

~~Dr. Glau~~  
file

U.S. DEPARTMENT OF COMMERCE  
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION  
NATIONAL WEATHER SERVICE  
SYSTEMS DEVELOPMENT OFFICE  
TECHNIQUES DEVELOPMENT LABORATORY

TDL OFFICE NOTE 81-1

A USER'S GUIDE TO COSMOS  
(COMPOSITE OIL SPILL MODEL FOR OPERATIONAL SERVICES)

Kurt W. Hess

January 1981

## CONTENTS

	Page
1. INTRODUCTION	2
2. MODEL PHYSICS	2
3. OPERATIONAL USE OF THE MODEL	4
4. DESCRIPTION OF THE DATA INPUT FILES	5
REFERENCES	8
Appendix I. Sample Run #1: Submitting a Job	9
Appendix II. Sample Run #2: Listing a Job Output	11
Appendix III. Sample Output from Files	14
Appendix IV. JCL and Data Listing	17
Appendix V. Listing of Main Program	20

## PREFACE

This User's Guide is meant to describe the use of the National Weather Service's oil spill behavior forecast model, COSMOS (Composite Oil Spill Model for Operational Services), produced by the Techniques Development Laboratory. The model is designed to predict the behavior of floating oil from a fixed source point in the coastal zone (shore line out to 360 miles), excluding small bays. A forecast of the oil slick geometry for each 12 hours, out to 48 hours is plotted on a background map showing the local coastline. The primary input data for the model are the latitude and longitude of the spill site, the width of the map desired, the oil flow rate, and the initial distribution of oil on the water. Wind forecasts for the spill are made automatically by COSMOS using atmospheric model pressure and temperature forecasts.

This manual contains a brief description of the model physics, and gives a detailed explanation of the input data format. Sample runs and outputs are given in appendices to help acquaint the model user with COSMOS.

USER'S GUIDE TO COSMOS  
(COMPOSITE OIL SPILL MODEL FOR OPERATIONAL SERVICES)

Kurt W. Hess

1. INTRODUCTION

COSMOS is the National Weather Service's (NWS's) oil spill behavior model. This version computes the two-dimensional motion of a finite thickness of oil at the sea surface under the action of wind stress and water currents. The position of the oil slick is plotted each 12 hours on a map which includes the local geography.

The user gives the latitude-longitude coordinates of the spill, and COSMOS goes to the Limited-area Fine Mesh (LFM) model 1000-mb forecasts of pressure and temperature to compute the surface geostrophic wind. Then COSMOS uses a steady Rossby number similarity model of the planetary boundary layer to compute the wind stress at the sea surface. This stress drives a hydrodynamic model of the continental shelf region, which computes horizontal velocities and water surface elevations. Then the current at the surface is used to calculate the stress at the under side of the oil. Another model for two-dimensional oil motion is used to compute the time history of the oil slick. The positions of oil on the water are drawn on a map which uses the National Meteorological Center (NMC) geography files. Map width (degrees) and height can vary.

COSMOS is accessed by the program WE10ILY7. The data necessary to run COSMOS is stored on five files, and these data can be changed at will for specific user needs. The following is a brief description of the technical aspects of COSMOS. For more details, refer to Hess and Kerr (1979).

2. MODEL PHYSICS

The vector equation for oil motion comes from the depth-integrated form of the horizontal fluid momentum equation. The mass equation comes from the vertically-integrated continuity equation and gives the oil thickness. The equations are solved on a finite-difference grid of 1-km size. The mass equation uses a mass flux correction scheme to eliminate nearly all artificial diffusion. The vector momentum and mass conservation equations are:

$$\frac{\partial \underline{u}}{\partial t} = - \frac{\rho_w - \rho_o}{\rho_o} g \nabla h + \frac{1}{\rho_o} (\underline{\tau}_s - \underline{\tau}_b) + f \hat{k} \times \underline{u}, \text{ and}$$

$$\frac{\partial h}{\partial t} = - \nabla \cdot (h \underline{u})$$

where  $u$  = oil velocity vector (m/s),  
 $\tilde{\rho}_w$  = mass density of water (gm/cc),  
 $\rho_o$  = mass density of oil (gm/cc),  
 $g$  = gravitational acceleration (m/s<sup>2</sup>),  
 $h$  = oil thickness (m),  
 $\tau_s$  = surface tangential stress vector ( $\frac{\text{gm} - \text{m}}{\text{s} - \text{cm}^3}$ ) =  $\rho_a V_*^2$ ,  
 $\rho_a$  = mass density of air (m/s),  
 $V_*$  = friction velocity of air (m/s),  
 $\tau_b$  = bottom tangential stress vector ( $\frac{\text{gm} - \text{m}}{\text{s} - \text{cm}^3}$ ),  
 $\hat{f}$  = Coriolis parameter (s<sup>-1</sup>), and  
 $\hat{k}$  = unit vector in the vertical.

The wind stress is obtained by applying an atmospheric boundary layer model (BLM) to compute the friction velocity and surface deflection angle. The input for this BLM is the geostrophic wind computed from the LFM 1000-mb heights and 1000-mb temperatures. Implicit equations for the friction velocity and deflection angle, based on Rossby number similarity, are:

$$\ln(R_o) = A - \ln(V_*/G) + ((kG/V_*)^2 - B^2)^{1/2} \text{ and}$$

$$\sin(\alpha) = BV_*/kG$$

where  $R_o$  = surface Rossby number =  $G/fZ_o$ ,  
 $G$  = magnitude of the geostrophic wind (m/s),  
 $Z_o$  = surface roughness height (m) =  $0.035V_*^2/g$ ,  
 $A = 1.1 + 0.20 S_x - 0.40 S_y$ ,  
 $B = 4.3 - 0.32 S_x - 0.35 S_y$ ,  
 $S_x = -(k/f)^2 (g/T) \partial T/\partial x$ ,  
 $S_y = (k/f)^2 (g/T) \partial T/\partial y$ ,  
 $T$  = boundary layer temperature (°K),  
 $k$  = von Karman's constant = 0.40, and  
 $\alpha$  = deflection angle from geostrophic wind to the stress vector.

