NASA TM-83290

NASA Technical Memorandum 83290

NASA-TM-83290 19820015738

ANALYSIS OF OCEAN COLOR SCANNER DATA FROM THE SUPERFLUX III EXPERIMENT

Craig W. Ohlhorst

March 1982

National Aeronautics and
Space Administration

Langley Research Center
Hampton, Virginia 23665

SUMMARY

The Ocean Color Scanner collected data on October 15, 20, and 22, 1980, during the Superflux III Experiment. Single-channel gray-scale data products generated 5 minutes after the scanner were collected and showed details of the Chesapeake plume structure, suggesting that this quick-look capability could have potential use for experiments in real time. The Chesapeake Bay plume extended offshore about 5 nautical miles on October 15, and 7 nautical miles on October 20.

Using the October 15, 1980, data, a correlation coefficient of r = 0.889 was obtained between chlorophyll a and the ratio of band 7 (664-684 nanometers) to band 9 (746-766 nanometers). This ratio was then used to calculate the average surface chlorophyll a concentration of the water flowing out of the Chesapeake Bay. A ratio from the Ocean Color Scanner bands was created to simulate the ratio that the Multichannel Ocean Color Sensor uses to calculate chlorophyll a concentrations. Using the October 15, 1980, data set, this ratio had a correlation coefficient of r = -0.739 with the log of the chlorophyll a concentration. No correlation was found between the log of chlorophyll a and the ratio of band 2 minus band 4 to band 2 plus band 4 of the Ocean Color Scanner. No correlation was found between the Ocean Color Scanner data and total suspended solid measurements made on October 15, 1980.

On October 20, 1980, only chlorophyll samples were collected. No correlation was found between the Ocean Color Scanner data and chlorophyll a measurements.

INTRODUCTION

In order to assess the possibility of relating high altitude remotely sensed spectral signatures to Chesapeake Bay plume features, an Ocean Color Scanner (OCS) was flown at an altitude of 12.5 kilometers (41 000 feet) during the Superflux III Experiment on October 15, 20, and 22, 1980.

The OCS is a 10-band instrument covering the spectral range of 418 to 804 nanometers. Each channel has bandwith of 20 nanometers. The instantaneous field-of-view at nadir is 60 meters at the 12.5-kilometer altitude. The center wavelengths for the 10 bands are listed in Table 1. An integral part of the OCS system is a set of instruments that allows for real-time transmission of a single channel of scanner data. The image can be generated 5 minutes after the data are collected, given investigators a real-time look at the data. A film recorder is used to create the singe-channel image. The recorded image is a gray-scale film product with the shades of gray corresponding to the backscattered light intensity levels recorded in a particular channel. The single-channel images can be used to qualitatively indicate the location and distribution of suspended particulate matter.

EXPERIMENT

The OCS was flown on October 15, 20, and 22, 1980. There were six flight lines flown on October 15 (see fig. 1). Flight line 4 was flown twice, once in a southeast direction (line 4) and later, in a northwest direction (line 6). The arrows on the flight lines in figure 1 indicate the direction in which the aircraft flew, while the times listed are the start times of each flight line. The tide times shown in figure 1 are for the Chesapeake entrance for October 15. A comparison of the flight times with the tide schedule indicates that the overflights bracketed slack after ebbtide, which met one objective of the experiment (i.e., to view maximum plume expansion). The beginning and ending flight line coordinates, the starting times, aircraft heading, Sun azimuth, and Sun elevation are listed in Table II.

On the 15th, five boats participated in sea-truth collection; 18 data sets were collected. Five stations were sampled at the time of the first and third flight lines. Four stations were sampled during flight line 5. One station was sampled during flight line 6, and three stations were sampled about a half hour after the last flight ended. The positions of the 18 stations are shown in figure 2. Only 17 stations are shown since Station J was sampled at two different times. The time of each station collection and the boat position coordinates are listed in Table III. On this day, the winds were out of the southwest at 10 knots.

On October 20, 1980, the OCS flew three flight lines, as shown in figure 3. The arrows indicate the direction the aircraft flew while the times represent the start time for each line. The October 20 tide times at the Chesapeake entrance are also shown in figure 3. The flight line times bracket the maximum ebbtide time. The beginning and ending flight line coordinates, the start time, aircraft heading, Sun azimuths and Sun elevation are listed in Table IV. Strong winds from the northwest of about 18 knots kept all the sea-truth collecting boats inshore, except the Kelez which collected seven sea-truth data points under flight line 1. The stations are located as shown in figure 4. The times and location coordinates of the stations are given in Table V.

The OCS flew a third mission on October 22. The purpose of this mission was to fly at the same time as the Multichannel Ocean Color Sensor being flown on a P-3 aircraft at a lower altitude. Two parallel flight lines were flown (fig. 5). The first covered an area from the mouth of the Chesapeake Bay to as far west as 74°40' west longitude. The second flight was flown 180° to and about 3 nautical miles north of the first line. (See table VI).

DATA ANALYSIS

The single-channel gray scale data products generated did show details of the Chesapeake Bay plume structure. Analysis of the multispectral scanner data requires: (1) preprocessing of the digital data, and (2) correlation of digital data with sea-truth data. One of the preprocess steps is a scan angle correction. The OCS has a scan angle of $\pm 45°$. As the angle increases, the distance from the scanner to the water surface element being viewed increases and increasingly greater amounts of Sun and sky radiation scattered by the atmosphere reach the scanner and contribute to the total radiation sensed. At the same time, the longer pathlength results in increased atmospheric attenuation of the radiation originating from the water. The scan angle correction normalizes the radiance at non-zero scan angles to that at nadir. For this work, the correction is made empirically. Figure 6 shows the shape of a typical algorithm used to correct the digitized data. The correction differs from channel to channel and can also differ in the same channel from flight line to flight line.

After the scan angle correction was applied, false color images were generated from band 7 (664-684 nanometers) of the October 15 and 20 digitized data. Black and white copies of the color originals are shown in figures 7, 8, and 9. Figure 7 is a mosaic of flight lines 2, 3, and 4 collected on October 15. On this day, the winds were from the southwest at 10 knots and the scanner data were collected around slack after ebbtide. The radiance color code is shown under the 9:34 EST flight line. The shade of gray on the left represents the lowest radiance levels while those on the right represent the highest radiance levels. So within the bay, the chalk color represents a body of water with a lower radiance level than the surrounding dark gray color water. Areas with lighter shades of gray within the dark gray body of water represent radiance levels that are higher than the surrounding dark gray. A variety of features can be pointed out. There is a lower radiance level body of water that extends from the mouth of the York River to a line roughly parallel with the mouth of the Hampton Roads. From the Hampton Roads mouth to the mouth of the Chesapeake Bay, the water radiance level is higher, as indicated by the dark shade of gray color. Still higher radiance levels are seen hugging the coast around both Cape Henry and Cape Charles. Off Virginia Beach, the water has a high radiance level. If it is assumed that the dark gray color water mass extending out of the bay mouth represents the Chesapeake plume, then the plume extended about 5 nautical miles offshore.

On the 15th, flight lines 1, 3, and 5 covered the mouth of the bay. Figure 8 shows the three lines. This figure gives a short time history of the water movement around the Bay mouth. The gray scale is the same as in figure 7. If the three flight lines are viewed in their time sequence, then the chalk colored water mass is seen to move south. The dark gray water mass also seems to move southeast out of the bay. These flight lines have not been normalized for Sun angle differences so the apparent movement of the dark gray water mass out of the Bay may be due, in part, to an increase in water radiance caused by an increase in Sun elevation.

Figure 9 presents a mosaic of flight lines 1 and 3 that was taken on October 20. On this day, the winds were out of the northwest at about 18 knots. The scanner data were collected around ebbtide. The gray scale color code is shown under the 12:10 EST flight line. A definite plume is seen coming out around Cape Henry flowing south. It extends farther south than the October 15 plume. There is a second outflow from the middle of the Bay mouth. There also seems to be a third outflow around Cape Charles. Water in both the Thimble Shoal Channel and the Chesapeake Channel has a lower radiance than the surrounding water. The Chesapeake plume seems to extend about 7 nautical miles offshore which is farther than it was on October 15.

