Space's Critical Role in Understanding our Planet

"The vantage point of space enables us to see the extent to which Earth's ever-changing processes influence our lives."
– National Academies' Decadal Strategy for Earth Observations, 2017

The Unique Vantage Point of Space

Our current understanding of the Earth's climate and the interconnected system behind it would not be possible without space-based observations. We have been monitoring the Earth from space since the beginning of the space age. Today, Earth observational satellites make up for 890 of the 3,372 operational satellites in space with over 2,500 more expected within the next decade.[i] From the vantage point of space, these satellites allow us to study Earth as a holistic system, as well as to provide a historical record of environmental change going back over 60 years.

Multiple U.S. government agencies, in collaboration with the aerospace industry and international partners, are responsible for our space-based Earth observation systems.

- **The U.S. Geological Survey's** Landsat system, a partnership with NASA, has been operational since 1972, taking 115-mile swath observations of every point on Earth every 16 days. This imaging archive is a critical tool for climate scientists and decision-makers, with almost 25 million downloads of Landsat image data used since 2011 alone. A USGS study estimated that Landsat imagery provided users an annual benefit of $2.19 billion in 2011, with U.S. users accounting for $1.79 billion of those benefits.[ii]
- **NOAA**'s operational environmental satellites generate the data sets that drive the Nation's weather prediction systems, providing key environmental intelligence to protect life and property and to contribute to our economy and security. NOAA provides a critical link between satellite operations, data collection, data processing and data analysis to climate science by generating products that support everyday decision by individuals and decision-makers across the Nation. NOAA satellites are designed and developed to collect the most impactful ocean, land, and atmosphere measurements that are shared across the U.S. government, including with NESDIS, NCEI, DOD and 16 Cooperative Institutes consisting of 43 universities and research institutions in 20 states, the District of Columbia, Puerto Rico, and the US Virgin Islands.
- **NASA** has 36 active Earth Science missions collecting atmospheric data and remotely sensing the Earth to help scientists understand the key features and relationships of Earth's systems. The International Space Station also serves as an Earth observing platform, hosting instruments that have tracked climate behavior for over 20 years.
- **Private companies** also capture images and data of the planet and atmosphere, and work with the U.S. government to enhance the Earth observation record.

Space-Based Observations Benefit Life on Earth

Data collected through space operations ranges from atmospheric temperature measurements, water and air quality estimates, and Earth images. These data help us to understand the changes to Earth's climate and to predict and prepare for better climate responsiveness in the future.

"The space-based vantage point also ensures that we can observe processes occurring over a wide range of time scales, from the abrupt (such as earthquakes) to the decadal (such as growth and shrinkage of the world's great ice sheets), and at all time scales in between."

– National Academies' Decadal Strategy for Earth Observations, 2017

- **Agricultural Impacts** – Space data from atmospheric measurements helps farmers and decision-makers prepare for potential agricultural changes. Weather predictions, water quantity and air quality, and geographical threats such as wildfires or drought can drastically influence crops, and therefore long-term food stability. Space data collected about these threats can be used to better prepare for such challenges and protect agricultural communities and global populations. NOAA collaborates with the U.S. Department of Agriculture to manage the Joint Agricultural Weather Facility and publish the Weekly Weather and Crop Bulletin. The bulletin includes data from NOAA's GOES and JPSS satellites, allowing farmers and livestock producers easy access to agricultural weather forecasts.

- **Sea Level Rise** - Satellite data provides scientists, coastal communities, and decision-makers with critical insights on rising water levels due to ice sheet melts – enabling them to predict the changes in water levels and the threats to affected communities, ecosystems, and coastlines. NASA's GRACE and ICESat missions reported data showing rapid and unexpected changes to Earth's large ice sheets, and the Jason missions 1, 2, and 3 recorded the rising sea level. These data from these different missions informed the Intergovernmental Panel on Climate Change in 2007 and will continue to predict ice and sea changes in the future.

- **Wildfires** – Observing and documenting the Earth's fluctuating temperatures allows scientists to predict and model the threat of wildfires in the dry seasons. NOAA satellites GOES-16 (GOES East), GOES-17 (GOES West), NPP VIIRS, and the MODIS instrument onboard NASA's Terra and Aqua satellites are monitoring wildfires in near real-time. As of June 17, 2021, satellite imaging is tracking 33 large active fires that are covering over 440,000 acres of the United States. Satellite imaging also allows first responders to visually process the scope of an ongoing fire and to organize their responses more effectively. The GOES satellites use an Advanced Baseline Imager (ABI) with an increased resolution and coverage. This gives fire responders enhanced imaging to deploy fire retardant when smoke plumes severely limit visibility. Additionally, multi-satellite data integration from VIIRS, MODIS, GOES, Landsat and other satellites provides fire and land managers with actionable information for pre- and post-wildfire management and resilience planning.

