U.S. – South Korean Space Cooperation

A background on South Korea's space program, America's geopolitical influences, and future areas for strategic collaboration.

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September 2010

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Summary

The purpose of this project was to gain a better understanding of South Korea's civil, commercial, and cooperative space activities, with a focus on the United States (U.S.), China, and Japan. Researching the historical and political aspects of neighboring Asian space faring nations was crucial in understanding U.S.–South Korean space relations. In 1979, the U.S. and South Korea signed a Memorandum of Understanding (MOU) restricting South Korea's development of long range missile capabilities. While the Missile Technology Control Regime (MTCR) signed in 2001 allowed the South Koreans to pursue launch capabilities, there were still obstacles in obtaining the necessary knowledge to develop independent space technologies. Therefore during the past 20 years, South Korea's space policy has concentrated on advancing indigenous space technology with the "learning by doing" method; especially through seeking support from experienced space faring nations in satellite and launch development. However, after gaining indigenous satellite building capabilities, South Korea's priorities shifted to building its own independent space launch technology. Because there are other areas of space technology that can benefit an emerging space nation, South Korea will also need to expand their national and international space policy to be integrated with the international space community. Therefore this paper intends to examine South Korea's strengths and consider potential areas for increasing U.S.–South Korean relations under the current international environment.

Introduction

As opposed to the U.S. and Russia's space programs which began in the late 1950's, South Korea's interest in space technology started thirty years later. As their economy grew throughout the 1980's, so did their motivations for developing a knowledge based economy based upon investments in science, technology, and innovation. These initial investments in 1989 were in building sounding rockets and satellites. The launch of the nation's first satellite, a university built satellite called KISAT-1, was only in 1992. The launch of the nation's first sounding rocket, KSR-I, followed a year later in 1993. Within the span of two decades, the country has managed to develop their space capability with limited resources, embedding space applications into everyday services. From 2005-2008, the Korean aerospace workforce has increased an average of 11.2%. This is due to a growing number of aerospace specialists in private industry, research institutions, and universities.[1] The South Korean space program budget has increased from $58 million USD in 1997 to $317 million in 2008, exemplifying their commitment to space technology development (Table 1). While the budget is much smaller than the U.S. and Japan, South Korea has been able to utilize their investments towards developing a broad range of space technology. Today, South Korea strives to be one of the seven scientific and technologically advanced countries in the world and claim a seat as one of the top ten space faring nations.[2] Similar to the beginnings of many

other space nations, rapid technological development cannot be pursued alone and requires the support of fellow knowledgeable nations.

Table 1: Korea's Civil Space Program Budget from 1997-2008 (Million USD)

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Budget	58	32	59	61	100	113	114	150	186	331	317	317

Source: "Government Space Markets to 2017", Euroconsult, 2008

Since the establishment of the Korean Aerospace Research Institute (KARI) under the accordance of the Korea Aerospace Promotion Law of 1989[3], South Korea has aimed to work with advanced space faring nations for technological capabilities; especially the United States. However, international cooperation in space technology often has limits due to the fear of potential technology transfer misuse and offsetting regional balance of powers with the dual use nature of space capabilities. Therefore past missile technology agreements with the U.S. has influenced how South Korea forms regional allies and can be considered a hindrance to their growth as one of the Northeast Asian space powers. Still, with the current political atmosphere between Washington and Northeast Asia, South Korea is a promising long term ally where further space cooperation can strengthen soft power diplomacy and geopolitical strategies for balancing the region.

Within Northeast Asia, regional space cooperation has been limited by historical and political issues. Unless rivalries and power struggles decrease, any potential discussions towards strengthening long term regional relations will not be taken seriously. Thus, the purpose of this paper is to examine the background of South Korea's space development history, their current relationship between the U.S., China, and Japan, and provide recommendations for strengthening U.S.- South Korean bilateral relations; which in turn will be capable of strategically increasing regional space cooperation.

South Korea's Space Program

Background

The start of South Korea's space initiatives was in 1989, when the government recognized the potential benefits of space technology to the nation and took the first steps towards investing in space development by creating the Korea Aerospace Research Institute (KARI). Established as one of several

Korea Institute of Machinery and Materials (KIMM) affiliates, KARI was one of the research institutions to help transform the nation from a light industry goods producer to a world leader in high-technology industries. KARI has proceeded over the past two decades in developing sounding rockets and satellites, with goals to achieve indigenous satellite technology and launch capabilities.[4]

KARI is based in Daejeon, South Korea, in the technology cluster the late President Park Jung-hee created in 1974 to centralize science and innovation. To encourage government-invested institutions – industry – academic collaboration, science and technology companies along with universities were encouraged to become established in the city. Companies congregated in the northern part of Daejeon, forming the research and development hub of Daedeok Valley. To spur advanced science and engineering education in the Daedeok technology cluster, the Korea Advanced Institute of Science and Technology (KAIST) was founded in 1971. Created under a special law that subsidizes the university with government funds and dubbed the Massachusetts Institute of Technology (MIT) of Korea, KAIST is conveniently located next to KARI, other research institutes, and science and technology companies. Therefore much of Korea's space activities history has been intertwined between government, university and research institutions.

Part of Korea's space program also originated at KAIST, where a great deal of investment in technology and innovation research occurred. While KARI started to develop satellite and sounding rocket technology through the 1990's, KAIST Professor Dr. Soon-dal Choi founded a KAIST research center for satellite technology and applications research, the Satellite Technology Research Center (SaTReC). With Dr. Choi's previous background working for and holding prestigious positions at renowned institutes such as: NASA's Jet Propulsion Laboratory, the National Research Foundation of Korea (formerly known as the Korean Science and Engineering Foundation, KOSEF)[i], the President of KAIST, and Minister of Post and Telecommunications; he used his influence to gain the necessary support to send the first batch of young engineering graduate students to the University of Surrey to learn and acquire the skills required for satellite development. Dr. Choi's investment in the SaTReC students was successful; they effectively launched the nation's first satellite KITSAT-1 and continued to have two more successful satellites developed and launched. Furthermore, a handful of those students later became the founding members of several Korean aerospace companies.

As KARI and SATReC began their initiatives, a long term strategic plan was developed to ensure South Korea was on a path towards developing space capabilities and establishing a successful space program. While there have been difficulties and delays towards South Korea's goal in cultivating indigenous space capabilities, the nation's motto of "learning by doing" has built a sturdy technological foundation and a knowledge based economy.

