implements scientific instrumentation.¹⁰⁶ DIACE operates two Peruvian space observatories and one weather station with remote instrumentation capable of studying solar and atmospheric phenomena from Antarctica.¹⁰⁷

Three divisions utilize space capabilities to directly support domestic development. The Space and Geomatics Applications Directorate (Dirección de Aplicaciones Espaciales y Geomática [DIAPG]) performs geospatial research and development for national and international community benefits.¹⁰⁸ Specifically, this division produces a diverse range of products for Peruvian institutions using satellite imagery. For example, a DIAPG analyzed imagery from multiple satellites from 2017–2019 to estimate Peruvian coca cultivation across the country's geographically varying districts.¹⁰⁹ DIAPG also partnered with the Peruvian national emergency center to aid with natural disaster preparation and response.

¹⁰⁵ Reglamento de organización y funciones de la agencia espacial del Perú [Regulations for the organization and functions of the Peruvian space agency], ROF-001-OPP-001 § (2020), <https://cdn.www.gob.pe/uploads/document/file/1319076/ROF%20CONIDA%20APROBADO%20DEL%2023-09-2020.pdf>.

¹⁰⁶ Reglamento de organización y funciones de la Comisión Nacional de Investigación y Desarrollo Aeroespacial [Regulations for the organization and functions of the National Commission for Aerospace Research and Development], N° 060–2020-JEINS-CONIDA § (2020), https://cdn.www.gob.pe/uploads/document/file/1319075/RJ%20060-2020%20AUTORIZA%20ROF%20ACTUALIZADO_23.09.pdf.

¹⁰⁷ “Proyectos e investigaciones” [Projects and research], Comisión Nacional de Investigación y Desarrollo Aeroespacial [National Commission of Aerospace Research and Development], December 21, 2020, <https://cdn.www.gob.pe/uploads/document/file/1489772/Brochure%20FINAL.pdf.pdf>.

¹⁰⁸ Reglamento de organización y funciones de la Comisión Nacional de Investigación y Desarrollo Aeroespacial [Regulations for the organization and functions of the National Commission for Aerospace Research and Development].

¹⁰⁹ Comisión Nacional de Investigación y Desarrollo Aeroespacial [National Commission of Aerospace Research and Development], “Proyectos e investigaciones” [Projects and research].

The Space Technologies Directorate (Dirección de Tecnología Espacial [DITEC]) develops and advances the nation's rocket program and satellite technologies.¹¹⁰ The National Center for Satellite Imagery Operations (Centro Nacional de Operaciones de Imágenes Satelitales [CNOIS]) operates the nation's EO satellite imagery system, PerúSAT-1, which supports national development, security, and defense. Together, DITEC and CNOIS develop and acquire the space technology and personnel expertise required to transform Peru into a major regional space power.

According to a former head of CONIDA, 20 Peruvian public institutions purchased satellite imagery to carry out their functions before PerúSAT-1.¹¹¹ Between 2011 and 2015, these institutions spent the equivalent of \$570,000 to purchase an average of 38 images per year. Since the operational handover of PerúSAT-1 from Airbus in December of 2016,¹¹² CONIDA has provided free satellite images to these institutions and other registered users.¹¹³ CNOIS reported that over 76,000 images were distributed across 574 users between January 2017 and October 2020.¹¹⁴ Furthermore, the report claims that PerúSAT-1 has saved its users over \$1.28 billion compared to the cost of purchasing foreign satellite imagery. At that rate, the Peruvian government recovered PerúSAT-1's \$211 million contract cost¹¹⁵ in the first year of satellite operations alone.

¹¹⁰ Reglamento de organización y funciones de la Comisión Nacional de Investigación y Desarrollo Aeroespacial [Regulations for the organization and functions of the National Commission for Aerospace Research and Development].

¹¹¹ Carlos Caballero León, "PeruSAT-1: La carrera espacial Peruana con tareas pendientes [PeruSAT-1: The Peruvian space race with pending tasks]," *Gestión*, September 9, 2019, <https://gestion.pe/opinion/perusat-1-la-carrera-espacial-peruana-con-tareas-pendientes-noticia/>.

¹¹² "Peruvian Government: 'Satellite Investment Recovered after First Year of Operations,'" Airbus, December 7, 2017, <https://www.airbus.com/newsroom/press-releases/en/2017/12/Perusat-first-year-of-operations.html>.

¹¹³ Caballero León, "PeruSAT-1: La carrera espacial Peruana con tareas pendientes" [PeruSAT-1: The Peruvian space race with pending tasks].

¹¹⁴ Comisión Nacional de Investigación y Desarrollo Aeroespacial [National Commission of Aerospace Research and Development], "Proyectos e investigaciones" [Projects and research].

¹¹⁵ Peter B. de Selding, "Airbus Beats Crowded Field To Build Peru a Reconnaissance Satellite," *SpaceNews*, April 25, 2014, <https://spacenews.com/40333military-space-quarterly-airbus-beats-crowded-field-to-build-peru-a/>.

a. Launch Capabilities

The launch base Punta Lobos, located south of Lima on Peru's coast, was established shortly after the foundation of CONIDA. Operated by the Peruvian Air Force, Punta Lobos was extensively used between the 1970s and 1990s by NASA, among other foreign research organizations, to conduct sounding-rocket atmospheric research.¹¹⁶ Peru only participated in this collaborative project in a supporting role, but the collaboration prepared Peru to develop its national rocket program.

A joint venture between CONIDA and the Peruvian Air Force produced the nation's first sounding rocket. Named Paulet I, this sounding rocket was launched from the Punta Lobos launch facility in December 2006 and carried scientific devices that measured upper-atmospheric conditions.¹¹⁷ The follow-on rocket, Paulet 1M, was successfully launched in September 2009. In September 2011, CONIDA launched an experimental sounding rocket named X-PAX-II,¹¹⁸ which paved the way for the June 2013 launch of the Paulet 1B, lauded as Peru's first rocket built exclusively with indigenous technology.¹¹⁹

CONIDA continues to advance its rocket program through DITEC and plans to launch its next generation of sounding rockets in the near future. The proposed Paulet 1C and Paulet 1D sounding rockets are estimated to reach an altitude of 120 kilometers using an upgraded rocket-propulsion system.¹²⁰ The sustained development of Peruvian rocket and instrumentation technology signals that Peru may soon develop the equipment necessary to reach low-Earth orbit and advance its rocket program towards the sovereign ability to access and utilize space freely.

¹¹⁶ Juan Martín Canales Romero, "Sounding Rocket Program in Peru," in *SpaceOps 2012 Conference*, SpaceOps Conferences (American Institute of Aeronautics and Astronautics, 2012), 4, <https://doi.org/10.2514/6.2012-1275893>.

¹¹⁷ Martín Canales Romero, 6.

¹¹⁸ Martín Canales Romero, 6.

¹¹⁹ Sarli et al., "Review of Space Activities in South America," 220.

¹²⁰ Comisión Nacional de Investigación y Desarrollo Aeroespacial [National Commission of Aerospace Research and Development], "Proyectos e investigaciones" [Projects and research].

b. Satellite Production

Peruvian academic institutions led the nation's research in satellite development and fielded four small scientific satellites in the last eight years. Teachers and students from the Pontifical Catholic University of Peru (Pontificia Universidad Católica del Perú) developed the first two satellites.¹²¹ The PUCP-Sat-1 and Pocket-PUCP launched from Russia's Dombrovsky Air Base on November 21, 2013.¹²² The smaller Pocket-PUCP payload was deployed 15 days later from PUCP-Sat-1 on December 6, 2013.¹²³ Together, these satellites monitor environmental conditions and calculate time and distance to orbit the Earth.

Two other universities produced the final two Peruvian scientific satellites launched in 2014. Students and professionals from Alas Peruanas University (Universidad Alas Peruanas) developed the UAPSAT-1 to monitor satellite telemetry and environmental conditions using amateur radio broadcasts.¹²⁴ NASA launched the satellite in January 2014 from its Wallops Flight Facility in Virginia. The fourth and final Peruvian-built satellite was based on a Stanford University CubeSat design and constructed by students at Peru's National Engineering University (Universidad Nacional de Ingeniería).¹²⁵ Chasqui-I was hand-released by a Russian Cosmonaut in August 2014 during an International Space Station spacewalk.¹²⁶ Chasqui-I was an imaging satellite designed to take EO photos from low-Earth orbit.¹²⁷ One source reported that the satellite passed validation tests at the

¹²¹ Sarli et al., "Review of Space Activities in South America," 220.

¹²² William Graham, "Russian Dnepr Conducts Record Breaking 32 Satellite Haul," NASA Space Flight, November 21, 2013, <https://www.nasaspaceflight.com/2013/11/russian-dnepr-record-breaking-32-satellite-haul/>.

¹²³ Froehlich, Soria, and De Marchi, *Space Supporting Latin America: Latin America's Emerging Space Middle Powers*, 423.

¹²⁴ Sarli et al., "Review of Space Activities in South America," 220.

¹²⁵ Harding, *Space Policy in Developing Countries*, 158.

¹²⁶ Jerry Wright, "Station Spacewalkers Deploy Nanosatellite, Install and Retrieve Science," NASA, August 17, 2014, <http://www.nasa.gov/content/station-spacewalkers-deploy-nanosatellite-install-and-retrieve-science>.

¹²⁷ Harding, *Space Policy in Developing Countries*, 158.

university and later Russia;¹²⁸ however, two sources concluded that Chasqui-I produced no post-launch data¹²⁹ due to the absence of satellite downlink signals.¹³⁰ Despite the efforts by Peru's civil educational institutions, CONIDA has not expressed interest in the indigenous development of a national satellite.

c. Satellite Operations

Peru entered the modern age of space capabilities when it acquired its high-tech EO satellite. Following a government-to-government agreement with France,¹³¹ CONIDA partnered with Airbus Defense and Space and signed a 2014 contract in which the French company developed PerúSAT-1 for the Peruvian space agency.¹³² The agreement included an Airbus-built image analysis and processing center and training for 50 Peruvian engineers in satellite construction and image analysis.¹³³ The satellite was launched from Kourou, French Guiana, on September 16, 2016, and is controlled and operated by CONIDA members via the CNOIS satellite ground station near Lima, Peru.¹³⁴ This station can manage all of PerúSAT-1's satellite functions, including status monitoring, commanding, image processing, and registered external user requests.¹³⁵ In addition, the

¹²⁸ "Peruvian Chasqui I Satellite Was Launched into Space," Geospatial World, February 7, 2014, <https://www.geospatialworld.net/news/peruvian-chasqui-i-satellite-was-launched-into-space/>.

¹²⁹ Erik Kulu, "Chasqui-I," Nanosats Database, March 22, 2020, <https://www.nanosats.eu/sat/chasqui-i.html>.

¹³⁰ "Chasqui 1," Gunter's Space Page, accessed February 12, 2021, https://space.skyrocket.de/doc_sdat/chasqui-1.htm.

¹³¹ Caballero León, "PeruSAT-1: La carrera espacial Peruana con tareas pendientes" [PeruSAT-1: The Peruvian space race with pending tasks].

¹³² "PerúSAT-1 Mission," Airbus, accessed November 16, 2020, <https://www.airbus.com/space/earth-observation/perusat.html>.

¹³³ "Vega To Launch Peruvian Imaging Satellite Along with Skybox Craft," SpaceNews, March 25, 2015, <https://spacenews.com/vega-to-launch-peruvian-imaging-satellite-along-with-skybox-craft/>.

¹³⁴ Froehlich, Soria, and De Marchi, *Space Supporting Latin America: Latin America's Emerging Space Middle Powers*, 424.

¹³⁵ "Centro nacional de operaciones de imágenes satelitales" [National center for satellite imagery operations], Comisión Nacional de Investigación y Desarrollo Aeroespacial [National Commission of Aerospace Research and Development], accessed February 11, 2021, <https://www.gob.pe/10396-comision-nacional-de-investigacion-y-desarrollo-aeroespacial-centro-nacional-de-operaciones-de-imagenes-satelitales>.

Airbus Defense and Space contract gave CONIDA access to request and download images from six other French-built EO satellites.

The capabilities derived from PerúSAT-1 align with Peru's domestic and strategic objectives. Airbus states that PerúSAT-1's 70-centimeter very-high-resolution optical imager is capable of both civil and military applications. These applications range from "homeland security and border monitoring, coastal surveillance and the fight against illegal trafficking to mining, geology, hydrology, disaster management, and environmental protection."¹³⁶ PerúSAT-1 originated as a Peruvian national public investment project designed to provide national benefits in defense, agriculture, mining, and forestry.¹³⁷ PerúSAT-1's capabilities deliver products throughout the Peruvian government, non-profit agencies, academic institutions, the press, and the general public. Collaboration with state institutions has helped detect irregularities in public works, drug trafficking intelligence, response to natural disasters, tracking of deforestation, and generation of national cartography.¹³⁸ DIAPG generated reports to the Peruvian Ministry of Health on the status of public compliance to pandemic restrictions utilizing PerúSAT-1 imagery.¹³⁹ Peru continues to find innovative ways to apply satellite imagery to achieve domestic objectives and validate its space-capabilities investments.

2. Sino-Peruvian Space Cooperation

Unlike Bolivia and Venezuela, which cooperate bilaterally with China on space programs, Peru is engaged in multilateral Chinese space cooperation. APSCO "provides a cooperative mechanism for developing countries in the Asia-Pacific region to be able to

¹³⁶ Airbus, "PerúSAT-1 Mission."

¹³⁷ Comisión Nacional de Investigación y Desarrollo Aeroespacial [National Commission of Aerospace Research and Development], "Centro nacional de operaciones de imágenes satelitales" [National center for satellite imagery operations].

¹³⁸ Airbus, "Peruvian Government: 'Satellite Investment Recovered after First Year of Operations.'"

