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The Expedition of the Research Vessel "Polarstern" to the Antarctic in 2003 (ANT-XX/3)

Edited by
Otto Schrems
with contributions of the participants

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GEMEINSCHAFT

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ANT-XX/3

25 January - 16 February 2003
Cape Town - Bremerhaven

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Otto Schrems

Koordinator / Coordinator
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1. ZUSAMMENFASSUNG UND FAHRTVERLAUF

Otto Schrems
Alfred-Wegener-Institut für Polar- und Meeresforschung

Der dritte und letzte Fahrtabschnitt der 20. Reise des Forschungsschiffes *Polarstern* in die Antarktis begann am 25. Januar 2003 in Kapstadt (Südafrika). Auf dieser Meridionalschnittfahrt, die auf direktem Wege Bremerhaven ansteuerte, wurde ein umfangreiches Atmosphärenforschungsprogramm durchgeführt, an dem sowohl deutsche als auch britische Wissenschaftler beteiligt waren.

Untersuchungen der Ozonverteilung sowohl in der Troposphäre als auch der Stratosphäre bildeten einen Schwerpunkt dieser Messkampagne. So wurden im Verlauf der Reise 25 Ozonsonden gestartet, die eine Höhe von ca. 30 km erreichten, um Ozonprofile zu erhalten. Eng damit verknüpft waren die Messungen der solaren UV-A und UV-B Strahlung mit einem neu entwickelten UV-Spektralradiometer in den unterschiedlichen Klimazonen, die auf dieser Reise durchquert wurden.

Messungen von zahlreichen weiteren atmosphärischen Spurenstoffen wurden mit spektroskopischen Methoden durchgeführt, wie der FTIR Spektroskopie und dem DOAS Verfahren, bei denen jeweils die Sonne als Lichtquelle genutzt wird. Mit dem DOAS-Spektrometer kann die Häufigkeit verschiedener atmosphärischer Spurengase, wie z.B. NO_2, H_2O, HCHO, IO und SO_2 in verschiedenen Höhen ermittelt werden. Mit dem FTIR-Spektrometer können in Ergänzung hierzu z.B. die in der Stratosphäre vorkommenden Spurengase O_3, HCl, HNO_3 und NO_2, und die troposphärischen Spurengase CO, C_2H_2, C_2H_6, CH_2O, HCN und OCS gemessen werden. Diese Messungen dienen u.a. auch zur Validierung von Messinstrumenten des europäischen Umwelt-Satelliten ENVISAT, der am 1. März 2002 in eine Erdumlaufbahn geschickt wurde.

Ein weiteres Projekt befasste sich mit der Bestimmung leichtflüchtiger Organo-halogenverbindungen aus marinen Quellen. Ferner wurde ein Messprogramm zur Bestimmung der Verteilung von langlebigen organischen Schadstoffen (POPs = Persistant Organic Pollutants) in der Süd- und Nordhemisphäre durchgeführt. Hierzu wurden sowohl Luft- als auch Wasserproben genommen, um neben der Verteilung dieser Stoffe in der Atmosphäre auch deren Verteilungsprofile in der Wassersäule des Atlantiks zu bestimmen.

Einen weiteren Schwerpunkt des Messprogramms bildete das atmosphärische Aerosol, dessen Auswirkung auf die Durchlässigkeit der Atmosphäre („optische Dicke") mit einem Sonnenphotometer gemessen wurde. So konnte z. B. entlang der westafrikanischen Küste in Höhe der Kapverdischen Inseln eine erhebliche Trübung der Atmosphäre beobachtet werden, die durch den Eintrag von Saharastaub in die Atmosphäre verursacht wurde. Da alle Messverfahren, die auf dieser Schiffsmesskampagne eingesetzt wurden, voll funktionsfähig waren und begünstigt durch hervorragende Wetterbedingungen während der gesamten Fahrt, war die Messkampagne ein voller Erfolg. Die Reise endete einen Tag früher als ursprünglich geplant am 16. Februar 2003, 14.00 Uhr Ortszeit, im Heimathafen der *Polarstern* in Bremerhaven.

SUMMARY AND ITINERARY

The third and last leg and return voyage of the twentieth cruise of the research vessel *Polarstern* to Antarctica started on 25 January 2003 in Cape Town (South Africa). During this cruise, which took the shortest possible route to Bremerhaven, a comprehensive atmospheric research programme was carried out with participation of German and British scientists.

Investigations of the ozone distribution in the troposphere as well as in the stratosphere were a focal point of this shipborne campaign. During the entire cruise a total of 25 ozone sondes were launched, which reached an altitude of about 30 km and provided ozone profiles. Strongly linked to these activities were measurements of solar UV-A and UV-B radiation which were carried out with a newly developed spectroradiometer in the various climate zones that were crossed during this cruise.

Measurements of numerous other atmospheric trace gases were performed with spectroscopic methods, like FTIR spectroscopy and the DOAS method, both using the sun as light source. With the DOAS spectrometer the occurrence of various trace gases, like NO_2, H_2O, HCHO, IO and SO_2 can be determined at different altitudes. Complementary, with the FTIR spectrometer, stratospheric trace gases like O_3, HCl, HNO_3 und NO_2 can be measured in addition to selected tropospheric trace gases like CO, C_2H_2, C_2H_6, CH_2O, HCN and OCS. These measurements serve also for validation of atmospheric instruments aboard the European ENVISAT satellite, which was launched on 1 March 2002.

In a further project volatile organo-halogen compounds from marine sources were investigated. Furthermore, a measurement programme for the determination of the distribution of persistent organic pollutants (POPs) in the southern and northern hemisphere was performed. For this purpose air and sea water samples were collected in order to study the distribution of POPs in the atmosphere as well as in the water column of the Atlantic.

A further focus of the measuring programme was the atmospheric aerosol, whose impact on the transmittance of the atmosphere (“optical depth”) was measured with a sun photometer. The results obtained along the West African coast in the vicinity of Cap Verde Islands show a remarkable turbidity of the atmosphere which was caused by Saharan dust. Since all measurement techniques, which were applied during this cruise, were fully operational throughout the entire cruise, the campaign was a great success. The voyage ended in Bremerhaven on 16 February 2003 at 2 p.m., one day earlier as originally planned.

