

SPECIAL REPORT

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China's Space Collaboration with Africa: Implications and Recommendations for the United States

By Julie Michelle Klinger and Temidayo Isaiah Oniosun



Ethiopia's state-owned EBC broadcasts the launch of the nation's first satellite, ETRSS-1, at the Entoto Observatory near Addis Ababa on December 20, 2019. (Photo by Mulugeta Ayene/AP)

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Summary

- Outer space is no longer the domain of a few powerful countries pursuing strategic and technological objectives. Today, more than 20 African countries have space programs entrusted with achieving an array of development, security, and governance goals.
- China is increasingly supportive, offering space science and space cooperation as an incentive for African states to form closer ties to Beijing. The actors involved include government agencies, private and quasi-private companies, and academic institutions in both China and African partner states.
- Four cases illustrate how China supports the development of African capacities in satellite communications and Earth observation. China has provided financing and training, built satellites and ground stations, and cooperated on satellite navigation and climate monitoring.
- Although US actors—both private and government—are engaged in Africa's space sector, their activities are not coordinated with broader US foreign policy objectives.
- The United States should relax restrictions on international space business development and access to US satellite imagery while deepening scientific collaboration with regional institutions.

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ABOUT THE REPORT

This report is based on academic research conducted in several languages and on four continents on global space development and investment patterns, with a particular focus on China's overseas activities. It is significantly informed by the original data analytics and market research generated by Space in Africa. Preliminary research on this topic was supported by a grant from the Johns Hopkins University School of Advanced International Studies China-Africa Research Initiative (SAIS-CARI) in 2019–20. The report was commissioned by the Asia Center at the United States Institute of Peace.

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Demeke Mekonnen, deputy prime minister of Ethiopia, arrives for the launch of the nation's first satellite, ETRSS-1, at the Entoto Observatory near Addis Ababa on December 20, 2019. (Photo by Mulugeta Ayene/AP)

Introduction

This report provides an overview and assessment of an important dimension of the “new normal” of global outer space affairs: the development of space programs by African countries across the continent and the growing role China is playing in them. In the past, outer space was primarily the domain of a few powerful countries and generally considered separate from broader concerns of human security and development. In the new normal, outer space is a dynamic arena in which most nations actively engage. Many national governments and major international organizations agree that outer space development is essential to addressing their most pressing challenges, including but not limited to climate change, poverty, terrorism, and forced migration.

This means that outer space is a primary domain for both cooperation and competition, with a much wider range of actors and institutions involved than is generally conveyed by mainstream media and policy publications. China and other major space powers, such as Japan, Russia, and the United Kingdom, as well as many private firms located throughout the world, provide cost-competitive means for other governments to develop space technologies. Commercial, research, and military actors in developing countries readily cooperate with each other and with a range of overseas partners to address immediate security threats and longer-term vulnerabilities.

Space capacity is crucial for low- and middle-income countries to achieve an array of national development goals. This has been recognized by the United Nations Development Programme, the World Bank, and other major multilateral development organizations. African governments have pursued both the development of their own space programs and international partnerships with established and emerging space actors. Robust national and intracontinental space development is proceeding alongside deepening cooperation with diverse overseas partners, including China. Space development is seldom pursued for its own sake. In most cases, African governments want to acquire outer space capability in order to pursue other development and governance objectives.

Although US federal agencies and universities are actively involved in research partnerships with several African countries, space technology is not a focus of US foreign policy in Africa. China, by contrast, makes space science and space cooperation one of the range of incentives—including investment deals, medical assistance, cultural and educational exchanges, and military assistance—it offers to African states to form closer ties to Beijing.

In this report, particular attention is given to the role of China’s space technology and cooperation between China and several African countries in the domains of counterterrorism and natural disaster preparedness and monitoring. These are the primary domains for which African governments are increasing space capabilities, so they constitute the greatest spheres of activity. The report presents four cases of cooperation which represent a range of wholly domestic initiatives, partnerships with China, and collaboration with other overseas partners.

Abbreviations

AfSA	African Space Agency
AICTO	Arab Information and Communication Technology Organization
AUC	African Union Commission
BDS	BeiDou Satellite
CALVT	China Academy of Launch Vehicle Technology
CASC	China Aerospace Science and Industry Corporation
CAST	China Academy of Space Technology
CBERS-4	China-Brazil Earth Resources Satellite 4
CGWIC	China Great Wall Industry Corporation
CNSA	China National Space Administration
CSLTG	China Satellite Launch and Tracking Control General
DSA	Defence Space Administration
EO	Earth observation
NASRDA	National Space Research and Development Agency
NOAA	National Oceanic and Atmospheric Administration
ROSES	NASA Research Opportunities in Space and Earth Sciences
USAID	United States Agency for International Development

Awareness within US policymaking circles of the dynamism of space development is essential if the United States is to successfully pursue the following three policy priorities:

1. Formulate effective and innovative policy to broaden avenues of peaceful international cooperation in the space domain.
2. Accurately identify and effectively mitigate threats to peace and stability within and emerging from the context of continental Africa.
3. Build or strengthen partnerships with US allies in an era characterized by China's significant and growing role in international relations and global affairs.

The outer space domain is central to achieving all three of these policy priorities, yet there remains a pervasive perception within Washington that space activities are somehow separate from development and security for countries in the Global South and that space capacity is simply out of reach for them. As this report shows, this antiquated view means that key policy opportunities for the United States to advance peace and cooperation abroad are likely being overlooked. With other major space actors such as China, Russia, Japan, India, the United Kingdom, France, and Brazil building space partnerships across the globe, it is important for the United States to revisit the role of space cooperation in its foreign policy.

