AD-A189 178 A RELATIONSHIP BETWEEN OCEAN CIRCULATION AND VOLUME REVERBERATION IN THE..(U) NAVAL UNDERWATER SYSTEMS CENTER NEW LONDON CT NEW LONDON LAB.. D G BROWNING ET AL. 26 JUN 86 NUSC-TD-7681 F/G 8/3 1/1

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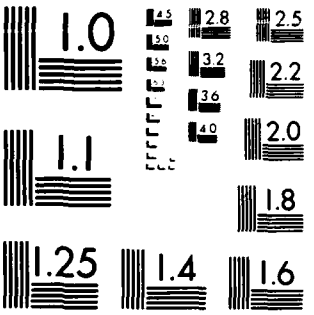

NUSC Technical Document 7681
26 June 1986

A Relationship Between Ocean Circulation and Volume Reverberation in the Subarctic Northeast Pacific Ocean (Gulf of Alaska)

A Paper Presented at the 111th Meeting of the Acoustical Society of America, Cleveland, Ohio, 12-16 May 1986

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PREFACE

This research was conducted under NUSC Project No. A60080; Subproject No. RS–11–1220; Principal Investigator, Dr. Azizul H. Quazi (Code 3315); Program Manager, Ronald Tompkins (Code 33A); Sponsor Theo Koij, Office of Naval Technology.

REVIEWED AND APPROVED: 26 June 1986

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SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION / AVAILABILITY OF REPORT Approved for public release; distribution unlimited.
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) NUSC TD 7681	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION Naval Underwater Systems Center 6b. OFFICE SYMBOL (If applicable) 3331	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (City, State, and ZIP Code) New London Laboratory New London, CT 06320	7b. ADDRESS (City, State, and ZIP Code)
8a. NAME OF FUNDING / SPONSORING ORGANIZATION Office of Naval Technology 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State, and ZIP Code) Washington, DC 20375	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO. A60080 / TASK NO. / WORK UNIT ACCESSION NO

11. TITLE (Include Security Classification)
A RELATIONSHIP BETWEEN OCEAN CIRCULATION AND VOLUME REVERBERATION IN THE SUBARCTIC NORTHEAST PACIFIC OCEAN (GULF OF ALASKA)

12. PERSONAL AUTHOR(S)
David G. Browning, R. G. Turner, and J. W. Power

13a. TYPE OF REPORT	13b. TIME COVERED FROM ____ TO ____	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
		86-06-26	14

16. SUPPLEMENTARY NOTATION
A Paper Presented at the 111th Meeting of the Acoustical Society of America, Cleveland, Ohio, 12-16 May 1986

17 COSATI CODES		
FIELD	GROUP	SUB-GROUP

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
Ocean Circulation
Subarctic Pacific Ocean
Volume Reverberation

19. ABSTRACT (Continue on reverse if necessary and identify by block number)
Earlier investigations have shown a significant change in integrated scattering and spectral characteristics when transmitting into the subarctic (above 40 north latitude) northeast Pacific Ocean. An analysis of an extensive series of volume reverberation measurements obtained by Turner indicates a strong influence of the counterclockwise circulation around the Alaskan Gyre on the distribution of scattering strengths. At higher frequencies (5-20 kHz) the greater scattering strengths are found in the relatively warm California undercurrent water which flows around the perimeter of the gyre. At lower (1.25-5 kHz) frequencies, the greater scattering strengths are found in the relatively cold water such is found in the upwelled subarctic water at the center of the gyre. This implies a significant change in the type of scatterers between these frequency domains. Keywords:

20. DISTRIBUTION / AVAILABILITY OF ABSTRACT	21. ABSTRACT SECURITY CLASSIFICATION
☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	UNCLASSIFIED
22a. NAME OF RESPONSIBLE INDIVIDUAL David G. Browning	22b. TELEPHONE (Include Area Code) (203)440-4173 22c. OFFICE SYMBOL 3331

DD FORM 1473, 84 MAR 83 APR edition may be used until exhausted
All other editions are obsolete

SECURITY CLASSIFICATION OF THIS PAGE

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VIEWGRAPH 1

This paper presents an apparent relationship between ocean circulation and volume reverberation in the Subarctic Northeast Pacific Ocean.

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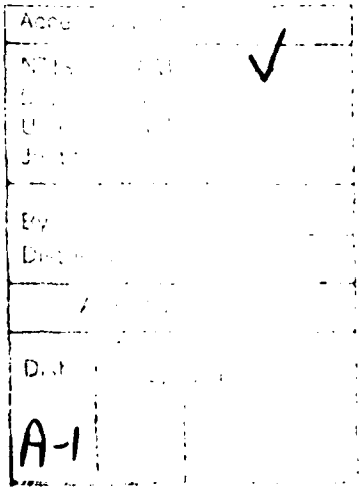