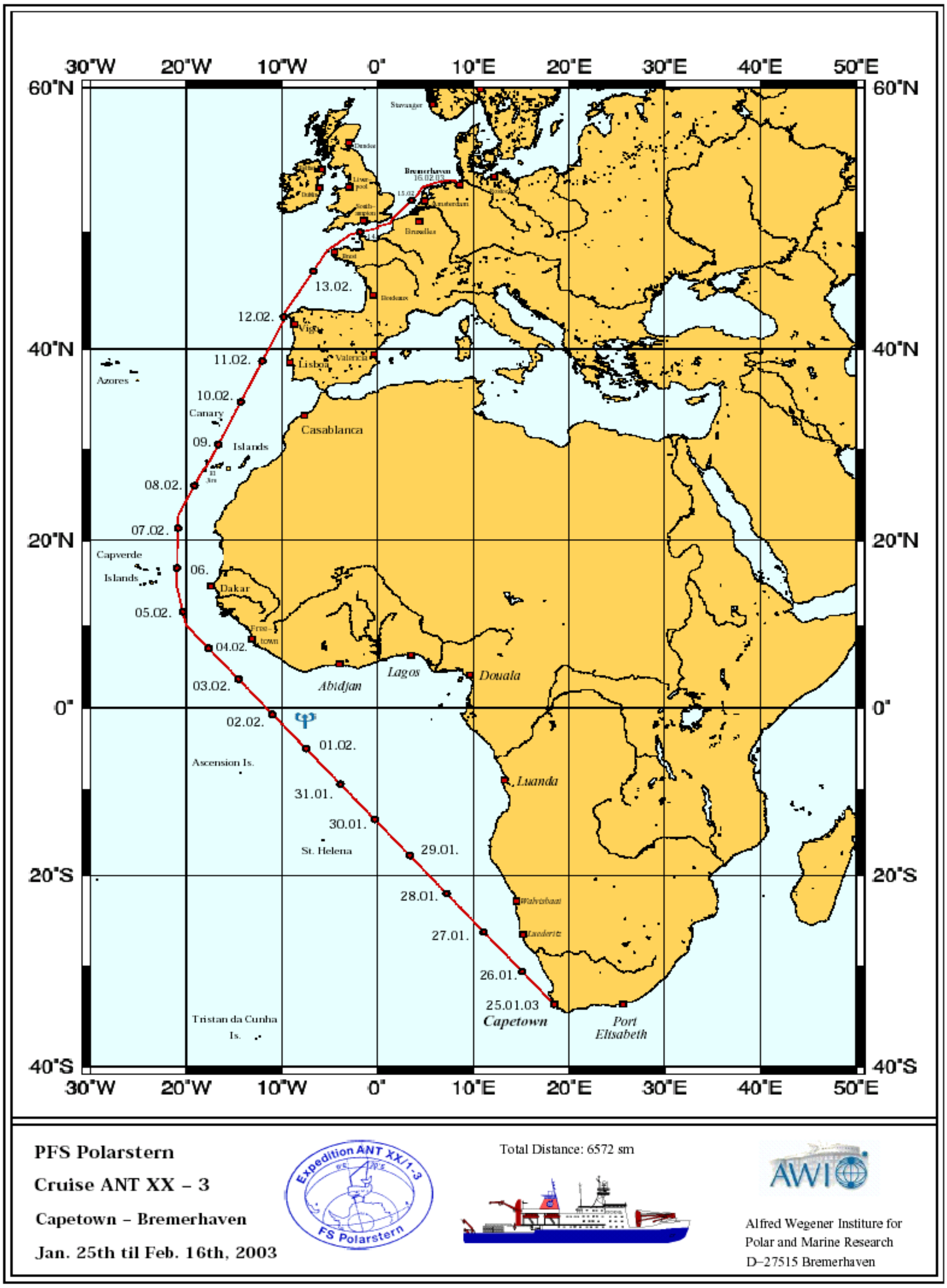

Abb. 1: Fahrtverlauf von ANT-XX/3
Fig. 1: Cruise track of ANT-XX/3

2. METEOROLOGICAL CONDITIONS

Hartmut Sonnabend
Deutscher Wetterdienst

After leaving Cape Town on 25 January 2003 at 18:00 h local time *Polarstern* passed a weak, hardly weather-effective cold front. Then, the southern hemispheric trade winds already took over due to the rapidly increasing high pressure influence during the night of 25 and 26 January. It was related to the extensive subtropical high with its centre east northeast from Tristan Cunha and Gough Island and the seasonally intensified heat low over the southern Africa. Due to the fluctuations of the intensity of the continental heat low depending on daytime, the wind velocities varied between 15 and occasionally close to 30 knots, while the direction essentially followed the coastline. During this phase the relative wind came predominantly from the aft.

With further north-westward course and increasing distance to the coast *Polarstern* crossed the northern edge of the South Atlantic subtropical high and reached the equatorial low pressure belt. Because of the relatively southern position of the South Atlantic subtropical high, the gradient to the equatorial low pressure belt was moderate. Thus the predominantly southeast trade winds extended with almost constant wind velocities from 12 to 16 knots into the direct vicinity of the Inter Tropical Convergence Zone (ITCZ). This meant for *Polarstern* - with 13 to 14 knots at north-westward course - frequently complete break-down of the relative wind over several days.

From 20° to 5° S the characteristic and extensive stratus and cumulus cloud fields occurred clearly less frequently than usual. On 29 January 2003, however, when *Polarstern* passed under the seasonal zenith position of the sun at 18° S, a strongly shielding cloud cover permitted only short bright periods below the well developed trade wind inversion.

The weather-active part of the tropical Convergence Zone (ITCZ) extended as a torn up, little organized cloud band from the Gulf of Guinea to the area south of Cape Palmas (Liberia) and from there between 1° and 4° N further westward. Some times the isolated, very small and short-lived cells with high-reaching convection, combined to narrow shower and thunderstorm lines. Such a line touched *Polarstern* in the early morning hours of 3 February at approximately 2° N. The lightning activity with 1 to 2 events per minute remained relatively small, just like the precipitation of 5.3 mm registered on board. The weak and turning winds in the area of the ITCZ assured at continuously high ship speed that the relative wind were from the front. After crossing of the ITCZ when reaching the north hemispheric trade winds also the true winds were from the front. The centre of the extensive North Atlantic subtropical high steering the trade winds with more than 1035 hPa was located next to the Azores.
The weak to moderate northwest winds later turned - essentially following the West African coast - over north to north-north-east and increased during the night of 5 to 6

February to forces from 5 to 6 Beaufort. Already on 4 February *Polarstern* encountered the dust cloud drifting west-south-westward from the Sahel zone and the southern Sahara over the West African coastal states. This frequent event which preferentially occurs between the northern edge of the ITCZ and about 20°N caused a significant reduction of the visibility to 6 km on 5 February.

An elongated and relatively broad band of high and medium high clouds extending from the Cape Verde Islands into western Sahara caused a temporary shield against the sun’s radiation. Such cloud bands occur in this region rather often and are normally close to the subtropics jet. A radiosonde ascent from *Polarstern* near the Mauritanian coast revealed wind velocities of up to 72 meters per second closely underneath the tropopause.

