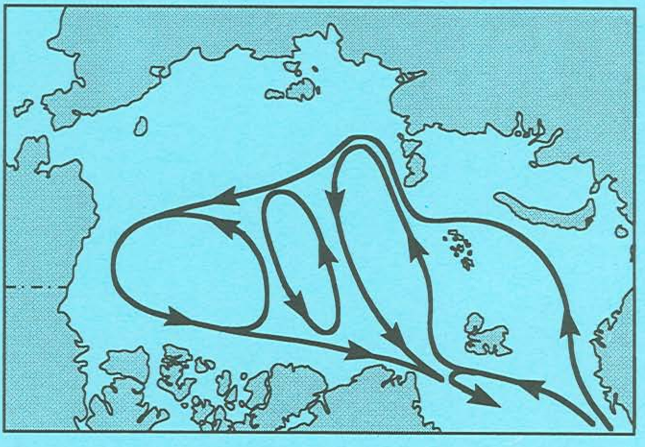
RV POLARSTERN

Expedition Programme No. 42

ARCTIC '96



ARK-XII
1996

ALFRED WEGENER INSTITUTE FOR POLAR AND MARINE RESEARCH
BREMERHAVEN, JULY 1996

RV POLARSTERN

Expedition Programme No. 42

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Coordinator and Chief Scientist:

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Alfred-Wegener-Institut
für Polar- und Meeresforschung
Bremerhaven

July 1996

1. Zusammenfassung

Das Vorhaben Arctic '96 wird als gemeinsame Expedition des deutschen Forschungschiffes *Polarstern* und des schwedischen Forschungsschiffes *Oden* durchgeführt.

Die Feldarbeiten sind zwischen den beiden Schiffen so aufgeteilt, daß - unter Nutzung der jeweiligen technischen Möglichkeiten - eine hohe Effizienz erreicht werden kann. Dementsprechend übernimmt die *Oden* vorrangig die geologischen und geophysikalischen Programme sowie die Untersuchungen zur Meereisfernerkundung, während die *Polarstern* sich auf die physikalische, dynamische und biologische Ozeanographie, die Meereisphysik und Atmosphärenphysik konzentriert.

Damit leisten die *Polarstern*-Messungen einen bemerkenswerten Beitrag zu der internationalen Arctic Climate System Study (ACSYS), die ein Teilprogramm des World Climate Research Programme (WCRP) darstellt. Modell- und Feldstudien haben in den letzten 20 Jahren die Vorstellungen erhärtet, daß das Nordpolarmeer mit den es umgebenden Schelfmeeren wirksam in die globale Ozeanzirkulation eingebunden ist und über den Einfluß auf die Erneuerung des Nordatlantischen Tiefenwassers an der Steuerung des globalen Klimas beteiligt ist. Darum ist die ACSYS hauptsächlich auf die Erforschung der Wassermassenmodifikation und der Energie- und Süßwassertransporte im Bereich des Nordpolarmeeres und der arktischen Schelfmeere ausgerichtet.

Aufgrund historischer Daten und neuerer Messungen der *Polarstern* (1991, 1993, 1995), der *Oden* (1991), der *Rossiya* (1990), der *Henri Larsen* und *Polar Star* (1993) und der *Louis St. Laurent* (1994) wurde ein Forschungskonzept für ACSYS entwickelt, in das sich das Programm dieser *Polarstern*reise ARK XII vollständig einfügt. Im Vordergrund stehen vier übergeordnete Ziele, und zwar

• die detaillierte Erfassung des hydrographischen Aufbaus des Ozeans auf einem Vertikalschnitt längs einer Traverse von Franz-Joseph-Land über die St. Anna- und Voronin-Tröge bis zur Insel Severnaya Zemlya

• eine Aufnahme der Ozeanzirkulation in den Nansen-, Amundsen- und Makarov-Becken unter besonderer Beachtung der topographischen Einflüsse durch die Gakkel- und Lomonossov-Rücken

• die quantitative Beschreibung der Ausbreitung und der zeitlichen Schwankungen des Atlantischen Wassers im Übergangsbereich zwischen der Laptevsee und dem Lomonossov-Rücken und

• die Bestimmung des atmosphärischen Antriebes auf das Meereis vor allem in der Transpolaren Drift nördlich der Laptevsee.

Zur Erfüllung dieser Aufgaben werden moderne Meßsysteme vom Schiff, von Hubschraubern und auf dem Meereis eingesetzt. Diese Messungen werden vervollständigt durch Daten von Satelliten, automatischen Meßstationen auf Eisschollen und Tiefseeverankerungen. Viele der Meßwerte dienen zum Antrieb, zur Überprüfung und zur Verbesserung von numerischen Modellen, unter denen ein neues hochauflösendes Ozean-Meereis-Modell besonders im Vordergrund steht.

Das Expeditionsprogramm wurde gemeinsam von britischen, deutschen, finnischen, irischen, kanadischen, russischen, schwedischen und us.amerikanischen Wissenschaftlern entwickelt, die auch an Bord zusammenarbeiten werden.

