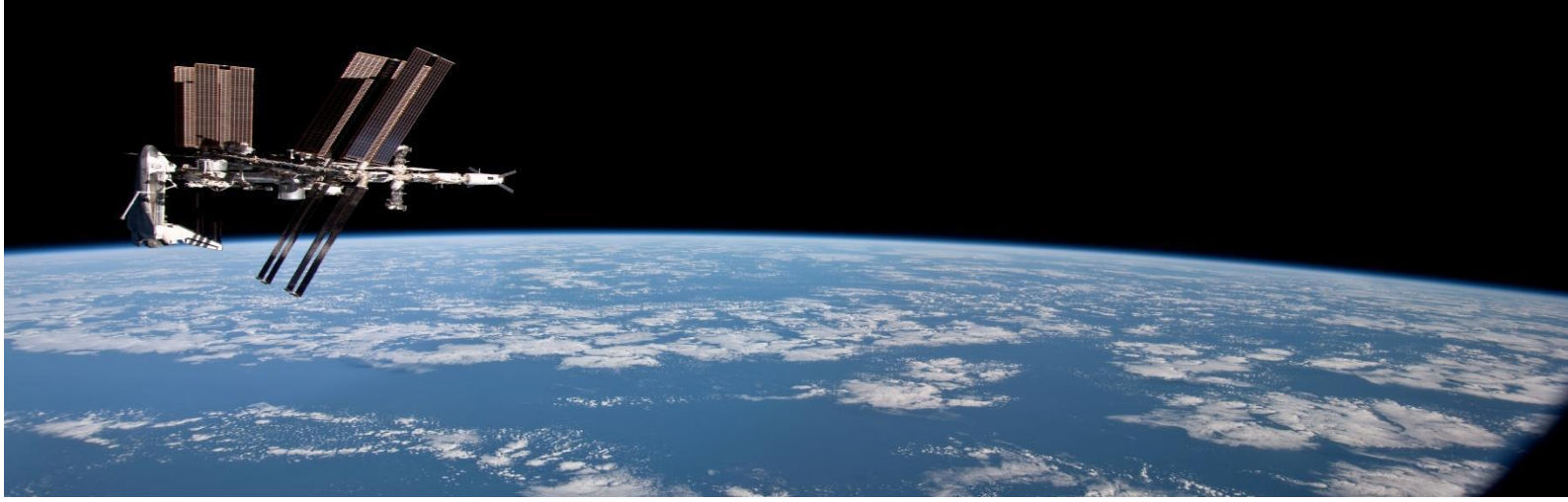

Space Alert

Volume IV, Issue 1 – January 2016

ORF Quarterly on Space Affairs

CONTENTS

COMMENTARIES

India Needs a More Determined Military Space Policy

Rajeswari Pillai Rajagopalan

India's footprint in outer space has grown immensely since it launched its first satellite a few decades ago. Like many other countries,

India's space orientation has been one of peaceful pursuit of space for betterment of its people. However, advancements in the outer space realm in India's own neighbourhod have called for a rethink in New Delhi's approach. The narrative around India's space programme is clearly changing. While the rethinking is yet to translate into concrete developments, launch of a dedicated military satellite for Indian Navy in August 2013 is a clear demonstration of the possible change in
India's space programme.

There are several factors that have contributed to this change. Global developments and regional dynamics relating to outer space have been strong imperatives. Growing military space programmes including China's anti-satellite (ASAT) test in 2007 are important push factors. Chinese ASAT test in fact became a wakeup call for India to the kind of challenges that exist in its backyard. The growing number of players and the rationale for the new entrants is also a consideration. While many countries in Africa and Latin America have begun pursuing space for their social and economic development, many in Asia are beginning to approach it from a national security perspective. This will have a significant bearing on many issues including the establishment of an effective outer space regime as well as India's own approach to outer space. Alongside the issue of growing number of actors, concerns also stem from the type of actors – today, the space business is no more restricted to state agencies. In fact, private entities, including big companies and universities are becoming major actors in space. There are also issues about weaponisation but the debate is between weapons in outer space versus ground-based assets that can be used for targeting assets in outer space. One can be reasonably certain that no state is going to actually place weapons in outer space but ASAT-like systems pose a much larger threat today. Global debate on this issue has gone nowhere with Russia and China proposing a draft treaty against the placement of weapons in outer space but the two fail to acknowledge the dangers from ASAT systems. Lastly, there are serious risks from the growing levels of space debris. States have to take measures not only to limit creation of additional debris but also find ways to cooperate in tackling the current space debris situation. States like Ecuador lost their one and only satellite because it was hit by space debris.