Surface water currents are computed on a grid representing the local bathymetry by the equations of momentum balance and continuity. The vertically-integrated flow rate is computed with the storm surge equations and wind stress; the bottom stress condition is the slip relationship (Jelesnianski, 1967). Continuity is used to find the surface elevation. Then the horizontal pressure gradient can be used in the horizontal momentum equation. The equation is solved with the same surface and bottom stresses. This equation is:

$$\frac{\partial w}{\partial t} = p - ifw + \frac{\partial}{\partial z} \left( E \frac{\partial w}{\partial z} \right) - rw$$

where  $w$  = complex horizontal velocity (m/s),  
 $p$  = complex horizontal pressure gradient term (m/s<sup>2</sup>),  
 $i$  =  $(-1)^{1/2}$ ,  
 $E$  = vertical eddy viscosity (m<sup>2</sup>/s), and  
 $r$  = linear damping factor (s<sup>-1</sup>).

Eddy viscosity varies from a surface value,  $E_0$ , linearly increasing with depth to a value  $E_1$  at depth  $D_1$ , and remains constant down to the bottom of the mixed layer, of depth  $D_e$ . Here

$$E_0 = kWZ_0 \text{ (m}^2\text{/s),}$$

$$W_* = \text{water friction velocity (m/s) = } (\tau_s / \rho_w)^{1/2}$$

$$E_1 = 0.004 W_*^2 / f \text{ (m}^2\text{/s),}$$

$$D_1 = E_1 / k \text{ (m), and}$$

$$D_e = 0.25 W_* / f \text{ (m).}$$

### 3. OPERATIONAL USE OF THE MODEL

COSMOS is permanently mounted on NWS production files for ready access on short notice. The model program takes less than a minute to execute, and has an operational priority for running on the NMC computer in Suitland, Md. COSMOS is accessible by submitting a batch or time-share job at an available terminal. If a remote terminal is unavailable, results of the model run can be telecopied to the field user.

For each oil spill, the input data expected to change are the latitude-longitude coordinates of the site, the width of the map upon which the oil slick is plotted, the initial distribution of oil on the water, and possibly the oil flow rate. Oil density is assumed to be 0.950 grams per cubic centimeter, and its value has little influence on the predicted oil behavior. Oil surface tension effects are not included in the model. Although COSMOS makes its own wind forecasts out to 48 hours over the coastal region around the oil spill, the user has the option of substituting his or her own wind forecast.

The output for COSMOS is given on files FT06F001, FT08F001, and FT12F001, of which the last is the most important. FT12F001 contains a list of the input data, a table giving the wind forecasts at the oil spill site, and a set of five maps, one each for the 0-, 12-, 24-, 36-, and 48-h forecasts (see Appendix III). Each map shows the local coastline and oil slick in a region centered about the latitude-longitude of the spill with the given map width. The heading block of each map explains what the various map symbols mean and gives the volume of spilled oil depicted.

File FT08F001 contains an array depiction of the oil corresponding to each map. The relative oil thickness, as a log of the ratio of thickness to the scale thickness, is given with the volume, in thousands of gallons. These data can be used as input, in file FT10F001, when making the next day's forecast. File FT06F001 contains details of the model calculations.

Data input for COSMOS is through several files. For the first day's run, the spill latitude and longitude and the map width are reset in file FT05F001 (see Appendix IV). Initial volume and distribution of oil are specified in FT10F001. And the flow rate, in thousands of gallons per day, is specified in

FT35F001. After any changes are made in the input files, the program is submitted for execution, and output returns shortly thereafter (usually within 5 minutes).

Other options the user is likely to exercise are described in the next section, in file FT05F001. The main features allow the user to:

- a. shift the spill site on the map using ID4, ID6, and ID7,
- b. read in 6-hourly, spatially constant water currents with ID10,
- c. read in 6-hourly winds (ID11) to modify or substitute for the wind forecast,
- d. change the LFM input data cycle time (ID12),
- e. add constant water velocities (WSNORT, WSEAST), and
- f. add a wave drift equal to a percentage (DFAX) of wind speed.

Furthermore, the user can change variables in the common blocks in the program (Appendix IV). Variables such as oil density (RHOO) and the oil-water interfacial drag coefficient (CDRGOW) can be altered this way.

#### 4. DESCRIPTION OF THE DATA INPUT FILES

##### File FT05F001

This file contains the essential model data and determines what other files are to be read.

##### Card 1

ID1, ID2, ID3, ID4, ID5, ID6, ID7, ID8, ID9, ID10,  
ID11, ID12, WSNORT, WSEAST, STRTCH, DFAX, DANG,  
TAMS, JD1, JD2, JD3. FORMAT(12I3, 6F5.2, 3I3).

ID1 = Model level:

- 1=Make a wind forecast only.
- 3=Run the full composite model.

ID2 = Width of map field (degrees), with a maximum of 14. Width is 80 spaces, height is 80-ID6-ID7 spaces. Height in degrees varies with latitude.

ID3 = Oil source at wind site (0=no, 1=yes)

ID4 = Number of plot spaces the source is moved to left from the center ( $39 \geq ID4 \geq -39$ ).

ID5 = Number of NMC model (0=LFM2, 2=Spectral)  
(COSMOS is presently set up to use only the LFM).

ID6 = Number of lines at top of geography array not plotted (if both ID6 and ID7 are zero, a default value of 20 is assumed for both).

ID7 = Number of lines at bottom of geography array not plotted.

ID8 = Maximum forecast projection time + 1 (hours).

ID9 = (Vacant).

ID10 = Read in 6-hourly water velocities (0=no,1=yes) (if ID10=0, WNO = WEA = 0.).

ID11 = Read in 6-hourly wind velocities:  
0=No.  
1=Multiply forecast wind by AD10 and add angle APhi (APhi is in degrees and is measured clockwise from east. Direction is that toward which the wind blows).  
2=Substitute AD10 (kt) and APhi for forecast wind.

ID12 = Override time of latest NMC forecast (0=no,1=yes).

WSNORT = Constant water speed to the north (m/s) added to the computed current.

WSEAST = Constant water speed to the east (m/s) added to the computed current.

STRTCH = Stretch factor for plotting (0.00=TSO, 0.41=HETRA).

