Waterway Ice Thickness Measurements The ship on the opposite page is a U.S. Steel Corporation tanker cruising through the ice-covered waters of the Great Lakes in the dead of winter. The ship's crew is able to navigate safely by plotting courses through open water or thin ice, a technique made possible by a multi-agency technology demonstration program in which NASA is a leading participant.

Traditionally, the Great Lakes-St. Lawrence Seaway System is closed to shipping for more than three months of the winter season because of ice blockage, particularly fluctuations in the thickness and location of ice cover due to storms, wind, currents and variable temperatures.

Shippers have long sought a system of navigation that would allow year-round operation on the Lakes and produce enormous economic and fuel conservation benefits. Interrupted operations require that industrial firms stockpile materials to carry them through the impassable months, which is costly. Alternatively, they must haul cargos by more expensive overland transportation. Studies estimate the economic benefits of year-round Great Lakes shipping in the hundreds of millions of dollars annually and fuel consumption savings in the tens of millions of gallons.

Under Project Icewarn, NASA, the U.S. Coast Guard and the National Oceanic Atmospheric Administration collaborated in development and demonstration of a system that permits safe year-round operations. It employs airborne radars, satellite communications relay and facsimile transmission to provide shippers and ships' masters up-to-date ice charts. Lewis Research Center contributed an accurate method of measuring ice thickness by means of

a special "short-pulse" type of radar.

In a three-year demonstration program, Coast Guard aircraft equipped with Side-Looking Airborne Radar (SLAR) flew over the Great Lakes three or four times a week. The SLAR, which can penetrate clouds, provided large area readings of the type and distribution of ice cover. The information was supplemented by short-pulse radar measurements of ice thickness. The radar data was relayed by a NOAA satellite to a ground station where NOAA analyzed it and created picture maps, such as the one shown at lower left, showing where icebreakers can cut paths easily or where shipping can move through thin ice without the aid of icebreakers. The ice charts were then relayed directly to the wheelhouses of ships operating on the Lakes.

Following up the success of the Great Lakes program, the Icewarn team applied its system in another demonstration, this one a similarly successful application designed to aid Arctic coast shipping along the Alaskan North Slope.

Further improvement of the ice-monitoring system is planned. Although aircraft-mounted radar is effective, satellites could provide more frequent data. After the launch this year of Seasat, an ocean-monitoring satellite, NASA will conduct tests to determine the ice-mapping capability and accuracy of satellite radar images.

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