FS „POLARSTERN“
Expeditionsprogramm Nr. 16

ANTARKTIS VIII
1 – 2
1989

ALFRED-WEGENER-INSTITUT FÜR POLAR- UND MEERESFORSCHUNG
BREMERHAVEN, AUGUST 1989

Expedition Programme No. 16

RV "Polarstern"

ANTARKTIS VIII (1-2)

1989

The Winter Weddell Gyre Study (WWGS) 1989
in cooperation with
RV Akademik Fedorov

Chief Scientists:

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Alfred Wegener Institute
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1. Zusammenfassung

Die ersten beiden Fahrtabschnitte der achten Antarktisreise des Forschungsschiffs *Polarstern* (Ant. VIII, 1-2) des *Alfred-Wegener-Instituts für Polar- und Meeresforschung* (AWI) beinhalten die atlantische Nord-Süd-Traverse von Bremerhaven nach Puerto Madryn (Argentinien) und die multinationale *Winter Weddell Gyre Study* 1989 (WWGS ´89) im zentralen Weddellmeer. Das letztgenannte Programm wird gemeinsam mit dem Forschungsschiff *Akademic Federov* des *Arktischen und Antarktischen Forschungsinstituts* (AARI) der USSR unter weiterer Beteiligung britischer, kanadischer und US-amerikanischer Forschungsgruppen durchgeführt. Dieser Abschnitt endet für *Polarstern* in Kapstadt (Südafrika) und für *Akademic Fedorov* in Buenos Aires (Argentinien).

Das FS *Polarstern* läuft am 5. August 1989 von Bremerhaven aus und erreicht Puerto Madryn am 5. September 1989. Auf dem Nord-Süd-Schnitt im Atlantik werden luftchemische Größen von mehreren deutschen Instituten und die atmosphärische Ozonkonzentration nahe der Meeresoberfläche sowie in der gesamten Luftsäule von Mitgliedern des AARI gemessen. Darüber hinaus sollen die neu eingebauten Echolotsysteme *Hydrosweep* und *Parasound* unter Beteiligung der Lieferfirma erprobt und dann dem AWI übergeben werden. Ferner soll der Zentralbereich der *Romanche Fracture Zone* vermessen werden. Hierbei werden zunächst bekannte Tiefseeprofile abgefahren, anschließend wird das Vermessungsgebiet auf der *Romanche Fracture Zone* für geowissenschaftliche Untersuchungen in Richtung Westen erweitert.

Die *Winter Weddell Gyre Study* 1989 ist die zweite Unternehmung des AWI zur Erforschung des Meereises und seiner Wechselwirkung mit Ozean und Atmosphäre sowie seines Einflusses auf marine Lebensgemeinschaften im antarktischen Spätwinter bei maximaler Meereisbedeckung. Das zentrale Anliegen dieser Expedition ist die quantitative Erfassung der Zirkulation des ozeanischen Weddellwirbels und der mit ihr verknüpften Wärme- Salz- und Eistransporte. Zu diesem Zweck legen die beiden Schiffe *Akademic Fedorov* und *Polarstern* drei engmaschige hydrographische Schnitte durch den nördlichen Bogen und einen durch das Zentrum des Wirbels. Letzterer, der von der Spitze der Antarktischen Halbinsel zum Kapp Norwegia reicht, erlaubt eine abgeschlossene Haushaltsbetrachtung des südlichen Weddellbeckens und eine Abschätzung der dort ablaufenden Wassermassenänderungen. Die hydrographischen Messungen der *Polarstern* auf dieser Traverse werden durch Strommesserverankerungen, die etwa ein Jahr lang liegen bleiben, und ein Netz automatisch arbeitender Oberflächenbojen vervollständigt.
Ein wichtiger Teilbeitrag zur Erforschung der tiefen Vermischung westlich des Maud Rückens, einem Gebiet mit wiederholt verminderter Eiskonzentration, soll mit Hilfe einer etwa zehntägigen Zeitserie in einem engmaschigen Meßnetz, gebildet von der *Akademic Federov* und mehreren Eisstationen, geleistet werden.

Die ozeanographischen Untersuchungen mit Multisonden und Verankerungen werden durch Messungen der turbulenten vertikalen Impuls-, Wärme- und Salzflüsse unter dem Meereis an mehrtägigen Stationen mit neuen Meßgeräten ergänzt. Darüber hinaus liefern die vorn genannten

Oberflächenbojen die atmosphärischen Antriebsfelder, sowie Langzeitregistrierungen der ozeanischen Deckschichttiefe, der Dicke und der horizontalen Bewegung des Meereises. Ferner werden an den Schiffen regelmäßig die turbulenten vertikalen Wärme- und Impulstransporte sowie die Strahlungsflüsse am unteren Rand der Atmosphäre gemessen. Ebenso werden täglich Eiskerne zur Bestimmung der Struktur und der physikalischen Eigenschaften sowie der biologischen Einschlüsse des Meereises gewonnen. Zusätzlich werden horizontale Bohrprofile zur detaillierten Vermessung der Eisdickenverteilung großer Schollen angelegt. Satellitenbilder und Luftaufnahmen vom Hubschrauber aus geben Aufschluß über die Eiskonzentration und Schollengrößenverteilung in der weiteren bzw. näheren Umgebung der Schiffe. Schließlich liefern aktive und passive Mikrowellenmessungen weitere Meereischarakteristika, die vor allem für Vergleiche mit Satellitenbeobachtungen genutzt werden sollen. In Fortsetzung der Studien des *Winter Weddell Sea Projektes* 1986 (WWSP ´86) sollen die Lebensgemeinschaften im Meereis und in der oberen Wassersäule (bis 1500 m Tiefe) diesmal vor allem im westlichen Teil des Weddellwirbels - mit den dort größeren Anteilen mehrjährigen Eises - untersucht werden.

