**Centre for Ocean Climate Chemistry**

**Cruise 9201**

**Freon Data Report**

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Introduction 3

Methods 3

Sampling 3

Water 3

Air 4

Analysis 4

Calibration 4

Standards 4

Daily Calibration 4

Results 5

Station Data 6

Station P16 - February 6, 1992 6

Station P20 - February 7, 1992 8

Station P26 - February 9,1992 10

Station P26 - February 10, 1992 12

Tests 14

Verification of Subsampling Techniques 14

Bottle Blanks 15

Precision Test 15

Precision by Pooled Standard deviation of Duplicates 16

GC Integration Test 16

Restrips of water samples 17

Samples stored overnight (Station P12 510m Multiple syringes) 17

Air 18

Freon Levels of Outside Air 18

Freon Levels of Lab Air 18

Discussion 19

Comparison of earlier data 19

Cruise OC-85-OS-02 - Station P26 19

Cruise OC-85-OS-03 - Station P26 20

Gammon 1980 21

Comparison of F11 at Station Papa over time 22

Comparison of F12 at Station Papa over time 23

Conclusions 24

Recommendations 24

References 24

# Introduction

The February 1992 COCC cruise to Station Papa was the first test of the Freon Analysis System in the field. Preliminary testing of the system was carried out and a few initial hydrocasts sampled.

# Methods

## Sampling

### Water

Freon samples were taken from 10 liter Niskin bottles only since the large bottles have a better O-ring surface area/water volume ratio than smaller Niskins. These bottles were fairly well aged, but no specific precautions had been taken to lessen contamination of Freon from O-rings or elastic tubing in these Niskin bottles. They were however, stored closed with the remnants of the previous sample out on deck where the air is not so heavily contaminated with CFC's. The Freon samples were the first samples drawn from the Niskin since they are the most easily contaminated by air entering the head space of the bottle. The samples were drawn directly into 100 cm precision ground glass syringes.

Once the Niskin bottle was on deck, the integrity of the bottle was verified by pushing in the drain valve while the vent remained closed. If there was no leakage, the syringe valve was inserted into the drain valve and the vent opened. The syringe was filled with about 10 cc. of seawater The hydrostatic pressure of the water in the Niskin bottle forced the syringe plunger outward thus reducing the chance of drawing an air bubble into the syringe which is likely if the plunger was pulled out. The syringe was then removed while the water was still flowing and emptied into the outflow (but not into the Niskin). This 10 cc rinse was repeated three times and then the syringe was filled with approximately 100cc, inverted and plunger spun to send any bubbles to the top. while pushing out bubbles and sample. The three 10 cc rinse technique was repeated and the syringe then filled to about 100cc; stopcocks closed. An elastic was put on the syringe to maintain a positive pressure on the water sample. The syringe was placed in a sample bucket filled with fresh seawater at least one inch above the syringe barrel. If an air bubble was drawn into the syringe while sampling, the rinses were started all over again. The bucket of samples was kept in a sink in the lab, with a continual overflow of seawater from the seawater loop manifold.

Subsampling and analysis techniques were verified with a high and low Freon level sample. One Niskin bottle was sampled from 50m at station P04 and another from 512m at station P12. These bottles were subsampled with multiple syringes. Hydrocast Freon profiles were done at stations P16, P20, and P26. Bottle blanks were evaluated with 1200 meter water at station P26 using four Niskin bottles normally used to sample 500, 800, 1000, and 1200 meters. Precision of analyses was checked at station J5 where three Niskins were tripped in the mixed layer at 45, 50 and 55 meters Three subsamples from each Niskin were drawn and analyzed. An instrument detection limit was determined for low level Freons by changing the threshold and analyzing multiple syringes drawn from one 1000m bottle at Station J5.

Carrier blanks, stripper blanks, restriped samples, lab air, sampling deck air, helicopter deck ("clean") air and sea loop samples were also analyzed throughout the cruise.

### Air

Syringe air samples were taken from the Helicopter deck, sampling deck and inside the lab. The designated air syringe was flushed at least ten times, then a sample drawn, stopcock closed, and tension elastic put in place.

