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REPORT

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Project Title: SIMBIOS Validation Studies in the Antarctic Commercial Cruise of R/V *Akademik Ioffe*

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Abstract

This report describes the scientific activity on board the Research Vessel (R/V) *Akademik Ioffe* on two Atlantic transects from Kiel to Ushuaia in October-November 2001 and from Ushuaia to Kiel in March-April 2002 and during the tourist cruises in the Antarctic region from November 2001 to March 2002. A broad instrumental set was prepared and installed onboard R/V *Akademik Ioffe* to measure (without ship stopping) the characteristics required for validation of satellite ocean color algorithms. Totally 337 stations were made. Comparison between the data on some characteristics measured by different means were made that allowed to check the obtained results and estimate their uncertainties. Such comparison were also performed between the values of bio-optical characteristics based on *in situ* data and retrieved from SeaWiFS satellite data (water-leaving radiance, chlorophyll concentration, and the particle backscattering coefficient); a quite reasonable agreement between the field data and the satellite-based values of the above mentioned characteristics has been shown. Seven bio-optical provinces with diverse productivity were selected based on SeaWiFS data; also three zones with diverse productivity were selected in the Antarctic area of studies. The features and seasonal variability of their bio-optical characteristics were considered which are of vital importance for development of regional bio-optical algorithms.

CONTENTS

1. INTRODUCTION

The Russian R/V *Akademik Ioffe* crossed the Atlantic ocean from Kaliningrad to Ushuaia in October-November 2001, then performed several tourist cruises in Antarctic in November 2001-March 2002, and crossed the Atlantic ocean in the opposite direction from Ushuaia to Kaliningrad in March-April 2002. All of the above legs (lumped together as the "Ioffe_10 cruise") were used for making optical and biological measurements for implementation of the SIMBIOS (Sensor Intercomparison and Merger for Biological and Interdisciplinary Ocean Studies) program.

A goal of the measurements was to collect *in situ* data for studying spatial changeability of atmospheric and oceanic characteristics in the Atlantic Ocean between 50^{o}N and 55^{o}S in two different seasons as well as their mesoscale variability for poorly studied area south of 55^{o}S from November to March and comparing the obtained field data with concurrent satellite data.

A broad instrumental set was prepared and installed onboard R/V *Akademik Ioffe* to measure (without the ship stopping) the characteristics required for validation of satellite ocean color algorithms.

The scientific activities during the cruises included:

- Measurement of aerosol optical thickness and diffuse marine reflectance by SIMBAD radiometer (provided by Robert Frouin, Scripps Institute of Oceanography, San Diego, USA);
- Measurement of the spectral remote sensing reflectance by a deck spectroradiometer and continuous monitoring of surface irradiance at a fixed wavelength by a monitor photometer (Shirshov Institute of Oceanology, Moscow, Russia);
- Continuous semi-automated measurements with the Portable Radiation Package which includes Fast-Rotating Shadow-band Spectral Radiometer to measure direct, diffuse and global irradiance in seven channels (visible and IR) as well as the broadband solar and IP Eppley radiometers (provided by Michael Reynolds, Brookhaven National Laboratory Upton, New York, USA);
- Sampling, sample handling and determination of spectral absorption coefficients of particles, dissolved material and phytoplankton for surface water samples (the equipment provided by Robert Frouin).
- Measurements of seawater spectral absorption coefficient by a laboratory spectrophotometer (Shirshov Institute of Oceanology, Moscow, Russia);
- Determination of chlorophyll-a concentration by a spectrophotometric method (Shirshov Institute of Oceanology, Moscow, Russia);

- Sampling, handling and storage in liquid nitrogen samples for HPLC pigment analyses (the equipment provided by Robert Frouin).

2. SHIP, INSTRUMENTATION, PERSONNEL

2.1. The ship

R/V *Akademik Ioffe* (Fig.1) was designed to carry out multivarious scientific oceanic studies. Its endurance is 60 days at 13.5 knots, the length overall is 117 m, the breadth 18 m, the full load displacement 6600 t; there are 14 scientific laboratories and a hundred cabins for scientists as well as a library, a conference hall, a sport-room, a swimming-pool, two saunas on board.

2.2. Sampling strategy

Sampling during Ioffe_10 was mainly performed while the ship was underway. Measurements were carried out daily within ± 2 hours from the time of SeaWiFS overpass; under good weather conditions it was 5 times daily (2 and 1 hour before, just at the moment, 1 and 2 hours after the SeaWiFS viewing time); in other cases it was less or not at all. The Station Log is presented in Appendix A; there are hours before (-) and after (+) the time of SeaWiFS overpass given in round brackets.

2.3. SIMBAD radiometer

The instrument is described by Frouin et al. (2000). It measures direct sunlight intensity by viewing the sun, and water-leaving radiance by viewing the ocean surface at 45^{o} from nadir and 135^{o} from the sun's vertical plane in five spectral bands centered at 443, 490, 560, 670, and 870 nm. Aerosol optical thickness and diffuse marine reflectance are calculated from the measured data.

2.4. Deck spectroradiometer

This device is an advanced modification of the instrument described by Goldin et al. (1983). It is mounted on the ship bow and measures three spectral quantities: surface irradiance, $E_s(\lambda)$; nadir upwelling radiance, $L_w(\lambda)$; and zenith sky radiance, $L_{sky}(\lambda)$; these values are used to calculate the water radiance reflectance, $\rho(\lambda)$. The light fluxes are collected by three collectors, then come to the rotating mirror distributor, and are directed by turns to the monochromator. The field -of-view (2θ) for the water and sky radiance collectors is 6^{o}; the spectral range of the instrument is 390-670 nm; the spectral resolution 7 nm. Its photometrical characteristics are presented in Table 1.

Table 1. The photometrical characteristics of the deck spectroradiometer

Quantity	Downwelling irradiance	Upwelling radiance	Sky radiance
Units	W m^{-2} nm^{-1}	W m^{-2} nm^{-1} sr^{--1}	W m^{-2} nm^{-1} sr^{--1}
Saturation value	2.7	0.12	0.72
Minimum value	$3x10^{-2}$	$1x10^{-3}$	$6x10^{-3}$
SNR at minimum	20:1	20:1	20:1
Digital resolution	$6x10^{-4}$	$3x10^{-5}$	$2x10^{-4}$

2.5. Monitor photometer

This device was constructed for checking the absolute calibration of irradiance channels of floating and deck spectroradiometers, and continuous monitoring surface irradiance at 454 nm during measurements by these radiometers. The characteristics of the monitor photometer:

Saturation irradiance – 2.6 W m^{-2} nm^{-1};

Minimum irradiance - $3x10^{-2}$ W m^{-2} nm^{-1};

SNR at minimum – 2000:1;

Digital resolution - $6x10^{-4}$.

2.6. Fast-Rotating Shadow-band Spectral Radiometer (FRSR)

This instrument is described by Frouin et al. (2000). FRSR makes continuous semi-automated shipboard measurements of the direct-normal, diffuse, and global irradiance in seven channels (415, 500, ~610, ~660, ~862, 936 nm and broadband) with 2-minute time resolution. The measured data are combined with information about the pitch, roll, and the ship heading. From the obtained data the aerosol optical thickness can be computed during clear sky periods and the fractional cloudiness can be evaluated.

2.7. Sampling and sample handling

The water samples were taken underway by bucket. The procedure for sample handling was in accordance with Mitchell et al. (2000) and Bidigare and Trees (2000). There were four filtration systems used: 1) HPLC filtration system (6 place rig); 2) Ap-Ad filtration rig (5 places); 3) As filtration rig (3 cups); 4) Chl-spectrophotometric filtration system under gravity (without a vacuum pump). The samples for HPLC and Ap were filtered just after collection through Whatman 25 mm GF/F glass fiber filters , 0.7 µm pore size; the filtration volume was from 1.08 l in eutrophic waters to 5.46 l in oligotrophic areas. The samples for As were filtered through 0.2 µm Nucleopore filters. The samples for spectrophotometric chlorophyll were filtered through 0.85 µm Synpore membrane or 0.45 μm Vladipore membrane filters; the filtration volume was from 5 to 11 l; before filtration 20 ml suspended carbonate of barium was added on the surface of the filters.

2.8. Spectrophotometer for measurements of spectral absorption coefficients of particles, dissolved material and phytoplankton

It was Cary 50 instrument: dual beam with reference correction, Czerny-Turner monochromator, 190-1100 nm wavelength range, approximately 1.5 nm fixed spectral bandwidth, full spectrum Xe pulse lamp single source with exceptionally long life, dual Si diode detectors, quartz overcoated optics, scan rates up to 24 000 nm/min, 80 data points per second maximum measurement rate, non measurement phase stepping wavelength drive, room light immunity, centrally controlled by PC with Windows interface. Wavelength accuracy: ± 0.5 nm at 541.9 nm; standard error in absorbance was ~0.001 optical density unit. Sample preparation for particle and soluble absorption measurements were in accordance with Mitchell et al. (2000).

2.9. Laboratory absorption meter

It was constructed to measure the true absorption by seawater particulate and dissolved matter (Kopelevich et al. 1974). It is a double-beam spectrophotometer with an integrating sphere to collect the scattered light on photoreceiver; the sample and reference cuvettes are placed inside of the integrating sphere. The sample cuvette is filled by the studied seawater, the reference cuvette by purified fresh water; by this means the absorption by seawater particulate and dissolved matter is measured with the proviso that fresh water in the reference cell is properly purified. The characteristics of the laboratory absorption meter as follows:

spectral range: 350-760 nm;

spectral resolution: < 5 nm;

wavelength accuracy: 1 nm;

measured range of the absorption coefficient, m^{-1}: 0.002-200 m^{-1};

accuracy: ~0.002 m^{-1} with minimum values or 1% with high values of the absorption coefficient.

2.10. Determination of chlorophyll-a concentration by a spectrophotometric method

The procedure was in accordance with the standard spectrophotometric method (Jeffrey & Humphrey 1975, SCOR-UNESCO, 1966) with acetone extraction. After filtration the filters with material were kept in the liquid nitrogen for a week. Then the material collected was homogenized and extracted two times for a 30 minutes with 5 ml 95% acetone. After each extraction the extract was centrifuged for a 15 minutes. The total volume of extract was 9-10 ml.

The absorption spectra of the extracts were measured by Cary-50 spectrophotometer; the optical density at 630, 647, 664, and 750 nm was determined. Chlorophyll «a» concentration in the extract was calculated by Jeffrey and Humphrey (1975) formula.

Chlorophyll «a» concentration in water sample was calculated by formula

$$Chl_s = (Chl_{ex} / V_s)\, V_{ex}\ , \qquad (1)$$

where Chl_s - chlorophyll «a» concentration in water sample (mg/m^3); Chl_{ex} - chlorophyll «a» concentration in acetone extract; V_s - volume of sample (l); V_{ex} - volume of extract (ml).

2.11. Preparation of samples for HPLC pigment analyses

The procedure was in accordance with Bidigare and Trees (2000). The samples were filtered through 0.7 µm Whatman GF/F, 25 mm glass fiber filters and stored in liquid nitrogen. The samples were processed using HPLC and fluorometric techniques by J.R.Perl and C.C.Trees at Center for Hydro-optics and Remote Sensing, San Diego State University.

2.12. Personnel

Most of measurements during the cruise were performed by three members of the staff of SIO/RAS:

- Anatoly Grigoriev – engineer – during the whole of the cruise;
- Andrey Demidov – scientist, Ph.D. (biology) – during the whole of the cruise;
- Alexander Khrapko – engineer – from 2 Oct to 14 Dec 2001 and from 14 Mar to 2 May 2002.

Dr. Ajit Subramaniam from University of Maryland together with his assistant worked onboard from 22 Dec 2001 to 8 Jan 2002, and Dr. Robert Frouin from SIO/UCSD from 7 to 14 Mar 2002.

This report was prepared by Dr. Oleg Kopelevich, Dr. Vladimir Burenkov, Svetlana Ershova, Sergey Sheberstov, and Dr. Andrey Demidov (all from SIORAS).

3. CRUISE TRACK

A summary of the major scheduling milestones for Ioffe_10 is given in Table 2. The cruise tracks from Kiel to Ushuaia (SDY 277-320, 2001) and from Ushuaia to Kiel (SDY 67-119, 2002) are shown in Fig 2, 3. The ship's location during the Antarctic cruises (SDY 321-365, 2001 and 1-66, 2002) are given in Table 3.

Duration of the cruise was 212 days; 71 days of them were stays in ports and near Antarctic islands. Totally 337 stations were made.

Table 2. Major scheduling milestones for Ioffe_10.

Date	SDY	Activity
27 Sep – 1 Oct 01	270-274	Loading and installation of Russian equipment onboard
2 Oct 01	275	Leaving Kaliningrad for Bremerhaven
4-5 Oct 01	277-278	Loading and installation of the equipment brought by R.Frouin and M.Reynolds in Kiel and Bremerhaven
6 Oct 01	279	Leaving Bremerhaven for Recifi
17-30 Oct 01	290-303	Polygon with geological studies centered by 7.5^{o}N, 34.0^o W
3 Nov 01	307	Dock at Recifi
4 Nov 01	308	Sail for Ushuaia
16 Nov 01	320	Dock at Ushuaia
18 Nov – 5 Dec	322-339	Ushuaia-Falkland Islands-South Georgia-Peninsula-Ushuaia
6-14 Dec 01	340-348	Ushuaia – Peninsula - Ushuaia
15-22 Dec 01	349-356	Ushuaia – Peninsula - Ushuaia
23-30 Dec 01	357-374	Ushuaia – Peninsula - Ushuaia
31 Dec 01-8 Jan 02	365-008	Ushuaia – Peninsula - Ushuaia
9-17 Jan 02	009-017	Ushuaia – Peninsula - Ushuaia
18-28 Jan 02	017-028	Ushuaia – Peninsula - Ushuaia
29 Jan – 15 Feb 02	029-046	Ushuaia-Falkland Islands-South Georgia-Peninsula-Ushuaia
16-25 Feb 02	047-056	Ushuaia – Peninsula - Ushuaia
26 Feb-07 Mar 02	057-066	Ushuaia – Peninsula - Ushuaia
08 Mar 02	067	Sail for Montevideo
13 Mar 02	072	Dock at Montevideo
15 Mar 02	074	Sail for Kiel
25-28 Mar 02	84-87	Polygon with geological studies centered by 20.5^{o}S, 11.5^{o}W
5-11 Apr 02	95-101	Polygon with geological studies centered by 07.0^{o}N, 33.0^{o}W
29 Apr 02	119	Dock at Kiel
30 Apr 02	120	Sail for Kaliningrad
2 May 02	122	Dock at Kaliningrad

Table 3. The daily ship's locations at 12:00 GMT during the *Ioffe* Antarctic cruises 2001/02

Date	Location	Date	Location	Date	Location
17 Nov 01	Ushuaia	27 Dec 01	Peninsula	05 Feb 02	South Georgia
18	53.94 S, 63.95 W	28	62.07 S, 64.34 W	06	55.80 S, 38.41 W
19	Falkland Islands	29	57.22 S, 66.80 W	07	57.94 S, 44.32 W
20.	Falkland Islands	30	Ushuaia	08	60.04 S, 50.00 W
21	52.17 S, 53.23 W	31 Dec 01	56.99 S, 64.66 W	09	South Shetlands
22	53.11 S, 44.88 W	01 Jan 02	61.98 S, 59.64 W	10	Peninsula
23	South Georgia	02	Peninsula	11	Peninsula
24.	South Georgia	03	Peninsula	12	Peninsula
25.	South Georgia	04	Peninsula	13	61.70 S, 64.56 W
26.	South Georgia	05	South Shetlands	14	56.80 S, 66.99 W
27	56.99 S, 39.92 W	06	62.42 S, 65.68 W	15	Ushuaia
28	South Orkney Islands	07	57.18 S, 67.07 W	16	54.81 S, 68.30 W
29	63.14 S, 53.63 W	08	Ushuaia	17	60.77 S, 68.01 W
30	South Shetlands	09	56.64 S, 64.50 W	18	Peninsula
01.Dec 01	Peninsula	10	61.10 S, 58.49 W	19	Peninsula
02.	Peninsula	11	Peninsula	20	Peninsula
03.	62.06 S, 64.37 W	12	Peninsula	21	Peninsula
04	58.22 S, 66.35 W	13	Peninsula	22	South Shetlands
05	Ushuaia	14	Peninsula	23	60.59 S, 63.80 W
06	56.80 S, 65.79 W	15	61.83 S, 64.48 W	24	56.38 S, 67.14 W
07	61.99 S, 63.98 W	16	56.94 S, 66.91 W	25	Ushuaia
08	Peninsula	17	Ushuaia	26	54.69 S, 68.29 W
09	Peninsula	18	57.00 S, 66.47 W	27	56.44 S, 65.02 W
10	Peninsula	19	61.01 S, 66.32 W	28	Peninsula
11	South Shetlands	20	Peninsula	01 Mar 02	Peninsula
12	60.49 S, 61.76 W	21	Peninsula	02	Peninsula
13	56.68 S, 66.57 W	22	Peninsula	03	Peninsula
14	Ushuaia	23	Peninsula	04	South Shetlands
15	56.38 S, 64.72 W	24	Peninsula	05	61.91 S, 64.42 W
16	60.54 S, 58.46 W	25	South Shetlands	06	56.92 S, 67.00 W
17	Peninsula	26	61.05 S, 63.42 W	07 Mar 02	Ushuaia
18	Peninsula	27	56.63 S, 66.89 W		
19	South Shetlands	28	Ushuaia		
20	60.01 S, 62.38 W	29	54.16 S, 64.22 W		
21	56.62 S, 66.70 W	30	Falkland Islands		
22	Ushuaia	31 Jan 02	Falkland Islands		
23	56.50 S, 64.67 W	01 Feb 02	52.20 S, 53.00 W		
24	61.58 S, 60.51 W	02	53.12 S, 44.85 W		
25	South Shetlands	03	South Georgia		
26 Dec 01	Peninsula	04 Feb 02	South Georgia		

4. COMPARISON BETWEEN DATA MEASURED BY DIFFERENT MEANS

The measurements of the same characteristics by different means provided possibilities to check the data obtained in *Ioffe_10* and to estimate their uncertainties. It concerns chlorophyll-a, a_{pg} absorption, water-leaving radiance, aerosol optical thickness. Results of the analysis for some of the above characteristics are given below.

4.1. Determination of chlorophyll-a concentration

Chlorophyll-a concentration was measured in the cruise by three techniques: HPLC, fluorometric and spectrophotometric methods. As it was mentioned in Section 2, the spectrophotometric measurements were performed just onboard, the HPLC and fluorometric analyses were made at CHORS/SDSU after the cruise. As for now, the data of HPLS and fluorometric determination obtained from CHORS cover the period from the beginning of the cruise to Montevideo – 197 stations. Fig. 4 and 5 show results of comparison between data measured by three different techniques.

The statistical evaluation of the HPLC and fluorometric data (N=173) based on log-transformed data (natural logarithm) shows very good agreement between them (Fig.4): regression slope = 0.981; regression intercept = -0.0195; coefficient of determination (R^2) = 0.985; root-mean-square error (RMS) = 0.140. As seen from Fig.4, there is no systematic discrepancy between the HPLC and fluorometric data: average ln(Chl-HPLC) = -1.276 and average ln(Chl-Fluo) = -1.271.

Agreement between the spectrophotometric and HPLC data is much worse: regression slope = 1.090; regression intercept = -0.247; coefficient of determination (R^2) = 0.956; root-mean-square error (RMS) = 0.266. The average ln(Chl-Spectro) is -1.637, in comparison with the average ln(Chl-HPLC) = -1.276. It can be seen from Fig.5 that underestimation of chlorophyll concentration by the spectrophotometric method is higher for oligotrophic and mesotrophic waters (Chl-a < 0.5 $mg \cdot m^{-3}$). The reasons of that will be analyzed later.

Chlorophyll concentrations retrieved from the water-leaving radiance data measured by SIMBAD and SeaWiFS are compared with the data of direct determination in Section 5. Unfortunately, as it was mentioned before, Chl-HPLC data are only available to Montevideo, so Chl-Spectro data are used for the Atlantic transect in March-April 2002. As seen from Fig.5, those data display correctly relative changes of chlorophyll concentration but their absolute values can be underestimated as much as two times in oligotrophic waters.

4.2. Comparison between the data on particle and soluble absorption measured by Cary 50 spectrophotometer and SIORAS laboratory absorption meter

Two instruments were used to measure the spectral absorption coefficients of particulate and dissolved matter: Cary 50 spectrophotometer and SIORAS laboratory absorption meter. Verification of the spectral and quantitative accuracy of the absorption coefficients measured was carried out for the both instruments.

Cary 50 spectrophotometer. It is a dual beam with reference correction instrument running in the single beam mode. The blank and sample filters (for a_p-a_d measurement) or 0.1 m cuvettes (for a_g measurement) were run by turns in accordance with Mitchell et al. (2000). The particle (ap or ad) and soluble (a_g) absorption coefficients are calculated by formulae

$$a_p(\lambda) = 2.303A/\beta V \cdot [OD_f(\lambda) - OD_{bf}(\lambda)], \quad (2)$$

$$a_g(\lambda) = 2.303/l \cdot [OD_s(\lambda) - OD_{bs}(\lambda)], \quad (3)$$

where $\cdot OD_f(\lambda)$, $OD_{bf}(\lambda)$ and $OD_s(\lambda)$, $OD_{bs}(\lambda)$ are, respectively, the optical densities of the sample and the blank filters and the sample and the blank cuvettes, A is the clearance area of the filter, V is the volume of water filtered, β is the pathlength amplification parameter, l is the cuvette pathlength.

Assuming that the errors (s_{ODf}, s_{ODbf}, s_{ODs}, and s_{ODbs}) in measuring $OD_f(\lambda)$, $OD_{bf}(\lambda)$, $OD_s(\lambda)$, and $OD_{bs}(\lambda)$ are random, independent and equal in pairs ($s_{ODf} = s_{ODbf} = s_f$) and ($s_{ODs} = s_{ODbs} = s_s$), the random errors (s_{ap}, s_{ad} and s_{ag}) of determining the a_p -a_d and a_g absorption coefficients are calculated by formulae

$$s_{ap} = 2.303A/\beta V \cdot s_f \cdot \sqrt{2}, \quad (4)$$

$$s_{ag} = 2.303/l \cdot s_s \cdot \sqrt{2}. \quad (5)$$

The A value was equal to 5.29 10^{-4} m^2, V was changed from 1.08 in eutrophic waters to 5.46 10^{-3} m^3 in oligotrophic, β was taken as 2 in accordance with Roesler (1998), l was equal to 0.1 m. The values of s_f and s_s were estimated as the standard deviations from numerous data of the blank measurements in the long wavelength range during the cruise. The value of s_f is equal to 0.016, $s_s \sim 10^{-3}$. ` It is seen from (4) that the standard error for a_p and a_d depends on the volume V: the greater is V, the longer is pathlength of the measured water sample; it is about 2 m with V=1.08 l (eutrophic waters) and more 10 m with V=5.46 l (oligotrophic waters). The errors are equal, respectively, to 0.013 m^{-1} and 0.0025 m^{-1} .

The value of s_s , according to our estimate, was ~10^{-3}, that is about 16 times less than s_f . But the pathlength of the measured water sample (which is equal to the cuvette pathlength in the case of measurement of soluble absorption) was only 0.1 m, and the standard error s_{ag} = ~ 0.03 m^{-1}.

SIORAS laboratory absorption meter. This instrument has been in operation since 1971 (Kopelevich et al. 1974) and provided several hundreds of the absorption spectra measured in the Atlantic, Pacific and Indian Oceans (Kopelevich 1983). The advantage of this device over a commercial instrument like Cary is application of the integrating sphere collecting overall scattered light; so such a device can measure both filtrated and seawater samples with no correction for scattering. Before the cruise, the repair and modernization of the instrument had been carried out. Unfortunately, some defects could not be detected on shore, such as the influence of ship rolling, pitching and vibration; they were found and eliminated (not completely) during the cruise. For this reason the accuracy ~0.002 m^{-1} indicated in paragraph 2.9 was not realized in the cruise.

The procedure for measurement and treatment of data measured by SIORAS absorption meter is very similar to one for measurement of soluble absorption with Cary 50 spectrophotometer, and the standard error s_{apg} can be calculated by using (5). The cuvette pathlength is equal to 0.145 m, the error s_w was estimated from the measured data as $2 \cdot 10^{-3}$. Finally, the error s_{apg} is equal to ~0.02 m^{-1}.

Examples of the comparison. They are shown in Fig.6. It is seen that discrepancies between the measured data from SIORAS meter and Cary 50 spectrophotometer are mostly within the errors indicated above.

Consistency of data on the phytoplankton absorption coefficient and chlorophyll concentration. The phytoplankton absorption coefficients are calculated as a difference between the particulate and detritus absorption coefficients:

$$a_{ph} = a_p - a_d. \quad (6)$$

Fig.7a, b show scatterplots of the phytoplankton absorption coefficient at 440 and 676 nm measured by Cary 50 versus Chl-HPLC. It is seen that the correlation between absorption and chlorophyll concentration is rather strong: R^2 is equal to 0.767 at 440 nm and 0.847 at 676 nm (N=173).

The regression equations are

$$\mathrm{Ln}[a_{ph}(440)] = 0.574 \ln[\mathrm{Chl\text{-}HPLC}] - 3.132, \quad (7)$$

$$\mathrm{Ln}[a_{ph}(676)] = 0.832 \ln[\mathrm{Chl\text{-}HPLC}] - 3.830 \quad (8)$$

It is interesting to compare the above equations with the analogous equations from Bricaud et al. (1995)

$$Ln[a_{ph}(440)] = 0.668 \ln[Chl\text{-}HPLC] - 3.211, \quad (9)$$

$$Ln[a_{ph}(676)] = 0.841 \ln[Chl\text{-}HPLC] - 3.912. \quad (10)$$

A good agreement between (8) and (10) can be considered as evidence of no systematic error in our measurements. A discrepancy between (7) and (9) can be explained by variations of pigment composition. It is more important for the absorption at 440 nm than at 676 nm: the latter is caused by chlorophyll-a only whereas the former is also by other pigments.

4.3. Comparison between data on water-leaving radiance obtained from different measurements.

Field measurements of water-leaving radiance were carried out by SIMBAD radiometer and SIORAS deck spectroradiometer. The deck spectroradiometer was in operation from beginning of the expedition to 11/09/2001, when it was broken by waves during a strong storm. The main problem of measurements with that instrument is influence of sun glints and reflection of direct sun from the ship board (Artemiev et al. 2000). To solve the problem, the deflection mirror was used for measurements of upwelling radiance to provide the viewing angle about 20^o. But the quality check of the obtained data showed that the turn through 20^o is not sufficient to exclude the influence of the above mentioned factors. The weather during the cruise was mostly far from perfect (rough sea, broken cloudiness) and the data were reliable only for several stations.

Field data from SIMBAD and the deck spectroradiometer were also compared with the values of spectral radiance reflectance $\rho(\lambda)$ derived from SeaWiFS data (the spectral radiance reflectance $\rho(\lambda)=\pi\ r_{rs}$ where r_{rs} is the value of remote sensing reflectance just beneath the sea surface). SeaWiFS Lwn data were received from GSFC DAAC (LAC and GAC) and transformed to the values of ρ using formulae by Gordon et al. (1988) and Lee et al. (1998). The results of comparison between different data on spectral radiance reflectance are presented in Fig.8-10. There are different cases seen there. At St.87 (Fig.8) a reasonable agreement between data from different instruments can be seen. At St.86 (Fig.8) the data from SIMBAD and deck spectroradiometer are in good agreement but differ from the SeaWiFS data. This difference can be explained by cloudy conditions. The most part of the field measurements were carried out in the presence of clouds, which could lead to overestimation of water-leaving radiance if clouds were in the neighbourhood. Due to this reason the SeaWiFS normalized water-leaving radiances could also be essentially greater than the field ones. This is well seen in many SeaWiFS imageries where overestimated values of normalized water-leaving radiances and chlorophyll concentrations are observed in the nearest pixels around cloudy areas. So the appropriate selection of SeaWiFS data is needed. In Fig.9 the deck spectroradiometer data are greater than data from SIMBAD and SeaWiFS. This can be explained by influence of reflection of the incident light from the ship board. In Fig.9 the SeaWiFS data differ from SIMBAD data for the spectral band 443 nm. It is seen that SeaWiFS spectral reflectance decreases to the wavelength 412 nm in contrast to SIMBAD and the deck spectroradiometer data. This can be explained by errors in SeaWiFS atmospheric correction. Such underestimation of upwelling radiance in the SeaWiFS data for the spectral band 412 usually takes place in cases of large solar zenith angles (for the St.8 value of solar zenith angle was 53^o).

The scatterplots of SeaWiFS and SIMBAD data at three spectral channels are presented in Fig.10. SeaWiFS data on L_{wn} were averaged over 9 nearest pixels around the station point. Unfortunately, in most cases a part of that pixels were contaminated by clouds. If a number of "clear" pixels was less than four, the SeaWiFS data were not used in further analysis. Such a rejection procedure led to essentially better agreement between field and satellite data (especially for the spectral band 555 nm). It is seen that a reasonable agreement between SeaWiFS and SIMBAD data takes place for all spectral bands. Our estimates with Student's t test show that the discrepancies between the SeaWiFS and SIMBAD means at 443 and 490 nm as well as the deviations of the regression slopes from 1 are not statistically significant. It is not true for the regression slope in the case of SeaWiFS channel 555 nm and SIMBAD 560 nm, and more detailed analysis is needed.

5. Spatial distribution and seasonal change of bio-optical characteristics according to SeaWiFS and *in situ* data

5.1. Chlorophyll

Atlantic transects. The mean monthly chlorophyll concentrations for October-November 2001 and March-April 2002 derived from SeaWiFS data are shown in Figures 11 and 12. Point out that on 1 November 2001 the ship was near the equator and on 1 April 2002 at 7-8^o S. A general resemblance between the spatial distributions is observed with some distinctions in the details. As seen, both *Ioffe* passages crossed the waters with diverse productivity. Seven bio-optical provinces were selected based on the SeaWiFS data.