The first and second sections of this report present, in turn, succinct accounts of the development, capabilities, and structure of China's space program and of the rapid recent growth in space development in Africa. The third section examines African cooperation with China in the context of Africa's international cooperation on space and presents a list of two dozen bilateral and multilateral partnerships between China and African countries. The following section describes Africa-China space cooperation in the area of Earth observation (EO) for development and security. The fifth and final section surveys the current, limited extent of US space cooperation with African partners and offers policy recommendations for expanding that cooperation and competing more effectively with China in the space and development domains.

Background and Context: China

China has advanced space capabilities. In 2003, it became the third country to achieve human spaceflight, and less than two decades later, in 2021, it launched a space station. Today, China's space sector is advanced and diversified across military, research, and commercial institutions. China's National Space Administration (CNSA) was formed in 1993 as an outgrowth of the Number Five Research Academy of the Ministry of National Defense. The ministry was established in 1949 by the newly formed People's Republic of China, in the shadow of the US detonation of nuclear weapons in Japan and on Pacific islands. This geopolitical context helps explain why the academy's first mandate was to develop nuclear weapons and ballistic missiles in close collaboration with the former Soviet Union from 1950 until 1957. After the Sino-Soviet split in 1957, China's planners relied heavily on scholars educated overseas to advance space and nuclear weapons capabilities within the Ministry of Defense.¹

China's central government created the Ministry of Astronautics in 1998 to oversee the development of the country's space program.² In 1993, the ministry was dissolved, with two state-owned

enterprises taking over its former functions: the CNSA took over responsibility for China's obligations under international treaties (such as registering objects launched into space, rescuing and returning foreign astronauts, and compensating others for damage caused by space objects); and the China Aerospace Science and Industry Corporation (CASC) became the space program's main contractor for the design and manufacture of rockets, missiles, and launch systems.

CASC, despite being a de facto state-owned and state-run organization, operates much the same as the space agencies of other major powers by working with private and quasi-private contractors in its procurement and competitive bidding processes. A subsidiary of CASC, the China Great Wall Industry Corporation (CGWIC), provides commercial space services to other countries. Over the last 30 years, CGWIC has won contracts to build and launch satellites for space programs around the world, in particular those with new and developing space programs. CGWIC subcontracts with the China Academy of Space Technology (CAST), the China Academy of Launch Vehicle Technology (CALVT), and the China Satellite Launch and Tracking Control General (CSLTCCG); these entities in turn subcontract with smaller component manufacturers to complete orders. Each of these subcontractors is responsible for different aspects of satellite design, development, construction, launch, and operation. Since 1990, Chinese rockets have carried communications and earth observation satellites into space for private firms, universities, and national space programs, many of which are based in African nations.

China pursues space cooperation with countries in Africa in an instrumental and context-specific manner, emphasizing where it can contribute to China's climate change and economic development priority areas: energy, mining, construction, and telecommunications. Intergovernmental, state-owned, university, and private sector actors from many countries are all competitively engaged in this domain. Competition can occur with other foreign entities (such as other national space programs or space service providers) and among Chinese entities (such as service providers bidding for contracts).

