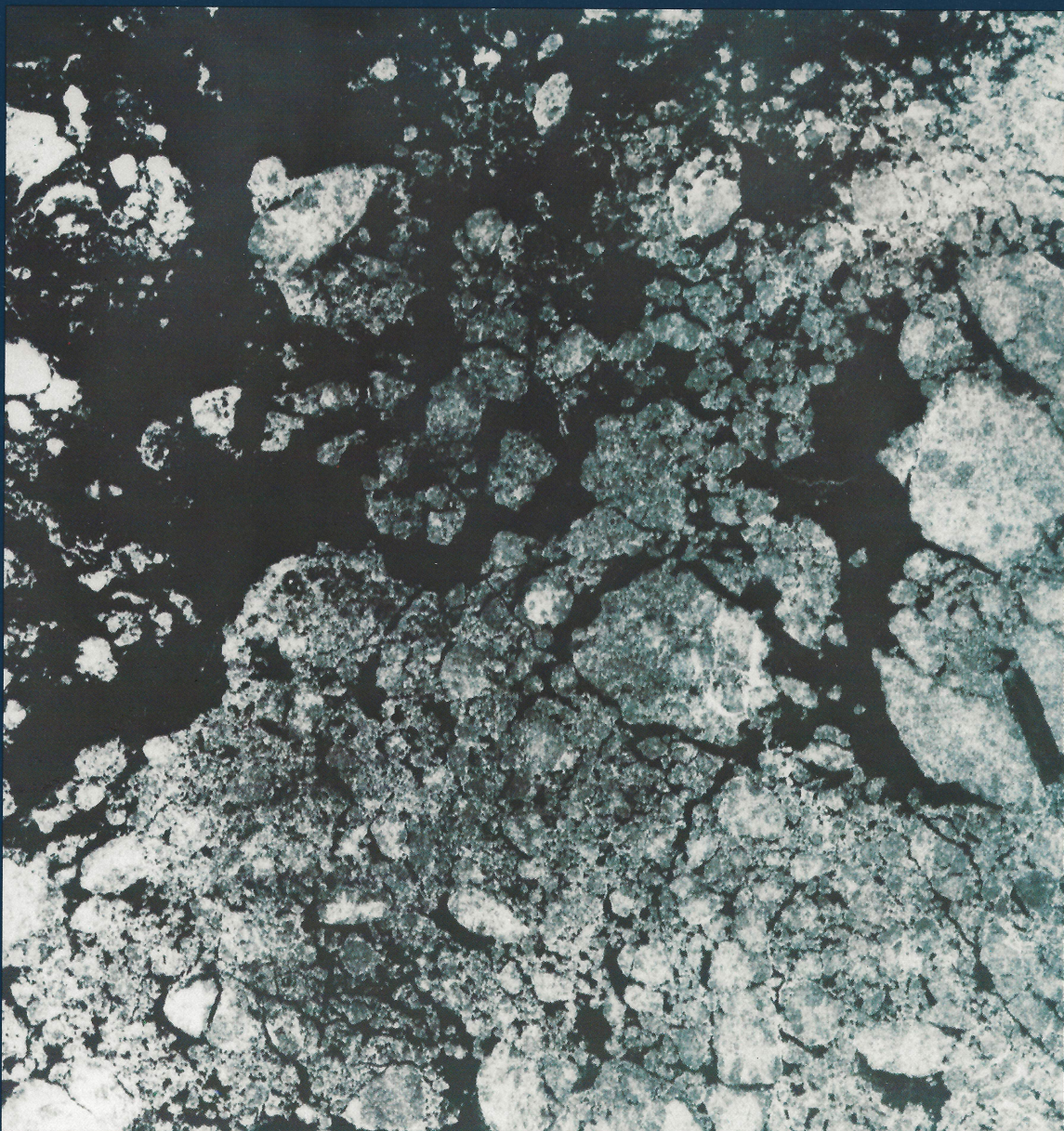
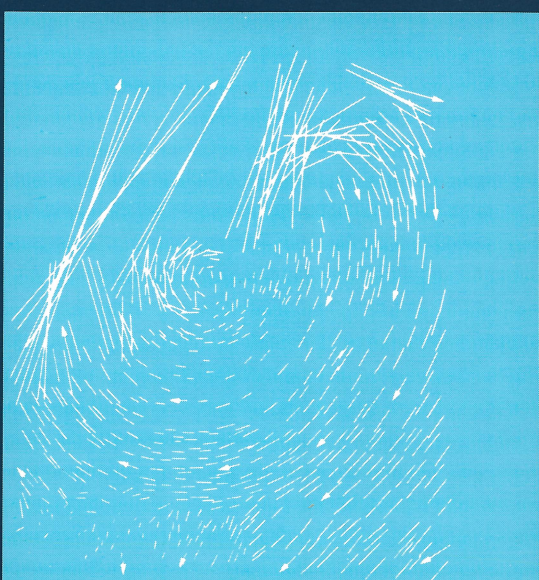