[i] KOSEF is the equivalent of the National Science Foundation in the United States.

1996 National Space Development Plan

South Korea has been developing their space program over the past two decades based upon a development plan created in the mid 1990s. In November 1996, KARI became an independent government funded institute from KIMM as the nation became serious about their space technology development. The National Space Development Plan was released soon after, with minor revisions in 1998, 2000, and 2005. The 2005 *Space Development Promotion Act* states, "The Government shall formulate a basic program on space development promotion containing the following items for the promotion of space development and the use and administration of space objects." Thus, the act required a legalized basic space plan to be formulated every five years and provide the nation the decree to implement its space activities. This is how the 1996 *National Space Development Plan*, now called the *Basic Space Development Promotion Plan*, became enacted to have legal status.[ii]

2005 Space Development Promotion Act

In addition to establishing the *Basic Space Development Promotion Plan* as a legal document for implementation, the Act seeks to promote space development in a systematic way and ensuring the efficient use and administration of space objects. Therefore the 2005 *Space Development Promotion Act* also includes Korea's basic space law for national space activities. Korea's basic space law essentially reiterates the nation's adherence to the international space treaties. The Act also establishes a National Space Committee to deliberate on space matters regarding the space program, policies, licensing, and investments.

It is also worthy to note that under the *Space Development Promotion Act*, the "Minister of Science and Technology may designate and support a special agency to pursue space development projects in a systematic and efficient way."[5] Such tasks have been pursued by KARI; however, since the institution has not been designated as the special agency they only act as a government agency without having the same legal entity as their U.S. counterpart NASA.

2007 Basic Space Development Promotion Plan

The 2007 *Basic Space Development Promotion Plan* extended the space development goals until 2016. The twenty year plan laid out the foundational steps needed to achieve independent space capability in hopes to exemplify the nation as one of the space powers and means to benefit the national economy. Ideally, the current basic development would lead to a long term harmonious collaboration between research institutions, universities, and commercial companies. Through this plan, Korea has focused mainly on two areas: satellite development and indigenous launch capability. The revisions over the years have been minor; mainly to reflect mission delays, cancelations, and further details to missions

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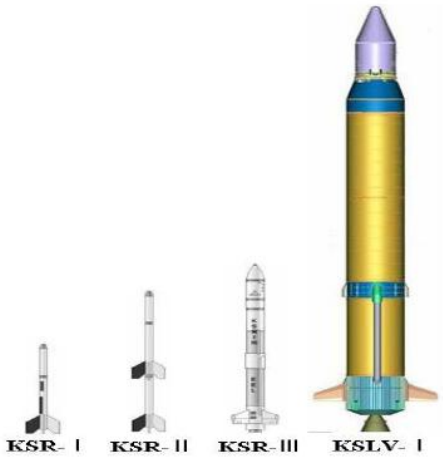
[ii] According to the 2005 Space Development Promotion Act, the law states the government should have a national plan; therefore the updated 2007 version of the National Space Development Plan became enacted into a legal status. "Introduction to Space Activities of Korea." KARI. December 11, 2008. <http://www.albummania.co.kr/gallery/view.asp?seq=103491&path=&rpage>

and the long term strategic vision since most technological development plans are still under implementation. The plan, while simplified to those two main priorities, has allowed the nation to focus on basic space development with the intention of expanding their strengths and niches upon mastering fundamental space technologies.

Rocket Technology

While origins of Korean rocket technology stemmed from the U.S. - supplied Nike and Honest John missiles in the 1960s[6], Korea did not start developing non-military rocket technology until July 1990. Through KARI's Sounding Rocket Program, Korea launched the first indigenous sounding rocket, Korea Sounding Rocket – 1 (KSR-420S-1, or KSR-1) in 1993. A total of three types of rockets were developed in the Korea Sounding Rocket series (Figure 1), with a total of five sounding rocket launches carried out. The KSR-I series was developed as a one-stage solid propellant rocket and the KSR-II series was upgraded to the two-stage solid propellant rocket.[7] KSR-III was a turning point for Korean rocket technology since the rocket used a liquid propulsion system; liquid propulsion is a foundational technology considered applicable towards their ambitions for an indigenous space launch vehicle.[8]

Figure 1. Korea's Rocket Program



Building upon their sounding rocket development experience, South Korea intends to obtain indigenous launch capabilities. They will start with a small lift launch vehicle KSLV-I (Korea Space Launch Vehicle -1) as a learning tool and build upon their knowledge towards a heavy launch vehicle, KSLV-II. In order to gain experience and technology support with developing launch capabilities, KARI sought to cooperate on launch technology development with a nation experienced in the field. The South Koreans were interested in the potential investment of working with the Ukrainians on their air launch concept; however, upon return from initial optimistic discussions, the proposal never came into fruition. The Koreans also sought assistance from the U.S., only to be rejected over concerns of rocket technology proliferation. Finally, KARI signed an inter-governmental agreement with Russia's Khrunichev State for

Research and Production Space Center for the first stage Angara engine and construction of Naro Launch Center facilities in 2004.[iii] The intergovernmental agreement was later supplemented with a Technology Safeguard Agreement (TSA) in October 2006 amidst U.S. pressures against the transfer of Russian rocket technology. Despite the TSA, valuable experience was still gained from operating launch support equipment, computer systems and launch sequence.

After multiple launch delays, the two KSLV-I rockets launched in August 2009 and June 2010 ended in failures. The first attempt failed due to the payload fairing separation system malfunctioning on the Korean second stage, and the second attempt failed in the process of boosting the Russian first-stage rocket.[9] Based upon the contractual agreement between KARI and Russia, whereby if any of the two agreed launches failed and found to include Russian responsibility, the two institutions will work together on the third KSLV-I development.[10] While the third launch is scheduled for 2011, KARI has started the preliminary research for KSLV-II.

Satellite Technology

The Korean strategy towards obtaining space technology has been two-fold: they have relied on foreign technology companies to manufacture and place communication satellites in orbit. Meanwhile, they gained indigenous technology through building small satellites and launching to low earth orbit under technology cooperation agreements.[11] Korea's first satellite, KITSAT-1, was a university based collaboration between KAIST and the University of Surrey. The university based technology transfer allowed the first batch of Korean engineers to gain knowledge into satellite-making. Under a Korea Research Foundation Engineering Research Center grant[iv], KAIST continued to build and successfully launch KITSAT-2 and -3. Meanwhile, KARI initiated collaboration overseas to build KOMPSAT-1. Through these investments in the 1990's, the nation has developed the skills necessary in the satellite manufacturing trade to build advanced satellites.

