CIRCULATION AND WATER MASSES IN THE GULF OF ALASKA

by

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Final Report
Outer Continental Shelf Environmental Assessment Program
Research Unit 289

March 1981

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I. SUMMARY

In the last year of this OCS project, analysis of prior oceanographic data from the Gulf of Alaska has continued with several new ideas and concepts evolving. In addition to the continued treatment of archived OCS data, more recent hydrographic and meteorological data gathered on other projects, are being incorporated into the analysis. For example, two cruises in Fall 1980 occupied many of the stations in the OCS grid. These additional data have provided new insights into the coastal circulation in the Gulf of Alaska. In particular, an hypothesis has been developed that suggests that processes affecting sea level in the estuaries can drive an alongshore coastal flow and/or vice-versa. We have evidence of a closely-coupled Prince William Sound - Alaska Coastal Current system which supports this idea. The time scale for circulation responses in this system are of the order of hours to days.

The major milestone of the past year's OCSEAP work is the determination of a vast coastal fresh water discharge for Southeast and Southcoast Alaska, which is slightly greater than the discharge from the Mississippi River. This discharge is in the form of numerous small streams, not major rivers, and thus has generally been overlooked as a major fresh water source. The coastal current responds to this discharge on both an annual and inter-annual basis. Wind stress also plays an important role in modifying this coastal flow. The fresh water discharge is speculated to be an important influence on the circulation of the Alaska Current and hence the circulation of the North Pacific Ocean.

'11. INTRODUCTION

No new hydrographic data have been gathered during the past year under sponsorship of OCS. Analysis of previous data has continued, however. This recent work has resulted in three additional reviewed-journal papers on the circulation of the Gulf of Alaska and its forcing mechanisms. A preprint of the discussion of the fresh water discharge in the northeast Pacific is included as the first appended report following this report.

The majority of the funds for the past year's research was allocated to the continued satellite monitoring of Alaskan coastal waters. We have achieved both the visible and IR data with many enhanced images. A list of these data is included as Appendix I of the second appended report.

III. CURRENT STATE OF KNOWLEDGE

The most complete reference for the state of knowledge of the circulation of the Gulf of Alaska is the "Review of the physical oceanography of the northeast Gulf of Alaska, with emphasis on its implications to oil and gas development," which was included as an appendix to the 1980 annual report of RU289.

Within the past year, the research on this contract has evolved to a level where the use of analytic models is appropriate. While no models have been directly applied to our data, the general results of these models are useful. For example, the analytic estuary-coastal current model of Klinck *et al.* (1981) suggests that sea levels within an estuary and along the coast are related. Thus, a mechanism for driving the circulation of either exists; that is, a change in either will affect the other. These models allow us to think more clearly about the importance of various processes on the coastal circulation. The models do not mimic the observations as numerical models might do, but instead address the physics of the problem. The use of these models is discussed in more detail in Section VI.

IV. STUDY AREA

Field work under this research unit has ranged over the continental shelf of the southern Alaska coastline from Yakutat to Umiak Pass from the coastline to tens of kilometers beyond the shelf break. The satellite data collected for OCSEAP by this unit covers the entire Alaskan coastline from the Beaufort Sea to Southeast. The analysis portion of the past year's work has addressed the entire Gulf of Alaska region.

V. SERVICES, METHODS AND RATIONALE OF DATA COLLECTION

The primary data collection method used in previous years by this research unit was the CTD/STD (salinity - temperature - depth) profile. Some current meter and bottom pressure gauge deployments have also been undertaken to supplement the hydrographic data. From the CTD/STD data, contour maps of salinity, temperature, density and dynamic height were constructed. The contours provide information on the direction and intensity of the flow. The current meter measurements provide a means of "calibrating" the currents obtained from the density fields. The sea level as measured at the coastline by NOS (National Ocean Survey) stations was used in conjunction with the bottom pressure data to determine changes in the slope of sea level between the positions and hence provide a measure of current changes.

The CTD/STD station positions were chosen by 1) a knowledge of the spatial scales of the features to be measured and 2) requirements to continue a time history of oceanographic parameters at a particular location. The objective has been an improved understanding of changes in the oceanographic parameters, spatially and temporally.

VI. RESULTS AND DISCUSSION

Remote Sensing Activities

During the last half year of the project until September 15, 1980 all incoming NOAA-AVHRR satellite imagery has been monitored at the NOAA-NESS CDA-Satellite Station at Gilmore. During this time, a total of 846 prints, including 46 gray scale enhancements and 114 enlargements, made specifically for us, were produced by the tracking station. This number also includes copies of 142 enhancements originated by the Satellite Service Station in Anchorage. The collection of satellite imagery is contained in 41 ring-binders and is divided into two geographical areas: (a) the Arctic Ocean and Bering Sea and (b) the Gulf of Alaska. Most of these binders have been transferred to the Remote Sensing Library of the Geophysical Institute for archiving.

About 25% of the 846 prints produced were requested by persons working outside this project. More than half of that imagery was produced in support of a Master of Science Thesis for an Institute of Marine Science student studying processes along the shelf break in the SE Bering Sea. The next largest request for satellite support was made by a Sea Grant project studying the Bering Sea ice edge. In addition, the temperature structure along the ice edge in the Chukchi Sea was kept under surveillance in support of an OCS study to predict bird migrations.

The satellite facility, as in years past, has maintained some international connections through discussions of the use of satellite data with visiting Japanese scientists and instructions in the use of satellite data for a student from Taiwan. A request for satellite data for the Russian Arctic, however, had to be referred to other sources.

Some joint work on the sea-ice conditions in the Bering Sea was conducted during March and July with a visiting OCS-supported scientist from PMEL in Seattle. When the funding for this project ended in September, a ringbinder containing 125 satellite enlargements for the Norton Sound area, from 5 December 1979-21 May 1980, was mailed to PMEL to be analyzed there.

This satellite project was supported by NOAA-NESS and then OCS grants from 1974 to 1980. Numerous gray scale enhanced negatives for surface temperature studies have been produced. To make this information available to other scientists, a report entitled "Surface temperature enhanced NOAA-satellite infrared imagery for the Bering, Chukchi, and Beaufort Seas and the Gulf of Alaska, May 1974 - September 1980" was prepared (University of Alaska, Institute of Marine Science Technical Report R80-2). This report, which we have included as our second appended report, contains a listing of all negatives and digitized tapes of special interest that have been saved. The report also shows how the enhanced imagery has been used and gives a background and summary of the NOAA-satellite project since the tracking station at Gilmore became operational for real-time Alaskan imagery in 1974.

Coastal Circulation in the Gulf of Alaska

The bulk of the principal investigator's research effort in the last year has been devoted to analysis of nearshore circulation in the northern Gulf of Alaska and Prince William Sound. The influence of fresh water and winds on this coastal circulation has been discussed in previous annual reports and will soon be published in the May 1981 issue of the Journal of Marine Research. For that work, a very simple hydrology model is used. In the past year, a more advanced treatment of the fresh water discharge has been undertaken with some significant results. The details of this work are contained in our first appended report, "Coastal fresh water discharge in the northeast Pacific," a brief summary of which is given below.

The Yukon has long been considered as the largest Alaskan river; however, there is a larger fresh water source in Alaska. Recent studies of the coastal flow in the Gulf of Alaska at the Institute of Marine Science have revealed a large, river-like, fresh water coastal jet along Southcoast and Southeast Alaska. This jet moves from Southeast toward the north at speeds in excess of two knots (1 knot = 1 nautical mile per hour). It is approximately 10 miles wide, and because of the earth's rotation it generally stays near the coast. The flow continues around the Gulf of Alaska; a portion enters Prince William Sound, then moves past Kodiak Island and along the Aleutian Islands.

The average flow in this jet is considerably greater than that of the Yukon River (23,000 m^3/s versus 6,796 m^3/s). Incidentally, the average flow is greater than that of the Mississippi River which is 18,123 m^3/s, in effect giving Alaska a claim to the largest U.S. river. The maximum seasonal flow occurs approximately in October coincident with the maximum precipitation.

The minimum coastal flow is in March. Its maximum flow is also greater than the maximum Mississippi River discharge.

Why has this significant fresh water source gone unnoticed until now? The primary reason is the absence of large rivers in the region. Though residents of Southeast Alaska brag about their high rates of precipitation, no major rivers are associated with that rainfall. The enormous annual rainfall, which occasionally exceeds 8 meters (26 feet), enters the ocean by way of numerous small streams rather than joining to form large river networks. Since few of these streams are gauged, the water in this coastal jet has to be determined indirectly from drainage areas and precipitation rates. These rates are subject to considerable error, so the estimates given here are very rough.

This section of coastline contains over two-thirds of the North American ice fields. Climatic changes which alter the size of these ice fields could affect the amount of fresh water available to the coastal jet. Thus, this coastal circulation might be very sensitive to climatic changes.

There are numerous consequences of this coastal jet. Because the flow is quite steady, vessels navigating the coastal areas in the Gulf of Alaska can use it to their advantage when traveling west-northwest from Southeast to Southcentral Alaska, but should avoid it when moving in the opposite direction. The coastal jet probably has important biological implications and may influence the distributions of fishes and marine mammals. Unfortunately, this current is also a mechanism that can transport pollutants from one coastal harbor to another without significant offshore dilution.

If the analytic two-layer model of Heaps (1980) is applied to our system, it predicts that there will be an offshore flow of about 20% of the alongshore flow. Thus, after several hundred miles of travel along the coast, the fresh water should be spread over the entire shelf. Since it appears that this does not occur, a mechanism must exist to concentrate the flow at the coast. The predicted offshore fresh water movement has a very similar appearance to an Ekman upwelling situation. Therefore, if Ekman downwelling conditions are superimposed on this fresh water coastal current, a very intense narrow flow will occur. This type of response coincides with recent observations of this coastal jet near Seward. It is less than 10 km wide and it has speeds at the surface in excess of one knot. Apparently the sampling along the Seward line and elsewhere on the hydrographic grid used in the OCSEAP studies was too coarse to resolve adequately the baroclinic velocities. As suggested previously in earlier annual reports, the baroclinic transports are correct as they do not depend on station spacing.

In addition to the previous hydrographic stations being too far apart, recent non-OCSEAP data from November 1980 indicate that the Seward line poorly represents direction and width of the coastal flow. This is a consequence of downstream topographic features--a peninsula and several islands. These obstructions divert the flow offshore as it crosses the Seward line, making it appear to separate from the coast at the point. This also causes an apparent counterflow on the adjacent downstream hydrographic section at Seal Rocks. Thus, the Seward line should be used to determine baroclinic transports only--not baroclinic speeds or the position of the coastal current.

The use of the analytic model by Heaps (1980) also predicts that the barotropic effect of adding fresh water to a coastal current is small. Instead, the alteration of the cross-shelf density by the fresh water is the important dynamic consequence. Incidentally, the fresh water discharge for the northern

Gulf of Alaska is approximately twice the discharge that Heaps used in his model for the Norwegian coast. Similarly, our transports are about twice his values.

An analytic model developed by Klinck *et al.* (1981) of fjord and coastal circulation helps shed light on the interactions between the sea level within an estuary and the coastal current flowing alongshore. Their model indicates that an elevation in sea level within the estuary will accompany an acceleration in the alongshore flow. The implication of this effect is that routine sea level observations can be used to estimate the alongshore flow. Of course, this phenomenon has not yet been verified for the Gulf of Alaska. This application of the analytic model serves not only to understand better the physics of the system but also may provide an inexpensive monitoring scheme.

The relatively narrow, intense coastal flow found throughout southeast and southcoast Alaska presents an interesting problem in estuarine circulation. For estuaries with below average fresh water discharge, the coastal current can serve to drive the circulation in a reverse manner, that is, in at the top and out at the bottom. Even for the usual estuarine circulation, the coastal current would serve to reduce the flow since fresher water could be found outside the estuary.

The other major feature of the circulation of the Gulf of Alaska is the Alaska Current which flows westerly along the shelf break. The coastal current and Alaska current are weakly coupled in several ways. First, the coastal current can mix directly with the Alaska Current south of Kayak Island where the coastal current is directed southward and the shelf becomes very narrow. To the west, the Alaska Current displays the low salinity signature of the coastal current. The Alaska Current also appears to shed eddies which propagate from west to east along the shelf break. These perturbations accelerate the cross-shelf mixing over the shelf. The third manner in which the coastal and shelf-break currents interact is through the continuous supply of fresh water at the coast. This maintains a cross-shelf density gradient which can in turn drive the Alaska Current. If this latter conjecture is true, the coastal precipitation would be important to the circulation of the entire North Pacific.

In any case, the high rate of coastal precipitation presents an interesting meteorology problem since a vast amount of latent heat will be released to the atmosphere. Combine this warm air with the continental air masses found over the interior of Alaska and very abrupt thermal gradients will be created over the coastal mountain range. This atmospheric system is responsible for the glacial fields found along the coastal margin. Thus, the hydrology, glaciology and oceanography are closely coupled here.

VII. CONCLUSIONS AND OUTLOOK

The continued support of this research unit by BLM and NOAA over the past seven years is gratefully acknowledged. I especially appreciate the opportunity, in the past several years, to be allowed to pursue the research of the coastal flows, which has led to a better understanding of the circulation of the northern Gulf of Alaska.

As a consequence of these OCS studies, new programs are being initiated for the continued study of the Alaska Coastal Current. Support for this work is being sought from the National Science Foundation with some contribution requested from BLM. The focus of these new studies is the dynamics of the coastal current. An analytic model is expected to be developed in this effort.

The coastal current is also the object of studies into the biology, chemistry and geology of the northern Gulf of Alaska which are being organized at the Institute of Marine Science. Researchers in fisheries and marine mammals are frequently requesting information on this flow. This coastal flow is vital to studies of estuary circulation in the Gulf of Alaska. It also serves as an important medium to transfer pollutants along the coast, while limiting the pollutant movement across the shelf. Studies of the circulation of the Gulf of Alaska will continue, building upon the knowledge gained in this OCS research program.

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APPENDIX

REVIEWED JOURNAL PAPERS SPONSORED BY BLM/NOAA OCS PROGRAM - RESEARCH UNIT 289

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University of Alaska

March 1981

APPENDIX

Reviewed Journal Papers Sponsored by BLM/NOAA OCS Program - Research Unit 289

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Royer, T. C. Coastal sea level influences in the Northeast Pacific. (To be submitted to *J. Geop. Res.*).

Royer, T. C. Circulation of Prince William Sound and adjacent waters. (To be submitted to *Coastal & Est. Mar. Sci.*).

Solomon, H., K. Ahlnäs, and G. R. Garrison. 1981. Satellite and Oceanographic Observations of the Warm Alaskan Coastal Current in Bering Strait and the Chukchi Sea. (in preparation).

COASTAL FRESH WATER DISCHARGE IN THE NORTHEAST PACIFIC

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Figure 5. Monthly fresh water discharge (same as Figure 2) for 1974 to 1979 (line) with **baroclinic** transport (dots) for 1-7 0/100 db superimposed. Range of the **baroclinic** transport is 0 to 1.5 x 10^6 m^3 s^{-1}.

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Abstract

Very high annual rates of precipitation in the coastal mountains which border the northeast Pacific Ocean produce large fresh water discharges (23000 $m^3 s^{-1}$). This discharge has been ignored previously since it does not enter the ocean in the form of large rivers, but instead, the water enters by way of numerous small rivers and streams. This coastal discharge contributes approximately 40% of the fresh water that enters the northeast Pacific from the atmosphere. The discharge is comparable to the mean annual discharge of the Mississippi River system.

The fresh water creates a density gradient which drives an along-shore baroclinic jet. The width of this jet is less than 25 km with velocities in excess of 100 cm s^{-1}. It extends along the coast from southeast Alaska to at least Kodiak Island. Apparently, the flow is maintained as a narrow current adjacent to the coast by wind stress which causes down-welling conditions here throughout most of the year.

1. Introduction

The importance of fresh water to the ocean circulation of the northeast Pacific has been recognized since Tully and Barber (1960) treated it as an estuary. More recently, coastal fresh water discharge has been identified as being a primary driving mechanism of local coastal circulation in the northwest Gulf of Alaska (Schumacher and Reed, 1980) and throughout the northern Gulf of Alaska (Royer, 1981). Baroclinic flow controlled by salinity distributions is possible here because of the relatively low water temperatures and high rates of fresh water discharge.

Previous discussions of the availability of the fresh water in the northeast Pacific are based either on river discharges or precipitation rates. Roden (1967) addresses the discharge of major river systems into the northeast Pacific and Bering Sea. The major river discharges are the Fraser River ($2.69 \times 10^3\ m^3 s^{-1}$) in British Columbia and the Copper River ($1.05 \times 10^3\ m^3 s^{-1}$) in Alaska. Roden also included six other minor rivers which have a combined average discharge of less than $3 \times 10^3\ m^3 s^{-1}$. Another method of assessing the availability of fresh water in the northeast Pacific is through the use of oceanic precipitation estimates. However, as can be seen by two recent estimates of maximum precipitation rates for the northeast Pacific, the calculated fresh water input can differ considerably. Reed and Elliott (1979) report a precipitation rate of 100 cm yr^{-1} while Dorman and Bourke (1979) show a rate of 180 cm yr^{-1} for the same area. This discrepancy is primarily caused by Dorman and Bourke correcting the oceanic precipitation using Tucker's method. They correct using coastal station data, and because coastal rainfall rates are high in the northeast Pacific the oceanic rates are enhanced.

2. The Discharge Computations

The high precipitation rates suggested by Dorman and Bourke (1979) are consistent with the rates used by Royer (1979, 1981) to obtain the coastal fresh water discharge in the northern Gulf of Alaska. The coastal discharges are determined using a 150 x 600 km drainage area to represent the coastal region. To calculate discharges, the monthly mean U.S. Weather Service divisional precipitation rates for southcoast Alaska are used. Two U.S. Weather Service climatic divisions are used in this work; the southcoast Alaska (approximately 140°W to 150°W) and the southeast Alaska (approximately 130°W to 140°W) (see Figure 1). Depending on the monthly mean air temperature, the precipitation is allowed either to runoff during the month or be stored as snow. The snow is released later when the air temperature is above freezing. It is released gradually over a period of several months, with a pattern that closely approximates the river discharge of those rivers which drain the coastal mountain ranges. An approach involving indirect computations is required here because direct measurements of the discharges of the myriad of rivers and streams is not possible.

To improve the estimate of coastal fresh water discharge into the northeast Pacific, the simple computations have been modified to better approximate actual drainage areas. This improved method still uses the monthly mean divisional precipitation and air temperatures as its input, but incorporates more realistic drainage areas and allows the interannual ablation or growth of the glacial fields which are found in these coastal mountains. This type of response is necessary since glaciers occupy approximately 20% of this coastal drainage area. Abnormally high summer air temperatures are permitted to cause a higher than normal fresh water discharge with abnormally low temperatures causing low fresh water drainages.

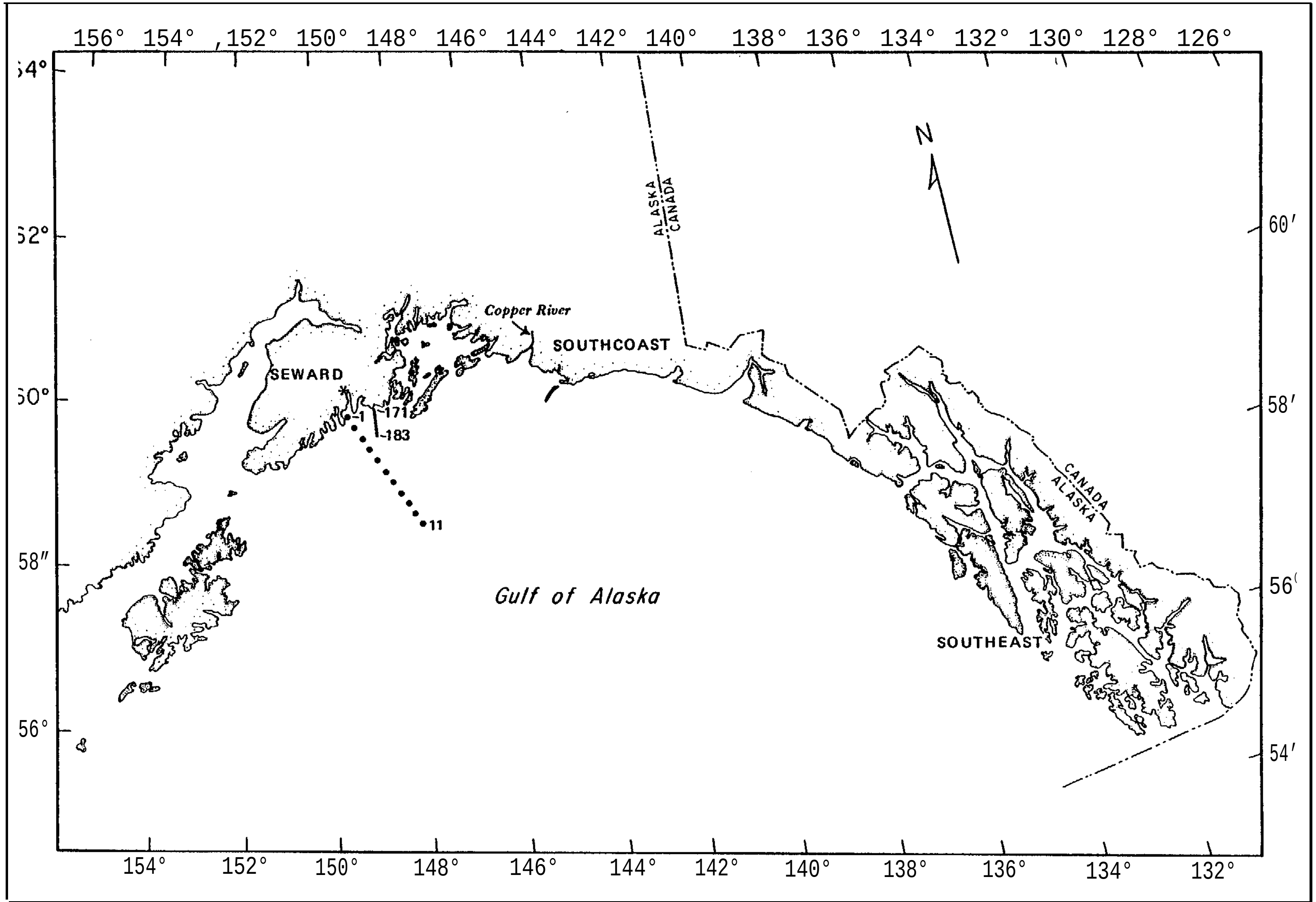

Figure 1. Coastal region of northeast Pacific Ocean.

Two separate drainage areas, southeast and southcoast Alaska are used in the computations (Fig. 1). Precipitation and air temperatures are available for each of the two divisions. Transit times in the form of phase shifts in the discharge are incorporated in this method. A northwestward coastal flow averaging about 30 cm s^{-1} from southeast to southcoast Alaska is approximated by lagging the southeast discharge by one month. The discharges from streams and rivers that are gauged are not included separately. The contribution from the Copper River, which drains a portion of interior Alaska, is not included because its records do not cover the same time period as the precipitation and air temperature records. As will become more evident later in this paper, its contribution (1000 m^3 S-l) is less than 5% of the total coastal discharge and is insignificant in comparison with other errors in the hydrology model.

The coastal topography and the precipitation distributions here are similar to other high latitude regions, such as the coast of Scandinavia (Bergeron, 1949). Along that coast the moist marine air masses impinging on the coastal mountain ranges are elevated adiabatically and precipitation takes place. Analogous processes occur at the northeast Pacific Coast where mountains with heights exceeding 4 km are common in the Alaska Coastal Range. The orographic control of precipitation causes higher rates at higher elevations. Thus, the 180 cm yr^{-1} precipitation rate measured at sea level probably translates into a much greater rate at the higher elevations. The location of meteorological observing sites in coastal communities, therefore, leads to an underestimate of regional precipitation rates. However, other areas on the leeside of the mountains will have lower rates. It is beyond the scope of this paper to evaluate the magnitude of these errors, since precipitation rates over these sparsely inhabited areas are not well known. Though detailed seasonal variations in rainfall are not well documented, the most complete representation of the spatial distribution of precipitation is given by Selkregg (1979). Annual precipitation rates in excess of 240 inches (610 cm) are present for the glacial areas, with one area in southeast Alaska having a 320 inch (813 cm) contour. Thus, while the use of the divisional precipitation averages *(about 240* cm) might be an underestimate it will be used in lieu of a suitable substitute. The high rate of coastal precipitation extends to the south along the British Columbia coast. Kendrew and Kerr (1955) indicate that the 100 inch (254 cm) precipitation contour is continuous along the British Columbia coast from Alaska to Washington. The effects of the British Columbia discharge will not be included in this study, though they are undoubtedly important.

3. Fresh Water Discharge

The addition of the monthly fresh water discharges for southcoast and southeast (lagged by one month) Alaska from 1931 through 1979 (Fig. 2) demonstrates a large seasonal signal (Fig. 3). This seasonal cycle in the fresh water discharge closely resembles the discharge reported in Royer (1979). The minimum in February-March coincides with oceanographic winter. The submaximum in May represents spring runoff followed by a general increase toward the October maximum. This increase is a result of the meltwater discharge and increased seasonal precipitation rate. The sharp decline in November-December is a consequence of air temperatures becoming less than 0°C.

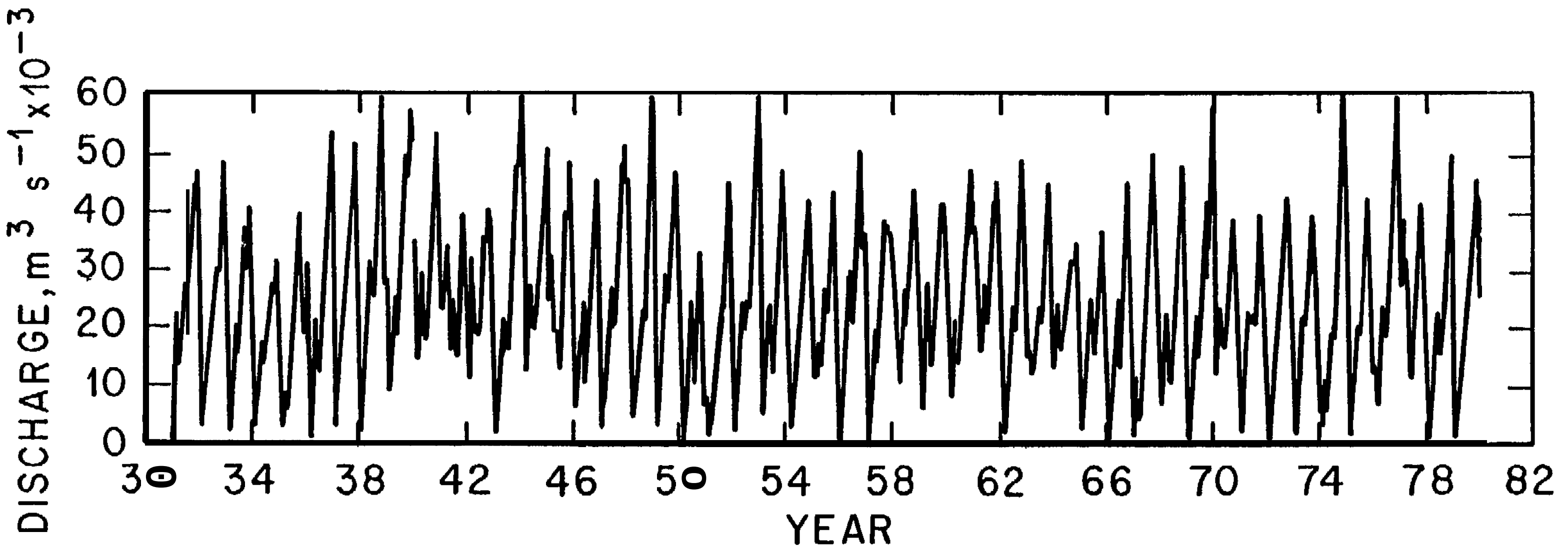

Figure 2. Monthly fresh water discharge for northeast Pacific with southeast Alaska discharge lagging southcoast Alaska discharge by one month.

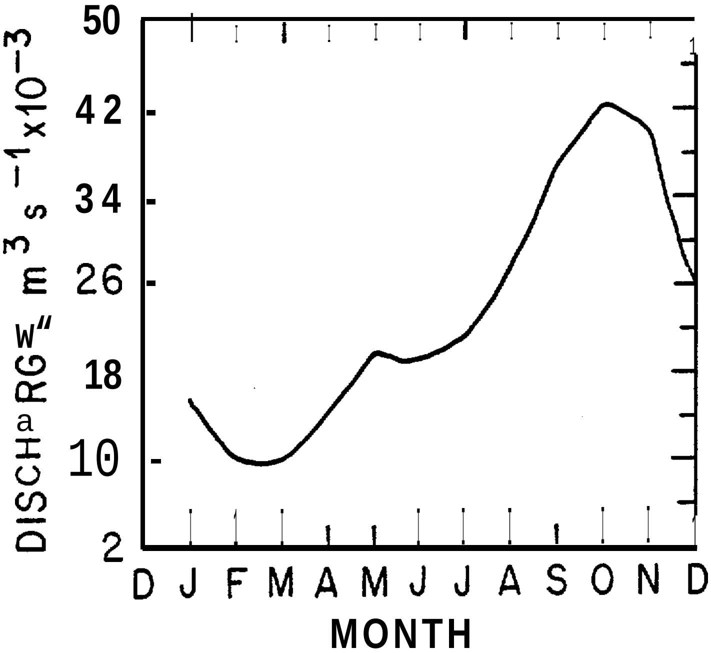

Figure 3. Mean monthly fresh water discharge determined in same manner as Figure 2, using data from 1931 to 1979.

The total discharge (Fig. 2) varies from nearly zero to greater than 60,000 $m^3 s^{-1}$. To better illustrate long-term trends the monthly air temperatures, precipitation and discharges are used to determine annual means (Fig. 4). As expected, the air temperatures for southcoast Alaska are always less than those for southeast. The curves of mean annual temperature and precipitation are quite similar for southcoast and southeast Alaska, indicating that the same atmospheric system probably influences both regions. The below freezing annual mean southcoast air temperatures for 1934 (-.31°C) and 1935 (-.16°C) are especially interesting since they were more than two degrees below any others and were accompanied by a subnormal precipitation rate. The discharge for 1934 and 1935 were 16000 $m^3 s^{-1}$ and 18000 $m^3 s^{-1}$ respectively which are well below the 1931-1979 average of 23000 $m^3 s^{-1}$. The minimum annual discharge occurred in 1950 when the average was slightly less than 16000 $m^3 s^{-1}$. This decreased discharge was the result of subnormal temperatures and precipitation rates in November 1950, yielding a discharge of only 16000 $m^3 s^{-1}$ compared with the normal, 40,000 $m^3 s^{-1}$. Throughout 1950, the monthly discharges were slightly below normal also. The maximum discharge occurred in 1940 with 33,000 $m^3 s^{-1}$ afterwhich there was a general decline in discharge until about 1971. The precipitation and air temperatures contain similar patterns. Because oceanographers commonly deal with transports of the order of 10^6 $m^3 s^{-1}$ these discharges seem to be insignificant. However, the mean annual discharge of the Mississippi River is about 18000 $m^3 s^{-1}$.