## Analysis

Analysis were carried out using the Chloroflorocarbon Analytical System built by Glenn Smith, Centre for Ocean Climate Chemistry, Institute of Ocean Sciences. The COCC analytical system is a modified version of the one described by Bullister and Weiss (1988).

## Calibration

### Standards

Standard tank number 63088 was used throughout this cruise. This standard was made up of outside air and nitrogen by Glenn Smith using the COCC facilities. The tank was calibrated against Ocean Chemistry's Freon standard tank # 70016 (F11, 271.0 ppt, standard deviation of 0.42; F12, 511.8 ppt, corrected standard deviation of 0.69). The Ocean Chemistry Freon standard was obtained and certified by Weiss's lab. The COCC Freon standard tank value for F11 was 445.41 ppt, standard deviation of 6.95, and for F12 257.3 ppt, standard deviation of 0.88.

### Daily Calibration

Calibration curves used to determine sample concentrations were generated by multiple injections of predetermined volumes of standard gas. Verifying the carrier blank would be the first procedure of the day. This was followed by a suite of S(small loop)\*1, S\*2, S\*3, S\*4, and L(large loop)\*1. If these areas looked reasonable based on the previous days results, a stripper blank was analyzed and then water sample analyses begun. A L\*1 standard was run every four to six samples, approximately hourly throughout the day to monitor drift in detector sensitivity.

# Results

Over two hundred and sixty Freon analysis runs were carried out during this cruise. A total of a hundred water samples were analyzed.

Data reduction was carried out using the Ocean Chemistry/NOGAP PC adapted computer program based on the Scripps computer program (Weiss). This program requires salinity and temperature for calculations; the former was taken from CTD cast data; and the latter was read from the sample bucket when the syringe was removed and attached to the extraction system. An area of 1 was entered if no area was integrated because the program would not accept zero values. (The program was altered upon return from sea and will now accept zero values) The Instrument detection limit while set at threshold 2, was found to be F11 x<0.032 (Pmol/Kg) and F12 x<0.046 (Pmol/Kg).

There are two weak points in the calculation procedure. The first is that the caliper readings may not be as consistent as desired, due to the variation of the curve of the glass syringe. Secondly, a slight variation of second aliquot results could be due to the temperature change as the sample warms up in the air; since the temperature used for calculation is that of the sample storage bucket.

After returning from sea many necessary improvements were made to the Freon data reduction program. These included such changes as:

1) accepting zero values instead of hanging the program;

2) notifying operator if a syringe serial number did not have a matching diameter on file rather than just defaulting to the first value in the file;

3) different calibration report depending on whether program in preview yes or preview no, changed so no report issued when in preview yes;

4) caliper initial and final headings corrected;

5) calibration curve plots now state which equation was used.

6) CREATE RUN entry was separated into eight different forms so that only the pertinent fields need be entered.

This is an informal data report only. Because of the nature of the Freon data reduction program, confirming recalculation of the results would be advisable before considering results for publication. The results presented in this report are in raw form with no sample handling or bottle blank corrections. Until a standard protocol has been decided upon, no corrections shall be applied to data report results.

## Station Data

### Station P16 - February 6, 1992

Calibration Curve, Percent Standard Error: F11 = 1.207; F12 = 0.667

|  |  |  |
| --- | --- | --- |
| **DEPTH** (M) | **F11** Pmol/Kg | **F12** Pmol/Kg |
| 49 | 4.571 | 2.090 |
| 49 | 4.547 | 2.035 |
| 196 | 2.011 | 0.910 |
| 196 | 1.961 | 0.910 |
| 496 | 0.659 | 0.298 |
| 496 | 0.635 | 0.266 |
| 803 | 0.188 | 0.074 |
| 803 | 0.161 | 0.108 |
| 1209 | 0.082 | <0.046 |
| 1203 | 0.070 | <0.046 |