¹³⁹ "Coronavirus: satélite PerúSAT-1 monitorea situación de cuarentena" [Coronavirus: PeruSAT-1 satellite monitors quarantine situation], Andina, May 18, 2020, <https://andina.pe/agencia/noticia-coronavirus-satelite-perusat1-monitorea-situacion-cuarentena-797793.aspx>.

mainstream peaceful uses of space as a driver of development.”¹⁴⁰ APSCO’s founding nine members signed the Convention of APSCO in 2005 and 2006: Bangladesh, China, Indonesia, Iran, Mongolia, Pakistan, Peru, Thailand, and Turkey. Indonesia failed to ratify the protocols set forth by various national governments, and thus APSCO was inaugurated in December 2008 with the remaining eight nations as member states.¹⁴¹ The convention defines the PRC as APSCO’s host government,¹⁴² clearly cementing China’s leadership role within the organization.

APSCO’s key fields of operations comply with Peru’s desire to utilize space and advance its native capabilities for domestic development. These fields of cooperation include space technology and applications, such as EO, environmental management, SATCOM, navigation and positioning, centralized space-data banks, education, and training.¹⁴³ Article 7 of the Convention of APSCO lists the basic activities all dues-paying member states shall participate in, and Article 8 allows for participation in optional activities.¹⁴⁴ Peru plays a role within some of these fields of cooperation and activities as follows.

One of CONIDA’s observatories is situated in the mountainous Huancayo region of central Peru. DIACE manages this space observation center, and its instruments include Global Navigation Satellite System (GNSS) monitoring equipment¹⁴⁵ and a 15-centimeter-aperture electro-optical telescope.¹⁴⁶ The monitoring equipment is part of APSCO’s

¹⁴⁰ “APSCO Brochure” (Asia-Pacific Space Cooperation Organization, 2018), <http://www.apsco.int/upload/file/20180703/201807031400255205.pdf>.

¹⁴¹ James Clay Moltz, *Asia’s Space Race: National Motivations, Regional Rivalries, and International Risks* (New York: Columbia University Press, 2011), 94.

¹⁴² Asia-Pacific Space Cooperation Organization, *Convention of the Asia-Pacific Space Cooperation Organization* (2005), <http://www.apsco.int/upload/file/20180525/2018052510341620388.pdf>.

¹⁴³ Asia-Pacific Space Cooperation Organization.

¹⁴⁴ Asia-Pacific Space Cooperation Organization.

¹⁴⁵ Manop Aorpimai, “APSCO IGMA Network” (Fourteenth meeting of the UNOOSA ICG, Bengaluru, India, December 9, 2019), https://www.unoosa.org/documents/pdf/icg/2019/icg14/WGS/icg14_wgs_16.pdf.

¹⁴⁶ Comisión Nacional de Investigación y Desarrollo Aeroespacial [National Commission of Aerospace Research and Development], “Proyectos e investigaciones” [Projects and research].

International GNSS Monitoring and Assessment (IGMA) project that promotes understanding and cooperation of GNSS monitoring among APSCO member states. The Space Technology Applications Network, one of six APSCO cooperative programs, initiated the IGMA project.¹⁴⁷ The telescope is part of the Asia-Pacific ground-based Optical Space object Observation System (APOSOS) and is the prioritized project of a second APSCO cooperative program called the Ground-Based Optical Space Object Observation Network.

APOSOS is a multilateral SSA program designed to track space objects. Peru is one of three global APOSOS observation nodes; Pakistan and Iran have identical 15-centimeter-aperture telescopes.¹⁴⁸ The SSA network aims to track and acquire astrometric measurements of space objects owned by APSCO members. It can also track any item with a diameter as small as 10 centimeters in low Earth orbit (LEO) or one meter in geosynchronous Earth orbit (GEO). Observational data is routed to the Data and Operation Management Center in the Chinese Academy of Science's National Astronomical Observatory. The center is also responsible for network coordination, observation schedule, orbit determination, and more.¹⁴⁹ Heavy Chinese investment in APOSOS has resulted in predominantly Chinese management of the program.

The third cooperative program that Peru contributes to is the Education and Training Center (ETC) Network. To facilitate the frequent exchange of information and knowledge among member states, APSCO has commissioned an ETC in all member-state locations.¹⁵⁰ The ETC center in APSCO's headquarters in Beijing serves as the educational focal point for online distance education. Peru led online courses as recently as October 2020, when a Peruvian Air Force engineer taught an introductory satellite subsystems

¹⁴⁷ Asia-Pacific Space Cooperation Organization, "APSCO Brochure."

¹⁴⁸ Xiaozhong Guo et al., "Introduction to APOSOS Project: 15 Cm Aperture Electro-Optical Telescopes to Track Space Objects," *Advances in Space Research* 65, no. 8 (April 15, 2020): 1990–2002.

¹⁴⁹ Guo et al., 1990.

¹⁵⁰ Asia-Pacific Space Cooperation Organization, "APSCO Brochure."

course to APSCO members.¹⁵¹ In return, CONIDA members and Peruvian students have participated in numerous APSCO-sponsored technical training courses, Chinese higher-education resident programs such as MASTA and DOCSTA, international symposiums, and microsatellite competitions.¹⁵² Peru's small contribution to the ETC Network is a high return on investment due to the immense opportunities provided by China's host role in APSCO.

The Disaster Monitoring Network is a fourth cooperation program to which Peru directly contributes into. Its objective is to optimize best practices for disaster monitoring and rescue operations among APSCO member states.¹⁵³ Basic activities within this network include programs that integrate satellite and ground observations for earthquake signatures and precursors, such as ground-based ionosphere monitoring and space-based electromagnetic observations.¹⁵⁴ Other disasters of concern to the Asia-Pacific region are droughts, forest fires, and various storms. APSCO's website describes these programs as running smoothly under the leadership of Chinese government institutions.¹⁵⁵

The remaining two APSCO cooperative programs rely almost exclusively on Chinese investment due to Peru and other member states' absent capabilities. APSCO's Data Sharing Network was initiated in 2012 to meet member state demands for a wide range of satellite imagery.¹⁵⁶ By April 2014, the Data Sharing Service Platform was fully

¹⁵¹ "Ingeniero Peruano dicta curso internacional sobre satélites a países miembros de APSCO" [Peruvian engineer gives international course on satellites to APSCO member countries], Comisión Nacional de Investigación y Desarrollo Aeroespacial [National Commission of Aerospace Research and Development], October 13, 2020, <https://www.gob.pe/institucion/conida/noticias/307090-ingeniero-peruano-dicta-curso-internacional-sobre-satelites-a-paises-miembros-de-apsco>.

¹⁵² Froehlich, Soria, and De Marchi, *Space Supporting Latin America: Latin America's Emerging Space Middle Powers*, 422.

¹⁵³ Asia-Pacific Space Cooperation Organization, "APSCO Brochure."

¹⁵⁴ "Disaster Monitoring and Mitigation Network," Asia-Pacific Space Cooperation Organization, July 4, 2018, <http://www.apsco.int/html/comp1/content/DisasterMonitoringNetwork/2018-07-04/45-173-1.shtml>.

¹⁵⁵ Asia-Pacific Space Cooperation Organization.

¹⁵⁶ Asia-Pacific Space Cooperation Organization, "About Asia-Pacific Space Cooperation Organization."

operational and ready for member states to request images. China is the sole provider of the platform's data via a constellation of nine Chinese EO satellites.¹⁵⁷

Finally, the Space Segment Network and Interconnection of Ground Systems program utilize APSCO's joint Small Multi-Mission Satellite (SMMS) constellation as a platform for member states to receive shared satellite data.¹⁵⁸ Despite calling it a joint program, China is currently the sole contributor, launching the first participating satellite in 2008¹⁵⁹ and providing the current SMMS constellation with three on-orbit imaging satellites.¹⁶⁰ Peruvian socioeconomic development benefited from the SMMS program's start because APSCO was a source of CONIDA's procured foreign satellite imagery before acquiring PerúSAT-1.¹⁶¹

Peru possibly may not include PerúSAT-1 into the SMMS constellation, or any APSCO cooperative program, due to probable agreements with Airbus Defense and Space. A summary of space objects owned by APSCO member states reveals that Peru owns two active satellites while China owns 253 of the remaining 283.¹⁶² Therefore, every space segment of an APSCO cooperation program will depend on heavy Chinese investment and contribution. Peru, and many non-Chinese member states, can only contribute to APSCO's objectives via the ground segment of space programs and through exchanges of education and training.

3. Analysis

Long-term Chinese space cooperation through APSCO may define CONIDA's preferred method for future space engagement. Although China did not bid during

¹⁵⁷ Asia-Pacific Space Cooperation Organization, "APSCO Brochure."

¹⁵⁸ Asia-Pacific Space Cooperation Organization.

¹⁵⁹ Garvin, "Launching Latin America," 73.

¹⁶⁰ Asia-Pacific Space Cooperation Organization, "APSCO Brochure."

¹⁶¹ Serna, "The U.S.-Latin America Space Cooperation Equation," 32.

¹⁶² Guo et al., "Introduction to APOSOS Project: 15 Cm Aperture Electro-Optical Telescopes to Track Space Objects," 1991.

PerúSAT-1's official request for proposal,¹⁶³ despite five years of APSCO cooperation at the time, Peru signaled the significance of Airbus' commitment to training dozens of Peruvian engineers during satellite development.¹⁶⁴ In addition, the partnership with France provided Peru with long-term opportunities for EO capacity development and technology transfer. China offers Peru similar domestic development opportunities through APSCO but expands shared technical capabilities, training, and educational programs beyond one type of space system.

The framework for future Chinese-led multilateral space cooperation was published in the APSCO's Development Vision 2030 document. APSCO aims to significantly enhance its member states' space capabilities to realize "the Asia-Pacific dream of common development, prosperity, and improvement."¹⁶⁵ The goals, priorities, and objectives outlined in the 2018 document concentrated on resource sharing, capacity building, and talent cultivation to enable member states to benefit from space technology's socioeconomic applications. Overall, APSCO has launched 13 joint research projects, recruited 250 master's and Ph.D. candidates, and trained over 1,000 technicians.¹⁶⁶ Since China provides most of the organization's resources, Peru benefits from maintaining this long-term cooperation if China can continue sponsoring it.

China expands its ground-based space capabilities from Peru's membership in APSCO and utilizes space cooperation as a tool to advance its geopolitical and economic ambitions. Western hemisphere access to Peruvian ground stations provides China with expanded BeiDou satellite monitoring and near-full SSA coverage in GEO and LEO. APSCO is a permanent observer at COPUOS and participates in all meetings, including legal and technology subcommittees,¹⁶⁷ presenting China with an additional international

¹⁶³ Serna, "The U.S.-Latin America Space Cooperation Equation," 31.

¹⁶⁴ Sarang, "Changing Objectives in Achieving Space Sovereignty in Latin America," 130.

¹⁶⁵ Asia-Pacific Space Cooperation Organization, *Development Vision 2030 of The Asia-Pacific Space Cooperation Organization (APSCO)*.

¹⁶⁶ Asia-Pacific Space Cooperation Organization.

¹⁶⁷ "International Cooperation," Asia-Pacific Space Cooperation Organization, accessed January 17, 2021, http://www.apsco.int/html/comp1/content/International_Cooperation/2019-02-21/17-252-1.shtml.

forum to promote its agenda. China's white paper on its space activities in 2016 highlighted APSCO's strategy alignment with the BRI for "Facilitating Regional Capacity Building of the Asia-Pacific Countries."¹⁶⁸ The paper also called for creating the BRI Space Information Corridor, distinguishing space-related development projects from the broader BRI framework.

As the only LAC member state of both APSCO and the BRI, Peru is a unique model for Chinese space cooperation in the region. Although Peru acquired its EO satellite through an agreement with France, China invested heavily and is continuously advancing Peru's ground-based space capabilities, personnel training, and shared space data and applications. APSCO is an example of a successful multilateral alternative to U.S. space cooperation, and its membership promotes long-term space engagements in the LAC region.

C. VENEZUELA

The Bolivarian Republic of Venezuela is South America's northernmost Andean nation bordered by Colombia, Brazil, Guyana, and the Caribbean Sea. Most of the country's 30 million inhabitants are concentrated in the northern and western highlands along the north end of the Andes Mountain range.¹⁶⁹ The urban population accounts for almost ninety percent of the total population, leaving roughly 3 million scattered in remote and rural regions. Once a relatively stable democracy and one of Latin America's fastest-rising economies, Venezuela's oil-export-dependent economy has declined since the 1980s, and its democratic institutions have devolved to authoritarian rule.¹⁷⁰ It is now

¹⁶⁸ China State Council, *White Paper on China's Space Activities in 2016*, pt. V.

¹⁶⁹ "Venezuela - The World Factbook," Central Intelligence Agency, June 29, 2021, <https://www.cia.gov/the-world-factbook/countries/venezuela/>.

¹⁷⁰ Marcos Ommati, "From Riches to Rags, the History of the Venezuelan Crisis," *Diálogo Americas*, July 26, 2019, <https://dialogo-americas.com/articles/from-riches-to-rags-the-history-of-the-venezuelan-crisis/>.

estimated that ninety-six percent of Venezuela's population live in poverty, and seventy percent live in extreme poverty.¹⁷¹

Venezuela's leftist authoritarian rule began in 1999 with the late ex-president Hugo Chavez and now continues with Nicolas Maduro, both of whom have outspokenly denounced and criticized the U.S. government and its foreign policies. Venezuela created a national space agency during this period of economic decline and political instability and acquired Chinese-built space capabilities. Negative U.S. relations opened the opportunity for China to become Venezuela's space-cooperation partner of choice. This close association of two U.S.-challenging regimes in the LAC region may contest U.S. space security and further CCP interests from within the hemisphere.

1. Space Activities Overview

Venezuela's National Constitution of 1999 served as its first legal framework for developing its space activities. It established Venezuela's rights in outer space, recognized the value of outer space as a common heritage of mankind, and affirmed compliance with established international space agreements.¹⁷² Additionally, Venezuela could now participate in international space forums, such as the United Nations, to coordinate space activities following international law. The Venezuelan government then created relevant institutions to manage the nation's indigenous space efforts.