DFAX = Percent of wind speed (square root of stress) assumed for wave (Stokes) drift.

DANG = (Vacant).

TAMS = Temperature of air minus that of sea (°C) (Non-neutral version not fully tested. Keep=0.00).

JD1 = Print out wind and drift calculations (0=no,1=yes).

JD2 = Print out grid setup calculations (0=no,1=yes).

JD3 = Print out water velocity and oil calculations (0=no,1=yes).

Card 2

PLAT, PLON  
FORMAT (2F7.2)

PLAT = North latitude (°) of oil spill site.

PLON = West longitude (°) of oil spill site.

File FT10F001

This file contains information about the initial slick position and volume. Output in this format is printed each 12 hours on file FT08F001.

Card 1

GAL,DL,MA,MB,NA,NB  
FORMAT(2F10.2,4I4)

GAL = Initial oil volume, thousands of gallons.

DL = Grid length (m).



MA,MB = First and last row with oil 50 x 50 grid (numbering from top to bottom).

NA,NB = First and last column with oil (left to right).

Cards 2 to J (IH(N,M),N=NA,NB) on row M.  
J=MB-MA+2      FORMAT (50I1)

IH = Log10 of (oil thickness/minimum thickness)(see output file FT08F001 for a sample of the IH array).

File FT15F001

This file contains additional water speeds (m/s) which are added to the surface wind drift current. Only read if ID10=1. WNO is the current to the north, WEA is current to the east. Values are for each 6 hours from 0 out to 48 hours.

Card 1      WNO(I),I=1,9      FORMAT(9F7.2)

Card 2      WEA(I),I=1,9      FORMAT(9F7.2)

File FT25F001

This file contains wind speed and direction forecasts which replace those generated by the LFM and boundary-layer models in COSMOS. Speed is in knots and angle is degrees clockwise from east. Read only if ID11=1. Values are for each 6 hours from 0 out to 48 hours.

Card 1      AD10(I),I=1,9      FORMAT(9F7.2)

AD10 = Wind speed at 10 meters (kt) each 6 hours.

Card 2      APHI(I),I=1,9      FORMAT(9F7.2)

APHI = Wind direction at 10 meters (°) each 6 hours.

File FT35F001

This file contains the position and status of initial oil slick on the surface. Grid size and oil volume (thousands of gallons). First card always read.

Card 1      MAXST,IDAY      FORMAT(2I3)

MAXST = Number of oil model timesteps (at 72 per day, the usual model 2-d forecast will have 144 steps).

IDAY = Number of values of GALDAY(N) to be read.

Card 2      (GALDAY(N),N=1,IDAY)  
            FORMAT(10F7.2)

GALDAY = Oil discharge rate (thousands of gallons per day).

#### REFERENCES

- Hess, K. W. and C. L. Kerr, 1979: A model to forecast the motion of oil on the sea. Proceedings 1979 Oil Spill Conference, Los Angeles, Amer. Petroleum Inst., Environ. Prot. Agency, U.S. Coast Guard, 653-663.
- Jelesnianski, C. P., 1967: Numerical computations of storm surges with bottom stress. Mon. Wea. Rev., 95, 740-756.

## APPENDIX I

### SAMPLE RUN #1; SUBMITTING A JOB

The following is a step-by-step listing of terminal commands used to submit a run. The steps correspond to commands and responses listed on the next page. For batch processing, new data are punched on the cards and the deck is submitted.

Step	Remarks
1	Log on the terminal.
2	Enter the user ID.
3	Set the number of printed characters per line to 130.
4	Using the quick editor option, enter the COSMOS program.
5	Enter the verify command to insure printing of changes.
6	Find the character +, which is in the first line of the data input cards.
7	Move down one line.
8	Change the latitude, 25 to 40.
9	Change the longitude to 80.
10	Move up one line.
11	Change the map width from 2 to 3 degrees.
12	Save the altered program.
13	Exit the quick editor.
14	Sub the job.
15	After the job runs, the user is notified.

```

1 ○ LOGON
IKJ56700A ENTER USERID -
2 ○ $WE20KH/MARINE SIZE (250)
$WE20KH LOGON NOT 195 TSD AT 11:48:56 ON SEPTEMBER 5, 1980
NO BROADCAST MESSAGES
READY
3 ○ TERMINAL LINESIZE (130)
READY
4 ○ QED 'NWS.SDO.TDL.PROD.HURICANE.SURGE.DATA (COSMO2)'
QED
5 ○ V
6 ○ F /+/
00690 +03 2 1 0 0 0 0 49 0 0 0 0 0.0 0.0 0.0 0.0 15.0 0.0 000
7 ○ +
00700 25.00 80.00
8 ○ c /25/40/
00700 40.00 80.00
9 ○ c /80/73/
00700 40.00 73.00
10 ○ -
00690 +03 2 1 0 0 0 0 49 0 0 0 0 0.0 0.0 0.0 0.0 15.0 0.0 000
11 ○ c /2/3/
00690 +03 3 1 0 0 0 0 49 0 0 0 0 0.0 0.0 0.0 0.0 15.0 0.0 000
12 ○ S
SAVED
13 ○ END
READY
14 ○ SUB 'NWS.SDO.TDL.PROD.HURICANE.SURGE.DATA (COSMO2)'
JOB WE1DILY7 SUBMITTED
READY
ST WE1DILY7
IKJ028A STATUS REQUEST ACCEPTED
READY
I0906 JOB 5253,WE1DILY7 PRTY=(10,17) R=(300K,300K),TBM(C),PI(C),MA(A),TBM(C),ACD
S,PR,PU(C)
15 ○ IEF404I WE1DILY7 ENDED TIME=11.57.49
ADSG19 DATA SET CATALOGED, DATA SET NAME = $WE20KH.WE1DILY7.SYSMSG.DATA
ADSG19 DATA SET CATALOGED, DATA SET NAME = $WE20KH.WE1DILY7.SYSPRINT.DATA
ADSG19 DATA SET CATALOGED, DATA SET NAME = $WE20KH.WE1DILY7.FT06F001.DATA
ADSG19 DATA SET CATALOGED, DATA SET NAME = $WE20KH.WE1DILY7.FT08F001.DATA
ADSG19 DATA SET CATALOGED, DATA SET NAME = $WE20KH.WE1DILY7.FT12F001.DATA

```

## APPENDIX II

### SAMPLE RUN #2; LISTING A JOB OUTPUT

When the forecast for the oil behavior is made, the user retrieves the results. The steps correspond to commands listed on the following two pages.

