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A note on the comparison of salinity values from samples taken on the ICNAF larval herring surveys, 1975

by

R. Schlitz

National Marine Fisheries Service
Northeast Fisheries Center
Woods Hole, Massachusetts 02543

Abstract

In order to intercalibrate analytical methods duplicate salinity determinations from approximately 50 samples were made for three ICNAF Larval Herring Cruises in Fall, 1975. The first two cruises were carried out by R/V BELOGORSK and the third by R/V ANTON DOHRN; one salinity was determined on board while the other was stored and taken to Woods Hole for analysis. The mean salinity differences for the raw data were 0.048 °/oo (n=49), -0.223 °/oo (n=49), and 0.042 °/oo (n=56), respectively. The large mean difference for the second cruise is examined more closely and possible explanations for the differences are given.

Introduction

The comparability of data taken by different investigators in a cooperative research program has been a continuing concern. The ICNAF Larval Herring Surveys for 1975 were the first series of cruises that planned complete oceanographic coverage by all participating investigators, with samples collected on R/V BELOGORSK, R/V ANTON DOHRN and R/V ALBATROSS IV for salinity, oxygen, nutrients, and chlorophyll. The greatest uncertainty in the comparability of data appeared to be salinity since the oxygen determinations were made using identical automatic titrating equipment and the chlorophyll and nutrient samples were frozen for later analysis in Woods Hole.

Therefore a small experiment was planned to compare the inductive salinometers used by the USSR and FRG against an inductive salinometer. About 50 duplicate water samples were collected on each cruise, one of which was to determine salinity at sea and the other returned for analysis in Woods Hole. The duplicates from the two ALBATROSS IV cruises were not taken because illness necessitated curtailment of at sea salinity determinations. Therefore a total of about 150 duplicate samples were available for comparisons.

Results

Salinities were determined by the individual inductive salinometers using Normal Water for standardization and the same or a sub-standard water for drift determinations every 15-20 samples. These data by cruise are presented in Tables 1-3. The means and standard deviations are 0.048, -0.223, 0.042, and 0.130, 0.570, 0.093, respectively. If station 057 on the second cruise of R/V BELOGORSK was eliminated the mean and standard deviation would become 0.060 and 0.070, much closer to the other two values.

Within the raw data a number of samples appear out of order, but only two samples on station 33 of the R/V ANTON DOHRN cruise (Table 3) could be changed with any certainty. The three samples from station 477 of the first R/V BELOGORSK cruise (Table 1) were used since an improper trip of the bottles should have no effect on any comparisons.

Discussion

There are two prominent results that appear from this experiment. First, the salinities determined from the salinometer in Woods Hole are ~0.04-0.05 $^{o}/_{oo}$ higher than either of the other salinometers (if station 057 is eliminated) and second there are very large negative differences on station 57.

Since the salinity differences are well outside the accuracies quoted by manufacturers of inductive salinometers ($\pm$ 0.005 $^{o}/_{oo}$) and predominately of one sign a source of systematic error is possible between the salinometer used in Woods Hole and the other two. However, the Hytech model 6220 used for the comparisons was completely calibrated on 3 March 1975 with the indicated salinity lower than a standard salinity by 0.001 $^{o}/_{oo}$ at 30.020 $^{o}/_{oo}$ and 0.007 $^{o}/_{oo}$ at 35.009 $^{o}/_{oo}$. This would seem to indicate another explanation for the differences unless the salinometer drifted considerably in nine months, or the other two salinometers were biased by an equal amount.

A feasible explanation may be in the storage of samples for a period of time before salinity determinations. Although these changes occur slowly in deep oceanic water there is evidence from Mr. M. Stalcup of WHOI (personal communication, 1976) that storage of duplicate samples collected in shallow water could lead to increased salinity on the order of 0.02 $^{o}/_{oo}$ quite rapidly (~30 days). However, the time differences in the present experiment range from 5 weeks down to 8 days, and no apparent trend is present. The differences between instruments are not readily explained then and a better experimental design may be required and an experiment repeated.

