#554
Earth Sc

STS-2

CALIBRATED RADIANCE TAPE

81-111A-05A

Table of Contents

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1. INTRODUCTION:

The documentation for this data set was originally on paper, kept in NSSDC's Data Set Catalogs (DSCs). The paper documentation in the Data Set Catalogs have been made into digital images, and then collected into a single PDF file for each Data Set Catalog. The inventory information in these DSCs is current as of July 1, 2004. This inventory information is now no longer maintained in the DSCs, but is now managed in the inventory part of the NSSDC information system. The information existing in the DSCs is now not needed for locating the data files, but we did not remove that inventory information.

The offline tape datasets have now been migrated from the original magnetic tape to Archival Information Packages (AIP’s).

A prior restoration may have been done on data sets, if a requestor of this data set has questions; they should send an inquiry to the request office to see if additional information exists.

2. ERRATA/CHANGE LOG:

NOTE: Changes are made in a text box, and will show up that way when displayed on screen with a PDF reader.

When printing, special settings may be required to make the text box appear on the printed output.

Version	Date	Person	Page	Description of Change
01				
02				

3 LINKS TO RELEVANT INFORMATION IN THE ONLINE NSSDC INFORMATION SYSTEM:

http://nssdc.gsfc.nasa.gov/nmc/

[NOTE: This link will take you to the main page of the NSSDC Master Catalog. There you will be able to perform searches to find additional information]

4. CATALOG MATERIALS:

a. Associated Documents — To find associated documents you will need to know the document ID number and then click here. http://nssdcftp.gsfc.nasa.gov/miscellaneous/documents/

b. Core Catalog Materials

REQ. AGENT	RAND NO.	ACQ. AGENT
GLS	V0158	YPS

STS-2

CALIBRATED RADIANCE TAPE

81-111A-05A ESOD-00003

This data set catalog contains 2 magnetic tapes. Each tape is 9-track, 1600 BPI, binary and contain 4 files of data. The first file contains documentation information in 2 mixed-mode records. The first record of each data file is an orbit segment documentation record also written in mixed-mode. The binary data records are written in the Variable Block format with a logical record length of 5428 bytes. These tapes were created on an IBM 360 computer. The D number and C numbers and Time Segments on each tape are as follows:

D#	C#	TIME SEGMENTS	
D-53322	C-22683	11/14/81 - 11/14/81	(PART 1)
D-53323	C-22684	11/14/81 - 11/14/81	(PART 2)

I. DESCRIPTION OF OCE DATA

a) THE OCE DATA SYSTEM.

The shuttle OCE data, 8-channel spectral radiance data in PCM format were transferred from the Orbiter payload upon landing at the Dryden Flight Research Center on Nov 14 1981.

The conversion of OCE data recorded on-board the Space Shuttle into a form which is conviently usable by the analyst required several data processing steps: Upon the receipt of the PCM tapes, the following processings were done at GSFC.

1. Time code synchronization
2. Analog to binary coord. conversion
3. Scanline reformatting
4. Ephemeris data and calibration incorporation
5. Deblocking and reformatting to the final calibrated radiance tape format.

b) DATA QUALITY CONTROL SCREENING

The OCE tapes which are to be distributed to experimenters and archived for public use are in a format which can be readily used in analysis programs, as described in the following section. The data includes extensive document files on timimg, specific geographic location information on the data taking, and radiometric calibration constants. The tapes have incorporated the STS-2 ancillary data that have been provided by the mission office.

The screening of the OCE data quality was done by the Principal Investigator.

In comparision to the originally planned 120 minutes, the OCE acquired 118 minutes of data during the Orbiter's three day flight which began on Nov 12 1981 and terminated on Nov 14 1981, after 54.25 hours. The ground tracks where OCE data collection took place are shown in Fig. 1.

Many areas of the data acquisition were not the areas which had been designated in the original plan. The deviations from the original flight plans were caused by the following operational difficulties:

(a) The actual launch of the orbiter on November 12 was delayed by three hours from the originally planned 7:00 a.m. EST. This delay caused siginificant changes in the solar zenith angles at the target sites when the orbiter passed. Alternative orbital passes, mostly in ascending orbital portions, had to be selected to get proper solar zenith angles.

(b) Relatively low Sun angles in the month of November in the Northern Hemisphere substantially limited the number of chlorohpyll target areas that could be selected.

(c) Also, because of spacecraft malfunctions, the STS-2 mission time was shortened by two days.

(d) During the mission, two large storm systems covered both East and West coast of the U.S. The South Atalantic Bight which extends from Cape Canaveral to Cape Hattaras, S. Carolina was one of the OCE's important predesignated test sites. Thus relatively low percentage of cloud free scenes among the total data resulted in about 20 to 30 minutes of data out of the total 2 hours of data.

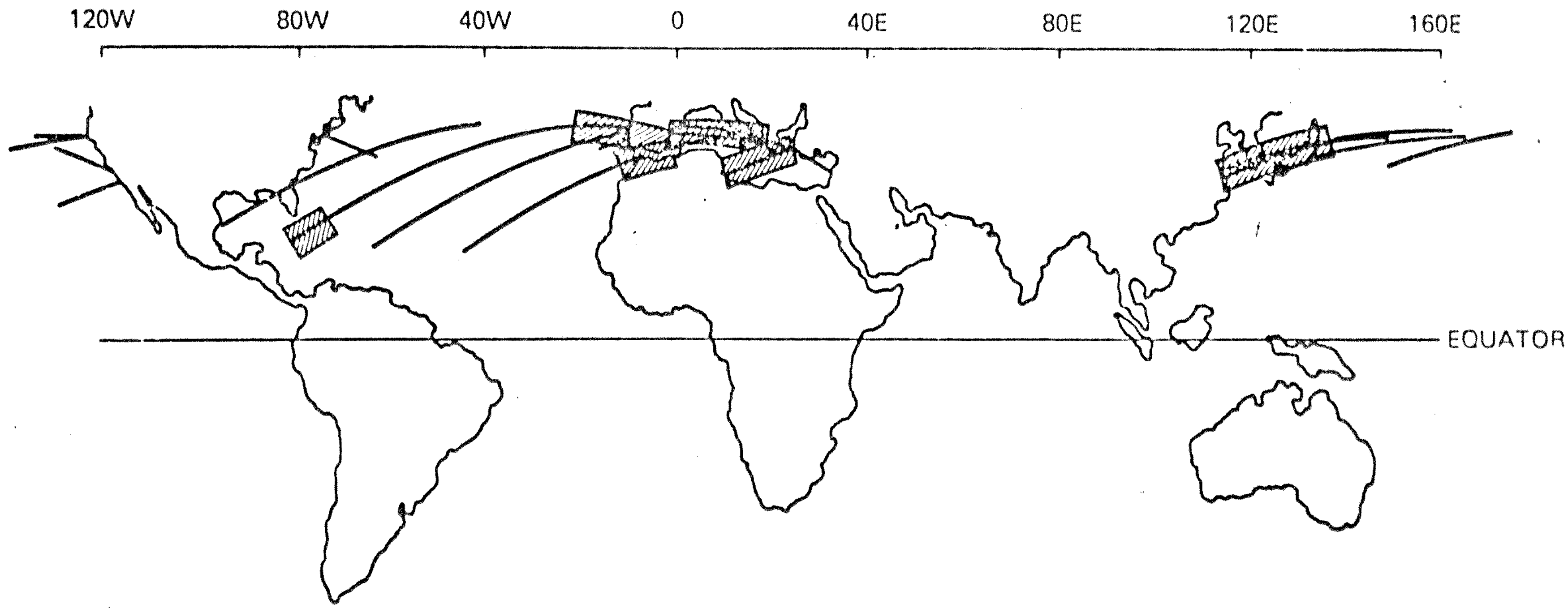


Figure 1. The Shuttle, "Columbia's", ground tracks where OCE data were acquired during November 12–14, 1981. The areal coverage of clear ocean view data that were of sufficient quality to process are shown in hatched areas.

Segments of the OCE data which show clear views and subsequently submitted to the National Space Science Data Center (NSSDC) are:

ORBIT NO.	Time Segment D/Hr/Min/Sec(GMT)	Geographical Location
24	318:01:32:00 318:01:42:15	Yellow Sea/Sea of Japan and Pacific Ocean
29	318:09:00:00 318:09:05:00	Gulf of Libya/Greece (partially cloud covered)
30	318:10:29:00 318:10:36:15	Portugal Coast and Med. Sea
31	318:12:08:00 318:12:15:00	Spanish Coast to Italy (partially cloud cover
32	318:13:23:32 318:13:26:00	Great Bahama Bank
32	318:13:39:00 318:13:42:15	Strait of Gibraltar

II. CALIBRATED RADIANCE TAPE FORMAT

a) TAPE AND RECORD FILES

The calibrated data tape from the OCE is a 9-track, 1600 BPI, multifile tape. The records are written in the Variable Block (VB) format with a logical record length of 5428 bytes. The format and content of records are listed in the following:

OCEAN COLOR EXPERIMENT DATA TAPES

TAPE CHARACTERISTICS

1. 1600 BYTES PER INCH(BPI)
2. 9 TRACK, 8 BITS PER BYTE, 1 PARITY BIT
3. NO MACHINE-TYPE DEPENDENT TAPE LABELS
4. PHYSICAL RECORDS SEPARATED BY INTER-RECORD GAPS
5. FILES SEPARATED BY TAPEMARKS

FILE STRUCTURE

1. FIRST FILE-DOCUMENTATION INFORMATION(2 RECORDS)
   A)PHYSICAL RECORD ONE(636 BYTES)-TAPE DOCUMENTATION RECORD
   B)PHYSICAL RECORD TWO(220 BYTES)-MASTER CALIBRATION TABLE RECORD
2. FILES 2 THROUGH N - OCE DATA FILES (N-1 ORBIT SEGMENTS ON TAPE)
   A)PHYSICAL RECORD ONE(172 BYTES) - ORBIT SEGMENT DOCUMENTATION
   B)PHYSICAL RECORDS TWO THROUGH M(5428 BYTES EACH) - OCE SCAN DATA OCE SCAN DATA RECORDS (M-1) OCE SCANS IN THIS ORBIT SEGMENT

CONTENTS OF RECORDS

1. FIRST FILE
   A)TAPE DOCUMENTATION RECORD (TABLE T1)
      I.EXPERIMENT NAME AND DATE
      II.ORBIT SEGMENT NUMBERS
      III.NUMBER OF DATA BANDS(8) AND CHANNEL NUMBERS
      IV.NUMBER OF ORBIT SEGMENTS ON TAPE
      V.FILE NUMBERS FOR EACH ORBIT SEGMENT
      VI.GEOGRAPHIC AREA OF ORBIT SEGMENT
      VII.START TIME AND END TIME FOR EACH ORBIT SEGMENT

   B)CALIBRATION TABLES RECORD (TABLE T2)
      I.COEFFIECIENTS FOR CONVERSION FROM CALIBRATED DIGITAL DATA COUNTS TO IRRADIANCE; ONE COEFFIECIENT FOR EACH CHANNEL
      II.INSTRUMENT VOLTAGE TO IRRADIANCE CONVERSION CONSTANTS; ONE FOR EACH CHANNEL

2-2

• DATA FILES (FILES 2-N)

A) ORBIT SEGMENT DOCUMENTATION RECORD (TABLE T3)

I. ORBIT SEGMENT NUMBER

II. AVERAGE SPACECRAFT HEADING

III. AVERAGE SOLAR ZENITH ANGLE

IV. AVERAGE ALTITUDE

V. GEOGRAPHIC LOCATION DESCRIPTION

VI. SEGMENT STARTING POINT

VII. SEGMENT END POINT

VIII. SEGMENT START TIME

IX. SEGMENT END TIME

X. EXPERIMENTER'S NAMES

XI. DATE OF OCE CALIBRATION

XII. NUMBER OF SCAN LINES IN THIS SEGMENT

XIII. BYTE INCREMENT TO NUMBER OF DATA SAMPLES/CHANNEL

XIV. TOTAL NUMBER OF POSITIONS(SAMPLES) AVAILABLE IN DATA RECORD FOR DATA FROM EACH CHANNEL(270)

XV. AVERAGE NUMBER OF SAMPLES USED FOR EACH CHANNEL

B) DATA RECORDS (TABLE T4)

I. REEL SEQUENCE NUMBER(1)

II. DIGITIZING DATE

III. TIME OF SCAN START PULSE IN DAYS, HOURS, MINUTES, SECONDS

IV. TIME OF START PULSE IN TOTAL SECONDS

V. NUMBER OF VALID DATA POINTS PER CHANNEL
NOTE1: IF THIS NUMBER IS 270, THEN THE TOTAL SCAN IS INVALID(DROPOUT) AND ALL POINTS ARE SET TO ZERO.