October 15, 1980 Chlorophyll Analysis

Stations 804, 807, and 811 were not used in the analysis since they were collected about a half hour after the last flight line was completed. After correcting the digital scanner data for geometric distortion, the 15 sea-truth stations were located in the digital data. The digital data were smoothed by averaging four columns and four lines of data. This was done as an attempt to smooth out some of the instrument noise. Since radiance conversion values were not available, raw counts were used in the data analysis. Band 6 (622-642 nm) and band 10 (784-804 nm) were left out of the analysis since the data in those bands were mostly noise. Table VII lists the radiance count values for the eight remaining bands for all 15 data stations. Chlorophyll a values for the stations are listed in Table VIII.

Linear step-wise regression analysis was performed on all individual bands and all possible band ratio combinations with chlorophyll a measurements. The highest correlation between an individual band and chlorophyll a concentration was r = 0.544, for band 2. Of the ratios, bands 5 to 9 had the best correlation with chlorophyll a (r =0.669). Neither correlation coefficient was sufficient to suggest a significant correlation between chlorophyll a and the data collected.

The ground stations were grouped by boat and the residual values were added in absolute terms for each group. The sum was then divided by the number of stations within a group to give an average. The values from the Kelez had the largest average deviation. It was decided to try the regression analysis leaving out the four Kelez stations. None of the eight individual bands had a significant correlation with chlorophyll a using this new data set. When the band ratios were regressed against chlorophyll a, the ratio of band 7 (664-684 nm) to band 9 (746-766 nm) had a correlation coefficient of r = 0.899. The equation generated had an F-ratio of 38.1. The equation was

$$\text{Chl } \underline{a} \ (\text{mg/m}^3) = -65.251 + 59.580 \left(\frac{\text{band } 7}{\text{band } 9}\right). \qquad (1)$$

The standard error was 1.59 mg/m^3 and the root mean square error was 1.44 mg/m^3.

Four other data sets were then created by dropping out the other groups of boat stations one at a time from the total data set. Linear step-wise regression was performed using these new data sets. No statistically significant equations were generated in the linear regression analysis of these four data sets. Figure 10 shows a plot of the ratio of band 7 to band 9 versus chlorophyll a. All 15 data points are plotted. The regression line shown is that generated from the eleven point data set that had the four Kelez stations left out. The four Kelez stations are all bunched at the far left of the figure scattered around the regression line. Inclusion of those four stations would push the regression line to a more horizontal position since stations 808 and 809 are so far above the regression line. A closer look at this figure shows a clustering of data collected by some of the individual boats. The four Kelez stations (808, 809, 821, 810) are clustered in the left of the plot.

The three Holton stations (69, 802, 803) are clustered in the center. The three John Smith stations (805, 70, 806) are clustered in the center, upper right hand portion of the plot. This clustering could be an indication of differences in data sampling or could also mean that in the area of the experiment, there was more than one water type. One possible reason for the fact that the correlation improved when the Kelez stations were dropped out is that the Kelez seemed to be out of the Chesapeake plume, and so the spectral water characteristic of those four stations might have been different from that of the other stations.

Equation (1) was used to quantify the scanner data in flight lines 1, 3, and 5. The area that was quantified was from the mouth of the bay to just past the John Smith boat stations (805, 70, 806). The end product of this quantification was an average chlorophyll a value and a standard deviation for each flight line. The values are listed below:

Flight Line	Chlorophyll a mg/m^3	Standard Deviation
1	7.3	2.8
3	6.0	2.7
5	4.0	2.1

The chlorophyll a concentrations decrease from flight line 1 to 5. The center of flight line 3 was 4.6 km northeast of flight line 1 and flight line 5 was 4.6 km northeast of flight line 3. So each succeeding flight line was farther out in the ocean where the chlorophyll levels were lower. Thus, the average concentration decreased.

Multichannel Ocean Color Sensor Simulation with October 15, 1980, Chlorophyll Data

One objective in this experiment was to see whether the ratio used by the Multichannel Ocean Color Sensor (MOCS) to quantify chlorophyll a could be used by the OCS instrument to calculate chlorophyll a values. Bandwidths and band center wavelengths are not identical between instruments so the ratio cannot be exactly duplicated (see table IX for the MOCS bands). For this analysis, the MOCS ratio of band 7 squared divided by the product of band 6 and band 8 was simulated with the ratio of OCS band 3 squared divided by the product of band 2 and band 4. The linear regression analysis correlation coefficient was r = -0.626 between the ratio and chlorophyll a measurements. A higher correlation coefficient of r = -0.739 was calculated using logarithmic regression analysis. Neither correlation coefficient value was sufficiently high to suggest a strong correlation between the simulated MOCS ratio and chlorophyll a. Besides the bonds not being identical, a second possible cause for the poor correlation is the affect of the atmosphere on the spectral data. The OCS has a larger atmospheric component since it was collected at 12.5 km compared to the MOCS data being collected at 2.3 km.

Goddard OCS Ratio Simulated

In reference 1, it was shown that an equation of the form

$$C = ae^{bR}$$

could be used to quantify chlorophyll a concentrations using an OCS flown at 19.8 km (65 000 ft) with

C = chlorophyll a concentration

a, b = are coefficients, and

R = ratio $\frac{\text{band 2} - \text{band 4}}{\text{band 2} + \text{band 4}}$,

The ratio was generated for the eleven point (Kelez left out) October 15, 1980, data set and logarithmic least squares regression analysis was tried. No statistically significant equation was generated. The correlation value was $r = -0.147$. The data used in reference 1 were collected in clean ocean water with negligible amounts of background suspended inorganic material. Coastal water containing both inorganic suspended material and chlorophyll was studied in Superflux III. The spectral characteristics of coastal and open ocean water are different, so it was not surprising that the model used in reference 1 was not applicable to this data set.

October 15, 1980 Scanner - Total Suspended Sediment Regression Analysis

The same kind of regression analysis techniques were used between the suspended sediment sea-truth measurements and the remote-sensing measurements as had been used on the chlorophyll measurement set. Suspended sediment samples were not collected at stations J and J-1 so there was a maximum of 13 data stations. When all stations were regressed against individual bands, the highest correlation coefficient was $r = -0.140$ (band 2). When band ratios were linearly regressed against Total Suspended Solids (TSS) the best correlation was $r = 0.447$ $(\frac{7}{9})$. The four Kelez stations were dropped from the data set, and this time the highest correlation that was found with individual bands was $r = -0.712$ (band 2) and with ratios the highest, r value was $r = 0.725$ $(\frac{5}{9})$.

To simulate a MOCS algorithm for calculating suspended solids concentrations, the ratio of

$$\frac{(\text{band 4})^2}{\text{band 3} \times \text{band 5}}$$

was generated from the OCS. This ratio was both linearly and logarithmically regressed against TSS measurements. The highest r value calculated from either technique was r = 0.147. So on October 15, 1980, the OCS data did not show any statistically significant correlation with surface total suspended solids concentrations.

Analysis of Data Collected on October 20, 1980

Only the Kelez was able to collect sea-truth samples due to the strong wind conditions that existed that day. The Kelez stopped and collected chlorophyll samples seven times along the nadir of flight line 1. Total suspended solids samples were not collected. Table X gives the chlorophyll a measurements for the seven stations. On this mission, all 10 bands of the scanner worked. The scanner count data for the seven stations are listed in table XI. Linear step-wise regression analysis was performed using all individual band values and all possible individual band ratio combinations. The single band that had the highest correlation with chlorophyll a was band 1. Its r value was r = 0.754. The ratio that had the highest correlation with chlorophyll was band 7 to band 8. The correlation coefficient values were r = -0.757. It was concluded after studying the F-ratio, the root mean square errors, and taking into account that the spread in chlorophyll concentrations was only 2 mg/m^3, neither of the equations had a meaningful correlation with chlorophyll a. In this data set, the ratio of band 7 to band 9 had a correlation coefficient of r = -0.363 with chlorophyll a.

