EPOS
EUROPEAN POLARSTERN STUDY

EUROPEAN SCIENCE FOUNDATION
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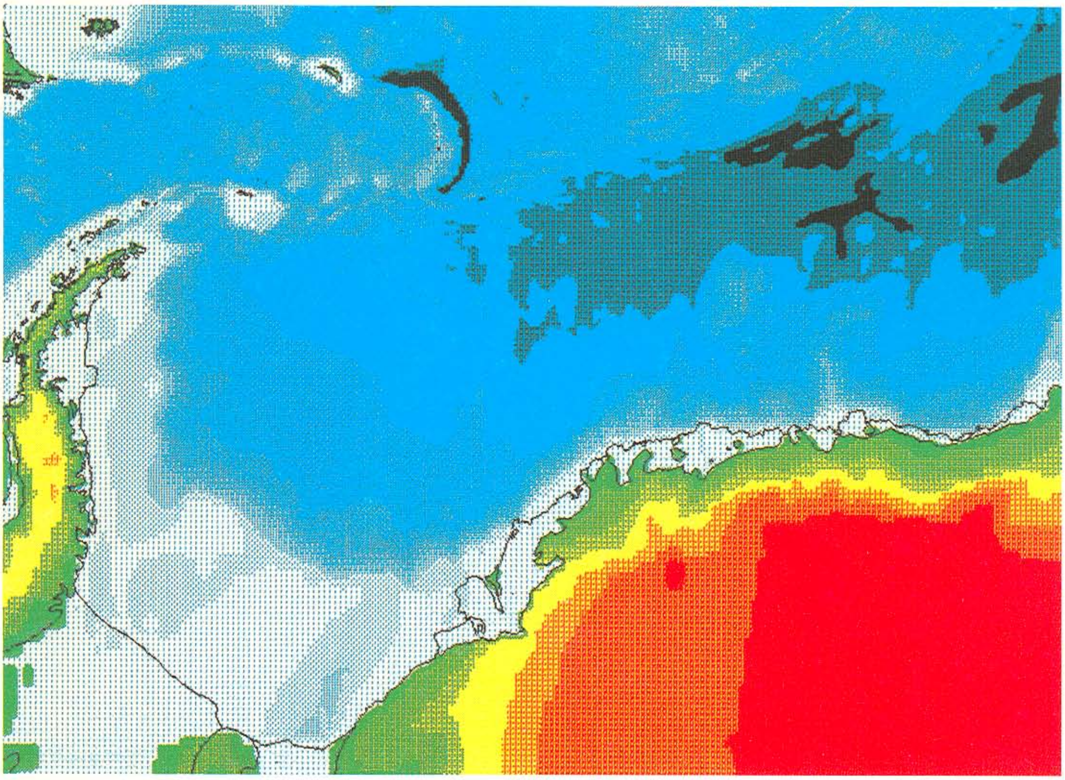
EUROPEAN "POLARSTERN" STUDY



ANTARKTIS VII

1988/89

Expeditionsprogramm Nr. 13

FS "POLARSTERN"

ANTARKTIS VII

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ANT VII/2: (EPOS 1) G. Hempel
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About this booklet

The Alfred-Wegener-Institute traditionally publishes a pre-cruise booklet containing the research plans of each RV "Polarstern" expedition. This booklet is the thirteenth in the series and differs from previous versions in being more than just an account of envisaged research. It is a summary of the background, goals and cruise plans of a joint European venture (EPOS) devoted to the study of Antarctic ecology. It is RV "Polarstern´s" seventh cruise to the Antarctic, hence the acronym ANT VII. For the sake of brevity, the research planned during the EPOS cruises has been presented within a general framework. We have also broken with tradition by presenting the first Leg of the expedition (ANT VII/1, the Atlantic Crossing) as an annex at the end, because this Leg is not a part of EPOS. The booklet was compiled by Dagmar Barthel and typed by Ingrid Lukait. Evi Nöthig and Renate Scharek helped with the final preparations.

Zu diesem Heft

Das Alfred-Wegener-Institut gibt regelmäßig ein Expeditionsprogramm mit den Forschungsvorhaben heraus, die auf FS "Polarstern" durchgeführt werden. Dieses dreizehnte Heft der Serie unterscheidet sich von früheren, weil es die Hintergründe, Ziele und zusammengefaßten Forschungsprogramme einer gemeinsamen europäischen Studie antarktischer Ökologie (EPOS) darstellt. Dieses Heft ist deshalb nur in englischer Sprache abgefaßt. Aus dem gleichen Grund erscheint das Programm für die Anfahrt (ANT VII/1), das nicht Teil der EPOS Studie ist, am Ende des Heftes. Das Heft wurde konzipiert und zusammengestellt von Dagmar Barthel; Ingrid Lukait sorgte mit tatkräftiger Unterstützung von Evi Nöthig und Renate Scharek für die Fertigstellung.

Victor Smetacek

THE EUROPEAN "POLARSTERN" STUDY (EPOS)

A JOINT VENTURE TO STUDY ANTARCTIC ECOLOGY

1. Introduction: The importance of EPOS within the frame of Antarctic research

The history of Antarctic marine research extends over more than one-and-a-half centuries. However, research has not progressed as far as in other areas because of the remoteness and great extent of the region (about 10% of the World Ocean), coupled with severe climatic conditions. While it is accepted that the Southern Ocean is of great importance in a global context, the means to carry out the necessary studies have been available only to a few nations and mostly for short periods, in particular the summers. EPOS is a venture attempting to overcome this problem by pooling manpower resources by bringing together scientists from most West-European countries on the icebreaking research vessel "Polarstern" as a convenient platform.

The oceans play an important role in the general global heat flux and consequently influence biological systems. Surface currents transport heat towards high latitudes and cold currents flow the opposite way. A pronounced formation of deep ocean water occurs primarily in the Norwegian-Greenland Seas and in the waters surrounding Antarctica in particular in the Weddell Sea. Together with geography and topography such processes play a major role in the distribution of marine floras and faunas, creating quite different conditions in the North and the South. In the North, the circulation pattern links the surface waters with other oceans, whereas the deep ocean basins are isolated. In the South the surface waters form a rather isolated entity in a biological sense while the deep links are wide open. Thus the two polar areas represent important and divergent marine biological systems.

Concerning management of natural resources, it is important to realise that the Southern Ocean, which at the peak of the whaling industry in the 1930s was contributing some 15% of the world marine harvest, may be a vital protein source in the future. On the other hand, tapping this resource might seriously disrupt the whole ecosystem, and a firm scientific basis is therefore essential to the future management. The Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR), which is responsible for this, is dependent on outside agencies for the provision of scientific data on which to base management policies. In the past, increasing concern about the sustainability of marine harvests and the susceptibility to perturbation of the marine environment in polar areas, coupled with the need to know more about the processes supporting this vast ecosystem, prompted the major SCAR/SCOR BIOMASS (Biological Investigations of Marine Antarctic Systems and Stocks) programme. The BIOMASS programme involved only a few of the western European nations besides USA, Japan and USSR, and did not properly reflect the traditions of European biological oceanography. EPOS, by bringing together expertise from many laboratories with distinguished histories of biological oceanography which have not previously (or recently) participated in Antarctic research, will stimulate the application of fresh ideas to answering the important scientific questions presented by the Antarctic marine ecosystem, as well as adding to the general store of knowledge necessary for the management of this major part of the World Ocean.

One major objective of EPOS is to investigate the role of sea ice for the pelagic system as well as to study the ice biota themselves. Another is to make a detailed study of the pelagic system in the region of the Weddell/Scotia Seas, while a third objective is to study fish and benthos in the southern Weddell Sea and in the virtually uninvestigated area off eastern Queen Maud Land. There is no better platform for such studies than the FRG vessel "Polarstern", and European cooperation here brings together specialists in various biological subdisciplines from eleven countries and thirty laboratories. There is no doubt that the results will advance our understanding of the Antarctic ecosystem. This is important on a long time scale where changes in parts of the environment will also cause changes in biological systems.

2. The European Science Foundation (ESF) and the ESF Network on Polar Science

The European Science Foundation (ESF) is an international non-governmental organization with its seat in Strasbourg (France); it is formally an association of its 49 member research councils and academies in 18 countries. The ESF brings European scientists together to work on topics of common concern, to coordinate the use of expensive facilities, and to discover and define new endeavours that will benefit from a cooperative approach. The scientific work sponsored by ESF includes basic research in the natural sciences, the medical and biosciences, the humanities and the social sciences.

The ESF links scholarship and research supported by its members and adds value by cooperation across national frontiers. Through its function as a coordinator, and also by holding workshops and conferences and by enabling researchers to visit and study in laboratories throughout Europe, the ESF works for the advancement of European science.

A scheme of European Networks of Scientific and Technological Cooperation was established at the First Conference of European Ministers responsible for Research held in Paris in September 1984 in an effort to strengthen intra-european cooperation in science.

Since 1985, the ESF has launched several European scientific networks, including one in Polar Science based on the realization that, despite a growing interest in polar areas and a strong need for collecting more scientific information, national resources would soon limit research. Thus, the launching of the ESF Network on Polar Science in 1986 was meant to allow the pooling of both scientific knowledge and logistic resources for arctic and Antarctic studies within Europe.

EPOS and the Network Concept

The Polar Science Network identified as one of its three main areas of activity an investigation into Antarctic marine ecology. Realization of this ambitious plan was greatly facilitated by the offer of the Alfred-Wegener-Institute for Polar and Marine Research , Federal Republic of Germany, (AWI) to use the research vessel "Polarstern" between the months of October 1988 and March 1989 for this purpose. The logistics needed for effective operation in the Antarctic are expensive investments, currently available only to a few countries. Resources of scientific manpower, expertise and instrumentation are more widely distributed. It therefore makes good sense to bring these together through a network concept in the expectation that not only will more effective use be made of both the manpower, instrumentation and the logistic facilities, but also that the cross-fertilization effect and training resulting from such cooperation will enhance future scientific research in the Antarctic. New concepts and models of marine ecology will be introduced to the study of the Southern Ocean.

"Polarstern" was planned with the intention that this major facility should, besides being the main operating platform of the AWI, also be a contribution to international collaboration in polar studies. The offer of the use of "Polarstern" made possible the realization of a European cooperation within the Polar Sciences Network.

In the case of EPOS the logistic means of attaining the intended activity were already secured before the final ends were defined. While this appears to be a reversal of the usual course of planning scientific activities, it should be pointed out that this is not unusual in marine studies, particularly when conducted in the Antarctic. For the first time in Antarctic research, specialists from all over western and northern Europe will coordinate their scientific expertise in one big study. The wealth of information that can be expected from the combination of results of different projects is probably greater than anything any single nation could provide in the near future.

3. The planning of EPOS

Planning for the European "Polarstern" Study (EPOS) began in April 1986. It was appreciated that a very full response was likely from the scientific community and a Management Group was set up to invite proposals for project elements from European laboratories and to develop a coherent programme.

The composition of the Management Group is:

Wolf Arntz, FRG
Bruno Battaglia, Italy
Nigel Bonner, U.K.
Jean-Claude Hureau, France
Victor Smetacek, FRG
Jarl-Ove Strömberg, Sweden (Chairman)
Jenne J. Zijlstra, Netherlands
Gotthilf Hempel, FRG (ex officio)

The Management Group has met five times:

1. 2-3 April 1986 in Bremerhaven
2. 2 September 1986 in Bremen
3. 23-24 March 1987 in Paris
4. 22 May 1987 in Bremerhaven
5. 13-15 January 1988 in Bremerhaven

The Group also arranged a First EPOS Workshop in Bremerhaven on 20-21 May 1987 with 27 participants from ten European countries (Belgium, Denmark, Federal Republic of Germany, Finland, France, Italy, Netherlands, Norway, Sweden and United Kingdom). On January 13-15 1988 a Second EPOS Workshop was arranged, again in Bremerhaven.

Emphasis is given to marine biology, but other marine disciplines (physical oceanography, marine chemistry and sedimentology) form essential parts of the programme. Each leg centres around an interdisciplinary ecological core theme, while projects concerned with physiology, taxonomy etc., are grouped around this core.

