**Statement of**
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**before the**

**Subcommittee on Space and Aeronautics**
**Committee on Science, Space, and Technology**
**U.S. House of Representatives**
**on**
**"NASA's Earth Science and Climate Change Activities: Current Roles and Future Opportunities"**

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Chairman Beyer, Ranking Member Babin, Chairwoman Johnson, Ranking Member Lucas and members of the Subcommittee, I am honored to appear before this Subcommittee to discuss NASA's Earth Science and climate change mission, the important role that commercial companies are playing today in support of that mission, and the opportunities that NASA has to better leverage commercial enterprise to meet their scientific and climate goals. As Congress and the Biden Administration look to focus on climate programs, this conversation is particularly well-timed to highlight the important role that space-based remote sensing satellites (both national assets and commercial constellations) have in providing the data needed to understand our changing world and empower better decisions by federal agencies, state and local governments, communities, companies, and individuals.

**Planet Overview**
Inspired by the idea that commercial components and an iterative Silicon Valley approach to satellite design could dramatically reduce the cost of satellites, Will Marshall, Chris Boshuizen, and I left NASA Ames and founded Planet 10 years ago. Today, Planet, based in San Francisco, CA, builds and operates the largest constellation of Earth-imaging satellites in history and enables, for the first time ever, the ability to capture daily changes to the entire Earth's landmass. Planet serves the medium- and high-resolution optical and near-infrared imagery needs of over 600 customers in 65 countries including commercial businesses, scientists, students, journalists, federal and local governments, and analysts. With 200 satellites in orbit, Planet provides global daily coverage to more than 20,000 users. Our ability to rapidly design, build, launch, and maintain a large, resilient satellite network provides greater understanding of our ever-changing planet. We continually refresh and upgrade our fleet of compact small satellites to monitor the changing globe daily for a range of humanitarian, scientific, commercial, and government applications.

We founded Planet with the mission of making geospatial information more available - to make change visible, accessible, and actionable. In the last decade, other U.S. entrepreneurs have joined Planet and pioneered novel, commercial remote sensing capabilities that operate at the speed of business and play a key role today in measuring and monitoring changes to our planet. These commercial data are enabling governments, a wide range of industries, leading scientific researchers, state and local communities, and individuals around the world to make better decisions.

NASA leads the way in utilizing commercial capabilities and creating programs to complement scientists' use of national assets. But more can (and should) be done. There is an opportunity to fully leverage the

unique capabilities of U.S. commercial space-based potential in tandem with national remote sensing programs. This unprecedented and unparalleled data access would serve to enable fasttrack efforts to confront the impact of environment and climate change, facilitate transparency and global understanding, and further accelerate America's leadership to solve global issues.

**Current NASA Earth Science Partnerships with Commercial Remote Sensing Companies**
The last decade has seen rapid growth in the number of companies building, launching, and operating Earth observing satellites that provide data and analytical tools to an expanding base of public and private sector users. Over 400 small satellites (SmallSats) were launched in 2019 and 2020 alone. As the largest Earth observing company, Planet has built and operated more than 450 SmallSats that provide over 15 Terabytes of high-resolution data to scientists, policymakers, and industry every day.  NASA's Science Mission Directorate has leaned forward and fostered a program within the Earth Science Division to leverage these commercially available datasets to support NASA's Earth Science research and application goals.

In FY2018, NASA's Earth Science Division (ESD) launched the Private-Sector Small Constellation Satellite Data Product Pilot to identify, evaluate, and acquire remote sensing imagery and data from commercial sources that support NASA's Earth Science research and application goals. Under the Pilot program, NASA awarded contracts to three Earth observing satellite companies (including Planet). NASA's conclusion – informed by evaluations and input by individual Earth scientists – was positive and informative. Specifically, NASA's "Commercial SmallSat Data Acquisition Program Pilot Evaluation Report"[1] (April 2020) stated the pilot "demonstrated the usefulness of commercial data and imagery for advancing scientific research and applications". The NASA report highlighted areas of improvement for the commercial partners and Planet has taken that feedback and incorporated it into product investments to increase the quality of our products to better serve NASA's needs.  This is the sort of commercial-government partnership that allows for U.S. industry to continue to innovate in the global market.