The ratio of

$$\frac{(\text{band } 3)^2}{\text{band } 2 \times \text{band } 4}$$

was both linearly and logarithmically regressed against chlorophyll a. There was no correlation between the ratio and chlorophyll a for either analysis. The r value was -0.033 when linearly regressed and r = -0.054 when logarithmically regressed. In sum, there was no meaningful correlation of remote sensing data with chlorophyll a measurements on the 20th of October.

CONCLUSIONS

Using all 15 of the data stations collected during OCS overflights on October 15, 1980, no significant correlations were found when either individual band radiance values or band ratios were linearly regressed with either chlorophyll a measurements or TSS measurements. When the four Kelez data stations were dropped from the data set a significant correlation coefficient of r = 0.889 was obtained between chlorophyll a and the ratio of band 7 to band 9. This improvement in the correlation is thought to arise from the observation that the Kelez stations are located out of the Chesapeake plume and so the spectral water characteristics of those four stations might be different.

The ratio that was created to simulate the Multichannel Ocean Color Sensor algorithm used to calculate chlorophyll a concentrations had a correlation coefficient of r = -0.739 with the chlorophyll a data set of eleven points (four Kelez stations left out) collected on October 15, 1980. The correlation was not significant enough to suggest that the OCS simulated MOCS algorithm could be used to calculate chlorophyll values

No correlation was found between the log of the chlorophyll a value and the ratio of band 2 minus band 4 to band 2 plus band 4.

On October 20, 1980, no correlation was found between the OCS radiance data and chlorophyll a measurements.

REFERENCES

1. Kim, H. H.; McClain, C. R.; Blaine, L. R.; Hart, W. P.; Atkinson, L. P., and Yoder, J. A.: Ocean Chlorophyll Studies from a U-2 Aircraft Platform. NASA TM 80574, August 1979.

TABLE I. - OCEAN COLOR SCANNER INFORMATION

Flight Altitude 12.5 km (41000 feet)

Bands	Center Wavelength
1	428 nm
2	466
3	508
4	549
5	592
6	632
7	674
8	714
9	756
10	794

Bandwidth 20 nm Ground Resolution 60 m, (197 feet)

TABLE II. - OCTOBER 15, 1980 FLIGHT DATA

Flight Line	Coordinates Begin	Coordinates End	Start Time EST	Aircraft Heading	Sun Azimuth	Sun Elevation
1	$36^{\circ}45.1'N \times 75^{\circ}51.3'W$	$37^{\circ}21.2'N \times 76^{\circ}21.9'W$	9:19	323.9°	132°	30°
2	$37^{\circ}18.5'N \times 76^{\circ}29.2'$	$36^{\circ}47.0' \times 76^{\circ}03.3'$	9:34	146.5°	135°	32°
3	$36^{\circ}36.2' \times 75^{\circ}39.5'$	$37^{\circ}23.6' \times 76^{\circ}21.1'$	9:50	325.5°	140°	35°
4	$37^{\circ}14.8' \times 75^{\circ}57.3'$	$36^{\circ}37.3' \times 75^{\circ}24.8'$	10:06	145.2°	143°	36°
5	$36^{\circ}35.6' \times 75^{\circ}35.5'$	$37^{\circ}17.2' \times 76^{\circ}11.6'$	10:25	325.3°	149°	39°
6	(4 over again) $36^{\circ}40.9' \times 75^{\circ}28.0'$	$37^{\circ}15.0' \times 75^{\circ}57.5'$	10:51	322.1°	155°	41°

Table III. - SEA TRUTH DATA COLLECTED UNDER OCS OCTOBER 15, 1980 FLIGHTS

	Kelez	John Smith	Judith Ann	RV Langley	Holton
FL-1					
Station	808	805	J	LY1	69
Time EST	9:14	9:19	9:30	9:20	9:19
Location	36°45.7'N	36°51.5'	36°59.3'	36°57.1'	36°55.0'
	75°54.67'W	75°55.4'	75°58.5'	76°02.2'	75°58.0'
FL-3					
Station	809	70	J-1	LY2	802
Time EST	9:50	9:58	9:48	9:58	9:50
Location	36°46.36'N	36°52.1'	36°59.5'	36°58.6'	36°56.0'
	75°48.77'W	75°52.6'	75°58.5'	76°00'	75°55.3'
FL-5					
Station	821	806		LY3	803
Time EST	10:28	10:32		10:40	10:33
Location	36°47.42'N	36°52.5'		37°01.5'	36°58.0'
	75°42.62'W	75°49.5'		75°56.2'	75°51.5'
FL-6					
Station	810				
Time EST	10:48				
Location	36°47.67'N				
	75°41.12'W				

TABLE III. - SEA TRUTH DATA COLLECTED UNDER OCS OCTOBER 15, 1980 FLIGHTS

(continued)

	Kelez	John Smith	Judith Ann	RV Langley	Holton
Station	811	807			804
Time EST	11:44	11:27			11:25
Location	$36^{\circ}48.73'$N	$36^{\circ}54.2'$			$37^{\circ}01.02'$
	$75^{\circ}32.26'$W	$75^{\circ}40.6'$			$75^{\circ}44.2'$

TABLE IV. - OCTOBER 20, 1980

Flight Line	Coordinates Begin	Coordinates End	Start Time EST	Aircraft Heading	Sun Azimuth	Sun Elevation
1	$36^{\circ}46.4'$N x $75^{\circ}51.1'$W	$37^{\circ}25.7'$N x $75^{\circ}57.4'$W	11:31	352.8°	168°	43°
2	$36^{\circ}43.2'$ x $75^{\circ}37.7'$	$37^{\circ}19.5'$ x $75^{\circ}42.4'$	11:58	355.1°	178°	44°
3	$37^{\circ}19.9'$ x $76^{\circ}10.9'$	$36^{\circ}49.9'$ x $76^{\circ}06.2'$	12:10	172.7°	184°	43°

TABLE V. - SEA TRUTH DATA COLLECTED UNDER OCS OCTOBER 20, 1980 FLIGHTS

Station	Time EST	Location
KZ 1	11:30	36°56.03'N x 75°53.00'W
KZ 2	11:35	36°56.58' x 75°52.95'
KZ 3	11:40	36°57.16' x 75°52.90'
KZ 4	11:45	36°57.72' x 75°52.81'
KZ 5	11:50	36°58.41' x 75°52.94'
KZ 6	11:55	36°59.07' x 75°53.01'
KZ 7	12:00	36°59.72' x 75°53.12'

TABLE VI. - OCTOBER 22, 1980

Flight Line	Coordinates: Begin	Coordinates: End	Aircraft Heading
1	36°59.5'N x 76°20'	36°59.5'N x 74°40'W	90°
2	37°02' x 74°40'	37°02' x 70°10'	270°

TABLE VII.- OCEAN COLOR SCANNER RADIANCE COUNT DATA FOR OCTOBER 15, 1980

STATION	BAND									
	1	2	3	4	5	6	7	8	9	10
808	98.797	128.360	100.110	103.453	74.125		96.453	69.953	85.922	
805	98.203	129.407	106.719	115.313	84.860		107.250	75.813	82.594	
69	99.719	131.969	107.594	114.203	81.063		102.594	71.844	85.703	
LY1	106.078	138.625	118.391	124.594	88.532		114.828	82.157	99.188	
J	101.797	133.110	108.563	111.516	78.516		103.188	74.657	89.344	
809	103.157	132.954	98.297	96.829	67.047		87.125	62.766	75.828	
70	106.313	135.078	106.735	111.282	78.157		96.907	68.750	79.157	
802	110.641	138.672	112.500	115.422	81.782		104.922	76.938	88.844	
LY2	112.969	143.563	117.563	122.172	87.172		110.656	31.860	98.282	
J-1	112.704	140.047	114.235	120.344	86.656		112.344	81.813	97.250	
821	110.594	141.469	106.375	103.813	71.500		94.157	69.250	83.625	
806	115.922	145.688	116.266	121.750	85.688		107.657	76.953	90.766	
803	113.813	145.688	114.719	117.078	81.063		104.110	76.469	89.719	
LY3	115.297	147.313	125.891	138.219	101.453		127.750	91.297	101.000	
810	111.594	144.063	109.547	108.735	73.547		98.360	71.719	85.781	