Die genannten Projekte werden - teils mit unterschiedlichen Schwerpunkten - von mehreren Forschergruppen auf beiden Schiffen bearbeitet. Dementsprechend wird auch die Aufbereitung, Analyse und wissenschaftliche Interpretation der Daten zwischen den Expeditionsteilnehmern abgestimmt und die Ergebnisse sollen - soweit wie möglich - gemeinsam veröffentlicht werden.

Im nachfolgenden englischen Text werden die Programme der einzelnen Teilbereiche ausführlicher beschrieben. Ferner enthalten die Tabellen im letzten Teil dieses Expeditionsheftes den Zeitplan, Angaben über die beteiligten Institute, die Fahrtteilnehmer und die Schiffsbesatzung der *Polarstern.*

2. Summary

The first two legs of the eighth Antarctic cruise (Ant: VIII, 1-2) of RV *Polarstern* are composed of a north-south transect from Bremerhaven to Puerto Madryn (Argentina) and the multinational *Winter Weddell Gyre Study 1989* (WWGS `89). The latter programme will be carried out jointly with RV *Akademik Federov* of the *Arctic and Antarctic Research Institute* (AARI) of the USSR in the central Weddell Sea. Research groups from Great Britain, Canada, FR Germany, USA and USSR will work together on both of the vessels.

On *Polarstern`s* first leg air chemistry and ozone studies form the basic research goals. Additionally, considerable efforts will be made to test the new multibeam sonar system *Hydrosweep* and the parametric sediment echo sounder *Parasound.* The calibration and test surveys shall be performed in the Bay of Biscay. Furthermore, a high precision deep sea bathymetric survey is planned in the central part of the *Romanche Fracture Zone.*
The Winter Weddell Gyre Study 1989 will complement and to a certain degree extend the scientific aims of *Polarstern`s* first Antarctic winter cruise in 1986. The core project of the WWGS `89 is the quantitative determination of the Weddell Gyre circulation and the heat, salt, and sea ice transports connected to it. For this purpose three more-or-less meridional hydrographic sections with a high resolution station sequence will be carried out in the northwestern part and one zonal section across the centre of the Weddell Gyre. The latter, which extends from the Antarctic Peninsula to Kapp Norwegia, provides a data base for budget calculations of energy and salt and for estimating water mass formation within the southern part of the Weddell Basin.

Approximately ten days of intensive oceanographic, meteorological, and sea ice measurements are planned in a mesoscale grid west of Maud Rise to investigate deep ocean mixing in this area of generally reduced sea ice concentration.

The oceanographic studies will be complemented by attempts to measure the vertical turbulent fluxes of momentum, heat, and salt under the ice with the aid of a new instrument system. Surface Argos-stations will provide continuous values on the atmospheric surface forcing field, of the sea ice movements and through thermistor chains, also of the ocean mixed layer structure.

At both ships the atmospheric vertical turbulent fluxes of momentum and heat as well as the radiative transports will be measured regularly at all stations and the vertical structure of the atmospheric boundary layer will be obtained from radiosonde ascents.

At least once daily sea ice cores will be sampled and detailed ice thickness distributions shall be derived from an extensive drilling programme. The sea ice characteristics will be further investigated with AVHRR satellite data and microwave observations from *Polarstern* as well as by airborne photography in the environment of both ships.

The biological research work concentrates on sea ice biota and on the ecological system in the upper water column below the sea ice. In general all above projects will be carried out jointly from both ships. Consequently the

data reduction, analysis and interpretation require close cooperation by the participating scientists.

The following chapters of this booklet contain some more details on the research programmes and indicate the time tables, participating institutions and scientists and crew members on board *Polarstern.*

3. Research Programmes

3.1 The Atlantic North-South-Transect of RV "Polarstern" (Ant VIII,1)

3.1.1 Calibration of Sonar Systems HYDROSWEEP and PARASOUND

Polarstern has been recently equipped with the new multibeam sonar *Hydrosweep* and the sub-bottom profiler *Parasound.* These two systems will be tested in ocean areas with well surveyed sea floor topography. Comprehensive software was developed to enable an extensive on board real time processing.

The *Hydrosweep* is a multibeam sonar system operating at a frequency of 15.5 kHz with an opening-angle of 90 degrees and 59 preformed beams (PFB). It achieves a projection of the sea bottom twice as wide as the water depth. The system is supplied with a self-calibrating mode, which enables the determination of the average sound velocity in the water column. This mode shall be compared with CTD- and XBT-measurements.
Parasound is a low-frequency sediment echo sounder with frequencies of 18 kHz, and 20.5 - 23.5 kHz. In the parametric mode a working frequency band of 2.5 - 5.5 kHz is generated which allows a narrow beam transmission of the signal.

The calibration and tests of these systems will be carried out in two phases. The first part takes place in well surveyed areas in the Bay of Biscay in cooperation with the engineers of the manufacturer *Krupp Atlas Elektronik.* At first a shallow-water test is planned north of Brest (Fig. 1, Location 3) and afterwards the cross-fan calibration system will be tested and verified in the Biscay Plain (Fig. 1, Location 1). Locations 2A and 2B on Figure 1 and Figure 2, respectively, are test areas of former sea trials.