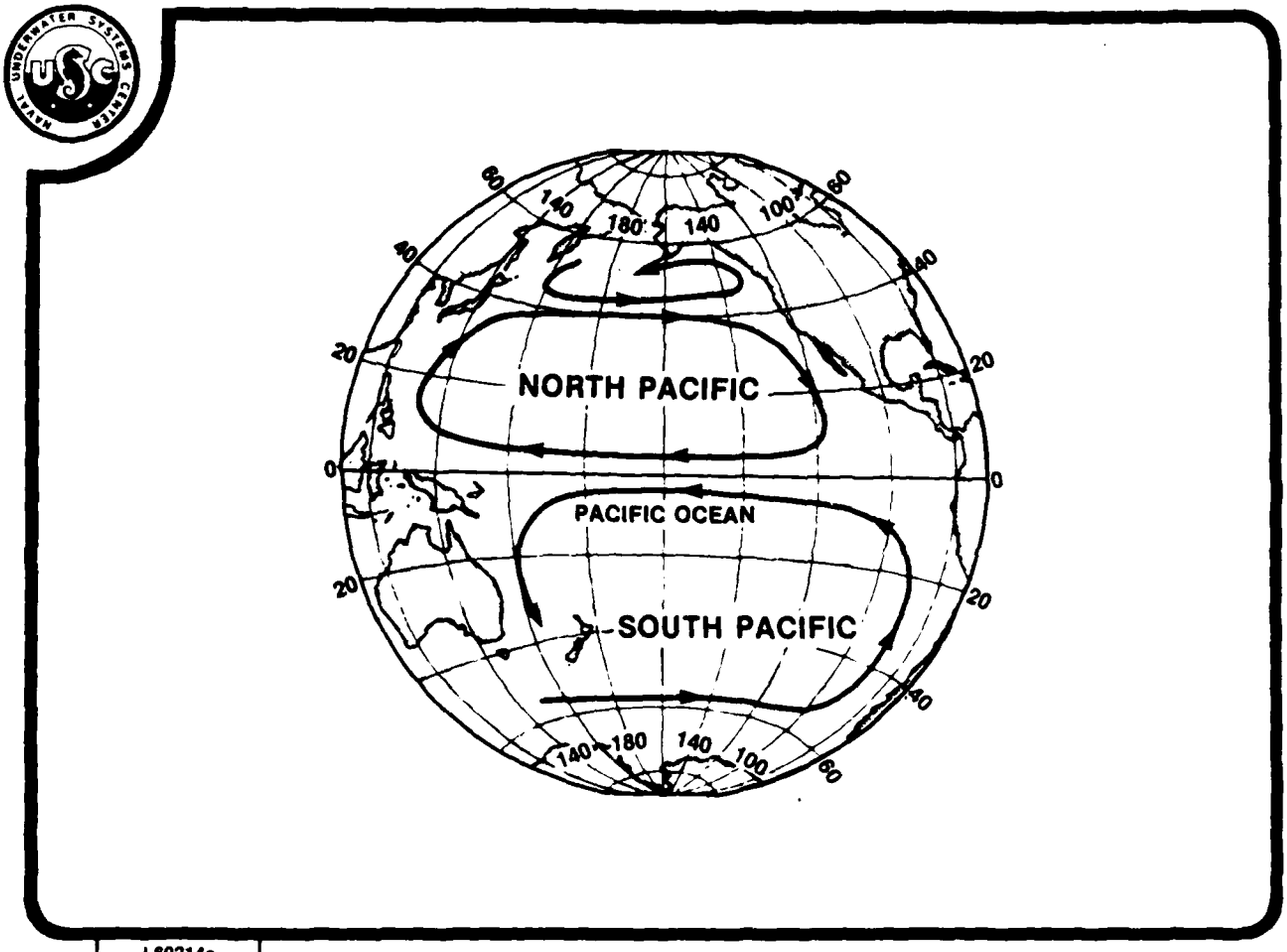

VIEWGRAPH 2

In the North Pacific Ocean the principal circulation gyre extends from the equator to only 40° North latitude (corresponding to the coast of Northern California). This leaves a large Subarctic region to the North that has its own unique characteristics.

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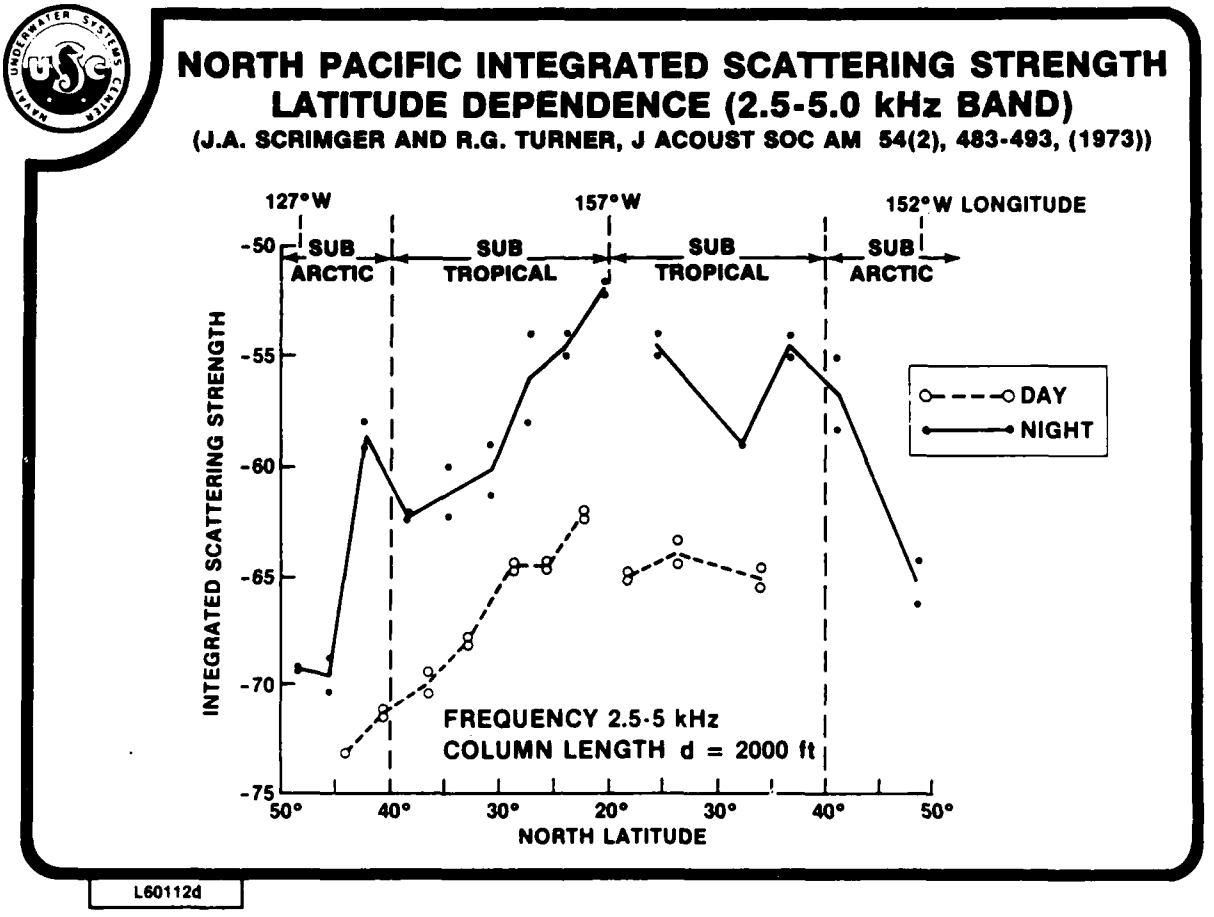

VIEWGRAPH 3

Scrimger and Turner have previously shown a significant change in integrated scattering strength when transiting into the Subarctic region. This was a track from Vancouver to Hawaii and back into the Subarctic region.