The Management Group selected about 40 proposals from the original 85 letters of intent received as a result of an invitation to contribute scientifically to EPOS. This careful selection meant a reduction of the more than 200 scientists involved to somewhere over half that number. Out of those about 70 scientists from eleven countries (in addition to those named above - Spain) met in Bremerhaven on January 13-15 1988 to discuss the details of the scientific planning of the cruise, including a final composition of the scientific crew for each of its three legs.

During the last Meeting of the Management Group on January 15, 1988, the final dates and cruise plans for each leg were settled. Also the lists of participants for the legs were more or less finalized, although in some few cases national money for participation by scientists had not yet been secured. Fortunately, the vast majority of scientists selected by the Management Group received national funding for participation in EPOS. The following time frames and scientific leadership now apply:

Leg 1 11 October - 20 November 1988.
Embarkation in Rio Grande do Sul, Brazil; disembarkation in Punta Arenas, Chile
Chief scientist: G. Hempel, FRG
Scientific adviser: J.-O. Strömberg, Sweden

Leg 2 22 November 1988 - 10 January 1989.
Embarkation and disembarkation in Punta Arenas, Chile.
Chief scientist: V. Smetacek, FRG
Scientific adviser: J.J. Zijlstra, Netherlands

Leg 3 12 January - 10 March 1989.
Embarkation in Punta Arenas, Chile; disembarkation Cape Town (provisional)
Chief scientist: W. Arntz, FRG
Scientific adviser: J.-C. Hureau, France

RV "Polarstern" will depart from Bremerhaven on 14 September 1988 and return on 31 March 1989. During the southbound voyage (Bremerhaven - Rio Grande, ANT VII/1) research on atmospheric chemistry and physical oceanography will be carried out. The research programme of this cruise (chief scientist: G. Krause) has been included in the annex.

4. The research vessel "Polarstern"

RV "Polarstern" is a strong, double-hulled ice-breaker with an interior well-protected against the cold. She can work even at outside temperatures of -50°C, which enables her to overwinter in Antarctica. She is equipped for research work in biology, geology and geophysics, geomorphology, glaciology, physical and chemical oceanography, meteorology and fisheries. Another speciality is the high loading capacity necessary to supply polar stations such as the permanent Antarctic station "Georg-von-Neumayer" in Atka Bay, and the Filchner summer station on the Filchner Ice Shelf, at the southern end of the Weddell Sea. The special design of "Polarstern" as ice-breaker, supply and research vessel and also as helicopter carrier is reflected in her bulky shape and in a draught of approx. 10.5 metres. The ship allows 40 scientists and technicians to work on board, and has additional room for about 25 scientists and technicians as "passengers" for work ashore and on polar stations, beside a permanent crew of about 41 members. Up to 11 containers can be carried by "Polarstern", on deck and in special holds. Most specialized work requiring either complicated, bulky instrumentation or an exceptionally clean environment is carried out in containers specially constructed for the purpose. This facility enables researchers to ship their equipment in place in the laboratory directly to the embarkation port.

SCIENTIFIC EQUIPMENT

RV "Polarstern" is a highly equipped multipurpose research vessel. On the wide wood-planked work deck, 8 winches are based for oceanographic and plankton work as well as for fishing and bottom sampling, even at great depths. Two telescope beams can be moved over the vessel's side with a reach of 3 metres. There exists also a 25-tons-crane with a working radius from 4 to 24 metres, the head of which can be lowered to the sea surface in order to minimize the swinging of the instruments attached to it. Bottom and midwater trawling as well as towing of heavy gear is done through a movable A-frame at the stern. Geologists have equipment available to take sediment cores up to 18 metres long; there are air-gun compressors and other facilities for geophysical work. Geomorphologists can use the narrow beam echosounder and the Sea Beam equipment for a spatial recording of the sea bottom beyond 1500 metres of water depth.

Part of the work deck is heated so that people can work there even at low temperatures. In case scientists want to do research at some distance from the ship, two helicopters.and the 12-metre-launch "Polarfuchs" are at their disposal. The latter is equipped for shallow water studies in hydrography and biology. It will, however, not be used in EPOS because it is not ice-protected. Inside "Polarstern", there are several kinds of laboratories which can be increased in number by adding 11 lab-containers on deck and in the laboratory container holds. Nine laboratories serve biology, geology, air and water chemistry, and fisheries. There exist also a computer room, space for data processing, for drawing, and a refrigeration plant producing variable temperatures down to -32°C in three chambers, where ice can be stored at its original temperature, and biological samples can be deep frozen. Special aquarium containers with several basins allow transportation of living animals to Bremerhaven.

The icebreaking vessel "Polarstern" in the ice of the Weddell Sea (H. Kohnen)


Helicopter in operation (G. Dieckmann)

Working deck of RV "Polarstern" (R. Krause)

A central board computer (VAX 11/750) is available for online- and post-processing of data. This computer is among others directly coupled with the Integrated Navigation and Data Collecting System (INDAS). The meteorological station can receive weather charts, and serves as meteorological observatory and radiosonde station.

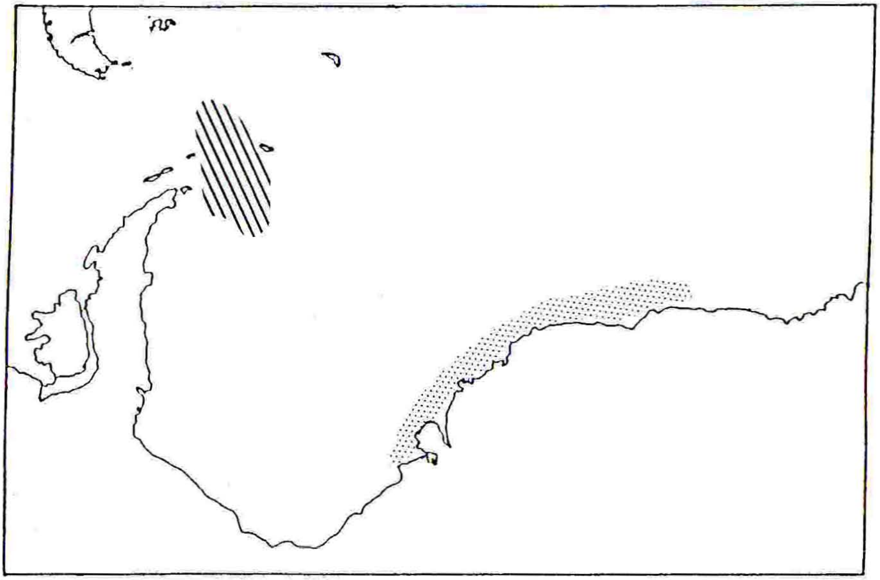
5. The EPOS cruise

Phase 2 of EPOS was approved by the Executive Council of the ESF on 24 November 1987. The main activity of Phase 2 will be the EPOS expedition itself. In order to provide as comprehensive a coverage as possible of the austral summer season, the cruise has been divided into three legs extending from late winter (October 1988) to late summer (March 1989), each dealing with specific features of the ecology of the Weddell Sea. Thus, **Leg 1** will study the physics and biology of multi-year sea ice that covers an extensive area of the western Weddell Sea. This ice mass moves northward and reaches the eastern Peninsula tip where it can be accessed in spring. The effects of ice melt on water column biology will also be addressed. **Leg 2** will focus on interaction between water column chemistry and biology as influenced by physical factors such as ice and mixed layer depth. Studies for comparison of water masses of different origin and hence biological past histories are planned. The study site has been chosen at the Weddell/Scotia Confluence, a broad frontal zone separating water of the circum-polar West Wind Drift from that of the Weddell Sea Gyre. **Leg 3** will operate along the south-eastern Weddell Sea shelf and concentrate on benthos and fish studies. This high-latitude benthos has so far received less attention than that of the more accessible Peninsula region.

Logistic reasons, proximity to ports of call in the case of Legs 1 and 2, and relief of the German Antarctic station during Leg 3 have also played a role in selection of each leg´s study sites.

The scientific rationale, cruise plan and list of participants for each of the legs are given below.

It should be noted that there is a strong joint element of interest in all three legs, i.e., to understand ice-related and pelagic processes during as long a period as possible of the austral spring and summer. Thus stations in approx. the same geographic area (between Clarence Island and South Orkney Islands) will be sampled during parts of all three legs.



Map of Weddell Sea
showing areas where research by EPOS legs will be conducted;
hatched: Legs 1, 2 and 3
dotted: Leg 3

5.1 Leg 1

5.1.1 Scientific rationale

The sea-ice and the ice-edge zone are the two most characteristic features of polar marine ecosystems. The former habitat, intuitively considered as hostile to life for many years, is now known to harbour a highly adapted and hence complex community of auto- and heterotrophs. The ice-edge zone, on the other hand, is known to sustain high spring phytoplankton production associated with a shallow surface layer stabilized by addition of low-salinity melt water. Algal biomass in this zone is augmented by cells released with the melting ice that seed the stabilized surface layer. Leg 1 will study both the sea-ice and water column with the aim to achieve a better understanding of processes influencing the biomass and community structure of both habitats and the interaction between them. The following aspects will receive special attention:

1) The relationship between the physical structure of ice and the biomass and community composition of ice biota must be influenced by a variety of factors as suggested by the marked small-scale patchiness of the biota. Regional, but also small-scale, vertical patterns in distribution will be obscured by seasonal changes, particularly those occurring during melting. It is possible that a biological succession occurs in the ice biota comparable to that characterizing the plankton. Multi-year ice should provide a record of successional change over several years but has not yet been adequately sampled and analysed. The northwestern Weddell Sea is one of the few regions where multi-year ice is likely to be accessible to the "Polarstern".

2) The abundance and distribution of ice biota is likely to be influenced both by seeding mechanisms occurring in the previous autumn as well as to subsequent growth determined by ecophysiological adaptations to specific environmental properties such as variation in light, nutrients, salinity etc. The role of these factors will be analysed in in vitro experiments and deduced from comparative studies of field samples.

3) The transition zone between the ice cover and the water column can provide a stable environment for algal biomass accumulation. Honeycombing of the ice during melting greatly increases surface area of this zone and encourages rapid proliferation of algae. The ice can hence function not only as a seed bed but also as a "nursery" for the phytoplankton bloom. For this purpose, it will be necessary to quantitatively sample both the ice as well as the associated water.

4) Antarctic ice-edge blooms are not as prominent as those in the Arctic. However, horizontal patchiness in biomass could well be a result of mesoscale hydrographical

structures such as eddies and melt-water lenses. Spatial and temporal variation in the depth of the mixed layer, by affecting the light regime, would fundamentally influence horizontal and vertical distribution of phytoplankton biomass. Additional factors, such as grazing and sedimentation, will affect removal rates and will also have to be studied.

5) Pelagic heterotrophs are geared in various ways to the environment, in particular to seasonality of food supply. The response of bacteria, protozoa and zooplankton to the dynamics of phytoplankton development and the patterns of interaction between these compartments of the pelagic biota will be addressed in integrated studies.

6) Antarctic animals exhibit an array of different life-cycle strategies. This applies not only to fish spawning patterns but also to zooplankton overwintering, feeding and breeding behaviour. An analysis of the spatial and temporal distribution patterns of dominant species will improve our understanding of functional responses of these groups to regional and seasonal features of the environment.

7) Krill is known to occur in abundance on the ice undersurface, although so far only larvae have been observed in this habitat in the Peninsula region. During spring, adult krill swarm and spawn here in the water column but their relationship to the ice is not known. The degree of affinity to ice might well vary with age and season as adult krill are abundant under the ice of the southern Weddell Sea. It is also not known whether krill remain under perennial ice. Hence, seasonal variation in krill distribution under the ice and in the water column will provide new insight into krill biology.

Besides using a Remotely Operated Vehicle and standard techniques for sampling in and under the ice, scuba diving will be carried out for sampling and in situ experiments.