### Station P20 - February 7, 1992

Calibration Curve, Percent Standard Error: F11 = 1.037; F12 = 0.471

|  |  |  |
| --- | --- | --- |
| **DEPTH** (M) | **F11** Pmol/Kg | **F12** Pmol/Kg |
| 20 | 4.602 | 2.104 |
| 51 | 4.705 | 2.116 |
| 101 | 4.765 | 2.159 |
| 152 | 4.220 | 1.887 |
| 202 | 3.398 | 1.559 |
| 304 | 2.075 | 0.970 |
| 508 | 0.752 | 0.329 |
| 815 | 0.280 | 0.108 |
| 1005 | 0.149 | <0.046 |
| 1206 | 0.081 | <0.046 |



### Station P26 - February 9,1992

Calibration Curve, Percent Standard Error: F11 = 4.065; F12 = 3.024

|  |  |  |
| --- | --- | --- |
| **DEPTH** (M) | **F11** Pmol/Kg | **F12** Pmol/Kg |
| 10 | 5.080 | 2.448 |
| 20 | 5.009 | 2.219 |
| 30 | 4.895 | 2.190 |
| 50 | 4.588 | 2.074 |
| 75 | 5.016 | 2.237 |
| 100 | 4.958 | 2.264 |
| 125 | 4.034 | 1.837 |
| 150 | 3.311 | 1.578 |
| 176 | 2.891 | 1.361 |
| 201 | 2.410 | 1.124 |
| 251 | 1.849 | 0.872 |
| 302 | 1.404 | 0.629 |
| 403 | 0.816 | 0.382 |
| 505 | 0.590 | 0.298 |
| 603 | 0.238 | 0.123 |
| 804 | 0.101 | 0.063 |
| 1006 | 0.041 | <0.046 |
| 1208 | 0.043 | <0.046 |
| 3043 | 0.143 | 0.221 |
| 4282 | 0.071 | 0.028 |

****

### Station P26 - February 10, 1992

Calibration Curve, Percent Standard Error: F11 = 0.620; F12 = 1.160

|  |  |  |
| --- | --- | --- |
| **DEPTH** (M) | **F11** Pmol/Kg | **F12** Pmol/Kg |
| 0 | 4.908 | 2.239 |
| 51 | 5.049 | 2.252 |
| 101 | 4.993 | 2.280 |
| 304 | 1.399 | 0.641 |
| 508 | 0.440 | 0.201 |
| 814 | 0.106 | 0.081 |
| 1202 | 0.032 | <0.046 |



## Tests

### Verification of Subsampling Techniques

Calibration Curve, Percent Standard Error: F11 = 2.723; F12 = 2.664

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Date GMT** | **STN** | **NISKIN** | **SYRINGE** | **DEPTH (M)** | **SALINITY** | **RUN #** | **F11 Pmol/Kg** | **F12 Pmol/Kg** |
| FEB 4 1992 | P04 | 7691 | 9828 | 50 | 32.242 | 62 | 4.414 | 2.033 |
| FEB 4 1992 | P04 | 7691 | 7636 | 50 | 32.242 | 63 | 4.507 | 2.022 |
| FEB 4 1992 | P04 | 7691 | 3 | 50 | 32.242 | 64 | 4.534 | 2.050 |
| FEB 4 1992 | P04 | 7691 | 5597 | 50 | 32.242 | 66 | 4.475 | 2.010 |
|  |  |  |  |  |  | MEAN | 4.482 | 2.029 |
|  |  |  |  |  |  | STD | 0.045 | 0.015 |
|  |  |  |  |  |  | %STD | 0.998 | 0.726 |

Calibration Curve, Percent Standard Error: F11 = 0.998; F12 = 1.343

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Date GMT** | **STN** | **NISKIN** | **SYRINGE** | **DEPTH (M)** | **SALINITY** | **RUN #** | **F11 Pmol/Kg** | **F12 Pmol/Kg** |
| FEB 5 1992 | P12 | 7691 | 9942 | 510 | 34.050 | 85 | 0.660 | 0.292 |
| FEB 5 1992 | P12 | 7691 | 100 | 510 | 34.050 | 86 | 0.675 | 0.267 |
| FEB 5 1992 | P12 | 7691 | 3 | 510 | 34.050 | 87 | 0.693 | 0.281 |
| FEB 5 1992 | P12 | 7691 | 5597 | 510 | 34.050 | 89 | 0.717 | 0.306 |
| FEB 5 1992 | P12 | 7691 | 9828 | 510 | 34.050 | 90 | 0.659 | 0.296 |
| FEB 5 1992 | P12 | 7691 | 7636 | 510 | 34.050 | 91 | 0.664 | 0.292 |
|  |  |  |  |  |  | MEAN | 0.678 | 0.289 |
|  |  |  |  |  |  | STD | 0.021 | 0.012 |
|  |  |  |  |  |  | %STD | 3.091 | 4.247 |

