the direct-diffuse flux ratio, column abundance of gas phase constituents, aerosol optical depth at multiple-wavelengths, phase functions, cloud statistics, and an estimate of the representative size of atmospheric particles. These measurements can be used to obtain an estimate of aerosol size distribution, refractive index, and particle shape.

Incident light is received at a light-reflecting (inner) surface, which is a truncated paraboloid. Light arriving from a hemispheric field of view (solid angle 2π steradians) enters the reflecting optic at an entrance aperture at, or adjacent to, the focus of the paraboloid, and is captured by the optic. Most of this light is reflected from an inner surface. The light proceeds substantially parallel to the paraboloid axis, and is detected by an array detector located near an exit aperture. Each of the entrance and exit apertures is formed by the intersection of the paraboloid with a plane substantially perpendicular to the paraboloid axis. Incident (non-reflected) light from a source of limited extent (the Sun) illuminates a limited area on the detector array. Both direct and diffuse illumination may be reflected, or not reflected, before being received on the detector array. As the Sun traverses a path in the sky over some time interval, the track of the Sun can be traced on the detector array.

A suitably modified Sun photometer might be used to study the dynamics of an environment on another planet or satellite with an atmosphere.

This work was done by Anthony W. Strawa of Ames Research Center. Further information is contained in a TSP (see page 1). ARC-15443-1

Surface Temperature Data Analysis

Goddard Space Flight Center, Greenbelt, Maryland

Small global mean temperature changes may have significant to disastrous consequences for the Earth's climate if they persist for an extended period. Obtaining global means from local weather reports is hampered by the uneven spatial distribution of the reliably reporting weather stations. Methods had to be developed that minimize as far as possible the impact of that situation.

This software is a method of combining temperature data of individual stations to obtain a global mean trend, overcoming/estimating the uncertainty introduced by the spatial and temporal gaps in the available data. Useful estimates were obtained by the introduction of a special grid, subdividing the Earth's surface into 8,000 equal-area boxes, using the existing data to create virtual stations at the center of each of these boxes, and combining temperature anomalies (after assessing the radius of high correlation) rather than temperatures.

This work was done by James Hansen and Reto Ruedy of Goddard Space Flight Center. For further information, contact the Goddard Innovative Partnerships Office at (301) 286-5810. GSC-16243-1

Modular, Autonomous Command and Data Handling Software With Built-In Simulation and Test

Commercial markets include telecommunications, remote sensing, and GIS imagers.

Goddard Space Flight Center, Greenbelt, Maryland

The spacecraft system that plays the greatest role throughout the program lifecycle is the Command and Data Handling System (C&DH), along with the associated algorithms and software. The C&DH takes on this role as cost driver because it is the brains of the spacecraft and is the element of the system that is primarily responsible for the integration and interoperability of all spacecraft subsystems. During design and development, many activities associated with mission design, system engineering, and subsystem development result in products that are directly supported by the C&DH, such as interfaces, algorithms, flight software (FSW), and parameter sets.

A modular system architecture has been developed that provides a means for rapid spacecraft assembly, test, and integration. This modular C&DH software architecture, which can be targeted and adapted to a wide variety of spacecraft architectures, payloads, and mission requirements, eliminates the current practice of rewriting the spacecraft software and test environment for every mission. This software allows mission-specific software and algorithms to be rapidly integrated and tested, significantly decreasing time involved in the software development cycle.

Additionally, the FSW includes an Onboard Dynamic Simulation System (ODySSy) that allows the C&DH software to support rapid integration and test. With this solution, the C&DH software capabilities will encompass all phases of the spacecraft lifecycle. ODySSy is an on-board simulation capability built directly into the FSW that provides dynamic built-in test capabilities as soon as the FSW image is loaded onto the processor. It includes a six-degrees-of-freedom, high-fidelity simulation that allows complete closed-loop and hardware-in-the-loop testing of a spacecraft in a ground processing environment without any additional external stimuli. ODySSy can intercept and modify sensor inputs using mathematical sensor models, and can intercept and respond to actuator commands.

ODySSy integration is unique in that it allows testing of actual mission sequences on the flight vehicle while the spacecraft is in various stages of assembly, test, and launch operations — all without any external support equipment or simulators. The ODySSy component of the FSW significantly decreases the time required for integration and test by providing an automated, standardized, and modular approach to integrated avionics and component interface and functional verification. ODySSy further provides the capability for on-orbit support in the form of autonomous mission planning and fault protection.

Modular C&DH FSW based on the architecture described in this tech brief was successfully demonstrated on-orbit as part of the United States Air Force Academy's FalconSat-5 technology demonstrator spacecraft, which launched in November of 2011. This flight program clearly demonstrated the benefits of the modular FSW approach, including built-in test via ODySSy, throughout the lifecycle of the FalconSat-5 spacecraft.

This work was led by John Cuseo of Advanced Solutions, Inc. for Goddard Space Flight Center. Further information is contained in a TSP (see page 1). GSC-16054-1

In-Situ Wire Damage Detection System

John F. Kennedy Space Center, Florida

An In-Situ Wire Damage Detection System (ISWDDS) has been developed that is capable of detecting damage to a wire insulation, or a wire conductor, or to both. The system will allow for real-time, continuous monitoring of wiring health/integrity and reduce the number of false negatives and false positives while being smaller, lighter in weight, and more robust than current systems. The technology allows for improved safety and significant reduction in maintenance hours for aircraft, space vehicles, satellites, and other critical high-performance wiring systems for industries such as energy production and mining.

The integrated ISWDDS is comprised of two main components: (1) a wire with an innermost core conductor, an inner insulation film, a conductive layer or inherently conductive polymer (ICP) covering the inner insulation film, an outermost insulation jacket; and (2) smart connectors and electronics capable of producing and detecting electronic signals, and a central processing unit (CPU) for data collection and analysis. The wire is constructed by applying the inner insulation films to the conductor, followed by the outer insulation jacket. The conductive layer or ICP is on the outer surface of the inner insulation film. One or more wires are connected to the CPU using the smart connectors, and up to 64 wires can be monitored in real-time.

The ISWDDS uses time domain reflectometry for damage detection. A fast-risetime pulse is injected into either the core conductor or conductive layer and referenced against the other conductor, producing transmission line behavior. If either conductor is damaged, then the signal is reflected. By knowing the speed of propagation of the pulse, and the time it takes to reflect, one can calculate the distance to and location of the damage.

This work was done by Martha Williams, Luke Roberson, Lanetra Tate, and Trent Smith of Kennedy Space Center; and Tracy Gibson, Pedro Medelius, and Scott Jolley of ASRC Aerospace Corporation. For more information, contact the Kennedy Space Center Innovative Partnerships Office at 321-867-5033. KSC-12866