Steps	Remarks
1	Use the quick editor on the desired data set
2	Verify
3	List the output, starting from the top. All input data are shown, and a list of the forecast winds given.
4	Enter the BREAK command to stop the listing.
5	Look for the last map by asking to find the set of characters 48HR.
6	List 80 lines starting from this one.
7	Enter END.

1 O QED WE1DAILY7.FT12P001.DATA  
DATASET NOT LINE NUMBERED-NONUM ASSUMED  
QED

2 O  
3 O

L COSMOS, THE 'COMPOSITE OIL SPILL MODEL FOR OPERATIONAL SERVICES', IS AT WORK.

\*\*\*\*\*  
READ IN THE FIRST DATA CARD:

1 2 3 4 5 6 7 8 9 10 11 12 W.NO W.EA S.TR D.FX D.AM T.AS J123  
3 3 1 0 0 0 0 49 0 0 0 0 0.0 0.0 0.0 0.0 15.00 0.0 000

READ IN THE SECOND DATA CARD

40.00 73.00 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

READ IN MAXST AND IGALEN = 144 2  
10.00 10.00

\*\*\*\*\*

WIND FORECAST AT LATITUDE= 40.00 LONGITUDE= 73.00

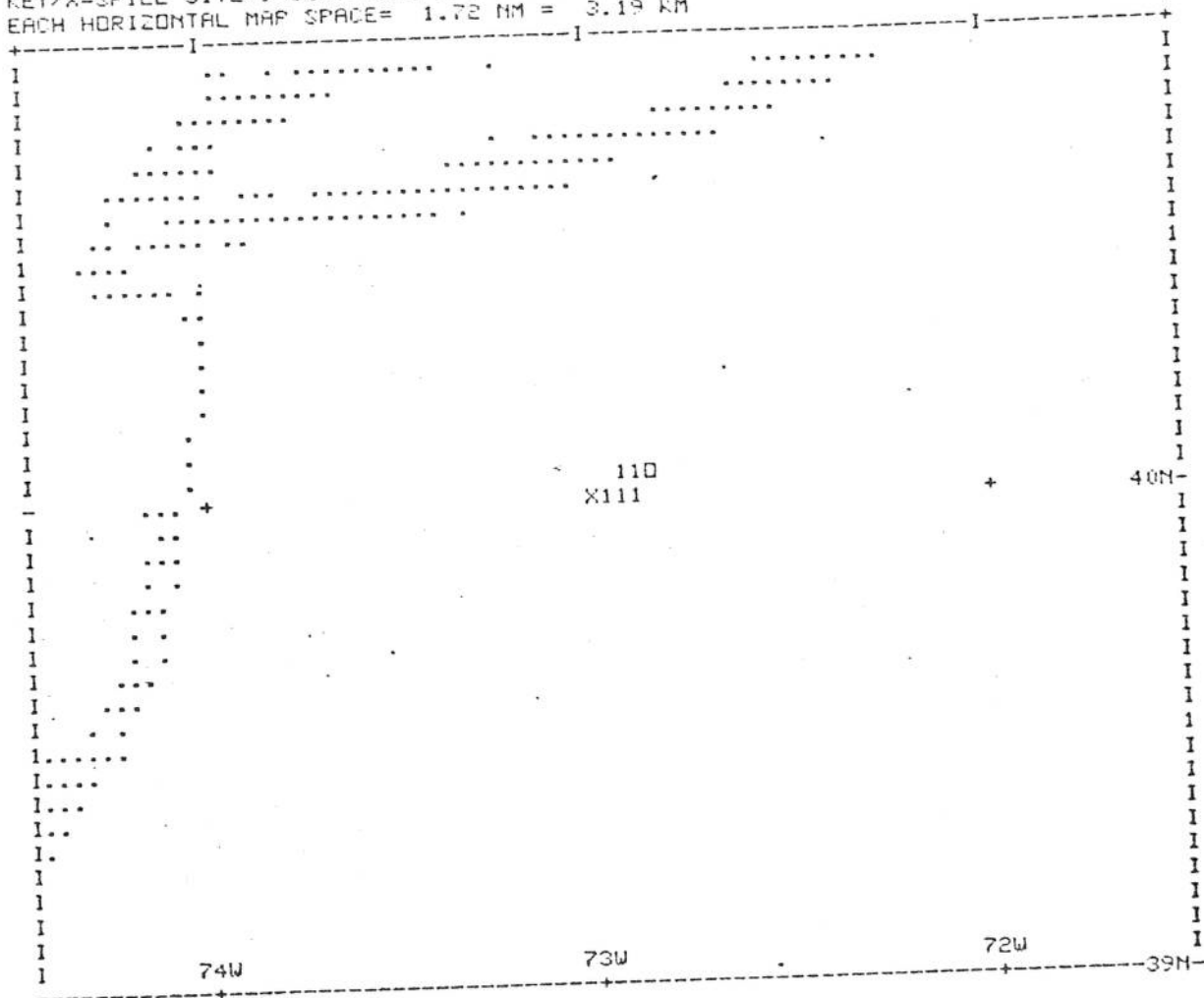
PROGRAM RUN AT 1557 HR, 5 SEP 80, W/DATA FROM 5 SEP 02 CYC OF LFM2

HR(Z)	WIND SPEED AT 10 M (M/S)	(KTS)	TD ANGLE (DEG) (+C.W. FROM EAST)
0	2.7	5.2	265.
6	2.3	4.5	294.
12	3.4	6.6	290.
18	2.0	3.9	306.
0	2.6	5.1	313.
6	2.6	5.0	3.
12	2.7	5.3	346.
18	1.7	3.3	20.
0	2.3	4.4	35.

