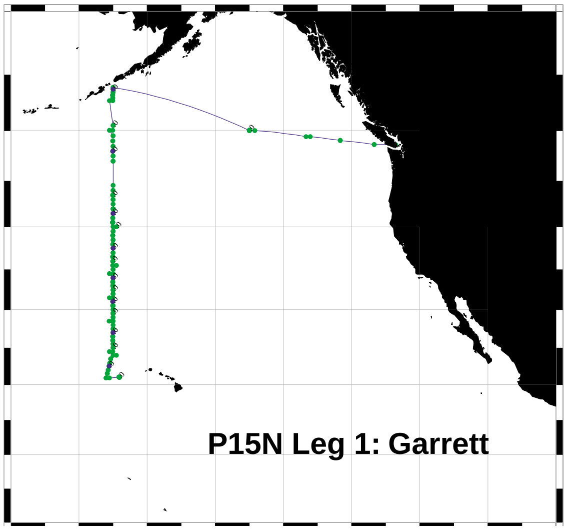
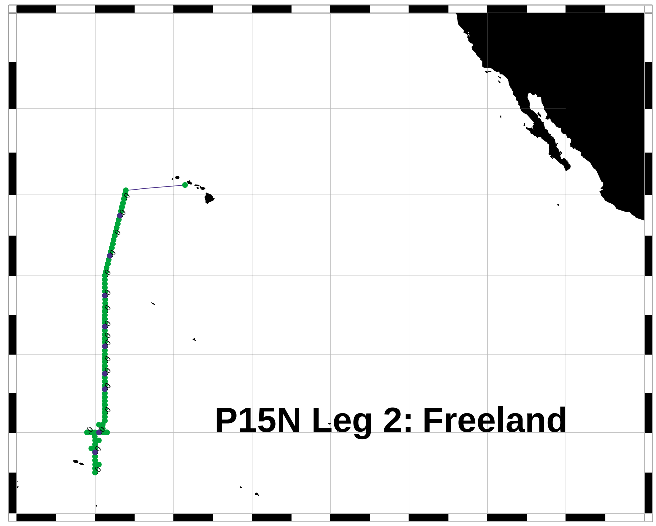
A. Cruise Narrative: P15N





A.1. Highlights

WHP Cruise Summary Information

WOCE section designations	**P15N, PR06, PRS1**	**P15N**
Expedition designations (EXPOCODES)	**18DD9403_1**	**18DD9403_2**
Chief Scientist(s) and their affiliation	**John Garrett/IOS**[†]	**Howard Freeland/IOS**[§]
Dates	1994.SEP.06 to 1994.OCT.10	1994.OCT.13 to 1994.NOV.10
Ship	R/V John P. Tully	
Ports of call	Dutch Harbor, Alaska to Honolulu, Hawaii	Honolulu, Hawaii to Pago Pago, American Samoa
Number of stations	177	191
Geographic boundaries of the stations	54 N 171 W 123 30 W 15 S	
Floats and drifters deployed	15 Argos drifters (7 shallow, 8 deep), 1 meteorological Drifter	
Moorings deployed or recovered	0	

[†] Institute of Ocean Sciences
P.O. Box 6000
9860 West Saanich Road
Sidney, B.C. V8L 4B2 CANADA
Phone: 604-363-6574
Fax: 604-363-6479
Email: jfg@ios.bc.ca

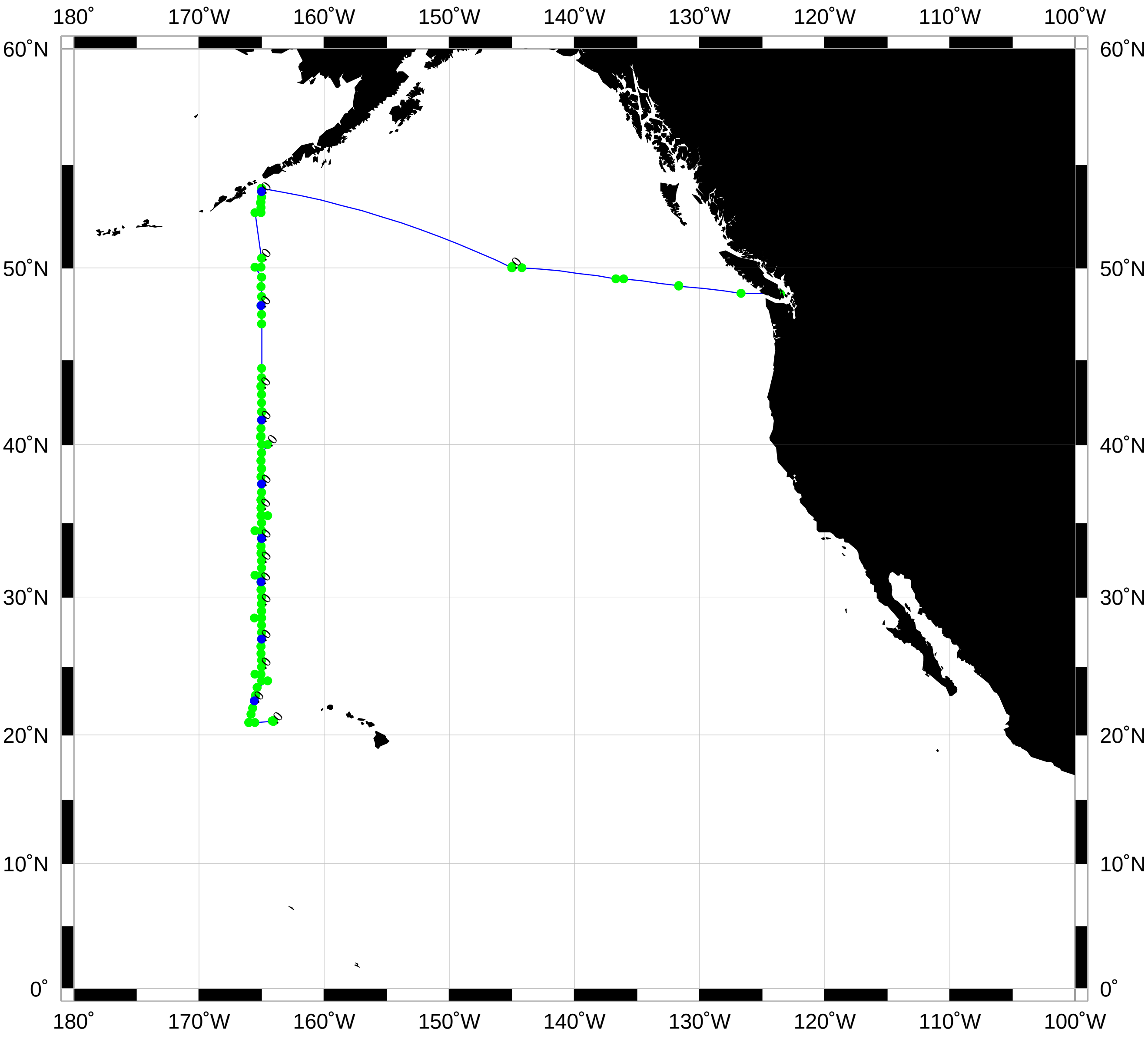
[§] Institute of Ocean Sciences
P.O. Box 6000
9860 West Saanich Road
Sidney, B.C. V8L 4B2 CANADA
Phone: 604-363-6590
Fax: 604-363-6746
Email: freelandhj@dfo-mpo.gc.ca

WHP Cruise and Data Information

Instructions: Click on any item to locate primary reference(s) or use navigation tools above.

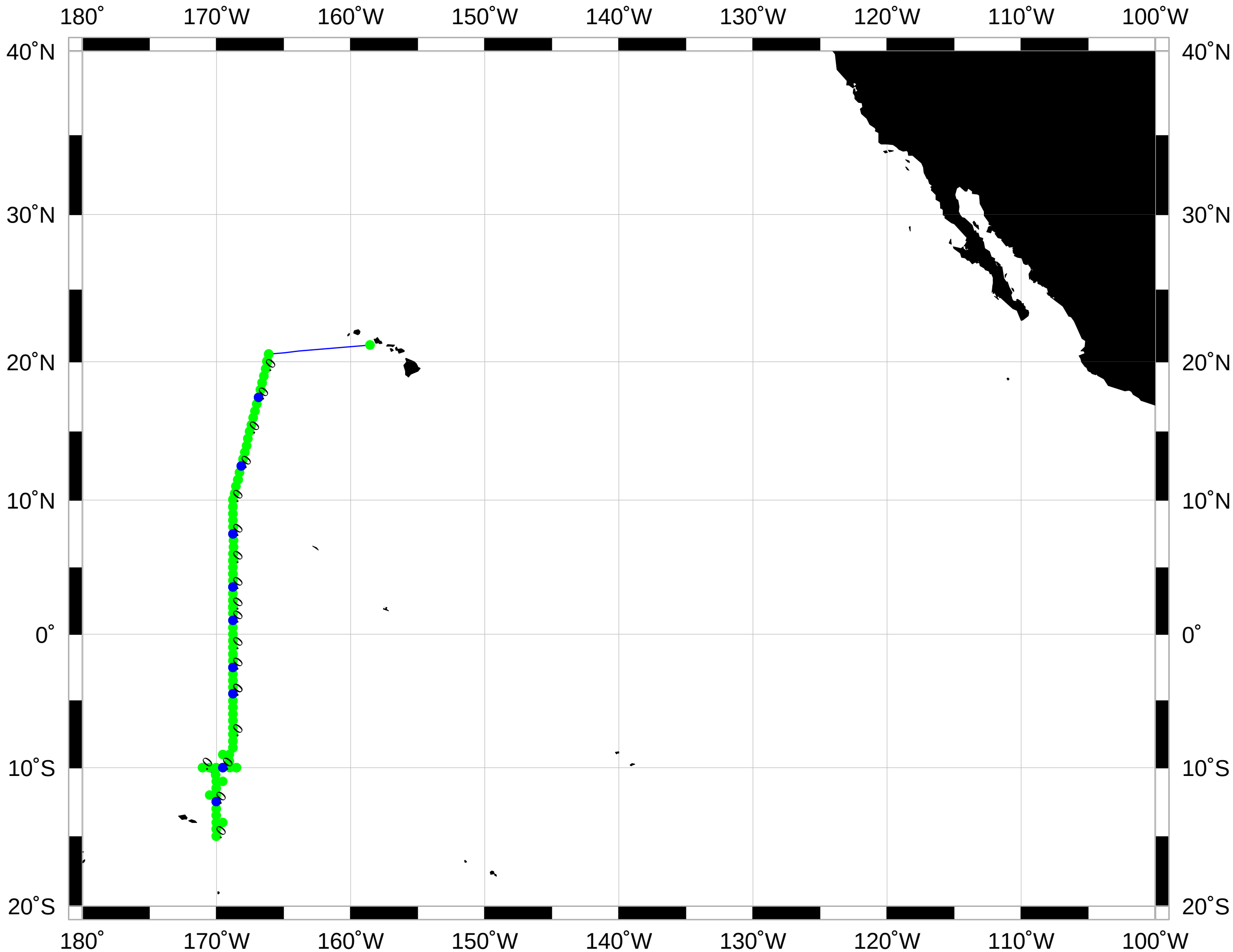
Cruise Summary Information	Hydrographic Measurements
Description of scientific program	CTD - general
	CTD - pressure
Geographic boundaries of the survey	CTD - temperature
Cruise track (figure) Leg 1 Leg 2	CTD - conductivity/salinity
Description of stations	CTD - dissolved oxygen
Description of parameters sampled	
	Salinity
Floats and drifters deployed	Oxygen
Moorings deployed or recovered	Nutrients
	CFCs
Principal Investigators for all measurements	
Cruise Participants	
Problems and goals not achieved	CO2 system parameters
Underway Data Information	**Acknowledgments**
Navigation	**References**
Bathymetry	
Acoustic Doppler Current Profiler (ADCP)	**DQE Reports**
Thermosalinograph and related measurements	
XBT and/or XCTD	CTD Leg 1 CTD Leg 2
Meteorological observations	S/O2/nutrients
Atmospheric chemistry data	CFCs
	Data Processing Notes

Station Locations for P15N Leg 1: Garrett



Produced from .sum file by WHPO-SIO

Station Locations for P15N Leg 2: Freeland



Produced from .sum file by WHPO-SIO

A.2 Cruise Summary Information

A.2.a Geographic boundaries

On September 6, the Tully sailed west from the mouth of Juan de Fuca Strait, along Line PR6. After completing 4 stations en route to Station PRS1, the vessel sailed for Dutch Harbor, Alaska, where it refueled. Section P15N started near Dutch Harbor and continued south along 165 W. At 24 N, we gradually shifted towards the West to coincide with a previous NOAA section and the planned route of P15S. Most of the scientific crew were changed in Honolulu after 35 days at sea. Leg 2 continued from 20 30 N, following a course that moved gradually westward to 168 45 W at 10(N. We remained on this longitude through the equator, then began a second southwestward course at 8 30 S that took us to 170 W at 10 S. At 15 S, Leg 2 ended and the vessel sailed to American Samoa.

A.2.b Stations occupied

CTD/rosette casts were done at 3 stations along PR6, PRS1 was reoccupied, and 70 CTD/rosette stations along P15N were done during the first leg. Two rosettes were used to collect 3225 samples for onboard analyses of salinity, oxygen, nutrients, CFCs, total CO_2 and alkalinity. Additional samples were stored for ^{13}C, ^{14}C, ^{18}O and CH_4. Continuous measurements of air and seawater CO2 were taken from the scientific seawater supply (Uncontaminated Sea Water). USW was also sampled for salinity, nutrients and chlorophyll a at almost all cast stations, and each degree of longitude between PRS1 and Dutch Harbor. Tracers were occasionally collected from the USW supply.

Table 1: Station Locations for USW

-123.500000	48.266700	-137.666700	49.650700	-158.021700	52.488300
-124.002500	48.299800	-138.667200	49.566500	-159.000200	52.666800
-124.500300	48.449800	-139.666700	49.633000	-160.117800	52.874800
-125.011700	48.539300	-140.662700	49.701200	-161.128300	53.041700
-125.546800	48.578200	-141.669500	49.767000	-162.024200	53.183000
-126.000000	48.600000	-142.658300	49.835000	-163.000200	53.286800
-126.333300	48.616700	-143.603200	50.000000	-164.000800	53.394300
-126.665700	48.649200	-144.303700	50.001200	-164.998300	53.640800
-126.171700	48.693300	-144.984500	50.003000	-164.989500	53.920700
-127.686700	48.743300	-146.009200	50.206300	-164.989300	53.744700
-128.666700	48.816700	-147.003500	50.401000	-164.995700	53.500300
-129.165800	48.856200	-148.009500	50.596000	-165.015000	53.249000
-129.662000	48.892700	-149.003800	50.786500	-165.003700	52.998200
-130.166700	48.933300	-150.008300	50.979700	-165.003000	52.739800
-130.661700	48.966700	-151.218300	51.208300	-165.495700	52.238000
-131.664700	49.044000	-152.007300	51.359700	-165.141700	51.358300
-132.664500	49.122500	-153.007000	51.550000	-164.990800	50.967200
-133.659200	49.200000	-154.061500	51.748200	-164.993200	50.499000
-134.669700	49.283700	-155.000800	51.924500	-165.003000	50.000300
-135.670000	49.350000	-156.001500	52.112200	-164.999000	49.493500
-136.661500	49.415300	-157.000000	52.295500	-165.007300	49.004200

-165.000000	48.500200
-164.999300	47.999500
-164.991500	47.503800
-164.995500	47.012700
-165.000300	46.498000
-164.999700	45.991800
-165.162700	45.504000
-164.755700	44.996700
-164.790200	44.500200
-164.995200	43.995000
-165.009300	43.487200
-164.990000	43.013300
-164.999200	42.500000
-164.995200	41.999700
-164.997200	41.496800
-165.005800	40.997700
-165.023300	40.494300
-165.000000	40.001300
-164.907200	39.498200
-165.000300	38.999200
-164.998300	38.504800
-165.003300	37.998300
-165.001800	37.501800
-164.999300	36.998000
-165.006200	36.504700
-165.002000	35.998000
-165.004200	35.495000
-164.995300	35.000800
-165.000800	34.514700
-164.993800	34.001300
-165.000200	33.496300
-165.014500	32.995300
-164.995800	32.505000
-164.995700	31.997700
-165.006000	31.503200
-165.006500	31.003700
-165.000700	30.503200
-164.984300	30.006700
-164.994500	29.504500
-164.994200	29.001800
-165.000800	28.503700
-164.998700	27.999800
-164.974300	27.512700

-164.994200	27.008500
-165.001500	26.499200
-165.005800	25.995000
-164.996500	25.505000
-164.998500	25.005300
-165.000800	24.498200
-164.997000	23.995200
-165.317700	23.504800
-165.463200	22.917000
-165.567500	22.500700
-165.703200	21.986800
-165.994700	20.899200
-158.548000	21.178300
-166.086200	20.508800
-166.189300	20.016700
-166.317200	19.502200
-166.439200	19.002500
-166.691000	18.001500
-166.843200	17.479700
-166.994300	16.970500
-167.108200	16.494800
-167.228200	15.993000
-167.349800	15.498300
-167.496500	14.998800
-167.616300	14.494800
-167.750200	13.976200
-167.871200	13.493000
-167.982800	13.000300
-168.118800	12.496000
-168.250200	11.996200
-168.375300	11.493800
-168.512000	11.006300
-168.623200	10.499500
-168.746000	10.006800
-168.749000	9.494200
-168.751000	8.996300
-168.754300	8.501000
-168.743300	8.001800
-168.741200	7.493500
-168.730700	7.002800
-168.726200	6.503500
-168.742000	6.001800
-168.739300	5.478000

-168.747300	4.997300
-168.752000	4.484700
-168.750200	4.007200
-168.747700	3.496500
-168.760000	3.004200
-168.755700	2.523300
-168.750300	2.010200
-168.762200	1.521500
-168.753200	1.009300
-168.760700	0.489000
-168.750700	-0.003200
-168.752500	-0.510800
-168.747800	-1.011800
-168.750700	-1.506800
-168.742800	-2.010300
-168.749000	-2.506800
-168.757000	-3.003300
-168.741200	-3.496300
-168.754800	-3.997800
-168.742200	-4.489200
-168.752800	-5.004700
-168.755200	-5.503800
-168.759200	-6.018000
-168.755800	-6.503800
-168.746000	-7.013000
-168.747800	-7.500500
-168.747200	-8.008300
-168.747200	-8.503500
-169.000200	-9.003500
-169.004200	-9.507300
-169.501300	-10.002300
-170.015500	-10.498200
-169.997500	-11.004300
-170.000000	-11.506500
-170.494200	-11.999000
-169.991500	-12.503800
-169.988500	-13.019000
-169.995300	-13.498800
-169.995500	-14.007200
-169.998300	-14.497500
-169.999500	-15.001300

A.2.c Floats and drifters deployed

At 4 stations, a total of 15 Argos drifters, 7 shallow (20 m drogues) and 8 deep (120 m drogues), were deployed. A single meteorological drifter was deployed for Department of the Environment near 47 N. About 2 dozen wine bottles with postcards inside were deployed at locations selected by a local school class.

A.2.d Moorings deployed or recovered

No moorings deployed or recovered

A.3 List of Principal Investigators

TABLE 2: Principal Investigators Principal

Investigator	Parameters	Institution
Howard Freeland	Climate change, XBTs,	IOS
	ADCP	
C.S. Wong	Climate chemistry	IOS
	TCO_2, AT, CFCs, ^{13}C, ^{14}C,	
	^{18}O, underway pCO_2	
Ron Perkin	Physical measurements	IOS
	CTD, salinity	
Frank Whitney	Chemical measurements	IOS
	Oxygen and nutrients,	
	chlorophyll a, meteorology,	
	bathymetry, thermosalinograph	

A.4 Scientific Programme and Methods

Features such as the Alaska Stream, sub-arctic front, 2200 m silicate maximum (37 to 43 N), shallow oxygen minimum north of the equator, equatorial upwelling, flow of Antarctic water through the Samoan Gap, etc. are readily identified in this data set. Surface waters in the subarctic region of the Pacific are evidently a strong sink for CO_2 in September.

Our deep ocean winch, rosette/CTD and heave compensation equipment worked very well to 6000 m, the first test it has had below 4200 m. Sampling from the Tully was equally successful. The ship was able to hold station in 40 knot winds, and aft deck sampling proved comfortable and safe in most conditions. Sampling was suspended whenever the rosette unweighted excessively, as recorded on a load sensor mounted between the rosette and cable.

A.5 Major Problems and Goals not Achieved

Several stations were omitted due to high winds (reaching 70 knots), and CTD casts only were attempted at another 12 stations in marginal conditions. Thus there is a gap in the hydrographic sampling between 47 N and 43 30 N. Sampling intervals were spaced to 250 or 500 m below 3000 m at many stations, allowing us to save time by carrying out only a single rosette cast. This spacing should result in negligible loss of information, since there is little structure in North Pacific deep waters.

Our deep ocean winch was damaged beyond repair following a cast at 10 S. Subsequent sampling was restricted to a maximum depth of 3800 m.

CFC instrumentation caused us continual grief, although about 75% of the stations were successfully analyzed. We had to return to Honolulu to pick up a replacement Gas Chromatograph at the beginning of Leg 2, costing us 3 days of ship time.

There were some difficulties encountered throughout the cruise that hampered obtaining optimal results for CFC-11 and CFC-12.

A problem with the consistency of the quality of the carrier gas meant having to subtract higher than normal stripper blanks.

The results of stations 83 to 97 may show zero at the 300 to 400 m depth because the threshold was initially set as per the 5890 GC program. This was modified for later stations in order to have very small peaks integrated. Thus these zero values may be a factor of threshold setting rather than a complete absence of CFCs.

During some of the earlier stations we encountered samples affected by some sort of interference. This resulted in the F11 peak being split or at other times summed, usually in the fifty meter sample. Neither using the split value or a summed value seemed to give a reasonable result so these samples were flagged as questionable or bad. This problem was also encountered on the first leg of the cruise.

Phosphate samples were frequently contaminated during the second half of the first leg. A nitrate reagent containing phosphoric acid was spilt on September 30 when Stations W044, W045, and W046 were analyzed. On October 1 it was noted in the nutrient log that the crew were washing the deck with soap - Stations W047, W048 and W049 were analyzed on this day.

Our water demineralizing system failed during Leg 2, which forced us to use low nutrient sea water 1) to establish a baseline during analyses, and 2) for the preparation of standards. Each day, a sample of 3.2% NaCl in double run Milli-Q water was analyzed to assess the zero concentrations for each nutrient. Silicate and phosphate in wash water typically was 2 and 0.2 mM higher than the clean salt water solution. All data have been corrected for this baseline offset. LNSW was also used as a rinse after acid cleaning.

The nitrite line developed a problem with crystal buildup at Station W123 and continued to the end of the cruise. This resulted in higher than expected values for deep samples and all data for Stations W123 - W137 has been labelled data quality 3 for both nitrite and nitrate. Nitrate data is questionable due to the doubtful subtraction of 0.1 to 0.3 umol/kg nitrite.

A.6 Other Incidents of Note

A.7 List of Cruise Participants

TABLE 3: Cruise Participants

Individual	Responsibility	Institution
Leg 1:		
John Garrett	chief scientist	IOS
Frank Whitney	coordinator, hydro. data	IOS
Dario Stucchi	CTD data processing	IOS
John Love	electronics, sampling, salinity	IOS
Bernard Minkley	sampling, salinity	IOS
Reg Bigham	sampling	IOS
Tim Soutar	sampling	IOS
Ron Bellegay	sampling	IOS
Valerie Knight	carbonate	IOS
Galina Pavlova	carbonates	POI
Linda White	nutrients	IOS
Andrei Andreev	nutrients	POI
Pavel Tishchenko	CFCs	POI
Ruslan Chichkin	CFCs	POI
Leo Rebele	CFCs	student
Sarah Thornton	Oxygen	student
Marie Robert	sampling	IOS
Louise Timmermans	sampling	student
Mary-Beth Derube	sampling	IOS

Individual	Responsibility	Institution
Leg 2:		
Howard Freeland	chief scientist	IOS
Ron Perkin	CTD data	IOS
Bernard Minkley	hydro data	IOS
John Love	electronics, sampling, salinity	IOS
Reg Bigham	sampling	IOS
Neil Sutherland	sampling	IOS
Dennis Sinnott	sampling	IOS
Hugh Maclean	sampling	UBC
Keith Johnson	carbonates	IOS
Marty Davelaar	carbonates	IOS
Janet Barwell-Clarke	nutrients	IOS
Mary Obrien	nutrient	IOS
Wendy Richardson	CFCs	IOS
Carol Stewart	CFCs	IOS
Tracy Feeney	CFCs	student
Bob Wilson	Oxygen	IOS
Taimi Mulder	sampling	student
Rhiannon Johnson	sampling	student
Robin Brown	sampling	IOS

Abbreviations:

IOS Institute of Ocean Sciences,
Sidney, B.C. Canada
POI Pacific Oceanological Institute,
Vladivostock, Russia
UBC University of British Columbia
Vancouver, B.C. Canada

B. Underway Measurements

B.1 Navigation and bathymetry

A SAIL (Standard ASCII Interface Loop) system onboard ship poles several sensors at 2 min intervals. Data is stored on a micro computer and is subsequently processed in a format that is accessible for general use. Ships speed, heading, and position plus ocean depth are logged.

B.2 Acoustic Doppler Current Profiler (ADCP)

A hull mounted current profiler logged upper layer currents every 5 min throughout the cruise.

B.3 Thermosalinograph and underway dissolved oxygen, etc

Temperature and conductivity sensors are installed near the intake of a sea water line that is used as a scientific supply in the laboratory. Data is logged on SAIL. Uncontaminated Sea Water (USW) was continuously pumped to the laboratory and used for half hourly measurements of pCO_2, continuous fluorometry (chlorophyll a) and discrete sampling at stations. An infrared analyzer was used to measure air, sea water and standard CO_2 concentrations every 30 minutes throughout the cruise. Sea water was equilibrated within a trapped air space to provide samples for measurements of pCO_2 in surface sea water (DOE 1994). Chlorophyll a samples were collected from the USW supply at most stations, and filtered through Whatman GF/F filters. Samples were then frozen for transport back to IOS.

