



## Algorithm for Automated Detection of Edges of Clouds

**The algorithm has been shown to be reliable and robust.**

*John F. Kennedy Space Center, Florida*

An algorithm processes cloud-physics data gathered *in situ* by an aircraft, along with reflectivity data gathered by ground-based radar, to determine whether the aircraft is inside or outside a cloud at a given time. A cloud edge is deemed to be detected when the in/out state changes, subject to a hysteresis constraint. Such determinations are important in continuing research on relationships among lightning, electric charges in clouds, and decay of electric fields with distance from cloud edges.

More specifically, the algorithm consists of an in-cloud detection component and a boundary detection component. The in-cloud detection component relies on the cloud-physics and weather-radar data to make a tentative determination of the in/out state. The boundary detection component examines the output of the in-cloud detection component and applies a hysteresis test, which helps prevent false boundary detections that would otherwise be triggered by momentary data fluctuations associated with isolated transient cloud puffs or data dropouts.

The algorithm was tested by applying it to a large set of data and comparing the results of the algorithm with results obtained through detailed manual examination of the data. The algorithm was found to be highly reliable and insensitive to transient instrumentation noise or data gaps, and it enabled full automation of detection of cloud edges.

*This work was done by Jennifer G. Ward and Francis J. Merceret of Kennedy Space Center. Further information is contained in a TSP (see page 1)..*  
KSC-12574

## Exploiting Quantum Resonance to Solve Combinatorial Problems

*NASA's Jet Propulsion Laboratory, Pasadena, California*

Quantum resonance would be exploited in a proposed quantum-computing approach to the solution of combinatorial optimization problems. In quantum computing in general, one takes advantage of the fact that an algorithm cannot be decoupled from the physical effects available to implement it. Prior approaches to quantum computing have involved exploitation of only a subset of known quantum physical effects, notably including parallelism

and entanglement, but not including resonance. In the proposed approach, one would utilize the combinatorial properties of tensor-product decomposability of unitary evolution of many-particle quantum systems for physically simulating solutions to NP-complete problems (a class of problems that are intractable with respect to classical methods of computation). In this approach, reinforcement and selection of a desired solution would be executed by

means of quantum resonance. Classes of NP-complete problems that are important in practice and could be solved by the proposed approach include planning, scheduling, search, and optimal design.

*This work was done by Michail Zak and Amir Fijany of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).*  
NPO-41902

## Hybrid Terrain Database

**Aerial photographs are draped onto digital elevation maps.**

*Langley Research Center, Hampton, Virginia*

A prototype hybrid terrain database is being developed in conjunction with other databases and with hardware and software that constitute subsystems of aerospace cockpit display systems (known in the art as synthetic vision systems) that generate images to increase

pilots' situation awareness and eliminate poor visibility as a cause of aviation accidents. The basic idea is to provide a clear view of the world around an aircraft by displaying computer-generated imagery derived from an onboard database of terrain, obstacle, and airport information.

The hybrid terrain database, which could constitute all or part of such an onboard database, can be characterized as an accurate model of terrain and obstacles of interest to a pilot. The hybrid terrain database contains (1) imagery derived from conventional aerial photo-