Phase I Project Summary

PSI-6296

Firm: Physical Sciences Inc.
Contract Number: NNX11CG55P
Project Title: Solid State Multiwavelength LIDAR for Volcanic Ash Monitoring

Identification and Significance of Innovation: (Limit 200 words or 2,000 characters whichever is less)

The 2011 eruption of the Eyjafjallajökull volcano in Iceland disrupted air traffic in the North Atlantic and Europe and resulted in an estimated $1.7B economic loss to the airlines. Controversy developed over whether air traffic, grounded for 6 days, could have resumed earlier. On-board sensing capability could allow aircraft, or scout aircraft, to fly in the presence of volcanic ash aerosol below damage threshold limits. This program showed the feasibility of a compact, multiwavelength Lidar with polarization analysis capability that will be able to identify volcanic ash clouds at distance. The system will be developed specifically for airborne deployment, including on Unmanned Aerial Systems. A UAS-equipped with such a Lidar could provide valuable supplementary information to that available from existing and planned satellite assets for defining and tracking volcanic ash plumes. The system footprint is minimized by taking advantage of all solid-state laser transmitters such as emerging rare earth doped fiber amplifiers.

Technical Objectives and Work Plan: (Limit 200 words or 2,000 characters whichever is less)

The technical objectives of the Phase I program were to establish the operating parameters for a multiwavelength backscatter Lidar via modeling and to create a conceptual design for an airborne Lidar payload capable of monitoring volcanic ash clouds to concentrations below the currently accepted damage threshold. The proposed program consisted of four tasks including a kick-off meeting with NASA personnel to identify the appropriate measurement and system requirements as well as the concept of operations for an airborne Lidar for volcanic ash detection, a System Modeling task to model the backscatter coefficient of volcanic ash clouds as a function of wavelength to determine optimal wavelengths for the Lidar transmitters, a Conceptual Prototype System Design task in which we developed a conceptual design for a compact, airborne Multiwavelength Backscatter Lidar and a System Design Review with NASA personnel to review the system design and determine the scope and goals of the Phase II program.

Technical Accomplishments: (Limit 200 words or 2,000 characters whichever is less)

During this successful Phase I program, Physical Sciences Inc. demonstrated the feasibility of the underlying technologies for a compact, rugged, all-solid state lidar for continuous monitoring of hazardous volcanic ash plumes from aircraft. The Phase I program determined the most appropriate wavelengths for use via system modeling and then selected laser transmitter hardware. Additional modeling determined the transmit pulse energy and receive aperture size. A conceptual design for an Airborne Multiwavelength Lidar was developed in two different configurations. It is intended that the Phase II program will design, fabricate and ground test a prototype Lidar system.

NASA Application(s): (Limit 100 words or 1,000 characters whichever is less)

NASA applications of a compact multiwavelength Lidar include monitoring transport of volcanic ash plumes and certain icing conditions for aircraft safety research, and monitoring Asian dust and biomass burning plumes for studies of related to climate change. The multiple wavelengths enable an estimate of the mass loading. The system is sufficiently compact for airborne or ground deployment. All solid state construction minimizes maintenance.

Non-NASA Commercial Application(s): (Limit 200 words or 2,000 characters whichever is less)

Commercial applications of a compact multiwavelength Lidar include monitoring transport of volcanic ash plumes and certain icing conditions for aircraft safety, and monitoring Asian dust and biomass burning plumes for human health. The multiple wavelengths enable an estimate of the mass loading. The system is sufficiently compact for airborne or ground deployment. All solid state construction minimizes maintenance.

Name and Address of Principal Investigator: (Name, Organization, Street, City, State, Zip)

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