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-