Canadian Space Agency

2018–19

Departmental Results Report

The Honourable Navdeep Bains, P.C., M.P.
Minister of Innovation, Science and Industry

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Minister's message

The Honourable Navdeep Bains
Minister of Innovation, Science and Industry

I am pleased to present the 2018–19 Departmental Results Report for the Canadian Space Agency (CSA).

Over the past year, the various organizations in the Innovation, Science and Economic Development Portfolio have together worked hard to make Canada a global innovation leader and to build an economy that works for everyone.

Our primary objectives were, and continue to be, to empower businesses to reach their innovation potential to compete in a global, knowledge-based economy; to enhance Canada's economic strengths by supporting science and research; and to promote Canadian tourism. These objectives were supported by new and existing policies and programs designed to help Canadian entrepreneurs from across the country and from diverse backgrounds grow and reach new markets. We also continued to implement multi-year investments in science, including historic investments in fundamental research, while our robust tourism industry was bolstered by support for national initiatives.

In 2018–19, a new national space strategy was released — *Exploration, Imagination, Innovation: A New Space Strategy for Canada.*[i] This strategy aims to create the right conditions to grow the Canadian space sector and ensure that Canada's space scientists are offered a rich environment in which to pursue science excellence.

This is just an example of the CSA's work on behalf of Canadians through collaboration, dialogue and partnerships across the country. We invite you to read this report to learn more about how we are working with and for Canadians to build our innovation nation.

Results at a glance

Financial and human Resources

2018–19 Total Actual Spending	2018–19 Total Actual Full-Time Equivalents FTEs
305,745,600	675.4

The year 2018–19 was a pivotal time in Canadian Space history. On March 6, 2019, the Minister of Innovation, Science and Economic Development (ISED) announced a new whole-of-government approach when *Exploration, Imagination, Innovation: A New Space Strategy for Canada*[i] was launched. This strategy aims to create the right conditions to grow the Canadian space sector and ensure that Canada's space scientists are offered a rich environment in which to pursue science excellence. Moreover, it aims to maximize the benefits of space for Canadians and help strengthen Canada's presence in space.

On February 28, 2019, Canada also officially announced its participation in the exciting next chapter of lunar exploration, the United States-led Lunar Gateway.[ii] This small space station which will orbit the Moon, will include a next generation, smart robotic system known as Canadarm3. As well, through a new initiative called Lunar Exploration Accelerator Program, Canada will support the development and demonstration of innovative Canadian science and technology destined for the Moon and deep space.

In 2018–19, the CSA achieved the following results which align directly with the newly launched Canadian Space Strategy's vision and objectives.

On December 3, 2018, CSA astronaut David Saint-Jacques[iii] flew to the ISS for a record 204-day mission, the longest Canadian mission to date. Long-duration astronaut missions on the ISS provide a rich environment in which to pursue science excellence and innovation and represent unique opportunities to inspire Canadians—across all genders, cultures and communities—in the pursuit of science, discovery and technological advancement. While in space, David Saint-Jacques' participated in 32 live events reaching over 263K Canadians.

The CSA took advantage of David's mission to invite young Canadians to promote science and technology in space as well and to engage in science, technology, engineering and mathematics (STEM) activities. In total, in 2018–19, there were 3.8M engagements on social media related to the CSA, which represents a significant increase from the 2.6M engagements generated in 2017–18, far exceeding the target of 1M engagements.

Through the CSA's Science, Technology and Expertise Development in Academia (STEDiA) initiative, the Canadian CubeSat Project[iv] gave over 450 post-secondary students from all provinces and territories an opportunity to take part in a real space mission, in which they are

helping to design, build and test their own miniature satellites that will be launched to and deployed from the International Space Station (ISS) in 2021. The CubeSat project will provide students with hands-on experience and make them more competitive in the job market.

As part of the CSA's objective to improve the lives of Canadians by providing space-based information and technologies to different Government of Canada departments and agencies, 96 services were offered to Canadians in 2018–19 that depended on data from CSA assets, representing an increase from the 83 services offered to Canadians in 2017–18 and exceeding the target of 85 services. CSA data and assets are used for services to Canadian in a wide range of important areas such as safety and security, ships' oil spill detection, as well as soil moisture, coastal erosion and climate change monitoring. The RADARSAT Constellation Mission[v] (RCM), which will expand and ensure data continuity and extend operational use to more departments and agencies through space-based solutions, was successfully launched in June 2019, a few months past the expected launch in 2018–19.

In 2018-19, the CSA invested $14M into the industry to advance innovative space technologies that will be required for future space missions. In combination with other sources of funding—from public and private sectors—business expenditures on research and development (BERD) was estimated at $363M in 2017 (the most recent available data).

At the same time, as a result of past investments by the CSA, 16 Canadian space technologies were adapted for use on Earth or re-use in space in 2017 (the most recent available data), thus generating economic benefits and improving the lives of Canadians.

By supporting the development and commercialization of space technologies and services, and by providing industry and academia with various demonstration platforms maturation, the CSA helped the Canadian space sector grow and create highly qualified and well-paying jobs for Canadians. The Canadian space sector generated $2.1B in exports and maintained 4,302 highly qualified jobs in 2017 (the most recent available data).

For more information on the Canadian Space Agency's plans, priorities and results achieved, see the "Results: what we achieved" section of this report.

Results: what we achieved

Core Responsibilities

Canada in space

Description

The CSA coordinates the space policies and programs of the Government of Canada; ensures that other government departments and agencies have access to space data, information, and services to deliver on their mandate; plans, directs and manages projects relating to scientific or industrial space research and the development of space science and technology; promotes the transfer and diffusion of space technology to and throughout the Canadian industry; and encourages the commercial exploitation of the space capabilities, technology, facilities and systems. The CSA also aims to build Canada's capacity and engage the next generation of space scientists and engineers and provide opportunities to inspire young people to develop the required skills and to pursue studies and careers in science, technology, engineering, and mathematics.

Results

This section presents key achievements against the commitment of CSA's core responsibility, Canada in Space. In 2018–19, the CSA chose to outline its achievements against the four departmental results outlined in its Departmental Results Framework: space research and development advances science and technology, Canadians engage with space, space information and technology improve the lives of Canadians and Canada's investments in space benefit the Canadian economy.

Result 1—Space research and development advances science and technology

Investments that support the full spectrum of the R&D innovation cycle, from inception through to commercialization, is critical for the Canadian space industry. In 2018–19, the CSA contributed to the advancement of technology and provided industry and academia with various demonstration platforms, which are outlined below, to advance innovative space science and technologies that will be required for future space missions.

In 2018–19, the CSA continued to implement the Quantum Encryption and Science Satellite[vi] (QEYSSat) demonstration mission, which aims to demonstrate quantum key distribution technology in space. Contracts were awarded in August 2018 to define the detailed requirements for the mission, in preparation for the design and building phase. By considerably advancing the understanding of quantum key distribution, which will support more secure communications in the age of quantum computing, various Government of Canada departments and agencies, including the Department of National Defence, Communications Security Establishment and National Research Council, will benefit from this mission through the identification of new ways

to safeguard Canadians' privacy and sensitive information. This mission is scheduled to launch in 2022–23.

