

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](mailto:danielb@caltech.edu). Refer to NPO-47092.*

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## 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<sub>2</sub> 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](mailto:sammy.a.nabors@nasa.gov). Refer to MFS-32549-1.*

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## 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*

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## 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 sub-grid 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