5.1.2 Gear to be deployed

a. 2 CTDs with Niskin samplers, fluorometer and irradiance meter
b. UV light meter
c. Rectangular Midwater Trawl 1+8
d. Bongo net
e. Multiple closing net
f. Neuston net
g. Apstein nets
h. Ice coring equipment
i. Helicopters
k. Underwater "vacuum cleaner" for sampling by divers
l. ROV

5.1.3 The cruise plan

Leg 1 commences at Rio Grande, Brazil, on 11 October 1988 and ends at Punta Arenas on 20 November 1988. The estimated sailing time to the area of investigation is 6 days. The area of investigation lies east of Joinville and west of the South Orkney Islands.

At least two long N/S transects will be conducted. The exact location of the first long transect will be determined after consideration of the prevailing ice situation, hopefully (if cloud cover permits) on the basis of satellite imagery. The ice edge is expected to lie at approx. 60°S. The second transect will be conducted in early November, when the ice situation should have improved sufficiently to enable access to the western shelf of the South Orkney Island. This N/S transect crossing the shelf will be repeated by Legs 2 and 3. In addition to the 2 long transects that will penetrate deep into the ice, particular attention will be paid to the phenomenon of biomass enhancement at the ice edge. This will be accomplished by a series of short additional transects "zig-zag" that will be conducted in the ice edge zone between both long transects (see diagram).

The short transects will be conducted across the pack-ice border with an aim to ascertaining mesoscale structures in this zone. The first and last of these are part of the long transects. Positioning of the zig-zag transect will be determined after consideration of the results from the first transect including surface measurements. Experience has shown that the zone of enhanced biomass can begin at some distance from the ice and reach a maximum before the first ice is encountered. However, it should be borne in mind that movement of the pack-ice field can differ significantly from that of the underlying water, hence we should not expect to encounter a clear spatial relationship between the position of the ice field and the zone of enhanced biomass.

Each transect (long and zig-zag) should begin well before the first ice and terminate when closed ice cover is reached. The positioning of stations along the transect should be determined, again ideally, by type of ice cover. The first station of the long N/S transect will be located well before the ice but after the Convergence (ca. 52°S) and followed by stations at approx. 1° intervals till the first encounter with ice. Thereafter, stations will be conducted according to ice type: brash or pancake ice, small ice floes, large ice floes, closed ice cover. The structure of the ice zone cannot be predicted; thus, it is possible that we encounter a clearly delineated packice border, in which case stations should be spaced at arbitrary intervals.

In addition to the above sampling strategy, counts of birds and mammals will be carried out at fixed intervals from deck.

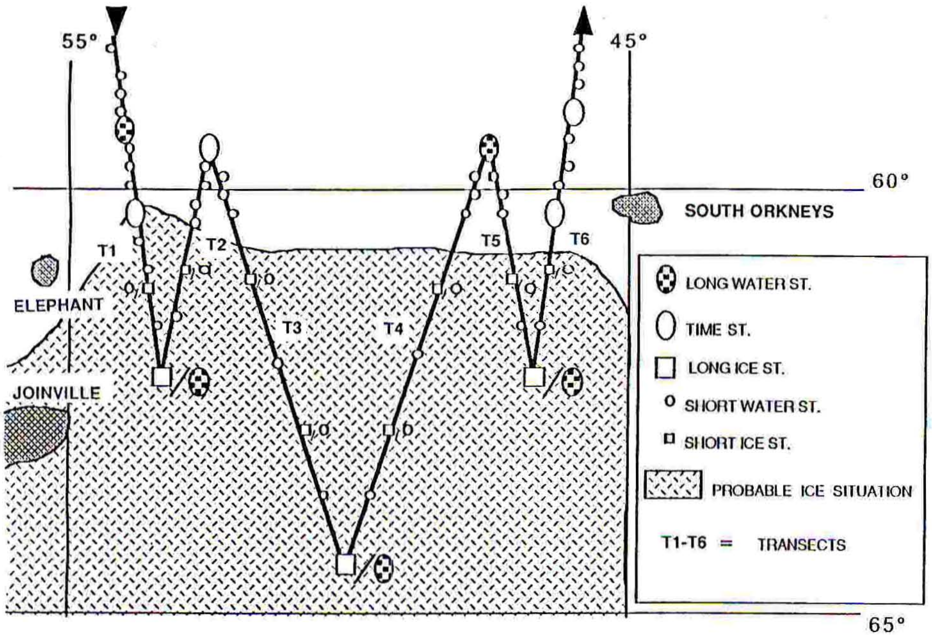


Diagram of planned cruise track- LEG 1

Preliminary cruise scheme (see also diagram for explanation)

Oct. 11	Depart Rio Grande
Oct. 16	Arrive Convergence, beginning of transect ± 5° north of the ice edge (test station)
Oct. 25	End of first long transect (T_1)
Nov. 11	End of zig-zag transect (T_2 - T_5)
Nov. 17	End of second long transect (T_6)
Nov. 20	Arrive Punta Arenas

Detailed objectives provided by the respective working groups fall into two major categories:
1) Water column investigations and
2) Sea ice investigations

1) The water column investigations entail the following:

A) Continuous monitoring of surface water
B) Water column stations

A) Continuous monitoring of surface water
Temperature, salinity and chlorophyll fluorescence will be recorded continuously; discrete samples from the ship's flow-through seawater system will be taken for measurements of various parameters as far as ice conditions permit.

B) Water column stations
Three types of water column stations will be carried out
a) Short stations b) Long stations c) Time-series stations.

a) *Short stations* will consist of one CTD-rosette cast with Niskin bottles including discrete sampling up to 12 depths and vertical net hauls (Apstein, Multinet) both down to maximum 400 m depth. The time allotted to a Short station will be not more than 1 hour, whereas more time (4-6 hrs) will be available in conjunction with Short ice stations.

b) *Long stations* will consist of CTD-rosette casts and various vertical and horizontal net hauls: RMT 1+8, Bongo net, Multi-net, Neuston-net, depending on specific requirements and ice situation. Various in situ incubation experiments will also be carried out. The time allotted to a Long station will be between 24 - 32 hrs.

c) *Time-series stations* will, in contrast to Long stations, involve CTD-rosette and net casts as mentioned in b) conducted at regular intervals. Horizontal net tows (see b) will be conducted between the regular CTD and net casts. The time required for a Time-series station will be 48 hrs.

Additional horizontal net hauls will be done during steaming between stations as far as ice conditions permit.

2) Sea ice investigations:

a) *Short ice stations* will entail ice coring and measurement of ice thickness from several sites within 100 m of the ship together with vertical sampling (by pumping) of the 2 metre water layer immediately underlying the ice. Short water column stations will be conducted and the ROV deployed concomitantly. Sampling by scuba diving will be done at selected stations. Duration of the short ice station will be 4-6 hrs.

b) *Long ice stations* (24 hrs) will be conducted only under conditions of stable, closed ice cover. In addition to the activities mentioned under Short ice stations, sampling and in situ incubations by scuba divers will also be carried out. Long water column stations will be done from the ship.

For both ice station types the sampling team will be deposited on the ice alongside the ship in a small open container ("mummy chair") using the ship´s crane or access to the ice will be via gangway on the ship´s backbord side. In addition, the helicopters can also transport ice sampling groups to selected stations during water column measurements in open water.

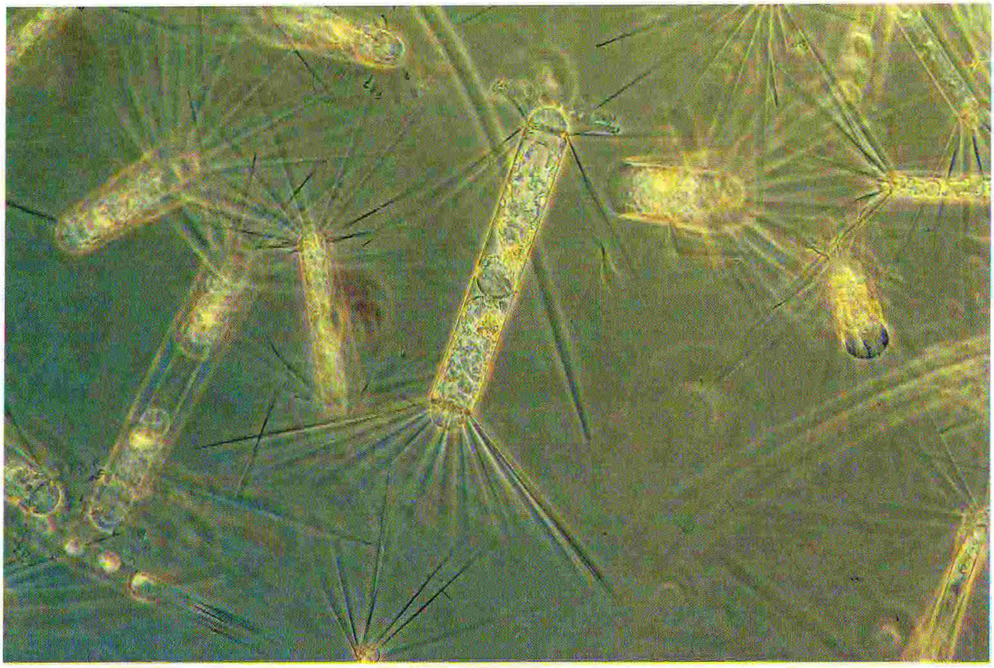
5.1.4 List of participants

Chief scientist:	Hempel (FRG)
Scient. adviser:	Strömberg (S)
Ice Physics:	Eicken (FRG), Lange (FRG), Vogel (FRG)
Ice Biota:	Bergström (S), Dieckmann (FRG), Kirst (FRG), Kristiansen (N), Nöthig (FRG), Nothnagel (FRG), Syvertsen (N), Wanzek (FRG
Phys. Oceanogr:	Dimmler(FRG), Larsson (S), Meyer (FRG), Sehlstedt (S),Ljungek (S),
Phytoplankton:	Bianchi (I), Bouquegneau (B), Cioce (I), Dubinsky (ISR), Gieskes (NL), Goffart (B), Hecq (B), Heusel (FRG, Joiris (B), Kraay (NL), Martinez (SP), Overloop (B), Socal (I), Tilzer (FRG)
Bacteria:	Delille (F), Kivi (SF), Kuosa (SF), Norrman (S),
Zooplankt./Fish:	Battaglia (I), Harm (FRG), I.Hempel (FRG), Kellermann (FRG), Marschall (FRG), North (UK), Rapp (FRG), Seim (N), Siegel (FRG)

A total of 45 scientists and assistants, and in addition a helicopter crew of 4.

Broken ice in ship´s wake showing brown discolouration due to phytoplankton and ice algae (K. Schaumann)

Pancake ice (anonymous)



A common Antarctic phytoplanktonic diatom (*Corethron criophilum*) (E. Nöthig)

Antarctic krill (*Euphausia superba*) (J. Plötz)

5.2 Leg 2

5.2.1 Scientific rationale

Factors governing production and biomass of pelagic auto- and heterotrophs in Antarctic waters are not well understood. Both types of pelagic system - those based on new or regenerated production - have been encountered in waters off the Antarctic Peninsula and evidence suggests that they succeed each other seasonally. Such a transition occurs annually in all productive waters and is believed to be controlled by exhaustion of new nitrogen (=nitrate) in the mixed layer. Phosphorus or silica might play this role in some regions. These factors are unlikely, however, to apply in Antarctic waters, as regenerating communities are routinely observed at high ambient nutrient levels. One (or a combination) of the following factors is therefore suggested to be responsible for changes in biomass and community structure.

1) Physical factors: Blooms are generally observed in shallow mixed layers formed by addition of melt water from the retreating ice edge. Subsequent deepening of the mixed layer terminates the bloom by diluting biomass; however, why this should result in establishment of a regenerating community is not clear.

2) Chemical factors: Biogenic elements other than nitrogen limit bloom biomass and form the basis for the regenerating system. Iron or a trace element is suggested to be the key factor here.

3) Intrinsic life cycle properties of the phytoplankton: The changes are triggered by internal rather than external factors i.e., they are to be sought in algal physiology. The mechanism of elimination of cells from the mixed layer would have to be sinking.

