



SOUTH AMERICAN SPACE ERA

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SOUTH AMERICAN SPACE ERA

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This paper address the past and current efforts of the South American region in the space area. The space activities in the region date back from the beginning of 1967, since then these countries achieved a relative modest capability through their national programs and sometimes international collaboration, with the space activities in the region are led by Brazil and Argentina space programs. In an era where missions explore the solar system and beyond, this paper focus on the participation of a region that is still at the early stages of its space technology development, but has considerably to offer in terms of material, specialized personal, launch sites and energy. In summary, this work perform a historical review of the main achievements in the region, and by analyzing past and present efforts, it projects a trend for the future of space in South America. It is also put in contest current efforts to continue the region integration such as the South American Space Agency proposal.

I. INTRODUCTION

Since the late 1950s, space has become another dramatic arena for countries to prove their technological superiority, military firepower and, by extension, its political-economic system. From 1967, in South America, Brazil started the first space activities in the region with the launch of "Sonda I". Since then South American countries have been developing space capacity individually in order to provide basic space-based services and a small autonomy in this area.

As the countries in the South America region develop their activities, the most significant steps have been initiated by Brazil, Argentina, Peru and Bolivia among others. Brazil currently has a well established institute of space research, one astronaut sent to the ISS and ongoing efforts to develop its own launch capability. Argentina, on the other hand, is currently

working in the construction of Tronador II, a light payload satellite injector, based on previous models Tronador Ia and Ib successfully launched from Puerto Belgrano naval base. In Peru, the national Aerospace Research and development commission (CONIDA) launched the first space Peruvian Probe, Paulet, from Punta Lobos air force base in Pucusana in 2006. Bolivia is also making its mark in the sector; with its first telecommunication satellite in 2013 and recent efforts to develop a remote sensing satellite. On 2011, Chile put in orbit its Earth Observation satellite SSOT/FASAT-Charlie that has the best resolution in South America.

The space programs in South America, not only address a technological gap, but also offer a chance to inspire people and bring to their attention the potential and benefits of the space sector. This paper provides a historical review of the evolution of the space activities

in South America and its relation with historical and political aspects, as well as important steps need to be taken to further develop the space sector in the region. This paper addresses directly the outcomes of the defense ministers meeting of the Union of South American Nations (UNASUR), in November 2011, where the representatives collectively deemed to prioritize the creation of a South American Space Agency and its collaboration through UNASUR.

Section II, discusses about the South American Space Agency and the UNASUR. The following sections from II to VIII present, individually, a historical review of the main accomplishments of each country. Section IX, takes into account past achievements and approaches to project future trends and collaborations. Section X, discuss the main points of this papers outlining the most significant aspects.

II. THE SOUTH AMERICAN SPACE AGENCY

The Union of South American Nations is an intergovernmental union targeted to better integrate the South American region integrating. In essence the Union joins two already established customs unions: the Mercosur and the Andean Community of Nations (CAN). The UNASUR Constitutive Treaty was signed on 23 May 2008, with Uruguay ratifying the agreement on 1 December 2010 as the last remaining country. The enrolment of the entire region gave the union full legality with the Constitutive Treaty reaching force on 11 March 2011, thus making UNASUR a legal entity.

The VI Conferencia Espacial de las Americas (CEA), held on Pachuca Mexico, in November 2010, approved the Pachuca Declaration, in which the creation of a Space Technical Consulting Group composed representatives of the national agencies or government bodies in charge of space affairs. This working group was to support the CEA and its executive secretariat. It was, in part, based on the works of this group that on November 2011 the defense ministers of Argentina, Brazil, Bolivia, Chile, Colombia, Ecuador, Paraguay, Peru, Surinam, Venezuela and the deputy-minister of Uruguay agreed on the creation of a South American Space Agency during a meeting of the Defense Council of UNASUR. Goals for this agency will be to focus efforts, in order to place satellites into orbit using a regional launch vehicle in order to reduce costs and increase the technological capabilities. In accordance with the United Nations Outer Space Treat, all the activities will be for peaceful.