NTE – North Temperate Eutrophic waters with chlorophyll concentration more than 0.5 mg·m^{-3}. Its southern border was well-defined in October and April near 45^o and 35-40^o N, respectively. .

NTM – North Temperate Mesotrophic waters with chlorophyll concentration 0.15-0.5 mg·m^{-3}. Its southern border was near 40^o N in October and 30^o N in April.

NSO – North Subtropical Oligotrophic waters with chlorophyll concentration less than 0.15mg·m^{-3}. Its southern border was 12-15^o N in October and April.

EM – Equatorial Mesotrophic waters with chlorophyll concentration 0.15-0.5 mg·m^{-3}. These waters occupied a broad area in the eastern equatorial part and a rather narrow strip in the western part.
SSO – South Subtropical Oligotrophic waters with chlorophyll concentration less than 0.15mg·m^{-3}. Its southern border was about 35^o S in November and April.
STM – South Temperate Mesotrophic waters with chlorophyll concentration 0.15-0.5 mg·m^{-3}. These waters occupied a narrow strip in November and more broad area in April.
STE – South Temperate Eutrophic waters with chlorophyll concentration more than 0.5 mg·m^{-3}. As it is seen in Fig.11, 12, the most productive waters were off the coast of the South America.
The position of the above mentioned borders is changeable: for example, it is seen in Fig.11 that the border between NTM and NSO waters shifted south from ~40^o N in October to ~35^o N in November. Also the border between SSO and STM waters shifted south from ~30^o S in October to ~35^o S in November. The shift in opposite direction (north) can be seen in Fig. 12 between March and April.
Fig.13 a, b shows changes of Chl-HPLC and Chl retrieved from SIMBAD and SeaWiFS data by the OC 4 algorithm (Chl-SIMBAD and Chl-SeaWiFS) on the Atlantic transect in October-November 2001. A good qualitative agreement between all curves is seen. A quantitative comparison between the data is presented by the scatterplots in Fig. 14 a, b. The statistical evaluation of the HPLC and SIMBAD data (N=34) based on log-transformed data (natural logarithm) gave the following results: regression slope = 0.816; regression intercept = -0.568; coefficient of determination (R^2) = 0.949; root-mean-square error (RMS) = 0.254. The statistical results for the regression Chl-SeaWiFS versus Chl-HPLC: regression slope = 0.759; regression intercept = -0.201; coefficient of determination (R^2) = 0.916; root-mean-square error (RMS) = 0.330. As seen, the values of root-mean-square error are rather high and the scatter of points is prominent in Fig.14 a, b. The Student's t test shows that the discrepancies between the SeaWiFS and SIMBAD regression coefficients are not statistically significant. Obviously, the errors in chlorophyll concentrations retrieved from SIMBAD and SeaWiFS depends on the quality of Lwn data which was not high (see 4.3).
The changes of Chl-spectrophotometric and Chl retrieved from SIMBAD and SeaWiFS data on the Atlantic transect in March-April 2002 are shown in Fig.15 (as it was mentioned before, HPLC data for that transect were not available). A good qualitative agreement between the curves is also seen. In Fig.16 the scatterplot of Chl-SeaWiFS versus Chl-SIMBAD for all data of the both transects (N=63) is given. The results of statistical evaluation: regression slope = 0.901; regression intercept = 0.311; coefficient of determination (R^2) = 0.893; root-mean-square error (RMS) = 0.323. As seen,

the values of Chl-SeaWiFS are systematically higher than of Chl-SIMBAD; the reasons of that will be analyzed later.

Antarctic waters The mean monthly chlorophyll concentrations in Antarctic derived from SeaWiFS data in December 2001, January and February 2002 are presented in Fig.17. Some analysis of the distributions can be made although the essential part of the studied area is without data due to cloudiness. Three zones can be selected:

- eutrophic waters near the South America;
- mesotrophic-oligotrophic waters in the central part of Drake Passage;
- eutrophic waters east of Antarctic Peninsula.

The seasonal changes can be observed: the highest chlorophyll concentration was in December, the lowest in February. In particular, the mesotrophic waters (Chl-SeaWiFS = 0.15-0.5 $mg \cdot m^{-3}$) in the central part of Drake Passage in December became oligotrophic (Chl-SeaWiFS <0.15 $mg \cdot m^{-3}$) in January and February.

5.2. Particle backscattering and aerosol optical thickness.

The mean monthly distribution of the particle backscattering coefficient b_{bp} at 555 nm derived from SeaWiFS data in October-November 2001 and March-April 2002 are presented in Fig.18-21 (left images). The right images in these figures are the mean monthly distributions of the aerosol optical thickness $\tau_a(865)$ at 865 nm. The b_{bp} values were retrieved by the simplified algorithm described by Burenkov et al. (2001); the $\tau_a(865)$ values were calculated with SeaDAS 4.1. There are the areas with different values of b_{bp} and $\tau_a(865)$ observed in Fig.18-22. A general resemblance is seen between the b_{bp} distributions and chlorophyll distributions in Fig.11, 12. It causes no surprise because the b_{bp} values depend on particulate matter in seawater that can originate in phytoplankton as a primary source. Not only the biogenous particles form the particle backscattering in near-surface layer but also the terrigenous ones which are brought to the ocean by rivers and winds (Kopelevich 1983, 1984). A general resemblance can be seen between the b_{bp} and $\tau_a(865)$ distributions in the central Atlantic where the area of high values of $\tau_a(865)$ due to transport of Sahara dust through the atmosphere in that region is observed. It is difficult to select contributions in the b_{bp} values arising from the terrigenous and biogenous particles because both $\tau_a(865)$ and chlorophyll concentration are high in the considered area. It is also worth keeping in mind that chlorophyll concentration can be connected with high $\tau_a(865)$ values because the winds bring into the ocean the mineral elements which are nutrients needed to increase primary production. Another case is observed off the Argentine coast. There are low values of $\tau_a(865)$ (less that 0.1) and high values of b_{bp} (more than 0.006 m^{-1}) there. This area displayed high chlorophyll concentration, and it is evident that the primary source of particles there is phytoplankton.

Fig.22 a, b show the changes of the b_{bp} values retrieved from SeaWiFS and SIMBAD data by the simplified algorithm (Burenkov et al. 2001) on the Atlantic transects in October-November 2001 and March-April 2002. There is a reasonable agreement between b_{bp}-SeaWiFS and b_{bp}-SIMBAD seen on the both transects. In a qualitative sense the both Figures are consistent with what is in Fig.13 a, b. The quantitative comparison between b_{bp} -SeaWiFS and b_{bp} -SIMBAD is presented in Fig.23 a, b. The statistical results (based on log-transformed data) for the transect October-November 2001 (N=22): regression slope = 0.816; regression intercept = -0.817; coefficient of determination (R^2) = 0.714; root-mean-square error (RMS) = 0.419; for the transect March-April (N=31): regression slope = 0.758; regression intercept = -1.311; coefficient of determination (R^2) = 0.707; root-mean-square error (RMS) = 0.241. The Student's t test shows that the deviation of the regression slope from unity is not statistically significant for the transect October-November 2001 but the difference exists with the level of significance of 0.02 for the transect March-April. The discrepancies between the SeaWiFS and SIMBAD means are not statistically significant in both cases.

5.3. Particulate, dissolved and phytoplankton absorption

The changes of the measured values of the soluble and particulate absorption coefficients $a_g(350)$ and $a_p(350)$ at 350 nm on the Atlantic transects in October-November 2001 are shown in Fig.24 and on the Atlantic transect in March-April 2002 in Fig.25. The changes of the phytoplankton absorption $a_{ph}(440)$ and $a_{ph}(676)$ at 440 and 676 nm on those transects are shown in Fig.26-27.

A general resemblance can be seen between all dependencies as well as between them and changes of chlorophyll concentration (Fig.13, 15).

It is of a great interest to compare the spectral values of particulate, dissolved and phytoplankton absorption in the different bio-optical provinces selected on the base of SeaWiFS chlorophyll (see 5.1). Revealing the regional features in seawater spectral absorption and its components is of vital importance for development of regional bio-optical algorithms and better accuracy of retrieval of chlorophyll, yellow substance and the particle backscattering from satellite ocean color data.

The examples of the spectral absorption coefficients of particulate, phytoplankton, detritus, and soluble matter in each of seven selected provinces for two seasons are given in Fig.28-34. Such examples for the Antarctic waters are given in Fig.35-36. Table 4 presents the values of phytoplankton absorption coefficients at 676, 440 and 330 nm, detritus and soluble absorption coefficients at 300 nm for different bio-optical provinces. The detailed analysis of the measured spectra should be made later; one of the pronounced features is noted below. The case in point is very changeable UV absorption near 330 nm; it was discussed before for Antarctic phytoplankton by Vernet et al. (1994). It can be seen that the values of $a_{ph}(330)$ are changed about fifty times from ~0.005 m^{-1} in the North Subtropical Oligotrophic waters in fall to 0.25 m^{-1} in the South Temperate Eutrophic waters in spring. There are well-defined peaks in the equatorial waters and in the Southern Hemisphere; in the Northern hemisphere such peaks are observed only in spring in the North Temperate Eutrophic and North Subtropical Oligotrophic waters.

Table 4. The values of phytoplankton absorption coefficients at 676, 440 and 330 nm, detritus and soluble absorption coefficients at 300 nm for different bio-optical provinces.

Waters	Season	$a_{ph}(676)$, m^{-1}	$a_{ph}(440)$, m^{-1}	$a_{ph}(330)$, m^{-1}	$a_d(300)$, m^{-1}	$a_g(300)$, m^{-1}
NTE	Spring	~0.03	~0.055	~0.03	~0.04	~0.4
	Fall	~0.02	~0.055	~0.03	~0.02	~0.5
NTM	Spring	~0.015	~0.03	~0.04	~0.06	~0.5
	Fall	~0.005	~0.017	~0.013	0.018	~0.4
NSO	Spring	~0.003	0.013	~0.01	0.017	~0.3
	Fall	~0.004	0.011	~0.005	~0.01	~0.2
EM	Spring	0.015	0.025	0.037	0.02	0.2
	Fall	~0.01	0.023	0.017	0.015	0.2
SSO	Spring	0.002	0.009	0.013	0.005	0.15
	Fall	0.003	0.014	0.010	0.005	0.25
STM	Spring	0.015	~0.03	0.03	~0.02	~0.2
	Fall	0.012	0.027	0.023	~0.03	~0.4
STE	Spring	~0.1	~0.17	~0.25	0.15	~0.5
	Fall	~0.05	~0.09	~0.06	~0.03	~0.4
APE *	Summer	~0.025	~0.04	0.095	~0.05	~0.4
SAE **	Spring	~0.03	~0.045	0.065	~0.04	~0.3
Drake Passage	Spring	~0.01	0.022	0.037	~0.03	~0.3
	Summer	~0.002	~0.007	0.011	0.016	~0.15

* Eutrophic waters near Antarctic Peninsula;

** Eutrophic waters near South America.

The further joint analysis of the features of spectral absorption and phytoplankton pigment composition is very desirable.

6. CONCLUSION

The main results of the performed work can be summarized as follows

- The broad instrumental set was prepared and installed onboard R/V *Akademik Ioffe* to measure (without ship stopping) the characteristics required for validation of satellite ocean color algorithms.
- The measurements were carried out on two Atlantic transects from Kiel to Ushuoya in October-November 2001 and from Ushuoya to Kiel in March-April 2002 as well as during the tourist cruises of R/V *Akademik Ioffe* in the Antarctic region from November 2001 to March 2002. Totally 337 stations were made. The obtained field data have been processed and prepared to be submitted to SeaBASS.
- Some of the characteristics were measured in the cruise by different means; comparison between the data allowed to check the obtained results and estimate their uncertainties. Such comparison was performed between chlorophyll-a concentrations measured in the cruise by HPLC, fluorometric and spectrophotometric methods; between the particle and soluble absorption coefficients measured by Cary50 spectrophotometer and SIORAS laboratory absorption meter; between data on water-leaving radiance obtained by SIMBAD radiometer and SIORAS deck spectroradiometer.
- A comparison between the values of bio-optical characteristics based on *in situ* data and retrieved from SeaWiFS satellite data (water-leaving radiance, chlorophyll concentration, and the particle backscattering coefficient) was performed. The comparison has shown a quite reasonable agreement between the field data and the satellite-based values of the above mentioned characteristics.
- The both Atlantic transects crossed the water with diverse productivity, and seven bio-optical provinces were selected based on SeaWiFS data; also three zones with diverse productivity were selected in the Antarctic area of studies. The features and seasonal variability of their bio-optical characteristics were considered. In particular, the spectral values of particulate, dissolved and phytoplankton absorption coefficients in the different bio-optical provinces were compared; the features observed are of vital importance for development of regional bio-optical algorithms.
- The great data set obtained in the cruise provides a good opportunity for further analysis of various aspects of ocean color and preparing serious manuscripts.

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Fig. 1 R/V *Akademik Ioffe*

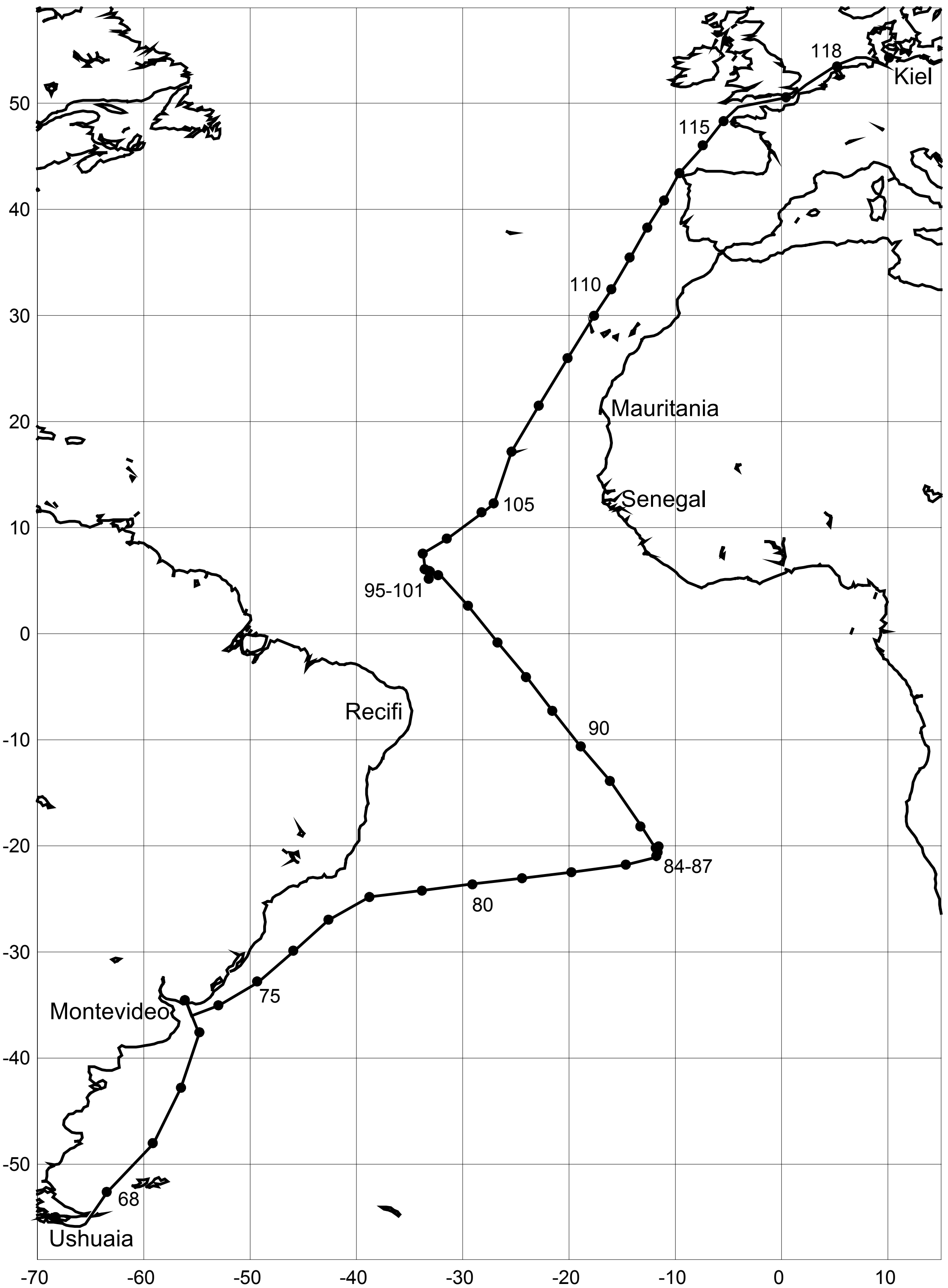


Fig.2 The Ioffe_10 cruise track for SDY 277-320, 2001. The solid circles denote the ship's position at 1200 GMT.

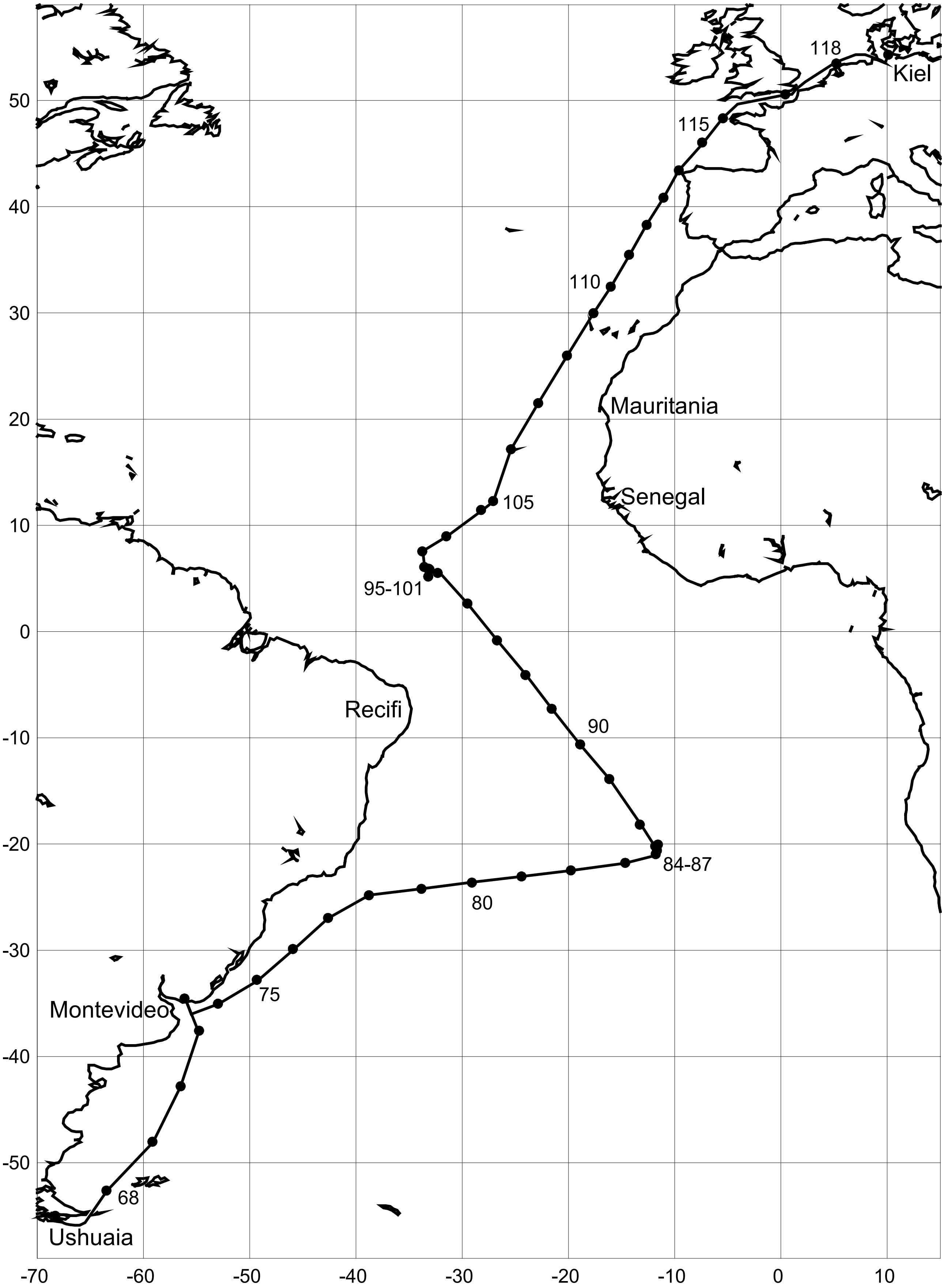


Fig.3 The Ioffe_10 cruise track for SDY 67-119, 2002. The solid circles denote the ship's position at 1200 GMT.

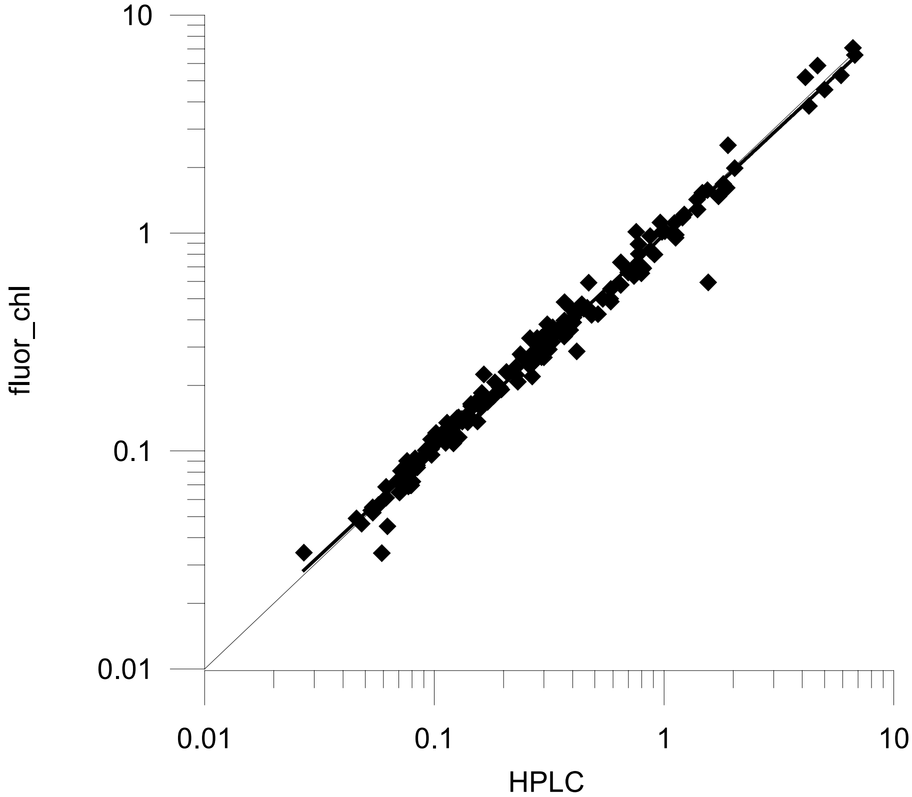


Fig.4. Scatterplot of Chl-Fluo versus Chl-HPLC (all data).

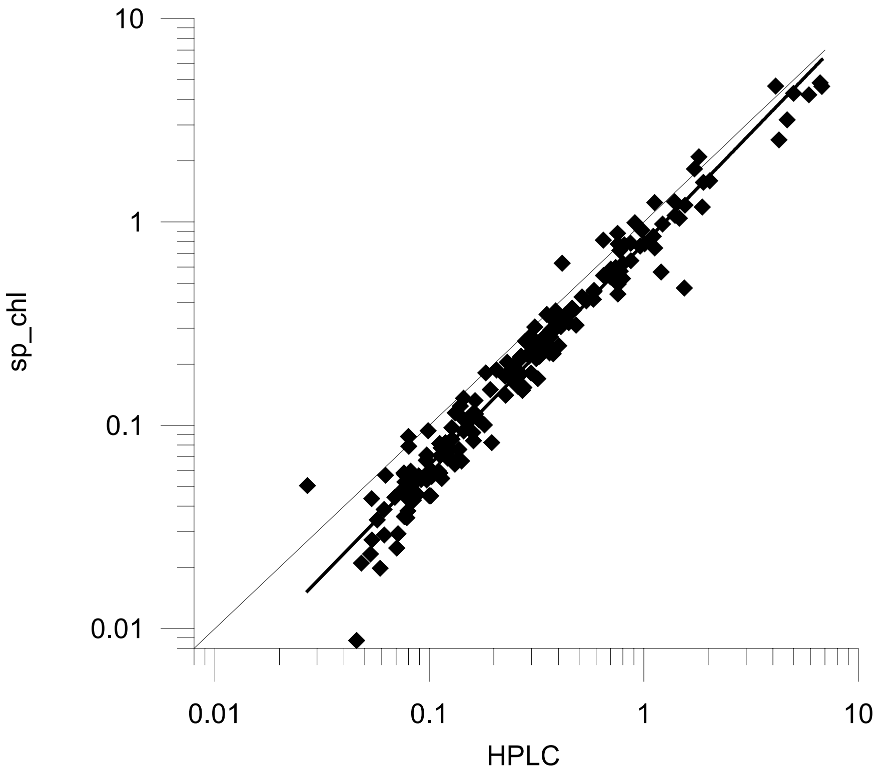
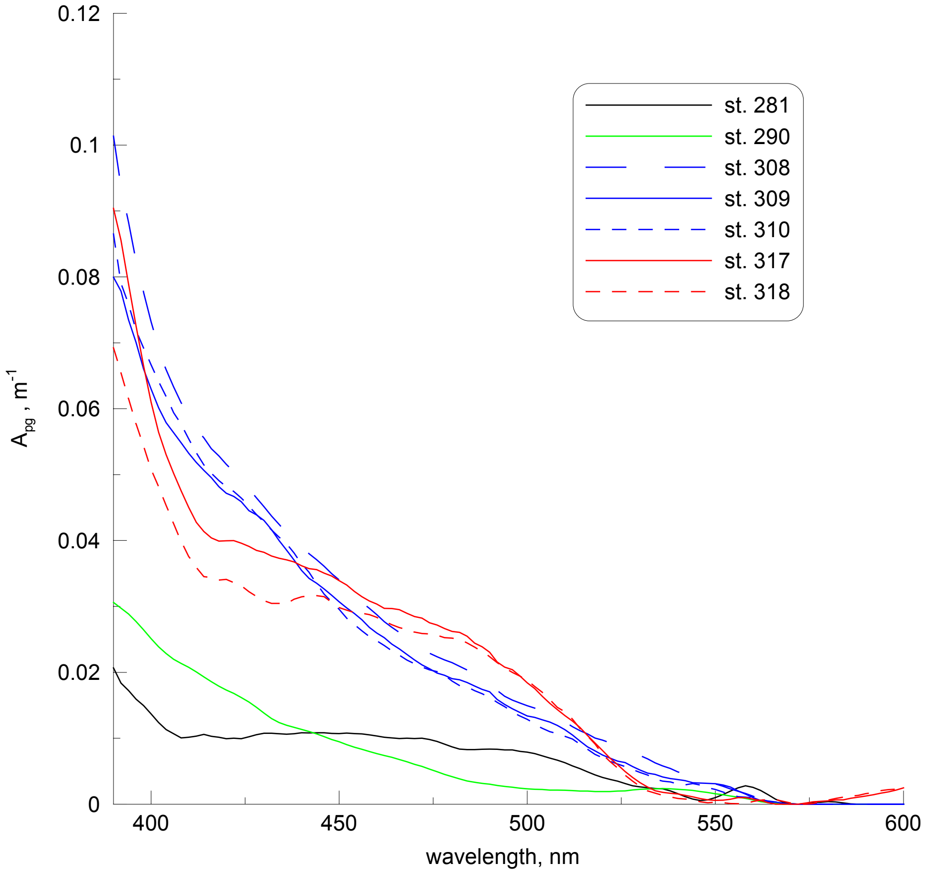
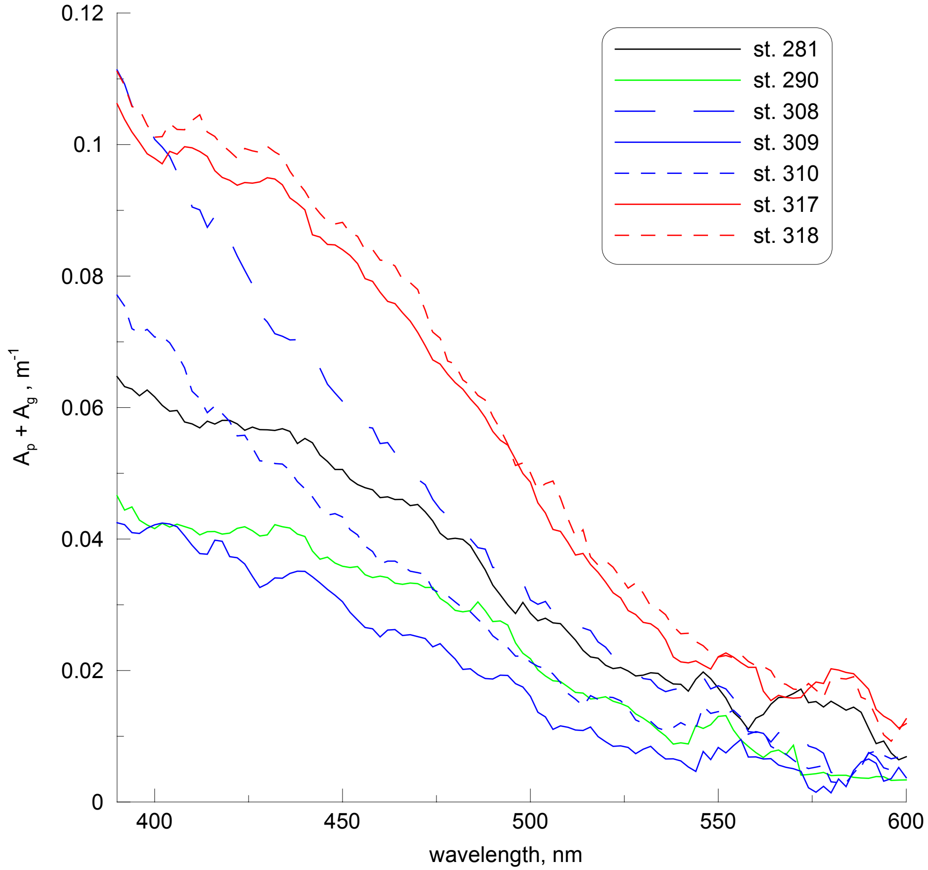


Fig.5. Scatterplot of Chl-Spectro versus Chl-HPLC (all data).