B.4 XBT and XCTD

XBTs (Type T-5, 1830 m) were used at several stations when bad weather prevented use of CTDs.

B.5 Meteorological observations

Logged on SAIL are wind speed and atmospheric pressure.

B.6 Atmospheric chemistry

C. Hydrographic Measurements

C.1. Water sampling

1. A 23 bottle rosette with a Guildline Model 8737 CTD was our primary sampling system (Niskin bottles numbers 1 to 23).

2. An 11 bottle rosette with a Guildline 8705 CTD was used for shallow casts (Niskin bottles number S1 to S11).

Water samples were collected from rosettes by both CFC analysts (Freons only) and sampling teams. Samples were drawn in the order CFCs, oxygen, carbonate suite (TCO_2, alkalinity, ^{13}C, ^{14}C) and methane, then nutrients, salinity and ^{18}O in any order.

CFC samples were drawn into 100 ml glass syringes that were thoroughly rinsed in a continuous stream of sample. CFC samplers checked each Niskin bottle for leaking by pushing in the sample spigot before opening the air vent. Gas samples were drawn through amber or Tygon tubing and were all allowed to overflow from one to two volumes. Carbonate samples were poisoned with 200 ml of saturated $HgCl_2$ solution per 250 ml. Methane samples were drawn through amber tubing into glass bottles. Rubber septa with syringe needles piercing their centers, were used to eliminate air from the samples. Septa were crimp sealed in place and samples were refrigerated.

Other sample containers were rinsed 3 times and filled as required. Nutrient samples were refrigerated until analysis. Salinity samples were warmed to lab temperature before being analyzed. 180 samples were tightly stoppered and refrigerated.

Standard Deviation of Pairs (Sp)

Standard Deviations of Pairs (Sp) were calculated from replicates drawn from Niskin bottles tripped within 2.3 db of each other using the following formula. Sp = {(summation of d**2)/2k}**0.5 where d = differences between pairs and k = number of pairs. Using this as a measure of precision includes all discrepancies introduced by leaking water samplers, sample collection, sample storage and analysis.

TABLE 4: Standard Deviation of Pairs (Sp)

Parameter	Range	Sp	k
Salinity (PSS-78)	33.576 - 35.923	0.003	46
Oxygen (umol/kg)	20.86 - 203.41	1.02	45
Silicate (umol/kg)	0.02 - 149.8	0.34	46
Nitrate (umol/kg)	0 - 42.9	0.11	44
Nitrite (umol/kg)	0 - 1.406	0.008	46
Phosphate (umol/kg)	0.04 - 3.13	0.02	46
CFC-11 (pmol/kg)	0.415 - 2.587	0.076	11
CFC-12 (pmol/kg)	0.263 - 1.359	0.040	11

C.2 CTD

CTD Calibrations

The P15N data was calibrated and processed to the stage of one metre average files using laboratory calibrations done before and after the cruise. The data were then examined for changes which may have occurred during the cruise, consistency between the three CTDís used and agreement with bottle salinities. The findings are given below.

Instruments

The three CTDís used were all Guildline CTDís, the primary instrument being the WOCE model (WOCE CTD) which was used for most of the deep casts using the 24 bottle rosette. The 12 bottle rosette used for shallow casts was equipped with a standard Guildline Digital CTD (OP CTD sn 58483). In weather too rough for launching a rosette, a modified Guildline Digital CTD was used (CTD6).

WOCE CTD, Guildline Model 8737 , SN 59901

This CTD was used for most of the casts in this cruise usually mounted in a bottle slot on a custom made 24 bottle rosette. It was interfaced to a GO pylon which triggered the 10-liter bottles in the 23 remaining slots; data gathering was not interrupted by the bottle triggers. Sensor data was digitally compensated for the effects of the electronics temperature which was monitored at all times. Additional sensors were a load cell giving the wire stress at the Rosette and two thermistor temperature sensors logged every half second.

Pressure

The Paros pressure sensor model 410K-101, Serial No. 50395 was calibrated on May 1, 1994 against a factory calibrated reference Paros pressure sensor. The correction was -1 +/-1 dbar for the entire range with no hysteresis. No correction was applied.

Temperature

Temperature calibrations are referenced to the triple point of water(.01 C) and the triple point of phenoxybenzene (26.868 C, IPTS-68, National Physical Laboratory, UK). Interpolation was done by a set of six reference thermistors calibrated at the National Research Council of Canadaís temperature standards lab. The thermistors were offset to match their calibrations at the triple point of water. Slope changes to match the high temperature triple point amounted to a change of -.0019 C at 30 C, the highest temperature measured. (Note: all WOCEdata is converted to ITS-90)

The main temperature sensor is a copper resistance thermometer, SN 51429. Through three years of use this sensor has been stable +/-.0065∞C with no slope correction necessary. It was calibrated in May, 1994 giving an offset of -.005C and in Jan., 1995 giving an offset of -.0065°C. Calibration shifts were tracked by two complementary calibration thermistors using a separate housing, interfacing and digitizing circuitry and scanned every half second. These sensors are slower than the main sensor and were corrected for a 3 second time constant. Data from low gradient regions, deeper than 2000 m, were used to track any calibration shifts which occurred during the cruise.

Because of factory changes in the internal circuitry done between the pre-cruise calibration and the start of the cruise, the post-cruise calibration was used and changes to the main temperature sensor were back-tracked using the calibration thermistors. Six digital SIS reversing thermometers were used on the rosette as an additional check. Of these, one failed to track the other sensors and others showed a tendency to drift to lower temperature. Three, #451, #647 and #679 were chosen by their consistency with each other and the reference thermistors and the fact that they were used in low gradient regions below 2000 m where time constant problems were minimal. Calibrations on the reversing thermometers were done in March ë94.

Temperature Corrections

Using the post-cruise calibration, new corrections for internal electronics temperature were computed for temperature(Tmain), conductivity and the two reference thermistors (th1 and th2). Calibration constants were determined as follows and used to re-process the data:

Table 5: Calibration Coefficients

```
CONDUCTIVITY CORRECTION FACTORS FOR P AND T
   g#(0) = -.0000032
   g#(1) =  .0000001

TEMPERATURE
   U(0) = -5.91775 - .0065
   U(1) =  7.7834E-05 / 2
   U(2) =  1.92916E-13 / 4

CONDUCTIVITY
   V(0) = -.000519#
   V(1) = 1.69181E-06
   V(2) = 0
   cELLK = 1!        ‘CELL CONSTANT TO BE ADJUSTED FOR BOTTLE SALINITIES
   Nref = rawdata&(13) - 3956   ‘Nref IS PROPORTIONAL TO ELECTRONICS TEMP.
   Nc& = rawdata&(0) + Nref * (-.472)      Conductivity
   Nt& = rawdata&(1) + Nref * 1.24         Temperature

TEMPERATURE = calctemp(U(0), U(1), U(2), Nt&)

conductivity = calccond(V(0),V(1),V(2),Nc&)*(1+g#(0)*TEMPERATURE+
                 g#(1)*PRESSURE) * cELLK

therm1raw = rawdata&(8) + (-.0545) * TREF
therm2raw = rawdata&(9) + (-.04) * TREF

  'calculate thermistor resistance(ohms) according to post P15n cal.

rt1 = 3591.57 - 6.540890000000001D-02 * therm1raw
rt2 = 3628.768 - .0766183# * therm2raw

th1 = thermtemp(.00101711365#, .000294395858#, .00000015683113#, rt1, th1off)
th2 = thermtemp(.00104554083#, .000290301739#, .00000015888418#, rt2, th2off)
'3 sec. slower thermistors. So with a +ve rate of change, they read colder.
  thermdelt = 3 * tgrad     'look back by one time const. diff.

   'the thermistors are -.13 m below the Copper T sensor.

  IF dz > 0 THEN ZOFF = -.13 ELSE ZOFF = .13
  IF ABS(dz) > .14 THEN thermdeld = -ZOFF * tgrad * dt / dz ELSE thermdeld = 0

 'total correction to thermistors is:
  thcorr = thermdelt + thermdeld
  tcomp = TEMPERATURE - ((th1 + th2) / 2 + thcorr)
PRINT #3, USING fprintf$; rawdata&(41); PRESSURE; TEMPERATURE; SALINITY;
conductivity; th1 + thcorr; th2 + thcorr; TREF; temp; TCOMP; Frame(KK)
```

In a typical cast starting at close to 30C and ending close to 1°C, the internal temperature monitor, Nref, will change by about 350 units. Over this range, corrections are as follows:

Tmain:(350*1.24*7.7e-5/2) = .016°C
Cond.: (-.472*350*1.69e-6) = -.000279(-.0159 in salinity)
Th1: (-.545*350*.065) = 12.3 ohms (.061 °C in temperature)

Comparisons for calibration purposes were generally made in water deeper than 2000 m where changes in Nref are much smaller than 350 units, typically 30 units.

Using the re-processed data, the average difference between th1 and Tmain were computed for each cast only for data below 2000 dbars. For the last 26 casts, th1 and Tmain agreed within .001C so the post cruise calibration was deemed valid for these casts. Systematic changes in the comparison through the course of the cruise were attributed to the main sensor because of its more sensitive construction. However, it was noticed that the correction was different for down and up casts by about .001°C and different by about .0049°C depending on whether or not the load cell used to monitor line stress at the Rosette was attached. These offsets were very stable and consistent. Removal of the load cell also removed the difference between down and up casts and resulted in good agreement between the CTD sensors and reversing thermometers. Although this effect has not been fully explained, tests in the shop show that there appears to be some interference between the sensors and the load cell. Work is proceeding to eliminate it but, for the purposes of this cruise, a compensating offset was applied.

Although Thermistor 2 was in good agreement(± 0.02 C) with thermistor 1, it did not fit the calibration bath thermistors or the main sensor as well as thermistor 1. So Thermistor 1 was used to track calibration shifts during the cruise. Its temperatures were offset to compensate for the .0049 C shift on casts with the load cell, the majority of the data.

The temperatures measured by the reversing thermometers were corrected according to their calibrations of March, 1994 and compared with Tmain (corrected for high and low triple points). There was a great deal of scatter in the comparisons so once again comparisons were limited to depths below 2000 m and three of the sensors were eliminated because of apparent drift problems or the depth limitation already mentioned. The remaining three (#451, #647 and #679) were in good agreement with the corrections determined by Thermistor 1 although #647 had apparently drifted by about .003C by the end of the cruise. A spot check on #647 a year later showed a change of .005C at low temperature. In general, these sensors are not as stable as they should be and some further work is being done to remove solder flux from the sensor areas. More frequent calibrations are also necessary.

Conductivity
The conductivity sensor is a 4-electrode Guildline Pyrex glass sensor. Conductivity data was corrected for the effects of pressure and temperature on Pyrex glass(Bennett, A. S., 1976, Conversion of in situ measurements of conductivity and salinity., D.S.R., vol. 23, pp.

157 to 165.); conductivities derived from bottle salinities were used to correct the cell constant as described below.

Calibration samples were drawn from the 10-liter Niskin bottles into Pyrex bottles and analyzed within a few days on board. Bottle salinities were determined using a Guildline Portasal salinometer referenced to Batch P121 standard seawater. The internal precision of the Portasal exceeds ±.001 C in salinity. Duplicate samples to test the precision of the procedure agreed with in .002 C. Other sources of error include sampling errors and mis-triggers and are thought to be either small or to have been corrected by visual inspection of outliers in the resulting salinity and chemical data. After determining the temperature corrections above and recomputing salinity, comparisons were made at the bottle points.

Upcast and downcast salinities were compared to bottle salinities and systematic pressure-dependent trends were removed. For the downcast data, an additional correction of P*(3E-8) was added to the conductivity to account for a small pressure dependency. For the upcasts, the trend was removed with a correction of P*(-1E-8). Possible causes of this effect are errors in the compensation for internal temperature, possibly due to thermal transients which would be stronger on the downcast.

In order to compare with bottles collected on the upcast, down cast salinities were interpolated to the matching upcast temperature to compensate for the vertical movement caused by internal waves during the roughly 3.4 hours of a cast. This was done by comparing temperatures in the appropriate depth range and offsetting salinity to the bottle temperature using the local TS slope estimated over a 10 dbar range. A careful processing, shown in the table below, of an example cast, #97, produced salinity agreement ±.002°C from 5826 dbar to 200 dbar. Higher errors near the surface are expected because of the instability of the water column, including the TS correlation.

Table 6. Hand processing of a typical down cast removes the effect of internal waves by interpolating to the temperature at which the bottle was triggered on the up cast. Agreement between bottle salinity and CTD salinity is good from 200 dbar down.

P15N Cast 97 Bottle Depths

	up cast data				Down cast data				Salinity Error
UP P	Cruise T	Corr.T	T(P-5)	T(P+5)	S(P-5)	S(P+5)	Sinterp	Sbott	Bott-Interp
11.56	23.0931	23.0994	23.07697	23.07167	34.59999	34.57936	34.68732	34.5555	-0.13182
49.02	16.0177	16.024	16.48648	15.08266	34.46396	34.44395	34.45737	34.3999	-0.05747
100.18	12.8362	12.8425	12.8824	12.66911	34.38542	34.36216	34.38107	34.3713	-0.00977
199.96	10.8816	10.8879	11.1023	10.90042	34.21864	34.18872	34.18687	34.1845	-0.00237
299.91	10.0152	10.0215	10.20157	10.08747	34.19784	34.1877	34.18183	34.1822	0.000369
399.98	8.6104	8.6167	8.464675	8.272387	34.08092	34.06794	34.09119	34.0905	-0.00069
601.26	5.4378	5.4441	5.278873	5.119783	34.00744	34.01951	33.99491	33.998	0.003088
799.94	4.0703	4.0766	4.089046	4.046349	34.16306	34.17121	34.16544	34.1641	-0.00134
1000.49	3.4009	3.4072	3.405389	3.37939	34.29684	34.30184	34.29649	34.294	-0.00249
1250.35	2.8679	2.8742	2.842024	2.819325	34.42956	34.43389	34.42342	34.421	-0.00242
1499.69	2.4731	2.4794	2.461347	2.439049	34.51694	34.51789	34.51618	34.5127	-0.00348
1750.54	2.1319	2.1382	2.145267	2.136668	34.56895	34.57033	34.57008	34.5699	-0.00018
1999.78	1.9248	1.9311	1.92798	1.919581	34.60301	34.60434	34.60251	34.6014	-0.00111
2250.18	1.7762	1.7825	1.77219	1.76839	34.62828	34.62888	34.62667	34.6259	-0.00077
2499.08	1.6601	1.6664	1.663897	1.661197	34.64509	34.64527	34.64493	34.6433	-0.00163
2748.77	1.5847	1.591	1.594001	1.590901	34.65649	34.65697	34.65695	34.6582	0.001246
2999.49	1.5395	1.5458	1.543304	1.542004	34.66485	34.66508	34.66443	34.6643	-0.00013
3500.81	1.4817	1.488	1.489108	1.487808	34.67585	34.67623	34.67617	34.6767	0.000525
3998.45	1.4721	1.4784	1.479308	1.478308	34.68221	34.68241	34.68239	34.6818	-0.00059
4499.44	1.4903	1.4966	1.495207	1.495507	34.68624	34.68627	34.68638	34.686	-0.00038
4999.78	1.5273	1.5336	1.532005	1.532705	34.68889	34.68897	34.68908	34.6884	-0.00068
5499.6	1.5753	1.5816	1.580302	1.581402	34.69106	34.69094	34.69092	34.691	8.35E-05
5826.5	1.6071	1.6134	1.6129	1.6115	34.6914	34.6914	34.6914	34.6911	-0.0003

Bulk processing of the data using local TS slopes estimated over 40 dbars produced a similar improvement although not quite as much as the detailed processing of cast #97. Below is a plot of the cell constants computed from each bottle at or below 2000 dbars for the whole cruise. These cell constants were averaged for each cast in order to compensate for the small systematic and random differences between the casts. Differences from this average cell constant were computed for each bottle and are shown plotted below on the same graph.

This CTD was used as a backup to the WOCE CTD and is also equipped with a Paros sensor for accurate pressure determination. It was used by itself when the weather was too rough to safely launch the Rosette so there are not many bottle samples to use for comparison. However, at Station W108, it was used in a cast to 5000 m with a set of 11 bottles from 1750 dbar to 5000 dbar. These bottles were used to determine the cell constant. In addition to the comparisons to the on-board thermistors, the temperatures were compared to the adjacent casts at stations W107 and W109 to verify the temperature calibration (see the section on temperature). Finally, the TS properties of CTD6 casts taken near the end of the cruise were compared with the set of corrected WOCE CTD temperatures and their matching bottle salinities as shown below in the section on conductivity.

Table 7 The initial calibration on which these changes take effect is given below:

*CALIBRATION
$TABLE: RAW CHANNELS

!Name	Units	Fmla	Pad	Coefficients
Time_stamp	none	10	n/a	(0 1)
Temperature:Analog_Probe	n/a	10	n/a	(0 1)
Voltage:reference	n/a	0	' '	
Voltage:reference:2	n/a	0	' '	
Temperature	'DEG C (ITS68)'	10	-9	(0 1)
Conductivity_ratio	n/a	63	-9	(0 1)
Pressure	DBAR	10	-9	(-10 1)
Temperature:thermistor1	n/a	34	-9	(4722.61 0.203168 0.1051772E-02 0.2894819E-03 0.155711E-06 0)
Temperature:thermistor2	n/a	34	-9	(4826.07 0.2058 0.1027592E-02 0.2916148E-03 0.1542955E-06 0)
Temperature:digiquartz	n/a	10	-9	(0 1)
Temperature:2	n/a	0	-9	
Transmissivity	n/a	0	-9	
Conductivity_ratio:2	n/a	0	-9	

$END

Pressure

The Paros pressure sensor model 410K-101, Serial No. 50500 was calibrated before the cruise on Aug. 26, 1994. At 22°C, the pressure correction was -3 dbar and at 3 C, the pressure correction was 0 dbar. There was no hysteresis. No correction was applied beyond the -10 dbar correction from absolute to gauge pressure.

Temperature

The main temperature sensor is a copper resistance thermometer. It is complemented by two calibration thermistors in a separate housing using separate interfacing circuitry. These sensors are slower than the main sensor and serve to track any calibration shifts which may occur during the cruise. CTD6 agreed well with its second thermistor +/-.002°C but not with the first which read .01C high. Thermistor 2 indicated an average correction of -.002 C.

Below is the temperature comparison at Stn. 108 which shows good agreement with the WOCE CTD values at adjacent stations (these were later corrected up by .001 C). At depths near 4000 dbar, the CTD6 temperatures seem to be a bit too high. Application of the above correction of -.002 C would bring the three casts into good agreement. Therefore, CTD6 temperatures were corrected by -.002 C. CTD6 was used near the end of the cruise without the benefit of bottle salinities. Comparison with bottles collected on other casts done with the WOCE CTD. The effect of applying the cell constant of .99984 results in good agreement in TS space between the two data sources.

Ocean Physics CTD (OP CTD)

This CTD was used mainly for casts with the 12-bottle Rosette to depths not exceeding 1500 dbar. Its main function was to provide temperature and pressure data for the bottles since each station was covered by full depth profile by one of the other CTD's. Comparisons in the upper 1500 m of the water column with the other CTD's showed a great deal of scatter due to water column variability so a lowered accuracy is claimed for this data. The calibration originally used was:

Table 8: More Calibration coefficients

*CALIBRATION

$TABLE: RAW CHANNELS

!	Name	Units	Fmla Pad	Coefficients
	Pressure	DBAR	10 –99	(0 3000)
	Temperature	'DEG C (ITS68)'	10 –99	(0.47653E-01 0.99872)
	Conductivity_Ratio	n/a	10 –99	(0.62E-03 0.99898)

$END

Pressure

The pressure sensor was calibrated before the cruise and during the cruise with a reversing pressure sensor. Of 25 calibrations, the average offset determined by the reversing pressure sensor was -4.6 dbar with a standard deviation of 2.1 dbar. The pressures for this CTD were therefore offset by -4.6 dbar.

Temperature

The main temperature sensor is a copper resistance thermometer. Comparison with reversing thermometer #679 and #647 gave a mean correction of .0076C. The scatter on temperature comparisons as a result of water column variability suggests an accuracy of .007 for these data.

Table 9. In-Situ calibrations for OP CTD (sn 58483)

REVERSING SENSORS

Bottle	CTD	CTD	Bottle	Sensor	Sensor			
	Pressure	Temp.	Salinity Trev	Prev	Trev	Trev-Tctd	Prev-Pctd	
#	(dbar)	(°C)	(psu)	(°C)	(dbar)	(°C)	(°C)	(dbar)
103	1002.97	2.994	34.3459	2.994	996.4	2.99924	0.00524545	-6.57
513	603.15	4.311	34.101	4.313	599	4.31847	0.00747693	-4.15
593	594.83	4.574	34.0393	4.571	593.3	4.57652	0.00252221	-1.53
671	496.05	6.363	33.9955	6.482	487	6.48785	outlier	-9.05
830	603	5.363	34.0015	5.372	598.2	5.37766	0.01466279	-4.8
910	598.42	6.124	33.9983	6.109	595.3	6.11479	-0.00920787	-3.12
944	600.3	6.284	33.9929	6.31	595.6	6.31582	outlier	-4.7
1001	599.02	5.899	33.9925	5.913	594.1	5.91875	0.01975773	-4.92
1058	795.6	4.201	34.1374	4.205	790.3	4.21045	0.00945798	-5.3
1115	799.5	4.31	34.1314	4.314	796.8	4.31947	0.00947711	-2.7
1172	601.88	6.306	34.0223	6.317	596.5	6.32863	0.01682863	-5.38
1229	1002.75	3.813	34.3584	3.822	997.3	3.82739	0.01439076	-5.45
1295	605.85	6.795	34.043	6.778	603.2	6.78390	-0.01109046	-2.65
2686	1000.35	4.667	34.5512	4.664	995.9	4.67579	0.00879269	-4.45
						averages	0.0074	-4.6

Conductivity
As previously mentioned, bottle comparisons in the upper 1000 m produced noisy data. However, comparison of downcasts with corresponding up cast bottle data resulted in the following data for determining the cell constant for this CTD.

The low value for the first cast, which was at Stn. P, was to some extent due to temporal variation because the upcast gave values near 1.0000. Based on these findings and accounting for the compression of the conductivity cell, the cell constant was set at 1.0001 and the accuracy of the salinity determinations was downgraded to .01, equivalent to .00025 in the cell constant.

SUMMARY

Processing was done according to the calibrations constants determined during the cruise. Salinity accuracy is estimated below for each CTD except in regions of the profiles where strong temperature and conductivity gradients result in errors due to sensor mismatches. Salinity spikes have been removed by hand in some profiles. Using bottle samples, on-board thermistors and reversing temperature and pressure sensors additional calibration constants were determined as follows:

WOCE CTD
No change to pressure.

The WOCE CTD was initially calibrated with the post-cruise calibration of (offset, slope) = (-.0015, .999938). To account for changes which occurred during the cruise the temperature offsets listed in the following table were applied.

Down cast salinities were matched to corresponding bottle salinities with a separate cell constant determined for each rosette cast (see table below). Agreement to a standard deviation of less than .001 in salinity with bottle samples below the 2000 dbar horizon was achieved. Temperature accuracy is estimated at .002C , salinity at .002.

CTD6
No pressure correction.
Temperature correction: -.002 °C.
Cell constant: .99984
Temperature accuracy is estimated to be .002 °C and salinity accuracy to be .005.

OP CTD (58483)
Pressure correction: -4.6 dbar
Temperature correction: .0074 °C.
Cell constant: 1.0002
Temperature accuracy is estimated to be .007 C and salinity accuracy to be.01

Calibration instructions for the WOCE CTD.

Processing of .1ma files.

The .1ma files have been edited to remove spikes, therefore, salinity cannot be recomputed from corrected temperatures and conductivities derived from the raw files. However, the conductivity has not been corrected for the pressure and temperature effects on the conductivity cell. In addition, three calibration steps are necessary to correct the data:

- a pressure-dependent conductivity correction
- a temperature offset and slope
- a cell constant to produce agreement with bottle salinities.

Since corrections are to be applied to the conductivity, it is easiest to generate a new conductivity using the despiked salinity and the SAL78 routine. The other alternative is to compute a salinity correction but because of the interaction of the temperature and conductivity corrections, this would be much harder and may lead to errors.

The conductivity cell correction can be combined with the pressure-dependent conductivity correction:

$$Rcorr = R1ma(1 + P*(1.3E\text{-}7) + T*(-3.2E\text{-}6))$$

The temperature offset should be applied in two steps:

1. add .004C to all WOCE CTD casts after 94030219.1ma to remove the old change in offset. This amounts to resetting the A0 in the temperature polynomial to -5.92425 for all casts.

2. add the temperature offset in the list supplied to each cast and apply slope of .999938 to all temperatures to compensate for high temperaturetriple point correction on the bath thermistors. The offset correction was included in the A0 figure quoted above.

Apply the cell constant in the supplied list to the conductivity.

$$Rfinal = Rcorr * Cellk$$

Recompute salinity using the the final values of R, T and P.