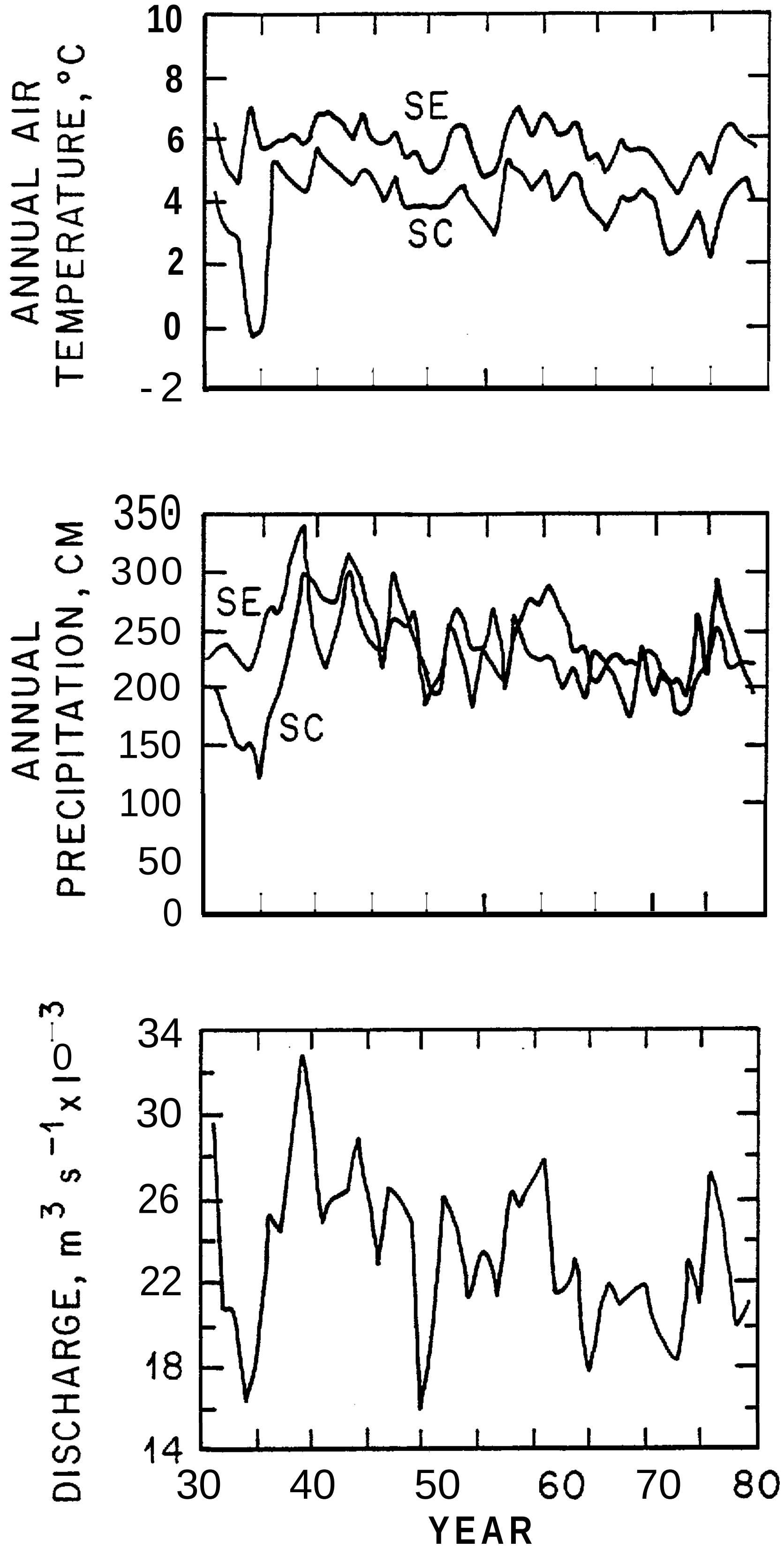

Figure 4. Annual mean air temperature (top" panel) for southeast Alaska (SE) and southcoast Alaska (SC), precipitation (middle panel) and fresh water discharge (lower panel).

4. Oceanic Response

The availability of hydrographic data for the Seward Line (Fig. 1) from 1974 through 1979 permits the comparison of the fresh water discharge with the alongshore baroclinic flow for this period (Fig. 5). The alongshore transport (0/100 db) between station pairs 1 and 2 and 1 and 7 (Fig. 1) are used for the correlation. Alongshore is defined here as being orthogonal to the section line (See Fig. 1). Lags for O to 3 months for the southeast discharge relative to the southcoast discharge are also used. Based on 22 samples, the best correlation (.763) between baroclinic transport and fresh water discharge occurs where the southeast discharge is lagged by one month. The confidence interval for this correlation is greater than 99.9%. The reduction in the correlation depending on lags is not sharp since the autocorrelation of discharge decreases slightly .847 at two months.

The above correlation between (0/100 db) transport and fresh water discharge contains a very large seasonal signal, so that the high correlation could be simply due to both responses having this annual signature. A better test of the relationship between fresh water discharge and baroclinic flow is done on the anomalies, that is, the time series remaining after the removal of each of their respective annual signals. The cross-correlation of the anomalies of (0/100 db) baroclinic transport for stations 1 - 7 and fresh water discharge with southeast lagged by one month is 0.603, which has a confidence interval of greater than 99.5%. This correlation is slightly higher than that determined previously for the simple runoff computations which was .580 (Royer, 1981). The more realistic methods used in this work probably better estimate the actual discharge.

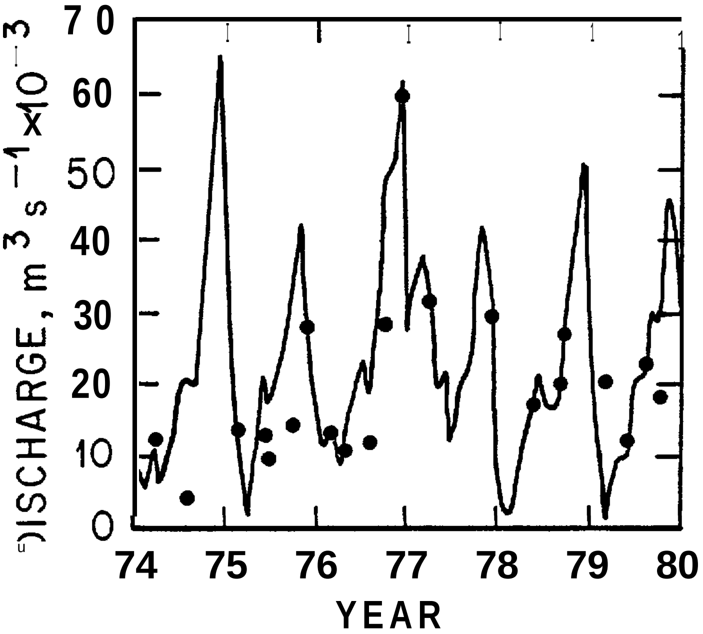

Figure 5. Monthly fresh water discharge (same as Figure 2) for 1974 to 1979 (line) with baroclinic transport (dots) for 1-7 0/100 db superimposed. Range of the baroclinic transport is 0 to 1.5 x 10^6 $m^3 s^{-1}$.

The representation of the coastal circulation by the flow across the Seward line is questionable in light of some more recent temperature and salinity cross-sections taken upstream from this line. In November 1980, the coastal current can be seen as a lens of low salinity water (< 31°/oo) near the surface between stations 1 and 2 on the Seward line (Fig. 6). The width of this lens is approximately 25 km. Because the flow is adjacent to the coastline, its direction will be strongly influenced by it. Islands and peninsulas to the *west* divert the flow southward across the Seward line, making that transect oblique to the current. This is verified by a section at Cape Fairfield (Fig. 7) taken a few hours prior to the Seward transect. At Cape Fairfield, the 31°/00 salinity band is only about 15 km wide. The difference could be a consequence of the cross-shelf spreading of the coastal current; however, for another section to the west of the Seward line, the coastal current is approximately 18 km wide. The conclusion is that the Seward line does not intersect the coastal current normal to the flow but rather obliquely. Thus, while the transports are valid, the width appears greater than it actually is, and the baroclinic current speeds are underestimated. These current widths are similar to the internal Rossby radius of deformation which ranges from 4 to 10 km for the Cape Fairfield line.

The dynamics of fresh water coastal currents has been investigated in the Norwegian Sea by Heaps (1980). He uses a two layer analytic model on a deep shelf similar to that of the Gulf of Alaska. The major difference between the two situations is that his fresh water discharge per unit length of coastline is about half of that for the Gulf of Alaska. As expected, his transports are about half of those for the. Seward line. One feature that

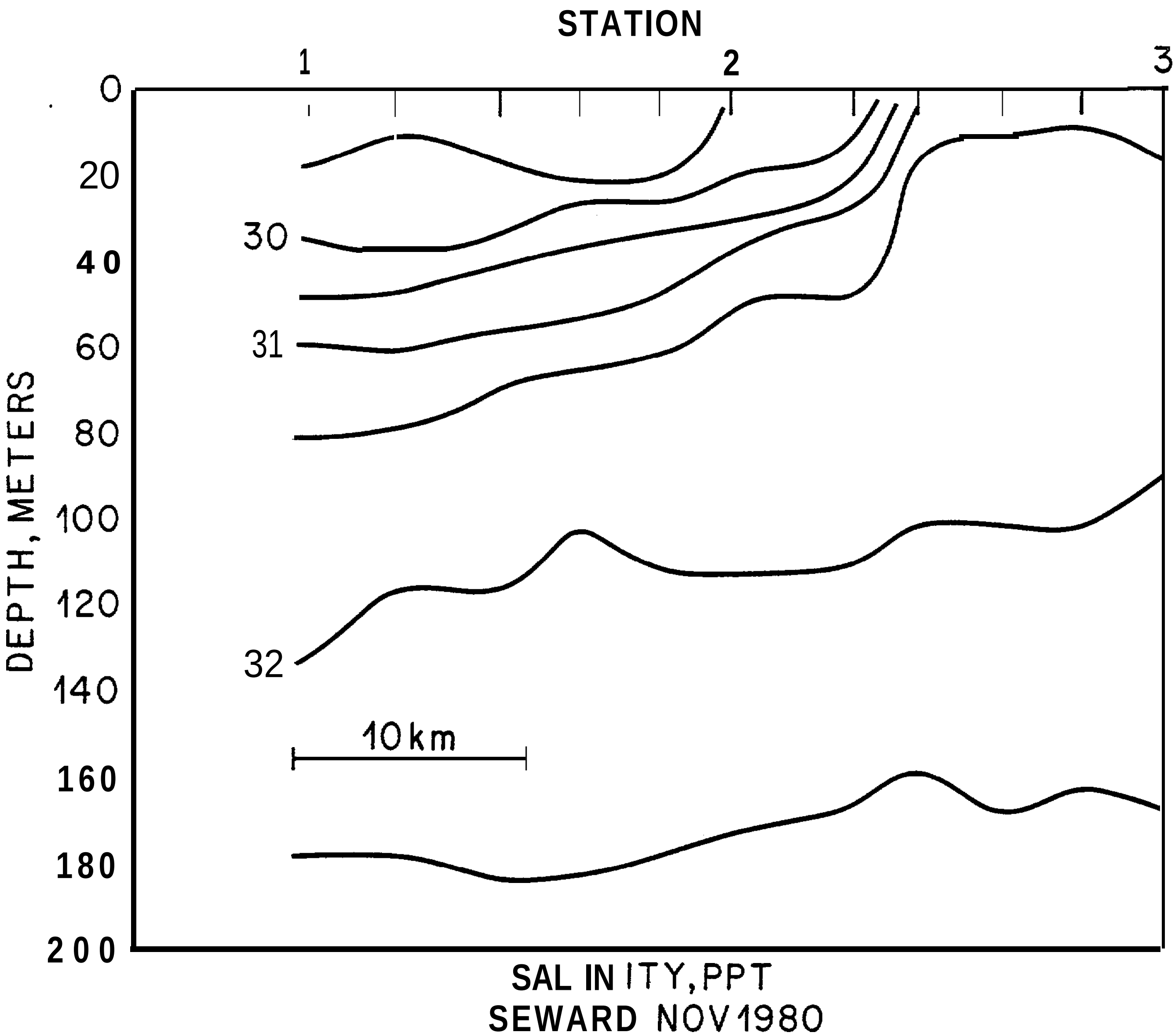

Figure 6. Salinity cross-section for Seward line looking eastward (see Figure 1), November 1980.

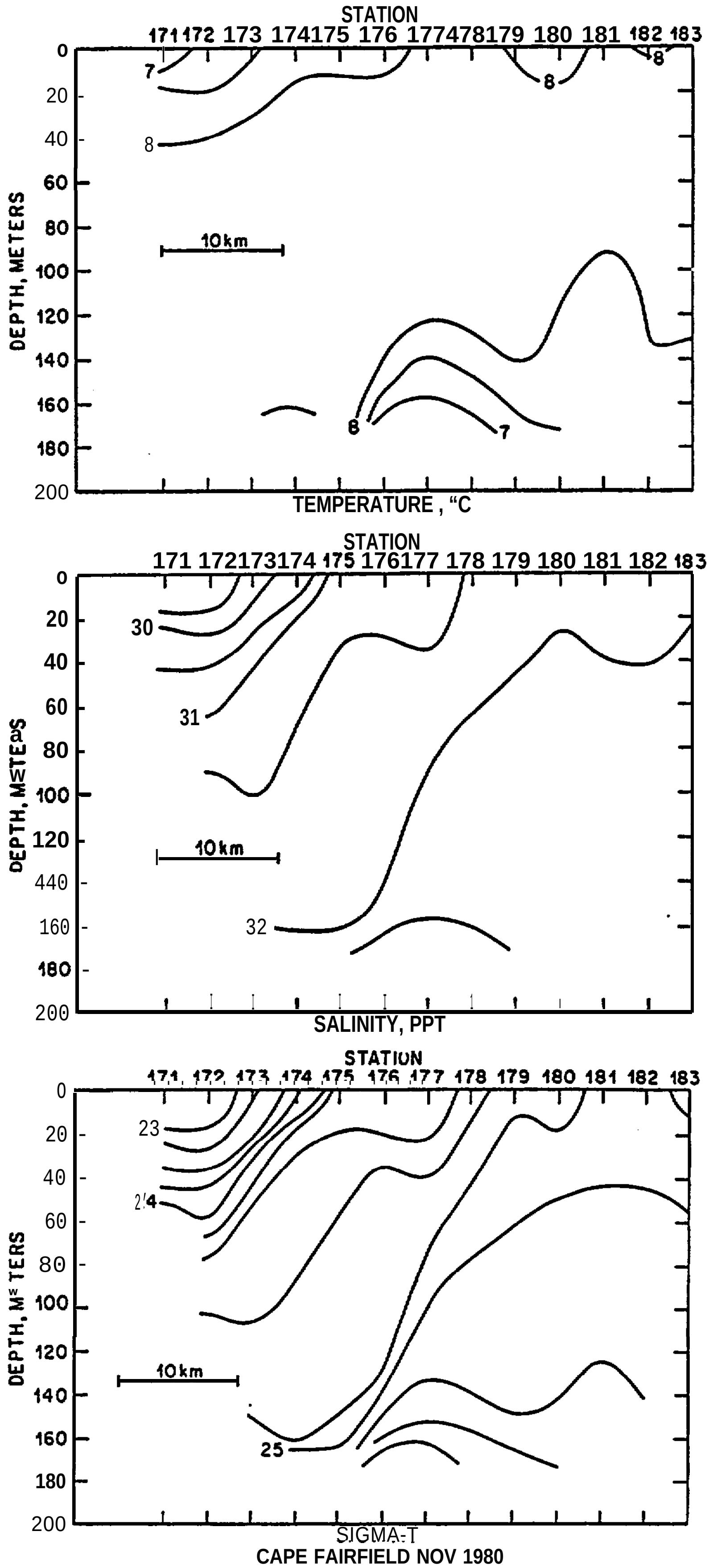

Figure **7.** Cross-sections of temperature (top panel), salinity (middle panel), and density (lower panel) **at** Cape Fairfield, November 1980 (see Figure 1 for locations).

he predicts but is not observed in our situation is a fairly rapid cross-shelf dissipation of the coastal flow. He predicts a cross-shelf velocity at the surface that is approximately 20% of the alongshore component. Thus, the coastal current should spread to encompass the entire shelf after traveling several hundred kilometers downstream. As can be observed in Figure 6, this does not occur here. The narrow current could be a result of flow being constricted as it exits Prince William Sound. However, other observations in the northern Gulf of Alaska (Royer *et al.*, 1979; Schumacher and Reed, 1980) verify a narrow flow elsewhere.

A mechanism which could concentrate this flow at the coast is wind stress. The wind stress, here expressed as upwelling indices, changes by an order of magnitude from summer to winter in the northern Gulf of Alaska (Royer, 1975). Throughout the year easterly winds are common so that the northern Gulf of Alaska usually has downwelling conditions (Livingstone and Royer, 1980). During the November 1980 cruise the mean downwelling index was 69 $m^3 s^{-1}$ (100 m of coastline)$^{-1}$ (Bakun, personal communication), which is typical for that time of year (Royer, 1979). The offshore transport in the upper layers as predicted by the Heaps (1980) model can be compensated by the onshore Ekman transport. Each of these processes has a lower layer of comparable thickness that moves in the opposite direction of the upper layer. Downwelling is phased so that it lags the maximum fresh water discharge by approximately three months; however, the maximum baroclinic transport remains in phase with the fresh water discharge (Royer, 1979). The narrow, intense coastal current can be considered to be created by the fresh water discharge and then modified by the winds.

Eddies are predicted for salinity induced flows under similar conditions (Elliott and Reid, 1976), but in this case the available hydrographic data are inadequate to address this problem. Eddies will form if there is cross-isobathic flow. Their existence will be investigated in a future study.

5. Conclusions

Through the use of runoff computations, the coastal fresh water discharge for southeast and southcoast Alaska is estimated as about 2300 $m^3 s^{-1}$. This computation does not include the Copper River or discharge from British Columbia, though the latter is probably significant. This water enters as a line source at the coast rather than as a point source as would be typical of large river input. This fresh water creates a cross-shelf horizontal density gradient driving an alongshore baroclinic flow which can exceed $1.3 \times 10^6 m^3 s^{-1}$. The winds, which are typically easterlies, converge this upper Ekman layer water at the coast and maintain the flow as an intense narrow current, generally less than 20 km wide.

The coastal mountain ranges bordering the Gulf of Alaska act as a barrier to the storms which move easterly across the North Pacific. Adiabatic elevation of these moist air masses cause very high rates of precipitation (> 8 m yr^{-1}) in the form of rain and snow. The precipitation can be retained for months or even years in the glacial fields which occupy approximately 20% of the region. Better estimates of the growth or ablation of these ice sheets would improve this method of determination of fresh water discharge. For example, what effect would be observed in the coastal current under glacial advance or retreat? With any increase in the fresh water discharge, the baroclinic transport would probably increase, what would be the current response? Will it become wider, deeper or simply faster? These types of questions should be answered through the application of the two layer baroclinic model.

Though it was stated that the volume of fresh water discharge was comparable to the flow of the Mississippi River, it is equally important to stress the significance of this source of fresh water to the Northeast Pacific circulation. The area of the Northeast Pacific from 60°N to 50°N, 150° to 140°W at 60°N and 150° to 130°W at 50°N is 1.11 x 10^6 km^2 and the annual precipitation rate is between 0.9 m yr^{-1} (Reed and Elliott, 1979) and 1.1 m yr^{-1} (Dorman and Bourke, 1979). Thus, the coastal freshwater discharge in the Northeast Pacific contributes between 38 and 43% of the total amount of fresh water that enters from the atmosphere. More importantly, this large *coastal* discharge can affect the dynamics since it creates a sharp horizontal density gradient which might drive alongshore flows at distances offshore.

Acknowledgement ts

The hydrology model was developed under sponsorship of the BLM/NOAA Outer Continental Shelf Environmental Assessment Program. The hydrographic data for November 1980 were obtained aboard *Alpha Helix* on the NSF/IDOE Seagrass Ecosystem Study (SES). Appreciation is extended to C. P. McRoy for making that sampling possible.

Valuable discussions with Professor Reid on this fresh water problem helped produce earlier papers, which form the base for this work.

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SURFACE TEMPERATURE ENHANCED NOAA-SATELLITE INFRARED IMAGERY FOR THE BERING, CHUKCHI, AND BEAUFORT SEAS AND THE GULF OF ALASKA

May 1974 - September 1980

by

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Institute of Marine Sciences
University of Alaska

March 1981

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ABSTRACT

A brief history is given of the NOAA-VHRR satellite project in Alaska, starting with the experimental NOAA-NESS supported Pilot Project in 1974. From 1975 to 1980 the project, under the sponsorship of OCS, has also addressed the needs of other scientists, particularly those supported by OCS grants.

During the progress of six years of satellite surveillance of Alaska and the surrounding oceans, numerous gray scale enhancements for surface temperature analysis have been performed. An introductory explanation of the theory behind the enhancements is given. All archived enhanced negatives are listed by date, temperature range and geographical location. Some digitized tapes that were saved because of special features are listed in the same manner. Some enhancements were performed for specific research interests. They are used as illustrations to show the applicability of enhanced infrared imagery.

The NOAA-NESS CDA Station at Gilmore generated all satellite products used by the satellite project. The final archiving, however, is spread out among different facilities in Alaska and Washington D.C. The specific locations for each product is given.

The purpose of this report is to bring the vast quantity of partly unused satellite data to the attention of the inquiring scientist.

SATELLITE BACKGROUND

Since 1960, American weather satellites have orbited the earth. In October 1972 a second generation of environmental satellites of the Improved TIROS Operational Satellites (ITOS) series, the NOAA-2, was launched. These satellites were in near-polar, sun-synchronous circular orbits at an altitude around 1500 km. On the NOAA-2 a new sensor was added, the dual-channel Very High Resolution Radiometer (VHRR). It scanned simultaneously in the visible (VIS), 0.6-0.7 µm, and the infrared (IR) 10.5-12.5 µm, bands. With the advent in October 1978 of the latest, third generation of polar orbiting environmental satellites, the TIROS-N, new sensors were again added to the spacecraft. The 2-channel VHRR of the previous satellites was replaced by the 4-channel AVHRR (Advanced Very High Resolution Radiometer). The scanning radiometers are sensitive to visible/near IR and IR radiation. Following is a table of the AVHRR channel characteristics from Hussey (1979).

Channel	Resolution at subpoint	Wavelength (µm)	Primary use
1	1 km	0.58 - 0.68*	Daytime cloud and surface mapping
2	1 km	0.725- 1.10	Surface water delineation
3	1 km	3.55 - 3.93	SST, Nighttime cloud mapping
4	1 km	10.5 -11.5	SST, Day/night cloud mapping
5	1 km	11.5 -12.5	SST

(Channel 5 to be added later to theAVHRR/2 instrument)
*0.55-0.90 µm on the TIROS-N

Channel 1 is almost identical to the VHRR VIS of 0.6-0.7 µm while the VHRR IR of 10.5-12.5 µm channel will be divided into two. The higher portion of the IR spectrum will make it possible to remove radiant contributions from atmospheric water vapor when determining surface temperatures. The lowest IR band, channel 3, used together with channel 4 will remove the ambiguity introduced by clouds in a portion of the image. The imagery produced by channels 1 and 2 look similar, but when compared, they provide an indication of ice/snow melt inception. Individually they are used to discern clouds, land-water boundaries and snow and ice extent. The spatial resolution for both systems is 1 km at nadir.

At NOAA's satellite Command and Data Acquisition (CDA) station at Gilmore Creek near Fairbanks, the area of coverage for the VHRR reached from NW Greenland to Seattle or south of the Aleutians. Another orbit covers the region from Hudson Bay to the East Siberian Sea. Thus, one satellite pass covered an area of about 2200 to 6600 km (Fig. 1). The satellites equipped with AVHRR fly at a lower altitude, around 850 km. Thus they cover a smaller area per orbit, but show it in a larger scale. The scale of the old NOAA imagery is about 1:9 million and the new AVHRR about 1:7.5 million. Figure 2 shows a typical mosaic of all descending NOAA-VHRR passes on 7 January 1975. The first pass comes across Baffin Bay, the NW Territories and British Columbia at 8:00 am AST. The second pass covers the Gulf and SE Alaska about 2 hours later. Around noon the third pass crosses over the Beaufort and Bering Seas and around 2:00 pm the last descending pass goes from Baffin Island to the Kamchatka Peninsula. The five ascending nighttime passes on 8 January 1975, cover the same area but from the opposite direction (Fig. 3). Due to the wintertime season both of the above mosaics are covered by infrared imagery only.

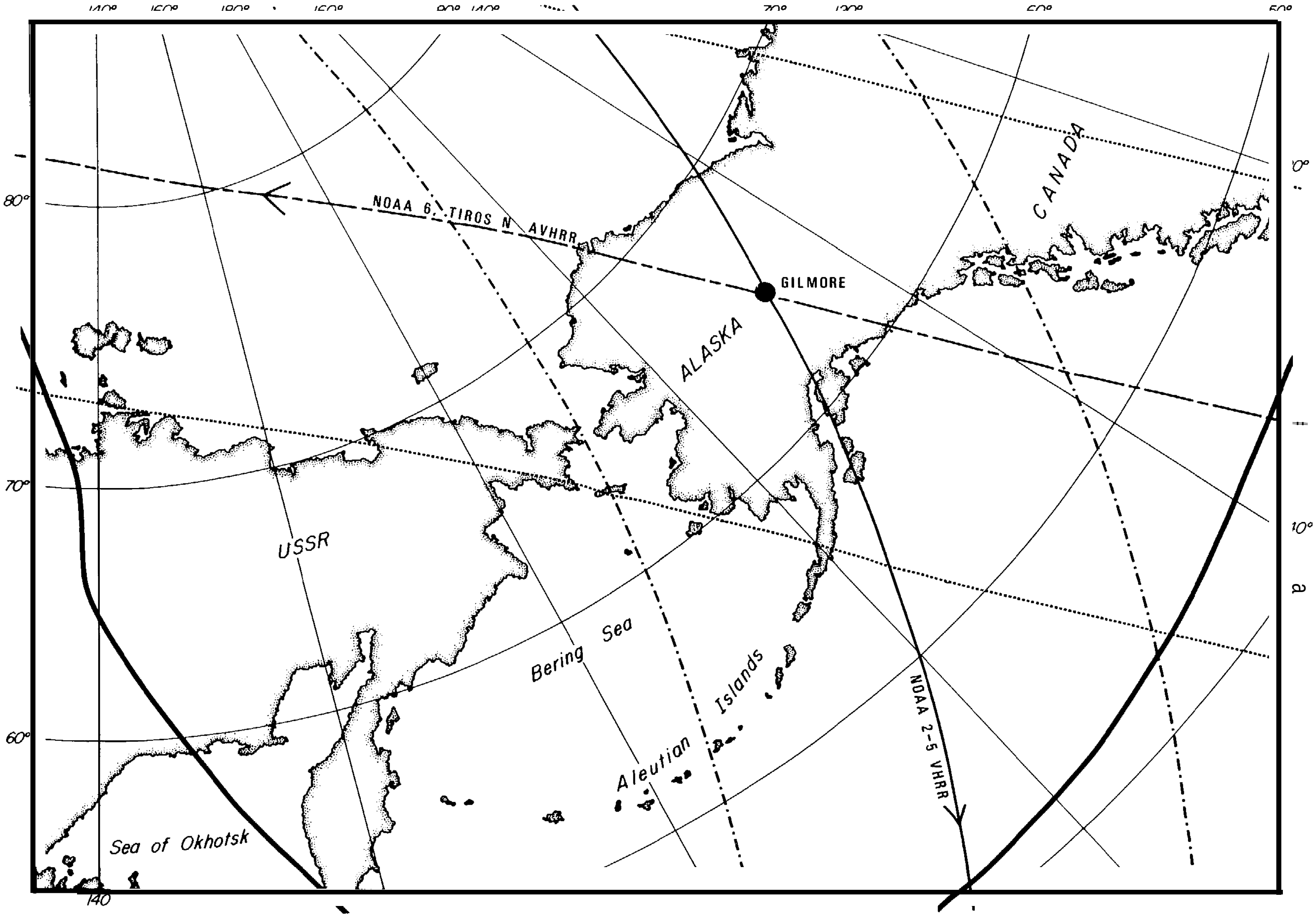


Figure 1. Areal coverage of the NOAA-VHRR and AVHRR satellites with sample orbits over the Gilmore Tracking Station.

Figure 2. Mosaic of NOAA-VHRR daytime descending orbits on 7 January 1975.

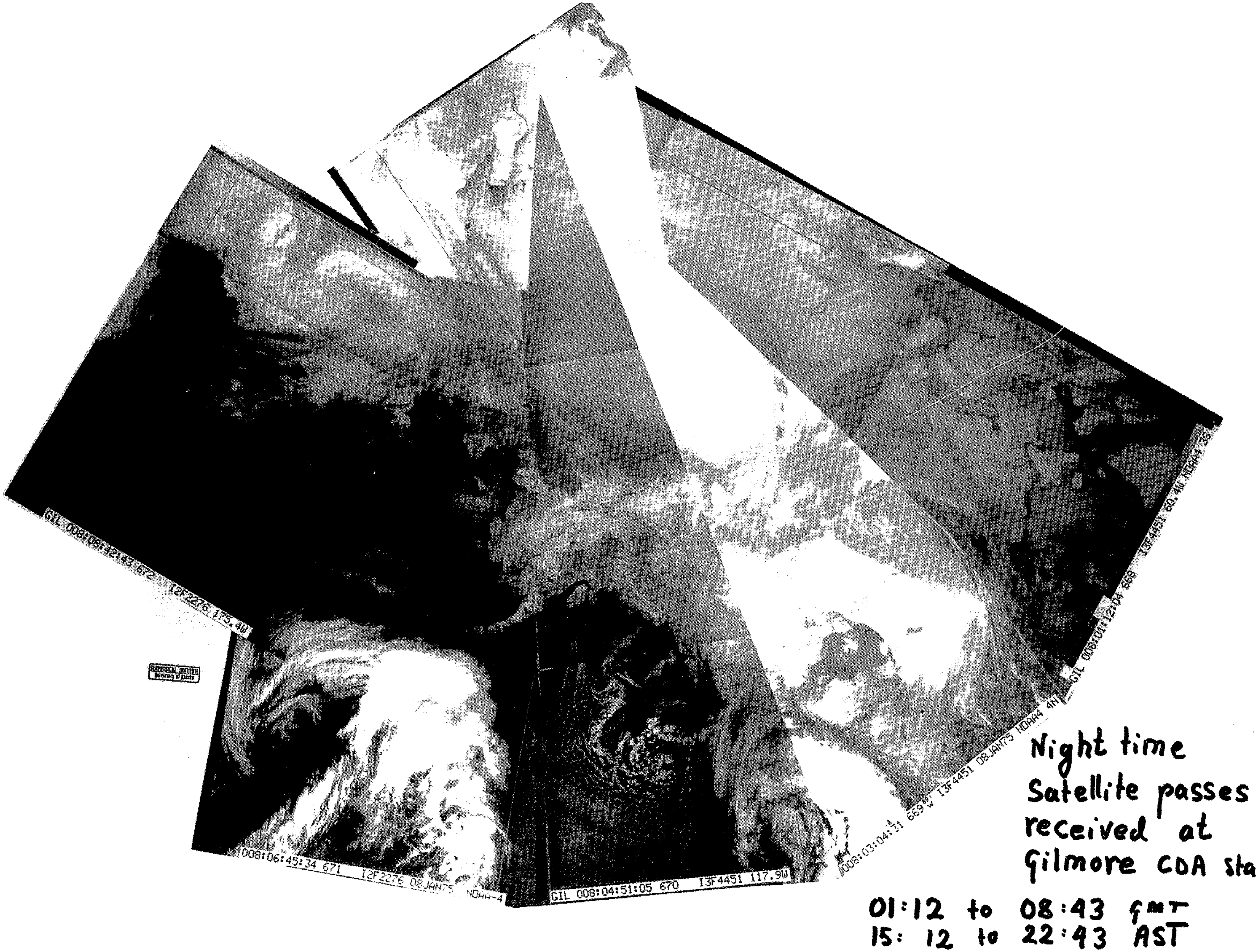


Figure 3. Mosaic of NOAA-VHRR nighttime ascending orbits of 8 January 1975.