In 2018–19, the CSA supported a total of 35 companies, for a total value of $20M, in such areas as artificial cognitive systems for medical diagnostics and optical systems for improved satellite downlink capacity. Furthermore, in fall 2018, an announcement of opportunity (AO) was published under the Space and Technology Development Program[vii] to invest $15M in innovative space technologies with strong commercial potential in different fields varying from low cost, mass-produced nanosatellites for telecommunication to advanced robotics for space. In addition, the CSA invested $1.3M over two years in the development of 13 health technologies for deep space missions. These technologies, such as just-in-time virtual reality medical training systems for deep space missions or hybrid AI architecture for support systems for spaceflight medical decisions, could also be used for the delivery of medical care on Earth, as there are synergies between terrestrial telehealth and space medicine concepts.

In summer 2018, a pre-space demonstration opportunity was offered through CSA's Stratospheric Balloon[viii] program (STRATOS). Eight Canadian technologies and science experiments were tested in a near-space environment, including three secondary and post-secondary student projects. Access to stratospheric balloon flights—which emulate space radiation, temperature and atmospheric pressure—is made possible through the CSA's collaboration with the "Centre national d'études spatiales" (CNES). Thanks to further collaboration efforts and the resigning of the agreement with CNES, the CSA was invited to join the HEMERA[ix] project, a collaboration between space agencies and balloon service providers in Europe and Canada to conduct research and technology development activities in priority areas, including the Arctic and climate change, using stratospheric balloons. By joining this consortium of 13 partners from seven different countries, fully funded by the European Union, the CSA will gain integrated access to balloon-borne platforms for the Canadian science and technology communities. The Gender Based Analysis+ found that the STRATOS launch site in Timmins, Ontario had a positive impact on Indigenous Canadians and their career development.

The CSA also conducted a second series of field tests in a southwest Quebec quarry in fall 2018 to simulate a rover mission to the Moon known as the Lunar Exploration Analogue Deployment[x] (LEAD), during which instruments and equipment were tested, to prepare for conducting science on the lunar surface.

Furthermore, in addition to performing critical robotic operations on the International Space Station with Canadarm2 and Dextre,[xi] in 2018–19, the CSA provided opportunities for industry and academia to perform studies that examine the effects of living in space on physical and mental health (such as Vascular, MARROW, At Home in Space) and technology development.

The CSA's investments in this area aimed to support Canada's business expenditures on research and development (BERD). In 2017 (the most recent available data), BERD was estimated at $363M, a significant increase from the $254M spent in 2016. This significant increase was largely attributable to specific projects.

In support of advancing space science and technologies, the CSA continued to fund the operations of SCISAT,[xii] which provided Canadian and international researchers with the data required to make key observations in the fields of ozone protection and atmospheric chemistry. SCISAT remains the only satellite worldwide that measures hydrofluorocarbon (HFC) from space. In addition to ozone data, for the first time ever, HFC data from SCISAT was also published in the 2018 United Nations/World Meteorological Organization (UN/WMO) Ozone Assessment Report[xiii] (OAR) and reported for the first time in the Montreal Protocol Assessment Report.[xiv] Data generated by this satellite has resulted in 440 SCISAT-supported publications to date, including 25 publications in 2018–19, thus demonstrating the ongoing importance of this science mission. Although the CSA targeted 30 publications in 2018–19, the fact that data users spent time contributing to the 2018 UN/WMO OAR, in addition to submitting manuscripts to a special journal issue celebrating the 15th anniversary of SCISAT, resulted in fewer but more impactful publications.

In 2018–19, the CSA invested in excess of $2.3M to support Canadian science teams participating in NASA's Curiosity[xv] rover mission on Mars, the OSIRIS-REx[xvi] asteroid sample return mission, and India's ASTROSAT[xvii] mission. Furthermore, the CSA invested $0.78M to extend the operations of the BRITE[xviii] constellation of astronomy nanosatellites, enabling Canadian scientists to participate in JAXA's XRISM[xix] astronomy mission. The investment also enabled funded scientists to participate in NASA's InSight Mars[xx] lander mission, ESA's Trace Gas Orbiter,[xxi] NASA's Imaging X-ray Polarimetry Explorer,[xxii] ESA's Euclid Space Telescope[xxiii] and NASA's New Horizon mission.[xxiv]

Also in 2018–19, the integration and testing of the James Webb Space Telescope[xxv] spacecraft continued. The team supported the Fine Guidance Sensor/Near-InfraRed Imager and Slitless Spectrograph (FGS/NIRISS), Canada's contribution to the Webb Telescope, integration activities and commissioning rehearsals as required by NASA. Due to technical difficulties, NASA has decided to postpone the launch from 2019 to 2021 to ensure mission success.

By providing access to high-quality scientific data and supporting researchers, the CSA helped Canada to maintain its top third ranking among Organization for Economic Co-operation and Development nations in terms of average relative citation index scores in space-related publications (Canada is ranked 11th out of 36 countries in this area).

Result 2—Canadians engage with space

By taking advantage of Canadians' interest in space and providing opportunities for youth to acquire the skills to pursue studies and careers in STEM, in 2018–19 the CSA supported the development of the next generation of space scientists and engineers through the various initiatives outlined below.

The CSA supported colleges and universities developing space science and technology, and the expertise required for the future, through its Science, Technology and Expertise Development in Academia (STEDiA) initiative by working on the Canadian CubeSat Project.[iv] Launched in 2017–18, the CubeSat project has allowed over 450 post-secondary students from each province and territory across Canada to take part in a real space mission, by designing, building and testing their own miniature satellites that will be launched to and deployed from the International Space Station in 2021. The CubeSat project will provide students with hands-on experience and make them more competitive in the job market. In 2018–19, the CSA awarded three grants each valued at between $0.2M and $0.25M to post-secondary institutions, bringing the total number of teams supported to 15. In addition, to increase the knowledge of all students, CSA experts delivered a series of technical webinars on topics essential to satellite building.

In 2018–19, the CSA also awarded 31 multi-year grants totalling $6.2M to 16 Canadian universities through its Flights and Fieldwork for the Advancement of Science and Technology[xxvi] (FAST) funding initiative to advance space science and technologies while training the next generation of space experts.

The CSA also invested $2.3M in 30 different Solar-Terrestrial[xxvii] and Earth System Science research grants. In 2018–19, 28 projects started using space-based data to improve our understanding and modelling of the Earth's atmosphere and near-Earth space environment. An investment of $0.4M in Science and Operational Applications Research in Earth Observation resulted in four academic institutions—University of Western Toronto, Institut national de la recherche scientifique in Quebec City, University of Guelph, Université du Québec à Montréal—developing new applications and innovative technologies using imagery from Canada's RADARSAT-2[xxviii] satellite in public health and agriculture.