A national body dedicated to developing space activities was formed in 2004 and is credited with beginning Venezuela's space history.¹⁷³ This commission paved the way for creating Venezuela's national space agency, the Bolivarian Agency for Space Activities (Agencia Bolivariana para Actividades Espaciales [ABAE]), in 2007. ABAE was structured under the Ministry of Science and Technology. Its philosophies were driven by

¹⁷¹ Noelani Kirschner, "Under Maduro, Nearly All Venezuelans Live in Poverty," ShareAmerica, August 3, 2020, <https://share.america.gov/under-maduro-nearly-all-venezuelans-live-in-poverty/>.

¹⁷² R. Acevedo et al., "Space Activities in the Bolivarian Republic of Venezuela," *Space Policy* 27, no. 3 (August 2011): 174, <https://doi.org/10.1016/j.spacepol.2011.02.003>.

¹⁷³ Froehlich, Soria, and De Marchi, *Space Supporting Latin America: Latin America's Emerging Space Middle Powers*, 432.

the advancement of society, the development of space capabilities through human training and technology transfer, and the establishment of international cooperation.¹⁷⁴

Guided by the country's National Plan for Science Technology and Innovation 2005–2030, ex-President Chavez aligned the social and economic developments that space capabilities contribute to with his Bolivarian socialist agenda.¹⁷⁵ Adherence to the peaceful use of outer space served as the main principle that drove the development and growth of its space capabilities to satisfy social needs, support national programs, promote regional integration and cooperation, and prioritize technology transfer and human training.¹⁷⁶ Thus, Venezuela advanced its space program to acquire SATCOM and EO capabilities, despite its troubled political and economic institutions.

a. Satellite Operations

ABAE acquired its first space capability through a communications satellite program called VENESAT-1. In November 2005, Venezuela signed a bilateral contract with China to manufacture and launch a satellite named Simón Bolívar, to construct ground control stations, and to train Venezuelan personnel.¹⁷⁷ The SATCOM payload operated in three frequencies and provided Venezuela and the continent with radio, TV, and data access.¹⁷⁸ The ground segment was managed and operated by ABAE personnel and consisted of a primary control station inside a Venezuelan military base and a backup facility in a different region. The satellite was launched from a Chinese space center in

¹⁷⁴ Acevedo et al., “Space Activities in the Bolivarian Republic of Venezuela,” 176.

¹⁷⁵ Delgado-López, “Sino-Latin American Space Cooperation,” 10.

¹⁷⁶ Acevedo et al., “Space Activities in the Bolivarian Republic of Venezuela,” 176.

¹⁷⁷ “VENESAT-1,” Agencia Bolivariana para Actividades Espaciales [Bolivarian Agency for Space Activities], accessed May 1, 2021, http://www.abae.gob.ve/?page_id=1090.

¹⁷⁸ Mariano Imbert, “China-Venezuela Space Cooperation Benefits and Review,” *Aerospace China* 17, no. 4 (October 20, 2016): 47–55.

October 2008, and although it had an estimated 15-year lifespan, it suffered an early mission-ending mechanical failure in March 2020.¹⁷⁹

Access to the regional services provided by the VENESAT-1 program improved existing applications that strengthened social development. Among these examples, telemedicine programs were expanded to rural areas and increased real-time interaction and response times.¹⁸⁰ VENESAT-1 also increased environmental monitoring data transfer to aid with disaster management and biodiversity conservation. Additionally, because most of Venezuela's population and development is concentrated in the north, poverty was reduced in the remote southern regions due to new communication infrastructure that promoted economic and educational growth. According to Venezuela's national telecommunications company, ninety percent of the satellite's capacity is used for mass social services.¹⁸¹ The early success of the VENESAT-1 program encouraged the country to continue its bilateral space cooperation with China to acquire and expand its space capabilities.

Venezuela distinguished itself from the other less-developed space nation case studies because it successfully acquired a second satellite capability. In May 2011, Venezuela signed a contract with CGWIC to develop and launch Venezuela's first EO satellite.¹⁸² The Venezuelan Remote Sensing Satellite program, or VRSS-1, included the Miranda satellite, ground infrastructure, technology transfer, and human training. Miranda was launched in September 2012, and its applications include environmental management, urban planning, disaster management, scientific research, defense, among others.¹⁸³ All

¹⁷⁹ Caleb Henry, "Solar Array Problem Killed Venezuela's VeneSat-1, Officials Confirm," SpaceNews, March 30, 2020, <https://spacenews.com/solar-array-problem-killed-venezuelas-venesat-1-officials-confirm/>.

¹⁸⁰ Acevedo et al., "Space Activities in the Bolivarian Republic of Venezuela," 177.

¹⁸¹ "La cooperación aeroespacial entre China y Venezuela" [Aerospace cooperation between China and Venezuela], Agencia Bolivariana para Actividades Espaciales [Bolivarian Agency for Space Activities], July 31, 2017, <http://www.abae.gob.ve/?p=885>.

¹⁸² Acevedo et al., "Space Activities in the Bolivarian Republic of Venezuela," 177.

¹⁸³ Imbert, "China-Venezuela Space Cooperation Benefits and Review," 49.

ground and satellite functions, including data processing and distribution, are performed by ABAE personnel.

Direct access to satellite imagery allowed Venezuela to freely share valuable data with a variety of national users. In September 2020, Miranda celebrated 8 years of operational use and distributed more than 58,000 images to public, private, national, and international organizations and institutions.¹⁸⁴ In addition, ABAE created basic courses and seminars to promote its space capabilities so that more of the population is aware of the benefits and the use of satellite imagery.¹⁸⁵ The success of Miranda facilitated the acquisition of a second Chinese-built EO satellite, the VRSS-2 program.

Venezuela signed a second EO satellite cooperation agreement with China in 2014, and the Sucre satellite was launched in October 2017.¹⁸⁶ Sucre's upgraded sensors provided higher resolution compared to Miranda and included the addition of an infrared camera.¹⁸⁷ Both satellites were placed in the same orbit with a phase of 180 degrees of separation for improved revisit and image acquisition. Sucre's capabilities complemented and improved Miranda's contribution to Venezuela's national and social development; as of June 2021, both satellites have captured over one million images and increased the technical expertise of ABAE personnel.¹⁸⁸

¹⁸⁴ "Venezuela celebra 8 años de puesta en órbita del satélite Miranda" [Venezuela celebrates 8 years since putting the Miranda satellite into orbit], Agencia Bolivariana para Actividades Espaciales [Bolivarian Agency for Space Activities], September 28, 2020, <http://www.abae.gob.ve/?p=1772>.

¹⁸⁵ Imbert, "China-Venezuela Space Cooperation Benefits and Review," 53.

¹⁸⁶ Froehlich, Soria, and De Marchi, *Space Supporting Latin America: Latin America's Emerging Space Middle Powers*, 443.

¹⁸⁷ "VRSS-2," Agencia Bolivariana para Actividades Espaciales [Bolivarian Agency for Space Activities], July 17, 2020, http://www.abae.gob.ve/?page_id=1094.

¹⁸⁸ "Satélites Miranda y Sucre han aportado más de un millón de imágenes para el beneficio del país" [Miranda and Sucre satellites have contributed more than one million images for the benefit of the country], Agencia Bolivariana para Actividades Espaciales [Bolivarian Agency for Space Activities], June 17, 2021, <http://www.abae.gob.ve/?p=2712>.

2. Sino-Venezuelan Space Cooperation

Bilateral cooperation with China is directly responsible for the achievements and advancements of Venezuela's national space capabilities and technological competency. Venezuela's national mandate states that all bilateral agreements must include SATCOM, EO, and scientific space program development, capacity building, personnel training, and technology transfer.¹⁸⁹ Furthermore, Venezuelan space cooperation efforts have emphasized South-South cooperation with countries that share those foreign policy principles.¹⁹⁰ Since 2005, China has satisfied Venezuela's requirements for space cooperation and continues to build a strong partnership based on mutual interests.

China and Venezuela have signed five cooperation agreements associated with the peaceful use of outer space. They include the satellite programs VENESAT-1, VRSS-1, VRSS-2, the creation of a Venezuelan space research and innovation center, and the establishment of a space science and technology training center in China.¹⁹¹ A unique joint work methodology model allowed Venezuelan staff to actively participate in all phases of the VRSS-2 program, allowing ABAE personnel to gain in-depth knowledge of satellite production.¹⁹² These Venezuelan milestones were realized through bilateral cooperation agreements with CGWIC and CASC. Based on these strong relationships, a VENESAT-2 program may soon become the sixth cooperation agreement due to VENESAT-1's recent on-orbit failure.

Bilateral cooperation also exists between both country's national space agencies. ABAE and China's National Space Administration (CNSA) signed an agreement to

¹⁸⁹ Sarli et al., "Review of Space Activities in South America," 221.

¹⁹⁰ Delgado-López, "Sino-Latin American Space Cooperation," 10.

¹⁹¹ "A 13 años de cooperación con China, Venezuela continúa su crecimiento en el área espacial" [After 13 years of cooperation with China, Venezuela continues its growth in the space area]. Agencia Bolivariana para Actividades Espaciales [Bolivarian Agency for Space Activities], January 28, 2018, <http://www.abae.gob.ve/?p=555>.

¹⁹² Agencia Bolivariana para Actividades Espaciales [Bolivarian Agency for Space Activities], "La cooperación aeroespacial entre China y Venezuela" [Aerospace cooperation between China and Venezuela].

exchange remote sensing satellite data and satellite applications.¹⁹³ A virtual constellation was formed with Venezuela's VRSS satellites and China's Gaofen EO satellites, allowing both countries to access satellite imagery from the constellation. In 2017, Venezuela's satellite ground station successfully conducted the first data receiving test from a Chinese Gaofen satellite. CGWIC stated the test was an implementation of the space agreements signed between CNSA and ABAE and an implementation of the BRI framework.¹⁹⁴ This statement aligns with China's intent outlined in its 2016 policy paper on LAC and is consistent with China's practice of space cooperation within the BRI Space Information Corridor framework in Latin America.

3. Analysis

Despite Venezuela's early attempt at space cooperation with South American countries, China emerged as the dominant space partner of choice in the mid-2000s. ABAE's partnerships with Chinese space corporations enabled the acquisition of three satellites, the construction of satellite ground stations, and the technical training of over 200 ABAE personnel¹⁹⁵ in eight short years. The declining state of Venezuela's economy caused government criticism for investing millions of dollars into space technology when other domestic needs were more critical.¹⁹⁶ However, government officials successfully argued that space technology investments contribute directly to the development and well-being of the country.

Political factors cannot be dismissed as a contributor to the close relationship between Venezuela and China. Hugo Chávez himself said that an increasingly strong China is needed to transfer technology to the world, and that he is grateful for China's non-

¹⁹³ Agencia Bolivariana para Actividades Espaciales [Bolivarian Agency for Space Activities].

¹⁹⁴ China Great Wall Industry Corporation, "CGWIC Helps Receipt of GF-2 Satellite Data in Venezuela," *Aerospace China* 18, no. 2 (Summer 2017): 57, <http://www.aerospacechina.org/EN/Y2017/V18/I2/57>.

¹⁹⁵ Simon Garcia, "Venezuela and China Share Knowledge on Space Cooperation," *Gobierno Bolivariano de Venezuela*, July 3, 2019, <http://www.mppre.gob.ve/en/2019/07/03/venezuela-china-space-cooperation/>.

¹⁹⁶ Delgado-López, "Sino-Latin American Space Cooperation," 10.

imperialistic cooperation methods.¹⁹⁷ In 2016, ABAE's executive director wrote that "it is not a coincidence that the strengthening of relations with China came under the government of President Hugo Chavez."¹⁹⁸ Chavez's Bolivarian revolution enabled strong Chinese space cooperation resulting in space technology that advanced Chavez's politics throughout the country and region.

Venezuela's political instability and humanitarian crisis caused by Maduro have not deteriorated Chinese relations. China's Foreign Ministry spokesperson said in 2020 that China would continue cooperation with Venezuela, despite U.S. sanctions threats.¹⁹⁹ While China may continue cooperation, it is important to highlight that Venezuela has been unable to repay \$60 billion in Chinese loans,²⁰⁰ and severing cooperation may be financially impossible for China. ABAE's Director of International Affairs hopes to acquire a replacement for the Simón Bolívar satellite in 2022,²⁰¹ and it is assumed that another agreement will be signed with China. Thanks to the ongoing Sino-Venezuelan space cooperation, Venezuela expanded its space participation to the international realm.

Since 2006, Venezuela has signed instruments of bilateral cooperation in the space field with five LAC countries, focusing on scientific and technological training.²⁰² Additionally, Venezuela was the third LAC country to join an international charter dedicated to delivering space data to those affected by major disasters. Within the United Nations, Venezuela's representative welcomed the PPWT proposed by Russia and China

¹⁹⁷ Agencia Bolivariana para Actividades Espaciales [Bolivarian Agency for Space Activities], "A 13 años de cooperación con China, Venezuela continúa su crecimiento en el área espacial" [After 13 years of cooperation with China, Venezuela continues its growth in the space area].

¹⁹⁸ Imbert, "China-Venezuela Space Cooperation Benefits and Review," 48.

¹⁹⁹ "China Will Carry out Cooperation with Venezuela Even If the Situation Changes," Global Times, accessed April 1, 2021, <https://www.globaltimes.cn/content/1208259.shtml>.

²⁰⁰ Antonio C. Hsiang, "Why Latin American Populism Is Bad News for China," The Diplomat, August 13, 2019, <https://thediplomat.com/2019/08/why-latin-american-populism-is-bad-news-for-china/>.

²⁰¹ Garcia, "Venezuela and China Share Knowledge on Space Cooperation."

²⁰² J.A. Pena and T. Yumin, "The Role of Venezuelan Space Technology in Promoting Development in Latin America," *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences* XLII-2/W7 (September 13, 2017): 851–56, <https://doi.org/10.5194/isprs-archives-XLII-2-W7-851-2017>.

and considered it a legal instrument to protect peace in outer space.²⁰³ The delegate continued to express “concern about the development of spy satellites, by some member states of the UN, which constitutes a violation of the sovereignty of States.” One implication of that statement is that Venezuela aligns with China’s rhetoric that the United States poses a security concern in the space domain.