For special features, enlargements in about 1:3 million have been made. Figure 4 shows a standard NOAA-2 VIS image of Alaska on 12 March 1974 in 1:9 million. The small white dot at the arrow is Harding Lake north of the Tanana River. Figure 5 is an extreme enlargement in 1:235,000 of a NOAA-VHRR IR imagery centered around Harding Lake. In this image the scan lines of the satellite radiometer are obvious as the distance between them is 1 km caused by the resolution.

In Alaska and the Arctic, the VIS band is only operational during part of the year, when the polar regions have daylight. The thermal IR band operates continuously, being independent of sunlight but sensitive to emitted terrestrial radiation. The purpose of this paper is to show some applications of the IR imagery and to list the NOAA-VHRR and AVHRR IR imagery that has been specially enhanced for surface temperature distribution.

THE ALASKA PILOT PROJECT

The NOAA satellite, equipped with the VHRR sensors, became operational with direct read-out at the Gilmore Creek station in March 1974. To investigate the usefulness and applicability of the satellite imagery to environmental needs in Alaska, a multi-disciplinary team from the University of Alaska was contracted by NOAA-NESS to carry out the pilot project (McClain 1975). This project operated for two years. In that time we demonstrated the usefulness of the satellite imagery to the Weather Service in Alaska, the Bureau of Land Management (BLM) for forest fire control and to the Arctic Sea Lift to Prudhoe Bay. In part as a result of our work, a satellite field service station was established in Anchorage. That station now distributes

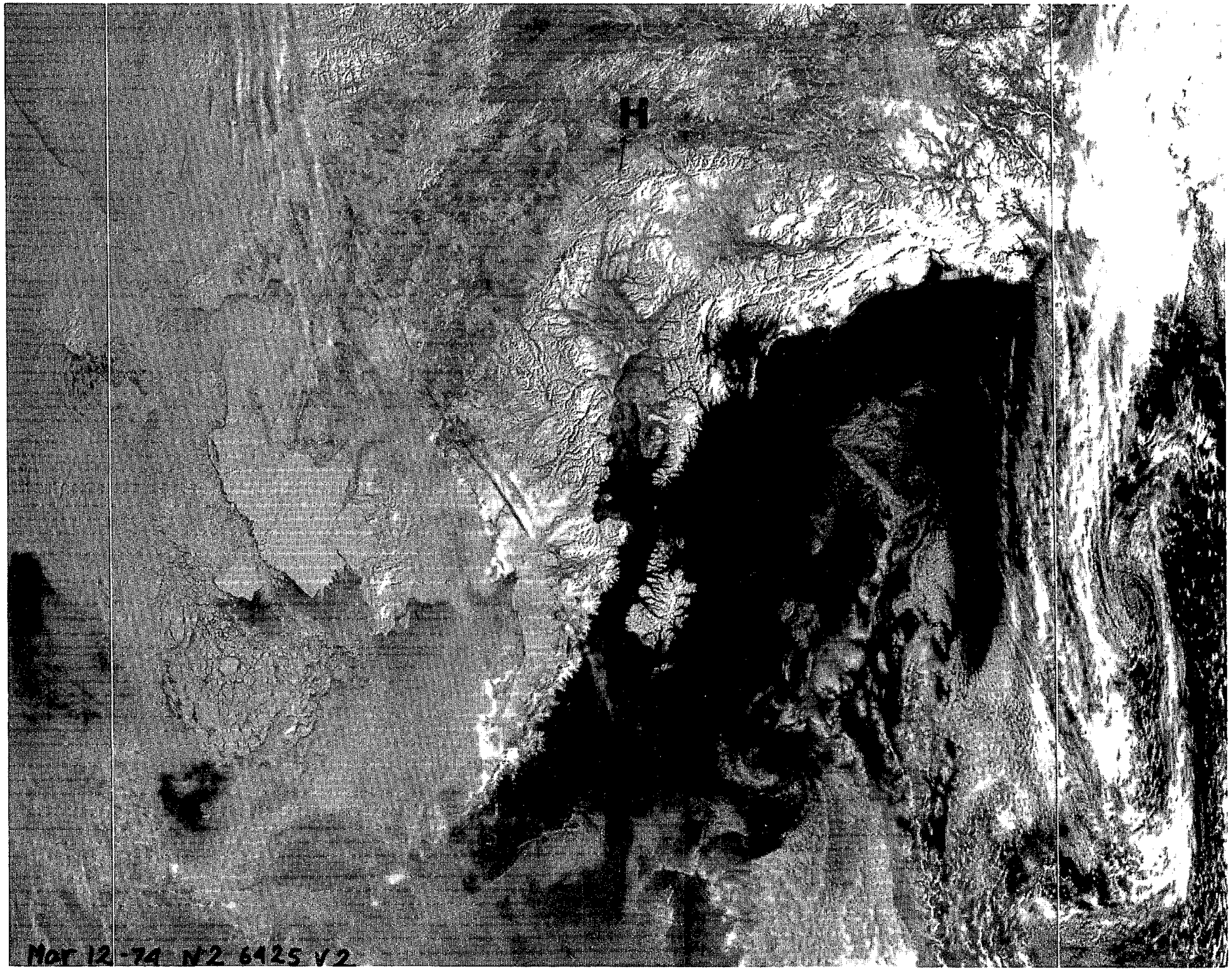


Figure 4. Standard size image of Alaska. Note Harding Lake at arrow by H. 12 March 1974, N2-6425 VIS. Scale 1:8.7x10

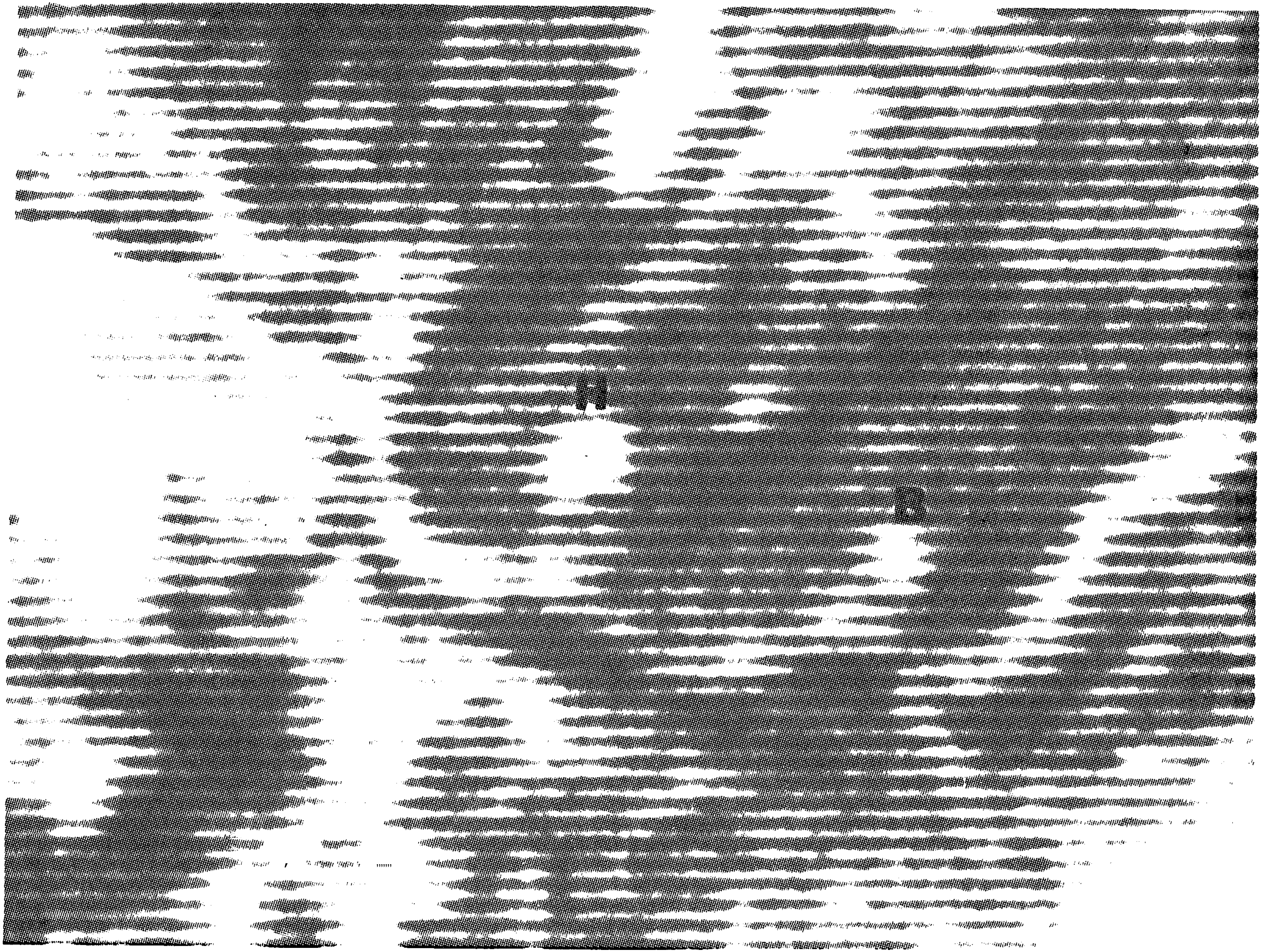


Figure 5. Harding Lake (H) and Birch Lake (B) along the Tanana River. NOAA-VHRR IR. Super enlargement, scale 1:235,000.

sea surface thermal and ice analysis charts for Bristol Bay and the Gulf of Alaska. After the pilot project ended, the Outer Continental Shelf Environmental Assessment Program (OCSEAP) took over sponsorship of the continued surveillance of satellite imagery for Alaska with surrounding ocean areas. As part of the program, gray scale enhancements were performed for surface temperature distribution of cloudfree ocean areas. A list of these enhancements is provided in this publication.

In most studies, the VIS and IR imagery were used to complement each other. The visible band shows the cloud cover and indicates which areas are cloudfree and hence applicable to surface temperature studies by the infrared band. Occasionally in the Arctic, thin, high clouds are transparent enough to let the surface features show through in the visible range. In the IR band, these same clouds are opaque and prevent the underlying higher surface temperature from being registered. Instead, the low temperature of the cloud tops is seen.

Forest Fire Control

About 90% of the acreage annually lost to forest fires in Alaska is caused by lightning fires. To survey the build-up of thunderstorms, aircraft were previously used extensively. During the pilot project, our research team found that thunderstorms could also be identified on the NOAA/VHRR imagery (Jayaweera and Ahlnäs, 1974). Thunderstorms are built Up of towering cumulus clouds which are very compact and easy to detect by their form and high reflectance in the VIS band. Since the clouds reach high altitudes, their tops are cold and consequently appear very bright also in the IR band. By convention, the gray tone in the NOAA-satellite

IR imagery is inversely proportional to the radiative temperature. By superimposing the simultaneous visible and IR imagery of the same orbit, the net imagery will show both the coldest clouds and the brightest areas (Fig. 6). Such bright areas can be attributed *to* large cumulus or possible thunderstorms.

The Auroral Zone

Enhancements of radiation have been observed by balloon measurements in the spectral interval 10-13 μm at auroral latitudes. This spectral window is slightly wider than the 10.5-12.5 μm IR band of the NOAA-VHRR. Thus, it appeared reasonable to assume that evidence of auroral activity would also be manifested in the NOAA imagery. Studying the standard IR imagery, areas of enhanced radiation were also found in the Arctic (Henriksen *et al.*, 1976; Fig. 7). However, no direct correlation was found to the auroral oval.

IR ENHANCEMENTS

The IR sensitivity of the NOAA satellites is 256 digital steps or 8 bits spread out over *a* temperature range from about -60 to 40°C. However, the capacity of the display device or satellite image is only 32 gray steps. When studying the surface temperature distribution, a narrow range is advantageous for gray scale contrast. Through a minicomputer that operates on the original digital tape of a specific satellite orbit, a chosen scene can be programmed to show any selected temperature range (Ahlnäs, 1979). On the 32-step gray scale the lowest temperature chosen will correspond to white and the highest to black with the temperature

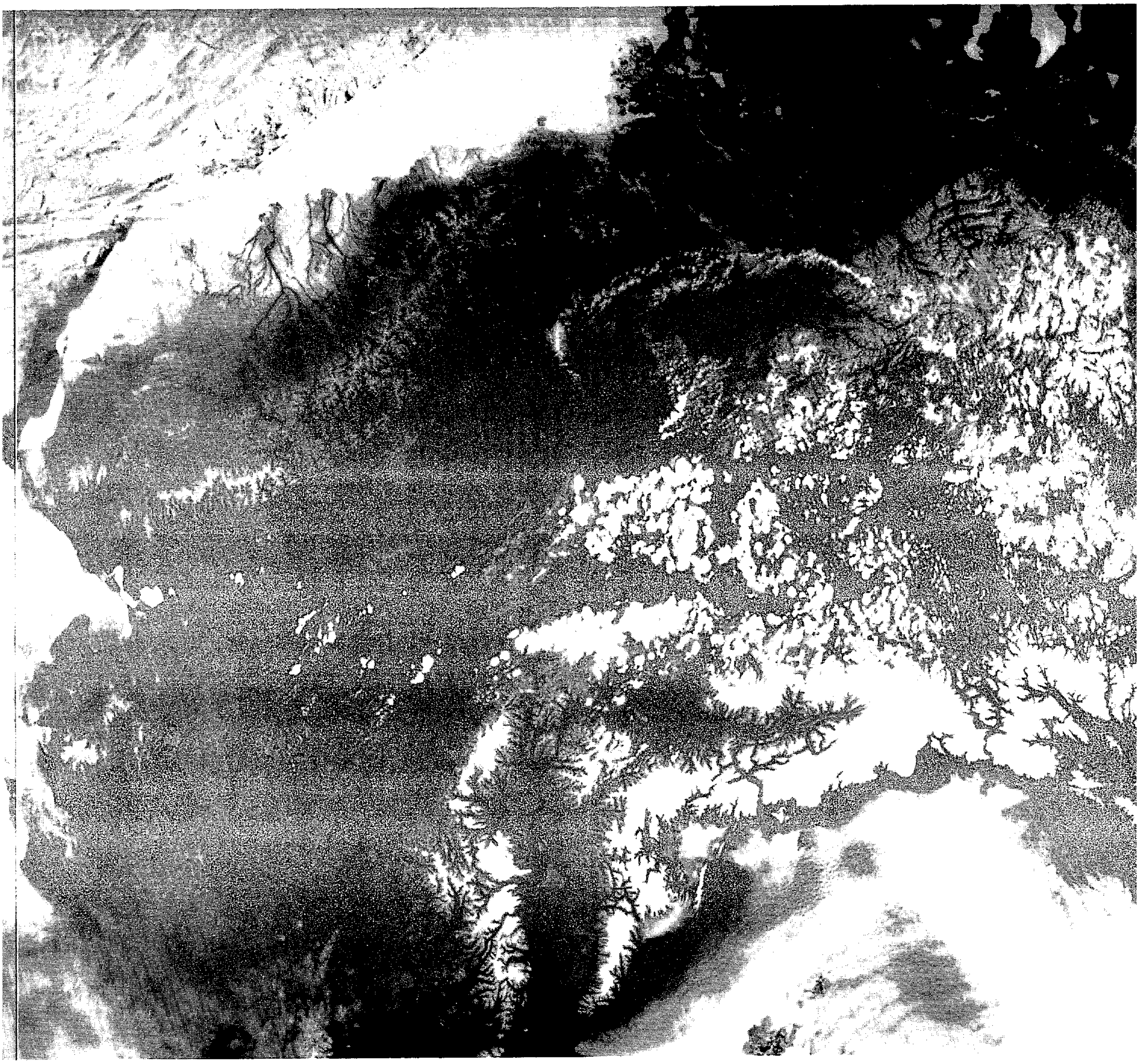


Figure 6. Prospective build-up of thunderstorms over Interior Alaska,29 May 1974, N3-2530 VIS + IR composite.

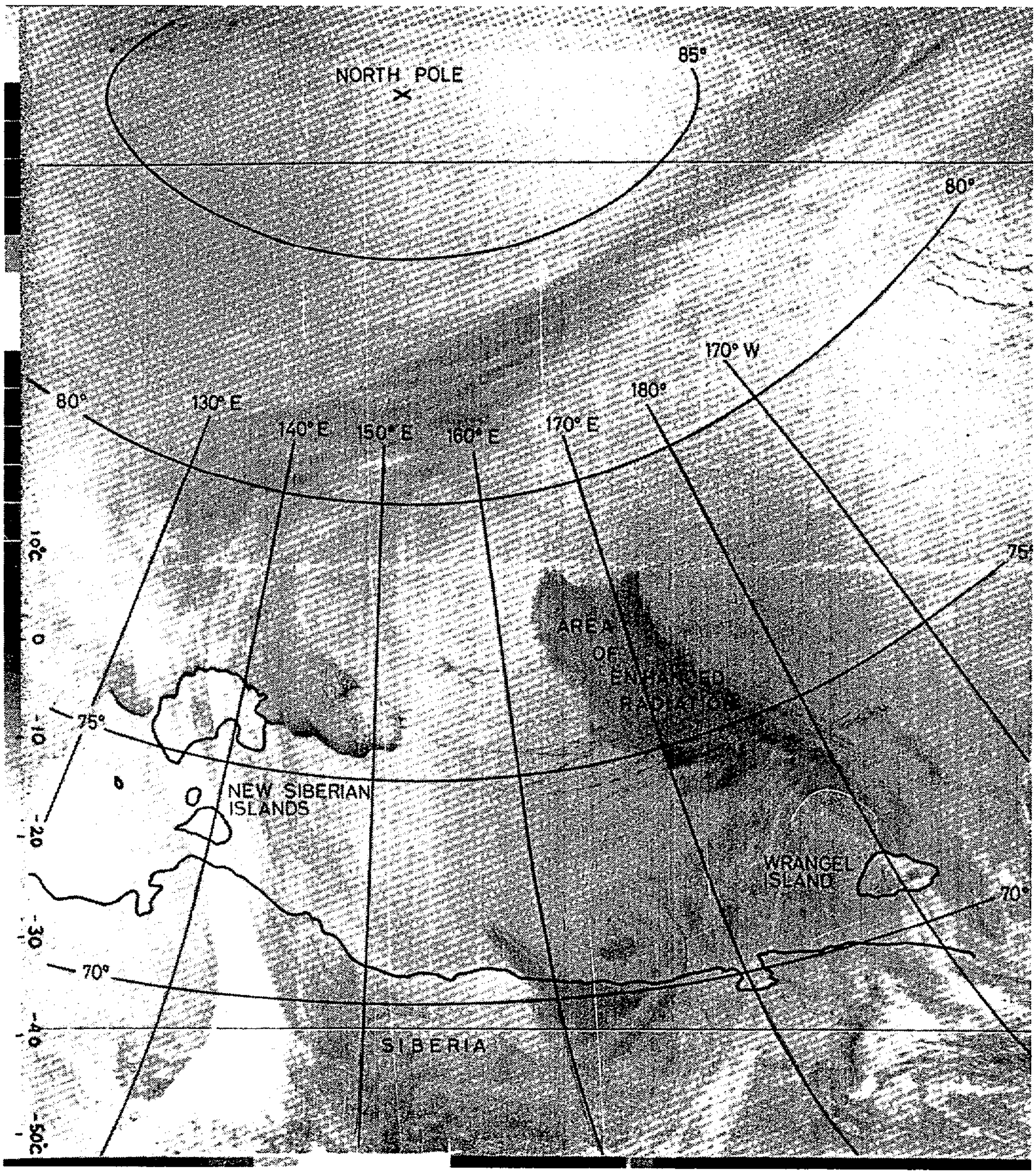


Figure 7. Area of enhanced radiation north of Siberia, 30 March 1975, N4-1684 IR.

range between white and black displayed by various shades of gray. The simplest enhancement uses a single scale with temperatures beyond the scale shown as black or white. This enhancement works well for sea-surface temperatures in summer when the surrounding land is very much warmer and any clouds present are colder. The resulting enhancement thus emphasizes the water areas, while the land shows in contrasting black for geographical orientation and the clouds are white. Figure 8a is a single scale enhancement from -3 to 6°C for the Gulf of Alaska on 22 May 1974. Part of the relatively warm Alaska Current with some meanders shows up very distinctly around 6°C. For comparison, the simultaneous visible image (Fig. 8b) shows that the offshore Gulf of Alaska is cloud free. However, the standard IR (Fig. 8c) shows some low cloud bands extending from the coast over the nearshore area. These cloud bands obstruct the temperature structure close to the coast. The black areas showing between the cloud bands indicate that the temperature is around or above 6°C. Royer and Muench (1977) used this same image among many others to study the ocean temperature distribution in the Gulf of Alaska.

In the wintertime, when both the land areas and the clouds are cold, coast definition can not be achieved from a single scale enhancement. In this case a double scale enhancement gives a more pleasing result. For this enhancement, the entire 32-step gray scale is used independently for two adjoining temperature ranges. The ocean area will still appear the same as it would on a single scale enhancement, but in addition details in another temperature range, such as land areas or sea ice, can be emphasized. The scale break, or temperature where the scales join, is chosen to coincide with the largest temperature gradient, such as the edge of open water at a

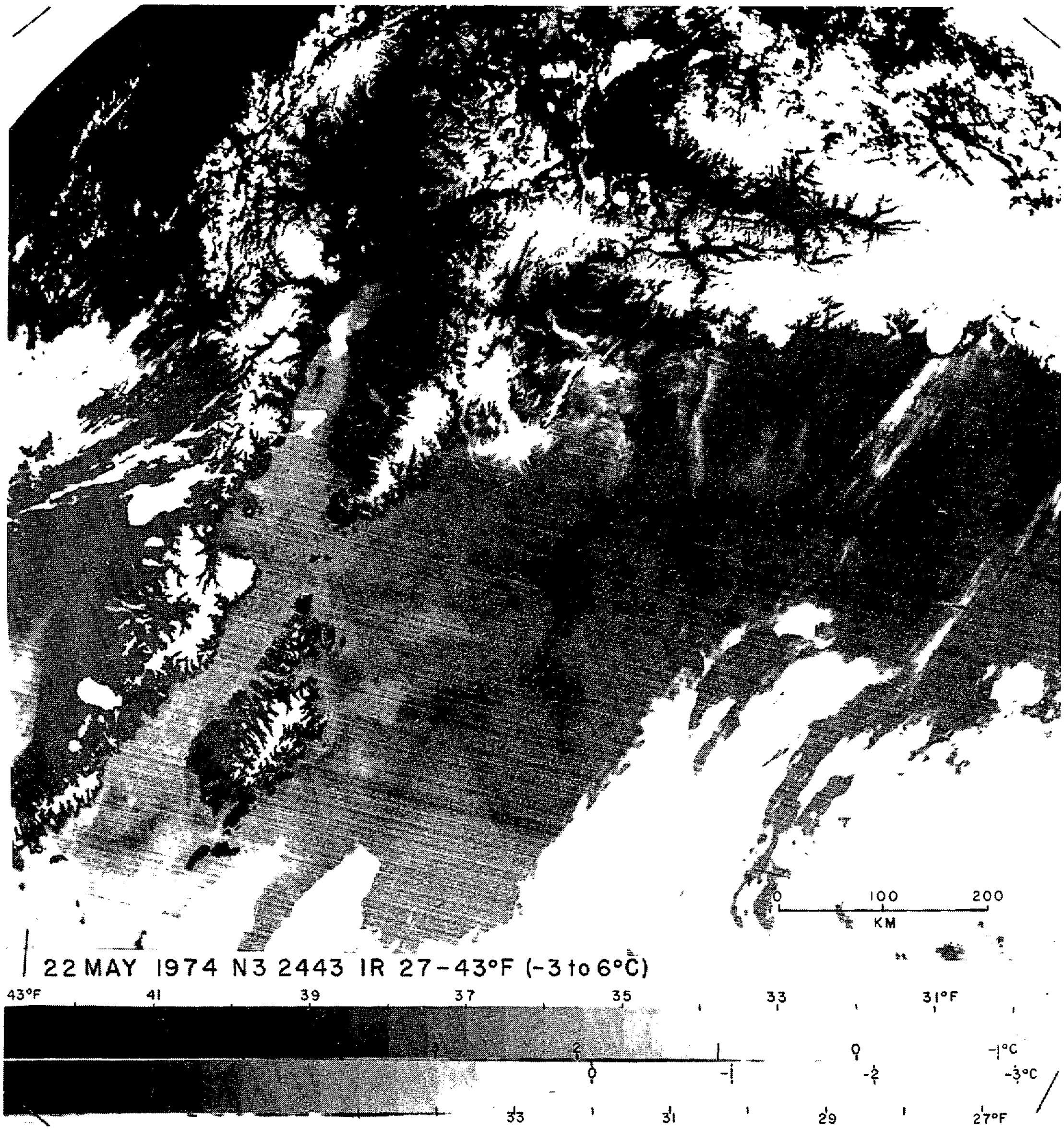


Figure 8a. Temperature-enhanced meanders in the Alaska current, 22 May 1974, N3-2443, enhanced IR -3 to 6°C.

Figure 8b. Visible image of a cloud-free Gulf of Alaska, 22 May 1974, N3-2443.

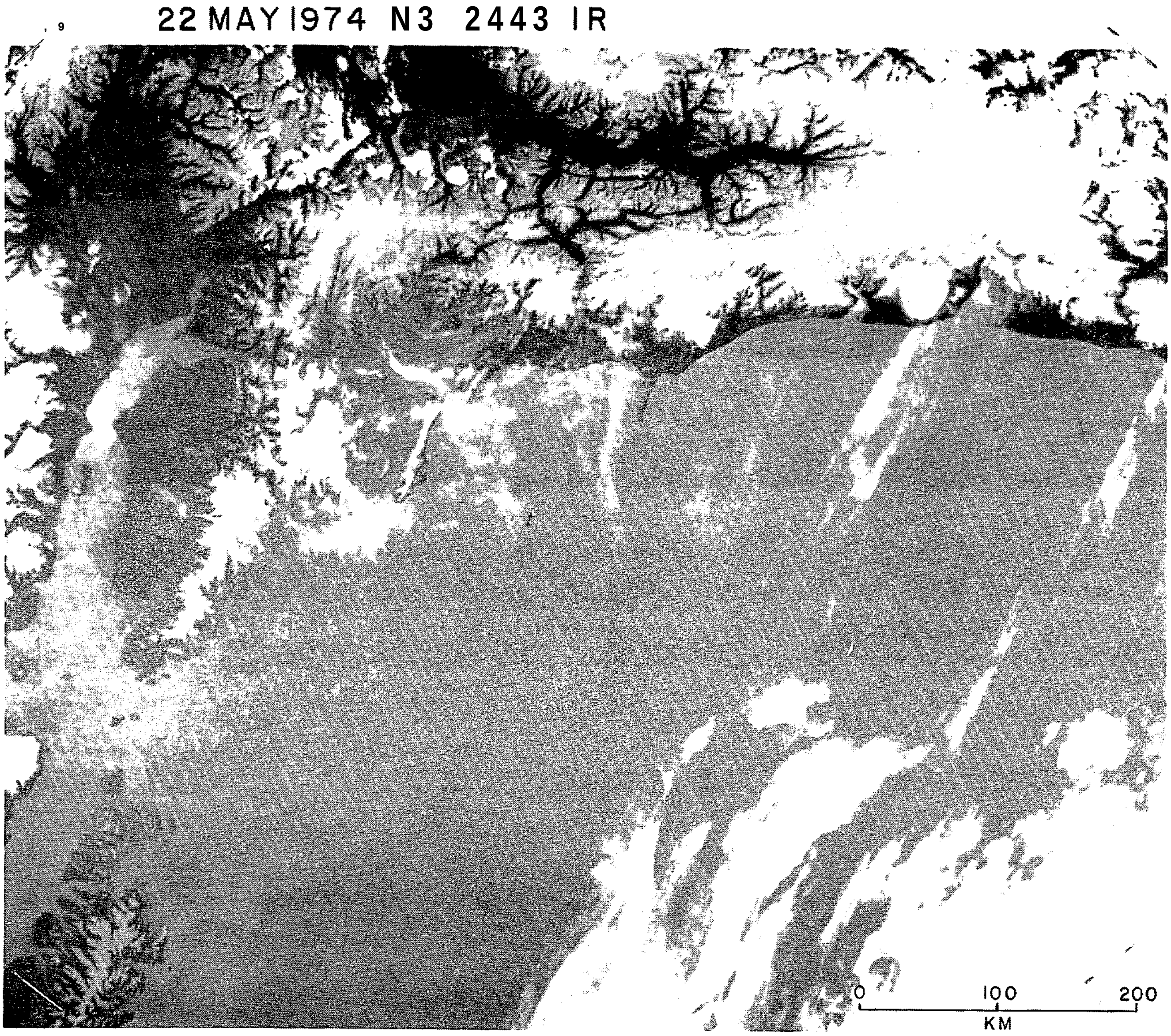


Figure 8c. Standard IR image showing thin coastal clouds, 22 May 1974, N3-2443.

coastline or ice edge. Figure 9 shows such an enhancement for the Gulf of Alaska on 1 March 1978. The scale break is chosen at the freezing point of sea water at –2°C. In the lower (-29 to -2*c) scale, -2° is black and in the higher (-2 to 5°C) scale, -2° is white. The abrupt black/white change coincides with the coastline, except in the ice covered Cook Inlet where it indicates the ice/water interface. The surface water circulation with the warm Alaska Current slightly offshore and the cold coastal jet hugging the northern coast is shown in detail in the higher -2 to 5°C scale. A similar double scale enhancement for 7 February 1975 was used by Royer (1977) to show ocean currents in the Gulf of Alaska.

When Coachman, Aagaard and Tripp (1975) wrote their book about the Bering Strait, the Alaska pilot project group was contacted to provide some satellite imagery for illustrations. A single enhancement from –8 to 6°C for 22 October 1974 showing a northward flowing warm current through the eastern part of the Bering Strait was chosen for the book. Figure 10 shows a double enhancement from (-8 to –2) and (-1 to 4)°C for the same satellite orbit. The scale break at the freezing point literally brings out the coastline around the Seward Peninsula and north of Kotzebue Sound. The northward flowing warm current through Bering Strait is frequently seen in satellite imagery. Its northeastward extension has been observed to extend beyond Barrow, Alaska. A paper investigating the warm water intruding into the Chukchi Sea is presently being prepared together with Solomon and Garrison.