4) Conditioning and competition: Various types of interaction between phytoplankton species or groups are known to occur. Of these, competitive exclusion for a limiting resource and chemical conditioning of the environment are suggested to be of importance in the Antarctic.

5) Grazing: Various types of herbivorous zooplankton (protozoans, copepods, salps, krill) increase grazing pressure in the course of the spring. Heavy selective grazing on phytoplankton could lead to a shift in species composition and significant reduction in biomass of larger, bloom-forming phytoplankters.

We intend to study the role of these factors in driving seasonality in Antarctic pelagic communities by means of large scale surveys and intensive process oriented investigations at time-series stations conducted in different types of system. All the factors listed above will be addressed during leg 2. The large-scale surveys will be repeated in the same region at intervals of weeks. The research goals of these surveys are to study the relationship between mesoscale hydrographical structures (eddies and fronts) and the chemistry and biology of surface water masses. Using the hydrographical data as a base for characterizing the physical environment, we hope to be able to follow temporal changes in structure of the pelagic system. Conventional measurements (temperature, salinity, light penetration, nutrients, primary production, phytoplankton and zooplankton biomass etc.) will be combined with measurements of parameters and rates not often recorded in Antarctic waters. We next list some of our research goals:

1) Turbulent mixing in the surface layer is an environmental property of fundamental importance to plankton biology about which little is known. Turbulence will be characterized by measuring the movement of individual particles with a Laser-Doppler velocimeter mounted on a special vehicle (Manta).

2) The concentrations of trace elements in the oceans are being re-estimated with ultra-clean sampling and recently developed analytical techniques. Patterns in distribution of these elements indicate many of them to be biologically active but, unlike the bulk nutrients, in specific ways. The concentrations of aluminium, barium, various trace metals and the rare earths will be compared with biological activity and species composition of plankton.

3) Hydrogen peroxide is emerging in importance as an indicator of biological activity. However, it is also formed photochemically, particularly by ultraviolet radiation. Measurements at the ice edge will provide a unique opportunity to assess the importance of the two processes and to further our understanding of the role of H_2O_2 in aquatic systems.

4) Dissolution mechanisms of diatom frustules are poorly understood but knowledge of the controlling factors are essential for interpreting the fossil record. Antarctic waters are considered to be a major site of silica deposition, hence measurements of these dissolution rates in relation to the environment are likely to provide interesting results.

5) Phytoplankton growth rates can be assessed by different methods which often provide conflicting results. The discrepancies might well be a function of the phytoplankton species composition and/or of specific features of the growth environment that influence the physiological state of the community. The ^{14}C, O_2 and ^{15}N methods will be combined with studies of the partitioning of photosynthate along different cellular pathways.

6) Our knowledge of Antarctic phytoplankton species distribution is largely restricted to robust forms (e.g. diatoms) although small flagellates are reported to predominate under certain conditions. The species composition of Antarctic flagellates will be assessed in order to enable comparisons with other regions and provide additional clues to understanding the enigma of Antarctic phytoplankton succession.

7) The microbial loop (the regenerating community) is receiving increased recognition as a major pathway of organic substance in the pelagial. There is evidence that this pathway is also important in Antarctic waters. A detailed study of bacterial production and biomass in relation to cyanobacterial as well as flagellate and ciliate biomass and composition will be conducted. Such detailed studies of the Antarctic microbial loop are necessary for comparison with other areas and will indicate to what extent, if at all, there are fundamental differences in structure and function of regenerating communities in waters with high and low nutrient concentrations respectively.

8) The grazing pressure exerted by protozoo- and metazooplankton will be studied under experimental conditions in order to ascertain the role of these organisms in controlling structure and function of the pelagic system as a whole. Such combined process-oriented studies have been rarely carried out to date and the results should provide information not only on Antarctic conditions but on pelagic ecology in general.

9) Life-cycle strategies of Antarctic mesozooplankton (copepods etc.) and krill are likely to be selected by the environment. The main aspects of life cycles are dormancy and reproductive strategies. Detailed studies of the vertical distribution of various stages together with quantitative collections of larvae will be undertaken in order to assess species-specific life-cycle strategies in relation to the environment.

The combination of these data sets, each a major contribution in its own right, is a challenging but formidable task for the post-cruise phase. The interpretation should provide unique insights into the interactions between physical, chemical and biological structures of the ocean.

In recent years, realization has been growing that distribution and transport of many elements in the sea is not a straight-forward function of physical factors but is mediated by complex biological processes that are triggered but not necessarily governed by the physical regime. In modelling oceanic properties, biological factors will hence have to be taken into account. These ideas form the rationale of the international Joint Global Ocean Flux Study (JGOFS) sponsored by SCOR that will be launched during the nineties. Parts of the leg 2 exercise can hence be regarded as a forerunner of JGOFS.

5.2.2 Gear to be deployed

a. Combined CTD-fluorometer-Irradiance probe Neil-Brown Mark III CTD
b. O_2 - sonde
c. 2 Rosette samplers with Niskin bottles: 40 á 12 l, 6 á 30 l
d. 10 reversible thermometer
e. Laser-Doppler (Manta)
f. (Radio)-buoy
g. Rubberboat
h. 9 double sediment traps plus lines & weight
i. High-speed zooplankton sampler
j. Vertical multinet
k. Nansen net
l. Watubox sampler (ca. 150 l)
m. 50 micron net
n. Kevlar cable and ultra clean bottles

5.2.3 The cruise plan

Leg 2 commences and ends at Punta Arenas. It starts on 22 November 1988 and ends on 10 January 1989.

A high degree of overlap with cruise tracks of leg 1 and leg 3 is desirable. Therefore the area of investigation will be between the Antarctic Peninsula and the South Orkney Islands, i.e., the transition region between the Scotia and the Weddell Seas. It is assumed that conditions encountered within the various water masses of this area are less variable in space than in time. The cruise track will comprise north-south directed transects, about 300 nautical miles long, starting in the Scotia Sea south of the Antarctic Convergence, crossing the West Wind Drift - Weddell Sea Confluence and ending in the ice of the Weddell Sea. Three transects in both directions are planned which will in general run over deep water and approximately cover the same area. During the southgoing part of the transect 6 micro stations (duration 1 hour) and 6 Short stations (duration 8 hours) are planned. Also ice-stations may be taken at the southern end. The total time for one southgoing track is estimated at 3.5 days. During the northgoing track there will be 3 time-stations (duration approx. 63 hours), one each in the open Weddell Sea water, Confluence water and Scotia Sea water. Total time for a northgoing track is estimated at 9 days. Thus one transect will have a duration of 12-13 days, depending on weather and ice conditions. This gives a total of 37.5 working days, 3.5 days in reserve and 8 days of steaming between port and study area.

A preliminary cruise scheme, open to alterations as dictated by ambient conditions, is as follows:

1)	Home port (Punta Arenas) - start of transect	4.0 days
2)	Southgoing survey	3.5 days
3)	Northgoing survey	9.0 days
4)	Southgoing survey	3.5 days
5)	Northgoing survey	9.0 days
6)	Southgoing survey	3.5 days
7)	Northgoing survey	9.0 days
8)	Return trip	4.0 days
	Reserve	3.5 days
Total		49.0 days

Description of Stations

Each north to south transect (30 hours steaming time) will consist of 6 micro stations (1 hour each) alternating with 6 Short stations (7-8 hours each). Throughout the subsequent south to north section there will be continuous underway sampling (CUS) while steaming towards the 3 time-series stations, where the CUS data will support decisions on exact positioning of the time series stations .Salinity, temperature and chlorophyll fluorescence will be measured continuously. Nutrients, pigment composition and some other parameters will also be monitored on discrete samples.

A. Micro Station

One CTD-sensors-rosette cast <1000 m (1 hour) includes discrete sampling at 5-10 depths.

B. Short Station

1) CTD/rosette cast <1000 m with normal Niskin and specialized Go Flo water bottles; one hour.

2) Multinet cast down to 1000 m; one hour
Oblique Bongo net haul; half hour.

3) Special water bottles for measurement of suspended particulate Barium (optional at all short stations)

4) Measurements of dissolved Silicon and Aluminium (Optional at only 1-3 short stations) will entail one extra deep cast towards the seafloor with CTD/rosette.

C. Time-series Station

1) Physical oceanography:
- CTD : to the bottom, per station
- CTD : to 300 m, 2 x per day
- Laser-Doppler (Manta): once a day for 3 hours

2) Chemical oceanography:
- Rosette to the bottom once per time station
- Rosette to 300 m twice a day (12 Niskin bottles are needed)
- Right at the beginning of a time station: 120 l seawater from ca. 20 m depth for culture work with diatoms.

3) Suspended particles:
- 24 depths: 30 l Niskin bottles (surface to the depth)
  The 24 depths are split into 4 sequences: 0-100 m (6 depths), 100-300 m (6 depths), 300-600 m (6 depths), 600-bottom (6 depths)

4) Sedimentation:
- A sediment trap will be deployed at the beginning of each time station

5) Phytoplankton:
- Optical profile each day at around noon.
- 1 Phytoplankton sample per time station from the euphotic zone for culturing
- For experimental studies: 300 l are needed from the euphotic zone
- On the first day one vertical profile for biomass estimation (pigments, Chl<u>a</u>) 25 l four times a day

6) Microbial loop
- 600 l for filling 6 x 100 l containers on the first and third day; every 6 hours about 20 l from the depth of the floating buoy; on the second day every 3 hours

7) Zooplankton:
- Multinet and high speed sampler:
  2 samplings to 1000 m and 300 m resp. around midday and
  2 around midnight, before one CTD profile to 1000 m is requested (water free)
  6 times per time station RMT to 500 m
- For live material of krill and copepods horizontal and vertical samples as often as possible
- Bongo net oblique hauls

5.2.4 List of participants

Chief scientist:	Smetacek (FRG)
Scient. adviser:	Zijlstra (NL)
Phys. Oceanogr.:	Cederlöf (S), Ober (NL), Svansson (S), Veth (NL)
Chem. Oceanogr.:	De Baar (NL), van Bennekom (NL), Dehairs (B), Goeyens (B), Masson (F), Morvan (F), Nolting (NL), Treguer (F)
Sedimentation:	Cadée (NL), Riebesell (FRG)
Phytoplankton:	Buma (NL), Estrada (SP), Granéli (S), Jacques (F), Lancelot (B), Larsen (DK), Pamatmat (FRG), Panouse (F), Richardson (DK), Sörensson (S) Thomsen (DK)
Microbial loop:	Bak (NL), Björnsen (DK), Becquevort (B), Kuparinen (SF), Mathot (B),
Zoopl./Nekton:	Cuzin-Roudy (F), Fransz (NL), Gonzales (NL), Mizdalski (FRG), Schiel (FRG)
Birds:	van Franeker (NL)

A total of 38 scientists and assistants.

5.3 Leg 3

5.3.1 Scientific Rationale

The inner Weddell Sea is of particular scientific interest because it is representative of the high latitude marine ecosystem where organisms are faced with especially severe conditions (for example a very low temperature and an extreme seasonality of production). It is therefore a quite different environment from the better studied maritime Antarctic ecosystem, and also very different from the High Arctic Basin in physical structure, isolation and geological history. Compared to the benthos of other Antarctic areas, that of the inner Weddell Sea is hardly investigated at all, as regular work there became only possible with the ice-breaking RV "Polarstern". According to Voß (1987) the inner Weddell Sea can be divided into three major communities, ie., the Southern Trench Community (ca. 620 - 1180 m), dominated by epistrate feeding holothurians; the Southern Shelf Community (ca. 220 - 530 m), dominated by bryozoans and the Eastern Shelf Community (ca. 200 - 450 m), dominated by sponges and bryozoans.