TABLE VIII.- CHLOROPHYLL a AND TOTAL SUSPENDED SOLIDS CONCENTRATIONS MEASURED ON OCTOBER 15, 1980

	KELEZ	JOHN SMITH	JUDITH ANN	RV LANGLEY	HOLTON
FL-1					
Station	808	805	J	LY1	69
Chlorophyll a mg/m^3	9.97	13.67	3.94	2.07	4.2
Total Suspended Solids mg/ℓ	7.4	12.2		4.6	4.6
FL-3					
Station	809	70	J-1	LY2	802
Chlorophyll a	7.48	9.97	4.70	3.10	4.2
Total Suspended Solids	5.3	10.0		3.9	3.2
FL-5					
Station	821	806		LY3	803
Chlorophyll a	2.03	4.51		8.17	4.56
Total Suspended Solids	7.9	4.6		3.9	2.4
FL-6					
Station	810				
Chlorophyll a	0.87				
Total Suspended Solids	2.6				

TABLE IX.- MULTICHANNEL OCEAN COLOR SENSOR SPECTRAL BANDS

Band	Center Wavelength (nanometers)	Band	Center Wavelength (nanometers)
1	400	11	552
2	415	12	568
3	430	13	584
4	445	14	601
5	460	15	616
6	475	16	631
7	490	17	647
8	506	18	663
9	521	19	678
10	537	20	694

TABLE X.- CHLOROPHYLL a CONCENTRATIONS ON OCTOBER 20, 1980

Station	Chlorophyll a mg/m^3
KZ1	4.08
KZ2	3.88
KZ3	4.30
KZ4	5.13
KZ5	4.30
KZ6	5.87
KZ7	5.87

TABLE XI.- OCEAN COLOR SCANNER RADIANCE COUNT DATA FOR OCTOBER 20, 1980

STATION	BAND									
	1	2	3	4	5	6	7	8	9	10
1	86.501	146.782	125.297	137.469	100.438	75.594	129.094	93.172	106.188	149.703
2	85.438	146.188	125.454	139.969	106.016	80.391	136.672	97.750	105.110	160.500
3	88.094	145.875	124.110	136.469	100.891	77.297	128.969	92.344	101.985	140.922
4	87.000	147.001	125.672	140.453	105.860	81.875	138.501	99.500	102.328	151.938
5	87.844	147.610	123.579	135.297	100.047	74.688	126.094	90.954	99.578	145.594
6	88.844	147.625	123.938	134.922	98.359	74.501	126.078	91.407	105.157	149.329
7	88.750	147.672	125.516	137.938	102.516	77.125	131.469	95.563	108.953	156.813

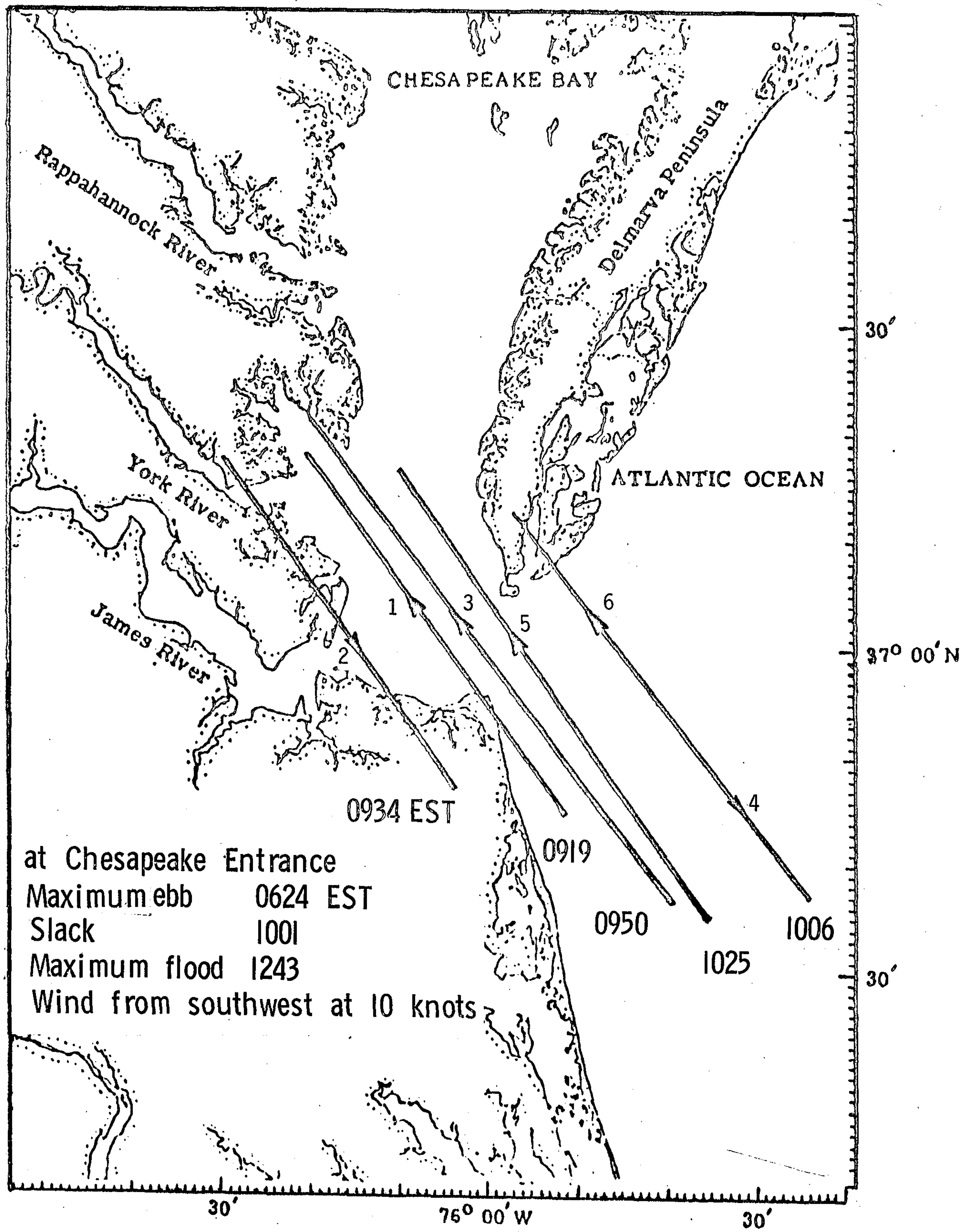

Figure 1.- Flight track of Lear Jet/OCS mapping mission on October 15, 1980.