Inside the frame of the agency Argentina proposes the intentions to use a regionally develop launch vehicle, which aligns with the national Tronador project. However, some of the countries are resistant to the proposal. Nevertheless, the goal of technological cooperation on the satellites area seem to attract more attention of the member states. The Argentine Defense

Ministry indicated, in the November 2011 meeting, its interest in developing a space agency project with (UNASUL). Brazil has positioned with caveats on the proposal, due to the costs involved in creating new structures and also by the civil character of the Brazilian space program, different from what was proposed. The main Brazilian argument is the expressive asymmetry of the South American space capabilities that would reduce advantages for Brazil cooperation. However, the development of the Alcántara Launch Center is a strong motivation, which would allow Brazil to develop a regional center for final assembly, testing, launch, control, and tracking.

Nowadays, there is a group of people in different governments pushing for the creation of this regional space agency. However, at the present day, the heads of the government did not agree nor dedicated funding for its creation. The South American Space Agency remains a goal that is been pursued in the region.

III. ARGENTINA

Argentina's first activities in the space field go back to 1961, when the National Commission for Space Research (Comisión Nacional de Investigaciones Espaciales, CNIE) was first established within the Argentine Air Forces area. A civil engineer, Mr. Teófilo Tabanera conducted the beginnings of the new entity as its first president. CONAE's Space Center in the province of Córdoba has been named in his honor. CNIE, working with local and international partners, carried out the first southern hemisphere scientific atmospheric physics using rockets and stratospheric balloons. Together with the Argentine Institute of Aeronautics and Space Research, CNIE designed and constructed a family of one- and two-stage sounding rockets, i.e. the Orion, the Rigel and the Castor, which were launched from Chical, in the Province of La Rioja.

The first Latin American course on space survey matters was organized by CNIE at the Bariloche Atomic Center, located in the Province of Rio Negro. NASA scientists and experts from Harvard, Iowa and Rice Universities lectured at this course, which was amply attended by Argentine professionals as well as by Brazilian, Chilean and Colombian colleagues. In 1991, the Argentine Government decreed the creation of the National Commission for Space Activities (CONAE) as a civil entity reporting directly to the President. Since 1996, this specialized agency accomplishes its mission governed by the Ministry of Foreign Affairs. The progress has continued through to today with the development of new satellite technologies within the government and private sector, reinforcing that Argentina is indeed an actor in the international space community. Therefore, it's important to bring new players, young and dedicated individuals to collaborate

and develop new ties with the international community to participate and bring space closer to us.

The Table 1 shows the chronology of the major events of the Argentinean Space Program.

Year	Event
1996	Launch of the SAC B satellite
1998	Launch of the SAC A satellite
2000	Launch of the SAC C satellite
2011	Launch of the SAC D satellite
2014	Launch of the ARSAT 1 satellite
2015	Launch of the ARSAT 2 satellite

Table 1: Main Space related events in Argentina over the past years.

IV. BOLIVIA

V. BRAZIL

"The main difficulty for air navigation is in progress of the engines...the steel has already been improved ... Another difficulty that presents itself to air navigation is to be located the airplane ... It is time, perhaps, to install a true school in an appropriate field...Bordering the line of the "Central do Brasil", especially in the vicinity of Mogi das Cruzes, I see fields that seem to be good. Students need to sleep next to the school, even if it is necessary to make adequate facilities ... I think, from every point of view, it is preferable to bring teachers from Europe and USA, instead of sending students there. My earnest desire is to see true Aviation Schools in Brazil. See the airplane, today powerful weapon of war, tomorrow through great transport, covering our vast regions, populating our sky, where, first, looked up ... Bartolomeu Lourenço de Gusmão" Santos-Dummont¹. This quote from Santos-Dummont in the beginning of the century XX shows one of the first thoughts of starting activities related to the aviation sector which later was the starting point for the development of space activities in Brazil. The region cited in the quote (Valley of Paraíba in state of São Paulo), received later some important schools, institutes of research and industries that corresponds to the main centre for aerospace activity in the country. Among some of them are: INPE (National Institute for Space Research), EMBRAER and several other industries of the aeronautical and aerospace sector, ITA (Technological Institute of Aeronautics), IAE (Institute of Aeronautics and Space), etc.

The period when the space sector started to obtain more interest from Brazilian government was during the period of military rule which began in 1964 and continued for 20 years. In this period the Brazilian space activity was at its inception, and as well as other activities of the country it was under military supervision². After the end of this period occurred the expansion of the activities of the INPE³ (now attached

to the Ministry of Science, Technology and Development) and the creation of undergraduate and post graduate studies in non-military institutions, the creation of the Brazilian Space Agency (AEB), the Brazilian Aerospace Association (AAB), the Brazilian Association of Aeronautical and Space Law (ABDAE), which contributed significantly to the expansion of space activity in Brazil. Today, there is greater freedom to for this sector than in the period of military supervision, allowing its greater expansion and technological development due to more interactions and contribution from academia and the industries.

