ray will be nearly parallel, and the angle between the direct ray and the reflected ray can be approximated as two times the glancing angle. Calculations to locate the pixel a direct ray enters are simple and involve for any candidate water pixel conversion of the 2D image coordinates to a 3D unit vector, negation of the *z* component of the unit vector, and conversion of the modified unit vector back to 2D image coordinates.

This work was done by Arturo L. Rankin and Larry H. Matthies of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

This software is available for commercial licensing. Please contact Daniel Broderick of the California Institute of Technology at danielb@caltech.edu. Refer to NPO-47092.

Nonlinear Combustion Instability Prediction

Marshall Space Flight Center, Alabama

The liquid rocket engine stability prediction software (LCI) predicts combustion stability of systems using LOX-LH_2 propellants. Both longitudinal and transverse mode stability characteristics are calculated. This software has the unique feature of being able to predict system limit amplitude.

New methods for predicting stability have been created based on a detailed physical understanding of the combustion instability problem, which has resulted in a computationally predictive algorithm that allows determination of pressure oscillation frequencies and geometry, growth rates for component modes of oscillation, development of steepened wave structures, limit (maximum) amplitude of oscillations, and changes in mean operation chamber conditions.

The program accommodates any combustion-chamber shape. The program can run on desktop computer systems, and is readily upgradeable as new data become available.

This program was written by Gary Flandro of the University of Tennessee, Space Institute, Calspan Center, for Marshall Space Flight Center. For further information, contact Sammy Nabors, MSFC Commercialization Assistance Lead, at sammy.a.nabors@nasa.gov. Refer to MFS-32549-1.

JMISR INteractive eXplorer

NASA's Jet Propulsion Laboratory, Pasadena, California

MISR (Multi-angle Imaging SpectroRadiometer) INteractive eXplorer (MINX) is an interactive visualization program that allows a user to digitize smoke, dust, or volcanic plumes in MISR multiangle images, and automatically retrieve height and wind profiles associated with those plumes. This innovation can perform 9-camera animations of MISR level-1 radiance images to study the 3D relationships of clouds and plumes. MINX also enables archiving MISR aerosol properties and Moderate Resolution Imaging Spectroradiometer (MODIS) fire radiative power along with the heights and winds. It can correct geometric misregistration between cameras by correlating off-nadir camera scenes with corresponding nadir scenes and then warping the images to minimize the misregistration offsets. Plots of BRF (bidirectional reflectance factor) vs. camera angle for points clicked in an image can be displayed. Users get rapid access to map views of MISR path and orbit locations and overflight dates, and past or future orbits can be identified that pass over a specified location at a specified time. Single-camera, level-1 radiance data at 1,100- or 275-meter resolution can be quickly displayed in color using a browse option.

This software determines the heights and motion vectors of features above the terrain with greater precision and coverage than previous methods, based on an algorithm that takes wind direction into consideration. Human interpreters can precisely identify plumes and their extent, and wind direction. Overposting of MODIS thermal anomaly data aids in the identification of smoke plumes. The software has been used to preserve graphical and textural versions of the digitized data in a Web-based database that currently contains more than 7,000 smoke plumes (http://www-misr2.jpl.nasa.gov/EPA-Plumes/).

This work was done by David L. Nelson of Columbus Technologies and Services; David J. Diner, Charles K. Thompson, Jeffrey R. Hall, and Brian E. Rheingans of Caltech; Michael J. Garay of Raytheon; and Dominic Mazzoni of Google, Inc. for NASA's Jet Propulsion Laboratory. For more information, download the MINX software package and User's Guide at http://www.openchannelsoftware.com/projects/MINX/. NPO-47098

Characterization of Cloud Water-Content Distribution

NASA's Jet Propulsion Laboratory, Pasadena, California

The development of realistic cloud parameterizations for climate models requires accurate characterizations of subgrid distributions of thermodynamic variables. To this end, a software tool was developed to characterize cloud water-content distributions in climate-model sub-grid scales.

