

merically by a combination of the Newton-Raphson and successive-substitution methods. The program includes subroutines that compute thermodynamic and thermophysical properties for 12 fluids and is integrated with a commercial program that gives thermodynamic properties of 36 fluids. Eighteen different options are provided for modeling momentum

sources or sinks in the branches. Additional capabilities, including new resistance options, new fluids, and nonlinear boundary conditions, can be added by means of subroutines. An audio-visual training CD (compact disk) containing lectures, demonstration of graphical user interface, and tutorial problems is available for learning to use the program.

This program was written by Alok Kumar Majumdar of Marshall Space Flight Center. Further information is contained in a TSP (see page 1).

This invention is owned by NASA, and a patent application has been filed. For further information, contact Sammy Nabors, MSFC Commercialization Assistance Lead, at sammy.a.nabors@nasa.gov. Refer to MFS-32125-1.

Program Predicts Performance of Optical Parametric Oscillators

Langley Research Center, Hampton, Virginia

A computer program predicts the performances of solid-state lasers that operate at wavelengths from ultraviolet through mid-infrared and that comprise various combinations of stable and unstable resonators, optical parametric oscillators (OPOs), and sum-frequency generators (SFGs), including second-harmonic generators (SHGs). The input to the program describes the signal, idler, and pump beams; the SFG and OPO crystals; and the laser geometry. The program calculates the electric fields of the idler,

pump, and output beams at three locations (inside the laser resonator, just outside the input mirror, and just outside the output mirror) as functions of time for the duration of the pump beam. For each beam, the electric field is used to calculate the fluence at the output mirror, plus summary parameters that include the centroid location, the radius of curvature of the wavefront leaving through the output mirror, the location and size of the beam waist, and a quantity known, variously, as a propagation constant or beam-

quality factor. The program provides a typical Windows interface for entering data and selecting files. The program can include as many as six plot windows, each containing four graphs.

This program was written by Patricia L. Cross of Langley Research Center and Mark Bowers of Aculight Corporation. Further information is contained in a TSP (see page 1). LAR-16529-1

Processing TES Level-1B Data

NASA's Jet Propulsion Laboratory, Pasadena, California

TES LIB Subsystem is a computer program that performs several functions for the Tropospheric Emission Spectrometer (TES). The term "LIB" (an abbreviation of "level 1B"), refers to data, specific to the TES, on radiometric calibrated spectral radiances and their corresponding noise equivalent spectral radiances (NESRs), plus ancillary geolocation, quality, and engineering data. The functions performed by TES LIB Subsystem include shear analysis, monitoring of signal levels, detection of ice

build-up, and phase correction and radiometric and spectral calibration of TES target data. Also, the program computes NESRs for target spectra, writes scientific TES level-1B data to hierarchical-data-format (HDF) files for public distribution, computes brightness temperatures, and quantifies interpixel signal variability for the purpose of first-order cloud and heterogeneous land screening by the level-2 software summarized in the immediately following article. This program uses an in-house-

developed algorithm, called "NUSRT," to correct instrument line-shape factors.

This program was written by Richard C. De Baca, Edwin Sarkissian, Mariyetta Madatyan, Douglas Shepard, Scott Gluck, Mark Apolinski, James McDuffie, and Dennis Tremblay 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 Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-35218.

Automated Camera Calibration

NASA's Jet Propulsion Laboratory, Pasadena, California

Automated Camera Calibration (ACAL) is a computer program that automates the generation of calibration data for camera models used in machine vision systems. Machine vision camera models describe the mapping between points in three-dimensional

(3D) space in front of the camera and the corresponding points in two-dimensional (2D) space in the camera's image. Calibrating a camera model requires a set of calibration data containing known 3D-to-2D point correspondences for the given camera system.

Generating calibration data typically involves taking images of a calibration target where the 3D locations of the target's fiducial marks are known, and then measuring the 2D locations of the fiducial marks in the images. ACAL automates the analysis of calibration target

images and greatly speeds the overall calibration process. ACAL consists of three modules:

1. ACALDOTS — the primary module — takes calibration target images, locates and measures the 2D locations of the target's fiducial marks and then synthesizes their corresponding 3D locations based on knowledge of the calibration target's geometry and its 3D location. ACALDOTS handles uneven lighting, large-scale variations due to range differences, and barrel distortion effects of the type found in wide-angle lenses. It understands

both planar and corner-cube (i.e., 3D) calibration target geometries.