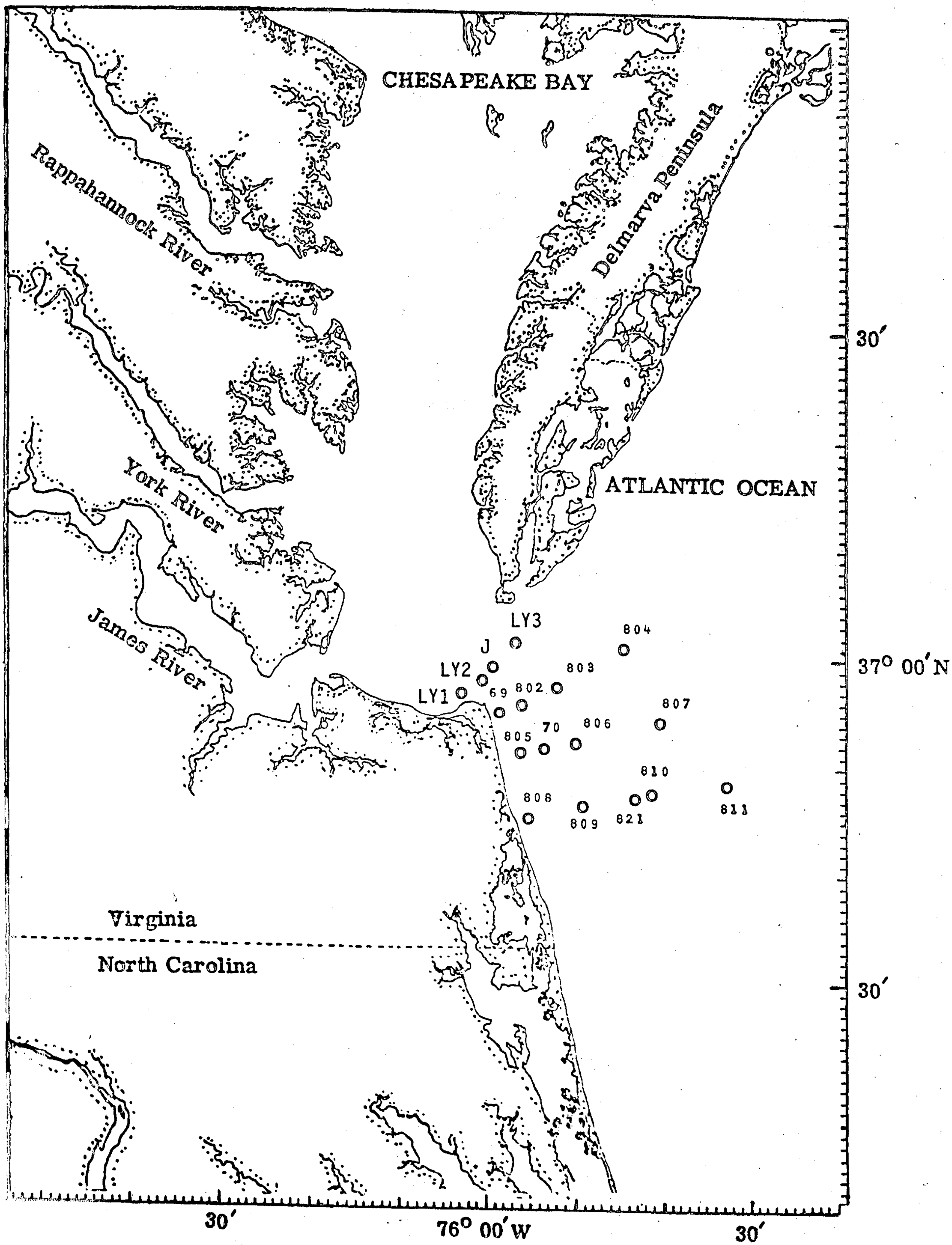

Figure 2. - Location of sea-truth stations on October 15, 1980.

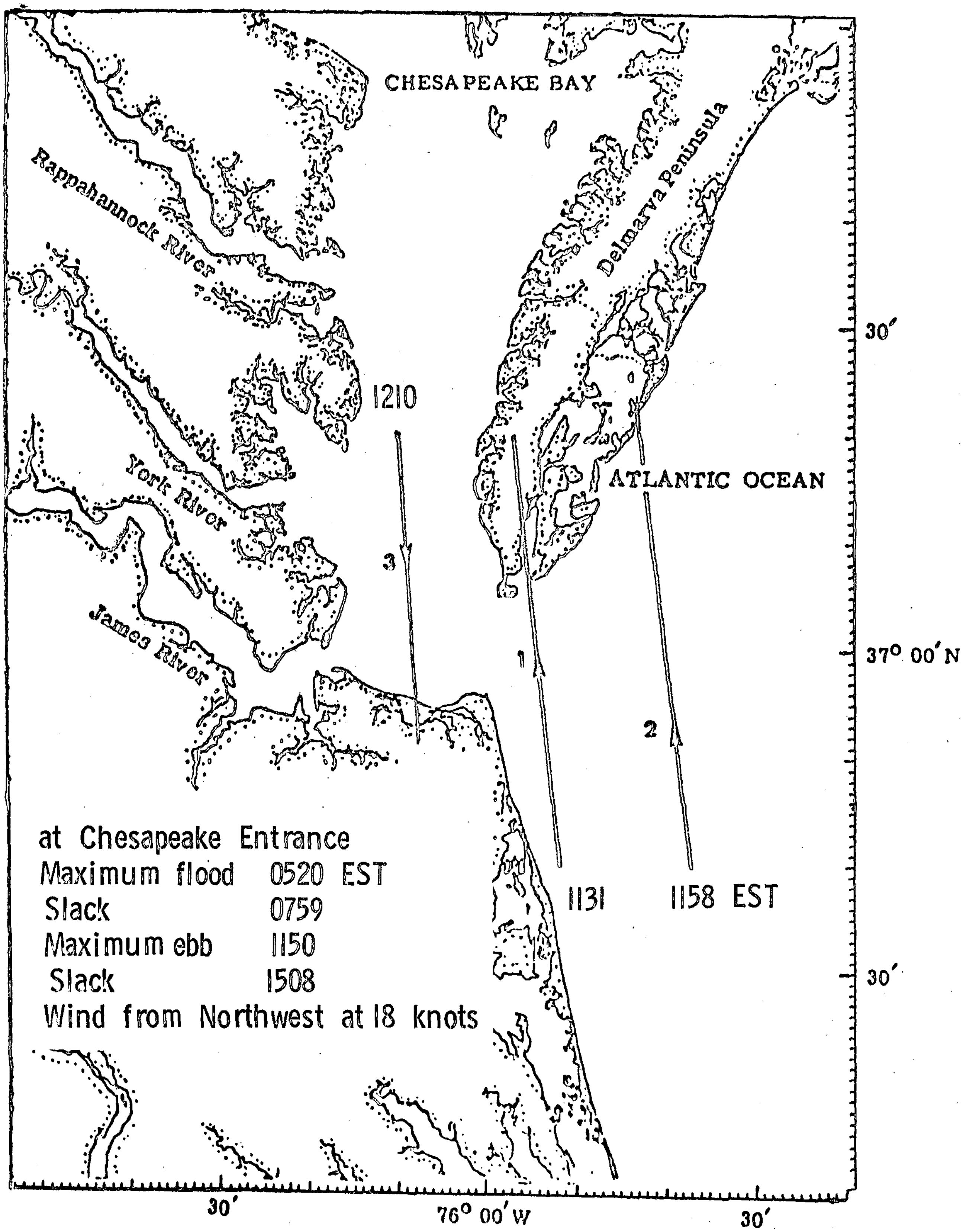

Figure 3.-Flight track of Lear Jet/OCS mapping mission on October 20, 1980.