All these developments have had the impact of pushing India to embrace the military aspects of its space programme in a more forceful manner. Satellite launches for specific military needs is an important component of this emphasis. Equally important is the change in institutional and policy architecture, which is long overdue. The debate on the establishment of a tri-service aerospace command under the Indian Air Force (IAF)

has been on for over a decade now. The debate picked up some momentum after the Chinese ASAT test in 2007. Thus, in 2008, then Defence Minister AK Antony announced the establishment of an Integrated Space Cell under HQ Integrated Defence Staff. The logic of this institutional set up was, as Anthony explained, to develop options in the face of

"offensive counter space systems like anti-satellite weaponry, new classes of heavy-lift and small boosters and an improved array of Military Space Systems ... in our neighbourhood." Antony went on to explain the need for the cell to operate as a window that does the job of integration between the military, Department of Space, and the Indian Space Research Organisation (ISRO).

It is seven year since then, and the government has yet to take concrete steps in materializing

India's separate aerospace command. It has been reported that the decision was pending at the civilian bureaucracy in the Ministry of Defence. However, in October 2015, media reports indicated that the Defence Ministry is fine-tuning the requirements for the establishment of three tri-service commands, cyber under the Indian Navy, aerospace under the IAF and special operations one under the Indian Army. These reports suggest that it will be another year before these commands come into being. Meanwhile, other reports gave a slightly different twist to say that the government plans to set up certain interim institutions such as Defence Cyber Agency (DCA), Defence Space Agency (DSA) and the Special Operations Division (SOD). According to reports, the current air chief, who is also the chairman of the chiefs of staff committee, Air Marshal Arup Raha categorized these as "interim arrangements" before the establishment of the full-fledged commands.

Even as India's demands on the military front have been growing, the response, particularly from the civilian bureaucracy has been found wanting. India has to be mindful of the developments both at the global and regional level and act with certain boldness if its national interests are to be protected. It also must enact a military space policy, at least the major elements of it, in the open. India's launch of dedicated military satellites is an acknowledgment of its growing military needs although this needs to be undertaken through a more systematic and institutional guidance rather than a disjointed approach, as it appears now. India needs to issue a general space policy, which does not neglect the growing military space needs.

(Rajeswari Pillai Rajagopalan is Senior Fellow and Head, Nuclear & Space Policy Initiative at the Observer Research Foundation. She served at the National Security Council Secretariat, Government of India from 2003 to 2007.)

(Back to Contents)

Developing a Strong Space Economy – Insights for India

Narayan Prasad

21st century economy is one that is heavily dependent on services provided by outer space infrastructure. Satellites add value to the 'common man' in several sectors including banking, weather, navigation and communication. There is no doubt that an effective space program can provide unprecedented support to boosting terrestrial economy and provide nations an opportunity to leap frog traditional developmental processes of societies.

India has had a tremendous run in space with thumping successes in launch vehicle development, remote sensing, communication, space exploration and is now set to complete the navigation system. With globally accorded first time success of the Mars mission, we are possibly at a tipping point where India needs to turn a page in the orientation of how the space programme is orchestrated.

This does not mean that we waver from the fundamental vision of Indian Space Research Organisation (ISRO) of focussing societal development, but providing further impetus to it in helping create jobs and capabilities in the local industry at turnkey level. This will allow ISRO to pursue complex technological and scientific endeavours that may not be possible in the local industry in India. It will also provide a growth trajectory for the local industry in possibly capturing a greater pie of the $300b global space industry. This recommendation has been around for a while and one has to look into why there is no movement in this front.

To provide insights on the same, I quote a couple of recent progressions of spacefaring nations coming out in support of local industry. The US President Obama signed into law 'Asteroid Resource Property Rights' which recognises the right of US citizens to own asteroid resources they obtain and encourages the commercial exploration and utilization of resources from asteroids. A bold move in the face of debates around the clause of 'non appropriation' according to the Outer Space Treaty. This potentially will act as a bouncing board for US companies to add a new dimension to the space economy, which is possibly several times bigger than the current 'earthly' space business revenues.