The large differences on station 057 of the second cruise of R/V BELOGORSK appear to be a temporary problem with the calibration of the shipboard salinometer or an incorrect conversion to salinity from conductivity ratio rather than an error caused by the salinometer in Woods Hole. This is based on two pieces of information, the salinities for the second series of comparisons from the R/V BELOGORSK were run on the same day and salinities from stations on either side of station 057 are much closer to the mean differences. Also waters with the temperature and salinity characteristics as reported do not exist in the North American Basin (Wright and Worthington, 1970). Plate 4 of the folio shows water of >37 $^{o}/_{oo}$, only with temperatures >20° C and water of >36% only with temperatures >13° C.

Dr. I. Sigaev (personal communication, 1976) suggests that water of similar salinity exists in the Sargasso Sea and may have been drawn into the area by a meander or ring, but examination of temperature and salinity sections at 32° N, 36° N, and 40° N (Fuglister, 1960) do not show values of salinity above 36 $^{o}/_{oo}$ in the temperature range reported on station 057. Examination of satellite photographs and weekly interpretations of these data (Figure 1) however show a ring needed for the transport of these waters, but again the temperature, salinity characteristics are outside the range found in this region.

Conclusions

Because of the unexplained differences between instruments of ~0.05 $^{o}/_{oo}$ in the determination of salinity (neglecting station 057) a better experiment should be planned for further cooperative studies. In this experiment the time differences between water sampling and salinity determination must be held to a minimum to avoid the salinity changes associated with storage of coastal waters. Also a highly accurate Guildline salinometer will be available for salinity determinations.

Acknowledgements

The cooperation of Dr. I. Sigaev, Mr. G. Joakimsson, and the scientific parties aboard the R/V BELOGORSK and R/V ANTON DOHRN are appreciated.

References

Fuglister, F. C. 1960. Atlantic Ocean atlas of temperature and salinity profiles and data from the International Geophysical Year of 1957-1958. The Woods Hole Oceanographic Institution, Woods Hole, Volume 1.

Wright, W. R., and L. V. Worthington. 1970. The water masses of the North Atlantic Ocean, a volumetric census of temperature and salinity. Serial Atlas of the Marine Environment, American Geographical Society, New York, Folio 19.

Table 1. Salinity comparisons for samples taken aboard R/V BELGOGORSK during ICNAF Larval Herring Cruise, 25 September-9 October 1975.

Station	Depth m	Date	Salinity °/oo	Date	Salinity °/oo	Difference (USA-USSR)
356	0	2 Oct.	34.142	10 Nov	34.204	0.062
	8		34.142		34.223	0.081
	16		34.142		34.174	0.032
	23		34.370		34.398	0.028
	39		34.370		34.402	0.032
	58		35.105		35.126	0.021
	78		35.271		35.291	0.020
	117		35.334		35.367	0.033
	156		35.511		35.536	0.025
	192		35.372		35.398	0.026
	228		35.132		35.304	0.172
	301		35.067		35.153	0.086
	374		35.031		35.096	0.065
	447		34.995		35.067	0.072
	593		34.957		35.023	0.066
	740		34.966		35.037	0.071
	915		34.838		35.058	0.220
	1178		34.957		34.992	0.035
377	0	5 Oct.	35.722	11 Nov.	35.588	-0.134
	10		35.538	10	35.562	0.024
	19		35.594	10	35.564	-0.030
	29		35.594	11	35.571	-0.023
	48		35.399	11	35.397	-0.002
	72		35.575	11	35.590	0.015
	97		35.734	10	35.739	0.005
	145		35.669	10	35.663	-0.006
	193		35.500	11	35.545	0.045
	283		35.215	11	35.247	0.032
	374		35.141	11	35.152	0.011
	464		35.549	11	35.553	0.004
	554		35.132	10	35.142	0.010
	734		35.004	10	35.022	0.018
	914		35.013	10	34.995	-0.018
	1094		35.585	10	35.005	-0.580
	1274		35.022		-	-
477	0	5 Oct.	32.641	11 Nov.	32.652	0.011
	10		32.892	10	33.026	0.134
	20		33.797	11	33.927	0.130
	50		34.417		34.497	0.080
	75		34.635		34.740	0.105
	100		35.334		35.888	0.554
	150		35.529		35.661	0.132
	200		35.390		35.435	0.045
	*111		35.918		36.005	0.087
	*134		34.554		34.595	0.041
	*178		35.307		35.379	0.072
	484		34.975		35.014	0.039
	581		34.894		35.033	0.139
	775		34.874		35.027	0.153
	968		34.894		34.984	0.090
			n=49		$\bar{x}$ =	0.048
					s =	0.130

