KNORR 151 LEG-III CRUISE SUMMARY: A20 HALIFAX--TRINIDAD

Robert S. Pickart, Chief Scientist (WHOI)

From 17 July--10 August, 1997 the research vessel KNORR occupied a hydrographic section extending from the Newfoundland shelf to the Suriname shelf, nominally along 52 degrees W. This section, known as A20, is part of the Atlantic Circulation and Climate Experiment (ACCE), and one of two North Atlantic WOCE ``Meridional Long-lines". The other meridional line, at 66 degreesW, was occupied during the subsequent leg (T. Joyce, chief scientist). Thirty one scientists representing 10 different projects participated on the cruise (Table 1 *(not included here)*).

Due to wonderful weather and excellent cooperation among the different groups, we ended up occupying more stations than originally planned for a total of 95.

At both ends the resolution on the shelfbreak was 3 mi, increasing to 10-15 mi on the continental slope, and finally 40 mi in the interior (except for the Gulf Stream where the spacing was 15-25 mi). A typical deep water station included a NBIS Mark-III CTD with oxygen sensor, lowered ADCP, and 33 10-liter Niskin bottle samples. Depending on the station up to 9 different WOCE quantities were measured: CFCs, Tritium/Helium, Oxygen, PCO2, TCO2, C14, Alkalinities, Nutrients, and Salts. On selected stations (such as TTO and GEOSECS repeat stations) all of the quantities were measured; more often a subset of them was collected. Table 2 gives the position/depth of each station and indicates which tracers (including numbers of samples) were drawn. Note that Oxygen, Nutrients and Salts were collected on every station (with the exception of the shelfbreak crossings where limited sampling was done).

In addition to the WOCE variables, Halocarbon measurements were made nominally once per day in the upper 200 m (usually from the shallowest 10 Niskin bottles, see Table 2*(not included here*>). Underway measurements included PCO2, Halocarbons, ADCP, and thermosalinograph (which was calibrated daily using surface salinity samples). A bio-optical cast was made once per day using a self contained winch and CTD package. This was done during the CTD cast falling closest to the noon hour. Eleven ALACE floats were launched in the Sargasso Sea, corresponding to CTD sites.

Brief Narrative

After occupying a test station in 3000 m of water near 57W, we steamed to the 1000 m isobath along the northern dog-leg and commenced dropping XBTs onto the shelf. This enabled us to identify the configuration of the Labrador Current prior to the CTD work (allowing us to optimally place the shelfbreak stations). This turned out to be quite useful as the Labrador Current contained an anomalous, large intrusion of warm water. For the shelfbreak work we used a 24-position 3.3-liter frame with a separate Mark-III, and collected water samples only within the core of the Labrador Current. At the 1000 m isobath we switched to the larger 36-position 10-liter package, which included the lowered ADCP. Water samples were taken according to the scheme described above. The dog-leg portion of the section nicely sampled the slopewater, including the Labrador Current, slopewater front/jet, Labrador Sea Water, and Deep Western Boundary Current (DWBC, Figure 3). It should be noted that there were four current meter moorings located along the dog-leg as part of a separate experiment.

A Gulf Stream warm core ring was located near the seaward edge of the dog-leg, and we seem to have crossed through the center of it. Shortly after this we encountered the Gulf Stream front. XBTs were used to identify the precise position of the north wall, and CTDs were subsequently placed in order to properly resolve the current. Interestingly the Gulf Stream was a factor of two narrower than normal at this longitude (only 80-90 km wide).

Upon reaching the Sargasso Sea we began the 40 mi spacing, which was maintained until the southern boundary. After crossing the Corner Seamounts (near 35N) we skirted along the outer flank of the Mid-Atlantic Ridge until roughly 15N (Figure 1). During this part of the survey we consistently steamed at 12-13 knots. This enabled us to make up time lost on the northern boundary (due to fog near the Grand Banks). Near 10N we dog-legged into the southern boundary, again sampling the boundary current system with more detailed measurements. As in the north, we changed to the small package at the 1000 m isobath (this time including the lowered ADCP) and took measurements onto the shelf across the North Brazil Current system.

Our section contains some familiar and expected features, as well as some surprises and puzzles. It is the third long line occupied near this longitude, the other two being an IGY line in 1956 and a high-quality CTD section occupied in 1983 (Figure 1). A major aim of our study is to use the 1997 ACCE lines in conjunction with the past data sets to investigate ocean climate change. The A20 salinity section (Figure 4a) shows many of the major water mass / circulation features. On the northern side note the high-salinity warm core ring and Gulf Stream front. Inshore of this, within the DWBC, resides the Labrador Sea Water whose low-salinity signal extends south of the Gulf Stream and is the cause of significant freshening at mid-depths. In the bottom-most layer the Antarctic Bottom Water becomes progressively fresher toward the southern boundary. In the upper 1000 m there is a pronounced core of Antarctic Intermediate Water extending from the southern boundary.

The suite of tracers measured on the cruise will provide valuable information in elucidating the water masses as well as understanding the climate signal. The oxygen section (Figure 4b) beautifully shows both the Labrador Sea Water and Norwegian-Greenland overflow water emanating from the northern boundary. Both these features appear again on the southern boundary. Note also the low oxygen of the Antarctic Bottom Water on the southern end of the section.

One of the surprises revealed by the tracers concerns the spreading of the Norwegian-Greenland overflow water from the northern boundary. The deep oxygen core extends into the Sargasso Sea centered near 3700 m (Figure 4b), whereas the analogous CFC core (not shown) is displaced roughly 500 m deeper. This perhaps reflects the difference in source functions of the two tracers in that CFCs have only entered the system in the last 50 years. Another unexpected feature is the complexity of the Labrador Sea Water signal along the northern boundary. It appears that discrete density layers are being ventilated, possibly the result of inter-annual variability in the formation of this water mass.

At the conclusion of the cruise the majority of the water sample data were merged into standard WOCE data files, and, aside from the post-cruise laboratory calibrations, the CTD data were nearly final. The combination of the 52W and 66W sections, along with the other ACCE fieldwork and previous hydrography, will provide a revealing look at the present state of the North Atlantic and its long-term variability.