Major spacefaring nations release formal space policies that outline support to local industry in creating jobs and in an effort to strengthen capacity in hopes of capturing a greater pie in the global space market. The UK released its National Space Policy with an aim for the commercial space sector to capture 10% of the global market supporting 100,000 new jobs and generating £40bn for their economy by 2030. Similarly, Japan also released its New Space Policy with a focus on restoring industry.

How are these spacefaring countries making such decisions in support of local industry and what are the key Insights for India? It is extremely important to develop 'metrics and frameworks' for continuously assessing the impact of the space programme. Although we in India have an outcome of budget declared by the Department of Space, there is no holistic information on the impact of the space programme on the economy. These metrics can typically include impact on downstream activities of Indian Remote Sensing (IRS), Indian National Satellite System (INSAT) and Indian Regional Navigation Satellite System

(IRNSS) usage as a support structure to the development of the nation. The only such studies on economics of space programme dates back to 2007. Therefore, there is room to create a Task Force or a dedicated team that can develop such metrics and frameworks can provide such insights for impact of the space programme. This can also act an excellent foundation for managers of the space programme to substantiate doing more in space when it comes to budgetary debates.

One can argue that international space agencies have undergone transitions and it is important for administrators to spearhead the transition, so that the benefits trickle down to the brick and mortar industries. As recently as 2006, NASA initiated the Commercial Orbital Transportation Services program, providing an opportunity for the private sector to ferry cargo to the International Space Station (ISS). These developments are possible due to vigorous mapping of capabilities, alongside providing a voice to all stakeholders (be it academic/industry/agency)within the country to express their interests in participation in the national goals.

Such an ecosystem is built on strong advisory boards that oversee the growth trajectory and set goals for next decades. For example, the Commission on the Future of the United States Aerospace Industry held six public meetings to hear testimonies and gain different perspectives 'to study the future of the US aerospace industry in the global economy, particularly in relationship to US national security; and to assess the future importance of the domestic aerospace industry for the economic and national security of the United States'. The Commission itself consisted of 12 members, six of whom were appointed by the President, and six appointed by Congress (three from the House and three from the Senate) and had a mix of academic, industry, defence, bureaucratic, political representatives. At this point in time, we need the Space Commission in India to take charge of matters in the very same way if industry/academic participation in Indian space efforts needs to leap frog.

A strong regulatory and policy ecosystem is built in many of the spacefaring nations due to the active engagement of parliamentarians taking a stand towards development of the space sector. Several reforms and bills are sponsored by legislators to support transparency, time-sensitive decision making and in avoiding any conflict of interests. There is very little active engagement from parliamentarians in the space sector considering countries such as US, where Senators actively engage themselves into driving home legislation that enable entrepreneurs to monetize business opportunities in the space sector (this bring investments/job/tax money to their jurisdictions). We in India are mostly limited to the Minister of State in-charge of Space making announcements during the sessions of Parliament. Therefore, there is also a cultural gap in how legislators act, which has an effect on the functioning of the ecosystem. Parliamentarians need to engage actively to bring about a comprehensive regulatory and policy structure in India to support the growth of the sector.

NewSpace has come to be a huge revolution with 'private companies and entrepreneurs who primarily target commercial customers, are backed by risk capital seeking a return, and seek to profit from innovative products or services developed in or for space'. Given the emerging space start-up ecosystem in India, will India see investments from successful entrepreneurs within the country into

NewSpace is a question that shall unfold in the next few years. One can draw a parallel from the investments made in Blue Origin by Jeff Bezos of Amazon, Elon Musk run SpaceX, Richard Branson's Virgin Galactic. However, for such investments more than money itself, one has to look into the culture of entrepreneurship. Such enterprises need a solid decade of investments before looking at large revenues. We have to ask ourselves if our entrepreneurial culture has reached anywhere close to supporting such visionary ideas.

A platform to voice the opinions of the industry is extremely important and there are several forums such as Society of Satellite Professionals Internationals as well as leading industry led conferences such as 'Satellite' which brings together voices of the industry to the administrators'/decision makers and act as catalysts. Currently there is no strong industry association in the space sector that can effectively make a case for itself with the government in India. This aligns to the fact that much of the private sector is still small-scale apart from a few handful of larger suppliers such as L&T, Godrej, Walchandnagar. Therefore, an organised effort from the industry (traditional and NewSpace) is also needed to make a case for itself to provide a larger voice for substantiating changes.