Table 10. WOCE CTD Corrections Relative to the post-cruise

Consec #	celk_avg	Temp offset
1	0.999874	0.008967
2	0.999874	0.008967
3	1.000084	0.008967
4	1.000084	0.008967
5	0.999975	0.008967
6	0.999975	0.008967
7	0.999952	0.007873
8	0.999952	0.008565
9	0.999952	0.007528
10	0.999952	0.007528
11	0.999952	0.007528
12	0.999952	0.007528
13	0.999952	0.007528
14	0.99998	0.007528
15	0.99998	0.008247
16	0.99998	0.007452
17	0.99998	0.007452
18	0.99998	0.007452
19	0.99998	0.007452
20	0.99998	0.007452
21	0.99998	0.007452
22	1.000003	0.007452
23	1.000003	0.007491
24	1.000003	0.007323
25	1.000003	0.007323
26	1.000003	0.007833
27	0.999915	0.006976
28	0.999915	0.008049
29	0.99996	0.006805
30	0.99996	0.008395
31	1.000006	0.00706
32	1.000006	0.008
33	1.000022	0.006856
34	1.000022	0.007994
35	1.000001	0.006858
36	1.000001	0.008517
37	0.999914	0.006794
38	0.999914	0.008112
39	1.000004	0.007239
40	1.000004	0.007831
41	0.999979	0.007011
42	0.999979	0.008248
43	0.999976	0.007022
44	0.999976	0.008251
45	0.999976	0.007333
46	0.999976	0.007333
47	0.999976	0.007333
48	0.999976	0.007333
49	0.999976	0.007333
50	0.999914	0.007333
51	0.999914	0.008126
52	0.999925	0.006856
53	0.999925	0.008557
54	0.999958	0.00672
55	1.000048	0.008258
56	1.000048	0.008069
57	1.000048	0.006733
58	1.000048	0.006733
59	1.000048	0.006733
60	1.000048	0.006733
61	0.999981	0.008607
62	0.999981	0.007265
63	1.000023	0.008451
64	1.000023	0.007009
65	1.000052	0.008704
66	1.000052	0.0085
67	1.000052	0.00729
68	1.000052	0.00729
69	1.000052	0.00729
70	1.000024	0.008214
71	1.000024	0.006935
72	1.000018	0.00845
73	1.000018	0.0067
74	1.000018	0.008257
75	1.000018	0.006689
76	1.000018	0.006689
77	1.000018	0.006689
78	0.99998	0.008199
79	0.99998	0.00683
80	0.999969	0.008258
81	0.999969	0.006682
82	0.999978	0.008042
83	0.999978	0.006981
84	1.000003	0.008231
85	1.000003	0.006532
86	1.000003	0.006532
87	1.000003	0.006532
88	0.999971	0.008156

Consec #	celk_avg	Temp offset
89	0.999971	0.006674
90	0.999946	0.007911
91	0.999946	0.006303
92	0.999946	0.006303
93	0.999946	0.006303
94	0.999946	0.006303
95	0.999966	0.008344
96	0.999966	0.006289
97	0.999966	0.007755
98	0.999966	0.006223
99	0.999999	0.008071
100	0.999999	0.00636
101	0.999999	0.00636
102	0.999999	0.00636
103	0.999956	0.008208
104	0.999956	0.006075
105	0.999956	0.00797
106	0.999956	0.006163
107	0.999956	0.006163
108	0.999913	0.007599
109	0.999913	0.00592
110	0.999913	0.00592
111	0.999913	0.00592
112	0.99989	0.007439
113	0.99989	0.005707
114	0.999946	0.007031
115	0.999946	0.00535
116	0.999946	0.00535
117	0.999946	0.00535
118	0.999894	0.007352
119	0.999894	0.005468
120	0.99992	0.007035
121	0.99992	0.005618
122	0.99992	0.005618
123	0.99992	0.005618
124	0.99995	0.006594
125	0.99995	0.005225
126	0.99995	0.005225
127	0.999942	0.00733
128	0.999942	0.005769
129	0.999942	0.005769
130	0.999942	0.005769
131	0.999947	0.007092
132	0.999947	0.005238
133	0.999976	0.006334
134	0.999976	0.005268

Consec #	celk_avg	Temp offset
135	0.999976	0.005268
136	0.999976	0.005268
137	0.999959	0.006557
138	0.999959	0.00538
139	0.999959	0.00538
140	0.999959	0.00538
141	0.999959	0.00538
142	0.999967	0.006914
143	0.999967	0.005579
144	0.999967	0.005579
145	0.999967	0.005579
146	0.999947	0.006437
147	0.999947	0.004717
148	0.999971	0.006279
149	0.999971	0.004864
150	0.999908	0.006209
151	0.999908	0.004681
152	0.999898	0.006197
153	0.999898	0.005034
154	0.999906	0.006135
155	0.999906	0.004743
156	0.999882	0.006066
157	0.999882	0.004782
158	0.999913	0.006024
159	0.999913	0.00525
160	0.999964	0.006435
161	0.999964	0.004984
162	0.999988	0.005913
163	0.999988	0.004589
164	0.999989	0.005864
165	0.999989	0.004678
166	0.999986	0.005753
167	0.999986	0.004637
168	0.999986	0.004637
169	0.999986	0.004637
170	0.999946	0.006031
171	0.999946	0.004525
172	0.999946	0.004525
173	0.999946	0.004525
174	0.999946	0.004525
175	0.999946	0.004525
176	0.999946	0.005627
177	0.999946	0.004717
178	0.999946	0.00577
179	0.999946	0.004102
180	0.999946	0.006606

Consec #	celk_avg	Temp offset
181	0.999946	0.006542
182	0.999995	0.006774
183	0.999995	0.004974
184	0.999995	0.004974
185	0.999995	0.004974
186	0.999979	0.006897
187	0.999979	0.005886
188	0.999979	0.005886
189	0.999979	0.005886
190	0.999997	0.006928
191	0.999997	0.005113
192	0.999997	0.005113
193	0.999997	0.005113
194	0.999997	0.005113
195	0.999997	0.005113
196	0.999997	0.005113
197	0.999997	0.005113
198	0.999997	0.005113
199	0.999997	0.005113
200	0.999997	0.005113
201	0.999997	0.005113
202	0.999966	0.006938
203	0.999966	0.005147
204	0.999919	0.006827
205	0.999919	0.00519
206	0.999943	0.006884
207	0.999943	0.005562
208	0.999886	0.006935
209	0.999886	0.004688
210	0.999918	0.006777
211	0.999918	0.004838
212	0.999951	0.00643
213	0.999951	0.005236
214	0.999951	0.005236
215	0.999951	0.005236
216	0.999998	0.006688
217	0.999998	0.004688
218	0.999933	0.006314
219	0.999933	0.004831
220	0.999957	0.002581
221	0.999957	0.001114
222	0.999986	0.001947
223	0.999986	0.000596
224	0.999936	0.001738
225	0.999936	0.000237
226	0.99998	0.002004

Consec #	celk_avg	Temp offset
227	0.99998	0.000515
228	0.999991	0.001325
229	0.999991	-0.00042
230	0.999956	0.00102
231	0.999956	-0.00056
232	0.999968	0.000492
233	0.999968	-0.0008
234	0.999982	0.000854
235	0.999982	-0.00054
236	0.999942	0.00079
237	0.999942	-0.00073
238	0.999926	0.000677
239	0.999926	-0.00107
240	0.999909	0.000873
241	0.999909	-0.00074
242	0.999952	0.000132
243	0.999952	-0.0008
244	0.999912	0.000461
245	0.999912	-0.00089
246	0.99993	0.000654
247	0.99993	-0.00093
248	0.99993	-0.00093
249	0.99993	-0.00093
250	0.999948	0.0005
251	0.999948	-0.00092
252	0.999915	0.001212
253	0.999915	-0.00103
254	0.999915	-0.00103
255	0.999915	-0.00103
256	0.999923	0.000493
257	0.999923	-0.00081
258	0.99991	0.000465
259	0.99991	-0.00077
260	0.99991	-0.00077
261	0.99991	-0.00077
262	0.99991	-0.00077
263	0.999938	0.001093
264	0.999938	-0.00095
265	0.999952	0.00048
266	0.999952	-0.0009
267	0.999952	-0.0009
268	0.999952	-0.0009
269	0.999944	0.000918
270	0.999944	-0.00095
271	0.999944	0.000918
272	0.999944	0.000918

Consec #	celk_avg	Temp offset
273	0.999944	0.000918
274	0.999944	0.000918
275	0.999944	0.000918
276	0.999944	0.000918
277	0.999944	0.000918
278	0.999944	0.000918
279	0.999963	0.000833
280	0.999963	-0.00085
281	0.999948	0.000392
282	0.999948	-0.00138
283	0.999946	0.000633
284	0.999946	-0.0015
285	0.999945	0.000806
286	0.999945	-0.00101
287	0.999945	-0.00101
288	0.999945	-0.00101
289	0.999933	0.00081
290	0.999933	-0.0011
291	0.999962	0.000557
292	0.999962	-0.00145
293	0.999949	0.000445
294	0.999949	0.000445
295	0.999949	0.000445
296	0.999949	0.000445
297	0.999943	0.000126
298	0.999943	-0.000081
299	0.999943	-0.000081
300	0.999943	-0.000081
301	0.999917	0.000447
302	0.999917	-0.00127
303	0.999913	-0.000021
304	0.999913	-0.00112
305	0.999913	-0.00112
306	0.999913	-0.00112
307	0.999966	0.000217
308	0.999966	-0.00112
309	0.999952	0.000131
310	0.999952	-0.00171
311	0.999952	-0.00171
312	0.999952	-0.00171
313	0.99991	0.000646
314	0.99991	-0.00092
315	0.999908	0.000633
316	0.999908	-0.00132
317	0.999908	-0.00132
318	0.999908	-0.00132

Consec #	celk_avg	Temp offset
319	0.999949	-0.000018
320	0.999949	-0.00085
321	0.999941	0.0000681
322	0.999941	-0.00093
323	0.999941	-0.00093
324	0.999941	-0.00093
325	0.9999	0.000256
326	0.9999	-0.00148
327	0.9999	-0.00215
328	0.999961	-0.000008
329	0.999961	-0.00101
330	0.999961	-0.00101
331	0.999961	-0.00101
332	0.999962	-0.00014
333	0.999962	-0.00139
334	0.999984	-0.000019
335	0.999984	-0.00122
336	0.999965	0.0000919
337	0.999965	-0.00116
338	0.999974	0.000235
339	0.999974	-0.00102
340	0.999984	-0.00023
341	0.999984	-0.00138
342	0.999995	0.000637
343	0.999995	-0.00122
344	0.999995	0.001024
345	0.999995	-0.00019
346	0.999995	0.001018
347	0.999995	-0.00019
348	0.999995	0.000468
349	0.999995	-0.00038
350	0.999995	0.000811
351	0.999995	-0.0004
352	0.999995	0.000455
353	0.999995	-0.00038
354	0.999942	-0.0000065
355	0.999942	-0.00047
356	0.999976	0.000123
357	0.999976	-0.00037
358	0.999958	0.000268
359	0.999958	-0.00022
360	0.99996	0.00031
361	0.99996	-0.00012
362	0.99996	-0.00019
363	0.99996	0.000261
364	0.99996	-0.0004

Consec #	celk_avg	Temp offset
365	0.99996	-0.00023
366	0.99996	0.000527
367	0.99996	-0.000068
368	0.99996	-0.000068
369	0.99996	-0.00024

Consec #	celk_avg	Temp offset
370	0.99996	0.00018
371	0.99996	0.00018
372	0.99996	0.00018
373	0.99996	0.000274
374	0.99996	-0.00025
375	0.99996	-0.00025

C.3. CTD

The CTD probes (Models 8737 and 8705) used during this cruise are made by Guildline Instruments of Smiths Falls, Ontario, Canada. Their resolution and accuracy will be provided when data is submitted.

An additional Guildline CTD with a high precision pressure sensor was used when weather would not allow rosette casts.

C.4. Salinity

Samples were collected in glass bottles and analyzed onboard ship using a Guildline Model 8410 Portasal. The Portasal was standardized daily with IAPSO standard sea water Batch P125. Salinity and nutrient measurements were made in an air conditioned lab (see Table 4.).

C.5. Oxygen

Samples were drawn through either amber rubber or Tygon tubing into 125 ml iodine flasks. The flasks were allowed to overflow twice their volume before being stoppered then unstoppered, fixed with manganous and iodide reagents according to Carpenter (1965), restoppered and shaken thoroughly. Sample temperatures were measured before initial stoppering to +± 0.5°C. To avoid outgassing during analyses, samples were initially all refrigerated at 4 °C for 1 to 24 hours before being titrated with an auto-burette (Brinkman Dosimat) to an iodine colorimetric endpoint.

By station W042, samples from the mixed layer were pulling in sizable air bubbles when they were cooled. At 2 stations (W050 and W058), the effect of air contamination of pickled samples was tested and shown to add 1 to 3 umol/kg oxygen to surface samples that are cooled. This bias remains in surface layer data from stations W042 to W050, and will vary in amount depending on the amount of cooling (volume change) for each sample. Surface layer samples from W051 to W070 were not cooled.

On Leg 2, flasks were sealed with tap water around the lip of the flask. This greatly reduced the amount of oxygen that enters a flask during cooling. Samples were routinely refrigerated before being analyzed.

Standards were prepared as outlined in WOCE Report 73/91.

C.6. Nutrients

Samples were collected in 50 ml polyethylene tubes and refrigerated for a maximum of 12h (rosette) or 30 h (USW) before being analyzed. A 4 channel Technicon Analyzer measured NO_3 + NO_2, NO_2, PO_4 and dissolved Si. Analytical procedures are essentially those described by Koroleff and Grasshoff (1983).

Concentrated standards were prepared from oven dried (80°C) reagents shortly before sailing on Leg 1 and again in Honolulu. Working standards were made every 1 to 2 days by diluting 1 to 6 ml of various stock solutions to 250 ml with 3.2% NaCl (w/v in double run Milli-Q water). Nitrate, nitrite and silicate standards were compared to Sagami standards. The nitrate standards agreed to within 0.1 mmol/l, but the silicate concentrations differed by 2%, an unusual finding since our prepared standards usually agree very well with the stable Sagami standards. Our silicate standard was checked on a recent cruise and again compared to Sagami and it was found to be low by 2.2%. We compared our results with data from one matching station on the Cruise TT190 of the R/V Thomas Thompson in 1985 and found that below 1000 m our silicate results are comparatively low by an average of 2.2%. No corrections have been applied to our data, although in consultation with a WOCE DQE, this might be done.

Nutrient lab temperatures were recorded approximately hourly during analyses and are recorded in

Table 11: Nutrient Lab Temperatures

Nutrient Lab Temperatures, Leg 1

Date	Station	Temperature (C)	Date	Station	Temperature (C)
7 Sep.	JF1-P04	22.4/22.8	27 Sep.	W035/36/33	22.4/22.4/23.2
8 Sep.	P13	23.1/23.8/23.9		W034	24.6
9 Sep.	P14 to P18	22.5/23.9	28 Sep.	W037/38/39	21.4/28.6/25
	P18	22.8/24.4	29 Sep.	W040/41/43	22.4/23.3/23.1
10 Sep.	P19 to P35	23.3/23.4		W042	23.0
	P26	23.4/24.3	30 Sep.	W044/45/46	23.5/22.7/23.7
16 Sep	W004	21.3/22.4/21	1 Oct.	W047/48/49	22.9/23.6/23.1
19 Sep	W002/3/4	23.2/23/23.4	2 Oct.	W051/50	24.2/24.3
	W005	23.6	3 Oct.	W052/53/54	23/23.8/24
20 Sep	W006/W011	23.7/23.9		W055	24
21 Sep	W012/13/14	23.8/23.8/23	4 Oct.	W056/58/59	24.8/24.8/24.9
	W015	24.4	5 Oct.	W060/61	25.2/24.8/24.9
22 Sep	W016/17/18	23.5/23.5/23.7	6 Oct.	W062/63/64	25.2/-/24.9
24 Sep.	W025	24.4		W065	25
25 Sep.	W026/27/28	22/22.5/24	7 Oct.	W067/66/68	24.7/25.7/-
	W029	24.3		W070	25.1
26 Sep.	W030/31/32	25.3/25.6/25.2			

Nutrient lab temperatures, Leg 2:

Date	Station	Temperature (C)	Date	Station	Temperature (C)
18 Oct.	W071/W072	25..0	29 Oct.	W108/W109	25.7/25.3
19 Oct.	W073/W074	25.8/25.5	30 Oct.	W111/W112	25.1/24.0
20 Oct.	W078/W079	23.8/24.9	31 Oct.	W113/W114W115	-/-/25.0
21 Oct.	W080/W081/	24.5/24.3	1 Nov.	W116/W117	26/25.3
	W082/W083	25.1/24.5		W118	24.8
22 Oct.	W084/W085	24.4/24.9	2 Nov.	W119/W120	24.9/25.2
	W086/W087	25.2/24.5			
23 Oct.	W088/W089	24.8/24.9	3 Nov.	W123/W124	-/25.9
	W090/W091	25.5/25.4		W125	26.1
24 Oct.	W092/W093	25.9/26.3	4 Nov.	W126/W127	22.9/23.5
25 Oct.	W096/W097	23		W128/W129	-/-
	W098	23/23.2			
26 Oct.	W099/W100	25.2/25.6	5 Nov.	W130/W131	23.1/24.1
	W101	25.6		W132	24.1
27 Oct.	W102/W103	24.7/26	7 Nov.	W133/W134	-/-
	W104/W105	25.8/24.6		W135	24.1
28 Oct.	W106/W107	25.6/26	8 Nov.	W136	24.6

Phosphate samples were occasionally contaminated during the second half of the first leg. A nitrate reagent containing phosphoric acid was spilt on September 30 when Stations W044, W045, and W046 were analyzed. On October 1 it was noted in the nutrient log that the crew were washing the deck with soap - Stations W047, W048 and W049 were analyzed on this day.

Our water demineralizing system failed during Leg 2, which forced us to use low nutrient sea water to establish a baseline during analyses, and for the preparation of standards. Each day, a sample of 3.2% NaCl in double run Milli-Q water was analyzed to assess zero concentrations. Silicate and phosphate in low nutrient wash water was typically 2 and 0.2 uM higher than the clean salt solution.

Crystals developed in the nitrite line from Station 123 onwards. This data has been labelled quality 3 for nitrite. An error is introduced into nitrate data since nitrite is subtracted from the NO3 & NO2 analysis results. Consequently, nitrates have also been assessed as questionable (quality 3) although the actual offset is only 0.1 to 0.3 umol/kg. Summing nitrite and nitrate will provide correct NO_3 + NO_2 values.

C.7. CFCs

CFC-11 and CFC-12 were analyzed by the method of Bullister and Weiss (1988). Our use of an aging Hewlett-Packard GC created problems. For the first days on Line PR6, corrosion on a circuit board shut the system down. Then as we sailed from Honolulu, the GC failed completely and we had to return to pick up another that was flown to us from IOS. Stations were occasionally skipped as columns were cleaned after they saturated with CFCs.

Carrier blanks, stripper blanks, and restripped samples were analyzed throughout the cruise. Syringe air samples were taken from above the bridge, the aft deck where sampling was done, and inside the lab container.

Working standard tank number 63098 was used for Stns 71, 72, 73 and 74 and tank number 63100 was used for the remaining stations. (Tank 63100 values: F-11, 583.10 ppt, standard deviation 2.05, and F-12, 279.18 ppt, standard deviation 1.04. Tank 63098 values: F-11, 443.63 ppt, standard deviation 2.63 and F-12, 502.81, standard deviation 1.91).

These standards were made up of outside air. The tanks were calibrated against COCC's lab standard tank number 63088 (F-11, 457.59 ppt, standard deviation 0.55; and F-12, 263.13 ppt standard deviation 0.76). This COCC lab standard was calibrated by John Bullister's lab in October 1993.

Data reduction was carried out using an adapted Scripps program (Weiss). This program requires salinity and temperature for calculations; the former was taken from Salinometer data; and the latter was read from the sample bucket when the syringe was removed and attached to the extraction system.

There were some difficulties encountered throughout the cruise that hampered obtaining optimal results:

(1) A problem with the consistency of the quality of the carrier gas meant having to subtract higher than normal stripper blanks.
(2) The results of stations 83 to 97 may show zero at the 300 to 400 m depth because the threshold was initially set as per the 5890 GC program. This was modified for later stations in order to have very small peaks integrated. Thus these zero values may be a factor of threshold setting rather than a complete absence of Freon.
(3) During some of the earlier stations we encountered samples affected by some sort of interference. This resulted in the F-11 peak being split or at other times summed, usually in the fifty meter sample. Neither using the split value or a summed value seemed to give a reasonable result so these samples were flagged as questionable or bad. This problem was also encountered on the first leg of the cruise.

The restrips of water samples demonstrated the high stripper efficiency of the Freon analysis system.

Air samples were usually taken around noon.

The values reported were initially calculated with the Freon analysis program. If a particular station had a stripper blank run, the program automatically subtracted this before printing the final results. If a station did not have a stripper blank, a manual blank subtraction was applied to the calculated results based on deep water values.

Limit of Detection Because contamination for F-12 was variable from day to day, detection limits were estimated each day as 3 times the standard deviation of deep sample concentrations. Thus from 2 to 7 samples were used to assess LODs in the range 0.025 to 0.244 umol/kg. Any value below this limit of detection was reported as zero.

Both carrier gas and bottle blanks (deep ocean samples) were consistently zero for F-11. The lowest discernible value was 0.045 umol/kg.

TABLE 12: Freon levels of air (ppt):

Stn	Above bridge		Sampling deck		Lab	
	F-11	F-12	F-11	F-12	F-11	F-12
74	252.44	612.17	280.13	852.97	300.20	615.32
74	281.21	504.43			287.27	595.06
86			271.60	507.90	315.61	366.25
86					277.83	602.34
98	279.67	673.46	271.10	571.56	273.99	493.60
101	272.04	531.47	281.40	1301.14	279.87	820.70
106	249.57	528.55	258.47	673.47	264.18	1194.8
108	263.07	518.75	261.66	516.57	265.45	689.58
113	360.34	580.22	271.18	765.35	321.11	524.49

C.8. Total CO_2

The coulometric procedure outlined in DOE (1994) was used to measure carbon dioxide in sea water. Samples were collected in 250 ml GS bottles, fixed with 200 ul of saturated $HgCl_2$ solution, and cool stored until analyzed.

C.9. Alkalinity

Following the method of DOE (1994), alkalinity was determined using a temperature stable (25°C) closed titration cell, a Metrohm 665 Dosimat, a Metrohm 649 stir apparatus and an Orion model 720A pH meter.

D. Acknowledgments

The officers and crew of the John P Tully undertook both Line P15N and the prepartory PR6 Lines with great zeal. Their good humor and skill made this voyage an experience to remember. Volunteers were an integral part of this section. In particular, the participation of 6 university students brought some youthful inquisitiveness and energy to the program. The overall enthusiasm of all participants was greatly appreciated.

Support for this work was supplied by the Department of Fisheries and Oceans, Panel for Energy Research Development Project #48105 and Green Plan Ocean Climate Project W1.

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F. WHPO Summary

Figures 3 and 4 are not presented in this report due to CTDOXY not being available.

Several data files are associated with this report. They are the 18DD9403_1.sum and 18DD9403_2.sum, 18DD9403_1.hyd and 18DD9403_2.hyd, 18DD9403_1.csl and 18DD9403_2.csl and *.wct files. The P13j.sum file contains a summary of the location, time, type of parameters sampled, and other pertinent information regarding each hydrographic station. The *.hyd file contains the bottle data. The *.wct files are the ctd data for each station. The *.wct files are zipped into one file called *wct.zip. The P13j.csl file is a listing of ctd and calculated values at standard levels.

The following is a description of how the standard levels and calculated values were derived for the *.csl file:

Salinity, Temperature and Pressure: These three values were smoothed from the individual CTD files over the N uniformly increasing pressure levels. using the following binomial filter-

$$t(j) = 0.25ti(j-1) + 0.5ti(j) + 0.25ti(j+1) \quad j=2....N-1$$

When a pressure level is represented in the *.csl file that is not contained within the ctd values, the value was linearly interpolated to the desired level after applying the binomial filtering.

Sigma-theta(SIG-TH:KG/M3), Sigma-2 (SIG-2: KG/M3), and Sigma-4(SIG-4: KG/M3): These values are calculated using the practical salinity scale (PSS-78) and the international equation of state for seawater (EOS-80) as described in the Unesco publication 44 at reference pressures of the surface for SIG-TH; 2000 dbars for Sigma-2; and 4000 dbars for Sigma-4.

Gradient Potential Temperature (GRD-PT: C/DB 10-3) is calculated as the least squares slope between two levels, where the standard level is the center of the interval. The interval being the smallest of the two differences between the standard level and the two closest values. The slope is first determined using CTD temperature and then the adiabatic lapse rate is subtracted to obtain the gradient potential temperature. Equations and Fortran routines are described in Unesco publication 44.

Gradient Salinity (GRD-S: 1/DB 10-3) is calculated as the least squares slope between two levels, where the standard level is the center of the standard level and the two closes values. Equations and Fortran routines are described in Unesco publication 44.

Potential Vorticity (POT-V: 1/ms 10-11) is calculated as the vertical component ignoring contributions due to relative vorticity, i.e. pv=fN2/g, where f is the coriolis parameter, N is the buoyancy frequency (data expressed as radius/sec), and g is the local acceleration of gravity.

Buoyancy Frequency (B-V: cph) is calculated using the adiabatic leveling method, Fofonoff (1985) and Millard, Owens and Fofonoff (1990). Equations and Fortran routines are described in Unesco publication 44.

Potential Energy (PE: J/M2: 10-5) and Dynamic Height (DYN-HT: M) are calculated by integrating from 0 to the level of interest. Equations and Fortran routines are described in Unesco publication 44.

Neutral Density (GAMMA-N: KG/M3) is calculated with the program GAMMA-N (Jackett and McDougall) version 1.3 Nov. 94.

G. Data Quality Evaluations

G.1. Evaluation of CTD data for WOCE line P15N, Leg 1

(Bob Millard)
June 3, 1998

WOCE cruise P15N is a North to South section along 165 W from South of the Aleutian Islands (54 N) to the Hawaiian Islands (21 N). A wide range of surface salinity and temperature is encountered as the overall potential temperature versus Salinity plot of figure 1a shows. All of the 2 decibar CTD data are displayed on this plot as are all up cast CTD and water bottle salinity. Station numbers have been modified to remove the W (i.e. W070 = 70) but otherwise are identical to those found in the ___.WCT and ____.hyd files. A second overall potential temperature versus Salinity (Theta/S) plot given in figure 1b shows the deeper water salinity variability. In the deep water Theta/S plot, figure 2b, the salinity variability increases as the potential temperature increases and the higher salinity values are found at the Southern end of the section. There are no CTD oxygen data reported and therefore oxygen is not examined. The CTD salinity data are generally well matched to the bottle values through out this cruise leg.

This report examines salinity, temperature and pressure data for both the 2 decibar CTD profiles (____.WCT) and the subset of the CTD data collected with the water samples in the _____.hyd file. Particular attention is given to the salinity comparisons. The documentation on laboratory and in situ calibrations of pressure and temperature are reviewed from the cruise report.