Polarstern wird am 12. Juli 1996 von Bremerhaven auslaufen. Am 18./19. Juli ist ein kurzer Hafenaufenthalt in Murmansk vorgesehen, um russische und finnische Fahrtteilnehmer und deren Geräte an Bord zu nehmen. Dann folgt das Schiff der in der Abb. 1 gezeigten Route, um zunächst bei etwa 60 E / 78 N zum ersten Mal mit der *Oden* zusammenzutreffen. Beide Schiffe fahren dann im Konvoi bis 65 E / 80.5 N, wo *Polarstern* die zonale Traverse westwärts beginnt, während die *Oden* den nordwärtigen Kurs fortsetzt. Mit engabständigen hydrographischen Vertikalprofilen (CTD und Rosette mit 36 Flaschen) soll - neben der Wassermassenstruktur - der Zufluß des in der Barentssee modifizierten Atlantikwassers durch die beiden Tröge (St. Anna und Voronin) in das tiefe Arktische Becken bestimmt werden. Neben den physikalischen Größen werden chemische Konzentrationen und spezifische Spurenstoffe gemessen. Sollten die Eisverhältnisse es nicht zulassen, den vorgesehenen östlichen Punkt der Traverse zu erreichen, wird der Kurs bereits weiter westlich (Alternative 2 in der Abb. 1) nach Norden abgesetzt.

Auf dem Wege vom Schelfrand der Karasee bis in das Makarov-Becken werden die hydrographischen Messungen mit unterschiedlicher räumlicher Dichte (abhängig von der Bodentopographie) fortgesetzt. Außerdem sind Arbeiten auf dem Meereis, Netzfänge und Hubschraubereinsätze für Meereisuntersuchungen und Messungen in der atmosphärischen Grenzschicht vorgesehen. Letztere werden gelegentlich durch den Betrieb einer Turbulenzmeßanlage am Bugkran ergänzt. Während die Arbeitsziele der physikalischen und chemischen Ozeanographie grundsätzlich dem des ersten Zonalschnittes gleichen, befassen sich die Meereisphysiker mit Analysen der Feinstruktur des Meereises und erkunden gemeinsam mit Biologen das Leben im Meereis. Außerdem werden laufend die großskalige Beschaffenheit der Eisdecke (wie Eisdicke, Schollengrößenverteilung, Eisrückenstatistik, Eiskonzentration) und die Strahlungseigenschaften ihrer Oberfläche registriert. Aus den Wasserproben der Rosette und mit Hilfe von Netzfängen bestimmen die Biologen die horizontale und vertikale Verteilung des Phyto- und Zooplanktons im Zusammenhang mit den Lichtbedingungen und dem Nährstoffangebot. Das Ziel dieser Arbeiten ist die quantitative Beschreibung der Phyto- und Zooplanktonökologie des Nordpolarmeeres.

Neben diesen Hauptprogrammen werden Wasserproben auch auf ihren Gehalt an gelöster organischer Substanz (DOM) und deren chemischer Struktur analysiert, um zwischen ozeanischen und terrigenen Anteilen zu unterscheiden sowie die Veränderungen letzterer während ihrer Ausbreitung in der Transpolaren Drift aufzuklären.

Schließlich soll an einigen Positionen die Belastung des Meerwassers mit radioaktiven Stoffen wie Plutonium, Americium und Strontium gemessen werden.

Ein zweites Treffen mit der *Oden* ist bei 140 E / 86 N vorgesehen, bevor der Abschnitt in das Makarov-Becken fortgesetzt wird. Weitere zonale Überquerungen des Lomonossov-Rückens sind bei 83 N und 81 N, wiederum verbunden mit hydrographischen Messungen, vorgesehen. Das südöstliche Meßnetz verbindet die Positionen von drei 1995 ausgebrachten Tiefseeverankerungen (Abb. 2), die gemeinsam mit der *Oden* geborgen werden sollen. In diesem Gebiet werden auch drei automatische Meßbojen ausgesetzt (Abb. 3), die Daten in der Atmosphäre, im Meereis und in dem oberen Bereich der Wassersäule aufnehmen. Das Meßprogramm endet am 10. September an der Position 135 E/ 79.5 N. Von dort läuft *Polarstern* zur Vilkitzky Straße, kreuzt die Karasee und erreicht über die östliche Barentssee am 22. September wiederum Murmansk. Nach dem Ausschiffen der russischen Teilnehmer beginnt am 23. September die Heimreise. Die Expedition endet am 29. September 1996 mit dem Einlaufen in Bremerhaven.

2. Summary

Arctic '96 is a joint research endeavour of two research vessels, the German *Polarstern* and the Swedish *Oden.*

The multidisciplinary research programme is shared between these two platforms in order to ensure the highest possible degree of efficiency in the field work with account to the specific technical capacity of each vessel. Consequently, the work on *Oden* concentrates on geological, geophysical and sea ice remote sensing studies, while the investigations on *Polarstern* are devoted to physical, chemical and biological oceanography, see ice physics and the atmospheric boundary layer.

The majority of the *Polarstern* measurements are designed to substantially contribute to the aims of the Arctic Climate System Study (ACSYS) of the World Climate Research Programme (WCRP). Several studies during the recent 20 years have provided evidence that the Arctic Ocean and the adjacent shelf seas play a major role in the deep thermohaline oceanic circulation and may thus significantly influence the global climate. Consequently, a special subprogramme, the Arctic Climate System Study (ACSYS) has been launched in the framework of the World Climate Research Programme (WCRP) to investigate the governing oceanic, atmospheric and hydrological processes of the Arctic region. The description and modelling of the water mass modification, the circulation, mass and energy transports in the Arctic Ocean and the neighbouring shelf seas are given the highest priority in ACSYS.