VI. CALIBRATED DIGITAL COUNTS(OCE VOLTAGE OUTPUT IN CENTIVOLTS) FOR UP TO 225 SAMPLES FROM ALL EIGHT CHANNELS
NOTE2: OCE ELECTRONIC DESIGN INCLUDED THE INSERTION OF A VOLTAGE STAIRCASE PERIODICALLY INTO THE DATA PORTION OF THE SCAN. THESE STAIRCASE OUTPUTS RESULTED IN THE LOSS OF SOME DATA AND APPEAR AS STRIPS OF DROPOUTS ABOUT 20 SCAN LINES WIDE.

b) OCE SCANNER PARAMETERS

EIGHT CHANNELS

CHANNEL	WAVELENGTH (NM)	CONVERSION CONSTANT (MW/MICRON-CM**2)/CENTIVOLT
1.	485.9	0.0659
2.	518.4	0.0500
3.	552.6	0.0353
4.	584.5	0.0278
5.	620.6	0.0223
6.	655.1	0.0179
7.	685.1	0.0162
8.	786.6	0.0108

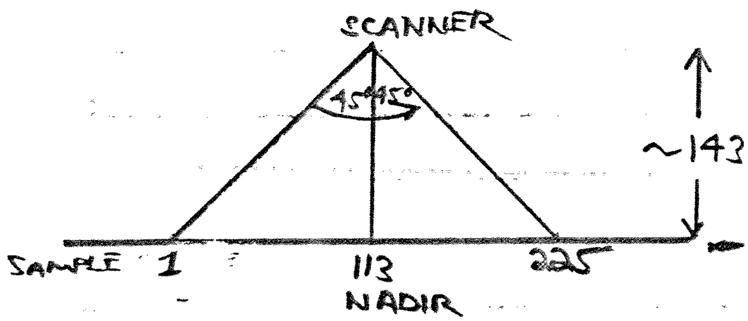
THE RADIANCE AT ANY PIXEL FORT EACH CHANNEL IS FOUND FROM

R(I,J)=C(I)*S(I,J)/PI

WHERE R(I,J)=RADIANCE FOR CHANNEL I AT PIXEL J
IN (MILLIWATTS/(MICRON-CM**2-STERADIAN)
C(I) =CONVERSION CONSTANT FOR CHANNEL I WHICH IS
FOUND IN SECOND RECORD OF TAPE DOCUMENATION FILE
S(I,J)=DIGITAL COUNT(IN CENTIVOLTS) FOR
AT SAMPLE J

THE OCE SCANNER ANGULAR RESOLUTION(IFOV) IS 3.5 MILLIRADIANS

APPPROXIMATELY 225 SAMPLES



ABOVE DIAGRAM ASSUMES SPACECRAFT IS HEADED INTO THE PLANE OF PAPER
WITH NEUTRAL ROLL, PITCH, AND YAW. (0 DEGREES)

THE ABOVE SETUP REQUIRES A LEFT-TO-RIGHT REFLECTION TO GET THE PROPER IMAGE ORIENTATION WHEN THE DATA IS READ INTO ANVIDEO DISPLAY FROM FIRST SCAN LINE TO LAST AND FROM LEFT TO RIGHT.

**********************TABLE T1**

OCE CALIBRATED DATA TAPE FORMAT

FILE ONE - RECORD ONE(TAPE DOCUMENTATION RECORD)

BYTES	FORMAT	DESCRIPTION
1- 60	EBCDIC	EXPERIMENT NAME, ORBIT SEGMENT NUMBERS, DATE
61- 64	I*4	NUMBER OF BANDS IN SCAN DATA RECORD
65- 68	I*4	CHANNEL NUMBER OF FIRST BAND (1)
69- 72	I*4	CHANNEL NUMBER OF SECOND BAND (2)
73- 76	I*4	CHANNEL NUMBER OF THIRD BAND (3)
77- 80	I*4	CHANNEL NUMBER OF FOURTH BAND (4)
81- 84	I*4	CHANNEL NUMBER OF FIFTH BAND (5)
85- 88	I*4	CHANNEL NUMBER OF SIXTH BAND (6)
89- 92	I*4	CHANNEL NUMBER OF SEVENTH BAND (7)
93- 96	I*4	CHANNEL NUMBER OF EIGHTH BAND (8)
97-104	NOT USED	
105-108	I*4	PROGRAM VERSION NUMBER (1)
109-128	NOT USED	
129-132	I*4	NUMBER OF FLIGHT SEGMENTS ON THIS TAPE
133-136	I*4	FILE NUMBER FOR FIRST SEGMENT (2)
137-156	EBCDIC	GEOGRAPHIC AREA OF FIRST SEGMENT
157-160	EBCDIC	START DAY OF FIRST SEGMENT
161-164	EBCDIC	START HOUR OF FIRST SEGMENT
165-168	EBCDIC	START MINUTE OF FIRST SEGMENT
169-172	EBCDIC	END DAY OF FIRST SEGMENT
173-176	EBCDIC	END HOUR OF FIRST SEGMENT
177-180	EBCDIC	END MINUTE OF FIRST SEGMENT
181-228	EBCDIC	SEGMENT INFORMATION(IF NEEDED) FOR SECOND SEGMENT USING SAME FORMAT USED FOR FIRST SEGMENT
229-276	EBCDIC	SEGMENT INFORMATION(IF NEEDED) FOR THIRD SEGMENT USING SAME FORMAT USED FOR FIRST SEGMENT
277-324	EBCDIC	SEGMENT INFORMATION(IF NEEDED) FOR FOURTH SEGMENT USING SAME FORMAT USED FOR FIRST SEGMENT
325-372	EBCDIC	SEGMENT INFORMATION(IF NEEDED) FOR FIFTH SEGMENT USING SAME FORMAT USED FOR FIRST SEGMENT
373-420	EBCDIC	SEGMENT INFORMATION(IF NEEDED) FOR SIXTH SEGMENT USING SAME FORMAT USED FOR FIRST SEGMENT
421-468	EBCDIC	SEGMENT INFORMATION(IF NEEDED) FOR SEVENTH SEGMENT USING SAME FORMAT USED FOR FIRST SEGMENT
469-516	EBCDIC	SEGMENT INFORMATION(IF NEEDED) FOR EIGHTH SEGMENT USING SAME FORMAT USED FOR FIRST SEGMENT
517-564	EBCDIC	SEGMENT INFORMATION(IF NEEDED) FOR NINTH SEGMENT USING SAME FORMAT USED FOR FIRST SEGMENT
565-612	EBCDIC	SEGMENT INFORMATION(IF NEEDED) FOR TENTH SEGMENT USING SAME FORMAT USED FOR FIRST SEGMENT
613-636	NOT USED	

NOTE: I*4 MEANS RIGHT JUSTIFIED FOUR-BYTE BINARY REPRESENTATION
EBCDIC MEANS EXTENDED BINARY CODED DECIMAL INTERCHANGE CODE

************************TABLE T2***********************************

OCE CALIBRATED DATA TAPE FORMAT

FILE ONE - RECORD TWO(MASTER CALIBRATION DOCUMENTATION RECORD)

BYTES	FORMAT	DESCRIPTION
1- 68	NOT USED	
69- 72	R*4	DIGITAL COUNT TO IRRADIANCE CONVERSION FOR CHANNEL 1
73- 80	NOT USED	
81- 84	R*4	DIGITAL COUNT TO IRRADIANCE CONVERSION FOR CHANNEL 2
85- 92	NOT USED	
93- 96	R*4	DIGITAL COUNT TO IRRADIANCE CONVERSION FOR CHANNEL 3
97-104	NOT USED	
105-108	R*4	DIGITAL COUNT TO IRRADIANCE CONVERSION FOR CHANNEL 4
109-116	NOT USED	
117-120	R*4	DIGITAL COUNT TO IRRADIANCE CONVERSION FOR CHANNEL 5
121-128	NOT USED	
129-132	R*4	DIGITAL COUNT TO IRRADIANCE CONVERSION FOR CHANNEL 6
133-140	NOT USED	
141-144	R*4	DIGITAL COUNT TO IRRADIANCE CONVERSION FOR CHANNEL 7
145-152	NOT USED	
153-156	R*4	DIGITAL COUNT TO IRRADIANCE CONVERSION FOR CHANNEL 8
157-180	NOT USED	
181-184	R*4	VOLT-IRRADIANCE CONVERSION FOR CALIBRATION CHANNEL 1
185-188	R*4	VOLT-IRRADIANCE CONVERSION FOR CALIBRATION CHANNEL 2
189-192	R*4	VOLT-IRRADIANCE CONVERSION FOR CALIBRATION CHANNEL 3
193-196	R*4	VOLT-IRRADIANCE CONVERSION FOR CALIBRATION CHANNEL 4
197-200	R*4	VOLT-IRRADIANCE CONVERSION FOR CALIBRATION CHANNEL 5
201-204	R*4	VOLT-IRRADIANCE CONVERSION FOR CALIBRATION CHANNEL 6
205-208	R*4	VOLT-IRRADIANCE CONVERSION FOR CALIBRATION CHANNEL 7
209-212	R*4	VOLT-IRRADIANCE CONVERSION FOR CALIBRATION CHANNEL 8
213-220	NOT USED	

NOTE: R*4 MEANS IBM 360, FOUR-BYTE, FLOATING POINT REPRESENTATION

***********************TABLE T3******************************

OCE CALIBRATED DATA TAPE FORMAT

FILES TWO-N (ASSUMING N-1 ORBIT SEGMENTS ARE ON THIS TAPE)
RECORD ONE(ORBIT SEGMENT DOCUMENTATION RECORD)

BYTES	FORMAT	DESCRIPTION
1- 80	EBCDIC	ORBIT NUMBER, SPACECRAFT HEADING, SOLAR ZENITH ANGLE, ALTITUDE, GEOGRAPHIC AREA DESCRIPTION
81- 84	EBCDIC	STARTING LATTITUDE (+/-DEGREES)
85- 88	EBCDIC	STARTING LATITUDE (+/-MINUTES)
89- 92	EBCDIC	STARTING LONGITUDE (+/-DEGREES)
93- 96	EBCDIC	STARTING LONGITUDE (+/-MINUTES)
97-100	EBCDIC	END LATITUDE (+/-DEGREES)
101-104	EBCDIC	END LATITUDE (+/-MINUTES)
105-108	EBCDIC	END LONGITUDE (+/-DEGRESS)
109-112	EBCDIC	END LONGITUDE (+/-MINUTES)
113-116	EBCDIC	START TIME DAY
117-120	EBCDIC	START TIME HOUR
121-124	EBCDIC	START TIME MINUTE
125-128	EBCDIC	END TIME DAY
129-132	EBCDIC	END TIME HOUR
133-136	EBCDIC	END TIME MINUTE
137-156	EBCDIC	EXPERIMENTER'S NAMES
157-164	EBCDIC	DATE OF CALIBRATION
165-166	I*2	NUMBER OF DATA SCAN LINES
167-168	I*2	BYTE INCREMENT TO NUMBER OF DATA SAMPLES/CHANNEL IN SCAN DATA RECORD (26)
169-170	I*2	MAXIMUM NUMBER OF DATA SAMPLES/CHANNEL IN SCAN DATA RECORDS (270)
171-172	I*2	AVERAGE NUMBER OF DATA SAMPLES/CHANNEL IN SCAN DATA RECORDS (ABOUT 225)

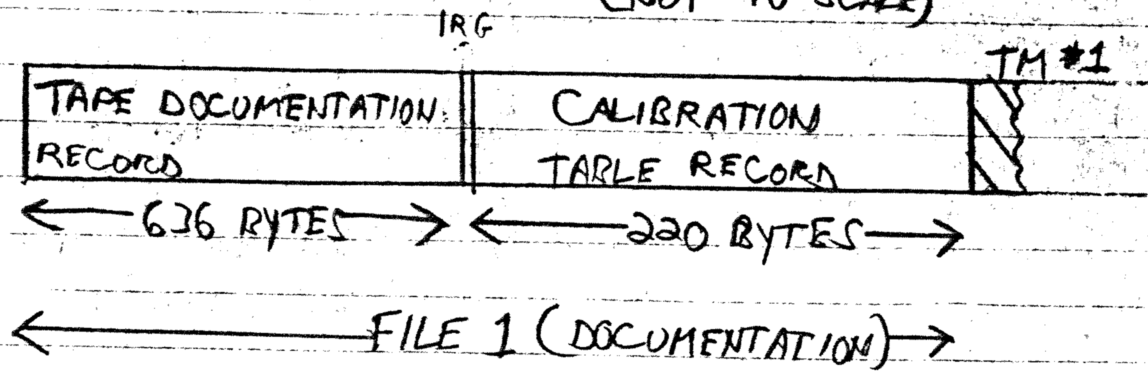
**************************TABLE T4**********************************

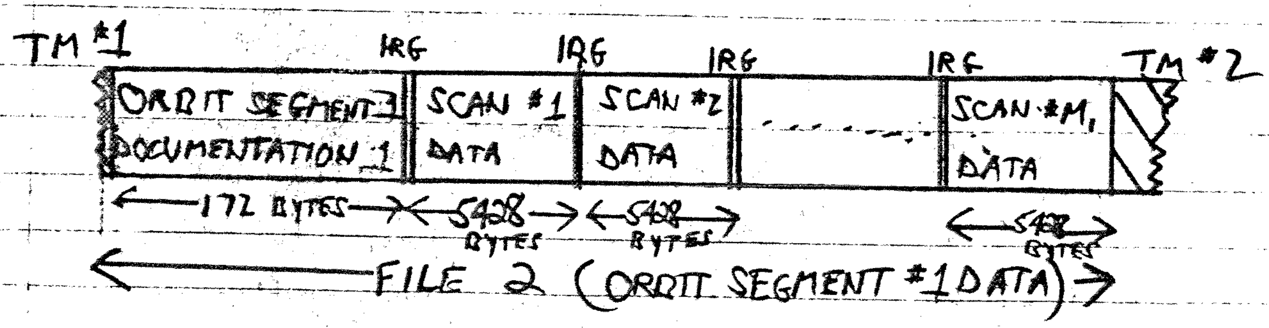
OCE CALIBRATED DATA TAPE FORMAT

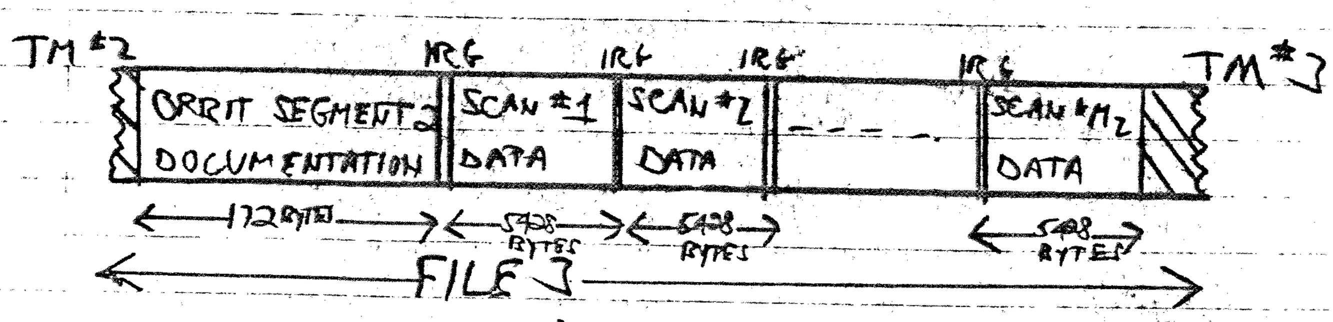
FILES TWO-N (ASSUMING N-1 ORBIT SEGMENTS ARE ON THIS TAPE)
RECORDS TWO-M(ASSUMING M-1 DATA SCANS IN THIS SEGMENT)
SCAN DATA RECORDS