At the latitude of Cape Blanc the trade winds started to turn further to northeast and reached their maximum on 8 February southwest of the Canary Islands with forces from 6 Beaufort and with further approach to the archipelago 7 Beaufort. Off the islands Hierro and La Palma nozzle effects strengthened the trade wind to occasional force 8 and gusts close to 9 Beaufort. The very rough sea reached at short notice wave heights of up to 4 meters. North the archipelago the trade wind came back to normal forces again, yet on 9 February still wind forces of 6 Beaufort occurred with further rough seas. On both days rapid changes between sunny and strongly cloudy phases occurred with isolated light showers.

With the entering a high pressure wedge extending from the North Atlantic subtropical high toward southwest Europe the northeast trade winds calmed down in the early hours of 10 February. The now only weak wind turned over north and northwest temporarily to western to southwest directions. Nearly at the same time a medium high and very long swell with characteristic heights of 3 to 3.5 meters came in from northwest direction. It originated from a series of heavy storm and/or gale lows, which propagated on a relatively northern course from southwest of Newfoundland over Iceland to Jan Mayen.

In the early hours of 11 February *Polarstern* met the wavy cold front of a storm low over Denmark Strait which weakened under high pressure influence. Within its reach occasional rain and drizzle occurred. The remarkable north-westerly swell increased further and reached maxima of 5 to 6 meters. A new high pressure cell approaching from the west forced the initially weak to moderate wind to turn over north to northeast. This high pressure cell moved to the western Gulf of Biscay and joint in with a new high pressure system approaching from Russia. Between this high pressure zone and a weak low pressure band east the Azores reaching toward North Africa the northeast wind increased again on 12 February to 6 Beaufort near the northwest Spanish coast. The significant north-westerly swell flattened only little and reached still wave heights of 4 to 5 meters.

The subsequent crossing of the Bay of Biscay on 13 February passed rather quietly. In the axis of a high pressure bridge, the wind forces ranged from 1 to 2 Beaufort. However in the course of a day the initially weak stratus/cumulus cloud cover solidified and some light rain showers occurred.

On the edge of the strong high pressure system with its centre over South Scandinavia and the North Sea, the journey through the English Channel and the Strait of Dover was dominated by fresh to strong winds from northeast to east. A persistent cloud cover occurred also during 14 February only interrupted by brief sunny sections. On 15 February, the last day at sea, it was still heavily overcast and hazy with initially strong and later moderate to fresh north to east winds.

In summary, a sharp division in terms of wind directions was observed. On the route from Cape Town to the ITCZ the winds were almost exclusively from south to southeast and thus from astern, and after crossing the ITCZ until Bremerhaven turned up to dominant strong winds with north-easterly to northerly directions which then came from the front.

Compared to previous trips, this time on the route from Cape Town to the Canary Islands a remarkably large number of clear and sunny days were registered. North of the Canaries phases with more clouds were dominant.

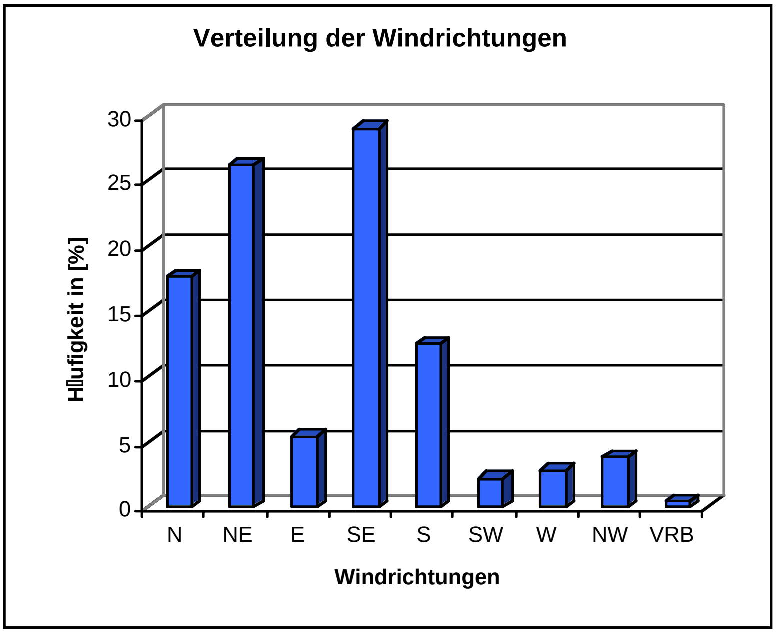

Fig. 2.1: Wind direction

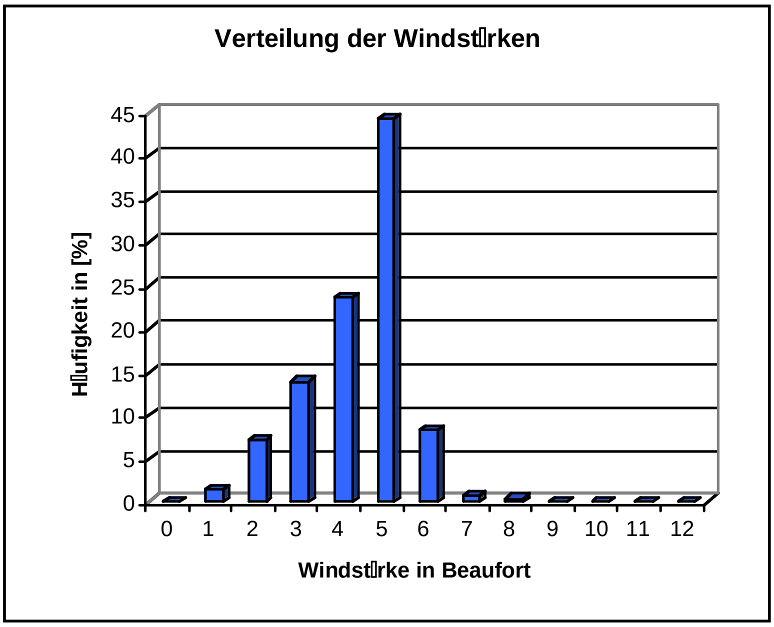

Fig. 2.2: Wind force

3. MEASUREMENTS OF OZONE PROFILES WITH ECC OZONE SONDES

Thaddäus Bluszcz, Ralph Lehmann and Otto Schrems
Alfred-Wegener-Institut

Objectives

The objective of this cruise was to obtain data on ozone concentration, temperature, pressure and humidity up to the middle stratosphere to extend the data set for the investigation of chemical and dynamical processes in the troposphere and stratosphere.

Work at sea

Daily launches of electro-chemical ozone sondes were performed. They yield vertical profiles of the ozone concentration, temperature, pressure and humidity up to the middle stratosphere. Some profiles stopped at lower altitudes because of balloon bursts or sensor or telemetry failures; however, most of the balloon launches reached altitudes well above the tropopause, so that the obtained profiles are valuable for the investigation of the UTLS region (Upper Troposphere / Lower Stratosphere).

The profiles obtained augment similar measurements carried out during previous cruises, thus enlarging the data set for the investigation of chemical and dynamical processes in the troposphere and stratosphere. Their advantages consist in the coverage of a broad band of latitudes (30°S to 50°N) combined with a high vertical resolution.

