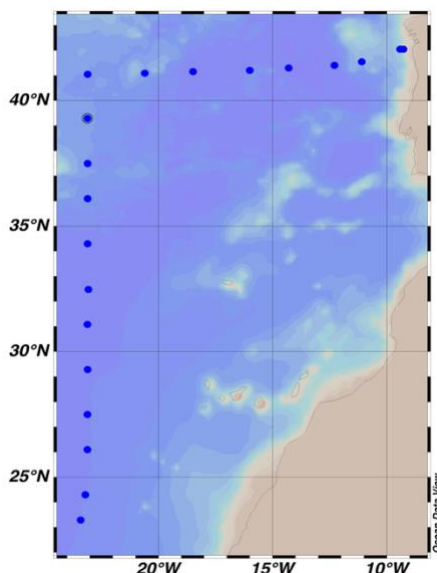


CRUISE REPORT: Biomass - IV

(Created: December 2025)



Highlights

Cruise Summary Information

Section Designation	ANA
Expedition Designation (ExpoCode)	67SL19881117
Chief Scientist	Aida F. Rios/ CSIC
Dates	17 November– 26 November 1988
Ship	R/V PROFESSOR SIEDLECKI
Ports of Call	Not listed
Geographic Boundaries	23° 4'W 42° 05'N 9° 28'W 23° 29'N
Stations	40 were stated in cruise report, 20 stations are in the dataset
Floats and Drifters Deployed	0
Moorings Deployed and Recovered	0

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*Sadly, Dr. Rios passed in 2015

Report assembled by Savannah Lewis by concatenating information from the following two articles:

[https://doi.org/10.1016/S0924-7963\(97\)00108-5](https://doi.org/10.1016/S0924-7963(97)00108-5)

[https://doi.org/10.1016/0198-0149\(92\)90093-9](https://doi.org/10.1016/0198-0149(92)90093-9)

Links to Selected Topics

Shaded sections are not relevant to this cruise or were not available when this report was compiled.

Cruise Summary Information	Hydrographic Measurements	
Description of Scientific Program	CTD Data:	
Geographic Boundaries	Acquisition	
Cruise Track (Figure): PI CCHDO	Processing	
Description of Stations	Calibration	
Description of Parameters Sampled	Temperature	Pressure
Bottle Depth Distribution (figure)	Conductivity	Oxygen
Deployments	Bottle Data	
Moorings Deployed or Recovered	Salinity	
	Oxygen	
Programs and Principal Investigators	Nutrients	
Scientific Personnel	Total CO ₂	
	CFCs and SF ₆	
Problems and Goals Not Achieved	Total Alkalinity	
	pH	
Underway Data Information	Lowered Acoustic Doppler Current Profiler	
Navigation Bathymetry		
Acoustic Doppler Current Profiler		
Thermosalinograph		
XBT and/or XCTD		
pCO ₂	Acknowledgements	
Atmospheric Chemistry Data		
Meteorological Observations		

Summary:

During the "ANA" cruise in November 1988, Western North Atlantic Water (WNAW) was found linked to the Azores Current (AC) at 23° W, where according to various authors Eastern North Atlantic Water (ENAW) forms a boundary with WNAW east of the Mid-Atlantic Ridge (MAR). This boundary changes position during the year.

The vein of Mediterranean Water (MW) moving towards the MAR seems to be connected with the AC, and restricts the penetration of ENAW of subpolar origin (ENAWP).

A subsurface front has been found along 42° N, separating ENAW of subtropical origin (ENAWT) that moves northeastwards generating a cyclonic eddy that is confined between the lower limit of surface layer and approximately isopycnal 27.06, and modified ENAWP that moves southwards forming various anticyclonic eddies.

Methods

During the "ANA" cruise of the "Biomass-IV" expedition on R/V "Professor Siedlecki" in November 1988, 20 stations were occupied between 42°53'N - 9°28.5'W and 23°29'N - 23°40.1'W. Nine stations lay on a perpendicular section to the NW coast of Galicia (Spain); the other eleven stations lay on a meridional section perpendicular to the first. The positions of stations are shown in Fig. 1.

During the 'ANA' cruise of the 'Biomass-IV' expedition on R/V 'Professor Siedlecki' in November 1988, 20 stations were sampled between 42°53'N–9°28.5'W and 23°29'N–23°40.1'W. Nine stations lay on a perpendicular section towards the NW coast of Galicia (Spain); the other 11 stations lay on 22°W nominal longitude. The positions of stations are shown in Fig. 1.

Salinity, temperature and pressure were measured with a 'Neil Brown' CTD model SN-01/1132 at each station. Bottle samples for salinity, nutrients, pH and alkalinity determinations were collected from surface to 1100 m depth. Salinity was measured with an induction salinometer (Plessey Environmental Systems Model 6230N) to an accuracy of 0.005. Oxygen samples were measured using an automated and potentiometric titration as a slight modification of the original Winkler method. The standard error for five replications was less than 2 $\mu\text{mol kg}^{-1}$. The apparent oxygen utilisation (AOU) defined by the deficit of oxygen concentration with regard to the saturation concentration at atmospheric pressure is used to describe the oxygen distributions. Nutrients were determined by colorimetric methods, using a Technicon Autoanalyser AAII. For silicate, a modified version of the method by Hansen and Grasshoff (1983) was used, in which β -silicomolybdenic acid is reduced with ascorbic acid. Nitrate was determined after reduction to nitrite in a Cd–Cu column. The standard deviation for duplicates was 0.07 $\mu\text{mol kg}^{-1}$ for silicate, 0.06 $\mu\text{mol kg}^{-1}$ for nitrate.

kg⁻¹ for nitrate and 0.01 $\mu\text{mol kg}^{-1}$ for phosphate. This is equivalent, to 0.3%, 0.5% and 0.8% (full scale) reproducibility, respectively.