BYTES	FORMAT	DESCRIPTION
1- 2	I*2	DIGITAL REEL SEQUENCE NUMBER
3- 8	EBCDIC	DIGITIZING DATE
9- 12	I*4	TIME OF SCAN START PULSE (DAY)
13- 14	I*2	TIME OF SCAN START PULSE (HOUR)
15- 16	I*2	TIME OF SCAN START PULSE (MINUTE)
17- 18	I*2	TIME OF SCAN START PULSE (SECONDS)
19- 20	I*2	ZERO
21- 24	I*4	TIME OF START PULSE (TOTAL IN SECONDS)
25- 26	I*2	ZERO
27- 28	I*2	NUMBER OF DATA POINTS/CHANNEL(SEE NOTE2, PAGE 2)
29- 30	I*2	DIGITAL COUNT, CHANNEL 1 SAMPLE 1
31- 32	I*2	DIGITAL COUNT, CHANNEL 1 SAMPLE 2
33- 34	I*2	DIGITAL COUNT, CHANNEL 1 SAMPLE 3
35- 478	I*2	DIGITAL COUNTS, CHANNEL 1, SAMPLES 4- 225
479- 568	NOT USED	
569-1018	I*2	DIGITAL COUNTS, CHANNEL 2, SAMPLES 1-225
1019-1108	NOT USED	
1109-1558	I*2	DIGITAL COUNTS, CHANNEL 3, SAMPLES 1-225
1559-1648	NOT USED	
1649-2098	I*2	DIGITAL COUNTS, CHANNEL 4, SAMPLES 1-225
2099-2188	NOT USED	
2189-2638	I*2	DIGITAL COUNTS, CHANNEL 5, SAMPLES 1-225
2639-2728	NOT USED	
2729-3178	I*2	DIGITAL COUNTS, CHANNEL 6, SAMPLES 1-225
3179-3268	NOT USED	
3269-3718	I*2	DIGITAL COUNTS, CHANNEL 7, SAMPLES 1-225
3719-3808	NOT USED	
3809-4258	I*2	DIGITAL COUNTS, CHANNEL 8, SAMPLES 1-225
4259-4348	NOT USED	
4349-5428	NOT USED	

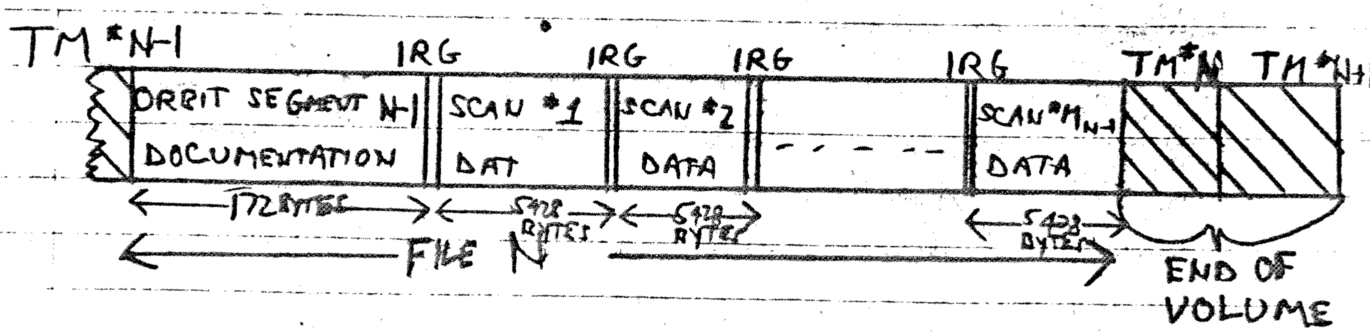
OCE DATA TAPE SCHEMATIC DIAGRAM
(NOT TO SCALE)







FILES 4, 5, 6, ..., N-1



IRG ⇒ INTER-RECORD GAP (...

The first tape contains DCT 24. 29. 30

```
**************** AIRCRAFT SENSOR ANALYSIS PACKAGE (ASAP)****************
              ** CURRENT FUNCTION--NEW SOURCE SPECIFICATION **

                    IMAGE TAPE SUMMARY--PASS 2 TAPE

EXPRMENT NAME--OCE NOV12*NOV14,1981* PLATFORM FLGT #-- STS*2 ORBIT NOS 24,
OSFT FLIGHT #--29,30                *
NUMBER OF CHANNELS--  8             * CHANNELS-- 1 2 3 4 5 6 7 8
NUMBER OF SEGMENTS--  3             *
SEGMENT NUMBER--  1                 * SEGMENT NUMBER--  2              *
   GEO. AREA---ORBIT24 YELLW SEA    *    GEO. AREA---ORBIT29 EAST MED  *
   START TIME-- 318  01  33         *    START TIME-- 318  09  00      *
   END TIME---- 318  01  42         *    END TIME---- 318  09  05      *
SEGMENT NUMBER--  3                 *
   GEO. AREA---ORBIT30 ATL TO SIC   *
   START TIME-- 318  10  29         *
   END TIME---- 318  10  36         *

ERROR-MISMATCH BETWEEN SELECTED SENSOR AND TAPE DATA.
DEPRESS (C)ONTINUE FOR ASAP TO TREAT TAPE DATA AS IF IT WERE THE
SELECTED SENSOR OR (R)ETURN TO RESELECT THE SENSOR
```

```
****************** AIRCRAFT SENSOR ANALYSIS PACKAGE (ASAP)*****************
            ** CURRENT FUNCTION--SEGMENT ACQUISITION **

SPECIFY THE DESIRED SEGMENT NUMBER (NN).


   EXPERIMENT       PLATFORM FLIGHT NUMBER    GSFC FLIGHT NUMBER

  ORBIT 24,HDG 087DEG,     SOL ZEN ANG 56DEG,AL     T 142NM,YELLOW SEA*S


   GEOGRAPHIC             STARTING         ENDING         EXPERIMENTERS
      AREA               LAT      LON     LAT      LON            NAMES

SOUTH KOREA*JAPAN       31  51 122  09  37  58 164  52 KIM,PIEPEN,YODER


          START TIME       END TIME       DATE OF CALIBRATION

         318 01  33     318 01  42              08*30*79


   IF SEGMENT IS DESIRED ONE,ENTER (C)ONTINUE  ELSE ENTER(N)O.
```

```
***************** AIRCRAFT SENSOR ANALYSIS PACKAGE (ASAP)*****************
              ** CURRENT FUNCTION--FUNCTION SELECTION **

BRIEF SYSTEM SUMMARY
EXPRMENT NAME--OCE NOV12*NOV14,1981  PLATFORM FLGT-- STS*2 ORBIT NOS 24,
GSFC FLIGHT $--29,30                  NUMBER OF BANDS--  8
BAND NUMBERS---  1  2  3  4  5  6  7  8      NUMBER OF SEGMENTS--  3
  CURRENT SEGMENT--  1  CURRENTLY DISPLAYED BANDS--  1  2  3  4  5
    START LATITUDE--  31  51       START LONGITUDE-- 122  09
    END   LATITUDE--  37  58       END   LONGITUDE-- 164  52
    START TIME--318 01  33         END TIME------318 01  42
      EXPMENTERS NAMES--KIM,PIEPEN,YODER      CALIBRATION DATE--08*30*79
      NO. OF LINES-- 2213  BYTE INC- 26  MAX. PIXLS- 270  AV. PIXLS-
SOURCE CHANNELS-- 1 2 3 4 5 VERSUS REFRESH CHANNELS-- 1 2 3 4 5

OPERATIONS SUMMARY




*************************************************************************

                           FUNCTION MENU
    1.SEGMENT ACQUISITION              *     9.TRANSFER IMAGE TO TAPE
    2.IMAGE SCAN AND DISPLAY           *    10.DUMP SCREEN TO LINE PRINTER
    3.RECTIFICATION                    *    11.ANNOTATION
    4.ENHANCEMENTS                     *    12.RATIO
    5.GROUND TRUTH CORRELATION         *    13.
    6.MONTAGE                          *    14.
    7.DATA ANALYSIS                    *    15.MISCELLANEOUS FUNCTIONS
    8.NEW SOURCE SPECIFICATION         *    16.EXIT ASAP

SELECT ONE OF THE ABOVE FUNCTIONS:
```

```
***************** AIRCRAFT SENSOR ANALYSIS PACKAGE (ASAP)*****************
            ** CURRENT FUNCTION--SEGMENT ACQUISITION **

SPECIFY THE DESIRED SEGMENT NUMBER (NN).
2

   EXPERIMENT        PLATFORM FLIGHT NUMBER     GSFC FLIGHT NUMBER

ORBIT 29,HDG 073DEG,     SOL ZEN ANG 58DEG,AL     T 142NM,N.AFRICA ACR


   GEOGRAPHIC             STARTING          ENDING          EXPERIMENTERS
      AREA              LAT      LON     LAT      LON             NAMES

MED TO GREECE          30  55 005  26  36  52 026  56 KIM,PIEPEN,VIOLLIER


           START TIME      END TIME      DATE OF CALIBRATION            R

          318 09  00     381 09  04             08*30*79


     IF SEGMENT IS DESIRED ONE,ENTER (C)ONTINUE  ELSE ENTER(N)O.
```

```
*****************  AIRCRAFT SENSOR ANALYSIS PACKAGE (ASAP)****************
            ** CURRENT FUNCTION--FUNCTION SELECTION **

BRIEF SYSTEM SUMMARY
  EXPRMENT NAME--OCE NOV12*NOV14,1981  PLATFORM FLGT-- STS*2 ORBIT NOS 24,
  GSFC FLIGHT #--29,30                 NUMBER OF BANDS--  8
  BAND NUMBERS---  1  2  3  4  5  6  7  8      NUMBER OF SEGMENTS--  3
     CURRENT SEGMENT--  2  CURRENTLY DISPLAYED BANDS--  1  3  5  8  0
       START LATITUDE--  30  55      START LONGITUDE-- 005  26
       END   LATITUDE--  36  52      END   LONGITUDE-- 026  56
       START TIME--318 09  00        END TIME-----381 09  04
         EXPMENTERS NAMES--KIM,PIEPEN,VIOLLIER   CALIBRATION DATE--08*30*79
         NO. OF LINES-- 1173  BYTE INC- 26  MAX. PIXLS- 270  AV. PIXLS-
     SOURCE CHANNELS-- 1 3 5 8 0 VERSUS REFRESH CHANNELS-- 2 3 4 5 0

OPERATIONS SUMMARY




*************************************************************************

                         FUNCTION MENU
    1.SEGMENT ACQUISITION              *     9.TRANSFER IMAGE TO TAPE
    2.IMAGE SCAN AND DISPLAY           *    10.DUMP SCREEN TO LINE PRINTER
    3.RECTIFICATION                    *    11.ANNOTATION
    4.ENHANCEMENTS                     *    12.RATIO
    5.GROUND TRUTH CORRELATION         *    13.
    6.MONTAGE                          *    14.
    7.DATA ANALYSIS                    *    15.MISCELLANEOUS FUNCTIONS
    8.NEW SOURCE SPECIFICATION         *    16.EXIT ASAP

SELECT ONE OF THE ABOVE FUNCTIONS:
```

```
***************** AIRCRAFT SENSOR ANALYSIS PACKAGE (ASAP)****************
          ** CURRENT FUNCTION--SEGMENT ACQUISITION **

SPECIFY THE DESIRED SEGMENT NUMBER (NN).


    EXPERIMENT          PLATFORM FLIGHT NUMBER     GSFC FLIGHT NUMBER

  ORBIT 30,HDG 077DEG,     SOLAR ZENITH ANGLE 5    7DEG,ALT 142NM,ATL O


    GEOGRAPHIC              STARTING          ENDING          EXPERIMENTERS
       AREA               LAT      LON      LAT      LON          NAMES

DER N.AFRICA TO SCLY    32  19*013 *47   37  56 013  25 KIM,PIEPIN,VIOLLIER


            START TIME       END TIME       DATE OF CALIBRATION           R

           318 10  28      318 10  36             08*30*79


    IF SEGMENT IS DESIRED ONE,ENTER (C)ONTINUE  ELSE ENTER(N)O.
```

```
****************** AIRCRAFT SENSOR ANALYSIS PACKAGE (ASAP)*****************
                ** CURRENT FUNCTION--FUNCTION SELECTION **

BRIEF SYSTEM SUMMARY
  EXPRMENT NAME--OCE NOV12*NOV14,1981  PLATFORM FLGT-- STS*2 ORBIT NOS 24,
  GSFC FLIGHT #--29,30                 NUMBER OF BANDS--  8
  BAND NUMBERS---  1  2  3  4  5  6  7  8       NUMBER OF SEGMENTS--  3
    CURRENT SEGMENT--  3  CURRENTLY DISPLAYED BANDS--  1  3  5  8  0
      START LATITUDE--  32  19      START LONGITUDE--*013 *47
      END   LATITUDE--  37  56      END   LONGITUDE-- 013  25
      START TIME--318 10  28        END TIME-----318 10  36
        EXPMENTERS NAMES--KIM,PIEPIN,VIOLLIER   CALIBRATION DATE--08*30*79
        NO. OF LINES--1918  BYTE INC- 26  MAX. PIXLS- 270  AV. PIXLS-
    SOURCE CHANNELS-- 1 3 5 8 0 VERSUS REFRESH CHANNELS-- 2 3 4 5 0

OPERATIONS SUMMARY




***************************************************************************

                          FUNCTION MENU
    1.SEGMENT ACQUISITION            *     9.TRANSFER IMAGE TO TAPE
    2.IMAGE SCAN AND DISPLAY         *    10.DUMP SCREEN TO LINE PRINTER
    3.RECTIFICATION                  *    11.ANNOTATION
    4.ENHANCEMENTS                   *    12.RATIO
    5.GROUND TRUTH CORRELATION       *    13.
    6.MONTAGE                        *    14.
    7.DATA ANALYSIS                  *    15.MISCELLANEOUS FUNCTIONS
    8.NEW SOURCE SPECIFICATION       *    16.EXIT ASAP

SELECT ONE OF THE ABOVE FUNCTIONS:
```

2nd tape contains 31. 32A. 32B.

```
*************** AIRCRAFT SENSOR ANALYSIS PACKAGE (ASAP)****************
**     ** CURRENT FUNCTION--NEW SOURCE SPECIFICATION **
**
**               IMAGE TAPE SUMMARY--PASS 2 TAPE
**
EXPRMENT NAME--OCE NOV12*NOV14,1981* PLATFORM FLGT #-- STS*2 ORBIT NOS 31.
SOFT FLIGHT #--32A,32B              *
NUMBER OF CHANNELS--  8             * CHANNELS-- 1 2 3 4 5 6 7 8
NUMBER OF SEGMENTS--  3             *
SEGMENT NUMBER--  1                 * SEGMENT NUMBER--  2              *
** GEO. AREA---ORBIT31B SW SPAIN    *    GEO. AREA---ORBIT32A BAHAMAS  *
** START TIME-- 318  12  08         *    START TIME-- 318 23  32       *
** END TIME---- 318  12  15         *    END TIME---- 318 26  08       *
SEGMENT NUMBER--  3                 *
** GEO. AREA---ORBIT32B ATL*GIBRLTR*
** START TIME-- 318  13  39         *
** END TIME---- 318  13  42         *
ERROR-MISMATCH BETWEEN SELECTED SENSOR AND TAPE DATA.
DEPRESS (C)ONTINUE FOR ASAP TO TREAT TAPE DATA AS IF IT WERE THE
SELECTED SENSOR OR (R)ETURN TO RESELECT THE SENSOR
```

13 23
13 26

for this 32A section is incorrect.