A region of special interest is the UTLS, because it is important for the exchange of air between the troposphere and stratosphere. Although a thorough analysis has to be carried out after the cruise, a quick look showed that the rather steep increase of the total ozone (=vertically integrated concentration) between 38°N and 43°N is a result of various processes taking place in a region of this height, namely between 10 km and 17 km.

Because of the above-mentioned coverage of a broad band of latitudes and the high vertical resolution, the profiles are well suited for the validation of satellite data, e.g. data from instruments on the ENVISAT satellite.

Ozone is an important trace gas because it absorbs ultraviolet radiation (UV-A and UV-B). UV-A and UV-B measurements were also carried out during this cruise. A comparison of these data with the total ozone obtained from the ozone soundings shows good agreement.

Tab. 3.1: Date, latitude and longitude of the ozone sonde launches as well as the maximum height achieved by the balloons and preliminary results for the ozone columns in Dobson units (DU).

Date	Latitude [deg]	Longitude [deg]	Max. Height [km]	Ozone Total [DU]
27.01.2003	26.9 S	11.6 E	22.9	
28.01.2003	22.5 S	7.6 E	31.6	258
29.01.2003	18.2 S	3.8 E	28.4	279
30.01.2003	13.8 S	0.1 E	33.3	268
31.01.2003	9.7 S	3.5 W	31.4	274
01.02.2003	5.4 S	7.1 W	31.6	273
02.02.2003	1.2 S	19.6 W	32.2	285
03.02.2003	3.1 N	14.2 W	16.0	
03.02.2003	3.8 N	14.8 W	31.9	280
04.02.2003	6.9 N	17.4 W	32.3	255
05.02.2003	11.1 N	20.2 W	24.9	
05.02.2003	12.0 N	20.4 W	33.5	280
06.02.2003	13.3 N	20.7 W	22.2	
07.02.2003	21.1 N	20.9 W	32.9	306
08.02.2003	25.6 N	19.4 W	22.0	
09.02.2003	30.1 N	16.9 W	18.6	
09.02.2003	30.8 N	16.5 W	31.6	350
10.02.2003	34.4 N	14.5 W	32.5	325
11.02.2003	38.4 N	12.3 W	34.6	323
12.02.2003	42.5 N	9.9 W	18.3	
12.02.2003	43.0 N	9.8 W	30.6	400
13.02.2003	47.1 N	6.5 W	30.8	371
14.02.2003	49.9 N	2.5 W	20.2	
15.02.2003	52.3 N	3.4 E	31.1	387

4. MEASUREMENTS OF SOLAR UV IRRADIANCE

Helmut Tüg[1)], Otto Schrems[1)] [1)]Alfred-Wegener-Institut
Thomas Hanken[2)] [2)]ISITEC

Objectives and work at sea

The project for the determination of the meridional distribution of tropospheric and stratospheric ozone was accompanied by the measurement of the solar UV irradiance with a UV spectroradiometer unit mounted in a thermostatted box on the star board side of *Polarstern*'s observation deck. It was the same instrument used during the ANT-XX/2 cruise from Neumayer Station to Cape Town, except that the cooling unit had to be exchanged.

The instrument is simultaneously operating in two wavelengths regions by two inbuilt independent spectroradiometers, namely in the UV-B from 280 to 320 nm and the UV-A spectral regions from 320 to 400 nm. Both radiometers are supplied with array detectors, which are a 32 channel photon counting MCP for the UV-B and a 256 channel diode array for the UV-A. A complete spectrum is obtained in a few seconds (1 sec for the UV-B, 2 to 32 seconds in the UV-A dependent on brightness). Thus, the relative spectral distribution of the solar irradiance is hardly influenced by variable atmospheric conditions like clouds or the solar zenith angle. The instrument was in operation day and night during the whole cruise from 25 January to 16 February. The spectra were stored as average values over time intervals of five minutes.

Figure 4.1 shows the irradiance spectra of the UV-B integrated from 280 to 315 nm with a time resolution of 5 minutes obtained during the cruise. When the ship crossed the meridian with the sun in the zenith on 29 January the expected maximum was significantly influenced by cloud cover. The irradiance values in the figure obviously are determined by three parameters, which are the solar zenith angle, cloud coverage and the ozone column.

The UV-B doses values (280 to 315 nm), obtained from the integral over a whole day is given in figure 4.2 as a function of the latitude (date).

The influence of cloud cover can be excluded by forming the ratio of two irradiance values of the same spectrum because the absorption of clouds is almost the same for two wavelengths which are not separated too far. The ratio obtained from the values at 300 and 320 nm is called the UV-B index which is shown in figure 4.3 for the same time resolution as in figure 4.1. The index is now only influenced by the solar zenith angle and the ozone, because the ozone absorption at 300 nm is rather high compared to that at 320 nm.

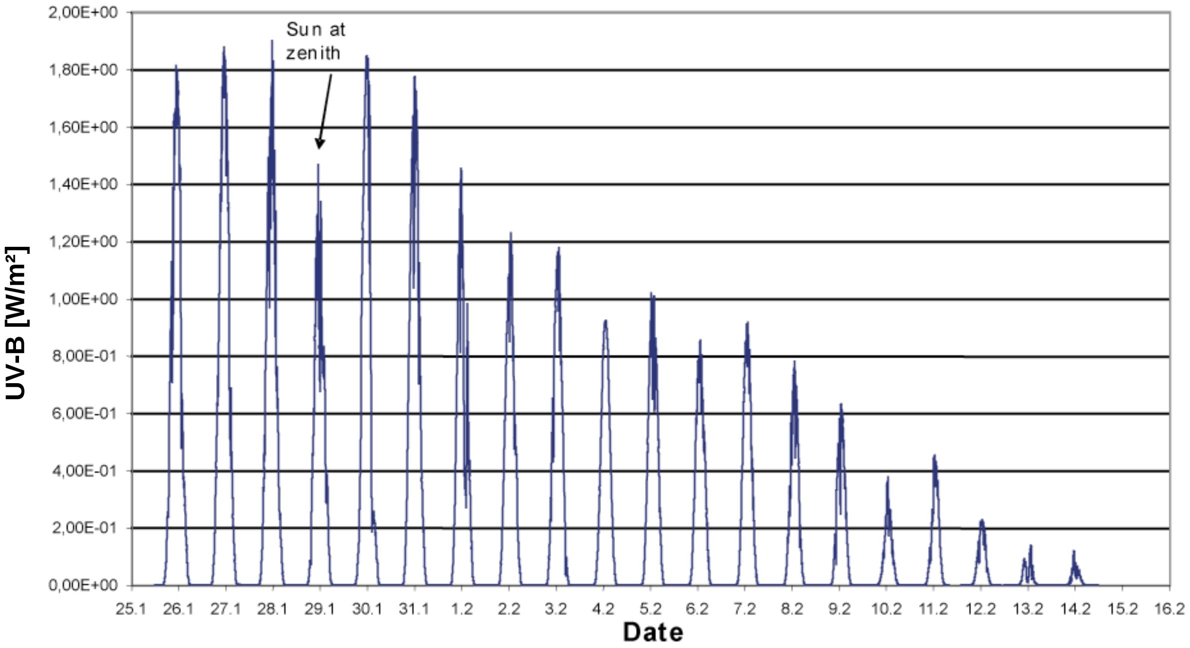

Fig. 4.1: UV-B irradiance (280-315 nm) measured during the cruise ANT-XX/3 (26.01. - 16.02.2003)