Birds as Temperature Detectors

The warm water entering the Chukchi Sea is also rich in biomass and has been observed to attract feeding birds. Cloudfree temperature enhanced

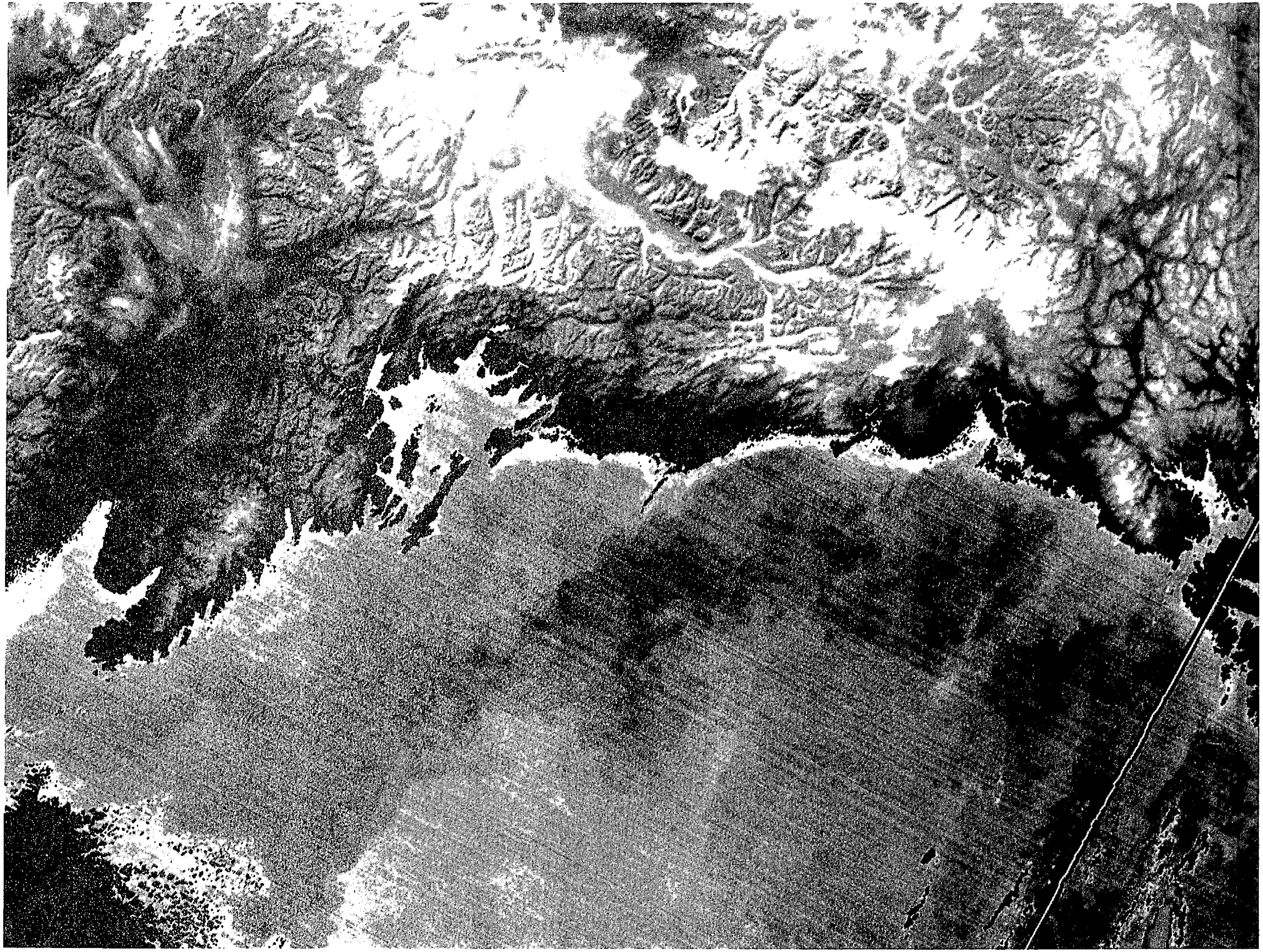


Figure 9. Surface temperatures structure in the Gulf of Alaska, 1 March 1978, N5-7181 IR; (-29 to -2)+(-2 to 5) °C.

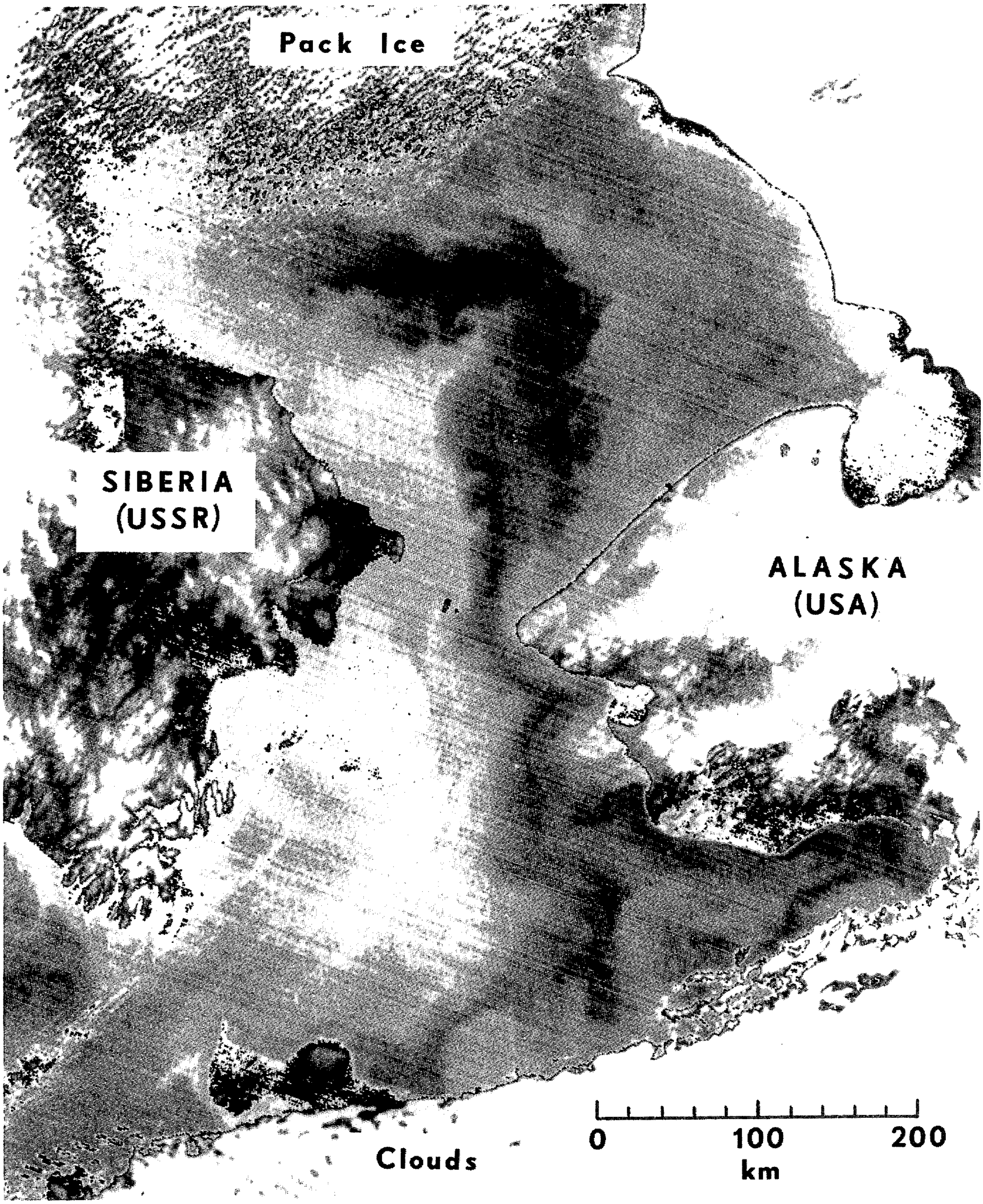


Figure 10. Northward flow of warm water through Bering Strait, 22 October 1974, N3-4340 IR; (-8 to -2)+(-1 to 4)°C.

IR satellite imagery for the first half of July is available from 1974 to 1979 for Ledyard Bay north of Cape Lisburne where Alan Springer has conducted bird observations. The satellite imagery shows a decline in surface temperature from 1974 to 1976 and an increase from 1976 to 1979. Springer (personal communication) has observed major changes in the productivity of the kittiwakes and food habits of birds in general during these years with a direct linear relation between the surface water temperature and the productivity. The surface temperature was also directly related to the extent of the sea-ice cover and the retreat of the ice edge. 1976 showed the lowest temperatures and productivity while 1979 had the highest. Springer could relate the kittiwake abundance to the timing of the fish, but has not yet established a relationship between the biomass and the temperature. Satellite imagery for July 1980, coinciding with Springer's observations off Cape Lisburne, show a band of warm surface water offshore. The birds were observed to be feeding in this area of warm water or along its interface with the cold Arctic water inshore. Since birds can respond to changes in surface water temperature, the distribution of birds might be used to indicate physical parameters.

Figure 11 is another example of how a coastline can be emphasized through a double scale enhnacement. The figure shows the Beaufort Sea coast on 14 August 1977. The temperature scale is -2 to 7 and 7 to 16°C. The 7°C scale break distinctly shows a narrow band of warm water along the coast between Barrow and Herschel Island. The outer edge of the warm water is fringed by black dots corresponding to 7°C in the lower scale, that continues into various gray shades in the offshore waters. The inner edge of the warm water is white to very light gray corresponding to

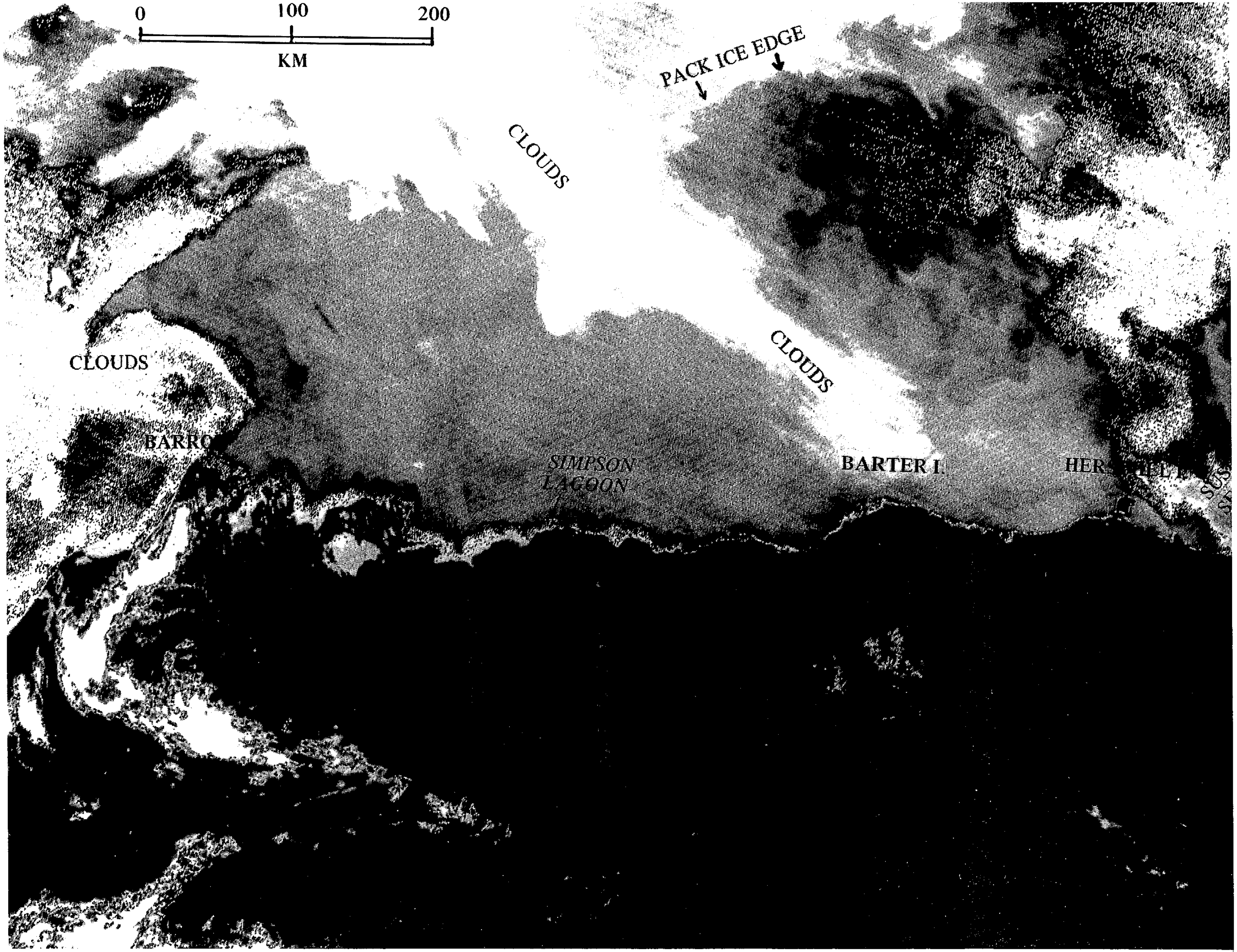


Figure 11. Band of warm water along the Beaufort Sea coast, 14 August 1977, N5-4718 IR; (-2 to 7)+(7 to 16)°C

7°C in the lower part of the higher scale that continues into black, corresponding to 16°c and above over the land. The existence of this warm coastal water was confirmed by data from the Simpson Lagoon and this same Figure 11 was given to Matthews for use in his OCS (1978) annual report.

IR Enhancements with Special Identity

In an IR enhancement any chosen temperature can be specially identified by matching the gray shade of the image with the appropriate shade in the 32-step gray scale. For rapid identification, a specific temperature or range of temperatures can be made either black or white. The first example of this by the Alaska pilot group was presented at the POAC-75 conference (Ahlnäs and Wendler, 1976). In that study we tried to detect open water in the Arctic Ocean in winter using satellite imagery. Figure 12 shows the ice cover in the Beaufort Sea on 17 March 1975. Integrated into the single scale enhancement from -43 to -3°C are -29°C shown by black dots in the medium gray section of the scale and -18°C shown by white dots in the dark gray part of the scale. Densitometer readings showed the coldest ice surface to be -41°C. The warmest ice is seen in a frozen lead just outside the shorefast ice. The only white dots corresponding to -18°C are seen along the southern edge of the lead. North of the lead is *a* wide belt of black dots corresponding to -29°C. From that area, strings of black dots extend to the northeast indicating the transition from the warmer ice in the refrozen leads to the surrounding cold ice of -41°C.

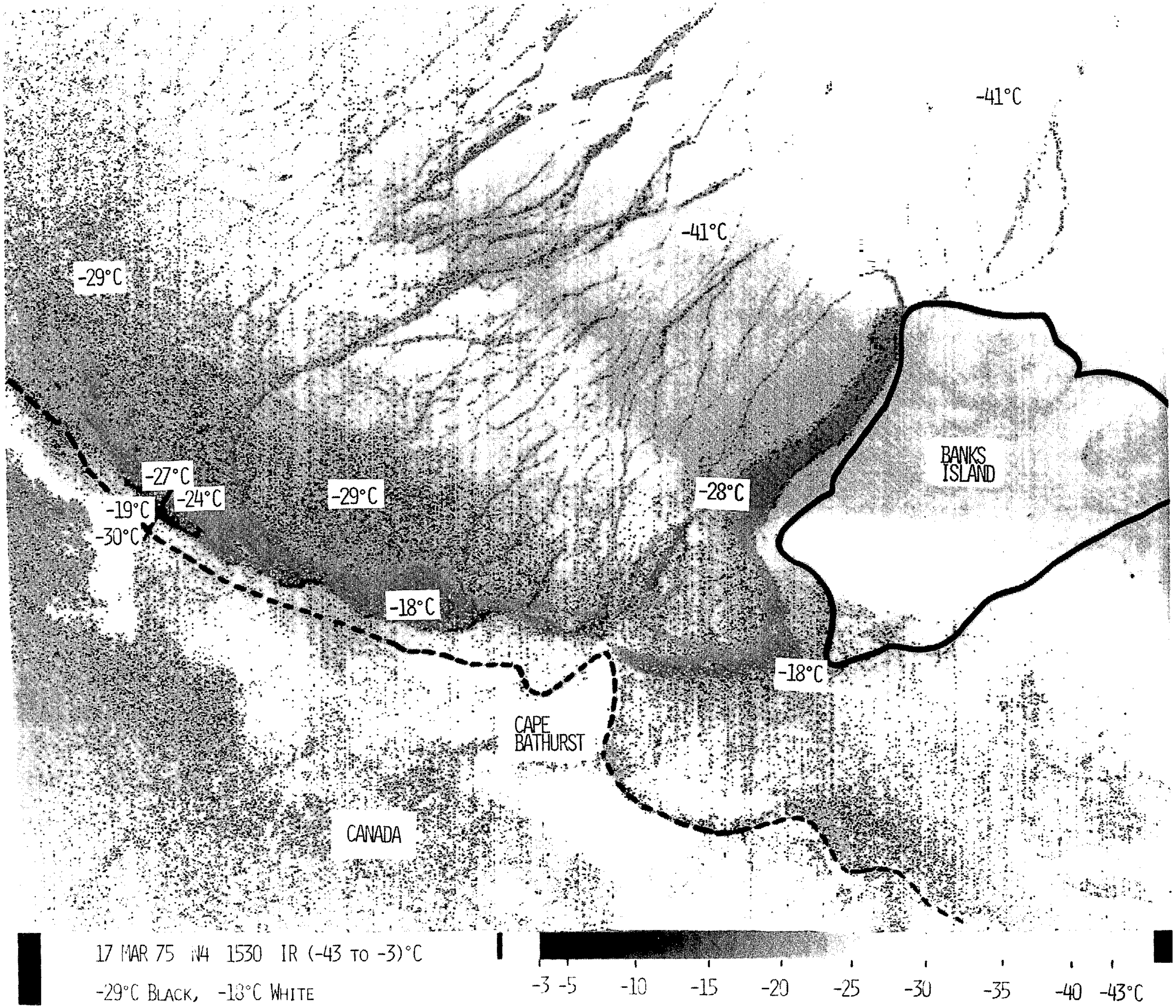


Figure 12. Beaufort Sea leads, 17 March 1975, N4-1530 IR; (-43 to -3)°C; -29°Bl, -18°Wh.

Sea-Ice Intrusions

Figure 13 shows a similar enhancement from -40 to -2°C, but the shades of gray for the special temperatures are the opposite, that is -18°C is black and -29°C is white. The enhancement shows an event of export of cold ice from the Chukchi Sea into the Bering Sea. The cold ice is recognized by its light gray color with the edges of the intrusion outlined by black dots corresponding to -18°C. The rest of the ice in the Bering Sea is dark gray and warmer. The only white dots are seen in the Chukchi Sea where the coldest ice is. Ahlnäs and Wendler (1979) studied two cases of ice transport through the Bering Strait. In both cases we found the reason for this transport to be the prevailing strong northerly winds associated with decreasing temperatures. Because of the well delineated extent of the ice intrusion on the satellite imagery we could measure the area of the cold ice. From that the mean speed with which the ice moved through the strait was calculated. For the longer lasting March episode the speed was 2.8 km/hr.

Kamchatka Eddies

In the above cases the specially selected temperatures outlined a transition between ice masses of different temperatures. When studying oceanic features a smaller temperature range is covered. From *time* to time, infrared satellite imagery has revealed eddies in the waters east of the Kamchatka Peninsula. Solomon and Ahlnäs (1978) made a study of these eddies using a single scale from 2 to 11°C. Through densitometer readings of the gray scale we found the cold core centers to be 3°C. The most likely source of that cold water is upwelling from greater depths. This seems to be a paradoxical explanation since the eddies are wound in an anticyclonic

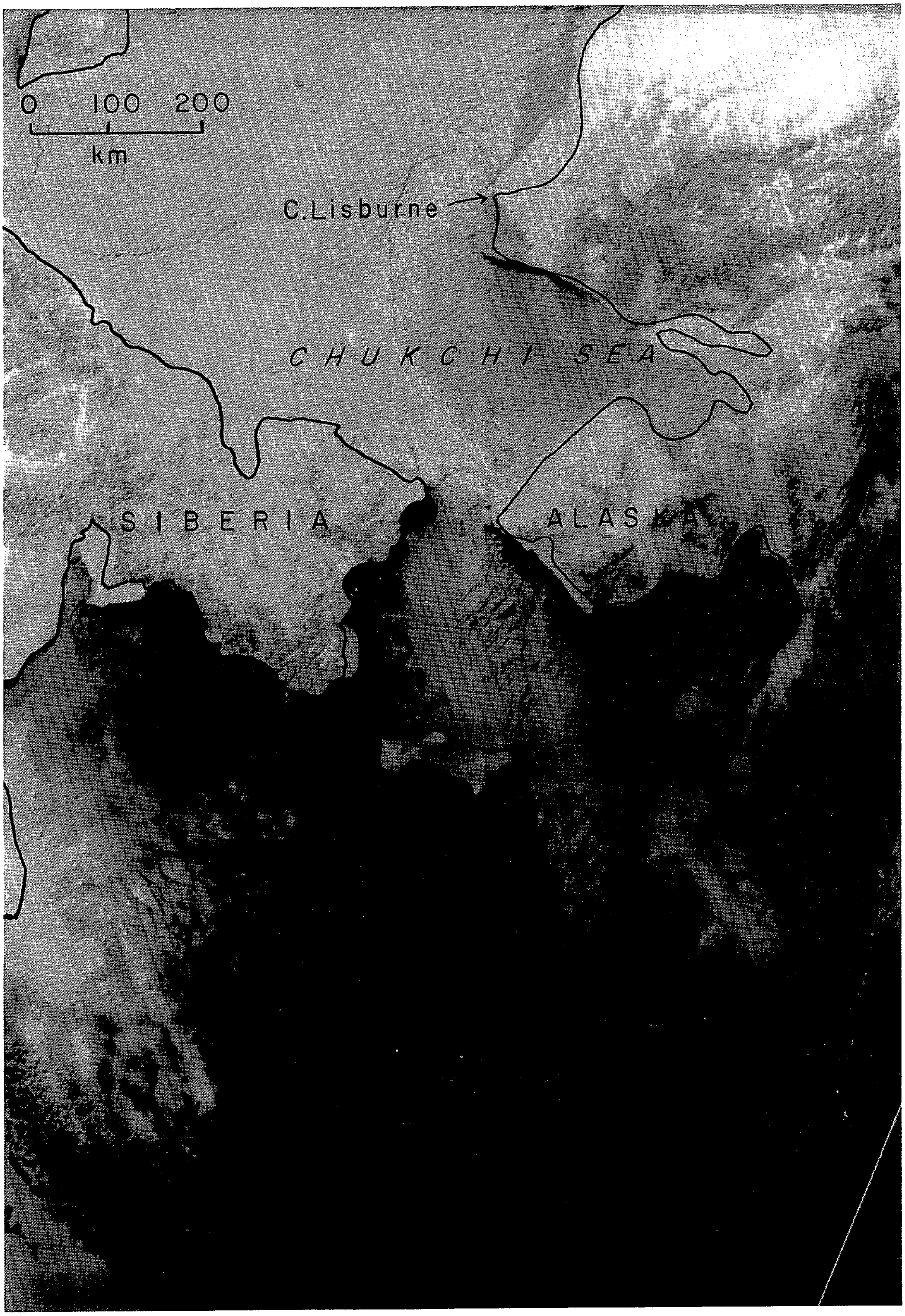


Figure 13. Flow of cold Chukchi Sea ice into the Bering Sea, 20 March 1978, N5-7417 IR; (-40 to -2)°C; -29°Wh, -18°Bl.

sense. However, it is beyond the goal of this paper to address the physics of these eddies. In the paper describing IR enhancement techniques, Ahlnäs (1979) used another case when the Kamchatka eddies were observed on 26 September 1977 to demonstrate some applications (Fig. 14). The cold cores of these eddies were also 3°C and they were wound anticyclonically as the ones observed a year earlier. The same single scale enhancement, 2 to 11°C was used. Within this range 3°C was made black and 6°c white. Consequently, the cold cores turned black. Some of the eddies have a warm 6°c rim which is white. This type of special enhancement makes the feature of interest, such as the cold cores in this case, stand out in a striking way.

SEA-ICE STUDIES

The Bering Sea harbors an annual sea-ice cover that for 6 months of the year extends far enough to the south to conflict with fishing interests. To guarantee safety to fishermen and their gear, the location of the exact ice edge and its predicted movements are important. In the absence of clouds , the visible imagery pin-points the ice edge. Its advancement is governed by wind speed and direction in addition to the surface temperature of the waters at the ice edge. Figure 15 shows a special double scale enhancement for the Bering Sea on 29 March 1977. The major part of the sea ice matches the lower scale (-46 to -4°C) while the higher scale, (-2 to 5°C) shows the temperature of the open water. The division -4 to -2°C between these scales is wider than normal and is shown in black. This range indicates newly frozen thin ice, that may not show up on the visible imagery. In addition, ice that may be ready to melt is in this range. Theoretically, the -2°C transition from black to white should coincide with

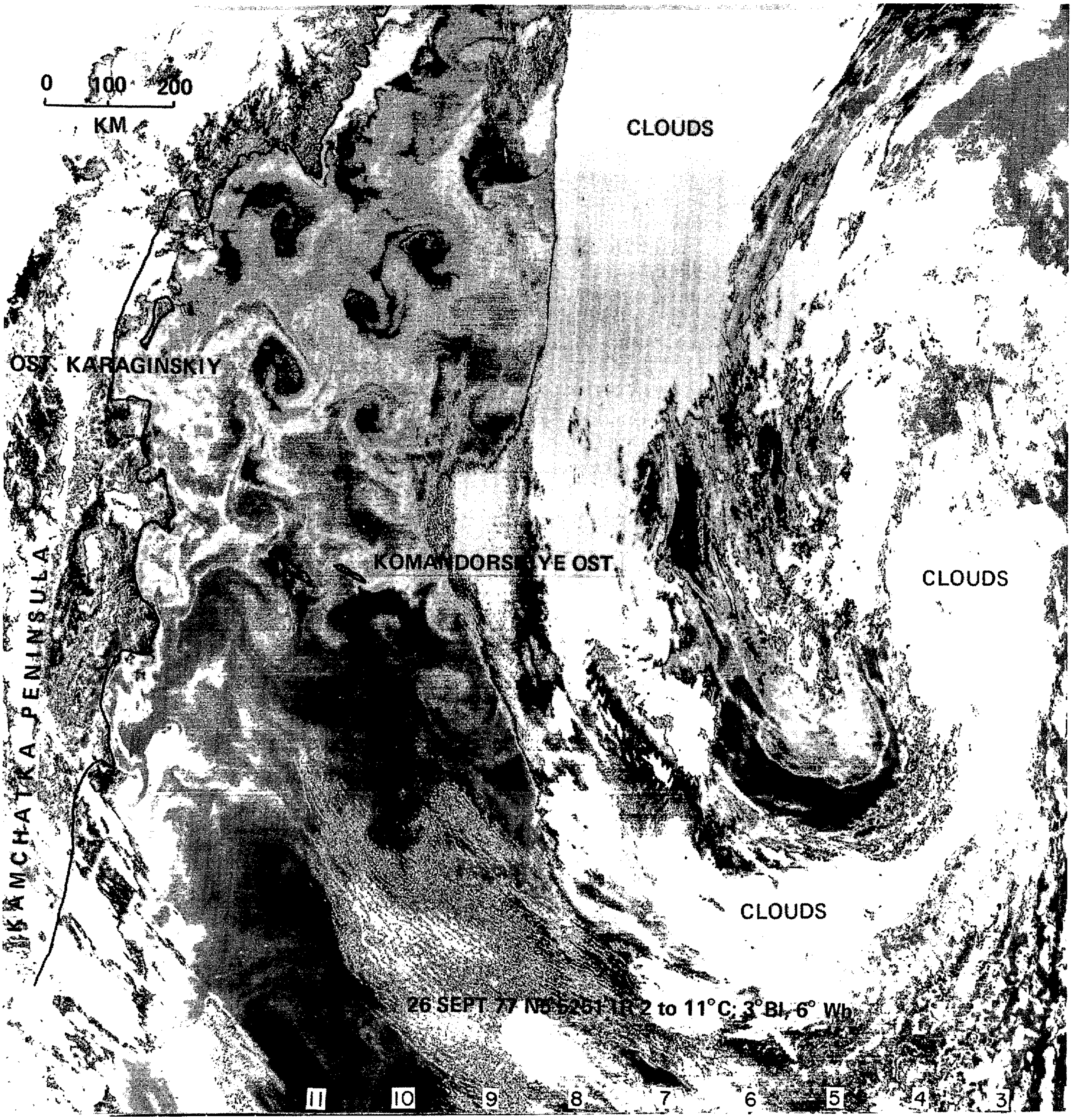


Figure 14. Oceanic eddies with cold cores east of Kamchatka, 26 September 1977, N5-5251 IR; (2 to 11)°C; 3″331, 6•Wh.