On December 3, 2018, CSA astronaut David Saint-Jacques[iii] flew to the ISS from Kazakhstan, as part of Expedition 58/59, aboard a Soyuz spacecraft for a record 204-day mission, the longest Canadian mission to date. This was Canada's third long-duration mission, following the mission of astronaut Robert Thirsk in 2009[xxix] and that of Chris Hadfield in 2012–13[xxx]. Long-duration astronaut missions on the ISS are high-profile and celebrated achievements that inspire and engage the Canadian public. Canadians were inspired as David Saint-Jacques successfully became the 4th Canadian astronaut to participate in a spacewalk on April 8, 2019.

The CSA took advantage of this unique opportunity to invite young Canadians to engage in STEM through events, exhibitions, contests and fun activities to do at home or in the class. The CSA actively collaborated and partnered with other government departments and agencies on outreach initiatives like Canada's Little Inventors—Inventions for Space with the Natural Sciences and Engineering Research Council (NSERC), the Living Space[xxxi] activity with Let's Talk Science and the Astro Pi challenge with the European Space Agency. These helped bring space into classrooms across Canada in 2018–19. Through outreach activities developed for David Saint-Jacques' mission, over 100,000 students and 4,200 schools were reached in 2018–19.

In 2018–19, 3.8M engagements on social media related to the CSA were generated, which represents a significant increase from the 2.6M engagements generated in 2017–18. This number is mainly explained by two unique and rare circumstances: astronaut David Saint-Jacques's six-month mission in space, and a historic announcement related to Canada's participation in NASA's Lunar Gateway made by the Prime Minister at CSA headquarters on February 28, 2019, which garnered significant social media attention.

Result 3—Space information and technologies improve the lives of Canadians

In 2018–19, the CSA provided space-based data, information and services to other government departments and agencies in support of the delivery of their mandates and encouraged the development of space capabilities, technologies, facilities and systems that can be adapted to generate economic benefit and improve the lives of Canadians. As a result of CSA efforts to provide space-based solutions, 96 services were offered to Canadians in 2018–19 that depended on data from CSA assets, such as ship detection, land-use mapping, wildfire detection and disaster support for flooding. This represents an increase from the 83 services offered to Canadians in 2017–18 and exceeds the target of 85 services. This result, largely above target, is mainly due to the addition of six open databases that were put online in 2018 as part of the Open Government initiative.

In 2018–19, the CSA continued to provide ongoing high-quality space radar data for government services using RADARSAT-2[xxviii] capabilities while preparing to launch the next-generation system, the RADARSAT Constellation Mission[v] (RCM). By March 31, 2019, all necessary work has been completed to ensure launch readiness of the three spacecraft, including transportation to the launch site and establishment of the operations team to support launch and initial operations. The RCM was successfully launched in June 2019, a few months after the expected launch in 2018–19. The RCM will include an automatic identification system, which will improve Canada's space-based capabilities to detect ships and manage marine traffic. The data resulting from the RCM will contribute to enhanced quality of existing services already being offered, as well as the possibility for new service offerings, such as land use evolution, coastal change, and human impacts on local environments.

The CSA, in collaboration with Natural Resources Canada (NRCan), provided public access to more than 36,000 processed RADARSAT-1[xxxii] images residing in Canada, resulting in a broader uptake of the RADARSAT-1 data archives, furthering the socio-economic benefits of this initiative. Two months after this dataset was released from commercial rights, RADARSAT-1 images residing in Canada were downloaded over 600 times by new users worldwide, and queries continue to increase. The general public now has access to RADARSAT-1 data in addition to traditional long-standing Government of Canada user departments.

Through an investment of $2.6M in 2018–19 in the Earth Observation Application Development[xxxiii] initiative, the CSA further supported government departments and agencies at the federal, provincial and territorial levels, as well as academic and industry stakeholders, to increase the number of services provided to Canadians. For instance, a new process using multiple sources of data has resulted in detailed forest maps that include information such as the height, age, volume biomass quantity and species composition of forests across Canada. This national satellite-driven mapping effort has resulted in new information regarding forest conditions, change and land cover, which is provided as open data, free for download without any restrictions. The data is being used to inform federal reporting and by provincial and territorial governments for information regarding detection of clear-cut and partial-cut harvesting, monitoring of forest regeneration and estimates of biomass and forest cover density.

In 2018–19, the CSA invested $2.2M in the joint NASA-CNES Surface Water Ocean Topography[xxxiv] (SWOT) mission by providing a set of extended interaction klystrons (EIKs), a key component of the radar instrument. The prototype model was upgraded to become the flight spare. Eliminating the need to construct an additional flight unit as a spare resulted in a $1.5M saving of the total mission investment. The first of the three units was delivered in August 2018. The CSA’s technology contribution will give Canada access to accurate measurements of Canada’s water resources, which in return will provide the scientific community with a better understanding of the dynamics of the world’s oceans and terrestrial surface water. The SWOT data is expected to improve water-related services, such as weather predictions and flood-warning systems, offered by Environment and Climate Change Canada and the Department of Fisheries and Oceans.

During the CSA astronaut David Saint-Jacques’s time aboard the ISS, he and his US crewmates broke records for the number of science hours. David Saint-Jacques dedicated a total of 49 hours performing a series of seven Canadian scientific experiments to understand the effects of spaceflight on astronauts’ physical, mental and psychological health. Among these, the Vascular Echo[xxxv] experiment examined changes in the blood vessels and the heart while astronauts are in space, and will follow their recovery after their return to Earth. At Home in Space[xxxvi] assessed the culture, values and psychosocial adaptation of astronauts to a space environment shared by multinational astronaut crews on long-duration missions as they deal with the isolated and confined environment of the spacecraft. It is expected that the knowledge acquired during these experiments

will have future applications on Earth. These science initiatives were supplemented by public engagement activities to enhance national awareness and interest in science and technology.

In 2018–19, the CSA also launched to the ISS two Canadian-developed technologies. The first is the Bio-Monitor,[xxxvii] a smart garment that records physiological parameters such as heart rate and temperature. The second is the Bio-Analyzer,[xxxviii] which performs sophisticated analyses of physiological samples such as blood. Commissioning for both instruments began and will extend into 2019–20. Both technologies will support human research on the ISS and are expected to find applications on Earth in areas such as health monitoring at home and in remote areas.

As per the most recently available data, past CSA investments resulted in 16 Canadian space technologies being adapted for use on Earth or re-use in space in 2017, thus generating economic benefits and improvement in the life of Canadians. This result is above target because space technologies are yielding an increasing number of applications on Earth. Thus, six of the reuse reported in 2017 are technologies that have been adapted for land use. For example, a technology developed by a Canadian company designed to extend the capabilities of a laser induced breakdown spectroscopy for use on future international planetary and asteroids missions was adapted and reused in food processing and safety processes and also for biomedical applications in clinics and hospitals.