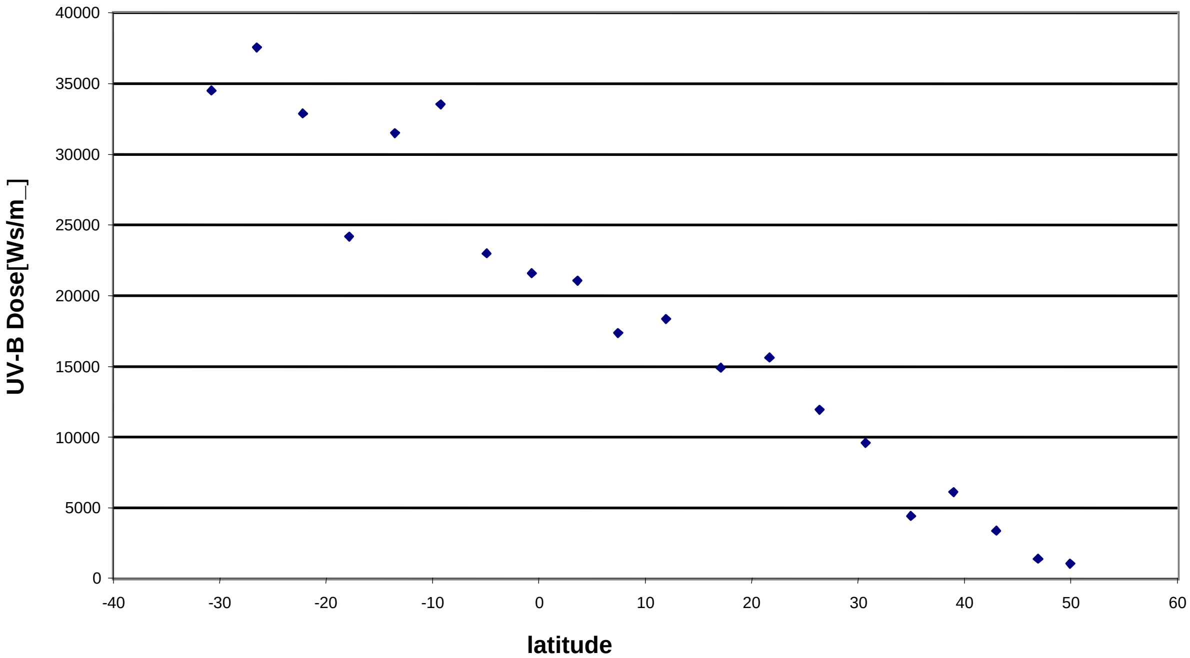

Fig. 4.2: UV-B daily doses (280-315 nm) obtained during the cruise ANT-XX/3 (26.01. - 16.02.03)

To look at the ozone variations one only has to get rid of the influence of the solar zenith angle, which means, the reverse index values at same airmasses have to be compared. Results are shown in figure 4.4 for the air mass 2 which corresponds to a solar zenith angle of about 60 degrees. This airmass was chosen with respect to the arrival date in Bremerhaven. At our destination of the cruise the air mass at the arrival date was not lower than 2. This also means that for all other days of the cruise we got two index values, one before and one after noon. Note, that between both values at a position close to the equator the time gap between both measurements can be more than 8 hours. The good agreement between both values as well as their difference when showing the tilt of the curve indicates that the accuracy is in between a few Dobson units when transformed on an absolute scale like in figure 4.4.

The absolute scale was derived from ozone sonde measurements performed at the same date. These total ozone values calculated by integrating the tropospheric and stratospheric ozone profiles are also shown in figure 4.4 for comparison.