In conclusion, a recent book launched by ISRO 'Fishing Hamlet to Red Planet' tells lots of enriching stories of the creation of the space programme and one of them is an important story of Dr. Vikram Sarabhai and his perspectives and efforts in the formation of the organisation. We can deduce that Dr. Sarabhai was not only a scientist but an entrepreneurial administrator who could align bureaucratic, political will to the vision itself. Taking inspiration from Sarabhai himself, we have to wonder what the visionary himself would have done in an India which flew to the Mars on the first attempt successfully.

(Narayan Prasad is the co-founder of Dhruva Space, a NewSpace company based out of Bengaluru, India.)

(Back to Contents)

Space-Based Monitoring of Climate Change

Vidya Sagar Reddy Avuthu

Climate change has emerged as one of the greatest challenges that can only be tackled by the collective effort of international community. While delegates from nearly two hundred countries sparred on various modalities of climate change and draft agreement at the Paris Climate Change Conference (COP21), the French space agency Centre National d'Etudes Spatiales (CNES) geared up to highlight the significance of space technology for addressing this global phenomenon. Joining this initiative were space agencies from US, India and China with which the CNES has built extensive collaborations.

Developing and underdeveloped countries are more prone to experiencing the disastrous effects of climate change. China and India emerged as the world's second largest and fastest growing economies respectively. But their dependency on fossil fuels for sustaining such economic growth rates has resulted in atmospheric particulate matter and other indicators of environmental degradation reaching dangerous levels in these countries.

Safeguarding the first and second largest concentrations of world's population in the face of climate change and onset of associated disasters is an impending problem. A UN report released before COP21 claimed that India and China account for more than three billion disaster affected people between 1995 and 2015.

Technology plays a critical role in better understanding the causes and resultant effects of climate change. Continuous observations on a global scale of essential climate variables as defined by the Global Climate Observing System (GCOS) help build better models and predict onset of disasters. Advances in Information and Communication Technologies (ICT) help relay communication between the early warning mechanisms and disaster response teams. Technology also assists in post-event analyses that will form a feedback into the forecast models as well as plans for reconstruction.

Space technology offers a unique perspective, position and platform in these situations. The space-based assets are capable of photographing various environmental degradation activities occurring on Earth and measuring their effects continually across the globe. It is possible to acquire images like that of the smog blankets covering New Delhi and Beijing as well as acquire measurements for determination of physical quantities like ozone, aerosols, dust, vegetation, glacier flows, ice coverage, sea level etc. with precision giving a global insight into Earth's weather and climate change patterns. The early warning systems in space have been particularly helpful in mitigating the human and economic costs of cyclones and floods.

In view of the fact that 26 out of the 50 essential climate variables defined by the GCOS can only be measured from outer space, the Mexico Declaration in September 2015 stressed practical international cooperation for observing, understanding and mitigating the adverse effects of climate change using space-based assets. The declaration also revealed that the international charter on space and major disasters that gives a country hit by a natural disaster priority access to global satellite data has been activated more than 400 times since 2000.In essence, space technology plays a critical role in all three major phases of climate change

viz., observations, mitigation and relief during natural disasters and sustainable reconstruction.

This work is possible through space-based Earth observation programmes constituted by many spacefaring countries. Availability of such technology and international cooperation for sharing these resources is a major positive step towards mitigating climate change. The American-French Topex-Poseidon satellite launched in 1992 measuring ocean surface topography is referred to as the primary and foremost example of utilizing space technology for realizing the dynamics of climate change.

CNES continued its collaboration with the National Aeronautics and Space Administration (NASA) by launching the Jason series and Surface Water & Ocean Topography (SWOT) missions as follow-ons to the Topex-Poseidon for observing global climate change patterns. France and Germany are actively collaborating on developing Methane Remote Sensing Lidar Mission that will observe and map both natural and anthropogenic causes of Methane emissions. Methane is one of the primary greenhouse gases on Earth which is more potent than carbon dioxide.

