INSTITUTO ESPAÑOL DE OCEANOGRAFÍA

IEO

CRUISE REPORT

CRUISE: OMEX-1099

Ship: B/O Thalassa

Chief Scientist: Manuel Varela (IEO-A Coruña)

Start Date: 13/10/99 **End Date:** 20/10/99

Start Port: Vigo **End Port:** A Coruña

Objectives:

The main objective of the cruise is the study of physical, chemical and biological properties in the continental shelf and shelf-break zone of the Galician coast near the Rias Baixas (NW Spain) during autumn. The results obtained will be used as input data to models and biogeochemical budgets to determine the exchange of matter between the continental shelf and the ocean. This cruise is part of Workpackage 2 of the project OMEX-II, Phase II. The study area is located between Cape Finisterre (43°00' N) and Ría de Vigo (42°09' N).

The specific objectives are:

1.- Physical and chemical oceanography:

1.1.- Measurement of vertical profiles of temperature, salinity and fuorescence in OMEX-II reference stations.

1.2.- Measurement of dissolved inorganic nutrient concentration in coastal upwelling stations and oligotrophic oceanic stations.

2.- Phytoplankton:

2.1.- Study of distribution patterns of different size-classes of phytoplankton in the area.

2.2.- Comparative study of carbon and oxygen fluxes through phyto and microplankton in coastal upwelling stations and oligotrophic oceanic stations.

2.3.- Study of the photosynthetically derived carbon fraction that fuels the microbial food-web in selected stations.

2.4.- Characterization of the dissolved organic matter (DOM) by chemical and optical methods.

3.- Microplankton:

3.1.- Measurement of the abundance of taxonomic and trophic groups of microplankton (bacteria, phytoplankton, flagellates and ciliates).

3.2.- Measurement of bacterial production rates in selected stations.

3.3.- Measurement of ammonium and dissolved organic nitrogen (DON) excretion rates of microplankton in selected stations.

3.4.- Measurement of production and respiraion rates of the microplankton community in selected stations.

4.- Zooplankton

4.1.- Measurement of mesozooplankton abundance and biomass.

4.2.- Measurement of herbivory rates of copepods in selected stations.

4.3.- Measurement of copepod respiration rates in selected stations.

4.4.- Measurement of ammonium excretion rates of copepods in selected stations.

4.5.- Measurement of DOC and DON production rates in presence of copepods in selected stations.

4.6.- Determination of egg and feces production rates of copepods in selected stations.

Participant Scientists:

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Distribution of tasks:

Task	Objective	Institution
1.1	CTD Measurements	IEO, UGBO
1.2	Inorganic nutrients	IEO
2.1	Photosynthetic pigments	UV
2.1	Phytoplankton species	IEO
2.2	Primary production	UV
2.3	DOC Production	UV
2.4	DOM characterization	UV
3.1	Bacteria, flagellates and ciliates abundance	IEO, UDC
3.2	Bacterial Production	IEO, UDC
3.3	Ammonium and DON excretion	IEO
3.4	Community production and respiration	UV
4.1	Mesozooplankton abundance and biomass	UO
4.2	Copepod herbivory	UO
4.3	Copepod respiration	UO
4.4	Ammonium excretion of copepods	UO
4.5	DOC and DON production with copepods	UO, UV
4.6	Egg and feces production of copepods	UO

Methods:

Sampling:

Sampling was made using CTD-Rossette casts and plankton hauls using nets. Stations were distributed in three transects normal to the coast (Figure 1), following the strategy adopted in OMEX-II Workpackage 2 cruises. Transect N was located in the vicinity of Cape Finisterre. Transect P was located near Ria de Muros, and Transect S was at the latitude of Ria de Vigo. In all stations a CTD cast down to 500 m depth was made, and water samples were collected by the Rossette bottles at standard depths to analyse inorganic nutrients. Zooplankton was also collected in all stations by vertical net hauls (WP_2) from 200 m (or near the bottom at coastal stations) to the surface. Irradiance vertical profiles and additional water samples for dissolved carbon and nitrogen determination, photosynthetic pigment analysis and plankton for on board experimentation were obtained in selected stations (Biological Stations). Each Biological Station was occuppied between 00:00 and 12:00 h (local time = GMT + 2) and there were made experimental measurements of primary production and DOC excretion, ammonium and DON regeneration, bacterial abundance, oxygen production and consumption by microplankton, and herbivory, ammonium excretion, egg and fecal pellet production rates of zooplankton.

Oceanographic stations: Positions of the first CTD cast at each station are given below:

Transect	Station	N Latitude	W Longitude	Biological Station	Depth (m)
S	2	42º 09.48'	08º 57.12'		72
	1	42º 09.24'	09º 08.27'	*	140
	3	42º 09.00'	09º 19.00'		208
	4	42º 08.51'	09º 28.25'	*	1041
	5	42º 08.48'	09º 38.37'		1925
	6	42º 08.09'	09º 59.55'		2482
P	8	42º 40.51'	09º 12.47'	*	94
	8a	42º 40.00'	09º 18.38'		111
	9	42º 40.07'	09º 30.34'		215
	9a	42º 40.06'	09º 33.24'		510
	10	42º 39.57'	09º 36.20'	*	963
	11	42º 40.00'	09º 50.40'		1944
	12	42º 40.04'	10º 00.07'		2219
N	19	42º 59.50'	09º 18.04'	*	38
	20	43º 00.04'	09º 24.00'		121
	16	42º 59.59'	09º 31.05'		213
	18	42º 59.56'	09º 38.56'		1500
	17	42º 59.59'	09º 42.55'		2230
	15	43º 00.21'	10º 01.11'		2995

Specific methods

1.- Descriptive variables (IEO):

Water samples were collected with 12 l Niskin bottles attached to a 24-position Rossette (General Oceanics). The rossette was coupled to a CTD Mark-III with temperature, conductivity, presure and fluorescence sensors. The CTD was calibrated in March 1998. At least one vertical profile from the surface to 500 depth was made with the CTD at all stations, where bathymetry permitted. In some transects, detailed measurements of conductivity, temperature, pressure, fluorescence and photosynthetically active irradiance (PAR) were obtained using a Chelsea Instruments UOR.

Irradiance and fluorescence vertical profiles were also measured at Biological Stations using a CTD Seabird SBE-25 (date of last calibration: May 1998). Crosscalibration of CTD probes was made after coupling all CTD to the rossette in one of the stations.

Water samples for the determination of dissolved inorganic nutrients (nitrate, nitrite, phosphate, silicate and ammonium) were collected at standard depths (5, 10, 20, 30, 40, 50, 60, 75, 100, 125, 150, 200, 300, 400, 500, 600, 700, 1000, 1500, 2000, 2500 and 3000 m). These samples were drwan directly from the Niskin bottles in polyethylene tubes and were immediately frozen until later analysis in the laboratory of IEO. Nutrient analysis were made using an Autoanalyser Technicon AA-II and the procedures described in Grasshoff *et al*. (1984).

The timing and positions of CTD casts are listed below:

Cast	Station	Date	Start time (GMT)	End time (GMT)	N Latitude start	W Longitude start	N Latitude end	W Longitude end	Depth (m)
0	2	14/10/99	10:48	11:05	42º 09.48	8º 57.12	42º 09.61	8º 57.08	72
1	6	14/10/99	15:22	15:46	42º 08.90	9º 59.55	42º 08.87	9º 59.09	2482
2	5	14/10/99	19:08	19:32	42º 08.49	9º 38.41	42º 08.83	9º 38.37	1925
3	4	14/10/99	21:49	22:07	42º 08.52	9º 28.25	42º 09.03	9º 28.50	1088
4	4	15/10/99	8:09	8:31	42º 08.55	9º 27.59	42º 08.77	9º 27.58	1041
5	3	15/10/99	10:41	10:56	42º 09.10	9º 19.00	42º 09.06	9º 18.77	208
6	1	15/10/99	20:07	20:19	42º 09.24	9º 08.27	42º 09.07	9º 08.27	140
7	1	16/10/99	7:40	7:54	42º 08.46	9º 08.30	42º 08.89	9º 08.36	138
8	12	16/10/99	14:56	15:18	42º 40.04	10º 00.07	42º 39.26	10º 00.37	2219
9	11	16/10/99	17:36	17:53	42º 40.00	9º 50.40	42º 40.08	9º 50.95	1944
10	10	16/10/99	20:50	21:08	42º 39.58	9º 36.20	42º 40.00	9º 36.70	963
11	10	17/10/99	7:47	8:04	42º 40.20	9º 36.16	42º 40.35	9º 35.69	939
12	9	17/10/99	9:36	9:45	42º 40.07	9º 30.34	42º 40.11	9º 30.09	215
13	9a	17/10/99	10:57	11:12	42º 40.06	9º 33.24	42º 40.22	9º 33.18	510
14	8a	17/10/99	13:30	13:45	42º 40.01	9º 18.38	42º 40.00	9º 18.56	111
15	8	17/10/99	14:37	14:42	42º 40.52	9º 12.47	42º 39.87	9º 12.11	94
16	8	17/10/99	20:30	20:37	42º 40.52	9º 12.47	42º 40.09	9º 12.47	94
17	8	18/10/99	7:41	7:52	42º 40.09	9º 12.37	42º 40.80	9º 13.00	94
18	15	18/10/99	14:06	14:26	43º 00.21	10º 01.11	42º 59.96	10º 01.39	2995
19	17	18/10/99	17:09	17:30	42º 59.59	9º 42.55	43º 01.15	9º 42.52	2230
20	18	18/10/99	18:50	19:15	42º 59.56	9º 38.56	43º 00.22	9º 38.40	1500
21	19	18/10/99	21:00	21:07	42º 59.50	9º 18.04	42º 59.86	9º 17.88	38
22	19	19/10/99	7:42	7:51	42º 59.50	9º 18.04	42º 59.71	9º 18.31	38
23	20	19/10/99	9:13	9:23	43º 00.04	9º 24.00	43º 00.05	9º 23.99	41
24	16	19/10/99	11:41	11:52	42º 59.59	9º 31.05	42º 59.74	9º 30.89	213

2. Phytoplankton (UV, IEO):

The following table list stations where dissolved oxygen (Dis. O_2), size-fractionated chlorophyll a, b and c (SF Chla) and primary production (SF Prod), DOC production rate (DOC Prod), oxygen production and respiration rate (O_2 Prod), free and combined dissolved carbohydrates (Dis. Carbo) and fluorescence characteristics of DOM (DOM fluor), was measured in 3 to 5 depths within the euphotic zone listed in the table below:

CAST	Station	SF Chla	SF Prod	DOC Prod	O_2 Prod
0	2	5,20,30,40,60			
1	6	5,20,30,40,50,75			
2	5	5,20,30,40,50,75			
4	4	5,10,20,40,50,60	5,10,20,40,50	5,10,20,50	5,10,20,50,100
5	3	5,10,20,40,50,60			
7	1	5,10,25,30,40,50	5,10,25,30,40	5,10,25,40	5,10,25,40,75
8	12	5,10,20,30,40,60			
9	11	5,10,30,40,50,60			
11	10	5,10,20,30,40,50	5,10,30,40,50	5,10,30,50	5,10,30,50,100
12	9	5,10,20,30,40,50			
17	8	5,10,20,30,40,60	5,10,20,30,40	5,10,20,40	5,10,20,40,75
18	15	5,10,20,40,50,60			
19	17	5,20,30,50,55,60			
20	18	5,20,30,50,55,75			
22	19	5,10,15,20,30,40	5,10,15,20,30	5,15,30	5,10,20,30,75
23	20	5,10,20,30,40,60			
24	16	5,10,20,30,40,60			

Samples for the determination of phytoplankton species were collected at the same depth as primary production determinations. These samples were preserved with Lugol's solution until later observation in the laboratory.