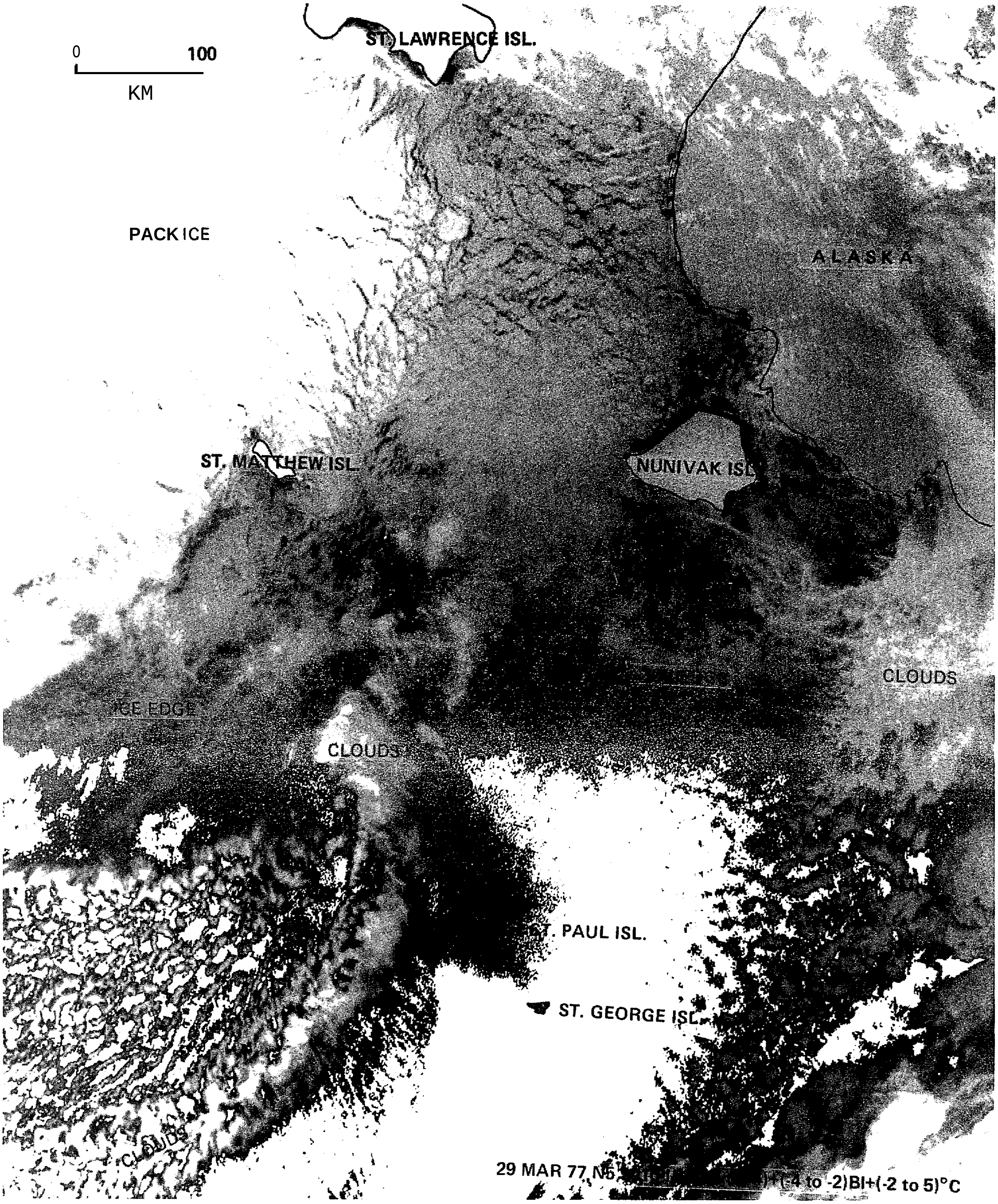
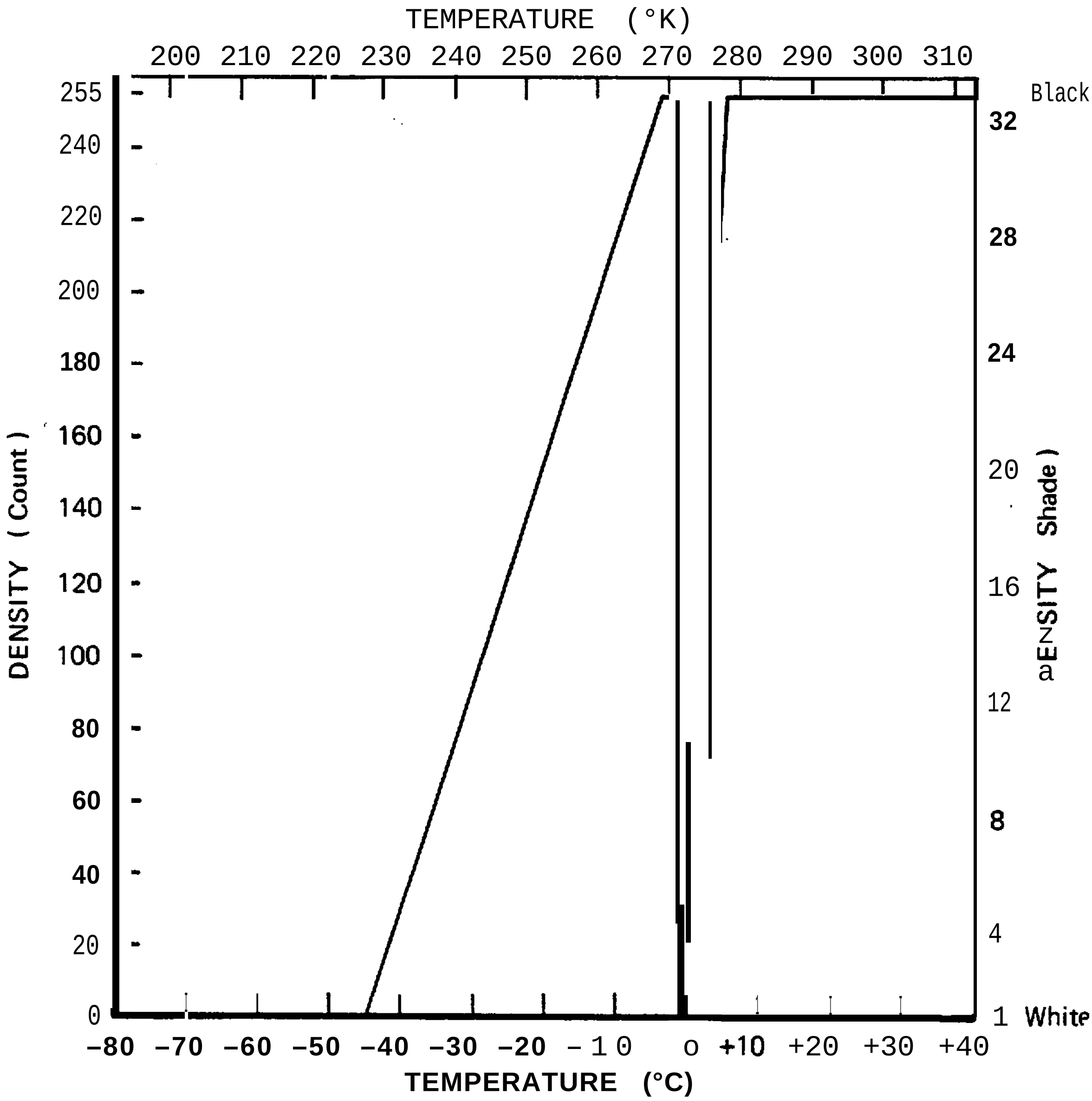


Figure 15. Ice edge between the Pribilof Islands of St. Paul and St. George, 29 March 1977, N5-3010 IR; (-45 to -4)+(-4 to -2)Bl + (-2 to 5)°C.

the ice edge. Due to the effects of atmospheric interference, the precision of the sensors and the digital tape, the true accuracy of the satellite derived sea surface temperatures is ± 1.5°C. Through comparison with the visible imagery it appears that the ice edge in Figure 15 is delineated by -4°C.

It is interesting to note that the black area of cold water surrounds St. Paul Island but leaves nearby St. George Island outside its reach. This is a common occurrence frequently observed on satellite imagery. When the ice edge does extend further south, it often stays between these two islands of the Pribilofs. Another commonly observed feature is a narrow ring of cold water individually surrounding these islands. The above mentioned features were brought to attention after an inquiry from a bird observer, George Hunt (personal communication). Hunt had observed a delay in migration and nesting habits of birds on St. Paul as compared to St. George. Cloud free imagery was sent to Hunt from 1975. Starting with the field season of 1977, the Pribilof Islands were kept under continuous surveillance and temperature enhancements were made when the area was clear. This imagery provided an explanation for the timing of the birds' arrival to the two islands. By supplementing hydrographic data with the satellite data, Hunt and Kinder (personal communication) found the cool surface waters ringing the islands to be caused by tidal mixing. In addition, they could show bird densities inside the rings of well-mixed water to be higher than outside.

IR enhancements produced by the AVHRR have a better resolution and contrast than the VHRR although the true accuracy is the same or ± 1.5°C. The IR enhancement table (Fig. 16) used in Figure 15 to show the ice edge,



BREAKPOINTS

Segment	From	To
1	<-80°C/000	-45°C/000
2	-45°C/000	- 4°C/255
3	- 4°C/255	- 2°C/255
4	- 2°C/255	- 1°C/000
5	- 1°C/000	5°C/255
6	5°C/255	>40°C/255

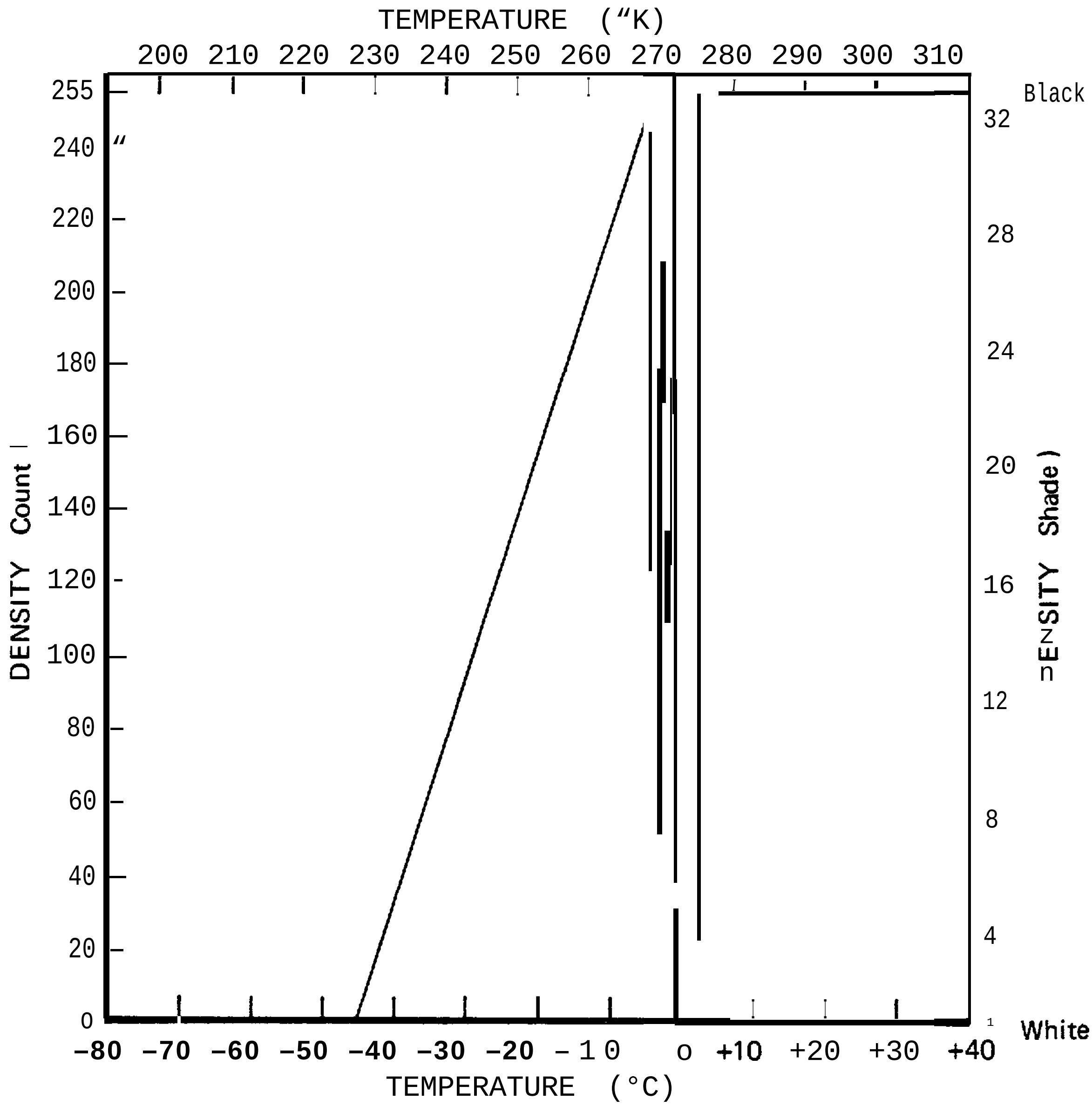
Figure 16. IR enhancement curve used in Figure 15 from "Polar spacecraft AVHRR sensor enhancement tunes" NESS-CDA station (1980).

shows the entire temperature range from -4 to -2*C freezing/melting conditions in black. After discussing the problem with Don Sundgren at the Gilmore Tracking Station, he devised a table that divided the temperature range from -4 to -1*C into 4 contrasting shades of gray between limits of black (Fig. 17). This table is called 64P, where 6 stands for the spacecraft used, NOAA-6, and 4 for IR Channel 4. The same table using the TIROS-N satellite would consequently be called N4P. Spelled out table 64P would read:

(-45 to -5)+	(-5 to -4)+	(-4 to -3.5)+	(-3.5 to -3)+	(-3 to -2)+	(-2 to -1.5)+	
000	250	52	156	208	104	255
WH	BL	LLG	DG	DDG	LG	BL
white	black	light light grey	dark grey	dark dark grey	light grey	black

(-1.5 to -1)+	(-1 to 5)°C	
255	000	255
BL	WH	BL
black	white	black

The numbers under the temperatures indicate the density count on a scale from 000 for white to 255 for black. This table borders on the accuracy of the system, but during suitable temperature conditions the result can be striking. Figure 18 is a demonstration of table 64P, informally called the ice table. On 29 January 1980 the ice edge extended to Bristol Bay and bordered the Bering Sea side of the Alaska Peninsula. The black edge is nearly freezing water at -1.5°C forming an intrusion into Bristol Bay. The light gray band inside is the actual ice edge at -2°C followed by a dark gray band of -3°C ice, a medium gray at -3.5°C and a very light gray at -4°C; -5°C is almost black. The temperature of the rest of the ice cover south of Nunivak Island is in the upper part of the -45 to -5°C range. With this table, open water within the ice pack or along the coast



BREAKPOINTS

Segment	From	To
1	<–80°C/000	–45°C/000
2	–45°C/000	– 5°C/250
3	– 5°C/250	– 4°C/052
4	– 4°C/052	-3.5″C1156
5	–3.5°C/156	– 3°C/208
6	– 3°C/208	– 2°C/104
7	– 2°C/104	– 1°C/255
8	– 1°C/255	– 1 C/000
9	– 1°C/000	5°C/255
10	5°C/255	>40°C/255

Figure 17. IR Enhancement curve, “ice table”, 64P/N4P used in Figure 18.

Figure 18. Ice edge structure in Bristol Bay and the warm Alaska current SW of Kodiak, 29 January 1980, N6-3072 IR; “ice table” 64p.

can be readily seen as for example in Nushagak and Kvichak Bay in the eastern Bristol Bay. The warmest part of this ice table, -1 to 5*C, shows the surface temperature of open water. The warm Alaska Current can be seen east of Kodiak Island directed to the southwest. This possibly accounts for the warmer water seen in the Bering Sea extending north through Unimak Pass. The waters west and southwest of Kodiak Island have an irregular distribution, as evidenced by the spiral type surface temperature structure.

Figure 19 is another example of the use of the ice table, N4P, for the TIROS-N satellite on 14 December 1979. ‘i’he ice edge in this figure is colder than on 29 January and does not show the gradual temperature decrease over a wide area. Instead, great detail is seen in the open water south of the ice edge in the -1 to 5°C range. The isotherms are roughly concentric with the ice edge and both seem to be connected with the bathymetry. Theresa Paluszkiewicz is presently working on this relationship in addition to frontal systems based on satellite evidence for her master's thesis at the Institute of Marine Science, University of Alaska.

CORRECTIONS FOR GEOGRAPHIC DISTORTION

The satellite imagery is produced by horizontally scanning radiometers on the spacecraft passing vertically through the center of the image. This causes geographical distortion along the edges of the image. New software at the tracking station now makes it possible to rectify this distortion by stretching the image. Figure 20 is a stretched version of Figure 19. The correction here is most obvious in Bristol Bay, located at the edge of the image. In addition, the temperature range is offset -4°C. This brings

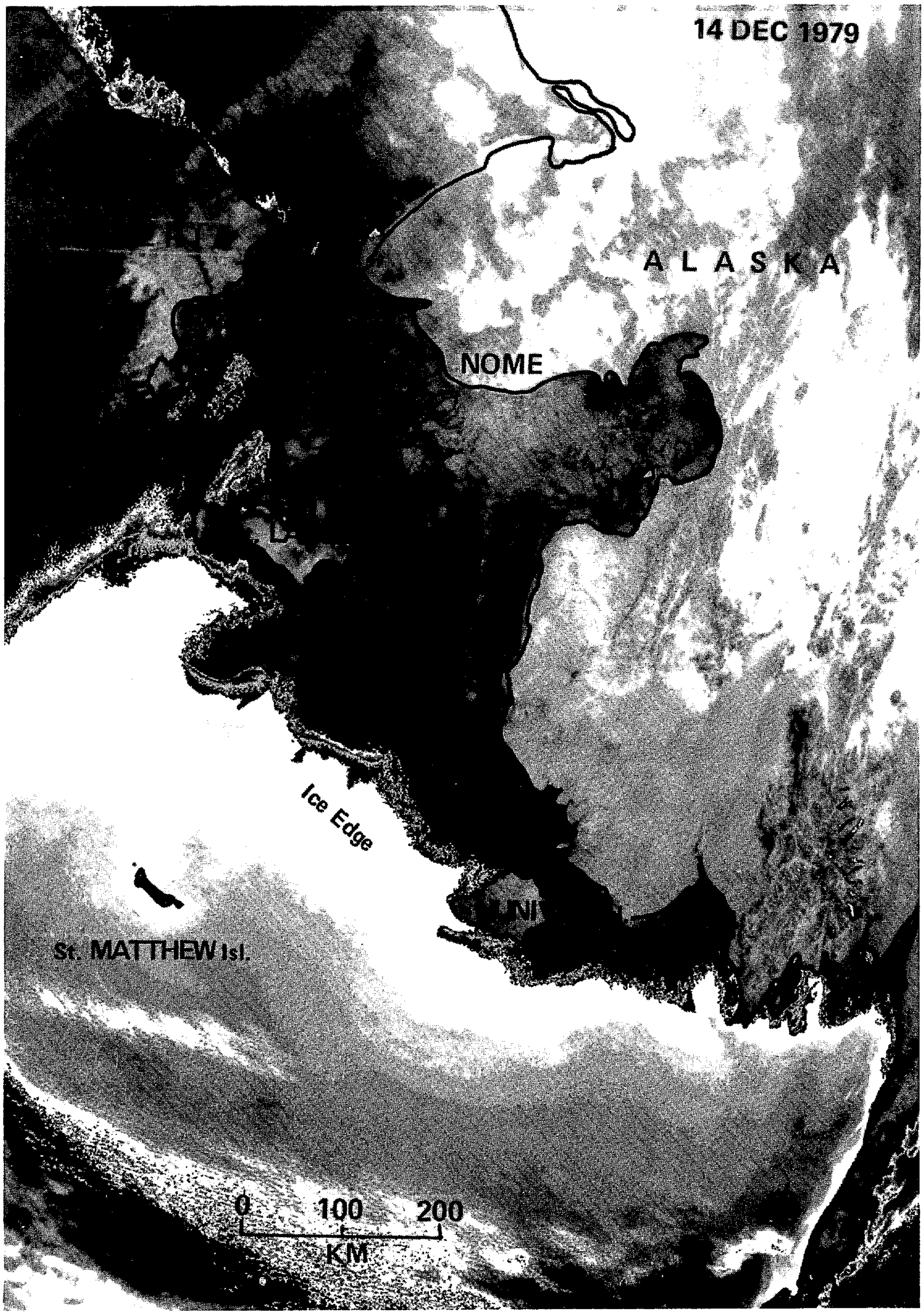


Figure 19. Bering Sea ice edge with surface temperature structure in waters over the continental shelf, 14 December 1979, TN-6025 IR; "ice table" N4P.

Figure 20. Image from Figure 19 with temperature table offset -4°C and stretched to rectify geographic distortion in Bristol Bay.

detail designed for the ice edge into the open water, where great contrast in the sea surface temperature structure can be observed over the continental shelf.

SATELLITE DATA ARCHIVES

Since the first satellite imagery was produced, its use has rapidly increased. New applications are continuously incorporated as technology advances. As more people become aware of the vast possibilities satellite imagery offers, its use will increase even further. When approaching a problem, historical comparisons are important and so there is always a new use for the previous imagery. The early negatives for the enhancements listed in this publication (Appendix I) are stored at the University of Alaska while most of the negatives since 1976 are stored at the Gilmore Tracking Station. The enhancements are produced from the original satellite digitized tapes which are normally only kept for 30 days before being reused. Over 100 tapes of special interest have been permanently stored at the University of Alaska Remote Sensing Library at the Geophysical Institute. A listing of these tapes is attached (Appendix II). Standard VIS and IR negatives for all Alaska passes processed at the tracking station are mailed monthly to:

Satellite Data Services Branch
National Climatic Center
World Weather Bldg. Rm. 606
Washington, D.C. 20233
Attn: Mr. Gene Hoppe

Standard VIS and IR contact prints can be ordered from there.

A NOAA-satellite pass is divided into three frames. For a descending orbit frame 1 covers the Arctic, frame 2 Alaska and the central Bering Sea and frame 3 SE Alaska and the Aleutian chain. Positive transparencies of frames 2 and 3 for the orbit covering central Alaska and the Bering Sea are archived at the Geophysical Institute, Remote Sensing Library where they can be reviewed on a light table. During the time period of the Alaska Pilot Project, from March 1974 to 31 October 1975, the three frames for each satellite pass were taped together. During that period, we received up to three daytime passes and one night IR pass. This imagery is archived at the Gilmore Tracking Station. About a thousand copies of this imagery including other cloudfree imagery of interest through 1976 is stored in 12 ringbinders. From 1977 to 15 September 1980 cloudfree imagery concentrating on the Gulf of Alaska and Arctic Ocean/Bering Sea has been archived in 28 additional binders including the enhanced imagery listed here and selected enlargements. Altogether this image collection consists of about 5000 prints stored at the Remote Sensing Library.

ACKNOWLEDGEMENTS

The compilation of this work was supported under contract 03-5-022-56 between the University of Alaska and NOAA, Department of Commerce through the Outer Continental Shelf Environmental Assessment Program to which funds were provided by the Bureau of Land Management, Department of the Interior. The NOAA-NESS CDA Station manager at Gilmore, Gregory White, and former managers, Everitt Kendall and Edward Wrightsman, have been most helpful in providing necessary assistance. All station personnel have shown continuous interest and have been very willing to help throughout the entire satellite project. Special appreciation and thanks are extended to Donald Sundgren for performing most of the IR enhancements and to Kenneth Meyer for all of the photographic processing of the imagery. The careful reviewing of the manuscript by Thomas Royer and help in preparation" by the Institute of Marine Science Publications department, led by Helen Stockholm, are also gratefully acknowledged.

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APPENDIX I

IR ENHANCEMENTS FOR SURFACE TEMPERATURE

<u>IR ENHANCEMENTS FOR SURFACE TEMPERATURE</u>

DATE		ORBIT	FRAME	TEMPERATURE °F)	AREA
1974	May 22	N3-2443	I3500	27 to 43	Gulf of Alaska
	"	"	"	36 to 44	"
	June 25	N3-2865	I2600	34 to 66	Bering Strait
	"	"	I2700	35 to 45	"
	June 25	N3-2865	I3700	32 to 50	Aleutians, Unalaska
	"	"	"	35 yo 45	"
	June 25	N3-2865	I3700	41 to 45	Aleutians, Unalaska
	July 1	N3-2940	I2800	32 to 48	Bering Strait
	"	"	"	34 to 58	"
	"	"	"	32 to 64	"
	July 13	N3-3089	I2600	34 to 58	Chukchi Sea
	"	"	"	34 to 66	"
	July 13	N3-3089	I2700	32 to 50	Chukchi Sea
	"	"	"	(?)25 to 40	Siberia topography
	July 14	N3-3101	I1, 2	34 to 66	Ellesmere, Bering Strait
	"	"	I2	(?)25 to <40	Siberia-Alaska
	July 14	N3-3101	I2700	32 to 50	Siberia, Bering Strait
	"	"	"	(?)25 to <40	"
	July 17	N3-3137	I2	42 to 50	Gulf of Alaska
	"	"	"	42 to 66	"
	July 17	N3-3137	I2400	42 to 60	Gulf of Alaska
	"	"	"	42 to 66	"
	Aug 14	N3-3484	I2	42 to 66	Gulf of Alaska
	Aug 16	N3-3509	I3800	40 to 60	Gulf, "Octopus legs"
	Aug 21	N3-3572	I4555	49 to 57	Norton Sound, Kotzebue Sound
	"	"	"	34 to 66	"

DATE	ORBIT	FRAME	TEMPERATURE (°F)	AREA
1974 Aug 30	N3-3687	11, 2	28 to 66	Seattle-Anchorage
Sept 4	N3-3745	12700	49 to 58	Norton, Bristol, Iliamna Lake
"	"	"	28 to 62	"
Sept 5	N3-3758	11	(18 to 29)+(30 to 45)	Chukchi Sea
"	"	"	28 to 66	"
Sept 8	N3-3795	12480	(18 to 29)+(30 to 45)+(46 to 61)	Chukchi, Barrow Canyon
"	"	12481	28 to 50	Chukchi, Bering Strait
Sept 8	N3-3795	12	30 to 64	Chukchi, sediments
Sept 29	N3-4055	12	29 to 62	Cook Inlet, Alaska Peninsula
"	"	13125	29 to 62	Aleutians, Alaska Stream
"	"	"	49 to 58	"
Sept 30	N3-4067	12	30 to 63	Prince William Sound
Ott 3	N3-4104	12	28 to 41	P. William, Norton Sound
"	"	"	32 to 48	"
Ott 11	N3-4203	12930	28 to 41	Gulf of Alaska Low
"	"	15205	8 to 57	"
Ott 14	N3-4241	12	28 to 51	N. Bering Strait
"	"	"	-1 to 36	Warm plume NW Alaska
Ott 18	N3-4921	12	18 to 43	Alaska W. coast
Ott 21	N3-4328	12	28 to 39	Bering Strait
Ott 22	N3-4340	12	18 to 43	Bering Strait
"	"	"	(18 to 28)+(29 to 40)	"
Nov 8	N3-4551	12	(O to 28)+(29 to 40)	N. Bering Sea, Chukchi Sea
Nov 16	N3-464 9	12	28 to 41	Gulf of Alaska
[illegible] 18	[illegible]	11515	24 to 46	Gulf, Alaska Peninsula

DATE	ORBIT	FRAME	TEMPERATURE (°F)	AREA
1974 Nov 18	N3-4679	12	(?)20 to 42	Gulf, Alaska Peninsula
Nov 20	N3-4700	12840	18 to 36	Bering Sea
Nov 26	N3-4774	10880	18 to 34	Bering Sea
Nov 28	N3-4799	10880	18 to 34	N. Bering Sea
Nov 30	N3-4824	12090	-70 to 50; -4 to 4 Bl	Chukchi leads
"	"	"	-70 to 50; -4 to 4 Wh	"
Nov 30	N3-4824	12090	-70 to 50; -4 to 4 Bl, 28 to 32 Wh	Chukchi leads
"	"	"	-70 to 50; -4 to 4 Wh, 28 to 32 Bl	"
Nov 30	N3-4824	12090	-26 to -14	Chukchi leads
"	"	"	-40 to 33	"
Nov 30	N3-4824	12090	21 to 33	Chukchi leads
"	"	"	-16 to 12	"
Nov 30	N3-4824	12090	-26 to -16	Chukchi leads
"	"	"	-33 to -22	"
Nov 30	N3-4824	12090	-38 to -28	Chukchi leads
"	"	"	-20 to -10	"
Dec 1	N3-4836	11700	-40 to 33	Bering, Chukchi Sea
"	"	"	27 to 38	"
Dec 2	N3-4848	13	(-30 to 25)+(25 to 50)	Bristol, Aleutians
"	"	12900	(-30 to 25)+(25 to 50)	Bering Sea
Dec 2	N3-4848	12900	-40 to 33	Bering Sea
"	"	"	27 to 38	Bering, ice edge
Dec 2	N3-4849	13400	(?) (0 to 27)+(28 to 38)	Bering Sea
"	"	13000	27 to 38	Bering, ice edge
Dec 3	N3-4861	13090	27 to 38	Bering, Chukchi Sea
"	"	"	-40 to 33	"
Dec 3	N3-4861	13200	(?) (0 to 27)+(28 to 38)	Bering Sea
Dec 4	N3-4873	12	-40 to 32	Bering, Chukchi Sea
"	"	12750	-40 to 35	"

DATE	ORBIT	FRAME	TEMPERATURE (“F)	AREA
1974 Dec 5	N3-4885	12	-41 to 33	NW Alaska coast
Dec 6	N3-4898	12	-40 to 32	Chukchi Sea
Dec 7	N3-4910	12650	-40 to 19	Chukchi Sea
Dec 8	N3-4923	12700	26 to 38	Chukchi Sea
"	"	"	-40 to 33	"
Dec 9	N3-4935	12	-40 to 32	Chukchi Sea
"	"	12500	-40 to 35	Chukchi, Cook Inlet
Dec 10	N3-4947	12	-40 to 32	NW Alaska coast
Dec 13	N3-4985	12890	-40 to 33	Bering Sea
Dec 14	N3-4997	12626	-40 to 33	Bering Sea
Dec 15	N3-5009	12730	-50 to 29	Bering Sea
Dec 16	N4-0390	12	8 to 42	Gulf of Alaska, N. Bering
"	"	"	-40 to 39	"
Dec 16	N4-0390	12400	-40 to 32	Gulf of Alaska, N. Bering
"	"	13030	-30 to 32	"
Dec 17	N4-0403	12800	-50 to 32	Bering Sea
Dec 18	N4-0415	11850	-50 to 35	E. Chukchi & Bering Sea
Dec 19	N4-0428	12700	-50 to 35	Bering Sea
Dec 26	N4-0516	13200	(?)(0 to 27)+(28 to 38)	Bering Sea
Dec 27	N4-0520	11850	-50 to 50	Bering Sea
"	N4-0528	12800	-50 to 32	Gulf of Alaska, Bering
Dec 28	N4-0541	13160	(-48 to 28)-l-(29 to 41); -20B1, OWh	Bering Sea
Dec 29	N4-0553	12400	-50 to 32	Gulf of Alaska, Bering
"	"	"	(-70 to 3); -50B1, -34/-20 spec.	"
Dec 31	N3-0578	12880	(-60 to 28)+(29 to 40); -20B1, OWh	Gulf of Alaska, Bering Sea
"	"	13200	(?)(() to 27)+(28 to 38)	"

DATE	ORBIT	FRAME	TEMPERATURE (“F)	AREA
1975 Jan 2	N4-0603	13500	-50 to 31	Gulf of Alaska, Bering Sea
Jan 5	N4-0641	13260	(-20 to -1)+(0 to 23)+(24 to 43)	Bering Sea
Jan 6	N4-6053	12750	-40 to 40	Cook Inlet, E. Bering Sea
"	"	12752	-50 to 50	"
Jan 7	N4-0665	12940	(-42 to 27)+(28 to 45)	Gulf to Kodiak
"	"	"	30 to 48	"
Jan 7	N4-0666	13260	(-20 to -1)+(0 to 23)+(24 to 43)	Bering Sea
Jan 8	N4-0678	12500	(-70 to 5); -70Bl, 2Wh	Bering Sea, Alaska
"	"	"	(-70 to 6); -60Bl, -20Wh	"
Jan 8	N4-0678	12500	(-60 to 31); -50Bl, 0Wh	Bering Sea, Alaska
"	"	"	(-60 to 31); -44 to -40Bl	"
Jan 8	N4-0678	12500	(-60 to 31)	Bering Sea, Alaska
"	"	12700	(-52 to 27)+(28 to 49)	Bering Sea, Alaska Weather map
Jan 9	N4-0683	11260	(-50 to 28)	Bering Sea
"	N4-0691	13400	?(-20 to -1)Wh to 3/4Bl+(0 to 24)3/4Bl to Bl+(25 to 43)	Bering Sea
Jan 9	N4-0691	14000	(-20 to 24)-t-(25 to 35)	Bering Sea
Jan 10	N4-0703	12667	(-34 to 28)+(30 to 45)	Unimak Pass
Jan 13	N4-0741	13165	(-52 to 2); -40Bl, -20Wh	Bering Sea
"	II	"	(-30 to 18); -20Bl, 0Wh	"
Jan 20	N4 -0829	10875	(-50 to 30); -20Bl, 28/29Wh	Arctic Ocean
"	"	12392	(-50 to 30); -20Bl, 28/29Wh	Bering Sea
Jan 29	N4-0941	12	(-27 to 28)+(30 to 45)	Cook Inlet-Unimak Pass
Jan 31	N4-0966	12	(-30 to 27)+(28 to 46)	Gulf of Alaska
II	"	"	(-43 to 28)+(29 to 37)	"
Feb 1	N4-0978	12 (2/3 res)	(-30 to 27)+(28 to 46)	Gulf of Alaska