### Bottle Blanks

Only the Niskins used for deep water sampling were evaluated for bottle blanks. Accordingly, only those used for the 500, 800, 1000, and 1200 meter sampling were blank tested.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **DATE** | **STN** | **SAMPLE** | **NISKIN** | **SYRINGE** | **DEPTH** | **SALINITY** | **RUN #** | **F11 Pmol/Kg** | **F12 Pmol/Kg** |
| FEB 9 1992 | P26B | 133 | 8575 | 28 | 1200 | 34.451 | 208 | 0.059 | 0.000 |
| FEB 9 1992 | P26B | 133 | 8575 | 27 | 1200 | 34.451 | 209 | 0.054 | 0.000 |
| FEB 9 1992 | P26B | 132 | 7683 | 5 | 1200 | 34.451 | 210 | 0.038 | 0.000 |
| FEB 9 1992 | P26B | 132 | 7683 | 16 | 1200 | 34.451 | 211 | 0.049 | 0.000 |
| FEB 9 1992 | P26B | 132 | 7683 | 26 | 1200 | 34.451 | 212 | 0.059 | 0.000 |
| FEB 9 1992 | P26B | 130 | 8573 | 100 | 1200 | 34.447 | 214 | 0.057 | 0.102 |
| FEB 9 1992 | P26B | 130 | 8573 | 13 | 1200 | 34.447 | 215 | 0.050 | 0.000 |
| FEB 9 1992 | P26B | 130 | 8573 | 9830 | 1200 | 34.447 | 216 | 0.050 | 0.056 |
| FEB 9 1992 | P26B | 129 | 8581 | 7636 | 1200 | 34.444 | 218 | 0.032 | 0.000 |
| FEB 9 1992 | P26B | 129 | 8581 | 5597 | 1200 | 34.444 | 219 | 0.044 | 0.046 |
| FEB 9 1992 | P26B | 129 | 8581 | 25 | 1200 | 34.444 | 220 | 0.034 | 0.000 |
|  |  |  |  |  |  |  | Mean | 0.048 | 0.019 |
|  |  |  |  |  |  |  | STD | 0.009 |  |

### Precision Test

The samples for the precision test were taken from the "mixed layer". Three syringes were drawn from each of three Niskins.

Calibration Curve, Percent Standard Error: F11 = 1.667; F12 = 0.387

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **DATE GMT** | **STN** | **SAMPLE** | **NISKIN** | **SYRINGE** | **DEPTH (M)** | **SALINITY** | **RUN #** | **F11 Pmol/Kg** | **F12 Pmol/Kg** |
| FEB 12 1992 | J5 | 164 | 8581 | 7636 | 45 | 32.301 | 243 | 4.741 | 2.221 |
| FEB 12 1992 | J5 | 164 | 8581 | 5 | 45 | 32.301 | 244 | 4.597 | 2.085 |
| FEB 12 1992 | J5 | 164 | 8581 | 27 | 45 | 32.301 | 246 | 4.687 | 2.117 |
| FEB 12 1992 | J5 | 165 | 8573 | 16 | 50 | 32.301 | 247 | 4.558 | 2.081 |
| FEB 12 1992 | J5 | 165 | 8573 | 26 | 50 | 32.301 | 248 | 4.593 | 2.073 |
| FEB 12 1992 | J5 | 165 | 8573 | 9830 | 50 | 32.301 | 249 | 4.639 | 2.095 |
| FEB 12 1992 | J5 | 166 | 8575 | 7636 | 55 | 32.307 | 252 | 4.571 | 2.096 |
| FEB 12 1992 | J5 | 166 | 8575 | 13 | 55 | 32.307 | 254 | 4.613 | 2.103 |
| FEB 12 1992 | J5 | 166 | 8575 | 5597 | 55 | 32.307 | 255 | 4.720 | 2.126 |
|  |  |  |  |  |  |  | MEAN | 4.635 | 2.111 |
|  |  |  |  |  |  |  | STD | 0.062 | 0.042 |
|  |  |  |  |  |  |  | %STD | 1.34 | 1.99 |