Chlorophyll concentration was analysed after subsequent filtration of 150 ml of sample through 5 and 2 μm polycarbonate and glass fiber (APFF) Millipore filters. The extraction of pigments was made in 90 % cold acetone during 10 h. Fluorescence due to chlorophylls a, b and c was measured using a SAFAS FLX spectrofluorimeter calibrated with pure pigments extracts obtained by HPLC. Calculations were made using the following equations:

$$F\ (432/667) = 2.53\ Ca + 20.207\ Cb + 18.329\ Cc$$
$$F\ (463/652) = 644.2\ Ca + 3.546\ Cb + 11.61\ Cc$$
$$F\ (451/633) = 1408.3\ Ca + 58.47\ Cb + 2.516\ Cc$$

where F is fluorescence at the corresponding excitation/emission wavelenghts and Ca, Cb and Cc are the concentrations (mg m^{-3}) of chlorophylls *a*, *b*, and *c*, respectively. In addition, parallel measurements of chlorophyll *a* concentration were made with a Turner-Designs fluorometer and the results were used to calibrate the 'in situ' fluorescence measurements obtained with the fluorometer of the Mark-III CTD.

Size-fractionated primary production rates were measured using four (1 dark) 80 ml seawater samples drawn from the Niskin bottles and innoculated with 370 KBq (10 µCi) of $NaH_{14}CO_3$. Samples were kept in an on-deck incubator simulating the irradiance experienced by the cells at their original depth. Bottles were incubated for 4 h at noon and then filtered subsequently through 5 µm, 2 µm polycarbonate filters and Millipore APFF glass fiber filters which were exposed to concentrated HCl fuming for 12 h. Four ml of scintillation cocktail were added to each vial and the radiactivity determined with a LKB ß-scintillation counter.

Dissolved organic carbon production rates were determined using four 30 ml seawater samples collected from selected depths, inoculated with 1295 KBq (35 µCi) of $NaH^{14}CO_3$ and incubated in an on-deck incubator for 2 h. Two 8 ml subsamples were drawn from each bottle and filtered through Millipore APFF glass fiber filters. Filtrates were acidified with 40 µl of HCl 50% and bubbled with CO_2 free air for 12 h. Filters were decontaminated as described above. Scintillation cocktail was then added to both filters and filtrates. Duplicate blank tests were run in parallel by inoculating, incubating and processing 0.2 µm filtered seawater in the same way as mentioned before.

Oxygen production and respiration rates were measured in twelve 125 ml seawater samples collected from the Niskin bottles into individually calibrated borosilicate glass bottles. Four samples were immediately fixed, four were kept in the dark for 24 h and the four remaining were kept under a light-dark diel cycle in an on-deck incubator. Dissolved oxygen concentration was meassured through automated precision Winkler titration performed with a Metrohm 716 DMS Titrino, using a potentiometric end point.

Dissolved mono and polysaccharides and DOM fluorescence were determined in 30 ml seawater samples, filtered through pre-combusted Millipore APFF glass fiber filters using acid-washed Teflon syringes. The filtrate was disposed into pre-combusted glass ampoules which were sealed immediately after sampling and subsequently kept frozen (-20 °C) until further analysis ashore. Dissolved carbohydrates were determined according to Myklestad *et al*. (1997). DOM fluorescence was measured with a Safas flx spectrofluorometer at excitation/emission wavelengths corresponding to tyrosine-like substances (230/290), tryptophane-like substances (270/320) and humic compounds (254/440 and 308/440). Raman correction was performed following Determan et al. (1994).

3. Bacteria and Microplankton:

3.1. Bacteria (UA):

Samples for determination of abundance and biomass of pelagic bacteria were collected at biological stations, filtered on black membrane 0.2 µm pore-size filters and stained with DAPI (Diamidino-phenil-indole) on board. Filters were mounted on slides with low fluorescence oil and stored frozen until observation under UV light in the laboratory using an epifluorescence microscope (Porter and Feig, 1980).

At some stations bacteria were incubated with ^{3}H-Thymidine for the determination of some parameters of bacterial production: incubation time, saturation of Leucine uptake and conversion factor between Leucine and carbon uptake (Kirchman and Ducklow, 1993). In all cases 3 replicates of 1 ml were incubated with ^{3}H-Thymidine following the procedure described by Kirchman (1993). Labelled bacteria were collected by centrifugaction (Smith and Azam, 1992).

The samples and experiments were as follows:

Station	Cast	Activities	Depths (m)
6	12	Saturation experiment Conversion factor	5 5
4	5	Abundance & Biomass Incubation time	5, 10, 20, 40, 50 5
1	8	Abundance & Biomass	5, 10, 25, 30, 40
12	9	Conversion factor	5
10	12	Abundance & Biomass Saturation experiment	5, 10, 20, 30, 40 5
8	18	Abundance & Biomass	5, 10, 20, 30, 40
19	23	Abundance & Biomass Incubation time Saturation experiment	5, 10, 15, 20, 30 5 5

3.2. Microplankton (IEO):

Samples for determination of phytoplankton species, flagellates and ciliates were collected with the Rossete at selected depths of biological stations and preserved with Lugol's solution. In addition, vertical hauls in the euphotic zone with plankton nets (20 µm mesh) collected "net phytoplankton" samples that were preserved with buffered formalin. Samples will be observed with an inverted microoscope in the laboratory and counts will be made using the Uthermöhl (1958) method.

The following table list the collected samples:

Station	Cast	Samples	Depths (m)
2	0	net phytoplankton	100
6	1	net phytoplankton	100
4	4	net phytoplankton, Lugol samples	100 5, 10, 20, 40 and 50 m
1	7	net phytoplankton, Lugol samples	100 5, 10, 25, 30 and 40 m
12	8	net phytoplankton	100
10	11	net phytoplankton, Lugol samples	100 5, 10, 30, 40 and 50 m
8	17	net phytoplankton, Lugol samples	100 5, 10, 20, 30 and 40 m
19	22	net phytoplankton Lugol samples	25 5, 10, 15, 20 and 30 m

3.3. Ammonium and DON excretion (IEO):

Experimental determination of ammonium and DON excretion rates by the microplanktonic community were made at three depths within the euphotic layer of biological stations. Duplicate water samples from the Niskin bottles were placed in polycarbonate bottles, inoculated with trace concentrations of $(^{15}NH_4)_2\ SO_4$ and incubated in an on-deck incubator simulating irradiance levels of the sampling depths with filters. Incubations were terminated by filtration through glass-fiber filters (Millipore AF) and both the particulate material and the filtrate were kept for further determination of particulate and dissolved nitrogen concentrations and ^{15}N enrichment. Two replicates were inoculated and immediately filtered to determine initial nitrogen concentrations. All samples were frozen until further processing in the laboratory using the method of Slawyk and Raimbault (1995). Inorganic nitrogen concentrations will be analysed using the methods of Grasshoff et al. (1983) and a Technicon AAII autoanalyser. Particulate nitrogen concentration and ^{15}N enrichment will be determined using an isotope-ratio mass spectrometer (Integra-N).

The stations and depths studied are listed below.

Station	Cast	Depths (m)
4	4	5, 20, and 50 m
1	7	5, 15 and 40 m
10	11	5, 30 and 50 m
18	17	5, 20 and 40 m
19	22	5, 15 and 20 m

3.4. Respiration of the microplanktonic community: (see section 2. Phytoplankton)

4. Zooplankton (UO):

Mesozooplankton samples to determine abundance and biomass were collected at all stations by means of vertical hauls (0-200 m) of a WP_2 triple net of 40 cm diameter and 200 µm mesh size. In order to study diel patterns, night (1 h aprox.) and day (11 h aprox.) samples were collected at biological stations. All samples were fractionated in three size classes using meshes of 200, 500 and 1000 µm. Samples for systematic analysis were fixed in 4% formalin, and those for biomass measurement were filtered on preweighted GF/A glass-fiber filters and frozen until dry-weight determiantions and analysis of carbon and nitrogen content using a CNH elemental analyser.

Mesozooplankton grazing was estimated by the gut pigment method (Mackas and Bohrer, 1976) at all stations, using both night and day samples at biological stations. Vertical tows from 200 m depth to the surface were fractionated in three size classes as those for biomass. After fractionation animals were filtered on skin filtres and inmediately frozen in dark. Also, unfractionated samples were preconcentrated in 30 ml of filtered seawater and inmediately frozen in liquid nitrogen, to estimate the gut content of gelatinous organisms, principally appendicularians and doliolids. In order to capture living animals for experiments, vertical tows using an RF net were performed. Evacuation rates were obtained from experiments during the night in intensive stations to obtain the gut passage time. The animals were fractionated and inmediately placed on filtered (0.2 µm) sea water. Some individuals were filtered as for the gut content method at consecutive time intervals.

Experiments to determine the influence of the phytoplankton size on the ingestion of the mesozooplankton size classes were performed at the intensive stations. Size fractionated animals were maintained during 7 h in filtered seawater to empty their gut. Water samples from the deth of the chlorophyll maximum were prefiltered by different mesh sizes, and animals of different size fractions were incubated for 3 or 4 hours. At the beginning and the end of the experiments, water subsamples were taken to measure chlorophyll a concentration, C, N and Si. Subsamples of the fecal pellets produced were preserved either in Lugol's solution for qualitative analysis or frozen for the determination of C and N content. All animals used in the experiments were preserved for counting and determination.

Fecal pellet production rate by copepods of three size classes was determined in experiments at biological stations where the animals were fed for 24 hours with water of the chlorophyll maximum. The obtained fecal pellets were preserved frozen for C, N and chlorophyll analysis. Chlorophyll concentrations of the incubation water were determined at the start and at the end of the experiments.

Experiments to determine the specific ratios of respiration and excretion of the mesozooplankton were performed at biological stations in the same size fractions as those for biomass. The individuals were collected by net tows and maintained in filtered seawater for acclimatization for two hours. Unselected animals of the whole community were introduced in one liter oxygen bottles, and maintained at the temperature of surface water for 20 to 24 hours. Subsamples for initial and final oxygen, ammonia and phosphate were taken. The organisms were filtered on Whatman GF/A filters and frozen until analysis of C and N content at the laboratory.

The role of herbivorous mesozooplankton on DOC and DON production was estimated at station 16, in collaboration with UV and IEO, by incubation of three replicated samples of prefiltered (200 µm mesh size) seawater in 125 ml polycarbonate bottles, as for DOC and DON production determinations (see sections 2. Phytoplankton and 3.3 Ammonium and DON excretion). In addition, three aditional replicates were incubated with 4 adult specimens of *Calanus helgolandicus* and similar experimental bottles were incubated to analyse copepod grazing, collecting subsamples of water at the beginning and the end of the incubations for chlorophyll, C, N and dissolved carbohydrates analysis.

Secondary production was estimated by the egg production method (Hay, 1995) in the most abundant species of the different size classes. The species used were *Calanus helgolandicus, Calanus tenuicornis, Calanoides carinatus, Centropages typicus, Acartia clausi.* Mature females were selected from vertical net hauls (200 m depth to surface) and incubated in water from the chlorophyll maximum for 24 to 48 hours. The eggs produced in the two 24 hours intervals as well as the incubated females were filtered and preserved until laboratory analysis of C and N.