	DATE	ORBIT	FRAME	TEMPERATURE (°F)	AREA
1975	Feb 3	N4-1003	12	(-30 to 27)-i-(28 to 46)	Gulf of Alaska coast line
	"	"	11800	(-44 to 28)+(29 to 38)	"
	Feb 4	N4 -1016	I1517=I2 (2/3 res)	(-44 to 28)+(29 to 42)	P. William to SE Alaska
	Feb 5	N4-1028	11815	(-45 to 27)+(28 to 41)	P. William to SE Alaska
	Feb 6	N4-1041	11735	(-45 to 27)+(28 to 41)	P. William to SE Alaska
	Feb 7	N4-1053	11900	(-31 to 27)+(28 to 45)	Gulf of Alaska with Stream
	Feb 8	N4-1058	11, 2	(-30 to 28)+(29 to 46)	Seattle-Anchorage
	Feb 9	N4-1078	12	(-31 to 26)+(27 to 45)	P. William, SE Alaska
	"	"	12300	(-31 to 28)+(29 to 43)	P. William, Alaska Stream
	Feb 9	N4-1079	11980	(-31 to 26)+(27 to 45)	Alaska Stream
	"	"	12500	(-31 to 28)+(29 to 43)	"
	Feb 13	N4-1129	11640	(-60 to -40)+(-39 to 29)+(30 to 40)	Bering Sea, Cook Inlet
	"	"	"	(-46 to 10); -40Bl, -20Wh	"
	Feb 13	N4-1129	11640	(lo to 30); -15Bl, 29Wh	Bering Sea, Cook Inlet
	Feb 14	N4-1142	11880	(-60 to -40)+(-38 to 27); -20Bl	Bering Sea, Chukchi Sea
	"	"	"	(-33 to 29)+(30 to 45)	"
	Feb 14	N4-1142	12400	(-8 to 24)+(25 to 35)	Bering Sea
	Feb 16	N4-1167	10230	(-60 to -31)+(-30 to -1)+(0 to 29)	Beaufort leads
	"	"	11500	(-60 to -31)+(-30 to -1)+(0 to 29)	Bering Sea, Chukchi Sea
	Feb 16	N4-1167	10825	(-45 to 30); -30Bl, OWh	Beaufort leads
	"	"	11760	(-45 to 30); -30Bl, OWh	Bering Sea
	Feb 16	N4-1167	10230	-31 to 29	Beaufort leads
	"	"	12505	(-31 to 29)+(30 to 48)	Bering Sea
	Feb 23	N4-1254	12330	(-45 to 28)+(29 to 37)	Bristol Bay
	Feb 24	N4-1267	11940	(-45 to 28)+(29 to 37)	Bering Sea
	Mar 1	N4-1329	11840	(-29 to 28)+(29 to 46)	Gulf of Alaska
	"	"	"	(-29 to 28)+(29 to 40)	"

DATE	ORBIT	FRAME	TEMPERATURE ("F)	AREA
1975 Mar 4	N4-1367	12180	(-38 to 0)+(1 to 29)	Norton Sound-Bristol Bay
Mar 5	N4-1379	12300	(-28 to 28)+(29 to 46)	Alaska Stream
"	"	"	(-28 to 28)+(29 to 40)	"
Mar 5	N4-1379	12300	(-28 to 28)+(29 to 34)	Alaska Stream
Mar 6	N4-1392	12340	(0 to 28)	Cook Inlet
"	"	"	(0 to 28)+(29 to 40) .	Cook, P. William Sound
Mar 9	N4-1429	10940	(-52 to 12); -20Bl, 0Wh	Arctic leads
Mar 14	N4-1492	10710	(-40 to 0); -20Wh	Arctic leads
"	"	"	(-42 to 28); -1/0Wh	"
Mar 14	N4-1492	10710	(-50 to 12); -40Bl, -20Wh	Arctic leads
"	"	11700	(-lo to 17)	Interior, Arctic leads
Mar 14	N4-1492	11700	(-2 to 27)	Interior, Norton, Cook
"	"	"	(-2 to 36)	"
Mar 14	N4-1492	11700	(20 to 34)	Cook Inlet, Kodiak Island
"	"	"	(-19 to 27)+(28 to 45)	Cook, Kodiak, Interior
Mar 14	N4-1492	12100	(0 to 31); 29/30Wh	Cook Inlet, Kodiak Island
"	"	"	(0 to 15)+(16 to 25)	Cook Inlet, Bristol Bay
Mar 15	N4-1505	12222	(0 to 29)+(30 to 46)	Bering ice edge
"	"	"	(-20 to 31)+(32 to 42)	Bering ice edge, Pribilofs
Mar 15	N4-1505	12222	(-40 to 0)+(1 to 32)	Bering ice edge, Pribilofs
Mar 17	N4-1529	11880	(-27 to 28)+(29 to 46)	Gulf of Alaska
Mar 17	N4-1530	10855	(-45 to 26); 0Wh	Arctic leads
"	"	"	(-45 to 26); -20Bl, 0Wh	"
Mar 17	N4-1530	10855	(-45 to -1)+(0 to 29)	Arctic leads
"	"	12347	(-45 to -1)+(0 to 29)	Bering Sea
Mar 17	N4-1530	12347	(-45 to 26); 0Wh	"
Mar 19	N4-1555	11000	(-42 to 0)+(2 to 27); 30 Bl, 10Wh	Arctic leads
"	"	12087	(-42 to 0)+(2 to 27)+(28 to 41)	Beaufort Sea-St. Lawrence
Mar 19	N4-1555	13180	(-42 to 0)+(2 to 27); -30Bl, 10Wh	Bering Sea
Mar 21	N4-1580	I1492=I2	(-42 to 27); -20Bl, 0Wh	Bering Sea

DATE	ORBIT	FRAME	TEMPERATURE (°F)	AREA
1975 Mar 23	N4-1605	12340	(-42 to 27); -19B1, OWh	Bering Sea
Mar 25	N4-1630	10565	(-42 to -10); -40B1	Arctic leads
"	II	"	(-42 to 27); -20B1, OWh	"
Mar 25	N4-1630	12057	(-42 to 27); -20B1, OWh	Bering Sea
"	"	"	(-18 to 14); -10B1, 10Wh	"
Mar 28	N4-1667	10715	(-42 to 27); -20B1, OWh	Arctic leads
Mar 30	N4-1692	10500	(-40 to 28); 20Wh	Arctic leads
"	"	"	(-50 to 12); -20B1, OWh	"
Apr 2	N4-1730	12060	(-28 to 28)+(29 to 40)	Gulf of Alaska, Bering Strait
"	"	"	-38 to 30; 28/29Wh	"
Apr 3	N4-1742	12790	(-28 to 27)+(29 to 40)	Gulf of Alaska
Apr 4	N4-1754	I1492=I2	(-27 to 28)+(29 to 41)	SE Alaska
Apr 6	N4-1781	12	-28 to 30; 28/29Wh	Chukchi Sea
Apr 7	N4-1793	12640	(-25 to 28)+(29 to 40)	Bering Sea
Apr 10	N4-1829	12530	(-27 to 29)+(30 to 45)	"Octopus legs", W. Seattle
Apr 10	N4-1830	12467	(-27 to 28)+(29 to 45)	E. Bering, Unimak
Apr 13	N4-1868	10500	-28 to 8; -20B1, OWh	Beaufort Sea
Apr 17	N4-1918	11950	(-18 to 28)+(29 to 45)	Bering Sea
Apr 21	N4-1968	10845	-30 to 34; 10 to 15 Wh	Beaufort Sea
"	"	It	-30 to 3; -20B1, OWh	"
Apr 22	N4-1980	11800	(-40 to 24)+(25 to 28)B1+29 to 34)	Gulf of Alaska
"	"	I2238=I2	(-11 to 28)+(29 to 45) (vertical compression)	Gulf of Alaska
Apr 23	N4-1993	13000	(-18 to 28)-I-(29 to 45)	Gulf of Alaska, Bering
Apr 24	N4-2005	12 (2/3 res)	(-17 to 28)+(29 to 45)	Gulf of Alaska

DATE	ORBIT	FRAME	TEMPERATURE (“F)	AREA
1975 Apr 24	N4-2006	10685	(-34 to 10)+(11 to 27)B1+ (28 to 32)Wh; 33B1	Beaufort Sea
Apr 25	N4-2018	10910	-30 to 10; 28 to 32Wh	Beaufort Sea
Apr 26	N4-2031	12050	(-16 to 28)+(29 to 45) (vertical compression)	Bering Sea
Apr 30	N4-2081	12800	(0 to 28)+(29 to 46)	Bering Sea
May 8	N4-2181	IR	(-28 to -2)+(-2 to 3)	Banks Island polynya
May 14	N4-2256	12	(0 to 31)+(32 to 34)Wh+(35 to 50)B1	Alaska snow melt
May 16	N4-2281	12828	(1 to 28)+(29 to 50)	Norton Sound
"	"	"	25 to 45	Norton Sound, Bristol Bay
May 17	N4-2294	13660	25 to 46	Bering Sea
"	"	"	20 to 50	"
May 17	N4-2294	12380	(-2 to 28)+(29 to 45)	Norton Sound
"	"	13130	(-2 to 23)+(24 to 40)	Bering Sea
May 21	N4-2344	13160	25 to 46	Bering Sea
"	"	"	17 to 42	"
May 22	N4-2356	13530	24 to 46	Gulf of Alaska
May 23	N4-2368	12790	20 to 49	Gulf of Alaska
"	"	"	(-2 to 28)+(29 to 45)	"
May 23	N4-2368	13030	24 to 45	Gulf of Alaska
May 26	N4-2407	13388	24 to 45	W. Bering Sea
May 29	N4-2444	12900	24 to 45	Bering Sea
May 31	N4-2469	13380	24 to 45	Bering Sea
June 1	N4-2482	12335	24 to 45	Norton Sound
June 2	N4-2492	12980	24 to 45	Norton Sound, Bristol Bay

	DATE	ORBIT	FRAME	TEMPERATURE (“F)	AREA
1975	June 4	N4-2519	12700	24 to 45	Norton Sound
	June 5	N4-2532	I2238=I2	24 to 45	Norton Sound, Gulf of Anadir
	June 6	N4-2544	12	24 to 45	N. Bering Sea
	June 9	N4-2582	12940	17 to 42	Bering Sea, Pribilofs
	June 10	N4-2594	12920	17 to 42	Bering Sea
	June 14	N4-2644	12	18 to 42	Norton Sound
	June 24	N4-2769	13080	18 to 42	Aleutians
	June 26	N4-2794	12	18 to 42	Gulf of Alaska, Mackenzie Delta
	July 3	N4-2882	12	22 to 45	Bering Strait, Norton Sound
	July 5	N4-2907	12810	22 to 46	Bering Strait, Gulf of Alaska
	July 10	N4-2969	12	26 to 49	Gulf of Alaska
	"	"	"	42 to 66	"
	July 20	N4-3095	12	28 to 59	Bering Sea
	"	"	"	22 to 46	"
	July 22	N4-3120	12	22 to 46	Bering Sea, Chukchi Sea
	July 24	N4-3137	12	28 to 59	Bering Strait
	July 25	N4-3158	13300	22 to 46	Bering Sea, Chukchi Sea
	July 27	N4-3182	12900	26 to 49	Gulf of Alaska, Alaska Stream
	July 28	N4-3196	I4451=I3	(10 to 29)+(30 to 50)	Kamchatka volcanoe eruption
	Aug 2	N4-3258	12920	26 to 50	Bering Sea
	Aug 3	N4-3270	12430	26 to 49	Gulf of Alaska, Alaska Stream
	Aug 4	N4-3282	12	26 to 49	Gulf of Alaska
	"	"	"	28 to 59	"

DATE	ORBIT .	FRAME	TEMPERATURE (“F)	AREA
1975 Aug 5	N4-3295	12808	22 to 46	Nunivak-Kodiak
"	"	"	28 to 59	"
Aug 6	N4-3307	12	26 to 49	Gulf of Alaska
"	"	"	28 to 59	"
Aug 7	N4-3321	13270	28 to 59	Bering Sea, Chukchi Sea
Aug 8	N4-3333	12600	22 to 46	Bering Sea
"	"	"	28 to 59	"
Aug 9	N4-3345	13070	22 to 46	Bering, Pribilofs, Gulf of Alaska
"	"	"	28 to 59	"
Aug 26	N4-3557	12	27 to 59	SE Alaska
Aug 27	N4-3570	12	27 to 59	Prince William Sound
Aug 28	N4-3583	12	27 to 59	Gulf of Alaska
Aug 29	N4-3595	12790	27 to 59	Gulf of Alaska
Aug 30	N4-3600	10780	27 to 59	Gulf of Alaska
Aug 30	N4-3609	13	23 to 48	Aleutians
Sept 13	N4-3783	12858	28 to 60	Alaska Stream, Cook Inlet
Sept 25	N4-3934	12500	(-1 to 27)+(28 to 51)	Chukchi-Norton Sound
Ott 6	N4-4071	12	30 to 62	Gulf of Alaska, Kodiak
Ott 7	N4-4076	11250	28 to 60	Gulf of Alaska, Kodiak
Ott 9	N4-4101	10710	29 to 61	Gulf of Alaska, Kodiak
Ott 25	N4-4309	12808	(-1 to 27)+(28 to 51)	Gulf of Alaska, Alaska Stream
Ott 26	N4-4322	13000	(-1 to 27)+(28 to 51)	Alaska Stream
Ott 27	N4-4334	12	(-1 to 27)+(28 to 51)	Gulf of Alaska
"	"	13000	(-1 to 27)+(28 to 51)	Gulf of Alaska, Alaska Stream
Nov 30	N4-4760	13140	(0 to 28)-t-(29 to 44)	Alaska Stream, Aleutians

DATE	ORBIT	FRAME	TEMPERATURE (“F)	AREA
1976 Feb 28	N4-5887	13238	(-30 to 28)+(29 to 41)	Gulf of Alaska to 10″E
Feb 29	N4-5892	12	(-30 to 28)+(29 to 41)	Gulf of Alaska
"	"	"	23 to 50	"
Feb 29	N4-5899	12820	-30 to 28)+(29 to 41)	Gulf of Alaska to 25°E
Apr 14	N4-6463	13300	-4 to 28)+(29 to 45)	Gulf of Alaska
"	"	"	26 to 34	"
Apr 29	N4-6650	13300	(-4 to 28)+(29 to 45)	Gulf to SE Alaska
Apr 30	N4-6663	13300	(-4 to 28)+(29 to 45)	Gulf of Alaska
May 20	N4-6914	13300	30 to 38	Alaska Stream
"	"	"	32 to 36	"
May 20	N4-6914	13300	34 to 42	Alaska Stream
May 29	N4-7026	13500	30 to 38	Alaska Stream
May 30	N4-7039	13400	30 to 38 (too cold)	Prince William Sound
"	"	"	34 to 50	"
May 31	N4-7051	13300	30 to 38 (too cold)	Prince William Sound
"	"	"	34 to 50	"
June 8	N3-11714	13450	30 to 38 (too cold)	Gulf of Alaska
June 10	N3-11739	12238	30 to 38	Bering Strait
June 11	N4-7189	13500	30 to 38 (too cold)	Alaska Stream
June 12	N3-11764	10775	30 to 38	Bering Sea & Pribilofs
July 3	N4-7465	14180	32 to 48	Alaska Stream, eddies
"	"	"	40 to 48	"
July 10	N4-7553	12	32 to 48	Bering Strait
July 11	N4-7565	IR	32 to 48	Bering Strait
"	"	"	28 to 60	"

DATE	ORBIT	FRAME	TEMPERATURE (°F)	AREA
1976 July 12	N4-7578	12	32 to 48	Bering Strait
"	"	"	28 to 60	"
July 23	N4-7715	12	28 to 60	Norton Sound
July 25	N4-7740	13200	28 to 60	Gulf of Alaska
July 31	N4-7816	10004	0 to 32	Stratus clouds
"	"	12279	0 to 32	"
Aug 1	N4-7827	13200	28 to 60	Gulf of Alaska
Aug 21	N4-8078	13600	28 to 60	Gulf, Alaska Stream
Aug 22	N4-8090	13500	28 to 60	Gulf of Alaska
Aug 25	N5-0336	12200	28 to 50	Arctic coast
Aug 26	N5-0349	12200	28 to 50	Arctic
Sep 7-20	N5-0496→0657	IR	32 to 59	British Columbia coast (Coast Guard Study)
Sep 16	N5-0609	13000	28 to 60	Kamchatka eddies
"	"	13001	36 to 52	"
Sep 18	N5-0634	13500	29 to 52	Kamchatka eddies
Ott 1	N5-0794	12	(0 to 28)-l-(29 to 52)	Gulf of Alaska
"	"	"	32 to 48	Gulf of Alaska, Yakutat sediments
Ott 2	N5-0806	13000	36 to 48; <35B1	Gulf of Alaska
"	"	"	(O to 19)+(20 to 28) B1+(29 to 48)	"
Ott 2	N5-0806	13000	(O to 31)+(32 to 48)	Gulf of Alaska
"	"	12	(O to 28)+(29 to 52)	"
Ott 2	N5-0807	13000	(O to 28)+(29 to 44)	Bering Sea, Norton Sound
"	"	"	(O to 28)+(29 to 52)	"
Ott 2	N5-0807	13000	(O to 31) B1+(32 to 46)	Bering Sea, Norton Sound
"	"	"	40 to 48	Norton Sound

DATE	ORBIT	FRAME	TEMPERATURE (°F)	AREA
1976 Ott 3	N5-0819	12	(O to 28)+(29 to 44)	Norton Sound
Ott 7	N5-0869	13	(0 to 28)+(29 to 44)	Islands of 4 Mountains
Ott 8	N5-0880	13200	(O to 28)+(29 to 52)	Gulf of Alaska
Ott 10	N5-0906	12	(O to 28)+(29 to 44)	Kotzebue Sound
Ott 14	N5-0955	11160	(O to 28)+(29 to 44)	Mackenzie, Amundsen Gulf
Ott 14	N5-0956	13	(O to 28)+(29 to 44)	Kamchatka eddies
Ott 15	N5-0968	13	(O to 28)+(29 to 44)	Cape Olyutorskiy, Kamchatka
Ott 23	N5-1066	13400	32 to 48	N. Gulf of Alaska coast
Ott 23	N5-1067	12	(-20 to 28)+(29 to 44)	Arctic ice, Pt. Hope
Ott 24	N5-1079	12	(-20 to 28)+(29 to 44)	Chukchi Sea, Norton Sound
Oct 25	N5-1092	13600	(-20 to 28)-I-(29 to 37)	Cape Olyutorskiy, Kamchatka
Ott 28	N5-1129	13300	(-20 to 28)-t-(29 to 37)	Chukchi, Cape Olyutorskiy
Ott 29	N5-1141	13400	(-20 to 28)-I-(29 to 37)	Cape Olyutorskiy, Kamchatka
It	II	13600	(-20 to 28)+(29 to 45)	Cape Olyutorskiy, Aleutians
Ott 30	N5-1154	13200	(-20 to 28)+(29 to 37)	Chukchi, Cape Olyutorskiy
Ott 31	N5-1166	12920	(-30 to 20)+(21 to 28) B1+(29 to 37)	Chukchi, Cape Olyutorskiy
"	"	"	(-20 to 28)+(29 to 37)	"
Nov 4	N5-1215	12888	(-20 to 28)+(29 to 37)	E. Bering: Pt. Hope-Nunivak
Nov 5	N5-1228	I2888	(-20 to 28)+(29 to 37)	E. Bering, Chukchi
"	"	II	(-30 to 24)+(25 to 28)B1+(29 to 37)	11
Nov 9	N5-1277	13500	(-30 to 24)+(25 to 28)B1+(29 to 45)	Bristol Bay, Norton Sound
Nov 10	N5-1290	12, 3	(-30 to 24)+(25 to 28)B1+(29 to 37)	Bering Sea, Kamchatka
Nov 29	N5-1525	12626	(-40 to 24)+(25 to 28)B1+(29 to 37)	Chukchi, Bering Sea
Nov 30	N5-1537	12626	(-40 to 24)+(25 to 28)B1+(29 to 37)	Chukchi, Bering Sea

DATE	ORBIT	FRAME	TEMPERATURE (“F)	AREA
1976 Dec 1	N5-1550	12920	(-40 to 24)+(25 to 28) B1+(29 to 37)	Chukchi, Bering Sea
Dec 2	N5-1562	12820	(-50 to 24)+(25 to 28)B1+(29 to 37)	Chukchi, Bering Sea
Dec 6	N5-1611	13200	(-50 to 28)-l-(29 to 41)	Gulf of Alaska
"	"	"	(-50 to 24)+(25 to 28)B1+(29 to 37)	"
Dec 6	N5-1611	13200	(-50 to 28)+(29 to 37)	Gulf of Alaska
Dec 7	N5-1624	12880	(-50 to 24)+(25 to 28)B1+(29 to 37)	Chukchi, Bering Sea
Dec 8	N5-1636	12920	(-50 to 24)+(25 to 28)B1+(29 to 37)	Chukchi, Bering Sea, Cook Inlet
Dec 9	N5-1649	13300	(-50 to 24)+(25 to 28)B1+(29 to 37)	Chukchi, Bering Sea
Dec 10	N5-1661	13200	(-50 to 24)+(25 to 28)B1+(29 to 37)	Chukchi, Bering Sea
Dec 12	N5-1686	14000	(-50 to 24)-t-(25 to 28)B1+(29to 37)	Kamchatka
Dec 16	N5-1735	13100	(-50 to 28)+(29 to 37)	Cook Inlet, Aleutians
Dec 17	N5-1747	12626	(-50 to 28)+(29 to 41)	Yakutat coast
"	"	"	(-50 to 28)+(29 to 37)	"
Dec 18	N5-1760	12820	(-50 to 24)+(25 to 28) B1+(29 to 37)	Bering Sea
Dec 22	N5-1810	14000	(-50 to 24)+(25 to 28)B1+(29 to 37)	Kamchatka
Dec 28	N5-1884	13100	(-50 to 24)+(25 to 28)B1+29) to 37)	Bering Sea

DATE	ORBIT	FRAME	TEMPERATURE ("F)	AREA
1977 Jan 5	N5-1982	13200	(-50 to 28)+(29 to 41)	Cook Inlet, Kodiak Island
Jan 6	N5-1995	11650	(-50 to 24)+(25 to 28) B1+(29 to 37)	NW Alaska coast
Jan 14	N5-2094	11940	(-50 to 24)+(25 to 28)B1+(29 to 37)	Arctic coast to Pt. Hope
Jan 21	N5-2181	13150	(-50 to 24)+(25 to 28)B1+(29 to 37)	Bering Sea
Jan 26	N5-2243	13250	(-50 to 24)+(25 to 28)B1+(29 to 37)	W. Bering Sea
Jan 29	N5-2279	11800	(-50 to 28)+(29 to 45)	"Octopus legs" in Gulf of Alaska
Jan 29	N5-2280	12920	(-50 to 24)+(25 to 28)B1+(29 to 37)	Bering Sea, E. Chukchi leads
Jan 30	N5-2292	12720	(-50 to 24)-i-(25 to 28)B1+(29 to 37)	Bering Sea, E. Chukchi leads
Jan 31	N5-2305	13065	(-50 to 24)+(25 to 28)B1+(29 to 37)	Bering Sea, plume N. St. Lawrence
"	"	13070	(-30 to 24)+(25 to 28)B1+(29 to 37)	Bering Sea
Feb 1	N5-2317	12480	(-50 to 24)+(25 to 28)B1+(29 to 37)	Bering Sea, NW Alaska coast
"	"	"	(-60 to 24)+(25 to 28)B1+(29 to 37)	"
Feb 2	N5-2330	12676	(-50 to 24)+(25 to 28) B1+(29 to 37)	Bering Sea, NW Alaska coast
Feb 3	N5-2342	12960	(-50 to 24)+(25 to 28) B1+(29 to 37)	Bering Sea, NW Alaska coast
Feb 6	N5-2379	13200	(-50 to 24)+(25 to 28)B1+(29 to 37)	Bering Sea
Feb 9	N5-2416	10485	(-50 to 24)+(25 to 28)B1+(29 to 37)	Arctic leads, breakup Barrow
Feb 11	N5-2441	12670	(-50 to 24)+(25 to 28)B1+(29 to 37)	Arctic leads, Bering floebergs
Feb 12	N5-2453	12770	(-50 to 24)+(25 to 28)B1+(29 to 37)	W. Bering-Barrow "plume" N. St. Lawrence Island
Feb 13	N5-2466	12044	(-50 to 24)+(25 to 28)B1+(29 to 37)	Chukchi floebergs
"	"	13700	(-50 to 24)+(25 to 28)B1+(29 to 37)	W. Bering Sea
Feb 14	N5-2478	12820	(-50 to 24)+(25 to 28)B1+(29 to 37)	W. Bering, Chukchi Sea
Feb 16	N5-2503	13	(-50 to 24)+(25 to 28)B1+(29 to 37)	W. Bering, Kamchatka
Feb 18	N5-2528	12, 3	(-50 to 24)+(25 to 28)B1+(29 to 37)	NW Alaska coast, Kamchatka ice eddies

DATE	ORBIT	FRAME	TEMPERATURE ("F)	AREA
1977 Feb 20	N5-2552	13600	(-50 to 28)+(29 to 45)	Aleutians
Feb 21	N5-2565	13	(-50 to 24)+(25 to 28)B1+(29 to 37)	Ice eddies off Kamchatka
Feb 22	N5-2577	12725	(-50 to 24)+(25to 28)B1+(29 to 37)	NW Alaska coast breakup, Bristol
Feb 23	N5-2589	12100	(-50 to 28)+(29 to 45)	NW Alaska coast, Prince William
Feb 24	N5-2602	11, 2	(-50 to 24)+(25 to 28)B1+(29 to 37)	NW Alaska coast breakup
Feb 25	N5-2613	12	(-50 to 28)+(29 to 45)	Gulf, Arctic coast
Feb 25	N5-2614	11, 2	(-50 to 28)-I-(29 to 45)	Gulf, Arctic coast
Feb 27	N5-2639	11000	(-50 to 24)+(25 to 28)B1+(29 to 37)	Chukchi Sea
"	"	13200	(-50 to 24)+(25 to 28)B1+(29 to 37)	Bering Sea, Bristol Bay
Feb 28	N5-2651	12040	(-50 to 24)+(25 to 28) B1+(29 to 37)	Chukchi Sea
Mar 2	N5-2676	12920	(-50 to 24)+(25 to 28) B1+(29 to 37)	Bering Sea
Mar 3	N5-2688	12	(-70 to -30)+(-29 to 28)+(29 to 37)	Bering ice edge ∿250 km north of St. Paul
II	"	12240	(-30 to 24)+(25 to 28)B1+(29 to 41)	II
Mar 4	N5-2701	12	(-50 to 24)+(25 to 28)B1+(29 to 37)	Bristol ice free, Bering ice edge,
"	"	12240	(-30 to 24)+(25 to 28)B1+(29 to 41)	∿175 km south of Nunivak
Mar 5	N5-2713	12	(-50 to 24)+(25 to 28)B1+(29 to 37)	Bering Sea
Mar 6	N5-2726	14240	(-50 to 24)+(25 to 28)B1+(29 to 37)	W. Bering ice edge, Kamchatka
Mar 7	N5-2737	12	(-50 to 24)+(25 to 28)B1+(29 to 41)	Gulf of Alaska, Prince William
Mar 7	N5-2738	12725	(-50 to 24)+(25 to 28)B1+(29 to 37)	Bering Sea
II	"	12726	(-30 to 24)-t-(25 to 28)B1+(29 to 41)	Bering Sea
Mar 8	N5-2750	12	(-50 to 24)+(25 to 28)B1+(29 to 41)	Bering Sea/Gulf of Alaska
"	"	12240	(-30 to 24)+(25 to 28)B1+(29 to 41)	"
Mar 9	N5-2763	13200	(-50 to 24)-t-(25 to 28)B1+(29 to 37)	Bering Sea/Gulf of Alaska
"	"	13201	(-30 to 24)+(25 to 28)B1+(29 to 41)	"

DATE	ORBIT	FRAME	TEMPERATURE (“F)	AREA
1977 Mar 10	N5-2775	13100	(-50 to 24)+(25 to 28) B1+(29 to 37)	Bering Sea/Gulf of Alaska
"	"	13101	(-30 to 24)+(25 to 28)B1+(29 to 41)	"
Mar 11	N5-2787	12	(-50 to 24)-t-(25 to 28)B1+(29 to 41)	Gulf/Kodiak warm current
Mar 12	N5-2799	12	(-50 to 24)+(25 to 28)B1+(29 to 41)	Prince William Sound
Mar 13	N5-2811	13100	(-50 to 24)+(25 to 28)B1+(29 to 41)	Kodiak Island
Mar 13	N5-2812	12	(-50 to 24)+(25 to 28)B1+(29 to 41)	Bristol Bay
Mar 14	N5-2824	11300	(-50 to 24)+(25 to 28)B1+(29 to 41)	Prince William Sound
Mar 14	N5-2825	11, 2	(-50 to 24)+(25 to 28)B1+(29 to 37)	Arctic leads, Kamchatka
Mar 15	N5-2837	11560	(-50 to 24)+(25 to 28)B1+(29 to 37)	Arctic leads, Kamchatka
Mar 17	N5-2861	12500	(-50 to 24)+(25 to 28)B1+(29 to 41)	Gulf of Alaska
Mar 17	N5-2862	11,2,3	(-50 to 24)+(25 to 28) B1+(29 to 37)	W. Bering, Barrow leads
"	"	10775	(-50 to -18); OWh	Beaufort Sea leads
Mar 18	N5-2873	12	(-50 to 24)+(25 to 28)B1+(29 to 41)	Gulf of Alaska
Mar 18	N5-2874	10900	(-50 to 24)+(25 to 28) B1+(29 to 37)	Barrow lead
Mar 18	N5-2874	10901	(-50 to -18); OWh	Barrow lead
"	"	13150	(-50 to 24)+(25 to 28) B1+(29 to 37)	W. Bering Sea
Mar 19	N5-2887	12, 3	(-50 to 24)+(25 to 28)B1+(29 to 41)	W. Bering, Arctic leads
Mar 20	N5-2899	12	(-50 to 24)+(25 to 28)B1+(29 to 41)	Bering Sea
Mar 21	N5-2910	12	(-50 to 24)+(25 to 28)B1+(29 to 41)	Prince William Sound
Mar 21	N5-2911	10440	(-50 to 24)+(25 to 28)B1+(29 to 41)	Arctic leads
"	"	12678	(-50 to 24)+(25 to 28)B1+(29 to 41)	Bering Sea
Mar 22	N5-2923	12820	(-50 to 24)-I-(25 to 28)B1+(29 to 41)	E. Bering Sea
Mar 22	N5-2924	13500	(-50 to 24)+(25 to 28)B1+(29 to 41)	W. Bering Sea
Mar 23	N5-2935	13600	(-50 to 24)+(25 to 28)B1+(29 to 41)	Gulf of Alaska
Mar 23	N5-2936	12530	(-50 to 24)+(25 to 28)B1+(29 to 41)	Bering Sea
Mar 25	N5-2961	13200	(-50 to 24)+(25 to 28)B1+(29 to 41)	Bering (Chukchi very cold, Barrow (-30 to -35°F 3/27)

DATE	ORBIT	FRAME	TEMPERATURE (°F)	AREA
1977 Mar 27	N5-2985	12	(-50 to 24)+(25 to 28) Bl+(29 to 41)	Gulf of Alaska
"	"	11	-50 to -18; OWh	Banks Island leads
Mar 28	N5-2998	11450	-50 to 0; -30Bl, -10Wh	Chukchi leads
Mar 29	N5-3010	13500	(-50 to 24)+(25 to 28)Bl+(29 to 41)	Bering Sea, Pribilofs
"	"	13501	"N4P" (see p. 114)	"
Mar 30	N5-3022	13200	(-50 to 24)+(25 to 28)Bl+(29 to 41)	Gulf of Alaska
Mar 30	N5-3023	13800	(-50 to 24)+(25 to 28)Bl+(29 to 41)	W. Bering, Pribilofs, Kamchatka
Mar 31	N5-3035	12820	(-50 to 24)-I-(25 to 28) Bl+(29 to 41)	Bering Sea
Apr 4	N5-3085	12	(-50 to 0); -30Bl, -10Wh	Chukchi lead
Apr 5	N5-3097	12	(-50 to 0); -30Bl, -10Wh	Chukchi lead
Apr 8	N5-3133	12	(-50 to 24)-t-(25 to 28)Bl+(29 to 41)	Kayak-Yakutat
"	"	"	(0 to 28)+(29 to 45)	"
Apr 8	N5-3134	13200	(-50 to 24)+(25 to 28)Bl+(29 to 41)	W. Bering ice edge eddies
Apr 15	N5-3221	13	(-50 to 28)+(29 to 41)	S. Kamchatka
"	"	14470	24 to 32	"
Apr 15	N5-3221	14471	16 to 32	S. Kamchatka
"	"	14472	(0 to 28)+(29 to 41)	"
Apr 15	N5-3221	14473	24 to 32 rerun	S. Kamchatka
Apr 16	N5-3232	12600	(0 to 28)+(29 to 45)	Gulf of Alaska
Apr 18	N5-3258	12	-50 to 0; -20Bl, -10Wh	Chukchi Sea
"	"	12240	0 to 32	"
Apr 18	N5-3258	12241	(-32 to -1)+(0 to 32)	Chukchi Sea
Apr 21	N5-3294	12	(0 to 28)+(29 to 45)	Gulf of Alaska
Apr 23	N5-3319	12	(0 to 28)+(29 to 45)	Prince William Sound
Apr 23	N5-3320	13600	20 to 36	Kamchatka ice eddies
Apr 26	N5-3357	12920	(0 to 28)+(29 to 45)	E. Bering Sea, Pribilofs

