**Written Testimony before the**
**U.S. House of Representatives, Space, Science and Technology Committee,**
**Subcommittee on Environment and Subcommittee on Space and Aeronautics**

**Joint Hearing Entitled:**
**"Space Weather: Advancing Research, Monitoring, and Forecasting Capabilities"**

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Good Afternoon -- Chairman Fletcher and Chairman Horn, Ranking Members Marshall and Babin and distinguished Members of the Subcommittee, it is my honor to appear before you today at this important hearing to discuss Advancing Research, Monitoring, and the Forecasting Capabilities for Space Weather.

GeoOptics has been fulfilling its NOAA NESDIS contract under the Commercial Weather Data Pilot (CWDP) program and has successfully delivered over 350,000 high data accuracy GPS-Radio Occultation profiles by the end of September 2019. Having successfully demonstrated our data, we look forward to NOAA NESDIS soon announcing its Commercial Data Buy Program.

Our success in demonstrating our technological capability to NOAA NESDIS would not have been possible without the leadership and support of many on this committee and especially Congressman Frank Lucas, Congresswoman Suzanne Bonamici and former Congressman Jim Bridenstine for their support of the Commercial Weather Data Program in the Weather Research and Forecast Innovation Act of 2017.

Our founder Tom Yunck originally proposed the GPS-RO technique in 1988 and oversaw the development and improvement of the world's leading capability at the Jet Propulsion Laboratory. Over the last decade a series of government-funded satellites have refined the RO technology and proven out its tremendous capability. GeoOptics' CICERO (Community Initiative for Cellular Earth Remote Observation) nano-satellites is the only US-based RO provider with "the JPL gold standard" for some of the most accurate weather and climate data available, offering significantly more impact per measurement than traditional weather instruments.

We have worked with our partners at the Jet Propulsion Laboratory and Tyvak Nano-Satellite Systems to commercialize and miniaturize this technology. By launching smaller, less expensive satellites, we will be able to make orders of magnitude more data available to weather forecasters and scientists around the world. And, our pledge to the scientific community is that all is CICERO data will be provided free for any research purpose.

Radio Occultation data provides high-resolution temperature and water vapor profiles by gaining measurements of bending angle profiles in the troposphere and the stratosphere with high vertical resolution and accuracy. The measurement of bending angles can be used to obtain information on refractivity profiles, which can be used to retrieve atmospheric temperature and humidity profiles, as well as surface pressure. A secondary objective is to provide space-weather information through measurement of electron density and its profile in the middle and high atmosphere.[1]

There is a robust interest from other private sector / space weather technology companies to work with federal agencies to develop and implement solutions to deal with Space Weather. For example, GeoOptics is a member of the American Commercial Space Weather Association (ACSWA), which is comprised of 19 member companies with the common goal of developing, delivering, and sustaining key space weather products and services to mitigate threats to societal infrastructure. ACSWA plays an essential role in the academic-governmental-commercial triad that forms the space weather enterprise. ACSWA companies provide the insight, innovation, and cost-benefit to our Nation's preparedness and responsiveness to space weather threats.[2]

ACSWA is a collective voice for the commercial space weather sector and an advocate for the enterprise. Since its inception in 2010 beginning with five companies, ACSWA has quadrupled in size. ACSWA serves as a catalyst for collaboration between various organizations and the commercial space weather industry. ACSWA works with government agencies, academia, and industry stakeholders to strengthen the space weather enterprise and to promote space weather, space weather partnerships, and public/commercial initiatives.

Last year NOAA NESDIS issued its final report of the NOAA Space Platform Requirements Working Group (SPRWG) in support of the NOAA Satellite Observing System Architecture (NSOSA) study. As a part of this study, NESDIS initiated the Space Platform Requirements Working Group (SPRWG) to evaluate the future needs and relative priorities for weather, space weather and environmental remote sensing (excluding land mapping) space-based observations for the 2030 timeframe and beyond. [3]

One has only to look at the ranking of the space weather measurements that were identified by leading NOAA and university research scientists in the SPRWG Report and compare them to the technological capabilities offered by ACSWA member companies. [4]

Increased investments are needed from Congress to continue to fund the Commercial Data Buy Program for GPS-RO data that benefit Nowcasting and Numerical Weather Prediction.

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[1] https://www.eumetsat.int/website/home/Satellites/FutureSatellites/EUMETSATPolarSystemSecondGeneration/RO/index.html

[2] http://www.acswa.us/about.html

[3] https://www.nesdis.noaa.gov/sites/default/files/SPRWG_Final_Report_20180325_Posted.pdf.

[4] http://www.acswa.us/capabilities.html

Congress should also consider creating a Commercial Space Weather Data Program for commercial sector providers to provide cost effective solutions for the challenges of Space Weather as defined in the NOAA SPRWG Report.

Jet Propulsion Laboratory and California Institute of Technology scientists [5]recommended: "...Cubesat swarms, either as a dedicated constellation or an ad-hoc constellation deployed via launches of opportunity, would be a profoundly useful resource for advancing Atmosphere-Ionosphere-Magnetosphere science, providing plasma measurements to accompany other measurements of the forces that influence ionospheric structure such as solar extreme ultraviolet radiation (EUV), thermo-spheric winds and composition, and ionospheric electric fields." That was written in 2010 and many of these recommendations are included in the recommendations of NOAA SPRWG Report that was issued in 2018.

My esteemed panelists could better answer this point, but if the United States were to suffer a huge coronal mass ejection like the 1859 Carrington Event in Missouri, conservative estimates would be around $20 Trillion for the US to manage the destruction from a massively crippling solar storm on our electronic infrastructure[6]. Therefore, it is critically important in the Nation's vital self-interest to find solutions to the challenges of Space Weather that could adversely affect life here on Earth.

The American Commercial Space Weather Association and its member companies look forward to working with federal agencies advance their knowledge and understanding of Space Weather.

Thank you for your consideration. I will do my best to address any questions that you may have.

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[5] GNSS1 Geospace Constellation (GGC): A Cubesat Space Weather Mission Concept Anthony J. Mannucci, Jeff Dickson, Coutney Duncan, Ken Hurst Jet Propulsion Laboratory, California Institute of Technology

[6] https://www.sciencealert.com/here-s-what-would-happen-if-solar-storm-wiped-out-technology-geomagnetic-carrington-event-coronal-mass-ejection