

Figure 2. Volumetric census for the southeast Pacific region identified with Pacific AAIW. Volumes are in thousands of cubic kilometers; dots signify volumes less than .05 percent; hatched lines enclose potential temperature salinity class intervals with volumes greater than .05 percent of the total water volume in the region, 9815 x 1,000 cubic kilometers.

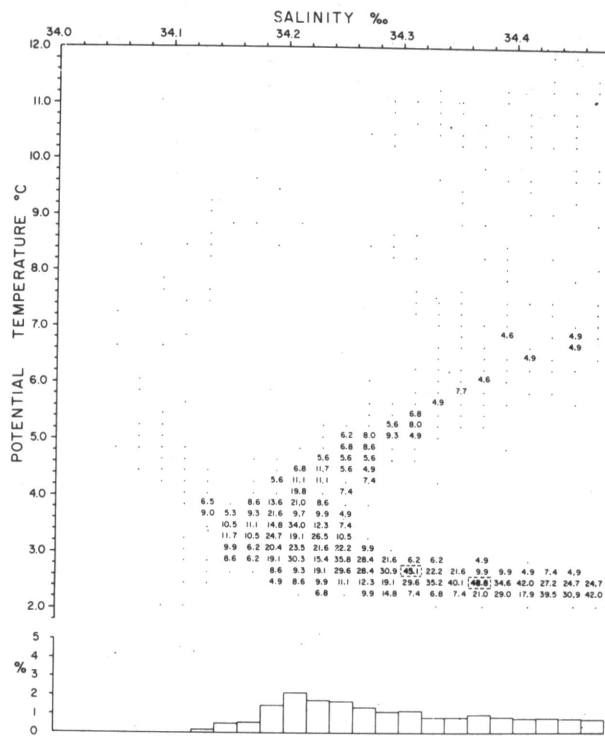


Figure 3. Volumetric census for the southwest Atlantic region. Volumes are in thousands of cubic kilometers; dots signify volumes less than .05 percent; hatched lines bound volumes in excess of .5 percent of the total water volume in the region, 8996 x 1,000 cubic kilometers.

Scotia Sea. Assuming that the poleward heat flux at the northern boundary, compared with the southern boundary, of the SAMW is small and that the heat flux to the atmosphere is much greater than the flux from the deep waters, then a heat loss for the SAMW's can be calculated, which is the result of a poleward and/or a heat flux to the atmosphere. These heat fluxes can be compared with recently derived poleward heat flux due to low frequency motions of the Antarctic Circumpolar Current (Bryden, 1978) and the heat flux to the atmosphere (Bunker, personal communication). From these comparisons it appears that both the poleward and the heat flux to the atmosphere are of the right order of magnitude, but a factor of two too small, to account for the observed temperature difference between Atlantic and Pacific AAIW. These results must be considered preliminary because of uncertainties in the actual winter hydrographic and atmospheric conditions and the lack of true heat flux divergence measurements. Thus it appears possible that the Atlantic AAIW derives from

the southeast Pacific SAMW; but the relative importance of cross-frontal mixing or the sea-air heat exchange is not yet clear.