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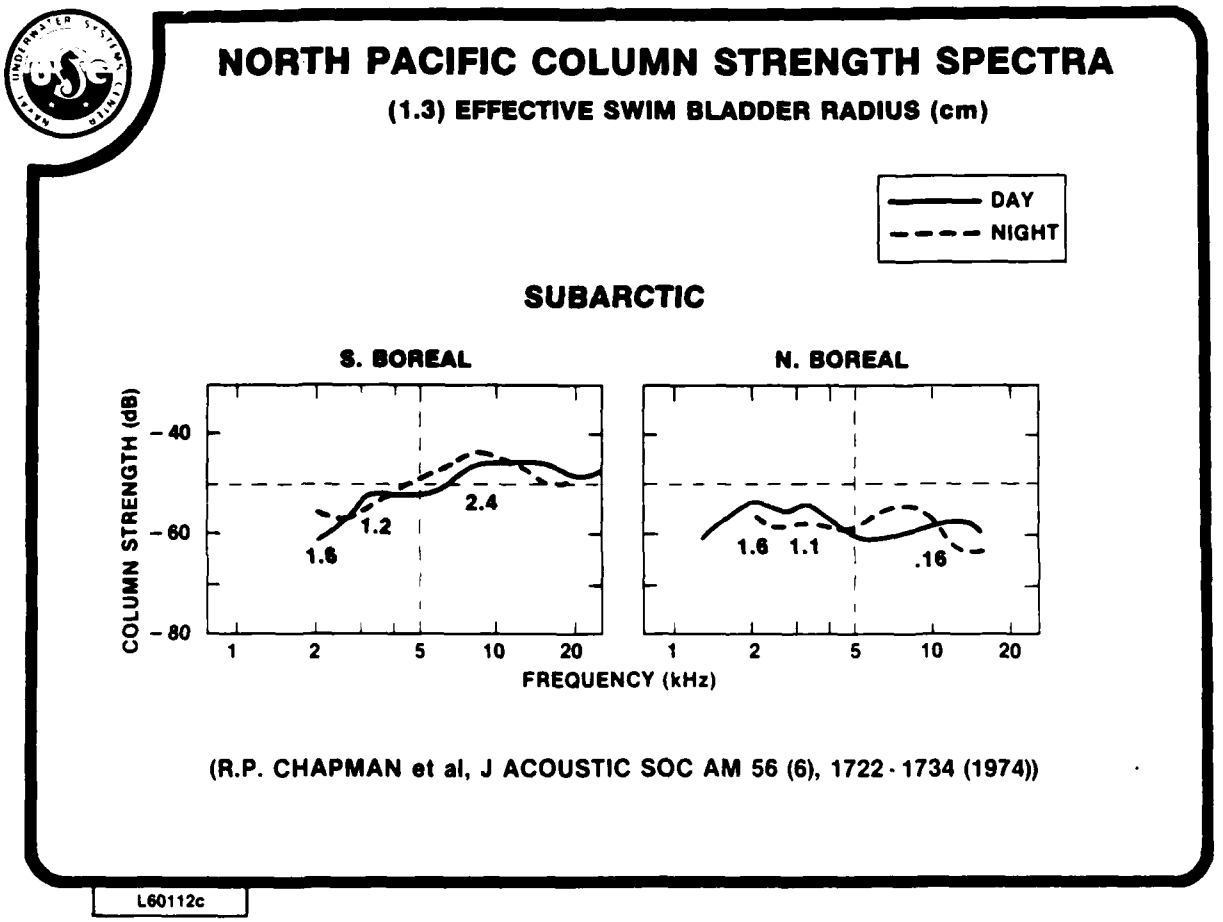

VIEWGRAPH 4

Chapman, et al., as part of their epic circumnavigation of the western hemisphere, reported a change in the spectral content of column strength for two stations in this Subarctic region. Specifically, there appeared to be two independent mechanisms, one below 5 kilohertz and one (or more) above.

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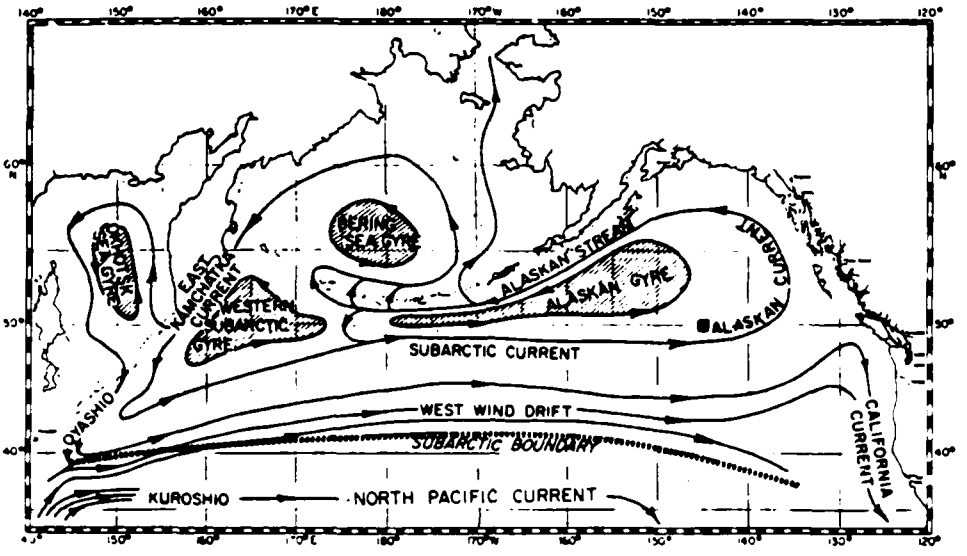
CIRCULATION SYSTEMS IN THE SUBARCTIC NORTH PACIFIC



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VIEWGRAPH 5

The circulation in the Subarctic Northeast Pacific is dominated by flow around the Alaskan gyre. Relatively warm water circulates around the perimeter while relatively cold water upwells in the center of the gyre.