Under the *National Basic Space Development Plan*, Korea has a goal of developing 12 satellites (Figure 2) over the course of 20 years: the KOMPSAT (Korea Multi-Purpose Satellite) program includes 1, 2, 3, 3A, 5; KITSAT/Uribol- 1, 2, 3; ST-SAT (Science and Technology Satellite) 1, 2a, 2b, 3; and the Communication, Ocean and Meteorological Satellite (COMS). While the KOMPSAT program has only been planned up to KOMPSAT-5, there are intentions to continue the series with a sixth and seventh satellite.

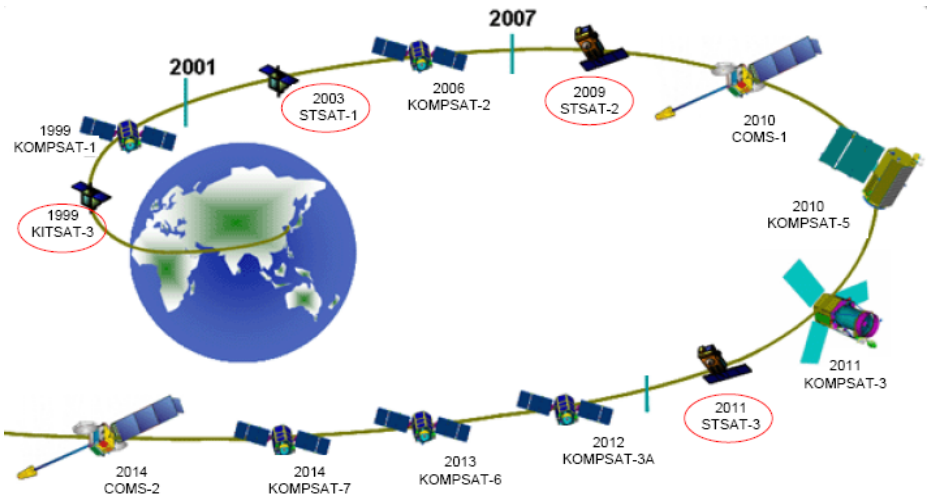
Most of the satellites that have been developed were partially supported by international contractors. However, the long term plan is to gain independent technological capabilities for space development and be one of the top ten nations in the space industry by competing in the global market. Therefore

[iii] Khrunichev State for Research and Production Space Center is the state-run commercial entity of the Russia launch program.

[iv] The Korean Engineering Research Center (ERC) grant was for $1million USD for nine years. This was based off of an initiative similar to the National Science Foundation grant that was $3 million USD for twelve years.

the KOMPSAT-3A mission is designed to transfer satellite manufacturing technology from KARI to a Korean satellite consortium, AP Systems and Korean Aerospace Industries (KAI).

Figure 2. Korea's Satellite Development Timeline



Space Application and Future Technology

Since South Korea's plans have focused on completing their development-oriented *National Basic Space Development Plan*, heavy investments in areas such as space policy, law, space science, and applications has been limited.

However, this branch of KARI has been the most known in the international community for collaborative work and soft power diplomacy. Dr. Soyeon Yi, Korea's first Cosmonaut, gave the nation international recognition as having placed the 49th female astronaut in space, thus spurring national pride. Her trip to the International Space Station included conducting experiments with international space faring partners such as the Japanese Aerospace Exploration Agency (JAXA). While there are no foreseeable plans for a second Korean to travel in space, Dr. Soyeon Yi has become a national icon, stimulating youth to become interested in space.

Furthermore investments in earth observation and national disasters have resulted in supporting regional collaborative projects, such as the Asia Pacific Regional Space Agency Forum (APRSAF) and sharing these outputs through the Regional Space Applications Programme for Sustainable Development (RESAP).

Ministerial Level

The Ministry of Education Science and Technology (MEST) has been the lead in KARI activities and is the major government body for formulating and executing the national space development plan.[12] However, the interdisciplinary side of space has encouraged the participation from other ministries through the 2005 *Space Development Promotion Act*. The Act created the National Space Committee, a governmental body that aids in the formulation of space policy in Korea. This entity is placed in control of the President and chaired by MEST. The committee includes approximately 15 committee members including nine ministers of related ministries.[13] Committee members currently also include Korean aerospace industry heads and university professors. Similar to NASA's Advisory Council, this committee provides advice and counsel where Korean space policy is concerned.

Therefore, while KARI provides the technical arm for Korea's space activities and the capability to give the necessary support and expertise to the government, the final decisions are made at the ministerial level and further consultations are made through the National Space Committee.

Military Space Activities

While the focus of research is on civil space activities, it is important to mention South Korea's limited military space activities. Currently the Korean Air Force does have a Space Division; however their space activities have only been to conduct medical examinations for Dr. Soyeon Yi, on ground/air support for KARI hardware tests in the field, and supporting the annual "Space Challenge" water rocket contest.[14] In 2005, South Korea's Agency for Defense Development (ADD) opened an operations center in Daejeon to control military satellite communications.[15] The KOMPSAT satellite series provides the military with remote sensing intelligence data and Koreasat-5 provides protected secured military communications for the Korean defense forces.

Korean Commercial Space Industry

One of the main goals in the *Korean Basic Space Development Plan* is to promote a commercial space industry that is competitive in the global space economy. Based on the *Space Development Promotion Act,* Korea aims to "promote the peaceful use and scientific exploration of outer space and to boost the national economy."[16] This goal is to be achieved through investments towards a prosperous world, raising the national standard of living through space applications, and promoting international cooperation.[17]

The Korean commercial space industry has been focused in the services sector where IT products are infused with space technology. The signals from the Global Positioning System (GPS) are imbedded in mobile phones and navigation systems that provide real time television services. The Digital Media Broadcasting (DMB) technology is also widely popular by enabling people to watch real-time TV on their mobile phones while on a bus or subway. Through the use of space technology, South Korea's domestic market was approximately $2 billion USD in 2008.[18] The Korean space industry exported $14.5 million USD, and imported $112.6 million USD worth of space products and services in 2008.[19] Revenue from the space industry alone was $0.86 billion USD; if GPS navigation equipment was included in the sales (approximately $600million USD), the total would amount to $1.4billion USD.[20] However, in regards to

hardware capabilities, there are a limited number of companies dedicated to providing space qualified hardware.