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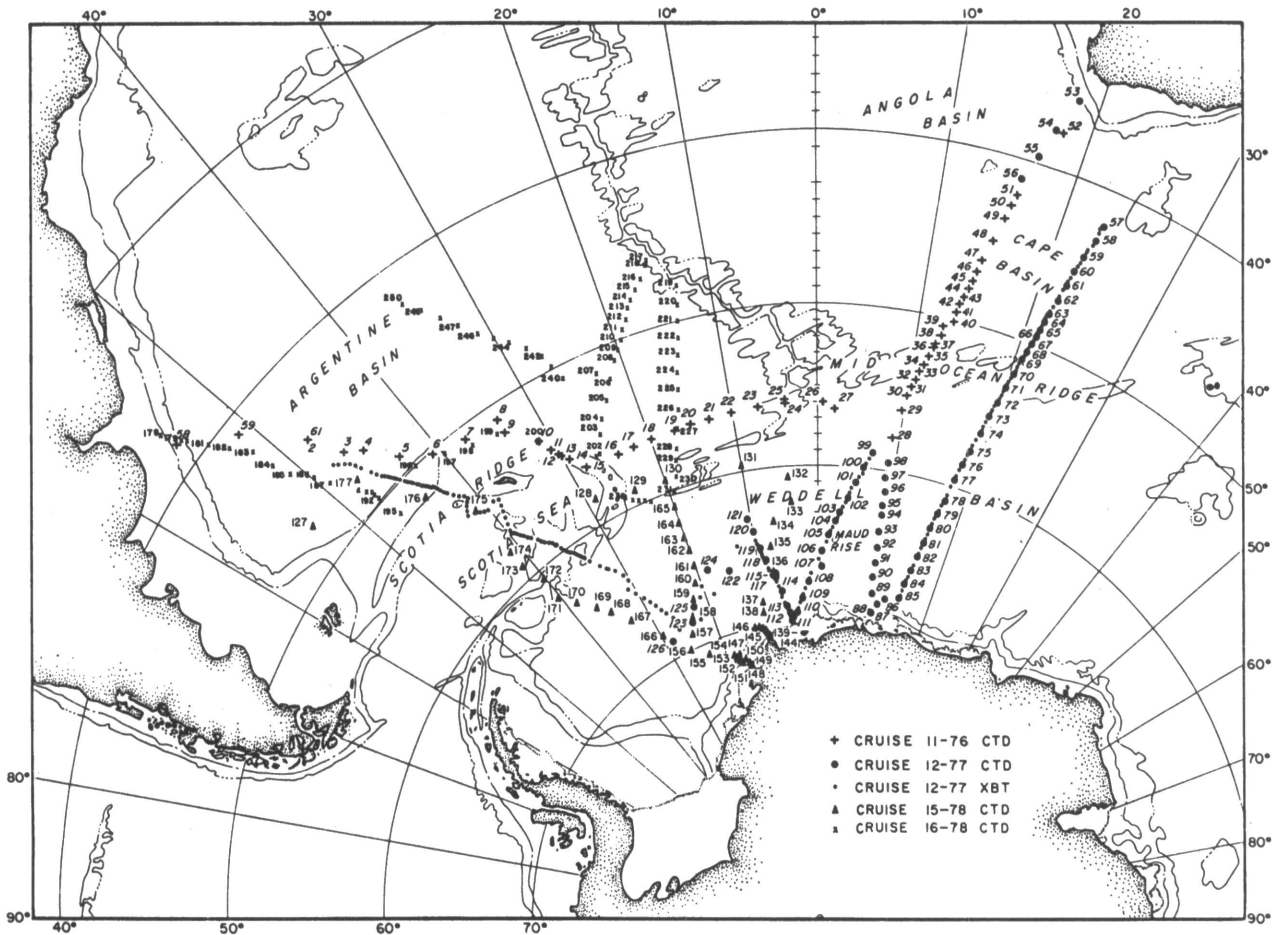
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South Atlantic oceanography

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From November 1976 to May 1978 ARA *Islas Orcadas* made four cruises into the Atlantic sector of the Southern Ocean to perform hydrographic stations. These cruises are a component, perhaps the final component, of the circumantarctic survey begun in 1962 by the same ship, then USNS *Eltanin*. The South Atlantic sector remained the most extensive gap in coverage by modern hydrographic stations. The 250 hydrographic stations obtained during the four cruises (see figure) do much to fill the void.



Hydrographic stations obtained during four *Islas Orcadas* cruises in Atlantic sector of Southern Ocean, November 1976 to May 1978.

The four cruises were: 11-76 (Sclater *et al.*, 1977) and 12-77 (Gordon and LaBrecque, 1977), made during the 1976-77 austral summer, 15-78 (16 January to 11 March 1978), and 16-78 (5 April to 28 May 1978).

The distribution of hydrographic station, shown in the figure, was obtained with a Neil Brown CTD-O₂, which measures nearly continuously conductivity (salinity), temperature, pressure (depth), and oxygen of the water columns. The CTD-O₂ was lowered at nearly all stations to within a few meters of the sea floor as determined by a pinger. Water samples for CTD-O₂ sensor calibration and additional nutrient chemistry (silicate and phosphate) were obtained with a 24-bottle rosette system housed around the CTD-O₂. On board, display of the CTD-O₂ was made possible with a Hewlett-Packard minicomputer.

The hydrographic station data were supplemented by water samples collected to determine tritium and stable isotope. Between CTD-O₂ stations, XBT (expendable bathythermograph) observations were made. The XBT data were plotted on an expanded scale record (Georgi, 1977). With each XBT observation, surface-water samples were obtained for salinity and silicate. Surface-water temperature was measured nearly continuously along the ship's track.

Processing of the CTD-O₂ hydrographic station and XBT data will begin on 1 October 1978 and will be ready for distribution in late 1979. The data will be analyzed to define the

thermohaline-chemical distribution of water masses and frontal structures found in the Atlantic sector of the Southern Ocean. The objective primarily is to learn about the existing advective-mixing patterns, specifically the impact of the Pacific and North Atlantic derived water properties in the area, and the oceanography of the Weddell Basin waters and waters south of Africa, which connect the Atlantic and Indian Oceans.

