

César Costa¹, Thyrso Villela^{1,2}, Alessandra Brandão¹, Fernando Bueno¹

¹ Center for Strategic Studies and Management – CGEE

² National Institute for Space Research – INPE

Email: ccosta@cgée.org.br

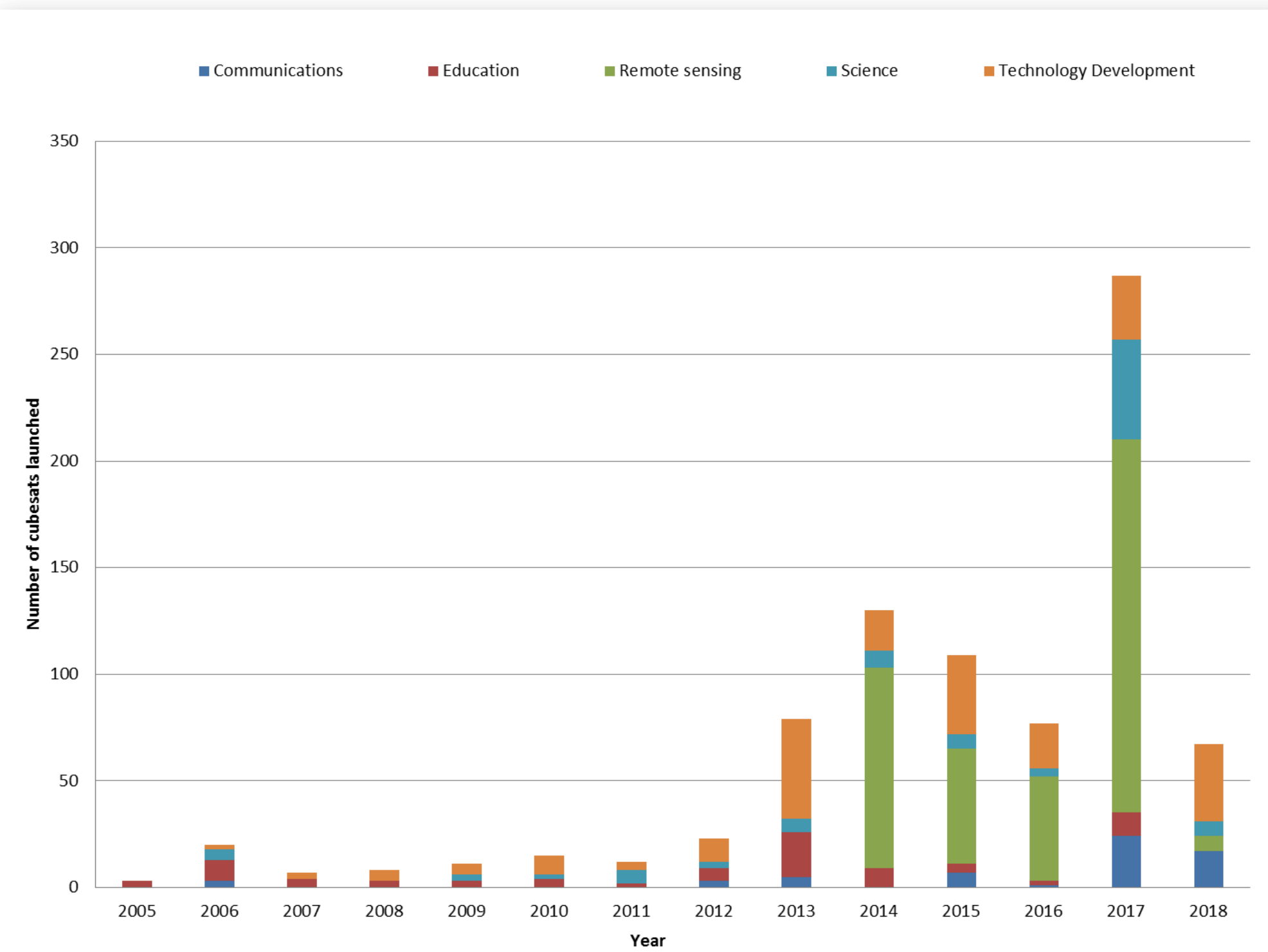
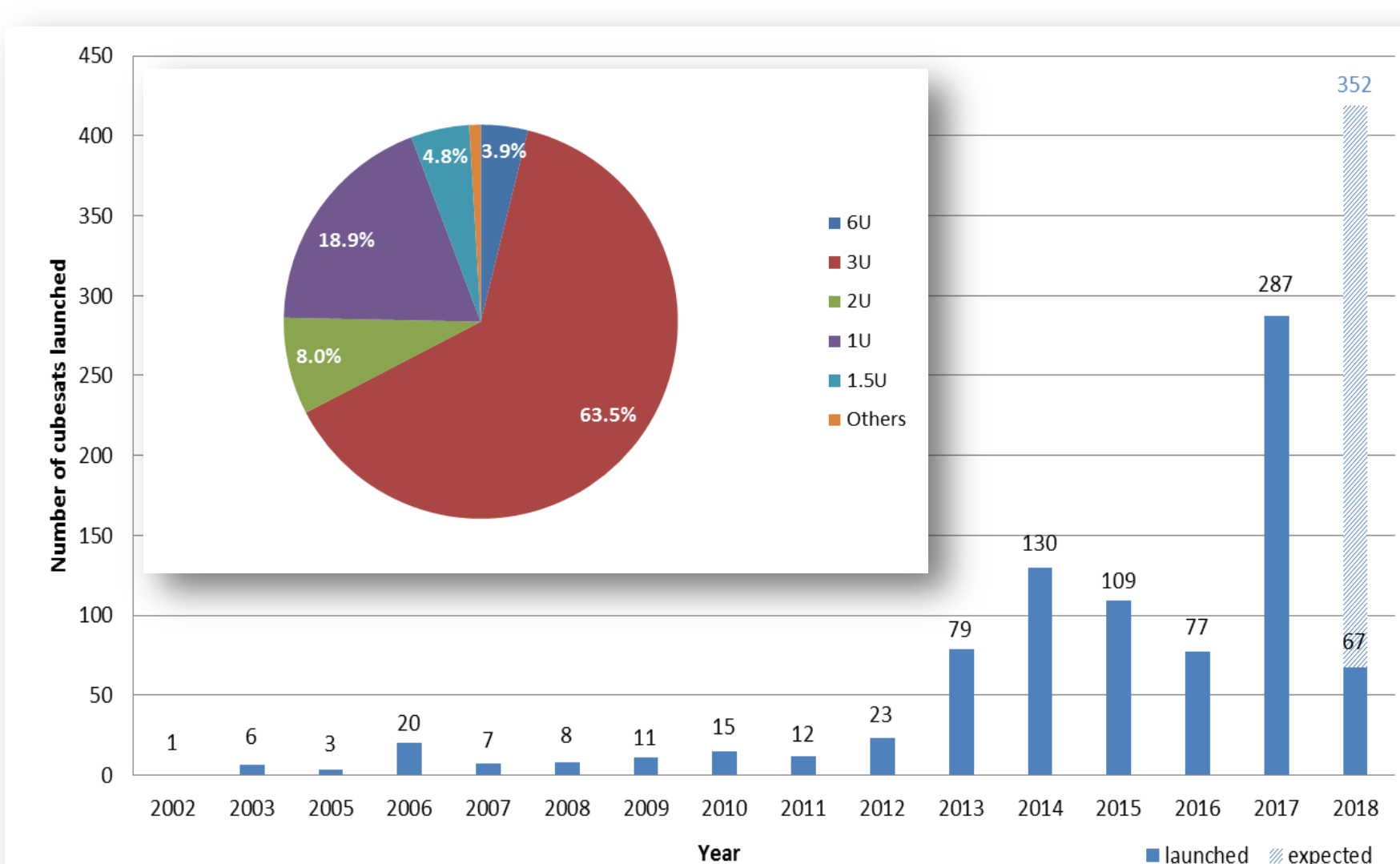
Abstract