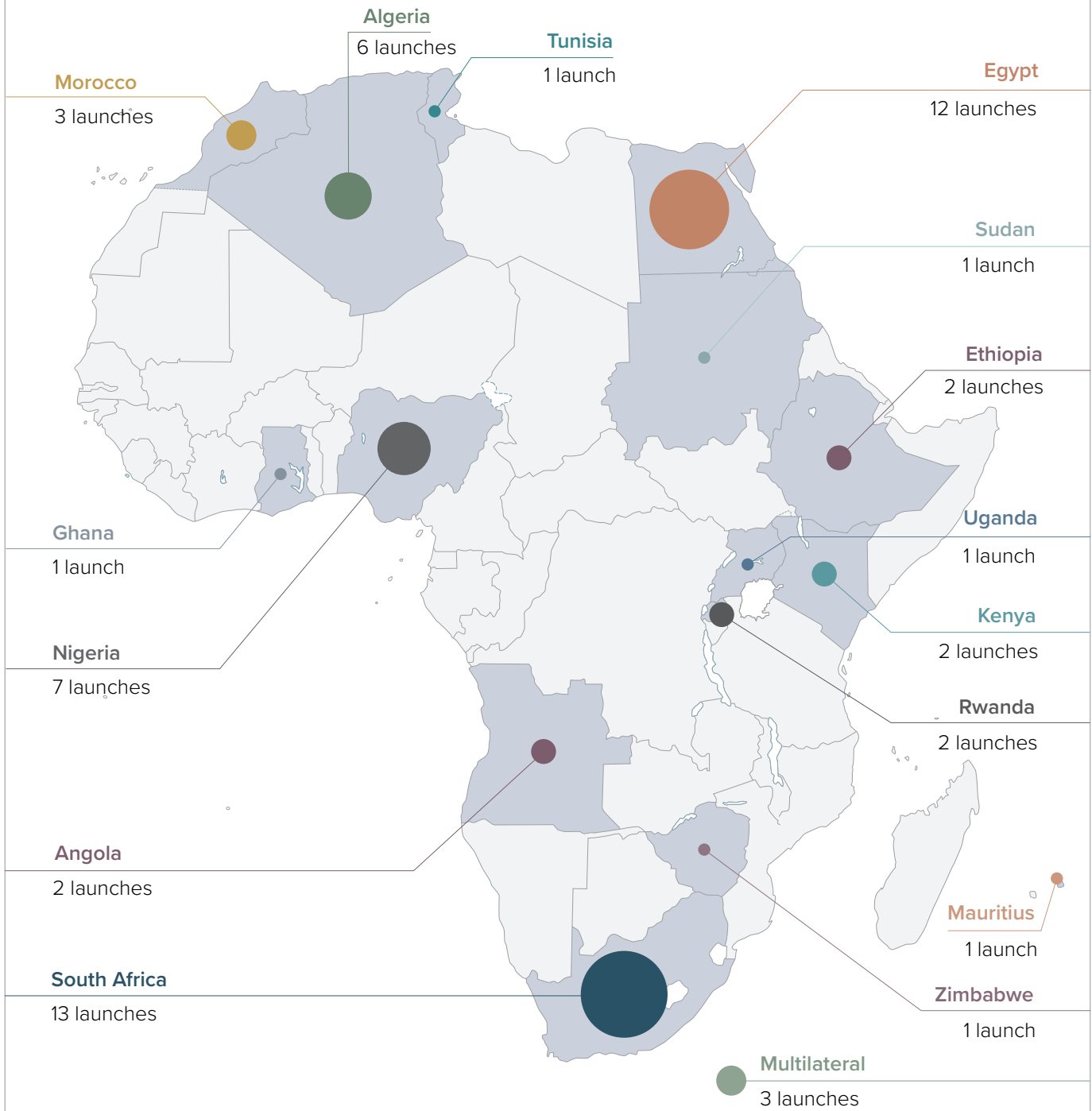
Background and Context: Africa

Since the turn of the millennium, countries across Africa have demonstrated an interest in developing their space capabilities to address socioeconomic issues rather than to participate in the much more costly and controversial race for deep space exploration or militarization. This surge of interest among African countries coincides with the increased internationalization of China's space policy, the integration of space-based infrastructure into China's Belt and Road Initiative, and the enhanced international profile of private space companies from China.³ The majority of satellite projects in Africa are funded by African institutions via a range of financing mechanisms. Since 2005, \$4 billion has been spent on acquiring and manufacturing satellite technologies by African countries. Of this, \$2.6 billion worth of contracts went to France, \$871.5 million went to China, \$587 million went to Russia, \$101 million to the United Kingdom, and \$250 million to the United States.⁴

In 2020, Africa accounted for 0.7 percent of global space expenditure, the fourth-highest-spending region after North America (primarily driven by the United States), Europe, and Asia.

FIGURE 1.

Satellites launched by African countries as of April 2023



Source: Space in Africa. Adapted from artwork by Rainer Lesniewski/Shutterstock.

This amount (\$503 million) is small compared with the sums spent by those three regions, but it is nearly double Africa's budget for 2018, when it accounted for just 0.39 percent of the global total. Although no African country has yet demonstrated capability in human spaceflight, nor do any currently plan to do so, many African countries have used space technologies to address various challenges across different domains.

More than 20 African countries now have space programs, fueling an industry that generated \$19.49 billion in 2022 and is expected to generate over \$22.64 billion by 2026.⁵ As of May 2023, 15 African countries had launched a total of 55 satellites (see figure 1). Their satellites emphasize socioeconomic development functions, including EO (25), communications (15), technology demonstration (14), education (2), agriculture (1), and military surveillance (1). Three of these satellites were built through regional collaboration involving a number of countries on the continent. As of early 2023, at least 11 additional countries had begun developing their first satellite. They include Botswana, Burkina Faso, Cape Verde, Côte d'Ivoire, Djibouti, Democratic Republic of the Congo, Gabon, Senegal, Tanzania, Togo, and Zambia.

In addition to individual countries' programs, the African Union Commission (AUC) continues to pursue a continental space program following its enactment of the African Space Policy in 2016 and approval of the African Space Strategy. In "Agenda 2063: The Africa We Want," a "blueprint and master plan for transforming Africa," the African Union has identified space technologies as a critical tool that "can boost Africa's economic growth and development and lead to the rapid transformation of the continent."⁶ The commission set up the African Space Agency (AfSA) in Egypt with an initial budget of \$10 million.⁷ Promoting collaboration among African countries is the goal of one of AfSA's first initiatives, which is designed to implement a data-sharing policy and reduce redundancies and duplication of projects.

While many bilateral relationships exist between African and non-African countries, pan-African collaboration on space projects has been less common. A notable exception is the African Resource Management Satellite Constellation initiative between Algeria, Kenya, Nigeria, and South Africa, which seeks to create a shared and affordable EO satellite constellation to provide data to support environmental monitoring and resource management across the continent. In addition, the Regional African Satellite Communication Organization is made up of 45 countries and provides telecommunication services, direct TV broadcast services, and internet access in rural areas of Africa through a communications satellite launched in 2010.

Algeria, Egypt, and South Africa have demonstrated local satellite manufacturing capabilities. Given the availability of a lower-cost skilled workforce, several other countries plan to develop these capacities to create globally competitive satellite manufacturing hubs on the continent. Of the 58 African satellites launched thus far, 19 were manufactured locally (this includes cases of international collaboration at local institutions), while foreign institutions manufactured the remaining 39.