Ignore Headers ~~that with the~~ for ~~this~~

32A ~~section~~

See the page I for correct ephemeris data

```
****************** AIRCRAFT SENSOR ANALYSIS PACKAGE (ASAP)*****************
            ** CURRENT FUNCTION--SEGMENT ACQUISITION **

SPECIFY THE DESIRED SEGMENT NUMBER (NN).


     EXPERIMENT       PLATFORM FLIGHT NUMBER    GSFC FLIGHT NUMBER

 ORBIT 31B,HDG 101DEG    ,SOL ZEN ANG 60DEG,A    LT 142NM,SE.SPAIN TO


     GEOGRAPHIC             STARTING        ENDING         EXPERIMENTERS
        AREA              LAT      LON     LAT      LON             NAMES

EAST MEDITERREAN       38  08 001   18  31  40 034  15 KIM,PIEPEN,VIOLLIER


            START TIME       END TIME       DATE OF CALIBRATION          R

           318 12  08      318 12  15            08*30*79


     IF SEGMENT IS DESIRED ONE,ENTER (C)ONTINUE  ELSE ENTER(N)O.
```

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***************** AIRCRAFT SENSOR ANALYSIS PACKAGE (ASAP)*****************
          ** CURRENT FUNCTION--FUNCTION SELECTION **

BRIEF SYSTEM SUMMARY
EXPRMENT NAME--OCE NOV12*NOV14,1981  PLATFORM FLGT-- STS*2 ORBIT NOS 31,
GSFC FLIGHT #--32A,32B                  NUMBER OF BANDS--  8
BAND NUMBERS---  1  2  3  4  5  6  7  8          NUMBER OF SEGMENTS--  3
  CURRENT SEGMENT--  1  CURRENTLY DISPLAYED BANDS--  0  0  0  0  0
    START LATITUDE--  38  08        START LONGITUDE-- 001  18
    END   LATITUDE--  31  40        END   LONGITUDE-- 034  15
    START TIME--318 12  08          END TIME-----318 12  15
      EXPMENTERS NAMES--KIM,PIEPEN,VIOLLIER   CALIBRATION DATE--08*30*79
      NO. OF LINES-- 1719  BYTE INC- 26  MAX. PIXLS- 270  AV. PIXLS-
  SOURCE CHANNELS-- 0 0 0 0 0 VERSUS REFRESH CHANNELS-- 0 0 0 0 0

OPERATIONS SUMMARY




*****************************************************************************

                              FUNCTION MENU
    1.SEGMENT ACQUISITION              *     9.TRANSFER IMAGE TO TAPE
    2.IMAGE SCAN AND DISPLAY           *    10.DUMP SCREEN TO LINE PRINTER
    3.RECTIFICATION                    *    11.ANNOTATION
    4.ENHANCEMENTS                     *    12.RATIO
    5.GROUND TRUTH CORRELATION         *    13.
    6.MONTAGE                          *    14.
    7.DATA ANALYSIS                    *    15.MISCELLANEOUS FUNCTIONS
    8.NEW SOURCE SPECIFICATION         *    16.EXIT ASAP

SELECT ONE OF THE ABOVE FUNCTIONS:
```

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****************** AIRCRAFT SENSOR ANALYSIS PACKAGE (ASAP)******************
                ** CURRENT FUNCTION--SEGMENT ACQUISITION **

SPECIFY THE DESIRED SEGMENT NUMBER (NN).

     EXPERIMENT          PLATFORM FLIGHT NUMBER     GSFC FLIGHT NUMBER

  OCE OSTA*1 SEGMENT18     ,ORBIT32,SZA69*60,GU     LF OF MEXICO TO SPAI

     GEOGRAPHIC             STARTING           ENDING          EXPERIMENTERS
        AREA              LAT      LON       LAT      LON              NAMES

  NOV14,198100000194    21   00 *82 *12   35   18 *00 *30 KIM ET AL ORBIT32 OC

            START TIME      END TIME      DATE OF CALIBRATION              OC

           318 13  24     318 ****42           NOV 1981

     IF SEGMENT IS DESIRED ONE,ENTER (C)ONTINUE  ELSE ENTER(N)O,
```

```
****************** AIRCRAFT SENSOR ANALYSIS PACKAGE (ASAP)*****************
              ** CURRENT FUNCTION--FUNCTION SELECTION **

BRIEF SYSTEM SUMMARY
EXPRMENT NAME--OCE NOV12*NOV14,1981  PLATFORM FLGT-- STS*2 ORBIT NOS 31,
GSFC FLIGHT #--32A,32B               NUMBER OF BANDS--  8
BAND NUMBERS---  1  2  3  4  5  6  7  8        NUMBER OF SEGMENTS--  3
  CURRENT SEGMENT--  2  CURRENTLY DISPLAYED BANDS--  1  3  5  8  0
    START LATITUDE--  21  00        START LONGITUDE-- *82 *12
    END   LATITUDE--  35  18        END   LONGITUDE-- *00 *30
    START TIME--318 13  24          END TIME-----318 ***42
      EXPMENTERS NAMES--KIM ET AL ORBIT32 OC  CALIBRATION DATE--NOV 1981
      NO. OF LINES--4500  BYTE INC- 26  MAX. PIXLS- 270  AV. PIXLS-
  SOURCE CHANNELS-- 1 3 5 8 0 VERSUS REFRESH CHANNELS-- 2 3 4 5 0

OPERATIONS SUMMARY




****************************************************************************

                              FUNCTION MENU
    1.SEGMENT ACQUISITION                *     9.TRANSFER IMAGE TO TAPE
    2.IMAGE SCAN AND DISPLAY             *    10.DUMP SCREEN TO LINE PRINTER
    3.RECTIFICATION                      *    11.ANNOTATION
    4.ENHANCEMENTS                       *    12.RATIO
    5.GROUND TRUTH CORRELATION           *    13.
    6.MONTAGE                            *    14.
    7.DATA ANALYSIS                      *    15.MISCELLANEOUS FUNCTIONS
    8.NEW SOURCE SPECIFICATION           *    16.EXIT ASAP

SELECT ONE OF THE ABOVE FUNCTIONS:
```

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****************** AIRCRAFT SENSOR ANALYSIS PACKAGE (ASAP)*****************
**            ** CURRENT FUNCTION--FUNCTION SELECTION **
**
BRIEF SYSTEM SUMMARY
**EXPRMENT NAME--OCE NOV12*NOV14,1981  PLATFORM FLGT-- STS*2 ORBIT NOS 31,
**GSFC FLIGHT #--32A,32B                NUMBER OF BANDS--  8
**BAND NUMBERS---  1  2  3  4  5  6  7  8       NUMBER OF SEGMENTS--  3
**  CURRENT SEGMENT--  3  CURRENTLY DISPLAYED BANDS--  1  3  5  8  0
**    START LATITUDE--  37  49       START LONGITUDE--*016 *04
**    END   LATITUDE--  35  19       END   LONGITUDE-- 000 *33
**    START TIME--318 13  38         END TIME-----318 13  42
**      EXPMENTERS NAMES--KIM,PIEPEN,VIOLLIER   CALIBRATION DATE--08*30*79
**      NO. OF LINES-- 799 BYTE INC- 26  MAX. PIXLS- 270  AV. PIXLS-
***SOURCE CHANNELS-- 1 3 5 8 0 VERSUS REFRESH CHANNELS-- 2 3 4 5 0
**
OPERATIONS SUMMARY
**
**
**
**
****************************************************************************
**
**                          FUNCTION MENU
**   1.SEGMENT ACQUISITION            *     9.TRANSFER IMAGE TO TAPE
     2.IMAGE SCAN AND DISPLAY         *    10.DUMP SCREEN TO LINE PRINTER
     3.RECTIFICATION                  *    11.ANNOTATION
     4.ENHANCEMENTS                   *    12.RATIO
     5.GROUND TRUTH CORRELATION       *    13.
     6.MONTAGE                        *    14.
     7.DATA ANALYSIS                  *    15.MISCELLANEOUS FUNCTIONS
     8.NEW SOURCE SPECIFICATION       *    16.EXIT ASAP

SELECT ONE OF THE ABOVE FUNCTIONS:
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*************** AIRCRAFT SENSOR ANALYSIS PACKAGE (ASAP)***************
        ** CURRENT FUNCTION--SEGMENT ACQUISITION **

SPECIFY THE DESIRED SEGMENT NUMBER (NN).
3

   EXPERIMENT        PLATFORM FLIGHT NUMBER    GSFC FLIGHT NUMBER

 ORBIT 32,HDG 101DEG,    SOL ZEN ANG 58DEG,AT    L 143NM,ATLANTIC SOU


   GEOGRAPHIC          STARTING          ENDING          EXPERIMENTERS
     AREA             LAT      LON      LAT      LON           NAMES

 EAST TO GIBRALTAR      37   49*016 *04   35   19 000 *33 KIM,PIEPEN,VIOLLIER


          START TIME       END TIME       DATE OF CALIBRATION           R

         318 13  38      318 13  42             08*30*79


     IF SEGMENT IS DESIRED ONE,ENTER (C)ONTINUE  ELSE ENTER(N)O.
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NASA

Technical Memorandum 83943

The Results of Initial Analysis of OSTA-1/Ocean Color Experiment (OCE) Imagery

Hongsuk H. Kim and William D. Hart

May 30, 1982

National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland 20771

TM 83943

THE RESULTS OF INITIAL ANALYSIS OF OSTA-1/OCEAN COLOR EXPERIMENT (OCE) IMAGERY

Hongsuk H. Kim
National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771

and

William D. Hart
Science Systems and Applications, Inc.
Seabrook, Maryland 20801

May 30, 1982

GODDARD SPACE FLIGHT CENTER
Greenbelt, Maryland

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ABSTRACT

Ocean view images from the Ocean Color Experiment (OCE) were produced at three widely separated locations on the earth. Digital computer enhancement and band ratioing techniques were applied to radiometrically corrected OCE spectral data to emphasize patterns of chlorophyll distribution and, in one shallow, clear water case, bottom topography. The chlorophyll pattern in the Yellow Sea between China and Korea was evident in a scene produced from Shuttle Orbit 24. The effects of the discharge from the Yangtze and other rivers were also observed.

Two scenes from orbits 30 and 32 revealed the movement of patches of plankton in the Gulf of Cadiz. Geometrical corrections to these images permitted the existing ocean current velocities in the vicinity to be deduced. The variability in water depth over the Grand Bahama Bank was estimated by using the blue-green OCE channel. The very clear water conditions in the area caused bottom reflected sunlight to produce a sensor signal which was related inversely to the depth of the water.

THE RESULTS OF INITIAL ANALYSIS OF OSTA-1/OCEAN COLOR EXPERIMENT (OCE) IMAGERY

EXPERIMENTAL PLANS

The Ocean Color Experiment (OCE) was designed to map ocean features using an eight-channel scanning radiometer installed on the second orbital flight test of the National Aeronautics and Space Administration's (NASA) shuttle, Columbia. The operational principle of this instrument relied on a process whose feasibility has been recognized for some time.(1) For instance, NASA began in 1972 high altitude aircraft sensor investigations known as the U-2 Ocean Color Scanner (OCS) program.(2) Then in October, 1978, the Coastal Zone Color Scanner (CZCS) was launched aboard the Nimbus-7 free flyer spacecraft to make periodic observations of ocean color primarily in coastal areas.(3) The development of the concept of a shuttle-borne scanner was conceived in this environment and was based on the experience gained from these earlier instruments.

The primary goal established for the experiment was to demonstrate the ability to detect phytoplanktonic algae on a global basis and determine the chlorophyll pigment concentrations. In order to implement the scientific objectives, a team of scientific investigators (H. H. Kim, N. E. Huang, R. S. Fraser, C. R. McClain, L. R. Blaine from Goddard Space Flight Center (GSFC) and H. v.d. Piepin from DFVLR, W. Germany) was formed to formulate the experimental plan. The primary features of the plan are as follows:

(a) The OCE data collection was to focus mainly on deepwater areas in contrast to the purported objectives of the CZCS. This was to avoid the complicated spectral characteristics of coastal waters which are induced by the influence of the coastal marine constituents introduced by continental sources. The relationships between the radiometric spectra and water content are not well understood.