SIORAS laboratory absorption meter



Cary 50 spectrophotometer

Fig.6. Comparison between the absorption coefficients of particulate plus dissolved materials measured by SIORAS laboratory absorption meter (left) and calculated from Cary 50 data as a sum of ap+ag.

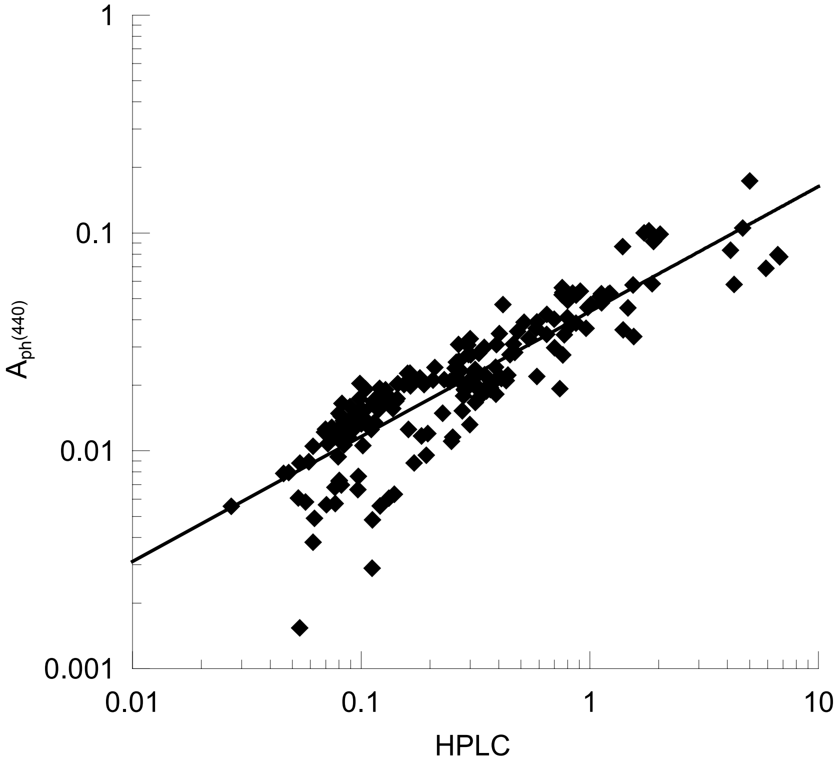


Fig.7a Scatterplot of the phytoplankton absorption coefficient aph(440) at 440 nm versus CHL-HPLC (all data).

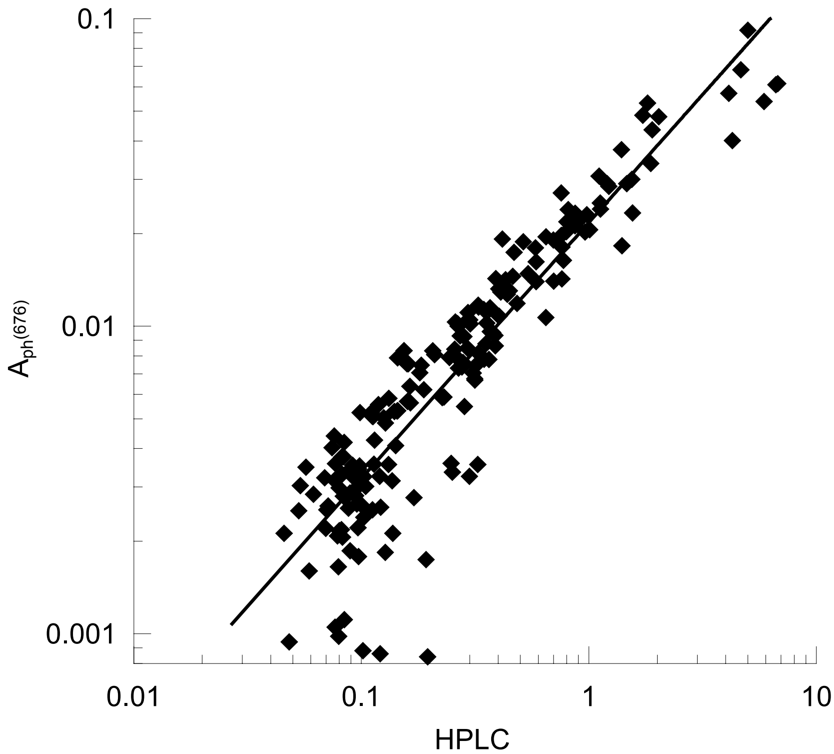


Fig.7b Scatterplot of the phytoplankton absorption coefficient aph(676) at 676 nm versus CHL-HPLC (all data).

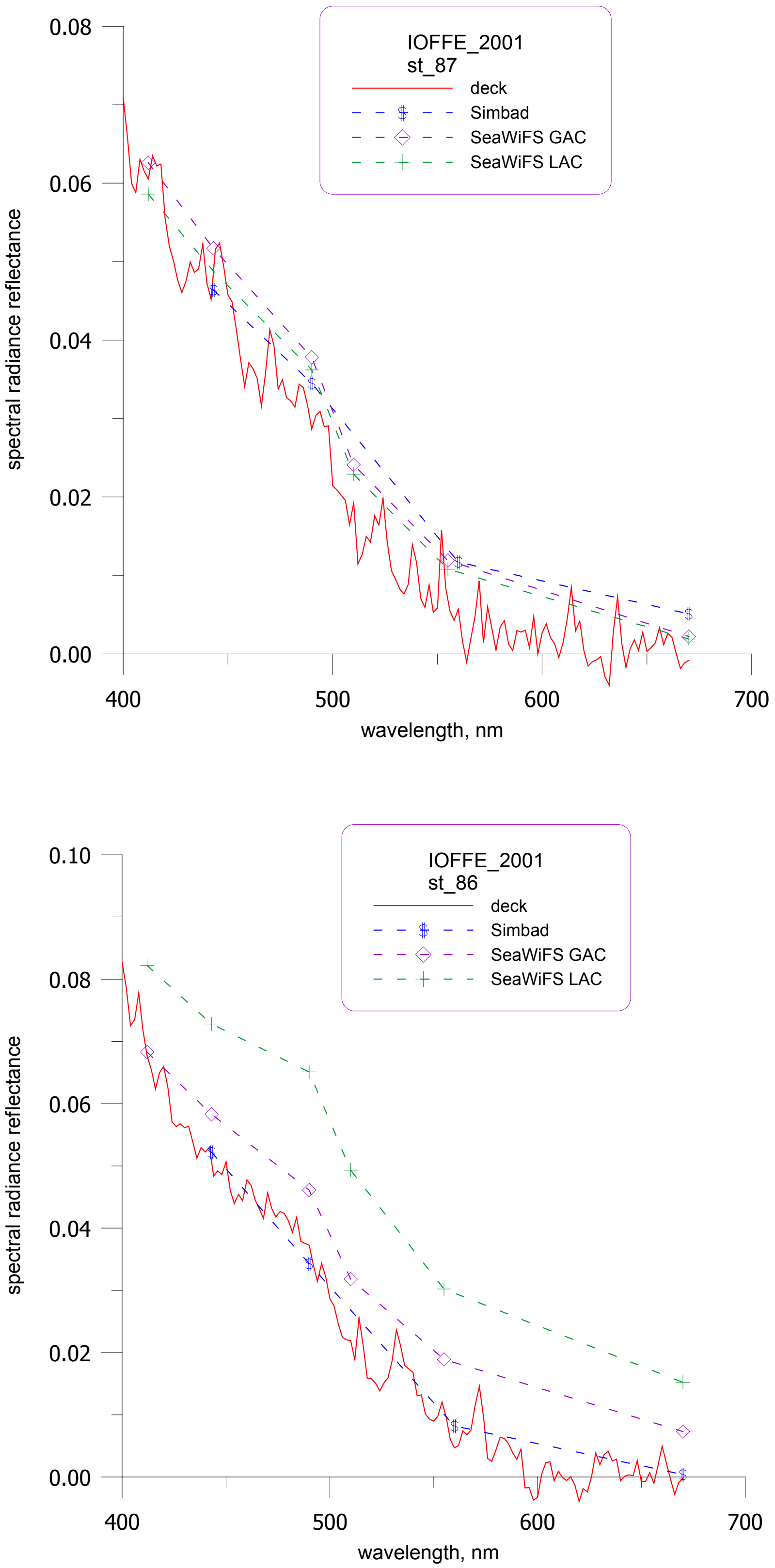


Fig.8. Comparison between the values of spectral radiance reflectance derived by different means at St.87 (upper) and 86 (lower).

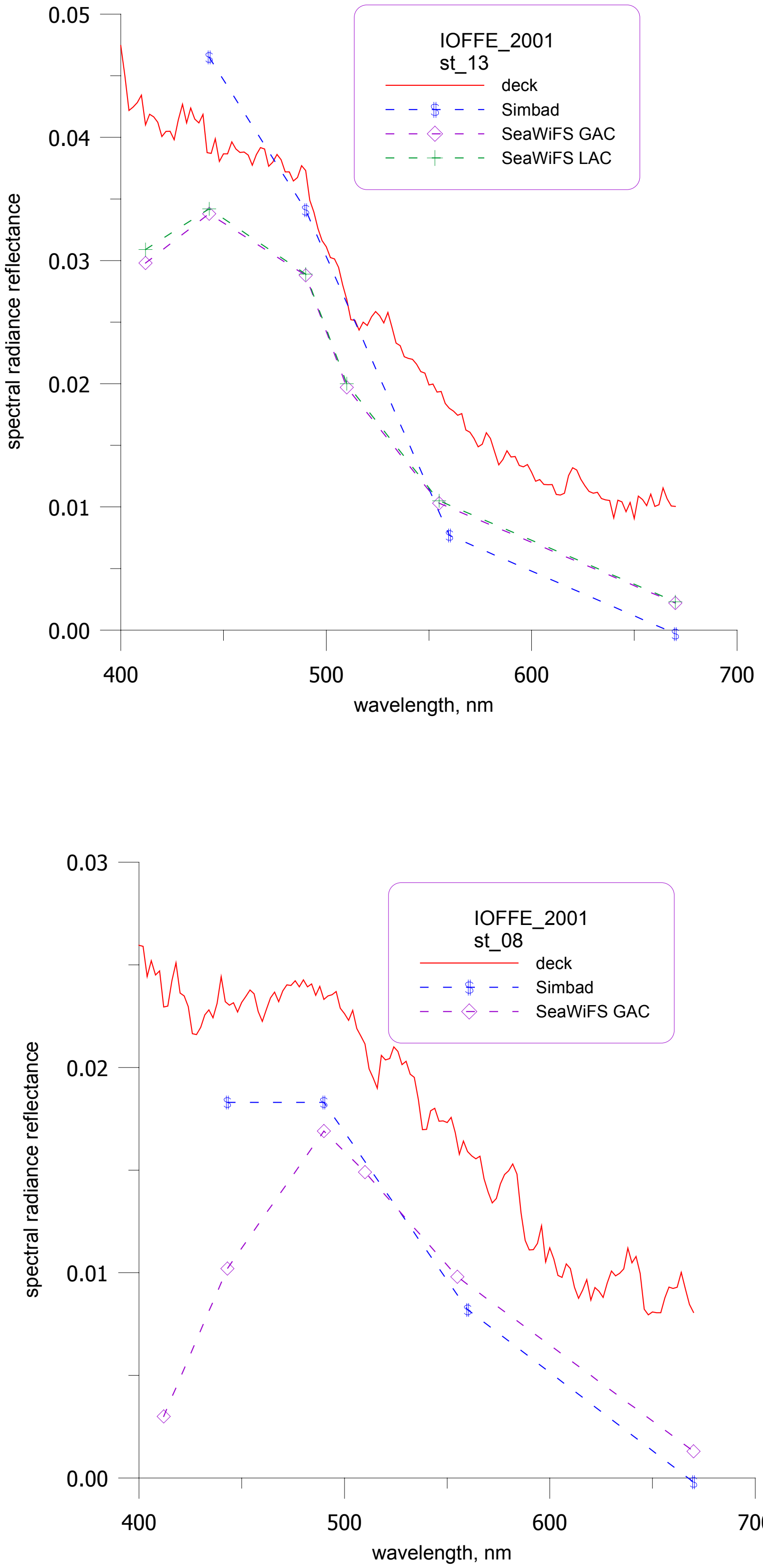
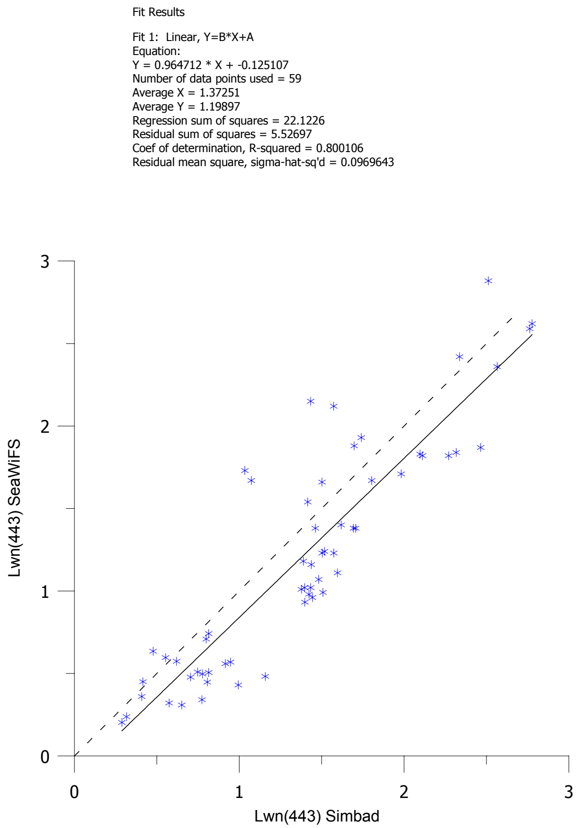
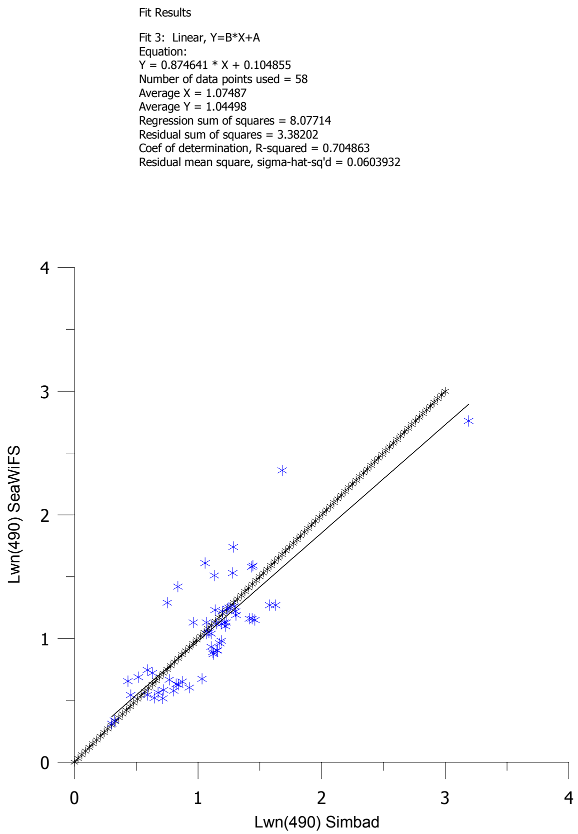


Fig.9 Comparison between the values of spectral radiance reflectance derived by different means at St.13 (upper) and 8 (lower).





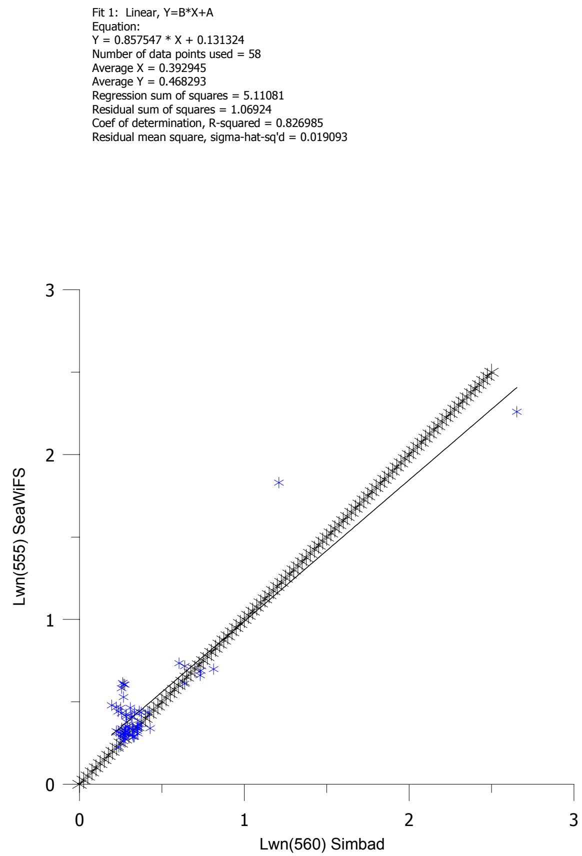


Fig.10. Scatterplots of the Lwn values derived from SeaWiFS and SIMBAD data at 443 nm (left), 490 (middle), and 555-560 nm (right).

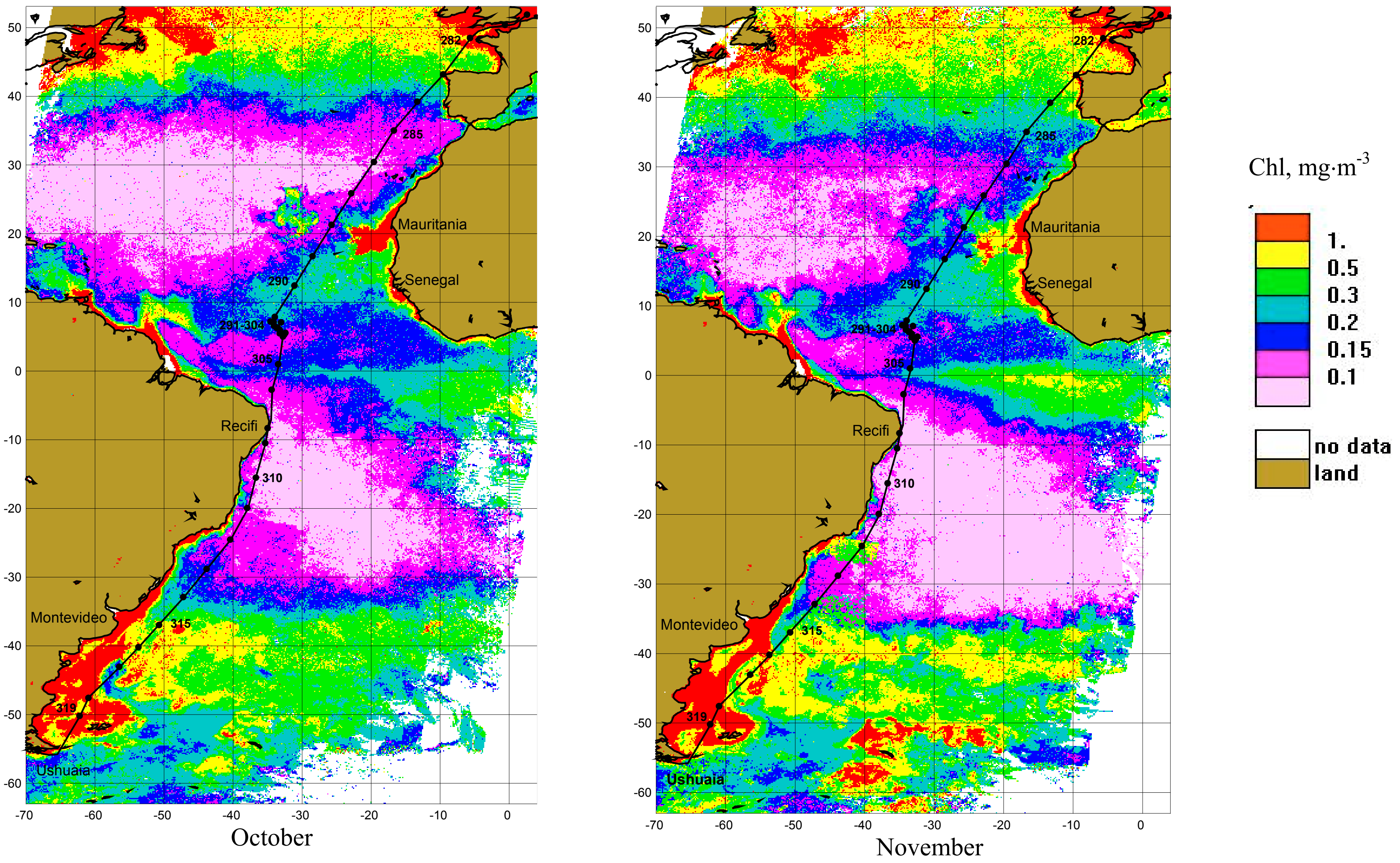
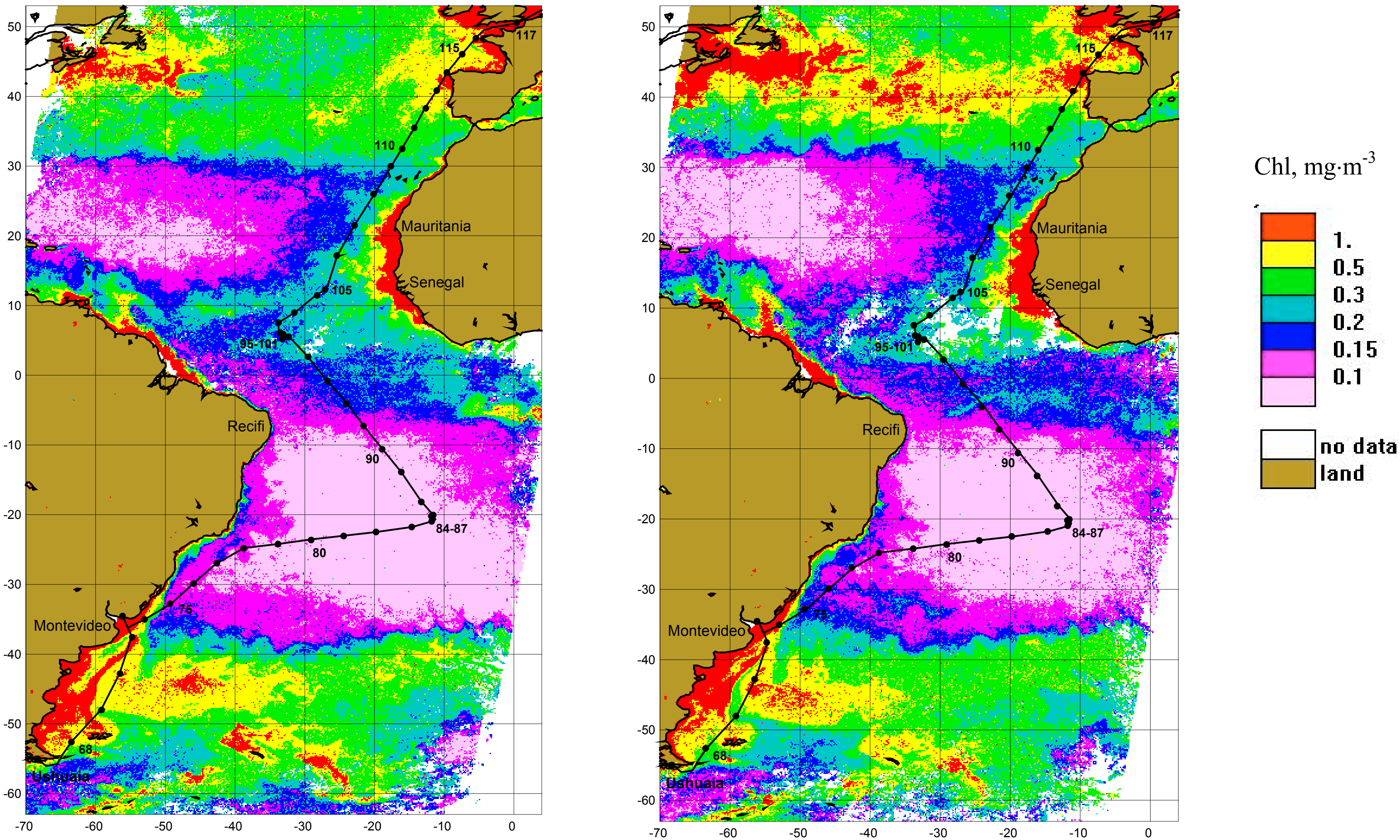


Fig. 11. SeaWiFS monthly composite of chlorophyll concentration for the Atlantic Ocean for October and November 2001



March

April

Fig.12. SeaWiFS monthly composite of chlorophyll concentration for the Atlantic Ocean for March and April 2002

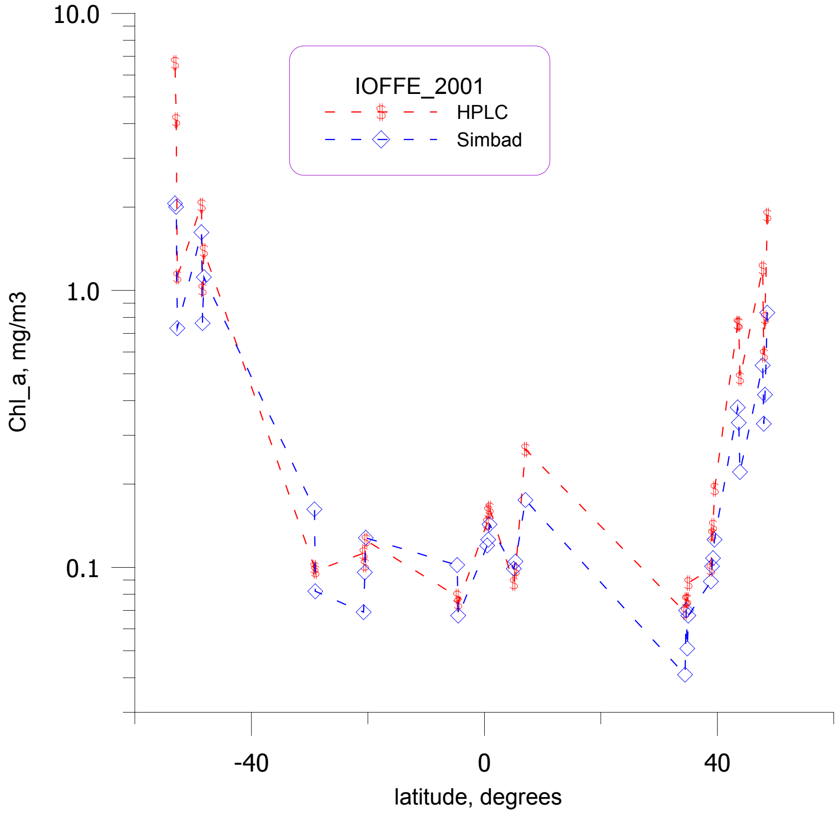


Fig.13 a. Changes of Chl-HPLC (red) and Chl retrieved from SIMBAD data (blue) on the Atlantic transect in October-November 2001.

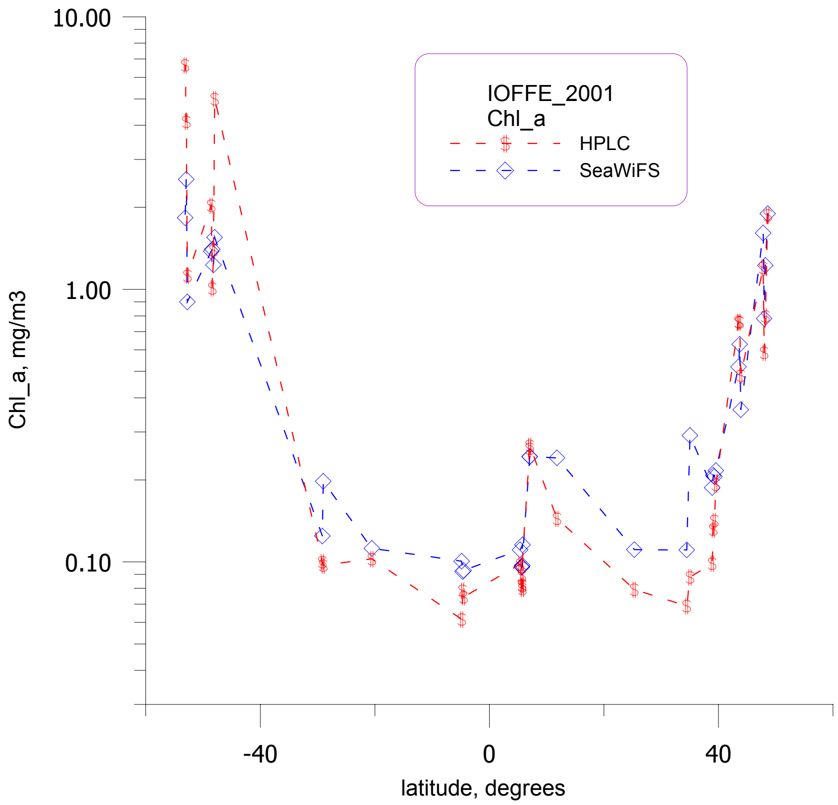


Fig.13 b. Changes of Chl-HPLC (red) and Chl retrieved from SeaWiFS (blue) on the Atlantic transect in October-November 2001.

