NASA SBIR 2019 Phase I Solicitation

S5.02 Commercial Geospatial Analysis Platforms for Earth Science Applications

Lead Center: JPL

Participating Center(s): JPL, MSFC

Technology Area: TA11 Modeling, Simulation, Information Technology and Processing

The mission of the NASA Applied Sciences Program within the Earth Science Division is to transfer the results of earth science research for use by commercial firms, other government agencies, and non-profit organizations as part of decision support systems. As a research organization, NASA works via collaboration with the private sector understand and deliver earth science application tools and data sets in formats useful to end users.

NASA Earth Science Division and the NASA Applied Science Program within the Science Mission Directorate (SMD) are continually looking to increase utilization and extend the benefit of NASA Earth Science data and research. Relevant goals and challenges include:

- Increasing the utilization of NASA Earth Science data in organizationsâ€™ policy, business, and management decisions through the commercialization and operationalization of applied research and information products;
- Accelerating the transfer of NASA Earth Science data and science data systems into the cloud, enabling the re-formatting and reprocessing required for more geospatial analysis organizations, particularly commercial companies, to use and apply NASA data more easily;
- Accelerating NASA's leveraging of driving commercial technologies (e.g., cloud-enabled global-scale analyses, modern data science tools, advanced algorithms and visualization) to increase the utilization of NASA tools and services for a broad suite of non-research users;
- Accelerating NASA's utilization of open-source tools and NASA software tools hosted within open source communities;
- Enabling focused commercial activities on specific challenging NASA problems related to future SMD missions, such as extracting insights from the hyperspectral data cube or resolving characteristics of features using multi-modalities of data from multiple sources (e.g., fusing radar, radiometer, and GNSS-derived data) to both support future missions (e.g., hyperspectral) and ongoing missions;
- Aligning NASA SBIR investments more closely with DoD and Intelligence Community-funded programs such as the NGA Commercial GEOINTActivity (CGA) and DARPA STO's Geospatial Cloud Analytics (GCA) program, as well as help accelerate NASA's own EOSDIS Cloud Evolution.

The NASA Earth (http://science.nasa.gov/earth-science/) and Applied Science (http://appliedsciences.nasa.gov/) programs seeks to increase the utilization and extend the benefit of Earth Science data and research to better meet societal needs. The objective of this subtopic is to provide commercial geospatial analytics firms with improved access to and translation of NASA data and applied research to support advancement of commercial geospatial analytics capabilities, specifically applied to hyperspectral measurements.

Hyperspectral measurements have been demonstrated by NASA through the Hyperion instrument on EO-1 as well as other developments like the Hyperspectral Thermal Emission Spectrometer (HyTES) and the Airborne Visible / Infrared Imaging Spectrometer (AVIRIS) to have significant value to both Decadal-class science requirements such as surface biology and geology (SBG) as well as non-NASA applications including, disaster response, agricultural and food security, water resource management, ecological forecasting, land surface modeling, air quality and health. Hyperspectral imagery in the visible and shortwave infrared, multi- or thermal IR is identified as a designated observable in the latest Earth Science Decadal Survey demonstrating a long-term need by NASA for geospatial analysis platforms specifically able to address the hyperspectral data cube problem to accelerate access and use.

Hyperspectral image processing is a challenging problem due to the several hundred continuous spectral channels produced for a given multi-spatial dimensional scene, particularly for global-scale, low latency processing of continuously imaging missions. Maintaining research-grade science data systems to perform orthorectification and radiometric calibration for a single sensor is challenging and will become more so as the number and diversity of hyperspectral measurements from air and space grows. Providing the resultsÂ in formats and at locations, in particular in commercial cloud environments, that lower the barriers to utilization by various communities including commercial companies, but with proper provisions for access to other communities in compliance with NASA's open data standards will become increasingly important. Innovative methods to process the data at low-cost and at high sampling rate are currently in development across industry and academia, as well as within NASA. Following these data processing steps, the ability to extract insights without humans in the loop presents another "big data" problem. Likewise, innovative methods to extract insights from hyperspectral data at low cost and at high sampling rates are currently in development across industry and academia using traditional image processing techniques as well as machine learning and other modern methods

This subtopic seeks proposals to develop data science tools that efficiently process NASA hyperspectral data, provision the data broadly to the commercial and applied research community, particularly in commercial cloud environments, and autonomously extract new insights aimed at driving information product development for the commercial sector and supporting increased utilization of NASA data by non-NASA users. Licensing of NASA-developed tools such as the Hyperspectral Image Interpretation and Holistic Analysis Tools (HiiHAT) (https://hyperspectral.jpl.nasa.gov/) is encouraged and is available open source (https://sourceforge.net/projects/hiihat). Note that licensing of NASA Caltech/JPL software for government use under an SBIR subcontract, typically at no cost, can be an effective approach to evaluating new intellectual property before committing to commercial licensing. Transfer and reformatting of applicable NASA hyperspectral data such as from the Hyperion instrument flown on the EO-1 mission (https://earthexplorer.usgs.gov/) and the ongoing Airborne Visible / Infrared Imaging Spectrometer (AVIRIS) (https://aviris.jpl.nasa.gov/alt_locator/) mission into commercial cloud environments to enable low-cost, high rate processing at global scales is highly encouraged.