CubeSats became an interesting innovation in the space sector. Such platforms are being used for several space applications. As of May 31st, 2018, 855 CubeSats had been launched. In this paper, we present an analysis of the current situation regarding CubeSats worldwide, through the use of a dataset built to encompass information about these satellites. CubeSats have been used to address several space applications, such as education, Earth remote sensing, science, defense, among others. Fifty eight countries have already been involved with developing CubeSats. The most used CubeSat configuration is 3U (about 64%), followed by 1U (18%), while 6U platforms account for about 4%. Remote sensing application is the main sector in which CubeSats are being used, corresponding to about 45% of all applications. This fact indicates the commercial potential of such platform. The overall success rate of the CubeSat missions is increasing over time. Considering CubeSat missions as a Bernoulli experiment, and excluding launch failures, the current success rate was estimated, as a parameter of a binomial distribution, to be about 75%. By using a logistic model and considering that the launching number keeps following the current tendency, one can expect that one thousand CubeSats will be launched in 2021, within 95% certainty. The thousandth CubeSat is expected to be launched still during 2018.

CubeSats by the numbers

CubeSats Launched

MEPSI, the first CubeSat-like picosatellite was launched in 2002. Up to May 31, 2018, 855 CubeSats were launched. The drop in the number of CubeSats launchings observed in the years 2015 and 2016 was due to a launcher failure which held off many scheduled launches. More than 67 have already been launched in 2018, and another 285 CubeSats are programmed to be launched, making the total number expected for this year to be more than 350.