(b) The OCE was to address particular problems of the radiometry of the ocean-atmospheric system. The investigators realized that the albedo of the ocean is small compared to that of most land surfaces. For instance, less than 10 percent of the blue spectral radiance is returned to the atmosphere by oceanic scattering. Thus, most of the light received by the sensor in space would never have interacted with the subsurface water mass but would only have interacted with the molecular and particulate components of the atmosphere and the ocean surface. Therefore the experiment was to study the problem associated with the aerosols, sea state and other parameters which mask the perceived sub-surface oceanic radiance.

The scanner used for the shuttle experiment was originally built as an aircraft instrument by NASA-GSFC. It was modified to meet the shuttle payload specifications. By late 1979, the hardware development of the sensor was completed and it was mounted on the shuttle payload pallet by the spring of 1980. The allocation and characteristics of the eight spectral channels are summarized in Table 1. The signal-to-noise ratio was superior to that of the original aircraft instrument. The geometrical and optical design of the OCE gave it a swath of 506 km and an instantaneous field-of-view (IFOV) at nadir of about 1 km^2 at orbiter altitude. With this IFOV and a scan frequency of 4 rps, the scanner undersampled by a factor of 50 percent. This permitted a data recording rate which met the quota allotted to the OCE for storage on a recorder in the orbiter's cabin.

The general data plan of the OCE was to collect 120 minutes of data during the orbiter's passes over selected test sites. The sites chosen were known from previous experiments and experience to be likely to produce interesting chlorophyll distribution patterns which were produced, in some cases, by mesoscale anomalous flow patterns in the regions.

In order to augment the interpretation of the OCE results, the data plan included establishment of several in-situ data collection projects. These involved collecting ocean samples, ground

Table 1

Spectral Channel (nm)	Spectral Bandwidth (FWHM) (nm)	S/N Ratio	Peak Spectral Radiance (mW/cm^2-μ-sr)	Spectral Region	Purpose
1. 485.9	23	1200:1	53.7	Blue	Chlorophyll Absorption (max.) Atm. Rayleigh Scattering
2. 518.4	23	1400:1	37.8		Chlorophyll Hinge Point
3. 552.6	23	1200:1	26.8	Green	Chlorophyll Absorption (min.)
4. 584.5	23	1000:1	21.0		Backscattering (water and atm.)
5. 620.6	23	800:1	16.3		Backscattering (water and atm.)
6. 655.1	23	800:1	13.4	Red	Non-fluorescence band
7. 685.1	23	680:1	11.6		Chlorophyll Fluorescence at 685m
8. 786.6	52.4	550:1	7.5	Near Infrared	Atm. backscattering (Mie)

based observations of the atmospheric transmissivity, and correlative aircraft underflights. The location of predesignated test sites and participating experimenters were:

1. Off the Coast of Portugal
   - A. G. Fiuza, University of Lisbon, Portugal
   - H. van der Piepen, DFVLR, W. Germany
   - M. Viollier, University of Lille, France

2. Warm Core Eddy Rings in the Northwestern Atlantic
   - P. Wiebe, Woods Hole Institute of Oceanography

3. South Atlantic Bight
   - J. A. Yoder and L. P. Atkinson, Skidaway Inst. of Oceanography

4. Off the Coast of Costa Rica
   - V. Klemas, University of Delaware

5. Frontal Zones of the Kuroshio Current near Honshu Island

M. Takahashi, University of Tsukuba, Japan

In comparison to the originally planned 120 minutes, the OCE acquired 118 minutes of data during the orbiter's three-day flight which began on November 12, 1981 and terminated on November 14, 1981, after 54.25 hours. The ground tracks where the OCE data collection took place are shown in Figure 1. Many areas of the data acquisition were not the areas which had been designated in the original plan. The deviations from the original flight plans were caused by the following operational difficulties:

(a) The actual launch of the orbiter on November 12 was delayed by 3 hours from the originally planned 7:00 a.m. EST. This delay caused significant changes in the solar zenith angles at the target sites when the orbiter passed. Alternative orbital passes, mostly in ascending orbital portions, had to be selected to get proper solar zenith angles.

(b) Relatively low Sun angles in the month of November in the Northern Hemisphere substantially limited the number of chlorophyll target areas that could be selected.

(c) Also, because of spacecraft malfunctions, the STS-2 mission time was shortened by 2 days.

(d) During the mission, two large storm systems covered both the East and West coast of the U.S. The South Atlantic Bight which extends from Cape Canaveral to Cape Hattaras, S. Carolina was one of the OCE's important predesignated test sites. Thus relatively low percentage of cloud free scenes among the total data resulted in about 20 to 30 minutes of data out of the total 2 hours of data.

In spite of all these difficulties, the device acquired enough data to meet its basic objectives by demonstrating the ability to map chlorophyll concentration and identify ocean circulation features.

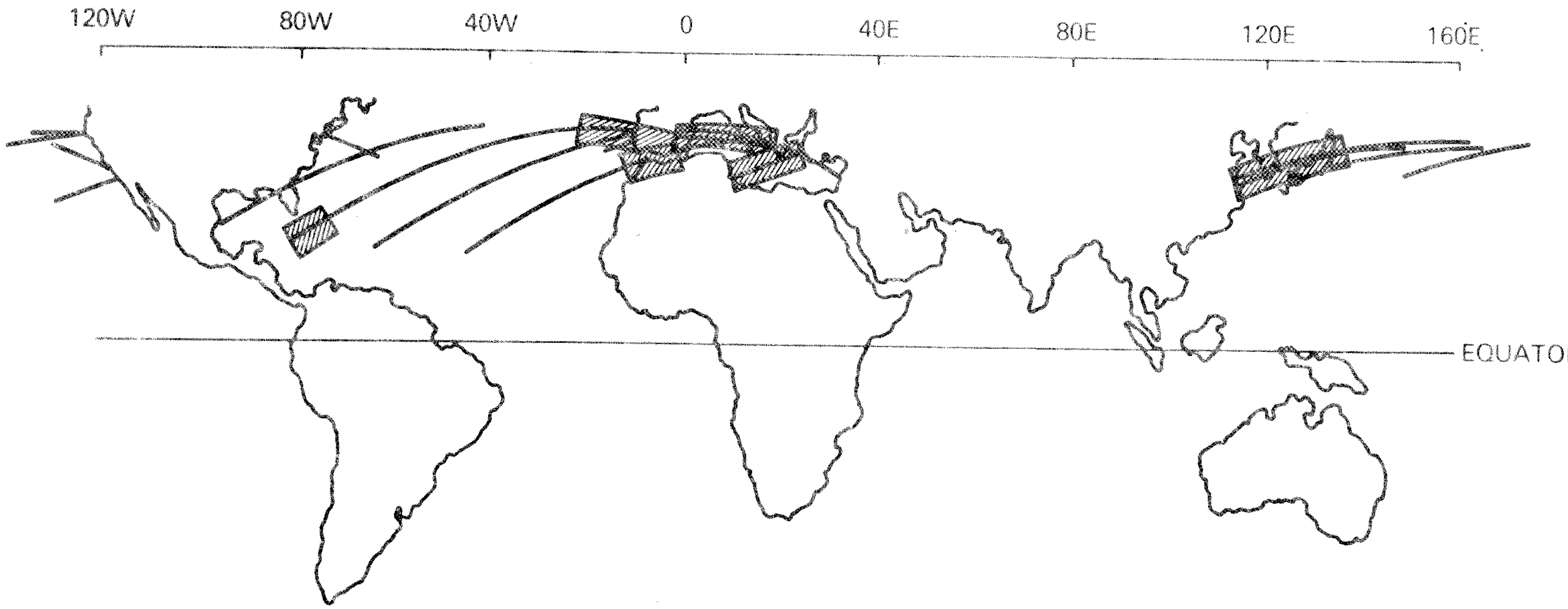

Figure 1. The Shuttle, "Columbia's", ground tracks where OCE data were acquired during November 12–14, 1981. The areal coverage of clear ocean view data that were of sufficient quality to process are shown in hatched areas.

Excellent ocean scenes from some of unplanned areas became available from the mission. Segments of the OCE data which show clear ocean views are:

Orbit No.	Time Segment D/Hr/Min/Sec (GMT)	Geographical Location
24	318:01:32:00 318:01:42:15	Yellow Sea/Sea of Japan and Pacific Ocean
29	318:09:00:00 318:09:04:00	Gulf of Libya/Greece (partially cloud covered)
30	318:10:28:00 318:10:36:15	Portugal Coast and Med. Sea
31	318:12:08:00 318:12:15:00	Spanish Coast to Italy (partially cloud covered)
32	318:13:20:30 318:13:26:00	Great Bahama Bank
32	318:13:39:00 318:13:42:15	Strait of Gibraltar

In addition to the above OCE data, coordinated low flying aircraft data taken with a similar instrument flown by a West German team, and shipborne measurements of oceanic parameters from the Portugese coast are available for November 10–14, 1981.

It will require some time to process, analyze, and correlate the OCE observations with the ground truth and aircraft data. However, initial assessments of the OCE data are given in the following sections.

CHLOROPHYLL ANALYSIS

Figure 2 is a false color image of the Yellow Sea showing the chlorophyll distribution of the area on November 13, 1981. The data were taken as the orbiter emerged from mainland China and headed toward the Japanese Islands during its 24th orbit. The image is created by ratioing the difference of data from Bands 1 and 3 to their sum after the atmospheric obscuration effects are calculated and subtracted by using Band 8 (near IR) data. The chlorophyll features are

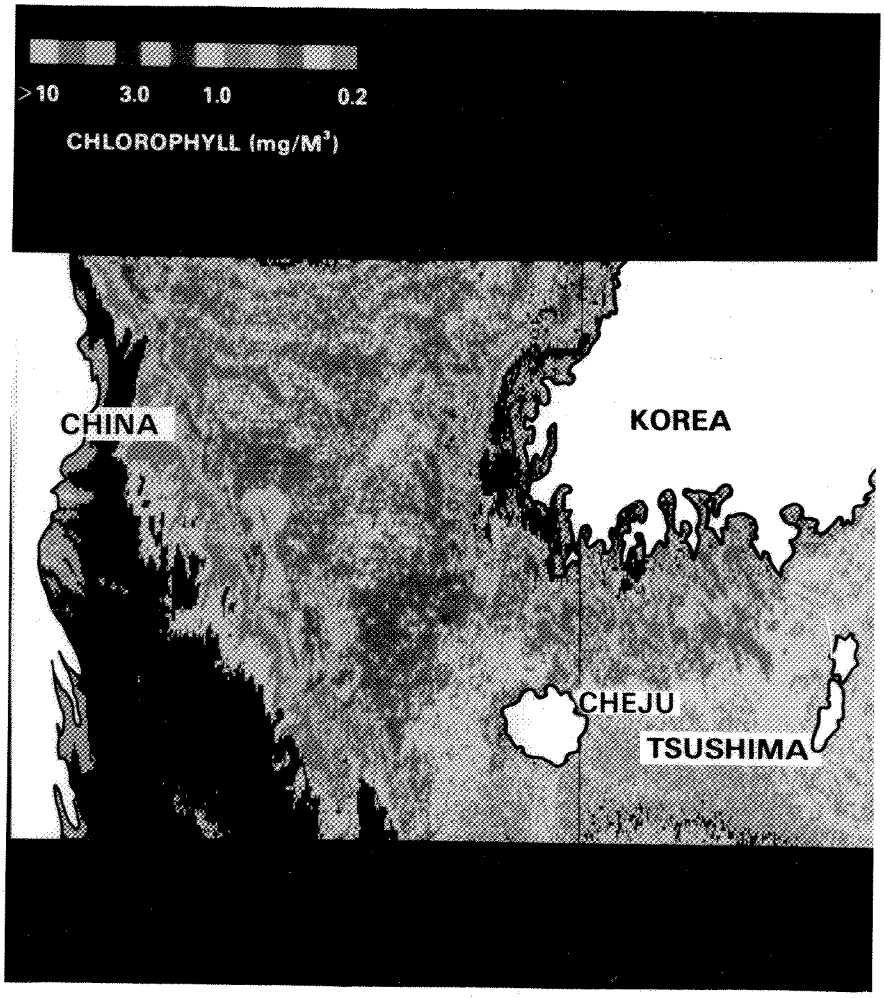

Figure 2. A map of chlorophyll pigments in the Yellow Sea on November 13, 1981, from STS-2 Orbit 24. This false color image shows the distribution patterns of chlorophyll pigment bearing phytoplankton. The color bar scale gives the quantity of pigments associated with each color in the figure.

digitally enhanced. The scaling of the pigment concentration was done by using the following empirical relationship which defines a correlation between the shipboard measurement of concentration, C, and the derived water radiance products, R:

$$C = 17.5 \text{ Exp } (-5.44 \times R)$$

Where

$$R = \frac{I^{W}(482\text{nm}) - I^{W}(552\text{nm})}{I^{W}(482\text{nm}) + I^{W}(552\text{nm})}$$

The $I^{W}(\lambda)$ is the ocean spectral radiance obtained after applying a correction to eliminate the atmospheric radiance. Table 2 lists all the radiance components of an OCE data set from Figure 2. This particular set was taken from an area just east of the Cheju Island. Quantitative estimates of surface chlorophyll requires that the contributions of backscattered radiation from the atmosphere (last column) and the sea surface (column 7 of Table 2) removed from the total upwelling radiance measured in the Column 1.

In OCE radiative analysis, a proven atmospheric radiative transfer computation method commonly known as Dave Code was used.(4) In the analysis, an effective albedo of the lower boundary is determined for each pixel using total upwelling radiance measured by the scanner (2nd column). Certain reasonable assumptions are needed to construct an appropriate atmospheric model. The primary assumption is that the particle sizes of the aerosols are distributed according to the Jungean size distribution with a Jungean parameter 3.0. This model gave upwelling radiance values of 0.22 for Rayleigh sky conditions and 0.56 mw/cm^2-μ-sr for a columnar aerosol content of 2.77×10^8. The measured OCE radiance of the 786 nm was 0.37 as shown in Table 2 from which a particle content of 1.55×10^8 was interpolated from the model and used as input to the calculations for other channels.