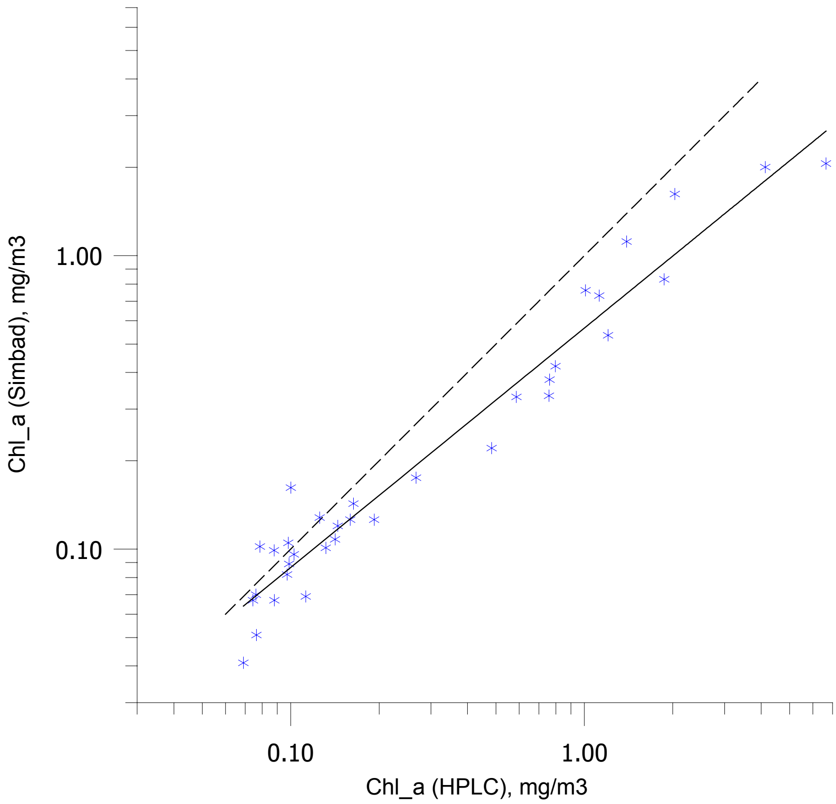


Fig.14 a Scatterplot of the Chl values retrieved from SIMBAD data versus Chl-HPLC on the Atlantic transect in October-November 2001. Dash line corresponds to the regression slope equal to 1, solid line is the statistical result.

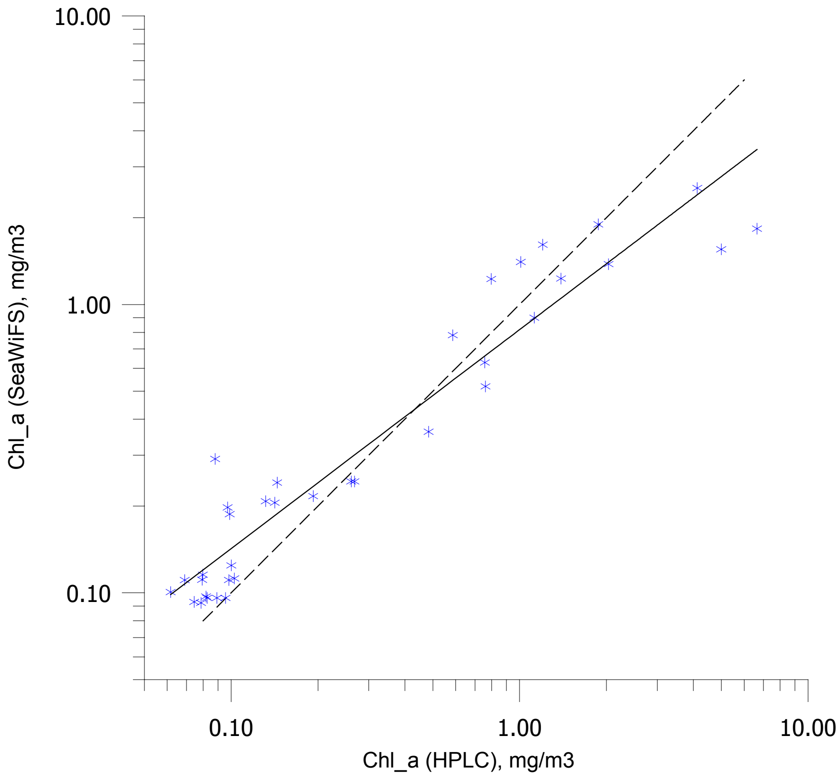


Fig.14 b Scatterplot of the Chl values retrieved from SeaWiFS data versus Chl-HPLC on the Atlantic transect in October-November 2001. Dash line corresponds to the regression slope equal to 1, solid line is the statistical result.

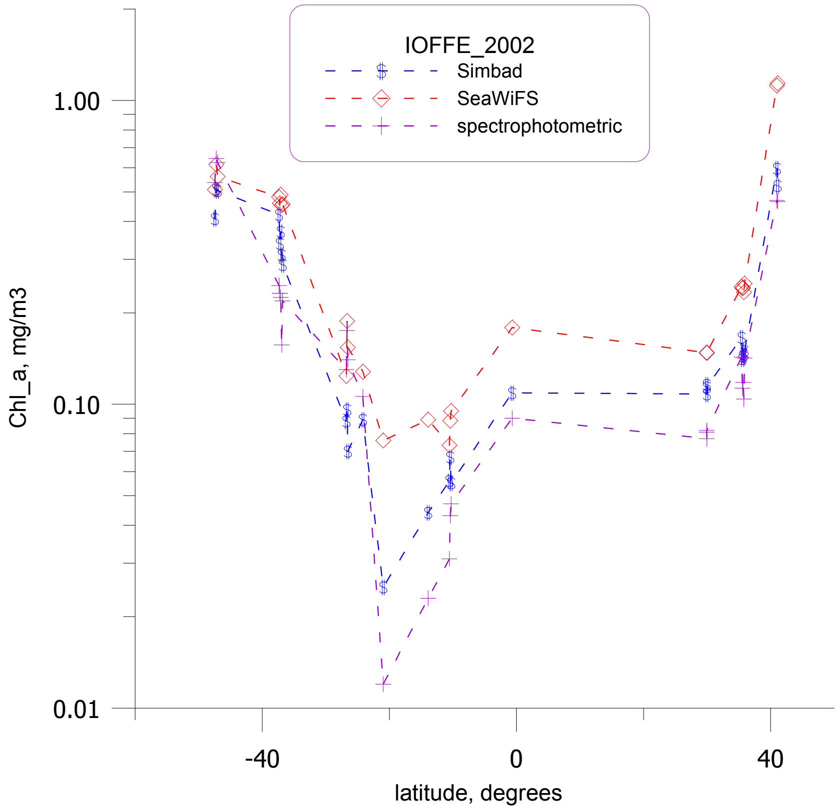


Fig.15 Changes of Chl-spectrophotometric (lilac) and Chl retrieved from SIMBAD (blue) and SeaWiFS (red) data on the Atlantic transect in March-April 2002

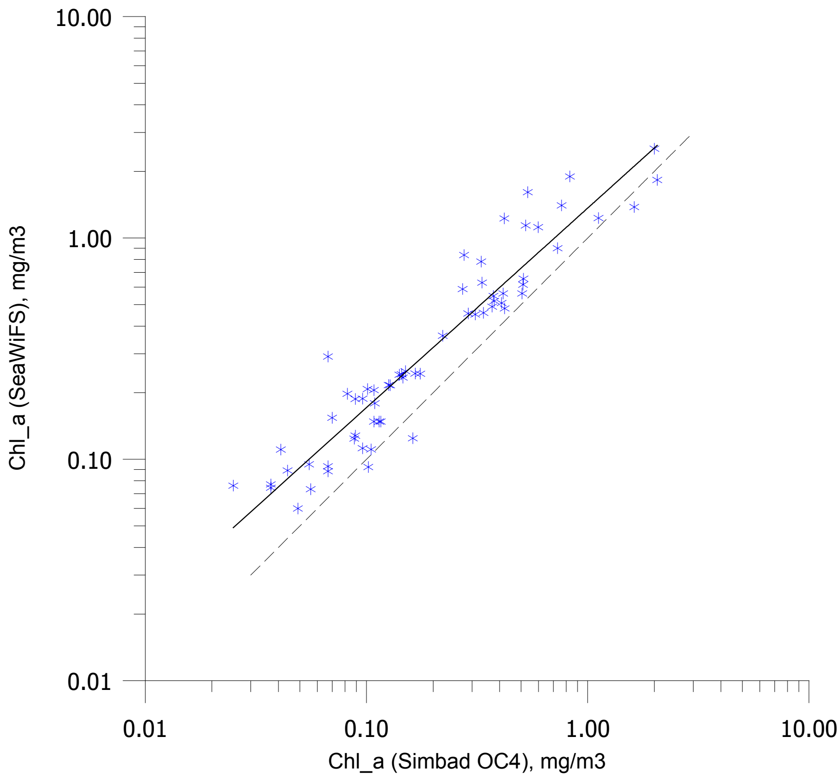


Fig.16. Scatterplot of Chl values retrieved from SeaWiFS and SIMBAD data on the both Atlantic transects (October-November 2001 and March-April 2002). Dash line corresponds the regression slope equal to 1, solid line is the statistical result.

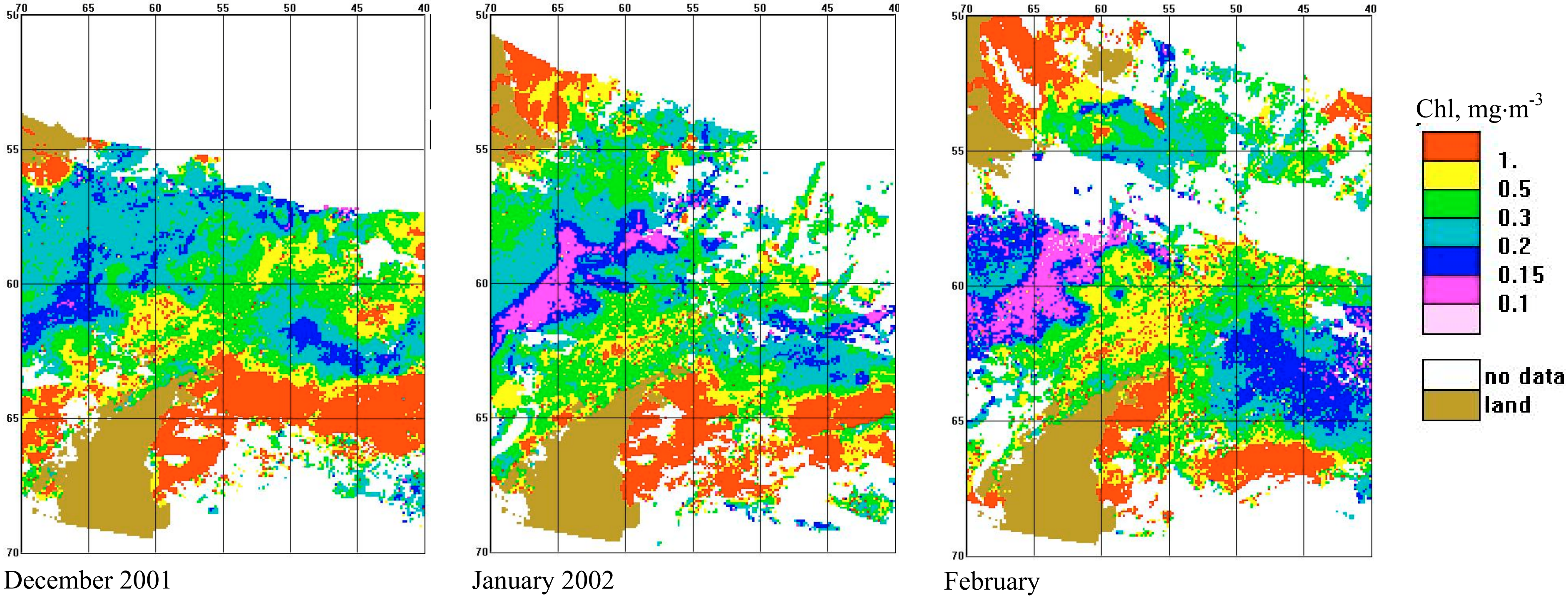
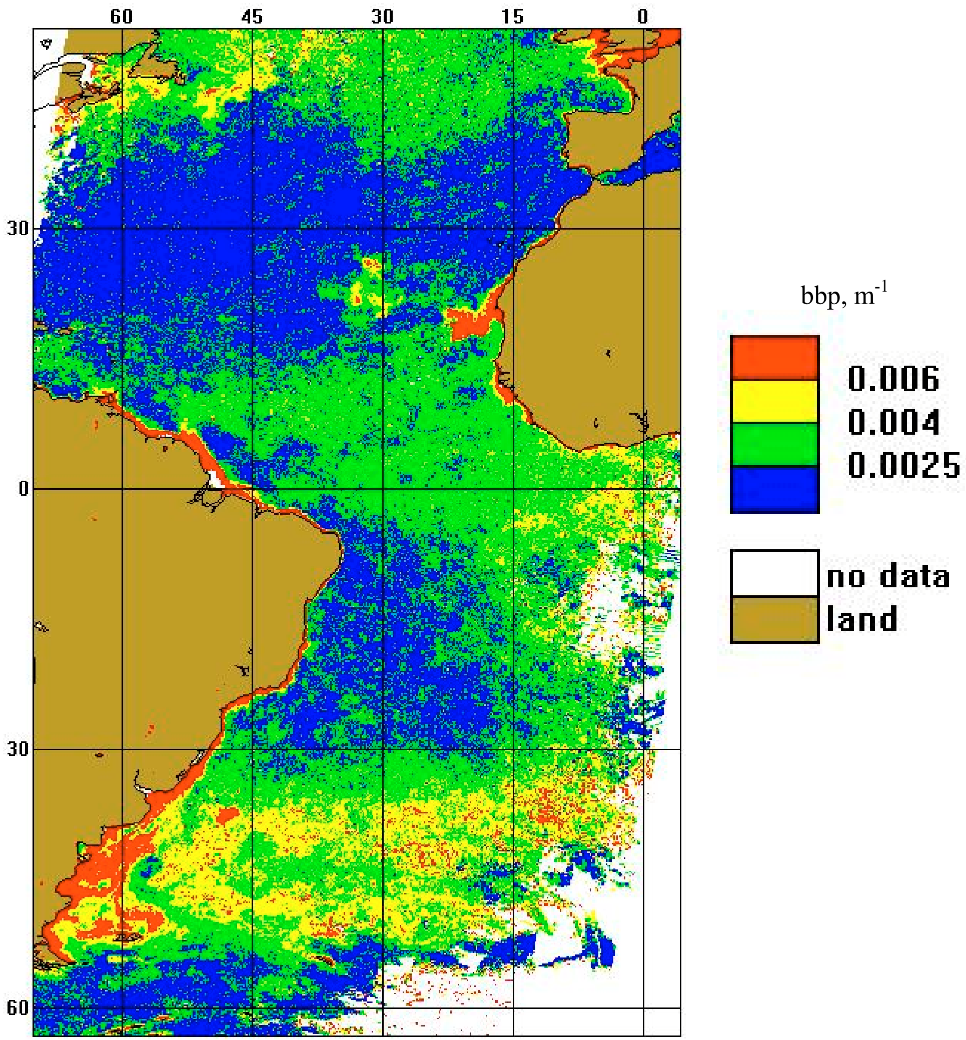
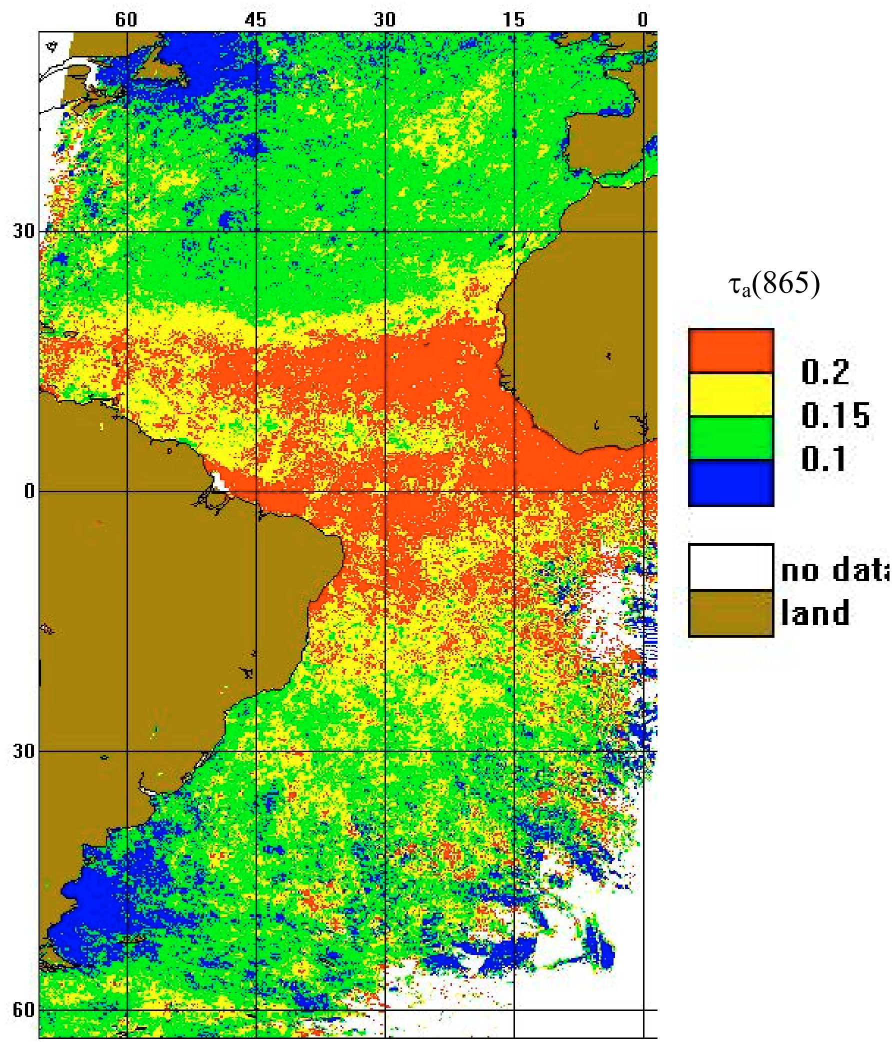


Fig.17. SeaWiFS monthly composite of chlorophyll concentration for the Antarctic for December 2001-February 2002

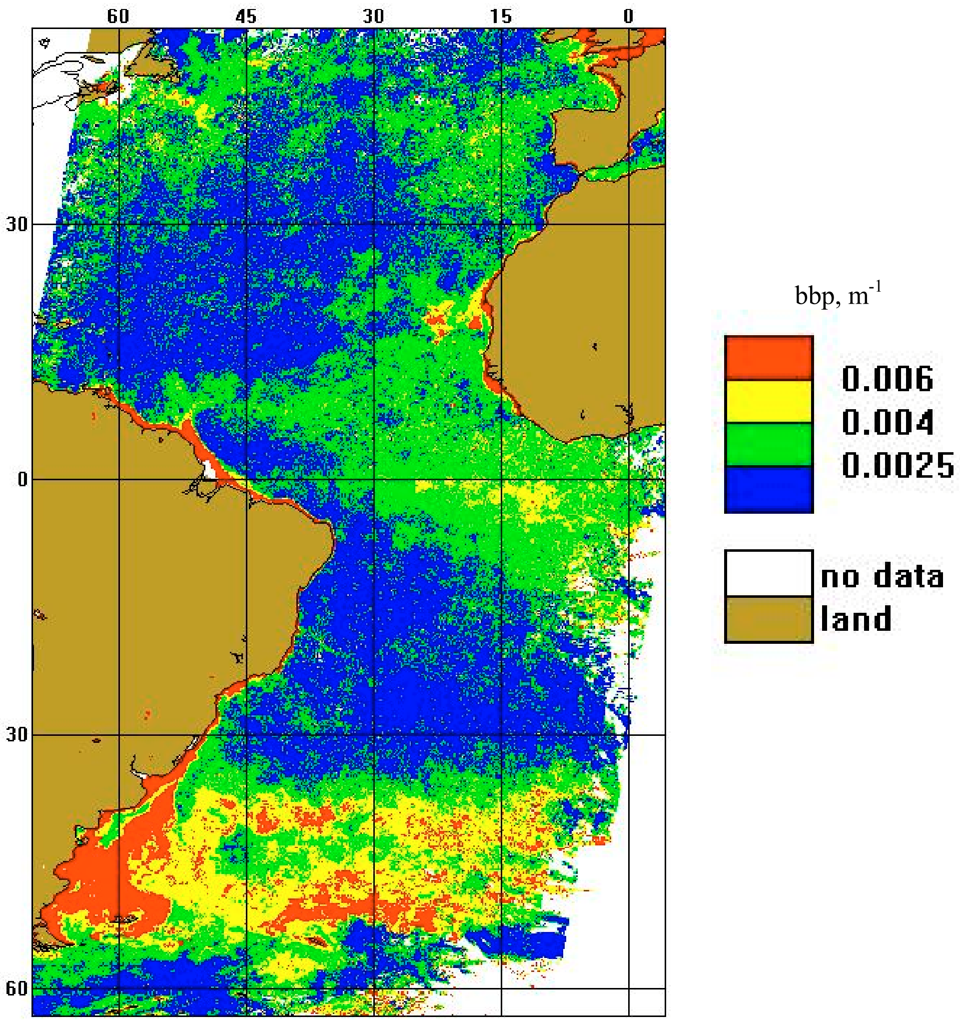


bbp

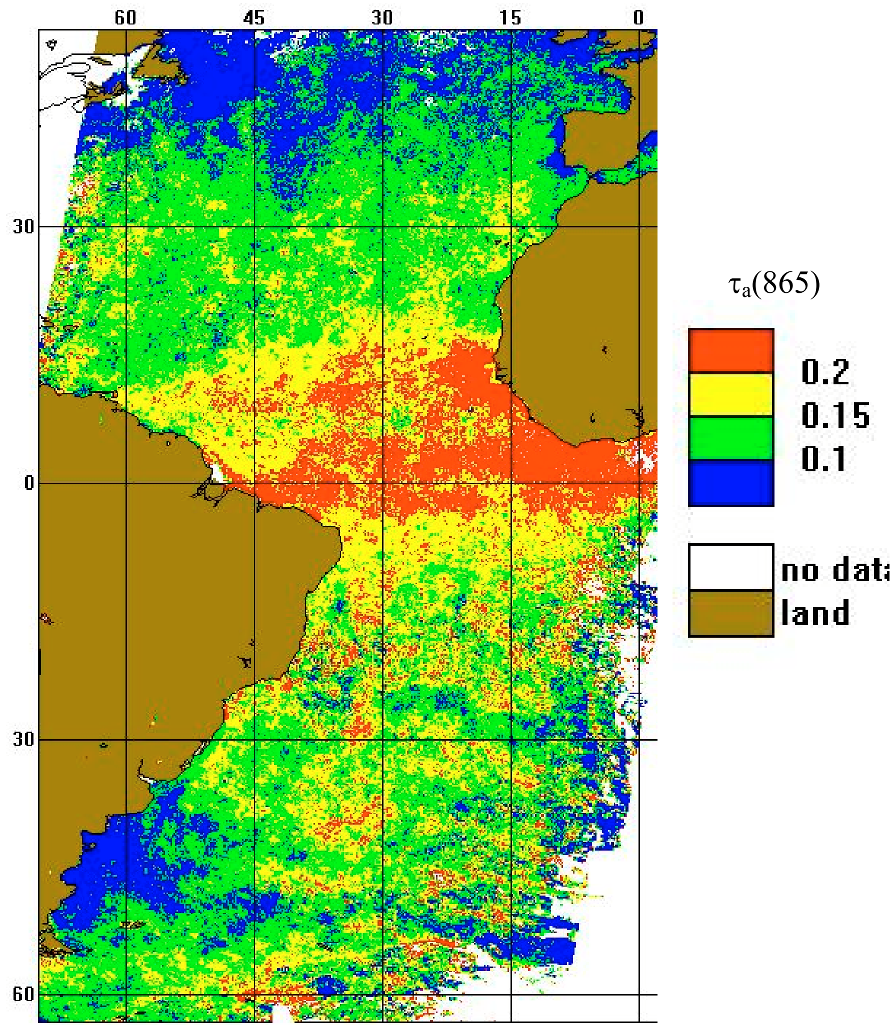


$\tau_a(865)$

Fig.18. SeaWiFS monthly composite of the particle backscattering coefficient (left) and the aerosol optical thickness (right) for the Atlantic Ocean for October 2001

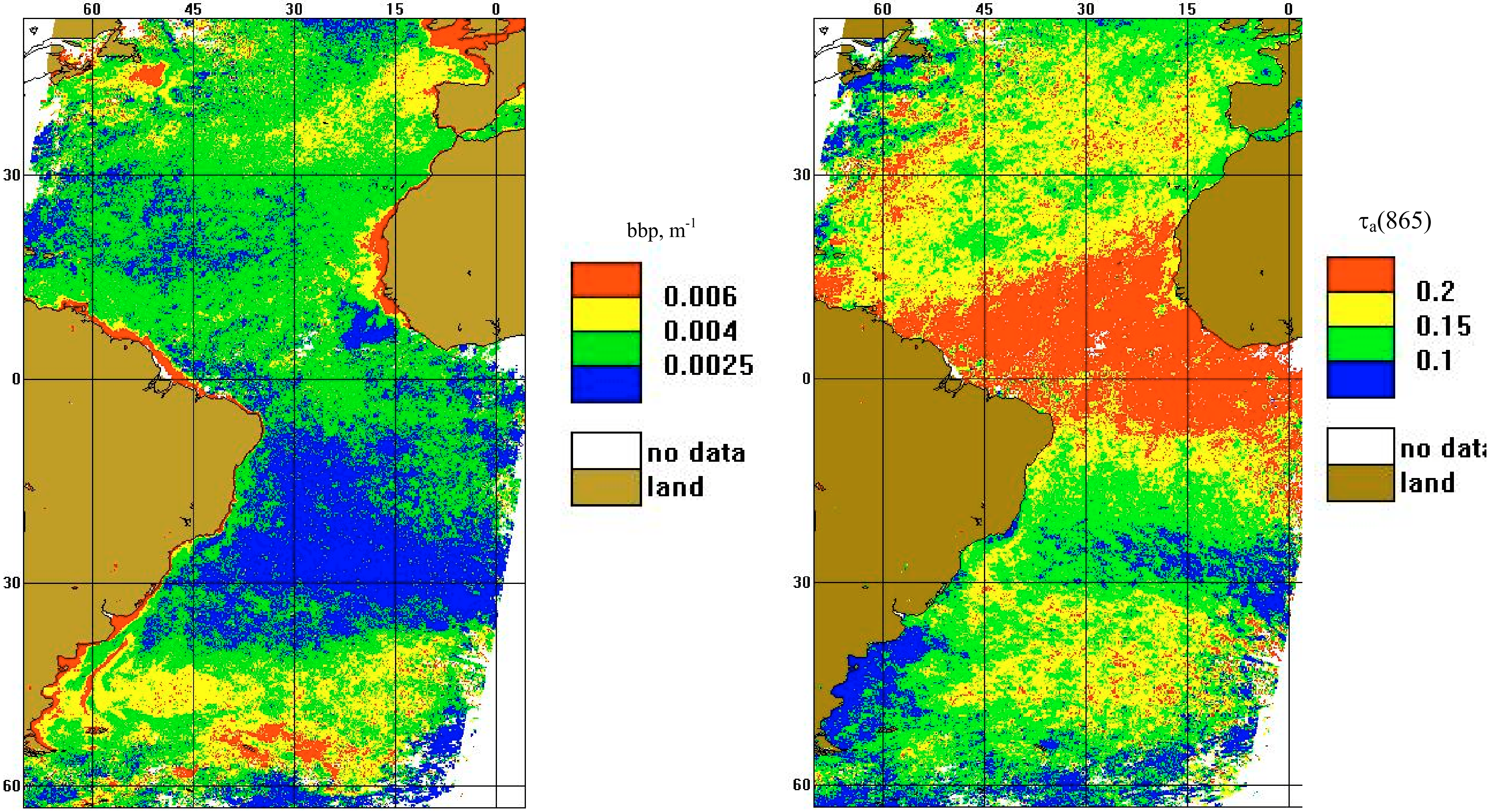


bbp



$\tau_a(865)$

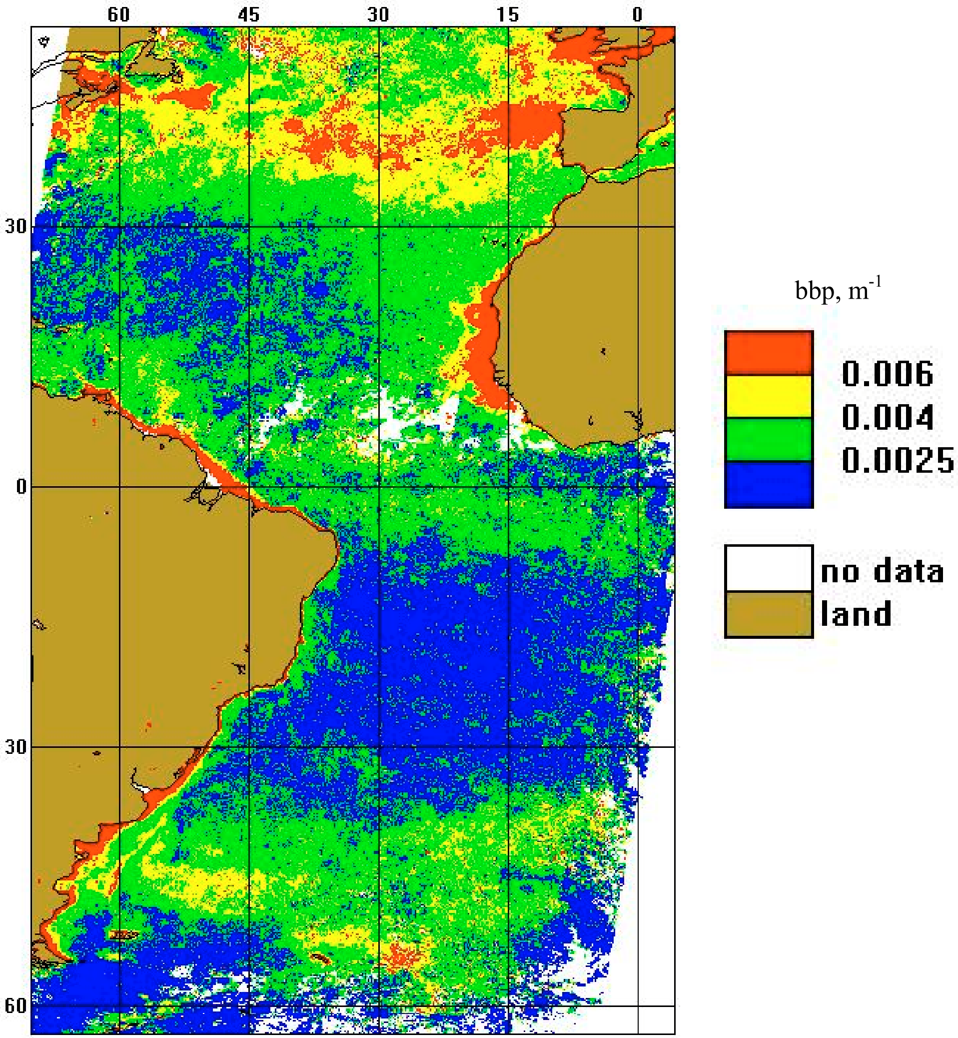
Fig.19. SeaWiFS monthly composite of the particle backscattering coefficient (left) and the aerosol optical thickness (right) for the Atlantic Ocean for November 2001



