WHOI-90-12
COPY 2

Woods Hole Oceanographic Institution

Report on R.V. *Akademik Vernadsky* Cruise 39, Stage IV
June 17 – July 17, 1989

by

Nick P. Fofonoff,
Ellen Levy,
A. James Kettle,
and
Richard C. Navitsky

April 1990

Technical Report

Funding was provided by Vetelsen, the Education Office of Woods Hole Oceanographic Institution, and a Dr. William B. Richardson Summer Fellowship provided by Alden Products Company.

Approved for public release; distribution unlimited.

WHOI-90-12

Report on R.V. *Akademik Vernadsky* Cruise 39, Stage IV June 17 – July 17, 1989

by

Nick P. Fofonoff,
Ellen Levy,
A. James Kettle,
and
Richard C. Navitsky

Woods Hole Oceanographic Institution
Woods Hole, Massachusetts 02543

April 1990

Technical Report

Funding was provided by Vetelsen,
the Education Office of Woods Hole Oceanographic Institution, and
a Dr. William B. Richardson Summer Fellowship provided by
Alden Products Company.

Approved for Distribution:

Robert C Beardsley

Robert C. Beardsley, Chairman
Department of Physical Oceanography

Contents

List of Figures

List of Tables

Abstract

Participation by U.S. personnel on Cruise 39, Leg IV (June 17 – July 17, 1989) of the Marine Hydrophysical Institute's research vessel *Akademik Vernadsky* provided valuable information, documented in the present report, for planning future cooperative projects with Soviet oceanographers. Detailed descriptions are given of the ship, its scientific laboratories, computers and on-board instrumentation. Planning and operating procedures are described and examples are given of daily work plans, seminars, menus and social activities. Personal accounts by the U.S. participants are also included. Many of the shipboard activities were recorded on VHS video cassettes.

The oceanographic data collected in the Gulf Stream survey region during Leg IV are documented in the report. Copies of data sets were provided to the U.S. participants in exchange for U.S. data from the region during the survey period.

1 Introduction

1.1

MARINE HYDROPHYSICAL INSTITUTE

Academy of Sciences of the Ukrainian SSR
28 Lenin Street, Sevastopol, 335000, U.S.S.R.

The Marine Hydrophysical Institute (MHI) of the USSR Academy of Sciences — originally the Marine Hydrophysical Laboratory — was founded in Moscow in 1948. In 1961 the Institute was affiliated to the Ukr. SSR Academy of Sciences and in 1963 transferred to Sevastopol. Academician V. V. Shuleikin was its first director. Since 1987 the Institute is directed by Prof. Valery N. Eremeev.

Presently, the Marine Hydrophysical Institute is reputed to be one of the leading oceanographic centers in the Soviet Union. Its staff consists of the highly qualified researchers, including an academician and two corresponding members of the Ukrainian SSR Academy of Sciences, and nearly thirty professors.

The research Institute in Sevastopol, comprising a special designing bureau and experimental production subdivision also has three branches — the experimental department in Katsively (Crimea), the hydroacoustic department in Odessa, and the continually acting research group in Conakry (Guinean Republic) that handles problems of oceanography, heliophysics, material and manufactured article testing in tropical conditions.

Foundation of MHI was dictated by the need to intensify research in the domain of physical oceanology and applied hydrophysics, conducted by the USSR Academy of Sciences, with the purpose of rational use of the world ocean resources and evnironmental monitoring.

The primary goal of the Institute's research center in Sevastopol is to explore physics of the ocean. The Institute comprises fifteen research departments that conduct investigations in the following fields: air–sea interaction; theoretical and experimental studies of oceanic large-scale circulation; elaboration of the theory and experimentation aimed at the study of surface and internal waves; development of the principles of satellite hydrophysics; development of new methods and means for system study of physical processes in the ocean.

The Institute is an organization of experimental and theoretical profile. Therefore, alongside with the elaborating theory and laboratory experimentation, the Institute's vessels are continually involved in complex field research. Aside from this, MHI has available a modern scientific and technological base, which incorporates specially equipped hydrophysical test areas (Tendra spit; Odessa) and oceanographic platform in Katsively; automated systems for collecting and processing oceanographic data (stationary, ship-mounted, and airborne ones) through the agency of mini- and large computers; circular aerohydrochannel in Katsively; high-class standard measuring instrumentation and laboratory equipment, as well as oceanographic instruments and measuring sets designed and manufactured in the Special Designing Bureau. The Institute disposes of five research vessels — R.V. *Akademik Vernadsky* (displacement 6.929 t), R.V. *Mikhail Lomonosov* (5.960 t), R.V. *Professor Kolesnikov* (890 t), R.Vs. *Trepang* and *Ustritsa* (385 t each). For remote sensing purposes, planes and satellites are used.

The Marine Hydrophysical Institute has contributed to the realization of such international programs as the global atmospheric research program (GARP), Soviet–American program bearing upon the investigation of synoptic vorticity in the ocean (POLYMODE), the joint program of investigations of the Caribbean Sea and adjacent regions (MOCARIB), the Soviet–French program COFRASOV, programs TOGA, VOCE, COMARAF, etc.

Scientific activity of the Institute's researches is amply depicted in multiple papers published in Soviet and international journals. Full account of it is given in more than 160 volumes of collected papers and 50 fundamental studies.

The *Marine Hydrophysical Journal* published in the Marine Hydrophysical Institute of the Ukrainian SSR Academy of Sciences as a leading institution and re-published by Dutch VSP Company under the title of *Soviet Journal of Physical Oceanography* attained a world-wide recognition.

—— reprinted from their brochure

1.2 Visit of R.V. *Akademik Vernadsky*

The visit of the scientists and crew of the research vessel *Akademik Vernadsky* to Woods Hole and subsequent participation of staff and students on the Woods Hole – Canary Islands cruise leg opened opportunities to learn about Soviet oceanography — their equipment and operational methods, their scientific and social life aboard ship for extended (4-month) periods away from their home port, Sevastopol. The purpose of this report is to describe those facilities and activities on board as an aid for future contacts and preparation for future joint projects.

1.3 Preparation for Visit

Word of the proposed visit of the *Akademik Vernadsky* to USA came in January, 1989 via a Telemail notice from Dr. M. Briscoe (Office of Naval Research, Washington). The notice included an invitation for American oceanographers to join the cruise from Boston to the Canary Islands. In February, Dr. C. Hollister contacted me with a suggestion that we send one or two students (and me) on the cruise in response to their invitation. After a short deliberation, I agreed to go and circulated an invitation to the students in our department to contact me if interested. Dr. Dorman, director, then issued an invitation for the R.V. *Akademik Vernadsky* to visit WHOI during their stay in USA. Considerable time passed before we were able to obtain confirmation of the visit and the location and duration of their scientific work on the subsequent leg. The duration (1 month) proved to be a deterrent for potential participants. One by one, the interested students informed me that their summer commitments and plans would not allow them to by away for as long as a month. For a while I thought I would be going alone. But in the last days before the visit we were able to get two summer students, Richard Navitsky and James Kettle, to go, thanks to the initiative of Dr. Dorman and Jane Smith of the education office. Ellen Levy, a former research assistant, called me to express a wish to go. After getting our full complement, I had several additional inquiries from students in other departments that had to be turned down. Clearly, considerable interest exists in working with Soviet oceanographers even though participation on such short notice is not readily arranged.

Because of the uncertainties of the cruise schedule and lack of knowledge about the shipboard facilities, we did not plan to bring aboard any equipment of our own to carry out an independent program of measurements. Instead, our plan was to work with them on their programs since they had stated that we would be given copies of their data. We did bring a portable computer and printer to give us access to their measurements while at sea.

1.4 Boston Visit

The R.V. *Akademik Vernadsky* arrived in Boston on June 13, 1989. Paul Dudley Hart and I visited the ship on the morning of their arrival to confirm the schedule for their visit to WHOI. In addition to discussing arrangements for their visit, they raised the question of future collaboration. Chief Scientist, Vitaly Ivanov, gave us a list of projects (see Section 7) that they wanted us to consider. They also invited several US oceanographers to serve on the editorial review board of the *Soviet Journal of Physical Oceanography* published in English in the Netherlands. We replied that we would communicate the invitations to our colleagues but that it would take time to prepare a response. We finished our discussions over lunch served in the Chief Scientist's stateroom. I was particularly interested in seeing their laboratories so that I would have a better idea of the items that we needed to bring with us on the next leg of their cruise. Chief Engineer V. N. Novoselets showed us through the laboratories after lunch. I was surprised to learn that several of the labs were equipped with IBM personal computers. This would greatly simplify access and exchange of data. The labs are described in more detail later.

1.5 WHOI Visit

Arrival at Woods Hole on Friday morning, June 16, was delayed about one hour because of heavy fog in the harbor. Fortunately, the fog cleared enough for the ship to dock before the high-tide window closed. A meeting was held at Clark Building to discuss future joint programs. V. Ivanov outlined a "strawman" program for our consideration. A copy in reproduced in Section 7. Visits to Falmouth as well as WHOI labs were arranged for the scientist and crew. The ship departed Saturday, June 17, for the Gulf Stream part of their program of observations.

2 Chronology of R.V. *Akademik Vernadsky* Visit and Cruise 39, Stage IV

1989

Jan 10: Notice of visit on OMNET bulletin board by M. Briscoe.

Jan 17: Memo from T. Murray noting Dorman's interest in inviting ship to WHOI.

Feb 10: Letter from Dorman inviting visit and suggesting participation by Fofonoff and student.

Apr 1: R.V. *Akademik Vernadsky* departed from Sevastopol.

Apr 3: Arrived at Istanbul, Turkey.

Apr 18: Arrived at Conakry, Guinea.

Apr 28: Memo from Coburn noting that no request received yet from USSR for visit.

May 2: Telex to R.V. *Akademik Vernadsky* inviting visit to WHOI.

May 16: Arrived at Belem, Brazil.

May 16: Memo from Broadus concerning confusion about dates of visit.

May 19: Telex from MHI director Eremeev acknowledging invitation and forwarding invitation to ship.

May 31: Telex from Dorman with information about visit.

Jun 6: Telex from Capt. Malinovsky confirming visit and inviting Fofonoff, Kaharl and two students for WHOI–Canaries leg.

Jun 13: Ship arrived Boston. P. Hart and N. Fofonoff visited to make arrangements for WHOI visit.

Jun 16: Arrived WHOI in heavy fog.

Jun 17: Departed WHOI with Fofonoff, Levy, Kettle and Navitsky on board.

Jun 18: Started Gulf Stream program.

Jun 26: Rescue of Bermuda Race yacht *Belatrix*. Man aboard yacht fatally struck by boom during night.

Jun 28: Towed yacht towards New York. Picked up by Coast Guard.

Jun 29: Back on plan.

Jul 8: Plan completed. Departed for Canaries.

Jul 17: Arrived Santa Cruz de Tenerife.

Jul 19: Departed Santa Cruz.

Jul 20: Fofonoff and Levy returned to WHOI. Kettle and Navitsky stayed extra day in Tenerife.

Aug 3: R.V. *Akademik Vernadsky* returned to Sevastopol.

3 Acknowledgements

The authors wish to thank Chief Scientist Vitaly A. Ivanov, Captain Anatoli S. Malinovsky and the scientists and crew of R.V. *Akademik Vernadsky* for their generous support and warm hospitality during the month-long cruise from Woods Hole, Massachusetts to the Canary Islands.

Participation on the cruise was made possible by support from the Vetlesen fund for Nick Fofonoff and Ellen Levy. The summer student fellows, James Kettle and Richard Navitsky, were funded by the Education Office and the William B. Richardson Summer Fellowship provided by the Alden Products Company.

We wish to thank Dr. Craig Dorman, Director, for his active encouragement and generous support of our participation on the cruise.

4 Description of Ship

4.1 General Specifications

The R.V. *Akademik Vernadsky* (Figure 1) was built as a passenger liner in East Germany in 1968 and converted on the slip for research purposes. Since then, it has made 39 cruises to all oceans of the world. It is now currently based in Sevastopol, USSR.

The specifications are presented in the first table below.

Table 1: Specifications for R.V. *Akademik Vernadsky*

Port of registration	Sevastopol 86	
Call signal	ULYN	
Ship owner	Marine Hydrophysical Institute, Sevastopol	
Built	1968.GDA.Wismar	
Type	Scientific-research vessel	
Registered tonnage:	Gross	5560.63 t.
Registered tonnage:	Net	1401.20 t.
Deadweight		2020 t.
Length overall		124.20 m.
Width overall		17.06 m.
Draft		6.00 m.
Total number of personnel (Cruise 39)		161
Rated power	main engine	2 × 4000 e.h.p.
Capacity bow	underwater rudder	2 × 140 e.h.p.
Capacity active	rudder	300 e.h.p.
Minimum turning radius	4 cables (0.4 miles) in	6 m 50 s

Further details about the engine room, radio room and hospital are given below. It should be reiterated that the ship was designed as a passenger liner with the comfort of its occupants in mind. Thus, for example, with rough weather stabilizers, the vessel has not been observed to roll more than 12 degrees. As well, the decks are high above the influence of ocean waves as given below.

4.2 Decks and Winches

Deck heights and winch specifications are summarized in Tables 2 and 3. The locations are shown in Figure 2.

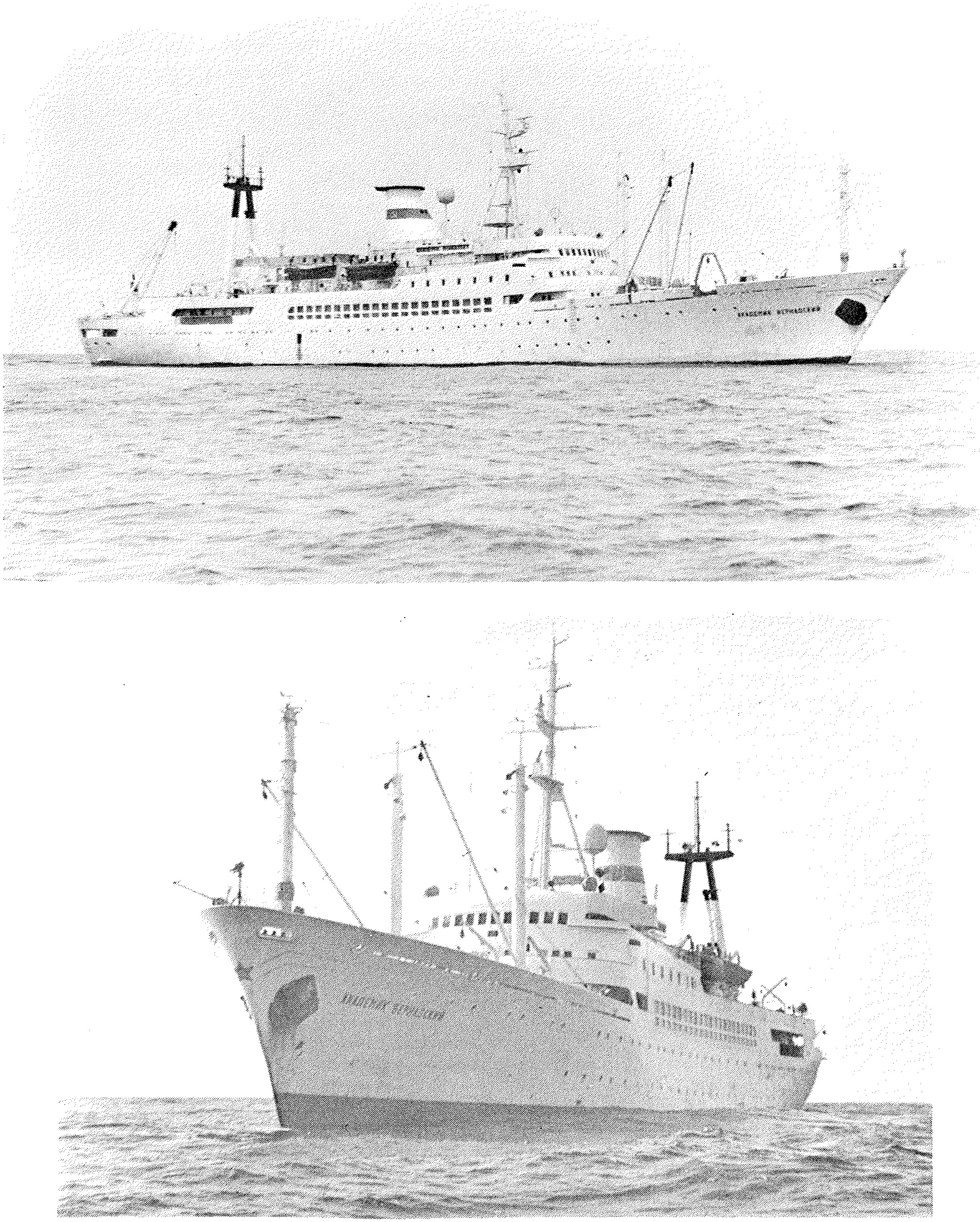

Figure 1: R.V. ***Akademik Vernadsky***, Marine Hydrophysical Institute, Sevastopol, U.S.S.R. (see Table 1 for specifications).

Table 2: Deck Height Above Water Line

	Height	Room Numbers
Main Deck	3.5 m	300, 400
Upper deck (second deck)	6.5 m	200
Boat deck	10 m	100
Bridge/Navigation deck	13 m	10
Upper bridge deck	16 m	

The ship is equipped with a variety of lifting apparatus. There are nine winches, for example, in six different locations:

Table 3: Winch Specifications

Name	Location on deck	Wire length (m)	Wire thickness (mm)	Coiling speed (m/s)	Max. wgt (kg)	Motor power (kw)	Free fall ability
LEROK-1-2	3, 4, 7	12,500	3.0–5.1	1.75 (1200 kg) 4.5 (225 kg)	1,200	35	no
LGG-1	2, 5	8,000 6,000	4.4 6.3	2 (max)	1,200		yes
V406	1	3,000	12	1.5	5,000		no
V407	6	2,500	12	1.5	3,000		no
LK-2	8	2,500	15	1.2	2,000	35	yes
Geological winch	below bow	15,000	6.5–14	1.5 (max) (5 speeds)	10,000		yes

With respect to the wire coiled on the winches, several different kinds are used on the ship with different tension capabilities. For example, the cable on which the CTD is lowered is about 1 cm in diameter, has three internal conductors and a breaking strength of 6000 kg. The 0.6 cm diameter cable does not have an internal conductor and can support 3000 kg. The length of cable varies with the drum capacity of the winch.

4.3 Ship Cranes

There are three cranes distributed about the ship. Two are at the front of the upper deck, and can lift 3 tons individually but only 1.5 tons on a combined load. The single crane at the stern has a variable capacity depending on extension of the boom. The capacity is 3.2 tons at the full extension of 14 m and 5 tons at 4.5 m extension.

The exact mass that can be placed on the decks was not determined but the load capacity is 1.3 tons per square meter for the upper deck and 1.0 ton per square meter for the boat deck. On this cruise, both decks were supporting the weight of compact cars purchased in Boston. All decks are made of steel, but wooden planking covers the volleyball court at the back of the boat deck and most of the upper deck except for the bow. This prevents equipment from being clamped on to the deck on an *ad hoc* basis.

4.4 Shipboard Scientific Equipment and Laboratories

With respect to measuring apparatus, the vessel comes equipped with a permanent set of scientific equipment, with scientific and engineering staff to maintain it. This equipment includes:

1) ISTOK (MHI 4102) conductivity, temperature, pressure (CTD) profiler

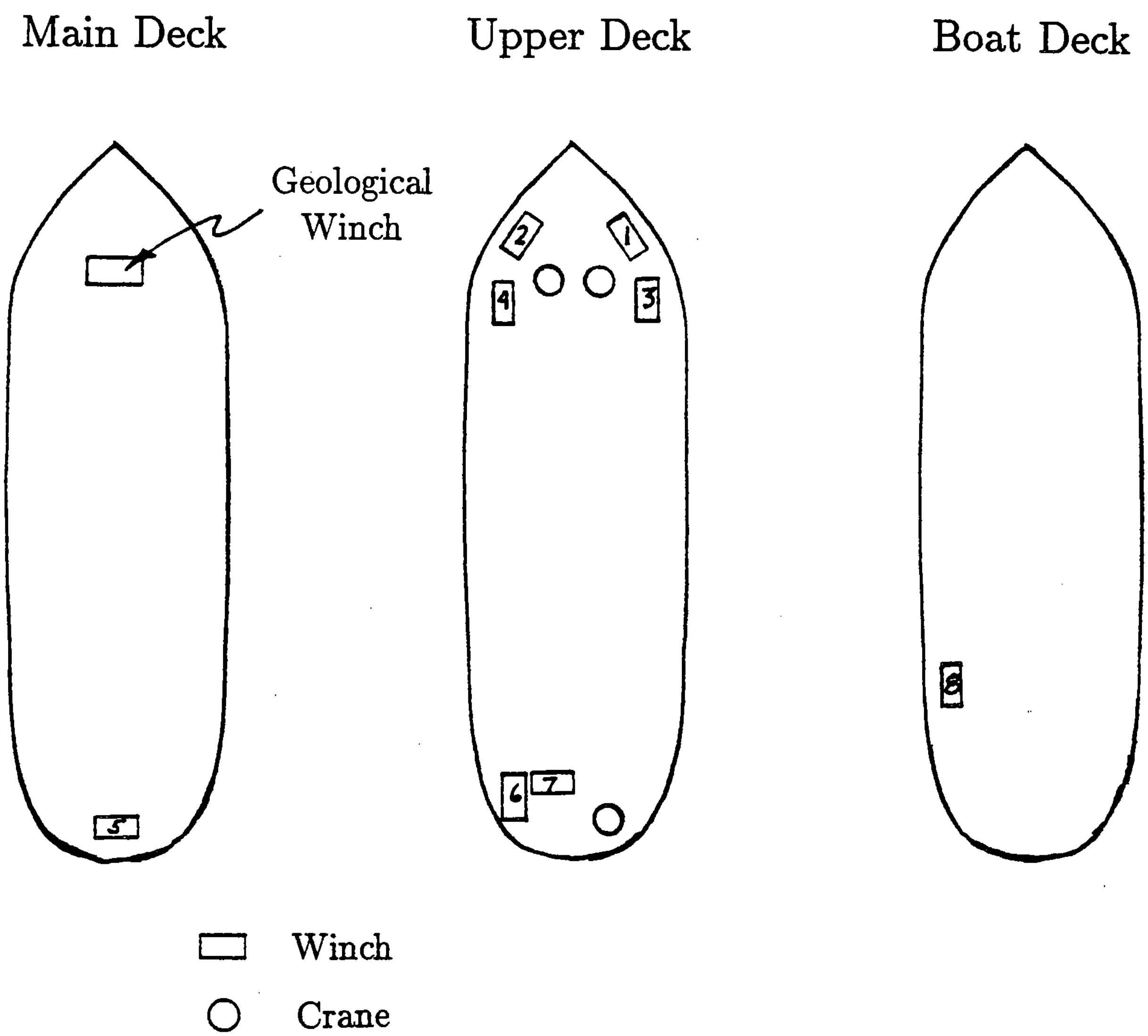

Figure 2: Winch locations.

2) Minisonde (MHI 4207), small, streamlined, towed CTD profiler

3) Current meter (MHI 1301)

4) Meteorological instruments

5) Computing center with 3 computer systems

6) Satellite receiving station (URAN)

7) Navigation and sonar equipment in Room 6

8) Electronica-60 computers

The ship carries 4 lifeboats (2 boats 7.5 m × 2.4 m × 1.1 m with 37 (75 kg) person capacity; 2 boats 8 m × 2.8 m × 1.15 m with 51 (75 kg) person capacity; powered 6 kts capability) These boats can be used for scientific investigations if necessary. One 6 m lifeboat of older (open) design is used only for scientific investigation.

There were 15 laboratory groups on the ship. Some conducted only theoretical work and shared lab space in an office-type environment. Other groups took their own data acquisition equipment with them and their labs were filled with signal receiving, processing and storage equipment. Typical labs varied in size from 25 m^2 to about 70 m^2, with most of them in the range of 40 m^2. All of the labs had finished counter tops without holes or tie downs for securing equipment. All counters had raised rims to prevent equipment from sliding off. There is a standing order that all equipment must be tied down, that is satisfied on an *ad hoc* basis.

There are 18 laboratory rooms on the ship, some of them with permanently installed devices as follows:

Table 4: Laboratory Facilities

	Room #	Sink	Permanent facility
1	16	no	Satellite image lab
2	17	no	
3	130	yes	Meteorological lab
4	140	no	
5	142	no	Satellite receiving station
6	203	yes	
7	205	yes	Current lab
8	208	yes	
9	209	yes	
10	210	yes	
11	254	no	Acoustics lab
12	265 (a&b)	yes	
13	266	yes	CTD equipment
14	269	yes	
15	411	yes	
16	413 (2 rooms)	yes	
17	414 (2 rooms)	yes	
18	549	no	Computer center

4.5 Engine Room

The main powerplants in the ship are two diesel engines, whose specifications may be summarized as follows:

Table 5: Engine Specifications

number of cylinders per engine	6
total area of cylinder heads	1285 decimeter^2
mass of engine	130 tons
power rating of engine	4000 hp
rpm necessary to maintain maximum speed	200
diesel fuel capacity	1400 tons
diesel consumption at 15.5 knots	25 tons/day
rate of cooling water circulation	200 l/hr

In addition to the two driving screws, there are two maneuvering screws positioned perpendicular to the ship's axis, powered by two electrical motors of 140 kW each. A fifth screw is positioned on the rudder, driven by a 220 kW motor. Power for this and all electrical equipment on the ship is provided by five 350 kW generators (VEB, Schaermachinenban "Karl Liebknecht" Magdeberg). On our visit to the control room, only three of these generators were being utilized. Other control surfaces on the hull include four retractable "wings", a pair at front and back whose purpose is to steady the ship in heavy seas (i.e. effective only at "7 balls"; sea state 7).

