

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.

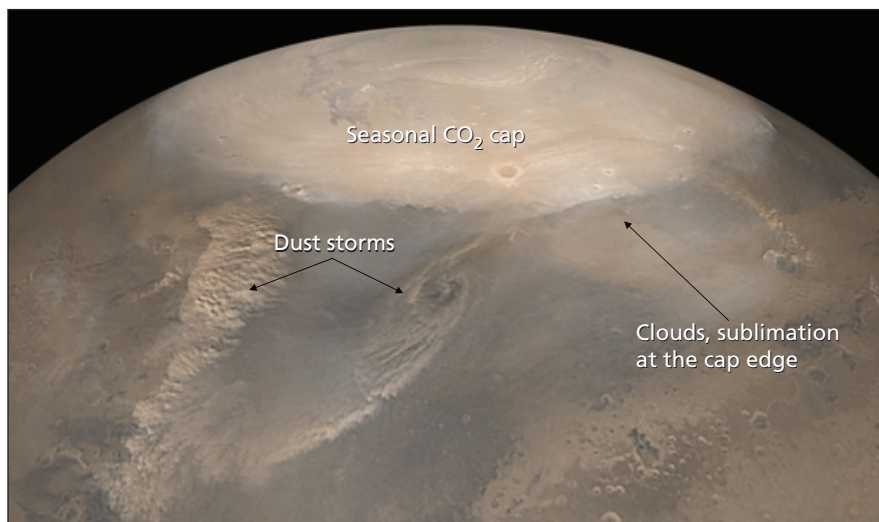
This program was written by Siqi Chen, Yang Cheng, and Reg Willson of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

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).

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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