

INFLUENCE OF THE YUKON RIVER ON THE BERING SEA

K. Dean and C. P. McRoy

✓(Annual Progress Report)
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ORIGINAL SCIENTIFIC
COLOR ILLUSTRATIONS

As specified by the contract this is the annual progress report concerning NAS 5-28769 entitled, "Influence of the Yukon River on the Bering Sea". The purpose of this project is to use satellite data to study relationships between discharge of the Yukon River to currents and biologic productivity in the northern Bering Sea.

Amended specific objectives are:

1. to develop thermal, sediment and chlorophyll surface maps using TM data of the discharge of the Yukon River and the Alaska Coastal Current during the ice free season;
2. to develop a historical model of the distribution of the Yukon River discharge and the Alaska Coastal Current using Landsat MSS and NOAA satellite imagery; and
3. to use high resolution TM data to define the surface dynamics of the front between the Alaska Coastal Current and the Bering Shelf/Anadyr Current.

Landsat MSS and TM, and AVHRR data were recorded during the 1985 ice-free period. The satellite data coincided with shipboard measurements acquired by ISHTAR project scientists (ISHTAR: Inner Shelf Transfer and Recycling is an NSF funded project in the area). Circumstances were such, that on July 5 and July 22, all three sensors recorded data creating a unique data base for analysis. The remote sensing data has been registered to a common map projection and map base, then contrast stretched, color composited, and density sliced.

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Distinct water masses and turbid water were delineated on the satellite data. AVHRR data, thermal infrared band, provide a synoptic perspective of the northern Bering sea. The extent and boundaries of the warm Alaskan coastal water, cooler shelf water and a cold up-welling near the Siberian coast can be observed (fig. 1).

The location of the currents observed on the imagery were compared to measurements in the water column acquired by ISHTAR project scientists (fig. 2). The distribution of the remote-sensing-derived water masses relate to the distribution of chlorophyll and nutrients measured in the water column. For example, the largest concentration of surface chlorophyll and nitrate that were measured (fig. 3 & 4) are located along the boundary and east of the cold up-welling near Siberia (fig. 1). Large concentrations of chlorophyll also occur along the boundary of the Alaska Coastal Current. Turbid water, mostly derived from the Yukon river, has been analyzed on the imagery as previously reported in the first progress report. An integrated model of changes in the distribution of the water masses during the ice-free period has also been compiled.