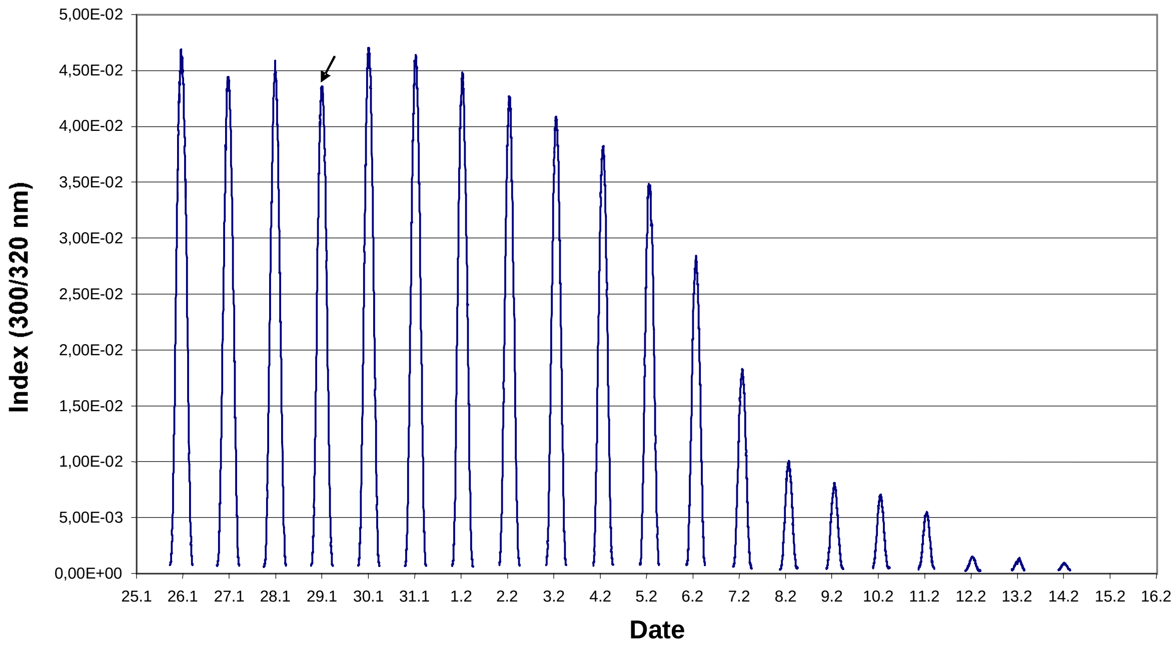

Fig. 4.3: Index (300/320 nm) versus date

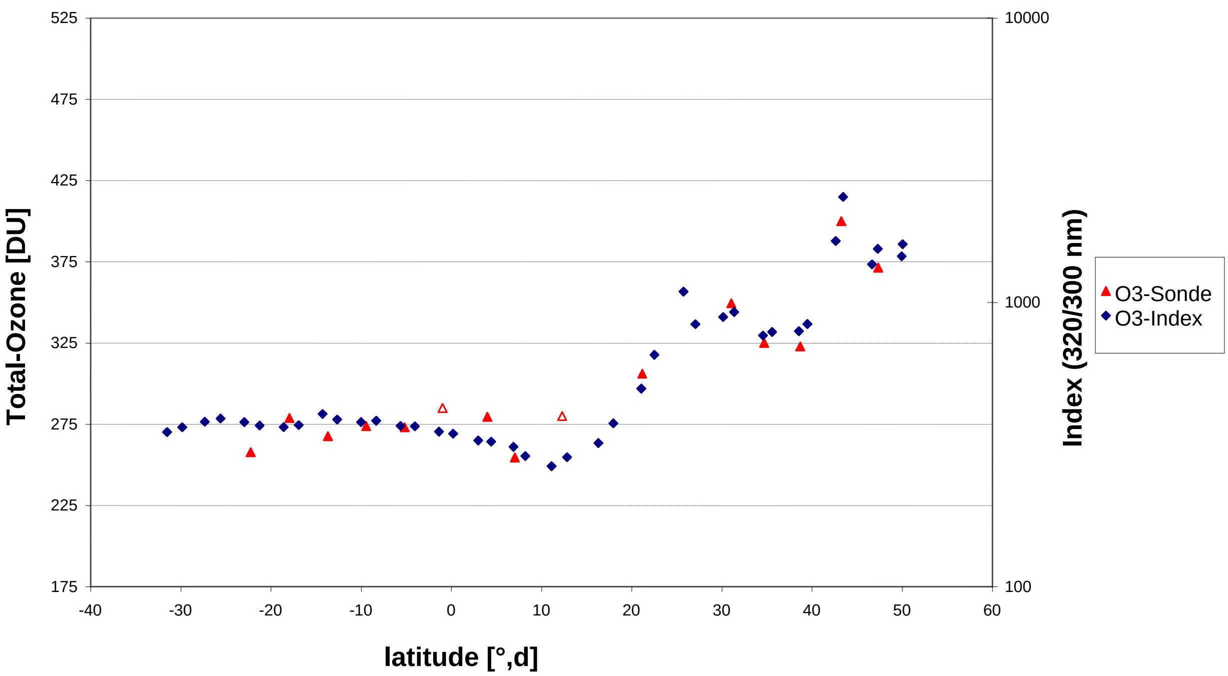

Fig. 4. 4: Total ozone columns [DU] derived from ozone sondes and Index (320/300 nm) from UV measurements versus latitude (date)

5. TRACE GAS MEASUREMENTS WITH A MAXDOAS SPECTROMETER

Lena Kritten,
Universität Heidelberg (IUPH)
not on board: Ulrich Platt, Thomas Wagner (IUPH)

Objectives and work at sea

As in the two previous cruises (ANT-XX/1, ANT-XX/2), the Institute of Environmental Physics of Heidelberg University has operated a MAXDOAS instrument during ANT-XX/3 in order to identify and measure the concentration of trace gases such as BrO, SO_2, HCHO, H_2O, IO, O_3, NO_2, OCIO and O_4.

MAXDOAS observations during extended ship cruises are important for several reasons. First, measurements carried out with one instrument over long ranges of latitude and longitude yield very homogeneous data sets. Thus, they allow to study the variations of atmospheric trace gases on a global scale. Second, it is possible to reach remote regions, Finally, the global data sets are well suited for the validation of satellite data. The MAXDOAS measurements are carried out in the UV spectral range, where the specific absorption features of many atmospheric trace gases can be analysed. Our MAXDOAS instrument observes scattered solar photons in various directions; thus they yield (limited) information on the atmospheric height profiles of these trace gases.

The Multi-Axis Differential Optical Absorption Spectroscopy (MAXDOAS) technique allows to separate the absorptions taking place at different altitudes in the atmosphere by observing scattered sun light from a variety of viewing directions. This is possible because for most measurement conditions, the observed light is scattered in the free troposphere. Thus, air masses located close to the ground are traversed on a slant absorption path determined by the viewing direction; in contrast, stratospheric air masses are traversed on a slant absorption path determined by solar zenith angle. In addition to the partial columns of various trace gases also information on the aerosol profile can be retrieved.

During the cruise ANT-XX/3 we obtained about 15 GB of data which have been saved on the controlling computer and on CD`s. The measured spectra will be analysed in Heidelberg using the DOAS method. The wavelength calibration is performed by fitting the measured spectra to a high resolution solar spectrum.

6. MERIDIONAL AEROSOL OPTICAL DEPTH DISTRIBUTION OVER THE ATLANTIC OCEAN

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Alfred-Wegener-Institut
not on board: Andreas Herber, Alfred-Wegener-Institut

Objectives

During the cruise ANT-XX/3 from Cape Town to Bremerhaven, measurements of aerosol optical depth (AOD) were performed out as a continuation of the programme which was carried out during the entire ANT-XX cruise (legs 1-3). The aim of this task is to study the distribution of aerosol optical depth from Southern to Northern hemisphere, specifically over the Atlantic Ocean.

Work at sea

The measurement of AOD was performed using a sunphotometer type SP1A which was coupled to a suntracker type SPTRV2 (both fabricated at Dr. Schulz & Partner GmbH, Germany). The 17 channels of the sunphotometer cover a wavelength range of 351-1062 nm. Measurements were made on 17 days with relatively clear sky and bright sun. The missing days are due to intense cloud coverage throughout the day.

Preliminary results showed high AOD level between 1 to 6 February 2003 where the ship sailed in the region between the Equator and Cape Verde Islands. Low AOD level was observed outside of this time period.

Next steps of the data analysis will include comparison of the AOD data obtained from this cruise with that from ANT-XX/1-2, study of trajectories, satellite images and aerological data corresponding to the cruises ANT-XX/1-3.

7. MEASUREMENTS OF ATMOSPHERIC TRACE GASES FOR THE VALIDATION OF THE SCIAMACHY INSTRUMENT ON BOARD THE ENVISAT SATELLITE

Voltaire Velazco[2)], Christine Weinzierl[2)], Astrid Schulz[1)], Otto Schrems[1)]
not on board: Justus Notholt[2)]
[1)]Alfred-Wegener-Institut
[2)]University of Bremen

Objectives and work at sea

Measurements of atmospheric trace gases were conducted aboard the research vessel *Polarstern* during the cruise ANT-XX/3 from Cape Town (South Africa) to Bremerhaven (Germany). This was accomplished using a Fourier Transform Infrared (FTIR) spectrometer mounted inside a custom-made shipping container which was located at the observation deck of *Polarstern*. Absorption spectra with a maximum resolution of 0.005 cm^{-1} were recorded using the sun as light source. However, to record such high resolution spectra, very stable weather conditions are needed. Such conditions were available on 15 days. On 4 other days, the measurements were limited to spectra with lower resolution (see table below). Measurements on other days were prevented by dense cloud fields.