Two CTD are used . A WOCE accuracy Guildline CTD #6 for deep casts and an Ocean Physics CTD for shallow casts. Electronic reversing thermometers and pressure sensors were available to monitor pressure and temperature calibrations in the field. The electronic thermometers were used to correct the Ocean Physics CTD pressure and temperature and pressure but not the Guildline CTD.

I didn't examine the shallow (500 to 1000 decibars) CTD cast with Transmissometer. There were often 2 casts in bottle file to obtain more than 24 water samples. For this evaluation I treated both casts of bottle file as one cast associated with the deep CTD cast.

Only the Guildline CTD data is evaluated in this report. The Paros pressure transducer is corrected to the laboratory calibrations. There is no mention of how the Paros sensor was calibrated in the laboratory (i.e. type of deadweight tester or some other pressure transfer standard?). I found the temperature calibration description confusing . The data report mentions that the Guildline CTD6 did not have a pre cruise temperature calibration. Wasn't one done at the factory before being returning?. The post cruise temperature calibration was relied on together with monitoring of the primary temperature against two addition slow responding thermistors and the electronic thermometers. Only one of the thermistors was found to be reliable and the electronic reversing thermometers evidently were not found to be accurate enough to make calibration adjustments. An adjust of 0.002 C was applied to the Guildline copper thermometer based on comparisons with neighboring stations below 4000 dbars . It is not clear if the temperature comparisons are made with neighboring stations from other WOCE cruises. There was no mention of other cruises, dates, etc.? Is the temperature correction applied as a bias at all temperatures (most likely) or only at pressures greater than 4000 dbars as implied in the cruise report..

Salinity evaluation:

The water bottle salinity samples were analyzed on a Guildline PortaSal using standard water batch P121. A discussion of the variability of recent batches of standard water has been carried out by Micho Ayamo and others. which shows the salinity adjustment of standard water batches including P121. P121 has a measured salinity that is lower than the label salinity by 0.001 to 0.0015 psu.

Comparisons of water sample and CTD salinity are cared out to assess how well the CTD salinity matches the bottle salts for all stations and at all pressure levels. The salinity difference Ds = (CTD - WS) [Water Sample] for the up profile data taken from the water sample ____.hyd file is displayed in figures 2a, b, &c. The down profile salinity differences (interpolated at pressure levels) are displayed in figures 2d, e & f. The salinity differences at all pressure levels are displayed in the first panels (a & d) followed by only the differences at pressures greater than 2000 dbars (2 b & e) and finally all stations are displayed versus pressure in panels (2c & f). No individual stations salinity stands out as poorly calibrated to the bottle salinity. There is a slight indication that the CTD salinity is a little higher than the bottles below 4500 dbars in figures (2c & f). Also a few deep up cast comparisons exceed -0.005 psu in figure 2c. A waterfall plot of up cast salinity differences are displayed in figure 3a and indicate that the deep salinity difference of station 27 are offset fresh. An expanded scale display of this plot (figure 3b) shows that station 27 in deed has larger differences than those of neighboring stations while the down profile Ds waterfall plot (figure 3c) of the same station group shows no such offset. A plot of the Theta/S shows the Up cast CTD of station 27 to be to fresh and should be flagged as such in the bottle file (___.hyd). Histograms of salinity differences over the following 6 pressure intervals of 0 to 500, 500 to 1000 , 1000 to 1500, 1500 to 3000, 3000 to 4500 and 4500 to 6500 dbars for both the up CTD salinity in figure 4a and down CTD salinity in figure 4b. The standard deviation of salinity differences below 3000 dbars are extremely well behaved ranges from less than 0.001 psu in the pressure interval 4500 to 6500 dbars to 0.0015 psu in the pressure range from 3000 to 4500 dbars. The average salinity difference from 3000 to 6500 dbars is nearly zero. (.0002 psu or less). This seems to contradict figure 2 c & f which suggests that the CTD salinity appears to be high compared to the bottle data below 4500 dbars.

An average salinity profile at potential temperature intervals was formed for stations 4 through 70 and is plotted with +/- one standard deviation of salinity for the deep water in figure 5. The red circles are water sample salinity values which appear to be nicely distributed on either side of average CTD salinity. A plot of salinity anomalies from the average theta/s clearly shows the salinity at a potential temperature level increases from North to South above 1.15 C. The magnitude of the North/south salinity variation on a pot. temp. surface increases with increasing potential temperature but below 1.15 C this pattern is not evident although this may be due to the lack of a salinity signal large enough to be distinguished from the uncertainty of the salinity measurements.

Deep potential temperature versus salinity (THETA/S) plots for a couple of problem CTD stations are shown in figures 6 a - b. An examination of deep Theta/S plots like figures 6 a & b for all stations (see figure 1b) shows many of the 2 dbar CTD stations appear to be salty compared to water bottle salts below potential temperatures of 1.15 C. The salinity of station 6 is fresh by 0.003 psu compared to neighboring stations shown on figure 6 a & b or any other profile taken on this leg although the CTD salinity does match the water sample salts. The CTD salinity profiles for station W024 appears to be 0.005 psu salty for theta's below 1.4 C compared to station to the North or South. Station W023 is also slightly salty (~0.002 psu) deep. The salinity difference of both of these stations with neighbors decreases with decreasing potential temperature. Both stations 23 and 24 have an increased salinity noise level discussed later. The up cast CTD profile for station 27 (black circles on figure 6b) clearly shows the up CTD salinity values deep to be fresh compared to the water samples and neighboring profiles around 1.1 C (as mentioned earlier in conjunction with the waterfall delta-s plots of figure 3b).

Comparison with Historical data: TPS47 and TPS24

Two earlier East-West hydrography Sections were carried out along 24 and 47 North in 1985. Referred to as the transpacific sections (TPS), one was along 47 N (TPS47) and the other along 24 N (TPS24). The water sample salinity samples for both of these cruises were standardized to P96. Stations at or near the crossing of 165 W are shown for 47 N and 25 30 N together with the comparable stations from P15N in figures 7 a & b. Both of these potential temperature versus salinity plots indicate that the deep salinity observations of P15N are salty compared with these earlier cruises. The water sample data for cruises TPS24 and TPS47 is shown as red (X's) while TPS47 CTD data of TPS24 and TPS47 are red, magenta and also green (TPS24). The TPS24 CTD data is also distinguishable by the coarser 0.001psu salinity quantizing (figure 7b). The TPS47 CTD and water sample salinity are fresh by 0.0025 psu compared to P15N salinity over the entire range of potential temperature shown in figure 7a. The TPS24 CTD and water sample salinity are fresh by 0.001 psu in figure 7b compared to P15N salinity but this salinity difference decreases at lower potential temperatures. When the theta/S plots of TPS47 and TPS24 are overlaid their salinity curves are observed to merge at coldest common value of 1.10 C which reinforces the earlier observation from the P15N mean Theta/S profile that observable North-South salinity variations around this potential temperature are to small to be resolved in the transpacific sections as well. Since the comparison of TPS 24 and TPS47 involves two standard water (SSW) batches P96 and P121, the works of Mantyla (1980 and 1987) and Aoyama, et al. (1998? DSR) should be consulted before drawing any conclusions on adjustments to salinity data. Aoyama ,et al. (1998?) gives a plot of SSW variations Ds= (Smeasured-Slabel) that includes both P96.

Salinity Noise:

The CTD salinity is high-pass filtered to exclude salinity variations with vertical scales longer than 25 dbars . Figure 8a shows the RMS of the salinity scatter on a station by station basis for two depth intervals: the red curve is from 3000 dbars to the bottom given in figure 8c and the green curve is from 1000 dbars to the bottom. Assuming that oceanic salinity variations with scales less than 25 dbars are absent below 3000 dbars the red curve gives an indication of the instrumental salinity noise. The salinity fluctuations below 3000 dbars in the 4 to 25 dbars wavelengths has an station averaged RMS of.00017 psu and a minimum RMS of 0.00012 psu. The minimum RMS noise level in salinity is probably an indication of instrumental noise which at 0.00012 psu is at the low end of values observed other data sets examined which varies from 0.0001 to 0.00035 psu. The RMS salinity plot versus station allows unusually noisy stations for salinity to be better identified without a point by point examination. Two Stations 23 & 24 have noisy salinity's signals relative to other stations which was identified earlier in figure 6b. These two stations have an RMS salinity 2.5 times the average salinity noise level for pressures greater than 3000 dbars. Station 57 also has noise in salinity but doesn't extend to 3000 dbars. All three these CTD stations (23, 24 and 57) are missing corresponding water sample data in the bottle file which perhaps indicates that the CTD and rosette misbehaved together?

The final graph (figure 9) shows the pressure level of those stations which exhibited density inversions in excess of -0.005 and -0.01 kg/m^3/dbar. A total of 16 observations listed in Table I and plotted in figure 9 have density instabilities exceeding -0.005 g/m^3/dbar while only 12 exceed the -0.01 kg/m^3/dbar criteria. The 16 density instability observations of the 10 stations listed in Table I are the values plotted on figure 9 should be reviewed.

Table I

dsg/dp	Station #	Pressure	Salinity
-1.0054632e-002	4.0000000e+000	5.6000000e+001	3.2588900e+001
-7.6895939e-003	6.0000000e+000	5.0000000e+001	3.2581400e+001
-9.2450718e-003	1.6000000e+001	5.2000000e+001	3.2924600e+001
-1.2499790e-002	3.1000000e+001	7.4000000e+001	3.3872300e+001
-7.8494724e-003	3.3000000e+001	1.1400000e+002	3.4127600e+001
-5.1070095e-003	3.4000000e+001	1.2400000e+002	3.4227400e+001
-6.7298463e-003	3.8000000e+001	4.0000000e+000	3.4503300e+001
-1.3519456e-002	3.8000000e+001	8.0000000e+000	3.4459200e+001
-1.3213828e-002	3.8000000e+001	1.0000000e+001	3.4423900e+001
-6.1580665e-003	3.8000000e+001	1.2000000e+001	3.4407800e+001
-1.0596627e-002	3.8000000e+001	1.4000000e+001	3.4379500e+001
-1.8276013e-002	4.8000000e+001	8.6000000e+001	3.4583300e+001
-5.8305896e-003	4.8000000e+001	8.8000000e+001	3.4567400e+001
-1.6425674e-002	5.0000000e+001	7.0000000e+001	3.4688900e+001
-1.0469056e-002	5.0000000e+001	7.8000000e+001	3.4650900e+001
-1.3821924e-002	6.3000000e+001	2.2200000e+002	3.4723100e+001

References:

Aoyama, Michio, T. M. Joyce, T. Kawano, and Y. Takatsuki (1998?) Offsets of the IAPSO Standard Seawater for P103 through P129. Submitted Deep_sea Research .

Mantyla, A.W. (1980) Electrical conductivity comparisons of standard seawater batches P29 to P84. Deep_sea Research 27A, 837-846.

Mantyla, A.W. (1987) Standard Seawater comparison Updates Physical Oceanography, 17, 543-548.

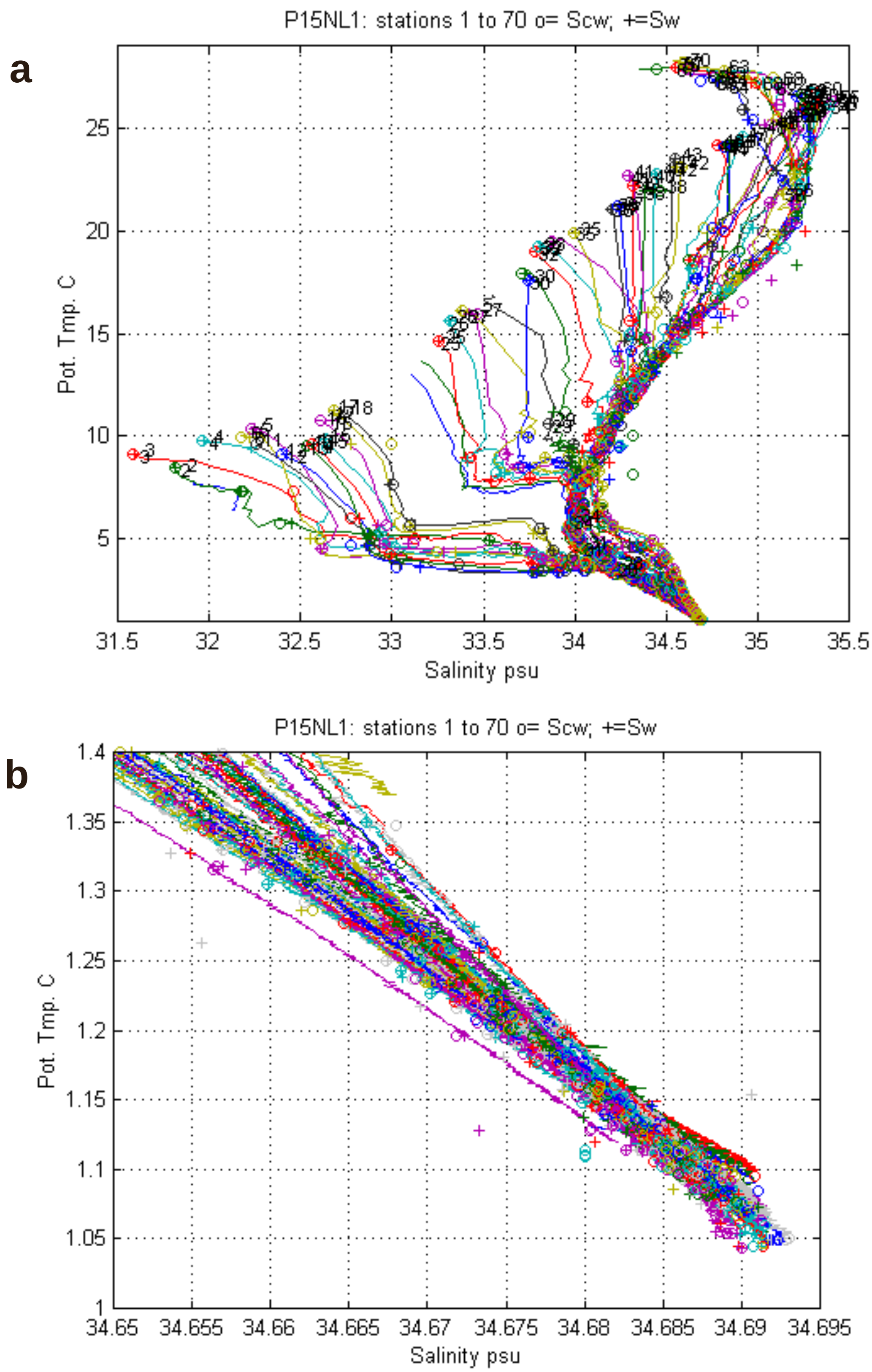


Figure 1 All Bottle & CTD a: Overall Theta/S
b: Deep Theta/S

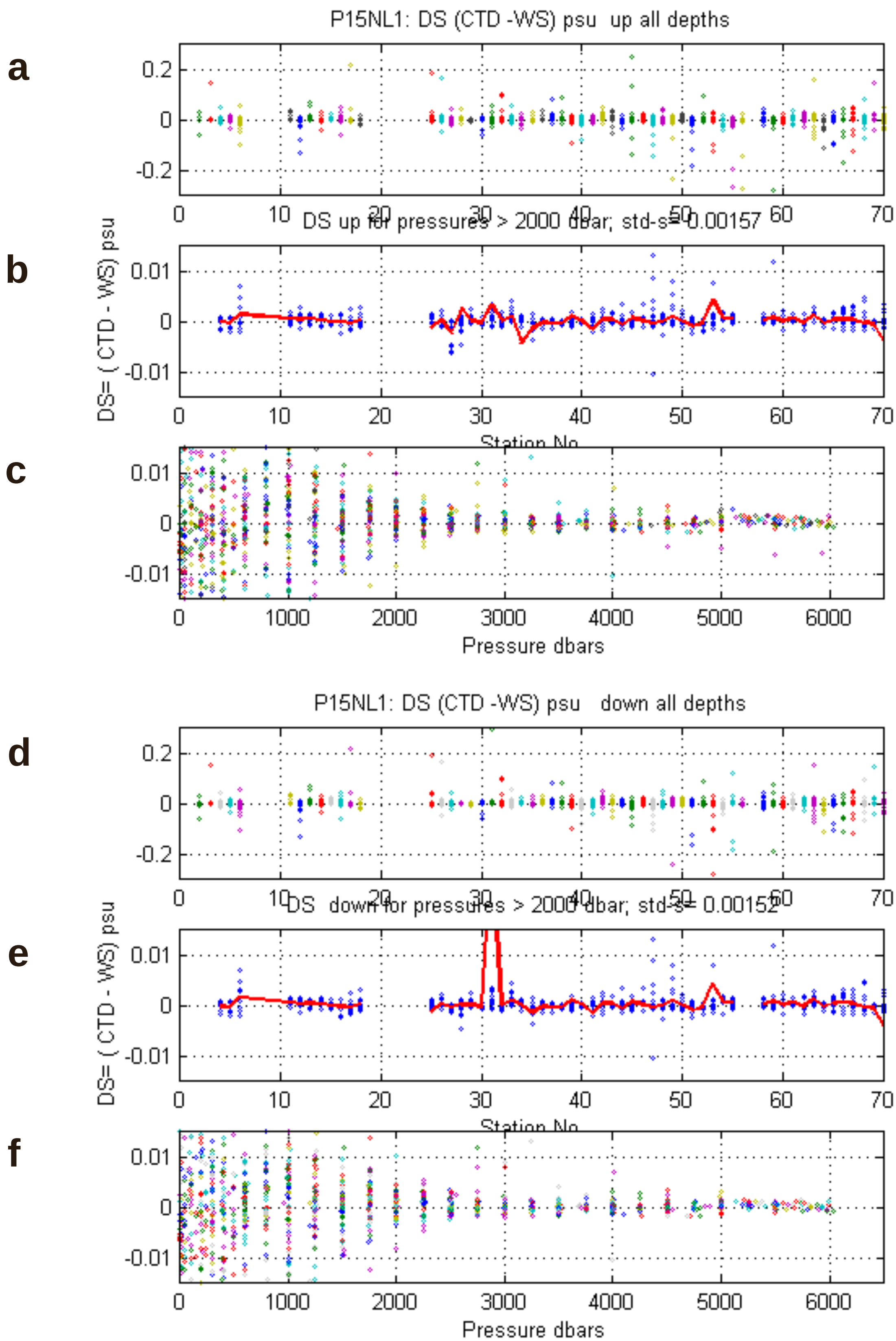


Figure 2: Salinity differences a-c] (CTD up cast - WS) d-f] (CTD down cast -WS)

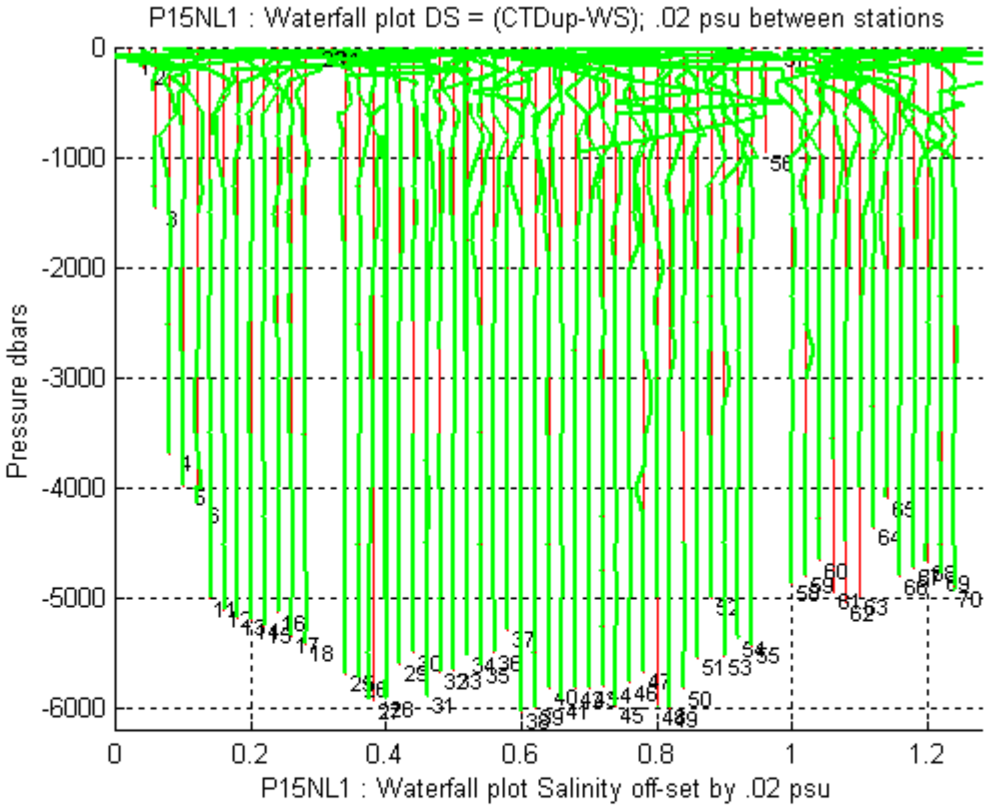
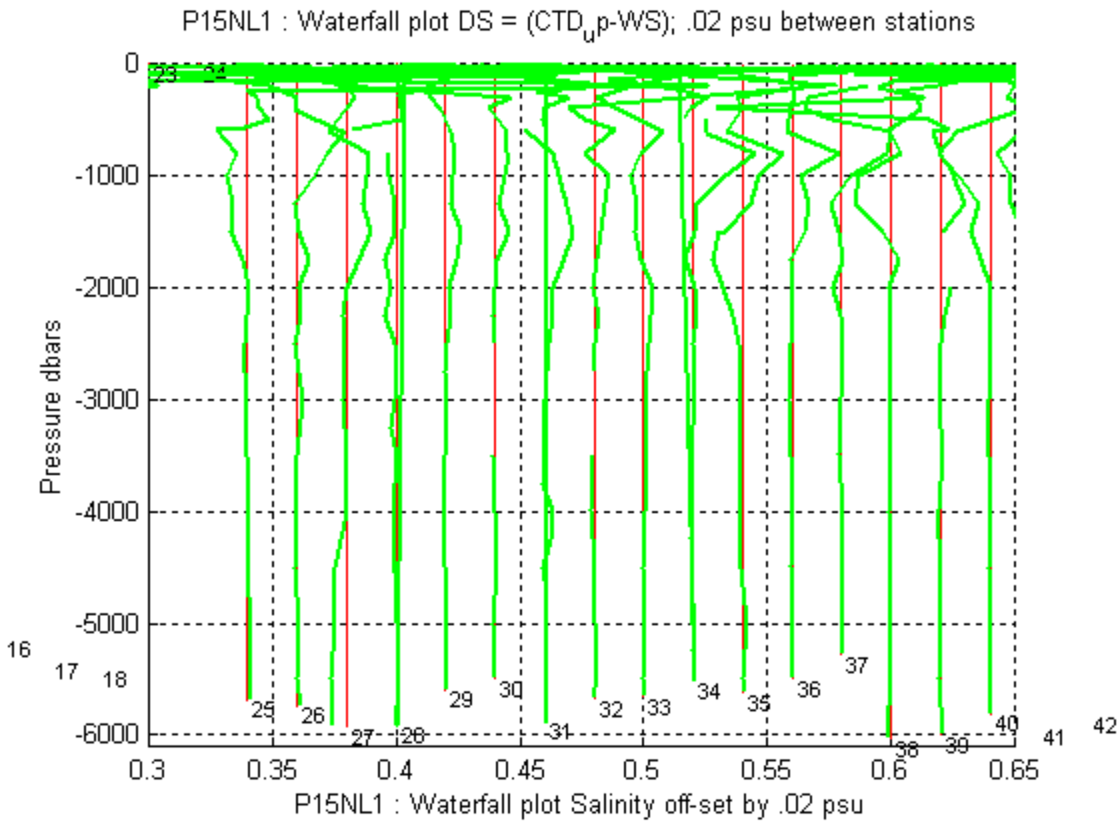