Samples collected and the different measurements are summarized below:

Mesozooplankton WP2					
Date	**Time GMT**	**Station**	**Depth (m)**	**Samples**	**Experiments**
10/15/99	09:30	2	70	Spp. abundance	
10/15/99	16:30	6	200	Biomass, gut-content, spp. abundance	
10/15/99	19:45	5	200	Biomass, gut-content, spp. abundance	
10/15/99	22:15	4	200	Biomass, gut-content, spp. abundance	Secondary Production Respiration - Excretion. Evacuation
10/16/99	09:00	4	200	Biomass, gut-content, spp. abundance	
10/16/99	11:00	3	190	Biomass, spp. abundance	
10/16/99	20:45	1	100	Biomass, gut-content, spp. abundance	Secondary Production Respiration - Excretion. Evacuation Fecal Pellet Production
10/17/99	08:10	1	100	Biomass, gut-content, spp. abundance	
10/17/99	16:00	12	200	Biomass, gut-content, spp. abundance	
10/17/99	18:20	11	200	Biomass, gut-content, spp. abundance	
10/17/99	21:20	10	200	Biomass, gut-content, spp. abundance	Secondary Production Respiration - Excretion. Evacuation
10/18/99	08:15	10	200	Biomass, gut-content, spp. abundance	
10/18/99	10:00	9	100	Biomass, gut-content, spp. abundance	
10/18/99	21:15	8	80	Biomass, gut-content, spp. abundance	Secondary Production Respiration - Excretion. Evacuation Fecal Pellet Production
10/19/99	08:15	8	80	Biomass, gut-content, spp. abundance	
10/19/99	14:50	15	200	Biomass	
10/19/99	17:45	17	200	Biomass, gut-content, spp. abundance	
10/19/99	21:00	19	30	Biomass, gut-content, spp. abundance	Secondary Production Respiration - Excretion. Evacuation
10/19/99	19:00	18	200	Biomass, gut-content, spp. abundance	
10/20/99	08:00	19	30	Biomass, gut-content, spp. abundance	DOC Production

Microzooplankton					
Date	**Time GMT**	**Station**	**Cast**	**Experiment**	**Samples**
10/15/99	00:30	4	4	Yes	Chlorophyll maximum
10/16/99	00:30	1	7	Yes	Chlorophyll maximum
10/17/99	15:33	12	9	No	5, 10, 20, 30, 40, 60
10/17/99	17:15	11	10	No	5, 10, 30, 50, 60, 75
10/17/99	23:30	10	11	Yes	Chlorophyll maximum
10/18/99	07:21	10	12	No	5, 10, 20, 30, 40, 50
10/18/99	09:29	9	13	No	5, 10, 20, 30, 40, 60
10/18/99	23:00	8	17	Yes	Chlorophyll maximum
10/19/99	07:36	8	18	No	5, 10, 20, 30, 40, 60
10/19/99	23:00	19	22	Yes	Chlorophyll maximum
Nu-Shuttle (UOR)	**Start GMT**	**End (GMT)**	**Track (Stations)**		**Samples cytometry**
10/15/99	16:45	18:40	6-5		Chlorophyll maximum
10/15/99	20:20	21:35	5-4		Chlorophyll maximum
10/16/99	09:15	10:10	4-3		No
10/16/99	11:58	13:46	3-1-2		No
10/17/99	08:31	14:21	1-12		Chlorophyll maximum
10/18/99	22:10	06:44	8-12-8		No
10/19/99	08:45	13:37	8-15		No
10/19/99	22:45	04:21	16-18-17-15-17-18-16		Chlorophyll maximum
					No
					Chlorophyll maximum

Results:

Due to the time available and weather conditions, the oceanic stations of each OMEX-II transect (see Cruise Report for OMEX-0898) were not sampled during OMEX-1099 cruise. In contrast with the summer cruise (OMEX-0898) during OMEX-1099 there were no upwelling conditions in the study area. Sea surface temperature images provided by RSG-Plymouth showed the presence of thermal fronts near the mouth of the rias and cold waters over the shelf during the week before the cruise (Figure 2). The fronts weakened and waters homogeneized during the cruise. As we can see later in the vertical CTD profiles, the cold waters over the shelf were a consequence of mixing of surface and subsurface cold waters and not a direct consequence of upwelling.

In Transect S, oceanic waters were warmer (Figure 3) and saltier (Figures 4 amd 5) than coastal waters. Maxima of fluorescence and transmitance occurred in areas of cold waters (Figures 6 and 7). The presence of fluorescence maxima near the surface suggests the existence of local upwelling conditions, although further analysis taking into account nutrient and chlorophyll concentrations and primary production values are required to confirm this hypothesis. Towards the north, waters were progressively colder and the differences between oceanic and coastal waters dissapear both in Transect P (Figures 8, 9, 10, 11 and 12) and N (Figures 13, 14, 15, 16 and 17). However, mid-shelf waters in both transects were slightly warmer than those at coastal and oceanic ends.

Waters were clearly stratified in all transects, and the isotherm of 13 ºC was near 100 m, except in Transect N where it was located at 150 m. Transect P displayed an elevation of isotherms at both ends, associated to local fluorescence maxima. Transect N also exhibited a small elevation of isotherms (Figure 14) along with relative maxima of fluorescence and transmitance near the coast (Figure 17). However, the highest values of fluorescence and transmitance of Transect N occurred at the oceanic end and did not seem associated to water mass elevations.

The most remarkable characteristic of OMEX-1099 cruise was the observation of the Poleward Current, probably for the first time in this time of the year in Galicia. This current was clearly indicated in Transect S by the presence of a salinity maximum (> 35.90 psu) located from 80 to 100 m between Stations 5 and 3 (Figure 4). The salinity maximum (> 35.80 psu) of Transect P was located between 80 and 150 m, while in Transect N was between 80 and 180 m except at Station 18 where it narrows to a layer between 80 and 100 m (Figure 15). In summary, a subsurface saline intrusion generally between 80 and 120 m was detected, especially in Transect S.

On the other hand, phytoplankton counts showed the dominance of small flagellates (8 µm), dinoflagellates (< 30 µm) and cryptophycae through the study area, particularly in Transects S and P. However, diatoms were always present in small numbers. In contrast, the only station studied in Transect N displayed higher abundance values of diatoms compared to stations located in southern transects, although small phytoplankters were still dominant.

Acknowledgements:

All cruise participants acknowledge the collaboration of the crew and technical team of the B/O Thalassa, who always contributed to the success of the cruise, particularly the captain Ms Hervé Piton. This cruise was funded by IEO, the Spanish National Program of Marine Sciences and Technologies (CYTMAR, Project no. MAR97-191-CE) and the European Project OMEX-II- Phase II (Program MAST-III, Contract no. MAS3-CT97-0076).

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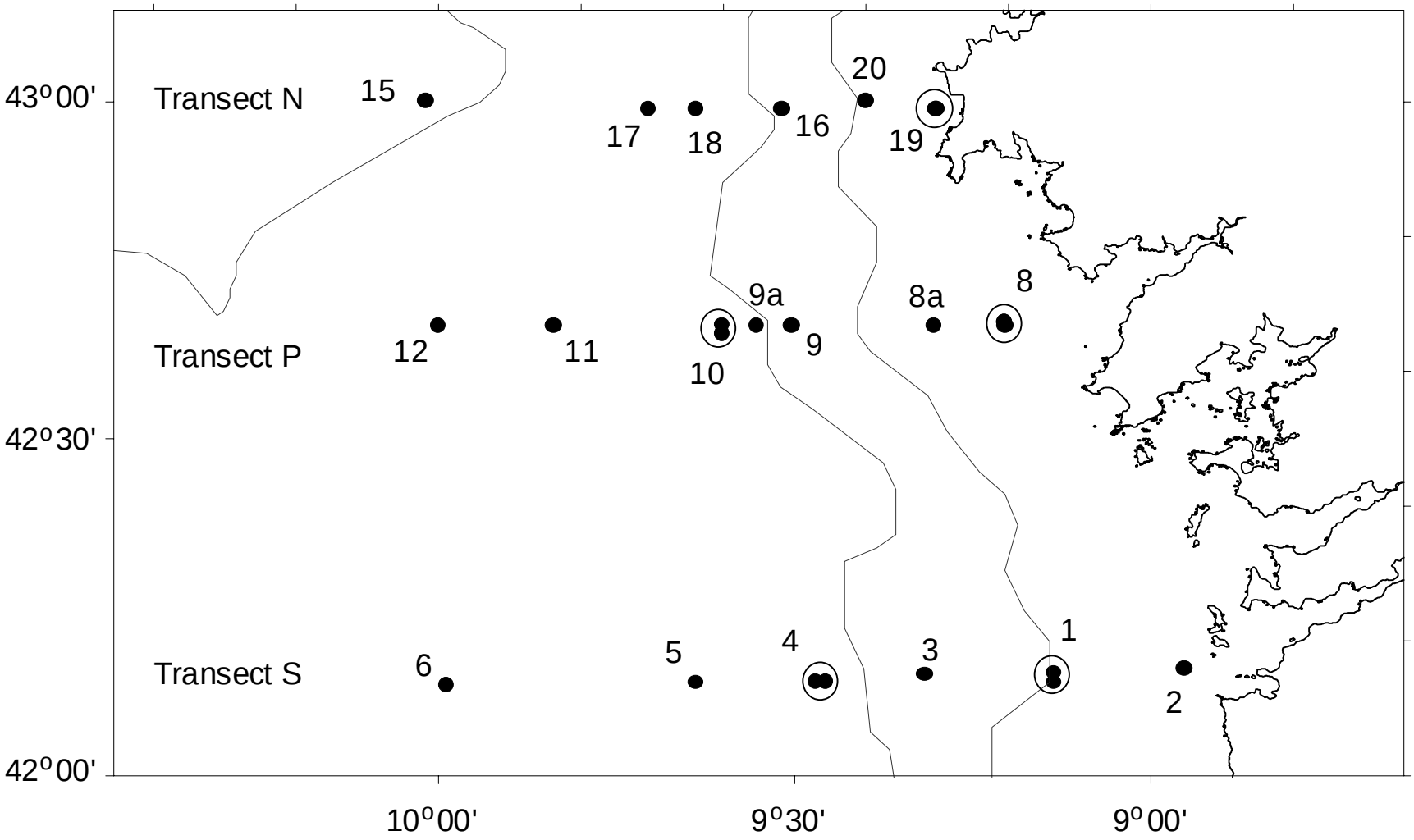

Figure 1. Map of sampling stations. Biological stations are encircled.