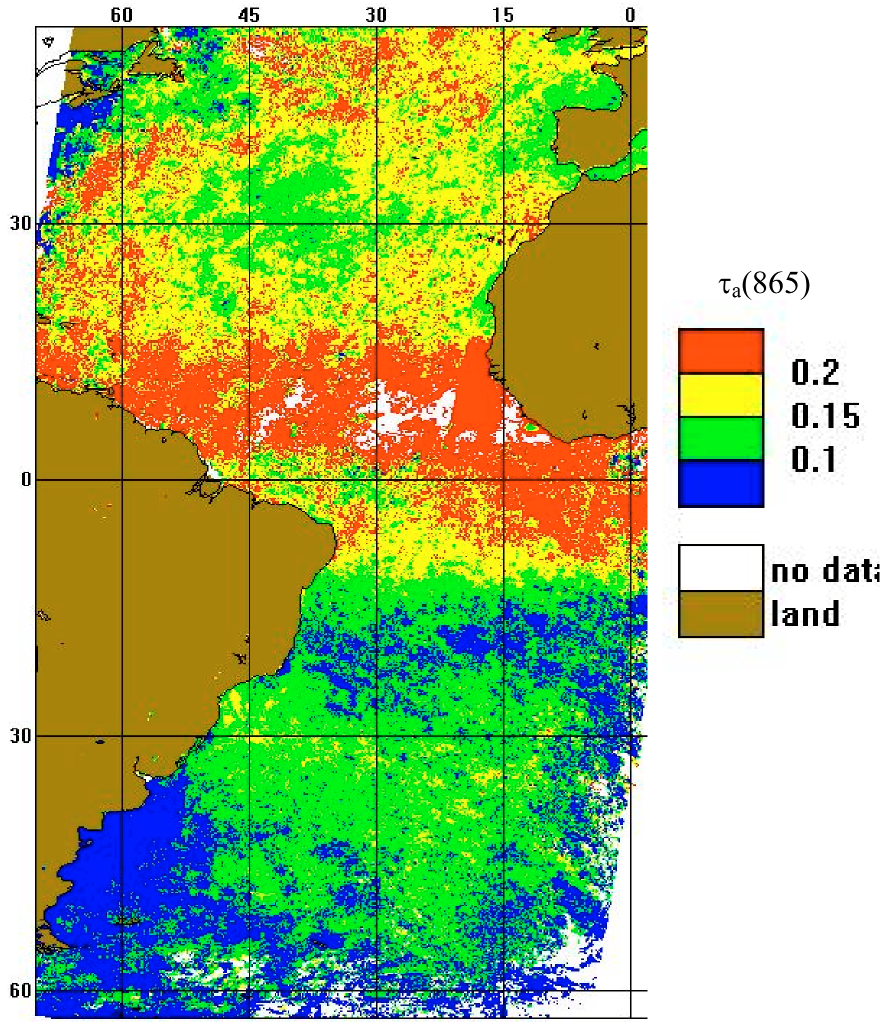
bbp

$\tau_a(865)$

Fig.20. SeaWiFS monthly composite of the particle backscattering coefficient (left) and the aerosol optical thickness (right) for the Atlantic Ocean for March 2002



bbp



$\tau_a(865)$

Fig.21. SeaWiFS monthly composite of the particle backscattering coefficient (left) and the aerosol optical thickness (right) for the Atlantic Ocean for April 2002

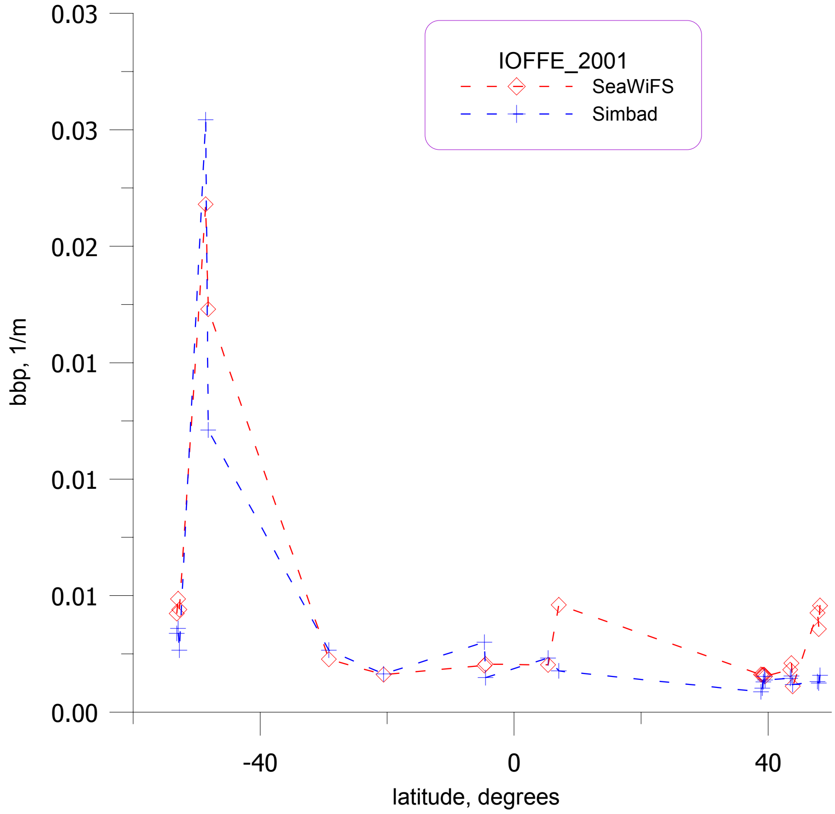


Fig.22a Changes of the bbp values retrieved from SeaWiFS (red) and SIMBAD (blue) data on the Atlantic transect in October-November 2001.

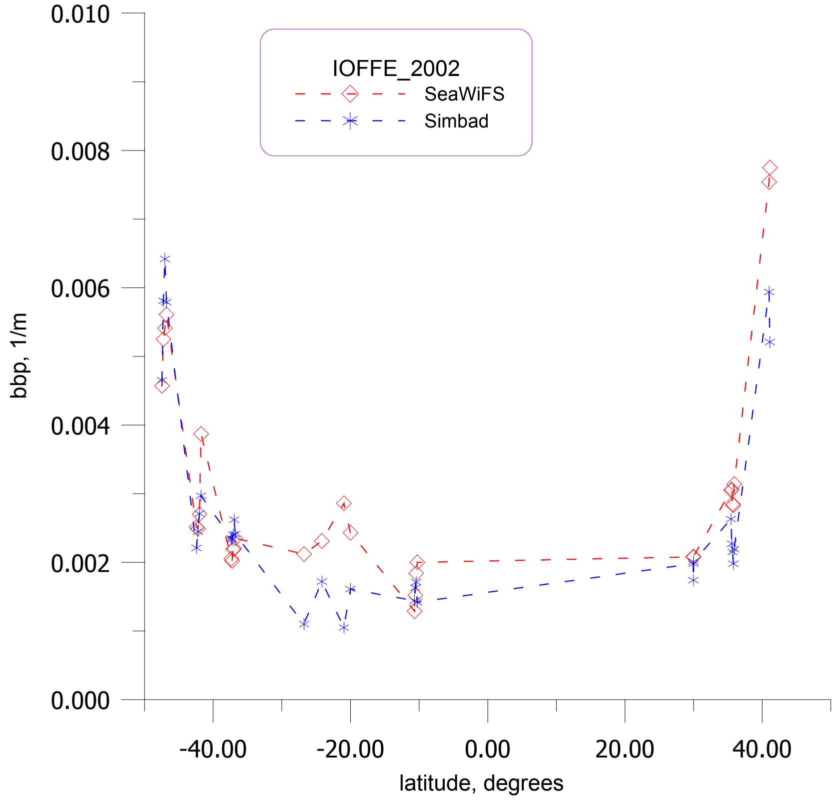


Fig.22b Changes of the bbp values retrieved from SeaWiFS (red) and SIMBAD (blue) data on the Atlantic transect in March-April 2002.

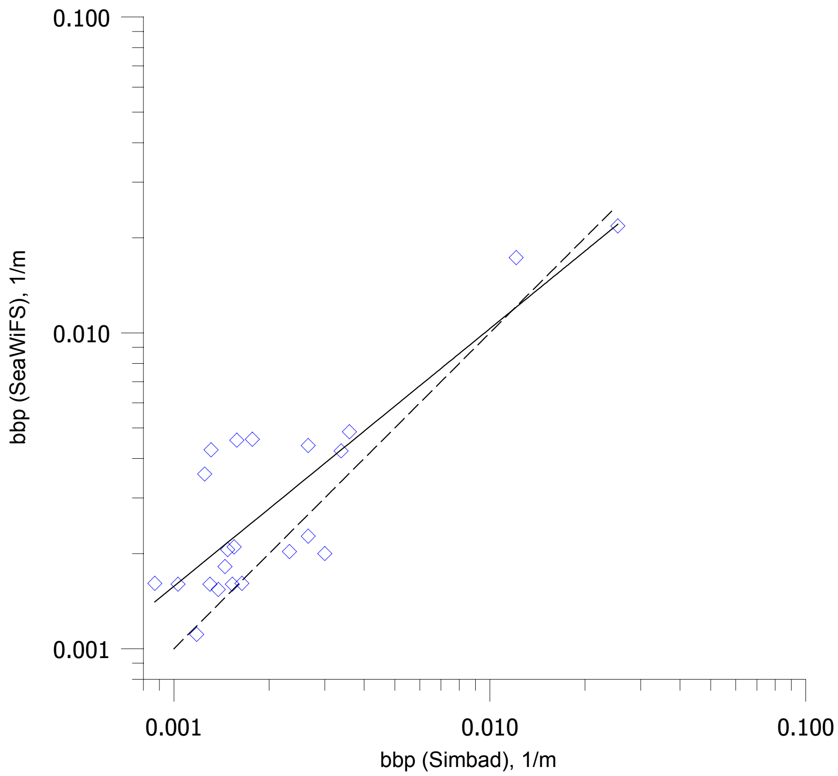


Fig.23a Scatterplot of the bbp values retrieved from SeaWiFS and SIMBAD data on the Atlantic transect in October-November 2001. Dash line corresponds the regression slope equal to 1, solid line is the statistical result.

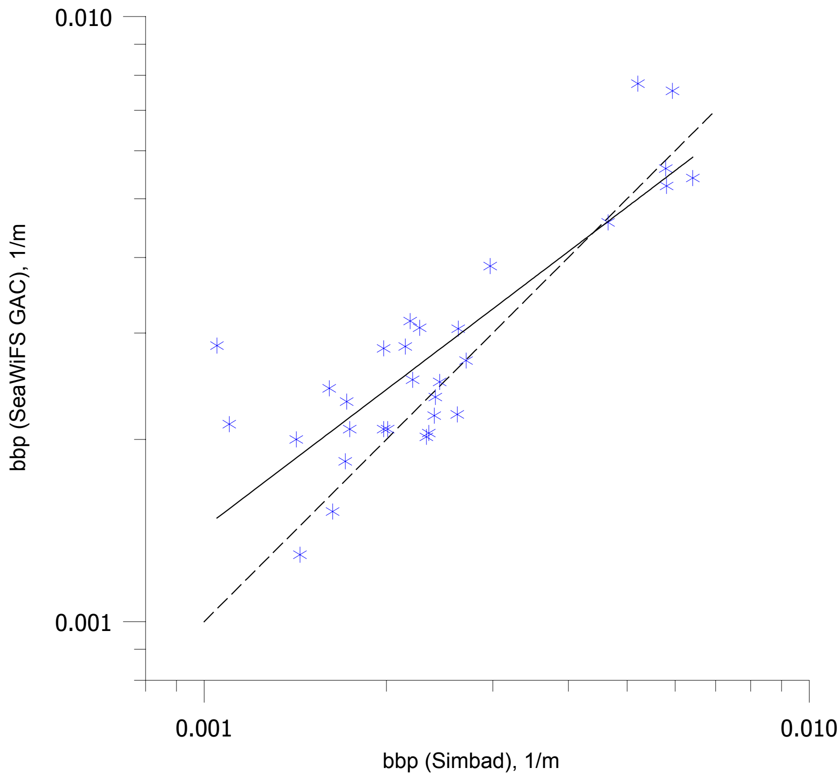
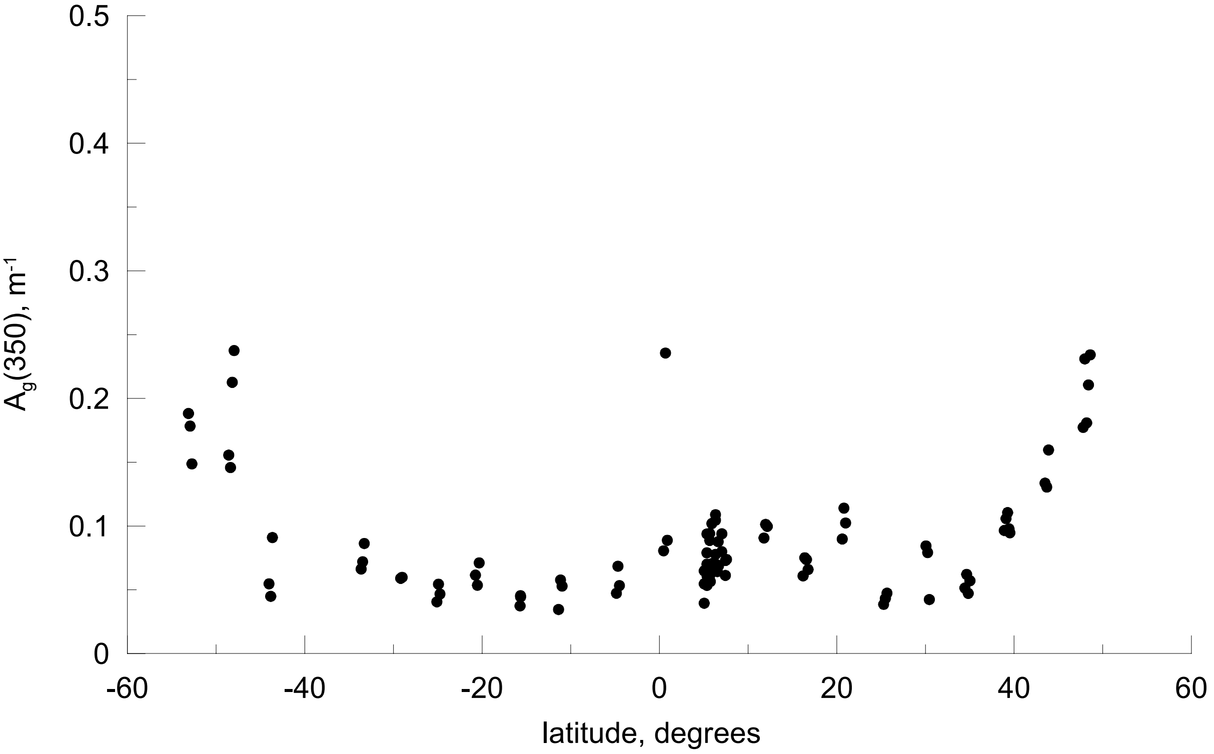
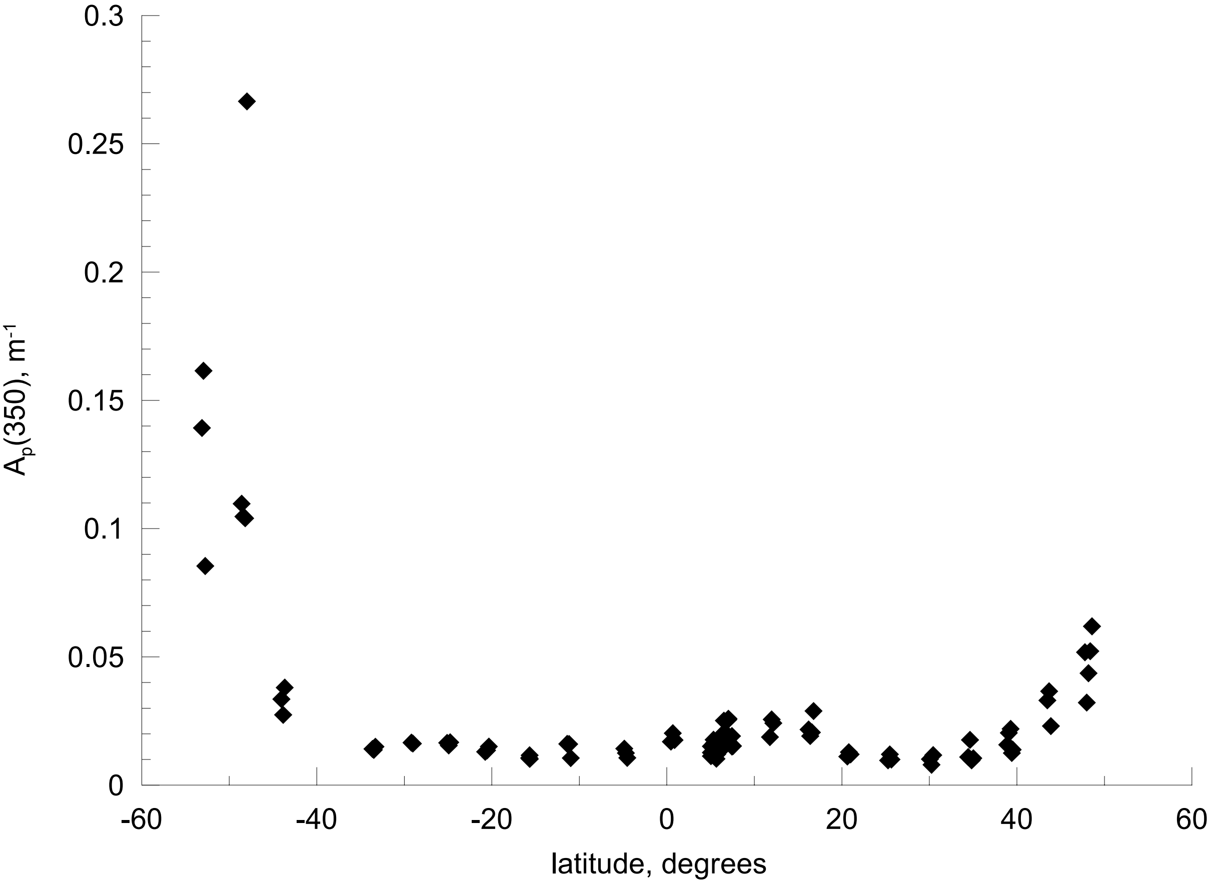


Fig.23b Scatterplot of the bbp values retrieved from SeaWiFS and SIMBAD data on the Atlantic transect in March-April 2002. Dash line corresponds the regression slope equal to 1, solid line is the statistical result.

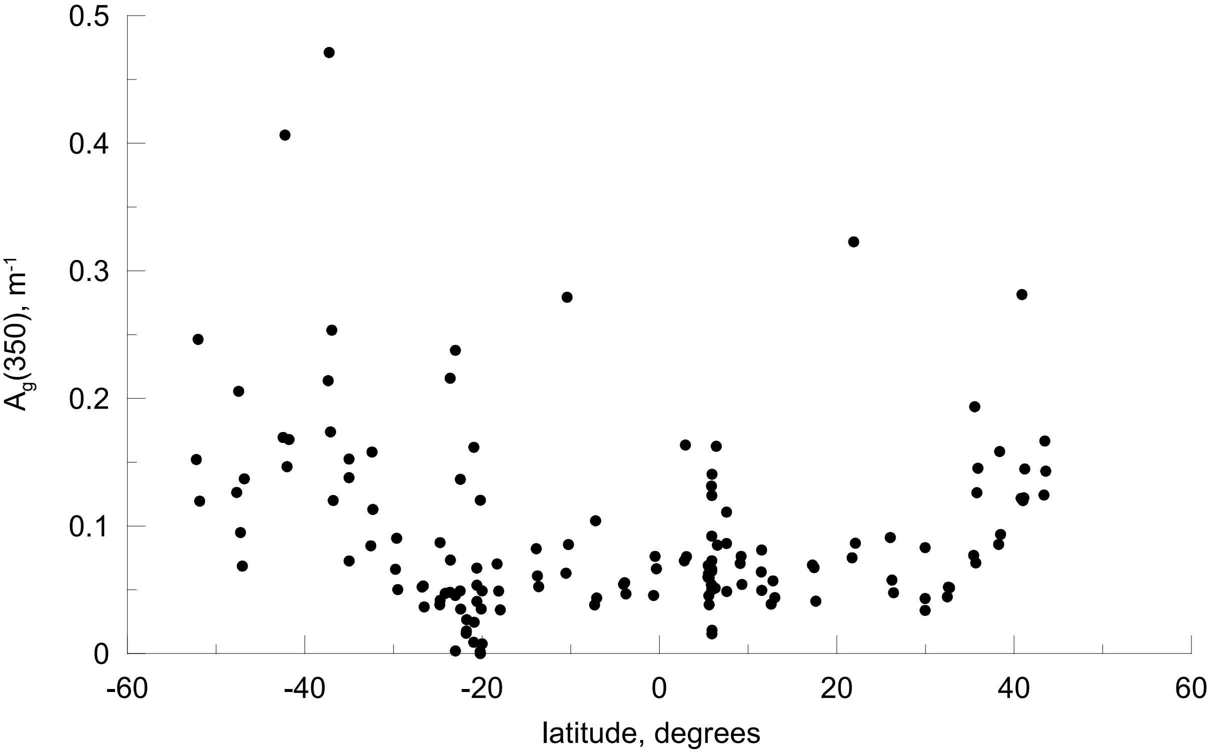


$a_g(350)$

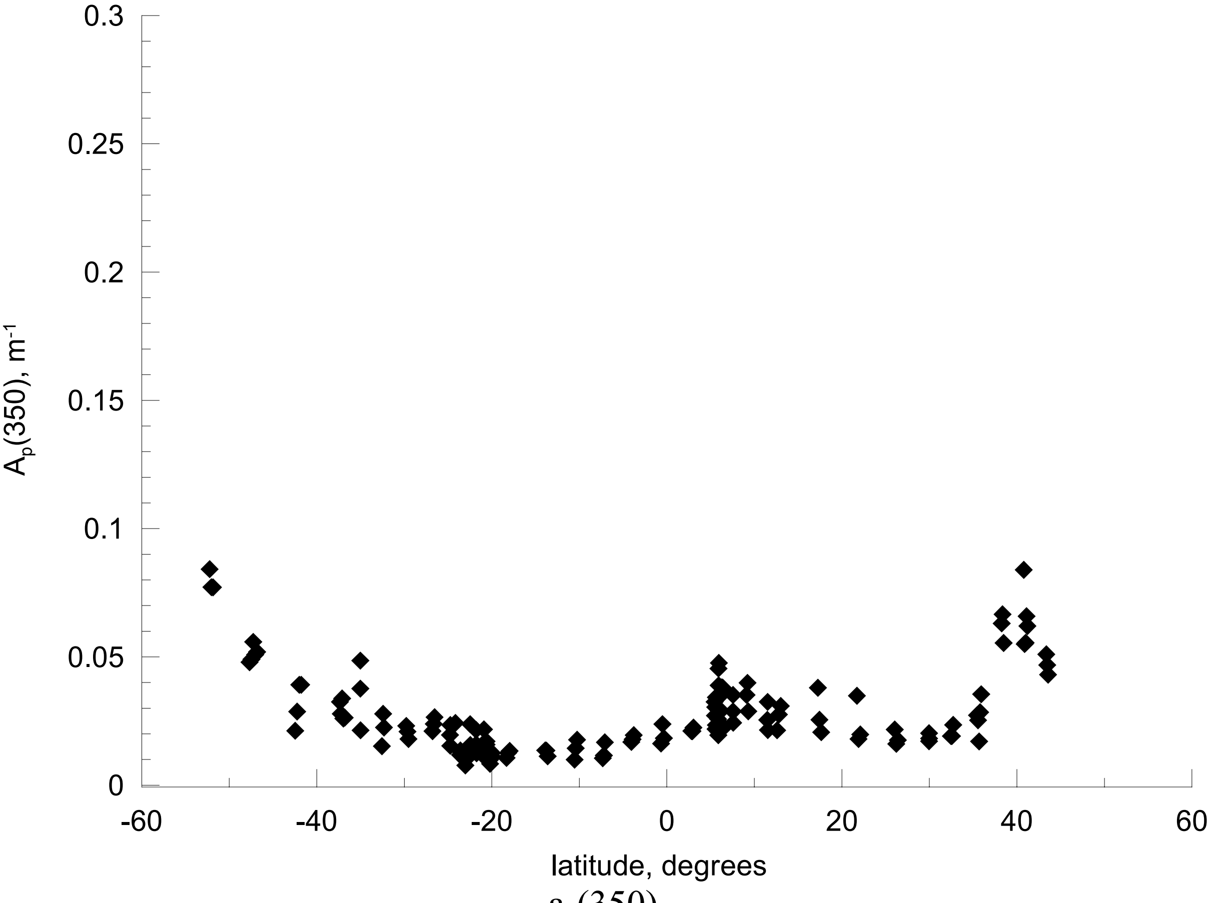


$a_p(350)$

Fig.24. Changes of the measured values of the soluble (upper) and particulate (lower) absorption coefficients at 350 nm on the Atlantic transect in October-November 2001.