Figure 3a: Waterfall up cast salt differences (CTDup-WS) psu

b



c

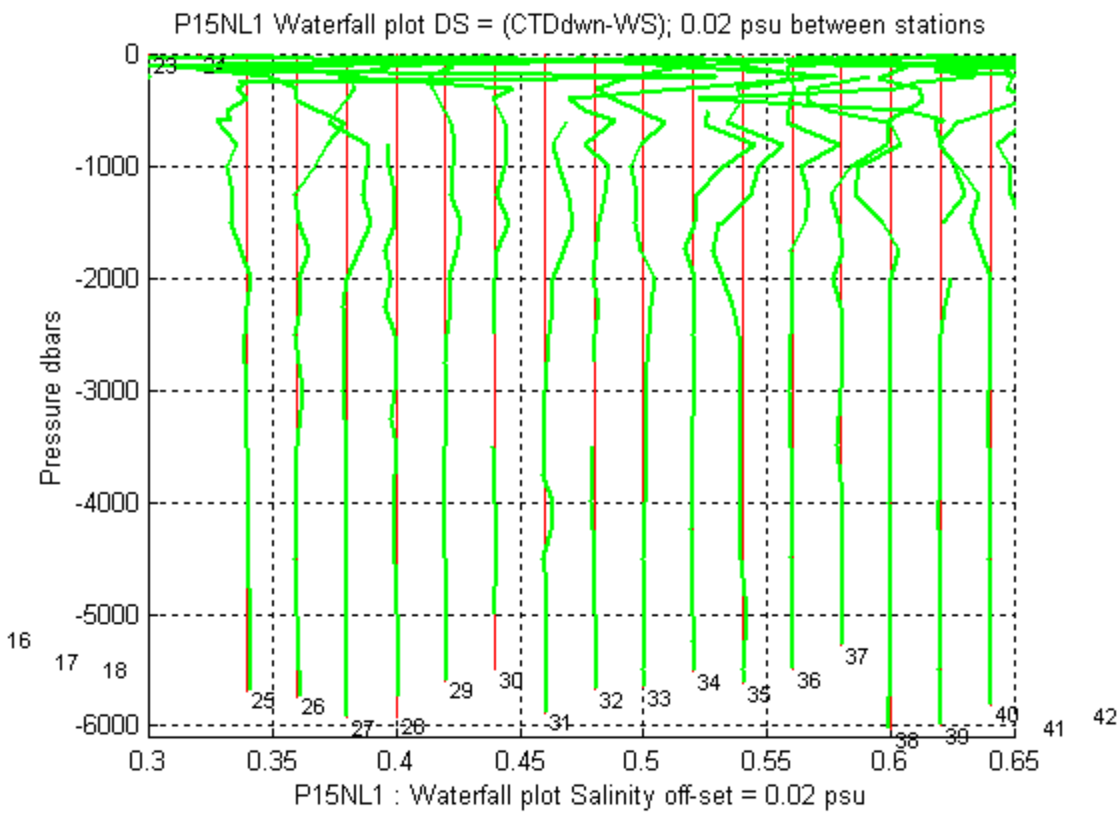
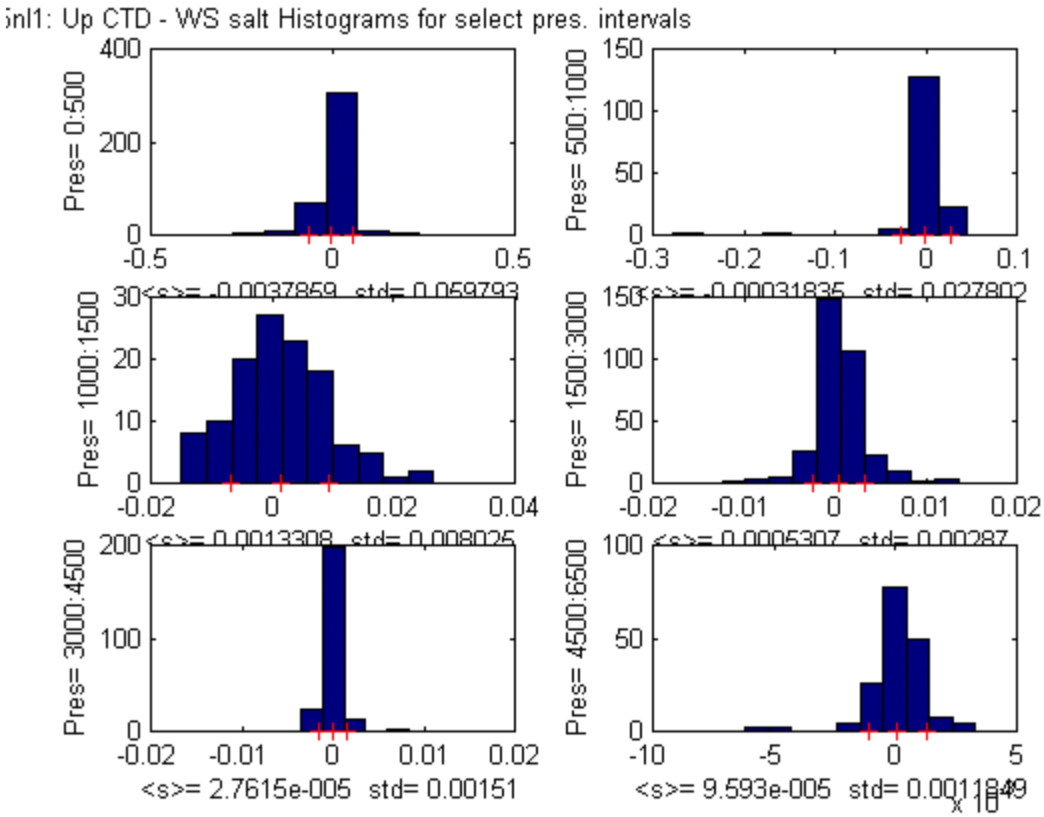


Figure 3b, 3c: Waterfall plots sta. 25 to 40 b: up cast c: down cast

a



b

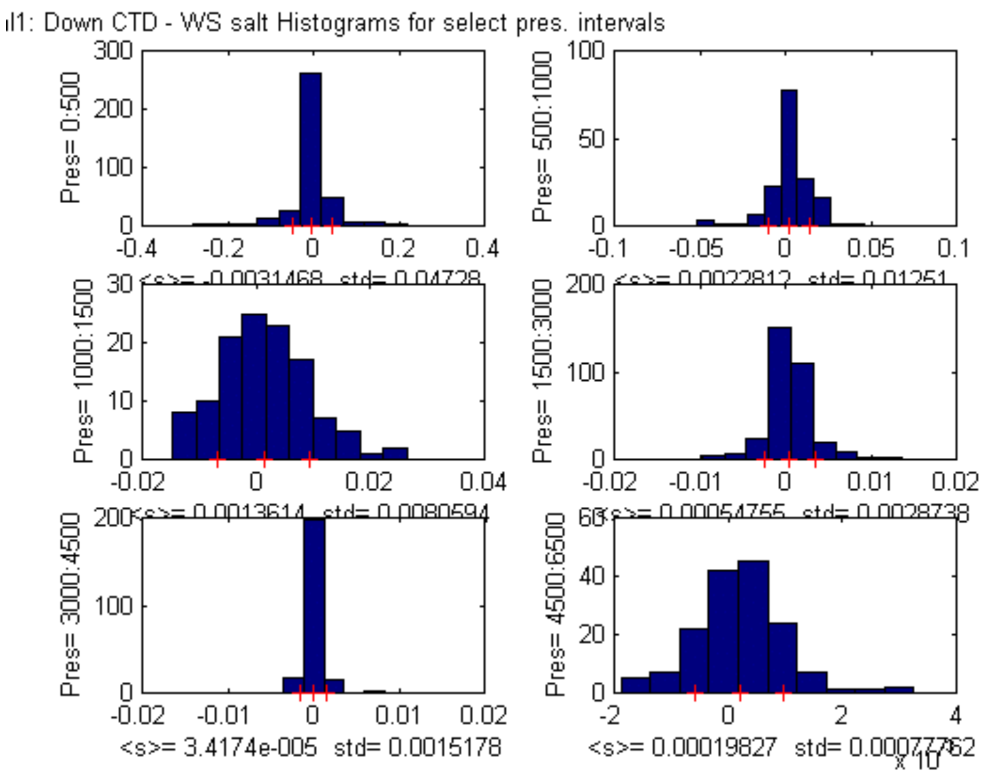


Figure 4a & 4b: Histograms salinity differences for indicated intervals:
4a: (CTD up-WS) 4b: (CTD down - WS)

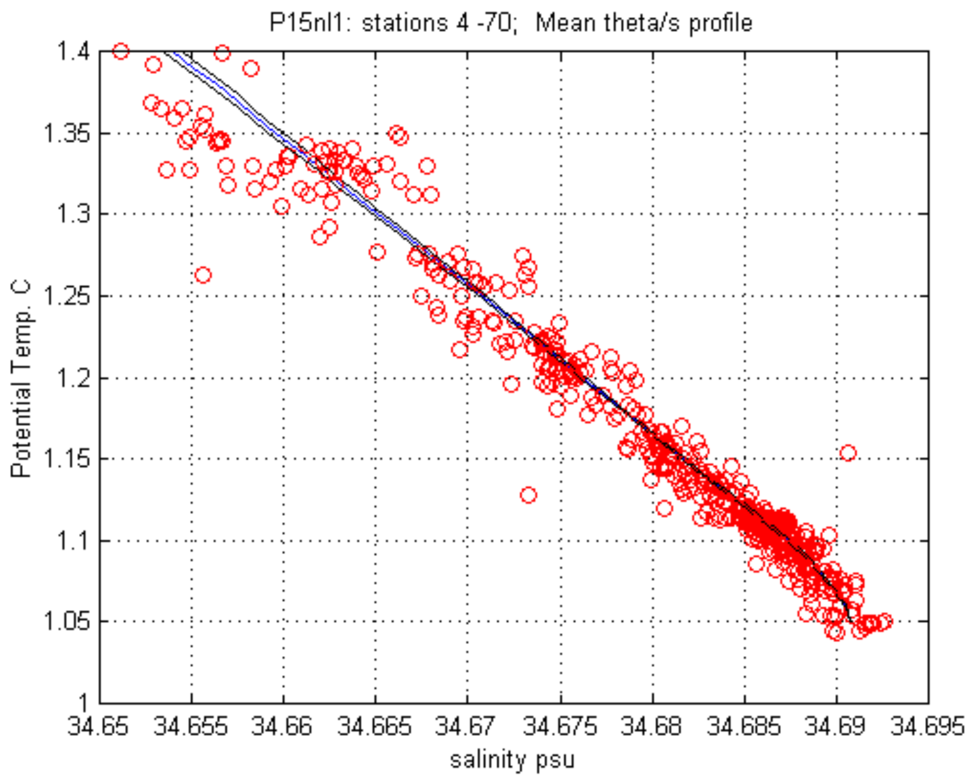


Figure 5: CTD mean theta averaged salinity with over plot of bottle salinity (red o)

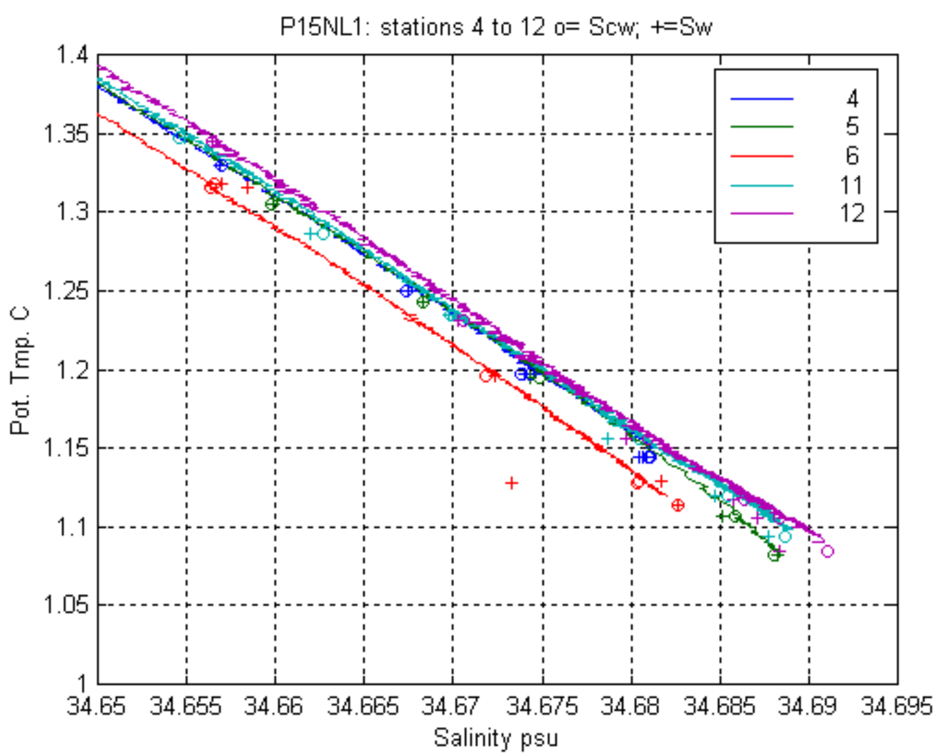


Figure 6a Deep CTD Theta/S shows Station 6 is fresh along with WS salinity

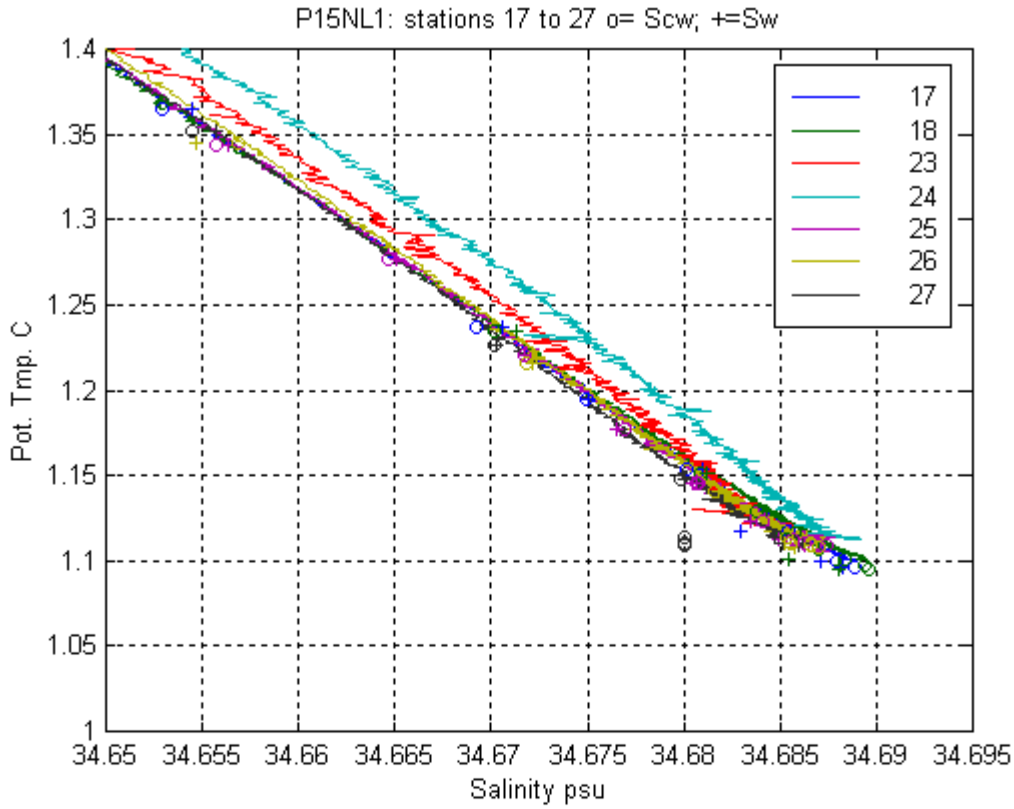
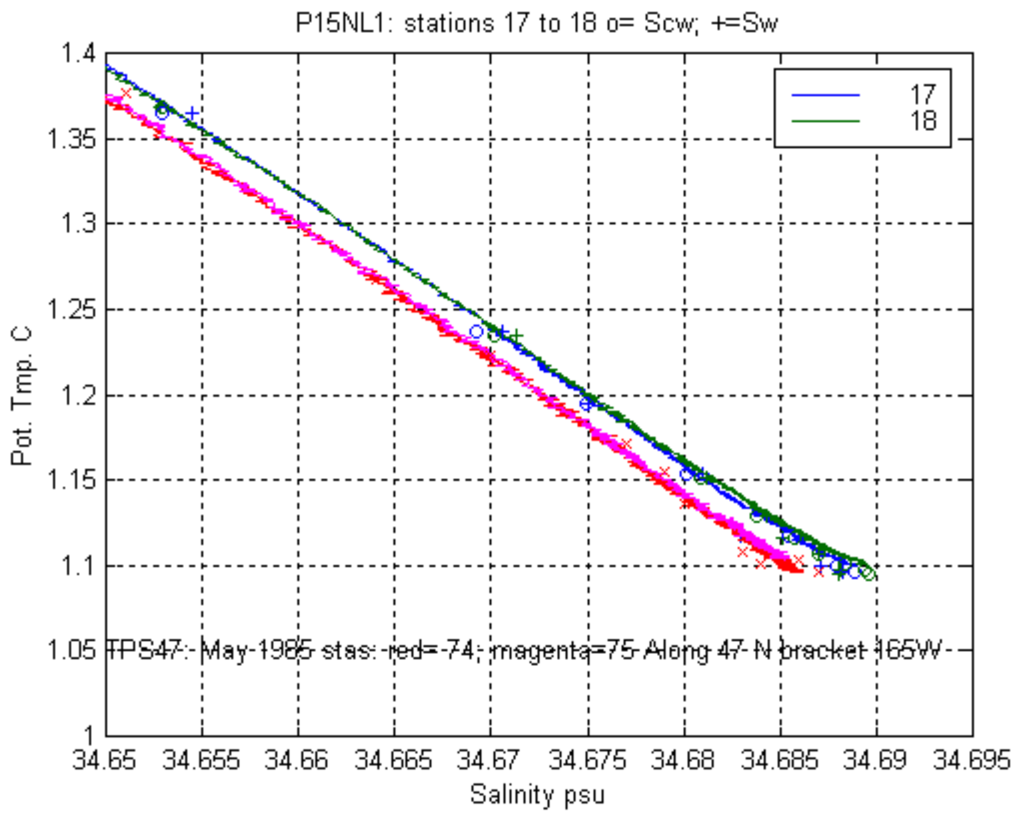


Figure 6b: Deep Theta/S shows stations 23 & 24 salty and noisy

a



b

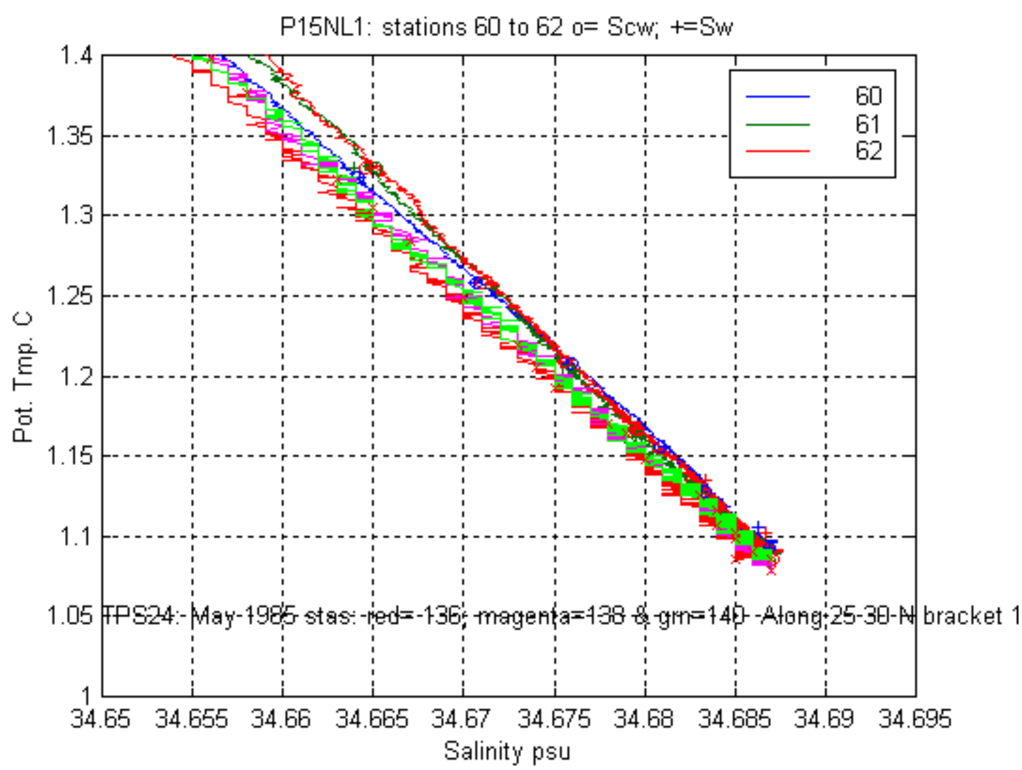


Figure 7a & 7b: Historical East/West Hydrographic sections
7a: 47 North; TPS47 7b: 25 N TPS24

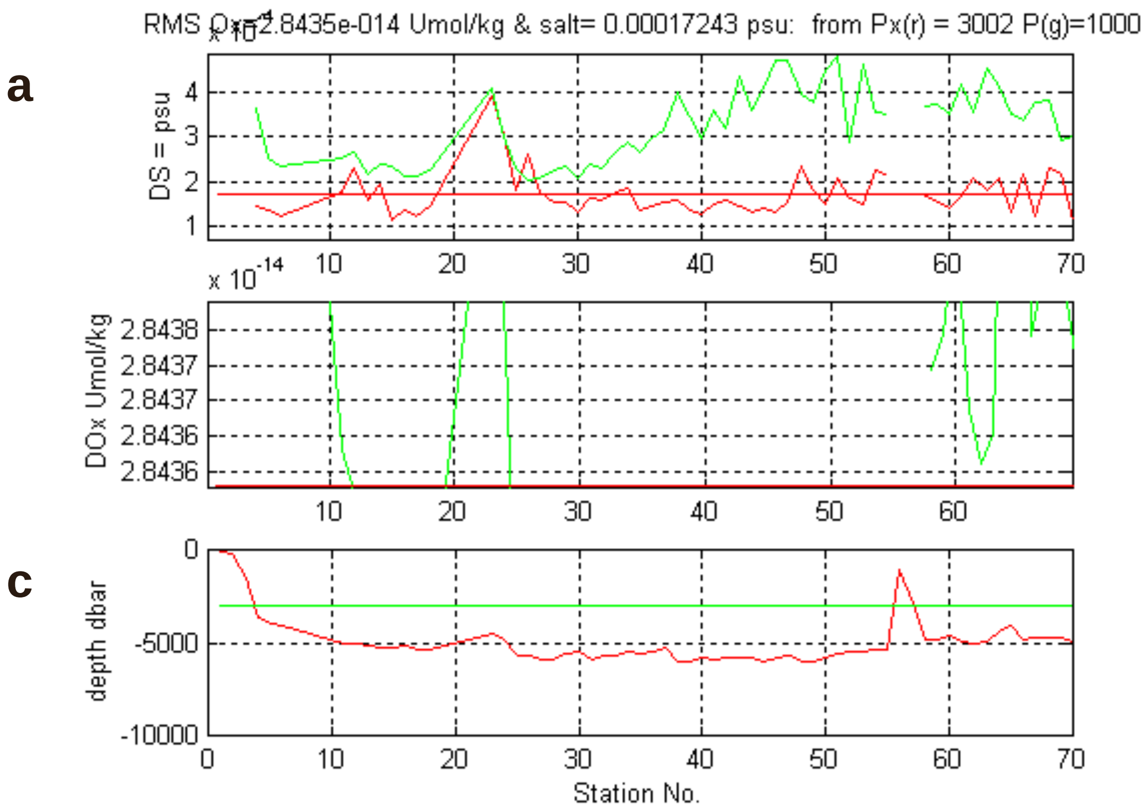


Figure 8: a) Upper panel: red = Salinity noise estimate (P>3000 dbars); green = 1000 to 3000 dbarvariance up to 25 dbar cut-off
c) Lower panel: Station bottom pressure. ignore middle Oxygen panel

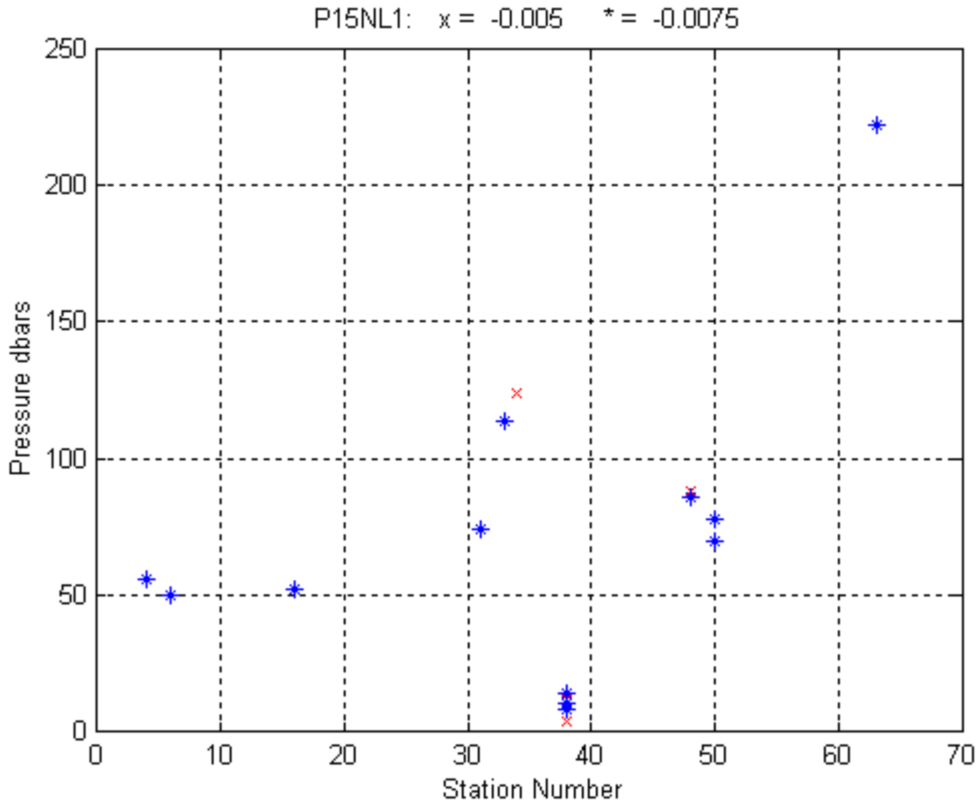


Figure 9: Density inversions: x = -.005 kg/m3/dbar & * = -.0075 kg/m3/dbars

G.2 Evaluation of CTD data for WOCE line P15N LEG 2

(Bob Millard)
November 4, 1998

WOCE cruise P15N, second leg , is a North to South section along 165 W beginning in Hawaii (21 N) and ending at America Samoa (15 S). The range salinity and temperature encountered is indicated in the overall potential temperature versus Salinity plot shown in figure 1a. All of the 2 decibar CTD data are displayed on this plot as are all up cast CTD (o) and water bottle salinity (+). Some bottle salinities fall outside of the envelope of the CTD down salinity profiles A second overall potential temperature versus Salinity (Theta/S) plot shown in figure 1b gives the deep water salinity variability. Figure 2b, indicates that the geographic variability of salinity increases with increasing potential temperature. The higher salinity values in the deep water are observed to be at the Southern end of the section. There are no CTD oxygen data reported and therefore no discussion of oxygen quality is included. The CTD salinity data are generally very well matched to the bottle values throughout P15N leg 2 .

This report examines salinity, temperature and pressure data for both the 2 decibar CTD profiles (____.WCT) and the subset of the CTD data collected with the water samples in the _____.hyd file. Throughout this report, the CTD station numbers have been modified by removing the W (i.e. W071 = 71 to facilitate handling by Matlab) but otherwise are identical to those found in the ___.WCT and ____.hyd files. The documentation on laboratory and in situ calibrations of pressure and temperature described in the cruise report are reviewed .