While the Korean aerospace industry has come a long way, the industry is still in its infancy when it comes to focusing solely on space hardware.[21] KARI has contracted subsystems out to Korean aerospace companies on various projects; however since most do not have a complete set of the aerospace expertise needed in KARI projects, the research institute has relied mainly on foreign companies to acquire the crucial technologies for independent development. Nonetheless, KARI has involved several companies for satellite development projects, including Korea Aerospace Industry Co. (KAI), Korean Air, Hanwha, Doowon Heavy Industrial, Daewoo Heavy Industries and Machinery and SaTRec-Initiative (SaTReC-I). In regards to the development of the Korean Sounding Rocket and Space Launch Vehicle, ROTEM, Korean Air, Hankook Fiber, Hanwha, Doowon Heavy Industrial and Samsung Techwin were KARI subcontractors. However, besides SaTReC-I, space development technology consists of only a small portion of Korean aerospace companies' portfolio.

Currently SaTReC-I is the only Korean company focused solely on space hardware and satellite development. The company was founded by former SaTReC researchers in 1999, upon completion of KITSAT-3 and the end of the Korea Research Foundation funding. With nowhere to go and firsthand experience working on the KITSAT programs, Dr. Choi Soon-dal suggested to spin off a small satellite development venture company—based upon the Surrey Satellite Technology Limited (SSTL) business model from their experience at the University of Surrey. Through this model, SaTReC-I has not only catered to the government projects and KARI, the company has also worked internationally, collaborating on small satellites technology transfer with Malaysia's Razak-sat and the United Arab Emirates' Dubai-sat 1 and Dubai-sat 2.

While KARI works with various Korean space companies, technology transfer to the industry has been limited. However as previously mentioned, the KOMPSAT 3A program is focused on co-developing with an aerospace industry partner. A consortium between AP Systems Inc. and Korea Aerospace Industries (KAI) was formed to receive the first official mission for technology transfer into the Korean industry. AP Systems is known for satellite communications systems manufacturing; and while KAI has focused on aircraft development, such as the domestic T-50 trainer, they have experience supporting the development of KOMPSAT 3 & 5 and COMS.

Regional Cooperation

Geopolitics has been a major factor in limiting regional space cooperation despite an understanding that further cooperation can be beneficial to all nations. This stems from historical issues and rivalries for the leadership role in the Asia Pacific region. However, regional cooperation has been discussed mainly when national interests, security, and economic growth are involved. In December 2008, China, Japan, and Korea announced that they will "enhance cooperation in developing a comprehensive disaster

management framework, working out measures to reduce vulnerability to disaster and minimize its damage, and strengthening effective disaster management at the national, local and community levels."[22] In May 2010, South Korea hosted the R.O.K.-Japan-China Trilateral Summit, where the three nations released a joint statement reinforcing science and innovation cooperation.[23] Nonetheless the leadership role is vied between the three countries, especially China and Japan. Therefore on the governmental level, South Korean has mainly participated with international multilateral institutions in conducting cooperative space activities. Participation on an international level includes the United Nations Committee on the Peaceful Uses of Outer Space (UN COPUOS), Global Exploration Strategy (GES), and the International Lunar Network (ILN).

Regionally, South Korea is involved in UN Economic and Social Commission for Asia and the Pacific (ESCAP) Regional Space Applications Programme for Sustainable Development (RESAP), Asia Pacific Regional Space Agency Forum (APRSAF), and Asia Pacific-Multilateral Cooperation in Space Technology and Applications (AP-MCSTA). After South Korea successfully hosted the 2009 International Astronautical Congress (IAC) in Daejeon, they were asked to lead the International Astronautical Federation (IAF) regional group, a new initiative under the Daejeon Declaration on Space for International Cooperation and Peace.[24] The regional group is still in its developmental phase, thus further information is not available.

Space Cooperation between Korea and China

There have been limited considerations for bilateral cooperation with China in the past due to concerns of breaching the MTCR and U.S. export control regulations. The Chinese Long March 2E failures incident in 1995 led to stricter U.S. space export controls, and this coincided with the time South Korea started seeking launch service providers for their satellites.[v25] With U.S. International Traffic in Arms Regulation (ITAR) components on Korean space systems, South Korea has not been allowed to use Chinese rockets for their launches. On the university level, SATReC had to reconsider launching from a Chinese launch vehicle for the KITSAT-2 program.[26] On a national level, this complicated the launch of KOMPSAT-2. After signing a launch agreement with China in 2001, South Korea was told that U.S. components on the Korean satellite would prevent the nation from using China as a launch provider. Furthermore, the U.S. "showed a stern posture that it would no longer supply any parts of satellites in the future if South Korea abides by it, stating that such technology could be transferred to a country with proliferation potentiality via China, which is not a partner of the MTCR."[27] This forced South Korea to find a new launch provider and lose the launch deposit they paid to China. However, on the multilateral level, cooperation with China has also been limited.

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[v] The U.S. satellite manufacturers and China worked together to create an analysis of the failure of the Hughes-built Apstar 2 and Space Systems/Loral-built Intelsat 708 Long March 2E launches. This led to the illegal transfer of U.S. space technology.

As mentioned before, South Korea was involved with the AP-MCSTA, a precursor to the current China-led Asia Pacific Space Cooperation Organization (APSCO).[vi] Through AP-MCSTA, Korea cooperated on their Small Multi-Mission Satellite (SMMS) for environmental monitoring and disaster management.[28] However, the activities have been aimed more towards aspiring space nations in need for basic space technology development; moreover, the financial and legal commitment to APSCO requires careful considerations. South Korea has not joined the organization despite invitations. Additionally, China's involvement in Pakistan-North Korea trades in nuclear and missile technology is also a contributing factor for declining further involvement.[29] While China and Korea are both considered APRSAF participants, China has not played an active role in the forum's activities.