China's Growing Role in the African Space Sector

One of the continent's most important bilateral partners for imports of civilian space technologies and services is China, which has found receptive partners among African countries interested in reducing costs, building capacity, and fostering technology transfer. China launched Nigeria's first two communications satellites (the first in 2007 and the second in 2011), Algeria's first communications satellite (in 2017), and the first satellites for Ethiopia and Sudan (both in 2019). Each of these contracts was won through a competitive bidding process. China's firms do not always win. For example, Ghana contracted with the Kyushu Institute of Technology and Japan Aerospace Exploration Agency to launch its first satellite in 2017. Russia's space agency launched a satellite for Angola that same year, and Japan launched satellites for Rwanda and Egypt in 2019. As of October 2021, 23 of continental Africa's 54 countries had bilateral space partnerships with China.

Thus far, only five African-owned satellites have been funded by foreign entities. ETRSS-1, owned by Ethiopia, was funded by China and was launched in 2019. Three other satellites have been partly funded by China—ET-SMART-RSS, owned by Ethiopia; EgyptSat-2, owned by Egypt; and AlSat-1N, owned by Algeria—and Japan partly funded 1KUNS-PF, a satellite owned by Kenya. In addition to those five, Nigeria's communications satellite NigComSat-1 was financed with loans from China, while Angola's communications satellite AngoSat-1 was financed with loans from Russia.⁸ The table in the appendix (see page 18) summarizes China's bilateral and multilateral partnerships with African countries.

Africa-China Space Cooperation in Earth Observation

Since the turn of the millennium, China has expanded its security footprint in Africa in a number of ways. From a longer history of military equipment sales to the establishment of China's first overseas military base in Djibouti in 2017 and the first China-Africa Security and Defense Forum held in Beijing in 2018, these developments have garnered significant interest from Western observers. However, the crucial role of satellite communications and EO is seldom discussed. Space technologies are important for addressing security concerns, including terrorism and violent extremism, within the territories of African governments; and security issues are aggravated by, and sometimes inseparable from, climate and environmental issues. Because space technology can address all these domains, and because China's foreign policy approach aims to be comprehensive, space technology development is a clear point of synergy in bilateral and multilateral Africa-China relations.

These relations play out differently in each country context. The costs of space technology development for conflict mitigation and counterterrorism are sometimes included in military

expenditures; other times, they are administered entirely by the civilian national space agency; and in still other cases, they are part of special international projects. As with China's approach to space development in general, China's space expenditures in African countries integrate development with counterterrorism and peace and security applications and are part of much broader contexts of domestic programs and diverse international partnerships. Several examples are discussed below. The first illustrates the role of Chinese finance in Nigeria's satellite development. The second highlights China's role in ground station development in Ethiopia. The third surveys China's multilateral cooperation on satellite navigation and positioning. The fourth looks at China's multilateral cooperation on climate monitoring and disaster management.

CHINESE FINANCE IN NIGERIA'S SATELLITE DEVELOPMENT

The first Nigeria-China satellite cooperation agreement was signed in December 2004, when the Nigerian government contracted with CGWIC to build the country's second satellite, NigComSat-1. This relationship has been important for the development of Nigeria's domestic space capacity. In 2006, Nigeria's Ministry of Finance signed an agreement with the Export-Import Bank of China for \$200 million in preferential buyer's credit to help fund the project.

Other partners in the African space sector

Europe is well established as a source of space technologies for the African Union Commission's space program, the African Space Agency. As a precursor, the African Union Commission is implementing the Global Monitoring of the Environment and Security project in Africa, a €30 million joint project of the African Union and the European Commission. Through a grant scheme, the program supports 12 African consortia across 45 countries, with at least two in each of Africa's five regions, in developing earth observation-based applications for natural resources management, including marine and coastal areas management.⁹ Non-European initiatives with Africa include a satellite monitoring program developed by Brazil's National Institute for Space Research called Capacitree, which has provided training for scientists and technicians to use earth observation data and remote sensing technologies for forest monitoring in 18 African countries.¹⁰ In many cases, except in the provision of GPS services and Landsat satellite imagery, the United States lags behind other major space powers in promoting space development partnerships in Africa because it is not a major priority in US foreign policy to Africa.

Notes

- a. Space in Africa, "Institutions from 45 African Countries Are Implementing Earth Observation Projects through GMES & Africa," July 16, 2019, <https://africanews.space/institutions-from-45-african-countries-are-implementing-earth-observation-projects-through-gmes-africa>.
- b. The 18 countries are Algeria, Burkina Faso, Burundi, Cameroon, the Central African Republic, Chad, the Democratic Republic of the Congo, Equatorial Guinea, Gabon, Ghana, Guinea, Kenya, Morocco, São Tomé e Príncipe, South Africa, Tanzania, Tunisia, and Zambia. Capacitree is supported by the United Nations Food and Agriculture Organization, the Japan International Cooperation Agency, the Caribbean Community, the Amazon Cooperation Treaty Organization, and the Inter-American Development Bank; for more information, see Instituto Nacional de Pesquisa Espacial, "Projetos e Pesquisas: Capacitree," www.inpe.br/cra/projetos_pesquisas/capacitree.php. For a broader overview of Africa's multilateral space cooperation, see Julie Michelle Klinger, "China, Africa, and the Rest: Recent Trends in Space Science, Technology, and Satellite Development," Working Paper no. 2020/38, China Africa Research Initiative, Johns Hopkins University School of Advanced International Studies, May 2020.