A Ross Orion 81-04 electrode calibrated with 7.413 NBS buffer, was used to determine pH. The temperature was also measured by means of a Pt-100 probe. pH values were normalised to 15°C to avoid the temperature effect over pH (Pérez and Fraga, 1987a). Automatic titration was used to measure alkalinity to a final pH of 4.44 with HCl (Pérez and Fraga, 1987b). The precision was 2 $\mu\text{mol kg}^{-1}$ (0.1%) for alkalinity and 0.005 for pH. In order to correct for the drift and bias during the cruise due to slight changes in the reference electrodes, routine and daily measurements of both variables for a large container (25 l) were made. Dissolved inorganic carbon (DIC) and partial pressure of CO₂ (pCO₂) were estimated from pH15 and alkalinity using the equations of the carbonate system (Dickson, 1981) and the constants determined by Mehrbach et al. (1973) and Weiss (1974). We use Mehrbach's constants because they are determined in natural sea water and reproduce very well the experimental temperature effect on pCO₂ (Takahashi et al., 1993; Millero et al., 1994). In addition, the NBS scale was used in the TTO cruise, whose data are here compared with ANA data. In any case, the use of the new set of constants (Roy et al., 1993; Lee and Millero, 1995) give only a positive difference of $1.4 \pm 0.15 \mu\text{mol kg}^{-1}$ in the DIC calculations which is lower than the precision of the analytical determination. The total propagation error of alkalinity and pH15 over DIC and pCO₂ was 4 $\mu\text{mol kg}^{-1}$ and 6 μatm respectively (Millero, 1995; Ríos and Rosón, 1996). The normalised DIC (NDIC) defined by $\text{NDIC} = \text{DIC} \cdot 35/S$ was used to describe the carbonic variability.

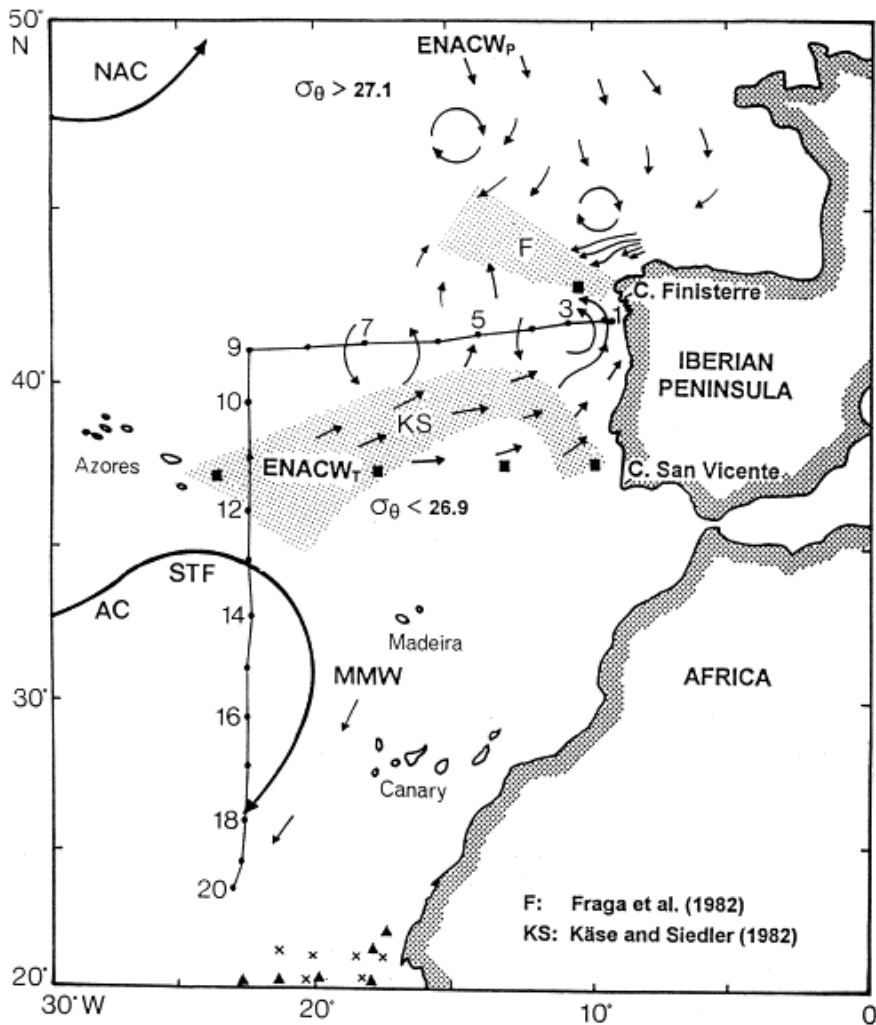


Fig. 1. The location of stations of ANA cruise (•) and the TTO (■), ATLOR II (▲), ATLOR VII (×) stations used to validate the model. The circulation scheme of NACW varieties according to Ríos et al. (1992) is also superimposed. The main hydrographic features are also represented: NAC (North Atlantic Current), F (Subsurface Front between ENACWP and ENACWT; Fraga et al., 1982), AC (Azores Current), STF (Subtropical Front) and KS (Frontal Band; Käse and Siedler, 1982). The displacement of East North Atlantic Central Water of subtropical (ENACWT) and subpolar (ENACWP) origin, and the Madeira Mode Water (MMW) are given.

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