Arctic Pack-Ice Motion



Arctic Pack-Ice Motion

At high latitudes, the oceans are covered to a seasonally varying extent by sea ice. The central Arctic Ocean is covered in summer by about eight million square kilometers (three million square miles) of ice; this doubles in area during the winter. At the opposite pole conditions are very different, with a vast ice sheet resting on the continent of Antarctica. In wintertime, sea-ice coverage around Antarctica is similar in extent to that in the Arctic; however, the summertime coverage in the Antarctic is only about 20% of the winter maximum. A major reason for the sharp contrast between the extent of summer sea-ice cover in the two polar regions is the marked difference in the character of the two polar oceans.

Many rivers flow into the Arctic, producing a near-surface layer of comparatively fresh, cold water which, because of its low density, inhibits convection of warmer but saltier water from below. Consequently, Arctic sea ice is protected from basal melting by this "cap" of low-salinity water. In contrast, there is negligible fresh-water run-off from Antarctica, with little to prevent deep, warm water from rising to the surface. Thus, sea ice around Antarctica can be melted from beneath, even in winter. In addition, frequent strong winds coming off Antarctica push newly formed ice northward away from the coast, permitting much more ice to form than would otherwise.

The intensity of heat exchange between the ocean and atmosphere at any time depends critically upon the amount of open water within the sea-ice cover. In winter, heat transfer in these areas is about 100 times greater than where there is an ice cover. During the summer, much of the heat for melting ice is derived from solar radiation absorbed by leads and pools of open water. In both seasons, it is extremely difficult to observe the open-water fraction within the sea-ice cover with sufficient accuracy to provide useful estimates of heat transfer rates. A potentially viable technique that can provide such observations is the spaceborne synthetic aperture radar (SAR). SAR typically has a spatial resolution of about 25 m (80 ft) and can provide all-weather images of the sea-ice cover.

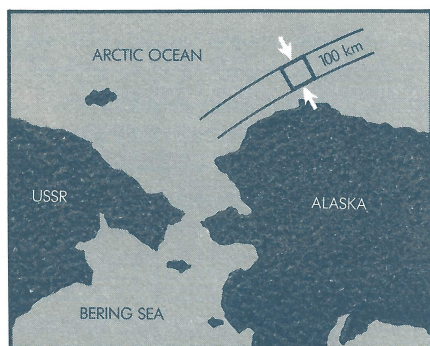
The two SAR images shown here were obtained by NASA's Seasat satellite during October 1978. They cover the same 100-km-wide (60-mi-wide) area in the southwestern Beaufort Sea, but were taken three days apart. Bright regions in a SAR image are areas that reflect energy back towards the spacecraft and generally have surface roughness characteristics with a

scale of a few centimeters (one inch). Examples are old and ridged sea ice and the wind-ruffled ocean. Smooth, horizontal surfaces, such as calm water and new ice, reflect energy away and appear black in the image.

In these images, most of the sea ice has a range of gray tones. New ice is dark in the October 5 image (on the left), and can easily be confused with calm water. However, in the October 8 image (upper right), much of the open water appears white with dark streaks; these most likely are bands of new ice aligned with the wind, which itself is roughening the water. Sequential observations such as these can provide a good estimate of how the open-water area and the formation of new ice change with time. Moreover, a comparison of the positions of identifiable ice floes in the two images provides an estimate of ice motion during the three-day interval. In this example produced by Frank Carsey at the Jet Propulsion Laboratory, the entire ice field shifted to the northwest during the period. Consequently, in order to accentuate the relative motion shown as velocity vectors in the lower right image, the mean movement was subtracted from each.

Ice-motion data such as these are important for at least three reasons. First, both the absolute- and relative-motion vectors provide an estimate of ocean surface currents. Second, the relative motion gives a measure of the opening and closing of the pack ice, and the rate at which open-water leads are formed. Finally, these observations have important operational applications for ship routing and for mining and drilling operations at high latitudes.

The capability to monitor motions of this scale will be realized in the early 1990's when several SAR-equipped satellites will be launched into polar orbits. These include the European Remote Sensing Satellite, the Japanese Earth Resources Satellite, and the planned Canadian Radarsat. NASA is supporting these activities by constructing a ground receiving, processing, and archival facility — the Alaskan SAR Facility (ASF) — at the University of Alaska at Fairbanks. The ASF will enable the acquisition of SAR observations over much of the Arctic, including the entire state of Alaska. As a complement to NASA research activities, NOAA plans to use these data to demonstrate the utility of SAR for operational applications. In addition to the ASF, ground stations operated by the European Space Agency and Canada collectively will facilitate acquisition of SAR data from most of the ice-covered northern waters, thus providing the first opportunity for routine measurement of the characteristics and movement of the Arctic ice pack.



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