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Reports of the

**U.S. ~ U.S.S.R.  
WEDDELL POLYNYA  
EXPEDITION**

October - November

1981

Volume 1  
Introduction





REPORTS OF THE  
US - USSR WEDDELL POLYNYA EXPEDITION

OCTOBER - NOVEMBER 1981

VOLUME 1

INTRODUCTION

L-DGO - 83 - 3

NATIONAL SCIENCE FOUNDATION GRANT DPP 80 05765

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NEW YORK 1983

## INTRODUCTION

Studies of the oceanography of the Southern Ocean have been limited to analyzing data collected mainly during periods when research vessels could operate unhindered by the seasonal sea ice cover. Since the Deutschland expedition in 1912, there has been no data obtained in the Weddell Sea under winter conditions, resulting in an unfortunate gap in the data base and, therefore, in our understanding of the physics of the ocean, sea-ice and atmosphere in this important area. Satellite images of the ice covered Weddell Sea obtained in the mid-seventies revealed a previously undetected ice-free region of some 250,000 km<sup>2</sup> occurring near the Greenwich Meridian. The discovery of this feature (called the Weddell Polynya) further emphasized the need for modern austral winter.

In an effort to partially fulfill this need, and in the hope of investigating the Weddell Polynya, a joint Soviet-American expedition was planned: The US-USSR Weddell Polynya Expedition.

The expedition took place during October and November of 1981, yielding a data set unique in its scientific scope which will serve as a valuable base for continued Southern Ocean research and for planning future field work. The data are reported in a series of seven volumes (listed in Table 1). This report is the first volume, and is intended to provide an overview of the expedition, as well as serving as an index for the subsequent reports. An hourly event log is provided at the end of this volume to guide the user in correlating information from the various reports.



TABLE 1

## Reports of the US - USSR Weddell Polynya Expedition

<u>Volume</u>	<u>Title</u>	
1	Introduction	B.A. Huber and S.E. Rennie
2	Hydrographic Data	B.A. Huber, J.Jennings, C. T. Chen, J. Marra, S.E. Rennie, P. Mele and A. L. Gordon
3	Biology	J. Stepien, J. Marra, L. Burckle and J. Morley
4	Ice Cores	S.F. Ackley, D.B. Clarke and S.J. Smith
5	Sea Ice Observations.	S.F. Ackley and S.J. Smith
6	Upper-Air Data	E. L. Andreas
7.	Surface-Level Meteorological Data	E.L. Andreas and A.P. Makshtas

## Expedition Planning, Logistics and Cruise Objectives

Plans for the expedition were developed between the US Coordinator (A. L. Gordon) and the USSR National Coordinator for the USSR POLEX-South Program (E. I. Sarukhanyan) during June 1980 in Leningrad. Representatives of the US and Soviet participating programs continued to work out scientific and logistic details during meetings held in February and April 1981 at Lamont-Doherty Geological Observatory. The overall objectives of the expedition as developed during the meetings were to penetrate as far as possible into the Weddell Sea ice cover during the time of maximum ice extent obtaining physical, chemical and biological oceanographic data, sea-ice data and atmospheric data. In addition, it was hoped that a polynya would develop in 1981, and if so, the second objective of investigating the polynya could be met.

The expedition vessel was provided by the Arctic and Antarctic Research Institute of Leningrad; NES MIKHAIL SOMOV. The SOMOV is an ice-breaking supply vessel 133 meters in length equipped with modest laboratory spaces normally used for routine observational work performed during supply runs to Soviet Antarctic bases. The US team provided most of the instrumentation, including CTD's, 7000 meters of electro-mechanical cable, computers, an autoanalyzer, biology sampling gear, atmospheric boundary layer instrumentation, a salinometer, ice coring gear and atmospheric profiling gear. All scientific gear was shipped to Helsinki, Finland where three members of the US team met SOMOV and assisted with loading the 300 or so boxes on board on September 9, 1981. During the subsequent transit to Montevideo,

Uruguay, much of the equipment was installed and tested, including three motor-generator sets used to convert the ship's 50Hz power to 60Hz power required by the US instrumentation. In order to accommodate the large volume of science gear, substantial modifications were made to some of the ship's laboratory spaces.

The remaining 10 US participants were met in Montevideo on October 8. SOMOV left Montevideo on October 9, and headed to its first encounter with the outer fringe of the ice edge near 56°S, 5°E, on October 20. The vessel maneuvered until 14 November, leaving the ice near 57°S, 0°E, allowing 3 1/2 weeks of work time within the sea ice covered region. The expedition ended at Montevideo on November 25, 1981.

#### The Scientific Programs

Twenty-six scientists participated in the cruise, 13 each from the United States and Soviet Union. The participants and their institutional affiliations are listed in Table 2. Six programs were represented, with Americans and Soviet scientists integrated into teams to carry out the work. Funding for the US participating programs is acknowledged in Table 3, which lists program titles and principal investigators.