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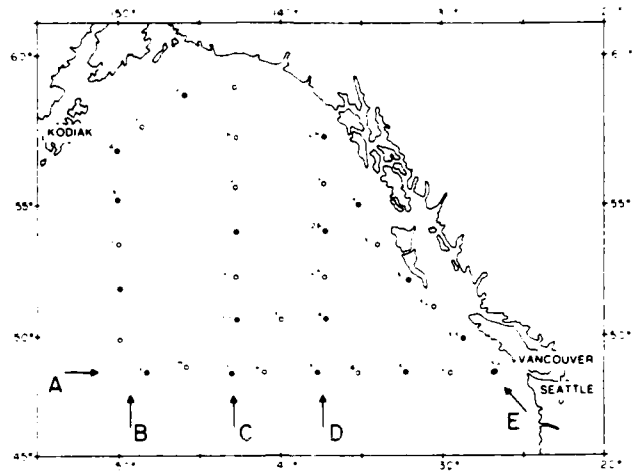
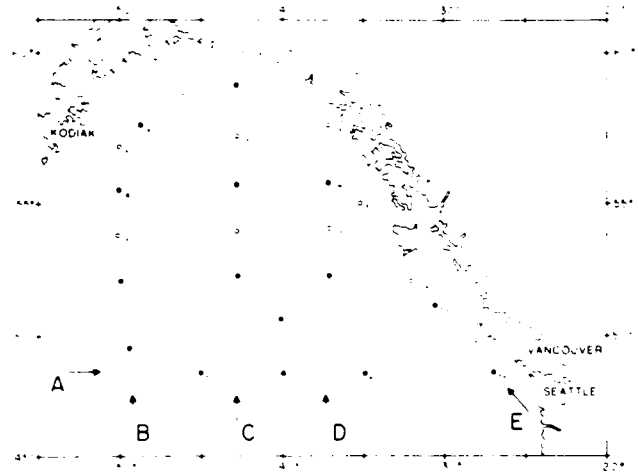


September 1971 stations showing station numbers and positions. Open and closed circles indicate daytime and nighttime stations, respectively.*



April 1972 stations showing station numbers and positions. Open and closed circles inoicate daytime and nighttime stations, respectively.*

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VIEWGRAPH 6

To quantify volume reverberation throughout the Northeast Subarctic Pacific (Gulf of Alaska), Turner conducted an extensive series of measurements for both summer and winter conditions. The standard measurement technique with explosive sources was used and data were reported for four octave frequency bands - - 1.25 to 2.5 kHz, 2.5 to 5 kHz, 5 to 10 kHz, and 10 to 20 kHz. Night stations are shown by dark circles, day stations by light circles.

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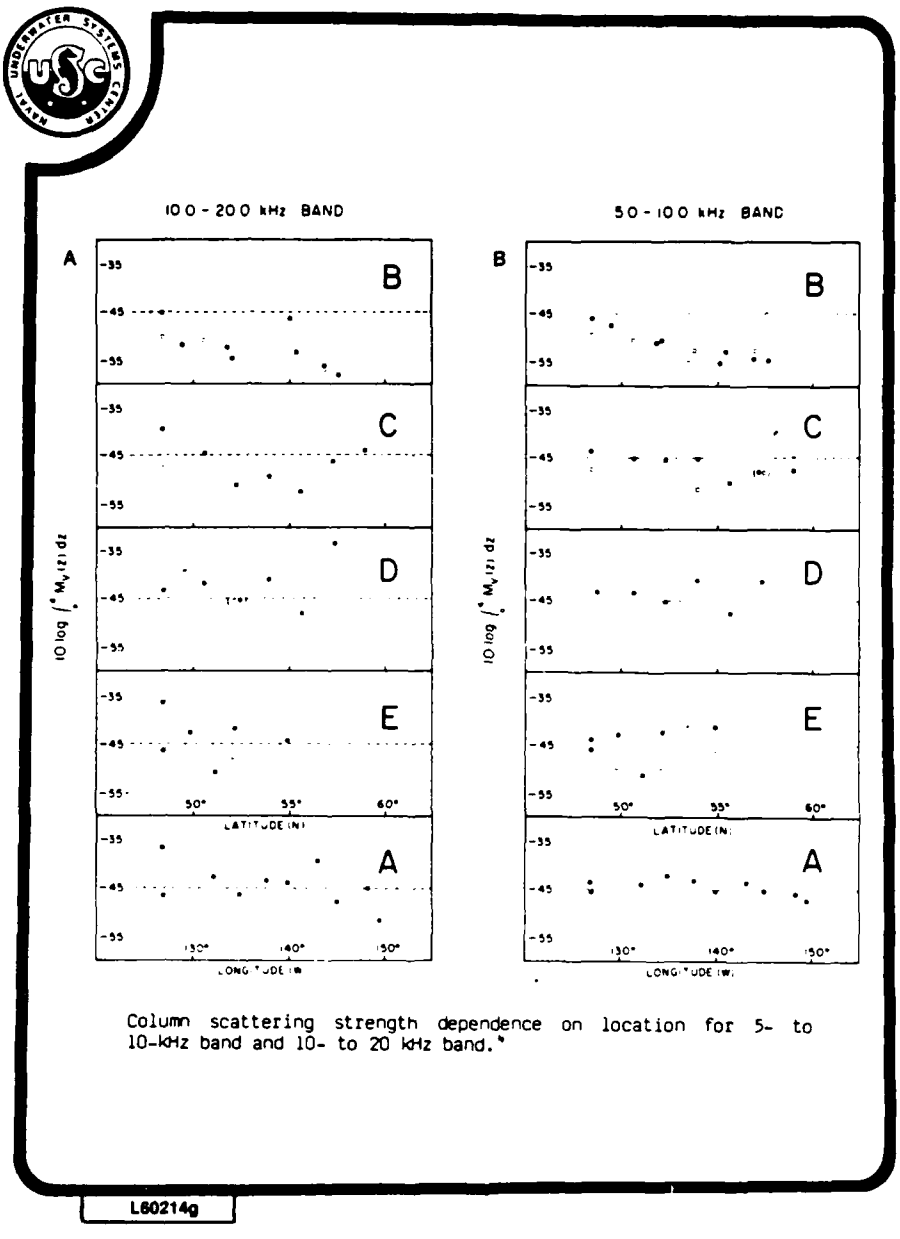

Column scattering strength dependence on location for 5- to 10-kHz band and 10- to 20 kHz band.*

VIEWGRAPH 7

Turner initially plotted the data as a function of latitude for all but one track. Typical results are shown here for the 10 to 20 kHz and 5 to 10 kHz bands. Rather than showing a simple trend the data have some unexpected changes.