4 O TIME= 0HR. OIL SLICK THIC:!  
QED

5 O  
6 O

F /48HR/  
L \* 80  
TIME= 48HR. OIL SLICK THICKNESS DISTRIBUTION FORECAST. NET OIL= 20500 GALI  
TIME= 48HR. OIL SLICK THICKNESS DISTRIBUTION FORECAST. NET OIL= 20500 GALI  
KEY/X=SPILL SITE/. =COASTLINE/O.1,2,3=OIL ON WATER/\* =BEACHED OIL= 0 GALI  
EACH HORIZONTAL MAP SPACE= 1.72 NM = 3.19 KM



END OF COSMOS RUN  
END OF DATA

### APPENDIX III

#### SAMPLE OUTPUT FROM FILES

- A. Sample Output from FT12F001 appears on page 15. The first 11 lines of text show the original data used for the run. The next 13 lines of text give the spill site and the wind forecast. The last 46 lines show the map of the spill region. The heading block gives the volume of the oil spilled, the time, and the volume of beached oil.
  
- B. Sample Output from FT08F001 appears on page 16. For each time interval, the heading gives the time, the time step, and the volume of oil. The arrays of numbers below the headings give the oil thicknesses in logarithm form. Within the 50x50 array, only columns NA to NB and rows MA to MB contain oiled elements.



COCMOS, THE 'COMPOSITE OIL SPILL MODEL FOR OPERATIONAL SERVICES', IS AT WORK.

READ IN THE FIRST DATA CARD.

1 2 3 4 5 6 7 8 9 10 11 12 W.NO W.EA C.TR D.FX D.AM T.AS J123  
 3 3 1 0 0 0 0 49 0 0 0 0 0.0 0.0 0.0 0.0 15.00 0.0 000

READ IN THE SECOND DATA CARD

40.00 73.00 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

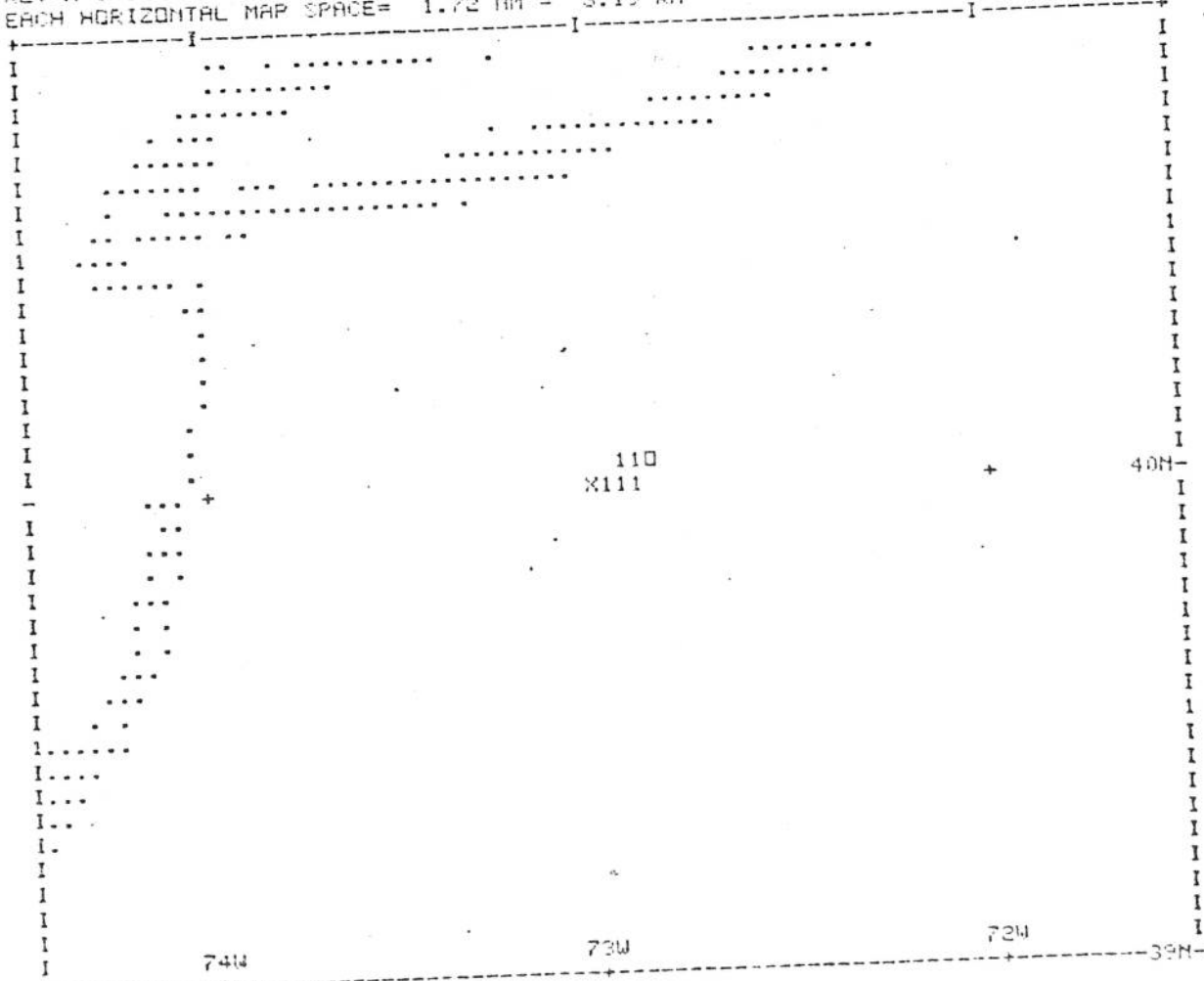
READ IN MAXST AND IGAL6H = 144 2  
 10.00 10.00

WIND FORECAST AT LATITUDE= 40.00 LONGITUDE= 73.00

PROGRAM RUN AT 1557 HR) 5 SEP 80, W/DATA FROM 5 SEP 02 CYC OF LFM2

HR(Z)	WIND SPEED AT 10 M (M/S)	(KTS)	TO ANGLE (DEG) (+C.W. FROM EAST)
0	2.7	5.2	265.
6	2.3	4.5	294.
12	3.4	6.6	290.
18	2.0	3.9	306.
0	2.6	5.1	313.
6	2.6	5.0	3.
12	2.7	5.3	346.
18	1.7	3.3	20.
0	2.3	4.4	35.