A total of 37 stations were occupied within the ice, entailing a variety of data collection activities. Expendable bathythermographs (XBT's) were deployed along the cruise track, especially as the ship crossed from open water to ice and back. Station operations near the ice edge were impossible due to large



CRUISE PARTICIPANTS

Chief Scientist: Ed I. Sarukhanyan (AARI)

Deputy Chief Scientist: Arnold L. Gordon (L-DGO)

Physical Oceanography:

US: Bruce Huber, L-DGO  
David Woodroffe, L-DGO  
Walter Richter, SIO  
Jan Szelag, URI

USSR: Ivan Chuguy  
Nikolai Antipov  
Nikolai Bagriantsev  
Vladimir Romanov

Chemistry:

US: Arthur Chen (carbonate system), OSU  
Joe Jennings (nutrients and silicon), OSU  
Gerry Metcalf (oxygen, carbonate system and Radon), WHOI  
USSR: Victor Haritonov  
Vladimir Feodorov

Biology:

US: Jeanne Stepien (zooplankton), L-DGO  
Bavid Boardman (chlorophyll, primary productivity), L-DGO  
Diane Clarke (diatoms), L-DGO  
USSR: Valyeri M. Zhuravlev (zooplankton)

Sea Ice:

US: Stephen Ackley, CRREL  
USSR: Boris Sustenov  
Alexandre Samoshkin

Meteorology:

US: Ed Andreas, CRREL  
USSR: Alexandre Makshtas  
Ed Lysakov

Velocity of Sound in the Ocean:

USSR: Peter Bogarodski

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All Soviet participants from Arctic and Antarctic Research Institute (AARI), Leningrad, except Zhuravlev from VNIRO, Moscow.

L-DGO: Lamont-Doherty Geological Observatory  
CRREL: Cold Regions Research & Engineering Lab  
OSU: Oregon State University  
URI: University of Rhode Island  
SIO: Scripps Institution of Oceanography



TABLE 3  
PARTICIPATING PROGRAMS

TITLE	PRINCIPAL INVESTIGATORS	AFFILIATION	FUNDING AGENCY AND GRANT #
US-USSR Weddell Polynya Expedition	A. L. Gordon	Lamont-Doherty Geological Observatory of Columbia University	NSF DPP 80-05765
Air-Sea Interaction and Sea-Ice Studies of the Joint Weddell Polynya Expedition	S. F. Ackley E. L. Andreas	U.S. Army Cold Regions Research and Engineering Laboratory	NSF DPP 80-06922
Winter Nutrient Cycling In The Weddell Sea	L. I. Gordon D. Nelson	Oregon State University	NSF DPP 80-07620
The Weddell Sea In Winter-- Plankton Distribution	J. Marra, J. Stepien, J. D. Hays, J. J. Morley, L. H. Burckle	Lamont-Doherty Geological Observatory of Columbia University	NSF DPP 80-08011
The Increase of Total CO <sub>2</sub> In The World Oceans	C. T. Chen	Oregon State University	DOE 81 EV10611
Assessment of Carbon Dioxide Sink/Source in the Ocean Areas	T. Takahashi	Lamont-Doherty Geological Observatory of Columbia University	DOE DE-AC02--81ER60000

NSF - National Science Foundation  
DOE - Department of Energy

amplitude, long period swell propagating into the ice edge zone. The XBT lines thus extend the temperature data set across the ice edge. Station positions and the cruise track are presented in Figure 1, with station activities summarized in Table 4.

Discussions of the programs have been published in an issue of the Antarctic Journal (Table 5). A brief summary of the content of the programs is presented here.

#### Physical Oceanography

The main objective of the physical oceanography program was to resolve the major horizontal and vertical scales of variability in the thermohaline structure of the ice-covered Weddell Sea. Continuous profiles were obtained with a Neil Brown Instrument Systems CTD/O<sub>2</sub> equipped with a General Oceanics rosette water sampler. Several casts extended to within 10 or so meters of the bottom. Temporal variability was investigated by repeated short casts (Yo-Yo stations) and by suspending the CTD at a fixed depth for up to 13 hours while on station. Soviet current meters were deployed during the CTD time series. Profiles of sound velocity were obtained with an instrument of Soviet design on several stations. Dissolved oxygen profiles were available on some of the stations, and discrete water samples were titrated for oxygen on most casts. The data was recorded in digital form and partially processed during the cruise using a Hewlett-Packard computer system.