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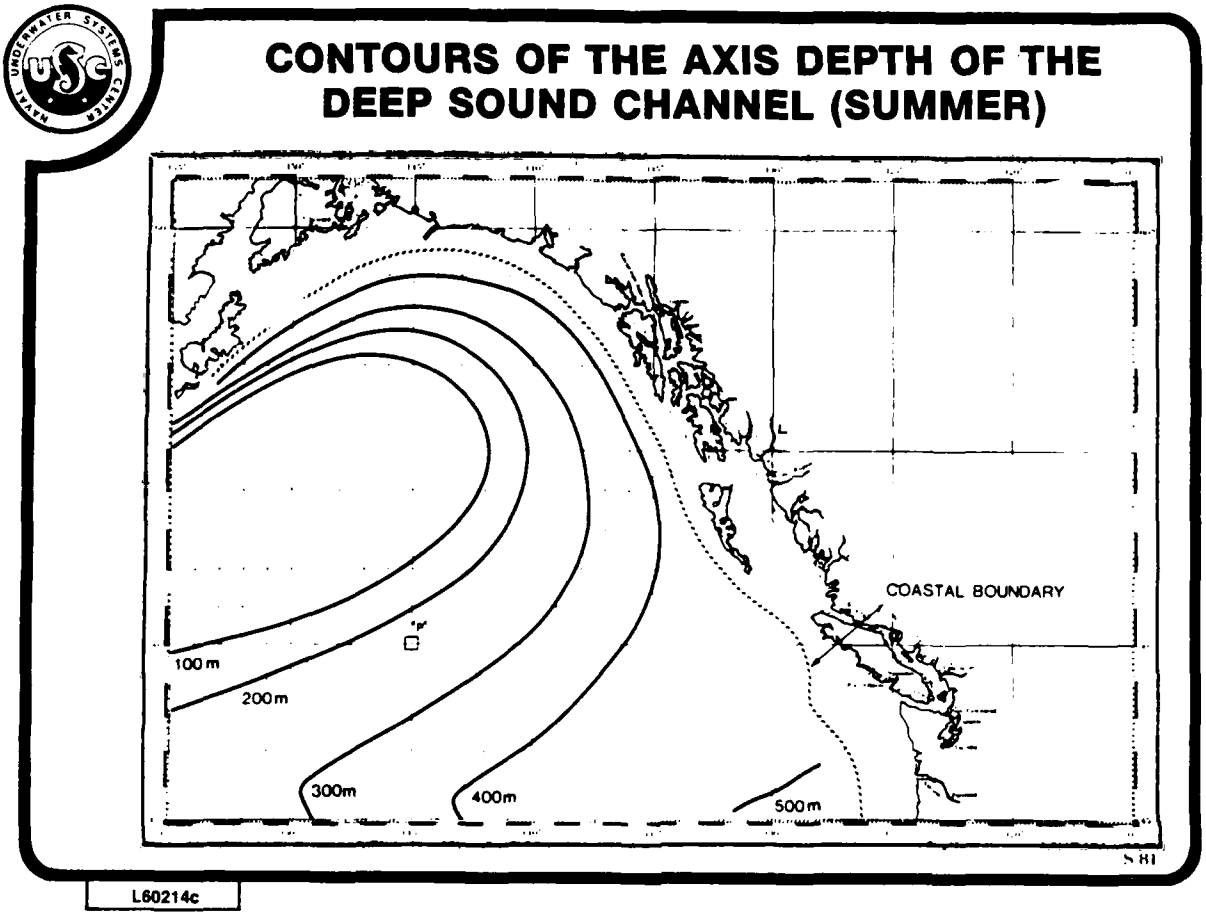

VIEWGRAPH 8

Recently Powell, Chow, and Browning have shown that the depth of the deep sound channel axis in the Subarctic Northeast Pacific does not decrease with latitude but rather contours are concentric about the Alaskan gyre. The deepest axis depth is associated with the warm water around the perimeter, the shallowest with the cold water in the center of the gyre.

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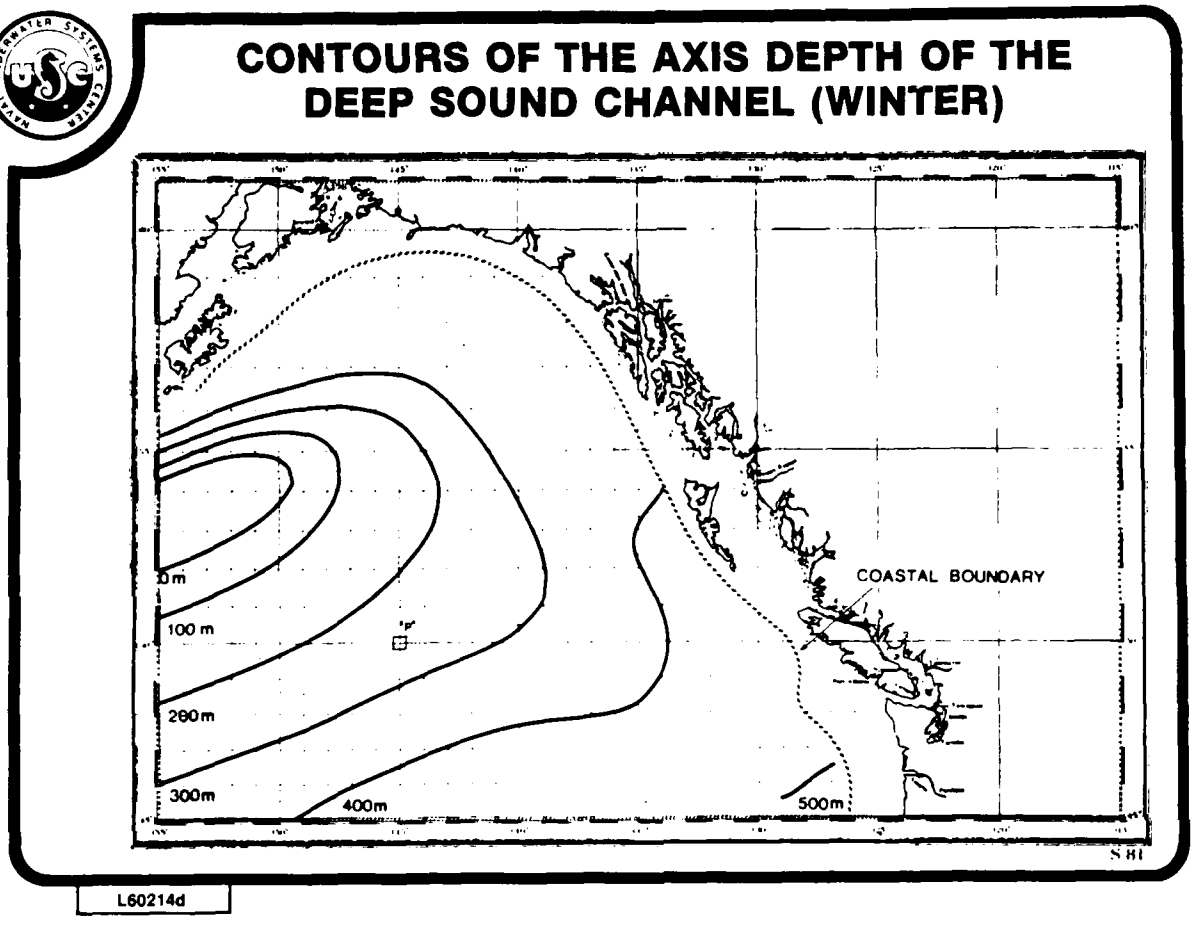