On the basis of historic data from expeditions of the former Soviet Union, Canada and the United States of America as well as of recent measurements [cruises of *Polarstern*(1991, 1993, 1995), *Oden* (1991), *Rossiya* (1990), *Henri Larsen* and *Polar Star* (1993) and *Louis St. Laurent* (1994)] hydrographic cross-sections and the deployment of moorings have been recommended by the ACSYS Scientific Steering Group for the Arctic region. The plan for the *Polarstern* Cruise ARK XII is in full accordance with these suggestions, which concentrate on four major aims, namely

- to specify the hydrographic structures along a transect from Franz Joseph Land to Severnaya Zemlya in order to quantify the exchanges between the Kara Sea and the Arctic Ocean particularly through the St. Anna and Voronin Troughs

- to observe the circulation within the Nansen, Amundsen and Makarov Basins and parallel to to the Gakkel and Lomonossov Ridges in order to determine the topographic influence on the oceanic flow

- to quantitatively describe the spreading and the time variations of the Atlantic Water at the transition region between the Laptev Sea and the Lomonossov Ridge and

- to measure the atmospheric forcing on sea ice and the reaction of the latter north of the Laptev Sea where most of the sea ice is generated which is advected westwards by the transpolar drift.

Modern instruments to be applied from the ships, from helicopters and on ice floes together with satellite data, moorings and drifting automatic devices provide a sufficient experimental background for the field work. Advanced numerical models which are presently under construction will lead to a significant improvement of our knowledge on the climate related processes in the Arctic Ocean.

Scientists and technicians from British, Canadian, Finish, German, Irish Russian, Swedish and USAmerican research institutions and universities have jointly developed a field programme which will be carried out cooperatively during the ARK XII cruise of R/V *Polarstern*.

The vessel will depart from Bremerhaven on July 12th, 1996. The next port call is scheduled for July 18/19th, at Murmansk where the rest of the scientific crew will embark. As portrayed in Figure 1 *Polarstern* will cross the Barents Sea to meet *Oden* at 60 E / 78 N for the first time. Both vessels will then sail in a convoy to 65 E / 80.5 N where *Polarstern* turns towards East and *Oden* continues her northward course.

The field work on *Polarstern* starts with a zonal hydrographic section across the St. Anna and Voronin Troughs if ice conditions are favourable enough. Otherwise the northward route will be started further west (option 2 on

Figure 1). On the way from the shelf break of the Kara Sea to the Makarov Basin all disciplines will carry out measurements from the ship, with the aid of helicopters or on ice floes. A second rendezvous with *Oden* is foreseen at about 140 E / 86 N. East of the Lomonossov Ridge *Polarstern* will first transit south to 155 E/ 83 N and then carry out a zonal hydrographic section towards 130 E / 83 N. From this position the course is set southward to 130 E / 81 N to continue with the third hydrographic section across the Lomonossov Ridge. During the latter cruise leg the first of three moorings will be recovered presumably in cooperation with *Oden* (third rendezvous). Both vessels will operate closely together during the recovery of all three moorings in this area. The measurements will end at 135 E / 79.5 N on about September 10th, 1996. *Polarstern* will then sail to the Vilkitsky Street, cross the Kara Sea, enter the Barents Sea and stop for the second port call at Murmansk on September 22/23rd 1996. There a part of the scientific crew will disembark. Finally the ship cruises southward to terminate the expedition at Bremerhaven on September 29th, 1996.