TIME= 48HR. OIL SLICK THICKNESS DISTRIBUTION FORECAST. NET OIL= 20500 GALI  
 KEY: X=SPILL SITE, =COASTLINE/0,1,2,3=OIL ON WATER/+ =BEACHED OIL= 0 GALI  
 EACH HORIZONTAL MAP SPACE= 1.72 NM = 3.19 KM



END OF COCMOS RUN

STEP= 0 TIME(HR)= 0.0 END OF DAY 0.0 NS=25 MS=25  
MA= 3 MB=48 NA= 3 NB=48 GAL= 0.0 CL= 1000.00

STEP= 36 TIME(HR)= 12.00 END OF DAY 0.50 NS=25 MS=25  
MA=20 MB=29 NA=22 NB=30 GAL= 5419.1 CL= 1000.00

20 000000000  
21 000000000  
22 000344300  
23 000454300  
24 000444000  
25 000430000  
26 000020000  
27 000000000  
28 000000000  
29 000000000

STEP= 72 TIME(HR)= 24.00 END OF DAY 1.00 NS=25 MS=25  
MA=17 MB=27 NA=22 NB=33 GAL= 10537.5 CL= 1000.00

17 000000000000  
18 000000000000  
19 000000003300  
20 000000044400  
21 000002344400  
22 000000444300  
23 000003440000  
24 000344430000  
25 000444400000  
26 000000000000  
27 000000000000

STEP= 108 TIME(HR)= 36.00 END OF DAY 1.50 NS=25 MS=25  
MA=15 MB=28 NA=23 NB=37 GAL= 15518.9 CL= 1000.00

15 00000000000000  
16 00000000000000  
17 00000000000000  
18 000000000002000  
19 000000000003300  
20 0000000000044300  
21 0000000000354300  
22 000000002444000  
23 000000004430000  
24 000000344400000  
25 004444444000000  
26 000344440000000  
27 000000000000000  
28 000000000000000

STEP= 144 TIME(HR)= 48.00 END OF DAY 2.00 NS=25 MS=25  
MA=17 MB=30 NA=23 NB=40 GAL= 20500.2 CL= 1000.00

17 0000000000000000  
18 0000000000000000  
19 0000000000000000  
20 00000000000002000  
21 000000000000023200  
22 000000000000444300  
23 000000000002444000  
24 000000000024443000  
25 004442222244400000  
26 004444444444000000  
27 000444444440000000  
28 000003344400000000  
29 000000000000000000  
30 000000000000000000

APPENDIX IV

JCL AND DATA LISTING

The following is a listing of the COSMOS program JCL and data which are stored in data set NWS.SDO.TDL.PROD.HURRICANE.SURGE.DATA(COSMOS2)

```
//WE10ILY7 JOB (WE2700306902024,TDL-10),HESS,TIME=(1,00),REGION=300K,
// NOTIFY=WE20KH
// *MAIN CLASS=NMCOPIER1
// *FORMAT AC,DDNAME=SYSSMSG,PRINT=YES
// *FORMAT AC,DDNAME=SYSPRINT,PRINT=YES
// *FORMAT AC,DDNAME=FT06F001,PRINT=YES
// *FORMAT AC,DDNAME=FT08F001,PRINT=YES
// *FORMAT AC,DDNAME=FT12F001,PRINT=YES
// *FORMAT PR,DDNAME=,DEST=GRAPHX,CONTROL=SINGLE
// EXEC NWSOPYFM,CYCLE=00Z
// COPY,FT06F001 DD DUMMY
// EXEC NWSOPYFM,CYCLE=12Z
// COPY,FT06F001 DD DUMMY
// EXEC NFORXCLG,PARM.FORT=XL,PARM.LKED='OVLY,LET,LIST,MAP'
// FORT.SYSIN DD *
```

```
BLOCK DATA
APRIL 1979 K. W. HESS TDL IBM 360/195
PURPOSE - TO INITIALIZE MANY OF THE COSMOS CONSTANTS
VARIABLES -
CL = OIL MODEL GRID SIZE
LPRIN = (UNUSED)
MSORCE = X-DIR (DOWN) OIL GRID INDEX OF SPILL SITE
NSORCE = Y-DIR (RIGHT) OIL GRID INDEX OF SPILL SITE
SUM = SUM OF ALL H(N,M) ON OIL GRID
UNAREA = RATIO OF SINGLE GRID AREA TO ORIGINAL AREA
COMMON/AUX4/CL,IGRID,SUM,UNAREA,LPRIN,NSORCE,MSORCE
DATA CL,SUM,UNAREA,LPRIN,NSORCE,MSORCE/1000.,0.0,1.0,1.25,25/
END
```

```
BLOCK DATA
APRIL 1979 K. W. HESS TDL IBM 360/195
PURPOSE - TO INITIALIZE MANY OF THE COSMOS CONSTANTS
VARIABLES -
AT = TIMESTEP OF THE HYDRODYNAMIC MODEL (S)
AG = GRAVITATIONAL ACCELERATION (M/S**2)
AL = HYDRO MODEL GRID SIZE (M)
CG = OIL MODEL GRAV. ACCELERATION (M/S**2)
CL = OIL MODEL GRID SIZE (M)
CDRGAW = AIR-WATER INTERFACIAL DRAG COEFFICIENT
CDRGOW = OIL-WATER INTERFACIAL DRAG COEFFICIENT
CMU,CMS = FACTORS MULTIPLYING WATER VELOCITIES FOR PRINT
CVISC1 = FRACTION OF LATEST EDDY VISCOSITY USED TO UPDATE
CVISC2 = (UNUSED)
CVISC3 = EDDY VISCOSITY COEFFICIENT (E1=CVISC3*WST**2/F)
CVISC4 = (UNUSED)
CVISC5 = (UNUSED)
FRICT = LINEAR DAMPING COEFFICIENT, WATER TRANSPORT EQN
FSIG = (UNUSED)
GRDANG = ANGLE HYDRO BASLINE ROTATED CW FROM NORTH (DEG)
INTVEL = POINTS SKIPPED IN GRAPH ROUTINE
IPSEUV = INDEX FOR WATER PRINTOUT(01=VEL,10=TIME,11=BOTH)
ISTART = FIRST POINT IN GRAPH ROUTINE
IT = ARRAY HOLDING HYDRO GRID INDICES (WATER,LAND)
IMAX = MAXIMUM X-DIMENSION (+DOWN) OF HYDRO GRID
MODE1 = INDEX FOR WINDS (0=2LM, 1=FT05)
MODE2 = INDEX FOR HYDRO (0=ZDATA2, 1=XDEPTH)
MODE3 = (UNUSED)
```



```

//GO.SYSIN DD *
+03 2 1 0 0 0 0 49 0 0 0 0 0.0 0.0 0.0 0.0 15.0 0.0 000
34.20 119.70
//GO.FT10FC01 DD *
0.00 0.00 0 0 0 0
1000
0100
0010
0001
//GO.FT15F001 DD *
00.00 00.00
00.00 00.00
(WNO, WEA)
//GO.FT25F001 DD *
00.00 00.00
00.00 00.00
(AV10, APHI)
//GO.FT35F001 DD *
144 2
10.00 10.00
(MAXST, DAYS)
(GALDAY(I), I=1, DAYS, IN THOUSANDS OF GALLONS)
//FT06FC01 DD SYSOUT=A
//FT08FC01 DD SYSOUT=A
//FT12F001 DD SYSOUT=A
//FM0000 DD DSN=&&FM0000Z,DISP=OLD
//FM1200 DD DSN=&&FM1200Z,DISP=OLD
//FM2400 DD DSN=&&FM2400Z,DISP=OLD
//FM3600 DD DSN=&&FM3600Z,DISP=OLD
//FM4800 DD DSN=&&FM4800Z,DISP=OLD
//FM0012 DD DSN=&&FM0012Z,DISP=OLD
//FM1212 DD DSN=&&FM1212Z,DISP=OLD
//FM2412 DD DSN=&&FM2412Z,DISP=OLD
//FM3612 DD DSN=&&FM3612Z,DISP=OLD
//FM4812 DD DSN=&&FM4812Z,DISP=OLD
//