This software characterizes distributions of cloud water content with respect to cloud phase, cloud type, precipitation occurrence, and geo-location using CloudSat radar measurements. It uses a statistical method called maximum likelihood estimation to estimate the probability density function of the cloud water content.

A crude treatment of sub-grid scale cloud processes in current climate models is widely recognized as a major limitation in predictions of global climate change. At present, typical climate models have a horizontal resolution on the order of 100 km and a variable vertical resolution between 100 m and 1 km. Since climate models cannot explicitly resolve what happens at the sub-grid scales, the physics must be parameterized as a function of the resolved motions. The fundamental problem of cloud parameterization is to characterize the distributions of cloud variables at sub-grid scales and to relate the sub-grid variations to the resolved flow. This software solves the problem by estimating the probability density function of cloud water content at the sub-grid scale using CloudSat measurements.

This work was done by Seungwon Lee of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov.

This software is available for commercial licensing. Please contact Daniel Broderick of the California Institute of Technology at danielb@caltech.edu. Refer to NPO-47248.

Autonomous Planning and Replanning for Mine-Sweeping Unmanned Underwater Vehicles

NASA's Jet Propulsion Laboratory, Pasadena, California

This software generates high-quality plans for carrying out mine-sweeping activities under resource constraints. The autonomous planning and replanning system for unmanned underwater vehicles (UUVs) takes as input a set of prioritized mine-sweep regions, and a specification of available UUV resources including available battery energy, data storage, and time available for accomplishing the mission. Mine-sweep areas vary in location, size of area to be swept, and importance of the region. The planner also works with a model of the UUV, as well as a model of the power consumption of the vehicle when idle and when moving.

The planner begins by using a depth-first, branch-and-bound search algorithm to find an optimal mine sweep to maximize the value of the mine-sweep regions included in the plan, subjected to available resources. The software issues task commands to an underlying control architecture to carry out the activities on the vehicle, and to receive updates on the state of the world and the vehicle. During plan execution, the planner uses updates from the control system to make updates to the predictions of the vehicle and world states. The effects of these updates are propagated into the future and allow the planner to detect conflicts ahead of time, or to identify any resource surplus that might exist and could allow the planner to include additional mine-sweep regions.

This work was done by Daniel M. Gaines of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov.

This software is available for commercial licensing. Please contact Daniel Broderick of the California Institute of Technology at danielb@caltech.edu. Refer to NPO-47018.

Dayside Ionospheric Superfountain

NASA's Jet Propulsion Laboratory, Pasadena, California

The Dayside Ionospheric Superfountain modified SAMI2 code predicts the uplift, given storm-time electric fields, of the dayside near-equatorial ionosphere to heights of over 800 kilometers during magnetic storm intervals. This software is a simple 2D code developed over many years at the Naval Research Laboratory, and has importance relating to accuracy of GPS positioning, and for satellite drag.

This work was done by Bruce T. Tsurutani, Olga P. Verkhoglyadova, and Anthony J. Mannucci of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov.

This software is available for commercial licensing. Please contact Daniel Broderick of the California Institute of Technology at danielb@caltech.edu. Refer to NPO-47209.

In-Situ Pointing Correction and Rover Microlocalization

NASA's Jet Propulsion Laboratory, Pasadena, California

Two software programs, marstie and marsnav, work together to generate pointing corrections and rover micro-localization for *in-situ* images. The programs are based on the PIG (Planetary Image Geometry) library, which handles all mission dependencies. As a result, there is no mission-specific code in either of these programs. This software corrects geometric seams in images as much as possible (some parallax seams are uncorrectable).

First, marstie is used to gather tiepoints. The program analyzes the input image set, determines which images overlap, and presents overlapping pairs to the user. The user then manually creates a number of tiepoints between each pair, by identifying the locations of features that are common to both images. An automatic correlator assists the user in getting subpixel accuracy on these tie-