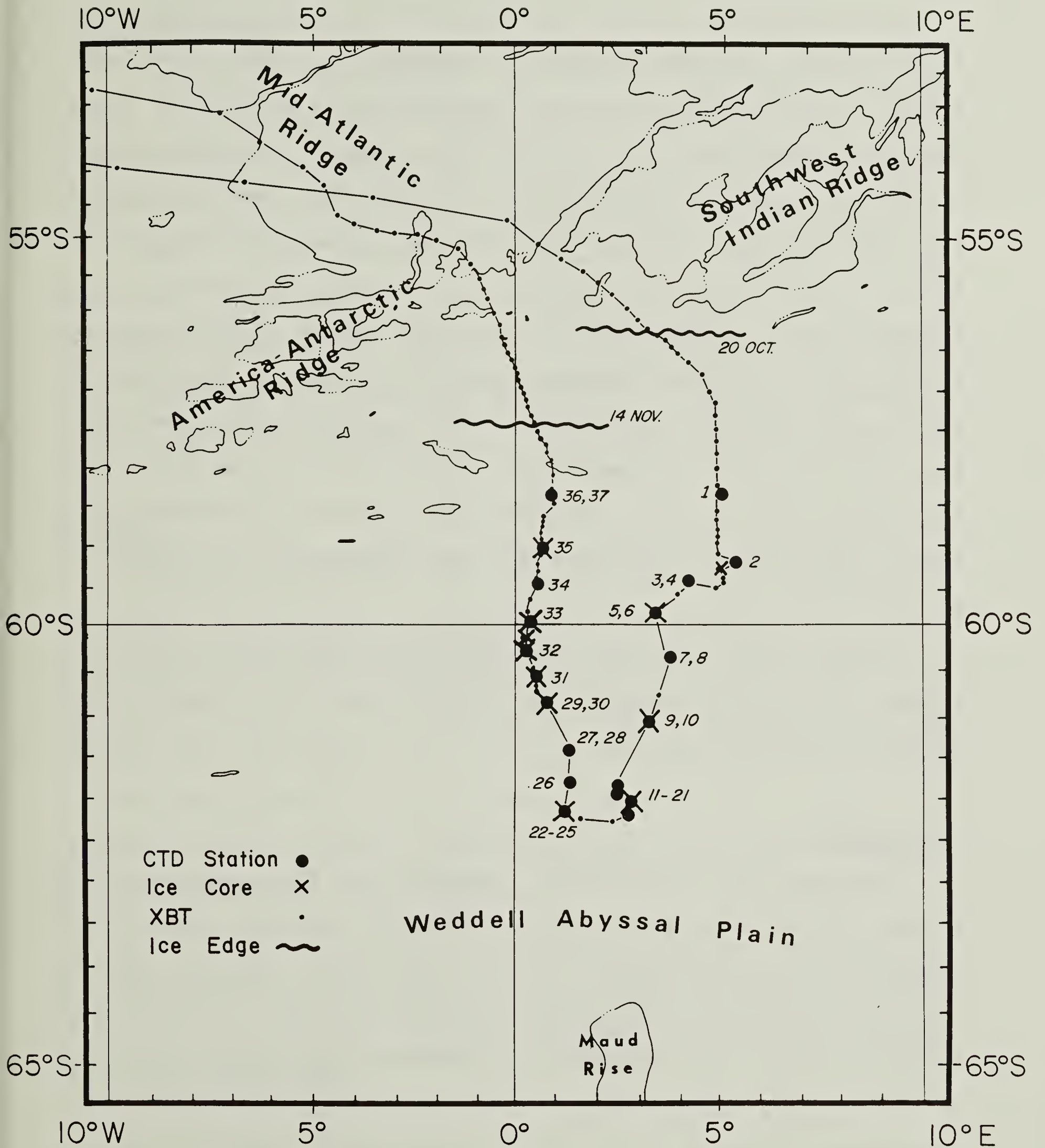


Figure 1



## Atmospheric Physics

The atmospheric study was comprised of four distinct, but complimentary programs: upper-air soundings, surface layer profiling, routine meteorological observations and surface layer turbulence measurements. A MicroCORA Automatic Sounding System (leased from Vaisala of Helsinki, Finland) was used to provide wind velocity, temperature, humidity and pressure profiles twice daily. More frequent profiles of temperature, humidity and pressure were obtained with an Airsonde system manufactured by A.I.R., Inc. Standard meteorological observations were made at three hour intervals, and included wind speed and direction; air, water and dew point temperatures; ice conditions; and cloud type and cover. Total sun and sky radiation, reflected shortwave radiation, net all-wave radiation and ice temperature were recorded hourly.

Surface layer profiles and turbulence measurements were obtained from an instrumented boom deployed from the helicopter deck above the stern of the ship.

## Ice Studies

Underway ice observations, surface ice floe sampling, and coring of the ice pack comprised the ice program. Soviet and American ice observations have been compiled to create a map of daily ice conditions and a companion narrative log. A total of 27 cores and 13 surface samples were obtained from 11 stations. The cores have been analyzed for ice structure, nutrient content, fluorescence, chlorophyll a and phaeopigment, diatom species enumeration, bacteria content, and salinity.



## Nutrient Chemistry

The program was designed to study the distribution and cycling of nutrients under end-of-winter conditions and to obtain the first data set describing the distribution and production/dissolution rates of particulate silicate in the Weddell Sea.

Water samples obtained from the rosette sampler and from hydrocasts were analyzed for nitrate, nitrite, silicate and phosphate using an auto analyzer. Several large volume samples from hydrocasts were partially processed at sea and returned to the laboratory at OSU for analysis of particulate silicate.

## Biology

Biological sampling consisted of measurements designed to ascertain the abundance, distribution, and activity of bacteria, phytoplankton and macrozooplankton in and under the ice. Water samples obtained by bucket and from sampling bottles at various depths, and ice samples were analyzed for chlorophyll a, diatom species and abundance and bacterial content. Surface samples were incubated with  $^{14}\text{C}$  under a variety of light conditions to measure photosynthesis/light relationships.

Zooplankton collections consisted of vertical net hauls at the ice edge and within the ice pack. Observations of krill distribution, abundance and biomass, feeding habits and reproductive state were emphasized.

Carbonate Chemistry and CO<sub>2</sub> Studies.

Water samples were analyzed for pH, total alkalinity, total CO<sub>2</sub> and CO<sub>2</sub> partial pressure. Atmospheric CO<sub>2</sub> was also measured.