Following the successful pilot, NASA established the Commercial SmallSat Data Acquisition (CSDA) Program[2] and contracted with the three companies from the pilot program to provide NASA-funded researchers with access to their Earth observation data. Since its inception, NASA has released subsequent RFI's to onramp new commercial data vendors and evaluate data for its potential to advance NASA's Earth Science research and applications activities.  Additionally, to support the further utilization of this commercial remote sensing data, NASA released the Commercial SmallSat Data Analysis solicitation (ROSES A.42) in 2020.

In order to continue the success of NASA's CSDA program and build a community of researchers that utilize commercial remote sensing data along with national assets, NASA's Science Mission Directorate is expanding the program's user community beyond NASA-funded researchers to include scientific researchers from Federal civilian agencies. This is part of an effort to standardize the End User License Agreements (EULAs) and to increase the scientific collaboration and information sharing across the US research community.  This represents a much needed step and is a strong sign that commercial remote sensing data is valuable for researchers across a variety of disciplines within the government. Inspired by NASA's Landsat program to spur scientific and technical innovation, Planet launched its Education and Research program on Earth Day four years ago with a license to stimulate scientific innovation on high

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[1] https://cdn.earthdata.nasa.gov/conduit/upload/14180/CSDAPEvaluationReport_Apr20.pdf
[2] https://earthdata.nasa.gov/esds/csdap

cadence land monitoring applications. Today, there are now over 1,000 peer-reviewed publications and conference papers that have used Planet's data for their research. A year ago we had just over 600 publications and now this ongoing contribution to the global knowledge base of our world is accelerating at a rate of new paper every 24 hours.

Beyond the pure research side, NASA is using commercial remote sensing data in their programs to address international food insecurity and provide information on the COVID pandemic. COVID-19 has severely impacted the global food system, requiring rapid response in affected countries to design and enact aid programs. In spring 2020, the Government of Togo approached NASA Harvest to create a country-wide map of cropland as part of an effort to distribute aid to farmers to boost food production. Working with Planet, NASA Harvest was able to create this map and deliver it to the Togolese government in only 10 days. NASA's COVID-19 Dashboard features data collected by both public and commercial satellites, as well as instruments aboard the International Space Station and ground-based networks. Comparing complementary datasets on the dashboard helps reveal a deeper story of how society and the environment have changed due to COVID-related shutdowns. Commercial imagery was ingested into the dashboard for major cities like San Francisco to monitor changes in surface transportation and air travel.

**Commercial Remote Sensing Data Enables Climate Action and Better Decisions**
Planet's daily global imagery, along with data from other commercial providers, enable scientists, governments, corporations, and more, to formulate effective data-based solutions to monitor, measure, and anticipate the effects of climate change. These datasets complement government-operated space and ground-based sensors, and dramatically improve the spatial, temporal, and spectral resolution available to government scientists and decision makers. From monitoring real-time changes in wildfire spread in California, to recording daily changes in Arctic ice, to better understanding crop production and food security around the world, Planet and commercial imagery is empowering governments, companies, and individuals with the daily data they need to address the challenges of climate change.

To demonstrate the diversity of use-cases for this commercial data, below are a few programs that highlight work that is being done in the Earth Science and climate fields with private companies, universities, non-governmental organizations (NGOs), and international government partnerships.
- Education and Research - Planet has provided access to more than 10,000 students and researchers at more than 1,000 universities throughout the world, and empowered more than 50 universities with increased access that has fostered classroom education and research programs.
- California Forest Observatory is a data-driven forest monitoring system that leverages Planet satellite data and artificial intelligence to map drivers of wildfire behavior across California – including vegetation fuels, weather, topography, and infrastructure.
- Cloud to Street combine's Planet's high-resolution Basemaps and building analytics with flood risk models to inform development planning and preparedness in communities.
- In response to hurricane's Michael and Florence, FEMA used Planet's imagery for situational assessment of impacts upon citizens, communities and infrastructure. Planet's extensive archive was used for preliminary assessment and Planet's daily monitoring provided images on the first clear days and was used to cue higher resolution assets.
- Norway's International Climate and Forests Initiative (NICFI), a pioneering program to stop global deforestation, procured Planet data across 64 tropical countries to support the prevention of deforestation and help save the world's tropical forests, providing that data to the UN Food and Agriculture Organization (FAO), the 64 nations Ministries of Forestry, researchers and NGOs, and some of the data is made universally open as a digital public good.