Space Cooperation between Korea and Japan

General cooperation between Korea and Japan has strengthened over the past several years due to the necessity to cooperate for economic benefits; however historical tensions have strained relations on the bilateral level. Nonetheless a general bilateral agreement between South Korea and JAXA was signed in 2006. With this agreement, KARI and JAXA worked on joint experiments and experimental hardware aboard the ISS Japanese Experiment Module, KIBO; KARI will be conducting 2 or 3 experiments with Japanese scientists in the future. [30] Working together on ISS experiments allowed the Koreans to participate in the ISS, develop experimental hardware, and allow further discussions between the Korean and Japanese scientists.

Besides ISS scientific collaborations, the two nations also held brief discussions at an April 2008 summit meeting and agreed to give more focus on furthering Korean-Japanese space cooperation.[31] These discussions may have factored into the Korean decision of working with Mitsubishi Heavy Industries to launch the KOMPSAT-3 on the Japanese H2-A rocket. While currently direct cooperation between KARI and JAXA has mainly involved joint ISS experiments, the two organizations has continually collaborated successfully through multilateral forums, especially in the Asia Pacific Regional Space Agency Forum (APRSAF).

Through APRSAF initiatives, the two countries exchanges researchers for the Satellite Technology for the Asia-Pacific Region (STAR) program, designed to develop small satellites using engineers and researchers in the Asia-Pacific region. Furthermore South Korea contributes satellite data to the Sentinel Asia, an APRSAF program created to improve disaster preparedness and early warning. The two nations use their

[vi] Based in Beijing, China, APSCO is modeled on the structure and activities of the European Space Agency. The APSCO Convention is created as an international legal person with the mission to foster multilateral cooperation development, peaceful applications of space science and technology, and bring more socio-economic benefits to each of the Member States. Currently, Bangladesh, Indonesia, Iran, Mongolia, Pakistan, Peru, Thailand and Turkey are Member States of APSCO, while Argentina, Brazil, the Philippines, the Russian Federation and Ukraine have joined as Observers.

space technologies and experiences to both play a leading role in these programs for socioeconomic benefits of the region.

Fortunately, commercial benefits do not face the difficulties of historical issues and there has been a successful Korean-Japanese joint initiative. Mobile Broadcasting Corporation (MBCO) of Japan and SK Telecom of Korea came together in a joint venture to invest in the construction of a digital multimedia broadcasting satellite in 2004. MBSAT is a geostationary satellite that provides high-quality music, video and data to mobile users in Japan and Korea through a variety of mobile terminals, including cars, ships, trains, handheld terminals, personal digital assistants, cellular phones and home portables.[32] This partnership successfully includes 77 partnering companies with MBCO and 18 million subscribers throughout Korea with SK Telecom.[33]

U.S. – South Korean Space Relations

U.S. - Korean space cooperation started in the 1990's, during a time when the U.S. perceived South Korea as a regional imbalance if the nation developed indigenous ballistic missile capabilities, and there were U.S. national security concerns on launch technology transfers after U.S. satellite companies aided in the launch failure analysis of the Chinese Long March 2E. While the Korean War bonded the two nations together through the 1953 Mutual Defense Treaty, U.S. interest in South Korea mainly occurred during times of Northeast Asian security concerns. Therefore the 1979 bilateral agreement signed with Seoul limited Korean missile development range up to 180km, with inspections continuing throughout the 1990's until 1999.[34] Rather, the agreement originally signed to prevent provocation of an arms race with North Korea and the Northeast Asia region left the nation behind in developing launch technologies. It was not until 2001 that the 1979 MoU was lifted, and South Korea's request to join the Missile Technology Control Regime (MTCR) was accepted. Through the MTCR, South Korea was eligible to receive technology transfer for peaceful space exploration purposes.[vii] Furthermore, joining the MTCR allowed the Koreans to also increase their ballistic missile range to 300km. However, the MTCR also hindered potential collaborations with non-MTCR nations, and at times, seen as a tool that deterred Korean development. Nonetheless, the South Koreans have continuously perceived cooperation with the Americans as advantageous, which in turn can strategically benefit both nations if the alliance continues.

Missile Technology Control Regime

Indeed, while joining the MTCR now allowed South Korea to receive technology transfer for peaceful space exploration purposes, as it is "not designed to impede national space programs or international

[vii] Seoul and Washington came to an agreement on lifting the restrictions of the 1979 MoU.

cooperation in such programs as long as such programs could not contribute to delivery systems for weapons of mass destruction,"[35] there were still obstacles in seeking launch technology from other nations. Follow-up on initial positive discussions for investment in Ukraine's then-current air launch research and development project in exchange for technology transfer mysteriously never came into fruition. Seeking launch technology support from the Americans was rejected. As mentioned earlier, Russia' Khrunichev State Research and Production Center agreed to sell the Ankara first stage to South Korea—only later to renegotiate and have the Koreans sign a Technology Safeguard Agreement (TSA). While KARI considers the development of their KSLV-1 launch vehicle as a collaborative development, KARI is responsible for independently learning how to put together the rocket while the Russians only supply the first stage. Therefore while the MTCR allows South Korea to freely build space launch capabilities, political pressure has hindered on the process of development.

KARI – NASA Cooperation

KARI has been highly interested in cooperating with their U.S. counterparts, as any cooperation with a technologically advanced country allow insight into some of the lessons learned. South Korea has expressed interest in not simply being an emerging space nation, but as one of the top space nations with well-rounded technological capabilities. Initial steps towards finding potential collaborations between KARI and NASA included space science activities. These basic discussions over time led the Korean Ministry of Education, Science and Technology and NASA to sign a Statement of Intent for Cooperation in Civil Space and Aeronautics in October 2008. In attempts to show national growth on the global level, Korea signed a Statement of Intent to the Global Exploration Strategy and International Lunar Network, with goals to build their own lunar lander by 2020.

Government-Industry Cooperation

While the focus has been on U.S. - Korean governmental space cooperation, the origin of collaboration came in the form of KARI working with foreign industry partners. This continues to be the trend for many cooperative projects between the two nations. TRW Inc., an American company, provided the technology transfer necessary for KARI to build their first government satellite, KOMPSAT-1. Korean engineers were sent to the U.S. to pursue a joint development project with American engineers and gain the necessary satellite development experience for independent satellite capabilities. Thus, ITAR has been a complication in obtaining certain U.S. space components, but it has not hindered U.S. - Korean space activities on the civil and commercial level.