The objectives of these programs were:

- a. To assess the utility of calcium, carbonate and pH as water mass tracers;
- b. To estimate the penetration depth of fossil fuel produced CO<sub>2</sub>; and
- c. To assess the degree to which Southern Ocean waters are a sink or source of atmospheric CO<sub>2</sub>.

TABLE 4  
Station Summary

CTD Number	Date	Latitude	Longitude	Depth of CTD Cast, Other Activities
1	Oct. 21	58°28.4'S	5°08.1'E	225 m
2	Oct. 22	59°21.0'S	5°16.9'E	2000 m
3	Oct. 23	59°28.7'S	4°00.3'E	2000 m; Basic Biology
4	Oct. 23	59°28.4'S	4°04.4'E	Yo-Yo Series to 500 m
5	Oct. 24	59°53.7'S	3°24.9'E	2000 m; Basic Biology
6	Oct. 24	59°54.7'S	3°29.2'E	Yo-Yo Series to 500 m
7	Oct. 25	60°26.9'S	3°37.1'E	2000 m; Basic Biology
8	Oct. 26	60°27.0'S	3°37.2'E	Yo-Yo Series to 500 m
9	Oct. 26	61°10.8'S	3°06.9'E	3000 m; Basic Biology
10	Oct. 27	61°10.7'S	3°06.6'E	Yo-Yo Series to 500 m
11	Oct. 29	62°00.3'S	2°26.2'E	3000 m; Basic Biology
12	Oct. 29	61°59.0'S	2°22.6'E	Time Series in Pycnocline
13	Oct. 30	61°55.3'S	2°25.4'E	2000 m; Basic Biology
14	Oct. 30	61°55.8'S	2°25.7'E	Time Series in temperature Maximum
15	Oct. 31	62°04.9'S	2°52.5'E	3000 m; Basic Biology
16	Oct. 31	62°05.3'S	2°51.6'E	Yo-Yo series to 500 m
17	Nov. 2	62°13.6'S	2°50.0'E	Bottom; Basic Biology; Primary Productivity
18	Nov. 2	62°14.8'S	2°58.8'E	Yo-Yo Series; Silicon Particulate Sampling
19	Nov. 2	62°16.2'S	2°54.9'E	Time Series in Temp. Max; Current Meter Time Series
20	Nov. 3	62°19.8'S	3°06.1'E	Yo-Yo series to 500 M; Radiolarian tow
21	Nov. 3	62°19.8'S	3°06.1'E	2000 m; Primary Productivity
22	Nov. 5	62°12.0'S	1°04.3'E	2000 m; Basic Biology; Primary Productivity
23	Nov. 5	62°11.1'S	1°07.9'E	Bottom; Silican Particulates; Carbonates
24	Nov. 5	62°10.6'S	1°11.1'E	Yo-Yo Series; Silicon Particulates; Primary Prod.
25	Nov. 5	62°10.2'S	1°13.3'E	Time Series in Temp. Max; Current Meter Time Series

Table 4 (continued)

CTD Number	Date	Latitude	Longitude	Depth of CTD Cast	Other Activities
26	Nov. 6	61°56.1'S	1°11.2'E	1000 m	
27	Nov. 7	61°29.1'S	1°05.3'E	1000 m;	Basic Biology
28	Nov. 8	61°30.1'S	1°07.9'E	Bottom	
29	Nov. 8	60°56.7'S	0°43.0'E	Bottom;	Basic Biology; Silicon Particulates
30	Nov. 9	60°56.7'S	0°45.7'E	4200 m	
31	Nov. 9	60°40.5'S	0°27.6'E	2000 m;	Basic Biology; Carbonates Intercomparison
32	Nov. 10	60°17.0'S	0°15.3'E	Bottom;	Basic Biology; Chemistry Intercomparison
33	Nov. 11	59°59.0'S	0°18.6'E	3000 m;	Basic Biology; Radiolarian Tow
34	Nov. 12	59°29.6'S	0°30.3'E	3000 M;	Basic Biology; Silicon Particulates; Prim. Prod.
35	Nov. 12	59°04.9'S	0°39.2'E	3000 m;	Diatom Sampling; Carbonates
36	Nov. 13	58°20.8'S	0°45.5'E	2000 m;	Basic Biology; Silicon Particulates; Prim. Prod.
37	Nov. 13	58°24.5'S	0°58.5'E	Bottom;	Silicon Particulates; Radiolarian Tow

Comments

Basic Biology - Zooplankton vertical tows from 500 and 200 m. Radiolarian tows 200-100 m, and 100 m to surface.  
Diantom samples from upper 100 m.

Sound velocity profiles of upper 100-200 m obtained at each station.

CRREL atmospheric sampling boom deployed at a number of station sites.



TABLE 5

Articles appearing in The Antarctic Journal, vol. XVII no. 5, 1982.

"The US - USSR Weddell Polynya Expedition," Arnold L. Gordon.

"Physical Oceanography During The US-USSR Weddell Polynya Expedition." Arnold L. Gordon and Bruce A. Huber.

"Nutrient Chemistry Program During the US-USSR Weddell Polynya Expedition." Joe Jennings, David Nelson and Louis I. Gordon.

"Carbonate Chemistry During The US-USSR Weddell Polynya Expedition." Chen-Tung Arthur Chen.

