NASA SBIR 2014 Phase I Solicitation

S1.01 Lidar Remote Sensing Technologies

Lead Center: LaRC

Participating Center(s): GSFC, JPL

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, 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 systems 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.

Proposals relevant to the development of lidar instruments that can be used in planned missions or current technology programs are highly encouraged. Examples of planned missions and technology programs are:

- Active Sensing of CO_2 Emissions over Nights, Days, and Seasons (ASCENDS).
- Aerosols-Clouds-Ecosystems (ACE).
- Doppler Wind Lidar (3D-WINDS).
- Laser Interferometer Space Antenna (LISA).
- Ozone Lidar.
- Lidar for Surface Topography (LIST).
- Mars atmospheric sensing, atmospheric entry and descent sensors for Mars and Earth, and tracking large-scale water movement (GRACE-II).

In addition, innovative technologies relevant to the NASA sub-orbital programs, such as Unmanned Aircraft Systems (UAS) and Venture-class focusing on the studies of the Earth climate, carbon cycle, weather, and atmospheric composition, are being sought. Compact, high efficiency lidar instruments for deployment on unconventional platforms, such as balloon, small sat, and cube sat, are also considered and encouraged.

The proposals should target advancement of lidar technologies for eventual space utilization. Phase I research should demonstrate the 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. For the 2014 SBIR Program, we are soliciting the component and subsystem technologies described below.

Solid state, single frequency, pulsed, laser transmitters operating in the 1.0 µm to1.7 µm range with a wall-plug efficiency of greater than 25% suitable for CO_2 measurement, and free-space laser communication applications. The laser transmitters must be capable of generating frequency transform-limited pulses with a quality beam M^2 of less than 1.5 with an approximately 20 W of average power. We are interested in two different regimes of repetition rates: from 5 kHz to 20 kHz, and from 20 Hz to 100 Hz. In addition, development of non-traditional optical amplifier architectures that yield optical efficiency of >70% are of interest.

Compact and rugged single-frequency CW laser systems operating at 1.06 mm, 1.57 mm, 1.651 mm and 2.05 mm wavelengths suitable for precision space interferometry applications such as LISA, GRACE-II, and coherent detection lidars. The lasers must be developed with space environment considerations and demonstrate a clear path to space. Proposed lasers must be able to generate at least 20 mW of power with less than 10 kHz linewidth over a tunable range of about 50 nm. Systems must be highly wavelength stable and come with full supporting electronic systems for thermal and power control.

Long wavelength solid state laser transmitter technology (e 10 µm) is needed for atmospheric lidar and possible terrain altimeter instruments for Venus. The highly dense atmosphere, volatile clouds, and thick scattering layers make this measurement a low probability event, but should be possible with significant pulse energies at long wavelengths. In combination of large, lightweight receiver, we can maximize the possibility of achieving a round trip remote sensing link from low Venus orbit. Minimum pulse energies of e 100 mJ are needed to reach the surface in the best conditions, such as with periodic holes and gaps in the clouds. Repetition rates of e 10Hz are desired for reasonable footprint spacing should a link be achieved.

Ultra-low noise photo receiver modules, operating either at 1.6 or 2.0 micron wavelengths for measuring CO_2 concentration, comprising of the detection device, complete Dewar/cooling systems, and associated amplifiers. General requirements are: large active detection diameter (>200 micron), high quantum efficiency (>85%), noise equivalent power of the order of 10-14 W/sqrt(Hz), and bandwidth greater than 20 MHz.

Lightweight scanning telescopes capable of a conical pattern with nadir angle fixed in the range of 30 to 45 degrees. The lightweight scanning telescopes are sought for both direct and heterodyne detection wind lidars and tropospheric ozone lidars. For winds, the direct detection lidar operates in 355 nm to 1064 nm wavelength region and the heterodyne detection lidar in 1550 nm to 2050 nm. For ozone, these systems should operate between 280-300 nm. The ozone systems are designed to support NASA's TOLNet network providing data for satellite validation and the study of anthropogenic pollution. High optical efficiency and near diffraction-limited performance are among major considerations. The proposer must show a clear path to space by addressing scalability to apertures greater than 1 m, materials (e.g., substrates and coatings) selection compatible with a space environment, and thermally-stable design. Phase II should result in a prototype unit capable of demonstration in a high-altitude aircraft environment, with aperture of at least 10 inches in diameter.