The smog blankets that engulf Beijing and New Delhi every winter have become characteristic of climate change phenomenon in these countries. The extent and impact of China's smog blanket is now revealed through satellite images. In January 2015, China and France signed an agreement to construct a joint satellite named China France Oceanography Satellite (CFOSat) that will carry instruments from both countries to monitor the movement of wind and waves at the ocean surface on a global scale. The CNES President Jean-Yves Le Gall observed that this satellite would contribute towards gaining deeper insight into the processes driving climate change.

Le Gall also conferred with his counterpart in New Delhi recently reaffirming the significance of space-based assets in monitoring climate change. The Indian Space Research Organization (ISRO) and CNES have collaborated on studying climate change with the launch of joint space missions Megha-Tropiques in 2011 and SARAL in 2013. This partnership is set to expand with the possible launch of a third satellite in this order as well as development of a thermal imaging instrument that could detect urban heat islands across India from space. Data from space platforms help identify the causes of environmental degradation activities and implement required remedial measures.

Le Gall stands along with his counterparts who called climate change a great challenge confronting this world and vow to allocate maximum financial and technological resources possible for monitoring these changes through space assets. These assets can also be helpful in localizing emissions as well as imaging their sources and sinks. China recently announced that it is launching dedicated satellite(s) for observing its greenhouse gas emissions. Emission figures calculated using ground-based equipment are prone to errors, coverage problems as well as tampering. Satellites help rectify such defects improving the accuracy of these measurements.

China's announcement follows such a measure from Japan in 2009 and the US in 2014.Japan's Greenhouse Gases Observing Satellite was designed to localize areas with high emissions of carbon dioxide and Methane

to partly monitor international compliance with the Kyoto Protocol. The American Orbiting Carbon Observatory-2 is a dedicated remote sensing satellite for colleting global measurements of atmospheric carbon dioxide to characterize its sources and sinks on regional scales of ≥1000km. This mission is conceived to validate space-based measuring approach for future carbon dioxide monitoring missions.

India's Ministry of Environment, Forest and Climate Change is also pushing a proposal for acquiring a dedicated satellite that would help it survey, monitor and manage the country's forest cover. The final proposal might include carrying other monitoring sensors as well.

As these satellites orbit the Earth, it is possible to acquire measurements from other countries to verify treaty or agreement promises thus morphing space platforms into climate police. However, countries that are found to be violating their agreements can deny the authenticity of satellite data or claim political and economic pressures. Le Gall believes joint access to satellite data will remove such suspicions which will be practiced by France and China with regard to CFOSat, thus setting an international precedent.

Still, variations in computing codes which use satellite data for generating the final measurements can lead to disruptions. The incapacity of certain developing and most underdeveloped countries at receiving and utilizing satellite data compounds this problem. Therefore, an international organization recognized by majority of countries with optimum technological and scientific resources can be constituted at the earliest to scrutinize satellite data and report emissions from individual countries.

The momentum generated at the COP21 represents the global perception on climate change and immediate need to reverse dangerous impact. Such momentum helps build international cooperation and partnership among spacefaring countries. Satellite images and data have personified the fragile nature of Earth and are effectively guiding preservation of its ecosystem and human existence on this 'pale blue dot.'

(Vidya Sagar Reddy Avuthu is a Researcher at the Observer Research Foundation, New Delhi.)

(Back to Contents)

FROM THE MEDIA

ISRO launches six Singapore satellites

ISRO's PSLV C-29 rocket lifted off from the first launch pad of the Satish Dhawan Space Centre here and in about 21 minutes, it placed all six Singapore satellites in the intended orbit

Source: *The Hindu*, December 17, 2015

Nearly 30 satellite launch orders at hand for ISRO's Antrix

ISRO's commercial arm Antrix Corporation has almost 30 orders at hand from different countries for satellite launches which are scheduled to be completed in next two to three years.

Source: *IBNLive*, December 18, 2015

Now, Isro to launch 6 to 12 satellites a year

Isro will increase the number of satellite launches to between six and 12 annually from next year as against four to five at the moment, Isro chairman A S Kiran Kumar announced.

Source: *The Times of India*, November 18, 2015

GSLV Mark III rocket modified, ground tests done: ISRO

Based on last year's GSLV Mark III's experimental flight, modifications have been done to solid rocket S-200 motors to change dynamic pressure and forces and ground tests have been done, a top ISRO official said today.