Other miscellaneous equipment that we were shown in the engine room included:

1. Sewage treatment system:

   Neptunatic

Type	MSD
Model	Petro
Delivered	June 1983

2. Hot water generator:

   Neshaupt Monarch

Pressure	30 kg cm^{-2}
Vapor production	10 kg vapor/hr

3. Water purifying (for washing, etc.): 100 tons of drinking water was brought from Sevastopol to be used for food and drinking.

Power outlets on the ship operate at 220 V $\pm$ 1.2 V. (The voltage fluctuation is less than $\pm 5\%$ when checked every month.) Cabin circuits can draw about 1 kW of power. Circuits to labs have greater capacity.

4.6 Radio Room

Located on the bridge deck starboard side is the radio room (Room 5). They have a variety of radio transmitters and receiving sets as well as satellite communication (specifications below). Via satellite one can be reached by phone or telex. The number is 1401407 ULYN X. It is possible to make calls to the USA for about $10.00 per minute. Payment is made to the radio operator.

Transmitters:

1. 1.5 mHz to 30 mHz, 1.5 kW
2. medium wave length, 400 watts
3. 1 kHz to 30 mHz, 400 watts

Receivers:

1. 1.5 mHz to 30 mHz

2. 12 kHz to 30 kHz
3. 1 kHz to 30 kHz

Satellite:

- linked with INMARSAT and OKEON

4.7 Hospital

The hospital is on the 3rd level in the starboard aft. The doctor, Irina V. Sidorova, on this cruise is a surgeon. She has performed some surgery (appendectomy) on board, as well as removal of teeth. There is an X-ray machine, cardiogram, autoclave, oxygen and everything necessary for surgery as well as general practice equipment (i.e. hearing test machine, scales, etc.) The equipment looked a little dated but in good working condition. There is also a poster which gives information on AIDS. From all this it appears that the doctor and hospital are well prepared for general practice and emergencies.

5 Description of Laboratories

5.1 List of Scientific Laboratories

1.	Hydrology	206
2.	Current Dynamics	205
3.	Internal Waves	414
4.	Hydrobiology	413
5.	Radar Research	210, 265
6.	Remote Sensing	17
7.	Profiling Equipment	269
8.	Mathematical Services	Computer Center
9.	Thermodynamics	206
10.	Upper Layer Dynamics	142
11.	Surface-Active Film Dynamics	208
12.	Dynamics of Boundary Layers	139
13.	Fine Structure	269
14.	Small-Scale Air–Sea Interactions	411
15.	Materials Laboratory	431

5.2 Chief Scientists

1.	Ivanov	Vitaly Alexandrovich	Chief Scientist
2.	Federovsky	Alexander Dimitrievich	Deputy Chief Scientist
3.	Kudriavtsev	Vladimir Nikolaevich	"
4.	Lisichenok	Alexander Dimitrievich	"
5.	Sustreteva	Natalya Stepanovna	Science Secretary

The scientific work was organized by the Chief Scientist with the assistance of the Deputy Chief Scientist. Vladimir Kudriavtsev had the responsibility for shipboard processing and remote sensing. Alexander Lisichenok organized the shipboard measurements. Alexander Federovsky was responsible for shipboard instrumentation. Work orders and schedules were prepared and distributed by the Science Secretary, Natalya Sustreteva.

5.3 Hydrology Laboratory (Room 206)

6.	Yastreb	Victor Pavlovich	Chief
7.	Polakova	Antonina Vladimirovna	Science Worker
8.	Kuftarkov	Andrei Yurevich	"
9.	Kosarev	Alexei Nilovich	"
10.	Pivnenko	Olga Petrovna	"

This lab is similar to the Thermodynamics lab in the respect that they represent a department (Physical Oceanography) at MHI. They did not carry out the experiments, except in the Brazilian polygon (Stage II of Cruise 39), but rather, helped in the decision-making and processing. They make sure that the proper data is stored for use back at MHI. They are also responsible for interpreting minisonde profiles and work very closely with the Fine Structure lab, Profiling lab and Meteorological lab. The major aim is the investigation of temperature–salinity structure in the tropical Atlantic and includes the following:

- Obtaining vertical profiles of temperature, salinity and density.
- Estimation of the heat capacity in the upper layer in the northwestern part of tropical Atlantic.
- Hydrological characterization of synoptic eddies and estimates of their energy.
- Study of oceanic fronts and their peculiarities.
- Study of hydrological condition's influence on internal wave formation and existence.
- Study of vertical stability of sea water properties and the estimation of available potential energy (A.P.E.).
- Measurements of main hydrological parameters are carried out by means of following probes: MHI 4207 probe — used on drift stations and while the ship is underway, and MHI 4102 probe — used only on drift stations.
- Information is recorded on compact cassettes and stored on the IBM AT hard disk.
- Information from the IBM AT is transferred to the ES-1033 mainframe, where primary processing is carried out.

This lab accumulated continuous surface temperature and salinity measurements with a CTD probe during the Brazilian polygon. They also collected a limited number of water samples for onboard salinity measurements.

More specifically, Dr. Victor Yastreb is interested in the heat transfer of the tropical Atlantic. His lab group has been generating wave spectra of the tropics and have determined the Rossby wave number for the divergent eddies and Kelvin wave number for convergent eddies. He estimates the Rossby length to be about 100 miles for the divergent eddies of the tropical Atlantic off the equatorial counter current.

5.4 Current Dynamics Laboratory (Room 205)

11.	Blatov	Alexei Sergeivich	Chief
12.	Chigrakov	Konstantin Ivanovich	Science Worker
13.	Savanov	Vladimir Leonidovich	"
14.	Lepekhina	Irena Nikolaevna	"
15.	Lamanova	Inna Alexeeva	"
16.	Zaikin	Veniamin Mikhailovich	"

Consisting of oceanographers from different institutions (Moscow State University Energetic Institute and MHI), this lab is responsible for maintaining, employing and interpolating data from the current meters. The current meters MHI 1301 and MHI 1304 (described below) are strung below surface and subsurface buoys. In the Brazilian polygon, this lab launched five underwater buoys and three surface buoys, trailing six and ten current meters, respectively, to maximum depths of 3000 m. They also lowered a line of current meters, while drifting in the Gulf Stream, but did not launch any buoy systems.

Major scientific tasks:

- Investigation of large scale circulation of waters in northwestern part of the tropical Atlantic and heat transport in the system of currents.
- Studies of synoptic and mesoscale variability of hydrophysical fields in the northwestern part of the tropical Atlantic.
- Investigation of wave–eddy fluctuations of hydrophysical fields in the northwestern part of the tropical Atlantic.

Methods of processing information:

Primary processing of information is carried out aboard by means of the ES 1033 mainframe computer.

Traditional and nontraditional methods of analysis are used to determine wave number frequency spectra and correlate experimental results with best fit functions of synoptic mesoscale variability.

Quasiperiodic oscillations of the ocean current velocity are investigated by the numerical narrowband filtering method. The evolution of graphic models of the general characteristics of these oscillations, patterned on ellipse relationships are analyzed. Such analyses include the space–time variance of the orientation of the oscillation in a horizontal plane, the variance of the extreme velocities in the cycle of the oscillation and the variance of the quasiperiodic vector of rotation.

Physical interpretations of space–time variability of internal waves on synoptic and mesoscale ranges are made using numerical models developed on the ES 1033 mainframe and extended period correlations developed on the IBM AT.

They do most of their theoretical work with other scientists at their home institutions, however, some research is carried out at sea. The most obvious work involved the statistical properties of the mesoscale velocity oscillations in the tropical currents on the order of a few minutes to about ten hours. They tested the theories of both C. Frankignoul (*Journal of Physical Oceanography*, 1974, 4(4), 625–634) and that of K. Chigrakov (*Marine Hydrophysical Research Journal*, 1989, No. 1), which parameterizes the variability with the velocities of currents. They claim their data fits the theory very well.

Equipment:

Complex MHI 1301 is a three-channel instrument with one channel each for current speed, direction and point temperature, or alternatively, one channel each for current speed, direction and pressure.

Table 6: Specifications for Complex MHI 1301 Current Meter

Range of speed	0.015 – 1.8 m/s	± 0.01–0.04 m/s
Direction	0 – 360°	± 6°
Temperature	0 – 35°C	± 0.15°C
Pressure	0 – 25 MPa	
Power	10 volts (8 NiCd cells)	
Maximum sampling depth	3000 m	
Operation time	180 hours with measurement intervals of 50 s.	
	900 hours with meaurement intervals of 5 min.	
	1800 hours with measurement intervals of 10 min.	

Specifications are given in Table 6; a sketch of the current meter is shown in Figure 3. The Internal

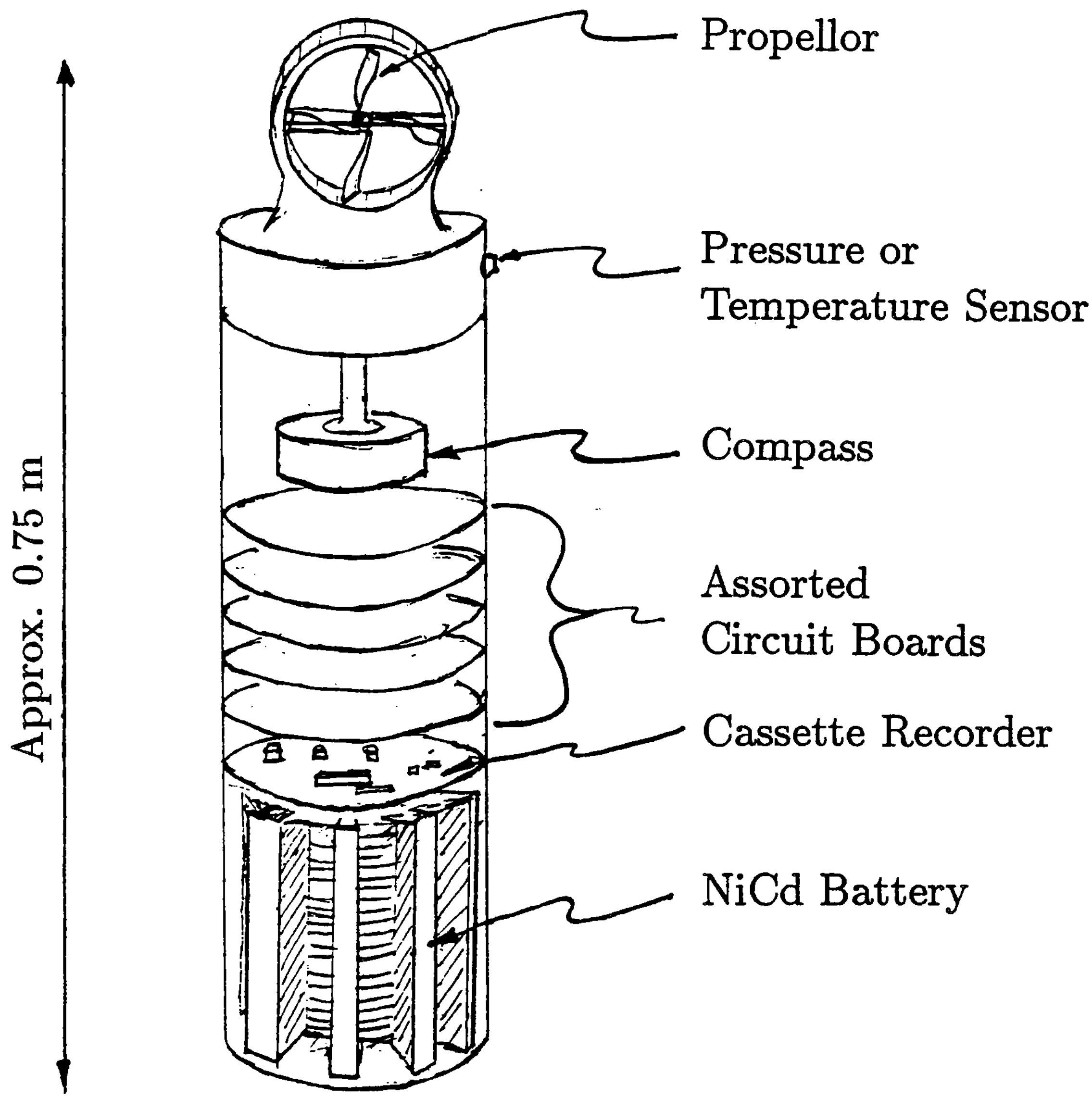

Figure 3: Complex MHI 1301: Current meter deployed from moored buoys.

Waves group uses both configurations, while the Current Dynamics group maintains only the latter.

Complex MHI 1304 is a three-channel instrument with two channels for point temperature and one for integral temperature.

5.5 Internal Waves Laboratory (Room 414)

17.	Gorachkin	Yuri Nikolaevich	Chief
18.	Vlasenko	Vasilia Ivanovich	Science Worker
19.	Belaev	Alexander Valerevich	"
20.	Arkhipkin	Victor Semeonovich	"
21.	Vorobaev	Vladimir Vladimirovich	"
22.	Fomin	Vladimir Vladimirovich	"

Scientists in this laboratory measure and investigate internal waves in the ocean. Their work during this expedition included:

- Investigation of the conditions for the existence and formation of internal waves.
- Investigation of space–time and energetic characteristics of internal waves.
- Investigation of processes of internal waves and their interaction with currents and waves of other scales.
- Comparison of internal wave parameters determined by numerical modeling with experimental data.

More specifically, during this cruise the lab has measured short period internal waves over the range of 1 s to 10 hours. They carry out this work with the Complex MHI 4206 (see specifications in Table 7, and Fig. 4). These devices are attached horizontally to a line and spaced at intervals of 25, 50 and 100 m. The maximum depth of operation is 500 m, but most measurements are taken within the thermocline. For a spatial investigation an array of three lines is usually used, however on our leg of the cruise they had only one line (one line was lost off the coast of Brazil and another had circuit problems). They can carry out measurements while the ship is moving at 6 knots, which permits extensive investigation in an active area. For example, in the Sargasso Sea, they found many large-amplitude internal waves near a seamount and they were able to close a polygon, as well as take a couple of sections.

Table 7: Specifications for Complex MHI 4206 Temperature Profiler

Depth of measurements	0 – 500 m
Speed of towing	5 – 7 kts
Discretion of measurements	5 – 60 s
Range of measurements of temperature	−2 – 35 °C
Temperature data error	± 0.02 °C
Pressure data error	± 0.023 MPa

The Complex MHI 4206 is able to measure temperature differences accurately (±0.02°C) which they use to measure internal waves. The signal is carried by wire to an amplifier (BLK) and then to an interpreter console (MP-8001) where the signal becomes a digital code. The code is then recorded on paper tape and the physical data recorded on a KSP-4 paper graph. The paper tape data is later processed on the main frame computer and stored on magnetic tape. The data takes approximately one week to process, if they do not have to share computer time; no work from the Sargasso had been finished. Some displays of internal wave spectra from the Brazilian polygon were available; these spectra were higher than the Garrett–Munk internal wave spectra.

A complete set consists of 3 to 4 lines, which are distributed in space and form a horizontal antenna (each line is one antenna).

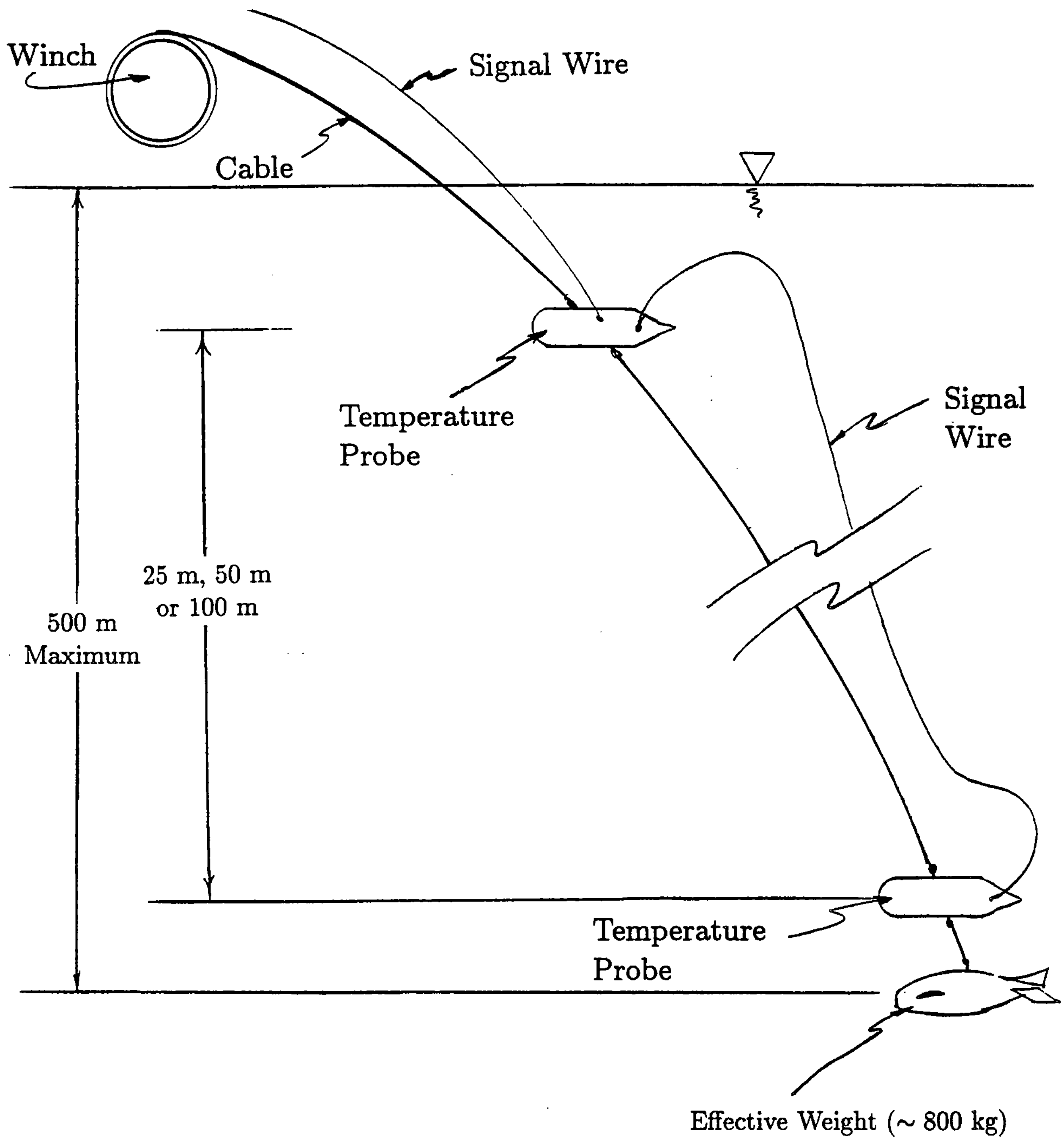

Figure 4: Complex MHI 4206: Device for internal wave measurements.

On the buoy stations an autonomic measurer MHI 1304 is used. It is analogous with the Complex MHI 4206. Please refer to Section 5.4 on the Current Dynamics Laboratory for a description of this instrument.

5.6 Hydrobiology Laboratory (Room 413)

23.	Georga-Kopylos	Ludmilla Alexandrovna	Chief
24.	Eremin	Oleg Yurevich	Science Worker
25.	Zheltanik	Alexander Vasilevich	"

The Institute of Biology of the Southern Seas of the Academy of Sciences of the Ukranian S.S.R. always participates in R.V. *Akademik Vernadsky* cruises as the laboratory of Hydrobiology. The lab has a fume exhaust hood, large sink and a variety of chemicals. Samples are collected in large buckets from the bow of the ship.

The main scientific task in the cruise is the study of dissolved organic substances extracted from sea water by means of chloroform. Infra-red spectroscopy is used as rapid-analysis of sea water to determine the presence of oil hydrocarbon. Samples were taken every two hours in the Gulf Stream and twice a day at all other positions. Extracts are taken from sea water with chloroform analyses by means of apparatus IRS-29 (firm LOMO). The results are recorded on graph paper (as % of absorption versus wavelength (400–4200 nm). Analysis of the data was begun during the cruise.

Presence of detergents in the surface film is determined by means of a chemical method based on the capacity of detergents to combine with the methylene-blue complex, when dissolved in chloroform. Determination of detergents in extracts of chloroform is carried out by a colorimeter, KFK-2. These results are tabulated in a log book for use back at the Institute.

Zooplankton samples are also collected in simple plankton nets for population and species studies.

5.7 Radar Research Laboratory (Room 210)

26.	Malinovsky	Vladimir Vasilivich	Chief
27.	Bolshakov	Alexander Nicholaevich	Science Worker
28.	Shein	Vyacheslav Mikhaelovich	"
29.	Penkov	Mikhael Nicholaevich	"
30.	Gorlovsky	Michael Vladimirovich	"
31.	Rosenberg	Anatoli Davidovich	"

This laboratory is part of the Remote Sensing Department at MHI. Their objectives this cruise were to:

- Study the fine time–spatial structure of radar signal with different geometries and polarizations of emissions under different hydro-meteorological conditions and internal waves.
- Investigate the radar signal connection with sea surface parameters and determine the radar wave modulation transfer function.
- Perfect radiophysical sea surface model using the collected data.

A stationary DECCA 110 radar system is utilized to obtain an analog signal from the sea surface. The size of this section is a rectangle about 10 m by 2.5 m. Together with the Small-Scale Air–Sea Interaction Lab's accelerometer, they obtain sea surface wave spectra as well as spectra from the radar signal. These spectra are both calculated using Fourier transforms. They have performed this experiment for different sea states and different radar signals.

Their prominent work is to collect data to test parameterizations of sea surface state with remote sensing (i.e. radar signals). One such parameterization is:

$$MTF^2 = \frac{S_p(\omega)}{{P_0}^2 S_H(\omega) K^2}$$

MTF (Modulation Transfer Function) is a constant characteristic of a given sea state. The other variables are radar spectra $S_p(\omega)$, surface wave spectra $S_H(\omega)$ and radar intensity P_0, and wave number $K(\omega)$.

Another parameterization of radar signal with internal waves is:

$$K = 8/7\beta^{-1}\mu^2\epsilon\log^{-2}\left(\frac{K_m\,\omega^2}{g}\right)\left[\frac{\log(1+c_i/c_g)}{\log(1+c_i/c_0)}\right] .$$

which was published in the *Marine Hydrophysical Journal*, No. 6, 1988.

The data from these experiments is amplified through an array of hand-fashioned circuit boards. The analog signal is processed on a Soviet mode microcomputer (Electronika) and stored on cassette. This data is later processed using the mainframe computer.

Equipment:

Radar	DECCA 110	X-band
	wavelength	3.2 cm
	frequency	9475 MHz

5.8 Part 1. Remote Sensing Laboratory (Room 17)

32.	Tsvetkov	Andrei Vasilevich	Chief
33.	Nikishov	Alexei Alexevich	Science Worker
34.	Sherbak	Oleg Georgevich	"
35.	Klyushnikov	Sergei Ivanovich	"
36.	Rodionova	Arisa Petrovna	"

The scientific interest of this laboratory centers around the study of the surface of the ocean, mostly by means of remote sensing techniques, but also by some direct measurements of ocean parameters. Within this area, the research group has conducted specific investigations in the following areas:

- Satellite image analysis
- Analyzing surface structure phenomena (e.g. intensity of wind, wave breaking or two-dimensional energy spectrum of surface waves) to elicit information about larger scale dynamic processes (e.g. internal waves and synoptic scale motions).
- Diurnal warming cycle in the upper 10 m of the ocean.

Satellite image research is pursued along several lines. First, satellite images are used as a means of determining sea surface temperature, terrestrial radiation budgets and characteristics of the propagation of electromagnetic radiation in the atmosphere. Other objectives include addressing the problems associated with eliciting information from satellite images and formulating a true picture of the sea surface, the filtering of clouds for example. Another problem is utilizing the edges of a satellite image (comprising 1/5 of the total picture) which have heretofore been discarded as unreadable, because of anomalous water reflections and atmospheric absorption effects.

On the ship, this laboratory fulfills a much more immediate role in being responsible for actual satellite image reception and the plotting of ocean fronts. This information is used to coordinate the vessel's activities on a daily basis. Images from KOSMOS, METEOR and NOAA satellites are received in signal room 140 and viewed in the Acquiring and Processing Data lab, where they are also stored on magnetic tape. On this voyage, transmissions from the NOAA-10 satellite in near-polar orbit were received twice a day between 2 and 4 o'clock (local time) morning and evening. Two images were received in each transmission corresponding to wavelengths 0.6 μm (visible) and 10 μm (infrared) in daytime and 3.7 μm and 10 μm (both infrared) at night. These images were corrected on the ship for geographical distortion and finally a map 25.6 deg by 25.6 deg was recorded on a grid 256 by 256 pixels for a total map resolution of 0.1 deg.

The remote sensing of the ocean surface phenomena is carried out using a television camera to record the incidence of ocean surface breakers and radar to obtain two-dimensional wave spectra. Set on an upper deck, the television camera records an image of the surface of the ocean which is digitized and sent to a small local computer. Here the proportion of the ocean covered by surface breakers is calulated by threshold method and the data is recorded on paper tape.

Diurnal warming experiments are carried out during drift stations throughout the cruise by the Upper Layer Dynamics Lab. A given experiment takes place over the course of a day, during which oceanographic and meteorological parameters are recorded from aboard the ship and from a lifeboat. Specifically, surface drifters are released and collected from the lifeboat at 40 minute intervals to record temperatures and relative current velocities at depths of 0, 0.35 m, 3 m and 10 m. At the same time, temperature profiles are logged from the ship using a freely falling 10-m temperature probe, a 10-m integral temperature line and the CTD. The aim of such experiments is to evaluate a model of diurnal warming, with an ultimate view to perhaps correlating observed surface phenomena with satellite images.