For image processing, such computation processes can be performed for each picture element, on a pixel by pixel basis, to construct an entire ocean image corrected for atmospheric effects.

Table 2
Radiance Components: OCE Orbit 24
Loc: 33°:15N, 126°:40E Time: 318:01:34:00 (GMT)
SZA = 56°, Azimuthal Angle = 70°

OCE Band	Measured Rad.*	Effective Albedo (%)	Downwelling Fluxes†			Upwelling Rad.*			
			Total	Sun.	Diffused	Fresnel	Total	Water	Atm. Rad.
1	3.92	3.4	96.3	70.3	26.0	0.08	1.04	0.96	2.88
2	2.75	2.15	92.4	70.6	21.7	0.069	0.63	0.561	2.12
3	2.00	1.7	89.0	71.2	17.7	0.057	0.48	0.423	1.52
4	1.49	0.95	90.2	72.9	17.2	0.049	0.27	0.221	1.22
5	1.00	0	81.5	67.8	13.7	0.041	0.041	0	0.96
6	0.88	0	82.6	69.9	12.7	0.036	0.036	0	0.88
7	0.69	0.35	78.4	67.3	11.1	0.031	0.07	0.04	0.62
8	0.37	0	65.2	57.5	7.7	0.004	0.004	0	0.366

*(mW/cm^2-μm-sr)
†(mW/cm^2-μm)

However, such measures would require a considerable amount of computer processing time. Alternatively, the method of taking a proportionality constant between the atmospheric channel and other visible channels has been discussed elsewhere.[(2)]

These atmospheric effects correction algorithms were repeatedly tested using high altitude U-2 aircraft data which were taken during the oceanographic field experiments studying Gulf Stream frontal eddies in 1979 to 1981. These aircraft experiments have given us valuable experience to refine our atmospheric effects correction algorithms. Also they have provided us with an empirical relationship which correlates the shipboard measurements of chlorophyll concentration with the derived radiance ratios.

It is important to note that the quantitative assessment of chlorophyll is valid only in cases of open ocean waters. The total upwelling spectral radiances of the open ocean water vs. coastal

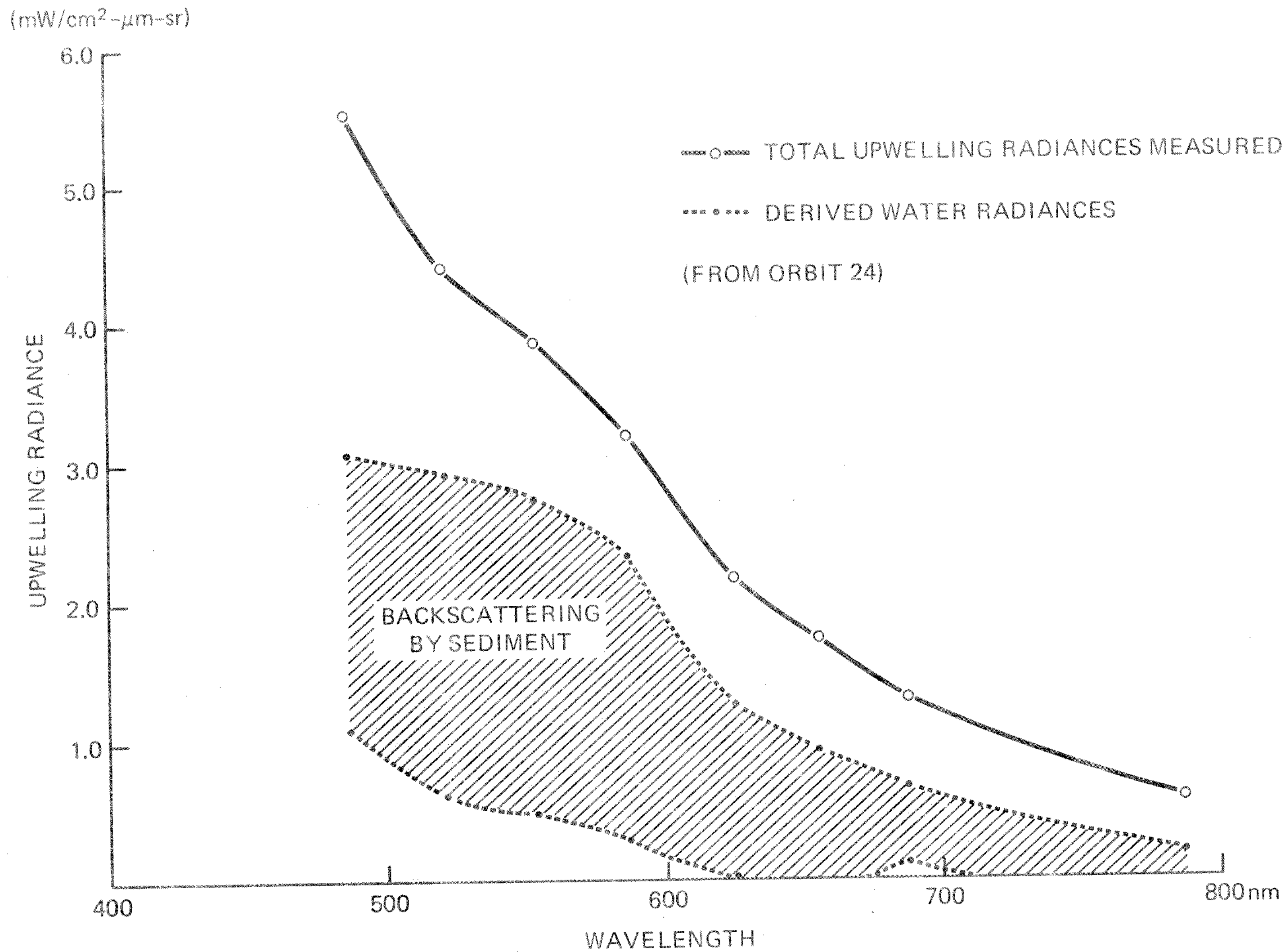

Figure 3. Upwelling spectral curves from two selected areas of the Yangtze scene in Figure 2. The top solid curve is the total upwelling radiance of the river plume perceived by the scanner. Upper dotted line corresponds to the derived water radiance of the plume. For comparison derived water radiance for the open ocean water case from just east of the Cheju Island is shown in lower dotted line. The hatched area corresponds to the portion of radiance attributed to the backscattering of sediments.

nature can be seen in the same scene. Figure 3 pertains to such upwelling spectral radiances of a clear water case, obtained from a point just East of the Cheju Island, and of a turbid water case which was sampled from a pixel in the middle of Yangtze River plume shown in black shade in Figure 2. The upwelling spectra of the river plume show considerable enhancement in the regions of Bands 3 to 8 indicating that the area plume contains significant amount of sediment particles as well as perhaps high chlorophyll concentration. Knowledge of radiative transfer in the turbid water still remains too incomplete to provide reliable chlorophyll data products of this zone. In any event, the absence of strong shelf circulation in the area causes remarkable plume patterns in the discharge from the Yangtze easily distinguishable from the surrounding waters.

REMOTE MEASUREMENT OF CURRENT VELOCITY

R. Legeckis in 1979[5] reported how high resolution thermal infrared data from polar orbiting satellite can be used to track water features in currents. One example is the time variation in the flow of the Gulf Stream between Florida and Cape Hatteras. Similarly, visible color imagery of the ocean offers another interesting means of assessing current patterns. The spatial resolution of the visible imagery in general is better than the thermal imagery and the measurement of the current velocity based on the chlorophyll patch drift patterns is more precise and directly related to the water mass transport phenomena. An opportunity to demonstrate the possibility of using color images to measure ocean circulation occurred when the Shuttle passed over the entrance of Gibraltar Strait twice on the same day. As shown in Figures 4 and 5, similar chlorophyll contour images of the Gulf of Cadiz were taken from Orbit 30 and 32 as the orbiter passed over the area at 10:32 a.m. and 1:40 p.m. on November 14, 1981. In these images areas of high chlorophyll concentration are represented by darker shade. What appears to be an elongated chlorophyll feature which stretches from the entrance of the Gibraltar Strait to the middle of the Gulf of Cadiz and then curls north toward the southern Spanish shore is visible in both images. However, careful geometrical corrections allowed observation of changes in the shape and relative positions of the patches during the 3 hour time span. Figure 6 is a schematic diagram

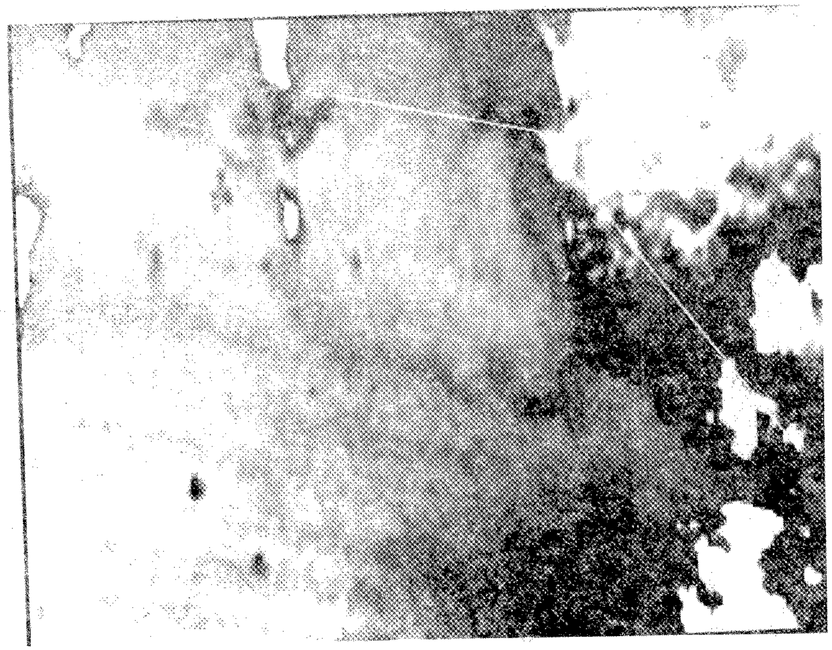

Figure 4. Chlorophyll image of the Gulf of the Cadiz taken on November 14, 1981 (GMT) from STS-2, Orbit 30. The elongated dark feature, in center, stretches from the entrance of the Gibraltar Strait to the southern Spanish shore.

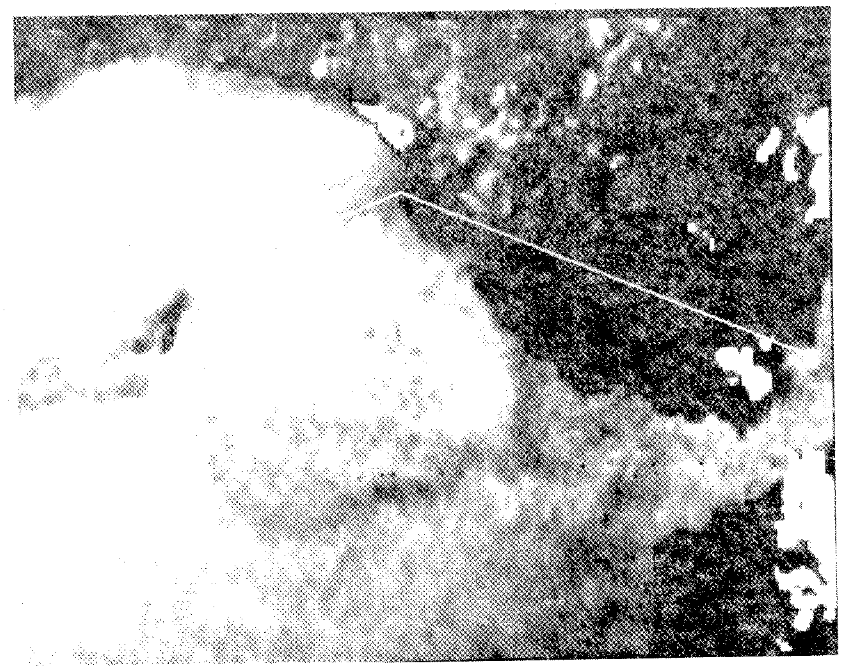

Figure 5. The same chlorophyll features in Figure 4 are also visible in this OCE image which was taken 3 hours later from Orbit 32. Careful measurements of the salient features reveal motion of the chlorophyll patches.