Nowadays, Brazil has two launch sites Alcantara Launch Center and Barreira do Inferno Launch Center, makes, assembles and tests sounding rockets, satellites and rocket engines. Also, Brazil is currently developing a launch vehicle nationally and a second launcher family in collaboration with the Russian Federal Space Agency. By mean of the IAE and the aerospace industry, Brazil has designed and produced a successful set of probe vehicles. These rockets have provided the realization of numerous scientific and technological experiments. The field of probe rockets technology formed the basis for the development of a Satellite Launch Vehicle (VLS), an artifact of four stages, with about 50 tones at take-off, capable of launching satellites from 100 kg to 350 kg in altitudes of 200 km to 1000 km⁴. The operational vehicles of the class of probe rockets are used for suborbital space exploration missions and are able of launching payloads composed of scientific and technological experiments. They supply most of Brazil's needs and have a history of successful releases. The project for these ones began in 1967, when the rocket SONDA I performed the inaugural flight, first release of a Brazilian national rocket. This launch was held at Barreira do Inferno Launch Center. During a period of 12 years, over 200 rocket experiments of this type were performed. The policy of incentive the involvement of universities and research centers in the space program is resulting in an increased demand for these vehicles, which has led to the continuation of its production.

Satellites developed under this program were the SCD-1 and 2 (the Data Collection Satellite), launched in 1993 and 1998, respectively⁵. Moreover, China and Brazil signed in July 1988, a cooperation agreement for the development project known as Satellite China-Brazil Earth Resources Satellite (CBERS). The CBERS satellites are intend for monitoring climate changes, water resources management, tax collection, images for licensing and monitoring of the environmental, among other applications. Their images are used in Brazil by private companies and institutions such as IBAMA, INCRA, Petrobras, Aneel, Embrapa and government administration⁶. Three satellites are being developed by INPE, responsible for implementing the projects

"Amazonia-1", which will be used for imaging of the Amazon region, "Sabia-Mar" developed in cooperation with Argentina for ocean studies, and "GPM-Brasil", for meteorological studies⁷. The operations of SCD and CBERS satellites also are/were performed by INPE.

The Table 3 shows the chronology of the major events of the Brazilian Space Program until July 2015.

Year	Event
1961	Creation of Organizing Group of the National Commission on Space Activities (GOCNAE)
1963	The GOCNAE becomes the National Commission on Space Activities (CNAE)
1965	Inauguration of the Launch Center of Barreira do Inferno (CLBI)
1967	Launch of the rocket "Sonda I" at CLBI
1969	Launch of the rocket "Sonda II" at CLBI; Creation of the "Empresa Brasileira de Aeronáutica" SA (Embraer)
1971	Extinction of CNAE and establishment of the Institute for Space Research, today the National Institute for Space Research (INPE); Creation of the Institute for Space Activities' Center, at CTA, today DCTA
1973	Brazil becomes the third country in the world having an operating station to receive satellite images
1979	Approval of the Brazilian Complete Space Mission (MECB)
1983	Inauguration of Alcantara Launch Center (CLA)
1987	Opened the Integration and Testing Laboratory (LIT)
1988	Brazil and China sign cooperation agreement for the development of Chinese-Brazilian Earth Resources Satellite (CBERS)
1993	Launched the first Brazilian satellite, the Data Collection Satellite (SCD-1) with a mission to collect environmental data
1994	Creation of the Brazilian Space Agency (AEB)
1997	First test flight on the Satellite Launch Vehicle of Brazil (VLS-1) at CLA; Brazil joins the International Space Station (ISS) Program
1998	Launched of the Brazilian satellite SCD-2
1999	CBERS-1 satellite is launched; Flight of the second prototype of the VLS-1; Launched of scientific microsattellites SACI 1 and SACI 2
2002	Launch of HSB (Humidity Sounder of Brazil) as part of NASA's Aqua Satellite
2003	Accident with the third VLS-1 prototype at CLA; Launched of CBERS-2

2006	Realization of Centenary Mission in honor of the centenary of the first manned flight of an airplane, the 14-BIS by Santos-Dumont. The main objective was to send the first Brazilian astronaut, Marcos Pontes, into space by a Soyuz nave to conduct experiments aboard the International Station Space (ISS)
2007	Launched of CBERS-2B
2013	Launched of CBERS-3
2014	Launched of the first Brazilian nanosatellite, the NanosatC-Br1; Launched of CBERS-4
2015	Launched the first cubesat fully developed in Brazil, the AESP-14

Table 3: The chronology of major historical events of the Brazilian Space Program until July 2015.