Use and Users

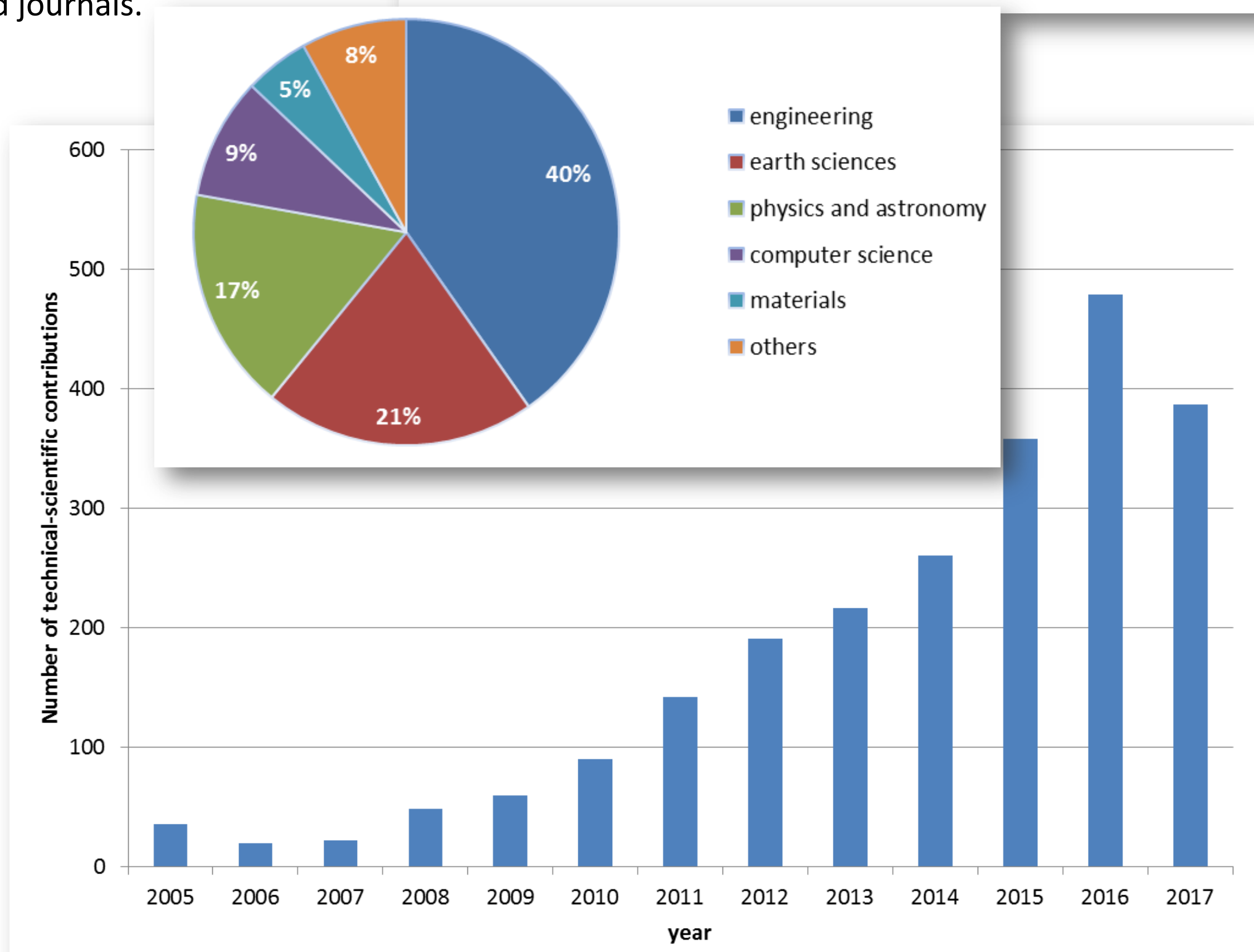
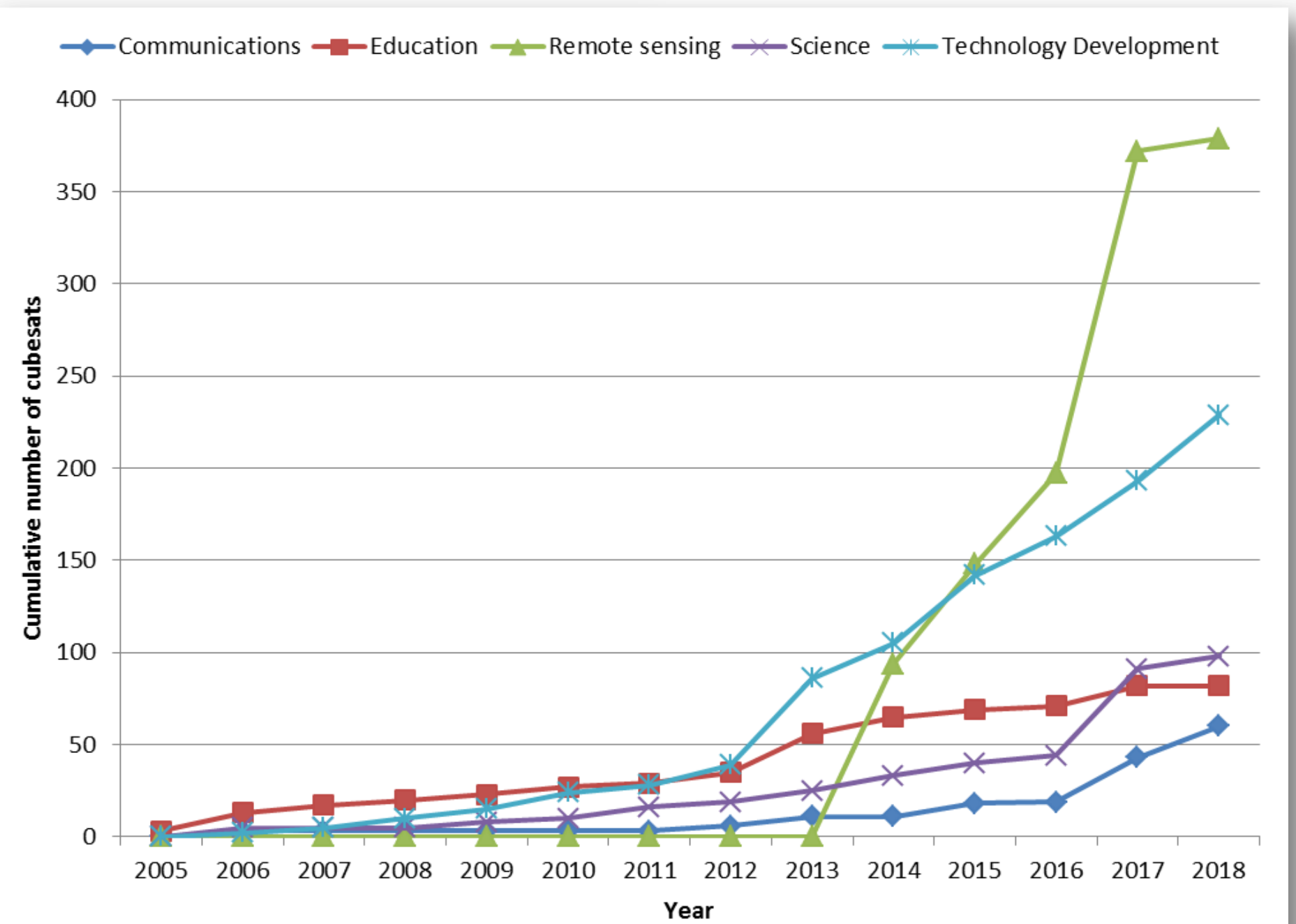
These small devices are leaving academy and becoming an important contributor to the commercial sector. Companies are changing how Earth imaging commerce is done in many different ways by applying CubeSat platforms.