²⁰³ Simon Garcia, “Venezuela Exhorts to Respect the Principle of Non-Militarization of the Space,” Gobierno Bolivariano de Venezuela [Government of Venezuela], October 25, 2018, <http://www.mppre.gob.ve/en/2018/10/25/venezuela-exhorts-to-respect-the-principle-of-non-militarization-of-the-space/>.

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III. CASE STUDIES: MAJOR-DEVELOPED SPACE NATIONS

This chapter introduces the case studies of Argentina and Brazil. These countries were selected and grouped because they each have a national space agency, a history of Chinese space cooperation, and “major-developed” space capabilities. These countries have participated in space activities as far back as the 1950s when Argentina researched and developed rocket engines²⁰⁴ and Brazil built a satellite reception station.²⁰⁵ This chapter is important because Argentina and Brazil prioritize advancing their national space industries and the need for sovereign space capabilities. Unlike the less-developed space nations, both countries seek mutual-benefit space cooperation and do not favor agreements leading to technological dependency. Therefore, Chinese space cooperation with Argentina and Brazil is uniquely different, yet shaped to promote long-term space partnerships.

Argentine and Brazilian politics influenced space cooperation partners throughout the development of their space programs. Initially, both countries were aligned with the United States over their common opposition to communism in Latin America during the Cold War.²⁰⁶ However, as missile and nuclear proliferation emerged as facets of their bilateral regional competition, the United States placed export control restrictions on these regimes and limited the potential for space cooperation programs. This drove “Latin American space programs to seek other partners, including nations hostile to U.S. interests.”²⁰⁷

Argentina and Brazil have a history of space cooperation with the United States, among other international actors, but a preferred space partner is not yet apparent. Both countries are currently involved in Chinese space cooperation agreements, such as a

²⁰⁴ Froehlich, Soria, and De Marchi, *Space Supporting Latin America: Latin America's Emerging Space Middle Powers*, 149.

²⁰⁵ Froehlich, Soria, and De Marchi, 200.

²⁰⁶ Robert C. Harding, “Emerging Space Powers of Latin America: Argentina and Brazil,” in *Yearbook on Space Policy 2012/2013: Space in a Changing World*, ed. Cenan Al-Ekabi et al. (Vienna: Springer, 2015), 230, https://doi.org/10.1007/978-3-7091-1827-6_6.

²⁰⁷ Garvin, “Launching Latin America,” 53.

Chinese space station for Argentina and the China-Brazil joint satellite program for Brazil, engagements that are designed to be decades-long. Through bilateral and multilateral space cooperation, China has been allowed unprecedented access to space capabilities in the western hemisphere.

A. ARGENTINA

Argentina's geographical territory accounts for most of the continent's Southern Cone region and shares a border with Bolivia, Brazil, Chile, Paraguay, and Uruguay. One-third of its 45.9 million inhabitants live in the capital city of Buenos Aires, while the remainder is primarily distributed among population masses in the northern and central regions.²⁰⁸ Once one of the wealthiest countries in the world, "Argentina suffered during most of the 20th century from recurring economic crises, persistent fiscal and current account deficits, high inflation, mounting external debt, and capital flight."²⁰⁹ Despite the constant financial turmoil and political instability, Argentina transformed itself into one of the LAC region's most advanced and technologically independent space nations.

Argentina presently faces another economic crisis that negatively impacts its space sector. Although Argentina has one of the largest economies in the region with abundant natural resources in energy, minerals, and agriculture,²¹⁰ its current inflation rate is forty percent, and close to thirty percent of the population is unemployed.²¹¹ The government's crushing \$324 billion debt caused two loan defaults in the last 20 years,²¹² and it is avoiding its third default by negotiating with the International Monetary Fund on a \$45 billion

²⁰⁸ "Argentina - The World Factbook," Central Intelligence Agency, August 23, 2021, <https://www.cia.gov/the-world-factbook/countries/argentina/>.

²⁰⁹ Central Intelligence Agency.

²¹⁰ "The World Bank in Argentina," The World Bank, April 5, 2021, <https://www.worldbank.org/en/country/argentina/overview>.

²¹¹ Patrick Gillespie, "Covid Layoff Ban Backfires in One of World's Worst Job Markets," Bloomberg, December 10, 2020, <https://www.bloomberg.com/news/articles/2020-12-10/covid-layoff-ban-backfires-in-one-of-world-s-worst-job-markets>.

²¹² "Argentina in Default for Second Time This Century," Deutsche Welle, May 23, 2020, <https://www.dw.com/en/argentina-in-default-for-second-time-this-century/a-53542302>.

debt.²¹³ In 2016, government investments in national satellite manufacture, launch, and operation fell by fifty-five percent.²¹⁴ The economic strain caused a 2019 ESA space launch contract breach for an Argentine telecommunications satellite that was never developed.²¹⁵ Argentina faces a situation where it must abandon progress in its space sector or seek new international space cooperation or investment opportunities to advance its national space plan objectives.

1. Space Activities Overview

Argentina's National Commission for Space Research (Comisión Nacional de Investigaciones Espaciales [CNIE]) was founded in 1960 and marked the nation's entry into the space domain.²¹⁶ CNIE immediately collaborated with the Argentine Air Force to produce and launch the region's first domestic rocket into space.²¹⁷ Early engagements with U.S. space officials resulted in a NASA-CNIE MoU, leading to many of Argentina's successful 1960s rocket launches.²¹⁸ CNIE inherited political ideologies that promoted nationalism through militarism and domestic technology development,²¹⁹ yet Argentina's space program developed in close collaboration with U.S. partnership.

In the mid-1970s, Argentina's space activities were affected by political turmoil that resulted in a military coup. Scientific rocket research was halted, and a military missile program named Condor, in collaboration with a West German company, took priority.²²⁰

²¹³ "IMF and Argentina Cite Progress in \$45 Bln Debt Talks," Reuters, July 13, 2021, <https://www.reuters.com/world/americas/imf-cites-progress-debt-talks-with-argentina-2021-07-13/>.

²¹⁴ Gabriel Martínez and Guillermo Rus, "Cae un 55% la inversión en el sector espacial argentino" [Investment in the Argentine space sector falls by 55%], *Motor Economico* [Economic Motor], November 2016, <http://motoreconomico.com.ar/cruda-realidad/cae-un-55-la-inversin-en-el-sector-espacial-argentino>.

²¹⁵ Caleb Henry, "Argentine Operator Arsat Revives Plans for Third Satellite," *SpaceNews*, March 19, 2020, <https://spacenews.com/argentine-operator-arsat-revives-plans-for-third-satellite/>.

²¹⁶ Sarli et al., "Review of Space Activities in South America," 211.

²¹⁷ Harding, *Space Policy in Developing Countries*, 148.

²¹⁸ Serna, "The U.S.-Latin America Space Cooperation Equation," 37.

²¹⁹ Serna, 36.

²²⁰ Harding, "Emerging Space Powers of Latin America," 228.

Tensions with Chile plus Argentina's 1982 defeat in the Falklands War promoted cooperation with Egypt and Iraq to develop a more advanced Condor II ballistic missile. Political and financial factors, including U.S. pressure, terminated the program in the 1980s.²²¹ The United States also obstructed the Argentine military's pursuit of nuclear technology when it withdrew its support and prevented external assistance to the program.²²² Later, Argentina reallocated the accumulated experience and infrastructure towards national civil space efforts.

Argentina's shift from militarizing space to civilian purposes resulted in the establishment of its national space agency. In 1991, the Argentine president issued a decree that dissolved CNIE and created the National Commission of Space Activities (Comisión Nacional de Actividades Espaciales [CONAE]).²²³ CONAE released its first national space plan in 1995 that focused on three components: Earth observation, peaceful exploration and use of outer space, and technological developments for space use.²²⁴ Space activity was declared state policy to generate a high impact and benefit for social, environmental, economic, scientific, technological, and academic development.²²⁵

Unlike the less-developed space nations, Argentina's mature space sector focused on advancing national capabilities beyond social development needs. Policy dictated CONAE to pursue international cooperation of an associative character, a model that moved away from countries helping each other and shifted to building partnerships for mutual development.²²⁶ For example, CONAE participated in the deep space networks of

²²¹ Harding, 229.

²²² Garvin, "Launching Latin America," 25.

²²³ Serna, "The U.S.-Latin America Space Cooperation Equation," 57.

²²⁴ "Plan espacial nacional" [National space plan], Comisión Nacional de Actividades Espaciales [National Commission of Space Activities], May 30, 2018, <https://www.argentina.gob.ar/ciencia/conae/plan-espacial>.

²²⁵ "La CONAE inició la revisión estratégica del Plan Espacial Nacional 2021–2030" [CONAE initiated the strategic review of the National Space Plan 2021–2030], Comisión Nacional de Actividades Espaciales [National Commission of Space Activities], June 18, 2021, <https://www.argentina.gob.ar/noticias/la-conae-inicio-la-revision-estrategica-del-plan-espacial-nacional-2021-2030>.

²²⁶ Delgado-López, "Sino-Latin American Space Cooperation," 11.

the ESA and the CLTC²²⁷ and partnered with NASA on the scientific Aquarius mission to study the Earth's surface and oceans.²²⁸ These cooperation agreements inserted the country among nations and organizations dedicated to space research and exploration. Argentina's regionally advanced space program is thus highly cooperative and open to space cooperation with countries like China that share policies of South-South mutual development.

a. Launch Capabilities

Argentina's desire to reach space was the main driver for its earliest space efforts. Initial rocket research success led to a tactical ballistic missile development program during Argentina's military rule. CONAE's establishment consolidated the nation's launch capabilities and repurposed the efforts for civil use. Indigenous space launch capability to place national satellites in orbit is now one of CONAE's fundamental goals.²²⁹

Currently, CONAE's space launch vehicle program remains in the research and development phase. The Tronador series of launch vehicles have been under development since 2007 and should have the capacity to put a 250-kilogram and a 1,000-kilogram satellite into polar orbit.²³⁰ CONAE conducted Tronador experimental tests and launches at two Argentinean space launch centers, the Punta Indio Space Center²³¹ and the Manuel

²²⁷ "Uso del espacio ultraterrestre" [Use of outer space], Comisión Nacional de Actividades Espaciales [National Commission of Space Activities], May 30, 2018, <https://www.argentina.gob.ar/ciencia/conae/plan-espacial/uso-del-espacio-ultraterrestre>.

²²⁸ "Aquarius," Comisión Nacional de Actividades Espaciales [National Commission of Space Activities], March 2, 2018, <https://www.argentina.gob.ar/ciencia/conae/misiones-espaciales/sac-d>.

²²⁹ "Acceso al espacio" [Access to space], Comisión Nacional de Actividades Espaciales [National Commission of Space Activities], April 4, 2018, <https://www.argentina.gob.ar/ciencia/conae/acceso-al-espacio>.

²³⁰ Comisión Nacional de Actividades Espaciales [National Commission of Space Activities].

²³¹ "Centro Espacial Punta Indio" [Punta Indio Space Center], Comisión Nacional de Actividades Espaciales [National Commission of Space Activities], May 30, 2018, <https://www.argentina.gob.ar/ciencia/conae/centros-y-estaciones/centro-espacial-punta-indio>.

Belgrano Space Center, located within Argentina's Puerto Belgrano Naval Base.²³² Consequently, third-party international organizations have performed all space launches for Argentina's satellites.

b. Satellite Production

Argentina relied on a state-owned enterprise to fulfill its national satellite development. In 1979, INVAP was founded to address national technological needs by transferring academic knowledge to the industrial sector.²³³ The company initially developed state nuclear technology and later became the contractor for the nation's space program. INVAP is the only LAC company capable of providing complete satellite programs and has produced seven satellites for CONAE since 1996.²³⁴ In addition, the state-run Argentine Satellite Solutions Company (Empresa Argentina de Soluciones Satelitales [ARSAT]) contracted with INVAP to develop national telecommunications satellites.²³⁵ INVAP has partnered with international agencies such as NASA, ESA, the Center for Space Studies in France (Centre National D'Etudes Spatiales [CNES]), the Brazilian Space Agency (Agência Espacial Brasileira [AEB]),²³⁶ and Turkish Aerospace.²³⁷ Much like CONAE's foreign policy, INVAP built international associations for the common development of satellite production.

c. Satellite Operations

As one of the region's major-developed space nations, Argentina develops, owns, and operates SATCOM, EO, and scientific satellites. Argentina achieved sovereign

²³² "Centro Espacial Manuel Belgrano" [Manuel Belgrano Space Center], Comisión Nacional de Actividades Espaciales [National Commission of Space Activities], May 30, 2018, <https://www.argentina.gob.ar/ciencia/conae/centros-y-estaciones/centro-espacial-manuel-belgrano>.

²³³ Sarli et al., "Review of Space Activities in South America," 211.

²³⁴ "Scientific Application Satellites," INVAP, accessed July 26, 2021, <https://www.invap.com.ar/en/divisions/aerospace/scientific-application-satellites/>.

²³⁵ "Communication Satellites," INVAP, accessed July 26, 2021, <https://www.invap.com.ar/en/divisions/aerospace/communication-satellites/>.

²³⁶ INVAP, "Scientific Application Satellites."

²³⁷ INVAP, "Communication Satellites."

satellite capabilities via national and private organizations and through international cooperation. Argentina's National Space Plan prioritized the creation of higher education and job opportunities in the space sector.²³⁸ CONAE and the National University of Córdoba offer a master's degree in space applications and a doctorate in geomatics and space systems.²³⁹ Additionally, CONAE and the Colomb Institute offer three master's degrees in radio astronomy research. Argentina's investment in human capital and capacity building has contributed to the success of native satellite production and operations.