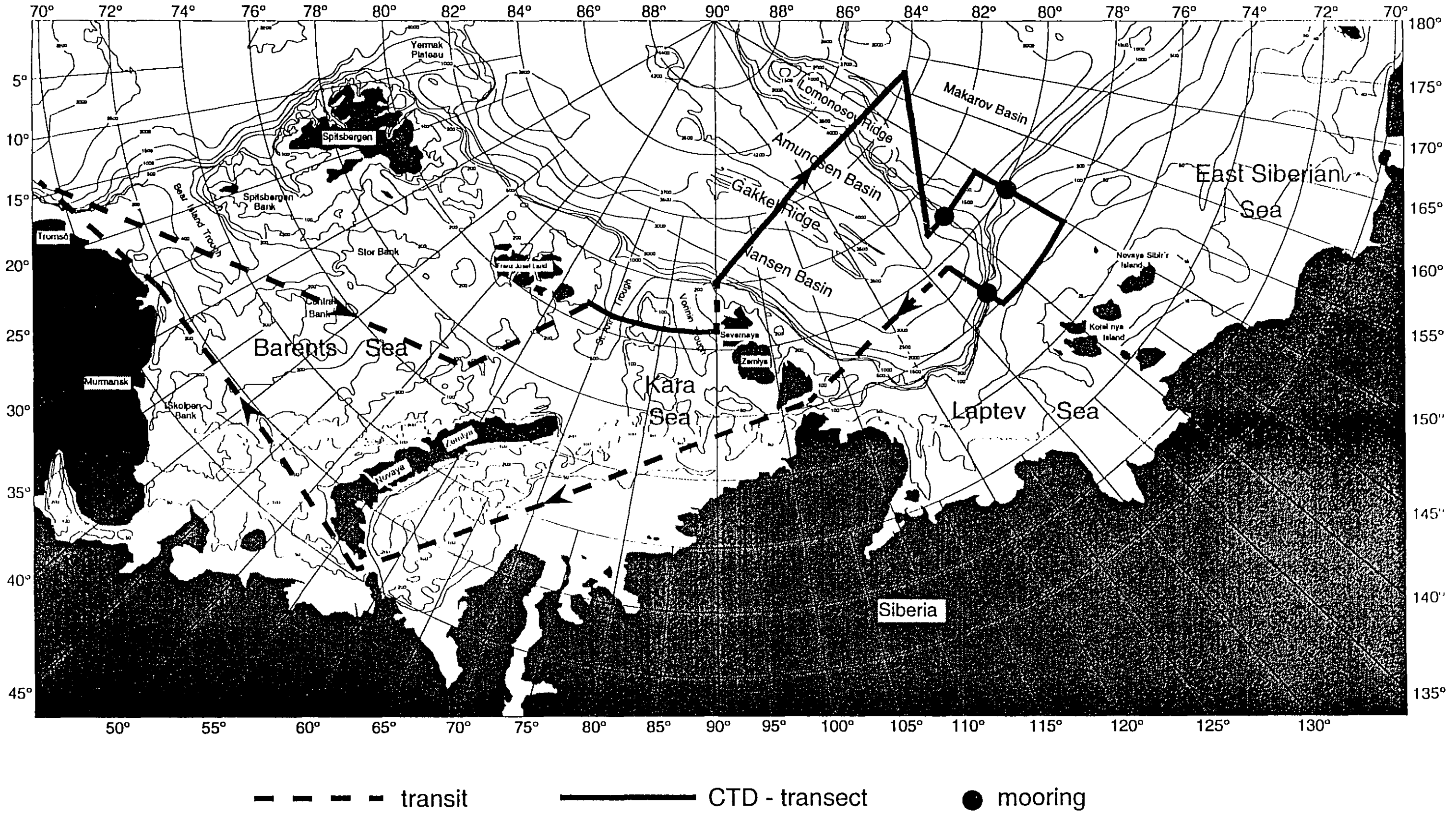


Fig. 1

Cruise Track of RV *Polarstern* / Fahrtroute des FS *Polarstern*

3. The Scientific Programme

3.1 Physical Oceanography
(AARI, AWI, ESR, GU, IfMH, SIO, UW)*

- *Scientific Aims*

The aim of physical oceanography is to study the modification and ventilation of water masses and their circulation patterns in the Arctic Ocean.

The thermohaline circulation in the Arctic Basins is largely controlled by processes which occur on the Eurasian shelves and at the continental slopes. Of special importance is the flow from the Barents Sea through the St. Anna and Voronin Troughs into the Nansen Basin. It transports Atlantic Water which competes with the flow of intermediate and deep water entering through Fram Strait and propagating along the shelf break. The German-Russian cruises in 1993 and 1995 have shown that the Barents Sea branch dominates the intermediate water in the eastern Eurasian Basins. It seems partly to cross the Lomonossov Ridge towards the Canadian Basin. The Atlantic Warm Water passing through Fram Strait is deflected from the shelf slope on its way further to the east and finally turns westward within the Eurasian Basins. The upper waters of the central Arctic are dominated by a strong Arctic halocline which originates from the Eurasian shelf seas. Obviously the upper regime is decoupled from the circulation of the deeper layers.

The following features will be investigated:

- the characteristics of the inflow of Atlantic water into the central Arctic through the St. Anna and Voronin Troughs
- the exchange of intermediate and deep water between the Nansen, Amundsen and Makarov Basins
- the circulation in the different basins
- the thermohaline structure of the water column along the cruise transects.
- the fate of deep water from the Nordic Seas entering the Arctic Ocean through Fram Strait

(see chapter 4 for acronyms of institutions)

• mixing processes between intrusions of shelf water and basin water and
• turbulent fluxes in the surface layer and across the halocline
• optical charcteristics of sea water
• gas (oxygen and carbon dioxide) fluxes in the upper water column

- *Observational Methods:*

Along the sections hydrographic stations will be implemented with horizontal distances ranging between 10 km (at the slopes) and 40 km (in the basins). Altogether, 140 stations are anticipated.

At each station, a CTD (conductivity-temperature-depth) system combined with a 36-bottle rosette-sampler (CTD-36) will be launched covering the depth range form the sea surface to the sea floor.

At some selected stations a second CTD with a 10-bottle rosette (CTD-10) and a self-contained Acoustic Doppler Current Profiler (ADCP) will be applied.

The following quantities are measured at hydrographic stations:

CTD-36: pressure, temperature, conductivity, light transmission, fluorescence

CTD-10: pressure, temperature, conductivity, light transmission, water velocity

Water samples will be analysed for:

Salinity, dissolved Oxygen, Nutrients (silicate, phosphate, nitrate),
Chlorofluorocarbons (CFC-11, CFC-12. CFC-113, carbon tetrachloride),
Helium, Tritium, Oxygen-18, Carbon-14.

In addition, water samples will be used for the determination of further chemical and biological quantities (see following sections).

Turbulence measurements in the upper water column will be carried out occasionally from ice floes. The turbulence device consists of small rotor-type current meters and rapid response temperature and salinity sensors mounted on a rigid mast. High-frequency measurements are obtained of the three-dimensional current vector, temperature, salinity and instrument depth.