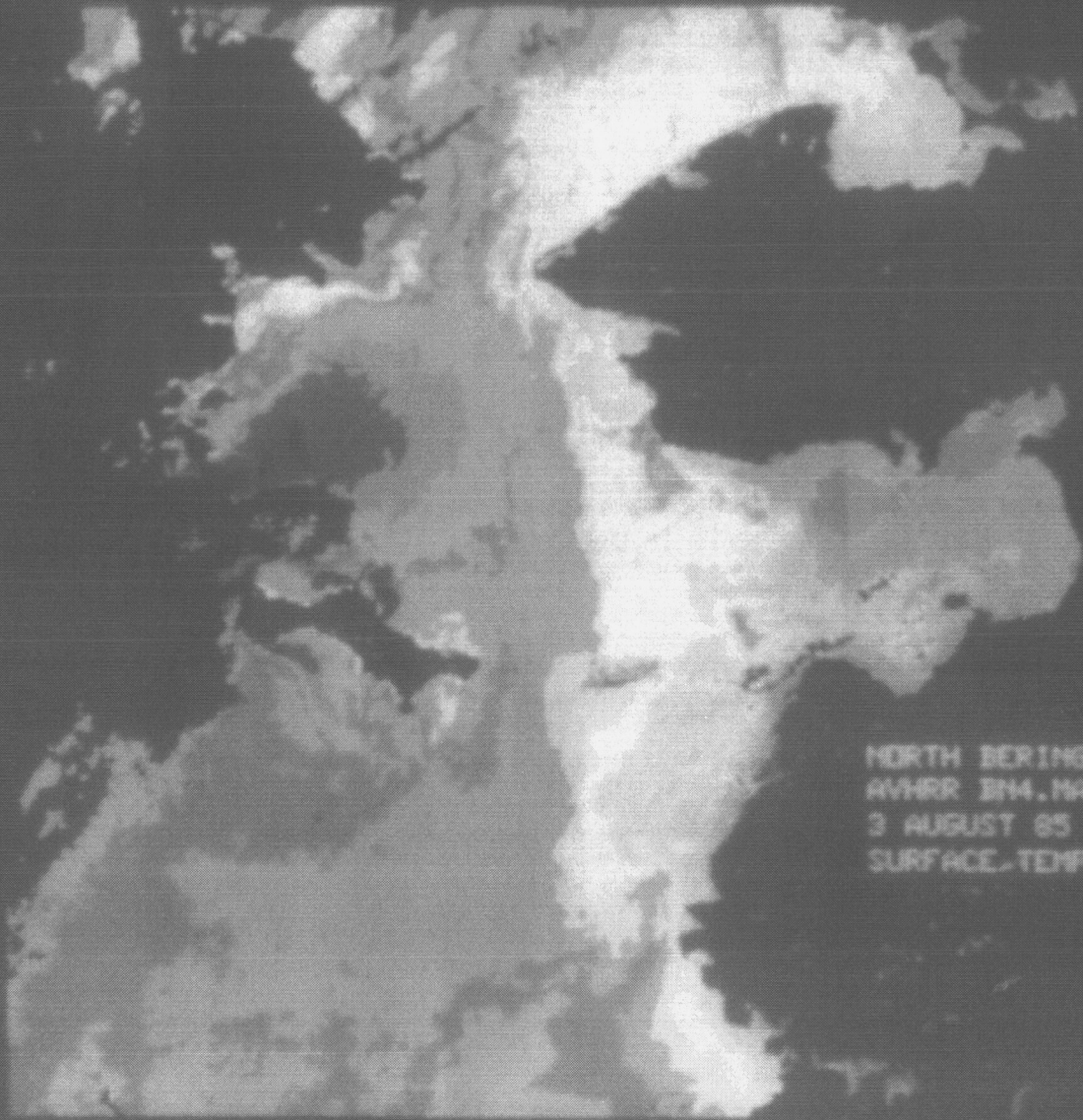
Digital bathymetric data was acquired of the northern Bering Sea, and sea-bottom contours and perspective views were generated. Bathymetry is closely related to the boundaries of the water masses. The turbid water and sea-surface temperatures recorded on AVHRR data were also contoured and perspective views generated (fig. 5).

TM data has been analyzed and enhanced images displayed at reduced resolution. Reduced resolution was utilized so that software could be refined and analysis techniques tested. Even though the TM resolution has been

degraded, the thermal infrared band provides detailed information concerning oceanic circulation that AVHRR data could not detect (fig. 6). The TM data will be analyzed at full resolution in the near future.

Presently, the relationship between the interannual distribution of turbid water discharged by the Yukon River and meteorologic, hydrologic, oceanic and geologic factors are being analyzed. The results of this analysis are being prepared to be published in a refereed journal.

Figure 1. Density slice of AVHRR thermal infrared image recorded on 3 August 1985. The boundary between the Alaska Coastal water mass (red-orange-yellow) and the Bering Shelf/Anadyr water mass (blues-green) is distinct and related to bathymetry and ship-board measurements of biological and chemical factors in the water column. A cold up-welling (dark blue) is present near the Siberian coast, left-center.