"CO<sub>2</sub> Partial Pressure in Surface Waters of the Antarctic Ocean. During the US-USSR Weddell Polynya Expedition." Taro Takahashi and David Chipman.

"Observations of Pack Ice Properties During the US-USSR Weddell Polynya Expedition." Stephen F. Ackley, Sandra J. Smith and Diane B. Clarke.

"Physical, Chemical and Biological Properties of Winter Sea Ice During the US-USSR Weddell Polynya Expedition." Diane B. Clarke and Stephen F. Ackley.

"Zooplankton in the Weddell Seas, October-November 1981." Jeanne C. Stepien.

"Sea Ice and Water Column Plankton Distributions in the Weddell Sea in Late Winter." John Marra, Lloyd Burckle and Hugh W. Ducklow.

"Atmospheric Boundary Layer Measurements During the US-USSR Weddell Polynya Expedition". Edgar L. Andreas.

### ACKNOWLEDGEMENTS

The success of an endeavor of this magnitude required the cooperation of a great many talented people. We are especially grateful to Captain F. A. Pesyakov and the officers and crew of the NES MIKAIL SOMOV. They provided us with much needed help in establishing laboratory space on the ship, offering materials, advice and technical assistance wherever needed. Equally important, we were welcomed aboard and were provided with a living environment in which we felt at home.

The collection of the data was truly a cooperative effort. Our Soviet colleagues worked with diligence and care to ensure the high quality and scientific value of the data collected.

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## APPENDIX

### Hourly Event Log

Navigation during the cruise was provided by satellite navigator fixes and dead reckoning. The following tables list hourly positions computed from the available good fixes by interpolation. Underway events and observations and station activities are entered to the nearest hour. All times are GMT.

### Key to event log

#### Labels and Entries:

CTD	- CTD station number (biology station #)
XBT	- XBT number
SST	- Sea surface temperature (°C) from bucket sample
SSS	- Sea surface salinity from bucket sample
CL	- Total cloud cover in OKTAS
WIND	- Direction (ten degrees) speed (meters/sec)
WX	- Weather type (WMO code 4677)
PRESS	- Atmospheric pressure (millibars)
AIRT	- Air temperature (°C)
DEW	- Dew point temperature (°C)
SST	Sea surface temperature (°C) from Soviet underway system.
VAP	- Water vapor pressure (millibars)
MET.PRFL	- Meteorological profile (type and #)
	SLPnn - surface layer profile number
	Mnn - MicroCORA profile
	Ann - Airsonde profile
	BIOnn - Biology station number

Other events indicated by text comments at right.





















OCTOBER 27

HOUR	LAT	LONG	CTD XBT	SST	SSS	CL WIND	WX	PRESS	AIRT DEW	SST	VAP RH	MET. PRFL	COMMENTS
0	-61 10.8	3 6.7	10			8 13	3 71	954.2	-4.5	-6	-1.8	3.9	96 SLP3,M23 S.Vel 6 c4
100	-61 10.6	3 6.4											SLP4
200	-61 10.4	3 6.2				8 2	6 71	955.7	-2.9	-4	-1.8	4.6	93
300	-61 10.3	3 5.9											
400	-61 10.1	3 5.6											
500	-61 9.9	3 5.3				8 17	10 71	958.2	-1.9	-3	-1.8	4.7	90
600	-61 10.5	3 4.4											
700	-61 12.3	3 2.3											
800	-61 14.1	3 0.2				8 18	9 71	959.9	-6.6	-8	-1.8	3.3	88
900	-61 15.7	2 58.1											
1000	-61 16.9	2 56.2											
1100	-61 17.0	2 55.7											
1200	-61 17.2	2 55.4				8 18	12 2	961.8	-7.8	-10	-1.8	2.9	86 M24,A9
1300	-61 17.5	2 54.8											
1400	-61 17.9	2 54.4											
1500	-61 18.2	2 53.9				8 20	11 71	963.5	-7.9	-9	-1.8	3.1	93
1600	-61 19.2	2 54.0											
1700	-61 20.9	2 54.9				8 20	7 71	963.5	-9.4	-10	-1.8	2.9	98
1800	-61 21.9	2 54.3											
1900	-61 22.1	2 51.5											
2000	-61 23.2	2 48.0											
2100	-61 26.8	2 51.1				8 21	13 71	966.9	-10.8	-12	-1.8	2.5	93
2200	-61 26.9	2 51.7											
2300	-61 26.4	2 52.0											

