

**WOCE Line:** AR19  
**WOCE ExpoCode:** 06GA350\_1  
**Cruise Plan:** Gauss Cruise No. 350/1

**Expedition:** **MEridional TRAnsports in the North Atlantic (MeTRaNA)**

**Ship:** FS Gauss, DBBX,  
L.o.a 68.9 m, 1599 GRT,  
Inmarsat 3218 111210  
email: science.gauss@bsh.d400.de  
**Ports:** Hamburg, Germany via Horta, Azores to St. John's, Canada  
Eastbound St John's via great circle to Irish shelf - Hamburg  
**Dates:** 06 May 2000 – 05 July 2000

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## Overview

We plan to run the WOCE repeat section AR19 in the North Atlantic Ocean again along nominally 48° N to WHP one-time survey standards in June 2000. The section runs from the Irish Shelf at 49° 10'N, 10°W along the track of the Hudson 1982 cruise and essentially the Discovery track of 1957 to 47°N, 27°W, continuing to 42°N, 45°W and cutting onto the Newfoundland Shelf to 43° 30'N, 50°W. The latter part parallels the former BIO mooring array. This section essentially follows the zero wind stress line, separating the subpolar from the subtropical gyre. This track has been worked with identical station positions before in 1993 (Gauss 226), 1994 (Meteor M30/2 to full WHP one-time standards), in June 1996 (FS Gauss 276) and in June 1997 (Meteor M39/3) and in June 1998 (Gauss G316/1).

The section is to quantify the changes in water mass properties and to measure the northward flow of the North Atlantic Current and the southward recirculation in the Eastern Basin. The southward flow of the Western Boundary Current and the boundary current regimes on both sides of the Mid-Atlantic Ridge (MAR) are to be well resolved. It will be used to determine the Meridional Overturning Circulation MOC in the Atlantic. The cruise aims to improve the scientific knowledge of the distribution and sources of water masses, and their flows, velocities and patterns by obtaining high-accuracy measurements of temperature, salinity, nutrients and oxygen content. These data will be used to estimate geostrophic velocities and transports, and to

map properties, mainly nutrient distributions, to deduce the circulation over the entire depth, particularly of the deep basins. Previous recent occupations have been with Gauss 226 in July 1993 as AR19 (G226/2), Meteor M30/2 in October 1994 and Meteor M39/3 in June 1997 as A2 and as AR19 with FS Gauss in May/June 1996 (G276/1) and June 1998 (G316/1). In the context of previous occupations since 1957 (IGY) this data will provide another estimate of the MOC at this latitude. Its variations have shown a systematic pattern and appear to be linked to large-scale changes in the forcing and water mass modifications. A close linkage to changes in the NAO index have recently been published by Lorbacher (2000).

Measurements planned include ca. 85 CTD-stations with a Neil Brown MkIIIb CTDO and water samples with a GO 24x10 l rosette system at 24 levels. Samples will be analysed on board for salinity, oxygen and nutrients (silicate, nitrate, nitrite and phosphate). Duplicate samples for salinity will be drawn at random for parallel analysis on board and ashore. A I-ADCP will be deployed on each cast to measure the vertical profile of velocity.

Hydrographic stations are planned at nominally 30 nm station spacing, with closer spacing over changing topography (500 m depth steps) and slightly larger spacing over abyssal plains (50 nm) if time becomes a constraint. All stations will be run to within 5 - 10 m from the sea floor.

Underway measurements will include bathymetry with a Parasound system, sub-surface temperature and salinity from the sea-water supply and standard meteorological observations including a prototype of a rain-gauge to WMO standards. In addition deep XBTs will be dropped between stations to improve the resolution of the temperature structure.

Ancillary work will include the service of two full-depth moorings west of the Mid-Atlantic Ridge at sites occupied from 1993 to 1995 and since 1996. All moorings will be recovered in the summer of 1998. Also seven profiling floats, APEX will be deployed across and in the vicinity of the moorings, re-seeding previous sites.

Gauss will again work a hydrographic section following the great circle between Flemish Cap and Porcupine Bank on the Irish shelf on the eastbound voyage. The specifications follow the AR19 details. The previous coverage was in 1998 with Gauss on G316/2.

## **Scientific Goals**

Besides providing estimates of the water mass characteristics, their spreading paths and mixing history as a snap-shot in early summer of 1997, the data from this cruise are to be compared with historical data sets and recent repeats to determine long-term changes of these properties. The North Atlantic being the most active ocean it subsequently shows the better signal-to-noise ratio of these changes on time-scales of years to decades. Furthermore, the transport estimates from the

DWBC array and other current meter arrays will be used to calculate the meridional transports of heat, salt and freshwater through this section and their changes. We also aim at describing the property transfer at intermediate and greater depths, between the western and eastern basins, either through boundary currents or spillover across the MAR.