It is possible cite two of the innovative and successful activities being performed in the Brazilian space sector: 1) The ASTER mission⁸⁹ that is the first Brazilian deep space mission that intends to send a spacecraft to investigate a triple system formed by three asteroids (2001SN263). It is budgeted at R\$ 40 million, but still there is no fund raising. If this mission is successful, Brazil will become the fifth space power to send a spacecraft to an asteroid, behind the United States, European Union, Japan and China, and the first to send a spacecraft to an asteroid triple. The program also seeks cooperation with the Russian Federal Space Agency; and 2) The work of IAE and the national industry producing a set of suborbital vehicles¹⁰¹¹, including the SONDA series and the VS series. The main characteristics that distinguish them sounding rockets and other vehicles for access to space is low development cost, ease of launch, speed in accomplishing the mission, reuse rocket experiment with recovery and flexibility of the launch site. For this reason, these vehicles serve the wide variety of applications, as well as providing a microgravity environment for several minutes, which provides research opportunities in a wide variety of disciplines such as materials science, fluid physics, biology, astronomy, geophysics, atmospheric sciences, among others. It is estimated that the Sounding Rockets Program of the American Space Agency (NASA) and ESA Microgravity achieve more than 50 launches of suborbital vehicles per year, supporting scientific and technological research. Equivalent amount of missions is conducted by other countries, including Brazil.

According to the National Program of Space Activities¹², the objective of development of space research in a strategic scenario for the next decade includes the following topics: the program for the development of critical technologies; the actions of technological absorption in the development of the

Geostationary Satellite Defense and Strategic Communications (SGDC); the new directions for the Sectoral Funds; the National Defense Strategy (END); actions of the Sectoral Technological Schedule (ATS) in the context of "Plano Brasil Maior" ; the special role of the Science Without Borders program for space research; legislative initiatives for the unburdening of the sector, among other government actions. Strategic guidelines: 1) Consolidate the Brazilian space industry, increasing its competitiveness and increasing its capacity for innovation, including through the use of purchasing power of the State, and partnerships with other countries; 2) Develop intensive program of critical technologies, encouraging capacity building in the sector, with greater participation of academia, government S&T institutions and industry; 3) Expand partnerships with other countries, prioritizing the set of technological and industrial development projects of mutual interest; 4) Encourage the funding of footwear programs in public and/or private partnerships; 5) Promote greater integration of the governance system of space activities in the country, through increased synergy and effectiveness of actions among its main actors and the creation of a National Council on Space Policy, directly led by the president; 6) Improving legislation to streamline space activities, encouraging and facilitating government purchases, increased resources for the Space Sector Fund, and the exoneration of the industry; 7) Encourage the training of specialists needed to Brazilian space industry, both domestically and abroad; 8) Promote awareness of public opinion on the relevance of the study, use and development of the Brazilian space industry. The list of current and future initiatives of the Brazilian Space Program and that can be modified strategically is: 1) Working with the CBERS's family of satellites; 2) Satellites for Earth Observation Series Amazon (Amazon-1 and its successors); 3) Suborbital rockets and re-entry platforms; 4) Launch Vehicles based in Southern Cross Program; 5) Infrastructure Release for access to space (Space Complex Alcantara - CEA) and commercial launch services (Brazil-Ukraine Agreement); 6) Geostationary Satellite Defense and Strategic Communications (SGDC); 7) Satellite Earth Observation Radar (SAR); 8) Geostationary Meteorological Satellite (GEOMET).

Regarding the satellites, the projects cited are to meet major national needs in the areas of earth observation, meteorology, telecommunications and sciences. Regarding the launch vehicle and launch pads, their development should seek to meet both domestic demands, as the foreign compatible with vehicles that will be operated from the national territory. There are other initiatives involving the industries, universities, research centers: 1) Organize and strengthen the supply chain of space industry; 2) Mastering the critical

technologies necessary for our development; 3) Expand the market for space products and services and 4) Increase participation in international cooperation projects.

VI. COLOMBIA

The following represents a summary of the space related activities in Colombia. The country has always counted with organizations interested in the aeronautic development, and more recently, more efforts have been made in the development of the space sector. The developments are provided in a chronological manner, and the main milestones are summarized in Table 4.