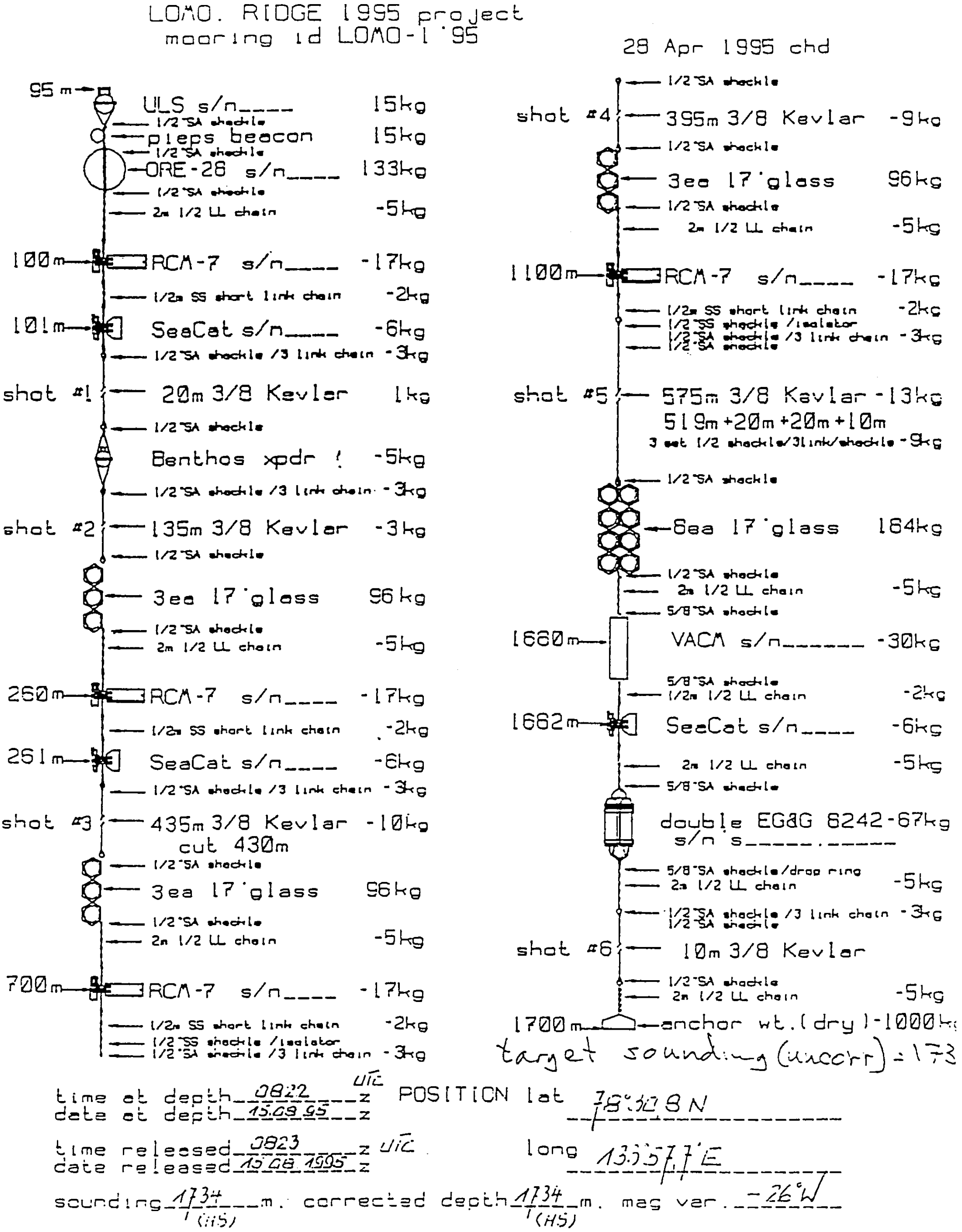


Fig. 2

Mooring at Lomonossov Ridge / Verankerung auf dem Lomonossov Rücken

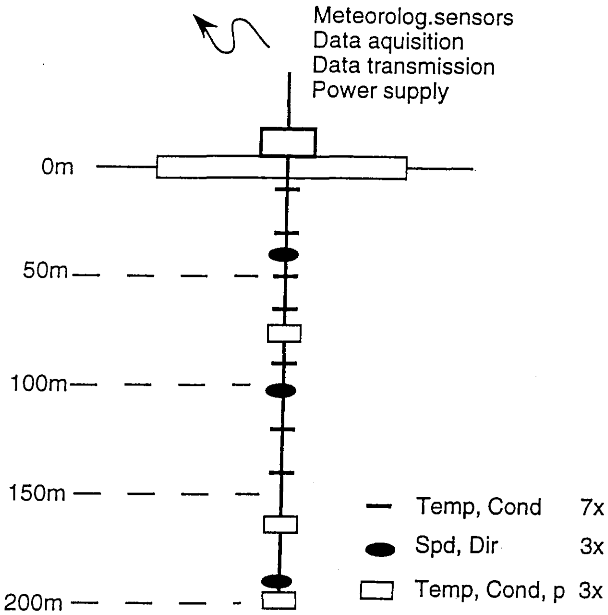
Ship-borne observations with an Acoustic Doppler Sonar Profiler will provide vertical current profiles in the upper 150 to 300 m of the water column.

Three moorings will be recovered which have been deployed 1995 at the continental slope and at the Lomonossov Ridge at the following positions:

78°30.8'N, 133°57.7'E
81°04.5'N, 140°54.0'E
80°19.3'N, 150°03.5'E

They are equipped with current meters, temperature/salinity recorders and Upward Looking Sonars (ULS) (Figure 2). The ULS will provide information on the ice thickness.

Three drifting surface buoys (Figure 3) will be deployed in a triangle around the mooring position at 80°N, 140°E. These buoys are equipped with sensors for air temperature and air pressure, and they carry a 200 m long subsurface chain with sensors for temperature, pressure, conductivity and velocity (see attached figure). The positions of the drifting buoys are determined by the Global Positioning System (GPS). The data are transmitted ashore with the aid of the Argos system. The buoys will be deployed on thick ice floes.