Two CTD instruments were used to collect stations on the cruise. A WOCE accuracy Guildline CTD number 9901 was used for deep casts and an Ocean Physics CTD for shallow casts. I have not looked at the shallow CTD casts that used the Ocean Physics CTD with Transmissometer. Sometimes there were o two bottle casts to obtain more than 24 water samples. For this evaluation the data from both bottle casts were combined and associated with the deep CTD cast.

The following comments refer to the calibration description in the cruise report for Guildline CTD number 9901. The Paros pressure transducer was corrected to the laboratory calibrations but no mention is made of how the Paros sensor was calibrated in the laboratory (i.e. type of deadweight tester or other pressure reference ?). I found the use of event number and station number to be confusing and prefer station number . The post cruise temperature calibration was relied on together with monitoring of the primary temperature against two addition slow responding thermistors. Figure 2 is taken from data of Table 10 from the cruise report shows temperature offset and conductivity slope adjustment versus event number (event # 301 = CTD station 117) for the Guildline CTD stations of leg 2. The temperature offset applied to the Guildline copper thermometer shows a shift in temperature adjust at event 220. I wonder how much of the temperature offset adjustment should be attributed to an uncertainty of temperature ? The conductivity slope variation does not show much pattern with event # (station) but then the total range of adjustments is has an effect on salinity is less than 0.004 psu.

Salinity evaluation:

The water bottle salinity samples were analyzed on a Guildline PortaSal using standard water batch P121. A discussion of the variability of recent batches of standard water can be found in Micho Ayamo, et al. (1998?) and Mantyla (1980, 1987). The salinity adjustment of standard water batches including P121 is given in tabular and graphical form. The measured salinity of P121 is lower than the labeled salinity by between 0.001 to 0.0015 psu according to Ayamo, et al.

To assess how well the CTD salinity matches the bottle salts, the difference of CTD and water sample (WS) salinity are displayed versus both station and pressure. The up profile salinity difference Ds = (CTD - WS) are from the water sample data file (DD9403l2.hyd) and plotted in figures 3a, b, &c. The down profile salinity differences (interpolated from the 2 decibar data files ___.wct at the bottle pressure levels) are displayed in figures 3d, e & f. The salinity differences at all pressure levels are displayed in the first panels (a & d). The differences at pressures greater than 2000 dbars (2 b & e) also have the station mean salinity (red) with +/- one standard deviation (dashed magenta). Finally all stations are displayed versus pressure in panels (3c & f). No stations standout as having salinities off from the water samples. In general the CTD conductivity (salinity) match to the bottle salinity is very close. There is an indication that the CTD salinity is a bit higher than the bottles between 1000 and 3000 dbars in figures (3c & f). The deep CTD salinity match to the bottles has a low scatter (standard deviation=0.00134 psu) indicating careful handling of water sample salinities.

Histograms of salinity differences over the following 6 pressure intervals of 0 to 500, 500 to 1000 , 1000 to 1500, 1500 to 3000, 3000 to 4500 and 4500 to 6500 dbars for both the up CTD salinity in figure 4a and down CTD salinity in figure 4b. The standard deviation of salinity differences below 3000 dbars are extremely well behaved ranges from less than 0.001 psu in the pressure interval 4500 to 6500 dbars to 0.0015 psu in the pressure range from 3000 to 4500 dbars. The average up and down salinity differences in the pressure intervals 1000:1500 and 1500:3000 is 0.0015 and 0.0011 psu respectively indicating CTD salinity to be slightly to high compared to the water sample salinities in these pressure ranges both for the down and up casts.

An average salinity profile with potential temperature for stations 71 through 142 is shown figure 5a (overall) with +/- one standard deviation of salinity scater indicated. A similar plot for the deep water is presented in figure 5b . The black circles are water sample salinities and they seem to be very nicely distributed about the average CTD salinity and for the most part bounded by the one standard deviation envelope. The red (+ and *) indicate deep bottle salinities flagged in the bottle file as questionable (+) or bad (*) . It is not clear why these bottle salinities are marked as they seem to have a good agree with both the CTD and neighboring station water sample salinities. The (x) symbol indicates salinity differences Ds = ABS (CTD-WS) Ds > .01 for P>1000 dbars and Ds>.02 for P>500 &

<1000 and Ds>.2 P<500. I have flagged these observations as questionable in the accompanying water sample file. I used the QUALT2 of attached bottle file (P15L2DQE.hyd) to indicate changes. A second file is abbreviated to include only those bottle levels where QUALT1 and QUALT2 differ (P15NL2DQE.CHG).

The variations of deep water (potential temperature range .8 and 2.0 C) salinity from the P15N LEG 2 average theta/s shows the salinity becoming progressively saltier in the most northern stations (stations 71 to 85) and then at around 12 N the salinity variation becomes weak for the remainder of the section. As was observed in P15N leg 1, below a potential temperature of 1.15 C no pattern of salinity variations is evident (perhaps a good region to compare P15N leg 2 with historical data) although this may be due to the lack of a salinity signal large enough to be distinguished from the uncertainty of the salinity measurements.

Comparison with Historical data: Moana Wave cruise 893

An earlier East-West hydrography section was carried out along 9.5 degrees North on the R/V Moana Wave cruise 893 (MW893) in March of 1989 along WOCE line P4. The water sample salinity samples of this cruise were standardized to standard sea water (SSW) batch P97. Three stations around the crossing of 165 W (MW893 stations 113, 114, & 115) are plotted together with comparable stations near 9.5 N from P15N LEG 2 in figures 6. The agreement between the P15N LEG 2 stations (93 & 94) and the earlier Moana Wave cruise 893 stations (113, 114, & 115) is remarkable good and not just below a potential temperature of 1.115 C. The salinity agreement may be fortuitous , since the comparison of MW893 and P15N LEG 2 involves two standard water (SSW) batches P97 and P121. The work of Mantyla (1980 and 1987) and Aoyama, et al. (1998? DSR) should be consulted before coming to any conclusions. Aoyama ,et al. (1998?) has a plot of SSW variations Ds = (S_measured - S_label) that includes both P97 and P121.

Salinity Noise:

The CTD salinity is high-pass filtered to exclude salinity variations with vertical scales longer than 25 dbars . Figure 7a shows the RMS of the salinity scatter on a station by station basis for two depth intervals: the red curve is from 3000 dbars to the bottom given in figure 7b and the green curve is from 1000 to 3000 dbars. Assuming that oceanic salinity variations with scales less than 25 dbars are absent below 3000 dbars the red curve gives an indication of the instrumental salinity noise. The salinity fluctuations below 3000 dbars in the 4 to 25 dbars wavelengths has an station averaged RMS of.000217 psu and a minimum RMS of 0.00017 psu. The minimum RMS noise level in salinity is probably an indication of instrumental noise which at 0.00017 psu falls in the lower middle of values I have observed from other data sets examined which varies from 0.0001 to 0.00035 psu. The RMS salinity plot versus station allows unusually noisy stations for salinity to be better identified without a point by point examination. Two stations 116 & 138 stand out as having a possibly noisy salinity signal relative to other stations. These two stations have an RMS salinity 2.5 times the average salinity noise level for pressures greater than 3000 dbars. A Plot of station 116 versus pressure is shown in figures 8 while station 138 is shown versus pot. temp. in figure 9 (138 is the green profile , station 142, the blue profile is also noisy). A salinity shift can be seen to cause the excessive noise in station 116 while station 138 shows a generally noisier salinity profile deep.

CTD salinity calibration

The potential temperature versus salinity plot (figure 10a) indicates that station 125 (event 325) is 0.002 psu fresh compared to neighboring stations but appears to match its water sample. Referring back to figure 2a, the CCR value for event 325 is below the mean by -.00005 (equivalent to ~ -0.002 psu). The potential temperature versus salinity plot of figure 10b shows station 130 (red) to be slightly noisy and salty (~0.002 psu) at the bottom, potential temp. < .9 C while figure 9 indicates station 142 (blue) to be ~`0.003 salty below a pot. temp. of 1.2 C.

The final plot, figure 11, indicates the pressure levels of those stations which display density inversions in excess two thresholds. The 22 observations listed in Table I and also plotted in figure 11 and represent those density instabilities exceeding -0.005 g/m^3/dbar (x) or the 7 observations (*) exceeding -0.0075 kg/m^3/dbar. These data should be reviewed.

Table I

ww	Station #	Pressure	Salinity
-5.0652578e-003	7.1000000e+001	1.9000000e+002	3.4885900e+001
-6.9063507e-003	7.1000000e+001	2.3600000e+002	3.4611900e+001
-5.2530943e-003	8.6000000e+001	1.7200000e+002	3.4584100e+001
-1.1897481e-002	8.7000000e+001	2.3200000e+002	3.4316700e+001
-5.6016986e-003	8.8000000e+001	9.8000000e+001	3.4788100e+001
-8.6937644e-003	8.8000000e+001	1.4400000e+002	3.4567600e+001
-5.3238841e-003	8.9000000e+001	1.4600000e+002	3.4520900e+001
-1.9042638e-002	9.2000000e+001	9.2000000e+001	3.4668500e+001
-5.3296535e-003	1.0900000e+002	1.0000000e+001	3.5140700e+001
-1.4713326e-002	1.1100000e+002	1.6800000e+002	3.5025700e+001
-2.0049596e-002	1.1100000e+002	1.8000000e+002	3.5003700e+001
-7.3997328e-003	1.1400000e+002	1.9400000e+002	3.5152800e+001
-5.4391194e-003	1.1500000e+002	1.9000000e+002	3.5106100e+001
-5.1336623e-003	1.2300000e+002	2.0200000e+002	3.5637900e+001
-5.1641391e-003	1.2800000e+002	6.0000000e+000	3.5289200e+001
-5.8081470e-003	1.2800000e+002	3.1200000e+002	3.4874900e+001
-5.0208606e-003	1.3000000e+002	2.2400000e+002	3.5467900e+001
-5.0407261e-002	1.3200000e+002	4.7600000e+002	3.4593700e+001
-3.7438432e-002	1.3500000e+002	2.4400000e+002	3.5736900e+001
-1.8335791e-002	1.3800000e+002	2.0000000e+000	3.5119400e+001
-9.9007993e-003	1.4000000e+002	3.4800000e+002	3.4907400e+001

shown versus pot. temp. in figure 9 (138 is the green profile , station 142, the blue profile is also noisy). A salinity shift can be seen to cause the excessive noise in station 116 while station 138 shows a generally noisier salinity profile deep.

CTD salinity calibration

The potential temperature versus salinity plot (figure 10a) indicates that station 125 (event 325) is 0.002 psu fresh compared to neighboring stations but appears to match its water sample. Referring back to figure 2a, the CCR value for event 325 is below the mean by -.00005 (equivalent to ~ -0.002 psu). The potential temperature versus salinity plot of figure 10b shows station 130 (red) to be slightly noisy and salty (~0.002 psu) at the bottom, potential temp. < .9 C while figure 9 indicates station 142 (blue) to be ~`0.003 salty below a pot. temp. of 1.2 C.

The final plot indicates the pressure levels of those stations which display density inversions in excess two thresholds. The 22 observations listed in table I and also plotted in figure 11 and represent those density instabilities exceeding -0.005 g/m^3/dbar (x) or the 7 observations (*) exceeding -0.0075 kg/m^3/dbar. These data should be reviewed.

Table I

dsg/dp	Station #	Pressure	Salinity
-5.0652578e-003	7.1000000e+001	1.9000000e+002	3.4885900e+001
-6.9063507e-003	7.1000000e+001	2.3600000e+002	3.4611900e+001
-5.2530943e-003	8.6000000e+001	1.7200000e+002	3.4584100e+001
-1.1897481e-002	8.7000000e+001	2.3200000e+002	3.4316700e+001
-5.6016986e-003	8.8000000e+001	9.8000000e+001	3.4788100e+001
-8.6937644e-003	8.8000000e+001	1.4400000e+002	3.4567600e+001
-5.3238841e-003	8.9000000e+001	1.4600000e+002	3.4520900e+001
-1.9042638e-002	9.2000000e+001	9.2000000e+001	3.4668500e+001
-5.3296535e-003	1.0900000e+002	1.0000000e+001	3.5140700e+001
-1.4713326e-002	1.1100000e+002	1.6800000e+002	3.5025700e+001
-2.0049596e-002	1.1100000e+002	1.8000000e+002	3.5003700e+001
-7.3997328e-003	1.1400000e+002	1.9400000e+002	3.5152800e+001
-5.4391194e-003	1.1500000e+002	1.9000000e+002	3.5106100e+001
-5.1336623e-003	1.2300000e+002	2.0200000e+002	3.5637900e+001
-5.1641391e-003	1.2800000e+002	6.0000000e+000	3.5289200e+001
-5.8081470e-003	1.2800000e+002	3.1200000e+002	3.4874900e+001
-5.0208606e-003	1.3000000e+002	2.2400000e+002	3.5467900e+001
-5.0407261e-002	1.3200000e+002	4.7600000e+002	3.4593700e+001
-3.7438432e-002	1.3500000e+002	2.4400000e+002	3.5736900e+001
-1.8335791e-002	1.3800000e+002	2.0000000e+000	3.5119400e+001
-9.9007993e-003	1.4000000e+002	3.4800000e+002	3.4907400e+001

References:

Aoyama, Michio, T. M. Joyce, T. Kawano, and Y. Takatsuki (1998?) Offsets of the IAPSO Standard sea water for P103 through P129. Submitted Deep Sea Research .

Mantyla, A. W. (1980) Electrical conductivity comparisons of standard sea water batches P29 to P84. Deep Sea Research 27A, 837-846.

Mantyla, A. W. (1987) Standard sea water comparison Updates Physical Oceanography, 17, 543-548.

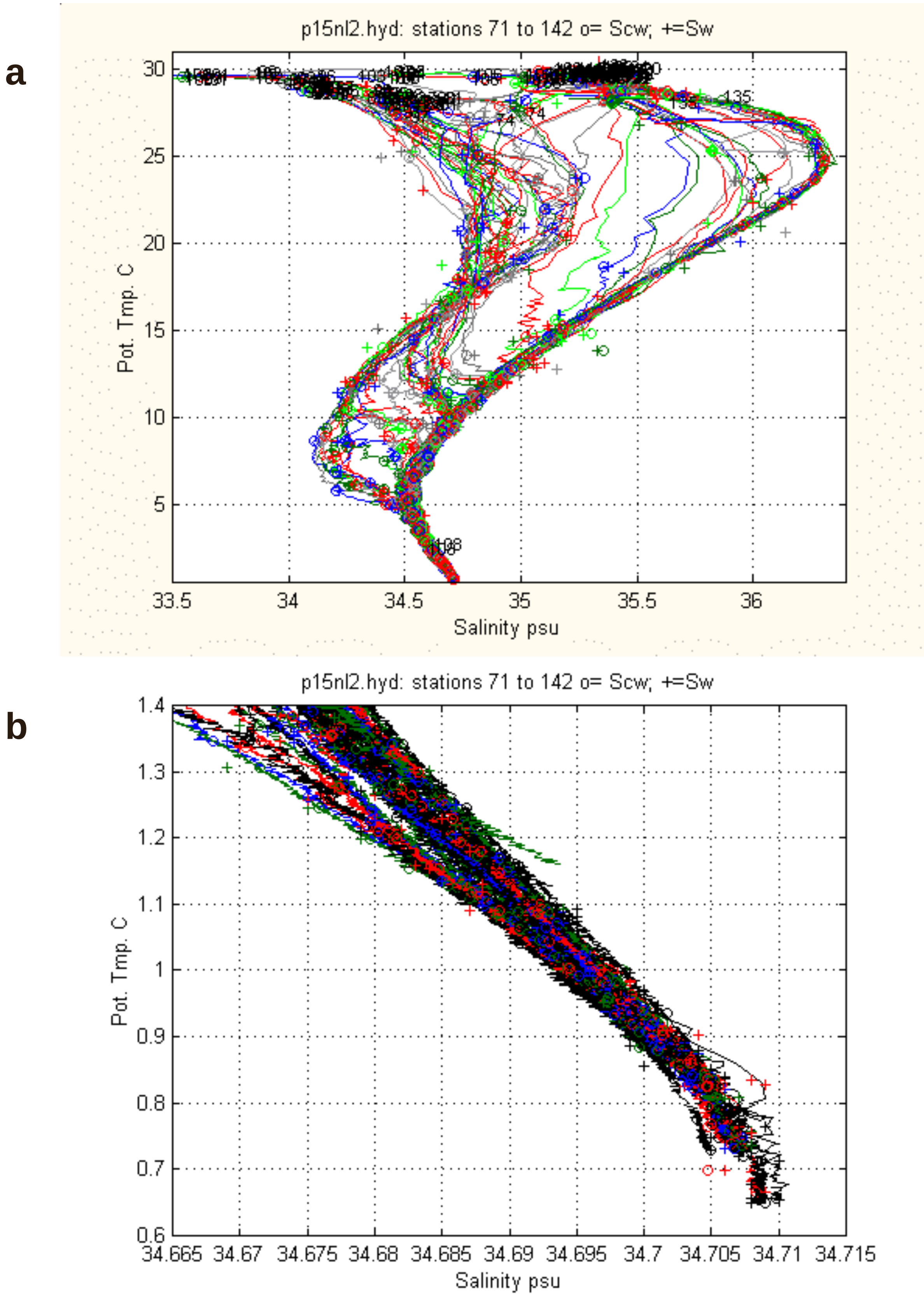


Figure 1: All 2 dbar & bottle salinities (a) overall
(b) deep

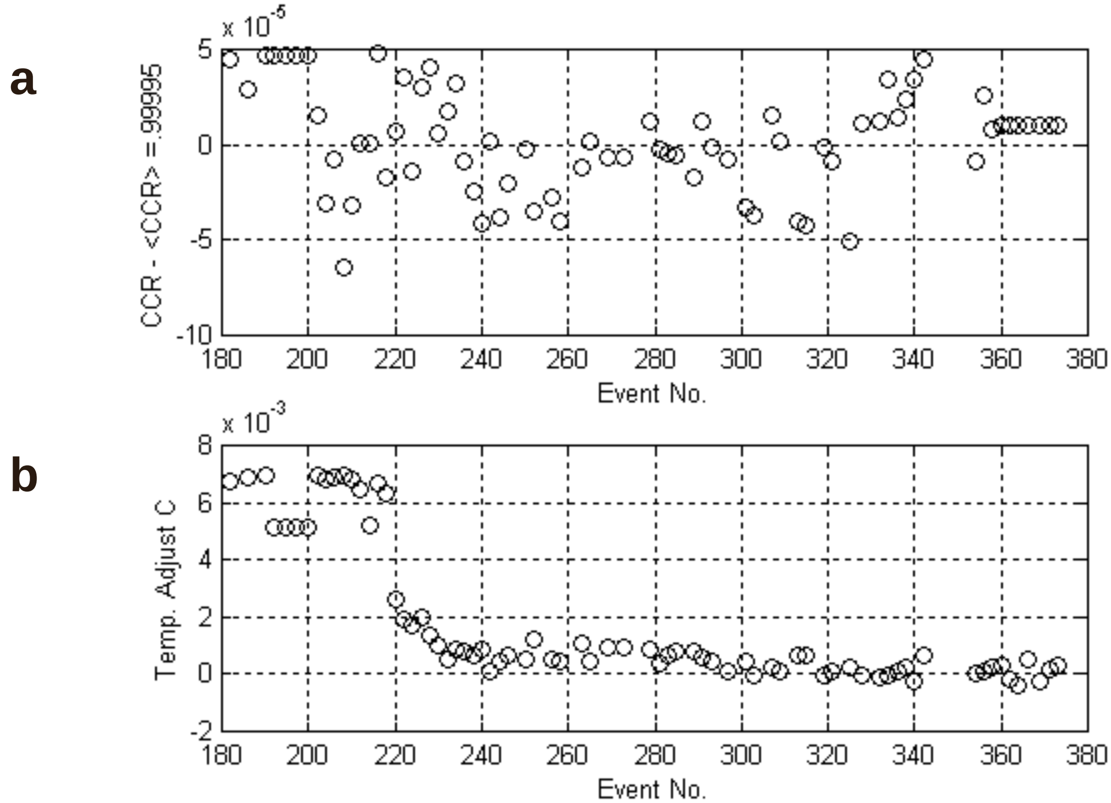


Figure 2: (a) Cond. slope corrections
(b) temp. adjustments

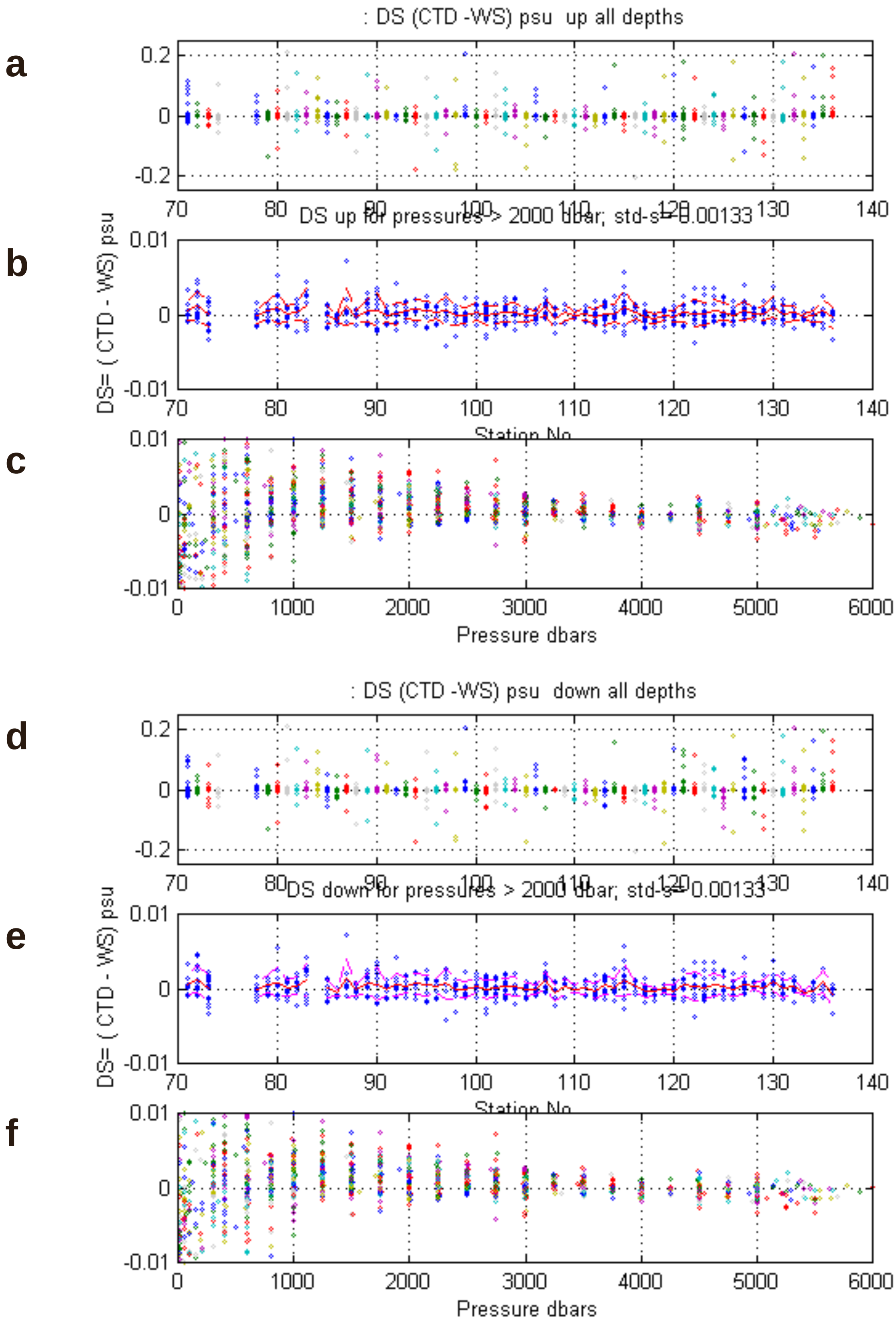
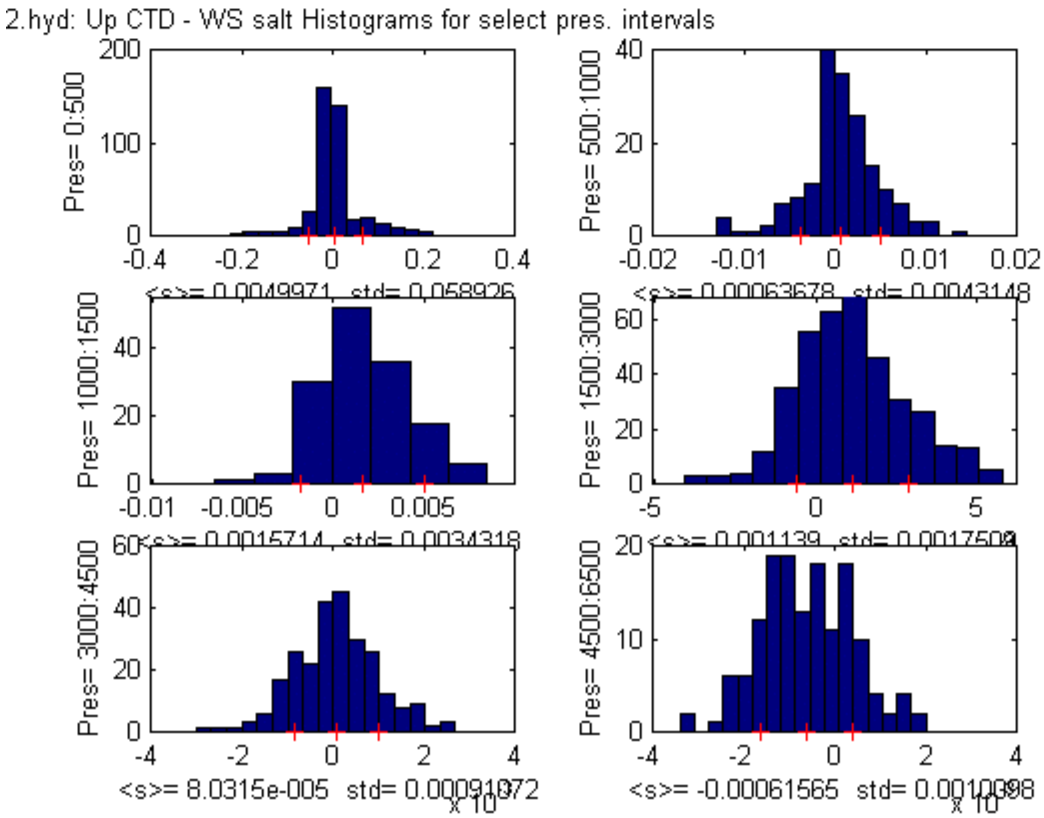