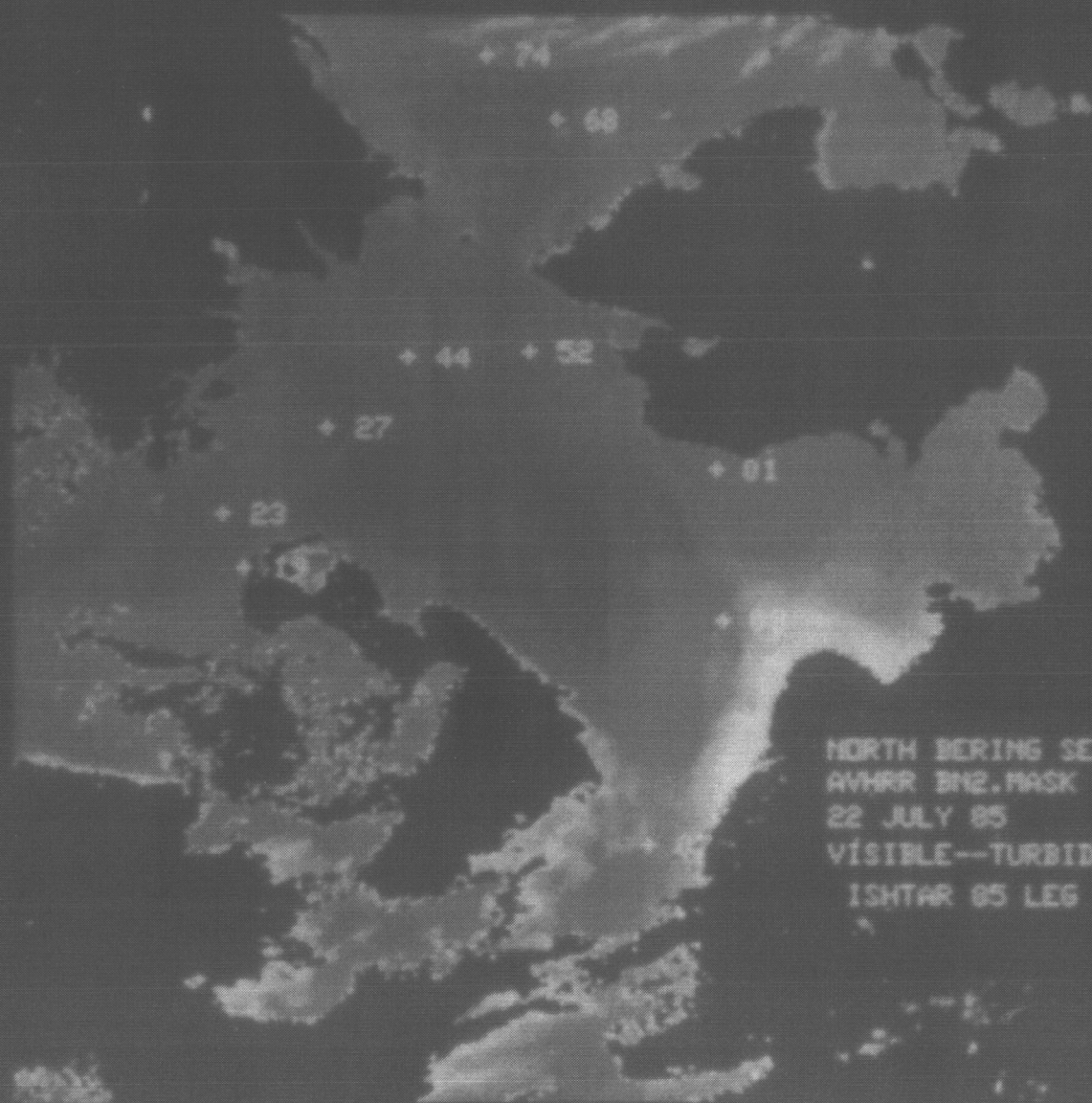
NORTH BERING SEA
AVHRR IM4 MASK
3 AUGUST 85
SURFACE TEMPERATURE SLICE

19

3 C



Figure 2. Contrast stretch of AVHRR visible image recorded on 7 July 1985.
Shipboard sampling stations are positioned on the image.