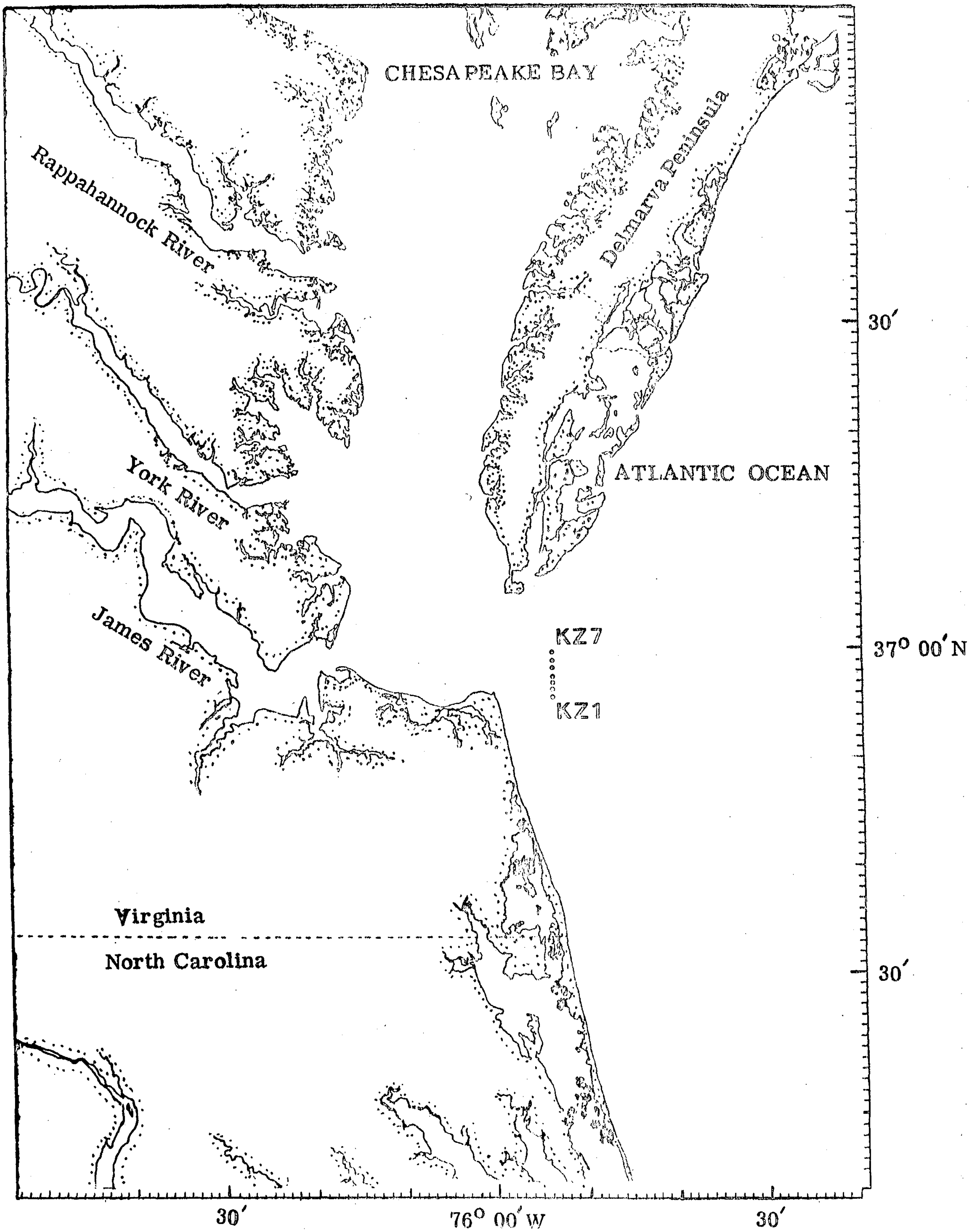

Figure 4. - Location of sea-truth stations on October 20, 1980.

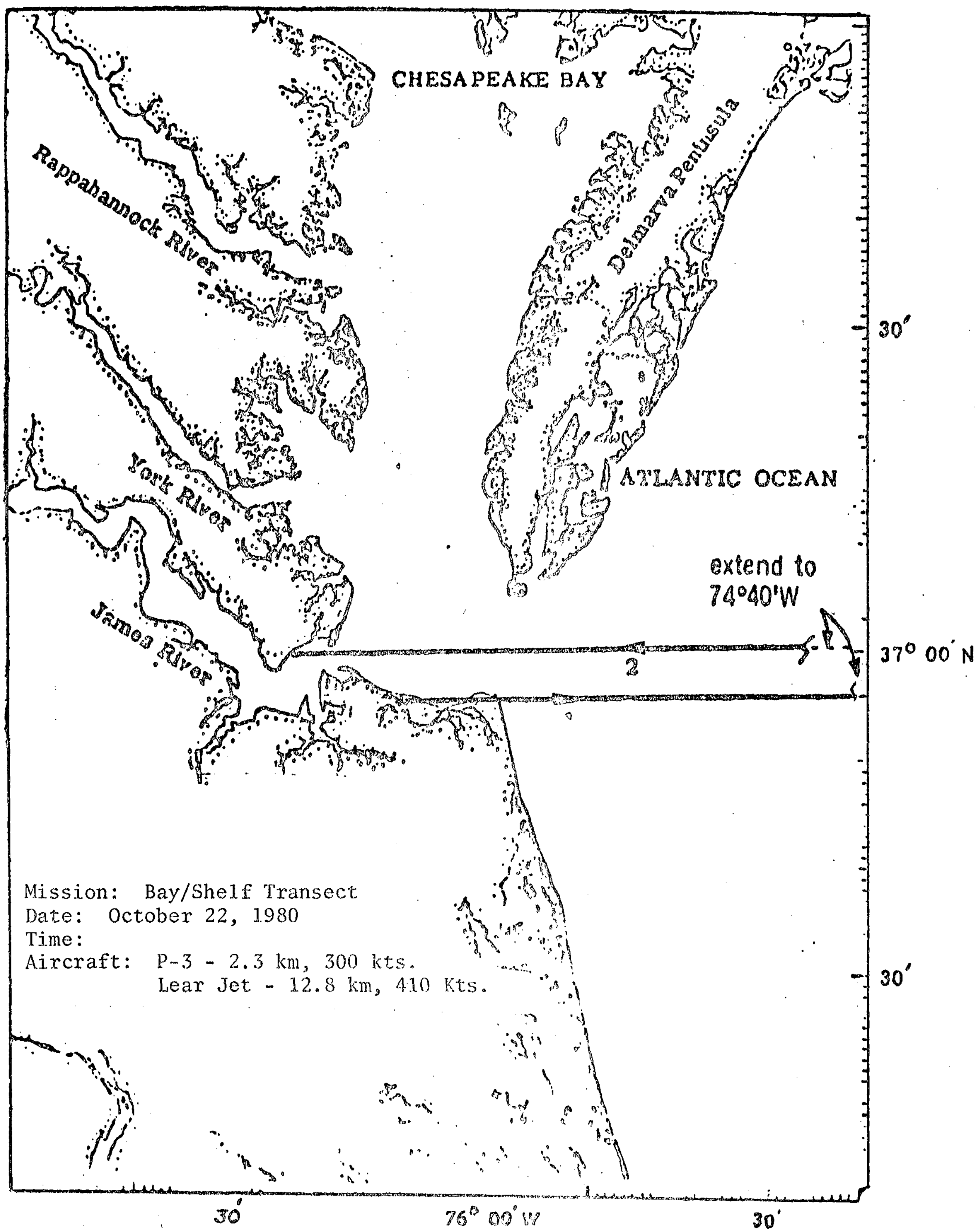

Figure 5.- Flight tracks of P-3/MOCS and Lear Jet/OCS missions on October 22, 1980.