On November 29th, 1971, Colombia signed the United Nations Outer Space Treaty, which was recognized by the Colombian Supreme Court on November 13th, 2013. Colombia also signed the agreement to register satellites in orbit on November 12th, 1974, whose approval by the Colombian Supreme Court took place on April 17th, 2013¹³.

In 2006, the Colombian Government created Colombian Space Committee whose main goal is to provide access to space technologies in telecommunication, remote sensing and navigation. The CSC has seven work groups to achieve its objectives, amongst which are satellite navigation, remote sensing, astronautics and astronomy, knowledge management, telecommunications, space policy and finally geospatial database¹⁴.

In 2007 the Sergio Arboleda University launched the "Libertad I" which is the first Colombian satellite in orbit. The "Libertad I" is a picosatellite of approximately 1kg and its main goal was to perform technological demonstrations of the Colombian capabilities in space systems¹⁵. The mission successfully accomplished all its goals and until now remains the only Colombian satellite in orbit.

The Colombian Presidency created the Presidential Program for Space Development on November 15th, 2013, aiming to lead the projects to promote universities and companies to enroll in the space development in the country¹⁶. This commission continued working towards the acquisition of a remote sensing satellite¹⁷, until the government decided to cancel the Presidential Program for Space Development in 2014 under the argument that it was cheaper to buy remote sensing data from third parties instead of buying and operating its own satellite¹⁸.

On December of 2014 were launched 2 high altitude balloons with 4 scientific experiments on board, three out of which were conducted by the University of Antioquia and one had been thought of and carried on by a group of primary school students from a public school from Medellín¹⁹. This mission was designed and executed by the local company Ideatech²⁰.

The University Sergio Arboleda is currently leading its second nanosatellite design and development, which will be called “Libertad II”²¹ and the same university projects bigger developments in the near future. At the same time, other universities around the country are considering devoting part of their budget and working hours to develop their own nanosatellites²².

In 2015, Ruta N (Medellín’s Science, Technology and Innovation Foundation) launched the program “Medellín Espacial” (Medellín in Space), which will support startups and university research projects working on business ideas in the aerospace industry based in the city of Medellín²³.

Year	Event
1971	Signature of the Outer Space Treaty
2006	Creation of Colombian Space Committee
2007	Launch of first Colombian nanosatellite – Libertad I
2013	Creation of Presidential Program for Space Development
2014	Cancellation of the Presidential Program for Space Development and the Colombian Remote Sensing satellite
2014	Launch of the 2 high altitude balloons carrying 4 scientific payloads
1998	Medellin in Space Program is created

Table 4: Main Space related events in Colombia over the past 50 years.

Colombia is still at a very early stage in its space development projects, due to the fact that the country still lacks having one operational satellite like the other Latin-American countries have at the moment. This fact shows the urgent need to transform the Colombian Space Committee into a formal Space Agency that promotes the development of equipment and space technologies acquisition.

On the other hand, the academic and private sectors have been the actors who have focused on the development of space technologies in Colombia, which highlights the need to make the Colombian Government more actively involved managing and supporting financially this type of initiatives.

VII. CHILE

The following represents a summary of the space related activities in Chile. From the late 1950’s Chile has played a role in the space activities of other major countries providing ground support. There is not much published information about the developments of activities in Chile, hence the section’s author has used what was available and benchmarked it with its knowledge from its work at the Chilean Space Agency during 2010. The developments are provided in a

chronological manner, and the main milestones are summarized in Table 5.

In 1957 before the creation of NASA, two ground stations were installed. One in Salar del Carmen (near Antofagasta) and the other one in Peldehue (North of the capital Santiago). Both were part of the US Army’s **Minitrack Network**²⁴. This is considered first milestone for Chilean involvement in space activities. With the launch of Sputnik-I, on October 27th the same year²⁵, the station capabilities were verified. With the creation of NASA in 1958 these ground stations were passed to civilian operators (for Chile was the University of Chile). With the following technological developments in 1963 the station at the Salar del Carmen was closed and the one in Peldehue reached a peak ~200 employees during the 70’s. It remains open with far less personnel to date, after being sold to the Swedish Space Corporation in 2009²⁶.

Later in 1968 the national telecommunications company ENTEL started to operate its Longovilo ground station for telephone and data via satellite. This was the first of its kind in South America and it allowed to receive the Moon landing in 1969²⁷.