Result 4—Canada's investments in space benefit the Canadian economy

In 2018–19, the CSA fostered innovation in the space sector and enabled Canadian innovators and entrepreneurs to take advantage of growth opportunities which created well-paying jobs and grew the middle class. These benefits are the ultimate goal of the Innovation and Skills Plan[xxxix], an ambitious effort to make Canada a world-leading centre for innovation.

In 2018–19, the CSA, through its Earth Observation Application Development Program (EOADP), invested $1.2M in contributions to support Canadian industry in the development of novel applications and services, including agriculture, lake ice hazards, maritime navigation and resource management using Earth observation space-based data and information. The variance of $0.4M between planned and actual expenditures stems from delays in the implementation of three agreements. These innovative applications and services seek to integrate data from CSA-supported missions with other data sources to help Canadian companies gain competitiveness by tapping into the possibilities offered by big data, cloud computing and machine-to-machine technologies. Combining CSA data such as RADARSAT-1[xxxii] and RADARSAT-2[xxviii] data with free and open satellite data (such as Sentinel, Envisat, Landsat), commercial satellite data, in-situ measurements, and products like soil maps and weather models will only further the impact of the CSA's investments.

In 2018–19, the CSA assessed proposals received in response to the publication of the CSA's first challenge under Innovation, Science and Economic Development Canada's Innovative Solutions

Canada[xl] (ISC) initiative, which aims to prove the scientific and technical feasibility, and commercial potential of a novel idea that addresses a public sector challenge. This particular challenge for small businesses focused on applying artificial intelligence and big data analytics to bring tangible advancements in the operation and utilization of satellites, their data and ground infrastructure in support of government operations, public safety, public health and discovery. The industry responded massively to this call and, as a result, the CSA decided to support five projects instead of two, with a total investment of $0.75M. The initial results of the initiative will be available in spring 2020, at which time the CSA will assess them in order to select the most promising projects for a second phase and provide lessons learned.

Finally, Canada renewed its cooperation with the European Space Agency (ESA) through the renewal of the Canada-ESA Cooperation Agreement.[xli] This renewal maintains the Canadian space sector's ability to participate in ESA programs until 2030 and provides the Canadian space sector with new business opportunities in Europe, as well as spaceflight opportunities to demonstrate and advance Canadian technologies and products. Since 2010, more than 175 contracts worth $161M have been awarded to Canadian organizations through this partnership.

By supporting the development, maturation and commercialization of space technologies and services, the CSA fully supported the goals of the Innovation and Skills Plan by helping the Canadian space sector to grow and create highly qualified and well-paying jobs for Canadians. The Canadian space sector generated $2.1B in exports, which represents an increase from the $2B generated in 2017–18 and maintained 4,302 highly qualified jobs in 2017 (according to the most recent available data).

Results achieved

Departmental results	Performance indicators	Target	Date to achieve target	2018–19 Actual results	2017–18 Actual results	2016–17 Actual results
1: Space research and development advances science and technology	I1: Business Expenditures in Research and Development (BERD) in the space sector	$195M	March 31, 2019	$363M[1] (2017)	$254M (2016)	$256M (2015)
	I2: Canada's rank among OECD nations on the citation score of space-related publications	11	March 31, 2019	11 (2017)	11 (2016)	N/A New indicator
2: Canadians engage with space	13: Number of new people and organizations entering space-related fields as a result of CSA funding	Baseline year. Target will be set for 2019-20	March 31, 2019	206 (2017)	N/A New indicator	N/A New indicator
	I4: Number of engagements on social media related to the CSA	1,000,000	March 31, 2019	3,884,506[2] (2018)	2,591,031 (2017)	2,351,059 (2016)

[1] In 2017 (the most recent available data), BERD was estimated at $363M, a significant increase from the $254M spent in 2016. This significant increase was largely attributable to specific projects. The BERD target will be reviewed in the next Departmental Plan.

[2] The CSA benefited from two rare events in 2018–19: CSA astronaut David Saint-Jacques's 6-month mission in space, and a historic announcement made by the Prime Minister at our headquarters that garnered significant social media attention. The number of engagements is exceptional and is due to these unique circumstances.

Departmental results	Performance indicators	Target	Date to achieve target	2018–19 Actual results	2017–18 Actual results	2016–17 Actual results
3: Space information and technologies improve the lives of Canadians	I5: Number of services offered to Canadians dependent on CSA information (such as remote sensing data, including satellite imagery and science observations)	85	March 31, 2019	96[3] (2018)	83 (2017)	N/A New indicator
	I6: Number of Canadian space technologies adapted for use on Earth or re-use in space	7	March 31, 2019	16[4] (2017)	13 (2016)	5 (2015)
4: Canada's investments in space benefit the Canadian economy	I7: Number of highly qualified people in the Canadian space sector	4,250	March 31, 2019	4,302 (2017)	4,085 (2016)	4,264 (2015)
	I8: Value of exports of the Canadian space sector	$1.6B	March 31, 2019	$2.1B[5] (2017)	$2B (2016)	$1.6B (2015)

[3] Six open databases were put online in 2018 and were included in the results. These databases will help researchers to perform their research.

[4] This result, largely above the target, is mainly due to the fact that more and more technologies developed for the space domain have applications on Earth. Thus, six of the reuses reported in 2017, are technologies that have been adapted for land use.

[5] Exports to Europe from one company in particular increased significantly in 2016 and were maintained in 2017. This explains the variance between the target and actual results.

Budgetary financial resources (dollars)

2018–19 Main Estimates	2018–19 Planned spending	2018–19 Total authorities available for use	2018–19 Actual spending (authorities used)	2018–19 Difference (Actual spending minus Planned spending)
301,093,697	301,093,697	368,822,267	254,711,091	(46,382,606)

The significant variance of $46M in total spending is mainly due to the launch delay for the RCM, which was originally scheduled for November 2018 and slipped to June 12, 2019.

Human resources (full-time equivalents)

2018–19 Planned full-time equivalents	2018–19 Actual full-time equivalents	2018–19 Difference (Actual full-time equivalents minus Planned full-time equivalents)
390.3	390.0	(0.3)

Financial, human resources and performance information for the Canadian Space Agency's Program Inventory is available in the GC InfoBase.[xlii]

Internal Services

Description

Internal Services are those groups of related activities and resources that the federal government considers to be services in support of programs and/or required to meet corporate obligations of an organization. Internal Services refer to the activities and resources of the 10 distinct service categories that support Program delivery in the organization, regardless of the Internal Services delivery model in a department. The 10 service categories are:

- Acquisition Management Services
- Communications Services
- Financial Management Services
- Human Resources Management Services
- Information Management Services
- Information Technology Services
- Legal Services
- Materiel Management Services
- Management and Oversight Services
- Real Property Management Services

Results

In 2018–19, and as part of its policy function, the CSA continued to build on its knowledge of the Canadian space sector and the opportunities and challenges facing its growth and competitiveness. Building on the recommendations of the Space Advisory Board, it worked with ISED on the development of Canada's new Space Strategy.