Source: *The Economic Times*, October 3, 2015

Manned mission not a priority: Isro chief

The much-publicized manned space mission is not a priority for Indian Space Research Organization (Isro), Isro chairman AS Kiran Kumar said.

Source: *The Times of India*, November 7, 2015

India may get three unified commands for special operations, battles in space, on web

India is now working towards creating three new tri-service organisations to handle the rapidly-expanding challenges in the crucial domains of space, cyberspace and clandestine warfare, which will be headed by two-star generals, in a synergised manner.

Source: *The Times of India*, October 17, 2015

ISRO set to test scramjet engine

Engineers at ISRO are gearing up to test the scramjet engine developed in-house to power the Reusable Launch Vehicle (RLV) due to undergo the first experimental flight shortly.

Source: *The Hindu*, November 28, 2015

U.S. Considers Making it Easier To Launch from India

The Office of the U.S. Trade Representative (USTR) is starting a review of a decade-old policy that discourages the use of Indian launch vehicles by American companies, an official said.

Source: *SpaceNews*, October 23, 2015

Disasters: NDRF Inks Pact With ISRO Arm to Get Satellite Data

In order to obtain the vital "third eye" to tackle disasters, the NDRF on Wednesday inked a pact with the National Remote Sensing Centre which will provide the force with geo-spatial and other satellite data for sharpening its relief and rescue operations.

Source: *NDTV*, October 29, 2015

Japan to stay in space station project through 2024

Prime Minister Shinzo Abe announced Tuesday that Japan will remain part of the U.S.-led International Space Station project when it is extended until 2024.

Source: *The Japan Times*, December 8, 2015

US, China Set Up Space Hotline To Avoid Satellite Warfare

The United States and China have set up a space hotline between them. This connection will be used to facilitate the exchange of information between the two countries and prevent satellite-related conflicts and misunderstandings.

Source: *TechTimes*, November 24, 2015

U.S. Air Force Declares GSSAP Surveillance Sats Operational

Two U.S. Air Force high-orbiting space surveillance satellites successfully completed testing and are now operational

Source: *SpaceNews*, October 8, 2015

President Obama Signs Bill Recognizing Asteroid Resource Property Rights into Law

This law recognizes the right of U.S. citizens to own asteroid resources they obtain and encourages the commercial exploration and utilization of resources from asteroids.

Source: *Spaceref*, November 25, 2015

For the first time in 27 years, U.S. produces plutonium-238 to power space missions

After a 27-year gap, the U.S. Department of Energy has resumed producing plutonium-238, the radioactive fuel that powers NASA's Curiosity rover on Mars and the New Horizons mission to Pluto and beyond.

Source: *Geekwire*, December 22, 2015

China aims to go deeper into space

As China's exploration of the moon progresses, its space experts have begun considering going deeper into the solar system - to Mars, asteroids and Jupiter - and a manned deep-space mission.

Source: *SpaceDaily*, October 16, 2015

Chinese team expects to launch first robot in space by 2020 to fix orbiting satellites

China will launch its first robot in space by 2020 to carry out a range of tasks from refuelling satellites to building space stations and even conducting military operations, according to researchers involved in the project.

Source: *South China Morning Post*, November 25, 2015

Israel accepted into UN space coalition after 32-year wait

Thirty-two years after establishing its space agency the Jewish state got the nod into the United Nations Committee on the Peaceful Uses of Outer Space, receiving the nod from 117 nations.

Source: *New York Post*, October 29, 2015

Bangladesh Taps Thales Alenia To Build 1st Telecom Satellite

The government of Bangladesh contracted with manufacturer Thales Alenia Space to build the Bangabandhu-1 telecommunications satellite, ushering a new nation into the large group of Asian countries with their own national satellite capacity.

Source: *SpaceNews*, November 11, 2015

Europe and Russia mission to assess Moon settlement

The European and Russian space agencies are to send a lander to an unexplored area at the Moon's south pole.

Source: *BBC*, October 16, 2015

SpaceX successfully landed its Falcon 9 rocket after launching it to space

SpaceX's Falcon 9 rocket successfully landed upright on solid ground at Cape Canaveral, Florida this evening, after travelling into space and back. It's the first time SpaceX has been able to gently touch down the Falcon 9 post-launch.

Source: *The Verge*, December 21, 2015

Deal at UN Meeting Opens Way for Satellite Tracking of Jets

A deal reached at a U.N. meeting on Wednesday opens the way for satellite tracking of airliners, a major breakthrough motivated by the mystery disappearance of a Malaysia Airlines jetliner last year.