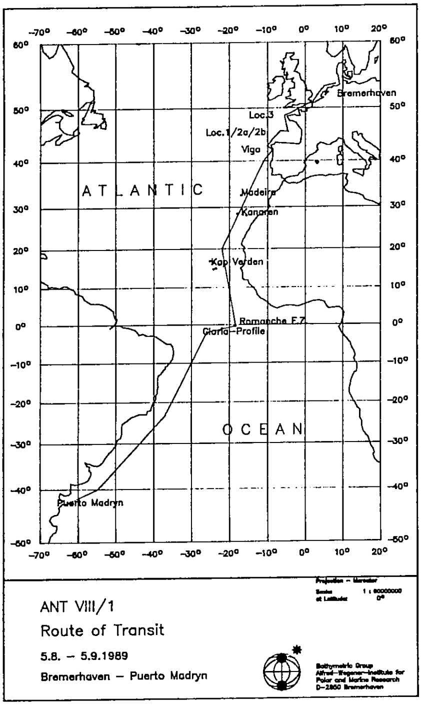

Figure 1: Route of POLARSTERN ANT 8, 1

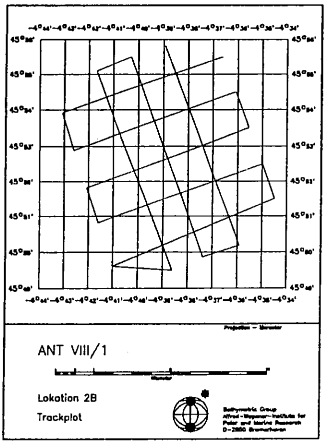

Figure 2: Test Area in the Bay of Biscay

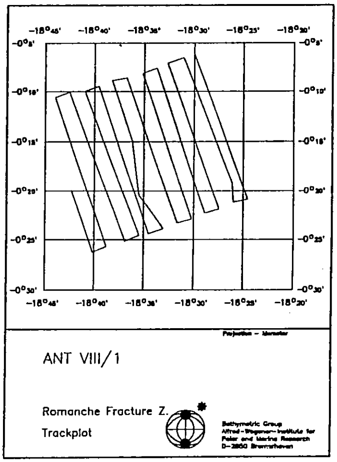

Figure 3: Tracks on Romanche Fracture Zone

In the Bay of Biscay the positionning shall be performed by GPS in differential mode. For this purpose members of the University Hannover will install a reference station in Brest. This first test-phase ends at the port of Vigo (Spain).

Afterwards the ship leaves for the *Romanche Fracture Zone* where depth range and accuracy tests will be carried out (Figure 3). The *Romanche Fracture Zone* is a vast depression of the Mid-Atlantic-Ridge with depths down to 7800 m. The southern slope of the fracture zone has an inclination of about 45 degrees, where special effects and faults of multibeam sonar-systems may become obvious. The central part of the fracture zone contains sediments, so that the sediment penetration capability of the *Parasound* in regions of great water depths can be tested.
Finally, the ship will cruise along a *Gloria-Profile* to the Mid-Atlantic-Ridge to continue its survey work. On the way to Puerto Madryn the geophysical survey will be continued. Our data will be compared later with former surveys of the research vessels *Polarstern* , *Meteor* and *Jean Charcot.*

3.1.2. Ship Attitude Control with Differential-GPS

Up to 4 dual frequency GPS receivers TI-4100 on board and up to 2 receivers on a reference station on land (Brest) will be used to determine precise ship positions and attitudes which are time dependent.

During the first part of the cruise (Bay of Biscay) the main emphasis will be put on precise postioning of the *Hydrosweep*. Observations will be done in relative mode with a reference station near Brest. Depending on the satellite coverage an attempt will be made to use more than 4 GPS-satellites by interfacing two TI-4100 receivers at one antenna.

From Vigo to Puerto Madryn reference measurements on land stations are not possible. GPS will be used for position determination of *Polarstern* whenever precise positions are needed. GPS will be applied also for precise attitude control (time dependent behaviour of the vessel in 3-D space). With the use of carrier phase data an accuracy of less than 1 mrad is possible. GPS results can be compared with the ship´s azimuth and roll/pitch sensor data.

All data will be stored on board and will be made available for independent postprocessing.

3.1.3 Reactive Nitrogen Components over the Atlantic Ocean

A meridional concentration profile of NH (3) and HNO (3) will be measured in order to obtain detailed information on the behaviour of these two gaseous N-components and their products in the marine atmosphere. HNO(3) is a product of the atmospheric N-oxidizing processes that reacts with alkaline substances, like seasalt aerosol and seawater, and dissociates into NO(3) - and H+. Presumably continental NO(X) emissions are the main HNO(3) and NH(3) sources. Acidic aerosols, like small sulfuric acid containing aerosols and rainfall, are possibly atmospheric sinks for NH(3).

If concentrations of gases and their products in the boundary layer can be determined, it may be possible to estimate transfer rates between the ocean and the troposphere.

3.1.4 Sulfur Compounds in the Atmosphere and in Seawater

The biogenic emission of reduced sulfur gases from the ocean is the most important natural source of atmospheric sulfur. In the atmosphere these gases are mainly oxidized by hydroxyl radicals to sulfur dioxide (SO(2)) which is further oxidized to sulfate (SO(4)=). This sulfate represents a substantial fraction of the marine background aerosol.

During this cruise leg the concentration of the reduced sulfur gases dimethyl sulfide (DMS), carbonyl sulfide (COS), carbon disulfide (CS(2)) and hydrogen sulfide (H(2)S) will be determined simultaneously in the atmosphere and in seawater. Samples of surface water will be taken by means of the ship's pumping system. The measurements will be performed in 6-hour intervalls to detect diurnal variations and possible source and sink mechanisms of these compounds. In addition vertical concentration profiles of DMS, COS, CS(2) and H(2)S in the surface layer of the ocean will be measured. The fluxes of DMS, COS, CS(2) and H(2)S from the ocean to the atmosphere will be calculated from the observed concentrations in the surface water and in the atmosphere. The reduced sulfur gases as well as sulfur dioxide will be analysed by cryogenic enrichement and subsequent detection by gas chromatography/flame photometric detection.
In parallel the aerosol concentrations of the oxidation products sulfate and methanesulfonate will be determined. Particles will be enriched on filters which will be analysed by ion chromatography later in the home laboratory.