Figure 3: Salinity differences at bottles (a, b, &c) [CTD up cast - WS]
(d, e, & f) [CTD down cast - WS]

a



b

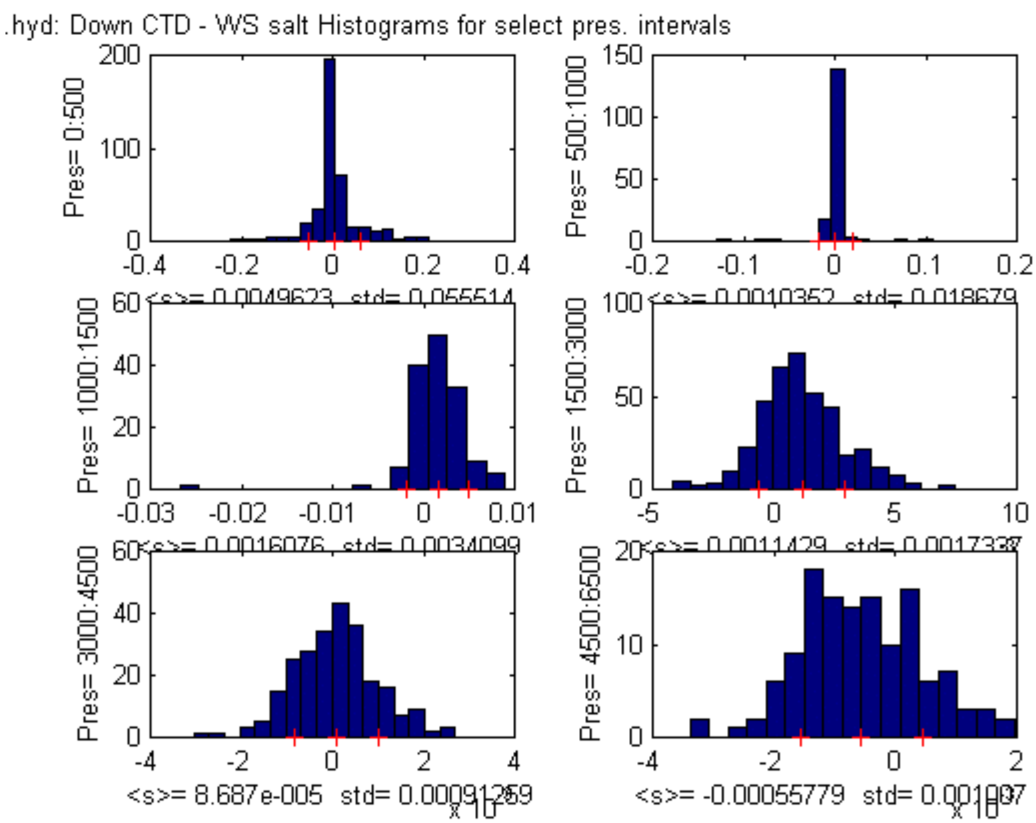


Figure 4: Histograms (a) [CTD up cast -WS]
(b) [CTD down cast - Ws]

a

b

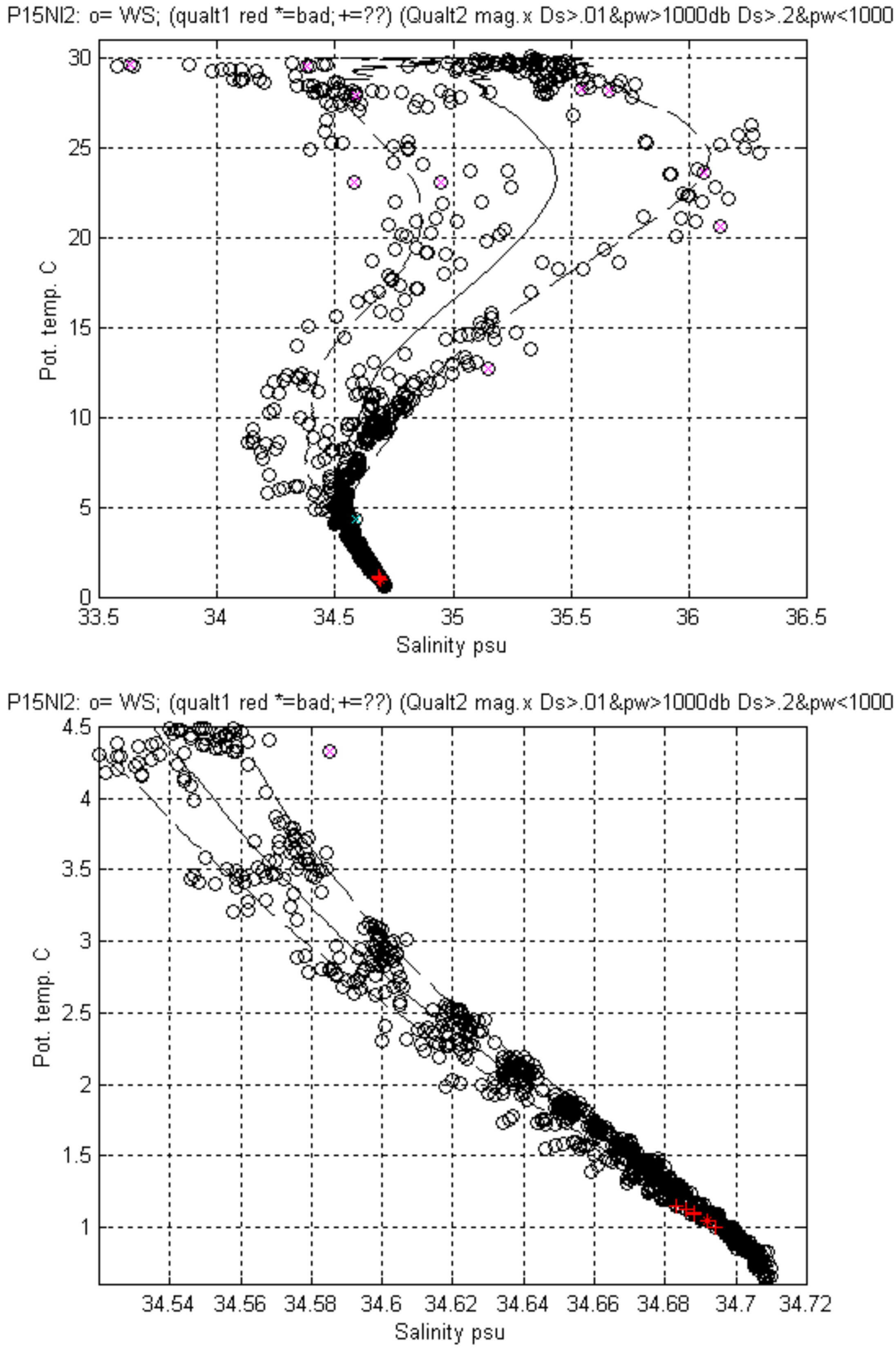


Figure 5: Pot. temp. average profile with WS (o) & quality (+) & (x): (a) Overall
(b) Deep

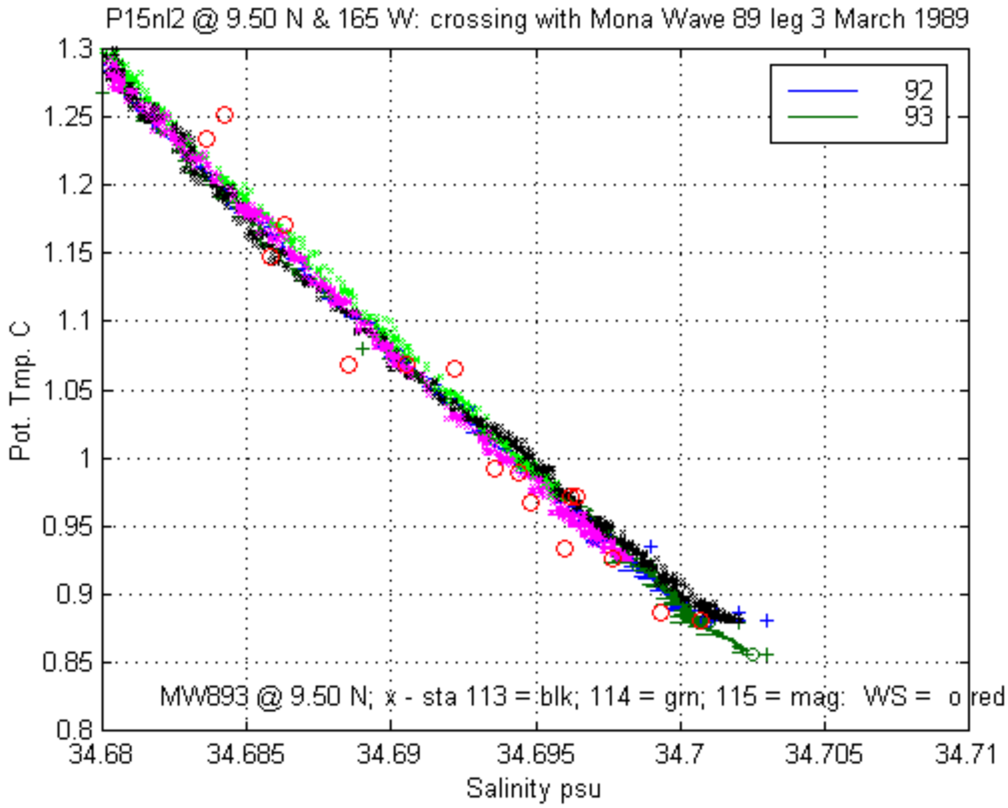


Figure 6: Comparison with R/V MW893 leg 3

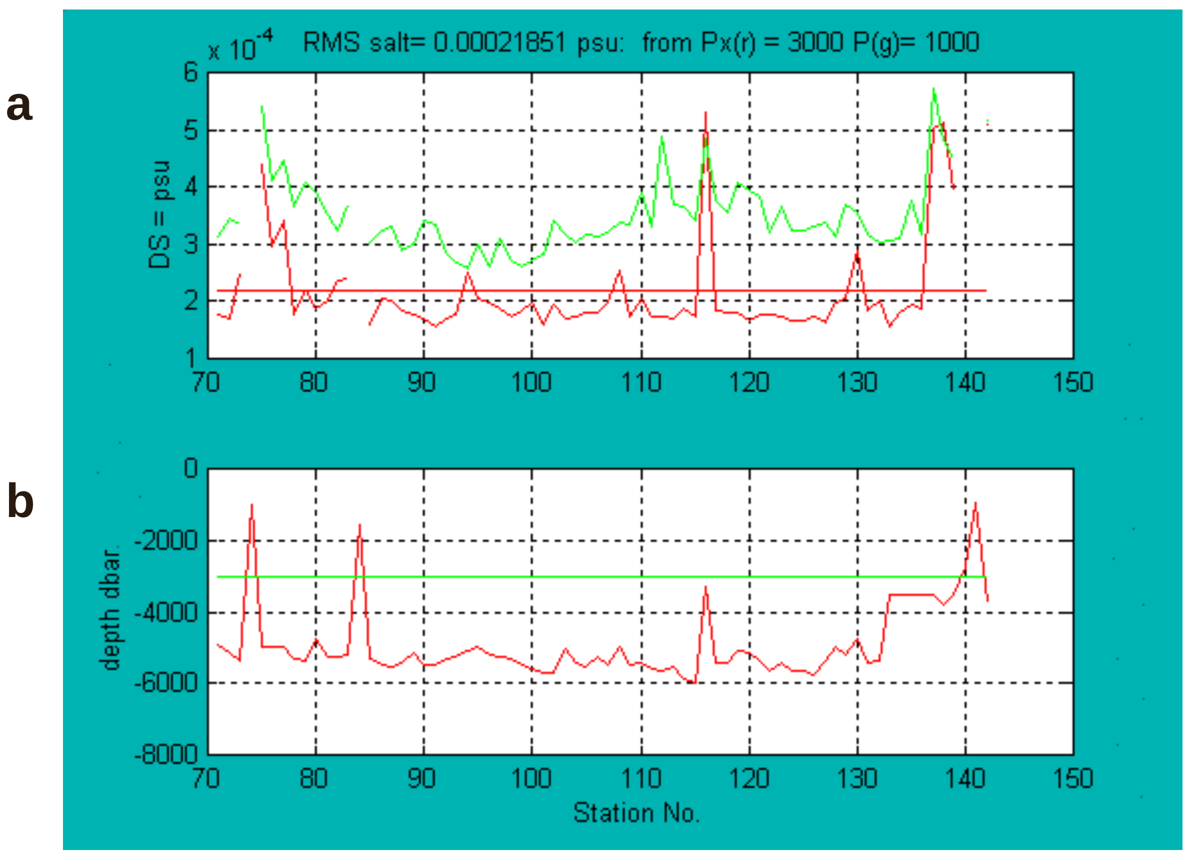


Figure 7: Salinity noise variance (4 to 25 dbars): red p = 3002 dbars
green p = 1000 dbars

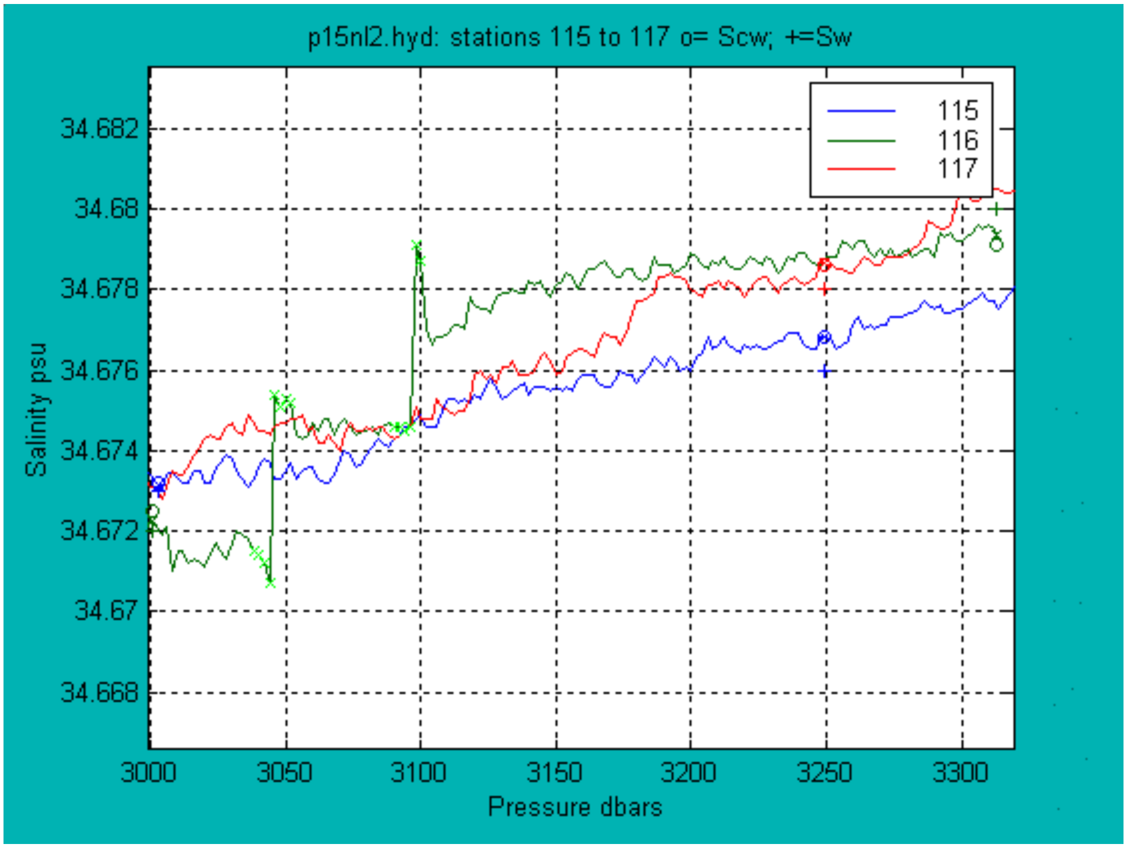


Figure 8: Salinity noise source station 116: prs. 3050 to 3100 dbars

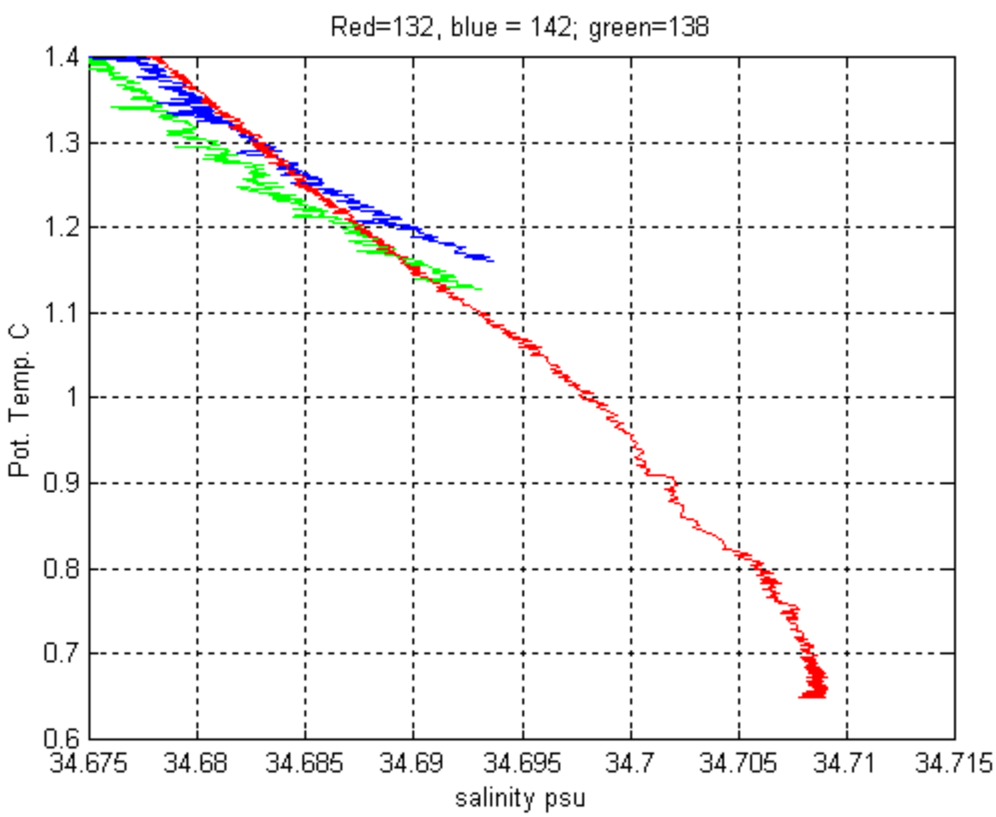


Figure 9: noise salinity station 138 (green)
station 142 (blue) is salty deep

a

b

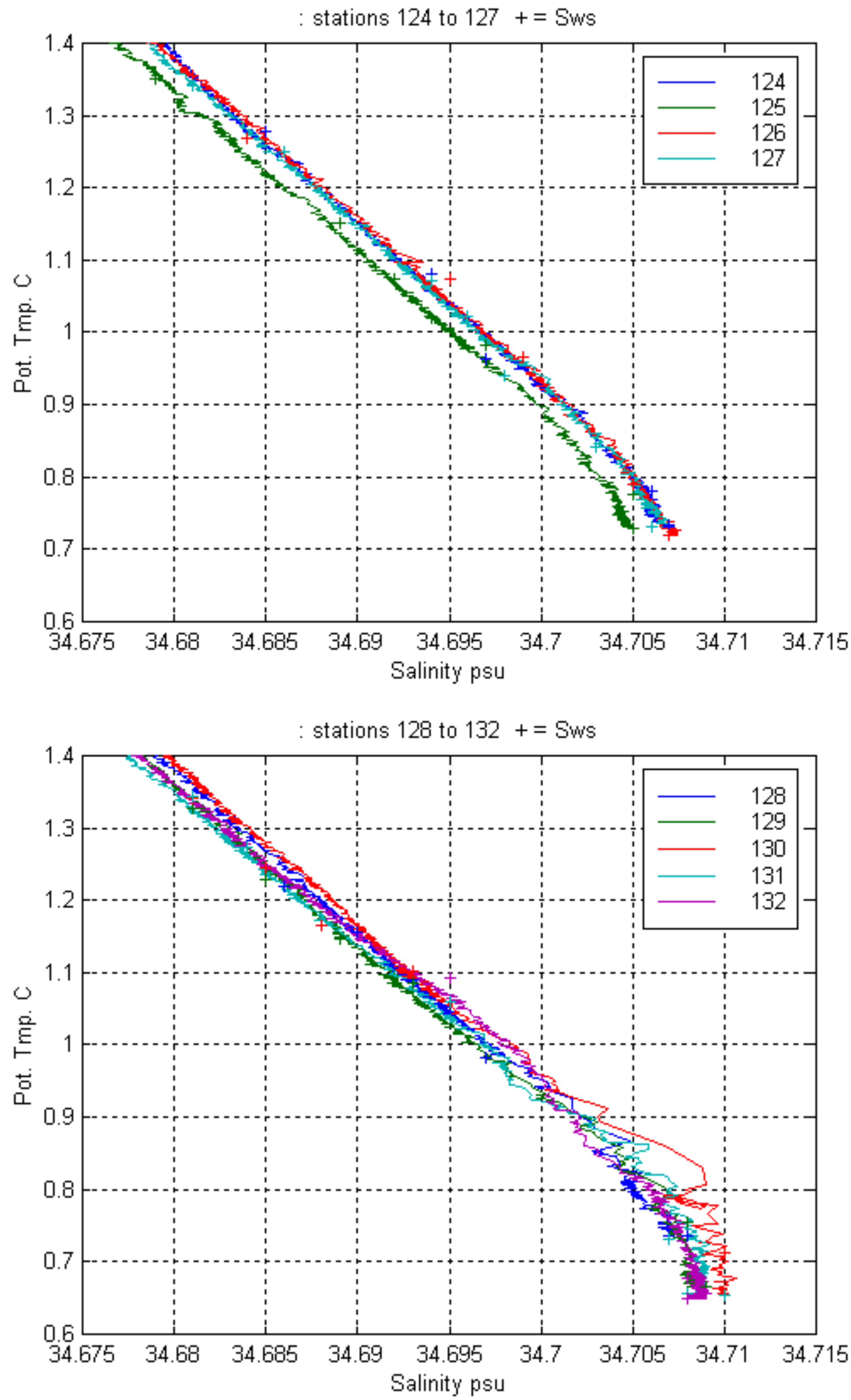


Figure 10: (a) Station 125 (green) fresh
(b) Station 130 (red) salty near bottom

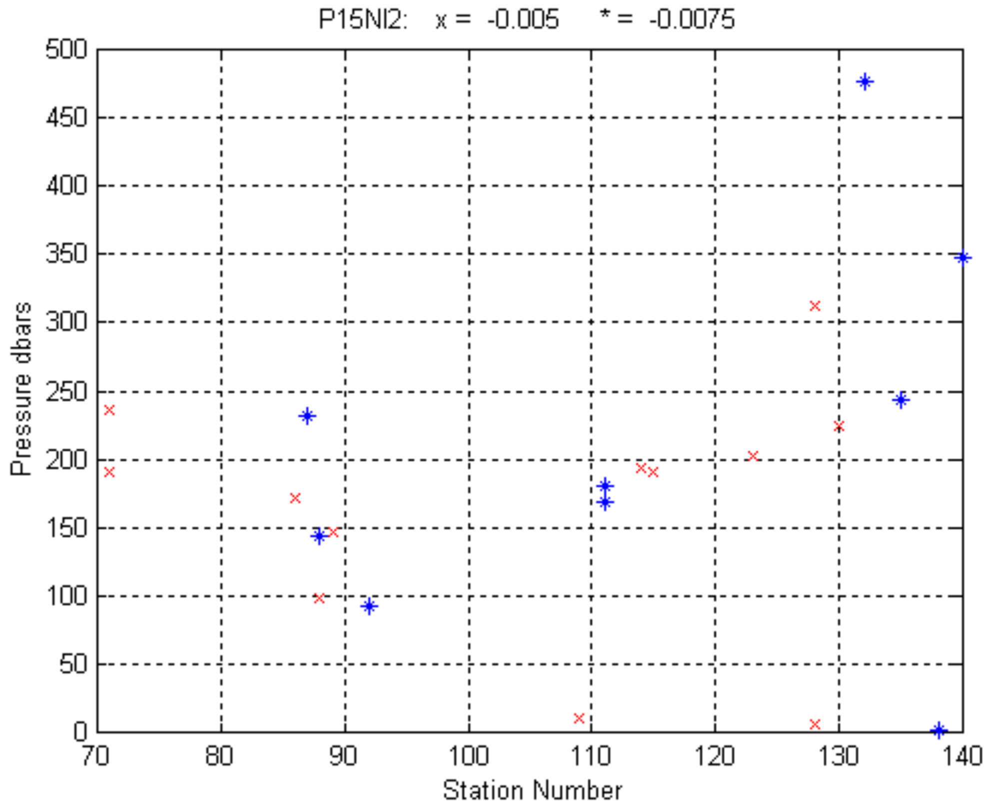


Figure 11: Density inversions versus pressure: (x) = -0.005 kg/m3/dbar
(*) = -0.0075 kg/m3/dbars

G.3. DQ Evaluation of P15N Bottle Data

(Arnold W. Mantyla)
28 March 2000

WOCE Section P15N ran from the Aleutian Islands south to Samoa along 165W to 170W close to the pre-salinometer era Alaska to Antarctica section that appears in Reid's classic "Intermediate Waters of the Pacific" monograph. With the closer WOCE station spacing, and more sensitive analytical techniques available to measure even more water constituents precisely, a clearer picture of the major Pacific gyre characteristics and water masses are now available. Although the analytical precision on the WOCE cruise was quite good, and comparisons with other cruises (WOCE, P04C, P02, TPS24, TPS47, INDOPAC and GEOSECS) agree reasonably well, there were a number of areas that did not meet WOCE guide- lines.