While the differences between the Trench Community on the one hand and Shelf Communities on the other are clearly based on large scale factors such as depth, hydrographic regime and the ensuing food availability and sediment structure, the differences between the two Shelf Communities cannot be attributed to such large scale effects and remain a matter of speculation up to now. It is very likely, however, that small scale hydrographic/topographic and also various biological interactions are responsible for the structural differences observed, and it is these questions that have to be addressed next. We cannot hope to solve the problem by investigating large diverse areas in a low resolution survey, instead we must try to improve our knowledge on the single communities before comparing them. Thus, the overall objective of Leg 3 is to extend our knowledge about the richest and most diverse of the three, the Eastern Shelf Community. Larvae and adult fish populations are an important compartment as well, and understanding their adaptations of physiology (e.g., enzyme kinetics, metabolic rates) and behaviour (feeding strategies, reproduction) will tell a great deal about how environmental factors govern the ecosystem. We thus aim at performing a comprehensive programme including benthos and fish studies as well as oceanographic surveys to yield a detailed picture of the Eastern Shelf ecosystem. This will be achieved by an integrated study of the Vestkapp area. Special emphasis will be laid on work with underwater video (ROV), as this gear will make accessible informations about structures otherwise lost by trawl catches, grab samples etc. Between the various groups, positive interactions have been identified. These include, but are not limited to: cooperation between specialists of various animal taxa and the sponge group on the topic of sponges as biogenic substrates; cooperation between suspended matter and sediment structure investigators and bottom infauna specialists; coordination between research of zooplankton dynamics group and postlarval fish group. By bringing together specialists in a variety of disciplines and with varied scientific backgrounds to work intensively in a relatively small box on the same material, we hope to be able to discover processes of general validity that otherwise might escape the single investigator. Thus, the results of the Leg 3 can be expected to be greater than the sum of individual results.

In order to achieve maximum integration of Leg 3 with the previous two legs a transect of 6 CTD stations to 500 metres, crossing from Scotia Sea to Weddell Sea water, on the way to Atka Bay, will be carried out.

Specific objectives:

1. An integrated study of the pelagic and demersal fish, benthos and meiofauna of the Vestkapp area of the inner Weddell Sea, in relation to depth.

2. A study of the vertical distribution, and the carbon and nitrogen metabolism, of water column phytoplankton, bacteria and suspended material in relation to depth and the underlying benthic communities of the inner Weddell Sea.

3. A detailed study of the ecology and quantitative distribution of selected groups of benthic organisms in the inner Weddell Sea. Particular attention will be paid to soft-bottom infauna, suspension feeding communities, sponges, molluscs and echinoderms.

4. Detailed studies of the physiological adaptations of selected organisms to particular features of the high latitude of the inner Weddell Sea. Special attention will be directed to abiotic factors such as the low temperature and also pressure (depth) on locomotor ability, growth and reproductive investment.

5.3.2 Gear to be deployed

a. Large box corer (50 x 50 cm)
b. Multiple box corer (macrofauna)
c. Meiofauna multiple corer
d. Agassiz trawl (a minimum of 2 frames, with spare nets; fitted with 10mm mesh cod-end)
e. Bottom trawl (140 ft, 22m x 3m mouth, 10 or 20mm mesh cod-end)
f. Pelagic trawl
g. Bongo nets
h. RMT 8+1 combination
i. CTD + rosette. This will be the BIO-CTD with fluorometer. It has a maximum depth of 1000 m. Provision will need to be made to prevent freezing of probes on contact with the cold air. 24 x 5 litre and/or 12 x 10 litre rosette.
k. Sediment traps
l. Baited traps for fish. These should be of steel construction and heavily weighted. If possible an automatic release (on acoustic signal) should be employed.
m. ROV

5.3.3 The cruise plan

Leg 3 commences at Punta Arenas on 12 January 1989 and ends in Cape Town (provisional) on 10 March 1989. Estimated sailing time to the main area of investigation, including a transect in the area where the previous two legs worked, is 10 days and 1 working day. (The "Georg-von-Neumayer" station will be relieved during 3 days (22-24 January) and another day for steaming is necessary to reach Kapp Norvegica where a current meter array will be deployed. 26 days (26 January to 21 February) will be spent in the vicinity of Vestkapp with extensive studies carried out in a one area ("box"). In this box full transects, short transects, CTD transects and detailed sampling will be carried out. Steaming back to the Neumayer station, relief of the station and transportation to the area of the Astrid Ridge will require at least 2 days. In this area short transects with mainly collection of fish and bottom fauna will take place during 5 days.

Steaming time from Astrid Ridge to Cape Town is estimated to 12 days, but includes en route collection and redeployment of sediment traps on Maud Rise.

This gives a total of approximately 34 working days and 23 days for station relief and transportation.

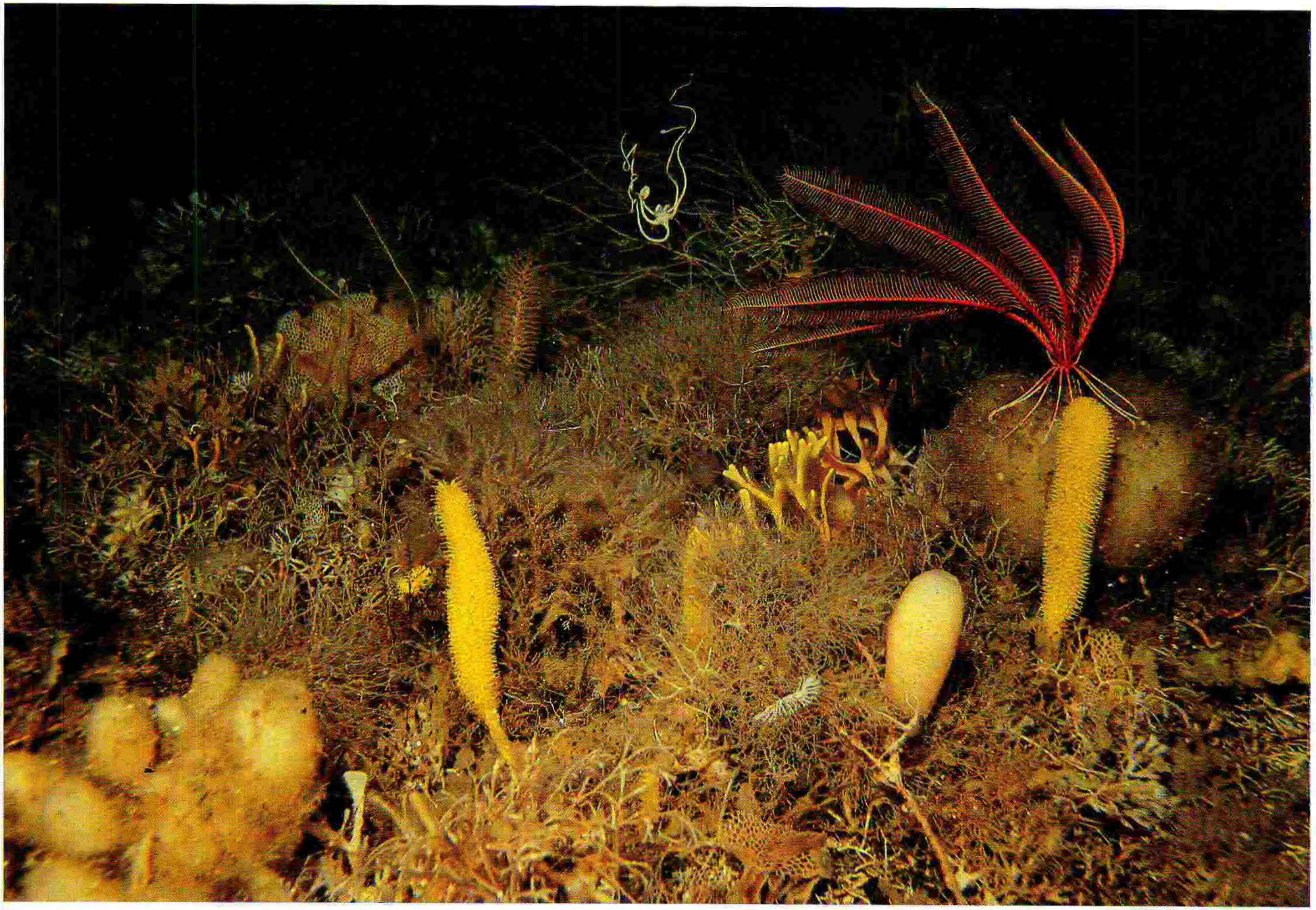
Detailed cruise schedule:

Jan 12	Depart Punta Arenas	
Jan 22	Arrive Atka Bay. En route 6 CTD/rosette stations with some zooplankton work (Bongo, Multinet) and 2 bottom trawls in the area of the South Orkneys.	
Jan 22-24	Relief of Neumayer Station	
Jan 24	Depart Atka Bay. Steaming to Kapp Norvegia	
Jan 25	Deployment of current meter array, CTD transect. Steaming to Vestkapp	
Jan 26 to Feb 21	Vestkapp Box. Provisional schedule	
	Full transect	14 days
	Short transect	3 days
	Detailed work	8 days
	CTD transect at Kapp Norvegia and return to Atka Bay	1 day
	Total:	26 days
Feb 22	Relief of Neumayer Station Steaming to Astrid Ridge	
Feb 23-27	Astrid Ridge Box. Short transect 5 days	
Feb 27	Depart Astrid Ridge	
Mar 10	Arrive Cape Town (provisional). (En route: collect and redeploy two sediment trap arrays, from Maud Rise.)	

This schedule has been drawn up to allow a comparative zooplankton and CTD/rosette transect across the Scotia/Weddell Confluence in late January, but still relieve Neumayer at the required time and allow sufficient time in the Vestkapp Box for a full scientific programme to be undertaken. Additional work at any point (for example the Scotia/Weddell Confluence, increasing CTD work at the current meter moorings, or extra work associated with sediment trap retrieval) can only be accommodated by delaying arrival at Cape Town.

Adult copepods of various sizes from vertical net haul from the Peninsula region collected in summer 1982 (E. Mizdalski)

Weddell Sea shelf benthos with benthic fish (*Trematomus* sp.), at 200 m depth (J. Gutt)



The rich epibenthic fauna of the northeastern Weddell Sea shelf (200 m) comprises sponges, echinoderms, bryozoans, hydrozoans and ascidians (J. Gutt)

Outline of work at each station:
For the first phase of the Vestkapp Box study, the full depth transect, each station will comprise:

CTD/rosette cast to 500 m	0600
Bongo or RMT plankton trawl	0700
Multiple or 50x50 cm box core	0830
Meiofauna multiple core	0930
Bottom or Agassiz trawl	1000

Once the first benthic/fish haul is in, then the programme for the remainder of the day will be decided. This may involve a short Agassiz haul for high-quality specimens, further water column or box-core work, or operation of the ROV. The station will then conclude with a final Agassiz trawl.

During the second phase, stations will consist of a mixture of CTD/rosette casts, multiple or box-core work, bentho-pelagic hauls and/or directed Agassiz hauls. Some stations will also involve 24 hour cycles of CTD/rosette casts.

The third phase (the concentrated study of two selected depth strata) will involve box-cores, bottom trawls, Agassiz trawls and ROV work, interspersed with water column and meiofaunal work. Detailed operating procedures will only be worked out once the first phase has been completed and the depth strata selected.

Work on the Astrid Ridge Box will be similar to that in the Vestkapp Box, only in a shortened form. Again specific decisions will be made only once the nature of the ground and biota are known.

Working areas:
Between South America (Punta Arenas) and arrival at Atka Bay, 6 stations will be undertaken for CTD/rosette samples and zooplankton. These stations will be to 1000 m and will enable the water column work of Leg 3 to be related directly to that of Legs 1 and 2. Some benthic trawls (maximum 2) will be made on the continental shelf at the northern end of the Antarctic Peninsula; again these will enable Leg 3 to be compared with the fauna of the area studied during Legs 1 and 2 (when no benthic work will be done, but whose fauna is reasonably well described).

After leaving Atka Bay, 15 hours will be taken to deploy an array of current meter moorings. The main working area off Vestkapp is too far away from Neumayer Station (where meteorological data will be taken for 12 months), and so the array will be deployed at Kapp Norvegia. The shore fixed-point will be at 70°10'S, 11°20'W and the array will be deployed along a line perpendicular to the coast in depths of 400, 1000 and 2000 m. At the same time a series of CTD casts will be made.

