

## The growth of the commercial sector in space science

JL Gannon<sup>1</sup>, N Lugaz<sup>2</sup>

1: CPI, Boulder CO

2: University of New Hampshire, Durham NH

The commercial sector of space science is thriving. Exciting examples come to mind more easily today than ever before, including commercial spaceflight and launches, ride shares for public-sector missions, and the deployment of countless satellites that support communications and human infrastructure. What may be surprising to some is the breadth and depth of the private sector contribution that goes beyond the largest, most high-profile examples. Companies, large and small, are doing fundamental science, and becoming high-quality data providers.

The increasing participation of the commercial sector in the National Oceanic and Atmospheric Administration (NOAA)'s annual Space Weather Workshop (SWW) over recent years is evidence of this growth – and it is not just from the large prime contractors. Small businesses are becoming more significant players in science, engineering, and operations. In this year's SWW, seven presentations were given by small businesses that are a part of the American Commercial Space Weather Association, on topics across atmospheric, ionospheric, magnetospheric, solar, and geomagnetic science, models, and instrumentation.

The science that is being done by these companies is not solely in the applied domain. Although government and academic groups are often recognized as the traditional centers of fundamental research, there is significant work being done in the private sector. As in academia, these efforts in the United States are supported by the National Science Foundation (NSF), National Aeronautics and Space Administration (NASA), National Oceanic and Atmospheric Administration, and other government grant programs, as well as funding and collaborative mechanisms that are unique to public-private partnerships, such as Small Business Innovative Research grants (SBIRs), Cooperative Research And Development Agreements (CRADAs), and internal investments by the companies themselves.

Perhaps these contributions should not be so surprising in space weather, since it is a field that is often defined by the impacts on commercial end users such as airlines, pipelines, satellite operators and power utilities. Many of the data sets that support space weather science – measurements of geomagnetically-induced currents and catalogs of satellite anomaly records, in particular – have their roots in the private sector by necessity. These incredibly important observations spur the development of and provide the ground-truth for new models. This natural public-private partnership has driven alignments between the sectors that make space weather somewhat unusual in helioscience.

As the commercial space sector continues to grow and thrive, it is likely that models and data sets will continue to emerge that can augment traditional academic and government resources.

It is also likely that new difficulties will arise that require cooperation and collaboration to overcome. An example that was discussed in preparation of the 2050 Heliophysics decadal survey is the formalization of mechanisms to ensure that private space weather and space science data can be used for research and ways for curation, validation, and publication of these private data to be funded, similar to NOAA Commercial Weather Data Pilot and Purchase. Proprietary data and models are often used in publications in *Space Weather* and the editorial and publication team ensures that the descriptions and potential availability of the data and models satisfy requirements for proper reviewing and reproducibility of the research. The role of the *Space Weather* journal is to promote collaboration and communication between academia, government and private sector and since its founding publishes contribution from all sectors. As a space weather community, we should look forward to, encourage, and support collaboration across public and private sectors, as access to a diversity of solutions will always lead to the strongest possible science.