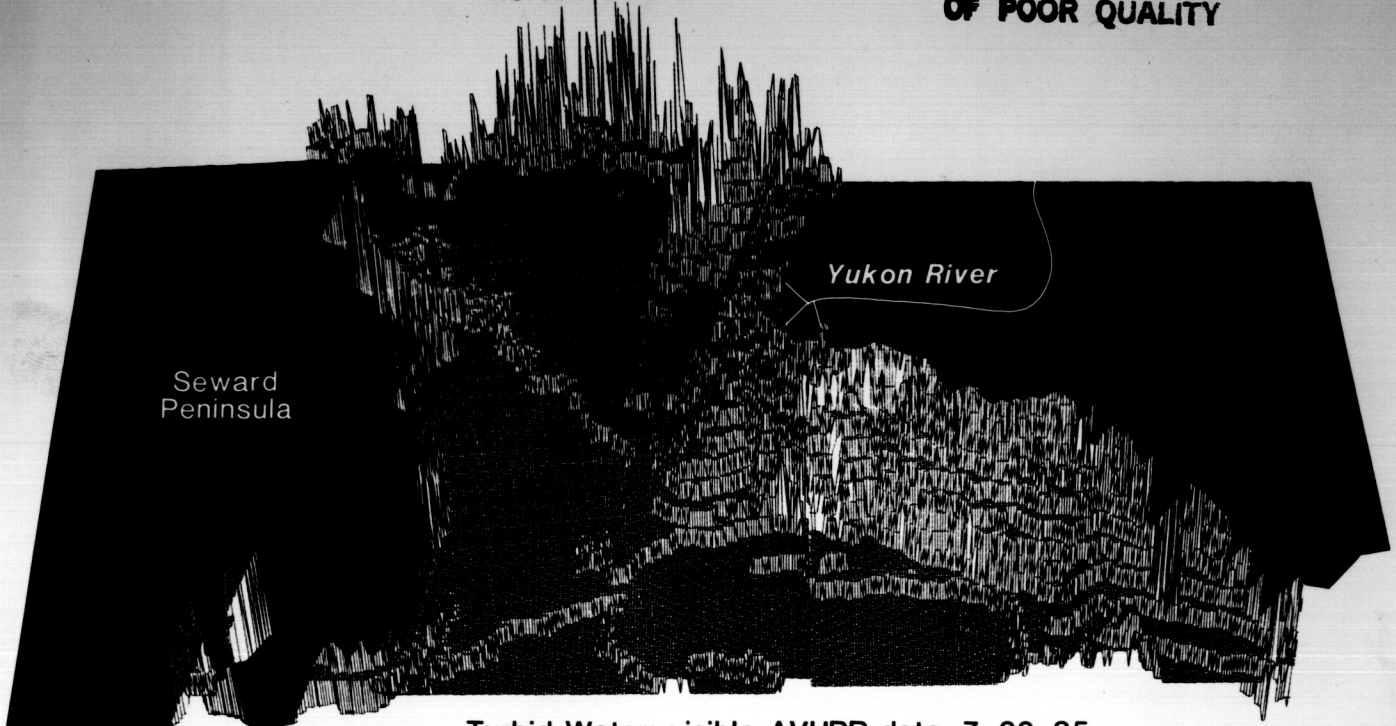
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Figure 3. Integrated surface chlorophyll measured by ISHTAR investigators in 1985. High values measured in early summer are located at the boundary of the cold, Siberian upwelling and at the boundary of the Alaska Coastal Current (fig. 1). These values rapidly decrease shoreward of the boundaries.