In 1973 Chile joined the COPUOS, and its counterpart has always remained at the Foreign Affairs Ministry. Chile has participated in its sessions and has signed and ratified all 5 space treaties²⁸.

In 1980 the Committee for Space Matters (Comite de Asuntos Espaciales) is created under the Defense Ministry with the objective of proposing a text for the **National Space Policy** as well as the **Law to create a Space Agency**. This committee had evolved over the years with different names, becoming the Presidential Advisory Commission, known as the Chilean Space Agency in 2001²⁹. It remained under Defense until 2009³⁰ when it was moved to the Under Secretariat of Economy (a civilian ministry with the idea of fulfilling Chile’s obligations under the COPUOS). On December 2011, the agency disappears as no budget is allocated for its functioning.

In 1985 and following the developments of the US Space Shuttle Program, the Mataverí agreement was signed. Under this agreement, NASA enlarged the Eastern Island airport runway to be used as backup for emergency Shuttle landings from near Polar missions/orbits. The Space Shuttle never landed here.

During the 90s and agreement with DLR was signed in order to support the operations of their antenna located in Antarctica 30 meters from the Chilean Army’s base O’Higgins. Under this agreement the radar images from ERS-1 and ERS-2 were downloaded at the station.

On August 31st 1995, FASAT-ALFA, first Chilean satellite developed by the Air force at the University of Surrey was launched into orbit. Unfortunately, issues with the separation mechanism didn’t allow for it to

deploy. After this failure, and using the insurance, the development of FASAT-BRAVO where immediately started. This was successfully launched on July 10th 1998, and fulfill successfully its mission contributing to the scientific development of the country³¹. After this attempt in the 90s, the satellite developments took a long break until the process for procuring the 3rd Chilean Satellite SSOT where started around 2007.

On July 25th, 2008 the contract for the construction of SSOT, also known as FASAT-Charlie, is signed with EADS (now Airbus group). The satellites is launch with a delay of 2 years on December 16th 2011. With its resolution of 1.45 m in panchromatic and 5.8 m I multi spectral is the **optical satellite with highest resolution in South America**

After a period without a space agency, a high level body was created in 2014 a Ministerial council with the tasks of promoting, and developing the space activities was formed³².

The Defense minister as well as the Ministerial Council has announced the process for replacing the Earth Observation satellite, which is coming to an end of its orbital lifetime towards the end of 2016, are on their way. Also a new Space Agency should be created under the “new” Science and Technology Ministry to be created next year^{33,34}. There are also discussion regarding a Communication Satellite, which are fueled by the experienced loss of communications during the 2010 Earthquake.

Year	Event
1957	First ground support stations installed in Chile as part of the Minitrack Network
1968	National telecommunications company started operations of its ground station for telephone and data via satellite (first of its kind in South America)
1973	Joined COPUOS
1980	Creation of committee for space matters
1985	Mataverí agreement for use of Easter Island runway as backup for Space Shuttle polar mission emergency landings
1995	Launch of first Chilean satellites FASAT-ALFA, built at University of Surrey (Unsuccessful deployment)
1998	Successful launch of FASAT-BRAVO
2011	Launch of SSOT/FASAT-CHARLIE
2015	Discussion on the replacement of SSOT

Table 5: Main Space related events in Chile over the past 70 years.

Since 1980, with the creation of different committees, several attempts to form a National Space Agency have failed. The defense side of space, has been covered by three satellites being already procured using its own budget, however the civilian side has remain

very constrained. Hence the main thing is to gather political support in order to allocated a long term budget to be administered by a Civilian Space Agency with a mid to long term strategy.

The latest developments, new satellite process and re activation of the Agency under the Science and Technology Ministry, point in the right direction. Key for the success of this endeavor will be to attack young professional, who with the appropriate political and monetary support could lead the country to develop its full potential in terms of applications and research.

VIII. PERU

The following represents a summary of the space related activities in Peru, which it has recently experienced an important growth in the space sector.

Peru has a very long tradition in aerospace activities, in 1895 the Peruvian engineer and scientist Pedro Paulet (1874–1945) designed and built the first liquid fuel engine. The impulse of this engine reached 90 kg and worked without deformations during 1 hour. Beginning of last century he proposed a futuristic, for his time, spacecraft propelled by rockets called the Torpedo Plane.