The equipment used by this lab may be described as follows:

1. TV system for registering and analyzing wind–wave breaking characteristics of the sea surface.

paper tape punch	
television camera	
name	B3OP
lens focal length	75 mm
filter	polarizing
computer analyzer	
name	Electronica 60 (15 BYMC-28)
calculation time	
fixed point addition	112 μs
floating point addition	218 μs
floating point multiplication	360 μs
baud rate to printer	180 char/s
RAM	64 kbytes
languages	BASIC, QUESIC, assembler (MACRO, MAC8U)

2. System of registering a two-dimensional radar sea-surface image for analysis of the evolution of long surface waves and surface manifestations of internal waves.

radar type	NAYADA-5
description	rotating shipboard radar
wavelength	3 cm
field of view	0.8 deg
frequency	3 kHz
pulse duration	70 ns
method of recording data	black and white film
radar type	DECCA 110
description	portable stationary mount for use when ship is moving
wavelength	3.2 cm
field of view	2 deg
frequency	3 kHz
pulse duration	80 ns
method of recording data from computer	D3-28, to cassette

3. Systems for satellite image reception, visualization and analogue processing.

types of satellites received	NOAA, METEOR and KOSMOS
computer analyzer	Electronica 60 (15 BYMC-28)
viewing monitor	BARC CRM 51
printer	Robotron 1156, ES 7183-11, SM 6301

4. Electromagnetic sensor of surface current (see section 5.9, Remote Sensing Lab)
5. Line distributed temperature sensor (see section 5.9, Remote Sensing Lab)
6. Surface drifters (see section 5.13, Upper Layer Dynamics Lab)
7. Wavegraphic system (see wave staff for Small-Scale Air–Sea Interaction Lab, section 5.17)
8. CTD sonde (see ISTOK, minisonde)

5.9 Part 2. Remote Sensing Laboratory (Room 265)

(Radar Lab Room #5 and Receiving and Processing of Images Lab Room #8)

This room is used by the Radar Research Lab and the Acquiring and Processing of Data Lab, both from the same department at MHI. Together, they are responsible for the GEK device for measuring surface currents. The signal from the GEK is recorded on paper tape and processed by the mainframe computer at a later time.

Temperature profiling of the upper 10 m of the ocean is coordinated from this room on drift stations. Two instruments are used: a falling temperature probe and an integral temperature probe. The falling temperature probe used for the upper 10 m, Figure 5, consists of copper wire spun around a hex skeleton about 100 times. There are two sensors on the probe.

Since the temperature probe is only accurate to ±0.1 degrees C, it is only used to profile large temperature gradients in the upper 10 m of the ocean.

The integral temperature instrument consists of a 10 m length of copper wire (0.1 mm, personal estimation). They can indirectly measure the whole change in temperature within the 10 m surface by measuring the resistivity. They use the integral temperature data to sense internal waves and their energy.

Both of these results, as well as continuous wind speed (from Meteorological Lab anemograph) are recorded on a paper chart with the chart recorder as a digital signal. These measurements of wind speed and integral temperature are recorded in real time at 50-s intervals on paper tape. The falling temperature probe, with falling time of 30 s, cannot be recorded directly on paper tape in real time and the information must be subsequently manually entered on paper tape from a paper chart. One of the uses of this data is for the diurnal temperature profiling program developed by Andrei Tsvetkov.

5.10 Profiling Equipment Laboratory (Rooms 266, 269)

37.	Grekov	Nicholai Aleksandrovich	Chief
38.	Perov	Alexei Alexandrovich	Science Worker
39.	Tomakhin	Nicholai Georgevich	"
40.	Khazanov	Dimitiri Markovich	"
41.	Ivanenko	Mikhail Ivanovich	"
42.	Kim	Victoria Mikhailovna	"

Members of this laboratory are divided into two rooms. They work closely with the Fine Structure Lab and with those labs who use the Minisonde (MHI 4207). They are primarily an applied engineering lab developing unproved instrumentation and methods of ocean profiling. They are responsible for the calibration of many of the profiling instruments, such as MHI 4102, MHI 4204, MHI 4205, MHI 4207 and assist the labs using the minisonde and other profilers.

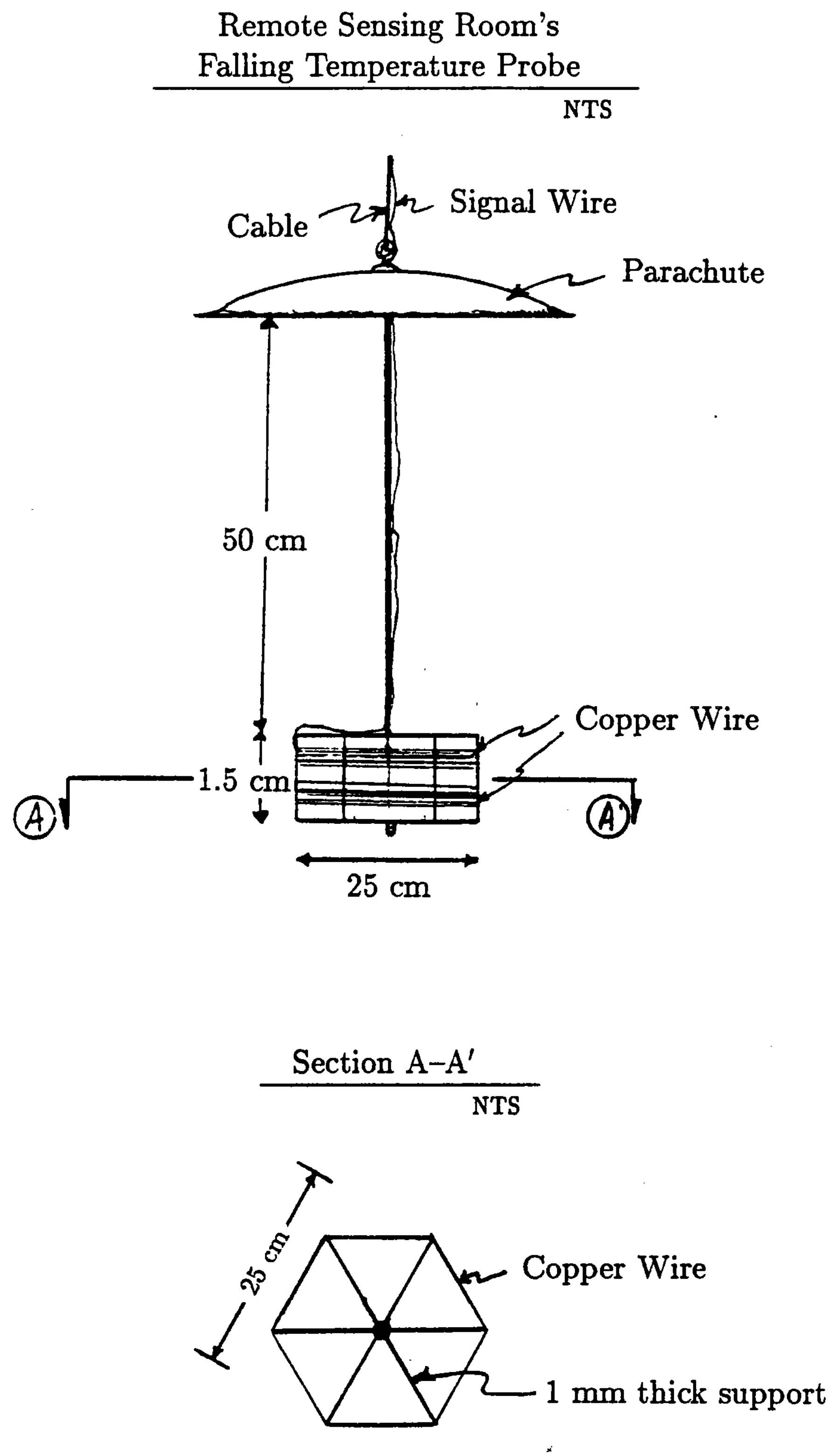

Figure 5: Temperature probe for surface layer measurements.

On this cruise they have tested a new profiling device, Kalmar (see below). It differs from the minisonde only in its 18-bottle rosette. According to Dr. Grekov, it has performed as expected and will be ready for use on future cruises. This group also studies the processes of measurement and the optimization of shipboard procedures.

The minisonde MHI 4207 is operated from room 266 by various lab personnel and ship's crew. The signals are inductive and are amplified. This amplified signal is then processed in real time with an IBM AT. The temperature, salinity and density profiles are viewed on the monitor. The data is stored on the hard disk and transferred to a floppy disk at a later time.

The calibration for each of the intruments is explained below as well as the specifications of standards.

Salinity

Shipboard calibration of seawater is performed by means of the machine Electrosolemer-65 using standard seawater from Moscow. The machine is a conductivity meter and works on the principal of an AC bridge (unknown frequency). It operates with a battery as an alternative power supply. The relevant specifications for the instrument may be summarized as follows:

Table 8: Specifications for Electrosolemer-65

conductivity meter dimensions	550 × 375 × 220 mm
battery dimensions	400 × 240 × 230 mm
power requirement	110 W (AC), 12 W (DC)
power supply requirements:	
AC source voltage	220 V (+10 percent, −15 percent)
(actual ship supply, checked each month)	220 V ±5 percent
frequency	50 ±1 Hz
DC cell source	12 V (+3 V, −1 V)
mass of salinity meter	16 kg
mass of battery	15 kg
conductivity ratio (salinity) measurement range	0.16900 to 1.17600 (4.993 ppt to 42.032 ppt)
summation of errors associated with instrument	±0.011 ppt
error associated with instrument	(80% confidence)

Conductivity (Salinity) Range	Temperature Range (°C) 20(±5)	10–15 or 25–30
0.16900–0.79300 (4.993–27.013)	±0.00075 (±0.03 ppt)	(±0.044 ppt)
0.79300–1.17600 (27.013–42.032)	±0.00050 (±0.02 ppt)	±0.00075 (±0.03 ppt)

Approximate amount of sample required for measurement: 50 to 60 g.

Pressure

They have three different pressure sensors (listed below in Table 9). The pressure is equated from the frequency of a current passed through a steel coil. They calibrate the pressure sensor of their intruments by subjecting them to the same pneumatic pressure at intervals of 0, 5, 25, 50, 75, 95 and 100% of standard maximum.

Table 9: Specifications for the Pneumatic Compressor manually operated—MTU 60

Standard Pressure Sensors	Range	Variablility	Devices calibrated
-50 A	0–5 MPa	±0.15%	MHI 1301
-200 A	0–20 MPa	±0.15%	MHI 4207
-500 A	0–50 MPa	±0.15%	MHI 4102

Temperature

The temperature sensors are tested at 0, 8, 16, 24 and 32 degrees Celsius against a quartz standard, which has been calibrated against a platinum standard at MHI. The temperature is a function of a frequency, displayed on a digital display (No. 43–57). An average is taken and compared with a standard:

Quartz Standard

Range -2 - 35°C ±0.001°C

Instruments

ISTOK (MHI 4102)

This CTD device is designed to measure temperature, conductivity and hydrostatic pressure. Water samples are taken only from drift stations. There are two modifications of the ISTOK design on the ship (I and II), each having been used twice on the cruise. See Table 10.

Table 10: Technical Characteristics of the ISTOK (MHI 4102)

Data Channel	Range	Sensitivity	Accuracy	Time Constant
Temperature	-2 – 35°C	0.0025°C	±0.025°C	0.05 s
Conductivity(I)	1.5–5.5 sm/m	0.00025 sm/m	$\pm(0.002 + 3 \times 10^{-4}\mathrm{K})$	—
(K) (II)	2.5–6.5 sm/m			
Hydrostatic (I)	0–20 MPa	$(0.025\%) \times (P_{max})$	$(0.5\%) \times (P_{max})$	—
(II)	0–60 MPa	$(0.02\%) \times (P_{max})$	$(0.5\%) \times (P_{max})$	
	Number of sample bottles (I only)		16	
	Volume of sample bottles (I only)		1 litre	
	Dimensions of instrument		600 × 820 mm	
	Weight of lowered instrument		100 kg	
	Maximum lowering rate		2 m/s	
	Sampling frequency		4 Hz	
	Maximum lowering depth		(I) 2000 m	
			(II) 6000 m	

MHI 4204 — Earlier version of the Minisonde

This CTD device is designed to measure temperature, conductivity ratio and hydrostatic pressure. It can be used on drift stations and when the ship is underway (up to 15 knots). There are two modifications of this device: I, TY-MD-T-60 and II, PDR-015. The first device was used for 60 stations on this cruise. Table 11 gives technical characteristics.

Table 11: Technical Characteristics of the Minisonde (MHI 4204)

Data Channel	Range	Sensitivity	Accuracy	Time Constant
Temperature	-2 – 35°C	0.01°C	±0.05°C	0.05 s
Conductivity (I)	0.15–0.95	0.00025	$\pm 1.25 \times 10^{-3}$	—
ratio (II)	0.7–1.6			
Hydrostatic (I)	0–4 MPa	0.01 MPa	±2.5%	—
pressure (II)	0–10 MPa	0.003 MPa	±0.25%	
Dimensions of instrument		162 × 1002 mm (with added weight)		
Weight of lowered instrument		40 kg		
with added ballast		80 kg		
Maximum lowering rate		(I) 5 m/s		
		(II) 3.3 m/s		
Sampling period		1.5 ±0.1 s		
Maximum lowering depth		(I) 400 m		
		(II) 1000 m		

Minisonde — Miniprofiler (MHI 4207)

This complex (see Table 12) is designed to measure temperature, conductivity ratio and hydrostatic pressure of marine waters for detailed underway surveys at speeds of 15 knots or profiling from drift stations.

Maximum depth to 1000 m.

Table 12: Technical Characteristics of the Minisonde — Miniprofiler (MHI 4207)

Signal/Channel	Range	Sensitivity	Accuracy	Time Constant
Temperature	-2 – 35°C	0.003°C	±0.05°C	0.05 s
Conductivity	(I) 0.15–0.95	8×10^{-5}	$\pm 9 \times 10^{-4}$	—
ratio	(II) 0.7–1.65			
Hydrostatic	0–10 MPa	3×10^{-3} MPa	±0.025	—
pressure				
conductivity = conductivity ratio × 4.2902				
	Sampling frequency		10 Hz	
	Weight of lowered instrument		35 kg	
	with added weights		100 kg	
	Maximum lowering speed		4 m/s	

Kalmar (no official MHI designation because it is still under development)

Complex hydrophysical underway-profiler with Bathymeter Kalmar

The complex (see Table 13) is designed to measure temperature, conductivity ratio, hydrostatic pressure and water samples and for extended underway tows at speeds to 15 knots and sounding from on board drifting ship or underway at speeds to 15 knots. Maximum depth of lowering, 3000 m.

Table 13: Technical Characteristics of Kalmar

Data/Channel	Range	Sensitivity	Accuracy	Time Constant
Temperature	$-2 - 32°C$	$0.003°C$	$0.025°C$	0.05 s
Conductivity ratio	0.15–1.65	8×10^{-5}	$\pm 9 \times 10^{-4}$	—
Hydrostatic pressure	0–30 MPa	1.10–2 MPa	±0.025	
conductivity = conductivity ratio ×4.2902				
Number of sample bottles	18			
Volume of sample bottles	0.3 l			
Weight of lowered instrument	40 kg (200 with added weights)			
Maximum lowering rate	4.6 m/s at ship speed of 15 knots			
Sampling frequency	10 Hz			

5.11 Mathematical Services Laboratory (Room 549)

43.	Chmytov	Michail Vladimirovich	Chief
44.	Izyumin	Igor Nikolaevich	Science Worker
45.	Salnikova	Natalia Vladimirovna	"
46.	Kisenkova	Nadezhda Alexandrovna	"
47.	Babai	Vladlen Ivanovich	"

The Mathematical Services Laboratory maintains and services the computer systems that are used for data acquisition and processing on the ship. Three main computer systems are used: the ES 1033 mainframe, the SM era mainframe and four IBM AT computers that operate in local set network, which allows them to share resources. All systems are linked to allow data exchange as shown in Figure 6.

Some software for these machines, ranging from the fundamental operating programs (operating system, utilities, editors, translators, etc.) to applications software for oceanography has been developed at MHI.

ES 1033 Mainframe

The ES 1033, similar to our IBM 360, is used by the various labs on the ship for model calculations, data processing and data storage on magnetic tape for subsequent processing. The relevant specifications are as follows:

CPU –

component devices	ES 1033, ES 2433, ES 3208
storage	512 kbytes
processing speed	300,000 operations per second
high level languages	ALGOL, FORTRAN-IV, PL/I

Hard Disk Storage –

hard disk drives	four ES 5061
western equivalent	IBM 2313
storage of one disk	29 Mbytes

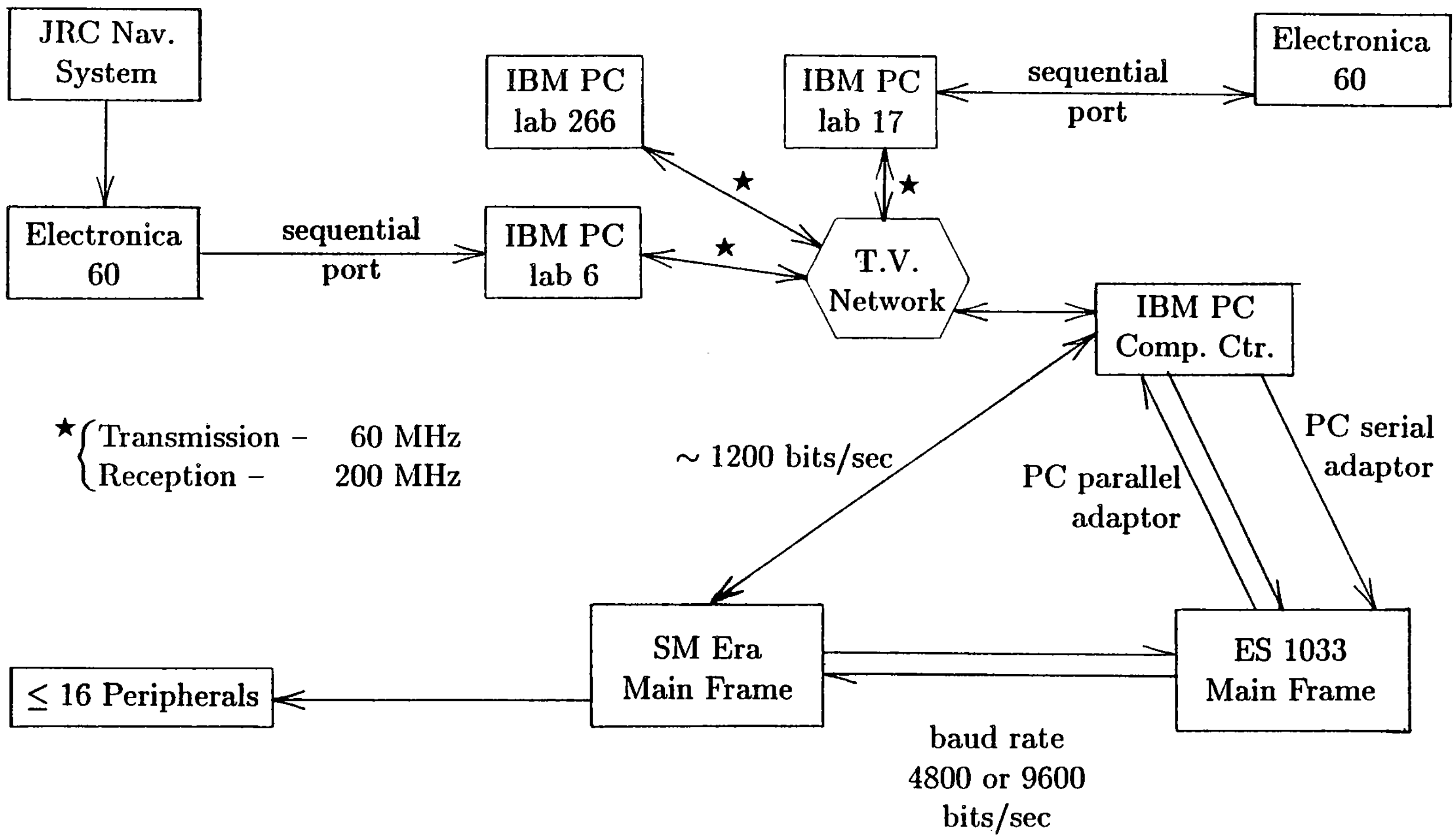

Figure 6: Block diagram of shipboard computer network.

Magnetic Tape Storage –	
magnetic tape drives	three ES 5017 02 one ES 5017 03
controller	ES 5517 3BM
maufacturer	Carl Zeiss/Jena
number of tracks	9
magnetic tape density	800 bpi (low density only)
total tape storage	14 or 28 Mbytes
Input Devices –	
"perfocard" punch	2 MINPRIBOR, NA80-2-3M
"perfocard" reader	
cassette tape	
paper tape reader	FS 1501 (for data input only)
terminal	ES 7168
Output Devices –	
printer	ES 7032, 128 character printer
plotter	ES 705 ZM
paper tape punch	PL-150M

SM Mainframe

The SM mainframe is a Russian designed, Polish built computer, which is used on the ship to fulfill rapid analysis and calculations and to exchange information with the ES 1033 and IBM AT machines. Its relevent specifications may be summarized as follows:

Main Computer Unit –	
computer name	SM era
western equivalent	PDP 11
magnetic tape drives	two SM 5300.01
memory storage	4 Mbytes
diskette drives	2 exist, but are not used because controller is only one sided
Magnetic Tape Recorder –	"IZOT" SM 5300.01
speed of data exchange	10 kbytes/s
density and method of writing	32 bit/mm (800 bpi) BH-1 (NRZ -1)
number of tracks and format	9 track, in accordance with ISO 1863-1976 and point 5
head two-gaps with separation between gaps	 3.81 ±0.1 mm
maximum reel diameter	216 mm (8.5 in.)
type of magnetic tape	ISO 1864-1975
working speed of tape	31.75 cm/s ±5%
start–stop time	30 ±2 m/s or 25 ±3 m/s
rewind time	<300 s
power single phase with voltage	220 V +10%, –15% 50/60 ±1 Hz
power consumption	<150 volt-amp
dimensions	310.3 x 482.6 x 325 mm
weight	<30 kg
interface TTL logic	Logical "1" is low level

Magnetic Tape Recorder (continued)	
error note	<1 in 10 to the 8 bits
mean time to failure	750 hrs.
mean time for setup(?) to recover(?)	1 hr

Hard Disk Storage –	
hard disk drive	MERA 9450/SM 5401
number of hard disks	four can be utilized simultaneously
capacity	24 Mbytes

Input/Output Devices –

Terminals	seven MERA Elzab SM 7209 terminals located in various labs currently on line to computer 1 output line to printer 1 output line to SM 1033 and PC AT computers Total capacity for 16 computers
Printers	1 SM 6300 158 character line printer used by both SM and PC machines three ES 7189/SM6325 attached only to individual SM terminals
Interface	KAMAK international interface

IBM AT Computers

The IBM AT personal computer (PC) set is situated in rooms 17 and 6, the CTD profiling room and the computer center. Their main functions are to receive information directly from measuring apparatus, to perform a preliminary processing of this data and to provide a means of viewing the preliminary results. This data may then be transferred to the ES 1033 or SM machines for further calculations, after which the PC can again provide a convenient means of visual display. Versatile machines, the PCs are used by many labs for small programming and modelling tasks. Their specifications may be summarized as follows:

computers	four IBM AT
hard disk	30 M
RAM	640K
printers	4 Proprinter XL

5.12 Thermodynamics Laboratory (Room 206)

48.	Chepurin	Gennadi Alekseevich	Chief
49.	Smirnova	Tatyana Yureva	Science Worker
50.	Shevchenko	Ella Alexandrovna	"
51.	Bulgakov	Sergei Nikolaevich	"

This lab group represents the Department of Theory and Dynamics of the Ocean at MHI. They do not actively take part in the experimentation, but see that the proper data is obtained for their department. They also help other labs, including Hydrology, Profiling, Currents and meteorology, determine the execution of experiments. Most of their effort is spent compiling this data onto disk and magnetic tape, though their leader Gennadi Chepurin also tests his computer model with the new data.

The department at MHI is interested in general circulation modelling. More specifically, the physical mechanisms of seasonal variations in the tropics. They have accumulated a large amount of data from this region.

During this cruise, they collaborated and overlapped their study off the coast of Brazil with the research vessel *Dimitri Ushakov* from the State Ocean Agency (similar to NOAA?) from Odessa. The period of study for the *Akademik Vernadsky* was from April 24 to May 14 and from May 7 to June 2 for the *Dimitri Ushakov.*

The model, used by Genna Chepurin on the ship's computer, is a quasi-geostrophic assimilative of the tropical Atlantic. He filters out local variations by taking data over a large area and uses this modified data for his model. His specialty is the seasonal variation in the tropical Atlantic and he gave a seminar during this cruise, which has been recorded on a video cassette.

5.13 Upper Layer Dynamics Laboratory (Rooms 16, 17)

52.	Dulov	Vladimir Alexandrovich	Chief
53.	Shulgin	Oleg Victorovich	Science Worker
54.	Grodsky	Semen Anatolevich	"
55.	Burdyugov	Vacheslav Mikhaelovich	"

The members of this laboratory are from the Department of Remote Sensing at MHI and work closely with the Radar Sensing Lab and the Receiving and Processing of Images Lab on board. Some of their interests during this expedition include transformation of wind wave parameters in non-uniform currents, daytime variation of sea surface parameters and life time of internal waves, as well as research of stability and diurnal heating.

Their experiments during this cruise consisted of a number of crosses through the Gulf Stream jet with registration of current (ECM), wave breaking intensity (TV camera), wind wave spatial spectra (bridge radar), "drifter experiments" and internal wave measurement. On calm days ($u < 5$ m/s) when the ship is on station, this group would obtain temperature and velocity at the surface, 0.35, 3.0 and 10 m, from a six-meter lifeboat about one mile from the ship. They measured temperature (reversing thermometer) and the velocity (buoys with a vane). The buoys would be deployed from the same location and time and the lifeboat's location taken by the ship's radar. After 40 minutes the buoys would be retrieved and the position of the lifeboat would again be recorded by the ship's radar. They also used integral and differential temperature of the upper 10 m and continuous wind speed which is recorded in the Data Acquisition room 265 (see that lab and Lab 139 for details about instrumentation).