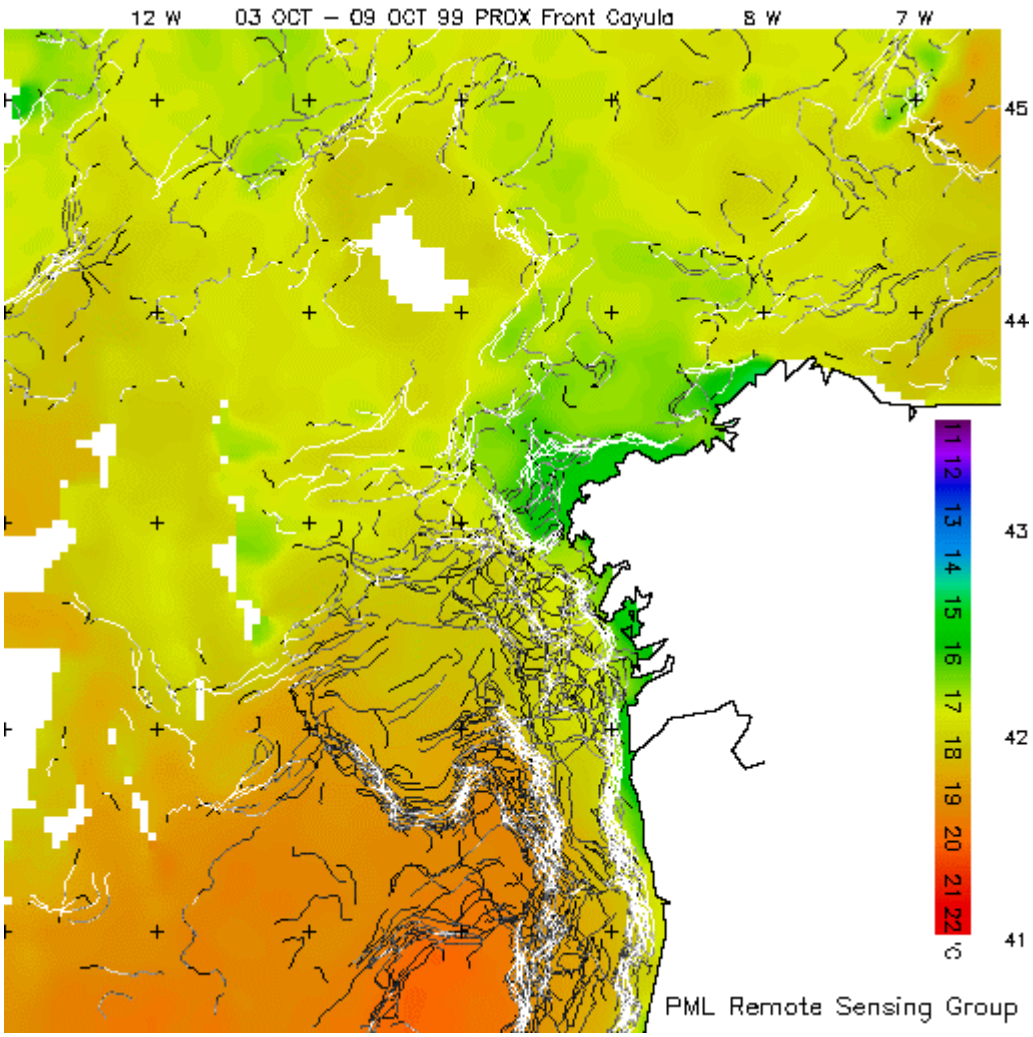

Figure 2. A. Sea surface temperature values derived from the best images of AVHRR infrarred sensor in the study area between 3 and 9 October 1999. Lines indicate thermal fronts. Satellite images processed by RSG-Plymouth for OMEX-II Project.

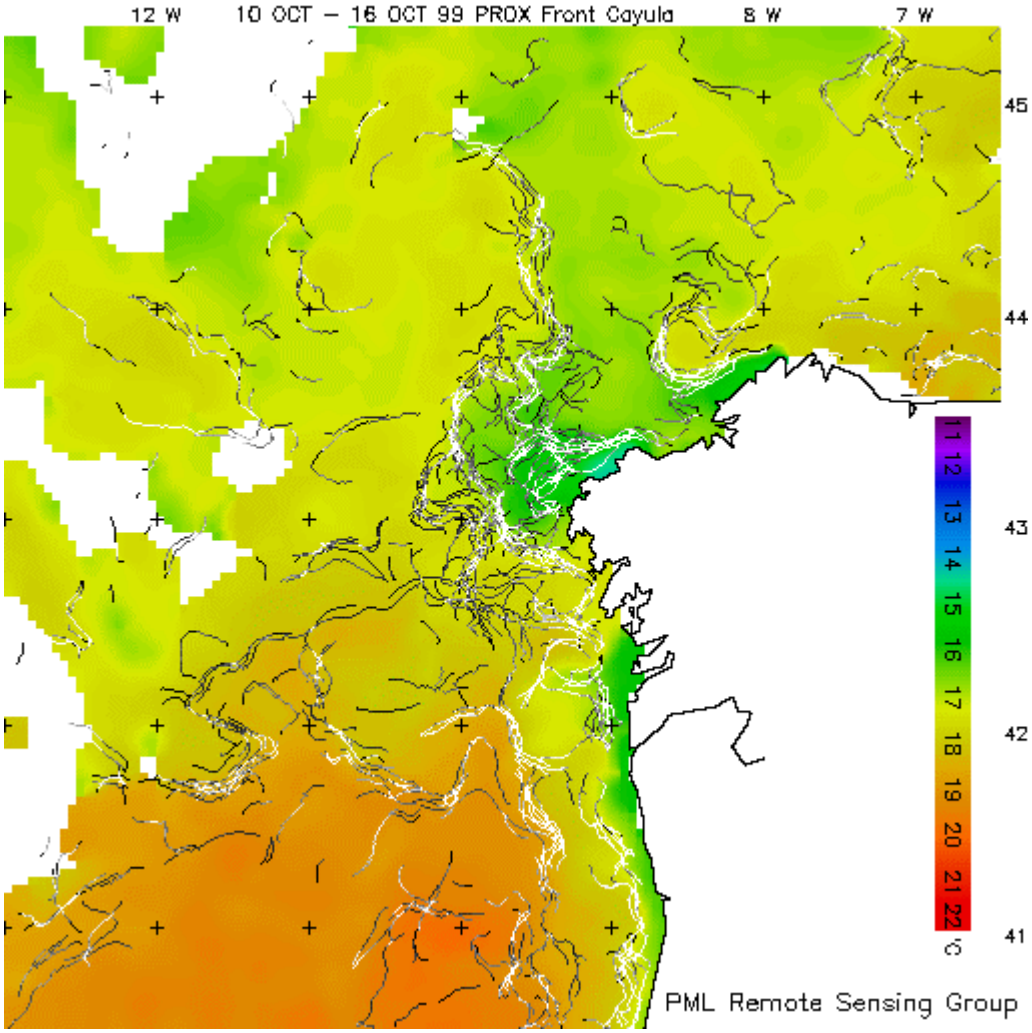

Figure 2. B. Sea surface temperature values derived from the best images of AVHRR infrarred sensor in the study area between 10 and 16 October 1999. Lines indicate thermal fronts. Satellite images processed by RSG-Plymouth for OMEX-II Project.

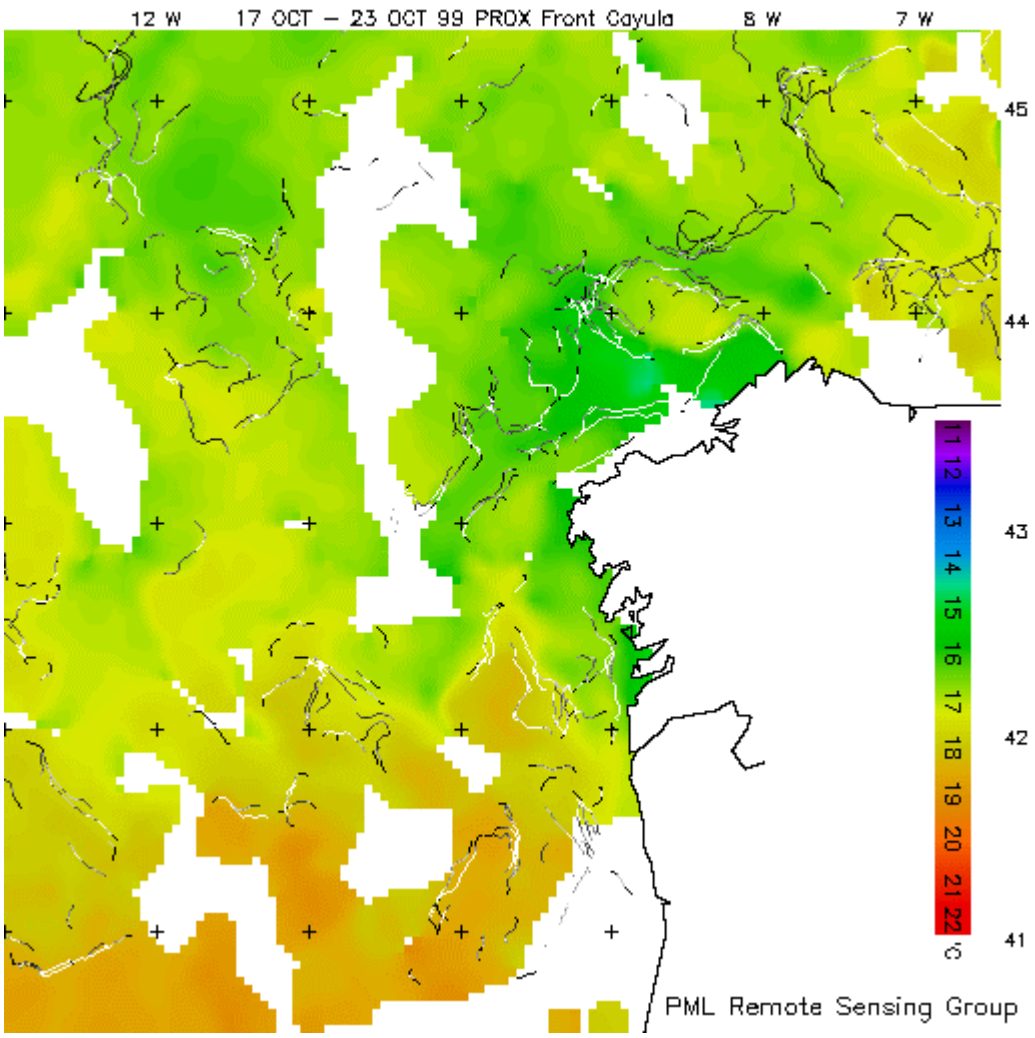

Figure 2. C. Sea surface temperature values derived from the best images of AVHRR infrarred sensor in the study area between 17 and 23 October 1999. Lines indicate thermal fronts. Satellite images processed for RSG-Plymouth to OMEX-II Project.

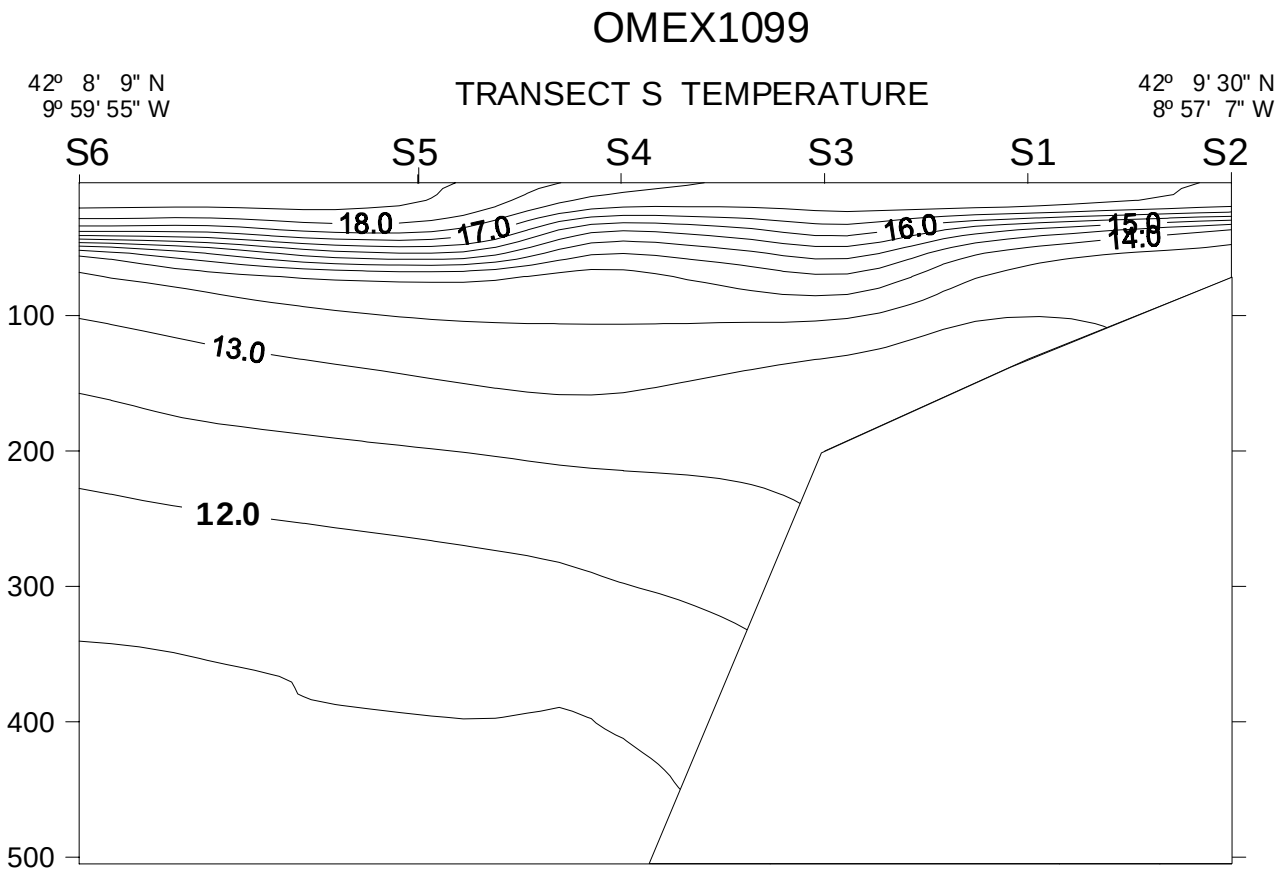

Figure 3. Distribution of temperature (°C) in Transect S.