Military industries are also becoming interested in developing CubeSats for some applications.

Growing Applicability

Earth remote sensing has been the main application to what CubeSats have been devoted to. Earth observation has been an interesting driver for CubeSats. Technology demonstration also represents an important fraction of the total number of launched CubeSats.

That is reflected in scientific publications in many knowledge fields, according data collected from the Scopus platform show that there is an increasing production of papers related to CubeSats, in conferences and refereed journals.



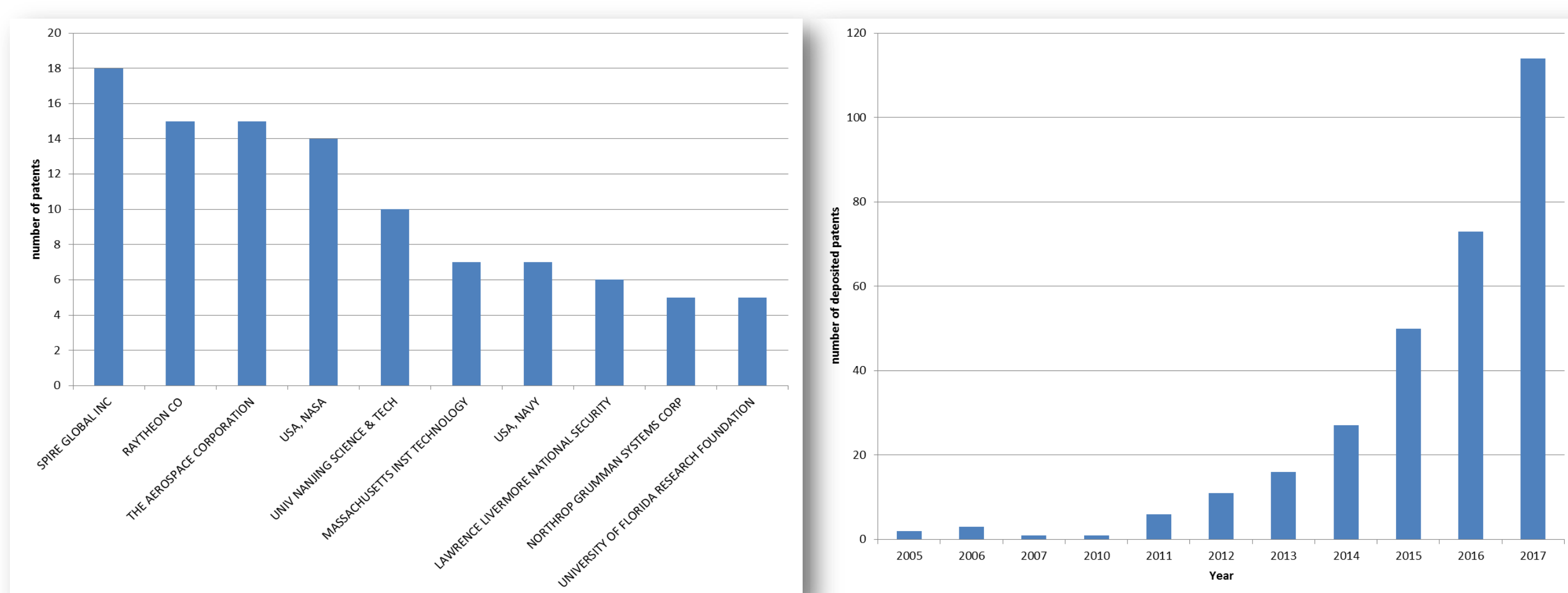
The CGEE CubeSat database

The Center for Strategic Studies and Management - CGEE maintains a dataset on CubeSats, with several information regarding these artifacts. CGEE's interest on CubeSats began a few years ago when a routine activity to monitor potential innovations in the space sector, known as Space Technology Observatory – OTE, detected an overall increase of the use of small-size satellites to address several demands for space applications. In particular, within this satellite category, CubeSats presented an interesting potential an interesting potential to truly become a space innovation, due to their low development costs and broad applicability. In order to follow this innovation, it was decided to create a database with relevant information regarding CubeSats.