Sampling interval 60 min
Duration < 1 year
no recovery planned

		no. of channels
7 x	Temp, Cond	14
3 x	Speed, Dir	6
3 x	Temp, Cond, P	9
	total	**29**

Fig. 3
Automatic Drift Station / Automatische Driftstation

3.2 Chemical Oceanography
(AARI, AWI, BIO, GU, IfMK, LDEO, UIH, UCD)

- *Scientific Aims*

The chemical programme contributes to the detection of water mass modification and of circulation features. It will also provide information on transport processes for chemical constituents with particular emphasis on carbon. Specific features like shelf plumes can be identified from chemical signatures. Finally, nutrients provide a powerful means for the correction of carbon concentrations in accounting for biological influences. Special emphasis will be put on the analysis of the chlorofluorocarbons, CFC-11, CFC-12 and CFC-113. These substances as well as Carbon Tetrachloride are emitted into the atmosphere by human activities during much of this century. The ocean surface waters which are in contact with the atmosphere reflect the atmospheric concentrations. When the water leaves the surface the CFC-signal is conserved and thus provides a clock by which the age of the water mass can be determined and from the concentrations of the different CFC ventilation rates can be calculated. From Carbon Tetrachloride the anthropogenic CO_2 in the deeper ocean will be derived.

The oceanic branch of the global carbon and nitrogen cycle is closely connected to the dissolved organic matter (DOM) in the sea water. Some of the DOM can change its structure to become stable humic substances which are resistant to microbiological degradation and may thus act as a sink of CO_2. A considerable part of the DOM in the Arctic Ocean originates from the outflow of Siberian rivers. During its transport along the transpolar drift chemical, biological and physical processes modify the chemical patterns of DOM. These changes and the composition of DOM at specific locations of the Arctic Ocean will be determined.

Halocarbons which are naturally produced in sea water are to a certain extent emitted into the atmosphere and some brominated and chlorinated compounds migrate to the stratosphere where they participate in the depletion of ozone. Therefore it seems to be relevant to investigate the biological production rates of halocarbons in the water column and in sea ice as well as their emission into the atmosphere.

The processes which control the horizontal and vertical dispersion of certain radionuclides in polar oceans are not yet satisfactorily known. Therefore, measurements will be carried out to provide a sufficient background for a model-based assessment of consequences which would emanate from the release of radiocative material to the Arctic marine environment. Particular emphasis will be given to the determination of plutonium, americium and radiostrontium in the Arctic Ocean and to the distinction between filtered and suspended particulate phases.

The chemical analyses will be used to investigate:

- the propagation of shelf water along the shelf break and into the deeper basins
- details of the boundary current, when it reaches the Lomonssov Ridge
- mixing between shelf water and water of the deep basins
- sources and pathways of fresh water
- the lateral and vertical transport of carbon
- the age of water masses
- the distribution of nutrients in the Arctic Ocean
- the distribution and composition of DOM
- the production and fluxes of halocarbons
- the distribution and composition of certain radionuclides

- *Observational Methods*

All chemical, nutrient, radionuclide, DOM and tracer analyses will be made from the water samples of the hydrocasts. Total carbonate, alkalinity, pH, nutrients, radionuclides and CFC will be analysed as soon as possible on board after collection with the aid of modern industrially manufactured equipment. Further analyses will be done also in home laboratories after the cruise.

3.3 Sea Ice Physics
(AARI, AWI, HUP, SPRI)

- *Scientific Aims*

Sea ice development depends on the atmospheric and oceanic forcing and sea ice fabrics and physical properties suffer from considerable annual variations. In the Arctic Ocean in particular a large amount of particles may be incorporated into the sea ice during its generation in the shallow shelf regions. Consequently, manifold observations are required to satisfactorily investigate the thermodynamic, radiative and dynamic state of the sea ice.

Observations will be made at various positions of the Transpolar Drift which transports sea ice from the generation area of the Laptev Sea across the Arctic basins towards Fram Strait. The in situ measurements from ice floes and helicopter-borne longwave radiation laser altimeter, line scan and SLAR data will be complemented by satellite SAR and AVHRR values.

Sea ice morphology and ice thickness as well as floe size spectra and ridge statistics will be derived to determine the conditions for ship traffic in different parts of the Arctic Ocean.

Emphasis will also be laid on studies of the physiochemical properties of brine channels which are of high importance to the biological sea ice habitat.

The final target of most of these studies is to test and to improve a hierarchy of numerical sea ice concepts which are applied e. g. in coupled ocean-ice-atmosphere models. For this purpose coordinated observations will be carried out on both research vessels, the *Oden* and the *Polarstern.*

- *Observational Methods*

The ice thickness and morphology will be measured with the aid of drill-holes, an electromagnetic induction method (frequency 9.8 kH2) and a laser-theodolite. A laser altimeter will be operated from a helicopter to determine the ice morphology for larger areas and further details on the ice cover will be observed with the aid of a Russian sideward looking real aperture radar (SLAR).

Physical, chemical and structural ice properties and biological inclusions will be investigated from ice cores. The latter will be sampled frequently with standard (0.1 m diameter) power drills. A Seabird SBE19 CTD and a radiometer will be lowered through ice holes to measure the temperature and salinity in the water directly below the ice.

The short wave radiation at the surface and in the interior of the ice will be detected with spectral radiometers and the long wave emission of ice or snow surfaces is determined with so called KT-4 radiation thermometers. These instruments are used on the helicopter, on the ship and on a sledge.