3.1.5 Light Non-Methane Hydrocarbons, PAN, CO and H_2 in the Atmosphere and Volatile Hydrocarbons in the Surface Water of the Atlantic

Non-methane hydrocarbons play an important role in the chemistry of the maritime atmosphere. Especially the alkenes are important due to their high photochemical reactivity and their oceanic sources. PAN is a product of the photochemical removal of hydrocarbons. In the presence of NO_2 it is an important reservoir for nitrous oxides.
All species will be measured in situ by different gas chromatographic devices. PAN and the hydrocarbons are cryogenically preconcentrated to reach the required sensitivity. The lower limit of detection for PAN is 0.5 ppt, for atmospheric hydrocarbons about 10-20 ppt. In seawater about 0.05 nl of dissolved hydrocarbons gas per liter seawater are detectable. The water samples from about 11 m below the sea surface will be supplied by a stainless steel pump. Additionally samples down to about 50 m will be taken with the aid of a stainless steel sampler.

3.1.6 Detection of Nitric Acid and Ammonia in Air by a Laser-Photolysis Fragment-Fluorescence (LPFF) Method

Nitric acid (HNO_3) is a final product of atmospheric NO_X and HO_X chemistry. Hence it is an indicator for two of the most important cycles in clean and polluted atmospheres. Ammonia (NH_3), one of the most important bases in air, is especially produced by biological processes. It has been found in clean and polluted atmospheres.

Our method to measure HNO_3 in the air is based on the sequential two-photon ArF (193 nm)-laser photolysis yielding exited OH. The fluorescence intensity is taken as a measure for the HNO_3 mixing ratio. At the present time the detection limit for long integration times (one hour) is 0.04 ppb and for shorter times about 0.2 ppb.

The apparatus can also be applied to measure the concentration of gaseous NH_3. In this case exited NH radicals are produced. The NH-fluorescence intensity provides a measure for the NH_3 mixing ratio. For the measurements of NH_3 we are expecting a detection limit of about 0.35 ppb for integration times of one hour.

Finally the ozone concentration at a level of 20 meter above sea level will be recorded.

3.1.7 Improvements of the Atmospheric Correction of NOAA-AVHRR Data

The commonly used "split-window" algorithmns for the NOAA-AVHRR data have the following disadvantages:
The correction is based on semi-empirical data of mean atmospheric conditions which do not account for situations of special geographical regions. The correction can be applied only to the 5-channel version of the AVHRR. Thus 50 % of the data cannot be corrected sufficiently.

The thermal radiance of the atmosphere, the total amount of water vapour and the aerosol-optical thickness are the three major components controlling the atmospheric attenuation of infrared radiance. Therefore the atmospheric part of the detected radiance should be determined under consideration of the total amount of water vapour and of the atmospheric thermal radiance. Both quantities will be obtained during the cruise from radiosonde measurements. The aerosol-caused part of the atmospheric attenuation will be derived from the aerosol-optical thickness of the visible part of the spectrum. The latter will be measured by the AVHRR visible channels as well as with a shipborne photometer.
From all of these quantities the atmospheric component of the detected signal can be calculated. The results will be compared with ground-based measurements of the outgoing visible and infrared radiances and of the physical temperature of the sea surface. Over water surfaces the consideration of the aerosol-influence should improve the present correction methods.

3.1.8 XBT-measurements and Radiosonde Ascents

From Bremerhaven to Puerto Madryn atmospheric and oceanographic soundings (radiosondes and XBTs) shall be carried out on horizontal distances of one degree of latitude. Similar measurements have been executed from *Polarstern* since 1983 on its north-south Atlantic transects. The data are archived to monitor long-term trends in the atmosphere and in the upper layer of the ocean after a sampling time of about 10 years.

3.2 The Winter Weddell Gyre Study 1989 (WWGS `89) of *RV Polarstern* (Ant VIII, 2) and *RV Akademik Fedorov*

3.2.1 The Weddell Gyre Circulation and Water Mass Formation

The Weddell Sea is one of the few oceanic regions with deep vertical mixing. Approximately 70% of the Antarctic Bottom Water is formed in this area. Details of the formation processes as well as on their spatial and temporal variabilities are still unknown. Considerable uncertainties also exist with respect to a quantitative knowledge of the mass, heat and salt transports by the Weddell Gyre circulation as portrayed on Figure 4. Therefore, the observational oceanographic programme of this expedition is considered as the first step, to be followed by at least three more, to determine the lateral gyre transports and the water mass formation particularly in the southern basin.

For this purpose the two ships will execute 4 hydrographic CTD sections perpendicular to the gyre circulation (Figure 5). The core section from the tip of the Antarctic Peninsula to Kapp Norwegia (Figure 6) will be repeated during the Austral summers 1990/91 and 1992/93 and in winter 1992. During *WWGS`89* seven current meter moorings will be deployed as shown on Figure 6 to provide information on the ocean flow characteristics particularly at the western and eastern shelf breaks. This array will be expanded to a total number of 25 to operate from January 1991 to January 1993.

The hydrographic and mooring measurements will be complemented by chemical and isotope analyses of bottle samples for dissolved oxygen and nutrients (nitrate, nitrite, phosphate and silicic acid). The full data set will be applied to quantify the Weddell Gyre circulation and the heat and salt transports related to it at the end of the winter season.

One particular area where deep mixing might occur during sea ice formation in winter is located west of Maud Rise. Here a large polynya was observed from 1973 to 1976. In this region the oceanic mesoscale structure will be investigated with the aid of a dense observational array, the so-called Mesopolygon, displayed on Figure 7. Measurements from the *Akademik Fedorov,* a manned ice station, and a helicopter supported network are designed to detect convective phenomena or eddies which may contribute to effective mixing between the ocean surface and relatively deep water layers.