*bottles tripped incorrectly.

Table 2. Salinity comparisons for samples taken aboard R/V BELOGORSK during ICNAF Larval Herring Cruise, 16-30 October 1975.

Station	Depth m	Date	Salinity °/oo	Date	Salinity °/oo	Difference (USA-USSR)
099	0	17 Oct.	31.873	12 Nov.	31.840	-0.033
	10		31.963		31.968	0.005
	19		32.310		32.369	0.059
	29		32.489		-	-
	48		32.928		32.984	0.056
	73		33.465		33.533	0.068
	97		33.289		33.334	0.045
	121		33.741		33.829	0.088
	145		34.088		34.160	0.072
	169		34.608		34.689	0.081
	194		34.883		34.979	0.096
	232		35.031		-	-
094	0	17 Oct.	31.864	12 Nov.	31.858	-0.006
	8		31.793		31.847	0.054
	17		33.018		33.165	0.147
	42		35.123		35.336	0.213
	63		35.585		35.687	0.102
	84		36.169		36.277	0.108
	126		36.012		36.051	0.039
	168		35.585		35.677	0.092
	211		35.372		35.259	-0.113
	254		35.197		35.406	0.209
	340		35.022		-	-
	427		34.948		-	-
	514		34.921		-	-
	688		34.912		-	-
	862		34.883		-	-
078	0	20 Oct.	35.141	12 Nov.	35.215	0.074
	10		35.141		35.235	0.094
	19		35.141		35.204	0.063
	28		35.141		-	-
	47		35.343		35.420	0.077
	71		35.716		35.782	0.066
	94		35.716		35.801	0.085
	141		35.603		35.672	0.069
	188		35.473		35.624	0.151
	237		35.289		35.334	0.045
	286		35.150		35.216	0.066
	384		35.013		-	-
	483		34.957		-	-
	577		34.939		-	-
057	0	22 Oct.	35.529	12 Nov.	34.271	-1.258
	10		35.529		34.297	-1.232
	19		35.556		34.297	-1.259
	48		36.238		35.065	-1.173
	71		36.702		35.429	-1.273
	95		37.051		35.740	-1.311
	142		36.881		35.550	-1.331
	190		36.722		35.421	-1.301
	245		36.059		35.259	-0.800
	298		36.796		34.738	-2.058
	406		36.348		-	-
	517		36.301		-	-
	619		36.245		-	-
	822		36.245		-	-
	1024		36.225		-	-

Table 2. continued.

Station	Depth m	Date	Salinity °/oo	Date	Salinity °/oo	Difference (USA-USSR)
013	0	28 Oct.	34.480	12 Nov.	34.469	-0.011
	10		34.444		34.458	0.014
	20		34.417		34.465	0.048
	30		34.530		34.755	0.225
	50		34.713		34.559	-0.154
	75		35.179		35.208	0.029
	100		35.298		35.325	0.027
	125		35.417		35.451	0.034
	150		35.417		35.444	0.027
			n=49		$\bar{x}$ =	-0.223
					s =	0.570
			excluding station 057			
			n=39		$\bar{x}$ =	0.060
					s =	0.070
			Total for both R/V BELOGORSK cruises			
			excluding station 057			
			n= 88		$\bar{x}$ =	0.054
					s =	0.109

Table 3. Salinity comparisons for samples taken aboard R/V ANTON DOHRN during ICNAF Larval Herring Cruise, 31 October-16 November, 1975.