Polarstern is also equipped with a High Resolution Picture Receiving (HRPT) station and an APT receiving system to record data from the NOAA (USA) and Okean (Russia) satellites several times per day. Very high resolution pictures of the surface (e.g. to determine melt puddels, nilas etc.) will be obtained from a multichannel line scan camera flown on a helicopter.

3.4 Atmospheric Boundary Layer
(AARI, AWI, OAP, IMKH)

- *Scientific Aims*

The sea ice development and sea ice transports are primarily controlled by atmospheric forcing on the one hand and sea ice determines the dynamic, thermal and radiative lower boundary conditions of the atmosphere on the other hand. Therefore, the coupling between the sea ice and the lower atmosphere (atmospheric boundary layer) shall be investigated to derive satisfactory algorithms for the representation of the atmosphere-sea ice-ocean interactions of the central Arctic in large scale circulation and climate models. The present programme concentrates on measurements of the atmospheric turbulent vertical momentum, latent and sensible heat fluxes over different sea ice conditions for various large scale atmospheric flow fields.

Furthermore, the vertical profiles of temperature, relative humidity and the horizontal wind velocity will be measured twice a day with the aid of balloon ascents.

- *Observational Methods*

The vertical turbulent fluxes at various levels in the lowest 500 m of the atmosphere will be measured with a new sophisticated system which is flown at a cable 10 m below the cabin of a helicopter. In addition to these area covering measurements the turbulent fluxes will be obtained at 5 levels between 2 and 17 m height at the bow of the ship to basically explore the influence of single leads and ridges on the exchange processes at the lower atmospheric boundary. The helicopter will furthermore record the sea ice characteristics along the flight tracks with special digital cameras and with a laser altimeter.

The vertical thermodynamic and kinematic structure of the lower atmosphere will be detected with ballon borne radiosondes equipped with a GPS navigational module for accurate wind tracking.

Finally, the atmospheric near surface quantities, the ice (snow) surface temperature, the ice motion as well as the vertical temperature and salinity distributions in the upper 300 m of the water column will be measured at the three automatic drifting stations (see also section 3.1).

3.5 Marine and Sea Ice Biology
(AWI, IPÖ, MMBI)

- *Scientific Aims*

The biological processes in the Arctic Ocean depend among others on the local environmental conditions and on the advection of matter from the shelf seas into the central Arctic. Therefore, attempts shall be made to determine the three-dimensional distribution of phyto- and zooplankton species as well as their production rates and the downward flux of organic matter through the water column (phytoplankton and zooplankton ecology). Observations will be carried out and samples will be taken along the entire cruise track from the Kara Sea through the central basins across the Lomonossov Ridge into the Laptev Sea. The water samples will be complemented by sea ice data from ice cores.

Sea ice provides a habitat for a variety of microscopic organisms ranging form bacteria, algae, fungi to proto- and metazoans such as ciliates, nematodes, turbellarians and crustaceans. Ice algae as producers contribute up to 30 % to the annual primary production in the Arctic Ocean. Ice organisms inhabit the brine filled channels and pockets between ice crystals. To explore the living conditions of the various sea ice organisms several experiments will be conducted as e. g. single studies with proto- and metazoans as well as investigations with the entire ice community.

- *Observational Methods*

Organic and inorganic matter in the water column will be determined from the Rosette water samples in cooperation with marine chemistry. Biological material will be gathered with the aid of various net systems like bongo net, rectangular midwater trawl (RMT) as well as with the help of sediment traps to be deployed for short periods from ice floes. A fluorescence sonde will be operated during station stops through the moonpol of *Polarstern*. Biological intrusions of sea ice will be extracted from ice cores which are drilled when the ship stops for hydrographic stations.

4. Participating Institutions / Beteiligte Institutionen

	Acronym	*Institution*	*No. of Participants*
Germany	AWI	Alfred-Wegener-Institut für Polar- und Meeresforschung Am Handelshafen 12 27570 Bremerhaven	13
		AERODATA Flugmeßtechnik GmbH Forststr. 33 38108 Braunschweig	1
	DWD	Deutscher Wetterdienst Seewetteramt Postfach 30 11 90 20304 Hamburg	2
	HSW	Helicopter-Service Wasserthal GmbH Kätnerweg 43 22393 Hamburg	4
	IfMH	Institut für Meereskunde der Universität Hamburg Troplowitzstr. 7 22529 Hamburg	2
	IfMK	Institut für Meereskunde der Universität Kiel Düsternbrooker Weg 20 24105 Kiel	2
	IMKH	Institut für Meereskunde und Klimatologie der Universität Hannover Herrenhäuser Str. 2 30419 Hannover	2
	IPÖ	Institut für Polarökologie der Universität Kiel Wischofstr. 1-3, Geb. 12 24148 Kiel	2
	IUH	Institut für Umweltphysik der Universität Heidelberg Im Neuenheimer Feld 366 69120 Heidelberg	1
Russia	AARI	Arctic and Antarctic Research Institute 38, Ul. Bering 199226 St. Petersburg	3