OCTOBER 28

HOUR	LAT	LONG	CTD XBT	SST	SSS	CL WIND	WX	PRESS	AIRT DEW	SST	VAP RH	MET. PRFL	COMMENTS
0	-61 26.0	2 49.0				8 20	9 71	968.2	-12.0	0	-1.8	0.0	0 M25
100	-61 25.7	2 42.8											
200	-61 25.3	2 36.5											
300	-61 25.0	2 30.3				8 21	12 71	969.0	-11.8	0	-1.8	0.0	0
400	-61 24.5	2 24.1											
500	-61 22.0	2 35.3											
600	-61 19.3	2 43.2				8 24	11 71	971.5	-12.3	0	-1.8	0.0	0
700	-61 22.2	2 42.8											
800	-61 26.6	2 42.1											
900	-61 22.3	2 41.9				8 23	10 2	972.2	-13.2	0	-1.8	0.0	0
1000	-61 20.9	2 41.6											
1100	-61 24.5	2 41.9											
1200	-61 28.0	2 38.2				8 22	12 2	972.9	-12.5	0	-1.8	0.0	0 M26
1300	-61 31.3	2 33.7											
1400	-61 33.5	2 30.8											
1500	-61 31.9	2 34.1				8 26	7 2	973.7	-11.7	0	-1.8	0.0	0
1600	-61 30.3	2 37.4											
1700	-61 28.7	2 40.7											
1800	-61 33.0	2 33.0				8 28	3 2	974.2	-13.0	0	-1.8	0.0	0
1900	-61 33.3	2 32.2											
2000	-61 33.3	2 32.4											
2100	-61 33.1	2 32.3				8 27	4 2	975.5	-13.9	0	-1.8	0.0	0
2200	-61 33.0	2 32.3											
2300	-61 33.2	2 32.6											SLP5

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OCTOBER 31

HOUR	LAT	LONG	CTD XBT	SST	SSS	CL WIND	WX	PRESS	AIRT DEW	SST	VAP RH	MET. PRFL	COMMENTS
0	-61 57.4	2 25.5				8	1 12 2	980.2	-14.0	0	-1.8	0.0	0 M31
100	-61 58.1	2 25.7											
200	-61 58.8	2 26.0											
300	-61 59.5	2 26.2				8	3 13 71	973.9	-12.9	0	-1.8	0.0	0
400	-62 0.1	2 25.8											
500	-62 0.7	2 25.4				8	4 14 71	969.8	-11.7	0	-1.8	0.0	0
600	-62 1.3	2 24.9											
700	-62 1.9	2 24.5											
800	-62 2.3	2 24.2											
900	-62 2.8	2 23.9				8	4 11 71	966.5	-7.5	-9	-1.8	3.2	91
1000	-62 3.2	2 24.6											
1100	-62 3.5	2 24.2				7	4 8 2	964.7	-2.7	-4	-1.8	4.4	88 M32
1200	-62 3.6	2 24.4											
1300	-62 3.3	2 25.3											
1400	-62 3.0	2 26.3				8	28 4 2	964.6	-2.2	-4	-1.8	4.4	85
1500	-62 2.7	2 27.2											
1600	-62 2.5	2 29.5											
1700	-62 2.3	2 36.5				8	28 4 2	964.6	-2.9	-6	-1.8	3.9	80 M33
1800	-62 3.4	2 43.6											
1900	-62 4.7	2 51.4											
2000	-62 5.0	2 51.5				8	26 5 2	967.5	-3.2	-6	-1.8	4.0	83
2100	-62 5.1	2 51.5	15 (B10 7)										
2200	-62 5.2	2 51.7											
2300	-62 5.3	2 51.7	16										

S. Vel 9 c1

S. Vel 9 c2  
S. Vel 9 c3, c4  
S. Vel 9 c5

NOVEMBER 1

HOUR	LAT	LONG	CTD XBT	SST	SSS	CL WIND	WX	PRESS	AIRT DEW	SST	VAP RH	MET. PRFL	COMMENTS
0	-62 5.3	2 52.0				8	0 0 2	968.2	-3.6	-9	-1.8	4.0	85 M34
100	-62 5.5	2 51.6											
200	-62 5.8	2 51.2											
300	-62 6.1	2 50.8				8	28 9 71	968.9	-4.7	-5	-1.8	4.1	96
400	-62 6.4	2 50.3											
500	-62 5.6	2 53.5				8	27 9 71	968.9	-4.5	-6	-1.8	3.8	88
600	-62 6.2	2 55.6											
700	-62 7.3	2 57.2											
800	-62 9.4	2 56.2				8	29 5 2	970.1	-3.2	-5	-1.8	4.2	87
900	-62 11.5	2 54.5											
1000	-62 11.5	2 54.1											
1100	-62 11.3	2 54.1				7	28 4 2	971.7	-1.3	-3	-1.8	4.8	85 M35
1200	-62 11.3	2 53.6											
1300	-62 11.2	2 53.7											
1400	-62 11.2	2 53.8											
1500	-62 11.6	2 52.5				7	29 2 1	973.9	1.2	-1	-1.8	5.8	87
1600	-62 12.2	2 51.0											
1700	-62 12.7	2 49.6											
1800	-62 12.9	2 49.5				7	22 2 2	975.7	-2.9	-5	-1.8	4.1	84
1900	-62 13.1	2 49.9											
2000	-62 13.2	2 50.3											
2100	-62 13.4	2 49.9				7	11 3 2	974.8	-5.6	-8	-1.8	4.0	83
2200	-62 13.5	2 49.6											
2300	-62 13.7	2 49.6											