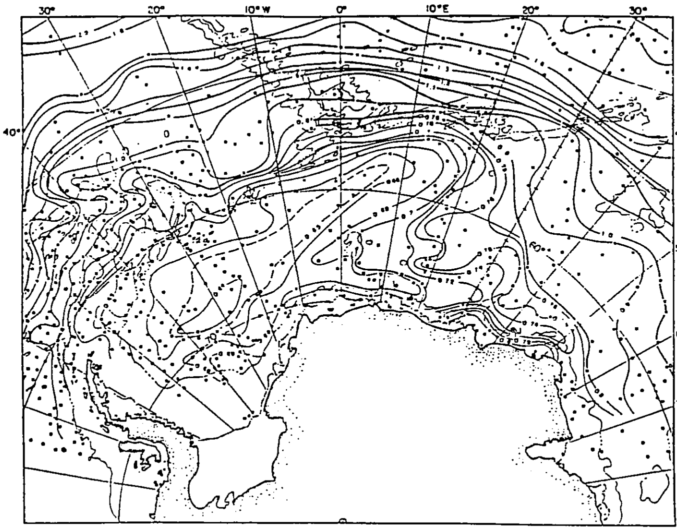

Figure 4: Dynamic topography of the Weddell Gyre after Comiso and Gordon (1987)

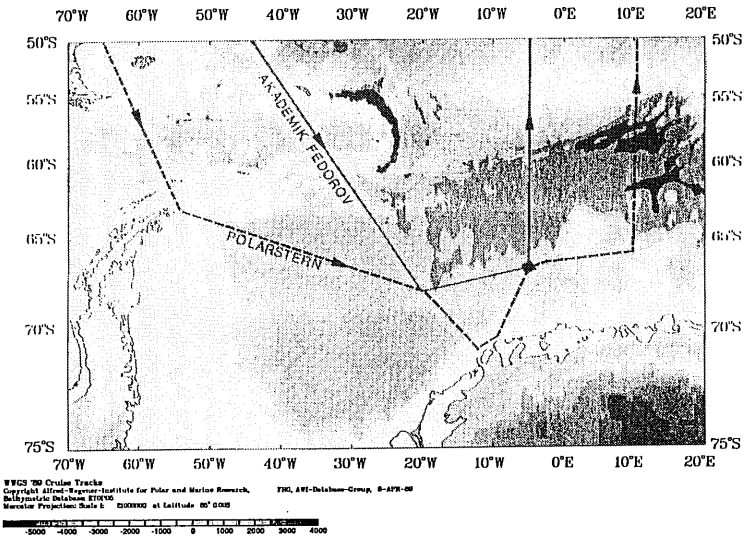

Figure 5: Cruise tracks of *RV Polarstern* (dashed) and *RV Akademik Fedorov* (full) during WWGS `89. Dark square: intercallibration meeting point of the ships

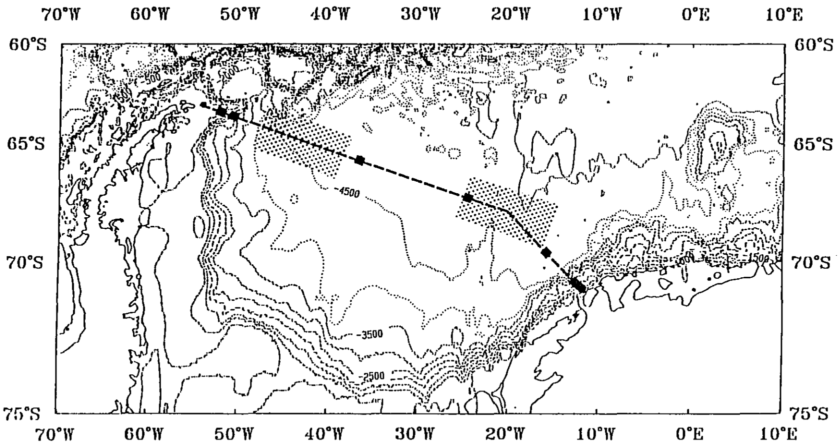

Figure 6: Mooring positions (squares) and Argos buoy areas (hatched) on the cross-section from the Antarctic Peninsula to Kapp Norwegia

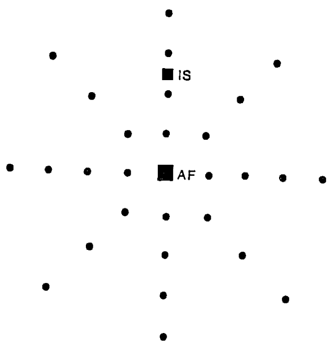

Figure 7: Mesopolygon with *Akademik Fedorov (AF)*, ice station (IS) and helicopter stations (dots). Station spacing: 10 to 20 km

Special efforts will be made at RV *Akademic Federov* to study the water pollution in the Antarctic marine environment. In particular concentrations of heavy metals, hydrocarbons and pesticides will be observed.

3.2.2 Atmosphere-Sea Ice-Ocean Interactions

The development of sea ice and its horizontal motions are mainly forced by heat and momentum exchanges between the ocean and the atmosphere.
The relevant processes involved in these air-ice-water interactions still need to be investigated in great detail in order to provide satisfactory parameters for their representation in coupled ocean-atmosphere-sea ice models. For this purpose the atmosphere large scale surface fields, the turbulent vertical heat and momentum as well as radiative fluxes in the atmosphere and the turbulent vertical momentum, heat and salt fluxes in the ocean below the sea ice will be measured.