DATE	ORBIT	FRAME	TEMPERATURE ('F)	AREA
1977 Apr 27	N5-3368	13200	(0 to 28)+(29 to 45)	Gulf of Alaska
Apr 27	N5-3369	13000	(0 to 28)+(29 to 45)	Bering Sea/Gulf of Alaska
Apr 28	N5-3381	12	(0 to 28)+(29 to 45)	Gulf of Alaska
May 4	N5-3455	13100	(0 to 28)+(29 to 45)	Gulf of Alaska
May 13	N5-3566	13000	(0 to 28)+(29 to 45)	Gulf of Alaska
May 15	N5-3591	13200	(0 to 28)+(29 to 45)	SE Alaska
May 17	N5-3617	13800	(0 to 28)+(29 to 45)	SW Bering Sea
"	"	13801	24 to 41	"
May 18	N5-3628	12820	(0 to 28)+(29 to 45)	SE Alaska
"	"	12821	34 to 50	"
May 18	N5-3628	12822	30 to 50	SE Alaska
May 19	N5-3642	13	(0 to 28)+(29 to 45)	Kamchatka oceanic eddies
May 21	N5-3666	12	(0 to 28)-I-(29 to 41)	Bering Sea, Norton Sound
May 26	N5-3727	13000	34 to 50	Gulf of Alaska
May 30	N5-3777	12	34 to 50	Gulf, Middleton upwelling
June 1	N5-3802	12850	34 to 50	Cook Inlet, Alaska Peninsula
June 7	N5-3876	12	34 to 50 (slightly >50F)	Gulf of Alaska
June 12	N5-3939	13	29 to 45	Kamchatka
June 15	N5-3976	12820	34 to 50	Upwelling St. Paul, Pribilofs
"	"	12821	36 to 44	"
June 15	N5-3976	12822	29 to 45	Upwelling St. Paul, Pribilofs
June 26	N5-4112	12	28 to 60	Yukon sediments, Norton warm
June 30	N5-4161	12725	28 to 60	Yukon sediments, eddies
"	"	"	34 to 66	S. Aleutians

DATE	ORBIT	FRAME	TEMPERATURE (“F)	AREA
1977 July 7	N5-4247	12240	34 to 50	SE Alaska
"	"	"	34 to 66	"
July 10	N5-4 284	12920	40 to 64	Gulf, Alaska Stream
July 12	N5-4310	11560	28 to 44	Chukchi Sea
"	"	11700	(28 to 52)+(53 to 70)	Interior, sand dunes
July 15	N5-4347	11750	20 to 36	Chukchi Sea
"	"	11751	32 to 48	"
July 15	N5-4347	11850	(32 to 48)+(49 to 65)	Chukchi Sea
July 17	N5-4371	13200	40 to 64	Gulf of Alaska
July 18	N5-4383	13200	40 to 56	Kodiak, Alaska Stream
July 19	N5-4396	12920	40 to 56	Pribilofs, Alaska Stream
"	"	12921	(36 to 44)-t-(45 to 61)	"
July 22	N5-4434	11840	32 to 48	Pribilofs, Chukchi Sea
"	"	11841	(32 to 48)+(49 to 65)	"
July 28	N5-4507	12	40 to 64	Gulf of Alaska
July 31	N5-4545	12300	28 to 60	B. Strait, flow through smoke
"	"	12301	30 to 46	"
July 31	N5-4545	12440	34 to 66	B. Strait, flow through smoke
"	"	12441	(34 to 66)-I-(67 to 99)	"
Aug 1	N5-4557	12000	28 to 60	Pribilofs, Arctic coast
"	"	12001	30 to 46	"
Aug 1	N5-4557	12002	(28 to 44)+(45 to 68)	Pribilofs, Arctic coast
"	"	12003	(28 to 42)+(43 to 68)	"
Aug 1	N5-4557	12004	(28 to 40)+(41 to 68)	Pribilofs, Arctic coast
"	"	12005	(28 to 44)+(45 to 60)	"
Aug 1	N5-4557	13500	36 to 52	Pribilofs, Arctic coast
"	"	13501	36 to 68	"
Aug 1	N5-4558	13	36 to 52	Kamchatka oceanic eddies

DATE	ORBIT	FRAME	TEMPERATURE (*F)	AREA
1977 Aug 8	N5-4644	13800	40 to 64	St. Matthew & Pribilofs
Aug 12	N5-4694	13	40 to 64	Komandorskiy & W. Aleutians
Aug 13	N5-4706	13	40 to 56	Amchitka upwelling
Aug 14	N5-4718	I1 0001	28 to 44	Arctic coast open
"	"	10002	(28 to 44)+(45 to 60)	Arctic coast open
Aug 20	N5-4792	12	40 to 56	Gulf of Alaska
"	II	12240	40 to 64	"
Aug 21	N5-4805	12820	40 to 56	Bering Sea, Pribilofs
Aug 23	N5-4830	12725	40 to 56	Bering Sea
"	"	12726	36 to 68	"
Aug 27	N5-4879	12530	36 to 68	E. Bering Sea, St. Paul Island
It	"	12531	(36 to 52)+(53 to 68)	"
Sept 12	N5-5077	12240	36 to 52	Gulf→Kodiak ("noisy")
Sept 16	N5-5127	14470	36 to 52	Kamchatka eddies
"	"	14471	36 to 52; 37/38B1, 42/43Wh	"
Sept 17	N5-5139	14140	36 to 52	Pribilof upwelling N. Kamchatka eddies
Sept 26	N5-5251	14470	36 to 52	Kamchatka eddies
"	"	14471	36 to 52; 37/38B1, 42/43Wh	"
Sept 26	N5-5251	14472	36 to 44; 37/38B1, 42/43Wh	Kamchatka eddies
Nov 19	N5-5918	12240	(-20 to 28)+(29 to 45)	SE Alaska
Nov 21	N5-5943	13200	(-20 to 28)+(29 to 45)	P. William Sound, Cook Inlet
Nov 21	N5-5944	14470	(-40 to 28)-t-(29 to 37)	Kamchatka
Nov 22	N5-5955	13200	(-20 to 28)+(29 to 45)	Gulf of Alaska
Nov 22	N5-5956	12820	(-40 to 28)+(29 to 45)	Bering Sea
Nov 23	N5-5968	12600	(-40 to 28)+(29 to 45)	Gulf of Alaska/Bering Sea
Nov 23	N5-5969	12820	(-40 to 28)+(29 to 45)	Bering Sea

DATE	ORBIT	FRAME	TEMPERATURE (“F)	AREA
1977 Nov 24	N5-5980	12400	(-40 to 28)+(29 to 45)	Gulf of Alaska
Nov 24	N5-5981	12725	(-40 to 28)+(29 to 45)	Bering Strait flow, Bristol
Nov 28	N5-6031	14475	(-40 to 28)+(29 to 45)	Kamchatka ice/water: <<45
Nov 30	N5-6055	12240	(-40 to 28)+(29 to 45)	Aleutians, Bristol, Karman vort.
Dec 1	N5-6067	13600	(-40 to 28)+(29 to 45)	Gulf of Alaska cloud free
Dec 2	N5-6079	13200	(-40 to 28)+(29 to 45)	Gulf of Alaska
Dec 3	N5-6092	13500	(-40 to 28)+(29 to 45)	Alaska Stream
Dec 6	N5-6129	12820	(-40 to 28)-I-(29 to 45)	Bristol Bay/Gulf of Alaska
Dec 10	N5-6179	13675	(-40 to 28)+(29 to 45)	Bering Sea, Pribilofs
Dec 13	N5-6216	13300	(-40 to 28)+(29 to 45)	Bristol Bay, Karman vortices

DATE	ORBIT	FRAME	TEMPERATURE (°F)	AREA
1978 Jan 2	N5-6463	12400	(-40 to 28)+(29 to 45)	Gulf coast sediment or cold water
Jan 3	N5-6475	13000	(-40 to 28)+(29 to 45)	SE Alaska, Gulf of Alaska
Jan 7	N5-6526	13800	(-40 to 28)+(29 to 37)	Kamchatka, Bering Sea
Jan 8	N5-6538	12000	(-40 to 28)+(29 to 37)	Bering ice edge
Jan 15	N5-6624	13200	(-40 to 28)+(29 to 41) .	Gulf of Alaska
Feb 27	N5-7156	13000	(-20 to 28)+(29 to 41)	SE Alaska
Feb 28	N5-7168	12725	(-20 to 28)+(29 to 41)	Gulf of Alaska
Feb 28	N5-7169	12725	(-40 to 28)+(29 to 37)	Alaska coastline: Norton-Bristol
Mar 1	N5-7181	12626	(-20 to 28)+(29 to 41)	Gulf of Alaska, Bristol Bay
Mar 2	N5-7194	12820	(-40 to 28)+(29 to 37)	Bering Sea
"	"	"	(-40 to 20)+(21 to 37)	"
Mar 3	N5-7206	12920	(-40 to 28)+(29 to 37)	Bering Sea
"	"	12921	(-40 to 20)+(21 to 37)	"
Mar 18	N5-7392	12240	(-40 to 4)+(5 to 37)	Bering ice; cloud free
Mar 19	N5-7404	12530	(-40 to 4)+(5 to 37)	Bering Sea
"	"	12531	(-40 to 28)+(29 to 37); OB1, -20Wh	"
Mar 20	N5-7417	12530	(-40 to 28)+(29 to 37); OB1, -20Wh	Bering Sea
Mar 21	N5-7429	12240	(-40 to 28)+(29 to 37); OB1, -20Wh	Bering Sea, Bristol ice edge
Mar 22	N5-7441	12300	(-40 to 28)+(29 to 37); OB1, -20Wh	Bering Sea
"	"	12301	(-20 to 19)+(20 to 36)	"
Mar 23	N5-7454	13150	(-40 to 28)+(29 to 37); OB1, -20Wh	Bering Sea, Pribilofs, Bristol
Mar 26	N5-7491	12920	(-20 to 28)+(29 to 37); OWh	Bering Sea
Apr 2	N5-7577	12240	(-20 to 28)-I-(29 to 27); OWh	Ice edge Bristol, Alaska Stream

DATE	ORBIT	FRAME	TEMPERATURE (°F)		AREA
1978 Apr 10	N5-7676	13400	(0 to 28)+(29 to 45)	(table adjusted)	Gulf of Alaska
Apr 12	N5-7701	12675	(0 to 28)+(29 to 45)		Gulf of Alaska
Apr 13	N5-7713	12240	(0 to 28)+(29 to 45)	water apparently colder than Apr 10, 12, 14: Rerun	Gulf of Alaska
Apr 13	N5-7713	12241	(0 to 28)+(29 to 45)	no change!	Gulf of Alaska
Apr 14	N5-7725	13100	(0 to 28)+(29 to 45)		Gulf of Alaska
Apr 16	N5-7750	13400	(0 to 28)+(29 to 45)		Gulf, Kodiak, Alaska Stream
Apr 18	N5-7775	12500	(0 to 28)+(29 to 45)		Gulf, Kodiak, Alaska Stream
Apr 19	N5-7787	13000	(0 to 28)-I-(29 to 45)		Gulf of Alaska, ~45°F
Apr 26	N5-7875	12950	(0 to 28)+(29 to 45)		Bering Sea, Norton Sound
Apr 28	N5-7899	13000	(0 to 28)+(29 to 45)		Norton Sound
May 14	N5-8097	12400	34 to 50		Gulf of Alaska
"	"	12401	(0 to 28)+(29 to 45)		"
May 16	N5-8122	12300	(0 to 28)+(29 to 45)		Norton Sound
May 20	N5-8171	12300	(0 to 28)+(29 to 45)		Gulf of Alaska
"	"	12301	34 to 50		"
May 27	N5-8258	12820	(0 to 28)+(29 to 45)		Norton Sound
May 27	N5-8259	13500	(0 to 28)+(29 to 45)		Bering Strait, Gulf of Anadyr
June 7	N5-8394	13200	34 to 50		E. Kodiak
June 11	N5-8443	13000	34 to 50		Gulf of Alaska
"	"	13001	34 to 66		"
June 11	N5-8443	13002	40 to 56		Gulf of Alaska
June 20	N5-8554	12626	34 to 66		Gulf of Alaska
July 3	N5-8716	12626	34 to 66		Bering Strait

DATE	ORBIT	FRAME	TEMPERATURE (“F)	AREA
1978 July 6	N5-8754	14475	34 to 50	Kamchatka eddies
"	"	14476	34 to 66	"
July 15	N5-8865	11540	(32 to 48)-I-(49 to 65)	E. Chukchi, Kotzebue Sound
July 29	N5-9037	13000	40 to 56	Gulf of Alaska
July 30	N5-9050	12240	40 to 56	Gulf of Alaska, Bristol Bay
"	"	12241	40 to 64	"
July 31	N5-9062	12820	40 to 56	Gulf of Alaska & SE Alaska
"	"	12821	40 to 64	"
Aug 5	N5-9125	13700	36 to 52	Pribilof Islands
Aug 6	N5-9137	13300	40 to 64	Yukon delta, Pribilofs
Aug 15	N5-9248	12240	40 to 64	Cook Inlet, P. William Sound
Aug 18	N5-9285	12820	40 to 64	Gulf of Alaska
Aug 21	N5-9322	12600	40 to 64	Gulf of Alaska
Aug 25	N5-9372	13400	40 to 64	Kodiak Island
Sept 2	N5-9471	12500	40 to 64	Gulf of Alaska
Sept 9	N5-9557	12240	40 to 64	Gulf of Alaska rivers
Sept 16	N5-9644	13400	40 to 56	Alaska Stream, Kodiak
Sept 17	N5-9656	13000	40 to 56	Gulf coast & SE Alaska
"	"	13001	(30 to 39)+(40 to 64)	"
Sept 23	N5-9731	13100	40 to 56	Alaska Stream
Sept 29	N5-9805	12240	32 to 48	Gulf of Alaska, Norton Sound
"	"	12241	(30 to 39)+(40 to 56)	"
Ott 1	N5-9830	13200	(30 to 39)+(40 to 56)	Norton Sound, Bristol Bay

DATE	ORBIT	FRAME	TEMPERATURE (“F)	AREA
1978 Ott 2	N5-9843	12920	(30 to 39)+(40 to 56)	Kotzebue Sound, Bristol Bay
Nov 8	N5-10300	13000	(0 to 28)-t-(29 to 45)	Gulf of Alaska, coastal sediments
"	"	13001	(-20 to 28)-i-(29 to 53)	"
Nov 11	N5-10337	12240	(0 to 28)+(29 to 45)	Kayak-Glacier Bay
"	"	12241	(-20 to 28)+(29 to 53)	"
Nov 12	N5-10350	14275	(-20 to 28)+(29 to 53)	Atka-Umnak, tidal mixing
Nov 17	N5-10411	12600	(-20 to 28)+(29 to 53)	Gulf coast & SE Alaska
Dec 26	N5-10894	12240	(-20 to 28)+(29 to 53)	P. William Sound-SE Alaska

DATE	ORBIT	FRAME	TEMPERATURE (“F)	AREA
1979 Jan 3	N5-10993	12240	(-40 to 28)+(29 to 45)	Kayak Island-SE Alaska
Jan 8	N5-11056	12530	(-40 to 28)-I-(29 to 37)	Bering Sea ice
Jan 9	N5-11068	12240	(-40 to 28)+(29 to 37)	Bering Sea, open ∿ Nunivak
Feb 5	N5-11402	12200	(-60 to 28)+(29 to 37)	Bristol Bay, Pribilofs
Feb 6	N5-11415	12600	(-60 to 28)+(29 to 37)	Bering Sea ∿ St. Matthews
Feb 11	N5-11476	13500	(-40 to 28)+(29 to 45)	Gulf of Alaska
Feb 22	N5-11612	12240	(-40 to 28)+(29 to 45)	Gulf of Alaska, SE Alaska-Kodiak
"	"	12241	(-40 to 28)+(29 to 37)	"
Feb 23	N5-11624	13300	(-40 to 28)+(29 to 45)	Gulf of Alaska, SE Alaska-Kodiak
"	"	13301	(-40 to 28)+(29 to 37)	"
Feb 25	N5-11650	13400	(-60 to 28)+(29 to 37)	Eddies along ice edge West of St. Matthew

DATE	ORBIT	START TIME	START POINT	ZOOM/ ENLARG .	TABLE	TEMPERATURE (‘C)	AREA
1979 Mar 27	TN-2334	23:18:15				2 to 12	Vancouver Island
Apr 12	TN-2560	23:54:17				(-18 to -2)+(-2 to 7)	Gulf of Alaska
Apr 22	TN-2701				N4W	o to 13	Vancouver Island
June 30	TN-3661	01:22:50				(0 to 9)+(9 to 18)	Bering, Chukchi Sea
July 10	TN-3802	01:15:45				4 to 13	Pribilof Islands
July 11	TN-3816	01:03:45				4 to 13 (<<13)	Alaska Stream, Aleutians
July 16	TN-3886	00:14:15				(0 to 9)+(9 to 18)	Beaufort Sea coast
July 19	TN-3942	23:31:15				(0 to 9)+(9 to 18)	Beaufort coast, P. William
July 26	TN-4027	00:08:00	0896	R3	N4X	(?) 0 to 13 step	Cook Inlet
July 26	TN-4035	14:01:36	0512	R3	N4X	(?) 0 to 13 step	Cook Inlet, Kodiak
Sept 24	TN-4882	15:09:41	1024	R2	N4W	0 to 13 smooth	Cook Inlet, Kodiak
"	"	"	"	"	N4X	0 to 13 step	"
Ott 11	TN-5121	13:48:40	0256	R3	N4W, N4X	o to 13	Kodiak
"	"	"	"	"	N4Z	(?) 3 to 12	Kodiak
Ott 11	TN-5122	15:30:28	0640	R3	N4X	(?) 0 to 13	Yukon delta
Ott 19	TN-5234	14:03:26	0512	R2	N4W, N4X	o to 13	Cook Inlet & Kodiak
Ott 20	TN-5248	13:52:36	0384	R2	N4X	o to 13	Cook Inlet-Yakutat
Ott 23	TN-5291	15:01:21	0384	R3	N4X	(?) 0 to 13	Yukon & Kuskokwim delta
"	"	15:02:11	1024	R3	N4X	o to 13	Bristol Bay
Ott 24	TN-5305	14:53:46	0640	R2	N4W, N4X	o to 13	S. Kodiak & Bristol Bay
Ott 27	TN-5347	14:19:19	0256	R2	N4W, N4X	o to 13	S. Kodiak & Bristol Bay
Ott 28	TN-5353	00:13:16	0896	R2	N4W, N4X	o to 13	S. Kodiak & Bristol Bay
Nov 5	TN-5474	14:21:00	0930	R2	N4X	o to 13	Gulf of Alaska

DATE	ORBIT	START TIME	START POINT	ZOOM/ ENLARG.	TABLE	TEMPERATURE ('C)	AREA
1979 Nov 11	N6-1940	03:12:28	0896	R2	64w	0 to 13 smooth	Queen Charlotte Sound
"	"	"	"	R2	64X	0 to 13 step	"
Nov 13	TN-5587	14:36:09	0512	R2	N4W, N4X	o to 13	Kodiak & Bristol Bay
Nov 14	TN-5593	00:31:25	0640	R2	N4W, N4X	0 to 13	Alaska Current
Nov 14	TN-5601	14:25:00	0512	R2	N4W, N4X	0 to 13	Alaska Current→Kodiak
Nov 15	TN-5607	00:20:19	0640	R2	N4W, N4X	0 to 13	Kodiak
Nov 16	N6-2020	18:34:36	0512	R2	64W, 64x	0 to 13	Montague Island
Nov 26	TN-5770	13:55:23	0123/4	R2	N4W, N4X	0 to 13	Kodiak
Nov 26	N6-2162	18:19:21	0257/8	R2	64W, 64x	0 to 13	Kodiak
Dec 3	N6-2254	05:20:58	0257/8	R2	64w, 64X	0 to 13	Kodiak
Dec 5	N6-2290	18:24:48	0384	R2	64W, 64x	0 to 13	Kodiak-Montague
Dec 11	TN-5974	00:39:07	0123/4	R2	N4W, N4X	0 to 13	Kodiak
Dec 11	TN-5982	14:33:05	0893/4	R2	N4W, N4X	0 to 13	Kodiak-P. William Sound
"	"	14:34:05	0893/4	R2	N4W, N4X	0 to 13	Kodiak
Dec 13	TN-6010	14:11:18	0123	R2	N4W	0 to 13	Kodiak-P. William Sound
"	"	"	1023	R2	N4W	0 to 13	Cordova-Yakutat
Dec 13	TN-6010	14:11:18	0124	R2	N4X	0 to 13	Kodiak-P. William Sound
"	"	"	1024	R2	N4X	0 to 13	Cordova-Yakutat
Dec 13	TN-6011	15:52:41	0123/4	R2	N4W, N4X	0 to 13	St. Matthew
"	"	"	1023/4	R2	N4W, N4X	0 to 13	Bristol Bay
Dec 14	TN-6025	15:40:01	0	--	N4P*		St. Matthew, Bering
"	"	15:40:02	0	..		(-45 to -1)+(0 to 5)	St. Matthew, Bering
Dec 14	TN-6025	15:40:06	0	-.		(-45 to -3)+(-2 to 5)	St. Matthew, Bering
"	"	15:40:05	0	-.		(-45 to -4)+(-3 to 5)	St. Matthew, Bering

* N4P =	(-45 to -5)	+(-5 to -4)	+(-4 to -3.5)	+(-3.5 to -3)	+(-3 to -2)	+(-2 to -1.5)	+(-1.5 to -1)	+(-1 to 5)
64P	000	250	052	156	208	104	255	000	255
	WH	BL	LLG	DG	DDG	LG	BL	WH	BL
	white	black	light light grey	dark grey	dark dark grey	light grey	black	white	black

DATE	ORBIT	START TIME	START POINT	ZOOM/ ENLARG.	TABLE	TEMPERATURE (°C)	AREA
1979 Dec 14	TN-6025	15:40:04	0	--		(-45 to -5)+(-4 to 5)	St. Matthew, Bering
"	"	15:40:03	0	--		(-45 to -6)+(-5 to 5)	St. Matthew, Bering
Dec 14	TN-6025	15:40:07	DY348	STRECH	N4P*		St, Matthew, Bristol
Dec 15	TN-6031	01:36:31	0	--	N4P		St. Matthew, Bering
"	"	01:36:32	0	--		(-51 to -1)+(0 to 5)	St. Matthew, Bering
Dec 16	TN-6053	15:17:51	0	--	N4P		St. Matthew, Bering
"	"	15:17:52	0	--		(-51 to -1)+(0 to 5)	St. Matthew, Bering
Dec 17	TN-6067	15:08:48	0004	R2	N4Y	-3 to 10 smooth	St. Matthew
"	"	"	0003	R2	N4 Z	-3 to 10 step	St. Matthew
Dec 17	TN-6067	15:07:03	0001	R2	N4P		Bering Strait
"	"	15:08:48		R2	N4P		St. Matthew
Dec 18	TN-6073	01:04:01	0	--	N4P		St. Matthew, Bering
"	"	01:04:02	0	--		(51 to -1)+(0 to 5)	St. Matthew, Bering
Dec 18	TN-6073	01:03:33	0	--	N4R	(-11 to -l); OWh, >OLG	St. Matthew, Bristol
"	"	01:03:34	DY352	STRECH	N4P		St. Matthew, Bristol
Dec 23	N6-2538	04:47:28	0767/8	R2	64Y, 64Z	-3 to 10	Kodiak
Dec 30	N6-2638	05:38:24	0384	R2	64P		Norton, St. Lawrence
"	"	05:36:43	0384	R2	64P		Bristol Bay
Dec 31	TN-6256	00:22:20	0763/4	R3	N4Y, N4Z	-3 to 10	N. Kodiak
"	"	00:22:05	0123/4	R3	N4Y, N4Z	-3 to 10	P. William-Cross Sound
Dec 31	TN-6256	00:20:50	0003/4	R3	N4Y, N4Z	-3 to 10	SE Alaska
Dec 31	N6-2660	19:03:18	0513/4	R3	64Y, 64Z	-3 to 10	Bristol Bay
"	"	"	0512	R3	?		Bristol Bay

DATE	ORBIT	START TIME	START POINT	ZOOM/ ENLARG.	TABLE	TEMPERATURE (°C)	AREA
1980 Jan 1	TN-6270	00:11:18	0893/4	R3	N4Y, N4Z	-3 to 10	North Kodiak
"	"	00:11:03	0383/4	R3	N4Y, N4Z	-3 to 10	Prince William
Jan 1	TN-6270	00:11:18	0896	R3	N4P*		Cook Inlet
Jan 2	TN-6293	15:34:50	0640	R2	N4P		Nunivak, ice edge
Jan 2	N6-2688	18:19:05	0127/8	R2	64Y, 64z	-3 to 10	Kodiak
"	"	"	0128	R2	64P*		Kodiak
Jan 3	TN-6312	23:37:57	1024	R2	N4P		Prince William Sound
Jan 8	TN-6377	14:28:19	0763/4	R2	N4Y, N4Z	-3 to 10	Kodiak
"	"	14:28:49	0003/4	R2	N4Y, N4Z	-3 to 10	Bristol, Kodiak
Jan 8	TN-6377	14:27:41	0	--	NMA	(-45 to -2)+(-1 to 7)	Gulf, Alaska Current
"	"	14:28:19	0768	R2	N4P		Kodiak
Jan 9	N6-2779	03:39:28	0897/8	R2	64Y, 64z	-3 to 10	Cook Inlet-Cross Sound
"	"	03:37:43	0647/8	R2	64Y	-3 to 10	SE Alaska-BC coast
Jan 9	N6-2780	05:20:59	0128	R3	64P		Cook Inlet
Jan 10	TN-6397	00:11:51	0	--	NMA	(-45 to -2)+(-1 to 7)	Gulf of Alaska
Jan 10	TN-6405	14:06:17	0384	R3	N4P		Cook Inlet
Jan 10	TN-6406	15:47:02	0001	R2	N4P		Ice edge, St. Matthew
"	"	15:47:17	0896	R2	N4P		Ice edge, Bristol
Jan 10	TN-6406	15:46:21	0	--	N4P		Bering, St. George eddy
"	"	15:46:22	0	--	NMc	(-45 to -1)+(0 to 5)	Bering, St. George eddy
Jan 11	TN-6412	01:42:21	0	--	N4P		Bering, St. George eddy
"	"	01:42:22	0	--	NMC	(-45 to -1)+(0 to 5)	Bering, St. George eddy
Jan 11	TN-6420	15:36:21	0	--	N4P		Bering Sea
"	"	15:36:22	0	--	NMC	(-45 to -2)+(-1 to 5)	Bering Sea
Jan 12	N6-2822	04:15:35	1024	R3	64P		Cook Inlet
Jan 16	N6-2888	19:55:56	0256	R3	64P		Ice edge, St. Matthew
"	"	"	0896	R3	64P		Ice edge, Nunivak

* N4P =	(-45 to -5)+	(-5 to -4)-l-	(-4 to -3.5)+	(-3.5 to -3)-l-	(-3 to -2)+	(-2 to -1.5)+	(-1.5 to -1)+	(-1 to 5)	
64P	000	250	052	156	208	104	255	000	255
	WH	BL	LLG	DG	DDG	LG	BL	WH	BL

DATE	ORBIT	START TIME	START POINT	ZOOM/ ENLARG.	TABLE	TEMPERATURE (‘C)	AREA
1980 Jan 17	TN-6505	16:10:46	0256	R2	N4P		Ice edge, W. Bering
"	"	"	1024	R2	N4P		Central Bering
Jan 21	N6-2959	19:47:35	0256	R3	64P		Ice edge @ St. Matthew
"	"	"	0896	R3	64P		Ice edge, E. Bering
Jan 21	N6-2959	19:47:35	1280	R3	64P		Bristol Bay
Jan 22	N6-2973	19:24:31	0001	R2	64P		St. Lawrence, Norton
"	"	19:26:01	0001	R2	64P		Nunivak, Pribilofs
Jan 22	N6-2973	19:24:31	0896	R2	64P		SW Alaska
"	"	19:26:01	0896	R2	64P		Bristol, Kodiak
Jan 23	N6-2979	05:16:09	0896	R2	64P		Bristol, Nunivak
"	"	"	0001	R2	64P		Kodiak, Alaska Current
Jan 23	N6-2987	19:03:10	1027/8	R2	64Y, 64Z	-3 to 12	Prince William Sound
Jan 25	N6-3007	04:31:43	0133/4	R2	64Y, 642	-3 to 12	Prince William→SE Alaska
Jan 26	N6-3021	04:09:44	0133/4	R2	64Y, 64z	-3 to 12	Prince William→SE Alaska
Jan 28	N6-3058	18:55:38	0256	R2	64P		Bristol, S. Kodiak
"	"	18:54:38	1024	R3	64P		Cook Inlet-Prince William
Jan 29	N6-3072	19:38:27	0001	R2	64P		Bristol Bay, Kodiak
"	"	18:35:50	0640	R2	64P		Cook Inlet, Kodiak
Jan 30	N6-3087	19:51:27	0128	R2	64P		St. Lawrence-St. Matthew
"	"	19:51:42	1024	R2	64P		Bristol Bay
Jan 31	N6-3093	05:42:01	0	--	64P		Bering Sea
"	"	05:43:30	0384	R2	64P		Norton Sound-Nunivak
Jan 31	N6-3093	05:42:45	0384	R2	64P		Bristol Bay
Jan 31	N6-3101	19:30:05	0512	R2	64P		Bristol Bay, Pribilofs
Feb 5	TN-6773	i6:03:23	0128	R2	N4P		Olyutorskiy-St. Matthew
"	"	16:03:23	1024	R2	N4P		St. Matthew Island
Feb 13	N6-3285	18:06:15	0256	R2	64P		Prince William Sound