Data analysis will be performed after the cruise. Total column densities of more than 20 trace gases, including O_3, HCl, NO_2, CO, C_2H_2, C_2H_6, CH_2O, HCN and OCS will be retrieved from the gathered measurements. In addition, height-resolved information from high resolution spectra can be retrieved for some trace gases. This will yield concentration profiles with a resolution of 6 - 8 km.

Data of selected trace gases (e.g. CO, O_3, NO_2) will be used for the validation of the SCIAMACHY instrument on the ENVISAT satellite. The measurements in the tropical regions are of special interest for the validation since there are only few measuring sites at these latitudes. The collected data will also be interpreted in comparison to cruise data obtained in October 1996 (Bremerhaven-Punta Quilla) and December 1999 (Bremerhaven-Cape Town), where the measurements in the tropics are also of special interest.

The upper troposphere in the tropical regions act as a reservoir for gases entering the stratosphere, and is therefore of high interest for stratospheric research. The previous ship based measurements in this region have implied that trace gases originating predominantly from biomass burning in the African and the South American continents were enhanced in the upper tropical troposphere. It is thus likely that biomass burning has an influence on the stratospheric composition. With the large number of measurements in the tropical regions obtained during this cruise, we are looking forward to bringing new insights in the composition of the tropical free troposphere. Table 7. 1 summarizes the days of measurements along with the latitudes and longitudes where they were performed.

Tab. 7.1: Summary of the measurements and their location

Date	Approx. Latitude	Approx. Longitude	Data
24.01.2002	34 S	18 E	High resolution
26.01.2003	30 S	15 E	High resolution
27.01.2003	26 S	11 E	High/Low resolution
28.01.2003	22 S	7 E	High/Low resolution
30.01.2003	14 S	0 E	High/Low resolution
31.01.2003	9 S	4 W	High resolution
01.02.2003	6 S	7 W	High resolution
02.02.2003	1 S	11 W	High resolution
03.02.2003	4 N	15 W	High resolution
04.02.2003	7 N	18 W	High resolution
05.02.2003	11 N	20 W	High resolution
06.02.2003	17 N	21 W	High resolution
07.02.2003	21 N	21 W	Low resolution
08.02.2003	26 N	19 W	High resolution
09.02.2003	31 N	16 W	High resolution
11.02.2003	40 N	11 W	Low Resolution
12.02.2003	43 N	10 W	Low Resolution
13.02.2003	47 N	7 W	High/Low Resolution
14.02.2003	50 N	0 W	Low Resolution

8. MARINE SOURCES OF REACTIVE ORGANO-IODINES AND BROMINES

David Wevill
University of York
not on board: Lucy Carpenter, University of York

Objectives and work at sea

The aim of this project was to investigate the sources of reactive halogen radicals such as iodine oxide (IO) and bromine oxide (BrO). Air monitoring was carried out using an automated Perkin Elmer Turbomass GC-MS. The sampling interval was ~70 mins and the instrument was running 24 hours a day excluding blanks and calibrations. Of the 13 species monitored only 9 have been detected. The species not detected were the very short-lived compounds which last only 5 – 20 mins at noon, and as these species are produced mainly by coastal algae (seaweeds) it is unlikely they would persist long enough to be measured. No meaningful data can be presented at this time as the method used for calibration relies on weighing liquid filled tubes (used to generate the calibration gas) on return to York.

Continuous CO measurements were also taken during the cruise with an Aerolaser instrument and showed the expected increase in concentration as we reached Europe, further detailed analysis will be performed in Leeds by the group responsible. Bottle samples were also taken each day around noon UCT for post analysis of non-methane hydrocarbons.

9. LATITUDINAL DISTRIBUTION AND AIR-SEA EXCHANGE OF PERSISTENT ORGANIC POLLUTANTS: MEASUREMENTS AND MODELLING

Louise Durham[1)], Armanod Caba[2)]
[1)]Lancaster University
[2)]GKSS

Objectives

Persistent organic pollutants (POPs) include several different chemical classes. Some examples include polychlorinated biphenyls (PCBs), chlorinated pesticides (*e.g.* HCHs), polybrominated diphenyl ethers (PBDEs) and fluorinated compounds (PFOS). Each one has different atmospheric sources and different properties which control their persistence in the environment and their air-sea exchange processes. Analysis of different classes of compounds will provide “clues” about the environmental processes which influence the fate of these chemicals.

During ANT-XX/3 and the previous leg, ANT-XX/1, we hoped to investigate the influences: air mass, air sea exchange, phytoplankton uptake and sinking fluxes of organic matter have on prevailing POP concentrations. Simultaneous air and seawater samples were taken from South Africa to Europe.

Work at sea

A continuous flow of surface water (11 m depth) from the ship’s inlet system was used for water samples. This water was analysed for chlorophyll, POC and DOC. Also, water was taken (20 l) and extracted with hexane for HCH analysis. In addition to these surface samples, there was one deep CTD station at 21° 4.5' N / 20° 51.9' W. Water samples were taken at the surface (11 m) and 6 additional depths for HCH analysis. These depths were 100 m above bottom (4,000 m), 3,000 m, 2,000 m, 1,000 m, 300 m and 70 m).

For the POP analysis, a total of 8 PAD columns were exposed to an average of 800 l of seawater and another 13 extraction columns containing a different extraction resin (XAD-7) were exposed to 200 l of seawater to look for PFOS compounds.

Daily air samples were taken from high volume samples for POPs when the wind direction was favourable. However, during the first part of the cruise, we experienced south-easterly winds, and very few air samples were taken for the traditional POPs. This allowed some sampling to be done in order to determine the extent of shipboard contamination. Passive air samplers were also placed around the ship to monitor the ship’s air during the cruise.

Diurnal sampling was also performed to evaluate any day/night trades in POP air concentrations. Other sampling times were 24 hours for a second PUF sample and an average of 48 hours for a XAD-PUF sample. As well, there was 6 samples taken for PFOS analysis with an average 72 hr. exposure time.

Both the air and water extraction columns will be analysed for a PCBs, PAHs, PBDEs HCHs, and selected pesticides. Since all samples for both water and air most undergo further analysis in the laboratory, no preliminary data can be shown at the end of this expedition.