Data from the internal wave and wind wave experiments is recorded by a 37-channel data acquisition system for processing on the ES 1033 and MERA computers. The data from the "drifter experiments" are all recorded on paper, by hand or graphed by plotter. This data is processed by the IBM AT with self-written programs and stored on disk. Samples of data and programs are available on disk. This data is used by scientists on the ship and will be used at MHI.

This group forms part of the theoretical half of the Department of Remote Sensing. The long term goal of this department is to develop a means by which satellites and radar can be used to detect certain phenomena in the ocean. Some processes that need to be looked at in more detail are internal waves, diurnal thermocline phenomena, wind waves in non-uniform currents and the occurrence of spatial variation of wave spectra and white caps in non-uniform currents.

Drifter Buoys — Used for obtaining velocity profiles:

surface — four 20 × 15 × 1 cm blocks of wood are attached by twine at two corners to form a row.

subsurface — a 30 × 24 × 6 cm block of styrofoam with a thin strip of wood 40 cm high and capped by a metal reflector supports a vane by wire at the given depths. The vane consists of four 50 × 30 cm panels, at 90 degree angles. See Figure 7.

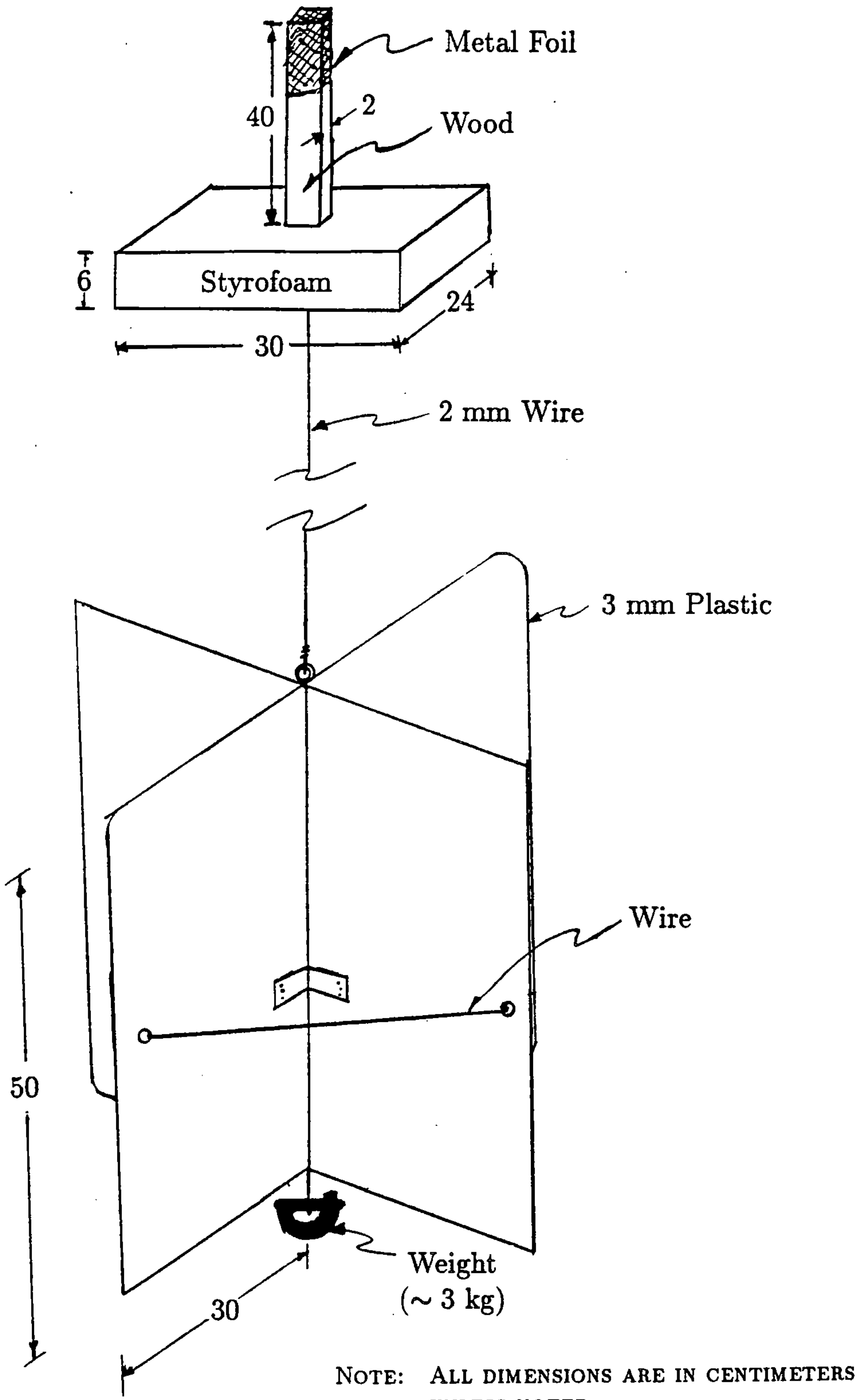

Figure 7: Drifter with subsurface drogue.

5.14 Surface-Active Film Dynamics Laboratory (Room 206)

56.	Pelinovsky	Efim Naumovich	Chief
57.	Salashin	Sergei Gregorevich	Science Worker
58.	Panchenko	Alexander Rosteslavovich	"
59.	Talipova	Tatyana Georgievna	"
60.	Kozlov	Sergei Ivanovich	"

The main interest, of this lab group from the Institute of Applied Physics in Gorki, is the study of ocean surface phenomena. Their scientific tasks on this cruise may be summarized as follows:

- To study the physical characteristics of surface-active films of slicks and ordinary sea water in different regions of the ocean. In this field of study, attempts were made to generate and investigate an artificial slick using sunflower oil. Although this experiment was aborted, the effect of such a slick would have been to suppress the formation of waves with a wavelength of less than 10 cm, while not affecting the generation of wavelengths greater than 20–30 cm.
- To study the dynamics of surface-active films in the field of internal waves, including nonlinear theory of internal waves.
- To estimate the possibilities of remote definition of the characteristics of surface-active films through spectral contrast of wave number spectrum components.

The measuring equipment used in these investigations consists of the following:

1. Optical spectrum analyzer (of wind waves)
   purpose: passive device to obtain cross sections of wave number spectrum in four directions in a scale of real time.
   wavelength range investigated: 5 cm – 3 m
2. Scatterometer
   purpose: to measure backscattered power from the sea surface and its Doppler frequency.
   description: coherent 8 mm K-band radar system with frequency modulated signal.

   Signal registration and processing apparatus (for both optical spectrum analyzer and scatterometer)
   H-338 multi-channel recorder
   TEAC R 280 C 14-channel tape recorder
   Bruel & Kjar 2031 spectrum analyzer
3. Line sensor of temperatures
   purpose: to measure internal waves
   number of channels: 8
   length of sensor: 30 m
   means of operation: thermosensitivity of channels change along the length in proportion to a Legendre polynomial function. The result is a depth record of ten isothermal lines which is recorded in real time to a two-coordinate Bruel & Kjar 2031 recorder.
4. Film elasticity meter of surface-active films
   purpose: to measure elasticity of surface-active films
   method: (a) screen technique used to recover top 3 mm of water from sea surface. Lengmuire balance used to find elasticity. Bruel & Kjar 2031 recorder used to record the results of measurements in the form of isothermal lines.
   (b) in-situ measurement of surface tension using spreading oil technique.

5. Anemometer
   specifications: same as that of Dynamics of Boundary Layers Laboratory.
   method of logging data: TEAC R 280C 14-channel tape recorder.

5.15 Dynamics of Boundary Layers Laboratory (Room 139)

61.	Lemeshko	Eugenii Mikhailovich	Chief
62.	Valentyuk	Roman Anatolovich	Science Worker
63.	Shokurov	Mikhail Victorovich	"
64.	Denisov	Vladimir Alexandrovich	"
65.	Shutova	Eugenia Nikolaevna	"

The daily routine of this laboratory centers mainly around meteorological and climatological study. Specific investigations, however, are diverse and may be summarized as follows:

1. To conduct standard meteorological observations and collect physical parameters that can be used by other lab groups in the development of models, etc. These observations include collecting data about wind speed and direction, clouds, atmospheric pressure, humidity, visibility, wind waves, etc. All data is logged either by hand or on plotters.

2. To collect actinometric observations, that is, to measure direct and net radiation from the sun.

3. To receive and analyze facsimile maps of cloudiness, atmospheric pressure, wind speed, etc. transmitted by such WMO regional centers as Rota (Spain), Norfolk (Virginia), Dakar, Moscow and Kiev. Transmissions are received across a ten-minute window on shortwave radio frequencies from an antenna that runs along the uppermost deck. The principal receiving equipment, located in Room 2A, include the following devices:
   - heat sensitive printing device,
   - device to convert signal from binary code,
   - two devices (STURM) for tuning to the correct frequency; each device tuning to two decimal places, a total resolution of ± 1 Hz.

4. To analyze NOAA satellite data in the infrared range. This satellite data is received twice daily in Room 17. The research associated with this data is diverse, but infrared maps have been used to assess trends in outgoing longwave radiation anomaly. Such research is aimed toward establishing global teleconnections in climate.

The principal instruments associated with this laboratory may be described as follows:

1. Aneroid Barometer: this device records the reaction of a sealed metal cylinder to changes in atmospheric pressure. Measurements are corrected for the temperature of the laboratory, recorded by means of a mercury thermometer.

   device number M67, #3602
   height above sea level 10 m
   error in pressure determination:
   two times the smallest scale graduation
   $= 2 \times (1 \text{ mm Hg})$
   $= 2$ mm Hg
   method of logging data: manually

2. Aneroid Baromometer (different from above)
   method of logging data: pen writing on a 24-hr drum of paper rotated by clockwork mechanism.

3. Anemograph

device number	M63MP
height above sea level	20 m
error in wind speed	±0.3 m/s
error in wind direction	±5.0 deg

measurement capability — wind direction, instantaneous and maximum wind speed, average wind speed across 2 or 10 minutes.
method of recording data — KSP-4 plotter, 6 channels
rate of paper advance = 60, 180, 600, 800, 2400 or 7200 mm/hr.

4. Psychrometer: this device consists of a wet- and dry-bulb thermometer set in a protective steel jacket with a clockwork mechanism to draw air across the mercury resevoirs.

device number	MB-24170
height above sea level	13 m
location of device	uppermost deck above bridge, at one of two locations facing wind.
method of logging data	by hand
error in thermometers	±0.4 °C

error in determination of relative humidity as follows:

Temp.	Relative Humidity (%) (±)									
(°C)	10	20	30	40	50	60	70	80	90	100
5	6.0	5.5	5.5	4.0	4.0	3.5	3.5	2.5	2.5	2.5
10	5.0	5.0	4.0	3.0	3.0	3.0	3.0	2.0	2.0	2.0
20	4.0	4.0	3.0	3.0	3.0	3.0	2.0	2.0	2.0	2.0
30	3.0	3.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
40	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0

5. Actinometer

device number	M3 #5613
height above sea level	13 m
location	uppermost deck above bridge
method of recording	on paper plotter
error in measurement	±1 to 2%

6. Pyranometer

device number	M115M; two devices #338, #1499
height above sea level	13 m
location	each side of deck above bridge
error in measurement	±3 to 4%
method of recording	-instantaneous record on KSP-4 plotter -instantaneous and 50 minute average values displayed every hour on device GELIOS-M and recorded on paper tape.

7. Sea Surface Thermometer: this instrument consists of a temperature-sensitive metal probe about 4 cm long set inside a protective steel basket. It is pulled alongside the vessel on a steel cable to which are attached two sacrificial aluminum anodes.

device number	MHI 4203
error in measurement	±0.15 °C on manufacturer's specifications. device calibrated to ±0.01 °C
method of recording data	-instantaneous readings on meter with three temperature scales, graduated on 0.2 °C intervals. -permanent record on KSP-4 plotter.

8. Rain Gauge

height above sea level	12 m
description	galvanized steel cylinder

5.16 Fine Structure Laboratory (Room 269)

66.	Efremov	Oleg Ivanovich	Chief
67.	Chekhlan	Boris Kuzmich	Science Worker
68.	Kiseleva	Olga Abramovna	"
69.	Kropinov	Vladimir Anatolovich	"
70.	Moiseev	Gennadi Alexandrovich	"

This lab obtains small-scale CTD profiles of the upper ocean (from 0 to about 900 m). Unlike the minisonde data, which is taken at intervals of 5 m (±0.2 m), there are 15 to 16 measurements taken per meter giving a depth interval of about 7.5 cm. This data is used on board by Oleg Efremov, Gennadi Moiseev, Olga Kiseleva and later by other scientists at MHI to study internal waves, turbulence, double diffusion and intrusive phenomena.

The instrument used is the Complex I (MHI 8101), Table 14 and Figure 8, which slides along a cable through the water column at a speed of about 1 m/s. To ensure that the ship's movement will not interfere with the measurements, they first lower the cable to the desired depth and let the Complex fall freely. The instrument's speed is kept constant by an umbrella-like parachute.

The signal is carried inductively through the cable to the surface where it is amplified on a system they called "block on boards." The raw data is stored on hard disk and cassette (backup). A dynamic error is introduced by the fact that the conductivity and temperature probes have different minimum response times, 0 and 0.05 s, respectively. This is compensated for by filtering or by shifting the temperature time scale by the appropriate amount.

Since there is such a bulk of data, it cannot be processed in real time. After a polygon is completed, they process the data on the mainframe and then use an IBM AT to view and plot finished data.

The actual research of this lab on the ship involves statistical analysis of frequency histograms categorizing the magnitude of temperature difference across adjacent water layers and is meant to expand on the work of T. Joyce, M. Gregg and Y. Desaubies. They want to explain the fine structure CTD profiles (e.g. salt fingering) that they measure. Ten to fifteen years ago, 90% of fine structure phenomena were explained in terms of waves, but this was superceded by double diffusion theory. Moiseev believes that actual structure is caused by a combination of processes and is fundamentally non-linear in nature. He is a mathematician who believes that fine structure cannot be parameterized in simple equations and that only a statistical approach can succeed.

Table 14: Specifications for Complex I small-scale CTD profiler (MHI 8101)

Signal	Range	Sensitivity	Accuracy	Time Constant
Temperature	−1.5 – 33 °C	0.0015°C	±0.05°C	0.05 s
Conductivity:				
Scale I	1.8 – 5.1 sm/m	0.0001 sm/m	±0.005 sm/m	—
Scale II	2.9 – 6.0 sm/m	0.0001 sm/m	±0.005 sm/m	—
Pressure	0 – 20 MPa	0.0004 MPa	±0.005 MPa	
	Sampling frequency		16.7 Hz	
	Weight of lowered instrument		70 Kg	
	Freefall velocity		1.0 – 1.3 m/s	
	Maximum depth		2000 m	

They have also developed a second profiler, Complex I-M (MHI 8102), however, it did not function correctly during this cruise and no data was collected.

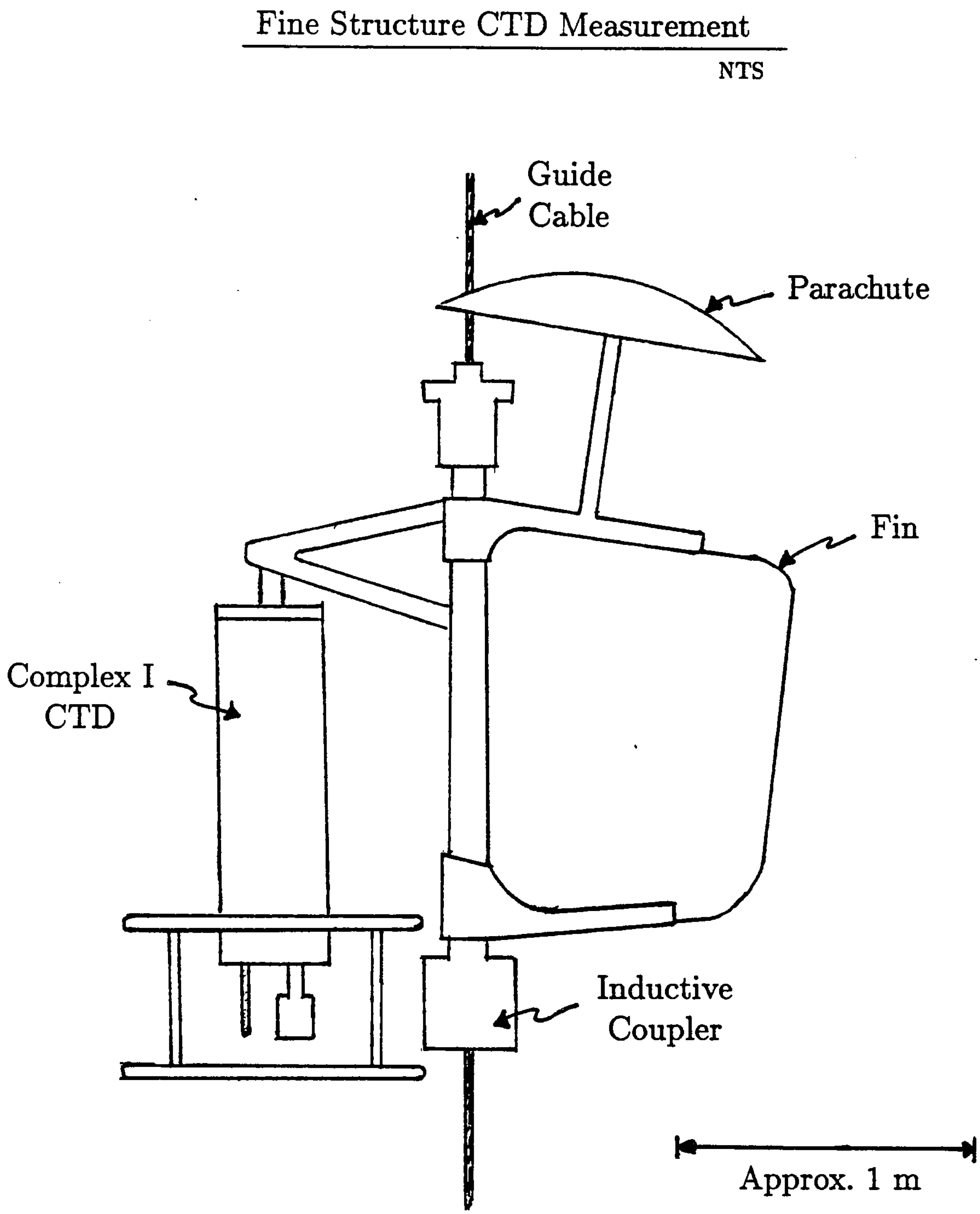

Figure 8: Complex I MHI 8101: Inductively coupled fine structure CTD probe.

5.17 Small-Scale Air–Sea Interaction Laboratory (Room 411)

71.	Proshenko	Vladimir Gregorevich	Chief
72.	Krivinskai	Boris Borisovich	Science Worker
73.	Golovan	Tatyana Martinovna	"
74.	Babanin	Alexander Vladimirovich	"
75.	Verkeev	Peter Prokhorovich	"
76.	Toloknov	Eri Nikolaevich	"

All aspects of wind waves are of interest to this laboratory. One of their responsibilities is to collect data for their department (Atmosphere and Ocean Interaction) at MHI. They also work with the Radar group on board the ship. Some of the processes of wind waves that they investigate are generation, augmentation, development, propagation, dissipation, space and time structure of wind wave fields, fetch and time dependence and interaction with currents and internal waves. They consider both linear and non-linear waves in a time spectra and group properties of wind waves.

More specifically, in the Brazilian polygon, this lab pursued investigations of energy exchange between wind waves and internal waves propagating in opposite directions. They looked for strong wind waves in passat zone and found that they added energy to internal waves. In this way, internal waves receive energy from the wind. This data supported theoretical research done by Vladimir Kudriavtzev (#3). He gave a seminar on this cruise which has been recorded on video tape. Also in the Brazilian polygon they investigated the influence between wind and internal waves in variable currents and their connection with internal waves. There are good correlations between changes in different scales of equilibrium range of wind wave spectra and phase of internal waves.

Off the east coast of North America, they have investigated the interaction between wind waves and areas of the ocean where there are large horizontal velocity gradients, such as in the Gulf Stream. One of their findings includes a significant change in the distribution of energy of wind waves as they enter the Gulf Stream. Analyzing wave spectra plots, they have found a loss of the energy by main spectral components and shift of the energy maximum to the higher frequencies for waves propagating normal to the current. When waves propagate opposite to currents, they receive energy from the currents and grow more rapidly than in free conditions (approximately 1.5 times for our situation).

They have two means to measure surface waves. One is a wave staff. They use this to measure high frequency waves and they are able to filter low frequency components. The other instrument is the accelerometer, which measures acceleration as it moves on the ocean surface. This instrument freely drifts 200–300 m from the ship and is connected by a line which transmits the signal to their lab.

The signal is sent to a computer, transformed and recorded on cassette. This data is analyzed on the mainframe and the finished data is stored on magnetic tape. The primary data is still kept on cassette for other scientists back at MHI.

This lab works with the Radar Sensing lab and with the Internal Waves lab.

Accelerometer

The accelerometer is used to study the character of the waves while riding on a float at the surface. The float assembly is released from the stationary ship on 400 m of 160 kg test (strength) military telephone cable. The cable is kept afloat by small styrofoam floats tied at approximately 30-m intervals. It takes 15 minutes to release all the cable, 20 minutes to complete a trial and 15 minutes to reel in the cable.

Capacity: NiCd cells (20)	0.9 amp-hr, 1.2 volts
Frequency range of receptor	0-32 Hz
Frequency range of buoy	1.25 Hz
Amplitude measurement range in frequency range of buoy	0.1 mm to 10 m
Dimensions of receptor	15 × 15 × 30 mm
Dimensions of buoy	60 cm
Mass	8.5 kg

5.18 Materials Laboratory

77.	Nesterov	Valerie Lesnidovich
78.	Prakhin	Alexander Alexandrovich
79.	Gordina	Alexei Niholaevich

This lab group consists of three people from the Material Problem Institute of Kiev, whose research centers on studying the process of corrosion in the natural marine environment on different types of marine construction materials.

On the ship two types of corrosion experiments are carried out:

1. In one experiment, different kinds of construction materials covered with different protective films have been placed in three locations on the ship. At each location, samples of aluminum, steel, wood and circuit boards have been placed on racks and exposed to different marine conditions. For example, one rack of matrials has been placed on the deck above the bridge exposed to direct solar radiation, rain and air. Another rack has been placed in a large screen (resembling a Stevenson screen), exposed to the atmosphere, but not the sun. A final rack has been placed in a forward hold. At each of the three stations, the following items are found:

   - Petri dish of distilled water: to measure daily Cl^- fluctuations.
   - Hygrometer (M21-AC): to measure relative humidity by recording the expansion of a horse hair on a 24-hr paper drum rotated by clockwork drive.
   - Thermograph (M16-AC): similar to hygrometer except it measures the expansion of a metal bar.

   Investigation of corrosion takes place in two stages; qualitative observation of the corrosion process aboard the ship with the aid of a magnifying stereoscope and a detailed chemical analysis of the samples back in the USSR.

2. The second experiment, located in the hydrology lab, is an investigation of the corrosion rates of three samples each of six different aluminum alloys that have been immersed in sea water. Two of the three samples are attached to sacrificial anodes consisting of Al(0.8)Zn(0.15)Ca(0.05) while one is left as an unprotected control. The potential between the anode and corroding metal is checked periodically with a dual function ammeter/voltmeter.

5.19 Instrument Signal Receiving Room (Room 256)

This room is used as the signal reception center for those labs on the ship which are associated with the Department of Remote Sensing at MHI. On the ship, these labs include the Radar Research Lab (#5), Receiving and Processing of Images Lab (#6), Upper Layer Dynamics Lab (#10) and Current Dynamics Lab (#2).

The essential receiving equipment in this lab includes a 16-channel amplifier (custom made); a digitizer (custom made); a paper tape punch; 3 paper tractors, KSP-4 (recorder one channel each) and 2 paper tractors, KSP-2 (also recorder one channel each). The number of signals that can be reached is limited by the amplifier.

The devices whose signals have been recorded in this room include:

1. Falling temperature probe: the relative temperature profile of the upper 10 m of the sea is measured by one of two temperature probes. These consist of 2 coils of fine copper wire whose resistance is temperature-dependent. The time constant for the device is about 1 s and the device is lowered over a time interval of 30–40 s. The minimum temperature resolution is about 0.1°C. This data is used to compare to the diurnal computer program by Andrei Tsvetkov (#32).

2. Integral temperature probe: this consists of a strand of wire 10 m long, also with a temperature resolution of 0.1°C. This data is used to measure internal wave energy.

3. Sea surface temperature probe (MHI 4203): this device is identical to the meteorological device except that it does not have the sacrificial anodes; it has been put in the water only for specific experiments since June 1 and is recorded on paper tape.

4. Current meter (GEK, GM 15-M): this consists of 2 electrodes, trailed in a line with the ship, separated from each other by 100 m, with the near one at a distance of 300 m from the ship. They are pulled at depths of 0 m and 0.5 m for the near and far electrodes respectively. The minimum current resolution is about 5–7 cm/s. The perpendicular components of currents are measured by sailing the ship in squares of about 15 miles on a side and looping at intervals in order to zero the electrode bias.

5. Wind speed is also recorded continuously (80 s) here on graph recorders. They use the same wind meter as the meteorological lab.

The Materials Laboratory also has a work station here.

6 Report on Work of Stage IV (Gulf Stream Region)

A preliminary report of the work carried out during the WHOI to Canary Islands leg of the 39th cruise was prepared on board the R.V. *Akademik Vernadsky* prior to its arrival in Santa Cruz de Tenerife. The report is translated from the original and included as part of our overall documentation of the cruise.