- <u>Allen Coral Atlas</u> leverages Planet data to map the entirety of the world's shallow-water coral reefs in unprecedented detail, and monitor them for change. The program combines machine learning, field data, and Planet satellite imagery to generate habitat maps that are made publicly available to scientists, academics, policymakers, and protected area managers to more effectively target conservation and restoration interventions.
- Tropical forests absorb and store carbon dioxide from the atmosphere and are one of our best defenses against the threat of climate change. Researchers from Arizona State University used machine learning to combine airborne LiDAR data with Planet's high-spatial and temporal resolution satellite imagery to comprehensively measure <u>above ground carbon stocks and emissions of every hectare in Peru</u>. This technique can be expanded to all tropical forests and can play an important role in setting precedent for sustainable management of these vital ecosystems and can serve as a transformative tool to quantify the climate change mitigation benefits they provide.
- <u>Carbon Tracker</u> uses Planet data to track greenhouse gas emissions with unprecedented detail and speed.  Such capabilities can be used to verify progress toward climate commitments such as global coal power plant decommissioning.
- <u>Carbon Mapper</u>, a new nonprofit organization, and its partners (Planet, the State of California, NASA's Jet Propulsion Laboratory, the University of Arizona, Arizona State University, High Tide Foundation and RMI) announced recently a pioneering program to help improve understanding of and accelerate reductions in global methane and carbon dioxide emissions.  The consortium will deploy a ground-breaking hyperspectral satellite constellation with the ability to pinpoint, quantify and track methane and carbon dioxide emissions with the first satellites launching in 2023.
- <u>Commercial agricultural</u> customers use Planet imagery in their farm management platforms allowing farmers to make more informed decisions around ideal investments in seed and crop protection products and when to plant and harvest.  Satellite imagery provides the almost daily coverage necessary to conduct crop yield analysis, land use change and monitor additional impacts to farms.
- Researchers at DOE's <u>Lawrence Berkeley National Lab</u> leverage Planet's daily monitoring to produce statistically reliable indicators including: earlier detection of crop health including disease detection, crop discrimination, drought tolerance, nitrogen efficiency, better data on infection from disease, responses to drought and heat, grain yield and quality, and automated measurements like phenotyping to save costs and time for farmers.
- The <u>United States Forest Service</u> and forest managers internationally use Planet data to monitor and forecast bark beetle disease spread.  The daily imagery is used to determine the latest dead forest stand to make derivative products available to the public to enable prompt removal of dead and infected trees to mitigate spread.
- <u>San Francisco International Airport</u> (SFO) - Airports undergo major infrastructure upgrades and maintenance and require high frequency and high resolution imagery that is cost effective to monitor these developments.  SFO uses Planet's biweekly Basemaps to perform more efficient reviews of airport plan updates in collaboration with the FAA around airport planning, design, operations and maintenance decisions.
- <u>State of New Mexico Land Office</u> - The Land Office leases 9 million acres of surface land across the state. Entities can be difficult to regulate, especially given that they operate in highly remote areas and/or are undeterred by fines. Lack of visibility into these areas prohibits the Land Office from uncovering infractions, recovering fines, and bringing people into compliance.  The Land Office uses Planet imagery to monitor leased and to-be leased land in the state. Planet imagery helps ensure that their lessee and other related parties are compliant with permits and guidelines.
- <u>San Luis Obispo County, CA</u> - Planet imagery is used to monitor the county for building code and water usage infractions. The county is now proactively searching for violation and seeking

compliance at a much greater rate than previously - when suspected infractions needed to be actively reported by citizens or discovered by inspections.

