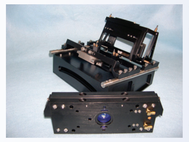
Earth Science Technology Office (ESTO) Investments in support of the

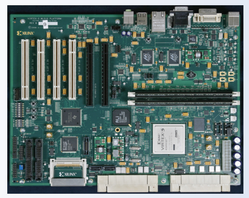
Aerosol-Cloud-Ecosystems (ACE) Decadal Survey Mission

For over 10 years, the Earth Science Technology Office (ESTO) has been actively funding and developing a broad range of technologies that enable scientific measurements of Earth, mission operational requirements, and other related applications. A substantial subset of these technologies are directed broadly toward atmospheric composition, aerosols, ocean carbon, and ecosystem measurements and many relate directly to the goals and requirements for the Aerosol-Cloud-Ecosystems (ACE) Decadal Survey Mission. Below are a few examples of current and completed ESTO technology development efforts that may aid the formulation of the ACE mission.

Polarimeter Instrument Technologies

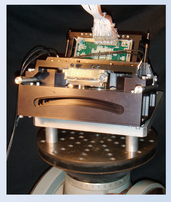


The Shortwave Infrared Aerosol/Cloud Polarimetric Imager project seeks to extend the ACE polarimetric spectrometer into the shortwave infrared (SWIR) band as well as develop miniature SWIR filters, a quarter-waveplate with visible-to-SWIR performance, and integrate and test the brassboard camera (shown above). *[David Diner, Jet Propulsion Lab]*



This development board (above) is part of an on board processing system being developed specifically for the Multiangle SpectroPolarimetric Imager (MSPI) for the ACE mission. The project team seeks to demonstrate a system that would optimize data processing for MSPI and achieve a 2-orders-of-magnitude reduction in data rate for polarimetric data processing with improvements in the instrument digital signal processing (DSP) design train. *[Paula J. Pingree, Jet Propulsion Lab]*

Below is a brassboard Aerosol Spectropolarimetric Camera (ASPC) that recently graduated from ESTO funding. This project designed and fabricated the camera and demonstrated its functional capability for imaging polarimetry with the potential to meet 0.5% Degree of Linear Polarization (DOLP) accuracy for the Decadal Survey ACE Mission. *[David Diner, Jet Propulsion Lab]*

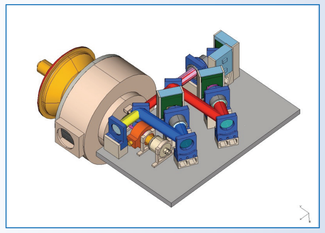


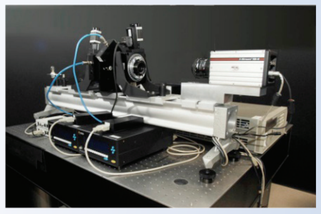
Additional Projects:

- Multi-angle Imaging SpectroRadiometer 2 (MISR-2), David Diner, Jet Propulsion Lab
- Full Spectropolarimetric validation and performance enhancements for the Hyperspectral Polarimeter for Aerosol Retrievals (HySPAR), Stephen Jones, Aerodyne Research Inc.
- Multi-Spectral Staring CMOS Focal-plane Array for Oceanographic Imaging Applications, Mithu Pain, Jet Propulsion Lab

Spectrometer Instrument Technologies

The Ocean Radiometer for Carbon Assessment (ORCA) project is building a prototype instrument to provide information on the ocean phytoplankton species composition and uptake of CO2 by measuring ocean color. The project team expects to evolve a test bed version into a portable prototype with telescope scanning capability. They also intend to perform system-level characterization at the National Institute of Standards and Technology. Below is an engineering model of the optical bench. *[Charles McClain, Goddard Space Flight Center]*



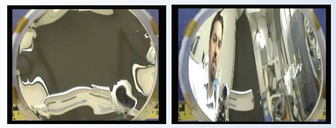


A current project at Ball Aerospace is developing a Temporal Polarization Scrambler (PolZero) component that provides polarization sensitivity reduction without using beam replication, introducing image distortion, or requiring a specialized optical path. Above is a photo of the polarimeter testbed. The team aims to complete airborne demonstrations of PolZero in a model spectrometer in late 2010. *[Rainer Illing, Ball Aerospace]*

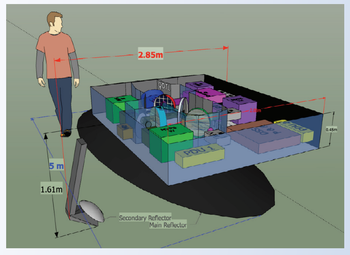
Additional Projects:

- Wide Field Imaging Spectrometer (WFIS), Randy Pollock, Hamilton-Sundstrand
- Advanced UV and Visible Ultra-narrow Interference Filter Technology Development, John Potter, Barr Associates Inc

Radar Instrument Technologies

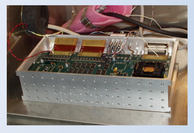


The above images show an optical-quality, Poly-Vinylidene Fluoride (PVDF), film that deforms from a flat shape to a concave shape with the application of voltage. This electro-active membrane technology will be leveraged along with several other recently developed material technologies, for a large, high-precision deployable reflector for Ka- and W-band Earth remote sensing. Particularly suitable for the ACE mission, this technology project may offer an order of magnitude higher precision than the currently used tensioning cable truss reflector. *[Houfei Fang, Jet Propulsion Lab]*