Academy of Sciences Uk. SSR
Marine Hydrophysical Institute

Research Vessel
Akademik Vernadsky

Report on Work During
Stage IV of
Cruise 39
18.06 - 16.07.89

Chief Scientist
Dr. Phys. Math. Sci.
V. A. Ivanov

Ship Captain
Deep-Sea Captain
A. C. Malinovsky

6.1 Basis and Purpose of Investigation

Research during Stage IV of the 39-th cruise of R.V. *Akademik Vernadsky* 18.06 – 16.07.89 was carried out on the basis of the cruise program plan established by the Presidium of the Academy of Sciences, Uk. SSR, 2 Feb., 1989 and also in response to the Proclamation 5030 by the President of USA, March 1989 for carrying out basic research in the US economic zone.

The following questions were examined during the stage:

A. Investigation of the energetic and space–time parameters of internal waves in regions of frontal surfaces and local bottom topography.

B. Study of transformation of wind-wave parameters in non-uniform surface flow.

C. Study of fine structure of temperature and salinity in frontal sections.

D. Study of the evolution of vertical structure of temperature and velocity in the upper 10-m ocean layer during periods of daytime heating.

6.2 Work Plan

The plan of work was ratified by the Scientific/Technical Council and composed of the following "experimental blocks" directed to resolving the basic questions of this stage:

1. Hydrological CTD survey of a mesoscale polygon 60 × 60 miles (Complex MHI 4207 and GEK) (see Fig. 9 for planned CTD survey).

   Participating labs: PIL, HYD, DSL, STS[1]

2. Study of the transformation of wind waves in the Gulf Stream. A series of sections across the Gulf Stream with measurements of currents (GEK), temperature and electrical conductivity (MHI 4207), characteristics of wind waves.

   Participating labs: DSL, APO, RAL, SAF, PIL, STS

3. Study of the variability of fine structure and structure of the ocean surface in sections across the frontal surface of the Gulf Stream. Two sections across the Gulf Stream with a series of six drift stations 10 miles apart of two hours' duration each with measurement of fine structure (MHI 8101, MHI 4207), spectra of wind waves (wave gauge, spectroanalyzer); scattering properties of the surface (RAL, Scatterometer). Plankton tows with net "Malaya Djeda."[2]

   Participating labs: FSL, PIL, STS, SSI, SAF, DSL, RAL, GBL

4. Measurement of spatial–temporal structure of internal waves; structure of the surface and near-surface layer of the ocean during daytime heating (calm conditions)[3]; vertical fine structure and its temporal variation; surface phenomena of surface active films; plankton tows with net "Malaya Djeda." Drift station:

   a. Antenna RDT, wave gauge, remote sensing, SAF drifters;

   b. Same as "a", except in place of RDT, profiling with MHI 8101, Complex MHI 4207.

   Participating labs: IWL, FSL, STS, PIL, SSI, SAF, DSL, RAL

5. Measurement of internal wave parameters in the Gulf Stream frontal zone. Tows with Complex MHI 4206 at low speed (5–7 kts) and profiles with Complex MHI 4207.

   Participating labs: IWL, PIL, STS

6. Measurement of angular characteristics of ripples, indicators of scattering.

   Participating labs: SAF, RAL

7. Investigation P.A.B.S., lowering Complex MHI 1301, profiling with Complex MHI 4207.

   Participating labs: STS, PIL, MAT

6.3 Cruise Track

In Figure 10 is shown the ship's track for carrying out **1**, **2**, **3**; location of multi-day drift stations (**4**); points where vertical CTD profiles with MHI 4207 were taken; continuous line of ship track during work

[1] Laboratory Abbreviations:

APO — Acquiring and processing of observations	MAP — Math. processing
DBL — Dynamics of boundary layer	MAT — Materials lab
DSL — Dynamics of ocean surface layer	PIL — Profiling instrument lab
FSL — Fine structure lab	RAL — Radar lab
GBL — Group biology lab	SAF — Surface-active film lab
HYD — Hydrology lab	SSI — Small-scale air–sea interaction lab
IWL — Internal wave lab	STS — Science/technical service group

[2] Plankton tows with "Malaya Djeda" net will be done outside the USA economic zone.

[3] In absence of calm weather, work on investigation of daytime warming and surface-active film phenomena will be conducted en route to Santa Cruz.

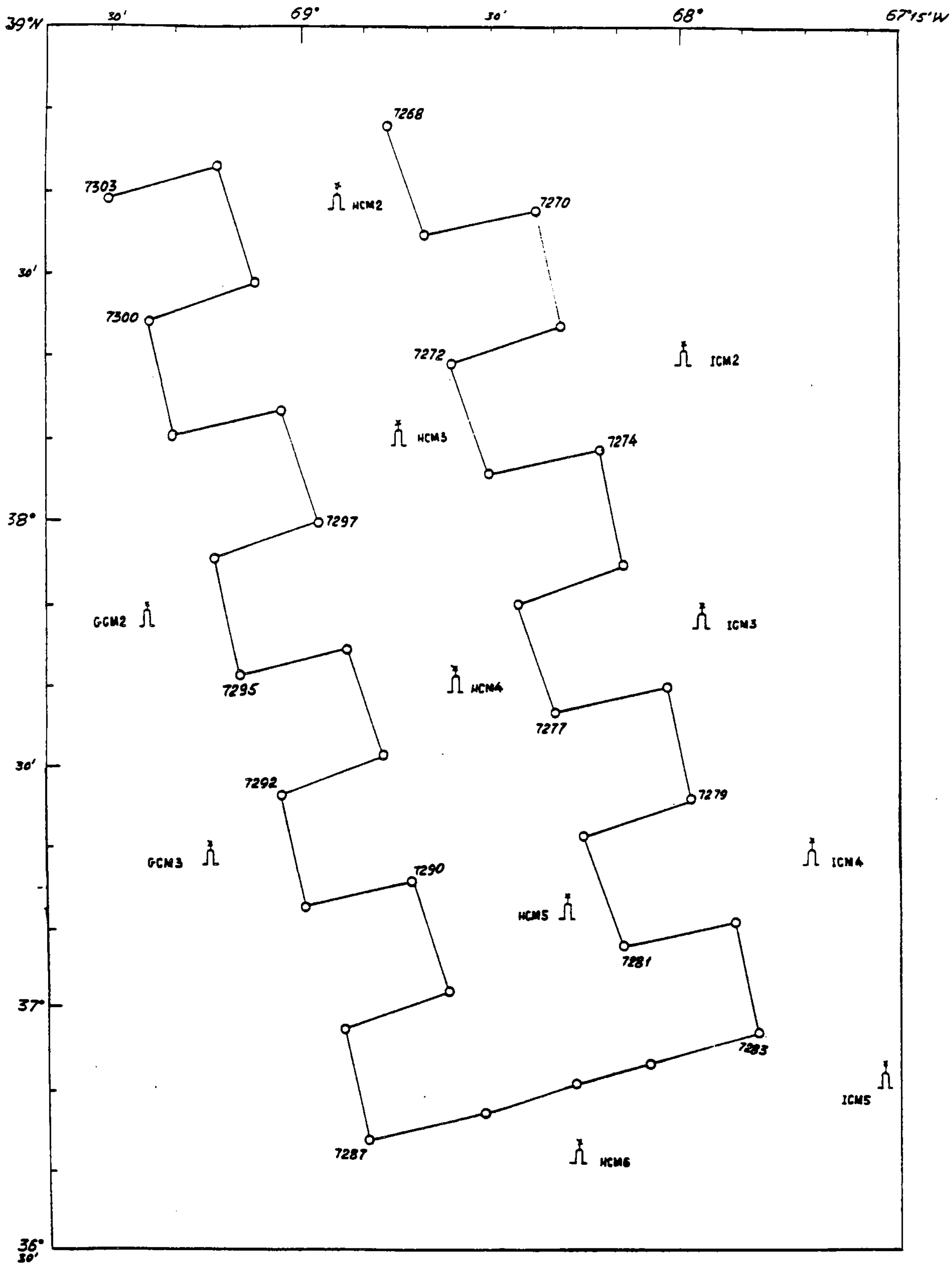

Figure 9: Planned CTD survey in region of the western SYNOP moored buoy array.

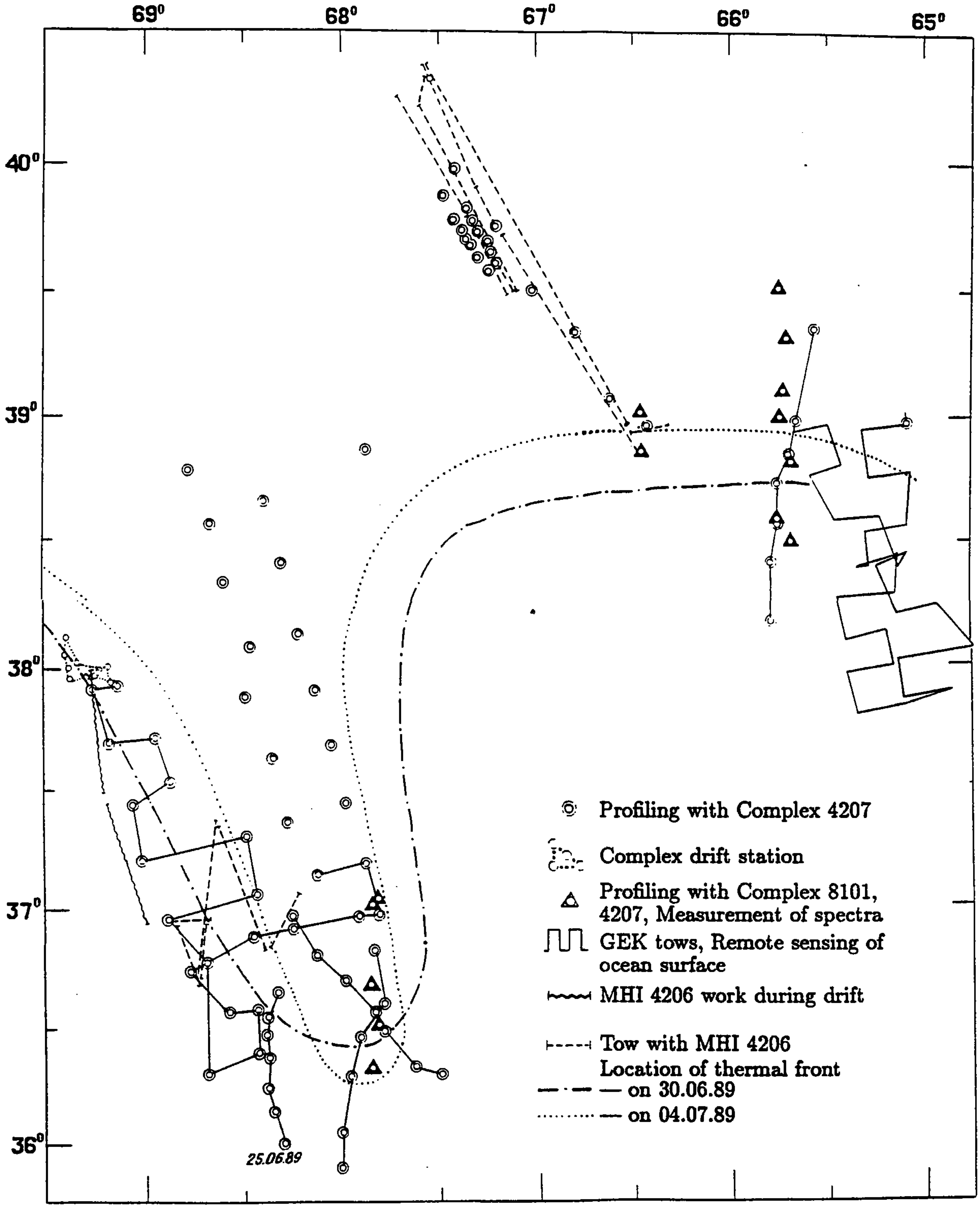

Figure 10: Summary of measurements carried out during Stage IV of Cruise #39.

on 2; stations indicated by triangles where investigations on 3 were carried out; dotted line shows ship's track where tows with Complex MHI 4206 were completed.

In Figure 10 is shown schematically the maximum horizontal temperature gradient (Gulf Stream core) from NOAA-10.

6.4 Data Given USA

Below are listed the experimental data given to the USA in person of WHOI scientist N. Fofonoff.

6.4.1 Data from tows of Complex MHI 4206

Technical characteristics of Complex MHI 4206. Complex MHI 4206 consists of a lowered submerged part (LSP) in which is found temperature and pressure sensors, upper submerged part (USP) which contains a temperature sensor. In between is placed a linear average temperature sensor, 50 m long, consisting of a precise, insulated conductor. The entire line is coupled to shipboard instruments by a conducting cable. A depressor is secured to the lower part of array (see Fig. 4).

Temperature range	–2 – 35 deg C
Pressure range	0 – 5 MPa
	95% confidence limits
Point temperature sensor	± 0.02 deg C
Average temperature sensor	± 0.06 deg C
Pressure error	± 0.023 MPa
Time interval of measurement	60 s
Working depth	500 m
Underway speed	< 7 kts

Description of files of exchanged information. Each tow is written on a separate file and contains the measured parameters, for example, file D23:

70.52 24.23 20.52 16.18

where the first number is depth (meters); second, temperature (degrees C) upper sensor; third, average temperature of middle layer (degrese C); fourth, temperature measured by the lower sensor.

On all tows, the towing speed was 6.5 kts (relative to the water), the effective length of the middle sensor was 34 m. Therefore, in the given example, the temperature at depth 70.52 m was 16.18 deg C, at depth 36.52 m (70.52 m – 34 m) – 24.23 deg C. The average temperature between these two points was 20.52 deg C. For work while drifting, the effective length is 50 m (wire angle near zero).

See Table 15.

6.4.2 Data from profiling Complex MHI 8101

Technical characteristics. Hydrophysical profiling Complex MHI 8101 is designed to measure temperature, specific electrical conductivity and hydrostatic ocean pressure. The measurements are made during drifting stations with free fall of the weighted structure PU-01K along a single-stranded cable lowered to 2000 m. Transfer of the measured parameters PU-01K to the shipboard apparatus is made with the help of an (indicator ?). The results of the measurements are recorded on compact cassettes and diskettes on board the ship in a form convenient for operational display and subsequent processing on an IBM AT.

Metrological characteristics of the temperature channel:

1. Range of measurement — from –1.5 to +33 deg C
2. Output code — 16-bit binary code
3. Value of single bit output code — not greater than 0.0015 deg C
4. Limit of systematic error at 95% confidence level < 0.05 deg C
5. Time constant of the primary temperature converter < 0.05 s.

Table 15: Combined Table of Measurements with Complex MHI 4206

No.	File name	Type sta.	Time Start	Time Finish	Coordinates Start	Coordinates Finish	Int. Sec	Quant.	Comment
1.	D23	Drift	04.32 23.06.89	02.55 24.06.89	37 59.1 69 15.5	37 29.1 69 12.4	60	1338	
2.	D24	Drift	03.39 24.06.89	12.07 24.06.89	37 26.2 69 12.2	36 55.5 68 59.3	60	509	
3.	B8 1	Tow	14.24 24.06.89	17.11 24.06.89	36 42.2 68 43.8	36 56.1 68 41.2	20	503	
4.	B8 2	Tow	17.18 24.06.89	18.33 24.06.89	36 57.3 68 40.4	36 56.1 68 52.5	20	228	
5.	B8 3	Tow	18.48 24.06.89	20.00 24.06.89	36 55.8 68 50.3	36 40.8 68 43.6	20	219	
6.	B8 4	Tow	20.10 24.06.89	03.22 25.06.89	36 42.0 68 44.3	37 21.2 68 38.1	20	1296	
7.	B8 5	Tow	03.29 25.06.89	07.50 25.06.89	37 21.4 68 37.2	36 49.1 68 23.2	20	786	
8.	B8 6	Tow	08.01 25.06.89	10.16 25.06.89	36 50.1 68 22.3	37 03.6 68 12.3	20	407	
9.	D01	Drift	18.00 02.07.89	19.21 02.07.89	39 02.1 66 15.7	39 00.3 66 15.4	20	245	
10.	B9 1	Tow	19.34 02.07.89	22.17 02.07.89	38 58.0 66 18.1	38 56.0 66 30.2	20	489	
11.	B9 2	Tow	22.24 02.07.89	12.26 03.07.89	38 58.3 66 31.2	40 22.1 67 34.0	20	2530	
12.	B9 3	Tow	12.47 03.07.89	16.34 03.07.89	40 22.0 67 35.2	39 54.2 67 18.1	20	685	
13.	B9 4	Tow	16.40 03.07.89	17.34 03.07.89	39 54.0 67 17.2	39 45.0 67 11.8	20	164	
14.	B9 5	Tow	02.34 04.07.89	11.08 04.07.89	39 43.1 67 10.2	38 51.3 66 27.4	20	1555	Garbage on av. temp. ch.
15.	B10 1	Tow	22.36 04.07.89	23.29 04.07.89	40 19.0 67 34.9	39 30.0 67 35.8	20	160	
16.	B10 2	Tow	23.35 04.07.89	06.31 05.07.89	40 13.4 67 35.8	39 30.0 67 05.1	20	1252	
17.	B10 3	Tow	06.48 05.07.89	14.03 05.07.89	39 30.2 67 05.4	40 15.5 67 42.8	20	1319	
18.	B10 4	Tow	22.04 05.07.89	01.49 06.07.89	39 29.1 67 07.8	39 49.8 67 22.1	20	613	

Metrological characteristics of the electrical conductivity channel:

1. Range of measurement:
   I - subrange — from 1.8 to 5.1 sm/m;
   P - subrange — from 2.9 to 6.0 sm/m.
2. Output code — 16-bit binary code
3. Value of single bit output code — not greater than 0.00015 sm/m
4. Limit of systematic error at 95% confidence level < 0.005 sm/m

Metrological characteristics of the hydrostatic pressure channel:

1. Range of measurement from 0 to 200 kg/cm^2 (0 – 20 MPa)
2. Output code — 16-bit binary code
3. Value of single bit output code — not greater than 0.004 kg/cm^2.
4. Limit of systematic error at 95% confidence level < 0.5 kg/cm^2.

Dimensions and mass of the lowered unit PU-01K:

1. Dimensions — less than 1680 × 1070 × 650 mm
2. Mass — not greater than 70 kg.

Summary of Information. Files of type K36.TAB contain data of depth (m), temperature (in situ deg C), salinity (‰), potential density (kg/m^3) at intervals of 7.5 cm.

Time and position are summarized in the following table:

Number Profile	Time GMT	Latitude Deg N	Longitude Deg W
35	14.30	37 56.32	69 09.22
36	15.30	37 57.35	69 11.09
37	16.30	37 57.70	69 11.73
45	00.30	37 59.45	69 13.08
46	01.30	37 59.06	69 13.68
47	02.30	37 58.56	69 14.68
55	10.30	37 58.90	69 21.79
56	11.30	37 59.38	69 22.62
57	12.30	37 59.95	69 23.01

6.4.3 Experimental data for daytime heating

Short description of experimental methods and apparatus. The experiment is designed to study the evolution of vertical structure of temperature and velocity in the upper 10-m layer of the ocean during the period of daytime heating during a many-hour drift station. The following parameters were measured:

a) Temperature profile in layer 0 – 10 m. Vertical resolution better than 0.3 m, sensitivity of temperature fluctuations better than 0.02 deg C;

b) Velocity shear vector between levels: 0.02 m, 0.35 m, 3 m, 10 m. The measurements were made with drifters, with an accuracy of shear velocity of ± 0.02 m/s;

c) Average temperature in layer 0 – 10 m. Measurement taken with distributed temperature sensor, fluctuation sensitivity ~ 0.02 deg C;

d) Meteorological parameters: Temperature and humidity of air, wind speed, net solar radiation, cloud cover index.

Description of transmitted information. All files contain the following structure:

Time Parameter 1 ...... Parameter N
Time Parameter 1 ...... Parameter N

Measurements on 20, 21, 22, 23 June and 12 July 1989:

Files named:

jn20int.dat	(time interval 100 s)
jn21int.dat	"
jn22int.dat	(time interval 50 s)
jn23int.dat	"
jl12int.dat	"

contain information:

1) Time of observation (decimal hours)
2) Real wind velocity (m/s)
3) Variation of integral temperature (deg C)

Files named:

jn20met.dat	(time interval 1 hour)
jn21met.dat	"
jn22met.dat	"
jn23met.dat	"
jl12met.dat	"

contain information:

1) Time of observation (decimal hours)
2) Solar radiation (KW/m^2)
3) Azimuth direction of wind (deg)
4) Wind speed (m/s)
5) Water temperature (deg C)
6) Relative humidity

Files named:

jn21drf.dat
jn22drf.dat
jn23drf.dat
jl12drf.dat

contain information on displacement velocities in different layers (depths: 0.02, 0.35, 3, 10 m):

A) Location of workboat with radar, on recovery of drifters
B) Location of drifters with radar
C) Measurement of angular departure of drifters by optical sighting

Location of parameters in each line of the files:

1) Time (decimal hours)
2) Velocity difference 0.02 m relative to 10 m (cm/s)
3) Velocity difference 0.35 m relative to 10 m (cm/s)
4) Velocity difference 3.0 m relative to 10 m (cm/s)
5) Azimuth difference 0.02 m relative to 10 m (deg)
6) Azimuth difference 0.35 m relative to 10 m (deg)
7) Azimuth difference 3.0 m relative to 10 m (deg)
8) Velocity difference 0.35 m relative to 0.02 m (cm/s)
9) Velocity difference 3.0 m relative to 0.02 m (cm/s)
10) Velocity difference 10 m relative to 0.02 m (cm/s)
11) Azimuth difference 0.35 m relative to 0.02 m (deg)
12) Azimuth difference 3.0 m relative to 0.02 m (deg)
13) Azimuth difference 10 m relative to 0.02 m (deg)
14) Velocity difference 0.35 m relative to 3.0 m (cm/s)

15) Azimuth difference 0.35 m relative to 3.0 m (deg)
16) Temperature water at 0.3 m (deg Celsius)
17) Temperature water at 3 m (deg Celsius)
18) Temperature water at 10 m (deg Celsius)
19) Difference of temperature between 0.3 and 3 m (deg Celsius)
20) Difference of temperature between 0.3 and 10 m (deg Celsius)

Files named:

jn20zon.dat
jn21zon.dat
jn22zon.dat
jn23zon.dat
jl12zon.dat

contain information on the variation of temperature with depth at different times:

1) Hours divided by 0.24 (days*100)
2) Depth (decimeters)
3) Variation of temperature with depth (deg C)

Time and location of experiments are listed in Table 16.

6.4.4 Data from electromagnetic current meter (GEK) GM-15M

Surface currents were measured with standard electromagnetic current meter GM-15M, with ship moving along a "broken" curve.

Trajectory of ship movement in the form of a "snake" was incorporated in the cruise track (see section 6.3). All necessary information is contained in files: EMCM18.06, EMCM07.07.

File name	Time of measurement	Variables
EMCM18.06	18 – 20 June 1989	v, k, x, y
EMCM07.07	7 – 8 July 1989	T, v, k, x, y

v (cm/s) — vector component of velocity perpendicular to ship track (positive to right of ship track)

k (deg) — ship's course (measured clockwise from north)

x, y (deg) — geographical coordinates

T (hours) — ship time (T > 24 indicates following day)

Data suitable for averaging is taken from the continuous signal from the electromagnetic current sensor at 400-s intervals. For file EMCM18.06, starting from line 36 to the end, the interval is 160 s.

6.4.5 Information about NOAA satellite data

Each file consists of two images — maps in equiangular cartographic projection with resolution of 0.1 deg in latitude and longitude (256 × 256 pixels). The first (left) map consists of the channel with the initial image, containing the lesser value of the spectral window of the radiometer AVHRR (2-channel 0.8 MHz, 3-channel 3.7 MHz, 4-channel 10.8 MHz). One pixel — one byte of information. Representation of radiational temperature (byte contents) in channels 3 and 4 (infrared) are as follows:

Magnitude: 64 — corresponds to 0 degree Celsius;

Magnitude: 0 — corresponds to 64 degree Celsius;

Temperature range from 64 to 0 deg with resolution of 1 deg.

Magnitude 252 — corresponds to 47 deg C;

Table 16: Time and Location of Experiments

No.	File name	Date	Start (ship clock)	Finish (ship clock)	Location	Volume (bytes)
1.	jn20met.dat	20.06.89	06.00	24.00	Start drift	
2.	jn20int.dat	same	11.00	21.00	37 42 68 57	21889
3.	jn20zon.dat	same	11.00	21.00	End drift	
					37 59 69 13	35001
4.	T-ship = T-GMT – 4					
5.	jn21met.dat	21.06.89	06.00	24.00	Start drift	
6.	jn21int.dat	same	09.00	23.00	38 03 69 23	493999
7.	jn21zon.dat	same	09.00	23.00	End drift	57501
8.	jn21drf.dat	same	09.00	23.30	38 01 69 21	2025
	T-ship = T-GMT – 4					
9.	jn22met.dat	22.06.89	06.00	24.00	Start drift	
10.	jn22int.dat	same	09.00	24.00	38 04 69 23	57685
11.	jn22zon.dat	same	09.00	24.00	End drift	55001
12.	jn22drf.dat	same	09.26	23.40	38 03 69 23	2025
	T-ship = T-GMT – 4					
13.	jn23met.dat	23.06.89	06.00	24.00	Start drift	
14.	jn23int.dat	same	08.30	16.00	38 04 69 23	31405
15.	jn23zon.dat	same	08.30	16.00	End drift	27501
16.	jn23drf.dat	same	08.56	14.50	38 03 69 23	553
	T-ship = T-GMT – 4					
17.	jl12met.dat	12.07.89	09.00	23.30	Start drift	
18.	jl12int.dat	same	11.00	23.30	36 08 41 43	
19.	jl12zon.dat	same	11.00	23.30	End drift	
20.	jl12drf.dat	same	11.00	23.30	36 07 41 41	
	T-ship = T-GMT – 2					

Temperature range from 0 to 47 deg C with resolution 0.25 deg.