The large scale horizontal atmospheric pressure, temperature and wind velocity distributions will be monitored with the aid of two Argos buoy arrays which will be deployed in the shaded areas of Figure 6. Each array consists of 8 buoys, 6 of which form a hexagon of about 150 km side length and two are located symmetrically in the centre part of each grid. These centre systems will be additionally equipped with two types of thermistor chains, one to measure the ice thickness and the other to record the temperature of the upper 250 m of the water column.

The turbulent atmospheric fluxes will be measured with sonic instruments at both ships and occasionally masts for wind and temperature profile measurements in the atmospheric surface layer will be set up on ice floes. Both ships are also equipped with long and short wave radiation sensors.
The vertical momentum, heat and eventually salt fluxes under the sea ice will be measured during two "ice stations" of 3 to 4 days duration with new instrumental equipment near RV *Polarstern.* The entire data set for the ocean and atmosphere surface layers together with further sea ice information to be described below will enable one to test and to improve sea ice models and provide sufficient information on the ocean-sea ice-atmosphere boundary conditions for coupled model studies.

3.2.3 Sea Ice Physics

The physical sea ice studies are closely related to the investigations of air-sea ice-water interaction mentioned above and they furthermore form the backbone of the sea ice biology programme. Considerable efforts will be made to obtain statistically significant high resolution thickness distributions by means of drilling with power driven mechanical augers and pressurized hot water drills (across ridges). The snow thickness will be determined as well during the daily ice stations. An acoustic sensor and a radar scatterometer will be installed on *Polarstern* to monitor the upper surface topography of the sea ice while the ship is moving. The radar data may also help to better interpret GEOSAT altimeter values. Furthermore, attempts will be made to detect the high resolution bottom topography of the sea ice by a sonar instrument.

The texture and various physical properties of the sea ice will be derived from ice cores to be sampled routinely from both ships. Of particular value in this respect are isotope analyses of $^{18}O/^{16}O$ and H/D ratios. These data may help to investigate ice composition, brine migration and recrystallisation processes.

A special ice deformation programme is planned in the Mesopolygon Array by *Akademik Fedorov.* The ice movements will be determined on various spatial scales by Argos stations, Omega radiosondes and strain-meters during a time span of several days.

Finally, the ice concentration, floe size and ice type distribution will be observed by aerial photography, airborne video and line scan camera data in the near environment of the ships.

3.2.4 Plankton Ecology in and under Sea Ice

3.2.4.1 Sea Ice Biology

The biological sea ice investigations concentrate on the exploration of the horizontal and vertical distribution of organisms in the sea ice at late winter in first-year and multiyear ice. The detailed analysis of ice cores will include biological, physical and chemical quantities in order to describe the ice biota as well as their physical and chemical environmental conditions. Emphasis will be put on comparing the Antarctic and the Arctic ice communities in first-year and multiyear ice floes. The ice studies will be complemented by pelagic plankton samples in the upper water column.

3.2.4.2 Pelagic Marine Biology

The plankton community in the upper layers of the *Weddell Sea* can be subdivided into opportunistic and steady state categories. The life cycles of the first ones are distinctly dependent on the physical environmental conditions. Therefore, their populations may undergo rapid fluctuations on short time scales. The biomass of the second ones shows neither remarkable seasonal nor regional variations. The species of this group seem to be closely linked together through several feedback loops. Recent observations in 1986 suggest an active heterotrophic plankton population under the ice also during the winter season.

The biological samples of this expedition will be utilized to study the composition, biomass and winter activity of the major pelagic compartments in the upper 1500 m of the water column. Samples will be taken on both ships by various techniques on all cruise legs through the ice and at the ice edge. On biological stations the following values will be measured: chlorophyll a, particulate organic carbon and nitrogen, phyto- and zooplankton compositions and ambundances in the water column to a maximun depth of 1500m. Special efforts will be made to obtain samples immediately under sea ice. Experiments with artificially simulated light conditions will be carried out on board *Polarstern* to study primary production and incubation in water samples of various depths. The pelagic sedimentation will be detected by sediment traps at two of the oceanographic moorings, one near the Antarctic Peninsula and the other in the central Weddell Sea.

3.2.5 Remote Sensing

Several remote sensing techniques will be applied mainly to sea ice investigations. *Polarstern* will carry a receiving station for the Advanced Very High Resolution Radiometer (AVHRR) of NOAA satellites to provide images of clouds and sea ice. In particular the visible channel will be used to determine the floe size distribution, the ice concentration and the ice drift velocity. The required software has been prepared and tested in advance so that real time processing on board is possible. Attempts will be made to improve the atmospheric correction schemes over ice surfaces. For this purpose the thermal radiance and water vapour effect of the atmosphere will be determined from aerological radiosonde ascents and the aerosol optical thickness will be estimated from photometer measurements in the visible range of the spectrum.

The microwave characteristics of sea ice and snow surfaces will be studied at different wavelengths between 5 and 90 GHz. Radiometers will be installed on *Polarstern* to measure at different incidence angles. The 37 GHz channel is dual polarized while the others can be operated with either horizontal or vertical polarization. The snow or ice surface temperatures are continuously monitored with an infrared radiometer. During the ship`s stations the physical properties of snow and ice relevant for passive microwave radiation will be determined by in situ techniques. Finally a UHF radiometer is planned to be operated from *Polarstern* to detect the ice structure and to measure the ice thickness (less than about 100 cm).

Besides serving basic research the remote sensing investigations provide a good means to improve the interpretation of passive microwave satellite signatures of sea ice and snow.

3.2.6 Upper Air Measurements, Air Chemistry and Atmospheric Routine Observations

The vertical thermodynamic and kinematic structure of the atmosphere will be measured with radiosondes launched from both ships at least twice daily. At *Akademik Fedorov* the low level vertical wind velocity profile is additionally detected in greater detail with a Doppler SODAR. To obtain more complete information on the three-dimensional large scale tropospheric field the radiosonde soundings of the German *Georg-von-Neumayer-Station* will be included in the analysis.