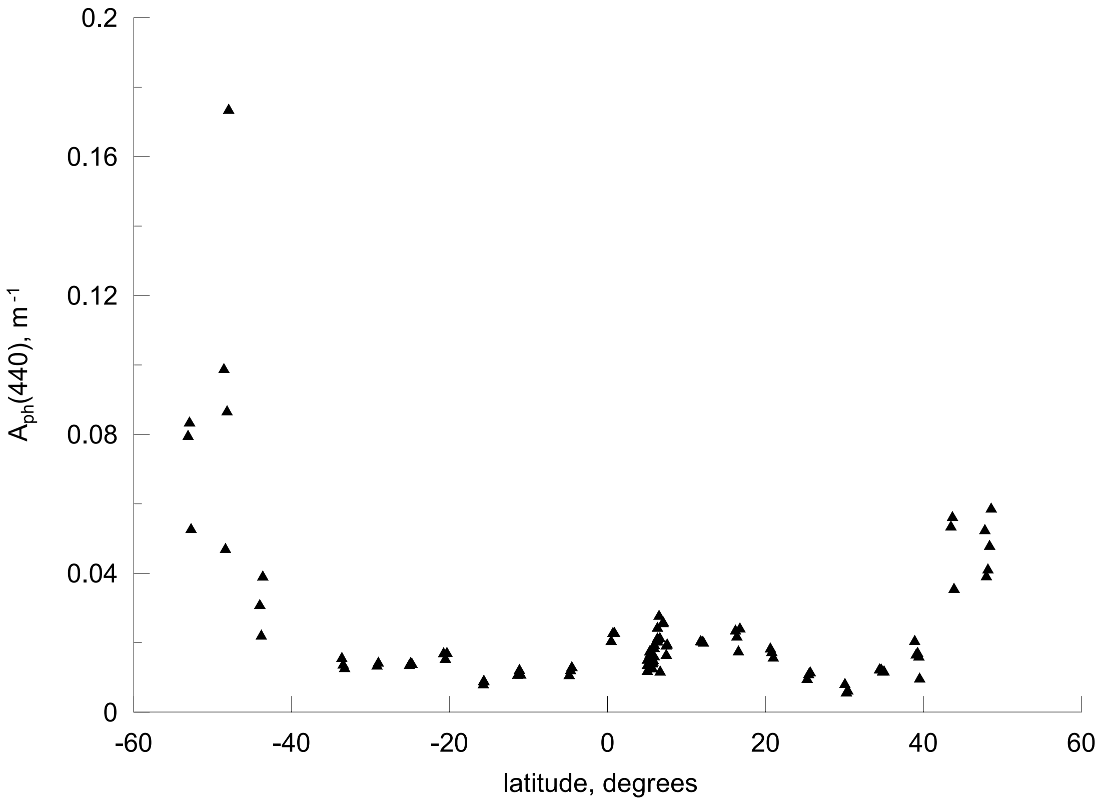


$a_g(350)$

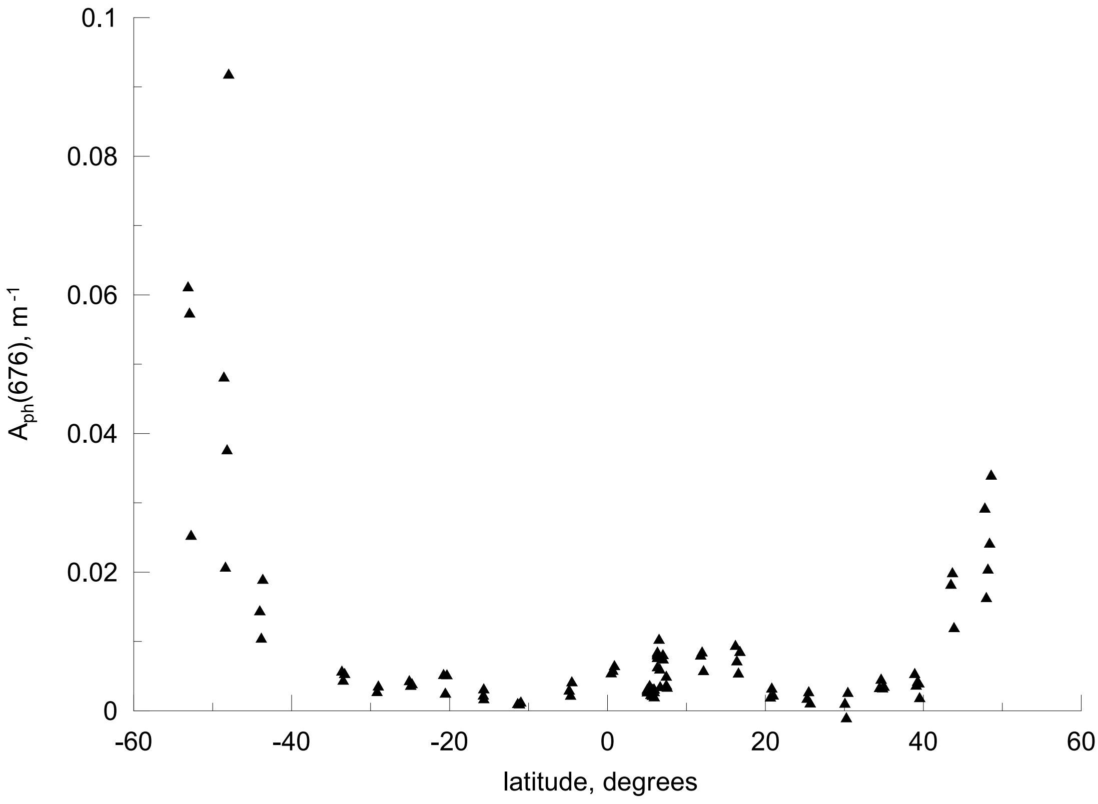


$a_p(350)$

Fig.25. Changes of the measured values of the soluble (upper) and particulate (lower) absorption coefficients at 350 nm on the Atlantic transect in March-April 2002.

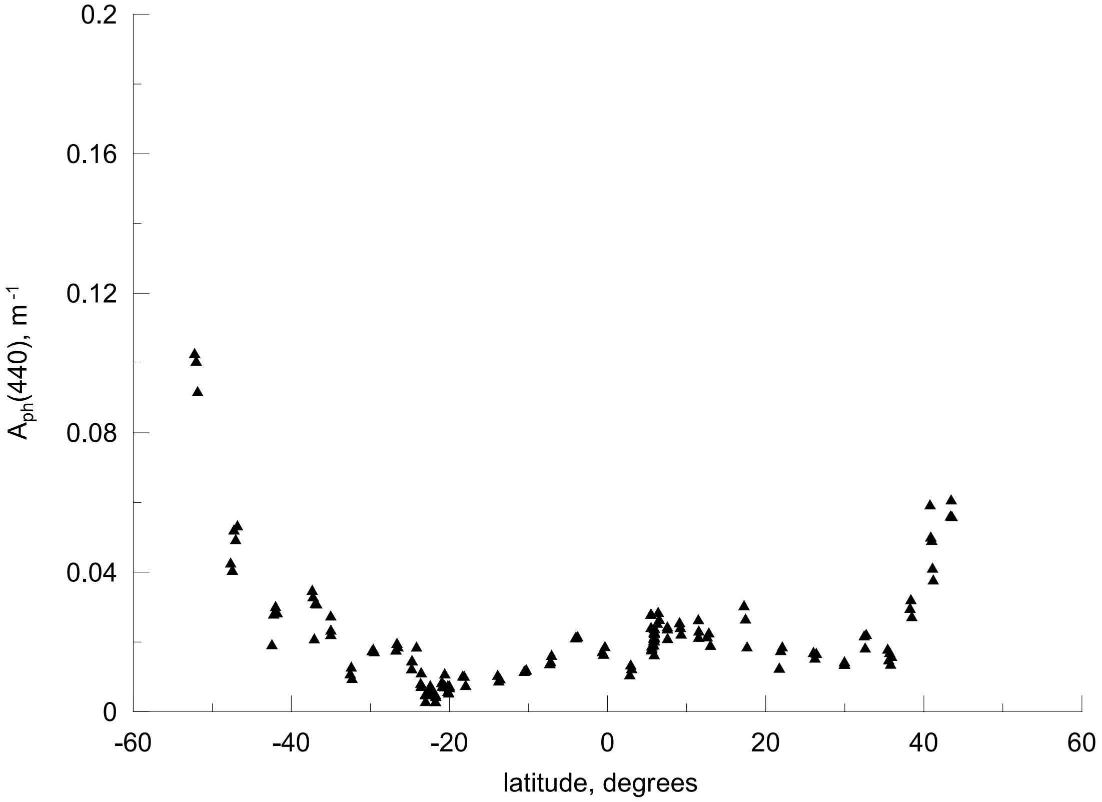


$a_{ph}(440)$

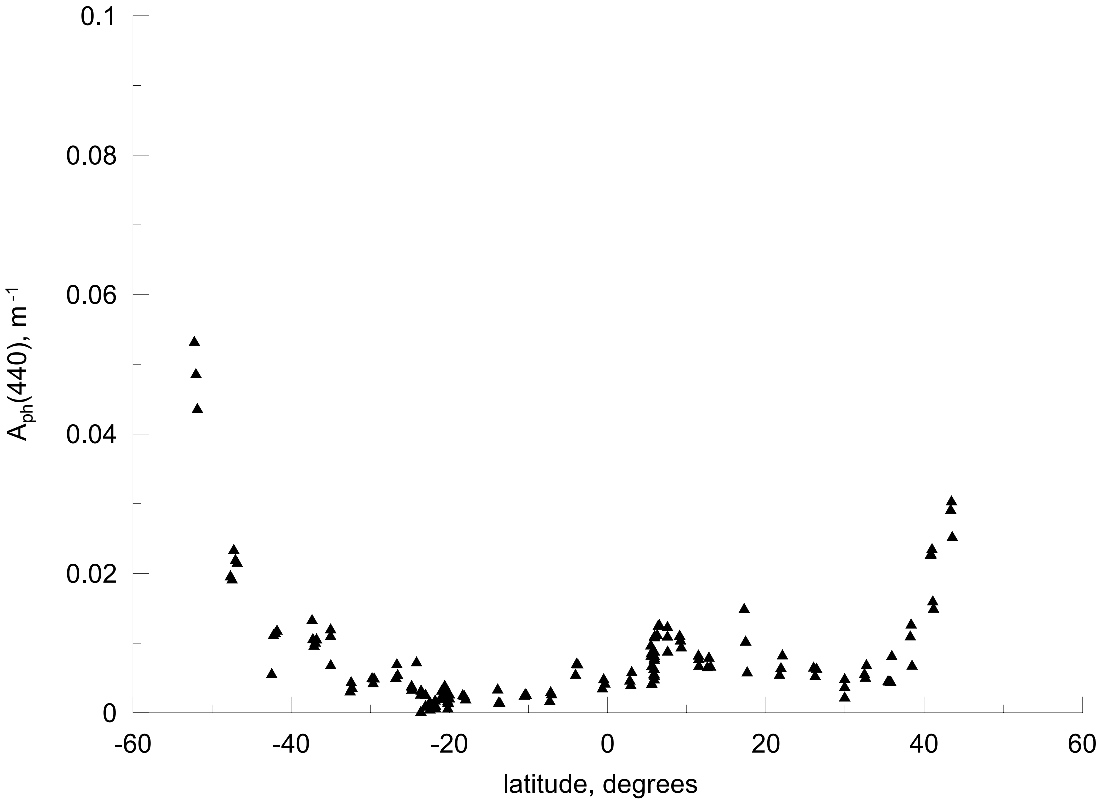


$a_{ph}(676)$

Fig.26. Changes of the measured values of the phytoplankton absorption coefficients at 440 nm (upper) and 676 nm (lower) on the Atlantic transect in October-November 2001.

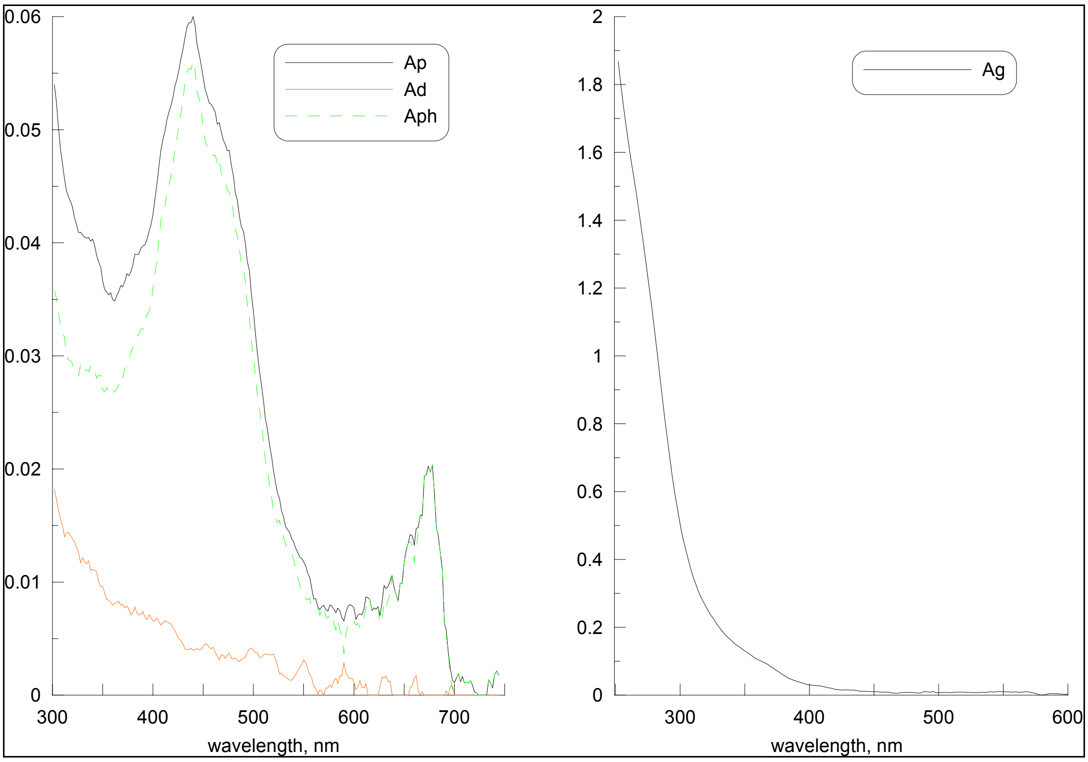


$a_{ph}(440)$

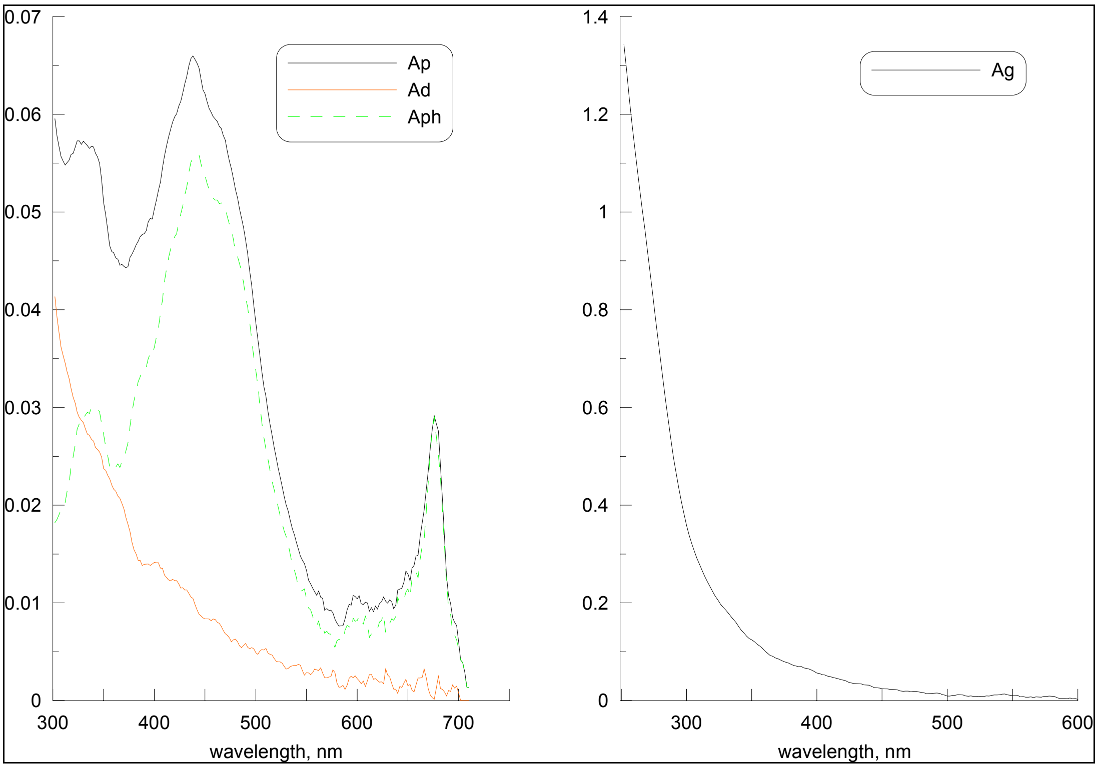


$a_{ph}(676)$

Fig.27. Changes of the measured values of the phytoplankton absorption coefficients at 440 nm (upper) and 676 nm (lower) on the Atlantic transect in March-April 2002.

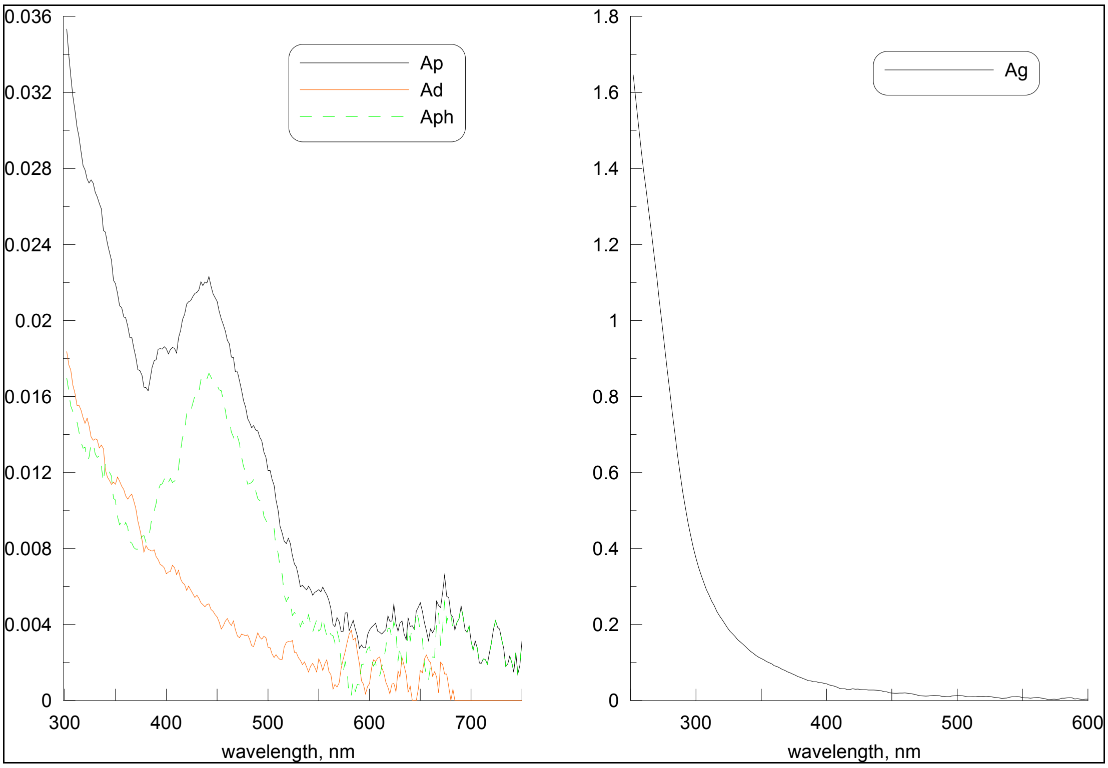


October 2001, St.7

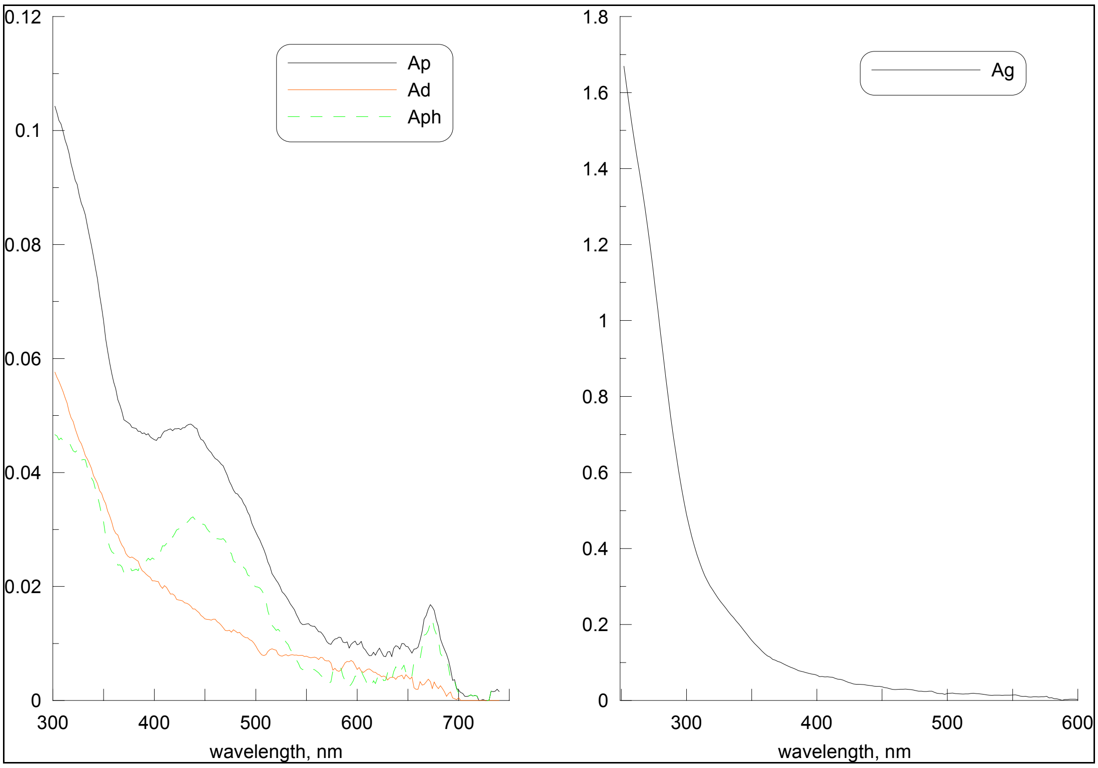


April 2002, St. 320

Fig.28. Examples of the spectral absorption coefficients of particulate (Ap), phytoplankton (Aph), detritus (Ad) and soluble (Ag) matter in the North eutrophic waters in October 2001 (upper) and April 2002 (lower).

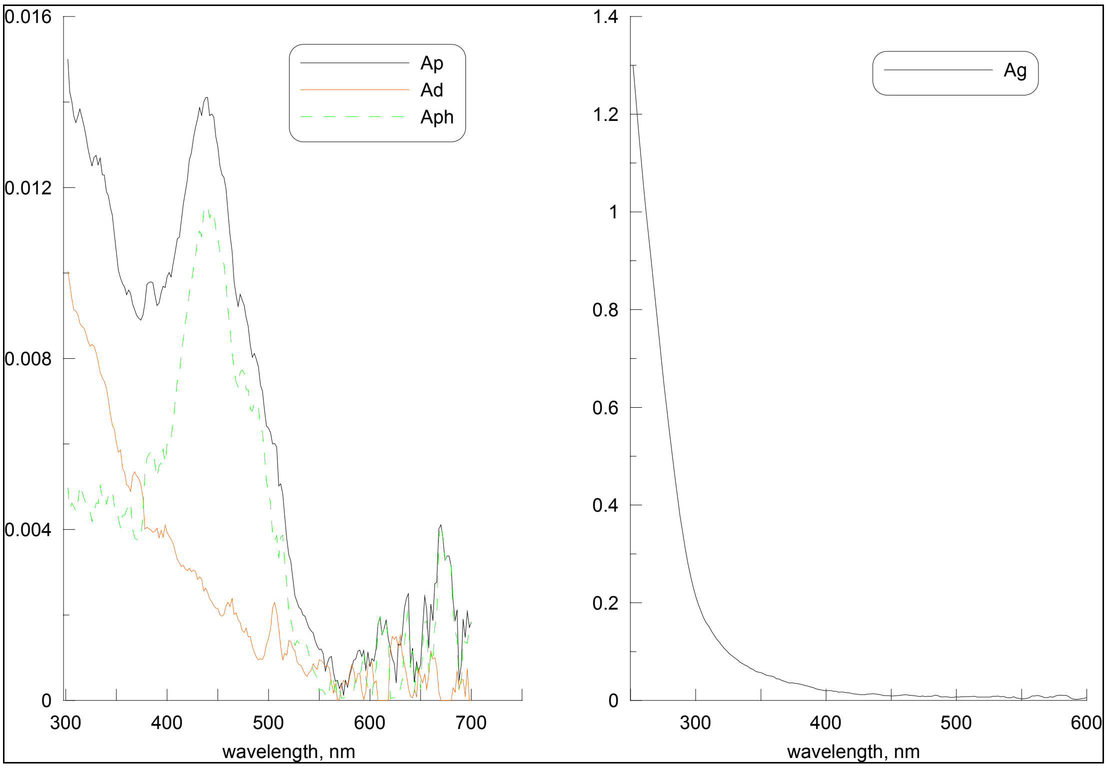


October 2001, St.11

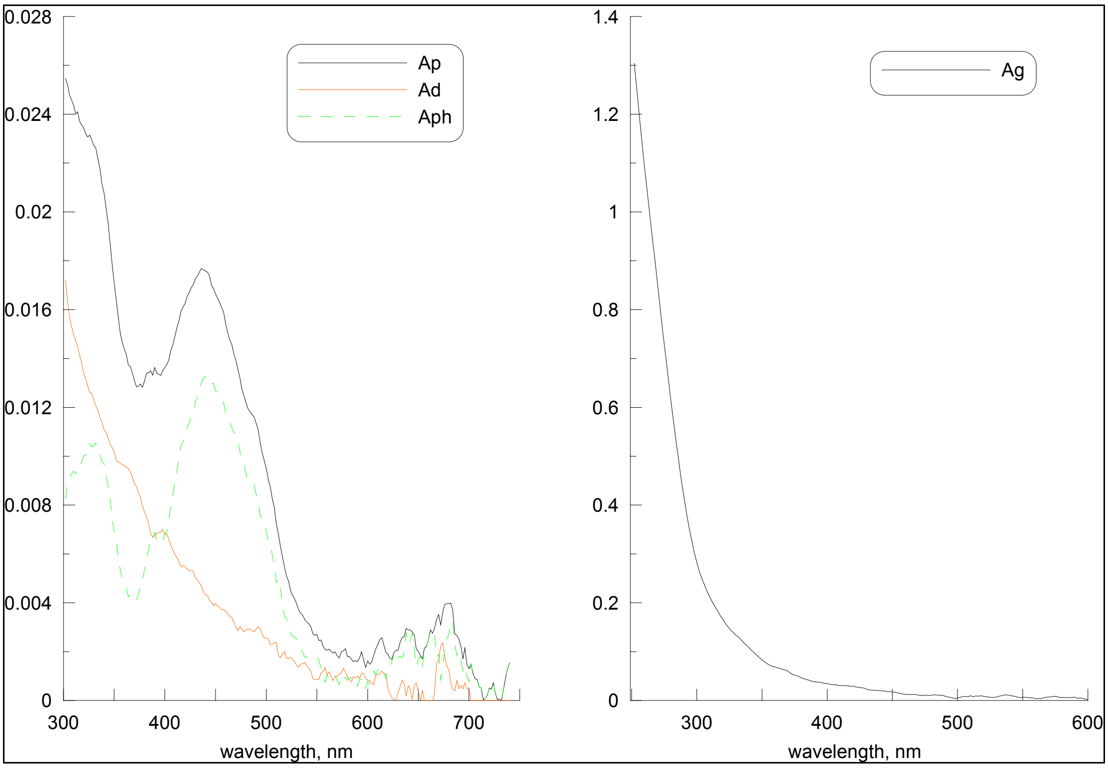


April 2002, St. 313

Fig.29 Examples of the spectral absorption coefficients of particulate (Ap), phytoplankton (Aph), detritus (Ad) and soluble (Ag) matter in the North mesotrophic waters in October 2001 (upper) and April 2002 (lower).

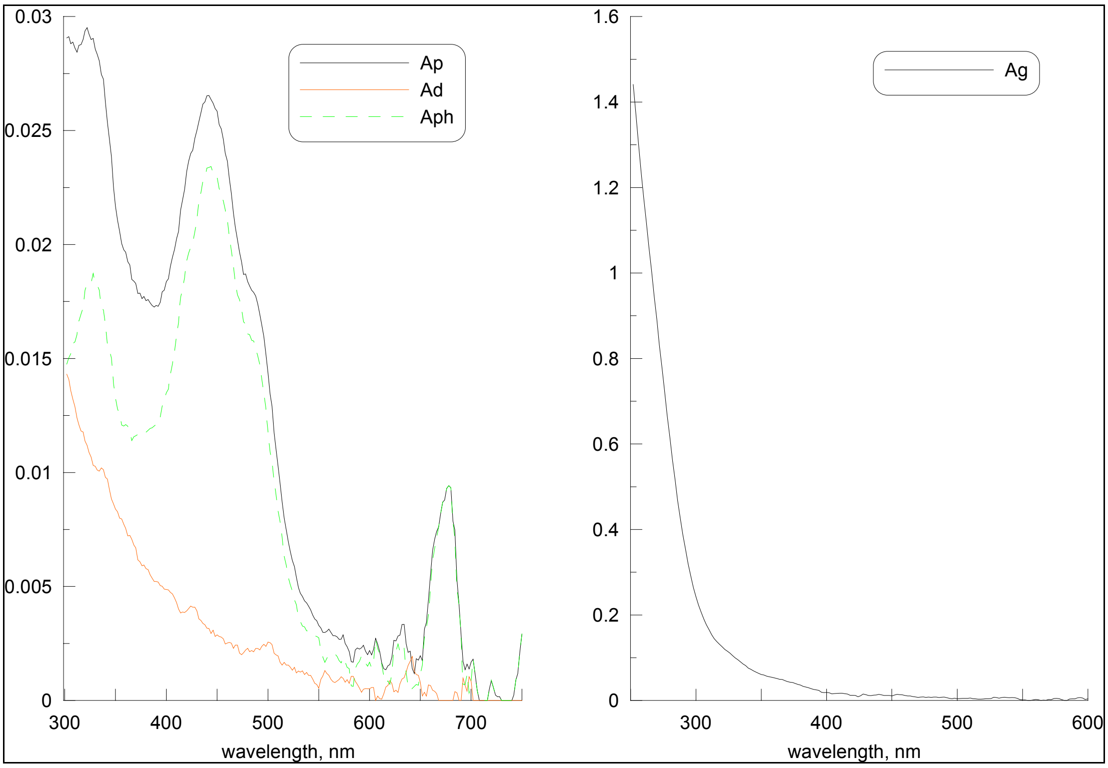


October 2001, St.14

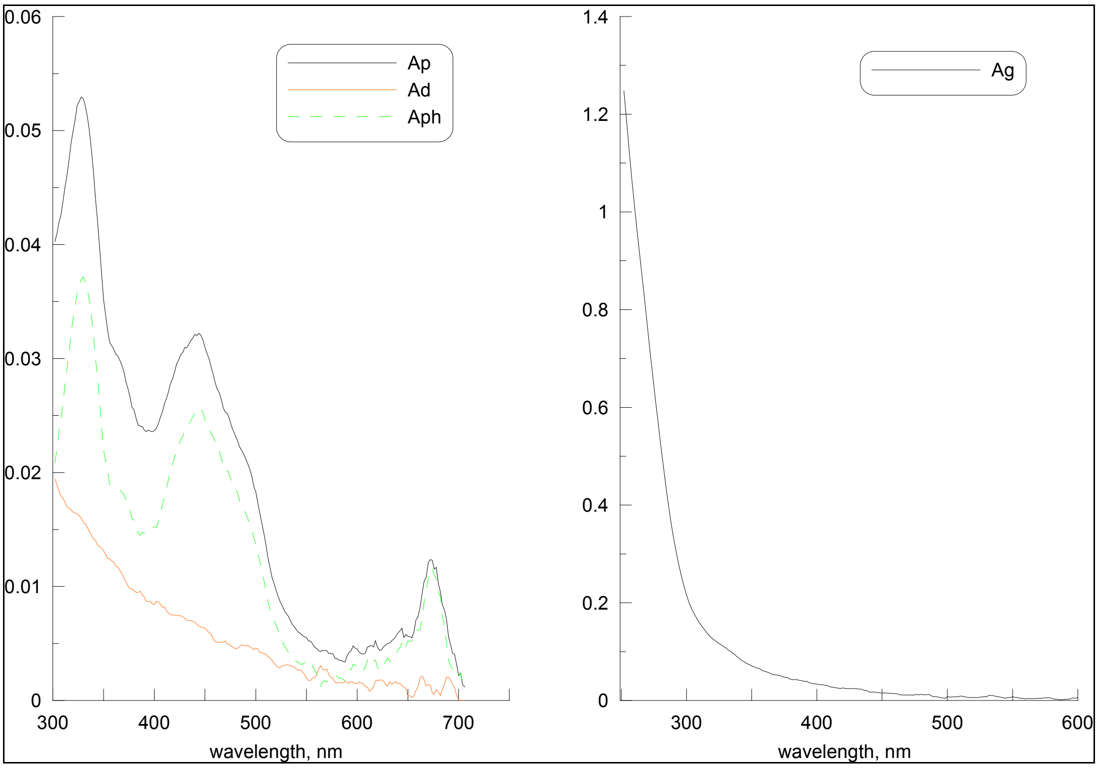


April 2002, St. 302

Fig.30. Examples of the spectral absorption coefficients of particulate (Ap), phytoplankton (Aph), detritus (Ad) and soluble (Ag) matter in the North oligotrophic waters in October 2001 (upper) and April 2002 (lower).