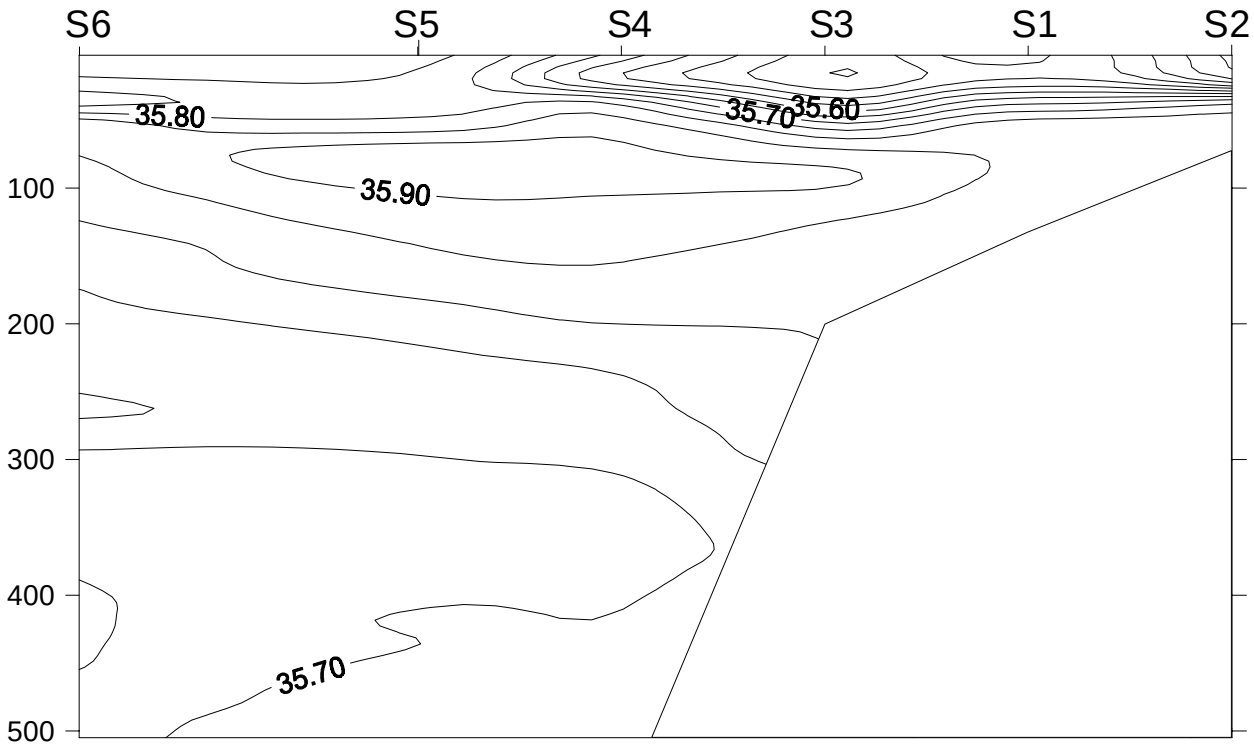

Figure 4. Distribution of salinity (psu) in Transect S.

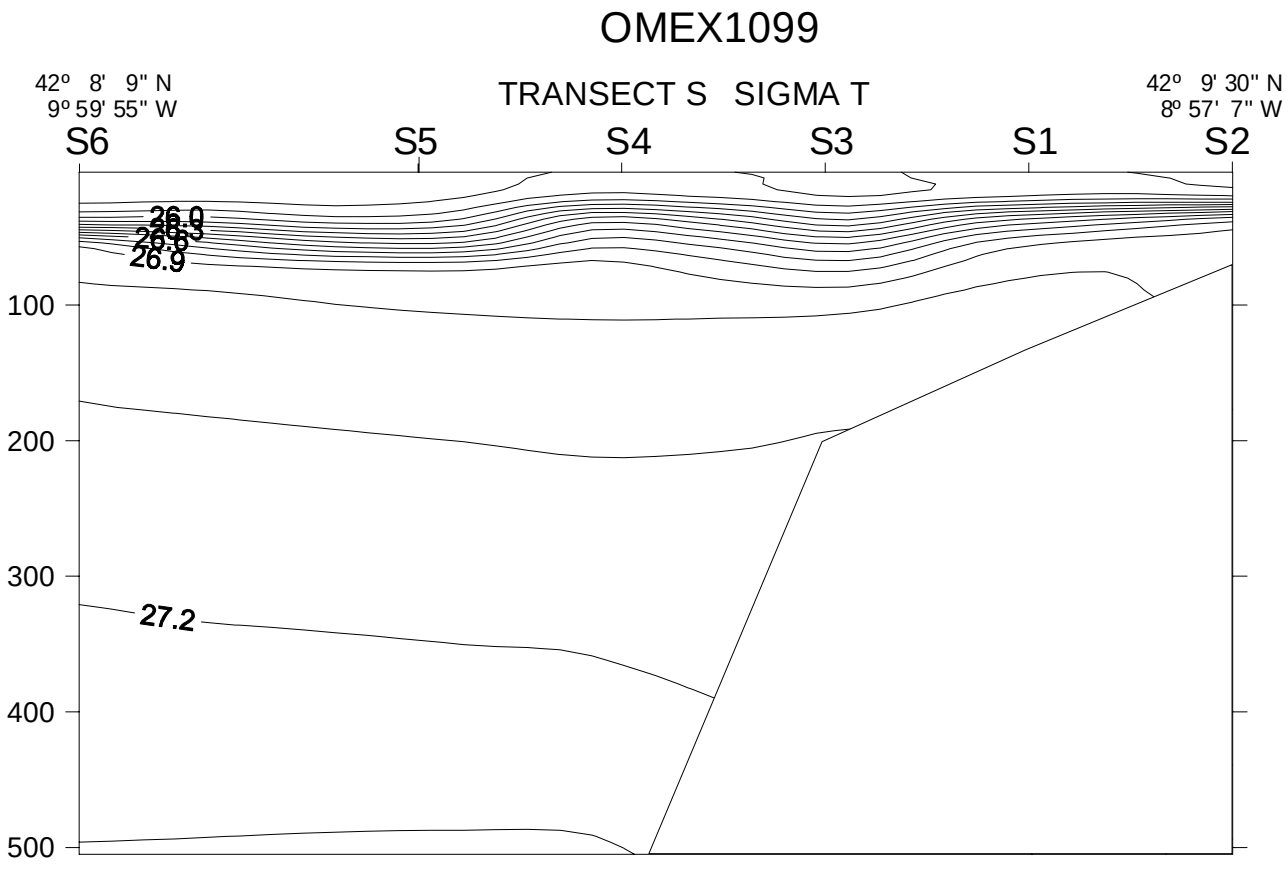

Figure 5. Distribution of sigma-t in Transect S.

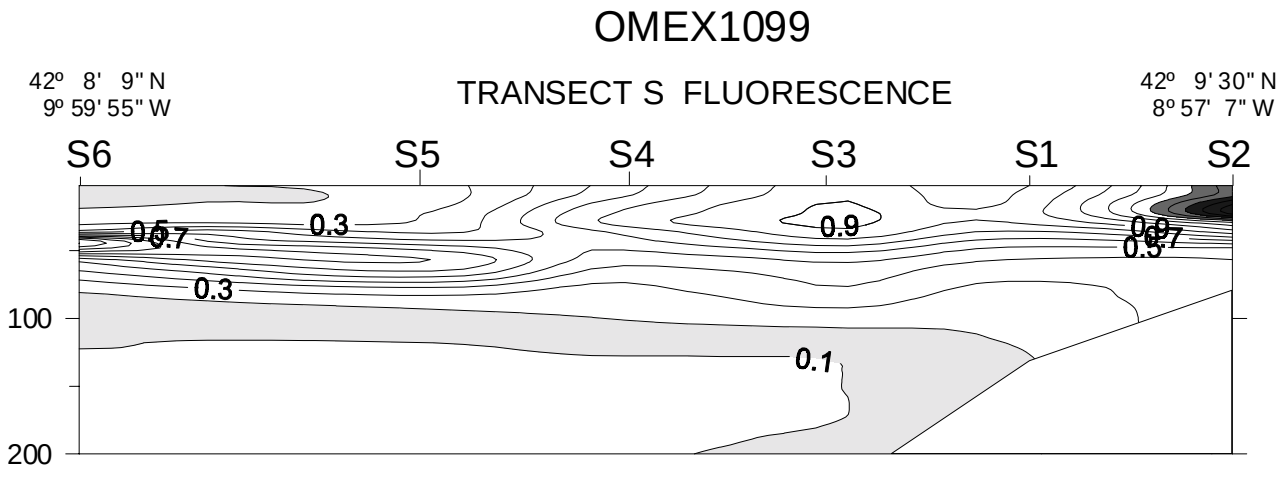

Figure 6. Distribution of fluorescence (relative units) in Transect S.