In March 2019, Exploration, Imagination, Innovation: A New Space Strategy for Canada[i] was released by the Minister of Innovation, Science and Economic Development Canada. Based on the recommendations[xliii] of the Space Advisory Board, the strategy identifies the five new pillars of Canada's vision for space and the initiatives that will take Canada there. The cornerstone of Canada's new Space Strategy is the contribution of a Canadarm3 system to the US-led Lunar Gateway mission[ii] which will operate near the moon. Initiatives outlined in the strategy will further each of the CSA's Departmental Results.

In 2018–19, the CSA strengthened its knowledge of the Canadian space sector and the opportunities and challenges facing its growth and competitiveness through studies on the potential return on investment of deep space telecommunications technologies, the socio-economic benefits

of space utilization for Canadians; and a review and comparative analysis of the return on investment of CSA-funded space projects.

In order to ensure modern, efficient and relevant delivery of internal services, in 2018–19, the CSA continued the implementation of its various renewal initiatives to create an efficient organization that will allow the CSA to meet the challenges ahead:

- The CSA updated its Investment Governance and Monitoring Framework, the Agency-wide investment process for projects, to ensure that it maintains its leadership in this area.

- The CSA continued to implement its Workforce Management Plan (2017-20), which promotes a healthy and inclusive work environment and values the full potential of employees to build a productive, competent and equipped workforce. In addition, the CSA also successfully completed the activities of the Pay Stabilization Action Plan.

- Work on all approved Accelerated Infrastructure Refit projects at the David Florida Laboratory was substantially completed as well as a complete renovation of the Larkin Kerwin Library at headquarters to provide work spaces focussed on innovation and collaboration.

- The CSA's greening government vision, internal objectives, and way forward to further develop the long-term plan were approved in March 2019 and a number of important preliminary studies and analyses were carried out to guide the CSA's overall greening government strategy.

- IT projects have been implemented to improve enterprise technologies in the workplace and improve digital services. In information management, the CSA has started planning activities with regard to the appropriate use of information on network drives. The CSA supported the implementation of the Directive on Open Government with a particular focus on open science activities in order to ensure a greater dissemination of open data and information related to CSA's activities. Finally, the CSA data centre of expertise's business model was developed to respond to the needs of all sectors within the Agency.

Budgetary financial resources (dollars)

2018–19 Main Estimates	2018–19 Planned spending	2018–19 Total authorities available for use	2018–19 Actual spending (authorities used)	2018–19 Difference (Actual spending minus Planned spending)
47,779,400	47,779,400	52,316,172	51,034,509	3,255,109

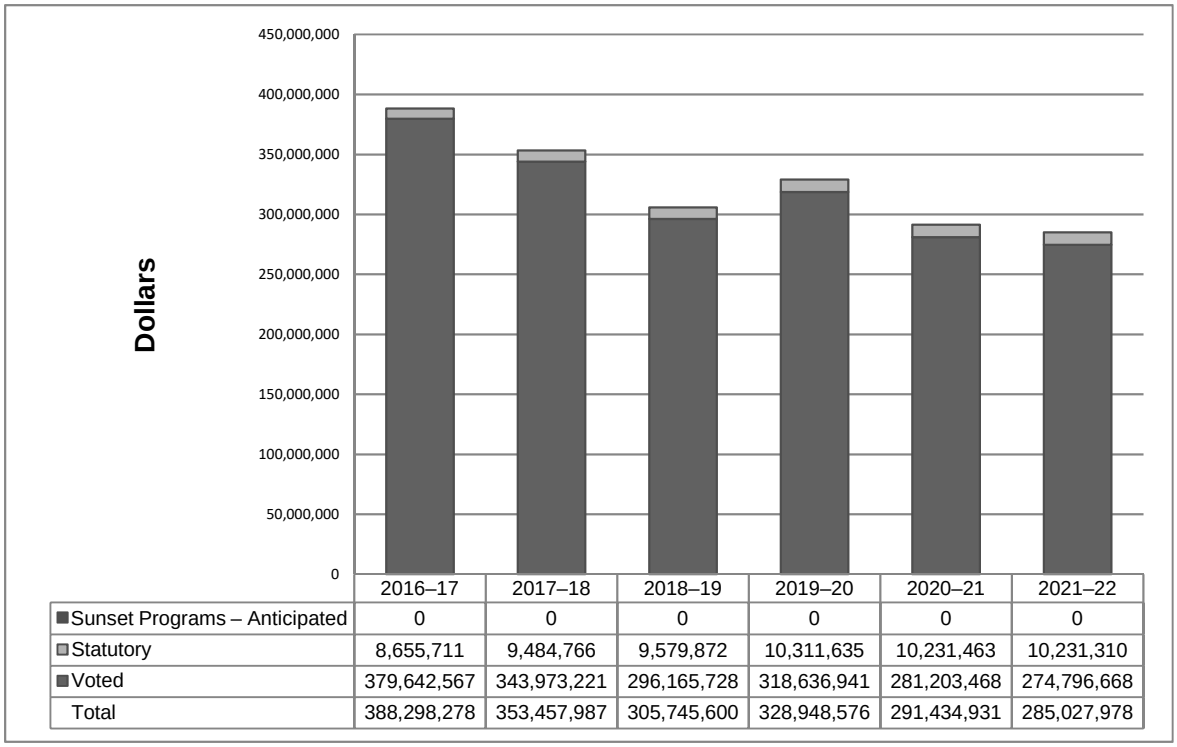
Human resources (full-time equivalents)

2018–19 Planned full-time equivalents	2018–19 Actual full-time equivalents	2018–19 Difference (Actual full-time equivalents minus Planned full-time equivalents)
271.2	285.4	14.2

Analysis of trends in spending and human resources

Actual expenditures

Departmental spending trend graph



	2016–17	2017–18	2018–19	2019–20	2020–21	2021–22
Sunset Programs – Anticipated	0	0	0	0	0	0
Statutory	8,655,711	9,484,766	9,579,872	10,311,635	10,231,463	10,231,310
Voted	379,642,567	343,973,221	296,165,728	318,636,941	281,203,468	274,796,668
Total	388,298,278	353,457,987	305,745,600	328,948,576	291,434,931	285,027,978

The variances in spending outlined above are mainly due to specific funding allocated to the following initiatives, which were above the CSA's ongoing resource allocations.

- Additional funding of $374M over six fiscal years (2013–14 to 2018–19) was allocated for the RCM ($140M was new funding from the fiscal framework and $234M was transferred from user government departments to the CSA).
- Additional funding and expenditure authority of $8M over two years (2015–16 and 2016–17) was authorized for the M3MSat project due to the increased cost of the launch provider and associated launch delay.
- Additional funding of $10M over two years (2015–16 and 2016–17) was authorized to perform accelerated infrastructure upgrades and repairs at the David Florida Laboratory (DFL) in line with the 2014 Economic Action Plan—Federal Infrastructure announcements.
- Additional funding of $10M through the re-profiling of funds from the fiscal framework to 2016–17 was authorized for the provision of value-added satellite reports/images for humanitarian needs.

