



## NASA SBIR 2019 Phase I Solicitation

### S1.01 Lidar Remote Sensing Technologies

Lead Center: LaRC

Participating Center(s): GSFC, JPL

Technology Area: TA8 Science Instruments, Observatories & Sensor Systems

NASA recognizes the potential of lidar technology in meeting many of its science objectives by providing new capabilities or offering enhancements over current measurements of atmospheric and topographic parameters from ground, airborne, and space-based platforms. To meet NASA's requirements for remote sensing from space, advances are needed in state-of-the-art lidar technology with an emphasis on compactness, efficiency, reliability, lifetime, and high performance. Innovative lidar subsystem and component technologies that directly address the measurement of atmospheric constituents and surface topography of the Earth, Mars, the Moon, and other planetary bodies will be considered under this subtopic. Compact, high-efficiency lidar instruments for deployment on unconventional platforms, such as balloon, small sat, and CubeSat are also considered and encouraged.

Proposals must show relevance to the development of lidar instruments that can be used for NASA science-focused measurements or to support current technology programs. Meeting science needs leads to four primary instrument types:

- *Backscatter* - Measures beam reflection from aerosols to retrieve the opacity of a gas.
- *Ranging* - Measures the return beam's time-of-flight to retrieve distance.
- *Doppler* - Measures wavelength changes in the return beam to retrieve relative velocity.
- *Differential absorption* - Measures attenuation of two different return beams (one centered on a spectral line of interest) to retrieve concentration of a trace gas.

The proposed subtopic addresses many missions programs, and project identified by the Science Mission Directorate including:

- *Aerosols* - missions ongoing and planned include ACE (Aerosols/Clouds/Ecosystems), PACE (Plankton, Aerosol, Cloud, ocean Ecosystems), and MESCAL (Monitoring the Evolving State of Clouds and Aerosols).
- *Greenhouse Gases* - missions planned include sensing of carbon dioxide and methane. The ASCENDS (Active Sensing of CO<sub>2</sub> Emissions over Nights, Days, and Seasons) mission was recommended by the Decadal Survey.
- *Ice Elevation* - missions ongoing and planned include ICESat (Ice, Cloud, and land Elevation Satellite), as well as aircraft-based projects such as IceBridge.
- *Terrestrial Ecosystem Structure* - missions ongoing and planned include GEDI (Global Ecosystems Dynamics Investigation). Ocean sensing applications are also of interest to NASA.
- *Atmospheric Winds* - missions planned include 3D-Winds, as recommended by the Decadal Survey. Lidar wind measurements in the Mars atmosphere are also under study in the MARLI (Mars Lidar for Global

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- Climate Measurements from Orbit) program.
  - *Planetary Topography* - altimetry similar to Earth applications is being planned for planetary bodies such as Titan and Europa.
  - *Automated Landing, Hazard Avoidance, and Docking* - technology development is called for under programs and missions such as ALHAT (Autonomous Landing and Hazard Avoidance Technology), COBALT (COoperative Blending of Autonomous Landing Technologies), and Kodiak.

Phase I research should demonstrate technical feasibility and show a path toward a Phase II prototype unit. Phase II prototypes should be capable of laboratory demonstration and preferably suitable for operation in the field from a ground-based station, an aircraft platform, or any science platform amply defended by the proposer.

The expected Technology Readiness Level (TRL) range at completion of the project is 3-6.

**References:**

- NASA missions are aligned with the National Research Council's decadal surveys, with the latest survey published in 2018 under the title "Thriving on Our Changing Planet: A Decadal Strategy for Earth Observation from Space" (<http://sites.nationalacademies.org/DEPS/esas2017/index.htm>).
- NASA lidar applications and technology needs for Earth Science are also summarized in the report "NASA ESTO Lidar Technologies Investment Strategy: 2016 Decadal Update" (<https://ntrs.nasa.gov/search.jsp?R=20180002566>).
- Conference proceeding on NASA lidar interests in earth science, exploration, and aeronautics can be found at the Technical Interchange Meeting on Active Optical Systems (<https://www.nasa.gov/nesc/tim-active-optical-systems>).