The repeats since 1993 are part of a long-term assessment of changes in the transports of heat, salt and fresh-water through 48°N that continued with this re-occupation with FS Meteor M39/3 in June 1997 as part of the WOCE - ACCE. While the full-depth hydrographic sections will look at changes at time-scales of years and longer, an on-going XBT/XCTD programme on AX3 has already built up more than 140 almost monthly repeats since June 1988, resolving monthly to annual changes.

The previous data have shown a massive invasion of newly formed LSW into the Northwestern Atlantic that has continued into the Northeastern Basin in 1994. Core properties, particularly temperature, density and core layer depth have changed dramatically from known estimates, suggesting a close coupling to the new LSW production phase in the Labrador Sea. The repeats in the 1990s also suggest a cooling of the bottom layers and a warming and salinification of the top 1000 m. The 1998 data indicate that this invasion has slowed down. But the winter 1999/2000 SST in the eastern North Atlantic are again anomalously warm, compared to long-term climatologies.

By using forcing fields for momentum, fresh-water and heat exchange with the atmosphere from ECMWF products, we hope to resolve changes of the North Atlantic transports in relation to changes in these forcing fields.

## **Data**

Data storage and distribution information can be obtained at all time from the WOCE Hydrographic Programme Office at the Scripps Oceanographic Institution and from the Chief Scientist. Cruise information and information about the status of the data will be made available through the WOCE Data Information Unit WOCE DIU.

## **Cruise responsibilities**

The major groups involved in this WHP programme are the BSH/CTD - group, a BSH underway sampling group. Oxygen and nutrients measurements as well as CO<sub>2</sub>-sampling to JGOFS standards will be done as a joint operation by a group from IfM Kiel.

**Persons to contact are besides the chief scientist:**

<b>Principal Investigators</b>	
CTD operation	K.P. Koltermann/G.Stelter; BSH
CTD processing	H. Mauritz, BSH
L-ADCP	G. Stelter, BSH
ADCP	K. Jancke, BSH
salinity	P. Einfeld, BSH
oxygen	H. Johannsen/IfMK, F. Schmiel/BSH
nutrients	H. Johannsen/IfMK
underway measurements	G. Stelter, BSH
moorings	K.P. Koltermann, H. Giese /BSH
XBT	A. Sy, BSH
CO <sub>2</sub>	C. Neill, H. Lüger, IfMK
N <sub>15</sub> -sampling	H. Lüger, IfMK

<b>Cruise participants</b>	
Peter Koltermann (BSH)	chief scientist
Gerd Stelter (BSH)	data quality, operations
Petra Einfeld (BSH)	salinity
Gerd Stelter (BSH)	CTD/rosette electronics
Holger Giese (BSH)	moorings, moored instruments
Heiko Mauritz (BSH)	CTD processing
Hergen Johannsen (IfMK)	nutrients
Franziska Schmiel (BSH)	oxygen
Heike Lueger (IfMK)	CO <sub>2</sub> -components
Craig Neill (IfMK)	CO <sub>2</sub> -components
Ilse Gottschalk (BSH)	hydro watch
Victor Gouretski (IfMK)	hydro watch
Katja Lorbacher (BSH)	hydro watch
Helmut Rick (BSH)	hydro watch

## Associated work

### Moorings

Full-depth moorings will be serviced at two sites west of the MAR where previous deployments from 1993 - 1995 have shown the need to continue the time series.

Code	latitude	longitude	sounding	levels	PI
BSH-K1	46 20N	30 00W	3200	5cm,4seacats	Koltermann
	deploy June 2000 recover Jun 01 3 Tempchains				
BSH-K3	45 20N	33 08W	3900	5cm,4seacats	Koltermann
	deploy June 2000 recover Jun 01 3 Tempchains				

### P-ALACE

Across and west of the Mid-Atlantic Ridge seven APEX floats will be deployed at 1500 m depth according to the specifications and as part of the North Atlantic Float Programmes.

### CO<sub>2</sub>-sampling

A complete suite of samples for determining the components of the CO<sub>2</sub>-system will be collected and analysed on board (D. Wallace, IfMK). Previous work on this section in 1994 (M30/2) and 1997 (M39/3) has shown a considerable variability that seem to be intimately associated with the observed changes in the meridional overturning circulation MOC.

### N-15 sampling

On an experimental basis water samples will be collected to investigate the role of nitrate fixation of the role of the N-budget in the North Atlantic (GKSS, Voss). N<sub>15</sub>-isotope pattern of nitrate will be investigated for the subtropical part of the North Atlantic where it can be assumed that the N<sub>2</sub>-fixation is underestimated.