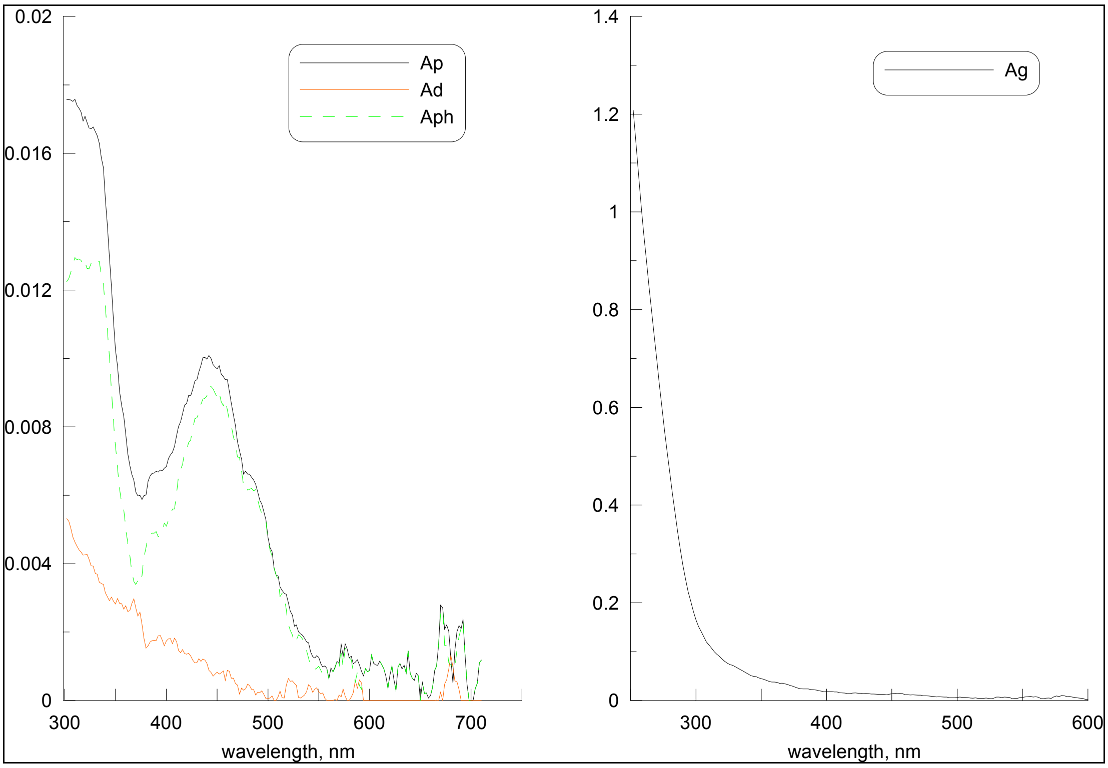


October 2001, St.30

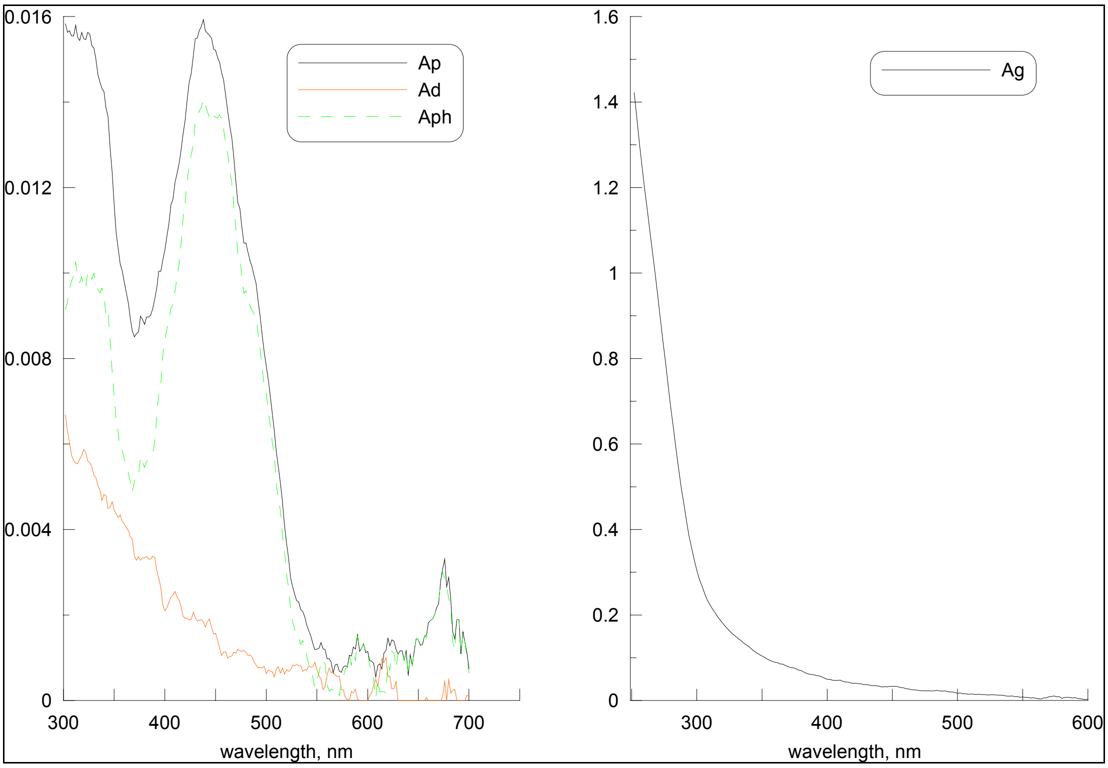


April 2002, St. 283

Fig.31. Examples of the spectral absorption coefficients of particulate (Ap), phytoplankton (Aph), detritus (Ad) and soluble (Ag) matter in the equatorial mesotrophic waters in October 2001 (upper) and April 2002 (lower).

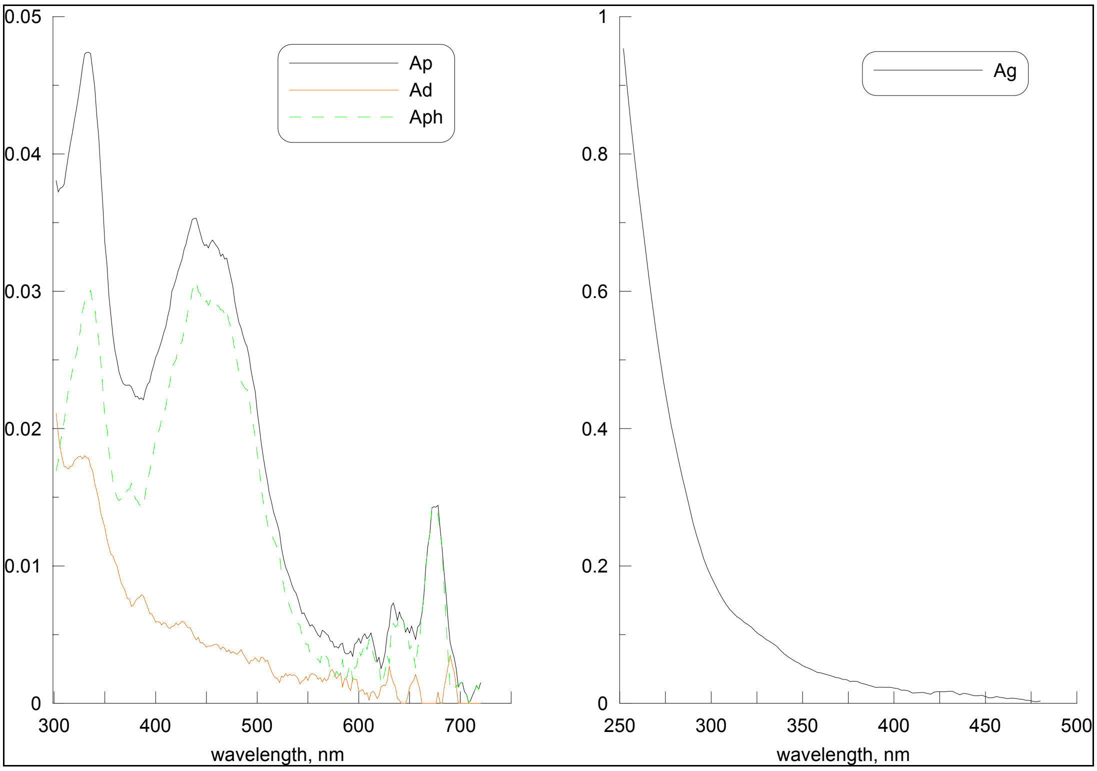


November 2001, St.78

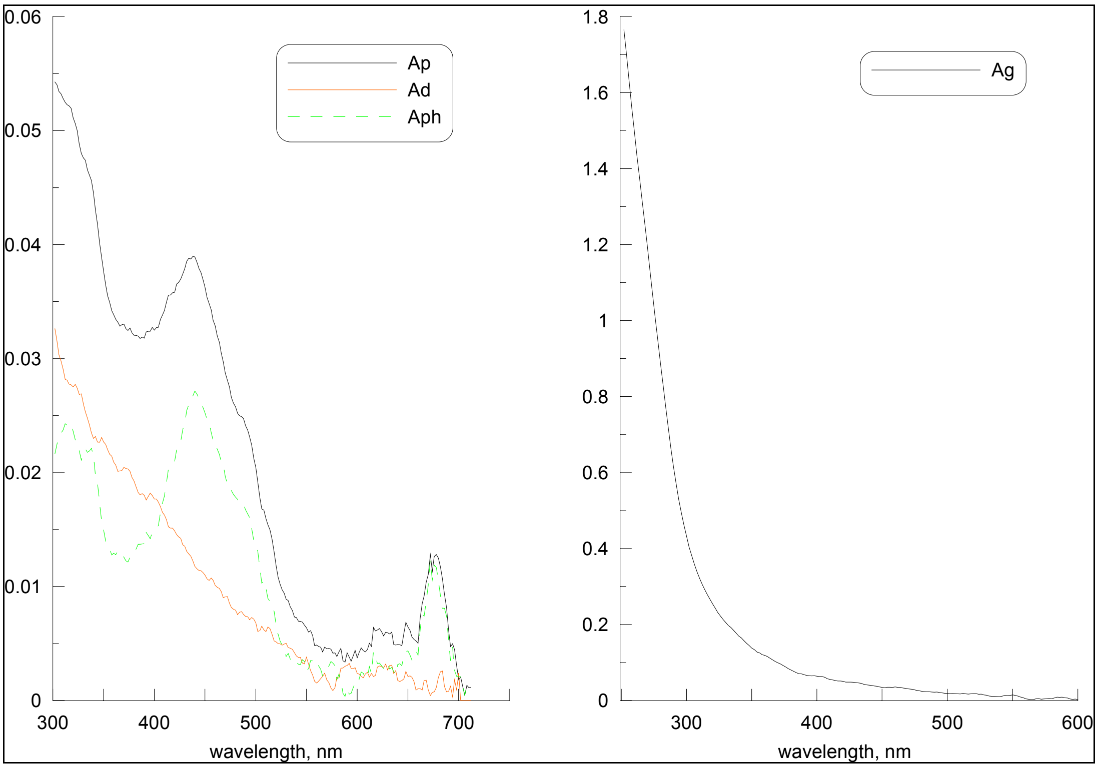


April 2002, St. 248

Fig.32. Examples of the spectral absorption coefficients of particulate (Ap), phytoplankton (Aph), detritus (Ad) and soluble (Ag) matter in the South oligotrophic waters in November 2001 (upper) and April 2002 (lower).

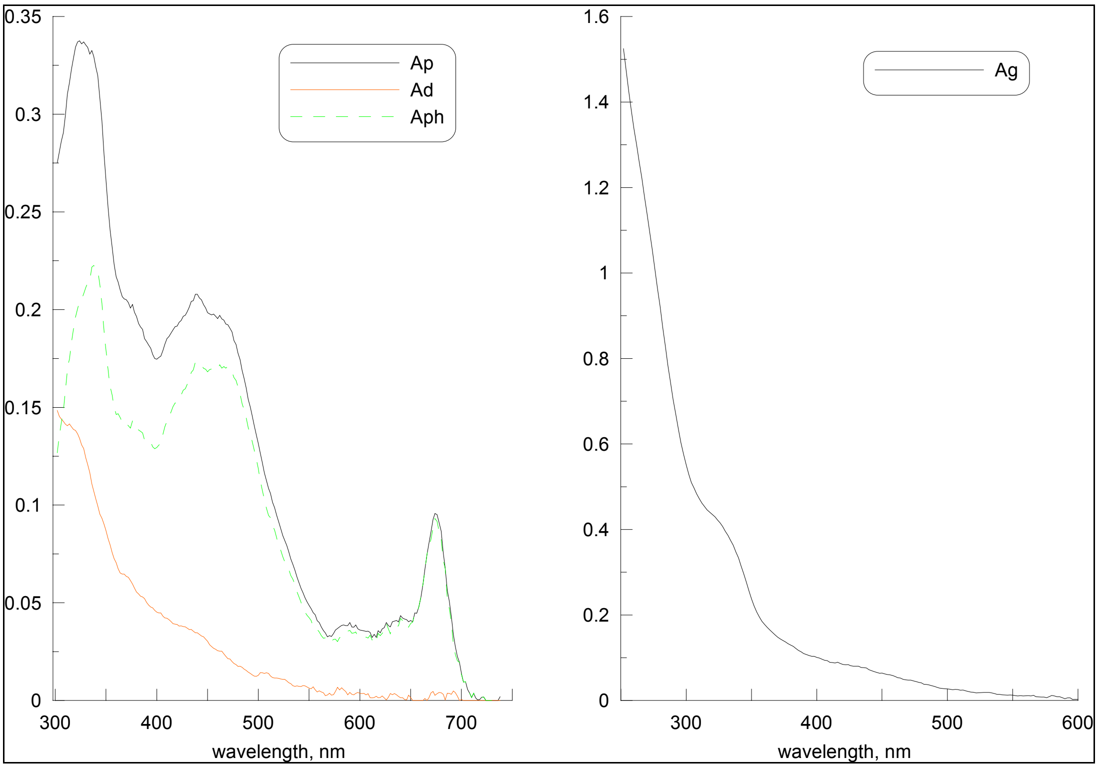


November 2001, St.93

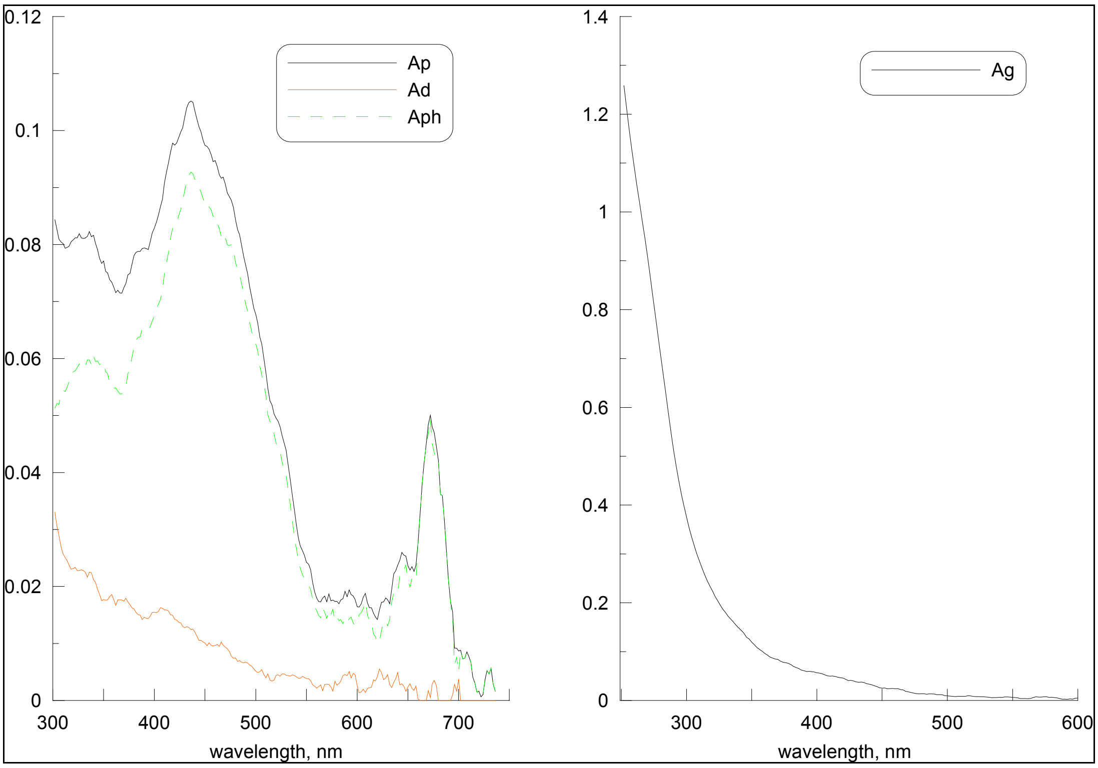


March 2002, St. 199

Fig.33. Examples of the spectral absorption coefficients of particulate (Ap), phytoplankton (Aph), detritus (Ad) and soluble (Ag) matter in the South mesotrophic waters in November 2001 (upper) and March 2002 (lower).

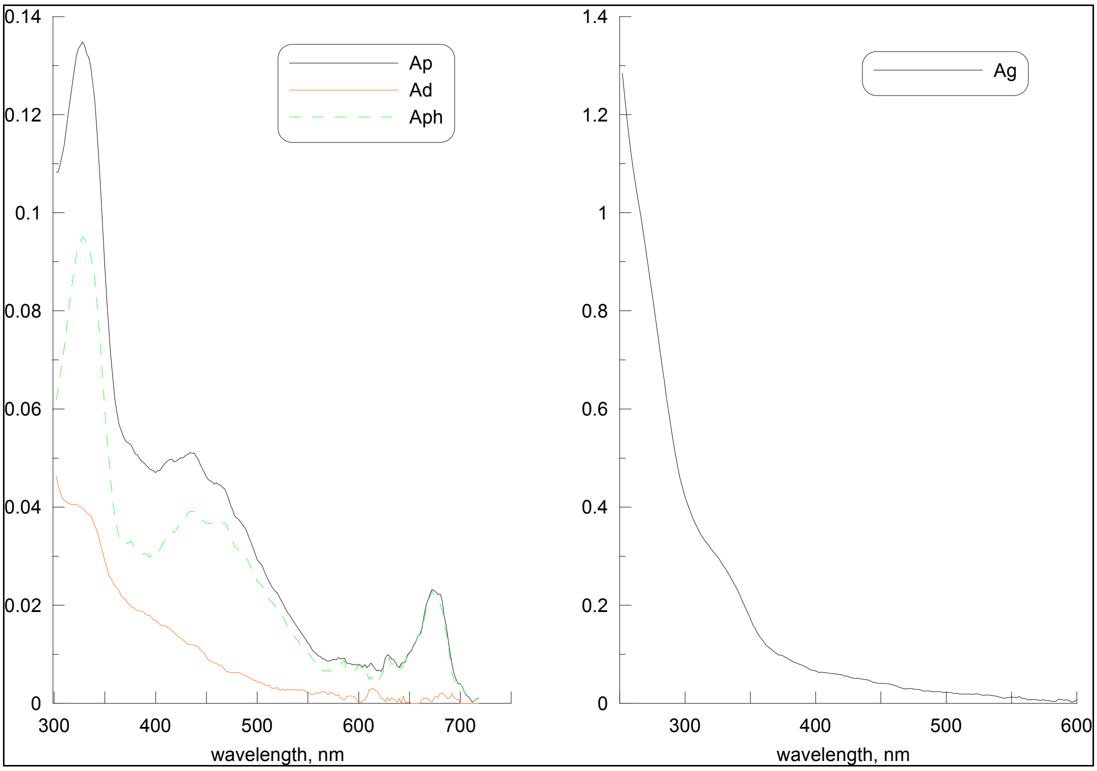


November 2001, St.94

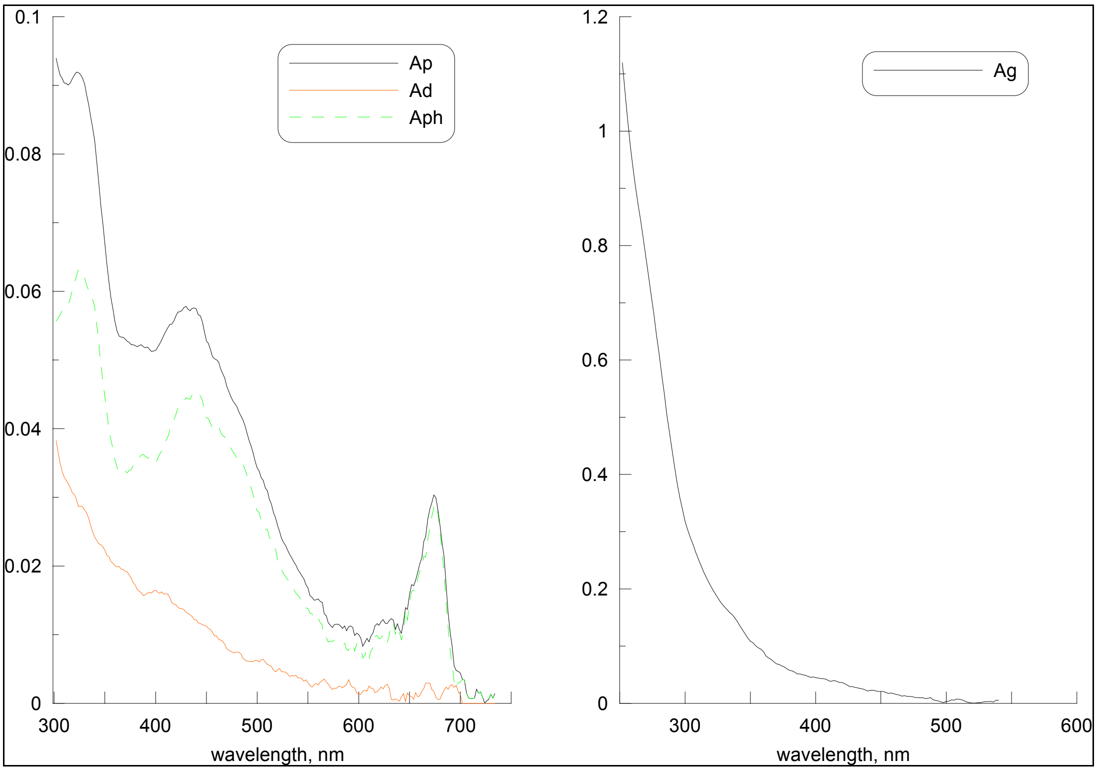


March 2002, St. 183

Fig.34. Examples of the spectral absorption coefficients of particulate (Ap), phytoplankton (Aph), detritus (Ad) and soluble (Ag) matter in the South eutrophic waters in November 2001 (upper) and March 2002 (lower).

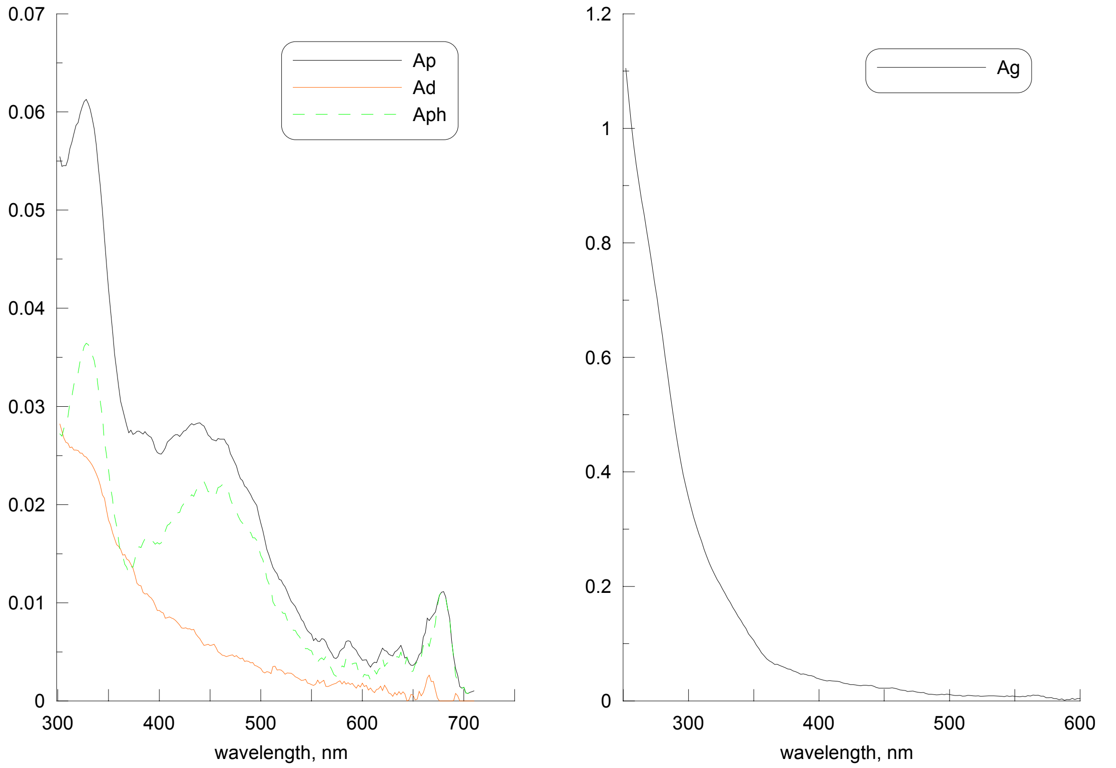


February 2002, St.176

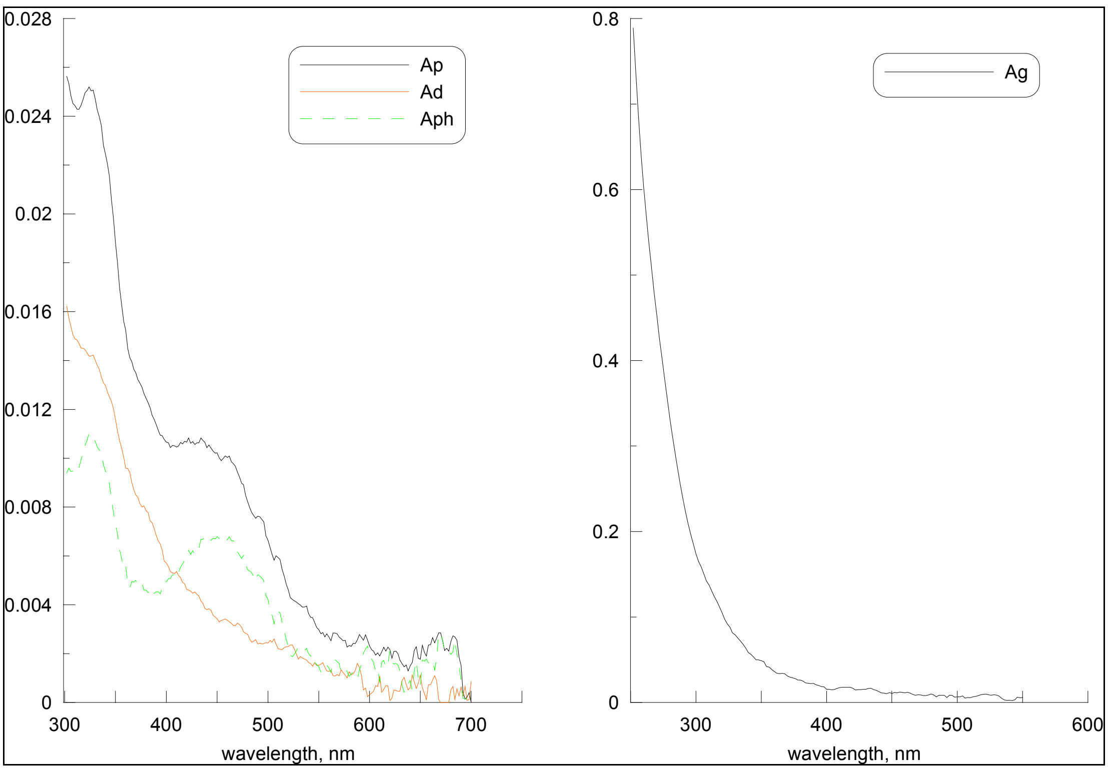


November 2001, St. 102

Fig.35. Examples of the spectral absorption coefficients of particulate (Ap), phytoplankton (Aph), detritus (Ad) and soluble (Ag) matter in the Antarctic eutrophic waters: near Antarctic Peninsula – St.176 (upper) and near South America - St.102 (lower).