VIEWGRAPH 9

This pattern intensifies under winter conditions with the axis reaching the surface in the center of the gyre.

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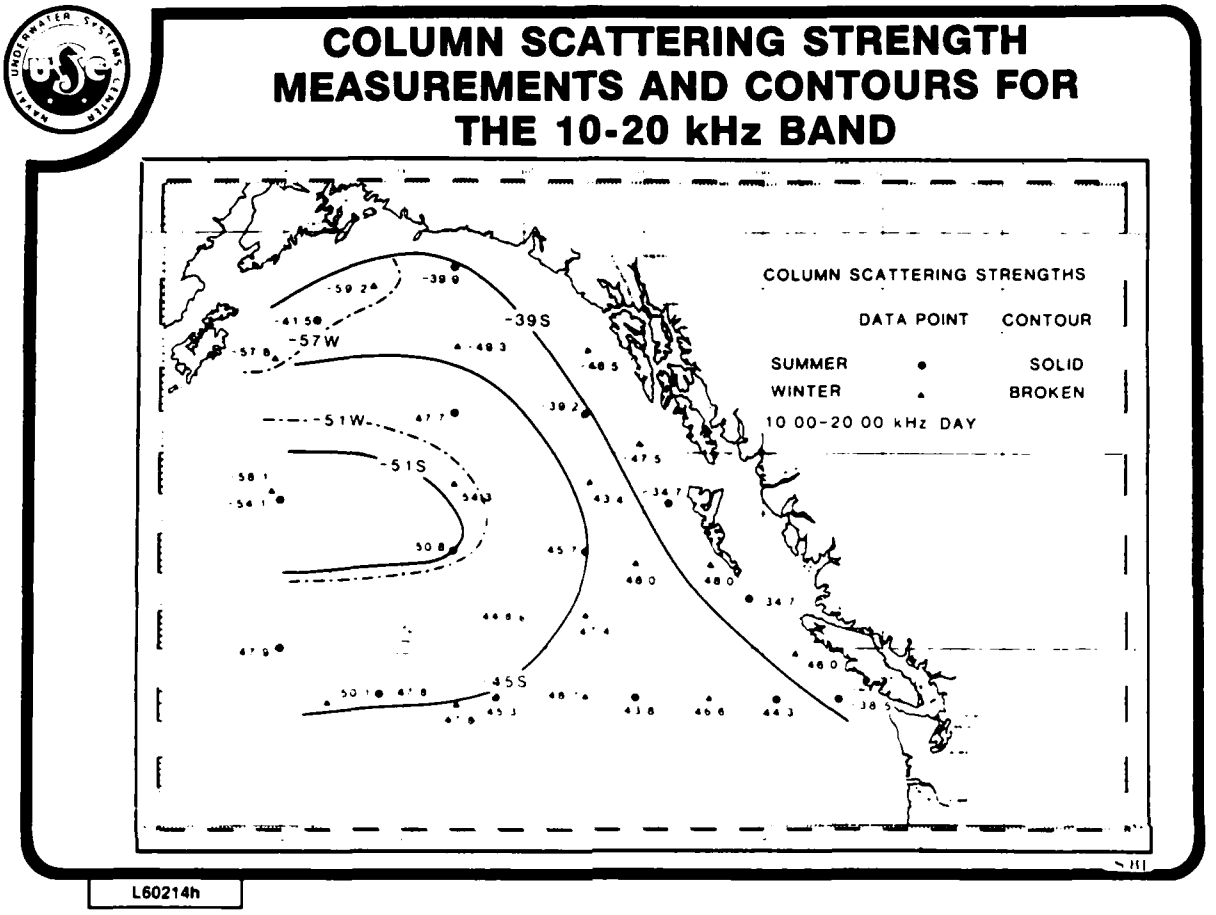

VIEWGRAPH 10

It seemed logical to analyze Turner's data to see if a similar pattern developed. Here is the result for the highest frequency band (10 to 20 kilohertz), the solid contours are for summer, the dashed contours for winter. The highest column scattering strengths are associated with the warmer water around the perimeter of the gyre; here levels are generally lower under winter conditions.

The lowest levels are found in the colder water at the center of the gyre.