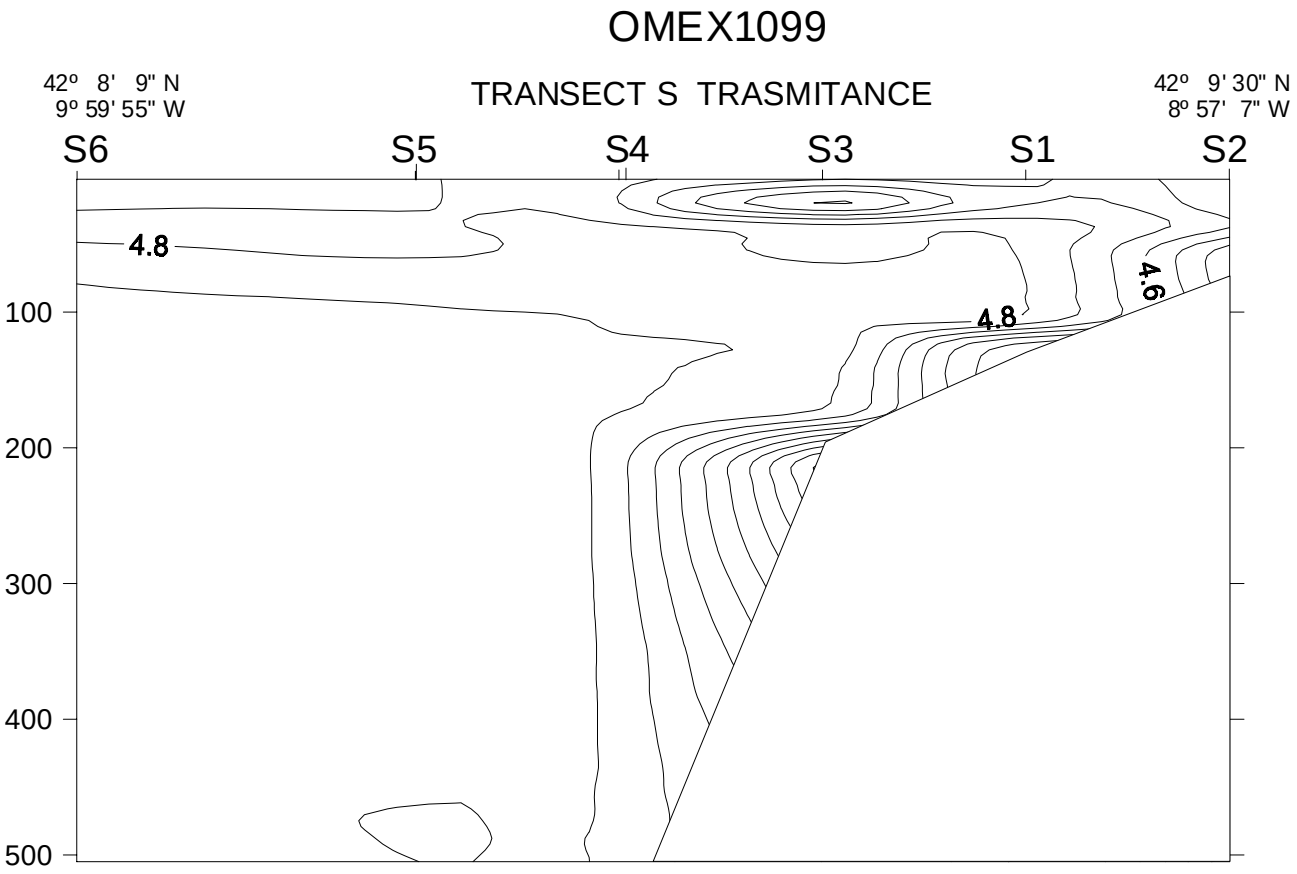

Figure 7. Distribution of transmitance (relative units) in Transect S.

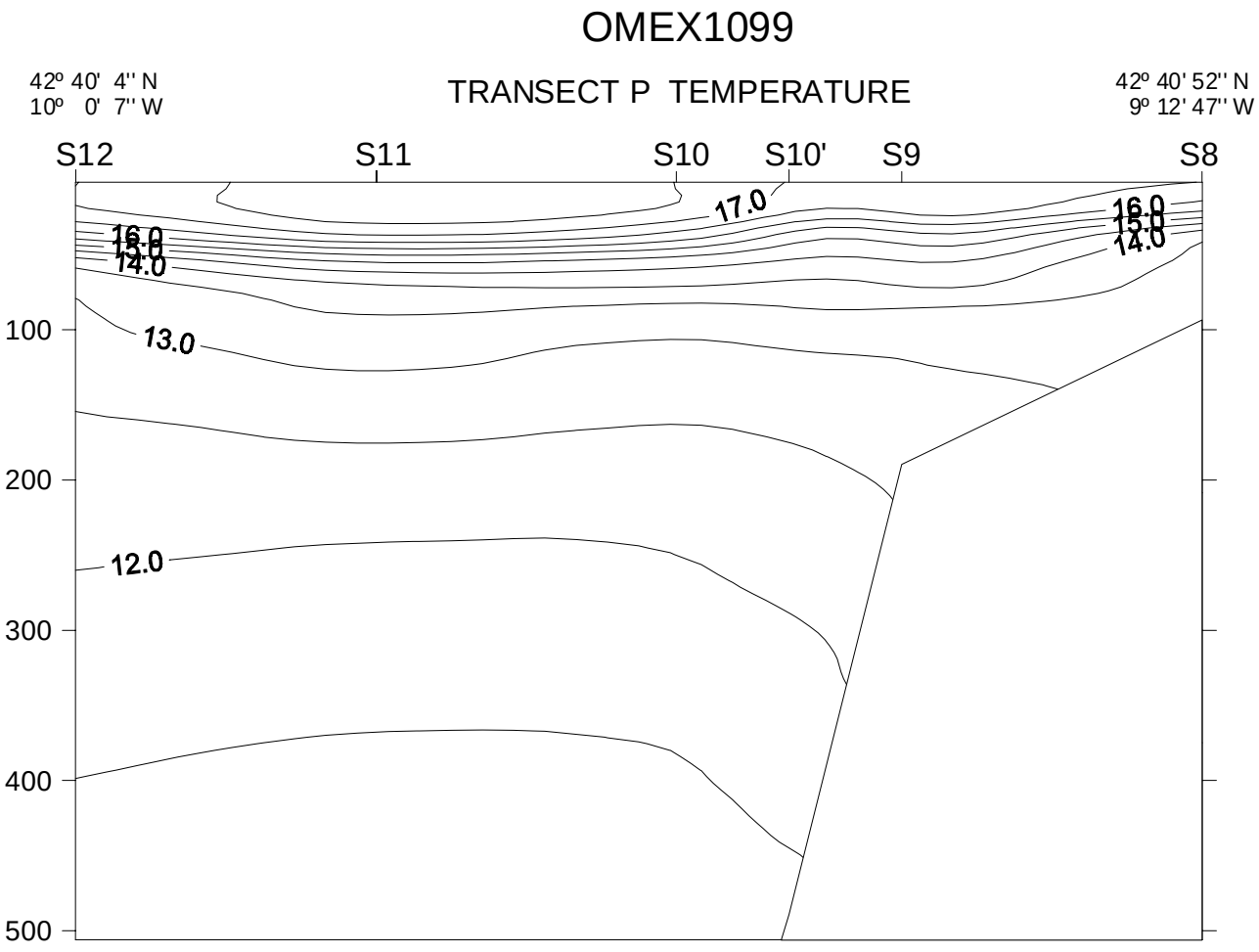

Figure 8. Distribution of temperature (°C) in Transect P.

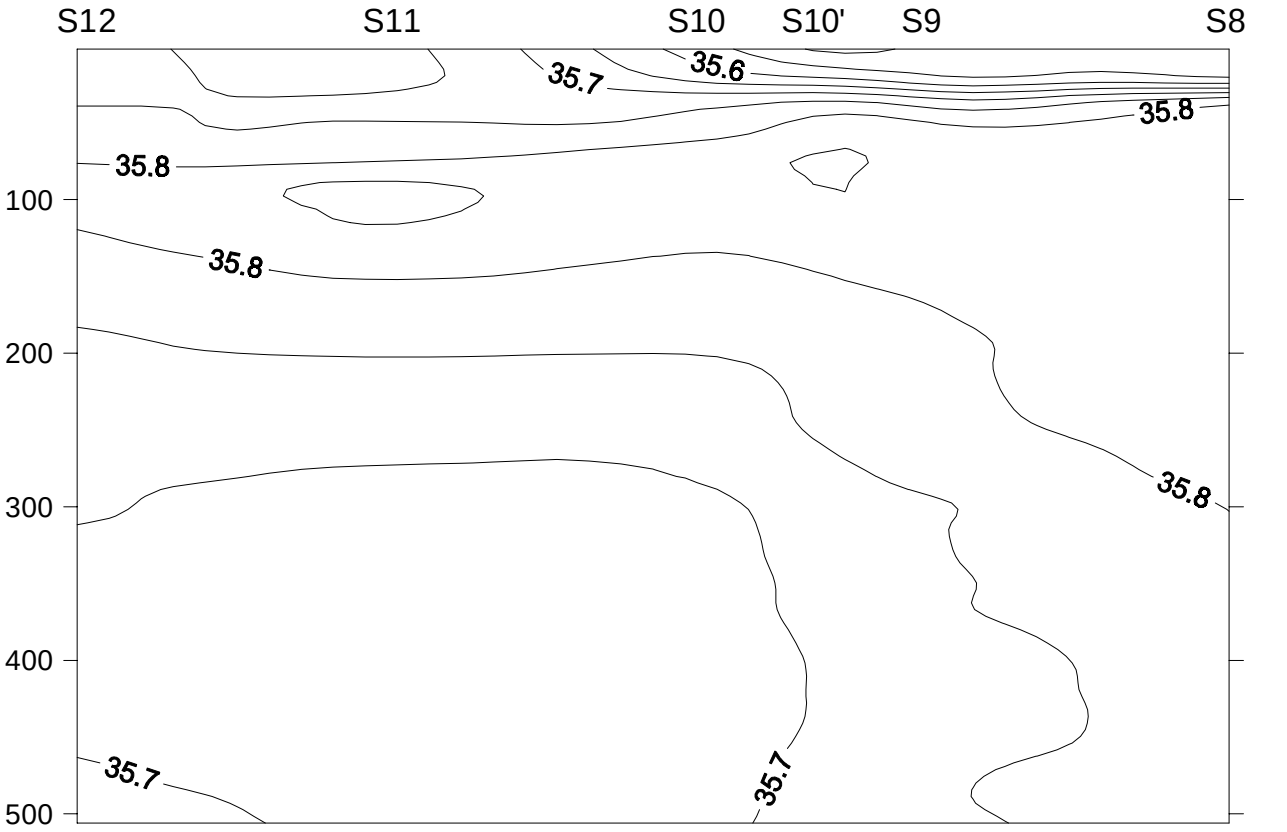

Figure 9. Distribution of salinity (psu) in Transect P.

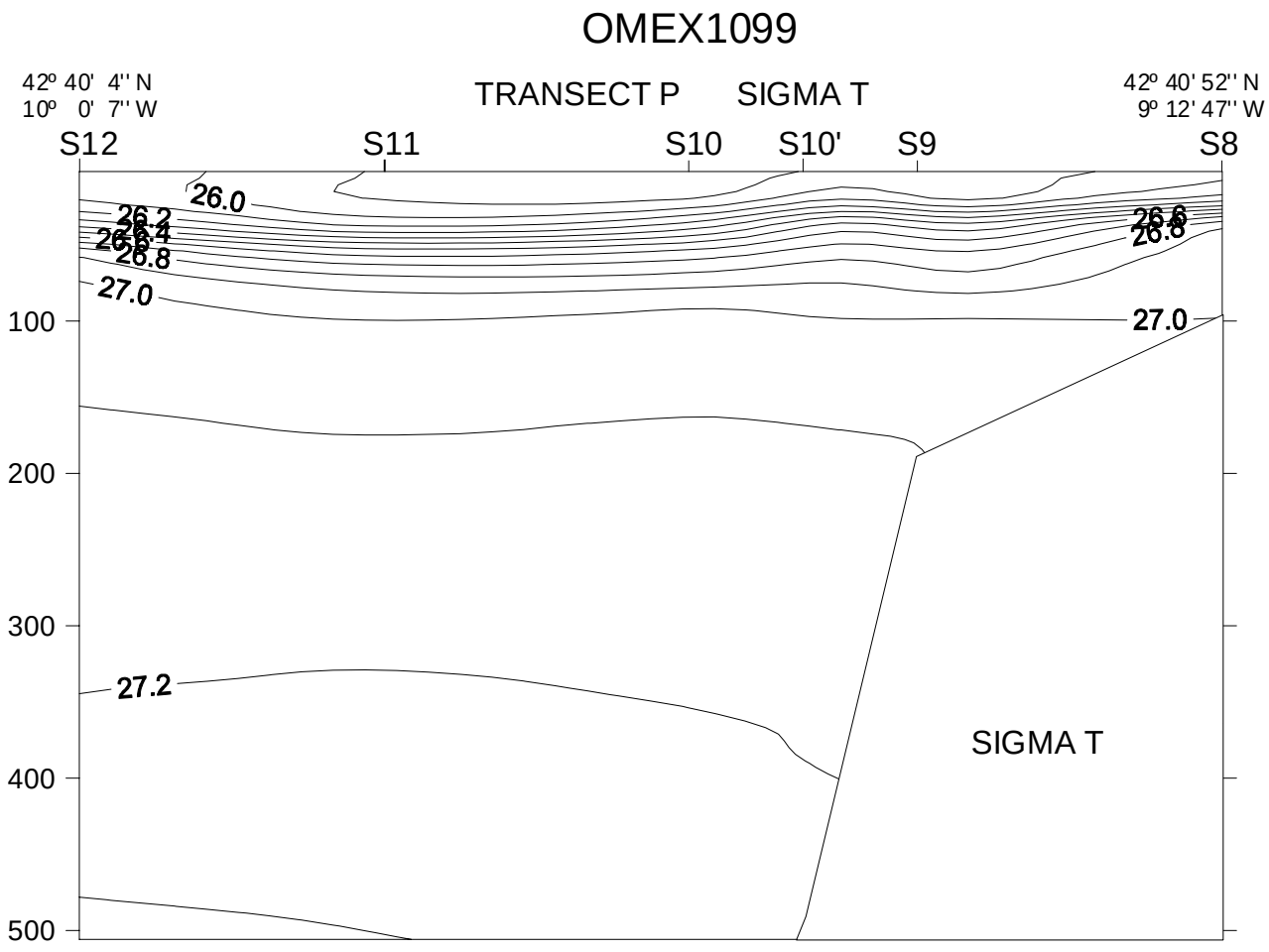

Figure 10. Distribution of sigma-t in Transect P.