The following nitrogen components of the surface air will be sampled at *Polarstern*: HNO3, NH3, Nitrate and Amonium. If possible the vertical distribution of these concentrations will be derived from air samples taken with the aid of helicopters. At *Akademik Federov* CO2, Radon, Radium 226 and 228 will be determined in the surface air. At *Polarstern* the ozone concentration in the surface air and the total ozone in the atmospheric air column will be measured more-or-less continuously.

A full set of meteorological surface observations will be obtained in three hourly intervalls and charts of weather analyses and forecasts will be received several times per day. This material will be combined for improved surface analyses of the atmospheric forcing conditions on the ice covered ocean. Efforts will also be made to determine suitable predictors for the cloud ceiling and visibility to better assist helicopter and aircraft operations.

4. Zeitplan / Time Table

RV Polarstern

Departure from Bremerhaven	05 August 1989
Arrival at Vigo (Spain)	14 August 1989
Departure from Vigo (Spain)	14 August 1989
Arrival at Puerto Madryn (Argentina)	05 September 1989
Departure from Puerto Madryn	06 September 1989
WWGS-Work	11 September to 23 October 1989
Arrival at Cape Town (South Africa)	31 October 1989

RV Akademik Fedorov

Departure from Leningrad	13 August 1989
Arrival at Bremerhaven	18 August 1989
Departure from Bremerhaven	19 August 1989
Arrival at Montevideo	08 September 1989
Departure from Montevideo	11 September 1989
WWGS-Work	16 September to 04 November 1989
Arrival at Buenos Aires	11 November 1989

5. Beteiligte Institute / Participating Institutions on RV "Polarstern"

Adresse Address		Teilnehmer participants	Fahrtabschnitt leg
Federal Republic of Germany			
AWI	Alfred-Wegener-Institut für Polar- und Meeresforschung Postfach 12 01 61 2850 Bremerhaven	37	1,2
DWD	Deutscher Wetterdienst Bernhard-Nocht-Straße 76 2000 Hamburg 4	3	1,2
GEO	Geophysic Consulting GmbH Büro für Angewandte Geophysik Martastrafle 10 2300 Kiel 1	2	1
HLTS	Hapag-Lloyd Transport & Service GmbH Geo-Plate-Straße 2850 Bremerhaven-Kaiserhafen	3	1
HSW	Helicopter Service Wasserthal GmbH Kätnerweg 43 2000 Hamburg 65	4	2
IfBG	Georg-August-Universität Forstwissenschaftlicher Fachbereich Institut für Bioklimatologie Büsgenweg 1 3400 Göttingen	2	1,2
IFE	Institut für Erdmessung der Universität Hannover Nienburger Straße 6 3000 Hannover 1	1	1
IMH	Institut für Meteorologie und Klimatologie der Universität Hannover Herrenhäuserstraße 2 3000 Hannover 1	5	2
IfMG	Institut für Meteorologie und Geophysik der Universität Frankfurt Feldberstraße 47 6000 Frankfurt/Main 1	3	1

KAE	Krupp Atlas Elektronik GmbH Sebaldsbrücker Heerstraße 235 2800 Bremen 44	7	1
KFA	Kernforschungsanlage Jülich GmbH Institut für Atmosphärische Chemie Postfach 19 13 5170 Jülich	4	1
MPIfM	Max-Planck-Institut für Meteorologie Bundesstraße 55 2000 Hamburg 13	1	2
RB	Radio Bremen Heinrich-Hertz-Straße 2800 Bremen	1	2
RUB	Ruhr-Universität Bochum Fakultät für Chemie Lehrstuhl für Physikalische Chemie I Universitätsstraße 150 4630 Bochum 1	1	2
UNIB	Universität Bremen Bibliothekstraße 2800 Bremen	3	2
UNIK	Universität Konstanz Limnologisches Institut Mainaustraße 212 7750 Konstanz	2	2

Canada

AES	AES/Cress Microwave Group Petrie 014-York University 4700 Keele Street North York, Ontario Canada M3J 1P3	1	2
PCT	Pulsearch Consolidated Technology Ltd. Suite 700, 10201 Southport Road S.W. Calgary, Alberta Canada T2W 4X9	1	1
UC	The University of Calgary Faculty of Engineering 2500 University Drive NW Calgary, AB Canada T2N 1N4	1	1

Republic of China

CRA	Chenese Research Academy Environmental Sciences Beiynan Beijing Volksrepublik China	2	1

United Kingdom

SPRI	Scott Polar Research Institute Lensfield Road Cambridge CB2 1ER	3	2

United States of America

CRREL	US Army Cold Regions Research and Engineering Laboratory 72 Lyme Road Hanover, NH 03755	2	2
GSFC	NASA/Goddard Space Flight Center Lboratory for Oceans, Code 61 Greenbelt, Maryland, 20771	1	2
OSU	Oregon State University College of Oceanography Oceanography Admin. Bld. 104 Corvallis, Oregon 97331-5503	3	2
UNIM	University of Massachusetts Amherst, MA 01003	1	2

Union of Socialistic Soviet Republics

AARI	Arctic and Antarctic Research Institute 38 Berin Street 19226 Leningrad	2	1, 2
IFB	Institute for Botany Academy of Sciences 2 Popov Street 197022 Leningrad	1	1, 2
IFO	Institute of Fishery and Oceanography 17 a Verkhnyaya Krasnoselskaya 107140 Moskau	1	1, 2
SGC	Soviet Geophysical Committee Molodezhnaya 3 117296 Moscow	1	1