Data collected recently in the Drake Passage and Scotia Sea by the ISOS (International Southern Ocean Studies) program (Gordon, 1975; Nowlin *et al.*, 1975, 1976; Whitworth, 1977), the IWSOE (International Weddell Sea Oceanographic Expedition) in the western part of the Weddell Basin (Foster, 1976), and the work of R/V *Conrad* cruise 17 in the southwest Indian Ocean (Jacobs and Georgi, 1977) are of particular value since they define the oceanographic characteristics at the boundary of the *Islas Orcadas* data set. A significant lack of closely spaced, modern hydrographic data is found in the belt 30-45°S. (with the exception of the Cato data near the Rio Grande Ridge [Reid *et al.*, 1977]) across the entire South Atlantic.

The success of the collection of the *Islas Orcadas* data results from the dedicated work of many people, particularly the Lamont physical oceanographic department and the officers and crew of the ARA *Islas Orcadas*.

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Spatial variation of the K1, O1, and M2 constituents of the southern Ross Sea tide

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We completed our survey of the southern Ross Sea tide during the 1977-78 antarctic field season by measuring tidal

Tidal harmonic constituents in the southern Ross Sea.

Site	Record length ^a	K1		P1		O1		M2		S2		N2	
		A ^b	P ^c	A	P	A	P	A	P	A	P	A	P
Base(82.5°S.-166.0°W.)	44	43	186	14	186	35	174	8	213	10	112	9	87
J9(82.4°S.-168.6°W.)	30	37	191	12	191	37	172	7	205	8	106	7	60
RI(80.2°S.-161.6°W.)	36	44	160	15	160	38	140	5	130	10	26	9	12
C36(79.8°S.-169.1°W.)	34	37	160	12	160	32	153	3	75	6	25	4	22
C13(79.3°S.-180.7°W.)	29	30	200	10	200	34	190	3	300	4	130	5	153
O19(79.6°S.-196.7°W.)	39	31	208	10	208	29	196	4	340	2	190	3	180
C16(81.2°S.-189.5°W.)	76	31	200	10	200	27	190	3	310	2	160	4	140
F9(84.3°S.-171.3°W.)	58	41	206	14	206	40	190	8	258	11	142	8	143
LAS(78.2°S.-162.3°W.)	30	34	154	11	154	25	141	3	35	5	342	5	344
McM(77.9°S.-193.4°W.)	—	23	212	8	213	21	195	4	242	2	327	2	263

^aRecord length in days.

^bAmplitude in centimeters.

^cPhase angle in degrees relative to the Greenwich Meridian.

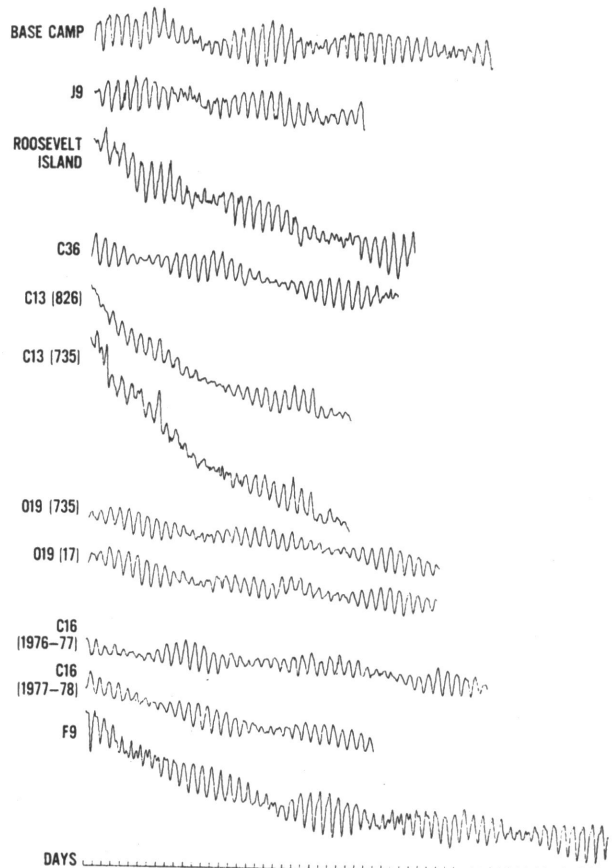


Figure 1. Tidal gravity records from eight locations on the Ross Ice Shelf.

variations of gravity for 39 days at site O-19 (79.6°S. 196.7°W.) and for 30 days at site C-16 (81.2°S. 189.5°W.). Results from C-16 are in close agreement with those we obtained there 1 year earlier. Measurements were repeated at C-16 to help us evaluate the reliability of our recording gravimeters. Field operations at O-19 and C-16 were similar to those described by Robinson *et al.* (1977) for the other six sites we have occupied since beginning our survey in 1973. Measurements at these sites (figure 1) and earlier results from Little America (Thiel *et al.*, 1960) and McMurdo Sound (Heath, 1971) provide information about the ocean tide at 10 locations (table) over the southern Ross Sea.