### Precision by Pooled Standard deviation of Duplicates

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **F11 X** Pmol/Kg | **F11 Y** Pmol/Kg | **F11 X-Y** Pmol/Kg | **F12 X** Pmol/Kg | **F12 Y** Pmol/Kg | **F12 X-Y** Pmol/Kg |
| 4.571 | 4.547 | 0.024 | 2.090 | 2.035 | 0.055 |
| 2.011 | 1.961 | 0.050 | 0.910 | 0.910 | 0.000 |
| 0.659 | 0.635 | 0.024 | 0.298 | 0.266 | 0.032 |
| 0.188 | 0.161 | 0.027 | 0.074 | 0.108 | -0.034 |
| 0.082 | 0.070 | 0.012 |  |  |  |



Using the above equation to calculate the precision by the pooled standard deviation of duplicates the results were as follows.

**F11** For the range 0.070 - 4.571 Pmol/Kg, the pooled standard deviation for duplicates was 0.075 Pmol/kg.

**F12** For the range 0.074 - 2.090 Pmol/Kg; the pooled standard deviation for duplicates was 0.072 Pmol/Kg.

### GC Integration Test

These samples were analyzed to substantiate the change to the GC integrator program which involved setting the threshold to 1 in order to integrate smaller peaks. This was done Feb 12 1992; at Station J5; with Sample 167; Niskin 7683; from a Depth of 1000m; with a Salinity of 34.355

Calibration Curve, Percent Standard Error: F11 = 1.667; F12 = 0.387

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **SYRINGE** | **RUN #** | **F11 Area** | **F11 Pmol/Kg** | **F12 Area** | **F12 Pmol/Kg** |
| 28 | 260 | 4857 | 0.036 | 1887 | 0.044 |
| 24 | 261 | 5968 | 0.052 | 1588 | 0.037 |
| 108 | 262 | 6163 | 0.053 | 1101 | 0.025 |
| 2 | 263 | 5759 | 0.047 | 1582 | 0.036 |
| 25 | 264 | 6433 | 0.058 | 931 | 0.021 |
|  |  | MEAN | 0.049 | MEAN | 0.033 |
|  |  | STD | 0.007 | STD | 0.008 |

### Restrips of water samples

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **STN** | **SAMPLE RUN #** | **RESTRIP RUN #** | **SAMPLE F11 Pmol/Kg** | **RESTRIP F11 Pmol/Kg** | **CARRYOVER F11 %** | **SAMPLE F12 Pmol/Kg** | **RESTRIP F12 Pmol/Kg** | **CARRYOVER F12 %** |
| P04 | 54 | 55 | 4.269 | 0.035 | 0.82 | 2.063 | 0.018 | 0.87 |
| P04 | 66 | 67 | 4.475 | 0.036 | 0.80 | 2.010 | 0.025 | 1.24 |
| P04 | 68 | 69 | 4.858 | 0.028 | 0.58 | 2.075 | 0.016 | 0.77 |
| P12 | 91 | 92 | 0.664 | 0.000 | 0.00 | 0.292 | 0.000 | 0.00 |
| P16 | 112 | 113 | 0.141 | 0.000 | 0.00 | 0.023 | 0.000 | 0.00 |
| P20 | 139 | 140 | 0.752 | 0.037 | 4.92 | 0.329 | 0.000 | 0.00 |
| J5 | 255 | 256 | 4.720 | 0.014 | 0.30 | 2.129 | 0.011 | 0.52 |
| J5 | 264 | 265 | 0.043 | 0.000 | 0.00 | 0.022 | 0.000 | 0.00 |

The above table demonstrates the high stripper efficiency of the Freon analysis system on this cruise.