6. Fahrtteilnehmer / Participants

ANT VIII/1

Name Name	Institut Institute	
Aechter, B.	KAE	to Vigo
Beckmann, H.	HLTS	to Vigo
Braun, M.	KAE	to Vigo
Briedenhahn, C.	HLTS	to Vigo
Brokhoff, J.	GEO	to Vigo
Bruns, R.	KAE	to Vigo
Castellier, E.	AWI	
Döscher, Th.	AWI	
Focke, J.	AWI	
Freking, B.	KAE	to Vigo
Fricke, M.	IfMG	
Gärtner, Th.	AWI	
Goldan, H.	AWI	
Helmes, L.	AWI	
Hinze, H.	AWI	
Höppe, G.	AWI	
Hoppe, Th.	IFE	
Hussmann, C.	HLTS	to Vigo
Ibrom, A.	IFBG	
Jonen, F.	KFA	
Kloft, H.	KAE	to Vigo
Knickmeyer, E. Fr.	UC	to Vigo
Knickmeyer, E. Hr.	PCT	to Vigo
Koppmann, R.	KFA	to Vigo
Kuhn, G.	AWI	to Vigo
Lyullev, M.	AARI	
Makarov, R.	IFO	
Munsch, I.	AWI	
Niederjasper, F.	AWI	
Nikolaev, V.	IFB	
Nohr, G.	KFA	
Österle-Zell, A..	KAE	to Vigo
Ochsenhirt, W. T.	DWD	
Papenbrock, Th.	RUB	
Plaß, C.	KFA	
Qi, L.	CRA	
Schacht, M.	AWI	
Schenke, H. W.	AWI	
Staubes, R.	IfMG	
Steinmetz, S.	AWI	
Tietze, G.	GEO	to Vigo
Udintsev, G.	SGC	to Vigo
Uhrbrock, J.	KAE	
Villinger, H.	AWI	to Vigo
Weber, M.	AWI	to Vigo
Wolz, G.	IFMG	
Yurganov, L.	AARI	
Zai, Y.	CRA	

ANT VIII/2

Name Name	Institut Institute
Augstein, E.	AWI
Bathmann, U.	AWI
Beyer, K.	AWI
Bredemeier, M.	IfBG
Carbonell, M. C.	OSU
Casarini, M. P.	SPRI
Claffey, K.	CRELL
Comiso, J.	GSFC
Crane, D.	SPRI
Dittmer, K.-P.	DWD
Eicken, H.	AWI
Engelbart, D.	IMH
Fahl, K.	AWI
Fahrbach, E.	AWI
Frieden, W.	IMH
Fromme, J.-P.	AWI
Garrity, C.	AES
Gerdes, A.	RB
St. Germain, K.	UNIM
Gradinger, R.	AWI
Hehl, O.	IMH
Helmes, L.	AWI
Helwig, A.	HSW
Heusel, R.	UNIK
Ibrahim, J.	HSW
Jennings, J.	OSU
Lange, M.	AWI
Lemke, P.	MPI, HH
Lytle, V.	CRREL
Lyeleev, M.	AARI
Mahler, G.	HSW
Mahnke, P.	AWI
Makarov, R.	IfO
Meyer, G.	AWI
Möhrke, H.	HSW
Nikolaev, V.	IfB
Nöthig, E.-M.	AWI
Ochsenhirt, W.-T.	DWD
Olf, J.	IMH
Reisemann, M.	AWI
Rohardt, G.	AWI
Ross, A.	OSU
Schenk, C.	AWI
Schröder, M.	AWI
Schütt, E.	UNIB
Surkow, R.	IMH

Viehoff, Th.	AWI
Vogeler, A.	AWI
Wadhams, P.	SPRI
Weissenberger, J.	AWI
Wicke, A.	UNIB
Wieser, Th.	UNIK
Witte, H.	AWI
Wisotzki, A.	UNIB
Wolf-Gladrow, D.	AWI
Yurganov, L.	AARI

7. Participants from FR Germany on *RV Akademik Fedorov*

Wamser, C.	AWI
König-Langlo, G.	AWI
Loose, B.	AWI
Stichternaht, A.	UNIB
Bosse, J.	UNIB
Genz, G.	UNIB

8. Schiffsbesatzung /Chip`s Crew

	ANT VIII/1	ANT VIII/2
Kapitän	Jonas	Jonas
1. Offizier	Gerber	Gerber
Naut. Offizier	Schiel	Schiel
1. Offizier Ladung	Varding	Fahje
Naut. Offizier		NN
Arzt	Dr. Reimers	Dr. Reimers
Ltd. Ingenieur	Dietrich	Dietrich
1. Ingenieur	Schulz	Schulz
2. Ingenieur	Fengler	Delff
2. Ingenieur	Erreth	Simon
Elektriker	Schuster	Erdmann
Elektroniker	Elvers	Elvers
Elektroniker	Hoops	Hoops
Elektroniker	Both	Both
Elektroniker		Muhle
Funkoffizier	Geiger	Butz
Funkoffizier	Wanger	Müller
Koch	Tanger	Klasen
Kochsmat	Kubicka	Klauck
Kochsmaat	Bender	Kröger
1. Steward	Scheel	Peschke
Krankenschwester/ Stewardess	Pötzsch	Lieboner
Stewardess	Friedrich	Hoppe
Steward/Stewardess	Ambo Masse	Hopp
Steward/Stewardess	Busro Amran	Gollmann
2. Steward	Chang	NN
2. Steward	Chau	NN
3. Steward	Shyu	Yang
Lagerhalter	Barth	Barth
Maschinenwart	Jordan	Jordan
Maschinenwart	Fritz	Fritz
Maschinenwart	Heurich	Heurich
Maschinenwart	Buchas	Buchas
Maschinenwart	Reimann	Reimann