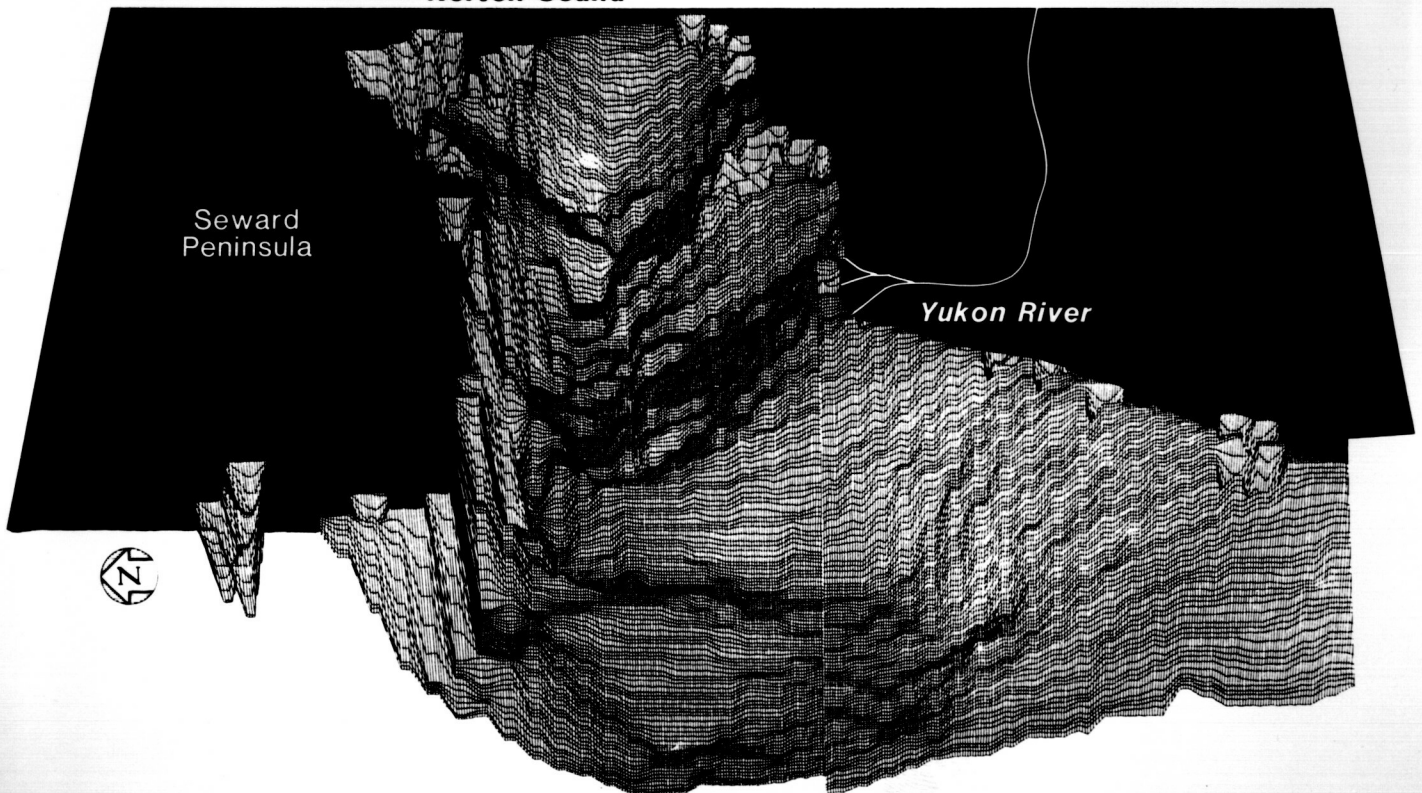
Norton Sound

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Turbid Water: visible AVHRR data, 7-22-85

Norton Sound

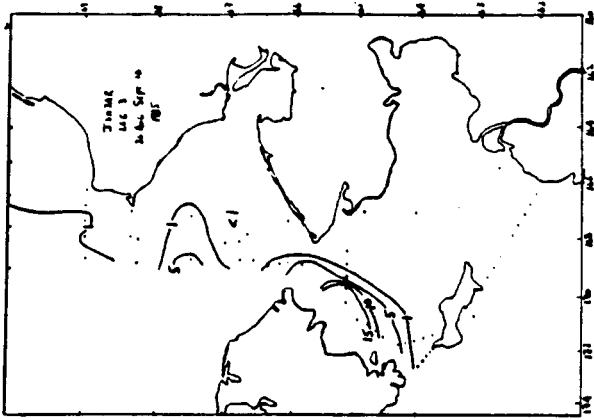


Bathymetry: 5 min. grid

PERSPECTIVE SURFACES OF WATER: NORTON SOUND

Figure 4. Surface nitrate measured by ISHTAR investigators in 1985. High values are located at the boundary of the cold Siberian upwelling. These values rapidly decrease away from the boundary.

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SURFACE NITRATE
($\mu\text{g-at liter}^{-1}$)