```

APPENDIX V

LISTING OF MAIN PROGRAM

The following is a listing of the main program called in the program COSMOS.

```

//WEKHL51A JOB (WE2700ARC6382024,GRAMX-10),*KURT HESS*,CLASS=F,
// REGION=256K,MSGLEVEL=(1,1),TIME=(,20),NOTIFY=#WE20KII
// *FORMAT PP,DDNAME=,DEST=GRAMX,CONTROL=SINGLE
// EXEC NFORXCL,PARM.FORT='OPT(3),MAP,XREF,XL'
// FORT.SYSIN DD *
C*****MAIN PROGRAM FOR THE NWS OIL SPILL BEHAVIOR MODEL
MAY 1979 HESS TDL IBM 360/195

PURPOSE
TO READ LFM FIELDS, COMPUTE GEOSTROPHIC WINDS FOR A LOCAL
BOUNDARY LAYER MODEL TO GET SURFACE WINDS AND STRESSES.
ALSO TO COMPUTE OIL DRIFT TRAJECTORIES BASED ON A PERCENT
OF THE WIND SPEED, OR TO COMPUTE TOTAL OIL BEHAVIOR
BASED ON ACCELERATIONS OF OIL DUE TO WIND AND WATER STRESS.
OUTPUT IS A GEOGRAPHIC MAP WITH OIL DISTRIBUTION EACH 6 HRS

DATA SET USE
FT03 - NMC GEOGRAPHY DATA SETS (INPUT)
FT04 - HESS BASIN DATA FILES (INPUT)
FT05 - GENERAL DATA (INPUT)
FT06 - GENERAL PRINTING (OUTPUT)
FT08 - SURFACE DRIFT POSITION ARRAY (OUTPUT)
FT09 - SPLASH BASIN DATA SETS (INPUT)
FT10 - INITIAL SURFACE DRIFT POSITIONS (LEVEL=2) (INPUT)
      OR INITIAL 2-D OIL DISTRIBUTION (LEVEL=3) (INPUT)
FT12 - FORECAST WINDS AND OIL POSITION PLOTS (OUTPUT)
FT15 - ADDITIONAL WATER SURFACE VELOCITIES (INPUT)
FT25 - REPLACEMENT WIND FORECASTS (INPUT)
FT35 - NUMBER OF STEPS AND GALLONS OF OIL SPILLED (INPUT)
      (LEVEL=3 ONLY)

VARIABLES
ID1 = MODEL LEVEL
      0 = DRAW MAP ONLY
      1 = COMPUTE SURFACE WINDS ONLY
      2 = RUN THE DRIFT MODEL
      3 = RUN THE TWO-DIMENSIONAL OIL BEHAVIOR MODEL
ID2 = WIDTH OF MAP FIELD (DEGREES)
ID3 = OIL SOURCE AT WIND SITE (0=NO, 1=YES)
ID4 = NUMBER OF PLOT SPACES THE SOURCE IS MOVED TO
      LEFT FROM THE CENTER.
ID5 = NUMBER OF NMC MODEL (0=LFM2, 1=7LPE)
      (COSMO IS PRESENTLY SET UP TO USE ONLY THE LFM)
ID6 = NUMBER OF LINES AT TOP OF GEOG ARRAY NOT PLOTTED
      (IF BOTH ID6 AND ID7 ARE ZERO, A DEFAULT VALUE
      OF 20 IS ASSUMED FOR BOTH)
ID7 = NUMBER OF LINES AT BOT OF GEOG ARRAY NOT PLOTTED
ID8 = MAXIMUM FORECAST PROJECTION TIME (IF NOT 48 HR)
ID9 = NUMBER OF INITIAL LAT/LON POINTS IF OIL PRESENT
ID10 = READ IN INITIAL 6-HOURLY WATER VELS (0=NO,1=YES)
      (IF ID10=0, WNO = WEA = 0.)
ID11 = READ IN INITIAL 6-HOURLY WIND VELS (0=NO,1=YES)
ID12 = OPTION TO CHANGE IZZ (0=NO,1=YES)
      IF LEVEL=3,
          1=WIND TIMES AD10, ANGLE ROTATED APhi DEG CW
          2=WIND IS AD10 KTS, ANGLE IS APhi.