2. ACALINFO takes the calibration data produced by ACALDOTS and estimates an initial 3D position and orientation (i.e., camera pose) for the camera to seed the estimation of the remaining camera model parameters.

3. ACALFIX takes the original calibration data and the camera model produced from it and generates a refined set of calibration data by removing localization errors in the 2D fiducial mark positions introduced by perspective foreshortening caused by the calibration

target's orientation and geometry.

The automation in ACAL is robust enough that under even extreme image conditions, the required input from the user averages to no more than about one mouse click per target fixture.

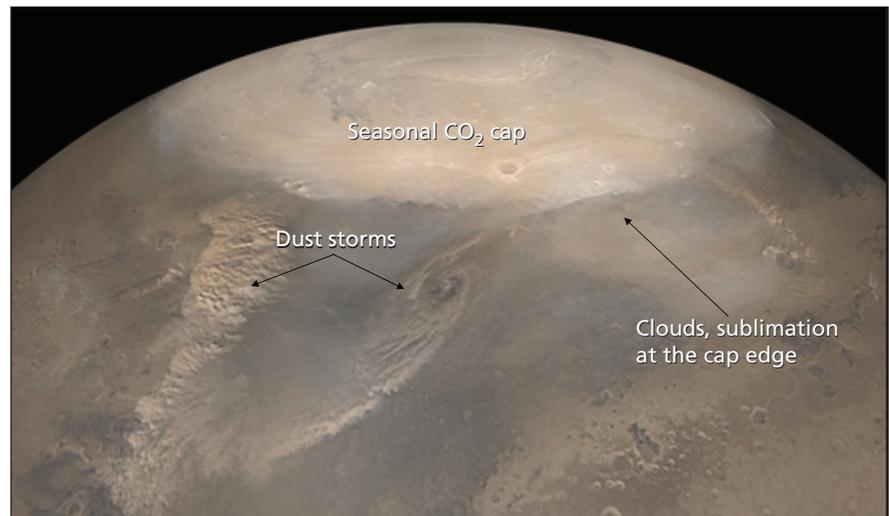
This program was written by Siqi Chen, Yang Cheng, and Reg Willson of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

This software is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-41312.

Tracking the Martian CO₂ Polar Ice Caps in Infrared Images

NASA's Jet Propulsion Laboratory, Pasadena, California

Researchers at NASA's Jet Propulsion Laboratory have developed a method for automatically tracking the polar caps on Mars as they advance and recede each year (see figure). The seasonal Mars polar caps are composed mainly of CO₂ ice and are therefore cold enough to stand out clearly in infrared data collected by the Thermal Emission Imaging System (THEMIS) onboard the Mars Odyssey spacecraft. The Bimodal Image Temperature (BIT) histogram analysis algorithm analyzes raw, uncalibrated data to identify images that contain both "cold" ("polar cap") and "warm" ("not polar cap") pixels. The algorithm dynamically identifies the temperature that separates these two regions. This flexibility is critical, because in the absence of any calibration, the threshold temperature can vary significantly from image to image. Using the identified threshold, the algorithm classifies each pixel in the image as "polar cap" or "not polar cap," then identifies the image row that contains the spatial transition from "polar cap" to "not polar cap." While this method is useful for analyzing data that has already been returned by THEMIS, it has even more significance with respect to data that has not yet been col-



Recession of the Seasonal CO₂ Cap is shown for Northern Martian Spring.

lected. Instead of seeking the polar cap only in specific, targeted images, the simplicity and efficiency of this method makes it feasible for direct, onboard use. That is, THEMIS could continuously monitor its observations for any detections of the polar-cap edge, producing detections over a wide range of spatial and temporal conditions. This effort can greatly contribute to our understanding

of long-term climatic change on Mars.

This work was done by Kiri L. Wagstaff, Rebecca Castano, and Steve Chien 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 Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-41732.

Processing TES Level-2 Data

NASA's Jet Propulsion Laboratory, Pasadena, California

TES Level 2 Subsystem is a set of computer programs that performs functions complementary to those of the program summarized in the immediately preced-

ing article. TES Level-2 data pertain to retrieved species (or temperature) profiles, and errors thereof. Geolocation, quality, and other data (e.g., surface characteris-

tics for nadir observations) are also included. The subsystem processes gridded meteorological information and extracts parameters that can be interpolated to