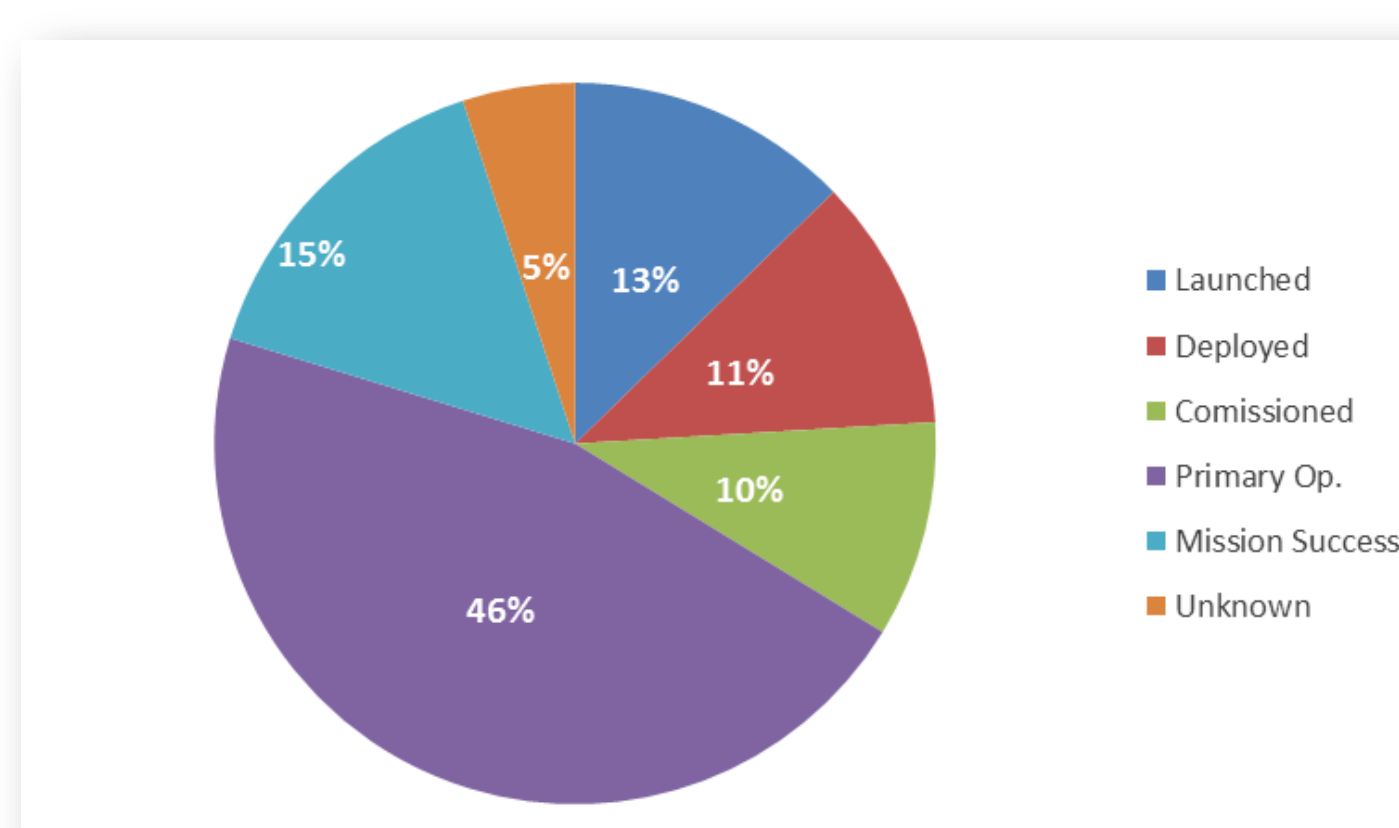
It also contains information about patents and patent owner regarding CubeSats applications.