**Opportunities/Recommendations**

NASA is leading the way among civil agencies to realize the value of commercial remote sensing data to help them achieve their scientific and climate goals.  Credit goes to leadership at NASA's Science Mission Directorate, the Earth Science Division, and the Office of Management and Budget for leaning forward to leverage this new capability.  But challenges remain and opportunities exist for better utilization of the commercial capabilities and to stimulate additional industrial investments to serve growing science and climate needs.  To that end, here are a few opportunities to expand upon NASA's successes and embrace the advantages of the commercial remote sensing ecosystem:

1. **Commercial Capabilities as an Enhancement to NASA Earth Science Missions**
   Consistent with the 2017-2027 Decadal Survey for Earth Science and Applications from Space[3], NASA is encouraged to seek commercial or international partnership opportunities with the goal of reducing implementation costs and enabling overlapping mission capabilities.  NASA Earth Science and climate missions should consider commercial remote sensing capabilities during the initial architecture designs and systems should be designed to focus on interoperability between commercial, international, and national programs.  This is a change in paradigm of how commercial capabilities are often considered by Earth Science missions.  Instead of thinking of commercial companies as a supplement that can be added on to missions as a bonus, NASA would benefit from first asking "what can I acquire from commercial companies today to meet my mission needs" with a risk adjusted forecast of viable commercial services and then develop the NASA run missions around the cutting edge capabilities that currently are not likely to be available commercially, or do not have a robust commercial market.  Thinking about missions in this way will enable NASA to focus on the cutting edge capabilities, it will reduce mission development and operation costs (allowing NASA to invest in more high priority missions); it will prevent NASA from developing duplicative capabilities as the commercial sector; and it will support a domestic industry (instead of compete with it).  Commercial companies design and develop their next generation capabilities based on the market signals sent by customers.  NASA can send strong signals into the market and shape a commercial industry where commercial constellations are designed in tandem with NASA missions with interoperability built in from the beginning.

2. **Landsat Next Leveraging Commercial Capabilities**
   Commercial companies have created datasets that are complementary to the Landsat and Sentinel-2 constellations, providing increased temporal and spatial resolution to users of the public datasets.  Planet's SuperDove bands are specifically designed to be interoperable with public Earth Observation datasets.  This alignment allows for the fusion of higher spatial resolution and improved temporal resolution from Planet imagery with exquisite instrumentation calibration provided by Landsat and Sentinel.  Many studies today utilize Planet's high spatial and temporal resolution – augmented by the capabilities of Landsat and/or Sentinel-2 – to capture dynamic processes that would be impossible to observe with any one sensor in isolation. With today's focus on sustainability and an increased maturity of Earth Observation applications powered by cloud-native geospatial protocols and machine learning technologies, demand for higher spatial and temporal resolution has widely emerged allowing for users to monitor for change and make data-driven decisions.  By combining these commercial and national datasets together, scientists and agency users are able to dramatically improve the sensitivity and

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[3] https://www.nap.edu/catalog/24938/thriving-on-our-changing-planet-a-decadal-strategy-for-earth

robustness of their monitoring of Earth with a monitoring service at the temporal rate of human activities.

Across the public and commercial remote sensing sectors, there is increasing investment in data fusion to improve interoperability and agency response. These initiatives include the Harmonized Landsat-Sentinel effort, ESA's 'Sen2Like', and Planet's own Fusion product development. Planet is supporting cross-agency efforts toward data fusion that ensure that decision makers and scientists are able to access fully resolved datasets that exceed the performance of any one sensor in isolation. Planet's dense time series data has proven indispensable in these efforts.

Unfortunately, the commercial community is receiving mixed messages from the Landsat Next program at NASA and USGS. Recently, material and unexplained changes and inconsistencies between the Landsat Next Instrument Study Presolicitation published on February 18, 2021 and the Landsat Next RFI published on October 13, 2020 suggest that rather than looking for novel new approaches to meet and exceed the Landsat mission requirements, the NASA Landsat Next team has predetermined the constellation and instrument structure for Landsat Next. In the most recent instrument study, NASA included requirements that respondents to the study assume prescribed and specific orbital altitude and minimum swath width that favor a more traditional and expensive architecture toward large satellite designs. Such prescriptive requirements (particularly in an early study) will limit innovation in the Landsat Next architecture, constrain what NASA may learn from the Instrument Study, and may ultimately restrict the Landsat Next mission to coarser spatial resolution and lower revisit rate. These outcomes are likely to negatively impact the Landsat user community and result in an inefficient use of U.S. taxpayer resources. The effect of such requirements during an instrument study could be to limit the possible responses/offerors and predetermine the instruments and architecture for the Landsat Next system.

Commercial companies do not replace national systems - they complement, improve, and enable National systems to more affordably push the scientific frontiers. Like other Earth Science missions, Landsat Next should be open and receptive to commercial capabilities and consider how novel solutions can be leveraged by Landsat Next to help meet and exceed the science mission objectives for Landsat.