- In line with Budget 2015 and Budget 2016 announcements, additional funding of $30M over four years starting in 2016–17 was authorized for Canada's continued participation in ESA's Advanced Research in Telecommunications Systems program.
- As per Budget 2015 announcements as well as up to $379M in new funding made available in Budget 2016, additional funding of $164M over eight years starting in 2017–18 was authorized to support ISS activities until 2024–25.
- Additional funding of $8M was received in 2017–18 from Budget 2016 related to safety improvements at the John H. Chapman Space Centre, as well as the purchase and installation of absorber material for the DFL Bay 2 Anechoic Chamber.
- As per Budget 2017 announcement, additional funding of $23M over four years (from 2018–19 to 2021–22) for the detailed planning, design, development, and launch of a space-based platform to test and demonstrate quantum key distribution (QKD) from space.

The cumulative impact of the reallocation of unused funds to subsequent years (re-profiling) resulting from sound management of high-risk projects, along with high technology risks, long-term development cycles and uncertainties with work schedules, has also impacted the CSA's spending trend over the past few years.

Budgetary performance summary for Core Responsibilities and Internal Services (dollars)

Core Responsibilities and Internal Services	2018–19 Main Estimates	2018–19 Planned spending	2019–20 Planned spending	2020–21 Planned spending	2018–19 Total authorities available for use	2018–19 Actual spending (authorities used)	2017–18 Actual spending (authorities used)	2016–17 Actual spending (authorities used)
Canada in space	301,093,697	301,093,697	278,432,275	242,931,635	368,822,267	254,711,091	293,157,159	341,948,633
Subtotal	**301,093,697**	**301,093,697**	**278,432,275**	**242,931,635**	**368,822,267**	**254,711,091**	**293,157,159**	**341,948,633**
Internal Services	47,779,400	47,779,400	50,516,301	48,503,296	52,316,172	51,034,509	60,300,828	46,349,645
Total	**348,873,097**	**348,873,097**	**328,948,576**	**291,434,931**	**421,138,439**	**305,745,600**	**353,457,987**	**388,298,278**

The variances in spending outlined above are mainly attributable to specific funding allocated to the following initiatives, above the CSA's ongoing budget allocation. An additional $374M over six years (2013–14 to 2018–19) allocated to the RCM from the Fiscal Framework and $234M was transferred from user government departments to the CSA.

- Work that could not be delivered in FY 2018–19 on the RCM: The RCM was successfully launched in June 2019, a few months after the expected launch in 2018–19.

- As per Budget 2015 announcements as well as up to $379M in new funding made available in Budget 2016, additional funding of $164M over eight years starting in 2017–18 was authorized to support ISS activities until 2024–25.

- The cumulative impact of re-profiling resulting from sound management of high-risk projects, also has impacted the CSA's spending trend over the past years.

Actual human resources

Human resources summary for Core Responsibilities and Internal Services (full-time equivalents)

Core Responsibilities and Internal Services	2016–17 Actual full-time equivalents	2017–18 Actual full-time equivalents	2018–19 Planned full-time equivalents	2018–19 Actual full-time equivalents	2019–20 Planned full-time equivalents	2020–21 Planned full-time equivalents
Canada in space	361.6	387.3	390.3	390.0	399.9	395.7
Subtotal	**361.6**	**387.3**	**390.3**	**390.0**	**395.7**	**395.7**
Internal Services	252.4	266.7	271.2	285.4	294.7	292.4
Total	**614.0**	**654.0**	**661.5**	**675.4**	**694.6**	**688.1**

The variance between actual and planned FTEs in 2018–19 is mainly due to the reallocation of resources to CSA astronaut David Saint-Jacques' mission to the ISS and additional personnel requirements to address some gaps and priorities, which include revised departmental requirements related to human resources management and certain security requirements.

Expenditures by vote

For information on the Canadian Space Agency's organizational voted and statutory expenditures, consult the Public Accounts of Canada 2018–19.[xliv]

Government of Canada spending and activities

Information on the alignment of the Canada Space Agency's spending with the Government of Canada's spending and activities is available in the GC InfoBase.[xlii]

Financial statements and financial statements highlights

Financial statements

The Canadians Space Agency's financial statements (unaudited) for the year ended March 31, 2019, are available on the CSA's website.[xlv]

Financial statements highlights

Condensed Statement of Operations (unaudited) for the year ended March 31, 2019 (dollars)

The financial highlights presented below are intended to serve as a general overview of the Canadian Space Agency's financial position and operations. More detailed information is provided in the CSA's financial statements available online in the section on Departmental Results Reports[xlv] (DRRs), which are prepared on an accrual accounting basis. Below are explanations for the variances in each major grouping based on the most significant factors that affected each grouping during 2018–19.

Financial information	2018–19 Planned results	2018–19 Actual results	2017–18 Actual results	Difference (2018–19 Actual results minus 2018–19 Planned results)	Difference (2018–19 Actual results minus 2017–18 Actual results)
Total expenses	355,337,143	334,472,584	353,808,683	(20,864,559)	(19,336,099)
Total revenues	28,833	30,481	10,281	(1,648)	20,200
Net cost of operations before government funding and transfers	355,308,310	334,442,103	353,798,402	(20,866,207)	(19,356,299)

Total planned expenses for 2018–19 were $355M, an overstatement of $21M compared to actual results of $334M. The variance between planned and actual expenses is mainly due to the

acquisition of machinery and material categories such as RADARSAT-2 data (imagery) being lower than projected ($14M), as well as amortization expenses and professional and special services being lower than projected ($9M).

In 2018–19, total expenses were $334M, a decrease of $19M compared to the previous year's total expenses of $354M. The decrease is mainly due to a $11M decrease in the acquisition of RADARSAT-2 data (imagery) combined with a $5M decrease in transfer payments, mainly attributable to variations in the European Space Agency's payment schedule.

The CSA's total revenues were $0.03M in 2018–19 ($0.01M in 2017–18). For the purpose of this report, this amount represents the respendable part of the overall revenues of $1.3M. The majority of these revenues are reported under the sale of goods and services provided by the DFL, i.e. sale of goods and services to private business or other government organizations, rental and use of public property, as well as other revenues.

Condensed Statement of Financial Position (unaudited) as of March 31, 2019 (dollars)

Financial Information	2018–19	2017–18	Difference (2018–19 minus 2017–18)
Total net liabilities	82,971,608	100,562,706	(17,591,098)
Total net financial assets	75,154,787	93,515,843	(18,361,056)
Departmental net debt	7,816,821	7,046,863	769,958
Total non-financial assets	1,547,839,023	1,571,107,197	(23,268,174)
Departmental net financial position	1,540,022,202	1,564,060,334	(24,038,132)

Total net liabilities of $83M are mostly made up of accounts payable and accrued liabilities. These represent goods and services received at year-end but that have not been paid by the Agency.