Between 1996–2011, CONAE carried out four scientific satellite missions with cooperation and contributions from NASA, the Italian Space Agency, CNES, the Danish Space Research Institute, and the Canadian Space Agency.²⁴⁰ This series of Scientific Applications Satellites (Satélite de Aplicaciones Científicas [SAC]) demonstrated technology, tested space instruments, and took scientific Earth observations and environmental measurements. CONAE personnel operated the SAC satellites via the Córdoba Earth Station located in the country's Teófilo Tabanera Space Center. INVAP was the prime contractor for developing the satellites, and NASA provided the space launch service.²⁴¹

Argentina achieved its domestic SATCOM capabilities through a state-owned company. In 2006, federal law created ARSAT for the domestic development of GEO SATCOM satellites, the provision of satellites facilities, and the commercialization of

²³⁸ Froehlich, Soria, and De Marchi, *Space Supporting Latin America: Latin America's Emerging Space Middle Powers*, 178.

²³⁹ "CONAE cumple 30 años afianzando la tecnología espacial argentina" [CONAE celebrates 30 years strengthening Argentine space technology], Argentina Ministerio de Ciencia, Tecnología e Innovación [Argentina Ministry of Science, Technology and Innovation], May 28, 2021, <https://www.argentina.gob.ar/noticias/conae-cumple-30-anos-afianzando-la-tecnologia-espacial-argentina-0>.

²⁴⁰ "Misiones cumplidas" [Accomplished missions], Comisión Nacional de Actividades Espaciales [National Commission of Space Activities], March 2, 2018, <https://www.argentina.gob.ar/ciencia/conae/misiones-espaciales/misiones-cumplidas>.

²⁴¹ Comisión Nacional de Actividades Espaciales [National Commission of Space Activities].

satellite services.²⁴² INVAP was the primary developer for the ARSAT-series satellites and performed all satellite testing and continued operations.²⁴³ ESA space vehicles launched ARSAT-1 in 2014 and ARSAT-2 in 2015, and the constellation offered coverage for the entire western hemisphere, including Antarctica and the Falkland Islands.²⁴⁴

CONAE's latest satellite program provided the nation with EO capabilities. The Argentine Microwave Observation Satellite (Satélite Argentino de Observación Con Microondas [SAOCOM]) program's primary objective was to deliver socio-economic benefits in the agriculture, hydrology, and health sectors.²⁴⁵ The satellite's indigenous synthetic aperture radar provides soil moisture maps that support regional decisions related to sowing, fertilization, irrigation, fumigation, and flood forecasting.²⁴⁶ INVAP built two identical SAOCOM satellites, and they were launched in 2018 and 2020 by U.S.-based SpaceX. A bilateral agreement between CONAE and the Italian Space Agency allowed both agencies to share EO data between satellites for the purpose of emergency and disaster management.²⁴⁷

2. Sino-Argentine Space Cooperation

Argentina and China announced the signing of a bilateral space cooperation agreement in 2004. This partnership allowed China to provide Argentina with commercial launch services, satellite components, and other space-related technology.²⁴⁸ In 2005,

²⁴² Froehlich, Soria, and De Marchi, *Space Supporting Latin America: Latin America's Emerging Space Middle Powers*, 155.

²⁴³ "Communication Satellites."

²⁴⁴ "Satelital" [Satellite], ARSAT, accessed July 26, 2021, <https://www.arsat.com.ar/satelital/>.

²⁴⁵ "Objetivos" [Objectives], Comisión Nacional de Actividades Espaciales [National Commission of Space Activities], March 1, 2018, <https://www.argentina.gob.ar/ciencia/conae/misiones-espaciales/saocom/objetivos>.

²⁴⁶ "SAOCOM," Comisión Nacional de Actividades Espaciales [National Commission of Space Activities], March 1, 2018, <https://www.argentina.gob.ar/ciencia/conae/misiones-espaciales/saocom>.

²⁴⁷ "Misiones satelitales" [Satellite missions], Comisión Nacional de Actividades Espaciales [National Commission of Space Activities], March 1, 2018, <https://www.argentina.gob.ar/ciencia/conae/misiones-espaciales>.

²⁴⁸ Klinger, "A Brief History of Outer Space Cooperation Between Latin America and China," 56.

representatives from Argentina traveled to China to observe the inauguration of the multilateral space cooperation organization named APSCO, however, Argentina never joined. That same year, Argentina's University of San Juan collaborated with China National Astronomical Observatories and the China National Academy of Science to develop a satellite laser ranging facility.²⁴⁹ Despite these mid-2000s space cooperation efforts, the most significant Chinese partnership outcomes occurred in the following decade.

Sino-Argentine space cooperation resulted in the construction of a Chinese-operated satellite launch and tracking facility in Argentina. The CLTC-CONAE-NEUQUEN Station was the product of interinstitutional agreements between the CLTC, CONAE, the province of Neuquén, and a 2014 intergovernmental agreement between the Argentine Republic and the PRC.²⁵⁰ China invested \$300 million to construct a 35-meter primary antenna, a 13.5-meter antenna, an operations center, and an educational center.²⁵¹ CONAE stated the facility was leased tax-free to China for 50 years and is for the communication, command, and data acquisition of Chinese Lunar Exploration Program (CLEP) missions, and for the observation and exploration of deep space and radio astronomy.²⁵² As China's first satellite control station outside its borders, this agreement allows China to communicate with its satellites and space mission vehicles when they are in view from the western hemisphere.

China first utilized the CLTC-CONAE-NEUQUEN Station in 2018 during a historic Moon mission. On December 7, China launched the Chang'e 4 mission to land a rover on the far side of the Moon. In conjunction with Chinese stations in China and Namibia, the Argentine station tracked and communicated with the Chang'e 4 spacecraft

²⁴⁹ Klinger, 56.

²⁵⁰ "Antecedentes" [Background], Comisión Nacional de Actividades Espaciales [National Commission of Space Activities], June 1, 2018, <https://www.argentina.gob.ar/ciencia/conae/centros-y-estaciones/antecedentes-1>.

²⁵¹ Victor Robert Lee, "China Builds Space-Monitoring Base in the Americas," *The Diplomat*, May 24, 2016, <https://thediplomat.com/2016/05/china-builds-space-monitoring-base-in-the-americas/>.

²⁵² Comisión Nacional de Actividades Espaciales [National Commission of Space Activities], "Antecedentes" [Background].

and Chinese relay satellites.²⁵³ These ground stations were later utilized in the success of the Chang'e 5 mission that retrieved samples from the Moon²⁵⁴ and the Tianwen-1 mission, which landed a Chinese rover on the surface of Mars.²⁵⁵

Argentina dimly benefited from the construction of the Chinese station in various ways. The cooperation agreement granted CONAE access to 10 percent of the antenna's use time to develop national scientific research projects and regional and international cooperation.²⁵⁶ In addition, CONAE may install onsite equipment and utilize the network of space ground stations in Chinese territory to support Argentine space missions. CONAE stated that the facility promoted the community's economic, technological, and educational development by creating jobs and promoting tourism to its education center.²⁵⁷

In 2020, China and Argentina resumed and expanded on the space cooperation agreements established in 2014. The deal focused on the “development of ships and other instruments for space exploration, as well as land infrastructure to launch and control space missions and satellites.”²⁵⁸ The agreement also increased space data sharing, research, and academic findings between CONAE and CNSA. The establishment of long-term space cooperation and the creation of the CLTC-CONAE-NEUQUEN Station have tied both countries into a 50-year agreement of joint efforts toward advancing their space capabilities.

²⁵³ Andrew Jones, “China Launches Chang’e-4 Spacecraft for Pioneering Lunar Far Side Landing Mission,” SpaceNews, December 7, 2018, <https://spacenews.com/china-launches-change-4-spacecraft-for-pioneering-lunar-far-side-landing-mission/>.

²⁵⁴ Adam Mann, “China’s Chang’e 5 Mission: Sampling the Lunar Surface,” Space, December 10, 2020, <https://www.space.com/change-5-mission.html>.

²⁵⁵ “Presencia argentina en la misión espacial China a Marte” [Argentine presence in the Chinese space mission to Mars], Comisión Nacional de Actividades Espaciales [National Commission of Space Activities], July 23, 2020, <https://www.argentina.gob.ar/noticias/presencia-argentina-en-la-mision-espacial-china-marte>.

²⁵⁶ “Usos” [Uses], Comisión Nacional de Actividades Espaciales [National Commission of Space Activities], June 1, 2018, <https://www.argentina.gob.ar/ciencia/conae/centros-y-estaciones/usos-0>.

²⁵⁷ Comisión Nacional de Actividades Espaciales [National Commission of Space Activities].

²⁵⁸ Gillespie, “China and Argentina Resume Joint Venture for Space Exploration.”

3. Analysis

In 2011, Delgado-Lopez noted that China had not played an important role in Argentina's space program but that China was sure to remain an important player in Argentina's economic and political future.²⁵⁹ Argentina faced a financial crisis in the late 1990s through the early 2000s, and U.S.-Argentine relations declined; the governing Kirchner political party and the Argentine population blamed U.S. policies as one reason for the economic meltdown.²⁶⁰ The United States failed to offer any financial assistance, and, as a result, Argentina increased bilateral relations with China.²⁶¹ The recent space cooperation agreements with China, including the Chinese-operated ground station, were due to Kirchner's return to political office.

In 2015, then Argentine President Cristina Fernández de Kirchner announced the prospect of "military sales and defense cooperation agreements extending beyond the scope of any made between China and a Latin American nation to date."²⁶² Under space cooperation, Argentina endorsed the Chinese construction of the CLTC-CONAE-NEUQUEN Station. CONAE stated the installation's CLEP mission and the Chinese body in charge, the CLTC, are purely civil.²⁶³ However, a China Aerospace Studies Institute report emphasized that "there are strong indications that [the CLTC] is a major component—or potentially synonymous with—the PLA [Strategic Support Force] SSF Space Systems Department."²⁶⁴ The bilateral agreement allowed China to utilize the

²⁵⁹ Delgado-López, "Sino-Latin American Space Cooperation," 12.

²⁶⁰ Garvin, "Launching Latin America," 61.

²⁶¹ Janie Hulse, *China's Expansion Into and U.S. Withdrawal from Argentina's Telecommunications and Space Industries and the Implications for U.S. National Security*: (Fort Belvoir, VA: Defense Technical Information Center, 2007), 46, <https://doi.org/10.21236/ADA471923>.

²⁶² Jordan Wilson, *China's Military Agreements with Argentina: A Potential New Phase in China-Latin America Defense Relations* (Washington, DC: U.S.-China Economic and Security Review Commission, 2015), 3.

²⁶³ Comisión Nacional de Actividades Espaciales [National Commission of Space Activities], "Antecedentes" [Background].

²⁶⁴ Peter Wood, Taylor A. Lee, and Alex Stone, *China's Ground Segment: Building the Pillars of a Great Space Power* (Montgomery, AL: China Aerospace Studies Institute, 2021), 22, https://www.airuniversity.af.edu/Portals/10/CASI/documents/Research/Space/2021-03-01%20Chinas%20Ground%20Segment.pdf?ver=z4ogY_MrxaDurwVt-R9J6w%3D%3D.

facility tax-free for 50 years to communicate with current and future satellites and space missions visible over the western hemisphere, with the potential for unregulated military use.

Argentina faces another financial crisis, and China may provide relief for its debt and its underfunded space program. In November 2020, Argentina’s ambassador to China confirmed that Argentina “is making plans to join the Belt and Road Initiative (BRI) very soon.”²⁶⁵ The BRI would provide Argentina with much-needed opportunities for cooperation in infrastructure projects, financial assistance, and access to Space Silk Road programs. China is Argentina’s largest trading partner and considers Argentina a comprehensive strategic partner, a status few countries have,²⁶⁶ in a period where the United States seeks to rebuilt relations.

B. BRAZIL

The Federative Republic of Brazil is the largest and most populated country in the LAC region. Its area covers nearly half of the continent and borders every South American nation except Chile and Ecuador.²⁶⁷ A military dictatorship governed Brazil from 1964–1985. During this period, the military prioritized the development of missiles and a nuclear program.²⁶⁸ The country returned to democracy in 1988, and its space program was converted to a civilian agency. The military’s focus on space capabilities helped advance the country’s development of satellites, launch vehicles, and launch centers.²⁶⁹

²⁶⁵ Michael Zarate, “‘Argentina Will Join the Belt and Road Initiative’ —Interview with the Argentine Ambassador to China Luis María Kreckler,” *China Today*, November 3, 2020, http://www.chinatoday.com.cn/ctenglish/2018/ii/202011/t20201103_800225649.html.

²⁶⁶ Michael Zarate.

²⁶⁷ “Brazil - The World Factbook,” Central Intelligence Agency, August 24, 2021, <https://www.cia.gov/the-world-factbook/countries/brazil/>.

²⁶⁸ Delgado-López, “Sino-Latin American Space Cooperation,” 11.

²⁶⁹ Froehlich, Soria, and De Marchi, *Space Supporting Latin America: Latin America’s Emerging Space Middle Powers*, 201.

Between 2003–2014, Brazil underwent an economic and social progress boom where more than 10 percent of the population left poverty.²⁷⁰ Economic advances and geopolitical efforts by Russia and China to supplant the G-7 allowed Brazil to join the BRICS global grouping of emerging economies. According to 2020 World Bank nominal GDP data, Brazil ranks first among the largest economies in the LAC region and twelfth in the world.²⁷¹ It is unquestionably a regional power and “sometimes considered a great or a middle power in international affairs.”²⁷² However, since 2015, crippling recessions, unemployment, and national debt have halted much of Brazil’s economic progress from the previous decade.²⁷³ Despite economic and technological setbacks, Brazil continues to have the most capable and diverse space program in the LAC region.

1. Space Activities Overview

Brazil’s space efforts can be described as a “complex web of civilian and military institutions that have evolved since the late 1950s.”²⁷⁴ Following the post-war efforts of the United States and the Soviet Union, Brazil sought to develop its own ballistic missile and nuclear technologies during its authoritarian military rule.²⁷⁵ Brazil’s space development was seen “as a natural extension of the country’s long-running strategy to establish itself, at a minimum, as Latin America’s hegemon, with respect not only to South America but to the entire South Atlantic Ocean region.”²⁷⁶ Like Argentina, Brazil’s space advancements during military rule created the momentum to develop into a regional space power.