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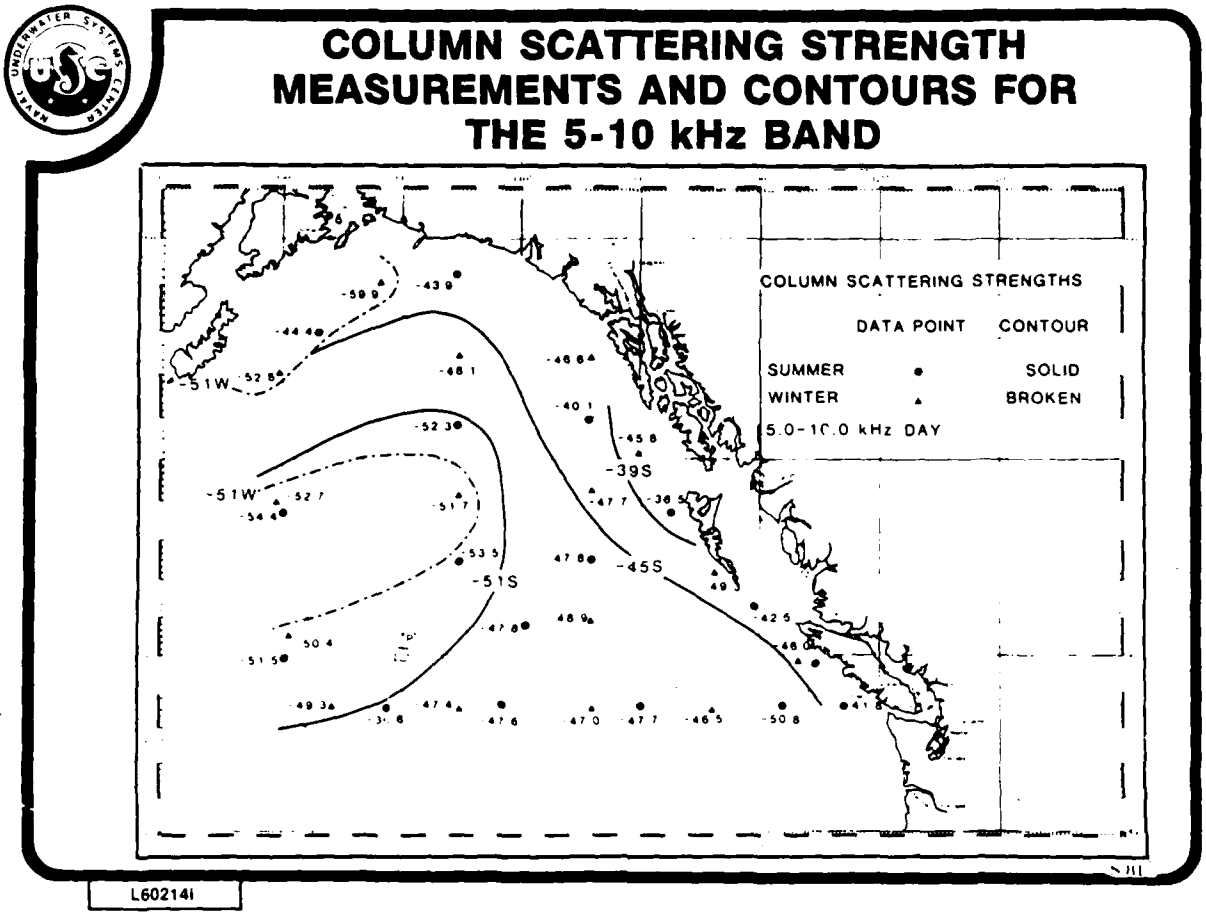

VIEWGRAPH 11

A similar pattern is found for the next lower frequency band, 5 to 10 kilohertz. In all these figures, we are showing day stations only.

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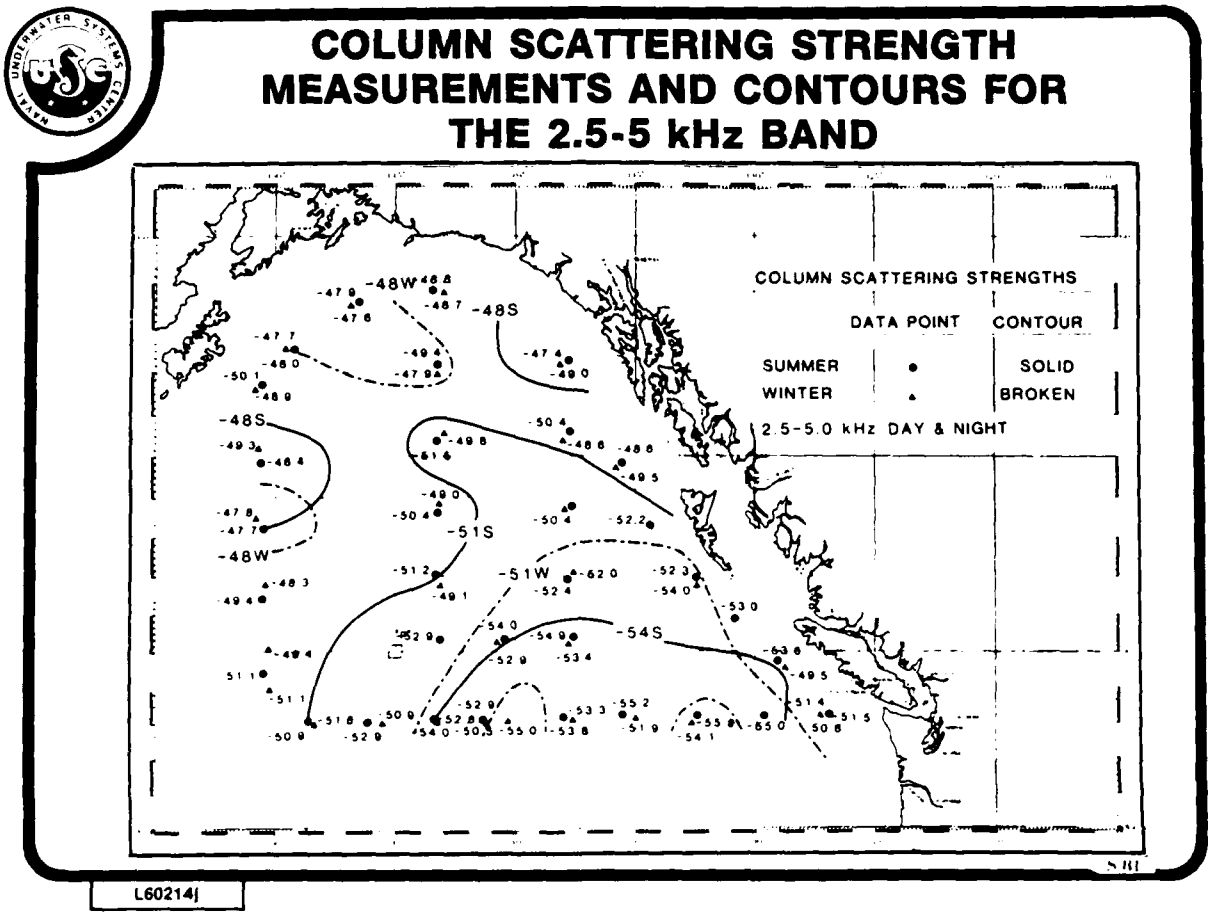

VIEWGRAPH 12

As we go to lower frequencies, the 2.5 to 5 kilohertz band, the pattern changes. More importantly, the trend completely reverses. The lowest column strengths now appear to be associated with the warm water influx in the southeast corner. The area of highest column strength is associated with the colder water to the northwest and this region expands southeastward during the winter.