<https://www.cgée.org.br/web/observatorio-espacial/bancos-de-dados>



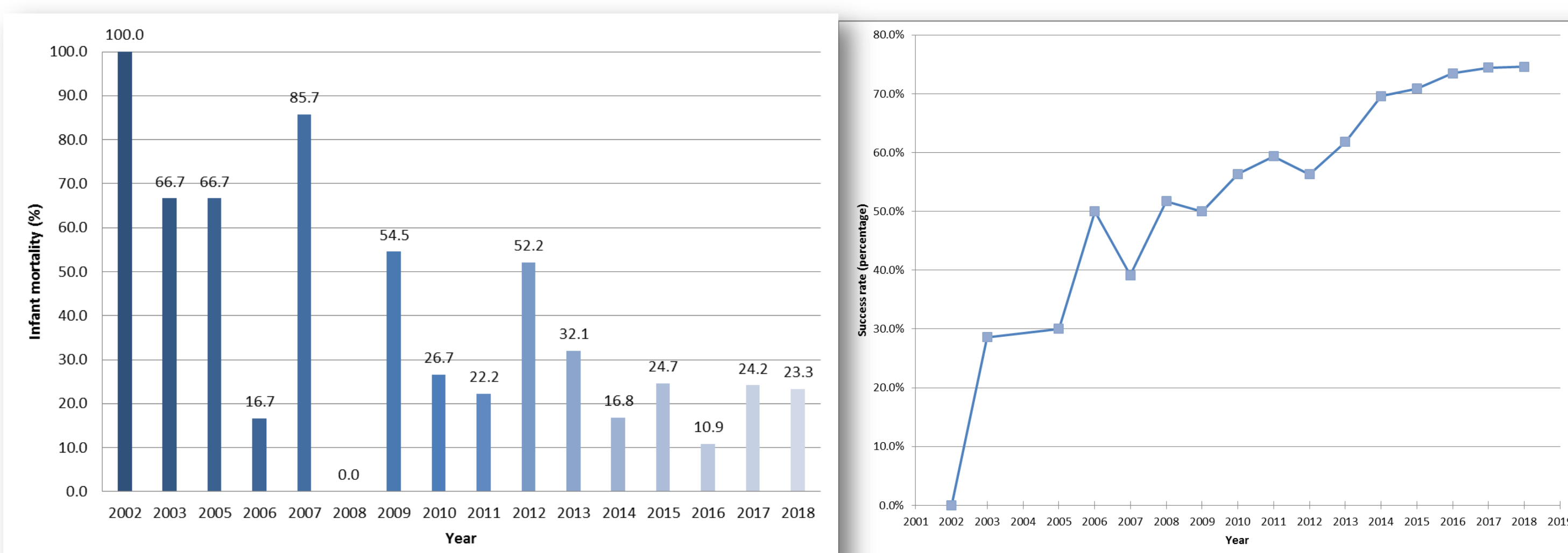
CubeSats reliability



Mission Status

“Launched” means that the satellite has left Earth but it has not been deployed yet (i.e. it might be waiting in the ISS); “deployed” means the deployment system worked, but no signal was received from the device after that; “commissioned” means the CubeSat made at least one successful downlink and uplink, but then communication was lost;

“primary op.” status corresponds to the CubeSats which have accomplished good part of their mission or the mission is still in progress; “mission success” refers to CubeSats that successfully accomplished their missions and might still be operational. CubeSats themselves cannot be blamed for all mission failures. Around 20% of all failures occurred either during launch or deployment phase. The success rate of the overall CubeSat missions is increasing over time, currently being about 75%.



CubeSats launching forecast

Despite the drop in launching numbers in 2015 and 2016, in 2017 the trend of exponential growth presented up to 2014 was recovered. If launching number keeps following the current tendency (logistic model), one thousand CubeSats might be launched annually by 2021, with 95% confidence. According to our estimate, and based on information of future launchings, the thousandth CubeSat is expected to be launched by 2018.