Leveraging of existing NASA Earth Science data tools and service are encouraged. Key components include:

- Common Metadata Repository (CMR), a spatial and temporal metadata registry and order broker for all NASA Earth science data (https://cmr.earthdata.nasa.gov/search/);
- Earthdata Search Client (ESDC) (https://search.earthdata.nasa.gov/search), a search tool for CMR and other repositories;
- Global Imagery Browse Services (GIBS) image repository (https://earthdata.nasa.gov/gibs).

Use of open source tools and developments within open source communities is highly encouraged. A sample of NASA open source resources include:

- Apache Science Data Analytics Platform (sdap.apache.org) â€“ A suite of GIS-based data analytics services integrated as a platform for the cloud;
- Open Climate Workbench (climate.apache.org) â€“ used for climate model evaluation;
- Apache OODT (oodt.apache.org) â€“ framework for science data processing and management systems;
- NASA GIBS (github.com/nasa-gibs) â€“ the core for NASA's Global Image Browse Services (GIBS) and many NASA's current browser-based GIS solutions, including the PO.DAAC SOTO and Mars Trek, Moon Trek, Water Trek, Vesta Trek, etc.;

- HySDS (github.com/hysds/hysds) â€“ Hybrid cloud-based data processing framework;
- Pomegranate (pomegranate.jpl.nasa.gov) â€“ webservice for data access and geospatial subsetting;
- NASA Common Mapping Client (https://github.com/nasa/common-mapping-client) â€“ browser-based GIS visualization framework.

To promote interoperability and the use of NASA data services, the proposals should consider metadata and service interface standards that are already part of the NASA data infrastructure, including standards such as Open Search,

ISO-19115-2, FGDC, and Open Geospatial Consortium (OGC).

Use of commercial cloud environments is encouraged. NASA and other government agencies are increasingly leveraging commercial cloud vendors for secure, maintainable, cost-effective, and versatile computing infrastructure. Proposals should consider developing cloud-agnostic architecture to take advantage of commercially-provisioned solutions (e.g., serverless solutions, analytic and machine learning services, GPUs, etc.). Proposals that employ robust automated testing infrastructure and continuous integration tools to ensure maintainable, modern software through development cycles are encouraged.

Proposers must describe their commercial information product end use to demonstrate commercial potential and feasibility. Work under this subtopic should be performed consistent with NASA's NASA Earth Science Data Policy (https://science.nasa.gov/earth-science/earth-science-data/data-information-policy/).

Desired deliverables would be to describeÂ the deployment of:

- NASA data in the cloud.
- Contractor-developed software and tools in the cloud; potentially.
- Case studies of application of tools to commercial space information products/insight generation; and potentially.
- Description of process and lessons learned during the development.

Expected TRL for this project is 3 to 6.

Subset of missions that would benefit from this subtopic:

- The Hyperion instrument flown on the EO-1 mission;
- The Hyperspectral Thermal Emission Spectrometer (HyTES) mission;
- The Airborne Visible / Infrared Imaging Spectrometer (AVIRIS) mission;
- The selected Mapping Imaging Spectrometer for Europa (MISE) planned for the Europa Clipper mission;
- The planned Hyperspectral Infrared Imager (HyspIRI) mission, a potential realization of the decadal-class science measurement need.

This subtopic was developed in collaboration between the Applied Science System Engineering group and the Computer Science For Data Intensive Applications group, both within the Instrument Software and Science Data Systems section at JPL and represent the two key groups behind the strategy to engage in a more focused way with innovative small businesses to advanced Earth science data science and applications objectives.

References:

- SMD Earth Science http://science.nasa.gov/earth-science/
- SMD Applied Sciences http://appliedsciences.nasa.gov/
- NASA Earth Data Portal https://earthdata.nasa.gov/
- AVIRIS Mission https://aviris.jpl.nasa.gov/
- AVIRIS Data Portal https://aviris.jpl.nasa.gov/alt_locator/
- EO1 Extended Mission and Data Portal https://eo1.usgs.gov/
- Europa Clipper Mission https://www.jpl.nasa.gov/missions/europa-clipper/

- HyspIRI Mission https://hyspiri.jpl.nasa.gov/
- Hyperspectral Thermal Emission Spectrometer (HyTES) https://hytes.jpl.nasa.gov/
- HiiHAT Hyperspectral Analysis https://hyperspectral.jpl.nasa.gov/ https://sourceforge.net/projects/hiihat.
- USGS Data Portal https://earthexplorer.usgs.gov/
- DAPRA Geospatial Cloud Analytics https://www.darpa.mil/news-events/2017-10-11
- NGA Commercial GEOINT Activity https://www.nga.mil/Partners/Pages/Commercial-GEOINT-Activity.aspx
- JPL Tech Transfer https://ott.jpl.nasa.gov/
- NASA Software Catalog https://software.nasa.gov/
- NASA Earth Science Data Policy https://science.nasa.gov/earth-science/earth-science-data/data-information-policy/
- Apache Science Data Analytics Platform https://sdap.apache.org
- Open Climate Workbench https://climate.apache.org
- NASA Global Imagery Browse Service https://github.com/nasa-gibs
- NASA Common Mapping Client https://github.com/nasa/common-mapping-client
- HySDS https://github.com/hysds/hysds
- Pomegranate https://pomegranate.jpl.nasa.gov