NASA Advanced Component Technology Program, Investments in Remote Sensing Technologies

Janice L. Buckner
NASA - Goddard Space Flight Center
Earth Science Technology Office
Mail Code 407
Greenbelt, Md. 20771
301-286-0171
Janice.L.Buckner@nasa.gov

***Abstract*—Investments in remote sensing technologies have become increasingly important as Earth Scientists strive to better understand changes of the Earth System on a global scale. This paper discusses investments in active and passive remote sensing technologies that will provide new measurement capabilities for advanced observing satellites systems. Such measurements will enable more reliable predictions of weather, climate and other globally important elements of the Earth's system. The Earth Science Technology Office, Advanced Component Technology program manages this portfolio of technology developments for the Earth Science Enterprise.**

INTRODUCTION

The Advanced Components Technology (ACT) program manages investments in component and system-level technologies that will enable development of future instruments with new or unique measurement capabilities. More than 85% of the investments in the ACT portfolio consist of new technology components for active and passive remote sensing instrumentation.

VALUE OF TECHNOLOGY INVESTMENTS

As the Earth Science Enterprise (ESE) strives to better understand the critical interactions in the Earth's system we must perform observations that will provide solutions to unanswered science questions. But, our ability to fully achieve critical Earth Science measurements is constrained by the need for new technology solutions that can overcome current limitations. As ESE moves to deploy advanced observation satellites to make the first global observations of important parameters such as atmospheric carbon and ocean surface salinity, new and innovative sensing technologies that will enable these measurements are sought.

The ACT is one of ESTO's technology-development programs—along with the Instrument Incubator and Advanced Information System Technologies programs—that invest in component and subsystem level technologies for instruments. These new technologies, when integrated into the next generation of instrument systems, will help NASA better understand the Earth's system-science and improve the prediction of climate, weather and natural hazards.

Information regarding the ACT program and its upcoming solicitations is available on the ESTO homepage, http://www.esto.nasa.gov.

REMOTE-SENSING INSTRUMENTATION

As the ESE forges into the future, a variety of sensing techniques that afford new and unique capabilities are needed. Active remote sensing instruments include advanced imaging spectrometers, advanced microwave sounders, spaced-based lidars, and advanced hyperspectral radiometers. In the passive-sensing arena, large aperture antennas radiometers and Synthetic Aperture Radars will perform various other measurements. These instrument types will provide data continuity in the study of aerosols, greenhouse gases, land and coastal ocean interactions and provide new data that will allow us to characterize regional air pollution, soil moisture, and ocean surface salinity. Although many of these technologies have multiple applications, most are developed and optimized to perform specific ESE measurements.

Active Remote Sensing Technologies

Active sensing systems employ an artificial source of optical radiation and a receiver that collects and detects the emitted radiation either directly or after its reflection from the target scene. Typical ACT investments in active sensing technologies are listed in Table 1.

TABLE 1
ACTIVE REMOTE SENSING TECHNOLOGIES

Technology Task	Primary Objective
Laser Sounder for Atmospheric CO_2	Laser and receiver technology w higher spectral resolution and precision than passive spectrometers, for carbon dioxide measurements
Remote Sensing Laser Technology	Increase electrical efficiency of solid state laser for space-base remote sensing
High Beam Quality Nd Laser for Global Ozone	Provides a space qualified 1-micron laser technology for space based ozone DIAL instrument
2 Micron Laser for Multiple Lidar Applications	2-micron laser transmitter for atmospheric carbon dioxide and global wind measurements
Adv Optical Heterodyne Receiver Development for Coherent Doppler Wind Lidar	Direct applications to coherent lidar remote sensing of atmospheric winds

Passive Remote Sensing Technologies

Passive remote sensing devices detect or measure radiation emitted by the target. These sensing systems do not emit energy that illuminates the target to perform the measurement. Hence, passive sensors are sensitive to radiation of natural origin such as reflected sunlight or radiant energy emitted by an object. Passive sensing technology components and subsystems in the ACT program are listed in Table 2.

TECHNOLOGY INFUSION OPPORTUNITIES

As the technology development tasks in the ACT program mature, opportunities for their infusion into ESE missions appear. The following are just a few examples of ACT program technology tasks that are of high interest to the Earth Science community.