### Samples stored overnight (Station P12 510m Multiple syringes)

Calibration Curve for Feb 5, Percent Standard Error: F11 = 0.999; F12 = 1.343

Calibration Curve for Feb 6, Percent Standard Error: F11 = 1.206; F12 = 0.668

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Syringe** | **F11 Feb 5** | **F11 Feb 6** | **% Change** | **F12 Feb 5** | **F12 Feb 6** | **% Change** |
| 28 | 0.779 | 0.681 | -12 | 0.340 | 0.430 | +26 |
| 5597 | 0.717 | 0.664 | -7 | 0.306 | 0.258 | -15 |
| 9828 | 0.659 | 1.085 | +65 | 0.296 | 2.565 | +761 |
| 7636 | 0.664 | 0.648 | -2 | 0.292 | 0.250 | -14 |
| 26 | 4.247 | 4.127 | -2.8 | 1.974 | 1.927 | -2.4 |

The bucket of samples was kept in the lab sink with a continual overflow of seawater from the seawater loop manifold. Only one syringe seemed to pick up significant Freon overnight. However these results also point out the necessity of analyzing low level samples first since they are subject to the greatest percent change.

## Air

### Freon Levels of Outside Air

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **DATE** | **STN** | **RUN TIME** | **RUN #** | **SAMPLE** | **F11 ppt** | **F12 ppt** |
| FEB 5 1992 | P04 | 0023 | 70 | SAMPLING DECK AIR | 271.75 | 543.04 |
| FEB 5 1992 | P12 | 2243 | 83 | SAMPLING DECK AIR | 274.19 | 523.58 |
| FEB 7 1992 | P16 | 0021 | 125 | SAMPLING DECK AIR | 286.94 | 509.06 |
| FEB 7 1992 | P16 | 0032 | 126 | HELI DECK AIR | 283.09 | 517.39 |
| FEB 7 1992 | P20 | 2213 | 138 | SAMPLING DECK AIR | 288.51 | 539.79 |
| FEB 8 1992 | P20 | 0216 | 153 | HELI DECK AIR | 268.91 | 506.46 |
| FEB 8 1992 | P20 | 0239 | 155 | HELI DECK AIR | 288.51 | 556.99 |
| FEB 10 1992 | P20 | 0347 | 222 | SAMPLING DECK AIR | 254.68 | 499.77 |
| FEB 12 1992 | J5 | 2149 | 240 | HELI DECK | 259.46 | 520.63 |
| FEB 12 1992 | J5 | 2200 | 241 | SAMPLING DECK | 279.81 | 509.23 |

### Freon Levels of Lab Air

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **DATE** | **STN** | **RUN TIME** | **RUN #** | **SAMPLE** | **F11 ppt** | **F12 ppt** |
| FEB 4 1992 | P04 | 1827 | 49 | LAB AIR | 328.61 | 740.86 |
| FEB 7 1992 | P16 | 0047 | 127 | LAB AIR | 372.61 | 1477.84 |
| FEB 8 1992 | P20 | 0251 | 156 | LAB AIR | 356.40 | 1467.20 |
| FEB 12 1992 | J5 | 2137 | 239 | LAB AIR | 470.71 | 2421.72 |

# Discussion

## Comparison of earlier data

A summary of results from Station Papa over several years and their comparison plots from December 1980, August and November 1985, and February 1992 are shown on the following pages. These data are from Gammon (1992), Schwarz (1988) and the data presented in this COCC 9201 Cruise report.