APPENDIX

A.1 BETEILIGTE INSTITUTE / PARTICIPATING INSTITUTES

A.2 FAHRTTEILNEHMER / CRUISE PARTICIPANTS

A.3 SCHIFFSBESATZUNG /SHIP'S CREW

A.4 STATIONSLISTE / STATION LIST PS 63

A1. BETEILIGTE INSTITUTE / PARTICIPATING INSTITUTES

	Address
AWI	Alfred-Wegener-Institut für Polar- und Meeresforschung in der Helmholtz-Gemeinschaft Postfach 120161 27515 Bremerhaven/Germany
CHYORK	University of York Department of Chemistry York, YO10 5DD / United Kingdom
DWD	Deutscher Wetterdienst Hamburg Abteilung Seeschifffahrt Bernhard-Nocht-Str. 76 20359 Hamburg/Germany
FIELAX	FIELAX Gesellschaft für wissenschaftliche Datenverarbeitung mbH Schiffer-Str. 10 - 14 27568 Bremerhaven/Germany
GKSS	GKSS Forschungszenrum Geesthacht Institut für Küstenforschung Max Planck-Str. 1 21502 Geesthacht / Germany
IENS	Lancaster University Environmental Science Lancaster, LA1 4YQ / United Kingdom
ISITEC	ISITEC GmbH Stresemannstr. 46 27570 Bremerhaven / Germany
IUP	Institut für Umweltphysik Universität Bremen – FB 1 Postfach 330440 28334 Bremen / Germany

A.2 FAHRTTEILNEHMER / CRUISE PARTICIPANTS ANT-XX/3

Name	Vorname/ First Name	Institut/ Institute	Beruf/ Profession
Bluszcz	Thaddäus	AWI	Technician
Bretfeld	Holger	Fielax	Technician
Caba	Armando	GKSS	Engineer
Durham	Louise	IENS	Scientist
Hanken	Thomas	Isitec	Engineer
Kritten	Lena	University Heidelberg	Student
Lehmann	Ralph	AWI	Scientist
Roschinsky	Jörg	Fielax	Technician
Sandradewi	Jisca	AWI	Student
Schrems	Otto	AWI	Professor
Sonnabend	Hartmut	DWD	Technician
Tüg	Helmut	AWI	Scientist
Velazco	Voltaire	University Bremen	Student
Weinzierl	Christine	University Bremen	Engineer
Wevill	David	University of York	Student

A.3 SCHIFFSBESATZUNG / SHIP'S CREW

No.	Name		Rank
01.	Domke	Udo	Master
02.	Spielke	Stefan	1. Offc.
03.	Pluder	Andreas	Ch. Eng.
04.	Szepanski	Nico	2. Offc.
05.	Thieme	Wolfgang	2. Offc.
06.	Koch	Georg	R. Offc.
07.	Delff	Wolfgang	1. Eng.
08.	Ziemann	Olaf	2. Eng.
09.	Zornow	Martin	3. Eng.
10.	Muhle	Heiko	Electr.Tech.
11.	Clasen	Burkhard	Boatsw.
12.	Reise	Lutz	Carpenter
13.	Gil Iglesias	Luis	AB
14.	Pousada Martinez	S.	AB
15.	Kreis	Reinhard	AB
16.	Schulz	Ottmar	AB
17.	Burzan	G.-Ekkehard	AB
18.	Moser	Siegfried	AB
19.	Hartwig	Andreas	AB
20.	Preußner	Jörg	Storekeep.
21.	Ipsen	Michael	Mot-man
22.	Voy	Bernd	Mot-man
23.	Elsner	Klaus	Mot-man
24.	Hartmann	Ernst-Uwe	Mot-man
25.	Grafe	Jens	Mot-man
26.	Haubold	Wolfgang	Cook
27.	Völske	Thomas	Cookmate
28.	Silinski	Frank	Cookmate
29.	Jürgens	Monika	1. Stewardess
30.	Wöckener	Martina	Stewardess/KS
31.	Czyborra	Bärbel	2. Stewardess
32.	Silinski	Carmen	2. Stewardess
33.	Gaude	Hans-Jürgen	2- Steward
34.	Möller	Wolfgang	2. Steward
35.	Huang	Wu-Mei	2. Steward
36.	Yu Kwok	Yuen	Laundrymen

A.4 STATIONSLISTE / STATION LIST PS63

Station	Date/Time	Postition Latitude	Position Longitude	Elevation	Gear	Area name
PS63/219-1	2003-02-04T09:15	6.89890	-17.39180	-4870	CTD/ Rosette	North Atlantic Ocean
PS63/220-1	2003-02-07T09:11	21.06970	-20.86330	-4141	CTD/ Rosette	Canarias Sea
PS63/22509	2003-02-03T09:54	3.07000	-14.19000		Radiosonde	
PS63/22523	2003-02-13T10:18	46.59000	-6.95000		Radiosonde	
PS63/22524	2003-01-27T10:01	-26.94000	11.65000		Radiosonde	
PS63/22525	2003-01-28T10:08	-22.47000	7.56000		Radiosonde	
PS63/22526	2003-01-29T09:54	-18.21000	3.77000		Radiosonde	
PS63/22527	2003-01-30T09:51	-13.97000	0.11000		Radiosonde	
PS63/22528	2003-01-31T09:56	-9.74000	-3.50000		Radiosonde	
PS63/22529	2003-02-01T09:51	-5.45000	-7.09000		Radiosonde	
PS63/22530	2003-02-02T09:58	-1.23000	-10.62000		Radiosonde	
PS63/22531	2003-02-03T14:16	3.82000	-14.81000		Radiosonde	
PS63/22532	2003-02-04T09:59	6.90000	-17.39000		Radiosonde	
PS63/22533	2003-02-05T09:53	11.08000	-20.23000		Radiosonde	
PS63/22534	2003-02-05T14:13	12.02000	-20.42000		Radiosonde	
PS63/22535	2003-02-06T10:03	16.26000	-20.96000		Radiosonde	
PS63/22536	2003-02-07T09:53	21.07000	-20.86000		Radiosonde	
PS63/22537	2003-02-08T09:48	25.64000	-19.39000		Radiosonde	
PS63/22538	2003-02-09T09:54	30.07000	-16.87000		Radiosonde	
PS63/22539	2003-02-09T13:42	30.77000	-16.51000		Radiosonde	
PS63/22540	2003-02-10T09:49	34.45000	-14.53000		Radiosonde	
PS63/22541	2003-02-11T09:51	38.44000	-12.29000		Radiosonde	
PS63/22542	2003-02-12T09:56	42.48000	-9.89000		Radiosonde	
PS63/22543	2003-02-12T13:01	43.00000	-9.79000		Radiosonde	
PS63/22544	2003-02-13T13:56	47.11000	-6.50000		Radiosonde	
PS63/22545	2003-02-14T09:48	49.88000	-2.47000		Radiosonde	
PS63/22546	2003-02-15T09:53	52.31000	3.41000		Radiosonde	
PS63/3-track	2003-01-23T12:00	-34.00000	18.00000		Measure ments along cruise track	

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