Station	Depth m	Date	Salinity °/oo	Date	Salinity °/oo	Difference (USA-ERG)
56.1	3	9 Nov.	35.29*	18 Nov.	35.302	0.012
	10		35.29		35.311	0.021
	30		35.33		35.341	0.011
	50		35.28		35.337	0.057
	75		35.79		35.793	0.003
	100		35.94		35.947	0.007
	150		35.81		35.913	0.103
	200		35.60		35.609	0.009
	300		35.61		35.621	0.011
	400		35.09		35.202	0.112
	500		35.03		35.046	0.016
	600		35.00		35.016	0.016
	800		34.98		34.989	0.009
	1000		34.99		34.988	-0.002
	1500		34.96		35.030	0.070
56	3	9 Nov.	33.05	18 Nov.	33.076	0.026
	10		33.25		33.257	0.007
	30		33.62		33.634	0.014
	50		35.48		35.492	0.012
	75		35.65		35.659	0.009
	100		35.33		35.369	0.039
	150		35.32		35.318	-0.002
55	3	9 Nov.	32.50	18 Nov.	32.603	0.103
	10		32.49		-	-
	30		32.86		33.552	0.692
	50		34.16		34.168	0.008
	75		34.63		34.759	0.129
	94		34.71		34.713	0.003
54	3	9 Nov.	32.46	18 Nov.	32.475	0.015
	10		32.45		32.500	0.050
	30		32.46		32.512	0.052
	50		32.46		32.492	0.032

continued.

Table 3. continued.

Station	Depth m	Date	Salinity °/oo	Date	Salinity °/oo	Difference (USA-FRG)
53	3	9 Nov.	32.30	18 Nov.	32.362	0.062
	10		32.30		32.327	0.027
	30		32.30		32.349	0.049
	50		32.30		32.320	0.020
52	3	9 Nov.	32.24	18 Nov.	32.249	0.009
	10		32.24		32.267	0.027
	30		32.24		32.257	0.017
	58		32.22		32.235	0.015
51	3	9 Nov.	32.02	18 Nov.	32.038	0.018
	10		32.02		32.030	0.010
	30		32.02		32.090	0.070
	50		32.08		32.106	0.026
	75		32.20		32.274	0.074
	89		32.31		32.328	0.018
50	3	9 Nov.	31.98	18 Nov.	32.005	0.025
	10		31.99		32.039	0.049
	30		32.02		32.058	0.038
	75		32.23		32.233	0.003
	100		32.58		32.601	0.021
33	3	10 Nov.	32.06	18 Nov.	32.079	0.019
	10		32.06		x32.078	0.018
	30		32.20		x32.218	0.018
	50		32.49		32.506	0.016
	75		32.71		32.728	0.018
	100		33.03		33.056	0.026
			n=56		$\bar{x}$ = 0.042	
					s = 0.093	

*Reported to ± 0.01 °/oo
xSample bottles appeared reversed and changed for calculations