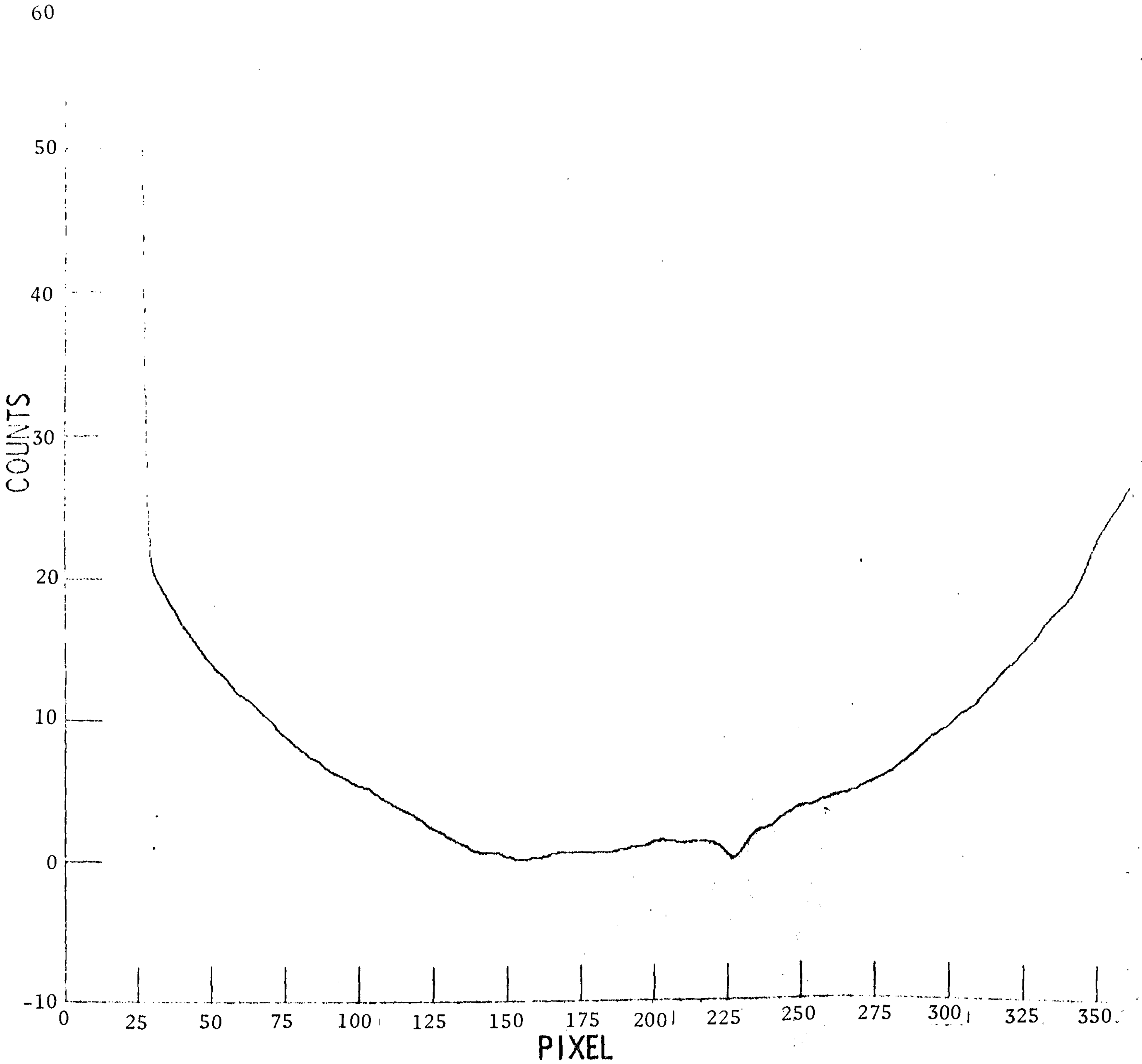

Figure 6. - Scan angle correction curve.

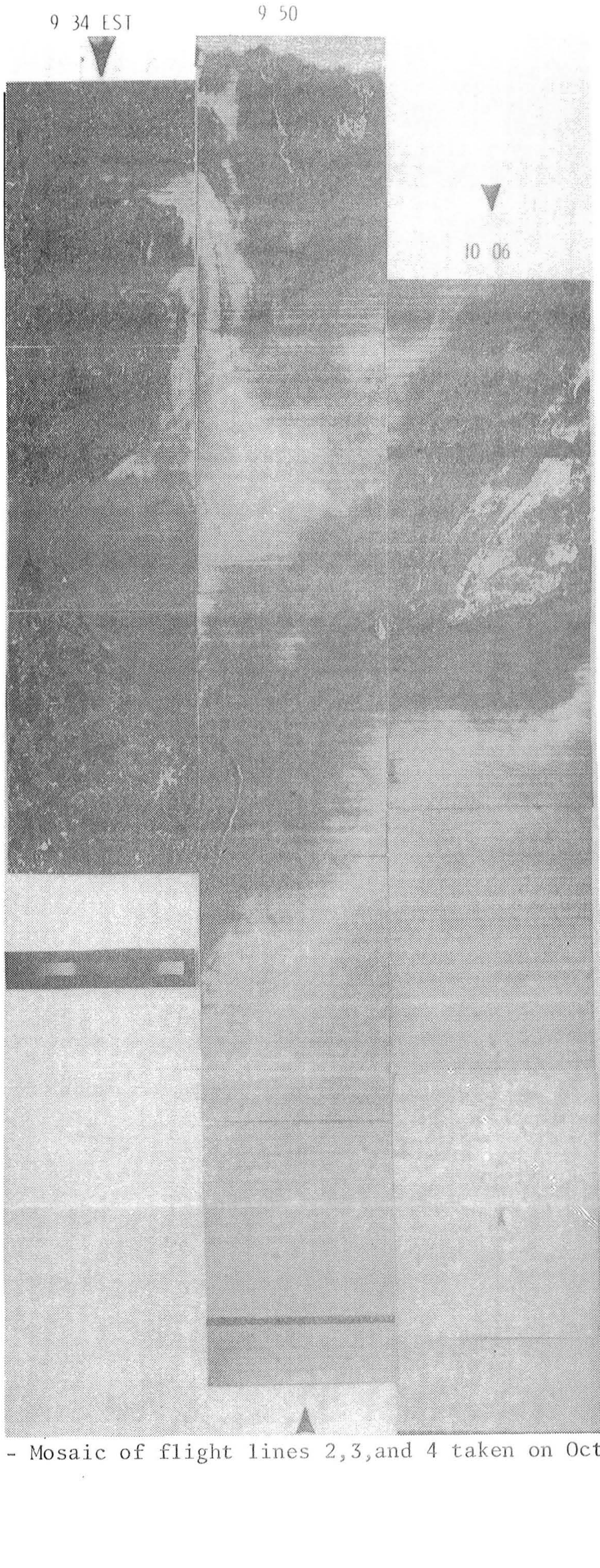

Figure 7. - Mosaic of flight lines 2,3,and 4 taken on October 15, 1980.