Ice Core 9, 10, 11



NOVEMBER 4

HOUR	LAT	LONG	CTD XBT	SST	SSS	CL WIND	WX	PRESS	AIRT DEW	SST	VAP RH	MET. PRFL	COMMENTS
0	-62 22.1	1 51.4				8 28 12	2	968.9	-7.0	-7	-1.8	3.0 81	M40
100	-62 21.9	1 51.5											
200	-62 21.5	1 51.2											
300	-62 20.9	1 50.3				8 30 10	71	966.9	-7.3	-8	-1.8	3.4 96	
400	-62 19.3	1 43.6											
500	-62 18.6	1 43.5											
600	-62 18.8	1 45.5				8 29 11	71	966.9	-8.0	-9	-1.8	3.0 90	
700	-62 19.0	1 47.1											
800	-62 19.0	1 47.1											
900	-62 19.0	1 43.3				8 28 10	71	966.2	-6.7	-8	-1.8	3.4 91	
1000	-62 17.8	1 41.0											
1100	-62 16.1	1 32.5											
1200	-62 15.3	1 21.4				7 29 11	2	965.3	-5.5	-7	-1.8	3.6 88	M41
1300	-62 13.3	1 18.3	72										
1400	-62 11.4	1 27.0	78			8 28 12	2	965.9	-6.7	-9	-1.8	3.1 83	
1500	-62 10.3	1 23.4											
1600	-62 9.2	1 18.9											
1700	-62 7.4	1 12.8				8 28 8	2	965.9	-7.0	-10	-1.8	2.9 80	Ice Core 12, 13, 14
1800	-62 7.8	1 4.4											
1900	-62 11.9	1 2.6											
2000	-62 13.0	1 1.7											
2100	-62 13.3	1 1.4				8 26 9	2	967.5	-7.5	-10	-1.8	2.8 82	
2200	-62 13.1	1 1.9											
2300	-62 12.9	1 2.5											SLP15

NOVEMBER 5

HOUR	LAT	LONG	CTD XBT	SST	SSS	CL WIND	WX	PRESS	AIRT DEW	SST	VAP RH	MET. PRFL	COMMENTS
0	-62 12.7	1 3.1				8 26 10	71	968.3	-7.8	-9	-1.8	3.0 90	SLP16, M42
100	-62 12.4	1 3.7											
200	-62 12.2	1 4.4											
300	-62 12.1	1 4.4				8 27 11	71	968.9	-8.0	-9	-1.8	3.2 45	
400	-62 12.0	1 4.3											
500	-62 11.5	1 6.0	22 (B10 9)			8 27 18	71	969.1	-8.7	-10	-1.8	2.8 89	A21
600	-62 11.2	1 7.0											
700	-62 11.1	1 7.8											
800	-62 11.1	1 8.7											
900	-62 10.9	1 9.7	23			8 29 11	2	969.8	-7.7	-19	-1.8	3.0 89	A22
1000	-62 10.8	1 10.3											
1100	-62 10.7	1 10.8	24			8 29 9	2	970.2	-5.4	-7	-1.8	3.5 86	M43
1200	-62 10.5	1 11.5											
1300	-62 10.3	1 12.8	25										
1400	-62 9.9	1 13.3				8 25 8	2	970.6	-4.0	-6	-1.8	3.8 85	A23
1500	-62 9.7	1 14.0											
1600	-62 9.4	1 14.7											
1700	-62 8.9	1 15.1											
1800	-62 8.5	1 14.9				8 23 10	2	972.2	-5.0	-7	-1.8	3.6 86	A24
1900	-62 8.0	1 15.1											
2000	-62 7.7	1 14.8											
2100	-62 7.2	1 14.5				8 23 10	2	976.2	-6.6	-7	-1.8	3.0 80	A25
2200	-62 6.7	1 14.4											
2300	-62 6.4	1 13.9											

S. Vel 12  
Particulate Si









NOVEMBER 10

HOUR	LAT	LONG	CTD XBT	SST SSS	CL WIND	WX	PRESS	AIRT DEW	SST	VAP RH	MET. PRFL	COMMENTS
0	-60 40.7	0 31.4			8 31 9 2		993.6	0.0 -2	-1.8	5.4 89	M52	
100	-60 40.7	0 31.6										
200	-60 40.6	0 31.8			8 30 7 2		994.9	.2 -2	-1.8	5.5 90		
300	-60 40.6	0 31.8										
400	-60 40.6	0 31.8										
500	-60 40.3	0 33.1			8 26 10 2		996.6	.9 0	-1.8	5.9 90		
600	-60 40.0	0 34.2										
700	-60 39.9	0 35.3										
800	-60 39.7	0 36.8			8 26 10 2		999.1	1.4 0	-1.8	6.0 88		Ice Core 20.22
900	-60 39.2	0 37.3										
1000	-60 38.9	0 37.9										
1100	-60 38.5	0 38.6			8 26 10 2		1001.4	2.1 0	-1.8	6.1 86	M53	
1200	-60 38.1	0 40.0										
1300	-60 37.5	0 41.8										
1400	-60 36.8	0 44.0			8 28 10 2		1004.3	.2 -2	-1.8	5.2 84		
1500	-60 35.0	0 40.7										
1600	-60 31.7	0 30.9										
1700	-60 30.1	0 30.5			8 26 7 2		1006.1	-1.0 -4	-1.8	4.7 83		
1800	-60 27.9	0 29.0		83 -1.75								
1900	-60 22.8	0 21.1										
2000	-60 18.9	0 15.7			8 30 7 2		1006.7	-1.7 -4	-1.8	4.5 84		Intercalibration S. Vel 17 c1 - c5
2100	-60 17.0	0 15.2										
2200	-60 17.3	0 15.5	32 (BIO 13)									
2300	-60 17.6	0 15.8										