December 2001, St.134



January 2002, St. 149

Fig.36. Examples of the spectral absorption coefficients of particulate (Ap), phytoplankton (Aph), detritus (Ad) and soluble (Ag) matter in the central part of Drake Passage:
December 2001 – St.134 (upper) and January 2002 – St. 149 (lower).

STALOG

Cruise	Station	Date [GMT]	Time [GMT]	LAT [deg]	LON [deg]
Ioffe_10	A (-2)	10/07/2001	10:04	52.24	3.04
Ioffe_10	B (-1)	10/07/2001	11:04	52.06	2.81
Ioffe_10	1 (-2)	10/09/2001	11:31	48.59	-5.58
Ioffe_10	2 (-1)	10/07/2001	12:31	48.39	-5.76
Ioffe_10	3 (0)	10/09/2001	13:31	48.18	-5.92
Ioffe_10	4 (+1)	10/09/2001	14:31	47.98	-6.10
Ioffe_10	5 (+2)	10/09/2001	15:31	47.79	-6.26
Ioffe_10	6 (-1)	10/10/2001	11:36	43.89	-9.47
Ioffe_10	7 (0)	10/10/2001	12:36	43.69	-9.62
Ioffe_10	8 (+1)	10/10/2001	13:36	43.49	-9.78
Ioffe_10	9 (-2)	10/11/2001	11:19	39.53	-13.05
Ioffe_10	10 (-1)	10/11/2001	12:19	39.43	-13.14
Ioffe_10	11 (0)	10/11/2001	13:19	39.27	-13.27
Ioffe_10	12 (+1)	10/11/2001	14:19	39.09	-13.42
Ioffe_10	13 (+2)	10/11/2001	15:19	38.90	-13.57
Ioffe_10	14 (-2)	10/12/2001	12:03	35.02	-16.59
Ioffe_10	15 (-1)	10/12/2001	13:03	34.83	-16.74
Ioffe_10	16 (0)	10/12/2001	14:03	34.65	-16.89
Ioffe_10	17 (+1)	10/12/2001	15:03	34.45	-17.03
Ioffe_10	18 (-1)	10/13/2001	12:09	30.44	-19.85
Ioffe_10	19 (0)	10/13/2001	13:09	30.25	-19.98
Ioffe_10	20 (+1)	10/13/2001	14:09	30.06	-20.12
Ioffe_10	21 (-1)	10/14/2001	12:52	25.67	-22.98
Ioffe_10	22 (0)	10/14/2001	13:52	25.48	-23.11
Ioffe_10	23 (+1)	10/14/2001	14:52	25.29	-23.23
Ioffe_10	24 (-1)	10/15/2001	13:35	21.00	-25.93
Ioffe_10	25 (0)	10/15/2001	14:35	20.81	-26.05
Ioffe_10	26 (+1)	10/15/2001	15:35	20.62	-26.17
Ioffe_10	27 (-2)	10/16/2001	11:41	16.77	-28.52
Ioffe_10	28 (-1)	10/16/2001	12:41	16.58	-28.63
Ioffe_10	29 (0)	10/16/2001	13:41	16.39	-28.74
Ioffe_10	30 (+1)	10/16/2001	14:41	16.20	-28.85
Ioffe_10	31 (-1)	10/17/2001	13:25	12.16	-31.29
Ioffe_10	32 (0)	10/17/2001	14:25	11.98	-31.41
Ioffe_10	33 (+1)	10/17/2001	15:25	11.79	-31.52
Ioffe_10	34 (-1)	10/18/2001	14:08	7.56	-33.87
Ioffe_10	35 (0)	10/18/2001	15:08	7.45	-33.87
Ioffe_10	36 (+1)	10/18/2001	16:08	7.44	-33.98
Ioffe_10	37A (-1)	10/19/2001	13:13	7.27	-34.59
Ioffe_10	37 (0)	10/19/2001	14:13	7.28	-34.58
Ioffe_10	37B (+1)	10/19/2001	15:13	7.29	-34.57
Ioffe_10	38 (0)	10/20/2001	14:55	7.12	-34.10
Ioffe_10	39 (0)	10/21/2001	14:00	7.10	-33.60
Ioffe_10	40 (-1)	10/22/2001	13:42	7.04	-34.27
Ioffe_10	41 (0)	10/22/2001	14:42	7.03	-34.26
Ioffe_10	42 (0)	10/23/2001	13:46	6.59	-34.52
Ioffe_10	43 (0)	10/24/2001	14:28	6.33	-33.53
Ioffe_10	44 (+1)	10/24/2001	15:28	6.32	-33.51
Ioffe_10	45 (-1)	10/25/2001	14:10	6.33	-33.59
Ioffe_10	46 (0)	10/25/2001	15:10	6.33	-33.60
Ioffe_10	47 (+1)	10/25/2001	16:10	6.33	-33.60
Ioffe_10	48 (-1)	10/26/2001	13:15	6.67	-32.96
Ioffe_10	49 (0)	10/26/2001	14:15	6.62	-32.88

Ioffe_10	50 (+1)	10/26/2001	15:15	6.53	-32.93
Ioffe_10	51 (-1)	10/27/2001	13:57	5.91	-33.19
Ioffe_10	52 (0)	10/27/2001	14:57	5.91	-33.18
Ioffe_10	53 (+1)	10/27/2001	15:57	5.91	-33.17
Ioffe_10	54 (-1)	10/28/2001	13:01	5.36	-33.16
Ioffe_10	55 (0)	10/28/2001	14:01	5.36	-33.14
Ioffe_10	56 (+1)	10/28/2001	15:01	5.36	-33.16
Ioffe_10	56A (+2)	10/28/2001	16:01	5.38	-33.11
Ioffe_10	57 (-2)	10/29/2001	12:43	5.67	-32.94
Ioffe_10	58 (-1)	10/29/2001	13:43	5.67	-32.94
Ioffe_10	59 (0)	10/29/2001	14:43	5.68	-32.96
Ioffe_10	60 (+1)	10/29/2001	15:43	5.75	-33.03
Ioffe_10	61 (+2)	10/29/2001	16:43	5.77	-33.04
Ioffe_10	62 (-1)	10/30/2001	12:48	5.49	-32.96
Ioffe_10	63 (0)	10/30/2001	13:48	5.38	-32.92
Ioffe_10	64 (+1)	10/30/2001	14:48	5.35	-32.86
Ioffe_10	65 (-1)	10/31/2001	13:31	5.05	-32.88
Ioffe_10	66 (0)	10/31/2001	14:31	5.05	-32.89
Ioffe_10	67 (+1)	10/31/2001	15:31	5.05	-32.90
Ioffe_10	68 (-1)	11/01/2001	12:37	0.89	-33.48
Ioffe_10	69 (0)	11/01/2001	13:37	0.68	-33.50
Ioffe_10	70 (+1)	11/01/2001	14:37	0.47	-33.53
Ioffe_10	71 (-1)	11/02/2001	13:20	-4.51	-34.17
Ioffe_10	72(0)	11/02/2001	14:20	-4.68	-34.19
Ioffe_10	73 (+1)	11/02/2001	15:20	-4.85	-34.21
Ioffe_10	74 (-1)	11/05/2001	13:51	-10.98	-35.42
Ioffe_10	75 (0)	11/05/2001	14:51	-11.15	-35.47
Ioffe_10	76 (+1)	11/05/2001	15:51	-11.38	-35.54
Ioffe_10	77 (-1)	11/06/2001	12:55	-15.67	-36.72
Ioffe_10	78 (0)	11/06/2001	13:55	-15.66	-36.74
Ioffe_10	79 (+1)	11/06/2001	14:55	-15.72	-36.76
Ioffe_10	80 (-1)	11/07/2001	13:38	-20.33	-38.02
Ioffe_10	81 (0)	11/07/2001	14:38	-20.53	-38.08
Ioffe_10	82 (+1)	11/07/2001	15:38	-20.75	-38.14
Ioffe_10	83 (-1)	11/08/2001	12:43	-24.75	-40.63
Ioffe_10	84 (0)	11/08/2001	13:43	-24.92	-40.78
Ioffe_10	85 (+1)	11/08/2001	14:43	-25.10	-40.91
Ioffe_10	86 (-1)	11/09/2001	13:27	-29.02	-44.05
Ioffe_10	87 (0)	11/09/2001	14:27	-29.18	-44.18
Ioffe_10	87A (+1)	11/09/2001	15:27	-29.35	-44.32
Ioffe_10	88 (-1)	11/10/2001	14:10	-33.29	-47.62
Ioffe_10	89 (0)	11/10/2001	15:10	-33.47	-47.77
Ioffe_10	90 (+1)	11/10/2001	16:10	-33.64	-47.92
Ioffe_10	90A (0)	11/11/2001	14:15	-37.23	-51.06
Ioffe_10	91 (-1)	11/13/2001	14:41	-43.65	-57.09
Ioffe_10	92 (0)	11/13/2001	15:41	-43.84	-57.28
Ioffe_10	93 (+1)	11/13/2001	16:41	-44.03	-57.47
Ioffe_10	94 (-1)	11/14/2001	13:47	-47.97	-61.02
Ioffe_10	95 (0)	11/14/2001	14:47	-48.18	-61.14
Ioffe_10	96 (+1)	11/14/2001	15:47	-48.38	-61.24
Ioffe_10	97 (+2)	11/14/2001	16:47	-48.58	-61.36
Ioffe_10	98 (-1)	11/15/2001	14:30	-52.73	-63.73
Ioffe_10	99 (0)	11/15/2001	15:30	-52.93	-63.85
Ioffe_10	100 (+1)	11/15/2001	16:30	-53.12	-63.96
Ioffe_10	101A (-2)	11/18/2001	14:00	-53.68	-63.65
Ioffe_10	101 (-1)	11/18/2001	15:00	-53.55	-63.50
Ioffe_10	102 (0)	11/18/2001	16:00	-53.40	-63.33

Ioffe_10	103 (+1)	11/18/2001	17:00	-53.25	-63.15
Ioffe_10	104 (-1)	11/21/2001	13:50	-52.25	-52.58
Ioffe_10	105 (0)	11/21/2001	14:50	-52.29	-52.17
Ioffe_10	106 (+1)	11/21/2001	15:50	-52.33	-51.89
Ioffe_10	107 (-1)	11/22/2001	12:54	-53.14	-44.56
Ioffe_10	108 (0)	11/22/2001	13:54	-53.18	-44.20
Ioffe_10	109 (+1)	11/22/2001	14:54	-53.22	-43.85
Ioffe_10	110 (-1)	11/27/2001	13:10	-58.02	-41.33
Ioffe_10	111 (0)	11/27/2001	14:10	-58.22	-41.54
Ioffe_10	112 (+1)	11/27/2001	15:10	-58.42	-41.75
Ioffe_10	113 (-1)	12/03/2001	14:08	-61.65	-64.57
Ioffe_10	114 (0)	12/03/2001	15:08	-61.53	-64.64
Ioffe_10	115 (+1)	12/03/2001	16:08	-61.39	-64.72
Ioffe_10	116 (-1)	12/06/2001	14:36	-57.39	-65.59
Ioffe_10	117 (0)	12/06/2001	15:36	-57.63	-65.51
Ioffe_10	118 (+1)	12/06/2001	16:36	-57.86	-65.45
Ioffe_10	118A (0)	12/07/2001	14:40	-62.52	-63.78
Ioffe_10	119 (-1)	12/15/2001	14:23	-56.86	-64.22
Ioffe_10	120 (0)	12/15/2001	15:23	-57.01	-64.04
Ioffe_10	121 (+1)	12/15/2001	16:23	-57.21	-63.78
Ioffe_10	122 (-1)	12/16/2001	14:28	-60.87	-57.67
Ioffe_10	122A (-1)	12/20/2001	14:38	-59.59	-62.94
Ioffe_10	122B (0)	12/20/2001	15:38	-59.43	-63.13
Ioffe_10	122C (+1)	12/20/2001	16:38	-59.27	-63.35
Ioffe_10	123 (-1)	12/23/2001	15:05	-57.16	-64.34
Ioffe_10	124 (0)	12/23/2001	16:05	-57.38	-64.22
Ioffe_10	125 (+1)	12/23/2001	17:05	-57.60	-64.12
Ioffe_10	126 (-1)	12/24/2001	14:10	-62.00	-60.09
Ioffe_10	127 (0)	12/24/2001	15:10	-62.19	-59.89
Ioffe_10	128 (+1)	12/24/2001	16:10	-62.30	-59.79
Ioffe_10	129	12/27/2001			
Ioffe_10	130 (-1)	12/28/2001	13:43	-61.71	-64.54
Ioffe_10	131 (0)	12/28/2001	14:43	-61.50	-64.66
Ioffe_10	132 (+1)	12/28/2001	15:43	-61.29	-64.76
Ioffe_10	133 (-1)	12/31/2001	14:10	-57.45	-64.23
Ioffe_10	134 (0)	12/31/2001	15:10	-57.66	-64.02
Ioffe_10	135 (+1)	12/31/2001	16:10	-57.83	-63.87
Ioffe_10	136	01/02/2002			
Ioffe_10	137 (-1)	01/06/2002	13:30	-62.12	-65.77
Ioffe_10	138 (0)	01/06/2002	14:30	-61.91	-65.83
Ioffe_10	139 (+1)	01/06/2002	15:30	-61.70	-65.88
Ioffe_10	140 (-1)	01/07/2002	14:11	-56.70	-67.19
Ioffe_10	141 (0)	01/07/2002	15:11	-56.47	-67.24
Ioffe_10	142 (+1)	01/07/2002	16:11	-56.25	-67.30
Ioffe_10	143 (-1)	01/09/2002	13:57	-57.00	-64.06
Ioffe_10	144 (0)	01/09/2002	14:57	-57.19	-63.81
Ioffe_10	145 (+1)	01/09/2002	15:57	-57.38	-63.56
Ioffe_10	146 (+2)	01/09/2002	16:57	-57.58	-63.31
Ioffe_10	147 (-1)	01/19/2002	14:25	-61.31	-67.03
Ioffe_10	148 (0)	01/19/2002	15:25	-61.48	-67.11
Ioffe_10	149 (+1)	01/19/2002	16:25	-61.68	-67.12
Ioffe_10	150 (-1)	01/26/2002	14:26	-60.56	-63.82
Ioffe_10	151 (0)	01/26/2002	15:26	-60.36	-63.99
Ioffe_10	152 (+1)	01/26/2002	16:26	-60.16	-64.16
Ioffe_10	153 (-1)	01/29/2002	14:52	-53.74	-63.73
Ioffe_10	154 (0)	01/29/2002	15:52	-53.61	-63.58
Ioffe_10	155 (+1)	01/29/2002	16:52	-53.48	-63.42

Ioffe_10	156 (-1)	02/01/2002	13:41	-52.26	-52.43
Ioffe_10	157 (0)	02/01/2002	14:41	-52.30	-52.10
Ioffe_10	158 (+1)	02/01/2002	15:41	-52.34	-51.78
Ioffe_10	159 (-1)	02/02/2002	12:45	-53.14	-44.60
Ioffe_10	160 (0)	02/02/2002	13:45	-53.17	-44.27
Ioffe_10	161 (+1)	02/02/2002	14:45	-53.21	-43.94
Ioffe_10	162A (0)	02/13/2002	14:57	-61.08	-64.88
Ioffe_10	162B(+1)	02/13/2002	15:57	-60.87	-64.99
Ioffe_10	162 (-1)	02/17/2002	13:28	-61.06	-68.02
Ioffe_10	163 (0)	02/17/2002	14:28	-61.27	-68.09
Ioffe_10	164 (+1)	02/17/2002	15:28	-61.48	-68.14
Ioffe_10	165 (-1)	02/18/2002	14:10	-66.23	-67.64
Ioffe_10	166 (0)	02/18/2002	15:10	-66.38	-67.65
Ioffe_10	167 (+1)	02/18/2002	16:10	-66.46	-67.69
Ioffe_10	168 (-1)	02/23/2002	14:24	-60.11	-64.19
Ioffe_10	169 (0)	02/23/2002	15:24	-59.92	-64.35
Ioffe_10	170 (+1)	02/23/2002	16:24	-59.70	-64.27
Ioffe_10	171 (-1)	02/27/2002	13:55	-56.81	-64.68
Ioffe_10	172 (0)	02/27/2002	14:55	-57.00	-64.49
Ioffe_10	173 (+1)	02/27/2002	15:55	-57.19	-64.30
Ioffe_10	174 (+2)	02/27/2002	16:55	-57.38	-64.13
Ioffe_10	175 (-1)	02/28/2002	14:37	-61.43	-60.37
Ioffe_10	176 (0)	02/28/2002	15:37	-61.63	-60.19
Ioffe_10	177 (+1)	02/28/2002	16:37	-61.92	-60.14
Ioffe_10	178 (-1)	03/05/2002	13:13	-61.65	-64.57
Ioffe_10	179 (0)	03/05/2002	14:13	-61.44	-64.68
Ioffe_10	180 (+1)	03/05/2002	15:13	-61.22	-64.80
Ioffe_10	181 (-1)	03/09/2002	13:56	-52.23	-63.17
Ioffe_10	182 (0)	03/09/2002	14:56	-52.03	-62.97
Ioffe_10	183 (+1)	03/09/2002	15:56	-51.85	-62.76
Ioffe_10	184 (-2)	03/10/2002	13:36	-47.68	-58.95
Ioffe_10	185 (-1)	03/10/2002	14:36	-47.46	-58.81
Ioffe_10	186 (0)	03/10/2002	15:36	-47.25	-58.66
Ioffe_10	187 (+1)	03/10/2002	16:36	-47.04	-58.53
Ioffe_10	188 (+2)	03/10/2002	17:36	-46.82	-58.41
Ioffe_10	189 (-1)	03/11/2002	13:39	-42.45	-56.34
Ioffe_10	190 (0)	03/11/2002	14:39	-42.23	-56.24
Ioffe_10	191 (+1)	03/11/2002	15:39	-42.00	-56.14
Ioffe_10	192 (+2)	03/11/2002	16:39	-41.78	-56.04
Ioffe_10	193 (-2)	03/12/2002	13:19	-37.36	-54.79
Ioffe_10	194 (-1)	03/12/2002	14:19	-37.25	-54.81
Ioffe_10	195 (0)	03/12/2002	15:19	-37.10	-54.82
Ioffe_10	196 (+1)	03/12/2002	16:19	-36.95	-54.83
Ioffe_10	197 (+2)	03/12/2002	17:19	-36.79	-54.85
Ioffe_10	198 (-1)	03/15/2002	14:44	-35.01	-52.47
Ioffe_10	199 (0)	03/15/2002	15:44	-35.01	-52.26
Ioffe_10	200 (+1)	03/15/2002	16:44	-35.00	-52.07
Ioffe_10	201 (-1)	03/16/2002	13:47	-32.55	-49.07
Ioffe_10	202 (0)	03/16/2002	14:47	-32.42	-48.92
Ioffe_10	203 (+1)	03/16/2002	15:47	-32.32	-48.79
Ioffe_10	204 (-1)	03/17/2002	12:50	-29.77	-45.82
Ioffe_10	205 (0)	03/17/2002	13:50	-29.64	-45.67
Ioffe_10	206 (+1)	03/17/2002	14:50	-29.51	-45.51
Ioffe_10	207 (-1)	03/18/2002	13:30	-26.77	-42.41
Ioffe_10	208 (0)	03/18/2002	14:30	-26.64	-42.27
Ioffe_10	209 (+1)	03/18/2002	15:30	-26.53	-42.14
Ioffe_10	210(-1)	03/19/2002	14:11	-24.77	-38.30

Ioffe_10	211 (0)	03/19/2002	15:11	-24.74	-38.07
Ioffe_10	212 (+1)	03/19/2002	16:11	-24.73	-37.93
Ioffe_10	213 (0)	03/20/2002	14:14	-24.16	-33.37
Ioffe_10	214 (-1)	03/21/2002	12:18	-23.63	-29.03
Ioffe_10	215 (0)	03/21/2002	13:18	-23.60	-28.81
Ioffe_10	216 (+1)	03/21/2002	14:18	-23.57	-28.59
Ioffe_10	217 (-1)	03/22/2002	12:59	-23.02	-24.20
Ioffe_10	218 (0)	03/22/2002	13:59	-23.01	-24.14
Ioffe_10	219 (+1)	03/22/2002	14:59	-23.01	-24.11
Ioffe_10	220 (-1)	03/23/2002	12:02	-22.48	-19.78
Ioffe_10	221 (0)	03/23/2002	13:02	-22.45	-19.55
Ioffe_10	222 (+1)	03/23/2002	14:02	-22.42	-19.33
Ioffe_10	223 (-1)	03/24/2002	11:06	-21.80	-14.81
Ioffe_10	224 (0)	03/24/2002	12:06	-21.77	-14.65
Ioffe_10	225 (+1)	03/24/2002	13:06	-21.74	-14.49
Ioffe_10	226 (-1)	03/25/2002	11:47	-20.95	-11.82
Ioffe_10	227 (0)	03/25/2002	12:47	-20.93	-11.68
Ioffe_10	228 (+1)	03/25/2002	13:47	-20.90	-11.54
Ioffe_10	229 (-1)	03/26/2002	10:50	-20.59	-11.67
Ioffe_10	230 (0)	03/26/2002	11:50	-20.59	-11.67
Ioffe_10	231 (+1)	03/26/2002	12:50	-20.60	-11.69
Ioffe_10	232 (-1)	03/27/2002	11:32	-20.10	-11.56
Ioffe_10	233 (0)	03/27/2002	12:32	-20.00	-11.62
Ioffe_10	234 (+1)	03/27/2002	13:32	-20.00	-11.76
Ioffe_10	235 (-1)	03/28/2002	12:13	-20.20	-11.84
Ioffe_10	236 (0)	03/28/2002	13:13	-20.20	-11.86
Ioffe_10	237 (+1)	03/28/2002	14:13	-20.21	-11.84
Ioffe_10	238 (-1)	03/29/2002	11:16	-18.31	-13.20
Ioffe_10	239 (0)	03/29/2002	12:16	-18.13	-13.32
Ioffe_10	240 (+1)	03/29/2002	13:16	-17.95	-13.44
Ioffe_10	241 (-1)	03/30/2002	11:56	-13.89	-16.16
Ioffe_10	242 (0)	03/30/2002	12:56	-13.76	-16.25
Ioffe_10	243 (+1)	03/30/2002	13:56	-13.62	-16.36
Ioffe_10	244A (-2)	03/31/2002	11:37	-10.67	-18.86
Ioffe_10	244 (-1)	03/31/2002	12:37	-10.54	-18.96
Ioffe_10	245 (0)	03/31/2002	13:37	-10.41	-19.08
Ioffe_10	246 (+1)	03/31/2002	14:37	-10.26	-19.19
Ioffe_10	247 (-1)	04/01/2002	11:40	-7.31	-21.55
Ioffe_10	248 (0)	04/01/2002	12:40	-7.20	-21.64
Ioffe_10	249 (+1)	04/01/2002	13:40	-7.08	-21.73
Ioffe_10	250 (-1)	04/02/2002	12:21	-4.05	-24.08
Ioffe_10	251 (0)	04/02/2002	13:21	-3.92	-24.19
Ioffe_10	252 (+1)	04/02/2002	14:21	-3.78	-24.29
Ioffe_10	253 (-1)	04/03/2002	13:01	-0.66	-26.87
Ioffe_10	254 (0)	04/03/2002	14:01	-0.49	-27.01
Ioffe_10	255 (+1)	04/03/2002	15:01	-0.34	-27.13
Ioffe_10	256 (-1)	04/04/2002	13:42	2.81	-29.65
Ioffe_10	257 (0)	04/04/2002	14:42	2.93	-29.76
Ioffe_10	258 (+1)	04/04/2002	15:42	3.05	-29.88
Ioffe_10	259 (-1)	04/05/2002	12:46	5.53	-32.38
Ioffe_10	260 (0)	04/05/2002	13:46	5.50	-32.51
Ioffe_10	261 (+1)	04/05/2002	14:46	5.47	-32.64
Ioffe_10	262 (-1)	04/06/2002	13:27	5.61	-33.18
Ioffe_10	263 (0)	04/06/2002	14:27	5.60	-33.20
Ioffe_10	264 (+1)	04/06/2002	15:27	5.57	-33.21
Ioffe_10	265 (-1)	04/07/2002	12:31	5.86	-33.14
Ioffe_10	266 (0)	04/07/2002	13:31	5.87	-33.18

Ioffe_10	267 (+1)	04/07/2002	14:31	5.88	-33.19
Ioffe_10	268 (-1)	04/08/2002	13:11	5.90	-33.19
Ioffe_10	269 (0)	04/08/2002	14:11	5.90	-33.19
Ioffe_10	270 (+1)	04/08/2002	15:11	5.89	-33.20
Ioffe_10	271 (-1)	04/09/2002	13:52	5.91	-33.18
Ioffe_10	272 (0)	04/09/2002	14:52	5.91	-33.16
Ioffe_10	273 (+1)	04/09/2002	15:52	5.91	-33.17
Ioffe_10	274 (-1)	04/10/2002	12:55	5.92	-33.21
Ioffe_10	275 (0)	04/10/2002	13:55	5.93	-33.21
Ioffe_10	276 (+1)	04/10/2002	14:55	5.93	-33.21
Ioffe_10	277 (-1)	04/11/2002	13:37	6.28	-33.67
Ioffe_10	278 (0)	04/11/2002	14:37	6.41	-33.71
Ioffe_10	279 (+1)	04/11/2002	15:37	6.54	-33.76
Ioffe_10	280 (-1)	04/12/2002	12:40	7.57	-33.83
Ioffe_10	281 (0)	04/12/2002	13:40	7.57	-33.94
Ioffe_10	282 (+1)	04/12/2002	14:40	7.59	-34.05
Ioffe_10	283 (-1)	04/13/2002	13:22	9.11	-31.32
Ioffe_10	284 (0)	04/13/2002	14:22	9.21	-31.19
Ioffe_10	285 (+1)	04/13/2002	15:22	9.31	-31.06
Ioffe_10	286 (-1)	04/14/2002	12:25	11.49	-28.18
Ioffe_10	287 (0)	04/14/2002	13:25	11.53	-28.12
Ioffe_10	288 (+1)	04/14/2002	14:25	11.54	-28.11
Ioffe_10	289 (-1)	04/15/2002	13:29	12.60	-26.98
Ioffe_10	290 (0)	04/15/2002	14:29	12.81	-26.89
Ioffe_10	291 (+1)	04/15/2002	15:29	13.02	-26.81
Ioffe_10	292 (-1)	04/16/2002	12:33	17.26	-25.35
Ioffe_10	293 (0)	04/16/2002	13:33	17.45	-25.24
Ioffe_10	294 (+1)	04/16/2002	14:33	17.64	-25.13
Ioffe_10	295 (-1)	04/17/2002	13:14	21.73	-22.72
Ioffe_10	296 (0)	04/17/2002	14:14	21.91	-22.61
Ioffe_10	297 (+1)	04/17/2002	15:14	22.10	-22.50
Ioffe_10	298 (-1)	04/18/2002	12:17	26.04	-20.10
Ioffe_10	299 (0)	04/18/2002	13:17	26.23	-19.99
Ioffe_10	300 (+1)	04/18/2002	14:17	26.41	-19.87
Ioffe_10	301 (-1)	04/19/2002	12:58	29.97	-17.67
Ioffe_10	302 (0)	04/19/2002	13:58	29.97	-17.69
Ioffe_10	303 (+1)	04/19/2002	14:58	29.97	-17.71
Ioffe_10	304 (-1)	04/20/2002	12:02	32.47	-16.02
Ioffe_10	305 (0)	04/20/2002	13:02	32.59	-15.94
Ioffe_10	306 (+1)	04/20/2002	14:02	32.72	-15.88
Ioffe_10	307 (-2)	04/212002	11:44	35.44	-14.32
Ioffe_10	308 (-1)	04/21/2002	12:44	35.56	-14.25
Ioffe_10	309 (0)	04/21/2002	13:44	35.68	-14.18
Ioffe_10	310 (+1)	04/21/2002	14:44	35.80	-14.11
Ioffe_10	311 (+2)	04/21/2002	15:44	35.92	-14.04
Ioffe_10	312 (-1)	04/22/2002	11:48	38.26	-12.65
Ioffe_10	313 (0)	04/22/2002	12:48	38.37	-12.58
Ioffe_10	314 (+1)	04/22/2002	13:48	38.48	-12.52
Ioffe_10	315 (-2)	04/23/2002	11:29	40.79	-11.09
Ioffe_10	316 (-1)	04/23/2002	12:29	40.89	-11.03
Ioffe_10	317 (0)	04/23/2002	13:29	41.00	-10.96
Ioffe_10	318 (+1)	04/23/2002	14:29	41.10	-10.90
Ioffe_10	319 (+2)	04/23/2002	15:29	41.20	-10.84
Ioffe_10	320 (-1)	04/24/2002	11:33	43.37	-9.65
Ioffe_10	321 (0)	04/24/2002	12:33	43.47	-9.55
Ioffe_10	322 (+1)	04/24/2002	13:33	43.57	-9.46