Brightness in channel 2 is given without conversion.

Each file consists of 129 blocks of 1024 bytes each.

The first block is a service block, the remaining 128 values for the pixel map.

Each block contains in two lines two images in the following order: odd line first map, odd line second map, even line first map, even line second map.

The service block, first in the file, contains the following information (ARR (1024) — byte volume of first block).

1) ICH = ARR(1) — time acquisition (hours)
2) IMI = ARR(4) — time acquisition (min.)
3) IDA = ARR(7) — date acquisition (day)
4) IMS = ARR(10) — date acquisition (month)
5) IGD = ARR(13) — date acquisition (year)
6) PRV = ARR(22) — sign of orbit (0- descending) (1- ascending)
7) BSH = (1 - 2*ARR(33)*(100*ARR(34) + ARR(35)) - latitude of upper left pixel of the map multiplied by 10.
8) BFL = (1 - 2*ARR(36)*(100*ARR(37) + ARR(38)) - longitude of upper left pixel of the map multiplied by 10.

The list of files with maps (images) may be found in Table 17.

Table 17: List of Files with Maps (Images)

File No.	Date	Time GMT	Channel left	AVHRR right
1	19.06.89	06.48	3	4
2	20.06.89	06.36	–	–
3	22.06.89	06.16	–	–
4	23.06.89	17.30	2	4
5	20.06.89	18.01	2	4
6	24.06.89	05.55	3	4
7	24.06.89	17.20	2	4
8	26.06.89	18.41	2	4
9	01.07.89	06.23	3	4
10	01.07.89	17.48	2	4
11	30.06.89	17.54	2	4
12	03.07.89	06.03	3	4
13	03.07.89	17.29	2	4
14	27.06.89	18.30	2	4
15	04.07.89	05.50	3	4
16	04.07.89	17.17	2	4
17	05.07.89	05.41	3	4
18	05.07.89	17.08	2	4
19	06.07.89	16.57	2	4
20	07.07.89	16.47	2	4

6.4.6 Data from profiling Complex MHI 4207

Technical characteristics

a) The Complex contains the following channels

- Temperature channel
- Relative electrical conductivity channel
- Hydrostatic pressure channel
- Control code channel

b) Range of measurement

- Temperature from −2 to 35 deg C
- Relative electrical conductivity from 0.15 to 0.95 for first subrange
- From 0.7 to 1.65 for second subrange
- Hydrostatic pressure from 0 to 10 MPa

c) Limits of allowable error at 95% confidence level for measurement channels

- Temperature — less than 0.01 deg C
- Conductivity ratio — less than $\pm\ 1.25 \cdot 10^{-3}$;
- Hydrostatic pressure — less than ± 0.025 MPa;

d) Magnitude of least bit change in output code for measurement channels

- Temperature — less than 0.01 deg C
- Conductivity ratio — less than $2.5 \cdot 10^{-4}$;
- Hydrostatic pressure — less than $3 \cdot 10^{-3}$ MPa

e) Time constant of primary temperature sensor for flow rate of 0.5 m/s — less than 0.05 s.

f) Measurement interval for transfer and recording of all parameters — 0.1 s.

g) Time of measurement for each parameter (21 ± 5) millisec

h) Power characteristics of the Complex

- Voltage supply — (220 ± 22) volts
- Frequency of power — (50 ± 2.5) Hz
- Power requirement for complex — less than 150 volt-amps
- Power requirement for PU — less than 5 volt-amps

Characteristics of transmitted data. General quantity of vertical profiles, 144; of these, 53 profiles were made during drift.

The information is in the form of files, with station number as the file name. The hydrological data includes the following characteristics: depth, temperature, salinity, potential temperature, density anomaly, potential density anomaly. In addition, in a separate file (STATIONS.DAT) are given the characteristics of each station: latitude, longitude, month, day, year, time, ocean depth at station, depth of station, and the serial number of the instrument.

6.4.7 Data of distribution of wind wave breaking in frontal regions

An example to illustrate the study of the variability of the intensity of wind wave breaking in the Gulf Stream region. In the file is given the data for experiment 25.06.89 for forward and return section across the Gulf Stream:

- component of current velocity perpendicular to ship's course from GEK GM-15M.
- comparison of this component with geostrophic component calculated from CTD profiles;
- surface temperature;
- surface of ocean covered with whitecaps;
- wind speed;
- schematic representation of velocity shear (vorticity).

A file describing the experimental data is included on the 5-1/4" floppy disk.

7 Exchange of Data

A formal agreement to exchange data was drawn up and signed. I pointed out that the data requested from the US was could not be committed without negotiations with the scientists collecting the data.

NOTICE
Chief Scientist 39^{th} Cruise
R.V. *Akademik Vernadsky*
Dr. Phys.-Math. Sci.
V. A. Ivanov

ACT

Exchange of Hydrophysical Data

1. We, signed below, Prof. N. Fofonoff and Cand. Phys.-Math. Sci. V. Kudriavtsev confirm the exchange of hydrophysical information, obtained by MHI AS USSR on IV stage of the 39^{th} cruise of R.V. *Akademik Vernadsky* 18.06–16.07.89 in the course of joint Soviet–American investigations in the following volumes:

   1.1 490 miles of track with complex MHI-4206;

   1.2 Nine vertical profiles of fine structure with complex MHI-8101;

   1.3 Four cycles of investigation of thermal and dynamical structure of upper 10-meter ocean layer during period of daytime warming, including meteorological observations;

   1.4 710 nautical miles of track with electromagnetic current meter (GEK) GM-15M;

   1.5 20 normalized, geometrically corrected, geographically located images of the ocean with satellites of "NOAA" type in the infrared and visible spectral range;

   1.6 144 CTD-profiles with Complex MHI-4207;

   1.7 Two sections perdendicular to the Gulf Stream measuring intensity of breaking of wind waves, currents, hydrological structure and wind speed;

2. From its direction, Woods Hole Oceanographic Institution plans to send to the Marine Hydrophysical Institute Acad. Sci. Uk. SSR the following information:

   2.1 XBT survey carried out by R.V. *Oceanus* during 06.06–20.06.89

   2.2 Data from current measurements from subsurface buoys, including acoustic profiles for the period from 06.06.89 to 20.07.89;

   2.3 NOAA images of the ocean in the infrared spectral range.

From MHI AS USSR
C.P.-M.S. V. Kudriavtsev

From WHOI
Prof. N. Fofonoff

8 Proposals for Future Projects

The document reproduced in the following table, contains the suggested projects presented by the Chief Scientist, Vitaly Ivanov, to us during the visit to WHOI. The document was reviewed again near the end of the WHOI–Canary Islands leg and names of scientists interested in the projects listed in the table were added. The corresponding WHOI scientists have not yet been identified.

Table 18: Project of Collaboration between Marine Hydrophysical Institute (MHI) of the Ukrainian SSR Academy of Sciences and Woods Hole Oceanographic Institution, USA (1990 – 1995)

N	Subjects of investigation	Responsible person of MHI	Responsible person of WHOI	Expected results	Actions, realization and fulfilment
1.	Local dynamic experiments in the tropical Atlantic (or any area).			More accurate definition of parameters, clearing up of large-scale circulation mechanisms of formation, structure of waters and their variability. Quantitative estimations of heat, substance and energy flows through frontal zones and natural surfaces. Creation of theoretical models. Final monograph. Staged discussion on the meetings and final conference.	Cooperative investigations during the expeditions on research vessels. Work on probation and business trips for joint processing data of observations and modeling. (4 or 5 persons per year).
1.1	Investigation of large scale circulation and structure of water.	N. P. Bulgakov G. K. Korotaev A. B. Shapiro V. V. Konish V. V. Efimov			
1.2	Studies of synoptic and mesoscale variability of hydrophysical and hydrochemical fields.	G. K. Korotaev V. V. Efimov V. A. Ivanov			
1.3	Investigation of near-surface, deep and intra-thermocline eddies.	N. P. Bulgakov I. A. Panteleev			
1.4	Investigation of hydrodynamic instability of boundary currents and trans-frontal transport of heat, energy and substance.	V. A. Ivanov G. K. Korotaev			
1.5	Investigation of hydrodynamic subduction phenomena and flows on natural boundary surfaces.	V. N. Eremeev			
2.	Elaboration of new methods and means of environment condition control.	A. D. Fedorovsky N. N. Karnoshenko V. A. Gaiski V. N. Kudriavtsev		Cooperative elaboration and production of several complete sets of apparatus with following tests in the USA and USSR. Collections of papers. Staged discussion on the meetings and final conference.	Tests on research vessels, work on probation and business trips for cooperative tests (4 or 5 persons per year).
3.	Investigation of long period, seasonal and synoptic variability of hydrophysical and hydrochemical fields, dynamics of sulphuretted-hydrogen zone, anthropogenic influence on the ecosystem of the Black Sea.	V. N. Eremeev V. A. Ivanov S. G. Bogoslavsky A. N. Kosarev A. S. Blatov		Few-parameter models of ecosystem and forecast of possible changes in the ecosystem under influence of natural and anthropogenic factors. Collection of papers. Final monograph. Staged discussion on the meetings and final conference.	Cooperative investigations on MHI research vessels, work on probation and business trips (4 or 5 persons per year). Include cooperative investigations with Moscow University.

9 Personal Accounts

9.1 *Vernadsky* Diary — N. P. Fofonoff

June 13–17, 1989

Having been aboard Soviet oceanographic vessels in the past, I had a reasonably realistic appreciation of what to expect during the month-long cruise to the Canary Islands. Of course, changes must have occurred during the 13 years since my last cruise aboard the research vessel *Akademik Vernadsky*. I was rather looking forward to spending some time to see personally the changes brought about by time and "perestroika". Our preliminary visit to the ship in Boston reassured me that our scientific interaction would be greatly simplified by the presence of several IBM personal computers that they were using for data acquisition. It meant that we could join them in examining the data collected during their proposed hydrographic survey in the same area as the ONR/NSF funded array of moorings set out by Dr. Randy Watts of the University of Rhode Island. We were engaged in a "de facto" joint experiment by their choice of the Gulf Stream area to examine.

During their visit at Woods Hole, we had several opportunities and meetings to discuss future cooperative projects. The Chief Scientist, Vitaly Ivanov, outlined a "strawman" plan suggesting possible projects for our consideration and response. The Soviet oceanographers appear ready and eager to enter into collaborative efforts with western scientists.

The ship departed Woods Hole on Saturday evening, June 17th with a warm farewell from their WHOI friends. Shortly after departure we retired to the officers' mess for our evening meal. Vitaly scheduled a meeting for 10 p.m. that evening to brief us about shipboard arrangements and procedures. At the meeting we were introduced to the Deputy Chief Scientists, Alexander Lisichenok, responsible for shipboard measurements and Vladimir Kudriavtsev, for shipboard processing and remote sensing. In addition, we met Prof. Alexei Kosarev from Moscow State University who translated conversations into English for us. We were formally introduced to the Captain, Anatoly Malinovsky, and the Assistant Chief Mate, Leonid Olvin, who was responsible for navigation and ship safety. Leonid spoke good English and assisted with translations. Captain Malinovsky noted the special warm welcome and send-off given the ship's crew and scientists. He said the send-off "warmed my heart". I got the impression that the Woods Hole visit was the highlight of Cruise #39.

June 18, 1989

The next morning, after breakfast at 0730 of ham pâté, bread and tea, we met at 9 a.m. in the Chief Scientist's stateroom for our morning briefing on the work schedule. These meetings were held every morning to coordinate the day's plan with the Deputy Chief Scientists. The Science Secretary, Natalya Sustreteva, typed and distributed the minutes of the meetings (see Appendix 10.1). After some discussion, we agreed to set up our operation in the hydrology laboratory and have the students, Richard Navitsky and Jamie Kettle, work in the internal wave laboratory. Our equipment consisted of a Compaq SLT-286 lap-top computer, an external disk reader for 5-1/4" diskettes and a C. Itoh Prowriter 5810A dot matrix printer. Except for the printer, our units had automatic switching power supplies that could be plugged into 220 volt/50 Hz without any changes. The Chief Engineer, Vladimir Novoselits, replaced the plug on a 3-outlet extension cord that I brought to make it compatible with their wall sockets in the lab. The third outlet was used to recharge the battery on my video camera which also had an automatic switching power supply. I must say that I held my breath involuntarily while plugging several thousand dollars worth of equipment into their 220 volt line for the first time. However, the equipment worked flawlessly throughout the cruise and even after the trip home. Vladimir also provided the transformer needed to power our printer, the one unit that required 110 volts. We arrived at the survey area at noon local time.

During the afternoon, we visited the lab (5.14) next door, occupied by a group from the Applied Physics Institute in Gorki, for a description of their work followed by tea and snacks. Almost all of our visits to labs on the ship ended with an invitation to tea and pastries, preserves or fruit. I video-taped some of the descriptions and the lab equipment. I wondered what they would think of my taping the labs and activities on the ship. However, there were no objections or restrictions placed on us (see

Appendix 10.4 for a list of video scenes). We were free to go anywhere on the ship, including the bridge and radio room.

June 19, 1989

The morning briefing consisted of plans for the "minisonde" (CTD) and GEK survey. Natalya, the science secretary, collected our passports to record our presence on their crew list. We were also asked to attend a meeting on ship safety following afternoon tea. The first dozen CTD stations were delivered to us by Natalya Salnikova on a 5-1/4" floppy disk. Natalya worked in the computer center three decks below us. The files contained the observed data but no times or geographical positions. Those came later.

At the safety briefing, the Chief Mate, Vladimir Kulagin, explained shipboard hazards such as:
- standing near operating winches,
- standing in line or stepping over cables under tension,
- standing near or under crane loads,
- having open flames near or flammable liquids in lab sinks,
- using water heaters or electric kettles in cabins,
- not fastening heavy equipment in labs.

In case of fire, dial 2-40 to warn the Bridge. For emergency, a long ring, 25 – 30 seconds, will sound. Get lifejacket, papers, clothes and proceed to lifeboat #1 for all science visitors.

During the evening, I visited the satellite lab, headed by Andrei Tsvetkov, a young scientist who spoke good English. They receive APT images on board, digitize and process them on IBM ATs and on their central computer.

June 20, 1989

The ship was stopped the entire day to allow work from a small launch setting surface drifters and making measurements in the surface layer away from the influence of the large vessel. A schedule for seminars was set up. I agreed to give two, one on WHOI on June 23rd and another on Gulf Stream studies later. Talked to one of the scientists, Sergei Bulgakov, about his work on the flows through Bosphorus Straits.

Vitaly invited Ellen and me to a party in his stateroom that evening for informal discussions and exchange of information over tea, Hungarian wine and "zakuski". We spent some time trying to explain the organizational structure of WHOI, particularly the role of the trustees and corporation members. They were intrigued by the differences between WHOI and SIO as well as other academic and federal laboratories. They pointed out that their institute could carry out research for U.S. oceanographers under contract and asked how they could go about setting up such arrangements. Why should the U.S. send ships all the way to the Black Sea when they could easily do the work from their vessels in local waters. Acad. Federovsky mentioned that instrumentation could be developed jointly. He admitted that electronics could be a problem but that that could be handled by cooperative arrangements. He asked about descriptions of U.S. instrumentation. I suggested that Marine Technology publications might be a good source of information on the latest instrumentation. Also publications such as *Sea Technology* would be another source of information.

June 21, 1989

I was strongly encouraged by Prof. Kosarev to join several scientists for a half hour of exercise at 6 a.m. on the top deck. He insisted that a half hour was mandatory to remain healthy. I learned later that others had exercise equipment (weights, springs, etc.) in their cabins while some, including myself, enjoyed skipping rope, running or lifting weights outside. The ship's radar and radios were turned off (except in fog) during the exercise time.

We tried calling R.V. *Oceanus* on the UHF marine channel but got no response. We learned later that they had finished early and were already back in Woods Hole. I was able to send several Telex messages via the radio operator. The radio room was also equipped with an INMARSAT transceiver for telephone links to shore. There was no facsimile machine connected to the satellite system.

June 22, 1989

Natalya Salnikova brought a diskette with descriptions of the shipboard laboratories that they had prepared for their "open ship" displays. We had requested a copy to help with our descriptions of the functions performed in each of the labs. Also got copies of the time series CTD stations, including times and locations. Made our first plots of the data using a program I wrote for our lap-top.

June 23, 1989

Tried to contact Randy Watts at URI to ask about data exchange. Got a Telex number but could not make contact. Gave seminar at 16:30, following afternoon tea, about WHOI organization and activities. I described each department briefly taking most of the material from the latest annual report. Prof. Kosarev translated. A couple of the many questions following the presentation were: What did WHOI do with all the treasure recovered fron the *Titanic*? How does one get a job at WHOI? A party for "boys only" in the Chief Scientists' stateroom during evening. We discussed many topics including more questions about WHOI trustees, appointment policies, salaries, cruise schedules, social life at sea, women at sea and so on, interspersed with toasts to all at sea and ashore.

June 24, 1989

Up at 6 a.m. for exercise. Ellen and I were seated at the Chief Scientists' table for all meals. The students were seated at a nearby table. Meals were served by a waitress or waiter who alternated according to their work schedule. Menus for all meals were posted in the mess. Examples are given in Appendix 10.3.

June 25, 1989

The work plan now turned to part II which called for perpendicular sections across the Gulf Stream with GEK and minisonde profiling as well as sampling wind waves along the sections.

June 26–28, 1989

When I went out at 6 a.m. for exercise, I noticed a yacht about 100 yards off the starboard bow with its sail down, rolling heavily in the swell. Vitaly happened by and informed me that the skipper of the yacht was aboard together with a corpse recovered from the yacht during the night. Apparently, *Vernadsky* received a Mayday call on the VHF marine channel shortly before midnight from the yacht *Belatrix*. The boom had swung across the deck during a heavy roll striking the man's head and inflicting a mortal wound as well as damaging their steering. The *Vernadsky* headed for the yacht reaching it about 2 a.m. after steaming about 40 miles. They came alongside and several sailors jumped aboard the yacht to transfer the injured man and the skipper to the ship. The injured man was taken to the ship's hospital where apparently the ship's doctor and the skipper confirmed the death. The deceased was a professor of pediatrics at the University of British Columbia. Both he and the skipper, a neuro-surgeon, were graduates from U.B.C. medical school.

The skipper, radio operator and chief mate spent several hours during the night communicating to the U.S. Coast Guard details of the accident. They determined that the yacht would be towed to New York. I took the skipper, Skip Peerless, to my cabin to make him a cup of coffee and supply him with a razor and a WHOI tee shirt. He came aboard with only the clothes he was wearing. Vitaly had a bed made up for him in the Chief Scientists' stateroom. After coffee, I escorted him to Vitaly's room for a much needed rest.

The yacht could be towed initially at only six knots because of the heavy seas. As the wind and sea moderated, the tow speed was increased to eight knots. At this speed it would take two days to reach New York and a day to return to the work area. To save time, it was decided not to transfer the five remaining crew members from the yacht.

Vitaly invited me to join him in the sauna. He was scheduled for a 2-hour period on Monday afternoons. Everyone of the crew and scientists were assigned times on a weekly schedule. The sauna consisted of an outer air-conditioned room used to change clothes and sip tea or mineral water between sessions in the heated room. A middle room contained showers and a salt water tub about 2 m × 2 m × 1.5 m deep. The inner sauna had electric heaters that kept the air temperature at 90 – 100 °C. The dry heat could be tolerated for about 10 – 15 minutes if followed by a dip in the salt water tub and a cool shower. About 3 or 4 sessions in the sauna mingled with recovery and replenishment of fluids in the outer room constituted the weekly sauna ritual. It provided wonderful opportunities for conversations on many topics of interest. Later that afternoon we met in Prof. Kosarev's cabin for coffee with Skip and others. During the evening, we were invited to the Chief Scientists' and Captain's staterooms for more conversations, toasts and snacks.

On Tuesday, the weather had moderated considerably. We were on our way to New York to meet the Coast Guard ship to transfer the yacht and crew. Work on board proceeded as usual but no new measurements were made. After afternoon tea, Prof. Pelinovsky gave his seminar on interaction of waves and currents. He delivered the talk in English for our benefit. I recorded his and subsequent seminars on video cassettes so that we could show them to interested scientists back at WHOI.

Wednesday morning after breakfast we spotted a Coast Guard helicopter that circled the ship several times before the Coast Guard cutter arrived to take Skip and his deceased friend from our ship. The transfer was completed by 9:00 a.m. and we headed back to sea. We did not come within sight of land to the disappointment of many.

June 29, 1989

Started second part of program taking sections across the Gulf Stream. Had some problems with sargasso weed fouling the towed GEK eloctrodes.

June 30, 1989

Invited to a birthday party for Alexei Blatov of Moscow State University. Snacks included krill from the Antarctic, salmon, kolbasa, cheese, fruit, layer cake plus vodka and champagne for toasts.

July 1, 1989

Canada Day. We are working east of the deep meander making sections with the minisonde as well as stopping for fine structure stations. They were concerned about making measurements in the U.S. economic zone. After some discussion, they decided to go ahead with a section toward George's Bank. They wanted to reach shallow water for their internal wave investigation. (This proved to be too difficult because of the number of fishing boats on the banks.) We talked about data exchange. Deputy Chief Scientist Vladimir Kudriavtsev told me they were planning to give us copies of their minisonde (CTD) stations and GEK records, their internal wave and meteorological data, and the satellite images and samples of wave spectra.

July 2, 1989

After tea, we looked at the video of Prof. Pelinovsky's seminar. It was disappointing to discover that a high background hum from the air conditioner in the room made it difficult to understand the audio signal. Watched a volleyball game between the scientists and crew. Crew team won. Later in the evening, the Fine Structure lab put on a fish fry using fish caught earlier in the day. Delicious food!

July 3, 1989

Heavy fog. Turned back at the 500 m depth contour because of the heavy concentration of fishing boats ahead. Met with Nikolai Grekov to discuss algorithms used for processing CTD data. Basically, they use the same algorithms except for sound speed (Del Grosso, 1974) and potential temperature (Bryden formula). Sauna in afternoon. Very relaxing.

July 4, 1989

Vladimir Kudriavtsev gave a seminar on the growth and decay of internal waves by interaction with surface waves. This was the third in the seminar series. There was good attendance at all seminars. I took off the microphone with the preamplifier and found a reduction in the background noise.

Several of the ladies cooked cakes for us as July 4th presents. We were also given Paul McCartney records made in the USSR on his concert tour there. A colorful poster congratulating us on Independence Day was put up on their display board in the forward stairwell. The Chief Scientist and Captain threw a party for Ellen and me in the evening. The students were entertained at another party. We were well cared for by our shipboard colleagues.

July 5, 1989

Worked on a proposal that had to be sent to WHOI by Telex. Also started collecting notes for our cruise report.

July 6, 1989

Gave proposal text to radio operator on a 5-1/4" floppy disk. He was able to take it to their computer room to transfer the text to a paper tape that could be read and transmitted by the equipment in the ship's radio room.

During the afternoon, the ship's company was invited to the crew's mess to help make "pelmeni" for the evening meal. We were told that pelmeni were a Siberian food made of little patties of pork, reindeer and bear meat mixed together and covered with a layer of flour dough (ours were made with pork and ground beef). These were frozen and used for food by the hunters in the forests. A bag of pelmeni would provision a hunter for his trip. Siberian temperatures presumably took care of preservation. I took my video camera to the event. Several men including the "macho" bosun joined the women in making several thousand pelmeni to feed about 160 people on board. It was an entertaining event!

July 7, 1989

Rain forced cancellation of my morning exercise. We were still working on GEK and wind wave measurements on sections across the Gulf Stream to examine the effects of current shear on the waves. I talked to the metrologist, Victoria Kim, about calibration of their minisonde. I had noted a possible descrepancy with pressure of the salinities. They scheduled a calibration station to check.

July 8, 1989

Winds were calmer so a small boat was launched to make near-surface current measurements with drifters that were tracked by the ship's radar. The minisonde was detached from the cable so that the calibration station could be made. A different CTD "ISTOK," capable of holding 16 water samplers, was attached. The changeover was a lengthy operation, so I could see why calibration checks were not made frequently. Victoria collected samples from 400, 800 and 970 m depths for shipboard salinity determinations against their standard sea water maufactured in Moscow. A second lowering was made to collect water samples for the biology lab.

I called my wife during the evening over the INMARSAT link. The quality of the connection was excellent. The cost — $10.00/minute.

July 9, 1989

This was the last day of work in the Gulf Stream. A celebration was scheduled for the evening in the Officers' mess. Entertainment included amateur performances for prizes. The celebration had a threefold purpose: July 9th was fisherman's day; their 100th day at sea and the end of the "polygon." The performances consisted of songs by members of the scientific party and crew, evaluated by a panel of judges. Prizes were handed out to performers with humorous commentary about their skills. Following the amateur performances, chairs were cleared away and music put on for dancing. One of the ladies I danced with explained that Russian women judged men's character by how they sang, how they danced and how they loved! Several of us left the dance around midnight for more tea and pastries and more songs before retiring.

July 10, 1989

A slow day following the night before. Worked on our cruise report and made a video for the radio operator of his radio room and the bridge, also of volleyball and English lessons.

July 11, 1989

Steaming to the Canary Islands. Prof. Alexei Kosarev gave his seminar on problems of Black Sea studies. One of the scientists brought me a heating coil to heat water for coffee and tea in my cabin. I had ruined the kettle given to me earlier by forgetting to unplug it before going out of my cabin. It overheated and unsoldered the bottom seam. I could see why the practice of making tea in one's cabin was officially prohibited, even though widely practiced.