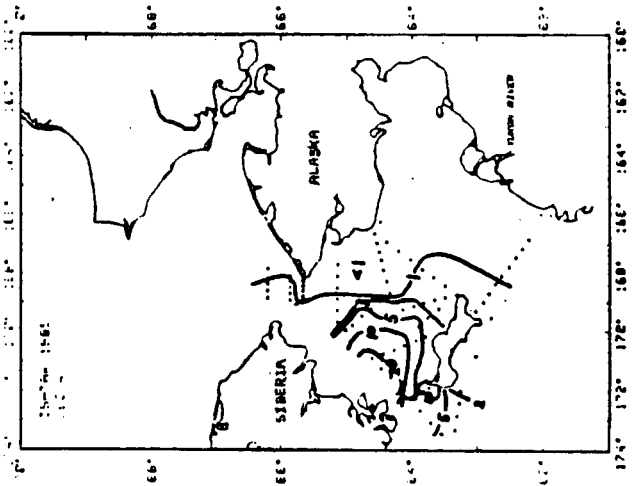
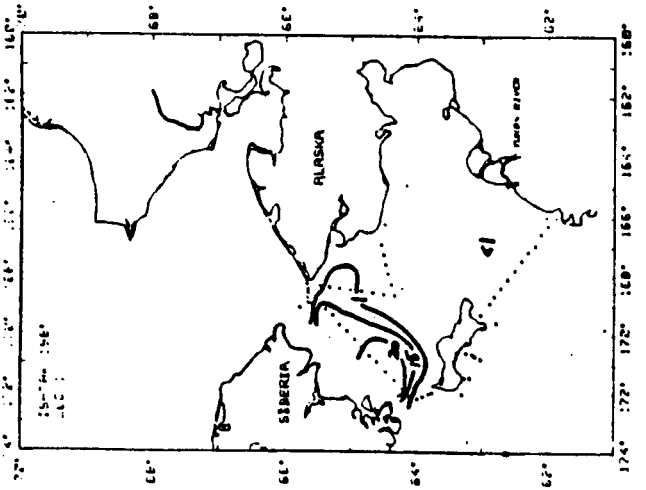
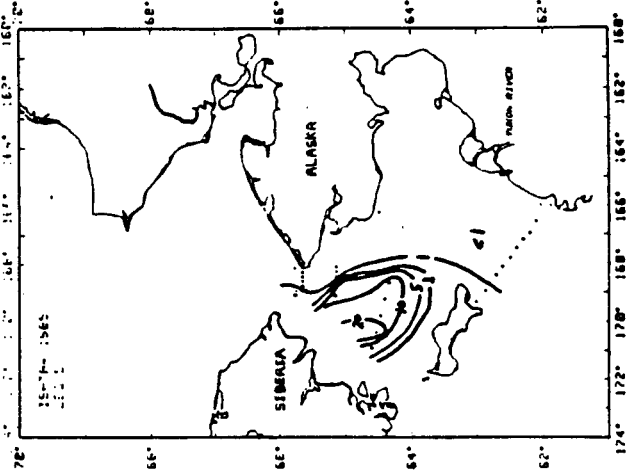
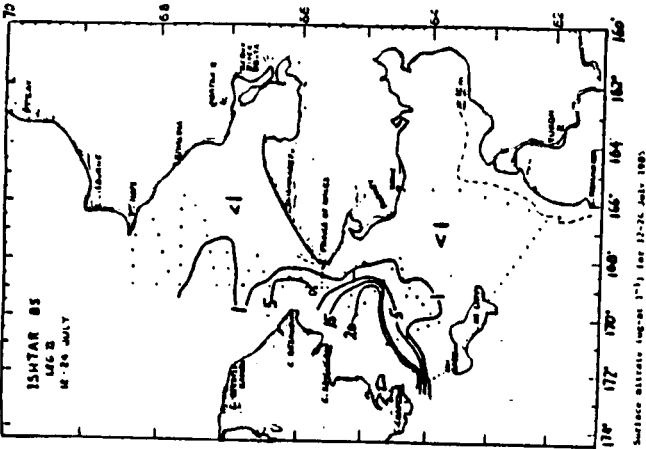
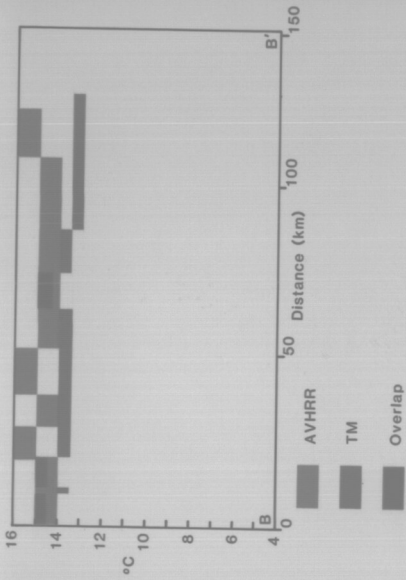
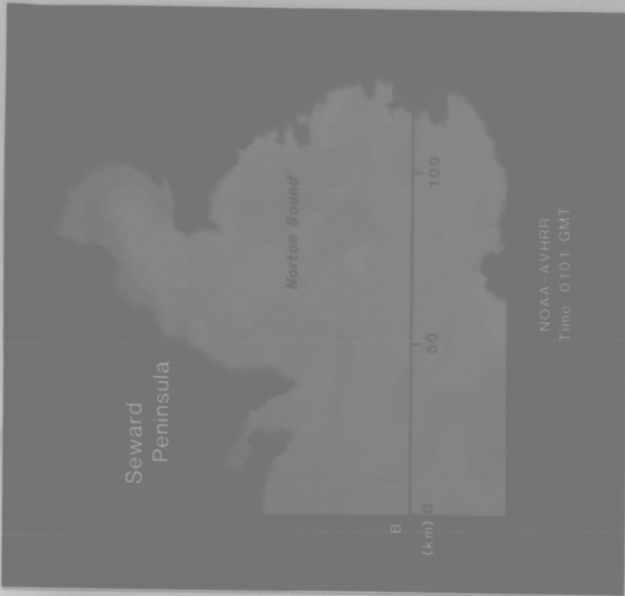