Multi-Spectral CMOS Focal-plane Array for Oceanographic Imaging Applications

Engineers at the Jet Propulsion Laboratory and the University of Miami are designing a new type of focal plane array (FPA). This technology will enable new oceanographic measurements by increasing the spatial resolution on the FPA, reducing optical scatter and electronic cross-talk, achieving high signal-to-noise ratio even in high contrast scenes, and allowing the user to choose a set of spectral bands in real-time, instead of using pre-determined filters sets.

Wide Field-of-View (WFOV) Adaptive Optical (AO) systems for Lightweight Deployable Telescope Technologies

Researchers in adaptive optical systems at Ball Aerospace conducted experiments to validate and move the WFOV AO technology from an engineering concept to a laboratory demonstration. WFOV AO is a passive optical technology for long dwell, high orbit missions that require large deployable telescopes. These systems will need WFOV AO to correct the wavefront errors that result from alignment uncertainties due to the deployment of the telescopes. WFOV systems can be used, for example, to conduct synoptic studies of the atmosphere and oceans, high spectral resolution radiometry, backscatter LIDAR or Differential Absorption Lidar (DIAL), and critical Tropospheric or Stratospheric chemistry missions.

Hybrid digitizer for Glow Instrument

Syagen Technologies has developed an Integrated Digitizer and Counter (IDAC) technology for the Goddard Space Flight Center Lidar Observatory for Wind (GLOW) Instrument. This analog-to-digital converter (ADC) extends the dynamic range of high-speed ADC that enables a conventional transient digitizer to operate as a multi-bit counter. Benefits include atmospheric monitoring LIDAR including wind Doppler LIDAR, air-borne and space-borne LIDAR for profile imaging applications, and time-of-flight mass spectrometry (TOFMS).

TABLE 2
PASSIVE REMOTE SENSING TECHNOLOGIES

Technology Task	Primary Objective
Monolithic GaAs Hyperspectral Infrared QWIP Imaging System	4-band detector/ Ideal for several remote sensing measurements
Multi-spectral Staring CMOS Focal Plane Array for Oceanographic Imaging	An Advanced, Vis/NIR staring multi-spectral digital focal-plane array
Low Power Digital Correlator Detector for Microwave Polarimetry and Radiometry	High-speed digital correlator chip for microwave polarimetry, STAR, and spectrometer technologies
Compact, light weight dual-frequency Microstrip Antenna Feed	For future Soil Moisture and Sea Surface Salinity Missions
Lightweight, Deployable, dual-frequency/polarization microstrip antenna array	For Remote Sensing of Precipitation
Low Power, Radio - freq, Analog to Digital Converter	For Digital Microwave Radiometry w application to (10K) Soil Moisture Remote Sensing

GaAs Hyperspectral QWIP Imager

Engineers at GSFC, JPL, and the Army Research Lab have successfully developed a GaAs Quantum Well Infrared Photodetector (QWIP). This device is a four band, 640 x 512, 23um x 23um pixel array that incorporates a Linear Variable Etalon (LVE) filter

providing over 200 spectral bands across the 4-15.4 um wavelength region. Future opportunities include possible agreements between the US and Thailand to establish a research effort to evaluate a variety of environmental phenomena using-low flying aircraft. NASA's GOES project has expressed interest in this technology, and the medical community is evaluating the possibility of using this technology for cancer research.

CONCLUSION

As the NASA strives to better understand the Earth system, the ACT Program continues to invest in innovative remote sensing component technologies that will help Earth Scientist overcome current limitations and deploy a new series of advanced observations satellites. ACT investments provide new capabilities that are crucial to the advancement of future generations of remote sensing instrumentation. Potential end users of these technologies include NASA, NOAA, the USGS and other U.S. government agencies, as well as academia, private industry, and our international Earth Science partners.

REFERENCES

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AUTOBIOGRAPHY

Ms. Janice L. Buckner is a Technology Program Manager in the Earth Science Technology Office at NASA/Goddard Space Flight Center. She manages a portfolio of component level technology developments for the Earth Science Enterprise. She has a Bachelors of Science in Electrical Engineering from Howard University and a Masters of Science in Engineering Management from George Washington University. She is married and is the mother of two children.