	MMBI	Murmansk Marine Biological Institute 17, Vladimirskaya St. Murmansk 183010	2
	OAP	Obuchov Institute of Atmospheric Physics Pyzhevskiy Pereulok 3 109017 Moscow	1
Sweden	GU	Göteborg University Dept. of Oceanography Earth Science Centre 41381 Göteborg Dept. of Analytical and Marine Chemistry 41296 Göteborg	7
Canada	BIO	Bedford Institute of Oceanography P.O. Box 1006 Dartmouth N.S. B2Y 4A2	3
USA	UW	University of Washington, APL 1013 NE 40th Seattle, WA 98105	1
	ESR	Earth & Space Research 1910 Fairview E., no. 102 Seattle, WA 98102-3699	1
	SIO	SCRIPPS Institution of Oceanography University of California, San Diego La Jolla, CA 92093-0214	2
	LDEO	Lamont-Doherty Earth Observatory of Columbia University RT 9W Palisades, New York, 10964-8000	1
Finland	HUT	Helsinki University of Technology Tietotie 1 02150 Espoo	1
U.K.	SPRI	Scott Polar Research Institute University of Cambridge Lensfield Road Cambridge, CB2 1ER	1
Ireland	UCD	University College Dublin Dept. of Experimental Physics Belfield, Dublin 4	1

5. Participants / Fahrtteilnehmer

Name	Institution	Nationality
Abrahamsson, Katarina	GU	Swedish
Andersson, Leif	GU	Swedish
Auel, Holger	IPÖ	German
Augstein, Ernst	AWI	German
Bahrenfuß, Kristin	IfMK	German
Björk, Göran	GU	Swedish
Buchner, Jürgen	HSW	German
Bussmann, Ingeborg	AWI	German
Chierici, Melissa	GU	Swedish
Cohrs, Wolfgang	AWI	German
Cottier, Finlo Robert	SPRI	British
Darnall, Clark	UW	USAmerican
Darovskikh, Andrey	AARI	Russian
Drübbisch, Ulrich	IfMH	German
Druzhkov, Nikolay V.	MMBI	Russian
Ekdahl, Anja	GU	Swedish
Ekwurzel, Brenda	LDEO	USAmerican
England, Joachim	DWD	German
Fitznar, Hans-Peter	AWI	German
Frank, Markus	IUH	German
Fransson, Agneta	GU	Swedish
Friedrich, Christine	IPÖ	German
Grachev, Andrey	OAP	Russian
Haas, Christian	AWI	German
Hiller, Scott	SIO	USAmerican
Hingston, Michael Patrick	BIO	Canadian
Hofmann, Michael	IMKH	German
Ivanov, Vladimir	AARI	Russian
Johnsen, Klaus-Peter	AWI	German
Jones, Edward Peter	BIO	Canadian
Larsson, Anne-Marie	GU	Swedish
Lensu, Mikko	HUT	Finnish
Leon Vintro, Luis	UCD	Spanish
Lundström, Volker	HSW	German
Lüpkes, Christof	AWI	German
Muench, Robin	ESR	USAmerican
NN (Ice Pilot)	Murmansk Shipping	Russian
NN (Observer)	Murmansk Shipping	Russian
Pivovarov, Sergey	AARI	Russian
Riewesell, Christian	HSW	German
Rudels, Bert	IfMH	Swedish
Schauer, Ursula	AWI	German
Scherzinger, Till	AWI	German

Schreiber Detlev	HSW	German
Schürmann, Mathias	AERODATA	German
Siebert, Holger	IMKH	German
Sonnabend, Hartmut	DWD	German
Strohscher, Birgit	AWI	German
Templin, Michael	AWI	German
Timmermann, Axel	AWI	German
Timofeev, Sergey	MMBI	Russian
Weissenberger, Jürgen	AWI	German
Wilhelm, Dietmar	IfMK	German
Williams, Bob	SIO	USAmerican
Zemlyak, Frank	BIO	Canadian

6. Ship's Crew / Schiffsbesatzung

Profession	Name
01. Captain	Greve, Ernst-Peter
02. 1. Officer	Pahl, Uwe
03. 1. Officer	Rodewald, Martin
04. Chief Engineer	Knoop, Detlef
05. 2 Officer	Grundmann, Uwe
06. 2 Officer	Spielke, Steffen
07. Medical Doctor	Bennemann, J.
08. Radioperator	Koch, Georg
09. 2 Engineer	Erreth, Mon. Gyula
10. 2 Engineer	Ziemann, Olaf
11. 2 Engineer	Fleischer, Martin
12. Electronic Technician	Lembke, Udo
13. Electronic Technician	Muhle, Helmut
14. Electronic Technician	Greitemann-Hackl, A.
15. Electronic Technician	Roschinsky, Jörg
16. Electrician	Muhle, Heiko
17. Boatswain	Clasen, Burkhard
18. Carpenter	Reise, Lutz
19. Sailor	Winkler, Michael
20. Sailor	Bindernagel, Knuth
21. Sailor	Gil Iglesias, Luis
22. Sailor	Pousada Martinez, S.
23. Sailor	Kreis, Reinhard
24. Sailor	Schultz, Ottomar
25. Sailor	Burzan, G.-Ekkehard
26. Sailor	Pulss, Horst
27. Technician	Arias Iglesias, Enrique
28. Technician	Preußner, Jörg

29. Technician	Ipsen, Michael
30. Technician	Husung, Udo
31. Technician	Grafe, Jens
32. Storekeeper	Müller, Klaus
33. Chief Cook	Haubold, Wolfgang
34. Cook	Völske, Thomas
35. Cook	Yavuz, Mustafa
36. 1 Stewardess	Jürgens, Monika
37. Stewardess/Nurse	Dähn, Ulrike
38. Stewardess	Czyborra, Bärbel
39. Stewardess	Deuß, Stefanie
40. Stewardess	Neves, Alexandra
41. 2. Steward	Huang, Wu Mei
42. 2. Steward	Mui, Kee Fung
43. Laundryman	Yu, Kwok Yuen