Nigerian scientists and engineers traveled to China to receive training and participate in satellite design and construction. In anticipation of the launch of Nigeria's—and Africa's—first communications satellite, NigComSat-1, a private spin-off from the country's National Space Research and Development Agency (NASRDA) was incorporated in 2006 to provide fixed satellite services to much of Africa and Italy (parts of which, thanks to their geographical location, can get the signal). In 2018, in exchange for a share in NigComSat, China's Export-Import Bank and CGWIC agreed to fully finance a \$550 million project for two additional communications satellites for Nigeria.

China also is indirectly involved in the counterterrorism and military aspects of Nigeria's satellite development.⁹ Nigeria's Defense Space Administration (DSA) was established in 2014 to develop and manage Nigeria's military space technologies, support military operations both within and outside the country, and assist security agencies responsible for internal security. DSA provides space and cyberspace capabilities for the Nigerian military and law enforcement agencies and had an operating budget of \$7 million in 2019, \$5.48 million in 2020, and \$11.45 million in 2021.¹⁰ Using satellites developed in partnership with UK entities and launched from Russia, NASRDA has contributed satellite imagery to a number of international partners. It produced data and satellite images of southwest Mali during the conflicts in 2012—including a topographic map provided to West African peacekeeping troops with geographical knowledge of the crisis zone—and conducted image mapping and terrain analysis of the Dargol area of Niger Republic, the site of a 2013 Nigerian Air Force jet crash.¹¹ Current satellite technology is useful to general terrain reconnaissance, but it is not of a fine enough resolution to assist in near real-time tactical operations.

China's emphasis on satellite communications technologies, contracts, and businesses in the context of Nigeria is consistent with broader moves to expand the telecommunications footprint on the continent.

CHINESE SATELLITE AND GROUND STATION CONTRIBUTIONS TO ETHIOPIA

China has built a strategic partnership with Ethiopia in the space sector that has resulted in the development of two satellites (ETRSS-1 and ET-SMART-RSS) and two ground stations, including a multi-satellite ground receiving station. The ETRSS-1 satellite was China's first "foreign-aid satellite," meaning that most of the cost was covered with a grant. It cost \$8 million, with China providing a grant to cover \$6 million. The remaining \$2 million was funded by the Ethiopian government. The contract was signed in October 2016 between China's National Development and Reform Commission and Ethiopia's Ministry of Science and Technology. In May 2018, the project officially commenced and the satellite was delivered to Ethiopia in March 2021. The optical remote sensing satellite was designed and developed by DFH Satellite Company, a subsidiary of CAST. The ground station was built by CAST.¹²

The ET-SMART-RSS satellite is a result of a strategic partnership between the Ethiopian Space Science and Technology Institute and Beijing Smart Satellite Technology, a Chinese space startup that funded the \$1.5 million project through the Belt and Road Initiative. At a signing ceremony held in August 2019 at Beijing Sun Valley Industrial Park, both sides pledged to jointly expand into the African space market in the future.

The Ethiopian Multi-Satellite Ground Receiving Station was the second satellite ground station built in Ethiopia. The high-resolution data comes from five different EO satellites: the China-Brazil Earth Resources Satellite 4 (CBERS-4); China's high-definition EO Gaofen 1, Gaofen-3, and Gaofen-5 remote sensing satellites; and the SuperView-1, which is operated by Beijing Space View Technology.¹³ The station also receives data from both ETRSS-1 and ET-SMART-RSS. The data is useful for agriculture, forestry, land use management, urban mapping, natural resource monitoring, disaster monitoring, and mining.

These examples illustrate how cooperation among public, private, and academic institutions in China and an African partner state can generate multiple agreements to enable data transfer and expand the scope and impact of infrastructure construction.

COOPERATION ON SATELLITE NAVIGATION AND POSITIONING

Satellite navigation and positioning is a major growth area both in China's overseas space activities and in Africa. This is significant because it constitutes an alternative and possible competitor to the United States' GPS system. In April 2018, the first overseas center for China's BeiDou Satellite (BDS) Navigation System, the China-Arab Beidou Center, opened in Tunisia. Located in the Jazala Science Park on the northern outskirts of Tunis, the center is a pilot project between China and the Tunisia-based Arab Information and Communication Technology Organization (AICTO), an Arab governmental organization under the Arab League. The center is strategically positioned to promote international exchanges and cooperation and to encourage the global application of BDS.

Since the center was opened, Africans have shown increasing interest in the BDS system. In November 2021, the first China-Africa BDS Satellite Cooperation Forum was organized by China, Senegal, and the AUC. Government representatives, industry leaders, and researchers from China, together with representatives from nearly 50 African nations, including not only scholars and experts but also eight government ministers and eight ambassadors to China, attended the virtual event. One of the resolutions adopted at the event was a joint agreement to take advantage of the BDS system to enhance Africa's social, economic, and environmental development.

In December 2021, the South African National Space Agency signed a memorandum of understanding with the China Satellite Network Office for partnership on BDS applications for the benefit of both nations. The memorandum specifies the intention to collaborate in satellite navigation, strengthen exchanges and cooperation in satellite navigation technologies, and conduct joint research on applications of the BDS in geophysics, space science, geodetic surveying, and other sectors. As of early 2022, talks were ongoing with the AUC on the commercial rollout of the BDS navigation system in Africa and its further integration into existing positioning and navigation infrastructures.

COOPERATION ON CLIMATE CHANGE MONITORING AND DISASTER MANAGEMENT

Climate change cooperation has been central to China-Africa relationships since the 2012 meeting in Beijing of the Forum on China-Africa Cooperation, the main multilateral platform for consultation and coordination between China and Africa. Renewals and affirmations of this priority

area regularly feature in policy and media discussions, both in general and in relation to space technologies.¹⁴ Plans to develop a constellation of 20 EO satellites and receiving stations for each of Africa's five regions to provide full data coverage over the entire continent are underway.