July 12, 1989

The morning meeting was devoted to discussion of the CTD calibration station. The samples showed that the minisonde salinities at depth were slightly low and needed to be recomputed. I spent some time inspecting their temperature calibration carried out in the lab. The temperature sensor was calibrated over 0 – 30 °C against a quartz thermometer as a shipboard standard. The quartz thermometer, in turn, was calibrated against a platinum resistance thermometer at their shore metrology lab.

A birthday party for Prof. Pelinovsky provided entertainment for the evening. I presented him with a WHOI cap. The gifts were generally small but most brought something to give.

July 13, 1989

Worked on my second seminar during the day. Most of the material was written on large sheets of paper. There were no copiers or overhead projectors on board. The seminar on problems of Gulf Stream studies was given following afternoon tea. During the evening, I put on a video show using tapes that I had made of social activities. The visit to Woods Hole and the farewell scenes were viewed with interest. The pelmeni making and the amateur performances were hits. I was asked to give a repeat showing the following night.

July 14, 1989

We discussed data exchange and possible future projects at our morning meeting. They mentioned again the possibility of joint work on their ships. They would welcome projects that could be loaded and offloaded in the Canary Islands, for example. Apparently, it is too expensive for them to make many port calls in North America. The Black Sea could be the subject of an international program involving U.S., Turkey and U.S.S.R. Platforms anchored in 40 and 2000 m are being prepared. Prof. Kosarev offered to write an article about the Black Sea (and Caspian Sea, if desired) for *Oceanus* magazine.

My last sauna with the Gorki group. We had tea after in their lab.

July 15, 1989

The reports of work on the Gulf Stream "polygon" were given by the lab chiefs following afternoon tea. I was able to video tape most of the session, although I was near the end of my cassette supply. The talks are listed in Appendix 10.2.

July 16, 1989

Most of the data from the Gulf Stream leg was given to us on 5-1/4" diskettes or on 800 bpi magnetic tape together with a cruise report (in Russian) which is included in translation as part of our report. The report gives data formats and sensor specifications as well as locations and descriptions of the different data sets. Vitaly informed us that they were planning a farewell party for us on the 18^{th}.

July 17, 1989

We arrived in Santa Cruz de Tenerife harbour during the morning. Formalities with officials kept us on board until after lunch. The local agent took Ellen, Richard, Jamie and myself to Iberia airlines office to change or confirm our return flights. After waiting in line for an hour, we were informed that we would have to go to a TWA office to make the flight changes. Of course, many of the offices and stores were closed for the afternoon. We finally managed to discover by 5 p.m. that the flight changes had already been made by the WHOI travel office as requested.

After returning to the ship, the Captain, Chief Scientist and I went over to the Maritime Academy training ship *Texas Clipper* from Galveston, Texas that was docked nearby to meet the Captain and invite the students to visit the *Akademik Vernadsky*. The Captain was not on board, but we were given a tour of the ship by one of the cadets. I met Bill Merrill, whom I had known from his tour of duty at NSF in Washington, D.C.

July 18, 1989

Most of the day was spent sight-seeing and shopping in Santa Cruz. We were docked about 20 minutes away by foot from the center of the city. The farewell party was started in the Chief Scientists' stateroom with many wishes and toast for future meetings and joint projects. We later moved to the fantail to enjoy the night air and conversations with others. It was a enjoyable, but tiring, conclusion to our month-long stay.

July 19, 1989

Richard and Jamie picked up a rental car and tranferred our baggage to a resort hotel near the south end of the island near the airport. After lunch, we went on a short tour, getting a view of the 12,000 foot high volcano that was one of the spectacular attractions of the Island. We returned to the ship to see them off at their scheduled 7 p.m. sailing. After waving goodbye, we drove to our hotel for supper and rest. Prices were quite reasonable, a room with a kitchenette cost $25 per day. Supper, buffet-style, about $10.

July 20, 1989

Richard drove Ellen and me to the airport at 7 a.m. for our return flight to Boston. Because of our computer and other material we had to get into lines to pay for excess baggage. Since we had confirmations only for our flight to Madrid, we waited in lines at Madrid airport as well. On arrival in New York we found two suitcases missing from our baggage. By the time we confirmed this and checked with the service desk we had missed our connection to Boston and had to transfer to a later flight. That flight was two hours late leaving JFK airport and waited over 30 minutes in Boston for a gate. As luck would have it, another baggage item was misplaced between New York and Boston causing more delays. We finally rented a car after midnight and arrived home early morning on the 21st — tired but very happy to have completed a memorable cruise. The students opted to stay an extra day to enjoy the sights of Tenerife. The lost baggage came two days later.

9.2 Personal Account — Ellen Levy

The R.V. *Akademik Vernadsky* was due to leave Woods Hole Saturday evening and I found out I was definitely going on Friday morning. There was very little time to prepare for the cruise: airline tickets, traveller's cheques, pay household bills, find someone to take care of my plants, take my own work to a good stopping place and pack, let alone think about this upcoming trip on a Russian research vessel where communication alone could prove to be an ordeal. I had worked for Nick in the Physical Oceanography Department in the past so I knew there would be no problem with the work on board.

We were all made to feel right at home as soon as we went on board. We had nice accommodations and between Nick's and my cabin was that of the chief radio operator who immediately let us know that he spoke English and if we had any problems to let him know. Everything was different right from the start. The ship was twice as large as any that I had been on previously. It was built for science but designed as a cruise ship with the comfort of passengers in mind. Everyone dressed nicely during the trip. Yes, the ladies on board wore skirts and dresses and everyone smiled whether or not we could exchange any words. A few people understood no English, but most could understand some and some understood and spoke English quite well. In Russia, at least three years of English is required in school. I was surprised at this and immediately set to the task of trying to learn Russian. I was interested in basic communication rather than trying anything formal at this time. The words and phrases I learned were concerned with salutations, weather and ship-related ideas. I had a daily class of Russian and conversational English with the chief radio operator and in the evening I met with two women, one a scientist studying vertical structure and one a computer programmer who felt a kinship through FORTRAN if not Russian or English. We became good friends and exchanged English for Russian words. I plan to continue my Russian courses now that I'm back.

Other than language, the largest difference between this cruise and the other cruises I've been on is the way science is carried out. Although our ships may go out for years at a time, our scientists do not. Two months is about the longest period I've noticed and most are shorter. The *Vernadsky* left Sevastopol for four months with everyone who would be working during that time and would return with all hands. There were 15 laboratories with investigators, though not all were concerned with the Gulf Stream in the area covered by our Woods Hole to Santa Cruz leg. These labs were interdisciplinary. On this physical oceanography cruise, there was also a hydrobiology lab and a materials lab studying corrosion of various alloys. The labs also involved different institutes; Kiev, Moscow, Sevastopol. Some labs studied the area off Brazil and worked up data for the rest of the cruise. There were science meetings every morning where logistics were worked out to satisfy all the labs involved. Some labs, such as the Surface-Active Film lab, were dependent on weather and sea conditions, while other labs were more flexible. On previous American cruises one or two groups were the norm.

The many labs on board were able to share their findings through seminars. All of the scientists were very open with us concerning their data and presented Nick with floppy disks and tapes of data collected during the cruise. I was not impressed with the current meters, especially after working in our Buoy Group for eight years. However, I was impressed with their minisonde, the CTD type instrument that was able to make a survey of an area while the ship was underway at speeds of up to 15 knots. Large areas could be covered in a short time.

The Russians I met on board were very emotional and friendships were very important. Tea or coffee groups exist everywhere. Preparation of the tea was very important and something was always offered whether it was fruit compote or bon bons brought from home or fruit retrieved from suppers. Hospitality was very important and I was grateful to some of my friends ashore who gave me some treats to bring on board. During these tea groups, we talked, listened to music, looked at pictures they had of home and Woods Hole and sang. Birthday parties were also celebrated in style. There were also large gatherings on board. During one of their seagoing holidays, there was a song fest. A contest where individuals and groups signed up to sing and compete for prizes of homemade cakes. Then a dance was held afterwards. This year the Fourth of July celebration was very special to me. A poster was put on the main bulletin board celebrating Independence Day. Everyone wished us a happy celebration in English and Russian and a party was given in the evening with wonderful food and drink.

Other social activities included a nightly movie, league volleyball followed by pickup games (the volleyball was on a tether), ping pong — a challenge since the table was located in a small, very hot room in the bow, billiards and dominoes on deck.

All in all, the month passed very quickly. I learned a lot about Russian science and Russian people and I'm very grateful to WHOI, Craig Dorman, Nick Fofonoff and the crew of the *Vernadsky* for giving me this wonderful opportunity. I hope our scientific and personal relations will continue to improve in the future.

9.3 The Opportunity — Jamie Kettle

My mind was racing. It was the opportunity of a lifetime. I mean, how many times does a person actually get a chance to make a one-month cruise on a Soviet research vessel to the Canary Islands. So when Jim Price stomped into my room that Thursday morning with this very proposition, I jumped at the opportunity without giving it a second thought.

But then I did start thinking:

I am going on a one-month cruise on a Soviet research vessel to the Canary Islands.

It sounds different if you say it slowly. One month on a ship is no overnight camping trip, especially if you've never been on a cruise before. The fact that all of your fellow campers on the cruise will be speaking a foreign language — not the comfortable French that you learned in high school — might possibly give you further cause for concern. In addition, there is entire connotation of not being on any ship, but rather sailing on a "Soviet" vessel. For me, at least, this simple word, "Soviet," conjured up a collage of images from the world of Hollywood cinema, most not entirely pleasant. Making an effort to keep everything in perspective, I guess you could say that I was having second thoughts. I was possibly even becoming nervous.

This is not to say that all my expectations came from James Bond films. I was also receiving information from all the "old salts" from Woods Hole and elsewhere who had been to sea before. Stories of winter storms abounded, and not a few times was it emphasized how the ship would be tossed around like a cork in the ocean swells. At the same time, people tried to tell me about what the daily routine on the ship would be like: about the automatic laundry services, about the high quality of food, and important details like that. Of course, there is little need to repeat the numerous warnings I received about how the Russians drink their vodka.

Ultimately, I guess none of us really knew what to expect during the month. The number of people at WHOI who could give a competent, first-hand assessment of life on a Russian ship could be counted on all of your fingers and toes, if you took your shoes and socks off. For my part, I was a bit skeptical of the third person reports, so I did a little investigating of my own before the *Akademik Vernadsky* sailed. From my own wanderings around the boat, I must admit that the *Love Boat* comparison was quite apt. I mean, the ship was big, spacious, and clean. It even had a volleyball court and a sauna — everything to cater to human comfort. Except toilet paper. When Rick did inform me about the alarming absence of toilet paper from the bathroom nearest the cabin, it dawned on me that sauna or no, it had the potential to be a very, very long month at sea.

And so it was with three boxes of saltine crackers and 12 rolls of toilet paper safely stowed aboard that I shook Jim Price's hand for the last time and intrepidly strode up the gangplank. With mixed feelings, I stood beside the "hammer and sickle" flapping in the Atlantic breeze and watched America fade slowly into the scarlet sunset. A new adventure had begun.

From the start, it was clear that the focus of my fears and expectations had been far off base. That first night, we were shuttled from cabin to cabin, meeting the various scientific groups on board the ship. Everyone whom we met was in good spirits after the visit to Woods Hole, and indeed it was with good spirits that we spent most of that first evening drinking toasts to the friendship between the USSR and the United States. Everybody made it clear from the start that he would do his utmost to help if ever we needed anything.

This established the air of friendliness which was to characterize the rest of the trip. Time and time again, these words were proven true as the Russians tried their best to understand and answer all of our questions. Whatever our query — whether it was about going to the sauna or how the ship receives a satellite image — all were considered with the same degree of thoughtfulness and attention to detail. Overnight, I had come from being a lowly undergraduate from Newfoundland to being an appreciated guest on a prestigious Soviet research vessel. It was an incongruous situation to be sure, but it was this which characterized the voyage, and this which impressed me the most.

It was reflected in the daily routine of life. For example, there were four meals scheduled each day. I have to admit that I never completely got used to the menu and skipped certain meals. However, suddenly it mattered whether the American guests showed up to dinner, and a small controversy erupted when it was discovered that we were not eating to capacity. The Russians took special pains to sneak food into our room, and the stewardess in the mess hall was always chasing us down to give us biscuits and buns. On July 4, we even found a cake in the room, which brightened our spirits immensely and was certainly a hit at the Independence Day celebration that evening. Ours was perhaps not the ideal communist situation, but the surprises were kind of fun, and the attention was always appreciated.

Contrary to popular conception back at Woods Hole, laundry turned out to be an individual responsibility (at least for us students). However, even here there were helping hands to help us use the machines. Indeed, if there had not been such help, we would not have been able to distinguish the buttons for the Russian labels and would have really been in trouble for the month. We even had a woman come to tidy our cabin every week, which was kind of embarrassing since the place always looked like a bombshell hit it. All in all, life was pretty good aboard the *Akademik Vernadsky*, so perhaps the *Love Boat* analogy was appropriate.

The Russians, themselves, seemed to be always working, and took the term "academic freedom" to extremes. Work and play were sort of merged together in one big twenty-four-hour cycle, every day identical with the next. Labs were places to hang out; that is, places to process data or, when the work got boring, places to sip tea. There were formal diversions to be sure, and among these billiards, dominoes, volleyball, and the once-a-week sauna were universal favorites. However, wandering around the ship in the early hours of the morning, I also managed to spot scientists fishing for octopus, and scientists huddled around video monitors playing computer games. Indeed, I will never forget the night I saw the Russians playing Jet Simulator on an IBM PC, piloting F14 Tomcats to blow MiG's out of the electronic aether. The incongruity of it all was striking.

Were there communications problems? I would be lying if I said there were not. Many people knew some English or French, however, and I ended up getting more practice in French than I've ever had in my life. There was always some kind of translator nearby. Yet for me, the biggest problem turned out to be not understanding the Russian language but rather trying to comprehend the math they were using.

Even so, there was still the occasional problem in the interfacing of ideas. For instance, I left Woods Hole with the voice of Jim Price ringing in my ears: "get parameters for the optical properties of seawater: use a Secchi disk if you have to." Like a good student, I tried to follow this up to the letter, but even with pictures, I had the toughest time communicating that I wanted a small, white metal disk to lower into the sea. At first the Russians could not find one, so the problem was discussed among the highest echelon of scientists who eventually decided to issue a work order to have one made. Then, a Secchi disk was found, and plans were made to lower the humble object into the sea with 100 kg of ballast on a one-ton winch. Clearly, there was something wrong here, and I finally convinced them that maybe a hand line might be more appropriate. Looking back on it, I am still not sure what the Soviets thought of the crazy Americans on their ship.

In the end, I guess that my most lasting impressions of the Russians were developed by simply sitting down and talking to them. At morning coffee and evening sessions and at parties, we exchanged endless questions, our mutual curiosity of the other's culture never quite satisfied. Ultimately, I realized that my initial fears of going on a Soviet ship were unfounded. After all, I had discovered a group of friends who live in faraway Sevastopol who were not much unlike me; a people who have families, who enjoy outdoor activities, who laugh and tell jokes just like me. It is these people who I will remember. Whether or not I continue with oceanography, the memory of my month on the Soviet research vessel will remain with me forever.

9.4 A Fourth of July — Richard Navitsky

I have not been able to write a brief accurate personal account of my stay on the Research Vessel *Akademik Vernadsky.* Instead I have chosen to write about a particular day in order to give my reader some insight to the cruise. I am able to say that I have learned much more than oceanography.

I was helping Andrew compile some of the 'drifter' data, which we had collected two days earlier, when Oleg came in and explained that there was to be a party that evening. It was to be a Fourth of July party held in my honor (in Jamie's honor also but it was to be his first Fourth of July). Originally I did not believe that I would have an opportunity to celebrate this holiday on the cruise. The idea suprised me and I hesitated before accepting. Andrew and I continued our work of inputting the numbers onto an IBM AT. This computer had not been as foreign as everything else and I was able to accomplish some useful tasks for the Soviets. Andrew mentioned that the drifter experiment might go out again that afternoon and asked if I wanted to help out again.

I enjoyed the drifter experiments because I would be able to ride in a small life boat about a mile from the ship. Our tasks included measuring the temperature of the upper 10 meters with a reversing thermometer, and obtaining the velocity profile with buoys. The buoys — painted block of styrofoam, with a slab of wood placed in the center, supporting a vane by a wire of given length — were hand made by Senya, the scientific captain of our little vessel. This is real oceanography, I believe.

The last time we ran the experiment the water was rather smooth and the sky cloudless. I had forgotten my suntan lotion and fried my skin. While trying to stretch for one of the buoys I lost my footing. I only fell in up to my waist because I caught the railing on the way down. Slava, one of the seamen who was always smiling, rushed to rescue me from the water, in which we planned to swim later.

While taking temperature readings Senya tried to tell me about his home, Sevastopol, and about his son, who recently had a birthday. Our discussions also included the future of the cold war and the craziest thing we had each done in college. He also attempted to teach me a few Russian words but I could only remember a few.

Oleg assured me if I went out on the boat they would push back the party. We left a couple hours before supper and would work to ten o'clock. I did not mind missing the meals because I rarely ate them even if I attemped to enter the dining room. After the sun set we put battery powered christmas-tree-like bulbs onto the wooden slabs of the buoys. They then looked much like candles floating upon the surface. We chased these drifting lights under the night sky and continued our talks of anything to fill the time.

In my cabin, when I returned, was the dinner I purposely avoided. I thought it was a pork patty with boiled barley but I gave it a proper burial at sea before I could be sure. There was also a delicious white cake which some of the women had prepared for Independence Day. Jamie and I were saving it for the party because we did not have anything to bring except for some beer I had stowed away.

Dr. Kudriavtsev's cabin was full of a dozen people whose names I still had trouble with. They all congratulated me on my Independence. Similar to other parties on the ship everyone had brought some of their stored rations to eat, ranging from pig's feet to chocolate bars. We popped open a bottle of champagne and ate everything in sight. I was able to communicate with them if I spoke very slowly and distinctly. By this time I was very fluent in broken English.

They asked questions revolving around independence and American politics. They seemed to know as much as I did, so we tried to tell some jokes. There were a few that just did not translate well. Things started to get a little silent. Then Genna asked if I had been scared to spend four weeks on a ship full of Russians. I said 'no' because I had met some of them at the parties in Woods Hole. I explained one particular meeting with a Soviet scientist at the Fenno House party.

I started to tell my story.

'I had told this scientist that I was going on the cruise with the ship and I asked him what I should bring. He responded without hesitation, "You must take with you beer, food, vodka, American music and computer games." As he said this, he pinched each finger on his left hand while proceeding through his list.'

The Soviets found this particularly funny because they all knew the scientist with whom I spoke. They all were laughing hysterically and it became contagious. The next thing I noticed was that we all had tears in our eyes from laughing. It reminded me of elementary school when a friend of mine would start to laugh uncontrollably with milk in his mouth and it would end up running out his nose. It was this type of hysterics. Finally after the giggling ceased as well as most the drink and food, Dr. Kudriavtsev produced another bottle of vodka. We continued to have a good time drinking, listening to music, and discussing nothing in particular. As they were leaving, they all mentioned that it had been their best Fourth of July ever. I said the same.

10 Appendices

10.1 Daily Work Schedules

Laboratory Abbreviations:

APO — Acquiring and processing of observations
DBL — Dynamics of boundary layer
DSL — Dynamics of ocean surface layer
FSL — Fine structure lab
GBL — Group biology lab
HYD — Hydrology lab
IWL — Internal wave lab
MAP — Mathematical processing lab
MAT — Materials lab
PIL — Profiling instrument lab
RAL — Radar lab
SAF — Surface-active film lab
SSI — Small-scale air–sea interaction lab
STS — Science/technical service group

NOTICE
Chief Scientist 39^{th} Cruise
R.V. *Akademik Vernadsky*
Doctor Phys.-Math. Science
V. A. Ivanov
12 June 1989

Plan of Work June 18 - July 16 1989
(Stage IV)

1. Hydrological CTD survey of mesoscale polygon 60 × 60 n. miles (Complex MHI 4207 and GEK)

   Labs: PIL, DSL, FSL, STS — 48 hrs

2. Investigation of transformation of wind waves in the Gulf Stream. Series of sections across Gulf Stream with current measurements (GEK), temperature and conductivity (MHI 4207), characteristics of wind waves.

   Labs: DSL, APO, RAL, SAF, PIL, STS — 96 hrs

3. Investigation of variability of vertical fine structure and structure of the ocean surface on sections across the Gulf Stream front, two sections across the Gulf Stream and a series of six drift stations every 10 miles of two hours duration each with measurements of fine structure (MHI 8101, MHI 4207), spectra of wind waves (wave graph, spectral analyzer) scattering properties of the surface (PL, scatterometer), plankton tow ("Malaya Djeda").

   Labs: FSL, PIL, SSI, SAF, DSL, RM, GB, STS — 48 hrs

4. Measurement of space–time structure of internal waves structure, surface and near-surface layer ocean during daytime warming (calm conditions), vertical fine structure and its time dependence, surface manifestation of SAF, plankton tow "Malaya Djeda."

   Drift Station:

   a) antenna RDT, wave graph distance measure, Drifters SAF;

   b) also, same as 'a', but instead of antenna RDT, sounding with MHI 8101, Complex MHI 4207

Labs: IWL, FSL, STS, PIL, SSI, SAF, DSL, RAL, GBL 48 hrs

5. Measurement of parameters of internal waves in the Gulf Stream frontal zone. Survey with Complex MHI 4207.

   Labs: IWL, PIL, STS 96 hrs

6. Measurement of angular characteristics of ripples, indicator of scattering.

   Labs: SAF, RAL 24 hrs

7. PABS, lowering of Complex MHI 1301, sounding with Complex MHI 4207.

   Labs: STS, PIL, APO 24 hrs

* In absence of calm weather work on daytime warming and surface phenomena SAF will be carried out during the crossing to Santa Cruz (allowed 48 hrs).

** Plankton tow not done in USA economic zone.

Chief Scientist of Expedition
Cand. Phys. Math. Sci. A. D. Lisichenok

NOTICE
Expedition Head 39th Cruise
Doctor Phys. Math. Science
V. A. Ivanov

NOTICE
Captain R.V. *Akademik Vernadsky*
Captain
A. C. Malinovsky

Work Plan on 18.06.89 to 20.06.89

Date, Time	Station no.	Location	Depth	Laboratories
18.06.89				
13.45–14.15	7267	38 51.7 N 67 52.0 W	4000	Profiling to 1000 m with Complex 4207 while drifting. Water samples.
16.15–16.55	7268	38 53.0 68 28.0	4000	STS, PIL, HYD, (work with GEK) DSL
17.25–18.05	7269	38 47.8 68 46.1	4000	Profiling with Complex MHI 4207 underway (at 14 kts) to 500 m: PIL, HYD, STS
19.35–20.15	7270	38 34.7 68 40.1	4000	same
20.45–21.15	7271	38 37.7 68 22.7	4000	- " -
21.55–22.35	7272	38 23.7 68 19.7	4000	- " -
23.05–23.45	7273	38 19.2 68 35.7	4000	- " -
19.06.89				
00.15–00.55	7274	38 05.7 68 29.8	4000	- " -
01.25–02.05	7275	38 08.8 68 12.0	4000	- " -
02.35–03.15	7276	37 55.0 68 08.2	4000	- " -
03.45–04.25	7277	37 50.2 68 25.2	4000	- " -
04.55–05.35	7278	37 37.0 68 19.3	4000	- " -
06.05–06.45	7279	37 39.8 68 01.4	4000	- " -
07.15–07.55	7280	37 26.2 67 57.6	4000	- " -
08.25–09.05	7281	37 21.2 68 15.0	4000	- " -
09.35–10.15	7282	37 07.8 68 08.5	4000	- " -
10.45–11.25	7283	37 10.6 67 50.8	4000	- " -
11.55–12.35	7284	36 57.0 67 47.5	4000	- " -
13.05–13.45	7285	36 53.2 68 04.6	4000	- " -
14.15–14.55	7286	36 50.5 68 16.2	4000	- " -
15.25–16.00	7287	36 47.0 68 31.0	4000	- " -
16.35–17.15	7288	36 44.0 68 48.5	4000	- " -

Date, Time	Station no.	Location	Depth	Laboratories
19.06.89 (continued)				
17.45–18.25	7289	36 57.5 68 53.2	4000	Profiling with complex MHI 4207 underway (at 14 kts) to 500 m: PIL, HYD, STS
18.55–19.35	7290	37 02.2 68 36.8	4000	same
20.05–20.45	7291	37 15.8 68 42.5	4000	- " -
21.15–21.55	7292	37 12.7 68 59.7	4000	- " -
22.25–23.05	7293	37 26.5 69 03.3	4000	- " -
20.06.89				
23.35–00.15	7294	37 31.2 68 47.0	4000	- " -
00.45–01.25	7295	37 44.3 68 52.9	4000	- " -
01.55–02.35	7296	37 41.2 69 09.8	4000	- " -
03.05–03.45	7297	37 55.3 69 13.5	4000	- " -
04.15–04.55	7298	38 00.0 68 57.9	4000	- " -
05.25–06.06	7299	38 13.3 69 03.0	4000	- " -
06.35–07.15	7300	38 10.3 69 20.3	4000	- " -
07.45–08.25	7301	38 24.3 69 24.0	4000	- " -
08.55–09.35	7302	38 28.8 69 07.1	4000	- " -
10.05–10.45	7303	38 43.0 69 13.3	4000	- " -
11.15–11.55	7304	38 39.1 69 30.2	4000	- " -

Deputy Chief Scientist: A. D. Lisichenok

Footnote: Underway measurements by Dynamics of Boundary Layer (DBL) group (measurement of ocean surface temperature); measurement of temperature and salinity underway in the central shaft with Complex MHI 4204; underway radar measurements, recording sound scattering layer.