Main working area: This will be a box based on the area south of Vestkapp (74°S, 21°W). This Vestkapp Box has been chosen on the basis of past experience, as being an area which is generally free of ice and where damage to bottom gear is minimal. Stations will be made at 100 m depth intervals along a transect running in a NW direction (perpendicular to the coast), from 200 to 1500 m depth. These full stations will involve a complete spectrum of water column, fish and benthos studies, including ichthyoplankton and pelagic juvenile fish. This study will be followed by a short transect (200 to 700 m depth) looking at the fish fauna in more detail with the bentho-pelagic trawl. At the same time more detailed water column studies will be made (for example 24 hour stations to study possible diel periodicity). The third and final phase of work within the Vestkapp Box will involve detailed studies of the benthos and fish fauna of two selected strata. These will be chosen on the basis of the results of the first two phases, and will be directed at areas of specific scientific interest.

Contingency plans:
Whenever marine biological work is undertaken in Antarctic waters, and particularly at such high latitudes, it is necessary to have contingency plans. It is possible that ice conditions, for example, may prevent work within the Vestkapp Box. We have chosen two back-up areas for study should we be unable to work in the Vestkapp Box. These have been chosen on the basis of scientific interest and ease of access (both based on previous experience of "Polarstern" in the inner Weddell Sea). They are:

1) The area of shelf close to Halley Bay
2) The area of the Filchner Overflow.

Subsidiary working area:
Following the return to Atka Bay to pick up personnel from Neumayer Station (see cruise plan), further scientific work will be undertaken to the east, off Dronning Masud Land. This area is almost completely unknown biologically and the precise choice of area will be made on the basis of information to be provided by the USSR. The study will, however, probably centre on Astrid Ridge, starting in 200 m at about 69°S, 11°E and working into deeper water. In this area we will undertake an integrated study of water column, fish and benthos similar to that in the Vestkapp Box but on a smaller scale and with fewer stations.

From Astrid Ridge "Polarstern" will head north to Cape Town (provisional). On the way, two sediment trap arrays will be recovered.

5.3.4 List of participants

Chief scientist:	Arntz (FRG)
Scient. adviser:	Hureau (F)
Water column:	Boldrin (I), Döhler (FRG), Nieuwland (NL), Gouleau (F), Rabitti (I), Rohardt (FRG), Ruhland (FRG), Vosjan (NL), Schleif (FRG)
Fish:	Balguerias (SP), Duhamel (F), Hureau (F), Johnson (UK), Johnston (UK), Kock (FRG), Kunzmann (FRG), Ozouf-Costal (F), Piatkowski (FRG), Rankin (UK), St. Paul (FRG), White (UK), Wöhrmann (FRG), NN(UK)
Benthos:	Arnaud (F), Barthel (FRG), Blome (FRG), de Broyer (B), Clarke (UK), Gore (UK), Gutt (FRG), Hain (FRG), Herman (B), Höpner-Petersen (DK), Klages (FRG), Klindt (FRG), Meisch (B), Schiötte (DK), Segonzac (F), Tendal (DK), Westphal (FRG)

A total of 42 scientists and technicians, 10 over-winterers for G.v.Neumayer station + 4 technicians + 5 British personnel for relief of Halley Station + 2 meteorologists and 4 helicopter crew brings the overall total to 67.

6. Management of the EPOS - results

The efforts of the various project groups in the different legs will yield an enormous amount of data and other information which will give rise to a great number of publications. To fulfil the true purpose of EPOS, however, it will be necessary to enhance and facilitate communication and data exchange between project groups. To this end, leg- and theme-oriented workshops and an EPOS symposium will be held according to the following time schedule:

1989:	Post - EPOS leg-oriented workshops for data evaluation
1989 :	Post - EPOS theme-oriented workshops for data interpretation
1989:	Steering Group Meeting at AWI for preparing EPOS - Symposium
1990:	EPOS - Symposium at AWI, Bremerhaven FRG
1990 or 1991:	Post - Symposium meeting (possibly Editorial Board) to organize publication of symposium proceedings.

The costs of the EPOS Secretariat, costs related to the workshops and symposium and the costs of publication of the results will be met mainly by the ESF. The helicopter and satellite communication costs will be shared by ESF and AWI. The ESF funding was possible thanks to a special grant from the Stimulation Action of the Commission of the European Communities.

7. Future objectives, ambitions and perspectives

The cooperative efforts during EPOS will undoubtedly lead to better and closer connections between scientists working on problems in the polar marine environments.

The interaction between scientists from different nations and laboratories will increase international cooperation also on a long-term scale and the likelihood of a better utilization in the future of European facilities and heavy equipment in polar areas is great. This will be particularly pronounced since cooperation will rest on a common interest in scientific problems, rather than simply being internationalized.

Joint European use of shore stations as well as of research vessels would be a natural future trend, economizing expenditures in an expensive field of research.

In order to further such trends, another expedition like EPOS should be launched within the next 5-year period. One potential site might be the summer polynya in the western Fram Strait off East-Greenland. The Arctic Ocean Science Board is presently developing a concept for an ecological study of this area which offers interesting comparisons to the Weddell Sea studies in EPOS.

8. RV "POLARSTERN"

In order to lay a sound basis for a continuous scientific engagement, the Federal Republic of Germany decided in 1978/79 to develop a comprehensive polar research programme, to establish a permanent research station in the Antarctic, to found a polar institute, and, last not least, to construct the ice-breaking research and supply vessel "Polarstern". RV "Polarstern" was commissioned on 9 December 1982. She was built for operations in Arctic and Antarctic waters, including the pack-ice zone, which is amongst the least known parts of our world.

TECHNICAL DATA

RV "Polarstern" was constructed at Howaldtswerke/Deutsche Werft in Kiel, and at Werft Nobiskrug in Rendsburg, in consultation with SCHIFFKO and ZMS (Zentralstelle für Schiffahrts- und Maschinentechnik), both in Hamburg. The special design was developed by HSVA (Hamburgische Schiffsbauversuchsanstalt). Her owner is the Federal Ministry of Research and Technology. Operator is the Alfred-Wegener-Institute for Polar Research in Bremerhaven. The ship is run by the shipping company Hapag-Lloyd.

The ship´s specifications are:
Overall length: 118 metres
Length between end perpendiculars: 102 metres
Maximum beam: 25 metres
Beam at designed waterline: 24 metres
Draught: max. 10,9 metres
Displacement at maximum draught: 16.600 tons
Weight of empty ship: 11.400 tons
Engine output (4 engines): approx. 14 000 kW (or 20 000 HP)
Maximum speed: 16 knots
Economical cruising speed (2-3 engines): 10-12 knots
Classification: Germanischer Lloyd, 100 A 4 Arc 3, MC Arc 3 Aut 16/24, strengthened for hull pressure of 9 N/mm^2 in the fore part and 6,5 N/mm^2 admidship.

The vessel passes through one year old ice, up to 1.5 metres thick, at a speed of 5.8 knots. Multiyear sea-ice with a heavy snow cover has to be broken by ramming. In open water, the vessel performs better than most ice-breakers.

The main propulsion of the ship is produced by two variable pitch propellers in nozzles, driven by four diesel engines able to burn heavy fuel. There also exist transverse thrusters fore and aft, and folding fin stabilizers. Precise positioning is obtained by Joystick single lever steering. A detailed technical description of the vessel is published in HANSA 6, 1983 (in German).

9. Institutions and scientists participating in EPOS

BELGIUM

Museum voor Dierkunde Laboratoria voor Morfologie en Systematiek K.L. Ledeganckstraat 35 B-9000 Gent	Herman
Koninkliik Belgisch Instituut voor Natuurwetenschappen Vautierstraat 29 B-1040 Brussel	de Broyer, Meisch
Laboratoire d´Océanologie Université de Liège 86 Sart-Tilman B-4000 Liège	Bouquegneau
Unité d`Ecohydrodynamique B5 Université de Liège Sart-Tilman B-4000 Liège	Goffart, Hecq
Vrije Universiteit Brussel Laboratorium voor Ecotoxicologie Pleinlaan 2 B-1050 Brussel	Joiris, Overloop
Vrije Universiteit Brussel-Anch Pleinlaan 2 B-1050 Brussel	Dehairs, Goeyens
Université Libre de Bruxelles Groupe de Microbiologie des Milieux Aquatiques Campus de la Plaine Boulevard du Triomphe, CP 221 B-1050 Brussel	Becquevort, Lancelot, Mathot

DENMARK	
Danmarks Fiskeri-og Havundersøgelser Charlottenlund Slot DK-2920 Charlottenlund	Richardson
Københavns Universitet Marine Biological Laboratory Strandpromenaden 5 DK-3000 Helsingør	Björnsen
Københavns Universitet Zoologisk Museum Universitetsparken 15 DK-2100 København 0	Höpner Petersen, Schiötte, Tendal,
Institut for Sporeplanter Københavns Universitet Øster Farimagsgade 2D DK-1353 København K	Larsen, Thomsen
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Laboratoire de Chimie des Ecosystème Marins Institut d'Etudes Marines 6 avenue Le Gorgeu F-29287 Brest Cedex	Masson, Tréguer
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Muséum National d'Histoire Naturelle Ichtyologie 43, Rue Cuvier F-75231 Paris Cedex 05	Duhamel, Hureau, Ozouf-Costal
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École Nationale Supérieure de Chimie ENSCR Avenue du Général Leclerc F-35700 Rennes-Beaulieu	Morvan

F.R. GERMANY

Alfred-Wegener-Institut für Polar- und Meeresforschung Columbusstraße D-2850 Bremerhaven	Arntz, Dieckmann, Dimmler, Eicken, Gutt, Hain, Hempel, Kellermann, Klages, Klindt, Lange, Marschall, Meyer, Mizdalski, Nöthig, Pamatmat, Riebesell, Rohardt, Schiel, Smetacek, Vogel

Universität Kiel Institut für Polarökologie Olshausenstraße 40-60 2300 Kiel 1	I.Hempel, Wöhrmann, Kunzmann Rapp
Bundesforschungsanstalt für Fischerei Institut für Seefischerei Palmaille 9 D-2000 Hamburg 50	Harm, Kock, Siegel
Universität Bremen FB2, (FB5) Postfach 33 04 40 D-2800 Bremen 33	Kirst, Nothnagel, Wanzek, (Ruhland)
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Institut für Meereskunde Abt. Meeresbotanik Düsternbrooker Weg 20 D-2300 Kiel 1	Barthel, Piatkowski, Westphal
Universität Konstanz Limnologisches Institut Postfach 55 60 D-7750 Konstanz	Heusel, Tilzer
Botanisches Institut der Universität Siesmayerstr. 70 D-6000 Frankfurt 11	Döhler
Universität Oldenburg, FD 7 Postfach 2503 D-2900 Oldenburg	Blome

GREAT BRITAIN

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University College of North Wales School of Animal Biology Deiniol Road Bangor, Gwynedd LL57 2UW	Rankin

ISRAEL

Department of Life Sciences Bar Ilan University 52 100 Ramat Gan	Dubinsky

ITALY

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THE NETHERLANDS

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Nederlands Instituut voor Onderzoek der Zee Postbox 59 NL-1790 AB Den Burg/Texel	de Baar, Bak, Bennekom, Buma,Cadée Fransz, Gonzales, Kraay, Nieuwland, Nolting, Ober, Veth, Vosjan,Zijlstra

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NORWAY

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SPAIN

Centro de Estudios Avanzados de Blanes Camí de Sta. Bàrbara s/n SP-17300 Blanes, Girona	Martinez
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SWEDEN

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Göteborgs Universitet Dept. of Marine Microbiology Carl Skottsbergs Gata 22 S-41319 Gothenburg	Sörensson
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Umeas Universitet Department of Microbiology S-90187 Umea	Norrman
Kristinebergs Marinbiologiska Station Kristineberg 2130 S-45034 Fiskebäckskil	Bergström, Strömberg