Security issues are inextricably intertwined with climate-related issues. Space technologies are important in measuring, assessing, and addressing these intertwined challenges, and African governments and institutions pursue multiple partnerships to mount responses to emergent issues. These institutions build their own international partnerships with continental and overseas counterparts, which include entities in China.

Two examples help to further contextualize China's role in this domain: one that directly involves China and one that does not. In the first example, South-South scientific networks provided the basis to expand and formalize cooperation among universities and international organizations. The China Academy of Science, working with the United Nations Environment Programme, built a network of Chinese and African climate scientists to focus on monitoring and resilience, with a particular focus on agriculture.¹⁵ This network was launched at a 2017 conference held in Nairobi that was organized by a social scientist from China, Zhang Linxiu, who had built networks earlier as a 2014 fellow in the World Academy of Sciences.¹⁶ The network launched in Nairobi played a key role in drawing up a scientific cooperation plan that was announced at the 2018 Forum on China-Africa Cooperation.¹⁷

In the second example, the government of Angola has been cooperating with a wide range of actors to expand climate, development, and security projects. Angola's involvement with China does not preclude cooperation with entities from other countries, and vice versa. For example, to address droughts that have affected at least 1.3 million people in Angola, the country's government has pursued international partnerships to build a satellite data mining system to monitor droughts and improve water management.¹⁸ China is not directly involved in this project, which is being implemented in partnership with the Massachusetts Institute of Technology Media Lab Space Enabled Research Group and experts from institutions such as the International Space University in France; the University Space Engineering Consortium, which includes representatives from Germany, Lithuania, Turkey, and Italy; and the University of Tokyo. However, although China has not participated in this project, it has been in contact with key Angolan actors. For instance, the Angolan Space Agency has received delegations from CGWIC, and the Ministry of Defense has received counterparts from China.

US Engagement in the African Space Sector

China's commitment to pursue a diverse but coordinated array of collaborative ventures with actors in the African space sector—and to reap the consequent economic, diplomatic, and security benefits—contrasts sharply with the US government's approach to that sector.

The problem for the United States is not that US actors are absent from Africa's growing space sector. A number of US universities and federal agencies are actively involved in research

partnerships with several African countries. For example, researchers from Cornell University began in 2021 to develop the first high-resolution carbon monitoring system for East Africa that combines “bottom-up” ecological modelling with “top-down” satellite data, thanks to a three-year, \$1 million grant from NASA.¹⁹ NASA is also funding a project—implemented by researchers from the University of Buffalo—to map species and ecosystems at the southwestern edge of South Africa. The continent is also encompassed by the SERVIR program, a major space-related development initiative supported by NASA and the United States Agency for International Development (USAID). Established in 2004, SERVIR works with regional organizations around the world to “help developing countries use information provided by Earth observing satellites and geospatial technologies . . . to manage challenges of food security, water resources, land use change, and disasters.”²⁰ In 2008, the SERVIR Eastern and Southern Africa hub was established in partnership with the Kenya-based Regional Centre for Mapping Resources for Development, while the West Africa hub was established in 2016 in partnership with the Agrometeorology, Hydrology and Meteorology Regional Center in Niger. The objective of the hubs is to improve the capabilities of regional institutions to apply geospatial analysis to strengthen the region’s resilience to the impacts of climate change and to ensure sustainable land management and reduction of greenhouse gas emissions. In 2019, NASA Research Opportunities in Space and Earth Sciences (ROSES) provided additional funding for 20 projects across SERVIR global hubs totaling \$13.7 million; eight of these projects are implemented through West Africa and Eastern and Southern Africa hubs.²¹

But while US actors—both private and government—are thus actively engaged in Africa’s space sector, that support for space technology development is not coordinated with broader US foreign policy objectives. Consequently, opportunities created by investments in multilateral scientific research collaboration, which can build strong networks between US and African institutions and researchers, are often not capitalized on by US foreign policy in order to strengthen bilateral and multilateral ties. This is a missed opportunity, particularly as a significant share of the \$8.5 billion in foreign aid that the United States sent to 47 African countries in 2020 could potentially be better integrated with space technologies to enhance aid impact and efficacy.²² It should be noted that space technology development in several African countries already supports national and regional development across the broad categories that US foreign aid addresses—succinctly described by George Ingram as “humanitarian assistance for life-saving relief from natural and manmade disasters; development assistance that promotes the economic, social, and political development of countries and communities; and security assistance, which helps strengthen the military and security forces in countries allied with the United States.”²³

China, by contrast, combines space science and cooperation in Africa with investment deals, medical assistance, cultural and educational exchange, arms deals, and military assistance. Furthermore, it is common practice for Chinese counterparts involved in one initiative to be consulted or involved in facilitating new initiatives in other areas, a practice that has been credited with expediting the deepening of ties and partnerships. China has also demonstrated strategic flexibility: space cooperation in Nigeria is accompanied by Chinese investment in telecommunications, while cooperation in Tunisia has been part of a comprehensive infrastructure construction package.

Conclusion and Recommendations

Going forward, US policymakers should be mindful of China's diverse practices and consider taking a more integrated approach to promoting research that enhances international collaboration and supports the specific science and technology development goals of African partner states. Supporting space science and technology development in Africa also means supporting broader human development and security goals.