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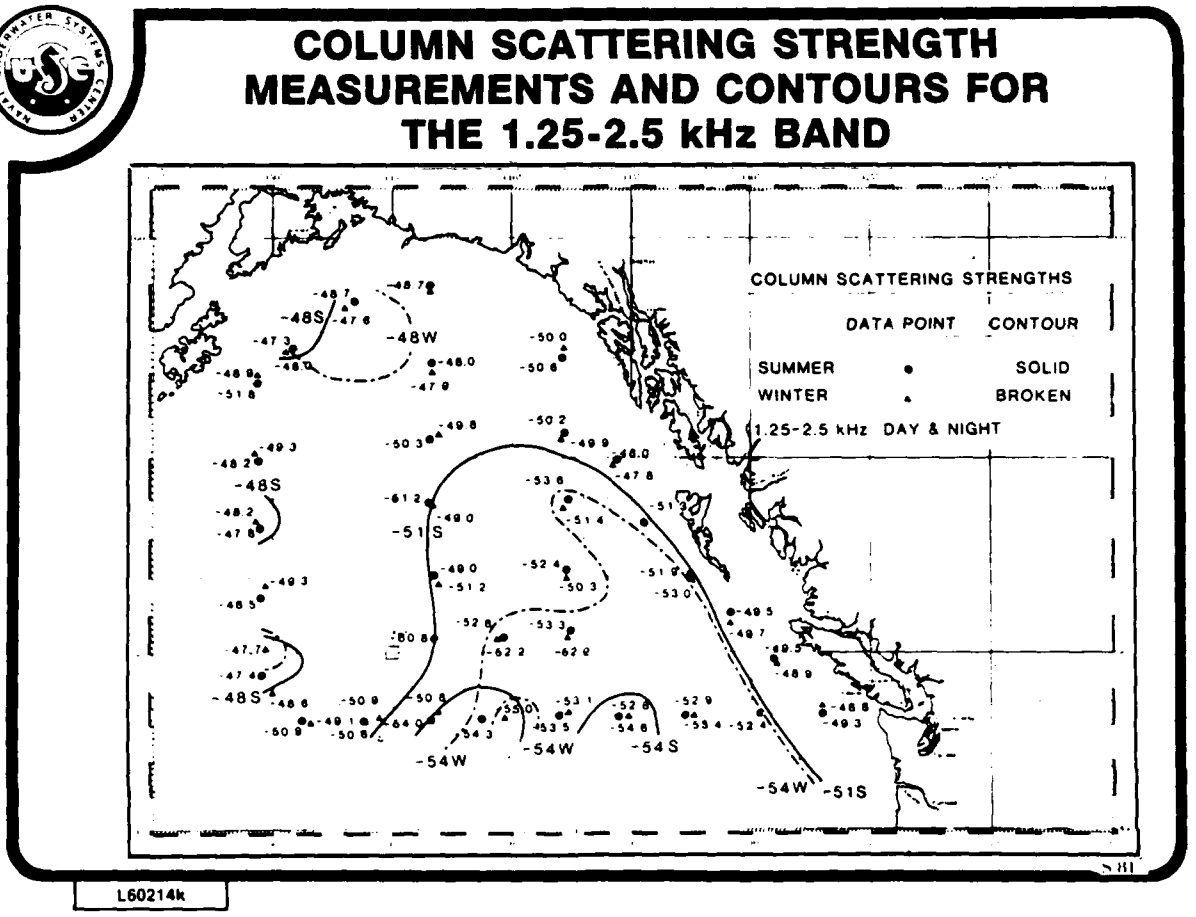

VIEWGRAPH 13

This pattern is confirmed by the lowest frequency band, 1.25 to 2.5 kilohertz. As Chapman's earlier work had indicated, we appear to have two distinct and independent frequency regimes with the demarcation being at 5 kilohertz.

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CONCLUSIONS
SUBARCTIC NORTHEAST PACIFIC OCEAN (GULF OF ALASKA)

- AT HIGHER FREQUENCIES (5-20 kHz) GREATER VOLUME REVERBERATION FOUND IN WARMER WATER AROUND NORTHERN AND EASTERN PERIMETER OF ALASKAN GYRE
- AT LOWER FREQUENCIES (1.25-5 kHz) GREATER VOLUME REVERBERATION FOUND IN COLDER WATER UPWELLED IN THE CENTER OF THE ALASKAN CYRE
- RESULTS SUGGEST THE POSSIBILITY OF TWO DISTINCT SCATTERING REGIMES AND MECHANISMS

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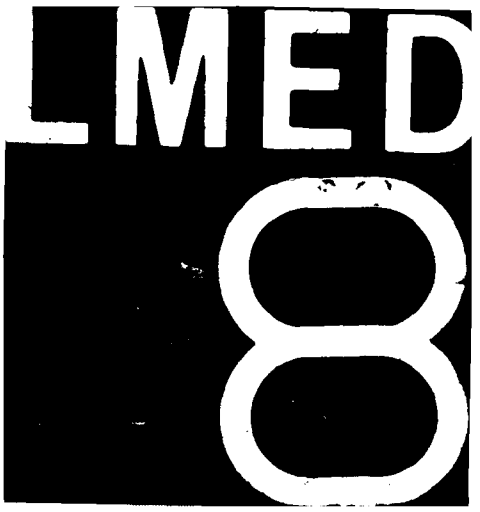
VIEWGRAPH 14

We can summarize our results as follows:

- o At higher frequencies (5 to 20 kilohertz) greater volume reverberation is found in warmer water around the perimeter of the Alaskan gyre.
- o For lower frequencies (1.25 to 5 kilohertz) greater volume reverberation is found in relatively colder water.

These results suggest the possibility of two distinct scattering regimes and mechanisms.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