The National Commission of Investigation and Aerospace Development (CONIDA) plays the role of the aerospace agency in Peru. Its mission is to promote scientific research, to develop space technology for national interests, and to create services for driving the national aerospace program. The major tasks of CONIDA are:

- Promote in Peru the development and peaceful research in the space field.
- Organize studies, theoretical and practical research about space topics with national and foreign entities
- Conclude cooperation agreements with similar national and international institutions.
- Encourage the exchange of technology and support and execute the training of national specialists.
- Administrate the national law and legislation applicable to space.
- Support national and educational space projects³⁵.

On July 4 2015, Peruvian defense minister Jakke Valakivi announced the construction of its National Satellite Imagery Operations Centre (Centro Nacional de Operaciones de Imágenes Satelitales: CNOIS). CNOIS is being built at the Peruvian Air Force's Punta Lobos logistics base in the Pucusana district, about 40 miles (64 km) south of Lima. CNOIS is part of a PEN600 million (USD188 million) government-to-government contract with France signed in 2014³⁶. On June 12 2013, Peru successfully launched its first rocket built with 100 percent Peruvian technology with the capacity to reach the stratosphere, at the scientific base

of Punta Lobos in Pucusana, south of the country's capital Lima. The manufacturing of Paulet 1-B was a milestone in Peru's aerospace industry, because it was the first time that a device built solely with Peruvian technology was launched into space³⁷. The Peruvian Institute of Radioastronomy of "Pontificia Universidad Catolica del Peru" University developed two satellites with academic and research in space science and engineering purposes. The PUCP-Sat 1 and Pocket-PUCP were launched into orbit today from the Russian Baikonur Yasny, with academic and research in science and space engineering purposes, the construction of which was attended by teachers and students of the specialties of Physics, Mechanical Engineering, Electrical Engineering and Telecommunication engineering³⁸. On 4 February 2014, during the 181st spacewalk for assembly and maintenance of the International Space Station (ISS) Russian cosmonauts Alexander Skvortsov and Oleg Artemyev released by hand a 1-kg Peruvian nanosatellite dubbed Chasqui 1. Students at the National University of Engineering in Peru built the satellite for the purpose of gaining experience in satellite manufacturing and Information and Communication Technology (ICT). The satellite was designed for Earth observation and will deliver pictures of Earth to a designated ground station³⁹. U.S. space agency NASA launched a cube-shaped satellite designed by students and faculty from Peruvian university "Universidad Alas Peruanas". The satellite, known as UAP SAT-1, was sent into space inside Orbital Sciences' Antares rocket from NASA's Wallops Flight Facility in Wallops Island, Va. at around 13:00 p.m. (Peru time) Thursday, Jan. 9 2014. The UAP SAT-1 weighs less than a kilogram and is programmed to return data regarding its status and environment by means of amateur radio broadcasts. The project has been underway since 2010 and represents an investment of over US\$500,000⁴⁰.

Table 6 presents a historical summary of Peru's main space achievements.

Year	Event
1895	Peruvian engineer and scientist Pedro Paulet (1874 – 1945) designed and built the first liquid fuel engine.
1974	Foundation of the National Commission of Investigation and Aerospace Development of Peru (CONIDA)
2013	Launching of CONIDA - PAULET 1-B Rocket. Launching of "PUCP-SAT" satellite, built at "Pontificia Universidad Catolica del Peru".
2014	Launching of satellite "Chasqui-I", built at "Universidad Nacional de Ingenieria". Launching of "UAPSAT-I" satellite, built

at "Universidad Alas Peruanas".
2015 Construction of National Satellite Imagery Operations Centre (CNOIS)

Table 6: Main space related events in Peru over the past 150 years.

IX. CONCLUSIONS AND FUTURE TRENDS

The success of ESA following the success of the U.S. and former U.S.S.R. motivated South America nations to institute long-term space technology efforts for both space access and utilization. Today, space access is available to virtually any nation willing to purchase a launch, and competitively offered by more than eight nations who are able to provide a launch vehicle for payload delivery. Launch suppliers today include: U.S., Russia, Ukraine, China, Japan, India, ESA-member countries (France and Italy), and several additional nations following closely behind with their own government-sponsored launch vehicles.

Today, worldwide launch rates are appreciable and sustained. It is worth noting that the mix of missions among the three major types is shifting toward an increased diversity of missions, sponsors, and providers. In looking closer at this mix, we are able to identify noteworthy trends about an emerging international industrial base for space products and services manufactured in South America.