Methane – The recently released Intergovernmental Panel on Climate Change (IPCC) report stressed the importance of methane action in helping us achieve the global climate goals. The 2021 United Nations Climate Change Conference (COP26) saw nearly 90 countries join a U.S and E.U-led pledge to cut methane emission levels by 30% by 2030. Numerous airborne and space-based instruments have been developed to support methane emissions monitoring needs, and these instruments will be key enablers to meet the pledge. MethaneSAT, LLC is a team of aerospace organizations from both the commercial and public sectors that is currently developing a satellite system to measure and track methane emissions across the globe, with unmatched accuracy and precision. When launched in late 2022, MethaneSAT will be the world's first satellite fielded by a NGO, offering its data free to everyone. Similarly, scientists from NASA's Jet Propulsion Laboratory are modifying airborne sensors for precise detection of methane emissions from space. This technology is being adapted for a future spacecraft mission, Carbon Mapper, in partnership with the State of California and private industry and supported by philanthropic funds.

- **Air Quality** – In southeast Michigan and along the southern border of Ontario, where the surface ozone level is higher than the U.S. federal standard, NASA is contributing data to a joint research project to study the air quality. Using a Gulfstream III aircraft, NASA will fly a Geostationary Coastal and Air Pollution Events (GEO-CAPE) Airborne Simulator (GSAS) to measure emission hotspots. These flights will serve as a test for NASA's future Tropospheric Emissions: Monitoring of Pollution (TEMPO) mission which will take hourly measurements of air pollution over North America and identify socioeconomic disparities in air quality around metropolitan areas.[iii]

- **Space Weather** – There is weather in space that impacts life on Earth and our space activities. Both space and Earth weather are heavily influenced by the Sun, and solar irradiance is an important area of study for environmental science missions. Solar storms caused by solar flares and coronal mass ejections can cause electrical disruptions to satellites, impacting infrastructure on Earth such as communications networks and power grids. Solar storms and irradiance have been studied by NOAA's Space Weather Prediction Center to understand how they can weaken Earth's atmosphere, possibly impacting temperature and climate instability. For example, NOAA's DSCOVR satellite provides data used to generate space weather predictions such as geomagnetic storms or solar variations that can influence terrestrial weather. NASA's Solar and Heliophysics Observatory also monitors the sun closely for any coronal activity that could pose a threat to satellites, communications, or the atmosphere.

Enhancing Our Understanding

Our space-based Earth observation tools require regular replenishment and refinement to enhance our ability to understand climate change and its impacts. New technologies allow us to take additional measurements that expand our understanding of climate change and allow for

more robust resilience planning and response. Our space-Earth Science systems would be enhanced by:

- Fully funding **NASA's FY23 Earth Science** budget, including Earth Science Research and Analysis, Earth Science Decadal Survey missions (including Earth Venture Class programs), Earth System Science Pathfinder Missions, and Earth Explorer missions.
- Fully funding NASA's FY23 Heliophysics budget, including Heliophysics Explorer missions, Solar Terrestrial Probes, and the Geospace Dynamics Constellation (GDC).
- Funding **NOAA's FY23 weather satellite programs,** including developing the next generation weather forecasting systems and supporting climate research. AIA supports increasing the NOAA satellite systems funding by $500 million to $2 billion, as well as directing NOAA to release a five-year budget plan to execute the NOAA Satellite Observing System Architecture (NSOSA).
- Funding aging ground-based and space-based infrastructure that is overstressed to accommodate the growing space sector.

The Aerospace Industries Association (AIA) represents over 300 companies across the aerospace and defense supply chain, from small business component manufacturers to large system integrators, and from publicly traded, to privately held, to venture funded entities. Our member companies design, manufacture, operate, and launch space vehicles across the commercial, civil, and national security space sectors with missions spanning from low Earth orbit to cislunar space and beyond. Contact Mike French mike.french@aia-aerospace.org to learn more about our work.

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[i] Aerospace
[ii] https://pubs.er.usgs.gov/publication/ofr20191112
[iii] https://www.nasa.gov/feature/langley/nasa-maps-air-quality-in-ozone-hot-spot