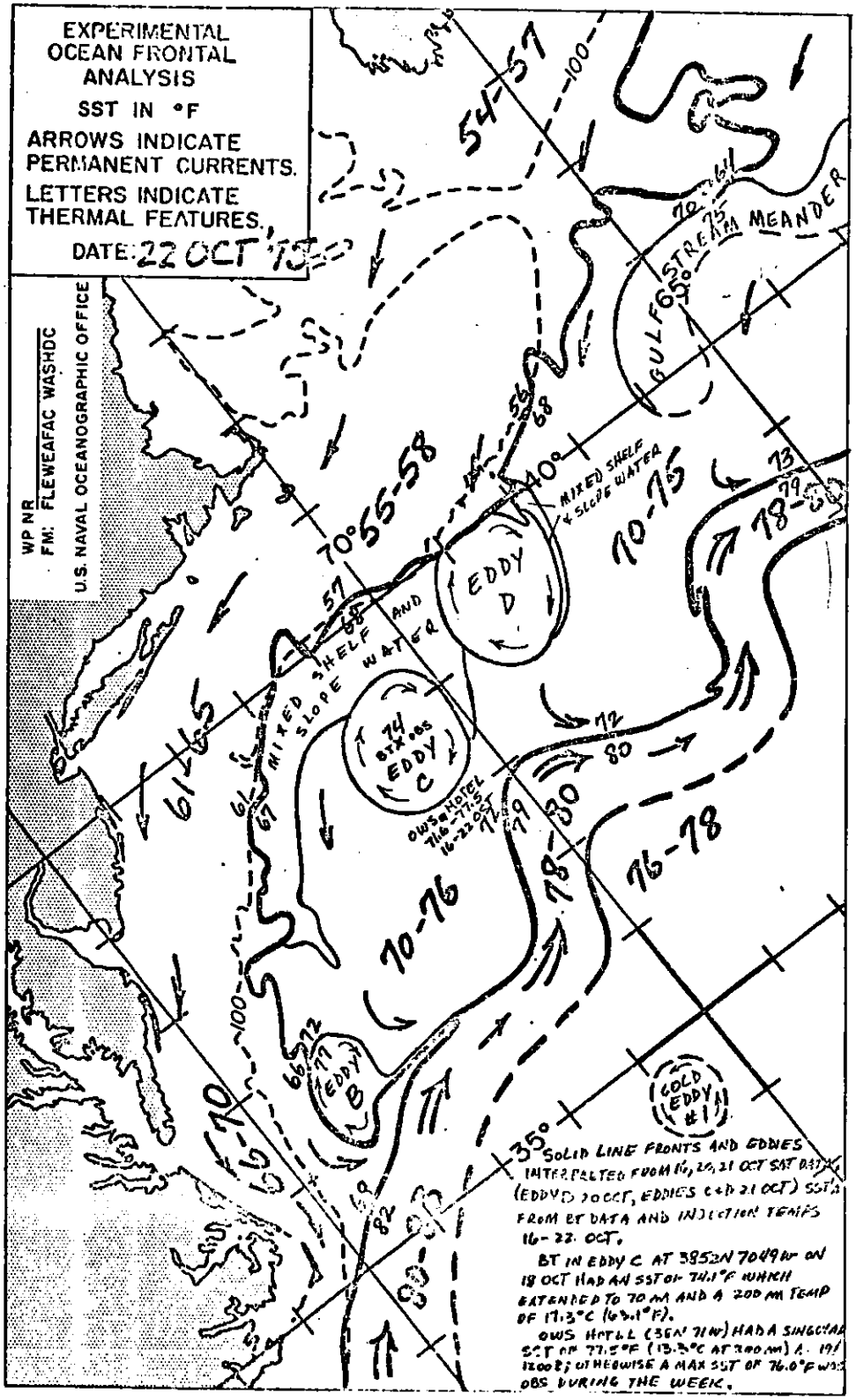
EXPERIMENTAL
OCEAN FRONTAL
ANALYSIS
SST IN °F
ARROWS INDICATE
PERMANENT CURRENTS.
LETTERS INDICATE
THERMAL FEATURES.
DATE: 22 OCT '75
WP NR
FM: FLEWEAFAC WASHDC
U.S. NAVAL OCEANOGRAPHIC OFFICE
GULF STREAM MEANDER
MIXED SHELF & SLOPE WATER
EDDY D
EDDY C
EDDY B
COLD EDDY #1
SOLID LINE FRONTS AND EDDIES INTERPOLATED FROM 16, 20, 21 OCT SAT DATA (EDDY D 20 OCT, EDDIES C+D 21 OCT) SST'S FROM BT DATA AND INJECTION TEMPS 16-22 OCT.
BT IN EDDY C AT 3852N 7049W ON 18 OCT HAD AN SST OF 74.1°F WHICH EXTENDED TO 70 M AND A 200 M TEMP OF 17.3°C (63.1°F).
OWS HOTEL (36N 71W) HAD A SINGULAR SST OF 77.5°F (25.3°C AT 200 M) A. 19/1200Z; OTHERWISE A MAX SST OF 76.0°F WAS OBS DURING THE WEEK.

Figure 1.