The $18M decrease in net liabilities ($83M for 2018–19 compared to $101M for 2017–18) is mainly due to a $17M decrease in accounts payable and accrued liabilities. These variations are to be expected, as payment schedules may vary from one year to another, especially those related to the ISS, the RCM and ESA.

Total assets were $1.6B at the end of 2018–19 ($75M in net financial assets and $1.5B in non-financial assets), a $42M (2.6%) decrease compared with the previous year's total of $1.7B.

Non-financial assets are mainly composed of space-related assets ($1.4B or 86.5%).

Supplementary information

Corporate information

Organizational profile

Appropriate minister:
The Honourable Navdeep Bains, P.C., M.P.
Minister of Innovation, Science and Economic Development

Institutional head:
Sylvain Laporte, President

Ministerial portfolio:
Innovation, Science and Economic Development

Enabling instrument(s):
Canadian Space Agency Act, S.C. 1990, c. 13

Year of incorporation/commencement:
Established in March 1989

Other:
The Canadian Space Agency was established in 1989. Approximately 84% of its employees work at headquarters located at the John H. Chapman Space Centre in Saint-Hubert, Quebec. The remaining personnel serve the CSA at the David Florida Laboratory in Ottawa, Ontario, and its policy and planning offices in Gatineau, Quebec, with officials in Houston, Washington and Paris.

Raison d'être, mandate and role

"Raison d'être, mandate and role: who we are and what we do" is available on the Canadian Space Agency's website.[xlv]

Operating context and key risks

Information on operating context and key risks is available on the Canadian Space Agency's website.[xlv]

Reporting framework

The Canadian Space Agency Departmental Results Framework and Program Inventory of record for 2018–19 are shown below:

Graphical presentation of Departmental Results Framework and Program Inventory

Departmental Results Framework	**Core Responsibility: Canada in space**		**Internal Services**
	Departmental Result: Space research and development advances science and technology	Indicator: Business Expenditures in Research and Development in the space sector	
		Indicator: Canada's rank among OECD nations on the citation score of space-related publications	
	Departmental Result: Canadians engage with space	Indicator: Number of new people and organizations entering space-related fields as a result of CSA funding	
		Indicator: Number of engagements on social media related to the CSA	
	Departmental Result: Space information and technologies improve the lives of Canadians	Indicator: Number of services offered to Canadians dependent on CSA information	
		Indicator: Number of Canadian space technologies adapted for use on Earth or re-use in space	
	Departmental Result: Canada's investments in space benefit the Canadian economy	Indicator: Number of highly qualified people in the Canadian space sector	
		Indicator: Value of exports of the Canadian space sector	
Program Inventory	Program: Space Capacity Development		
	Program: Space Exploration		
	Program: Space Utilization		

Supporting information on the Program Inventory

Financial, human resources and performance information for the Canada Space Agency's Program Inventory is available in the GC InfoBase.[xlii]

Supplementary information tables

The following supplementary information tables are available on the Canadian Space Agency's website.[xlv]

- Departmental Sustainable Development Strategy
- Details on transfer payment programs of $5 million or more
- Gender-based analysis plus
- Response to parliamentary committees and external audits
- Status report on projects operating with specific Treasury Board approval
- Status report on transformational and major Crown projects

Federal tax expenditures

The tax system can be used to achieve public policy objectives through the application of special measures such as low tax rates, exemptions, deductions, deferrals and credits. The Department of Finance Canada publishes cost estimates and projections for these measures each year in the Report on Federal Tax Expenditures.[xlvi] This report also provides detailed background information on tax expenditures, including descriptions, objectives, historical information and references to related federal spending programs. The tax measures presented in this report are the responsibility of the Minister of Finance.

Organizational contact information

Communications and Public Affairs
Telephone: 450-926-4370
Fax: 450-926-4352
Email: asc.medias-media.csa@canada.ca
Website: http://www.asc-csa.gc.ca

Appendix: definitions

appropriation (crédit)

Any authority of Parliament to pay money out of the Consolidated Revenue Fund.

budgetary expenditures (dépenses budgétaires)

Operating and capital expenditures; transfer payments to other levels of government, organizations or individuals; and payments to Crown corporations.

Core Responsibility (responsabilité essentielle)

An enduring function or role performed by a department. The intentions of the department with respect to a Core Responsibility are reflected in one or more related Departmental Results that the department seeks to contribute to or influence.

Departmental Plan (plan ministériel)

A report on the plans and expected performance of an appropriated department over a three-year period. Departmental Plans are tabled in Parliament each spring.

Departmental Result (résultat ministériel)

A Departmental Result represents the change or changes that the department seeks to influence. A Departmental Result is often outside departments' immediate control, but it should be influenced by program-level outcomes.

Departmental Result Indicator (indicateur de résultat ministériel)

A factor or variable that provides a valid and reliable means to measure or describe progress on a Departmental Result.

Departmental Results Framework (cadre ministériel des résultats)

Consists of the department's Core Responsibilities, Departmental Results and Departmental Result Indicators.

Departmental Results Report (rapport sur les résultats ministériels)

A report on an appropriated department's actual accomplishments against the plans, priorities and expected results set out in the corresponding Departmental Plan.

experimentation (expérimentation)

Activities that seek to explore, test and compare the effects and impacts of policies, interventions and approaches, to inform evidence-based decision-making, by learning what works and what does not.

full-time equivalent (équivalent temps plein)

A measure of the extent to which an employee represents a full person-year charge against a departmental budget. Full-time equivalents are calculated as a ratio of assigned hours of work to scheduled hours of work. Scheduled hours of work are set out in collective agreements.

gender-based analysis plus (GBA+) (analyse comparative entre les sexes plus [ACS+])

An analytical process used to help identify the potential impacts of policies, Programs and services on diverse groups of women, men and gender differences. We all have multiple identity factors that intersect to make us who we are; GBA+ considers many other identity factors, such as race, ethnicity, religion, age, and mental or physical disability.

government-wide priorities (priorités pangouvernementales)

For the purpose of the 2018–19 Departmental Results Report, those high-level themes outlining the government's agenda in the 2015 Speech from the Throne, namely: Growth for the Middle Class; Open and Transparent Government; A Clean Environment and a Strong Economy; Diversity is Canada's Strength; and Security and Opportunity.

horizontal initiative (initiative horizontale)

An initiative where two or more departments are given funding to pursue a shared outcome, often linked to a government priority.

non-budgetary expenditures (dépenses non budgétaires)

Net outlays and receipts related to loans, investments and advances, which change the composition of the financial assets of the Government of Canada.

performance (rendement)

What an organization did with its resources to achieve its results, how well those results compare to what the organization intended to achieve, and how well lessons learned have been identified.

performance indicator (indicateur de rendement)

A qualitative or quantitative means of measuring an output or outcome, with the intention of gauging the performance of an organization, program, policy or initiative respecting expected results.

performance reporting (production de rapports sur le rendement)

The process of communicating evidence-based performance information. Performance reporting supports decision making, accountability and transparency.

plan (plan)
The articulation of strategic choices, which provides information on how an organization intends to achieve its priorities and associated results. Generally a plan will explain the logic behind the strategies chosen and tend to focus on actions that lead up to the expected result.

planned spending (dépenses prévues)
For Departmental Plans and Departmental Results Reports, planned spending refers to those amounts presented in Main Estimates.