10. EPOS Participants

EPOS Leg 1

1. Battaglia, Bruno (I),
2. Bianchi, Franco (I),
3. Bergström, Bo (S)
4. Bouquegneau, Jean M. (B),
5. Cioce, Fabricio (I),
6. Delille, Daniel (F),
7. Dieckmann, Gerhard (FRG),
8. Dimmler, Werner (FRG),
9. Dubinsky, Zvy (ISR),
10. Eicken, Hajo (FRG),
11. Gieskes, Winfried (FRG)
12. Goffart, Anne (B),
13. Harm, Urte (FRG),
14. Hecq, Jean-Henri (B),
15. Hempel, Gotthilf (FRG)
16. Hempel, Irmtraud(FRG),
17. Heusel, Reiner (FRG)
18. Joiris, Claude (B),
19. Kellermann, Adolf (FRG),
20. Kirst, Günther (FRG),
21. Kivi, Kai (SF),
22. Kraay, Gysbert (NL)
23. Kristiansen, Svein (N),
24. Kuosa, Harri (SF),
25. Lange, Manfred (FRG),
26. Larsson, Anne-Marie (S),
27. Ljungek, Göran (S),
28. Marschall, Peter (FRG),
29. Martinez, Rosa (SP),
30. Meyer, Kurt (FRG),
31. Norrman, Bosse (S),
32. North, Anthony (UK),
33. Nothnagel, Jürgen (FRG),
34. Nöthig, Eva-Maria (FRG),
35. Overloop, William (B),
36. Rapp, Frank (FRG),
37. Sehlstedt, Per-Ingvar (S),
38. Seim, Björnar (N),
39. Siegel, Volker (FRG)
40. Socal, Giorgio (I),
41. Strömberg, Jarl-Ove (S)
42. Syvertsen, Erik (N),
43. Tilzer, Max (FRG)
44. Vogel, Ute (FRG)
45. Wanzek, Michael (FRG

EPOS Leg 2

1. Baar, Hein de (NL),
2. Bak, Ralf (NL),
3. Becquevort, Sylvie (B),
4. Bennekom, Johan van.(NL),
5. Björnsen, Peter K. (DK),
6. Buma, Anita (NL),
7. Cadée, Gerhard (NL),
8. Cederlöf, Ulf (S),
9. Cuzin-Roudy, Janine (F),
10. Dehairs, F. (B),
11. Estrada, Marta (SP),
12. Franeker, Jan A. van (NL)
13. Fransz, George (NL),
14. Goeyens, Leo (B),
15. Gonzales, S.R. (NL),
16. Granéli, Edna (S),
17. Jacques, Guy (F),
18. Kuparinen, Jorma (SF),
19. Lancelot, Christiane (B),
20. Larsen, Jacob (DK),
21. Masson, Annick (F),
22. Mathot, Sylvie (B),
23. Mizdalski, Elke(FRG),
24. Morvan, Jean (F),
25. Nolting, R. (NL),
26. Ober, (NL),
27. Pamatmat, Mario(FRG),
28. Panouse, Michel (F),
29. Richardson, Katherine (DK),
30. Riebesell, Ulf (FRG)
31. Schiel, Sigrid (FRG)
32. Smetacek, Victor (FRG)
33. Sörensson, Fred (S)
34. Svansson, Artur (S),
35. Thomsen, Helge (DK)
36. Treguer, Paul (F)
37. Veth, C. (NL)
38. Zijlstra, Jenne (NL)

41. Zijlstra, Jenne (NL)

EPOS Leg 3

1. Arnaud, Patrick (F),
2. Arntz, Wolf (FRG)
3. Balguerias, Eduardo (SP),
4. Barthel, Dagmar (FRG),
5. NN Uni Oldenburg
6. Boldrin, Alfredo (I),
7. Broyer, Claude de (B),
8. Clarke, Andrew (UK),
9. Döhler, Günter (FRG),
10. Duhamel, Guy (F),
11. Gore, Deborah (UK),
12. Gouleau, Dominique (F),
13. Gutt, Julian (FRG),
14. Hain, Stefan (FRG),
15. Herman, Rudy (B),
16. Höpner-P., Gottfried (DK),
17. Hureau, Jean-Claude (F),
18. Johnson, Tim (UK),
19. Johnston, Ian A. (UK),
20. Klages, Michael (FRG),
21. Klindt, Holger (FRG),
22. Kock, Karl-H. (FRG),
23. Kunzmann, Andreas (FRG),
24. Nieuwland, Gerard (NL),
25. Ozouf-Costaz, Catherine (F),
26. Piatkowski, Uwe (FRG),
27. Rabitti, Sandro (I),
28. Rankin, Cliff (UK),
29. Rohardt, Gerd (FRG),
30. Ruhland, Götz (FRG)
31. Schiötte, Tom (DK),
32. Schleif, Udo (FRG)
33. Schockaert, Ernest (B)
34. Segonzac, Michel (F),
35. St. Paul, Ulrich (FRG),
36. Tendal, Ole (DK),
37. Vosjan, Jan (NL),
38. Westphal, Kathrin (FRG)
39. White, Martin (UK),
40. Wöhrmann, Andreas (FRG)

11. Programme for cruise leg ANT VII/1
Bremerhaven - Rio Grande do Sul 14.09. - 09.10.1988

Introduction

There are not many research vessels which repeat crossings of the Atlantic over both hemispheres on long distances. The transits of "Polarstern" to and from the Antarctic offer almost unique chances to carry out measurements for the investigation of global processes in ocean and atmosphere. One project aims at the measurement of vertical ozone profiles with balloons.

As in the past, this possibility will be intensively used on the transit to the EPOS project. Most projects centre around the measurement of trace gases in the marine atmosphere with the intention to study their global distributions and their chemical reactions in the boundary layer over the sea.

Another project deals with the optical properties of surface water. This knowledge is a basis for many methods of satellite remote sensing of water masses and plankton distributions. Finally, a statistical data set on marine fronts in surface layers will be gathered.

"Polarstern" will proceed to 35°N, 30°W, will head due south until approximately 30°S and finally travel to Rio Grande do Sul.

Physical Oceanography (AWI)

Numerous methods of measurement in physical, biological and satellite oceanography require a knowledge of optical properties of sea-water. We plan to install a package of optical sensors into the hydrographic well of the ship in addition to the sensors for conductivity and temperature. The following parameters will be measured:

fluorescence of chlorophyll	--->	concentration of phytoplankton
fluorescence of yellow substance	--->	influx of river water/zooplankton
Raman backscattering	--->	turbidity/penetration of daylight
Mie scattering	--->	concentration of particles

The optical data will be used to investigate the effect of accumulation of organisms and particles in the frontal zones between the various water masses and current systems. As the frontal zones extend predominantly in a zonal direction, the North-South transect is at right angles.

Additionally the data set will contribute to the fields of satellite remote sensing, particle flux studies (JGOFS), trace gases and phytoplankton distribution, and to development of a depth-profiling LIDAR-system within the EUROMAR project.
Participants: G. Krause, W. Baranski, W. Schneider

Measurements of NO_2, HCHO, HCl and H_2O_2 by laser-diode spectroscopy (MPI, Mainz)

We will use our tunable diode laser spectrometer to measure the latitudinal distribution and diurnal variations of trace gas mixing ratios. The spectrometer will be configured to measure formaldehyde, nitrogen dioxide, carbon monoxide and, if the necessary development work can be successfully carried out, HCl. We will also have the option of measuring hydrogen peroxide if problems are encountered in the HCl work.

Anticipated detection limits are < 25 pptv for NO_2, ≈ 50 pptv for HCHO, ≈ 300 pptv for HCl and H_2O_2 and < 1 ppb for CO. These detection limits are quoted for approximately 5 minute time resolution and can often be further reduced by longer signal averaging. The instrument is designed to provide quasi continuous data 24 hours per day. The spectrometer will be located in a laboratory container situated on the starboard side of the compass deck and will sample air through a roof mounted 10 m long teflon inlet manifold. Calibration is carried out by standard addition of known flows of the target gases at the ambient air inlet.
Participants: G.W Harris, T. Zenker and D. Klemp.

Measurement of gaseous nitric acid with the Laser Photolysis Fragment Fluorescence (LPFF)-Method (RUB)

It is planned to measure the concentration of gaseous nitric acid as a function of day-time and geographical latitude. We want to show diurnal variations of the HNO_3 concentration in comparison with measurements over the continent. Because nitric acid is an important final product of the NOx-cycle, its quantitative determination is a necessary supplement of the NOx and NOy data, respectively.
Participant: Th. Papenbrock.

Oxidation mechanisms and inorganic trace elements (UP)

The measurements proposed by the LPCA (Paris) during the "Polarstern" cruise are relevant to two major topics.

1. Oxidation mechanisms of organic trace compounds in unpolluted oceanic air masses (P. Carlier et al.)

2. Atmospheric input of various inorganic trace elements to the ocean by wet deposition (G. Bergametti et al.).

Concerning the first theme, we propose to perform atmospheric concentration measurements for organo-sulphur compounds and carbonyl compounds.
Organo-sulphur compounds, mainly DMS, constitute the sources of reduced sulphur in the oceanic atmosphere. Their oxidation leads to SO_2, SO_3, DMSO and ultimately H_2SO_4. Those species will be measured by GPC/FPD after preconcentration on solid absorbent and thermodesorption.

The carbonyl compounds result from the first oxidation step of organic compounds. Their photolysis is a major source for free radicals in the lower troposphere. Their measurement is consequently essential to understanding the oxidation rate. They will be measured by HPLC/UV after sampling by bubbling in an acidifed solution of 2,4 di nitro phenylhydrazine in acetonitrile at 2°C and derivatisation in 2,4 dinitro phenyl hydrazone.

The "Polarstern" cruise will allow one of the first studies about the fluctuation of these compound concentrations along a N-S transect in the Atlantic Ocean.

Concerning the second subject, there is now strong evidence that the atmospheric input of trace elements constitutes a major source for the oceans. This is especially true for elements such as Fe and Mn, but also for toxic pollutants such as Pb and Zn. It has been shown that wet deposition is the principal transfer pathway for these elements from the atmosphere to the ocean.

During this "Polarstern" cruise, we propose to focus on the soluble/insoluble partitioning for the elements previously mentioned. It will be necessary to perform rain samplings with ultra clean procedures. The samples will be immediately filtered in a clean air chamber to separate the soluble and insoluble fraction. pH and conductivity will be measured immediately. Aerosol samples will also be performed to characterize the mineral species present in the oceanic atmosphere.

The analyses will be made at the laboratory in Paris.

* for the soluble fraction by:
- Ionic chromatography (Cl^-, SO_4^{2-}, NO_3^-)
- Atomic absorption (Na, K, Ca)

- Flameless atomic absorption (Al, Fe, Pb, Zn, Mn)
- Colorimetric methods (HCO_3^-, Phosphates)

* for the aerosol and the insoluble fraction by:
- X ray fluorescence spectrometry (Al, Fe, Mn, Zn, P.)
- Flameless atomic absorption (Na, Pb).

Participants: P. Carlier, S. Pashalidis, R. Losno.

Spectroscopic measurements of NO_2, NO_3, SO_2, CH_2O, 03 and IO (IHC3)

Continuous measurements of the free radicals NO_2, NO_3 and IO and additionally of ozone, sulfur dioxide and formaldehyde by differential optical absorption spectroscopy (DOAS) are planned. This "non contact" measurement technique yields detection limits in the ppt-(parts per trillion) range, if absorption path lengths of the order of kilometres are used. The light path is folded about 200-times in a multiple reflection system (mounted on the compass deck). The measurements will give insight into the latitudinal distribution as well as the sources and sinks of these species. Knowledge of the maritime concentrations of NO_3^- and IO radicals allow, for instance, the quantitative calculation of the dimethyl sulfide degradation. In addition to this the data base of the distributions of NO_2, SO_2, and CH_2O will be expanded by measurements with an independent technique (DOAS).
Participants: U. Platt, J. Callies, T. Brauers.