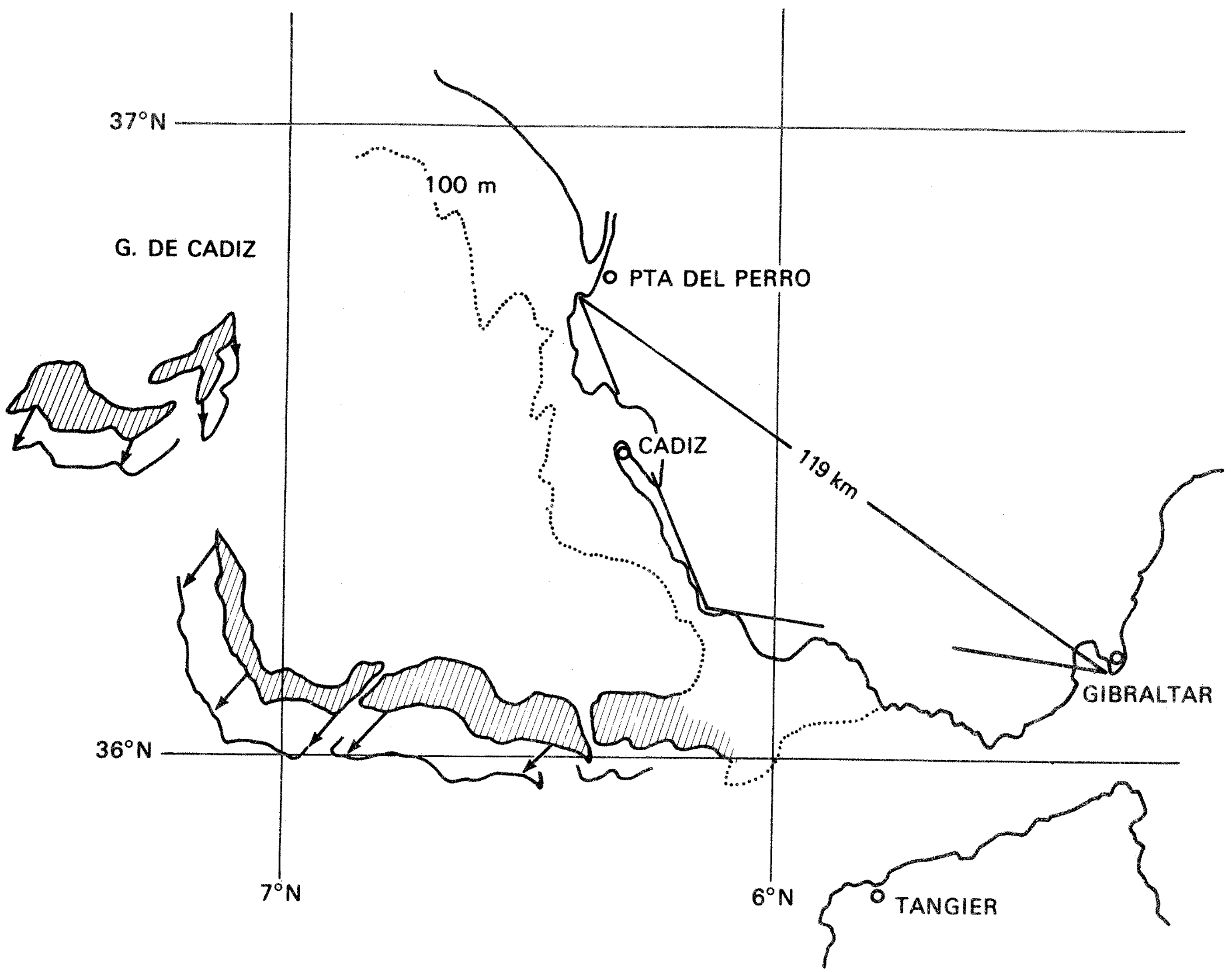

Figure 6. Relative motion of chlorophyll patches is given in exaggerated vectors. The presence of a clockwise circulation in the Gulf of Cadiz on November 13, 1981, is suggested by the directional patterns of the patch drift.

which illustrates the net motion of the chlorophyll patches. The positioning of the feature was accomplished by triangulating several salient features of the patches relative to three on-shore anchor points located near the water edge. The spatial resolution of the ratio corrected OCE imagery provides accuracy of 0.5km. Analysis of the images showed relatively rapid southeastward movement, away from the Gibraltar entrance at a rate of 5.5km (11 pixels) in 3:10 hours and relatively slow southwestward flow at a rate of 2.0km (4 pixels) in 3:10 hours along the shallow coastal lines. The net motion depicts the presence of an anticyclonic circulation in the Gulf. Ultimately the compatibility of the OCE data analysis with the sea-truth will have to be tested when the buoy measurements and wind field data for November 14, 1981 become available. However, near the Strait entrance historical current measurements show a strong surface current in the upper 100 meter layer which flows into the Mediterranean sea along the coast of N. Africa and Spain. Also, a relatively saline Mediterranean undercurrent flows out from the narrow strait at greater than 100 meter depth and surfaces at some distance into the Atlantic.

BATHYMETRY

The Great Bahama Bank forms a semicircular shoal whose depth ranges from few meters to tens of meters. Gradients in depth occur at the northern edges known as the Tongue of the Ocean. This interesting topographic feature is surrounded with sea water with low oxygenation. Thus the area is characterized by the scarcity of the planktonic forms of marine life. Combination of the above circumstances make the area among the clearest ocean water area suitable for visual observation of the underwater topography. The blue-green components of visible light, in the absence of chlorophyll pigment, penetrate deep into the water and reflect from the bottom and yield return signals. The data taken from Orbit 32 at 8:24 a.m., (EST), in the vicinity of Nassau and Andros Islands were processed to depict the under water topographic features of the Bank as shown in Figure 7. The enhanced false color image is based on the upwelling radiance of the 518nm band. The return signal is related inversely to the depth of the water. The upwelling spectral radiances taken from a shallow zone and from a deep water zone of Figure 7 are

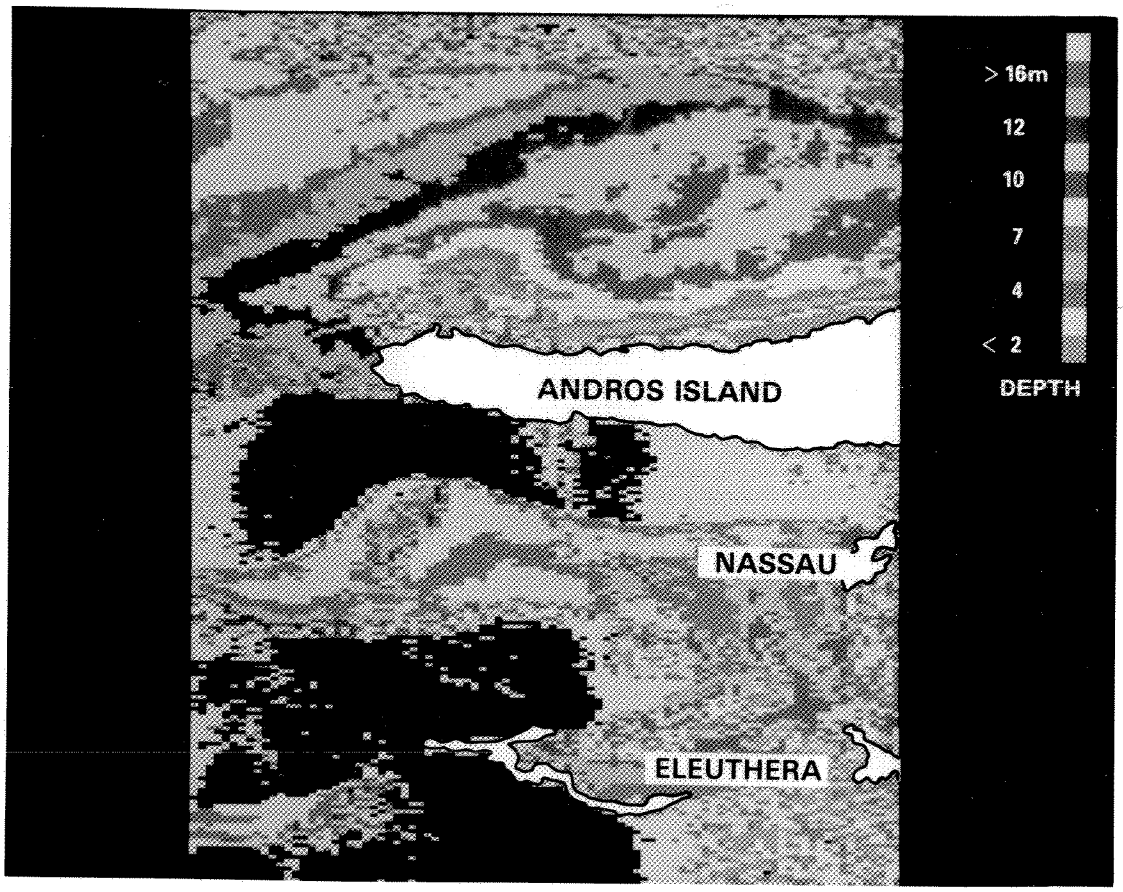

Figure 7. False color image of the Great Bahama Bank and its vicinity on November 14, 1981, 8:25 a.m. (EST) from Orbit 32. The ocean depth is depicted by the various colors assigned by the color bar.

shown in Figure 8. The dotted lines of water sub–surface radiance are corrected for the atmospheric effects. The hatched areas represent signals which are from the bottom reflections.

The differences between the spectra of bottom reflection in Figure 8 and that of the sediment laden backscattering in Figure 3 are interesting. These spectra clearly illustrate the difficulties one can encounter in analyzing coastal chlorophyll.

DISCUSSION

Because of the orbiter's shortened mission, the OCE netted only a minimum amount of clear ocean view data. Also some of the surface experiments designed to validate interpretations of OCE observation were not carried out because of the delays and rescheduling of the Shuttle launch date.

In spite of these difficulties, the authors believe, the primary objectives of the OCE were achieved. The three cases presented exemplify a wide variety of ocean phenomena that were observed and analyzed from the color expressions of the ocean.

The OCE has demonstrated that, properly treated, the ocean colorimetry will provide a simple and direct method of remote sensing of the oceans. Up to now, oceanographic studies incorporating satellite imagery of visible color would be limited to inferring near shore and estuarine circulation. In those regimes, a high reflectivity by suspended material provides relatively easy signature to identify. The method of detecting variation in chlorophyll concentration in spatial and time domains promises a new dimension.

In order to measure the concentrations of phytoplankton pigments in the ocean, the radiance detected at satellite altitudes needs to be corrected for the atmospheric effects. The method devised to remove the aerosol effects for CZCS is a possible alternate method.[6] But in our OCE analysis, a sophisticated model was incorporated to account for all the components in absolute radiance as given in Table 2. The outcome of such a method provides us with a consistent

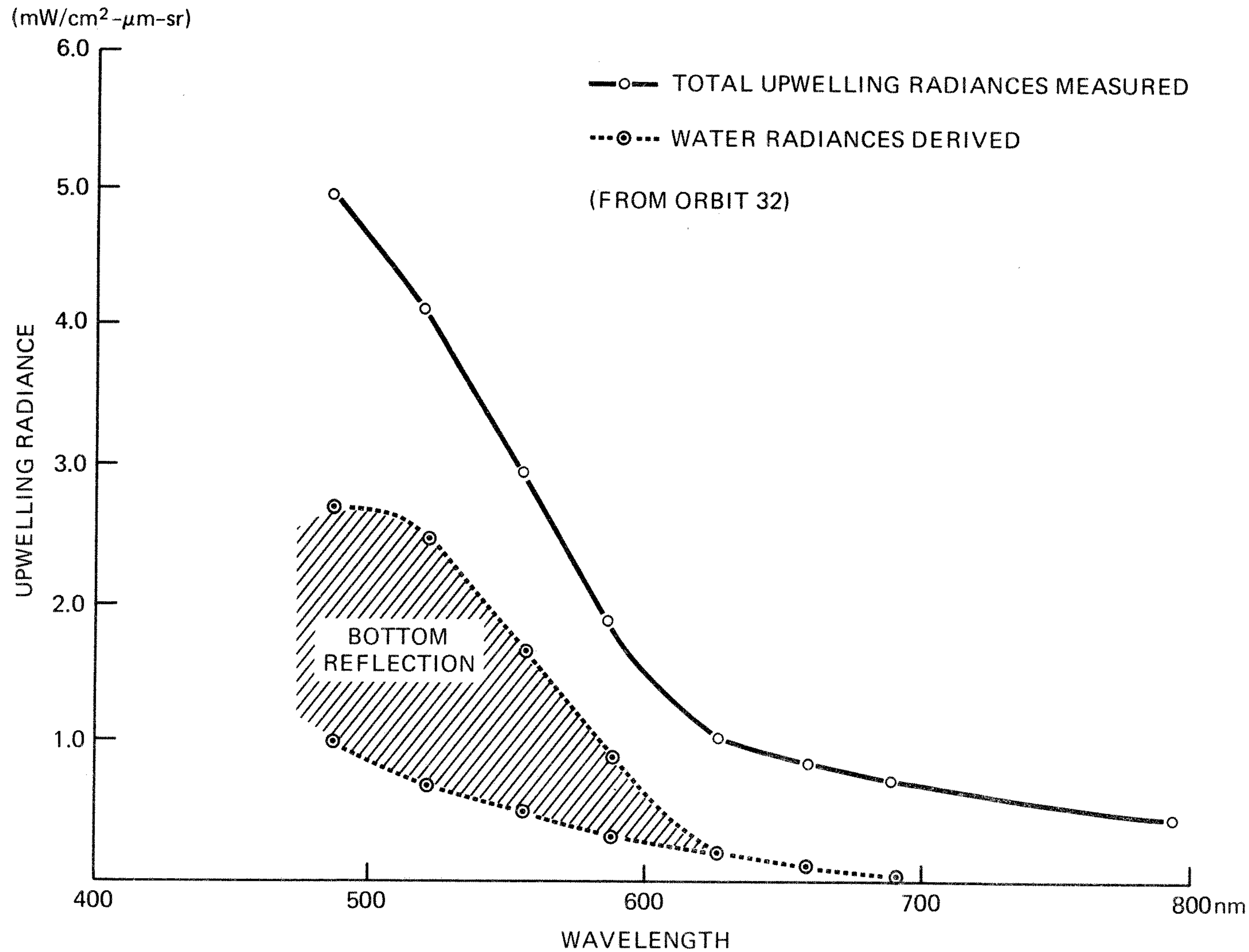

Figure 8. Upwelling spectral curves from two selected areas of the Great Bahama Bank scene (Figure 7). The top solid curve is the total upwelling radiance from a shallow zone perceived by the sensor, and upper dotted line is the derived water radiance. The derived water radiance from a deep water, the Tongue of the Ocean area, is given in dotted line lower case. The hatched area corresponds to the portion of radiance attributed to the ocean bottom reflection.

relationship between the signal measured and the concentration of the chlorophyll pigments in the open ocean.[7] However, the spectral curves in Figures 3 and 8 imply that chlorophyll analyses are still limited to the type of oceanic conditions of hydrospheric homegeneity and clarity.

The method of using chlorophyll concentration as tracers promises an interesting aspect in deducing oceanic flow patterns of a large area (Figure 6). Plankton patches are a natural drifter which can be tracked by satellites. Thus the color scanner, properly operated, has proven to be directly applicable to studies of circulation models and features in addition to studies of biological processes. Finally, the analyses and results in this paper are only an initial assessment and other in depth studies by colleagues are expected to follow. Those data of clear ocean view listed in page 6 will be archived at the National Space Science Data Center (NSSDC) located at the NASA/Goddard Space Flight Center, Greenbelt, Maryland 20771, and will be made available to the public.