Even though some countries can rent a launching site, or share a compartment with the payload, especially in the case of nano and pico satellites, like in the most recently launching of Tita, the third Argentinian nano satellite, using a Russian rocket that also carried another 30 satellites from different countries. Despite the space activity in South America region is not strong⁴¹, the idea of possess an own launching site for LEO and GEO orbits, could bring the same benefits that they have brought for other countries in the world

IX.I Space Launch Infrastructure and Activity

One of the biggest challenges for South America is undoubtedly to develop a launching site. ETO launch providers include governments and corporations located on three of the seven continents of the world (North America, Europe, and Asia), and are the product of aggressive R&D from national space agencies. Both new and derivative models of launchers have evolved according to individual nation's space policies and strategies. Their respective launch sites are located around the globe on land, coastal areas, and even on the ocean itself. A review of this diversity of capability is an integral part of understanding South American trends and the possibility to count with an own launching site. As South America continues to shape up as a hotbed for the satellite industry, Venezuela is looking to become a more relevant player in this market. With two satellites

already launched, and more ambitious space projects in the pipeline, the country is quickly becoming a pioneer for developing a space-based capability in Latin America⁴².

Peru launched the mars dessert research station⁴³ as an activity to simulate the life in mars, promoting a new culture and involving different sectors of the academy in this ambitious idea. The ARSAT-1 satellite is the first to be constructed with local technology in Latin America⁴⁴ in 2014. Bolivia's long-awaited first foray into space took place in China when the Asian superpower launches the Andean nation's "Tupac Katari" the first telecommunication satellite⁴⁵. An event that this year shocked the space community was about Brazil, which has decided to unilaterally cancel the bilateral accord reached with Ukraine in 2003 to build a joint center for launching satellites at Brazil's Alcantara aerospace base, officials said⁴⁶.

IX.II. Economic Incentives for Cooperation

A space project in the region requires a large budget an effort to be definitely reached, UNASUR has a clear ambition to reach an integral level of cooperation on multiple levels between its member countries, based on the social dimension of integration and in the local needs of each of the member countries.

The objective of UNASUR is to build an integration space of the South American peoples. The region undergoes an important moment of democratic stability and social progress, which is a consequence, among other factors, of the benefits resulting from the political coordination among the countries. The organization has proved to be possible to strengthen integration and find consensus, respecting plurality

The group's ability to cooperate is affected by the disproportionate size of Brazil's economy, which accounts for about 60 percent of UNASUR's total economic output. World Bank data, shows that Brazil, is country with the strongest internal market in South America and also the least trade-dependent economy in UNASUR, Fig 1. A common vision, the disproportion can be a benefit for the region.

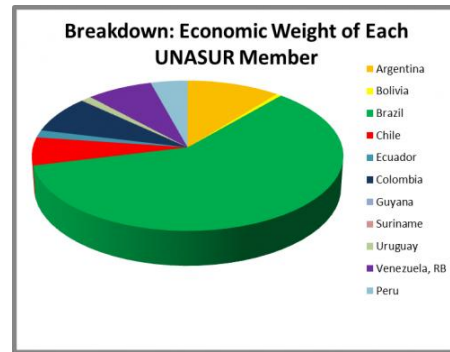


Fig. 1 World Bank World Development Indicators database figures for 2011⁴⁷

IX.III. Shared Vision for Space Utilization

The socio-techno-political climate for an exponentially expanding⁴⁸ for South America industrial space, age may depend first upon the national strategic and economic interests of prospective participants. Unfortunately, the enabling technological infrastructure for future collaboration appears to not be maturing rapidly and strengthening until now. More ambitious and long-term endeavors on space flight will rest on government resources, yet here too, there appear to be more options for government customers in terms of suitable launch vehicles and launch sites around the world. National governments and their respective space agencies need to make concerted efforts to leverage South American experience and knowledge in exploring space and exploiting technology to serve their Union of American Nations (UNASUR) constituent's needs on Earth. A more detailed examination of the space services market place (access and utilization) is possible in terms of the success and failure of cooperatives, the pace of development of new space access capability (either private or governmental), or the operations and sustainment of such capability, where multiple geographically-dispersed parties are involved. The maturation of the space sector is occurring at a rapid pace with the many actors playing a role. There is no doubt that the internationalization of space is enjoying a period of ascendancy⁴⁹. "Earth is the cradle of humanity, but one cannot live in a cradle forever", Konstantin Tsiolkovsky.

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