Measurement of the concentration of atmospheric ^{14}CO and $^{14}CO_4$ (ICH2/UUP)

The atmospheric mixing ratio of ^{14}CO is about 10-19 to 10-20. It is formed by the reaction of cosmic neutrons with atmospheric nitrogen. The production rate of ^{14}CO as a function of latitude and altitude is known. ^{14}CO is nearly exclusively removed by reaction with OH-radicals in the atmosphere. If the atmospheric ^{14}CO concentration is known, the concentration of OH radicals can be calculated from the ^{14}CO budget. During this cruise the latitude dependence of ^{14}CO will be measured. For the measurements, CO (including ^{14}CO) will be concentrated from roughly 200 m^3 of air on board the ship.

The ^{14}CO content of the samples will be determined later in the laboratory. This procedure has already been used during the ANT V/5-Expedition, where the samples were shown to be contaminated, which was detected in the home laboratory. An improved type of absorber will now be used and the apparatus is extended for the additional measurement of 14CH4.
Participants: H. Smit, S. Gilge, C. Pfleiderer

Measurements of NO, NO2 and NOy (KFA)

We wish to measure the NO-, NO_2^- and NOy-mixing ratios with a sensitive NO-chemoluminescence detector and converters. Together with the ozone concentration and the radiation flux we can examine the photostationary state. The latitudinal distributions are then compared with the distributions in higher altitudes obtained by aircraft
Participants: F. Rohren, D. Brüning

Determination of H_2O_2 in the atmospheric gas and liquid phase and in seawater (ISAS) - Determination of carboxylic acids (C_1 - C_3) in air

The aim is to measure H_2O_2 in air, rain- and surface seawater by peroxyoxalate chemoluminescence. Of particular interest is the sampling of gaseous H_2O_2 by a cryotechnique, which avoids losses and artifacts of H_2O_2. Beside this, it is planned to use the same sampling technique for carboxylic acids (C_1 - C_3) in air, with subsequent determination by HPLC.
Participant: P. Jacob

Measurement of the latitude/altitude distribution of tropospheric Ozone (ICH2)

Due to atmospheric chemical (precursor for OH-radicals, decomposition of trace gases), climatological and toxicological reasons, ozone is one of the most important trace gases. In order to understand the natural processes which control ozone, probes will be flown twice per day - that is approximately every 1.5 degrees latitude. For this purpose modified electrochemical sensors are used, which are specially adapted for measurements of ozone in the troposphere.

This experiment will enable a two-dimensional ozone-distribution map (longitude versus altitude) which was already successful in March/April 1987 during the ANT V/5-expedition between 40°S and 45°N.

During this cruise, the latitude/altitude distribution of ozone will be determined in another part of the year, in order to observe possible seasonal effects. The obtained data will then provide in connection with other data (radiation, hydrocarbons, NOx and meteorological parameters etc.), valuable information on the transport and production of ozone in different air masses.
Participants: H. Smit, S. Gilge

Measurements of light hydrocarbons in the surface water of the Atlantic Ocean (ICH 3)

During the past years many indications were found that the oceans are a source of a number of hydrocarbons. Our special interest is focussed on ethene and propene because of their high atmospheric reactivity and their assumed production by phytoplankton.

The experimental programme is carried out in connection with atmospheric measurements of light hydrocarbons and uses the same analytical technique: gaschromatography. Our aim is to expand our knowledge on production of light hydrocarbons in the ocean and their transfer across the sea-air boundary.

Samples of seawater are taken by use of the stainless steel pump-manifold from about 11 m below the water surface and delivered to an outgassing device. Water volumina of about 1 l are stripped with Helium, preconcentrated and measured in the gaschromatograph with a detection limit of about 10 nl gaseous hydrocarbon/ml seawater.
Participants: Ch. Plaß, J. Rudolph.

Measurements of the latitudinal dependence and the diurnal cycles of atmospheric hydrocarbons (ICH3)

During the past years it has been recognized that non-methane hydrocarbons play an important role in the chemistry of the marine atmosphere.

The light alkenes (ethene and propene) especially are of considerable importance. Due to their high reactivity towards OH and O_3 they contribute significantly to the photochemical reactions in the troposphere, and they are the precursors of a number of reaction products such as aldehydes, ketones and, in the presence of nitrogen oxides, also peroxyacetylnitrate (PAN).

With this programme the measurements of the latitudinal dependence of light hydrocarbons carried out successfully during the cruise ANT V/5 will be continued.

The measurements are made by gaschromatography after preconcentration of the trace gases from about 4 l of air. Part of the measurements are made on board, other measurements are made by collection of whole air samples and analysis in the laboratory later on. The detection limits are in the range of 5-10 pptV.
Participants: R. Koppmann, J. Rudolph.

Measurements of peroxyacetylnitrate and nitric acid in the marine atmosphere (ICH3)

PAN is not only important as a toxic product of photochemical pollution but may also act as an important reservoir for nitrogen oxides outside polluted areas, because there exist no primary sources for PAN. It is only formed during photochemical oxidation of non methane hydrocarbons in the atmosphere in the presence of NO_2.

On board there will be an automated gaschromatographic system that reaches a lower detection limit of 0.1 ppt by a cryogenic enrichment technique with a periodic cycle of about 30 minutes. The purpose is to have the complete latitudinal variation of PAN combined with the measurement of the most important chemical precursors.

Nitric acid as a final product of the oxidation of nitrogen oxides will also be sampled by enrichment on filter surfaces.The time resolution is determined by the overall detection limit and reaches about 4 hours in the southern hemisphere. Total aerosol will be sampled in parallel to ensure low nitrate interference.

It is proposed sampling lower fatty acids such as formic acid and acetic acid by a suitable procedure. The analysis by ionchromatography will take place in our laboratory after return.
Participants: K.P. Müller, J.Rudolph.

Natural sulfur cycle in the marine atmosphere (University of Frankfurt, UFF)

By means of cryogenic enrichment and gaschromatographic analysis, the atmospheric concentration of the sulfur compounds dimethylsulfide, carbonylsulfide, carbon disulfide, hydrogen sulfide and sulfur dioxide will be examined. The measurement of the daily variations should give informations about possible source- and sink-mechanisms of these compounds. At the same time, the concentrations of dimethylsulfide, carbonylsulfide and carbon disulfide in the surface water will be measured to determine their flux from the ocean to the atmosphere. Parallel to the atmospheric concentration of dimethylsulfide, the concentrations of its most important reaction products (sulfur dioxide(---> sulphate) and methanesulfonic acid) will be studied. Methanesulfonic acid and sulphate in the aerosol will be enriched on filters and detected by ionchromatography. Additionally the concentration of methanesulfonic acid and sulphate will be analysed in rainwater.
Participants: S. Bürgermeister, R. Staubes.

Net Total Radiation at Sea (DWD-MOH)

Knowledge of the spatial and temporal distribution of net total radiation and its components at the sea-surface is important for numerous meteorological and oceanographic investigations. The following radiation components will be recorded:

Global solar radiation, reflected solar radiation, atmospheric radiation and ocean surface radiation. Further, direct solar radiation, sunshine duration and UV-B global radiation shall be measured.

The objectives of the investigations are:

- to determine the net total radiation and its components, including statistical parameters, for the climatic regions of the Atlantic Ocean,
- to compute the turbidity factor of the atmosphere from direct solar radiation,
- to investigate the UV-B-portion of global solar radiation for the climatic regions of the Atlantic Ocean,
- to investigate the dependency of global solar radiation on total cloud amount and atmospheric radiation,
- to compare the measured atmospheric radiation with model values derived from radiosonde data,
- to compare the measured global radiation with model values derived from Meteosat data,
- to compute diffuse solar radiation from measured global and direct solar radiation.

Participant: H.D. Behr

12. Institutions and Participants of ANT VII/1

Institution	Participants
AWI: Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven (FRG)	Baranski, Krause, Schneider
ICH3: Kernforschungsanlage Jülich GmbH Institut für Chemie 3 Atmosphärische Chemie (FRG)	Bauer, Brauers, Brüning, Callies, Koppmann, Mathieu, Müller, Plaß, Platt, Rohrer, Rudolph
ICH2: Kernforschungsanlage Jülich GmbH Institut für Chemie 2 (FRG)	Gilge, Smit
MPI: Max-Planck-Institut für Chemie Abt. Luftchemie, Mainz (FRG)	Harris, Klemp, Zenker
RUB: Ruhr-Universität Bochum Abtlg. Chemie 1 (FRG)	Papenbrock
UP: Universität Paris VII Laboratoire de Physico-Chimie de l'atmosphere (France)	Carlier, Losno or E.Remoudaki Pashalidis, M.Remoudaki
UD: Universität Dortmund Lehrstuhl für Anorganische Chemie (FRG)	Jacob
UH: Universität Heidelberg Institut für Umwelsphysik (FRG)	Pfleiderer
UFF: Johann Wolfgang Goethe Universität Institut für Meteorologie und Geophysik, Frankfurt (FRG)	Bürgermeister, Staubes
DWD-MOH: Deutscher Wetterdienst Meteorologisches Observatorium Hamburg (FRG)	Behr

Baranski, Wlodzimierz
Bauer, R.
Behr, Hein Dieter
Brauers, T.
Brüning, Dirk
Bürgermeister, S.
Callies, Jörg
Carlier, Parreck
Gilge, S.
Harris, Geoffrey W.
Jacob, P.
Klemp, D.

13. Ship´s Crew

Dienstgrad	ANT VII/1+EPOS 1	EPOS 2	EPOS 3
Kapitän	Greve	Greve	Jonas
1. Offizier	Allers	Allers	Götting
Naut. Offizier	Stehr	Schiel	Schiel
Naut. Offizier	Fahje	Fahje	Varding
zusätzl. Offizier	NN	NN	NN
Arzt	Dr. Berg	Dr. Berg	Dr. Rose
Ltd. Ingenieur	Müller	Müller	Briedenhahn
1. Ingenieur	Knoop	Schulz	Schulz
2. Ingenieur	Delff	Delff	Hedden
2. Ingenieur	Simon	Simon	Erreth
Elektriker	Erdmann	Erdmann	Schuster
Elektroniker	Mutter	Elvers	Nitsche
Elektroniker	Thonhauser	NN	NN
Elektroniker	Husmann	Husmann	Elvers
Elektroniker	NN	Hoops	Mutter
Funkoffizier	Geiger	Geiger	Butz
Funkoffizier	Raeder	Raeder	Müller
Koch	Tanger	Tanger	Klasen
Kochsmaat/Bäcker	Kubicka	Kubicka	Klauck
Kochsmaat/Koch	Bender	Bender	Unger
1. Steward	Scheel	Scheel	Peschke
Stewardess/Nurse	Pötzsch	Pötzsch	Lieboner
Stewardess	Friedrich	Friedrich	Hoppe
Stewardess	NN	NN	Feigler
Stewardess	Gollmann	Gollmann	Hopp
2. Steward	NN	NN	NN
2. Steward	Lai	Lai	Lai
Wäscher	Yang	Yang	Shuyzu
Bootsmann	Woltin	Schwarz	Schwarz
Zimmermann	Marowsky	Marowsky	Kassubeck
Matrose	Suarez Peisal	Suarez Peisal	Meis, T.A.
Matrose	Bermudes Balbino	Bermudes B.	Meis, T.M.
Matrose	Soage Curra	Soage C.	Sobral Sob.
Matrose	Gil Iglesias	Gil.I.	Novo Lov.
Matrose	Abreu Dios	Abreu Dios	Prol Otero
Matrose	Pousada Martinez	Rousada M.	Pereira P.
zusätzl. Matrose	NN	Hopp	Hopp
zusätzl. Matrose	NN	NN	NN
Lagerhalter	Schierl	Schierl	Barth
Masch-Wart	Wittfoth	Wittfoth	Jordan
Masch-Wart	Dufner	Dufner	Fritz
Masch-Wart	Carstens	Carstens	NN
Masch-Wart	Husung	Husung	Buchas
Masch-Wart	Ulbricht	Ulbricht	Reimann