The biggest deficiency was inadequate sampling in the vertical; the WOCE standard of 36 discrete levels was not matched on any station on this cruise. Two rosette systems were available, a 23 place and an 11 place system. Both of the rosettes were only used on about 1/4 of the stations sampling about 26 to 31 separate depths (less than the maximum available due to excessive duplicate depth trips). The 23 place rosette alone was used on the majority of the stations, with only 20 to 23 depths sampled in water as deep as 6000m. Occasional missing or contaminated measurements resulted in rather gappy profiles, 36 different sampling depths are really needed to properly cover the full water column for the chemical constituents. Because of the limited number of rosette bottles available, it would have been better to not waste any of them for multiple trips at the same depth. The multiple trips were often in high gradient regions, and the spread in the analytical results between duplicate bottle trips reflect more the difficulty in sampling the same water when in high gradients, than they do the intended measure of sample collection, storage, and analysis precision. For example, the standard deviation of the salinity differences between duplicate trips was .003, but nearly all of the deep water CTD and bottle salinity comparisons were closer to .001, which indicates that both the CTD and salinometer results were really quite good. The duplicate trips were not a good way to evaluate the analytical precision achieved on the cruise (unless the comparisons are limited to the mixed layer, or to other fairly uniform layers in the ocean). Likewise, targeting the same depth on both the shallow and deep casts serves no useful purpose other than to reveal the ocean is variable. The ideal way to sample 36 different depths with a 24 place and 12 place rosette is to select the 36 depths to sample from the down full water depth CTD salinity and oxygen profiles, with an awareness of the depths of anticipated nutrient extrema based upon earlier station profiles, or from nearby historical data. Counting up from the bottom, trip the 24 bottles at depths 1 to 23, and at depth 25. Then with the shallow 12 place rosette, sample depth 24 and then 26 to 36. Duplicate trips, if really needed, can be done at shallower stations with no loss of information. Another way to evaluate data quality without loss of trip levels would be to compare data on several constant potential temperature surfaces over the whole cruise. Station to station offsets and analytical scatter can easily be spotted and evaluated.

The stations from 133 to the end of the cruise were limited to the top 3500m in water as deep as 5100m, because of winch problems. Those stations were recovered on P15S with full water column 36 place rosette casts; so the latter stations are to be preferred for the 170W section.

The .sum file was not filled out very carefully. There were many duplicate cast times, as well as times that were clearly 12 or 24 hours off (times from one part of a cast appearing in the middle of a later station). The most obvious errors have been corrected, but someone with access to the original records should do a thorough re-check of the information.

The .sea file did not show any CTD O2 data; that data would have been helpful in evaluating the water sample data. With no continuous CTD oxygen profile available, the few water sample oxygens are critical for defining the water column structure. Therefore, I was a little more apt to accept oxygen data that was only about 1% off, than were the data originators; slightly off data is better than no data at all.

Water sample salinities were only listed to 3 decimal places after station 70, they should be listed to 4 places as was done on leg I, and also as was done with the CTD salinities on both legs.

Salinities:
There is a discrepancy in which Standard Sea Water batch used on the cruise; P125 according to the cruise report, and P121 according to the CTD DQE report. Should verify which one was actually used. The P15N salinities tended to be about .001 higher than the comparison cruises, which is within the expected variation of SSW standards.

Oxygen:
The whole bottle Carpenter oxygen technique was used on the cruise and the data agreement with crossing cruises was quite good, generally within about 1um. There were some small systematic errors for refrigerated warm water samples noted in the cruise report, introducing an error of plus 1-3um, or about 1% in those samples. That is in the same ballpark as the duplicate trip agreement, so I would prefer to accept those as ok rather than being flagged bad. I have changed some of the flags, but more could be accepted as ok and used in the vertical sections.

A minor modification in sampling procedure could improve the oxygen analytical precision. The cruise report indicates the samples were collected after 200% overflow, stoppered, unstoppered, pickles, and re-stoppered. The re-stoppering step is difficult to do without introducing small air bubbles. If the pickling reagents can be kept near the rosette frame, then the sample can be pickled immediately and then stoppered without contamination while the flared part of the flask still contains sample water. The improved precision can easily be demonstrated by collecting and analyzing 10 samples out of a single large Niskin bottle both ways. The one-time stoppering method will usually result in a lower standard deviation for the 10 replicates.

Also, if very low ambient oxygen water is sampled, they should be collected in clean, dry flasks, without rinsing, and with 300% overflow, (per Horibe, et al, J. Ocean. Soc. Japan, 28:203-206, 1972).

In spite of the above comments, the oxygen data for this cruise generally look quite good, with no large offsets from other WOCE cruises.

Silicate:
The cruise report indicates that their primary silicate standard was 2% low compared to Sagami standards, unlike their usually good agreement with the Sagami standards. Also, the cruise results tend to be low compared to the WOCE crossing cruises by that amount. The PIs feel that the silicate data should be increased by 2%, but they have not done so. I agree, and recommend the data be multiplied by 1.02.

Phosphate:
Phosphates were the most frequently contaminated nutrient, with numerous scattered values clearly bad. The sparse vertical sampling intervals made the loss of any PO4 data regrettable, use of 36 place rosette might have minimized the information loss due to isolated bad PO4's. The deep PO4's tended to be about .05um high compared to other WOCE cruises, while numerous unlikely near zero surface values near the end of the first leg point toward a possible baseline or reagent blank problem. I have not flagged any of the zero um values, but I consider them to be questionable. The uncertainty only occurred on the first leg, there were no zero values on the second leg. Also, surface PO4's were often higher than the next deeper sample. This is a common problem when running low level nutrients immediately after a high level standard: To avoid the problem, run two surface samples and discard the first one.

Nitrite:
An analytical problem late in the cruise resulted in artificial deep NO2 values of 0.1 to 0.3, so much of the NO2 data after station 123 was flagged bad. The loss of the NO2 data is not serious, little occurs in deep water, but the problem created some uncertainty in the nitrate data.

Nitrate:
The NO2 error of 0.1 to 0.3 is large for nitrite, but small for NO3. The nitrate analyses involves the reduction of NO3 to NO2 and what is finally detected is the sum of the NO3 and NO2 originally in the sample. The NO2 present is usually subtracted from the NO3+NO2 to get the nitrate alone. Since many of the NO2's were doubtful on this cruise, many of the "corrected" NO3's were also considered to be doubtful. Since the NO2 error was in the NO2 analyzer alone, the erroneous NO2 values should not have been subtracted from the NO3 results (although they are "NO3+NO2", the deep NO2's are essentially zero). Therefore I recommend the NO3's be restored to their original values and the flags be re-set to ok. The corrected values will result in somewhat better agreement with historical data and with P15S, and will avoid a data gap in the vertical section.

STA. 18: The deep NO_2's below 200m are doubtful and have been flagged. If the second decimal place of the NO_3's are available, the NO_2 "corrections" should be added back in and the NO_3's accepted as ok.

STA. 27: The bottom 4 CTD salinities appear to have been truncated to .01, and are about .006 low. They have been flagged uncertain, but the original data should be checked to see if an error had occurred in the data tabulation. The PO_4's appear to be about .1 low on all. Suggest re-check the factor or baseline offset. If calculated ok, recommend "u"ing all.

STA. 31, cast 3 bottle 1: The data are listed at 5db, without any temperature, but are clearly from the bottom (even the listed CTD salinity). The data have been flagged uncertain, but would be ok if listed at the bottom with bottle number 2.

STAS. 44-46: The majority of the oxygens have been flagged uncertain or bad, but the profiles agree well with adjacent stations and appear better than sta. 42. I would prefer to keep these as ok, unless there is a compelling reason to believe that they are indeed very poor.

STAS. 45,47, 49, 51, 53, and 55: Bottles S9 and S10 are listed at different depths, but the salinity and nutrients are essentially identical, suggesting a double trip at the S10 bottle depth. Oxygen is at a local high gradient maximum, so the 2 trips are not necessarily the same in oxygen. I recommend flagging bottle S9 water samples as doubtful for these stations.

STA. 50: The salinity at 4000db is exactly 0.3 off. Could this be a key entry error?

STA. 52: Bottles 22 and 232 at 5db have no data, not even CTD temperature. Suggest delete, as no useful information.

STA. 53: Bottles S7 and S9 at 115db and 145db appear to be listed one depth too deep, they would be ok one depth up. all of the water samples have been flagged uncertain.

STA. 61, 5db: No CTD or water data, suggest delete.

STAS. 63 and 65: Nitrates seem low, suggest re-check calculation factor compared to nearby stations.

STAS. 66 and 69, 5db: No data suggest delete.

STA. 74, bottle S1: No data, not even pressure. Suggest delete.

STA. 94, 1248db: The nitrate was flagged bad, but would be ok if the poor NO_2 correction was added back.

STA. 108, cast 9, bottle S10: No data, not even CTD pressure. Suggest delete level (2503db).

STA. 111: There was a shift (lower) in the phosphate on this and the following station, but not in nitrate, suggesting a change in standards. This should be looked into, and corrected, if possible.

STAS. 123-136: All of the NO2's and NO3's have been "u"ed, however the NO3's would be ok if uncorrected for the NO2. Suggest adding the NO2 back to the NO3's and accepting the nitrates as ok.

G.4 Final CFC Data Quality Evaluation (DQE) Comments on P15N.

David Wisegarver
Dec 2000

This data set, in its current form, does not meet the relaxed WOCE standard for CFC's. The original CFC flags (QUALT1) assigned by the PI have not been altered. During the DQE process, CFC QUALT1 flags of '2' (good) assigned by the PI have been given QUALT2 flags of '3' (questionable). Detailed comments on the DQE process have been sent to the PI and to the WHPO.

The CFC concentrations have been adjusted to the SIO98 calibration Scale (Prinn et al. 2000) so that all of the Pacific WOCE CFC data will be on a common calibration scale. For further information, comments or questions, please, contact the CFC PI for this section (C. S. Wong, WongCS@pac.dfo-mpo.gc.ca) or David Wisegarver (wise@pmel.noaa.gov). Additional information on WOCE CFC synthesis may be available at: http://www.pmel.noaa.gov/cfc.

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Prinn, R. G., R. F. Weiss, P. J. Fraser, P. G. Simmonds, D. M. Cunnold, F. N. Alyea, S. O'Doherty, P. Salameh, B. R. Miller, J. Huang, R. H. J. Wang, D. E. Hartley, C. Harth, L. P. Steele, G. Sturrock, P. M. Midgley, and A. McCulloch, A history of chemically and radiatively important gases in air deduced from ALE/GAGE/AGAGE J. Geophys. Res., 105, 17,751-17,792, 2000.

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WHPO DATA PROCESSING NOTES

H18DD9403_1			
Date	**Contact**	**Data Type**	**Data Status Summary**
07/02/97	Millard	CTD	DQE Begun with jswift's OK
10/28/97	Freeland Garrett, orig chf. sci. is retired	CTD/BTL	Data are Public
06/15/98	Millard	CTD	DQE Report rcvd @ WHPO
09/08/99	Talley	SUM/BTL	Update Needed, passing along to S. Anderson
10/11/99	Mantyla	NUTs/S/O	DQE Begun
12/07/99	Muus	BTL	Reformatted by WHPO

NOTES for P15N bottle and summary file changes by D. Muus Sept 30, 1999.

p15nahy.txt p15nasu.txt
p15nbhy.txt p15nbsu.txt

1. Changed silicate Station 069, Sample 1534, 1751.3db from 0.00 to 141.6.
2. Changed STNNBR "NEWS" to "9991" and STNNBR "FREON" to "9992" per Lynne Talley and Frank Whitney messages Sept 22, 1999.
3. Changed longitude Station 9991 Cast 1 Code BE from 123 degrees to 158 degrees to make all longitude degrees for Station 9991 consistent with date and time. 123 deg was Longitude of first station of p15na.
4. Removed letters "P" and "W" from STNNBRs per Lynne Talley and Frank Whitney messages Sept 22,1999. Left letters on STNNBRs not in bottle data file.
5. Moved all Left-Justified BTLNBRs to Right-Justified. (All were 2nd (shallow) rosette bottles with "S" before numbers to distinguish them from main rosette bottles) p15nbhy.txt: Stations 72, 73 & 74 all cast 2.
6. WOCE SECT PRS01 (old weather station Papa?) listed in summary file with station number P26 but has station number PRS1 in bottle file. Summary file has bottle samples indicated for Casts 5, 6, 7 & 9. Bottle file has bottle data for Casts 4, 5, 6 & 8. Lynne T. questioned what we plan to do with PRS01 data. Probably should go back to originator to be straightened out before we do anything. Left all PRS01 data unchanged in p15na files.
7. Swapped CTDSAL and THETA data columns to match Manual format. 8. Moved PR06 data out of p15nahy.txt into pr06_ihy.txt and p15nasu.txt into pr06_isu.txt to avoid duplicate station numbers after Item 4 above.

Summary of PR06 sequence designators:

	Dates		**Vessel**	**Ch Sci**	**Status per Web**
a)	Oct 17 - Nov 1,	1991	Endeavor	Bellegy	WHPO
b)	Feb 3 - 14,	1992	Tully	Whitney	WHPO NP
c)	Mar 26 - Apr 13,	1992	Endeavor	Perkin	WHPO NP
d)	Sep 8 - 29,	1992	Tully	Whitney	WHPO NP (See PR05)
e)	Feb 26 - Mar 17,	1993	Tully	Perkin	WHPO NP
f)	May 14 - Jun 3,	1993	Tully	Whitney	WHPO NP (See PR05)
g)	Feb 7 - 21,	1994	Tully	Perkin	PI
h)	May 10 - 25,	1994	Tully	Whitney	WHPO NP (See PR05)
i)	Sep 6 - Oct 10,	1994	Tully	Garrett	WHPO (See P15N)

Date	Contact	Data Type	Data Status Summary

Moved to separate PR06 files Oct 5, 1999

j)	Feb 7 - 23,	1995	Tully	Whitney	PI
k)	May 8 - 26,	1995	Tully	Whitney	?
l)	Aug 22 - Sept 13	1995	Tully	Boyd	
m)	Feb 19 - Mar 8	1996	Tully	Whitney	?
n)	May 6 - 30	1996	Tully	Boyd	?

ADDITIONAL NOTES Oct 19, 1999, D. Muus

9. Moved PRS01 data out of p15nahy.txt into prs01_hy.txt p15nasu.txt into prs01_su.txt Awaiting resolution of prs01 cast numbering problem before making final prs01 files for Sep 11, 1994.

Addition to summary of PR06 sequence designators:

o)	Aug 14 - Sep 4	1996	Tully	Whitney	WHPO (*.XLS files in 9618.ZIP)

ADDITIONAL NOTES Dec 6, 1999, D. MUUS

10. Re Item 7 above: When CTDSAL and THETA columns were swapped, I forgot to swap the 7 asterisks denoting QUALT1 numbers. Swapped the 7 "*"s today (Dec. 6, 1999) and placed the corrected p15nahy.txt p15nbhy.txt in /usr/export/ftp/pub/ WHPO/MUUS/P15N.

04/04/00	Mantyla	NUTs/S/O	DQE Report rcvd @ WHPO
04/20/00	Key	DELC14	No Data Submitted

Unfortunately, I can provide no new information on the C14 status for cruises P15N and P24. I do know that acquiring data from CS Wong (P15N) has been very difficult. I'll try to investigate.

07/19/00	Wong	ALKALI	Submitted; needs extensive reformatting
07/19/00	Talley	CO2/O18	Data Request to C.S. Wong
08/11/00	Muus	ALKALI	Bartolocci asked D. Muus to do reformatting

Aug 17, 2000 Dave Muus

TCO2 and TALK from C.S. Wong files P15NLEG1.dat and P15NLEG2.DAT have been merged with the p15nahy.txt and p15nbhy.txt files. (TCARBN & ALKALI)

Uncontaminated Sea Water (USW) data are not included in the .SEA files so the TCO2 and TALK data for USW were put in separate files after conversion to mrgsea usable files: p15naUSWalkco2 & p15nbUSWalkco2 PR06 and PRS01 data from P15NA were recombined and the corresponding TCO2 and TALK data were merged: pr06_ihy.txt pr06_isu.txt "i"is the sequence designator used during my reformatting last year. I am not sure it is still the proper designator.

Data discrepancies noted:

	STA	CAST	SMPL	PRESS			
P15NA	016	3	all		ALKALI present but	QUALT1	= 1
	052	3	all		ALKALI present but	QUALT1	= 1
PR06	26	8	117	2800.6	ALKALI missing but	QUALT1	= 2

H18DD9403_1

Date	Contact	Data Type	Data Status Summary			
	USW	64	2	L113	3.0	ALKALI 2305.9 but QUALT1 = 9
		79	3	L126	3.0	ALKALI missing but QUALT1 = 2
		96	2	L143	3.0	ALKALI missing but QUALT1 = 2
		134	2	L181	3.0	ALKALI missing but QUALT1 = 2
		136	2	L183	3.0	CO2&ALK missing but " both = 2
		138	3	L185	3.0	ALKALI missing but QUALT1 = 2
		140	2	L187	3.0	TCARBN missing but QUALT1 = 2
		142	2	L189	3.0	CO2&ALK missing but " both = 2

08/18/00 Bartolacci ALKALI/TCARBN btl file (tcarbn, alkali, qualt1) reformatted:

Total alkalinity and Dissolved Inorganic Carbon have been merged into P15N_a and P15N_b by D. Muus. In doing so, he removed the PRS01 and PR06 stations from the P15N_a bottle file. This creates a missmatch between the current P15N_a sumfile and the new bottle file, since the sumfile has retained PRS01 (but not PR06). PR06 and PRS01 have been split off into separate sum and bottle files for this cruise and need to be put online. This matter should be rectified, and correct stations be placed in the P15N files before any further events take place on this line.

09/11/00 Bartolacci BTL/SUM Data Merged into BTL file

PR06 and PRS01 segments reinserted, see note:

At the request of J. Swift the PR06 and PRS01 segments of the P15 cruise were reinserted back into the P15 bottle and sumfiles. The table entry for PRS01 and PR06 will be linked to the P15 index.htm page

1. PR06/PRS01 data were obtained from the directory

   .../p15na/original/2000.07.24_P15N_TALK_DIC_WONG/pr06_ihy.txt

   .../p15na/original/2000.07.24_P15N_TALK_DIC_WONG/pr06_isu.txt these files were originally extracted by D.Muus these files were inserted into the current online summary file and the previously formatted bottle file of 1999.10.01 by D. Muus.
2. The current online files were moved from: p15nahy.txt to /original/p15nahy_rplcd_2000.09.11.txt p15nasu.txt to /original/p15nasu_rplcd_2000.09.11.txt
3. New complete files were renamed p15nahy.txt and p15nsu.txt
4. Added name/date stamp.
5. Ran sumchk - no errors.
6. Ran wocecvt -with errors corresponding to stations 13, 18, 39. error output stated that following station/cast combinations could not be matched between sumfile and bottle file:

PR06	13/3
PR06	18/3
P15	013/3
P15	018/3
P15	039/5

Date	Contact	Data Type	Data Status Summary

interpretation of this output was difficult.

7. Edited CTD file headers to match changes made by D. Muus to summary and bottle files so station designators would match bottle and summary station designators: changed expocode in all files from 18DD9403/1 to 18DD9403_1 removed "W" from all station numbers changed "FREON" in station designator to "9992" as per D. Muus.
8. Ran wctcvt - with errors corresponding to stations 4,13, 39. error output stated that the following station/cast combinations could not be matched between sumfile and ctd file:

    P15 004/1
    P15 013/1
    P15 018/2
    P15 039/4

   all of these station casts are in both ctd and sum files so interpretation of this output was difficult.
9. moved current zipped ctd files from p15nact.zip to original/p15nact_rplcd_ 2000.09.11.zip moved newly formatted zipfile into p15nact.zip

Date	Contact	Data Type	Data Status Summary
10/11/00	Uribe	DOC	

Files were found in incoming directory under whp_reports. This directory was zipped, files were separated and placed under proper cruise. All of them are sum files. Received 1997 August 15th.

Date	Contact	Data Type	Data Status Summary
11/29/00	Wisegarver	CFCs	DQE Report rcvd @ WHPO
12/11/00	Uribe	DOC	Submitted

File contained here is a CRUISE SUMMARY and NOT sumfile. Documentation is online.

Date	Contact	Data Type	Data Status Summary
03/15/01	Key	DELC14	Measured as per .DOC

Funding now available to analyze Got word from Eric this A.M. that he will fund NOSAMS at the rate of 1000/year to analyze previously collected, but unfunded C14 samples. Highest priority will be to fill in Pacific "holes" starting with P14S15S (NOAA), P15N (Wong) and P1 (Japan). Policy decision supported by WOCE SSC. Eric would, if possible, like these data to be included in the atlas. In reality I don’t know if this is possible/practical, but I will do everything possible to expedite. Scheduling at NOSAMS will be complicated, but order listed above is the "scientific" priority as of now.

Date	Contact	Data Type	Data Status Summary
06/22/01	Uribe	BTL	Website Updated CSV File Added

Bottle file in exchange format has been put online.

Date	Contact	Data Type	Data Status Summary
10/29/01	Muus	CFCs	new cfcs merged into online btl file

Merged July 2001 CFCs into bottle file and placed new woce format and exchange format files on web. Made minor modification to Summary file. Changed Quality Code 1 to 9 where appropriate.

Notes on P15Na CFC merging Oct 29, 2001. D. Muus

1. New CFC-11 and CFC-12 from:

   /usr/export/html-
   public/data/onetime/pacific/p15/p15n/p15na/original/
   20010709_CFC_UPDT_WISEGARVER_P15N_ALL_LEGS/
   20010709.173723_WISEGARVER_P15N_p15n_CFC_DQE.dat

Date	Contact	Data Type	Data Status Summary

merged into SEA files from web Oct 17, 2001. (20000908WHPOSIODMB) for P15Na

Prior to merging:Changed all "1"s in QUALT1 to "9"s and then copied QUALT1 to QUALT2. Changed all missing values for DELC14 from -9 to -999.0.

2. Summary file modified by putting
   Station P13 Cast 1 before Station 13 Cast 2 BE, and putting
   Station P18 Cast 1 before Station 18 Cast 2 BE.
   Both were between Cast 2 BE and BO in correct time sequence but wocecvt "skipped" both casts and the exchange conversion duplicated both casts. Now in correct cast sequence but out of sequence for times. Both wocecvt and exchange conversion okay.
3. New exchange file checked using Java Ocean Atlas.

Date	Contact	Data Type	Data Status Summary
02/04/02	Uribe	CTD	Website Updated CSV File Added

CTD has been converted to exchange and put online.

18DD9403_2

Date	Contact	Data Type	Data Status Summary
07/02/97	Millard	CTD	DQE Begun Leg 2 only
06/15/98	Millard	CTD	DQE Report rcvd @ WHPO
08/04/00	Kappa	data hist	Updated for data hist see P15N 18DD9403_1

Until today these 2 distinct data files were treated as if they were one continuous cruise.

Date	Contact	Data Type	Data Status Summary
08/18/00	Bartolacci	ALKALI/TCARBN	Bottle file (tcarbn, alkali, qualt1) reformatted

Total alkalinity and Dissolved Inorganic Carbon have been merged into P15N_a and P15N_b by D. Muus. In doing so, he removed the PRS01 and PR06 stations from the P15N_a bottle file. This creates a missmatch between the current P15N_a sumfile and the new bottle file, since the sumfile has retained PRS01 (but not PR06). PR06 and PRS01 have been split off into separate sum and bottle files for this cruise and need to be put online. This matter should be rectified, and correct stations be placed in the P15N files before any further events take place on this line.

Date	Contact	Data Type	Data Status Summary
06/22/01	Uribe	BTL	Website Updated CSV File Added

Bottle file in exchange format has been put online.

Date	Contact	Data Type	Data Status Summary
10/29/01	Muus	CFCs	July 2001 cfcs merged into online btl file

Merged CFCs into bottle file and placed new woce format and exchange format files on web. Changed Quality Code 1 to 9 where appropriate.

Notes on P15Nb CFC merging Oct 19, 2001. D. Muus

1. New CFC-11 and CFC-12 from:

   /usr/export/html- public/data/onetime/pacific/p15/p15n/p15na/original/
   20010709_CFC_UPDT_WISEGARVER_P15N_ALL_LEGS/
   20010709.173723_WISEGARVER_P15N_p15n_CFC_DQE.dat

   merged into SEA file from web Oct 17, 2001. (20000817WHPOSIODM)
   Prior to merging:

   Changed all "1"s in QUALT1 to "9"s and then copied QUALT1 to QUALT2.
   Changed all missing values for DELC14 from -9 to -999.0.

   Found duplicate sample number used for two different bottles:

Sta	Cast	Sample#	Bottle#	Pressure
111	2	2552	13	1500.4
111	2	2552	12	1749.2

   No CFCs taken from either bottle, but TCARBN and ALKALI were measured and the values for Bottle #13 (2325.6 & 2409.9) had been merged into both bottles. Corrected Bottle #12 TCARBN and ALKALI values (2334.5 & 2417.9).

   Station 108, Cast 9, Sample 2492, Bottle S10 has CTDPRS = -9.0. All other samples also -9. Bottle quality code is 4 "did not trip correctly". CTDSAL quality codes are 2 while all other quality codes are 9. Changed CTDSAL quality codes to 9.

2. New exchange file checked using Java Ocean Atlas.

18DD9403_2

03/20/02	Bartolacci	CTD	Update Needed	

CTD cast numbers do not match SUM file CTD station files for this cruise contain station numbers that do not match those station numbers contained in the summary file. No CTD exchange files have been generated at this time. Station numbers need to be resolved/corrected.

07/02/02	Kappa	DOC	PDF cruise reports added, text doc updated

Added CTD, HYD and CFC Data Quality Reports to the online cruise report. Compiled PDF version with all updates and figures.