²⁷⁰ Froehlich, Soria, and De Marchi, 198.

²⁷¹ “GDP (Current US\$),” The World Bank, accessed August 31, 2021, https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?most_recent_value_desc=true.

²⁷² Froehlich, Soria, and De Marchi, *Space Supporting Latin America: Latin America’s Emerging Space Middle Powers*, 198.

²⁷³ Daniel Gallas and Daniele Palumbo, “What’s Gone Wrong with Brazil’s Economy?,” BBC News, May 26, 2019, <https://www.bbc.com/news/business-48386415>.

²⁷⁴ Garvin, “Launching Latin America,” 17.

²⁷⁵ Harding, “Emerging Space Powers of Latin America,” 223.

²⁷⁶ Harding, *Space Policy in Developing Countries*, 108.

Brazil created the Brazilian Space Agency (Agência Espacial Brasileira [AEB]) in 1994. Brazil's national space plan, the National Space Activities Program (Programa Nacional de Atividades Espaciais [PNAE]), was based on three strategic focuses. PNAE emphasized the development of space applications to respond to national problems and societal needs, the sovereignty of space capabilities, and the development and competitiveness of its space industry.²⁷⁷ The desire for technological independence led Brazil to partner with multiple countries in an effort to achieve autonomy in the satellite and launch sectors. Brazil historically saw international space cooperation as a necessity for the future of its space program and a means to answer national needs.²⁷⁸ Additionally, cooperation was seen as a method for joint development and not seeking technical assistance or dependency. As a result of shared values, the first Sino-Brazilian space cooperation program began in the 1980s and the agreement continues to this day.

a. Launch Capabilities

The military's prioritization of a missile program led to Brazil closely following Argentina's initial progress in rocket technology. In 1965, the nation's aerospace technical center established Brazil's first launch facility: the Barreira do Inferno Launch Center (Centro de Lançamento da Barreira do Inferno [CLBI]).²⁷⁹ That same year, CLBI launched the nation's first indigenous rocket. Over the next 12 years, CLBI hosted over 200 national and international sounding rocket launches, tests, and experiments.²⁸⁰ In total, Brazil

²⁷⁷ "Programa Nacional de Atividades Espaciais" [National Program of Space Activities], Agência Espacial Brasileira [Brazilian Space Agency], August 31, 2021, <https://www.gov.br/aeb/pt-br/programa-espacial-brasileiro/politica-organizacoes-programa-e-projetos/programa-nacional-de-atividades-espaciais>.

²⁷⁸ José Monserrat Filho, "Brazilian-Chinese Space Cooperation: An Analysis," *Space Policy* 13, no. 2 (May 1997): 153–70, [https://doi.org/10.1016/S0265-9646\(97\)00002-7](https://doi.org/10.1016/S0265-9646(97)00002-7).

²⁷⁹ "Centros de lançamento" [Launch centers], Agência Espacial Brasileira [Brazilian Space Agency], March 5, 2020, <https://www.gov.br/aeb/pt-br/programa-espacial-brasileiro/infraestrutura-de-solo/centros-de-lancamento>.

²⁸⁰ "Transporte espacial" [Space transport], Agência Espacial Brasileira [Brazilian Space Agency], September 3, 2020, <https://www.gov.br/aeb/pt-br/programa-espacial-brasileiro/transporte-espacial/transporte-espacial>.

launched 28 sounding rockets.²⁸¹ The technical knowledge and experience gained from the sounding rocket program were the basis for Brazil attempting a space launch program.

In 1979, the federal government approved the Brazilian Complete Space Mission (Missão Espacial Completa Brasileira [MECB]) to prioritize the development of indigenous satellites, space launch vehicles, and space launch centers.²⁸² A larger space launch center was required and the Alcantara Launch Center (Centro de Lançamento de Alcântara [CLA]) was inaugurated in 1983. National agencies were charged with executing the MECB, and the VLS-1 space launch vehicle program began.

Brazil's 1995 decision to join the Missile Technology Control Regime opened doors to space cooperation, such as an International Space Station agreement that led to the first Brazilian astronaut to go into space.²⁸³ But, it also prevented the acquisition of missile technologies, forcing ABE to develop indigenous solutions for the VLS-1 program.²⁸⁴ ABE developed the rocket prototype in 1997, but a mechanical malfunction destroyed it during liftoff.²⁸⁵ The second prototype suffered a similar fate in 1999. In 2003, the third prototype ended in disaster when it exploded on the CLA launch pad, killing 21 personnel.²⁸⁶ Reports indicated that an insufficient budget, obsolete parts, and questionable procedures may have contributed to the incident.²⁸⁷

²⁸¹ Brian Harvey, Henk H.F. Smid, and Theo Pirard, *Emerging Space Powers: The New Space Programs of Asia, the Middle East and South-America*, Springer Praxis Books (Chichester, UK: Praxis, 2010), 339.

²⁸² "História do CLA" [CLA history], Centro de Lançamento de Alcântara [Alcantara Launch Center], accessed September 3, 2021, <https://www2.fab.mil.br/cla/index.php/historias>.

²⁸³ Garvin, "Launching Latin America," 35.

²⁸⁴ Froehlich, Soria, and De Marchi, *Space Supporting Latin America: Latin America's Emerging Space Middle Powers*, 206.

²⁸⁵ "VLS-1," Agência Espacial Brasileira [Brazilian Space Agency], March 6, 2020, <https://www.gov.br/aeb/pt-br/programa-espacial-brasileiro/transporte-espacial/vls-1>.

²⁸⁶ Moltz, "Brazil's Space Program: Dreaming with Its Feet on the Ground," 15.

²⁸⁷ Larry Rohter, "Brazil's Soaring Space-Age Ambitions Are Shy of Cash and Sapped by Calamity," *The New York Times*, January 23, 2004, <https://www.nytimes.com/2004/01/23/world/brazil-s-soaring-space-age-ambitions-are-shy-of-cash-and-sapped-by-calamity.html>.

Since the disaster, Brazil leveraged its geographically favorable launch centers to try to foster international space cooperation. Brazil entered into checkered agreements with Ukraine, Russia, and Germany with hopes to generate revenue for its space program and receive technical information and assistance, diverting from MECB's focus on technological independence.²⁸⁸ In 2021, AEB announced the selection of three American and one Canadian commercial companies to utilize CLA facilities to launch non-governmental space vehicles.²⁸⁹ These agreements may be Brazil's necessary first steps to be financially and technologically prepared to resume its indigenous launch capabilities.

b. Satellite Production

Brazil's first national satellite was operational in 1993, and it was the first country in the region to achieve this feat. Brazil's National Institute of Space Research (Instituto Nacional de Pesquisas Espaciais [INPE]) developed the Data Collection Satellite (Satélite de Coleta de Dados [SCD]).²⁹⁰ SCD-1 performed environmental monitoring and provided a radio link to data receiving stations throughout Brazil. In 1997, ABE attempted to launch a second SCD-2A satellite with its indigenous launch vehicle; however, it was destroyed onboard the first VLS-1 mishap. INPE constructed a third SCD-2 satellite in 1998, and like SCD-1, SCD-2 was successfully launched on a Pegasus rocket by the late American company Orbital Sciences.²⁹¹ Additionally, INPE developed a SACI series of scientific satellites in the late 90s.²⁹² However, neither satellite became operational due to launch or operational failures.

²⁸⁸ Moltz, "Brazil's Space Program: Dreaming with Its Feet on the Ground," 15–16.

²⁸⁹ "First companies to launch non-governmental launches from the Alcântara spaceport announced," Agência Espacial Brasileira [Brazilian Space Agency], April 30, 2021, <https://www.gov.br/aeb/pt-br/assuntos/noticias/first-companies-to-launch-non-governmental-launches-from-the-alcantara-spaceport-announced>.

²⁹⁰ "Satélites," Agência Espacial Brasileira [Brazilian Space Agency], March 5, 2020, <https://www.gov.br/aeb/pt-br/programa-espacial-brasileiro/satelites/satelites>.

²⁹¹ Agência Espacial Brasileira [Brazilian Space Agency].

²⁹² "Objetos espaciais Brasileiros" [Brazilian space objects], Agência Espacial Brasileira [Brazilian Space Agency], June 30, 2021, <https://www.gov.br/aeb/pt-br/programa-espacial-brasileiro/objetos-espaciais-brasileiros>.

INPE recently developed Brazil's next generation of EO satellites. Amazonia 1 was based on a cost-cutting multi-mission platform and was indigenously designed, integrated, and tested in Brazil.²⁹³ It was launched in February 2021 onboard an Indian space launch vehicle. Various national companies were awarded contracts to manufacture the satellite's different subsystems and equipment.²⁹⁴ Amazonia 1's development led to valuable technological gains and national industry consolidation of satellite subsystem knowledge.

c. Satellite Operations

Brazil is a regional major-developed space nation that operates national SATCOM, EO, and scientific satellites. INPE is the agency responsible for satellite and ground center operations. Its satellite tracking and control capabilities are achieved through a satellite control center and two tracking and control stations.²⁹⁵ The three series of satellites that INPE currently manages are SCD, CBERS, and Amazonia.

As part of the MECB, Brazil built data collection satellites to initiate and develop its indigenous satellite program. The SCD series of satellites served environmental and scientific missions. The payload is a communications transponder that receives meteorological and ecological information from automatic data collection platforms throughout Brazil; the satellite then relays the data to INPE Earth stations.²⁹⁶ The data is used in the monitoring of river basins and for the country's Amazon surveillance system.²⁹⁷

²⁹³ "Amazon Mission," Instituto Nacional de Pesquisas Espaciais [National Institute for Space Research], accessed September 1, 2021, <http://www.inpe.br/amazonia1/en/>.

²⁹⁴ Instituto Nacional de Pesquisas Espaciais [National Institute for Space Research].

²⁹⁵ "Satellite Tracking and Control Center," Instituto Nacional de Pesquisas Espaciais [National Institute for Space Research], May 24, 2018, <http://www.inpe.br/crc/ccs.php>.

²⁹⁶ "SCD-1," Instituto Nacional de Pesquisas Espaciais [National Institute for Space Research], accessed September 2, 2021, http://www.inpe.br/scd1/site_scd/scd1/osatelite.htm.

²⁹⁷ Agência Espacial Brasileira [Brazilian Space Agency], "Satélites."

In February 2021, SCD-1, designed with a 1-year lifespan, celebrated 28 years of operations.²⁹⁸

Brazil's second national satellite capability was achieved through a joint program with China. The CBERS-series of EO satellites gave Brazil the ability to monitor its vast territory. Since 1999, China has launched six CBERS satellites; CBERS-3 was lost during a launch failure, three have been decommissioned, but two remain operational.²⁹⁹ The most recent satellite was launched in 2019. The images captured by the CBERS satellites are used in various sectors to control deforestation, monitor water resources and agriculture, optimize city planning, facilitate education, and more.³⁰⁰ Brazil and China alternate command and control of the CBERS satellites every 10 months.³⁰¹ However, each country operates the EO payload whenever a satellite passes over its territory.

Amazonia 1 is Brazil's indigenous EO satellite under national control. Its mission improves the Amazon deforestation alert system, and its sensor complements the capabilities of the current generation of CBERS.³⁰² Additionally, the data is available to government agencies and the scientific community to monitor coastal regions, water reservoirs, and environmental disasters.³⁰³

Brazil's national communications satellite was designed for dual civil-military use. The ministry of defense, the ministry of science, technology, and innovation, AEB, INPE, and the telecommunications company Telebras formed the agreement for the Geostationary

²⁹⁸ "SCD-1 completa 28 anos em operação" [SCD-1 completes 28 years of operations], Instituto Nacional de Pesquisas Espaciais [National Institute for Space Research], August 20, 2021, <https://www.gov.br/inpe/pt-br/assuntos/ultimas-noticias/satelite-de-coleta-de-dados-1-scd-1-completa-28-anos-em-operacao>.

²⁹⁹ Agência Espacial Brasileira [Brazilian Space Agency], "Objetos espaciais Brasileiros" [Brazilian space objects].

³⁰⁰ "CBERS História," Instituto Nacional de Pesquisas Espaciais [National Institute for Space Research], February 5, 2018, <http://www.cbbers.inpe.br/sobre/index.php>.

³⁰¹ "Perguntas Frequentes" [Common Questions], Instituto Nacional de Pesquisas Espaciais [National Institute for Space Research], accessed September 2, 2021, <http://www.inpe.br/faq/index.php?pai=17>.

³⁰² Agência Espacial Brasileira [Brazilian Space Agency], "Satélites."

³⁰³ "Amazon Mission."

Defense and Strategic Communications Satellite (Satélite Geoestacionário de Defesa e Comunicações Estratégicas [SGDC]) program.³⁰⁴ The French company Thales Alenia Space manufactured the GEO defense and strategic communications satellite and was launched in May 2017 by an ESA Ariane V rocket from French Guiana.³⁰⁵ SGDC was designed to provide civil high-speed internet and communications for the entire country, reaching all remote regions and increasing service to schools and hospitals. Brazil's armed forces operate the satellite from a military space operations center,³⁰⁶ and they are allotted thirty percent of the satellite's capacity for secure satellite communications.³⁰⁷ An MoU between AEB and Thales Alenia Space permitted the training of 30 Brazilian engineers and allowed technology transfer contracts.³⁰⁸ The Brazilian government plans to procure a second SGDC satellite and hopes to incorporate Brazilian components to increase local industry capacity.³⁰⁹

2. Sino-Brazilian Space Cooperation

AEB traces the history of Sino-Brazilian space cooperation back to 1988. In that year, the governments of Brazil and China signed a bilateral agreement for the joint research and production of the China-Brazil Earth Resources Satellites.³¹⁰ The MECB

³⁰⁴ Agência Espacial Brasileira [Brazilian Space Agency], "Satélites."

³⁰⁵ "Conheça o SGDC" [Meet SGDC], Telebras, accessed September 2, 2021, <https://www.telebras.com.br/telebras-sat/conheca-o-sgdc/>.