In regards to industry collaboration, the Korea Telecom company worked with Lockheed Martin for their telecommunications satellite construction of Koreasat-1 and 2. Their long established relationship has allowed Koreasat-3 to be manufactured with the participation of a Korean team that includes: Daewoo Heavy Industries, Doowon, Electronics and Telecommunications Research Institute, Halla Engineering and Heavy Industries, Hyundai Electronics Industries, Korea Aerospace Research Institute, and Korean Air.[36]

Although Korean space companies have used U.S. companies as a means of collaboration and technology building, entry into the U.S. markets for Korean space industries is still an obstacle. The requirements level necessary to compete in the U.S. space market listing, such as the NASA Spacecraft Catalog of vendors, causes difficulties for Korean companies in seeking business prospects in the United States. However, some manufacturers have used a U.S. partner company to enter into the U.S. market. For example, Hyundai joined the communications satellite business by collaborating with Loral/Qualcomm on the Globalstar project. In return for Hyundai's $28.5 million investment contribution, the company secured as the role of Globalstar service provider in Korea, as well as a portion of the satellite manufacturing activity and the necessary transfer of the technology, and a role in the assembly integration and test of the satellites.[37]

Implications for U.S. - Korean Relations

This leads to the question of whether Korean space development and diplomatic ties would be further along without U.S. influence. Has the U.S. hindered on South Korean technological growth? While the U.S. ITAR has caused a direct financial loss to the South Koreans after the need to find a new launch provider for KOMPSAT-2, and discouraged nations from providing the South Koreans the technical assistance for launch development, the nation has continued to build a steady space program despite delays and mission failures. Therefore the U.S. has hampered on Korean space technology development, but only in instances considered to be a compromise to U.S. national security or a threat to regional imbalance. This is has been the case with Korean-Sino space cooperation. While NASA – KARI space activities have been limited, the U.S. influence has not prevented the growth of Korea's space technology other than obtaining launch capabilities. However, such a relationship in the space sector is not positive for two allying nations, and further discussions on ways to cooperate is necessary for creating a sustainable and peaceful use of outer space.

Therefore while South Korea considers the U.S. to be their top ally, the nation has and will continue to seek assistance elsewhere if the U.S. is unwilling to support Korea's civil space ambitions. This is exemplified when South Korea went to find alternative options after the U.S. rejected to aid in launch technology transfer. This led to South Korea seeking help from Russia, thereby strengthening South Korean-Russian relations. Similar to how Sino-Russian cooperation has been driven by China's desire to become politically and economically integrated at the international level due to sanctions from American policies, there is a potential for South Korea to bolster political and economic ties with Russia.[38] If the alliance with Russia increases, U.S. influence in the region may potentially become more limited. With South Korea strategically placed between China and Japan, and below North Korea, it is necessary to consider long term ramifications if U.S.-South Korean relations are not strengthened.

Future U.S. - Korean Space Cooperation

Within the past two decades, South Korea has quickly changed from a nation lacking satellite development capabilities, to a nation learning to build rockets with hopes in joining international endeavors for planetary exploration. Economically, the nation has grown from a developing country to one of the twenty largest economies in the world.[39] Regionally, the nation has extended support to less developed countries in the Asia Pacific, played a founding member role in the Asia Pacific Economic Cooperation (APEC) and a leadership role along with China and Japan in the ASEAN+3. Internationally, they will be hosting the G20 Seoul Summit in November 2010, showcasing that the nation is no longer a developing nation, but an up and coming developed country that participates on global affairs. Therefore, when South Korea proudly hosted the International Astronautical Congress in 2009, the nation was not only displaying the nation's space technology accomplishments, but also showed an active interest to be involved in future international endeavors. Currently as the United States' seventh largest trading partner[40], there are other areas to cultivate a closer partnership. While South Korea may not have the space capabilities parallel to the half century of U.S. invest space exploration, there are still potential benefits in strengthening relations with a non-traditional space nation.

Upon accomplishing the *National Space Development Plan* for technology independence, the future vision states there will be a new plan that encourages further national involvement and strengthening space development. As KARI is currently in the midst of developing the Vision 2030 and deciding about future missions and strategies for the space research institution, both nations should take the broader U.S. - South Korean alliance and current regional tensions into consideration, and use the space arena as an opportunity to strengthen U.S.-South Korean diplomatic relations.

Under the 2010 *U.S. Space Policy*, the nation will "identify areas of mutual interest and benefit, lead in the responsible behavior in space, promote full and open access to government environmental data, promote appropriate cost and risk-sharing in international partnerships, and leverage the space capabilities of allies and space partners." Taking the *U.S. Space Policy* and current Korean space development activities into consideration, some recommendations for cooperation include opening up discussions in the areas of Global Navigation Satellite Systems (GNSS), increasing joint space science experiments aboard the International Space Station, enhancing trilateral relations between U.S. - South Korea - Japan, strengthening Transparency and Confidence Building Measures (TCBM), and fostering U.S. – Korean education exchanges and academic research space projects.

Collaboration on future GNSS systems

One section of the 2010 *U.S. Space Policy* emphasizes the need to "maintain and enhance Space-based Positioning, Navigation, and Timing Systems." Within the *Space Development Promotion Plan*, a GNSS Master Plan was developed in 2005 with an interest to develop GNSS core technology and infrastructure to support applications and services for Korea. They have signed an agreement to collaborate with the European Galileo GNSS system, however discussions on the extent of collaboration has been limited. As GNSS services in South Korea account for approximately $600M USD, the Korean Ministry of

Construction and Transportation has been interested in developing a Regional Navigation Satellite System (RNSS).[41] With the limited frequency allocations and the growing number of GNSS systems currently in its developmental phase, Korea should work closely with current operational GNSS and RNSS providers to ensure interoperability and compatibility in their future system. Another discussion has been for the development of a Korean satellite-based augmentation system (SBAS); while this would encourage U.S. - Korean cooperation through the utilization of the U.S. GPS system, decisions are currently far from finalized.[viii]

In the meantime, the South Korean government should be aware of the international discussions on GNSS, such as the International Committee on GNSS (ICG), where GNSS providers convene to define technical terms and guidelines. These definitions would go beyond current bilateral discussions on collaboration with the European Galileo GNSS system, as the ICG discusses the common international language for interoperability and compatibility. South Korea may find a greater technical accuracy in integrating their future system with other regional systems, such as the Japanese Quasi-Zenith Satellite System (QZSS). Nonetheless, the nation should be engaged in these international discussions and work closely with current providers to ensure interoperability and compatibility amongst all systems.