NOVEMBER 11

HOUR	LAT	LONG	CTD XBT	SST SSS	CL WIND	WX	PRESS	AIRT DEW	SST	VAP RH	MET. PRFL	COMMENTS
0	-60 17.9	0 16.1			8 35 7 2		1007.5	-2.8 -5	-1.8	4.1 83	SLP19, M54 SLP20	
100	-60 18.1	0 16.3										
200	-60 16.9	0 16.6			8 1 10 2		1005.7	-4.2 -6	-1.8	3.9 86		
300	-60 14.6	0 16.9										
400	-60 12.3	0 17.3										
500	-60 10.0	0 17.6			8 2 10 2		1004.7	-1.8 -5	-1.8	4.2 89		
600	-60 7.3	0 16.8		84 -1.75								
700	-60 6.1	0 15.8										
800	-60 5.0	0 14.9			8 36 14 2		1004.7	.5 -2	-1.8	5.1 80	A26 A27	
900	-60 5.0	0 14.3										
1000	-60 5.4	0 14.1			8 34 9 2		1005.4	1.3 -1	-1.8	5.6 83	M55	
1100	-60 5.8	0 14.2										
1200	-60 6.1	0 15.8			9 36 8 45		1005.0	2.1 2	-1.8	6.9 98	A28	
1300	-60 6.3	0 17.5										
1400	-60 6.5	0 18.5										
1500	-60 6.4	0 18.8			9 36 8 45		1004.1	.3 0	-1.8	6.1 98	A29	
1600	-60 6.4	0 19.1		85 -1.70 34.306								
1700	-60 0.1	0 11.7		86 -1.73 34.282								
1800	-59 59.3	0 13.0			8 1 14 2		1002.6	.5 -1	-1.8	5.8 91	A30 SLP21	
1900	-59 59.1	0 15.8										
2000	-59 58.9	0 18.6										
2100	-59 59.8	0 19.1	33 (BIO 14)									
2200	-60 0.6	0 19.6										
2300	-60 1.5	0 20.5										

S. Vel 18

S. Vel 18











NOVEMBER 18

HOUR	LAT	LONG	CTD XBT	SST	SSS	CL WIND	WX	PRESS	AIRT DEW	SST	VAP RH	MET. PRFL	COMMENTS				
0	-51	7.7	-14	40.5		0	28	19	1	1017.4	3.5	1	1.0	6.4	81		
100	-51	3.7	-14	48.6													
200	-50	59.7	-14	56.7													
300	-50	56.2	-15	6.5	153	2.70	33.924	0	29	16	2	1017.5	3.5	1	2.7	6.5	83
400	-50	52.9	-15	16.5													
500	-50	49.6	-15	26.5													
600	-50	46.0	-15	37.1													
700	-50	42.1	-15	48.4	154	2.75	33.862	8	30	12	3	1016.8	3.0	0	2.7	6.1	81
800	-50	37.8	-15	59.9													
900	-50	33.9	-16	10.6	155	2.55	33.803	0	33	12	1	1016.4	3.9	1	3.0	6.5	80
1000	-50	30.2	-16	22.1													
1100	-50	26.0	-16	33.6	156	1.75	33.892										
1200	-50	21.5	-16	46.3	157	2.31	33.910	0	33	15	2	1014.8	3.8	1	1.9	6.4	80
1300	-50	17.2	-16	57.9	158	3.08	33.876										
1400	-50	12.8	-17	9.6	159	2.90	33.824										
1500	-50	8.6	-17	22.0	160	2.90	33.833	8	33	11	2	1010.6	3.8	1	1.8	6.5	82
1600	-50	3.4	-17	36.4	161	2.70	33.882										
1700	-49	57.2	-17	51.3													
1800	-49	51.2	-18	7.7	163	3.50	33.905	8	33	11	2	1010.6	3.8	1	1.8	6.5	82
1900	-46	17.3	-18	24.8	164	3.25	33.824										
2000	-49	39.0	-18	40.9	165	3.53	33.765										
2100	-49	33.0	-18	57.5	166	3.65	33.742	8	33	11	2	1010.6	3.8	1	1.8	6.5	82
2200	-49	27.2	-19	14.2	167	3.85	33.780										
2300	-49	21.3	-19	31.1	168	3.45	33.814										

NOVEMBER 19

HOUR	LAT	LONG	CTD XBT	SST	SSS	CL WIND	WX	PRESS	AIRT DEW	SST	VAP RH	MET. PRFL	COMMENTS
0	-49	15.7	-19	47.7	169	3.55	33.826						
100	-49	10.4	-20	3.9	170	3.42	33.822						
200	-49	4.7	-20	19.9	171	3.70	33.794						
300	-48	58.3	-20	36.8	172	3.65	33.797						
400	-48	52.7	-20	52.4	173	3.65	33.827						
500	-48	45.9	-21	8.6	175	3.45	33.883						
600	-48	39.5	-21	23.3	176	3.55	33.899						
700	-48	33.2	-21	38.6	177	4.40	33.947						
800	-48	26.9	-21	54.9	178	3.75	33.877						
900	-48	20.6	-22	12.2	179	2.85	33.859						
1000	-48	15.0	-22	28.1	180	2.85	33.878						