³⁰⁶ Jonathan Jayme, "Cerimônia marca inauguração das instalações do centro de operações espaciais [Ceremony marks the inauguration of the space operations center]," Força Aérea Brasileira [Brazilian Air Force], June 24, 2020, <https://www.fab.mil.br/noticias/mostra/35918/ESPA%C3%87O%20-%20Cerim%C3%B4nia%20marca%20inaugura%C3%A7%C3%A3o%20das%20instala%C3%A7%C3%B5es%20do%20Centro%20de%20Opera%C3%A7%C3%B5es%20Espaciais>.

³⁰⁷ Telebras, "Conheça o SGDC" [Meet SGDC].

³⁰⁸ "The Brazilian SGDC Dual-Use Communication Satellite Is Ready to Be Shipped to Kourou Launch Pad in French Guyana," Thales, February 3, 2017, <https://www.thalesgroup.com/en/worldwide/space/press-release/brazilian-sgdc-dual-use-communication-satellite-ready-be-shipped>.

³⁰⁹ Caleb Henry, "Brazil to Order Second Dual Civil-Military Communications Satellite," SpaceNews, April 10, 2019, <https://spacenews.com/brazil-to-order-second-dual-civil-military-communications-satellite/>.

³¹⁰ "China," Agência Espacial Brasileira [Brazilian Space Agency], September 11, 2020, <https://www.gov.br/aeb/pt-br/programa-espacial-brasileiro/cooperacao-internacional/china>.

motivated Brazil's participation because it encouraged remote sensing capabilities.³¹¹ PNAE classified the partnership as strategic to promote technology transfer and develop the ability to monitor Chinese and Brazilian territory and its natural resources.³¹² The agencies responsible for executing the program were INPE and the China Academy of Space Technology (CAST).

Agreements for early CBERS satellites had China as the prime contributor. Until 2007, China provided seventy percent of the financial and technological investment for the first three CBERS satellites.³¹³ Afterward, Brazil planned to contribute half of the investment for the remaining three satellites, aligning with the concept of mutual development. When the fourth CBERS satellite was destroyed in 2013 due to a Chinese launch problem, Brazil's half of the \$250 million satellite project was lost.³¹⁴ This failure implies that China may have subsidized some of Brazil's future CBERS investment contributions. Despite the setbacks, Sino-Brazilian space cooperation remains a mutual development program that meets "strategic objectives of the Brazilian Space Program, notably regarding the expansion and consolidation of the space industry."³¹⁵ The CBERS satellite capabilities have made Brazil the world's largest provider of free satellite images.³¹⁶

In 2015, China proposed the multilateral establishment of a BRICS constellation of EO satellites. The network of remote sensing satellites and infrastructure were to be established by Brazil, Russia, India, China, and South Africa to "deal with global

³¹¹ Instituto Nacional de Pesquisas Espaciais [National Institute for Space Research], "CBERS História."

³¹² Agência Espacial Brasileira [Brazilian Space Agency], "Programa Nacional de Atividades Espaciais" [National Program of Space Activities].

³¹³ Instituto Nacional de Pesquisas Espaciais [National Institute for Space Research], "Perguntas Frequentes" [Common Questions].

³¹⁴ Moltz, "Brazil's Space Program: Dreaming with Its Feet on the Ground," 17.

³¹⁵ Froehlich, Soria, and De Marchi, *Space Supporting Latin America: Latin America's Emerging Space Middle Powers*, 250.

³¹⁶ Shi Yinglun, "Experts Hail China-Brazil Satellite Program as Model for BRICS Sci-Tech Endeavors," XinhuaNet, November 12, 2019, http://www.xinhuanet.com/english/2019-11/12/c_138549867.htm.

challenges such as climate change, major disasters, and environmental deterioration.”³¹⁷ The agreement was recently signed in August 2021 and became the first space infrastructure project by BRICS countries. CBERS joined Chinese, Russian, and Indian satellites to form the constellation.³¹⁸ Additionally, Brazil’s satellite control center was selected as a global data receiving node for the constellation, elevating Brazil’s global space capabilities provider status. In turn, China gained western hemisphere capabilities and international recognition for leading BRICS countries in space cooperation.

3. Analysis

Brazil’s early focus on international space cooperation led to a long, ongoing bilateral partnership with China. The CBERS satellite program allowed the two developing space countries to meet domestic goals of improving socioeconomic conditions, advancing space technologies, and achieving sovereign space capabilities. CBERS’ success led to the agreement of a 2002 protocol that provided a more robust framework for future Sino-Brazilian space cooperation.³¹⁹ The protocol was lauded as a good example of South-South cooperation among developing countries. Although China initially offered most CBERS investment, Brazil has since provided nearly half of the funding for the current generation of satellites. Even so, CBERS satellites remain manufactured and launched in China.

As part of the BRICS economic bloc, Brazil gained distinction in multinational space cooperation. Brazil appears to use its space capabilities to exert global power projection to “establish itself as a regional hegemon and... to raise its prestige and standing internationally.”³²⁰ In 2015, Brazil signed an MoU on cooperation in science, technology,

³¹⁷ Zhao Lei, “BRICS to Set up Remote-Sensing Satellite Network,” China Daily, August 18, 2021, <https://www.chinadaily.com.cn/a/202108/18/WS611d1022a310efa1bd669a63.html>.

³¹⁸ Deng Xiaoci, “BRICS Countries Agree to Enhance Cooperation in Remote Sensing Satellite Data Sharing to Cope with Climate Change, Major Disasters - Global Times,” Global Times, August 18, 2021, <https://www.globaltimes.cn/page/202108/1231874.shtml>.

³¹⁹ Yun Zhao, “The 2002 Space Cooperation Protocol between China and Brazil: An Excellent Example of South–South Cooperation,” *Space Policy* 21, no. 3 (2005): 213, <https://doi.org/10.1016/j.spacepol.2005.05.003>.

³²⁰ Delgado-López, “Sino-Latin American Space Cooperation,” 11.

and innovation between the BRICS governments to strengthen space cooperation.³²¹ The agreement led to a Chinese-proposed initiative that, in 2021, created a virtual constellation of EO satellites owned, operated, and shared among BRICS nations. Brazil contributed to this initiative through CBERS and its satellite control center. However, the constellation did not include Brazil's newest Amazonia 1 EO satellite.

Recent political shifts in Brazil's government may contribute to a weakening in Sino-Brazilian space cooperation. Under ex-President Lula da Silva, Brazil's left-leaning politics favored Chinese cooperation as an alternative to the traditional great powers.³²² Over the last decade, bilateral relations expanded in many fields of cooperation, and the two countries grew closer than ever. The strategic partnership between Brazil and China caused bilateral trade to reach a historic high, mutual investment to grow in different economic sectors, and initiatives to expand in space exploration.³²³

In 2019, a far-right politician named Jair Bolsonaro became president of Brazil. Bolsonaro's frequent critiques of China "marked [a] departure from the historical trend in Brazil-China relations, which has trended toward deeper economic and political relations."³²⁴ Favorable U.S. sentiments within Brazil's new government led to renewed space cooperation by signing a technology safeguard agreement (TSA). The TSA allowed U.S. companies to conduct space launches from CLA while protecting sensitive space technology, challenging the future of Sino-Brazilian space launch cooperation.³²⁵

³²¹ "BRICS," Agência Espacial Brasileira [Brazilian Space Agency], November 9, 2020, <https://www.gov.br/aeb/pt-br/programa-espacial-brasileiro/cooperacao-internacional/brics>.

³²² Moltz, "Brazil's Space Program: Dreaming with Its Feet on the Ground," 16.

³²³ Danilo Marcondes, Pedro Henrique, and Batista Barbosa, "Brazil-China Defense Cooperation: A Strategic Partnership in the Making?," *Journal of Latin American Geography* 17, no. 2 (July 2, 2018): 141, <https://doi.org/10.1353/lag.2018.0025>.

³²⁴ Harold Trinkunas, "Testing the Limits of China and Brazil's Partnership," Brookings, July 20, 2020, <https://www.brookings.edu/articles/testing-the-limits-of-china-and-brazils-partnership/>.

³²⁵ Sean Kelly, "Why the U.S. Is Partnering with Brazil in Space Race against China," The Hill, April 2, 2019, <https://thehill.com/opinion/international/436967-why-the-us-is-partnering-with-brazil-in-space-race-against-china>.

Likewise, Brazil strengthened its space cooperation with India by selecting an Indian space launch vehicle for its Amazonia 1 mission. This agreement was a milestone for the Indian-Brazilian strategic partnership because it marked the first time Brazil chose an Indian space launch vehicle over a Chinese one.³²⁶ Furthermore, the two countries signed 15 new agreements, which included enhanced space cooperation. As a result, India could use Brazilian satellite control and tracking stations to track and receive data from Indian satellites and collaborate on future Indian lunar robotic and manned space missions.³²⁷ These actions could be agreements among the BRICS nations or a shift away from future Sino-Brazilian space partnerships.

³²⁶ Juan Pons, “Brazil Expands Strategic Alliance with India to Balance China’s Influence,” Atalayar, March 5, 2021, <https://atalayar.com/en/content/brazil-expands-strategic-alliance-india-balance-chinas-influence>.

³²⁷ Juan Pons.

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IV. CONCLUSION

This thesis aimed to analyze Sino-LAC space cooperation with those countries that have prioritized space development enough to have a national space program. The reason for this analysis was to answer the following questions: what are the motivations behind Sino-LAC space cooperation, and what do the parties stand to gain? How is Sino-LAC space cooperation structured, and is China promoting long-term technological dependencies with LAC countries? What challenges does this pose to U.S. space security, and is U.S. space policy effectively responding to the reality of regional Chinese proliferation within the space domain?

China's LAC and space activities policy papers aspire to unify and strengthen the PRC to become a global model for other developing countries. Ultimately, LAC countries seek Chinese space cooperation for two primary reasons: the need to acquire Chinese-built space capabilities to benefit national socioeconomic development or for mutual technological development to achieve sovereign space autonomy. This thesis argues that in relation to the less-developed space nations, China uses space cooperation as one tool to control developing economies and as a method to exert its geopolitical influence within the western hemisphere. In relation to the major-developed space nations, China uses space cooperation to advance its space capabilities in the western hemisphere. In both cases, China mostly designs Sino-LAC space cooperation to foster long-term space engagements and potential dependencies while promoting China's international space projection goals. Furthermore, this thesis concludes that a threat to U.S. space security due to Sino-LAC space cooperation is feasible, and that U.S. space policy is not appropriately implemented to predict, detect, and deter such a concern.

A. SUMMARY OF RESEARCH

To answer the major research questions asked in Chapter I, two sets of case studies were formed. Chapter II examined the case studies of Bolivia, Peru, and Venezuela to understand the dynamics of Sino-LAC space cooperation with regionally developing space nations. Chinese space cooperation with all three countries originated between 2005-2010,

a period in which China emerged as a major global provider of satellite products, applications, and space launch services. All three countries sought space cooperation to satisfy national development goals and to advance technological competency. Political or economic alignments and national prestige were also noteworthy motivators for Bolivia, Peru, and Venezuela to select China as a space cooperation partner.

Bolivia and Venezuela acquired their first space capabilities through bilateral agreements to purchase turn-key Chinese satellite solutions. Bolivia's acquisition of a Chinese-built communications satellite saw immediate cost-cutting benefits while satisfying constitutional obligations, meeting national socioeconomic development goals, and promoting the government's socialist agenda. Venezuela was China's first LAC customer to purchase satellite solutions. Chinese SATCOM and EO satellite programs were designed to enhance Venezuela's capacity building, personnel training, and technology transfer. Space capabilities and their applications were also used to advance the socialist politics of Hugo Chavez and Nicholas Maduro.

Bolivia is expected to acquire its second Chinese communications satellite by 2022.³²⁸ It is also predicted that China will develop Venezuela's second communications satellite to replace the failed VENESAT-1. All satellite development contracts bolstered China's commercial and national space sectors. Chinese organizations like GWIC, CASC, and CAST advanced their satellite development capabilities while increasing their international customer portfolios. China's national space agency signed agreements with LAC space agencies to share capabilities and data. Risky financing through Chinese national banks highly subsidized these space programs, creating opportunities for indebted control over regional economies.

Peru requested a remote-sensing satellite proposal, yet China withheld from the bidding process. Instead, Sino-Peruvian space cooperation is based on a Chinese-led multilateral organization, where China provides most of the investment and dependency. Peru gains from APSCO membership by having access to six cooperative programs, two of which resulted in constructing Chinese space infrastructure in Peru. China gained by

³²⁸ Wight, "China, Eyeing Bolivia's Lithium Riches, Helps Country into Space."

using APSCO's global infrastructure to increase its space capabilities and by leading APSCO in international forums to advance its space agenda. Furthermore, all space cooperation is integrated into China's BRI framework, allowing a seamless correlation with Chinese trade, finance, and infrastructure programs for Bolivia, Peru, and Venezuela.

Chapter III examined the case studies of Argentina and Brazil to understand the dynamics of Sino-LAC space cooperation with regionally advanced space nations. Both nations began their space efforts in the 1950s and now possess developed space-based capabilities, indigenous development capacities, and space launcher programs. China and Brazil initiated bilateral space cooperation in the 1980s, and the resultant CBERS satellite program is a successful example of enduring South-South space cooperation. As developing nations of the time, the CBERS framework was designed for mutual benefit. Yet, China ultimately controls manufacturing, launch, and most of the financing. In addition, Brazil's multilateral inclusion in the BRICS grouping allows for Chinese-influenced space cooperation. The resultant BRICS virtual EO constellation allows China increased access to EO imagery. Brazil's satellite control center, selected as a constellation downlink node, may download Chinese satellite imagery from the western hemisphere.