Regional Cooperation: Promoting U.S. – Korea - Japan Trilateral Relations

As mentioned earlier, Korean – Japan space cooperation has been focused on a multilateral level, with a few direct relations through space science experiments, data and expert exchanges, and commercial collaborations. However, Korea – Japan relations are still strained - despite positive top level discussions leading to the agreement of Mitsubishi Heavy Industries launching KOMPSAT-3, the media and public opinion in Korea were unfavorable towards the decision to use a Japanese launcher. While the agreement can be viewed as a symbolic step towards closer relations, Mitsubishi's involvement in World War II wartime productions still evokes negative sentiments from the Koreans who remember the crimes Japan committed against the nation.

With August 29, 2010 marking 100 years since the Japanese colonization of the Korean Peninsula, Japanese Prime Minister Naoto Kan and South Korean President Lee Myung-bak "shared the recognition that it is of great importance to deepen and thicken the bond between Japan and the ROK which share such common values as democracy, freedom, and market economy and are both allies of the United States."[42] Both countries see the U.S. as a common ally, and the U.S. can use the tie to encourage a positive dialogue between the two nations. Therefore it may be of great diplomatic interest for South Korea, Japan, and the United States, under those common values, to explore space activities and experiments that are of mutual benefit. Increasing collaborative activities between South Korea and Japan can strengthen the image of regional stability in space activities, and build a collaborative model for other nations in the region to work under such common values. Trilateral relations would also be

[viii] There are discussions that the decision for constructing a GNSS or augmentation system are expected to be made in the next one to two years.

beneficial for the U.S. in accordance to the 2010 *U.S. Space Policy* – it is an opportunity for the nation to strengthen U.S. space leadership by fostering soft power diplomacy in the Asia Pacific region, and work with South Korea and Japan to encourage responsible behavior and peaceful use of outer space.

Space Science Experiments on the International Space Station

With the ISS is near completion, there are many potential opportunities to conduct science experiments with non-traditional space partners interested in utilizing the laboratory. South Korea has been keen on expanding investment in basic space sciences under their branch of space sciences and applications research. One possibility is to cooperate on space projects that also include the participation of Japan. Continuing space science research through the KIBO module would strengthen relations between democratic Northeast Asian nations and the U.S. Furthermore, this trilateral relationship can help build trust between South Korea and Japan.

Transparency and Confidence Building Measures

Transparency and Confidence-Building Measures (TCBMs) is emphasized under the international cooperation section of the 2010 *U.S. Space Policy*, and it is inherent in U.S. collaborations. While current non-space endeavors in military activities portray a strong U.S. - Korean alliance, this must also be reflected in its space activities. Currently as South Korea is developing technological capabilities, most of its space-related documents are in their national language, Korean. The *National Space Development Plan* has not been translated, thereby causing difficulties for nations interested in South Korea's space activities. Therefore while the space technology development plans are publically available through KARI's website, the flow and exchange of information is hindered by language. It is recommended that South Korea shares their space development plans and activities in an international working language, such as English.

Fostering U.S. - Korean Education Exchanges or Cooperative Research Projects in Space

Educational exchange programs encourage dialogues and cultural understanding and are tools in conducting soft power diplomacy. The exchange of young scientists and engineers would cultivate long term professional relationships, establishing a trust and understanding in future collaborative activities. Over the past two years, the National Research Foundation of Korea established collaborative research exchanges between Korean and U.S. university researchers through the World Class University (WCU) initiative. While the WCU initiative is not focused on space activities, the two nations should consider smaller projects for students as a means for cooperation, such as developing a cube satellite or a joint research experiment to be flown aboard the ISS. For example, KAIST and NASA Ames Research Center have signed a memorandum to initiate technical discussions on specific areas of potential collaboration involving small satellite research and development.[43] Furthermore the data received from university collaborations can also increase academic research and spur innovative ideas. Increasing investment in international educational exchanges and projects would not only help develop the next workforce of space engineers and scientists, but also encourage the future generation to gain an intercultural and international perspective of space missions.

Conclusion

Within two decades, South Korea has committed to a timeline for developing long term space capabilities. Stemming from hands-on knowledge transfer to building indigenous capability, they have acquired a great deal of international experience in cultivating a sustainable and peaceful use of space that increases socioeconomic benefits for the nation. Since the beginning of their space program, South Korea has admired the United States as their top ally and space leader. Despite U.S. regulations on the nation's space technology development, South Korea has continually courted the U.S. for assistance, whether it is working with U.S. satellite manufacturing companies for satellite development, or seeking the aid for indigenous space launch capabilities.

While launch technology support may not be the first step in establishing U.S.-Korean space relations, there are other valuable areas the two nations can engage in discussions. For example, GNSS technology and applications are vital to everyday life, and the U.S. can encourage South Korea to become involved in discussions for interoperability and compatibility of GNSS systems. As seen with Obama's visit to China in November 2009, where there was a dialogue to open discussions for potential cooperation, finding possible collaborations is possible if there is top level interest. On the other hand, South Korea will pursue alliances with other nations to meet national priorities if there is a lack of U.S. interest and encouragement. Therefore the U.S. opinion has factored into South Korea's space program, and this influence should be carefully considered in planning future strategic bilateral relations.

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[1] *2009 Status of Korea's Space Industry.* Ministry of Education, Science and Technology. November 2009.

[2] "Becoming a S&T Power Nation through the 577 Initiative." Ministry of Education, Science and Technology and Korea Institute of S&T Evaluation and Planning.

[3] "A Brief Timeline of South Korea's Commercial and Military Missile Program." Stratfor Global Intelligence. Date Accessed: August 11, 2010.

[4] Choi, Soon D. "Space Technology Build-Up of Korea." Presentation. UN/ESCAP - Meeting of Eminent Experts on ICST. August 3-4, 2006. <http://www.unescap.org/idd/events/2006_Eminent_Experts/Presentations/Soon%20Dal%20Choi-%20Space%20Tech.%20Build-up%20of%20Korea.pdf>.

[5] *2005 Space Development Promotion Act.* Unofficial translated version. *Journal of Space Law*. Vol. 33. <http://www.spacelaw.olemiss.edu/library/space/Korea/Laws/33jsl175.pdf>.