```



```

C      READ IN SPILL LAT AND LONG, AND CONVERT TO NMC MODFL GRID NUMS
C      WRITE(12,500)
500    FORMAT(/,1X,26HREAD IN THE SECOND DATA CARD,/,1X,10(7H      .  ))
C      READ(5,600)((PLAT(I),P_ON(I)),I=1,INTLOC)
600    FORMAT(10F7.2)
C      WRITE(12,700)((PLAT(I),PLON(I)),I=1,INTLOC)
700    FORMAT(F8.2,9F7.2)
C      SLAT=PLAT(1)
C      SLOM=PLON(1)
C      IF(LEVEL.EQ.0)GOTO2700

C      IF NECESSARY, READ WATER VELOCITIES
C      IF(ID10.EQ.0)GOTO1100
C      WRITE(12,800)
900    FORMAT(/,1X,41HREAD IN ADDITIONAL WATER SURF. VELOCITIES)
C      READ(15,900)(WHO(J),J=1,9)
C      READ(15,900)(WEA(J),J=1,9)
C      WRITE(12,1000)(WHO(J),J=1,9)
C      WRITE(12,1000)(WEA(J),J=1,9)
900    FORMAT(10F7.2)
1000   FORMAT(1X,9F7.2)
1100   CONTINUE

C      READ IN AUGMENTING WIND DATA
C      IF(ID11.EQ.0)GOTO1400
C      WRITE(12,1200)
1200   FORMAT(/,1X,26HREAD IN THE WIND FORECASTS)
C      READ(25,900)(AD10(J),J=1,9)
C      READ(25,900)(APHI(J),J=1,9)
C      DO 1300 J=1,9
1300   AV10(J)=AD10(J)*1852./3600.
C      WRITE(12,1000)(AD10(J),J=1,9)
C      WRITE(12,1000)(APHI(J),J=1,9)
1400   CONTINUE

C      READ IN OIL FLOW RATES
C      IF(LEVEL.NE.3)GOTO1700
C      READ(5,300)MAXST,IGAL6H
C      WRITE(12,1500)MAXST,IGAL6H
1500   FORMAT(/,1X26HREAD IN MAXST AND IGAL6H =,2I5)
C      IF(IGAL6H.LE.0)GOTO1700
C      READ(35,600)(GAL6H(I),I=1,IGAL6H)
C      WRITE(12,1000)(GAL6H(I),I=1,IGAL6H)
1600   GAL6H(I)=GAL6H(I)*1000.
1700   CONTINUE
C      WRITE(12,1800)
1800   FORMAT( 1X,79(1H*))

C      CHOOSE EITHER THE 00Z OR THE 12Z CYCLE. W3FQ02 R-TURNS GREEN-
C      WICH TIME FOR SUITLAND, MD.
C      CALL W3FQ02(ITIME,ICYCLT)
C      IZZ=1 ITIME(5)/(1700)
C      IF(ID12.EQ.1)IZZ=3-IZZ
C      FIND THE NMC MODEL COORDINATES
C      CALL LAT2XY(SLAT,SLOM,XPOINT,YPOINT)
C      WRITE(12,1900)SLAT,SLOM
1900   FORMAT(/,1X26HWIND FORECAST AT LATITUDE=,F6.2,5X,10HLONGITUDE=F6.2)
C      NC=YPOINT
C      MC=XPOINT
C      IF(TEST1) WRITE(6,2000)YPOINT,YPOINT,NC,MC
2000   FORMAT(/,5X,'X=',F5.2,3X,'Y=',F5.2,5X,'NC=',I2,3X,'C=',I2,/)

C      MAKE THE WIND COMPUTATIONS HERE
C      IF(ID11.GT.0.AND.LEVEL.LE.2)GOTO2200
C      JU=0
C      DO 2100 JTIME=1,JTMAX,6
C      J=(JTIME-1)/6+1
C      JU=JU+1
C      CALL FILES
C      CALL GWIND

```



```

IF (ID11.EQ.2.AND.LEVEL.EQ.3)GOTO2100
CALL RILIN
KU=JU
CALL PLMOD
IF (ID11.EQ.1.AND.LEVEL.EQ.3)V10=AV10(J)
IF (ID11.EQ.1.AND.LEVEL.EQ.3)DPHI=DPHI-APHI(J)
AV10(J)=V10
AD10(J)=V10*3600./1852.
APHI(J)=-DPHI
IF (APHI(J).LT.0.) A PHI(J)=360.+APHI(J)
2100 CONTINUE
2200 CONTINUE
C
      PRINT OUT THE PRINCIPAL RESULTS
WRITE (12,2300)
2300 FORMAT(/1X,5HHR(Z),3X,18HWIND SPEED AT 10 M,3X,14HTO ANGLE (DEG),/
1,9X,5H(M/S),8X,5H(KTS),3X,17H(+C.W. FROM EAST))
JX=JTMAX/6+1
K=12*(IZZ-1)
DO 2500 J=1,JX
WRITE (12,2400)K,AV10(J),AD10(J),APHI(J)
2400 FORMAT(3X,I2,4X,F4.1,9X,F4.1,4X,F4.0)
K=K+6
IF (K.GE.24) K=k-24
2500 CONTINUE
DO 2600 I=1,80
DO 2600 J=1,80
JPL(I,J)=0
2600 CONTINUE
2700 CONTINUE
C
      IMPLEMENT THE OIL SPILL BEHAVIOR MODEL
IF (LEVEL.EQ.1)GOTO3000
CALL GEOGRY
IF (LEVEL.EQ.0)GOTO2800
IF (LEVEL.EQ.3)GOTO2900
CALL DRIFT1
GO TO 3000
2800 CONTINUE
CALL PLOTD1
GO TO 3000
2900 CONTINUE
CALL CBASIN
CALL OILSET
3000 CONTINUE
WRITE (12,3100)
3100 FORMAT(1X17HEND OF COSMOS RUN)
STOP
END
//LKED,SYSLMOD DD DSH=N,NWS.SDO.TDL.KH.LOAD.H2D(KHCOS1A),PIGP=SHR
//

```