NOTICE	NOTICE
Expedition Head 39th Cruise	Captain R.V. *Akademik Vernadsky*
Doctor Phys. Math. Science	Captain
V. A. Ivanov	A. C. Malinovsky

Work Plan on 20–21 June 1989

Date, Time	Work	Labs
Start	Drifting ship 38°N Lat.	DSL
20.06.89	68°57′ W Lon.	APO
09–00	-Work on small boat with drifters	SAF
	-Vertical profiling from bow to 10 m	PIL
	-RDT from winch #4	STS, FSL
	-Profiling with MHI-8101	DBL
	MHI-4207 every hour to 900 m	
	-Remote sensing from bow	
	-Hourly meteorological observations	

Footnote: In case of calm winds work with small boat will also be carried out at night. Work is coordinated by deputy chief scientist of the expedition, V. N. Kudriavtsev.

Deputy Chief Scientist of Expedition
Cand. Phys. Math. Sci. A. D. Lisichenok

NOTICE
Expedition Head 39th Cruise
Doctor Phys. Math. Science
V. A. Ivanov

NOTICE
Captain R.V. *Akademik Vernadsky*
Captain
A. C. Malinovsky

Work Plan for 21–22.06.89

Date, Time	Work	Labs
Start	Drifting ship 38°N Lat.	DSL
21.06.89	68°57′ W Lon.	APO
0900	-ST 7302	SAF, PIL
	-Small boat using drifters	STS
	-Vertical Profiling from	DBL
	bow of ship to 10 m	MAP: V. I. Babai
Finish	-Current meters MHI-1301	
22.06.89	hung from ship	
0900	-Remote sensing from bow	
	of ship	
	-Hourly meteorological observations	
	-Profiling with MHI-4207	

Footnote: In case of calm winds, work on launch will be carried out also at night. Work is coordinated by Assist. Chief of Expedition V. N. Kudriavtsev. Duration of sampling with MHI-4207 will be decided later.

Assistant Chief Scientist of Expedition
Cand. Phys. Math. Sci. A. D. Lisichenok

NOTICE	NOTICE
Expedition Head 39th Cruise	Captain R.V. *Akademik Vernadsky*
Doctor Phys. Math. Science	Captain
V. A. Ivanov	A. C. Malinovsky
21 June 1989	21 June 1989

Work Plan on 22–25 June 1989

Date, Time	Work	Labs
Station 7302	Drifting ship 38°N Lat. 68°57′ W Lon.	
22.06.89		
0800–1000 1200	Profiling with MHI-4207* to 100 m	STS, PIL Hydrography
1000–1100	Recovery of MHI-1301 instruments	MAP (Babai, V. I.)
22.06–25.06		
0800–1930	-Work with drifters on launch	DSL
	-Vertical sounding from bow	APO
	-Remote sensing from bow	DBL
	-Hourly meteorological observations	
22.06.89		
1100–1400	-Experiment "artificial slick"** Ship moves around slick	SAF
1400–1630	-Testing rubber samples	MAT
1630–1930 22.06	-Placement of Complex MHI-4206	IWL Deck crew
22.06–25.06.89		
1930–1930	-Measurement of internal wave characteristics with three lines MHI-4206	IWL

Footnotes:

* Profiling with MHI-4207 at 1200 will be carried out in case of cancellation of work on item 4

** Work on item 4 will be carried out for winds > 5 m/s

Assistant Chief Scientist of Expedition
C.P.M.S. A. D. Lisichenok

Work Plan
25 June 89 to 29 June 89

Date, Time	Type of Work	Labs
25 June 89	Series of sections across	DSL
Start	Gulf Stream at full speed	PIL, STS, SAF
1000	with measurement of velocity	RAL, DBL
	spectra with GEK. Profiling	APO
	with MHI-4207 to 500 m.	
	Remote sensing of ocean surface.	
	Meteorological measurements.	
29 June 89		
End		

Footnote: Work is coordinated by deputy chief scientist V. N. Kudriavtsev. Cruise track will be decided operationally depending on received results. Exact end of experiment will depend on weather conditions.

Deputy Chief Sci. Exp. 39th cruise
R.V. *Akademik Vernadsky*
C.P.M.S. A. D. Lisichenok

<table>
<tr>
<td align="center">NOTICE
Expedition Head 39th Cruise
Doctor Phys. Math. Science
V. A. Ivanov</td>
<td align="center">NOTICE
Captain R.V. Akademik Vernadsky
Captain
A. C. Malinovsky
29 June 1989</td>
</tr>
</table>

Work Plan
29.06.89 to 30.06.89
Work from Port Side (Drifting)

Station	Time	Coordinates	Depth	Type of Work, Labs
7304	0800–1930	37°02′ N 67°48′ W	3800 m	Profiling with Complex MHI 4207 to 1000 m (Winch #6); Profiling with MHI 8101 to 1000 m (Winch #8) Measurement of characteristics of surface waves with ABV. Labs: PIL, STS, HYD, FSL, SSI
7305	2030–2200	36°52′ N 68°48′ W	3000 m	"
7306	2300–0030 29.06–30.06	36°42′ N 67°48′ W	3000 m	"
7307	0130–0300	36°32′ N 67°48′ W	3000 m	"
7308	0400–0530	36°22′ N 67°48′ W	3000 m	"
7309	0630–0800	36°12′ N 67°48′ W	3000 m	"

Deputy Chief Scientist
C.P.M.S. A. D. Lisichenok

NOTICE
Expedition Head 39th Cruise
Doctor Phys. Math. Science
V. A. Ivanov

NOTICE
Captain R.V. *Akademik Vernadsky*
Captain
A. C. Malinovsky

Work Plan
01.07.89 to 02.07.89
Work from Port Side (Drifting)

Station	Time	Coordinates	Depth	Type of Work, Labs
	01.07.89			
7324	1400–1530	39°30.0 N 65°43.5 W	3800 m	Profiling with Complex MHI 4207 to 1000 m (Winch #6); Profiling with MHI 8101 to 1000 m (Winch #8). Measurement of characteristics of surface waves with ABV. Labs: PIL, STS, HYD, FSL, SSI
7325	1700–1830	39°20.0 65°43.5	3000 m	"
7326	2000–2130	39°10.0 65°43.5	3000 m	"
	01.07.89–02.07.89			
7327	2300–0030	39°00.0 65°43.5	3000 m	"
7328	0200–0330	38°50.0 65°43.5	3000 m	"
7329	0500–0630	38°40.0 65°43.5	3000 m	"

Deputy Chief Scientist
A. D. Lisichenok

NOTICE
Expedition Head 39th Cruise
Doctor Phys. Math. Science
V. A. Ivanov
1 July 1989

NOTICE
Captain R.V. *Akademik Vernadsky*
Captain
A. C. Malinovsky
1 July 1989

Work Plan
From 02.07.89 to 07.07.89

Date, time	Work	Labs
02.07.89	Underway to 39 N Lat. 66 30 W Lon.	DSL APO, PIL, STS, HYD
0630–0800	-ST 7331	
0800–2000	-Work from launch with drifters,* vertical profiling from bow to 10 m.	
0800, 0900, 1000 1100, 1200, 1300	-Profiles with MHI 4207 (first to 1000 m, rest to 100 m)	
0800–1600	Experiment with artificial slick**	SAF
1600–2000	-Setting of MHI 4206	Internal Waves, Deck Crew
02.07.89 2000 –	Survey with complex MHI 4206***	Internal Waves, STS
07.07.89	(Speed Survey 5–7 kts)	
0800–1000	-Recovery of MHI 4206	Internal Waves, Deck Crew

Footnotes:

Underway work of the Dynamics of Boundary Layer Lab (measurement of surface temperature of the ocean); measurement of temperature and salinity in the central shaft while underway with Complex MHI 4204; underway radar observations; recording of sound scattering layer and bottom topography; meteorological observations.

* Work on point * will be done in calm weather (w < 5 m/s).

** Work on point ** will be done in weak winds (w < 9 m/s).

*** In case of storm winds (w > 15 m/s) survey with MHI 4206 will be terminated and work will be carried out on study of wind waves in the Gulf Stream region.

Assistant Chief Scientist of Expedition
Cand. Phys. Math. Sci. A. D. Lisichenok

NOTICE
Expedition Head 39^{th} Cruise
Doctor Phys. Math. Science
V. A. Ivanov

NOTICE
Captain R.V. *Akademik Vernadsky*
Captain
A. C. Malinovsky

Work Plan
From 07.07.89 to 08.07.89

Date, Time	Type of Work	Labs
07.07.89	Series of cross sections of Gulf Stream underway with measurement of velocity by GEK, profiling to 500 m with MHI 4207*	Dynamics of Surface Layer, Profiling Equipment (PIL). STS, SAF, Radar Lab, GEK, Dynamics of Boundary Layer; Analysis of observations.
08.07.89	Remote sensing of ocean surface	
2400 End	Meteorological observations	

Footnote: Profiling with MHI 4207 to be determined later. The work is coordinated by Deputy Chief Scientist V. N. Kudriavtsev. Cruise track will be determined operationally depending on the obtained results.

Assistant Chief Scientist of Expedition, 39^{th} Cruise
Cand. Phys.-Math. Sci. A. D. Lisichenok

10.2 Seminars

NOTICE
Chief Scientist 39th Cruise
R.V. *Akademik Vernadsky*
Dr. Phys.-Math. Sci.
V. A. Ivanov
20 June 1989

Plan of Scientific Seminars
17.06 – 17.07

No.	Title	Author	Date
1.	Organization of W.H.O.I. and its Basic Research Objectives	Prof. N. P. Fofonoff	23.06
2.	Interaction of Waves and Currents	Prof. E. N. Pelinovsky	27.06
3.	On Growth and Decay of Internal Waves by Interaction with Wind Waves	C.P.M.S. V. N. Kudriavtsev	04.07
4.	Seasonal Changes of Large Scale Circulation of Tropical Atlantic	C.P.M.S. G. A. Chepurin	07.07
5.	Problems of Black Sea Ecology	D.H.S. A. N. Kosarev	11.07
6.	Problems of Gulf Stream Studies	Prof. N. P. Fofonoff	13.07

10.3 Daily Menus

NOTICE
2nd Mate A. V. Afanaskin

MENU

21.06 Breakfast: Goulash, Butter, Tea, Lemon
Lunch: Borsch, Meat with Buckwheat, Compote
Tea: Eggplant, Lavash, Tea
Dinner: Bean Soup, Ragou, Fruit

22.06 Breakfast: Cheese, Cocoa, Butter & Bread
Lunch: Borsch, Chops with Rice, Compote
Tea: Milk, Bun
Dinner: Rice Soup, Solyanka, Fruit

23.06 Breakfast: Sausages, Butter, Tea with Lemon
Lunch: Vegetable Soup, Fried Chicken with "Feathers," Kissel
Tea: Fried Peppers, Butter, Tea
Dinner: Fish Soup, Mashed Potato (hash browns) with Egg, Fruit

24.06 Breakfast: Bacon, Butter, Tea, Lemon
Lunch: Borsch, Boiled Meat with "Rozhkami," Compote
Tea: Keffir, Cookies
Dinner: Homemade Soup, Fried Fish, Puree, Fruit

25.06 Breakfast: Ham, Butter, Tea, Lemon
Lunch: Borsch, Goulash with Wheat Kasha, Kissel
Tea: Herring, Potatoes, Tea
Dinner: Soup with Meatballs, Macaroni and Meat, Fruit

26.06 Breakfast: Cheese, Butter, Tea, Lemon
Lunch: Vegetable Soup, Chops with Rice, Compote
Tea: Salad, Tea
Dinner: Rice Soup, Potato Sauce, Fruit

27.06 Breakfast: Goulash, Butter, Tea, Lemon
Lunch: Borsch, Beef Stroganoff with Millet, Compote
Tea: Milk Soup Vermisheli
Dinner: Fish Soup, Cutlets with Puree, Fruit

28.06 Breakfast: Meat Pie, Butter, Tea, Lemon
Lunch: Borsch, Chakhokhbili with Rice, Compote
Tea: Keffir, Waffles
Dinner: Soup "Lapsha," Liver with "Rozhkami," Fruit

29.06 Breakfast: Poached Egg, Tea, Butter, Lemon
Lunch: Borsch, Meat with Macaroni, Compote
Tea: Salad, Tea
Dinner: Soup "Perlovai," Blini with Meat, Fruit

30.06 Breakfast: Kolbasa, Tea, Butter, Lemon
Lunch: Borsch, Chops with "Rozhkami," Compote
Tea: Bun, Milk
Dinner: Field Soup, Lyulya-kebob, Fruit

01.07 Breakfast: Ham, Butter, Tea, lemon
Lunch: Borsch, Tongue with Rice, Compote
Tea: Keffir, Cookies
Dinner: Rice Soup, Potato Sauce, Fruit

02.07 Breakfast: Kolbasa (sausages), Tea, Butter, Lemon
Lunch: Borsch, Cutlets with "Rozhkami," Compote
Tea: Herring with Potato, Tea
Dinner: Homemade Soup, Eggplant with Potato Puree

03.07 Breakfast: Omelet, Butter, Tea, Lemon
Lunch: Borscht, Steak with Macaroni, Compote
Tea: Fried Peppers, Butter, Tea
Dinner: Soup, Lazy "Golybtsi," Compote

04.07 Breakfast: Cheese, Butter, Cocoa
Lunch: Borscht, Fried Chicken with Rice, Compote
Tea: Rolls, Butter, Tea
Dinner: Field (polevoi) Soup, Mashed Potatoes, Compote

05.07 Breakfast: Chopped Liver, Butter, Tea, Lemon
Lunch: Borsch, Cutlets with "Rozhkami," Compote
Tea: Milk Soup Vermisheli
Dinner: Field Soup, Mashed Potatoes, Compote

06.07 Breakfast: Goulash, Butter, Tea, Lemon
Lunch: Borscht, Tongue with Rice, Compote
Tea: Caviar, "Lavash," Tea
Dinner: Rice Soup, "Pelmeni," Fruit

07.07	Breakfast: Boiled Egg, Butter, Tea, Lemon Lunch: Borscht, Beef Stroganoff with "Perlovkov" (Millet?), Compote Tea: Milk, Cookies Dinner: Homemade Soup, Baked Potato, Kissel
08.07	Breakfast: Brazil Sausages, Butter, Tea, Lemon Lunch: Borscht, Cutlets with Rice, Compote Tea: Roll, Tea, Butter Dinner: Rice Soup, Fried Potatoes and Eggs, Compote
09.07	Breakfast: Kalbasa, Tea, Butter Lunch: Borscht, Meat with Wheat Kasha, Compote Tea: Herring, Potato, Tea Dinner: Soup with "Galyshkami," Goulash with "Feathers," Kissel
10.07	Breakfast: Ham, Tea, Butter, Lemon Lunch: Borscht, Fried Chicken with Rice, Compote Tea: Keffir, Cookies Dinner: Fish Soup, Vegetable Ragou, Kissel

Head	Yu, N. Gorachkin
	O. A. Belozer
	U. B. Sidorova
Chef-Cook	G. Sh. Averladze

"Lavash" — Georgian unleavened bread
"Galyshka" — small boiled dumpling
"Kissel" — slightly jelly-like fruit juice
"Keffir" — fermented goat's milk
"Rozhkami" — macaroni-like pasta
Compote — stewed fruit

10.4 Index of Video Scenes

A list of scenes recorded on VHS cassettes during the cruise:

Cassette #1

Index Video	VCR	
		Arrival of R.V. *Akademik Vernadsky*, June 16, 1989
0000	0000	Start top of Bigelow building
0085	0064	Antenna in fog
0169	0127	Thick fog
0170	0128	Some commentary
0239	0179	Dorman on dock
0295	0221	View of Eel Pond
0390	0292	R.V. *Akademik Vernadsky* in sight
0650	0488	" " " approaching dock
0800	0600	Line thrown to dock
		Departure, June 17, 1989
0870	0652	Departure scenes at WHOI dock
1450	1088	End of departure scenes
		Shipboard Scenes
1452	1089	Profiling lab
1690	1268	Minisonde lowered into ocean
1750	1312	Boris and Ellen
1790	1342	Surface-active film lab
2100	1575	Forgot to turn off video
2665	1999	Outdoor scene
2710	2032	Shots of floor!
2868	2151	Meteorology lab
2915	2186	Lowering of launch
3030	2272	Launch in water
3407	2555	Fine structure lab
3460	2595	Launch
3487	2615	Meteorology lab
3500	2625	Volleyball
3683	2762	Winch
3700	2775	Launch
3850	2888	Ladies on deck
3880	2910	Hydrolab, Irina at terminal
3940	2955	Mounting current meters on cable
4150	3112	Testing subsurface buoy
4230	3172	Lifeboat launch
4468	3351	Volleyball
4542	3406	Internal wave "shark"
4590	3442	Internal wave lab

Cassette #1 (continued)

Index	Video	VCR	
	4810	3608	Laundry
	4880	3660	Zoya, laundress
	4978	3734	Lenin
	5033	3775	Pool table
	5093	3820	Biology lab
	5490	4118	End of Cassette #1, June 24, 1989

Cassette #2

Index	Video	VCR	
	0000	0000	Kudriavtsev explaining cruise plan
	0913	0685	GEK lab
	1040	0780	GEK electrode
	1280	0960	Rescue of Bermuda Race yacht
	1570	1178	Line attached to yacht
	1810	1358	Yacht under tow to New York
	1852	1389	June 26, 1989
	1981	1486	June 26, 1989, 15:20 EST
	2180	1635	Volleyball, June 26, 5:53 p.m. EST
	2270	1702	Coast Guard helicopter, June 28, 7:13 a.m. EST
	2435	1826	Coast Guard boat
	2500	1875	Line dropped to boat
	2870	2152	Skipper aboard
	3000	2250	Stretcher on board Coast Guard boat, 8:19 a.m. EST
	3140	2355	Ladies on fantail
	3184	2388	Satellite lab
	3344	2508	Sargasso weeds
	3390	2542	Large slick(?) on satellite image
	3575	2681	Central shaft through hull
	3706	2780	Jamie at work
	3736	2802	Ellen
	3791	2843	Rosenberg, Federovsky, Kosarev, Levy talking
	3840	2880	Internal wave probe hauled onboard (SAF lab)
	3890	2918	July 4^{th} poster
	3980	2985	Hydrolab, Irina
	3989	2992	Napoleon cake for us, July 4, 9:05 a.m. EST
	4030	3022	July 5, 1989, 19:24
	4030	3022	Making pelmeni, July 6, 1989
	4480	3360	Ship's kitchen
	4579	3434	Tasting pelmeni
	4593	3445	Start of CTD calibration station
	4853	3640	July 8, 4:16 p.m. EST
	4887	3665	Start lowering CTD
	5040	3780	V. Kim getting water samples
	5091	3818	Radio room
	5171	3878	Hauling wave gauge on fantail
	5221	3916	Start of Fisherman's Day concer
	5827	4370	End of concert part 1
	5828	4371	Temperature calibration of CTD
	5869	4402	End of tape

Cassette #3

Index	Video	VCR		
	0000	0000	Concert continued	
	1796	1347	End of concert	
	1797	1348	Small boat launch	
	1813	1360	July 12, 5:15 a.m. EST	
	1888	1416	Start of scientific reports	
	1904	1428	July 15, 12:11 p.m. EST (16:05 ship time)	
	1944	1458	Malinovsky	(Radar lab)
	2211	1658	Yastreb	(Hydrology lab)
	2621	1966	Lemeshko	(Surface Boundary Layer lab)
	3117	2338	Efremov	(Fine Structure lab)
	3580	2685	Moiseev	(Fine Structure lab)
	3917	2938	Tsvetkov	(Data Processing lab)
	4264	3198	Proschenko	(Small-Scale Air–Sea Interaction lab)
	4315	3236	Babanin	(Small-Scale Air–Sea Interaction lab)
	4624	3468	Gorachkin	(Internal Wave lab)
	4804	3603	July 15, 1:31 p.m. EST	
	4976	3732	Dulov	(Surface Layer lab)
	5397	4048	Kudriavtsev	(Assistant Chief Scientist)
	5624	4218	Arrival in Santa Cruz de Tenerife harbor	
	5779	4334	July 18, 2:50 a.m. EST	
	5856	4392	End of Tape	

Cassette #4

Index	Video	VCR	
	0000	0000	Picture display of Boston, WHOI visit, shipboard scenes, July 19, 3:44 a.m. EST
	0297	0223	Touring Tenerife by car, Pico del Teide (volcano)
	0424	0318	Panoramic view of western side of island
	0587	0440	Start back to Santa Cruz
	0720	0540	July 19, 10:55 a.m. EST (15:49 local time)
	0900	0675	On main highway to Santa Cruz
	0933	0700	Radio Club hill
	1527	1145	Return to *Akademik Vernadsky*
	1528	1146	July 19, 12:56 p.m. EST (17:50 local time)
	1677	1258	Irina Tatarinskia (our waitress)
	1781	1336	Agent getting off ship
	1880	1410	Hydrofoil ferry
	1973	1480	Ship pulling away from dock
	2377	1783	Waving goodbye to *Akademik Vernadsky*
	2379	1784	On road to hotel
	2840	2130	End of tape

Cassette #5 (Seminars)

Index Video	VCR	
0000	0000	Prof. E. Pelinovsky: Interaction of waves and currents.
3883	2912	(In English).
3883	2912	Dr. V. Kudriavtsev: On growth and decay of internal
5811	4358	waves by interaction with wind waves. (In Russian).

Cassette #6 (Seminars)

Index Video	VCR	
0000	0000	C.P.M.S. G. A. Chepurin: Seasonal changes of large scale
2890	2168	circulation of tropical Atlantic. (In Russian).
2890	2168	D.H.S. A. N. Kosarev: Problems of Black Sea ecology.
5725	4294	(In Russian with English introduction)

DOCUMENT LIBRARY

January 17, 1990

Distribution List for Technical Report Exchange

Attn: Stella Sanchez-Wade
Documents Section
Scripps Institution of Oceanography
Library, Mail Code C-075C
La Jolla, CA 92093

Hancock Library of Biology &
Oceanography
Alan Hancock Laboratory
University of Southern California
University Park
Los Angeles, CA 90089-0371

Gifts & Exchanges
Library
Bedford Institute of Oceanography
P.O. Box 1006
Dartmouth, NS, B2Y 4A2, CANADA

Office of the International
Ice Patrol
c/o Coast Guard R & D Center
Avery Point
Groton, CT 06340

NOAA/EDIS Miami Library Center
4301 Rickenbacker Causeway
Miami, FL 33149

Library
Skidaway Institute of Oceanography
P.O. Box 13687
Savannah, GA 31416

Institute of Geophysics
University of Hawaii
Library Room 252
2525 Correa Road
Honolulu, HI 96822

Marine Resources Information Center
Building E38-320
MIT
Cambridge, MA 02139

Library
Lamont-Doherty Geological
Observatory
Columbia University
Palisades, NY 10964

Library
Serials Department
Oregon State University
Corvallis, OR 97331

Pell Marine Science Library
University of Rhode Island
Narragansett Bay Campus
Narragansett, RI 02882

Working Collection
Texas A&M University
Dept. of Oceanography
College Station, TX 77843

Library
Virginia Institute of Marine Science
Gloucester Point, VA 23062

Fisheries-Oceanography Library
151 Oceanography Teaching Bldg.
University of Washington
Seattle, WA 98195

Library
R.S.M.A.S.
University of Miami
4600 Rickenbacker Causeway
Miami, FL 33149

Maury Oceanographic Library
Naval Oceanographic Office
Bay St. Louis
NSTL, MS 39522-5001

Marine Sciences Collection
Mayaguez Campus Library
University of Puerto Rico
Mayagues, Puerto Rico 00708

Library
Institute of Oceanographic Sciences
Deacon Laboratory
Wormley, Godalming
Surrey GU8 5UB
UNITED KINGDOM

The Librarian
CSIRO Marine Laboratories
G.P.O. Box 1538
Hobart, Tasmania
AUSTRALIA 7001

Library
Proudman Oceanographic Laboratory
Bidston Observatory
Birkenhead
Merseyside L43 7 RA
UNITED KINGDOM

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. WHOI-90-12	2.	3. Recipient's Accession No.

4. Title and Subtitle Report on R.V. *Akademik Vernadsky* Cruise 39, Stage IV June 17– July 17, 1989	5. Report Date April, 1990 6.
7. Author(s) Nick P. Fofonoff, Ellen Levy, A. James Kettle and Richard C. Navitsky	8. Performing Organization Rept. No. WHOI 90-12
9. Performing Organization Name and Address The Woods Hole Oceanographic Institution Woods Hole, Massachusetts 02543	10. Project/Task/Work Unit No. 11. Contract(C) or Grant(G) No. (C) (G)
12. Sponsoring Organization Name and Address Funding was provided by Vetelsen, the Education Office of Woods Hole Oceanographic Institution, and a Dr. William B. Richardson Summer Fellowship provided by Alden Products Company.	13. Type of Report & Period Covered Technical Report 14.

15. Supplementary Notes

This report should be cited as: Woods Hole Oceanog. Inst. Tech. Rept., WHOI-90-12.

16. Abstract (Limit: 200 words)

Participation by U.S. personnel on Cruise 39, Leg IV (June 17 – July 17, 1989) of the Marine Hydrophysical Institute's research vessel *Akademik Vernadsky* provided valuable information, documented in the present report, for planning future cooperative projects with Soviet oceanographers. Detailed descriptions are given of the ship, its scientific laboratories, computers and on-board instrumentation. Planning and operating procedures are described and examples are given of daily work plans, seminars, menus and social activities. Personal accounts by the U.S. participants are also included. Many of the shipboard activities were recorded on VHS video cassettes.

The oceanographic data collected in the Gulf Stream survey region during Leg IV are documented in the report. Copies of data sets were provided to the U.S. participants in exchange for U.S. data from the region during the survey period.

17. Document Analysis a. Descriptors

1. U.S. – Soviet oceanography
2. Gulf Stream
3. wave-current interaction

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
Approved for publication; distribution unlimited.	UNCLASSIFIED	87
	20. Security Class (This Page)	22. Price

(See ANSI-Z39.18) *See Instructions on Reverse*

OPTIONAL FORM 272 (4-77)
(Formerly NTIS-35)
Department of Commerce