[6]"A Brief Timeline of South Korea's Commercial and Military Missile Programs." *Stratfor Global Intelligence*. March 6, 2001.

[7] Gwang-Rae Cho, Jeong-Ju Park, et al. "The Korean Sounding Rocket Program." *Acta Astronautica*. Volume 62, Issue 12, June 2008, Pages 706-714.

[8] Ibid.

[9] "Moscow 'Tacitly Admits Failure in Korean Rocket Launch." *The Chosun Ilbo*. August 17, 2010. <http://english.chosun.com/site/data/html_dir/2010/08/17/2010081700673.html>.

[10] Ibid.

[11] Park, Won-hwa. "Recent Space Developments in South Korea." *Space Policy* 26 (2010), p 117-118.

[12] Hwang, Chin Young. "Space Activities in Korea – History, current programs and future plans." *Space Policy* 22(2006) 194-199.

[13] Ibid.

[14]Kim, Na-ri. "Space Challenge 2010 Kicks Off." Arirang News. May 16, 2010. <http://www.arirang.co.kr/News/News_View.asp?nseq=103093&code=Ne2&category=2>.

[15] "South Korea to Launch First Military Communication Satellite and Improved Observation Satellite." *WMD Insights*. April 2006. < http://www.wmdinsights.com/i4/ea3_southkoreatolaunch.htm>.

[16] *Space Development Promotion Act*, Article 1.

[17] "Space Development Policy and International Cooperation." Basic Research Bureau, Ministry of Science and Technology. November 2007. <http://www.aprsaf.org/data/aprsaf14_data/day2/P09_APRSAF-14-Korea-Plenary-Final.pdf>.

[18] *2009 Status of Korea's Space Industry*. Ministry of Education, Science and Technology. November 2009.

[19] Ibid.

[20] Ibid. The statistics accounted for GPS navigation systems separately.

[21] Hwang, Chin-Young. "Vision and Strategy of the Korean Aerospace Industry." *Korea Overseas Information Service*, February 10, 2008. <http://www.defense-aerospace.com/article-view/verbatim/90868/vision-and-strategy-of-the-korean-aerospace-industry.html>.

[22] Brown, Peter. "China Making Leaps In Space." *Asia Times Online.* January 9, 2009. <http://www.atimes.com/atimes/China/KA09Ad01.html>.

[23] "Joint Press Release of the Third Trilateral Summit Meeting among the Republic of Korea, Japan and the People's Republic of China." Japanese Ministry of Foreign Affairs. May 30, 2010. <http://www.mofa.go.jp/region/asia-paci/jck/summit1005/joint_pr.html>.

[24] "Daejeon Declaration on Space for International Cooperation and Peace." International Astronautical Federation. October 2009. <http://www.iafastro.com/index.html?title=Daejeon_Declaration>.

[25] Zelnio, Ryan. "A Short History of Export Control Policy." *Space Review*. January 9, 2006. <http://www.thespacereview.com/article/528/1>.

[26] Interview with Dr. Soon-dal Choi. August 16, 2010.

[27] Rhee, Sang-Myon. "Regional Cooperation in Asia relating to space activities – Northeast Asian Issues." Space Law Conference 2006 : Asian Cooperation in Space Activities: A common approach to legal matters. August 2-3, 2006. Pg 144.

[28] "Joint Technical Coordination Meeting of the Small Multi-Mission Satellite (SMMS) Project held in Beijing." *APSCO*. 2008. <http://www.apsco.int/SMMS.aspx>.

[29] Rhee, Sang-Myon. "Regional Cooperation in Asia relating to space activities – Northeast Asian Issues." Space Law Conference 2006 : Asian Cooperation in Space Activities: A common approach to legal matters. August 2-3, 2006. Pg 144.

[30] "Space Development Policy and International Cooperation." Korea Ministry of Science and Technology. November 2007. <http://www.aprsaf.org/data/aprsaf14_data/day2/P09_APRSAF-14-Korea-Plenary-Final.pdf>.

[31] Interview with Eun-Jin Park, ITAR Desk Officer at the Korean Ministry of Foreign Affairs. August 9, 2010.

[32] "Space Systems/Loral-Built MBSat Satellite Successfully Completes In-Orbit Testing: Japanese-Korean joint venture accepts delivery on orbit of advanced mobile broadcast satellite for innovative mobile services." Space Systems/Loral Press Release. April 27, 2004. <http://www.ssloral.com/html/pressreleases/040427.html>.

[33] Ibid.

[34] Pinkston, Daniel A. "South Korea, Russia Seek to Accelerate Development of South Korean Space Launch Vehicle." *WMD Insights.* May 2007.

[35] "Guidelines for Sensitive Missile-Relevant Transfers." Missile Technology Control Regime. <http://www.mtcr.info/english/guidetext.htm>.

[36]"Republic of Korea." Lockheed Martin Missiles & Space Website. 2010. <http://www.lockheedmartin.com/asia_pacific/korea/>.

[37] Evans, J.V. "June 4, 1997 - Site Visit: Hyundai Electronics Industries Co., Ltd. (HEI)." *WTEC*. December 2008. <http://www.wtec.org/loyola/satcom2/d_03.htm>.

[38] Mathieu, Charlotte. "Assessing Russia's space cooperation with China and India – Opportunities and challenges for Europe*." Acta Astronautica* 66 (2010) 355-361.

[39] "South Korea: Economy Overview." *CIA World Factbook.* Updated August 3, 2010. <https://www.cia.gov/library/publications/the-world-factbook/geos/ks.html>.

[40] "Background Note: South Korea." U.S. Department of State Bureau of East Asian and Pacific Affairs. May 29, 2010. <http://www.state.gov/r/pa/ei/bgn/2800.htm>.

[41] *2009 Korean Space Industry Statistics.* Ministry of Education, Science and Technology. November 2009.

[42] "Telephone Conversation between Mr. Naoto Kan, Prime Minister of Japan, and Mr. Lee Myung-bak, President of the Republic of Korea." Press Release. Japan Ministry of Foreign Affairs. August 10, 2010. <http://www.mofa.go.jp/announce/announce/2010/8/0810_01.html>.

[43] "NASA Ames Explores Possible Collaboration with South Korea." *NASA News Release.* January 28, 2008. <http://www.nasa.gov/centers/ames/news/releases/2008/08_07AR.html>.