ACKNOWLEDGMENT

An experiment as complex as this OCE involves many individual and space is too limited to acknowledge the contributions of each individual. However, the authors would like to make a special acknowledgment of the contribution rendered by two project engineers at GSFC, Dave Clem and Bertrand Johnson, who were responsible for the flawless performance of the OCE instrument during the mission.

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BIBLIOGRAPHIC DATA SHEET

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16. Abstract

Ocean view images from the Ocean Color Experiment (OCE) were produced at three widely separated locations on the earth. Digital computer enhancement and band ratioing techniques were applied to radiometrically corrected OCE spectral data to emphasize patterns of chlorophyll distribution and, in one shallow, clear water case, bottom topography. The chlorophyll pattern in the Yellow Sea between China and Korea was evident in a scene produced from Shuttle Orbit 24. The effects of the discharge from the Yangtze and other rivers were also observed.

Two scenes from orbits 30 and 32 revealed the movement of patches of plankton in the Gulf of Cadiz. Geometrical corrections to these images permitted the existing ocean current velocities in the vicinity to be deduced. The variability in water depth over the Grand Bahama Bank was estimated by using the blue-green OCE channel. The very clear water conditions in the area caused bottom reflected sunlight to produce a sensor signal which was related inversely to the depth of the water.

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(2960)	01740171	018F019E	01A601A8	01B201AB	01AD01AF	01A701AF	01A101A1	01A2019C	01AC01A9	01B601B0
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(3040)	01BF01CA	01C301C2	01D301E1	01B901BD	01B601BA	01AD01C4	01B201B3	01C201C4	01CD01D5	022D02D0
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(3160)	01CD01C5	01BD01B5	01AD01A3	019A0192	02E90000	00000000	00000000	00000000	00000000	00000000
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(3320)	02AA02A7	02B002AF	02AC02A8	029F028A	028202A7	02AA029F	02AE028A	028502AC	02950274	02730268
(3360)	0268025B	025B024E	0247023F	021E0211	0215020C	02150229	02220228	022E023A	02350222	021E022C
(3400)	022B0218	020F020D	020F020B	02060207	020F020F	02020210	02030201	01FD01FD	01F101FA	02100210
(3440)	01FB01F3	022201FF	01F701FF	021F01F3	02220225	02950296	028E029D	02B102AD	02AC02B1	02DC02F6
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(4160)	02BB02B4	02CC02D7	02E702BA	02DC02FF	03200320	03200320	03200320	03200320	03200320	03200320
(4200)	03200320	03200320	03200320	03200320	03200320	03180320	03200320	02C70294	02BD0285	02700271
(4240)	0266025B	024F0245	023A022D	02210216	02E90000	00000000	00000000	00000000	00000000	00000000
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(5360)	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
(5400)	00000000	00000000	00000000	00000000	00000000	00000000	00000000			

FILE	INPUT RECS.	DATA RECORDS INPUT	MAX. SIZE	READ ERROR SUMMARY PERM	ZERO B	SHORT	UNDEF.	INPUT RETRIES #RECS.	TOTAL#
2	2214	2214	5428	0	0	0	0	0	0

EOJ DUMP STOPPED AFTER FILE 2 # OF PERMANENT READ ERRORS 0

START TIME 10/18/82 10:43:41 STOP TIME 10/18/82 10:45:23

$$

D-53323
C-22684

```
$NOP
$NOP
$NOP ******************  EBCDIC LIST OF GOUT-2  ************************
$EXE TPLIST BS

INPUT PARAMETERS ARE:  ED SR=1=1 2

 TAPE NO.   1              FILE NO.   1
 RECORD   1                LENGTH   636
OCE NOV12-NOV14,1981 STS-2 ORBIT NOS 31,32A,32B
                                          ORBIT31B SW SPAIN     318  12  08 318  12  15     ORBIT32A BAHAM
AS      318  23  32 318  26  00     ORBIT32B ATL-GIBRLTR 318  13  39 318  13  42



 TAPE NO.   1              FILE NO.   2
 RECORD   1                LENGTH   172
ORBIT 31B,HDG 101DEG,SOL ZEN ANG 60DEG,ALT 142NM,SE.SPAIN TO EAST MEDITERREAN      36  08 001  18  3
1  40 034  15318 12  08  318 12  15  KIM,PIEPEN,VIOLLIER 08/30/79

***** JOB DONE.
$AVF IN 3
$EXE TPLIST BS

INPUT PARAMETERS ARE:  ED SR=1=1

 TAPE NO.   1              FILE NO.   1
 RECORD   1                LENGTH   172
ORBIT 32,HDG 101DEG,SOL ZEN ANG 58DEG,ATL 143NM,ATLANTIC SOU EAST TO GIBRALTAR     37  49-016 -04  3
5  19 000 -33318 13  38  318 13  42  KIM,PIEPEN,VIOLLIER 08/30/79

***** JOB DONE.
$EXE TPDUMP BS
```

DUMP OF TAPE GOUT-2

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INPUT TAPE  GOUT-2  ON  MT1
DATA INPUT    H9 NF 2 SR 1 2 1 SR 2 2 1

 FILE       1  RECORD        2  LENGTH     220BYTES
 (      0)  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000
 (     40)  00000000  00000000  00000000  00000000  00000000  00000000  00000000  401256E7  00000000  00000000
 (     80)  3FCDE7EA  00000000  00000000  3F92AD81  00000000  00000000  3F72A5A4  00000000  00000000  3F590C0A
 (    120)  00000000  00000000  3F491298  00000000  00000000  3F3F52FC  00000000  00000000  3F2EEB46  00000000
 (    160)  00000000  00000000  00000000  00000000  00000000  417289F  41506E97  41394BC6  412CC8B4  4122C8B3
 (    200)  411C8B43  4118BC6A  40FFBE75  00000000  00000000

        FILE   INPUT    DATA RECORDS    MAX.         READ ERROR SUMMARY           INPUT RETRIES
               RECS.       INPUT        SIZE     PERM  ZERO B   SHORT  UNDEF.  #RECS.  TOTAL#
          1       2          2           636       0      0       0       0       0       0
******     EOF ON COMPLETION OF DUMP FOR REQUEST SR=1=2=1

 FILE       2  RECORD        2  LENGTH    5428BYTES
 (      0)  0001D5E5  F1F9F8F1  18AD013E  000C0008  00140000  01A3E7B4  000000E1  02C3015E  016801A5  01810159
 (     40)  0151015C  01500139  015B0161  015F015B  01450125  0129014B  0153014A  01530141  01660151  01630165
 (     80)  01510111  01270152  014B0130  01160117  01140142  01420144  013E012E  01120129  01290106  01010108
 (    120)  010D0107  00FE0120  0139010D  0111011A  0110011B  01170119  011C0115  0125011E  0120012F  012D0119
 (    160)  01150104  00FE011D  01470159  0141013C  01320154  013F0138  01210148  012A0146  01510154  013A0159
 (    200)  01770213  011B01EA  0160014B  012F019B  020101E7  010D027D  03200158  012D021E  01900152  01BA0320
 (    240)  03200320  03200320  032001EA  0120023F  024E0277  03200320  01F4011B  0122013F  01390152  010300FD
 (    280)  010F0132  01D8021C  024A0190  01F50320  02EA02E9  03200320  03120177  02460320  03200320  03200320
 (    320)  03200320  015301AF  01A0015B  011F012D  01300120  010E00F8  00EB00E3  00E200E0  00E400E3  00E200E4
 (    360)  00E800F3  00EF00ED  00ED00EA  00EA00EF  00EE00EE  00F200F3  00F800F8  00FA00FC  01010109  010B010C
 (    400)  010E0111  01150117  011D0122  0125012A  012F0134  01380137  01380136  01330130  012D0127  0124011D
 (    440)  0119010D  00FF00F4  00E700DD  00D900D5  00CF00C9  00C500C0  00BB00B5  00B200AD  00A800A3  01720000
 (    480)  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000
 (    520)  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000
 (    560)  00000000  00000000  02D801AA  01AE0206  02100190  01860197  01820163  0195019E  019C0197  017B014E
 (    600)  0159018E  019A0187  0194017A  01B30194  01AD01AF  018E012E  014D0195  0183015B  01390138  01310174
 (    640)  01740179  016F0157  0133015B  01590121  01200127  012D0127  011A0150  01740131  01380142  01330144
 (    680)  0140013F  0148013D  0155014E  01510166  01640146  01420128  0120014F  019201AD  01880181  016F01A1
 (    720)  01830178  01540190  0161018E  019A01A0  017A01A0  01C00251  0143025E  019C0197  015F01EE  02440229
 (    760)  011902CE  03200190  0164029F  01E90186  01FC0320  03200320  03200320  03200249  014602A6  022302AE
 (    800)  03200320  0200013C  01600174  01690199  0123011D  0134015D  0243029D  02C001D7  02510320  03100318
 (    840)  03200320  032001AC  02AE0320  03200320  03200320  03200320  016601F8  01D90180  0138014A  014A0136
 (    880)  011E0103  00F400EC  00EC00ED  00F000EF  00EE00F1  00F40102  00FD00FA  00FB00F8  00FA00FC  00FB00FE
 (    920)  01030105  0108010D  010F0113  01180124  01250128  01280130  0134013A  01420140  014D0154  015B0161
 (    960)  01660166  01680165  01620161  01580156  0152014E  01450139  012A011D  010F0104  00FF00FA  00F400EF
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 (   1040)  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000
 (   1080)  00000000  00000000  00000000  00000000  00000000  00000000  00000000  03200252  025002B6  02DF021D
 (   1120)  01F8021F  01FF01CB  020E0219  02200214  01F301B9  01BC0211  022A0209  021801F3  02550220  024B024B
 (   1160)  021E0184  01B00217  020201C3  018C0190  018401DA  01E401EC  01DB01BB  01CE01CE  01D70179  016C017A
 (   1200)  0134017B  016801BA  01F9018D  019901A1  018801A0  019E019E  01AE019D  01C501B7  01BD01DD  01810184
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 (   1280)  024302DD  01AC02F2  0228021F  01E70275  02B402CE  018402F1  0320024F  01D702F6  028801F5  02710320
 (   1320)  03200320  03200320  032002FC  019F02DF  02F90315  03200320  02AC01B9  01BA01DB  01C60224  017C0165
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 (   1440)  01130126  011F011B  01180118  0118011E  011E0120  0123012B  01320135  013A0141  01490157  0159015B
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 (   1600)  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000
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(2320)	026B0227	01E50263	03200320	03200320	03170320	031902F6	02910304	02CF02AB	031C0320	02CA02DD
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(3040)	01840151	01320125	01270128	01300132	01310136	01440166	015A0157	01580155	01580161	01620167
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(3320)	03200232	02B3031C	032002D7	023A024E	0238030A	03200320	03200319	028D030C	03200257	02130230
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(3520)	023C028E	03200320	03200320	03200320	03200320	03200320	032002BB	03200320	03200320	03200320
(3560)	03200320	021502BD	02EB027C	01AC01DC	01DE01AE	01780145	0126011A	011B011C	01250127	0127012D
(3600)	013A015F	0153014F	0151014D	0151015B	015C0162	01710178	01860190	019B01A8	01BC01D5	01DC01E3
(3640)	01EF01FF	020C021E	02360247	0255026A	027F0290	02A502AE	02C202CB	02D202DA	02D502D4	02D502D6
(3680)	02CE02BD	02A5028F	02760268	025F0255	0249023F	02340228	021D0214	020C01FF	01F401EB	025C0000
(3720)	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
(3760)	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
(3800)	00000000	00000000	03200320	03200320	03200320	03200320	03200320	03200320	03200320	03200320
(3840)	03200320	03200320	03200320	03200320	03200320	03200320	03200320	03200320	03200320	03200320
(3880)	03200320	03200320	03200320	03200320	03200320	03200320	03200320	03200320	03200320	03200320
(3920)	03200320	03200320	03200320	03200320	03200320	03200320	03200320	03200320	03200320	03200320
(3960)	03200320	03200320	03200320	03200320	03200320	03200320	03200320	03200320	03200320	03200320
(4000)	025E0319	03200320	03200320	03200320	03200320	03200320	03200320	03200320	02EB0320	03200320
(4040)	03200320	02FD0320	03200320	03200320	03200320	03200320	03200320	03200320	03200320	03200320
(4080)	03200320	032002EE	03200320	03200320	03200320	03200320	022102B6	02530291	01C201F4	01F4018D
(4120)	017E0145	01210115	0119011B	0126012A	012A0134	01440173	0165015E	01630160	01650173	01750176
(4160)	0190019A	01AD01BB	01CA01DA	01F40216	0221022A	023C0251	02620278	029602AE	02C002DA	02F70309
(4200)	0319031F	03200320	03200320	03200320	03200320	03200320	03200320	03200320	03200320	0320031F
(4240)	031A0312	030902FE	02ED02D8	02C602B5	02F20000	00000000	00000000	00000000	00000000	00000000
(4280)	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
(4320)	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
(4360)	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000

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( 4440)  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000
( 4480)  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000
( 4520)  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000
( 4560)  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000
( 4600)  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000
( 4640)  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000
( 4680)  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000
( 4720)  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000
( 4760)  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000
( 4800)  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000
( 4840)  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000
( 4880)  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000
( 4920)  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000
( 4960)  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000
( 5000)  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000
( 5040)  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000
( 5080)  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000
( 5120)  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000
( 5160)  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000
( 5200)  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000
( 5240)  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000
( 5280)  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000
( 5320)  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000
( 5360)  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000  00000000
( 5400)  00000000  00000000  00000000  00000000  00000000  00000000  00000000

      FILE   INPUT    DATA RECORDS    MAX.         READ ERROR SUMMARY            INPUT RETRIES
             RECS.       INPUT        SIZE      PERM  ZERO B   SHORT  UNDEF.   #RECS.   TOTAL#
        2    1720     1720            5428        0      5       0      0        5        5

 EOJ        DUMP STOPPED AFTER FILE   2          # OF PERMANENT READ ERRORS  0

START TIME 10/18/82  10:41:31         STOP TIME 10/18/82  10:42:52
```

```
$$
$ASS IN TD2
```