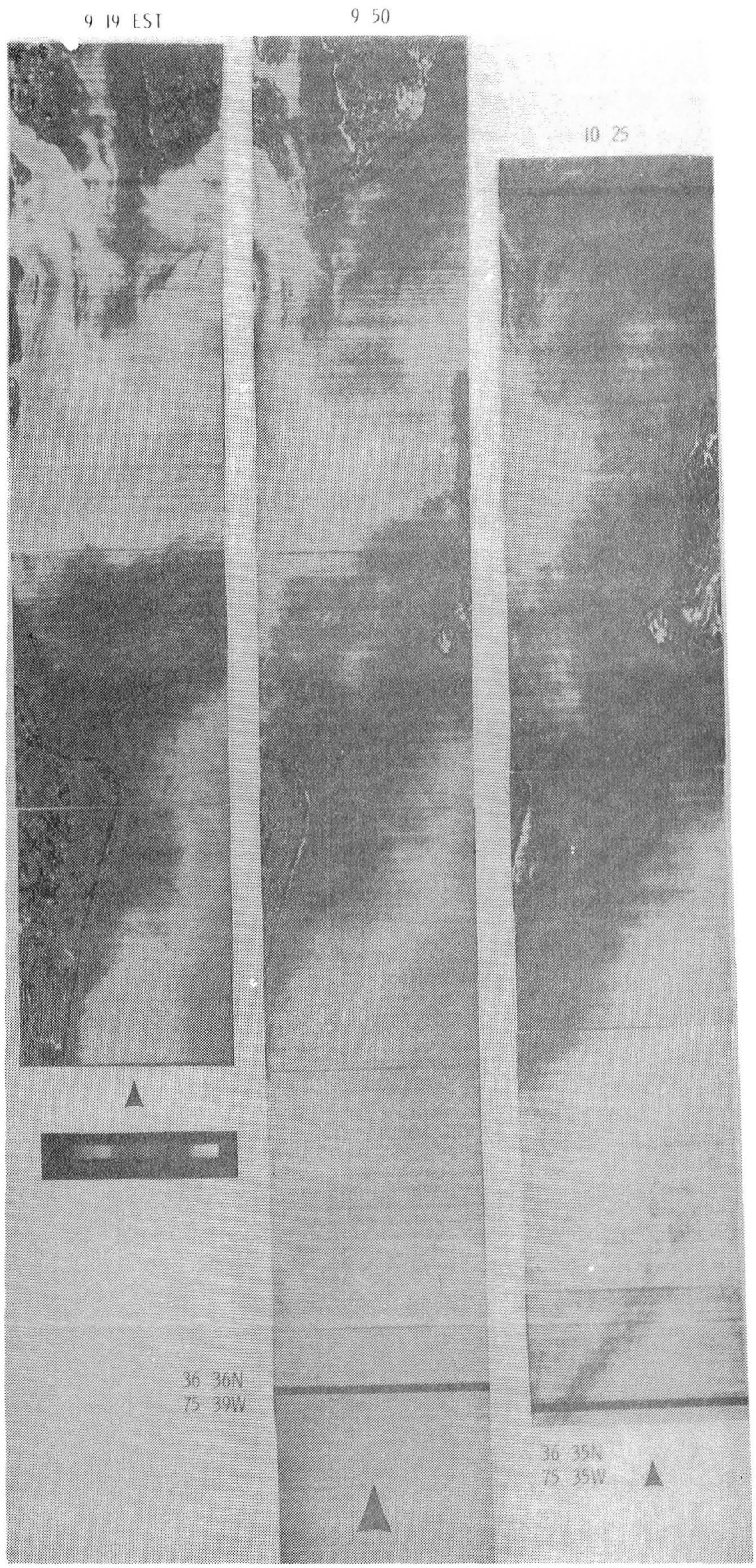

Figure 8. - Composite of flight lines 1,3, and 5 taken on October 15, 1980.

Figure 9. - Mosaic of flight lines 1 and 3 taken on October 20, 1980.

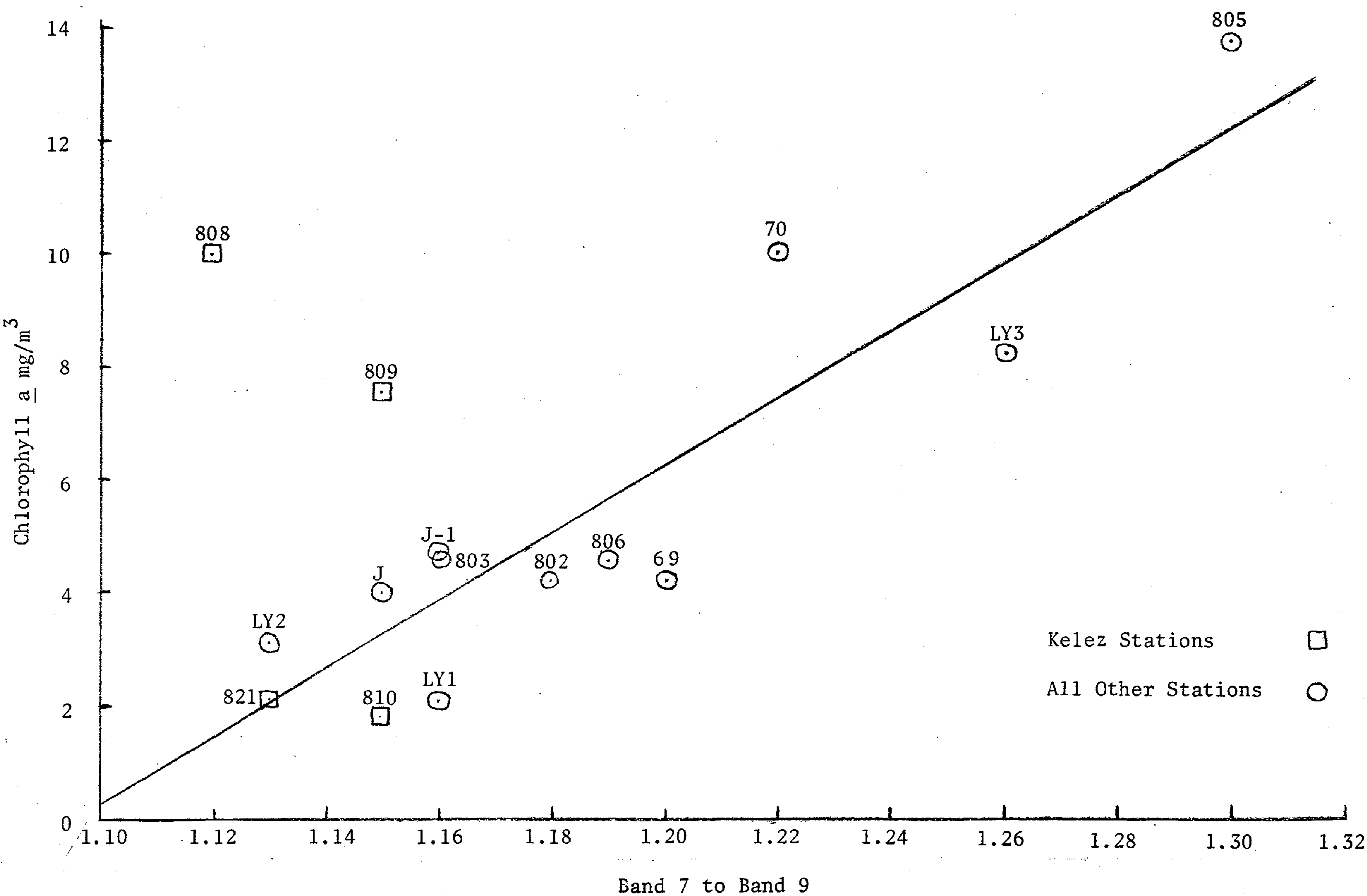

Figure 10.- Plot of Chlorophyll a versus the ratio of band 7 to band 9 for the October 15, 1980, data set.

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
TM 83290		

4. Title and Subtitle	5. Report Date
Analysis of Ocean Color Scanner Data from the Superflux III Experiment	March 1982
	6. Performing Organization Code 146-40-15-07
7. Author(s) Craig W. Ohlhorst	8. Performing Organization Report No.
9. Performing Organization Name and Address NASA Langley Research Center Hampton, VA 23665	10. Work Unit No.
	11. Contract or Grant No.
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Washington, DC 20546	13. Type of Report and Period Covered Technical Memorandum
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

The Ocean Color Scanner collected data on October 15, 20, and 22, 1980, during the Superflux III Experiment. Single-channel gray-scale data products generated 5 minutes after the scanner were collected and showed details of the Chesapeake plume structure, suggesting that this quick-look capability could have potential use for experiments in real time. The Chesapeake Bay plume extended offshore about 5 nautical miles on October 15, and 7 nautical miles on October 20.

Using the October 15, 1980, data, a correlation coefficient of r = 0.889 was obtained between chlorophyll a and the ratio of band 7 (664-684 nanometers) to band 9 (746-766 nanometers). This ratio was then used to calculate the average surface chlorophyll a concentration of the water flowing out of the Chesapeake Bay. A ratio from the Ocean Color Scanner bands was created to simulate the ratio that the Multichannel Ocean Color Sensor uses to calculate chlorophyll a concentrations. Using the October 15, 1980, data set, this ratio had a correlation coefficient of r = -0.739 with the log of the chlorophyll a and the ratio of band 2 minus band 4 to band 2 plus band 4 of the Ocean Color Scanner. No correlation was found between the Ocean Color Scanner data and total suspended solid measurements made on October 15, 1980.

On October 20, 1980, only chlorophyll samples were collected. No correlation was found between the Ocean Color Scanner data and chlorophyll a measurements.

17. Key Words (Suggested by Author(s))	18. Distribution Statement
Ocean Color Scanner chlorophyll a remote sensing Chesapeake Bay Regression Analysis	Unclassified - Unlimited

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price*
Unclassified	Unclassified	30	A02

* For sale by the National Technical Information Service, Springfield, Virginia 22161