Adopting and implementing a more integrated approach is likely to be a long-term process, but the United States has several immediate opportunities to expand cooperation with African countries and to better engage in productive competition with China in the space and development domains. The following three recommendations are provided to help the US formulate effective and innovative policy to broaden avenues of peaceful cooperation; to accurately identify and effectively mitigate threats to peace and stability within and emerging from the context of continental Africa, and to build or rebuild alliances essential to international cooperation in an era characterized by China's significant and growing role in international relations and global affairs.

The first recommendation is to **expand high-resolution data and imagery transfer for sustainable development and remove restrictions on the types of US satellite imagery available to bring the United States into line with widely accepted international norms.** The United States can leverage its long history of Landsat imagery transfer to build partnerships. The US-driven Landsat program (a series of EO satellite missions jointly managed by NASA and the US Geological Survey) was revolutionary when it was launched in the late 20th century. It made satellite imagery available to the world, which greatly enhanced global scientific research and national development policy and practice around the world. However, there is a need for images of higher resolution and greater frequency to support planning, governance, and security efforts—and this need cannot be met by Landsat imagery. Other sources, such as Europe's Sentinel-2, offer greater resolution and frequency, and the European Commission has made this imagery freely available to African institutions.

While African countries are pursuing the development of their own high-resolution EO satellites, the US EO satellite fleet has a wealth of high-resolution and high-frequency satellite data that could be made freely available to African governments and researchers to address their immediate needs. This would have three benefits for the United States. First, it would strengthen US diplomatic relations with African governments by providing a public good of immediate utility. Second, it would differentiate US foreign policy from Russian and Chinese foreign policy, which have strict limits on satellite data sharing. Third and not least, it would immediately support the development goals of African governments, civil society organizations, and research institutions.

A second recommendation is to **introduce legislation that removes restrictions on international space business development.** Given the robust growth of the African commercial space sector, more attention should be given to market-based approaches that prioritize projects implemented through African commercial entities. Well-designed commercialization plans would

generate the profits to guarantee program continuity and sustainability. This approach would support the most dynamic aspects of Africa's burgeoning commercial space sector and open a promising area for further cooperation.

A number of private sector satellite imagery providers in the United States have not been able to do business overseas because of US legal prohibitions. A rule passed in May 2020 by the National Oceanic and Atmospheric Administration (NOAA) on licensing of private remote sensing space systems that allows US operators to sell satellite imagery in foreign markets no matter the resolution is a move in the right direction.²⁴ This rule presents an immediate-term market-based solution that enables African institutions to purchase high-resolution imagery on an ad hoc basis to address emergent challenges. Although this is not a substitute for a comprehensive and accessible data-sharing regime as suggested above, it provides a stopgap measure for African institutions and greater business opportunities for US companies.

The third recommendation is to **deepen scientific and educational collaboration with regional institutions to support continental integration and long-term US-Africa cooperation.** The US government, through NASA and NOAA, should explore collaboration and partnership with the AUC in the launch of the African Space Agency, specifically through continent-wide programs that enhance data sharing, capacity development, and access to new technologies. As has been extensively documented and critiqued in academic research on development failures in Africa, much of the funding allocated to projects in Africa goes to US-based institutions, and project goals are not always aligned with African needs or priorities. Directly collaborating with the AUC and the African Space Agency could catalyze the needed paradigm shift away from fragmented and short-term space projects and toward a policy of comprehensive space cooperation directly supporting and empowering African institutions to achieve development and security objectives.

The US lags far behind China in the funding of educational scholarships. Since the 1960s, China's government has provided scholarships to students from African countries to complete undergraduate and graduate education in China. These comprehensive programs have covered transportation, housing, medical, and living expenses principally (though not exclusively) for science and engineering students and their families to relocate to China for the duration of the program of study. In 2018, President Xi Jinping announced that an additional 50,000 scholarships and 50,000 training opportunities would be awarded to African students and researchers over the following three years, increasing the number of students enrolled in both educational and training programs by more than half.²⁵ Each year, between 400,000 and 500,000 international students study in China, with over 80,000 coming from African countries.²⁶ This creates an important legacy of human capital development and diplomatic engagement between China and African partner states that is now several generations old. Although the United States offers less in the way of support and opportunities to African students, it remains an appealing educational destination, and an expansion of educational opportunities for students from Africa would surely be welcomed. If that expansion included scholarships for Africans studying space-related subjects, it would generate new and extensive networks of collaboration in space science and technology.

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Space technology development is the new normal for the majority of the world's countries, including the countries of Africa. It is, therefore, both a critical domain of geopolitical and commercial competition and fertile ground for many different types of collaboration. With the exception of a relatively small number of projects, the US government has largely ignored the development of space programs in Africa. Given the importance of space technology in multiple domains, this oversight may be undermining broader shared diplomatic, economic, and security objectives. Updating US foreign policy toward African countries to emphasize space collaboration could help address the continuity problem faced by aid projects, nongovernmental organizations, and international institutions implementing development and security projects across Africa.

Appendix

One of the continent’s most important bilateral partners for imports of civilian space technologies and services is China, which has found receptive partners among African countries interested in reducing costs, building capacity, and fostering technology transfer. The following table summarizes China’s bilateral and multilateral partnerships with African countries.