### Cruise OC-85-OS-02 - Station P26

|  |  |  |  |
| --- | --- | --- | --- |
|  | **DEPTH (m)** | **F11 Pmol/Kg** | **F12 Pmol/Kg** |
| AUG 17 1985 | 0 | 2.84 | 1.23 |
|  | 50 | 4.03 | 1.65 |
|  | 100 | 4.48 | 1.76 |
|  | 200 | 2.08 | 0.80 |
|  | 400 | 0.63 | 0.19 |
|  | 993 | 0.23 | 0.10 |
|  | 1489 | 0.19 | 0.06 |
|  | 1985 | 0.14 | 0.05 |
|  | 2482 | 0.12 | 0.16 |
| AUG 18 1985 | 0 | 2.96 | 1.33 |
|  | 20 | 3.34 | 1.52 |
|  | 40 | 3.99 | 1.75 |
|  | 60 | 4.05 | 1.81 |
|  | 80 | 4.40 | 1.87 |
|  | 100 | 4.26 | 2.03 |
|  | 120 | 3.31 | 1.45 |
|  | 140 | 2.74 | 1.38 |
|  | 160 | 2.08 | 0.93 |
|  | 180 | 1.73 | 0.79 |
|  | 200 | 1.53 | 0.67 |
| AUG 19 1985 | 0 | 2.91 | 1.17 |
|  | 10 | 3.12 | 1.27 |
|  | 50 | 3.94 | 1.63 |
|  | 100 | 4.24 | 1.71 |
|  | 150 | 2.43 | 0.87 |
|  | 200 | 1.67 | 0.59 |
|  | 250 | 1.35 | 0.99 |
|  | 400 | 0.61 | 0.27 |
|  | 500 | 0.38 | 0.12 |
|  | 600 | 0.35 | 0.14 |
|  | 800 | 0.35 | 0.12 |
|  | 990 | 0.28 | 0.11 |
|  | 1000 | 0.37 | 0.17 |

### Cruise OC-85-OS-03 - Station P26

|  |  |  |  |
| --- | --- | --- | --- |
|  | **DEPTH**  **(m)** | **F11**  **Pmol/Kg** | **F12**  **Pmol/Kg** |
| NOV 6 1985 | 0 | 3.40 | 1.50 |
|  | 10 | 3.35 | 1.52 |
|  | 20 | 3.52 | 1.56 |
|  | 40 | 3.31 | 1.52 |
|  | 61 | 3.88 | 1.70 |
|  | 81 | 4.16 | 1.83 |
|  | 101 | 4.40 | 1.88 |
|  | 202 | 2.04 | 0.87 |
|  | 303 | 1.05 | 0.44 |
|  | 403 | 0.44 | 0.19 |
|  | 504 | 0.21 | 0.10 |
|  | 604 | 0.20 | 0.06 |
| NOV 7 1985 | 0 | 3.40 | 1.60 |
|  | 49 | 3.34 | 1.67 |
|  | 98 | 3.98 | 2.03 |
|  | 117 | 3.97 | 1.95 |
|  | 147 | 3.03 | 1.52 |
|  | 197 | 2.10 | 1.07 |
|  | 247 | 1.37 | 0.76 |
|  | 297 | 1.10 | 1.31 |
|  | 347 | 0.59 | 0.36 |
|  | 398 | 0.41 | 0.29 |
|  | 498 | 0.21 | 0.16 |
|  | 598 | 0.17 | 0.17 |
|  | 794 | 0.00 | 0.14 |
|  | 982 | 0.00 | 0.06 |
| NOV 8 1985 | 0 | 3.72 | 1.60 |
|  | 40 | 3.41 | 1.67 |
|  | 50 | 3.33 | 1.57 |
|  | 60 | 3.55 | 1.63 |
|  | 70 | 4.55 | 1.96 |
|  | 75 | 4.25 | 1.83 |
|  | 80 | 4.33 | 1.92 |
|  | 90 | 4.29 | 1.94 |
|  | 100 | 4.33 | 1.99 |
|  | 110 | 4.33 | 1.87 |
|  | 130 | 3.37 | 1.56 |
|  | 150 | 2.75 | 1.31 |