Source: *NBCNews*, November 11, 2015

New kind of moon rock found by Chinese Yutu rover

China's Yutu moon rover has discovered a new kind of rock on the lunar surface. The find suggests the moon's make-up is more diverse than previously thought, and will help interpret future satellite-based observations.

Source: *New Scientist*, December 22, 2015

(Back to Contents)

OPINIONS AND ANALYSES

Jim Cantrell, " Old Space Meets New Space," *SpaceNews*, October 19, 2015

Frank Stratford, " Mars and the transport revolution," *The Space Review*, November 23, 2015

Madhumathi DS, " All they want is a sliver of space," *The Hindu*, November 2, 2015

Brian Weeden, " Dancing in the dark redux: Recent Russian rendezvous and proximity operations in space," *The Space Review*, October 5, 2015

Dr. Sten Odenwald, " The Myth of Space Mining," *Huffington Post*, October 30, 2015

Ari Rabinovitch, " Space age perils: hackers find a new battleground on the final frontier," *Reuters*, October 22, 2015

Liyuan Xiao, " Space Debris Mitigation and Potential Difficulties," *The Cornell Daily Sun*, October 22, 2015

Danny Bradbury, " Google Lunar X prize: India's moonshot at the space race," *The Guardian*, November 27, 2015

Paul Spudis, " Simulating Human Space Missions: Are Earth analogs helpful?," *Smithsonian Air & Space Magazine*, December 14, 2015

Keith Wagstaff, " Here's Why the SpaceX Rocket Landing Is Such a Big Deal," *NBC News*, December 22, 2015

Devangshu Datta, " Shooting for the moon," *Business Standard*, December 19, 2015

Jeff Foust, " Expanding the space industry," *The Space Review*, November 30, 2015

Jennifer Hackett, " New Law Paves the Way for Asteroid Mining – but Will It Work?," *Scientific American*, December 4, 2015

(Back to Contents)

NEW PUBLICATIONS

REPORTS/FACTSHEETS/STATEMENTS

" Year End Review: Achievements of Department of Space during the year 2015," Department of Space, Government of India, December 28, 2015

Frank Rose, Assistant Secretary, Bureau of Arms Control, Verification and Compliance, " Challenges to Arms Control in Space and Pragmatic Way Ahead," 3rd ARF Workshop on Space Security, 30 November, 2015

" China's Space and Counterspace Programs," 2015 Annual Report to Congress by the US-China Economic and Security Review Commission, November 17, 2015

" Statement by the Chinese Delegation at the Thematic Discussion on Outer Space at the First Committee of the 70th Session of the UNGA," Permanent Mission of the People's Republic of China to the United Nations Office at Geneva and other International Organizations in Switzerland, October 26, 2015

" NASA's Journey to Mars: Pioneering Next Steps in Space Exploration," National Aeronautics and Space Administration, October 8, 2015

JOURNAL ARTICLES

Fabio Tronchetti, "The Space Resource Exploration and Utilization Act: A move forward or a step back?," *Space Policy*, vol. 34, November 2015, pp. 6-10.

Capt. Daniel Moomey, "A Call to Action: Aid Geostationary Space Situational Awareness with Commercial Telescopes," *Air & Space Power Journal*¸ vol. 29, no. 6, November-December 2015.

AS Kiran Kumar et. al., "Indian Mars-Colour-Camera captures far-side of the Deimos: A rarity among contemporary Mars orbiters," *Planetary and Space Science*, vol. 117, November 2015, pp. 470-474.

SMSgt Mitchell Overton, "Purposeful Development of the Intelligence, Surveillance, and Reconnaissance for Space Cadre," *Air & Space Power Journal*¸ vol. 29, no. 6, November - December 2015.

Dr. Peter Wegner, "How to Make Disaggregation Work," *Air & Space Power Journal*, vol. 29, no. 6, November-December 2015

BOOKS/MONOGRAPHS/OCCASIONAL PAPERS

PV Manoranjan Rao eds., *Fishing Hamlet to Red Planet*, ISRO e-book

Louis Friedman, *Human Spaceflight: From Mars to the Stars* (University of Arizona Press: US, November 2015)

(Back to Contents)