Bilateral partnerships				
Country	Space or space-related agency	Founded	Satellites launched	Space partnership with China
Algeria	Algerian Space Agency (ASAL)	2003	6	AlComSat-1 designed, built, and launched by CAST, CGWIC, CSLTCG, and CALVT. China is expected to build AlComSat-2 as part of Algeria’s National Space Program 2020–2040 plan.
Angola	National Space Program Management Office	2013	1	Hosted a delegate visit from CGWIC in September 2019.
Botswana	Botswana’s Ministry of Environment, Natural Resources Conservation and Tourism (MENT)	n.d.	0	Space Star Technology Co., Ltd. is building the Botswana Meteorological Satellite Transportable Ground System (BMTGS).
Côte d’Ivoire	Ministry of Telecommunications	n.d.	Scheduled mid-2020	CGWIC lost the satellite contract to France’s Airbus Defence and Space in 2018.
Democratic Republic of the Congo	National Satellite Telecommunications Network (Renatelsate)	1991	0	Contracted with CAST to build and launch CongoSat-1 in 2012.
Egypt	Egypt Space Agency	2018	12	CNSA gave grants of \$23 million (2016), \$45 million (2018), and \$72 million (2021) for the EgyptSat program and an assembly and integration testing facility. More than 1,500 Chinese IT and telecommunications companies are in Egypt. Egypt is working with China on MisrSat-II, which is expected to be launched on a Chinese launch vehicle in 2022.
Ethiopia	Ethiopian Space Science and Technology Institute (ESSTI)	2016	2	Data-receiving ground station will receive high-resolution data from the China-Brazil Earth Resources Satellite 4 (CBERS-4), China’s SuperView-1, Gaofen 1, Gaofen 3, and Gaofen 5. Training and capacity development from CAST and DFH Satellite Company. ET-SMART-RSS built and launched by Smart Satellite and CAST with a \$6 million grant from Chinese government; agreement for a communication satellite with the Chinese Rocket Company in 2019.

Bilateral partnerships *(continued)*

Country	Space or space-related agency	Founded	Satellites launched	Space partnership with China
Gabon	L'Agence gabonaise d'études et d'observations spatiales (AGEOS)	2007	0	Receives satellite imagery and capacity training from joint Brazil-China CBERS for Africa initiative.
Ghana	Ghana Space Science and Technology Centre (GSSTC)	2011	1	In talks with the China Development Bank for financing and with CNSA for technical advice for future satellite programs.
Kenya	Kenya Space Agency	2017	2	In talks with CNSA for assistance developing satellites. A Machako University physics experiment was selected to be conducted on China's space station.
Libya	Libya Center for Remote Sensing and Space Science (LCRSSS)	1989	0	None found.
Malawi	Malawi Communications Regulatory Authority	n.d.	0	A China-funded satellite television project provided 20 households in each of 500 villages access to digital TV through Startimes. Plans to develop space agency announced in 2022.
Mauritius	Mauritius Research Innovation Council (MRIC)	2019	1	None found.
Morocco	Royal Center for Remote Sensing Space (CRTS)	1989	3	None found.
Namibia	Namibian Institute of Space Technology at the Namibian University of Science and Technology	n.d.	0	The jointly owned China Telemetry, Tracking, and Command Station built in Swakopmund became operational in 2001. Hosted a visit of Chinese astronauts in 2010 and 2019.
Nigeria	National Space Research and Development Agency (NASRDA)	1999	7	NigComSat-1 and NigComSat-1R were designed, manufactured, and launched by CGWIC; they were contracted in 2004 and 2009 and launched in 2007 and 2011, respectively; funding was provided by China through a loan. The People's Insurance Company of China provided insurance for NigComSat-1. A China-funded satellite television project provided 20,000 households in 1,000 villages access to digital TV through Startimes.
Rwanda	Rwandan Space Agency	2020	1	A China-funded satellite television project provided 6,000 households in 300 villages access to digital TV through Startimes.

Bilateral partnerships <i>(continued)</i>				
Country	Space or space-related agency	Founded	Satellites launched	Space partnership with China
Senegal	Ministry for Higher Education, Research, and Innovation	n.d.	Scheduled 2023	None found.
South Africa	South African National Space Agency (SANSA)	2010	13	Developed components for China's Chang-e lunar rover, which landed on the Moon in January 2019. The private firm NewSpace Systems, Ltd. produces satellite components for retailers in China, India, Japan, the Netherlands, and the United States; 2019 partnership agreement with China on the Square Kilometre Array project. The China-South Africa Workshop on the Big Data Challenge in Astronomy is held annually. Satellite data sharing is conducted as part of the BRICS grouping.
Sudan	National Remote Sensing Center	1977	1	The SRSS-1 satellite was built by Shenzhen Aerospace Oriental Red Sea Satellite Co. and launched by China's Long March 4B rocket in November 2019.
Tunisia	National Mapping and Remote Sensing Center	1988	1	Ground receiving station for the BeiDou satellite navigation system was opened near Tunis in April 2018; it is jointly operated by CNSA and the Arab Information and Communication Technology Organization.
Zimbabwe	Zimbabwe National Geospatial and Space Agency	2018	1	None found.
Multilateral partnerships				
African Union	African Space Agency	2018	0	In talks with the China Development Bank for potential financing.
Arab League	Arab Satellite Communications Organization (ArabSat)	1976	13	Broadcasts the Arabic-language edition of the China Global Television Network.

Source: This table is an updated version of the table in Julie Michelle Klinger, "China, Africa, and the Rest: Recent Trends in Space Science, Technology, and Satellite Development," Working Paper no. 2020/38, China Africa Research Initiative, Johns Hopkins University School of Advanced International Studies, May 2020.

Notes

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