### Gammon 1980

Gammon's Freon results were given in Pmol/L.(Gammon et al 1982). An average density of 1.023, calculated using an analysis temperature of 20 degree C and salinity of 33, was used to convert to Pmol/Kg for comparison to more recent data.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Depth (m)** | **F12 Pmol/l** | **F12 Pmol/l** | **F11 Pmol/Kg** | **F12**  **Pmol/Kg** |
| CAST #41 | 19.00 | 2.77 | 1.25 | 2.71 | 1.22 |
| 50.14N | 19.00 | 2.76 | 1.28 | 2.70 | 1.25 |
| 140.15W | 41.00 | 2.87 | 1.41 | 2.80 | 1.38 |
|  | 41.00 | 2.56 | 1.18 | 2.50 | 1.15 |
|  | 82.00 | 3.25 | 1.22 | 3.18 | 1.19 |
|  | 82.00 | 3.21 |  | 3.14 |  |
|  | 99.00 | 3.49 | 1.35 | 3.41 | 1.32 |
|  | 99.00 | 3.27 | 1.35 | 3.20 | 1.32 |
|  | 149.00 | 2.16 | 0.92 | 2.11 | 0.90 |
|  | 149.00 | 2.17 | 0.89 | 2.12 | 0.87 |
|  | 198.00 | 1.16 | 0.44 | 1.13 | 0.43 |
|  | 198.00 | 1.28 | 0.49 | 1.25 | 0.48 |
|  | 301.00 | 0.69 | 0.26 | 0.67 | 0.25 |
|  | 301.00 | 0.66 | 0.23 | 0.65 | 0.22 |
|  | 396.00 | 0.40 | 0.13 | 0.39 | 0.13 |
|  | 396.00 | 0.37 | 0.14 | 0.36 | 0.14 |
|  | 601.00 | 0.06 |  | 0.06 |  |
|  | 601.00 | 0.05 |  | 0.05 |  |
|  | 798.00 | 0.08 |  | 0.08 |  |
|  | 798.00 | 0.13 |  | 0.13 |  |
|  | 1004.00 | 0.04 |  | 0.04 |  |
|  | 1004.00 | 0.08 |  | 0.08 |  |
| CAST #50 | 20.00 | 3.06 | 1.30 | 2.99 | 1.27 |
| 50.09N | 20.00 | 3.06 | 1.28 | 2.99 | 1.25 |
| 140.19W | 40.00 | 2.72 | 1.21 | 2.66 | 1.18 |
|  | 40.00 | 3.02 | 1.23 | 2.95 | 1.20 |
|  | 80.00 | 2.92 | 1.28 | 2.85 | 1.25 |
|  | 80.00 | 3.27 | 1.30 | 3.20 | 1.27 |
|  | 100.00 | 2.77 | 1.26 | 2.71 | 1.23 |
|  | 100.00 | 3.06 | 1.24 | 2.99 | 1.21 |
|  | 125.00 | 2.28 | 1.01 | 2.23 | 0.99 |
|  | 125.00 | 2.22 | 1.01 | 2.17 | 0.99 |
|  | 173.00 | 1.26 | 0.53 | 1.23 | 0.52 |
|  | 173.00 | 1.27 | 0.62 | 1.24 | 0.61 |
|  | 227.00 | 0.86 | 0.42 | 0.84 | 0.41 |
|  | 227.00 | 0.85 | 0.35 | 0.83 | 0.34 |
|  | 299.00 | 0.52 | 0.25 | 0.51 | 0.24 |
|  | 299.00 | 0.54 | 0.22 | 0.53 | 0.22 |
|  | 401.00 | 0.26 | 0.16 | 0.25 | 0.16 |
|  | 401.00 | 0.28 | 0.17 | 0.27 | 0.17 |
|  | 600.00 | 0.08 | 0.02 | 0.08 | 0.02 |
|  | 600.00 | 0.10 |  | 0.10 |  |
|  | 804.00 | 0.05 | 0.02 | 0.05 | 0.02 |
|  | 804.00 | 0.13 |  | 0.13 |  |

### Comparison of F11 at Station Papa over time



### Comparison of F12 at Station Papa over time



# Conclusions

During the February 1992 COCC cruise the new Climate Chemistry Freon system was successfully tested and samples analyzed.

# Recommendations

As stated previously no particular precautions, other than storing the Niskin bottles on deck, were employed to reduce the Freon levels of the Niskin bottles. If it is considered important to lower our deep water results and blanks, an attempt to treat the Niskins as described by Bullister and Weiss (1987) should be made. This requires replacing the elastic tubing with epoxy coated stainless steel springs, baking the O-rings for several days and then storing them in a gas tight container until installed on the bottles at sea.

# References

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