A department is expected to be aware of the authorities that it has sought and received. The determination of planned spending is a departmental responsibility, and departments must be able to defend the expenditure and accrual numbers presented in their Departmental Plans and Departmental Results Reports.

priority (priorité)
A plan or project that an organization has chosen to focus and report on during the planning period. Priorities represent the things that are most important or what must be done first to support the achievement of the desired Strategic Outcome(s) or Departmental Results.

program (programme)
Individual or groups of services, activities or combinations thereof that are managed together within the department and focus on a specific set of outputs, outcomes or service levels.

result (résultat)
An external consequence attributed, in part, to an organization, policy, program or initiative. Results are not within the control of a single organization, policy, program or initiative; instead they are within the area of the organization’s influence.

statutory expenditures (dépenses législatives)
Expenditures that Parliament has approved through legislation other than appropriation acts. The legislation sets out the purpose of the expenditures and the terms and conditions under which they may be made.

Strategic Outcome (résultat stratégique)
A long-term and enduring benefit to Canadians that is linked to the organization’s mandate, vision and core functions.

target (cible)
A measurable performance or success level that an organization, program or initiative plans to achieve within a specified time period. Targets can be either quantitative or qualitative.

voted expenditures (dépenses votées)

Expenditures that Parliament approves annually through an Appropriation Act. The Vote wording becomes the governing conditions under which these expenditures may be made.

Endnotes

i Canadian Space Strategy, http://asc-csa.gc.ca/eng/publications/space-strategy-for-canada/default.asp
ii Lunar Gateway, http://asc-csa.gc.ca/eng/astronomy/moon-exploration/lunar-gateway.asp
iii David St-Jacques, http://www.asc-csa.gc.ca/eng/missions/expedition58/default.asp
iv CubeSat, http://www.asc-csa.gc.ca/eng/satellites/cubesat/default.asp
v RADARSAT Constellation Mission, http://www.asc-csa.gc.ca/eng/satellites/radarsat/default.asp
vi QEYSSat, http://asc-csa.gc.ca/eng/sciences/qeyssat.asp
vii STDP, http://www.asc-csa.gc.ca/eng/programs/stdp/Default.asp
viii STRATOS, http://asc-csa.gc.ca/eng/sciences/balloons/default.asp
ix HEMERA, https://www.hemera-h2020.eu/
x LEAD, http://www.asc-csa.gc.ca/eng/rovers/mission-simulations/lunar-exploration-analogue-deployment.asp
xi Mobile Servicing System, http://www.asc-csa.gc.ca/eng/iss/mobile-base/overview.asp
xii SCISAT, http://asc-csa.gc.ca/eng/satellites/scisat/default.asp
xiii Scientific Assessment of Ozone Depletion: 2018, https://www.esrl.noaa.gov/csd/assessments/ozone/2018/downloads/2018OzoneAssessment.pdf
xiv Montreal Protocol Assessments, https://public.wmo.int/en/media/press-release/montreal-protocol-assessment-reveals-healing-ozone-untapped-potential-climate
xv Curiosity, http://www.asc-csa.gc.ca/eng/astronomy/mars/curiosity.asp
xvi OSIRIS-REx, http://www.asc-csa.gc.ca/eng/satellites/osiris-rex/default.asp
xvii ASTROSAT, http://www.asc-csa.gc.ca/eng/sciences/astrosat.asp
xviii BRITE, http://www.asc-csa.gc.ca/eng/satellites/brite/default.asp
xix XRISM, http://www.asc-csa.gc.ca/eng/satellites/xrism/default.asp
xx InSight, http://www.asc-csa.gc.ca/eng/astronomy/mars/insight.asp
xxi Trace Gas Orbiter, http://www.asc-csa.gc.ca/eng/astronomy/mars/canada-exomars-pictures.asp
xxii Polarimetry Explorer, https://ixpe.msfc.nasa.gov/
xxiii EUCLID, https://sci.esa.int/web/euclid/
xxiv New Horizons, https://www.nasa.gov/mission_pages/newhorizons/main/index.html
xxv James Webb Space Telescope, http://www.asc-csa.gc.ca/eng/satellites/jwst/default.asp
xxvi FAST, http://www.asc-csa.gc.ca/eng/funding-programs/programs/fast/default.asp
xxvii Solar terrestrial, http://www.asc-csa.gc.ca/eng/sciences/solar-terrestrial.asp
xxviii RADARSAT-2, http://asc-csa.gc.ca/eng/satellites/radarsat2/default.asp
xxix Robert Thirsk, http://www.asc-csa.gc.ca/eng/missions/expedition-20-21.asp
xxx Chris Hadfield, http://www.asc-csa.gc.ca/eng/missions/expedition34-35/default.asp
xxxi Living Space, http://www.asc-csa.gc.ca/eng/missions/expedition58/activities/living-space.asp
xxxii RADARSAT-1, http://asc-csa.gc.ca/eng/satellites/radarsat1/default.asp
xxxiii EOADP, http://asc-csa.gc.ca/eng/funding-programs/programs/eoadp/default.asp
xxxiv SWOT, http://www.asc-csa.gc.ca/eng/satellites/swot.asp
xxxv Vascular Echo, http://www.asc-csa.gc.ca/eng/sciences/vascular.asp
xxxvi At Home in space, http://www.asc-csa.gc.ca/eng/sciences/at-home-in-space.asp
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xxxviii Bio-Analyzer, http://www.asc-csa.gc.ca/eng/iss/bio-analyzer.asp
xxxix Innovation and Skills Plan, https://www.ic.gc.ca/eic/site/062.nsf/eng/home
xl Innovative Solution Canada, https://www.ic.gc.ca/eic/site/101.nsf/eng/home
xli Canada-ESA Cooperation Agreement, http://www.asc-csa.gc.ca/eng/funding-programs/canada-esa/about-cooperation-agreement.asp

xlii. GC InfoBase, https://www.tbs-sct.gc.ca/ems-sgd/edb-bdd/index-eng.html#start

xliii Space Advisory Board, https://www.ic.gc.ca/eic/site/082.nsf/eng/03996.html

xliv. Public Accounts of Canada 2018–2019, http://www.tpsgc-pwgsc.gc.ca/recgen/cpc-pac/index-eng.html

xlv Reports to Parliament, http://www.asc-csa.gc.ca/eng/publications/rp.asp

xlvi. Report on Federal Tax Expenditures, http://www.fin.gc.ca/purl/taxexp-eng.asp