This radar configuration concept drawing depicts a dual-frequency (35/94 GHz) multi-parameter atmospheric profiling radar currently under development for cloud and precipitation measurements. Named ACERAD, this radar instrument could be a key element of the ACE mission. *[Stephen Durden, Jet Propulsion Lab]*

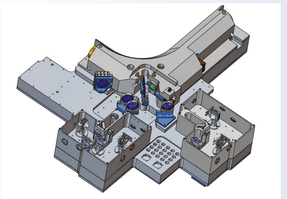
At right is an FPGA-Based On-Board Processor/Controller for Satellite-Borne Radars. The 4 channel radar data processing unit was successfully demonstrated aboard several airborne deployments. *[Andrew Berkun, Jet Propulsion Lab]*



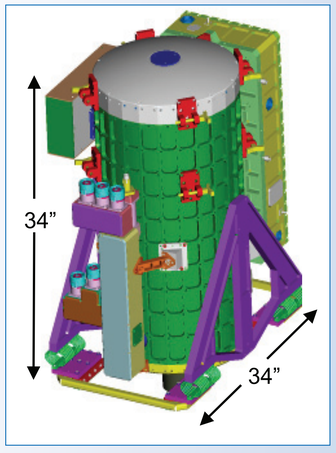
Additional Projects:

- High-Altitude Imaging Wind and Rain Airborne Profiler (HIWRAP), Gerald Heymsfield, Goddard Space Flight Center
- An On-Board Processor for a Spaceborne Doppler Precipitation Radar, Stephen Durden, Jet Propulsion Lab
- 2nd-Generation Precipitation Radar (PR-2) Adaptable for Multi-Mission and Orbit Applications, Eastwood Im, Jet Propulsion Lab
- Advanced Precipitation Radar Antenna and Instrument (APRA), Eastwood Im, Jet Propulsion Lab
- Ka-band Active Array for Remote Sensing of Precipitation, Greg Sadowy, Jet Propulsion Lab

Lidar Instrument Technologies



The above is a drawing of the Optical Autocovariance Direct Detection Wind Lidar (OAWL) receiver, which is an interferometric direct-detection lidar focused on aerosols. The technology is applicable to doppler lidar for wind profiles as well as the high spectral resolution lidar required by the ACE Mission. *[Christian Grund, Ball Aerospace]*

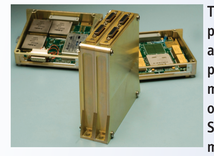


Above is an instrument concept drawing for a combined High Spectral Resolution Lidar (HSRL) and Differential Absorption Lidar (DIAL) instrument to measure tropospheric aerosols and ozone. This project may enable unique and important measurements of ozone and aerosol optical & microphysical properties from space-based and advanced airborne platforms (UAVs) in support of the ACE Decadal Survey Mission. *[Chris Hostetler, Langley Research Center]*

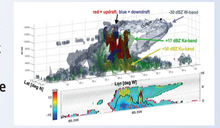
Additional Projects:

- Detector Technology Development for Cloud-Aerosol Transport Lidar, Matthew McGill, Goddard Space Flight Center
- Strategic Investments toward Lidar Detectors for ACE, Chris Hostetler, Langley Research Center

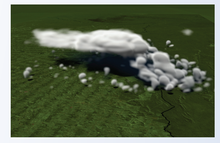
Information Systems Technologies



The SpaceCube 2.0 project seeks to develop an advanced on-board processing system to meet the requirements of a variety of Decadal Survey mission instruments. Building upon the SpaceCube 1.0 system (shown here), the project team aims to design, build, and test a radiation hardened version coupled with advanced software techniques for reconfiguration, event detection, and real time data products. *[Tom Flatley, Goddard Space Flight Center]*



At right is one example of the output from the Instrument Simulator Suite for Atmospheric Remote Sensing (ISSARS), a service-based tool suite that provides simulated measurements of the atmosphere based on input from atmospheric models. *[Simone Tanelli, Jet Propulsion Lab]*



The above high-fidelity cloud motion simulation is from the Goddard Cloud Ensemble (GCE) model – one of the modelling systems that will be integrated in a project titled “Coupling NASA Advanced Multi-Scale Modeling and Concurrent Visualization Systems for Improving Predictions of Tropical High-Impact Weather (CAMVis)”. One goal of this project is to improve the understanding of cloud-radiation-aerosol interactions. *[Bo-Wen Shen, University of Maryland]*

Additional Projects:

- Sensor-Web Operations Explorer (SOX), MeeMong Lee, Jet Propulsion Lab
- Adaptive Sky, Michael Burl, Jet Propulsion Lab
- Spatiotemporal Data Mining System for Tracking and Modeling Ocean Object Movement, Yang Kai, Carnegie Mellon University
- A Smart Sensor Web for Ocean Observation, Payman Arabshahi, University of Washington
- Autonomous In-situ Control and Resource Management in Distributed Heterogeneous Sensor Webs (CARDS), Ashit Talukder, Jet Propulsion Lab
- Telesupervised Adaptive Ocean Sensor Fleet, John Dolan, Carnegie Mellon University
- A Reconfigurable Computing Environment for On-Board Data Reduction and Cloud Detection, Jacqueline Le Moigne, Goddard Space Flight Center