By contrast, China did not play a significant role in Argentina's developing space program. However, Argentina's financial crisis and anti-U.S. political factors of the late 1990s through early 2000s played an influential role in evolving Sino-Argentine space cooperation. Sino-Argentine space cooperation began in the 2000s. A decade later, a 50-year tax-free bilateral space cooperation agreement permitted China to build and operate a space tracking and control facility in Argentina. The station's space object tracking and control functions allowed China to successfully communicate with Chinese satellites and a space mission vehicle to land a rover on the far side of the Moon. More significantly, it is China's first military-operated space station outside of its borders. Both Argentina and China state the station's peaceful uses of outer space, yet concern regarding China's ability to utilize the station for military applications has made headlines in recent years. Recurring Argentine financial crises and reemerging shared political interests have reinvigorated Sino-Argentine cooperation. Argentina stated it plans to join the BRI, and new Sino-

Argentine agreements will increase space data sharing and allow for the new construction of Chinese space infrastructure in Argentina.

B. FINDINGS AND IMPLICATIONS

Chinese space cooperation is an intricate network of bilateral and multilateral frameworks tied to geopolitical, economic, and military policies. Defining Chinese space cooperation and its strategic motivations requires understanding the driving politics and doctrines behind them. One such policy driver uncovered in the research is China's BRI. In 2016, China published a white paper on its space activities and called for creating the BRI Space Information Corridor (also referred to as the Space Silk Road) to distinguish space-related development projects from the broader BRI framework. This association implies that China uses space cooperation as one tool to control developing economies.

A BRI MoU has been signed with 19 out of 33 LAC countries, including Bolivia, Peru, and Venezuela. A *Foreign Policy* article stated that China's continuous lending through the BRI created a trend in which indebted nations put up strategic assets as collateral via these predatory deals.³²⁹ The article also mentioned an International Monetary Fund study from 2013 to 2016 that showed China nearly doubled its contribution to the foreign debt of heavily indebted developing nations. Furthermore, It continued by citing that "observers suspect that the [BRI] is partly motivated by China's desire to stimulate its economy, obtain strategic assets, and convert its economic access into political and strategic influence in recipient nations."³³⁰ In 2020, Secretary of Defense Mark Esper said the PRC is using the BRI to leverage "its overseas investments to force other nations into sub-optimal security decisions. This has wide-reaching ramifications for the United

³²⁹ Mark Green, "China's Debt Diplomacy," *Foreign Policy*, April 25, 2019, <https://foreignpolicy.com/2019/04/25/chinas-debt-diplomacy/>.

³³⁰ Green.

States and our allies in critical areas like data security, interoperability, and military readiness.”³³¹

Published data showed that between 2005 and 2020, China has amassed roughly \$183 billion in LAC investments and contracts across many sectors.³³² Consequently, China is now the top trading partner and a preferred lender across the region,³³³ signaling a trend of diminishing U.S. economic influence.

However, the PRC cannot ignore that the four largest economies in the region, Argentina, Brazil, Colombia, and Mexico, have not joined the BRI,³³⁴ although Argentina recently declared it would soon join. Five years have passed since the PRC updated its policy papers on the LAC region and its space activities, and it may revise the conditions in an attempt to incorporate the region's most influential economic and spacefaring nations into the BRI. Doing so could increase the PRC's global infrastructure project's legitimacy while strengthening Chinese-LAC space cooperation.

The future of Chinese-led multilateral space cooperation was published in APSCO's Development Vision 2030 document. APSCO, as a participating organization in the BRI, provides relevant space services within the BRI framework.³³⁵ The PRC acknowledged that the organization relies heavily on Chinese technological and financial support due to the limited space capabilities and modest economies of its seven non-Chinese APSCO

³³¹ Mark T. Esper, “As Prepared Remarks by Secretary of Defense Mark T. Esper at the Munich Security Conference,” U.S. Department of Defense, February 15, 2020, <https://www.defense.gov/Newsroom/Speeches/Speech/Article/2085577/as-prepared-remarks-by-secretary-of-defense-mark-t-esper-at-the-munich-security/>.

³³² American Enterprise Institute, “China Global Investment Tracker.”

³³³ “The U.S. and China Are Battling for Influence in Latin America, and the Pandemic Has Raised the Stakes,” Time, accessed February 26, 2021, <https://time.com/5936037/us-china-latin-america-influence/>.

³³⁴ Pepe Zhang, “Belt and Road in Latin America: A Regional Game Changer?,” *Atlantic Council's Adrienne Arsht Latin America Center*, October 8, 2019, 12.

³³⁵ Mingyan Nie, “Asian Space Cooperation and Asia-Pacific Space Cooperation Organization: An Appraisal of Critical Legal Challenges in the Belt and Road Space Initiative Context,” *Space Policy* 47 (February 1, 2019): 224–31.

member states.³³⁶ APSCO's longevity may become problematic if the PRC cannot expand membership to more economically and technologically capable nations.

APSCO is open to all UN members in the Asia-Pacific region; however, any UN member state outside the region may apply as an associate member and access cooperative activities.³³⁷ Expanding APSCO membership for LAC nations would create greater international recognition, economic and technological backing, and regional space influence for China. Because associate member terms are negotiable,³³⁸ China could propose favorable terms for advanced space countries to join. Indeed, Argentina and Mexico have already been invited to join, yet neither have become members.

Since its inception, APSCO has launched 13 joint research projects, recruited 250 master's and Ph.D. candidates, and trained over 1,000 technicians.³³⁹ China could extend these advanced training and educational opportunities to entice countries like Argentina and Brazil that seek sovereign space autonomy. In addition, the PRC could tailor shared access to space systems or data to developing LAC countries seeking space capabilities to meet domestic development or technological goals. For instance, Peru acquired a Chinese EO satellite used for disaster management and environmental protection, but it doesn't have national SATCOM capabilities. Bolivia acquired a Chinese communications satellite to expand services to remote regions, but it doesn't have national EO capabilities. The PRC and Chinese state-run technical companies could open more space technologies to the LAC region, including easier and cheaper access to launch services or technical assistance. In that case, China could better leverage space cooperation to deepen economic and technological ties with LAC nations.

³³⁶ Nie.

³³⁷ Asia-Pacific Space Cooperation Organization, *Convention of the Asia-Pacific Space Cooperation Organization*.

³³⁸ Asia-Pacific Space Cooperation Organization.

³³⁹ Asia-Pacific Space Cooperation Organization, *Development Vision 2030 of The Asia-Pacific Space Cooperation Organization (APSCO)*.

C. RECOMMENDATIONS FOR U.S. POLICY

China's strategic objective is to become a modern superpower, but its methods of achieving such a status, and end state, are opaque. Chinese President Xi Jinping aims to modernize its military and national defense by 2035 and transform the PLA into a world-class military by 2049.³⁴⁰ While the PRC does not clearly define the meaning of "world-class," it is believed that China will emphasize military-civil fusion in developing space technologies to modernize its military and boost economic growth.³⁴¹ Such investments are considered threats to U.S. space assets because China is advancing its dual-use counterspace technologies to deny adversarial access to space assets through kinetic and non-kinetic capabilities. This strategy presents a threat to national security because China's pursuit of space superiority is described as a zero-sum game that "harms U.S. economic competitiveness, weakens U.S. military advantages, and undermines strategic stability."³⁴²

The 2016 Chinese LAC policy paper opened by addressing the PRC's agenda based on its short- and long-term modernization goals. China claimed its development could not occur without the co-development of emerging LAC countries.³⁴³ This version introduced space cooperation as a means of strengthening economic partnerships, removing prior military utility implications, despite the PLA's military-civil space integration.³⁴⁴ China recognized the beneficial domestic applications of space technologies in developing LAC countries and promoted mutual space cooperation in the region.³⁴⁵ Significant efforts included establishing bilateral and multilateral partnerships and forums that promoted

³⁴⁰ "Xi Focus: Building a Peace-Loving World-Class Military," XinhuaNet, August 1, 2021, http://www.xinhuanet.com/english/2021-08/01/c_1310101198.htm.

³⁴¹ Mark Stokes et al., *China's Space and Counterspace Capabilities and Activities* (Arlington, VA: Project 2049 Institute, 2020), 3, https://www.uscc.gov/sites/default/files/2020-05/China_Space_and_Counterspace_Activities.pdf.

³⁴² Stokes et al., 3.

³⁴³ China State Council, *White Paper on China's Space Activities in 2016*, pt. I.

³⁴⁴ Kevin Pollpeter, Michael Chase, and Eric Heginbotham, *The Creation of the PLA Strategic Support Force and Its Implications for Chinese Military Space Operations* (Santa Monica, CA: RAND Corporation, 2017), https://www.rand.org/pubs/research_reports/RR2058.html.

³⁴⁵ China Ministry of Foreign Affairs, *China's Policy Paper on Latin America and the Caribbean 2016*.

South-South cooperation for rapid development in trade, investment, finance, infrastructure, and various types of personnel exchanges. China utilized the LAC policy papers as a blueprint to introduce an intertwined mix of multilateral global infrastructure, economic development, and space cooperation projects to the region, such as APSCO, the BRI, and BRICS.

The 2020 Report to Congress of the U.S.-China Economic and Security Review Commission stressed that over the past 15 years, China had turned its focus toward surpassing the United States by promoting the ruling CCP's system and values as an alternative to the United States.³⁴⁶ In 2019, the PRC released a national defense white paper where it described the space domain as a critical component in international strategic competition.³⁴⁷ Thus, the PRC may utilize LAC nations as geostrategic associates to undermine the United States and its alliance system. If successful, the PRC will expand its space capabilities into the western hemisphere, challenge U.S. space security and influence, and increase its impact on international forums to promote Chinese space interests.

U.S. policies and reports on space security quickly highlight competitive technical challenges posed by countries such as China. Unclassified documents have surfaced that detail advanced Chinese space- and ground-based space capabilities, the threats posed to U.S. space systems, and the need for the United States to deter and defend against such threats. Yet, mostly absent from these reports are the implications of Chinese space cooperation and space infrastructure partnerships to national space security.

The National Space Policy (NSP) of the United States of America says it must “adapt [U.S.] national security organizations, policies, strategies, doctrine, security classification frameworks, and capabilities to deter hostilities, demonstrate responsible behaviors, and, if necessary, defeat aggression and protect United States interests in

³⁴⁶ Robin Cleveland and Carolyn Bartholomew, *2020 Report to Congress of the U.S.-China Economic and Security Review Commission* (Washington, DC: U.S.-China Economic and Security Review Commission, 2020), 1, https://www.uscc.gov/sites/default/files/2020-12/2020_Annual_Report_to_Congress.pdf.

³⁴⁷ China State Council, *China's National Defense in the New Era* (Beijing, China: China State Council, 2019), 13, http://english.www.gov.cn/archive/whitepaper/201907/24/content_WS5d3941ddc6d08408f502283d.html.

space.”³⁴⁸ It suggests a diplomatic, information, military, and economic (DIME) strategic approach to counter malicious activities that may threaten U.S. space security.

An integrated DIME approach to counter increasing Sino-LAC space cooperation within the LAC region is necessary to predict, detect, and deter threats to U.S. space security. Increased space security focus must be devoted to the evolving Sino-LAC space cooperation, which is based on a complex system of civil, commercial, and military policies and organizations with ties to the PRC’s geopolitical and economic agenda. If Sino-LAC space cooperation results in the Chinese control of regional space infrastructure and capabilities, then an opportunity to deter threats against U.S. space security will have been lost.

The NSP stated the Department of Defense shall “detect, characterize, warn, attribute, and respond to, in coordination with the Secretary of State and other relevant agencies, space-related behaviors and activities that threaten the space interests of the United States, its allies, or partners, international peace and security, or the long-term sustainability of the space environment.”³⁴⁹ Furthermore, the NSP charged the U.S. Space Force as the responsible government agency to pursue national security space objectives.³⁵⁰ Thus, the U.S. Space Force is responsible for organizing, training, and equipping regionally focused space professionals to lead DIME efforts to counter adversarial space cooperation. These military space professionals could have operations, acquisitions, or intelligence backgrounds with appropriate regional language, cultural competency, and whole-of-government approach knowledge; however, these U.S. Space Force positions do not exist.

These proposed U.S. Space Force liaison officers should be assigned to geographic combatant commands, strategically stationed at U.S. embassies around the globe, to coordinate with other heads of agencies to consolidate U.S. civil, commercial, and military efforts with partner nations. Within the scope of this thesis, U.S. Southern Command could

³⁴⁸ President of the United States, *National Space Policy of the United States of America* (Washington, DC: President of the United States, 2020), 27, <https://trumpwhitehouse.archives.gov/wp-content/uploads/2020/12/National-Space-Policy.pdf>.

³⁴⁹ “National Space Policy of the United States of America,” 30.

³⁵⁰ “National Space Policy of the United States of America,” 27.

divide space liaison efforts in South America across three different regions, the Andean states, the Southern Cone, Brazil, and the Guianas, for example.

U.S. Southern Command priorities are summed into three lines of efforts: strengthen partnerships, counter threats, and build our team.³⁵¹ In his 2020 posture statement before the 116th Congress Senate Armed Services Committee, U.S. Southern Command Commander Admiral Craig Faller said, “Beijing sees immense value in South America’s strategic location for space activity and is actively pursuing additional access to regional space infrastructure.”³⁵² U.S. Space Force personnel are currently not assigned to U.S. embassies, or partner nations, within U.S. Southern Command to lead U.S. space security efforts.

The U.S. military considers the space domain a contested, degraded, and operationally limited environment. Chinese counterspace capabilities and threats to U.S. space systems are well documented, and the U.S. Space Force and U.S. Space Command have prioritized combatting these operational threats. Yet, when the space domain extends to international cooperation and away from space operations, U.S. space policy is not adequately executed in the LAC region. If the U.S. Space Force plans to accomplish its NSP objectives and contribute to U.S. Southern Command’s lines of efforts, it must develop space liaison officers to synchronize DIME efforts to combat potential space security threats posed by Sino-LAC space cooperation.

³⁵¹ “SOUTHCOM Lines of Effort,” U.S. Southern Command, accessed July 21, 2021, <https://www.southcom.mil/Lines-of-Effort/>.

³⁵² *Posture Statement*, 116th Cong. (2020) (statement of Craig S. Faller, Commander, U.S. Southern Command).

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