NASA SBIR 2020 Phase I Solicitation

S1.08 Suborbital Instruments and Sensor Systems for Earth Science Measurements

Lead Center: LaRC

Participating Center(s): ARC, GSFC, JPL

Technology Area: TA8 Science Instruments, Observatories & Sensor Systems

Scope Description

NASA seeks measurement capabilities that support current satellite and model validation, advancement of surface-based remote sensing networks, and targeted Airborne Science Program and ship-based field campaign activities as discussed in the Research Opportunities in Space and Earth Science (ROSES) solicitation. Data from such sensors also inform process studies to improve our scientific understanding of the Earth System. In-situ sensor systems (airborne, land, and water-based) can comprise stand-alone instrument and data packages; instrument systems configured for integration on ship-based (or alternate surface-based platform) and in-water deployments, NASA's Airborne Science aircraft fleet or commercial providers, Unmanned Aircraft Systems (UAS), or balloons, ground networks; or end-to-end solutions providing needed data products from mated sensor and airborne/surface/subsurface platforms. An important goal is to create sustainable measurement capabilities to support NASA's Earth science objectives, with infusion of new technologies and systems into current/future NASA research programs. Instrument prototypes as a deliverable in Phase II proposals and/or field demonstrations are highly encouraged.

Complete instrument systems are generally desired, including features such as remote/unattended operation and data acquisition, and minimum size, weight, and power consumption. All proposals must summarize the current state of the art and demonstrate how the proposed sensor or sensor system represents a significant improvement over the current state of the art.

Specific desired sensors or mated platform/sensors include:

- A hyperspectral radiometry system with polarization capability covering the UV-Vis-NIR wavelength range (350-865 with a minimum resolution of 5 nm; 2.5-nm desired). The instrument shall measure hyperspectral above water upwelling radiance, sky radiance, downwelling irradiance and polarization state of the atmosphere and ocean, and be capable of autonomously positioning itself with respect to the sun for optimized measurement geometry.
- An in situ hyperspectral ocean water absorption instrument (ocean submersible to 300 m) covering the UV-Vis wavelength range (resolution of ?2nm for 350-750 nm and ?5nm for 300-350nm) with an accuracy better than 0.005 m^{-1} or 5% of the signal and precision better than 0.001 m^{-1}. Instrument design must mitigate/correct for the confounding effects of scattering and fluorescence.
- In-situ measurements of ocean particulate backscatter, depolarization, beam attenuation, and diffuse attenuation coefficients relevant for combined ocean-atmosphere lidar remote sensing (355, 473, 486, 532, 1064 nm wavelengths and 170-180° scattering angle with ?1 degree angular resolution).

- In situ polarized hyperspectral UV-Vis volume scattering function (VSF) instrument (ocean submersible to 300 m) covering the angular range close to 0 degrees and, more importantly so, as far as 180 degrees (with ?2 degree angular resolution). Instrument should have ability to measure (at least) horizontal and vertical aspects of linear polarization. Degree of resolution in angles and wavelength can be decreased for instrument portability and robustness (such as for autonomous underwater vehicle (AUV) deployments).
- Portable hyperspectral UV-Vis-NIR radiometric calibration system with a stabilized optical light source for verification of field radiometer stability by traceable NIST standards with variable flux levels. System must include thermal stabilization for the instrument to be independent of ambient temperature for evaluation of radiometric stability as function of time.
- Innovative, high-value sensors directly targeting a stated NASA need (including aerosols and trace gases) may also be considered. Proposals must identify a specific, relevant NASA subject matter expert.

Expected TRL or TRL range at completion of the project is: 4 to 7

Desired Deliverables of Phase II: Prototype, Hardware, and/or Software

Desired Deliverables Description: The ideal Phase II effort would build, characterize, and deliver a prototype instrument to NASA including necessary hardware and operating software. The prototype would be fully-functional, but the packaging may be more utilitarian (i.e., less polished) than a commercial model.

State of the Art and Critical Gaps

The S1.08 subtopic is and remains highly relevant to NASA Science Mission Directorate (SMD) and Earth Science research programs, in particular the Earth Science Atmospheric Composition, Climate Variability & Change, and Carbon Cycle and Ecosystems focus areas. In situ and ground-based sensors inform NASA ship and airborne science campaigns led by these programs and provide important validation of the current and next-generation of satellite-based sensors (e.g., PACE, OCO-2, TEMPO, SGB, and A-CCP – see links in references). The solicited measurements will be highly relevant to current and future NASA campaigns with objectives and observing strategies similar to past campaigns, e.g., NAAMES, EXPORTS, CAMP2EX, FIREX-AQ, KORUS-AQ, DISCOVER-AQ (see links in references).

References:

Relevant current and past satellite missions and field campaigns include:

PACE Satellite Mission, scheduled to launch in 2022 that focuses on observations of ocean biology, aerosols, and clouds (https://pace.gsfc.nasa.gov/)

Decadal Survey Recommended ACCP Mission focusing on aerosols, clouds, convection, and precipitation/Aerosols and Clouds, Convection and Precipitation (ACCP) (combined) (https://science.nasa.gov/earth-science/decadal-surveys)

Decadal Survey Recommended SGB Mission focusing on surface biology and geology/ Surface Biology and Geology (https://science.nasa.gov/earth-science/decadal-surveys)

OCO-2 Satellite Mission that targets spaceborne observations of carbon dioxide and the Earth's carbon cycle (https://www.nasa.gov/mission_pages/oco2/index.html)

TEMPO Satellite Mission focusing on geostationary observations of air quality over North America (http://tempo.si.edu/overview.html)

NAAMES Earth Venture Suborbital field campaign targeting the North Atlantic phytoplankton bloom cycle and impacts on atmospheric aerosols, trace gases, and clouds (https://naames.larc.nasa.gov)

EXPORTS field campaign targeting the export and fate of upper ocean net primary production using satellite observations and surface-based measurements (https://oceanexports.org)

CAMP2Ex airborne field campaign focusing on tropical meteorology and aerosol science (https://espo.nasa.gov/camp2ex)

FIREX-AQ airborne and ground-based field campaign targeting wildfire and agricultural burning emissions in the United States (https://www.esrl.noaa.gov/csd/projects/firex-aq/)

AToM airborne field campaign mapping the global distribution of aerosols and trace gases from pole-to-pole (https://espo.nasa.gov/atom/content/ATom)

KORUS-AQ airborne and ground-based field campaign focusing on pollution and air quality in the vicinity of the Korean Peninsula (https://espo.nasa.gov/korus-aq/content/KORUS-AQ)

DISCOVER-AQ airborne and ground-based campaign targeting pollution and air quality in four areas of the United States (https://discover-aq.larc.nasa.gov/)