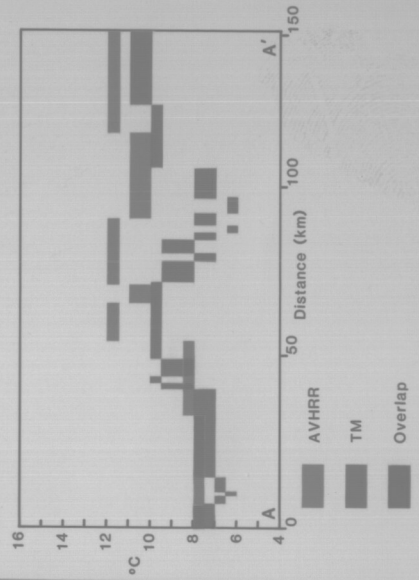
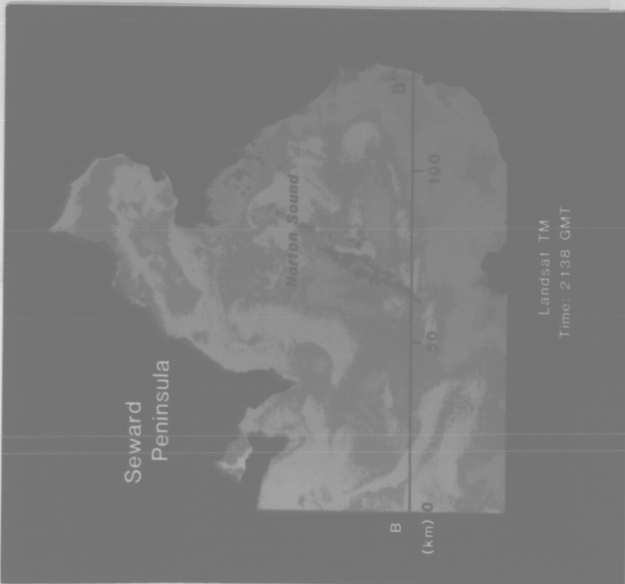
Figure 5. Perspective view of bathymetry and turbidity in Norton Sound. The highly turbid water to the south (right) and a shallow water and low bathymetric gradient compared to the north (left) is at least partly caused by sediments discharged by the Yukon River.

Figure 6. Comparison of sea surface temperatures measured by TM and AVHRR data acquired on the same day. The high resolution of TM records subtle details concerning oceanic circulation.



22 JULY 1985 (GMT)

NORTH BERING SEA - NORTON SOUND
COMPARISON OF SEA-SURFACE TEMPERATURES:
Landsat TM and NOAA-AVHRR



5 JULY 1985 (GMT)

NORTH BERING SEA - NORTON SOUND
COMPARISON OF SEA-SURFACE TEMPERATURES:
Landsat TM and NOAA-AVHRR