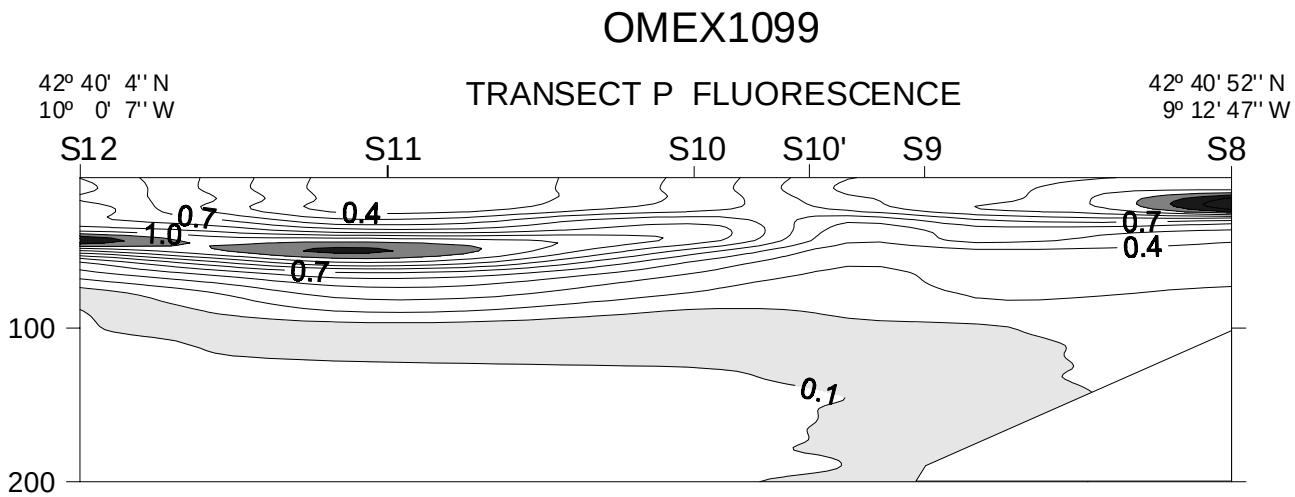

Figure 11. Distribution of fluorescence (relative units) in Transect P.

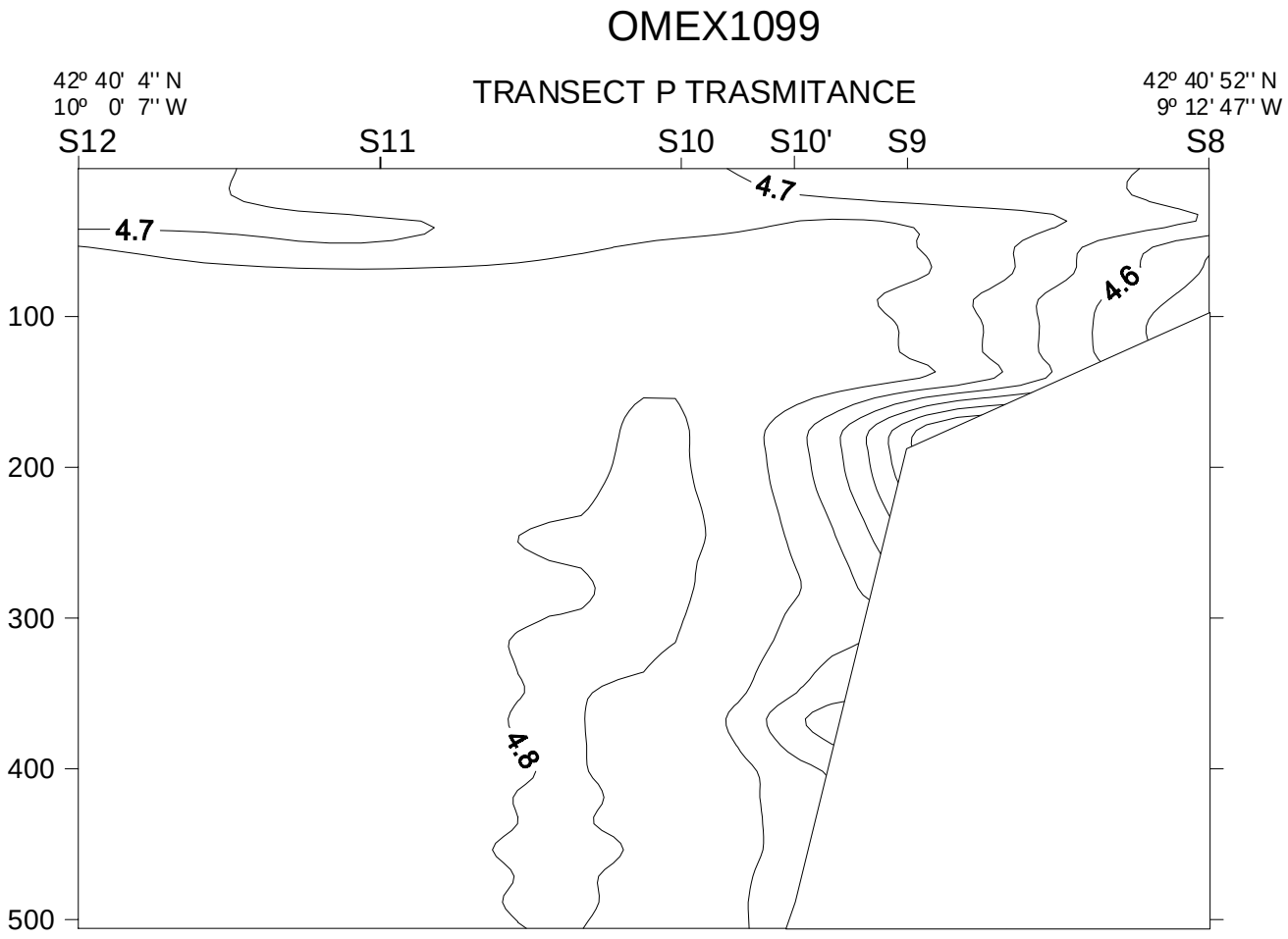

Figure 12. Distribution of transmitance (relative units) in Transect P.

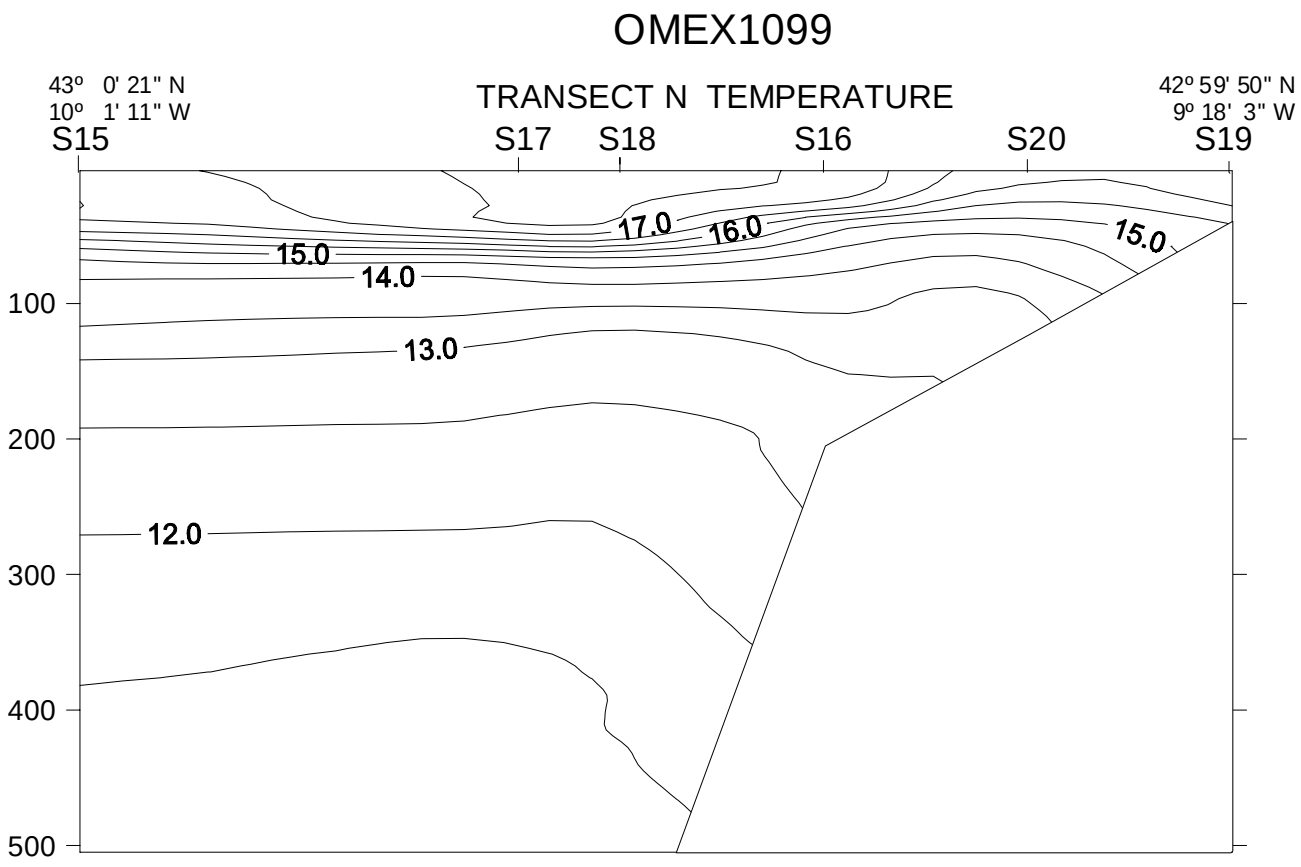

Figure 13. Distribution of temperature (°C) in Transect N.