3. **Support NASA's Commercial Smallsat Data Acquisition Program**
   Through direction and support of leadership at NASA's Science Mission Directorate and the Earth Science Division, the CSDA Program currently provides all NASA-funded researchers with access to commercial remote sensing data including Planet's daily, global imagery. This NASA program is actively moving to include more commercial datasets that are relevant for NASA researchers as well as expand the potential science user community. This program is a model program that other civil agencies can follow to integrate commercial data into their existing pipelines and use-cases. Despite these successes and the demonstrated desire by NASA to grow the program both in terms of user community and in terms of onramping new commercial providers, the program does not exist in statute and its funding has been flat since the initial pilot in FY2018. Congress can show support to this program and similar endeavors to leverage commercial data by putting the CSDA Program into statute in the next NASA Authorization Bill and by robustly funding the program to reflect the growth and value it is demonstrating.

4. **Whole-of-Civil-Government Approach to Commercial Databuys**
   There is an opportunity to empower federal civilian agencies, scientists, and climate action decision-makers with access to daily global commercial imagery, of the entire United States and global land mass – an unprecedented new capability enabled by U.S. commercial services leveraging small satellites – to advance America's climate, infrastructure, environmental justice,

commercial, and global innovation competitiveness priorities. Through a whole-of-civil-government approach, Congress and the Administration can facilitate federal agencies to fully leverage the unique capabilities of U.S. commercial space-based observatories in tandem with existing national remote sensing programs. These combined data products create unprecedented and globally unparalleled services that can be an enabling tool that fasttracks efforts to confront the impact of environment and climate change, facilitate transparency and global understanding, and further accelerate America's leadership in deploying domestic innovation and technology to solve global issues. Congress and the Administration can accelerate adoption of these imagery and analytics sources by embracing a whole-of-civil-government approach to making scientifically accurate and factual earth observation data available to all federal civilian agencies, scientists, and climate action decision-makers. These efforts to purchase commercial data for both scientific and operational uses across all civilian agencies could be led by NASA in partnership with NOAA and USGS.

5. **Regulations and Demand Signals to Enable International Competition**
   Recent years have seen an increased investment by international companies and nations in the fields of remote sensing and geospatial analytics. This increased international interest is motivated both by scientific and climate priorities as well as by national security and power projection aspirations. These, often government backed, entities are competing with U.S. companies in the growing international commercial market for geospatial imagery and analytics. In order to support U.S. enterprise and maintain our leadership position in this technology field, we need regulatory policies that enable U.S. companies to compete internationally and we need U.S. federal agencies to directly support national capabilities by prioritizing commercial databuys and programs that leverage commercial services. NASA should work with relevant partner agencies (including NOAA, USGS, FAA, FCC, and State Department) to ensure that regulatory policies not only foster a safe environment for space operations, but also support American enterprise. Remote sensing regulations, launch payload regulations, orbital debris regulations, and spectrum regulations all play a critical role in allowing U.S. companies to successfully compete internationally. Similarly, the demand signals sent by federal agencies prioritizing leveraging commercial capabilities (rather than developing competing national systems) greatly impacts the health of the broader U.S. commercial remote sensing market.

**Summary**

Space-based remote sensing by national missions led by NASA's Earth Science Division and by commercial constellations (such as Planet's) play a key role in providing the data needed to understand our changing world and empower better decisions. U.S. entrepreneurs have built upon the legacy of NASA Earth Science missions and pioneered novel commercial remote sensing capabilities that complement national assets and today play a key role in measuring and monitoring changes to our planet. The commercial remote sensing community is vibrant and provides data and analytics tools used by scientists, researchers, companies, communities, federal agencies, climate action decision-makers, and individuals to make better data-based decisions.

NASA's Science Mission Directorate is a leader among civilian federal agencies at leveraging these commercial capabilities and purchasing data for their scientific user community. Moving forward, NASA and the federal government should prioritize leveraging commercial remote sensing capabilities as it designs the next generation of national remote sensing assets. An investment in making commercial data available across federal civilian agencies, scientists, and climate action decision-makers will take advantage of space-based remote sensing innovation founded and built in the U.S. and advance the Nation's climate priorities.