DATE	ORBIT	START TIME	START POINT	ZOOM/ ENLARG.	TABLE	TEMPERATURE (“C)	AREA
1980 Feb 14	N6-3291	03:54:52	0	--	6MA	(-45 to -2)+(-1 to 7)	P. William-Vancouver 1s1.
Feb 14	N6-3299	17:45:11	0123	R2	N4Y	-3 to 12 smooth	Yaku ta t
"	"	"	1023/4	R2	N4Y, N4Z	-3 to 12	Queen Charlotte Island
Feb 15	N6-3305	03:33:32	0	--	6MA	(-45 to -2)+(-1 to 7)	P. William-Vancouver 1s1.
Feb 15	N6-3313	17:22:02	0	--	6MA	(-45 to -2)+(-1 to 7)	SE Alaska
Feb 18	N6-3356	17:58:15	0256	R3	64P*		Cook Inlet-Prince William
Feb 19	TN-6970	15:08:18	0001	R2	N4P*	TN IR sensors ∿2°C off	Norton Sound-St. Matthew
Feb 20	TN-6976	01:05:49	1024	R2	N4P		St. Lawrence Island
"	"	01:04:39	1024	R2	N4P		Bristol Bay
Feb 20	TN-6976	01:04:01	0	--	NME†		Bering Sea
Feb 26	TN-7069	15:31:33	0128	R2	N4P		St. Lawrence Island
"	"	"	1024	R2	N4P		E. Norton, N. Bristol
Feb 26	TN-7069	15:33:34	0128	R2	N4P		Pribilof Islands
"	"	"	1024	R2	N4P		Bristol Bay
Feb 26	TN-7069	15:31:01	0	--	NME		Bering Sea
Feb 26	N6-3471	20:03:21	0	--	6ME†		Bering ice edge
Feb 27	N6-3477	01:29:34	0640	R2	?		St. Lawrence Island
"	"	01:27:03	0512	R2	?		Bristol Bay
Feb 27	N6-3477	05:55:11	0	--	6ME		Bering Sea
Feb 27	N6-3485	19:41:31	0	--	6ME		Bering Sea, Pribilofs
Feb 29	TN-7111	14:58:25	1152	R3	N4L**	“cloud top table”	Cook, Prince William
"	"	"	1152	R3	N4P		Cook, Prince William

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* N4P = (-45 to -5)+(-5 to -4)+(-4 to -3.5) +(-3.5 to -3)+(-3 to -2)+(-2 to -1.5) +(-1.5 to -1)+(-1 to 5)
64P 000 250 052 156 208 104 255 000 255
WH BL LLG DG DDG LG BL WH BL

t NME = (-45 to -5)+(-5 to -4)+(-4 to -3.5)+(-3.5 to -3)+(-3 to -2)-l-(-2 to -1.5)+(-1.5 to -1)+(-1 to 7)
6ME 000 250 052 156 208 104 255 000 255
WI-I BL LLG DG DDG LG BL WH BL

**N4L = (-35 to -35)+(-35 to -21)+(-21 to -21)+(-21 to -14)+(-14 to -14)+(-14 to -4)+(-4 to -4)
255 050 050 165 165 10(I 100 000

DATE	ORBIT	START TIME	START POINT	ZOOM/ ENLARG .	TABLE	TEMPERATURE (‘C)	ARRA
1980 Mar 5	N6-3585	20:30:46	1024	R2	64P		Bristol Bay
Mar 9	N6-3641	19:02:45	1152	R3	64P		Cook-Prince William
Mar 10	TN-7252	14:48:11	1152	R3	N4Y, N4Z	-3 to 12	Prince William Sound
Mar 12	N6-3684	19:37:15	0128	R2	64P		Norton-St. Lawrence
"	"	"	1024	R2	64P		N. Bristol Bay
Mar 12	N6-3684	19:39:00	0128	R2	64P		Pribilof Islands
"	"	"	1024	R2	64P		Bristol Bay
Mar 17	N6-3746	04:01:53	1280	R3	64P		Cook Inlet
Mar 19	TN-7371	00:55:58	0007/8	R3	N4Y, N4Z	-3 to 12	Cook-Prince William
Mar 19	N6-3775	04:57:58	0256	R3	64Y	-3 to 12	Cook-Prince William
"	"	"	0256	R3	64P		Cook-Prince William
Mar 26	N6-3883	19:31:45	0	--	64P		Norton, St. Lawrence
Mar 28	N6-3911	18:48:32	0648	R2	64Z	-3 to 12 step	N. Kodiak
Apr 3	TN-7590	14:44:04	0768	R2	N4Z	-3 to 12 step	SE Alaska
Apr 4	N6-4011	19:36:21	0750	R2	6ME		Bristol Bay
Apr 7	TN-7639	00:47:36	0768	R2	N4P		Norton Sound-Point Hope
Apr 8	N6-4068	19:48:01	0	--	6ME		E. Bering Sea
Apr 9	TN-7667	00:22:12	0124	R3	N4 Z	-3 to 12 step	SE Alaska
Apr 10	TN-7681	00:11:32	0512	R4	N4Y	-3 to 12 smooth	Cook Inlet-Yakutat
Apr 10	N6-4096	19:04:21	0	--	6ME		E. Bering Sea
Apr 11	N6-4102	04:55:11	0	--	6ME		E. Bering Sea
Apr 18	N6-4210	19:28:51	0	--	64P		E. Bering Sea
"	"	19:30:36	0780	R2	6MB	-4 to 4	Bristol Bay
May 5	N6-4452	19:58:19	1027/8	R2	N4Y, N4Z	-3 to 12	Bristol Bay
May 8	N6-4494	18:51:20			6MA	(-45 to -2)+(-1 to 7)	Bristol Bay

DATE	ORBIT	START TIME	START POINT	ZOOM/ ENLARG.	TABLE	TEMPERATURE (“C)	AREA
1980 May 9	N6-4508	18:30:00	900	R2	6MA	(-45 to -2)+(-1 to 7)	Gulf of Alaska
May 10	N6-4514	04:18:20	0	--	6MA	(-45 to -2)+(-1 to 7)	Kayak Isl.→Q. Charlotte Sound
May 15	N6-4585	04:09:34	0001	R2	64x	0 to 14 step	SE Alaska
May 20	N6-4665	19:29:26	0256	R2	64X	0 to 14 step	Bristol Bay
May 21	N6-8260	00:57:44	0800	R2	N4P		Bering Strait
May 26	TN-8344	23:44:50	0128	R2	N4X	0 to 14 step	Q. Charlotte Island
"	"	23:46:35	0128	R2	N4Z	0 to 14 step	SE Alaska
June 1	N6-4835	18:25:28	0512	R2	64V	3 to 16 step	Kayak Island→N. Kodiak
"	"	"	"	R2	64W, 64x	0 to 14	Kayak Island→N. Kodiak
June 2	N6-4849	18:03:09	1024	R2	64X	0 to 14 step	SE Alaska
June 5	TN-8479	13:40:00	0128	R2	N4X	0 to 14 step	Gulf of Alaska
"	"	"	1024	R2	N4X	0 to 14 step	SE Alaska
June 8	TN-8514	00:53:34	0512	R2	N4X	0 to 14 step	Kodiak, Bristol Bay
June 9	N6-4949	18:49:37	1152	R3	64v	3 to 16 step	Prince William Sound
June 15	N6-5035	19:54:40	0	--	64P		Chukchi Sea-Prudhoe Bay
June 16	116-5049	19:33:23	0	--	64P		Chukchi Sea-Barter Island
June 23	N6-5140	04:54:20	0512	R2	64v	3 to 16 step	S. Kodiak, N. Bristol Bay
June 23	TN-87 39	23:32:45	0896	R2	N4X	0 to 14 step	Kayak Island-Cape Spencer
June 24	TN-8753	23:19:06	0768	R2	N4W, N4X	0 to 14	Queen Charlotte Island
"	"	23:20:49	"	R2	N4X	0 to 14 step	Yakutat-SE Alaska
June 24	TN-8 753	23:21:06	0768	R2	N4W	0 to 14 smooth	Yakutat-SE Alaska
June 28	TN-8796	00:28:23	0700	R2	N4V	3 to 16 step	Kodiak
July 2	N6-5267	03:19:15	1024	R2	64T	“thunderstorm table”	North Slope clouds
July 3	TN-8880	23:20:51	0224	R2	N4T	“thunderstorm table”	Clouds around Great Bear Lake

DATE	ORBIT	START TIME	START POINT	ZOOM/ ENLARG .	TABLE	TEMPERATURE (“C)	AREA
1980 July 9	N6-5368	05:42:20	--	--	6MA	(-45 to -2)+(-1 to 7)	SE Bering Sea
July 11	N6-5405	20:23:25	--	--	64Z	3 to 12 step	Bering Strait
July 18	N6-5504	19:29:00	--	--	64z	3 to 12 step	Bering Sea
July 19	N6-5518	19:08:15	--	--	64V	3 to 16 step	Norton Sound, Bristol Bay
"	"	19:06:59	--	--	64z	3 to 12 step	Bering Sea
July 19	N6-5519	20:47:12	--	--	64Z	3 to 12 step	Bering Strait
July 20	TN-9107	01:23:40	--	--	N4U, N4V	3 to 16	Bering Strait
"	"	01:21:25	--	--	N4V	3 to 16 step	Bristol Bay
July 20	N6-5532	18:47:11	--	--	64v	3 to 16 step	Bristol Bay, Kodiak
July 21	TN-9121	01:11:56	0768	R2	N4V	3 to 16 step	Norton, Nunivak
"	"	01:10:00	0512	R2	N4V	3 to 16 step	Bristol Bay, Kodiak
July 21	N6-5547	20:04:13	- -	--	64v	3 to 16 step	Bristol Bay
July 22	N6-5553	05:56:20	- -	--	64v	3 to 16 step	Bering Sea
July 22	N6-5561	19:42:30	- -	--	64v	3 to 16 step	Bering Sea
July 23	N6-5567	05:34:15	- -	--	64v	3 to 16 step	Bering Sea
July 23	N6-5575	19:18:51	- -	--	64z	-3 to 12 step	Chukchi Sea
July 24	N6-5589	18:59:00	- -	--	64V	3 to 16 step	Bristol Bay
July 25	N6-5596	06:28:50	- -	--	64v	3 to 16 step	SE Bering Sea
July 28	TN-9 233	23:36:02	0256	R2	N4V	3 to 16 step	Vancouver Island
July 29	TN-9234	01:23:32	0256	R2	N4Z	-3 to 12 step	Chukchi Sea
July 30	N6-5675	20:04:43	- -	--	N4P		Chukchi Sea
Aug 3	N6-5731	18:38:56	0128	R2	64U, 64v	3 to 16	Cook Inlet, Kodiak
"	"	"	1024	R2	64u	3 to 16 smooth	Prince William
Aug 4	N6-5745	18:16:38	0768	R2	64v	3 to 16 step	Prince William-Yakutat
Aug 5	N6-5759	17:54:31	0128	R2	64v	3 to 16 step	Prince William-Yakutat
"	"	"	1024	R2	64v	3 to 16 step	SE Alaska

DATE	ORBIT	START TIME	START POINT	ZOOM/ ENLARG.	TABLE	TEMPERATURE (°C)	AREA
1980 Aug 11	N6-5844	17:22:06	0500	R2	64U, 64v	3 to 16	SE Alaska
Aug 19	TN-9538	14:35:43	0640	R2	N4U, N4V	3 to 16	Gulf of Alaska
Aug 21	N6-5988	20:20:30	- -	--	64V	3 to 16 step	Bering and Chukchi Sea
Aug 22	N6-6002	20:00:00	- -	--	64V	3 to 16 step, Stretch	SE Bering Sea
Aug 23	N6-6015	17:55:20	- -	--	64 Z	-3 to 12 step, Stretch	Cook-Yakutat
Aug 23	N6-6016	19:34:19	--	--	64P*		Beaufort Sea coast
"	"	19:38:10	- -	--	64X	0 to 14 step, Stretch	SE Bering Sea
Aug 24	N6-6030	19:16:00	- -	--	64x	0 to 14 step, Stretch	SE Bering Sea
Aug 25	TN-9615	01:14:51	0128	R2	N4V	3 to 16 step	Bristol-Prince William
"	"	"	1024	R2	N4V	3 to 16 step	Bristol, Pribilofs
Aug 25	N6-6036	05:05:30	- -	--	64X	0 to 14 step, Stretch	Bristol, Alaska Peninsula
Aug 25	N6-6044	18:54:00	- -	--	64x	0 to 14 step, Stretch	Kodiak
Aug 26	TN-9629	01:03:44	0128	R2	N4V	3 to 16 step	Kodiak-P. William
Sep 1	TN-9727	23:42:58	0768	R2	N4V	3 to 16 step	Prince William-SE Alaska
Sep 2	N6-6149	03:48:56	0768	R2	64v	3 to 16 step	Prince William-SE Alaska
Sep 9	N6-6258	20:00:01	- -	--	6MEt		Norton Sound, Chukchi
Sep 9	TN 9840	23:56:42	0896	R2	N4 Z	-3 to 12 step	Chukchi Sea
Sep 10	N6-6272	19:36:45	- -	--	64P*		Chukchi Sea
Sep 12	N6-6299	17:15:35	- -	--	64X	0 to 14 step	SE Alaska

*N4P =	(-45 to -5)+	(-5 to -4)+	(-4 to -3.5)+	(-3.5 to -3)+	(-3 to -2)+	(-2 to -1.5)+	(-1.5 to -1)-I-	(-1 to 5)	
64P	000	250	052	156	208	104	255	000	255
	WH	BL	" LLG	DG	DDG	LG	BL	WH	BL

†NME =	(-45 to -5)+	(-5 to -4)+	(-4 to -3.5)+	(-3.5 to -3)+	(-3 to -2)+	(-2 to -1.5)+	(-1.5 to -1)+	(-1 to 7)	
6ME	000	250	052	156	208	104	255	000	255
	W-H	BL	LLG	DG	DDG	LG	BL	WH	BL

APPENDIX II

NOAA VHRR DIGITIZED TAPES SAVED
(September 1980)

NOAA VHRR DIGITIZED TAPES SAVED

(September 1980)

DATE	GMT	ORBIT #	EQUATOR CROSSING	COMMENTS	ENLARGEMENT AIR*	STORAGE**
		N3				
9/ 8/74	21:28	3795 IR	7W	Good Arctic Ocean ice edge; maximum ice retreat; cold water west Bering Strait; Yukon sediment plume; warm current northwest Barrow		A
9/ 8/74	21:28	3795 VIS				A
10/22/74	20:50	4340 IR	2E	Warm current east Bering Strait	AIR	A
11/ 9/74	20:40	4563 VIS	5E	Most of Aleutians clear; Carman vortices		A
11/26/74	21:16	4774 IR	4W	Good ice; frozen east of line: Cape Point Wales - *east* St. Lawrence - west Nunivak	AIR	A
		N4				
12/28/74	21:40	0541 IR	9W	Bering Strait, Bering Sea clear		A
12/31/74	20:37	0578 IR	7E	Bering Strait; Alaska Peninsula; Illiamna freeze-up	2.5	A
1/29/75	22:17	0942 IR	18W	Chukchi/Beaufort, Arctic leads		A
2/ 8/75	04:26	1058 IR	113W	Night IR; clear Cook Inlet - Seattle		A
3/ 5/75	19:55	1379 IR	18E	Bristol Bay, west Gulf of Alaska clear	AIR	A
3/14/75	20:30	1492 IR	9E	Cook Inlet; Beaufort leads	AIR	A
3/19/75	21:15	1555 IR	2W	Bering/Beaufort, clear, very good		A
4/ 3/75	19:41	1742 IR	22E	Gulf of Alaska	AIR	A
4/ 3/75	19:41	1742 VIS				A

* Temperature enhancement.
**Storage: A - Geophysical Institute Archives Room 118, Shelf 151.
GEO - Geophysical Institute (Jayaweera).
IWR - Institute of Water Resources (Seifert).

DATE	GMT	ORBIT #	EQUATOR CROSSING	COMMENTS	ENLARGEMENT AIR*	STORAGE**
				AIDJEX TAPES		
		N4				
4/13/75	21:10	1868 IR	1W	First Convair 990 flight.		A
4/13/75	21:10	1868 VIS		New floebergs(?) east Wrangel		A
4/16/75	21:58	1906 IR	13W	Convair to Greenland. Bering		A
4/16/75	21:58	1906 VIS		Sea ice edge clear, motion around floeberg		A
4/17/75	21:00	1918 IR	2E	New floebergs. Ice movement		A
4/17/75	21:00	1918 VIS		through Bering Strait		A
4/19/75	20:55	1943 IR	3E	Convair 990 return from Green-		A
4/19/75	20:55	1943 VIS		land, Beaufort Sea cloudy		A
4/21/75	20:50	1968 IR	4E	Convair flight, KA aboard, AIDJEX camp cloudy	AIR	A
4/21/75	22:43	1969 IR	25W			A
4/21/75	22:43	1969 VIS				A
4/22/75	17:57	1979 IR	48E	Convair flight		A
4/22/75	19:51	1980 IR	19E	Interior and Prince William		A
4/22/75	19:51	1980 VIS		clear, Arctic cloudy		A
4/23/75	20:45	1993 IR	5E	Cook Inlet, Prince William,		A
4/23/75	20:45	1993 VIS		north Bristol Bay. Eye in Karman vortices		A
4/24/75	19:46	2005 IR	20E	Convair flight, KA on board; Gulf clear	AIR	A
4/24/75	21:39	2006 IR	8W			A
4/24/75	21:39	2006 VIS				A
4/26/75	21:35	2031 IR	7W	Convair flight. Bering Sea		A
4/26/75	21:35	2031 VIS		clear, Beaufort Sea partly clear		A
4/29/75	20:31	2068 IR	9E	Open north Bristol Bay, partly clear Interior and Bering Sea		IWR
5/ 1/75	20:27	2093 IR	10E	Open south of land areas in Bering Sea		IWR
5/ 8/75	21:05	2181 IR	0E	Clear: East central Bering Sea.		IWR
5/ 8/75	21:05	2181 VIS		Polynya west Banks Island, ice patch Bristol Bay		IWR

DATE	GMT	ORBIT # N4	EQUATOR CROSSING	COMMENTS	ENLARGEMENT ΔIR*	STORAGE**
5/10/75	21:00	2206 IR	1E	Bering Sea mainly cloudy, Beaufort Sea transparent clouds		IWR
5/11/75	20:01	2218 IR	16E	Interior clear, open along Barrow-Point Hope coast		A
5/12/75 5/12/75	20:55 20:55	2231 IR 2231 VIS	3E	Bering Sea partly clear, wide polynya Barrow-Point Hope		IWR IWR
5/13/75	19:56	2243 IR	18E	Interior to Brooks clear, Beaufort Sea thin clouds		IWR
-5/14/75 5/14/75	20:50 20:50	2256 IR 2256 VIS	4E	Most of Alaska clear, Bering Sea cloudy, polynya Barrow-Point Hope	1:3.7	IWR IWR
5/16/75	20:46	2281 IR	5E	Clear Barrow polynya and Bering Sea coastal water	AIR 1:3.7	A
5/19/75	21:35	2319 IR	7W	Only north Gulf of Anadyr partly clear		GEO
5/20/75 5/20/75	20:36 20:36	2331 IR 2331 VIS	8E	Northwest Alaska clear. West Barrow - Point Hope po lynya		IWR lWR
5/22/75	20:31	2356 IR	9E	∿100 km wide clear area Nunivak-Unalaska	AIR 1:3.7	GEO
5/23/75	19:32	2368 IR	24E	Gulf of Alaska and Cook Inlet clear		IWR
5/24/75	20:26	2381	10E	Yukon-Anvik river flooding		IWR
5/25/75	21:21	2394	4W	Bering Sea cloudy		IWR
5/27/,75	21:16	2419	2W	East Norton Sound clear		IWR
5/29/75	21:12	2444	1W	Flooding Yukon river delta	AIR 1:3.7	IWR
5/31/75	21:06	2469 IR	0E	Ice flow along east Bering Sea	1:3.7	A
6/ 1/75	20:07	2481 IR	15E	Northwest Alaska clear, floes in Banks Island polynya		IWR
6/ 2/75 6/ 2/75	21:01 21:01	2494 IR 2494 VIS	1E	Norton Sound and east Bering Strait clear		IWR IWR

DATE	GMT	ORBIT #	EQUATOR CROSSING	COMMENTS	ENLARGEMENT AIR*	STORAGE**
6/ 5/75	21:50	N4 2532 IR	11W	Clear north St. Lawrence	AIR 1:3.7	A
6/ 6/75	20:55	2544	4E	Clear and open south facing coasts and north Bering Sea		IWR
6/ 9/75	21:40	2582 IR	9W	Bering Sea (St. George open, St. Paul ice)		A
6/10/75	20:41	2594 IR	6E	Bering Sea ice patch-east Lawrence-Yukon Delta-west Nunivak-St. Mathew Island	AIR 1:3.7	GEO
6/16/75	20:28	2669 IR	10E	Clear west Banks Island		GEO
6/22/75	20:13	2744 IR	14E	Cloudy		GEO
6/24/75	20:09	2769 IR	15E	Temperature structure in North waters, clear around Kodiak Island, Cook Inlet and Canadian Archipelago, east Beaufort Sea good	AIR	A
6/25/75	21:03	2782 IR	1E	Sharp, clear broken ice in east Beaufort Sea. Large lead Banks Island-Ellesmere		A
6/27/75		2807 IR	2E	Arctic clouds		GEO
7/ 3/75	20:42	2882 IR	6E	Hot spots north of Galena and on Seward Peninsula >75°F. Norton Sound clear	AIR	A
7/ 5/75	20:38	2907 VIS	7E	North Bering Strait, head of Norton Sound and Bristol Bay clear	AIR	IWR
7/ 6/75	19:39	2919 VIS	22E	Interior clear (dark)		IWR
7/ 6/75	21:32	2920 IR	7W	Arctic coast clear, "floeberg"		GEO
7/ 6/75	21:32	2920 VIS				IWR
7/ 7/75	20:32	2932 IR	9E	Open Mackenzie mouth-Banks Island	1:3.7	A
7/ 7/75	20:32	2932 VIS				IWR
7/10/75	19:28	2969 IR	25E	Gulf of Alaska clear	ΔIR	A
7/15/75	20:13	3032 VIS	13E	(print missing)		IWR

DATE	GMT	ORBIT #	EQUATOR CROSSING	COMMENTS	ENLARGEMENT AIR*	STORAGE**
7/18/75	21:02	N4 3070 VIS	1E	Beaufort Sea, Chukchi Sea, Norton Sound clear		IWR
7/19/75	20:03	3082 VIS	16E	North Slope clear		IWR
7/20/75	20:57	3095 IR	2E	North Bering Sea clear		GEO
7/22/75	20:52	3120 IR	3E	North Bering Sea and north-west Arctic coast clear; open to Barrow; (to McClain)	AIR	A
7/22/75	20:52	3120 VIS			1:3.7	IWR
7/23/75	19:53	3132 IR	18E	North Slope clear		GEO
7/23/75	05:13	3137 IR	125W	Bering Sea clear		A
7/24/75	20:47	3145 IR	5E	Bering Sea clear	AIR	A
7/24/75	20:47	3145 VIS				IWR
7/25/75	21:41	3158 IR	9W	Bering Sea clear "	AIR	A
7/25/75	21:41	3158 VIS				IWR
7/27/75	19:44	3182 IR	21E	East Kodiak Island clear	AIR	A
7/28/75	22:30	3196 IR	22W	Kamchatka Volcanoe eruption (first seen July 9) Smoke plume 174 km (860 km)	1:2.5	IWR
7/28/75	22:30	3196 VIS				IWR
7/31/75	21:28	3233 IR	5W	Norton Sound, Gulf of Anadyr clear		GEO
8/ 2/75	21:23	3258 IR	4W	East Aleutians, north Bering Strait clear	AIR	A
8/ 4/75	19:25	3282 IR	26E	Northwest Gulf of Alaska clear	AIR	A
8/ 5/75	20:19	3295 IR	12E	North Bristol Bay, Canadian Archipelago clear	AIR	A
8/ 6/75	19:20	3307 IR	27E	Southeast Kodiak Island clear	AIR	A
8/ 6/75	21:13	3308 IR	2W	East Beaufort Sea, Kotzebue Sound clear		A
8/ 7/75	20:14	3320 IR	13E	East Bering Strait clear		A
8/ 7/75	22:06	3321 IR	15W	East Bering Strait clear, Kamchatka volcanoe plume.	AIR	A

DATE	GMT	ORBIT #	EQUATOR CROSSING	COMMENTS	ENLARGEMENT AIR*	STORAGE**
		N4				
8/ 8/75	21:07	3333 IR	0w	East Bering Sea clear		GEO
8/ 9/75	20:09	3345 IR	14E	East Bering Sea clear	AIR	A
8/10/75	21:03	3358 IR	1E	Gulf of Alaska clear; ice moved in past Icy Cape		A
8/11/75	20:04	3370 IR	16E	Beaufort Sea, Barrow, Interior Alaska clear		A
8/12/75	20:58	3383 IR	2E	East Beaufort Sea, west Chukchi Sea, Interior clear		A
8/13/75	19:59	3395 IR	17E	Mackenzie Delta, Barrow clear		GEO
8/15/75	19:54	3420 IR	18E	North Alaska to Mackenzie Delta clear		A
8/16/75	20:48	3433 IR	4E	East Beaufort Sea clear, Amundsen Gulf open		A
8/17/75	19:49	3445 IR	19E	Mackenzie River and Delta clear		A
8/19/75	21:38	3471 IR	8w	Bering Strait partly clear	AIR	A
8/20/75	20:39	3483 IR	7E	Beaufort Sea clear. (Pass to McClain)		GEO
8/21/75	21:33	3496 IR	7W	Bering Strait cloudy, clear Chukchi Sea to Icy Cape		A
8/22/75	20:34	3508 IR	8E	Kuskokwim-Nushagak coast clear		A
8/23/75	21:28	3521 IR	6w	Contrail (?) northeast from Barter Island; Barrow clear and iced in, clouds southwest	1:3.7	A
8/24/75	20:30	3533 IR	9E	Coastal clouds ∿ Barrow and Wainwright + shorefast (?) pack		A
8/26/75	18:39	3557 IR	39E	Southeast Alaska clear	AIR	A
8/28/75	20:20	3583 IR	12E	Prince William Sound clear with cloud streaks		GEO
8/29/75	19:21	3595 IR	27E	Gulf of Alaska clear	AIR	A

DATE	GMT	ORBIT #	EQUATOR CROSSING	COMMENTS	ENLARGEMENT AIR*	STORAGE**
		N¼				
8/30/75	04:40	3600 IR	117W	Gulf of Alaska clear	AIR	A
8/30/75	22:07	3609 IR	16w	West Aleutians clear	AIR	A
8/31/75	21:08	3621 IR	1W	Arctic ice edge (bordering cloud bank) clear		A
8/31/75	21:08	3621 VIS				A
9/ 5/75	19:59	3683 IR	17E	Cloudy . Tight Low east Beaufort Sea		A
9/ 6/75	20:53	3696 IR	3E	Cloudy, North Slope ice edge visible		A
9/ 9/75	21:43	3734 IR	low	West Bering Sea and Aleutians clear		A
9/10/75	20:44	3746 IR	6E	St. Matthew Island clear, strong front northeast Pacific to Arctic		A
9/11/75	21:39	3759 IR	8W	Chukchi Sea, central Bering Sea clear		A
9/12/75	20:39	3771 IR	7E	Clear around Queen Charlotte Island. Weak "Octopus" legs off coast. Ice apparently shorefast around Barrow. Pack off coast to east		GEO
9/13/75	19:40	3783 IR	22E	Cook Inlet and Alaska Range clear		A
9/21/75	21:13	3884 IR	2W	North Slope, Norton Sound partly clear		A
9/23/75	21:10	3909 IR				GEO
9/24/75	22:03	3922 IR	15W	Arctic "ice edge clear		A
9/25/75	21:04	3934 IR	OE	Interior and Bering Sea clear. Open around Barrow		GEO
9/26/75	21:58	3947 IR	13W	Bering Strait and Chukchi Sea clear		A
9/27/75	20:59	3959 IR	2W	Yukon clear		A
10/ 3/75	20:44	4034 IR	5E	East Beaufort Sea partly clear		GEO

DATE	GMT	ORBIT #	EQUATOR CROSSING	COMMENTS	ENLARGEMENT AIR*	STORAGE**
		N4				
10/ 6/75	19:40	4071 IR	22E	Gulf of Alaska clear		GEO
10/ 6/75	21:34	4072 IR	7W	Central Chukchi Sea ice edge clear		A
10/ 6/75	05:01	4076 IR	122W	Gulf of Alaska clear		GEO
10/ 8/75	21:29	4097 IR	6W	Northwest Alaska clear		GEO
10/ 9/75	04:56	4101 IR	121W	East Kodiak Island clear		GEO
10/14/75	21:15	4172 IR	2W	West Coast and Chukchi Sea clear		GEO
10/25/75	19:51	4309 IR	19E	Gulf of Alaska clear		GEO
10/26/75	20:45	4322 IR	5E	West Gulf of Alaska clear	AIR	GEO
10/27/75	19:46	4334 IR	20E	Gulf of Alaska, Chukchi Sea and Brooks Range clear		A
10/29/75	05:09	4364 IR	~100W	Alaska coast clear from Barrow to Cook Inlet		A
11/30/75	20:24	4760 IR	12E	Bristol Bay, Alaska peninsula	AIR	A
				END OF SPION PROJECT		

	Satellite					
2/29/76	N4	5899 IR	25E	Gulf of Alaska warm current	AIR	A
7/ 3/76	N4	7465 IR	1E	Eddies along Gulf side of Aleutians	AIR	A
9/16/76	N5	0609 IR		Eddies off Cape Olyutorskiy,		A
9/16/76	N5	0609 VIS		Kamcha tka		A

1/31/77	N5	2305 IR		Bering Sea, plume of cold ice north St. Lawrence		A
2/ 1/77	N5	2317 IR		Bering Sea, cold ice plume, northwest Alaska coast break up		A

DATE	SATELLITE	ORBIT #	EQUATOR CROSSING	COMMENTS	ENLARGEMENT AIR*	STORAGE**
2/ 3/77	N5	2342 IR		Bering Sea, cold ice plume, northwest Alaska coast break up		A
2/11/77	N5	2441 IR		Bering Sea, Arctic leads, floe-bergs in Chukchi Sea		A
3/18/77	N5	2873 IR		Gulf of Alaska		A
3/20/77	N5	2899 IR		Bering Sea		A
3/20/77	N5	2899 VIS				A
3/21/77	N5	2911 IR		Bering Sea, Arctic leads		A
3/23/77	N5	2935 IR		Alaska Stream off Kodiak		A
3/23/77	N5	2935 VIS		Island		A
3/23/77	N5	2936 IR		Southwest Bering Sea		A
3/23/77	N5	2936 VIS		(beautiful)		A
3/29/77	N5	3010 IR		Bering Sea, Pribilofs. (tape copies from here on)		A
5/17/77	N5	3617 IR	11W	Southwest Bering Sea		A
5/18/77	N5	3628 IR	29E	Southeast Alaska		A
5/19/77	N5	3642 IR	18W	Kamchatka water eddies		A
6/30/77	N5	4161 IR	6E	Alaskan Stream eddies		A
7/12/77	N5	4310 IR		Chukchi Sea		A
7/31/77	N5	4545 IR		Bering Strait flow through smoke		?
8/ 1/77	N5	4557 IR		Arctic coast, Pribilofs		A
9/16/77	N5	5127 IR		Kamchatka water eddies		A
9/26/77	N5	5251 IR		Kamchatka water eddies		A
11/19/77	N5	5918 IR		Southeast Alaska		A
11/24/77	N5	5981 IR		Bering Strait flow, Bristol Bay		A
12/ 1/77	N5	6067 IR		Gulf of Alaska clear		A

DATE	SATELLITE	ORBIT #	EQUATOR CROSSING	COMMENTS	ENLARGEMENT ΔIR*	STORAGE*'
1/ 3/78	N5	6475 IR		Southeast Alaska, Gulf of Alaska		A
2/ 5/78	N5	6884 IR		Bering Sea ice, Unimak volcano eruption		A
3/ 1/78	N5	7181 IR		Gulf of Alaska, Bristol Bay		A
4/ 2/78	N5	7577 VIS	16E	Gulf of Alaska, cloud free Interior		A
12/14/79	TN	6025 IR		Bering Sea ice edge		A
12/18/79	TN	6073 IR		Bering Sea ice edge		A
						A: 123