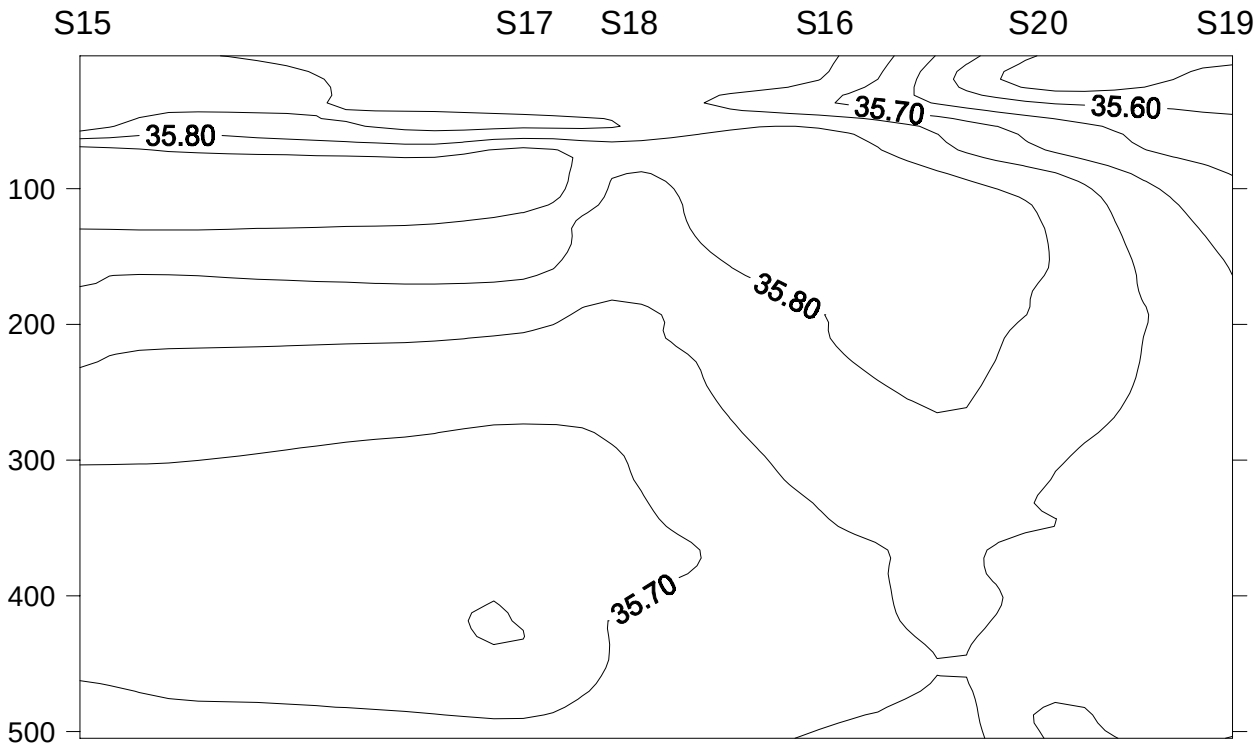

Figure 14. Distribution of salinity (psu) in Transect N.

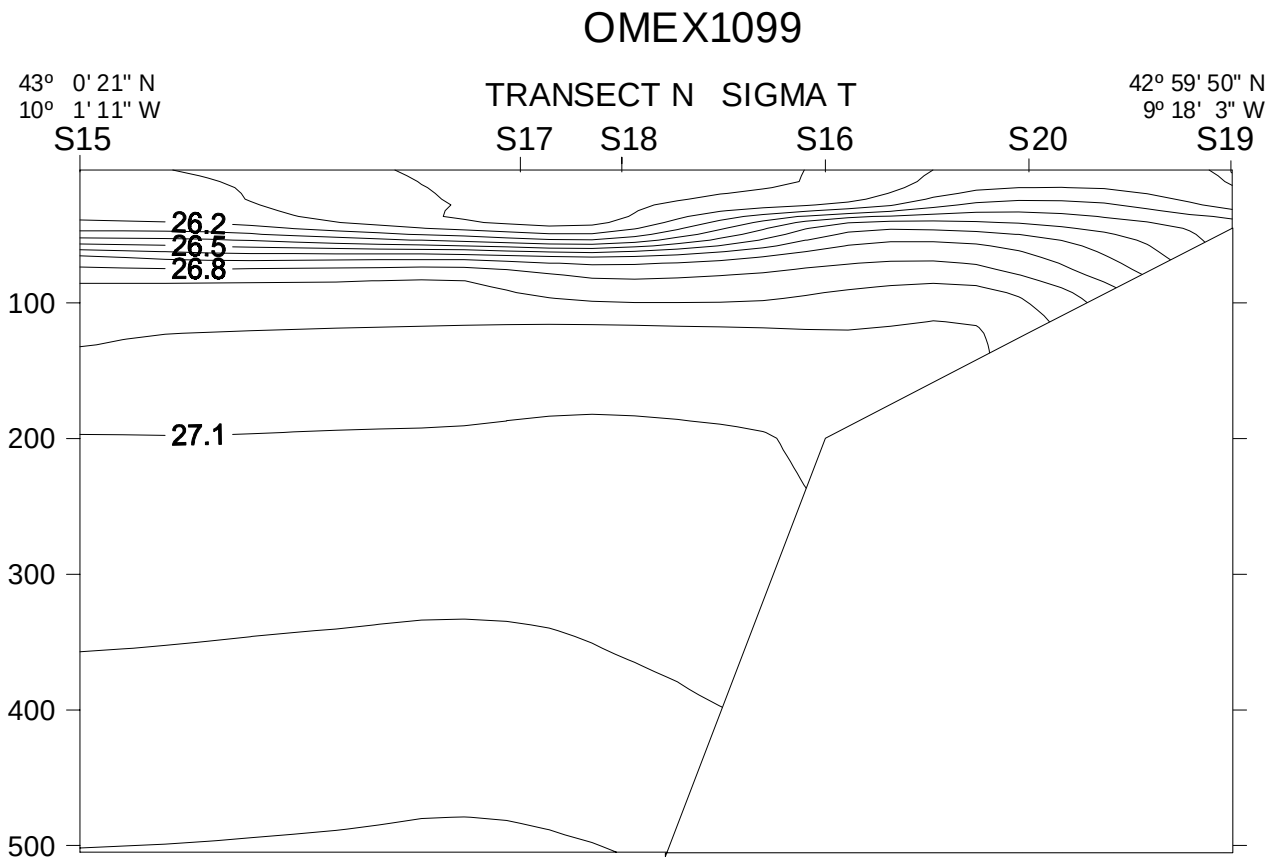

Figure 15. Distribution of sigma-t in Transect N.

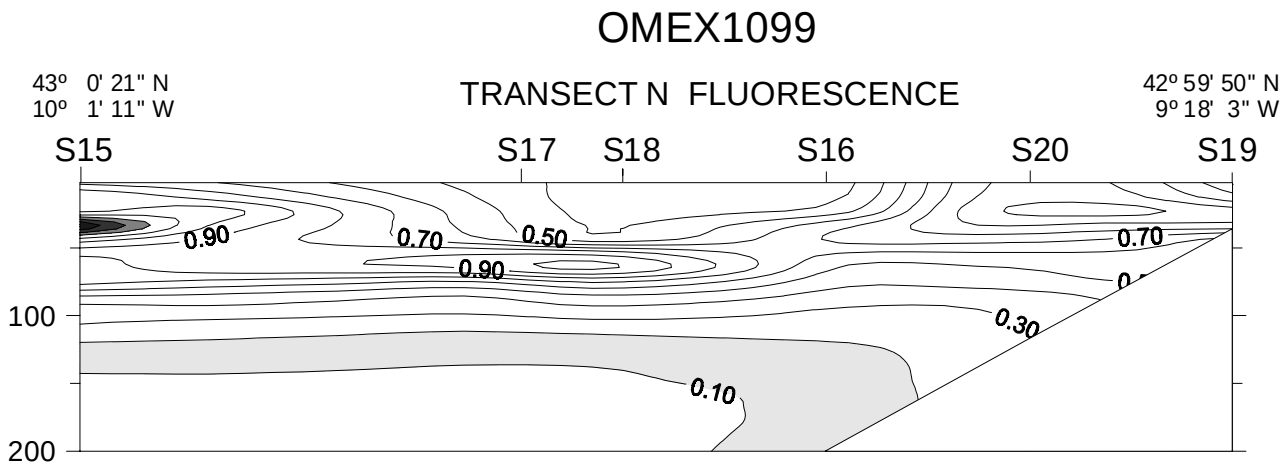

Figure 16. Distribution of fluorescence (relative units) in Transect N.

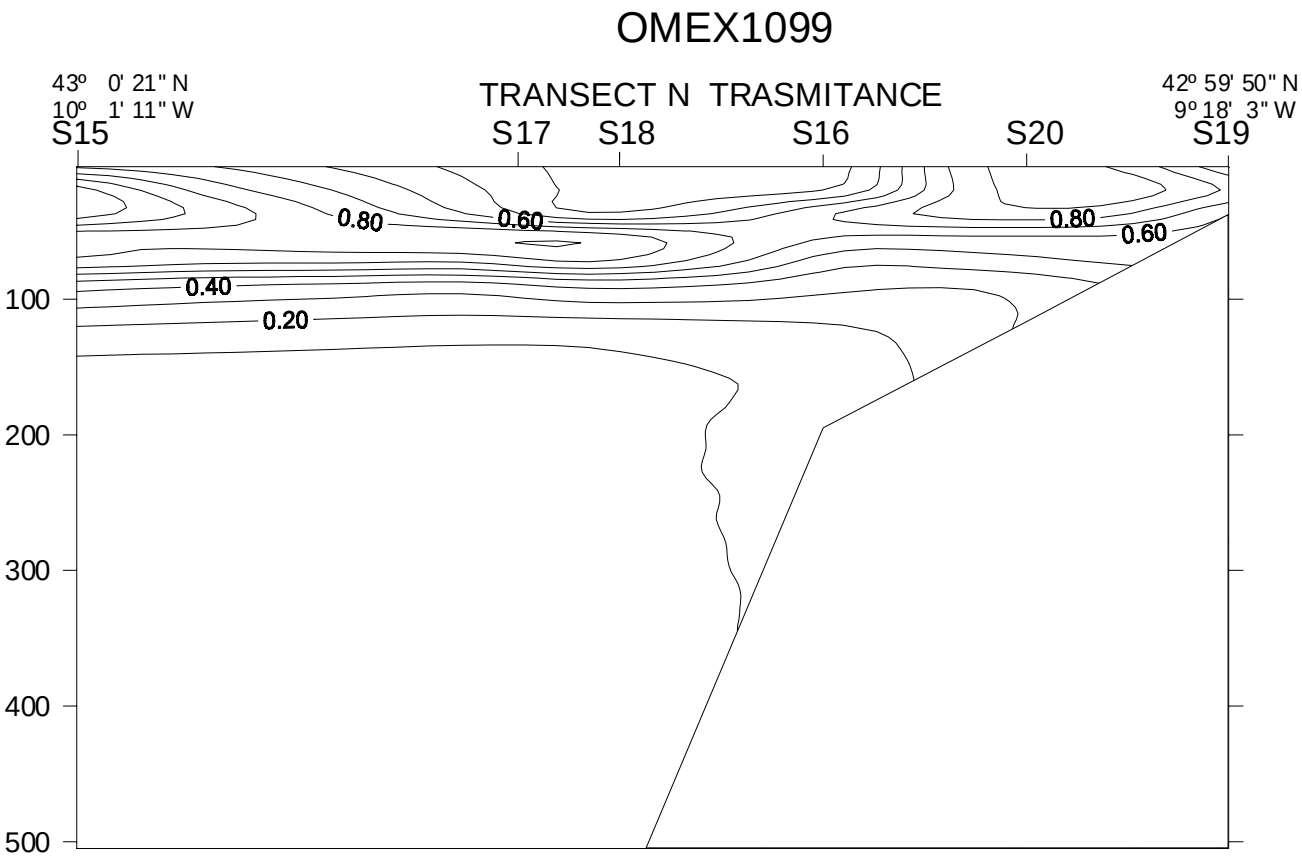

Figure 17. Distribution of transmitance (relative units) in Transect N.